Sites Reservoir Daily Divertible & Storable Flow Tool

1. Objective

The Daily Divertible & Storable Flow Tool (Divertible Flow Tool/Daily Modeling Tool) has been developed to evaluate and test diversion criteria in a real-time operations context. The Divertible Flow Tool determines daily divertible and storable flow for the Project during October 1st, 2008 – May 31st, 2018 based on water availability and user specified conveyance constraints and diversion criteria. The spreadsheet generates time series of diverted and stored flow at two intake locations – Red Bluff and Hamilton City. The Daily Divertible & Storable Flow Tool was originally developed when bypasses at the Delevan intake location were considered as part of the Project; this is no longer the case. Therefore, at the Delevan intake location diversions are defaulted to zero. Furthermore, the Divertible Flow Tool can be used to supplement CalSim II by:

- Representing the effects of operations criteria on a daily timestep
- Allowing for relative comparisons between monthly and daily approaches
- Providing results for more recent years (water years [WY] 2009 – 2018)

Several differences between CalSim II and the daily Divertible Flow Tool should be considered when both models are used in conjunction to evaluate Project operations. First, CalSim II yields results on a monthly timestep and the Divertible Flow Tool operates on a daily timestep. Different approaches are sometimes necessary to simulate monthly conditions as opposed to daily conditions, and implementing operation criteria on a daily timestep tends to be more conservative. Additionally, the two modeling tools include different simulation periods. CalSim II includes WY 1922 – 2003 while the Divertible Flow Tool includes WY 2009 – 2018. Table 1-1 shows the difference in proportion of Water Year Types (WYTs) for each modeling tool. As shown, the Divertible Flow Tool includes a drier period than does CalSim II.

Table 1-1. Proportion of Water Year Types in CalSim II and the Daily Divertible Flow Tool

WYT	CalSim II (1922-2003)	Divertible Flow Tool (2009-2018)
Wet	32%	20%
Above Normal	15%	0%
Below Normal	17%	40%
Dry	22%	20%
Critical	15%	20%

WYT = water year type.

Another key difference is that CalSim II provides a continuous simulation over an 82-year period, while the Divertible Flow Tool simulates each year as a separate event. Furthermore, the daily modeling tool only provides estimated fill volumes, whereas CalSim II also includes release operations.

With the above considerations in mind, the daily Divertible Flow Tool serves as a valuable resource that can supplement CalSim II by evaluating Project operations in real-time.

2. Available, Divertible, and Storable Flow

The Divertible Flow Tool uses outputs from the Flow Availability Tool, which estimates flow available for potential diversion to Sites Reservoir, subject to hydrology and regulations outside the scope of Project operations (i.e., Delta outflow standards, downstream water quality regulations, and other criteria from D-1641). The Divertible Flow Tool can then be used to evaluate various combinations of hydrology and Project-related operations criteria. Divertible and storable flow are defined as follows:

- Divertible Flow = Flow available for potential diversion to Sites Reservoir subject to flow requirements and conveyance constraints associated with Project.

- Storable Flow = "Divertible flow" subject to storable capacity.

3. User Specifications and Input Assumptions

Figure 3-1 shows a snapshot of the Divertible Flow Tool's dashboard, where users can specify various regulations and constraints corresponding to Project operations. The table situated in the top-center displays monthly available, divertible, and storable flows associated with user specifications. The charts show daily hydrographs for the Sacramento River and the divertible and storable flow available at each intake.

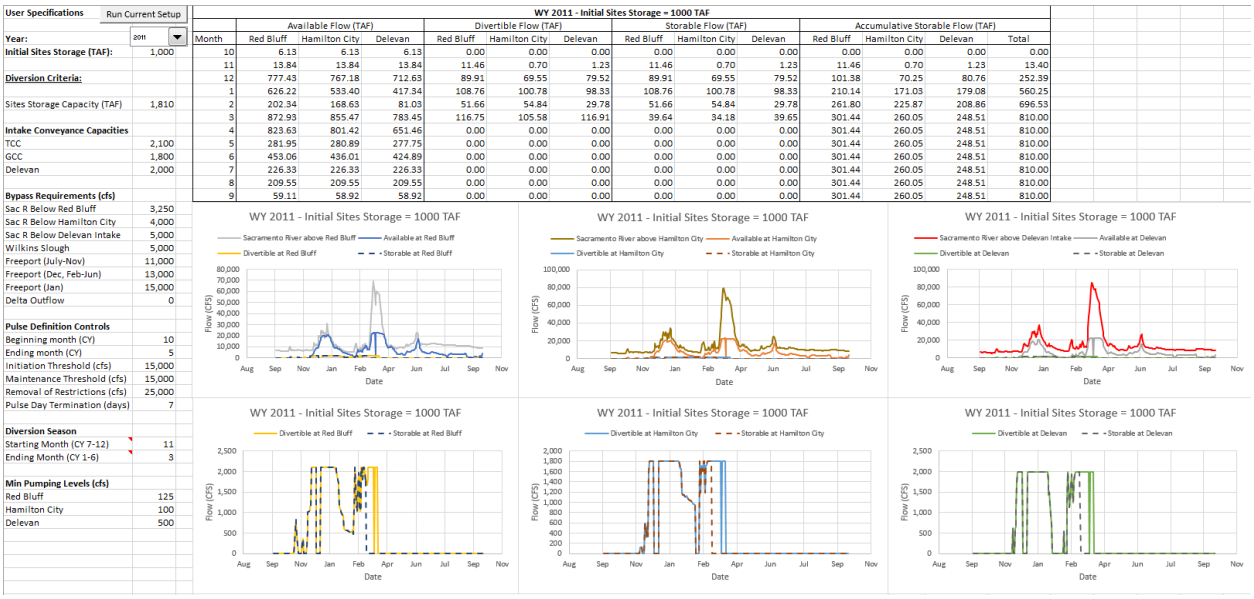

Figure 3-1. Snapshot of the Divertible Flow Tool's User Dashboard.

The dashboard gives users the ability to specify the following:

- Year (hydrology) (WY 2009 – 2018)

- Initial Sites Storage (end of September storage)

- Climate Conditions (Historic or 2035CT)

- Sites Storage Capacity (TAF)
- Intake Conveyance Capacity (cfs)
    - Red Bluff (TCC)
    - Hamilton City (GCC)
    - Delevan
- Bypass Flow Requirements (cfs)
    - Sacramento River at Red Bluff
    - Sacramento River at Hamilton City
    - Sacramento River at Delevan
    - Sacramento River at Wilkins Slough
    - Sacramento River at Freeport
- Pulse Flow Criteria at Bend Bridge
    - Initiation Flow Threshold
    - Maintenance Flow Threshold
    - Pulse Duration Limit
- Delta Outflow Criteria
- Fremont Weir Notch (on/off switch)
- Weir Spill Protection
    - Fremont Weir Spills
    - Aggregate Weir Spills to Sutter Bypass (from Moulton Weir, Colusa Weir, & Tisdale Weir)
- Minimum Pumping Level (cfs)
    - Red Bluff (TCC)
    - Hamilton City (GCC)
    - Delevan
- Low Level Pumping (diversion rate at each intake when Sacramento River flow at a certain location is less than its associated bypass flow requirement) (cfs)
    - Wilkins Slough Bypass override
    - Freeport override

    - Bend Bridge pulse protection override
- Intake Prioritization
- Diversion Season (range of months)
- Intake Season (specify when diversions are permitted at each intake) (range of months)
- Surplus Outflow (February – March)

3.1 Year (Hydrology)

Users can toggle through 10 different Water Years (WYs) – 2009 through 2018. However, WY 2018 only includes information up to May 31st. Each year provides a different hydrologic condition. The water year hydrologic classifications associated with each year are provided in Table 3-1. Each year is associated with flow availabilities that were estimated in the Flow Availability Tool.

Table 3-1. Water Year Hydrologic Classification Index

Water Year	Water Year Type
2009	D
2010	BN
2011	W
2012	BN
2013	D
2014	C
2015	C
2016	BN
2017	W
2018	BN

Source: California Data Exchange Center. 2019. T WRWSIHIST 2104121329/ Department of Water Resources, California Cooperative Snow Surveys. Chronological Reconstructed Sacramento and San Joaquin Valley, Water Year Hydrologic Classification Indices. Available: https://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST.

BN = Below Normal; C = Critically Dry; D = Dry; W = Wet

3.2 Initial Sites Storage (End of September)

Initial Sites storage has potential to affect the quantity of flow that is stored in the reservoir. Through a range of initial Sites storages, users can evaluate the duration for the reservoir to reach capacity, which occurs when storable flow no longer equals divertible flow. In drier years, storage capacity may never be reached even when initial storage is set relatively high. The default initial storage is 60 TAF.

3.3 Hydrologic Climate Conditions

Flow inputs to the Divertible Flow Tool can be adjusted for historic conditions or 2035CT conditions using the climate switch in Cell B5 of the User_Specifications sheet. The flow inputs effected by climate change can be found in the "Divertible_Flows_Calcs" sheet.

3.4 Sites Storage Capacity

The default Sites storage capacity is 1.5 MAF. However, users can enter any desired value.

3.5 Intake Capacity

The default intake capacities of the TC Canal (Red Bluff intake), GCID Main Canal (Hamilton City intake) are 2,100 cfs and 1,800 cfs, respectively. However, users can enter any desired value.

3.6 Bypass Flow Requirements

A bypass flow requirement can be specified along the Sacramento River at five locations:

1. Red Bluff (default = 3,250 cfs)
2. Hamilton City (default = 4,000 cfs)
3. Delevan (default = none)
4. Wilkins Slough (default = 8,000 cfs in April – May)
5. Freeport (default = none)

Furthermore, users can specify a range of months at which the Wilkins Slough and Freeport bypass requirements are implemented (by entering the starting month in column C and entering the ending month in column D). Freeport includes four different cells at which bypass criteria can be entered. The first cell ("B22") dictates bypass criteria over a user-specified range of months. The next three cells ("B23:B25") dictate bypass criteria that persist under the primary Freeport bypass criteria for various times of the year.

3.7 Pulse Flow Criteria at Bend Bridge

The pulse flow criteria at Bend Bridge was developed to protect fish migration during naturally occurring, storm-induced, pulse flow events in the Sacramento River. Pulse flows are defined as extended peak river flows at Bend Bridge that originate from storm event tributary inflows downstream of Keswick Dam. A pulse is initiated once the three-day running average flow at Bend Bridge exceeds the "Initiation Threshold". The pulse persists as long as the three-day running average flow at Bend Bridge remains above the "Maintenance Threshold". If the three-day running average flow at Bend Bridge exceeds the "Removal of Restrictions Threshold", then Sites diversions are permitted if flow at Bend Bridge remains above the Maintenance Threshold. The "Reset Threshold" represents the value at which the 3-day moving average flow at Bend Bridge must not exceed for a given number of days before another pulse protected event can be triggered. The "Pulse Protection Duration" can be used to set the number of

consecutive days that a pulse period can last before the protection criteria is removed. For example, if the Pulse Duration Limit is set to 7 days, then diversions to Sites are permitted after flow at Bend Bridge exceeds the pulse flow threshold for over 7 consecutive days. The Bend Bridge pulse protection criteria can be further modified in the "BB_Pulse_Definitions" tab. The current set of criteria assumes the following:

1. Season:
    a. Pulse protection can be initiated in October through May
2. Initiation:
    a. 3-day moving average Sacramento River flow at Bend Bridge must exceed 8,000 cfs,
    b. And the 3-day moving average tributary flow upstream of Bend Bridge (Cow Creek, Cottonwood Creek, and Battle Creek) must exceed 2,500 cfs
3. Duration:
    a. Pulse protection lasts for 7 days upon initiation
4. Re-setting condition:
    a. After completion of a pulse protection period, the following conditions must occur before another pulse event is triggered:
        i. 3-day moving average of Bend Bridge flow was less than 7,500 cfs for 7 consecutive days,
        ii. 3-day moving average tributary flow upstream of Bend Bridge (Cow Creek, Cottonwood Creek, and Battle Creek) was less than 2,500 cfs for 7 consecutive days

3.8 Delta Outflow Criteria

The Divertible Flow Tool includes a few options to constrain Sites diversion based on Delta outflow requirements. "Delta Outflow (SWP ITP)" is intended to represent the 44,500 cfs flow requirement included in the 2020 SWP Incidental Take Permit. "Delta Outflow (Additional)" is intended for any supplemental Delta outflow constraints.

Users can also turn on or off NDOI criteria, which implements Delta outflow targets for a specified period (default of March 1st through May 31st) based on WaterFix longfin smelt protection criteria (Incidental Take Permit No 2081-2016-055-03, WaterFix, CDFW, page 186). Outflow targets are determined based on a table derived from a linear relationship between the 50% exceedance forecast for the current month's Eight River Index (8RI) and recent historic Delta outflow (1980 – 2016). These tables have been stored in the "Ref. Tables" tab. The NDOI criteria is set off by default.

3.9 Fremont Weir Notch Spill Protection

The Fremont Weir Notch and its associated flow protection criteria can be turned on or off in the Divertible Flow Tool. Spills over the Fremont Weir Notch are based on a rule curve used in CalSim II. Furthermore, the Sites diversion criteria protects spills of up to 6,000 cfs from November 1st through March 15th. Figure 3-2 and Figure 3-3 demonstrate the effect of the Fremont Weir notch and its associated protection criteria on spills and diversions to Sites in an example scenario for WY 2010. The notch protection criteria cause a reduction in diversions to Sites, most notably in February when nearly all diversions are restricted because notch spills range from 0 – 6,000 cfs for most of the month.

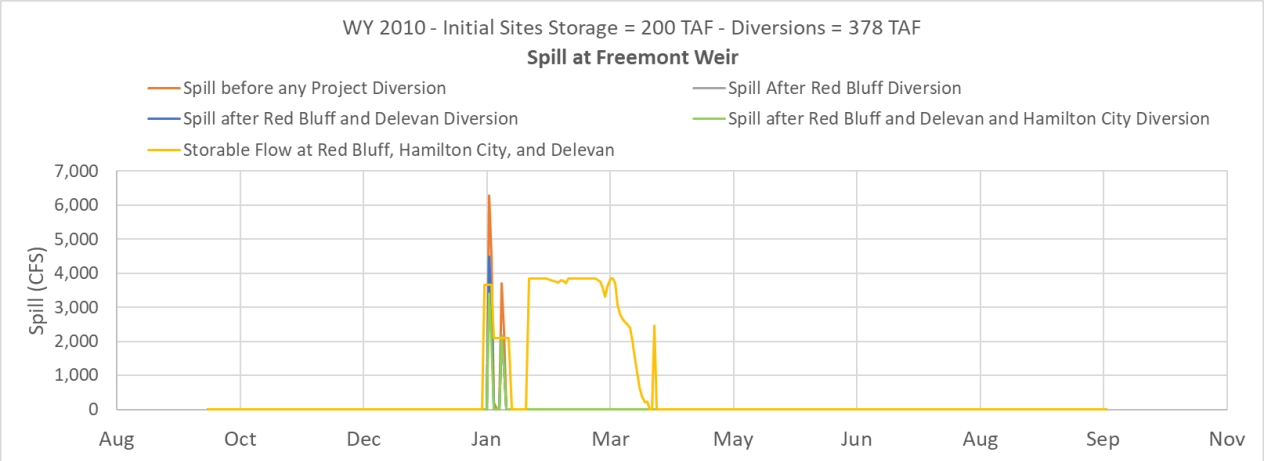

Figure 3-2. Spill at Fremont Weir vs Storable Flow – Without the Fremont Weir Notch.

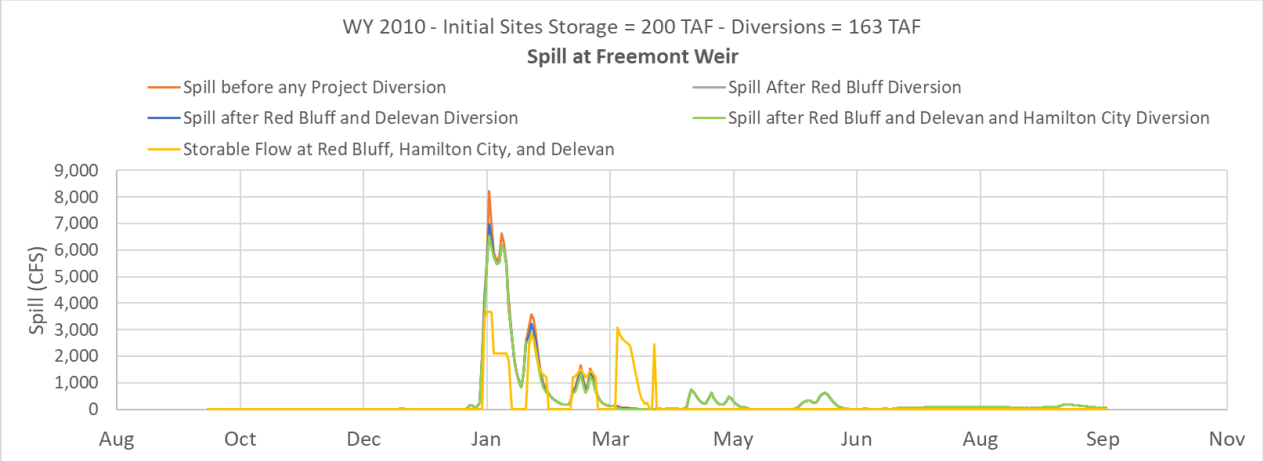

Figure 3-3. Spill at Fremont Weir vs Storable Flow – With the Fremont Weir Notch (and Associated Protection Criteria).

In the daily modeling tool, users may specify buffer values for Fremont Weir Notch protection. Two buffer values may be specified – one for spills between 0 and 600 cfs (low-spill buffer), and one for spills between 600 and 6,000 cfs (high-spill buffer). The buffer values are entered as percentages of flow above certain thresholds that may be diverted to Sites. For example, consider a case where the user enters a low-spill buffer of 1% and a high-spill buffer of 10%. The following would take effect:

- November 1 – March 15
    - When spills range between 0 – 600 cfs, 1% of the spill may be impacted for Sites diversion
    - When spills range between 600 – 6,000 cfs, 10% of the of the spill may be impacted for Sites diversion

3.10 Protection of Aggregate Weir Spills to the Sutter Bypass

The Tool provides users the ability to implement protection of spills into the Sutter Bypass via Colusa Weir, Moulton Weir, and Tisdale Weir. Users can specify the upper bound of the total spill range that must

be protected, a buffer on the specified spill range, and the percent of spill that can be diverted to Sites in the specified spill range. Aggregate Sutter Bypass weir spill protection is set off by default.

3.11 Minimum Pumping Level

Each intake is assigned a minimum level of flow that can be diverted into Sites Reservoir. If flow availability is below an intake's minimum pumping level, then the intake will not be utilized. The smallest pumps at Red Bluff and Hamilton City have capacities of 125 cfs and 100 cfs, respectively.

3.12 Low Level Pumping

Users can specify low level pumping rates when Sacramento River flow at a certain location is less than its associated bypass flow requirement and above the user specified "low level pumping initiation flow". For example, if the low level pumping rate at Red Bluff is set to 300 cfs, the initiation flow rate at Wilkins Slough is 5,000 cfs, the bypass flow rate at Wilkins Slough is 10,000 cfs, and the actual flow rate at Wilkins Slough is 8,000 cfs, then the Red Bluff intake can divert up to 300 cfs from the river. Low level pumping rates can be used to override three bypass flow criteria: Bend Bridge pulse protection, Wilkins Slough bypass flows, and Freeport bypass flows. Low level pumping is set off by default.

3.13 Intake Prioritization

Intake prioritization is not modifiable in this version of the Divertible & Storable Flow Tool. The current setup prioritizes diversions at Red Bluff and then at Hamilton City (by default, Delevan is not used in version 2022-06-02).

3.14 Diversion Season

A diversion window can be defined to constrain the months in which the Divertible Flow Tool will attempt to allocate water into Sites Reservoir. Users can enter a starting month (from July through December) and ending month (from January through June). The default diversion season is November through May. Diversions to Sites would not be expected in June through October, as this is the period coincides with the season of Sites deliveries.

3.15 Intake Season

The Intake Season refers to the months in which diversions are permitted at each intake. For example, if the Red Bluff starting month is set to 1 and its ending month is set to 6, then diversion through the Red Bluff intake can only be made from January through June. By default, the Red Bluff and Hamilton City intakes are only limited by the diversion season (default = November through May), while the intake season for Delevan is turned off.

3.16 Freeport Pulse and Post Pulse Protective Criteria

Pulse & Post-Pulse criteria based on the 2016 CWF ITP have been integrated into the Daily Divertible Flow Tool. These criteria are set off by default. If specified by users, Sites intakes can be operated within a range of pulse protection and post-pulse protection levels (1 through 3) in place when winter run chinook salmon (CHNWR) and spring run chinook salmon (CHNSR) migration is occurring. The post-pulse protection operations are defined in Sub Table A of the CWF ITP. In the daily modeling tool, two interpretations of the criteria for transition among pulse-protection levels are included:

- Fish presence (Knights Landing Catch Index (KLCI)) (CWF ITP)
- Sacramento River flow at Freemont (CalSim II based logic)

Table 3-2 identifies the assumptions implemented in the CWF ITP (criteria based on fish presence) and the assumptions implemented in CalSim II.

Table 3-2. Pulse and Post-Pulse Assumptions of CWF ITP vs CalSim II.

Pulse and Post-Pulse Assumptions	
CWF ITP	**CalSim II**
• **All pulses** of CHNWR and CHNSR shall be protected from October 1 – June 30.	• **One or two pulses** shall be protected from October 1 – June 30 (depending on whether a pulse ends before December 1).
• Beginning October 1st, whenever the initial pulse begins, low level pumping takes effect.	• Beginning October 1st, whenever the initial Sacramento River pulse begins, low level pumping takes effect.
• A Sacramento River pulse is determined based on real-time monitoring of juvenile fish movement (see Condition of Approval 9.9.5.1). A fish pulse is defined as a **Knights Landing Catch Index (KLCI) ≥ 5** where KLCI = (# of CHNWR + # of CHNSR)/(Total Hours Fished/24). • Pulse protection operations shall be implemented within 24 hours of detection of a fish pulse.	• The initiation of the pulse is defined by the following criteria: (1) **Wilkins Slough flow changing by more than 45% within a five day period** and (2) **Wilkins Slough flow becomes greater than 12,000 cfs**.
• Pulse protection ends after **five consecutive days of daily KLCI < 5**.	• The pulse protection and the low level pumping continues until (1) **Wilkins Slough returns to pre-pulse flows** (flow on first day of the within-5 day increase), (2) **Wilkins Slough flows decrease for five consecutive days**, or (3) **Wilkins Slough flows are greater than 20,000 cfs for 10 consecutive days**.
• Number of allowable pulses is not specified; ASSUME ALL ELIGIBLE PULSES (KLCI ≥ 5) ARE PROTECTED.	• Number of allowable pulses in unlimited; ASSUME ALL ELIGIBLE PULSES ARE PROTECTED.
• Once the pulse protection ends, **post-pulse bypass flow operations may remain at Level 1 diversion depending on fish presence, abundance, and movement in the north Delta**; however, the exact levels will be determined through initial operating studies evaluating the level of protection provided at various levels of diversions.	• After a pulse has ended, the allowable diversion will go to post-pulse operations through June that can transition through three levels of protection.
• The criteria for transitioning between and among pulse-protection, **Level 1, Level 2, and/or Level 3 operations are based on real-time fish monitoring** and hydrologic/ behavioral cues upstream of and in the Delta that will be studied as part of the Project's Adaptive Management Program. Based on the outcome of the studies	• After the initial pulse(s), **Level I post-pulse bypass rules are applied until 15 days of bypass flows above 20,000 cfs have accrued since the pulse ended**. Then **Level II post-pulse bypass rules are applied until 30 days of bypass flows above 20,000 cfs have accrued** since the

Pulse and Post-Pulse Assumptions	
CWF ITP	**CalSim II**
pursued under that program, additional information about appropriate triggers, off-ramps, and other RTO management of NDD intake operations may be integrated into the Test Period Operations Plan and the Full Project Operations Plan.	pulse ended. Then Level III post-pulse bypass rules are applied.
• **The NDDTT shall develop criteria for transitioning between and among pulse protection, Levels 1, 2 and 3 based on best available science**. The NDDTT shall recommend transitional criteria to the TOT and IICG for consideration through the Adaptive Management Program, to ensure that the Project will achieve the objectives of Biological Criteria 1 and 2.	• Under the post-pulse operations allowable diversion will be greater of the low-level pumping or the diversion allowed by the following post-pulse bypass flow rules.

Note: cfs = cubic feet per second; CHNSR = spring run Chinook salmon; CHNWR = winter run Chinook salmon; IICG = Interagency Implementation and Coordination Group; NDD = North Delta Diversions; NDDTT = North Delta Diversions Technical Team; RTO = Real Time Operations; TOT = Technical Oversight Team.

Bold and highlighted text identifies differences between CWF ITP and CalSim II assumptions.

Taken from the "Pulse_Post-Pulse_Figs" tab of the daily modeling tool, Figure 3-4 and Figure 3-5 demonstrate the difference in pulse and post-pulse protection levels under the two interpretations. In Figure 3-4, the purple dots represent the KCLI for winter run and spring run Chinook salmon. Whenever the KCLI exceeds 4, pulse protection operations are initiated, as represented by the red shading. In the daily modeling tool, users may specify KCLI thresholds to determine pulse and post-pulse conditions. In this example, post-pulse Levels 1 and Level 2 have KCLI thresholds of 3 and 1, respectively. Thus, if the KCLI for a given day is between 3 and 5, Level 1 is implemented. If the KCLI is between 1 and 3, Level 2 is implemented. Finally, if the KCLI is 0, Level 3 operations take effect.

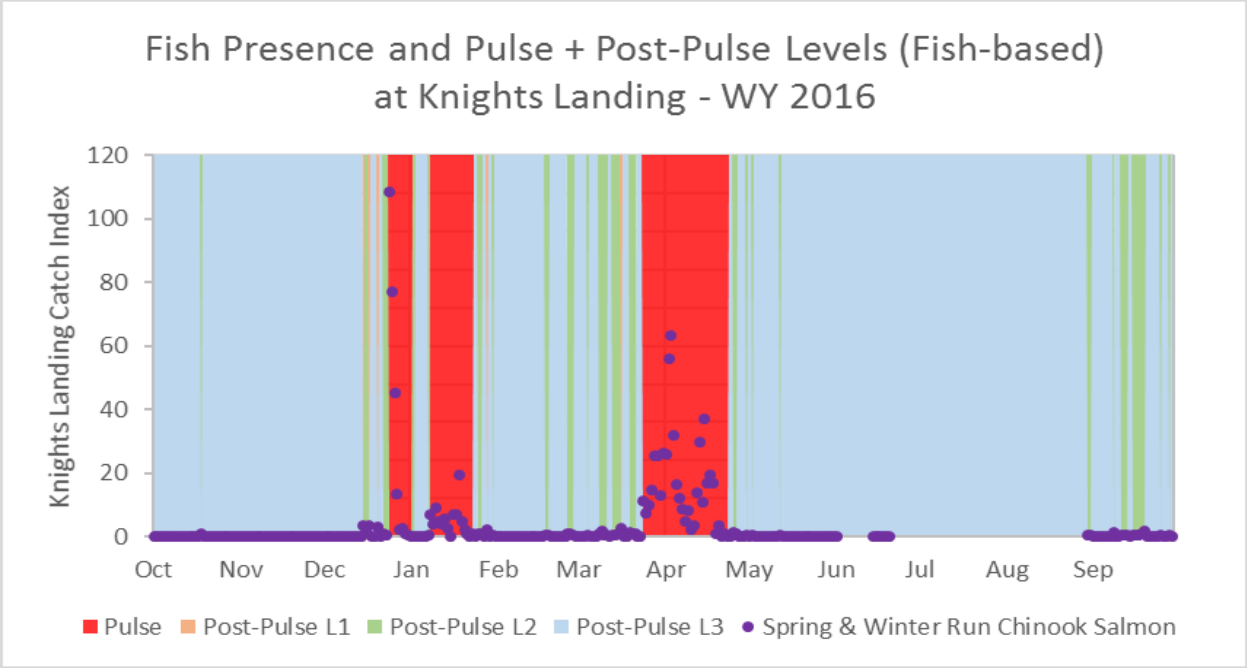

Figure 3-4. Fish-Based Pulse and Post-Pulse Protection Levels in WY 2016.

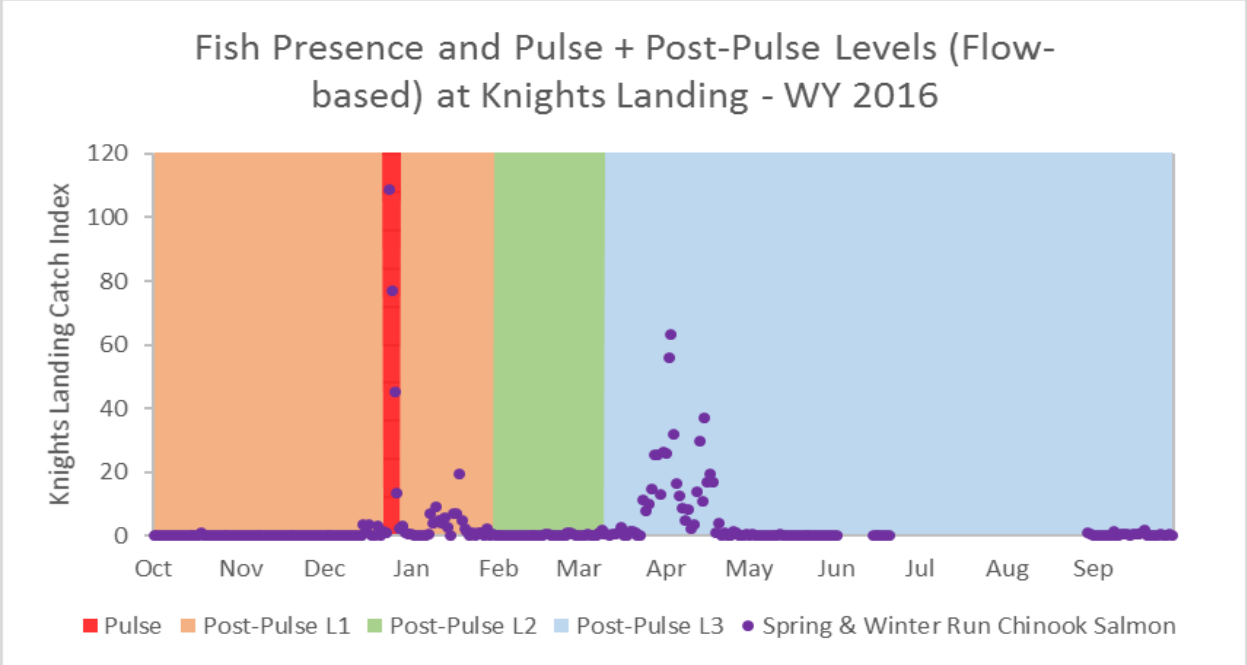

Figure 3-5. Flow-Based (CalSim II) Pulse and Post-Pulse Protection Levels in WY 2016.

In the daily modeling tool, users may specify starting and ending months of the pulse and post-pulse protection periods (i.e., the October through June period defined in the CWF ITP may be modified).

3.17 Surplus Outflow (February–March)

This criterion provides a margin of safety to prevent shifting the regulatory burden of X2 onto SWP or CVP operations. It is only applied to February and March. Diversions are only permitted after a specified number of days that flow is available in February through March (default = 7 days).

3.18 Additional Protective Criteria

The “Table1” and “ProtectiveCrit” tabs include additional protective criteria to limit Project diversions under user-specified flow conditions and time periods. The table in “Table1” can be used to implement a set of rules to limit diversion at each intake to a certain percentage of total Sacramento River flow, based on local conditions. Inputs to this table can be specified in the “Protective Criteria & Ramp Down Specs” section of the “User_Specifications” tab.

The tables in “ProtectiveCrit” perform similar functions; however, diversions are instead limited to a proportion of total intake conveyance capacity.

The additional protective criteria are set off by default and are only activated if Cell B91 in the “User_Specifications” tab is set to “Yes”.

4. Results

The Divertible Flow Tool evaluates various combinations of hydrographs, diversion regulations, and initial storage conditions. For example, users can manipulate pulse flow protection criteria, minimum pumping levels, or intake diversion seasons to generate different divertible and storable flow results under a range of hydrologic conditions. Consequently, the tool may be useful in evaluating the effects of varying operations criteria on diversions to Sites Reservoir.

4.1 Sacramento River Flow, Delta Outflow, and X2

Monthly available, divertible, and storable flow results for a given water year are displayed in the table and figures of the “User_Specifications” tab. The table also includes accumulated storage, representing the total amount of water diverted into Sites throughout the year.

The “Hydrographs” tab includes figures that show Sacramento River flows before and after Project diversions at the following locations:

- Red Bluff
- Hamilton City
- Delevan
- Wilkins Slough
- Knights Landing
- Spill at Fremont Weir
- Freeport

The “Hydrographs” tab also includes the figures demonstrating the effect of Sites diversions on Delta outflow and X2 position. Figure 4-1 through Figure 4-9 demonstrate example charts from the “Hydrographs” tab.

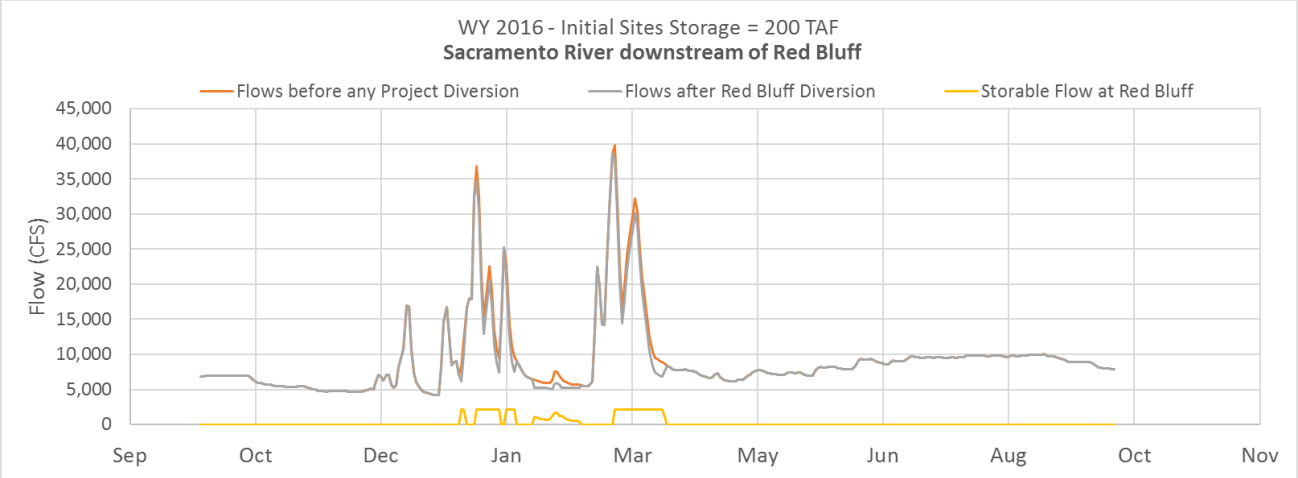

Figure 4-1. Sites Storable Flow Effect on Sacramento River Flow at Red Bluff – WY 2016.

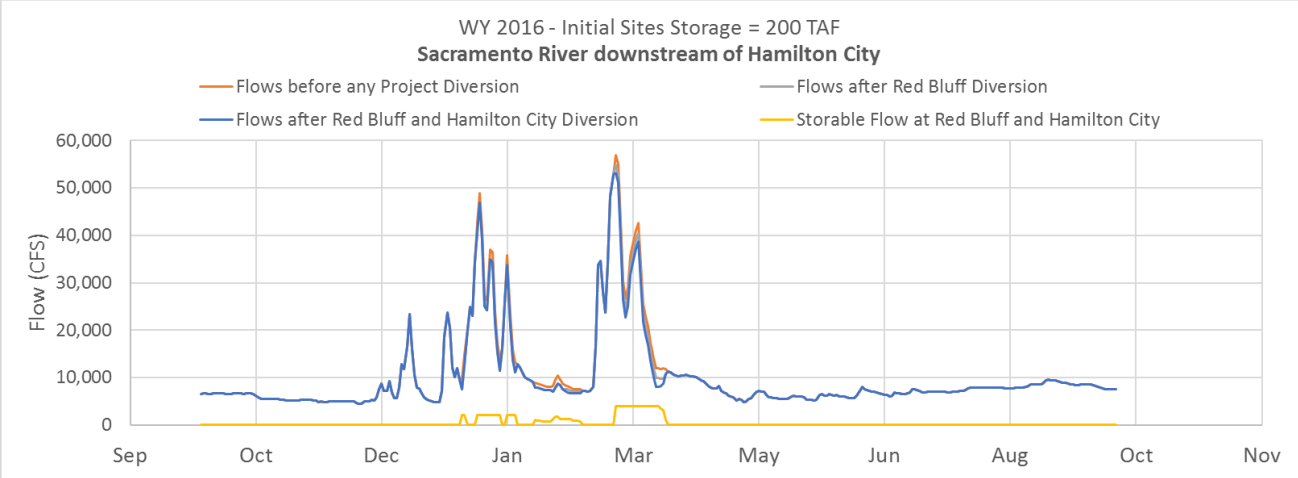

Figure 4-2. Sites Storable Flow Effect on Sacramento River Flow at Hamilton City – WY 2016.

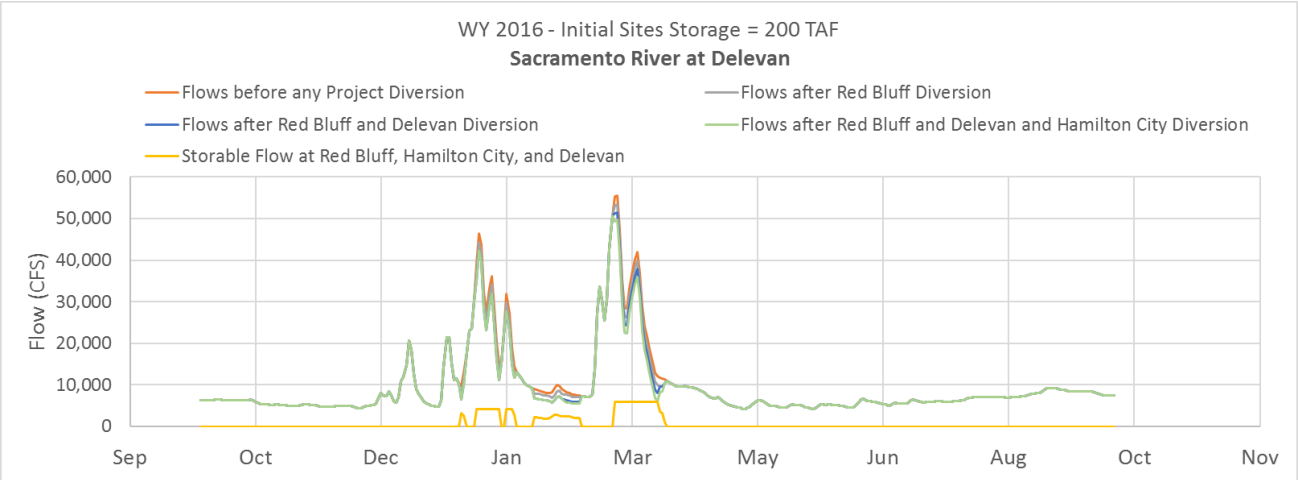

Figure 4-3. Sites Storable Flow Effect on Sacramento River Flow at Delevan – WY 2016.

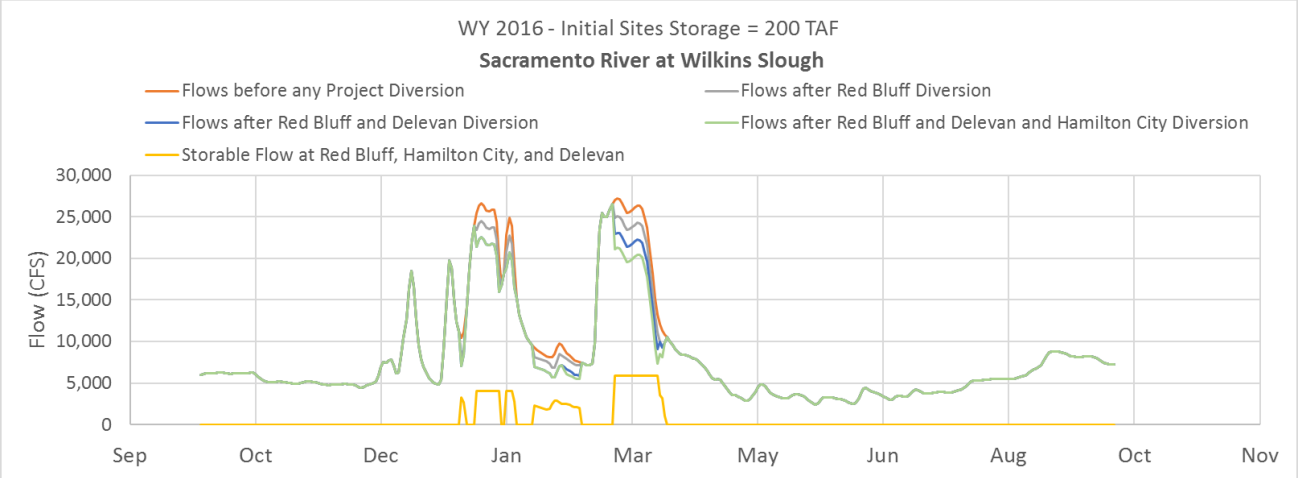

Figure 4-4. Sites Storable Flow Effect on Sacramento River Flow at Wilkins Slough – WY 2016.

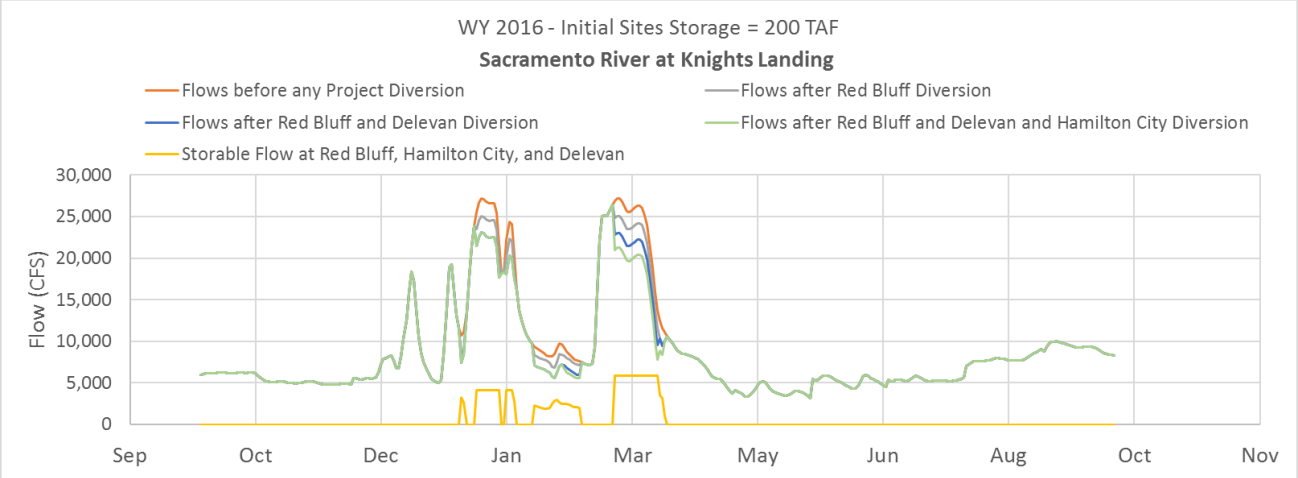

Figure 4-5. Sites Storable Flow Effect on Sacramento River Flow at Knights Landing – WY 2016.

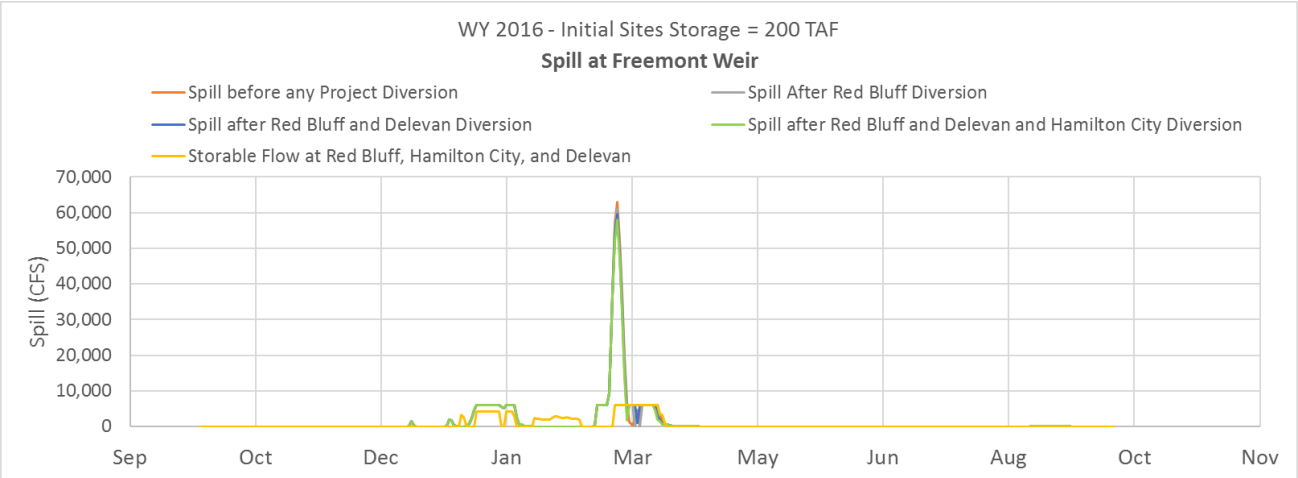

Figure 4-6. Sites Storable Flow Effect on Fremont Weir Spills – WY 2016.

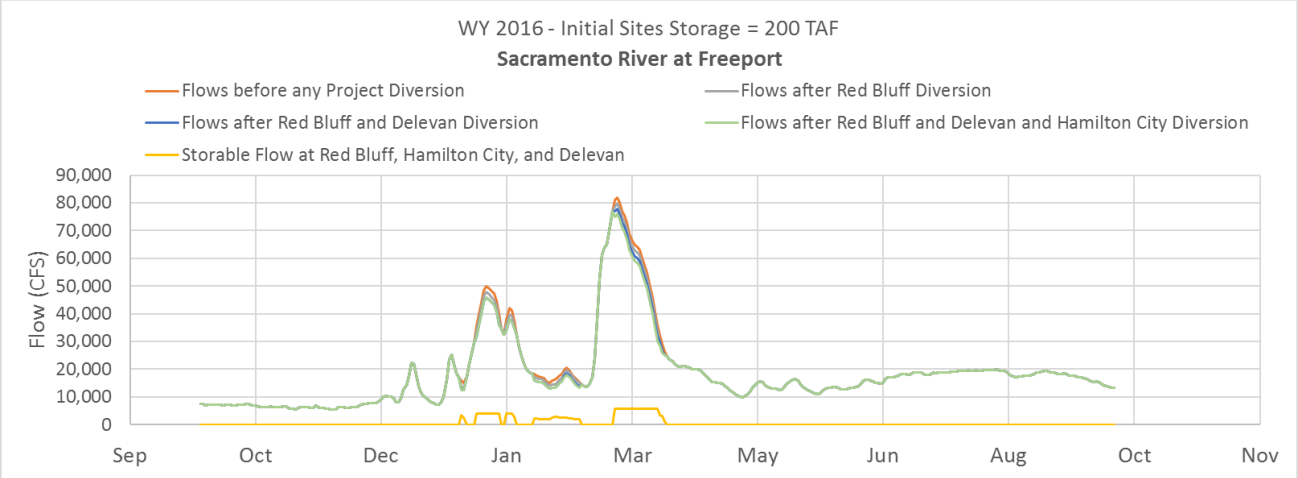

Figure 4-7. Sites Storable Flow Effect on Sacramento River Flow at Freeport – WY 2016.

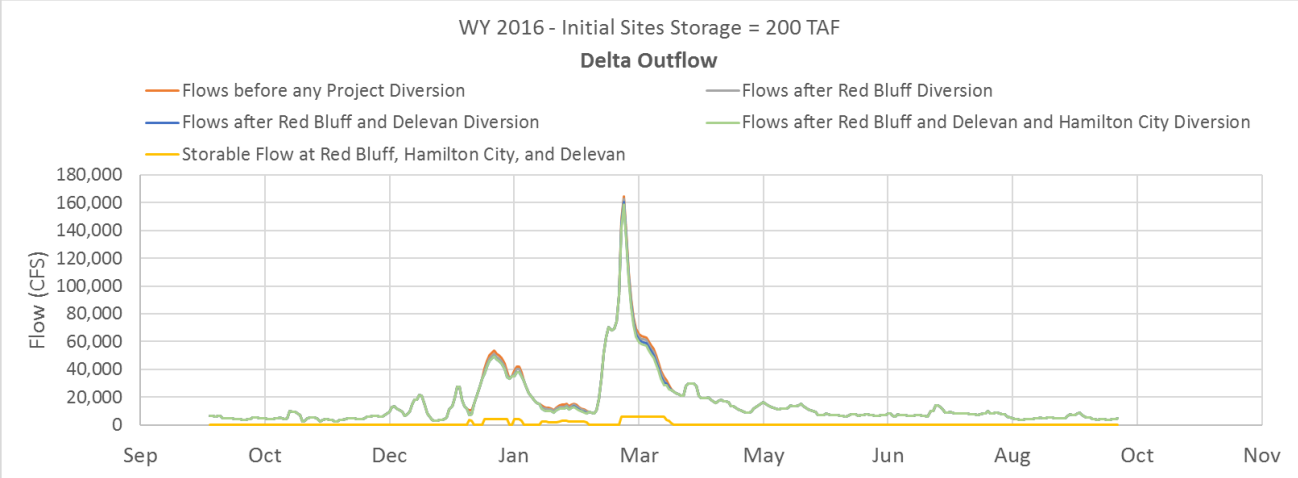

Figure 4-8. Sites Storable Flow Effect on Delta Outflow – WY 2016.

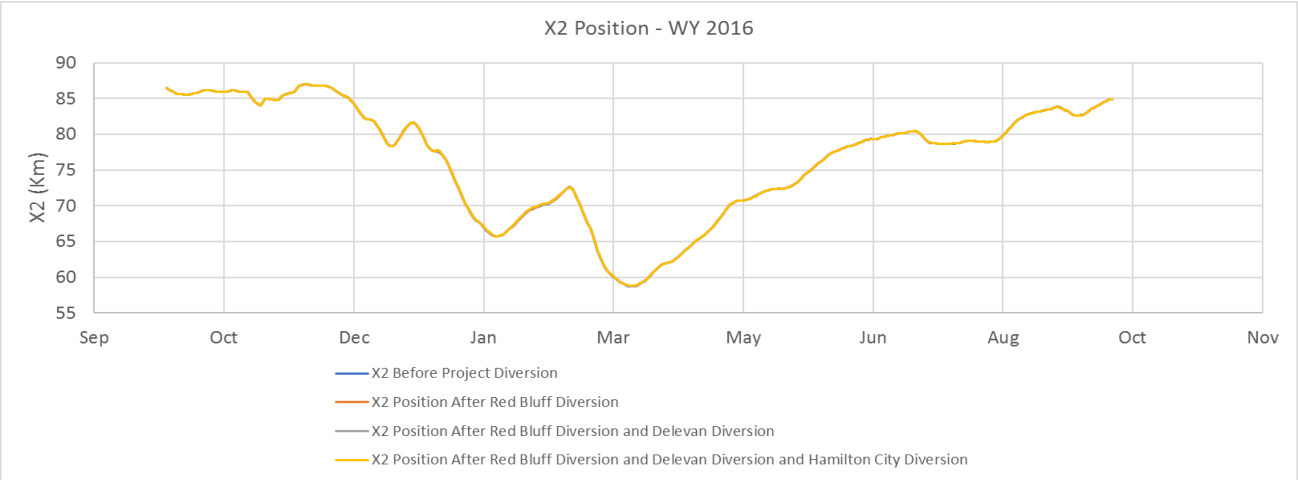

Figure 4-9. Sites Storable Flow Effect on X2 – WY 2016.

4.2 Fish Presence

Sacramento River fish data has been collected and integrated into the Divertible Flow Tool at the following locations:

- **Red Bluff Dam** (October 1st 2008 – May 31st 2018)
    - Source: Red Bluff Fish & Wildlife Office, USFWS (collated into a spreadsheet by LeAnne Rojas, 4/15/2019, using data from: http://www.cbr.washington.edu/sacramento/data/query_redbluff_daily.html)
- **Hamilton City** (March 2nd 2013 – May 31st 2018)
    - Source: GCID (collated into a spreadsheet by LeAnne Rojas on 4/16/2019, based on data provided by GCID (Josef Loera) via John Spranza (HDR) on 4/1/2019)
- **Tisdale** (July 7th 2010 – May 31st 2018)
    - Source: CDFW (collated into a spreadsheet by LeAnne Rojas on 4/18/2019, from data provided by Diane Coulon (DFW) on 4/11/2019)
- **Knights Landing** (October 1st 2008 – May 31st 2018)
    - Source: CDFW (collated into a spreadsheet by LeAnne Rojas based on workbooks provided by Jason Julienne (DFW) on 4/24/2019)

The relationship between flows and fish presence can be evaluated in several tabs towards the back of the spreadsheet. The “Fish_Count_OneYr” tab include figures of Sacramento River flow and storable flow vs fish count at the four locations listed above. Figure 4-10 demonstrates an example figure from this tab. At Red Bluff, the term “fish count” is defined as the estimated daily number of fish passage through the Sacramento River at Red Bluff. At Hamilton City, Tisdale, and Knights Landing, “fish count” is defined as the estimated daily number of fish caught in rotary screw traps at each location.

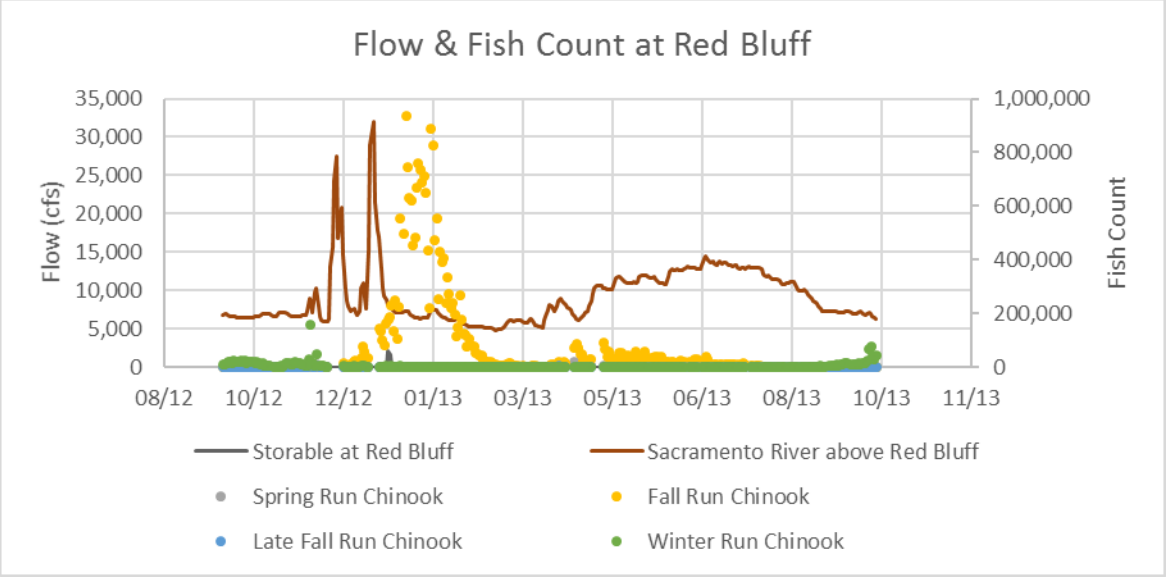

Figure 4-10. Sacramento River Flow vs Fish Presence at Red Bluff in WY 2013.

4.3 Controlling Constraints

The “Controls” tab includes tables displaying the number of instances each constraint controls the quantity of storable flow in each month of the selected year. A controlling constraint is defined as the primary limiter of storable flow to Sites Reservoir. For example, if no flow is available for the project because the river is in “Balanced Conditions”, then the controlling constraint is identified as “Balance” in the Divertible Flow Tool. A table of controls has been developed for each intake location (Red Bluff, Hamilton City, and Delevan) in the “Controls” tab. Additionally, daily time series of controlling constraints can be viewed in columns “BG:BH” of the “Divertible_Flow_OneYr” tab.

4.4 Annual Simulations

On the “User_Specification” tab, users can generate results for all 10 years (WY 2009 – 2018) by clicking on the “Run Current Setup” button at the top of the page. This button will simulate available flow, divertible flow, and storable flow for each year under current user specifications. Furthermore, the initial Sites storage will be reset at the start of each year. Daily inputs and outputs will be copied into the “ScenID_Main” tab, monthly results are populated in the “Monthly_Report” tab, and annual inputs and outputs are populated in the “Ann_Fills” tab.

The Excel spreadsheet includes several macros to iterate through multiple combinations of years and input conditions (user-specified constraints). Before running one of these macros using the “Run Full Simulation Period” button on the “User_Specifications” tab, the macros should be updated to accommodate for whatever analysis is desired. The daily, monthly, and annual results will be copied into the “ScenID_Main” tab, “Monthly_Report” tab, and “Ann_fills” tab. Each 10-year period will be assigned a Scenario ID number corresponding to a particular set of inputs.

5. Limitations

5.1 Exclusion of Release Operations, Evaporation, and Losses

The Divertible Flow Tool does not include full operations of Sites Project. Fill volumes are estimated each year without the consideration of Sites Reservoir releases. The storage level is only dependent on the user-specified initial storage condition and diversions to the reservoir. Evaporation and losses are not explicitly considered. In addition, the storage level is re-set to the user-defined initial storage condition at the beginning of each year.

5.2 Simulation Period

The Divertible Flow Tool is limited to 10/1/2008 – 5/31/2018, a period that is quite dry relative to the years simulated by CalSim II (WY 1922 – 2002). The Divertible Flow Tool lacks Above Normal years, as determined by DWR’s Water Year Hydrologic Classification Indices. Extending the Divertible Flow Tool’s simulation period would allow it to provide more insight on the daily effects of Sites Project and its corresponding operations criteria by including greater hydrologic variability.

5.3 2035CT Climate Adjustment

The 2035CT flow inputs were calculated using scaling ratios between historic and 2035CT average monthly flows from recorded and simulated data. Operational conditions, such as reservoir releases, are not explicitly modified in the adjustment from historic to 2035CT conditions. Flow availability inputs (from the Flow Availability Tool) are not adjusted when users select 2035CT climate conditions. Sacramento River flow at Freeport is also not updated with the 2035CT adjustment.