DSM2 Tidal Modeling of the Delta Corridors Plan

Revised Version (2019) of:

Tidal Hydraulics Modeling (DSM2) of the Delta Corridors Plan

Prepared for:
South Delta Water Agency
and

Central Delta Water Agency

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EXECUTIVE SUMMARY

The Delta Corridors Plan (DC Plan) is an alternative configuration for the Delta channels that would improve water quality by eliminating the recycle of San Joaquin River salinity at the exports and protect Delta fish by separating the SJR fish and the Old River habitat from entrainment effects. The CVP and SWP exports would be diverted from the Sacramento River and conveyed to the south Delta pumps using the existing Mokelumne River and Middle River channel network. Large fish screens at the DCC and at Georgiana Slough would prevent migrating juvenile Sacramento River fish from entering the DCC and Georgiana Slough diversions to the south Delta exports. The export water supply would be protected from seawater intrusion following a major levee failure by the separation of the Old River and Middle River corridors. San Joaquin River water released from the tributary reservoirs could be exported as soon as the pumps were inspected and repaired following a major seismic event. Full export capacity could be restored as soon as the levees separating Middle River and Old River were repaired.

The first technical report on the DC Plan (Jones and Stokes 2007) evaluated the feasibility of separating the SJR water in Old River from the CVP and SWP exports in Middle River and identified the volume of dredging in Middle River and Victoria Canal that would be needed to allow full permitted exports (11,280 cfs). The tidal elevations and tidal flows with the existing channel geometry and with the DC Plan changes in channel configurations were compared with the Delta Simulation Model II (DSM2) using August 1975 as the example month. Understanding the existing tidal flows in the major Delta channels allows the effects of the DC Plan on the tidal flows to be accurately evaluated.

The DC Plan would not change tidal elevations or tidal flows in Suisun Bay or in the Suisun Marsh or Cache Slough or Sacramento River channels. The fish screen on Georgiana Slough would have a capacity of 10,000 cfs and would only slightly change the Georgiana Slough diversions from the Sacramento River. The DCC would be divided to allow the north gate to remain open for Mokelumne River fish to migrate directly to the Sacramento River while the south gate would be opened with a fish screen to divert water to the Mokelumne River channels and to the SJR channel and Middle River. The fish screen on the south gate of the DCC would have a capacity of 5,000 cfs. The DC Plan would have some effects on the tidal elevations and flows in the San Joaquin River and Mokelumne River channels. The DC Plan would have the greatest effects on the net flows in Old River, Grant Line Canal, and Middle River because all of the SJR flow would be routed north in Old River, and all of the CVP and SWP exports would be routed south in Middle River and Victoria Canal to West Canal.

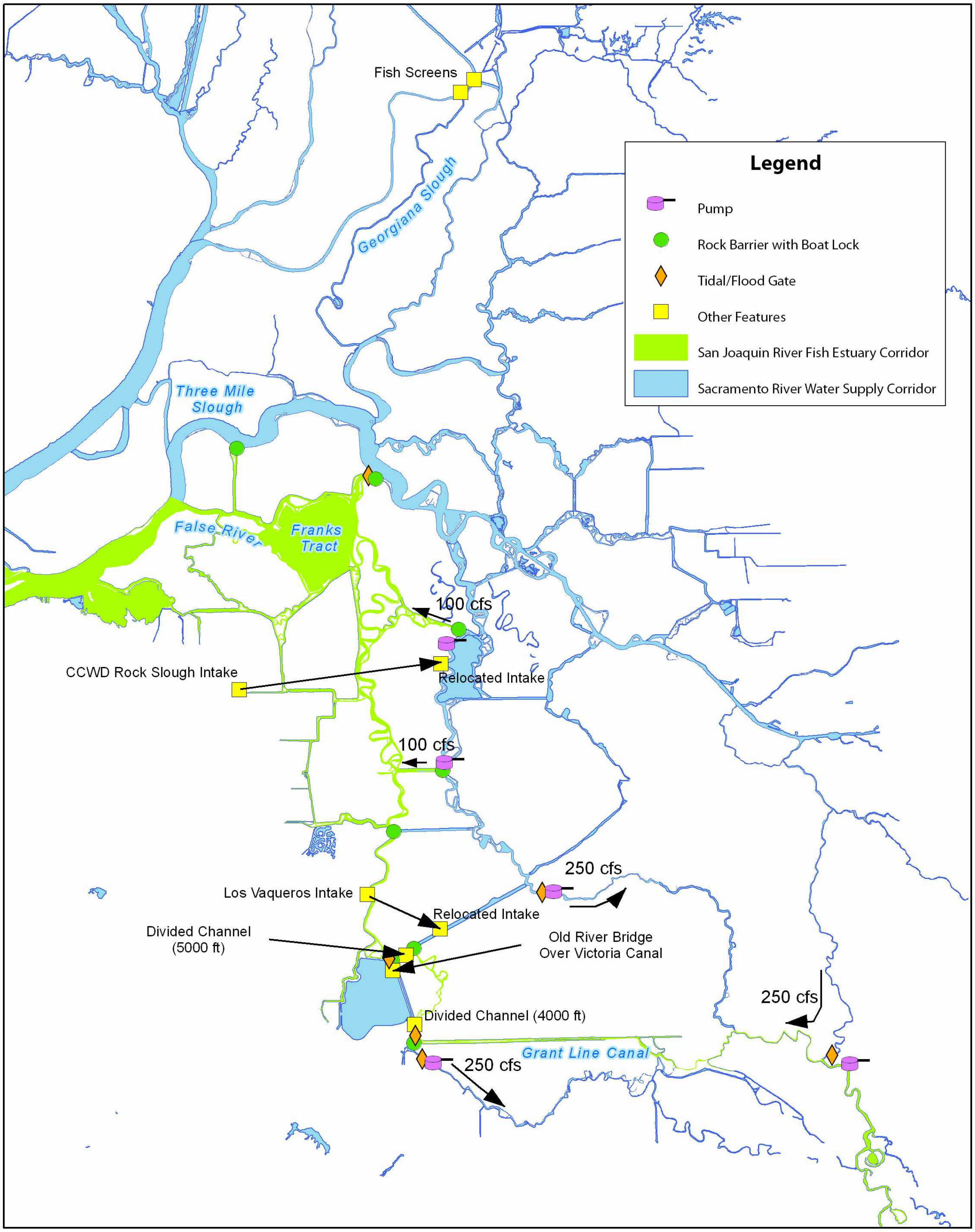
The DSM2 results indicated that dredging of about 10 million cubic yards in Middle River and Victoria Canal to a depth of 25 feet with a 3:1 bank slope for channel stability would be needed to convey the full existing CVP and SWP exports. The dredged material could be used to strengthen the levees along the water supply corridor (Middle River) and along the SJR-estuary corridor (Old River). The total dredging of about 10 million cubic yards would likely cost about $500 million ($50/yard), but this dredging would allow full existing exports to be conveyed in the Middle River corridor, and allow the entire San Joaquin River flow to be separated from the CVP and SWP exports to reduce export salinity and eliminate SJR fish entrainment (i.e., salvage and loss) at the CVP and SWP export pumps.

1 INTRODUCTION

The DSM2 model was used to investigate the feasibility of the Delta Corridors Plan (DC Plan) that was suggested to the Delta Vision (DV) and Bay Delta Conservation Plan (BDCP) stakeholder groups as an alternative to constructing a Peripheral Canal (PC) or tunnel to protect Sacramento–San Joaquin River Delta (Delta) fish and improve water quality. This plan would allow the exported water supply to be conveyed from the Sacramento River to the south Delta pumps using the existing Delta channel network. The entire San Joaquin River would be diverted into the head of Old River and be separated from the export pumping with a "river bridge" over large culverts at the south end of Victoria canal to allow the San Joaquin River water to flow down Old River to Franks Tract and the San Francisco Estuary. The migrating juvenile Sacramento River fish would be protected with large fish screens at the DCC and at Georgiana Slough. The major components of the DC Plan were described and the feasibility of transporting the full permitted exports in Middle River and Victoria Canal were investigated using the DSM2 tidal model of the Delta. The DSM2 model was also used to evaluate the likely changes in salinity in the south Delta channels as well as in the CVP and SWP exports, but only the changes in tidal elevations and tidal flows are described in this first technical report. The DSM2 tidal modeling results indicated that the DC Plan would be feasible for full permitted exports of about 12,000 cfs with about 10 million cubic yards of dredging in Middle River and Victoria Canal.

This initial investigation of the DC Plan was completed by Jones & Stokes for the South Delta Water Agency (SDWA) and the Central Delta Water Agency (SDWA) in 2007. Tidal elevations and tidal flows for the existing channels were compared to the tidal elevations and tidal flows with the DC Plan facilities and channel changes. The daily average (net) flows in the Delta channels were also evaluated for the existing conditions and with the DC Plan channel changes. The daily average flows are controlled by the Delta inflows and the channel diversions and Delta exports, as well as the flow divisions at channel junctions. Figure 1 shows the locations of the major new facilities and changes in the Delta channels for the DC Plan. The DC Plan would include:

A tidal-gate would be constructed across the San Joaquin River just downstream of the head of Old River to divert all of the SJR flow into Old River (Map 1). The tidal gate would be opened during flood-tides to provide an upstream flow into Old River during low SJR flows; fish-friendly pumps (similar to the Banta-Carbona fish-screen pump) would provide supplemental upstream flows from the San Joaquin River into the head of Old River. The tidal gate would be opened for flood-control purposes when the Vernalis flow exceeds about 10,000 cfs. Tidal gates on Old River at the DMC and on Middle River upstream of Victoria Canal (described below) would also be operated year-round unless the Vernalis flow is greater than about 10,000 cfs. These tidal gates will allow fish passage during flood-tides, provide upstream circulation for water quality and protect minimum elevations for agricultural diversions, as proposed in the South Delta Improvements Program (SDIP).



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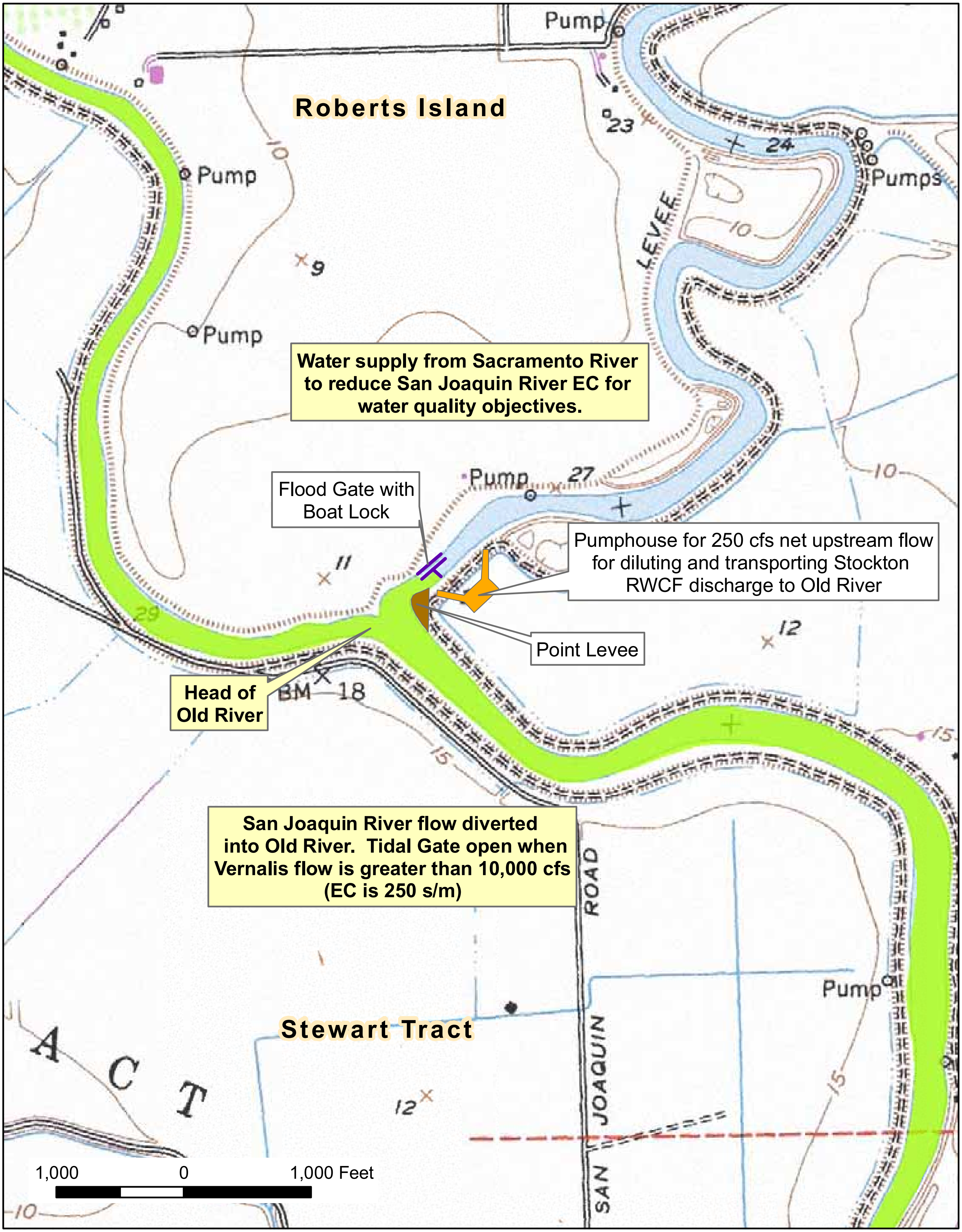
Jones & Stokes

Figure 1

Locations of the Major Features of the Delta Corridors Plan



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Map 1

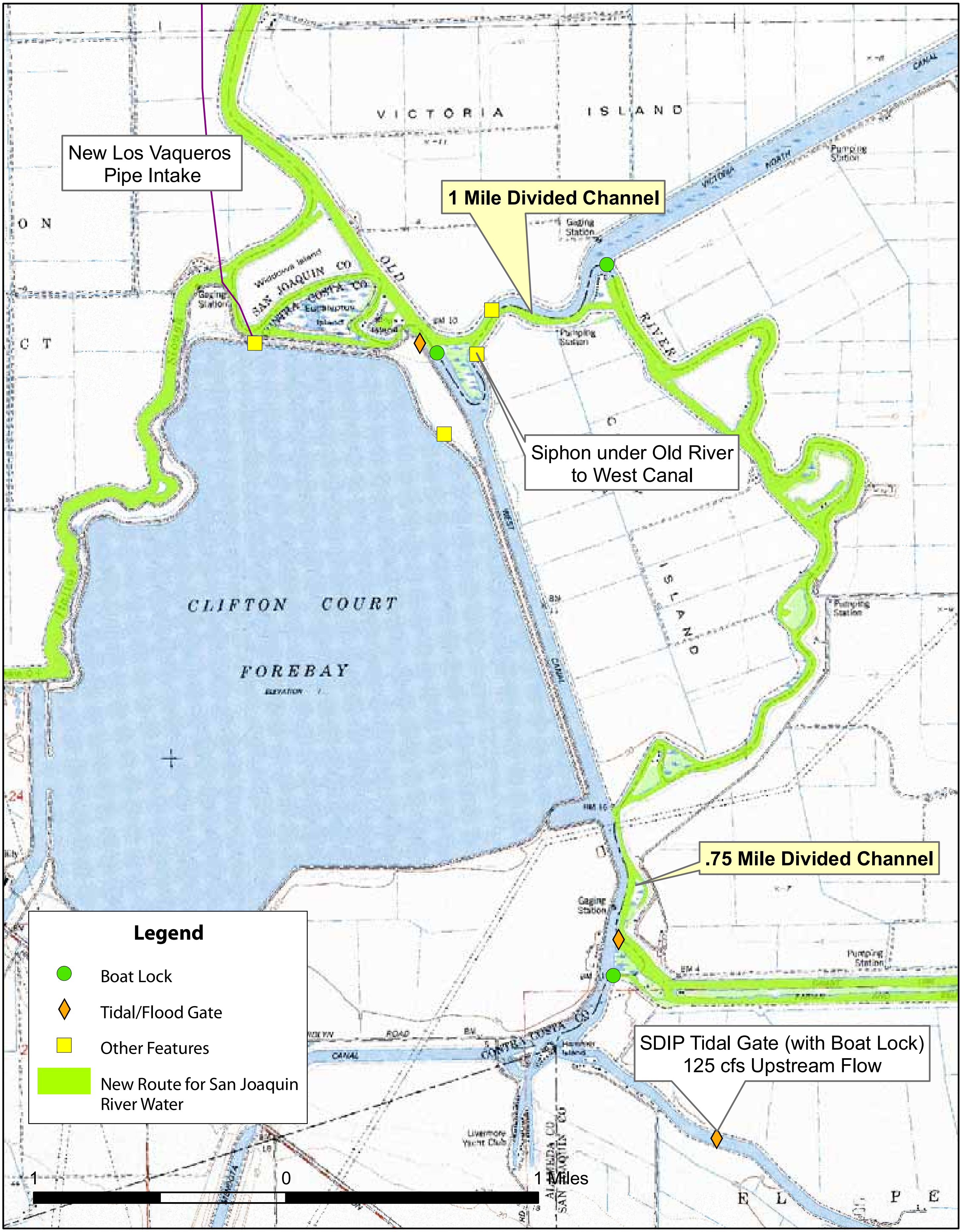
Old River between Fabian Tract and Coney Island (at the west end of Grant Line Canal) would be divided to allow the San Joaquin River to flow down Old River around Coney Island while the water supply flows from Middle River and Victoria Canal flow upstream in West Canal to the CCF gates and the Delta-Mendota Canal (DMC) intake (Map 2). The dividing wall would have flood gates that would be opened when SJR flow is greater than about 10,000 cfs.

Large culverts would be constructed at the south end of Victoria Canal to allow the water supply water to flow through the culverts to West Canal (Map 3). Old River will cross over the large culverts in a 15-feet deep "river bridge" channel between Coney Island and the tip of Victoria Island to allow the San Joaquin River water to continue down Old River to Franks Tract and the estuary. A concrete wall with a flood-gate would be constructed at the north end of West Canal to allow higher SJR flows to move down Old River to Franks Tract.

Concrete walls or rock barriers with boat locks would be constructed at the east end of Woodward Canal (Map 4), Santa Fe Canal (Map 5), and Connection Slough (Map 6). These barriers will separate the water supply corridor along Middle River from the San Joaquin River–estuary corridor along Old River. A concrete wall or rock barrier with a floodgate would be constructed across the mouth of Old River (Map 7), separating Franks Tract from the San Joaquin River. The floodgate will be opened when the San Joaquin River flow at Vernalis is greater than about 10,000 cfs.

The Clifton Court Forebay (CCF) gates would be opened during most of the tidal cycle. The CCF gates will be closed only if the CCF elevation is greater than the elevation in West Canal. A 2.25-mile long rock barrier would be constructed along the south shore of CCF to provide a "salvage corridor" channel from the CCF intake gates to the Skinner fish salvage facility. The top width would be about 200 feet and with an average depth of 12.5 feet would allow full pumping of 10,000 cfs to be conveyed to the Skinner fish salvage facility.

The Delta Cross Channel (DCC) would be divided with a concrete wall that will extend down Snodgrass Slough to Deadhorse Cut. The north gate of the DCC will be opened to allow fish passage to Snodgrass Slough and the Mokelumne River channels. A 1,000-feet long and 15-feet high flat-plate wedge-wire fish screen will be constructed along the Sacramento River levee to the Walnut Grove boat dock (Map 8). The south gate of the DCC will be automated to regulate the diversion flows during flood-tide to the fish-screen capacity of 5,000 cfs with a 0.33 ft/sec approach velocity. Another large flat-plate wedge-wire fish screen will be constructed across the upstream end of Georgiana Slough. The fish screens will extend 1,000-feet upstream and 1,000-feet downstream with a capacity of 10,000 cfs with a 0.33 ft/sec approach velocity. These fish screens would be similar to those designed for the BDCP and WaterFix to protect migrating juvenile Sacramento River fish from diversion into the central Delta or south Delta channels.



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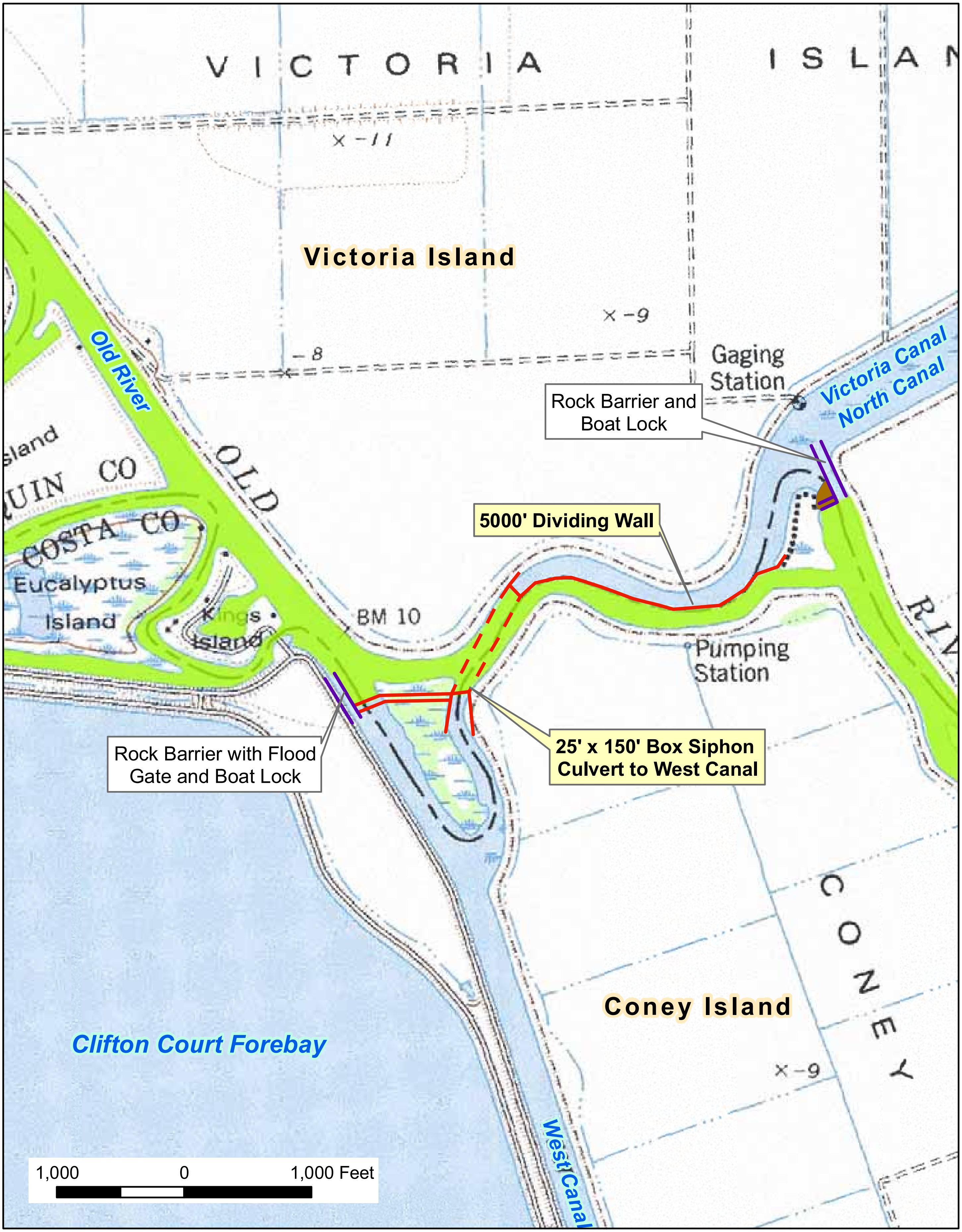
Map 2



Map 3

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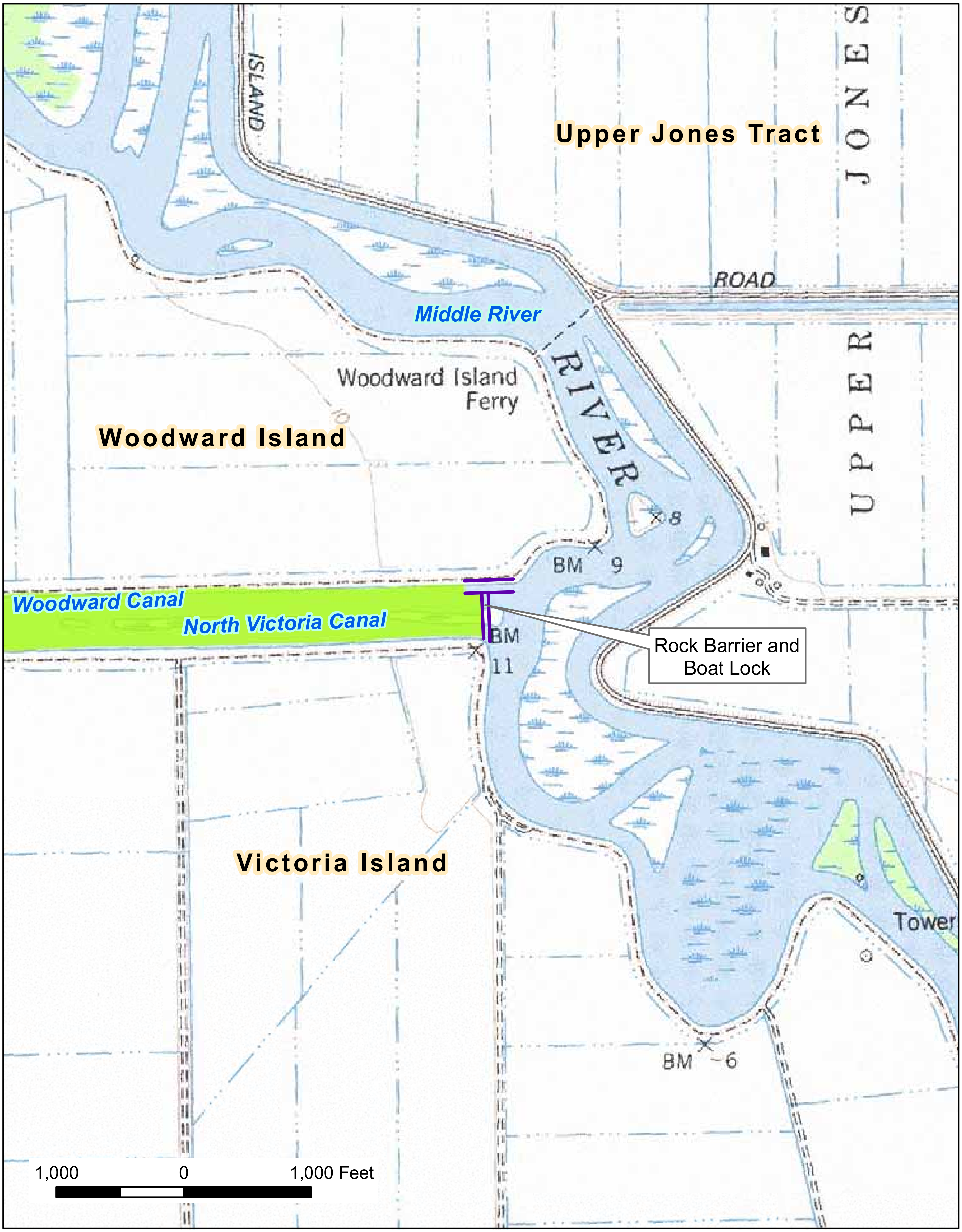

Map 4

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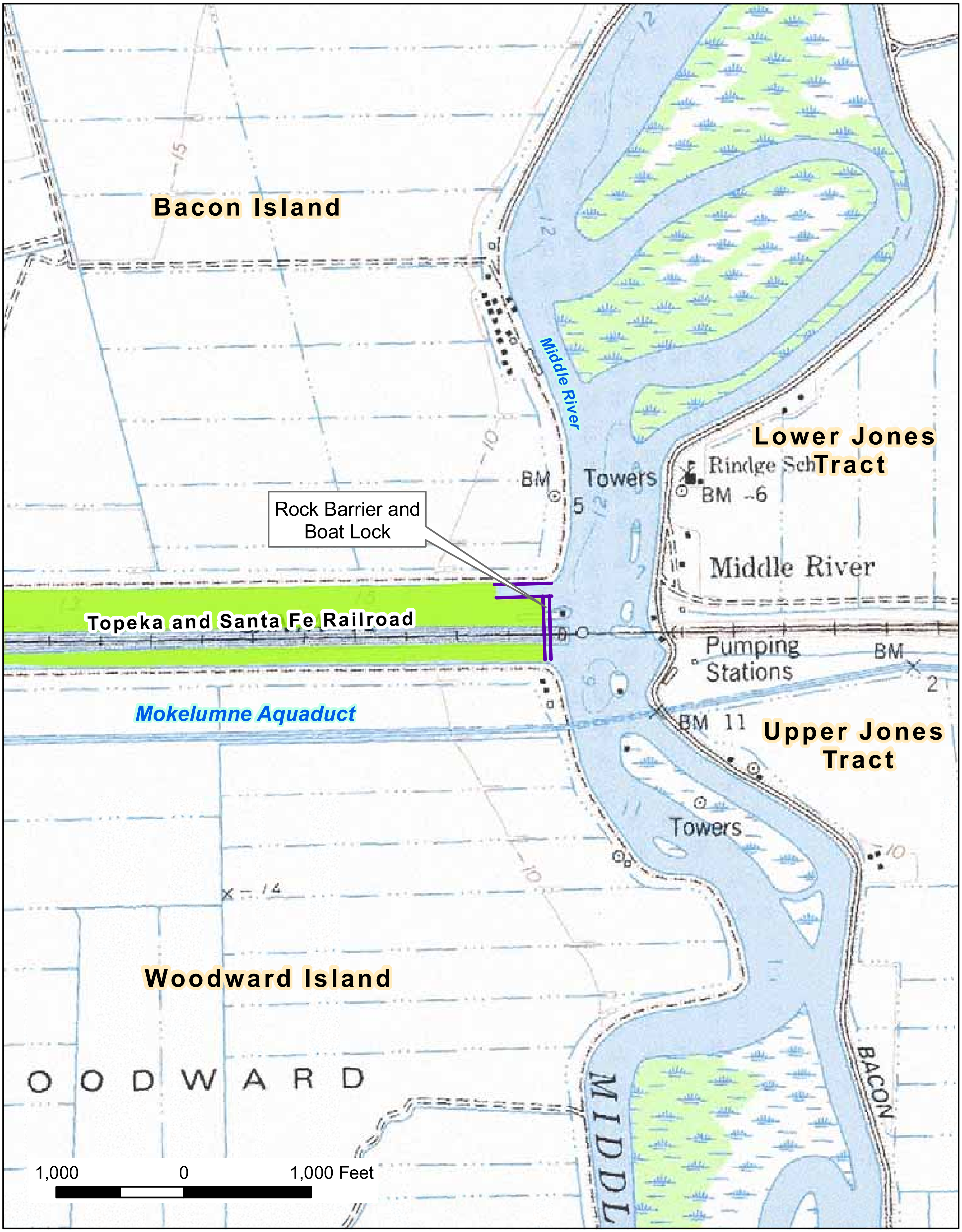

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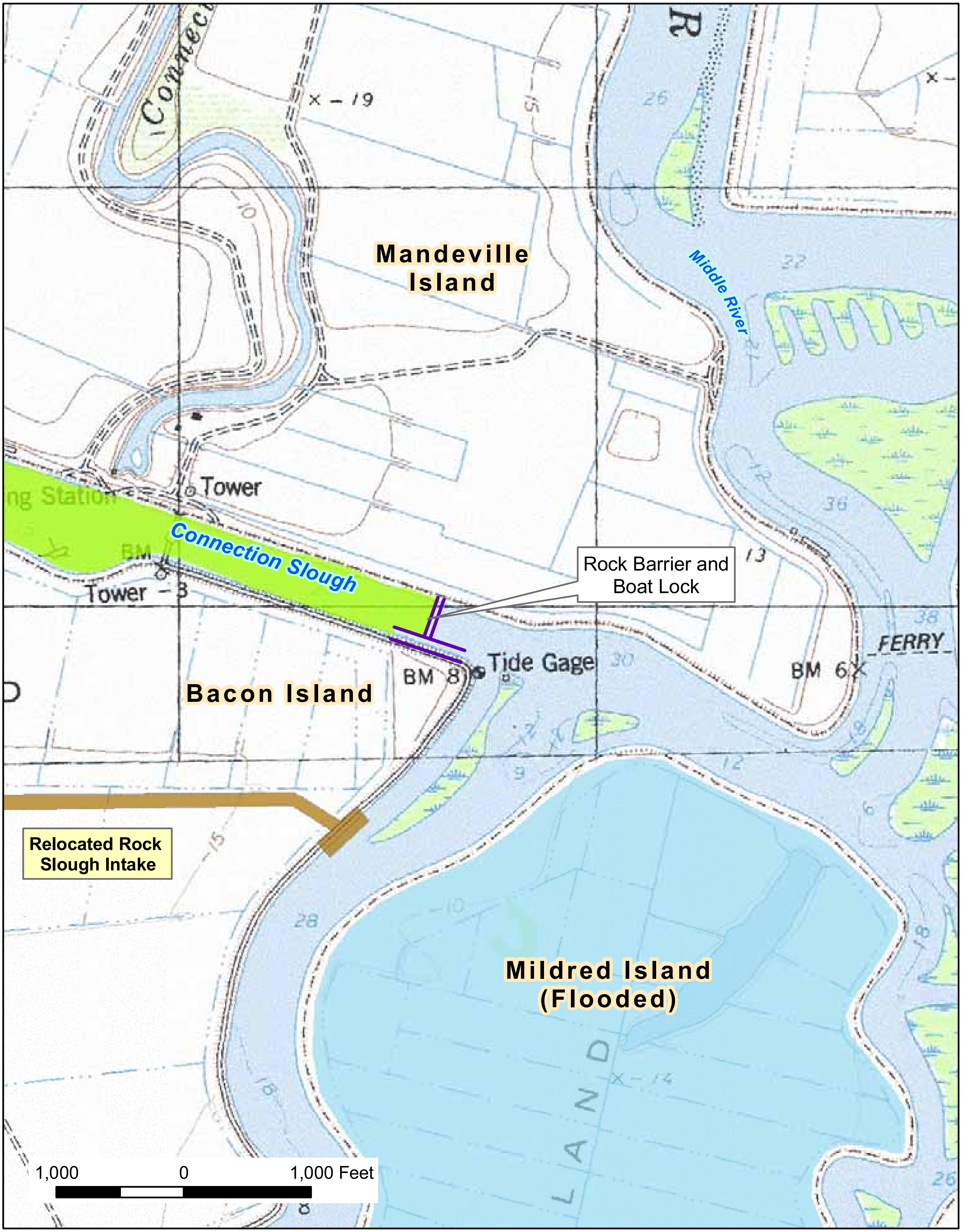
Map 5



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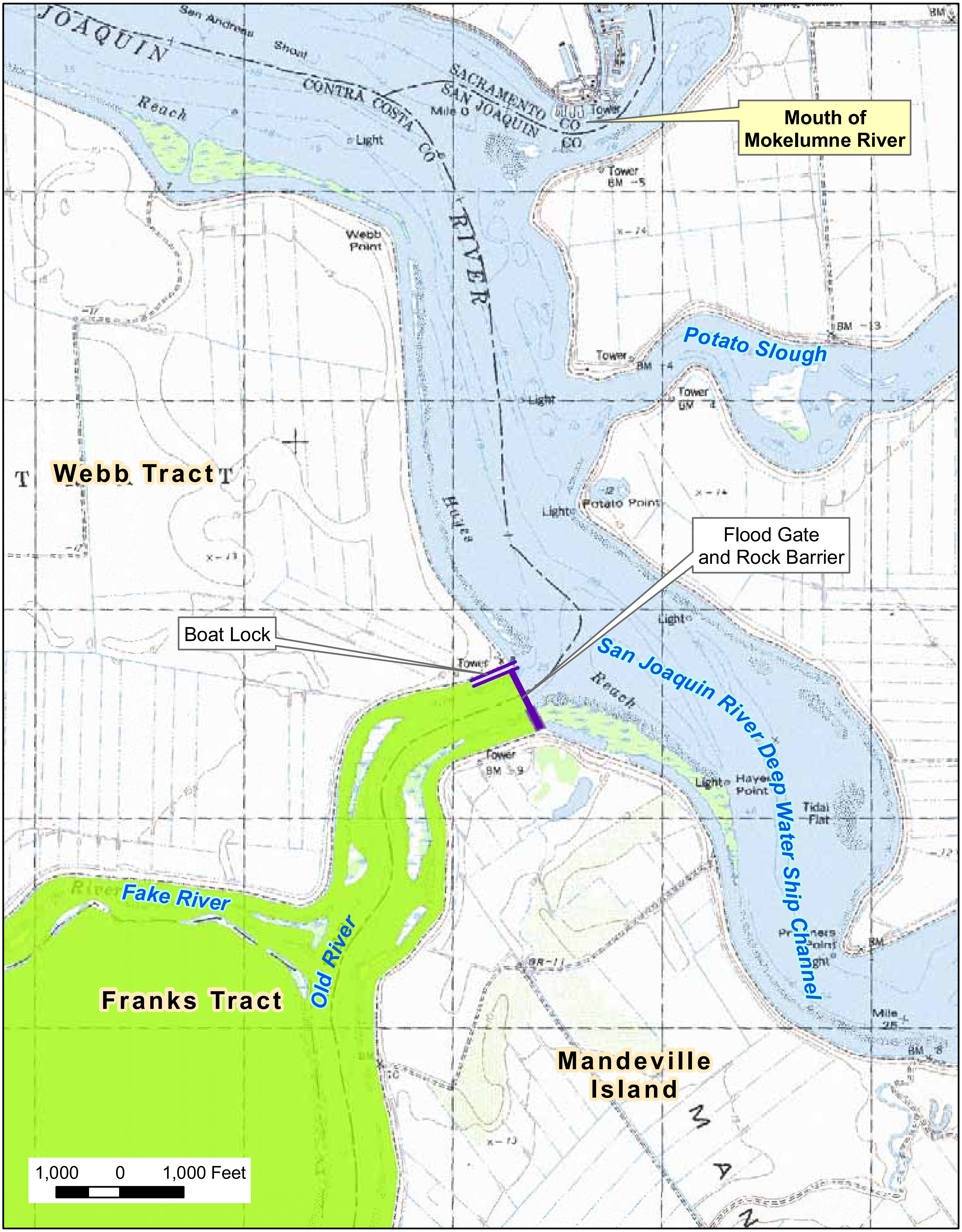
Map 6



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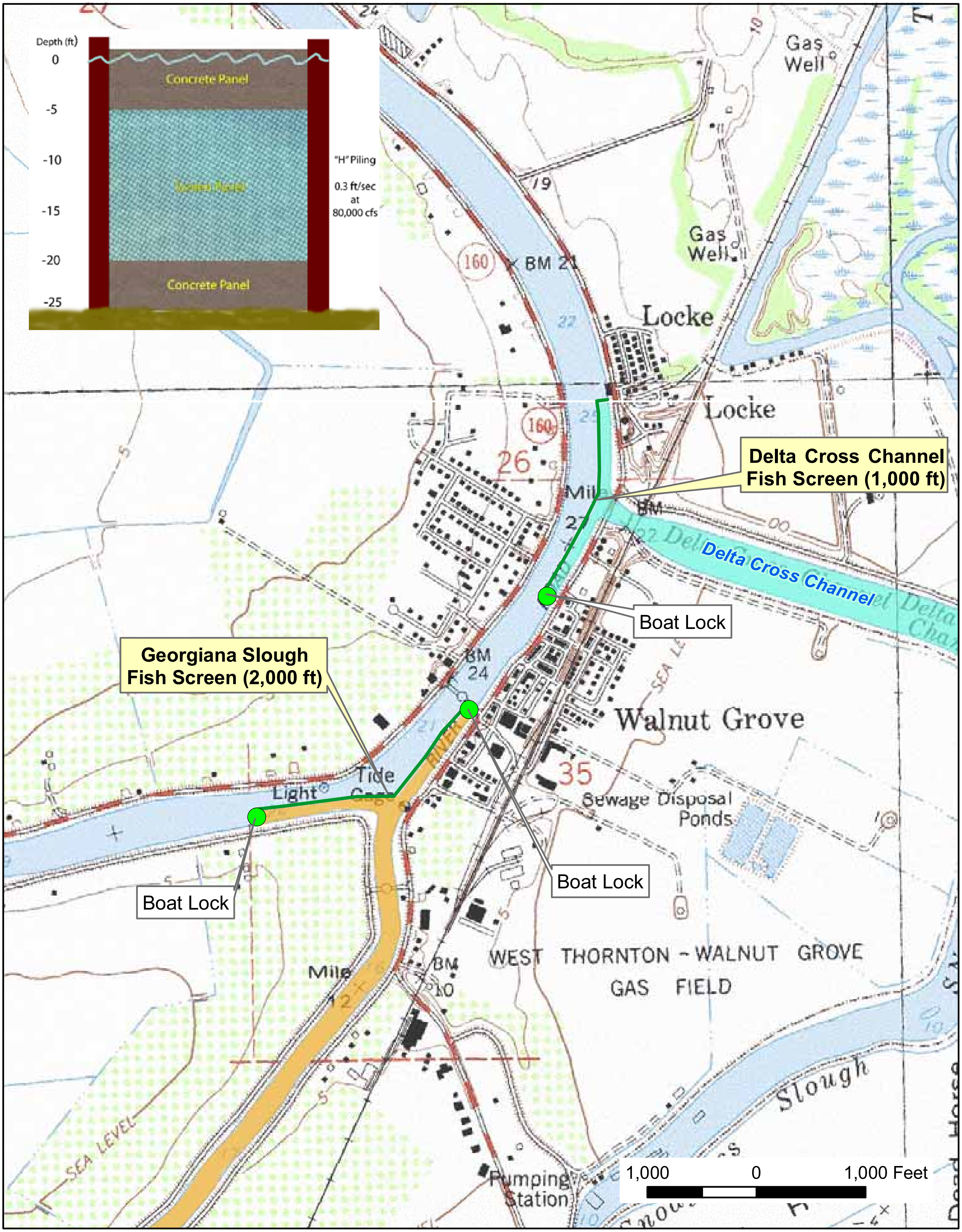
Map 7



Map 8

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Results from the initial DSM2 tidal model simulations of the DC Plan identified the changes in tidal elevations and tidal flows and net flows that would likely result from the DC Plan. The major issues that were evaluated with the DSM2 tidal flow modeling results were:

1. Would the Middle River and Victoria Canal water supply corridor have enough conveyance (channel cross- section area) to convey the full permitted Central Valley Project (CVP) and State Water Project (SWP) pumping of 11,280 cfs? The minimum elevations at the CVP and SWP pumping plants must remain above elevation -2 feet msl (0 feet NAVD) to prevent air cavitation damage to the pump blades. The calibrated DSM2 model matched the measured tidal elevations along Old River and Middle River; the model was used to calculate the tidal elevations in Middle River and Victoria Canal and West Canal with all of the water supply confined to Middle River and Victoria Canal. Increased cross-sections were simulated to increase the conveyance and reduce the tidal elevation gradient in Middle River and Victoria Canal.
2. Tidal elevations during SJR flood-flow conditions of greater than 10,000 cfs in the south Delta were evaluated with the DSM2 model. The effects of high SJR flows on higher water elevations along Old River indicated that some of the tidal-gates and flood-gates should be opened during high SJR flows. Because the measured SJR EC is about 250 uS/cm when SJR flows are greater than 10,000 cfs, this flow was initially selected as the threshold for opening the tidal gate on the SJR downstream of the head of Old River and opening the flood-gates separating Old River from West Canal at the south-end (mouth of Grant Line Canal) and at the north-end. The flood-gate at the mouth of Old River in Franks Tract would also be opened. The high SJR flows would move downstream in all Delta channels and would be pumped at the CVP and SWP intakes, just as high SJR flows move down the Delta channels and to the export pumps under existing conditions.

2 SIMULATED TIDAL ELEVATIONS AND TIDAL FLOWS FOR EXISTING CHANNELS

The existing tidal flow conditions for evaluating the proposed DC Plan were the future conditions simulated for the South Delta Improvements Program (SDIP) 2005 Draft Environmental Impact Statement/Environmental Impact Report (EIS/EIR). These future south Delta conditions would include tidal gates in the south Delta (in Middle River upstream of Victoria Canal, in Old River upstream of the DMC intake, and in Grant Line Canal at the mouth) to regulate minimum tidal elevations for agricultural diversions and at the head of Old River to protect juvenile San Joaquin River Chinook salmon and steelhead from diversion into Old River. Tidal elevations and tidal flows in all other Delta channels were not affected by the tidal gates in the south Delta channels.

The simulated Delta inflows and exports were different from historical inflows and exports and reflect current reservoir operations and Delta objectives (D-1641). The 16-year period of 1976–1991 generally is used by DWR to represent the full range of Delta hydrology (inflows) and salinity (EC) conditions. However, only the DSM2 tidal elevation and tidal flow results for August 1975, with full permitted CVP and SWP exports and maximum agricultural diversions, are shown in this report to compare the simulated existing tidal conditions and the simulated tidal conditions with the proposed DC Plan. The DSM2 results demonstrated the feasibility of using the Middle River corridor (with dredging in Middle River and Victoria Canal) to convey the full permitted CVP pumping (4,600 cfs) and SWP pumping (6,680 cfs) to the south Delta.

The following sections provide a discussion of the simulated existing conditions for August 1975, when CVP exports were 4,500 cfs and SWP pumping was 6,680 cfs. The simulated Sacramento River inflow was about 16,000 cfs and the San Joaquin River inflow was about 2,000 cfs. The simulated tidal elevations and tidal flows for this moderate inflow month characterize tidal conditions within the Delta for existing geometry with south Delta tidal gates. The simulated existing tidal conditions were compared to simulated tidal conditions with the proposed DC Plan. Tidal conditions throughout the Delta are described although the DC Plan will not change the existing tidal conditions in most of the Delta channels.

2.1 DOWNSTREAM BOUNDARY AND SUISUN BAY

Figure 2 (top graph) shows the simulated tidal elevations and tidal flows at Martinez, near the downstream end of Suisun Bay, which is the downstream DSM2 model boundary. The semi-diurnal tides (i.e., two tidal cycles per day) vary with the spring-neap lunar cycle within the month, but are generally characterized by two unequal tidal fluctuations each day. There is generally a higher-high tide followed by a lower-low tide and then a lower-high tide followed by a higher-low tide. During neap-tide periods (moon and sun offset) the two tidal variations are

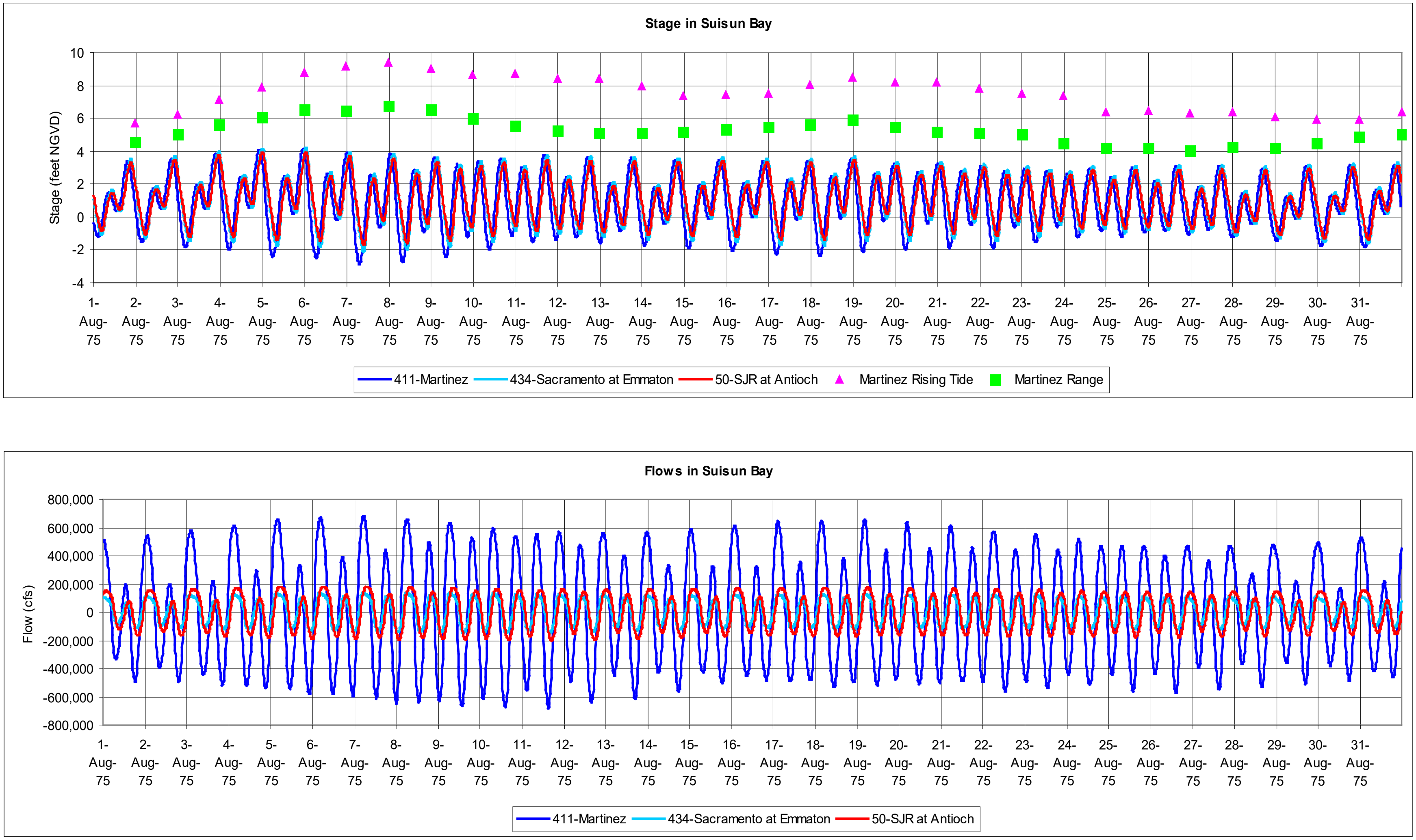

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Figure 2

Simulated Tidal Elevations and Tidal Flows at Martinez (Downstream Boundary) and at Antioch and Emmaton during August 1975 for Existing Conditions with Tidal Gates

more moderate and similar in magnitude. The tidal period is about 24.75 hours, so the high tide occurs about 45 minutes later each day. The high tide occurs on the second tidal cycle on August 1, but this high tide crosses the midnight line on August 7 to become the first tidal cycle; the high tide "switches" to the second tidal cycle about August 10, and switches back to the first tidal cycle on August 24. This daily sequence of unequal tidal variations will be slightly different for each month because of seasonal changes in the earth's orbit and rotation angle.

The tidal variations can be summarized either by the daily tidal elevation range (high tide minus low tide) or by the total rising-tide elevation (cumulative rise during the flood-tide periods) within each day. Both these measures of tidal variation are shown on the top graph of Figure 2. The average tidal range at Martinez was about 5.25 feet and the average tidal-rise was about 7.5 feet for the historical August 1975 tides. The minimum tidal range was about 4 feet and the maximum tidal range was more than 6 feet during spring-tide periods (e.g., August 7). The minimum tidal-rise was about 6 feet and the maximum tidal-rise was about 9.5 feet (also on August 7). The DSM2 model accurately simulates the tidal flows throughout the Delta channels for this range of tidal fluctuations and upstream surface area (i.e., geometry). The simulated tidal variations at Emmaton (Sacramento River) and Antioch (San Joaquin River) were only slightly smaller than at Martinez. The high tides were slightly less and the low tides were slightly more at these upstream locations. The tidal variations were delayed at these upstream stations, with the high tides delayed by about an hour and the low tides delayed by about 2 hours from the Martinez tides.

Figure 2 (bottom graph) shows the simulated tidal flows at Martinez (downstream boundary) and at Antioch (San Joaquin River side of the Delta) and at Emmaton (Sacramento River side of the Delta). The tidal flows at Martinez were very large, with maximum upstream (flood-tide) flows of about 600,000 cfs during spring-tide (moon and sun aligned) periods with the greatest tidal range (e.g., August 7). These simulated tidal flows were somewhat reduced at upstream locations because some of the tidal volume fills Suisun Bay, and the tidal flow is then split between the Sacramento and San Joaquin River channels, so the maximum simulated flood-tide flows were about 200,000 cfs at Antioch and about 175,000 cfs at Emmaton. Because the tidal flows fluctuate throughout the tidal cycle, the tidal flows can be summarized with the average flood-tide flow (flows greater than the average flow) and average ebb-tide flow (flows less than the average flow). If these are adjusted to 12-hr average flows, the flood-tide flow and the ebb-tide flow are equal. The average simulated 12-hr tidal flow at Martinez was about 339,000 cfs, the average simulated 12-hr tidal flow at Antioch was about 108,000 cfs, and the average simulated 12-hr tidal flow at Emmaton was about 79,000 cfs.

2.2 Tidal Volumes and Tidal Energy

Figure 3 shows the calculated tidal flows (top graph) and tidal volumes (bottom graph) in the Sacramento River at Emmaton and in the San Joaquin River at Antioch for existing conditions with tidal gates for August 1975. The positive (ebb-tide) tidal volume is the cumulative tidal flow volume from high tide to low tide, with the tidal flow moving downstream. The negative (flood-tide) tidal volume is the cumulative tidal flow volume from low tide to high tide, with the tidal flow moving upstream. Emmaton and Antioch are both about 5 miles upstream of the confluence of the Sacramento and San Joaquin Rivers near Collinsville. The tidal volumes at these two locations include all the tidal flow moving into and out of these two major upstream sections of the Delta. The cumulative tidal flow volumes for both tidal cycles are more uniform from day to day than the daily fluctuations in tidal flows would indicate; the tidal flow volumes for both tidal cycles reflect the daily tidal rise and are sometimes called the tidal prism (tidal change in upstream channel volume).

Tidal flows are controlled by the changes in tidal elevations at the downstream model boundary at Martinez. The net flows from river inflows or from Delta exports or channel diversions are generally superimposed (i.e., added) to the tidal flows in each channel segment. The flood-tide volume and ebb-tide volume are identical for the same tidal elevation change, if the tidal volumes are calculated as the cumulative flows greater than or less than the net flow. For August 1975 conditions the average (net) flow in the San Joaquin River at Antioch was -1,642 cfs (upstream) and the average 12-hr San Joaquin River tidal flow was about 108,000 cfs, which is a tidal volume of about 108,000 acre-feet (af) during the two ebb-tide periods (12-hours) because 1 cfs x 12 hours is about 2 af. The average (net) flow in the Sacramento River at Emmaton was 5,557 cfs and the average Sacramento River tidal flow was about 79,000 cfs, which is a tidal volume of about 79,000 af during the two ebb-tide periods (12-hours). Because of the character of San Francisco Bay tides, the flood-tides (negative flow volume) are more uniform than the ebb-tides (positive flow volume), which usually include a higher-high to lower-low major tidal outflow each day. The average flood-tide volume (6-hours) of about 40,000 af on the Sacramento River side of the Delta suggests that the upstream surface area is about 13,500 acres. Filling this upstream area with an average 3-foot tidal prism requires about 40,000 af. The average flood-tide volume (6-hours) of about 54,000 af on the San Joaquin River side of the Delta suggests that the upstream area is about 18,000 acres including the Mokelumne River channels which are tidally connected to the San Joaquin River.

[Note: The DSM2 model geometry did not include the 5,200 acres of flooded Liberty Island in the Yolo Bypass north of Cache Slough. Therefore, the upstream surface area for the Sacramento River at Emmaton is about 18,500 acres and the tidal flows and tidal volumes in the Sacramento River at Emmaton would be higher than simulated with DSM2 for this comparative study. Recent DSM2 simulations indicate that the tidal flows in the Sacramento River at Emmaton with flooded Liberty Island are about 101,000 cfs and the tidal flows in the San Joaquin River at Antioch are about 105,000 cfs].

The energy needed to produce these flood-tide flows can be estimated. The potential energy of the tidal prism at each high tide is calculated from the tidal volume and the average elevation

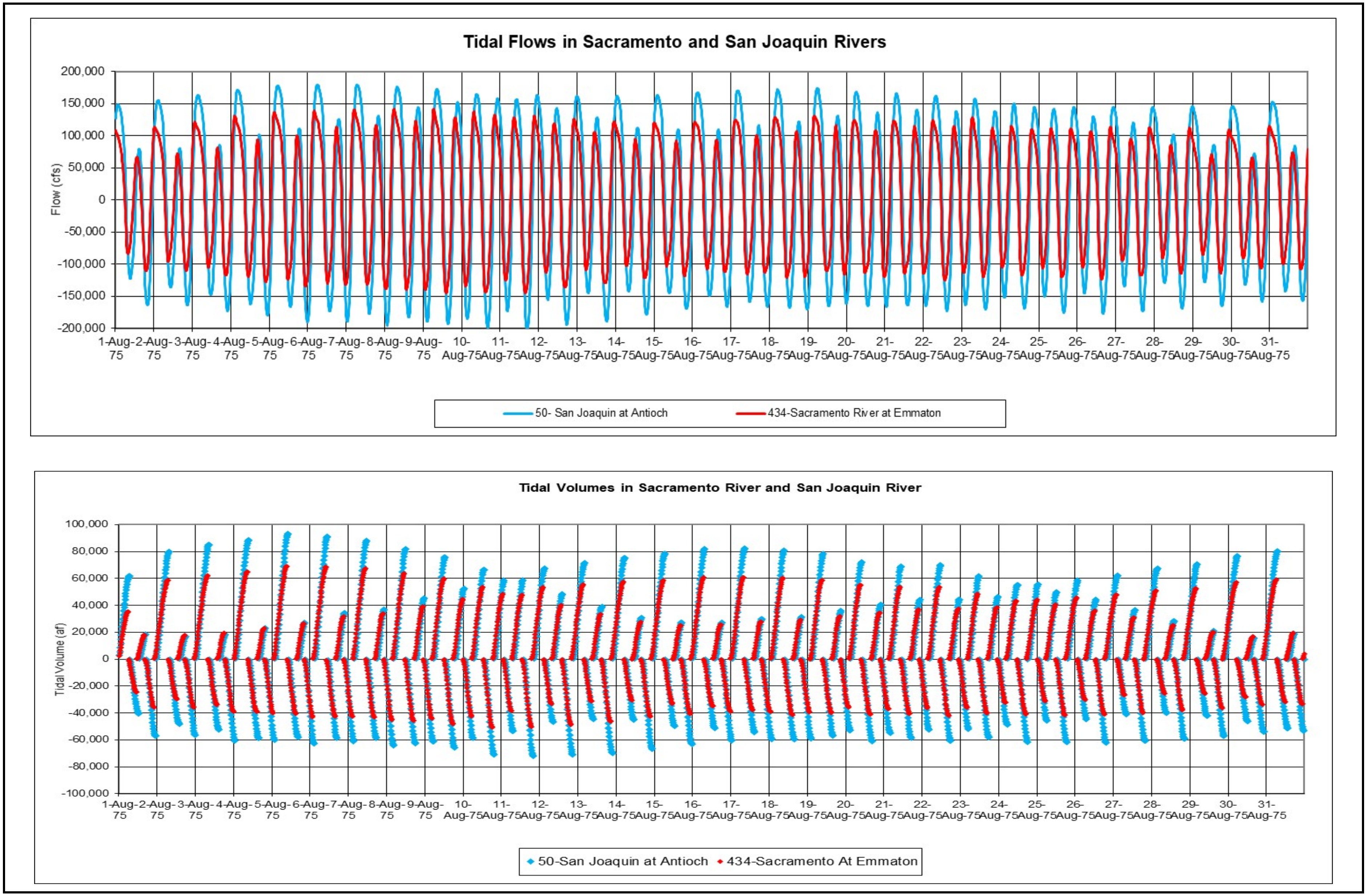

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Figure 3

Simulated Tidal Flows and Tidal Volumes in the Sacramento River at Emmaton and in the San Joaquin River at Antioch during August 1975 for Existing Conditions with Tidal Gates

rise (about 1.5 feet). The energy (kilowatt-hours [kWh]) in each flood tide is equal to the flood-tide volume (af) times the elevation change (feet) because, conveniently, the unit conversion between these units is about 1. Because there are about 2 high tides each day, the tidal energy of the Sacramento River upstream of Emmaton is about 120,000 kWh per day (i.e., 40,000 af x 1.5 feet x 2), which is equivalent to a 5.0-megawatt (MW) power plant. The tidal energy of the San Joaquin River upstream of Antioch is about 162,000 kWh per day (i.e., 54,000 af x 1.5 feet x 2), which is equivalent to a 6.8-MW power plant. This tidal energy is responsible for the movement of the water within the Delta channels, including the transport of Sacramento River water "across" the Delta to the south Delta pumping plants. The daily tidal energy (kWh) at any location can be estimated from the upstream tidal area (acres), assuming the average tidal prism is about 3 feet, as the upstream area (acres) times about 9.

2.3 Sacramento River Channels

Figure 4 shows the simulated tidal elevations and flows along the Sacramento River channels for existing conditions with tidal gates during August 1975. The tidal elevation variations at Emmaton and Rio Vista were generally the same, with a tidal range of –2 feet to about 4.5 feet mean sea level (msl). [Note: The DSM2 model and measured tidal elevations before 2010 used the 1929 NGVD datum (mean sea-level); the DSM2 model and measured tidal elevations are now reported using the 1988 NAVD datum. The difference is about 2 feet; an elevation of -2 feet (msl) on the graphs in this report is an elevation of 0 feet (NAVD)].

The peak tidal flows at Emmaton were about 125,000 cfs, although the daily peak tidal flows ranged from about 110,000 cfs to 140,000 cfs during the month (±10% of the mean) and the 12-hr average tidal flow was about 79,000 cfs. The tidal flows upstream of Rio Vista ranged from about –10,000 cfs to 15,000 cfs and the 12-hr average tidal flow was about 6,000 cfs. The tidal flows entering Cache Slough ranged from –40,000 cfs to 50,000 cfs during the month (±10% of the mean) and the 12-hr average tidal flow was 27,000 cfs. The tidal flows in Cache Slough had a "truncated" shape, where the initial flood or ebb tide flow is highest and the tidal flow decreases during the remainder of the tidal period. The tidal flows in Threemile Slough, connecting the Sacramento and San Joaquin Rivers, ranged from about 30,000 cfs to about –40,000 cfs and the 12-hr average tidal flow was about 21,000 cfs. Threemile Slough flows were like flows in a tributary to the Sacramento River, because the flood-tide entered Threemile Slough and flowed into the San Joaquin River, while ebb-tide flowed from the San Joaquin River into the Sacramento River.

Figure 5 shows the simulated tidal elevations and tidal flows in Sutter and Steamboat Sloughs for existing conditions with tidal gates during August 1975. The tidal elevations at the Sutter Slough and Steamboat Slough heads (upstream ends) ranged from about 1 foot to about 4.5 feet msl. The high tides were the same as at Rio Vista and Emmaton, but the low tides were 1-2

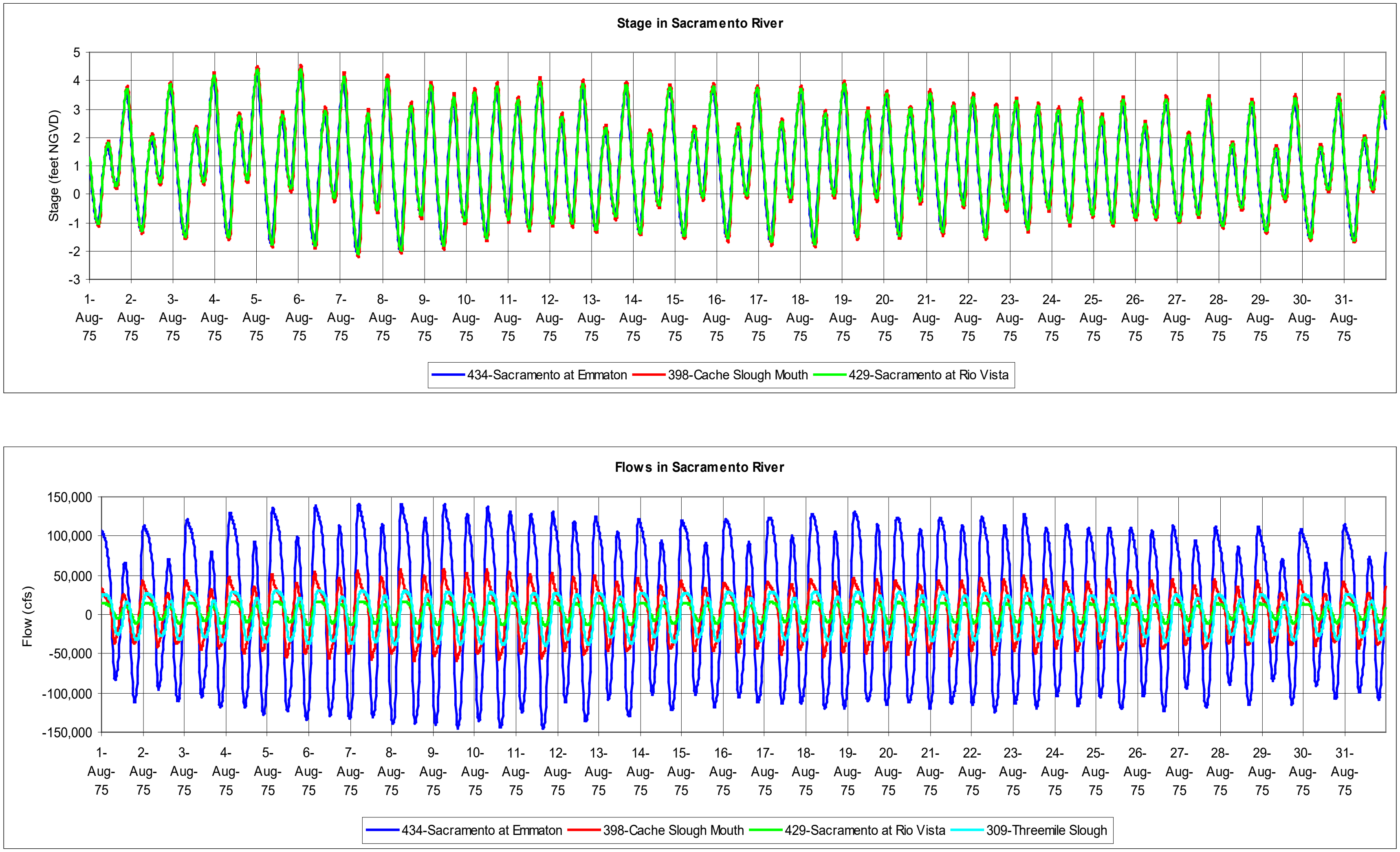

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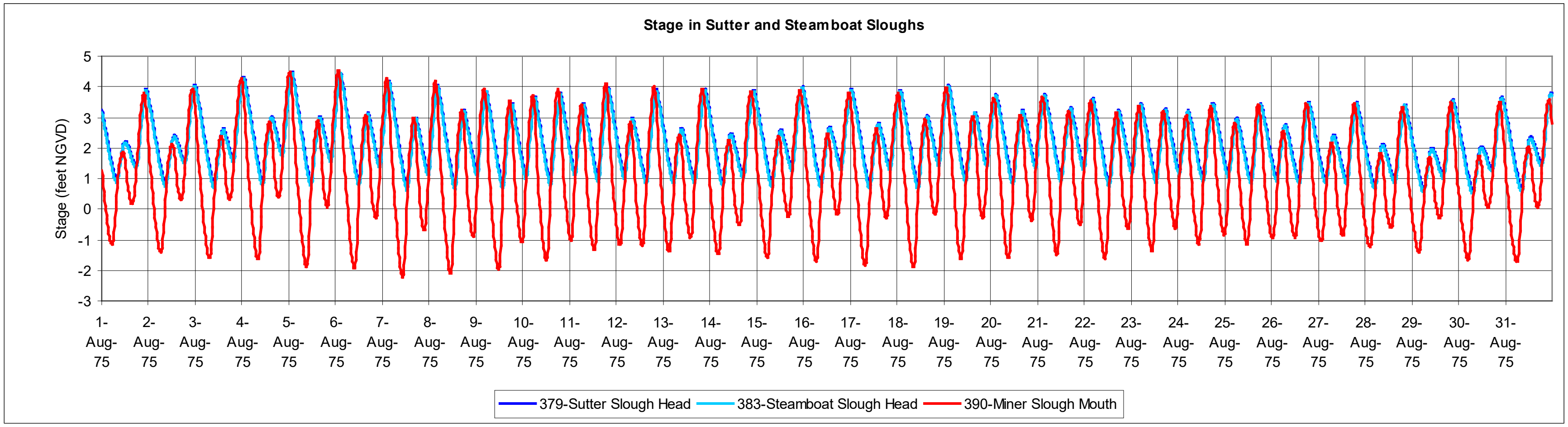
Figure 4

Simulated Tidal Elevations and Tidal Flows in Sacramento River Channel during August 1975 for Existing Conditions with Tidal Gates



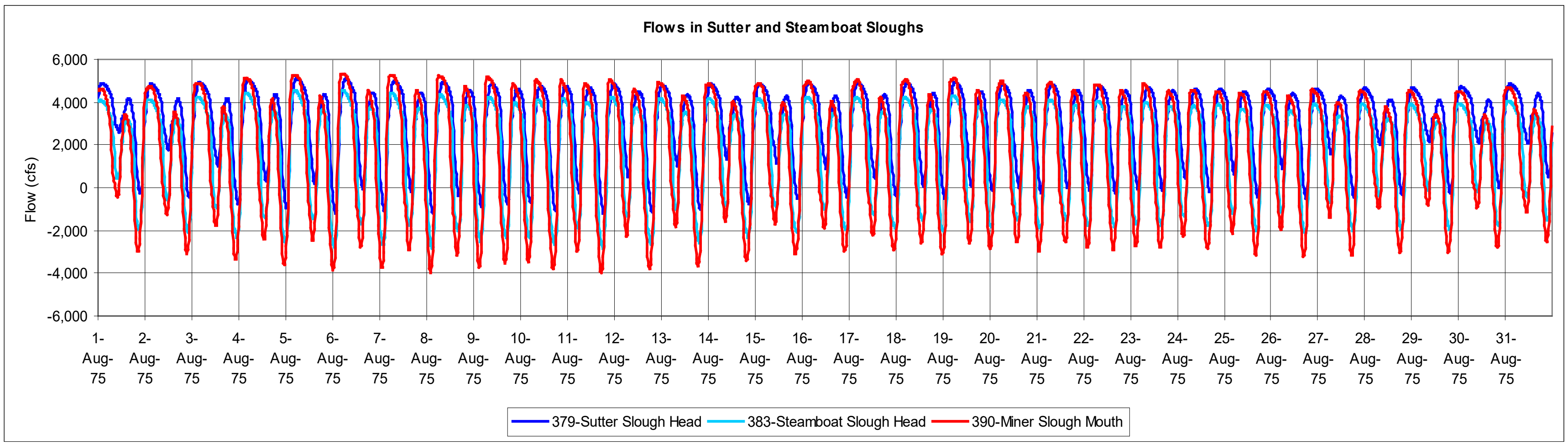


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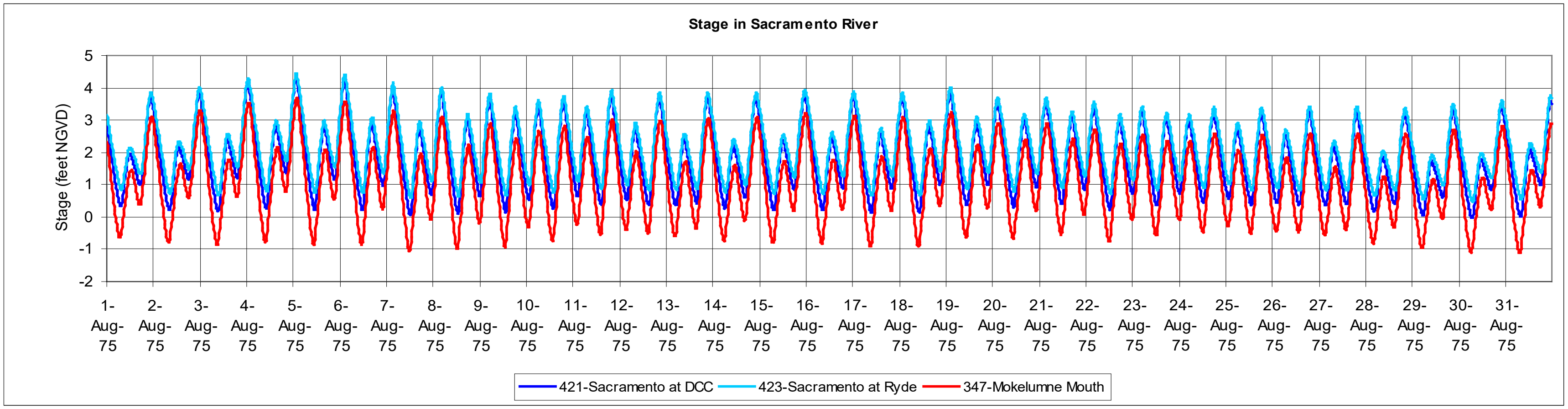
Figure 5

Simulated Tidal Elevations and Tidal Flows in Sutter and Steamboat Sloughs during August 1975 for Existing Conditions with Tidal Gates

feet higher because the Sacramento River upstream of Rio Vista had a riverine gradient (i.e., downstream slope) during low tides. The ebb-tide diversions into Sutter and Steamboat Sloughs were similar, with a maximum flow of about 5,000 cfs into Sutter and about 4,500 cfs into Steamboat, and the minimum ebb-tide flows were about 0 cfs to –1,000 cfs (during spring-tide periods). The 12-hr average tidal flow at the upstream end of Sutter Slough was about 2,000 cfs and the 12-hr average tidal flow at the upstream end of Steamboat Slough was about 2,500 cfs. Most of the Sutter Slough flow (upstream Sacramento River diversion) moved into Miners Slough. Steamboat Slough (located just downstream of Sutter Slough) flows returned to the Sacramento River just upstream of Rio Vista. An average of about 3,000 cfs was diverted into Sutter Slough and about 1,800 cfs was diverted into Steamboat Slough in August when the Sacramento flow was 16,000 cfs and the DCC gates were open. The Sutter and Steamboat diversions were about 30% of the Sacramento River flow and increased to about 35% when the DCC gates were closed.

Figure 6 shows the simulated tidal elevations and tidal flows in the Sacramento River near the DCC and Georgiana Slough for existing conditions with tidal gates during August 1975. The DCC and Georgiana Slough diversions depend on the tidal elevation differences between the Sacramento River at Walnut Grove and the Mokelumne River at New Hope Landing. The minimum simulated tide elevation at Ryde (downstream of Georgiana Slough) was about 0.5 feet msl, and the maximum simulated tide elevation was about 4 feet msl. The tidal elevations at Ryde were higher than the corresponding elevations at the DCC at low tide and during flood tide (rising tide elevation), causing a simulated upstream Sacramento River flow with a maximum of about –5,000 cfs during the high tide period of each day. The simulated tidal flows in the DCC and Georgiana Slough were highest during flood tide when upstream tidal flow from Ryde met the downstream river flow and “squeezed” water into the diversion channels. For August 1975, the simulated Freeport flow was about 16,000 cfs, and diversion flows into DCC and Georgiana Slough ranged from about 2,500 cfs to 12,500 cfs with an average diversion of about 7,250 cfs (45% of the Sacramento River flow). Because the diversions into Sutter and Steamboat Sloughs was about 30% of the Sacramento River flow, about 25% of the Sacramento River flow continued past Georgiana Slough to Rio Vista.

Figure 7 shows the simulated Sacramento River flow upstream of Walnut Grove and the diversion flows into the DCC and Georgiana Slough for existing conditions with tidal gates during August 1975. The Sacramento River flow upstream of the DCC ranged from about 6,000 cfs to about 15,000 cfs with an average of about 11,000 cfs. The simulated DCC flows were greater than the simulated Georgiana Slough flows, because the DCC has a larger simulated cross section. The DCC diversion flows ranged from about 2,000 cfs to about 8,000 cfs, with an average of 4,500 cfs, while the Georgiana Slough diversion flows ranged from about 1,500 cfs to about 4,500 cfs with an average of about 2,750 cfs. The 12-hr average tidal flow in the DCC was about 1,300 cfs and the 12-hr average tidal flow in Georgians Slough was about 700 cfs.



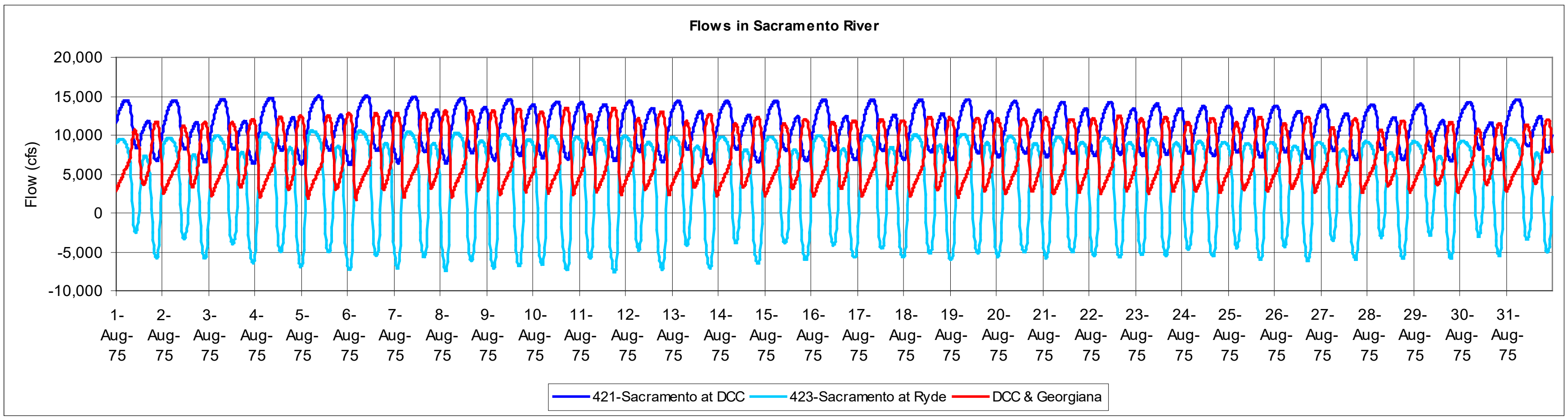


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Figure 6

Simulated Tidal Elevations and Tidal Flows in Sacramento River near the Delta Cross Channel and Georgiana Slough during August 1975 for Existing Conditions with Tidal Gates

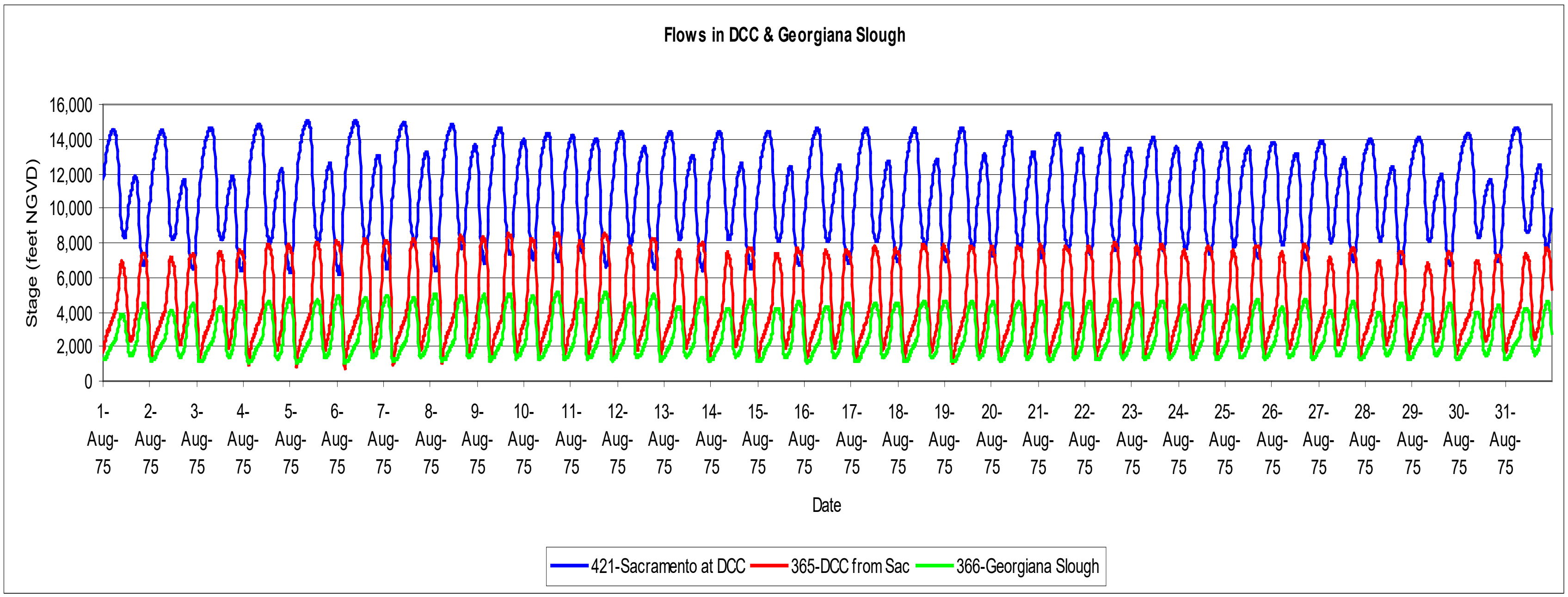

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Figure 7

Simulated Tidal Flows in the Delta Cross Channel and Georgiana Slough during August 1975 for Existing Conditions with Tidal Gates

These tidal flows along the Sacramento River channels, including the diversions from the Sacramento River into Sutter Slough and Steamboat Slough, the DCC, and Georgiana Slough are controlled by the existing channel geometry and the Sacramento River inflow and will not likely be changed substantially by any of the proposed DC Plan features. However, the fish-screens at Georgiana Slough and at the DCC may reduce the diversions into these channels; this would increase the Sacramento River elevations slightly and may increase the diversions to Sutter and Steamboat Sloughs. Threemile Slough diversions from the Sacramento River are controlled by the tidal elevations at the two ends of Threemile Slough and may be changed by the DC Plan features.

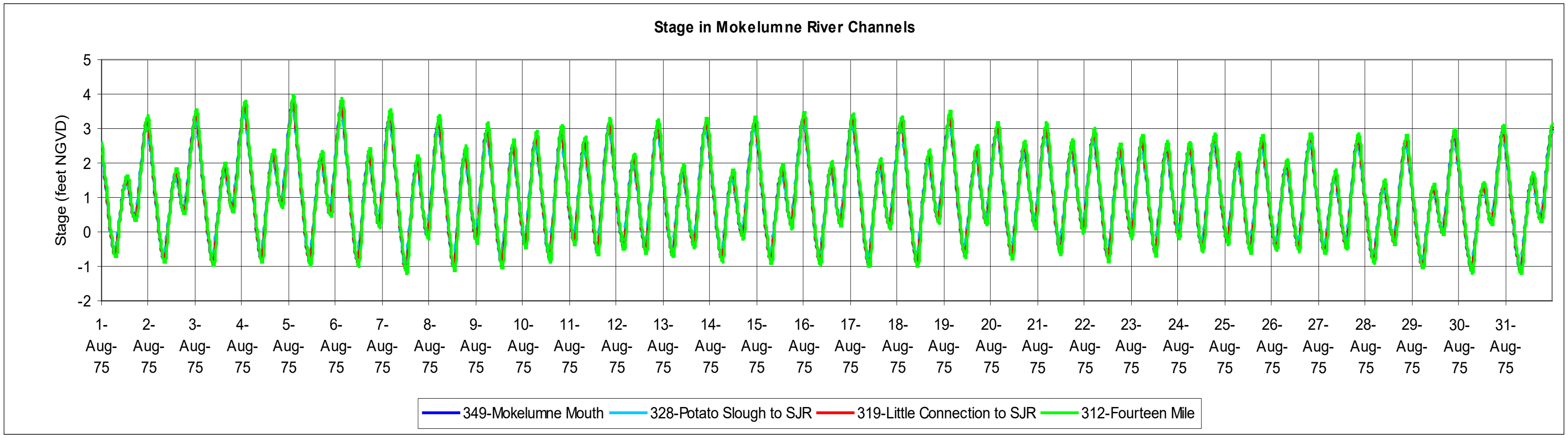
2.4 Mokelumne River Channels

Figure 8 shows the simulated tidal elevations and tidal flows in the Mokelumne River channels connecting to the San Joaquin River for existing conditions with tidal gates during August 1975. The Sacramento River diversions into DCC and Georgiana Slough, combined with the Mokelumne River and Cosumnes River inflows, provide the net flows in these channels. The tidal elevations at the mouth of these Mokelumne River channels ranged from about –1 foot to about 4 feet msl, and were very similar to the tidal fluctuations at Antioch. The simulated net outflow toward the San Joaquin River was about 5,250 cfs for the Mokelumne River, about 1,500 cfs in Little Connection Slough (east side of Venice Island), and about 1,000 cfs in Disappointment Slough (southeast side of Empire Tract). Potato Slough had almost no net flow but had a large tidal flow that moved from the San Joaquin River channel, around Venice Island, and back to the San Joaquin River channel through Little Connection Slough. There was almost no net flow in Fourteen Mile Slough.

The simulated tidal flows at the mouth of the Mokelumne River were dominated by the ebb tide (outflow toward the San Joaquin River and the bay) because the DCC and Georgiana Slough diversions from the Sacramento River (about 7,500 cfs for August 1975) provided a strong net outflow from these Mokelumne River channels. The simulated peak ebb-tide flows at the Mokelumne River mouth were about 10,000 cfs and the 12-hr average tidal flow was about 5,300 cfs. The peak simulated tidal flows at the downstream end of Potato Slough were about 12,000 cfs and the 12-hr average tidal flow was about 9,000 cfs. The net flow was just -139 cfs because this channel behaves like a side-channel to the San Joaquin River. The simulated 12-hr average tidal flows in Little Connection Slough were about 900 cfs, and the tidal flows in Disappointment and Fourteen Mile Slough were less than 500 cfs.

2.5 San Joaquin River Channels

Figure 9 shows the simulated tidal elevations and tidal flows in the lower San Joaquin River between Antioch and San Andreas Landing, just downstream of the mouth of the Mokelumne



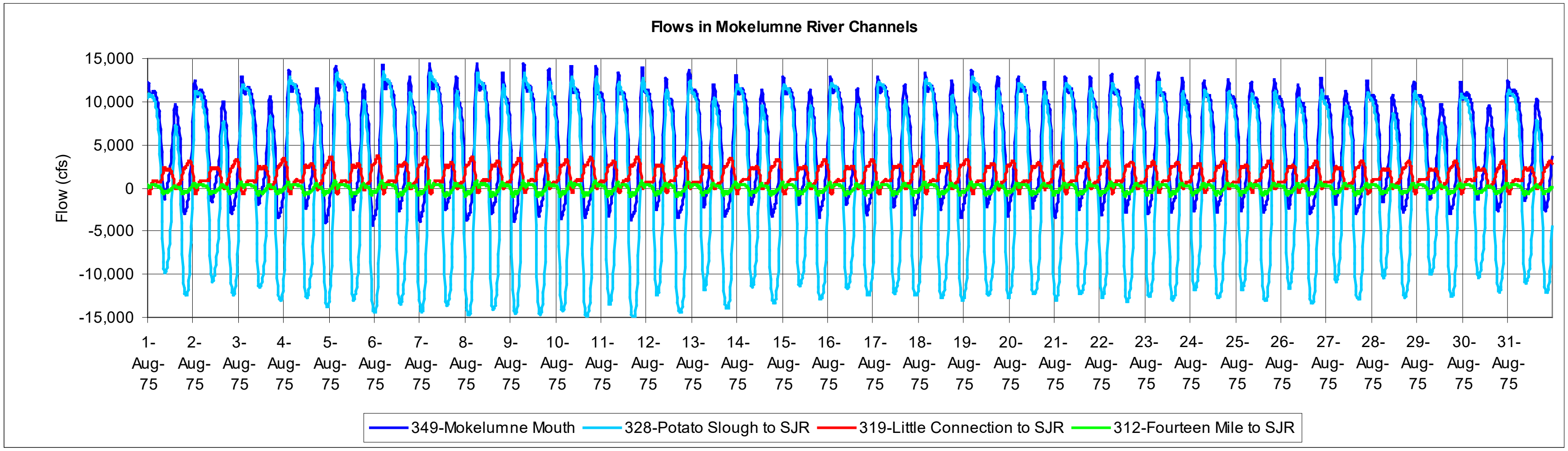


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Figure 8

Simulated Tidal Elevations and Tidal Flows in the Mokelumne River Channels Connecting with the San Joaquin River during August 1975 for Existing Conditions with Tidal Gates

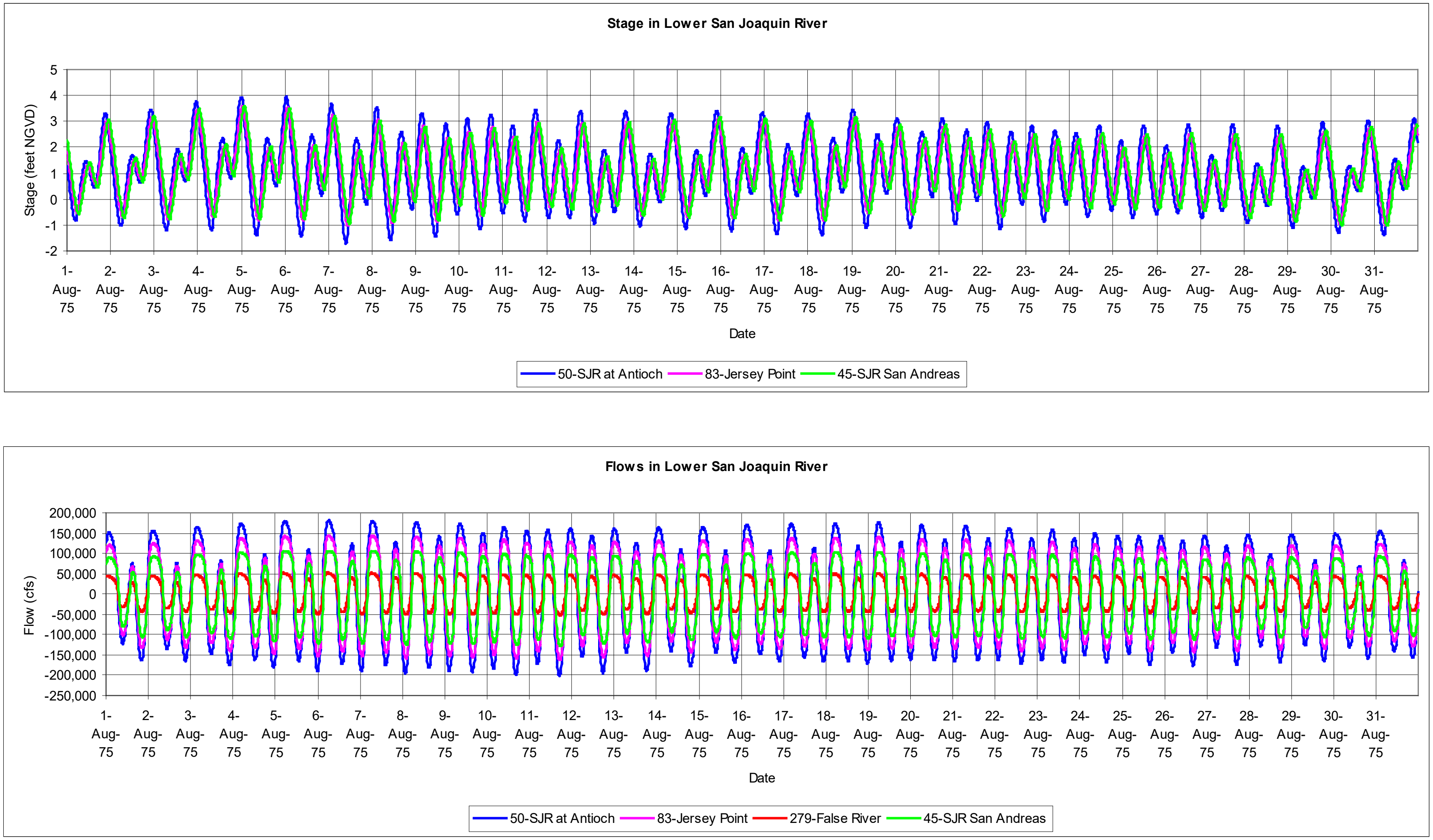

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Figure 9

Simulated Tidal Elevations and Tidal Flows in the Lower San Joaquin River Channels during August 1975 for Existing Conditions with Tidal Gates

River. The tidal elevations at Antioch ranged from about –1.5 feet to 4 feet msl. The tidal range at the mouth of the Mokelumne was slightly less, about –1 foot to 3.5 feet msl. The peak tidal flows at Antioch were about 150,000 cfs and the 12-hr average tidal flow was about 108,000 cfs. The 12-hr average tidal flows upstream at Jersey Point were about 91,000 cfs. The 12-hr average tidal flows in False River, connecting to Franks Tract and Old River, were about 32,000 cfs, and the 12-hr average tidal flows at San Andreas Landing were about 72,000 cfs. The tidal flows at San Andreas include the tidal flows of about 21,000 cfs from Threemile Slough, connecting with the Sacramento River.

Figure 10 shows the simulated tidal elevations and tidal flows in the vicinity of Franks Tract. The tidal elevation ranged from about –1 foot to about 3.5 feet msl. The tidal fluctuations on Old River at Bacon Island (upstream of Franks Tract) were about 1.5 to 2 hours delayed from the high and low tides at the mouth of Old River or at False River. Three channels connect the San Joaquin River channel to Franks Tract. The downstream connection is Dutch Slough, located upstream of Antioch. The simulated 12-hr average tidal flow in Dutch Slough was about 6,000 cfs, and the net flow was about –500 (upstream). False River is the major channel connecting Franks Tract with the San Joaquin River. The simulated maximum tidal flows in False River ranged from about –50,000 to 50,000 during the month and the 12-hr average tidal flow was about 32,000 cfs, with a net flow of just 720 cfs. The Old River mouth is across the San Joaquin River from the Mokelumne River mouth and had tidal flows that ranged from about –20,000 cfs to about 10,000 cfs with a 12-hr average tidal flow of about 10,000 cfs. The simulated net flow was about –5,700 cfs (upstream). The simulated Old River flow at Bacon Island, located upstream of Franks Tract, ranged from 5,000 cfs to about –20,000 cfs and the 12-hr average tidal flow was about 8,500 cfs with a net flow of about –5,700 cfs (upstream). This net upstream flow in Old River supplies about half of the CVP and SWP exports as well as half the agricultural diversions in the central and south Delta channels.

Figure 11 shows the simulated tidal elevations and tidal flows in the San Joaquin River upstream of the Old River mouth. The simulated tidal elevation ranged from about –1 foot to about 4 feet msl. The simulated 12-hr average tidal flow above Columbia Cut was about 11,000 cfs, the 12-hr average tidal flow above Turner Cut was about 6,500 cfs, and the 12-hr average tidal flow at Garwood Bridge, upstream of the Stockton Deep Water Ship Channel [DWSC], was about 1,850 cfs, with a net flow of about 1,400 cfs at Garwood and upstream at Turner Cut. Diversions from the San Joaquin River at Turner Cut, Columbia Cut, and the mouth of Middle River into the Middle River channel supplied about half of the CVP and SWP exports as well as half the agricultural diversions in the central and south Delta channels.

Figure 12 shows the simulated tidal elevations and tidal flows along the San Joaquin River upstream from Stockton near the head of Old River. This is the upstream end of the Delta on the San Joaquin River side, and the nearest inflow to the export pumps in the south Delta. The simulated tidal influence extended far upstream of Stockton to the Paradise Flood-Control Weir,

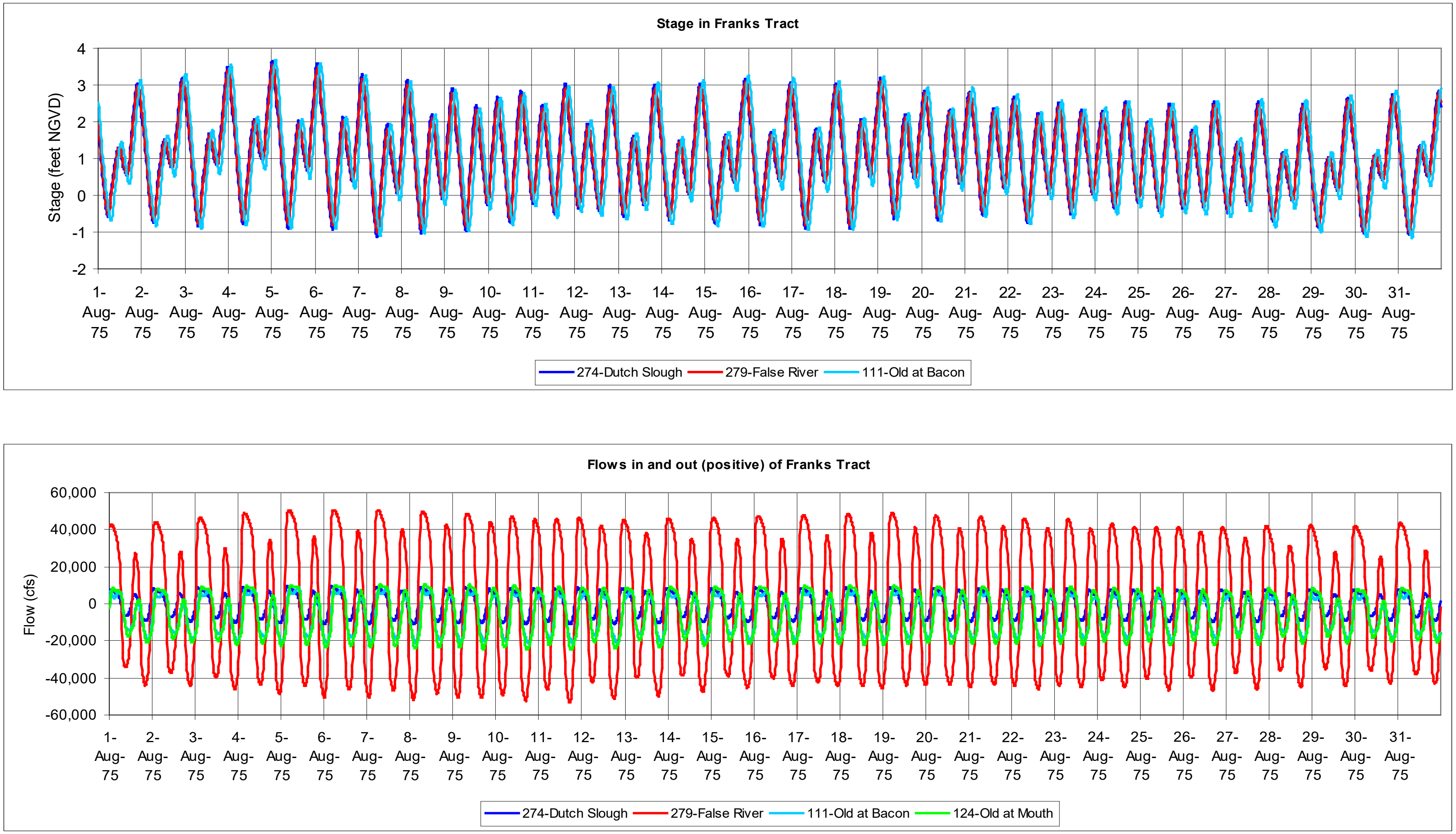

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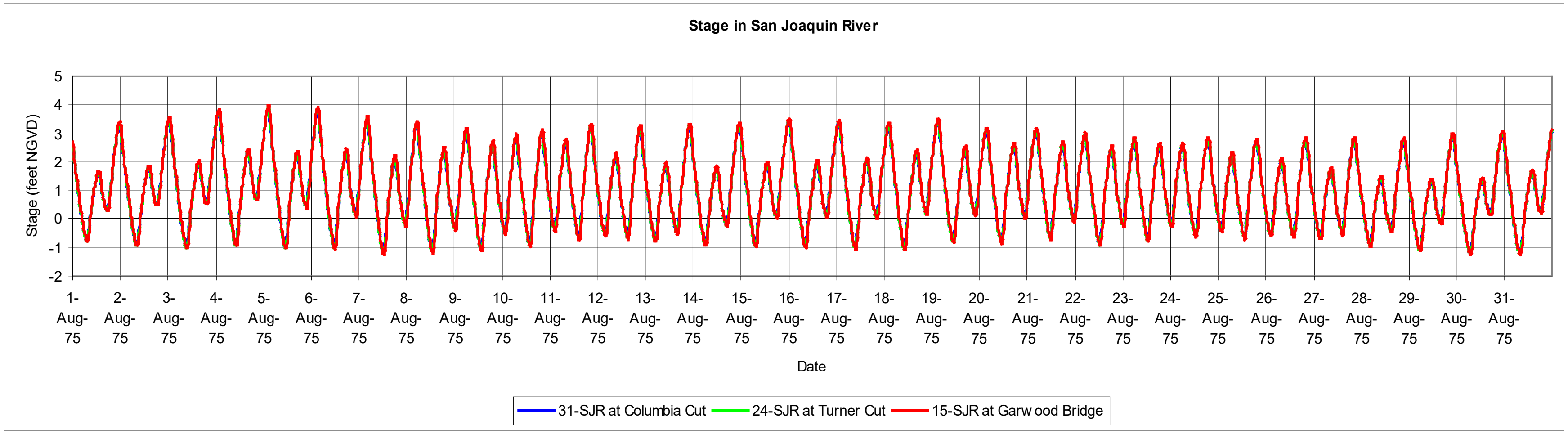
Figure 10

Simulated Tidal Elevations and Tidal Flows near Franks Tract during August 1975 for Existing Conditions with Tidal Gates



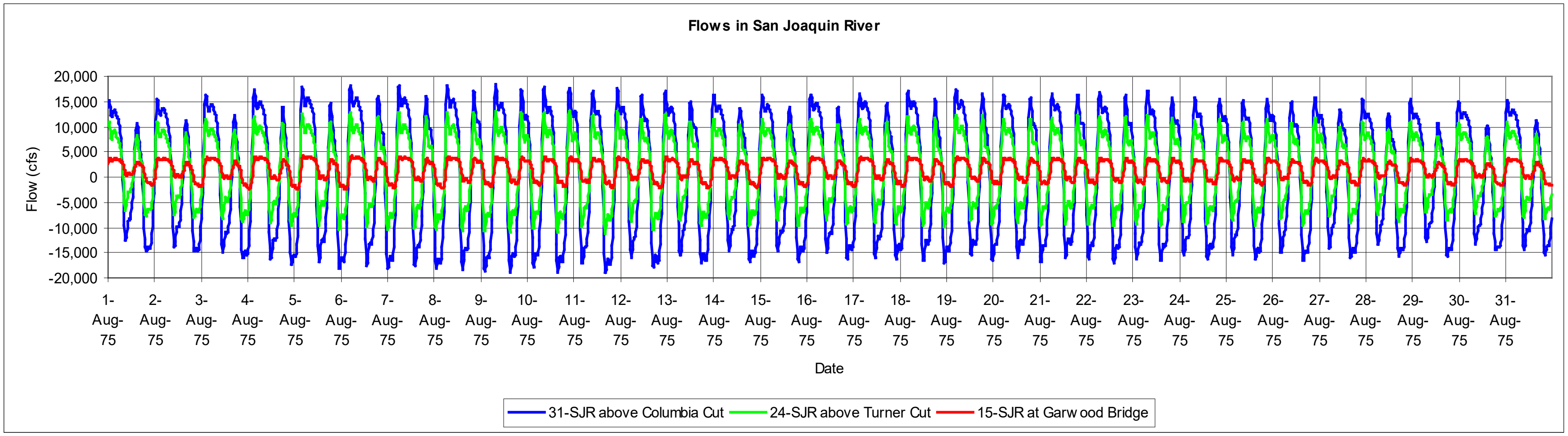


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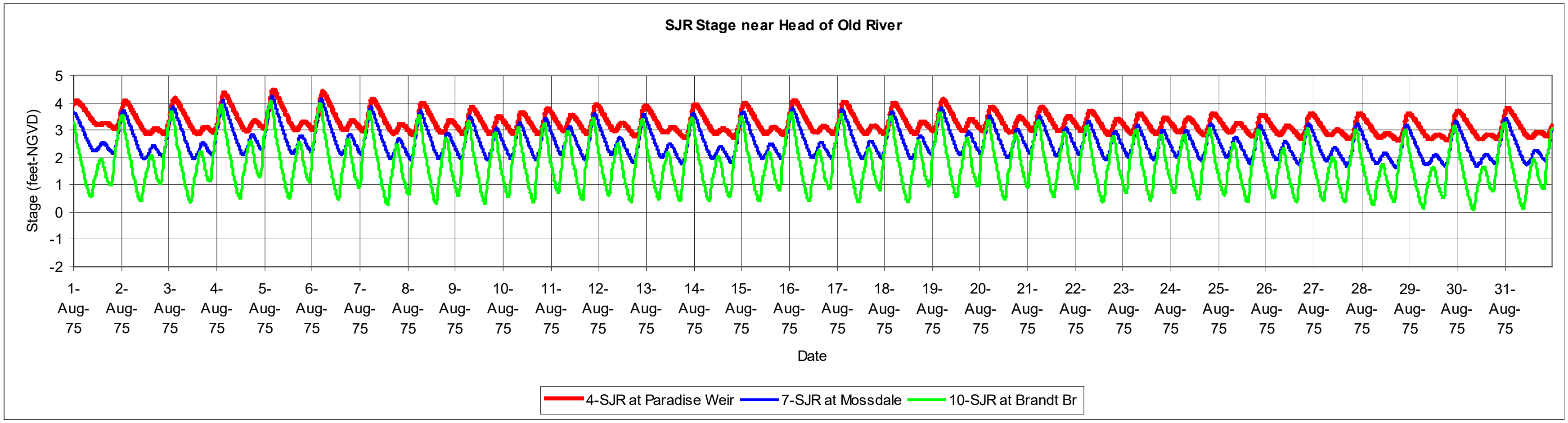
Figure 11

Simulated Tidal Elevations and Tidal Flows in the San Joaquin River Channels Upstream of the Mouth of Old River during August 1975 for Existing Conditions with Tidal Gates



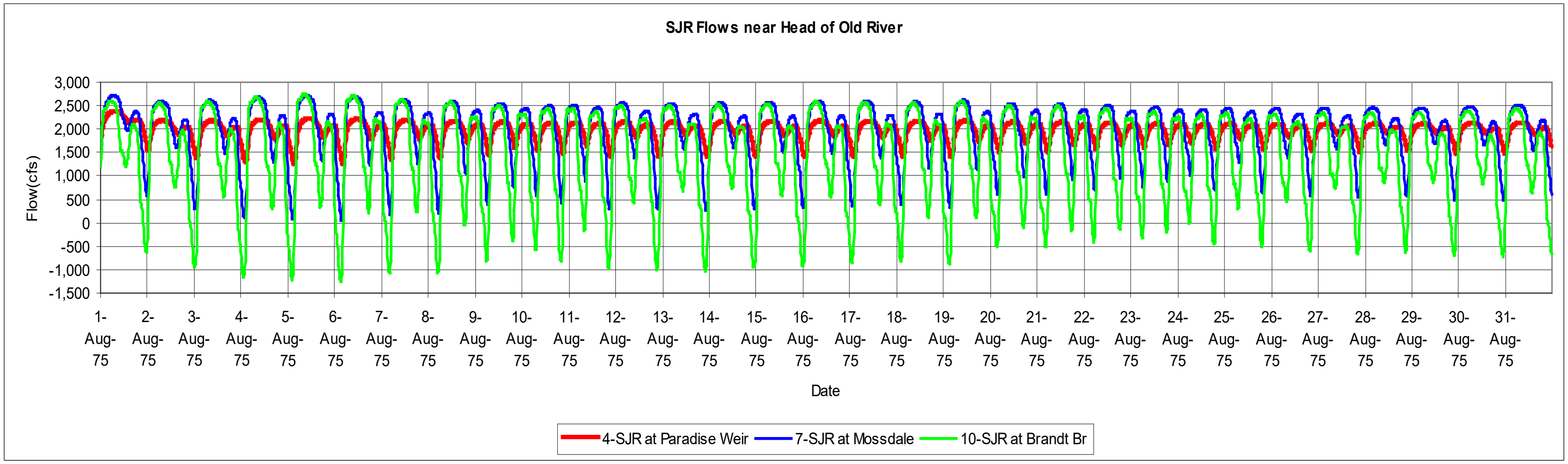


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Figure 12

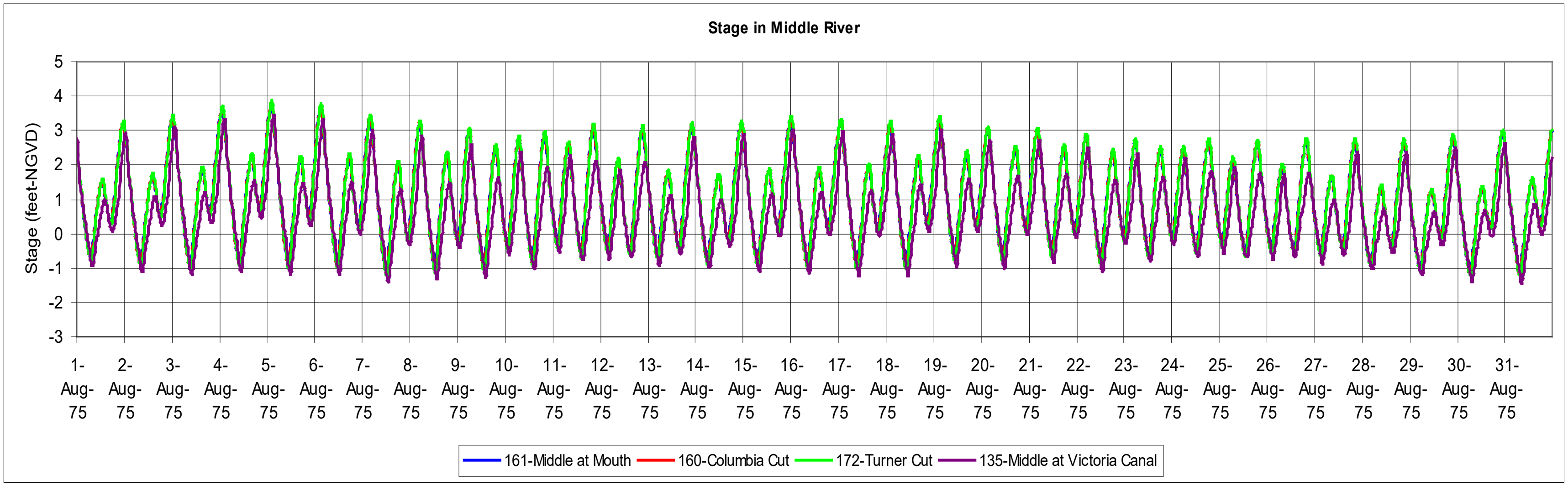
Simulated Tidal Elevations and Tidal Flows along the San Joaquin River near the Head of Old River during August 1975 for Existing Conditions with Tidal Gates

located at San Joaquin River mile 61, about 21 miles upstream of Stockton and about 11 miles downstream of Vernalis, which is at San Joaquin River mile 72. The simulated water elevation fluctuated from about 3 feet to 4.5 feet msl at the Paradise Weir. The flood tide reduced the downstream flow of about 2,000 cfs to about 1,500 cfs at the Paradise Weir. The tidal elevation fluctuated from about 2 feet to 4 feet at Mossdale, and the tidal flow varied from about 2,500 cfs during ebb tide to about 500 cfs during flood tide. At Brandt Bridge, located about 5 miles downstream of Mossdale, the tidal elevation fluctuated from about 0 feet to about 3 feet msl. The net flow at Brandt Bridge was reduced by the 500-cfs diversion into Old River. The tidal flow at Brandt Bridge ranged from –1,000 cfs during strong flood tide to about 2,500 cfs during ebb tide. Therefore, with a Vernalis flow of about 2,000 cfs simulated in August 1975, and with an assumed diversion of 500 cfs into Old River with tidal gates, the tidal flow was not quite strong enough to reverse the river flow at the head of Old River. Reverse (upstream) flow of several hundred cfs may occur for several hours each day during the flood-tide flow prior to the high tide if the Vernalis flow is less than about 1,000 cfs.

2.6 Old River and Middle River Channels

Figure 13 shows the simulated tidal elevations and tidal flows in the Middle River channels that connect with the San Joaquin River channel for existing conditions with tidal gates during August 1975. The simulated tidal elevations ranged from about –1 feet msl to about 4 feet msl during the month. The tidal elevations were nearly identical at the mouth of Middle River, at Columbia Cut, and at Turner Cut. There was a slight tidal lag of less than an hour between the mouth of Middle River and Turner Cut, located about 6 miles upstream on the San Joaquin River. The simulated 12-hr average tidal flow at the mouth of Middle River was about 13,000 cfs with an average flow of about –3,000 cfs (upstream). The simulated 12-hr average tidal flow at the mouth of Columbia Cut was about 4,000 cfs with an average flow of about –2,000 cfs (upstream). The simulated 12-hr average tidal flow at the mouth of Turner Cut was about 2,000 with an average flow of about –1,000 cfs (upstream). The SJR tidal flows decreased upstream because some of the tidal flows were filling and draining the Middle River channels. The combined net flows entering Middle River were about 6,000 cfs, and the combined 12-hr average tidal flows were about 19,000 cfs.

Figure 14 shows the simulated tidal elevations and tidal flows in Old River for existing conditions with tidal gates during August 1975. The simulated tidal elevations in Old River downstream of the Los Vaqueros intake (State Route [SR] 4 Bridge) ranged from about –1 foot msl to about 3.5 feet msl during the month. The simulated tidal elevations at the DMC intake were about 1.0 feet lower at high tide and about 0.5 feet lower at low tide, ranging from –1.5 to about 2.5 feet msl. The simulated tidal flows in Old River at Bacon Island ranged from about 5,000 cfs during ebb tides to about –20,000 cfs during flood tides and the 12-hr average tidal flow was 8,500 cfs. The simulated tidal flows at the Los Vaqueros intake ranged from about 2,000 cfs for some peak



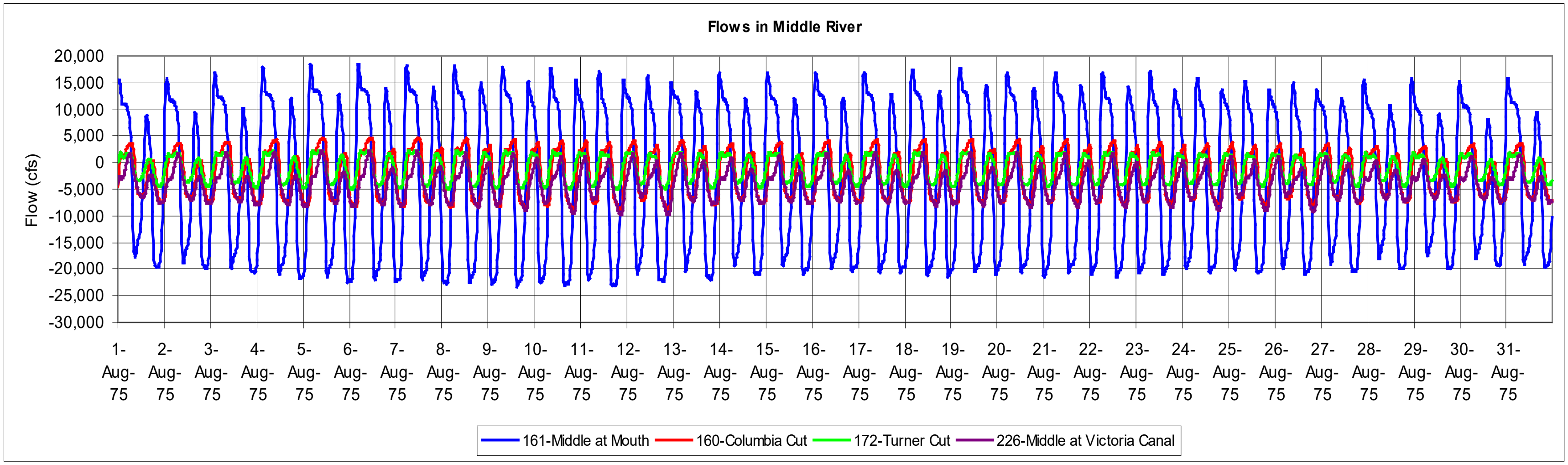


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Figure 13

Simulated Tidal Elevations and Tidal Flows in the Middle River Channels Connecting to the San Joaquin River during August 1975 for Existing Conditions with Tidal Gates

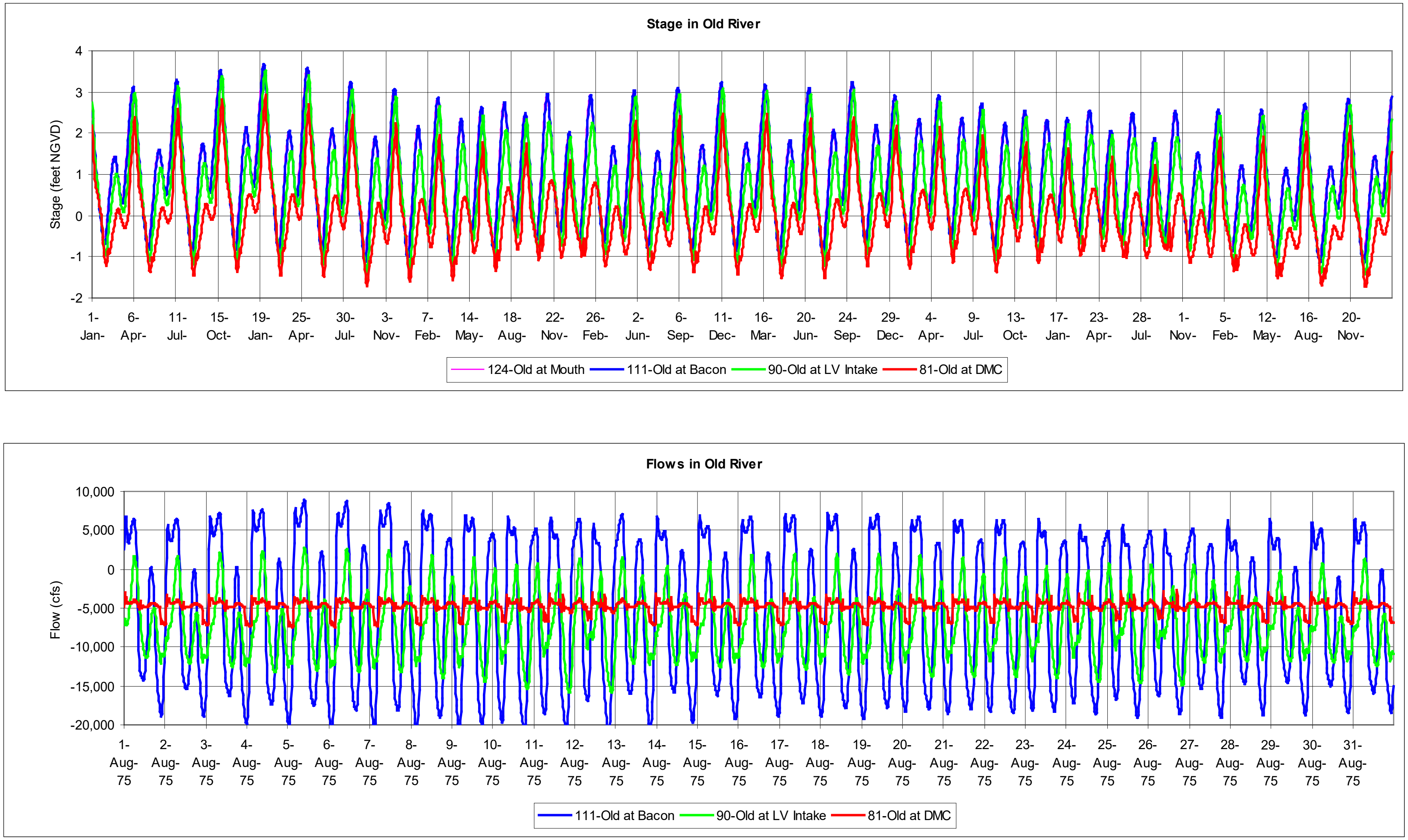

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Figure 14

Simulated Tidal Elevations and Tidal Flows in Old River during August 1975 for Existing Conditions with Tidal Gates

ebb tides to –15,000 cfs during several flood tides and the 12-hr average tidal flow was about 4,000 cfs. There was almost no tidal flow at the DMC intake, because the CVP pumps operate continuously and were simulated to be pumping about 4,500 cfs in August 1975. The net flow at Bacon Island was about -5,700 cfs upstream, and the net flow at the Los Vaqueros intake was about -7,200 cfs upstream, indicating that about 1,500 cfs was transferred from Middle River through Santa Fe and Woodward Cuts to Old River.

Figure 15 shows the simulated tidal flows in the channels connecting Old River and Middle River for existing conditions with tidal gates during August 1975. The tidal fluctuations were nearly the same as for Franks Tract and the San Joaquin River channel, with the tidal period delayed by about an hour. The tidal flows in these three connecting channels are important for understanding the conveyance of the water supply to the south Delta CVP and SWP export pumps. Connection Slough tidal flows were upstream from Old River to Middle River during flood tides and downstream from Middle River to Old River during ebb tides. The maximum flood-tide flow (negative, upstream) in Connection Slough was about –5,000 cfs when the Bacon River flow at Bacon Island was about –15,000 cfs and the 12-hr average tidal flow was about 4,200 cfs (about half of the Old River at Bacon tidal flow). The 12-hr average tidal flow in Santa Fe Cut was about 1,000 cfs and the average tidal flow in Woodward Cut was about 600 cfs.

The tidal flows in Santa Fe Cut and Woodward Cut were strongest during flood tide with tidal flows moving from Middle River to Old River. The bottom graph of Figure 15 shows that during flood-tide periods, the tidal flow in Middle River was reduced at Santa Fe Cut and Woodward Cut. The tidal "transfer" of about 5,000 cfs reduced the Middle River peak flood-tide flow (negative) from about -15,000 cfs to about -10,000 cfs. This reduced tidal flow moved upstream in Victoria Canal to join the Old River flow at West Canal. However, during ebb tide the flows in Santa Fe Cut and Woodward Cut were relatively small. During ebb tides, the downstream tidal flow was about zero in Middle River, and only about 5,000 cfs in Old River, because of the high CVP and SWP export pumping.

The net upstream flow in Middle River was reduced from about 6,000 cfs downstream of Santa Fe Cut to about 4,000 cfs at Victoria Canal, with a net flow of 1,150 cfs simulated in Santa Fe Cut and about 850 cfs simulated in Woodward Cut moving toward Old River. The Middle River and Victoria Canal corridor therefore was conveying only about 35% of the CVP and SWP exports, while the Old River channel was conveying about 65% of the CVP and SWP exports.

Because the DC Plan will separate Old River from Middle River, the connecting flows (transfers) between Old River and Middle River will be eliminated, and all the water supply would be conveyed in the Middle River and Victoria Canal channels. Dredging will likely be needed because the existing depth of Victoria Canal is only 15 feet in some sections. Dredging Victoria Canal to a depth of 25 feet below msl was assumed to determine whether the full existing

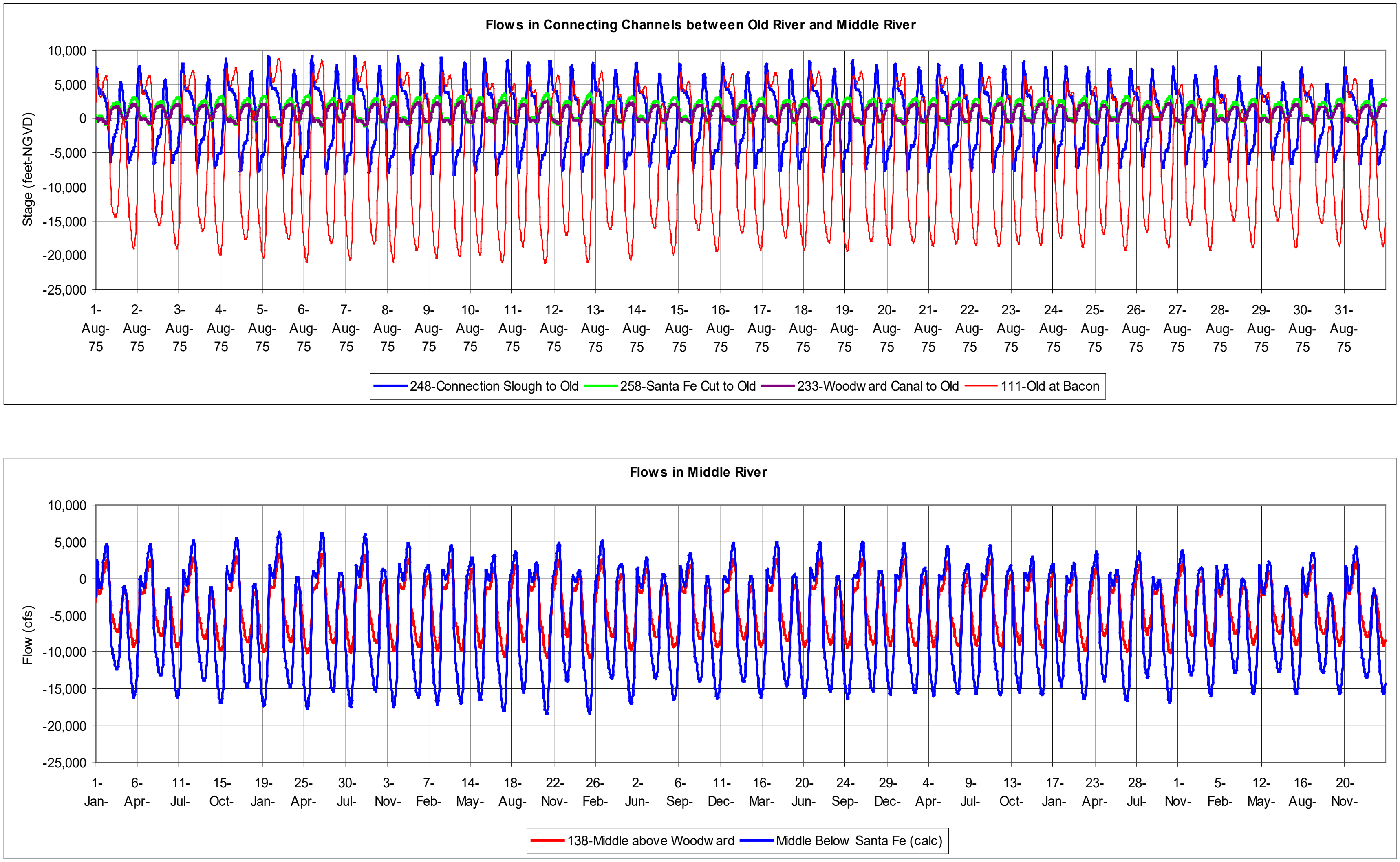

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Figure 15

Simulated Tidal Flows in the Middle River and in the Channels Connecting Old River and Middle River during August 1975 for Existing Conditions with Tidal Gates

exports of about 12,000 cfs could be conveyed through Middle River and Victoria Canal. This is more fully described in the DSM2 results for the DC Plan.

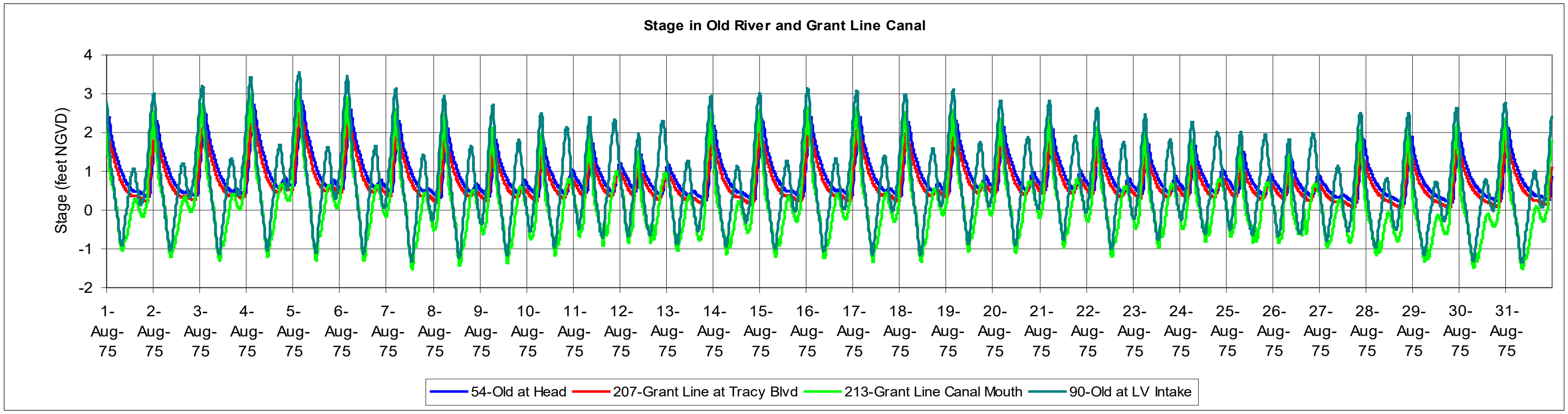
2.7 South Delta Channels

Figure 16 shows the simulated tidal elevations and tidal flows in Old River and Grant Line Canal for existing conditions with tidal gates during August 1975. Grant Line Canal flows are influenced by downstream tidal flows in Old River at the Los Vaqueros intake, inflows from the head of Old River (500 cfs for August 1975), and the tidal-gate upstream flows from Old River upstream of the DMC intake and Middle River upstream of Victoria Canal. The simulated tidal gates operated to allow upstream flows during flood-tide periods but then were closed to maintain minimum elevations of more than 0 feet msl upstream of these two tidal-gates.

The simulated minimum elevations upstream of the two tidal gates remained above 0.5 feet msl until the end of the month when about five days had minimum elevations of about 0 feet msl. The highest tide elevations upstream of the tidal gates were simulated to fluctuate between about 1.5 feet msl and 2.5 feet msl. Another important influence on the tidal elevations and flows in Old River and Grant Line Canal was the simulated operation of the CCF gates to preserve the higher-high tide elevation. This was achieved by closing the CCF gates during this flood-tide period each day. The results can be observed from the difference between the simulated tidal elevations at the Los Vaqueros intake and at the mouth of Grant Line Canal, opposite the CCF gates. When the CCF gates were closed, these flood-tide elevations are about the same, but when the CCF gates were opened, the flood-tide elevations at Grant Line Canal remained relatively constant because most of the tidal flow in Old River and West Canal was diverted into the CCF.

Figure 16 (bottom graph) shows the tidal inflows to CCF dominated the tidal flows in West Canal most of the time. The CVP pumping produced a nearly constant upstream flow in West Canal. The tidal-gates in Old River upstream of the DMC intake and in Middle River at Victoria Canal capture water from the high tide each day and provide a slowly declining flow in Grant Line Canal at Tracy Boulevard and at the mouth of Grant Line Canal, downstream of the simulated tidal-gate (with a weir crest at 0 ft msl). The Grant Line Canal tidal flow was upstream only during the highest tide period each day (when CCF gates were closed). The tidal flows in Old River at the Los Vaqueros intake were nearly always upstream, with peak upstream flows ranging from –12,000 cfs to –15,000 cfs during the month and a 12-hr average tidal flow of about4,000 cfs.

Figure 17 shows the tidal elevations and flows near the DMC intake to the Jones Pumping Plant and upstream of Old River near the DMC tidal gate. This tidal gate was simulated to be open on flood tide whenever the downstream elevation is higher than the upstream elevation, which generally occurred only once each day near high tide. The Old River at DMC tidal gate was



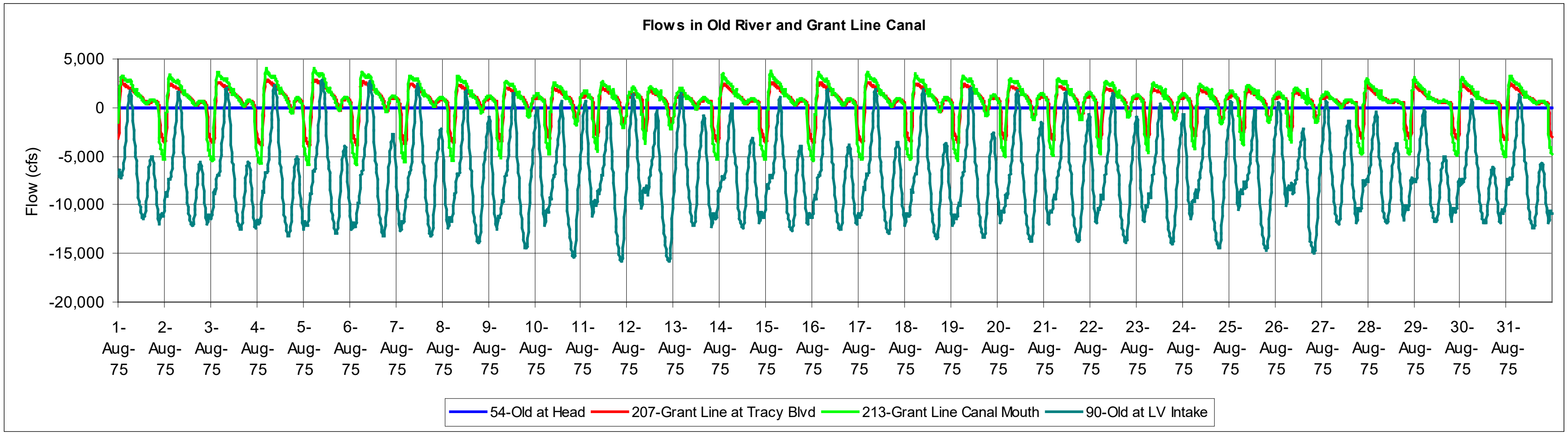


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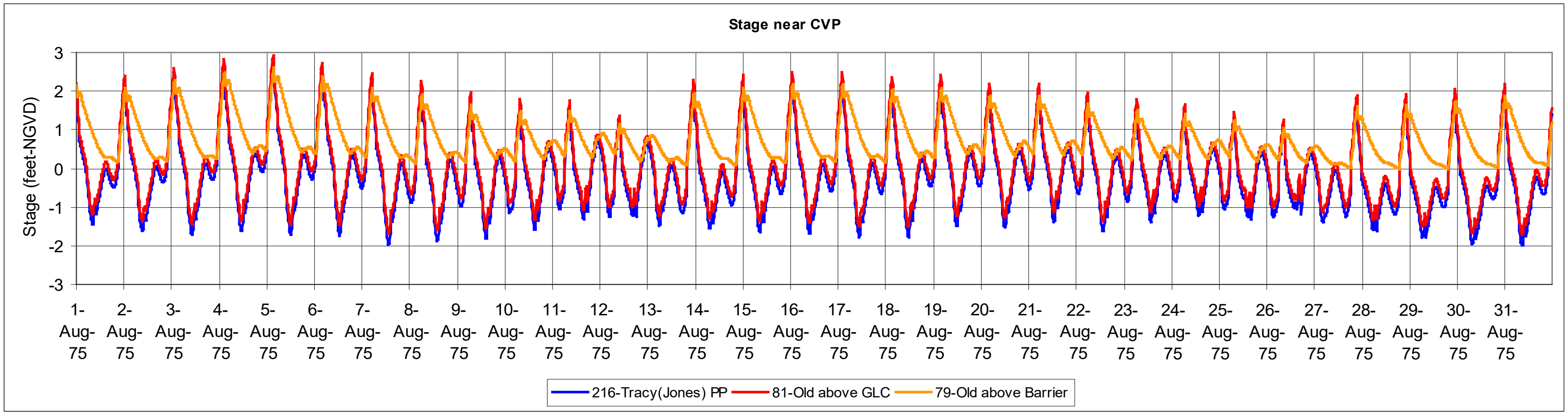
Figure 16

Simulated Tidal Elevations and Tidal Flows in Old River and Grant Line Canal during August 1975 for Existing Conditions with Tidal Gates



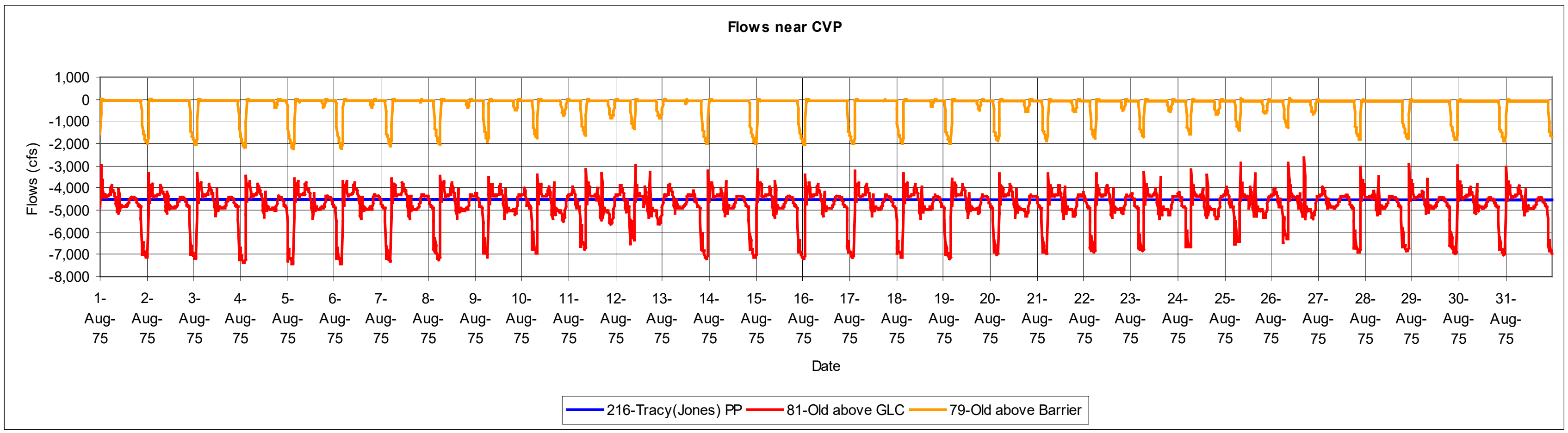


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Figure 17

Simulated Tidal Elevations and Tidal Flows near the Delta-Mendota Canal Intake on Old River during August 1975 for Existing Conditions with Tidal Gates

closed during ebb tides, with all flow moving upstream toward the upstream end of Grant Line Canal. The water elevations upstream of the DMC tidal gate remained above 0 feet msl. A more realistic simulation of the south Delta tidal-gates would allow the water elevations upstream of the tidal gates to decrease faster to a lower minimum elevation by regulating the opening and weir crest of the Grant Line Canal gate. This would increase the flood-tide flows at the Old River and Middle River tidal gates.

The CVP Jones Pumping Plant was simulated to be pumping about 4,500 cfs (permitted capacity of 4,600 cfs) in August 1975, and the simulated water elevations fluctuated between about –2 feet and 3 feet msl. The low tide elevations were only slightly lower (by about 1 foot) than the low tide in the San Joaquin River at Antioch (of about –1 feet msl) and indicate that the existing channels were capable of conveying the CVP and SWP exports without much of a reduced minimum elevation in the south Delta channels. The tidal energy that produces the high tides in the Delta channels allows this movement of water across the Delta without a corresponding reduction in the low-tide elevations. Water always moves toward lower surface elevations, but the higher tidal elevations provide the water surface gradient needed to move the water toward the pumps during flood-tide periods without requiring the low tides in the south Delta to be lowered by the pumps to provide the water elevation gradient needed for these flows.

Figure 18 shows the simulated tidal elevations and tidal flows in the vicinity of the CCF for existing conditions with tidal gates during August 1975. The CCF intake gates were assumed to be closed during the flood-tide period before the high tide each day to allow the high tide to flow into the south Delta channels. The simulated tidal elevation in West Canal at the CCF intake was compared with the tidal elevation at the mouth of Middle River to compare the existing tidal fluctuations along the Middle River and Victoria Canal and West Canal channels. The simulated tidal elevations at West Canal were usually lower than at the mouth of Middle River. The higher-high tides were about 0.5–1 foot lower, but the lower-high tides (when the CCF gate was open and diverting flows into CCF) were about 1 to 1.5 feet lower than at the mouth of Middle River. The simulated low tide elevations in West Canal ranged from –1 to –1.5 feet msl, and were only about 0.25 foot lower than the minimum elevation at the mouth of Middle River.

The simulated tidal flows in West Canal were always negative (upstream) and ranged from 0 cfs to about –17,500 cfs with a 12-hr average tidal flow of about 5,000 cfs. The CVP Jones Pumping Plant produced a constant upstream flow of –4,500 cfs, and the CCF intake gates allowed a maximum diversion of about 16,000 cfs. The CCF intake diversion is dependent on the elevation difference between West Canal and the CCF elevation. An elevation difference of 1 foot is enough to provide the maximum gate diversion of 16,000 cfs. The gates are partially closed to maintain this maximum diversion flow when the elevation difference is greater than 1 foot (during high tide periods). The CCF gates are closed whenever the West Canal tidal elevation drops below the CCF elevation. The simulated SWP pumping was 6,680 cfs during August 1975

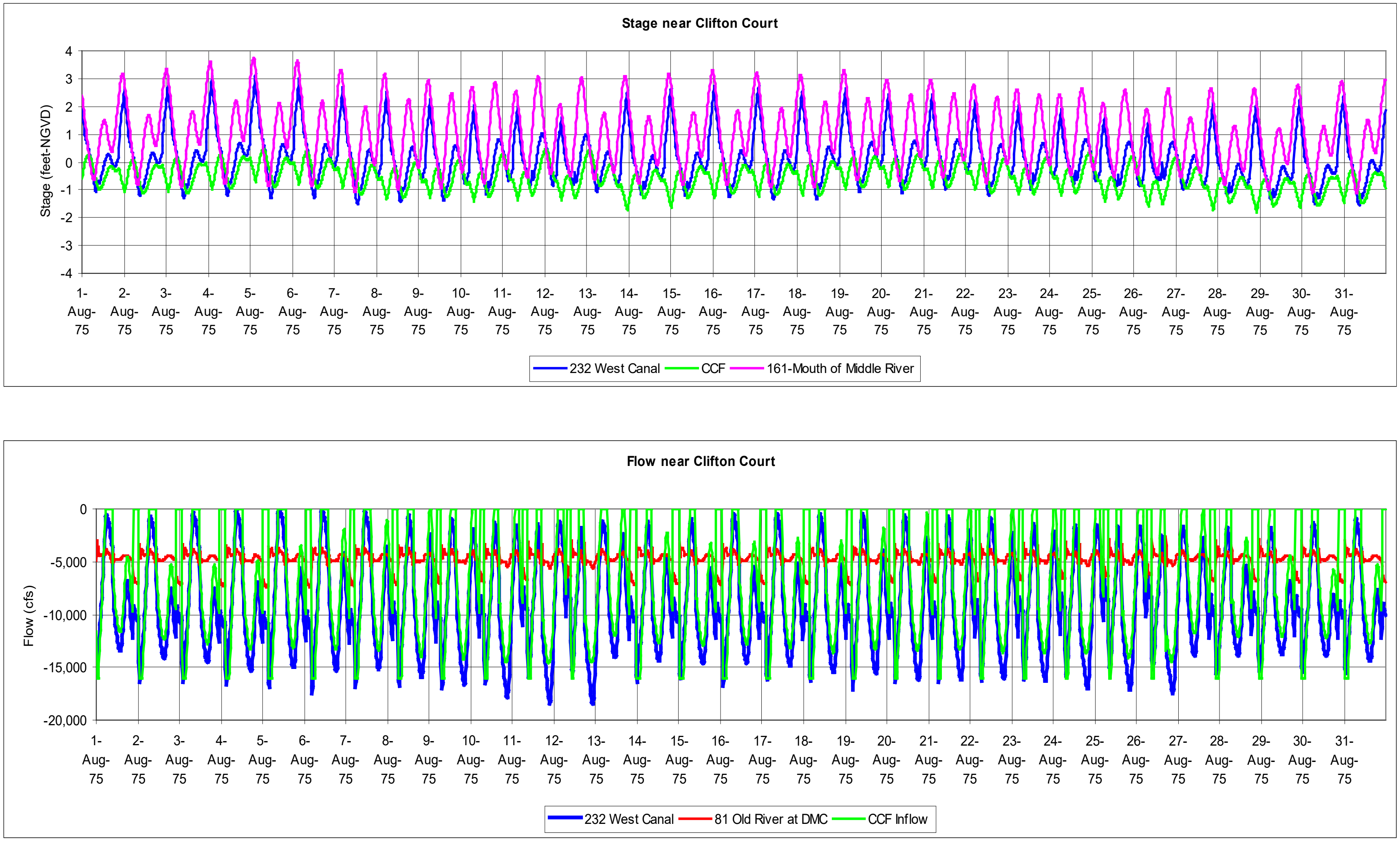

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Figure 18

Simulated Tidal Elevations and Tidal Flows in West Canal and Clifton Court Forebay during August 1975 for Existing Conditions with Tidal Gates

(permitted capacity), so the daily pumping volume was about 13,250 af. The CCF surface is about 2,000 acres at elevation 0 feet msl, so this pumping will reduce the CCF elevation by about 0.25 foot/hour without any inflow. When the CCF gates were closed for 4 hours during the higher flood-tide period each day, the CCF elevation was reduced by about 1 foot. The simulated range of CCF elevations was 0.5 feet to –1.5 feet msl. The CCF elevation is maintained above elevation –2 feet msl to prevent cavitation (air entrainment) damage to the pump blades at the SWP Banks Pumping Plant, located about 2.5 miles along a canal from the CCF.

Although the simulated August 1975 conditions were not compared with field data to demonstrate calibration of the DSM2 model, comparisons of measured tidal elevations and tidal flows for more recent periods demonstrate that the DSM2 model accurately simulates the tidal elevations and flows throughout the Delta channels. The next section will show the simulated tidal elevations and tidal flows for the DC Plan conditions for this same month (August 1975) and describe the changes in Delta tidal flows that resulted from the barriers, channel divides, culverts and tidal gates that would be needed to separate the San Joaquin River flows in Old River from the water supply diversions into the DCC, Georgiana Slough and Threemile Slough that would be conveyed along Middle River and Victoria Canal to West Canal.

3 Simulated Tidal Elevations and Tidal Flows for the Delta Corridors Plan

Because most of the DC Plan features are in the central and south Delta, there were few simulated changes in the tidal elevation variations or the tidal flows in Suisun Bay or the Sacramento River channels. There were some changes simulated for the Mokelumne River channels, with a shifting of the net daily flows from the mouth of the Mokelumne River toward the channels connecting with the San Joaquin River upstream of the Mokelumne River mouth (i.e., Little Connection, Disappointment, Fourteen Mile Sloughs). Table 1 gives the average net flows as well as the average positive (ebb-tide) and average negative (flood-tide) flows for several Delta locations for simulated August 1975 tidal conditions. Graphs of the tidal elevations and tidal flows for most of these locations will not be shown because they would look nearly identical to the graphs already shown for the existing tidal conditions.

Table 1 indicates that the DCC and Georgiana Slough diversion flows were the same as for the existing conditions. These tidal diversions depend on the channel geometry and the Sacramento River flow and the tidal elevations in the Sacramento River and in the Mokelumne River channels (Snodgrass Slough). Because the DC Plan would include flat-plate fish screens for both the DCC south-gate and Georgiana Slough diversions, some reductions in the diversion flows will occur because of the head-loss across the screens. In addition, because the peak tidal flows into the DCC during flood-tide were about 10,000 cfs (Figure 7) but the fish screen capacity for the south-gate channel would be about 5,000 cfs, the peak tidal flows in the south-gate channel would need to be restricted by partially closing the south DCC gate. More detailed modeling of the fish screen head-losses and the gate-regulated flows into the divided DCC would be required to accurately estimate the DCC diversions with the DC Plan. The combined diversions to Georgiana Slough and the south- gate of the DCC with fish screens would likely be greater than the diversions to Georgiana Slough with DCC closed under existing conditions for January-June.

The major changes in tidal flows and corresponding changes in tidal elevations will be in the Old River and Middle River channels, which will be separated from each other with the DC Plan. These simulated changes in net and tidal flows and tidal elevations will be described and the tidal elevation and tidal flow graphs for these Old River and Middle River locations will be shown.

3.1 Changes in Net Channel Flows

The DC Plan will block several central and south Delta channels and separate Old River from Middle River. A concrete wall and flood-gate at the mouth of Old River will cause all of the San Joaquin River water flowing in Old River to flow out of Franks Tract through either Dutch Slough, False River or Fisherman's Cut. The water supply from the Sacramento River diversions will no longer enter Franks Tract at the mouth of Old River flow and flow upstream (south) in Old River to the exports. All of the water supply diversions will flow from the mouth of the Mokelumne River upstream (south) in the San Joaquin River or Middle River channels. Table 1 summarizes these shifts in net channel flows from the existing conditions to the DC Plan conditions for August 1975.

All of the San Joaquin River inflow will be routed down the Old River channel to Franks Tract and will flow through Dutch Slough, False River or Fisherman's Cut toward Antioch. The San Joaquin River flows at Antioch will not change, with a net flow of about –1,640 cfs (upstream) for existing conditions and –1,620 with the DC Plan. The Dutch Slough net flow was –467 (upstream toward Franks Tract) for the existing conditions and increased slightly (less upstream flow) to –346 cfs with the DC Plan. False River net flow was 720 cfs for the existing conditions and increased to about 1,627 cfs with the DC Plan because about half of the SJR water that flows down Old River flows out of Franks Tract in False River. The net flow in Fisherman's Cut changed from about 398 cfs (towards Franks Tract) for the existing conditions to about 105 cfs with the DC Plan. The tidal flows in False River did not change with the DC Plan. The average tidal flows (ebb tide and flood tide) were about 32,000 cfs for the existing conditions and remained about 32,000 cfs with the DC Plan. Most of this tidal flow fills and drains the large Franks Tract surface area, but some fills and drains Old River and Grant Line Canal. The Old River flow at Bacon Island (upstream of Franks Tract) was about –5,709 cfs (upstream) for the existing conditions and increased to 1,320 cfs (downstream) with the DC Plan. This was a change of about 7,000 cfs between the existing conditions and the DC Plan conditions. The average tidal flows at Bacon Island were not changed substantially; they were about 8,500 cfs for the existing conditions and about 8,000 cfs with the DC Plan.

The San Joaquin River net flow at Bradford Island was –1,803 cfs (upstream flow) for the existing conditions and was increased to about -2,807 cfs (more upstream flow) with the DC Plan. The reverse flow at Bradford Island was increased by the DC Plan because the Old River outflow through False River was increased but the Delta outflow was not increased, so the reverse flow in the San Joaquin River channel upstream of False River was increased by about 1,000 cfs. The Threemile Slough net flow was about –2,031 (toward the San Joaquin River) for the existing conditions and was increased only slightly to –2,073 cfs with the DC Plan.

Table 1. Summary of DSM2 Modeled Tidal Flows for Existing Conditions and Delta Corridors Plan for August 1975

		Existing Tidal Flows				Delta Corridors Plan Tidal Flows			
DSM2 Channel	Location	Net Flow (cfs)	Positive Ebb-Tide (cfs)	Negative Flood-Tide (cfs)	Tidal Flow 12-hour (cfs)	Net Flow (cfs)	Positive Ebb-Tide (cfs)	Negative Flood-Tide (cfs)	Tidal Flow 12-hr (cfs)
441	Martinez	3,463	342,095	-335,181	338,638	3,474	342,480	-335,536	339,008
511	Montezuma Slough at Collinsville	-35	3,645	-3,736	3,690	-36	3,657	-3,749	3,703
434	Sacramento at Emmaton	5,557	84,686	-73,791	79,238	5,544	85,000	-74,132	79,566
431	Sacramento above Threemile	7,645	56,790	-41,696	49,243	7,674	56,940	-41,786	49,363
398	Cache Slough Mouth	1,177	28,250	-26,128	27,189	1,180	28,253	-26,110	27,182
429	Sacramento at Ryde	3,512	9,484	-2,520	6,002	3,528	9,495	-2,502	5,998
390	Miner Slough	1,617	4,305	-1,082	2,693	1,621	4,318	-1,087	2,703
383	Steamboat Slough Head	1,828	4,230	-606	2,418	1,834	4,233	-595	2,414
379	Sutter Slough Head	2,929	5,053	846	2,103	2,936	5,057	857	2,100
421	Sacramento above DCC	10,881	13,591	8,190	2,700	10,868	13,501	8,243	2,629
366	Georgiana Slough	2,742	3,463	2,063	700	2,753	3,444	2,104	670
365	Delta Cross Channel	4,607	5,951	3,323	1,314	4,568	5,891	3,300	1,296
357	N Fork Mokelumne Head	3,335	4,711	1,984	1,363	3,300	4,878	1,748	1,565
337	S Fork Mokelumne Head	1,215	1,664	788	438	1,211	1,588	838	375
347	S Fork Mokelumne Mouth	-812	4,399	-6,040	5,220	-958	4,417	-6,351	5,384
349	Mokelumne Mouth	5,266	10,569	-38	5,304	5,094	10,772	-586	5,679
323	Little Potato Slough to SJR	1,917	3,108	726	1,191	2,058	3,553	564	1,495
328	Potato Slough	-139	8,657	-8,946	8,801	-658	8,457	-9,786	9,121
319	Little Connection to SJR	1,454	2,342	569	887	1,846	3,277	476	1,400
312	Fourteen-mile Slough	-47	308	-407	358	106	482	-273	377
50	SJR at Antioch	-1,642	106,228	-109,545	107,886	-1,617	106,648	-109,926	108,287
83	SJR at Jersey Point	-1,093	89,943	-92,189	91,066	-1,189	89,956	-92,405	91,181
48	SJR at Bradford	-1,803	56,556	-60,220	58,388	-2,807	54,773	-60,442	57,608
45	SJR at San Andreas	-3,376	68,604	-75,468	72,036	-4,714	64,153	-73,706	68,929
309	Threemile Slough	-2,031	19,115	-23,197	21,156	-2,073	19,051	-23,216	21,133
274	Dutch Slough	-467	5,639	-6,580	6,109	-346	6,015	-6,717	6,366
279	False River	720	33,156	-31,728	32,442	1,627	34,443	-31,210	32,826
280	Fisherman's Cut	398	3,231	-2,438	2,835	105	3,548	-3,344	3,446
31	SJR above Columbia Cut	316	11,311	-10,702	11,007	-2,520	9,259	-14,326	11,793

24	SJR above Turner Cut	1,440	7,866	-4,998	6,432	-114	7,284	-7,526	7,405
15	SJR at Garwood Bridge	1,391	3,245	-464	1,855	-314	2,050	-2,681	2,365
10	SJR at Brandt Bridge	1,434	2,537	340	1,099	-271	775	-1,319	1,047
7	SJR at Mossdale	1,958	2,936	1,042	947	1,956	2,644	1,374	635
1	SJR at Vernalis	1,986	0	0	0	1,986	159	26,548	-13,195
124	Old River Mouth	-5,663	4,636	-15,962	10,299	2,203	2,960	1,567	696
111	Old at Bacon	-5,709	2,828	-14,254	8,541	1,320	9,395	-6,769	8,082
90	Old at LV Intake	-7,183	-3,301	-11,099	3,899	1,820	4,963	-1,326	3,145
81	Old at DMC Intake	-4,787	-4,985	-4,712	-137	-4,562	-4,988	-4,195	-396
79	Old above DMC	-223	-27	-718	345	0	27	-27	27
71	Old at Tracy Boulevard	-135	4	-275	139	90	459	-283	371
55	Old at Head	500	0	0	0	2,203	2,960	1,567	696
161	Middle at Mouth	-2,917	9,888	-15,737	12,812	-6,428	11,230	-24,120	17,675
160	Columbia Cut	-2,063	1,854	-5,989	3,922	-2,530	-1,373	-3,687	1,157
159	Middle Above Columbia	-4,963	7,924	-17,860	12,892	-8,941	6,404	-24,315	15,360
248	Connection Slough	6	4,208	-4,201	4,204	0	141	-142	141
172	Turner Cut	-1,102	1,007	-3,219	2,113	-2,383	-810	-3,979	1,584
135	Middle at Victoria	-3,958	-1,554	-6,364	2,405	-11,231	-8,869	-13,608	2,370
133	Middle at Tracy Blvd	-177	-101	-349	124	8	-30	-14	22
125	Middle at Head	-81	-26	-136	55	105	170	41	64
259	Santa Fe Cut	1,149	2,200	97	1,051	0	0	0	0
235	Woodward Cut	859	1,448	271	589	0	0	0	0
232	West Canal below CCF	-9,098	-4,305	-14,075	4,885	-11,214	-9,082	-13,350	2,134
	CCF Inflow	6,668	11,636	1,700	4,968	6,638	8,711	4,567	2,072
213	Grant Line Canal Mouth	574	2,199	-1,178	1,688	1,859	4,223	-529	2,376
207	Grant Line Canal at Tracy Blvd	590	1,844	-746	1,295	1,876	3,726	28	1,849
216	CVP Jones Pumping Plant	4,543	0	0	0	4,543	0	0	0

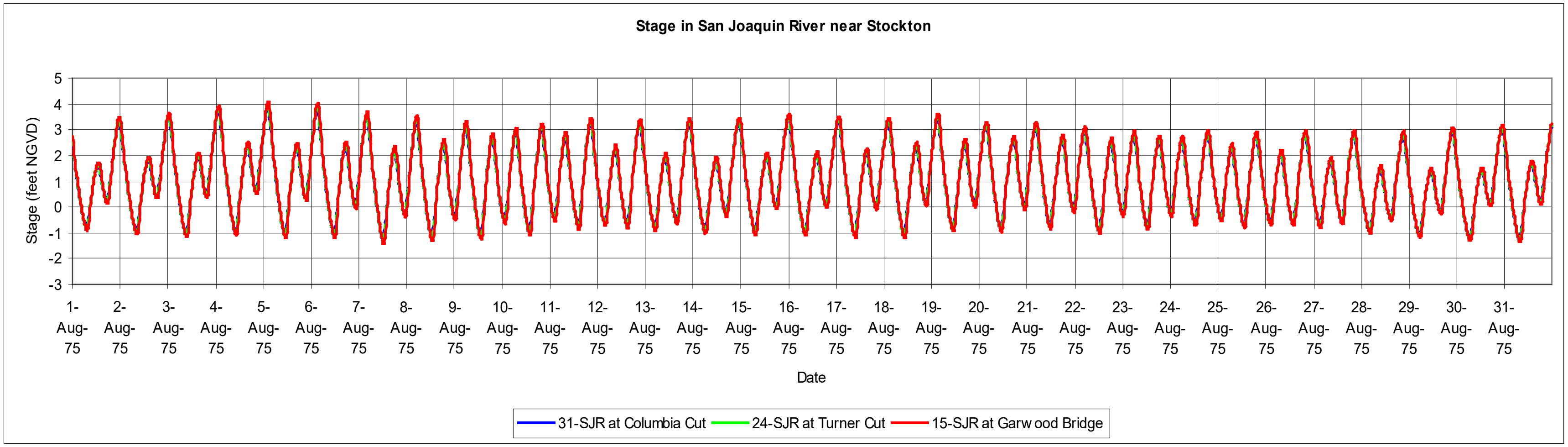
The San Joaquin River flow at San Andreas Landing, just downstream from the mouth of the Mokelumne River, was about –3,376 cfs for the existing conditions and increased (reverse flow) to about –4,714 cfs with the DC Plan. Because the mouth of Old River was blocked under the DC Plan, the San Joaquin River reverse flows upstream to the mouth of Middle River, Columbia Cut, and Turner Cut were increased. The flows at the mouth of Middle River were –2,917 for the existing conditions and were increased (upstream) to about –6,428 cfs with the DC Plan. The Columbia Cut flows were –2,530 cfs for the existing conditions and were increased (upstream) to about -2,383 cfs with the DC Plan. The Turner Cut flows were –1,102 cfs for the existing conditions and were increased (upstream) to about –2,383 cfs with the DC Plan. These Middle River reverse flows were increased from about –6,082 cfs to about –11,341 cfs, an increase of about 5,259 cfs (more reverse flows). The Middle River flow at Victoria Canal was about –3,958 cfs for the existing conditions and was increased (more upstream flow) to about –11,231 cfs with the DC Plan, which was an increase of about 7,272 cfs.

The Connection Slough net flow from Middle River to Old River was about 6 cfs for the existing conditions, although the tidal flows were about 4,000 cfs, and the net flow and tidal flows would be 0 cfs with the DC Plan because Connection Slough would be blocked with a concrete wall. The Santa Fe Cut net flow was about 1,150 cfs from Middle River toward Old River, with a tidal flow of about 1,050 cfs, and the Woodward Cut net flow was about 860 cfs from Middle River toward Old River, with a tidal flow of about 600 cfs for the existing conditions. The Santa Fe Cut and Woodward Cut tidal flows and net flows would be 0 cfs with the DC Plan because these channels would be blocked with concrete walls.

The San Joaquin River flows downstream from the head of Old River would be changed by the DC Plan tidal-gate that would divert all of the San Joaquin River flow into Old River. In addition, a 250-cfs low-head pump would be constructed to pump water upstream from Stockton (including Stockton's treated wastewater) and discharge this water into the head of Old River channel. The net flow at Brandt Bridge (near Stockton) was 1,434 cfs for the existing conditions and was reduced to –271 cfs (upstream) with the DC Plan. The head of Old River net flow was about 500 cfs for the existing conditions (that included a tidal gate regulating the diversion flow into Od River) and was increased to about 2,203 with the DC Plan (i.e., Mossdale flow plus 250 cfs pumped flow). The Grant Line Canal flow at the mouth was about 574 cfs for the existing conditions and was increased to 1,859 cfs with the DC Plan. The mouth of Grant Line Canal net flow was less than the head of Old River net flow because there was about 330 cfs of net agricultural diversions in the south Delta channels (Grant Line Canal, Middle River to Victoria, and Old River to DMC) for August 1975.

3.2 Changes in Tidal Elevations and Tidal Flows

Figure 19 shows the simulated tidal elevations and tidal flows for the San Joaquin River between Columbia Cut and Garwood Bridge (Stockton) for August 1975 with the DC Plan (compare to existing conditions shown in Figure 11). The simulated tidal elevations were not changed with the DC Plan (that includes dredging in Middle River and Victoria Canal). The simulated tidal flows upstream of Turner Cut were about 6,500 cfs for existing conditions and would be about



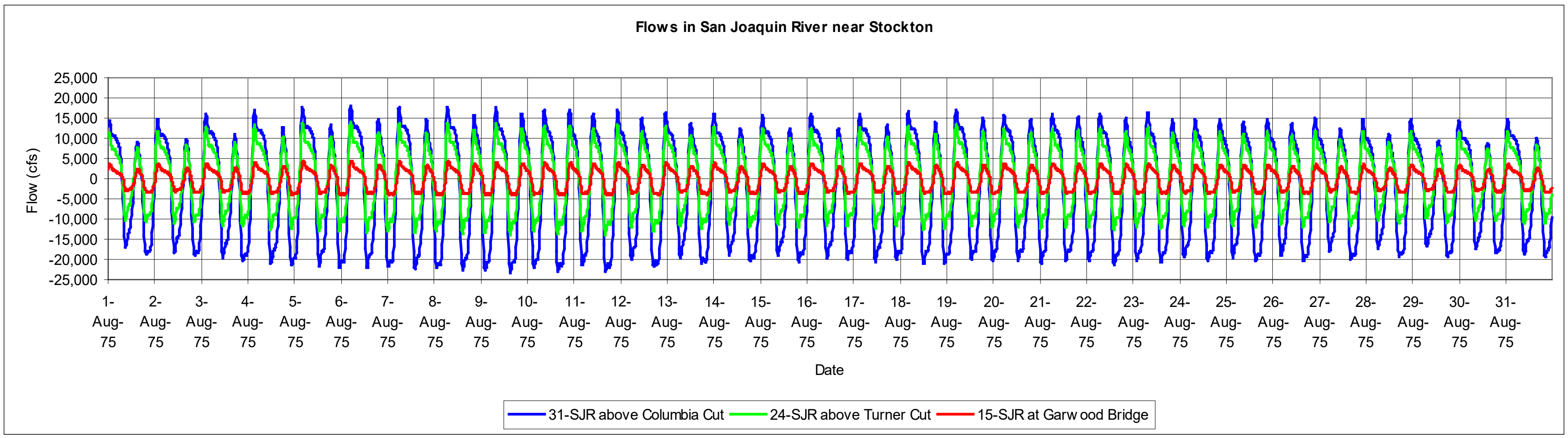


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Figure 19

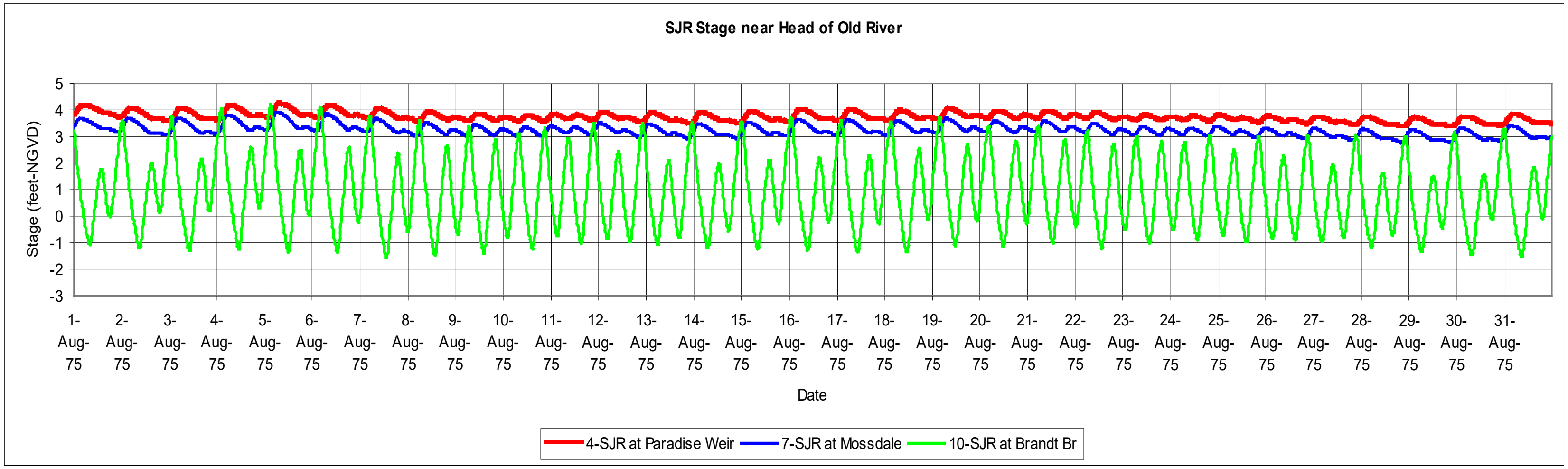
Simulated Tidal Elevations and Tidal Flows in the San Joaquin River near Stockton during August 1975 for the Delta Corridors Plan

7,500 cfs with the DC Plan. The simulated tidal flows at the Garwood Bridge near the Stockton Regional Wastewater Control Facility discharge were about 1,850 cfs for existing conditions and would be about 2,365 cfs with the DC Plan. All of the tidal flows in the Stockton DWSC and Stockton channels (e.g., Weber Point, Smith Canal, Calaveras River) would be water diverted from the Sacramento River; the Stockton water supply intake located near the mouth of Disappointment Slough would divert water supply corridor water. Although the San Joaquin River net flows upstream of the Mokelumne River mouth were changed by the DC Plan (higher reverse flows), the San Joaquin River tidal flows were similar to the existing conditions tidal flows because they were controlled by the upstream tidal surface areas which were not changed by the DC Plan.

Figure 20 shows the simulated tidal elevations and tidal flows for the San Joaquin River between Brandt Bridge and Paradise Weir for August 1975 with the DC Plan (compare to existing conditions shown in Figure 12). The DC Plan tidal gate located downstream of the head of Old River increased the minimum tide elevations at Mossdale from 2 feet to about 3 feet msl. The minimum tide elevations at Brandt Bridge were reduced by about 2 feet, from about 0.5 feet to about –1.5 feet msl because the reduced net SJR flows would allow the SJR channel to drain to a lower elevation during ebb-tide.

Figure 21 shows the simulated tidal elevations and tidal flows in the Middle River channels that connect with the San Joaquin River channel for August 1975 with the DC Plan (compare to existing conditions shown in Figure 13). The simulated tidal elevations range from about –1 feet msl to about 4 feet msl during the month. The tidal elevations were nearly identical at the mouth of Middle River, at Columbia Cut, and at Turner Cut. The simulated tidal flows at the mouth of Middle River were about 13,000 cfs for existing conditions and were about 18,000 cfs with the DC Plan. The simulated tidal flows at the mouth of Columbia Cut were about 4,000 cfs for existing conditions and were about 1,000 cfs with the DC Plan. The simulated tidal flows at the mouth of Turner Cut were about 2,000 cfs for existing conditions and were about 1,500 cfs with the DC Plan. The simulated tidal flows in Middle River at Victoria Canal were about 2,500 cfs for existing conditions and were also about 2,500 cfs with the DC Plan. The net reverse flows in Middle River were increased by about 7,500 cfs with the DC Plan but the tidal flows were increased by only about 1,500 cfs. Slightly more than half (55%) of the simulated net reverse flows enter the water supply corridor at the mouth of Middle River, about 25% enter at Columbia Cut, and 20% enter at Turner Cut.

Figure 22 shows the simulated tidal elevations and tidal flows in Old River for August 1975 with the DC Plan (compare to existing conditions shown in Figure 14). The tidal variations at Bacon Island and the Los Vaqueros intake were about the same as for the existing conditions. The tidal elevations at the DMC were much lower than the existing conditions because this section of Old River was connected to West Canal and the water supply corridor.



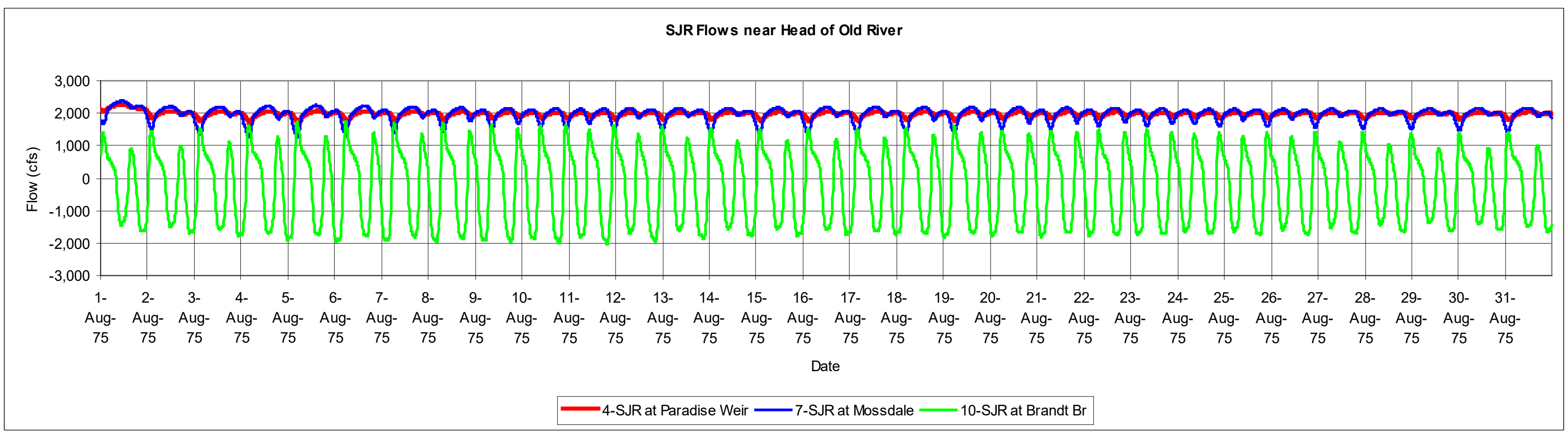


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Figure 20

Simulated Tidal Elevations and Tidal Flows in the San Joaquin River near the Head of Old River during August 1975 for the Delta Corridors Plan

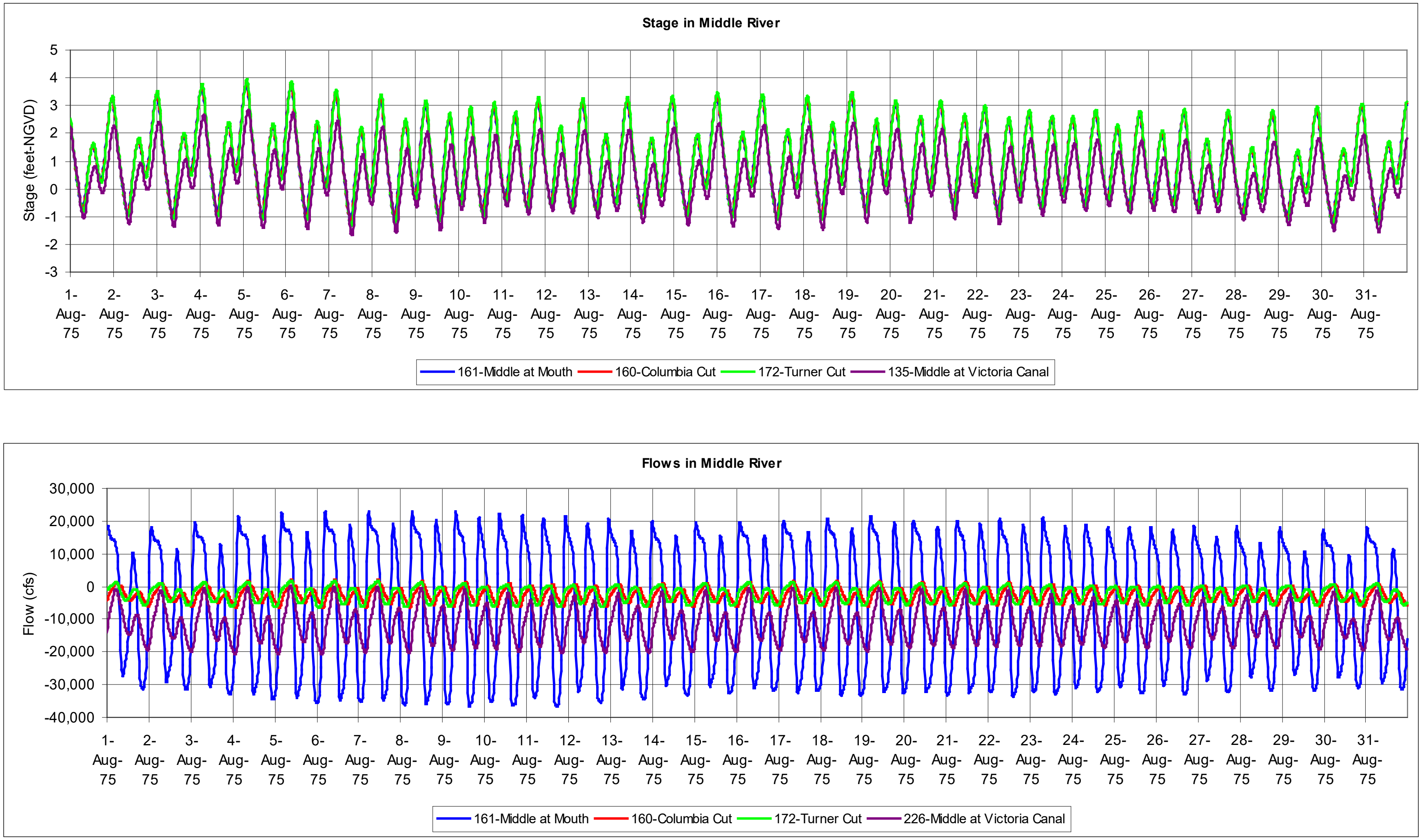

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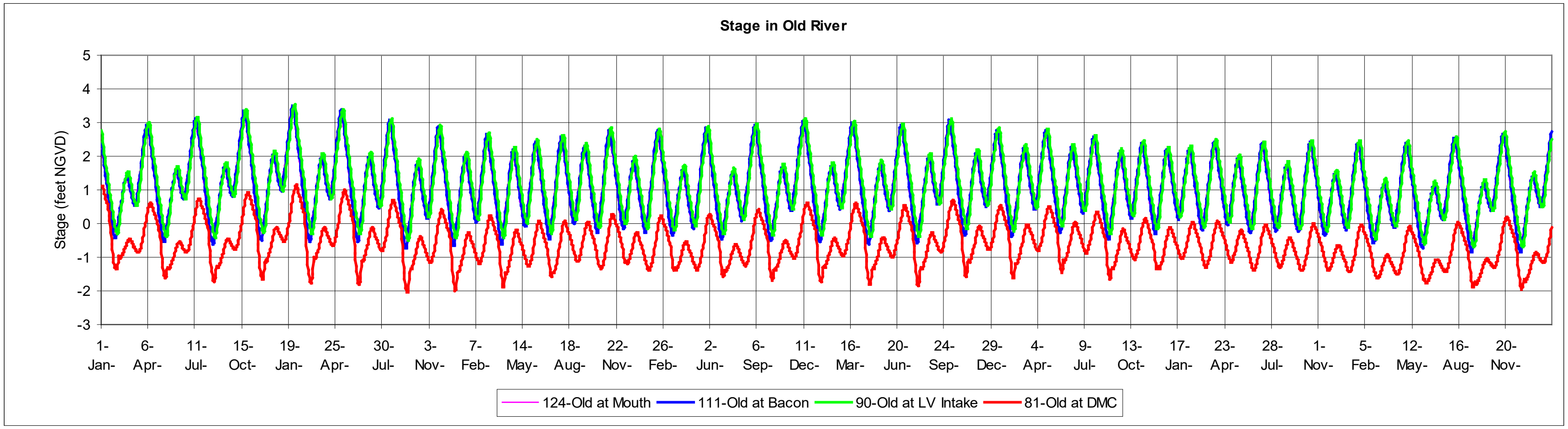
Figure 21

Simulated Tidal Elevations and Tidal Flows in the Middle River Channels Connecting to the San Joaquin River during August 1975 for the Delta Corridors Plan



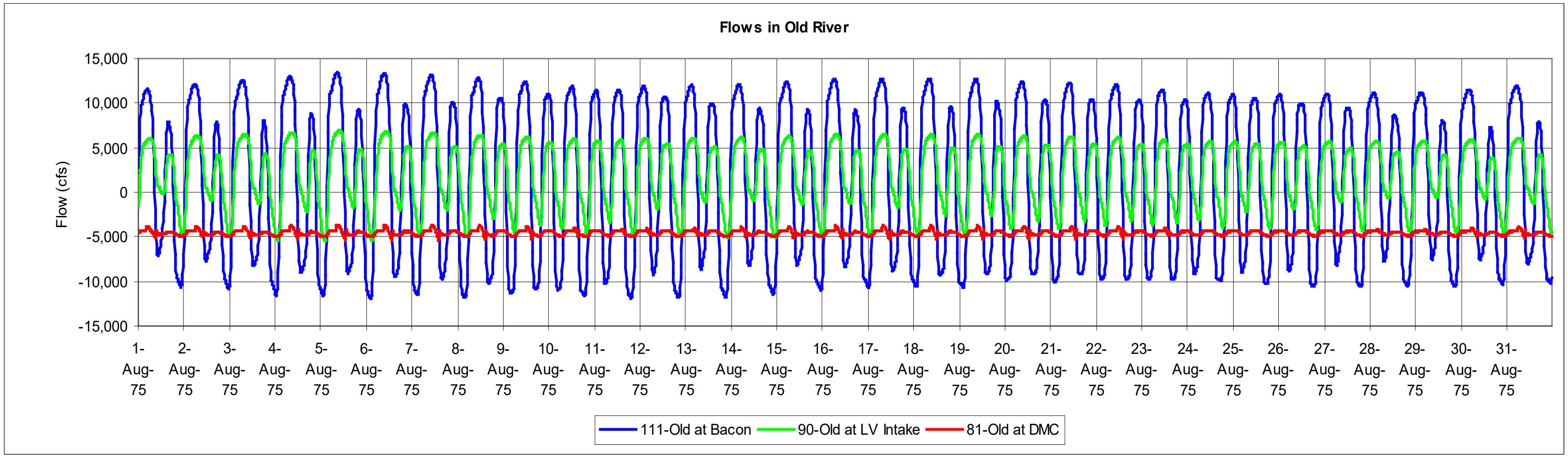


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Figure 22

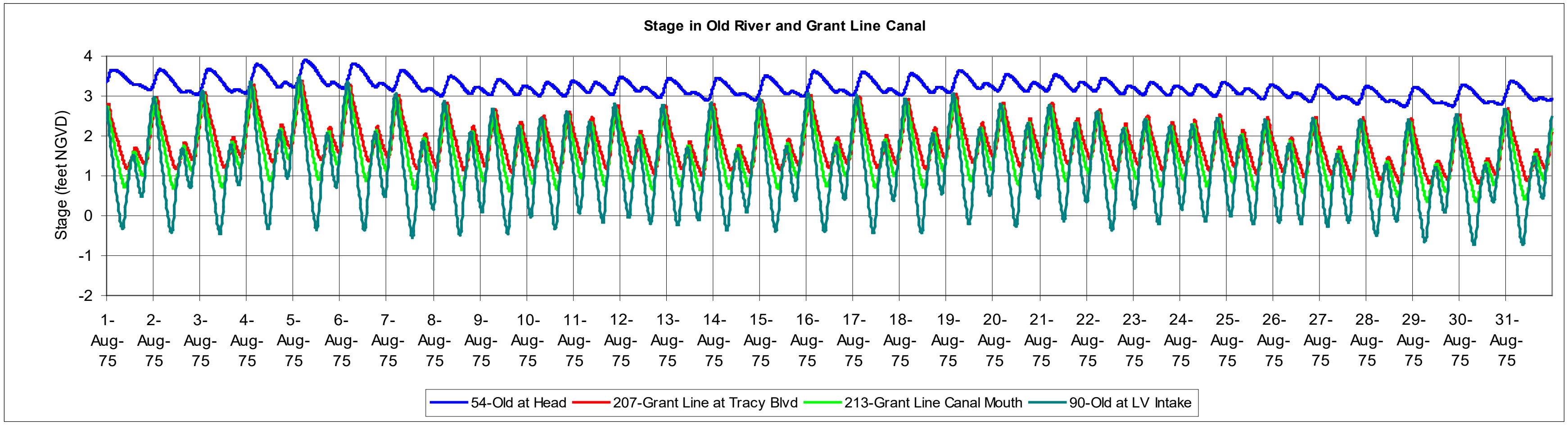
Simulated Tidal Elevations and Tidal Flows in Old River during August 1975 for the Delta Corridors Plan

Figure 23 shows the simulated tidal elevations and tidal flows in Old River and Grant Line Canal (SJR-estuary corridor) for August 1975 with the DC Plan (compare to existing conditions shown in Figure 16). The DC Plan would divert the entire San Joaquin River flow into Old River and Grant Line Canal. The San Joaquin River water would remain separated from SWP and CVP export pumping with a divided channel between the mouth of Grant Line Canal and Coney Island and then by crossing over large culverts in Victoria Canal and flowing down Old River to Franks Tract. The simulated head of Old River minimum tidal elevations remained above 3 feet msl with the DC Plan (above 0 feet msl for existing conditions). The simulated minimum tidal elevations in Old River at the CCWD Los Vaqueros intake were about 0 feet msl, but the simulated tidal elevation at the mouth of Grant Line Canal remained above 1 feet msl because the San Joaquin River inflow increased the minimum tidal elevations in Grant Line Canal and Old River upstream of the DMC.

The simulated San Joaquin River flow of about 2,000 cfs would be augmented at the head of Old River with 250 cfs pumped from downstream of the tidal-gate, but this pumping was not included in the DSM2 modeling. About 330 cfs was simulated to be depleted by agricultural uses in the south Delta channels and an additional 500 cfs was simulated to be depleted in the central Delta from Old River and connecting channels for agricultural uses. The simulated tidal flows at the mouth of Grant Line Canal were about 1,700 cfs for existing conditions and were about 2,400 cfs for the DC Plan. The flows at the Los Vaqueros intake were about 4,000 cfs for existing conditions and were about 3,000 cfs with the DC Plan.

Figure 24 shows the simulated tidal elevations and tidal flows in Old River near the DMC intake for August 1975 with the DC Plan (compare to existing conditions shown in Figure 17). The simulated tidal elevations at the DMC intake and at the CVP Jones pumping plant ranged from about –2 feet to 1foot msl. The simulated high-tide elevations were less than the high-tide tidal elevations for the existing conditions, but the low-tide elevations were similar to the existing conditions. This was the result of eliminating the existing condition operations of the CCF gates which close the gates to allow the high tides to flow into the south Delta channels. The SDIP tidal-gate weir was simulated on Old River upstream of the DMC intake, and this maintained a minimum tide elevation of about 1 foot msl in Old River upstream of the tidal gate for existing conditions. A low-head pump would be needed at the Old River tidal-gate because the downstream elevations were never greater than the upstream elevations for the DC Plan.

Figure 25 shows the simulated tidal elevations and tidal flows in West Canal and CCF for August 1975 with the DC Plan (compare to existing conditions shown in Figure 18). The CCF intake gates were simulated to be open except when the outside (West Canal) elevations were less than the CCF elevation. The simulated tidal elevations ranged from about –2 feet to 1 feet msl. This was considerably less than the tidal range simulated at the mouth of Middle River (shown for comparison). The simulated high-tide elevations in West Canal were less than the high-tide tidal elevations for the existing conditions, but the low-tide elevations were similar to the



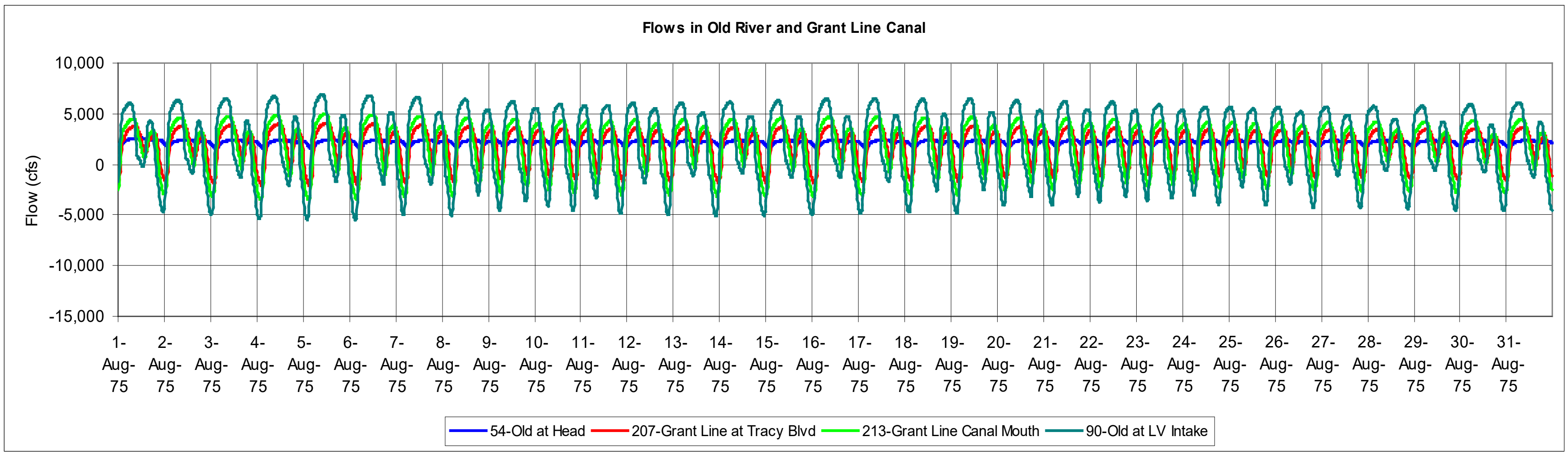


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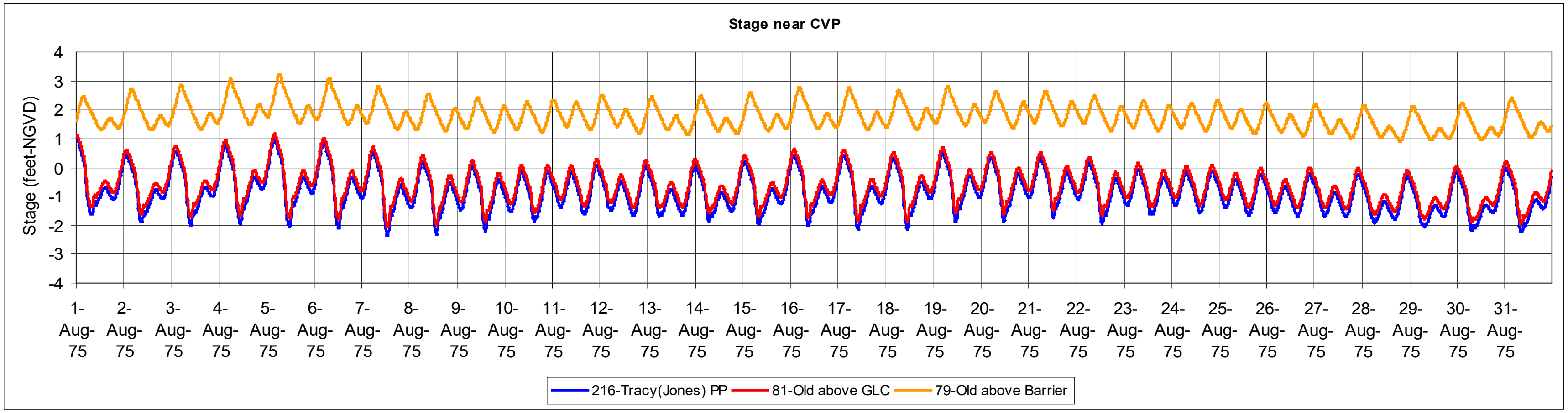
Figure 23

Simulated Tidal Elevations and Tidal Flows in Old River and Grant Line Canal during August 1975 for the Delta Corridors Plan



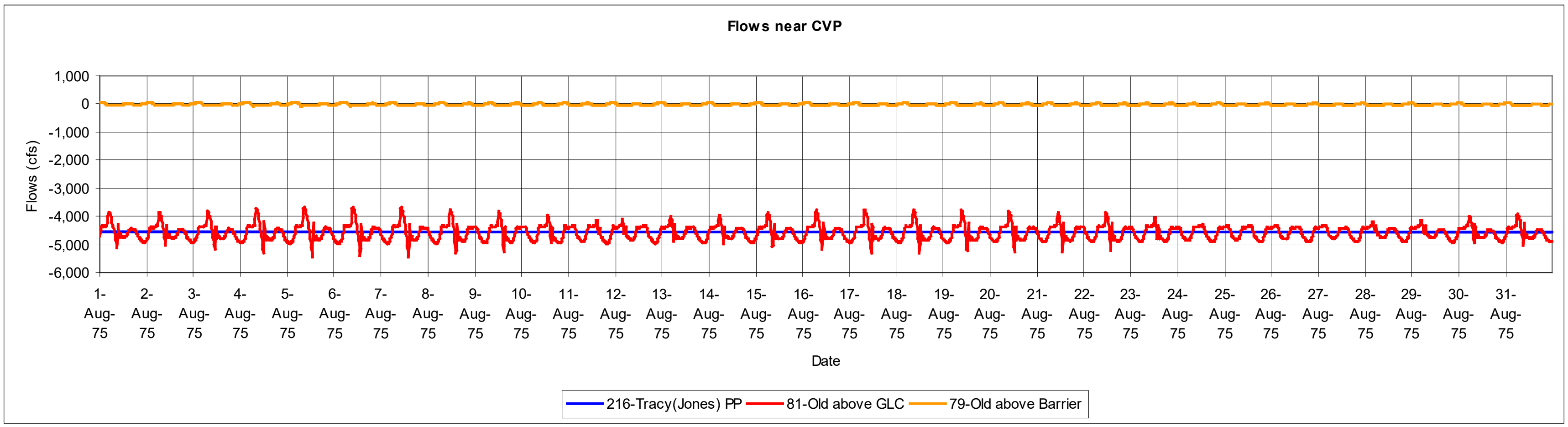


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Figure 24

Simulated Tidal Elevations and Tidal Flows near the DMC Intake on Old River during August 1975 for the Delta Corridors Plan

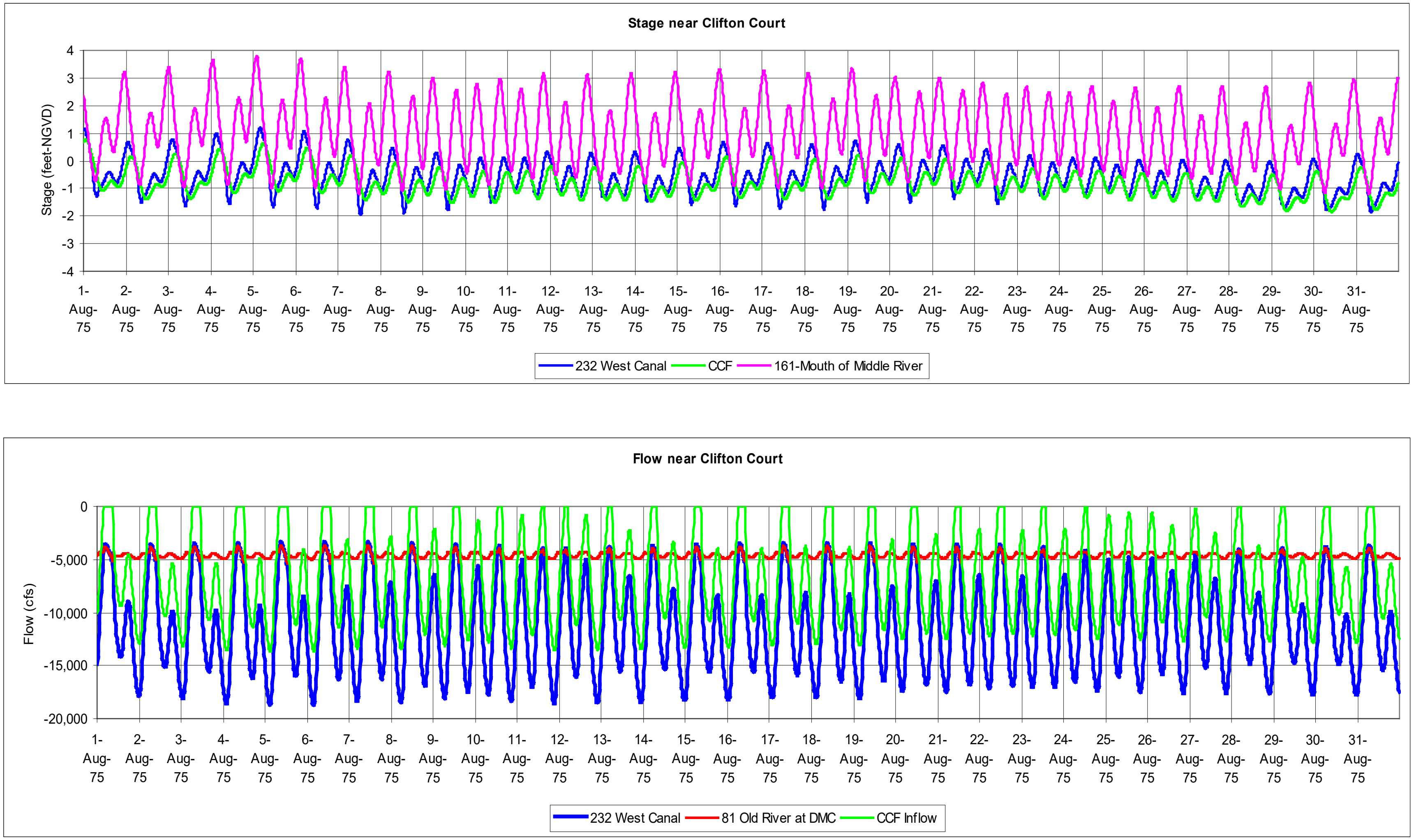

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Figure 25

Simulated Tidal Elevations and Tidal Flows in West Canal and Clifton Court Forebay during August 1975 for the Delta Corridors Plan

existing conditions elevations. The simulated flows into CCF fluctuated from 0 cfs (when West Canal elevations were higher than CCF elevations) to the maximum gate flow of 16,000 cfs. The tidal flows in West Canal downstream of the CCF intake were about 5,000 cfs for existing conditions and were reduced to about 2,000 cfs with the DC Plan because the tidal flows for Grant Line Canal were now in the divided Old River channel.

These simulated results for the DC Plan conditions indicated that the full existing CVP (4,500 cfs) and SWP (6,680 cfs) exports could be tidally transported in the dredged Middle River and Victoria Canal water supply corridor, while maintaining a CCF water elevation between about 1 foot and –2 feet msl (minimum elevation to prevent cavitation of the pumps). The DC Plan would allow the tidal energy of the Delta channels to continue to transport the full existing CVP and SWP exports to the south Delta during flood-tides. The dredging needed to maintain the minimum elevation of -2 feet msl with a net upstream flow of about 12,000 cfs is described in the next section.

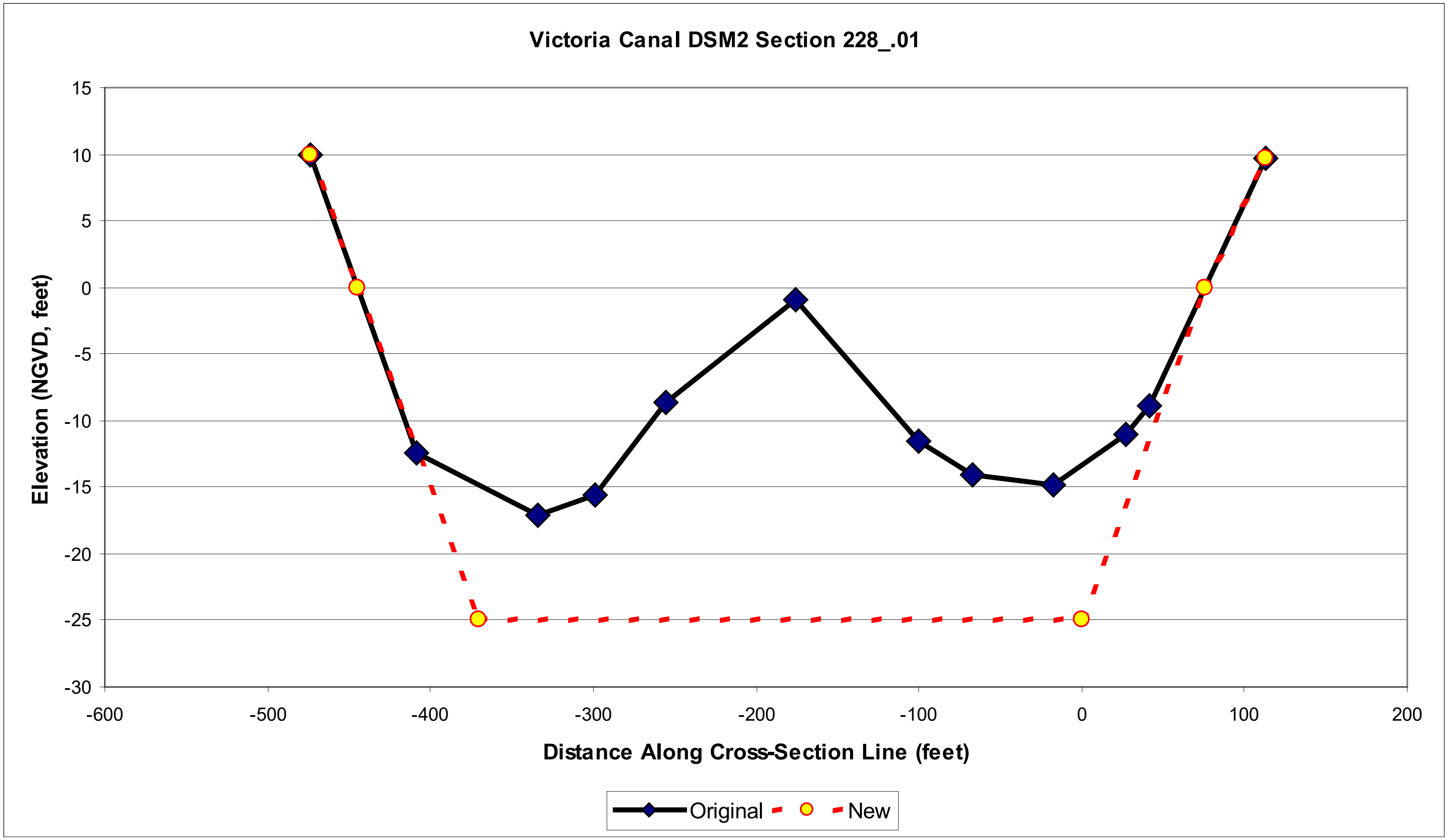
3.3 Dredging of Middle River and Victoria Canal

This section describes the changes in the modeled cross-sections of Middle River, Victoria Canal, and West Canal to simulate the effects of dredging. This process involved the use of the Cross Section Development Program (CSDP), which enables the viewing of Delta bathymetry and the creation or modification of cross-section input files used by DSM2. Initial DSM2 simulations of the DC Plan indicated that tidal flows were reduced (constricted) in Middle River adjacent to Victoria Island (DSM2 channels 135–138), in Victoria Canal (DSM2 channels 226–231) and in West Canal (DSM2 channels 81 and 232). The cross-sections in these channels could be deepened by dredging to a depth of –25 feet msl with a side slope of 3:1 (horizontal to vertical) to maintain levee stability. The dredged cross-sections were the same as the original cross-sections for elevations above 0 feet msl. Below an elevation of 0 feet, the new channels were assumed to have a 3:1 slope to a depth of –25 feet.

Figure 26 shows an example of an original and dredged cross-section for Victoria Canal. The new channel was assumed to be dredged all the way across the channel, eliminating the channel island between Victoria Canal and North Canal. The channel width at 0 feet msl was 520 feet, and the original cross-section area below 0 feet msl was 5,290 square feet with an average depth of about 10.2 feet. The perimeter was 526 feet, so the hydraulic radius was about 10.0 feet. This can be used to estimate the water surface slope required to convey 12,000 cfs in Victoria Canal. The flow equation (Manning's) is:

$$\text{Flow (cfs)} = \text{Area} * 1.5/n * R^{0.666} * s^{0.5}$$

Where Area is the cross-section area (square feet), R is the hydraulic depth (ft), s is the water surface slope (ft/ft), and n is the Manning's value. This can be rearranged to give the slope required



Channel width is 520 feet at 0 feet msl (NGVD) and the cross-section area is 5,290 square feet with average depth of about 10 feet. Dredged cross section area is 11,125 square feet with average depth of about 21.5 feet.

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Jones & Stokes

Figure 26

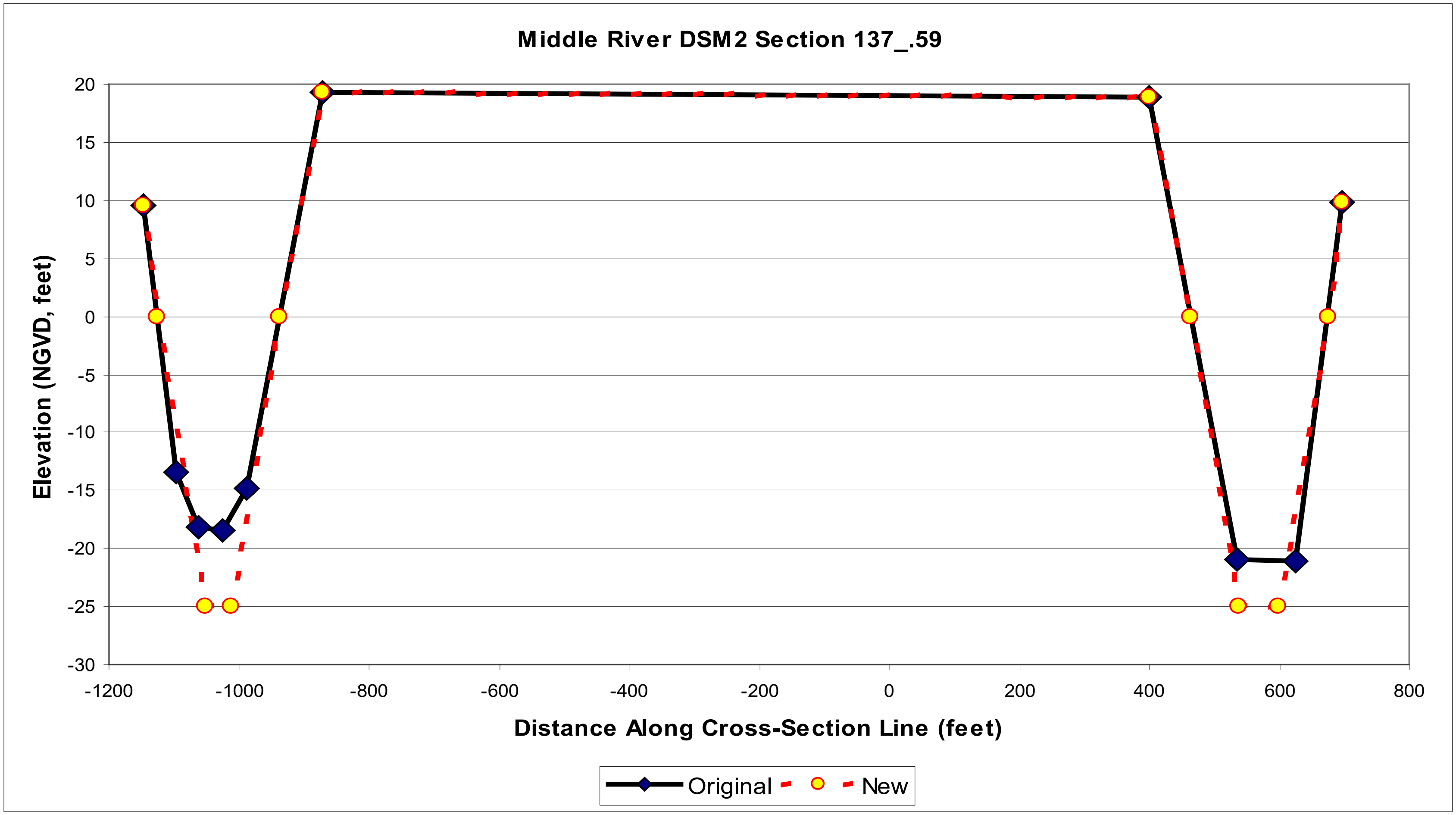
Comparison of Original and Dredged DSM2 Channel Section 228.01 Located along Victoria Canal

for a flow of 12,000 cfs with an assumed Manning's n value of 0.027. The required slope is about 0.0000775 or 0.4 feet/mile (5 inches/mile). This is a moderate river slope and would result in a large elevation change of 2.3 feet along the 5.5 miles of Victoria Canal. The dredging would produce a trapezoidal channel with side slopes of 3:1 for stability and a bottom width of 370 feet. The dredged cross-section area would be increased to 11,125 square feet and the average depth would be about 21.5 feet. Each side slope has a length of about 80 feet, so the perimeter would be 530 feet, and the hydraulic radius would be increased to 21 feet. This would reduce the required hydraulic slope needed for a tidal flow of 12,000 cfs to about 0.0000065 or 0.03 foot/mile (0.4 inches/mile). This slope is less than 10% of the slope with the original Victoria Canal section, and would result in an elevation change of just 0.2 feet along the 5.5 miles of Victoria Canal.

Figure 27 shows a section of the Middle River channel where the dredged cuts along Victoria Island and Jones Tract levees are separated by a wide island. The dredging was assumed to leave the island in the middle of the channel. This will limit the conveyance of the dredged channel, but if sufficient cross section can be achieved with the two dredged channels, leaving the channel island in the center of the Middle River corridor will preserve considerable tidal and aquatic habitat along the island perimeter. The width of the two channels of this section of Middle River was about 400 feet with a cross section area of 5,585 square feet and an average depth of about 14 feet. Dredging without widening the cuts would provide a new cross-section area of 6,250 square feet. This may not be enough for the 12,000-cfs water supply flow, and these two channels will likely need to be widened to provide a cross section of about 10,000 square feet. Other sections of Middle River without a channel island were assumed to be dredged to a depth of 25 feet depth across the entire channel.

Table 2 gives some summary values for the DSM2 channel sections that were modified for dredging evaluation of the DC Plan. The Middle River channel between Woodward Cut and Victoria Canal is about 3.5 miles long and would be dredged from existing depths ranging from about 15 feet to 20 feet to a uniform depth of 25 feet, with a channel width of about 400 feet (250 feet at the bottom). This would increase the average cross-section area from about 5,000 square feet to about 8,000 square feet. Victoria Canal would be dredged from a depth of about 15 feet to a depth of 25 feet, and the center island would be removed. Victoria Canal length is about 5.5 miles, and the channel width is about 500 feet. The cross-section area would be increased from about 5,000 square feet to about 10,000 square feet. The Victoria Canal channel was extended to simulate the large box culverts connecting to West Canal. West Canal would be dredged from a depth of about 20 feet to about 25 feet deep. The length of West Canal is about 1.5 miles, and the width is about 250 feet. The cross-section area would be increased from about 4,000 square feet to about 5,000 square feet.

The dredging volume was calculated using the differences between the original cross-section areas and the dredged cross-section areas. These dredged areas were then multiplied by the length of each channel section. The dredging along Middle River would require about 1.5 million cubic yards. A more detailed evaluation may suggest that the Middle River channel



Channel width is 400 feet at 0 feet msl (NGVD) and the cross-section area is 5,585 square feet with average depth of about 14 feet. Dredged cross-section area is 6,250 square feet with average depth of about 15.5 feet. This section may require widening to provide cross section area of about 10,000 square feet to convey the full existing water supply exports of about 12,000 cfs.

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Jones & Stokes

Figure 27

Comparison of Original and Dredged DSM2 Channel Section 137.59
Located along Middle River Upstream of Woodward Cut

sections need to be widened by about 100 feet to increase the average cross section by 2,500 square feet to about 10,000 square feet. This would increase the dredging volume by about 1.5 million cubic yards. The dredging in Victoria Canal would require about 5 million cubic yards. The dredging in West Canal would require about 1 million cubic yards. The total dredging would be about 10 million cubic yards at an estimated cost of about $500 million (i.e., $50/cubic yard) that would allow full existing exports to be supplied by the Middle River corridor, and allow the entire San Joaquin River flow to be separated from the water supply for the CVP and SWP exports to reduce export salinity and reduce fish entrainment impacts. The dredged material could be used to buttress the existing levees along Middle River and Old River.

Table 2. Assumed Dredging in Middle River, Victoria Canal, Old River, and West Canal Channels for the Delta Corridors Plan

Channels with	Cross Section	Channel	Cross-	Width at	Old Cross-	New Cross-	Dredge
81	81 .44	3,857	3,857	240	3,214	4,125	130,138
82	82_.95	2,609	2,609	264	4,238	4,725	47,012
135	135_.16	4,427	708	453	6,109	9,446	87,538
135	135_.75		1,107	464	4,380	9,716	218,742
135	middle part		2,612		5,245	9,581	419,513
136	136_.79	2,266	2,266	383	4,382	7,694	277,939
137	137_.59	3,983	2,350	400	5,584	6,254	58,328
137	137_.85		597	473	4,729	8,077	74,087
137	middle part		1,036	475	5,157	7,166	77,061
138	138_.31	7,131	2,211	417	5,843	8,128	187,046
138	138_.78		1,569		5,230	6,666	83,447
138	middle part		3,352		5,537	7,397	230,929
226	226_.15	4,153	4,153	480	5,761	10,126	671,386
227	228_.01	4,789	4,789	520	5,291	11,137	1,036,978
228	228_.01	3,218	3,218		5,291	11,137	696,804
229	229_.14	3,048	3,048	523	4,687	11,188	733,843
230	230_.02	13,402	5,712	425	4,394	8,743	920,062
230	231_.68		4,313	238	1,895	4,087	350,215
230	85_.08		3,377				0
231	231_.68	4,313	4,313		0	4,087	652,924

Channel Sections	Miles		Cubic yards
Middle River Woodward to Victoria	3.4		1,483,700
Victoria Canal to West Canal	5.4		5,062,212
Old River Victoria to West Canal	0.8	Extended channel	652,924
West Canal to Delta-Mendota Canal Intake	1.2		177,150
Total Dredging			6,953,992
Total Dredging with Middle River widened to provide 10,000 square feet cross-section			8,500,000

4 SUMMARY

This revised technical report on the Delta Corridors Plan (original report was Jones and Stokes 2007) evaluated the feasibility of separating the SJR water in Old River from the CVP and SWP water supply (exports) in Middle River and identified the volume of dredging in Middle River and Victoria Canal that would be needed to allow full permitted exports (11,280 cfs). The tidal elevations and tidal flows with the existing channel geometry and with the DC Plan changes in channel configurations and dredging were compared with the Delta Simulation Model II (DSM2) using August 1975 as the example month. Understanding the existing tidal flows in the major Delta channels allows the effects of the DC Plan on the tidal flows to be accurately evaluated. The DC Plan would not change tidal elevations or tidal flows in Suisun Bay or in Suisun Marsh. The DC Plan would not change the tidal elevations or tidal flows in the Sacramento River channels. The fish screen on Georgiana Slough would only slightly change the Georgiana Slough diversions from the Sacramento River. The Delta Cross Channel (DCC) would be divided to allow the north gate to remain open for Mokelumne River fish to migrate directly to the Sacramento River while the south gate would be opened with a fish screen to divert water to the Mokelumne River channels and to the SJR and to Middle River. The DC Plan would have a stronger effect on the tidal elevations and tidal flows and net flows in the San Joaquin River channels including Old River and Middle River and Grant Line Canal (i.e., south Delta channels).

Modeling results with the proposed dredging of Middle River and Victoria Canal indicate that the full permitted exports of about 12,000 cfs could be conveyed to the CVP and SWP exports without reducing the minimum tidal elevations to less than 0 feet NAVD (to prevent cavitation). This important result suggests that other aspects of the proposed Delta Corridors Plan should be further investigated and evaluated. More detailed tidal hydraulic modeling of the proposed fish-screens, tidal gates, culverts, dividing walls and flood-gates will be needed to develop preliminary designs for each of the proposed Delta Corridors Plan facilities. The first technical report on the feasibility of constructing and operating the Delta Corridors Plan, based on comparative results from DSM2 tidal modeling of the DC Plan, was prepared by Jones and Stokes with support from the SDWA and CDWA in 2007. A second technical report on the salinity benefits of the DC Plan was prepared by ICF Jones and Stokes with support from the SDWA and CDWA in 2009. This second technical report was based on the comparative results from the DSM2 tidal and water quality modeling for WY 1976-1991. The range of monthly flows and salinity throughout the Delta were described and evaluated. Separating the SJR from the exports will eliminate the recycle of irrigation drainage salts back to the DMC irrigated lands and reduce the export salinity by 25%. Potential fish benefits from separating the Sacramento River and San Joaquin River juvenile migrating fish from entrainment losses at the CVP and SWP export pumps were also described and discussed in the second technical report. Additional investigations of the likely estuarine fish benefits from the separation of the lower SJR, Franks Tract and Old River tidal habitats from entrainment losses at the export pumps and the likely benefits of allowing the SJR production of phytoplankton and zooplankton to enter the food-web rather than be pumped at the exports should be conducted.

4.1 References

Jones and Stokes. 2005. South Delta Improvements Program Draft Environmental Impact Statement/Environmental Impact Report. Prepared for U.S. Department of the Interior, Bureau of Reclamation and California Department of Water Resources.

Two sections of the 2005 SDIP EIS/EIR are most relevant for this DSM2 Modeling of the Delta Corridors Plan:

Section 5.2 "Delta Tidal Hydraulics" of the SDIP Draft EIS/EIR provides a great deal of useful information about the Delta channels and the tidal elevations and tidal flows and the net daily flows that are measured and modeled with DSM2. Available at: http://baydeltaoffice.water.ca.gov/sdb/sdip/documents/draft_eis_eir/vol-1/doc/chapter_05.pdf

Appendix D "DSM2 Tidal Hydraulics and Water Quality Modeling Methods and Results" of the SDIP Draft EIS/EIR describes the DWR DSM2 model of Delta tidal hydraulics and summarizes the model results that were used for the tidal hydraulics impact assessment of the SDIP alternatives. Available at: http://baydeltaoffice.water.ca.gov/sdb/sdip/documents/draft_eis_eir/vol-2/vol-2-appendices.html

Jones and Stokes. 2007. Tidal Hydraulics Modeling (DSM2) of the Delta Corridors Plan. November. Sacramento, CA. Prepared for the South Delta Water Agency and Central Delta Water Agency.