FUGRO WEST, INC.

DESKTOP STUDY
SAN JOAQUIN RIVER PIPELINE CROSSING REMEDIATION PROJECT, SACRAMENTO - SAN JOAQUIN DELTA, CALIFORNIA

Prepared for:
LONGITUDE 123, INC.

APRIL 2006

FUGRO WEST, INC.

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April 7, 2006
Project No. 3103.001.01

Longitude 123, Inc.
2100 Valley Meadow Drive
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Attention: Mr. Mark Steffy, President

Subject: Desktop Study, San Joaquin River, Sacramento - San Joaquin Delta, California

Dear Mr. Steffy:

Fugro is pleased to present this focused desktop study for the San Joaquin River pipeline remediation project. This focused desktop study was performed to identify potential significant geologic conditions and other factors that could affect the pipeline engineering/remediation options for several pipelines crossing the San Joaquin River at the southern end of Sherman Island.

The preliminary study is based solely on review of existing geologic and geophysical data and our knowledge of the project area. The scope of work performed for this focused study was based on discussions with Mr. Mark Steffy of Longitude 123, Inc.

Thank you for the opportunity to provide desktop study services as part of preliminary project input. Please contact either of the undersigned if you have questions on the information presented herein.

Sincerely,

FUGRO WEST, INC.

N Beedle

Nell Beedle
Senior Engineering Geologist/
Marine Survey Engineer

Jim Grant
Manager, Survey Services

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1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION AND PURPOSE

During August/September 2005, Pacific Gas & Electric Company of California (PG&E) conducted underwater surveys of various buried pipelines crossing the San Joaquin and Sacramento Rivers, in the vicinity of Sherman Island in the Sacramento - San Joaquin Delta (Plate 1). The pipeline surveys and diver investigations identified a number of pipeline exposures and unsupported spans along Pipeline Nos. SP4Z and 114 crossing the San Joaquin River just east of the Antioch Bridge (Plate 2). The extent of the pipeline exposures and unsupported spans is such that the pipelines were brought out of service and an investigation into pipeline remediation options is underway (April 2006).

In support of this remediation investigation, Fugro West, Inc. conducted a comprehensive site survey in March 2006 to provide additional information required to proceed with engineering/remediation options. The presence of sand waves and scour pits observed on the river bottom raises concerns of the possible scouring/shoaling effects that rock/gravel backfill may have on the pipeline corridors as well as the adjacent Antioch Bridge.

PG&E expects to complete interpretation of the available survey data, finalize remediation planning, and apply for remediation permits no later than June 1, 2006. PG&E recognizes that these pipeline crossings may require remediation and desires to conduct various remediation operations during either the August 1, to October 31, 2006 or 2007 in-water work windows in the San Joaquin River.

This focused desktop study was performed to identify potential significant geologic conditions and other factors that could affect the remediation options. The preliminary study is based solely on review of existing geologic and geophysical data and our knowledge of the project area. This study did not include underwater geophysical surveys or subsurface exploration.

1.2 WORK PERFORMED

The work performed for this desktop study consisted of the following:

- **Data Review.** Fugro reviewed readily available published geologic maps and geophysical data for the project area. Fugro also reviewed available survey data for the sites. The reviewed data are referenced at the end of this report.
- **Preliminary Geologic Evaluation.** Geologic information from the data review was evaluated to characterize the geologic conditions in the project area. The evaluations include a discussion of river bed morphology, existing infrastructure, and other activities that affect the river bed in the area (dredging, sand mining).
- **Reporting.** This report summarizes the general geologic conditions and potential geohazards for the project site.

1.3 AUTHORIZATION

The scope of work performed for this study was based on discussions with Mr. Mark Steffy of Longitude 123, Inc. The desktop study was authorized by Work Order and Consulting Agreement 3103.001, dated March 10, 2006.

1.4 COMMON ABBREVIATIONS AND ACRONYMS

CalTrans	California Department of Transportation
CSLC	California State Lands Commission
GRS80	Geodetic Reference System 1980
MLLW	Mean Low Low Water (vertical/tidal datum)
NAD83	North American Datum (horizontal datum) 1983
NAVD88	North American Vertical Datum 1988
NGVD29	National Geodetic Vertical Datum 1929
NOAA	National Oceanographic and Atmospheric Administration
PG&E	Pacific Gas & Electric Company
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USGS	United States Geological Survey

2.0 SITE LOCATION AND CHARACTERISTICS

2.1 SITE LOCATION AND DESCRIPTION

The study area lies just south of Sherman Island in the San Joaquin River (Plate 1). The area lies within the delta that forms at the confluence of the Sacramento and San Joaquin Rivers approximately 60 miles east of San Francisco. The delta encompasses 738,000 acres across six counties, and the San Joaquin River forms the boundary between Sacramento County to the north and Contra Costa County to the south. The PG&E pipelines discussed in this study cross the San Joaquin River, approximately parallel to and on both side of the Antioch Bridge (Plate 2). In the study area, the San Joaquin River is a single, west-trending channel with surveyed water depths along the pipeline routes ranging from 0 to approximately 47 feet (NAVD88).

Historically, the delta was a tidal marsh (Atwater et al., 1979, Gilbert, 1917). Beginning in about 1849, the delta was converted to agricultural production and transformed into a complex series of improved channels and islands protected by levees (Atwater et al., 1979, Florsheim and Mount, 2003). Navigable channels are periodically dredged to provide access to deep water inland ports for ocean-going vessels. The Stockton Deep Water Channel (Plate 2), maintained through the study area, was last dredged in 2003 to an average depth of 35 feet (MLLW) through the study area.

Wherever possible, mapped data will be presented in this study with the following geodesy:

Convention	California State Plane Coordinate System Zone 2
Horizontal Datum	NAD83
Ellipsoid	GRS80
Projection	Lambert Conformal Conic
Central Meridian	122°W
Latitude of Origin	37.666667°N
False Easting (ft)	6,561,666.666667
False Northing (ft)	1,640,416.666667

2.2 VESSEL TRAFFIC AND THE STOCKTON DEEP WATER CHANNEL

The inland waterways of the delta, including the San Joaquin River between Suisun Bay and the Port of Stockton, are areas of active vessel traffic. Ocean-going vessels up to 80,000 tons and 850 feet long use the Stockton Deep Water Channel to access inland ports. Additionally, the delta waterways are active areas of recreational boating and local commercial traffic. Commercial activities in the delta include ferry operations between some of the delta islands, and mining of river bed materials.

The PG&E pipelines cross the Stockton Deep Water [Ship] Channel (Plate 2) on the northern side the San Joaquin River, south of Sherman Island. The channel is approximately 350 to 400 feet wide, and the channel boundaries are indicated by channel markers and buoys. The deep water channel is periodically dredged to maintain a safe operating depth for larger vessels. The channel normally is dredged to a water depth of 35 feet (MLLW). The channels are maintained by the USACE with oversight from various state agencies, but inland navigation is regulated by the USCG (NOAA, 2006, Section 162.205).

2.3 UTILITIES AND INFRASTRUCTURE

The Antioch Bridge connects Sherman Island to the Contra Costa coastline (Plate 3). The 1.8 mile-long fixed span bridge has a minimum clearance of approximately 137 feet (MLLW, <www.portofstockton.com>), with a 460 foot-wide span over the San Joaquin River (<http://bata.mtc.ca.gov/bridges/antioch.htm>). The bridge superstructure is composed of steel plate girders spanning concrete piers in the river bed below and supporting a lightweight concrete slab above. The bridge is signed as part of California State Route 160 and is maintained by CalTrans. The flow of the river around the concrete piers has affected the river bed morphology, creating scour pits up to 50 feet deep that are visible in side-sonar and bathymetry data (Fugro, 2006).

An approximately linear debris field, visible in side-scan sonar imagery, parallels the Antioch Bridge to the east (Fugro, 2006). The debris field is interpreted to be the remains of the original Antioch Bridge that was privately built and operated beginning in 1926 until it was replaced by the new bridge between 1976 and 1978. The old bridge was 21 feet wide, low to the water, and had a draw-span to accommodate vessel traffic. A portion of the 1926 bridge remains as the Antioch/Oakley Bridge Fishing Pier located to the east of the existing bridge, on the south shore of the river (Plate 2). Fugro interprets the debris field (multiple hard sonar targets of variable sizes up to a few square feet) to be related to the demolition of the original bridge.

Source: www.lib.berkeley.edu/news_events/exhibits/bridge/antioch.html

Construction of the original Antioch Bridge in 1926.

There are no indications on publicly available charts and maps from NOAA and the USGS of buried power or telecommunication cables crossing the San Joaquin River in the study area. Generally, local and regional lines are located in utility corridors along highway and railroad alignments, including the Antioch Bridge (DPC, 1996). What is apparent on all maps and in aerial photos of the Sherman Island area is overhead high-voltage power lines that cross the river between towers located on land and/or the river bed. However, none of these lines pass through the study area.

Pipelines known to Fugro are shown on Plate 3 and listed in Table 1. Although individual pipelines are not displayed on local nautical charts, areas with submerged or buried pipelines crossing the rivers are indicated as corridors labeled "Pipeline Area" (Plate 2). However, unmapped pipelines may lie outside of these corridors, as is the case of a pipeline identified in survey data from the Sacramento River on the northern side of Sherman Island (Fugro, 2006).

Table 1. Project Pipeline Information

Pipeline ID	Diameter (inches)	No. of Lines	Location Description	Length (ft)
131	12	1	East of and parallel to Antioch Bridge	4,200
114	12	2	East of and parallel to Antioch Bridge	4,100
400	26	2	West of and parallel to Antioch Bridge	4,100
SP4Z	12	1	East of and parallel to Antioch Bridge	4,200

Source: DRS 2005a

The only municipal facility in the study area known to Fugro is a storm water discharge located on the southern San Joaquin River shoreline and within the "Pipeline Area" west of the Antioch Bridge. Fugro does not have further details about the nature of the discharge facility. Another suspected outfall pipe was located during diver survey (DRS, 2005b) along Pipeline No. 131. The suspected outfall is described as extending out from the southern bank of the San Joaquin River, and was located approximately 33 feet east of Pipeline No. 131. A hard, linear target was identified during the 2006 survey and is interpreted to be the same unidentified pipeline (Fugro, 2006).

The National Pipeline Mapping System (<www.npms.rspa.dot.gov/default.htm>), coordinated by the Pipeline and Hazardous Materials Safety Administration, is a database for use by government agencies for regulatory operations and emergency management. The database relies on industry participation and is built from data submitted by pipeline, LNG, and breakout tank facility operators. Since 2002, operators have been required to submit mapping information to the NPMS and to update their submissions annually. Access to the system is limited to Federal, State, and Local Government officials and pipeline operators; however, pipeline operators are only granted access to their own information.

Various states maintain pipeline information data repositories in conjunction with, or to supplement, the national system, including California. The Pipeline Safety Division of the California Office of the State Fire Marshal is responsible for the state-wide database for use in emergency response (<http://osfm.fire.ca.gov/gishead.html>). As in the case of the national database, the State relies on submissions from industry, and the information is not publicly available.

2.4 DREDGING AND MINING ACTIVITIES

The USACE conducts annual maintenance dredging in the deep water ship channels of the Sacramento - San Joaquin Delta. A description of the dredging limits for the Stockton Deep Water Channel within the study area was not available from the USACE at the time of this report (April 2006), but a partial description is available from various permit documents issued by the California Regional Water Control Board for discharge of dredged materials (available at <www.swrcb.ca.gov/rwqcb5/adopted_orders/>). Allowable maintenance dredging depths are defined to a "35-foot depth (plus two-foot allowable over dredge)" in the permit documents. Channel widths are described only as averaging 330 feet and varying in between 200 and 600 feet. No actual dredged channel boundaries are specified in the documents.

Sand mining by dredging of the river bottom sediments occurs within the delta. Large mining operations use hydraulic and clam-shell dredges and barges to transport the dredged materials. The materials are often "washed," sorted, and sold for use primarily as construction or industrial materials. Illegal mining has occurred, but is often limited to pumping slurry from near the river margin up onto the adjacent river bank, then transporting the material overland (R. Greenwood, pers. comm., April 4, 2006). The CSLC issues permits for mining in the inland waterways, and at the time of this report, a preliminary review of CSLC records indicates there are no active leases in the study area.

3.0 GEOLOGIC CONDITIONS

3.1 PHYSIOGRAPHY

The study area lies along the western margin of the Central Valley in the Great Valley geomorphic province (Plate 1) bounded to the west by the northwest-trending mountain ranges and valleys of the Coast Ranges Province. Farther to the east, the mountains of the Sierra Nevada Province form the eastern wall of the valley province. The valley floor is relatively flat to gently rolling, and generally has elevations of 500 feet or less. The northwest-trending, sediment-filled Central Valley has only one surface water outlet - the Carquinez Strait that flows into San Francisco Bay. Together, the Sacramento and San Joaquin Rivers drain most of the Central Valley, emptying westward into the upper part of San Francisco Bay through the Sacramento - San Joaquin Delta and the Carquinez Strait (Planert and Williams, 1995).

The Sacramento - San Joaquin Delta is really an accumulation of sediment where the San Joaquin and Sacramento Rivers empty into the headwaters of the San Francisco Bay estuary. The estuary was initially formed by the rapid Holocene rise in relative sea level at the end of the last ice age (about 12,000 years ago) and the drowning of the rivers that once flowed through what is now San Francisco Bay.

Over geologic time scales, the extent of the estuary tidal marshes and the upstream delta are largely controlled by the spatially- and temporally-variable rates of submergence (the rate rise in sea level relative to the land) (Atwater et al., 1979). The rate of submergence is a function of several factors including the rate of sea level rise, the rates of tectonic uplift and/or subsidence, and the rates of erosion and sedimentation. By about 6,000 years ago, the rate of submergence was balanced in the delta as sedimentation kept up with both the rising sea level and tectonic basin subsidence (Atwater et al., 1979, Florsheim and Mount, 2003).

In historic times, the extent and morphology of the delta have been significantly affected by human activities, the scope of which are beyond this study (of many references, for example, see Gilbert, 1917, Atwater et al., 1979, Florsheim and Mount, 2003, McKee et al., 2002, Wright and Schoellhamer, 2004, Mount and Twiss, 2005). Ultimately, the result is that human activities have led to significant impacts on the morphology of delta rivers, including significant changes in sedimentation rates that have led to localized deepening and shoaling of rivers, and levee construction that affects flow velocities and channel capacities.

The behavior and morphology of the river channels that transport sediment and water through the Sacramento - San Joaquin Delta are, at least on a local scale, very similar to deltas worldwide. As the rivers enter the delta region, the decline in gradient (or slope) causes the channel switching (avulsion), forming a complex network of anastomosing channels around organic-rich islands. In the absence of human interference, the channels of the delta would be highly ephemeral, switching or forming new channels, eroding islands and forming new ones, and flooding and depositing fine sediment in large tracts between channels.

3.2 REGIONAL GEOLOGY

The western margin of the Great Valley, the Coast Ranges-Great Valley geomorphic boundary, is underlain by a system of folds and seismically active thrust faults (Wakabayashi and Smith, 1994). This tectonic boundary separates the relatively undeformed sediment-fill of the Great Valley from the highly deformed rocks of the Coast Ranges.

The basement rocks in the upper elevations of the Diablo Range and western Contra Costa County include the highly distorted and fractured basalt and serpentine of the Coast Range Ophiolite underlain by Franciscan Complex metasediments (Graymer et al., 1994). The rocks were originally formed during the Middle- to Late-Jurassic epoch as volcanic and sedimentary deposits in an island arc environment. The rocks represent oceanic crust over which the 60,000-foot-thick Great Valley sequence of sandstones, mudstones, and limestones were deposited. The Great Valley sequence rocks are now found faulted against Franciscan Complex rocks, and highly disrupted by the relatively more recent regional activity associated with the San Andreas transform fault (however, there are no active faults mapped at the surface in the study area).

In the study area, the basement rocks of the Great Valley Sequence are overlain by younger fluvial (river-deposited) and eolian (wind-deposited) sediments that are hundreds of feet thick (Plate 4). These sediments are primarily layered clays, silts, sands, and gravels, derived from the Coast Ranges and Sierra Nevada far to the east, and deposited in alluvial fans, flood plains, flood basins, and lake and marsh environments.

3.3 LOCAL GEOLOGY

Holocene-age peat and muddy peat (unit Qhpm on Plate 4) deposited in tidal wetlands comprise the surficial geologic units on Sherman Island north of the San Joaquin River. These deposits are the time equivalents of the bay mud. Eolian dune deposits comprise the fine-grained, very well-sorted, well-drained sand that is the predominate geologic unit (Qds) south of the San Joaquin River.

Throughout the area, modern artificial fill deposits (unit af on Plate 4), comprise the levee and improved shoreline soils and are often derived from dredge spoils from the surrounding rivers and marshes.

Sediments on the modern river bed are laterally discontinuous deposits of predominately sand, with clay, silt, and gravel that locally may be reworked by variable flow and sediment load conditions (see, for example, a summary description at <http://ca.water.usgs.gov/program/sfbay/calfedsed/calfed_summary.html>).

Divers observed predominately sandy river bed sediments, with occasional clay and mud (mixed silt and clay), along the pipeline routes (DRS, 2005b). Diver observations of mud was limited to the river bed adjacent to the northern river margin and levee along pipeline No. 400. The river bed sediments gradually transitioned to fine sand and sand toward the center of the channel. Mixed sand and clay were noted along the middle group of pipelines (114W, 114E, and SP4Z) between approximately 540 and 600 feet from the northern river margin, while the river bed along the rest of the route was described as "sandy." Sand and clay with clay balls were observed along Pipeline No. 131 adjacent to the levee on the northern shore, and silty sand was observed along the southern river margin.

3.4 RIVER BED MORPHOLOGY

In the study area, the San Joaquin River bed has a single channel. Upstream (to the east) of the study area, the natural channel axis (thalweg) lies along the southern margin of the river channel (Plate 5). Within the study areas, the main channel axis is approximately 40 feet deep and runs along the northern margin of the river. At the western edge of the study area, a second channel axis parallels the southern margin of the river where the river flows around the low-lying, marshy West Island. Downstream of West Island, the southern channel continues as the natural thalweg of the river. While this section of the San Joaquin River is a single channel segment, the across-channel location of the main channel axis varies along the length of the river segment.

Throughout the study area, well-formed, mobile sediment waves and longitudinal bars are observed on the river bed (DRS, 2005a, DRS, 2005b, Fugro, 2006). Sand waves with amplitudes of 1 to 4 feet were observed by divers and visible in the bathymetry and side-scan sonar survey data. The wave crests are oriented generally transverse to the direction of down-stream flow. Sand wave wavelengths are variable across the river channel, but are generally between 20 and 60 feet.

Studies have been done on mobile sediments in the area, including an area where the Threemile Slough intersects the San Joaquin River at the east end of Sherman Island (Dinehart and Schoellhamer, 1999, Dinehart, 2000). Although dependent on river flow velocities and sediment loads, sediment waves of up to 9.8 feet high were observed and migration rates of up to 6.5 feet per day were observed. Changes in sand wave morphology were observed during changing river flow and sediment load conditions, including storm events and stronger tidal influence during periods of lower river discharge.

Fugro reviewed several bathymetric data sets during the course of this project, including:

- Delta Bathymetry (Foxgrover et al., 2003) compiled by the USGS;
- Report of results from single-beam echo sounder and diver survey of the PG&E pipelines (DRS, 2005a, DRS, 2005b); and

- Multi-beam echo sounder data acquired in the study area by Fugro (2006) that are presented in a separate report.

Direct comparison of these data sets to quantify discrete changes in river bed morphology is beyond the scope of this study because the data sets were collected over a period of several years, all have different grid resolutions, and all are referenced to different horizontal and vertical datums (for a brief discussion on methods of comparison, see Foxgrover et al., 2003).

What is clear from qualitative comparison of these data is that the large-scale river bed morphology has remained fairly constant over at least the last three years. For example, in the area of the pipelines, the morphology of the Antioch Bridge scour pit, the deep water channel and longitudinal bars is essentially the same in the USGS and Fugro data sets, and the absolute river depths for these features agree generally within a few feet.

3.5 OBSERVED SCOUR

Scour - or erosion of surface sediments - can be divided into three categories: general scour (general erosion or lowering of the river bed without obstacles), channel migration (lateral movement of the main stream channel), and local scour (scour generated by the presence of obstacles such as piers and abutments). Generally, altered flow patterns around fixed structures cause the development of scour pits, or erosional depressions, in the surrounding river bed.

<u>Antioch Bridge</u>. An elongate depression (defined by the 40 feet contour) extends from approximately 25 feet west of the middle PG&E pipeline group (114W, 114E, and SP4Z) downstream for about 1,000 feet, and measures about 600 feet wide at the widest point under the bridge structure (Plate 6). The water depths in the depression around the bridge piers are up to 14 feet deeper than the average ship channel depths of about 36 feet. Notably, the bridge piers on either side of the deep water ship channel are larger than the piers under the rest of the over-water bridge sections. Scour pits observed around the smaller bridge piers are roughly 100-feet-diameter depressions that are 5 to 10 feet deeper than the surrounding river bed.

<u>Middle Pipeline Group</u>. Survey bathymetric data indicate an elongate, steep-sided depression where water depths are 40 feet or deeper along the northern river margin. The depression measures 65 feet wide and 85 feet long, and is oriented parallel to the river channel axis (Plate 6). The depression is nearly continuous with the larger depression observed under the Antioch bridge to the west. Divers reported sandy bottom sediments in the area (DRS, 2005b). A second, shallower (4 feet) depression is located closer to the river bank and has a maximum water depth of 30 feet.

Exposed and suspended pipelines in the middle pipeline group (PG&E pipelines 114W, 114E, and SP4Z) were observed by divers north of the deep water ship channel. The three pipelines had various lengths of exposure and suspension along their respective routes, with observed spans between 55 and 75 feet long and suspended heights along the river bottom of 8 feet (DRS, 2005a, DRS, 2005b). The areas of exposure and spanning were located by divers as between 366 and 666 feet from the pipeline crossing marker located on the northern San Joaquin River shoreline (DRS, 2005b), limits generally confirmed with underwater survey data acquired by Fugro (2006).

Pipeline 400. The pipeline crosses an irregularly-shaped depression with water depths greater than 40 feet located along the northern river margin (Plate 6). The center of the depression, with a maximum depth of 47 feet, is located north of the deepwater ship channel boundary. Pipeline exposures were reported shoreward of this location in the 2005 survey (DRS, 2005a, DRS, 2005b), but no exposures were detected during the 2006 survey (Fugro, 2006).

A second, smaller depression occurs under the pipeline near the southern margin of the river (Plate 6). The depression is approximately 27 feet deep, or about 5 feet deeper than the surrounding secondary channel in which it occurs. The depression is located directly opposite a marina entrance (Plate 6) that may influence river flow in a way that leads to the formation of the depression.

4.0 CONCLUSIONS

Based on our interpretation of the existing data and on our knowledge of the project vicinity, it appears that pipeline remediation is feasible, providing that the plan takes into account the highly mobile river bed sediments and variable river flow regimes. The extent of remediation will depend on final analysis of subsurface survey data, among other factors, to determine if pipelines that lie near the surface but are not exposed will require additional protection. The San Joaquin River bed is a highly dynamic fluvial environment with river sediments, river depths and bed morphology subject to daily (tidal) and seasonal variation. Mobile sediments are clearly indicated by active bed forms (sand waves and bars) observed throughout the survey area.

During the course of this study, Mr. Steffy of Longitude 123, Inc. told Fugro that PG&E had decided to remove the middle group of pipelines (Nos. 114W, 114E, and SP4Z) across the San Joaquin River (Plate 2). The remaining pipelines are being studied to determine depth of burial (Fugro, 2006) and therefore appropriate mitigation strategies that don't necessarily require detailed subsurface geotechnical data.

Findings and opinions from this study are based solely on review of existing data and on our knowledge of the project vicinity.

4.1 OUTSTANDING INQUIRIES

- USACE Dredging Limits. An initial request to the USACE regarding dredging limits in the deep water ship channels was made to Mr. Mark Fugler of the Sacramento District Office. Ultimately, Fugro was referred to the District's communication officer and the USACE requested that Fugro make an official Freedom of Information Act request for the information. Fugro has made further inquiries to Mr. Mark Steffy of Longitude 123, Inc. for assistance in communicating directly with the USACE.

- River bed sand mining activities. Fugro has made contact with at least one mining contractor in the area to try to determine the extent of mining areas. Fugro has also initiated inquiries to Mr. Richard Greenwood (greenwr@slc.ca.gov) at CSLC for mining lease boundary information. No sand mining lease areas were found in a preliminary review of CSLC documents (R. Greenwood, pers. comm., April 4, 2006).
- Existing pipelines and cables. Particularly in the security environment after September 11, 2001, it is increasingly difficult to gather public domain data regarding utility infrastructure, particularly pipeline routes and utility outfalls/intakes. Fugro has made inquiries and will continue to pursue information regarding these installations from personnel at the CSLC.

5.0 LIMITATIONS

This desktop study has been prepared for the exclusive use of Longitude 123, Inc. for input in the permitting and planning processes for the proposed exposed pipeline remediation project. The report may not contain sufficient information for other parties or other uses.

This report and the figures contained in this report are for preliminary planning only, and are not intended for use in final permitting, design, or construction. This study is based solely on review of existing data and on our knowledge of the project vicinity. Subsurface exploration and/or site-specific field exploration was not performed as part of the preliminary geohazards study. Additional geotechnical studies, reports, and services will be needed if the project proceeds to design or construction.

The scope of our services did not include the assessment of the presence or absence of hazardous/toxic substances in the soil, ground water, surface water, or atmosphere. Statements in this report regarding odors or conditions observed are strictly for descriptive purposes and are not intended to convey engineering judgment regarding potential hazardous/toxic substances.

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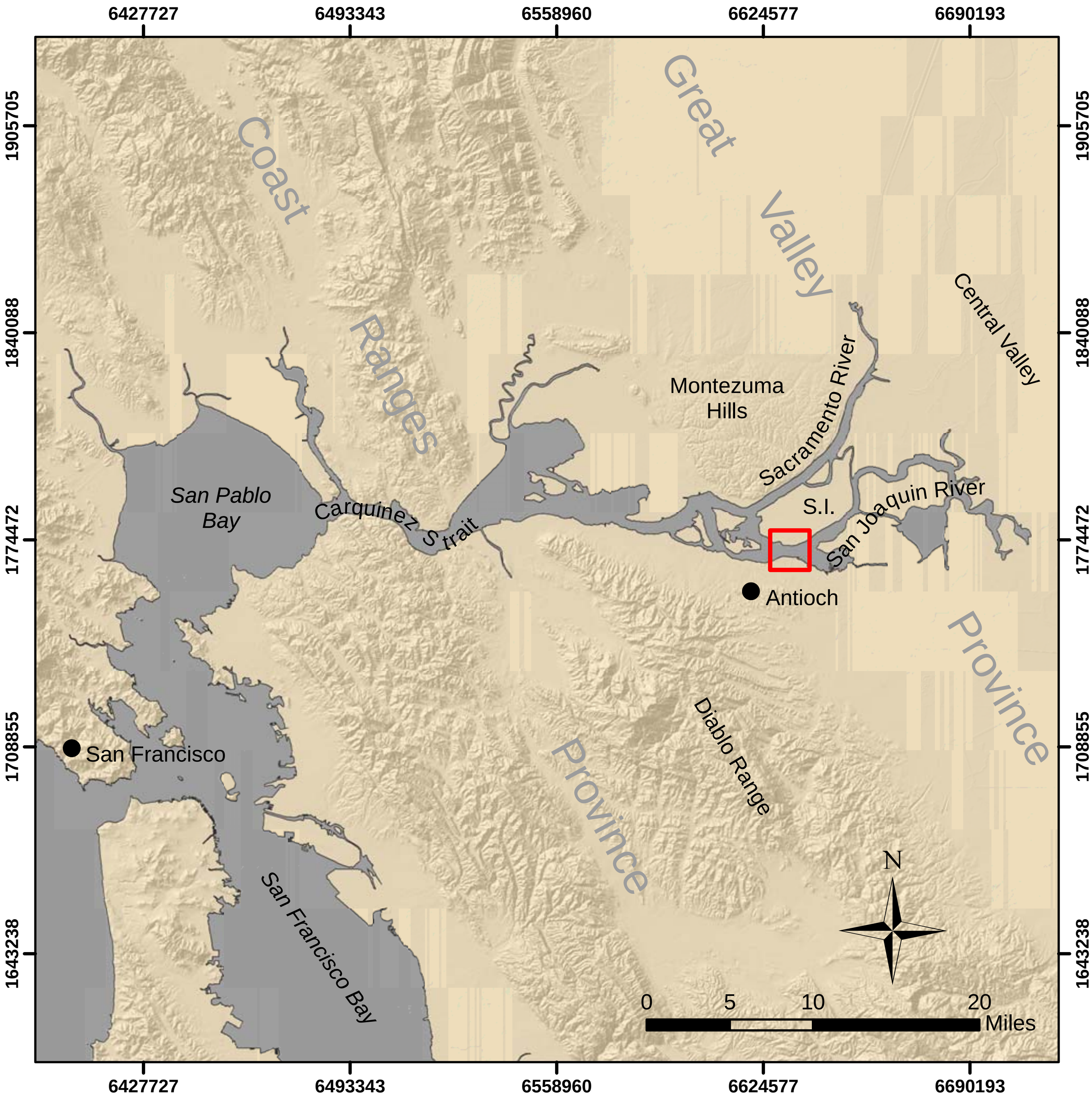
PLATES



SOURCE: Digital Elevation Map <http://casil-mirror1.ceres.ca.gov/casil/gis.ca.gov/dem/>. Horizontal units in feet (CSPCS Zone 2 [NAD83]). S.I. = Sherman Island

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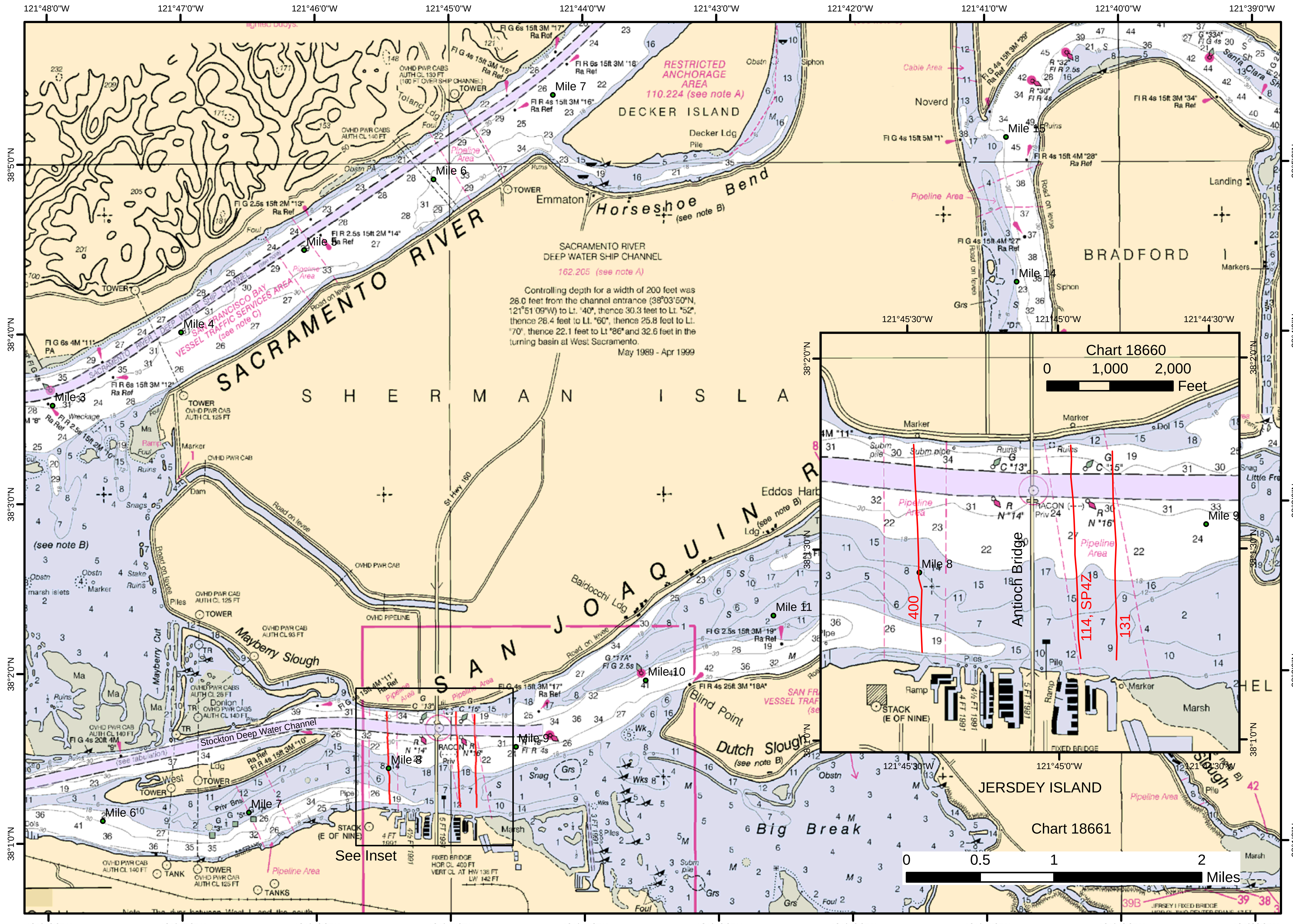
DESKTOP STUDY LOCATION MAP
San Joaquin River Pipeline Crossing Remediation Project
Sacramento - San Joaquin Delta, California

Longitude 123, Inc.
Project No. 3103.001.01



Source: NOAA Nautical Charts 18660 and 18661, 1999 ed.

Legend

- Deep Water Ship Channels
- River Mile Markers
- PG&E Pipelines (as found by Fugro)

NAUTICAL CHARTS 18661 AND 18660
San Joaquin River
Pipeline Crossing Remediation Project
Sacramento - San Joaquin Delta, Caliornia

PLATE 2

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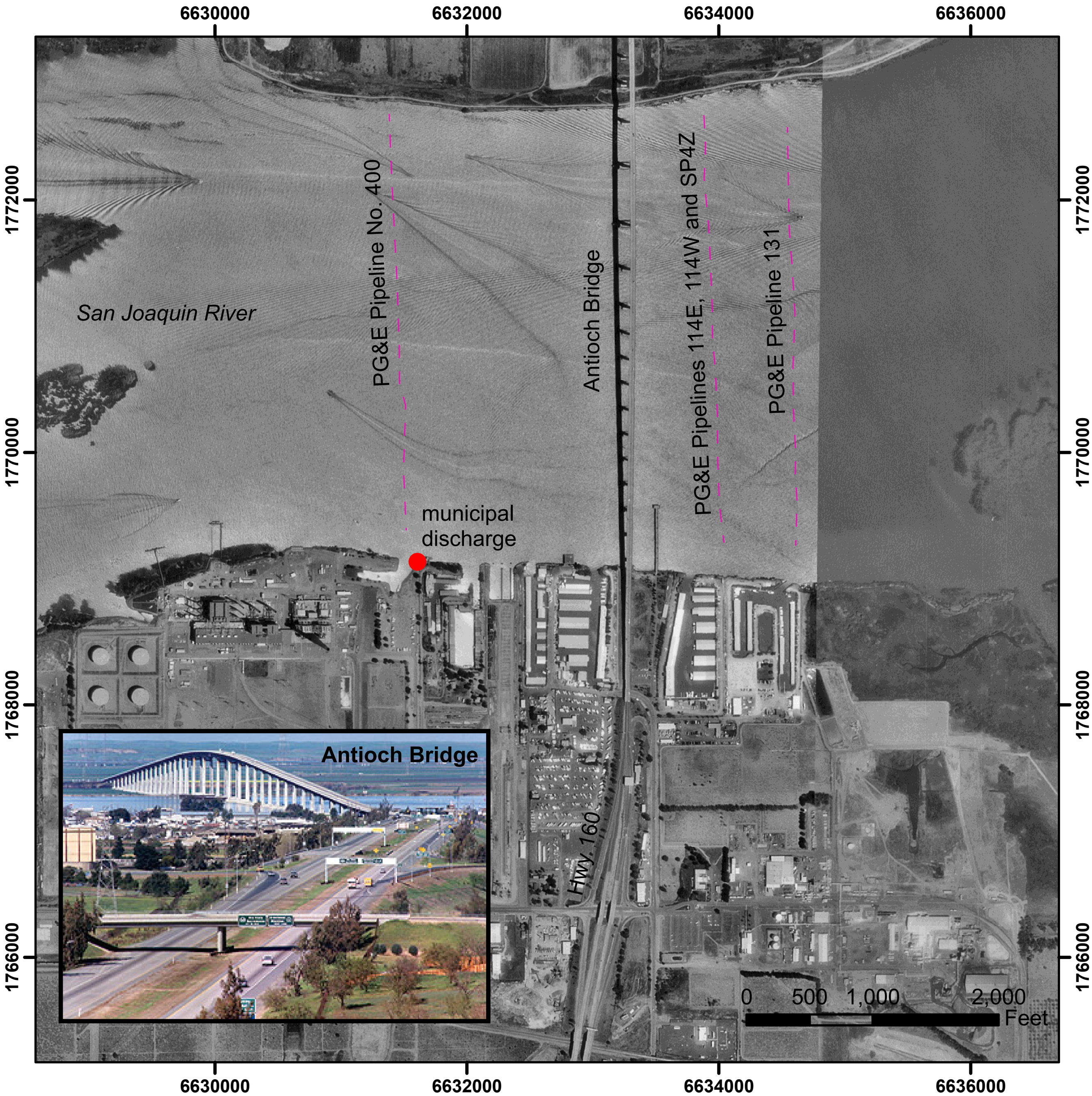
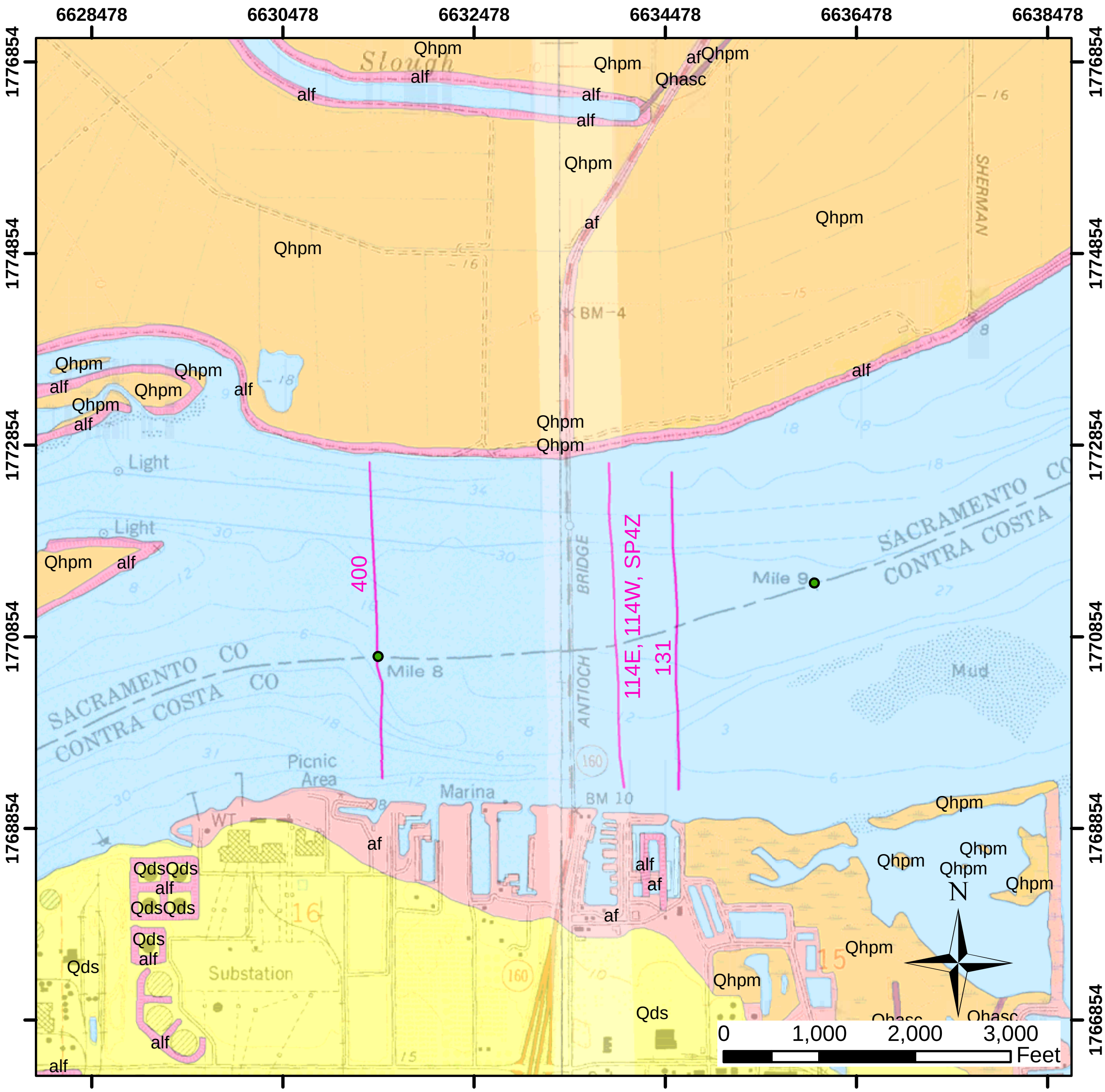


SOURCE: Digital photographs from <http://casil.ucdavis.edu/casil/usgs.gov/>. View to the northeast of Antioch Bridge from <http://bata.mtc.ca.gov/bridges/antioch.htm>. Pipeline locations approximately as found by Fugro (in prep).

AREA INFRASTRUCTURE AND UTILITIES

San Joaquin River Pipeline Crossing Remediation Project
Sacramento - San Joaquin Delta, California

PLATE 3



SOURCE: Geology from Helley and Graymer 1997, Digital USGS Quads from <http://gis.ca.gov/DRG.epl>

- River Mile Markers
- PG&E Pipelines (as found by Fugro)

af	Artificial Fill (Historic)
Qhpm	Peat and muddy Peat (Holocene)
Qds	Dune Sand (Pleistocene and Holocene)

SURFICIAL GEOLOGY
San Joaquin River Pipeline Crossing Remediation Project
Sacramento - San Joaquin Delta, California

PLATE 4

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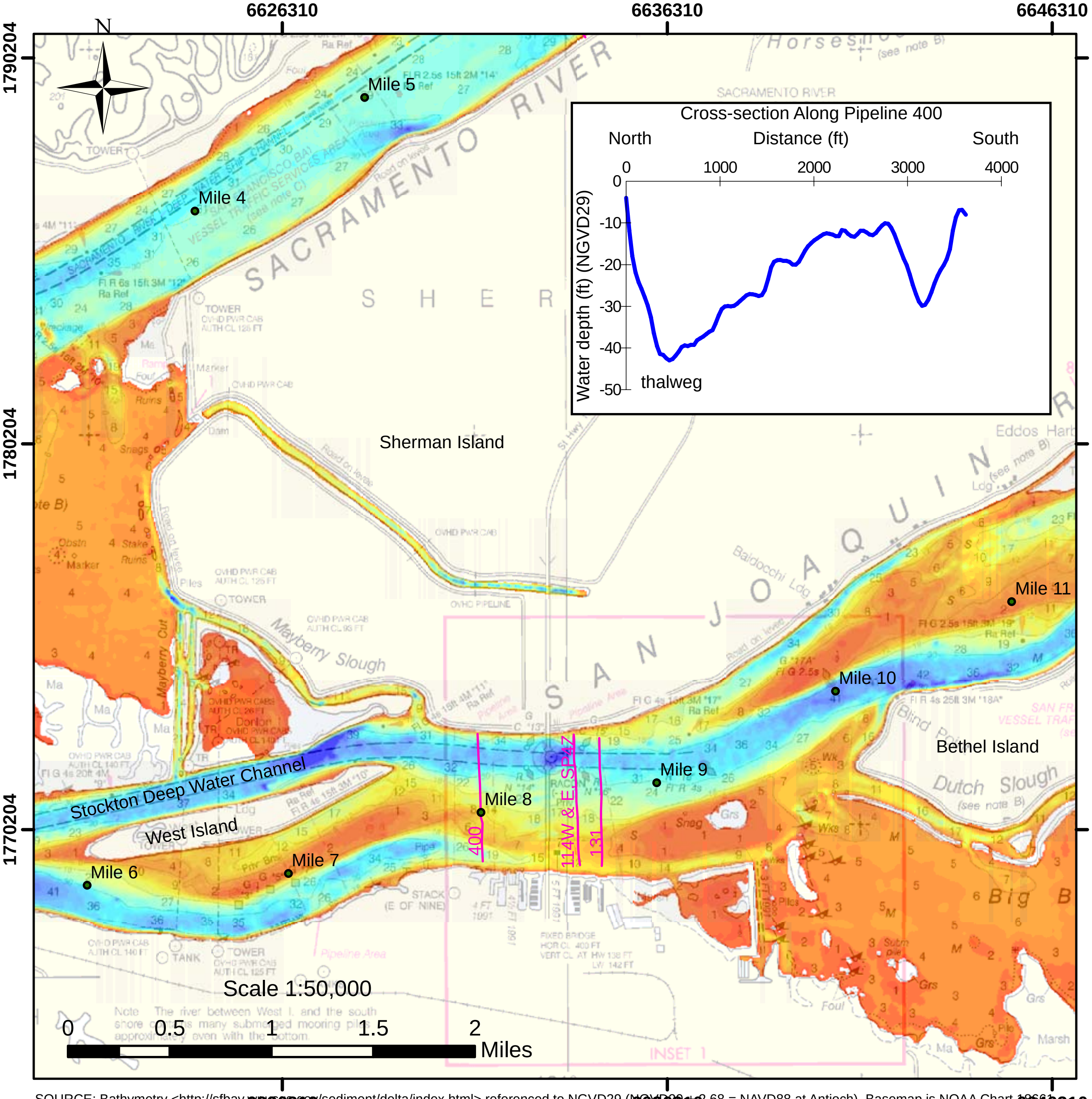
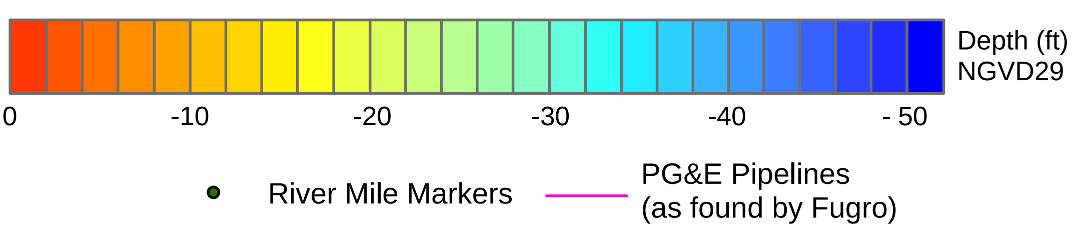


SOURCE: Bathymetry <http://sfbay.wr.usgs.gov/sediment/delta/index.html> referenced to NGVD29 (NGVD29 + 2.68 = NAVD88 at Antioch). Basemap is NOAA Chart 18661.
Cross-section vertical exaggeration 50x.



SAN JOAQUIN RIVER BATHYMETRY

San Joaquin River Pipeline Crossing Remediation Project
Sacramento - San Joaquin Delta, California

PLATE 5

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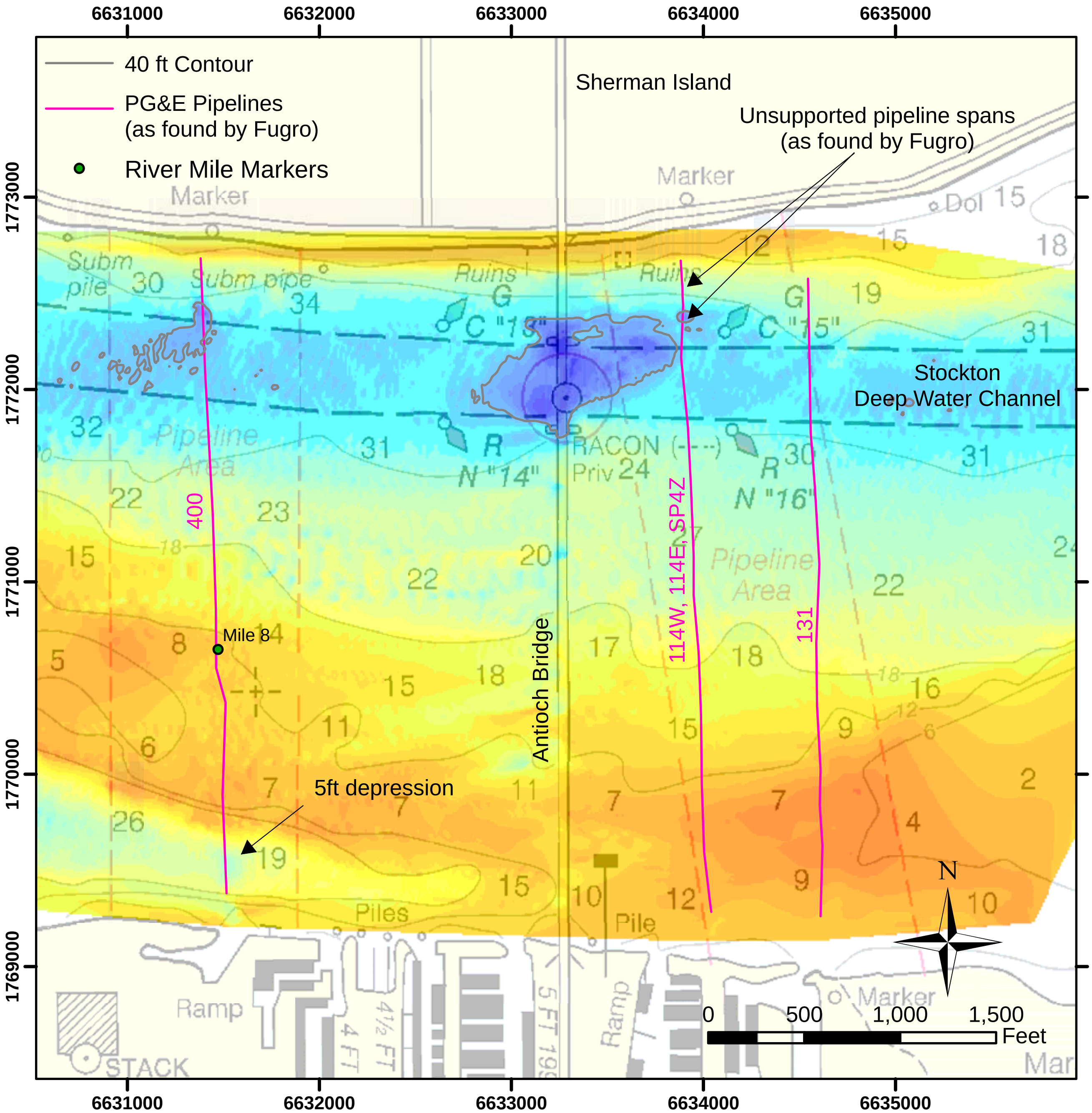
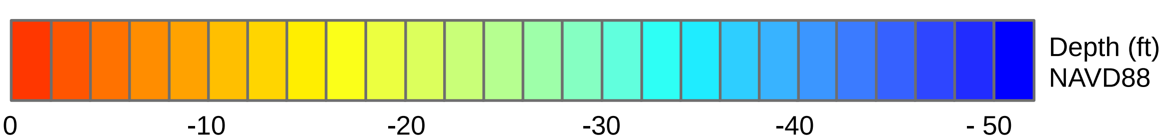


SOURCE: Fugro (in prep.). Basemap NOAA Chart 18660.



SURVEY BATHYMETRY

San Joaquin River Pipeline Crossing Remediation Project
Sacramento - San Joaquin Delta, California

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