MBK ENGINEERS
Water Resources ◆ Flood Control ◆ Water Rights

TECHNICAL MEMORANDUM

DATE: June 16, 2023

TO: Sites Project Authority

PREPARED BY: Wesley Walker, P.E., and Angela Bezzone, P.E., MBK Engineers

SUBJECT: Sites Diversions and the Voluntary Agreements

Introduction and Key Take-Aways

On January 5, 2023, State Water Resources Control Board (State Water Board) staff released their Draft Scientific Basis Report Supplement in Support of Proposed Voluntary Agreements for the Sacramento River, Delta, and Tributaries (SBRS)[1]. The SBRS includes modeling of the proposed Voluntary Agreements (VA), including the changes in Delta outflow under the proposed agreements. As the SBRS was released the day prior to when the Sites Project Authority (Authority) supplemental water right application materials were due, on January 6, it was not possible for the Authority to complete a quantitative analysis of the Sites Reservoir Project (Project) and the VAs in the Authority's submittal. Nevertheless, the Authority's January 6, 2023, submittal addressed the VAs qualitatively, reasoning that the Sites Project, "will not reduce or otherwise modify proposed VA additive flows because the additive flows are accounted for within existing water right demands used to calculate water available for the Sites Project and the results of the calculations show water is available for the Sites Project."

Through discussions with State Water Board staff, the Authority understands that State Water Board staff requested that the Authority prepare a quantitative analysis regarding the following:

1. How the Sites Project diversions may interact with the VA flow assets.
2. How the Sites Project may affect Delta outflow under the VAs.

As described in the Authority's letter to the State Water Board, dated April 27, 2023, the Authority has developed two quantitative analyses to answer each of these requests. The analyses presented in this Technical Memorandum evaluate the potential interaction of Sites diversions and VA flow assets, as well as the net change in Delta outflow resulting from Sites Project operations and VA flow assets. Each analysis provides information to enhance understanding of the potential changes in Delta outflow with Sites Project operations and VA flow assets. Each method is also subject to limitations.

These two different analyses, the Daily Comparison and the Monthly Comparison (as detailed below), inform the following key take-aways as explained further in the Conclusions section at the end of this memorandum:

[1] https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/docs/2023/202301-bd-draft-sbrsupp.pdf

- Potential Sites diversions and VA flow assets have limited interaction, as diversions to Sites Reservoir will occur during periods when flows are available above regulatory requirements, Project-specific requirements, and senior water right demands, while VA flow assets are proposed to be deployed during times when additional flow is expected to be most beneficial to the system. Most of Sites' diversions occur during December through March of Wet and Above Normal years. VA flow assets, as currently modeled, are utilized during March through May of Above Normal, Below Normal, and Dry years.
- Most instances of overlap between potential Sites diversions and VA flow assets occur in the spring months of Wet and Above Normal years. However, in these years, potential Sites diversions typically occur during periods with relatively high Delta outflow. In drier years, overlap between potential Sites diversions and VA flow assets is minimal, as potential Sites diversions typically occur during individual storm events in the winter months, outside of the primary period that VA flow assets are anticipated to be utilized under the Default Plan (explained below).
- The Sites Project would result in a limited reduction in Delta outflow, which would primarily occur in the winter months and largely in Wet and Above Normal years. On a water year basis, the Sites Project and the VA with LSJR result in essentially no change in Delta outflow in Wet years, with increases of approximately 3% in Above Normal years, 6% in Below Normal years, 9% in Dry years, and 4% in Critical years.

Daily Comparison Using the Sites Historical Analysis

A daily, historical analysis (Daily Comparison) was performed by combining the Sites Historical Water Availability Analysis (WAA) Tool and changes in Delta outflow under the VAs from the post-processed CalSim 3 results, which are the basis of the SBRS. The following sections describe these tools and analyses.

Historical WAA Tool

The Historical WAA Tool[2] was developed as part of the Sites Project water right application for the purpose of demonstrating a reasonable likelihood of water available for appropriation during the proposed diversion season of the Sites Project, from September 1 through June 14. The Historical WAA Tool is used to identify when Sites could divert based on Project-specific diversion criteria including a Wilkins Slough Minimum Bypass Flow Requirement; Bend Bridge Pulse Protection Criteria; and Delta conditions. These criteria are described in further detail in the Sites Amended Water Availability Analysis (Amended WAA), dated January 6, 2023. During periods when historical flows and Delta conditions meet the bypass requirements, potential Sites diversions are assumed to be the minimum of water available or the maximum combined diversion rate[3] requested in the water right application at the two

[2] See Appendix A of the Amended Water Availability Analysis for Sites Reservoir Water Right Application, dated January 6, 2023.
[3] Combined maximum diversion rate of 4,200 cubic feet per second (cfs) as listed in the Sites water right application; 2,200 cfs at the Tehama Colusa Canal POD; and 2,000 cfs at the Glenn-Colusa Irrigation District Main Canal POD.

Sacramento River diversion facilities: the Tehama-Colusa Canal point of diversion (POD) and the Glenn-Colusa Irrigation District Main Canal POD.

The Historical WAA Tool is not an operations model for the Sites Project and does not simulate diversions into Sites Reservoir as part of overall Project operations. The Historical WAA Tool identifies periods when diversions into Sites Reservoir would have been possible over the historical period of analysis. The calculation of potential Sites diversions in the Historical WAA Tool does not limit potential Sites diversions based on available reservoir capacity, reservoir operations, or other diversion facility constraints (i.e., hydraulic limitations, available canal capacity, and/or operational decisions). Accordingly, the volume and frequency of these potential Sites diversions can be considered to be the maximum possible diversions over the period of analysis (January 2000 – September 2021). For the above reasons, Sites diversions as estimated by the Historical WAA Tool, are referred to as "potential" Sites diversions. By including the simplifying assumptions itemized below for this analysis, the potential Sites diversions can be used to estimate the daily change in Delta outflow due to potential Sites diversions.

- For this analysis, face value water right demands are not included in the availability and diversion calculations produced by the Historical WAA Tool, which allows for a greater volume and frequency of potential diversions. Therefore, the maximum, potential effects to historical Delta outflow (DO) from Sites diversions are able to be estimated.
- A 1:1 reduction in Delta outflow from Sites' diversions is assumed, which:
    - Does not account for travel time from Sites' POD(s) to the Delta, and
    - Does not account for potential attenuation of flows between Sites' POD(s) and the Delta.
- Calculated Delta outflow from DAYFLOW[4] is used as the daily historical Delta outflow.

As the analysis only accounts for potential diversions by Sites, releases made from Sites Reservoir that increase Delta outflow both directly (environmental flow account releases) or indirectly (due to carriage water requirements) are not included. Furthermore, the Daily Comparison does not show the effect of Sites Reservoir operations, or other incidental effects from changed Central Valley Project (CVP) or State Water Project (SWP) operations, on Delta outflow. Therefore, the Daily Comparison provides a conservative analysis which shows larger changes in Delta outflow than are likely to occur when accounting for all Project operations. For these reasons, the Monthly Comparison (presented later in this document) provides a better representation of the overall effect of Sites Reservoir operations on Delta outflow.

SBRS Delta Outflow with VAs

The maximum, daily periods when Sites diversions could occur were combined with modeling results and analysis from the SBRS that represent the potential changes in Delta outflow that are expected to

[4] https://water.ca.gov/Programs/Integrated-Science-and-Engineering/Compliance-Monitoring-And-Assessment/Dayflow-Data

occur under the VAs. VA flow assets are proposed to occur during times when additional flow is expected to be most beneficial to the system. There are no daily estimates of the change in Delta outflow under the VAs; however, monthly estimates are available from CalSim 3 model results that reflect the monthly simulation of VA flow assets identified in rows 1 through 9 of SBRS Table 4-1. State Water Board staff post-processed these CalSim 3 results to create two separate scenarios which include additional VA flow assets. These VA scenarios: "VA without lower San Joaquin"[5] and "VA with lower San Joaquin"[6], are presented in Chapter 4 of the SBRS. Results presented in Chapter 4 of the SBRS assumed that the VA flow assets in rows 10 through 12 of SBRS Table 4-1 would occur during the seasonal periods identified in SBRS Table 4-11, but did not explicitly identify which months, nor in what volumes within each month, these flows assets would occur. For the purpose of the Daily Comparison, it is assumed that the VA flow assets in rows 10 through 12 of SBRS Table 4-1 are equally split between the months of April and May, and occur in the volumes identified by each water year type[7]. The monthly change in Delta outflow under the VA scenarios was then calculated on an average monthly basis according to Sacramento Valley water year type. This was achieved by taking the difference between the CalSim 3 Baseline, and the VA without lower San Joaquin and the VA with lower San Joaquin. The monthly volumes produced by this analysis are assumed to be equally distributed on a daily basis in the month they are simulated or assumed to occur. The monthly increases in Delta outflow are assumed to represent the presence of VA flow assets in Delta outflow.

The representation of VA flow assets in the CalSim 3 modeling and SBRS post-processing is approximate. The governance, objectives, and decision-making process to utilize VA flow assets are currently under development. The modeling and assumptions prepared by State Water Board staff for the SBRS represent the latest approximation of VA flow assets for a "Default Plan" flow schedule and the resulting changes in Delta outflow. The actual deployment of VA flow assets in the future will be done through the Governance Committee, based on real-time conditions, data, and objectives for what the VA flow assets are intended to achieve.

Daily Comparison Results

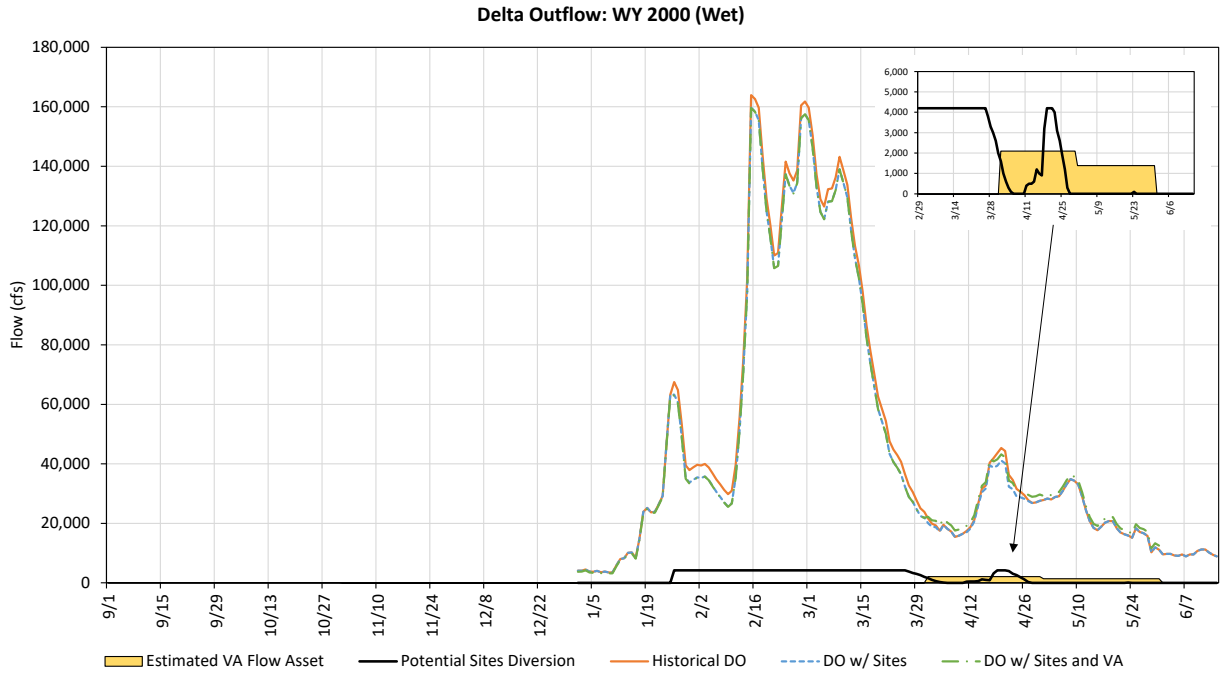
The Historical WAA Tool provides Delta outflows, and the maximum potential change, resulting from Sites diversions on a daily timestep. This daily information is combined with approximate average monthly changes by water year type for the VAs. The Daily Comparison results presented in the following figures provide more granular information that aids in understanding Delta outflow conditions during potential Sites diversions, as compared to what can be inferred from average monthly flows; average monthly flows by water year type; or seasonal volumes (subsequent tables). Diversions to Sites Reservoir occur during times of high flow when water available for the Sites Project exceeds regulatory requirements, Project-specific requirements, and senior water right demands. The figures show that while most potential Sites diversions are expected to occur in the winter of wetter years, there can be periods of high flows across all years and months of the diversion season proposed for the Sites Project (September 1 through June 14). Additionally, the Historical WAA Tool provides results for a 22-year

[5] CalSim 3 VA scenario post-processed with flow assets in rows 10 and 11 from SBRS Table 4-1.
[6] CalSim 3 VA scenario post-processed with flow assets in rows 10 – 12 from SBRS Table 4-1.
[7] The Lower San Joaquin River placeholder volumes (row 12, SBRS Table 4-1) were mapped from San Joaquin Valley water year types to Sacramento Valley water year types in the same manner as performed in the SBRS.

period of the recent past – January 2000 through September 2021. The analysis takes this recent period of observed Delta outflow, which reflects actual conditions, and layers on the effects of both potential Sites diversions and estimated changes in Delta outflow from the VAs. For these reasons, but subject to the aforementioned limitations, the Daily Comparison provides the most useful information regarding how potential Sites diversions may interact with the VAs flow assets (Question 1[8]).

Figure 1 through Figure 22 illustrate periods of potential Sites diversions and VA flow assets for each year of the analysis included in the Sites Historical WAA Tool. Each figure includes the historical Delta outflow; potential Sites diversions from the Historical WAA Tool; the change in Delta outflow under the CalSim 3 VA with lower San Joaquin River (LSJR)[9]; historical Delta outflow minus potential Sites diversions; and historical Delta outflow, minus potential Sites diversions, plus the change in Delta outflow under the CalSim 3 VA with LSJR. As previously noted, the average monthly change to Delta outflow from the VA with LSJR was converted to equal daily flow rates for each month. The change in Delta outflow under the VA with LSJR shown for each year is based on the average monthly volume by water year type, using the May 1 Sacramento Valley water year type applied to each calendar year (e.g., the Water Year 2012 figure shows changes in Delta outflow for a Wet year [2011] from September through December, and a Below Normal year [2012] for January through June). The May 1 water year type can vary from the final water year type, but was used as a representation of the potential VA flow assets in that year.

A short commentary is included for each year with observations regarding potential Sites diversions, historical Delta outflows, and VA flow assets. Please note that the magnitude of the y-axis changes each year relative to the magnitude of flows that occurred.



[8] From the Introduction section of this technical memorandum.
[9] Estimated VA Flow Asset

Figure 1. Water Year 2000: Potential Sites Diversions, VA Flows, and Delta Outflow

Water Year 2000 was a Wet year based on the May 1 forecast, though the final water year type was an Above Normal year. The majority of potential Sites diversions occurred from late-January through March, outside of modeled VA actions and largely during periods when Delta outflow was greater than 100,000 cfs. A shorter period of potential Sites diversions occurred in the latter half of April, primarily when Delta outflow was greater than approximately 40,000 cfs. This period overlapped with VA flows under the Default Plan flow schedule. Although most of the VA flow assets in Wet years are modeled to occur in April, the adaptive range allows for a portion of flows to be spread over any period from March through June. Based on current proposals and assumptions, VA flow assets in Wet years are small in comparison to VA flow assets in other water year types.

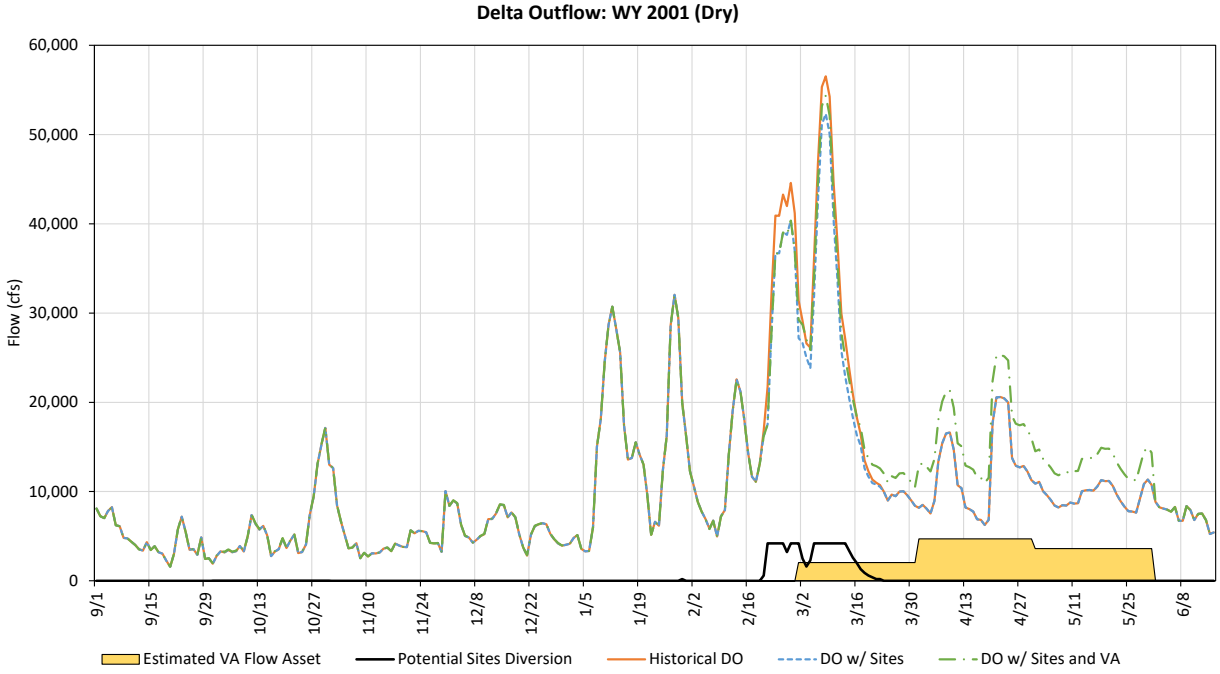


Figure 2. Water Year 2001: Potential Sites Diversions, VA Flows, and Delta Outflow

Water year 2001 was a Dry year, with limited opportunities for potential Sites diversions outside of late-February through early-March when Delta outflow typically exceeded 30,000 cfs. The modeled VA flows overlap with potential Sites diversions in the first part of March when Delta outflow ranged from approximately 20,000 to 50,000 cfs.

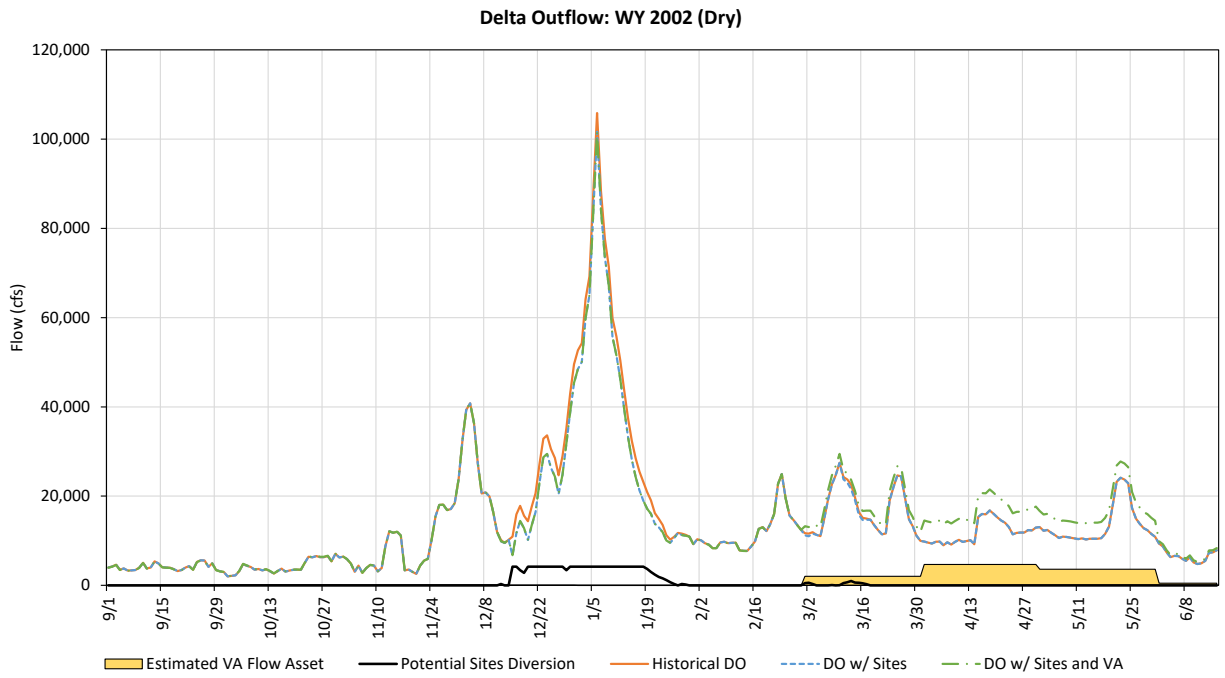


Figure 3. Water Year 2002: Potential Sites Diversions, VA Flows, and Delta Outflow

Water year 2002 was again a Dry year. Potential Sites diversions occurred in December and January when Delta outflow typically exceeded 20,000 cfs and peaked at approximately 100,000 cfs. The Historical WAA Tool indicates potential diversions for a short period of time at less than capacity in early March – the same time VA flows may have been present.

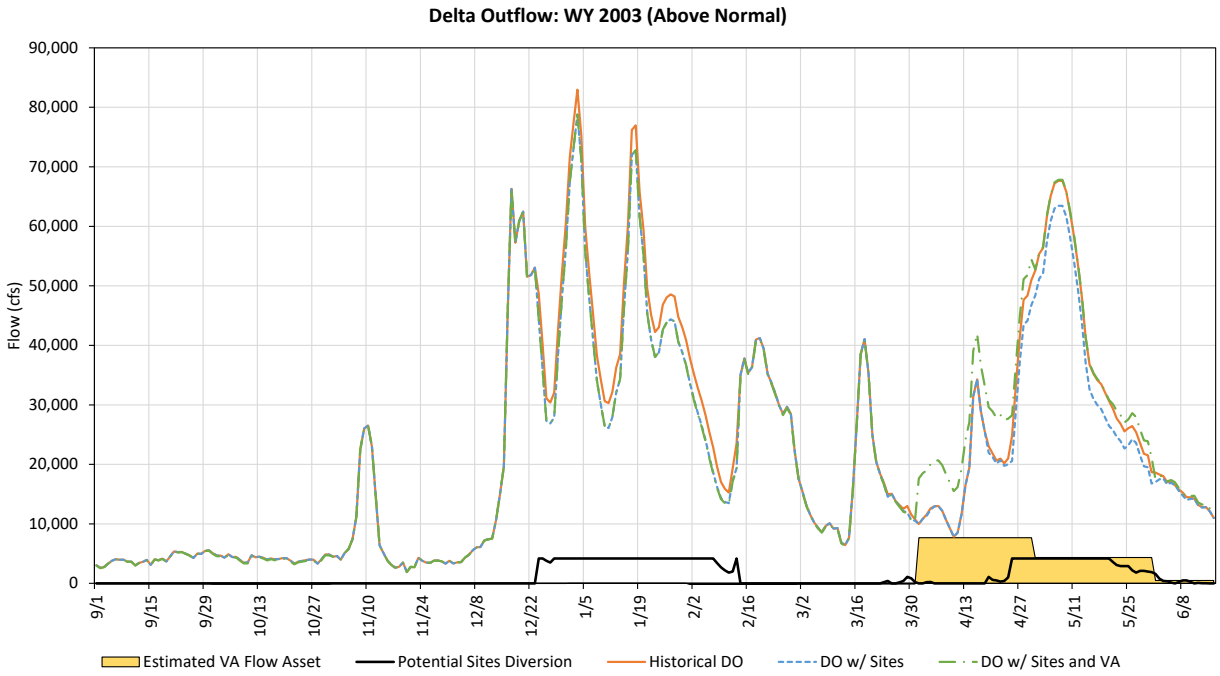


Figure 4. Water Year 2003: Potential Sites Diversions, VA Flows, and Delta Outflow

Water year 2003 was an Above Normal year, with Delta outflow ranging from approximately 30,000 to 80,000 cfs from mid-December through mid-February, and approximately 20,000 to above 60,000 cfs from late-April through May. The majority of potential Sites diversions would occur during these two periods, with the latter period overlapping modeled VA flow assets.

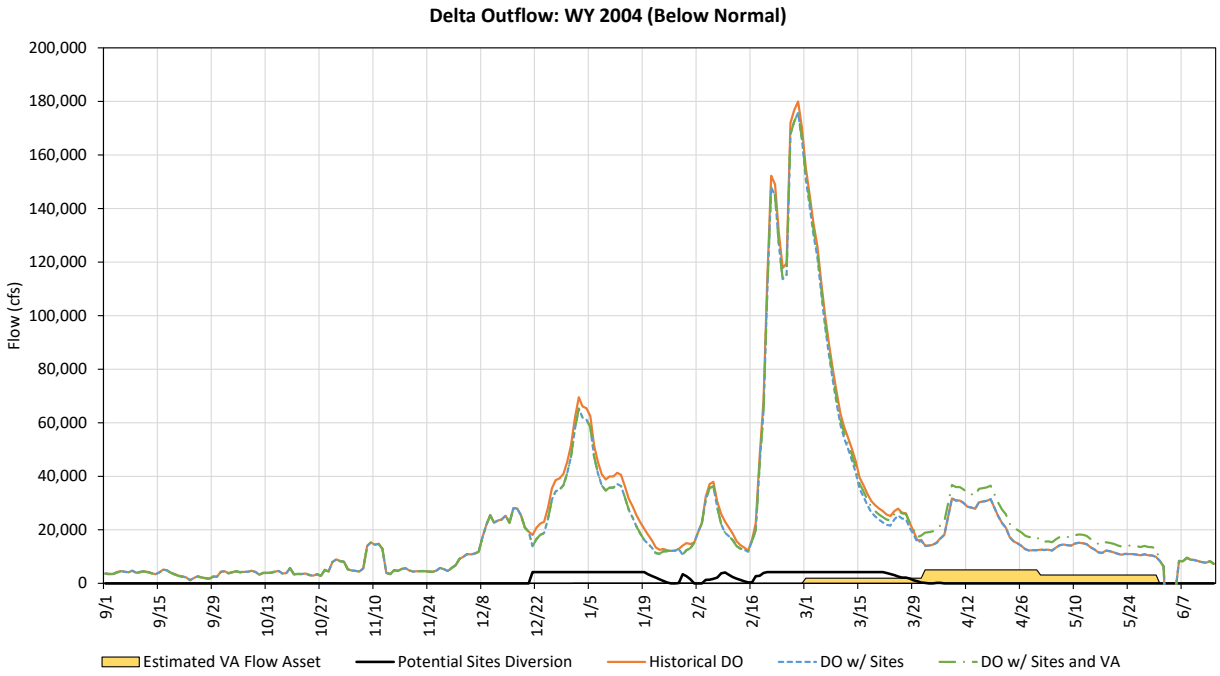


Figure 5. Water Year 2004: Potential Sites Diversions, VA Flows, and Delta Outflow

Water year 2004 was a Below Normal year, although conditions were generally wet enough to allow for potential Sites diversions for extended periods when Delta outflow frequently, but not always, exceeded 20,000 cfs. Potential overlap between Sites diversions and VA flow assets could have occurred during a period in March when Delta outflow exceeded 20,000 cfs and at times exceeded 100,000 cfs. Most VA flows in Below Normal years have flexibility to occur between March and May. Please note, Delta outflow of zero shown in June is due to the levee failure and flooding of Jones Tract.

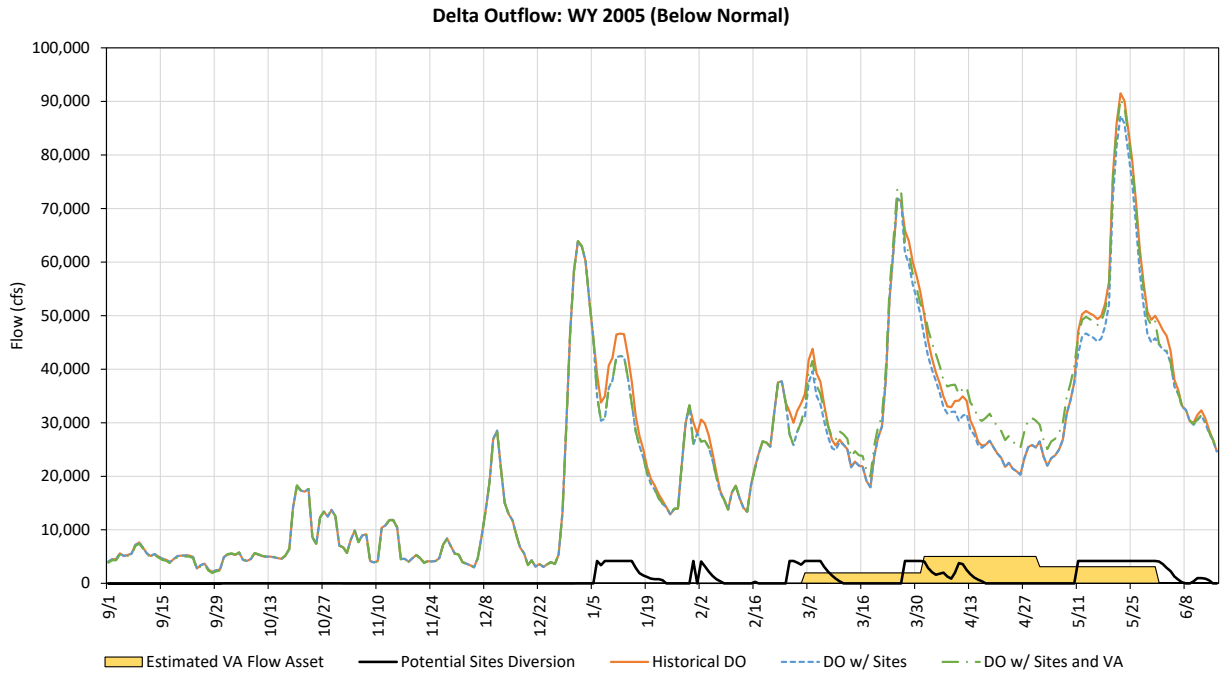


Figure 6. Water Year 2005: Potential Sites Diversions, VA Flows, and Delta Outflow

Water year 2005 was a Below Normal year based on the May 1 forecast (the final water year type was Above Normal) and would have allowed for five periods of potential Sites diversions. The latter three periods of potential Sites diversions would have overlapped with VA flow assets. During each of these periods Delta outflow exceeded at least 20,000 cfs, and often exceeded 40,000 cfs.

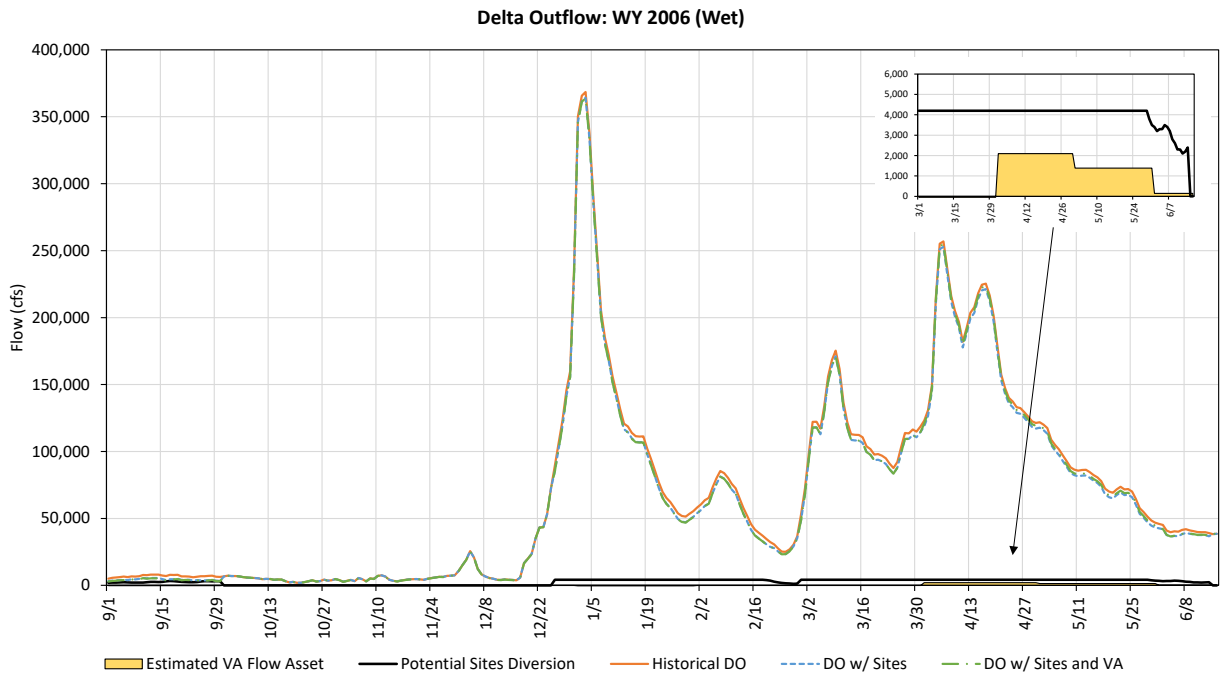


Figure 7. Water Year 2006: Potential Sites Diversions, VA Flows, and Delta Outflow

Water year 2006 was a Wet year, with the potential for nearly uninterrupted[10] Sites diversions from late-December through early-June. VA flow contributions to Delta outflow in Wet years are assumed to occur in April and May. Although potential Sites diversions and VA flows overlap during these months, daily Delta outflow exceeded 100,000 cfs in April and at least 45,000 cfs in May. Additionally, the potential diversion volume calculated by the Historical WAA Tool under this scenario exceeded 1.5 MAF – the capacity of Sites Reservoir and maximum annual diversion volume requested in the water right application. This volume illustrates how the potential Sites diversions in this analysis represent a maximum potential, and not actual operations. Under these circumstances, it would only be possible to divert up-to the reservoir capacity, and only possible to divert 1.5 MAF if the reservoir were empty at the start of the water year.

[10] Water year 2006 is the year with the largest potential Sites diversions in the Historical WAA Tool, 1.572 MAF, over the period of analysis.

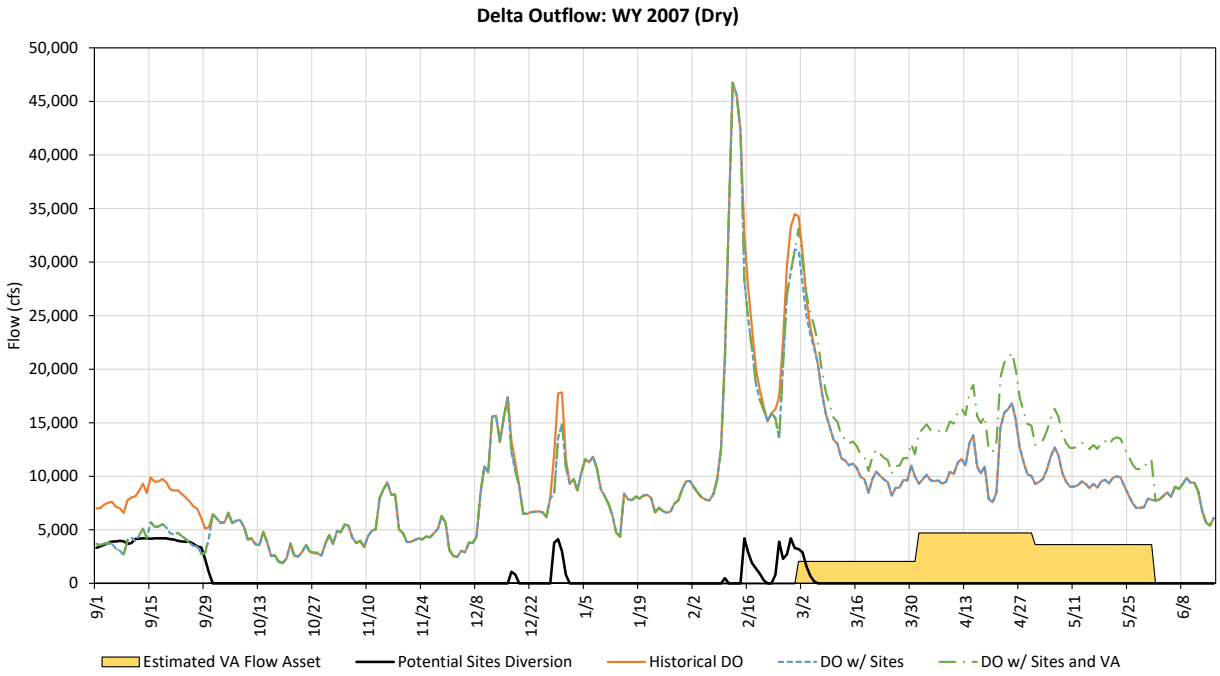


Figure 8. Water Year 2007: Potential Sites Diversions, VA Flows, and Delta Outflow

Water year 2007 was a Dry year, with a few opportunities of 11 continuous days or less for Sites to divert in December, February, and March. Potential Sites diversions and VA flow assets would have overlapped for five days at the beginning of March when Delta outflow exceeded 20,000 cfs.

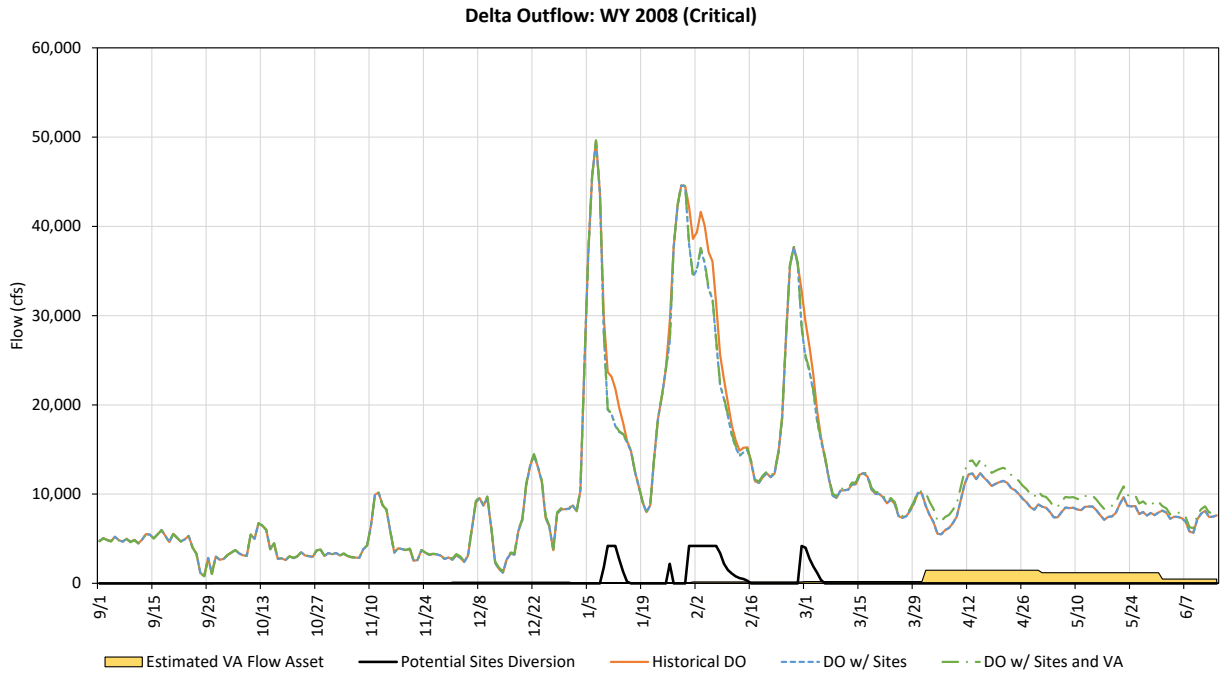


Figure 9. Water Year 2008: Potential Sites Diversions, VA Flows, and Delta Outflow

Water year 2008 was a Critical year, with potential Sites diversions only occurring during three storm events in January, February, and early-March. VA flow contributions to Delta outflow in Critical years are assumed to occur in April and May; thus, no overlap would have occurred between potential Sites diversions and VA flow assets.

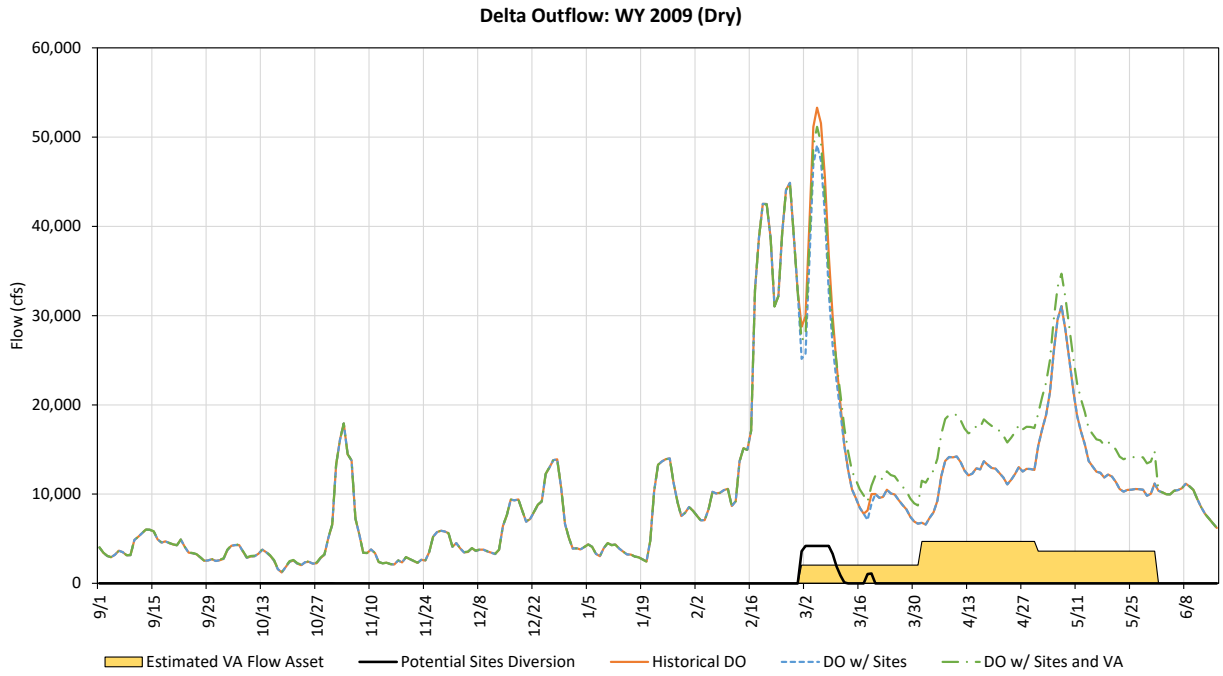


Figure 10. Water Year 2009: Potential Sites Diversions, VA Flows, and Delta Outflow

Water year 2009 was a Dry year, with only one period of potential Sites diversions in the first half of March, when historical Delta outflow typically ranged from approximately 20,000 to more than 50,000 cfs. Potential Sites diversions and VA assets would have overlapped during this time period.

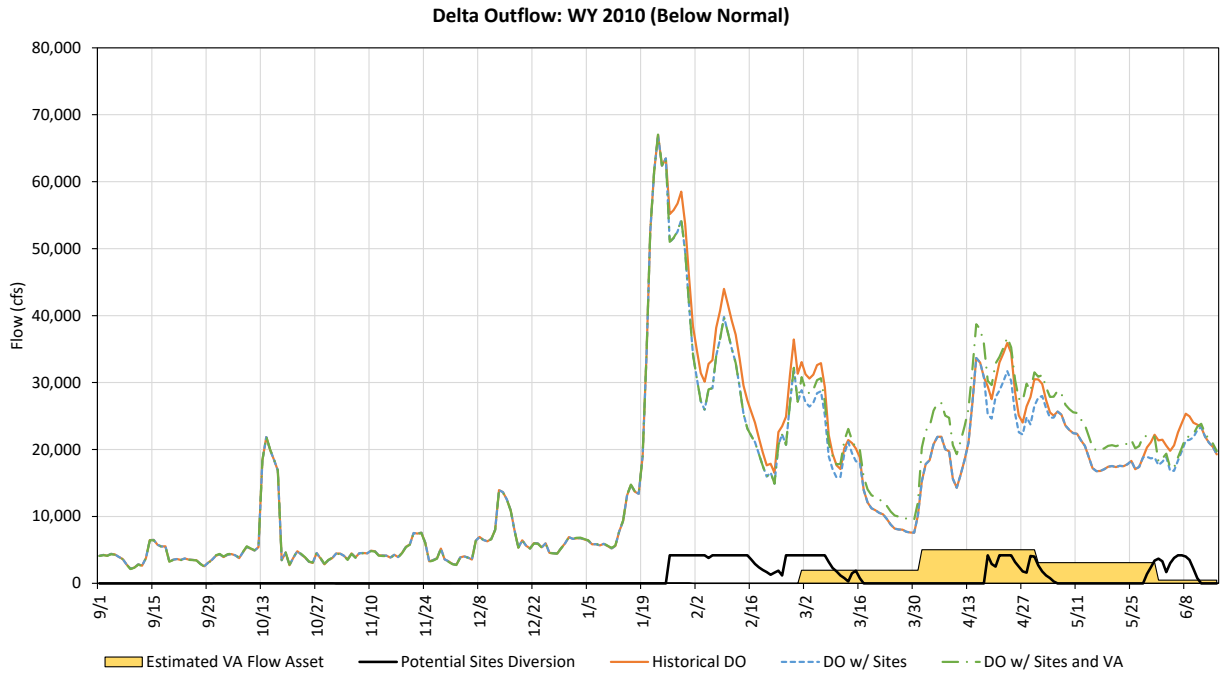


Figure 11. Water Year 2010: Potential Sites Diversions, VA Flows, and Delta Outflow

Water year 2010 was a Below Normal year, with three distinct periods of potential Sites diversions from late January through early March, mid-April through early May, and late-May through mid-June. During these potential periods the historical Delta outflow frequently, but not always, exceeded 20,000 cfs. Potential Sites diversions in the March through May period would have overlapped with VA flow assets.

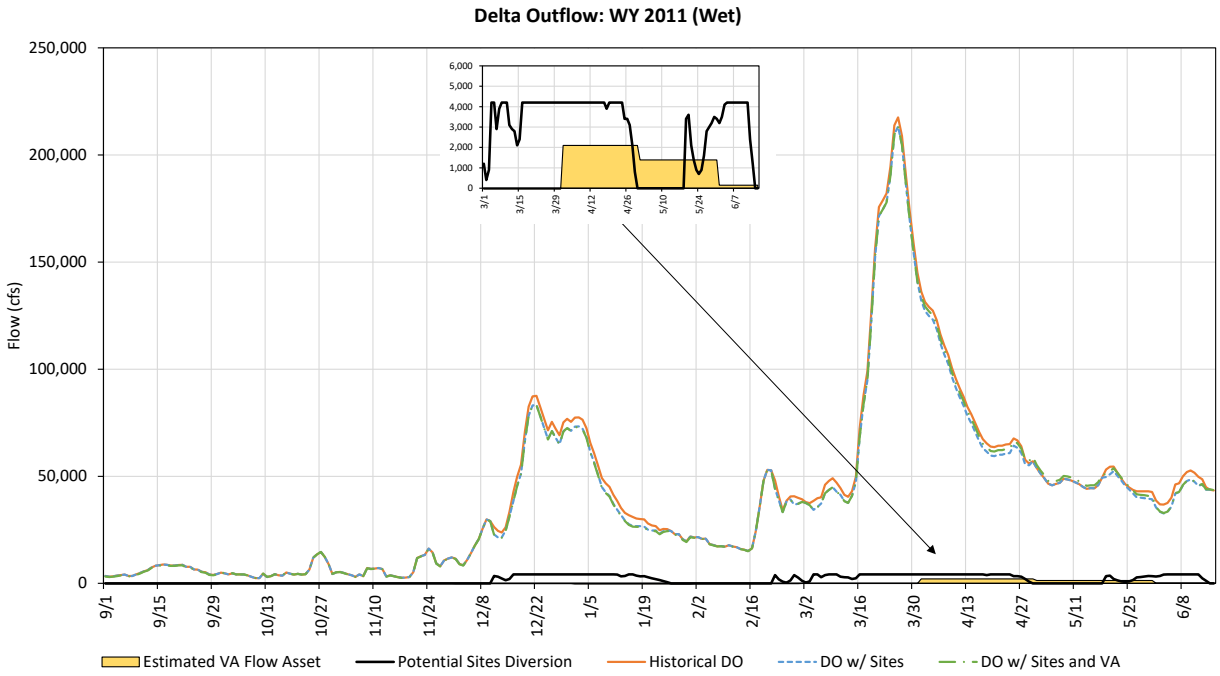


Figure 12. Water Year 2011: Potential Sites Diversions, VA Flows, and Delta Outflow

Water year 2011 was a Wet year with three extended periods of potential Sites diversions, of which the latter two may have overlapped with VA flow assets in April and May. Historical Delta outflow in April ranged from approximately 55,000 to 130,000 cfs, while historical Delta outflow in May ranged from approximately 40,000 to 50,000 cfs. Estimated potential diversions from the Historical WAA Tool totaled 1.2 MAF in 2011. Depending on reservoir storage at the beginning of the water year, diversions may have been limited by available reservoir capacity.

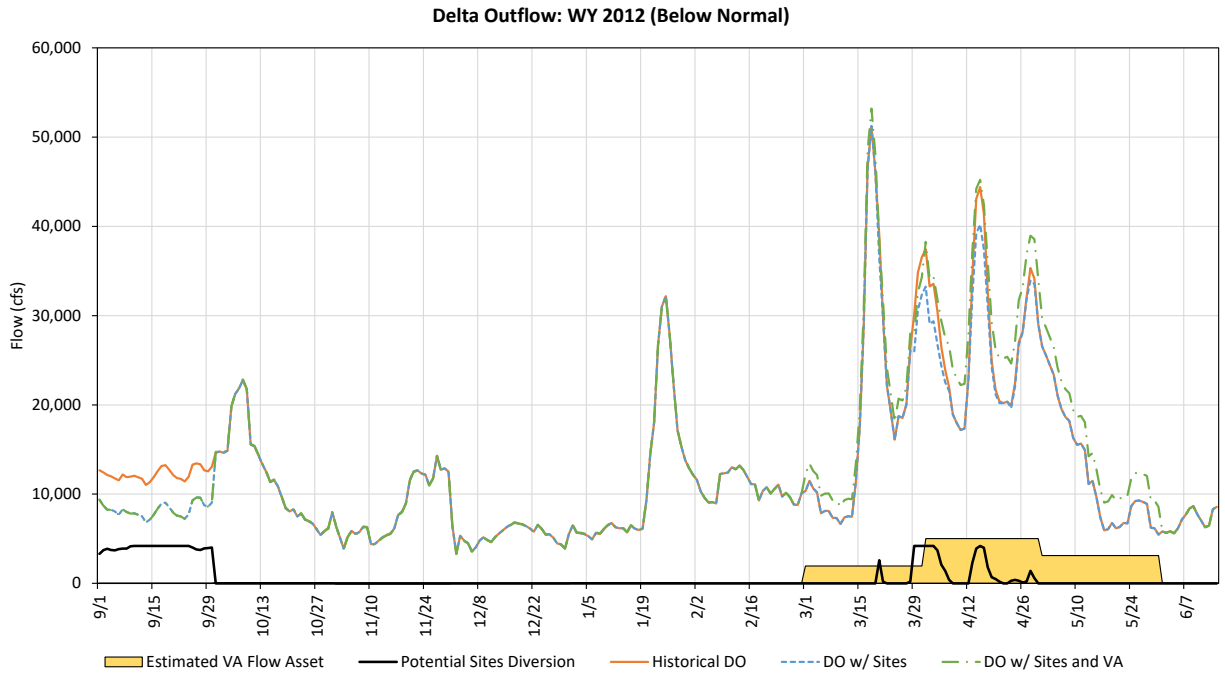


Figure 13. Water Year 2012: Potential Sites Diversions, VA Flows, and Delta Outflow

Water year 2012 was a Below Normal year, with potential Sites diversions in March and April when historical Delta outflow peaked and typically exceeded 20,000 cfs. Potential Sites diversions in late-April are less than the full diversion capacity. Potential Sites diversions would have overlapped with VA flow assets during these months.

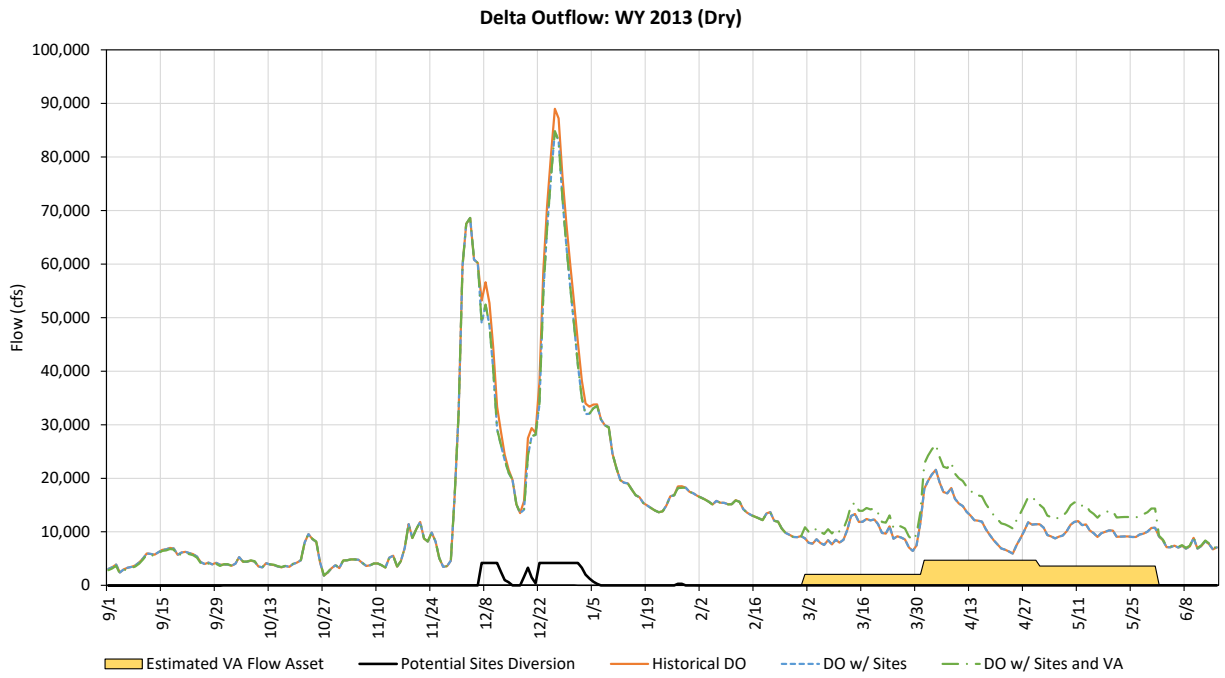


Figure 14. Water Year 2013: Potential Sites Diversions, VA Flows, and Delta Outflow

Water year 2013 was a Dry year, with potential Sites diversions during a period in December and early January. There was no modeled overlap between potential Sites diversions and VA flow assets.

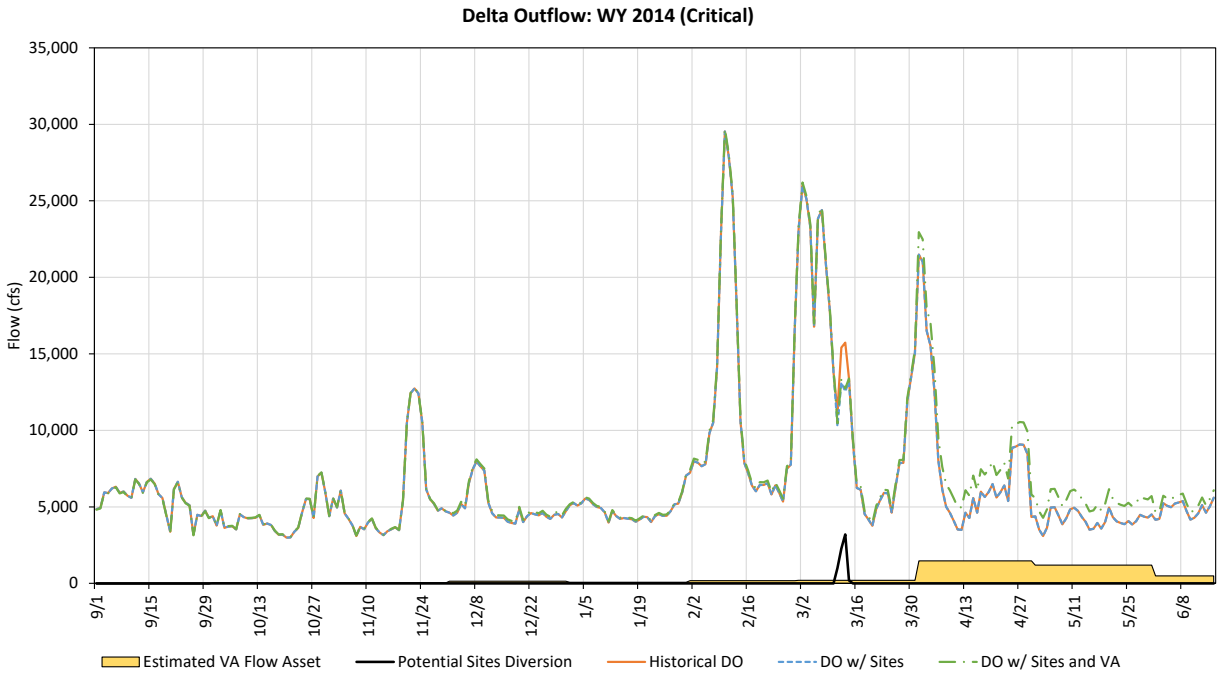


Figure 15. Water Year 2014: Potential Sites Diversions, VA Flows, and Delta Outflow

Water year 2014 was a Critical year with one brief period of potential Sites diversions in March. There was no modeled overlap between potential Sites diversion and VA flow assets.

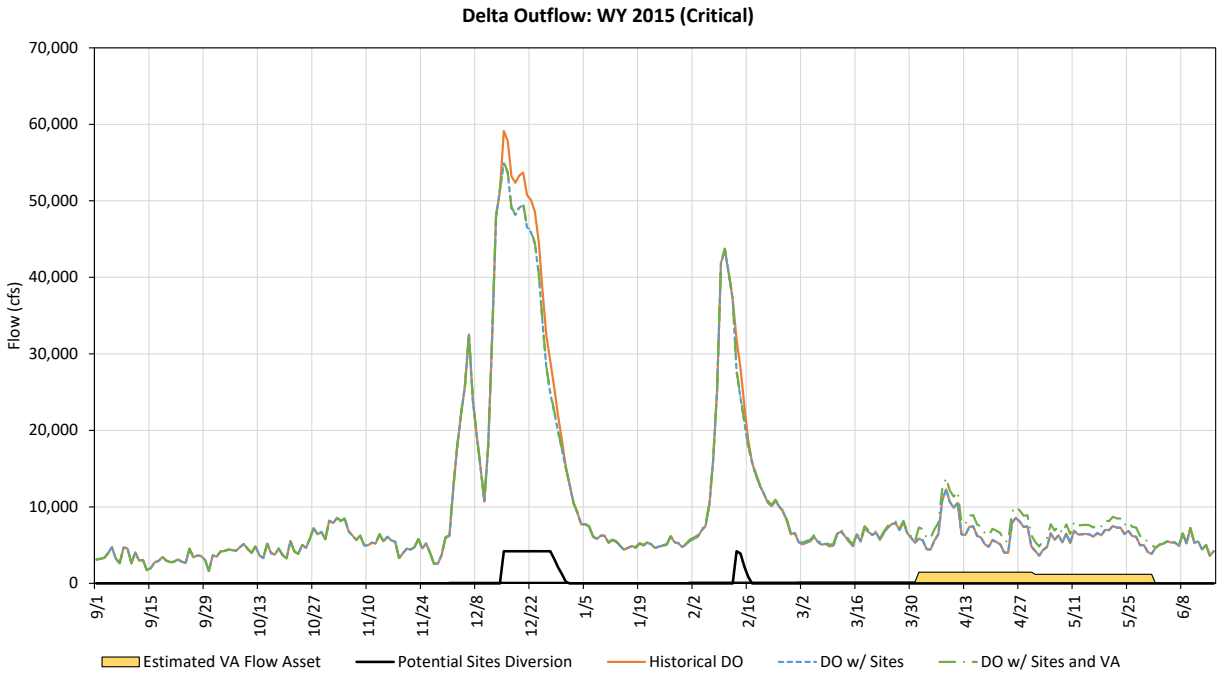


Figure 16. Water Year 2015: Potential Sites Diversions, VA Flows, and Delta Outflow

Water year 2015 was another Critical year with two brief periods of potential Sites diversions in December and early February. There was no modeled overlap between potential Sites diversions and VA flow assets.

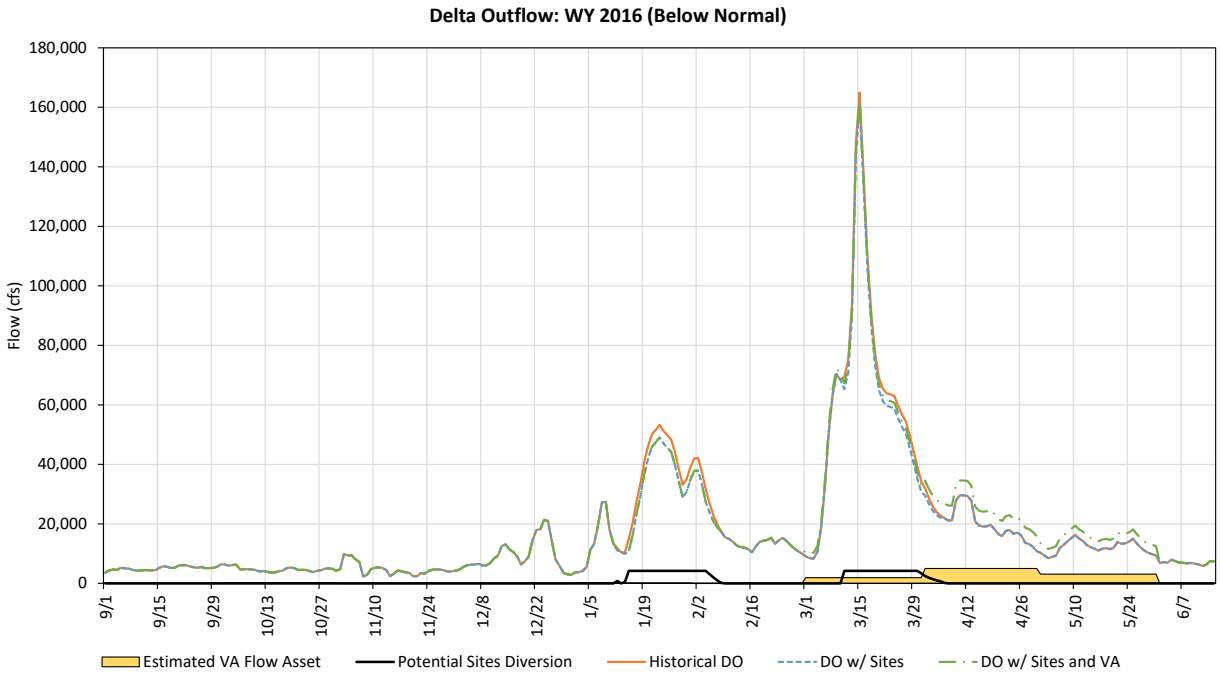


Figure 17. Water Year 2016: Potential Sites Diversions, VA Flows, and Delta Outflow

Water year 2016 was a Below Normal year with two periods of potential Sites diversions, the latter half of January and most of March. Potential Sites diversions in January did not overlap with VA flow assets. Potential Sites diversions in March overlapped with VA flow assets, but occurred when historical Delta outflow ranged from approximately 20,000 to 160,000 cfs.

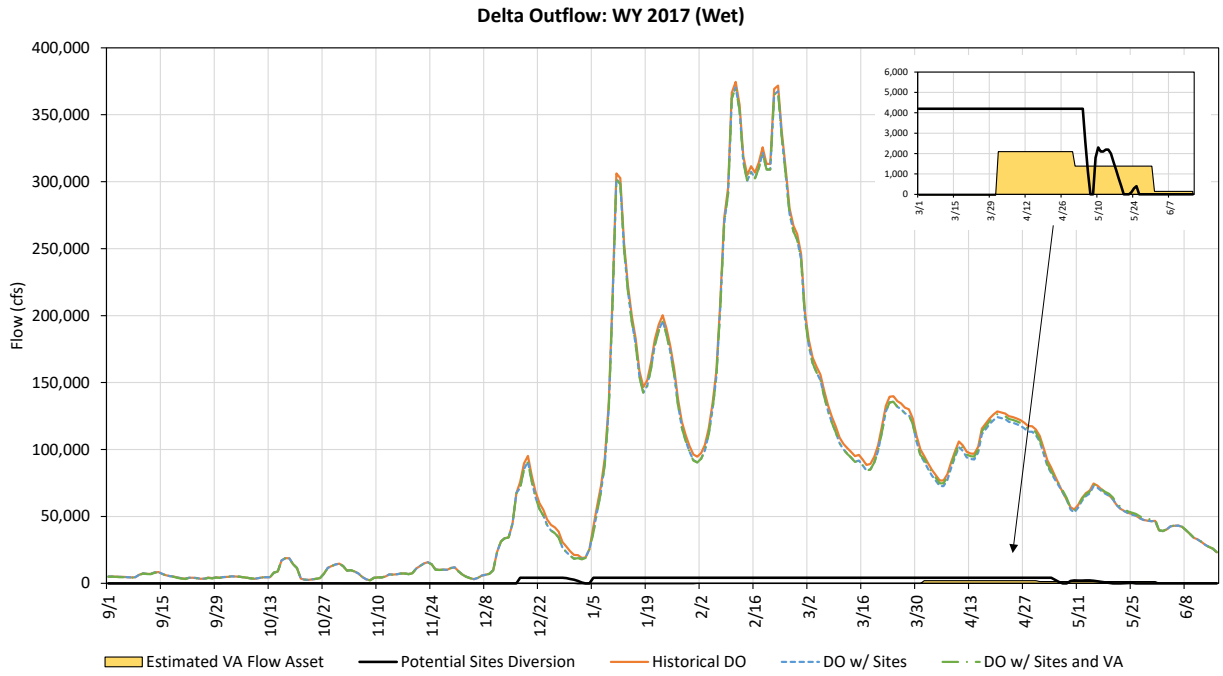


Figure 18. Water Year 2017: Potential Sites Diversions, VA Flows, and Delta Outflow

Water year 2017 was a Wet year, with potential Sites diversions occurring through most of the winter and spring. Delta outflow was above 100,000 cfs for most of this same period. There was modeled overlap of potential Sites diversions and VA flow assets in April and early-May, when Delta outflow exceeded 75,000 cfs. Estimated potential diversions in the Historical WAA Tool totaled 1.2 MAF in 2017. Depending on reservoir storage at the beginning of the water year, diversions may have been limited by available reservoir capacity.

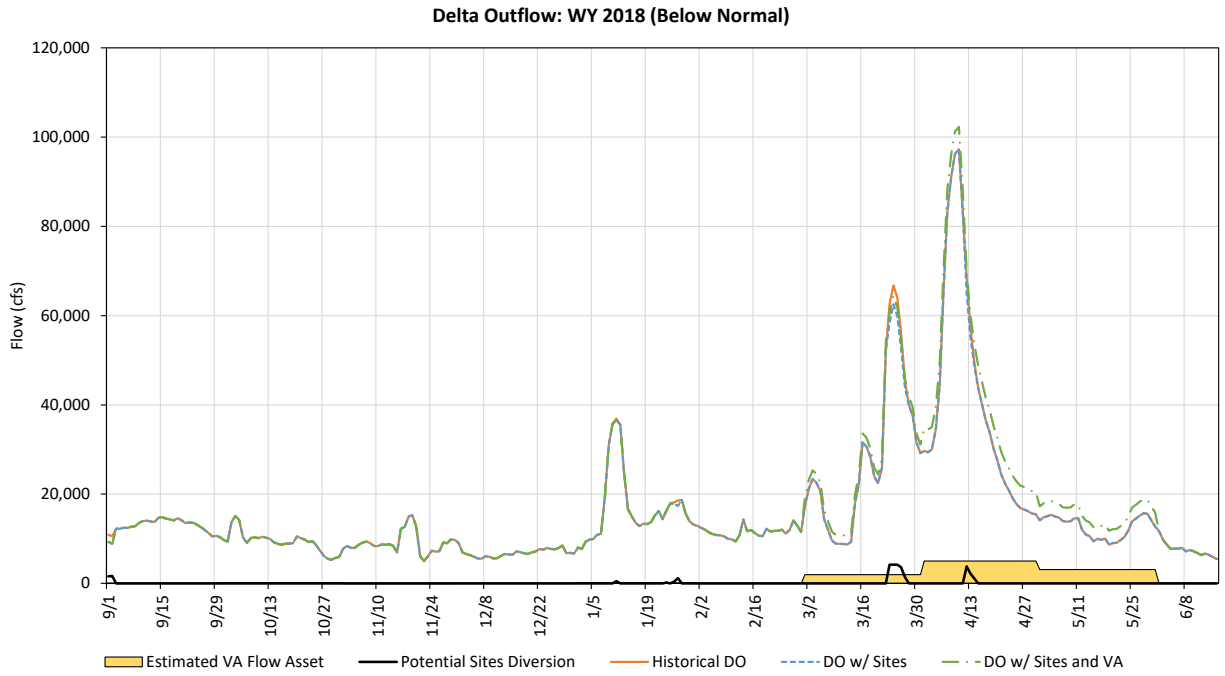


Figure 19. Water Year 2018: Potential Sites Diversions, VA Flows, and Delta Outflow

Water year 2018 was a Below Normal year with a relatively dry winter and wet spring. Potential Sites diversions overlapped with VA flow assets in March and April during periods of peak Delta outflow that exceeded 45,000 cfs.

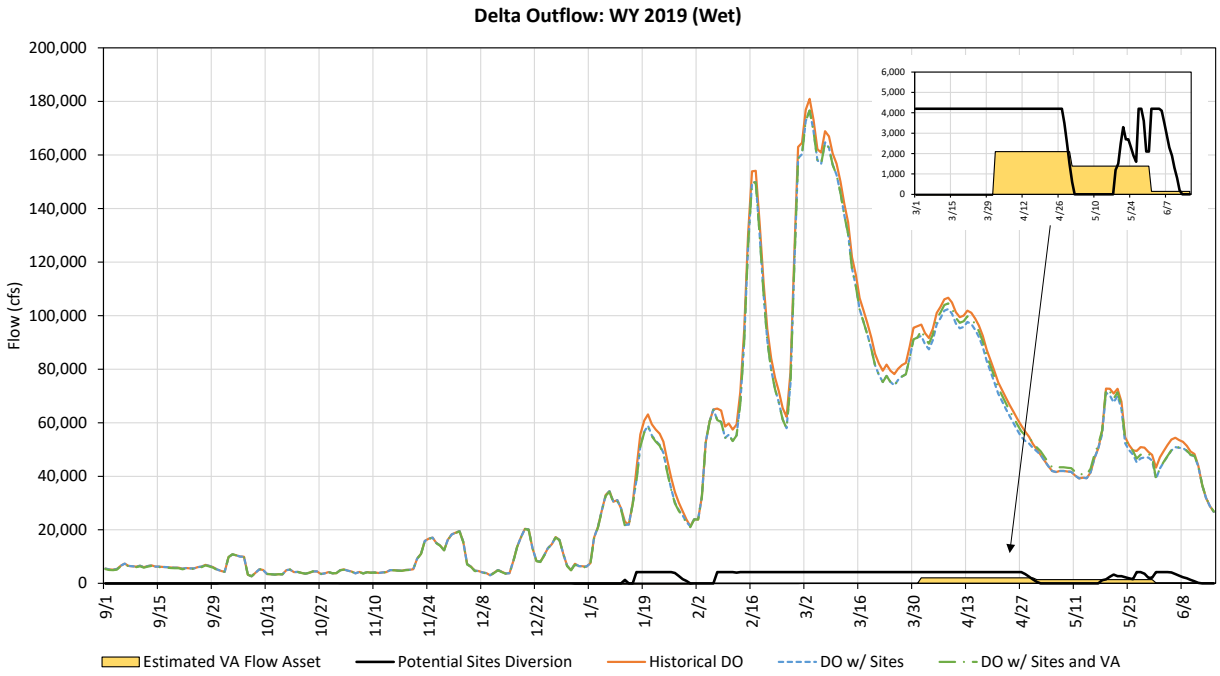


Figure 20. Water Year 2019: Potential Sites Diversions, VA Flows, and Delta Outflow

Water year 2019 was a Wet year, with potential Sites diversions over an extended period in January, most of February through April, and intermittently at the end of May and early June. Some modeled overlap occurred between potential Sites diversions and VA flow assets. However, Delta outflow was greater than 60,000 cfs during most of the periods of overlap. Estimated potential diversions in the Historical WAA Tool totaled 925 TAF in 2019. Depending on reservoir storage at the beginning of the water year, diversions may have been limited by available reservoir capacity.

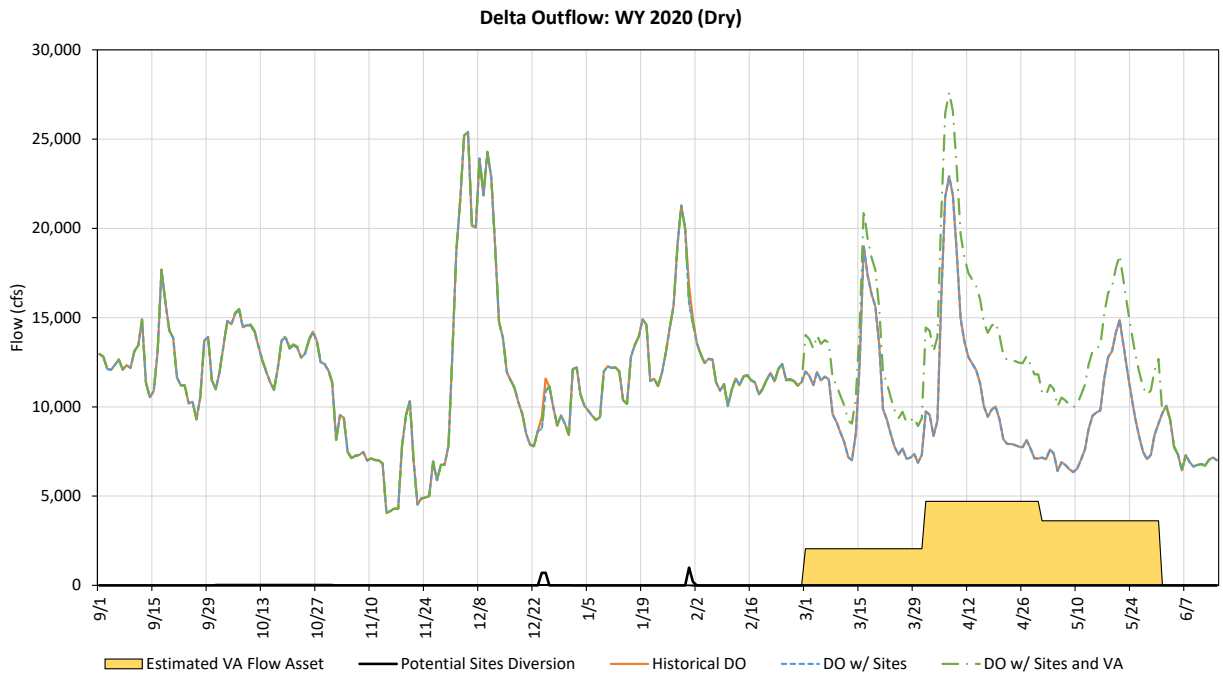


Figure 21. Water Year 2020: Potential Sites Diversions, VA Flows, and Delta Outflow

Water year 2020 was a Dry year, with two brief potential periods when Sites could divert, both outside of the period when VA flow assets were modeled to be deployed.

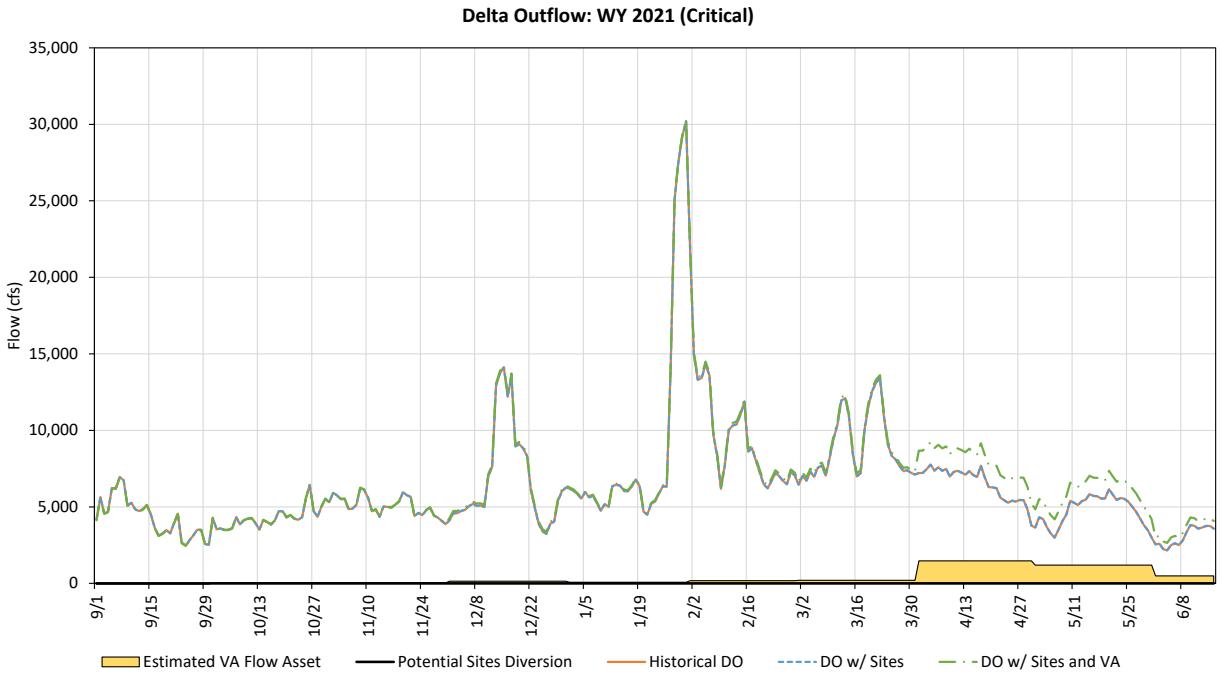


Figure 22. Water Year 2021: Potential Sites Diversions, VA Flows, and Delta Outflow

Water year 2021 was a Critical year that did not have any opportunities for Sites to divert; therefore, no potential overlap with VA flow assets occurred.

Table 1 is a summary of the potential Sites diversion days for each month during the period of analysis in the Daily Comparison. Months when VA flow assets may be deployed are highlighted. Diversions to Sites Reservoir will occur during periods when flows are available above regulatory requirements, Project-specific requirements, and senior water right demands. Whereas VA flow assets are proposed to occur during times when additional flow is expected to be most beneficial to the system. As previously stated, it is uncertain when and how VA flow assets may be deployed each year. The representation of VA flow assets is based on general assumptions and average monthly changes by water year type equally distributed across each day of a month. These results are one indication of the potential for overlap between Sites diversions and VA flow assets; however, the assumptions and caveats above are important when interpreting results in Table 1, and in the following sections.

Table 1. Days per Month of Potential Sites Diversions; Highlighted Months Indicate Potential Presence of VA Flow Assets.

WY Type	WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
AN	2000	-	-	-	6	29	31	22	1	0	-	-	0
D	2001	0	0	0	1	9	22	0	0	0	-	-	0
D	2002	0	0	18	28	0	10	0	0	0	-	-	0
AN	2003	0	0	8	31	13	7	14	31	9	-	-	0
BN	2004	0	0	11	29	26	31	3	0	0	-	-	0
AN	2005	0	0	0	19	11	15	16	21	12	-	-	30
W	2006	0	0	6	31	28	31	30	31	14	-	-	30
D	2007	0	0	6	0	13	5	0	0	0	-	-	0
C	2008	0	0	0	9	16	5	0	0	0	-	-	0
D	2009	0	0	0	0	0	14	0	0	0	-	-	0
BN	2010	0	0	0	6	28	16	13	8	11	-	-	0
W	2011	0	0	21	25	7	31	29	13	14	-	-	30
BN	2012	0	0	0	0	0	6	22	0	0	-	-	0
D	2013	0	0	22	8	0	0	0	0	0	-	-	0
C	2014	0	0	0	0	0	4	0	0	0	-	-	0
C	2015	0	0	17	0	4	0	0	0	0	-	-	0
BN	2016	0	0	0	19	8	21	6	0	0	-	-	0
W	2017	0	0	15	29	28	31	30	20	0	-	-	2
BN	2018	0	0	0	4	0	5	3	0	0	-	-	0
W	2019	0	0	0	15	22	31	30	15	12	-	-	0
D	2020	0	0	2	1	1	0	0	0	0	-	-	0
C	2021	0	0	0	0	0	0	0	0	0	-	-	0

Monthly and Seasonal Summary of Daily Comparison

The results from the Daily Comparison are summarized as average monthly change by Sacramento Valley water year type, and for each season where flow abundance relationships are discussed and evaluated in the SBRS. It is important to restate, the Historical WAA Tool is not an operations model for the Sites Project and therefore does not simulate diversions into Sites Reservoir as part of the overall operations. Results from the Historical WAA Tool provide a conservative, and in some cases an over estimation, of the potential impact of the Sites Project on Delta outflow. A better representation of the overall effect of Sites Project operations on Delta outflow is found in the Sites' Revised Draft

Environmental Impact Report/Supplemental Draft Environmental Impact Statement (RDEIR/SDEIS) and the upcoming Final Environmental Impact Report/Environmental Impact Statement (Final EIR/EIS). Analysis for the RDEIR/SDEIS and upcoming Final EIR/EIS evaluates all aspects of Sites Reservoir operations. The representation from the Final EIR/EIS is utilized in the Monthly Comparison, discussed later in this document.

Change in Delta Outflow with Potential Sites Diversions

Table 2 shows the average monthly change in Delta outflow by Sacramento Valley water year type resulting from potential Sites diversions over the period of analysis in the Sites Historical WAA Tool. As previously stated, this assumes a 1:1 change in Delta outflow, relative to potential Sites' diversions; does not account for travel time; and does not include releases from Sites that increase Delta outflow. Changes in Delta outflow are greatest in Wet and Above Normal years and the greatest monthly volumes generally occur in January through March.

Table 2. Average Monthly Change in Delta Outflow Resulting from Potential Sites Diversions in the Sites Historical WAA Tool. Values in 1,000 acre-feet.

WY Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Wet	0	0	-82	-191	-161	-249	-241	-117	-62	0	0	-117	-1,220
Above Normal	0	0	-32	-140	-129	-117	-66	-132	-16	0	0	-51	-684
Below Normal	0	0	-18	-79	-78	-109	-40	-6	-14	0	0	0	-343
Dry	0	0	-52	-35	-21	-38	0	0	0	0	0	0	-146
Critical	0	0	-30	-12	-27	-8	0	0	0	0	0	0	-79

Change in Delta Outflow for VA without Lower San Joaquin River

Table 3 shows the average monthly change in Delta outflow by Sacramento Valley water year type between the post-processed CalSim 3 VA study without LSJR and the CalSim 3 baseline. The proposed VA flow contributions (both those modeled in CalSim 3 and those that are post-processed) are concentrated in the months of April and May, with the largest volumes occurring in Above Normal, Below Normal, and Dry water year types. As such, the largest changes in Delta outflow generally occur in these months and year types.

Table 3. Average Monthly Change in Delta Outflow under the VA without Lower San Joaquin (VA without Lower San Joaquin minus CalSim 3 Baseline). Values in 1,000 acre-feet.

WY Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Wet	2	-4	-7	-19	-5	-3	98	59	-1	5	0	0	123
Above Normal	-8	0	-1	1	-11	-7	394	206	-3	23	10	-6	600
Below Normal	4	-4	-2	4	-1	120	246	138	9	11	9	12	521
Dry	4	0	2	-1	-2	126	227	170	29	28	14	-2	596
Critical	1	2	9	5	10	12	61	47	0	1	1	1	148

The potential changes in Delta outflow from the Sites Historical WAA Tool (Table 2) can be combined with the changes in Delta outflow from the CalSim 3 VA scenario without LSJR (Table 3) to suggest how potential Sites diversions and VA flow assets may overlap and/or interact. As the analysis blends output from two different models with different assumptions, baselines, and operating criteria, results of this

analysis are intended to be illustrative of the potential changes in magnitude and timing of Delta outflow with both Sites and the VAs. As modeling of the VAs is refined, it may be possible to further evaluate how flows and potential Sites diversions directly interact.

Table 4 shows the average monthly net change in Delta outflow by Sacramento Valley water year type when considering the modeled change in Delta outflow under the VAs without LSJR and the potential Sites diversions as calculated by the Sites Historical WAA Tool.

Table 4. Average Monthly Net Change in Delta Outflow under the VA without Lower San Joaquin and Sites Diversions. Values in 1,000 acre-feet.

WY Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Wet	2	-4	-89	-210	-166	-251	-143	-59	-63	5	0	-118	-1,097
Above Normal	-8	0	-33	-139	-140	-125	328	74	-19	23	10	-57	-84
Below Normal	4	-4	-21	-75	-79	12	206	133	-5	11	9	-12	178
Dry	4	0	-50	-35	-23	88	227	170	29	28	14	-2	451
Critical	1	2	-22	-8	-18	4	61	47	0	1	1	1	70

Change in Delta Outflow for VA with Lower San Joaquin River

Similar results were produced by combining the changes in Delta outflow from the CalSim 3 VA scenario with LSJR with potential Sites diversions from the Historical WAA Tool to suggest how potential Sites diversions and VA flow assets with the inclusion of LSJR contributions may overlap and/or interact.

Table 5 shows the average monthly net change by Sacramento Valley water year type in Delta outflow between the post-processed CalSim 3 VA study with LSJR and the CalSim 3 baseline. Results are similar to those presented in Table 4, albeit with a larger change to Delta outflow in April and May of all year types due to the added LSJR contribution to Delta outflow.

Table 5. Average Monthly Change in Delta Outflow under the VA with Lower San Joaquin (VA with Lower San Joaquin minus CalSim 3 Baseline). Values in 1,000 acre-feet.

WY Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Wet	2	-4	-7	-19	-5	-3	125	85	-1	5	0	0	177
Above Normal	-8	0	-1	1	-11	-7	456	268	-3	23	10	-6	723
Below Normal	4	-4	-2	4	-1	120	299	191	9	11	9	-12	627
Dry	4	0	2	-1	-2	126	280	223	29	28	14	-2	701
Critical	1	2	9	5	10	12	87	73	0	1	1	1	201

Table 6 shows the average monthly net change in Delta outflow by Sacramento Valley water year type when considering the modeled change in Delta outflow under the VA with LSJR (Table 5) and the potential Sites diversions, as calculated by the Sites Historical WAA Tool (Table 2).

Table 6. Average Monthly Net Change in Delta Outflow under the VA with Lower San Joaquin and Sites Diversions. Values in 1,000 acre-feet.

WY Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Wet	2	-4	-89	-210	-166	-251	-116	-32	-63	5	0	-118	-1,043
Above Normal	-8	0	-33	-139	-140	-125	390	136	-19	23	10	-57	40
Below Normal	4	-4	-21	-75	-79	12	259	186	-5	11	9	-12	284
Dry	4	0	-50	-35	-23	88	280	223	29	28	14	-2	556
Critical	1	2	-22	-8	-18	4	87	73	0	1	1	1	123

Resulting Delta Outflow Seasonal Summary

Table 7 provides a summary of the seasonal changes in Delta outflow for each of the VA scenarios, with and without Sites diversions. Differences in Delta outflow are smallest in Below Normal, Dry, and Critical years, as potential Sites diversions are greatest in Wet and Above Normal years. Potential Sites diversions from the Historical WAA Tool are typically greatest in the January through March period, so the January through June season shows the greatest difference since this season overlaps with Sites' highest monthly diversions. Differences in the seasonal volumes are the smallest in the March through June and March through May seasons, as these periods do not include two of Sites' largest diversion months (January and February). In particular, differences in Below Normal, Dry, and Critical years are increasingly small since Sites generally has limited to no diversion opportunities in the spring months of these water year types.

Table 7. Summary of Seasonal Changes in Delta Outflow. Values in 1,000 acre-feet.

Season	WY Type	VA without LSJR	VA without LSJR with Sites	VA with LSJR	VA with LSJR and Sites
Feb – May	Wet	149	-619	202	-565
	Above Normal	582	137	706	261
	Below Normal	503	271	609	377
	Dry	521	463	627	568
	Critical	130	94	183	147
Jan – Jun	Wet	129	-892	182	-839
	Above Normal	580	-20	704	104
	Below Normal	516	191	622	297
	Dry	550	457	655	562
	Critical	134	86	187	139
Mar – Jun	Wet	153	-516	207	-463
	Above Normal	590	259	714	383
	Below Normal	513	345	619	451
	Dry	553	514	658	620
	Critical	120	111	173	164
Mar – May	Wet	154	-453	208	-399
	Above Normal	593	278	717	402
	Below Normal	504	350	610	456
	Dry	523	485	629	590
	Critical	120	112	173	165

Monthly Comparison to the Scientific Basis Report Supplement Modeling Results

A monthly, CalSim-based analysis (Monthly Comparison) was developed to estimate how the Sites Project may affect Delta outflow under the VAs (Question 2[11]). The analysis was performed by combining the changes in Delta outflow under the VAs with the changes in Delta outflow with Sites Reservoir. Changes in Delta outflow under the VAs come from the post-processed CalSim 3 results that are the basis of the SBRS, while the change in Delta outflow with Sites Reservoir comes from the Alternative 3 CalSim II model produced in support of Sites' Final EIR/EIS. As the Sites CalSim II model simulates the complete operation (diversions and releases) of Sites Reservoir, compared to only the maximum potential diversions in the Sites Historical WAA Tool, the resulting change in Delta outflow provides a better estimate of how the Sites Project might affect Delta outflow under the VAs.

Sites CalSim II Modeling

To determine the change in Delta outflow with Sites Reservoir, the change in Delta outflow was calculated by taking the difference between Delta outflow under Sites Alternative 3 and Sites No Action Alternative (NAA). Results from Sites CalSim II modeling are summarized as monthly averages by Sacramento Valley water year type to be consistent and comparable with results from the post-processed VA modeling.

As it relates to the change in Delta outflow, it is important to keep in mind the timing and magnitude of simulated Sites diversions. Table 8 provides a summary of the average monthly simulated Sites diversions by Sacramento Valley water year type, as modeled in Sites Alternative 3. Diversions primarily occur during December through March, and occur in the greatest volumes in Wet and Above Normal years. Simulated diversion volumes in Wet years are similar to volumes in Above Normal years, as simulated diversions in some Wet years are limited by available reservoir and canal capacity.

Table 8. Sites Project Diversions as Modeled in Sites Alternative 3. Values in 1,000 acre-feet.

WY Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Wet	9	25	107	91	98	64	45	13	0	0	0	5	458
Above Normal	0	10	31	126	119	109	18	0	2	0	0	0	414
Below Normal	0	5	17	44	60	48	14	0	0	0	0	7	195
Dry	0	14	21	11	39	57	0	0	0	0	0	0	143
Critical	1	0	0	14	14	15	0	0	0	0	0	0	44

As modeled in CalSim II, Sites diversions do not necessarily result in a 1:1 change in Delta outflow, especially when considered on an annual (water year) basis. Table 9 shows the monthly average change in Delta outflow with Sites Reservoir under Sites Alternative 3, as compared to Sites NAA. There are several reasons for the differences between modeled Sites diversions and Delta outflow. These include changes in CVP/SWP operations (increased reservoir spills, changes in diversions and exports); increases

[11] From the Introduction section of this technical memorandum.

in carriage water to support export of Sites Project water conveyed across the Delta; and release of Sites Project water from Sites' environmental account.

Table 9. Average Monthly Change in Delta Outflow with Sites Reservoir (Alternative 3 minus NAA). Values in 1,000 acre-feet.

WY Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Wet	3	-10	-42	-79	-102	-43	-44	-6	-1	-1	21	23	-282
Above Normal	47	-19	-33	-110	-72	-106	-10	18	-9	5	22	28	-238
Below Normal	16	32	5	-48	-40	-50	-16	2	-4	5	9	11	-79
Dry	18	-4	-4	-17	-40	-39	1	0	0	7	15	12	-51
Critical	5	9	-7	-12	-5	-19	0	3	1	6	7	5	-8

Monthly Comparison Results

To calculate the change in Delta outflow under the VAs and with Sites Reservoir, the values in Table 9 were combined with the average monthly change in Delta outflow under the post-processed VA modeling, both with and without the LSJR (Table 5 and Table 3, respectively). Although the analysis developed provides a reasonable evaluation of the effects to Delta outflow with the Sites Project under the VAs, it is important to note several limitations of this approach:

1. Sites modeling was completed in CalSim II, while the VA modeling is developed from post-processed CalSim 3 runs. While the operational assumptions and model structure of CalSim II and CalSim 3 are similar, the difference in model detail and granularity can result in different simulated operations, particularly when evaluated over the entire simulation period.

2. As previously stated, the representation of VA flows in the post-processed CalSim 3 runs is approximate and based on the "Default Plan". The actual use of VA flow assets in the future will be based on real-time conditions, data, and objectives regarding what the VA flow assets are intended to achieve.

3. The analysis developed can provide a useful illustration of the potential effect to Delta outflow from Sites Reservoir under the VAs. However, a robust assessment of the potential effects would require development of a single model with both Sites Reservoir and the VAs.

Table 10 provides the average monthly net change in Delta outflow with Sites Reservoir and the VA without LSJR by Sacramento Valley water year type. Also included in parentheses is the percentage change from the CalSim 3 Baseline. The patterns and magnitude of changes are generally consistent with those observed in Table 3 and Table 9. These tables show reductions in Delta outflow in the winter months of all years, particularly in Wet and Above Normal years; and increases in Delta outflow in the spring months of all years (particularly in Above Normal, Below Normal, and Dry years). In some months, reductions in average monthly Delta outflow resulting from the Sites Project reduce the increase in Delta outflow from the VA flows. However, most of the reduction to the annual or seasonal increase in Delta outflow from VA flows results from the overlap in season, not the direct overlap of Sites diversions and presence of VA flow assets. Any average monthly reduction in Delta outflow in a specific water year type, due to the Sites Project as compared to the CalSim 3 Baseline, is less than or equal to 5%.

Table 10. Average Monthly Net Change in Delta Outflow with Sites Reservoir and the VA without LSJR. Values in 1,000 acre-feet.

WY Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Wet	5 (1%)	-15 (-2%)	-49 (-2%)	-98 (-2%)	-107 (-2%)	-46 (-1%)	54 (2%)	53 (2%)	-2 (0%)	4 (1%)	21 (5%)	22 (3%)	-158 (-1%)
Above Normal	39 (8%)	-19 (-5%)	-33 (-2%)	-109 (-4%)	-83 (-3%)	-113 (-4%)	384 (20%)	225 (14%)	-12 (-1%)	28 (5%)	33 (9%)	22 (4%)	362 (2%)
Below Normal	20 (5%)	29 (6%)	3 (0%)	-44 (-4%)	-41 (-3%)	70 (5%)	229 (28%)	140 (20%)	4 (1%)	15 (3%)	18 (7%)	-1 (0%)	442 (5%)
Dry	21 (6%)	-3 (-1%)	-1 (0%)	-18 (-2%)	-42 (-3%)	87 (7%)	229 (27%)	170 (23%)	29 (6%)	35 (11%)	29 (13%)	10 (5%)	545 (8%)
Critical	7 (2%)	11 (4%)	2 (0%)	-8 (-1%)	5 (1%)	-7 (-1%)	60 (11%)	50 (11%)	1 (0%)	7 (3%)	8 (4%)	5 (3%)	140 (3%)

Table 11 provides the average monthly net change in Delta outflow with Sites Reservoir and the VA with LSJR by Sacramento Valley water year type. Also included in parentheses is the percent change from the CalSim 3 Baseline. Observations and conclusions are essentially the same as those observed in Table 10, albeit with a greater increase in Delta outflow from the VAs due to the inclusion of the Lower San Joaquin River contributions.

Table 11. Average Monthly Net Change in Delta Outflow with Sites Reservoir and the VA with LSJR. Values in 1,000 acre-feet.

WY Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Wet	5 (1%)	-15 (-2%)	-49 (-2%)	-98 (-2%)	-107 (-2%)	-46 (-1%)	81 (3%)	80 (3%)	-2 (0%)	4 (1%)	21 (5%)	22 (3%)	-105 (0%)
Above Normal	39 (8%)	-19 (-5%)	-33 (-2%)	-109 (-4%)	-83 (-3%)	-113 (-4%)	446 (23%)	286 (18%)	-12 (-1%)	28 (5%)	33 (9%)	22 (4%)	486 (3%)
Below Normal	20 (5%)	29 (6%)	3 (0%)	-44 (-4%)	-41 (-3%)	70 (5%)	282 (34%)	193 (27%)	4 (1%)	15 (3%)	18 (7%)	-1 (0%)	548 (6%)
Dry	21 (6%)	-3 (-1%)	-1 (0%)	-18 (-2%)	-42 (-3%)	87 (7%)	281 (33%)	222 (31%)	29 (6%)	35 (11%)	29 (13%)	10 (5%)	650 (9%)
Critical	7 (2%)	11 (4%)	2 (0%)	-8 (-1%)	5 (1%)	-7 (-1%)	87 (15%)	76 (17%)	1 (0%)	7 (3%)	8 (4%)	5 (3%)	193 (4%)

Table 12 provides a summary of the average total seasonal Delta outflow during each of the seasons identified in the SBRS. The CalSim 3 Baseline, Post-processed Baseline, and each of the VA scenarios are provided for reference, along with each of the VA scenarios with Sites Reservoir. The largest seasonal differences in Delta outflow between the “VA-only scenarios” and the “VA scenarios with Sites Reservoir” occur in the January through June period, as this season includes more of Sites’ primary diversion months compared to other periods.

Table 12. Summary of Average Total Seasonal Delta Outflow for SBRS Scenarios and VA Scenarios with Sites Reservoir. Values in 1,000 acre-feet.

Season	WY Type	CalSim 3 Baseline	Post-processed Baseline	VA w/o LSJR	w/o LSJR & Sites	VA w/ LSJR	w/ LSJR & Sites
Feb-May	Wet	16,593	16,948	16,742	16,547	16,795	16,600
	Above Normal	9,130	9,355	9,712	9,542	9,835	9,666
	Below Normal	4,567	4,719	5,070	4,966	5,176	5,072
	Dry	4,005	4,118	4,527	4,449	4,632	4,554
	Critical	2,605	2,639	2,734	2,713	2,788	2,766
Jan-Jun	Wet	23,331	23,593	23,460	23,185	23,513	23,239
	Above Normal	12,796	12,919	13,376	13,088	13,500	13,211
	Below Normal	6,085	6,135	6,601	6,444	6,707	6,550
	Dry	5,273	5,398	5,823	5,727	5,928	5,832
	Critical	3,601	3,673	3,735	3,702	3,788	3,755
Mar-Jun	Wet	12,178	12,598	12,331	12,237	12,384	12,291
	Above Normal	7,145	7,420	7,736	7,629	7,860	7,753
	Below Normal	3,496	3,710	4,009	3,941	4,115	4,047
	Dry	3,252	3,339	3,804	3,767	3,910	3,872
	Critical	2,113	2,164	2,233	2,217	2,286	2,270
Mar-May	Wet	10,773	11,197	10,927	10,835	10,981	10,888
	Above Normal	6,207	6,520	6,801	6,703	6,924	6,826
	Below Normal	3,025	3,283	3,530	3,466	3,636	3,572
	Dry	2,777	2,875	3,301	3,263	3,406	3,368
	Critical	1,756	1,806	1,876	1,859	1,929	1,912

Conclusions

Available VA modeling from the SBRS was utilized, together with the Sites Historical WAA Tool and the available Sites CalSim II modeling, to produce a quantitative analysis which answers the two questions posed by State Water Board staff regarding:

1. How the Sites Project diversions may interact with the VA flow assets.
2. How the Sites Project may affect Delta outflow under the VAs.

The approach used two different analyses, the Daily Comparison and the Monthly Comparison, to help answer these questions. Both analyses informed the following conclusions:

1. The Daily Comparison is the most appropriate analysis to evaluate how potential Sites diversions may interact with VA flow assets. The Monthly Comparison is the most appropriate analysis to evaluate how the Sites Project may affect Delta outflow under the VAs.
2. Potential Sites diversions and VA flow assets have limited interaction, as diversions to Sites Reservoir will occur during periods when flows are available above regulatory requirements, Project-specific requirements, and senior water right demands, while VA flow assets are proposed to be deployed during times when additional flow is expected to be most beneficial to the system. Most of Sites' diversions occur during December through March of Wet and Above

Normal years. VA flow assets, as currently modeled, are utilized during March through May of Above Normal, Below Normal, and Dry years.

3. Most instances of overlap between potential Sites diversions and VA flow assets occur in the spring months of Wet and Above Normal years. However, in these years, potential Sites diversions typically occur during periods with relatively high Delta outflow. Given the approximate assumptions for the Default Plan included in the currently available modeling, it is unclear how and when VA flow assets would be deployed during these same times in actual operations. Additionally, Sites diversions may not occur in the spring months of these year types due to reservoir capacity limitations, conveyance canal availability, and/or other infrastructure related constraints. In drier years, overlap between potential Sites diversions and VA flow assets is minimal, as potential Sites diversions typically occur during individual storm events in the winter months, outside of the primary period that VA flow assets are anticipated to be utilized under the Default Plan.

4. The Sites Project would result in a limited reduction in Delta outflow, which would primarily occur in the winter months and largely in Wet and Above Normal years. On a water year basis, the Sites Project and the VA with LSJR result in essentially no change in Delta outflow in Wet years, with increases of approximately 3% in Above Normal years, 6% in Below Normal years, 9% in Dry years, and 4% in Critical years.. As compared to the CalSim 3 Baseline, the percent reduction in Delta outflow in any month under the Sites and VAs scenarios is less than or equal to 5%.

ATTACHMENTS

Attachment No. 1: “20230616B_Sites Historical WAA Tool&VA Analysis.xlsm”