

# Draft Carriage Water Overview for Non-Project Water Transfers

(October 2019 by SWP Water Transfer Conveyance Unit)

The purpose of this paper is to explain the concept of carriage water and how the Department of Water Resources (DWR) and the United States Bureau of Reclamation (Reclamation) calculate and apply carriage water to non-Project<sup>1</sup> water transfers.

As background, the Department of Water Resources (DWR) operates the State Water Project (SWP) and the United States Bureau of Reclamation (Reclamation) operates the Central Valley Project (CVP) (collectively, Projects). Projects' operations must comply with various requirements, including (but not limited to): (1) the State Water Resources Control Board (State Water Board) Water Right Decision 1641 (D-1641), (2) the 2008 U.S. Fish and Wildlife Service (USFWS) Biological Opinion for the coordinated operations of the CVP and SWP and its effects on the listed Delta smelt, and (3) the 2009 National Marine Fisheries Service (NMFS) Biological Opinion for the coordinated operations of the CVP and SWP and its effects on listed anadromous fish and marine mammals. The two Biological Opinions restrict the transfer window for exporting non-Project transfer water from the Sacramento-San Joaquin Delta (Delta) to July through September.

## Delta Salinity and Projects Export

The Delta is connected to the Pacific Ocean via the San Francisco Bay (Bay). Water in the Bay is more saline than fresh water from rivers upstream of the Delta. Salt water from the Bay enters the Delta through tidal effects and, if there was no Delta outflow, could move upstream potentially as far as the City of Sacramento on the Sacramento River and Vernalis on the San Joaquin River. Many factors affect salinity levels in the Delta, such as the quantity and quality of Delta inflow, tides, winds, the quantity and quality of in-Delta diverters' return flows, Delta channel conditions (e.g., capacities, water levels, and circulation), and SWP and CVP operations (e.g., Delta Cross Channel Gate positions, South Delta pumping rates, and temporary barrier conditions).

The Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan) includes water quality and flow objectives to protect the Bay-Delta watershed. D-1641 implements the Bay-Delta Plan and assigns to the Projects the responsibility for meeting the flow and water quality objectives. The Projects must manage export operations to comply with applicable regulatory requirements, including Delta salinity standards.

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<sup>1</sup> The term "non-Project water" refers to water that has not been appropriated or acquired by either DWR or Reclamation.

The Projects export water to serve their water supply contractors south and west of the Delta at the SWP Banks Pumping Plant and the CVP Jones Pumping Plant. These exports alter flow patterns in Delta channels and at times induce more saline ocean water to enter into the Delta from the Bay.

The terms “baseline” and “without-transfer” are hereinafter used interchangeably to describe conditions when only Project water is being exported. The term “with-transfer” is used to describe conditions when the Projects are exporting transfer water in addition to Project water.

## **Salinity Impact of Transfers and Carriage Water as Mitigation**

If the Projects were to export all transfer water south of the Delta that third parties make available, then there may be incremental impacts to Delta water quality due to increased disruption to natural flow conditions. To mitigate the potential for increased salinity, an additional water quantity is required to carry a unit of water across the Delta to the Projects' export facilities in order to maintain a constant salinity level at a given location or provide the additional outflow needed to offset the degradation to water quality as a result from the increased exports for transfers. In practice, carriage water is assessed by dedicating a portion of the transfer water as Delta outflow to keep Delta salinity at the same level as it would have been in the baseline (or without-transfer) conditions. Thus, carriage water is the additional water needed for Delta outflow to compensate for the additional exports made on behalf of a transfer to assure compliance with the water quality requirements of the SWP and CVP.

Carriage water is expressed as a percentage of the amount of transfer water. For example, if a transferor provides 100 acre-feet (AF) as Delta inflow from the Sacramento River at Freeport, and 30 AF is needed to offset the incremental increase in Delta salinity, then the remaining 70 AF of the transfer water is available for export. The assessment of carriage water in this example would be 30 percent (30/100). In other words, 30 percent of the transfer would be used to maintain Delta salinity conditions as it would have been absent the 100-AF transfer.

## **DSM2 for Carriage Water Calculation**

DWR uses the Delta Simulation Model 2 (DSM2) to simulate with and without-transfer conditions to determine carriage water during years when DWR and Reclamation facilitate water transfers from the Sacramento River. Since 2008, carriage water has varied between 20 and 35 percent of the transfer amount depending upon hydrology and other operational parameters. Based on DSM2 results, exporting transfer water originating from the San Joaquin River does not affect salinity at Jersey Point, Bethel Island, and Bacon Island; therefore, the Projects do not assess carriage water on San Joaquin River transfers. However, the Projects currently assess a conveyance loss of 10 percent, which is subject to update when new science and data is available, to transfer water through the San Joaquin River mainstem.

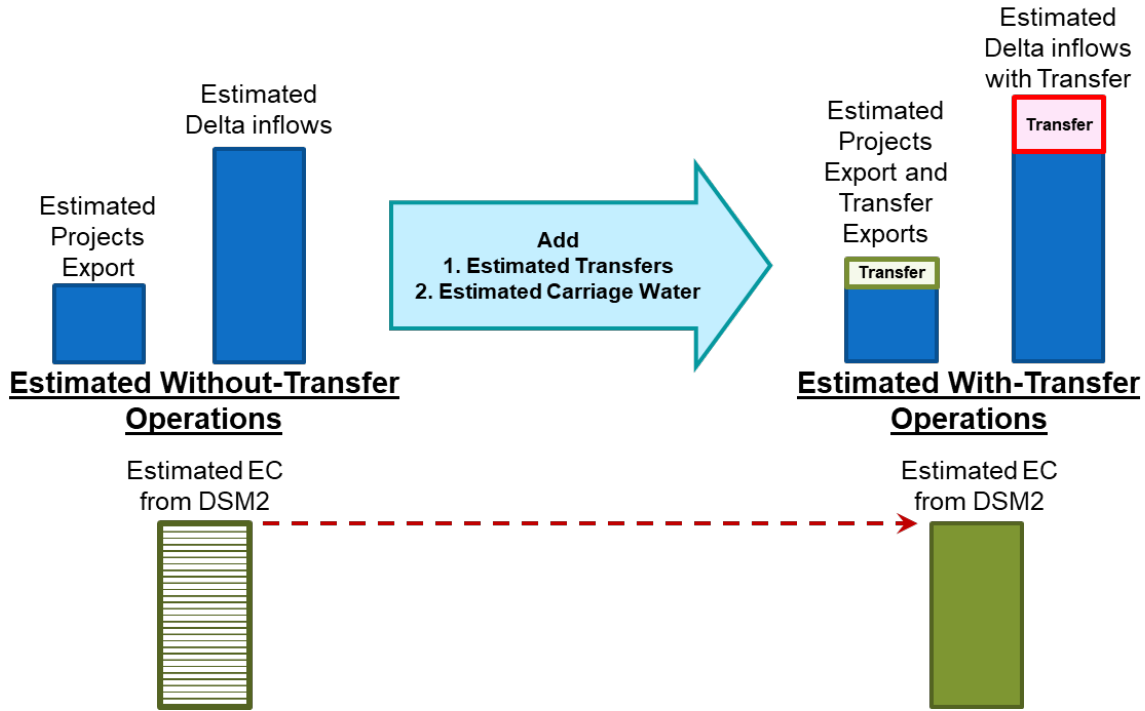
## Pre-Transfer Carriage Water Estimation

Before the water transfer window opens, DWR estimates the carriage water that will be applied to each transfer. DWR develops the carriage water estimate using an estimated amount of transfer water with an assumed pattern, forecasted hydrology, and forecasted operations through the following steps (see Figure 1):

1. Perform a DSM2 simulation for a baseline scenario to represent salinity conditions (expressed as electrical conductivity, or EC) that would have occurred absent the transfers while meeting all regulatory requirements.
2. Perform a DSM2 simulation for a with-transfers scenario with assumed carriage water.
3. Compare salinity results of the baseline (Step 1) to the with-transfers scenario (Step 2) at Jersey Point, Bethel Island, and Bacon Island (or Holland Island). These three locations provide a good representation of interior Delta salinity conditions that often control the Projects operations.
4. Repeat Step 2 and Step 3 by adjusting the carriage water percentage until the results of Step 2 show minimal EC differences from the results of Step 1.

Three stations, Jersey Point, Bethel Island, and Bacon Island (or Holland Island) have been identified to represent Delta locations with salinity standards or markers that often control Delta water operations (e.g., the 250 mg/l chloride standard at Contra Costa Canal in D-1641). The station with the highest carriage water percentage is controlling. For example, if 20 percent carriage water is needed to maintain the same salinity at Jersey Point, 25 percent at Bethel Island, and 30 percent at Bacon Island, then 30 percent is the estimated carriage water. Selecting less than 30 percent would result in impacts to the Projects through export reduction and/or additional reservoir releases to ensure that Bacon Island salinity is not affected by the water quality degradation from facilitating non-Project transfers.

After determining the estimated carriage water, DWR and Reclamation apply the same estimation to all transfers during the entire transfer period to negate temporal disparities of daily transfer amounts, avoid any priority conflicts, and address the effects of the antecedent water quality conditions to compliance concerns.



**Figure 1. Pre-Transfer Carriage Water Estimation**

**Analysis While Transfers Are in Progress**

While transfers are in progress, DWR and Reclamation operate the Projects in real-time to comply with all applicable regulatory standards. Pursuant to D-1641, DWR and Reclamation operate under the approved State Water Board’s Water Quality Response Plan and Water Level Response Plan (Response Plans). Per the Response Plans, the Projects must provide a seven-day notice to South Delta Water Agency (SDWA) prior to any third-party transfer operations. This seven-day notice includes DSM2 water quality and water level results<sup>2</sup> comparing baseline and with-transfer conditions. The Projects are to implement proper mitigation measures or may suspend the water transfer if the water transfer results in an incremental impact to water levels and/or water quality.

**Final Carriage Water Determination at Conclusion of Transfer Season**

Once the water transfer season is over, data collected during the water transfer period are used to develop a final carriage water value based on the actual conditions. The process to develop a final carriage water value is as follows (see Figure 2):

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<sup>2</sup> Water quality compliance locations are San Joaquin River at Brandt Bridge, Old River near Middle River, and Old River at Tracy Road Bridge. Water level compliance locations are Old River near Tracy Road Bridge, Doughty Cut above Grant Line Canal Barrier, and Middle River near the Howard Road Bridge.

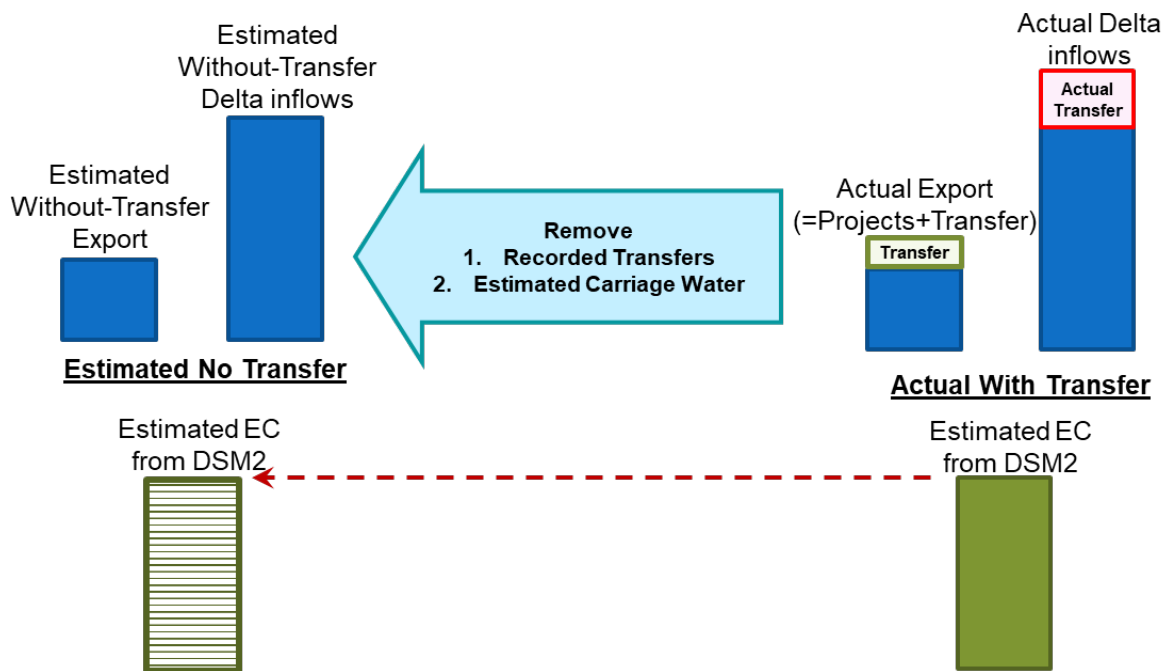
1. Perform a DSM2 simulation with actual data for with-transfer inflows and exports during the transfer period.
2. Perform a DSM2 simulation for a without-transfer scenario with hypothetical exports and Delta inflows:

$$\text{Without-transfer inflows} = \text{Actual inflow} - \text{Actual transfer amount into Delta}$$

$$\text{Without-transfer export} = \text{Actual pumping} - (1 - \text{estimated carriage water percentage}) \times \text{Actual transfer amount into Delta}$$

3. Compare salinity results of the actual with-transfer conditions (Step 1) to the estimated without-transfer conditions (Step 2) at Jersey Point, Bethel Island, and Bacon Island.
4. Repeat Step 2 and Step 3 by adjusting the carriage water percentage until the results of Step 2 show minimal EC differences from the results of Step 1. This is the final carriage water percentage.

As stated previously, the station with the highest carriage water percentage controls the final carriage water determination.



**Figure 2. Final Carriage Water Determination**

## Carriage Water Accounting and Adjustments for SWP Contractors

As provided for in the “Conveyance” article of all conveyance agreements involving DWR, carriage water and other water losses are assessed for water transfers facilitated

and approved by DWR. The estimated carriage water for each year is communicated to the buyers and sellers before any water transfers begin.

For SWP contractors who participate in transfers, the conveyance agreement also has a provision under the article titled “Reclassification of Transfer Water Deliveries” to allow for adjustment should the final carriage water value differ from the estimated value. There are two scenarios in which adjustments may be made to the accounting for the transfer water and Table A water that DWR delivered to a particular SWP contractor:

1. If the final carriage water is higher than the estimated carriage water, then the adjustment is to show DWR delivered less transfer water to the buyer, and the buyer received more Table A water. DWR reduces the buyer’s Table A carryover amount to compensate for the adjustment. There is no change to the actual overall quantity of water delivery for that year.
2. If the final carriage water is lower than the estimated carriage water, then the adjustment is to show DWR delivered more transfer water to the buyer, and the buyer received less Table A water. DWR increases the buyer’s Table A carryover amount to compensate for the adjustment. There is no change to the actual overall quantity of water delivery for that year.

The State Water Project Analysis Office maintains the delivery data and carryover amounts for the SWP contractors.

## **Carriage Water Accounting and Adjustments for Non-SWP Contractors**

For non-SWP contractors who participate in transfers facilitated by DWR, the process is more complicated and not as flexible. In the conveyance agreement, while there is an article titled “Conveyance” to address carriage water and other losses, there is no means for reclassifying the transfer water (as opposed to what is done for SWP contractors, as described above) should the final carriage water value differ from the estimated value. Therefore, the estimated carriage water is defined as a fixed value in the conveyance agreement.

The lack of reclassification is a result of the fact, that should the final carriage water be lower than the estimated carriage water, there is no simple way to return the water to the buyer. Likewise, should the final carriage water be higher than the pre-transfer estimation, there is no simple way for the buyer to return the water to DWR.