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| **Subject:** | **Barge Transportation Study (Final Draft)** |
| **Project feature:** | Site Development / Logistics |
| **Prepared for:** | California Department of Water Resources (DWR) / Delta Conveyance Office (DCO) |
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# 1. Organization

This technical memorandum (TM) includes the following eight sections.

- Introduction
- Executive Summary
- Tug and Barge Characteristics
- Primary Waterway Navigability
- Maps for Waterway Navigability and Landing Site Availability
- Operational Constraints
- Document History and Quality Assurance
- Appendixes

# 2. Introduction

## 2.1 Background

California DWR is conducting an environmental review and planning process for a single-tunnel Delta Conveyance. Construction of the single-tunnel solution would require moving labor, equipment, and material resources within the Delta, potentially using waterborne transportation systems. This report analyzes the logistics required to support this project by using the rivers and watercourses existing in the Delta.

## 2.2 Scope and Objective

This TM evaluates the potential tunnel alignments' accessibility by barges. It discusses the Sacramento – San Joaquin River Delta (Delta) waterways' navigability and landing site availability near potential tunnel shaft locations. The following aspects of barge transportation logistics and waterway navigability are discussed in this TM:

- Channel description based on bathymetry, width of waterways, and other applicable limitations
- Physical restrictions, including bridges
- Barge sizes in terms of length, width, capacity, and draft
- Potential tow configurations

- Potential supply and demand for barge services given the potential volumes associated with this project
- Potential barge-landing areas near intake shaft sites
- Operational constraints
- Effect of tidal currents on navigation
- Effect of seasonal variations in water levels and flooding in winter months
- Impacts to others pertaining to navigation
- Environmental restrictions and fish seasons

This study is based on the preliminary tunnel corridor maps. The maps, which were developed on a preliminary basis to provide a basis for this analysis, show potential tunnel alignments, shaft locations, and intake locations.

## 2.3 Executive Summary

Constructing tunnel launch shaft sites requires deliveries of tunnel boring machine components, equipment, tunnel liner precast concrete segments, aggregate, cement, and other building materials. These deliveries would otherwise result in a large number of truck trips during the construction period. The use of barges reduces the number of truck trips on highways and local roadways, which could also result in reduced costs for improving current roads and bridges. The barges could also be used to transfer reusable tunnel material (RTM) to other locations for reuse. Materials could be delivered by barge from existing ports near the Delta, including Port of Stockton, Port of Pittsburg, and Port of West Sacramento as well as commercial mooring facilities (for example, a facility in Rio Vista used to load barges with rock). Barge landings could be constructed near the tunnel launch facilities to facilitate off-loading tunnel liner pre-cast concrete segments and loading RTM. This TM analyzes the logistics required to support material transport in the Delta’s rivers and watercourses.

### 2.3.1 Tug and Barge Characteristics

Equipment characteristics for tug and barge equipment working on the Delta waterways were evaluated based upon equipment and configurations that experienced contractors have historically used for on-the-water work in the Delta. For barges, the ideal size would be 200 feet long by 50 feet wide, with a draft less than 12 feet and a hauling capacity of 2,000 tons. The ideal tug for the Delta would be 1,500 horsepower with drafts of 9 feet or less. Because of the width of many of the smaller waterways, the preferred towing configuration would be a single barge being pushed by a single tug. In some locations, a second tug would be needed to assist at tight turns. Barges also could need to be light-loaded to be able to navigate through shallow areas. Also, site-dependent variations could dictate whether smaller or larger tugs and barges (from the ideal specifications cited previously) are used because of the different site conditions.

### 2.3.2 Primary Waterway Characteristics

The waterways that could be used to haul materials and equipment were analyzed for depth, width, and bridge restrictions. The primary waterways evaluated included the Sacramento River, Sacramento River Deep Water Ship Channel (SRDWSC), Three Mile Slough, Mokelumne River Complex, San Joaquin River and Stockton Deep Water Ship Channel (SDWSC), Old River Complex, Connection Slough, Railroad Cut, Woodward Canal/North Victoria Canal, Potato Slough Complex, and Middle River Complex. The SRDWSC and SDWSC have enough depth and width to transport materials. Most of the watercourses have enough width to transport materials, but there are some areas of concern where the water depth is less than 12 feet during low tide throughout the year. These areas could require light-loaded barges that draft less than 10 feet or for barging to be scheduled during higher tides to provide depth to transport over the shallow areas. Opening bridges on these waterways could also affect the barge schedule. Waterway characteristic are summarized as follows:

- SRDWSC has adequate widths and depths; however, delays could occur for travel from Port of West Sacramento at the Rio Vista Bridge.
- Lower Sacramento River between Rio Vista and Clarksburg includes several shallow areas, and delays could occur at the Walnut Grove, Paintersville, and Isleton Bridges.
- Three Mile Slough includes several shallow areas, and delays could occur at the Three Mile Slough Bridge.
- North Fork Mokelumne River includes several shallow areas, and delays could occur at the Millers Ferry Swing Bridge.
- South Fork Mokelumne River includes several shallow areas, and delays could occur at the Mokelumne River Bridge along State Route 12.
- San Joaquin River and SDWSC have adequate widths and depths.
- Old River includes shallow and narrow areas, and delays could occur at the Orwood Bascule and Old River Railroad Bridges.
- Connection Slough includes shallow areas, and delays could occur at the Connection Slough Swing Bridge.
- Railroad Cut has adequate widths and depths for barges.
- Woodward Canal/North Victoria Canal includes shallow areas, and delays could occur at the new bridge between Woodward Island and Jones Tract.
- Potato Slough includes shallow depths and tight turns.
- Middle River Complex, including Columbia Cut, Empire Cut, Turner Cut, and Whiskey Slough, includes several shallow and narrow areas, and delays could occur at the Bacon Island Swing Bridge.

### 2.3.3 Operational Constraints

The ability to effectively use the water access routes would be periodically limited by tidal cycles, weather, and environmental constraints. Storm events cause higher currents from December through April. Higher flows reduce the speeds of tugs and loaded barges going upstream and increase speeds of empty barges going downstream. Tule fog in the Delta can shut down barging operations for 1 to 2 days per month on average during the winter months. Wind speeds and gusts affect tug and barge operations in the summer and fall months; however, these effects are not anticipated to be substantial.

Environmental constraints could affect the ability to operate barges or construct barge landings in some months or at night. The SRDWSC and SDWSC have enough width to accommodate passing oceangoing vessels and barges, and therefore, barge operations would not interrupt commercial vessel navigation. However, the Delta has over 130 marinas with multiple slips for recreational boaters; therefore, barge operations would require coordination with navigation regulatory agencies to protect recreational vessel navigation.

### 2.3.4 Recommendations

Tunnel launch shaft sites on Bouldin and Lower Roberts islands could be located near waterways that could be accessed by multiple barges. The tunnel launch shaft site on Bouldin Island could be accessed along a barge route on SDWSC and Potato Slough. The tunnel launch shaft site on Lower Roberts Island could be accessed along the adjacent SDWSC to the east of an existing Port of Stockton barge landing and Windmill Cove. These barge landings would be connected to the tunnel launch shaft sites by a combination of conveyors, roads, or rails.

Barges could directly access Bouldin Island and Lower Roberts Island barge landings from the Port of Stockton and ports in the San Francisco Bay Area. Barges from the Port of West Sacramento would navigate along the Sacramento Deep Water Ship Channel to the Sacramento River; and continue under two moveable bridges: one at Rio Vista along the Sacramento River and one at the confluence of the Sacramento River and Three Mile Slough. Navigation under the moveable bridges could result in delays. Some barge operations could be utilized at other locations such as water-based support of pile driving, rock slope placement and levee construction. These types of operations do not typically require extensive land-based support infrastructure.

Other work locations such as the intakes and Southern Complex are not recommended due to combinations of the constraints included above.

Major barge operations at the intakes are not recommended for the following reasons:

- Multiple Barge Landings or increased hauling on roadways would be needed
- Materials would be delivered on the opposite side of State Route 160 from the majority of the work that could be effectively supported by barge operations, requiring traffic interruptions.
- Multiple operable bridges would need to be passed on the inbound and outbound legs, effecting roadway traffic patterns.

Major barge operations at the Southern Complex are not recommended for the following reasons:

- Width and depth of waterways would limit barge speed and ability to pass.
- Passing the BNSF Railroad operable bridge would cause delays due to the number of trains that utilize this route.

## 3. Tug and Barge Characteristics

The key to successfully implementing waterborne equipment in the Delta is appropriate vessel width and draft for navigation within Delta waterways. The Delta has two major waterways—the Sacramento River Deep Water Ship Channel (SRDWSC) and the Stockton Deep Water Ship Channel (SDWSC)—both of which have ample width and draft to accommodate multiple barges pushed by a single tow or tug boat. By comparison, the Sacramento River and the other watercourses and canals that are examined in this study are limited in width and draft. This is due to bridge, marina, and draft restrictions.

The following subsections summarize information on barges, tugs and workboats, and deck barge sizes and capacities.

## 3.1 Deck Barges

The U.S. Army Corps of Engineers (USACE) 2017 database lists 8,049 deck barges, 99 of which are in California (USACE 2018). Thirty-one of these have a capacity greater than or equal to 2,000 tons (2,000-6,000 tons). Because of the proposed project's scale, it could draw interested marine operators and construction companies from other areas of the West Coast, including Oregon and Washington and beyond. For example, in Oregon, there are 54 deck barges in total, 20 of which are greater than or equal to 2,000 tons (2,000–17,000 tons). In Washington, there are 257 deck barges in total, 125 of which are greater than or equal to 2,000 tons (2,000–15,500 tons). On the West Coast, there are 410 deck barges in total, with 176 being greater than 2,000 tons.

### 3.1.1 Barge Sizes and Capacities

Contractors and tow operators that work on Delta watercourses typical.5ly limit tows to a single 2,000-ton barge, 50 feet in width and 250 feet in length that drafts 10 to 12 feet and is pushed by a 1,200- to 2,000-horsepower tug that drafts 9 feet or less (Walker, pers. comms. 2019a). The reason for this is that the Sacramento River and the other watercourses have not been dredged for many years and have known shoaling areas.

Key characteristics of the various barges used for levee repair projects in the Delta are provided in Table 1.

**Table 1. Sizes of Various Barges Used for Levee Work in the Delta**

| Barge | Capacity (tons)[a] | Net Register Tonnage[b] | Length (feet) | Width (feet) | Loaded Draft (feet) | Empty Draft (feet) |
|---|---|---|---|---|---|---|
| 1 | 2,500 | 946 | 178 | 50 | 10 | 2 |
| 2 | 2,500 | 946 | 178 | 50 | 10 | 2 |
| 3 | 2,500 | 1,143 | 200 | 54 | 11 | 3 |
| 4 | 2,750 | 1,255 | 200 | 60 | 10 | 2 |
| 5 | 3,500 | 316 | 188 | 60 | 10 | 2 |
| 6 | 3,500 | 1,224 | 248 | 48 | 10 | 3 |
| 7 | 3,500 | 1,372 | 236 | 50 | 14 | 3 |
| 8 | 4,300 | 960 | 200 | 45 | 10 | 3 |

[a] Maximum cargo capacity in short tons.

[b] Net register tonnage is a ship's cargo volume capacity expressed in "register tons," one of which equals a volume of 100 cubic feet.

## 3.2 Tugs and Workboats

The USACE database lists 5,810 tugs and workboats, of which 110 are in California, and 68 are located in the Bay Area. Fifteen are work boats (400–800 horsepower), 29 are harbor tugs (800–2,000 horsepower), 11 are coastal tugs (2,000–3,900 horsepower), and 15 are ocean tugs (4,300–6,772 horsepower). Given the potential project's scale, it is reasonable to assume that barges and tugs could be acquired and brought to the site from beyond the West Coast or could be purpose-built for the project from locations on the West, Gulf, and East Coasts of the United States.

The key tug requirement for pushing barges up to and into the Delta is draft. For many years, contractors and tow-boat operators have used tugs that draft 9 feet or less, usually a tug with 1,000 to 2,000 horsepower.

The *Sarah Reed*, a tug owned and operated by Dutra, and the *Terilyn*, owned and operated by Westar Marine Services, routinely transport rock barges to the levee repair sites in the Delta. The *Sarah Reed* is a 1,600-horsepower tug measuring 65 feet long and 24 feet wide. It has a draft of 7.5 feet (Dutra Group 2020). The *Terilyn* is a 1,550-horsepower tug measuring 70.6 feet long and 26 feet wide. It has a draft of 8.5 feet (Westar Marine Services 2020).

*Photos courtesy of The Dutra Group and Westar Marine Services*

**Figure 1. Tugboats *Sarah Reed* and *Terilyn***

## 3.3 Towing Configurations

The primary towing configuration in the Delta is typically a single 200-foot by 50-foot barge with a draft of 10 feet, pushed by a 1,500-horsepower harbor tug. This configuration is used because of the narrow widths, bridges, and shallow areas of the Sacramento River and other connecting river courses. The SRDWSC and SDWSC can accommodate multi-barge tows because of their ample width and deep drafts.

For levee repair projects in the Delta, tandem rock barge tows are common for hauling rock from a quarry in San Rafael, California, north of San Francisco, to a mooring at Rio Vista, if working on the Sacramento River, or to a mooring at False River if working the San Joaquin River tributaries. At moorings at Rio Vista or False River, the multi-barge tow is broken down to single-barge tows for subsequent distribution throughout the Delta. From these moorings, the tug pushes the barges through the narrow watercourses to the levee work areas. After a barge is emptied at the work area, it is returned to the mooring, and the other loaded barges are picked up by the tug and taken to the work area. The tightest restriction is on the Sacramento River just upstream of the bridge at Walnut Grove where there are three docking facilities: Dagmar’s Landing, Walnut Grove Public Dock, and Deckhand’s Marine & Supplies Dock, shown on Figure 2 (Walker, pers. comms. 2019b).


*Aerial Image © 2019 Google Earth. Annotation © 2019 DCDCA*

**Figure 2. Tug and Barge Restrictions on the Sacramento River at Walnut Grove**

# 4. Primary Waterway Navigability

The evaluation of the waterways provided in this section is based on three sources:

- **National Oceanic and Atmospheric Administration (NOAA) Nautical Charts 18661 and 18662 (NOAA 2009a, 2009b):** Both charts were published in 2009 and provide bathymetry data for the waterways of interest here. Water depths indicated on the charts are the soundings in feet at mean lower low water (MLLW) (NOAA 2020). The charts also provide key information on the bridges relevant to water traffic such as the maximum width between the bents and clearance under the deck (during both low tide and high tide).
- **DWR bathymetry database (State of California 2020):** This is a GIS-based online tool presenting the surveys performed between 2010 to 2018, using a color-coded scale. The tool also provides water depth at a selected point and depth profile between two selected points. The available data covers the majority of Old River and Middle River; however, there is only partial data available for the other Delta waterways.
- **Interview with marine contractors in the Delta:** Findings from the NOAA charts and the DWR online database confirmed with the vessel operators and the marine contractors operating in the Delta.

Key waterways that are relevant to Delta Conveyance Project are as follows:

- SRDWSC
- Sacramento River

- Three Mile Slough (TMS)
- Mokelumne River (North Fork and South Fork)
- San Joaquin River and SDWSC
- Old River
- Connection Slough
- Railroad Cut
- Woodward Canal and North Victoria Canal
- Potato Slough Complex
- Middle River (including Columbia Cut, Turner Cut, Empire Cut, and Whiskey Slough)

A brief description of these waterways, including vessel operations and restrictions, is provided in the following section.

## 4.1 Sacramento River Deep Water Ship Channel

The SRDWSC is a canal from the Port of Sacramento in West Sacramento, California, to the Sacramento River, which flows into San Francisco Bay. USACE completed canal construction in 1963. The channel is 30 feet deep, 200 feet wide, and 43 miles long. The SRDWSC was authorized by the *Rivers and Harbors Act of 24 July 1946*. The channel is part of the California Green Trade Corridor/Marine Highway project, which provides shippers a waterborne option to move cargo along the waterways between the Ports of Oakland, Stockton, and West Sacramento, reducing roadway freight traffic and improving goods movement through Northern California (USACE 1949; The Maritime Executive 2013). The Port of West Sacramento, which lies at the upper end of the SRDWSC, is an inland port and receives far less traffic than larger, deeper water ports. It handles primarily bulk goods rather than containers, which dominate the local shipping market. Current major shipments include 18 imported ships per year loaded with cement from Vietnam and 15 exported ships per year loaded with rice.

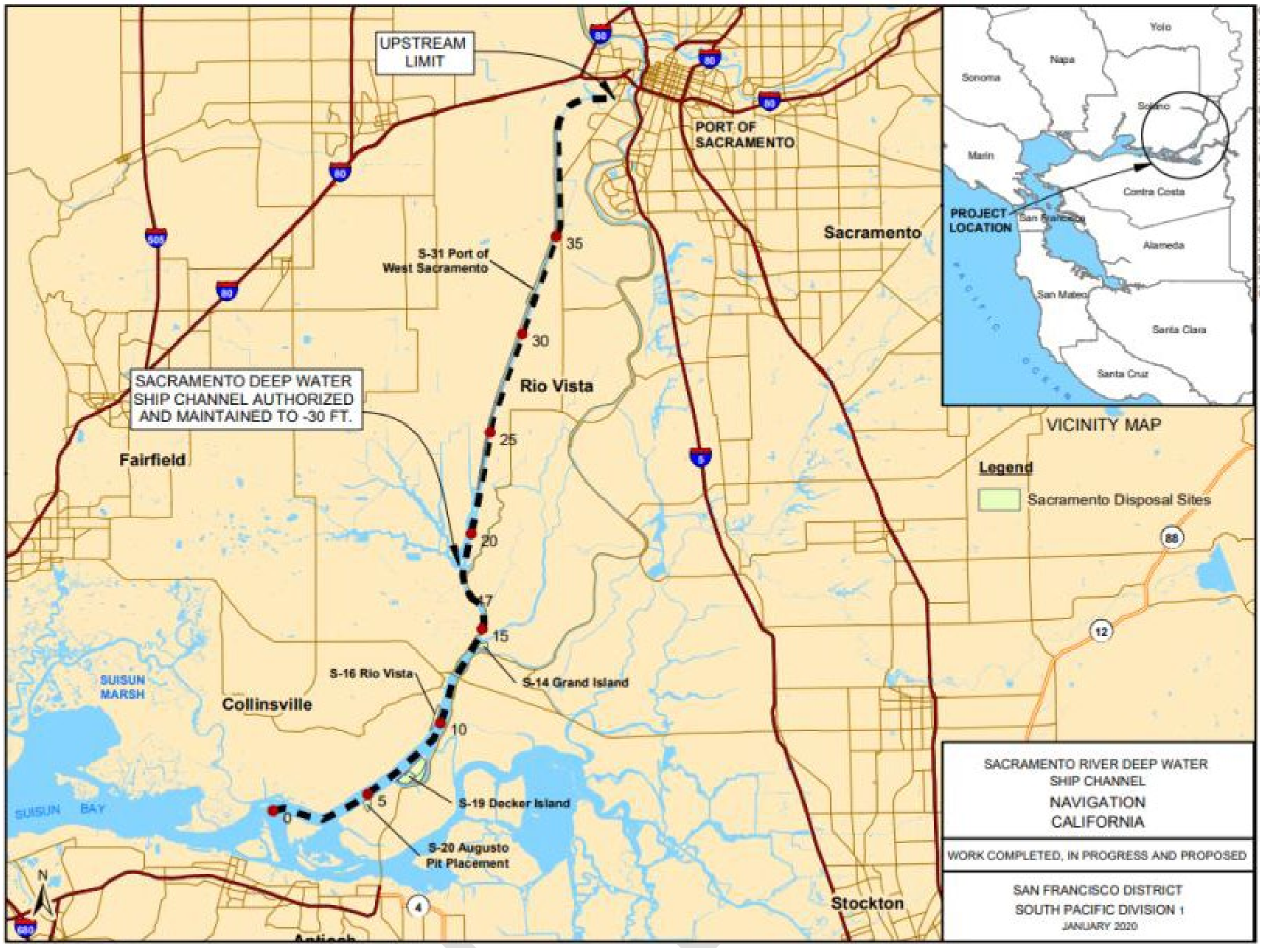
The SRDWSC is dredged periodically by USACE to achieve project depth in specific areas of the federal navigation channels. The project depth for the SRDWSC is minus 30 feet, with 1 foot of paid over-depth. In 2019, this amounted to a dredge contract of approximately 100,000 cubic yards (Dredging Today 2019).

### 4.1.1 Vessel Operations and Restrictions on the Channel

The San Francisco Bay Bar Pilots are responsible for vessel navigation on the SRDWSC and have confirmed the following restrictions:

- Vessels measuring greater than 650 feet long are restricted to daylight transits as a safety precaution.
- Vessels carrying a hazardous material must only navigate the channel during daylight hours.
- Deep-draft vessels must sometimes wait for high tide to safely maneuver the channel. This inactive waiting time is called a tidal delay.

The longest tidal delay for most vessels calling at the Port of West Sacramento is 12 hours, given that there are two high tides in a 24-hour time period. The San Francisco Bay Bar Pilots indicated that the average high tide in the SRDWSC approaches 3.6 feet. The shallowest point along the transit is referred to as the controlling depth, which is generally about 29 feet. Summing the average high tide of 3.6 feet and controlling depth of 29 feet, the maximum transitable depth in the channel is 32.6 feet.




*Source: USACE, San Francisco District*

**Figure 3. Map of the Sacramento River Deep Water Ship Channel**

For vessels except tankers, a mandatory 2-foot under-keel clearance requires that the “vertical difference between the lowest protruding section of the hull…and the minimum actual channel depth” be 2 feet (SFBP 2016). This safety measure helps prevent a vessel from running aground while mid-channel. Therefore, taking into consideration the controlling depth, average high tide, and minimum under-keel clearance requirements, vessels are generally able to navigate the SRDWSC to the Port of West Sacramento at a maximum draft of 30.6 feet for bulk and general carriers and 29.6 feet for liquid tankers. Of course, daylight restrictions, fog conditions, excessive shoaling, and other factors would further restrict the maximum allowable draft over the course of the year. According to the San Francisco Bay Bar Pilots, the maximum inbound vessel draft has remained constant at 30.6 feet. Similarly, the maximum outbound draft tends to be 6 inches lower at 30 feet. Because the tide moves up the channel, it is harder for an outbound vessel to maximize the greater water depth provided by high tide, thus accounting for the shallower average maximum draft for outbound vessels (USACE 2011).

A restriction on the SRDWSC is the Rio Vista Bridge, also known as the Helen Madera Memorial Bridge. The bridge is a continuous truss span with a vertical-lift bridge in the middle and carries California State Route 12 across the Sacramento River at Rio Vista. The existing bridge was completed in 1960. It carries approximately 21,000 vehicles per day. Records show that the bridge opens seven times per day (Atkins 2012). The bridge is located approximately 31 miles downstream of the Port of West Sacramento. When the bridge lifts, the width available for ship traffic is 306 feet, and the height is 135 feet (Smith et al

1960). The California Department of Transportation routinely performs maintenance on the bridge, but it does not stop the bridge from operating. Every 9 months, the bridge is closed for 2 hours to replace the oil in the gearboxes. Single lanes on the bridge could close from time to time for roadway maintenance that does not involve major construction. As of 2018, the bridge is currently undergoing a major renovation program consisting of painting and deck replacement, which would be ongoing for the next 4 years. The bridge requires 4 hours' notice to open for marine traffic (Johnson, pers. comms. 2019).

*Image © 2019 Google Street View*

**Figure 4. Rio Vista Bridge**

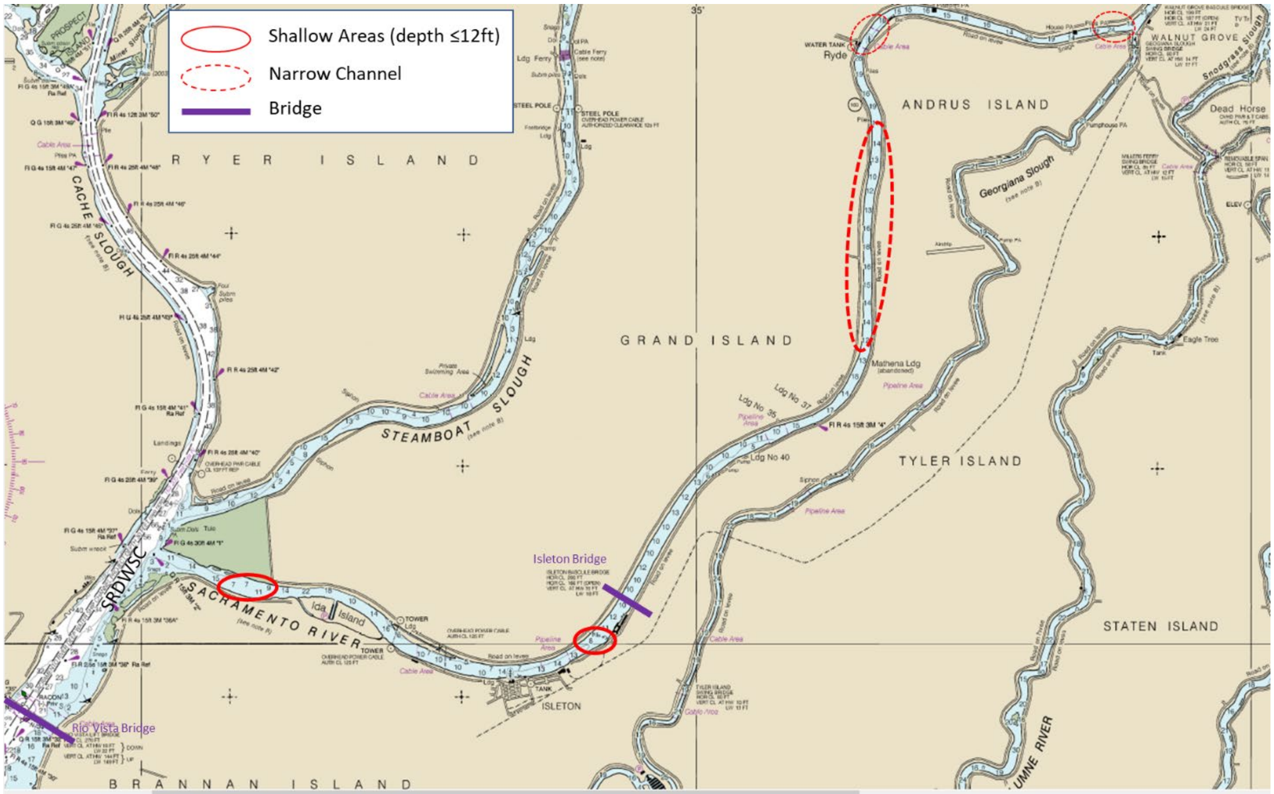
**Summary:** With an average channel width of 450 to 650 feet and a depth of 30 feet, there are no barge restrictions on the channel. Multi-barge tows can be accommodated. However, there could be periodic schedule constraints because of bridge operations and water stages.

## 4.2 Lower Sacramento River

Ships enter the Lower Sacramento River from San Francisco Bay through Suisun Bay to the confluence with the San Joaquin River near Collinsville. The Sacramento River extends from Collinsville to upstream of Shasta Lake near Redding. For this study, the Lower Sacramento River's navigability is considered between a location approximately 2 miles north of Rio Vista to Walnut Grove and between Walnut Grove to Clarksburg. The reach between Rio Vista and Walnut Grove includes the confluence of the Sacramento River and SRDWSC immediately upstream of Rio Vista.

### 4.2.1 Vessel Operations and Restrictions on the Channel

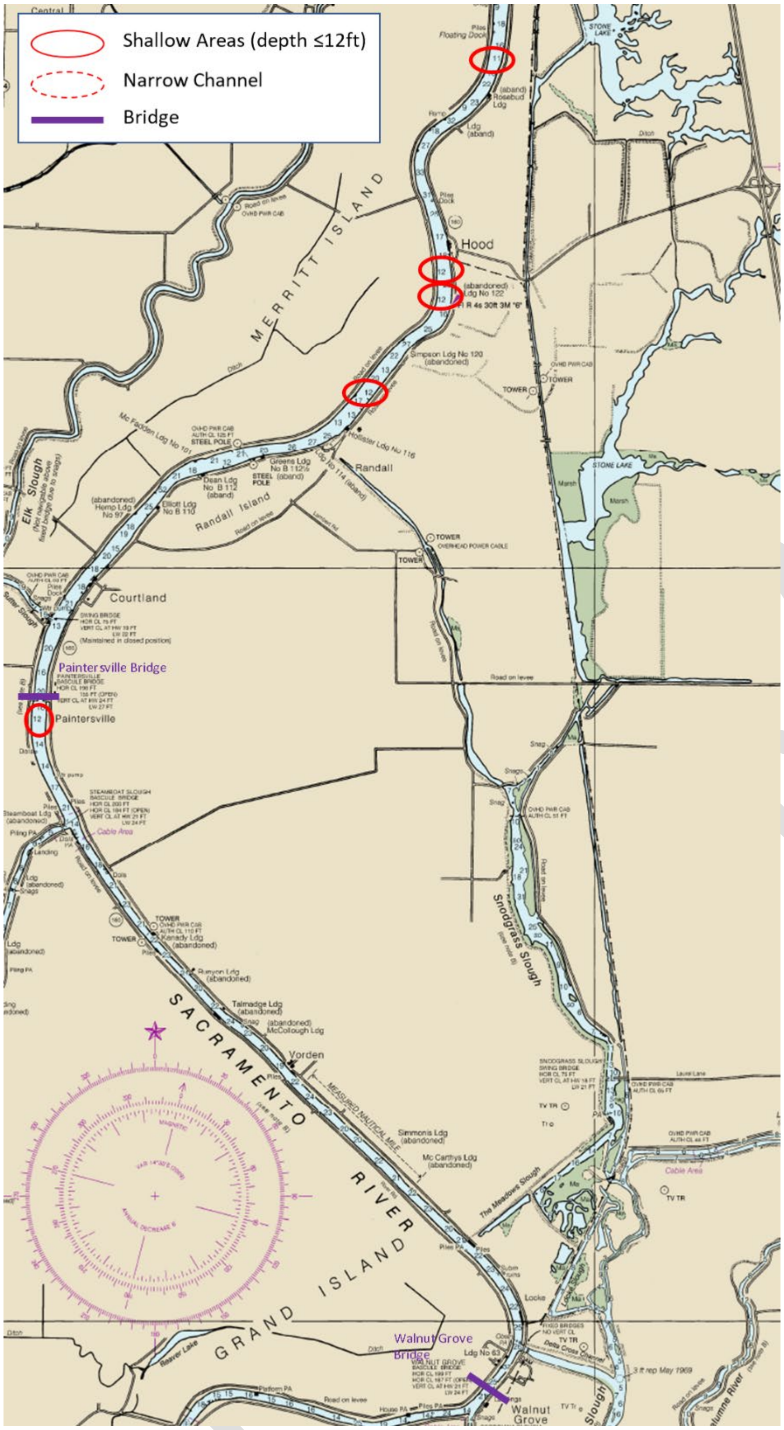
On the Sacramento River between Rio Vista and Walnut Grove, shown on Figure 5, the channel's average depth is 13.8 feet, and its average width is 402 feet. There are five areas of concern (highlighted in red on the Figure 5). Three of these areas have reduced width because of the exiting waterside facilities, and two of them have shallow locations where the water depth is as low as 7 to 8 feet. These depths were determined by soundings at MLLW. Note that these data were published in 2009 and are 10 years old. Shoaling and infill in certain areas have likely occurred during this period. Before considering project-related navigation on this portion of the river, new soundings should be taken to identify current depths. Because of the depth concerns and the narrow width of the Sacramento River channel between Rio Vista and Walnut Grove, the tow configuration would require a tug pushing a single barge. It could be necessary to light-load the barge to navigate the 7-foot draft near the restricted channel entrance. As an option, tugs and barges could need to wait for higher tides on this portion of the Sacramento River to navigate over the shallow areas.




*Source: National Oceanic and Atmospheric Administration*

**Figure 5. Sacramento River, Rio Vista to Walnut Grove**

On the Sacramento River between Walnut Grove and Clarksburg, shown on Figure 6, the channel's average depth is 19.76 feet, and its average width is 300 feet. There are five areas of concern: one with a depth measurement of 11 feet and four with a depth measurement of 12 feet (highlighted in red). These depths were determined by soundings at MLLW. Note that these data were published in 2009 and are 10 years old. Shoaling and infill in certain areas have likely occurred during this period. Before considering project-related navigation on this portion of the river, new soundings should be taken to identify current depths. Because of the depth concerns and the narrow width of the Sacramento River between Walnut Grove and Clarksburg, the tow configuration would be a tug pushing a single barge. It could be necessary to light-load the barge to navigate the 11-foot draft and be able to pass through the shallow portion of the waterway near Hood.




*Source: National Oceanic and Atmospheric Administration*

**Figure 6. Sacramento River Walnut Grove to Clarksburg**

The DWR database provides limited bathymetry data for the section of Sacramento River shown on Figures 5 and 6. The available data confirm the shallow sections near Isleton and Clarksburg.

Fixed restrictions on the Sacramento River include Isleton Bridge, Walnut Grove Bridge, and Paintersville Bridge, as summarized in Table 2. The Isleton Bridge is a tied arch and bascule bridge with a span of

226 feet. The Walnut Grove Bridge is a bascule bridge with a 226-foot open span. The Paintersville Bridge is a bascule bridge with a 226-foot opening. These bridges represent restrictions because of the wait time for opening the bridges when barge materials are being transported on the Sacramento River. Bridge operators require 4 hours' notice prior to opening. To conduct general maintenance, bridge operators close the bridge for 2 hours every 9 months to change out the oil in the gear boxes. Because of the bridges' ages, breakdowns do occur.

**Table 2. Bridges on the Sacramento River, SRDWSC and Three Mile Slough**

| Watercourse | Bridge | Type | Hours of Operation | Telephone | Clearance HW/LW (feet) | Open Width (feet) |
|---|---|---|---|---|---|---|
| Sacramento River Deep Water Ship Channel | Rio Vista Bridge | Lift | • Bridgetender service 24 hours per day | 707-374-2134 | 18/22 | 270 |
| Sacramento River | Isleton Bridge | Bascule | • May 1 to October 31: Bridgetender service 6 a.m. to 10 p.m.<br>• November 1 to April 30: Bridgetender service 9 a.m. to 5 p.m.<br>• Other times: 4 hours' advance notice required | 916-777-6763 | 15/18 | 200/166 (open) |
| Sacramento River | Walnut Grove Bridge | Bascule | • May 1 to October 31: Bridgetender service 6 a.m. to 10 p.m.<br>• November 1 to April 30: Bridgetender service 9 a.m. to 5 p.m.<br>• Other times: 4 hours' advance notice required | 916-776-1431 | 21/24 | 199/187 (open) |
| Sacramento River | Paintersville Bridge | Bascule | • May 1 to October 31: Bridgetender service 6 a.m. to 10 p.m.<br>• November 1 to April 30: Bridgetender service 9 a.m. to 5 p.m.<br>• Other times: 4 hours' advance notice required | 916-775-1474 | 24/27 | 198/155 (open) |
| Three Mile Slough | Three Mile Slough Bridge | Vertical Lift | • Bridgetender service 24 hours per day | 916-777-6619 | 10/16 | 150 |

*Data Sources: Hours of Operation, and Telephone Contact by Deltaboating.com; Type of Bridge by Bridgehunter.com; Clearance and Open Width by National Oceanic and Atmospheric Administration Charts.*

Notes:
HW = high water
LW = low water

**Summary:** With average channel widths of 300 to 400 feet and depths of 7 to 20 feet, there could be barge restrictions on the channel, which would require single barges or light-loaded barges, or tugs and barges could need to wait for higher tides on this portion of the Sacramento River to navigate over the shallow areas. In addition, bridge operations could affect barge schedules.

*Image © 2019 Google Street View*
**Figure 7. Isleton Bridge**

*Source: marinas.com*
**Figure 8. Walnut Grove Bridge**

*Image © 2019 Google Street View*
**Figure 9. Paintersville Bridge**

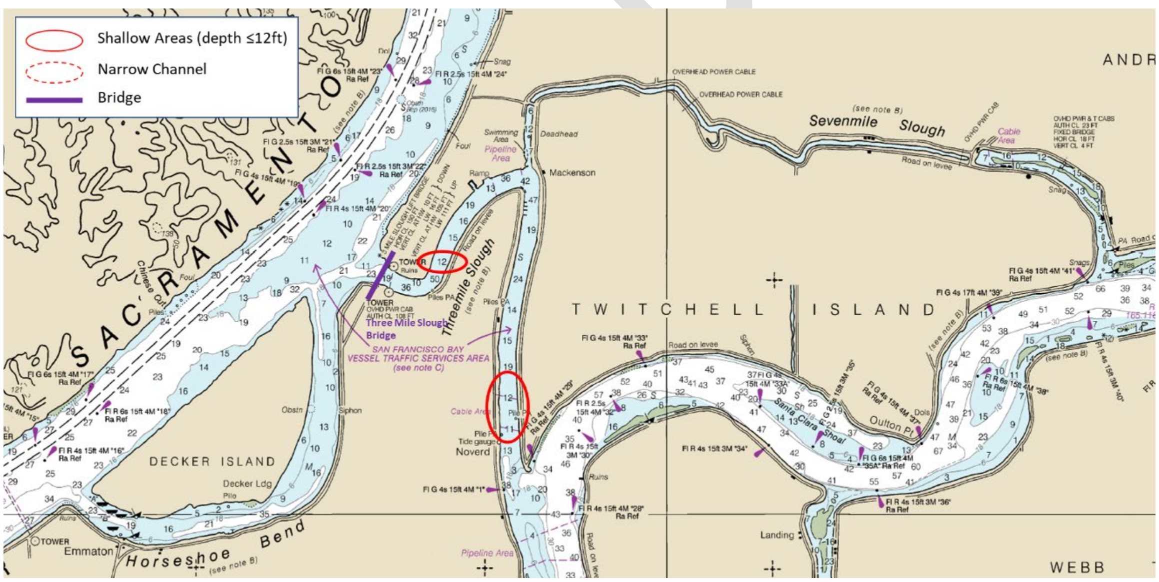
## 4.3 Three Mile Slough

TMS is a 3-nautical-mile-long watercourse that connects the Sacramento River to the San Joaquin River, as shown on Figures 10 and 11. The confluence with the Sacramento River and the TMS is approximately 3.5 miles south of Rio Vista.

*Aerial Image © 2019 Google Earth. Annotation © 2019 DCDCA*

**Figure 10. Three Mile Slough**






*Source: National Oceanic and Atmospheric Administration*

**Figure 11. Depths of Three Mile Slough**

### 4.3.1 Vessel Operations and Restrictions on the Channel

The average depth of TMS is 22.7 feet. There are three shallow areas: one at 11 feet and two at 12 feet. The DWR database provides partial data for near the southern end of TMS and confirms the shallow area in there. The channel's average width is 500 feet, with one narrow area at 250 feet in width caused by shoaling at the southern end.

There is a bridge at the western entrance that carries traffic on State Route 160. This bridge is a vertical-lift bridge that carries a daily traffic load of 14,300, as shown on Figure 12. The longest span is 175 feet, and the bridge's total length is 750 feet. When the bridge is open, it provides a passable channel width of approximately 150 feet.

*Image © 2019 Google Street View*

**Figure 12. Three Mile Slough Bridge**

Navigating TMS with tugs and barges could require waiting for higher tides to safely proceed over the shallower areas at the confluence with the San Joaquin River. The bridge operator requires 4 hours' notice to open the bridge (Table 2). The bridge closes for 2 hours every 9 months for routine maintenance.

TMS would provide an important connector between the Sacramento River and the San Joaquin River. For example, if it is decided to fabricate the precast tunnel segments at the Port of West Sacramento or Rio Vista, TMS would provide a route that could be 23 miles less than a route from the Sacramento River to Collinsville and then upstream along the San Joaquin River to the eastern confluence of the TMS and the San Joaquin River. Similarly, it if is determined that the Port of Stockton would be the best location for producing precast tunnel segments, TMS could be used to access the Sacramento River and the SRDWSC instead of a route downstream to Collinsville and then upstream along the Sacramento River.

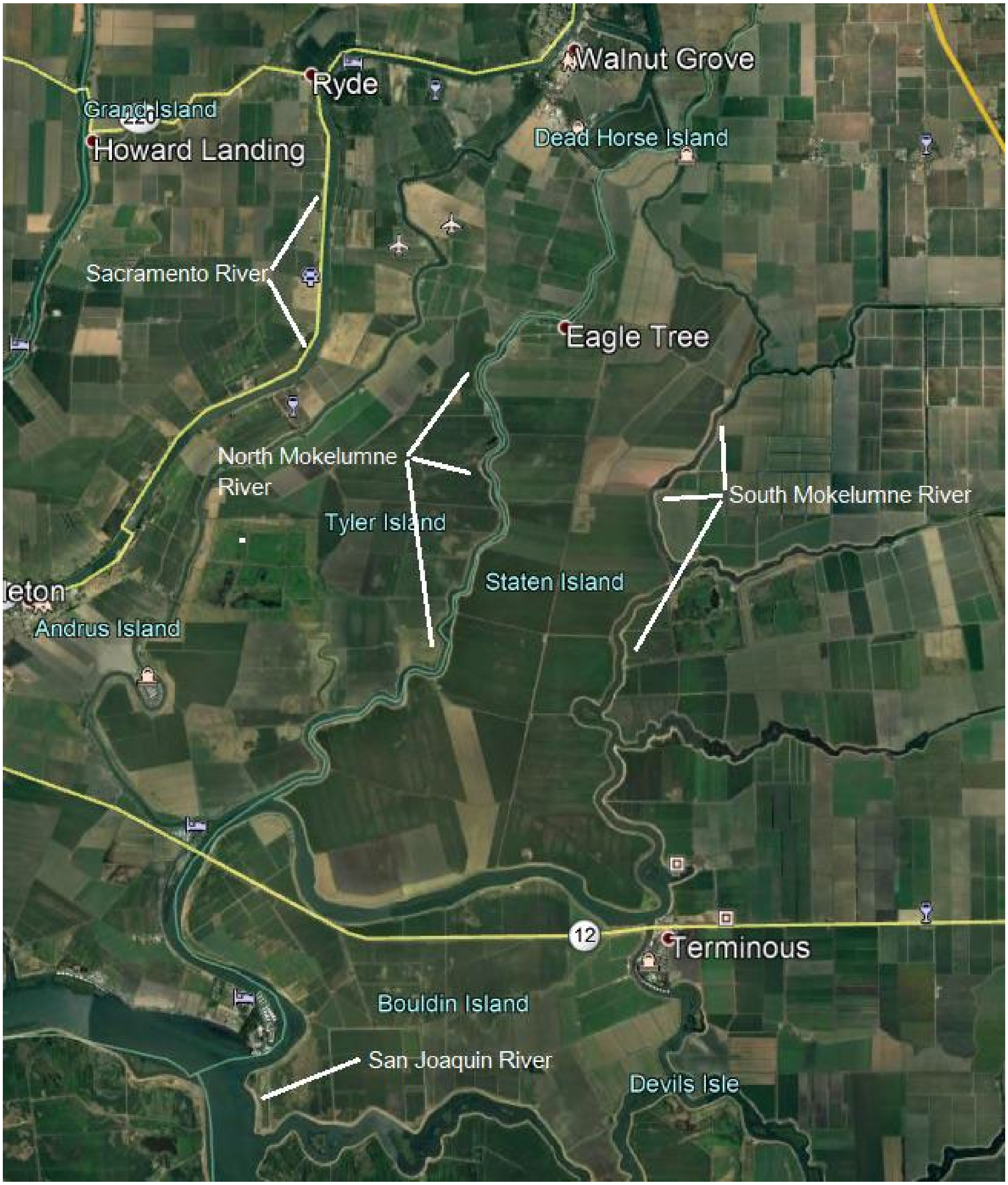
**Summary:** There could be barge restrictions on TMS, which would require single barges or light-loaded barges, or tugs and barges could need to wait for higher tides to navigate over the shallow areas. In addition, operations of the TMS Bridge could affect barge schedules.

## 4.4 Mokelumne River Complex

The Mokelumne River enters the Delta from the east where it becomes tidal and splits into a pair of distributaries—the North Fork Mokelumne River (NMR) and the South Fork Mokelumne River (SMR)—approximately 2 miles southeast of Walnut Grove and encircles Staten Island. The NMR meanders southwards for 15 miles before it reconnects with the SMR; after another 3 miles, it connects with the San Joaquin River and the SDWSC, as shown on Figure 13.

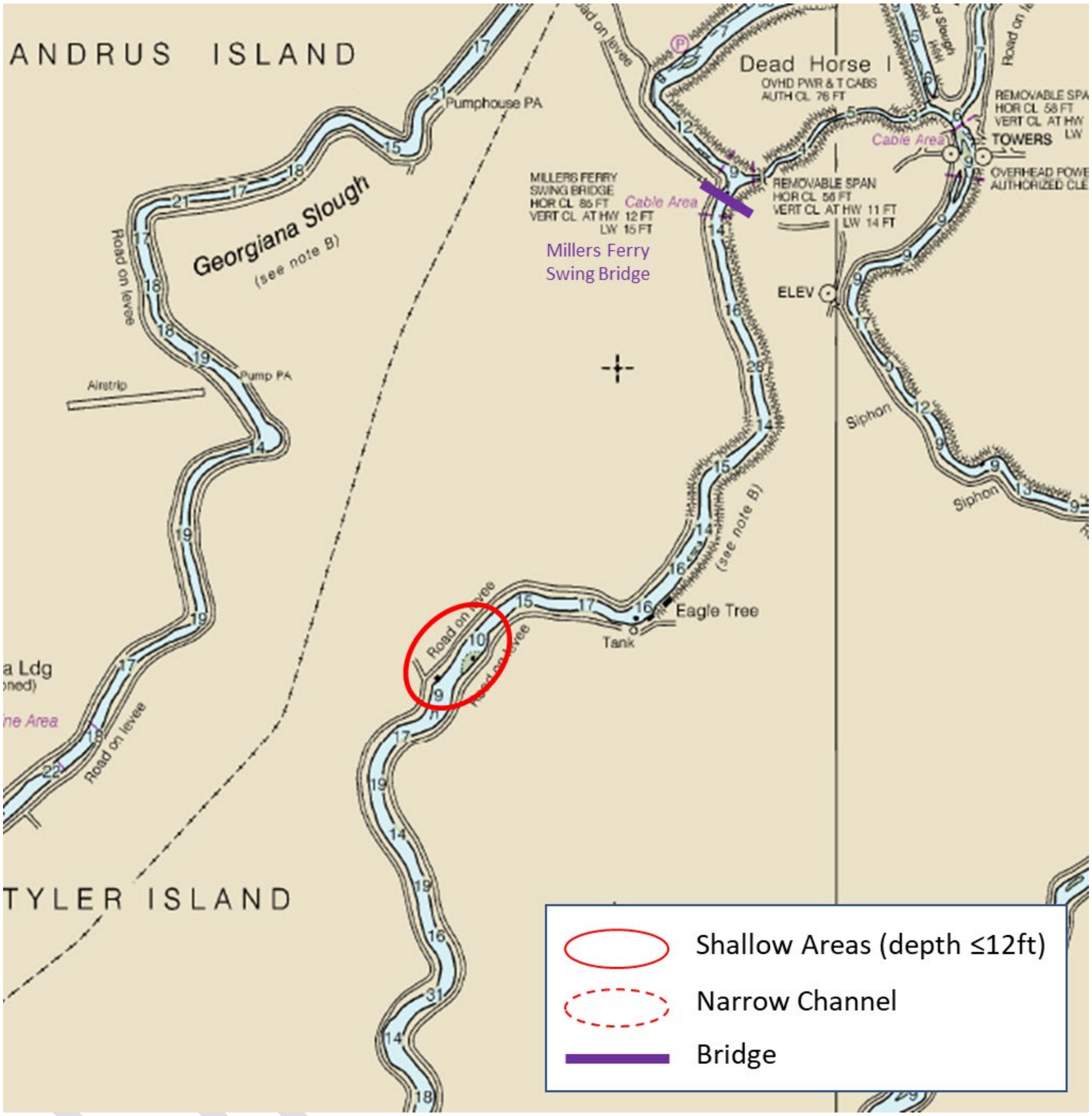
### 4.4.1 North Fork Mokelumne River

This section analyzes the NMR's navigability in terms of providing water transport to the receiving shaft on the northern end of Staten Island. Figures 14 and 15 show the NOAA charts of the NMR.



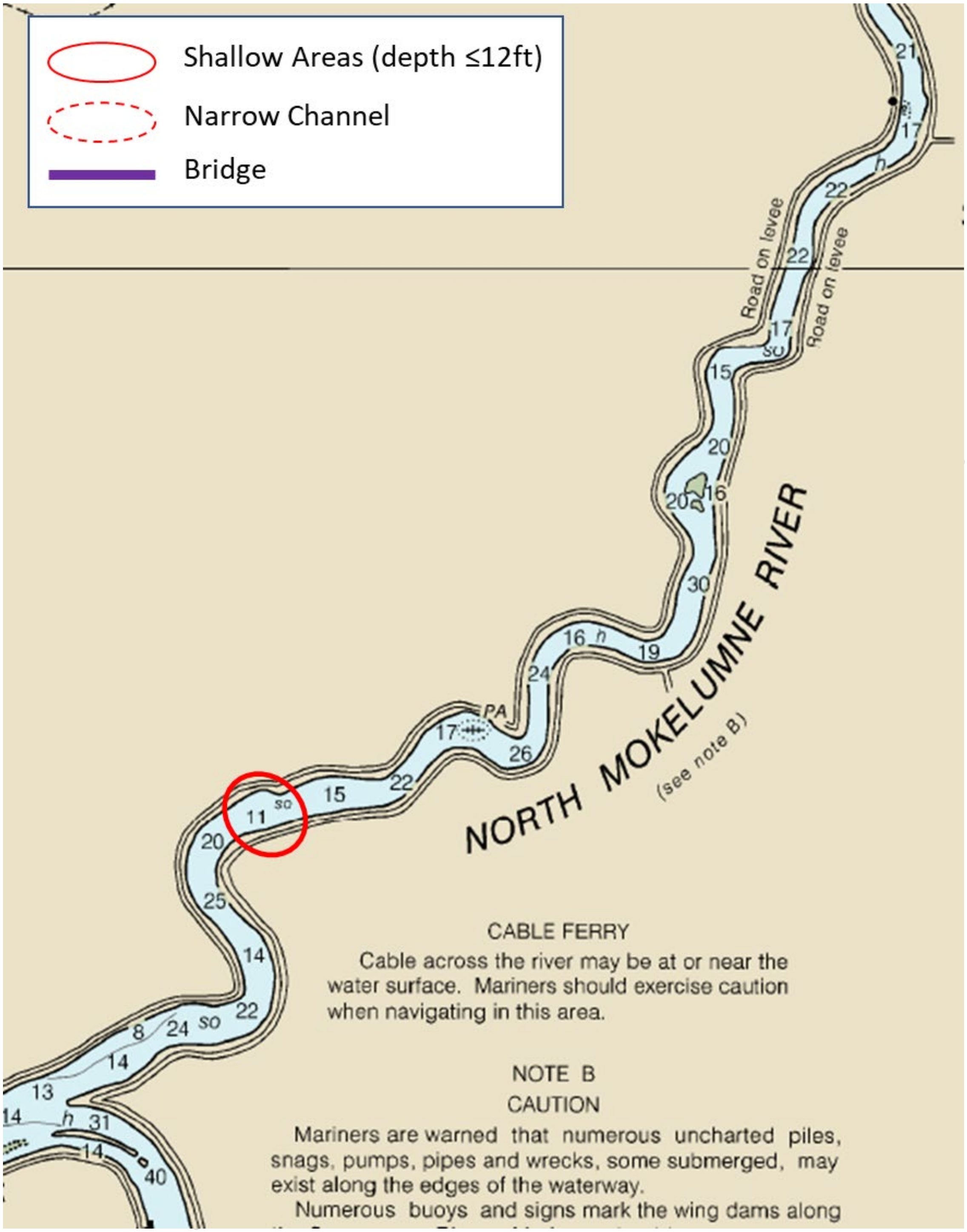

*Aerial Image © 2019 Google Earth. Annotation © 2019 DCDCA*

**Figure 13. North and South Mokelumne River**




*Source: National Oceanic and Atmospheric Administration*

**Figure 14. North Mokelumne River – Northern Section**




*Source: National Oceanic and Atmospheric Administration*

**Figure 15. North Mokelumne River – Southern Section**

#### 4.4.1.1 Vessel Operations and Restrictions on the Channel

As shown on Figures 14 and 15, there are two shallow areas (12 feet or less, assuming a 2,000-ton barge drafts 10 to 12 feet). The DWR database provides water depths for only the section of the river shown on Figure 14 and confirms the shallow area shown in that section. It could be necessary to light-load the barges or transport during high tide. Generally, the channel's navigable width is more than 200 to 250 feet. There are areas where the channel narrows below 200 feet as a result of shoaling. Millers Ferry Bridge is a swing bridge at the northern end of the channel. When the bridge is open, it provides a passable channel width of approximately 80 feet.

The NMR can handle a 2,000-ton barge with 12-foot draft up to the Millers Ferry Swing Bridge (Figure 16). The best configuration would be a tug pushing a single barge. Dutra confirmed that it could be possible to go north of the bridge, but the area needs to be sounded to confirm the depth. A second push boat would be necessary to proceed north of the bridge to make the turn just north of the bridge. Once beyond the bridge, the tugs and barges would have access to Snodgrass Slough on the eastern side of Walnut Grove. If the depth is less than 10 feet, barges would be light-loaded.

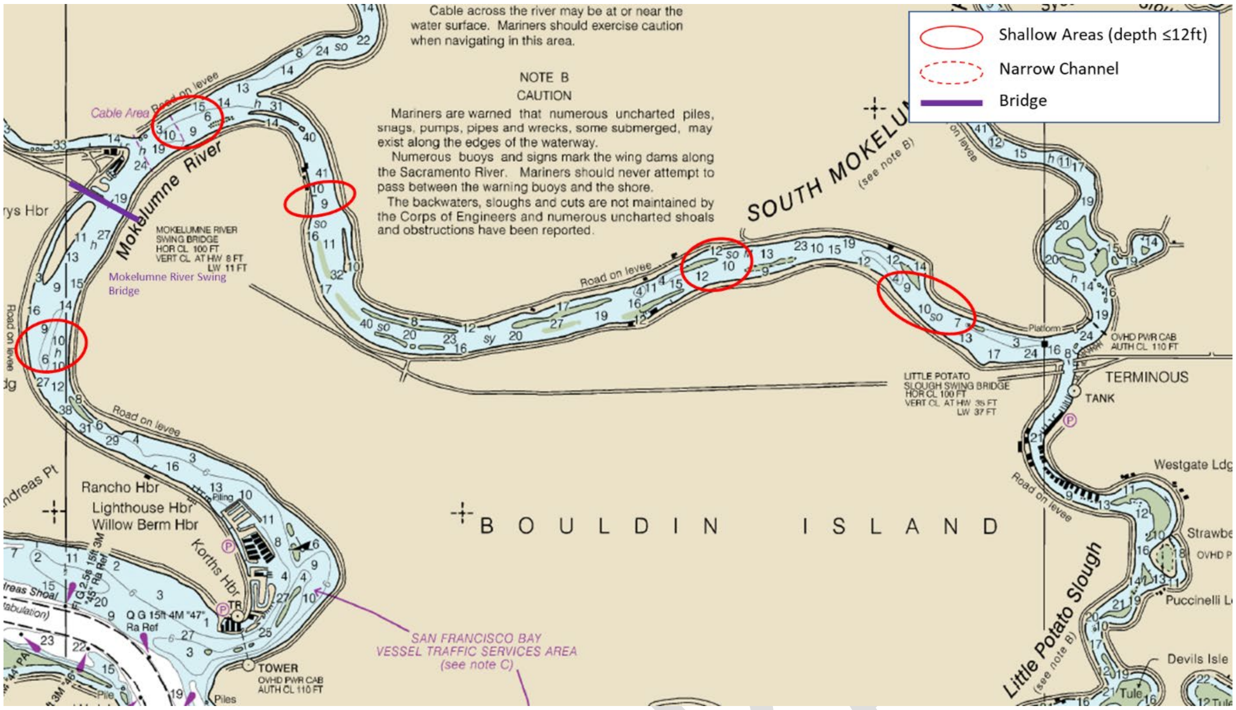
*Image © 2019 Google Street View*

**Figure 16. Millers Ferry Swing Bridge**

### 4.4.2 South Fork Mokelumne River

#### 4.4.2.1 Vessel Operations and Restrictions on the Channel

The SMR could provide a transportation route for the tunnel shafts on Bouldin Island and possibly on Dead Horse Island. The SMR section from the San Joaquin River to Little Potato Slough could provide barges to Bouldin Island, as shown on Figure 17.




*Source: National Oceanic and Atmospheric Administration*

**Figure 17. South Mokelumne River Bordering Bouldin Island**

The charts show multiple shallow areas (12 feet or less, assuming a 2,000-ton barge drafts 10 to 12 feet). These areas are confirmed by the DWR bathymetry data as well. It could be necessary to light-load the barges or transport during high tide. The channel's width indicates that some areas are around 250 feet wide.

Another restriction is the Mokelumne River Bridge, which carries traffic for State Route 12 (Figure 18 and Table 3). This bridge is approximately 2.9 miles northwest of the intersection between the San Joaquin River and the Mokelumne River. The bridge is a swing bridge and, when opened, provides a channel width of 120 feet. As with other bridges, this bridge requires 4 hours' notice for opening and is shut down for 2 hours every 9 months for routine maintenance. It is subject to break down and shut down for routine maintenance and testing.

*Source: marinas.com*

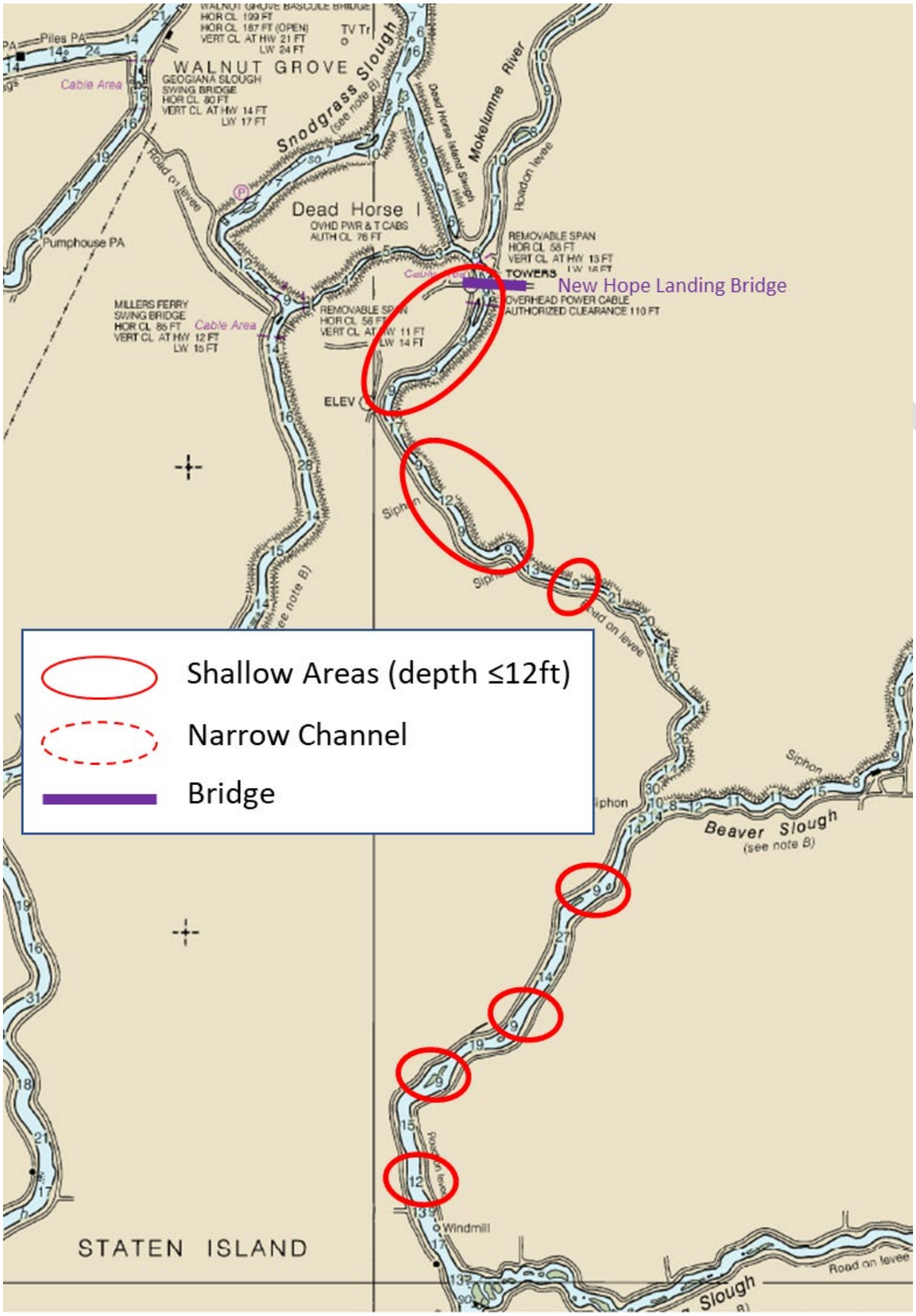
**Figure 18. Mokelumne River Swing Bridge**

The next area of the SMR extends from the confluence with Little Potato Slough north to the confluence with the NMR, as shown on Figures 19 and 20, which are two partial NOAA charts that provide SMR water depths.

**Table 3. Bridges on the Mokelumne River Complex**

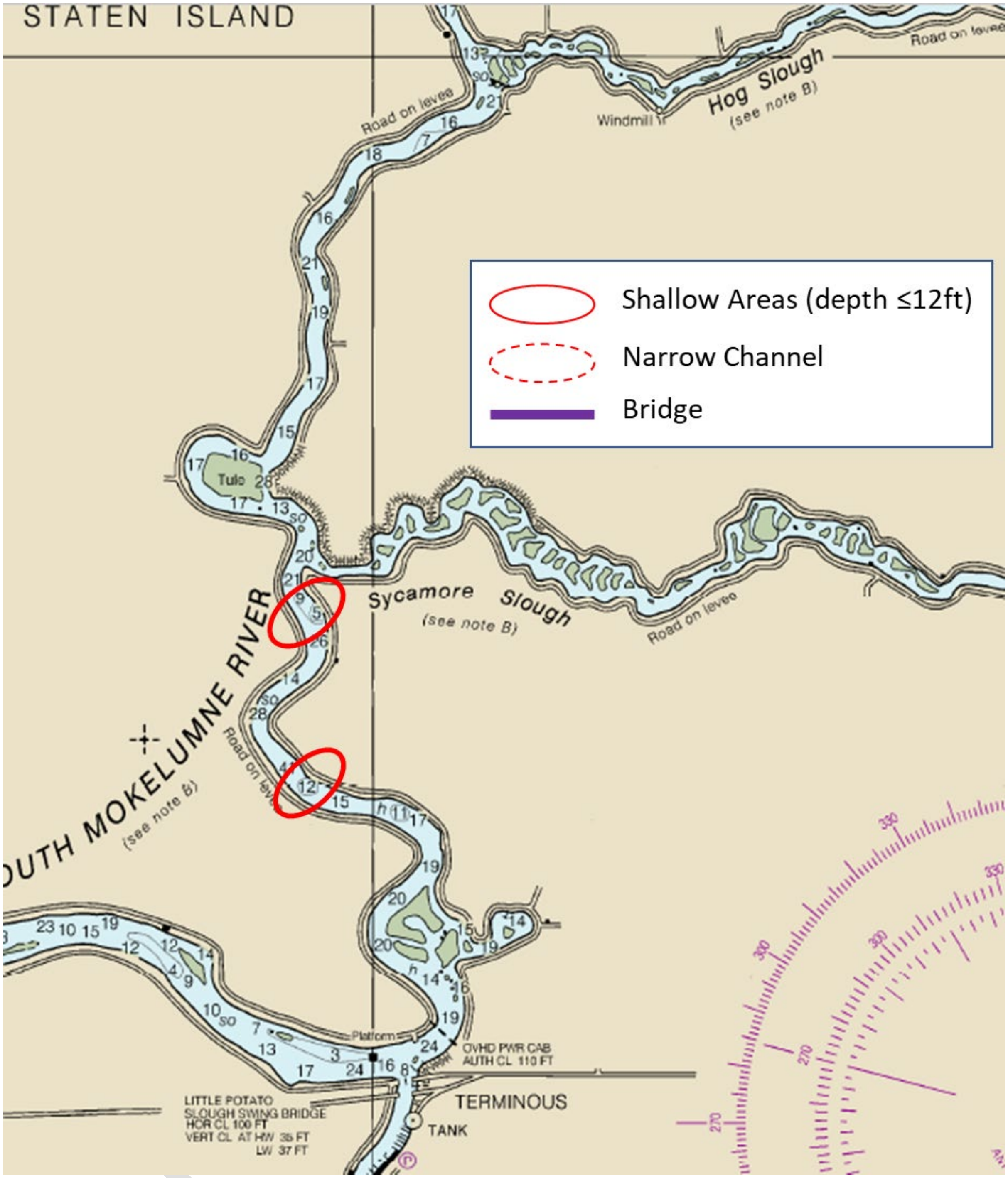
| Watercourse | Bridge | Type | Hours of Operation | Telephone | Clearance HW/LW (feet) | Open Width (feet) |
|---|---|---|---|---|---|---|
| Mokelumne River Complex | Mokelumne River Swing Bridge | Swing Bridge | • May 1 to October 31: Bridgetender service 6 a.m. to 10 p.m.; scheduled openings on the hour, 20 minutes past the hour, and 40 minutes past the hour as follows: Saturdays 10 a.m. to 2 p.m., Sundays 11 a.m. to 6 p.m., and Memorial Day, 4th of July, and Labor Day 11 a.m. to 6 p.m.<br>• November 1 to April 30: Bridgetender service 9 a.m. to 5 p.m.<br>• Other times: 4 hours' advance notice required | 916-777-6600 | 8/11 | 100 |

*Data Sources: Hours of Operation, and Telephone Contact by Deltaboating.com; Type of Bridge by Bridgehunter.com; Clearance and Open Width by National Oceanic and Atmospheric Administration Charts.*




*Source: National Oceanic and Atmospheric Administration*

**Figure 19. South Mokelumne River – Northern Section (i.e. North of Hog Slough)**




*Source: National Oceanic and Atmospheric Administration*

**Figure 20. South Mokelumne River – Southern Section (i.e. between Hog Slough and Terminus)**

For the SMR, the NOAA charts show multiple shallow areas. The DWR database provides bathymetry data only for the section on Figure 19 and confirms the shallow areas in that section. It could be necessary to light-load the barges or transport during high tide. The available bathymetry data indicate that there are some areas around 100 to 150 feet wide. The best configuration would be a tug pushing a single barge.

The New Hope Landing Bridge that carries traffic on County Highway J11 is located at the northern end of the SMR. The bridge is a removable span bridge, and tugs and barges are not able to pass. It is recommended that the river be sounded before considering the use of tugs and barges on the northern section of the SMR. If there are areas of depth less than 10 feet, the barges would need to be light-loaded.

**Summary:** There are multiple shallow areas in NMR and SMR with depths less than 12 feet. The channel widths can be only 250 feet wide in sections. Therefore, it could be necessary to light-load barges or transport during high tide. The bridges could also result in limitations for shipping.

## 4.5 San Joaquin River and Stockton Deep Water Ship Channel

The SDWSC extends from Chipps Island (near the confluence of the San Joaquin River and Sacramento River) to the Port of Stockton.

*Source: www.portofstockton.com*

**Figure 21. Ship on the Stockton Deep Water Channel**

There are three bridges on the SDWSC. The Carquinez Bridge is a fixed-span, high-level toll bridge across the Carquinez Strait, with a minimum clearance of 134 feet above mean high water and horizontal clearance of 440 feet. The Southern Pacific Railroad lift-span bridge crosses Suisun Bay 6.5 miles upstream from the Carquinez Bridge, with a minimum clearance above mean high water of 70 feet when closed and 135 feet when open. The horizontal clearance on the lift span is 291 feet. A third bridge, 22 miles above the Southern Pacific Bridge, is near Antioch (the Antioch Bridge). It is a fixed-span bridge with a minimum clearance above mean high water of 135 feet and a horizontal clearance of 400 feet (Port of Stockton 2019b).

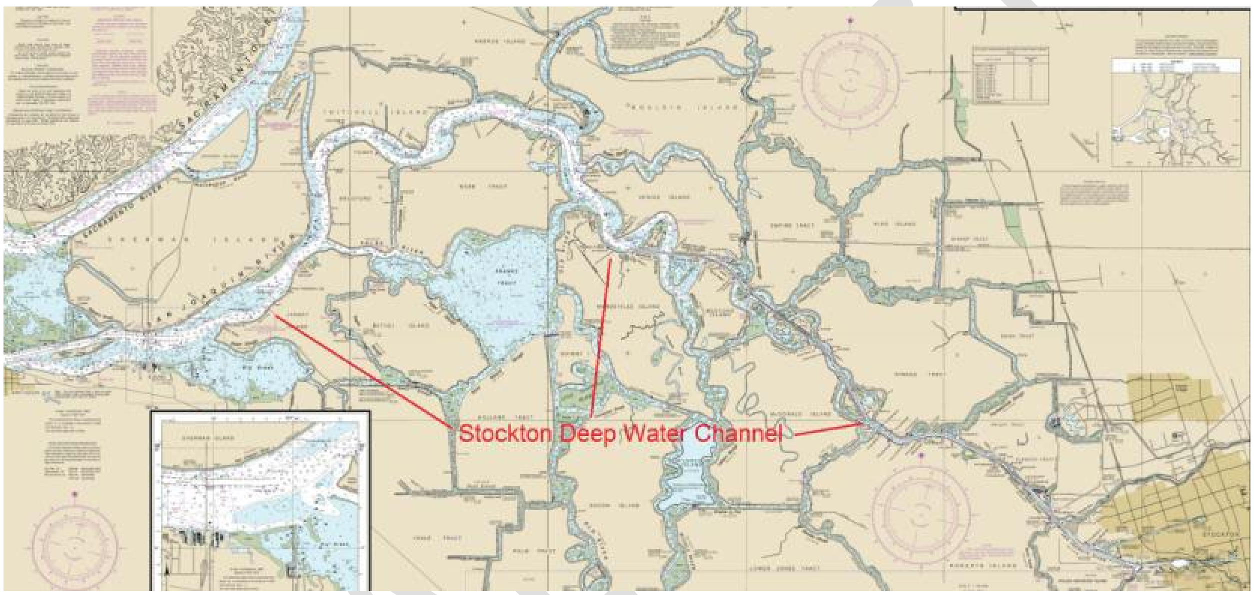
The SDWSC had 252 ship movements in 2018, with a total tonnage moved of 4.7 million metric tons. Twenty-four diversified commodities were shipped on the channel, with the top five being coal, bulk cement, liquid fertilizer, food-grade oil, and sulfur.

### 4.5.1 Vessel Operations and Restrictions on the Channel

The following are some of the limitations and challenges for navigating the SDWSC:

- During the period from December to April, rapid shoaling could occur, but this would not affect barges.
- Considerable delays could be experienced from November to March because of heavy fog. Travel time from the Golden Gate Bridge to the Port of Stockton averages 9 hours, depending on the individual vessel's characteristics (Margaronis 2016).

**Summary:** The SDWSC navigation channel can handle fully loaded vessels up to 55,000 short tons and up to 900 feet long.

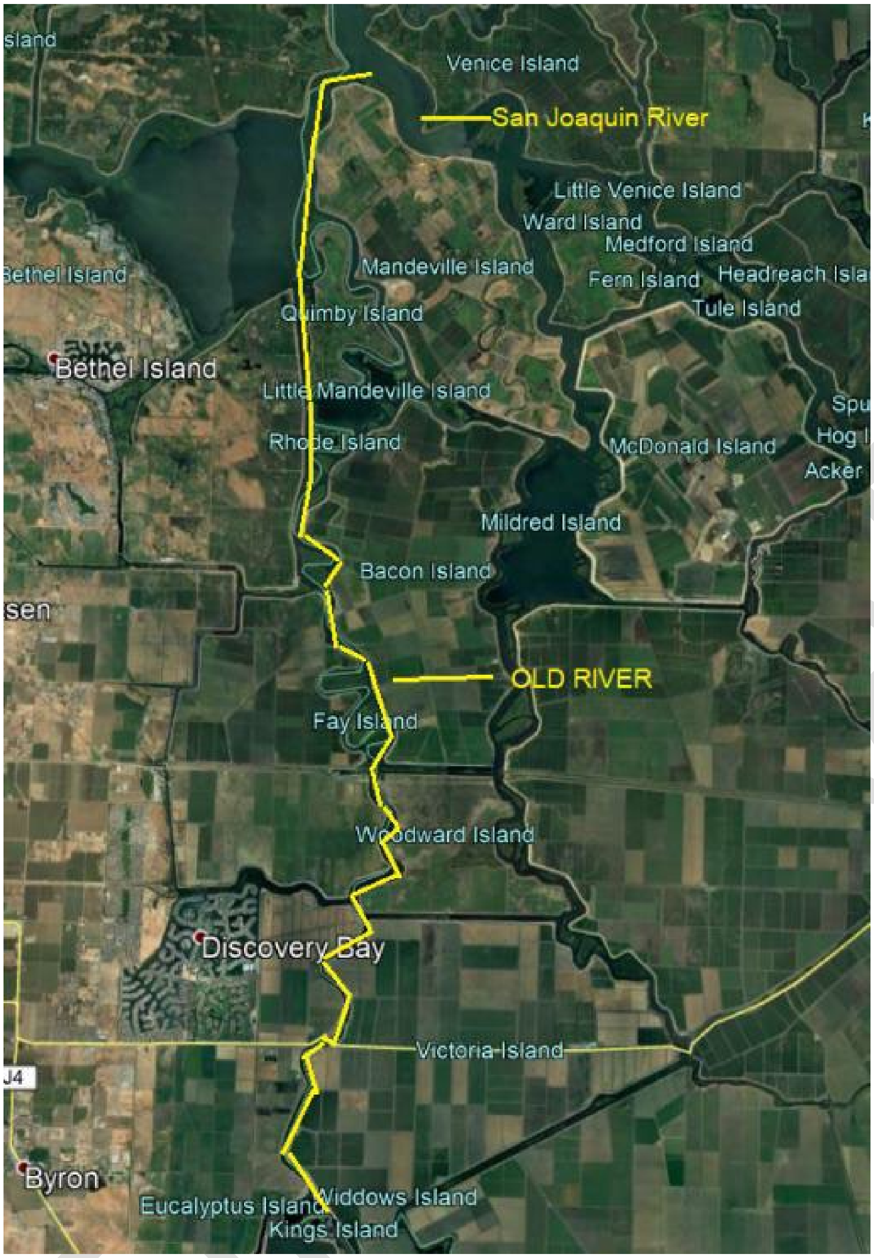



*Source: National Oceanic and Atmospheric Administration*

**Figure 22. Stockton Deep Water Channel Map**

## 4.6 Old River Complex

The Old River is a tidal distributary of the San Joaquin River that flows for about 40 miles through the Delta. The Old River was once the main channel of the San Joaquin River until navigation and flood control projects in the late 19th and 20th century moved the San Joaquin River to its present course near Stockton. The Middle River runs east of, and roughly parallel to, Old River. False River diverges from Old River about a mile above Old River's mouth and runs westwards to join the San Joaquin at a point closer to Antioch. Figure 23 shows the Old River route.

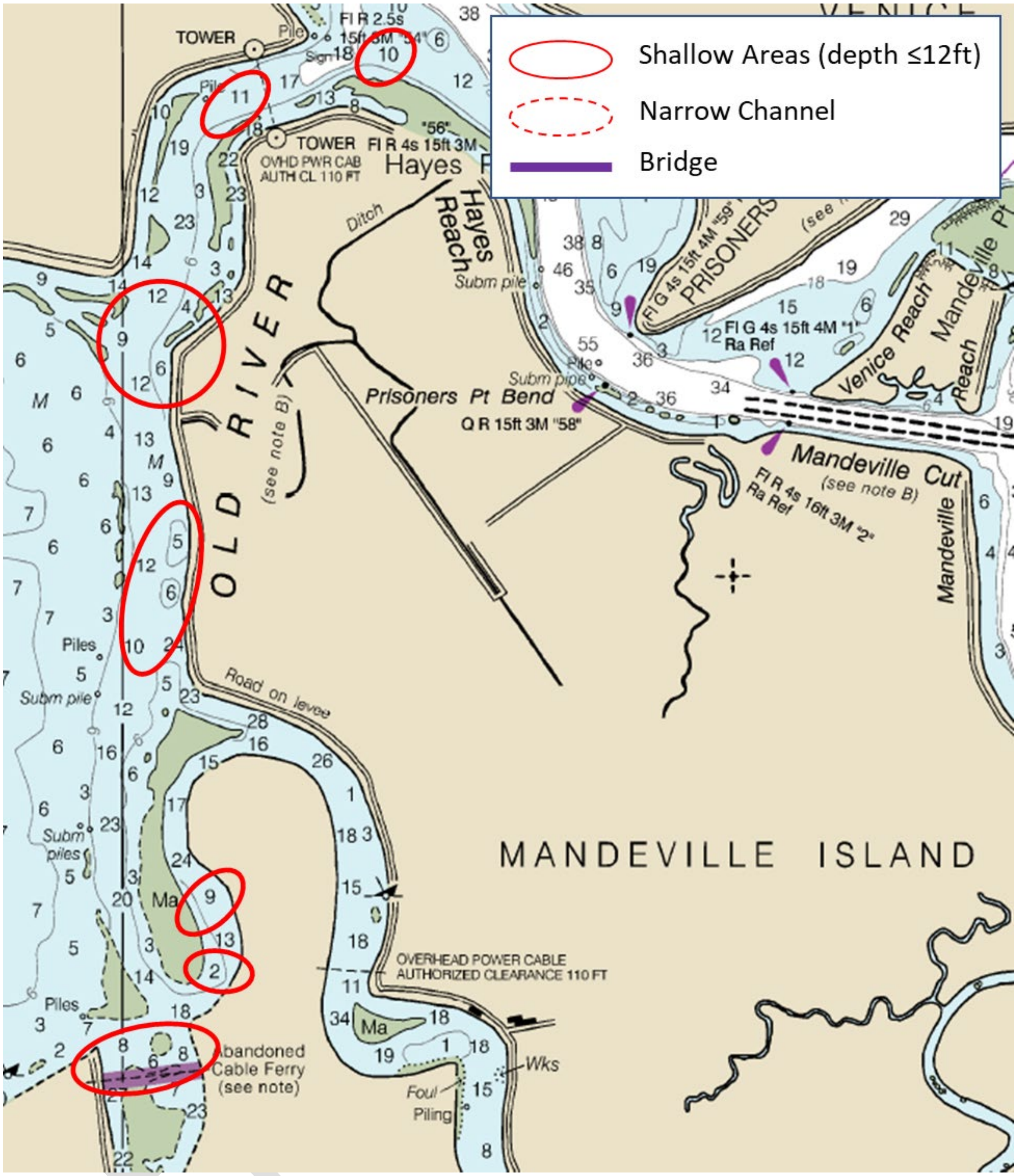



*Aerial Image © 2019 Google Earth. Annotation © 2019 DCDCA*

**Figure 23. Map of Old River**

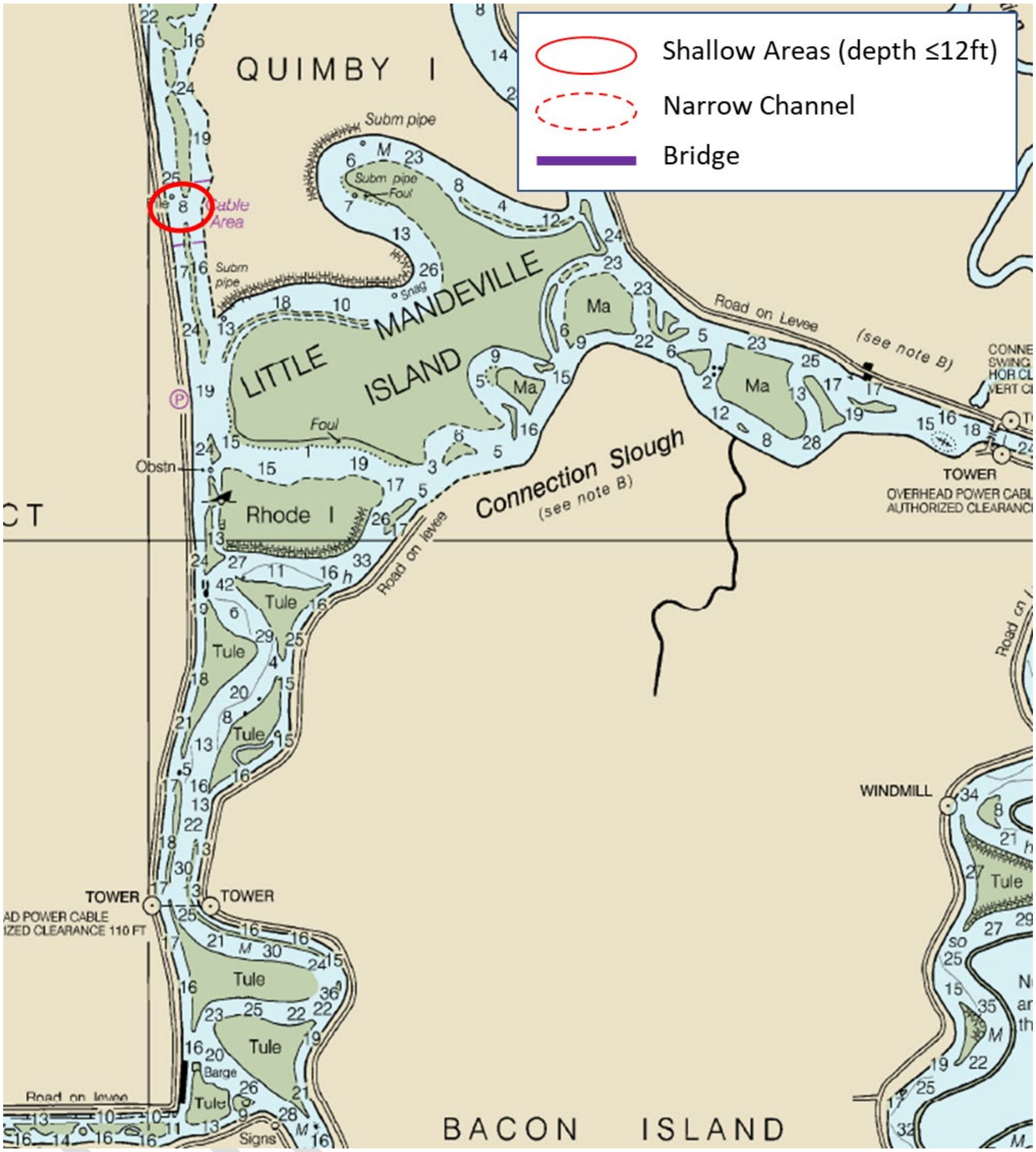
### 4.6.1 Vessel Operations and Restrictions on the Channel

Figures 24 to 27 present NOAA charts for the Old River that identify multiple shallow areas (12 feet or less, assuming a 2,000-ton barge drafts 10 to 12 feet). The DWR database confirms many of these areas. Therefore, it could be necessary to light-load barges or transport during high tide. There appears to be enough width on the watercourses to move barges with only a few areas where the widths are less than 200 feet.



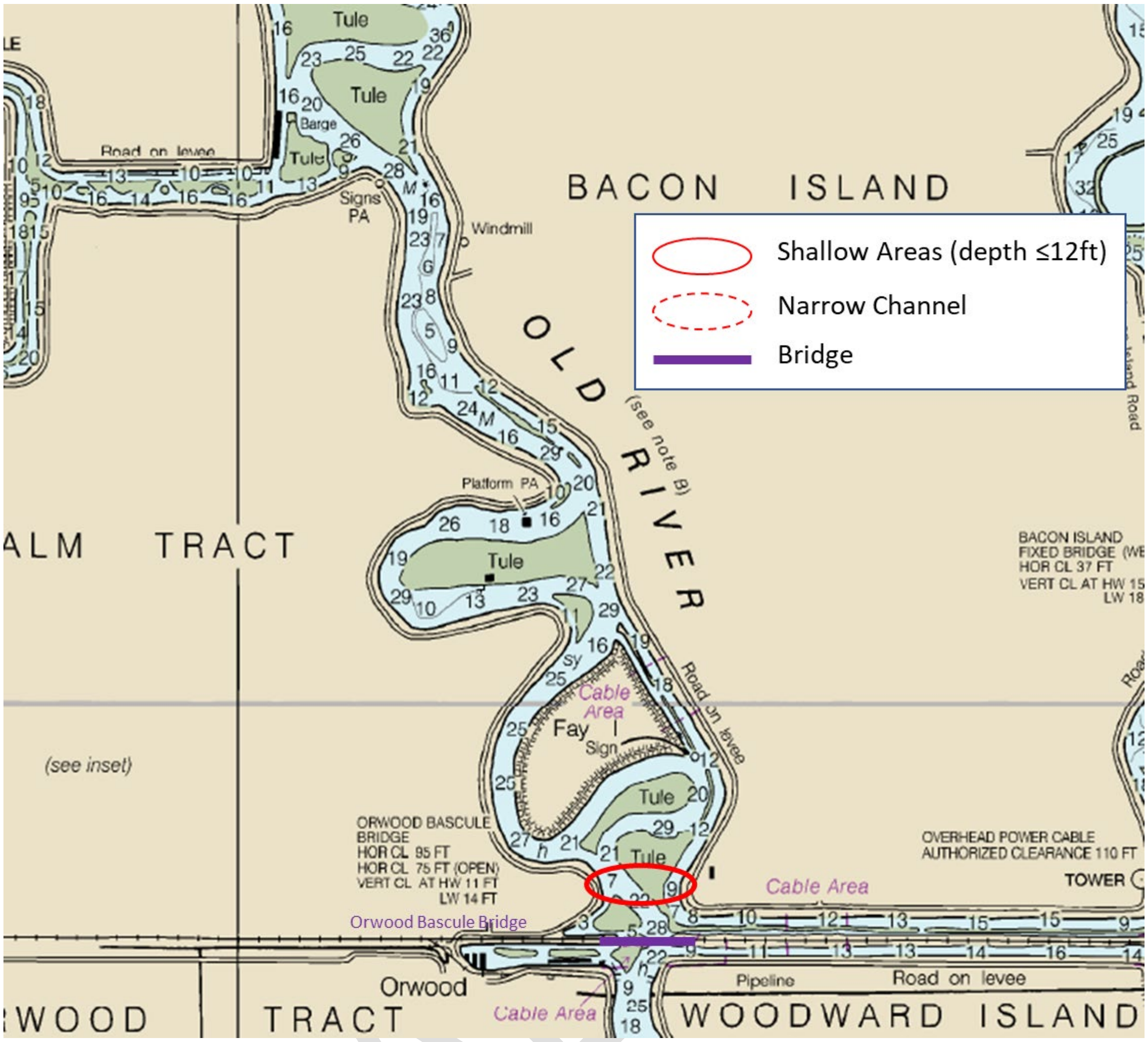

*Source: National Oceanic and Atmospheric Administration*

**Figure 24. Old River Chart 1 of 4**



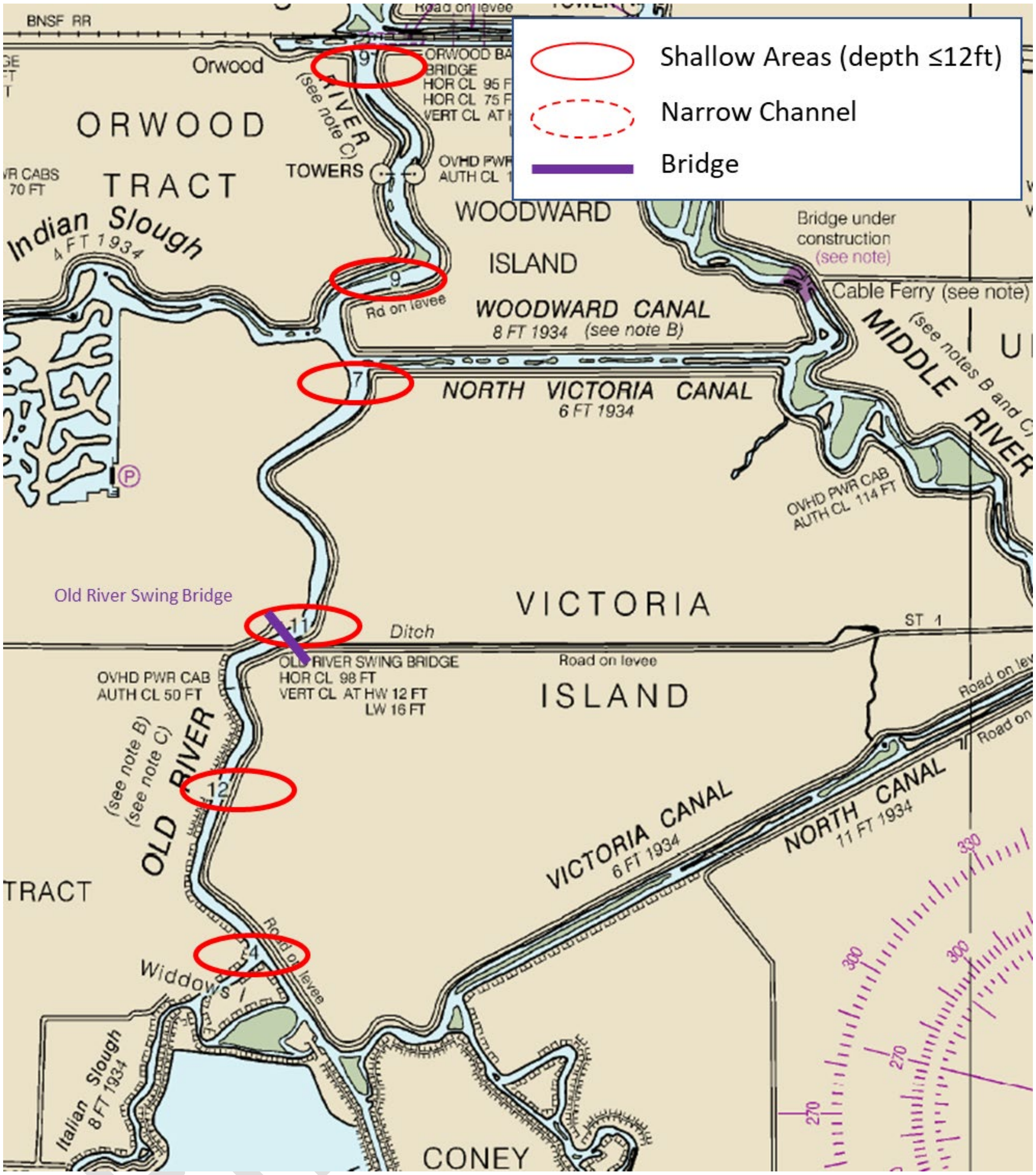

*Source: National Oceanic and Atmospheric Administration*

**Figure 25. Old River Chart 2 of 4**




*Source: National Oceanic and Atmospheric Administration*

**Figure 26. Old River Chart 3 of 4**




*Source: National Oceanic and Atmospheric Administration*

**Figure 27. Old River Chart 4 of 4**

One of the restrictions on Old River is the Orwood Bascule Bridge (Figure 28 and Table 4). This is a railroad bridge at the intersection of Palm Tract, Bacon Island, Orwood Tract, and Woodward Island. The bridge has an 11-foot closed vertical clearance with a 75-foot horizontal clearance at the center span when open (Marinas.com 2019c).

*Source: marinas.com*

**Figure 28. Orwood Bascule Railroad Bridge**

Another restriction on Old River is the Old River Swing Bridge in the middle of Byron Tract on the western bank and Victoria Island on the right (Figure 29).

*Source: marinas.com*

**Figure 29. Old River Swing Bridge**

The bridge carries State Route 4. It has a 12-foot closed vertical clearance with 98 feet of horizontal clearance at the center span. This bridge has a restricted opening schedule and requires 4 hours' notice prior to opening (Marinas.com 2019b).

**Table 4. Bridges on Old River**

| Watercourse | Bridge | Type | Hours of Operation | Telephone | Clearance HW/LW (feet) | Open Width (feet) |
|---|---|---|---|---|---|---|
| Old River | Orwood Railroad Bridge | Bascule | • Bridgetender service 24 hours per day | 209-942-5441 | 11/14 | 95/75 (open) |
| Old River | Old River Swing Bridge | Swing Bridge | • May 1 to October 31: Bridgetender service 6 a.m. to 10 p.m.<br>• November 1 to April 30: Bridgetender service 9 a.m. to 5 p.m.<br>• Other times: 4 hours' advance notice required | 707-374-2134 | 12/16 | 98 |

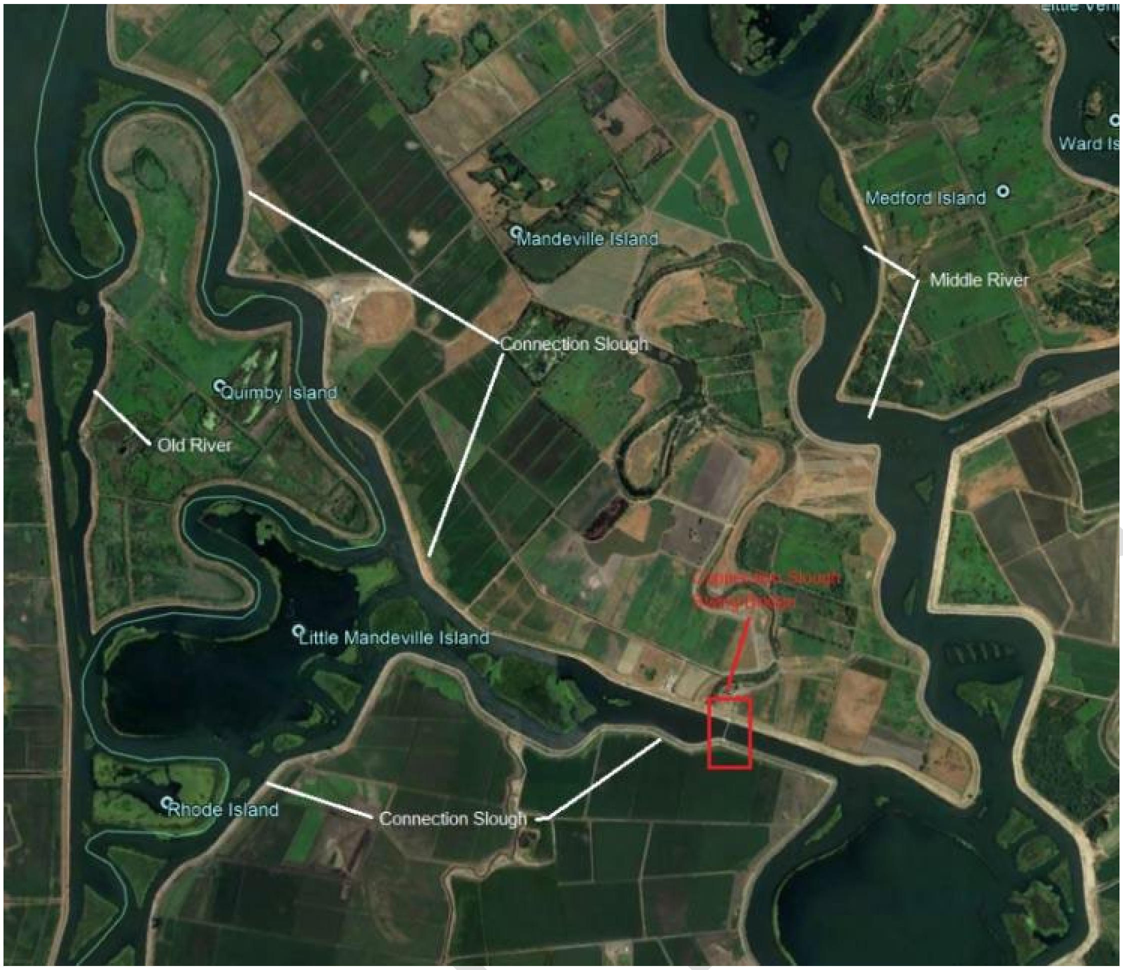
*Data Sources: Hours of Operation, and Telephone Contact by Deltaboating.com; Type of Bridge by Bridgehunter.com; Clearance and Open Width by National Oceanic and Atmospheric Administration Charts.*

Dutra indicated that the Old River can handle a 2,000-ton barge with 10-foot draft from the San Joaquin River to Clifton Court Tract. The best configuration would be a tug pushing a single barge. It is recommended that the river be sounded before considering the use of tugs and barges on the Old River. In areas with depths of less than 10 feet, the barges would be light-loaded.

**Summary:** Old River generally has depths to handle single barges with 10-foot drafts; however, the barges could require light-loading. In addition, travel under the bridges could be limited because of schedules.

## 4.7 Connection Slough

Connection Slough connects Old River to Middle River. Connection Slough has two branches: The northern watercourse starts at the eastern end of Franks Tract and ends at Mildred Island at a distance of 5.1 miles. The southern watercourse starts at Old River and ends at Mildred Island at a distance of 3.9 miles (Figure 30).



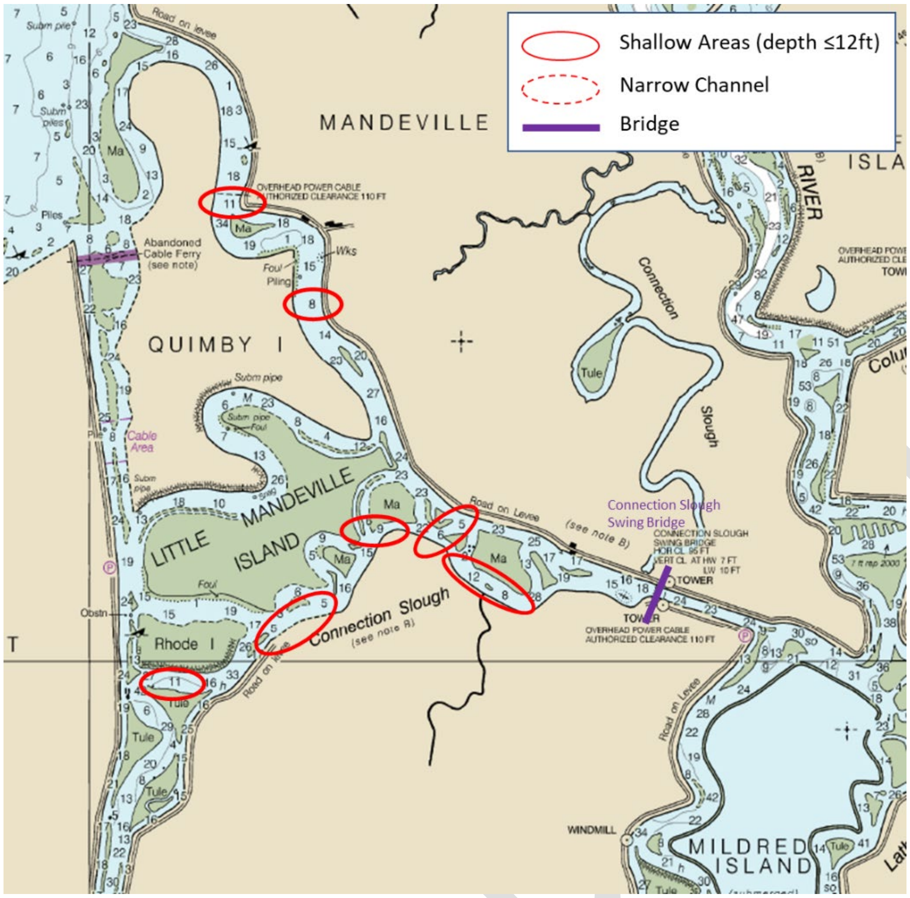

*Aerial Image © 2019 Google Earth. Annotation © 2019 DCDCA*

**Figure 30. Map of Connection Slough**

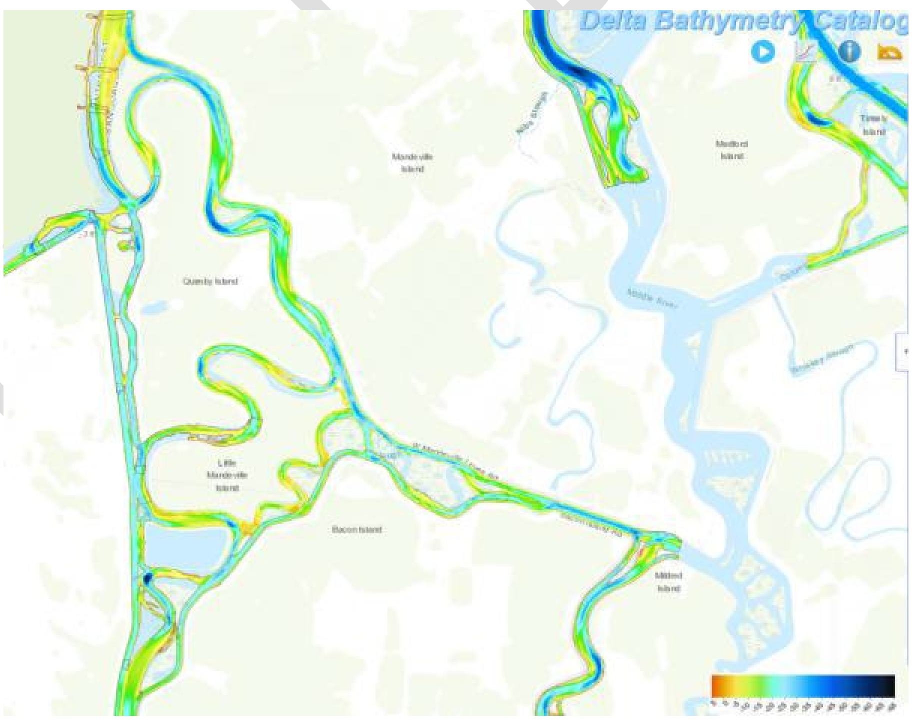
### 4.7.1 Vessel Operations and Restrictions on the Channel

The NOAA chart on Figure 31 identifies multiple shallow areas (12 feet or less, assuming a 2,000-ton barge drafts 10 to 12 feet). On the other hand, the DWR bathymetry map indicates fewer shallow areas. There appears to be enough width on the watercourses to move barges and only a few areas less than 200 feet wide.

Connection Slough can handle a 2,000-ton barge with a 10-foot draft. The best configuration would be a tug pushing a single barge. Further, the river should be sounded before considering the use of tugs and barges; if there are areas of depth less than 10 feet deep, the barges would be light-loaded.




*Source: National Oceanic and Atmospheric Administration*




*Source: California Department of Water Resources*

**Figure 31. Connection Slough Charts (Top: NOAA, Bottom: DWR)**

One of the restrictions on Connection Slough is the Connection Slough Swing Bridge (Figure 32 and Table 5). This bridge provides access to Bacon Island. The bridge has a 7-foot closed vertical clearance, with a 95-foot horizontal clearance at the center span when open (Marinas.com 2019a).

**Table 5. Bridges on Connection Slough**

| Watercourse | Bridge | Type | Hours of Operation | Telephone | Clearance HW/LW (feet) | Open Width (feet) |
|---|---|---|---|---|---|---|
| Connection Slough | Connection Slough Swing Bridge | Swing Bridge | • May 15 to September 15: Bridgetender service 9 a.m. to 5 p.m.; 12 hours' advance notice required 5 p.m. to 9 a.m.<br>• September 16 to May 14: 12 hours' advance notice required 9 a.m. to 5 p.m., 24 hours' advance notice required 5 p.m. to 9 a.m. | 209-464-2959 or 209.464.7928 weekdays 8 a.m. to 5 p.m.<br><br>209.993.8878 other times | 7/10 | 95 |

*Data Sources: Hours of Operation, and Telephone Contact by Deltaboating.com; Type of Bridge by Bridgehunter.com; Clearance and Open Width by National Oceanic and Atmospheric Administration Charts.*

**Summary:** Connection Slough has multiple shallow areas; the barges could require light-loading. In addition, travel under the bridges could be limited because of bridge opening schedules.

*Source: marinas.com*

**Figure 32. Connection Slough Swing Bridge**

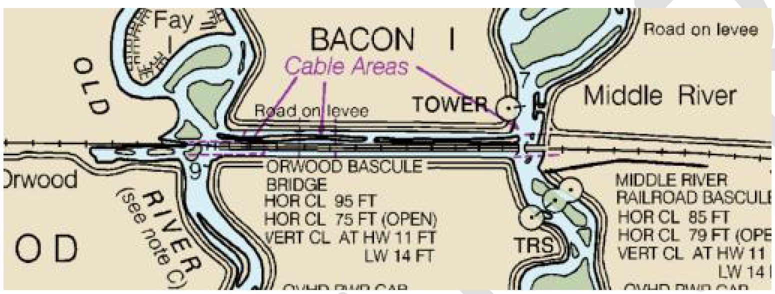
## 4.8 Railroad Cut

The Railroad Cut is a watercourse that connects the Old River to the Middle River (Figures 33 and 34). The Railroad Cut is a canal containing a railroad in the middle. North of the Railroad Cut is Bacon Island and

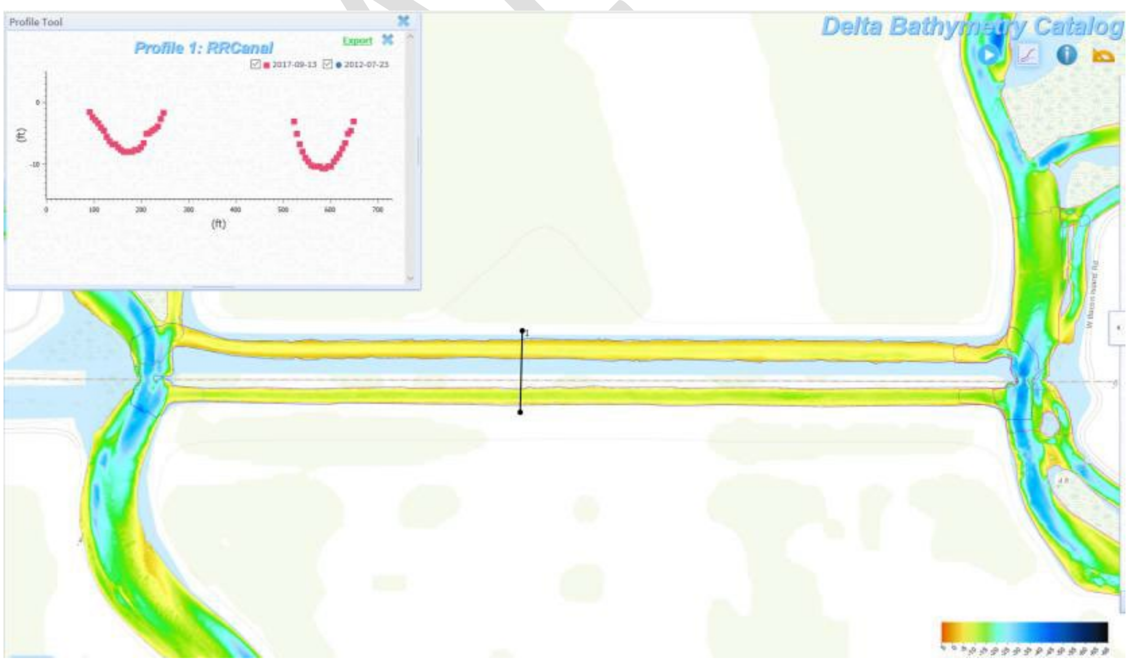
Woodward Island is at the south. The Railroad Cut has two canals: one on the northern side of the railroad and another on the southern side. Railroad Cut is 1.5 miles in length.


*Aerial Image © 2019 Google Earth. Annotation © 2019 DCDCA*

**Figure 33. Railroad Cut**




*Source: National Oceanic and Atmospheric Administration*




*Source: California Department of Water Resources*

**Figure 34. Railroad Cut Charts (Top: NOAA, Bottom: DWR)**

### 4.8.1 Vessel Operations and Restrictions on the Channel

No water depths were provided by the NOAA chart. On the other hand, the DWR bathymetry data shows an average depth of 8 feet for the northern canal and 10 feet for the southern canal. The width of the deep portion of the middle is 80 to 100 feet for both canals. There is also a fishing map indicating that the western end of the Railroad Cut has a depth of 14 feet, and the eastern end has a depth of 12 feet.

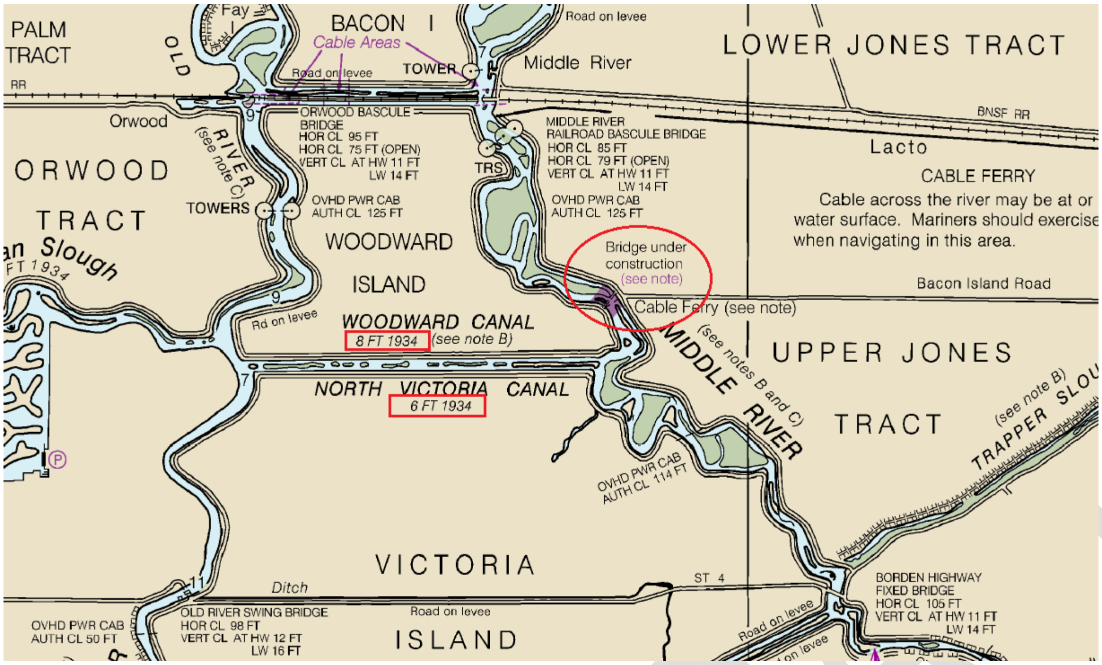
**Summary:** Railroad Cut has water depths from 8 to 12 feet, and the channel width ranges from 80 to 100 feet.

## 4.9 Woodward Canal and North Victoria Canal

Woodward Canal and North Victoria Canal are collocated as shown in the aerial image on Figure 35 and the NOAA chart on Figure 36. The canals are approximately 2.5 miles long and 470 feet wide (total). They connect the Old River to the Middle River.


*Aerial Image © 2019 Google Earth. Annotation © 2019 DCDCA*

**Figure 35. Woodward Canal and North Victoria Canal**




*Source: National Oceanic and Atmospheric Administration*

**Figure 36. Woodward Canal and North Victoria Canal**

### 4.9.1 Vessel Operations and Restrictions on the Channel

The current water depths of the canals are not provided in the NOAA charts. There is a note provided on the chart indicating that in 1934, the depth of Woodward Canal was 8 feet and North Victoria Canal was 6 feet. On the other hand, the DWR bathymetry data shows a depth of 10 to 12 feet for the Woodward Canal and 8 to 10 feet for the North Victoria Canal. The width of the deep portion of the middle is 80 to 100 feet for both canals. Only crane barges, light-loaded barges, and small push boats would have access on these canals.

There are no bridges on Woodward Canal/North Victoria Canal. However, access to this canal could be affected by a new 675-foot-long bridge that has been built over the Middle River between Woodward Island and Jones Tract on West Bacon Island Road. This new bridge replaces the Woodward Island Ferry, which had been in operation since 1936. The new one-lane bridge has a maximum capacity of 30 tons and allows the uninterrupted transport of agricultural goods and equipment. The bridge's 83-foot wide center section can be removed for unlimited vertical clearance for emergencies, allowing barges and cranes responding to flood damage to pass through. With the span in place, the vertical clearance is 30 feet, which might be shallow for tugs. Frequent passage of barges through this bridge would be impractical because of the need to lift the center span.

**Summary:** Woodward Canal/North Victoria Canal water depth ranges from 8 to 12 feet, and the channel width is approximately 100 feet. Travel to this canal could be limited by access under the new bridge on Middle River.

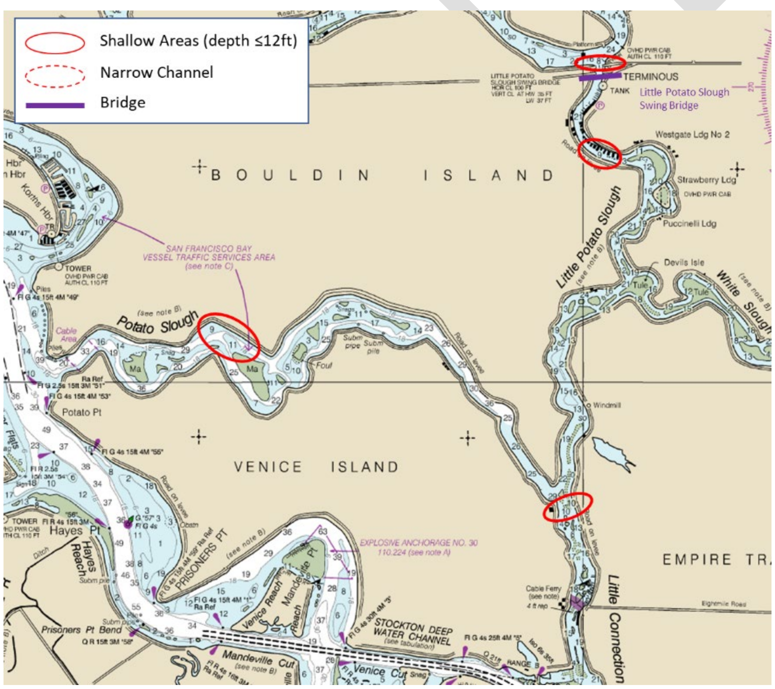
## 4.10 Potato Slough Complex

The Potato Slough Complex is made up of three watercourses: Potato Slough, Little Potato Slough, and Little Connection Slough, as shown on Figure 37. Potato Slough intersects the SDWSC approximately

16 miles west of Stockton. Potato Slough is 4.6 miles long and meanders around the southern side of Bouldin Island and the northern side of Venice Island to Little Potato Slough and Little Connection Slough. Little Potato Slough extends 3.9 miles to the SMR on the north and Little Connection Slough on the south. Little Connection Slough extends 2 miles south from the intersection of Potato Slough and Little Potato Slough and connects with the SDWSC. Figure 38 shows the NOAA chart of these watercourses.


*Aerial Image © 2019 Google Earth. Annotation © 2019 DCDCA*

**Figure 37. View of Potato Slough Complex**




*Source: National Oceanic and Atmospheric Administration*

**Figure 38. Potato Slough Complex**

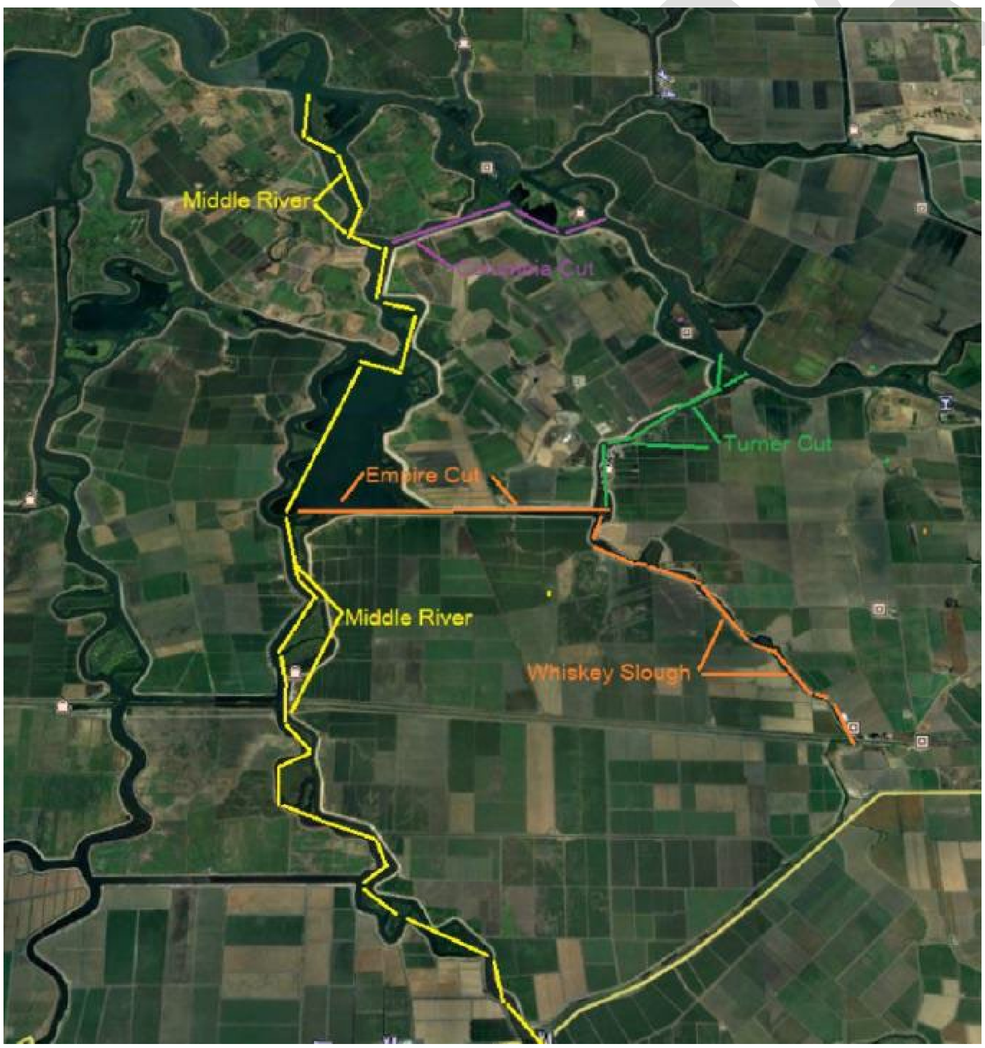
### 4.10.1 Vessel Operations and Restrictions on the Channel

Per the NOAA charts, there are a few shallow areas in the Potato Slough Complex. One of these areas is on Potato Slough, and it is located at about 1 mile east of the SDWSC. The other shallow areas are on Little Connection Slough and Little Potato Slough. There are no bathymetry data available for the Potato Slough Complex in the DWR database. The waterways in Potato Slough Complex include shallow areas; however, the channels' width is adequate for a 2,000-ton barge. There are several tight turns that could require the use of two push boats to turn a barge, especially while navigating through Little Connection Slough and Little Potato Slough.

**Summary:** The waterways in the Potato Slough Complex include shallow areas and tight turns. Even though the width of the channels is adequate for a 2,000-ton barge in general, tight turns could require the use of two push boats to maneuver a barge.

## 4.11 Middle River Complex

The Middle River Complex consists of the Middle River, Columbia Cut, Turner Cut, Railroad Cut, Empire Cut, and Whiskey Slough (Figure 39). Railroad Cut is described in Section 4.8.



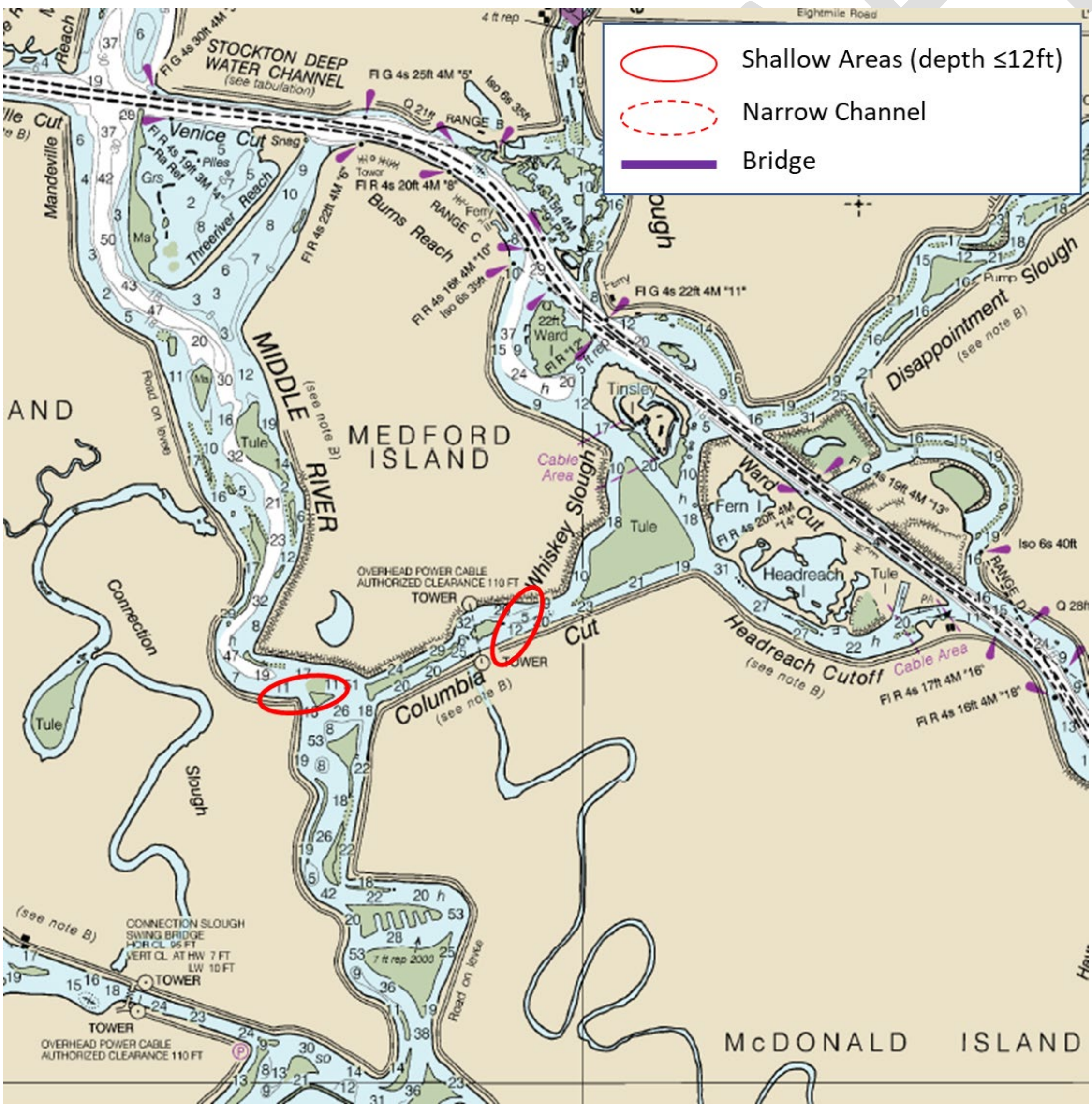

*Aerial Image © 2019 Google Earth. Annotation © 2019 DCDCA*
**Figure 39. Middle River Complex**

Middle River intersects the SDWSC approximately 13.5 miles east of Stockton. Middle River extends south from the SDWSC for approximately 14.5 miles along Mandeville Island, Bacon Island, Woodward Island, and Victoria Island on the western bank, and along Medford Island, McDonald Island, Lower Jones Tract, and Upper Jones Tract on the eastern bank.

### 4.11.1 Vessel Operations and Restrictions on the Channel

The section of Middle River between SDWSC and Connection Slough, shown on Figure 40, provides good draft depth and width to Mildred Island except for one area where the width is only about 250 feet. The DWR database provides bathymetry data only for the northern half of this section, and therefore, there is no water depth data available for the narrow area.

Columbia Cut extends to the northeast from the Middle River for 3 miles and intersects the SDWSC with good draft depths, except for one area where the width of the navigable portion of the channel is only about 150 feet because of shoaling. The DWR bathymetry data confirms these findings.

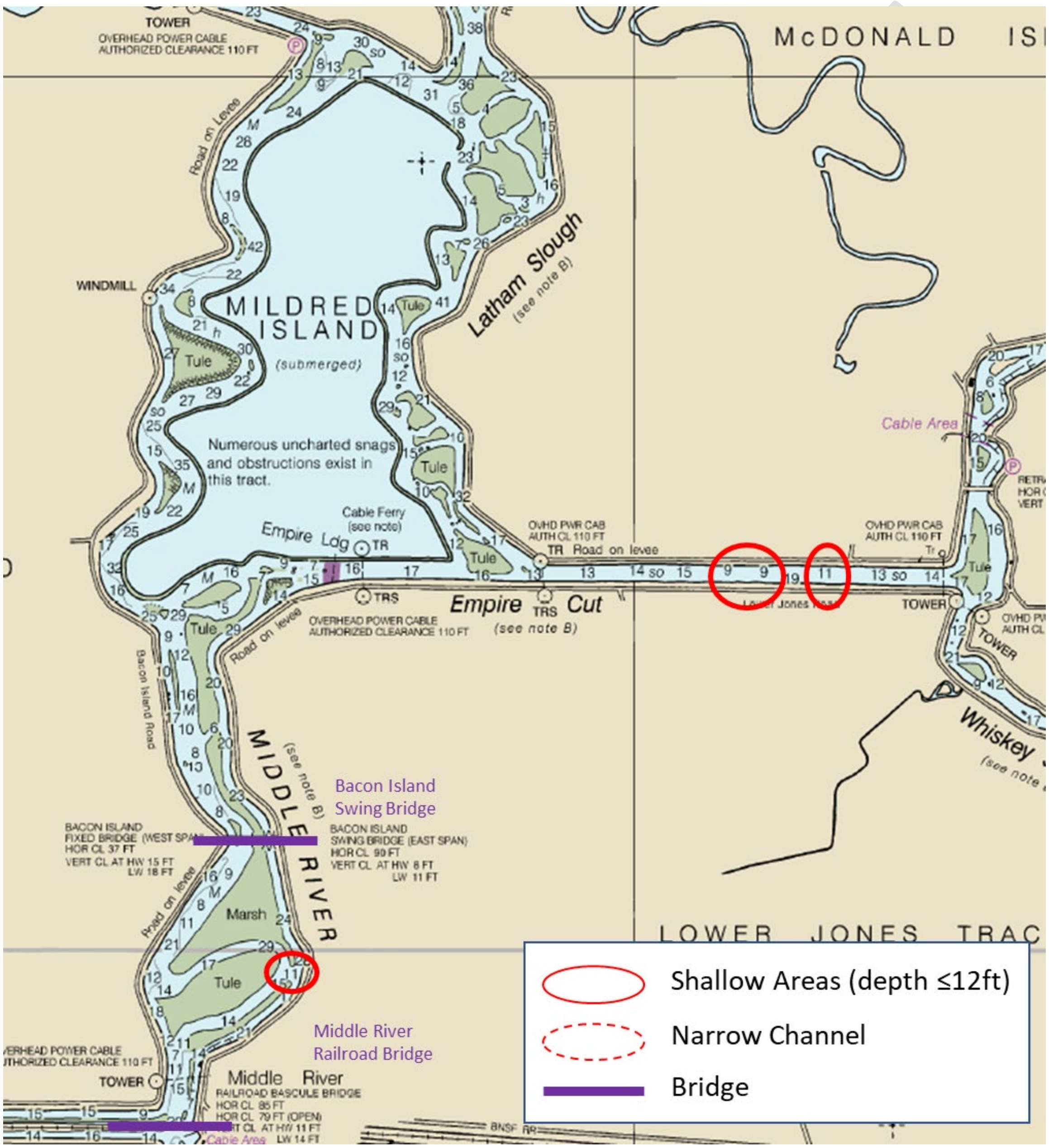



*Source: National Oceanic and Atmospheric Administration*

**Figure 40. Middle River (between SDWSC and Connection Slough) and Columbia Cut**

Figure 41 shows the NOAA chart for the section of the Middle River between Connection Slough and Railroad Cut. Similar to the first section in the north, this section of Middle River also provides good draft depths, except for one shallow area where the navigable portion of the waterway is about 100-foot wide. This section's bathymetry is also available in the DWR database, which confirms the observations from the NOAA charts.

The Empire Cut intersects the Middle River and proceeds 3.5 miles east to Turner Cut and Whiskey Slough. The Empire Cut has three shallow areas but provides enough width for barging.




*Source: National Oceanic and Atmospheric Administration*

**Figure 41. Middle River (between Connection Slough and Railroad Cut) and Empire Cut**

Bacon Island Swing Bridge crosses the Middle River (Figure 42 and Table 6). Bacon Island Swing Bridge, which is located about 13 miles west of Stockton, carries traffic across the Middle River from the western levee road on Middle River to Bacon Island Road. The vertical clearance under the deck ranges between 8 feet during high tide and 11 feet during low tide. The horizontal clearance of the center span is 90 feet. Water depths average 24 feet at mean low water.

At the Turner Cut intersection sits the Middle River Railroad Bascule Bridge (Figure 43 and Table 6). The bridge has a vertical clearance of 11 feet during high tide and a horizontal clearance of 79 feet.

*Source: marinas.com*

**Figure 42. Bacon Island Swing Bridge**



*Source: historicbridges.org*

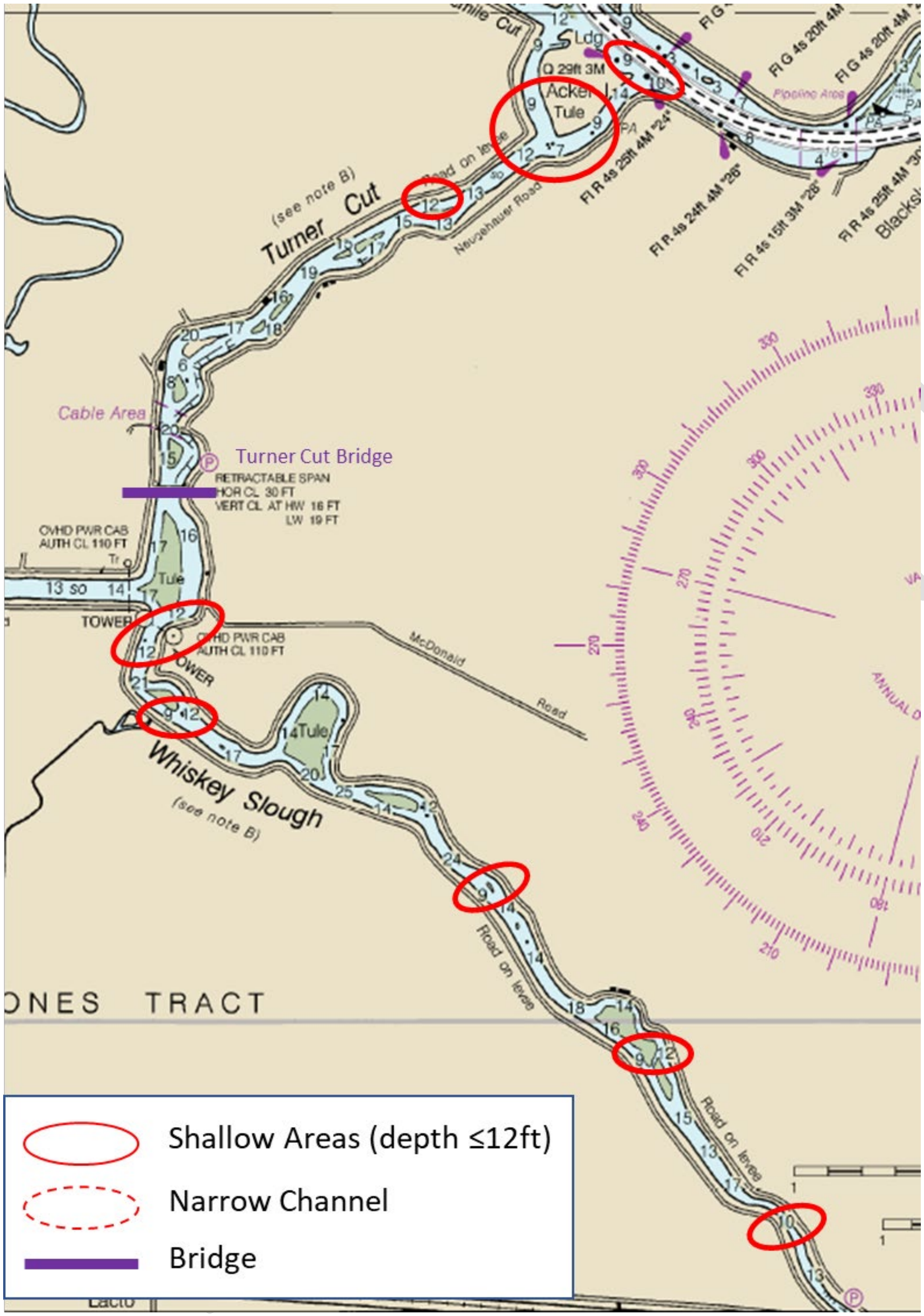
**Figure 43. Middle River Railroad Bascule Bridge**

**Table 6. Bridges on the Mokelumne River Complex**

| Watercourse | Bridge | Type | Hours of Operation | Telephone | Clearance HW/LW (feet) | Open Width (feet) |
|---|---|---|---|---|---|---|
| Middle River | Bacon Island Swing Bridge | Swing Bridge | • May 15 to September 15: 9 a.m. to 5 p.m.<br>• September 16 to May 14: 9 a.m. to 5 p.m. Thursday through Monday<br>• Other times: 12 hours' advance notice required to the San Joaquin County Department of Public Works | 209.468.3074 (Public Works) | 8/11 | 90 |
| Middle River | Middle River Railroad Bridge | Bascule | • 12 hours' advance notice required to the Burlington Northern Santa Fe Railway Manager of Structures at San Bernardino | 209-942-5411 | 11/14 | 85 / 79 (open) |
| Turner Cut | Turner Cut Bridge | Retractable Span | • Bridgetender service 24 hours a day | 209-464-1253 | 16/19 | 30 |

*Data Sources: Hours of Operation, and Telephone Contact by Deltaboating.com; Type of Bridge by Bridgehunter.com; Clearance and Open Width by National Oceanic and Atmospheric Administration Charts.*

The Turner Cut runs north from the Empire Cut about 3.5 miles and intersects the SDWSC. Whiskey Slough runs south from the Empire Cut for 3.8 miles and dead ends, as shown on Figure 44. Both the Turner Cut and Whiskey Slough have multiple shallow areas. Whiskey Slough is narrow especially at one end where the width is 120 feet.




*Source: National Oceanic and Atmospheric Administration*

**Figure 44. Turner Cut and Whiskey Slough**

Navigation on Turner Cut is also restricted at the Turner Cut Bridge, also known as the McDonald Island Bridge (Figure 45 and Table 6). The bridge is located 10 miles west of Stockton. It has a retractable span, and at the center span, the vertical clearance under the deck is 16 feet (during high tide), and the horizontal clearance is 30 feet. North of the bridge, water depths in the cut range from 8 to 17 feet, with the shallower depths occurring close to the marinas. Water depths increase to 11 to 14 feet south of the bridge. Although the bridge site can be accessed by barge from both sides, it is a tight fit for barges passing through (Walker, pers. comms. 2019c). The bridge is unusual in that instead of the bridge leaf's opening up towards the sky or a lift's pulling the bridge section upwards, the opening portion of this bridge merely slides back; therefore, it is known as a retractable bridge (Marinas 2019d).

*Source: marinas.com*

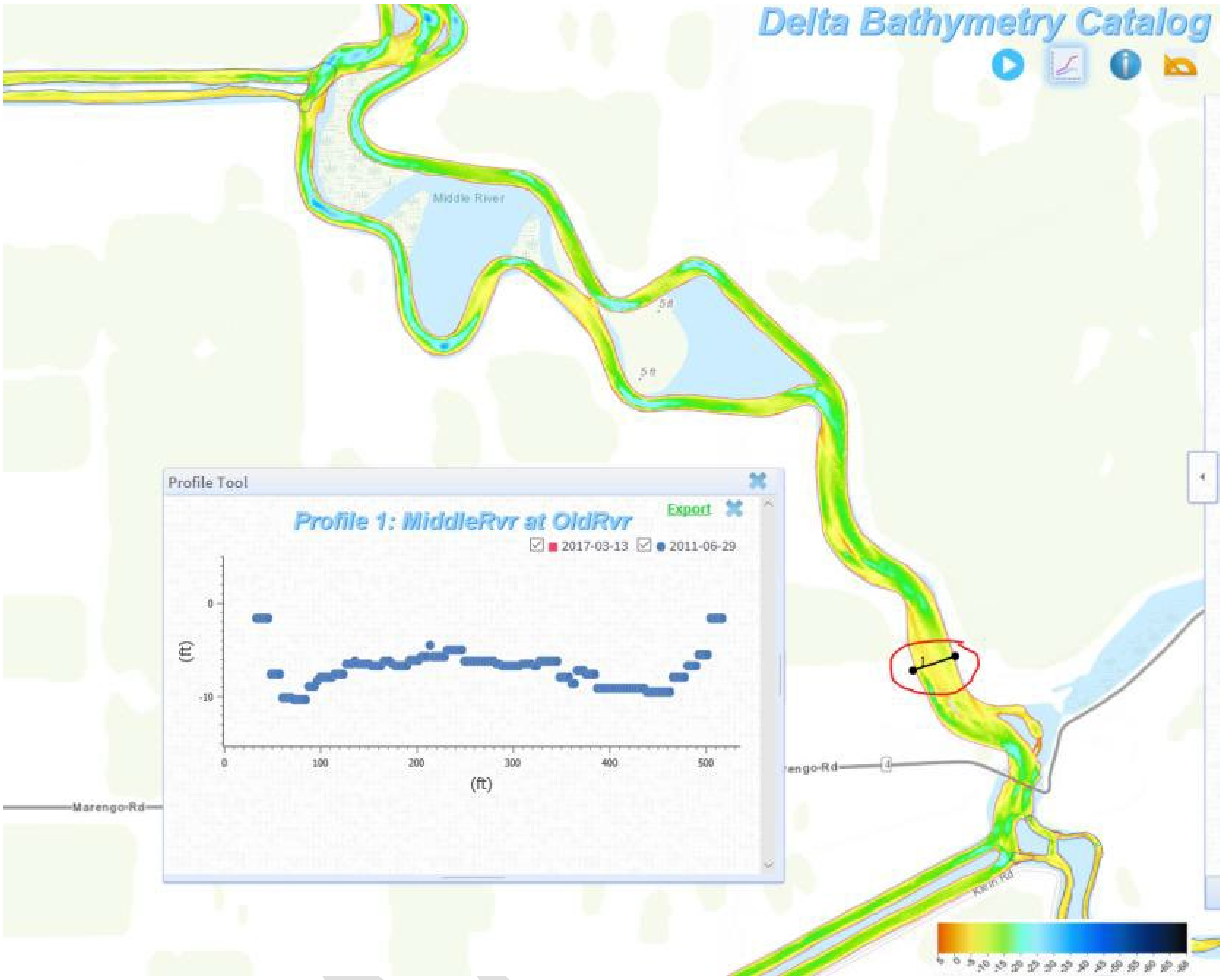
**Figure 45. Turner Cut Bridge**

Figure 46 and 47 show the bathymetry of Middle River at the southern side of Railroad Cut from the DWR database. There are no data available in the NOAA charts for this section. The depth and width of the waterway in this section allow barge traffic except at the one shallow area near Victoria Canal. The cross-section of the waterway at the shallow area is shown on Figure 47. The water depth is about 7 to 8 feet in this area, and it would be difficult to pass through with a 2,000-ton barge.

**Summary:** The waterways in Middle River Complex are adequate for a 2,000-ton barge in general, despite the shallow areas and tight turns, especially in Empire Cut, Turner Cut, and Whiskey Slough. Tight turns could require the use of two push boats to maneuver a barge.


*Source: California Department of Water Resources*

**Figure 46. Middle River between Railroad Cut and Woodward Canal**




*Source: California Department of Water Resources*

**Figure 47. Middle River between Woodward Canal and Victoria Canal**



# 5. Maps for Waterway Navigability and Landing Site Availability

Based on the findings from the evaluations presented in the previous section, the waterways in the Delta are divided into three classifications based on the barge navigability:

- **No restriction for barge operations (High):** Waterways in this group have no width or depth limitations. Two barges can be towed by a single tug.
- **Restricted barge access (Medium):** In these waterways, tugs can tow only a single barge because of width restrictions and frequent turns. At tight turns, a second tug could be needed to assist. Opening bridges could be present. Even though the MLLW is typically over 12 feet, there could be areas where the water depth is as low as 9 to 10 feet. Barges could need to be light-loaded to pass through these areas. Another option is to pass through these areas during high tide.
- **No barge access (Low):** Barge operations in these waterways were deemed either impossible or impractical because of either insufficient water depth (typically less than 9 feet) or presence of a fixed bridge with insufficient vertical or horizontal clearance.

In addition, the banks of the waterways are ranked based on the level of complexity associated with constructing a landing facility:

- **No obstructions:** In these areas, there is either a landing facility present, or a landing can be developed with minor modifications. The waterway's width is adequate to operate a landing facility at these locations without significant impact on traffic.
- **Potential levee enhancements:** Developing a landing facility would require enhancing the levee. There could be an unpaved access road on the levee or one or two small buildings nearby. The width of the waterway is adequate to operate a landing facility at these locations without a major impact on the traffic.
- **Potential levee enhancements plus interference with paved roads:** There is either a state highway or a county road that would need to be relocated. There could also be one or two small buildings nearby. The width of the waterway is adequate to operate a landing facility at these locations without a major impact on the traffic.
- **Potential levee enhancements plus interference with paved roads and structures:** There are several small buildings in the vicinity as well as a state highway or a county road on the levee. The width of the waterway is adequate to operate a landing facility at these locations without a major impact on the traffic.
- **Major interference or shallow areas:** Landing facility development at these locations was deemed either infeasible or impractical because of the presence of a bridge, marina, or urban/suburban settlement for example, or unnecessary because the location is not accessible by barge.

The maps in Appendix A show the navigability and landing site availability on waterways in the Delta as well as the potential tunnel corridors. The waterways that are likely to be used to support tunnel construction are color-coded based on the two previously noted criteria (that is, barge navigability and complexity of landing site). The color-coding is provided only near the central and eastern corridors, because DCO is focused primarily on these corridors.

# 6. Operational Constraints

Operational constraints for barge movements throughout the Delta could be limited by several items, including the following:

- Effects of tides and currents
- Effects of fog and wind
- Potential commercial traffic conflicts
- Potential recreational traffic conflicts
- Potential environmental constraints

## 6.1 Tide and Current Effects

Tide, river currents, and wind velocity would affect Delta watercourse navigation the by tugs and barges.

The tides in the Delta would affect the navigation of the tugs and barges. Figure 48 details the tidal effects of five locations: (1) Sacramento River at Rio Vista, (2) Sacramento River at Clarksburg, (3) San Joaquin River at Stockton, (4) South For, Mokelumne River at Terminus, and (5) San Joaquin River at Antioch (Delta Boating 2019). Key data on Figure 49 show the average time between tidal cycles, which averages approximately 6 hours between high tide and low tide and vice versa. Key data also show the average tide at each location. For example, if a watercourse has 10-foot depth at a location, and the barge draft is 12 feet, it could be necessary to wait until the tide cycles to high tide to navigate over the shallow area. This could result in up to a 6-hour delay in materials being delivered.

In the winter months, when flows increase because of storm events, changes in flows affect the rate at which tugs can move barges. During summer months, a tug can move a loaded barge upriver at 8 knots per hour. During the rainy season, the tug can only move at 6 knots per hour; however, downstream, empty barges can move at a higher rate of speed (Adair, pers. comms. 2019). Therefore, with increased flows in the winter months, it would take longer for the tugs and barges to reach their destinations.

**Tide Tables for Sacramento River and San Joaqin River**
Tide tables are based on Mean Lower Low Water.

**Sacramento River at Rio Vista Statiion**

| Month, 2019 | January | | February | | March | | April | | May | | June | | July | | August | | September | | October | | November | | December | | Average | Average time between Tide Cycles | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Average Tide | Hours | |
| High Tide | 0 | 3.1 | 300 | 3.6 | 100 | 3.6 | 300 | 3.7 | 500 | 3.8 | 300 | 4.4 | 300 | 4.8 | 1800 | 3.8 | 1900 | 4.3 | 1900 | 4.4 | 1900 | 4.2 | 1700 | 4.6 | 4.03 | 6.00 | High Tide to Low tide |
| Low Tide | 600 | 0.8 | 700 | 1.7 | 600 | 1.7 | 900 | 1.2 | 900 | 0.5 | 1100 | 0 | 1000 | 0.2 | 1200 | 2.2 | 1200 | 0.6 | 1200 | 0.1 | 200 | -0.3 | 1200 | -0.30 | 0.70 | 5.33 | Low tide to High Tide |
| High Tide | 1200 | 4.5 | 1300 | 4.6 | 1200 | 4.1 | 1400 | 3.7 | 1500 | 3.2 | 1500 | 3.2 | 1600 | 3.2 | 300 | 5.2 | 600 | 4.8 | 600 | 3.9 | 600 | 3.4 | 600 | 3.2 | 3.92 | 6.33 | High Tide to Low Tide |
| Low Tide | 1900 | 0 | 1700 | 0.2 | 2000 | 0 | 1700 | 0.1 | 2100 | 0.4 | 2100 | 1.5 | 2200 | 1.7 | 1200 | 0.3 | 1300 | 0 | 1300 | 0.6 | 1400 | 1.4 | 1100 | 1.5 | 0.64 | 6.33 | Low tide to High Tide |

**Sacramento River st Clarksburg**

| Month, 2019 | January | | February | | March | | April | | May | | June | | July | | August | | September | | October | | November | | December | | Average | Average time between Tide Cycles | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Average Tide | Hours | |
| High Tide | 2200 | 0 | 2300 | 0.2 | 2300 | 0 | 0 | 0.0 | 0 | 0.2 | 0 | 0.5 | 100 | 0.7 | 100 | 0.8 | 300 | 0.4 | 400 | 0 | 500 | -0.3 | 600 | -0.2 | 0.19 | 4.75 | High Tide to Low tide |
| Low Tide | 200 | 2.1 | 300 | 2.5 | 200 | 2.5 | 500 | 2.7 | 500 | 2.7 | 500 | 3 | 500 | 3.4 | 600 | 3.6 | 800 | 3.2 | 900 | 2.7 | 1100 | 2.3 | 1000 | 2.4 | 2.76 | 7.17 | Low tide to High Tide |
| High Tide | 900 | 0.4 | 1000 | 0.8 | 900 | 0.8 | 1100 | 0.7 | 1200 | 0.3 | 1300 | -0.10 | 1300 | -0.10 | 1500 | -0.30 | 1600 | 0 | 1600 | 0.3 | 1700 | 0.7 | 1600 | 0.8 | 0.36 | 5.08 | High Tide to Low Tide |
| Low Tide | 1500 | 3 | 1600 | 3.2 | 1400 | 2.7 | 1600 | 2.5 | 1700 | 2.2 | 1800 | 2.2 | 1900 | 2.3 | 2000 | 2.6 | 2100 | 2.9 | 2100 | 3 | 2100 | 2.8 | 2000 | 2.6 | 2.67 | 4.75 | Low tide to High Tide |

**San Joaquin River at Stockton**

| Month, 2019 | January | | February | | March | | April | | May | | June | | July | | August | | September | | October | | November | | December | | Average | Average time between Tide Cycles | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Average Tide | Hours | |
| High Tide | 238 | 2.9 | 400 | 2.9 | 300 | 3.3 | 500 | 3.6 | 500 | 3.7 | 500 | 4.2 | 500 | 4.7 | 600 | 4.8 | 800 | 4.3 | 900 | 3.6 | 1100 | 3.4 | 1000 | 3.2 | 3.72 | 6.58 | High Tide to Low tide |
| Low Tide | 835 | 0.7 | 1000 | 1.3 | 900 | 1.4 | 1100 | 1 | 1200 | 0.4 | 1300 | -0.2 | 1300 | -0.2 | 1400 | -0.3 | 1500 | -0.20 | 1500 | 0.5 | 1600 | 1.2 | 1600 | 1.40 | 0.58 | 5.25 | Low tide to High Tide |
| High Tide | 1433 | 4.2 | 1600 | 4.5 | 1400 | 2.8 | 1700 | 3.4 | 1700 | 3 | 1900 | 2.7 | 1700 | 3.2 | 1900 | 3.6 | 2100 | 4 | 2000 | 4.1 | 2100 | 3.7 | 2000 | 3.5 | 3.56 | 6.65 | High Tide to Low Tide |
| Low Tide | 2212 | -0.10 | 2300 | -0.1 | 2200 | 0 | 0 | 0.1 | 2100 | 0.4 | 0 | 0.9 | 0 | 1.4 | 100 | 1.3 | 200 | 0.7 | 300 | 0 | 500 | -0.3 | 400 | -0.3 | 0.33 | 5.52 | Low tide to High Tide |

**Mokelumne River South Fork at Terminous**

| Month, 2019 | January | | February | | March | | April | | May | | June | | July | | August | | September | | October | | November | | December | | Average | Average time between Tide Cycles (hrs) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Average Tide | | |
| Low Tide | 2150 | -0.1 | 2300 | 0.2 | 2300 | 0 | 2300 | 0.1 | 2300 | 0.3 | 2300 | 0.9 | 2400 | 1.4 | 2400 | 1.3 | 200 | 0.6 | 300 | 0 | 430 | -0.3 | 400 | -0.2 | 0.35 | 5.21 | Low tide to High Tide |
| High Tide | 230 | 2.5 | 300 | 2.5 | 100 | 2.7 | 500 | 3.1 | 500 | 3.1 | 500 | 3.5 | 500 | 3.8 | 500 | 4.3 | 800 | 3.7 | 800 | 3.2 | 1100 | 2.7 | 1000 | 2.8 | 3.16 | 6.90 | High Tide to Low Tide |
| Low Tide | 813 | 0.6 | 1000 | 0.8 | 900 | 1.3 | 1100 | 0.7 | 1200 | 0.4 | 1200 | -2.00 | 1300 | -0.30 | 1400 | -0.30 | 1500 | 0 | 1500 | 0.4 | 1600 | 1.3 | 1600 | 1.2 | 0.34 | 5.59 | Low tide to High Tide |
| High Tide | 1420 | 3.6 | 1600 | 3.2 | 1400 | 2.7 | 1700 | 2.7 | 1700 | 2.7 | 1800 | 2.5 | 1900 | 2.7 | 2000 | 3.2 | 2100 | 3.4 | 2000 | 3.6 | 2100 | 3.2 | 2100 | 3 | 3.04 | 6.30 | High Tide to Low Tide |

**San Joaquin River, Antioch**

| Month, 2019 | January | | February | | March | | April | | May | | June | | July | | August | | September | | October | | November | | December | | Average | Average time between Tide Cycles | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Time | Tide | Average Tide | | |
| Low Tide | 1900 | -0.1 | 1700 | -0.10 | 1900 | 0 | 2100 | 0.1 | 2000 | 0.4 | 2000 | 1.2 | 2100 | 1.7 | 2300 | 1.5 | 2300 | 0.9 | 0 | 0 | 200 | -0.3 | 100 | -0.3 | 0.42 | 5.83 | Low tide to High Tide |
| High Tide | 200 | 2.6 | 200 | 3.2 | 0 | 3.1 | 200 | 3.4 | 200 | 3.4 | 200 | 3.9 | 200 | 4.4 | 300 | 4.6 | 500 | 4.1 | 600 | 3.5 | 800 | 3 | 800 | 3.1 | 3.53 | 6.17 | High Tide to Low Tide |
| Low Tide | 600 | 0.7 | 700 | 1.6 | 500 | 1.7 | 800 | 1.1 | 900 | 0.5 | 1000 | -0.10 | 1000 | -0.30 | 1100 | -0.40 | 1200 | -0.1 | 1200 | 0.6 | 1300 | 1.4 | 1300 | 1.6 | 0.69 | 5.67 | Low tide to High Tide |
| High Tide | 1200 | 3.8 | 1300 | 4 | 1100 | 3.6 | 1300 | 3.2 | 1400 | 2.8 | 1600 | 2.7 | 1600 | 2.9 | 1700 | 3.4 | 1800 | 3.8 | 1800 | 3.9 | 1800 | 3.6 | 1800 | 3.3 | 3.42 | 6.17 | High Tide to Low Tide |

**Figure 48. Tide Tables for Sacramento and San Joaquin River**

The currents in the watercourse would also affect the speed of the tugs pushing the barges to the barge landings. The currents are mostly consistent. The graphs on Figures 49 to 51 show data for San Joaquin River at Stockton and provide the discharge, mean velocity, and the gage. The data show higher numbers from January through March 2017, which would be expected during the winter months. This incident was probably a flooding event.

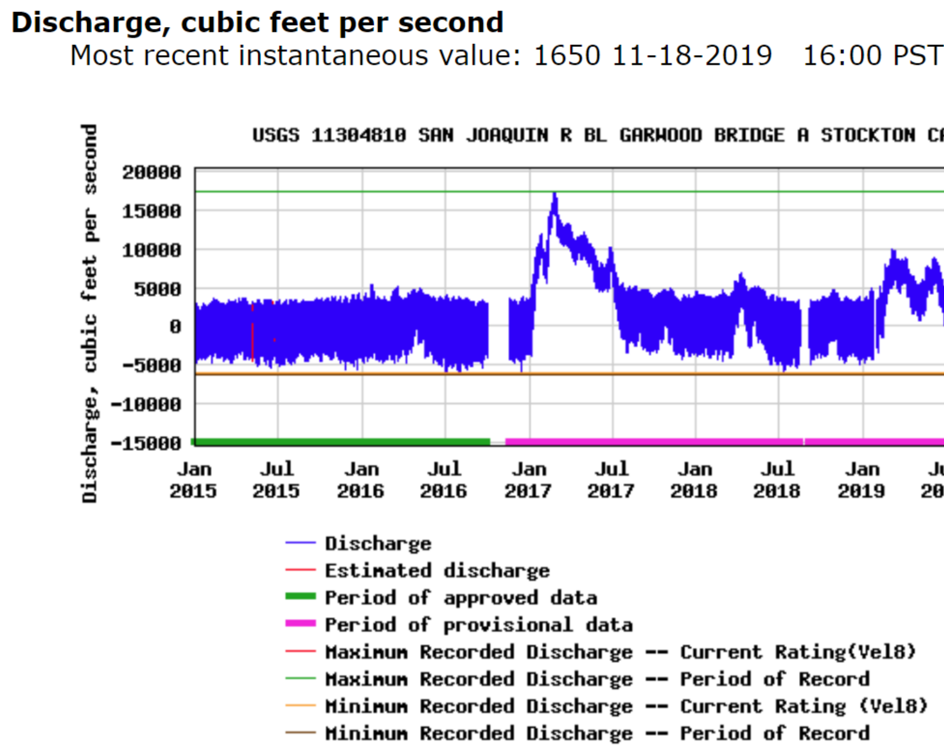



**Figure 49. San Joaquin River Discharge at Stockton, Cubic Feet per Second**

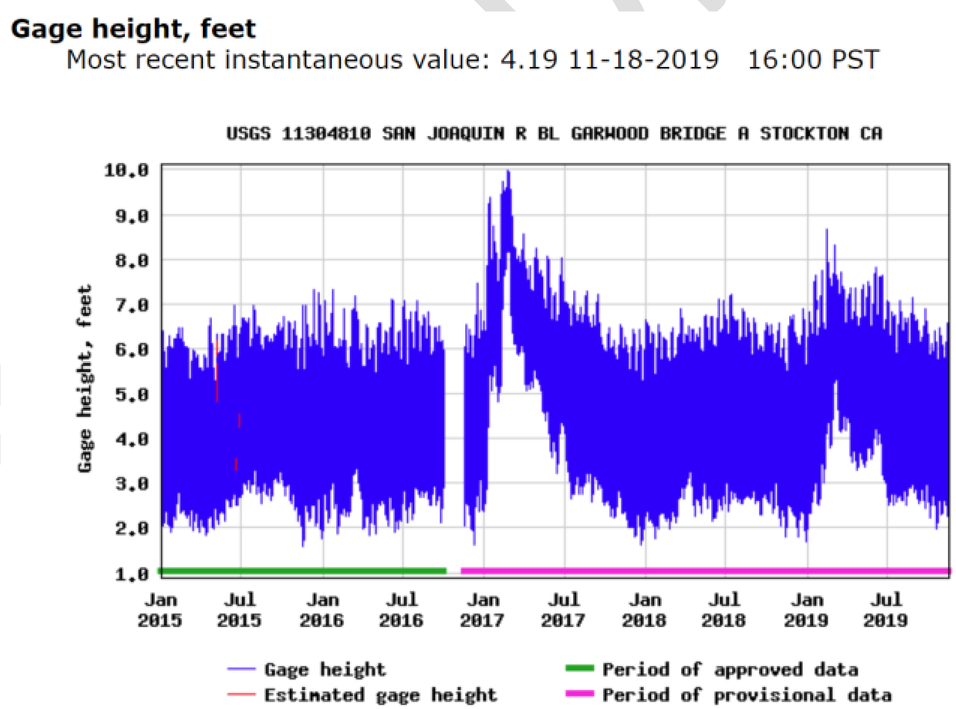



**Figure 50. San Joaquin River Gage Height at Stockton, Feet (Gage datum 0 feet above NAVD88)**

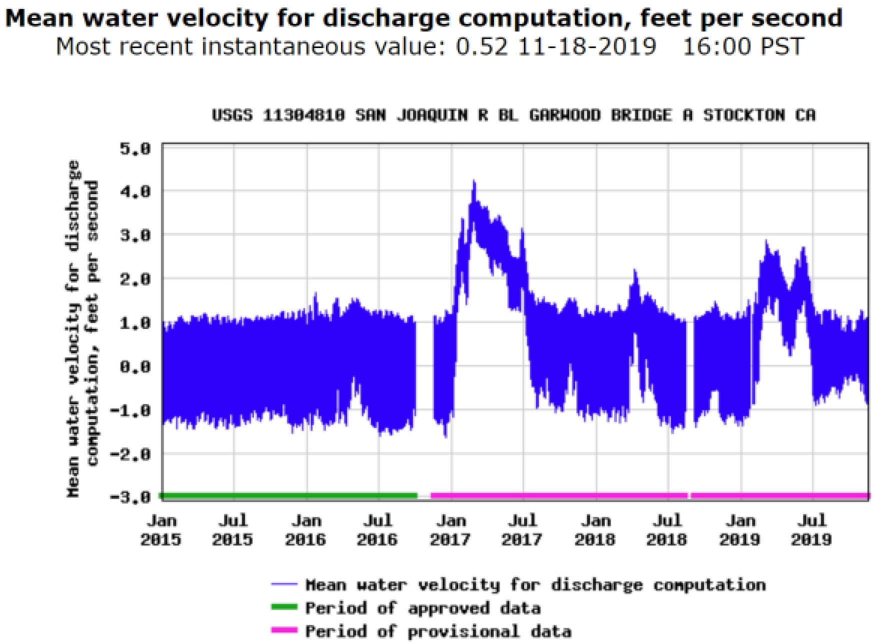



**Figure 51. San Joaquin River at Stockton Mean Water Velocity for Discharge Computation, Feet per Second**

Figures 52 to 54 show the same data for the Sacramento River at Rio Vista. As with the San Joaquin River, the Sacramento River had increased discharge and gage height between mid-December 2016 through April 1, 2017. During this period, rainfall in the area increased, and as a result, higher flow rates were experienced in the Delta.

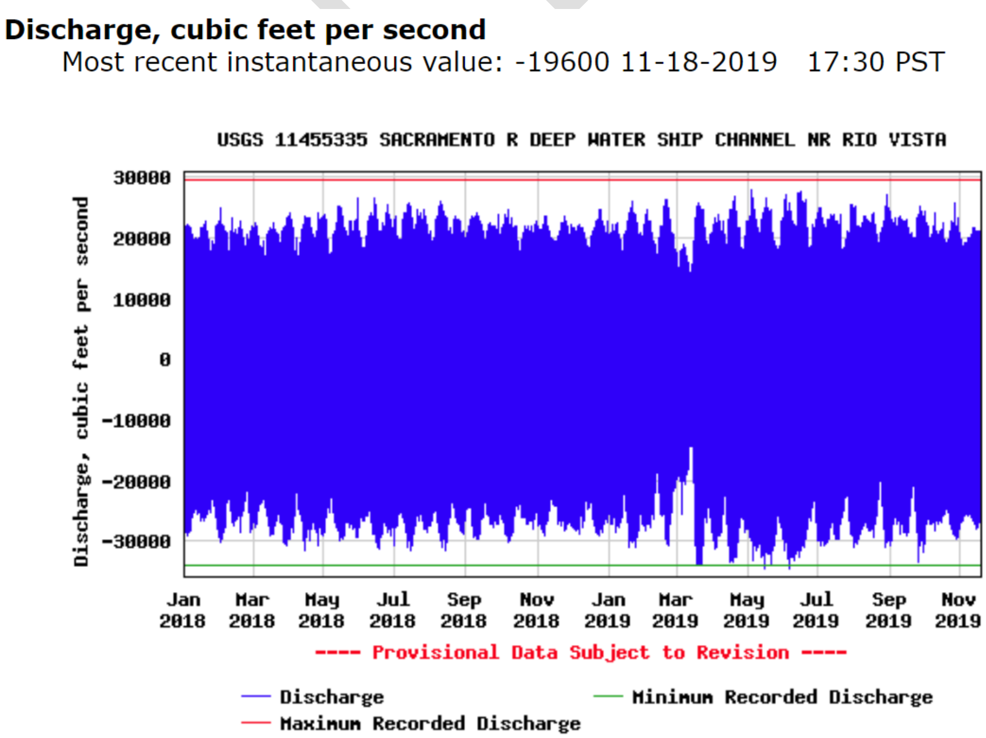



**Figure 52. Sacramento River Discharge at Rio Vista, Cubic Feet per Second**

**Gage height, feet**
Most recent instantaneous value: 23.25 11-18-2019 16:00 PST

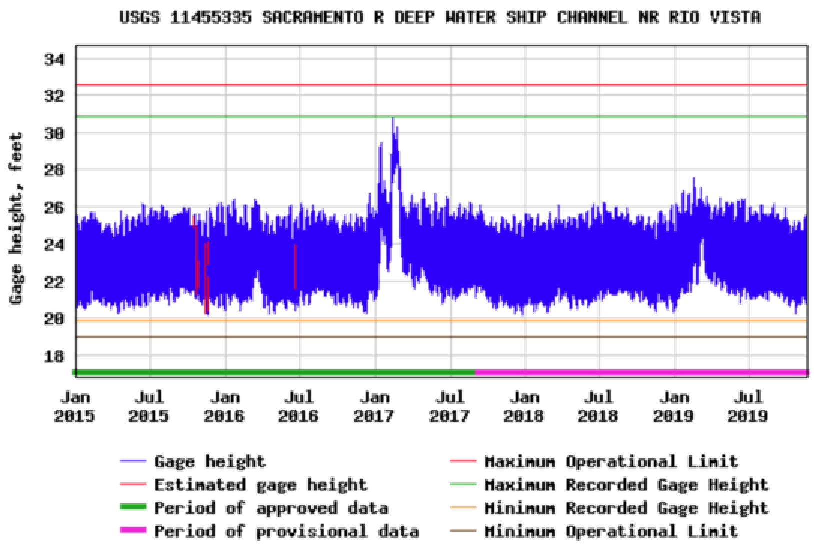



**Figure 53. Sacramento River at Rio Vista Gage Height, Feet**

**Mean water velocity for discharge computation, feet per second**
Most recent instantaneous value: -0.14 11-18-2019 16:00 PST

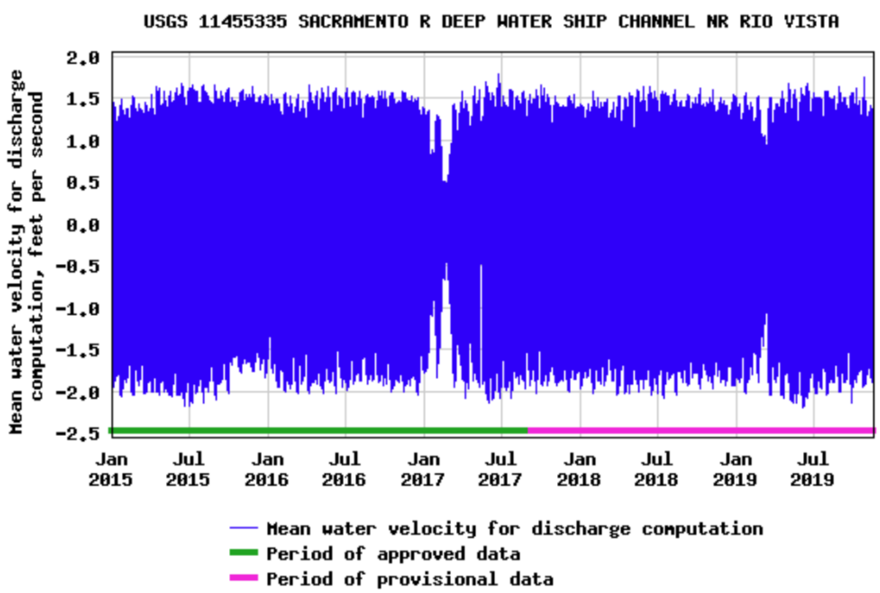



**Figure 54. Sacramento River at Rio Vista Mean Water Velocity for Discharge Computation, Feet per Second**

## 6.2 Effects of Fog and Wind

The fall and winter months in the Delta are also susceptible to fog. Historically, Tule fog would set in the Delta for 8 to 10 days and totally shut down shipping and barges navigating the river. However, in the past 10 years, operators in the Delta have indicated that Tule fog occurs only 1 or 2 days per month. Ship and tug captains have the authority to stop and tie up until safe conditions return. Bridge operators also have the discretion of keeping the bridges closed during unsafe conditions. In summary, Tule fog can be assumed to have a relatively minor overall impact on barging operations during a year.

Wind is also a factor in the Delta. Wind speeds and gusts increase in the summer and fall. This influences empty barges and makes it increasingly difficult to maneuver barges in the narrow watercourses. Figure 55 shows a historical record of wind measured at Rio Vista based on observations taken between August 2014 and April 2019 daily, from 7 a.m. to 7 p.m. local time. Average wind speeds (miles per hour) are shown on the bottom of the graph, and wind gusts are shown on the top of the graph (Windfinder.com 2019). In summary, wind speeds and directions do not change radically over time and are not presumed to be a significant operational factor on barge logistics.

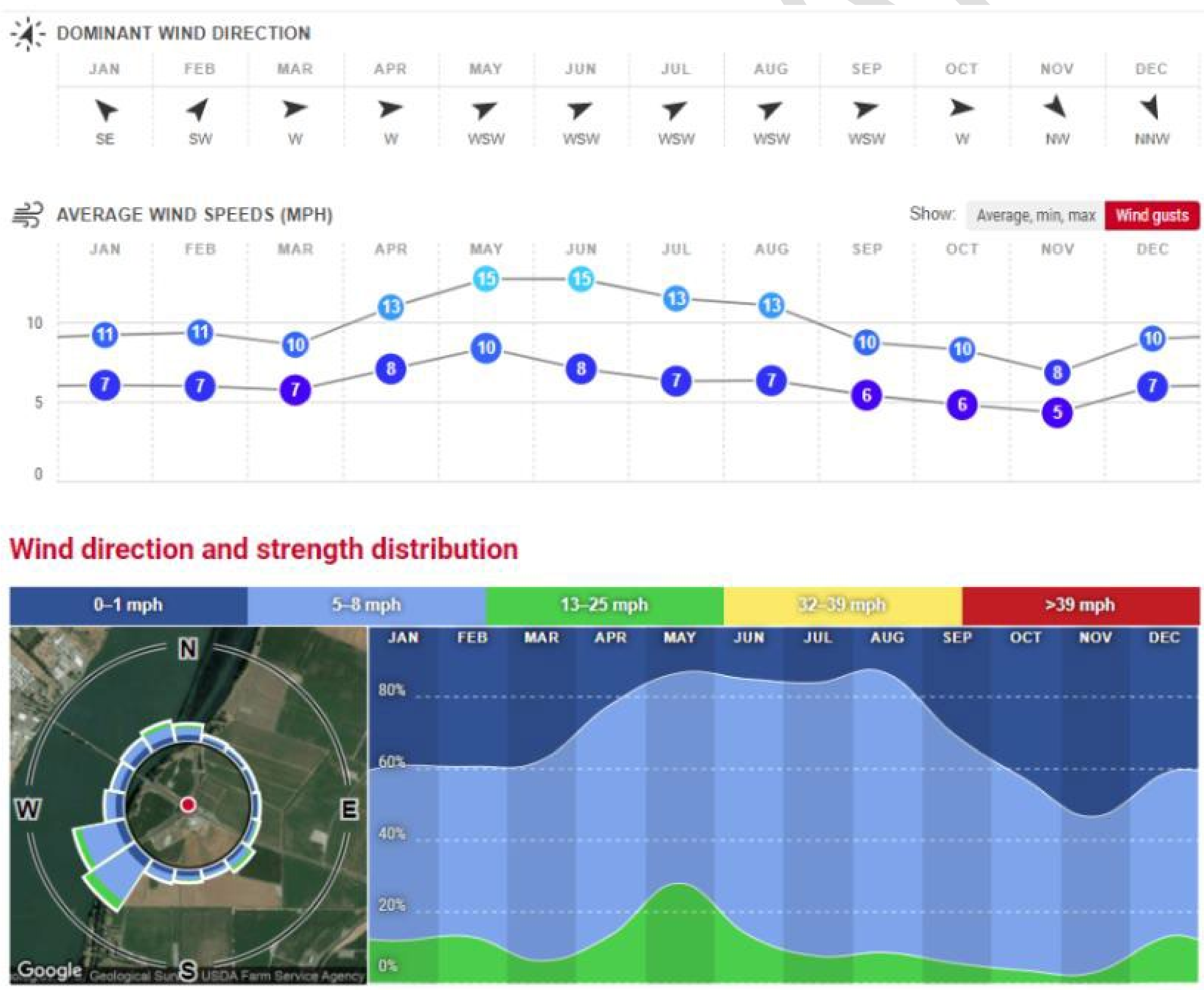



Figure 55. Wind Speed Averages and Directions for Rio Vista, California

## 6.3 Potential Commercial Traffic Conflicts

Commercial vessel traffic currently occurs only in the SRDWSC and SDWSC. Both SRDWSC and SDWSC provide adequate width for vessel traffic to pass. The narrowest section of the SRDWSC is near the Port of West Sacramento where it narrows to approximately 400 feet. The channel depth is 30 feet at MLLW and 35 feet at average high tide. The channel can accommodate fully loaded, oceangoing, Panamax-size vessels at high tide. SRDWSC had 30 ship movements in 2018, with a total tonnage moved of 840,000 metric tons. Rice and cement are the primary commodities shipped on the channel (Clark, pers. comms. 2019).

SDWSC provides adequate width for vessel traffic to pass. The narrowest section of SDWSC is near the Port of Stockton where it narrows to approximately 400 feet. The channel depth is 35 feet at MLLW and 40 feet at average high tide. SDWSC can accommodate fully loaded, oceangoing, Panamax-size vessels at high tide. SDWSC had 252 ship movements in 2018, with a total tonnage moved of 4,739,249 metric tons. Twenty-four diversified commodities were shipped on the channel, with the top five being coal, bulk cement, liquid fertilizer, food-grade oil, and sulfur (Port of Stockton 2019a).

In summary, barge transport for Delta Conveyance would have minimal impacts on commercial traffic in the Delta in coordination with the Bar Pilots and United States Coast Guard.

## 6.4 Potential Recreational Traffic Conflicts

The barge routes along the Sacramento River, Old River, Middle River, Mokelumne River, Potato Slough Complex, and other waterways would occur in the same waterways used for a high volume of recreational boating traffic, especially during the summer months. Numerous marinas, boat-launch ramps, beaches, marina resorts, and boat access recreational areas are located along the Sacramento River from the confluence with the San Joaquin River to the City of Sacramento. These facilities range from large marinas with hundreds of slips (for example, the Sacramento Marina and Antioch Marina) to popular beaches and put-in sites along the river used by windsurfers (for example, Refrigerator Beach and the Powerlines on Sherman Island near the City of Rio Vista). There are also various boating events throughout the Delta during summertime, mostly on the weekends, which could affect barging operations outside of the SRDWSC and SDWSC. Coordination and public outreach efforts would be required to minimize conflicts, impacts on recreational use, congestion, and potential safety issues.

## 6.5 Potential Environmental Constraints

Potential environmental constraints for barging would result in time constraints for barge movements and construction of barge moorings and landings.

Historically, there has been no constraint on seasonal or nighttime barge operations, and barge transport is routinely performed throughout the year and during nighttime hours to take advantage of the tidal cycles. Also, there have been no restrictions on weekend work. However, performing work during normal work hours is a goal of contractors working in the Delta to maintain good relationships with the communities (Walker, pers. comms. 2019c).

Previous studies by DWR described potential in-water work limitations from November 1 to February 28 to protect fish in Delta watercourses. However, this constraint is subject to specific review on a project-by-project basis.

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# 8. Document History and Quality Assurance

Reviewers listed have completed an internal quality review check and approval process for deliverable documents that is consistent with procedures and directives identified by the Engineering Design Manager (EDM) and the DCA.

| Approval Names and Roles | | | |
|---|---|---|---|
| **Prepared by** | **Internal Quality Control review by** | **Consistency review by** | **Approved for submission by** |
| Turel Gur / EDM Barge Specialist | Phil Ryan / EDM Design Manager | Gwen Buchholz / DCA Environmental Consultant | Terry Krause / EDM Project Manager |

This interim document is considered preliminary and was prepared under the responsible charge of Turel Gur, California Professional Engineering License C71853.

**Note to Reader**

This is an early foundational technical document. Contents therefore reflect the timeframe associated with submission of the initial and final drafts. Only minor editorial and document date revisions have been made to the current Conformed Final Draft for Administrative Draft Engineering Project Report version.

# Appendix A
# Waterway Maps


DCA DELTA CONVEYANCE DESIGN & CONSTRUCTION AUTHORITY

For Illustration Purposes Only

**POTENTIAL BARGE ACCESS ROUTES**


DCA DELTA CONVEYANCE DESIGN & CONSTRUCTION AUTHORITY

For Illustration Purposes Only

N

0 1 2 Miles

**POTENTIAL BARGE LANDING SITES**

# Appendix B
# Communication Logs

moffatt & nichol

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925-944-5411
www.moffattnichol.com

# MEMORANDUM/TELEPHONE LOG

| | |
|---|---|
| To: | File |
| From: | Jerry Neal |
| Date: | 11/1/2019 |
| Project: | Delta Conveyance |
| Subject: | Telephone Interview with Mr. Chuck Walker, Dutra Delta Operations Manager |
| M&N Job No.: | 10650 |

1. Can barges and tugs navigate the North Mokelumne River?
   **C. Walker**: Yes, there are a few areas that are shallow and would need to be sounded to get all the way to the Miller's Ferry Swing Bridge and Snodgrass Slough. Where the North Mokelumne intersects Snodgrass Slough, an extra tug needs to be waiting up there to help navigate the barge around the tight corner. Also, there is the Miller's Ferry Swing Bridge that makes that area a tight fit. Gorgiana Slough is also navigable. Snodgrass Slough is too shallow for the tug boats, but you could get a crane barge and work boat up the slough.

2. What about the South Mokelumne River?
   **C. Walker**: Yes, there are a few areas that are shallow and again would need to be sounded to make sure it is safe. It is possible to get a 2000-ton barge to the New Hope Landing bridge as long as the draft does not exceed 10'. The New Hope Landing bridge is a removable span and it is almost impossible to get it opened.

3. Can you get a barge and tug all the way to Clifton Court via the Old River?
   **C. Walker**: Yes. There are some shallow areas, but we (Dutra) have not had any problem getting 10' draft barges to Clifton Court. There is no way to go beyond Clifton Court because there are some shallow dams down that way and the last time we (Dutra) went down that way, we tore up one of the tugs on a shallow dam.

4. Connection Slough?
   **C. Walker**: Yes. There are some shallow areas, but we (Dutra) have not had any problem getting 10' draft barges through Connection Slough.

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|---|---|
| To: | File |
| From: | Jerry Neal |
| Date: | 11/2/2019 |
| Project: | Delta Conveyance |
| Subject: | Telephone Interview with Chuck Walker, Dutra Delta Operations Manager |
| M&N Job No.: | 10650 |

1. What is the best equipment configuration for working on the Delta waterways?

   **C. Walker:** When we (Dutra) tow rock from San Rafael, we will usually tow two rock barges. Depending on the location of the levee project and the waterway that will be used to get there, the two barge two will be broken down into one barge. In other words, one barge is moored at Rio Vista or False River. Then the other barge is pushed to the project site and unloaded. The key to working in the Delta is draft. There are some shallow areas and each area is sounded before a project begins. Dutra's goal is to keep the barge draft at around 10 feet. The Sarah Reed is at 9 feet of draft.

2. What about tug size?

   **C. Walker:** The Sarah Reed which has 1,600 horsepower and nine foot of draft is ideal for pushing and maneuvering barges.

   For example, the Sacramento River through Walnut Grove is a tight squeeze because after the tug and barge proceeds through the Walnut Gove bridge, the tow needs to move slightly left to miss the Walnut Grover Public Dock.

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# MEMORANDUM/TELEPHONE LOG

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|---|---|
| To: | File |
| From: | Jerry Neal |
| Date: | 11/6/2019 |
| Project: | Delta Conveyance |
| Subject: | Telephone Interview with Mr. Matthew Clark, Terminal Manager for SSA, Port of West Sacramento |
| M&N Job No.: | 10650 |

1. SSA manages the Port of West Sacramento for the city of West Sacramento. Mr. Clark has been at the Port of West Sacramento for about nine months, moving here from New Zealand.
2. Does the Port have room to support a 30-acre precast operation?
   **M. Clark:** The Port does have 30 acres in the backlands that could be developed into a precast operation. The task of SSA at the Port is to manage the waterfront on the Port with loading, receiving, and stevedoring services.
   The Port of West Sacramento is not a high capacity Port. The Port primarily imports cement and exports rice.
   The calls at the Port averages 2 ships per month.

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|---|---|
| To: | File |
| From: | Jerry Neal |
| Date: | 11/14/2019 |
| Project: | Delta Conveyance |
| Subject: | Telephone Interview with Mr. Chuck Walker, Dutra Delta Operations Manager |
| M&N Job No.: | 10650 |

1. Can barges and tugs navigate Turner Cut and Whiskey Slough?

   **Chuck Walker:** It is best to avoid Turner Cut because the bridge is not really passable with a barge. Whiskey Slough can be navigating, but not to the end as it gets very narrow and shallow. The best way to get to Whisky Slough is via the Middle River and Empire Cut.

2. Can you get a barge and tug all the way to Clifton Court via the Old River?
   **Chuck Walker:** Yes. There are some shallow areas, but we (Dutra) have not had any problem getting 10’ draft barges to Clifton Court. There is no way to go beyond Clifton Court because there are some shallow dams down that way and the last time we went down that way, we tore up one of the tugs on a shallow dam.

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|---|---|
| To: | File |
| From: | Jerry Neal |
| Date: | 11/19/2019 |
| Project: | Delta Conveyance |
| Subject: | Telephone Interview with AJ Johnson, Caltrans Bridge Supervisor |
| M&N Job No.: | 10650 |

1. How often is the Rio Vista bridge shut down for routine maintenance?

   **AJ Johnson:** The bridge does not shut down for routine maintenance except for two hours every nine months when the oil has to be changed out in the gear boxes. This takes approximately two hours. This is scheduled to be performed on graveyard shift.

   The only time the bridges are restricted is when major renovations such as deck replacement or bridge painting are being performed. When this happens, it usually involves a shut down on one of the lanes. The above maintenance applies to all the moveable bridges in the Delta.

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# MEMORANDUM/TELEPHONE LOG

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|---|---|
| To: | File |
| From: | Jerry Neal |
| Date: | 11/21/2019 |
| Project: | Delta Conveyance |
| Subject: | Telephone Interview with Mr. Robbie Adair, Pacific Tug Boats |
| M&N Job No.: | 10650 |

1. How does the winter season affect the tugs and barges transporting materials to the Delta?
   **R. Adair:** From December through April, the Delta is in the rainy season. With more rain and snow-melt, the rivers and canals increase in volume and speed. For example, when transporting barges from San Rafael (Dutra quarry) the normal tug speed would be 8 knots in summer and fall. But, during the rainy season, the average speed is around 6 knots.