

Technical Appendix A: Methodology Spreadsheet Description

This appendix outlines the process used to assess water supply and demand in the Sacramento-San Joaquin Delta (Delta) watershed and describes each input used for the analysis and output produced by the analysis. Each section of this document describes a separate tab in the Delta Water Unavailability Methodology Excel workbook (“spreadsheet”), the significance of each column, and data sources. While the spreadsheet posted on the [Delta Drought webpage](#) represents a single “snapshot” analysis conducted to determine water unavailability on a given day, it contains multiple interactive elements which allow the user to run a similar analysis with different input data. Each tab that contains static data (e.g., multipliers, streamflows, or water right records) indicates in the top-left cell the date that data was last updated. Archived spreadsheets containing the analyses supporting curtailments are available for each specific day that a weekly update was issued. These spreadsheets are available on the Water Board’s File Transfer Protocol (FTP) site; see the Delta Drought webpage for instructions to request credentials to access the FTP site.

NOTE: The spreadsheet is a large file with links to external online files and many complex formulas. It performs best with automatic formula calculation turned off so that recalculations can be done manually rather than each time a single value is changed.

Subwatersheds

This tab shows how Hydrologic Unit Code Level 8 (HUC8) watersheds from the U.S. Geological Survey (USGS) Watershed Boundary Database (WBD) are categorized into “subwatersheds” for the purpose of this analysis. It also indicates the primary watershed that each subwatershed is tributary to, as well as the subwatershed “type” (headwater or lower) assigned to each. These relationships underpin much of the analysis. A map of Delta subwatersheds can be found in Figure 5 of the main report.

Field Name(s)	Definition & Methodology	Data Source(s)
Watershed	The two primary river systems in the Delta watershed: Sacramento and San Joaquin.	USGS WBD

Field Name(s)	Definition & Methodology	Data Source(s)
Subwatershed	An area encompassing one or more HUC8 watersheds, determined based on geospatial mapping of stream and diversion locations and the unavailability of full natural flow (FNF) supply locations (“gages”). Subwatershed is the smallest area over which water unavailability is determined.	Staff-determined
Subwatershed Type	Subwatersheds are categorized as either “Headwater” or “Lower” for the purpose of this analysis: - A headwater subwatershed contains water demands that can only be met by water supplies in the subwatershed (i.e., there are no tributaries flowing into the subwatershed from another subwatershed). - A lower subwatershed can receive water supplies from outside its boundaries (i.e., it is located downstream of the headwaters).	Staff-determined
HUC8 ¹	The boundaries of watersheds which contain land that all drains to the outlet, as delineated and classified by the USGS. This delineation provides a consistent boundary for classifying water supplies and demands for the analysis.	USGS WBD

To the right of the data table is a key for the various colors used for each tab of the spreadsheet. **Yellow tabs** contain data fields that can be updated or revised to change the analysis; cells with modifiable data are **highlighted yellow** in those tabs. **Blue tabs** contain data related to water supply, **green tabs** contain data related to water demand, and **orange tabs** contain analyses and summaries of water unavailability that are used to determine water right curtailments.

¹ As described in Section 2.3.1 of the main report, any records assigned to the Upper Mokelumne, Middle San Joaquin-Lower Chowchilla, Fresno River, or Upper Calaveras California HUC8s (headwater subwatersheds) in the spreadsheet were based on a closer analysis of Hydrologic Unit Code Level 10 (HUC10) boundaries and other criteria. Points of Diversion (PODs) located in these HUC8s that did not meet these criteria are assigned to the Lower San Joaquin River or San Joaquin Delta HUC8s (lower subwatersheds) in this spreadsheet.

Supply Past

This tab contains available past water supply data, which is only used in the water unavailability analyses if the user-specified date range (see Supply Forecast section) includes dates in the past. Water supply data are obtained from the California Nevada River Forecast Center (CNRFC) and consist of full natural flow (FNF, also known as “unimpaired flow”) estimates in thousand acre-feet (TAF); daily data are available going back to water year 2013. Values must be manually entered into this tab; direct links to individual datasets for the current water year at each site are provided in the spreadsheet. Supply sites are described in more detail in the next section.

Supply Forecast

This tab contains both observed and forecasted water supply data for a user-specified date range. Water supply forecasts are obtained either from the California Department of Water Resources (DWR) Bulletin 120 Water Supply Forecast (B-120) or from CNRFC and consist of FNF estimates. Direct links to individual forecast datasets are provided in the spreadsheet. Supply volumes are provided in units of TAF. This tab is grouped vertically into six tables separated by gray rows.

User-Specified Variables

The top table contains user-specified start and end dates (inclusive) over which water supply and demand are calculated. These cells contain data validation to ensure the dates entered are between the first date with available supply date (see Supply Past section) and one year from the current date (e.g., if the spreadsheet is modified on February 1, 2022, dates between October 1, 2012 and February 1, 2023 could be entered). To compute supply for the specified period using CNRFC data, daily past and/or forecasted supply values are added for dates within the period. To compute supply using B-120 data, monthly values are converted to an average daily demand for each month, which is multiplied by the number of days in each month that fall within the specified period to calculate a total volume of water.

The top table also allows the user to select a supply forecast data source; selecting “CNRFC” will use those forecasts for all subwatersheds, while selecting “B120” will use those forecasts for the ten major subwatersheds and CNRFC for the smaller ones. If B120 is selected, data for the current water year (see the description of the fifth table below) will be used regardless of the date range entered. In the top table the user can also select to use calendar year 2018 or 2019 quality-controlled demand data in the analysis. Alternatively, a “2018 w/ Enhanced Reporting” dataset can be selected, which will replace 2018 demands with projected demands submitted for available month(s) by large rights and claims (see Enhanced Reporting section and Appendix B for more information on quality-controlled demand and Enhanced Reporting data). Finally, the

top table allows the user to select a demand scenario (i.e., which diversions will contribute to demand evaluated): only direct diversions, only diversions to storage, or the sum of direct and storage diversions, which was the basis for all previous analyses (see POD Demand section for more information on disaggregated direct and storage diversions).

Supply Forecast Selection

The second table allows the user to select one of seven supply exceedance probabilities for each subwatershed: 99% (equivalent to the minimum forecast), 90%, 75%, 50% (equivalent to the median forecast), 25%, 10%, and 1% (equivalent to the maximum forecast). Alternatively, a “Custom” forecast can be selected to use user-specified volumes entered in the second row. The colors of each subwatershed column header indicate which watershed it is tributary to; **blue cells** indicate Sacramento River watershed tributaries, **green cells** indicate San Joaquin River watershed tributaries, and **orange cells** indicate tributaries which flow directly into the Legal Delta (though these tributaries are still included in the respective watershed when necessary for certain calculations; see Analyses section for more information).

CNRFC Traces for Supply Forecast Period

The third table contains forecasted FNF values for each CNRFC gage. The far-left column of gage names includes direct links to each forecast comma-separated value (CSV) file on the CNRFC website, which are updated daily. To update the forecasts in the spreadsheet, the user must use Excel’s Edit Links window (in the Data toolbar) to open all forecast CSVs, then recalculate these formulas. This may be necessary even if the user-specified date range contains only days in the past. Forecasts are presented in the form of 42 different “traces” for each gage each day; this table contains the total forecasted supply volume over the user-specified time period in the top table, referencing the online forecast CSV file for each gage. If only dates in the past are entered, all values in this table will be zero. CNRFC forecast CSVs contain daily average FNF values in thousand cubic feet per second (TCFS), which are converted to volumes of TAF in the spreadsheet.

CNRFC Exceedances for Supply Forecast Period

The fourth table contains forecasted FNF values for the user-specified time period for each CNRFC gage in each subwatershed. Forecasts are presented as volumes over the user-specified time period for each of the seven forecast exceedance probabilities. Each forecast exceedance is calculated from the 42 different “traces” for the respective gage in the third table; the 90% through 10% exceedances are calculated using Excel’s exclusive percentile function, which is equivalent to computing plotting positions with the Weibull formula.

Bulletin 120 Supply Forecasts

The fifth table contains B-120 forecasted FNF values for the ten major subwatersheds, as published in monthly Water Supply Index (WSI) or weekly Distribution (DIST) products released by DWR January through June. These values must be entered manually, and the far-left column contains links to forecast data sources for each subwatershed. While monthly WSI products provide monthly forecasts for all six exceedance probabilities, weekly DIST products provide only 50% monthly forecasts. DIST products include forecasts for the Mokelumne and Cosumnes subwatersheds, which are not provided in WSI products. The third column in this table contains the calculated B-120 forecast for the user-specified period based on daily averages, including both forecasted and past values; B-120 values for past months are calculated FNF, which are equal for all forecast exceedances. While CNRFC forecasts are available up to one year from the current date, B-120 forecasts are only available until the end of September of the current water year.

Supply for Curtailment Analysis

The sixth table contains total water supply values, including both past and forecasted data, for seven exceedance probabilities for each subwatershed in units of acre-feet (AF). The bottom row is populated with forecasts based on the user-specified exceedance forecast for each subwatershed. Water supply computations for each subwatershed are explained in the table below. Some subwatersheds are computed using Gap Filling (GF) factors that are explained in the next section.

Field Name(s)	Definition & Methodology	Data Source(s)
Exceedance	The probability of the water supply over the user-specified period exceeding the given volume.	--
Sacramento Bend	Supply forecasts for the Sacramento River at Bend Bridge subwatershed: - CNRFC gage BDBC1. - B-120 SRWSI or DIST (50% only).	CNRFC, B-120
Stony	Supply forecasts for the Stony Creek subwatershed (at Black Butte Reservoir): - Augmented, CNRFC gage EPRC1 * GF Stony Increase Factor.	CNRFC w/ staff adjustments
Cache	Supply forecasts for the Cache Creek subwatershed (above Rumsey): - Extrapolated, Stony * GF Cache-Stony Ratio.	Staff estimates

Water Unavailability Methodology for the Delta Watershed
 Technical Appendix A
 January 19, 2023

Field Name(s)	Definition & Methodology	Data Source(s)
Upper Feather	Supply forecasts for the Upper Feather River subwatershed (at Lake Oroville): - CNRFC gage ORDC1. - B-120 SRWSI or DIST (50% only).	CNRFC, B-120
Yuba	Supply forecasts for the Yuba River subwatershed (at Englebright Reservoir or near Smartville plus Deer Creek): - CNRFC gage HLEC1. - B-120 SRWSI or DIST (50% only).	CNRFC, B-120
Bear	Supply forecasts for the Bear River subwatershed (near Wheatland): - Extrapolated, Upper Feather * GF Bear-Yuba Ratio.	Staff estimates
Upper American	Supply forecasts for the Upper American River subwatershed (at Folsom Lake): - CNRFC gage FOLC1. - B-120 SRWSI or DIST (50% only).	CNRFC, B-120
Putah	Supply forecast for the Putah Creek subwatershed (near Winters): - Extrapolated, Stony * GF Putah-Stony Ratio.	Staff estimates
Upper Sacramento Valley	Supply forecasts for the Upper Sacramento River Valley subwatershed (tributaries between Bend and Butte Slough, including Redbank, Elder, Thomes, Antelope, Mill, Deer, Big Chico, and Butte Creeks): - Augmented, CNRFC gages (EDCC1+TCRC1) * GF Elder-Thomes Increase Factor + (MLMC1+DCVC1+BKCC1) * GF Mill-Deer-Butte Increase Factor.	CNRFC w/ staff adjustments
Sacramento Valley Floor	Supply forecasts for the Sacramento Valley Floor subwatershed (minor east and west side tributaries between Stony Creek and the Delta, including tributaries to the Lower Feather and American Rivers): - Extrapolated, (Sacramento Bend+Upper Feather+Upper American) * GF Sacramento Valley Ratio.	Staff estimates

Water Unavailability Methodology for the Delta Watershed
 Technical Appendix A
 January 19, 2023

Field Name(s)	Definition & Methodology	Data Source(s)
Chowchilla	Supply forecasts for the Chowchilla River subwatershed (at Buchanan Reservoir): - CNRFC gage BHNC1.	CNRFC
Upper San Joaquin	Supply forecasts for the Upper San Joaquin River subwatershed (at Millerton Reservoir): - CNRFC gage FRAC1. - B-120 SJWSI or DIST (50% only).	CNRFC, B-120
Fresno	Supply forecasts for the Fresno River subwatershed (at Hensley Lake): - CNRFC gage HIDC1.	CNRFC
Merced	Supply forecasts for the Merced River subwatershed (at Exchequer Reservoir or below Merced Falls): - CNRFC gage EXQC1. - B-120 SJWSI or DIST (50% only).	CNRFC, B-120
Tuolumne	Supply forecasts for the Tuolumne River subwatershed (at New Don Pedro Reservoir or below La Grange Reservoir): - CNRFC gage NDPC1. - B-120 SJWSI or DIST (50% only).	CNRFC, B-120
Stanislaus	Supply forecasts for the Stanislaus River subwatershed (at New Melones Reservoir or below Goodwin Reservoir): - CNRFC gage NMSC1. - B-120 SJWSI or DIST (50% only).	CNRFC, B-120
Calaveras	Supply forecasts for the Calaveras River subwatershed (at New Hogan Reservoir): - CNRFC gage NHGC1.	CNRFC
Mokelumne	Supply forecasts for the Mokelumne River subwatershed (at Pardee Reservoir): - CNRFC gage CMPC1. - B-120 DIST (50% only).	CNRFC
Cosumnes	Supply forecasts for the Cosumnes River subwatershed (at Michigan Bar): - CNRFC gage MHBC1. - B-120 DIST (50% only).	CNRFC

Field Name(s)	Definition & Methodology	Data Source(s)
San Joaquin Valley Floor	Supply forecasts for the San Joaquin River Valley Floor subwatershed (minor east and west side tributaries between the Chowchilla and American Rivers, including Mariposa, Owens, and Bear Creeks): - Extrapolation, CNRFC gages MPAC1+OWCC1+MEEC1 + (Upper San Joaquin+Merced+Tuolumne+Stanislaus)* GF San Joaquin Valley Ratio + (Mokelumne+Cosumnes) * GF San Joaquin-Mokelumne-Cosumnes Ratio.	CNRFC, staff estimates
Delta Watershed Total	The sum of all supplies in the Delta watershed for the given forecast exceedance over the user-specified time period.	Calculated
% Sacramento/ San Joaquin	The percent of total Delta watershed supply for the given forecast exceedance over the user-specified time period which came from the respective watershed.	Calculated

Gap Filling

This tab contains monthly factors which are used to fill gaps in supply data for select subwatersheds, either to estimate unavailable past and forecasted data (extrapolation) or to adjust existing supply data (augmentation). These monthly average factors are computed outside the Methodology spreadsheet based on past supply data, and detailed methods for each subwatershed are described in the table below. Outlying values (outside the range of the overall mean plus or minus three times the overall standard deviation) were not included in the calculation of monthly mean factors shown in this tab. The bottom Supply Forecast Period row contains average calculated factors for the user-specified time period (see Supply Forecast section) based on the number of days in each month that fall within the specified period.

Field Name(s)	Definition & Methodology	Data Source(s)
Month	Month of the calendar year for which the gap-filling factor applies.	--

Water Unavailability Methodology for the Delta Watershed
 Technical Appendix A
 January 19, 2023

Field Name(s)	Definition & Methodology	Data Source(s)
Cache-Stony Ratio (CSR)	Factor used to extrapolate the FNF supply for the Cache Creek subwatershed based on data for the Stony Creek subwatershed: - CSR = DWR subbasin UF3 / DWR subbasin UF4 for WYs 1922-2014, removed outlying values and averaged by month. - GF Cache = CSR*(EPRC1*SIF).	Calculated
Stony Increase Factor (SIF)	Factor used to augment recent FNF supply values for the Stony Creek subwatershed to approximate the entire subwatershed's supply based on past DWR data (CNRFC gage EPRC1 is located upstream of several tributaries): - SIF = DWR subbasin UF4 / CNRFC gage EPRC1 for WYs 2013-2014, removed outlying values and averaged by month. - GF Stony = SIF*EPRC1..	Calculated
Bear-Yuba Ratio (BYR)	Factor used to extrapolate the FNF supply for the Bear River subwatershed based on data for the Yuba River subwatershed: - BYR = DWR subbasin UF10 / CDEC gage YRS for WYs 1922-2014, removed outlying values and averaged by month. - GF Bear = BYR*YRS.	Calculated
Elder-Thomes Increase Factor (ETIF)	Factor used to augment recent FNF supply values for west side tributaries in the Upper Sacramento River Valley subwatershed to approximate the supply of all west side tributaries based on past DWR data (CNRFC gages EDCC1 and TCRC1 do not include all west side tributaries): - ETIF = DWR subbasin UF5 / (CNRFC gages EDCC1+TCRC1) for WYs 2013-2014, removed outlying values and averaged by month. - GF Upper Sacramento Valley West = ETIF*(EDCC1+TCRC1).	Calculated

Water Unavailability Methodology for the Delta Watershed
 Technical Appendix A
 January 19, 2023

Field Name(s)	Definition & Methodology	Data Source(s)
Mill-Deer-Butte Increase Factor (MDBIF)	Factor used to augment recent FNF supply values for east side tributaries in the Upper Sacramento River Valley subwatershed to approximate the supply of all east side tributaries based on past DWR data (CNRFC gages MLMC1, DCVC1, and BKCC1 do not include all east side tributaries): - MDBIF = DWR subbasin UF7 / (CNRFC gages MLMC1+DCVC1+BKCC1) for WYs 2013-2014, removed outlying values and averaged by month. - GF Upper Sacramento Valley East = MDBIF*(MLMC1+DCVC1+BKCC1).	Calculated
Putah-Stony Ratio (PSR)	Factor used to extrapolate the FNF supply for the Putah Creek subwatershed based on data for the Stony Creek subwatershed: - PSR = DWR subbasin UF2 / DWR subbasin UF4 for WYs 1922-2014, removed outlying values and averaged by month. - GF Putah = PSR*(EPRC1*SIF).	Calculated
Sacramento Valley Ratio (SRVR)	Factor used to extrapolate the FNF supply for the Sacramento River Valley Floor subwatershed based on data for the Sacramento, Feather, and American Rivers (no recent or projected supply data exists for the Valley Floor): - SRVR = DWR subbasin UF1 / CDEC gages SBB+FTO+AMF for WYs 1922-2014, removed outlying values and averaged by month. - GF Sacramento Valley Floor = SRVR*(SBB+FTO+AMF).	Calculated

Field Name(s)	Definition & Methodology	Data Source(s)
San Joaquin-Mokelumne-Cosumnes Ratio (SJMCR)	Factor used to extrapolate the FNF supply for east side tributaries in the San Joaquin River Valley Floor subwatershed based on data for the Mokelumne and Cosumnes Rivers (no recent or projected supply data exists for the Valley Floor): - SJMCR = DWR subbasin UF12 / CDEC gages MKM+CSN for WYs 1922-2014, removed outlying values and averaged by month. - GF San Joaquin Valley Floor East = SJMCR*(MKM+CSN).	Calculated
San Joaquin-Merced-Tuolumne-Stanislaus Ratio (SJMTSR)	Factor used to estimate the FNF supply for west side tributaries in the San Joaquin River Valley Floor subwatershed based on data for the San Joaquin, Merced, Tuolumne, and Stanislaus Rivers (no recent or projected supply data exists for the Valley Floor): - SJMTSR = DWR subbasin UF24 / CDEC gages SJF+MRC+TLG+SNS for WY - 1922-2014, removed outlying values and averaged by month. - GF San Joaquin Valley Floor West = SJMTSR*(SJF+MRC+TLG+SNS) for WY 2015-Present and Forecasted.	Calculated

Instream Flows

This tab contains instream flow requirements for each subwatershed, which are used to increase available supplies to account for the abandonment of these dedicated flows below their intended reach. Flow requirements are sourced from the State Water Board’s Sacramento Valley Water Allocation Model (SacWAM) and Water Supply Effects (WSE) model. Only requirements which cross subwatershed boundaries or end near the bottom of a subwatershed (less than about 50 river miles from its mouth) are included. If the instream flow reach ends higher up in the subwatershed, such that it may meet demand in that subwatershed itself, the abandoned instream flow is not considered in the analysis. The source of each instream flow requirement is detailed in the Note column.

Flow values in the Instream Flows table are given in average cubic feet per second (CFS) by month, which the Supply Forecast Period column converts to a volume in

acre-feet (AF) for the user-specified time period (see Supply Forecast section) using daily averages and the number of days in each month that fall within the specified period. The supply contribution of each subwatershed to the Watershed-scale analysis is represented by the greater of either the forecasted full natural flow (FNF) or the abandoned instream flow in this table for the respective subwatershed (see Headwater Calculations for Watershed Analysis section). In other words, during very dry conditions instream flows are assumed to consist of supplemental reservoir releases which would replace available natural flows when abandoned below their intended reach. During wet conditions instream flows are assumed to consist of bypassed natural flows, which would not contribute abandoned water in excess of FNF below their intended reach.

Enhanced Reporting

This tab contains data on monthly projected demands that are submitted by the largest water right holders and claimants in the watershed (see Section 2.2.4 of the main report). Water right holders and claimants with a face value or recently reported annual diversions of 5,000 acre-feet or greater are required to submit these reports; right holders and claimants with a face value or recently reported annual diversions of 1,000 to 4,999 acre-feet are requested, though not currently required, to submit enhanced reports.

Enhanced reporting data is submitted through the Water Rights Form and Survey Submittal Portal (Survey Portal) monthly. Submitted data is exported from the Survey Portal after the reporting deadline and reviewed for quality control and assurance (see Appendix B for further information on demand quality control procedures) before it is used in the Methodology. Values in this tab will only be used in water unavailability analyses if “2018 w/ Enhanced Reporting” is user-selected as the Demand Year in the Supply Forecast tab. More information on Enhanced Reporting requirements, form deadlines, and the Delta Watershed Methodology Demand tool showing 2018 demands that are assumed in the Methodology, is available on the [Delta Watershed Enhanced Reporting webpage](#).

This tab contains only Project Demand data submitted through Enhanced Reporting; separate reports of Prior Diversions are also submitted monthly but are not used for the purpose of evaluating water unavailability at this time. Data in this tab is organized into sets of five columns for each month, beginning with November 2022 when simplified Enhanced Reporting forms were released. The top row specifies the dates that reporting datasets for each month were exported from the Survey Portal and finalized for Methodology use following quality control.

Field Name(s)	Definition & Methodology	Data Source(s)
Application ID	Application ID of the water right or claim for which reporting was submitted. Water rights or claims which did not submit enhanced reporting data, either because they failed to report or are not required to do so, do not appear in this tab.	Survey Portal
No Changes?	If the reporter has reviewed the 2018 demand information assumed in the Methodology for the respective month and determined that no changes are needed to reflect projected demands under their water right or claim (TRUE/FALSE).	Survey Portal
Direct (AF)	The amount of projected demand for direct diversion that was reported for the respective month. If No Changes? = TRUE, the 2018 Direct value for the respective month from the WR Demand tab will be used.	Survey Portal
Storage (AF)	The amount of projected demand for storage that was reported for the respective month. If No Changes? = TRUE, the 2018 Storage value for the respective month from the WR Demand tab will be used.	Survey Portal
Comment	Any reporter-submitted comments on the enhanced reporting data.	Survey Portal

WR Demand

This tab contains monthly water diversion (demand) data for water right (WR) records in the Delta watershed. This data originates from the State Water Board’s Electronic Water Rights Information Management System (eWRIMS) database. Technical Appendix B describes the process used to select these water right records and quality-control reported data to produce this dataset. In this tab each row quantifies reported water diversions for a single water right or claim in each month of the 2018 and 2019 calendar years, as well as 2018 with available Enhanced Reporting demand data replaced (see previous section). These reported diversions are used as proxies for current water demand in this analysis. Demand data are further distributed to individual

points of diversion (PODs) and adjusted to account for return flows in the POD Demand tab (see POD Demand section).

Field Name(s)	Definition & Methodology	Data Source(s)
Application ID	Water Right Application ID; each water right record on file with the State Water Board (Board) is assigned a unique Application ID.	eWRIMS database
Water Right Type	<p>Water right or claim type (see Appendix B for additional information on the different Statement assigned categories):</p> <ul style="list-style-type: none"> - Appropriative: A post-1914 appropriative water right pursuant to a permit or license from the Board. - Statement of Div[ersion] and Use (Riparian): A riparian water right claim. - Statement of Div[ersion] and Use (Riparian or Pre-1914): A riparian and/or pre-1914 appropriative water right claim. - Statement of Div[ersion] and Use (Pre-1914): A pre-1914 appropriative water right claim. - Statement of Div[ersion] and Use (Reserved): A federal reserved water right claim. - Statement of Div[ersion] and Use (Other): Any other category of water right claim (e.g., court decreed/adjudicated or contract/agreement). - Statement of Div[ersion] and Use (Unclassified): A water right claim with an unspecified category. - Statement of Div[ersion] and Use (Pending): A statement filed to document diversions while an appropriative water right application is pending. - Stockpond or Federal Stockpond: A water right for a small livestock watering impoundment constructed before 1969 (Water Code §1226). - Registration Domestic/Livestock/Cannabis: Water rights issued for certain small projects (Water Code §§1228-1229). 	eWRIMS database w/ staff adjustments

Water Unavailability Methodology for the Delta Watershed
 Technical Appendix A
 January 19, 2023

Field Name(s)	Definition & Methodology	Data Source(s)
	<ul style="list-style-type: none"> - Federal Claims: A claim of federal reserved water rights filed before July 1, 1984 (Water Code §1227). - Section 12 File: A specific type of water right, similar to a pre-1914 appropriative water right claim. 	
Water Right Status	<p>Status of the water right or claim:</p> <ul style="list-style-type: none"> - Licensed: A post-1914 appropriative water right for which the Board has issued a license. - Permitted: A post-1914 appropriative water right for which the Board has issued a permit. - Claimed: A water right claimed by the owner (i.e., Statements of Diversion and Use) which the Board has not verified. - Certified: A Stockpond, Federal Stockpond, or Section 12 File water right for which the Board has issued a certificate. - Registered: A Domestic, Livestock, Cannabis, or other small water right Registration which has been approved by the Board. 	eWRIMS database
Primary Owner	Name of the primary owner of the water right record.	eWRIMS database
Beneficial Use(s)	Concatenated list of the beneficial use(s) of water associated with the water right record, as defined by Water Code §§660-669.	eWRIMS database
Priority Date	<p>The priority date of the water right or claim (YYYY/MM/DD):</p> <ul style="list-style-type: none"> - Appropriative, Federal Stockponds, Registration Domestic/Livestock/Cannabis: The earlier of the Application Acceptance Date and Application Received Date values. - Statements (Riparian): “Riparian” and assumed to have a more senior priority date than all appropriative water rights and claims. - Statements (Pre-1914, “Riparian or Pre-1914,” Pending, Unclassified, or Other): Assumed to be January 1 of the earliest claimed Year Diversion Commenced attribute, which is present in both Initial Statements of Diversion and Use and annual Supplemental Statements of Diversion and Use. Some 	eWRIMS database

Field Name(s)	Definition & Methodology	Data Source(s)
	<p>claims that have been further investigated may have a specific pre-1914 date assigned.</p> <ul style="list-style-type: none"> - Stockpond: The earlier of the Application Acceptance Date or Application Received Date values, if this date is after 1977. Otherwise, assumed to be January 1 of the Year Diversion First Commenced value. - Federal Claims: Assumed to be January 1 of the Year Diversion First Commenced value if this date is before 1914. Otherwise, the earlier of the Application Acceptance Date and Application Received Date values. - Section 12 File: The Priority Date value. 	
Assumed Priority Date	<p>The date which carries over to all other parts of the spreadsheet. Equal to the Priority Date except for certain rights and claims:</p> <ul style="list-style-type: none"> - Statements (“Riparian or Pre-1914” or Other): Assumed to be “Riparian” because the statement does not contain sufficient information to designate a volume of demand to each type of claim. Conservatively assumed to have a more senior priority date than all appropriative water rights and claims.² - Statements (Pre-1914 or Unclassified) with a Priority Date after 1914: In 1914 but with the relative order of dates preserved by assigning sequential dates to each starting with 1914/01/02. - Statements (Pending): “Pending” and assumed to be the most junior of all records, because the statement was only filed to document diversions while an appropriative water right application is pending. - Appropriative Project water rights listed in Board Decision 1641: “Project” and assumed 	Staff-determined

² For claims in the Legal Delta, this categorization of colorable riparian claims is consistent with recent judicial decisions (see e.g., *Modesto Irrigation District v. Heather Robinson Tanaka*, 48 Cal.App.5th 898 (2020)) and with the legal principles described in a memorandum dated December 15, 2017, regarding Issues Related to Overlap between Pre-1914 and Riparian Water Right Claims in the Delta and available on the website of the Office of the Delta Watermaster (Overlap Memo).

Water Unavailability Methodology for the Delta Watershed
 Technical Appendix A
 January 19, 2023

Field Name(s)	Definition & Methodology	Data Source(s)
	to be junior to other appropriative water rights and claims. Per Board Decision 1422, two New Melones Project rights retain their underlying priority dates, and all four Friant Project rights also retain their underlying priority dates consistent with the decision in <i>City of Fresno v. California</i> (1963) 372 U.S. 627, 630)	
Face Value (AFA)	The maximum volume of water authorized for diversion annually under an appropriative water right. Statements, including Riparian and Pre-1914 Appropriative claims, do not have an assigned face value; for the purposes of this analysis, their face value is assumed to be zero. Face values are provided only for reference and do not affect the assumed demands which underpin the water unavailability analysis.	eWRIMS database
2018/2019/2018 w/ Enhanced Reporting Total Direct (AFA)	The total reported direct diversion of the water right record in the respective calendar year. Values for select water right records were manually reviewed by staff and corrected as necessary (see Direct Review value).	eWRIMS database w/ staff adjustments
2018/2019/2018 w/ Enhanced Reporting Total Storage (AFA)	The total reported diversion to storage of the water right record in the respective calendar year. Values for select water right records were manually reviewed by staff and corrected as necessary (see Storage Review value).	eWRIMS database w/ staff adjustments
2018/2019/2018 w/ Enhanced Reporting Total Diversion (AFA)	The total reported diversion of the water right record in the respective calendar year (sum of Total Direct and Total Storage values).	eWRIMS database w/ staff adjustments
2018/2019 Direct/Storage Review	Indicates whether and how the 2018 or 2019 reported diversion was reviewed or corrected by staff:	Staff-determined

Water Unavailability Methodology for the Delta Watershed
 Technical Appendix A
 January 19, 2023

Field Name(s)	Definition & Methodology	Data Source(s)
	<ul style="list-style-type: none"> - Estimated Downward: Staff reviewed and corrected the user-reported diversion value to be higher than reported. - Estimated Upward: Staff reviewed and corrected the user-reported diversion value to be lower than reported. - Reviewed Not Changed: Staff reviewed the reported diversion value but did not apply a correction. - Not Reviewed: Staff did not manually review the annual report. - Some rights or claims contain more specific comments with additional information. 	
2018/2019/ 2018 w/ Enhanced Reporting Jan-Dec Direct (AF)	The total reported direct diversion of the water right record in each month of the respective calendar year. Values for select water right records were manually reviewed by staff and corrected as necessary (see Direct Review value). The 2018 w/ Enhanced Reporting columns contain data from the Enhanced Reporting tab if a report was submitted for the respective month; if a report was not submitted or the record's No Changes? value is TRUE, the 2018 Direct value for the respective month is used.	eWRIMS database w/ staff adjustments
2018/2019/ 2018 w/ Enhanced Reporting Jan-Dec Storage (AF)	The total reported diversion to storage of the water right record in each month of the respective calendar year. Values for select water right records were manually reviewed by staff and corrected as necessary (see Storage Review value). The 2018 w/ Enhanced Reporting columns contain data from the Enhanced Reporting tab if a report was submitted for the respective month; if a report was not submitted or the record's No Changes? value is TRUE, the 2018 Storage value for the respective month is used.	eWRIMS database w/ staff adjustments
2018/2019/ 2018 w/ Enhanced Reporting	Direct demands of a given water right or claim for a given demand year for the user-specified period in the Supply Forecast tab, calculated based on a daily average for each month and	Calculated

Field Name(s)	Definition & Methodology	Data Source(s)
Period Direct (AF)	the number of days in each month that fall within the period.	
2018/2019/ 2018 w/ Enhanced Reporting Period Storage (AF)	Storage demands of a given water right or claim for a given demand year for the user-specified period in the Supply Forecast tab, calculated based on a daily average for each month and the number of days in each month that fall within the period.	Calculated
Selected Period Direct (AF)	Direct demands of a given water right or claim for the Demand Year value and user-specified period in the Supply Forecast tab.	Calculated
Selected Period Storage (AF)	Storage demands of a given water right or claim for the Demand Year value and user-specified period in the Supply Forecast tab.	Calculated

Return Flows

This tab contains factors which are used to adjust demand data to account for return flows in each subwatershed. Return Flow factors are calculated for each month in the Sacramento and San Joaquin River watersheds as the percent of diversion which returned as flow in the same month (Factor = $1 - \text{Total Return Flows} / \text{Total Diversions}$). Data used to determine the factors were sourced from CalSim3 results published by DWR and include return flows resulting from both agricultural and municipal water uses sourced from surface water natural flows, rediversions of previously stored water, and pumped groundwater.

All values in the Return Flows table are given as multipliers (i.e., a value of 0.60 means that the analysis will reduce demands in the given subwatershed in the given month by 40%). The Supply Forecast Period column calculates an equivalent factor for the user-specified period (see Supply Forecast section) based the number of days in each month that fall within the specified period. Demand values in the analysis are adjusted by multiplying direct diversion demands for a given water right or claim by the Supply Forecast Period factor for the appropriate subwatershed where it diverts; return flows are not applied to reduce demands for diversions to storage. Demand adjustments are done in the POD Demand tab of the spreadsheet (see next section).

POD Demand

This tab contains demand data for water rights and claims in the Delta watershed, modified from the WR Demand tab (see previous section) to account for return flows and the distribution of demand to individual points of diversion (PODs). This demand separation is necessary because annual water right reports, and thus the data in the WR Demand tab of the spreadsheet, are provided for each water right record rather than each POD. While the data necessary to separate demands to each POD originated from the eWRIMS database, some staff judgement is required to develop the Direct and Storage Weights listed in this tab based on the nature of PODs associated with each right. Demand adjustments to account for return flows are sourced from the Return Flows tab of the spreadsheet. Each row quantifies demands for the user-specified period and demand scenario (see Supply Forecast and WR Demand sections) for a single water right or claim POD.

Field Name(s)	Definition & Methodology	Data Source(s)
Application ID	Application ID of the water right or claim, sourced from the WR Demand tab. Water rights or claims with multiple PODs are split into multiple rows, one for each POD.	eWRIMS database
Water Right Type	Water right or claim type, sourced from the WR Demand tab.	eWRIMS database w/ staff adjustments
Primary Owner	Name of the primary owner of the water right record, sourced from the WR Demand tab.	eWRIMS database
POD ID	Unique numeric identifier for the POD.	eWRIMS database
Latitude/ Longitude	Latitude and longitude coordinates of the POD location (NAD83).	eWRIMS database

Water Unavailability Methodology for the Delta Watershed
 Technical Appendix A
 January 19, 2023

Field Name(s)	Definition & Methodology	Data Source(s)
HUC8	The name of the Hydrologic Unit Code Level 8 watershed where demand from the POD. Water right or claim PODs are automatically assigned a HUC8 value in eWRIMS based on their location. HUC8 values for some PODs in the Upper Mokelumne, Middle San Joaquin-Lower Chowchilla, and Fresno River were manually assigned to other HUC8s so that PODs in these HUC8s represent headwater subwatershed demands that can only be met by local supply.	eWRIMS database, USGS WBD
Subwatershed	Subwatershed where demand from the POD is row is located. Sourced from the Subwatersheds tab based on the HUC8 value.	Staff-determined
Watershed	The watershed in which the demand occurs: the Sacramento River watershed or the San Joaquin River watershed. Sourced from the Subwatersheds tab based on the HUC8 value.	eWRIMS database, USGS WBD
Legal Delta?	Indicates if that POD is located in the Legal Delta (TRUE/FALSE). Assigned based on the location of the POD.	eWRIMS database w/ staff adjustments
Priority Date	The priority date of a water right or claim, sourced from the Assumed Priority Date field in the WR Demand tab (YYYY/MM/DD, Riparian, Project, or Pending).	eWRIMS database w/ staff adjustments
Priority Year	The year of the priority date, sourced from the Priority Date value. Riparian, Project, or Pending priorities are shown as such.	eWRIMS database w/ staff adjustments

Field Name(s)	Definition & Methodology	Data Source(s)
Direct Weight	<p>The percent of a given water right or claim’s direct diversion demand which was assumed to occur from a given POD:</p> <ul style="list-style-type: none"> - Direct Weight = (1 if an active point of direct diversion, 0 if inactive or point of rediversion) / (total number of active points of diversion in the Delta watershed for the given record). - Equal to one for any records with only one POD. - Equal to zero for PODs associated only with storage (as long as the water right record has additional PODs associated with direct diversions). - The sum of Direct Weights for most water rights or claims is equal to one (see exception in Demand Comment column), regardless of whether they have reported direct diversions. 	Staff-determined using eWRIMS database
Storage Weight	<p>The percent of a given water right or claim’s diversion to storage demand which was assumed to occur from a given POD:</p> <ul style="list-style-type: none"> - Storage Weight = (1 if an active point of diversion to storage, 0 if inactive or point of rediversion) / (total number of active points of diversion to storage in the Delta watershed for the given record). - Equal to one for any records with only one POD. - Equal to zero for PODs associated only with direct diversions (as long as the water right record has additional PODs associated with storage). - The sum of Storage Weights for most water rights or claims is equal to one (see exception in Demand Comment column), regardless of whether they have reported diversions to storage. 	Staff-determined using eWRIMS database

Water Unavailability Methodology for the Delta Watershed
 Technical Appendix A
 January 19, 2023

Field Name(s)	Definition & Methodology	Data Source(s)
Demand Comment	Additional detail about the Direct or Storage Weights or other aspects of the demand: <ul style="list-style-type: none"> - POD(s) outside Delta watershed: The water right or claim has one or more associated PODs which divert from streams outside the Delta watershed (sum of Direct and/or Storage Weights is less than one). - Inactive: The POD is not actively used (Direct and Storage Weights are zero). - Rediversion: The POD does not divert natural flow (Direct and Storage Weights are zero). - Project: The water right is listed in Board Decision 1641 and its Priority Date is set to "Project." Indicates the associated project (e.g., Shasta). 	Staff-determined using eWRIMS database
Storage Comment	The name of a storage reservoir that appears to be associated with a given POD, with terms like "Reservoir," "Lake," "Pond," or "Dam" removed.	Staff-determined using eWRIMS database
2018/2019/2018 w/ Enhanced Reporting Period Direct/Storage (AF)	Monthly Direct or Storage demands of a given water right or claim POD for a given demand year for the user-specified period in the Supply Forecast tab. Calculated as follows: (Application ID Period demand, sourced from the WR Demand tab) * (Return Flow Factor for Supply Forecast period for subwatershed, sourced from Return Flows tab) * (Direct or Storage Weight)	Calculated
2018/2019/2018 w/ Enhanced Reporting Period Demand (AF)	Total demand of a given water right or claim POD for a given demand year for the user-specified period based on the user-specified Demand Scenario in the Supply Forecast tab (Direct, Storage, or Direct+Storage).	Calculated

Field Name(s)	Definition & Methodology	Data Source(s)
Selected Period Direct/Storage/Demand (AF)	Total demand of a given water right or claim POD for a given demand scenario for the user-specified Demand Year in the Supply Forecast tab. The Selected Period Demand value carries over to the Analyses tab of the spreadsheet.	Calculated

Analyses

This tab contains tabular water unavailability analyses for the 17 headwater subwatersheds in the Delta watershed, as well as the Sacramento and San Joaquin watersheds as a whole. In each analysis, water supplies (see Supply Forecast section) are compared to demands (see WR Demand and POD Demand sections) in order to determine water unavailability for each water right or claim in order of priority date. Rights or claims which are not expected to have water available to meet their demands due to limited supplies, either based on headwater subwatershed-scale or watershed-scale unavailability, are flagged for the potential receipt of a curtailment order. This tab is grouped vertically into nine sections of columns and a separate table of computations to the far-right; each of these sections is described in detail in the sections below.

The list of water rights and claims subject to this analysis is set-up as follows:

1. Starting with the list of water rights and claims in the POD Demand tab of the spreadsheet, any duplicate records (i.e., all PODs with the same Application ID, Subwatershed, and Legal Delta? values) are merged; this occurs for any records with multiple PODs in the same subwatershed.
2. Riparian-priority claims in each subwatershed are merged since water unavailability is not determined for individual Riparian-priority claims; they are merged into two distinct categories based on their Water Right Type (“Riparian” only or “Riparian or Pre-1914” and “Other” together). This results in a total of 54 Riparian-priority rows, one for each category in each subwatershed and rows for outside and within the Legal Delta for those subwatersheds that cross into the Legal Delta (Putah, Sacramento Valley Floor, Stanislaus, Calaveras, Mokelumne, Cosumnes, and San Joaquin Valley Floor).
3. Any records with total Direct and Storage Weight (see POD Demand section) sums of zero for the given Application ID, Subwatershed, and Legal Delta? values (i.e., with only inactive PODs or points of rediversion in the given area) are removed to ensure that water availability for these rights or claims is analyzed only based on where they divert natural flow. This only affects

unavailability calculations for four water rights owned by the U.S. Bureau of Reclamation: Black Butte Reservoir on Stony Creek, New Melones Reservoir on the Stanislaus River, and Hensley Lake on the Fresno River.

4. The list of rights and claims is sorted by priority date, with the most senior rights or claims first: Riparian, Pre-1914 Appropriative, multiple Appropriative types, Project, and Pending (see the description of Water Right Types and Assumed Priority Dates in the WR Demand section). All Riparian claims of right are assumed to have senior priority over all pre-1914 appropriative claims, which are in turn assumed to have priority over all post-1914 appropriative rights. No priority distinctions are made between Riparian-priority claims, but because each subwatershed’s Riparian-priority demands are quantified in individual rows it is necessary to choose an order in which to sort them; those in headwater subwatersheds are sorted first since it is assumed that they would use water when possible and that supply may not be available for diversion by other Riparian-priority users downstream. This would not affect analyses for any Riparian-priority rights, which are only determined to have water unavailable when there is zero total supply available. For rights or claims with the same priority date, records are sorted alphabetically by Application ID (i.e., the application or statement that assigned an earlier number because it was submitted earlier is assumed to be more senior).
5. For each right or claim in a subwatershed, a number of parameters are calculated. The table below describes the fundamental aspects of each record, while the calculations are described in each of the following sections. All calculations are made only for the user-specified time period in the Supply Forecast tab.

NOTE: Though this tab evaluates water unavailability for any user-specified time period entered in the Supply Forecast tab, water unavailability analyses for the purpose of issuing curtailments in the Legal Delta will not be performed on a timestep any shorter than one month.

Field Name(s)	Definition & Methodology	Data Source(s)
Watershed	The watershed in which the demand occurs, Sacramento River or San Joaquin River. Sourced from the POD Demand tab.	USGS WBD
Subwatershed	Smallest area over which water unavailability is determined, based on one or more HUC8s. Sourced from the POD Demand tab.	Staff-determined

Water Unavailability Methodology for the Delta Watershed
 Technical Appendix A
 January 19, 2023

Field Name(s)	Definition & Methodology	Data Source(s)
Application ID	Application ID of a given water right or claim, sourced from the WR Demand tab. Any duplicate Application IDs in a single subwatershed with the same Legal Delta? values are merged into a single row.	eWRIMS database
Primary Owner	Name of the primary owner of the water right or claim, sourced from the WR Demand tab.	eWRIMS database
Water Right Type	Water right or claim type, sourced from the WR Demand tab.	eWRIMS database w/ staff adjustments
Priority Date	The priority date of a water right or claim, sourced from the Assumed Priority Date field in the WR Demand tab (YYYY/MM/DD). For each possible subwatershed and Legal Delta? combination, Statements with “Riparian” priority are grouped together in two demand categories (Riparian-only or “Riparian or Pre-1914” and Other), all of which are assumed to have equal senior priority. Rights denoted as “Project” priority are assumed to be junior to other appropriative demands, and Statements with “Pending” priority are assumed to be junior to all other water rights and claims and are sorted last.	eWRIMS database w/ staff adjustments
Legal Delta?	If demand for that row occurs in the Legal Delta (TRUE/FALSE), sourced from the POD Demand tab.	eWRIMS database
Headwater Subwatershed?	If demand for that row occurs in a headwater subwatershed (TRUE/FALSE), sourced from the Subwatersheds tab based on the Subwatershed value.	Staff-determined

Field Name(s)	Definition & Methodology	Data Source(s)
Total Demand (AF)	Total demands by a given water right or claim for the respective Subwatershed and Legal Delta? values for the user-specified period, Demand Year, and Demand Scenario in the Supply Forecast tab. Summed from Selected Period Demand values in the POD Demand tab. These calculations are different for Riparian claims and Appropriative rights, so the first cell for each is highlighted gray to denote a different formula.	eWRIMS database w/ staff adjustments

Headwater Analysis Demand

This section represents the start of the headwater subwatershed-scale analysis. This analysis serves two purposes: to evaluate water unavailability at a local scale for rights and claims that only have access to supply from a single subwatershed and to exclude demands which cannot be met by local supplies from the later watershed-scale analysis (starting with the Watershed Analysis Distributed Demand section). If the headwater-scale analysis indicates that any Riparian claims of right (senior demands) would face water unavailability, supplies and demands from that subwatershed are excluded from its respective watershed-scale analysis (see Headwater Calculations for Watershed Analysis section). In other words, these streams are assumed to not have connectivity to the Delta watershed due to senior demands exceeding all available water supplies.

Only demands from the 17 headwater subwatersheds appear in this section: Sacramento River at Bend Bridge, Stony Creek, Cache Creek, Upper Feather River, Yuba River, Bear River, Upper American River, Putah Creek, Chowchilla River, Upper San Joaquin River, Fresno River, Merced River, Tuolumne River, Stanislaus River, Calaveras River, Mokelumne River, and Cosumnes River. Any demands located within any of these subwatersheds and in the Legal Delta are not included in this section.

Each column in this section quantifies the amount of the respective row’s demand which would be met by supply from that respective column’s subwatershed. If the Subwatershed value of a row matches that of a column in this section, the value will be equal to Total Demand (see previous section). Otherwise, it will equal zero. Rows which represent demands located in lower subwatersheds (Headwater Subwatershed? = FALSE) or in the Legal Delta (Legal Delta? = TRUE), including demands located in the downstream reaches of headwater subwatersheds that cross into the Legal Delta (Putah Creek, and the Stanislaus, Calaveras, Mokelumne, and Cosumnes Rivers) will also be equal to zero. These demands are only evaluated in the watershed-scale

analysis (starting with the Watershed Demand Distributed section), as they are assumed to have access to water from multiple upstream tributaries.

Headwater Analysis Supply Cumulative

For each of the 17 headwater subwatersheds, this section tracks the supply which is available to meet a given water right or claim's demand (see previous section) over the user-specified time period based on the user-specified Forecast Source (see Supply Forecast section). These values are calculated in each column as follows:

- For the first row of Riparian-only claims, equal to the Selected Supply Forecast value for the column's subwatershed from the Headwater Calculations for Watershed Analysis table. This row is highlighted gray to denote a different formula from those below it.
- For the next water right or claim, the Headwater Analysis Supply Cumulative available to the previous right or claim from the column's subwatershed minus the previous right or claim's Headwater Analysis Demand (see previous section) from the same subwatershed. Rights or claims not located in the column's subwatershed or located in the Legal Delta (Legal Delta? = TRUE) do not affect the available supply since their Headwater Analysis Demand values are equal to zero.
- Continued for each next junior water right or claim in each column until all Headwater Analysis Demand values are accounted for or the Headwater Analysis Supply Cumulative value is equal to zero (i.e., there is no remaining water supply available in the headwater-scale analysis).

Headwater Analysis Demand Potentially Met in Subwatershed

This section tracks the amount of a given water right or claim's demand which can be met by local supply from each of the 17 headwater subwatersheds over the user-specified time period. These values are calculated as follows:

- If a column's Headwater Analysis Supply Cumulative > Headwater Analysis Demand for the column's subwatershed, equal to its Headwater Analysis Demand value.
- If $0 < \text{Headwater Analysis Supply Cumulative} < \text{Headwater Analysis Demand}$ for the column's subwatershed, equal to Headwater Analysis Supply Cumulative for that subwatershed (i.e., only a portion of demand can be met).
- If Headwater Analysis Supply Cumulative = 0 for a column's subwatershed, equal to zero (i.e., Water Unavailable in Subwatershed).

Headwater Analysis Results

This section summarizes the results of the headwater subwatershed-scale analysis for the purpose of determining water unavailability on a local scale and to calculate parameters that carry over to the watershed-scale analysis. Rights or claims which are not expected to have water available to meet their demands are flagged for the potential receipt of a curtailment order based on the headwater subwatershed-scale analysis.

The Water Unavailable in Headwater Subwatershed? value indicates whether water is anticipated to be unavailable to a given water right or claim for the user-specified time period (TRUE/FALSE). Water is only considered unavailable to a given row if it is located in a headwater subwatershed outside the Legal Delta and the Headwater Analysis Supply Cumulative value for the row's subwatershed column is equal to zero. In other words, water is assumed to be available even if only a portion of demand can be met by available supply. These cells have conditional formatting to **highlight red** if water is unavailable for a given right or claim.

The Demand Potentially Met in Subwatershed value for a given water right or claim is the amount of demand which will carry over to the watershed-scale analysis. It is calculated for a given row as follows:

- If located outside the Legal Delta (Legal Delta? = FALSE) and in a headwater subwatershed (Headwater Subwatershed? = TRUE):
 - o If supply is less than the total demand of Riparian-priority Statements in the given headwater subwatershed (see Disconnected? value in the Headwater Calculations for Watershed Analysis section), equal to zero.
 - o Otherwise equal to the sum of all Headwater Analysis Demand Potentially Met in Subwatershed values for a given row.
- Otherwise equal to the Total Demand Value (i.e., all the demand carries over to the watershed-scale analysis since it does not need to be reduced to account for headwater availability).

The Demand Unmet in Subwatershed value is the amount of a given right or claim's demand which cannot be met by local water supply over the user-specified time period. It is equal to the difference between the Total Demand value and the Demand Potentially Met in Subwatershed value for each row.

Watershed Analysis Distributed Demand

This section represents the start of the watershed-scale analysis, which compares supplies and demands for the entire Delta watershed and accounts for the connectivity of its major tributaries. This analysis is necessary for rights and claims in headwater subwatersheds because, while there may be enough water present locally to meet a

given demand, water may not actually be available if it is needed to supply more senior rights or claims further downstream in the watershed. Demands include those within headwater subwatersheds which can be met by available local supplies (see previous sections) and those located in lower subwatersheds and in the Legal Delta which have access to supply from multiple upstream tributaries (including small tributaries in the lower subwatersheds). Supplies include observed and/or forecasted values for the user-specified period (see Supply Forecast section) with adjustments to account for disconnected subwatersheds and abandoned instream flow releases in excess of natural flows (see Headwater Calculations for Watershed Analysis section).

In this section the demand of a given water right or claim is distributed only among “upstream” tributaries which are expected to contribute available supply to meet this demand. Upstream tributaries include the subwatershed where it is located and any other subwatersheds which flow into it (see Figure 10 and Section 2.3.3 in the main report). The distribution of a given demand among upstream subwatersheds is calculated based on the Demand Potentially Met in Subwatershed value (see Headwater Analysis Results section) and the magnitude of supply that is available from each upstream tributary (see Watershed Analysis Supply Cumulative Section). If a right or claim is located in the Legal Delta and is not a Riparian-only claim, its demand is distributed among all 20 subwatersheds in the Delta watershed; per Board Order WR 89-8, Riparian-only claims in the Legal Delta are distributed only among upstream tributaries located in the same watershed. Compared to previous versions of the Methodology, this watershed-scale analysis now assumes that five headwater subwatersheds are tributary only to the Legal Delta and are not available to any demands in lower subwatersheds outside of the Legal Delta: Putah Creek and the Stanislaus, Calaveras, Mokelumne, and Cosumnes Rivers. The demand distribution calculations in this section represent a more spatially refined approach to evaluating water unavailability than previous versions of the Methodology.

Each column in this section quantifies the amount of the respective row’s demand which would be met by supply from that respective column’s subwatershed. The calculations for each subwatershed’s distributed demands value are described in the table below.

Field Name(s)	Definition & Methodology	Data Source(s)
Sacramento Bend	<p>Demand of a given record which would be supplied by the Sacramento Bend subwatershed:</p> <ul style="list-style-type: none"> - If Subwatershed = Sacramento Bend; 100% of Demand Potentially Met in Subwatershed - If Subwatershed = Upper Sacramento Valley; Demand Potentially Met in Subwatershed * [Sacramento Bend supply / (Sacramento Bend supply + Upper Sacramento Valley supply)] - If Subwatershed = Sacramento Valley Floor and Legal Delta? = FALSE; Demand Potentially Met in Subwatershed * [Sacramento Bend supply / (Sacramento Total supply – Putah supply)] - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = Sacramento; Demand Potentially Met in Subwatershed * (Sacramento Bend supply / Sacramento Total supply) - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = San Joaquin; zero - If Legal Delta? = TRUE and Water Right Type = Statement of Div and Use (Riparian or Pre-1914, Other); Demand Potentially Met in Subwatershed * [Sacramento Bend supply / (Sacramento Total supply + San Joaquin Total supply)] - Otherwise; zero 	Calculated

Water Unavailability Methodology for the Delta Watershed
 Technical Appendix A
 January 19, 2023

Field Name(s)	Definition & Methodology	Data Source(s)
Stony	<p>Demand of a given record which would be supplied by the Stony subwatershed:</p> <ul style="list-style-type: none"> - If Subwatershed = Stony; 100% of Demand Potentially Met in Subwatershed - If Subwatershed = Sacramento Valley Floor and Legal Delta? = FALSE; Demand Potentially Met in Subwatershed * [Stony supply / (Sacramento Total supply – Putah supply)] - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = Sacramento; Demand Potentially Met in Subwatershed * (Stony supply / Sacramento Total supply) - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = San Joaquin; zero - If Legal Delta? = TRUE and Water Right Type = Statement of Div and Use (Riparian or Pre-1914, Other); Demand Potentially Met in Subwatershed * [Stony supply / (Sacramento Total supply + San Joaquin Total supply)] - Otherwise; zero 	Calculated

Field Name(s)	Definition & Methodology	Data Source(s)
Cache	<p>Demand of a given record which would be supplied by the Cache subwatershed:</p> <ul style="list-style-type: none"> - If Subwatershed = Cache; 100% of Demand Potentially Met in Subwatershed - If Subwatershed = Sacramento Valley Floor and Legal Delta? = FALSE; Demand Potentially Met in Subwatershed * [Cache supply / (Sacramento Total supply – Putah supply)] - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = Sacramento; Demand Potentially Met in Subwatershed * (Cache supply / Sacramento Total supply) - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = San Joaquin; zero - If Legal Delta? = TRUE and Water Right Type = Statement of Div and Use (Riparian or Pre-1914, Other); Demand Potentially Met in Subwatershed * [Cache supply / (Sacramento Total supply + San Joaquin Total supply)] - Otherwise; zero 	Calculated

Water Unavailability Methodology for the Delta Watershed
 Technical Appendix A
 January 19, 2023

Field Name(s)	Definition & Methodology	Data Source(s)
Upper Feather	<p>Demand of a given record which would be supplied by the Upper Feather subwatershed:</p> <ul style="list-style-type: none"> - If Subwatershed = Upper Feather; 100% of Demand Potentially Met in Subwatershed - If Subwatershed = Sacramento Valley Floor and Legal Delta? = FALSE; Demand Potentially Met in Subwatershed * [Upper Feather supply / (Sacramento Total supply – Putah supply)] - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = Sacramento; Demand Potentially Met in Subwatershed * (Upper Feather supply / Sacramento Total supply) - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = San Joaquin; zero - If Legal Delta? = TRUE and Water Right Type = Statement of Div and Use (Riparian or Pre-1914, Other); Demand Potentially Met in Subwatershed * [Upper Feather supply / (Sacramento Total supply + San Joaquin Total supply)] - Otherwise; zero 	Calculated

Field Name(s)	Definition & Methodology	Data Source(s)
Yuba	<p>Demand of a given record which would be supplied by the Yuba subwatershed:</p> <ul style="list-style-type: none"> - If Subwatershed = Yuba; 100% of Demand Potentially Met in Subwatershed - If Subwatershed = Sacramento Valley Floor and Legal Delta? = FALSE; Demand Potentially Met in Subwatershed * [Yuba supply / (Sacramento Total supply – Putah supply)] - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = Sacramento; Demand Potentially Met in Subwatershed * (Yuba supply / Sacramento Total supply) - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = San Joaquin; zero - If Legal Delta? = TRUE and Water Right Type = Statement of Div and Use (Riparian or Pre-1914, Other); Demand Potentially Met in Subwatershed * [Yuba supply / (Sacramento Total supply + San Joaquin Total supply)] - Otherwise; zero 	Calculated

Water Unavailability Methodology for the Delta Watershed
 Technical Appendix A
 January 19, 2023

Field Name(s)	Definition & Methodology	Data Source(s)
Bear	<p>Demand of a given record which would be supplied by the Bear subwatershed:</p> <ul style="list-style-type: none"> - If Subwatershed = Bear; 100% of Demand Potentially Met in Subwatershed - If Subwatershed = Sacramento Valley Floor and Legal Delta? = FALSE; Demand Potentially Met in Subwatershed * [Bear supply / (Sacramento Total supply – Putah supply)] - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = Sacramento; Demand Potentially Met in Subwatershed * (Bear supply / Sacramento Total supply) - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = San Joaquin; zero - If Legal Delta? = TRUE and Water Right Type = Statement of Div and Use (Riparian or Pre-1914, Other); Demand Potentially Met in Subwatershed * [Bear supply / (Sacramento Total supply + San Joaquin Total supply)] - Otherwise; zero 	Calculated

Water Unavailability Methodology for the Delta Watershed
 Technical Appendix A
 January 19, 2023

Field Name(s)	Definition & Methodology	Data Source(s)
Upper American	<p>Demand of a given record which would be supplied by the Upper American subwatershed:</p> <ul style="list-style-type: none"> - If Subwatershed = Upper American; 100% of Demand Potentially Met in Subwatershed - If Subwatershed = Sacramento Valley Floor and Legal Delta? = FALSE; Demand Potentially Met in Subwatershed * [Upper American supply / (Sacramento Total supply – Putah supply)] - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = Sacramento; Demand Potentially Met in Subwatershed * (Upper American supply / Sacramento Total supply) - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = San Joaquin; zero - If Legal Delta? = TRUE and Water Right Type = Statement of Div and Use (Riparian or Pre-1914, Other); Demand Potentially Met in Subwatershed * [Upper American supply / (Sacramento Total supply + San Joaquin Total supply)] - Otherwise; zero 	Calculated

Field Name(s)	Definition & Methodology	Data Source(s)
Putah	<p>Demand of a given record which would be supplied by the Putah subwatershed:</p> <ul style="list-style-type: none"> - If Subwatershed = Putah and Legal Delta? = FALSE; 100% of Demand Potentially Met in Subwatershed - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = Sacramento; Demand Potentially Met in Subwatershed * (Putah supply / Sacramento Total supply) - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = San Joaquin; zero - If Legal Delta? = TRUE and Water Right Type = Statement of Div and Use (Riparian or Pre-1914, Other); Demand Potentially Met in Subwatershed * [Putah supply / (Sacramento Total supply + San Joaquin Total supply)] - Otherwise; zero 	Calculated

Field Name(s)	Definition & Methodology	Data Source(s)
Upper Sacramento Valley	<p>Demand of a given record which would be supplied by the Upper Sacramento Valley subwatershed:</p> <ul style="list-style-type: none"> - If Subwatershed = Upper Sacramento Valley; Demand Potentially Met in Subwatershed * [Upper Sacramento Valley supply / (Sacramento Bend supply + Upper Sacramento Valley supply)] - If Subwatershed = Sacramento Valley Floor and Legal Delta? = FALSE; Demand Potentially Met in Subwatershed * [Upper Sacramento Valley supply / (Sacramento Total supply – Putah supply)] - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = Sacramento; Demand Potentially Met in Subwatershed * (Upper Sacramento Valley supply / Sacramento Total supply) - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = San Joaquin; zero - If Legal Delta? = TRUE and Water Right Type = Statement of Div and Use (Riparian or Pre-1914, Other); Demand Potentially Met in Subwatershed * [Upper Sacramento Valley supply / (Sacramento Total supply + San Joaquin Total supply)] - Otherwise; zero 	Calculated

Water Unavailability Methodology for the Delta Watershed
 Technical Appendix A
 January 19, 2023

Field Name(s)	Definition & Methodology	Data Source(s)
Sacramento Valley Floor	<p>Demand of a given record which would be supplied by the Sacramento Valley Floor subwatershed:</p> <ul style="list-style-type: none"> - If Subwatershed = Sacramento Valley Floor and Legal Delta? = FALSE; Demand Potentially Met in Subwatershed * [Sacramento Valley Floor supply / (Sacramento Total supply – Putah supply)] - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = Sacramento; Demand Potentially Met in Subwatershed * (Sacramento Valley Floor supply / Sacramento Total supply) - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = San Joaquin; zero - If Legal Delta? = TRUE and Water Right Type = Statement of Div and Use (Riparian or Pre-1914, Other); Demand Potentially Met in Subwatershed * [Sacramento Valley Floor supply / (Sacramento Total supply + San Joaquin Total supply)] - Otherwise; zero 	Calculated

Field Name(s)	Definition & Methodology	Data Source(s)
Chowchilla	<p>Demand of a given record which would be supplied by the Chowchilla subwatershed:</p> <ul style="list-style-type: none"> - If Subwatershed = Chowchilla; 100% of Demand Potentially Met in Subwatershed - If Subwatershed = San Joaquin Valley Floor and Legal Delta? = FALSE; Demand Potentially Met in Subwatershed * [Chowchilla supply / (San Joaquin Total supply – Stanislaus supply – Calaveras supply – Mokelumne supply – Cosumnes supply)] - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = San Joaquin; Demand Potentially Met in Subwatershed * (Chowchilla supply / San Joaquin Total supply) - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = Sacramento; zero - If Legal Delta? = TRUE and Water Right Type = Statement of Div and Use (Riparian or Pre-1914, Other); Demand Potentially Met in Subwatershed * [Chowchilla supply / (Sacramento Total supply + San Joaquin Total supply)] - Otherwise; zero 	Calculated

Field Name(s)	Definition & Methodology	Data Source(s)
Upper San Joaquin	<p>Demand of a given record which would be supplied by the Upper San Joaquin subwatershed:</p> <ul style="list-style-type: none"> - If Subwatershed = Upper San Joaquin; 100% of Demand Potentially Met in Subwatershed - If Subwatershed = San Joaquin Valley Floor and Legal Delta? = FALSE; Demand Potentially Met in Subwatershed * [Upper San Joaquin supply / (San Joaquin Total supply – Stanislaus supply – Calaveras supply – Mokelumne supply – Cosumnes supply)] - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = San Joaquin; Demand Potentially Met in Subwatershed * (Upper San Joaquin supply / San Joaquin Total supply) - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = Sacramento; zero - If Legal Delta? = TRUE and Water Right Type = Statement of Div and Use (Riparian or Pre-1914, Other); Demand Potentially Met in Subwatershed * [Upper San Joaquin supply / (Sacramento Total supply + San Joaquin Total supply)] - Otherwise; zero 	Calculated

Field Name(s)	Definition & Methodology	Data Source(s)
Fresno	<p>Demand of a given record which would be supplied by the Fresno subwatershed:</p> <ul style="list-style-type: none"> - If Subwatershed = Fresno; 100% of Demand Potentially Met in Subwatershed - If Subwatershed = San Joaquin Valley Floor and Legal Delta? = FALSE; Demand Potentially Met in Subwatershed * [Fresno supply / (San Joaquin Total supply – Stanislaus supply – Calaveras supply – Mokelumne supply – Cosumnes supply)] - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = San Joaquin; Demand Potentially Met in Subwatershed * (Fresno supply / San Joaquin Total supply) - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = Sacramento; zero - If Legal Delta? = TRUE and Water Right Type = Statement of Div and Use (Riparian or Pre-1914, Other); Demand Potentially Met in Subwatershed * [Fresno supply / (Sacramento Total supply + San Joaquin Total supply)] - Otherwise; zero 	Calculated

Field Name(s)	Definition & Methodology	Data Source(s)
Merced	<p>Demand of a given record which would be supplied by the Merced subwatershed:</p> <ul style="list-style-type: none"> - If Subwatershed = Merced; 100% of Demand Potentially Met in Subwatershed - If Subwatershed = San Joaquin Valley Floor and Legal Delta? = FALSE; Demand Potentially Met in Subwatershed * [Merced supply / (San Joaquin Total supply – Stanislaus supply – Calaveras supply – Mokelumne supply – Cosumnes supply)] - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = San Joaquin; Demand Potentially Met in Subwatershed * (Merced supply / San Joaquin Total supply) - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = Sacramento; zero - If Legal Delta? = TRUE and Water Right Type = Statement of Div and Use (Riparian or Pre-1914, Other); Demand Potentially Met in Subwatershed * [Merced supply / (Sacramento Total supply + San Joaquin Total supply)] - Otherwise; zero 	Calculated

Water Unavailability Methodology for the Delta Watershed
 Technical Appendix A
 January 19, 2023

Field Name(s)	Definition & Methodology	Data Source(s)
Tuolumne	<p>Demand of a given record which would be supplied by the Tuolumne subwatershed:</p> <ul style="list-style-type: none"> - If Subwatershed = Tuolumne; 100% of Demand Potentially Met in Subwatershed - If Subwatershed = San Joaquin Valley Floor and Legal Delta? = FALSE; Demand Potentially Met in Subwatershed * [Tuolumne supply / (San Joaquin Total supply – Stanislaus supply – Calaveras supply – Mokelumne supply – Cosumnes supply)] - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = San Joaquin; Demand Potentially Met in Subwatershed * (Tuolumne supply / San Joaquin Total supply) - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = Sacramento; zero - If Legal Delta? = TRUE and Water Right Type = Statement of Div and Use (Riparian or Pre-1914, Other); Demand Potentially Met in Subwatershed * [Tuolumne supply / (Sacramento Total supply + San Joaquin Total supply)] - Otherwise; zero 	Calculated

Water Unavailability Methodology for the Delta Watershed
 Technical Appendix A
 January 19, 2023

Field Name(s)	Definition & Methodology	Data Source(s)
Stanislaus	<p>Demand of a given record which would be supplied by the Stanislaus subwatershed:</p> <ul style="list-style-type: none"> - If Subwatershed = Stanislaus and Legal Delta? = FALSE; 100% of Demand Potentially Met in Subwatershed - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = San Joaquin; Demand Potentially Met in Subwatershed * (Stanislaus supply / San Joaquin Total supply) - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = Sacramento; zero - If Legal Delta? = TRUE and Water Right Type = Statement of Div and Use (Riparian or Pre-1914, Other); Demand Potentially Met in Subwatershed * [Stanislaus supply / (Sacramento Total supply + San Joaquin Total supply)] - Otherwise; zero 	Calculated

Field Name(s)	Definition & Methodology	Data Source(s)
Calaveras	<p>Demand of a given record which would be supplied by the Calaveras subwatershed:</p> <ul style="list-style-type: none"> - If Subwatershed = Calaveras and Legal Delta? = FALSE; 100% of Demand Potentially Met in Subwatershed - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = San Joaquin; Demand Potentially Met in Subwatershed * (Calaveras supply / San Joaquin Total supply) - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = Sacramento; zero - If Legal Delta? = TRUE and Water Right Type = Statement of Div and Use (Riparian or Pre-1914, Other); Demand Potentially Met in Subwatershed * [Calaveras supply / (Sacramento Total supply + San Joaquin Total supply)] - Otherwise; zero 	Calculated

Field Name(s)	Definition & Methodology	Data Source(s)
Mokelumne	<p>Demand of a given record which would be supplied by the Mokelumne subwatershed:</p> <ul style="list-style-type: none"> - If Subwatershed = Mokelumne and Legal Delta? = FALSE; 100% of Demand Potentially Met in Subwatershed - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = San Joaquin; Demand Potentially Met in Subwatershed * (Mokelumne supply / San Joaquin Total supply) - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = Sacramento; zero - If Legal Delta? = TRUE and Water Right Type = Statement of Div and Use (Riparian or Pre-1914, Other); Demand Potentially Met in Subwatershed * [Mokelumne supply / (Sacramento Total supply + San Joaquin Total supply)] - Otherwise; zero 	Calculated

Water Unavailability Methodology for the Delta Watershed
 Technical Appendix A
 January 19, 2023

Field Name(s)	Definition & Methodology	Data Source(s)
Cosumnes	<p>Demand of a given record which would be supplied by the Cosumnes subwatershed:</p> <ul style="list-style-type: none"> - If Subwatershed = Cosumnes and Legal Delta? = FALSE; 100% of Demand Potentially Met in Subwatershed - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = San Joaquin; Demand Potentially Met in Subwatershed * (Cosumnes supply / San Joaquin Total supply) - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = Sacramento; zero - If Legal Delta? = TRUE and Water Right Type = Statement of Div and Use (Riparian or Pre-1914, Other); Demand Potentially Met in Subwatershed * [Cosumnes supply / (Sacramento Total supply + San Joaquin Total supply)] - Otherwise; zero 	Calculated

Field Name(s)	Definition & Methodology	Data Source(s)
San Joaquin Valley Floor	<p>Demand of a given record which would be supplied by the San Joaquin Valley Floor subwatershed:</p> <ul style="list-style-type: none"> - If Subwatershed = San Joaquin Valley Floor and Legal Delta? = FALSE; Demand Potentially Met in Subwatershed * [San Joaquin Valley Floor supply / (San Joaquin Total supply – Stanislaus supply – Calaveras supply – Mokelumne supply – Cosumnes supply)] - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = San Joaquin; Demand Potentially Met in Subwatershed * (San Joaquin Valley Floor supply / San Joaquin Total supply) - If Legal Delta? = TRUE, Water Right Type = Statement of Div and Use (Riparian), and Watershed = Sacramento; zero - If Legal Delta? = TRUE and Water Right Type = Statement of Div and Use (Riparian or Pre-1914, Other); Demand Potentially Met in Subwatershed * [San Joaquin Valley Floor supply / (Sacramento Total supply + San Joaquin Total supply)] - Otherwise; zero 	Calculated
Sacramento Total	Sum of distributed demands for subwatersheds in the Sacramento River watershed: Sacramento Bend, Stony, Cache, Upper Feather, Yuba, Bear Upper American, Putah, Upper Sacramento Valley, and Sacramento Valley Floor.	Calculated
San Joaquin Total	Sum of distributed demands for subwatersheds in the San Joaquin River watershed: Chowchilla, Upper San Joaquin, Fresno, Merced, Tuolumne, Stanislaus, Calaveras, Mokelumne, Cosumnes, and San Joaquin Valley Floor.	Calculated

Watershed Analysis Supply Cumulative

For each of the 20 subwatersheds in the Delta watershed, this section tracks the supply which is available to meet a given water right or claim’s distributed demand (see previous section) over the user-specified time period based on the user-specified

Forecast Source (see Supply Forecast section) in the watershed-scale analysis. These values are calculated in each column as follows:

- For the first row of Riparian-only claims, equal to the Total Supply value for the column's subwatershed from the Headwater Calculations for Watershed Analysis table. Because abandoned instream flow releases are assumed to not be available to Riparian-only claims, the Instream Flow in Excess of Supply value from the Headwater Calculations for Watershed Analysis table for the column's subwatershed is subtracted from the available supply. This row is highlighted gray to denote a different formula from those below it.
- For the next right or claim, the Watershed Analysis Supply Cumulative available to the previous claims from the column's subwatershed minus the previous right or claim's Watershed Analysis Distributed Demand (see previous section) from the same subwatershed.
- For the first row of "Riparian or Pre-1914" or Other claims, the Instream Flow in Excess of Supply value from the Headwater Calculations for Watershed Analysis table for the column's subwatershed is also added to the available supply. This row is highlighted gray to denote a different formula from those above and below it.
- Continued for each next junior water right or claim in each column until all Watershed Analysis Distributed Demand values are accounted for or the Watershed Analysis Supply Cumulative value is equal to zero (i.e., there is no remaining water supply available in the watershed-scale analysis).

Watershed Analysis Demand Met

This section tracks the amount of a given water right or claim's demand which can be met by the supply of upstream tributaries in the watershed-scale analysis over the user-specified time period. These values are calculated as follows:

- If a column's Watershed Analysis Supply Cumulative > Watershed Analysis Distributed Demand for the column's subwatershed, equal to its Watershed Analysis Distributed Demand value.
- If $0 < \text{Watershed Analysis Supply Cumulative} < \text{Watershed Analysis Distributed Demand}$ for the column's subwatershed, equal to Watershed Analysis Supply Cumulative for that subwatershed (i.e., only a portion of demand can be met).
- If Watershed Analysis Supply Cumulative = 0 for a column's subwatershed, equal to zero (i.e., water unavailable from that subwatershed).

Watershed Analysis Results

This section summarizes the results of the headwater subwatershed-scale analysis for the purpose of determining water unavailability on a local scale and to calculate parameters that carry over to the watershed-scale analysis. Rights or claims which are not expected to have water available to meet their demands are flagged for the potential receipt of a curtailment order based on the watershed-scale analysis. This is in addition to those flagged for potential receipt of a curtailment order based on the headwater subwatershed-scale analysis (see Headwater Analysis Results section).

The Water Unavailable in Watershed? value indicates whether water is anticipated to be unavailable to a given water right or claim for the user-specified time period (TRUE/FALSE). Water is only considered unavailable in a given row if Watershed Analysis Supply Cumulative values for all of its upstream tributaries are zero. In other words, water is assumed to be available even if only a portion of demand can be met by available supply. Subwatersheds where Riparian-priority demand exceeds supply (see Disconnected? value in next section) are marked as FALSE (i.e., water unavailability for rights and claims in disconnected subwatersheds is not evaluated on the watershed scale). These cells have conditional formatting to **highlight red** if water is unavailable for a given right or claim.

The Demand Met in Watershed value for a given water right or claim is the amount of demand which can be met by available supply in the watershed-scale analysis. It is calculated as the sum of Watershed Analysis Demand Met values across all subwatersheds for a given row.

The Demand Unmet in Watershed value for a given water right or claim is the amount of Headwater Analysis Demand Potentially Met in Subwatershed demand which cannot be met by available supply in the watershed-scale analysis. It is calculated as the difference between a row's Demand Potentially Met in Subwatershed and Demand Met in Watershed values.

The Total Demand Unmet is the amount of a water right or claim's Total Demand which cannot be met by available supply, either in the headwater subwatershed or watershed-scale analysis. It is calculated as the sum of a row's Demand Unmet in Subwatershed and Demand Unmet in Watershed values.

The Water Unavailable? Value indicates if water is anticipated to be unavailable to the given water right or claim over the user-specified time period (TRUE/FALSE), either in the headwater subwatershed-scale analysis (Water Unavailable in Headwater Subwatershed?) and/or the watershed-scale analysis (Water Unavailable in Watershed?) (i.e., will this right or claim potentially receive a curtailment order?). These cells have conditional formatting to **highlight red** if water is unavailable for a given right or claim.

Headwater Calculations for Watershed Analysis

This table in the upper right of the Analyses tab contains intermediate supply calculations which use the results of the water unavailability analyses at the headwater subwatershed-scale and other factors to inform inputs to unavailability analyses at the watershed scale.

Selected Supply Forecast values are simply the Selected Supply Forecast values from the Supply for Curtailment Analysis table in the Supply Forecast tab for each subwatershed.

Disconnected? values indicate if any Riparian-priority claims in each subwatershed faced water unavailability over the user-specified period (see Headwater Analysis Results section) (TRUE/FALSE). In other words, these cells identify if each subwatershed's supplies and demands should be excluded from the watershed-scale unavailability analysis due to lack of connectivity with the Delta watershed; they have conditional formatting to **highlight red** if the subwatershed lacks connectivity. Lower subwatersheds have static values of FALSE to indicate they are never disconnected from the watershed, **highlighted gray** to denote a difference from the surrounding formulas.

Headwater Riparian Demand Unmet values represent the total Riparian-priority demand within each headwater subwatershed that would be unmet by local supplies (see Headwater Analysis Demand and Headwater Analysis Demand Potentially Met in Subwatershed sections); this value will only be nonzero if the subwatershed is assumed to be disconnected from the watershed. These calculations do not include unmet demands of Riparian-only claims (i.e., Water Right Type = Statement of Div and Use (Riparian)). These unmet demands are assumed to be able to be met by instream flows in excess of natural supply. Lower subwatersheds have static values of FALSE to indicate they are never disconnected from the watershed, **highlighted gray** to denote a difference from the surrounding formulas.

Instream Flow Exceeds Supply? values indicate if any subwatershed's supply is less than its abandoned instream flow requirement for the user-specified period (see Instream Flows section), with conditional formatting to **highlight red** if the instream flow is greater (TRUE/FALSE).

Instream Flow in Excess of Supply values are the volumes of instream flow in excess of the FNF supply for each subwatershed; these volumes are not available to Riparian-only claims in the watershed-scale analysis (see Watershed Analysis Supply Cumulative section).

Total Supply values are the supply from each subwatershed that contributes to the watershed-scale analysis: if the subwatershed is disconnected its contributing supply is equal to the difference between its Instream Flow in Excess of Supply and its

Headwater Riparian Demand Unmet (i.e., the amount of abandoned instream flow not diverted by Riparian-priority claims in the subwatershed). Otherwise, Total Supply for a subwatershed is equal to its Selected Supply Forecast value plus its Instream Flow in Excess of Supply value. Total supply values for the Delta watershed and percent supply ratios for each watershed are provided for reference; though these values were used to prorate Legal Delta demands in previous versions of the Methodology, the refined watershed-scale analysis now distributes Legal Delta demands between subwatersheds based on the upstream tributary supplies available to each individual right or claim (see Watershed Analysis Distributed Demand section).

Legal Delta

This tab contains information on water rights and claims located in the Legal Delta. Because these rights and claims are assumed to have access to supplies from both the Sacramento and San Joaquin Rivers to meet their demands (see Watershed Analysis Distributed Demand section), this tab quantifies total demands and demands met from each watershed to identify which rights or claims may potentially receive notices of water unavailability or curtailment orders. Riparian-priority claims in the Legal Delta are merged into two rows (one for Riparian-only claims, one for “Riparian or Pre-1914” and Other claims) since water unavailability is not determined for individual Riparian-priority claims. Per State Water Board Order WR 89-8, this analysis assumes that demands by Statements of Diversion and Use claiming only Riparian water rights can only be met by supply from the watershed in which they are located.

Water rights or claims in the Legal Delta will only face water unavailability if water is unavailable from all upstream tributaries (i.e., both watersheds). This tab does not contain any new analysis, it only compiles values from the Analyses tab for rights or claims located in the Legal Delta (Legal Delta? = TRUE in the POD Demand tab). Duplicate rights are merged in this tab, so each row represents a single water right’s total demand. Water rights that have PODs both within and outside the Legal Delta, including several Project water rights diverting elsewhere in the watershed, are not included in this tab because they will only face water unavailability if water is unavailable from all potential sources; these rights can be found in the Curtailments tab (see next section).

NOTE: Though this tab evaluates water unavailability for any user-specified time period entered in the Supply Forecast tab, water unavailability analyses for the purpose of issuing curtailments in the Legal Delta will not be performed on a timestep any shorter than one month.

Water Unavailability Methodology for the Delta Watershed
 Technical Appendix A
 January 19, 2023

Field Name(s)	Definition & Methodology	Data Source(s)
Application ID	Application ID of a given water right or claim, sourced from the WR Demand tab.	eWRIMS database
Primary Owner	Name of the primary owner of the water right or claim, sourced from the WR Demand tab.	eWRIMS database
Water Right Type	Water right or claim type, sourced from the WR Demand tab.	eWRIMS database w/ staff adjustments
Priority Date	The priority date of a water right or claim, sourced from the Assumed Priority Date field in the WR Demand tab (YYYY/MM/DD). Statements with “Riparian” priority are grouped together as two demands at the top, and Project rights appear at the bottom (most junior)	eWRIMS database w/ staff adjustments
Sacramento/ San Joaquin Demand (AF)	Total demands by a given water right or claim in the respective watershed for the user-specified time period, Demand Year, and Demand Scenario, sourced from the Sacramento or San Joaquin Total values in the Watershed Analysis Distributed Demand section of the Analyses tab.	eWRIMS database w/ staff adjustments
Sacramento/ San Joaquin Supply (AF)	Water supply available to a given water right or claim in the respective watershed over the user-specified time period based on the user-specified Forecast Source, sourced from the Sacramento or San Joaquin Total values in the Watershed Analysis Supply Cumulative section of the Analyses tab.	Staff-determined

Field Name(s)	Definition & Methodology	Data Source(s)
Water Unavailable in Sacramento/ San Joaquin?	<p>If the water right or claim is anticipated to face water unavailability from the respective watershed based on the supply available to it from upstream tributaries (TRUE/FALSE):</p> <ul style="list-style-type: none"> - For other Riparian-priority claims, is there zero total Watershed Analysis Supply Cumulative available in the Analyses tab for Riparian-only claims? - For other Riparian-priority claims, is there zero total Watershed Analysis Supply Cumulative available in the Analyses tab for other Riparian-priority claims? - For appropriative water rights, is the Supply for the respective watershed zero? <p>These cells have conditional formatting to highlight red if water is unavailable for a given right or claim.</p>	Staff-determined
Sacramento/ San Joaquin Demand Met (AF)	Amount of a given right or claim's Demand in the respective watershed which can be met by available supplies, sourced from the Sacramento or San Joaquin Total values in the Watershed Analysis Demand Met section of the Analyses tab.	Staff-determined
Water Unavailable?	<p>If the water right or claim is anticipated to face water unavailability in both the Sacramento and San Joaquin River watersheds over the user-specified time period (i.e., will this right or claim potentially receive a notice of water unavailability or curtailment order based on the watershed-scale analysis?). These cells have conditional formatting to highlight red if water is unavailable for a given right or claim.</p>	Staff-determined

Curtailments

This tab contains information on the potential curtailment status of all water rights and claims in the Delta watershed. It does not contain any new calculations, it only compiles values from the Analyses tab to determine which rights or claims face water

unavailability over the user-specified time period in the Supply Forecast tab. Information presented for each right or claim includes ownership, location, total demands, and potential curtailment status based on either headwater subwatershed or watershed-scale water unavailability. Rights and claims only face unavailability if there is zero supply available to meet their demands (either based on local supply in the headwater subwatershed-scale analysis or watershed-wide conditions in the watershed-scale analysis). Any rights with multiple PODs are merged into single rows in this tab, including rights and claims in the Legal Delta that are assumed to have access to supplies from both the Sacramento and San Joaquin River watersheds or any other rights or claims with PODs in multiple subwatersheds that are assumed to have access to water from all of them (with the exception of subwatersheds with zero demand, as described in the Analyses section). These rights and claims will only face water unavailability if water is unavailable from all potential water sources (i.e., all subwatersheds where demand is distributed). This tab contains a primary data table and three separate tables of summary information to the far-right.

NOTE: Though this tab contains water unavailability determinations for any user-specified time period entered in the Supply Forecast tab, water unavailability analyses for the purpose of issuing curtailments in the Legal Delta will not be performed on a timestep any shorter than one month.

Field Name(s)	Definition & Methodology	Data Source(s)
Application ID	Application ID of a given water right or claim, sourced from the WR Demand tab.	eWRIMS database
Primary Owner	Name of the primary owner of the water right or claim, sourced from the WR Demand tab.	eWRIMS database
Water Right Type	Water right or claim type, sourced from the WR Demand tab.	eWRIMS database w/ staff adjustments
Priority Date	The priority date of a water right or claim, sourced from the Assumed Priority Date field in the WR Demand tab (YYYY/MM/DD, Riparian, Project, or Pending).	eWRIMS database w/ staff adjustments

Water Unavailability Methodology for the Delta Watershed
 Technical Appendix A
 January 19, 2023

Field Name(s)	Definition & Methodology	Data Source(s)
Watershed	The watershed in which the demand occurs, Sacramento River or San Joaquin River. Sourced from the POD Demand tab; water rights with multiple PODs that fall in both watersheds are denoted as “Both.”	USGS WBD
Subwatershed	Smallest area over which water unavailability is determined, based on one or more HUC8s. Sourced from the POD Demand tab; water rights with PODs in multiple subwatersheds are denoted as “Multiple.”	Staff-determined
Legal Delta?	If demand for that row occurs in the Legal Delta (TRUE/FALSE), sourced from the POD Demand tab; water rights with multiple PODs both within and outside the Legal Delta are denoted as “Partial.”	eWRIMS database w/ staff adjustments
Demand (AF)	Total demands by a given water right or claim for the user-specified time period, Demand Year, and Demand Scenario, sourced from Selected Period Demand values in the POD Demand tab.	eWRIMS database w/ staff adjustments
Demand Met (AF)	Amount of each right or claim’s Demand which can be met by available supply, sourced from the Demand Met in Watershed values in the Analyses tab. NOTE: This column does not compute partially met demands for Riparian-priority claims; these claims will either appear as having all of their demand met (if some supply is available) or having zero demand met (if there is zero total supply available in their respective subwatershed or watershed).	

Water Unavailability Methodology for the Delta Watershed
 Technical Appendix A
 January 19, 2023

Field Name(s)	Definition & Methodology	Data Source(s)
Water Unavailable in Subwatershed?	<p>If the water right or claim is anticipated to face water unavailability due to limited local supplies, as evaluated in the headwater subwatershed-scale analysis (TRUE/FALSE). Sourced from the Water Unavailable in Headwater Subwatershed? values in the Headwater Analysis Results section of the Analyses tab; will only equal TRUE if a given record is located in a headwater subwatershed outside the Legal Delta and there is zero supply available at its priority of right. Riparian claims will only equal TRUE if zero total supply is available in their respective subwatershed. Rights or claims PODs in multiple subwatersheds will only equal TRUE if all are located in a headwater subwatershed outside the Legal Delta and water is unavailable from all potential sources. These cells have conditional formatting to highlight red if water is unavailable for a given right or claim.</p>	Staff-determined

Water Unavailability Methodology for the Delta Watershed
 Technical Appendix A
 January 19, 2023

Field Name(s)	Definition & Methodology	Data Source(s)
Water Unavailable in Watershed?	<p>If the water right or claim is anticipated to face water unavailability due to limited supplies in its respective watershed, as evaluated in the watershed-scale analysis (TRUE/FALSE). Sourced from the Water Unavailable in Watershed? values in the Watershed Analysis Results section of the Analyses tab; will only equal TRUE if there is zero supply available at a given record's priority of right. Riparian claims will only equal TRUE if zero total supply is available in their respective watershed. Rights or claims in the Legal Delta or rights with PODs in multiple subwatersheds will only equal TRUE if water is unavailable from all potential sources. These cells have conditional formatting to highlight red if water is unavailable for a given right or claim.</p>	Staff-determined
Water Unavailable?	<p>If the water right or claim is anticipated to face water unavailability from all potential sources due to insufficient supplies in the headwater subwatershed-scale analysis and/or the watershed-scale analysis (i.e., will this right or claim potentially receive a notice of water unavailability or curtailment order?) (TRUE/FALSE). These cells have conditional formatting to highlight red if water is unavailable for a given right or claim.</p>	Staff-determined

Field Name(s)	Definition & Methodology	Data Source(s)
Curtailment Status	<p>If the water right or claim is curtailed for the user-specified time period. Depending on discretion exercised by the Deputy Director for Water Rights in the issuance of curtailments, this value may be based on the Water Unavailable in Headwater Subwatershed?, Water Unavailable in Watershed?, or Water Unavailable? values (TRUE = Curtailed, FALSE = Not Curtailed) and may be based on additional criteria.</p> <p>Certain types of water rights may have a more specific status:</p> <ul style="list-style-type: none"> - Pending Statements are marked as “Not Authorized to Divert” at all times. - Cannabis Registration rights are marked as “Not Authorized to Divert” if the user-specified time period (based on the Start Date in the Supply Forecast tab) is during the dry season forbearance period of April 1-October 31. <p>These cells have conditional formatting to highlight red if a given water right or claim is Curtailed or highlight orange if it is Unauthorized to Divert.</p>	Staff-determined

The Curtailment Details table to the right summarizes several aspects of curtailment details in each subwatershed. The Priority Date of First Curtailment columns display the priority date of the first right or claim to which water is unavailable in either the headwater subwatershed-scale analysis (see Headwater Analysis Results section) or the watershed-scale analysis (see Watershed Analysis Results section) for each subwatershed and the Legal Delta. These cells will display “-“ if there is no water unavailability in a given subwatershed, “Project if one or more Project water rights (assumed to be the most junior in the Delta watershed) are subject to water unavailability, or “Riparian” if there is zero total supply available in either analysis. In some cases, these cells may display the priority of a right that has no water available in that subwatershed but is not curtailed because it diverts from additional subwatershed(s) or is located in the Legal Delta; these rights are only curtailed if water is unavailable from all sources (see Curtailments section). The Demand Unmet columns display the total unmet demand within each subwatershed (as well as the

Legal Delta and the watershed as a whole for the watershed-scale analysis), while the Excess Supply columns quantify the amount of supply remaining after water unavailability has been evaluated for all rights and claims (i.e., the bottom row of Supply Cumulative values in the Analyses tab). If water is unavailable to some rights or claims in a subwatershed, its Demand Unmet would be nonzero and its Excess Supply would be zero. Excess Supply in the headwater-scale analysis may meet demands further downstream in the watershed, so these values are not equal between analyses.

The Project COA Rights Check table summarizes the Project rights subject to the Coordinated Operations Agreement (COA), their demands, and if water is unavailable to each of them in the watershed-scale analysis. In recognition of the provisions of the COA that identify how to distribute available supplies and responsibilities for meeting Delta requirements, curtailments of Project will not be implemented unless water is found to be unavailable for all Project rights. The top row of this table indicates if all Project rights subject to the COA have water unavailable in the watershed-scale analysis (TRUE/FALSE); if the value is FALSE, none of the listed Project rights will be curtailed. These cells have conditional formatting to **highlight red** if water is unavailable to a given Project right.

The Curtailment Details Simplified table is a concise version of the Curtailment Details table for discussion purposes, with the first curtailment values displayed as years only. The Headwater and Watershed Priority Year of First Curtailment fields incorporate the data in the Project COA Rights Check table, so “Project” will only be shown if all Project rights covered by the COA have water unavailable; the only exception to this is in the Stanislaus River headwater analysis, where New Melones rights covered by the COA may still face water unavailability due to limited local supply. The Effective Priority Date of First Curtailment column represents the more senior of these curtailment years between the headwater subwatershed and watershed-scale analyses. This table also summarizes the total number of curtailed rights and the Total Demand of those rights in each subwatershed, the Legal Delta, and the Delta watershed as a whole.