Draft Environmental Impact Report for Long-Term Operation of the California State Water Project

Volume 2: Appendices

State Clearinghouse No. 2019049121

State of California
Department of Water Resources

November 22, 2019

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for
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Lead Agency:
California Department of Water Resources
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Regulatory Compliance Branch
916/376-9700

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APPENDIX A

Initial Study of the Long-Term Operations of the State Water Project

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State of California
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Responsible Agency:
California Department of Fish and Wildlife

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ACRONYMS AND OTHER ABBREVIATIONS

°C	Celsius
°F	Fahrenheit
2008 USFWS Biological Opinion	2008 U.S. Fish and Wildlife Service Biological Opinion
2009 NMFS Biological Opinion	2009 National Marine Fisheries Service Biological Opinion
AB	Assembly Bill
AF	acre-feet
AMP	Adaptive Management Plan
AMT	Adaptive Management Team
ANSI	American National Standards Institute
B.P.	Before Present
Banks Pumping Plant	Harvey O. Banks Pumping Plant
basin plans	water quality control plans
BiOp	Biological Opinion
BLM	Bureau of Land Management
BSPP	Barker Slough Pumping Plant
CAL FIRE	California Department of Forestry and Fire Protection
CAL/OSHA	California Occupational Safety and Health Administration
CalEPA	California Environmental Protection Agency
California AB 32	California Global Warming Solutions Act of 2006
CalRecycle	California Department of Resources Recycling and Recovery
Caltrans	California Department of Transportation
CAP	Climate Action Plan
CARB	California Air Resources Board
CCF	Clifton Court Forebay
CCR	California Code of Regulations
CCSB	Cache Creek Settling Basin
CDE	California Department of Education
CDFG	California Department of Fish and Game
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act

cfs	cubic feet per second
CGS	California Geological Survey
CH4	methane
CHP	California Highway Patrol
CMIP5	Coupled Model Intercomparison Project
CNPS	California Native Plant Society
CO	carbon monoxide
CO2	carbon dioxide
CO2e	carbon dioxide equivalents
COA	Coordinated Operation Agreement
CRPR	California Rare Plant Ranks
CSAMP	Collaborative Science and Adaptive Management Program
CTC	California Transportation Commission
CTR	California Toxics Rule
CVP	Central Valley Project
CWA	Clean Water Act
D-1485	State Water Resources Control Board Water Rights Decision 1485
D-1641	State Water Resources Control Board Water Rights Decision 1641
dB	decibel(s)
dBA	A-weighted decibels
DCC	Delta Cross Channel
DDT	dichlorodiphenyltrichloroethane
DEIR	Draft Environmental Impact Report
Delta	Sacramento–San Joaquin Delta
Delta Methylmercury TMDL	Sacramento–San Joaquin Delta Estuary Methylmercury Total Maximum Daily Load
DMC	Delta–Mendota Canal
DPC	Delta Protection Commission
DPS	Distinct Population Segment
DSC	Delta Stewardship Council.
DSP	Delta Science Program
DTSC	California Department of Toxic Substances Control
DWR	Department of Water Resources

E/I	export/import
EC	electrical conductivity
EFH	Essential Fish Habitat
EIR	Environmental Impact Report
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ESA	federal Endangered Species Act
ESU	Evolutionary Significant Unit
FBD	Fish Barrier Dam
FCCL	Fish Conservation and Culture Laboratory
FERC	Federal Energy Regulatory Commission
FHWA	Federal Highway Administration
FMMP	Farmland Mapping and Monitoring Program
FMWT	Fall Midwater Trawl
FR	Federal Register
ft/sec	foot per second
GHG	greenhouse gas
GWh	gigawatt hour(s)
GWP	Global warming potential
GYSO	Goodyear Slough Outfall
HFC	hydrofluorocarbon
HORB	Head of Old River Barrier
Hz	hertz
I	Interstate
IEP	Interagency Ecological Program
IPCC	Intergovernmental Panel on Climate Change
IRP	Independent Review Panel
IS	Initial Study
ITP	Incidental Take Permit
ITS	incidental take statements
JPE	juvenile production estimate
JPOD	Joint Point of Diversion
K–12	kindergarten through 12th grade

km	kilometer
LADWP	Los Angeles Department of Water and Power
Ldn	day-night noise level
Leq	equivalent sound level
LFC	Low Flow Channel
Lmax	maximum sound level
LTO	long-term operation
M&I	municipal and industrial
MAF	million acre-feet
MERP	Mercury Exposure Reduction Program
mg/L	milligrams per liter
MIDS	Morrow Island Distribution System
mm	millimeter
MRZ	Mineral Resource Zone
mtCO2e	metric ton of carbon dioxide equivalent
NBA	North Bay Aqueduct
NEPDG	National Energy Policy Development Group
NFH	National Fish Hatchery
NMFS	National Marine Fisheries Service
NO2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NOD	Notice of Determination
NPDES	National Pollutant Discharge Elimination System
NSF	National Sanitation Foundation International
NTU	Nephelometric Turbidity Unit
OBI	Old River at Bacon Island
OCO	Operations Control Office
OMR	Old and Middle river
OMRI	Organic Materials Reviews Institute
PBT	Parentage Based Tagging
PCB	polychlorinated biphenyl
PFC	perfluorinated chemicals
PFMC	Pacific Fishery Management Council

PG&E	Pacific Gas and Electric Company
PM	particulate matter
PM10	PM equal to or less than 10 micrometers in diameter
PM2.5	PM equal to or less than 2.5 micrometers in diameter
POD	Pelagic Organism Decline
ppm	parts per million
ppt	part per thousand
PRC	Public Resources Code
Proposed Project	Long-Term Operation of the State Water Project
PSL	pre-screen loss
PTM	Particle Tracking Model
PWAs	Public Water Agencies
QUEST	Net flow on the San-Joaquin River at Jersey Point
RBDD	Red Bluff Diversion Dam
RCRA	Resource Conservation and Recovery Act
Reclamation	U.S. Bureau of Reclamation
RPA	Reasonable and Prudent Alternative
RPS	Renewables Portfolio Standard
RRDS	Roaring River Distribution System
RWQCB	Regional Water Quality Control Board
Delta	Sacramento–San Joaquin Delta
SB	Senate Bill
SCWA	Solano County Water Agency
SF6	sulfur hexafluoride
SFB	San Francisco Bay
SFEI	San Francisco Estuary Institute
Skinner Fish Facility	John E. Skinner Delta Fish Protective Facility
SJRRP	San Joaquin River Restoration Program
SLCP	short-lived climate pollutant
SLS	Smelt Larva Survey
SMARA	Surface Mining and Reclamation Act
SMGB	State Mining and Geology Board
SMPA	Suisun Marsh Preservation Agreement

SMSCG	Suisun Marsh Salinity Control Gates
SO2	sulfur dioxide
SR	State Route
SRA	State Responsibility Area
SRCD	Suisun Resource Conservation District
SRWTP	Sacramento Regional Wastewater Treatment Plant
State	State of California
State Implementation Policy	Policy for Implementing Toxic Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California
SVP	Society of Vertebrate Paleontology
SWC	State Water Contractors
SWP	State Water Project
SWPAO	State Water Project Analysis Office
SWRCB	State Water Resources Control Board
TAF	thousand acre-feet
TBP	DWR South Delta Temporary Barrier Project
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
TOC	total organic carbon
UC Davis	University of California, Davis
UCMP	University of California, Berkeley Museum of Paleontology
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WCRP	World Climate Research Programme
WGCM	Working Group on Coupled Modelling
Williamson Act	California Land Conservation Act
WOMT	Water Operations Management Team
WSPP	Western Systems Power Pool
WWR	Wetlands and Water Resources
YOY	young-of-the-year

1 INTRODUCTION

1.1 BACKGROUND

The Long-Term Operation of the State Water Project (Proposed Project) would continue the California Department of Water Resources' (DWR's) ongoing long-term State Water Project (SWP) operations consistent with applicable laws, contractual obligations, and agreements. DWR proposes long-term operation (LTO) of the SWP that will allow DWR to continue to store, divert, and convey water in accordance with its existing water rights to deliver water pursuant to water contracts and agreements up to full contract quantities. DWR is seeking to optimize water supply and improve operational flexibility while protecting fish and wildlife.

DWR operates the SWP in coordination with the Central Valley Project (CVP), under the Coordinated Operation Agreement (COA) between the federal government and the State of California (authorized by Public Law 99–546). The CVP and SWP operate pursuant to water rights permits and licenses that are issued by the State Water Resources Control Board (SWRCB). The CVP and SWP water rights allow appropriation of water by directly using and/or diverting water to storage for later withdrawal and use, or use and rediversion to storage further downstream for later consumptive use. Among the conditions of those water rights are requirements for projects either to bypass or withdraw water from storage and to help satisfy specific water quality, quantity, and operations criteria in source rivers and within the Sacramento–San Joaquin Delta (Delta).

DWR also operates the SWP in compliance with the California Endangered Species Act (CESA). DWR has obtained consistency determinations from the California Department of Fish and Wildlife (CDFW), pursuant to Section 2080.1 of the California Fish and Game Code. The 2008 U.S. Fish and Wildlife Service (USFWS) and 2009 National Marine Fisheries Service (NMFS) Biological Opinions are consistent with the requirements of CESA. CDFW's determinations signify that no further authorizations are necessary under CESA with respect to species that are listed under both the CESA and federal Endangered Species Act (ESA), including Delta Smelt, Winter-run Chinook Salmon, and Spring-run Chinook Salmon. DWR also holds an Incidental Take Permit (ITP) from CDFW, pursuant to Section 2081 of the California Fish and Game Code, covering Longfin Smelt, listed only under the CESA. The Incidental Take Permit for Longfin Smelt expires on December 31, 2019.

DWR intends to seek a new ITP from CDFW, pursuant to Section 2081 of the California Fish and Game Code. The new ITP will cover species that are listed under the CESA and are subject to incidental take from long-term operation of the SWP (i.e., Delta Smelt, Longfin Smelt, Winter-run Chinook Salmon, and Spring-run Chinook Salmon). CDFW is expected to rely on this document when issuing a decision on the DWR ITP application.

DWR is the lead agency for compliance with the California Environmental Quality Act (CEQA) and has prepared this Initial Study (IS). The IS has been prepared pursuant to CEQA, California Public Resources Code Section 21000, et seq., and the State CEQA Guidelines, Title 14 of the California Code of Regulations Section 15000, et seq.

DWR is seeking an ITP covering four CESA-designated species for the continued LTO of the SWP. ITPs are necessary for:

- Winter-run Chinook Salmon (*Oncorhynchus tshawytscha*) Sacramento River Evolutionary Significant Unit (ESU)
- Spring-run Chinook Salmon (*Oncorhynchus tshawytscha*) Central Valley ESU
- Delta Smelt (*Hypomesus transpacificus*)
- Longfin Smelt (*Spirinchus thaleichthys*) Bay–Delta Distinct Population Segment (DPS)

DWR has prepared this IS to identify potential significant environmental issues, and to narrow the scope of the Environmental Impact Report (EIR) being prepared to address the environmental consequences of the Proposed Project. In accordance with Section 15063 (3) of the State CEQA Guidelines, this IS presents an analysis addressing a full range of environmental topics and determines whether potential significant environmental effects may occur from the LTO of the SWP. This Initial Study is neither intended nor required to include the level of detail that must be included in an EIR.

The environmental topics that are determined to have no impact or a less-than-significant impact in this IS will be eliminated from further consideration in the EIR. Only the environmental topics that are determined to have a potentially significant impact from implementation of the Proposed Project will be further discussed in the EIR.

1.2 PROJECT OBJECTIVES

The objectives of the Proposed Project are to continue the coordinated long-term operation of the SWP for water supply and power generation, consistent with applicable laws, contractual obligations, and agreements, and to increase operational flexibility by focusing on non-operational measures to avoid significant adverse effects. DWR proposes to store, divert, and convey water in accordance with existing water contracts and agreements up to full contract amounts, including water service and repayment contracts, settlement contracts, exchange contracts, and other deliveries, consistent with water rights and applicable laws and regulations.

1.2.1 REQUIRED PERMITS AND APPROVALS

DWR operates the SWP in accordance with applicable statutes and regulations, including applicable water rights permits issued by the SWRCB, the Coordinated Operations Agreement with Reclamation, and biological opinions issued by the USFWS and NMFS, among other requirements. In accordance with Section 2081(b) of the California Fish and Game Code, CDFW may issue an ITP to authorize take that is otherwise prohibited by Section 2080 of the Fish and Game Code as long as the project meets the conditions set forth in Sections 2081(b) and 2081(c).

1.2.2 DOCUMENT ORGANIZATION

This Initial Study is organized as follows:

- **Chapter 1, "Introduction,"** describes the background of the Proposed Project, project objectives, and the organization of this document, and summarizes the findings of the environmental impact analysis.
- **Chapter 2, "Project Description,"** refers the reader to Chapter 3, "Project Description," presented in the Draft Environmental Impact Report (DEIR).
- **Chapter 3, "Environmental Checklist,"** identifies the environmental resource topics evaluated under CEQA and describes the environmental setting, significance criteria, and results of the analysis of potential environmental impacts of the Proposed Project. This chapter also identifies and summarizes the overall significance of any potential impacts on natural and cultural resources, cumulative impacts, and impacts on humans.
- **Chapter 4, "References,"** lists the sources of information cited in this IS, including literature citations and personal communications.
- **Chapter 5, "Document Preparation,"** lists the individuals who prepared this document.

1.3 SUMMARY OF FINDINGS

Chapter 3 of this IS contains the CEQA Environmental Checklist, which presents a brief discussion of each resource topic potentially affected and identifies the potential environmental impacts that would occur with implementation of the Proposed Project. The analysis focuses on potential effects on waterways of northern California, the Sacramento–San Joaquin Delta, and Suisun Marsh from the continued operation of the SWP facilities and issuance of the ITP.

In accordance with Section 15063(c)(3) of the State CEQA Guidelines, the purpose of preparing an initial study is to assist preparation of an EIR by focusing the EIR on the effects determined to be potentially significant, identifying resources that would be affected but determined not to be significant, and explaining the reasons for determining that potentially significant effects would not be significant.

Based on the information and analyses presented, this IS identifies and discusses those environmental resources that would not be affected by the long-term operation of the SWP under a new ITP. The Proposed Project would result in no impacts on the following resource topics:

- Aesthetics
- Agriculture and Forestry Resources
- Air Quality
- Biological Resources (Terrestrial)
- Cultural Resources
- Energy
- Geology and Soils
- Greenhouse Gas Emissions
- Hazards and Hazardous Materials
- Land Use and Planning
- Mineral Resources
- Noise
- Population and Housing
- Public Services
- Recreation
- Transportation/Traffic
- Tribal Cultural Resources
- Utilities and Service Systems
- Wildfire

However, implementation of the Proposed Project would have the potential to adversely affect the environment. The proposed long-term operation of the SWP would have the potential for adverse effects on the following resource topics:

- **Biological Resources (Fisheries and Aquatic Resources):** The proposed long-term operation of SWP may result in a significant adverse effect on fisheries and aquatic biological resources located in the Sacramento–San Joaquin Delta (Delta). These biological resources would include Delta Smelt; Winter-run Chinook Salmon, Spring-run Chinook Salmon, and Longfin Smelt, along with their associated habitat, population abundance, and viability.
- **Hydrology and Water Quality:** The proposed long-term operation of SWP may result in a significant adverse effect on water quality in the Delta. Because of the direct relationship between surface water hydrology and water quality in the Delta, both topics are discussed in the EIR.

The analysis presented in this IS finds that the Proposed Project would not affect a site, feature, place, cultural landscape that is geographically defined in terms of the size and scope of the landscape, sacred place, or object with cultural value to a California Native American tribe, and therefore no impact on Tribal cultural resources would occur. However, because the Tribal consultation process undertaken by DWR was not complete at the time of the Initial Study's preparation, the DEIR does address this topic further to document the extent of the consultation process and outcome, and the conclusion of no impact on Tribal cultural resources.

2 PROJECT DESCRIPTION

2.1 INTRODUCTION

The SWP includes water, power, and conveyance systems, conveying an annual average of 2.9 million acre-feet (AF) of water. The principal facilities of the SWP are the Oroville Reservoir and related facilities, the San Luis Dam and related facilities, facilities in the Delta, the Suisun Marsh Salinity Control Gates, the California Aqueduct including its terminal reservoirs, and the North Aqueduct and South Bay Aqueduct. DWR holds contracts with 29 public agencies in Northern, Central, and Southern California for water supplies from the SWP. Water stored in the Oroville facilities and water available in the Delta (consistent with applicable regulations) are captured in the Delta and conveyed through several facilities to SWP contractors. The SWP is operated to provide flood control and water for agricultural, municipal, industrial, recreational, and environmental purposes.

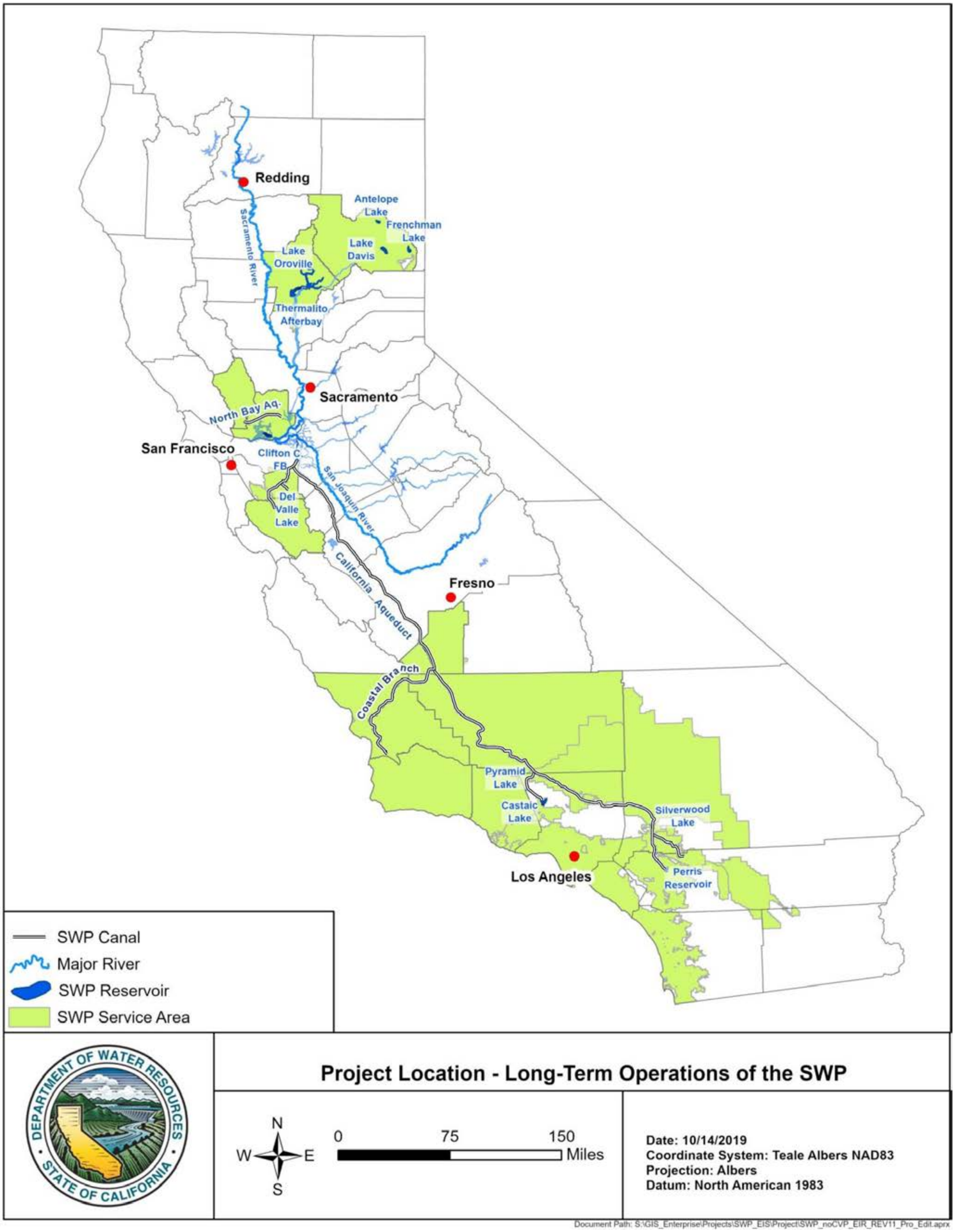
2.1.1 PROJECT OBJECTIVES

The objective of the Proposed Project is to continue the long-term operation of the SWP consistent with applicable laws, contractual obligations, and agreements. DWR proposes to store, divert, and convey water in accordance with DWR's existing water rights to deliver water pursuant to water contracts and agreements up to full contract quantities. DWR seeks to optimize water supply and improve operational flexibility while protecting fish and wildlife based on the best available scientific information.

2.1.2 PROJECT LOCATION

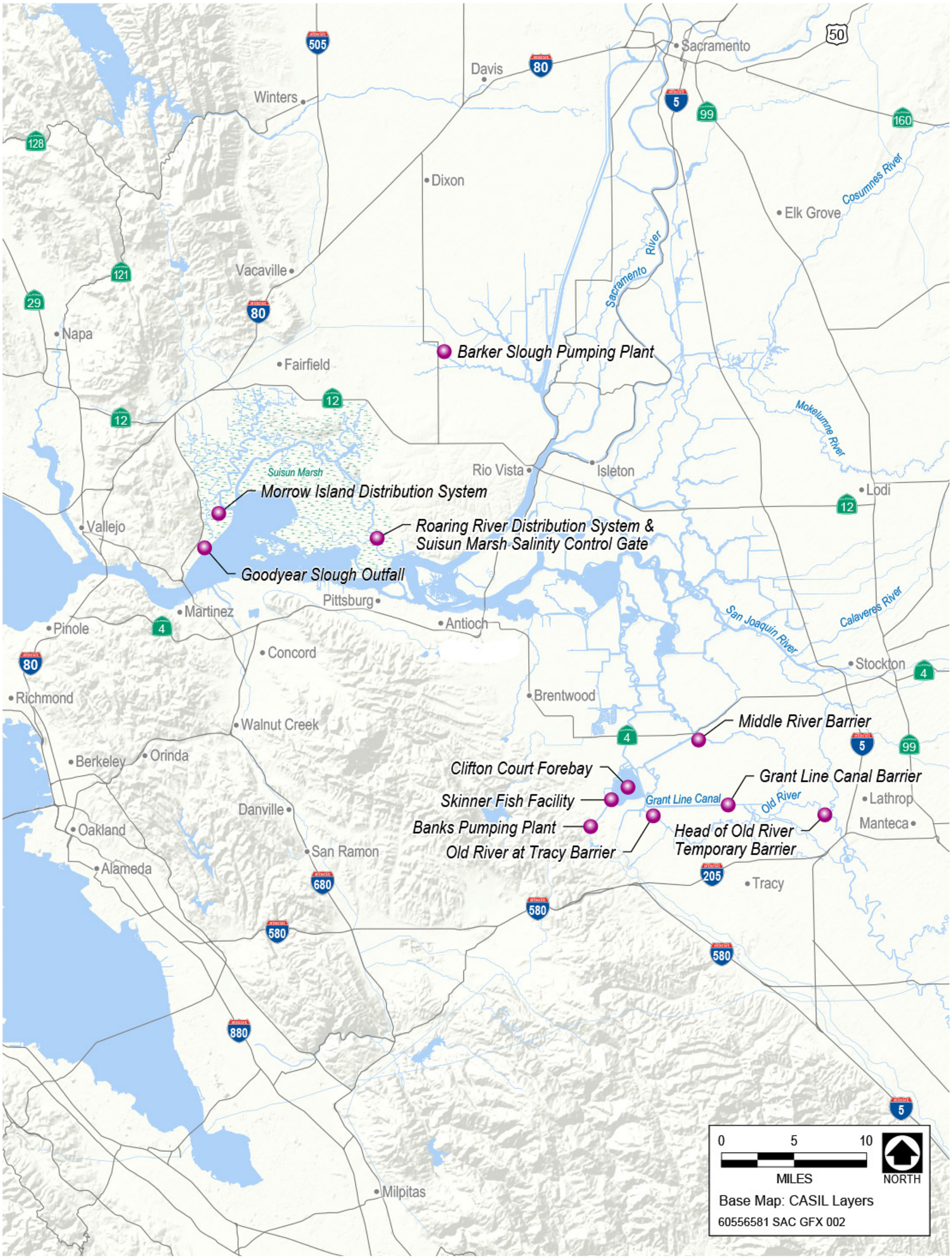
The project area includes the SWP Service Areas and existing SWP storage and export facilities located within the Delta and vicinity. Figure 2-1 shows the entire project area, including the SWP Service Areas, while Figure 2-2 shows those SWP facilities located in the Delta and vicinity.

The DWR operates the SWP in coordination with the CVP, under the Coordinated Operation Agreement (COA) between the federal government and the State of California (authorized by Pub. L. 99 546). The CVP and SWP operate pursuant to water rights permits and licenses issued by the State Water Resources Control Board. The CVP and SWP water rights allow appropriation of water by directly using and/or diverting water to storage for later withdrawal and use, or use and rediversion to storage further downstream for later consumptive use. Among the conditions of their water rights, are requirements of the SWP and CVP to either bypass or withdraw water from storage and to help satisfy specific water quality, quantity and operations criteria in source rivers and within the Delta.



Source: Data compiled by DWR in 2019

Figure 2-1. Long-Term SWP Operations Project Area



Source: Data compiled by AECOM in 2017

Figure 2-2. Locations of State Water Project Facilities in the Delta, Suisun Marsh, and Suisun Bay

2.1.3 DESCRIPTION OF EXISTING SWP FACILITIES

The SWP facilities in the Delta provide for delivery of water supply to areas within and immediately adjacent to the Delta, and to regions south of the Delta. The main SWP Delta features are Suisun Marsh and Bay facilities, the Harvey O. Banks Pumping Plant (Banks Pumping Plant), the Clifton Court Forebay (CCF), the John E. Skinner Delta Fish Protective Facility (Skinner Fish Facility), and the Barker Slough Pumping Plant (BSPP).

2.1.3.1 Harvey O. Banks Pumping Plant

The Banks Pumping Plant, located about 8 miles northwest of Tracy, marks the upstream end of the California Aqueduct. The plant discharges into five pipelines that convey water into a roughly 1-mile-long canal, which in turn conveys water to Bethany Reservoir (DWR and Reclamation 2015). The Banks Pumping Plant consists of 11 pumps—two rated at 375 cubic feet per second (cfs) capacity, five at 1,130 cfs capacity, and four at 1,067 cfs capacity—that provide the initial lift of water 244 feet from the CCF into the California Aqueduct. The rated capacity of the Banks Pumping Plant is 10,300 cfs. The plant maximum daily pumping rate is controlled by a combination of the SWRCB's D-1641 and permits issued by the U.S. Army Corps of Engineers (USACE) that regulate the rate of diversion of water into the CCF. The diversion rate is normally restricted to 6,680 cfs as a 3-day average inflow and 6,993 cfs as a 1-day average inflow to the CCF in accordance with the existing USACE Section 10 permit issued pursuant to the Rivers and Harbors Act (SWRCB 2017). The diversions may be greater in the winter and spring, depending on San Joaquin River flows at Vernalis (DWR and Reclamation 2015). As part of the adaptive management process, the SWP is permitted to pump an additional 500 cfs between July 1 and September 30 to offset water costs associated with fisheries actions, making the summer limit effectively 7,180 cfs (Reclamation 2008).

2.1.3.2 John E. Skinner Delta Fish Protective Facility

The Skinner Fish Facility is west of the CCF, about 2 miles upstream from the Banks Pumping Plant. The Skinner Fish Facility guides fish away from entering the pumps that convey water into the California Aqueduct. Large fish and debris are directed away from the facility by a 388-foot-long trash boom. Smaller fish are diverted from the intake channel into bypasses by a series of metal louvers. These smaller fish pass through a secondary system of screens, louvers, and pipes into seven holding tanks, where a subsample is counted and recorded. The salvaged fish are then returned to the Delta in oxygenated tank trucks.

2.1.3.3 Clifton Court Forebay

The CCF is located near the city of Byron in the South Delta. The Banks Pumping Plant pumps water diverted from the CCF via the intake channel past the Skinner Fish Facility A set of five radial gates are located at the CCF inlet near the confluence of the Grant Line and West Canal. They are operated so that they can be closed during critical periods of the ebb/flood tidal cycle to protect water levels experienced by local agricultural water users in the South Delta. The gates are operated on the tidal cycle to reduce approach velocities, prevent scour in adjacent channels, and minimize fluctuations in water elevation in the South Delta by taking water in through the gates at times other than low tide. Banks Pumping Plant pumping rates are constrained operationally by limits on CCF diversions from the Delta. The maximum daily diversion limit from the Delta into the CCF is 13,870 AF per day (6,990 cfs/day), and the maximum averaged diversion limit over any 3 days is 13,250 AF per day (6,680 cfs/day). In addition to these requirements, DWR may increase diversions from the Delta into the CCF by one-third of the San Joaquin River flow at Vernalis from mid-December through mid-March when flows at Vernalis exceed 1,000 cfs. These limits are listed in USACE Public Notice 5820A Amended (Oct. 13, 1981).

From July through September, the maximum daily diversion limit from the Delta into the CCF is increased from 13,870 AF per day (6,990 cfs/day) to 14,860 AF per day (7,490 cfs/day), and the maximum averaged diversion limit over any 3 days is increased from 13,250 AF per day (6,680 cfs/day) to 14,240 AF per day (7,180 cfs/day). These increases are for the purpose of recovering water supply losses incurred earlier in the same year to protect fish species listed under the federal Endangered Species Act (ESA). Those increases are a separate action permitted for short-term time periods.

2.1.3.4 Barker Slough Pumping Plant

The Barker Slough Pumping Plant diverts water from Barker Slough into the North Bay Aqueduct (NBA) for delivery to Napa and Solano counties. The NBA intake is located approximately 10 miles from the mainstem Sacramento River at the end of Barker Slough. In accordance with salmon screening criteria, each of the aqueduct's 10 pump bays are individually screened with a positive barrier fish screen consisting of a series of flat, stainless-steel, wedge-wire panels with a slot width of 3/32 inch. This configuration is designed to exclude and prevent the entrainment of fish measuring approximately 1 inch or larger. The bays tied to the two smaller units have an approach velocity of about 0.2 foot per second (ft/sec). The larger units were designed for a 0.5 ft/sec approach velocity, but actual approach velocity is about 0.44 ft/sec. The screens are routinely cleaned to prevent excessive head loss, thereby minimizing increases in localized approach velocities.

2.1.3.5 Suisun Marsh Operations

The Suisun Marsh Preservation Agreement (SMPA) among DWR, Reclamation, CDFW, and Suisun Resource Conservation District (SRCD) contains provisions for DWR and Reclamation to mitigate the impacts on Suisun Marsh channel water salinity from SWP and CVP operations and other upstream diversions. The SMPA requires DWR and Reclamation to meet salinity standards in accordance with D-1641, sets a timeline for implementing the Plan of Protection, and delineates monitoring and mitigation requirements.

There are two primary physical mechanisms for meeting salinity standards set forth in D-1641 and the SMPA: (1) the implementation and operation of physical facilities in the Marsh and (2) management of Delta outflow (i.e., facility operations are driven largely by salinity levels upstream of Montezuma Slough and salinity levels are highly sensitive to Delta outflow). Physical facilities (described below) have been operating since the 1980s and have proven to be a highly reliable method for meeting standards.

Physical facilities in the Suisun Marsh and Bay include the Suisun Marsh Salinity Control Gates (SMSCG), the Roaring River Distribution System (RRDS), the Morrow Island Distribution System (MIDS) and the Goodyear Slough Outfall (GYSO). The location and operation of these facilities is described below.

The SMSCG are located on Montezuma Slough about 2 miles downstream from the confluence of the Sacramento and San Joaquin rivers, near Collinsville. The objective of Suisun Marsh Salinity Control Gate operation is to decrease the salinity of the water in Montezuma Slough. The gates control salinity by restricting the flow of higher salinity water from Grizzly Bay into Montezuma Slough during incoming tides and retaining lower salinity Sacramento River water from the previous ebb tide. Operation of the gates in this fashion lowers salinity in Suisun Marsh channels and results in a net movement of water from east to west through Suisun Marsh.

The SMSCG are operated during the salinity control season, which spans from October to May. Operational frequency is affected by salinity at D-1641 compliance stations, hydrologic conditions, weather, Delta outflow, tide, fishery considerations, and other factors. The boat lock portion of the gate is now held partially open during SMSCG operation to allow an opportunity for continuous salmon passage opportunity. After an engineering solution is implemented to prevent boaters from entering the boat lock prior to the operator closing it, the gate will be held open at all times. However, the boat lock gates may be closed temporarily to stabilize flows to facilitate safe passage of watercraft through the facility.

Assuming no significant long-term changes in the drivers mentioned above, it is expected that gate operations will remain at current levels, or as needed to implement the summer action to benefit Delta Smelt.

The RRDS was constructed to provide lower salinity water to 5,000 acres of private and 3,000 acres of CDFW managed wetlands on Simmons, Hammond, Van Sickle, Wheeler, and Grizzly islands. The RRDS includes a 40-acre intake pond that supplies water to Roaring River Slough. Water is diverted through a bank of eight 60-inch-diameter culverts equipped with fish screens into the Roaring River intake pond on high tides to raise the water surface elevation in the RRDS above the adjacent managed wetlands. The intake to the RRDS is screened to prevent entrainment of fish larger than approximately 25 mm. After the listing of Delta Smelt, RRDS diversion rates have been controlled to maintain a maximum average approach velocity of 0.2 ft/sec at the intake fish screen except during the period from September 14 through October 20, when RRDS diversion rates are controlled to maintain a maximum average approach velocity of 0.7 ft/sec for fall flood up operations.

The MIDS allows Reclamation and DWR to provide water to the landowners so that lands may be managed according to approved local management plans. The system was constructed primarily to channel drainage water from the adjacent managed wetlands for discharge into Suisun Slough and Grizzly Bay. This approach increases circulation and reduces salinity in Goodyear Slough. The MIDS is used year-round, but most intensively from September through June. When managed wetlands are filling and circulating, water is tidally diverted from Goodyear Slough just south of Pierce Harbor.

The GYSO connects the south end of Goodyear Slough to Suisun Bay. Prior to construction of the outfall, Goodyear Slough was a dead-end slough. The GYSO was designed to increase circulation and reduce salinity in Goodyear Slough to provide higher water quality to the wetland managers who flood their ponds with Goodyear Slough water. GYSO has a series of four passive intakes that drain to Suisun Bay. The outfall is equipped with slide gates on the interior of the outfall structure to allow DWR to close the system as needed for maintenance or repairs. The intakes and outfall of GYSO are unscreened but are equipped with trash racks to prevent damage. Any fish that entered the system would be able to leave via the intake or the outfall, as GYSO is an open system.

2.1.3.6 South Delta Temporary Barrier Project

DWR's South Delta Temporary Barrier Project (TBP) was initiated in 1991. The objectives of the TBP are to increase water levels, circulation patterns, and water quality in the southern Delta area for local agricultural diversions. The existing SWP consists of installation and removal of temporary rock barriers at the following locations:

- Middle River near the Victoria Canal, about 0.5 mile south of the confluence of Middle River, Trapper Slough, and the North Canal
- Old River near Tracy, approximately 0.5 mile east of the Delta-Mendota Canal intake
- Grant Line Canal, approximately 400 feet east of the Tracy Boulevard Bridge

These rock barriers are designed to act as flow control structures, trapping tidal waters behind them after a high tide. These barriers improve water levels and circulation for local South Delta farmers and are collectively referred to as agricultural barriers.

Rock barriers at Old River near Tracy, Middle River, and the Grant Line Canal are in place from April 15 to September 30 each year. The Old River barrier near Tracy has been installed since 1991 and the Middle River barrier has been installed since 1987. A rock barrier was first installed in the Grant Line Canal in spring 1996, and since then the barrier has been installed in every year except 1998.

This document is focused on the operation of the barriers within the South Delta and does not analyze or address the construction or removal of the barriers, which is covered by a separate Biological Opinion (BiOp) and associated permits.

2.1.3.7 Head of Old River Barrier

The Head of Old River Barrier (HORB) is a temporary structure at the divergence from the San Joaquin River. The fall HORB is intended to keep water in the San Joaquin River, which may improve downstream dissolved-oxygen conditions. The spring barrier is intended to prevent downstream-migrating salmonid smolts in the San Joaquin River from entering Old River.

The HORB has been installed seasonally, between September 15 and November 30, in most years since 1963. Since 1992, the rock barrier has also been installed frequently in the spring, between April 15 and May 30. High flows in the San Joaquin River prevented installation of the HORB in 1993, 1995, 1998, 1999, 2005, 2006, and 2011. The spring installation of the HORB is currently required as part of the 2009 National Marine Fisheries Service Biological Opinion (2009 NMFS Biological Opinion). The construction and removal of the HORB is covered by a separate BiOp and associated permits.

2.1.3.8 San Luis Reservoir

San Luis Reservoir is an off-stream storage facility located along the California Aqueduct downstream of the Jones and Banks pumping plants. The CVP and SWP share San Luis Reservoir storage roughly 50/50 (CVP has 966 thousand acre-feet [TAF] of storage, and SWP has 1062 TAF of storage). San Luis Reservoir is used by both the SWP and CVP to meet deliveries to their contractors during periods when Delta pumping is insufficient to meet demands. San Luis Reservoir is also operated to supply water to the CVP San Felipe Division in San Benito and Santa Clara Counties.

San Luis Reservoir operates as a regulator on the CVP/SWP system, accepting any water pumped from the Banks and Jones pumping plants that exceeds contractor demands, then releasing that water back to the aqueduct system when the pumping at the Jones and Banks pumping plants is insufficient to meet demands. The reservoir allows the CVP/SWP to meet peak-season demands that are seldom balanced by Jones and Banks pumping.

As San Luis Reservoir is drawn down to meet contractor demands, it usually reaches its low point in late August or early September. From September through early October, demand for deliveries declines until it is less than the rate of diversions from the Delta at the Jones and Banks pumping plants. At this point, the additional diverted water is added to San Luis Reservoir, reversing its spring and summer decline and eventually filling the San Luis Reservoir—typically before April of the following year.

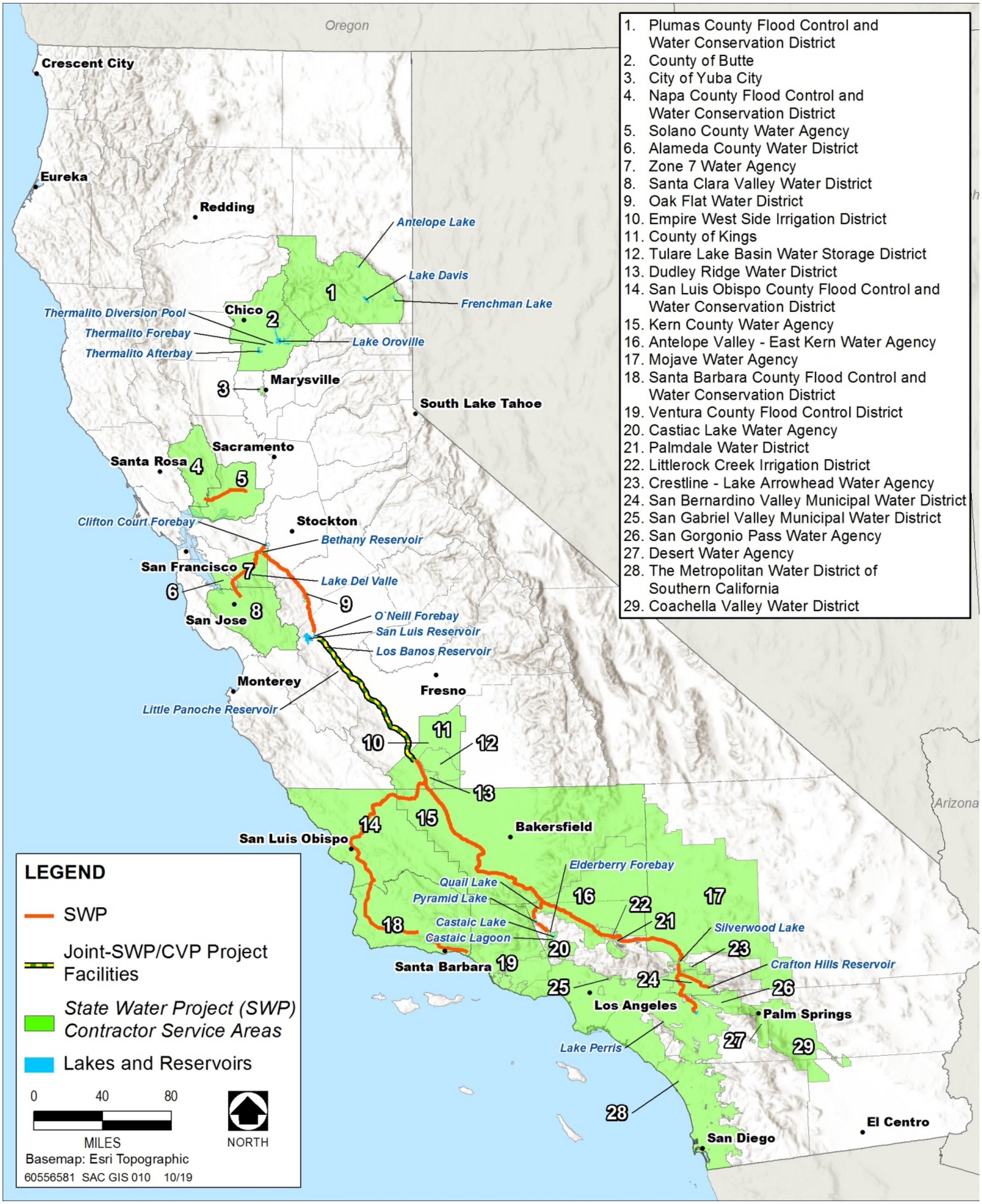
Operations of the San Luis Reservoir are not discussed further in this document, as there will be no changes to the operations of this reservoir and it is an off-stream facility.

2.1.4 DESCRIPTION OF EXISTING SWP WATER SERVICE CONTRACTS

DWR has signed long-term contracts with 29 water agencies statewide to deliver water supplies developed from the SWP system (Figure 2-3). These contracts are with both municipal and industrial (M&I) water users and agricultural water users. The contracts specify the charges that will be made by the water agency for both: (1) water conservation, and (2) conveyance of water. The foundation allocation of water to each contractor is based on their respective “Table A” entitlement, which is the maximum amount of water delivered to them by the SWP, on an annual basis.

DWR proposes to operate the SWP in accordance with contracts with senior water right holders in the Feather River Service Area (approximately 983 TAF). Furthermore, under statewide contracts, DWR allocates Table A water as an annual supply made available for scheduled delivery throughout the year. Table A contracts total 4,173 TAF with more than 3 million acre-feet (MAF) for San Joaquin Valley and southern California water users.

Article 21 of the long-term SWP water supply contracts provides an interruptible water supply made available only when certain conditions exist: (1) The SWP share of San Luis Reservoir is physically full, or projected to be physically full; (2) other SWP reservoirs south of the Delta are at their storage



Source: California Spatial Information Library, DWR 2019

Figure 2-3. The 29 Water Purveyors Under Contract to Receive SWP Water Deliveries

targets or the conveyance capacity to fill these reservoirs is maximized; (3) the Delta is in excess conditions; (4) current Table A demand is being fully met; and (5) the Banks Pumping Plant has export capacity beyond that which is needed to meet current Table A and other SWP operational demands.

Table 2-1 shows the maximum contracted annual water supply per water purveyor per DWR's most recent water supply reliability report.

Table 2-1. State Water Contractors

State Water Contractors	Table A Contracted Water Supply (acre-feet)	Purpose of Use
Butte County	27,500	M&I
Plumas County	2,700	M&I
Yuba City	9,600	M&I
Napa County Flood Control and Water Conservation District	29,025	M&I
Solano County Water Agency	47,756	M&I
Alameda County—Zone 7	80,619	M&I
Alameda County Water District	42,000	M&I
Santa Clara Valley Water District	100,000	M&I
Oak Flat Water District	5,700	Agriculture
Kings County	9,305	Agriculture
Dudley Ridge Water District	45,350	Agriculture
Empire West Side Irrigation District	3,000	Agriculture
Kern County Water Agency	982,730	Agriculture/M&I[1]
Tulare Lake Water Storage District	87,471	Agriculture
San Luis Obispo County	25,000	M&I
Santa Barbara County	45,486	M&I
Antelope Valley-East Kern Water Agency	144,844	Agriculture/M&I[2]
Santa Clarita Valley Water Agency	95,200	M&I
Coachella Valley Water District	138,350	M&I
Crestline-Lake Arrowhead Water Agency	5,800	M&I
Desert Water Agency	55,750	M&I
Littlerock Creek Irrigation District	2,300	M&I
Metropolitan Water District of Southern California	1,911,500	M&I
Mojave Water Agency	85,800	M&I
Palmdale Water District	21,300	M&I
San Bernardino Valley Municipal Water District	102,600	M&I
San Gabriel Valley Municipal Water District	28,800	M&I
San Gorgonio Pass Water Agency	17,300	M&I
Ventura County Watershed Protection District	20,000	M&I

Notes:

[1] Approximately 15% of the Kern County Water Agency Table A Amount is classified as municipal and industrial (M&I) supply.

[2] Approximately 25% of the Antelope Valley-East Kern Water Agency Table A amount is used for agricultural purposes.

Source: DWR 2016

M&I = municipal and industrial

2.1.5 SWP Allocation and Forecasting

At the beginning of each new water year, there is significant uncertainty as to the hydrologic conditions that will exist in the future several months, and hence, the water supplies that will be allocated by the SWP to its water contractors. In recognition of this, DWR uses a forecasting water supply allocation process that is updated monthly, incorporates known conditions in the Central Valley watershed to date, and forecasts future hydrologic conditions in a conservative manner to provide an accurate estimate of SWP water supplies that can be delivered to SWP contractors as the water year progresses.

There are many factors considered in the forecast-supply process. Some of these factors are the following:

- Water storage in Lake Oroville (both updated and end-of-water-year (September 30)
- Water storage in San Luis Reservoir (both updated and end-of-calendar-year)
- Flood operations constraints at Lake Oroville
- Snowpack surveys (updated monthly from February through May)
- Forecasted runoff in the Central Valley (reflects both snowpack and precipitation)
- Feather River settlement agreement obligations
- Feather River fishery flows and temperature obligations
- Anticipated depletions in the Sacramento and Delta basins
- Anticipated Delta standards and conditions
- Anticipated CVP operations for joint responsibilities
- Contractor supply requests and delivery patterns

Staff from both the Operations Control Office (OCO) and the State Water Project Analysis Office (SWPAO) coordinate their efforts to determine the current water supply allocations. OCO primarily focuses on runoff/operations models to determine allocations. SWPAO requests updated information from the contractors on supply requests and delivery patterns to determine allocations. Both OCO and SWPAO staff meet at least once a month with the Director of DWR to make final decisions on staff's proposed allocations.

The Initial Allocation for SWP Deliveries is made by December 1 of each year with a conservative assumption of future precipitation to avoid overallocating water before the hydrologic conditions are well defined for the year. As the water year unfolds, Central Valley hydrology and water supply delivery estimates are updated using measured and known information and conservative forecasts of future hydrology. Monthly briefings are held with the Director of DWR to determine formal approvals of delivery commitments announced by DWR.

Another water supply consideration is the contractual ability of SWP contractors to "carry over" allocated (but undelivered) Table A supplies from the previous year to the next if space is available in San Luis Reservoir. The carryover storage is often used to supplement an individual contractor's current year Table A allocations if conditions are dry. Carryover supplies left in San Luis Reservoir by

SWP contractors can result in higher storage levels in San Luis Reservoir. As SWP pumping fills San Luis Reservoir, the contractors are notified to take, or lose, their carryover supplies. Carryover water not taken, after notice is given to remove it, then becomes water available for reallocation to all contractors in a given year.

Article 21 (surplus to Table A) water which is delivered early in the calendar year may be reclassified as Table A water later in the year, depending on final allocations, hydrology, and contractor requests.

Reclassification does not affect the amount of water carried over in San Luis Reservoir, nor does it alter pumping volumes or schedules.

2.1.6 SWP Settlement Agreements

DWR has water rights settlement agreements to provide water supplies with entities north of Oroville, along the Feather River and Bear River and in the Delta. These agreements provide users with water supplies that they were entitled to prior to the construction of the SWP's Oroville Complex. Collectively, these agreements with more than 60 riparian diverters along the Feather and Bear rivers provide water for diversion. Table 2-2 summarizes the volume under the water right settlement agreements.

Table 2-2. SWP Settlement Agreements

Location	Entity	Amount (Acre-Feet)
North of Oroville	Andrew Valberde	135
North of Oroville	Jane Ramelli	800
North of Oroville	Last Chance Creek WD	12,000
Feather River	Garden Highway Mutual Water	18,000
Feather River	Joint Water Districts Board	620,000
Feather River	South Feather Water & Power	17,555
Feather River	Oswald WD	3,000
Feather River	Plumas Mutual Water	14,000
Feather River	Thermalito Irrigation District	8,200
Feather River	Tudor Mutual Water	5,000
Feather River	Western Canal/PG&E	295,000
Bear River	South Sutter/Camp Far West	4,400
Delta	Byron-Bethany ID	50,000
Delta	East Contra Costa ID	50,000
Delta	Solano Co./Fairfield, Vacaville and Benicia	31,620

Notes:
ID = Irrigation District
PG&E = Pacific Gas and Electric Company
WD = water district

2.1.7 Daily Operations

After the allocations and forecasting process, Reclamation and DWR coordinate their operations on a daily basis. Some factors Reclamation and DWR consider when coordinating their joint operations include required in-Delta flows, Delta outflow, water quality, schedules for the joint use facilities, pumping and wheeling arrangements, and any facility limitations. Both the SWP and CVP must meet the flood obligations of individual reservoirs. CVP operations must also consider flows at Wilkins Slough and associated pump intake elevations.

During balanced water conditions, Reclamation and DWR maintain a daily water accounting of CVP and SWP obligations. This accounting allows for flexible operations and avoids the need to change reservoir releases made several days in advance (due to travel time from the Delta). Therefore, adjustments can be made “after the fact,” using actual observed data rather than by prediction for the variables of reservoir inflow, storage withdrawals, and in-basin uses. This iterative process of observation and adjustment results in a continuous trueing up of the running COA account. If either the SWP or CVP is “owed” water (i.e., the project that provided more or exported less than its COA-defined share), each may request the other to adjust its operations to reduce or eliminate the accumulated account within a reasonable time.

The COA provides the mechanism for determining SWP and CVP responsibility for meeting in-basin use, but real-time conditions dictate real-time actions. Conditions in the Delta can change rapidly. For example, weather conditions combined with tidal action can quickly affect Delta salinity conditions and therefore the Delta outflow required to maintain joint salinity standards under D-1641.

Increasing or decreasing SWP or CVP exports can achieve changes to Delta outflow immediately. Imbalances in meeting each other’s initial shared obligations are captured by the COA accounting and balanced out later.

When more reaction time is available, reservoir release changes are used to adjust to changing in-basin conditions. If Reclamation decides the reasonable course of action is to increase upstream reservoir releases, the response may be to increase Folsom Reservoir releases first because the released water will reach the Delta before flows released from other CVP and SWP reservoirs. DWR’s Lake Oroville water releases require about 3 days to reach the Delta, while water released from Reclamation’s Shasta Reservoir requires 5 days to travel from Keswick Reservoir to the Delta. As water from another reservoir arrives in the Delta, Reclamation can adjust Folsom Reservoir releases downward. Alternatively, if sufficient time exists for water to reach the Delta, Reclamation may choose to make initial releases from Shasta Reservoir. Each occurrence is evaluated on an individual basis, and appropriate action is taken based on multiple factors. Again, the COA accounting captures imbalances in meeting each other’s initial shared obligation.

The duration of balanced water conditions varies from year to year. Balanced conditions never occur in some very wet years, while very dry years may have long continuous periods of balanced conditions, and still other years may have had several periods of balanced conditions interspersed with excess water conditions. Account balances continue from one balanced water condition through the excess water condition and into the next balanced water condition. When either the SWP or CVP enters into flood control operations, the accounting is zeroed out for that project.

Reclamation and DWR staff meet daily to discuss and coordinate CVP and SWP system operations. Several items are discussed at this daily meeting, including:

- Current reservoir conditions
- Pumping status and current outages (for both the CVP and the SWP and how they are affecting combined operations)
- Upcoming planned outages (CVP and SWP) and what that means for future operations
- Current reservoir releases and what changes may be planned
- Current regulatory requirements and compliance status
- Delta conditions to determine if CVP and SWP pumping make use of all available water

Reclamation and DWR also coordinate with Hydrosystem Controllers and Area Offices to ensure that, if necessary, personnel are available to make the desired changes. Once Reclamation and DWR each decide on a plan for that day and complete all coordination, the respective agencies issue change orders to implement the decisions, if necessary.

Reclamation and DWR are co-located in the Joint Operations Center. In addition, the California Data Exchange Center, California-Nevada River Forecast Center, and the DWR Flood Management Group are also co-located in the Joint Operations Center. This enables efficient and timely communication, particularly during flood events.

2.2 EXISTING REGULATIONS

2.2.1 U.S. ARMY CORPS OF ENGINEERS PERMITS

In Public Notice 5820A (October 1981), USACE limited the volume of daily SWP diversions from the Delta into Clifton Court Forebay, stating that such diversions may not exceed 13,870 AF and 3-day average diversions into the CCF may not exceed 13,250 AF. In addition, the SWP can increase diversions into the CCF by one-third of the San Joaquin River flow at Vernalis from mid-December to mid-March when the river's flow at Vernalis exceeds 1,000 cfs (USACE 1981).

In August 2013, the USACE issued Permit SPK-1999-0715 and raised the daily diversion from 13,870 AF to 14,860 AF and the 3-day average diversion from 13,250 AF to 14,240 for calendar years 2013 through 2016 (USACE 2013). These increased diversions also required compliance with applicable terms and conditions in the existing BiOps and installation of the South Delta temporary barriers.

In 2017, USACE issued a revised Permit SPK-1999-0715 and raised the daily diversion from 13,870 AF to 14,860 AF and the 3-day average diversion from 13,250 AF to 14,240 AF. The conditions in this permit apply to SWP operations from 2017 through 2020 (USACE 2016). The permit also required compliance with applicable terms and conditions in the existing BiOps and installation of the South Delta temporary barriers.

2.2.2 State Water Resources Control Board Water Rights and D-1641

Reclamation and DWR operate the CVP and the SWP in accordance with obligations under D-1641, which provides protection for fish and wildlife, M&I water quality, agricultural water quality, and Suisun Marsh salinity. D-1641 granted Reclamation and DWR the ability to use or exchange either SWP or CVP diversion capacity capabilities to maximize the beneficial uses of the CVP and SWP. The SWRCB conditioned the use of Joint Point of Diversion capabilities based on staged implementation and conditional requirements for each stage of implementation.

2.2.3 Federal Endangered Species Act

The SWP and CVP are currently operated in accordance with the 2008 USFWS Biological Opinion and the 2009 NMFS Biological Opinion, issued pursuant to Section 7 of the ESA. Both BiOps included Reasonable and Prudent Alternatives (RPAs) designed to allow the SWP and CVP to continue operating without causing jeopardy to listed species or adverse modification to designated critical habitat provided the RPAs were implemented.

On August 2, 2016, Reclamation and DWR jointly requested the Reinitiation of Consultation on the Coordinated Long-Term Operation of the CVP and SWP. The USFWS accepted the reinitiation request on August 3, 2016, and NMFS accepted the reinitiation request on August 17, 2016. Reclamation completed a biological assessment to support consultation under ESA Section 7, which documents the potential impacts of the proposed action on federally listed endangered and threatened species that have the potential to occur in the study area and on critical habitat for these species. The biological assessment also fulfills consultation requirements for the Magnuson-Stevens Fishery Conservation and Management Act of 1976 for Essential Fish Habitat.

When the new USFWS and NMFS Biological Opinions are issued, they will include incidental take statements (ITS) for Delta Smelt, Winter-run Chinook Salmon, Spring-run Chinook Salmon, Green Sturgeon, and steelhead. DWR will comply with the ITS in accordance with federal law in addition to state requirements. As a result of the difference in species listed under the CESA and ESA and the coordinated operation of the SWP and CVP, California's Proposed Project includes operations for the protection of federally listed steelhead and Green Sturgeon. These operations and the ITSs result in reductions in SWP pumping in addition to the reductions that would be necessary to comply with state law.

2.2.4 California Endangered Species Act

In 2009, the California Department of Fish and Wildlife (CDFW) issued an ITP for the ongoing and long-term operation of the SWP's existing facilities in the Delta for the protection of LFS. CDFW also issued consistency determinations to DWR for the NMFS and USFWS BiOps for continued operation of the SWP and other actions related to water diversion, storage, and transport that are described in the BiOps. CDFW determined that the BiOps, including the RPA requirements and related ITS, were consistent with CESA because the mitigation measures meet the conditions in Section 2081 of the Fish and Wildlife Code for CDFW to authorize incidental take of CESA species.

The 2009 Incidental Take Permit from CDFW for Longfin Smelt expires on December 31, 2019. DWR is seeking a new ITP from CDFW pursuant to Section 2081 of the California Fish and Game Code. The new ITP will cover aquatic species listed under CESA that are subject to incidental take from long-term operation of the SWP (Delta Smelt, Longfin Smelt, Winter-run Chinook Salmon, and Spring-run Chinook Salmon).

DWR has prepared this DEIR to address the continued operation of the SWP as described in the project description. CDFW will rely on this DEIR when issuing a decision on DWR's ITP application.

2.3 DESCRIPTION OF THE PROPOSED PROJECT

The Proposed Project, which is the preferred alternative in this DEIR, consists of multiple elements that characterize future operations of SWP facilities, modify ongoing programs being implemented as part of SWP operations, improve specific activities that would enhance protection of special-status fish species, or support ongoing studies and research on these special-status species to improve the basis of knowledge and management of these species. Implementation of these elements is intended to continue operation of the SWP and deliver up to the full contracted water amounts while minimizing and fully mitigating the take of listed species consistent with CESA requirements.

For discussion purposes in this DEIR, these elements are divided into four categories and consist of the following: (1) proposed operation of the SWP that can be described in detail and assessed on a project-level basis; (2) proposed operation of the SWP that can only be described generally and assessed on a program-level basis; (3) proposed environmental protective measures that would offset, reduce, or otherwise mitigate potential environmental impacts on special-status species; and (4) adaptive management actions that include establishing a governance framework, a compliance and reporting program, specific drought- and dry-year actions, and independent review panels, and conducting Four-Year Reviews of management measures.

Table 2-3 identifies the actions and facilities associated with the long-term operation of the SWP that are included in the Proposed Project.

Table 2-3. Proposed Project Elements – Table 2-3 a – Table 2-3 d

Table 2-3 a. Proposed Project Elements – Proposed Project-Level SWP Operations and Facilities

Facility or Action	Proposed Project Actions	Action Goal or Objective
Existing Regulatory Requirements	Comply with D-1641 and USACE Permit 2100.	Continue to comply with existing limits and permit requirements to protect water quality for the beneficial uses of fish and wildlife, agriculture and urban uses.
Minimum Export Rate	The combined CVP and SWP export rates at Jones Pumping Plant and Banks Pumping Plant will not be required to drop below 1,500 cfs.	Establish minimum export rate to protect human health and safety.
Old and Middle River Requirements	Manage OMR reverse flows based on species distribution, modeling, and risk analysis, with provisions for capturing storm flows.	Implement real-time OMR management to minimize entrainment and aquatic species loss during water operations at Bank Pumping Plant.

Facility or Action	Proposed Project Actions	Action Goal or Objective
Barker Slough Pumping Plant (BSPP)	Continue operating BSPP to minimize effects on Delta Smelt and Longfin Smelt, and continue implementing sediment removal and aquatic weed management actions as part of normal operations at Barker Slough Pumping Plant.	Implement actions as components of facility maintenance for continued water supply deliveries.
South Delta Temporary Barriers	Continue operation of three South Delta Temporary Barriers according to existing terms and conditions.	Maintain ongoing annual installation of three South Delta Temporary Barriers with goal of maintaining surface water levels and circulation) in the South Delta.
Suisun Marsh Operations	Operate the Suisun Marsh Salinity Control Gates, Roaring River Distribution System, Morrow Island Distribution System, and Goodyear Slough Outfall in compliance with D-1641.	Operate the Suisun Marsh Salinity Control Gates to improve habitat conditions for the benefit of Delta Smelt.
Delta Smelt Summer-Fall Habitat Action	Operate the Suisun Marsh Salinity Control Gate for up to 60 days (not necessarily consecutive) in June through October of below-normal, above-normal, and wet years. Project operations would maintain a monthly average 2 ppt isohaline at 80 kilometers (km) from the Golden Gate Bridge in above-normal and wet water years in September and October. Food enhancement actions would be similar to the North Delta Food Subsidies and Colusa Basin Drain Project, and Suisun Marsh Food Subsidies (Roaring River distribution system reoperation).	Operate the Suisun Marsh Salinity Control Gate to improve Delta Smelt food supply and habitat.
North Delta Food Subsidies and Colusa Basin Drain Project	Facilitate downstream transport of phytoplankton and zooplankton to areas inhabited by Delta Smelt.	Implement actions to transport productivity downstream to where it can be utilized by Delta Smelt.

Table 2-3 b. Proposed Project Elements – Proposed Program-Level Changes to SWP Operations and Facilities

Facility or Action	Proposed Project Actions	Action Goal or Objective
Water Transfers	Water transfers would occur during an expanded water transfer window, between July through November, with volumes up to 600 TAF.	Increase SWP operational flexibility.

Table 2-3 c. Proposed Project Elements – Proposed Environmental Protective Measures

Facility or Action	Proposed Project Actions	Action Goal or Objective
Clifton Court Forebay	Continue implementing actions to reduce mortality of listed fish species at the Clifton Court Forebay; these measures would include (a) continued evaluation of predator relocation methods and (b) controlling aquatic weeds.	Increase species survival and control weeds to reduce impacts on the SWP's physical facilities (clogging screens) and predation reduction.
Skinner Fish Facility	Continue implementing studies to better understand and continuously improve the performance of the Skinner Fish Facility, including (a) changes to release site scheduling and rotation of release site locations to reduce post-salvage predation and (b) continued refinement and improvement of the fish sampling and hauling procedures and infrastructure to improve the accuracy and reliability of data and fish survival.	Continue ongoing salvage fish at the Skinner Fish Facility and implement actions to reduce post-salvage predation and improve the accuracy and reliability of data and fish survival.

Facility or Action	Proposed Project Actions	Action Goal or Objective
Longfin Smelt Science Program	DWR proposes to continue implementing studies to better understand LFS population distribution and abundance in San Francisco Bay and the Delta.	Study of environmental factors affecting LFS distribution and reproduction.
Studies to Support Establishment of a Delta Fish Hatchery	Conduct further studies to locate, design, construct, and operate a hatchery facility that would be capable of producing a substantial number of Delta Smelt and other Delta fish species for reintroduction to the Delta and recovery of the species populations.	Protect the species and provide resiliency.
Conduct Further Studies to Prepare for Delta Smelt Reintroduction from Stock Raised at the U.C. Davis Fish Conservation and Culture Laboratory (FCCL)	Continue to support facilities and research to establish a Delta Smelt conservation population that is as genetically close as possible to the wild population and to provide a safeguard against extinction.	Protect the species and provide resiliency.
Additional elements related to real-time operation of the SWP	DWR proposes a governance structure for real-time operation of the SWP that includes compliance and performance reporting, monitoring, convening of independent panels, drought and dry year actions, and Four-Year Reviews.	Advancements in science and minimization of effects of project operations.

Table 2-3 d. Proposed Project Elements – Adaptive Management Actions

Facility or Action	Proposed Project Actions	Action Goal or Objective
Adaptive Management Plan	The Adaptive Management Plan (AMP) will be carried out to evaluate the efficacy of the operations and activities stated below. An Adaptive Management Team (AMT) will be established to carry out this AMP. The AMT will oversee efforts to monitor and evaluate the operations and related activities. In addition, the AMT will use structured decision-making to assess the relative costs and benefits of those operations and activities. The AMT will also identify proposed adaptive management changes to those operations and activities. The AMP will be developed before issuance of, and could be incorporated into, the Incidental Take Permit DWR is seeking for CESA coverage for the Proposed Project.	The objectives of the AMP are (1) to continue the long-term operation of the SWP consistent with applicable laws, contractual obligations, and agreements and (2) to ensure that the long-term operation of the SWP is consistent with the CESA.

Notes:
AMP = Adaptive Management Plan
AMT = Adaptive Management Team
CESA = California Endangered Species Act
cfs = cubic feet per second
D-1641 = State Water Resources Control Board's Water Rights Decision 1641
DWR = California Department of Water Resources
FCCL = Fish Conservation and Culture Laboratory
km = kilometers
LFS = Longfin Smelt
OMR = Old and Middle River
ppt = parts per thousand
Skinner Fish Facility = John E. Skinner Delta Fish Protective Facility
SWP = State Water Project
TAF = thousand acre-feet
USACE = U.S. Army Corps of Engineers

DWR is requesting an ITP for the exercise of discretion in operational decision-making, including how to comply with the terms of its existing water supply and settlement contracts (which include maximum deliveries under the terms of these contracts), and other legal obligations. DWR is not requesting an ITP from CDFW for the following actions:

- Flood control
- Oroville Dam and Feather River operations
- Prior execution of existing SWP contracts
- Coordinated Operation Agreement
- Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project
- Suisun Marsh Habitat Management Preservation and Restoration
- Suisun Marsh Preservation Agreement
- CVP facilities, operations and agreements

These facilities and operations activities are already covered under existing permits or addressed by other legal authorities. The actions included as elements of the Proposed Project are described in the following discussion.

2.3.1 OMR Management

DWR, in coordination with Reclamation, proposes to operate the SWP in a manner that maximizes exports while minimizing direct and indirect impacts on state and federally listed fish species. Old and Middle river (OMR) flow is a surrogate indicator of the influence of export pumping at the Banks Pumping Plant on hydrodynamics in the South Delta. The management of OMR flow, in combination with other environmental variables, can minimize or avoid entrainment of fish in the South Delta and at the SWP salvage facilities. DWR proposes to manage OMR flow by incorporating all available information into decision support for the management of OMR flow. The available information includes real-time monitoring of fish distribution, turbidity, temperature, hydrodynamic models, and entrainment models. The objective of the OMR management will be to provide focused protection for fish when necessary and to provide flexibility where possible. DWR, in coordination with existing multi-agency Delta focused technical teams, will use estimates of species distribution and other environmental variables based on ongoing monitoring.

From the onset of OMR management to the end, DWR, in coordination with Reclamation, will operate to an OMR flow index that is no more negative than a 14-day moving average of -5,000 cfs unless a storm event occurs (described below). Grimaldo et al. (2017) indicated that -5,000 cfs OMR flow is an inflection point for fish entrainment. OMR flow could be more positive than -5,000 cfs if additional real-time OMR restrictions are triggered (described below) or constraints other than OMR flow control exports. The OMR flow index would be computed using an equation presented in Hutton (2008). An OMR flow index allows for shorter-term operational planning and real-time adjustments. DWR, in coordination with Reclamation, will make a change to exports within 3 days of the trigger when monitoring, modeling, and the operational criteria indicate protection for fish is necessary. The 3-day period is consistent with the 2008 and 2009 Biological Opinions and allows for efficient power scheduling.

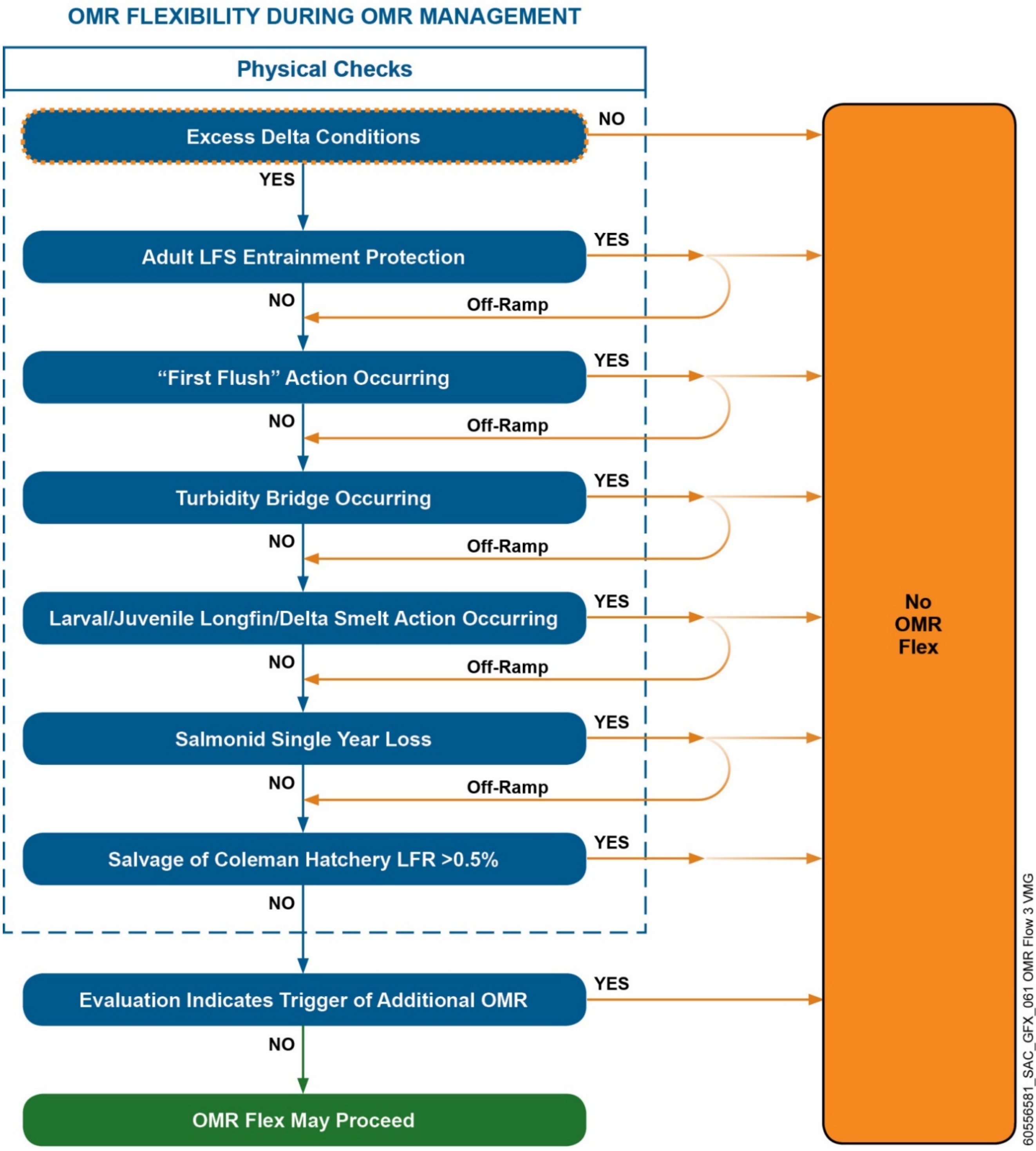


Figure 2-4. OMR Flexibility During OMR Management

2.3.1.1 Onset of OMR Management

DWR, in coordination with Reclamation, would start OMR management when one or more of the following conditions have occurred, as shown in Figure 2-4.

- Integrated Early Winter Pulse Protection (First Flush Turbidity Event): To minimize project influence on migration (or dispersal) of Delta Smelt, DWR and Reclamation would reduce exports for 14 consecutive days so that the 14-day averaged OMR index for the period would not be more negative than −2,000 cfs, in response to "First Flush" conditions in the Delta. The population-scale migration of Delta Smelt is believed to occur quickly in response to inflowing freshwater and turbidity (Grimaldo et al. 2009; Sommer et al. 2011). Thereafter, best available scientific information suggests that fish make local movements, but there is no evidence for further population-scale migration (Polansky et al. 2018). The "First Flush" action may be triggered between December 1 and January 31. The triggers include a running 3-day average of the daily flows at Freeport that is greater than 25,000 cfs and a running 3-day average of the daily turbidity at Freeport that is 50 Nephelometric Turbidity Unit (NTU) or greater; or real-time monitoring indicates a high risk of migration and dispersal into areas at high risk of future entrainment.
  - This "First Flush" action may only be initiated once during the December through January period.
- Salmonids Presence: After January 1, if more than 5% of any one or more salmonid species (wild young-of-the-year (YOY) Winter-run, wild YOY Spring-run, or wild California Central Valley Steelhead) are estimated to be present in the Delta as determined by their appropriate monitoring working group based on available real-time data, historical information, and modeling (e.g., SAC PAS).
- Longfin Smelt protection: After December 1, trigger adult LFS entrainment protection, if:
  - the cumulative salvage index (defined as the total estimated LFS salvage at the CVP and SWP in the December through February period divided by the immediately previous Fall Midwater Trawl (FMWT) LFS annual abundance[1] exceeds five,[2] or
  - real-time monitoring indicates a risk of movement into areas that may be subject to high entrainment.
- Adult LFS Entrainment Protection: From December 1 through February 28, DWR, in coordination with Reclamation will ensure that the OMR flow 14-day running average is no more negative than -5,000 cfs, unless:

[1] The Fall Midwater Trawl (FMWT) Survey annual abundance index for Longfin Smelt is calculated as the sum of September through December monthly abundance indices and is typically reported at about the same date as adult salvage begins in December. Early December salvage can be compared to September through November abundance as an approximation of the salvage index.

[2] Cumulative salvage index criteria may be modified as part of the adaptive management program in coordination with CDFW.

1. During any time OMR flow restrictions for Delta Smelt are being implemented, this measure will not result in additional OMR flow requirements for protection of adult LFS, or

2. When LFS spawning has been detected in the system, adult LFS migration and spawning action will terminate and Larval LFS Entrainment Protection will be implemented, or

3. Adult LFS migration and spawning action, including the OMR flow requirement, is not required or would cease if previously required when river flows are (a) greater than 55,000 cfs in the Sacramento River at Rio Vista or (b) greater than 8,000 cfs in the San Joaquin River at Vernalis, or

4. If subsequent to the high flows identified in number 3 above, flows go below 40,000 cfs in the Sacramento River at Rio Vista or below 5,000 cfs in the San Joaquin River at Vernalis, the OMR flow in the adult LFS migration and spawning action may resume if triggered previously and not precluded by another adult LFS migration and spawning action off ramp. In the implementation of this resumption, in addition to river flows, DWR personnel will review survey data and other pertinent biological factors that influence the entrainment risk of adult LFS. If the technical analysis supports relaxation or ceasing of this OMR flow requirement, DWR will share its technical analysis and supporting documentation with CDFW, seek their technical assistance, and discuss the risk assessment and future operations. If CDFW does not agree with DWR's technical analysis, the Director of CDFW will immediately notify the Director of DWR in writing of the disagreement. The Directors will then confer and attempt to reach a resolution within 3 days. If within 3 days (1) the Directors do not reach a resolution, and (2) CDFW provides an explanation and supporting documentation on how relaxing or ceasing of this OMR flow requirement would result in take that would not be minimized or fully mitigated, then DWR will not relax or cease OMR flow requirements. DWR will ensure that its proportional share of the OMR flow requirements described herein is satisfied. If either or both the conditions stated above are not met, DWR will continue with the operational change.

2.3.1.2 Real-Time OMR Limits and Performance Objectives

DWR, in coordination with Reclamation, would operate to an OMR flow requirement that is more positive than a -5,000 cfs OMR flow based on conditions that would protect the following fish species and groups of species from entrainment:

- Longfin Smelt
- Delta Smelt
- Salmonids

The conditions for each of these species and species groups (salmonids) are described below.

Longfin Smelt Entrainment Protections

Additional Real-time Consideration for Adult Longfin Smelt

From December 1 through February 28, DWR personnel will review survey data, salvage data and other pertinent biological factors that influence the entrainment risk of adult LFS. DWR will share its technical analysis and supporting documentation with CDFW on an as-needed basis and seek their technical assistance. If the technical analysis supports a more restrictive OMR flow requirement than -5,000 cfs, DWR will discuss the risk assessment and future operations with Water Operations Management Team (WOMT) at its next meeting. If CDFW does not agree with DWR's technical analysis, the Director of CDFW will immediately notify the Director of DWR in writing of the disagreement. The Directors will then confer and attempt to reach a resolution within 3 days. If within 3 days (1) the Directors do not reach a resolution, and (2) CDFW provides an explanation and supporting documentation on how the change in the OMR flow requirement would result in take that would not be minimized or fully mitigated, then DWR will not change the OMR flow requirement. DWR will ensure that its proportional share of the OMR flow requirement described herein is satisfied. If either or both the conditions stated above are not met, then DWR will continue with the operational change.

Larval and Juvenile Longfin Smelt

From January 1 through June 30, when a single Smelt Larva Survey (SLS) or 20 mm Survey (20 mm) sampling period results in one of the following triggers, DWR in coordination with Reclamation will ensure the OMR flow 14-day running average is no more negative than -5,000 cfs:

- LFS larvae or juveniles found in 8 or more of the 12 SLS or 20 mm stations in the Central Delta and South Delta (Stations 809, 812, 815, 901, 902, 906, 910, 912, 914, 915, 918, 919), or
- LFS catch per tow exceeds 15 LFS larvae or juveniles in four or more of the 12 stations in the Central Delta and South Delta (Stations 809, 812, 815, 901, 902, 906, 910, 912, 914, 915, 918, 919).

If QWEST is negative, and larval or monitoring detects juvenile LFS within the corridors of the Old and Middle rivers, DWR will assess potential entrainment impacts of fish in the corridors of the Old and Middle rivers relative to their estuarine-wide distribution from monitoring data (e.g., SLS and Enhanced Delta Smelt Monitoring Program [EDSM] for larvae; 20 mm Survey and EDSM for juveniles) using Particle Tracking Model (PTM) runs weighted by the distribution in the surveys. In addition to PTM outputs, DWR will use real-time hydrological conditions, salvage data, forecast models (e.g., statistical-based models of historical data), other potential hydrodynamic models, and water quality to assess entrainment risk and to determine appropriate OMR flow targets to minimize entrainment or entrainment risk, or both. In coordination with CDFW, DWR will determine the best available models, the model inputs, and the assessment methods for determining larval and juvenile Longfin Smelt entrainment risk.

DWR will determine if an OMR flow protection target is warranted and determine the timing (e.g., days or week) and magnitude of the action. Implemented OMR flow management actions will continue until it is determined the risk is abated based on changes in real-time conditions or until the off-ramp has been met as described in the "End of OMR Management" section below. DWR will share its technical analysis and supporting documentation for the modified OMR requirement or determination of the abatement of risk with CDFW on an as-needed basis and seek their technical assistance. If CDFW does not agree with DWR's technical analysis, the Director of CDFW will immediately notify the Director of DWR in writing of the disagreement. The Directors will then confer and attempt to reach a resolution within 3 days. If within 3 days (1) the Directors do not reach a resolution and (2) CDFW provides an explanation and supporting documentation on how the change in the OMR flow requirement or determination of the abatement of risk would result in take that would not be minimized or fully mitigated, then DWR will not change the OMR flow requirement. DWR will ensure that its proportional share of the OMR flow requirement described herein is satisfied. If either or both of the conditions stated above are not met, DWR will continue with the operational change.

Off-Ramps for Larval and Juvenile LFS Entrainment Protection

DWR will continue to manage OMR flows for the protection of Longfin Smelt until the offramp criteria have been met as described in the "End of OMR Management" section below or until one of the following offramp criteria are met.

1. During periods when OMR flow restrictions for larval and juvenile Delta Smelt are being implemented, this measure shall not result in additional OMR flow requirements for protection of larval and juvenile LFS, or
2. When river flows meet one of the following requirements, larval and juvenile LFS protections would not trigger, or would be relaxed if triggered previously:
    - Greater than 55,000 cfs in the Sacramento River at Rio Vista
    - Greater than 8,000 cfs in the San Joaquin River at Vernalis
3. If subsequent to the high flows identified in (2), flows drop below 40,000 cfs in the Sacramento River at Rio Vista or below 5,000 cfs in the San Joaquin River at Vernalis, larval and juvenile LFS protection will resume if triggered previously. In implementing this resumption, in addition to river flows, the DWR personnel will review all abundance and distribution survey data and other pertinent biological factors that influence the entrainment risk of larval and juvenile LFS. If the technical analysis supports relaxation or cessation of this OMR flow requirement, DWR will share its technical analysis and supporting documentation with CDFW, seek their technical assistance, and discuss the risk assessment and future operations.

As Longfin Smelt are not a federally listed species and because DWR has limited control over OMR flows, DWR can take actions to make OMR flows more positive, but there are circumstances when the actual OMR flow may not respond to DWR's actions, particularly if the CVP is operating differently. DWR will make efforts to coordinate with Reclamation, but Reclamation is not legally required to comply with the Longfin Smelt operations. DWR will ensure that its proportional share of the OMR flow requirements described for Longfin Smelt are satisfied.

Delta Smelt Entrainment Protections

Turbidity Bridge Avoidance (South Delta Turbidity)

After the Integrated Early Winter Pulse Protection (above) or February 1 (whichever comes first), until when a spent female is detected or April 1 (whichever is first), DWR, in coordination with Reclamation, would manage exports in order to maintain daily average turbidity in Old River at Bacon Island (OBI) at a level of less than 12 NTU. The purpose of this action is to minimize the risk to adult Delta Smelt in the corridors of the Old and Middle rivers, where they are subject to high entrainment risk. This action seeks to avoid the formation of a turbidity bridge from the San Joaquin River shipping channel to the South Delta fish facilities, which historically has been associated with elevated salvage of pre-spawning adult Delta Smelt. If the daily average turbidity at Bacon Island could not be maintained at less than 12 NTU, DWR, in coordination with Reclamation, would manage exports to achieve an OMR flow that is no more negative than -2,000 cfs until the daily average turbidity at Bacon Island drops below 12 NTU. However, if 5 consecutive days of OMR flow that is less negative than -2,000 cfs does not reduce daily average turbidity at Bacon Island below 12 NTU in a given month, DWR, in coordination with Reclamation, may determine that OMR restrictions to manage turbidity are infeasible and will instead implement an OMR flow target that is deemed protective based on turbidity and adult Delta Smelt distribution and salvage, but will not implement a more negative OMR than -5,000 cfs.

DWR and Reclamation recognize that readings at individual sensors or localized groups of sensors can generate spurious results in real time. Such changes could be incorrectly interpreted as a full turbidity bridge, when in fact the cause a result of local conditions or sensor error. To avoid excessive OMR restrictions during a sensor error or a localized turbidity spike, DWR, in coordination with Reclamation, will consider and review data from other locations and sources. Additional information that will be reviewed include regional visualizations of turbidity, alternative sensors, and boat-based turbidity mapping, particularly if there was evidence of a local sensor error.

DWR will share its technical analysis and supporting documentation with CDFW on an as-needed basis and seek CDFW's technical assistance if it determines the OMR requirement could be off-ramped after 5 days of implementation of the Turbidity Bridge Avoidance action or if it determines that this action is not warranted. If CDFW does not agree with DWR's technical analysis, the Director of CDFW will immediately notify the Director of DWR in writing of the disagreement. The Directors will then confer and attempt to reach a resolution within 3 days. If within 3 days (1) the Directors do not reach a resolution and (2) CDFW provides an explanation and supporting documentation on how off-ramping the Turbidity Bridge Avoidance action or not implementing this action would result in take that would not be minimized or fully mitigated, then DWR will implement (or continue to implement) this action. DWR will ensure that its proportional share of the OMR flow requirement described herein is satisfied. If either or both the conditions stated above are not met, DWR will continue with the operational change.

Larval and Juvenile Delta Smelt Protection

DWR, in coordination with Reclamation, will use results produced by life cycle models approved by CDFW and USFWS to manage the annual entrainment levels of larval and juvenile Delta Smelt. The

USFWS models will be publicly vetted and peer reviewed prior to March 15, 2020. CDFW and USFWS will coordinate with the Delta Fish Monitoring Working Group to identify a Delta Smelt recruitment level that Reclamation and DWR can use in OMR flow management. The life cycle models statistically link environmental conditions to recruitment, including factors related to loss as a result of entrainment such as OMR flows. In this context, recruitment is defined as the estimated number of post-larval Delta Smelt in June per number of spawning adults in the prior February-March period.

DWR, in coordination with Reclamation, CDFW and USFWS will operationalize the life cycle model results through the use of real-time monitoring for the spatial distribution of Delta Smelt. On or after March 15 of each year, if QWEST is negative and larval or juvenile Delta Smelt are detected within the corridors of the Old and Middle rivers based on real-time sampling of spawning adults or YOY life stages, Reclamation or DWR, or both, will run hydrodynamic models and forecasts of entrainment, informed by the EDSM or other relevant survey data to estimate the percentage of larval and juvenile Delta Smelt that could be entrained. If necessary, DWR and Reclamation will manage exports to limit entrainment to be protective based on the modeled recruitment levels. DWR, in coordination with Reclamation, will re-run hydrodynamic models when operational changes or new sampling data indicate a potential change in entrainment risk. This process will continue until the off-ramp criteria have been met as described in the “End of OMR Management” section below. In the event the life cycle models cannot be operationalized in a manner that can be used to inform real-time operations then Reclamation, DWR, CDFW, and USFWS will coordinate to develop an alternative plan to provide operational actions protective of this life stage.

If CDFW does not agree with the operational actions determined above, the Director of CDFW will immediately notify the Director of DWR in writing of the disagreement. The Directors will then confer and attempt to reach a resolution within 3 days. If within 3 days (1) the Directors do not reach a resolution and (2) CDFW provides an explanation and supporting documentation on how the operational actions determined above would result in take that would not be minimized or fully mitigated, DWR will then implement the operational action agreeable to CDFW. DWR will ensure that its proportional share of the OMR flow requirement described herein is satisfied. If either or both the conditions stated above are not met, then DWR will continue with the operational actions determined above.

Salmonid Entrainment Loss Protections

Cumulative Loss Thresholds

DWR, in coordination with Reclamation, would target exceedance of cumulative loss thresholds over the duration of the 2019 BiOps for natural Winter-run Chinook Salmon, hatchery Winter-run Chinook Salmon, natural Central Valley Steelhead from December through March, and natural Central Valley Steelhead from April 1 through June 15.

DWR, in coordination with Reclamation, proposes to avoid exceeding cumulative loss thresholds by 2030 as follows:

- Natural Winter-run Chinook Salmon (cumulative loss = 8,738)

- Hatchery Winter-run Chinook Salmon (cumulative loss = 5,356)
- Natural Central Valley Steelhead from December through March (cumulative loss = 6,038)
- Natural Central Valley Steelhead from April 1 through June 15 (cumulative loss = 5,826).

Natural Central Valley Steelhead would be separated into two time periods to protect San Joaquin-origin fish that historically appear in the Mossdale trawls later than Sacramento-origin fish. The loss threshold and loss tracking for hatchery Winter-run Chinook Salmon do not include releases into Battle Creek. Loss (for development of thresholds and ongoing tracking) for Chinook Salmon is based on length-at-date criteria.

The cumulative loss thresholds would be based on the cumulative historical loss from 2010 through 2018. DWR and Reclamation's performance objectives are intended to avoid loss such that the cumulative loss threshold (measured as the 2010-2018 average cumulative loss multiplied by 10 years) will not be exceeded by 2030.

If at any time prior to 2024, DWR, in coordination with Reclamation, were to exceed 50% of the cumulative loss threshold, DWR, in coordination with Reclamation, would convene an independent panel to review the actions contributing to this loss trajectory and make recommendations on modifications or additional actions to stay within the cumulative loss threshold, if any.

In the year 2024, DWR, in coordination with Reclamation, would convene an independent panel to review the first 5 years of actions and determine whether continuing these actions is likely to reliably maintain the trajectory associated with this performance objective for the duration of the period.

If during real-time operations, DWR, in coordination with Reclamation, were to exceed the cumulative loss threshold, DWR, in coordination with Reclamation, would immediately seek technical assistance from CDFW and NMFS, as appropriate, on the coordinated operation of the SWP and CVP, respectively for the remainder of the OMR management period. In addition, prior to the next OMR management season, DWR, in coordination with Reclamation would convene an independent review panel to review the actions contributing to this loss trajectory and make recommendations for modifications or additional actions to stay within the permitted take.

Single-Year Loss Thresholds

In each year, DWR, in coordination with Reclamation, would avoid exceeding an annual loss threshold equal to 90% of the greatest salvage loss that occurred in the historical record from 2010 through 2018 for each of the following:

- Natural Winter-run Chinook Salmon (loss = 1.17% of juvenile production estimate [JPE])
- Hatchery Winter-run Chinook Salmon (loss = 0.12% of JPE)
- Natural Central Valley Steelhead from December through March (loss =1,414)
- Natural Central Valley Steelhead from April through June 15 (loss = 1,552)

Natural Central Valley Steelhead would be separated into two time periods to protect San Joaquin-origin fish that historically appear in the Mossdale trawls later than Sacramento-origin fish.

The loss threshold and loss tracking for hatchery Winter-run Chinook Salmon does not include releases into Battle Creek. Loss (for development of thresholds and ongoing tracking) for Chinook Salmon are based on length-at-date criteria.

During the year, if SWP and CVP operations were to exceed the average annual loss threshold, DWR in coordination with Reclamation would review recent fish distribution information and operations with the fisheries agencies at the WOMT and seek technical assistance on future planned operations. DWR, Reclamation, USFWS, NMFS, and CDFW could elevate an issue from WOMT to a Directors' discussion, as appropriate.

During the year, if SWP and CVP operations exceed 50% of the annual loss threshold, DWR, in coordination with Reclamation, would restrict OMR flow to a 14-day moving average OMR flow index that is no more negative than −3,500 cfs, unless DWR, in coordination with Reclamation, determines that further OMR flow restrictions are not required to benefit fish movement because a risk assessment shows that the risk is no longer present based on real-time information.

The -3,500 OMR flow operational criteria adjusted and informed by this risk assessment will remain in effect for the rest of the season. DWR and Reclamation would seek CDFW and NMFS technical assistance on the risk assessment and real-time operations.

During the year, if Reclamation and DWR exceed 75% of the annual loss threshold, Reclamation and DWR will restrict OMR flow to a 14-day moving average OMR flow index that is no more negative than -2,500 cfs unless DWR and Reclamation determine that further OMR flow restrictions are not required to benefit fish movement because a risk assessment shows that the risk is no longer present based on real-time information.

The -2,500 OMR flow operational criteria adjusted and informed by this risk assessment will remain in effect for the rest of the season. DWR and Reclamation will seek CDFW and NMFS technical assistance on the risk assessment and real-time operations.

Regarding the risk assessments (identified above), DWR and Reclamation will evaluate and adjust OMR flow restrictions under this section by preparing a risk assessment that considers several factors, including, but not limited to, real-time monitoring, historical trends of salmonids exiting the Delta and entering the South Delta, fish detected in salvage, and relevant environmental conditions. Risks will be measured against the potential to exceed the next single year loss threshold. DWR and Reclamation will share its risk assessment and supporting documentation with CDFW, USFWS and NMFS, seek their technical assistance, discuss the risk assessment and future operations with WOMT at its next meeting and elevate issues to the Directors as appropriate.

DWR will share its risk assessment and supporting documentation with CDFW on an as-needed basis and seek their technical assistance if it determines the OMR requirement could be off-ramped. If CDFW does not agree with DWR's technical analysis, the Director of CDFW will immediately notify the Director of DWR in writing of the disagreement. The Directors will then confer and attempt to reach a resolution within 3 days. If within 3 days (1) the Directors do not reach a resolution and (2) CDFW provides an explanation and supporting documentation on how off-ramping the OMR flow requirement would result in take that would not be minimized or fully mitigated, then DWR will not off-ramp the OMR flow requirement. DWR will ensure that its proportional share of the OMR flow requirement described herein is satisfied. If either or both the conditions stated above are not met, DWR will continue with the operational change.

If during real-time operations, Reclamation and DWR were to exceed the single-year loss threshold, Reclamation and DWR would immediately seek technical assistance from CDFW, USFWS, and NMFS, as appropriate, on the coordinated operation of the CVP and SWP for the remainder of the OMR management period. In addition, Reclamation and DWR would, prior to the next OMR management season, convene an independent panel to review the OMR Management Action. The purpose of the independent review would be to review the actions contributing to this loss trajectory and make recommendations on modifications or additional actions to stay within the annual loss threshold, if any.

DWR, in coordination with Reclamation, would continue monitoring and reporting salvage at the Jones and Tracy fish facilities. DWR and Reclamation would continue the release and monitoring of yearling Coleman National Fish Hatchery (NFH) Late Fall-run and yearling Spring-run Chinook Salmon surrogates.

OMR Flexibility During Delta Excess Flow Conditions

DWR, in coordination with Reclamation, may operate to a more negative OMR flow up to a maximum (otherwise permitted) export rate (which could result in a range of OMR flow values) at the Banks and Jones pumping plants to capture excess flows in the Delta. Excess flows occur typically from storm-related events and are defined as flows in excess of that required to meet water quality control plan flow and salinity requirements and other applicable regulations. DWR, in coordination with Reclamation, would continue to monitor fish in real time and will operate in accordance with the "Additional Real-time OMR Restrictions," previously described.

Figure 2-4 shows the physical checks that would preclude implementation of an OMR flexibility action. As shown, if any other OMR flow limit is active, an OMR flexibility action would be precluded.

Unless the following species protections occur, DWR has the discretion to capture excess flows if:

1. Integrated Early Winter Pulse Protection or additional real-time OMR restrictions are triggered and the required OMR is more positive or less negative than -5,000 cfs. Under such conditions, DWR and Reclamation have already determined that more restrictive OMR is required.
2. An evaluation of environmental and biological conditions by DWR, in coordination with Reclamation, indicates a more negative OMR flow would likely trigger an additional real-time OMR flow restriction.
3. Salvage of yearling Coleman National Fish Hatchery Late Fall-run (as yearling Spring-run Chinook Salmon surrogates) exceeds 0.5% within any of the release groups.
4. DWR, in coordination with Reclamation, identifies changes in spawning, rearing, foraging, sheltering, or migration behavior beyond those anticipated to occur under OMR management.

DWR, in coordination with Reclamation, would continue to monitor conditions and could resume management of OMR flow to levels no more negative than −5,000 cfs if conditions indicate the defined off-ramps are necessary to avoid additional adverse impacts. If OMR flow flexibility causes the conditions in Real-Time OMR Limits and Performance Measures, DWR, in coordination with Reclamation, would implement additional real-time OMR flow restrictions.

DWR will share its technical analysis and supporting documentation with CDFW on an as-needed basis and seek their technical assistance if it determines the OMR flow flexibility is warranted. If CDFW does not agree with DWR's technical analysis, the Director of CDFW will immediately notify the Director of DWR in writing of the disagreement. The Directors will then confer and attempt to reach a resolution within 3 days. If within 3 days (1) the Directors do not reach a resolution and (2) CDFW provides an explanation and supporting documentation on how OMR flow flexibility would result in take that would not be minimized or fully mitigated, then DWR will not implement OMR flexibility. DWR will ensure that its proportional share of the OMR flow requirement described herein is satisfied. If either or both the conditions stated above are not met, DWR will continue with the operational change.

End of OMR Management

OMR flow criteria may control operations until June 30 or when the following species-specific off-ramps have occurred, whichever is earlier.

- Longfin Smelt and Delta Smelt: When the daily mean water temperature at the CCF reaches 77 degrees Fahrenheit (°F) (25 degrees Celsius [°C]) for 3 consecutive days.
- Salmonids: When more than 95% of Winter-run Chinook Salmon and Spring-run Chinook Salmon have migrated past Chipps Island, as determined by DWR and Reclamation's monitoring working group, or after daily average water temperatures at Mossdale exceed 72°F (22.2 °C) for 7 days during June (the 7 days do not have to be consecutive).

Real-Time Decision-Making and Loss Thresholds

When real-time monitoring demonstrates that criteria in "Additional Real-Time OMR Restrictions and Performance Objectives" are not supported, then Reclamation and DWR may confer with the Directors of NMFS, USFWS, and CDFW if they desire to operate to a more negative OMR flow than what is specified in "Additional Real-Time OMR Limits and Performance Objectives." Upon mutual agreement, the Directors of NMFS and USFWS may authorize DWR and Reclamation to operate to a more negative OMR flow than the "Additional Real-Time OMR Restrictions," but no more negative than -5,000 cfs. The Director of CDFW may authorize DWR to operate to a more negative OMR flow than the "Additional Real-Time OMR Restrictions," but no more negative than -5,000 cfs. This process would be separate from the risk analysis process described above.

If CDFW does not agree, the Director of CDFW will immediately notify the Director of DWR in writing of the disagreement. The Directors will then confer and attempt to reach a resolution within 3 days. If within 3 days (1) the Directors do not reach a resolution and (2) CDFW provides an explanation and supporting documentation on how the action would result in take that would not be minimized or fully mitigated, then DWR will not implement this action. DWR will ensure that its proportional share of the

OMR flow requirement described herein is satisfied. If either or both the conditions stated above are not met, DWR will continue with the operational change.

2.3.2 MINIMUM EXPORT RATE

Water rights, contracts, and agreements specific to the Delta include D-1641, COA and other related agreements pertaining to CVP and SWP operations and Delta watershed users. In order to meet health and safety needs, critical refuge supplies, and obligations to senior water rights holders, the combined CVP and SWP export rates at the Jones Pumping Plant and the Banks Pumping Plant will not be required to drop below 1,500 cfs. Reclamation and DWR propose to use the Sacramento River, San Joaquin River, and Delta channels to transport water to export pumping plants located in the South Delta.

2.3.3 DELTA SMELT SUMMER-FALL HABITAT ACTION

The Delta Smelt Summer-Fall Habitat Action is intended to improve Delta Smelt food supply and habitat, thereby contributing to the recruitment, growth, and survival of Delta Smelt. The current conceptual model states that Delta Smelt habitat should include low salinity conditions of 0 to 6 parts per thousand (ppt), turbidity of approximately 12 NTU, temperatures below 25°C, food availability, and littoral or open water physical habitats (FLaSH Synthesis, pp. 15-25). The Delta Smelt Summer-Fall Habitat Action is being undertaken recognizing that the highest-quality habitat in this large geographical region includes areas with complex bathymetry, in deep channels close to shoals and shallows, and in proximity to extensive tidal or freshwater marshlands and other wetlands. The Delta Smelt Summer-Fall Habitat Action is to provide the aforementioned habitat components in the same geographic area through a range of actions to improve water quality and food supplies.

DWR and Reclamation propose to use structured decision-making to implement Delta Smelt habitat actions. In the summer and fall (June through October) of below-normal, above-normal and wet years, based on the Sacramento Valley Index, the environmental and biological goals are, to the extent practicable, the following:

- Maintain low-salinity habitat in Suisun Marsh and Grizzly Bay when water temperatures are suitable;
- Manage the low salinity zone to overlap with turbid water and available food supplies.
- Establish contiguous low-salinity habitat from Cache Slough Complex to Suisun Marsh.

The action will initially include modifying project operations to maintain a monthly average 2 ppt isohaline at 80 km (X2) from the Golden Gate in above-normal and wet water years in September and October. DWR and Reclamation will also implement additional measures that are expected to achieve additional benefits. These measures include, but are not limited to:

- SMSCG operations for up to 60 days (not necessarily consecutive) in June through October of below-normal and above-normal years. This action may also be implemented in wet years, if preliminary analysis shows expected benefits.

- Food enhancement action (for example, those included in the Delta Smelt Resiliency Plan to enhance food supply). These projects include the North Delta Food Subsidies and Colusa Basin Drain project, and Suisun Marsh Food Subsidies (Roaring River distribution system reoperation). DWR and Reclamation will monitor dissolved oxygen at Roaring River distribution system drain location(s) during Delta Smelt food distribution actions.

These considerations (listed above) and implementation of other actions will be more fully defined and developed through the structured decision-making or other review process. The review will include selection of appropriate models, sampling programs, and other information to be used. The process will be completed prior to implementation and may be improved in subsequent years as additional information is synthesized and reviewed, as described below.

Reclamation and DWR will develop a Delta Smelt Summer-Fall Habitat Action Plan to meet the environmental and biological goals in years when summer-fall habitat actions are triggered. In above-normal and wet years, operating to a monthly average X2 of 80 km in September and October is the initial operation. In every action year, Reclamation and DWR will propose, based on discussions with the USFWS and CDFW, a suite of actions that would meet the action's environmental and biological goals. This action would be coordinated with Reclamation and categorized as an in-basin use for COA purposes. In the event that Reclamation does not meet its share of the Delta outflow to meet 80 km X2, DWR will implement its share of this action.

2.3.3.1 Food Enhancement Summer-Fall Actions

North Delta Food Subsidies and Colusa Basin Drain Project: DWR proposes to implement actions to improve flow conditions in the North Delta in summer and fall, thereby facilitating downstream transport of phytoplankton and zooplankton. While the Cache Slough Complex and the lower Yolo Bypass are known to have relatively high levels of food resources, local water diversions create net negative flows during summer and fall that may inhibit downstream food transport. By enhancing summer and fall flows through the Yolo Bypass, downstream transport of food could be improved.

DWR and partners would test two different ways to improve flow conditions in the North Delta. For the first approach, water would be provided by Sacramento River water districts, such as Reclamation District 108 and Glenn Colusa Irrigation District. The water districts would use their facilities to move freshwater into Colusa Drain. By adjusting the operations of Knights Landing Outfall Gates and Wallace Weir, much of this water would be routed into the Yolo Bypass.

The second approach would use agricultural drain water in fall, which is available in fall when valley rice fields discharge irrigation water at the end of the growing season. Agricultural drain water would be routed into the Yolo Bypass via Knights Landing Ridge Cut.

DWR proposes flow pulses would include summer actions using fresh Sacramento River water and fall actions using agricultural drain water from Colusa Drain. Initial results suggest that a target pulse of 27 TAF over a 4-week period would improve downstream transport of phytoplankton. This flow volume is not sufficient to inundate floodplain in Yolo Bypass, nor would it constitute a consumptive use of water because the water used for this action would be allowed to move through the North Delta and contribute to Delta outflow.

This food subsidy action is an adaptive management action that relies on monitoring and evaluation in order to optimize its efficacy. Similarly, the action depends on partnerships with local water users including Reclamation District 108, Glenn Colusa Irrigation District, Conaway Ranch, and Swanston Ranch. All actions should be developed in consultation with the needs of local water users and landowners. Food enhancement action design and implementation would be determined through the Summer-Fall Adaptive Management process.

Roaring River Distribution System Reoperations: Infrastructure in the Roaring River Distribution System may help drain food-rich water from the canal into Grizzly Bay to augment Delta Smelt food supplies in that area.

2.3.3.2 Delta Smelt Summer-Fall Habitat Action Adaptive Management Planning

Conceptual Model

The Delta Smelt Summer-Fall Habitat Action is intended to improve Delta Smelt food supply and habitat, thereby contributing to improved Delta Smelt habitat conditions. The current conceptual model is that Delta Smelt habitat should include low salinity conditions of 0 to 6 ppt, turbidity of approximately 12 NTU, temperatures below 25°C (77 °F), food availability, and littoral or open water physical habitats (FLaSH Synthesis, pp. 15-25). The Delta Smelt Summer-Fall Habitat Action is being undertaken recognizing that the highest quality habitat in this large geographical region includes areas with complex bathymetry, in deep channels close to shoals and shallows, and in proximity to extensive tidal or freshwater marshlands and other wetlands. The Delta Smelt Summer-Fall Habitat Action is to provide these habitat components in the same geographic area through a range of actions to improve water quality and food supplies.

Planning Process

The adaptive management process would be investigating the way in which SWP-CVP operations interact with the full range of components of Delta Smelt habitat. The process would be investigating the extent that providing flow and/or low salinity conditions of various volumes and locations improves the quality and quantity of Delta Smelt habitat in the summer and fall, and whether Delta Smelt survival, viability and/or abundance improves in relation to the Delta Smelt Summer-Fall Habitat Action.

An adaptive management plan will be developed following issuance of the Notice of Determination (NOD). The framework for the adaptive management plan is as follows:

- DWR and Reclamation shall form a Delta Coordination Group (Reclamation, DWR, USFWS, NMFS, CDFW, and representatives from federal and state water contractors).
- The Delta Coordination Group would use one of the existing structured decision-making models or adopt a new model to analyze proposed summer-fall habitat actions, making predictions regarding

the potential outcomes for various implementation scenarios. This structured decision-making process would inform each year's Habitat Action Plan.

- Within 6 months of signing the NOD, the Delta Coordination Group would meet to select a structured decision-making model; and complete initial model runs (and annual model runs thereafter) testing various approaches to satisfying the environmental and biological goals, utilizing the available tool box of approaches.
- Each year, the Delta Coordination Group would develop a Habitat Action Plan accounting for forecasted hydrology and temperatures over the summer and fall. The Habitat Action Plan would describe how the proposed action would meet the environmental and biological goals of the action. The Habitat Action Plan would include the hypotheses to be tested, the suite of actions and operations to test the hypotheses, and the expected outcomes. The Habitat Action Plan would be informed by the annual results of the structured decision-making process. In recognition of the time required for annual planning, the Habitat Action Plan process would occur every year so the Plan would be prepared in time for review by the USFWS and CDFW, in the event the action is triggered.
- CDFW and USFWS would review the Habitat Action Plan in each year in which an action is triggered and confirm that the impacts of the action are within what was analyzed in the BiOp and the California Fish and Game Code Section 2081 permit and that the action is consistent with the project description.
- After the completion of each Summer-Fall Habitat Action, DWR and Reclamation will share preliminary monitoring results through the Delta Coordination Group. At the beginning of the next water year, DWR and Reclamation would provide a synthesis of the monitoring results to the Delta Coordination Group. The Delta Coordination Group would review the synthesis of results and use the results of the monitoring to inform a subsequent structured decision-making modeling exercise using the tool box of available approaches.
- The Delta Smelt Summer-Fall Habitat Action would be included in the Four-Year Reviews under the Governance section of this Proposed Action. The structured decision-making model and the multi-year science and monitoring plan would be part of this Peer Review.

2.3.4 Real-time Water Operations Process

DWR, in coordination with Reclamation, would implement activities, monitor performance, and report on compliance with the commitments in the Proposed Project. Implementing the proposed action would require coordination between CDFW, DWR, USFWS, NMFS, Reclamation, and the SWP-CVP water contractors. The federal government is proposing a Real-Time Operations Charter to facilitate federal coordination with the State.

Investments in science, monitoring, and decision support tools since the 2008 and 2009 federal Biological Opinions, state Consistency Determinations, and the Fish and Game Code Section 2081 permit for Longfin Smelt provide the ability to reduce reliance on professional opinion and increase the use of qualitative and quantitative models to assess risk in real time based on the real-time monitoring of species and relevant other physical and biological factors. While DWR and Reclamation hold the responsibility for operating the SWP and CVP in a coordinated manner, many agencies and organizations assist in monitoring field conditions to provide information that assists in real-time decisions. Communication on real-time conditions and the implementation of water operations provides assurance that DWR, in coordination with Reclamation, is meeting the commitments within the Proposed Project.

Portions of the Proposed Project rely on real-time monitoring to inform DWR and Reclamation on how to minimize and/or avoid stressors on listed species. The Proposed Project seeks to take advantage of the expertise within the state and federal fish agencies in the real-time monitoring of species distribution and life stage. DWR, in coordination with Reclamation, would then use qualitative and quantitative tools to perform risk analyses that inform operations. Actions to address stressors in real-time include Old and Middle River Flow Management.

Some elements of the Proposed Project include seasonal input by the state and federal regulatory agencies on scheduling actions to benefit the fishery. Actions requiring seasonal input from CDFW include the Delta Smelt Summer-Fall Habitat Action.

DWR, in coordination with Reclamation, would demonstrate compliance with the commitments of the Proposed Project and provide sufficient information for evaluation of federal initiation triggers through regular monitoring and reporting. New information and changing conditions may exceed a federal reinitiation trigger and could require subsequent federal ESA Section 7 consultation. As the SWP and CVP must coordinate operations, a federal reinitiation of Section 7 consultation would require discussions with CDFW and possible need for a permit amendment.

- Real-Time Operation participants
- Action Agencies: DWR and Reclamation
- Regulatory Agencies: USFWS, NMFS, CDFW, SWRCB, USACE
- Stakeholders: state and federal water contractors
- Decision-Making for Real-Time Operations

Nothing in this project description modifies the rights and responsibilities of the agencies. Decisions shall be made consistent with the authorizing legislation and the regulations and policies under the federal and state Endangered Species Acts, as appropriate.

DWR and Reclamation shall retain sole discretion for:

- Water Operations of the SWP and CVP, including allocations, under Reclamation Law and the State Water Project, as appropriate
- Agency appropriations (budget requests, fund alignment, contracting, etc.)
- Section 7 Action Agency and Applicant (consultation)
- Coordination and cooperation with Public Water Agencies (PWAs) as required by contracts and agreements

CDFW, USFWS, and NMFS shall retain sole discretion for:

- Consultation under Section 7 of the federal ESA and California Fish and Game Code, as appropriate and the associated Incidental Take Statements/Permits
- Agency Appropriations

State Water Resources Control Board shall retain the sole discretion for:

- Enforcement as allowable under federal and state law (e.g., Clean Water Act and Porter-Cologne Water Quality Control Act)

State and federal water contractors shall retain all existing authority and discretion, and are participating in a technical and policy advisory capacity.

DWR would continue to coordinate with USACE, as appropriate, under existing permits as wells as in venues such as the Interagency Ecological Program (IEP). Other agencies (e.g., the U.S. Geological Survey [USGS]) may also be involved in monitoring physical conditions in the Delta.

2.3.4.1 Annual Process

Reclamation and DWR will continue to provide standard reporting on real-time operations, environmental conditions, and biological parameters, such as species distribution, life stage, and dynamics. These data are available daily through Reclamation and DWR websites and additional tools such as CDEC, NWIS, RWIS, SacPAS, Bay-Delta Live, and SHOWR.

Monitoring for the proposed real-time management includes:

- Delta flow, temperature, and salinity stations
- Chinook Salmon biological information:
    - Juvenile abundance and timing: Implementation of OMR management (Sacramento Trawl and Chipps Island Trawl)
    - Delta distribution: Informs OMR actions and is currently supported through beach seines, acoustic tagging, and EDSM
    - Salvage count: Informs the direct impacts on listed fish
    - Genetic identification: Informs the salvage of listed Chinook Salmon species versus non-listed Chinook Salmon species.
- Delta Smelt biological information:
    - Turbidity stations: Informs the potential for a “turbidity bridge” that would inform OMR actions.
    - Temperature stations: Informs the transition between life stages and the need for protective measures.
    - Water quality stations: Tracks the movement of the low salinity zone and parameters associated with the food web (e.g., chlorophyll)
    - Delta distribution: Informs the entrainment risk due to OMR actions and would be supported by EDSM.

- Fish condition: Informs when adults have spawned and the need for larval protections.
- Longfin Smelt biological information:
  - Water quality stations: Tracks the movement of the low salinity zone and parameters associated with the food web (e.g., chlorophyll)
  - Delta distribution: Informs the entrainment risk due to OMR actions.
  - Fish condition: Informs when adults have spawned and the need for larval protections

Status and Trend Monitoring

Status and trend monitoring characterizes the population of species and their environments over time including the impacts of stressors from sources other than the CVP and SWP. Recovery plans characterize the status and trends differently depending upon the species in the general categories of abundance, production, life history diversity, and geographic diversity. In addition to the Core Monitoring, a number of additional programs are anticipated to continue, the majority of which are supported by Reclamation and DWR for CVP, SWP, and Delta watersheds:

- Hatchery Proportion (Constant Fractional Marking)
- Genetic Analyses of California Salmonid Populations: Parentage Based Tagging (PBT) of salmonids in California Hatcheries
- Fall Midwater Trawl
- 20-mm Survey monitoring to determine distribution and relative abundance of Delta Smelt and Longfin Smelt
- Spring Kodiak Trawl
- Estuarine and Marine Fish Abundance and Distribution Survey
- Smelt Larva Survey (SLS)
- Summer Townet Survey
- Environmental Monitoring Program (EMP)

The coordinated operation of the SWP requires the following deliverables throughout the year. In addition to those identified herein, Reclamation would have additional deliverables that would be provided to USFWS and NMFS related to the operation of the CVP.

DWR and Reclamation will provide products on the schedule identified below:

1. Monitoring Program for Core Water Operations, Ongoing
2. December through June, Weekly and Biweekly, Real-Time Species Distribution and Life Stage
3. Monthly (and as needed), Water Operation Status
4. Monthly (and/or as needed), Specific operations for:
5. Old and Middle River Reverse Flow Storm Events (December through June)
6. Delta Smelt Fall Habitat and Suisun Marsh Salinity Control Gates (May)

7. Seasonal and Annual Compliance Reporting September, Annual Summary of Water Supply and Fish Operations

2.3.5 Monitoring Workgroups

DWR and Reclamation would continue to convene Monitoring Workgroups as needed. Reclamation would be solely responsible for convening Watershed Workgroups for each of the Upper Sacramento, American, and Stanislaus watersheds. Each of Reclamation's Watershed Workgroups would be responsible for real-time synthesis of fisheries monitoring information and providing recommendations on scheduling specific volumes of water for restorations actions described in the federal proposed action. DWR, in coordination with Reclamation, would convene the Delta Monitoring Workgroup, which would be responsible for integrating species information across watersheds, including Delta Smelt, Winter-run Chinook Salmon and other salmonids, and sturgeon. In addition to the Delta Monitoring Workgroup, the program may include smelt monitoring and salmonid monitoring teams. The Delta Monitoring Workgroup will include technical representatives from federal and state agencies and stakeholders and will provide information to DWR and Reclamation on species abundance, species distribution, life-stage transitions, and relevant physical parameters.

A WOMT comprised of agency managers will coordinate on overall water operations to oversee the implementation of various real-time provisions. The WOMT shall be responsible for overseeing the Watershed Monitoring Workgroups and elevating disagreements to the Directors of CDFW, DWR, Reclamation, USFWS, and NMFS, where necessary. The coordinated state and federal monitoring group structure is as follows:

- Directors
- WOMT
- Delta Monitoring Workgroup
  - Smelt Monitoring Team
  - Salmon Monitoring Team
  - Program Teams

The WOMT shall coordinate the preparation of seasonal and annual reporting in coordination with the Watershed Monitoring Teams.

DWR would continue to coordinate with the IEP for permitting and coordination for physical and biological monitoring. It would also continue to coordinate with the Collaborative Science and Adaptive Management Program for synthesis of monitoring and studies. In the event that either of these groups is unwilling or unable to provide for the commitments in the Proposed Project, DWR (in coordination with Reclamation) would confer with CDFW, USFWS, and NMFS on alternative implementation plans.

2.3.6 Four-Year Reviews

In January of 2024 and January of 2028, DWR, in coordination with Reclamation, would convene an independent panel to review OMR flow management and measures to improve survival through the South Delta and the Delta Smelt Summer-Fall Habitat Action.

Establishment of independent review panels composed of subject matter experts is a key component of DWR's proposed adaptive management approach to operation of the SWP. CDFW, NMFS, and USFWS may provide technical assistance and input regarding the panel and its panel charge. The panel would evaluate the efficacy of these and other project actions and make recommendations.

The independent panels would review actions for consistency with applicable guidance and will provide information and recommendations to DWR. DWR, in consultation with Reclamation, will provide the results of the independent review to CDFW, NMFS, and USFWS. DWR will coordinate with Reclamation to document a response to the independent review.

2.3.7 Drought and Dry Year Actions

DWR shall coordinate with Reclamation to develop a voluntary toolkit of drought actions that could be implemented at the discretion of DWR and/or Reclamation. On October 1, if the prior water year was dry or critical, DWR, in coordination with Reclamation, shall meet and confer with USFWS, NMFS, CDFW, and Public Water Agencies on voluntary measures to be considered if drought conditions continue into the following year. If dry conditions continue, DWR, in coordination with Reclamation, will regularly meet with this group (and potentially other agencies and organizations) to evaluate hydrologic conditions and the potential for continued dry conditions that may necessitate the need for development of a drought contingency plan (that may include actions from the toolkit) for the water year.

By February of each year following a critical hydrologic year type, DWR, in coordination with Reclamation, shall report on the measures employed and assess their effectiveness. The toolkit will be revisited at a frequency of not more than 5-year intervals.

2.3.8 Continued Installation of South Delta Temporary Barriers

DWR proposes to continue operating three temporary barriers at the Old River at Tracy, Middle River, and Grant Line Canal each year, when necessary to maintain operations of agricultural water users. These three rock barriers are designed to act as flow control structures, trapping tidal waters behind them after a high tide. These barriers improve water levels and circulation for local South Delta farmers and collectively are referred to as agricultural barriers.

The objectives of operating the three temporary barriers are to increase water levels, circulation patterns, and water quality in the South Delta area for local agricultural diversions. DWR installs and removes the temporary rock barriers at the following locations:

- Middle River near the Victoria Canal, about 0.5 mile south of the confluence of the Middle River, Trapper Slough, and the North Canal

- Old River near Tracy, approximately 0.5 mile east of the Delta-Mendota Canal intake
- Grant Line Canal, approximately 400 feet east of the Tracy Boulevard Bridge

The agricultural barriers will continue to be installed under existing permits starting in May, provided San Joaquin River flow at Vernalis is low enough to enable installation, typically less than 5,000 cfs. All three agricultural barriers operate until the fall and must be completed removed by November 30 of each year. Full closure of the Grant Line Canal Barrier requires NMFS, USFWS, and CDFW approval and a demonstrated need for the full closure based on actual conditions and modeling. Barriers would include at least one open culvert, to allow fish passage when water temperatures are less than 22°C (77 °F).

2.3.9 Barker Slough Pumping Plant Operations

The BSPP diverts water from Barker Slough into the NBA for delivery in Napa County and to the Solano County Water Agency (SCWA). The NBA intake is approximately 10 miles from the Sacramento River at the northwest end of Barker Slough. The maximum pumping capacity of this facility is 175 cfs. The annual maximum diversion is 125 TAF.

DWR will work with the USFWS to develop Delta Smelt minimization measures by the end of the 2019 calendar year. These minimization measures will aim to protect larval Delta Smelt from entrainment through the BSPP and will consider reduction in diversion through the NBA at the appropriate spring period and appropriate water year types by using effective detection measures or an appropriate proxy.

BSPP will be operated to protect larval Longfin Smelt from January 15 through March 31 of dry and critically dry years. The Water Year type is as defined in D-1641 for the Sacramento River Basin. If the Water Year type changes after January 1 to below normal, above normal, or wet, this action will be suspended. If the Water Year type changes after January to dry or critical, this action will occur.

DWR personnel in coordination with CDFW staff will review weekly the abundance and distribution survey data and other pertinent biological factors that influence the entrainment risk and detection of larval Longfin Smelt at Station 716. When conditions warrant, BSPP’s maximum 7-day average will not exceed 50 cfs from January 15 through March 31 within 5 days. During the 5-day period, the rate of diversion at BSPP will not increase. This restriction will be removed when larval Longfin Smelt are no longer detected at Station 716.

Operation of the BSPP also includes ongoing maintenance of the facility. Maintenance activities included in the Proposed Project include fish screen cleaning, sediment removal, and aquatic weed removal. Each of these activities is described below.

2.3.9.1 Fish Screen Cleaning

The 10 pump bays are individually screened with a positive-barrier fish screen consisting of a series of flat, stainless-steel, wedge-wire panels with a slot width of 3/32 inch. The screens are routinely cleaned to prevent excessive head loss and minimize increases in localized approach velocities (CDFG 2009).

2.3.9.2 Sediment Removal

Sediment accumulated on the concrete apron in front of the fish screen and in the pump wells behind the fish screen would be removed by suction dredge. Removal of sediment from within the pump wells would occur as needed, year-round.

Removal of sediment from the front apron would occur during summer and early fall months and during the annual NBA shutdown in March. The NBA is annually taken off-line for one to two-weeks for routine maintenance and repairs, and the BSPP is non-operational during this period.

Sediment would be tested and disposed at a suitable location or existing landfill.

2.3.9.3 Aquatic Weed Removal

The aquatic weed removal system consists of grappling hooks attached by chains to an aluminum frame. A boom truck, staged on the platform in front of the BSPP pumps, will lower the grappling system into the water to retrieve the accumulated aquatic vegetation. The removed aquatic weeds will be transported to two aggregate base spoil sites located near the pumping plant.

Removal of aquatic weeds from the BSPP fish screens would typically occur during summer and fall months when aquatic weed production is highest. Floating aquatic vegetation, i.e., water hyacinth, may need to be removed during spring months if water hyacinth becomes entrained into Barker Slough and accumulates in front of BSPP fish screens.

2.3.10 Clifton Court Forebay Operations

Clifton Court Forebay operations included in the Proposed Project include predator management and aquatic weed removal and disposal. Each of these operations is described below.

2.3.10.1 Predator Management

Fish entering the CCF must travel approximately 2.1 miles across the CCF to reach the Skinner Fish Facility. The loss of fish between the CCF Radial Gates and the Skinner Fish Facility is termed pre-screen loss (PSL). PSL includes, but is not limited to, predation by fish, birds, and other predatory species. Studies conducted by DWR and CDFW indicate that PSL of juvenile Chinook Salmon varies from 63% to 99% (Gingras 1997) and PSL of juvenile steelhead was 82 ± 3% (Clark et al. 2009). Predation by Striped Bass is thought to be the primary cause of high PSL in the CCF (Brown et al. 1996, Gingras 1997, Clark et al. 2009).

DWR proposes to continue the development of predator control methods including, but not limited to:

- Continued evaluation of the performance of various predator relocation methods
- Controlling aquatic weeds

Clifton Court Forebay Predator Studies

The Predator Reduction Interim Measure is a combination of the most effective predator removal elements of previous predator reduction efforts; the Clifton Court Forebay Predation Study, the

Predator Reduction Electrofishing Study, and the Predator Fish Relocation Study. The intent of this interim measure is to maximize the removal of predators from Clifton Court Forebay and relocate them to Bethany Reservoir, thereby reducing pre-screen losses.

2.3.10.2 Aquatic Weed Removal and Disposal

DWR will apply herbicides or will use mechanical harvesters on an as-needed basis to control aquatic weeds and algal blooms in the CCF (Table 2-4). Herbicides may include Aquathol K or copper-based herbicides. Algaecides may include peroxygen-based algaecides (e.g., PAK 27). These products are used to control algal blooms that can degrade drinking water quality through production of taste and odor compounds or algal toxins. Dense growth of submerged aquatic weeds can cause severe head loss and pump cavitation at the Banks Pumping Plant when the stems of the rooted plant break free and drift into the trash racks. This mass of uprooted and broken vegetation essentially forms a watertight plug at the trash racks and vertical louver array. The resulting blockage necessitates a reduction in the pumping rate of water to prevent potential equipment damage through cavitation at the pumps and excessive weight on the louver array causing collapse of the structure. Cavitation creates excessive wear and deterioration of the pump impeller blades. Excessive floating weed mats also reduce the efficiency of fish salvage at the Skinner Fish Facility. Ultimately, this all results in a reduction in the volume of water diverted by the SWP. In addition, dense stands of aquatic weeds provide cover for unwanted predators that prey on listed species within the CCF. Aquatic weed control is included as a conservation measure to reduce mortality of ESA-listed fish species within the CCF (see subsection 3.11.3, “Skinner Fish Facility Improvements”).

Mechanical Removal

Mechanical methods are used to manually remove aquatic weeds. A debris boom and an automated weed rake system continuously remove weeds entrained on the trash racks. During high weed load periods such as late summer and fall when the plants senesce and fragment or during periods of hyacinth entrainment, boat-mounted harvesters are operated on an as-needed basis to remove aquatic weeds in the Forebay and the intake channel upstream of the trash racks and louvers. The objective is to decrease the weed load on the trash racks and to improve flows in the channel. Effectiveness is limited due to the sheer volume of aquatic weeds and the limited capacity and speed of the harvesters. Harvesting rate for a typical weed harvester ranges from 0.5 to 1.5 acres per hour or 4 to 12 acres per day. Actual harvest rates may be lower due to travel time to off-loading sites, unsafe field conditions such as high winds, and equipment maintenance.

Table 2-4. Methods to Control Aquatic Weeds and Algal Blooms in Clifton Court Forebay

Algae and Weed Treatments	Control Target	Period of Use	Limits to Application	Other Conditions of Use
Aquathol K, an endothall-based aquatic herbicide and copper-based compounds, including copper sulfate pentahydrate and chelated copper herbicides	Pondweeds, *Egeria densa*, cyanobacteria, and green algae	As needed, from June 28 to August 31, when the average daily water temperature in the CCF is at or above 25°C	The herbicide application would not begin until after the radial gates have been closed. Applications of Aquathol K for pondweed control will be applied at a concentration of 2 to 3 ppm. Applications of copper herbicides for aquatic weed control will be applied at a concentration of 1 ppm with an expected dilution of 0.75 ppm dispersal in the water column. Application for algal control will be applied at a concentration of 0.2 to 1 ppm with expected dilution within the water column. The radial gates would remain closed for 12 to 24 hours after completion of the application.	The radial intake gates at the entrance to the CCF would be closed before application of pesticides to allow fish to move out of the targeted treatment areas and toward the salvage facility, and to prevent any possibility of aquatic pesticides diffusing into the Delta. The radial gates would remain closed for a minimum of 12 and up to 24 hours after treatment, to allow the recommended contact time between the aquatic pesticide and the treated vegetation or cyanobacteria in the CCF, and to reduce residual endothall concentrations for drinking water compliance. The radial gates would be re-opened after a minimum of 36 hours (24 hours pre-treatment closure plus 12 hours post-treatment closure). No more than 50% of the surface area of the CCF will be treated at one time. Water quality samples to monitor copper and endothall concentrations within or adjacent to the treatment area, per NPDES permit requirements, will be collected before, during, and after application.
Peroxygen-based algaecides (e.g., PAK 27)	Cyanobacteria	As needed, year-round	The radial gates would be closed before the application of the algaecide to prevent any possibility of the algaecide diffusing into the Delta. The radial gates may be re-opened immediately after the treatment, as the required contact time would be less than 1 minute and no residual by-product of concern would exist. Applied concentrations will be in the range of 0.3 to 10.2 ppm hydrogen peroxide.	No more than 50% of the surface area of the CCF will be treated at one time. Dissolved oxygen concentration will be measured prior to and immediately following application within and adjacent to the treatment zone.

Notes:
°C = degrees Celsius
CCF = Clifton Court Forebay
CDFW = California Department of Fish and Wildlife
DWR = California Department of Water Resources
ESA = federal Endangered Species Act
NMFS = National Marine Fisheries Service
NPDES = National Pollutant Discharge Elimination System
ppm = parts per million
USFWS = U.S. Fish and Wildlife Service

Aquatic Herbicide Application

Aquatic weed and algae treatments would occur on an as-needed basis depending upon the level of vegetation biomass, the cyanotoxin concentration from the harmful algal blooms (HABs), or the concentration of taste and odor compounds. The frequency of aquatic herbicide applications to control aquatic weeds is not expected to occur more than twice per year, as demonstrated by the history of past applications. Aquatic herbicides are ideally applied early in the growing season when plants are susceptible to them during rapid growth and formation of plant tissues; or later in the season, when plants are mobilizing energy stores from their leaves towards their roots for overwintering senescence. The frequency of algaecide applications to control HABs is not expected to occur more than once every few years, as indicated by monitoring data and demonstrated by the history of past applications. Treatment areas are typically about 900 acres, and no more than 50% of the 2,180 total surface acres.

Aquatic weed assemblages change from year to year in the CCF from predominantly *Egeria densa* to one dominated by curly-leaf pondweed, sago pondweed, and southern naiad. To effectively treat a dynamic aquatic weed assemblage and HABs, multiple aquatic pesticide compounds are required to control aquatic weeds and algal blooms in the CCF. The preferred products are the following:

- Aquathol K, an endothall-based aquatic herbicide that is effective on pondweeds
- Copper-based compounds that are effective on *E. densa*, cyanobacteria, and green algae; copper-based aquatic herbicides, including copper sulfate pentahydrate and chelated copper herbicides
- Peroxygen-based algaecides (e.g., PAK 27) that are effective on cyanobacteria

Aquathol K

The dipotassium salt of endothall is used for control of aquatic weeds and is the active ingredient in Aquathol® K (liquid formulation). Aquathol K is a widely used herbicide to control submerged weeds in lakes and ponds, and the short residual contact time (12 to 48 hours) makes it effective in both still and slow-moving water. Aquathol K is effective on many weeds, including hydrilla, milfoil, and curly-leaf pondweed, and begins working on contact to break down cell structure and inhibit protein synthesis. Without the ability to grow, the weed dies. Full kill takes place in 1 to 2 weeks. As weeds die, they sink to the bottom and decompose. Aquathol K is not effective at controlling *E. densa*.

Aquathol K is registered for use in California and has effectively controlled pondweeds and southern naiad in the CCF and in other lakes. Endothall has low acute and chronic toxicity effects on fish. The LC50 for salmonids is 20 to 40 times greater than the maximum concentration allowed to treat aquatic weeds. The U.S. Environmental Protection Agency (EPA) maximum concentration allowed for Aquathol K is 5 parts per million (ppm). A recent study (Courter et al. 2012) of the effect of Cascade® (same endothall formulation as Aquathol K) on salmon and steelhead smolts showed no sublethal effects until exposed to 9 to 12 ppm, that is, two to three times greater than the 5 ppm maximum concentration allowed by the EPA and about four to six times greater than the 2 to 3 ppm applied in past CCF treatments. In the study, steelhead and salmon smolts showed no statistical difference in mean survival between the control group and treatment groups, however, steelhead showed slightly lower survival after 9 days at 9 to 12 ppm. Based on the studies with salmonids, Aquathol K applied at or below the EPA maximum allowable concentration of 5 ppm poses a low to no toxicity risk to salmon, steelhead and other fish. No studies have assessed the exposure risk to Green Sturgeon.

When aquatic plant survey results indicate that pondweeds are the dominant species in the CCF, Aquathol K will be selected due to its effectiveness in controlling these species. Aquathol K will be applied according to the label instructions, with a target concentration dependent upon plant biomass, water volume, and forebay depth. The target concentration of treatments is 2 to 3 ppm, which is well below the concentration of 9 to 12 ppm where sublethal effects have been observed (Courter et al. 2012). DWR monitors herbicide concentration levels during and after treatment to ensure levels do not exceed the Aquathol K application limit of 5 ppm. Additional water quality testing may occur following treatment for drinking water intake purposes. Samples are submitted to a laboratory for analysis. There is no “real time” field test for endothall. No more than 50% of the surface area of the CCF will be treated at one time. A minimum contact time of 12 hours is needed for biological uptake and treatment effectiveness, but the contact time may be extended up to 24 hours to reduce the residual endothall concentration for National Pollutant Discharge Elimination System (NPDES) compliance purposes.

Copper-Based Aquatic Herbicides and Algaecides

Copper herbicides and algaecides include chelated copper products and copper sulfate pentahydrate crystals. When aquatic plant survey results indicate that *E. densa* is the dominant species, copper-based compounds will be selected due to their effectiveness in controlling this species. Application of Aquathol K does not affect *E. densa*. Copper-based algaecides are effective at controlling algal blooms (cyanobacteria) that produce cyanotoxins or taste and odor compounds.

Copper herbicides and algaecides will be applied in a manner consistent with the label instructions, with a target concentration dependent upon target species and biomass, water volume and the depth of the forebay. Applications of copper herbicides for aquatic weed control will be applied at a concentration of 1 ppm with an expected dilution to 0.75 ppm upon dispersal in the water column. Applications for algal control will be applied at a concentration of 0.2 to 1 ppm with expected dilution within the water column. DWR will monitor dissolved copper concentration levels during and after treatment to ensure levels do not exceed the application limit of 1 ppm, per NPDES permit required procedures. Treatment contact time will be up to 24 hours. If the dissolved copper concentration falls below 0.25 ppm during an aquatic weed treatment, DWR may opt to open the radial gates after 12 hours but before 24 hours to resume operations. Opening the radial gates prior to 24 hours would enable the rapid dilution of residual copper and thereby shorten the exposure duration of ESA-listed fish to the treatment. No more than 50% of the surface area of the CCF will be treated at one time.

Peroxygen-based Algaecides

The PAK 27 algaecide active ingredient is sodium carbonate peroxyhydrate. An oxidation reaction occurs immediately upon contact with the water destroying algal cell membranes and chlorophyll. There is no contact or holding time requirement, as the oxidation reaction occurs immediately and the byproducts are hydrogen peroxide and oxygen. There are no fishing, drinking, swimming, or irrigation restrictions following the use of this product. PAK 27 has National Sanitation Foundation International

(NSF)/American National Standards Institute (ANSI) Standard 60 Certification for use in drinking water supplies at maximum-labeled rates and is certified for organic use by the Organic Materials Reviews Institute (OMRI).

PAK 27, or an equivalent product, will be applied in a manner consistent with the label instructions, with permissible concentrations in the range of 0.3 to 10.2 ppm hydrogen peroxide. No more than 50% of the surface area of the CCF will be treated at one time.

Herbicide Application Procedure

The following are operational procedures to minimize impacts on listed species during aquatic herbicide treatment for application of Aquathol K and copper-based products and algaecide treatment for application of peroxide-based algaecides in the CCF:

- Apply Aquathol K and copper-based aquatic pesticides, as needed, from June 28 to August 31.
- Apply Aquathol K and copper-based aquatic pesticides, as needed, prior to June 28 or after August 31 if the average daily water temperatures within the CCF is at or above 77°F (25°C) and if Delta Smelt, salmonids, and Green Sturgeon are not at additional risk from the treatment as confirmed by NMFS and USFWS.
    - Prior to treatment outside of the June 28 to August 31 time frame, DWR will notify and confer with NMFS and USFWS on whether ESA-listed fish species are present and at risk from the proposed treatment.
- Apply Aquathol K and copper-based aquatic pesticides, as needed, during periods of activated Delta Smelt and salmonid protective measures and when the average daily water temperature in the CCF is below 77°F (25°C) if the following conditions are met:
    - Prior to treatment outside of the June 28 to August 31 time frame, DWR will notify and confer with NMFS and USFWS on whether ESA-listed fish species are present and at risk from the proposed treatment.
    - The herbicide application does not begin until after the radial gates have been closed for 24 hours or after the period of predicted Delta Smelt and salmonid survival within the CCF (e.g., after predicted mortality has occurred due to predation or other factors) has been exceeded.
    - The radial gates remain closed for 24 hours after the completion of the application, unless DWR confers with NMFS and USFWS and it is agreed that rapid dilution of the herbicide would be beneficial to reduce the exposure duration to listed fishes present within the CCF.
- Apply peroxygen-based aquatic algaecides, as needed, year-round.
- There are no anticipated impacts on fish with the use of peroxygen-based aquatic algaecides in the CCF during or following treatment.
- Monitor the salvage of listed fish at the Skinner Fish Facility prior to the application of the aquatic herbicides and algaecides in the CCF.
- For Aquathol K and copper compounds, the radial intake gates will be closed at the entrance to the CCF prior to the application of pesticides to allow fish to move out of the targeted treatment areas

and toward the salvage facility and to prevent any possibility of aquatic pesticide diffusing into the Delta.

- For Aquathol K and copper compounds, the radial gates will remain closed for a minimum of 12 and up to 24 hours after treatment to allow for the recommended duration of contact time between the aquatic pesticide and the treated vegetation or cyanobacteria in the forebay, and to reduce residual endothall concentration for drinking water compliance purposes. (Contact time is dependent upon pesticide type, applied concentration, and weed or algae assemblage.) Radial gates would be reopened after a minimum of 36 hours (24 hours pre-treatment closure plus 12 hours post-treatment closure).
- For peroxide-based algaecides, the radial gates will be closed prior to the application of the algaecide to prevent any possibility of the algaecide diffusing into the Delta. The radial gates may reopen immediately after the treatment, as the required contact time is less than 1 minute and there is no residual by-product of concern.
- Application will be made by a licensed applicator under the supervision of a California Certified Pest Control Advisor.
- Aquatic herbicides and algaecides will be applied by boat or by aircraft.
    - Boat applications will be by subsurface injection system for liquid formulations and by a boat-mounted hopper dispensing system for granular formulations. Applications would start at the shoreline and move systematically farther offshore, enabling fish to move out of the treatment area.
    - Aerial applications of granular and liquid formulations will be by helicopter or aircraft. No aerial spray applications will occur during wind speeds above 15 mph to prevent spray drift.
- Application would be to the smallest area possible that provides relief to SWP operations or water quality. No more than 50% of the CCF will be treated at one time.
- Water quality samples to monitor copper and endothall concentrations within or adjacent to the treatment area, per the NPDES permit requirements, will be collected before, during and after application. Additional water quality samples may be collected during the following treatment for drinking water compliance purposes. No monitoring of copper or endothall concentrations in the sediment or detritus is proposed.
- No monitoring of peroxide concentration in the water column will occur during and after application, as the reaction is immediate and there is no residual by-product of concern. Dissolved oxygen concentration will be measured prior to and immediately following application within and adjacent to the treatment zone.
- A spill prevention plan will be implemented in the event of an accidental spill.

Aquatic weed and algae treatments would occur on an as-needed basis. The timing of application is an avoidance measure and is based on the life history of Chinook Salmon and steelhead in the Central Valley's Delta region and of Delta Smelt. Green Sturgeon are present in the area year-round. Migrations of juvenile Winter-run Chinook Salmon and Spring-run Chinook Salmon primarily occur outside of the summer period in the Delta. Central Valley Steelhead have a low probability of being in the South Delta during late June, when temperatures exceed 77°F (25°C) through the first rainfall flush event, which can occur as late as December in some years (Grimaldo 2009). Delta Smelt are not expected to be in the CCF during this time period. Delta Smelt are not likely to survive when water temperatures reach a daily average of 77°F (25°C), and they are not expected to occur in the Delta prior to the first flush event. Therefore, the likelihood of herbicide exposure to Chinook Salmon, Central Valley Steelhead, and Delta Smelt during the proposed herbicide treatment time frame in the CCF is negligible.

Additional protective measures will be implemented to prevent or minimize adverse impacts from herbicide applications. As described above, applications of aquatic herbicides and algaecides will be contained within the CCF. The radial intake gates to the CCF will be closed prior to, during, and following the application. The radial gates will remain closed during the recommended minimum contact time based on herbicide type, application rate, and aquatic weed or algae assemblage. In addition, following the gate closure and prior to the applications of Aquathol K and copper-based pesticides, the water is drawn down in the CCF via the Banks Pumping Plant. This drawdown helps facilitate the movement of fish in the CCF toward the fish diversion screens and into the fish protection facility, lowers the water level in the CCF to decrease the total amount of herbicide needed to be applied per volume of water, and aids in the dilution of any residual pesticide post-treatment. Following reopening of the gates and refilling of the CCF, the rapid dilution of any residual pesticide and the downstream dispersal of the treated water into the California Aqueduct via the Banks Pumping Plant will reduce the exposure time of any ESA-listed fish species present in the CCF.

Avoidance and Minimization Practices

DWR implements the following best management practices during aquatic weed harvesting at Clifton Court Forebay to avoid and minimize potential impacts on sensitive resources:

- A pre-construction survey for nesting birds and Burrowing Owls is conducted by a qualified biologist within 2 weeks prior to the start of work. If Burrowing Owls are observed within 500 feet of the Proposed Project, non-disturbance buffers are established and/or a qualified biological monitor is present during disposal activities.
- On the first day of work, and as needed once work has begun, a qualified biologist surveys for floating grebe nests within the CCF and identifies avoidance areas to prevent take of nests.
- All on-site personnel participate in environmental awareness training for special-status species with the potential to occur in the project area.
- If any wildlife is observed within the aquatic weed removal and disposal areas, work is halted immediately and the wildlife are allowed to move out of the area on their own.
- Work does not take place during rain events or within 24 hours of significant precipitation when special-status species could potentially be traveling to breeding ponds.
- Aquatic weed disposal and vehicle travel are contained within the established roadways and identified work area.

2.3.11 Skinner Fish Facility Improvements

The Skinner Fish Facility has behavioral barriers to keep fish away from the pumps that lift water into the California Aqueduct. Large fish and debris are directed away from the facility by a 388-foot-long trash rack. Smaller fish are diverted from the intake channel into bypasses by a series of behavioral barriers (metal louvers), while the main flow of water continues through the louvers and toward the pumps. These fish pass through a secondary system of louvers or screens and pipes into seven holding tanks, where a subsample is counted and recorded. The salvaged fish then are returned to the Delta in oxygenated tank trucks. The sampling frequency at Skinner Fish Facility is generally 30 minutes of every 2 hours, but may be reduced based upon the presence of excessive numbers of fish or debris based upon procedures developed by CDFW. See Appendix G of the 2019 Biological Assessment for a summary of study results (Reclamation 2019).

DWR proposes to continue to salvage fish with the Skinner Fish Facility which is located about 2 miles upstream from the Banks Pumping Plant. In addition, DWR proposes the following:

- Operational changes to salvage release scheduling and location to reduce post-salvage predation
- Continued refinement and improvement of the fish sampling and hauling procedures and infrastructure to improve the accuracy and reliability of data and fish survival

2.3.12 Longfin Smelt Science Program

CDFW, DWR and the State Water Contractors (SWC) entered into an agreement in 2014 to implement a multiyear Longfin Smelt Science Program. The Longfin Science Program was described in a Study Plan that identified the Napa River, Coyote Creek, and other areas that required further study of environmental factors affecting the species distribution and reproduction. In addition, the Study Plan focused studies on sampling efficiency, including time of day, water transparency, and tidal conditions. The Study Plan was intended to address eight research questions, six of which will be examined over the course of an initial 5-year period of field study and data analysis. The Longfin Smelt Science Program would be continued. An updated Study Plan would be developed jointly with DWR, CDFW and the SWC and would address issues that include external issues influencing population abundance, distribution, and catchability, including vertical migration behavior and water transparency.

2.3.13 Conduct Further Studies to Prepare for Delta Smelt Reintroduction from Stock Raised at the UC Davis Fish Conservation and Culture Laboratory

DWR is proposing to continue supporting the operation and research being conducted by the University of California, Davis (UC Davis), Fish Conservation and Culture Laboratory (FCCL).

The two main goals of the FCCL are to maintain a refuge Delta Smelt population in captivity that is as genetically close as possible to the wild population and provide a safeguard against extinction. The culture technique has been improved continuously over the years and the survival rate of cultured Delta Smelt at the FCCL is high (UC Davis 2019).

The FCCL is undertaking multiple research projects that will continue to add to the understanding of Delta Smelt and other species. The laboratory works collaboratively with other researchers from different agencies and institutions, assisting them with research projects and providing them with experimental fish populations of all life stages. The FCCL currently is expanding and renovating existing facilities, increasing the capacity for culture and research. Ongoing and future studies include the following:

- The FCCL currently is conducting studies to characterize and better understand Delta Smelt spawning behavior. Because spawning behavior has never been observed in the wild and has not been formally described yet, it is unclear how and where Delta Smelt naturally spawn. In ongoing experiments, the laboratory is conducting studies that characterize Delta Smelt spawning behavior under natural conditions and examining spawning substrate preferences. The findings from these studies will be critical to continued recovery and conservation efforts.
- The FCCL is investigating the optimum conditions for hatching Delta Smelt eggs in the wild. The current laboratory practice has been optimized to hatch good-quality eggs within 10 days of spawning, although it is important to consider the conditions in which the eggs are spawned in the wild. The laboratory is studying the effects of salinity and flow rate on the survival and condition of Delta Smelt eggs. This information will inform the proposed egg frame trials as well as the conservation of suitable breeding grounds.
- The FCCL is testing the possibilities of using an egg frame, created by the Lake Suwa Fishing Collective in Hokkaido, Japan, for future restoration of Delta Smelt in the Delta. The frame was designed for hatching Wakasagi (*Hypomesus nipponensis*) into a body of water with constant flow. The water flow condition around the eggs in the frame will be studied using computational flow dynamics, and the results will be used to suggest a suitable environment for applying the egg frame in the Delta.
- The FCCL is taking steps toward promoting survival of individual families by conducting trials using small culture containers that can rear single families at a time. This method could reduce competition between families and increase the survival of each individual family. The FCCL is carrying out trials to assess this factor by individually incubating an equal number of eggs from one, four, or eight family groups; parentage analysis will assess the survival of each family in these groups.
- The FCCL was able to increase survival rates to a level sufficient for the successful culturing of Delta Smelt from the egg through adult stage; the first complete life cycle in captivity was established in 2000–2001. Currently, the FCCL focuses on improving existing rearing techniques, with the goals of increasing the system's efficacy and rearing success. Some of the laboratory's current areas of emphasis are as follows:
    - Tank size and system parameters As fish develop from newly hatched larvae to adults, they are transferred multiple times between fish-rearing systems to fulfill the needs of each life stage. Black interior tanks are used for all fish, as clear and acrylic tanks have been found to stress fish. Light is administered to the tanks, with varying intensities corresponding to what has been deemed optimal for each life stage. Each recirculating system provides ultraviolet (UV)

sterilization, both particle and biological filtration, and heat pumps for temperature control. Currently, the FCCL is testing stocking densities and feeding rates for each tank and also is developing smaller culturing systems for research purposes.

- Turbidity effect early-larval and late-larval stages require different turbidity environments to promote feeding. Although it is not completely understood why larval stages require turbidity, it is thought that the suspended particles provide a visual contrast that enables larval stages to better find their prey. Turbidity is introduced via the addition of concentrated algae. As fish mature into the adult stage, algal addition gradually is decreased to gently transition the fish into clearer water environments.
- Weaning strategies As the smelt develop, they are transitioned from a live prey diet to a dry feed diet. The FCCL currently is researching this topic to determine the best time for weaning.
- Salinity In their natural environment, Delta Smelt inhabit estuary areas of relatively low salinity. The precise environmental salinity values vary seasonally, in accordance with each year's freshwater availability. In collaboration with researchers at UC Davis, the FCCL is conducting experiments that analyze the physiological effects of salinity on Delta Smelt.

2.3.14 Continue Studies to Establish a Delta Fish Species Conservation Hatchery

The Delta Smelt (*Hypomesus transpacificus*) is currently in severe decline within its native range in the Sacramento-San Joaquin Delta. Delta Smelt have declined to such low numbers that it is difficult to detect them in traditional surveys, and it is possible that the species cannot sustain itself without additional recovery actions. In an effort to conserve the species, a refuge population has been maintained at the UC Davis FCCL in Byron, California, since 2006 (a smaller population exists as a backup to the FCCL at Livingston Stone Hatchery in Shasta Lake, CA). The refuge population provides fish for research purposes, but more importantly, is a reservoir of Delta Smelt genetic diversity that has been specifically managed for potential wild population supplementation or reintroduction.

Currently, FCCL fish have not been released into the Delta, except as part of a predation study in a South Delta fish facility (Castillo et al. 2012). Yet under the present circumstances, there is a need to at least have an emergency plan to guide possible release of refuge fish into the wild. Logic suggests that the easiest and most effective course of action at present may be to supplement the wild population before it goes extinct. Unfortunately, little is known about the most effective way to release Delta Smelt into the Delta for the purpose of recovering the species.

In recognition of this issue, since 2017 DWR has facilitated studies with the overarching goal of determining the best methods to manage Delta Smelt releases from the refuge population to benefit the wild with maximum survival, retention of genetic diversity, and minimal risk to the wild population. A first step was the organization of a public workshop that identified some of the major scientific uncertainties and to guide future studies (Lessard et al. 2018). This workshop has led to DWR's collaborative work with UC Davis, USFWS, CDFW, and Reclamation to conduct initial investigations. The current work plan includes work on genetics, pathology, behavior, a Hatchery and Genetic Management Plan, and test use of hatchery fish in experimental enclosures placed in the wild. Ultimately, the goal of this work is to develop an adaptive population supplementation plan that will assemble current knowledge about Delta Smelt, describe successful supplementation/reintroduction approaches for other fish species, identify research priorities, recommend monitoring approaches for evaluating supplementation strategies, and detail facility upgrade requirements for the refuge population.

DWR is proposing to continue collaborative laboratory and field work to develop a strategy for successful reintroduction of Delta Smelt to their natural environment in the wild and prevention of extinction. Since previous field work on hatchery smelt required the project team to secure CESA coverage for this project, we propose to include this work in our Project Description to allow continued laboratory and field research to support possible future supplementation. As in previous years, the work would be led by a hatchery advisory team, which could be the existing multi-agency group (CDFW, USFWS, Reclamation, DWR, UC Davis, USGS) or a potential new group organized by CDFW and USFWS.

For 2020 it is anticipated that the primary research activities will be deployment of custom smelt cages in multiple habitats (channel, tidal wetlands) and geographic areas (Suisun, Sacramento River, North Delta), genetic analysis of the wild and hatchery population, pathology, and behavioral studies. The specific details of the work will be subject to input and review by the agency hatchery advisory group.

No construction will occur as part of this proposal. Similarly, none of these studies are intended to directly augment the smelt population. Depending on study results, future decisions to proceed with supplementation would be subject to separate reviews under CESA, ESA, and CEQA.

2.3.15 Water Transfers

DWR and Reclamation propose to continue facilitating transfers of SWP water and other water supplies through CVP and SWP facilities, including north-to-south transfers and north-to-north transfers. The quantity and timing of Keswick releases would be similar to those that would occur absent the transfer. Water transfers would occur through various methods, including, but not limited to, groundwater substitution, release from storage, and cropland idling, and would include individual and multi-year transfers. The effects of developing supplies for water transfers in any individual year or a multi-year transfer is evaluated outside of this proposed action. North-to-South water transfers would occur from July through November in total annual volumes up to those described in Table 2-5.

Table 2-5. Proposed Annual North-to-South Water Transfer Volume

Water Year Type	Maximum Transfer Amount (TAF)
Critical	Up to 600
Dry (following Critical)	Up to 600
Dry (following Dry)	Up to 600
All other years	Up to 360

Note:
TAF = thousand acre-feet

As part of this proposed action, DWR and Reclamation will provide a transfer window from July 1 through November 30. Real-time operations may restrict transfers within the transfer window so that

Reclamation and DWR can meet other authorized project purposes, e.g., when pumping capacity is needed for CVP or SWP water.

2.3.16 Adaptive Management Plan

The Adaptive Management Plan (AMP) will be carried out to evaluate the efficacy of the operations and activities stated below. An Adaptive Management Team (AMT) will be established to carry out this AMP. The AMT will oversee efforts to monitor and evaluate the operations and related activities. In addition, the AMT will use structured decision-making to assess the relative costs and benefits of those operations and activities. The AMT will also identify proposed adaptive management changes to those operations and activities. The AMP will be developed before issuance of, and could be incorporated into, the ITP DWR is seeking for CESA coverage for the Proposed Project. Any proposed adaptive management changes should provide equivalent or superior conservation benefits to the listed species at equal or lesser societal costs. The objectives of the AMP are to: (i) continue the long-term operation of the SWP in a manner that improves water supply reliability and water quality consistent with applicable laws, contractual obligations, and agreements and (ii) use the knowledge gained from the scientific study and analysis described in the AMP to avoid, minimize and fully mitigate the adverse effects of SWP operations on CESA-listed aquatic species.

More specifically, the intent of this AMP is to:

- Create an adaptive management plan for ongoing operation of the SWP, as it operates in coordination with the CVP that will assist DWR in complying with applicable California law, including CESA.
- Develop and implement a monitoring protocol necessary to implement the AMP, working in coordination with the Collaborative Science and Adaptive Management Program (CSAMP) and the Delta Science Program (DSP) as appropriate.
- Identify the scope of the AMP, that is, the operations and activities that will be subject to adaptive management.
- Describe the decision-making and governance structure that will be used to implement the AMP including adaptive management changes.
- Describe the mechanisms that will be used to communicate among the Implementing Entities and with the broader stakeholder community regarding implementation of the AMP.
- Describe funding for the AMP.
- Describe the relationship between the AMP and real-time operations.

Each existing operation and activity and each adaptive management change must be accompanied by (1) a set of criteria that the Implementing Entities can use to determine whether the action is having the anticipated impacts (e.g., take limits derived from salvage data) and (2) monitoring that will provide the data necessary in order to determine whether the performance measures are being met. It may be necessary to undertake additional monitoring and research that build on existing efforts in order to carry out this adaptive management program. The AMP would draw upon the CSAMP and the

DSP, where appropriate, to assist with these monitoring and research efforts as well as program evaluation.

The AMP extends to specified operation of the SWP and activities undertaken by DWR concomitant to those operations. They include the following:

- Operation of the Banks Pumping Plant to comply with OMR flow requirements
- Delta Smelt Summer-Fall Habitat Action, including food enhancement actions
- Installation of the South Delta temporary barriers
- Spring outflow actions
- Clifton Court Forebay predator management
- Monitoring associated with all of the foregoing

While the AMP described in this document pertains only to specified operation of the SWP and activities undertaken by DWR concomitant to those operations and will be used to support the 2081 permit issued for operation of the SWP, upon unanimous agreement among the Implementing Entities, it may be (1) expanded in the future to include other operations and activities, or (2) implemented in a coordinated manner with other adaptive management programs covering such operations and activities. These may include ongoing operations of the CVP and implementation of voluntary agreements or other activities undertaken under the oversight of the State Water Resources Control Board.

3 INITIAL STUDY CHECKLIST

3.1 AESTHETICS

Table 3.1-1. Potential Impacts on Aesthetics

ENVIRONMENTAL ISSUES		ENVIRONMENTAL IMPACT SIGNIFICANCE
I.	**Aesthetics. Except as provided in Public Resources Code Section 21099, would the project:**	-
Have a substantial adverse effect on a scenic vista?		No Impact
a)	Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	No Impact
b)	Substantially degrade the existing visual character or quality of public views of the site and its surroundings? (Public views are those that are experienced from a publicly accessible vantage point.) If the project is in an urbanized area, would the project conflict with applicable zoning and other regulations governing scenic quality?	No Impact
c)	Create a new source of substantial light or glare that would adversely affect day or nighttime views in the area?	No Impact

Note:
"-" indicates blank cell

3.1.1 Environmental Setting

The visual appearance of the landscape is dependent on the underlying landform and its land cover. Natural landscape elements include topography, geology, hydrology, vegetation, and wildlife. Engineered landscape elements include buildings, roads, infrastructure, and settlement patterns. The visual character of a particular landscape is established by the interaction of these physical elements. The visual quality of the landscape considers the vividness, intactness, and unity of the viewshed, along with considerations related to viewer sensitivity (i.e., the number and type of viewers and the frequency and duration of views). (Federal Highway Administration 1988; U.S. Forest Service 1995).

3.1.1.1 Visual Character

Delta and Suisun Marsh

The Delta and Suisun Marsh, which extend west to the San Francisco Bay, mark the confluence of the Sacramento and San Joaquin rivers. Major waterways and sloughs provide connections between the Sacramento, San Joaquin, Mokelumne, Cosumnes, and Calaveras rivers to the southeast. The smaller waterways traverse a landscape that includes more than 50 named islands and tracts, with hundreds of smaller islands, which vary in size from a few acres to several thousand acres. The larger islands are protected by flood control levees. Most of these levees are armored with large boulders to prevent erosion and scour. Viewed from the water, the armoring on the levees appears in sharp contrast to the water and surrounding vegetation, decreasing the visual quality. The height of the levees restricts views of the interior of the islands from most locations on the water.

The Delta region is nearly flat, with only a few scattered stands of trees. Most of the Delta is used for agricultural purposes. Visible flood management and irrigation facilities include levees and other impoundments, pumping plants, and control gate structures. Transportation infrastructure is limited, with only a few scattered roads and bridges that access the larger islands.

Suisun Marsh is characterized by tidal and freshwater wetlands and riparian woodlands. Upland areas, such as the Montezuma Hills, provide a backdrop with rolling hills and occasional oak woodlands. Much of Suisun Marsh is managed wetland that provides habitat for fish and resident and migrating birds and waterfowl.

San Francisco Bay

The physical and natural environment of the San Francisco Bay is diverse, with a wide range of visual resources. The Bay itself ranges from approximately 3 to 12 miles wide and is approximately 60 miles long. Typical views and landscapes include heavy urban development, natural and altered open-space areas, major ridgelines, and scenic waterways. The terrain ranges from alluvial plains to gently sloping hills and wooded ravines. Striking scenic vistas of iconic scenes are available throughout the area: the San Francisco Bay, the San Francisco skyline, Angel Island, Alcatraz Island, Mount Tamalpais, the Peninsula foothills, and the East Bay hills. Views to the east are dominated by Mount Diablo and the adjacent Diablo Ridge and associated valleys. Views to the west are dominated by the Coast Ranges.

San Luis Reservoir

The SWP and CVP San Luis Reservoir complex is in the western foothills of the Coast Ranges, on the western side of the northern San Joaquin Valley. The CVP and SWP water conveyance facilities are at the base of the San Luis Reservoir. This area is sparsely populated and is characterized by mountainous to hilly terrain, with grasslands and scattered oak woodlands along narrow streams.

The predominant visual feature in the San Joaquin Valley is agricultural land. Where visible along the western and eastern margins of the valley, predominant visual features also include views of the Coast Ranges and Sierra Nevada, respectively.

The San Luis and Los Banos Creek reservoirs are part of the visual resources for the San Luis Reservoir State Recreation Area and Cottonwood Creek Wildlife Area. The shorelines of the reservoirs are undeveloped, except for recreational facilities. Views include annual grassland, coastal sage, and riparian woodland. When the reservoir waters are drawn down, broad bands of bare soil are exposed, detracting from the visual quality. Open water viewing opportunities also occur south of the San Luis Reservoir complex at the Little Panoche Reservoir, west of Interstate (I) 5.

SWP Service Areas

Areas along the Pacific Coast in San Luis Obispo, Santa Barbara, Ventura, portions of Los Angeles, portions of Orange, and San Diego counties are characterized by steep, craggy coastal mountains and coastal plains. The visual resources include beaches, sand dunes, coastal bluffs, headlands, wetlands, estuaries, islands, hillsides, and canyons. The foothills extend from the Pacific Ocean to more than 800 feet above mean sea level and generally are covered with mature trees (including native oaks, deciduous trees, and eucalyptus) and grasslands.

Inland from the Pacific Ocean, urban areas extend throughout large portions of the foothills and valleys of Los Angeles, Orange, San Diego, Riverside, and San Bernardino counties. Reduced abundance of natural features and scenic vistas and the dominating presence of non-urban land uses diminish the visual quality. However, in the Coachella Valley portion of Riverside County, the visual character is dominated by dramatic vistas of the Santa Rosa, San Jacinto, San Bernardino, Cottonwood, and Chocolate mountains, with high desert craggy rock outcroppings and sparse vegetation. The Salton Sea in the southern Coachella Valley provides dramatic vistas from the shoreline and highways that extend around the open water.

The inland areas also include major surface water resources that provide open water vistas associated with recreational activities, including the Twitchell Reservoir, Silverwood Lake, Diamond Valley Lake, Lake Perris, Lake Skinner, Vail Lake, and Lake Mathews, along with smaller water supply reservoirs. Many of these reservoirs store SWP water and are human-built reservoirs, located in the foothills or at the edge of the foothills.

3.1.1.2 Wild and Scenic Rivers

The National Wild and Scenic Rivers System was created by the U.S. Congress in 1968 (Public Law 90-542; 16 U.S. Code 1271 et seq.) to preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition and to protect the rivers and their immediate environments.

The California Wild and Scenic Rivers Act (California Public Resources Code Section 5093.50 et seq.) was enacted in 1972 to preserve designated rivers or river segments that are free-flowing and possess extraordinary wildlife, fishery, scenic, or recreational values. The act designates rivers or segments of rivers in the state as wild, scenic, or recreational for preserving the highest and most beneficial uses of those rivers.

After a river is designated as wild and scenic, existing recreation, agricultural practices, residential development, and other permitted uses (such as power generation and diversion under existing, permitted water rights) may continue. New uses that would substantially degrade the visual character are prohibited. Protection of the river is provided through regulation and programs of federal, State, local, or tribal governments, and through voluntary stewardship by landowners and river users. Six designated wild and scenic rivers are in the Central Coast and Southern California SWP service area: one in the mountains north of Santa Barbara, two in the Angeles National Forest, and three in the Santa Rosa–San Jacinto Mountains west of Palm Springs (National Wild and Scenic River System 2019).

3.1.1.3 State Scenic Highways

The California Scenic Highway Program is intended to protect and enhance California’s natural beauty, and to protect the social and economic values provided by the State’s scenic resources. The program is administered by the California Department of Transportation. A variety of roadways throughout the state have been officially designated as “scenic corridors.” Other roadways have been classified as "eligible" but have not been granted "scenic" status. A State-designed scenic corridor requires, at a minimum, the following actions that are designed to protect the existing visual quality (Caltrans 2018):

- regulation of land use and density of development;
- detailed land and site planning;
- control of outdoor advertising, including a ban on billboards;
- careful attention to and control of earthmoving and landscaping; and
- careful attention to design and appearance of structures and equipment.

Portions of the scenic viewshed around one scenic highway in the Northern California project area were burned by wildfires in 2018:

- SR 70 from Red Hill south of Lake Oroville northeast to Grizzly Creek burned in the 2018 Camp Fire (CAL FIRE 2018)

The existing visual quality of this scenic highway in the burn areas now is considered to be low because of the dominant appearance of brown and blackened vegetation.

Table 3.1-2 shows designated and eligible scenic highway corridors in the vicinity of SWP or CVP facilities or water bodies.

Table 3.1-2. Scenic Highways

Project Region	Description	Type of Designation
Sacramento Valley Region	-	-
Sacramento County	SR 160 from Freeport south to the border with Contra Costa County (paralleling the Sacramento River and crossing the Delta)	State
Contra Costa County	SR 160 from the border with Sacramento County to the intersection with SR 4, and south on SR 4 to Sellers Avenue (crossing the Delta and the lower San Joaquin River)	Eligible
Delta Region	-	-
Sacramento County	SR 160 from Freeport south to the border with Contra Costa County (paralleling the Sacramento River and crossing the Delta)	State
Contra Costa County	SR 160 from the border with Sacramento County to the intersection with SR 4, and south on SR 4 to Sellers Avenue (crossing the Delta and the lower San Joaquin River)	Eligible
San Francisco Bay Region	-	-
Solano County	SR 37 from Vallejo to Sears Point (crossing a portion of the northern San Francisco Bay)	Eligible

Sources: Caltrans 2017a, 2017b
SR = State Route
"-" indicates blank cell

Several State-designated scenic corridors are in the Central Coast and Southern California SWP service area. Most of these roadways have been designated based on views of agricultural land; a few are in mountainous areas where scenic mountain vistas are present (Caltrans 2017a).

3.1.2 DISCUSSION

a) Have a substantial adverse effect on a scenic vista?

The Proposed Project would not involve any new construction of water facilities, infrastructure, or result in land disturbance. Furthermore, no changes in land use (i.e., conversion from agricultural land to non-agricultural land) are anticipated because of the Proposed Project. Therefore, **no impact** on an existing scenic vista would occur.

Section 3.10, "Hydrology and Water Quality," of this IS concludes that the proposed long-term operation of the SWP would remain within the historic range of past SWP operations and would not result in altering downstream surface water flows that would alter existing visual resources or scenic vistas. **No impact** on an existing scenic vista would occur.

b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?

For the same reasons described in response to Item (a), the proposed long-term operation of the SWP would not substantially damage scenic resources within a designated state scenic highway. **No impact on** an existing scenic resource or views along a state scenic highway would occur.

c) Substantially degrade the existing visual character or quality of public views of the site and its surroundings? (Public views are those that are experienced from a publicly accessible vantage point.) If the project is in an urbanized area, would the project conflict with applicable zoning and other regulations governing scenic quality?

The proposed long-term operation of the SWP would not involve any new construction of water facilities, infrastructure, or land disturbance. No changes in land use (i.e., conversion from agricultural land to non-agricultural land uses) are anticipated because of the proposed long-term operation of the SWP.

The proposed long-term operation and maintenance of existing SWP facilities would have no effect on the existing visual character of the SWP facilities or their surroundings. The proposed long-term operation of the SWP would not reduce the scenic attributes or degrade the visual quality of associated streams and rivers or the surrounding landscape that would conflict with applicable zoning and other regulations governing scenic quality. **No impact on** the visual character of the landscape or the quality of public views would occur.

d) Create a new source of substantial light or glare that would adversely affect day or nighttime views in the area?

The Proposed Project would not involve any new construction of water facilities, infrastructure, or land disturbance that could require new nighttime lighting or create new sources of glare. The proposed long-term operation of the SWP also would not require new nighttime lighting or create new sources of glare. **No impact** would occur.

3.2 AGRICULTURE AND FORESTRY RESOURCES

Table 3.2-1. Potential Impacts on Agriculture and Forestry Resources

ENVIRONMENTAL ISSUES	ENVIRONMENTAL IMPACT SIGNIFICANCE
II. Agriculture and Forestry Resources. In determining whether impacts on agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997, as updated) prepared by the California Department of Conservation as an optional model to use in assessing impacts on agriculture and farmland. In determining whether impacts on forest resources, including timberland, are significant environmental effects, lead agencies may refer to information compiled by the California Department of Forestry and Fire Protection regarding the state's inventory of forest land, including the Forest and Range Assessment Project and the Forest Legacy Assessment project; and forest carbon measurement methodology provided in Forest Protocols adopted by the California Air Resources Board. Would the project:	-
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	No Impact
b) Conflict with existing zoning for agricultural use or a Williamson Act contract?	No Impact
c) Conflict with existing zoning for, or cause rezoning of, forest land (as defined in Public Resources Code section 12220(g)), timberland (as defined by Public Resources Code section 4526), or timberland zoned Timberland Production (as defined by Government Code section 51104(g))?	No Impact
d) Result in the loss of forest land or conversion of forest land to non-forest use?	No Impact
e) Involve other changes in the existing environment that, due to their location or nature, could result in conversion of Farmland to non-agricultural use or conversion of forest land to non-forest use?	No Impact

Note:
"-" indicates blank cell

3.2.1 ENVIRONMENTAL SETTING

3.2.1.1 Agricultural Resources

California ranks as the leading agricultural state in the United States in terms of farm-level sales. In 2017, California's farm-level sales totaled nearly $50 billion and accounted for 13% of total U.S. agricultural sales. Tulare and Kern counties rank among the leading agricultural counties in the nation (CRS 2015).

According to the 2017 Census of Agriculture (the most recent census for which data were available at the time of writing), there is approximately 24.523 million acres of farmland in California, and these acres represent slightly less than a quarter of California's total land area (USDA 2019). The acreage of farmland includes approximately:

- 9.6 million acres of cropland
- 11.6 million acres of permanent pasture and rangeland
- 1.85 million acres of pastured or unpastured woodlands
- 1.47 million acres in farmsteads, buildings, livestock facilities, roads, ponds and wastelands, etc.

The acreage of farmland, including irrigated farmland, in California has decreased over the past 20 years, down from approximately 8.89 million acres of farmland in 1997 to approximately 7.84 million acres of land in 2017 (USDA 2019).

The existing SWP plays an important role in California's agriculture, as approximately 30% of SWP water is used to irrigate approximately 750,000 acres of farmland, located mostly within the San Joaquin Valley (Water Education Foundation 2019). Table 3.2-2 shows the State Water Contractors that supply water for agricultural purposes.

Table 3.2-2. State Water Contractors that Supply Water for Agricultural Use

State Water Contractors	Table A Contracted Water Supply (acre-feet)
Oak Flat Water District	5,700
Kings County	9,305
Dudley Ridge Water District	45,350
Empire West Side Irrigation District	3,000
Kern County Water Agency[1]	982,730
Tulare Lake Water Storage District	87,471
Antelope Valley-East Kern Water Agency[2]	144,844

Notes:

1 Approximately 15% of the Kern County Water Agency Table A amount is classified as municipal and industrial supply.

2 Approximately 75% of the Antelope Valley-East Kern Water Agency Table A amount is used for municipal and industrial supply.

Source: DWR 2016

Approximately 14.8 million acres of California farmland reported enrollment in California Land Conservation Act (Williamson Act) contracts in 2015 (CDOC 2016). The Department of Conservation's Farmland Mapping and Monitoring Program (FMMP) identifies the suitability of agricultural lands in the state of California. The classifications of Prime Farmlands, Farmlands of Statewide Importance, Unique Farmland, Farmland of Local Importance, and Grazing Land are based on both land use and soil. Approximately 5.1 million acres of irrigated farmland in the state was identified as prime farmland in 2012, the most recent year for which statewide data were available (CDOC 2015).

The following discussion summarizes agricultural land use and irrigation practices within the project area, itemized by county and leading commodities.

Sacramento-San Joaquin Delta

The Delta Region includes Sacramento, Yolo, Solano, San Joaquin, and Contra Costa counties. Of these five counties, San Joaquin County has the highest acreage of total agricultural land, irrigated land, prime farmland, and land under Williamson Act contracts (Table 3.2-3).

Table 3.2-3. Delta Region Agricultural Land Uses

Land Use	Sacramento County	Yolo County	Solano County	San Joaquin County	Contra Costa County
Total Agricultural Land (acres)#	260,212	459,662	342,593	772,762	155,572
Total Irrigated Land (acres) #	100,399	234,703	110,396	487,147	22,625
Prime Farmland (acres)*	90,691	250,345	130,843	381,634	26,332
Farmland of Statewide Importance (acres)*	43,342	19,529	6,674	82,618	7,733
Unique Farmland (acres)*	15,540	46,095	10,346	81,920	3,392
Farmland of Local Importance (acres)*	57,910	49,671	0	68,903	60,416
Williamson Act Contracts (acres)+	174,656	NR	271,041	499,654	42,137
Leading Commodities^	Grapes (Wine), Milk, Poultry, Pears (Bartlett)	Almonds, Tomatoes, Grapes (Wine), Field Crops	Walnuts, Nursery, Almonds, Tomatoes	Grapes (Wine), Milk, Almonds, Walnuts	Cattle & Calves, Tomatoes, Corn (Sweet), Grapes (Wine)

Notes:
Total agricultural land and irrigated land data are from the 2017 Census of Agriculture (USDA 2019).
* Important farmland data are from the 2016 FMMP Inventory (CDOC 2016a).
+ Williamson Act Contract data are from 2015 Reported Acreage (CDOC 2016b).
^ Commodity data are from the 2017-18 California Agriculture Statistics Review (CDFA 2018).
FMMP = Farmland Mapping and Monitoring Program
NR = not reported

San Joaquin Valley Region

The San Joaquin Valley Region includes Stanislaus, Merced, Madera, Fresno, Kings, Tulare, and Kern counties. Of the seven counties in this region, Kern County has the highest acreage of agricultural land and land under Williamson Act contracts, while Fresno County has the highest acreage of irrigated land and prime farmland (Table 3.2-4).

San Francisco Bay Area Region

The San Francisco Bay Area Region includes Alameda, Napa, Santa Clara, and San Benito counties. Of these four counties, San Benito has the highest acreage of total agricultural land and land enrolled in Williamson Act contracts, while Napa County has the highest acreage of irrigated land and prime farmland (Table 3.2-5).

Central Coast Region

The Central Coast Region includes San Luis Obispo and Santa Barbara counties. Of these, San Luis Obispo County has the highest acreage of total agricultural land and Williamson Act contracts, while Santa Barbara has the highest acreage of irrigated land and prime farmland (Table 3.2-6).

Table 3.2-4. San Joaquin Valley Region Agricultural Land Uses

Land Use	Stanislaus County	Merced County	Madera County	Fresno County	Kings County	Tulare County	Kern County
Total Agricultural Land (acres)#	722,546	946,385	645,358	1,646,540	615,958	1,250,121	2,295,497
Total Irrigated Land (acres)#	380,590	493,726	300,234	972,576	371,699	568,184	730,711
Prime Farmland (acres)*	249,967	269,243	98,500	675,722	110,915	366,136	579,295
Farmland of Statewide Importance (acres)*	33,172	154,209	85,206	397,134	339,020	322,355	209,484
Unique Farmland (acres)*	116,210	115,235	180,291	94,902	18,920	11,691	91,323
Farmland of Local Importance (acres)*	26,029	61,671	8,751	191,782	10,984	157,937	0
Williamson Act Contracts (acres)+	575,705	464,031	538,340	1,473,924	674,445	1,097,727	1,673,306
Leading Commodities^	Almonds, Milk, Chickens, Nursery (Fruit/Vine/ Nut, non-bearing)	Milk, Almonds, Chickens, Cattle and Calves	Almonds, Milk, Pistachios, Grapes (Wine)	Almonds, Poultry, Pistachios, Milk	Milk, Cotton (Pima), Cattle and Calves, Almonds	Milk, Grapes (Table), Cattle and Calves, Oranges	Grapes (Table), Almonds, Milk, Pistachios

Notes:
[#] Total agricultural land and irrigated land data are from the 2017 Census of Agriculture (USDA 2019).
* Important Farmland data are from the 2016 FMMP Inventory (CDOC 2016a).
+ Williamson Act Contract data are from 2015 Reported Acreage (CDOC 2016b).
^ Commodity data are from the 2017-18 California Agriculture Statistics Review (CDFA 2018).
FMMP = Farmland Mapping and Monitoring Program

Table 3.2-5. San Francisco Bay Area Region Agricultural Land Uses

Land Use	Alameda County	Napa County	Santa Clara County	San Benito County
Total Agricultural Land (acres)#	183,282	255,778	288,084	520,127
Total Irrigated Land (acres)#	7,511	60,945	19,222	18,085
Prime Farmland (acres)*	3,392	30,619	14,909	26,833
Farmland of Statewide Importance (acres)*	1,127	9,593	3,273	7,107
Unique Farmland (acres)*	2,153	16,803	2,227	2,412
Farmland of Local Importance (acres)*	0	18,326	5,581	17,157
Williamson Act Contracts (acres)+	138,245	73,956	304,335	577,842
Leading Commodities^	Grapes (Wine), Cattle and Calves, Nursery (Woody Ornamental), Pasture	Grapes (Wine), Cattle and Calves, Livestock Products, Nursery Products	Mushrooms, Nursery (Products), Nursery (Woody Ornaments), Lettuce	Vegetables, Lettuce, Peppers (Bell), Grapes (Wine)

Notes:
[#] Total agricultural land and irrigated land data are from the 2017 Census of Agriculture (USDA 2019).
* Important Farmland data are from the 2016 FMMP Inventory (CDOC 2016a).
+ Williamson Act Contract data are from 2015 Reported Enrollment (CDOC 2016b).
^ Commodity data are from the 2017-18 California Agriculture Statistics Review (CDFA 2018).
FMMP = Farmland Mapping and Monitoring Program

Table 3.2-6. Central Coast Region Agricultural Land Uses

Land Use	San Luis Obispo County	Santa Barbara County
Total Agricultural Land (acres)#	931,291	715,067
Total Irrigated Land (acres)#	75,766	119,925
Prime Farmland (acres)*	41,188	66,978
Farmland of Statewide Importance (acres)*	22,697	13,194
Unique Farmland (acres)*	45,175	37,325
Farmland of Local Importance (acres)*	288,127	8,951
Williamson Act Contracts (acres)+	783,649	515,294
Leading Commodities^	Grapes (Wine), Strawberries, Vegetables, Cattle and Calves	Strawberries, Broccoli, Grapes (Wine), Vegetables

Notes:
[#] Total agricultural land and irrigated land data are from the 2017 Census of Agriculture (USDA 2019).
* Important Farmland data are from the 2016 FMMP Inventory (CDOC 2016a).
+ Williamson Act Contract data are from 2015 Reported Enrollment (CDOC 2016b).
^ Commodity data are from the 2017-18 California Agriculture Statistics Review (CDFA 2018).
FMMP = Farmland Mapping and Monitoring Program

Southern California Region

The Southern California Region includes Ventura, Los Angeles, Orange, San Diego, Riverside, and San Bernardino counties. Of these six counties, Riverside County has the highest acreage of total agricultural land, irrigated land, and prime farmland, while Ventura County has the highest acreage enrolled in Williamson Act contracts (Table 3.2-7).

Table 3.2-7. Southern California Region Agricultural Land Uses

Land Use	Ventura County	Los Angeles County	Orange County	San Diego County	Riverside County	San Bernardino County
Total Agricultural Land (acres)#	260,102	57,809	32,401	222,094	263,796	68,228
Total Irrigated Land (acres)#	98,074	13,800	4,214	42,653	126,217	22,205
Prime Farmland (acres)*	40,976	22,613	2,391	5,669	117,484	11,323
Farmland of Statewide Importance (acres)*	32,992	770	411	8,075	43,757	5,770
Unique Farmland (acres)*	28,950	962	2,913	43,618	32,565	2,738
Farmland of Local Importance (acres)*	15,590	3,045	0	155,566	226,029	562
Williamson Act Contracts (acres)+	127,170	41,093	-	-	54,468	4,717
Leading Commodities^	Strawberries, Lemons, Celery, Raspberries	Nursery Products, Vegetables, Field Crops, Livestock Products	Nursery (Woody Ornaments), Strawberries, Vegetables, Citrus	Nursery (Woody Ornaments), Flowers, Nursery (Plants), Avocadoes	Milk, Nursery (Woody Ornaments), Grapes (Table), Lemons	Milk, Cattle and Calves, Eggs (Chicken), Nursery (Woody Ornaments)

Notes:
[#] Total agricultural land and irrigated land data are from the 2017 Census of Agriculture (USDA 2019).
* Important Farmland data are from the 2016 FMMP Inventory (CDOC 2016a).
+ Williamson Act Contract data are from 2015 Reported Enrollment (CDOC 2016b).
FMMP = Farmland Mapping and Monitoring Program
^ Commodity data are from the 2017-18 California Agriculture Statistics Review (CDFA 2018).
"-" indicates blank cell

3.2.1.2 Forestry Resources

Forestland is defined by Section 12220[g] of the California Public Resources Code as land that can support 10% native tree cover and woodland vegetation of any species, including hardwoods, under natural conditions and that allows management of one or more forest resources, including timber, aesthetics, fish and wildlife, biodiversity, water quality, recreation, and other public benefits. Approximately 33 million acres of forest are present in California, mostly found in mountainous areas, including the Cascade Range, the Sierra Nevada, and the Coast Ranges, and in the cool, mesic fog belt along California's north and central coasts (USDA 2016).

Timberland is defined as forestland that is producing or capable of producing more than 20 cubic feet per acre per year of wood but excludes reserved forestland (areas permanently reserved from wood products use through statute or administrative designation). In California, timberlands account for 50% of California's total forestland area. The principal timberlands include California mixed conifer, ponderosa pine, Douglas fir, and redwood forests. Unreserved forestland, consisting of forestland not withdrawn from harvest by statute or administration regulation, makes up approximately 30% of forestland area. Reserved forestland, consisting of areas permanently reserved from wood products use through statute or administrative designation, makes up approximately 18% of forestland area. Reserved forestland includes national forest wilderness areas, national parks, and monuments (CDFA 2016).

The following discussion describes forestland resources within for each region.

Delta Region

Among the counties in the Delta Region, Yolo County has the largest amount of forest area, with 66,600 acres, and the largest amount of unreserved forest area. Sacramento County has the smallest amount of forest area, with 9,700 acres (Table 3.2-8).

Table 3.2-8. Delta Region Forestland

County	Unreserved Forest Area (thousand acres)	Reserved Forest Area (thousand acres)	Total Forest Area (thousand acres)
Contra Costa	23.9	19.3	43.2
Sacramento	9.7	N/A	9.7
San Joaquin	24.6	N/A	24.6
Solano	26.5	1.5	28.0
Yolo	66.6	N/A	66.6

Source: CDFA 2016

San Joaquin River Region

In the San Joaquin River Region, Tulare County had the largest amount of forest area, with 1,374,800 acres. Kings County had the smallest amount, with no forestland area. Kern County had the largest amount of unreserved forest area, with 724,700 acres (Table 3.2-9).

Table 3.2-9. San Joaquin River Region Forestland

County	Unreserved Forest Area (thousand acres)	Reserved Forest Area (thousand acres)	Total Forest Area (thousand acres)
Fresno	620.8	646.0	1,266.8
Kern	724.7	72.7	797.4
Kings	N/A	N/A	N/A
Madera	540.0	183.0	723.0
Merced	24.9	6.9	31.8
Stanislaus	85.8	17.7	103.6
Tulare	500.2	874.6	1,374.8

Source: CDFA 2016

San Francisco Bay Area Region

In the San Francisco Bay Area Region, Santa Clara County has the largest amount of forest area, with 280,000 acres, and the largest amount of unreserved forest area. Alameda County has the smallest amount of forest area, with 106,200 acres (Table 3.2-10).

Table 3.2-10. San Francisco Bay Area Region Forestland

County	Unreserved Forest Area (thousand acres)	Reserved Forest Area (thousand acres)	Total Forest Area (thousand acres)
Alameda	86.6	19.7	106.2
Napa	172.4	7.5	179.9
San Benito	150.2	N/A	150.2
Santa Clara	214.1	65.9	280.0

Source: CDFA 2016

Central Coast Region

In the Central Coast Region, Santa Barbara County has the largest amount of forest area, with 308,800 acres. San Luis Obispo County has the smallest amount of forest area, with 298,000 acres, but the largest amount of unreserved forest area (Table 3.2-11).

Table 3.2-11. Central Coast Region Forestland

County	Unreserved Forest Area (thousand acres)	Reserved Forest Area (thousand acres)	Total Forest Area (thousand acres)
San Luis Obispo	269.1	28.9	298.0
Santa Barbara	231.6	77.2	308.8

Source: CDFA 2016

Southern California Region

Among Southern California Region counties, San Bernardino County has the largest amount of forest area, with 528,800 acres, and the largest amount of unreserved forest area. Orange County has the smallest amount of forest area, with 13,900 acres (Table 3.2-12).

Table 3.2-12. Southern California Region Forestland

County	Unreserved Forest Area (thousand acres)	Reserved Forest Area (thousand acres)	Total Forest Area (thousand acres)
Los Angeles	211.4	37.3	248.7
Orange	11.1	2.8	13.9
Riverside	65.4	66.7	132.1
San Bernardino	333.3	195.5	528.8
San Diego	94.1	53.1	147.1
Ventura	179.5	88.1	267.6

Source: CDFA 2016

3.2.2 DISCUSSION

a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?

The proposed long-term operation of the SWP would not involve any new construction of water facilities, infrastructure, or land disturbance, and would therefore not have any direct impact on land uses in the project area. Proposed water deliveries to agricultural land uses as part of the long-term operation of the SWP would be consistent with historic deliveries, which fluctuate depending on water year type, water demands, and cropping patterns. The proposed long-term operation of the SWP would increase agricultural water deliveries to the seven SWP water contractors receiving agricultural water supplies by an average annual 59 thousand acre-feet (TAF). This increased supply would be divided by the SWP water contractors in three regions receiving agricultural water supplies, consisting of San Joaquin Valley 4 TAF, Tulare Basin 54 TAF, and South Coast 1 TAF.

Because the proposed long-term operation of the SWP would remain within the historic range of deliveries, the proposed long-term operation of the SWP would not cause indirect changes to agricultural lands. Therefore, there would be no conversion of lands designated as Prime Farmland, Farmland of Statewide Importance, or Unique Farmland as a result of the proposed long-term operation of the SWP. Thus, **no impact** would occur.

b) Conflict with existing zoning for agricultural use or a Williamson Act contract?

As discussed under (a) above, the proposed long-term operation of the SWP would not have any direct or indirect impact on agricultural land uses in the project area, as the proposed actions would not involve any new construction of water facilities, infrastructure, or land disturbance, and water deliveries would be consistent with historic deliveries. Therefore, the proposed long-term operation of the SWP would not conflict with existing agricultural land use or Williamson Act contracts. Therefore, **no impact** would occur.

c) Conflict with existing zoning for, or cause rezoning of, forest land (as defined in Public Resources Code section 12220(g)), timberland (as defined by Public Resources Code section 4526), or timberland zoned Timberland Production (as defined by Government Code section 51104(g))?

The proposed long-term operation of the SWP would not involve any new construction of water facilities, infrastructure, or land disturbance, and would not change existing land uses within the project area. Therefore, the proposed long-term operation of the SWP would not conflict with existing forest land zoning or cause rezoning of forest land or timberland. Thus, **no impact** would occur.

d) Result in the loss of forest land or conversion of forest land to non-forest use?

The proposed long-term operation of the SWP would not involve any new construction of water facilities, infrastructure, or land disturbance, and would not require any changes to SWP facilities that would convert forest land to non-forest uses. Therefore, the Proposed Project would not result in the loss of forest land or conversion of forest land to non-forest uses. **No impact** would occur.

e) Involve other changes in the existing environment that, due to their location or nature, could result in conversion of Farmland to non-agricultural use or conversion of forest land to non-forest use?

The proposed long-term operation of the SWP would not involve any new construction of water facilities, infrastructure, or land disturbance, and would not directly change existing land uses within the project area. The proposed long-term operation of the SWP would continue the conveyance of irrigation water to areas north and south of the Delta and would not reduce water deliveries to agricultural lands currently served by the SWP. Proposed water deliveries under the long-term operation of the SWP would be within the historic range of water deliveries. Therefore, the Proposed Project would not cause indirect changes that would result in conversion of Farmland to non-agricultural use.

The Proposed Project would not involve any construction activities or changes to SWP facilities that would convert forest land to non-forest uses. This project would not conflict with existing zoning for forestland, timberland or Timberland Production Zone, nor would it result in the conversion of forestland to non-forest use. Thus, **no impact on** existing farmland or forestry resources would occur.

3.3 AIR QUALITY

Table 3.3-1. Potential Impacts on Air Quality

ENVIRONMENTAL ISSUES	ENVIRONMENTAL IMPACT SIGNIFICANCE
III. Air Quality. Where available, the significance criteria established by the applicable air quality management district or air pollution control district may be relied on to make the following determinations. Would the project:	–
a) Conflict with or obstruct implementation of the applicable air quality plan?	No Impact
b) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is nonattainment under an applicable federal or state ambient air quality standard?	No Impact
c) Expose sensitive receptors to substantial pollutant concentrations?	No Impact
d) Result in other emissions (such as those leading to odors) adversely affecting a substantial number of people?	No Impact
e) Create objectionable odors affecting a substantial number of people?	No Impact

Note:
"-" indicates blank cell

3.3.1 ENVIRONMENTAL SETTING

California is divided geographically into 15 different air basins to manage the state's air quality on a regional basis. Air quality is defined as the concentration of pollutants in relation to their impact on human health. Ambient concentrations of air pollutants are determined by the amount of emissions released by pollutant sources and the ability of the atmosphere to transport and dilute such emissions. Natural factors that affect transport and dilution include terrain, wind, atmospheric stability, and the presence of sunlight. Therefore, existing air quality conditions in the project area are influenced by factors such as topography, meteorology, and climate, as well as the quantity of emissions released by air pollutant sources.

Individual air pollutants at certain concentrations may adversely affect human or animal health, reduce visibility, damage property, and reduce the productivity or vigor of crops and natural vegetation. Six air pollutants have been identified by the U.S. Environmental Protection Agency (EPA) and the California Air Resources Board (CARB) as being of concern, both on a nationwide and statewide level: ozone; carbon monoxide (CO); nitrogen dioxide (NO_2); sulfur dioxide (SO_2); lead; and particulate matter (PM), which is subdivided into two classes based on particle size: PM equal to or less than 10 micrometers in diameter (PM_{10}), and PM equal to or less than 2.5 micrometers in diameter ($PM_{2.5}$). Because the air quality standards for these air pollutants are regulated using human and environment health-based criteria, they commonly are referred to as "criteria air pollutants."

Air quality in the project area is regulated by federal and State agencies, including EPA and CARB. CARB regulates air quality in California through local air pollution control districts and air quality management districts. Local air districts administer air quality laws and regulations within the air basins. The local air districts have permitting authority over all stationary sources of air pollutants within their district boundaries and provide the primary review of environmental documents that are prepared for projects with air quality issues. Areas are classified under the federal Clean Air Act and California Clean Air Act as attainment, nonattainment, or maintenance (previously nonattainment and currently attainment) for each criteria pollutant, based on whether the federal and State air quality standards have been achieved.

The following subsections briefly describe the existing environmental setting by air basin for the project area. The counties within each air basin in the project area are shown in Table 3.3-2, along with nonattainment designations to characterize existing ambient air quality. Nonattainment designations indicate that concentrations of pollutants measured in ambient air exceed the applicable ambient air quality standards.

Table 3.3-2. Air Quality Status of the Project Area

County	Air Basin	Air District	Federal Nonattainment Designations	State Nonattainment Designations
Central Valley Region	-	-	-	-
Butte	Sacramento Valley	Butte	Ozone and $PM_{2.5}$ in Chico	Ozone, PM_{10}, $PM_{2.5}$
Yuba	Sacramento Valley	Feather River	–	Ozone, PM_{10}
Sutter	Sacramento Valley	Feather River	Ozone	Ozone, PM_{10}
Yolo	Sacramento Valley	Yolo-Solano	Ozone, $PM_{2.5}$	Ozone, PM_{10}
Sacramento	Sacramento Valley	Sacramento Metro	Ozone, $PM_{2.5}$	Ozone, PM_{10}
Plumas	Mountain Counties	Northern Sierra	–	$PM_{10,}$ $PM_{2.5}$ (Portola Valley)
San Joaquin	San Joaquin Valley	San Joaquin Valley	Ozone, $PM_{2.5}$	Ozone, PM_{10}, $PM_{2.5}$
Kings	San Joaquin Valley	San Joaquin Valley	Ozone, $PM_{2.5}$	Ozone, PM_{10}, $PM_{2.5}$
Tulare	San Joaquin Valley	San Joaquin Valley	Ozone, $PM_{2.5}$	Ozone, PM_{10}, $PM_{2.5}$
Kern	San Joaquin Valley, Mojave Desert	San Joaquin Valley, Kern	Ozone, $PM_{2.5}$, PM_{10} (East Kern)	Ozone, PM_{10}, $PM_{2.5}$ (San Joaquin Valley Air Basin)
San Francisco Bay Area Region	-	-	-	-
Napa	San Francisco Bay Area	Bay Area	Ozone, $PM_{2.5}$	Ozone, PM_{10}, $PM_{2.5}$
Solano	Sacramento Valley, San Francisco Bay Area	Yolo-Solano and Bay Area	Ozone, $PM_{2.5}$	Ozone, PM_{10}, $PM_{2.5}$
Contra Costa	San Francisco Bay Area	Bay Area	Ozone, $PM_{2.5}$	Ozone, PM_{10}, $PM_{2.5}$
Alameda	San Francisco Bay Area	Bay Area	Ozone, $PM_{2.5}$	Ozone, PM_{10}, $PM_{2.5}$
Santa Clara	San Francisco Bay Area	Bay Area	Ozone, $PM_{2.5}$	Ozone, PM_{10}, $PM_{2.5}$
San Benito	North Central Coast	Monterey Bay Unified	–	Ozone, PM_{10}
Central Coast Region	-	-	-	-
San Luis Obispo	South Central Coast	San Luis Obispo	Ozone (Eastern San Luis Obispo)	Ozone, PM_{10}

County	Air Basin	Air District	Federal Nonattainment Designations	State Nonattainment Designations
Santa Barbara	South Central Coast	Santa Barbara	–	Ozone, PM_{10}
Southern California Region	-	-	-	-
Ventura	South Central Coast	Ventura	Ozone	Ozone, PM_{10}
Los Angeles	South Coast, Mojave Desert	South Coast, Antelope Valley	Ozone, $PM_{2.5}$, Lead	Ozone; PM_{10}; $PM_{2.5}$
San Bernardino	South Coast, Mojave Desert	South Coast, Mojave Desert	Ozone, PM_{10}, $PM_{2.5}$	Ozone, PM_{10}, $PM_{2.5}$
Riverside	South Coast, Mojave Desert, Salton Sea	South Coast, Mojave Desert	Ozone, PM_{10}, $PM_{2.5}$	Ozone; PM_{10}; $PM_{2.5}$
Orange	South Coast	South Coast	Ozone, $PM_{2.5}$	Ozone, PM_{10}, $PM_{2.5}$
San Diego	San Diego County	San Diego	Ozone	Ozone, PM_{10}, $PM_{2.5}$

Note:
PM_{10} -= PM equal to or less than 10 micrometers in diameter
$PM_{2.5}$ = PM equal to or less than 2.5 micrometers in diameter
"-" indicates blank cell

3.3.1.1 Sacramento Valley Air Basin

The Sacramento Valley Air Basin encompasses nine air districts and 11 counties, including all of Shasta, Tehama, Glenn, Colusa, Butte, Sutter, Yuba, Sacramento, and Yolo counties; the westernmost portion of Placer County; and the northeastern half of Solano County. The air basin is bounded by tall mountains, including the Coast Range to the west, the Cascade Range to the north, and the Sierra Nevada to the east. This air basin is within the northern portion of the Central Valley Region of the project area.

When air stagnates or is trapped by an inversion layer in the valley, ambient pollutant concentrations can reach or exceed threshold levels. On-road vehicles are the largest source of smog-forming pollutants, and PM emissions primarily are from area sources, such as fugitive dust from paved and unpaved roads and vehicle travel (CARB 2013).

3.3.1.2 San Francisco Air Basin

The San Francisco Bay Area Air Basin consists of a single air district and nine counties, including all of Napa, Marin, San Francisco, Contra Costa, Alameda, San Mateo, and Santa Clara counties; the southern portion of Sonoma County; and the southwestern portion of Solano County (CARB 2013). The hills of the Coast Ranges bound the San Francisco and San Pablo bays and the inland valleys of the air basin. This air basin includes the San Francisco Bay Area Region of the project area.

The San Francisco Bay Area Air Basin includes the second largest urban area in California, hosting industry, airports, international ports, freeways, and surface streets. On-road vehicles are the largest source of smog-forming pollutants, and PM_{10} emissions primarily are from area sources, such as fugitive dust from paved and unpaved roads and vehicle travel (CARB 2013). Air quality in the San Francisco Bay Area often is good because sea breezes blow clean air from the Pacific Ocean into the air basin, but transport of pollutants from the San Francisco Bay Area can exacerbate air quality problems in the downwind portions of the San Francisco Bay Area Air Basin as well as in the Sacramento Valley and San Joaquin Valley air basins.

3.3.1.3 San Joaquin Valley Air Basin

The San Joaquin Valley Air Basin encompasses eight counties, including all of San Joaquin, Stanislaus, Madera, Merced, Fresno, Kings, and Tulare counties, and western Kern County. It is bounded on the west by the Coast Ranges, on the east by the Sierra Nevada, and in the south by the Tehachapi Mountains. This air basin is within the central and southern portions of the Central Valley Region of the project area.

The area is dominated by agricultural and other localized industries, such as forest products, oil and gas production, and oil refining. On-road vehicles are the largest source of smog-forming pollutants, and PM_{10} emissions primarily are from sources such as agricultural operations and fugitive dust from paved and unpaved roads and vehicle travel (CARB 2013). Air quality issues may be exacerbated under dry conditions. When water supplies and irrigation levels are decreased in urban, rural, and agricultural areas, increased potential exists for the formation and transport of fugitive dust.

3.3.1.4 North Central Coast Air Basin

The North Central Coast Air Basin includes Santa Cruz, San Benito, and Monterey counties (CARB 2013). This air basin includes San Benito County, which is within the San Francisco Bay Area Region of the project area. The North Central Coast Air Basin is in attainment for all National Ambient Air Quality Standards and is designated as nonattainment for the State ozone and PM_{10} standards (CARB 2014). Although separated by the Santa Cruz mountains and Coast Ranges to the north, wind can transport air pollution from the San Francisco Bay Area Air Basin and contribute to elevated ozone concentrations in the area (CARB 2013).

3.3.1.5 South Central Coast Air Basin

The South Central Coast Air Basin includes San Luis Obispo, Santa Barbara and Ventura counties. It is bordered by the Pacific Ocean on the south and west and lies just north of the highly populated South Coast Air Basin. This air basin includes the Central Coast Region and the northern Southern California Region of the project area.

Sources of pollutants in the air basin include power plants, oil production and refining, vehicle travel, and agricultural operations. San Luis Obispo, Santa Barbara, and Ventura counties are designated as nonattainment for the State ozone and PM_{10} standards. Eastern San Luis Obispo and Ventura counties are designated as nonattainment for the federal ozone standard (EPA 2015). Wind patterns link Ventura and Santa Barbara counties, resulting in pollutant transport between the South Central Coast and South Coast air basins. San Luis Obispo County is separated from these counties by mountains, and the air quality in San Luis Obispo County is linked more with conditions in the San Francisco Bay Area Air Basin and San Joaquin Valley Air Basin. In addition, air emissions from the South Coast Air Basin can be blown offshore and then carried to the coastal cities of the South Central Coast Air Basin. Under some conditions, the reverse air flow can carry pollutants from the South Central Coast Air Basin to the South Coast Air Basin and contribute to ozone violations there (CARB 2013).

3.3.1.6 South Coast Air Basin

The South Coast Air Basin is California's largest metropolitan region. The area includes the southern two-thirds of Los Angeles County, all of Orange County, and the western urbanized portions of Riverside and San Bernardino counties. The South Coast Air Basin is bounded by the Pacific Ocean on the west and by mountains on the other three sides. This air basin includes the west-central portion of the Southern California Region of the project area.

The area includes industry, airports, international ports, freeways, and surface streets. On-road vehicles are the largest source of smog-forming pollutants, and PM_{10} emissions primarily are from area sources, such as fugitive dust from paved and unpaved roads and vehicle travel (CARB 2013). One-third of the state's total criteria pollutant emissions are generated within the basin (CARB 2013). The pollutant emissions and fugitive dust generated in the South Coast Air Basin affects other air basins (e.g., the Salton Sea Air Basin and the Coachella Valley portion of Riverside County) (USGS 2014).

The persistent high-pressure system and frequent low inversion heights caused by the surrounding mountains on three sides of the air basin trap pollutants in the air basin, and the frequent sunny weather contributes to smog formation (CARB 2013). Portions of the South Coast Air Basin are designated as nonattainment for the federal and State ozone, PM_{10}, and $PM_{2.5}$ standards (CARB 2014; EPA 2015). Wind often transports air pollutants from the South Coast Air Basin to nearby air basins.

3.3.1.7 San Diego Air Basin

The San Diego Air Basin is in the southwestern corner of California and includes all of San Diego County. This air basin includes the southwestern portion of the Southern California Region of the project area.

The population and emissions are concentrated in the western portion of the air basin, which is bordered on the west by the Pacific Ocean.

The air basin includes industrial facilities, airports, an international port, freeways, and surface streets. The San Diego Air Basin is designated as nonattainment for the federal ozone standard and the State ozone, PM_{10}, and $PM_{2.5}$ standards (CARB 2014). Air quality in the San Diego Air Basin is affected not only by local emission sources, but also by transport of air emissions from the South Coast Air Basin and Mexico.

3.3.2 DISCUSSION

a) Conflict with or obstruct implementation of the applicable air quality plan?

The proposed long-term operation of the SWP would not result in construction of new facilities or infrastructure or other construction activities. Therefore, the proposed long-term operation of the SWP would not create a new source of air pollutant emissions or increase pollutant emissions that are associated with historical and current SWP operations. No new sources of pollutant emissions would be created that would violate applicable air quality standards or contribute to an existing or projected air quality violation. **No impact** would occur.

b) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is nonattainment under an applicable federal or state ambient air quality standard?

The proposed long-term operation of the SWP would not alter physical SWP facilities or result in SWP operations that would contribute to a cumulatively considerable net increase of criteria pollutants, and therefore the Proposed Project would not produce additional pollutants in the project area. Consequently, **no impact** would occur.

c) Expose sensitive receptors to substantial pollutant concentrations?

The proposed long-term operation of the SWP would not produce additional pollutant emissions in the project area that would expose sensitive receptors to pollutants. **No impact** would occur.

d) Result in other emissions (such as those leading to odors) adversely affecting a substantial number of people?

The proposed long-term operation of the SWP would not involve construction activities or changes in operations that would result in other emissions that would affect a substantial number of people. **No impact** would occur.

e) Create objectionable odors affecting a substantial number of people?

The proposed long-term operation of the SWP would not involve any activity or operation that would produce odors that could affect a substantial number of people. **No impact** would occur.

3.4 BIOLOGICAL RESOURCES

Table 3.4-1. Potential Impacts on Aquatic Biological Resources

ENVIRONMENTAL ISSUES	ENVIRONMENTAL IMPACT SIGNIFICANCE
IVa. Aquatic Biological Resources. Would the project:	-
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	Potentially Significant Impact
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, or regulations or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	No Impact
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	No Impact
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?	Potentially Significant Impact
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	No Impact
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?	No Impact

Note:
"-" indicates blank cell

3.4.1 AQUATIC BIOLOGICAL RESOURCES

3.4.1.1 Environmental Setting - Aquatic Biological Resources

The geographic area potentially affected by implementation of the Proposed Project includes regions that could be affected directly or indirectly by the SWP. The potentially affected area encompasses the following reservoirs, rivers, and land between the levees adjacent to rivers as well as areas that receive water from the SWP:

- Sacramento River from the confluence with the Feather River downstream to, and including, the Delta
- Feather River from the Federal Energy Regulatory Commission (FERC) boundary downstream to its confluence with the Sacramento River
- San Francisco Bay and Suisun Marsh
- Areas that are served water by the SWP

Fish and Aquatic Species for Detailed Consideration

For this analysis, fish and aquatic species retained for detailed consideration include species that are included in one or more of the following categories:

- species listed by the federal government as threatened or endangered;
- species listed by the State as threatened or endangered;
- species that are proposed formally for federal listing or are candidates for federal listing as threatened or endangered;
- species that are candidates for State listing as threatened or endangered;
- species that meet the definitions of rare, threatened, or endangered under CEQA;
- species identified by CDFW as species of special concern, species designated by California statute as fully protected (e.g., California Fish and Game Code, Sections, 4,700 [mammals], and 5,515 [fish]); and
- species that are recreationally or commercially important.

A total of 21 fish and aquatic species were identified with potential to occur in locations that could be directly or indirectly affected by the Proposed Project. The fish and aquatic species meeting these criteria are listed in Table 3.4-2.

Aquatic Resources within the Geographic Areas Potentially Affected by the Proposed Project

The fish species, water bodies, and aquatic habitat within the areas potentially affected by the Proposed Project are described in detail in Section 4.4 of the DEIR. Therefore, discussions of these species, water bodies, and aquatic habitat are not repeated in this IS.

3.4.1.2 Discussion - Aquatic Biological Resources

Would the Proposed Project:

a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?

Feather River

The lower Feather River is generally considered as that portion of the Feather River and its watershed that lies downstream of Oroville Dam, extending to the confluence with the Sacramento River at Verona. The river is almost entirely contained within a series of levees as it flows through the agricultural lands of the Sacramento Valley. Oroville Dam is a major component of the SWP, and it provides virtually all the water delivered by the California SWP. Flows are regulated for water supply and flood control through releases at Oroville Dam, and to a lesser extent, flows are regulated to maximize production of hydroelectric power.

Table 3.4-2. Special-Status and Commercially or Recreationally Important Fish and Aquatic Species Potentially Affected by Proposed Long-Term State Water Project Operations

Common Name	Scientific Name	Federal Status[1]	State Status[1]	Economically Important[2]	Recreationally Important[2]
Pacific Lamprey	*Entosphenus tridentatus*	N/A	SSC	N/A	N/A
River Lamprey	*Lampetra ayresi*	N/A	SSC	N/A	N/A
White Sturgeon	*Acipenser transmontanus*	N/A	SSC	Economically Important	Recreationally Important
Green Sturgeon, *Southern DPS*	*Acipenser medirostris*	FT	SSC	N/A	N/A
Steelhead, *Central California Coast DPS*	*Oncorhynchus mykiss*	FT	N/A	N/A	N/A
Steelhead, *Central Valley DPS*	*Oncorhynchus mykiss*	FT	N/A	Economically Important	Recreationally Important
Chinook Salmon, *Central Valley Fall-run ESU*	*Oncorhynchus tshawytscha*	SC	SSC	Economically Important	Recreationally Important
Chinook Salmon, *Central Valley Late Fall–run ESU*	*Oncorhynchus tshawytscha*	SC	SSC	Economically Important	Recreationally Important
Chinook Salmon, *Sacramento River Winter-run ESU*	*Oncorhynchus tshawytscha*	FE	SE	N/A	N/A
Chinook Salmon, *Central Valley Spring-run ESU*	*Oncorhynchus tshawytscha*	FT	ST	Economically Important	Recreationally Important
Longfin Smelt	*Spirinchus thaleichthys*	FC	ST	N/A	N/A
Delta Smelt	*Hypomesus transpacificus*	FT	SE	N/A	N/A
Sacramento Splittail	*Pogonichthys macrolepidotus*	N/A	SSC	N/A	N/A
Hardhead	*Mylopharodon conocephalus*	N/A	SSC	N/A	N/A
Central California Roach	*Lavinia symmetricus*	N/A	SSC	N/A	N/A
Striped Bass	*Morone saxatilis*	N/A	N/A	Economically Important	Recreationally Important
Largemouth Bass	*Micropterus salmoides*	N/A	N/A	Economically Important	Recreationally Important
Smallmouth Bass	*Micropterus dolomieu*	N/A	N/A	Economically Important	Recreationally Important
Spotted Bass	*Micropterus punctulatus*	N/A	N/A	Economically Important	Recreationally Important
American Shad	*Alosa sapidissima*	N/A	N/A	Economically Important	Recreationally Important
Killer Whale, Southern Resident DPS[3]	*Orcinus orca*	FE	N/A	N/A	N/A

Sources: CDFW 2017b; USFWS 2017a; Moyle et al. 2015

Notes:

DPS = Distinct Population Segment; ESU = Evolutionarily Significant Unit; N/A = not applicable

[1] Listing Statuses:
- FC = Federal candidate for listing
- FE = Federally listed as endangered
- FT = Federally listed as threatened
- SC = Federal species of concern (National Marine Fisheries Service)
- SE = State listed as endangered
- SSC = State species of special concern
- ST = State listed as threatened

[2] Species considered important because of existing regulatory management that limits commercial or recreational harvesting.

[3] Killer Whales of the Southern Resident DPS (federal status FE) are included because of their known relationship to the abundance of the salmon population.

DWR currently manages flows in the Feather River based on an agreement between DWR and CDFW signed in 1983. The *Agreement Concerning the Operation of the Oroville Division of the State Water Project for Management of Fish and Wildlife* established criteria for flow and water temperature in the Low Flow Channel and the reach of the Feather River downstream of the Thermalito Afterbay Outlet to the confluence with the Sacramento River to preserve salmon and steelhead spawning and rearing habitat.

On December 5, 2016, NMFS issued a Biological Opinion on the FERC's relicensing of the Oroville facilities (FERC Project No. 2100-134) (NMFS 2016), which evaluated the effects of DWR's proposed operations that would be implemented under a new FERC license. The BiOp evaluated effects of operations under the proposed license on federal Endangered Species Act-listed fish species in the Feather River and Essential Fish Habitat (EFH) for Chinook Salmon. FERC has not yet issued a new license to operate the facilities. Nonetheless, upon issuance of the new FERC license, DWR will operate the Oroville facilities according to the Proposed Action, incidental take authorization, and EFH Conservation Recommendations described in the BiOp. Because DWR is not proposing changes to current operations of the Oroville facilities or those evaluated in the BiOp for the Oroville facilities relicensing, DWR is not including operations of the Oroville facilities in the Proposed Project and is not seeking additional incidental take authorization under CESA for Oroville Facilities operations. Therefore, no further evaluation of Feather River aquatic resources is conducted.

State Water Project Service Area

SWP water from the Delta is delivered to San Luis Reservoir via the California Aqueduct. Water is released from the San Luis Reservoir into the California Aqueduct that extends to Lake Perris in Riverside County and delivers water to the San Joaquin Valley, Central Coast, and Southern California.

No sensitive fish species occur naturally in the California Aqueduct, Delta Mendota Canal, or the reservoirs receiving exported SWP. Special-status fish species and commercially or recreationally important fish species could occur in these water bodies if individuals are entrained by the SWP pumping facilities in the Delta. However, these individuals have already been lost to their populations. Therefore, analyses of potential changes in SWP service area water bodies are not conducted, and any potentially occurring special-status or commercially or recreationally important fish species are not considered further. Analyses of effects on special-status fish species and commercially or recreationally important fish species entrained into the SWP facilities are conducted as part of the analyses of effects of the SWP facilities in the Delta.

Effects in the San Francisco Bay and Pacific Ocean

San Francisco Bay and the Pacific Ocean and could potentially be affected by changes in Delta outflow. However, potential changes in Delta outflow of the magnitude associated with the Proposed Project have limited ability to influence the hydrodynamics, salinity, and hydrology of the San Francisco Bay and nearshore Pacific Ocean relative to existing conditions (see Section 3.10, "Hydrology and Water Quality"). Specifically, tributary inflow, non-tributary runoff, and tidal effects in these areas have much greater influence on potential habitat conditions (e.g., salinity, depth, velocity, etc.) than changes in Delta outflow associated with implementation of the Proposed Project. Therefore, no additional analyses are conducted for the San Francisco Bay and Pacific Ocean, and special-status or commercially or recreationally important fish species in these areas are not considered further in this analysis.

Effects in the Sacramento River Downstream of the Feather River and the Delta

Implementation of the Proposed Project potentially could affect flows in the Sacramento River below the Feather River confluence, which could affect migratory habitat for special-status anadromous species. In addition, hydrodynamic conditions in the Delta could be altered by implementation of the proposed long-term operation of the SWP, which could increase the entrainment potential of special-status and commercially and recreationally important fish species.

These hydrologic and hydrodynamic changes potentially could substantially affect habitat conditions, and increased entrainment potential could substantially and directly affect individuals and populations. Therefore, potential effects on the special-status species listed in Table 3.4-2 and their habitat will be evaluated in the DEIR. The impact would be **potentially significant**.

b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, or regulations or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?

Riparian habitat and other sensitive natural communities are addressed under "Wildlife Habitats" in Section 3.4.7, "Terrestrial Biological Resources Environmental Setting."

c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?

Federally protected wetlands are addressed under "Wildlife Habitats" in Section 3.4.2, "Terrestrial Biological Resources."

d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?

Implementation of the Proposed Project potentially could affect flows in the Sacramento River below the Feather River confluence, which could affect migratory habitat for special-status anadromous species. In addition, hydrodynamic conditions would be altered by implementation of the Proposed Project, which could increase the entrainment potential of special-status and commercially or recreationally important migratory or resident fish species.

These hydrologic and hydrodynamic changes potentially could substantially affect habitat conditions, and increased entrainment potential could affect individuals and populations substantially and directly. Therefore, potential effects on the special-status species and their habitats that are listed in Table 3.4-2 will be evaluated in the DEIR. The impact would be **potentially significant**.

e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?

Implementation of the proposed long-term operation of the SWP would not conflict with any local policies or ordinances protecting fish and aquatic resources in the Sacramento River downstream of the confluence with the Feather River or in the Delta. **No impact** would occur.

f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?

Implementation of the Proposed Project would not conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or State habitat conservation plan protecting fish and aquatic resources in the Sacramento River below the confluence with the Feather River or in the Delta. **No impact** would occur.

Table 3.4-3. Potential Impacts on Terrestrial Biological Resources

ENVIRONMENTAL ISSUES	ENVIRONMENTAL IMPACT SIGNIFICANCE
IVb. Terrestrial Biological Resources. Would the project:	-
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	No Impact
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, or regulations or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	No Impact
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	No Impact
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?	No Impact
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	No Impact
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?	No Impact

Note:
"-" indicates blank cell

3.4.2 Terrestrial Biological Resources

3.4.2.1 Environmental Setting - Terrestrial Biological Resources

Feather River

The Upper Feather River lakes, including Antelope Lake, Lake Davis, and Frenchman Lake, are SWP facilities on the upper Feather River, upstream from Lake Oroville. Lake Oroville is in the foothills on the western slope of the Sierra Nevada, about 1 mile downstream from the confluence of its major tributaries. Downstream from Oroville Dam, a portion of the river flow is diverted by Thermalito Diversion Dam and routed to the Thermalito Forebay, an offstream reservoir with a surface area of up to 630 acres (DWR 2007a, 2007b). Downstream from the forebay, water is stored in Thermalito Afterbay (up to 4,300 surface acres), which serves as a warming basin for agricultural water, among other purposes.

The majority of vegetation around Lake Oroville consists of a variety of native vegetation associations, including mixed oak woodlands, foothill pine/mixed oak woodlands, and oak/pine woodlands, with a mosaic of chaparral (DWR 2004a, 2007a). Open areas in the woodlands consist of annual grassland species. Native riparian habitats are restricted to narrow strips along tributaries consisting mostly of alder, willow, and occasional cottonwood and sycamore. Limited wetland vegetation exists around Lake Oroville, and most of the vegetation is associated with seeps and springs that are a natural part of the landscape above the high-water line. Emergent wetlands generally are absent in the drawdown zone of Lake Oroville.

Riparian vegetation occurs around the northern shore of the Thermalito Forebay as a thin strip of mixed riparian species (mostly willows), with an understory of emergent wetland vegetation. Cottonwoods and willows occur in scattered areas around the high-water surface elevation of the Thermalito Afterbay shoreline (FERC 2007). Emergent wetlands, ranging from thin strips to more extensive areas, are found around the Thermalito Forebay and Thermalito Afterbay. Waterfowl brood ponds, constructed in inlets of the Thermalito Afterbay, support emergent vegetation along much of their shores. Several invasive plant species are found around Lake Oroville and downstream in and around the Thermalito Complex. Invasive species associated with riparian and wetland areas include purple loosestrife, giant reed, tree-of-heaven, and red sesbania. About 85 of the roughly 900 acres of wetlands and riparian areas along the margin of the Thermalito Afterbay contain varying densities of purple loosestrife (DWR 2007a). Purple loosestrife adversely affects native vegetation.

The Feather River from Oroville Dam to its confluence with the Sacramento River supports stands of riparian vegetation, which have been restricted over time by flood control levees and land clearing for agriculture and urbanization. Consequently, the vegetation generally occurs in a narrow zone along much of the river in this reach. However, remnant riparian forest exists in areas where wide meander bends persist, such as at Abbott Lake and O'Connor Lake near the Lake of the Woods State Recreation Area (DWR 2004b). This area contains mixed riparian forests, including Fremont cottonwood, willow, boxelder, alder, and Oregon ash. The riparian strip along the river is bordered mostly by agricultural fields. Downstream from Yuba City near the confluence with the Sacramento River, valley oak and cottonwood riparian stands become more common.

Sacramento–San Joaquin Delta and Suisun Marsh

The Delta overlies the western portions of the Sacramento River and San Joaquin River watersheds. The Delta is a network of islands, channels, and marshland at the confluence of the Sacramento and San Joaquin rivers. The major waterways entering the Delta are the Sacramento River, flowing from the north, the San Joaquin River, flowing from the south, and eastside tributaries (the Cosumnes, Mokelumne, and Calaveras rivers).

Suisun Marsh is a tidally influenced brackish marsh about 35 miles northeast of San Francisco in southern Solano County. It is a critical part of the Sacramento–San Joaquin Delta estuary ecosystem. The Delta, Suisun Marsh, and greater San Francisco Bay make up the largest estuary on the west coast of North and South America (DWR 2009a).

The Delta once was composed of extensive freshwater and brackish marshes, with tules and cattails, broad riparian thickets of scrub willows, buttonwillow, and native brambles. In addition, it had extensive riparian forests of Fremont cottonwood, valley oak, Oregon ash, boxelder, white alder, and Goodding's black willow. Upland, nonriparian stands of valley oak and coast live oak occurred in a mosaic with seasonally flooded herbaceous vegetation, including vernal pools and alkali wetlands (SFEI 2012).

Substantial areas of the Delta and Suisun Marsh have been modified by agricultural, urban and suburban, and recreational land uses (Reclamation et al. 2011; SFEI 2012). Over the past 150 years, levees were constructed in the Delta and Suisun Marsh to provide lands for agricultural, municipal, industrial, and recreational land uses. The remaining natural vegetation is fragmented and largely restricted to the edges of waterways, flooded islands, and small protected areas such as parks, wildlife areas, and nature reserves (Hickson and Keeler-Wolf 2007). A substantial portion of the emergent wetlands exists as thin strips along the margins of constructed levees (SFEI 2012). Current habitat along the Delta waterways includes seasonal wetlands, tidal wetlands, managed wetlands, riparian forests, and riparian scrub.

Seasonal wetlands historically occurred along the riparian corridor at elevations that were inundated during high-flow events. Many of the levees were constructed along the riparian corridor edges; therefore, the historic seasonal wetlands were substantially modified (SFEI 2012). Adjacent areas of perennial wetlands on the water side of the riparian corridor were modified as levees were constructed and channels enlarged. In many of these areas, the perennial wetlands were replaced by seasonal wetlands.

Alkali-related habitats occur near salt-influenced seasonal and perennial wetlands. Alkali seasonal wetlands occur on fine-textured soils that contain relatively high concentrations of dissolved salts. These types of soils typically are found at the historical locations of seasonal ponds in the Yolo Basin, in and around the CDFW Tule Ranch Preserve, and upland in seasonal drainages that receive salts in runoff from upslope salt-bearing bedrock, such as areas near Suisun Marsh and the CCF. Alkali wetlands include saltgrass, alkali weed, saltbush, alkali heath, and iodine bush. Small stands of alkali sink scrub (also known as valley sink scrub) are characterized by iodine bush.

The tidal brackish wetlands occur either in relatively substantial tracts of complex tidal wetlands or in narrow bands of fringing tidal wetlands (Siegel et al. 2010). Fringing tidal marsh exists along the outboard side of exterior levees and generally has formed since diking for managed wetlands began. Fringing tidal wetlands vary in size and vegetation composition, exhibit less geomorphic complexity, and have a low area-to-edge ratio. Fringing tidal marshes lack connection with the upland transition, often are found in small, discontinuous segments, and can limit movement of terrestrial marsh species.

Plant zones in complex tidal wetlands are influenced by inundation regime and salinity. Tidal wetlands can be divided into three zones: low marsh, middle marsh, and high marsh (Reclamation et al. 2011). The low tidal wetland zone is tidally inundated once or twice per day. At the lowest elevations, vegetation is inhibited by frequent, prolonged, and often deep inundation, and by disturbance from waves or currents. The dominant plant species are bulrushes.

The middle tidal wetland zone is inundated tidally at least once per day; this zone has relatively little cover and offers no refuge from higher tides, which completely flood the vegetation of the middle marsh. The dominant plant species are pickleweed, saltgrass, and bulrush.

The high tidal wetland zone receives intermittent inundation during the monthly tidal cycle, with the higher elevations being inundated only during the highest tides. Historically, the high marsh was an expansive transitional zone between the tidal wetlands and adjacent uplands. The high marsh and associated upland transition zone have been affected by land use changes (e.g., managed wetlands, agriculture). The dominant plants are native species, such as saltgrass, pickleweed, and Baltic rush, and non-native species, including perennial pepperweed, poison hemlock, and fennel.

Managed wetlands are found primarily in Suisun Marsh and Cache Slough and near the confluence of the Mokelumne and Sacramento rivers within the historical limits of the high tidal marsh and adjacent uplands that were diked and leveled for agricultural purposes and later managed to enhance habitat values for specific wildlife species (CALFED 2000a, 2000b). Diked managed wetlands and uplands are the most typical land cover type in the Suisun Marsh area. Managed wetlands are considered seasonal wetlands because they may be flooded and drained several times throughout the year. Watergrass and smartweed typically are the dominant species in managed wetlands that use fresher water. Bulrush, cattail, and tule are the dominant species in managed wetlands that employ late drawdown management. Pickleweed, fat hen, and brass buttons are typical in the higher elevations of the managed wetlands. In marshes with higher soil salinity, pickleweed, saltgrass, and other salt-tolerant species are dominant.

Riparian forest areas still are present in some portions of the Delta, along many of the major and minor waterways, oxbows, and levees (CALFED 2000a, 2000b). Riparian forest and woodland communities, which are dominated by tree species, are limited mostly to narrow bands along sloughs, channels, rivers, and other freshwater features throughout the Delta. Isolated patches of riparian vegetation also are found on the interior of reclaimed Delta islands, along drainage channels, along pond margins, and in abandoned, low-lying fields. Cottonwoods and willows, Oregon ash, boxelder, and California sycamore are the most typical riparian trees in Central California. Valley oak and black walnut are typical in riparian areas in the Delta.

Riparian scrub in the Delta and Suisun Marsh consists of woody riparian shrubs in dense thickets (SFEI 2012). Riparian scrub thickets usually are associated with higher, sloping, and better drained edges of marshes or topographic high areas, such as levee remnants and elevated flood deposits, and along shorelines of ponds or banks of channels in tidal or non-tidal freshwater habitats. Willow-dominated habitat types appear to be increasing in extent in recent years; willows line many miles of artificial levees where waterways historically flowed into freshwater emergent wetland. Non-native Himalayan blackberry thickets are a typical element of riparian scrub communities along levees and riparian zones.

State Water Project Reservoirs

Bethany Reservoir, Patterson Reservoir, and Lake Del Valle are SWP facilities associated with the South Bay Aqueduct in Alameda County. Vegetative communities around Bethany Reservoir are characterized by annual grasslands with several areas of woodland habitat (DWR 2014). Emergent vegetation does not occur along the shoreline at Bethany Reservoir (DWR 2005).

Patterson Reservoir is a small, 100-acre-foot SWP reservoir, located along the South Bay Aqueduct between Bethany Reservoir and Lake Del Valle. Vegetation around Patterson Reservoir is characterized by grasslands and upland habitat. Lake Del Valle is a 77,100-acre-foot SWP facility, located along the South Bay Aqueduct (DWR 2001). Vegetation around Lake Del Valle includes grasslands, chaparral, shrub, oak woodland, and riparian and freshwater habitats (EBRPD 1996, 2001, 2012, 2013). The grasslands include non-native grasses and native perennial bunchgrass. Mixed deciduous riparian woodlands occur along perennial streams.

Wildlife Habitats

The value of a site to wildlife is influenced by a combination of the physical and biological features of the immediate environment. Species diversity is a function of abiotic and biotic conditions and may be greatly affected by human use of the land. The wildlife habitat quality of an area, therefore, ultimately is determined by the type, size, and diversity of the vegetation communities present and their degree of disturbance. For example, as a plant community is degraded by the loss of understory diversity, creation of openings, or reduction in area, generally a loss of structural diversity occurs. Degradation of the structural diversity of a community typically diminishes wildlife habitat quality and usually results in a reduced ability to support a variety of wildlife species.

Wildlife habitats typically are distinguished by vegetation type, with varying combinations of plant species providing different resources for use by wildlife. Because the project area spans such a wide geographical area, many sites are high in structural and species diversity, while many other sites are not. Sites described above as having a variety of large intact vegetation communities, broad floodplains and/or riparian corridors, and areas of continuous, connected vegetation communities have significant value to wildlife because those areas provide habitat for a suite of resident and migratory wildlife species typically found in the various habitats. In addition, sites with multiple vegetation communities provide edge habitats, such as the interface between grassland and scrub and grassland and woodland, which typically support a high diversity of wildlife species.

Lacustrine, riparian, freshwater marsh, and other wetland and aquatic habitats are very productive for wildlife because they offer water, food, and cover for a variety of species. Lakes and reservoirs attract resting and foraging waterfowl and other species that favor standing or slow-moving water. Wildlife species that use freshwater and seasonal wetlands include reptiles and amphibians, such as California red-legged frog, California tiger salamander, western pond turtle, garter snakes, western toad, Pacific chorus frog, and bullfrog; and avian species, such as green heron, mallard, and red-winged blackbird. Lacustrine riparian habitat provides excellent bird nesting habitat, and the impounded water in lakes and reservoirs also provide foraging habitat for eagles and other raptors that prey on fish (e.g., ospreys) and waterfowl.

Within riverine systems, backwater ponds, wetlands, and open water support wildlife species, such as pied-billed grebe, American bittern, green heron, great blue heron, great egret, duck species, American coot, common merganser, double-crested cormorant, American wigeon, Canada goose, western grebe, and gull species, as well as white-tailed kite, wood duck, yellow warbler, warbling vireo, dusky-footed woodrat, western gray squirrel, deer mouse, California vole, long-tailed weasel, and other mammals that use the adjacent woodlands and grasslands.

Lack of vegetative cover within the drawdown zone around Lake Oroville severely limits wildlife use of this area. Thirty-six wildlife species have been detected using habitats in the drawdown zone on at least one occasion during field surveys (DWR 2004a). Several of these species may use habitats in the drawdown zone for reproduction, including belted kingfisher, Canada goose, canyon wren, American dipper, killdeer, mallard, common merganser, and northern rough-winged swallow.

In contrast to the drawdown area around the margin of Lake Oroville, the drawdown zone of Thermalito Afterbay supports a richer wildlife community and greater habitat diversity. Survey data collected as part of the relicensing process indicate that exposed mudflats seasonally provide habitat for a variety of migratory waterbirds, including black-necked stilt, black tern, California gull, Caspian tern, Forster's tern, greater yellowlegs, least sandpiper, long-billed dowitcher, ring-billed gull, semipalmated sandpiper, spotted sandpiper, and white-faced ibis. Wading birds and other waterfowl have been observed on the mudflats as well as shallow flooded areas (DWR 2004a).

Potentially suitable giant garter snake habitat is present along portions of the afterbay and forebay margins. The existing waterfowl brood ponds provide a refuge for giant garter snakes during periods of afterbay drawdown. Species observed in the wetland margin of Thermalito Afterbay include barn swallow, black phoebe, white-tailed kite, black-tailed jackrabbit, brown-headed cowbird, bullfrog, common garter snake, common yellowthroat, gopher snake, northern harrier, Pacific tree frog, raccoon, red-winged blackbird, ring-necked pheasant, short-eared owl, striped skunk, tree swallow, Virginia opossum, and violet-green swallow (DWR 2004a).

The open water habitat of the Los Vaqueros Reservoir provides forage, winter, and brood habitat for Canada goose, American wigeon, gadwall, mallard, northern shoveler, northern pintail, green-winged teal, canvasback, redhead, greater scaup, lesser scaup, bufflehead, common goldeneye, hooded merganser, common merganser, and ruddy ducks; the reservoir's habitat provides other habitat values for grebe, sandpiper, pelican, cormorant, egret, heron, and gull. Annual grassland habitats surrounding many of the reservoirs in the proposed project area support species such as burrowing owl, horned lark, western meadowlark, turkey vulture, northern harrier, American kestrel, white-tailed kite, red-tailed hawk, Brewer's blackbird, mourning dove, savannah sparrow, white-crowned sparrow, western fence lizard, common garter snake, gopher snake, western skink, western rattlesnake, yellow-bellied racer, black-tailed jackrabbit, California ground squirrel, Botta's pocket gopher, western harvest mouse, California vole, California kangaroo rat, Audubon's cottontail, American badger, bobcat, mule deer, and coyote.

Riparian scrub, woodlands, and forests provide high value for wildlife and support a wide range of species of birds, mammals, reptiles, amphibians, and invertebrates. Riparian habitats support breeding, foraging, and roosting habitat for tree swallow, bushtit, white-breasted nuthatch, Nuttall's woodpecker, downy woodpecker, acorn woodpeckers, spotted towhee, northern flicker, yellow warbler, western scrub jay, white-tailed kite, Cooper's hawk, red-shouldered hawk, American kestrel, great horned owl, song sparrow, black phoebe, European starling, western bluebird, and tree swallow. Scrub habitat in particular supports species such as California quail, western scrub-jay, bushtit, California thrasher, spotted towhee, sage sparrow, western fence lizard, common garter snake, common king snake, western rattlesnake, deer mouse, and feral pig.

Riparian areas support mammal species, such as river otter, beaver, big brown bat, and Yuma myotis (bat), and they provide cover and habitat for common mammal species, such as raccoon, Virginia opossum, mule deer, coyote, striped skunk, deer mouse, harvest mouse, dusky-footed woodrat, and gray fox. Although riparian woodlands along the upper Sacramento River typically occur in narrow or discontinuous patches, they provide value for wildlife and support both common and special-status species of migratory and resident birds, raptors, waterfowl, mammals, reptiles, amphibians, and invertebrates.

In the Bay–Delta Region and Suisun Marsh, the low tidal wetland zone provides foraging habitat for waterfowl and shorebirds, California Ridgway's rail, California black rail, and other wading birds. The middle tidal wetland zone provides foraging habitat for salt marsh harvest mouse and Suisun shrew, as well as for common and special-status bird species, including waterfowl and shorebirds, California Ridgway's rail, California black rail, and other wading birds. This zone also provides nesting and foraging habitat for Suisun song sparrow and salt marsh common yellowthroat (Reclamation et al. 2011).

The high tidal marsh provides habitat for special-status plants, including Suisun marsh aster, soft bird's beak, and Suisun thistle (Siegel et al. 2010). The high marsh zone provides foraging and nesting habitat for waterfowl, shorebirds, California Ridgway's rail, California black rail, and other birds. It also provides foraging and nesting habitat for special-status species, such as salt marsh harvest mouse and Suisun shrew, and it provides escape cover for salt marsh harvest mouse and Suisun shrew during periods when the middle and lower portions of the high tidal wetland zone are inundated (Reclamation et al. 2011).

As in other locations in the study area, riparian trees in the Bay–Delta Region are used for nesting, foraging, and protective cover by many bird species, and riparian canopies provide nesting and foraging habitat for a variety of mammals. Understory shrubs provide cover for ground-nesting birds that forage among the vegetation and leaf litter. Willow thickets provide habitat for a wide range of wildlife species, including song sparrow, lazuli bunting, and valley elderberry longhorn beetle.

Many managed wetlands, found primarily in the Delta region, are managed specifically as habitat for wintering waterfowl species. Commonly referred to as "brood ponds," these wetlands are flooded during the spring and summer but may experience a 2- to 6-month dry period each year. These semi-permanent wetlands provide breeding ducks, ducklings, and other wetland wildlife with protection from predators and abundant invertebrate food supplies (CDFG and Yolo Basin Foundation 2008). Permanent wetlands remain flooded throughout the year. Because of year-round flooding, permanent wetlands support a diverse, but usually not abundant, population of invertebrates. Permanent managed wetlands provide deep water habitat for diving ducks, such as ruddy duck, scaup, and goldeneye, and for other water birds, including pied-billed grebe, coot, and moorhen. They often have dense emergent cover on their edges, which is the preferred breeding habitat for marsh wren and red-winged blackbird, and roosting habitat for black-crowned night heron, white-faced ibis, and egret.

Some unique habitats found in the proposed project area are native redwood and knobcone pine forests, located at the Upper San Leandro Reservoir. Non-native eucalyptus and Monterey pine forests occur at the San Pablo Reservoir and Lake Chabot. The eucalyptus trees provide specific habitat for hummingbird, bald eagle, great blue heron, and great egret.

Special-Status Species

For this analysis, special-status wildlife species are plants and wildlife that fall within any of the following categories:

- Species listed by the federal government as threatened or endangered;
- Species listed by the State as threatened, endangered, or rare (rare status is for plants only);
- Species that are formally proposed for federal listing or are candidates for federal listing as threatened or endangered;
- Species that are candidates for State listing as threatened or endangered;
- Species that meet the definitions of rare, threatened, or endangered under the California Environmental Quality Act;
- Species identified by USFWS as Birds of Conservation Concern;
- Species identified by CDFW as species of special concern, species designated by California statute as fully protected (e.g., California Fish and Game Code, Sections 3,511 [birds], 4,700 [mammals], 5,050 [reptiles and amphibians], and 5,515 [fish]), or bird species on the CDFW Watch List; and
- Species, subspecies, and varieties of plants considered by CDFW and the California Native Plant Society (CNPS) to be rare, threatened, or endangered in California. The CNPS Inventory of Rare and Endangered Plants of California assigns California Rare Plant Ranks (CRPR) categories for plant species of concern. Only plant species in CRPR categories 1 and 2 are considered special-status plant species in this document.
    - CRPR 1A — Plants presumed to be extinct in California.
    - CRPR 1B — Plants that are rare, threatened, or endangered in California and elsewhere.
    - CRPR 2 — Plants that are rare, threatened, or endangered in California but more common elsewhere.

Attachment 1 provides a complete list of species considered in assessing the direct and indirect impacts of SWP operations.

Tables 3.4-4 and 3.4-5 list the species that are discussed in this Initial Study. These are species with the potential to occur in areas in the project area that may be directly or indirectly affected by the proposed changes to the SWP because they occur 1) along rivers downstream from SWP facilities, 2) in potential habitat restoration areas in the Yolo Bypass and Suisun Marsh, or 3) in riparian corridors in the Delta. The geographic scope includes the Sacramento River from the Feather River confluence downstream to, and including, the Delta and Suisun Marsh.

Table 3.4-4. Special-Status Wildlife Species

Common Name	Scientific Name	Status Federal/State/CDFW
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	FT/–/–
Western pond turtle	*Emmys marmorata*	–/–/SSC
Giant garter snake	*Thamnophis gigas*	FT/ST/–
Tricolored blackbird (nesting colony)	*Agelaius tricolor*	BCC/ST/–
Tule greater white-fronted goose (wintering)	*Anser albifrons elgasi*	–/–/SSC
Short-eared owl (nesting)	*Asio flammeus*	–/–/SSC
Burrowing owl (nesting and wintering sites)	*Athene cunicularia*	–/–/SSC
Swainson's hawk (nesting)	*Buteo swainsoni*	BCC/ST/–
Western yellow-billed cuckoo (nesting)	*Coccyzus americanus occidentalis*	FT/SE/–
Yellow warbler	*Dendroica petechia brewsteri*	BCC/–/SSC
White-tailed kite (nesting)	*Elanus leucurus*	–/–/FP
Willow flycatcher	*Empidonax traillii*	BCC/SE/–
Saltmarsh common yellowthroat	*Geothlypis trichas sinuosa*	BCC/–/SSC
Greater sandhill crane (wintering)	*Grus canadensis tabida*	–/ST/FP
Bald eagle (nesting and wintering)	*Haliaeetus leucocephalus*	BCC/FD/SE/FP
Least bittern (nesting)	*Ixobrychus exilis*	BCC/–/SSC
Suisun song sparrow	*Melospiza melodia maxillaris*	BCC/–/SSC*
White-faced ibis (nesting colony)	*Plegadis chihi*	–/–/WL
California Ridgway's rail	*Rallus obsoletus*	FE/SE/FP
Bank swallow (nesting)	*Riparia*	–/ST/–
Least Bell's vireo (nesting)	*Vireo bellii pusillus*	FE/SE/–
Riparian (= San Joaquin Valley) woodrat	*Neotoma fuscipes riparia*	FE/–/SSC
Salt marsh harvest mouse	*Reithrodontomys raviventris*	FE/SE/FP
Suisun shrew	*Sorex ornatus sinuosus*	–/–/SSC
Riparian brush rabbit	*Sylvilagus bachmani riparius*	FE/SE/–

Source: CDFW 2019; USFWS 2019
Status Codes:
Federal—U.S. Fish and Wildlife Service:
BCC = bird species of conservation concern
FE = federally endangered
FT = federally threatened
FC = candidate for federal listing under the federal Endangered Species Act
FD = federal delisted
DPS = Distinct Population Segment
– = no status
State—California Department of Fish and Wildlife:
SE = state endangered
ST = state threatened
FP = California fully protected species
PT = proposed threatened
SSC = California species of special concern
WL = CDFW watch list
– = no status

Table 3.4-5. Special-Status Plants

Common Name	Scientific Name	Status Federal/State/CRPR*
Bolander's water hemlock	*Cicuta maculata* var. *bolanderi*	–/–/2.1
Delta button-celery	*Eryngium racemosum*	--/SE/1B.1
Delta tule pea	*Lathyrus jepsonii* var. *jepsonii*	--/--/1B.2
Mason's lilaeopsis	*Lilaeopsis masonii*	--/SR/1B.1
Soft salty bird's-beak	*Chloropyron molle* ssp. *molle*	FE/SR/1B.2
Suisun Marsh aster	*Symphyotrichum lentum*	--/--/1B.2
Suisun thistle	*Cirsium hydrophilum* var. *hydrophilum*	FE/--/1B.1

Source: CalFlora 2019; CDFW 2019; CNPS 2019; USFWS 2019
Status Codes
Federal—U.S. Fish and Wildlife Service:
E = endangered
– = no status
State—California Department of Fish and Wildlife:
E = endangered
– = no status
California Rare Plant Ranks (CRPRs):
1B = plant species considered rare, threatened, or endangered in California and elsewhere
2 = plant species considered rare, threatened, or endangered in California but more common elsewhere
California Rare Plant Rank Extensions:
1 = seriously endangered in California (>80% of occurrences are threatened and/or have high degree and immediacy of threat)
2 = fairly endangered in California (20–80% of occurrences are threatened)
3 = not very endangered in California

Special-status plant and wildlife species were included if they potentially could be directly or indirectly affected because of:

- potential changes to wildlife and plant habitat on river banks (changes in flows could affect plants and wildlife along stream and reservoir banks),
- potential changes to existing marshes and associated special-status species in the Delta region (habitat restoration may result in short-term loss of tidal marsh habitat), and
- potential changes to existing riparian areas and associated special-status species (habitat restoration may result in the loss of riparian habitat).

3.4.2.2 Discussion - Terrestrial Biological Resources

a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?

The Proposed Project would not involve construction of water facilities, infrastructure, or other projects that would result in disturbance to habitat supporting terrestrial plant and wildlife species, wetlands, or other sensitive plant communities. The Proposed Project would continue the conveyance of irrigation water to areas north and south of the Delta and would not reduce water deliveries to agricultural lands. Therefore, conditions would not change for wildlife species that rely on agricultural lands. Under the Proposed Project, flows in the Sacramento River would generally be similar to the Existing Conditions scenario, and hydrodynamic conditions would not differ such that riparian habitat or other existing plant or wildlife communities supporting special-status species would be altered substantially adjacent to the Sacramento River downstream of the confluence with the Feather River or within the Delta. Section 3.10, “Hydrology and Water Quality,” further discusses the hydrologic changes associated with the Proposed Project.

Tables 3.4-6 and 3.4-7 describe the impacts of the Proposed Project on focal special-status wildlife and plant species analyzed in this IS (i.e., those that could potentially occur adjacent to the Sacramento River downstream of the confluence with the Feather River, and in the Delta) and the rationale for determining potential impacts. As detailed within those tables, the Proposed Project would not impact any of the analyzed species. Therefore, **no impact** would occur.

b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, or regulations or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?

Proposed long-term operation of the SWP would remain within the historic range of past SWP operations and would not result in changes in reservoir surface elevations or downstream surface water flows that would alter riparian habitat, freshwater marshes, or other sensitive natural communities. Therefore, **no impact** would occur.

c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?

Proposed long-term operation of the SWP would not involve construction of water facilities, infrastructure, or other projects that would result in adverse effects on wetlands, marshes, vernal pools, or other federally protected wetlands. Therefore, **no impact** would occur.

Table 3.4-6. Special-Status Wildlife Species and Potential for Impact

Common Name	Scientific Name	Status Federal/ State/ CDFW*	Habitat/Distribution	Potential for Impact
Valley Elderberry Longhorn Beetle	*Desmocerus californicus dimorphus*	FT/–/–	Found only in association with its host plant, blue elderberry (*Sambucus nigra* ssp. *caerulea*). In the Central Valley, the elderberry shrub is found primarily in riparian vegetation. Known to occur in elderberry shrubs present in the riparian woodland and expected to occur in suitable habitat in other locations along the San Joaquin River. Recorded at Caswell Memorial State Park and other locations along the Stanislaus River.	None. No water facilities, infrastructure, or restoration projects proposed that would result in disturbance to elderberry shrubs, nor would changes occur in flows or surface water elevations affecting riparian habitat where elderberry shrubs could occur.
Western Pond Turtle	*Emmys marmorata*	–/–/SSC	Inhabits slow-moving streams, sloughs, ponds, irrigation and drainage ditches, and adjacent upland areas. Potentially occurs near New Melones Reservoir. Recorded within Whiskeytown Lake and Clear Creek and near Lewiston Reservoir. Known to occur in suitable habitat on the San Luis NWR complex, in the Mendota Wildlife Area, and at Mendota Pool; expected to occur in suitable habitat in other locations in the San Joaquin River Restoration Area.	None. No water facilities, infrastructure, or restoration projects proposed in areas supporting western pond turtle habitat, nor would changes occur in flows or water surface elevations in aquatic habitat for this species.
Giant Garter Snake	*Thamnophis gigas*	FT/ST/–	Marshes, ponds, sloughs, small lakes, low-gradient streams, and other waterways, and in agricultural wetlands, including irrigation and drainage canals, rice fields, and adjacent uplands. Current distribution extends from near Chico in Butte County south to the Mendota Wildlife Area in Fresno County. Known from White Slough/Caldoni Marsh and Yolo Basin/Willow Slough. Known to occur in suitable habitat on the San Luis NWR complex and in the Mendota Wildlife Area; reported from Mendota Pool.	None. No water facilities, infrastructure, or restoration projects proposed in areas supporting giant garter snake habitat, nor would SWP operations change flows or water surface elevations in aquatic habitat for this species, or change water deliveries to agricultural lands or wildlife refuges

Common Name	Scientific Name	Status Federal/ State/ CDFW*	Habitat/Distribution	Potential for Impact
Tricolored Blackbird (nesting colony)	*Agelaius tricolor*	–/BCC/ST	Nests colonially in tules, cattails, willows, thistles, blackberries, and other dense vegetation. Forages in grasslands and agricultural fields. Reclamation (2010) concluded this species occurs near New Melones Reservoir. Suitable nesting and foraging habitat is present in the upper Sacramento River area. Known to occur in suitable habitat on the San Luis NWR complex and other sites in the Yolo Bypass.	None. No water facilities, infrastructure, or restoration projects proposed in areas supporting tricolored blackbird habitat, nor would SWP operations change flows or surface elevations in aquatic habitat for this species, or change water deliveries to agricultural lands or wildlife refuges
Tule Greater White-fronted Goose (wintering)	*Anser albifrons elgasi*	–/–/SSC	Winters in California. Associated with dense tule–cattail marsh habitat. Has been documented near Sherman Island and at various locations in the Suisun Marsh. Winters at Sacramento Valley wildlife refuges and surrounding rice fields, Suisun Marsh, and Grizzly Island Wildlife Area.	None. No water facilities, infrastructure, or restoration projects proposed in areas supporting waterfowl wintering habitat, nor would SWP operations change flows or water surface elevations in aquatic habitat for this species, or change water deliveries to agricultural lands or wildlife refuges.
Short-eared Owl (nesting)	*Asio flammeus*	–/–/SSC	Widespread winter migrant, found primarily in the Central Valley, in the western Sierra Nevada foothills, and along the coastline. Usually found in open areas with few trees, such as annual and perennial grasslands, prairies, dunes, meadows, irrigated lands, and saline and fresh emergent wetlands. Occasionally still breeds in northern California. Known to occur in suitable habitat on the San Luis NWR complex, where it possibly also nests. Breeding range includes coastal areas in Del Norte and Humboldt counties, the San Francisco Bay Delta, northeastern Modoc plateau, the east side of the Sierra from Lake Tahoe south to Inyo County, and the San Joaquin Valley.	None. No water facilities, infrastructure, or restoration projects proposed in areas supporting short-eared owl nesting habitat.

Common Name	Scientific Name	Status Federal/ State/ CDFW*	Habitat/Distribution	Potential for Impact
Burrowing Owl (nesting and wintering sites)	*Athene cunicularia*	–/–/SSC	Nests and forages in grasslands, shrub lands, deserts, and agricultural fields, especially where ground squirrel burrows are present. Occurs near New Melones Reservoir. Unlikely to occur along the Sacramento River corridor due to a lack of suitable nesting habitat. Known to occur in suitable habitat in the Yolo Bypass, in the Chowchilla Bypass, on the San Luis NWR complex, and at Mendota Pool.	None. No water facilities, infrastructure, or restoration projects proposed in areas supporting burrowing owl nesting or wintering habitat.
Swainson's Hawk (nesting)	*Buteo swainsoni*	BCC/ST/–	Nests in riparian woodlands, roadside trees, tree rows, isolated trees, woodlots, and trees in farmyards and rural residences. Forages in grasslands and agricultural fields in the Central Valley. Occurs near New Melones Reservoir. Known to nest in suitable habitat on the San Luis NWR complex and Great Valley Grasslands State Park and other areas along the San Joaquin River. Suitable nesting and foraging habitat is present along Sacramento River.	None. No water facilities, infrastructure, or restoration projects proposed in areas supporting Swainson's hawk foraging or nesting habitat, nor would changes occur to water deliveries to agricultural lands or wildlife refuges that support this species.
Western Yellow-billed Cuckoo (nesting)	*Coccyzus americanus occidentalis*	BCC/FT/SE/–	Densely foliaged, deciduous trees and shrubs, especially willows, required for roosting sites. An uncommon to rare summer resident of valley foothill and desert riparian habitats in scattered locations in California. Breeding pairs known from Sacramento Valley. Reclamation (2010) concluded this species could potentially occur near New Melones Reservoir. Detected by BDCP surveys in 2009 near Walnut Grove. Likely to nest and forage in the upper Sacramento River area.	None. No water facilities, infrastructure, or restoration projects proposed that would result in disturbance to riparian habitat. nor would changes occur in flows or surface water elevations that would affect riparian habitat.
Yellow Warbler	*Dendroica petechia brewsteri*	BCC/–/SSC	Nests in riparian woodland and riparian scrub habitats. Forages in a variety of wooded and shrub habitats during migration. Reclamation (2010) concluded this species occurs near New Melones Reservoir. No recent nesting records, but potential nesting habitat present; known to occur during migration in suitable habitat on the San Luis NWR. Could nest and forage in the upper Sacramento River area. Likely to use riparian woodlands during migration.	None. No water facilities, infrastructure, or restoration projects proposed that would result in disturbance to riparian habitat. nor would changes occur in flows or surface water elevations that would affect riparian habitat.

Common Name	Scientific Name	Status Federal/ State/ CDFW*	Habitat/Distribution	Potential for Impact
White-tailed Kite (nesting)	*Elanus leucurus*	–/–/FP	Nests in woodlands and isolated trees; forages in grasslands, shrub lands and agricultural fields. Common to uncommon and a year-round resident in the Central Valley, in other lowland valleys, and along the entire length of the coast. Recent surveys in Yolo and Sacramento counties have documented active nest sites in riparian habitats in the Yolo Bypass and along Steamboat and Georgiana sloughs and along the Sacramento River. Suitable nesting and foraging habitat is present along the upper Sacramento River. Expected to occur in suitable habitat along the San Joaquin River and in the Yolo Bypass.	None. No water facilities, infrastructure, or restoration projects proposed in areas supporting white-tailed kite foraging or nesting habitat.
Saltmarsh Common Yellowthroat	*Geothlypis trichas sinuosa*	BCC/–/SSC	Primarily brackish marsh, but also brackish and fresh woody swamps and riparian areas. Ranges generally in the San Francisco Bay area.	None. No water facilities, infrastructure, or restoration projects proposed that would result in disturbance to brackish marsh or riparian habitat, nor would changes occur in flows or surface water elevations that would affect marshes or riparian habitat.
Greater Sandhill Crane (wintering)	*Grus canadensis tabida*	–/ST/FP	Eight distinct wintering locations in the Central Valley, from Chico/Butte Sink on the north to Pixley National Wildlife Refuge near Delano on the south, with more than 95% occurring within the Sacramento Valley between Butte Sink and the Delta. Unlikely to breed in the upper Sacramento River area. Known to occur during winter in suitable habitat on the San Luis NWR complex, along the San Joaquin River, and in the Delta.	None. No water facilities, infrastructure, or restoration projects proposed in areas supporting crane wintering habitat, or in water deliveries to agricultural lands or wildlife refuges.
Bald Eagle (nesting and wintering)	*Haliaeetus leucocephalus*	BCC/FD/SE/FP	Requires large bodies of water or free-flowing rivers with abundant fish and adjacent snags or other perches for foraging. Occurs near New Melones Reservoir, Whiskeytown Lake, Trinity Lake, and Lewiston Reservoir. Known to nest in suitable habitat around Lake Millerton and in the Chowchilla Bypass.	None. No water facilities, infrastructure, or restoration projects proposed in areas supporting bald eagle nesting habitat, nor would SWP operations change flows or water surface elevations in streams or reservoirs that provide eagle foraging habitat.

Common Name	Scientific Name	Status Federal/ State/ CDFW*	Habitat/Distribution	Potential for Impact
Least Bittern (nesting)	*Ixobrychus exilis*	BCC/–/SSC	Rare to uncommon April to September nester in large, fresh emergent wetlands of cattails and tules in the Sacramento Valley and San Joaquin Valley. Occurs in freshwater marsh habitats in the Yolo Bypass, east of the Sacramento River, and in the western Delta. Uncommon but regular breeder in suitable habitat in the San Joaquin Valley.	None. No water facilities, infrastructure, or restoration projects proposed in areas supporting bittern nesting habitat.
California Black Rail	*Laterallus jamaicensis coturniculus*	BCC/ST/FP	Tidal marshes in the northern San Francisco Bay estuary, Tomales Bay, Bolinas Lagoon, the Delta, Morro Bay, the Salton Sea, and the lower Colorado River. Found recently at several inland freshwater sites in the Sierra Nevada foothills in Butte, Yuba, and Nevada counties; the Cosumnes River Preserve in south Sacramento County; and Bidwell Park in Chico, Butte County.	None. No water facilities, infrastructure, or restoration projects proposed that would result in disturbance to tidal marshes or riparian habitat, nor would changes occur in flows or water surface elevations in tidal marshes.
Suisun Song Sparrow	*Melospiza melodia maxillaris*	BCC/–/SSC	Brackish marshes around Suisun Bay.	None. No water facilities, infrastructure, or restoration projects proposed that would result in disturbance to brackish marshes, nor would changes occur in flows or water surface elevations in brackish marshes.
White-faced Ibis (nesting colony)	*Plegadis chihi*	–/–/WL	Forages in wetlands and irrigated or flooded croplands and pastures. Breeds colonially in dense freshwater marsh. Known to occur in suitable habitat on the San Luis NWR complex and other sites in the Restoration Area and the Yolo Bypass.	None. No water facilities, infrastructure, or restoration projects proposed that would result in disturbance to ibis nesting habitat or in disturbance to water deliveries to agricultural lands or wildlife refuges.
California Ridgway's Rail	*Rallus obsoletus*	FE/SE/FP	Dense marshy areas of the Delta region.	None. No water facilities, infrastructure, or restoration projects proposed that would result in disturbance to Delta marshes.

Common Name	Scientific Name	Status Federal/ State/ CDFW*	Habitat/Distribution	Potential for Impact
Bank Swallow (nesting)	*Riparia*	–/ST/–	Neotropical migrant found primarily in riparian and other lowland habitats in California west of the deserts during the spring-fall period. In summer, restricted to riparian, lacustrine, and coastal areas with vertical banks, bluffs, and cliffs with fine-textured or sandy soils into which it digs nesting holes. Approximately 75% of the current breeding population in California occurs along banks of the Sacramento and Feather rivers in the northern Central Valley.	None. No water facilities, infrastructure, or restoration projects proposed that would result in disturbance to river banks supporting bank swallow colonies. Long-term SWP operations would not change existing peak flow regimes that create bank swallow nesting habitat.
Least Bell's Vireo (nesting)	*Vireo bellii pusillus*	FE/SE/–	Nests in dense, low, shrubby vegetation, generally early successional stages in riparian areas, particularly cottonwood-willow forest, but also in brushy fields, young second-growth forest or woodland, scrub oak, coastal chaparral, and mesquite brush lands, often near water in arid regions. Singing males observed in Yolo Bypass Wildlife Area. Successfully nested at the San Joaquin River NWR in 2005 and 2006.	None. No water facilities, infrastructure, or restoration projects proposed that would result in disturbance to early successional riparian habitat, nor would changes occur in flows or surface water elevations affecting riparian habitat.
Riparian (= San Joaquin Valley) Woodrat	*Neotoma fuscipes riparia*	FE/–/SSC	Historically found in riparian habitat along the San Joaquin, Stanislaus, and Tuolumne Rivers. Now known only from Caswell Memorial State Park on the Stanislaus River near its confluence with the San Joaquin River in a very low gradient portion of the river. No actions proposed that could affect this species in this area. Last reported at Caswell Memorial State Park in 2002. Likely still extant.	None. No water facilities, infrastructure, or restoration projects proposed that would result in disturbance to riparian habitat at Caswell State Park, nor would changes occur in flows or surface water elevations affecting riparian habitat.
Salt Marsh Harvest Mouse	*Reithrodontomys raviventris*	FE/SE/FP	Found only in saline emergent wetlands of San Francisco Bay and its tributaries. Pickleweed saline emergent wetland is preferred habitat, where it may be locally common. Grasslands adjacent to pickleweed marsh are used, but only when new grass growth affords suitable cover in spring and summer. Reported occurrences of the salt marsh harvest mouse from within the Delta are restricted to salt and brackish tidal marshes along the northern edge of the Sacramento River and the southern edge of the San Joaquin River as far east as the vicinity of Collinsville and Antioch, west of Sherman Island.	None. No water facilities, infrastructure, or restoration projects proposed that would result in disturbance to wetlands in the San Francisco Bay, tributaries or in the Delta, nor would salinity changes occur affecting saline wetlands that support this species.

Common Name	Scientific Name	Status Federal/ State/ CDFW*	Habitat/Distribution	Potential for Impact
Suisun Shrew	*Sorex ornatus sinuosus*	–/–/SSC	Historically known from tidal wetlands of Solano, Napa, and eastern Sonoma counties. Currently limited to the northern borders of San Pablo and Suisun bays.	None. No water facilities, infrastructure, or restoration projects proposed that would result in disturbance to wetlands in the San Francisco Bay, tributaries, or in the Delta, nor would salinity changes occur affecting wetlands that support this species.
Riparian Brush Rabbit	*Sylvilagus bachmani riparius*	FE/SE/–	Historical distribution may have extended along portions of the San Joaquin River and its tributaries on the valley floor from at least Stanislaus County to the Delta. Currently restricted to several populations at Caswell Memorial State Park, near Manteca in San Joaquin County, along the Stanislaus River, along Paradise Cut (a channel of the San Joaquin River in the southern part of the Delta), and a recent reintroduction on private lands adjacent to the San Joaquin River NWR.	None. No water facilities, infrastructure, or restoration projects proposed that would result in disturbance to riparian habitat, nor would changes occur in flows or surface water elevations affecting riparian habitat.

Sources: CDFW 2019, USFWS 2019, U.S. Bureau of Reclamation 2019

*Status Codes:

BCC = bird species of conservation concern

BDCP = Bay Delta Conservation Plan

CDFW = California Department of Fish and Wildlife

FC = candidate for federal listing under the federal Endangered Species Act

FD = federal delisted

FE = federally endangered

FP = California fully protected species

FS = Forest Service sensitive species

FT = federally threatened

NWR = National Wildlife Refuge

PT = proposed threatened

SE = state endangered

SSC = California species of special concern

ST = state threatened

WL = CDFW watch list

Table 3.4-7. Special-Status Plant Species and Potential for Impact

Common Name	Scientific Name	Status Federal/State/CRPR*	Habitat/Distribution	Potential for Impact
Bolander's Water Hemlock	*Cicuta maculata* var. *bolanderi*	–/–/2.1	Coastal fresh or brackish marshes and swamps in Contra Costa, Sacramento, Marin, and Solano counties. Present in the North and Central Delta and in Suisun Marsh.	None. No water facilities, infrastructure, or restoration projects proposed that would result in disturbance to coastal or brackish wetlands, nor would changes occur in flows, surface water elevations, or salinities that would affect habitat supporting this species.
Delta Button-celery	*Eryngium racemosum*	–/SE/1B.1	Vernally mesic clay depressions in riparian scrub. Extant occurrences recorded along the San Joaquin River in Merced County, and in the South Delta. Reclamation (2010) concluded this species could potentially occur near New Melones Reservoir.	None. No water facilities, infrastructure, or restoration projects proposed that would result in disturbance to habitat for this species.
Delta Tule Pea	*Lathyrus jepsonii* var. *jepsonii*	–/–/1B.2	Freshwater and brackish marshes and swamps in the Delta region. Known from the north, central, and west Delta, and Suisun Marsh. CNDDB documents occurrences at Snodgrass, Barker, Lindsey, Hass, and Cache sloughs; Delta Meadows Park; and Calhoun Cut.	None. No water facilities, infrastructure, or restoration projects proposed that would result in disturbance to freshwater or brackish wetlands, nor would changes occur in flows, surface water elevations, or salinities that would affect habitat supporting this species.
Mason's Lilaeopsis	*Lilaeopsis masonii*	–/SR/1B.1	Brackish or freshwater marshes and swamps, riparian scrub in Delta region. Known and locally common in certain regions of Delta and in Suisun Marsh. CNDDB documents occurrences of this species in Barker, Lindsey, Cache, and Snodgrass sloughs as well as in Calhoun Cut.	None. No water facilities, infrastructure, or restoration projects proposed that would result in disturbance to freshwater or brackish wetlands or riparian scrub, nor would changes occur in flows, surface water elevations, or salinities that would affect habitat supporting this species.
Soft Salty Bird's-beak	*Chloropyron molle* ssp. *molle*	FE/SR/1B.2	Coastal salt marshes and swamps in Contra Costa, Napa, and Solano counties.	None. No water facilities, infrastructure, or restoration projects proposed that would result in disturbance to coastal marshes, nor would changes occur in flows, surface water elevations, or salinities that would affect habitat supporting this species.
Suisun Marsh Aster	*Symphyotrichum lentum*	–/–/1B.2	Endemic to the Delta, generally occurs in marshes and swamps, often along sloughs, from 0 to 3 meters in elevation. Brackish and freshwater marshes and swamps in the Delta region. Known from many areas of the Delta and from Suisun Marsh.	None. No water facilities, infrastructure, or restoration projects proposed that would result in disturbance to brackish or freshwater marshes, nor would changes occur in flows, surface water elevations, or salinities that would affect habitat supporting this species.

Common Name	Scientific Name	Status Federal/State/CRPR*	Habitat/Distribution	Potential for Impact
Suisun Thistle	*Cirsium hydrophilum* var. *hydrophilum*	FE/–/1B.1	Salt marshes and swamps. Two known occurrences in Grizzly Island Wildlife Area and Peytonia Slough Ecological Reserve. Present at Suisun Marsh.	None. No water facilities, infrastructure, or restoration projects proposed that would result in disturbance to salt marshes and swamps, nor would changes occur in flows, surface water elevations, or salinities that would affect habitat supporting this species.

Sources: CDFW 2019; USFWS 201; CalFlora 2019; CNPS 2019; U.S. Bureau of Reclamation 2019.

Notes: Status Codes

Federal—U.S. Fish and Wildlife Service:

E = endangered

– = no status

State—California Department of Fish and Wildlife:

E = endangered

– = no status

California Rare Plant Ranks (CRPRs):

1B = plant species considered rare, threatened, or endangered in California and elsewhere

2 = plant species considered rare, threatened, or endangered in California but more common elsewhere

California Rare Plant Rank Extensions:

.1 = seriously endangered in California (>80% of occurrences are threatened and/or have high degree and immediacy of threat)

.2 = fairly endangered in California (20–80% of occurrences are threatened)

.3 = not very endangered in California

d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?

Proposed long-term operation of the SWP would not involve construction of water facilities, infrastructure, or other projects that may affect wildlife movement or nursery sites, and would not result in alterations in habitat that would interfere with wildlife movement and migratory wildlife corridors, or impede the use of native wildlife nursery sites. Therefore, **no impact** would occur.

e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?

Proposed long-term operation of the SWP would not involve activities that would conflict with local policies or ordinances protecting biological resources. Therefore, **no impact** would occur.

f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?

Proposed long-term operation of the SWP would not conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or State habitat conservation plan protecting special-status plants and wildlife or sensitive natural communities. Therefore, **no impact** would occur.

3.5 CULTURAL RESOURCES

Table 3.5-1. Potential Impacts on Cultural Resources

ENVIRONMENTAL ISSUES		ENVIRONMENTAL IMPACT SIGNIFICANCE
V.	**Cultural Resources. Would the project:**	-
a)	Cause a substantial adverse change in the significance of a historical resource as defined in Section 15064.5?	No Impact
b)	Cause a substantial adverse change in the significance of an archaeological resource pursuant to Section 15064.5?	No Impact
c)	Disturb any human remains, including those interred outside of formal cemeteries?	No Impact

Note:
"-" indicates blank cell

3.5.1 ENVIRONMENTAL SETTING

3.5.1.1 Prehistoric Context

The area of the Proposed Project has a long and complex cultural history with distinct regional patterns that extend back more than 11,000 years (Reclamation 1997, as cited in Reclamation 2019). The presence of prehistoric peoples in the area is represented by the distinctive fluted spear points called Clovis points. These artifacts have been found on the margins of extinct lakes in the San Joaquin Valley. The Clovis points are found on the same surface with the bones of animals that are now extinct, such as mammoths, sloths, and camels. The subsequent period from about 10,000 to 8,000 Before Present (B.P.) was characterized by a small number of sites with stemmed spear points instead of fluted spear points.

Approximately 8,000 years ago, many California cultures shifted the main focus of their subsistence strategies from hunting to seed gathering, as evidenced by the increase in food-grinding implements found in archaeological sites dating to this period. By approximately 4,000 B.P., people possibly from the Great Basin were hunting and gathering seasonally in the Sierra Nevada and the Sacramento Valley. The earliest evidence of widespread villages and permanent occupation of the lower Sacramento Valley and Suisun Marsh comes from several sites assigned to the Windmiller Pattern (previously, "Early Horizon"), dated circa 4,500 to 2,500 B.P. (Ragir 1972, as cited in Reclamation 2019; Reclamation 1997, as cited in Reclamation 2019; Reclamation et al. 2010, as cited in Reclamation 2019).

In the last 3,000 years, the archaeological record becomes more complex, as specialized adaptations to locally available resources were developed and populations expanded. Many sites dating to this period contain mortars and pestles or are associated with bedrock mortars, implying that the occupants exploited acorns intensively. The range of subsistence resources that were used increased, exchange systems expanded, and social stratification and craft specialization occurred, as indicated by well-made artifacts such as charm stones and beads, which have often been found with burials.

In the Bay–Delta region from 5,000 to 2,500 B.P., dense settlements extended from the coastal marshes to the interior grasslands and woodlands (Zone 7 Water Agency 2006, as cited in Reclamation

2019). From about 2,500 to 950 B.P., coastal communities relied on shellfish, and major shell mounds were created near these communities, including near the present Alameda County shorelines and some interior valleys. In the Sacramento Valley, the last 1,500 years is characterized by intensified hunting, fishing, and gathering subsistence with larger communities, highly developed trade networks, elaborate ceremonial and mortuary practices, and social stratification. Interaction among groups became more developed through time.

From approximately 1,650 to 950 B.P., evidence indicates that the people of the eastern San Joaquin Valley may have interacted with people in the Delta area, and from approximately 450 to 100 B.P., the people of the eastern San Joaquin Valley may have interacted with people in the Central Coast and Southern California areas (Reclamation 1997, as cited in Reclamation 2019).

Ethnographic Context

This section presents brief ethnographic sketches for each native cultural group whose traditional territories are in the study area. The Proposed Project area encompasses lands occupied by more than 40 distinct Native American cultural groups. Although most California tribes shared similar elements of social organization and material culture, linguistic affiliation and territorial boundaries primarily distinguish them from each other. Before European settlement of California, an estimated 310,000 native Californians spoke dialects of as many as 80 mutually unintelligible languages, representing six major North American language stocks (Cook 1978, as cited in Reclamation 2019; Moratto 1984; Reclamation 1997, as cited in Reclamation 2019; Shipley 1978).

Ethnography

Patwin

The Patwin lived along the western side of the Sacramento Valley, from what is now Princeton to Benicia, including Suisun Marsh (Kroeber 1925; Reclamation 1997, as cited in Reclamation 2019; Reclamation et al. 2010, as cited in Reclamation 2019). Within this large area, the Patwin traditionally are divided into the River, Hill, and Southern Patwin groups. Settlements generally were on high ground along the Sacramento River or tributary streams, or in the eastern Coast Range valleys (P. Johnson 1978b; Reclamation 1997, as cited in Reclamation 2019; Reclamation et al. 2010, as cited in Reclamation 2019).

Miwok

The Miwok cultures included the Coast Miwok, Lake Miwok, and Eastern Miwok divisions. The Eastern Miwok included five separate groups (i.e., Bay, Plains, Northern Sierra, Central Sierra, and Southern Sierra) who inhabited the area from present-day Walnut Creek in Contra Costa County and the Delta, along the lower Mokelumne and Cosumnes rivers and along the Sacramento River from present-day Rio Vista to Freeport, the foothill and mountain areas of the upper Mokelumne River and Calaveras River watersheds, the upper Stanislaus River and Tuolumne River watersheds, and the upper Merced River and Chowchilla River watersheds, respectively (Levy 1978; Reclamation 1997, as cited in Reclamation 2019; Shipley 1978).

In the Bay–Delta region, the Coast Miwok people lived along the lower San Joaquin River and San Pablo Bay and in the interior of present-day Contra Costa and Alameda counties (Reclamation 1997, as cited in Reclamation 2019; ECCCHCPA and USFWS 2006, as cited in Reclamation 2019; Kelly 1978, as cited in Reclamation 2019). The Bay Miwok villages were in the San Ramon Valley, and other settlements were on the western slopes of the Diablo Range (CCWD et al. 2009, as cited in Reclamation 2019). The Miwok people may have held lands on the peak of Mount Diablo.

Yokuts

Yokuts were a large and diverse group of people in the San Joaquin Valley and Sierra Nevada foothills of central California, including the Southern San Joaquin Valley Yokuts, Northern San Joaquin Valley Yokuts, and Foothill Yokuts (Reclamation 1997, as cited in Reclamation 2019; Reclamation and DWR 2011, as cited in Reclamation 2019; SJRRP 2011, as cited in Reclamation 2019). The three subdivisions of the Yokuts languages belong to the Yokutsan family, or Penutian stock (Shipley 1978).

The Southern Valley Yokuts inhabited the southern San Joaquin Valley from present-day Fresno to the Tehachapi Mountains (Wallace 1978a). The Northern Valley Yokuts inhabited the northern San Joaquin Valley from Bear Creek to the San Joaquin River near present-day Mendota, the western San Joaquin Valley near present-day San Luis Reservoir, and what is now eastern Contra Costa and Alameda counties (ECCCHCPA and USFWS 2006, as cited in Reclamation 2019; Wallace 1978b; Reclamation and State Parks 2013, as cited in Reclamation 2019; Reclamation and DWR 2011, as cited in Reclamation 2019). The Foothill Yokuts inhabited the western slopes of the Sierra Nevada foothills, from the Fresno River to the Kern River (Spier 1978, as cited in Reclamation 2019; Reclamation and State Parks 2013, as cited in Reclamation 2019).

3.5.1.2 Historical Context

In 1579, Sir Francis Drake and Spanish explorers led expeditions into the San Francisco Bay Area. However, initial contact between Europeans and Native Americans occurred with Spanish missionaries and soldiers, who entered California from the south in 1769, eventually founding 21 missions along the California coast (Reclamation 1997, as cited in Reclamation 2019).

Numerous expeditions travelled through the San Joaquin Valley between 1769 and 1848, but did not establish major settlements (Reclamation 2010, as cited in Reclamation 2019). Europeans, Americans, and Canadians initially may have entered the Sacramento Valley in the late 1700s and early 1800s as part of missionary or military expeditions (Reclamation 1997, 2005a, as cited in Reclamation 2019; Reclamation et al. 2006, as cited in Reclamation 2019; Placer County 2007, as cited in Reclamation 2019). Fur trappers moved through this area from the 1820s to 1840s.

When Mexico became independent from Spain in 1822, the mission lands were divided by government grants into large ranchos, often consisting of tens of thousands of acres (DSC 2011, as cited in Reclamation 2019). During the Spanish and Mexican periods, explorers entered the region. In 1848, the Treaty of Guadalupe Hidalgo transferred the lands of California from the Mexican Republic to the United States and initiated what is called the American Period in California history (Reclamation 1997, as cited in Reclamation 2019).

To support growth, extensive transportation systems were created to enable wagon routes, steamboats on the major rivers, and numerous railroads (Reclamation 1997, as cited in Reclamation 2019). During the latter part of the nineteenth century, American ranchers amassed large tracts of former rancho land, and several great cattle empires were formed. With development of irrigation and improved transportation in the 1880s, new crops, including vegetables, fruits, and nuts, were added to the grains obtained from dry farming.

Following the discovery of gold in the Sacramento Valley, settlements occurred in the Delta to provide support services and agricultural products for those traveling to the gold fields and the Sacramento and San Francisco areas. Passage of the Swamp and Overflow Act in 1850 led to the transfer of lands from the U.S. government in the Delta to the State of California, which subsequently sold the land to individuals. The new settlers in the Delta constructed levees to protect the lands from periodic flooding and drained other lands to reduce the potential for mosquito-borne diseases (DSC 2011, as cited in Reclamation 2019; Reclamation et al. 2010, as cited in Reclamation 2019).

Urban water supply and irrigation capabilities further expanded in the 1950s and 1960s with implementation of multiple water projects. The SWP includes water, power, and conveyance systems. The principal facilities of the SWP are Oroville Reservoir and its related facilities, San Luis Dam and its related facilities, and facilities in the Delta; the Suisun Marsh Salinity Control Gates; the California Aqueduct, including its terminal reservoirs; and the North and South Bay Aqueducts.

The SWP facilities in the Delta provide for delivery of water supply to areas within and immediately adjacent to the Delta and to regions south of the Delta. The main SWP Delta features are the Suisun Marsh facilities, the Harvey O. Banks Pumping Plant, the Skinner Fish Facility, and the Barker Slough Pumping Plant. The locations of these facilities are shown in Figure 2-2, and descriptions of each are presented in Section 2.1.3.

3.5.1.3 Known Cultural Resources

No physical or record surveys were conducted for this IS because no site-specific construction actions are proposed. The resources described in this subsection indicate the types of resources that occur in areas served by SWP water and adjacent areas.

Most of the cultural resources are located within areas that would not be affected by land use changes that could result from changes in SWP water supplies.

3.5.2 Discussion

The discussion in this section focuses on the potential impacts on cultural resources that may result from proposed long-term operation of the SWP and facilities described in detail in Section 3.1.2 and assessed on a project-level basis.

a) Cause a substantial adverse change in the significance of a historical resource as defined in Section 15064.5?

Proposed project-level actions would not increase water flow and raise water levels beyond existing conditions, would not include installation of additional barriers beyond those that already are in place, and would not involve any construction or land-disturbing activities. The Proposed Project includes removing sediment that builds up at the Barker Slough Pumping Plant (BSPP) intake gates and disposing of those materials at existing spoils locations at the BSPP. These activities must be done periodically as part of routine maintenance in order to keep the intake gates clear of debris and functioning. Sediment disposal sites are located on previously disturbed areas that were associated with construction and maintenance at the BSPP, including regular graveling and grading. All access routes are existing, maintained gravel roadways. Staging for the activities will occur within existing graveled and paved surfaces at the BSPP. No cultural resources were observed during the pedestrian survey of the BSPP. The windshield survey of the access road noted that the road exists on top of an unrecorded historical-era levee. The levee is a portion of Unit 107 of the USACE Sacramento River Flood Control Project. Therefore, **no impact** would occur.

b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to Section 15064.5?

Proposed project-level actions would not increase water flow nor raise water levels beyond existing conditions, would not include installation of additional barriers beyond those that already are in place, nor involve any construction or land-disturbing activities. Proposed program-level operations would continue water transfers and continue the removal of aquatic weeds, which would not result in impacts on archaeological resources. Proposed environmental protective measures would continue operations along with studies for installing additional facilities. Therefore, **no impact** would occur.

c) Disturb any human remains, including those interred outside of formal cemeteries?

Proposed project-level actions would not increase water flow nor raise water levels beyond existing conditions, would not include installation of additional barriers beyond those that already are in place, nor involve any construction or land-disturbing activities. Proposed program-level operations would continue water transfers and continue removal of aquatic weeds from SWP facilities, which would not result in impacts on human remains. Such activities would not alter undisturbed lands or waterway channels. Therefore, **no impact** would occur.

3.6 ENERGY

Table 3.6-1. Potential Impacts on Energy

	ENVIRONMENTAL ISSUES	ENVIRONMENTAL IMPACT SIGNIFICANCE
VI.	**Energy. Would the project:**	-
a)	Result in potentially significant environmental impact due to wasteful, inefficient, or unnecessary consumption of energy resources, during project construction or operation?	No Impact
b)	Conflict with or obstruct a state or local plan for renewable energy or energy efficiency?	No Impact

Note:
"-" indicates blank cell

3.6.1 ENVIRONMENTAL SETTING

This section describes the existing sources and amounts of energy used by the SWP and the types and amounts of energy generated by SWP facilities; it also describes energy use and generation by hydroelectric generation facilities and power demands for the SWP and how these facilities may be affected from the implementation of the proposed long-term operation of the SWP evaluated in this IS. Implementation of the alternatives could affect SWP power generation and energy demands through potential changes in operation of the SWP facilities.

Water and energy are often managed separately, despite the important links between the two. Water is used in the production of nearly every major energy source, and energy is used in multiple ways and at multiple stems in water delivery and treatment systems as well as in wastewater collection and treatment. Approximately 12% of California's total energy use is related to water.

The sources of energy used to power water activities are also directly linked to the volume of associated greenhouse gas (GHG) emissions. The primary environmental impact of wasteful, inefficient, or unnecessary consumption of energy resources is the increased emission of GHGs and the associated impacts on climate change. The potential climate change impacts from GHG emissions associated with the proposed long-term operation of the SWP are discussed in Section 3.8, "Greenhouse Gas Emissions." Therefore, this section focuses on whether proposed long-term operation of the SWP would result in wasteful, inefficient, or unnecessary consumption of energy or would conflict with relevant renewable energy or energy efficiency plans.

3.6.1.1 Relevant Regulations

The National Energy Policy, established in 2001 by the National Energy Policy Development Group (NEPDG), is designed to help the private sector and state and local governments promote dependable, affordable, and environmentally sound production and distribution of energy for the future (NEPDG 2001). Key issues addressed by the energy policy are energy conservation, repair and expansion of energy infrastructure, and ways of increasing energy supplies while protecting the environment.

The 2008 update to the 2005 Energy Action Plan II is the State's principal energy planning and policy document (State of California 2008). The updated document examines the State's ongoing actions in the context of global climate change and examines policy changes in the areas of energy efficiency, demand response, renewable energy, electricity reliability and infrastructure, electricity market structure, natural gas supply and infrastructure, research and development, and climate change. The 2005 Energy Action Plan II continues the goals of the original 2003 Energy Action Plan, describes a coordinated implementation plan for State energy policies, and identifies specific action areas to ensure that California's energy resources are adequate, affordable, technologically advanced, and environmentally sound.

In accordance with the 2008 Plan update, the first-priority actions to address California's increasing energy demands are energy efficiency and demand response (i.e., reduction of customer energy usage during peak periods to address system reliability and support the best use of energy infrastructure). Additional priorities include the use of renewable sources of power and distributed generation (i.e., the use of relatively small power plants near or at centers of high demand). To the extent that these actions are unable to satisfy the increasing energy demand and transmission capacity needs, clean and efficient fossil-fired generation is supported. California first established a state Renewables Portfolio Standard (RPS) in 2002 under Senate Bill (SB) 1078, when it set an RPS standard of 20% before 2017 for investor-owned utilities. California later accelerated this RPS requirement in 2006 under SB 107, when it moved the date up to 2010. In 2011, California expanded this requirement to include publicly owned municipal power and increased the RPS requirement to 33% by 2020 (i.e., Sacramento Municipal Utility) under SB X1-2.

The RPS program requires investor-owned utilities, electric service providers, and community choice aggregators to increase procurement from eligible renewable resources to 33% of total procurement by 2020. In 2015, passage of SB 350 created a 50% RPS requirement by 2030. During the 2017 legislative session, SB 100 was enacted and established a 60% RPS requirement by 2030, with a State policy requirement of 100% carbon-free by 2045. This also was captured in Gubernatorial Executive Order B-55-18 on carbon neutrality. For the State's RPS requirements, renewable energy resources do not include hydropower facilities over 30 megawatts, in accordance with Section 399.12(e) of the California Public Utilities Code and Section 25741 of the California Public Resources Code. However, hydropower generation is not precluded from counting toward the California carbon-free policy.

As described in Section 25741 (1) (a) of the Public Resources Code, a renewable electrical generation facility is defined as a facility that meets all of the following criteria: the facility uses biomass, solar thermal, photovoltaic, wind, geothermal, fuel cells using renewable fuels, small hydroelectric generation of 30 megawatts or less, digester gas, municipal solid waste conversion, landfill gas, ocean wave, ocean thermal, or tidal current, and any additions or enhancements to the facility using that technology. Section 14(1)(b) of the Public Utilities Code, as amended, states that an existing conduit hydroelectric facility of 30 megawatts or less shall be an eligible renewable energy resource.

Assembly Bill (AB) 32 requires California to reduce its total GHG emissions to 1990 levels by 2020, which represents about a 30% decrease from current levels. In September 2007, the California Air Resources Board (CARB) approved a list of nine Discrete Early Actions to reduce GHG emissions. CARB's Discrete Early Actions include maximizing energy efficient building and appliance standards; pursuing additional efficiency efforts, including new technologies and new policy and implementation mechanisms; and pursuing comparable investment in energy efficiency by all retail providers of electricity in California (including both investor-owned and publicly owned utilities).

3.6.1.2 Existing SWP Energy Use and Generation Facilities

The SWP is one of the largest electricity users in California (DWR 2019a). The amount of energy the SWP uses each year varies with the amount of water that moves through its network of pumping stations to meet the annual water allocations and water contractor demand. The amount of water delivered fluctuates each year because of the amount of water available in each year. Several factors are considered for water allocation, including what percentage DWR approves of the SWP water contractor allocation requests and the annual hydrological conditions. For example, dry years in Northern California usually result in reductions of water delivery and power generation; therefore, full deliveries cannot be made and less power can be used.

Table 3.6-2 shows energy consumption and water delivery volumes for the most recent 6 years for which data are available (2011 through 2016), and the total water delivered is higher during wet years, and lower during dry or critical years. Over this 6-year period, annual energy use ranged between approximately 2,800 and 8,600 gigawatt hours (GWh) per year. When controlling for fluctuations in the volume of water delivered each year, energy consumption during this period ranged from approximately 1.40 to 2.42 GWh per TAF, with an average of 1.83 GWh per TAF.

Table 3.6-2. Historic SWP Energy Use and Water Delivery 2011 through 2016

Year	Total Energy Consumed (GWh)	Total Water Delivered (TAF)	Average Energy/Water (GWh/TAF)	Hydrological Conditions[1]
2016	6,600	3,338	1.977	Below Normal/Dry
2015	3,490	2,104	1.659	Critical/Critical
2014	2,790	1,992	1.401	Critical/Critical
2013	5,740	3,371	1.703	Dry/Critical
2012	7,410	3,067	2.416	Below Normal/Dry
2011	8,550	4,631	1.846	Wet/Wet
Average	**-**	**-**	**1.834**	**-**

Notes:
GWh = gigawatt-hour(s); TAF = thousand acre-feet; "-" indicates blank cell.
[1]. Hydrological conditions are reported for the Sacramento Valley and San Joaquin Valley respectively, for the corresponding water year. Water years run from October through September.
Sources: DWR 2014; 2015a, 2015b; 2016a; 2017; 2019a, 2019b.

The majority of the energy used by the SWP is needed for pumping plants in the Delta, at the San Luis Reservoir, and along the California Aqueduct. From the Delta through the San Joaquin Valley to Southern California reservoirs, the SWP uses electricity to lift water to elevations as high as 1,926 feet before gravity can foster the rest of its conveyance from north to south. The SWP pumps are operated through an extensive computerized network to maximize efficiency. Pumping is minimized during on-peak hours, when power prices are highest. Maximum pumping is scheduled during off-peak periods (nights, weekends, and holidays), when power costs are lower.

Minor amounts of energy (electricity, natural gas, vehicle fuels, etc.) are also used during construction of individual projects, maintenance activities (such as flood protection, erosion repairs, annual equipment and facilities inspection and maintenance), and business practices (e.g., heating and cooling of DWR buildings, electricity used within buildings, business travel by DWR employees).

3.6.1.3 SWP Energy Generation

The SWP is the third-largest generator of hydroelectricity in California, generating between 4,000 and 7,000 GWh per year (approximately 14% of California's hydropower generation). The SWP includes five hydroelectric power plants and four pumping-generating plants, as summarized in Table 3.6-3. The total capacity of SWP generation facilities is more than 1,500 MW. Energy generation is highly variable due to changes in annual hydrologic conditions. Power generated by the SWP is transmitted by Pacific Gas and Electric Company (PG&E), Southern California Edison, and California Independent System Operator through other facilities (DWR 2019a).

Table 3.6-3. SWP Hydroelectric Generation Facilities

Facility	Installed Capacity (megawatts)
Oroville Facilities	-
Hyatt Pumping-Generating Plant	645
Thermalito Diversion Dam Power Plant	3
Thermalito Pumping-Generating Plant	114
William R. Gianelli (San Luis) Pumping-Generating Plant (SWP share)	222
Alamo Power Plant	15
Mojave Siphon Power Plant	29
Devil Canyon Power Plant	235
Warne Power Plant	67
Castaic Power Plant (joint development with LADWP)	214
TOTAL CAPACITY	**1,544**

Source: DWR 2016b, Clean Energy for the State Water Project (SWP)
Notes:
LAPWD = Los Angeles Department of Water and Power
"-" indicates blank cell

The SWP power generation facilities were developed to meet SWP energy use loads, but do not generate sufficient energy to meet its total operating load. The energy needed to operate the SWP therefore comes from a combination of its own hydroelectric generating plants and power purchased from and exchanged with other utilities. In a normal year, SWP generation facilities supply about two-thirds of the SWP's necessary operating power (DWR 2019a). For example, in 2016, (the most recent year for which data are available), the SWP used 6,600 GWh of energy, approximately 2,600 GWh of which were purchased by DWR (DWR 2019a).

DWR uses a portfolio of energy resources to make up the difference in energy between the electricity that SWP facilities generate and the amount of electricity needed to run the SWP. The composition of the SWP power portfolio varies throughout the year and from year to year, but the SWP power portfolio's electricity sources generally can be categorized as generation from large hydroelectric facilities, nonrenewable energy facilities, and thermal generation facilities, as well as purchased energy (DWR 2012). Table 3.6-4 summarizes the capacity and types of third-party energy sources under contract to the SWP (DWR 2016b).

Table 3.6-4. Non-SWP-owned Energy Sources

Facility and Fuel Type	Fuel Type	DWR's Share of Capacity (megawatts)	DWR's Share of Energy (gigawatt hours)	Contract Status
Pine Flat	Hydro	165	431	Active
MWD Phase I	Small Hydro	30	128	Active
Reid Gardner	Coal	235	1,024	Terminated in 2013
Lodi Energy Center – Combined Cycle Combustion Turbine	Natural Gas	99	422	Active
NCPA Geothermal 1 & 2; Ameresco Ox Mountain Energy	Geothermal; Landfill Gas	34	182	Active
Dominion – Camelot	Solar	45	130	Active
SPower – Solverde 1	Solar	85	240	Active
SunPower – Pearblossom	Solar	9.5	28	Active
MWD	Small Hydro	51.4	95	Active
TOTAL (Active Contracts)	**-**	**519**	**1,656**	**-**

Notes:

DWR = Department of Water Resources; MWD = Metropolitan Water District of Southern California; NCPA = Northern California Power Agency; "-" indicates blank cell

Source: DWR 2016b, Clean Energy for the State Water Project (SWP)

The SWP also markets energy in excess of the SWP demands to local utilities, such as PG&E and members of the Western Systems Power Pool (WSPP). The SWP has power contracts with electric utilities and the California Independent System Operator that act as exchange agreements with the utility companies for transmission and power sales and purchases.

3.6.1.4 Other Energy Resources for the State Water Project

Other energy supplies have been obtained by DWR from other utilities and energy marketers under agreements that allow DWR to buy, sell, or exchange energy on a short-term hourly basis or a long-term multi-year basis (DWR 2019a). DWR has a long-term purchase agreement with the Kings River Conservation District for approximately 400 million kilowatt-hours of energy from the 165-megawatt hydroelectric Pine Flat Power Plant. DWR also purchases energy from four hydroelectric plants with 29 megawatts of installed capacity that are owned and operated by the Metropolitan Water District of Southern California (DWR 2012).

DWR also purchases energy under short-term purchase agreements from utilities and energy marketers of the WSPP. In addition, the 1988 Coordination Agreement between DWR and the Metropolitan Water District of Southern California enables DWR to purchase and exchange energy. (DWR 2012).

3.6.1.5 SWP Energy Reduction and Efficiency Efforts

Operation of the SWP is responsible for approximately 99% of all GHG emissions by DWR (DWR 2016b). Most of these emissions come from non-hydropower electricity used by the pumping plants to move water from the Sacramento-San Joaquin Delta to other parts of the state. Because energy generation and use are a major component of GHG management, many of the GHG reduction strategies used by DWR focus on:

- minimizing energy use,
- maximizing hydroelectric generation,
- increasing use of renewable energy supplies, and
- using SWP lands for building renewable energy projects.

As discussed in more detail in Section 3.8, "GHG Emissions," DWR developed a Climate Action Plan (CAP) to guide DWR's programs, projects, and activities in response to a changing climate (DWR 2012). The CAP demonstrates how DWR will make substantial reductions in its GHG emissions in the near term (present to 2020), and how it will continue to reduce emissions beyond 2020 to achieve its long-term (2050) GHG emissions reduction goal. Since publication of the CAP, DWR has further reduced its emission reduction targets to 50% below 1990 levels by 2020 and 100% below 1990 levels by 2045 (DWR 2019c). The CAP identifies 11 GHG emissions reduction measures to meet near-term and long-term goals, which include:

- termination of its participation and associated delivery of electricity from a coal-fired power plant,
- efficiency improvements to DWR's existing facilities,
- purchase and development of renewable and high efficiency electricity supplies,
- comprehensive improvements to DWR's construction practices, and
- improvements to DWR's business activities that will reduce GHG emissions.

Some of these measures (e.g., cessation of use of electricity from coal-fired power plants) have already been completed; others (e.g., efficiency improvements to existing facilities, construction practices, and business activities) are ongoing.

3.6.2 Discussion

a) Result in potentially significant environmental impact due to wasteful, inefficient, or unnecessary consumption of energy resources, during project construction or operation?

The proposed long-term operation of the SWP would not involve construction of new or modification of existing SWP facilities, and therefore no construction-related energy would be used. SWP energy consumption for operational purposes would continue to vary on an annual basis due to fluctuations in water deliveries due to climatic variability and would remain within the range of energy consumption historically used by the SWP. Over time, the sources of energy used to power the SWP would become more renewable, and the efficiency of energy use would improve through compliance with DWR adopted plans, policies, and legislative mandates requiring increased reliance on renewable resources and energy efficiency. Therefore, the Proposed Project would not include any changes that would result in wasteful, inefficient, or unnecessary consumption of energy resources that would potentially result in significant environmental impacts. Because there would be an increase in energy efficiency over time, **no impact** would occur.

b) Conflict with or obstruct a state or local plan for renewable energy or energy efficiency?

The proposed long-term operation of the SWP would be similar in scale and intensity to existing and historic operations. DWR would continue to implement energy efficiency and measures in accordance with the CAP, and long-term operation of the SWP would not hinder the implementation of the CAP. As discussed further in Section 3.8, “Greenhouse Gas Emissions,” the CAP is consistent with State and local plans for renewable energy and energy efficiency; therefore, the Proposed Project would not conflict with or obstruct such a plan. **No impact** would occur.

3.7 GEOLOGY AND SOILS

Table 3.7-1. Potential Impacts on Geology and Soils

ENVIRONMENTAL ISSUES			ENVIRONMENTAL IMPACT SIGNIFICANCE
VII.	**Geology and Soils. Would the project:**		-
a)	Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving:		-
	i)	Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? (Refer to California Geological Survey Special Publication 42.)	No Impact
	ii)	Strong seismic ground shaking?	No Impact
	iii)	Seismic-related ground failure, including liquefaction?	No Impact
	iv)	Landslides?	No Impact
b)	Result in substantial soil erosion or the loss of topsoil?		No Impact
c)	Be located on a geologic unit or soil that is unstable, or that would become unstable because of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?		No Impact
d)	Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994, as updated), creating substantial direct or indirect risks to life or property?		No Impact
e)	Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?		No Impact
f)	Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?		No Impact

Note:
"-" indicates blank cell

3.7.1 ENVIRONMENTAL SETTING

3.7.1.1 Geology and Paleontology

Central Valley, and San Francisco Bay and Delta Regions

The Central Valley region extends from above Shasta Lake in the north to the Tehachapi Mountains in the south, and includes the Sacramento Valley, San Joaquin Valley, Delta, and Suisun Marsh. This region includes the Sacramento River, Clear Creek, Feather River, American River, Stanislaus River, and San Joaquin River watersheds. The Central Valley is an approximately 400-mile-long, 50-mile-wide valley. The faulted and folded sediments of the Coast Ranges extend eastward beneath most of the Central Valley. The igneous and metamorphic rocks of the Sierra Nevada extend westward beneath the eastern Central Valley. The valley floor is an alluvial plain, composed of late Mesozoic- and Cenozoic-era sediments, deposited by wind and rivers flowing out of the Coast Ranges and the Sierra Nevada.

The Delta is a flat-lying river delta that evolved at the inland margin of the San Francisco Bay Estuary as two overlapping and coalescing geomorphic units: the Sacramento River Delta to the north and the San Joaquin River Delta to the south. During large river-flood events, silts and sands were deposited adjacent to the river channel, which formed as a tidal marsh with few natural levees and was dominated by tidal flows, allowing landward accumulation of sediment behind the bedrock barrier at the Carquinez Strait. The sediment formed marshlands, which consisted of numerous islands that were surrounded by hundreds of miles of channels. Tule marshes became established on peat and organic soils in many portions of the Delta, including Suisun Marsh. Additional peat and other organic soils continue to form from repeated inundation and accumulation of sediment and marsh vegetation. The greater San Francisco Bay Area is located in the Coast Ranges, which are described above.

Table 3.7-2 shows the geologic formations in the Central Valley (Sacramento and San Joaquin Valley regions) and Delta regions. Table 3.7-2 also shows the results of the paleontological sensitivity assessment for these regional geographic areas, based on a review of geologic maps, a literature review, and a paleontological resources records search that was performed at the University of California, Berkeley Museum of Paleontology (UCMP) on April 16, 2019.

In its standard guidelines for assessment and mitigation of adverse impacts on paleontological resources, the Society of Vertebrate Paleontology (SVP 1996) established three categories of sensitivity for paleontological resources: high, low, and undetermined. Areas where fossils have been found previously are considered to have a high sensitivity and a high potential to produce fossils. Areas that are not sedimentary in origin and have not been known to produce fossils in the past typically are considered to have low sensitivity. Areas that have not had any previous paleontological resource surveys or fossil finds are considered to be of undetermined sensitivity until surveys and mapping are performed to determine their sensitivity. In keeping with the SVP significance criteria, all vertebrate fossils generally are categorized as being of potentially significant scientific value.

An individual vertebrate fossil specimen may be considered unique or significant if it is identifiable and well preserved, and it meets one of the following criteria:

- Type specimen (i.e., the individual from which a species or subspecies has been described)
- Member of a rare species
- Species that is part of a diverse assemblage (i.e., a site where more than one fossil has been discovered), wherein other species are also identifiable and important information regarding the life history of individuals can be drawn
- Skeletal element different from, or a specimen more complete than, those now available for its species
- Complete specimen (i.e., all or substantially all of the entire skeleton is present)

Table 3.7-2. Regional Geology and Paleontological Sensitivity

Project Area	Geologic Description	Paleontological Sensitivity
Sacramento Valley Region	-	-
-	**Sacramento River Watershed**	**-**
Red Bluff to the Delta	Pleistocene alluvial fan and terrace deposits, such as the Modesto and Riverbank formations	High
-	Holocene levee and channel deposits, basin deposits	Low
-	**Feather River Watershed**	**-**
West of Lake Oroville	Lovejoy Basalt (Miocene extrusive, fine-grained volcanic rocks); Tuscan Formation (Pliocene interbedded lahars, volcanic conglomerate, volcanic sandstone, siltstone, and pumiceous tuff); Laguna Formation (Pliocene interbedded alluvial gravel, sand, and silt); Holocene alluvial deposits; and Historic dredge and mine tailings	Low
-	Chico Formation (Cretaceous marine sandstone and minor siltstone), Ione Formation (Eocene light-colored conglomerate, sandstone, and claystone), Riverbank Formation (Pleistocene weathered reddish gravel, sand, and silt forming alluvial terrace and fan deposits), and Modesto Formation (Pleistocene unconsolidated, unweathered gravel, sand, silt, and clay)	High
Active channels of the Feather, Bear, and Yuba rivers and tributary streams	Holocene alluvial deposits (clay, silt, sand, gravel, cobbles, and boulders in various layers and mixtures), slickens (fine, clay-rich, light yellow-brown powdery residue from hydraulic mining), and Historic floodplain deposits	Low
Delta Region	-	-
Sacramento–San Joaquin Delta	Mesozoic bedrock, Holocene peat and organic soils, alluvium, levee and channel deposits, Bay Mud, and Merritt Sand (Pleistocene beach and dune sand deposits)	Low
-	Pleistocene alluvium (weakly to moderately consolidated, poorly sorted, interbedded clay, stilt, sand, and gravel)	High
Suisun Marsh Region	-	-
Suisun Marsh	Holocene intertidal deposits composed of Bay Mud and medium-grained alluvium	Low
San Joaquin Valley Region	-	-
San Luis Reservoir/O'Neil Forebay	Franciscan Complex (Jurassic chert, metagraywacke), Upper Jurassic-Lower Cretaceous marine sandstone and shale (Coast Ranges)	Low
-	Panoche Formation (Cretaceous marine sandstone and shale), Los Banos alluvium (Pleistocene coarse-grained terrace, pediment, and fan deposits), San Luis Ranch alluvium (Late Holocene-Early Pleistocene unweathered fine- to coarse-grained fan, mudflow, terrace, and floodplain deposits)	High

Note:
"-" indicates blank cell.
Sources: Fraticelli et al. 2012; Saucedo and Wagner 1992; Gutierrez 2011; Helley et al. 1979; Helley and Harwood 1985; UCMP 2019; Jefferson 1991a, 1991b; The Paleontology Portal (undated); Hotz 1971; Irwin 1997, 2009; Wagner et al. 1991; Dundas et al. 1996; Bateman 1992; Marchand and Allwardt 1981; Lettis 1982; Barnosky and Holroyd undated n.d.; Bailey et al. 1964

The value or importance of different fossil groups varies, depending on the age and depositional environment of the rock unit that contains the fossils, their rarity, the extent to which they already have been identified and documented, and the ability to recover similar materials under more controlled conditions (such as for a research project). Marine invertebrates generally are common; the fossil record is well developed and well documented, and they generally would not be considered a unique paleontological resource. Identifiable vertebrate marine and terrestrial fossils generally are considered scientifically important because they are relatively rare.

As shown in Table 3.7-2, in general, mountainous areas that are composed of bedrock (which formed from magma deep below the earth's surface) and rocks formed from volcanic activity on the Earth's surface do not contain fossils. Metamorphic rocks, which have been altered from their original condition by conditions of high temperature and pressure, contain few fossils, most of which are invertebrates. Therefore, with only a few exceptions (such as the Mehrten Formation, Hosselkus Limestone, and narrow bands of Pleistocene alluvial deposits immediately adjacent to river and stream channels), most of the rocks found in the Klamath Mountains, Coast Ranges, and Sierra Nevada do not contain unique paleontological resources requiring CEQA evaluation.

Most vertebrate fossils are found in sedimentary deposits. Fossils become a part of sedimentary rocks when sediments such as mud, clay, silt, sand, and pebbles cover plant and animal organisms and preserve their characteristics through time. The surface of the Central Valley, and extending in some places to depths of more than 2,000 feet below the surface, is composed of sedimentary deposits. Many of the rock formations that fill the Central Valley are known to have produced numerous vertebrate fossils (e.g., Turlock Lake, Riverbank, and Modesto Formations) or large numbers of plant assemblages (e.g., Ione Formation), and therefore are considered to be of high paleontological sensitivity. Geologic units that are of Holocene age (i.e., 11,700 years Before Present to Present Day) contain only the remains of extant, modern taxa (if any fossil resources are present), which are not considered "unique" paleontological resources.

Central Coast and Southern California Service Areas

The mountains and foothills of Orange County and portions of southern Los Angeles County, western San Diego County, northwestern San Bernardino County, and northern Riverside County in the SWP and CVP service areas are located in the Transverse Ranges. The mountains and valleys of the Transverse Ranges are oriented east-west, in contrast to most of the rest of California (which is oriented north-south). These ranges are being actively uplifted as the Earth's crust is being compressed along the east-west bend in the San Andreas Fault in this area. The geologic structure of the Transverse Ranges consists of Cenozoic sedimentary rocks, underlain by older Paleozoic granitic and metamorphic rocks. Portions of Santa Barbara and San Luis Obispo counties in the SWP and CVP service areas are located in the Coast Ranges. The geologic structure of the Coast Ranges is described above.

Low-lying portions of Los Angeles, Riverside, and San Bernardino counties are located in the Mojave Desert Geomorphic Province. This geomorphic province includes extensive alluvial basins that are filled with non-marine sediments, eroded from the surrounding mountains and foothills. Many isolated ephemeral lakebeds (also known as playas) occur in this region, with tributary streams from isolated mountain ranges. (Reclamation 2019).

Portions of Riverside County in the Coachella Valley are in the Colorado Desert Geomorphic Province (or Salton Trough), characterized by a geographically depressed desert that extends northward from the Gulf of California (at the mouth of the Colorado River) toward the Mojave Desert. Large portions of this geomorphic province were formed by inundation of an ancient lake and are filled with sediments several miles thick that originated from the historical Colorado River overflows and erosion of upland areas. The Salton Sea is in a trough along an ancient playa. (Reclamation 2019).

Fossilized remains of marine mammals and bony fishes are present in numerous marine sedimentary rocks from the Cenozoic era throughout the Central Coast and Southern California service areas. Vertebrate fossils of land mammals also are present in a variety of Cenozoic-era non-marine formations. Rock formations that are known to have yielded vertebrate fossils in the Central Coast and Southern California service areas include Bautista Beds, La Brea Tar Pits, San Timoteo Formation, Monterey Formation, Pico Formation, Modelo Formation, San Pedro Formation, Manix Formation, Punchbowl Formation, Hector Formation, Bedrock Spring Formation, Mission Valley Formation, Friars Formation, Santiago Formation, San Diego Formation, San Mateo Formation, Monterey Formation, and Caliente Formation, among others.

3.7.1.2 Seismicity

Seismicity in Northern California primarily is controlled by the San Andreas Fault Zone—which runs 150 miles from the Gulf of California through the Coast Ranges and ends offshore, north of Point Reyes—and the Cascadia subduction zone. The Cascadia subduction zone runs from Vancouver Island in Canada to Cape Mendocino in Northern California. The Pacific, North American, and Gorda tectonic plates meet at the Mendocino Triple Junction, located in the Pacific Ocean just west of Cape Mendocino. Along the Cascadia subduction zone, the Gorda Plate is being actively subducted (overridden) and driven underneath the North American Plate. The San Andreas Fault Zone is along portions of the active tectonic plate boundary (described above) and the historic tectonic plate boundary where the Farallon Plate became subducted underneath the North American Plate millions of years ago.

Over time, as subduction continues to occur, more of the Pacific Plate comes into contact with the North American Plate, resulting in strain along the rock strata. In some cases, this strain is relieved by very slow movement of the rocks past one another (known as fault creep). Periodically, the strain buildup becomes great enough so that an earthquake occurs. In recent years, scientists with the California Geological Survey (CGS) and U.S. Geological Survey (USGS) have determined that many of the faults along the Northern California coast that were once thought to operate independently of one another actually are interconnected strands of the San Andreas Fault Zone (Field and the 2014 Working Group on California Earthquake Probabilities 2015).

Surface fault rupture is fault movement that breaks to the surface of the Earth, either suddenly during earthquakes or slowly because of fault creep, and is from tectonic movement that originates deep in the Earth. “Active” or “Holocene-active” faults (i.e., faults showing evidence of displacement during the last 11,700 years) are more likely to result in both surface fault rupture and strong seismic ground shaking than pre-Holocene faults. Surface fault rupture and strong seismic ground shaking can severely damage buildings, roads, bridges, and underground pipelines. Strong seismic ground shaking also can trigger potentially damaging landslides (in areas of steep or unstable slopes) and liquefaction (in areas composed of young, unconsolidated, water-saturated sediments such as Bay mud).

Northern California's active faults are along the west coast because of ongoing strain from the interaction of the Pacific and North American continental plates. Active faults in the Sierra Nevada, on the other hand, are less common, primarily because most of the strain of tectonic plate movement today is relieved by faults in the Coast Ranges, which are closer to the boundary where the tectonic plates make contact with one another. With the exception of the region south of Bakersfield, the Central Valley generally does not contain active faults, and therefore is subject to a very low level of seismic activity. Therefore, most of the Central Valley and Sierra Nevada foothills generally are not subject to seismic hazards.

3.7.1.3 Soils

The types of soils in the project area vary, depending on the parent material. Soils in mountainous areas generally consist of a thin veneer overtop of bedrock. Soils in the foothills are somewhat more developed, but generally reflect volcanic and metamorphic origins, have lower fertility, and consist primarily of grasslands. Soils in the valley bottomlands are rich in organic matter and are very fertile. The Central Valley is one of the most productive agricultural areas in the world; more than half of the fruits, vegetables, and nuts grown in the U.S. come from the Central Valley. Soils in the Delta are rich in peat and decaying plant matter.

The different soil types all have different characteristics related to wind and water erosion, permeability, drainage, clay content, stormwater runoff potential, salinity, pH, and suitability for agricultural crops. Descriptions of the soil characteristics for all of the soil types in the project area are beyond the scope of this analysis. However, Table 3.7-3 shows a generalized description of soils in the project regions.

Table 3.7-3. Generalized Description of Soils

Project Region	Description of Soils
Central Valley (Sacramento and San Joaquin Valleys)	Foothill soils include serpentine soils (which include magnesium, nickel, cobalt, chromium, iron, and asbestos); sedimentary sandstones; shales; conglomerates; and sandy loam, loam, and clay loam soils above bedrock.
Central Valley (Sacramento and San Joaquin Valleys)	Terrace lands include brownish loam, silt loam, and/or clayey loam soils. The soils generally are loamy along the Sacramento Valley terraces and more clayey along the San Joaquin Valley terraces. Along the eastern boundaries of Sacramento and San Joaquin valleys, the terraces primarily are red silica–iron-cemented hardpan and clays, sometimes with calcium carbonate.
Central Valley (Sacramento and San Joaquin Valleys)	Surface soils of the Central Valley include alluvial and aeolian soils. The alluvial soils include calcic brown and noncalcic brown alluvial soils on deep alluvial fans and floodplains. The calcic brown soil primarily is made of calcium carbonate and is alkaline (also known as "calcareous" soils). The noncalcic brown soils do not contain calcium carbonate and are either slightly acidic or neutral in chemical properties. Aeolian soils (i.e., sand and silt-sized particles) are more susceptible to wind erosion than alluvial soils. Non-irrigated soils that have been disturbed by cultivation or other activities throughout the Central Valley are more susceptible to wind erosion and subsequent blowing dust than soils with more soil moisture.

Project Region	Description of Soils
Central Valley (Sacramento and San Joaquin Valleys)	Basin soils occur in the San Joaquin Valley and portions of the Delta. These soils include organic soils, imperfectly drained soils, and saline alkali soils. The organic soils are typically dark, acidic, and high in organic matter, and generally include peat. The organic soils occur in the Delta, as discussed below, and along the lower San Joaquin River adjacent to the Delta. The poorly drained soils contain dark clays and occur in areas with high groundwater in the San Joaquin Valley trough and as lake bed deposits. Selenium salts and other salts occur naturally in the western and central San Joaquin Valley soils that are derived from marine sedimentary rocks of the Coast Ranges.
Bay–Delta/Suisun Marsh	Basin floor/basin rim soils consist of organic-rich saline soils and poorly drained clays, clay loams, silty clay loams, and muck along the San Francisco Bay shoreline. Well-drained sands and loamy sands and poorly drained silty loams, clay loams, and clays occur on gently sloping alluvial fans of the Bay–Delta that surround the floodplain and valley lands. Drained loams, silty loams, silty clay loams, and clay loams interbedded with sedimentary rock and some igneous rock occur in the foothills. Terrace loams are along the southeastern edge of the Bay–Delta above the valley land. Soils in the Suisun Marsh consist of peaty and clayey muck, which are composed of fine-grained sediments that are poorly drained.
Central Coast	Near the ocean, soils range from sands and loamy sands in areas near the shoreline to shaley loams, clay loams, and clays in the terraces and foothills. Inland area soils range from sands, sandy loams, loams, shaley loams, to clay loams in the alluvial soils and along the shoreline. The terrace deposits include silty clays, clay loams, and clays.
Southern California	Soils include gravelly loams and gravelly sands, sands, sandy loams and loamy sands, and silty loams along the Pacific Coast shorelines and on alluvial plains. The mountains and foothills of the region include silty loams, cobbly silty loam, gravelly loam, sandy clay loams, clay loams, silty clays, and clays. The inland region in Riverside and San Bernardino counties has sand, silty clays, cobbles, and boulders on the alluvial fans, valley floor, terraces, mountains, and dry lake beds.

Source: U.S. Bureau of Reclamation 2019
Delta=Sacramento–San Joaquin Delta

3.7.2 Discussion

a) Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving:

i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? (Refer to California Geological Survey Special Publication 42.)

The proposed long-term operation of the SWP would not involve any new construction of water facilities, infrastructure, or other land disturbance. Thus, the project would not directly or indirectly cause an increased risk of loss, injury, or death from surface fault rupture. **No impact** would occur.

ii) Strong seismic ground shaking?

The proposed long-term operation of the SWP would not involve any new construction of water facilities, infrastructure, or land disturbance. Thus, the project would not directly or indirectly cause an increased risk of loss, injury, or death from strong seismic ground shaking. **No impact** would occur.

iii) Seismic-related ground failure, including liquefaction?

The proposed long-term operation of the SWP would not involve any new construction of water facilities, infrastructure, or land disturbance. Thus, the project would not directly or indirectly cause an increased risk of loss, injury, or death from seismic-related ground failure, including liquefaction. **No impact** would occur.

iv) Landslides?

The proposed long-term operation of the SWP would not involve any new construction of water facilities, infrastructure, or land disturbance. Thus, the project would not directly or indirectly cause an increased risk of loss, injury, or death from seismically induced landslides. **No impact** would occur.

b) Result in substantial soil erosion or the loss of topsoil?

The proposed long-term operation of the SWP would not involve any new construction of water facilities, infrastructure, or land disturbance. Furthermore, no changes in land use (i.e., conversion from agricultural land to non-agricultural land) are anticipated because of the Proposed Project. Therefore, **no impact** would occur.

c) Be located on a geologic unit or soil that is unstable, or that would become unstable because of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?

The proposed long-term operation of the SWP would not involve any new construction of water facilities, infrastructure, or land disturbance. Therefore, unstable geologic units or soils would not result in damages to new facilities. **No impact** would occur.

d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994, as updated), creating direct or indirect substantial risks to life or property?

The proposed long-term operation of the SWP would not involve any new construction of water facilities, infrastructure, or land disturbance. Therefore, the Proposed Project would not be located on expansive soil that could create direct or indirect substantial risks to life or property. **No impact** would occur.

e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?

The proposed long-term operation of the SWP would not require the use of septic systems or alternative waste water disposal systems. **No impact** would occur.

f) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?

The proposed long-term operation of the SWP would not involve any new construction of water facilities, infrastructure, or land disturbance. Thus, the Proposed Project would not directly or indirectly destroy a unique paleontological resource or site. Thus, the Proposed Project would not directly or indirectly destroy a unique geologic feature. **No impact** would occur.

3.8 GREENHOUSE GAS EMISSIONS

Table 3.8-1. Potential Impacts on Greenhouse Gas Emissions

ENVIRONMENTAL ISSUES	ENVIRONMENTAL IMPACT SIGNIFICANCE
VII. Greenhouse Gas Emissions. Would the project:	-
a) Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?	No Impact
b) Conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of greenhouse gases?	No Impact

Note:
"-" indicates blank cell

3.8.1 ENVIRONMENTAL SETTING

Greenhouse gas (GHG) emissions and their climate-related impacts are not limited to specific geographic locations but occur on global or regional scales. Whereas many pollutants with localized air-quality effects have relatively short atmospheric lifetimes of one or several days, GHGs have long atmospheric lifetimes and may persist for years. Greenhouse gas emissions contribute cumulatively to the overall heat-trapping capability of the atmosphere, and the effects of global warming, also known as climate change, are manifested in different ways across the globe. Therefore, from the standpoint of CEQA, the impacts of GHG emissions on global climate change are inherently cumulative.

Increases in GHG concentrations in the Earth's atmosphere are thought to be the main cause of human-induced climate change. Greenhouse gases naturally trap heat by impeding the release of solar radiation that is reflected back into space after hitting Earth. Some GHGs occur naturally and are necessary for keeping the Earth's surface inhabitable. However, increases in the concentrations of these gases in the atmosphere during the last 100 years have decreased the amount of solar radiation that is reflected back into space, intensifying the natural greenhouse effect and resulting in the increase in the average global temperature (DWR 2010).

The atmospheric concentration of GHGs is believed to be affecting the intensity of global warming, and the current levels are already leading to increases in global temperatures. The primary man-made processes that release these GHGs include the burning of fossil fuels for transportation, heating, and electricity generation; agricultural practices that release methane (CH_4), such as livestock grazing and crop residue decomposition; and industrial processes that release smaller amounts of gases with a high global warming potential, such as sulfur hexafluoride (SF_6), perfluorinated chemicals (PFCs), and hydrofluorocarbons (HFCs) (DWR 2010). Deforestation and land cover conversion have also been identified as contributing to climate change by reducing the Earth's capacity to remove carbon dioxide (CO_2) from the air and altering the Earth's albedo, or surface reflectance, allowing more solar radiation to be absorbed.

Scientific methods to rapidly reduce the impacts of climate change emphasize the need to immediately reduce emissions of short-lived climate pollutants, which include black carbon (soot), CH_4, and fluorinated gases (F-gases, including HFCs). About 40% of current net climate forcing can be attributed to these pollutants. Action to reduce these powerful super pollutants would provide immediate benefits by enabling reductions in long-lived GHGs to further unfold (CARB 2017).

3.8.1.1 Potential Effects of Climate Change in California

Warming of the atmosphere has broad implications for the environment. In California, one of the effects of climate change could be increases in temperature that could affect the timing and quantity of precipitation. California receives most of its precipitation in the winter months, and a warming environment would raise the elevation of snowpack and result in reduced spring snowmelt and more winter runoff. These effects on precipitation and water storage in the snowpack could have broad implications for the environment in California.

The following potential effects of a warming climate in California (California Climate Change Portal 2007) are some of the changes that may occur in the future:

- Loss of snowpack storage would cause increased winter runoff that generally would not be captured and stored because of the need to reserve flood capacity in reservoirs during the winter.
- Less spring runoff would mean lower early summer storage at major reservoirs, which would result in less hydroelectric power production.
- Higher temperatures and reduced snowmelt would compound the problem of providing suitable cold water habitat for salmonid species. Lower reservoir levels would also contribute to this problem and would reduce the flexibility of cold water releases.
- Sea level rise would affect the Delta, worsening existing levee problems, causing more saltwater intrusion, and adversely affecting many coastal marshes and wildlife reserves. Release of water to streams to meet water quality requirements could further reduce storage levels.
- Increased temperatures would increase the agricultural demand for water and increase the level of stress on native vegetation, potentially allowing for an increase in pest and insect epidemics and a higher frequency of large, damaging wildfires.

For calculating emissions, the California Air Resources Board (CARB) uses a metric developed by the Intergovernmental Panel on Climate Change (IPCC) to account for these differences and to provide a standard basis for calculations (CARB 2018). The metric, called the global warming potential (GWP), is used to compare the future climate impacts of emissions of various long-lived GHGs. The GWP of each GHG is indexed to the heat-trapping capability of CO_2 and allows comparison of the global warming influence of each GHG relative to CO_2. The GWP is used to translate emissions of each GHG to emissions of carbon dioxide equivalents, or carbon dioxide equivalents (CO_2e). In this way, emissions of various GHGs can be summed, and total GHG emissions can be inventoried in common units of metric tons per year of CO_2e. Most international inventories, including the United States inventory, use GWP values from the IPCC Fourth Assessment Report, per international consensus (IPCC 2007; EPA 2012).

The California Global Warming Solutions Act of 2006 (California Assembly Bill [AB] 32) requires California to reduce statewide emissions to 1990 levels by 2020. Executive Order (EO) B-30-15, signed by Governor Jerry Brown in 2015, established a goal for 2030 of reducing GHG emissions by 40% below 1990 levels.

In December 2007, in accordance with AB 32, CARB adopted an emission limit for 2020 of 427 metric tons per year of CO_2e. Increases in the statewide renewable energy portfolio and reductions in importation of coal-based electrical power contributed to meeting California's near-term GHG emission reduction goals. The CARB estimates that a reduction of 82 million metric tons net CO_2e emissions below the business-as-usual levels would be required by 2020 to meet the 1990 levels (CARB 2018). This amounts to approximately a 16% reduction from projected business-as-usual levels in 2020. California met this goal in 2016.

Building on the achievement of SB 32, SB 1383 (Lara, Chapter 395, Statutes of 2016) requires the Board to implement SB 605 (Lara, Chapter 523, Statutes of 2014), which requires CARB to develop a plan to specifically target and reduce emissions of short-loved climate pollutants (SLCPs). Senate Bill 1383 also sets targets for statewide reductions in SLCP emissions of 40% below 2013 levels by 2030 for methane and HFCs, and SLCP emissions of 50% below 2013 levels by 2030 for anthropogenic black carbon. Senate Bill 1393 also provides specific direction for reductions from dairy and livestock operations and from landfills by diverting organic materials (CARB 2017).

At a September 2008 meeting, the World Climate Research Programme Working Group on Coupled Modelling (WGCM), agreed to promote a new set of coordinated climate model experiments. These experiments comprise the fifth phase of the Coupled Model Intercomparison Project (CMIP5) (WCRP 2019). The objective of CMIP5 is to better understand past, present, and future climate changes arising from natural, unforced variability or in response to changes in radiative forcing in a multi-model context. Because it is the latest CMIP model version available for use at this time, CMIP5 is being used to characterize and estimate changes associated with future climate change in this document.

3.8.1.2 DWR Climate Action Plan

DWR developed a Climate Action Plan (CAP) to guide DWR's programs, projects, and activities in response to a changing climate (DWR 2012). The CAP demonstrates how DWR will make substantial reductions in its GHG emissions in the near term (present to 2020), and how it will continue to reduce emissions beyond 2020 to achieve its long-term (2050) GHG emissions reduction goal. Since publication of the CAP, DWR has further reduced its emission reduction targets to 50% below 1990 levels by 2020 and 100% below 1990 levels by 2045 (DWR 2019). The CAP identifies 11 GHG emissions reduction measures to meet near-term and long-term goals, which include:

- termination of its participation and associated delivery of electricity from a coal-fired power plant,
- efficiency improvements to DWR's existing facilities,
- purchase and development of renewable and high-efficiency electricity supplies,
- comprehensive improvements to DWR's construction practices, and
- improvements to DWR's business activities that will reduce GHG emissions.

3.8.1.3 Greenhouse Gas Emissions

The majority of DWR GHG emissions are emitted by non-hydroelectric generation facilities that are needed to convey water through the SWP system, including power used for contract water deliveries, environmental water deliveries, and water transfers (DWR 2012). Typically, the SWP power supply portfolio constitutes about 98% of all GHG emissions from DWR activities.[3]

Construction activities, initiated and completed as individual projects, represent approximately 1% of SWP total GHG emissions. Although the GHG emissions from an individual construction project can be considered to be limited and short-term, the combined GHG emissions from all DWR construction activities also are similar to a long-term source of annual emissions (DWR 2012).

DWR's maintenance activities contribute approximately 0.5% of SWP total GHG emissions. Maintenance activities support flood protection maintenance, which includes routine maintenance activities, small erosion repairs, and sediment removal projects, and SWP maintenance, which includes landscaping and weed control, annual equipment and facilities inspection and maintenance, additional routine activities performed annually as needed, and weir operations and maintenance (DWR 2012).

Business practices contribute approximately 0.5% of SWP total GHG emissions. Business practices include all emissions attributable to the day-to-day administrative and personnel operations of DWR, including the heating and cooling of buildings used by DWR, electricity purchases to run buildings used by DWR, and business travel by DWR employees (DWR 2012).

Table 3.8-2 shows the 1990 and 2007 to 2010 total annual emissions for operational activities, construction activities, maintenance, and business practices, and quantifies the emissions reductions required to meet 2020 and 2050 emissions reduction goals.

Table 3.8-2. DWR Greenhouse Gas Emissions and Reduction Goals ($mtCO_2e$)[1]

Emissions	Operational	Construction	Maintenance	Business Practices	Total Annual Emissions
Estimated 1990 Emissions	2,692,000	28,200	8,200	17,500	2,746,000
Estimated 2007-2010 Emissions	2,410,000	23,600	8,200	17,500	2,459,000 (10% below 1990 levels)
2020 Emissions Reduction Goal	N/A	N/A	N/A	N/A	1,373,000 50% below 1990 levels 44% below 2007–2010 levels

Source: DWR 2012

Notes: $mtCO_2e$ = metric ton of carbon dioxide equivalent

1. The estimates and projections were developed using observed data from historical operations, assumptions about past and future conditions, expert judgment, and complex operational models (DWR 2012: Appendix G).

For 2016, GHG emissions from operational activities, construction activities, maintenance, and business practices totaled approximately 1,045,605 metric tons of carbon dioxide equivalent ($mtCO_2e$), which was 59% below 1990 levels and 45% below 2010 levels (DWR 2016). Furthermore, 2016 GHG emissions were 327,395 $mtCO_2e$, or 24% below the 2020 reduction goal (1,373,000 CO_2e).

[3] DWR uses a portfolio of energy resources to make up the difference in energy between the electricity that SWP facilities generate and the amount of electricity needed to run the SWP. The composition of the SWP power portfolio varies throughout the year and from year to year, but SWP power portfolio's electricity sources generally can be categorized as generation from large hydroelectric facilities, non-renewable energy facilities, and thermal generation facilities, as well as purchased energy (DWR 2012).

3.8.2 Discussion

a) Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?

The long-term operation of the SWP would not generate new sources of GHGs that would significantly impact the environment because the Proposed Project would not construct new facilities or physically alter existing facilities. The long-term operation of the SWP would continue to be in compliance with the CAP goals established by DWR. Thus, **no impact** would occur.

b) Conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of greenhouse gases?

The Proposed Project would not conflict with any adopted plan, policy, or regulation addressing GHGs because it would not include construction of new facilities or modifications to existing facilities. **No impact** would occur.

3.9 HAZARDS AND HAZARDOUS MATERIALS

Table 3.9-1. Potential Impacts on Hazards and Hazardous Materials

	ENVIRONMENTAL ISSUES	ENVIRONMENTAL IMPACT SIGNIFICANCE
IX.	**Hazards and Hazardous Materials. Would the project:**	-
a)	Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	No Impact
b)	Create a significant hazard to the public or the environment through reasonably foreseeable upset and/or accident conditions involving the release of hazardous materials into the environment?	No Impact
c)	Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	No Impact
d)	Be located on a site that is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, therefore, would it create a significant hazard to the public or the environment?	No Impact
e)	For a project located within an airport land use plan or, where such a plan has not been adopted, within 2 miles of a public airport or public use airport, would the project result in a safety hazard or excessive noise for people residing or working in the project area?	No Impact
f)	Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?	No Impact
g)	Expose people or structures, either directly or indirectly, to a significant risk of loss, injury, or death involving wildland fires?	No Impact

Note:
"-" indicates blank cell

3.9.1 ENVIRONMENTAL SETTING

3.9.1.1 Hazardous Materials Transport, Handling, and Cleanup

The EPA regulates the generation, transportation, treatment, storage, and disposal of hazardous substances under the federal Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments of 1984. The California Environmental Protection Agency (CalEPA) is authorized by EPA to enforce and implement federal hazardous materials laws and regulations at the state level. The California Department of Toxic Substances Control (DTSC), which is part of CalEPA, protects Californians from exposure to hazardous waste, primarily under the authority of RCRA and the California Health and Safety Code.

The California Hazardous Materials Release Response Plans and Inventory Law of 1985 (Business Plan Act), administered by DTSC, requires preparation of hazardous materials business plans and disclosure of hazardous materials inventories. A business plan must include an inventory of hazardous materials handled, facility floor plans showing where hazardous materials are stored, an emergency response plan, and provisions for employee training in safety and emergency response procedures (California Health and Safety Code, Division 20, Chapter 6.95, Article 1). Statewide, DTSC has primary regulatory responsibility for management of hazardous materials, with delegation of authority to local jurisdictions that enter into agreements with the State.

The California Occupational Safety and Health Administration (Cal/OSHA) assumes primary responsibility for developing and enforcing workplace safety regulations in California. Cal/OSHA regulations pertaining to the use of hazardous materials in the workplace (California Code of Regulations [CCR], Title 8) include requirements for safety training, availability of safety equipment, accident and illness prevention programs, hazardous substance exposure warnings, and preparation of emergency action and fire prevention plans. Cal/OSHA enforces hazards communication program regulations that contain training and information requirements, including procedures for identifying and labeling hazardous substances, communicating hazard information related to hazardous substances and their handling, and preparation of health and safety plans to protect workers and employees at hazardous waste sites.

The U.S. Department of Transportation regulates transportation of hazardous materials between states. State agencies with primary responsibility for enforcing federal and State regulations and responding to hazardous materials transportation emergencies are the California Highway Patrol (CHP) and California Department of Transportation (Caltrans). Together, these agencies determine container types to be used and license hazardous waste haulers for transportation of hazardous waste on public roads.

Cleanup of hazardous material spills is regulated by CalEPA, DTSC, the SWRCB, Caltrans, the Governor's Office of Emergency Service, and the local Certified Unified Program Agency.

3.9.1.2 Cortese-Listed Hazardous Materials Sites

The provisions of Government Code Section 65962.5 commonly are referred to as the "Cortese List" (after the legislator who authored the legislation that enacted it). The Cortese List is a planning document that is used by the State and local agencies to comply with CEQA requirements in providing information about the location of hazardous materials release sites. Government Code Section 65962.5 requires CalEPA to develop an updated Cortese List annually, at minimum. The SWRCB and DTSC are responsible for a portion of the information contained in the Cortese List. Other State and local government agencies are required to provide additional hazardous material release information for the Cortese List.

Cortese-listed sites in the Northern California portion of the project area are located in major urban centers, such as Redding, Red Bluff, Chico, Yuba City/Marysville, Sacramento, Stockton, Modesto, Merced, and throughout the Bay Area. Similarly, Cortese-listed sites in the Central Coast and Southern California service areas primarily are located in major urban areas, such as such as San Luis Obispo, Lancaster, Los Angeles, San Bernardino, Palm Springs, and San Diego.

3.9.1.3 Hazards Associated with Agricultural Land Uses

Parts of the project area, particularly the Central Valley, historically have been and currently are being used mainly for agricultural purposes. Agricultural land use typically involves the application of pesticides and herbicides as well as the use of fuels, lubricants, and other fluids associated with operation and maintenance of agricultural equipment, the residues of which may remain in soils for years. Other agricultural hazards include underground storage tanks for chemicals and fuels, wells, and underground piping that can contain asbestos.

3.9.1.4 Wildfires

In general, wildfire is a serious hazard in undeveloped land with extensive areas of non-irrigated vegetation. In accordance with California Public Resources Code Sections 4201–4204 and Government Code Sections 51175–51189, the California Department of Forestry and Fire Prevention (CAL FIRE) has mapped areas of significant fire hazards, based on fuels, terrain, weather, and other relevant factors. The zones are referred to as Fire Hazard Severity Zones and represent the risks associated with wildland fires. Urban development within very high fire-hazard risk zones must comply with specific building and vegetation requirements that are intended to reduce property damage and loss of life within these areas.

CAL FIRE manages the State Responsibility Areas, and local fire districts manage Local Responsibility Areas. First responders typically are the local fire districts. The U.S. Forest Service provides wildfire protection, both independently and cooperatively with CAL FIRE. In addition, the National Park Service and Bureau of Land Management (BLM) provide resource management and fire protection on portions of federal lands.

Firefighting actions frequently involve helicopter transport of water from reservoirs located close to wildfires in the project area, including reservoirs owned by the U.S. Bureau of Reclamation and DWR. See Section 3.20, “Wildfire,” for additional details.

3.9.1.5 Handling of Hazardous Materials Near Schools

The California Education Code contains various provisions governing the siting of new public kindergarten through 12th grade (K–12) schools (e.g., California Education Code Sections 17211, 17212, and 17212.5). In addition, the California Department of Education’s (CDE) School Facilities and Planning Division has developed screening and ranking procedures based on criteria commonly affecting school selection (California Education Code Section 17251[b], 5 CCR Section 14001[c]).

The foremost consideration in the selection of school sites is safety, including proximity to airports, proximity to high-voltage power transmission lines, presence of toxic and hazardous substances, hazardous air emissions, and facilities handling hazardous materials within 0.25 mile, and proximity to railroads. Certain health and safety requirements are governed by State statutes and CDE regulations.

School-aged children (i.e., grades K–12) are considered to be particularly sensitive to adverse effects resulting from exposure to hazardous materials, substances, or waste. For this reason, California public Resources Code (PRC) Section 21151.4 requires that lead agencies evaluate projects proposed within 0.25 mile of a school to determine whether release of hazardous air emissions or handling of hazardous substances associated with project implementation would pose a human health or safety hazard.

In general, K–12 schools in the Northern California portion of the project area are concentrated in urban centers. However several schools are on the southwestern side of Lake Oroville. A few schools are located along rivers in the Sacramento and San Joaquin Valley and foothills, in rural portions of the central Sacramento and San Joaquin Valleys, and in the interior of the Delta. Similarly, in the Central Coast and Southern California portions of the project area, schools primarily are located in larger urban areas and incorporated cities, such as San Luis Obispo, Lancaster, Los Angeles, San Bernardino, Palm Springs, and San Diego.

3.9.2 DISCUSSION

a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?

Because the proposed long-term operation of the SWP would not involve any new construction of water facilities, infrastructure, or land disturbance, no construction-related hazards from routine transport, use, or disposal of hazardous materials would occur. Continued operation of SWP facilities would involve the storage, use, and transport of limited amounts of hazardous materials (e.g., fuel, lubricants, paint, pesticides). Transportation of hazardous materials on area roadways is regulated by the CHP and Caltrans, and use of these materials is regulated by DTSC, as outlined in Title 22 of the California Code of Regulations. **No impact** would occur.

b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and/or accident conditions involving the release of hazardous materials into the environment?

Because the proposed long-term operation of the SWP would not involve any new construction of water facilities, infrastructure, or land disturbance, no construction-related hazards from accidental release of hazardous materials would occur. Continued operation of SWP facilities would involve the ongoing use of minor amounts of hazardous materials (e.g., fuel, lubricants, paint). In addition, as described in Chapter 2, “Description of the Proposed Project,” DWR is proposing to treat the existing aquatic weed assemblage and harmful algal blooms at the Clifton Court Forebay with multiple aquatic herbicides (listed in Table 2.5-4).

Control of aquatic vegetation would improve fish salvage efficiency at the John E. Skinner Delta Fish Protective Facility and decrease debris management issues, both of which would promote salmonid survival. None of these materials would be acutely hazardous.

The storage and use of these chemicals is regulated at the federal and State level by agencies, including EPA, the Occupational Safety and Health Administration, Cal/OSHA, CalEPA, DTSC, and the SWRCB. Regulations promulgated and enforced by these agencies are designed to safeguard human health, protect water quality and aquatic life, prevent accidental spills, and regulate clean-up of accidental spills if they do occur. Therefore, proposed long-term operation of the SWP would not create a substantial hazard through accidental release of hazardous materials into the environment. **No impact** would occur.

c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?

Because the proposed long-term operation of the SWP would not involve any new construction of water facilities, infrastructure, or land disturbance, no construction-related hazards from accidental release of hazardous materials would occur. Continued operation of SWP facilities would involve the ongoing use of minor amounts of hazardous materials, such as fuel, lubricants, pesticides and paint. None of these materials would be acutely hazardous, and minor operation of existing facilities and equipment would not generate emissions to a level that would result in adverse health effects on workers or nearby school children. **No impact** would occur.

d) Be located on a site that is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, therefore, would it create a significant hazard to the public or the environment?

The proposed long-term operation of the SWP would not involve any new construction of water facilities, infrastructure, or other types of construction or land disturbance. **No impact** would occur.

e) For a project located within an airport land use plan or, where such a plan has not been adopted, within 2 miles of a public airport or public use airport, would the project result in a safety hazard or excessive noise for people residing or working in the project area?

The proposed long-term operation of the SWP would not involve any new construction of water facilities, infrastructure, or other types of construction or land disturbance that would place new buildings in proximity to airport hazards. Continued operation of the SWP would not increase the amount of bird habitat, and therefore would not increase the potential for wildlife-aircraft strikes, and the Proposed Project would not involve any activities that would cause other safety hazards to aircraft or to SWP personnel on the ground. **No impact** would occur.

f) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?

The proposed long-term operation of the SWP would not involve any new construction of water facilities, infrastructure, or land disturbance that would place new buildings or result in roadway closures that could impede emergency response or evacuation plans. Continued operation of the SWP would not involve any activities that would impede emergency response or evacuation plans. SWP water storage facilities, such as Lake Oroville, include emergency plans in the event of potential emergencies, which are designed to protect the public and the environment. **No impact** would occur.

g) Expose people or structures, either directly or indirectly, to a significant risk of loss, injury, or death involving wildland fires?

The Proposed Project would not involve any new construction of water facilities, infrastructure, or land disturbance that would place new buildings in high fire hazard areas. Some SWP facilities are located in rural areas where a high fire hazard risk exists because of the surrounding terrain and the amount of vegetation. As previously stated, CAL FIRE manages the State Responsibility Areas, and the U.S. Forest Service provides wildfire protection, both independently and cooperatively with CAL FIRE. In addition, the U.S. Forest Service and BLM provide resource management and fire protection on portions of federal lands. The proposed long-term operation of the SWP would not include any actions that would increase wildland fire probability. **No impact** would occur.

3.10 HYDROLOGY AND WATER QUALITY

Table 3.10-1. Potential Impacts on Hydrology and Water Quality

ENVIRONMENTAL ISSUES	ENVIRONMENTAL IMPACT SIGNIFICANCE
IX. Hydrology and Water Quality. Would the project**:**	-
a) Violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface or groundwater quality?	Potentially Significant Impact
b) Substantially decrease groundwater supplies or interfere substantially with groundwater recharge such that the project may impede sustainable groundwater management of the basin?	No Impact
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river or through the addition of impervious surfaces, in a manner that would: i) result in substantial on- or off-site erosion or siltation on- or off-site? ii) substantially increase the rate or amount of surface runoff in a manner that would result in flooding on- or off-site; iii) create or contribute runoff water that would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff; or	No Impact
d) In flood hazard, tsunami, or seiche zones, risk release of pollutants due to project inundation?	No Impact
e) Conflict with or obstruct implementation of a water quality control plan or sustainable groundwater management plan?	No Impact

Note:
"-" indicates blank cell

3.10.1 ENVIRONMENTAL SETTING

This section describes the surface water resources and water supplies managed by the SWP, and potential changes to surface water resources that could occur through implementing the Proposed Project. Implementation of the Proposed Project could affect these resources through potential changes in operation of the SWP.

Tributaries to the Sacramento and San Joaquin rivers that are not affected by SWP operations also are briefly discussed in this section because they contribute to conditions in the Delta. Baseline CalSim II results of flow conditions are presented for reservoirs and rivers that are affected by SWP operations.

For the San Francisco Bay Area, Central Coast, San Joaquin Valley, and Southern California water service areas, surface water streams generally are not used to convey SWP water supplies. The streams downstream from SWP water supply reservoirs generally receive either reservoir overflows in storm conditions or minimum instream flows related to water rights or aquatic resources beneficial uses, or both. After the minimum instream flow requirements are fulfilled, the remaining volumes of water are provided to contracted water users or others. Changes in SWP water operations will not affect the need to meet minimum instream flows or high flows during storm conditions.

3.10.1.1 Sacramento River

The Sacramento River flows about 351 miles from the north near Mount Shasta to the confluence with the San Joaquin River at Collinsville in the western Delta (Reclamation 2013a). The Sacramento River receives contributing flows from numerous major and minor streams and rivers that drain the basin. The Sacramento River also receives imported flows from the Trinity River watershed, as previously discussed.

Waterways in the Sacramento Valley that could be affected by the proposed long-term operation of the SWP include the following:

- Feather River, downstream from Oroville Reservoir to the confluence with the Sacramento River
- Yuba River, from New Bullards Bar Reservoir to the confluence with the Feather River
- Bear River, from Camp Far West Reservoir to the confluence with the Feather River

Flows from other tributaries to the Sacramento, Cosumnes, and Mokelumne rivers in the Sacramento Valley can affect SWP operations, particularly by contributing additional flows to the Delta. However, flows in these rivers would not be affected by changes in SWP operations. Therefore, the hydrologic conditions on these water bodies are not described further in this IS.

3.10.1.2 Feather River

The Feather River is the largest tributary to the Sacramento River in the Sacramento Valley (Reclamation 1997; DWR 2007). The Feather River enters the Sacramento River at Verona. At this location, the total flow of the Feather River includes water from the Yuba and Bear rivers.

Lake Oroville, the primary SWP water storage facility, has a capacity of 3,500 TAF and is located on the Feather River. Lake Oroville stores winter and spring runoff, which is released into the Feather River to meet SWP water demands. Long-term and critically dry-year average water storage volumes for Lake Oroville are shown in Figures 3.10-1 and 3.10-2.

A maximum 17,400 cubic feet per second (cfs) can be released from Lake Oroville through the Edward Hyatt Powerplant, and from the Thermalito Power Canal into the Thermalito Diversion Pool. Water continues through the Thermalito Diversion Pool into the Feather River Fish Hatchery and the 11,768 AF Thermalito Forebay, which was formed by the Thermalito Diversion Dam. Water is then released from the Thermalito Forebay through the Thermalito Powerplant into the Thermalito Afterbay and the low-flow channel of the Feather River. Water from Thermalito Afterbay flows into the Feather River. Long-term and critically dry-year average flows in the Feather River are shown in Figures 3.10-3 and 3.10-4.

Operations at Oroville Dam are performed in accordance with a FERC license, Project No. 2100, which defines maximum allowable Feather River low-flow channel ramp-down release requirements to prevent rapid reductions in water levels that potentially could cause redd dewatering and stranding of juvenile salmonids and other aquatic organisms. Water releases from Lake Oroville also are affected by temperature criteria (Reclamation 2015a).

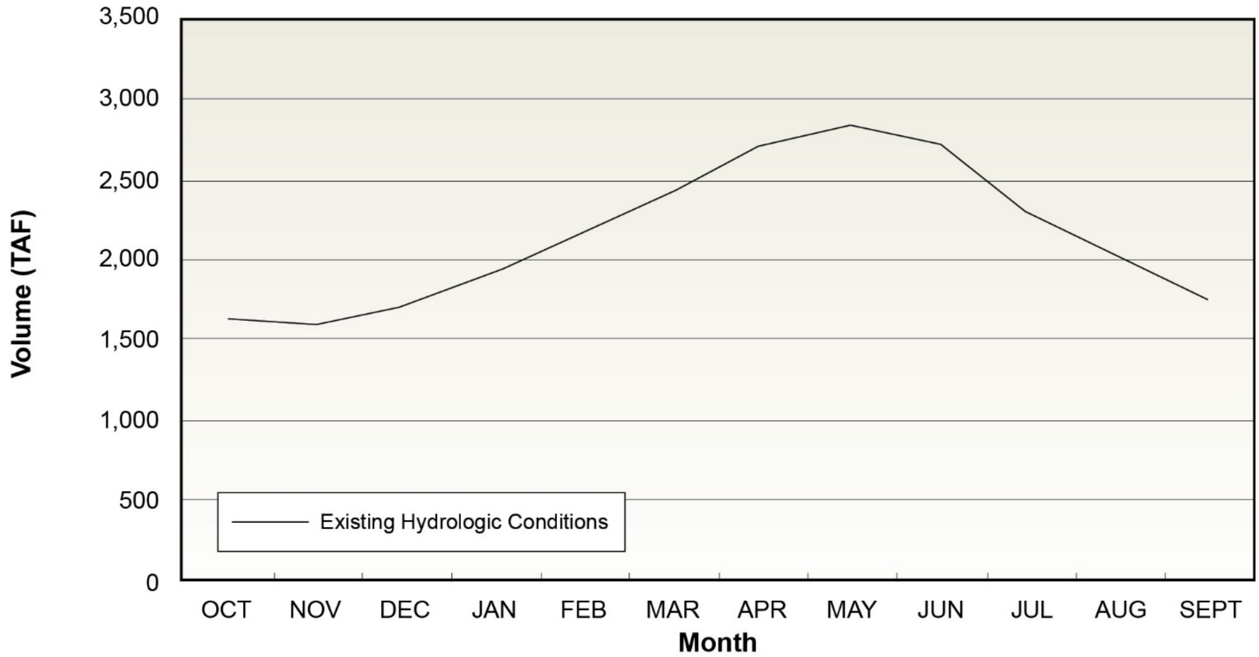


Figure 3.10-1. Lake Oroville, Long-Term Average Storage

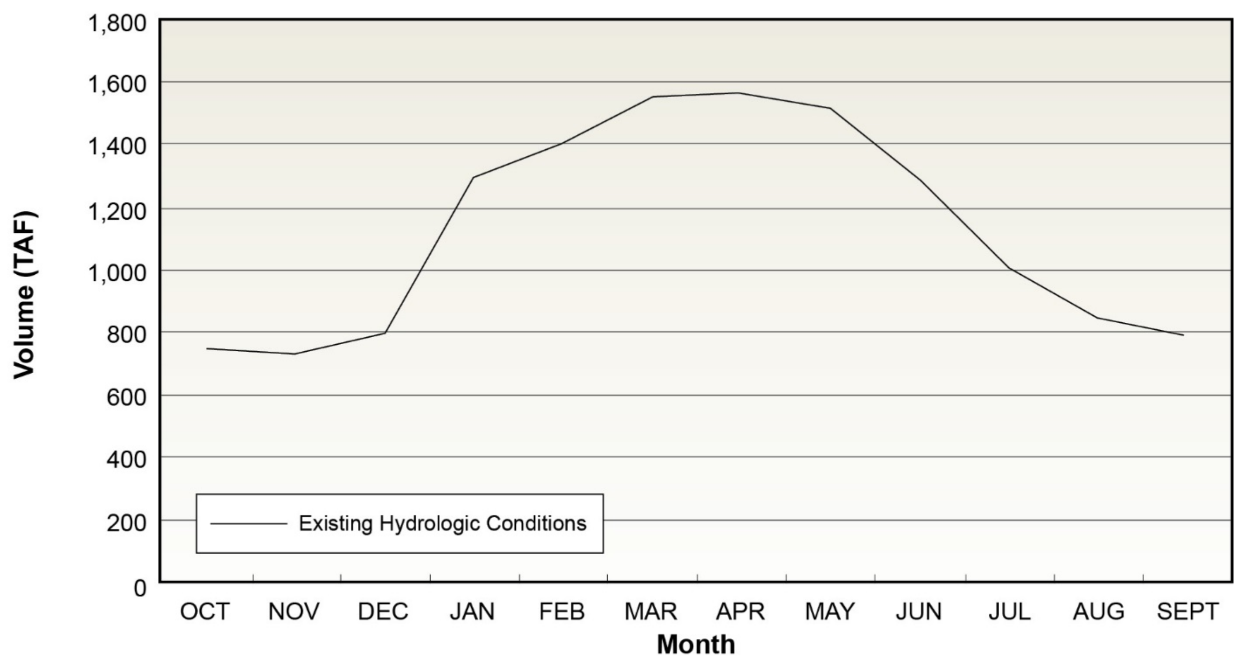


Figure 3.10-2. Lake Oroville, Critically Dry-Year Average Storage

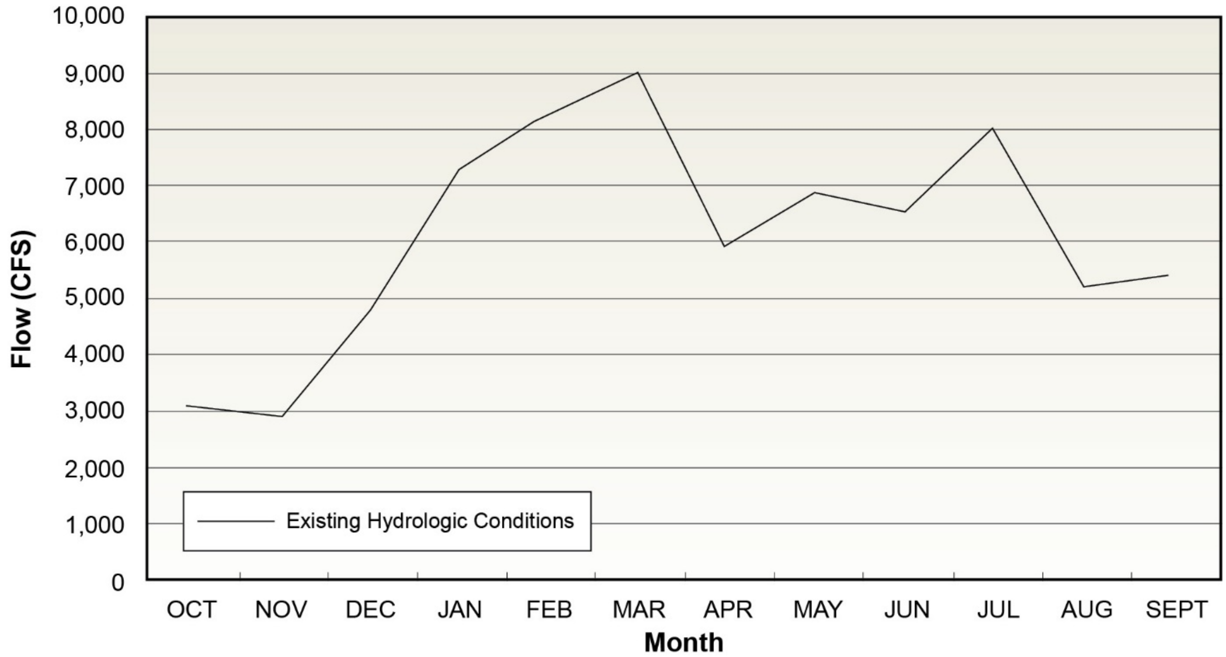


Figure 3.10-3. Feather River near Gridley, Long-Term Average Flow

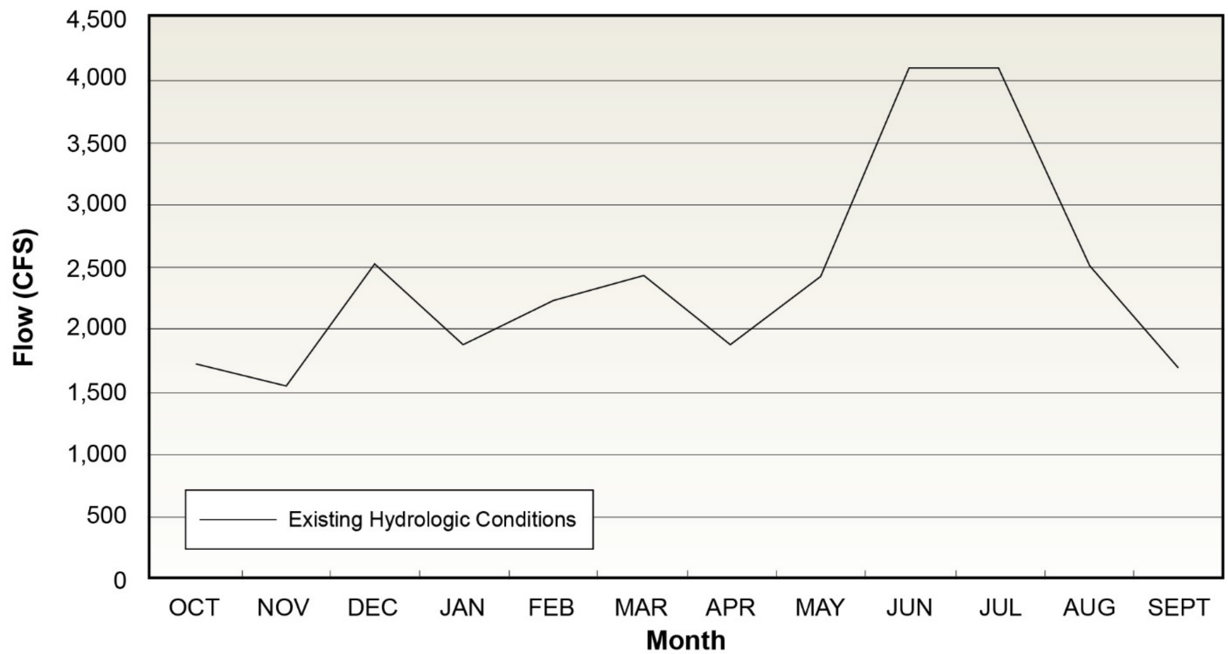


Figure 3.10-4. Feather River near Gridley, Critically Dry-Year Average Flow

3.10.1.3 Delta and Suisun Marsh

The Delta and Suisun Marsh encompass about 1,315 square miles and convey about 40% of the water draining from the state (DWR 2013). The Delta and Suisun Marsh are a complex of channels and islands located at the confluence of the Sacramento and San Joaquin rivers. The SWP use the Delta to convey water to State pumps in the South Delta.

Inflows to the Delta occur primarily from the Sacramento River system, the San Joaquin River, and other eastside tributaries, including the Mokelumne, Calaveras, and Cosumnes rivers. About 77% of the water enters the Delta from the Sacramento River, about 15% enters from the San Joaquin River, and about 8% enters from the eastside tributaries (DWR 1994). The daily, seasonal, and year-to-year differences in freshwater flows from the Sacramento and San Joaquin rivers and other Delta tributaries affect the Delta's water quality, particularly with regard to salinity (DWR et al. 2013).

The Sacramento River is the primary contributor to Delta freshwater inflows. North Delta channels convey Sacramento River and Yolo Bypass flows southerly and westerly. The Delta Cross Channel (DCC) gates divert flows from the Sacramento River to Snodgrass Slough, and then to the Mokelumne River, where the river flows into the Central Delta and South Delta. Circulation of water in the North Delta and Central Delta primarily is determined by flows in the Sacramento River; however, operations of the SWP alter the direction of the natural flow in the Central Delta, resulting in an altered flow path toward the South Delta pumps.

The San Joaquin River, the second largest contributor to Delta freshwater inflows, enters the Delta from the south. Although the natural direction of the flow is toward the north and west, channel flows in the South Delta are sensitive to SWP and CVP export operations (DWR et al. 2013).

Tidal flows have a major influence on Delta surface water circulation. Flow in the Delta channels can change direction because of tidal exchange, ebbing and flooding with the two tides per day. On average, tidal inflows to the Delta are approximately equal to tidal outflows. The tidal range can vary by about 30% between spring tide and neap tide conditions. Tidal flows at Martinez can be as high as 600,000 cfs. Because the Delta is tidally influenced; water surface elevations can vary from less than 1 foot in the east Delta to more than 5 feet in the west Delta (DWR 2013) on a daily basis.

Tidal flows enter and leave the Delta along the combined Sacramento and San Joaquin rivers at Chipps Island. Farther upstream in the Delta (e.g., in Old River near Bacon Island), tidal flows can be as high as 16,000 cfs, and in relatively upstream locations such as at Freeport or Vernalis, riverine conditions dominate the tidal effects.

The SWP pumping plant can affect the direction of flow of water in the Delta channels, particularly during periods of low freshwater inflow and large exports. Normally, net flows in the Delta travel westerly toward Suisun Bay and the San Francisco Bay. Diversion rates at the SWP South Delta intakes influence Delta hydraulics, changing the direction of the flow in some South Delta waterways. The most influential effects occur on Old and Middle rivers, where flows are reversed during periods of South Delta pumping. Reverse flows also occur in the False River in the west Delta and Turner Cut in the San Joaquin River, causing more saline water to move farther inland (DWR et al. 2013).

Temporary Agricultural Barriers

The DWR South Delta Temporary Barrier Project (TBP) was initiated in 1991 to seasonally construct and demolish four rock barriers across several South Delta channels. These barriers are intended to maintain water levels in South Delta waterways and promote San Joaquin River salmon migration through the South Delta. The TBP consists of installing and removing temporary rock barriers at the following locations:

- Middle River near Victoria Canal, about 0.5 mile south from the confluence of Middle River, Trapper Slough, and North Canal
- Old River near Tracy, about 0.5 mile east of the Delta–Mendota Canal (DMC) intake
- Grant Line Canal near Tracy Boulevard Bridge, about 400 feet east of Tracy Boulevard Bridge
- The Head of Old River Barrier (HORB) at the confluence of Old River and the San Joaquin River

The temporary barriers on the Middle River, the Old River near Tracy, and the Grant Line Canal are designed to improve water levels for agricultural diversions and are installed during the irrigation season. The HORB has been installed only from early September to November 30, when requested by CDFW if improvement of dissolved oxygen in the San Joaquin River is necessary. The HORB also has been installed in the spring months to improve outmigrating conditions for juvenile salmonids.

The agricultural barriers at Old and Middle rivers can be installed as early as March 1 if the HORB is installed. They can be operated fully as early as April 1 if the HORB is installed or as early as May 15 if the HORB is not installed. From May 15 to May 31 (if the HORB is removed), the Middle River and Old River barrier gates are opened. After May 31, the Middle River, Old River, and Grant Line Canal barriers are permitted to be operational until they are removed completely by November 30.

SWP Barker Slough Pumping Plant

The SWP Barker Slough Pumping Plant (BSPP) diverts water from Barker Slough into the SWP North Bay Aqueduct (NBA) for delivery to the Solano County Water Agency and the Napa County Flood Control and Water Conservation District. The 162.5-cfs NBA intake has a positive barrier fish screen and is about 10 miles from the Sacramento River at the end of Barker Slough.

The NBA was designed to convey up to 175 cfs. However, the ability of the BSPP to deliver water is limited because a bio-film growth has developed on its interior, restricting water conveyance to about 142 cfs. In addition, water quality in Barker Slough often is degraded during winter and spring rainfall events with elevated levels of coliform bacteria, organic matter, turbidity, and other pollutants. This degradation limits the amount of time that the BSPP can be operated.

The 2008 USFWS Biological Opinion reduced the total BSPP annual diversion to 71 TAF. In 2009, CDFW issued an ITP for the preservation of Longfin Smelt that restricted pumping rates during dry and critical dry years from January 15 to March 31.

South Delta Water Diversions

Delta channels have been modified to allow transport of Delta inflow to South Delta diversions, which reduces the effects of pumping on Delta water circulation and salinity intrusion. The water conveyance from the Sacramento River southward through the Delta to the South Delta intakes is aided by the DCC.

SWP's Clifton Court Forebay and the Banks Pumping Plant

The SWP facilities in the South Delta include the 31-TAF Clifton Court Forebay (CCF), about 10 miles northwest of the city of Tracy, and the Harvey O. Banks Pumping Plant (Banks Pumping Plant). Water is diverted from the Old River into the CCF to provide storage for off-peak withdrawals from the CCF, moderating the effects of the pumps on flow and stage fluctuations in adjacent Delta channels and collecting sediment before entering the Banks Pumping Plant and the California Aqueduct.

The California Aqueduct transports water to the O'Neill Forebay, where the water can be released either to the San Luis Canal, a portion of the California Aqueduct jointly owned by the SWP and CVP, or pumped into the San Luis Reservoir. Water from the San Luis Reservoir subsequently is released to the San Luis Canal, which terminates near Kettleman City. From this location, the California Aqueduct continues to Southern California.

The capacity of the Banks Pumping Plant is 10,300 cfs. Permits issued by U.S. Army Corps of Engineers (USACE) regulate the rate of diversion of water into the CCF. The diversion rate is normally restricted to 6,680 cfs as a 3-day average inflow to the CCF and 6,993 cfs as a 1-day average inflow. CCF diversions may be greater than these rates between December 15 and March 15, when the inflow into the CCF may be augmented by one-third of the San Joaquin River flow at Vernalis if those flows are equal to or greater than 1,000 cfs.

In 2000, the maximum diversion rate was increased during the months of July, August, and September to recover export reductions resulting from actions taken to protect fisheries resources. The expanded maximum allowable daily diversion rate into the CCF was increased from 13,870 to 14,860 AF; 3-day average diversions were increased from 13,250 to 14,240 AF (500 cfs per day equals 990 AF per day). Implementation of this action is contingent on meeting the following conditions:

- The increased diversion rate will not result in greater annual SWP water supply allocations than would occur in the absence of the increased diversion rate. Water pumped because of the increased capacity would be used only to offset reduced diversions that occurred or will occur because of actions taken to benefit fisheries.
- Use of the increased diversion rate will be in accordance with all terms and conditions of existing BiOps governing SWP operations.
- All three temporary agricultural barriers (i.e., Middle River, Old River near Tracy and Grant Line Canal) must be in place and operating when SWP diversions are increased.

Between July 1 and September 30, if the salvage of special-status fish species reaches a level of concern, the relevant fish regulatory agencies would determine whether the 500-cfs increased diversion may continue or be stopped.

The Banks Pumping Plant is operated to minimize its impact on power loads to the California electrical grid to the extent practicable. Generally, more pump units are operated during off-peak periods and fewer during peak periods, with water stored temporarily in the CCF. Because the installed capacity of the pumping plant is 10,300 cfs, the Banks Pumping Plant can be operated to reduce power grid impacts by running all available pumps at night and running fewer during the higher energy-demand hours. Long-term, dry-year, and critically dry-year average total Delta exports (sum of the Jones Pumping Plant and Banks Pumping Plant) are shown in Figures 3.10-5 through 3.10-7.

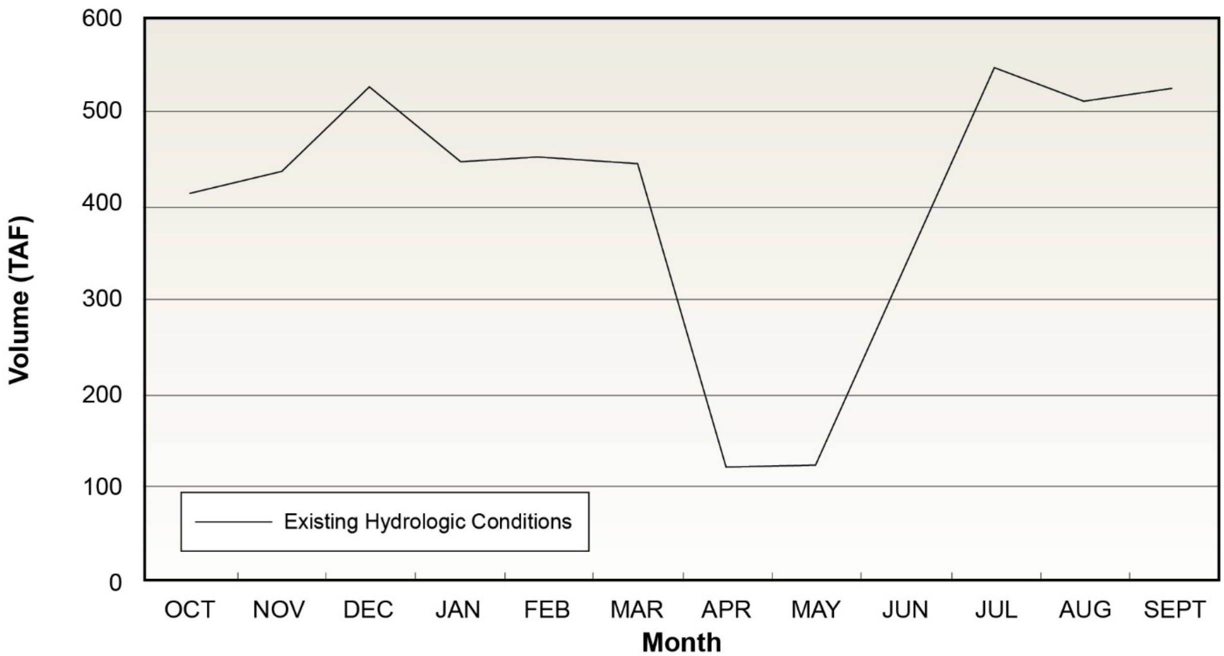


Figure 3.10-5. Total Delta Exports, Long-Term Average Delivery

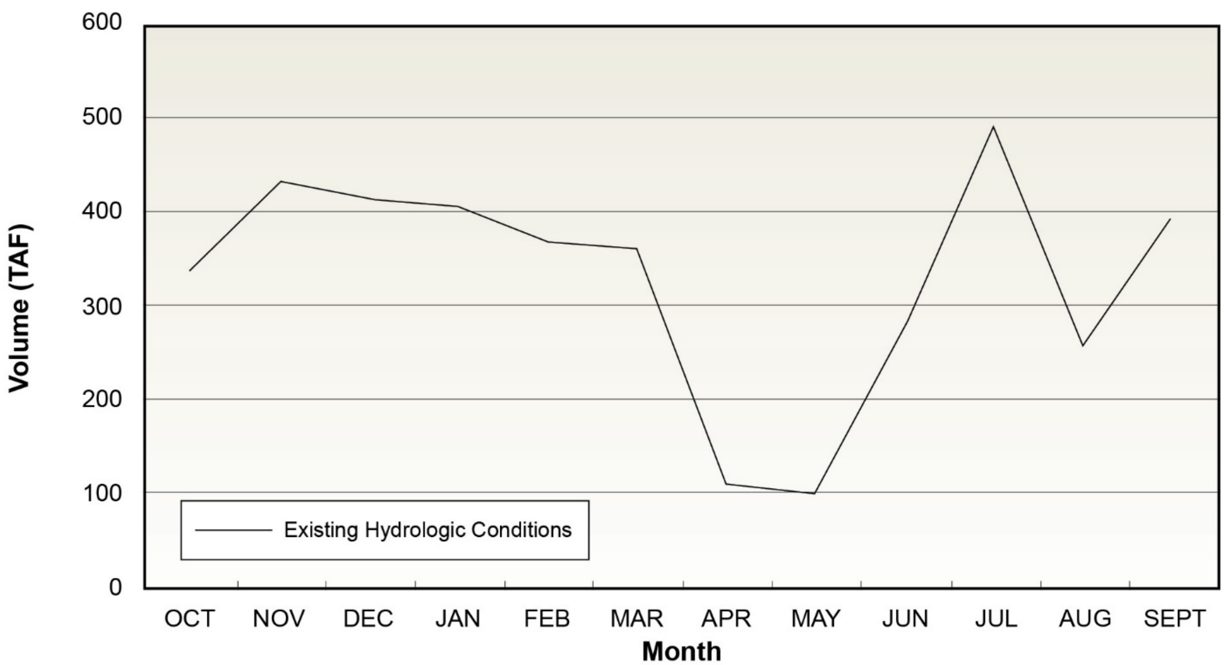


Figure 3.10-6. Total Delta Exports, Dry-Year Average Delivery

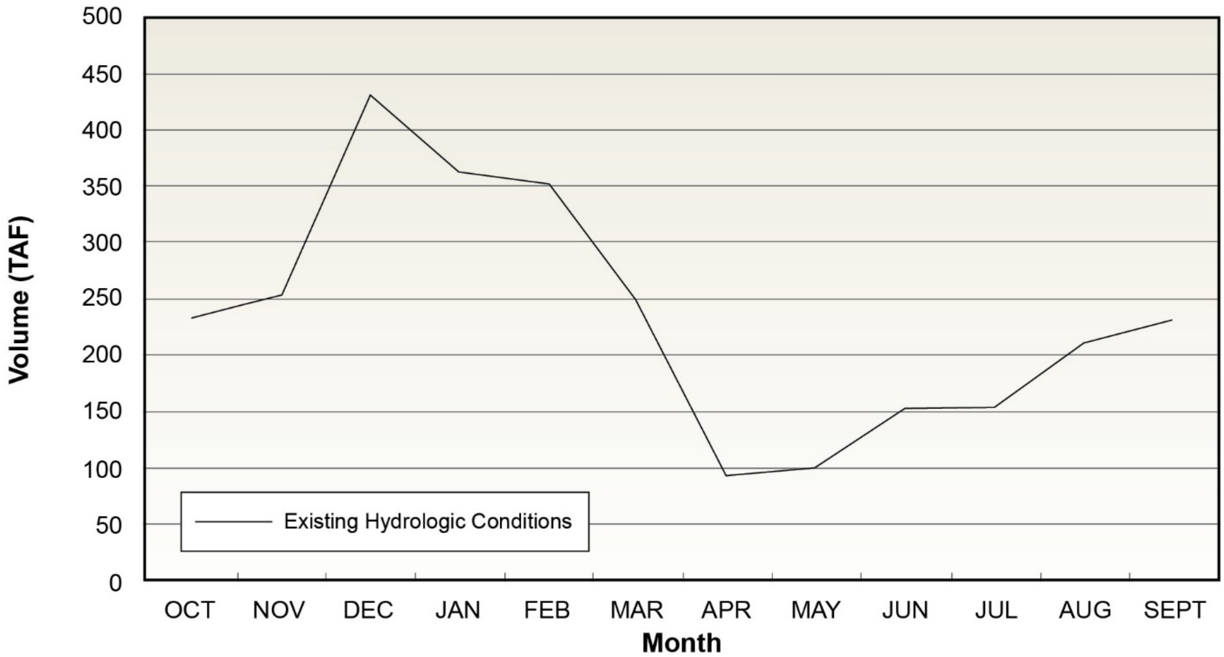


Figure 3.10-7. Total Delta Exports, Critically Dry-Year Average Delivery

Joint Facilities in Suisun Marsh

The SMPA requires DWR and Reclamation to meet salinity standards, sets a timeline for implementing the Plan of Protection, and delineates monitoring and mitigation requirements in accordance with D-1641 to implement and operate physical facilities in the Suisun Marsh.

Suisun Marsh Salinity Control Gates

The SMSCG are on Montezuma Slough near Collinsville. The objective of SMSCG operation is to decrease the salinity of the water in Montezuma Slough by restricting the flow of higher salinity water from Grizzly Bay into Montezuma Slough during incoming tides and retaining lower salinity Sacramento River water from the previous ebb tide. This operation lowers salinity in Suisun Marsh channels and results in a net movement of water from east to west.

When Delta outflow is low to moderate and the gates are not operating, tidal flow past the gate is about 5,000 to 6,000 cfs, while the net downstream flow is near zero. When operated, flood tide flows are arrested while ebb tide flows remain in the range of 5,000 to 6,000 cfs. The net downstream flow in Montezuma Slough becomes about 2,500 to 2,800 cfs.

The 2,800 cfs net downstream flow associated with SMSCG operation is effective at moving higher salinity concentrations downstream in Montezuma Slough. Salinity is reduced by roughly 100% at Belden’s Landing and by lesser amounts farther west along Montezuma Slough. At the same time, the salinity field in Suisun Bay moves upstream as net Delta outflow is reduced by gate operation. Net outflow through Carquinez Strait is not affected.

The USACE permit for the SMSCG requires that it be operated between October and May only when needed to meet Suisun Marsh salinity standards. Historically, the gate has been operated as early as October 1, although in some years (e.g., 1996) the gate was not operated at all. When the channel water salinity decreases sufficiently below the salinity standards or at the end of the control season, unrestricted flow is allowed through Montezuma Slough.

Roaring River Distribution System

The RRDS was constructed in 1979 and 1980 to provide lower salinity water to 5,000 acres of private wetlands and 3,000 acres of CDFW-managed wetlands on Simmons, Hammond, Van Sickle, Wheeler, and Grizzly islands.

The RRDS includes a 40-acre intake pond that supplies water to Roaring River Slough. Motorized slide gates in Montezuma Slough and flap gates in the pond control flows through culverts into the pond. A flap gate and flashboard riser are at the confluence of Roaring River and Montezuma Slough to enable drainage back into Montezuma Slough for controlling water levels in the distribution system and flood protection.

Water is diverted into the Roaring River intake pond during high tides to raise the water surface elevation in the RRDS above the adjacent managed wetlands. Managed wetlands north and south of the RRDS receive water, as needed.

Morrow Island Distribution System

The MIDS was constructed in southwestern Suisun Marsh in 1979 and 1980 to channel drainage water from the adjacent managed wetlands for discharge into Suisun Slough and Grizzly Bay. The MIDS increases circulation and reduces salinity in Goodyear Slough.

The MIDS is used year-round, but most intensively from September through June. When managed wetlands are filling and circulating, water is tidally diverted from Goodyear Slough just south of Pierce Harbor. Water is discharged into Grizzly Bay by way of the C-Line Outfall and into the mouth of Suisun Slough by way of the M-Line Outfall, rather than back into Goodyear Slough. This additional supply minimizes salinity increases that are caused by drainage water discharges into Goodyear Slough.

3.10.1.4 Delta–Mendota Canal/California Aqueduct Intertie

The connection between the DMC and the California Aqueduct allows water to flow between the SWP and CVP conveyance facilities. The DMC/California Aqueduct Intertie achieves multiple benefits, including meeting current water supply demands, allowing the maintenance and repair of the CVP Delta export and conveyance facilities, and providing operational flexibility to respond to emergencies.

3.10.1.5 San Luis Reservoir

The 2.027-MAF San Luis Reservoir, formed by Sisk Dam, is operated jointly by Reclamation and DWR, with about 0.965 MAF stored by the CVP and 1.062 MAF stored by the SWP. Water generally is diverted into the San Luis Reservoir in late fall through early spring, when irrigation water demands are lower and are being met directly by Delta exports.

By April or May, demands from both agricultural and M&I SWP water service contractors usually exceed the pumping rate at the Banks Pumping Plant, and releases from the San Luis Reservoir to the

SWP facilities are needed to supplement the Delta pumping at the Banks Pumping Plant to meet SWP contractor demands.

3.10.1.6 Joint Point of Diversion

D-1641 authorized the SWP and CVP to jointly use the Jones and Banks pumping plants in the South Delta (referred to as the Joint Point of Diversion [JPOD]), with conditional limitations and required response coordination plans. Use of the JPOD is based on staged implementation.

Each stage of the JPOD has regulatory terms and conditions that must be satisfied to implement the JPOD. All stages require a response plan to ensure water elevations in the South Delta will not be lowered that would injure local riparian water users and a response plan to ensure that the water quality in the South and Central Delta will not be degraded significantly by operation of the JPOD such that the water would cause injury to water users in the South Delta and Central Delta.

3.10.1.7 SWP Conveyance Facilities Downstream from San Luis Reservoir

Water from the San Luis Reservoir is released into the California Aqueduct, which conveys water supplies southward to Lake Perris in Riverside County. The first segment of the California Aqueduct downstream from San Luis Reservoir is called the San Luis Canal. This canal is owned jointly by the SWP and CVP and extends from the San Luis Reservoir to Kettleman City. Near Kettleman City, water is diverted into the SWP Coastal Branch Aqueduct to serve agricultural areas west of the California Aqueduct and communities in San Luis Obispo and Santa Barbara counties.

The California Aqueduct continues into Southern California through the Edmonston Pumping Plant, at the foot of the Tehachapi Mountains, which raises the water into Antelope Valley. At that location, the California Aqueduct divides into two branches—the East Branch and the West Branch. The East Branch conveys water into Silverwood Lake in the San Bernardino Mountains, with a capacity of 73,000 AF. From Silverwood Lake, water flows through the San Bernardino Tunnel to Lake Perris. Lake Perris, near the city of Riverside, provides up to 131,500 AF of storage and serves as a regulatory and emergency water supply facility for the East Branch. The East Branch Extension conveys water to the San Gorgonio Pass Water Agency and the eastern portion of the San Bernardino Valley Municipal Water District. The West Branch conveys water to Pyramid Lake in Los Angeles County. Water from Pyramid Lake is conveyed to the 324,000-acre-foot Castaic Lake.

3.10.1.8 Water Supplies Used by State Water Project Water Users

The SWP water supplies are the only water supplies available to some water users, including some communities served by the Antelope Valley–East Kern Water Agency. Other SWP water users rely on other surface water supplies and groundwater. However, when the SWP water supplies are limited because of lack of precipitation, the other surface water supplies also are limited.

Several SWP water users also rely on other imported water supplies, including water from the Solano Project, used by the Solano County Water Agency; the Hetch Hetchy Water Project, used by Alameda County Water District, Santa Clara Valley Water District, and Zone 7 Water Agency; the Mokelumne River, used by East Bay Municipal Utility District; and the Colorado River, used by portions of the service area of the Metropolitan Water District of Southern California and Coachella Valley Water District.

These surface water supplies also are subject to reductions because of hydrologic conditions. In the case of water users that rely on Colorado River water supplies, Delta water is used to dilute the salts and trace elements (e.g., selenium) found in the Colorado River water supply and to provide direct water supplies (Reclamation 2012).

In response to recent reductions in SWP water supply reliability, water agencies have been making improvements to regional and local water supplies through enhanced water conservation efforts, wastewater effluent and stormwater recycling, construction of local surface water and groundwater storage facilities, and construction of desalination treatment plants for brackish water sources and ocean water sources. In addition, many agencies have constructed conveyance facilities to allow sharing of water supplies between communities, including the recent Bay Area Regional Water Supply Reliability project, which provided conveyance opportunities between several SWP and CVP water users in the San Francisco Bay Area Region.

An exceedance plot of total SWP deliveries is shown in Figure 3.10-8.

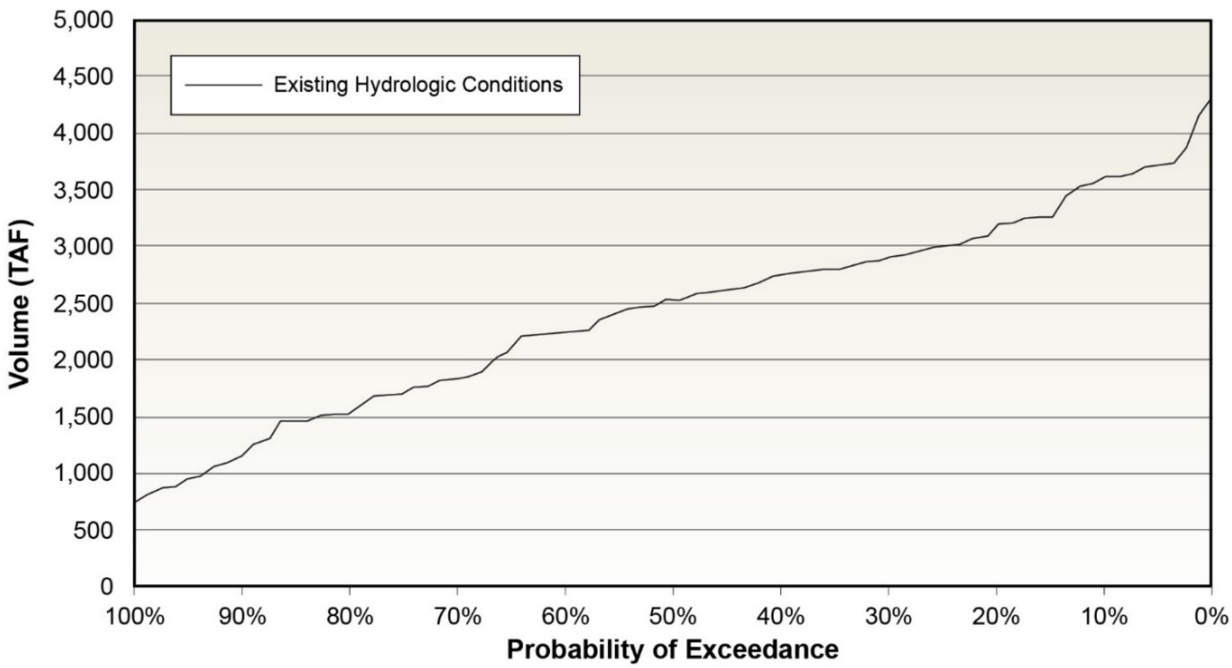


Figure 3.10-8. Exceedance Plot of Total SWP Deliveries

3.10.1.9 Water Transfers

Water transfers also are an integral part of water management. Historically, water transfers primarily were limited to in-basin transfers (e.g., Sacramento Valley to Sacramento Valley water users) (Reclamation 2013b; DWR et al. 2013). However, between 2001 and 2012, water transfers from the Sacramento Valley to areas south of the Delta increased to 298,806 AF, not including water transfers under the CALFED Bay-Delta Program's Environmental Water Account Program (DWR et al. 2013). These transfers occurred in drier years when water supplies were needed and capacity at the South Delta pumps was available.

In 2008, one of the first long-term water transfer agreements was approved by the SWRCB for the Lower Yuba River Accord. The plan was designed to protect and enhance fisheries resources in the Lower Yuba River, increase local water supply reliability, provide DWR with increased operational flexibility for protection of Delta fisheries, and provide additional dry-year water supplies to SWP and CVP water users.

In 2013, Reclamation approved an overall program for a 25-year period (2014–2038), to transfer up to 150,000 acre-feet per year of water from the San Joaquin River Exchange Contractors Water Authority to the U.S. Department of the Interior for refuge water supplies or SWP or CVP water users (Reclamation 2013b). Reclamation also approved a long-term water transfer program (2015–2024) from water sellers in the Sacramento Valley to water users in the San Francisco Bay Area and south of the Delta (Reclamation 2014).

3.10.1.10 Surface Water Quality

Environment Setting

Historical water quality conditions in the project area are described in this section. These conditions are compared with federal and State laws and regulations that protect identified beneficial uses.

Regulatory Framework

Many of the current water quality criteria were developed in accordance with the federal Water Pollution Control Act Amendments of 1972, also known as the Clean Water Act (CWA), as amended. The CWA established the institutional structure for EPA to regulate discharges of pollutants into waters of the United States, establish water quality standards to protect designated beneficial uses, conduct planning studies, and provide funding for specific grant projects. In California, EPA designated the SWRCB to act as the EPA agent to develop and enforce water quality objectives and implement water quality control plans (basin plans). The SWRCB designated Regional Water Quality Control Boards (RWQCBs) to develop basin plans and designate the beneficial uses of waters within each basin along with water quality objectives to protect those beneficial uses, pursuant to Section 303 of the CWA.

The Bay Delta Water Quality Control Plan for the Sacramento River and San Joaquin River basins designated drinking water municipal and domestic supply beneficial use for most waters in the Central Valley, including the Delta. The Bay–Delta Water Quality Control Plan includes narrative objectives for chemical constituents, taste and odor, sediment, suspended material, toxicity, and numeric objectives for chemical constituents and salinity; the plan incorporates by reference the primary and secondary maximum contaminant levels specified in Title 22 of the California Code of Regulations for waters designated for municipal uses.

In 2013, the Central Valley RWQCB adopted Resolution No. R5-2013-0098, an amendment to the Basin Plan to establish a drinking water policy for surface waters of the Delta and its upstream tributaries. The amendment, approved in 2014 by the SWRCB, California Office of Administrative Law, and EPA, included narrative water quality objectives for *Cryptosporidium*, *Giardia*, and organic carbon; established a Drinking Water Policy to maintain high quality of water; and included toxics standards for inland surface waters, enclosed bays, and estuaries.

The State of California adopted several California-based water quality policies, including the California Toxics Rule (CTR) and the Policy for Implementing Toxic Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (State Implementation Policy). The State also expanded waste discharge requirements to include discharges to groundwater to address the critical need to protect this drinking water source from contaminants.

The RWQCBs evaluate potential changes in flow patterns and water quality in each basin from changes in discharges into the water bodies, land use practices that effect drainage into the water bodies, or water diversion operations. Based on this information, the RWQCBs prepare lists of impaired water bodies in each basin (per Section 303[d] of the CWA) that do not comply with applicable water quality standards. The RWQCBs also develop Total Maximum Daily Load (TMDL, or the greatest pollutant load that a water body can receive and still meet water quality standards to protect designated beneficial uses.

Beneficial Uses in the Study Area

The Delta has high levels of naturally occurring and human-made water quality constituents. Some of the naturally occurring constituents, such as salinity and nutrients (including organic carbon), are important components of the Delta ecosystem and vary with the tidal cycles of the estuary. Human-made constituents, such as pathogens and contaminants, result from point and non-point source discharges into the Sacramento and San Joaquin rivers and the Delta.

Water quality criteria have been adopted by the SWRCB and Central Valley RWQCB to protect water users and ecological resources in the Sacramento and San Joaquin rivers and the Delta. Beneficial uses for water bodies in the study area are summarized in Table 3.10-2.

Table 3.10-2. Designated Beneficial Uses in the Study Area

Designated Beneficial Uses	Sacramento River: Feather River to Delta	Feather River: Oroville Dam to Sacramento River	Yolo Bypass	Sacramento-San Joaquin River Delta	San Luis Reservoir	California Aqueduct
Municipal and Domestic Supply	X	X	-	X	X	X
Agricultural Supply	X	X	X	X	X	X
Industrial Service Supply	X	-	-	X	X	X
Industrial Process Supply	-	-	-	X	-	X
Groundwater Recharge	-	-	-	X	-	-
Navigation	-	-	-	X	-	-
Hydropower Generation	-	-	-	-	X	X
Water Contact Recreation	X	X	X	X	X	X
Non-Contact Water Recreation	X	X	X	X	X	X
Commercial and Sport Fishing	-	-	-	X	-	-
Warm Freshwater Habitat	X	X	X	X	X	-
Cold Freshwater Habitat	X	X	X	X	-	-
Wildlife Habitat	X	X	X	X	X	X
Rare, Threatened, or Endangered Species	-	-	-	X	-	-

Designated Beneficial Uses	Sacramento River: Feather River to Delta	Feather River: Oroville Dam to Sacramento River	Yolo Bypass	Sacramento-San Joaquin River Delta	San Luis Reservoir	California Aqueduct
Migration of Aquatic Organisms	X	X	X	X	-	-
Spawning, Reproduction, and/or Early Development	X	X	X	X	-	-
Shellfish Harvesting	-	-	-	X	-	-
Estuarine Habitat	-	-	-	X	-	-

Note:

X indicates designated beneficial use; "-" indicates blank cell

Sources: CV RWQCB 2004, 2011; SFB RWQCB 2013; SWRCB 2006

TMDLs adopted or being developed to protect the beneficial uses of these waterways are summarized in Table 3.10-3.

Table 3.10-3. Total Maximum Daily Load Status in the Study Area

Water Body	Mercury	Toxicity	Pesticides	Other Constituents
Sacramento River from Feather River to the Delta	TMDL being developed	N/A	Dieldrin TMDL by 2022	N/A
Lake Oroville and Feather River to Sacramento River	TMDL by 2022	TMDL by 2019	Group A TMDL being developed Chlorpyrifos TMDL by 2019	PCB TMDL by 2022
San Luis Reservoir	TMDL by 2021	N/A	N/A	N/A
Delta	TMDL approved 2008	TMDL by 2019	Chlordane and Dieldrin in the northern Delta TMDL being developed Chlorpyrifos, DDT, Diazinon, Dioxin, Furan compounds, and Group A TMDLs being developed	PCB TMDL being developed Selenium TMDL being developed Invasive species TMDL by 2019

Source: SWRCB 2011a

Notes:

DDT = dichlorodiphenyltrichloroethane

N/A = not applicable

PCB = polychlorinated biphenyl

TMDL = Total Maximum Daily Load

Major Constituents that Could Adversely Affect Water Quality for Beneficial Uses

Implementing the proposed long-term operation of the SWP may have effects on salinity, chloride, mercury, and nutrients caused by altering the hydrology of the surface waters. Existing conditions of these constituents in the study area are discussed next.

Salinity

Salinity (a measure of dissolved salts in water) in the tidally influenced Delta can cause adverse effects on domestic supply, agriculture, industry, and wildlife (CALFED 2007). Salinity concentrations tend to increase from the North Delta to the South Delta, and from the east Delta to the west Delta. Salinity concentrations in the Delta follow predictable patterns, as influenced by the higher saline water from the San Joaquin River and less saline water from the Sacramento River and eastside streams in an ever-changing balance with marine tidal influence and the diversion from the South Delta SWP and CVP pumps.

The highest salinity concentrations occur during the late summer months, when the flows from the Sacramento and San Joaquin rivers are the lowest and the greatest level of sea water intrusion occurs. The lower Sacramento River at Collinsville experiences strong tidal influence during dry periods but is flushed with freshwater during the higher winter flow events.

Salinity concentrations are reported in multiple ways, including chlorides, total dissolved solids, and electrical conductivity (EC). EC is linked to salinity, and salinity is an important variable in the tidally influenced Delta to a variety of aquatic resources and water users (CV RWQCB 2011; CALFED 2007).

The Sacramento River has not been placed on the 303(d) impaired waterways list, approved by EPA for salinity. Delta waterways were placed on the Section 303(d) list as impaired by EC. Suisun Marsh was placed on the 303(d) list for impairment by salinity. Suisun Marsh is also impaired by chlorides and total dissolved solids. (SWRCB 2011a)

Water quality objectives for EC were established in the SWRCB Bay–Delta Water Quality Control Plan, to protect the beneficial uses of Delta waterways, including the agricultural water supply (SWRCB 2006). The Delta plan includes objectives for the Delta for agricultural as well as fish and wildlife beneficial use protection, which vary by month and water-year type. The objectives for agricultural protection are designed primarily to control salinity conditions in the interior and southern Delta channels, and San Joaquin River inflow to the Delta at Vernalis.

The salinity water quality objectives in the project area are shown in Table 3.10-4.

Table 3.10-4. Major Salinity Water Quality Objectives in the Study Area

Location of Water Quality Objective	Parameter	Description	Water Year per Time Period or Values
Contra Costa Canal at Pumping Plant #1 <u>or</u> San Joaquin River Antioch Water Works Intake	Chloride	Maximum mean daily 150 milligrams per liter (mg/L) chloride for at least the number of days shown during the calendar year. Must be provided in intervals of not less than 2 weeks duration.	Wet: Less than 150 to 240 days Above Normal: Less than 150 to 190 days Below Normal: Less than 150 to 175 days Dry: Less than 150 to 165 days Critical: Less than 150 to 155 days
Contra Costa Canal at Pumping Plant #1 <u>and</u> West Canal at gates of Clifton Court Forebay <u>and</u> Jones Pumping Plant <u>and</u> Cache Slough at City of Vallejo Intake <u>and</u> Barker Slough at North Bay Aqueduct Intake	Chloride	Maximum mean daily, in mg/L	All Water Year Types (Wet, Above Normal, Below Normal, Dry, Critical): 250 for all year

Location of Water Quality Objective	Parameter	Description	Water Year per Time Period or Values
Sacramento River at Emmaton	Electrical Conductivity (EC)	Maximum 14-day running average of mean daily EC millimhos per centimeter (mmhos/cm)	Wet: 0.45 from April 1 to August 15 Above Normal: 0.45 from April 1 to June 30 and 0.63 from July 1 to August 15 Below Normal: 0.45 from April 1 to June 19 and 1.14 from June 20 to August 15 Dry: 0.45 from April 1 to June 14 and 1.67 from June 15 to August 15 Critical: 2.78 from April 1 to August 15
San Joaquin River at Jersey Point	Electrical Conductivity	Maximum 14-day running average of mean daily EC (mmhos/cm)	Wet: 0.45 from April 1 to August 15 Above Normal: 0.45 from April 1 to August 15 Below Normal: 0.45 from April 1 to June 19 and 0.74 from June 20 to August 15 Dry: 0.45 from April 1 to June 14 and 1.35 from June 15 to August 15 Critical: 2.20 April 1 to until August 15
South Fork Mokelumne River at Terminus	Electrical Conductivity	Maximum 14-day running average of mean daily EC (mmhos/cm)	Wet, Above Normal, Below Normal, Dry: 0.45 from April 1 to August 15 Critical: 0.54 from April 1 to August 15
San Joaquin River at San Andreas Landing	Electrical Conductivity	Maximum 14-day running average of mean daily EC (mmhos/cm)	Wet, Above Normal, Below Normal: 0.45 from April 1 to August 15 Dry: 0.45 from April 1 to June 24 and 0.58 from June 25 to August 15 Critical: 0.87 from April 1 to August 15
San Joaquin River at and between Prisoners Point and Jersey Point	Electrical Conductivity	Fish and Wildlife Beneficial Use Objective Maximum 14-day running average of mean daily EC (mmhos/cm)	All Water Year Types (Wet, Above Normal, Below Normal, Dry, Critical): 0.44 from April 1 to May 31
San Joaquin River at Airport Way Bridge, Vernalis and San Joaquin River at Brandt Bridge Site, and Old River near Middle River and Old River at Tracy Road Bridge	Electrical Conductivity	Maximum 30-day running average of mean daily EC (mmhos/cm)	All Water Year Types (Wet, Above Normal, Below Normal, Dry, Critical): 0.7 from April 1 through August 31 and 1.0 from September 1through March 31
West Canal at mouth of Clifton Court Forebay and Delta-Mendota Canal at Jones Pumping Plant	Electrical Conductivity	Maximum monthly average of mean daily EC (mmhos/cm)	All Water Year Types (Wet, Above Normal, Below Normal, Dry, Critical):1.0 for all year

Source: SWRCB 2006

The water quality objectives for municipal and industrial water use are designed primarily to control salinity conditions in the central and southern Delta. The most restrictive salinity water quality criteria are intended to maintain a mean daily salinity of 150 mg/L as chloride for at least 150 days per year for the Contra Costa Canal Pumping Plant #1 (at Rock Slough). This facility serves the Contra Costa Water District or the City of Antioch Water Works Intake.

In addition, a maximum of 250 mg/L of salinity as chloride is maintained for the following locations: Contra Costa Canal Pumping Plant #1 (at Rock Slough), West Canal at the Clifton Court Forebay intake gates, Jones Pumping Plant approach channel, Cache Slough at the City of Vallejo intake, and Barker Slough at the North Bay Aqueduct Intake.

High salinity in irrigation water inhibits water and nutrients intake by plants, resulting in crop yield reduction. To protect salt-sensitive crops during the irrigation season, EC objectives are set in the lower Sacramento River at Emmaton; the San Joaquin River at Jersey Point, San Andreas Landing, Airport Way Bridge, and Vernalis; the Old River near Middle River and at Tracy Road Bridge; the South Fork Mokelumne River at Terminus; West Canal at the Clifton Court Forebay gates; and Delta Mendota Canal at Jones Pumping Plant.

Salinity also affects fish and wildlife habitat in the western Delta. Salinity effects are evaluated with respect to the location of "X2," the distance from the Golden Gate Bridge upstream toward the Delta, where the tidally averaged near-bottom salinity concentration of 2 ppt occurs. The X2 standard was established to improve shallow water estuarine habitat from February through June (USFWS 2008).

X2 is a constantly fluctuating position caused by the Delta freshwater (with salinity less than 2 ppt from upstream sources) and the marine tidal influence from downstream sources (with salinity greater than 2 ppt). The location of X2 is used in several water quality criteria in the Delta, including the following:

- The 2000 SWRCB Water Rights Decision 1641 (D-1641) provides the water quality objectives or the operations of the SWP and CVP includes "spring X2" criteria that require upstream reservoir releases from February through June to maintain freshwater and estuarine conditions in the western Delta to protect aquatic life.
- The 2008 USFWS Biological Opinion (USFWS 2008) includes meeting a Delta salinity requirement from September through November in wet and above-normal water years (referred to as Fall X2). Under this provision in September and October, X2 is maintained at 74 kilometer (km) in wet years, and at 81 km in above-normal water years when the preceding year was wet or above-normal based on the Sacramento Basin 40-30-30 index in the SWRCB D-1641. In November of these years, no specific X2 requirement exists; however, a requirement exists for inflow into SWP and CVP upstream reservoirs to be conveyed downstream to augment Delta outflow to maintain X2 at the same locations as in September and October. If storage increases during November under this action, the increased storage volume is to be released in December, in addition to the requirements under the SWRCB D-1641 net Delta Outflow Index.
- The X2 salinity objective for Suisun Bay was established as part of the Water Quality Control Plan of 1995 (SWRCB 1995).

Mercury

Mercury is a constituent of concern throughout California, both as total mercury and as biologically formed methylmercury. Methylation of mercury is an important step in the entrance of mercury into the food chain (EPA 2001) and can occur in both sediment and the water column. Methylmercury is absorbed more quickly by aquatic organisms than inorganic mercury, and it increases the concentration in predatory fish from eating smaller contaminated fish and invertebrates. Consumption of contaminated fish is the major pathway for human and avian exposure to methylmercury (EPA 2001). Current statewide water quality criteria for mercury were established in the CTR in 2000 (EPA 2000). These limits were set for the protection of human health, wherein total recoverable mercury limits were set for consumption of water as well as consumption of organisms.

The Sacramento River from Verona through the Delta and the lower Feather River are on the 303(d) impaired waterways list for mercury contamination (SWRCB 2011a). Mercury concentrations found in these waterways can be attributed to gold mine tailings from the upper Sacramento River, Feather River, Yuba River, and American River, from areas where mercury was used to extract gold in the nineteenth century (SWRCB 2011b). Singer et al. (2013) predicted that mercury-laden sediment will continue to be transported to the Sacramento River for the next 10,000 years. The Feather River transports to the Sacramento River much of the mercury that was released in the Sierra Nevada during gold mining operations (CV RWQCB 2010a). A portion of the contaminated sediments is deposited in Lake Oroville, preventing further transport downstream.

The Yolo Bypass conveys a significant amount of methylmercury and total mercury to the Delta. Although the Sacramento River is the primary source of mercury transported to the Delta in dry years, mercury loading from the Yolo Bypass increases in wet years and is comparable to that of the Sacramento River. Although only two-thirds of the Yolo Bypass floodplain are within the legal Delta, the entire floodplain was evaluated as part of the Delta Methylmercury TMDL (CV RWQCB 2010a). Compounding the issue of mercury contamination in the Yolo Bypass, the study noted that the Yolo Bypass has conditions conducive to the production of methylmercury, including stagnant waters and marshes with an abundance of sulfate and organic carbon (USGS 2002).

A major source of mercury transport to the Yolo Bypass is from Cache Creek. Existing mercury mine wastes have contributed relatively large mercury loading and high mercury concentrations in suspended sediment, making this area a priority for mercury reduction as part of the Delta Methylmercury TMDL (CV RWQCB 2010a).

Elevated methylmercury concentrations in the Colusa Basin Drain also are a concern (USGS 2002). The Cache Creek Settling Basin (CCSB) captures sediment and mercury transported by Cache Creek; however, sediment that is not captured is transported to the Yolo Bypass (approximately half of the sediment transported by Cache Creek). The CTR mercury criterion of 0.050 micrograms per liter for drinking water is exceeded in outflow from the CCSB (and possibly in other tributaries to Yolo Bypass); thus, when the Yolo Bypass is dominated by flows from Cache Creek, it also is expected to exceed the CTR criterion (CV RWQCB 2010a).

Mercury also is a constituent of concern for Suisun Bay and Suisun Marsh, which were placed on the 303(d) impaired waterways list (SWRCB 2011a). For Suisun Bay, a TMDL was specified in the San Francisco Bay Mercury TMDL (SFB RWQCB 2013), which was approved by EPA in February 2008, and the implementation plan is expected to attain the water quality standard by about 2028. For Suisun Marsh, a TMDL was specified in the Sacramento–San Joaquin Delta Methylmercury TMDL (CV RWQCB 2010a) and was completed in September 2012 (SFB RWQCB 2012).

The objective to control mercury concentrations in fish in the Delta has spawned the Mercury Exposure Reduction Program (MERP) Strategy, developed by the Central Valley RWQCB with the goal of pooling the resources of mercury dischargers to reduce human exposure from consuming Delta fish with high levels of mercury (Delta Conservancy 2016). MERP was included as part of an amendment to Basin Plan for the Sacramento River and San Joaquin River Basins in 2011 (CV RWQCB 2011), and is applicable to people eating one meal of specific fish per week (32 grams per day).

The two-phase program was put into effect on October 20, 2011, and will be completed in 2030. Phase 1 consists of implementing programs to minimize pollution, implementing interim mass limits for point sources, and controlling potentially methylated, sediment-bound mercury in the Delta and the Yolo Bypass. Phase 1 also includes developing a program to control mercury in tributaries upstream. Phase 2 includes implementing control programs and monitoring compliance. In addition to the Delta Control Mercury Program, the Central Valley RWQCB designated load and waste load allocations for point sources within and to the Delta, as specified in the Basin Plan.

Nutrients

The Delta was not placed on the 303(d) impaired waterways list for nutrients (SWRCB 2011a). However, nutrients are a cause of concern in the Delta (CV RWQCB 2010b) and have been the subject of considerable discussion.

Nutrients (e.g., nitrogen and phosphorus) come from natural sources, such as weathering of rocks and soil, and from the ocean when nutrients are mixed in the water current, as well as from animal manure, atmospheric deposition, and nutrient recycling in sediment (NOAA 2014; EPA 1998). Nutrients are essential to maintaining a healthy water system. However, overenrichment of nitrogen and phosphorus can contribute to a process known as eutrophication, in which an excessive growth of macrophytes, phytoplankton, or potentially toxic algal blooms occurs. Eutrophication also may lead to a decrease of dissolved oxygen, typically at night, when plants stop producing oxygen through photosynthesis but continue to use oxygen. Severely low dissolved oxygen conditions are referred to as anoxic and may enhance methylmercury production (SFB RWQCB 2012).

A decline in pelagic fish species in the Delta, including the endangered Delta Smelt, is known as the Pelagic Organism Decline (POD), which may be related to effects from nutrients, among other stressors (Baxter et al. 2010; Sommer et al. 2007). However, unlike most water bodies where nutrients cause too much primary production, the problem affecting beneficial uses in parts of the Delta is the limited primary production needed to support fish populations.

Nutrient effects associated with the POD are also influenced by flow and other factors, including temperature, turbidity, and the presence of invasive species.

The Delta is a major source of human-made ammonium loading to Suisun Bay, which exchanges nutrients with Suisun Marsh (Senn and Novick 2014; Tetra Tech and WWR 2013). Primary sources of human-made ammonium are erosion, agricultural runoff, urban runoff, and treated effluent from wastewater treatment facilities. The Sacramento Regional Wastewater Treatment Plant (SRWTP) is the largest major point source of ammonium in the Delta, contributing 90% of the ammonium in the river from 1986 to 2005 (Jassby 2008).

Nitrogen inputs to the Delta will change because the SRWTP National Pollutant Discharge Elimination System (NPDES) Permit (No. CA0077682) includes effluent limits for nitrogen, requiring the addition of nitrification and denitrification treatment to be installed and operational by 2020. Another source of ammonium loading already has changed because the Stockton Regional Wastewater Control Facility (which discharges to the San Joaquin River) began implementing nitrification and denitrification treatment of wastewater in 2007 (SWRCB 2012).

Suisun Marsh is a water body in the San Francisco Bay that was placed on the Section 303(d) list, approved by EPA as impaired by nutrients (SWRCB 2011a). According to the Final California 2010 Integrated Report (303[d] list / 305[b] Report) Supporting Information, nutrients in Suisun Marsh can be attributed to flow regulation and modification and urban runoff and storm sewers (SWRCB 2011c). More specific sources of nutrients to Suisun Marsh include agricultural, urban, and livestock grazing drainage through tributaries, the Sacramento River and San Joaquin River through the Delta, nutrient exchange with Suisun Bay, atmospheric deposition, and discharge from the Fairfield Suisun Sewer District wastewater treatment plant (Tetra Tech and WWR 2013).

Suisun Marsh was placed on the 303(d) list, approved by EPA in 2010 for organic enrichment (SWRCB 2011a). Organic enrichment enhances microbial production and activity, such as the methylation of mercury, and the decomposition of organic matter can cause low dissolved oxygen levels (Tetra Tech and WWR 2013). Nutrients, primarily nitrogen and phosphorous, may trigger excessive growth of algae or toxic blue-green cyanobacteria. However, within the Delta, nutrients generally are recognized as being too high in concentration to be limiting (e.g., as compared to light) (Jassby et al. 2002). The secondary effects of nutrient enrichment and associated oxygen depletion most often are found in the Central Delta and South Delta near Stockton, rather than in the Sacramento River.

The Stockton Ship Channel in the Delta waterways was placed on the Section 303(d) impaired waterways list for organic enrichment and pathogens (SWRCB 2011a).

Other Discharges of Pollutants

Municipal discharges and agricultural return flows to the Sacramento and San Joaquin river watersheds and the Delta contribute other pollutants and constituents of concern that potentially could degrade water quality. Nutrients (e.g., nitrogen and phosphorus) originate from natural sources and from human-made sources, including point and non-point source discharges. Overenrichment of nitrogen and phosphorus can contribute to eutrophication and toxicity. Eutrophication also results in elevated levels of total organic carbon (TOC), a disinfection byproducts precursor. The SWRCB Policy with Respect to Maintaining High Quality of Water in California (Resolution No. 68-16) incorporates the federal antidegradation policy and restricts reductions in water quality, even if beneficial uses are protected.

Point and non-point source discharges into Delta waters have the potential to introduce and elevate the levels of other contaminants. *Cryptosporidium* and *Giardia* are two main constituents of concern that are the focus of the drinking water regulatory requirements promulgated by EPA.

Nutrient concerns for the San Luis Reservoir are of concern to the Santa Clara Valley Water District and San Benito County Water District public water supplies. These districts withdraw their CVP supplies from the Upper Pacheco Intake at the San Luis Reservoir. This supply is at risk when water elevations in the reservoir decline to very low levels during late summer and early fall. High temperatures combined with low water levels foster algae growth, which can be as much as 35 feet thick on the water surface.

Algae captured in the intake and conveyed to these water users is not suitable for municipal water treatment or agricultural drip irrigation systems. As water levels continue to decline below the level of the intake, water supply to these water users ceases. The Santa Clara Valley Water District has partnered with Reclamation and the San Luis and Delta–Mendota Water Authority to complete the San Luis Low Point Improvement Project. The purpose of the Proposed Project is to identify a feasible alternative to address the uncertainty of CVP delivery schedules and the water supply reliability problems associated with the low-point issues.

3.10.2 Discussion

Would the Proposed Project:

a) Violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface or groundwater quality?

The proposed long-term operation of the SWP would alter surface water flows in the Delta. The modified Delta surface flows would have the potential to alter Delta water quality for several constituents, including EC, salinity, and organic carbon. Changes in these constituents may exceed the applicable water quality limits established by various regulatory actions. Such exceedances may result in violating applicable water quality standards. An exceedance of applicable water quality standards would be a **potentially significant** impact. Because the proposed long-term operation of the SWP may result in a potential significant impact on water quality, both surface water hydrology and water quality will be discussed further in the EIR.

b) Substantially decrease groundwater supplies or interfere substantially with groundwater recharge such that the project may impede sustainable groundwater management of the basin?

The proposed long-term operation of the SWP would only modify surface water hydrology to a limited extent that would remain within the range of historical operations. This limited change to surface water hydrology would not result in decreasing groundwater supplies, interfere with groundwater recharge, or impede sustainable groundwater management in the SWP project area. **No impact** would occur.

c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river or through the addition of impervious surfaces, in a manner that would:

i) result in substantial on- or off-site erosion or siltation on- or off-site?

The proposed long-term operation of the SWP would not include construction of new or modification of existing SWP facilities. Therefore, the Proposed Project would not alter existing drainage or river courses, nor create additional impervious surfaces that would induce or accelerate erosion or siltation.

The proposed long-term operation of the SWP would only modify surface water hydrology to a limited extent, and therefore the water hydrology would remain within the range of historical operations. Therefore, the Proposed Project would not create substantially different flow conditions that would induce or accelerate erosion or siltation. **No impact** would occur.

d) Substantially increase the rate or amount of surface runoff in a manner that would result in flooding on- or offsite?

The proposed long-term operation of the SWP does not include construction of new or modification of existing SWP facilities. Therefore, the Proposed Project would not increase the rate or amount of surface runoff that subsequently would result in flooding.

The proposed long-term operation of the SWP would modify only surface water hydrology to a limited extent, and therefore the water hydrology would remain within the range of historical operations. This limited change to surface water hydrology would not result in flooding to areas in the SWP project area. **No impact** would occur.

e) Create or contribute runoff water that would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?

The proposed long-term operation of the SWP would not include construction of new or modification of existing SWP facilities, and therefore would not exceed the capacity of existing or planned stormwater systems or substantial sources of polluted runoff. **No impact** would occur.

f) Risk release of pollutants in flood hazard, tsunami, or seiche zones due to project inundation?

The proposed long-term operation of the SWP would not include construction of new or modification of existing SWP facilities, and therefore would not result in increased flood hazard, tsunami risk, or risk of release of pollutants because of inundation. Surface water flow resulting from the Proposed Project would remain within the range of historical conditions and no change would occur. **No impact** would occur.

g) Conflict with or obstruct implementation of a water quality control plan or sustainable groundwater management plan?

As previously discussed under item a, the proposed long-term operation of the SWP would alter surface water flows in the Delta. The modified Delta surface flows potentially could alter Delta water quality for several constituents, including EC and salinity. Changes in these constituents may exceed the applicable water quality limits established by various regulatory actions. Operation of the SWP would not result in conflict with an applicable water quality control plan. **No impact** would occur because of a conflict with an applicable water quality control plan. However, because the proposed long-term operation of the SWP would have the potential to alter both surface water hydrology and water quality, these topics will be discussed further in the EIR.

3.11 LAND USE AND PLANNING

Table 3.11-1. Potential Impacts on Land Use and Planning

ENVIRONMENTAL ISSUES	ENVIRONMENTAL IMPACT SIGNIFICANCE
X. Land Use and Planning. Would the project:	-
a) Physically divide an established community?	No Impact
b) Cause a significant environmental impact due to a conflict with any land use plan, policy, or regulation adopted for the purpose of avoiding or mitigating an environmental effect?	No Impact

Note:
"-" indicates blank cell

3.11.1 Environmental Setting

3.11.1.1 Existing Land Uses

A wide range of land uses occur in the project area. These land uses include forestry, agriculture, water, urban (including industrial, commercial, and residential), rural residential, parks and recreation, and public open spaces. The following discussion briefly describes the land uses found in each region in the project area.

Sacramento Valley Region

The Sacramento Valley Region includes Butte, Colusa, El Dorado, Glenn, Nevada, Placer, Plumas, Shasta, Sutter, Tehama, and Yuba counties (Table 3.11-2). Only Butte and Yuba counties receive SWP water supplies.

Table 3.11-2. Sacramento Valley Region Land Use and Area of Potential Effect

County	Size (approx. square mile)	Major Communities	Predominant Land Use	Potential Areas of Effect from Long-Term Operation
Butte	1,680	Biggs, Chico, Gridley, Oroville, and Paradise	• Lands within national forests (Plumas and Lassen) and the Sacramento National Wildlife Refuge • 60% agriculture uses • 12% U.S. Forest Service managed land • 1.5% BLM managed land	Wildlife refuges, SWP facilities, CVP facilities, and areas along the Feather River
Yuba	644	Marysville and Wheatland	• 46% agricultural land use • Federally owned lands including Tahoe and Plumas National Forests, and Beale Air Force Base	Areas within Yuba County Water Agency facilities that provide water for environmental and water supply purposes within the Central Valley

Notes:
BLM = Bureau of Land Management
CVP = Central Valley Project
SWP = State Water Project

San Joaquin Valley Region

The San Joaquin Valley Region includes Fresno, Kern, Kings, Madera, Merced, Stanislaus, and Tulare counties (Table 3.11-3).

Table 3.11-3. San Joaquin Valley Region Land Use and Area of Potential Effect

County	Size (approx. square mile)	Major Communities	Predominant Land Use	Potential Areas of Effect from Long-Term Operation
Kern	8,202	Bakersfield, Delano, Oildale, Ridgecrest, Wasco, Arvin, Rosamond, Shafter, and Lamont	• 85% unincorporated lands designated for agricultural uses • <6% unincorporated lands designated residential uses	SWP water service areas
Kings	1,280	Avenal, Corcoran, Hanford, and Lemoore	• 90% agricultural uses • <1% residential uses in unincorporated areas and special districts	SWP water service areas

Notes: SWP = State Water Project

Sacramento-San Joaquin Delta Region

The Delta includes Contra Costa, Sacramento, San Joaquin, Solano, and Yolo counties (Table 3.11-4).

Table 3.11-4. Delta Region Land Use and Area of Potential Effect

County	Size (approx. square mile)	Major Communities	Predominant Land Use	Potential Areas of Effect from Long-Term Operation
San Joaquin	1,426	Stockton, Tracy, Manteca, Lodi, Lathrop, Ripon, and Garden Acres	• 75% agriculture uses • 4.4% residential • 10% incorporated cities • <1% federally owned land	SWP facilities (including facilities associated with the Rock Slough Pumping Plant, the Jones Pumping Plant, the Clifton Court Forebay, and the Harvey O. Banks Pumping Plant), areas along the Delta channels that use the surface waters
Solano	910	Benicia, Dixon, Fairfield, Rio Vista, Suisun City, Vacaville, and Vallejo	• 56.5% agriculture uses • 14% incorporated cities • 1% Travis Air Force Base	SWP facilities (North Bay Aqueduct intakes at Barker Slough), areas in the Yolo Bypass and along the Delta channels that use the surface waters, and SWP water service areas

Notes: SWP = State Water Project

San Francisco Bay Area Region

The San Francisco Bay Area Region in this analysis includes Alameda, Napa, San Benito, and Santa Clara counties (Table 3.11-5).

Table 3.11-5. San Francisco Bay Area Region Predominate Land Use and Area of Potential Effect

County	Size (approx. square mile)	Major Communities	Predominant Land Use	Potential Area of Effect from Reoperation
Alameda	738	Oakland, Fremont, Hayward, Berkeley, San Leandro, Livermore, Alameda, Pleasanton, Union City, and Castro Valley	• 59% unincorporated area • Agricultural and open space uses	SWP facilities (including the SWP South Bay Aqueduct), reservoirs that store CVP or SWP water, and SWP water service areas
Napa	793	American Canyon, Calistoga, Napa, and St. Helena, and the town of Yountville	• 95% unincorporated cities • 13% federally owned land • 8% state-owned land, including Lake Berryessa and the State Cedar Rough Wilderness and Wildlife Area	SWP water service areas
San Benito	1,386	Hollister and San Juan Bautista	• 99.5% unincorporated area • 84% agricultural uses • 4% federally owned and state-owned lands, including Pinnacles National Monument, Hollister Hills State Vehicular Recreation Area, and San Juan Bautista State Historic Park	SWP facilities (including San Justo Reservoir and other facilities to convey water from San Luis Reservoir)
Santa Clara	1,306	San Jose, Sunnyvale, Santa Clara, Mountain View, Milpitas, Palo Alto, Cupertino, Gilroy, Campbell, Morgan Hill, and Saratoga	• 83% incorporated cities • < 10% federally owned and state-owned lands, including Henry W. Coe State Park	SWP facilities (including the SWP South Bay Aqueduct and CVP facilities that convey water from San Luis Reservoir) and SWP water service areas

Notes:
CVP = Central Valley Project
SWP = State Water Project

Central Coast Region

The Central Coast Region includes San Luis Obispo and Santa Barbara counties (Table 3.11-6).

Table 3.11-6. Central Coast Region Land Use and Area of Potential Effect

County	Size (approx. square mile)	Location	Predominant Land Use	Potential Areas of Effect from Long-Term Operation
San Luis Obispo	3,594	Central California. Bound on the north by Monterey County, on the east by Kern County, on the south by Santa Barbara County, and on the west by the Pacific Ocean	• 83% rural and agricultural uses • 10% surface waters	SWP facilities (including facilities associated with the Central Coast Water Authority) and SWP water service areas
Santa Barbara	2,744	Central California. Bound on the north by San Luis Obispo, on the east by Ventura County, and on the south and west by the Pacific Ocean	• 82% agricultural uses • < 3% incorporated cities	SWP facilities (including facilities associated with the Central Coast Water Authority), recreation facilities at Cachuma Lake, which stores SWP water, and SWP water service areas

Notes: SWP = State Water Project

Southern California Region

The Southern California Region includes portions of Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura counties (Table 3.11-7).

Table 3.11-7. Southern California Region Predominate Land Use and Area of Potential Effect

County	Size (approx. square mile)	Major Communities	Predominant Land Use	Potential Area of Effect from Reoperation
Los Angeles	4,083	Los Angeles, Long Beach, Glendale, Santa Clarita, Lancaster, Palmdale, Pomona, Torrance, Pasadena, East Long Angeles, and El Monte	• 50% unincorporated land designated natural resources including Los Padres and Angeles National Forests • 39% rural • 3% residential	SWP facilities and SWP water service areas
Orange	948	Anaheim, Brea, Buena Park, Costa Mesa, Garden Grove, Orange, and Santa Ana	• 70% incorporated cities • 25% open space, including federally owned lands such as the Cleveland National Forest	SWP facilities and SWP water service areas
Riverside	7,295	Riverside, Moreno Valley, Corona, Murrieta, Temecula, Hemet, Menifee, Indio, Perris, and Eastvale	• 25% residential • 28% open space, recreation land, agriculture, and wildland preservation	SWP facilities, reservoirs that store SWP water (including Diamond Valley Lake and Lake Skinner), and SWP water service areas
San Bernardino	20,106	San Bernardino, Fontana, Rancho Cucamonga, Ontario, Victorville, Rialto, Hesperia, Chino, Chino Hills, Upland, and Apple Valley	• 81% federally owned and state-owned lands including 28 BLM wilderness areas, and San Bernardino and Angeles National Forests	SWP water service areas
San Diego	4,525	San Diego, Chula Vista, Oceanside, Escondido, Carlsbad, El Cajon, Vista, San Marcos, Encinitas, and National City	• 54.4% public agency lands • 33% private lands • 5.7% tribal lands	SWP facilities, non-SWP reservoirs that store SWP water (including Dixon Lake, San Vicente, Lower Otay, and Sweetwater Reservoir)
Ventura	1,873	Oxnard, Thousand Oaks, Simi Valley, Ventura, Camarillo, Moorpark, Santa Paula, Port Hueneme, and Fillmore	• 45% federally owned and state-owned lands including Los Padres National Forest, Chumash and Sespe wilderness area, Point Mugu Naval Air Station, California State University Channel Islands, and state beach parks	Lake Piru, which stores SWP water, and SWP water service areas

Notes:
BLM = Bureau of Land Management
SWP = State Water Project

3.11.1.2 Applicable Plans

Delta Stewardship Council Delta Plan

The Delta Reform Act of 2009 created the Delta Stewardship Council (DSC), with a primary responsibility to develop and implement a legally enforceable, long-term management plan for the Delta. The California Legislature required the Delta Plan to advance the co-equal goals of protecting and enhancing the Delta ecosystem and providing for a more reliable water supply for California, and to do so in a manner to protect and enhance the Delta as an evolving place (DSC 2013).

The Delta Plan is a comprehensive, long-term management plan to achieve these goals for the Delta. The Delta Plan generally covers five topic areas and goals:

- Increased water supply reliability
- Restoration of the Delta ecosystem
- Improved water quality
- Reduced risk of flooding in the Delta
- Protection and enhancement of the Delta

The DSC does not propose to construct, own, or operate any facilities related to these five topic areas. Rather, the Delta Plan sets forth regulatory policies and recommendations that seek to influence the actions, activities, and projects of cities, counties, and other federal, State, regional, and local agencies toward meeting the goals in the five topic areas.

Delta Protection Commission Land Use and Resource Management Plan

The Delta Protection Act of 1992 created the Delta Protection Commission (DPC), to guide conservation of the Delta while focusing on agriculture, recreation, and natural resources. The act also requires the DPC to develop and implement a Land Use and Resource Management Plan for the Primary Zone of the Delta (DPC 2010).

The Land Use and Resource Management Plan provides goals and policies for land use, agriculture, natural resources, recreation and accessibility, water, levees, and utilities and infrastructure. In addition, general plans and projects in the Delta counties must be consistent with the management plan and are subject to review by the DPC.

3.11.2 Discussion

a) Physically divide an established community?

The long-term operation of the SWP would not involve construction of new facilities or modification of existing facilities. No changes to land use would occur. Therefore, the proposed long-term operation would not divide an established community. **No impact** would occur.

b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to, a general plan, specific plan,

local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?

The long-term operation of the SWP would not involve construction of new facilities or modification of existing facilities. No changes to land use would occur. Thus, the long-term operation would not conflict with an applicable land use plan, policy, or regulation.

Because the Proposed Project would result in only minor revision to SWP facility operations and would not result in conflict with flow objectives established by the SWRCB Bay-Delta Water Quality Control Plan, the Proposed Project would be consistent with the Delta Plan pursuant to 23 CCR Section 5005. **No impact** would occur.

3.12 MINERAL RESOURCES

Table 3.12-1. Potential Impacts on Mineral Resources

ENVIRONMENTAL ISSUES		ENVIRONMENTAL IMPACT SIGNIFICANCE
XII.	**Mineral Resources. Would the project:**	-
a)	Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	No Impact
b)	Result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan?	No Impact

Note:
"-" indicates blank cell

3.12.1 ENVIRONMENTAL SETTING

3.12.1.1 Construction Aggregate

The loss of access to regionally important mineral deposits because of land uses that preclude mining is one of the problems that the California Surface Mining and Reclamation Act of 1975 (SMARA) was framed to address. SMARA mandates a two-phased mineral resource conservation process called classification-designation. Under SMARA, the State Mining and Geology Board (SMGB) may designate certain mineral deposits as being regionally significant to satisfy future needs. The SMGB decision to designate an area is based on a classification report prepared by the California Geological Survey (CGS) and on input from agencies and the public.

Mineral land classification studies have been prepared for most geographic regions. Mineral land classification studies identify known and potential deposits of Portland cement concrete-grade (construction) aggregate, precious metals, and other economically valuable minerals, such as kaolin clay. The primary focus of mineral land classification is on sand, gravel, and crushed rock, which are the most important mineral commodities classed as "Construction Materials." These commodities, collectively referred to as aggregates, provide bulk and strength to Portland cement concrete, asphaltic concrete, and plaster or stucco. Aggregates also are used as road base, subbase, and fill. Aggregates normally provide from 80% to 100% of the material by volume in the above uses. Table 3.12-2 shows the mineral resource zone classification system established by CGS to indicate the location and significance of key extractive resources. Table 3.12-3 shows an overview of mineral resources in the Northern California project area, in the vicinity of SWP and CVP facilities or water bodies.

Table 3.12-2. California Geological Survey Mineral Land Classification System

Classification	Description
MRZ-1	Areas where adequate information indicates that no significant mineral deposits are present or where it is judged that little likelihood exists for their presence
MRZ-2	Areas where adequate information indicates that significant mineral deposits are present or where it is judged that a high likelihood for their presence exists
MRZ-3	Areas containing mineral deposits, the significance of which cannot be evaluated from existing data
MRZ-4	Areas where available data are inadequate for placement in any other mineral resource zone

Source: Dupras 1977

Note: MRZ = Mineral Resource Zone

Table 3.12-3. Mineral Resources in the Northern California Project Area

Project Region	Description of Mineral Resources	MRZ Classification
Bay–Delta Region	-	-
Sacramento River Sacramento County	Classification extending along the Sacramento River from the I Street bridge to Collinsville for concrete-grade aggregate	MRZ-1
San Joaquin River Sacramento County	Classification extending along the San Joaquin River from the Cosumnes River to Collinsville for concrete-grade aggregate	MRZ-1
Delta	Known aggregate deposits in Antioch, Pittsburg, Martinez, and Benicia	MRZ-2
San Joaquin Valley Region	-	-
San Luis Reservoir	Classification includes San Luis Reservoir and O'Neil Forebay	MRZ-3

Notes: MRZ = Mineral Resource Zone; "-" indicates blank cell

Sources: The Diggings 2019; Dupras 1997, 1999; Foster 2001; Shumway 1997; Butte County 2012; Stinson et al. 1987a, 1987b; Jensen and Silva 1988; Rapp et al. 1997; Higgins 1997; Clinkenbeard 1999; Cole and Fuller 1988

Aggregate mineral resources are found in various locations throughout the Central Coast and Southern California SWP service areas (CGS 2019). Rock formations that are most likely to yield economically valuable deposits of aggregate resources consist of sedimentary deposits with interbedded layers of gravel, cobble, sand, and conglomerate. In particular, the streambeds of major rivers and large streams historically have served as excellent sources of aggregate resources throughout the state.

3.12.1.2 Oil and Gas

Oil and gas also represent an economically valuable form of naturally occurring deposits in Northern California. Natural gas well fields are concentrated primarily in the center of the Sacramento and San Joaquin valleys between Redding and Modesto, along the Sacramento River, and in the Delta (DOGGR 2019).

Oil production in California began in the 1860s, starting with the McKittrick field in western Kern County, at the western edge of the San Joaquin Valley. Today, oil resources in California are concentrated primarily in Kings and Kern counties, the most important being the McKittrick, Coalinga, Kern River, Midway–Sunset, Elk Hills, and Kettleman Hills oil fields (California Department of Conservation undated). None of these oil fields is in the vicinity of SWP facilities or water bodies.

In the Central Coast and Southern California SWP service area, the Los Angeles area was a major oil producing region from the late 1800s through the 1940s. Several large oil fields also were operated in Ventura County during this period. Today, most of the oil produced in the state comes from Kern and Kings counties. Natural gas commonly is associated with oil deposits. From the late 1800s through the 1940s, natural gas was provided to major urban centers in the Central Coast and Southern California SWP service area from supplies that were produced by the oil fields. In the 1930s, exploration began for additional sources of natural gas that were independent of the oil fields.

Most of the natural gas produced in California is found in the Sacramento and northern San Joaquin valleys. Today, most of the California's natural gas needs are met by importing this commodity from other states (California Department of Conservation n.d.).

3.12.2 DISCUSSION

a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?

The proposed long-term operation of the SWP would not involve any new construction of water facilities, infrastructure, or land disturbance. Thus, no new sources of development could result in the loss of availability of economically valuable state-designated mineral resource deposits (i.e., areas designed as MRZ-2). The proposed long-term operation of the SWP would not affect the ability to recover mineral resources in any of the areas designated as MRZ-2 that are adjacent to streams or rivers considered in this analysis because such mining activities would occur either on the land side of flood protection levees or behind raised berms, or at locations that are higher in elevation and set back from the stream. **No impac**t would occur.

b) Result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan?

For the same reasons described in (a) above, the proposed long-term operation of the SWP would not result in the loss of availability of a locally important mineral resource recovery site. **No impact** would occur.

3.13 NOISE

Table 3.13-1. Potential Impacts on Noise

ENVIRONMENTAL ISSUES		ENVIRONMENTAL IMPACT SIGNIFICANCE
XII.	**Noise. Would the project result in:**	-
a)	Generation of a substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?	No Impact
b)	Generation of excessive vibration or ground-borne noise levels?	No Impact
c)	For a project located within the vicinity of a private airstrip or an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	No Impact

Note:
"-" indicates blank cell

3.13.1 ENVIRONMENTAL SETTING

The SWP includes numerous storage facilities, reservoirs, lakes, and pumping plants; four pumping-generating plants; five hydroelectric power plants; and approximately 700 miles of open canals and pipelines. Noise sources associated with operation of SWP facilities include pumping plants, lift stations, and other conveyance facilities.

3.13.1.1 Sound, Noise, and Acoustics

Sound is the mechanical energy of a vibrating object transmitted by pressure waves through a liquid or gaseous medium (e.g., air). Noise is defined as sound that is unwanted (i.e., loud, unexpected, or annoying). Acoustics is the physics of sound.

The amplitude of pressure waves generated by a sound source determines the perceived loudness of that source. A logarithmic scale is used to describe sound pressure level in terms of decibels (dB). The threshold of human hearing (near-total silence) is approximately 0 dB. A doubling of sound energy corresponds to an increase of 3 dB. In other words, when two sources at a given location are each producing sound of the same loudness, the resulting sound level at a given distance from that location is approximately 3 dB higher than the sound level produced by only one of the sources. For example, if one automobile produces a sound pressure level of 70 dB when it passes an observer, two cars passing simultaneously do not produce 140 dB; rather, they combine to produce 73 dB.

The typical human ear is not equally sensitive to all frequencies of the audible sound spectrum. As a consequence, when assessing potential noise impacts, sound is measured using an electronic filter that de-emphasizes the frequencies below 1,000 hertz (Hz) and above 5,000 Hz in a manner corresponding to the human ears' decreased sensitivity to low and extremely high frequencies instead of the frequency mid-range. This method of frequency weighting is referred to as A-weighting and is expressed in units of A-weighted decibels (dBA). All noise levels reported in this section are in terms of A-weighting. A strong correlation exists between A-weighted sound levels and community response to noise. As discussed above, doubling sound energy results in a 3-dB increase in sound. In typical noisy environments, noise-level changes of 1 to 2 dB generally are not perceptible by the healthy human ear; however, people can begin to detect 3-dB increases in noise levels. An increase of 5 dB generally is perceived as distinctly noticeable, and a 10-dB increase generally is perceived as a doubling of loudness. The following are the sound level descriptors commonly used in environmental noise analysis:

- Equivalent sound level (L_{eq}): An average of the sound energy occurring over a specified time period. In effect, the L_{eq} is the steady-state sound level containing the same acoustical energy as the time-varying sound that actually occurs during the same period. The 1-hour, A-weighted equivalent sound level is the energy average of A-weighted sound levels occurring during a 1-hour period.
- Maximum sound level (L_{max}): The highest instantaneous sound level measured during a specified period.
- L_{dn} (day-night noise level): The 24-hour L_{eq} with a 10 dB "penalty" applied during nighttime noise-sensitive hours, 10 p.m. through 7 a.m. The L_{dn} attempts to account for the fact that noise during this specific period of time is a potential source of disturbance with respect to normal sleeping hours.
- L_n (Statistical Descriptor): The noise level exceeded n% of a specific period of time, generally accepted as an hourly statistic. An L_{10} would be the noise level exceeded 10% of the measurement period.

Sound from a localized source (i.e., point source) propagates uniformly outward in a spherical pattern, and the sound level attenuates (decreases) at a rate of 6 dB for each doubling of distance from a point/stationary source. Roadways and highways and, to some extent, moving trains consist of several localized noise sources on a defined path; these are treated as "line" sources, which approximate the effect of several point sources. Sound levels attenuate at a rate of 3 dB for each doubling of distance from a line source. Therefore, noise from a line source attenuates less with distance than noise from a point source with increased distance.

3.13.1.2 Existing Noise Environment

Background noise levels in the project area vary between rural and urban settings. Based on historical measured noise levels taken at representative rural and urban settings (EPA 1971), existing 1-hour L_{eq} noise levels at the remote rural sites are assumed to be in the range of 35 to 50 dBA during the day and 30 to 40 dBA at night. Daytime noise levels at sites in small towns are assumed to be 50 to 55 dBA. Daytime noise levels at sites within 100 feet of high-volume freeways or highways are assumed to be 55 to 65 dBA (Caltrans 2013). Sources of ambient noise in the project area include traffic, agricultural equipment, boats, and aircraft. Some locations in the project area are within airport land use planning or influence areas and may experience ambient noise from aircraft arrivals and departures. Rail transportation corridors in the project area are a source of rail noise and vibration from freight and commuter trains. The influence of these sources of noise on ambient levels depends on the proximity of receivers to highways, rail corridors, airports, and developed areas.

Existing ground-borne vibration levels generally are not discernible at locations beyond the road shoulders of highways or freeways. Proposed project activities are not expected to result in perceptible levels of vibration in sensitive buildings.

3.13.1.3 Noise-Sensitive Land Uses

Noise-sensitive land uses generally are defined as locations where people reside or where the presence of elevated noise emissions could significantly affect the use of the land. Noise-sensitive land use may be near access roads that are used for substantial haul truck traffic. Typical sensitive receptors include residences, schools, hospitals, and places of worship. Noise-sensitive receptors also can include parks, where quiet conditions are important for normal conversation between park users, and outdoor use areas at businesses, such as outdoor dining areas at restaurants.

3.13.2 Discussion

a) Generation of a substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?

Because the Proposed Project would not require any construction activities, introduce new land uses, or result in population increases in the project area, no new sources of noise would be introduced as part of the proposed long-term operation of the SWP. Noise levels from existing SWP facilities would remain the same as with existing conditions. The proposed long-term operation of the SWP would not generate noise levels that would conflict with applicable general plan noise elements or noise ordinances for other counties or cities in the project area. **No impact** would occur.

b) Generation of excessive vibration or ground-borne noise levels?

Because the proposed long-term operation of the SWP would not result in new construction activities, changes to land uses, or increase the population in the area, the project would not generate any excessive vibration or ground-borne noise. Therefore, **no impact** would occur.

c) For a project located within the vicinity of a private airstrip or an airport land use plan or, where such a plan has not been adopted, within 2 miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?

The proposed long-term operation of the SWP would not introduce new land uses or increase the population in the area. Therefore, the project would not expose people residing or working in the project area to excessive noise associated with public or public use airports. **No impact** would occur.

3.14 POPULATION AND HOUSING

Table 3.14-1. Potential Impacts on Population and Housing

ENVIRONMENTAL ISSUES	ENVIRONMENTAL IMPACT SIGNIFICANCE
XIII. Population and Housing. Would the project:	-
a) Induce substantial unplanned population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?	No Impact
b) Displace substantial numbers of existing people or housing, necessitating the construction of replacement housing elsewhere?	No Impact

Note:
"-" indicates blank cell

3.14.1 ENVIRONMENTAL SETTING

3.14.1.1 Population

Numerous communities with populations ranging from thousands (e.g., Pittsburg) to a few hundred (e.g., Locke) are located throughout the project area. Most of the population resides in or near the peripheral urban areas. The following discussion briefly describes each project area segment and presents population data for 2008 and 2018, and projected population data for each region.

Sacramento-San Joaquin Delta

The Delta includes Sacramento, Yolo, Solano, San Joaquin, and Contra Costa counties (Table 3.14-2). Among the counties evaluated in the Delta, Yolo and San Joaquin counties had the highest population growth over the last 10 years (2008 to 2018), with an average annual growth rate of 1.2%, and Solano County had the lowest population growth, with an average annual growth rate of 0.6%. Between 2008 and 2018, the Delta had an average annual growth rate of 1.7%. Population growth in the Delta Region is projected to continue through 2035.

Table 3.14-2. Population Characteristics in the Delta Region

County	Population in 2008		Population in 2018	Annual Average Growth Rate (percent) [2]	Projected Population in 2035
Contra Costa County	1,015,672		1,149,363	1.1%	1,356,101
Sacramento County	1,380,172		1,529,501	0.9%	1,850,265
San Joaquin County	665,304		758,744	1.2%	941,975
Solano County	411,998		439,793	0.6%	524,285
Yolo County	192,826		221,270	1.2%	276,308
Delta Region[1]	**3,665,972**		**4,098,671**	**1.7%**	**4,948,934**

Source: DOF 2015, 2018, 2019a
Notes:
[1] Calculated sum of population for all Sacramento Valley Region counties.
[2] Calculated annual average from 2007 to 2018.

San Francisco Bay Area Region

The San Francisco Bay Area Region includes Alameda, Napa, Santa Clara, and San Benito counties in the SWP service area (Table 3.14-3). Alameda and Santa Clara counties have experienced the greatest population growth over the past decades, with an average annual growth rate of 1.1%. San Benito County had the lowest population growth, with an average annual growth rate of 0.3%. Between 2008 and 2018, the San Francisco Bay Area Region had an average annual growth rate of 1.8%. All counties in the San Francisco Bay Area Region are projected to experience population growth through 2035.

Table 3.14-3. Population Characteristics in the San Francisco Bay Area Region

County	Population in 2008	Population in 2018	Annual Average Growth Rate (percent) [2]	Projected Population in 2035
Alameda County	1,470,622	1,660,202	1.1%	1,939,941
Santa Clara County	1,725,066	1,956,598	1.1%	2,298,794
San Benito County	54,948	57,088	0.3%	72,719
Napa County	132,537	141,294	0.6%	153,636
San Francisco Bay Area Region [1]	**3,383,173**	**3,815,182**	**1.8%**	**4,465,090**

Source: DOF 2015, 2018, 2019a

Notes:

[1] Calculated sum of population for all San Francisco Bay Area Region counties.

[2] Calculated annual average from 2007 to 2018.

Central Coast Region

The Central Coast Region includes San Luis Obispo and Santa Barbara counties (Table 3.14-4). Between 2008 and 2018, Santa Barbara County had the greatest population growth, with an annual average growth rate of 0.8%. Between 2008 and 2018, the Central Coast Region had an average annual growth rate of 1.2%. Both counties are projected to have positive population growth through 2035.

Table 3.14-4. Population Characteristics in the Central Coast Region

County	Population in 2008	Population in 2018	Annual Average Growth Rate (percent) [2]	Projected Population in 2035
San Luis Obispo County	262,982	280,101	0.6%	302,046
Santa Barbara County	414,750	453,457	0.8%	503,058
Central Coast Region[1]	**677,732**	**733,558**	**1.2%**	**805,104**

Source: DOF 2015, 2018, 2019a

Notes:

[1] Calculated sum of population for all Central Coast Region counties.

[2] Calculated annual average from 2007 to 2018.

Southern California Region

The Southern California Region includes Ventura, Los Angeles, Orange, San Diego, Riverside, and San Bernardino counties (Table 3.14-5). Among these counties, between 2008 and 2018, Riverside County had the highest population growth, with an average annual growth rate of 0.8%, and Los Angeles County had the lowest population growth, with an average annual growth rate of 0.6%. Between 2008 and 2018, the Southern California Region had an average annual growth rate of 1.2%. All the counties are projected to have positive population growth through 2035.

Table 3.14-5. Population Characteristics in the Southern California Region

County	Population in 2008	Population in 2018	Annual Average Growth Rate (percent) [2]	Projected Population in 2035
Ventura County	803,572	859,073	0.6%	932,262
Los Angeles County	9,780,808	10,283,729	0.5%	10,915,099
Orange County	2,960,659	3,221,103	0.8%	3,501,088
San Diego County	2,998,477	3,337,456	1.0%	3,706,919
Riverside County	2,049,902	2,415,955	1.5%	3,001,065
San Bernardino County	1,989,690	2,174,938	0.8%	2,594,824
Southern California Region[1]	**20,583,108**	**22,292,254**	**1.2%**	**24,651,257**

Source: DOF 2015, 2018, 2019a

Notes:

[1] Calculated sum of population for all Southern California Region counties.

[2] Calculated annual average from 2007 to 2018.

3.14.1.2 Housing

Housing density in the project area varies greatly, corresponding to the variation in population density. The following subsections present housing unit numbers for 2010 and 2018, for each project area segment.

Sacramento-San Joaquin Delta Region

Among the counties evaluated in the Delta region, Yolo, San Joaquin, and Solano counties had the highest housing unit growth between 2010 and 2018, with an average annual growth rate of 0.4%, and Sacramento and Contra Costa counties had the lowest growth, with an average annual growth rate of 0.3%. Between 2010 and 2018, the Delta region had an average annual growth rate of 0.3% (Table 3.14-6).

Table 3.14-6. Housing Characteristics in the Delta Region

County	Housing Units in 2010	Housing Units in 2018	Annual Average Growth Rate (percent) [2]
Contra Costa County	400,263	413,923	0.3%
Sacramento County	555,932	570,305	0.3%
San Joaquin County	233,755	243,420	0.4%
Solano County	152,698	158,786	0.4%
Yolo County	73,908	77,138	0.4%
Delta Region[1]	1,416,556	1,463,572	0.3%

Source: DOF 2019b

Notes:

[1] Calculated sum of population for all Sacramento Valley Region counties.

[2] Calculated annual average from 2010 to 2018.

San Francisco Bay Area Region

Among the counties evaluated in the San Francisco Bay Area Region, Santa Clara and San Benito counties had the highest housing unit growth between 2010 and 2018, with an average annual growth rate of 0.6%, and Napa County had the lowest growth, with an average annual growth rate of 0.1%. Between 2010 and 2018, the San Francisco Bay Area Region had an average annual growth rate of 0.5% (Table 3.14-7).

Table 3.14-7. Housing Characteristics in the San Francisco Bay Area Region

County	Housing Units in 2010	Housing Units in 2018	Annual Average Growth Rate (percent) [2]
Alameda County	581,372	601,967	0.4%
Santa Clara County	631,920	667,970	0.6%
San Benito County	17,870	18,935	0.6%
Napa County	54,759	55,157	0.1%
San Francisco Bay Area Region [1]	1,285,921	1,344,029	0.5%

Source: DOF 2019b

Notes:

[1] Calculated sum of population for all San Francisco Bay Area Region counties.

[2] Calculated annual average from 2010 to 2018.

Central Coast Region

Between 2010 and 2018, San Luis Obispo and Santa Barbara counties had approximately the same annual average growth rate of 0.4%. Between 2010 and 2018, the Central Coast Region had an average annual growth rate of 0.4% (Table 3.14-8).

Table 3.14-8. Housing Characteristics in the Central Coast Region

County	Housing Units in 2010	Housing Units in 2018	Annual Average Growth Rate (percent) [2]
San Luis Obispo County	117,315	121,661	0.4%
Santa Barbara County	152,834	158,622	0.4%
Central Coast Region[1]	270,149	280,283	0.4%

Source: DOF 2019b

Notes:

[1] Calculated sum of population for all Central Coast Region counties.

[2] Calculated annual average from 2010 to 2018.

Southern California Region

Among the counties in the Southern California Region, Orange and Riverside counties had the highest housing unit growth, with an average annual growth rate of 0.5%. Ventura County had the lowest housing unit growth between 2010 and 2018, with an average annual growth rate of 0.2%. Between 2010 and 2018, the Southern California Region had an average annual growth rate of 0.4% (Table 3.14-9).

Table 3.14-9. Housing Characteristics in the Southern California Region

County	Housing Units in 2010	Housing Units in 2018	Annual Average Growth Rate (percent)[2]
Ventura County	281,695	288,579	0.2%
Los Angeles County	3,443,087	3,546,864	0.3%
Orange County	1,046,118	1,094,254	0.5%
San Diego County	1,164,028	1,210,138	0.4%
Riverside County	800,707	840,904	0.5%
San Bernardino County	699,637	719,911	0.3%
Southern California Region[1]	7,435,272	7,700,650	0.4%

Source: DOF 2019b

Notes:

[1] Calculated sum of population for all Southern California Region counties.

[2] Calculated annual average from 2010 to 2018.

3.14.2 DISCUSSION

a) Induce substantial unplanned population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?

The proposed long-term operation of the SWP would not result in substantial unplanned population growth in an area, either directly or indirectly. Therefore, **no impact** would occur.

b) Displace substantial numbers of existing people or housing, necessitating the construction of replacement housing elsewhere?

The proposed long-term operation of the SWP would not result in the displacement of substantial numbers of existing people or housing that would necessitate construction of replacement housing elsewhere. Therefore, **no impact** would occur.

3.15 PUBLIC SERVICES

Table 3.15-1. Potential Impacts on Public Services

ENVIRONMENTAL ISSUES	ENVIRONMENTAL IMPACT SIGNIFICANCE
XIV. Public Services. Would the project:	-
a) Result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, or the need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, to maintain acceptable service ratios, response times, or other performance objectives for any of the public services:	-
Fire protection?	No Impact
Police protection?	No Impact
Schools?	No Impact
Parks?	No Impact
Other public facilities?	No Impact

Note:
"-" indicates blank cell

3.15.1 ENVIRONMENTAL SETTING

Law enforcement in the project area is provided by city police departments in incorporated areas and by county sheriff departments in unincorporated areas. While the overarching responsibility of these agencies is to prevent and respond to criminal activity and apprehend suspects, they provide specialized services to communities, such as special weapons and tactical teams, canine units, marine patrols, and swift water rescues. The State of California (State) provides assistance to the project area through the California Department of Fish and Wildlife and the California Highway Patrol (CHP). The CHP provides traffic regulation enforcement, emergency management, and assistance on California highways, interstate highways, and other major roadways.

Fire protection in the project area is provided by a variety of public and private entities. Communities within the project area are provided fire protection, rescue, and emergency services by a combination of fire protection entities, including cities, counties, fire protection districts, and volunteer fire departments, and they also receive supplemental services from the State.

Densely populated areas are served by municipal fire departments, and rural and unincorporated areas are served largely by fire protection districts and volunteer fire departments. Rural and unincorporated areas also receive supplemental services from the State. Mutual aid agreements exist between many of these departments to ensure that sufficient personnel and equipment are available to respond to emergencies no matter where the emergency occurs.

Portions of the project area receive wildfire protection services from the California Department of Forestry and Fire Protection (CAL FIRE) (see Section 3.20, "Wildfire," for further discussion). This State agency provides emergency services (such as fire, medical, rescue, and disaster relief services) throughout California (CAL FIRE 2019).

In addition, numerous private and public schools, public parks, and libraries exist throughout the project area, which are administered and managed by a variety of federal, state, and local entities.

3.15.2 Discussion

a) Result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, or the need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, to maintain acceptable service ratios, response times, or other performance objectives for any of the public services:

Fire protection?

The proposed long-term operation of the SWP would not involve construction of new facilities or modification of existing facilities that would affect existing response times, service ratios, or other performance objectives of local fire protection services. **No impact** would occur.

Police protection?

The proposed long-term operation of the SWP would not involve construction of new facilities or modification of existing facilities that would affect existing response times, service ratios, or other performance objectives of local police protection services. **No impact** would occur.

Schools?

The proposed long-term operation of the SWP would not involve construction of new facilities or modification of existing facilities that would affect existing school services or result in increased demand or need for additional school services. **No impact** would occur.

Parks?

The proposed long-term operation of the SWP would not involve construction of new facilities or modification of existing facilities that would affect existing parks. Furthermore, the proposed long-term SWP operation would not create additional demand for parks and recreation beyond existing levels. **No impact** would occur.

Other public facilities?

The proposed long-term operation of the SWP would not affect other public facilities, services, or demand levels. **No impact** would occur.

3.16 RECREATION

Table 3.16-1. Potential Impacts on Recreation

ENVIRONMENTAL ISSUES		ENVIRONMENTAL IMPACT SIGNIFICANCE
XV.	**Recreation. Would the project:**	-
a)	Increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	No Impact
b)	Include recreational facilities or require the construction or expansion of recreational facilities, which might have an adverse physical effect on the environment?	No Impact

Note:
"-" indicates blank cell

3.16.1 ENVIRONMENTAL SETTING

3.16.1.1 Reservoirs

The 12,700-acre San Luis Reservoir is jointly managed by DWR and Reclamation and serves both the SWP and CVP. San Luis Reservoir is part of the San Luis Joint-Use Complex, which also includes O'Neill Forebay and Los Banos Creek Reservoir. San Luis Reservoir is fed by the California Aqueduct and the Delta Mendota Canal via O'Neill Forebay. Recreational opportunities at the reservoir and forebay include camping, picnicking, hiking, fishing, swimming, and boating. No designated swimming areas or beaches are available at San Luis Reservoir, but O'Neill Forebay offers swimming, boating, fishing, and camping sites. Two adjacent wildlife areas provide hunting and hiking opportunities, and an off-highway vehicle area near O'Neill Forebay provides motorized recreational opportunities.

3.16.1.2 Waterways

The lower Feather River runs through the Oroville Wildlife Area and the communities of Gridley, Live Oak, Yuba City, and Marysville before joining the Sacramento River approximately 70 miles below Lake Oroville at Verona. Recreation activities along the lower Feather River include fishing, boating, hunting, camping, swimming, wildlife viewing, and picnicking. The several miles of river near Oroville and the Oroville Wildlife Area are renowned for trout and salmon fishing. Recreation facilities along this stretch of the Feather River include public and private launch ramps, day-use facilities, camping sites, and trails.

3.16.1.3 Delta Recreational Opportunities

The Delta contains numerous parks; extensive public lands; and a complex of interconnected rivers, sloughs, and other waterways, which are affected by both freshwater inflows and tidal action and which offer a variety of water-dependent and water-enhanced recreational opportunities. Privately owned commercial marinas and resorts allow access to the waterways and other recreational opportunities and services. Private lands also provide recreational opportunities, particularly hunting.

Boating is the most popular activity in the Delta, while popular land-based recreation activities include hunting, camping, picnicking, walking for pleasure, bicycling, and viewing and photographing wildlife.

Boating and related facilities are located throughout the Delta and include launch ramps, marinas, boat rental facilities, swimming areas, camping sites, dining and lodging facilities, and marine supply stores.

One of the larger bodies of water in the Delta is the Clifton Court Forebay (CCF). Fishing is the only recreation activity that occurs in the CCF because public access is restricted. Two marinas are near the CCF. Rivers End Marina and Storage is at the north end of Lindeman Road. Lazy M Marina is just east of Byron Highway, approximately 0.75 mile west of the intake canal that leads to the Harvey O. Banks Pumping Plant.

Suisun Marsh

Suisun Marsh provides water-related activities, including waterfowl hunting, boating, kayaking, hiking, wildlife viewing, fishing, and hunting. Water-related recreation occurs in the two major channels (Montezuma and Suisun sloughs) and in several moderately sized channels (Cordelia, Denverton, Nurse, and Hill sloughs). Duck hunting generates the most frequent recreation-related visits to Suisun Marsh.

Fishing in the Delta

The Delta supports regionally important recreational fisheries consisting of a variety of resident and migratory fish. Sport fish species known to occur in the Delta attract anglers to this location, and the species include White Sturgeon, White Catfish, Striped Bass, Largemouth Bass, and Chinook Salmon.

The majority of recreation-related fishing in the San Francisco Bay Estuary is sturgeon fishing, especially in San Pablo and Suisun bays. Fishing for White Sturgeon is limited to three sturgeons per person each year, with a daily bag limit of one fish per day and a size limit of 40 to 60 inches (from the nose tip to the fork in the tail) (CDFW 2019a). White Sturgeon fishing is not allowed in the San Francisco Bay from March 16 through December 31. Because of their life history, geographic distribution, and large size, white sturgeon have a lower vulnerability to entrainment into water diversions than many of the other fish inhabiting the Delta. Green Sturgeon fishing is not allowed at any time.

Striped Bass angling occurs throughout the year; however, fishing localities vary seasonally in accordance with the Striped Bass migratory pattern. In winter, Striped Bass are found from the San Francisco Bay throughout the Delta. By March, the bulk of the population is spread throughout the Delta and as far north as Colusa and Princeton on the Sacramento River. In summer and fall, Striped Bass fishing reaches its peak in the San Francisco Bay (CDFW 2018). Charter boat operators and private boaters fish for Striped Bass in the San Francisco, San Pablo, and Suisun bays; in the Delta; and in the upper Sacramento River. Shoreline fishing is popular along the Sacramento River from Courtland to Colusa in spring and along the San Joaquin River near Stockton in spring and fall. Striped Bass is limited to two fish per day per person, with a minimum size limit of 18 inches (CDFW 2019a).

Black Bass angling is possible all year, but is limited to five fish per day per person, with a minimum size limit of 12 inches (CDFW 2019b). In addition, the Delta is one of the most productive trophy bass fisheries in the nation, and numerous bass tournaments are held in the Delta throughout the year, including several corporate-sponsored tournaments. In 2018, 131 fishing contests with a total of approximately 8,400 participants were held in the Delta (CDFW 2019c). Approximately 18,000 Black Bass were caught during these contests (CDFW 2019c).

Section 3.4, "Biological Resources," describes these fish populations and their habitat found in the Delta in further detail.

3.16.1.4 Salmon Fishing along the Northern California Coast

Chinook Salmon, Coho Salmon, and steelhead are the primary recreation-related fish species found along the Pacific Coast of Northern California. Pacific salmon fisheries are managed by the Pacific Fishery Management Council (PFMC) from 3 to 200 nautical miles offshore (PFMC 2019). Along the California coast, salmon fisheries are managed by the California Department of Fish and Wildlife (CDFW) from 0 to 3 nautical miles offshore, governed by regulations that generally are similar to those applied by the PFMC. The PFMC analyzes the status of the fisheries each year and defines the length of the fishing season and minimum fish sizes allowed to be caught for commercial, recreational, and tribal salmon fishing activities. In general, recreation-related fishing for ocean salmon is open from May through October. The daily bag and possession limit is two salmon of any species, except Coho Salmon, with a minimum size limit of 20 inches (CDFW 2019a).

3.16.2 Discussion

a) Increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?

The proposed long-term operation of the SWP would not affect existing recreational facilities or cause substantial physical deterioration of recreational facilities. The Proposed Project would not introduce new land uses or increase the population of the project area, and would not increase the use of existing regional parks or other recreational facilities.

The proposed long-term operation of the SWP would not result in a shift in use of the area's recreational facilities to other existing regional recreational facilities. The proposed long-term operation of the SWP would not include construction activities that could affect recreation experiences by impairing access, generating noise, or creating negative visual effects.

As discussed in Section 3.10, "Hydrology and Water Quality," the proposed long-term operation of the SWP would remain within the historical range of past SWP operations. These changes would not result in a notable difference in Oroville Lake surface elevations or flows in the Sacramento River downstream from the Feather River confluence. Hydrodynamic conditions in the Delta would not be altered by the proposed long-term operation of the SWP in a manner that would reduce existing recreational opportunities. Therefore, proposed long-term operation of the SWP would not affect water-based recreational opportunities, including fishing, swimming, and boating, from occurring on Oroville Lake, the lower Sacramento River, or the Delta.

DWR proposes to continue implementation of predator control in the CCF. Predator control could result in mortality of recreationally important fish species (i.e., Striped Bass and Black Bass), but these controls would be limited to the CCF and would not result in the loss of individuals elsewhere in the

Delta or affect recreational fishing on a regional or Delta-wide basis. CDFW would continue to maintain regulations to promote sport fishing and would allow reasonable public angling opportunities. These regulations would remain in effect and would continue to provide protection of game fish found in the Delta.

Section 3.4, "Biological Resources," concludes that the proposed long-term operation of the SWP could affect migratory habitat for special-status anadromous species and could increase the entrainment potential of special-status or commercially or recreationally important migratory or resident fish species.

These changes potentially could substantially affect habitat conditions, and the increased entrainment potential could affect individuals and populations substantially and directly. However, the numbers of recreationally important fish species, such as Striped Bass, are abundant and are not showing adverse effects associated with the operations of the SWP. Therefore, potential effects on special-status and commercially and recreationally important fish species, including Striped Bass, Largemouth Bass, Smallmouth Bass, Spotted Bass, and American Shad, will not be discussed further.

The proposed long-term operation of the SWP would not substantially affect recreational fishing opportunities for these species. **No impact** would occur.

b) Include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?

The proposed long-term operation of the SWP would not involve construction of new or expansion of existing recreational facilities. In addition, the project would not increase the population of the project area by introducing new housing or employment opportunities that would result in construction or expansion of recreational facilities. Therefore, **no impact** would occur.

3.17 TRANSPORTATION/TRAFFIC

Table 3.17-1. Potential Impacts on Transportation and Traffic

	ENVIRONMENTAL ISSUES	ENVIRONMENTAL IMPACT SIGNIFICANCE
XVII.	**Transportation. Would the project:**	-
a)	Conflict with a program plan, ordinance, or policy addressing the circulation system, including transit, roadway, bicycle and pedestrian facilities?	No Impact
b)	Would the project conflict or be inconsistent with CEQA Guidelines section 15064.3, subdivision (b)?	No Impact
c)	Substantially increase hazards due to a geometric design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	No Impact
d)	Result in inadequate emergency access?	No Impact

Note:
"-" indicates blank cell

3.17.1 ENVIRONMENTAL SETTING

This section describes the environmental and regulatory setting and analyzes the Proposed Project's effects on transportation and circulation.

The roadway system in the project area contains numerous local streets as well as State and federal highways and freeways, all with varying capabilities and service levels. The U.S. Interstate Highway and U.S. Highway System are assigned at the national level. The evenly numbered highways run east to west, and the odd numbered highways run north to south. California has 21 Interstate highways and seven U.S. highways. Several major Interstate highways either cross or are in close proximity to the project area, including the following:

- **U.S. Route 101:** U.S. 101 was established in 1926 and stretches 1,540 miles, from Los Angeles north to Olympia, Washington. From Southern California to the San Francisco Bay Area, it follows much of the route of El Camino Real, the "royal road" of California's Spanish and Mexican-era missions, while north of San Francisco it becomes the famed Redwood Highway (Caltrans 2011).
- **Interstate 5:** I-5 travels north to south through the Central Valley, parallel to the Delta's Mendota Canal and the California Aqueduct. The entire length of I-5 is 796.8 miles.
- **Interstate 80:** I-80, connects San Francisco through Sacramento over the Sierra Nevada. It was the first California freeway opened under the Federal Highway Act (Caltrans 2011)

The California State Route System is managed by the California Department of Transportation (Caltrans) and designated by the California State Legislature. State Route (SR) 70, SR 99, SR 138, SR 152, and SR 299 are the major highways that either cross or are closely located to the project area, and are described as follows:

- **State Route 70:** SR 70 begins north of Sacramento and runs north through Sutter, Yuba, Butte, Plumas and Lassen counties. SR 70 has a portion that is a State Scenic Highway, where it turns northeast from Sacramento into the mountains, eventually running east out of California.
- **State Route 99:** SR 99 is a north-south state highway stretching almost the entire length of the Central Valley for 425 miles.
- **State Route 138:** SR 138 is an east-west state highway that follows the northern foothills of the San Gabriel Mountains. It was constructed in 1934 and is approximately 105 miles long.
- **State Route 152:** SR 152 is an east-west state highway and is approximately 104 miles long. It begins west of Highway 1 in Watsonville and ends at SR 99 in the Central Valley.
- **State Route 299:** SR 299 is an east-west route in northern California that is approximately 306 miles long. A part of SR 299 is known as the Trinity Scenic Byway.

The roadway systems in the project vicinity are regulated by federal and State agencies, as follows:

- The Federal Highway Administration (FHWA) coordinates the highway transportation program in cooperation with states and other partners to enhance the country's safety, economic vitality, quality of life, and environment. FHWA has programs that provide federal financial assistance to states for construction and improvement of the National Highway System, including urban and rural roads and bridges. This program provides funds for general improvements and development of safe highways and roads (FHWA 2018).
- Caltrans is responsible for operating and maintaining the State highway system. In the vicinity of the project area, several of the major highways and freeways, exit and entrance ramps, and intersections fall under the jurisdiction of Caltrans (Caltrans 2018).
- The California Transportation Commission (CTC) is responsible for the programming and allocating of funds for construction of highway, passenger rail, and transit improvements throughout California. The CTC also advises and assists the Secretary of the California State Transportation Agency and Legislature in formulating and evaluating State policies and plans for California's transportation programs. Furthermore, the CTC is an active participant in the initiation and development of State and federal legislation that seeks to secure financial stability for the State's transportation needs (CTC 2019).

Numerous regional agencies work with local jurisdictions to address regional transportation issues, including the Council of Governments, Association of Governments, and regional transportation commissions and authorities. These regional agencies often are responsible for developing policies, planning, and securing funding for transportation and transit facilities.

Generally, State agencies that are involved with the location or construction of facilities for the production, generation, storage, treatment, or transmission of water are not subject to local regulations. Inconsistency with local transportation regulations is not considered to be an adverse effect on the environment. The project area covers multiple counties with multiple cities throughout California. All of these counties and cities have General Plans that contain transportation and circulation elements, including policies to facilitate their respective Congestion Management Plans as well as local and regional transportation planning.

3.17.2 DISCUSSION

a) Conflict with a program plan, ordinance, or policy addressing the circulation system, including transit, roadway, bicycle and pedestrian facilities?

The proposed long-term operation of the SWP would not involve construction of new or modification of existing SWP facilities that would require construction employees or result in the need for additional operations and maintenance employees. Therefore, the project would not conflict with any program plan, ordinance, or policy addressing the circulation system, including transit, roadway, bicycle, and pedestrian facilities. **No impact** would occur.

b) Would the project conflict or be inconsistent with CEQA Guidelines section 15064.3, subdivision (b)?

The proposed long-term operation of the SWP would not involve construction of new or modification of existing SWP facilities that would conflict or be inconsistent with Section 15064.3(b) of the State CEQA Guidelines. This new CEQA guideline codifies a switch from Level of Service to Vehicles Miles Traveled as the metric for transportation impact analysis. **No impact** would occur.

c) Substantially increase hazards due to a geometric design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?

The proposed long-term operation of the SWP would not involve construction of new or modification of existing SWP facilities. Therefore, the project would not include any change to roadway design in the area or introduce incompatible uses. **No impact** would occur.

d) Result in inadequate emergency access?

The proposed long-term operation of the SWP would not require any construction activities or changes in land uses that would affect emergency response access or response time. Therefore, no impact would occur.

3.18 TRIBAL CULTURAL RESOURCES

Table 3.18-1. Potential Impacts on Tribal Cultural Resources

ENVIRONMENTAL ISSUES	ENVIRONMENTAL IMPACT SIGNIFICANCE
XVIII. Tribal Cultural Resources. Would the project cause a substantial adverse change in the significance of a tribal cultural resource, defined in Public Resources Code section 21074 as either a site, feature, place, cultural landscape that is geographically defined in terms of the size and scope of the landscape, sacred place, or object with cultural value to a California Native American tribe, and that is:	-
a) Listed or eligible for listing in the California Register of Historical Resources, or in a local register of historical resources as defined in Public Resources Code section 5020.1(k), or	No Impact
b) A resource determined by the lead agency, in its discretion and supported by substantial evidence, to be significant pursuant to criteria set forth in subdivision (c) of Public Resources Code Section 5024.1. In applying the criteria set forth in subdivision (c) of Public Resources Code Section 5024.1, the lead agency shall consider the significance of the resource to a California Native American tribe.	No Impact

Note:
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3.18.1 ENVIRONMENTAL SETTING

Assembly Bill 52 requires the lead agency to begin consultation with any California Native American tribe that is traditionally and culturally affiliated with the geographic area of the proposed project if (1) the California Native American tribe requested to the lead agency, in writing, to be informed by the lead agency through formal notification of proposed projects in the geographic area that is traditionally and culturally affiliated with the tribe and (2) the California Native American tribe responds, in writing, within 30 days of receipt of the formal notification and requests the consultation (Public Resources Code Section 21080.3.1[d]).

3.18.1.1 Native American Consultation

Letters were sent by certified mail, return receipt, on May 3, 2019, to 16 California Native American Tribes that had requested formal notification of proposed projects from DWR under Assembly Bill 52: Barona Band of Mission Indians, Big Pine Paiute Tribe of the Owens Valley, Fernandeño Tataviam Band of Mission Indians, Ione band of Miwok Indians, Karuk Tribe, Mechoopda Indian Tribe of Chico Rancheria, Middletown Rancheria of Pomo Indians of California, Pit River Tribe, San Luis Rey Band of Mission Indians, San Manuel Band of Mission Indians, Shasta Indian Nation, Tongva Ancestral Territorial Tribal Nation, United Auburn Indian Community of the Auburn Rancheria, Wilton Rancheria, Wintu Tribe of Northern California and Toyon-Wintu Center, and Yocha Dehe Wintun Nation.

Green receipts were received from 15 of the Tribes. The letter to the Wintu Tribe of Northern California was sent twice and returned twice, even though a phone call following the initial return of the letter confirmed that the address was correct. Six Tribes responded to DWR's letter with a letter or email. Five of the Tribes (Fernandeño Tataviam Band of Mission Indians, Karuk Tribe, United Auburn

Indian Community of the Auburn Rancheria, Wilton Rancheria, and Yocha Dehe Wintun Nation) requested consultation on the Proposed Project, while the sixth Tribe, San Manuel Band of Mission Indians, indicated no concerns and that they did not require additional consultation pursuant to CEQA.

DWR met with Wilton Rancheria on June 17, 2019. Letters acknowledging requests for consultation were sent on June 28, 2019, to the Fernandeño Tataviam Band of Mission Indians, Karuk Tribe, United Auburn Indian Community of the Auburn Rancheria, and Yocha Dehe Wintun Nation. DWR met with the Yocha Dehe Wintun Nation on September 6, 2019. DWR is currently reaching out to the Fernandeño Tataviam Band of Mission Indians, Karuk Tribe, and United Auburn Indian Community of the Auburn Rancheria.

3.18.2 Discussion

a) Listed or eligible for listing in the California Register of Historical Resources, or in a local register of historical resources as defined in Public Resources Code section 5020.1(k), or

b) A resource determined by the lead agency, in its discretion and supported by substantial evidence, to be significant pursuant to criteria set forth in subdivision (c) of Public Resources Code Section 5024.1. In applying the criteria set forth in subdivision (c) of Public Resources Code Section 5024.1, the lead agency shall consider the significance of the resource to a California Native American tribe.

On the basis of consultations with California Native American Tribes, it is determined that proposed long-term operation of the SWP will not cause a substantial adverse change in the significance of a tribal cultural resource, defined in Public Resources Code section 21074 as either a site, feature, place, cultural landscape that is geographically defined in terms of the size and scope of the landscape, sacred place, or object with cultural value to a California Native American tribe. Therefore, **no impacts on tribal cultural resources would occur**.

3.19 UTILITIES AND SERVICE SYSTEMS

Table 3.19-1. Potential Impacts on Utilities and Service Systems

ENVIRONMENTAL ISSUES	ENVIRONMENTAL IMPACT SIGNIFICANCE
XIX. Utilities and Service Systems. Would the project:	-
a) Require or result in the relocation or construction of new or expanded water, wastewater treatment or storm water drainage, electric power, natural gas, or telecommunications facilities, the construction or relocation of which could cause significant environmental effects?	No Impact
b) Have sufficient water supplies available to serve the project and reasonably foreseeable future development during normal, dry, and multiple dry years?	No Impact
c) Result in a determination by the wastewater treatment provider that serves or may serve the project that it has adequate capacity to serve the project's projected demand, in addition to the provider's existing commitments?	No Impact
d) Generate solid waste in excess of State or local standards, or in excess of the capacity of local infrastructure, or otherwise impair the attainment of solid waste reduction goals?	No Impact
e) Comply with federal, State, and local management and reduction statutes and regulations related to solid waste?	No Impact

Note:
"-" indicates blank cell

3.19.1 ENVIRONMENTAL SETTING

3.19.1.1 Water Supply

Water service providers in the project area include cities and counties, special districts, and private utilities. These water service providers range in size from those with a few service connections to others with thousands of connections. These providers obtain their water from surface water and groundwater, or a combination of these sources. The amount of water available to these providers is defined by water rights, water contract agreements, groundwater pumping limitations, and the infrastructure required to treat, pump, and deliver water.

3.19.1.2 Wastewater Collection, Conveyance, and Treatment

Wastewater generated in the project area is handled by sanitary sewer systems, treatment plants, and individual septic systems. Municipal and industrial wastewater typically is transported to a treatment facility and treated, and then the treated effluent is discharged into a receiving water body (i.e., rivers, streams, creeks, and sloughs). In some rural areas where sewer service is unavailable, residents and businesses use on-site septic systems. Treatment plants for individual non-industrial developments also exist in some areas to treat local wastewater from residential developments, mobile home parks, apartment complexes, and resorts. Methods of disposal include evaporation and percolation ponds or application to irrigated agricultural lands. Recycled effluent also is used for industrial purposes or agricultural irrigation during the summer months. In some cases, municipalities may provide wastewater collection infrastructure and services that discharge to regional facilities owned and operated by another municipality.

3.19.1.3 Solid Waste

Municipal governments in the project area collect solid waste or contract with private franchisers for collection and transport to transfer stations and landfills. Cities and counties are responsible for maintaining their own solid waste facilities, including transfer stations, disposal sites, and resource recovery facilities. They may own and/or operate them, contract with each other, or contract with a private company to provide or operate facilities. A solid waste facility, site, or operation may include one or more waste handling activities (units). Cities and counties must routinely inspect active and closed solid waste facilities to ensure compliance with applicable State minimum standards and permit conditions. The California Department of Resources Recycling and Recovery (CalRecycle) administers and provides oversight for all State-managed, non-hazardous waste handling and recycling programs. CalRecycle regulates and inspects California's active and closed solid waste landfills, as well as materials recovery facilities, solid waste transfer stations, and compost facilities.

3.19.1.4 Electrical, Natural Gas, and Communications

Power transmission facilities were developed in response to population growth in communities surrounding the project area segments. Electricity is generated through a combination of energy sources, including natural gas-fired plants, hydroelectric facilities, renewable resources (i.e., biomass, solar, wind, and geothermal), and coal.

Electrical service providers in the project area consist of investor-owned providers, publicly owned providers, joint utility agencies, rural cooperatives, and self-generators. In addition, the Western Area Power Agency markets and transmits wholesale electricity throughout the project area from multi-use water projects and hydroelectric power plants operated by Reclamation and the U.S. Army Corps of Engineers (see Section 3.6, "Energy," for further discussion of hydroelectric facilities).

Natural gas service providers in the project area consist of investor-owned providers, publicly owned providers, and private producers. Natural gas pipelines distribute natural gas to communities throughout the project area.

Communication infrastructure in the region includes underground cable and fiber optic lines, and communication and transmission towers.

3.19.2 Discussion

a) Require or result in the relocation or construction of new or expanded water, wastewater treatment or storm water drainage, electric power, natural gas, or telecommunications facilities, the construction or relocation of which could cause significant environmental effects?

The proposed long-term operation of the SWP would not involve construction of any new water facilities or infrastructure. The Proposed Project would not involve housing development or other activities that would create a need for new or expanded water, wastewater treatment, or stormwater drainage, electric power, natural gas, or telecommunications facilities. **No impact** would occur.

b) Have sufficient water supplies available to serve the project and reasonably foreseeable future development during normal, dry and multiple dry years?

The proposed long-term operation of the SWP would not involve housing development or other activities that would result in water use. No changes in land use (i.e., conversion from agricultural land to non-agricultural land) are anticipated because of the Proposed Project. The continued operation and maintenance of SWP facilities would not increase demand for water supplies. **No impact** would occur.

c) Result in a determination by the wastewater treatment provider that serves or may serve the project that it has adequate capacity to serve the project's projected demand, in addition to the provider's existing commitments?

The proposed long-term operation of the SWP would not involve housing development or other activities that would generate wastewater. Therefore, the Proposed Project would not use any provider's existing wastewater capacity or require construction of new wastewater plants or sewer lines to serve the Proposed Project. **No impact** would occur.

d) Generate solid waste in excess of State or local standards, or in excess of the capacity of local infrastructure, or otherwise impair the attainment of solid waste reduction goals?

The proposed long-term operation of the SWP would not involve any activities that would generate solid waste. Therefore, the Proposed Project would not generate solid waste in excess of State or local standards or use any existing landfill capacity. **No impact** would occur.

e) Comply with federal, State, and local management and reduction statutes and regulations related to solid waste?

The proposed long-term operation of the SWP would not generate any solid waste. **No impact** would occur.

3.20 WILDFIRE

Table 3.20-1. Potential Impacts on Wildfire

ENVIRONMENTAL ISSUES	ENVIRONMENTAL IMPACT SIGNIFICANCE
XIX. Wildfire. If located in or near State Responsibility Areas or lands classified as very high fire hazard severity zones, would the project:	-
a) Substantially impair an adopted emergency response plan or emergency evacuation plan?	No Impact
b) Due to slope, prevailing winds, and other factors, exacerbate wildfire risks and thereby expose project occupants to pollutant concentrations from a wildfire or the uncontrolled spread of a wildfire?	No Impact
c) Require the installation or maintenance of associated infrastructure (such as roads, fuel breaks, emergency water sources, power lines or other utilities) that may exacerbate fire risk or that may result in temporary or ongoing impacts on the environment?	No Impact
d) Expose people or structures to significant risks, including downslope or downstream flooding or landslides, therefore of runoff, post-fire slope instability, or drainage changes?	No Impact

Note:
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3.20.1 Environmental Setting

3.20.1.1 Wildfire Classifications

Fires are classified by where they burn in the fuel strata: surface fires, understory fires, and crown fires (California Forest Stewardship Program 2015). Surface fires are the most common. Depending on the fuels, weather, and topography, these fires can be low to high intensity. Understory fires have flame lengths of up to 10 feet. They consume surface fuels, small trees, brush, and the lower branches of overstory trees. Crown fires reach into the crowns of trees with flame lengths that are more than 10 feet.

3.20.1.2 Fire Season

Fire season is the period when fires are expected to occur, based on knowledge of long-term climate patterns. The typical fire season in California is from May to November, and the most intense fires occur in late September and October. The fire season has been expanding and is now about 70 days longer than 40 years ago (California Forest Stewardship Program 2015).

3.20.1.3 Wildfire Behavior

Wildland fire behavior is based on three primary factors: topography, weather, and fuels. This section briefly describes how each of these factors influences wildfire behavior.

Topography

Topographic features such as slope and aspect influence a fire's intensity, direction, and rate of spread. Fires burning in flat or gently sloping areas tend to burn more slowly and spread in wider ellipses than fires on steep slopes. Streams, rivers, and canyons can channel local diurnal and general winds, which can accelerate the fire's speed and affect its direction, especially during foehn (a warm, dry, and usually strong wind) events (California Forest Stewardship Program 2015).

Weather

Weather conditions influence the potential for fire ignition, rates of spread, intensity, and the direction(s) in which a fire burns. Temperature, relative humidity, and wind are the variables used to predict fire behavior. Coastal areas generally have a cool, stable temperature regime, and this marine influence can reduce fire hazards. With increasing distance from the ocean, the marine influence is less pronounced, and inland areas experience wider variations of temperature and lower humidity.

Wind plays a role in the flammability of fuels by removing moisture through evaporation, preheating fuels in a fire's path, and increasing spotting distances (the distance at which a flying ember might ignite a spot fire). Winds blowing more than 20 feet above the ground can carry embers downwind, causing spot fires. Fires during foehn events can result in extreme fire behavior because they are particularly strong and dry, thus reducing fuel moistures. This leads to easier ignitions and increased fire intensity and rate of spread (California Forest Stewardship Program 2015).

Fuels

Vegetation usually provides most of the fuel that feeds wildfire. The volume, character, distribution, and arrangement of vegetation all greatly influence fire behavior. Moisture content is critical to how easily a fire burns. Larger fuels take longer to absorb or lose moisture, while drier fuel fires generally spread faster, are more intense, and are consumed faster (California Forest Stewardship Program 2015).

3.20.1.4 Fire Hazard Severity Zones

Fire prevention areas considered to be under state jurisdiction are referred to as State Responsibility Areas, or SRAs, and the California Department of Forestry and Fire Protection (CAL FIRE) is responsible for vegetation fires within SRA lands.[4] In general, SRA lands contain trees producing or capable of producing forest products (timber, brush, undergrowth, and grass), whether of commercial value or not, that provide watershed protection for irrigation or for domestic or industrial use or lands in areas that are principally used or that are useful for range or forage purposes. In 2018, CAL FIRE managed 31 million acres of SRA land (CAL FIRE 2019).

Fire hazard severity zones are measured qualitatively based on vegetation, topography, weather, crown fire potential (a fire's tendency to burn upward into trees and tall brush), and ember production and movement within the area in question. CAL FIRE uses these factors to define three fire hazard levels for SRAs: moderate, high, and very high.

[4] California Public Resources Code (PRC) Sections 4125–4127 define a State Responsibility Area as land in which the financial responsibility for preventing and suppressing wildland fire resides with the State of California.

3.20.1.5 California Department of Forestry and Fire Protection Services

CAL FIRE’s jurisdiction extends throughout the state. Its emergency response and resource protection capability consist of approximately 6,100 full-time fire professionals, foresters, and administrative employees; 2,600 seasonal firefighters; 105 California Conservation Corps firefighters; 600 Volunteers In Prevention; and 3,500 inmates and wards (CAL FIRE 2019).

CAL FIRE responds to approximately 6,000 wildland fires that burn on average over 260,000 acres each year (CAL FIRE 2019). Firefighting actions frequently involve helicopter transport of water from reservoirs located close to wildfires in the project area, including reservoirs owned by the U.S. Bureau of Reclamation and DWR.

Individual CAL FIRE strategic fire plans document and assess the fire conditions within each of CAL FIRE’s 21 units and six contract counties.[5] Strategic fire plans include stakeholder contributions and priorities; identify strategic areas for pre-fire planning and fuel treatment; coordinate CAL FIRE’s pre-fire activities with adjacent CAL FIRE units, National Forests, and local collaborators; and provide the foundation for planning, prioritizing, and funding unit projects. The project area falls within 16 CAL FIRE units and five contract counties. The counties within each unit in the project area are shown in Table 3.20-2, along with the number of battalions and stations within each unit.

3.20.2 Discussion

a) Substantially impair an adopted emergency response plan or emergency evacuation plan?

The proposed long-term operation of the SWP would not involve any new construction of water facilities, infrastructure, or land disturbance that would place new buildings or result in roadway closures that could impede emergency response or evacuation plans. Continued operation of the SWP would not involve any activities that would impede emergency response or evacuation plans. **No impact** would occur.

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[5] Kern, Los Angeles, Marin, Orange, Santa Barbara, and Ventura counties contract with CAL FIRE to provide initial response to fires on SRA lands. CAL FIRE provides funding for fire protection services in these six counties, including the wages of suppression crews and funding for maintenance of firefighting facilities, infrastructure improvements, and equipment.

Table 3.20-2. CAL FIRE Units within the Project Area

Unit	County[1]	SRA Acreage	Battalions	Stations	Region
Los Angeles[3]	Los Angeles	468,800	22	174	Southern California Region
Orange[4]	Orange and portions of Riverside and San Diego	113,000	6	72	Southern California Region
Riverside[5]	Riverside and portions of Orange and San Diego	547,400	9	94	Southern California Region
San Bernardino	Inyo, Mono, San Bernardino	895,000	5	13	Southern California Region
San Diego	Imperial, San Diego	1.2 million	7	18	Southern California Region
San Luis Obispo	San Luis Obispo	1.5 million	6	48	Central Coast Region
Santa Barbara	Santa Barbara	3.4 million	2	9	Central Coast Region
Santa Clara	Alameda, Contra Costa, San Joaquin, Santa Clara, Stanislaus	1.6 million	8	12	Delta Region San Francisco Bay Area Region
Sonoma-Lake-Napa	Colusa, Lake, Napa, Solano, Sonoma, Yolo	2.3 million	10	20	Delta Region, San Francisco Bay Region
Tulare	Tulare	603,500	4	8	San Joaquin River Region
Ventura	Ventura	353,400	5	32	Southern California Region

SRA = State Responsibility Area

Source: CAL FIRE 2018

Notes:

1 The information provided for each county was found in each county's strategic fire plan.

2 The number of stations was not provided within the unit strategic fire plan.

3 The Los Angeles County Fire Department operates functionally as a unit of the California Department of Forestry and Fire Protection (CAL FIRE) and is responsible for all strategic fire plan activities within the county.

4 The Orange County Fire Authority is contracted by the State to provide all aspects of wildland fire management for SRA lands within Orange County and for designated adjacent SRA lands in both Riverside and San Diego counties.

5 The Riverside Unit provides wildland fire management to the majority of Riverside County and to 2,630 acres of SRA lands in Orange County and 620 acres of SRA lands in San Diego County.

b) Due to slope, prevailing winds, and other factors, exacerbate wildfire risks and thereby expose project occupants to pollutant concentrations from a wildfire or the uncontrolled spread of a wildfire?

In general, the use of construction equipment and diesel fuel can pose a wildfire risk because vehicle mufflers, combustion engines, gasoline-powered tools, and other equipment can produce a spark, fire, or flame. The proposed long-term operation of the SWP would not involve any new construction of water facilities, infrastructure, or land disturbance that could pose a wildfire risk.

Some SWP facilities are located in rural areas where a high fire hazard risk exists because of the surrounding terrain and amount of vegetation. As previously stated, CAL FIRE manages State Responsibility Areas, and the U.S. Forest Service provides wildfire protection, both independently and cooperatively with CAL FIRE. In addition, the U.S. Forest Service and Bureau of Land Management provide resource management and fire protection on portions of federal lands. The proposed long-term operation of the SWP would not include any actions that would increase the probability of a wildland fire. Therefore, the Proposed Project would not exacerbate wildfire risks or cause the uncontrolled spread of wildfire. **No impact** would occur.

c) Require the installation or maintenance of associated infrastructure (such as roads, fuel breaks, emergency water sources, power lines, or other utilities) that may exacerbate fire risk or that may result in temporary or ongoing impacts on the environment?

The proposed long-term operation of the SWP would not involve any new construction of water facilities, infrastructure, or land disturbance. The proposed long-term operation of the SWP would not require installation or maintenance of infrastructure that may exacerbate fire risk or possibly result in temporary or ongoing impacts on the environment. **No impact** would occur.

d) Expose people or structures to significant risks, including downslope or downstream flooding or landslides, therefore of runoff, post-fire slope instability, or drainage changes?

The proposed long-term operation of the SWP would not involve housing development or other buildings; therefore, the Proposed Project would not expose people or structures to significant risks because of runoff, post-fire slope instability, or drainage changes. **No impact** would occur.

3.21 MANDATORY FINDINGS OF SIGNIFICANCE

Table 3.21-1. Mandatory Findings of Significance

ENVIRONMENTAL ISSUES	ENVIRONMENTAL IMPACT SIGNIFICANCE
XVIII. Mandatory Findings of Significance.	-
a) Does the project have the potential to substantially degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	Potentially Significant Impact
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects.)	Potentially Significant Impact
c) Does the project have environmental effects that will cause substantial adverse effects on human beings, either directly or indirectly?	No Impact

Authority: Public Resources Code Sections 21083 and 21083.05.

Reference: Government Code Section 65088.4; Public Resources Code Sections 21080(c), 21080.1, 21080.3, 21083, 21083.05, 21083.3, 21093, 21094, 21095 and 21151; *Sundstrom v. County of Mendocino* (1988) 202 Cal.App.3d 296; *Leonoff v. Monterey Board of Supervisors* (1990) 222 Cal.App.3d 1337; *Eureka Citizens for Responsible Govt. v. City of Eureka* (2007) 147 Cal.App.4th 357; *Protect the Historic Amador Waterways v. Amador Water Agency* (2004) 116 Cal.App.4th at 1109; *San Franciscans Upholding the Downtown Plan v. City and County of San Francisco* (2002) 102 Cal.App.4th 656.

3.21.1 DISCUSSION

a) Does the project have the potential to substantially degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of an endangered, rare, or threatened species, or eliminate important examples of the major periods of California history or prehistory?

As discussed in Section 3.4, "Biological Resources," and Section 3.10, "Hydrology and Water Quality," the proposed long-term operation of the SWP has the potential to adversely affect fish habitat, cause a fish population to drop below self-sustaining levels, and substantially reduce the number or restrict the range of an endangered, rare, or threatened species by altering Delta hydrology and water quality. Therefore, proposed long-term operation of the SWP may have a **potentially significant effect** and will be addressed in further detail in the EIR.

b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects.)

As discussed in the relevant sections above, the Proposed Project would have no impacts on aesthetics, agricultural resources, air quality, cultural resources, energy, geology, greenhouse gas emissions, hazards and hazardous materials, land use, mineral resources, noise, population and housing, public services, recreation, transportation, tribal cultural resources, utilities and service systems, terrestrial biological resources, or wildfire. Because the proposed long-term operation of the SWP would not have an impact on these resource topics, the Proposed Project could not contribute to a potential cumulative impact on these resources. Cumulative impacts relating to these topics will therefore not be addressed in the EIR.

The potential for cumulative impacts from the proposed long-term operation of the SWP in relation to other topics is addressed in turn, in the following discussion.

3.21.1.1 Aquatic Biological Resources

The long-term operation of the SWP **may make a cumulatively considerable incremental contribution to a significant cumulative impact** on aquatic biological resources. These impacts, including the incremental contribution of the proposed long-term operation of the SWP when combined with impacts from past, present, and foreseeable future projects, will be addressed in the EIR.

3.21.1.2 Hydrology and Water Quality

The proposed long-term operation of the SWP **may make a cumulatively considerable incremental contribution to a significant cumulative impac**t on water quality. These impacts, including the incremental contribution of the proposed long-term operation of the SWP when combined with impacts from past, present, and foreseeable future projects, will be addressed in the EIR.

c) Does the project have environmental effects that will cause substantial adverse effects on human beings, either directly or indirectly?

The proposed long-term operation of the SWP would not have environmental effects that would cause substantial adverse effects on human beings, either directly or indirectly. **No impact** would occur.

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5 DOCUMENT PREPARATION

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ATTACHMENT 1

Terrestrial Plant and Wildlife Species Potentially Affected
by SWP Operations

TERRESTRIAL PLANT AND WILDLIFE SPECIES POTENTIALLY AFFECTED BY SWP OPERATIONS

Species considered are those that could be directly or indirectly affected by State Water Project (SWP) operations if they occur (1) along the shorelines of reservoirs that store SWP water supplies, (2) along rivers downstream from SWP reservoirs, (3) in potential habitat restoration areas in Yolo Bypass and Suisun Marsh, (4) wildlife refuges that receive SWP water supplies, (5) in riparian corridors within the Delta, and (6) in agricultural areas irrigated with SWP water supplies. The geographic scope includes:

- Sacramento River from the confluence with the Feather River downstream to, and including, the Delta;
- Feather River from the Federal Energy Regulatory Commission (FERC) boundary downstream to its confluence with the Sacramento River;
- San Joaquin River from Friant Dam downstream to, and including, the Delta;
- San Francisco Bay and Suisun Marsh;
- Nearshore Pacific Ocean on the coast from Point Conception to Cape Falcon in Oregon; and
- Areas that receive water from the SWP.

Table Att-1. Special-Status Wildlife Species Potentially Affected by the Proposed Long-Term Operation of the State Water Project

Common Name	Scientific Name	Status Federal/State/CDFW*
Invertebrates	-	-
Lange's metalmark butterfly	*Apodemia mormo langei*	FE/–/–
Conservancy fairy shrimp	*Branchinecta conservatio*	FE/–/–
Longhorn fairy shrimp	*Branchinecta longiantenna*	FE/–/–
Vernal pool fairy shrimp	*Branchinecta lynchi*	FT/–/–
San Diego fairy shrimp	*Branchinecta sandiegonensis*	FE/–/–
San Bruno elfin butterfly	*Callophrys mossii bayensis*	FE/–/–
Ohlone tiger beetle	*Cicindela ohlone*	FE/–/–
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	FT/–/–
Casey's June beetle	*Dinacoma caseyi*	FE/–/–
Delta green ground beetle	*Elaphrus viridis*	FT/–/–
El Segundo blue butterfly	*Euphilotes battoides allyni*	FE/–/–
Smith's blue butterfly	*Euphilotes enoptes smithi*	FE/–/–
Bay checkerspot butterfly	*Euphydryas editha bayensis*	FT/–/–
Quino checkerspot butterfly	*Euphydryas editha quino*	FE/–/–
Kern primrose sphinx moth	*Euproserpinus euterpe*	FT/–/–
Palos Verdes blue butterfly	*Glaucopsyche lygdamus palosverdesensis*	FE/–/–
Black abalone	*Haliotis cracherodii*	FE/–/–
Morro shoulderband (=banded dune) snail	*Helminthoglypta walkeriana*	FE/–/–
Hermes copper butterfly	*Lycaena hermes*	Candidate/–/–
Vernal pool tadpole shrimp	*Lepidurus packardi*	FE/–/–
Trinity bristle snail	*Monadenia infumata setosa*	–/ST/–
Shasta crayfish	*Pacifastacus fortis*	FE/SE/–
Mission blue butterfly	*Plebejus icarioides missionensis*	FE/–/–
Mount Hermon (=Barbate) June beetle	*Polyphylla barbata*	FE/–/–
Laguna Mountains skipper	*Pyrgus ruralis lagunae*	FE/–/–
Delhi Sands flower-loving fly	*Rhaphiomidas terminatus abdominalis*	FE/–/–
Callippe silverspot butterfly	*Speyeria callippe callippe*	FE/–/–
Behren's silverspot butterfly	*Speyeria zerene behrensii*	FE/–/–
Oregon silverspot butterfly	*Speyeria zerene hippolyta*	FT/–/–
Myrtle's silverspot Butterfly	*Speyeria zerene myrtleae*	FE/–/–
Riverside fairy shrimp	*Streptocephalus woottoni*	FE/–/–
California freshwater shrimp	*Syncaris pacifica*	FE/SE/–
Zayante band-winged grasshopper	*Trimerotropisiinfatilis*	FE/–/–
Reptiles and Amphibians	-	-
California tiger salamander	*Ambystoma californiense*	FT/ST/WL
Santa Cruz long-toed salamander	*Ambystoma macrodactylum croceum*	FE/SE/FP
Arroyo toad	*Anaxyrus californicus*	FE/–/SSC

Common Name	Scientific Name	Status Federal/State/CDFW*
Yosemite toad	*Anaxyrus canorus*	FT/–/SCC
Desert slender salamander	*Batrachoseps major aridus*	FE/SE/–
Kern Canyon slender salamander	*Batrachoseps simatus*	–/ST/–
Tehachapi slender salamander	*Batrachoseps stebbinsi*	–/ST/–
Southern rubber boa	*Charina umbratica*	–/ST/–
Green turtle	*Chelonia mydas*	FT/–/–
Barefoot gecko	*Coleonyx switaki*	–/ST/–
Leatherback sea turtle	*Dermochelys coriacea*	FE/–/–
Western pond turtle	*Emmys marmorata*	–/–/SSC
Blunt-nosed leopard lizard	*Gambelia sila*	FE/SE/FP
Desert tortoise	*Gopherus agassizii*	FT/ST/–
Limestone salamander	*Hydromantes brunus*	–/ST/FP
Shasta salamander	*Hydromantes shastae*	–/ ST/–
Alameda whipsnake	*Masticophis lateralis euryxanthus*	FT/ST/–
Scott Bar salamander	*Plethodon asupak*	–/ST/–
Siskiyou Mountains salamander	*Plethodon stormi*	–/ST/–
Cascades frog	*Rana cascadae*	–/CE/SSC
California red-legged frog	*Rana draytonii*	FT/–/SSC
Southern Mountain yellow-legged frog	*Rana muscosa*	FE/SE/WL
Oregon spotted frog	*Rana pretiosa*	FT/–/SSC
Sierra Nevada yellow-legged frog	*Rana sierrae*	FE/ST/WL
San Francisco garter snake	*Thamnophis sirtalis tetrataenia*	FE/SE/FP
Giant garter snake	*Thamnophis gigas*	FT/ST/–
Coachella Valley fringe-toed lizard	*Uma inornata*	FT/SE/–
Island night lizard	*Xantusia riversiana*	DL/–/–
Birds	-	-
Tricolored blackbird (nesting colony)	*Agelaius tricolor*	–/ST/SSC
Tule greater white-fronted goose (wintering)	*Anser albifrons elgasi*	–/–/SSC
Short-eared owl (nesting)	*Asio flammeus*	–/–/SSC
Burrowing owl (nesting and wintering sites)	*Athene cunicularia*	–/–/SSC
San Clemente sage sparrow	*Artemisiospiza belli clementeae*	FT/–/SCC
Marbled murrelet	*Brachyramphus marmoratus*	FT/SE/–
Cackling (=Aleutian Canada) goose	*Branta hutchinsii leucopareia*	Delisted/–/WL
Swainson's hawk (nesting)	*Buteo swainsoni*	BCC/ST/–
Western snowy plover	*Charadrius alexandrines nivosus*	FT/–/SSC
Black tern	*Childonias niger*	–/–/SSC
Gilded flicker	*Chelonia mydas*	BCC/SE/–
Western yellow-billed cuckoo (nesting)	*Coccyzus americanus occidentalis*	FT/SE/–
Yellow warbler (nesting)	*Dendroica petechia brewsteri*	BCC/–/SSC
White-tailed kite (nesting)	*Elanus leucurus*	–/–/FP

Common Name	Scientific Name	Status Federal/State/CDFW*
Willow flycatcher	*Empidonax traillii*	BCC/SE/–
Little willow flycatcher	*Empidonax traillii brewsteri*	BCC/SE/–
Southwestern willow flycatcher	*Empidonax traillii extimus*	FE/SE/–
American peregrine falcon	*Falco peregrinus anatum*	DL/DL/FP
California condor	*Gymnogyps californianus*	FE/SE/FP
Saltmarsh common yellowthroat	*Geothlypis trichas sinuosa*	BCC/–/SSC
Greater sandhill crane (nesting and wintering)	*Grus canadensis tabida*	–/ST/FP
Bald eagle (nesting and wintering)	*Haliaeetus leucocephalus*	BCC/FD/SE/FP
Least bittern (nesting)	*Ixobrychus exilis*	BCC/–/SSC
San Clemente loggerhead shrike	*Lanius ludovicianus mearnsi*	FE/–/SSC
California black rail	*Laterallus jamaicensis coturniculus*	BCC/ST/FP
Gila woodpecker	*Melanerpes uropygialis*	BCC/SE/–
Suisun song sparrow	*Melospiza melodia maxillaris*	BCC/–/SSC
Elf owl	*Micrathene whitneyi*	BCC/SE/–
Belding's savannah sparrow	*Passerculus sandwichensis beldingi*	–/SE/–
Osprey (nesting)	*Pandion haliaetus*	–/–/WL
California brown pelican	*Pelecanus occidentalis californicus*	DL/DL/FP
White-faced ibis (nesting colony)	*Plegadis chihi*	–/–/WL
Coastal California gnatcatcher	*Polioptila californica californica*	FT/–/SCC
Light-footed Ridgway's rail	*Rallus obsoletus levipes*	FE/SE/FP
California Ridgway's rail	*Rallus obsoletus obsoletus*	FE/SE/FP
Yuma Ridgway's rail	*Rallus obsoletus yumanensis*	FE/ST/FP
Bank swallow (nesting)	*Riparia riparia*	–/ST/–
California least tern	*Sternula antillarum browni*	FE/SE/FP
Great gray owl	*Strix nebulosi*	–/SE/–
Northern spotted owl	*Strix occidentalis caurina*	FT/ST/–
Scripp's murrelet	*Synthliboramphus scrippsi*	BCC/ST/–
Arizona bell's vireo	*Vireo bellii arizonae*	BCC/SE/–
Least bell's vireo (nesting)	*Vireo bellii pusillus*	FE/SE/–
Mammals	-	-
Nelson's antelope squirrel	*Ammospermophilus nelsoni*	–/ST/–
Guadalupe fur-seal	*Arcticephalus townsendi*	FT/ST/FP
Ring-tailed cat	*Bassariscus astutus*	–/–/FP
Gray wolf	*Canis lupus*	FE/SE/–
Fresno kangaroo rat	*Dipodomys nitratoides exilis*	FE/SE/–
Tipton kangaroo rat	*Dipodomys nitratoides nitratoides*	FE/SE/–
Morro Bay kangaroo rat	*Dipodomys heermanni morroensis*	FE/SE/FP
Giant kangaroo rat	*Dipodomys ingens*	FE/SE/–
Stephen's kangaroo rat	*Dipodomys stephensi*	FE/ST/–
Southern sea otter	*Enhydra lutris nereis*	FT/–/FP

Common Name	Scientific Name	Status Federal/State/CDFW*
Steller (=northern) sea-lion	*Eumetopias jubatus*	DL/–/SSC
California wolverine	*Gulo gulo*	PT/ST/FP
Lesser long-nosed bat	*Leptonycteris yerbabuenae*	DL/–/SSC
Humboldt marten	*Martes caurina humboldtensis*	–/CE/SSC
Riparian (= San Joaquin Valley) woodrat	*Neotoma fuscipes riparia*	FE/–/SSC
Peninsular bighorn sheep DPS	*Ovis canadensis nelsoni* pop. 2	FE/ST/FP
Sierra Nevada bighorn sheep	*Ovis canadensis sierrae*	FE/SE/FP
Fisher–West Coast DPS	*Pekania pennanti*	–/ST/SSC
Pacific pocket mouse	*Perognathus longimembris pacificus*	FE/–/SSC
Salt Marsh harvest mouse	*Reithrodontomys raviventris*	FE/SE/FP
Buena Vista Lake ornate shrew	*Sorex ornatus relictus*	FE/–/SSC
Suisun shrew	*Sorex ornatus sinuosus*	–/–/SSC
Riparian brush rabbit	*Sylvilagus bachmani riparius*	FE/SE/–
Santa Catalina Island fox	*Urocyon littoralis catalinae*	FT/ST/–
San Clemente Island fox	*Urocyon littoralis clementae*	–/ST/–
San Nicolas Island fox	*Urocyon littoralis dickeyi*	–/ST/–
San Miguel Island fox	*Urocyon littoralis littoralis*	DL/ST/–
Santa Cruz Island fox	*Urocyon littoralis santacruzae*	DL/ST/–
Santa Rosa Island fox	*Urocyon littoralis santarosae*	DL/ST/–
San Joaquin kit fox	*Vulpes macrotis mutica*	FT/ST/–
Sierra Nevada red fox	*Vulpes vulpes necator*	FC/ST/–
Mohave ground squirrel	*Xerospermophilus mohavensis*	–/ST/–

Sources: CNDDB 2019
"-" indicates blank cell
Status Codes:
Federal—U.S. Fish and Wildlife Service:
BCC = bird species of conservation concern
FE = federally endangered
FT = federally threatened
FC = candidate for federal listing under the federal Endangered Species Act
FD = federal delisted
FS = Forest Service sensitive species
DPS = Distinct Population Segment
– = no status
State—California Department of Fish and Wildlife:
SE = state endangered
ST = state threatened
FP = California fully protected species
PT = proposed threatened
SSC = California species of special concern
WL = CDFW watch list
– = no status

Table Att-2. Special-Status Plants Potentially Affected by the Proposed Long-Term Operation of the State Water Project

Common Name	Scientific Name	Status Federal/State/CRPR*
Adobe sanicle	*Sanicula maritima*	–/SR/1B.1
Algodones Dunes sunflower	*Helianthus niveus* ssp. *tephrodes*	–/SE/1B.2
Antioch Dunes evening primrose	*Oenothera deltoides* ssp. *howellii*	FE/SE/1B.1
Ash-gray paintbrush	*Castilleja cinerea*	FT/SE/1B.1
Ashland thistle	*Cirsium ciliolatum*	–/SE/2B.1
Large-flowered fiddleneck	*Amsinckia grandiflora*	FE/SE/1B.1
Bakersfield cactus	*Opuntia basilaris* var. *treleasei*	FE/SE/1B.1
Bakersfield smallscale	*Atriplex tularensis*	–/SE/1A
Baja California birdbush	*Ornithostaphylos oppositifolia*	–/SE/2B.1
Beach layia	*Layia carnosa*	FE/SE/1B.1
Beach spectaclepod	*Dithyrea maritima*	–/ST/1B.1
Ben Lomond spineflower	*Chorizanthe pungens* var. *hartwegiana*	FE/–/1B.1
Bensoniella	*Bensoniella oregona*	–/SR/1B.1
Big Bear Valley sandwort	*Eremogone ursina*	FT/–/1B.2
Bird-foot checkerbloom	*Sidalcea pedata*	FE/SE/1B.1
Big-leaved crownbeard	*Verbesina dissita*	FT/ST/1B.1
Bogg’s Lake hedge-hyssop	*Gratiola heterosepala*	–/SE/1B.2
Bolander’s water hemlock	*Cicuta maculata* var. *bolanderi*	–/–/2.1
Braunton’s milk-vetch	*Astragalus brauntonii*	FE/–/1B.1
Burke’s goldfields	*Lasthenia burkei*	FE/–/1B.1
Butte County meadowfoam	*Limnanthes floccosa* ssp. *californica*	FE/SE/1B.1
California dandelion	*Taraxacum californicum*	FE/–/1B.1
California jewelflower	*Caulanthus californicus*	FE/SE/1B.1
California orcutt grass	*Orcuttia californica*	FE/SE/1B.1
California seablite	*Suaeda californica*	FE/–/1B.1
Calistoga popcornflower	*Plagiobothrys strictus*	FE/ST/1B.1
Cammata Canyon amole	*Chlorogalum purpureum* var. *reductum*	FT/SR/1B.1
Canyon liveforever	*Dudleya cymosa* ssp. *agourensis*	FT/–/1B.2
Cuyamaca Lake downingia	*Downingia concolor* var. *brevior*	–/SE/1B.1
Chinese Camp brodiaea	*Brodiaea pallida*	FT/SE/1B.1
Clara Hunt’s milk-vetch	*Astragalus claranus*	FE/ST/1B.1
Coachella Valley milk-vetch	*Astragalus lentiginosus* var. *coachellae*	FE/–/1B.2
Coastal Dunes milk-vetch	*Astragalus tener* var. *titi*	FT/SE/1B.1
Colusa grass	*Neostapfia colusana*	FT/SE/1B.1
Conejo dudleya	*Dudleya parva*	FT/–/1B.2
Contra Costa goldfields	*Lasthenia conjugens*	FE/–/1B.1
Contra Costa wallflower	*Erysimum capitatum* var. *angustatum*	FE/SE/1B.1
Coast yellow leptosiphon	*Leptosiphon croceus*	–/SE/1B.1
Coyote ceanothus	*Ceanothus ferrisiae*	FE/–/1B.1
Crampton’s tuctoria	*Tuctoria mucronata*	FE/SE/1B.1
Crystal Springs fountain thistle	*Cirsium fontinale* var. *fontinale*	FE/SE/1B.1

Common Name	Scientific Name	Status Federal/State/CRPR*
Cushenbury buckwheat	*Eriogonum ovalifolium* var. *vineum*	FE/–/1B.1
Cushenbury milk-vetch	*Astragalus albens*	FE/–/1B.1
Cushenbury oxytheca	*Acanthoscyphus parishii* var. *goodmaniana*	FE/–/1B.1
Dehesa nolina	*Nolina interrata*	–/SE/1B.1
Delta button-celery	*Eryngium racemosum*	–/SE/1B.1
Delta tule pea	*Lathyrus jepsonii* var. *jepsonii*	–/–/1B.2
Del Mar manzanita	*Arctostaphylos glandulosa* ssp. *crassifolia*	FE/–/1B.1
Encinitas baccharis	*Baccharis vanessae*	FT/SE/1B.1
Few flowered navarretia	*Navarretia leucocephala* ssp. *pauciflora*	FE/ST/1B.1
Franciscan manzanita	*Arctostaphylos hookeri* ssp. *franciscana*	FE/–/1B.1
Gambel's watercress	*Nasturtium gambelii*	FE/ST/1B.1
Gaviota tarplant	*Deinandra increscens* ssp. *villosa*	FE/SE/1B.1
Geysers panicum	*Panicum acuminatum* var. *thermale*	–/SE/1B.2
Greene's tuctoria	*Tuctoria greenei*	FE/SR/1B.1
Hairy orcutt grass	*Orcuttia pilosa*	FE/SE/1B.1
Hartweg's golden sunburst	*Pseudobahia bahiifolia*	FE/SE/1B.1
Hearst's manzanita	*Arctostaphylos hookeri* ssp. *hearstiorum*	–/FE/1B.2
Hickman's cinquefoil	*Potentilla hickmanii*	FE/SE/1B.1
Hickman's knotweed	*Polygonum hickmanii*	FE/SE/1B.1
Hidden Lake bluecurls	*Trichostema austromontanum* ssp. *compactum*	DL/–/1B.1
Hoover's spurge	*Chamaesyce hooveri*	FT/–/1B.2
Humboldt County milk-vetch	*Astragalus agnicidus*	–/SE/1B.2
Indian knob mountainbalm	*Eriodictyon altissimum*	FE/SE/1B.1
Ione buckwheat	*Eriogonum apricum* var. *apricum*	FE/SE/1B.1
Ione manzanita	*Arctostaphylos myrtifolia*	FT/–/1B.2
Irish Hill buckwheat	*Eriogonum apricum* var. *prostratum*	FE/SE/1B.1
Kaweah brodiaea	*Brodiaea insignis*	–/SE/1B.2
Keck's checkerbloom	*Sidalcea keckii*	FE/–/1B.1
Kenwood Marsh checkerbloom	*Sidalcea oregana* ssp. *valida*	FE/SE/1B.1
Kern mallow	*Eremalche parryi* ssp. *kernensis*	FE/–/1B.2
Kneeland Prairie pennycress	*Noccaea fendleri* ssp. *californica*	FT/ST/1B.1
La Graciosa thistle	*Cirsium scariosum* var. *loncholepis*	FE/ST/1B.1
Laguna Beach dudleya	*Dudleya stolonifera*	FT/ST/1B.1
Lane Mountain milk-vetch	*Astragalus jaegerianus*	FE/–/1B.1
Lassics lupine	*Lupinus constancei*	–/SE/1B.1
Layne's ragwort	*Packera layneae*	FT/SR/1B.2
Livermore moonshine	*Deinandra bacigalupii*	–/SE/1B.1
Livermore tarplant	*Deinandra bacigalupii*	–/SE/1B.2
Loch Lomond button-celery	*Eryngium constancei*	FE/SE/1B.1
Lompoc yerba santa	*Eriodictyon capitatum*	FE/SR/1B.2
Lyon's pentachaeta	*Pentachaeta lyonii*	FE/SE/1B.1
Many-flowered navarretia	*Navarretia leucocephala* ssp. *plieantha*	FT/SE/1B.1
Marcescent dudleya	*Dudleya cymosa* ssp. *marcescens*	FT/ST/1B.1

Common Name	Scientific Name	Status Federal/State/CRPR*
Marin western flax	*Hesperolinon congestum*	FT/ST/1B.1
Mariposa lupine	*Lupinus citrinus* var. *deflexus*	–/ST/1B.2
Mariposa pussypaws	*Calyptridium pulchellum*	FT/–/1B.1
Marsh sandwort	*Arenaria paludicola*	FE/SE/1B.1
Mason's lilaeopsis	*Lilaeopsis masonii*	--/SR/1B.1
McDonald's rockcress	*Arabis mcdonaldiana*	FE/SE/1B.1
Menzie's wallflower	*Erysimum menziesii*	FE/SE/1B.1
Merced clarkia	*Clarkia lingulata*	–/SE/1B.1
Metcalf Canyon jewel flower	*Streptanthus albidus* ssp. *albidus*	FE/–/1B.1
Mexican flannelbush	*Fremontodendron mexicanum*	FE/SR/1B.1
Milo Baker's lupine	*Lupinus milo-bakeri*	–/ST/1B.1
Mojave tarplant	*Deinandra mohavensis*	–/SE/1B.3
Monterey spineflower	*Chorizanthe pungens* var. *pungens*	FT/–/1B.2
Morro manzanita	*Arctostaphylos morroensis*	FT/–/1B.1
Munz's onion	*Allium munzii*	FE/ST/1B.1
Napa blue grass	*Poa napensis*	FE/SE/1B.1
Nevin's barberry	*Berberis nevinii*	FE/SE/1B.1
Nipomo Mesa lupine	*Lupinus nipomensis*	FE/SE/1B.1
North Coast semaphore grass	*Pleuropogon hooverianus*	–/ST/1B.1
Orcutt's hazardia	*Hazardia orcuttii*	–/ST/1B.1
Orcutt's spineflower	*Chorizanthe orcuttiana*	FE/SE/1B.1
Otay Mesa mint	*Pogogyne nudiuscula*	FE/SE/1B.1
Otay tarplant	*Deinandra conjugens*	FT/SE/1B.1
Pacific manzanita	*Arctostaphylos pacifica*	–/SE/1B.1
Pallid manzanita	*Arctostaphylos pallida*	FT/SE/1B.1
Palmate-bracted bird's-beak	*Chloropyron palmatum*	FE/SE/1B.1
Parish's daisy	*Erigeron parishii*	FT/–/1B.1
Parish's meadowfoam	*Limnanthes alba* ssp. *parishii*	–/SE/1B.2
Pierson's milk-vetch	*Astragalus magdalenae* var. *peirsonii*	FT/SE/1B.2
Pine Hill flannelbush	*Fremontodendron decumbens*	FE/SR/1B.2
Pismo clarkia	*Clarkia speciose* ssp. *immaculate*	FE/SR/1B.1
Pitkin marsh lily	*Lilium pitkinense*	FE/SE/1B.1
Presidio clarkia	*Clarkia franciscana*	FE/SE/1B.1
Presidio manzanita	*Arctostaphylos hookeri* ssp. *ravenii*	FE/SE/1B.1
Red Hills vervain	*Verbena californica*	FT/ST/1B.1
Robust spineflower	*Chorizanthe robusta* var. *robusta*	FE/–/1B.1
Sacramento orcutt grass	*Orcuttia californica* var. *viscida*	FE/SE/1B.1
Salt Marsh bird's-beak	*Chloropyron maritimum* ssp. *maritimum*	FE/SE/1B.2
San Benito evening-primrose	*Camissonia benitensis*	FT/–/1B.1
San Bernardino blue grass	*Poa atropurpurea*	FE/–/1B.2
San Bernardino Mountains bladderpod	*Physaria kingii* ssp. *bernardina*	FE/–/1B.1
San Bruno Mountain manzanita	*Arctostaphylos imbricata*	–/SE/1B.1
San Diego ambrosia	*Ambrosia pumila*	FE/–/1B.1

Common Name	Scientific Name	Status Federal/State/CRPR*
San Diego button celery	*Eryngium aristulatum* var. *parishii*	FE/SE/1B.1
San Diego mesa mint	*Pogogyne abramsii*	FE/SE/1B.1
San Diego thorn-mint	*Acanthomintha ilicifolia*	FT/SE/1B.1
San Fernando valley spineflower	*Chorizanthe parryi* var. *fernandina*	FP/SE/1B.1
San Francisco lessingia	*Lessingia germanorum*	FE/SE/1B.1
San Francisco popcornflower	*Plagiobothrys diffusus*	–/SE/1B.1
San Luis Obispo fountain thistle	*Cirsium fontinale* var. *obispoense*	FE/SE/1B.2
San Jacinto valley crownscale	*Atriplex coronata* var. *notatior*	FE/–/1B.1
San Joaquin adobe sunburst	*Pseudobahia peirsonii*	FT/SE/1B.1
San Joaquin valley orcutt grass	*Orcuttia inaequalis*	FT/SE/1B.1
San Joaquin woollythreads	*Monolopia congdonii*	FE/–/1B.2
Santa Ana River woollystar	*Eriastrum densifolium* ssp. *sanctorum*	FE/SE/1B.1
San Mateo thorn-mint	*Acanthomintha duttonii*	FE/SE/1B.1
San Mateo woolly sunflower	*Eriophyllum latilobum*	FE/SE/1B.1
Santa Clara valley dudleya	*Dudleya abramsii* ssp. *setchellii*	FE/–/1B.1
Santa Cruz cypress	*Hesperocyparis abramsiana* var. *abramsiana*	FT/SE/1B.2
Santa Cruz tarplant	*Holocarpha macradenia*	FT/SE/1B.1
Santa Cruz wallflower	*Erysimum teretifolium*	FE/SE/1B.1
Santa Lucia purple amole	*Chlorogalum purpureum* var. *purpureum*	FT/–/1B.1
Santa Monica Mountains dudleya	*Dudleya cymosa* ssp. *ovatifolia*	FT/–/1B.1
Sand gilia	*Gilia tenuiflora* ssp. *arenaria*	SE/ST/1B.2
Scadden flat checkerbloom	*Sidalcea stipularis*	–/SE/1B.1
Scotts Valley spineflower	*Chorizanthe robusta* var. *hartwegii*	FE/–/1B.1
Seaside bird's-beak	*Cordylanthus rigidus* ssp. *littoralis*	–/SE/1B.1
Sebastopol meadowfoam	*Limnanthes vinculans*	FE/SE/1B.1
Short-leaved dudleya	*Dudleya brevifolia*	–/SE/1B.1
Slender horned spineflower	*Dodecahema leptoceras*	FE/SE/1B.1
Slender orcutt grass	*Orcuttia tenuis*	FT/SE/1B.1
Slender-petaled thelypodium	*Thelypodium stenopetalum*	FE/SE/1B.1
Small-leaved rose	*Rosa minutifolia*	–/SE/2B.1
Soft-leaved paintbrush	*Castilleja mollis*	FE/–/1B.1
Soft Salty bird's-beak	*Chloropyron molle* ssp. *molle*	FE/SR/1B.2
Southern Mountain buckwheat	*Eriogonum kennedyi* var. *austromontanum*	FT/–/1B.2
Spreading navarretia	*Navarretia fossalis*	FT/–/1B.1
Springville clarkia	*Clarkia springvillensis*	FT/SE/1B.2
Stebbin's morning glory	*Calystegia stebbinsii*	FE/SE/1B.1
Striped adobe lily	*Fritillaria striata*	–/ST/1B.1
Succulent owl's-clover	*Castilleja campestris* var. *succulenta*	FT/SE/1B.2
Suisun Marsh aster	*Symphyotrichum lentum*	–/–/1B.2
Suisun thistle	*Cirsium hydrophilum* var. *hydrophilum*	FE/–/1B.1
Surf thistle	*Cirsium rhothophilum*	–/ST/1B.2
Tahoe yellow cress	*Rorippa subumbellata*	–/SE/1B.1
Thorne's buckwheat	*Eriogonum thornei*	–/SE/1B.2

Common Name	Scientific Name	Status Federal/State/CRPR*
Thread-leaved brodiaea	*Brodiaea filifolia*	FT/SE/1B.1
Tiburon jewelflower	*Streptanthus niger*	FE/SE/1B.1
Tiburon mariposa lily	*Calochortus tiburonensis*	FT/ST/1B.1
Tiburon paintbrush	*Castilleja affinis* var. *neglecta*	FE/ST/1B.2
Tidestrom's lupine	*Lupinus tidestromii*	FE/SE/1B.1
Tree-anemone	*Carpenteria californica*	–/ST/1B.2
Triple-ribbed milk-vetch	*Astragalus tricarinatus*	FE/–/1B.2
Trinity buckwheat	*Eriogonum alpinum*	–/SE/1B.2
Two-fork clover	*Trifolium amoenum*	FE/–/1B.1
Vail Lake ceanothus	*Ceanothus ophiochilus*	FT/SE/1B.1
Vandenberg monkeyflower	*Diplacus vandenbergensis*	FE/–/1B.1
Ventura Marsh milk-vetch	*Astragalus pycnostachyus* var. *lanosissimus*	FE/SE/1B.1
Verity's dudleya	*Dudleya verityi*	FT/–/1B.1
Water howellia	*Howellia aquatilis*	FT/–/2B.2
Webber's ivesia	*Ivesia webberi*	FT/–/2B.2
Western lily	*Lilium occidentale*	FE/SE/1B.1
Willowy monardella	*Monardella viminea*	FE/SE/1B.1
White-rayed pentachaeta	*Pentachaeta bellidiflora*	FE/SE/1B.1

Sources: CalFlora 2019; CDFW 2019; CNPS 2019
"-" indicates blank cell
Status Codes
Federal—U.S. Fish and Wildlife Service:
E = endangered
FC = candidate for federal listing under the federal Endangered Species Act
– = no status
State—California Department of Fish and Wildlife:
E = endangered
– = no status
California Rare Plant Ranks (CRPRs):
1B = plant species considered rare, threatened, or endangered in California and elsewhere
2 = plant species considered rare, threatened, or endangered in California but more common elsewhere
California Rare Plant Rank Extensions:
.1 = seriously endangered in California (>80% of occurrences are threatened and/or have high degree and immediacy of threat)
.2 = fairly endangered in California (20–80% of occurrences are threatened)
.3 = not very endangered in California

APPENDIX B

2018 Coordinated Operation Agreement Addendum

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Tables

Figures

Acronyms and Abbreviations

AF/yr	acre-feet per year
Banks Pumping Plant	Harvey O. Banks Pumping Plant
BO	biological opinion
BSPP	Barker Slough Pumping Plant
CALFED	California Federal Bay–Delta
CCF	Clifton Court Forebay
CEQA	California Environmental Quality Act
cfs	cubic feet per second
COA	Agreement Between the United States of America and the State of California for Coordinated Operation of the Central Valley Project and the State Water Project" (Coordinated Operations Agreement)
CVP	Central Valley Project
D-893	SWRCB Water Rights Decision 893
D-1485	SWRCB Water Rights Decision 1485
D-1641	SWRCB Water Rights Decision 1641
DCC	Delta Cross Channel
Delta	Sacramento–San Joaquin Delta
DMC	Delta–Mendota Canal
DWR	California Department of Water Resources
ESA	Federal Endangered Species Act
FERC	Federal Energy Regulatory Commission
HOR	Head of Old River
HORB	Head of Old River Barrier
JPOD	Joint Point of Diversion
MAF	million acre-feet
MIDS	Morrow Island Distribution System
NBA	North Bay Aqueduct
NOE	Notice of Exemption
OMR	Old and Middle River
Reclamation	U.S. Bureau of Reclamation
RRDS	Roaring River Distribution System
SMPA	Suisun Marsh Preservation Agreement
SMSCG	Suisun Marsh Salinity Control Gates
SWP	State Water Project
SWRCB	State Water Resources Control Board
TAF	thousand acre-feet
TBP	Temporary Barrier Project

Trinity River ROD	Trinity River Mainstem Fishery Restoration Record of Decision
USACE	U.S. Army Corps of Engineers
USDOI	U.S. Department of the Interior
WQCP	Water Quality Control Plan

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INTRODUCTION

The 1986 Coordinated Operation Agreement (COA)[1] is the agreement between the California Department of Water Resources (DWR) and the U.S. Bureau of Reclamation (Reclamation) that governs how the State Water Project (SWP) and federal Central Valley Project (CVP) share water under their water rights and operate to meet specific water quality and outflow requirements in the Sacramento–San Joaquin Delta (Delta) (DWR and Reclamation 2018). It was based on negotiated principles of equitable sharing, arising from the requirement that their operations be coordinated and, as a matter of practical necessity, for two large projects to be able to operate together in a complex tidal estuary.

DESCRIPTION OF THE 1986 COA

Under the 1986 COA, the parties reduced the complexities of two large water projects in exporting water from the Delta to a simple agreed-on sharing of (1) rights to unstored water for export (55 percent CVP, 45 percent SWP), and (2) responsibility for providing stored water to meet Sacramento Valley in-basin uses under "balanced conditions" (75 percent CVP, 25 percent SWP), when both projects are operating to meet Delta standards. These provisions are contained in Article 6 of the agreement.

Many changes in conditions affecting operations and delivery capabilities of both projects have occurred since 1986, particularly in Delta water quality standards set by the SWRCB and based on Biological Opinions under the ESA, in CVP and SWP demand, and under the Central Valley Project Improvement Act of 1992. The COA was designed to respond to and work under a wide range of conditions except extreme drought; and it has been implemented successfully for more than 30 years. The COA also includes a provision for the sharing formulas to be updated to incorporate changing conditions. However, one item that the COA does not expressly address is sharing of export limits that have been imposed by the SWRCB and the federal ESA agencies since 1986. By informal agreement, the CVP and SWP have shared them equally.

KEY PROVISIONS IN THE 1986 COA

Several of the key provisions in the COA are described in the following descriptions.

SACRAMENTO VALLEY IN-BASIN USES

Sacramento Valley in-basin uses are defined in the COA as legal uses of water in the Sacramento Basin and the Delta. They include both diversion uses and regulatory uses, including SWRCB water quality and outflow standards.

[1] Agreement between the United States of America and the State of California for the Coordinated Operation of the Central Valley Project and the State Water Project.

Balanced and Excess Water Conditions

The COA defines balanced water conditions as periods when it is mutually agreed that releases from upstream reservoirs plus unregulated flows approximately equal the water supply needed to meet Sacramento Valley in-basin uses plus Delta exports.

Excess water conditions are periods when it is mutually agreed that releases from upstream reservoirs plus unregulated flows exceed Sacramento Valley in-basin uses plus Delta exports. Reclamation's Central Valley Operations Office and DWR's SWP Operations Control Office jointly decide when balanced or excess water conditions exist. During excess water conditions, when sufficient water is available to meet all beneficial needs, the CVP and SWP are not required to supplement the supply with additional releases from storage.

Sharing Export Facilities and Limits

Sharing Export Facilities and Limits Article 10 of the COA contains provisions for both projects to share each other's export facilities for facility outages; for the SWP to wheel water for the CVP to make up losses from SWRCB Water Rights Decision 1485 (D-1485) striped bass pumping limits, if the SWP would not be adversely affected; for an exchange of SWP wheeling for CVP water; and for a general provision for negotiating other such agreements. Although Article 6 addresses the sharing of obligations to meet in-basin uses, the COA contains no express provision for sharing pumping limits, which have been imposed since 1995 and shared 50-50 between the two projects by informal agreement.

Key Provisions of the 2018 COA Addendum

DWR and Reclamation executed an Addendum to the COA on December 12, 2018 (COA Addendum). The COA Addendum amended four key elements of the COA:

- Article 6(c) in-basin uses
- Article 10(b) CVP use of Harvey O. Banks Pumping Plant (Banks Pumping Plant)
- Article 10(i) export restrictions
- Article 14(a) the periodic review

These elements were amended as follows.

Article 6(c)

Article 6(c) of the 1986 COA is amended to provide:

> *(c) Sharing of Responsibility for Meeting Sacramento Valley In-Basin Use with Storage Withdrawals During Balanced Water Conditions: Each party's responsibility for making available storage withdrawals to meet Sacramento Valley in-basin use of storage withdrawals shall be determined by multiplying the total Sacramento Valley in-basin use of storage withdrawals by the following percentages:*

	United States	State
Wet Years	80%	20%
Above-Normal Years	80%	20%
Below-Normal Years	75%	25%
Dry Years	65%	35%
Critical Years	60%	40%

The water year classifications described in this Article 6(c) shall be based on the Sacramento Valley 40-30-30 Index as most recently published through the Department of Water Resources' Bulletin 120.

In a Dry or Critical Year following two Dry or Critical Years, the United States and State will meet to discuss additional changes to the percentage sharing of responsibility to meet in-basin use.

ARTICLE 10(b)

Article 10(b) of the 1986 COA is amended to provide:

(b) The State will transport up to 195,000 acre-feet of Central Valley Project water through the California Aqueduct Reaches 1, 2A, and 2B no later than November 30 of each year by direct diversion or by rediversion of stored Central Valley Project water at times those diversions do not adversely affect the State Water Project purposes or do not conflict with State Water Project contract provisions. The State will provide available capacity at the Harvey O. Banks Pumping Plant ("Banks") to the Central Valley Project to divert or redivert 195,000 acre-feet when the diversion capacity at the south Delta intake to Clifton Court Forebay is in excess of 7,180 cubic feet per second during the July 1 through September 30, except when the Delta is in Excess Water Conditions during July 1 through September 30, the diversion capacity at the south Delta intake to Clifton Court Forebay is in excess of 7,180 cubic feet per second shall be shared equally by the State and the United States This Article does not alter the Cross-Valley Canal contractors' priority to pumping at the Harvey O. Banks Pumping Plant, as now stated in Revised Water Rights Decision.

ARTICLE 10(I)

Article 10(i) is added to the 1986 COA to provide:

(i) Sharing of Applicable Export Capacity When Exports are Constrained. During periods when exports are constrained by non-discretionary requirements imposed on the SWP and CVP south Delta exports by any federal or state agency, applicable export capacity shall be shared by the following percentages:

	United States	State
Balanced Water Condition	65%	35%
Excess Water Condition	60%	40%

ARTICLE 14(a)

Article 14(a) of the 1986 COA is amended to provide:

> *(a) Prior to December 31 of the fifth full year following execution of this agreement, and before December 31 of each fifth year thereafter, or within 365 days of the implementation of new or revised requirements imposed jointly on Central Valley Project and State Water Project operations by any federal or state agency, or prior to initiation of operation of a new or significantly modified facility of the United States or the State or more frequently if so requested by either party, the United States and the State jointly shall review the operations of both projects. The parties shall (1) compare the relative success which each party has had in meeting its objectives, (2) review operation studies supporting this agreement, including, but not limited to, the assumptions contained therein, and (3) assess the influence of the factors and procedures of Article 6 in meeting each party's future objectives. The parties shall agree upon revisions, if any, of the factors and procedures in Article 6, Exhibits Band D, and the Operation Study used to develop Exhibit B.*

In addition to the amended articles presented above, pursuant to Article 11, COA Exhibit A also was updated to conform with Delta standards, established by the SWRCB in the 1995 Water Quality Control Plan (WQCP) for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary, as implemented by SWRCB Water Rights Decision 1641 (D-1641). COA Exhibit B also was updated, based on a joint operations study of the amendments in the 2018 COA Addendum.

ARTICLE 14(c)

A new Article 14(c) is added to the Agreement to provide:

> *(c) Prior to December 31 of the fifth full year following execution of this agreement, and before December 31 of each fifth year thereafter, or within 365 days of the implementation of new or revised requirements imposed jointly on Central Valley Project and State Water Project operations by any federal or state agency, or prior to initiation of operation of a new or significantly modified facility of the United States or the State or more frequently if so requested by either party, the United States and the State jointly shall review the operations of both projects. The parties shall (1) compare the relative success which each party has had in meeting its objectives, (2) review operation studies supporting this agreement, including, but not limited to, the assumptions contained therein, and (3) assess the influence of the factors and procedures of Article 6 in meeting each party's future objectives. The parties shall agree upon revisions, if any, of the*

factors and procedures in Article 6, Exhibits B and D, and the Operation Study used to develop Exhibit B.

CEQA Compliance for the 2018 COA Addendum

As part of approving the 2018 COA Addendum, DWR completed and filed a Notice of Exemption (NOE) for the ongoing operations of the SWP, in accordance with the California Environmental Quality Act (CEQA). The NOE presented the following conclusions.

Projects that were approved and implemented before enactment of CEQA on November 23, 1970 are exempt from the act's requirements. The SWP was constructed in relevant part and was operational prior to November 23, 1970, and the operational scope of SWP activities was broad, providing DWR with wide discretion to determine how to deliver water to the SWP service area, including how to operate pumps, manage carryover storage, and coordinate with Reclamation's CVP operations.

DWR will continue to operate the SWP to deliver water within its service area, following execution of the COA addendum. The 2018 COA Addendum shifted responsibilities for meeting CVP and SWP obligations; these adjustments are within the original scope of the SWP. In other words, the provisions in the 2018 COA Addendum are a normal, intrinsic part of ongoing operations of the SWP.

Furthermore, neither exception for the exemption for ongoing project applies (see Sections 15261[a][1] and [2] of the State CEQA Guidelines). SWP operations have been ongoing for several decades, and a great amount of money has been spent to carry out these operations. Furthermore, execution of the 2018 COA Addendum was not to modify SWP operations so as to result in a new significant effect on the environment.

Purpose of this Discussion of Environmental Effects

The Appendix considers whether implementation of the 2018 COA Addendum affected flows entering and exiting the Delta by assessing the operational and hydrologic conditions that occurred under the 1986 COA and the 2018 COA Addendum. This assessment was done for the purpose of determining whether the baseline conditions, as described in the EIR, sufficiently represent Delta conditions before execution of the 2018 COA Addendum as well as the existing physical conditions in the Delta. This Appendix also discusses how the 2018 COA Addendum relates to a wide range of resource areas for public information purposes only.

ENVIRONMENTAL SETTING

The area considered in this analysis is defined by CVP facilities and service areas, and by SWP facilities and service areas, as shown in Figure 1-1 in the DEIR.

CVP Facilities

The CVP facilities affected by the 2018 COA Addendum are reservoirs on the Trinity, Sacramento, and American rivers and associated distribution facilities; the Mendota Pool on the San Joaquin River; the Jones Pumping Plant; the Delta–Mendota Canal (DMC); the San Luis Reservoir; the San Felipe Division; and the CVP service area that is served with water from these facilities.

Stored water in CVP reservoirs north of the Delta is provided to the Delta for delivery through the Contra Costa Canal and Jones Pumping Plant. The Contra Costa Canal originates at Rock Slough near Oakley and extends to the Martinez Reservoir. Water from the Contra Costa Canal is delivered to the Contra Costa Water District.

The Jones Pumping Plant in the south Delta lifts the water into the DMC, delivering water to CVP contractors who divert water directly from the canal, and to San Joaquin River exchange contractors who also divert directly from the San Joaquin River and the Mendota Pool. In addition, CVP water is conveyed to the San Luis Reservoir for storage and subsequent delivery to CVP contractors through the San Luis Canal and the DMC. From the San Luis Reservoir, water is conveyed through the Pacheco Tunnel to CVP contractors in Santa Clara and San Benito counties.

SWP Facilities

The SWP facilities that were affected by the COA Addendum included Lake Oroville on the Feather River; rivers, streams, canals, and aqueducts used to convey SWP water; and the SWP service area that relies on water from these reservoirs, specifically: Lake Oroville on the Feather River; the Banks Pumping Plant in the south Delta; the North Bay Aqueduct; the South Bay Aqueduct; the California Aqueduct; SWP reservoirs, including Lake Del Valle, the San Luis Reservoir, and Pyramid, Castaic, Silverwood, and Perris lakes; the SWP service areas in the Sacramento and San Joaquin valleys, the San Francisco Bay Area, the Central Coast region, and the Southern California region.

Hydrological Conditions Affected by CVP and SWP Operations

This discussion describes the surface water resources and water supplies managed by the SWP and CVP, and potential changes to surface water resources that occurred because of implementation of the 2018 COA Addendum. Changes to SWP and CVP operations may result in changes to surface water hydrology on the Trinity River, on the Lower Klamath River, and the the Central Valley region. Some rivers in these regions are regulated by SWP facilities, others by CVP facilities, while some others are used to convey SWP and/or CVP water supplies.

Tributaries to the Sacramento and San Joaquin rivers not affected by SWP and CVP operations also are briefly discussed, as they contribute to conditions in the Delta. Baseline CalSim II modeling results of flow conditions are provided for reservoirs and rivers that are affected by SWP and/or CVP operations.

For the San Francisco Bay Area, Central Coast, San Joaquin Valley, and Southern California water service areas, surface water streams generally are not used to convey SWP and CVP water supplies. The streams that are downstream from SWP and CVP water supply reservoirs generally receive either reservoir overflows in storm conditions or minimum instream flows related to water rights and/or aquatic resources beneficial uses. After the minimum instream flow requirements are fulfilled, the remaining volumes of water are provided to contracted water users or others. Changes in SWP and CVP water operations will not affect the need to meet minimum instream flows or high flows during storm conditions.

TRINITY RIVER

For this analysis, the Trinity River includes the reach from Trinity Lake to the confluence with the Klamath River. The Trinity River flows about 112 miles, from Lewiston Dam to the Klamath River through Trinity Country, Humboldt County, and the Hoopa Indian Reservation. A large portion of flows that enter Trinity and Lewiston lakes is exported to the Sacramento River watershed through CVP facilities. In December 2000, the U.S. Department of the Interior (USDOI), adopted the Trinity River Mainstem Fishery Restoration Record of Decision (Trinity River ROD), which restored Trinity River flow and habitat to produce a healthy, functioning, alluvial river system. Variable annual instream flow releases from Lewiston Dam range from 368,600 acre-feet per year (AF/yr) in critically dry years to 815,000 AF/yr in extremely wet years.

Trinity Lake storage varies in accordance with upstream hydrology, downstream water demands, and instream flow requirements. Reclamation maintains at least 600 thousand acre-feet (TAF) in the Trinity Reservoir, except during the 10 to 15 percent of the years when Shasta Lake also is drawn down.

The Lewiston Reservoir water storage volume is more consistent throughout the year because this afterbay is used to regulate flow releases to the Trinity Powerplant, Clear Creek Tunnel, Whiskeytown Lake, and other downstream uses.

LOWER KLAMATH RIVER

The Lower Klamath River flows 43.5 miles from the confluence with the Trinity River to the Pacific Ocean (USFWS et al. 1999). Downstream from the Trinity River confluence, the Klamath River flows through Humboldt County, Del Norte County, the Hoopa Indian Reservation, the Yurok Indian Reservation, and the Resighini Indian Reservation (USDOI and CDFG 2012).

No dams are on the Klamath River downstream from the confluence with the Trinity River. About 85 percent of the flows in the Lower Klamath River occur during winter months (USDOI and CDFG 2012). The Klamath River estuary extends from about 5 miles upstream from the Pacific Ocean (USDOI and CDFG 2012). This area generally is influenced by tidal action, where salt water can intrude up to 4 miles from the coastline, when tides are high and Klamath River flows are low.

SACRAMENTO RIVER

The Sacramento River flows about 351 miles, from north near Mount Shasta to the confluence with the San Joaquin River at Collinsville in the west Delta (Reclamation 2013a). The Sacramento River receives contributing flows from numerous major and minor streams and rivers that drain the basin. The Sacramento River also receives imported flows from the Trinity River watershed, as previously discussed. Waterways in the Sacramento Valley that could be affected by SWP and CVP long-term operations include the following:

- Clear Creek, from Whiskeytown Reservoir to its confluence with the Sacramento River
- Sacramento River, from Keswick Dam to the confluence with the San Joaquin River in the Delta
- Feather River, downstream from Oroville Reservoir to the confluence with the Sacramento River
- Yuba River, from New Bullards Bar Reservoir to the confluence with the Feather River

- Bear River, from Camp Far West Reservoir to the confluence with the Feather River
- American River, from Nimbus Dam to the confluence with the Sacramento River

Other waterways entering the Sacramento River between Red Bluff and the Feather River—including Antelope, Elder, Mill, Thomes, Deer, Stony, Big Chico, and Butte creeks—would not be affected by long-term SWP or CVP operations. No major storage or diversion structures have been constructed on Antelope, Elder, Mill, and Thomes creeks, although several small seasonal diversions have been established for irrigation, domestic use, and hydroelectric power generation (Reclamation 1997).

The East Park and Stony Gorge reservoirs store water for irrigation deliveries and are operated by Reclamation as part of the Orland Project, which is independent of the SWP and CVP. Black Butte Dam is operated by the U.S. Army Corps of Engineers (USACE) for flood control and irrigation supply. These actions are coordinated with the CVP.

Flows from other tributaries to the Sacramento, Cosumnes and Mokelumne rivers in the Sacramento Valley can affect SWP and CVP operations, particularly by contributing additional flows to the Delta. However, flows in these rivers would not be affected by changes in SWP or CVP operations. Therefore, hydrologic conditions on these water bodies are not described further in this document.

CVP Facilities on the Sacramento River

Whiskeytown Dam, a CVP facility, is about 16.5 miles downstream from the headwaters (Reclamation 1997). Whiskeytown Lake, which is formed by the dam, has a storage capacity of 0.241 million acre-feet (MAF) and regulates local runoff from Clear Creek and water conveyed from the Trinity River watershed.

Whiskeytown Lake storage is relatively constant because of agreements between Reclamation and the National Park Service to maintain certain winter and summer lake elevations for recreation. Whiskeytown Lake outflow variations were greater prior to 2006, when Trinity River restoration flows were implemented, reducing the amount of water available for conveyance to CVP water users.

Shasta and Keswick dams are on the Sacramento River at about River Miles 308 and 299, respectively. Shasta Lake, with a maximum storage capacity of 4.552 MAF, is formed by Shasta Dam. Water flows from Shasta Lake along the Sacramento River into the 0.0238 MAF Keswick Reservoir, which operates as an afterbay for Shasta Lake hydropower operations. A temperature control device at Shasta Dam was constructed between 1996 and 1998, to enable release of cold water without power bypass to the Sacramento River downstream from Keswick Reservoir.

Baseline long-term and critically dry-year average water storage volumes for Shasta Lake are shown in Figures 1 and 2. Shasta Lake storage varies in accordance with upstream hydrology, downstream water demands, and instream flow requirements.

Keswick Reservoir water storage volume is relatively stable because it regulates flow and is not designed to provide long-term water storage. Water released from Shasta Dam travels approximately 245 miles over 3 to 4 days to the northern Delta boundary near Freeport (Reclamation 2013a). The upper reach of the Sacramento River flows approximately 60 miles from Keswick Dam to Red Bluff. The middle reach of the Sacramento River flows approximately 160 miles from Red Bluff to the confluence with the Feather River. The lower reach of the Sacramento River flows for approximately 20 river miles between the confluence with the Feather River and Freeport, immediately downstream from the confluence with the American River. Baseline long-term and critically dry-year average flows in the Sacramento River below Keswick and at Freeport (downstream from the American River confluence and near the northern boundary of the Delta) are shown in Figures 3 through 6. Flows in the Sacramento River generally peak during winter and spring storm events.

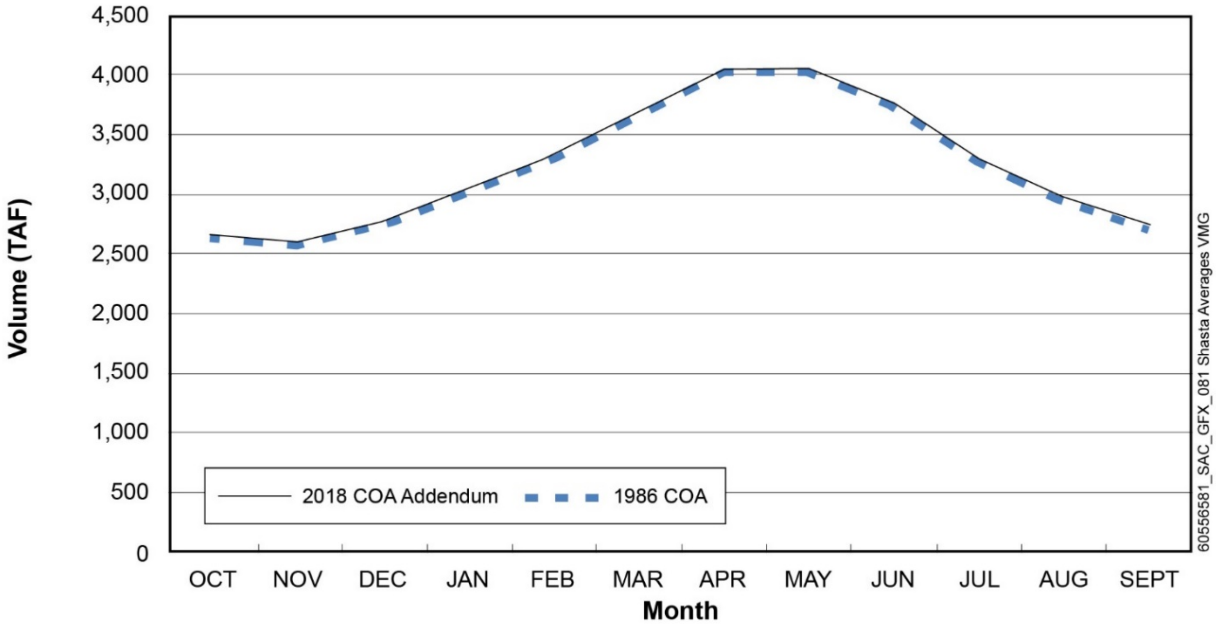

Figure 1. Shasta Lake, Long-Term Average Storage

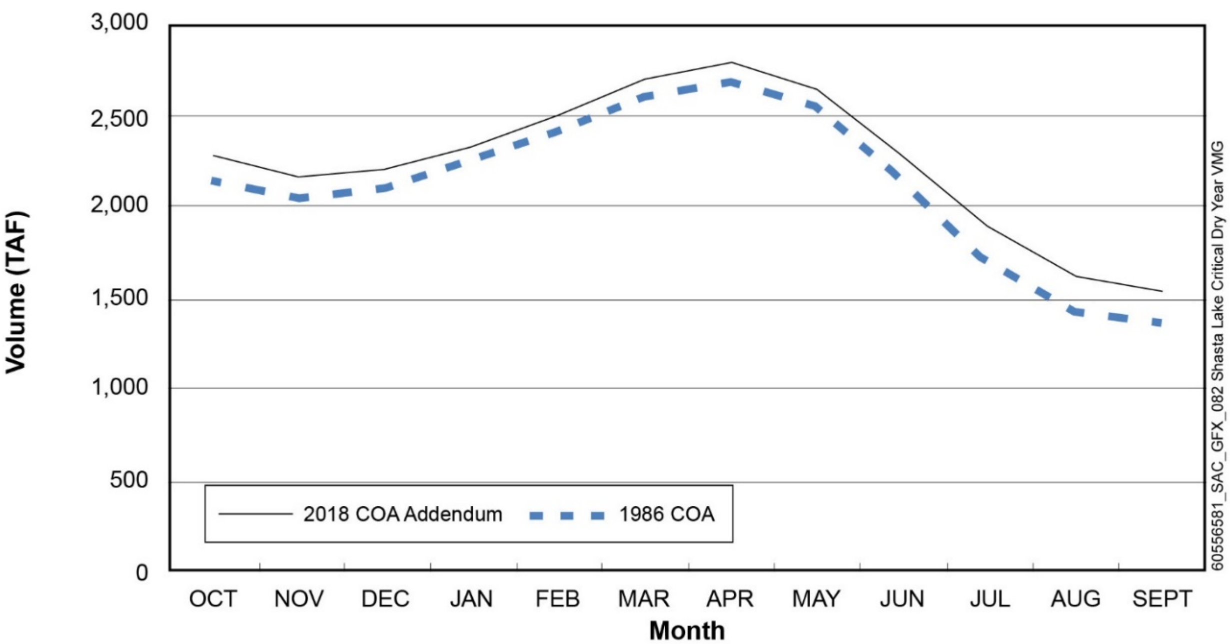

Figure 2. Shasta Lake, Critically Dry Year Average Storage

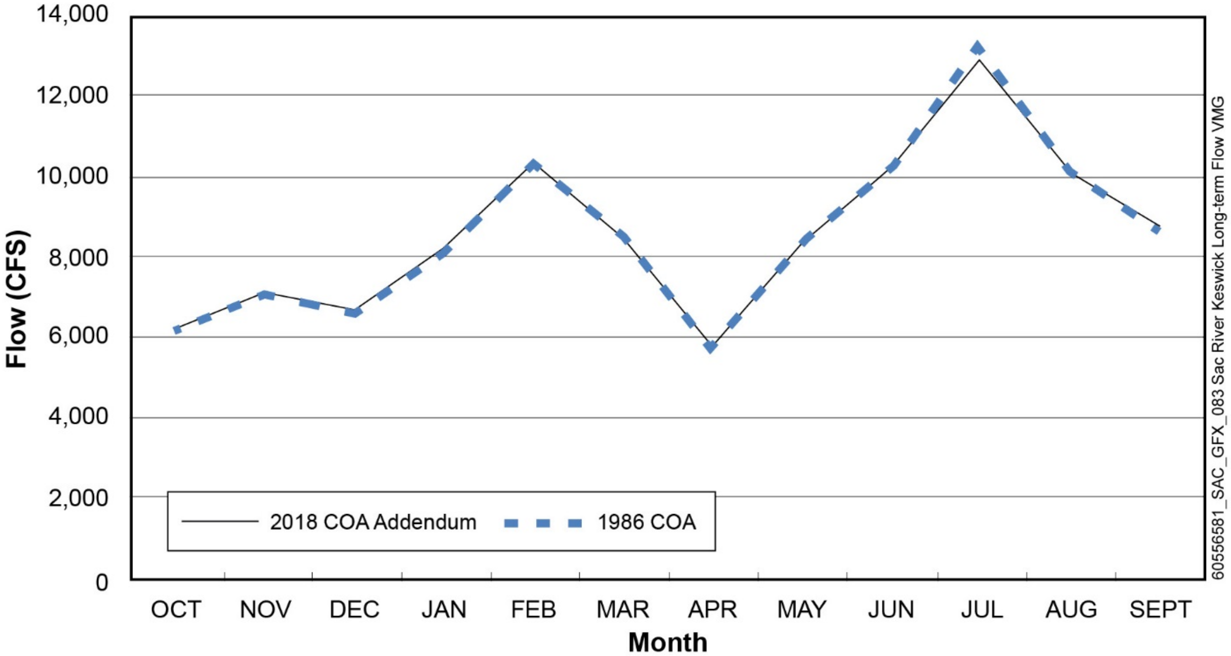

Figure 3. Sacramento River below Keswick, Long-Term Average Flow

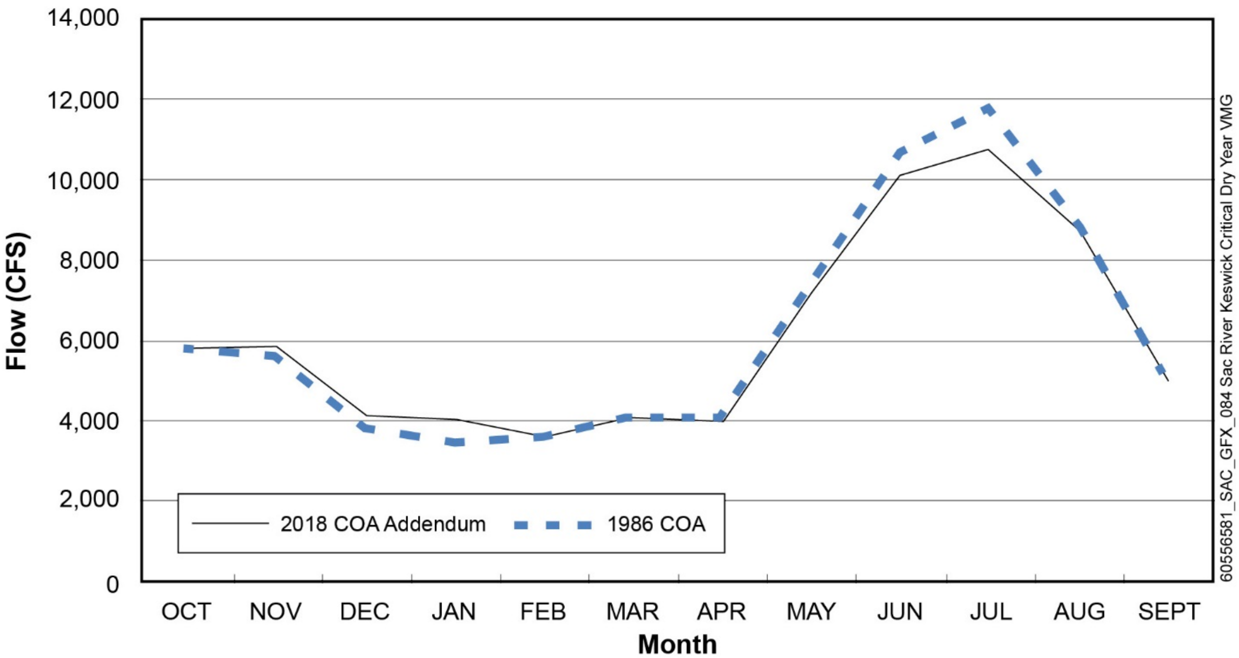

Figure 4. Sacramento River below Keswick, Critically Dry Year Average Flow

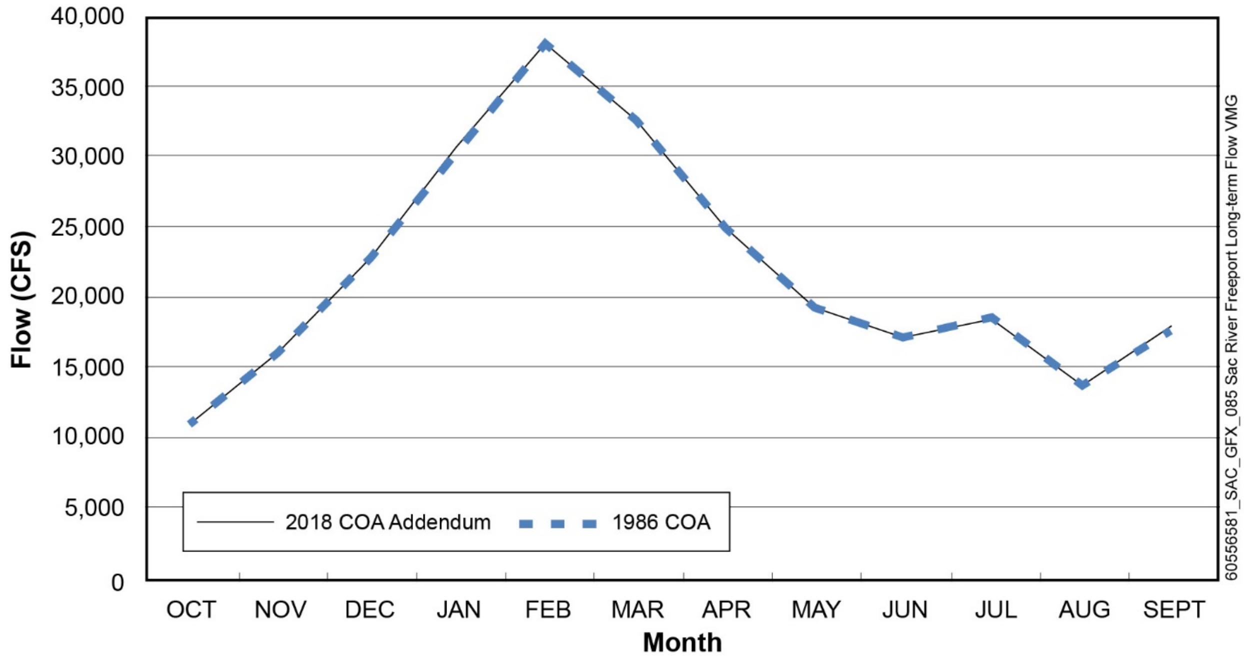

Figure 5. Sacramento River at Freeport, Long-Term Average Flow

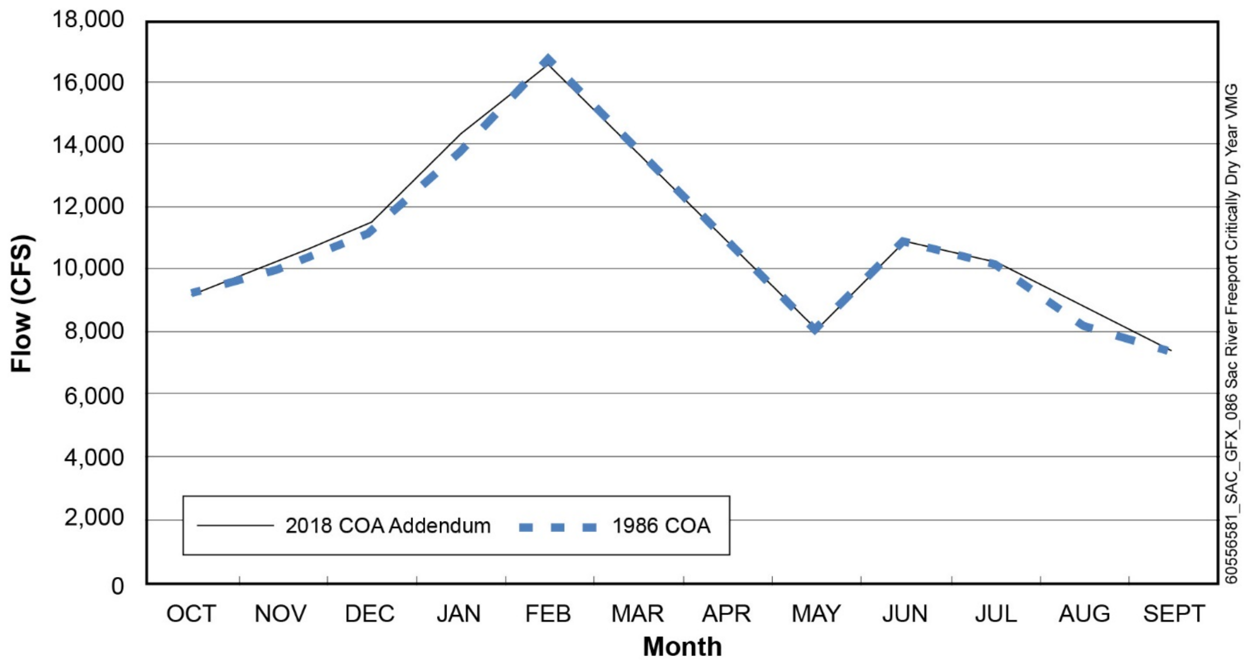

Figure 6. Sacramento River at Freeport, Critically Dry Year Average Flow

Sacramento River Drainage Features

The Sutter Basin overflow (Sutter Bypass), east of the Sacramento River and downstream from the Sutter Buttes, conveys floodwaters from the Butte Basin Overflow Area, Butte Creek, Wadsworth Canal, Reclamation Districts 1660 and 1500 drainage plants, State drainage plants, and Tisdale Weir to the confluence of the Sacramento and Feather rivers.

The Colusa Basin Drain provides drainage for a large portion of the irrigated lands on the western side of the Sacramento Valley in Glenn, Colusa, and Yolo counties; and conveys irrigation water to lands in this area. Water from the Colusa Basin Drain is discharged to the Sacramento River through the Knights Landing Outfall, a gravity flow structure, and prevents the Sacramento River from flowing into the Colusa Basin.

Flows from the Sacramento River, Feather River, Sutter Bypass, and Natomas Cross Canal join upstream from Verona. When the Sacramento River flows exceed 62,000 cubic feet per second (cfs), a large portion of the river flows over the Fremont Weir into the Yolo Bypass, a natural overflow area west of the Sacramento River. The Sacramento River Flood Control Project modified the basin, to allow Sacramento River flood flows to enter the Yolo Bypass over the Fremont and Sacramento weirs. The Yolo Bypass conveys floodwaters around the Sacramento metropolitan area and reconnects to the Sacramento River at Rio Vista. Tributaries entering the Yolo Bypass include flows from the Cache Creek Detention Basin, Willow Slough, and Putah Creek. Flows also enter the Yolo Bypass from the Colusa Basin, including flows from the Colusa Basin Drain through the Knights Landing Ridge Cut.

Feather River

The Feather River is the largest tributary to the Sacramento River downstream from Shasta Dam (Reclamation 1997; DWR 2007). The Feather River enters the Sacramento River at Verona. At this location, the total flow of the Feather River includes water from the Yuba and Bear rivers.

Lake Oroville, the primary SWP water storage facility with a capacity of 3,500 TAF, is on the Feather River. Lake Oroville stores winter and spring runoff, which is released into the Feather River to meet SWP water demands. It also provides hydropower pump-back capability, to allow on-peak electrical generation and 750 TAF of flood control storage. Lake Oroville also provides water for recreation, freshwater releases to control salinity intrusion in the Delta, and water for fish and wildlife protection. Long-term and critically dry-year average water storage volumes for Lake Oroville are shown in Figures 7 and 8.

A maximum 17,400 cfs can be released from Lake Oroville through the Edward Hyatt Powerplant and Thermalito Power Canal into the Thermalito Diversion Pool. Water continues through the Thermalito Diversion Pool into the Feather River Fish Hatchery and the 11,768 AF Thermalito Forebay that was formed by the Thermalito Diversion Dam. Water then is released from the Thermalito Forebay through the Thermalito Powerplant into the Thermalito Afterbay and the low-flow channel of the Feather River. Water from the Thermalito Afterbay flows into the Feather River. Long-term and critically dry-year average flows in the Feather River are shown in Figures 9 and 10.

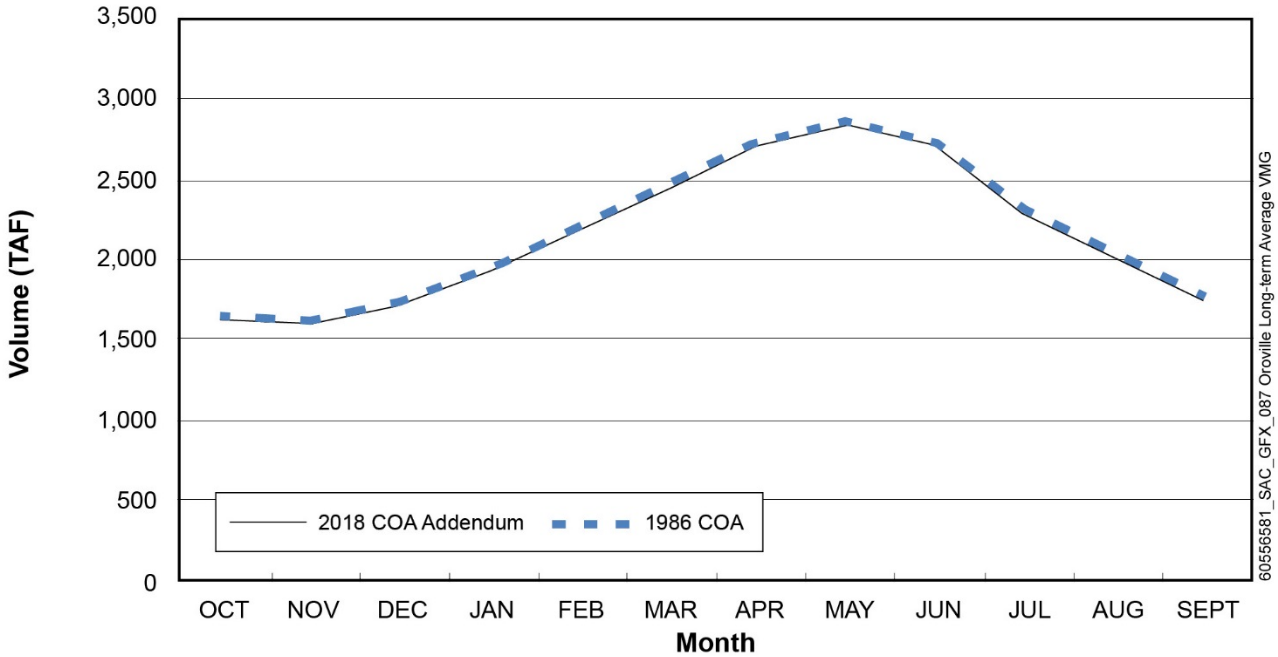

Figure 7. Lake Oroville, Long-Term Average Storage

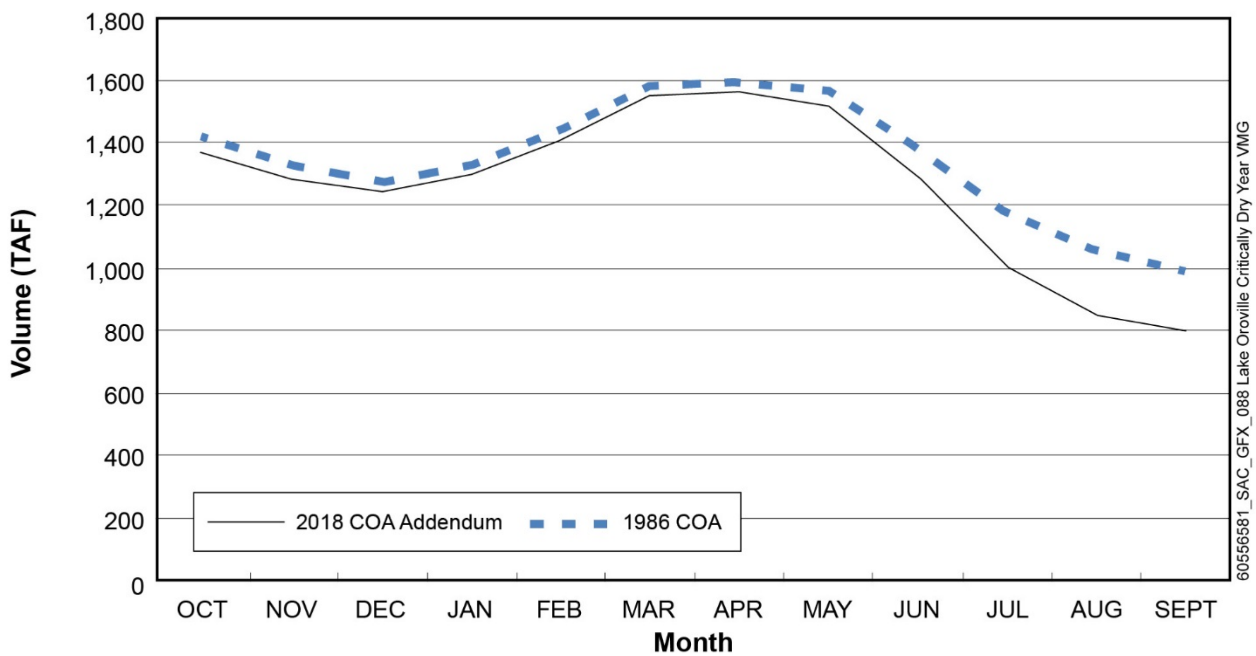

Figure 8. Lake Oroville, Critically Dry Year Average Storage

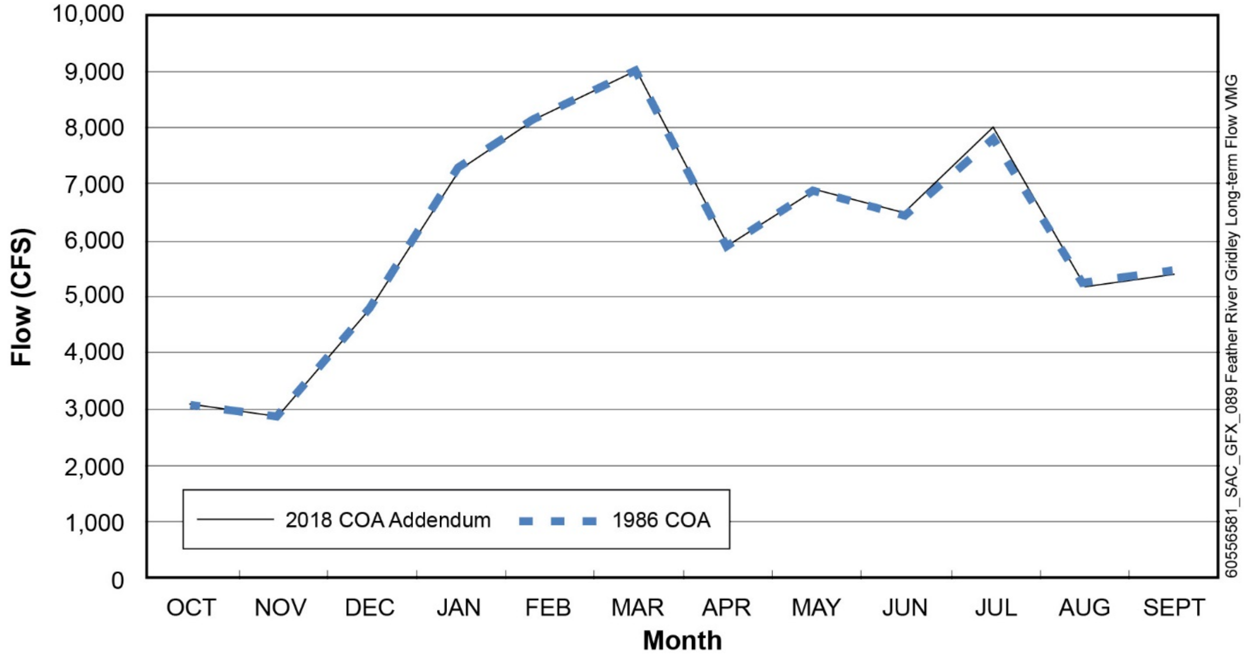

Figure 9. Feather River near Gridley, Long-Term Average Flow

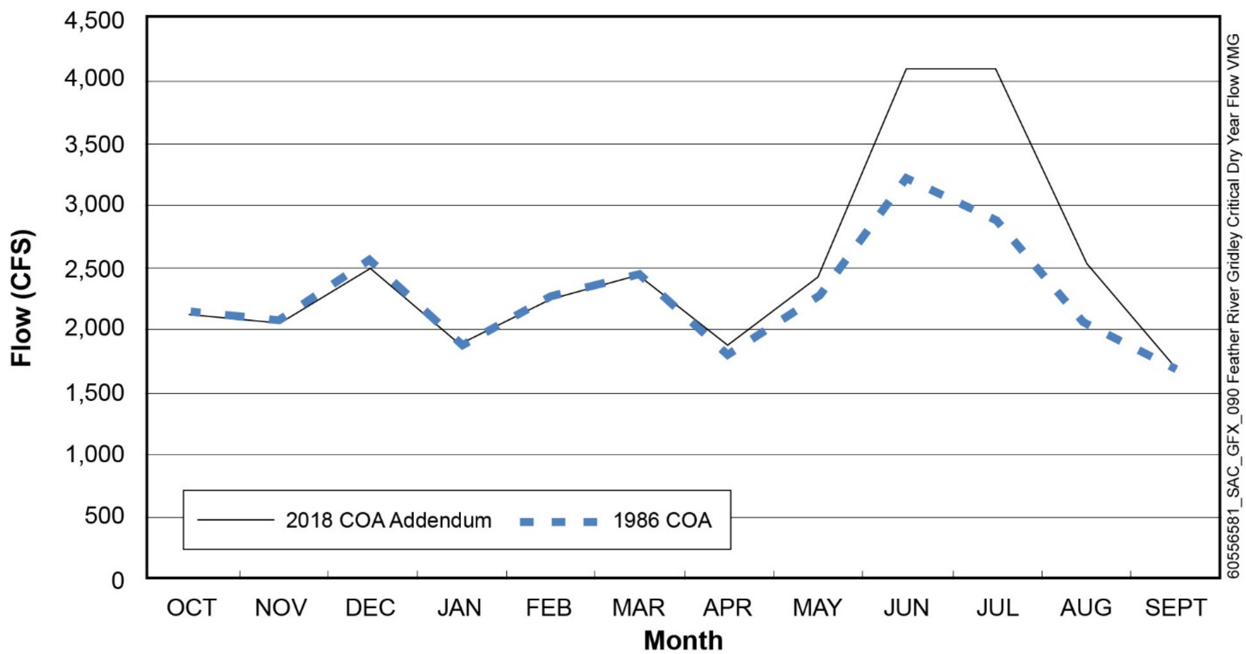

Figure 10. Feather River near Gridley, Critically Dry Year Average Flow

Operations of Oroville Dam are performed in accordance with a Federal Energy Regulatory Commission (FERC) license, Project No. 2100, which defines maximum allowable Feather River low-flow channel ramp-down release requirements to prevent rapid reductions in water levels that potentially could cause redd dewatering and stranding of juvenile salmonids and other aquatic organisms. Water releases from Lake Oroville also are affected by temperature criteria (Reclamation 2015).

AMERICAN RIVER FROM FOLSOM LAKE TO SACRAMENTO RIVER

Folsom Lake, a CVP facility formed by Folsom Dam, is 7 miles upstream from the CVP's Nimbus Dam (Reclamation et al. 2006). Folsom Lake has a capacity of 967 TAF. The American River flows 23 miles between Nimbus Dam and the confluence with the Sacramento River. The American River contributes about 15 percent of the flow in the lower Sacramento River.

Nimbus Dam creates Lake Natoma, a forebay built to re-regulate flows of the American River and direct water into the CVP's Folsom South Canal. Releases from Nimbus Dam to the American River pass through the Nimbus Powerplant, when releases are less than 5,000 cfs or the spillway gates for higher flows.

Historical water storage volumes for Folsom Lake for long-term and critically dry-year averages are shown in Figures 11 and 12.

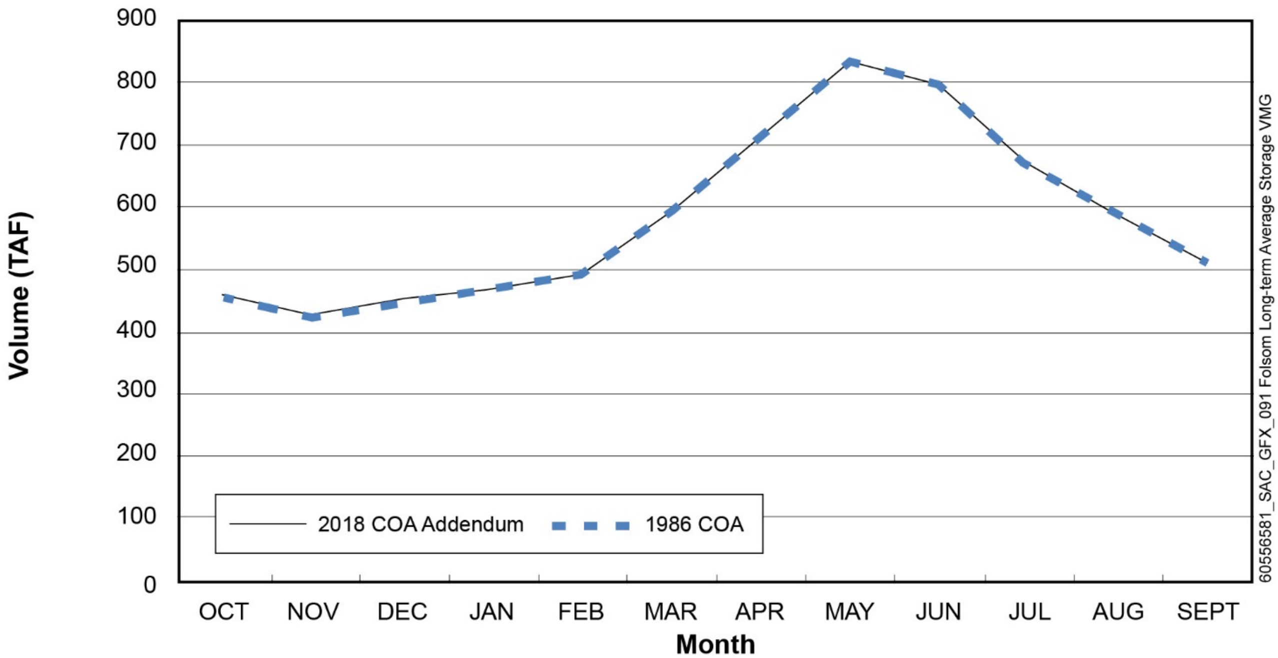

Figure 11. Folsom Lake, Long-Term Average Storage

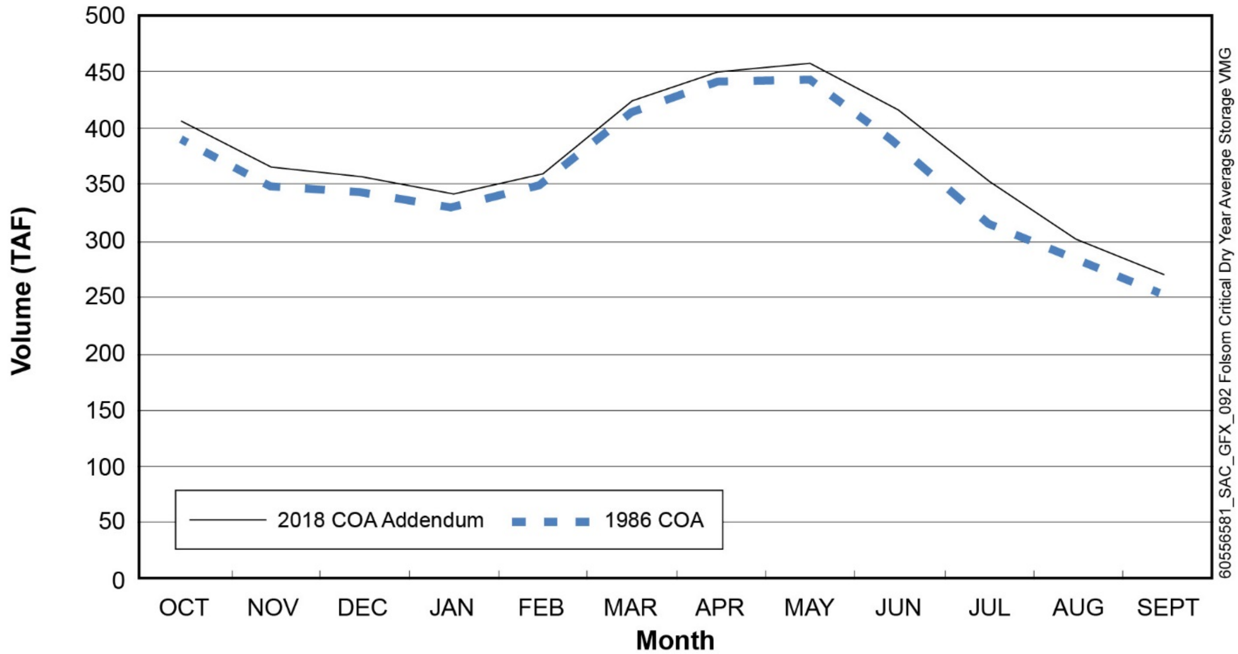

Figure 12. Folsom Lake, Critically Dry Year Average Storage

Flow patterns in the American River, downstream from Lake Natoma, are controlled by the coordinated operations of the SWP and CVP. Flows are managed to comply with American River instream flow requirements and Delta outflow and salinity requirements, as well as to contribute to CVP exports.

The minimum instream flow requirements of the lower American River are defined by SWRCB Water Rights Decision 893 (D-893), which states that releases ordinarily should not fall below 250 cfs between January 1 and September 15 or below 500 cfs at other times.

D-893 minimum flows rarely are the controlling requirements affecting CVP operations at Folsom Lake. Folsom Lake releases primarily are controlled during significant portions of a water year by flood control requirements or in coordination with other SWP and CVP releases, to meet CVP water supply and Delta water quality objectives. Folsom Lake releases generally exceed the D-893 minimum instream flow requirements, in all but the driest of conditions.

Reclamation operates Folsom Lake in compliance with Delta salinity and flow objectives, established to improve fisheries conditions. Weather conditions, combined with tidal action and local accretions from runoff and agricultural return flows, can affect Delta salinity conditions. Changes in salinity can require increases in spring Delta inflow to achieve required salinity standards. In accordance with federal and State regulatory requirements, the SWP and CVP frequently are required to release water from upstream reservoirs to maintain Delta water quality. As Folsom Lake is closer to the Delta than Lake Oroville and Shasta Lake, it generally is first to be used to meet Delta requirements.

Lower San Joaquin River

The Lower San Joaquin River flows about 100 miles from Friant Dam to the Delta. Flows in the San Joaquin River are regulated by the CVP's Friant Dam, which forms Millerton Lake. Millerton Lake has a capacity of 520 TAF. Flows downstream from Friant Dam are influenced by flows from tributary rivers and streams, including CVP operations at the New Melones Reservoir on the Stanislaus River. Flows on the San Joaquin River have changed since expiration of the Vernalis Adaptive Management Plan in 2012.

Operations of Millerton Lake and the CVP's Friant Division would not be modified by changes in SWP and CVP operations. Therefore, Millerton Lake and Friant Division are not addressed further in this document.

Two major tributaries, the Tuolumne and Stanislaus rivers, join the San Joaquin River between the confluence with the Merced River and Vernalis, at the southeastern boundary of the Delta. The flows in this reach are influenced by flow and water quality requirements at Vernalis as well as by discharges from the upstream reach and the two major tributaries.

The operating criteria for the New Melones Reservoir include limits set by water rights requirements, flood control operations, contractual obligations, federal requirements under the ESA, and the Central Valley Project Improvement Act. Reclamation operates the New Melones Reservoir to meet senior water rights and in-basin demands.

Required releases from the New Melones Reservoir include flows to meet flow and water quality requirements that are included in D-1641. This includes dissolved oxygen requirements in the Lower Stanislaus River, in accordance with the Central Valley Regional Water Quality Control Board's Basin Plan; minimum flow requirements, and the total dissolved solids requirement in the Lower San Joaquin River at Vernalis, in accordance with D-1641.

Delta and Suisun Marsh

The Delta and Suisun Marsh encompass about 1,315 square miles and convey about 40 percent of water draining from the state (DWR 2013a). The Delta and Suisun Marsh are a complex of channels and islands at the confluence of the Sacramento and San Joaquin rivers. The SWP and CVP use the Delta to convey water to State and federal pumps in the south Delta.

Inflows to the Delta occur primarily from the Sacramento River system, the San Joaquin River, and other eastside tributaries, including the Mokelumne, Calaveras, and Cosumnes rivers. About 77 percent of water enters the Delta from the Sacramento River, about 15 percent enters from the San Joaquin River, and about 8 percent enters from the eastside tributaries (DWR 1994). The daily, seasonal, and year-to-year differences in freshwater flows from the Sacramento and San Joaquin rivers and other Delta tributaries affect the Delta's water quality, particularly with regard to salinity (DWR et al. 2013).

The Sacramento River is the primary contributor to Delta freshwater inflows. North Delta channels convey Sacramento River and Yolo Bypass flows southerly and westerly. The Delta Cross Channel (DCC) gates divert flows from the Sacramento River to Snodgrass Slough and then to the Mokelumne River, where it flows into the central and south Delta. Circulation of water in the north and central Delta is determined primarily by flows in the Sacramento River; however, SWP and CVP operations alter the direction of natural flow in the central Delta, resulting in an altered flow path toward the south Delta pumps.

The San Joaquin River, the second largest contributor to Delta freshwater inflows, enters the Delta from the south. Although the natural direction of flow is toward the north and west, channel flows in the south Delta are sensitive to SWP and CVP export operations (DWR et al. 2013).

Tidal flows have a major influence on Delta surface water circulation. Flow in the Delta channels can change direction because of tidal exchange, ebbing, and flooding with the two tides per day. On average, tidal inflows to the Delta are approximately equal to tidal outflows. The tidal range can vary by about 30 percent between spring tide and neap tide conditions. Tidal flows at Martinez can be as high as 600,000 cfs. Because the Delta is tidally influenced, water surface elevations can vary from less than 1 foot in the east Delta to more than 5 feet in the west Delta (DWR 2013a) on a daily basis.

Tidal flows enter and leave the Delta along the combined Sacramento and San Joaquin rivers at Chipps Island. Farther upstream in the Delta, in the Old River near Bacon Island, tidal flows can be as high as 16,000 cfs, and at relatively upstream locations such as Freeport or Vernalis, riverine conditions dominate the tidal effects.

The SWP and CVP pumping plants can affect the direction of water flow in the Delta channels, particularly during periods of low freshwater inflow and large exports. Normally, net flows in the Delta travel westerly toward Suisun Bay and the San Francisco Bay. Diversion rates at the SWP and CVP south Delta intakes influence Delta hydraulics, changing direction of flow of some south Delta waterways. The most influential effects occur in the Old and Middle rivers (OMR), where flows are reversed during periods of south Delta pumping. Reverse flows also occur in the False River in the west Delta and Turner Cut in the San Joaquin River, causing more saline water to move farther inland (DWR et al. 2013).

Generally, opening the DCC gates can reduce salinity in some channels in the central and south Delta, particularly during the summer months, through transport of relatively lower salinity Sacramento River water into the central Delta (DWR et al. 2013).

Temporary Agricultural Barriers

The DWR South Delta Temporary Barrier Project (TBP) was initiated in 1991, to seasonally construct and demolish four rock barriers across several south Delta channels. These barriers were intended to maintain water levels in south Delta waterways and promote San Joaquin River salmon migration through the south Delta. The existing TBP consists of installing and removing temporary rock barriers at the following locations:

- Middle River, near Victoria Canal, about 0.5 mile south of the confluence of Middle River, Trapper Slough, and North Canal
- Old River, near Tracy, about 0.5 mile east of the DMC intake
- Grant Line Canal, about 400 feet east of the Tracy Boulevard Bridge
- Head of Old River (HOR), at the confluence of the Old River and the San Joaquin River

The temporary barriers on the Middle River, the Old River near Tracy, and Grant Line Canal are designed to improve water levels for agricultural diversions and are installed during the irrigation season. The Head of Old River Barrier (HORB) has been installed only from early September to November 30, when requested by CDFW if improvement of dissolved oxygen in the San Joaquin River is necessary. The HORB also has been installed in the spring months to improve out-migrating conditions for juvenile salmonids.

The agricultural barriers at the Middle River and the Old River can be installed as early as March 1, if the HORB is installed, and can be fully operated as early as April 1, if the HORB is installed, or May 15, if the HORB is not installed. From May 15 to May 31 (if the HORB is removed), the Middle River and the Old River barrier gates are opened. After May 31, the Middle River, the Old River, and Grant Line Canal barriers are permitted to be operational until they are completely removed by November 30.

SWP Barker Slough Pumping Plant

The SWP Barker Slough Pumping Plant (BSPP) diverts water from Barker Slough into the SWP's North Bay Aqueduct (NBA) for delivery to the Solano County Water Agency and the Napa County Flood Control and Water Conservation District. The 162.5 cfs NBA intake with a positive barrier fish screen is about 10 miles from the Sacramento River at the end of Barker Slough.

The NBA was designed to convey up to 175 cfs. However, the ability of the BSPP to deliver water is limited because a bio-film growth developed on its interior, restricting water conveyance to about 142 cfs. In addition, water quality in Barker Slough often is degraded, with elevated levels of coliform bacteria, organic matter, turbidity, and other pollutants during winter and spring rainfall events. This degradation limits the period that the BSPP can be operated.

The 2008 USFWS Biological Opinion (BO) reduced the total BSPP annual diversion to 71 TAF. In 2009, CDFW issued an incidental take permit for preservation of Longfin Smelt that restricted pumping rates during dry and critical dry years from January 15 to March 31.

South Delta Water Diversions

Delta channels have been modified, to allow transport of Delta inflow to south Delta diversions and reduce the effects of pumping on Delta water circulation and salinity intrusion. Water conveyance from the Sacramento River southward through the Delta to the south Delta intakes is aided by the DCC.

CVP Jones Pumping Plant

The CVP's Jones Pumping Plant, about 5 miles north of Tracy, has a permitted diversion capacity of 4,600 cfs and is connected to the end of a 2.5-mile-long, earth-lined intake channel that extends to the Old River. Water diverted at the Jones Pumping Plant is discharged to the DMC, which conveys the water about 117 miles to the Mendota Pool. The DMC has a capacity of 4,600 cfs at the Jones Pumping Plant and decreases to about 3,200 cfs at its terminus. Water exported by the Jones Pumping Plant also may be conveyed to and re-pumped into the O'Neill Forebay. Water then can be pumped into the San Luis Reservoir by the Gianelli Pumping-Generating Plant.

SWP Clifton Court and Banks Pumping Plant

The SWP facilities in the south Delta include the 31 TAF Clifton Court Forebay (CCF), about 10 miles northwest of the city of Tracy, and the Banks Pumping Plant. Water is diverted from the Old River into the CCF to provide storage for off-peak withdrawals from the CCF, moderating the effects of the pumps on flow and stage fluctuations in adjacent Delta channels, and collecting sediment before entering Banks Pumping Plant and the California Aqueduct.

The California Aqueduct transports water to the O'Neill Forebay, where it can be released either to the San Luis Canal or a portion of the California Aqueduct jointly owned by the SWP and CVP, or it can be pumped into the San Luis Reservoir. Water from the San Luis Reservoir subsequently is released to the San Luis Canal, which terminates near Kettleman City. From this location, the California Aqueduct continues to Southern California.

The capacity of the Banks Pumping Plant is 10,300 cfs. Permits issued by USACE regulate the rate of diversion of water into the CCF, normally restricted to 6,680 cfs as a 3-day average inflow to the CCF and 6,993 cfs as a 1-day average inflow. CCF diversions may be greater than these rates between December 15 and March 15, when the inflow into the CCF may be augmented by one-third of the San Joaquin River flow at Vernalis, if those flows are equal to or greater than 1,000 cfs.

In 2000, the maximum diversion rate was increased in July, August, and September, to recover export reductions resulting from actions taken to protect fisheries resources. The expanded maximum allowable daily diversion rate into the CCF was increased from 13,870 to 14,860 AF, and the 3-day average diversions from 13,250 to 14,240 AF (500 cfs per day equals 990 AF per day). Implementation of this action is contingent on meeting the conditions discussed next.

The increased diversion rate will not result in greater annual SWP water supply allocations than would occur in the absence of the increased diversion rate. Water pumped because of the increased capacity will be used only to offset reduced diversions that have occurred or will occur because of actions taken to benefit fisheries, and specifically:

- use of the increased diversion rate will be in accordance with all terms and conditions of existing BOs governing SWP operations; and
- all three temporary agricultural barriers (i.e., Middle River, Old River near Tracy, and Grant Line Canal) must be in place and operating when SWP diversions are increased.

Between July 1 and September 30, if the salvage of special-status fish species reaches a level of concern, the relevant fish regulatory agencies will determine whether the 500 cfs increased diversion may continue or will be stopped.

Banks Pumping Plant is operated to minimize its impact on power loads to the California electrical grid, to the extent practical. Generally, more pump units are operated during off-peak periods and fewer during peak periods with water stored temporarily in the CCF. Because the installed capacity of the pumping plant is 10,300 cfs, Banks Pumping Plant can be operated to reduce power grid impacts by running all available pumps at night and fewer during the higher energy-demand hours.

Long-term, dry-year, and critically dry-year average total exports (sum of Jones Pumping Plant and Banks Pumping Plant) are shown in Figures 13 through 15.

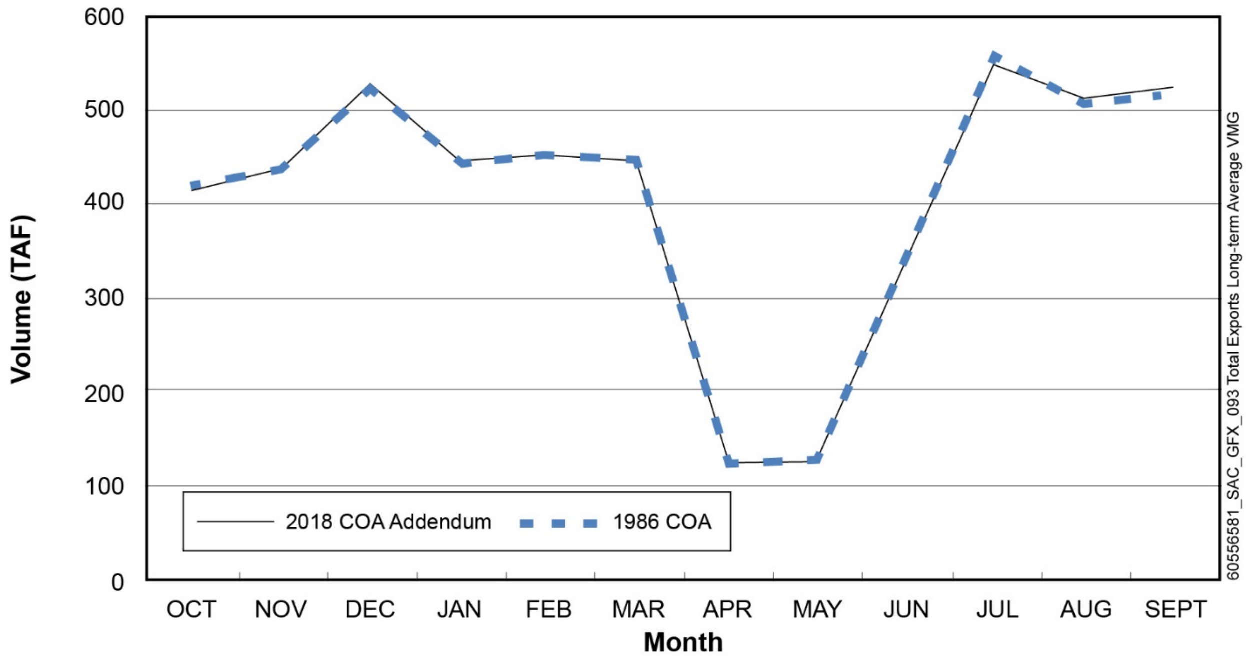

Figure 13. Total Exports, Long-Term Average Delivery

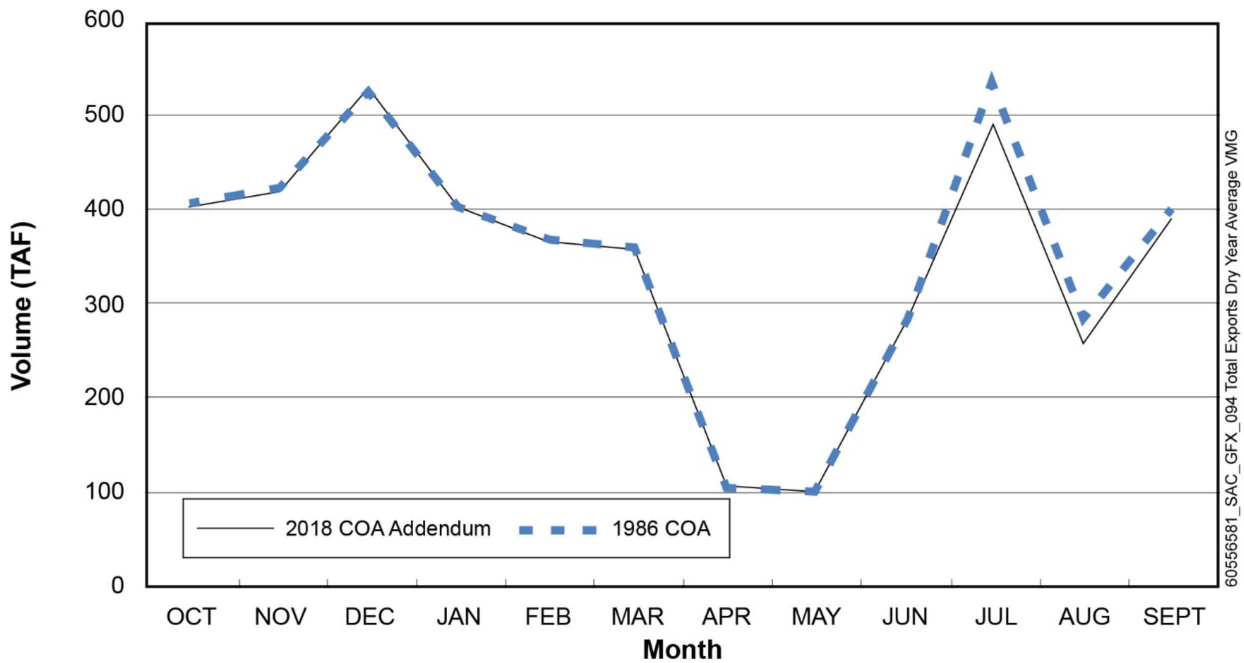

Figure 14. Total Exports, Dry Year Average Delivery

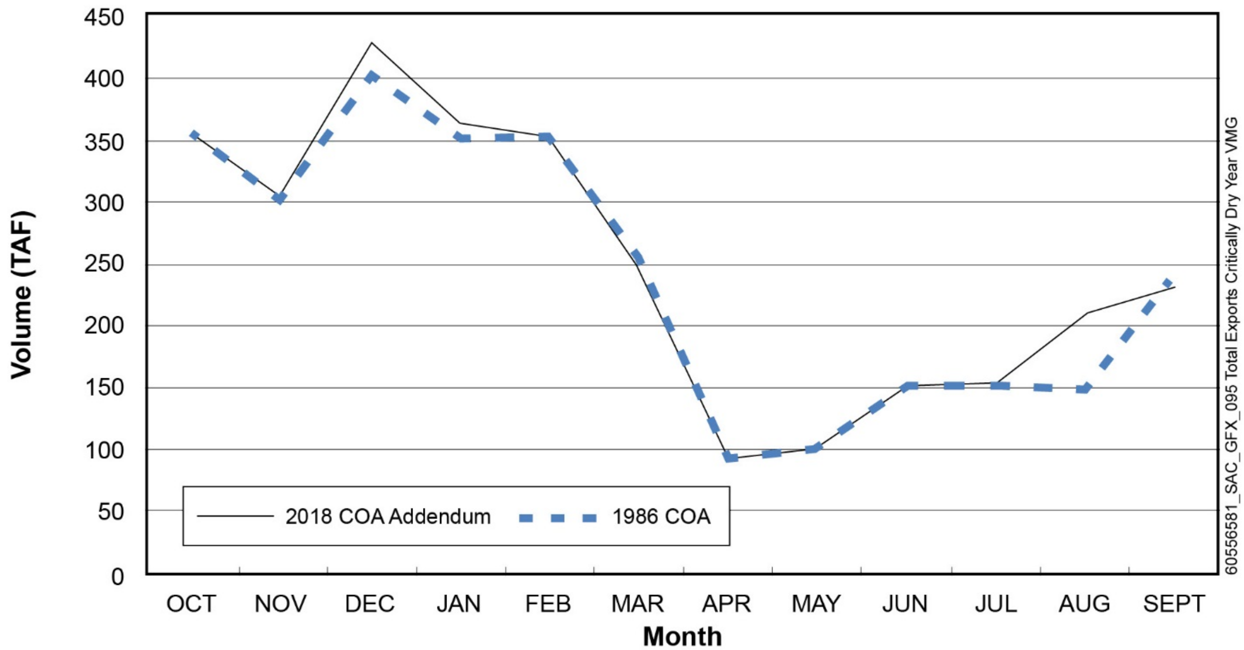

Figure 15. Total Exports, Critically Dry Year Average Delivery

Joint CVP and SWP Facilities in Suisun Marsh

The Suisun Marsh Preservation Agreement (SMPA) requires DWR and Reclamation to meet salinity standards, sets a timeline for implementing the Plan of Protection, and delineates monitoring and mitigation requirements in accordance with D-1641 to implement and operate physical facilities in the Marsh.

Suisun Marsh Salinity Control Gates

The Suisun Marsh Salinity Control Gates (SMSCG) are on Montezuma Slough near Collinsville. The objective of SMSCG operation is to decrease the salinity of the water in Montezuma Slough by restricting the flow of higher salinity water from Grizzly Bay into Montezuma Slough during incoming tides and retaining lower salinity Sacramento River water from the previous ebb tide. This operation lowers salinity in Suisun Marsh channels and results in a net movement of water from east to west.

When Delta outflow is low to moderate and the gates are not operating, tidal flow past the gate is about 5,000 to 6,000 cfs while the net flow is near zero. When operated, flood tide flows are arrested while ebb tide flows remain in the range of 5,000 to 6,000 cfs. The net flow in Montezuma Slough becomes about 2,500 to 2,800 cfs.

The 2,800 cfs net flow induced by SMSCG operation is effective at moving higher salinity concentrations downstream in Montezuma Slough. Salinity is reduced by roughly 100 percent at Belden's Landing, and by lesser amounts farther west along Montezuma Slough. At the same time, the salinity field in Suisun Bay moves upstream as net Delta outflow is reduced by gate operation. Net outflow through the Carquinez Strait is not affected.

The USACE permit for the SMSCG requires that it be operated between October and May, only when needed to meet Suisun Marsh salinity standards. Historically, the gate has been operated as early as

October 1, although in some years (e.g., 1996) the gate was not operated at all. When the channel water salinity decreases sufficiently below the salinity standards, or at the end of the control season, the SWP and CVP provide unrestricted flow through Montezuma Slough.

Roaring River Distribution System

The Roaring River Distribution System (RRDS) was constructed between 1979 and 1980, to provide lower salinity water to 5,000 acres of private and 3,000 acres of CDFW-managed wetlands on Simmons, Hammond, Van Sickle, Wheeler, and Grizzly islands. The RRDS includes a 40-acre intake pond that supplies water to Roaring River Slough. Motorized slide gates in Montezuma Slough and flap gates in the pond control flows through culverts into the pond. A flap gate and flashboard riser are at the confluence of the Roaring River and Montezuma Slough, to enable drainage back into Montezuma Slough for controlling water levels in the distribution system and to provide flood protection. Water is diverted into the Roaring River intake pond on high tides, to raise the water surface elevation in RRDS above the adjacent managed wetlands. Managed wetlands north and south of the RRDS receive water, as needed.

Morrow Island Distribution System

The Morrow Island Distribution System (MIDS) was constructed between 1979 and 1980 in southwestern Suisun Marsh, to channel drainage water from the adjacent managed wetlands for discharge into Suisun Slough and Grizzly Bay. The MIDS increases circulation and reduces salinity in Goodyear Slough.

The MIDS is used year-round but most intensively from September through June. When managed wetlands are filling and circulating, water is tidally diverted from Goodyear Slough just south of Pierce Harbor. Water is discharged into Grizzly Bay by way of the C-Line outfall and into the mouth of Suisun Slough by way of the M-Line outfall, rather than back into Goodyear Slough. This additional supply minimizes salinity increases that are caused by drainage water discharges into Goodyear Slough.

South of Delta Facilities

Both the SWP and CVP operate conveyance and storage facilities south of the Delta, conveying water supplies to their respective service areas and water users.

Delta–Mendota Canal/California Aqueduct Intertie

The connection between the DMC and the California Aqueduct allows water to flow between the SWP and CVP conveyance facilities. The DMC/California Aqueduct intertie achieves multiple benefits, including meeting current water supply demands, allowing maintenance and repair of the CVP Delta export and conveyance facilities, and providing operational flexibility to respond to emergencies.

San Luis Reservoir

The 2.027-MAF San Luis Reservoir, formed by Sisk Dam, is jointly operated by Reclamation and DWR, with about 0.965 MAF stored by the CVP and 1.062 MAF stored by the SWP. Generally, water is diverted into the San Luis Reservoir during late fall through early spring, when irrigation water demands are lower and are being met directly by Delta exports. By April or May, demands from both agricultural and M&I SWP water service contractors usually exceed the pumping rate at Banks Pumping Plant, and releases from the San Luis Reservoir to the SWP facilities are needed to supplement the Delta pumping at Banks Pumping Plant to meet SWP contractor demands.

Joint Point of Diversion

D-1641 authorized the SWP and CVP to jointly use the Jones and Banks pumping plants in the south Delta, with conditional limitations and required response coordination plans (referred to as Joint Point of Diversion [JPOD]). Use of JPOD is based on staged implementation. Each stage of JPOD has regulatory terms and conditions that must be satisfied to implement JPOD. All stages require a response plan to ensure that the water quality in the south and central Delta will not be significantly degraded through operations of the JPOD, to an extent that would cause injury to water users in the south and central Delta (Water Level Response Plan).

SWP and CVP Conveyance Facilities Downstream from the San Luis Reservoir

Water from the San Luis Reservoir is released into the California Aqueduct, which conveys water southward to Lake Perris in Riverside County. The first segment of the California Aqueduct downstream from the San Luis Reservoir is called the San Luis Canal. This canal is owned jointly by the SWP and CVP and extends from the San Luis Reservoir to Kettleman City. Near Kettleman City, the water is diverted into the SWP’s Coastal Branch Aqueduct to serve agricultural areas west of the California Aqueduct and communities in San Luis Obispo and Santa Barbara counties.

The California Aqueduct continues into Southern California through the Edmonston Pumping Plant at the foot of the Tehachapi Mountains, which raises the water into Antelope Valley. At that location, the California Aqueduct divides into two branches; the East Branch and the West Branch. The East Branch conveys the water into Silverwood Lake in the San Bernardino Mountains, with a capacity of 73,000 AF of water. From Silverwood Lake, the water flows through the San Bernardino Tunnel to Lake Perris. Lake Perris, near the city of Riverside, provides up to 131,500 AF of storage and serves as a regulatory and emergency water supply facility for the East Branch. The East Branch Extension conveys water to San Gorgonio Pass Water Agency and the eastern portion of the San Bernardino Valley Municipal Water District. The West Branch conveys the water to Pyramid Lake in Los Angeles County. The water from Pyramid Lake is conveyed to the 324,000-AF Castaic Lake.

Water Supplies Used by Central Valley Project and State Water Project Water Users

The SWP and CVP water supplies are the only water supplies available to some water users, including many of the CVP’s Sacramento River Settlement contractors, communities near Redding (Centerville, Clear Creek, and Shasta community services districts; Shasta County Water Agency), communities in the San Joaquin Valley (the cities of Avenal, Coalinga, and Huron), and some communities that are served by the Antelope Valley–East Kern Water Agency. Other SWP and CVP water users rely on other surface water supplies and groundwater. However, when the SWP and CVP water supplies are limited because of lack of precipitation, their other surface water supplies also are limited.

Several SWP and CVP water users also rely on other imported water supplies, including water from the Solano Project, used by the Solano County Water Agency; from the Hetch Hetchy Water Project used by the Alameda County Water District, Santa Clara Valley Water District, and Zone 7 Water Agency; the Mokelumne River used by the East Bay Municipal Utility District; and the Colorado River used by portions of the service area of the Metropolitan Water District of Southern California and Coachella Valley Water District.

These surface water supplies also are subject to reductions because of hydrologic conditions. In the case of water users who rely on Colorado River water supplies, Delta water is used to dilute the salts and trace elements (e.g., selenium) found in the Colorado River water supply, in addition to providing direct water supplies (Reclamation 2012).

In response to recent reductions in SWP and CVP water supply reliability, water agencies have been improving regional and local water supply reliability through enhanced water conservation efforts, wastewater effluent and stormwater recycling, construction of local surface water and groundwater storage facilities, and construction of desalination treatment plants for brackish water sources and ocean water sources. In addition, many agencies have constructed conveyance facilities to allow sharing of water supplies between communities. The Bay Area Regional Reliability partnership was formed in 2015 by six water districts and one water agency, to improve integrated regional water management and drought mitigation. This collaboration is providing conveyance opportunities between several SWP and CVP water users in the San Francisco Bay Area.

Exceedance plots of total SWP and CVP deliveries are shown in Figures 16 and 17. As shown, SWP deliveries would be reduced while CVP deliveries would increase. However, when total south of Delta exports are considered, as shown in Figure 13, total south of Delta deliveries would be reduced by about 2 TAF.

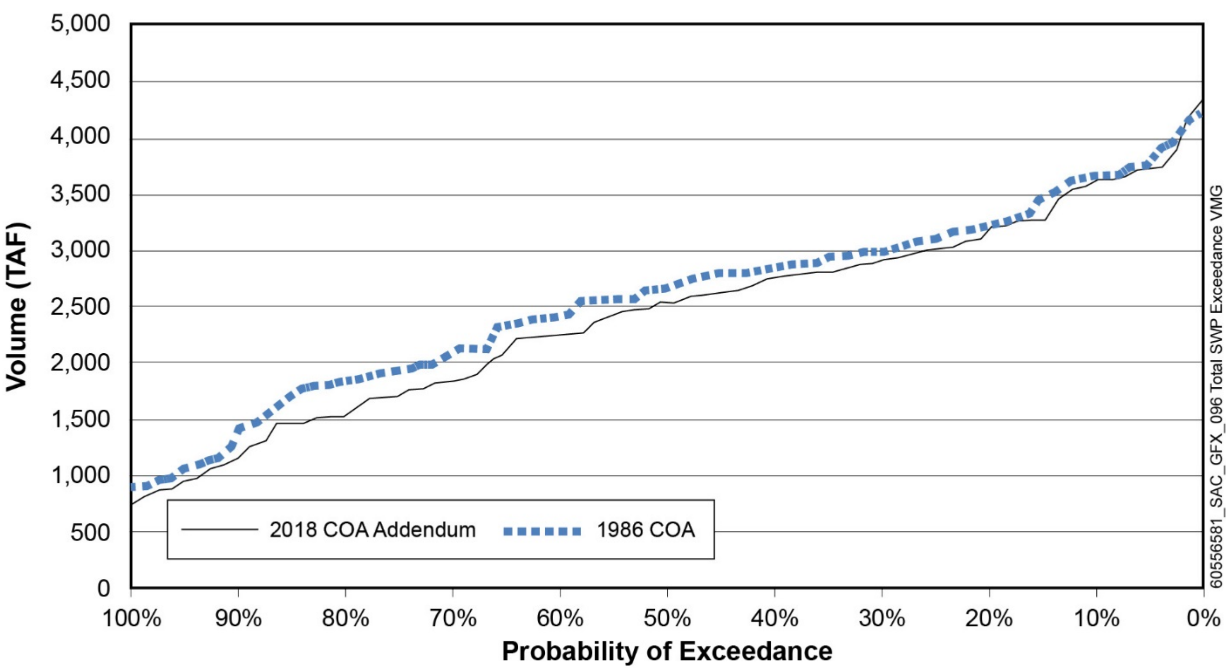

Figure 16. Exceedance Plot of Total SWP Deliveries

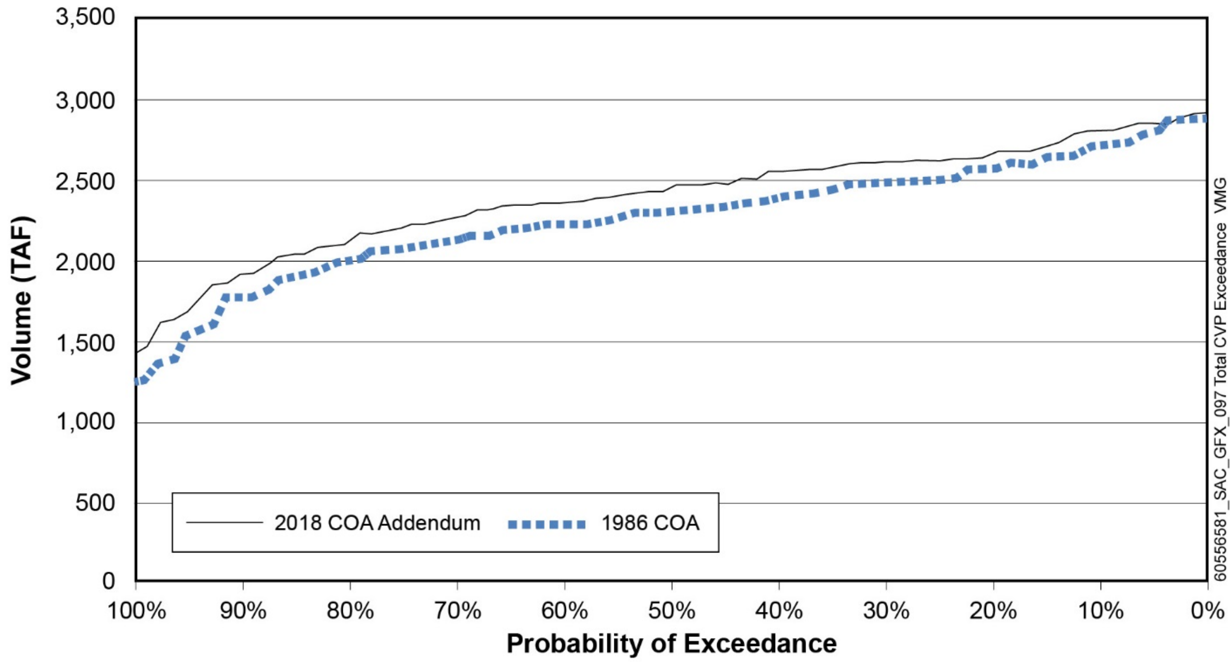

Figure 17. Exceedance Plot of Total CVP Deliveries

WATER TRANSFERS

Water transfers also are an integral part of water management. Historically, water transfers primarily were limited to in-basin transfers (e.g., Sacramento Valley to Sacramento Valley water users) (Reclamation 2013b; DWR et al. 2013). However, between 2001 and 2012, water transfers from the Sacramento Valley to areas south of the Delta increased to 298,806 AF, not including water transfers under the California Federal Bay–Delta (CALFED) Environmental Water Account Program (DWR et al. 2013). These transfers occurred in drier years, when water supplies were needed and capacity at the south Delta pumps was available.

In 2008, one of the first long-term water transfer agreements was approved by the SWRCB for the Lower Yuba River Accord. The plan was designed to protect and enhance fisheries resources in the Lower Yuba River, increase local water supply reliability, provide DWR with increased operational flexibility for protection of Delta fisheries, and provide additional dry-year water supplies to SWP and CVP water users.

In 2013, Reclamation approved an overall program for a 25-year time frame (2014 to 2038), to transfer up to 150,000 AF/yr of water from the San Joaquin River Exchange Contractors Water Authority to USDOI for refuge water supplies or SWP or CVP water users (Reclamation 2013b). Reclamation also approved a long-term water transfer program (2015 to 2024) from water sellers in the Sacramento Valley to water users in the San Francisco Bay Area and south of the Delta (Reclamation 2014b).

EFFECTS OF THE 2018 COA ADDENDUM

ANALYSIS OF EFFECTS–HYDROLOGY AND WATER SUPPLY

This section describes the changes to hydrology and water supply associated with implementation of SWP and CVP operations as regulated by the 2018 COA Addendum when compared to the 1986 COA. Detailed modeling results using the CalSim II computer model for all water-year types and long-term averages are provided in Appendix C.

The 2018 COA Addendum would modify operations and associated reservoir storage, downstream surface water flows, and diversions at selected SWP facilities and related waterways. Descriptions of estimated changes in hydrology are presented to provide a basis for understanding potential hydrologic effects on designated beneficial uses. Estimated changes in hydrology are summarized in the following discussions.

SACRAMENTO RIVER FLOWS DOWNSTREAM FROM THE FEATHER RIVER CONFLUENCE

The CalSim II model results indicate that flows of the Sacramento River downstream from the Feather River confluence would not change substantially with implementation of the 2018 COA Addendum. As shown in Figure 6, 2018 COA Addendum operations would result in surface water flows in the Sacramento River at Freeport similar to 1986 COA mean monthly flows. Changes to Sacramento River mean monthly flow would not exceed 1 percent. These changes would be within the range of model error.

During wet, above-normal, and below-normal water years, mean monthly Sacramento River flow at Freeport under 2018 COA Addendum operations is expected to vary, from a decrease of 1 percent (equal to a 6 cfs decrease in wet water years) to an increase of 2 percent (equal to a 30 cfs increase in above-normal water years), compared to 1986 COA conditions. During dry water years, mean monthly July flows would be reduced from 17,591 to 16,782 cfs (equal to 809 cfs or 5 percent), compared to 1986 COA conditions. In critical water years, mean monthly August flow would increase from 8,153 to 8,813 cfs (equal to 661 cfs or 8 percent).

SACRAMENTO–SAN JOAQUIN DELTA

To analyze conditions in the Delta, the following locations were assessed:

- Delta Outflow
- Old and Middle Rivers Flow
- Total Exports from Banks Pumping Plant

Delta Outflow

As shown in Figure 18, Delta outflow under 2018 COA Addendum operations would be similar to 1986 COA mean monthly flow conditions. Changes to Delta outflow mean monthly flow would not exceed 1 percent. These changes would be within the range of model error.

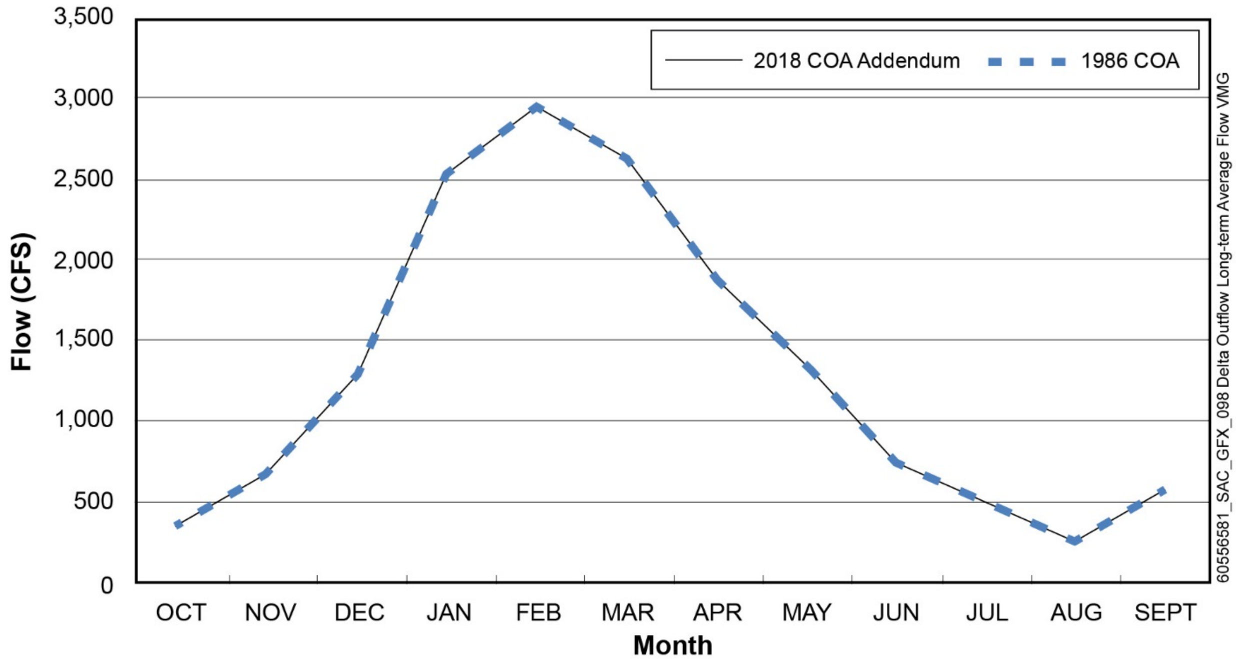

Figure 18. Delta Outflow With 2018 COA Addendum Operations

During wet, above-normal, below-normal, and dry water years, mean monthly flow at Freeport under 2018 COA Addendum operations would vary, from a decrease of 2 percent (equal to a 16 cfs decrease in above-normal water years) to an increase of 2 percent (equal to a 11 cfs increase in wet water years), compared to 1986 COA conditions. In critical water years, mean monthly August flows would be reduced by 279 cfs (7 percent).

Old and Middle Rivers Flow

Over the long term, OMR flow would be similar with the 2018 COA operations, compared to the 1986 COA conditions. The long-term average April flow would increase by 13 cfs. Changes to April OMR flow with 2018 COA Addendum operations would be within the range of model error, compared to 1986 COA conditions.

In wet water years, OMR flow would increase by 59 cfs (8 percent) in May under 2018 COA Addendum operations, compared to 1986 COA conditions. In the 11 other months, changes to OMR flow would vary from a decrease of 3 percent to an increase of 2 percent. In above-normal and below-normal water years, changes to OMR flow would vary, from a decrease of 4 percent to an increase of 3 percent. In dry water years, OMR flow would increase by 710 cfs (8 percent) in July and 391 cfs (8 percent) in August. In all other months of dry water years, changes to OMR flow would vary from a decrease of 2 percent to an increase of 1 percent. In critical water years, OMR flow would decrease by 365 cfs (7 percent) in December and 872 cfs (32 percent) in August, and would increase by 158 cfs (5 percent) in March.

Total Exports from Banks Pumping Plant

Over the long term, average annual Banks Pumping Plant exports would decrease by 190 cfs. These exports would decrease by 499 cfs (13 percent) in January, 374 cfs (9 percent) in February, 155 cfs (15 percent) in April, 142 cfs (15 percent) in May, and 400 cfs (15 percent) in June under 2018 COA operations, compared to 1986 COA conditions. In wet water years, Banks Pumping Plant exports would decrease by 358 cfs (7 percent) in January, 216 cfs (15 percent) in April, 229 cfs (15 percent) in May, 432 cfs (11 percent) in June, and 384 cfs (8 percent) in December under 2018 COA operations, compared to 1986 COA conditions. In above-normal water years, Banks Pumping Plant exports would decrease by 536 cfs (15 percent) in January, 389 cfs (9 percent) in February, 152 cfs (18 percent) in April, 123 cfs (16 percent) in May, and 510 cfs (17 percent) in June. In below-normal water years, Banks Pumping Plant exports would decrease by 547 cfs (17 percent) in January, 326 cfs (8 percent) in February, 127 cfs (16 percent) in April, 115 cfs (15 percent) in May, and 543 cfs (21 percent) in June. In dry and critical water years, Banks Pumping Plant exports would decrease by up to 602 cfs (20 percent) in January, up to 595 cfs (18 percent) in February, up to 456 cfs (17 percent) in March, up to 151 cfs (18 percent) in April, up to 112 cfs (15 percent) in May, up to 312 cfs (18 percent) in June, up to 547 cfs (24 percent) in July, and up to 700 cfs (58 percent) in August.

San Luis Reservoir

With implementation of 2018 COA Addendum operations, maximum and minimum annual storage at the San Luis Reservoir would decrease, compared to 1986 COA conditions (Figure 19). However, for the most part, the annual San Luis Reservoir storage range under 2018 COA Addendum operations would be similar to 1986 COA conditions, as shown in Figure 19. In years with limited annual San Luis Reservoir storage range, the storage range under 2018 COA Addendum operations would decrease, compared to 1986 COA conditions. These changes would be within the range of model error. Over the long term, the average San Luis Reservoir storage would be greater under 2018 COA operations, compared to the 1986 COA conditions, except in February and March, when storage would be similar (See Appendix C).

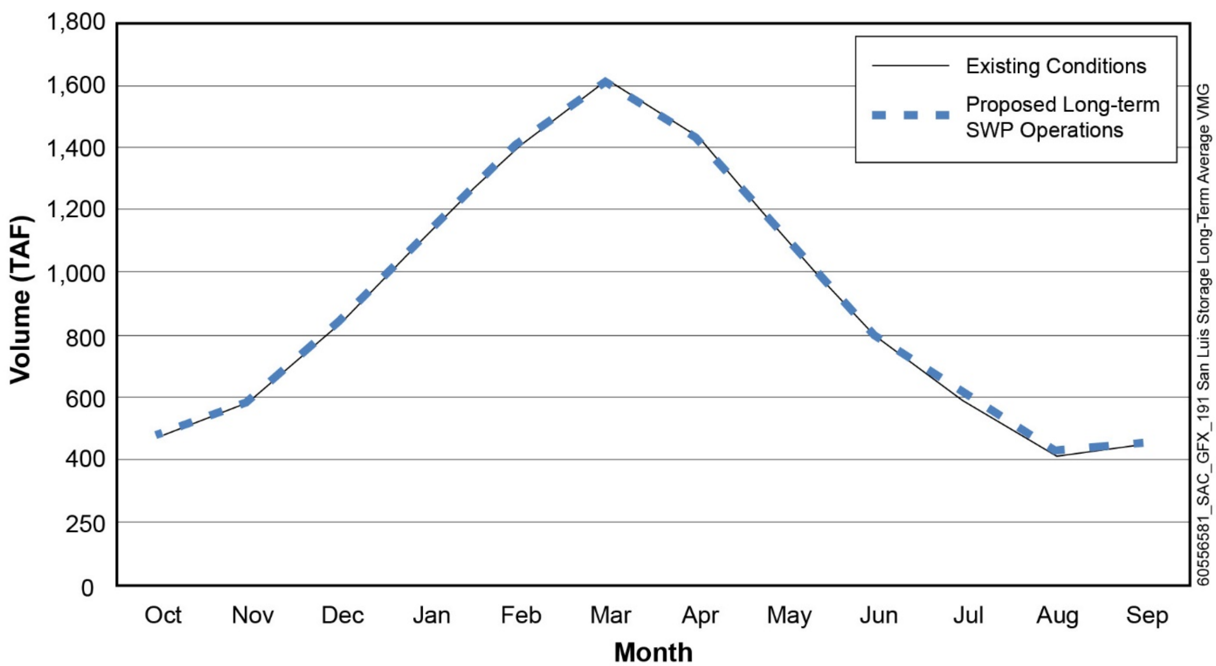

Figure 19. SWP Water Storage in San Luis Reservoir with 2018 COA Operations

SWP Contract Deliveries

Table 1 shows the total annual SWP deliveries for 1986 COA conditions and 2018 COA operations for long-term average period and for dry and critical water years. An exceedance plot of SWP deliveries also is shown in Figure 16.

Table 1. Annual SWP Regional Deliveries, 2018 COA Addendum Compared to the 1986 COA

Region	Delivery Type[a]	Average (Annual)	1986 COA (TAF)	2018 COA (TAF)	Change from the 1986 COA to 2018 COA (TAF/%)
SWP FRSA	Contract Delivery	Long-Term[b]	952	952	0 (0%)
SWP FRSA	Contract Delivery	Dry and Critical[c]	908	908	0 (0%)
SWP M&I	Contract Delivery	Long-Term	31	30	-1 (-3%)
SWP M&I	Contract Delivery	Dry and Critical	22	20	-2 (-9%)
SWP Ag	Contract Delivery (including Article 21)	Long-Term	3	3	0 (-5%)
SWP Ag	Contract Delivery (including Article 21)	Dry and Critical	2	2	0 (-14%)
SWP M&I	Contract Delivery (including Article 21, includes transfers to SWP contractors)	Long-Term	209	202	-7 (-3%)
SWP M&I	Contract Delivery (including Article 21, includes transfers to SWP contractors)	Dry and Critical	134	125	-9 (-7%)
SWP M&I	Contract Delivery	Long-Term	43	40	-2 (-5%)
SWP M&I	Contract Delivery	Dry and Critical	26	22	-4 (-13%)
SWP M&I	Contract Delivery	Long-Term	82	77	-5 (-6%)
SWP M&I	Contract Delivery	Dry and Critical	50	42	-8 (-15%)
SWP Ag	Contract Delivery (including Article 21)	Long-Term	621	585	-36 (-6%)
SWP Ag	Contract Delivery (including Article 21)	Dry and Critical	365	310	-55 (-15%)
SWP M&I	Contract Delivery (including Article 21)	Long-Term	273	260	-14 (-5%)
SWP M&I	Contract Delivery (including Article 21)	Dry and Critical	175	155	-20 (-12%)
SWP M&I	Contract Delivery (including Article 21, includes transfers to SWP contractors)	Long-Term	1,311	1,242	-69 (-5%)
SWP M&I	Contract Delivery (including Article 21, includes transfers to SWP contractors)	Dry and Critical	867	763	-104 (-12%)
SWP Ag	Contract Delivery (including Article 21)	Long-Term	8	7	-1 (-6%)
SWP Ag	Contract Delivery (including Article 21)	Dry and Critical	5	4	-1 (-13%)
Total SWP Supplies	Contract Delivery (FRSA, Ag, and M&I from SWP and Sites Reservoir)	Long-Term	3,532	3,399	-133 (-4%)
Total SWP Supplies	Contract Delivery (FRSA, Ag, and M&I from SWP and Sites Reservoir)	Dry and Critical	2,555	2,352	-202 (-8%)

Notes:
a. Based on CALSIM-II modeling over an 82-year simulation period.
b. Long-Term is the average quantity from October 1921 through September 2003.
c. Dry and Critical Years Average is the average quantity for the combination of the SWRCB D-1641 40-30-30 dry and critical years from October 1921 through September 2003.
Ag = Agricultural
M&I = Municipal and Industrial

Average annual SWP deliveries would decrease by 133 TAF under 2018 COA operations, compared to the 1986 COA conditions. This decrease would be consistent with the long-term average annual decrease at Banks Pumping Plant of 135 TAF. Delivery decreases would greatest during below-normal, dry, and critical water years. In the dry and critical water years, average annual SWP deliveries under 2018 COA operations would decrease by 202 TAF (8 percent), compared to the 1986 COA conditions.

DISCUSSION

Implementation of SWP 2018 COA Addendum operations would result in a similar hydrologic and water supply pattern, compared to 1986 COA operations. Although limited changes to surface water hydrology were observed in the model, these changes would be minimal, and usually would be limited to 1 or 2 months in a water year.

The Banks Pumping Plant exports figure is the only output parameter exhibiting a significant change. Implementation of the 2018 COA Addendum operations would result in long-term average decreases, compared to 1986 COA conditions. Decreases to exports would improve water quality, reduce fish entrainment, and benefit other environmental resources.

Therefore, the hydrologic changes discussed above do not merit further analysis to assess potential changes to designated uses and other environmental resource.

ANALYSIS OF EFFECTS–WATER QUALITY

As described in the analysis of effects on hydrology and water supply, those changes would be negligible. Therefore, changes to water quality constituents, exceedance of water quality standards, or violations of waste discharge requirements would not occur.

Implementation of the COA 2018 operations would not include construction of new or modified facilities. Therefore, no changes would occur to flows into existing drainage systems or new sources of polluted runoff. Because the flow patterns under the 2018 COA Addendum operations would be similar to COA 1986 conditions, no changes would occur that would result in a conflict with water quality control plans.

Because the SWP operations corresponding to the 2018 COA Addendum operations would be similar to 1986 COA operations, no changes would occur to water quality.

The analysis of surface water hydrology demonstrates that implementation of the 2018 COA Addendum had no effect on surface waters upstream from the Delta, as shown in Figure 3 for the Sacramento River downstream from Keswick Dam; nor had an effect on surface waters in the Delta upstream from the south Delta pumps (Figure 5) for the Sacramento River at Freeport. Total south of Delta water exports would not change substantially with implementation of the 2018 COA Addendum. As shown in Figure 13, the combined CVP and SWP water diversion is very similar to the 1986 COA operations. The 2018 COA Addendum did affect the allocation of water between the CVP and SWP at the south Delta pumping facilities, as shown in Figures 16 and 17.

Because of implementation of the 2018 COA Addendum, CVP water deliveries would increase and SWP deliveries would decrease by an average annual 130 TAF. This decrease would represent about 5 percent of the average annual SWP deliveries.

Table 2 shows the results of the analysis of impact on the environmental resource topics that are listed in Appendix G of the State CEQA Guidelines, which were used in this analysis to provide a wide range of potentially relevant environmental topics. Tribal Cultural Resources, listed in Appendix G, was not considered in this analysis. Furthermore, two environmental resource topics are further addressed in the discussion following Table 2: Agriculture and Forestry Resources; and Population and Housing.

Table 2. Effects of the 2018 COA Addendum on Various Environmental Resource Topics

Environmental Topic	Potential Environmental Effect
Aesthetics	No Effect – No new construction or physical effect on CVP or SWP facilities would occur that would adversely affect aesthetic resources. No change to aesthetic values or scenic vistas would occur.
Air Quality	No Effect – No new construction or physical effect on CVP or SWP facilities would occur that would adversely affect cultural resources. Re-allocation of water supplies from the SWP to CVP would not reduce the volume of water diverted and delivered to agricultural and municipal/industrial water users. Therefore, energy consumed and associated air pollutant emissions required to deliver the supply only would vary based on the relative efficiency of the CVP facilities compared to the SWP facilities. No substantive change in air pollutant emissions would occur.
Biological Resources	No Effect – No new construction or physical effect on CVP or SWP facilities would occur that would adversely affect terrestrial or aquatic resources. Re-allocation of water from the SWP to CVP would have no effect on Delta hydrology and water quality, and therefore no new adverse effect on Delta aquatic species. No adverse effect on terrestrial species would occur in SWP or CVP service areas.
Cultural Resources	No Effect – No new construction or physical effect on CVP or SWP facilities would occur that would adversely affect cultural resources. Re-allocation of water from the SWP to CVP would have no new impact on cultural resources.
Energy	No Effect – No new construction or physical effect on CVP or SWP facilities would occur that would adversely affect cultural resources. Re-allocation of water supplies from the SWP to CVP would not reduce the volume of water diverted and delivered to agricultural and municipal/industrial water users. Therefore, energy consumed to deliver the supply only would vary based on the relative efficiency of the CVP facilities compared to the SWP facilities. No substantive change in energy use would occur.
Geology and Soils	No Effect – No new construction or physical effect on CVP or SWP facilities would occur that would adversely affect geological and soil resources. Re-allocation of water from the SWP to CVP would have no new adverse effect on geology and soils.
Greenhouse Gas Emissions	No Effect – No new construction or physical effect on CVP or SWP facilities would occur that would affect greenhouse gas emissions. Re-allocation of water supplies from the SWP to CVP would not reduce the volume of water diverted and delivered to agricultural and municipal/industrial water users. Therefore, energy consumed and greenhouse gas emissions required to deliver the supply only would vary based on the relative efficiency of the CVP facilities compared to the SWP facilities. No substantive change in greenhouse gas emissions would occur.
Hazards and Hazardous Materials	No Effect – No new construction or physical effect on CVP or SWP facilities would occur that would create new hazards or cause release of hazardous materials.
Land Use and Planning	No Effect – No new construction or physical effect on CVP or SWP facilities would occur that would adversely affect existing land uses or land use plans.
Mineral Resources	No Effect – No new construction or physical effect on CVP or SWP facilities would occur that would adversely affect mineral resources. No change to mineral resources would occur.
Noise	No Effect – No new construction or physical effect on CVP or SWP facilities would occur that would adversely affect existing noise levels. SWP and CVP facilities would continue to operate within their respective historical range and would not generate new or louder noise emissions.

Environmental Topic	Potential Environmental Effect
Public Services	No Effect – No new construction or physical effect on CVP or SWP facilities would occur that would adversely affect public services.
Recreation	No Effect – No new construction or physical effect on CVP or SWP facilities would occur that would adversely affect recreational facilities or recreational opportunities.
Transportation	No Effect – No new construction or physical effect on CVP or SWP facilities would occur that would adversely affect existing roadways, traffic, or levels of service. No change to transportation systems would occur.
Utilities and Service System	No Effect – No new construction or physical effect on CVP or SWP facilities would occur that would adversely affect utilities or other service systems. No change to existing utilities, levels of service, or quality of service would occur.
Wildfire	No Effect – No new construction or physical effect on CVP or SWP facilities would occur that would pose a wildfire risk or exacerbate fire risk. No change to existing wildfire risk or wildfire management would occur.

Agriculture and Forestry Resources

The 2018 COA Addendum re-allocated an annual average 130 TAF of SWP water supplies to the CVP service area. If distributed proportionally to all CVP water users, about 92 percent of this volume (or 119 TAF of water) is expected to be made available to existing agricultural lands within the CVP service area (Reclamation 2018). The remainder would be made available to municipal and industrial land uses in the CVP service area.

Because these CVP water users historically have been subject to reduced water deliveries resulting from dryer hydrologic conditions and regulatory restrictions, the 130 TAF of water is expected to be applied as irrigation supplies to existing agricultural lands, or lands that have been retired recently because of limited water supplies.

The amount of water supply made available to the CVP is equivalent water volume capable of irrigating an area ranging from about 29,400 to 41,200 acres, depending on agricultural crop type and associated evapotranspiration requirements (Hanson 2010). This acreage is equivalent to about 0.9 to 1.3 percent of the total 3 million acres that are served by CVP water supplies for agricultural purposes.

The water provided to the CVP would not exceed existing maximum contract amounts for agricultural use. The additional water supply provided to the CVP by the 2018 COA Addendum equals about 0.4 percent of the maximum CVP agricultural historical water use of about 1,945,633 acres. Therefore, the increased CVP agricultural water supply provided by the 2018 COA Addendum would not substantially affect the acreage of agricultural lands in the CVP service area.

Population and Housing

As previously discussed for Agriculture and Forestry Resources, if distributed proportionally to all CVP water users, about two-thirds of the average annual 130 TAF of SWP supplies (or 86 TAF of water) is expected to be made available to existing agricultural lands within the CVP service area (Reclamation 2019a). The remainder (or about 43 TAF) would be provided for M&I land uses.

Based on an average of 100 gallons per day per capita for residential water use, 43 TAF of water would meet the needs of 51,300 people or about 17,950 residences with an average household of 2.86 people. This volume of water equals about 3.7 percent of the average annual M&I CVP water deliveries. This volume of water also equals about 2.5 percent of the maximum CVP M&I historical use.

Therefore, the increased CVP M&I water supply that would be provided by the 2018 COA Addendum would contribute to meeting M&I water demand to CVP water users that have been subject to reduced water deliveries resulting from dryer hydrologic conditions and regulatory restrictions. The additional water would not result in exceeding the maximum historical CVP M&I water use of 167 TAF.

The reduced water supplies available to SWP water contractors would need to be replaced by development of alternative water supplies, water conservation, or transfer of water supplies from other sources. Because the SWP provides water to about 27,000,000 people, the entire volume of water (130 TAF) re-allocated to the CVP would meet about 0.2 percent of the SWP M&I water demand. The reduced SWP volume of water would be negligible compared to the annual SWP M&I deliveries. Individual water contractors or retail water purveyors are expected to manage their respective systems accordingly, to compensate for the reduced water deliveries. Therefore, implementation of the 2018 COA Addendum would have no substantial effect on population and housing.

CONCLUSION

As concluded in the 2018 NOE, implementation of the 2018 COA Addendum would shift responsibilities for meeting obligations between the CVP and SWP. As demonstrated in this discussion, changes to surface water flow upstream from the Delta would be minimal. The shift in responsibilities would result in reduced SWP exports to south of Delta water users and an increase in export to CVP water users. These changes would be minor when compared to the total volume of water delivered by either the CVP or SWP. The minimal change to surface water hydrology and water deliveries would not induce new adverse effects on other environmental resources.

LONG-TERM OPERATION OF THE CALIFORNIA STATE WATER PROJECT

DWR is pursuing a California Endangered Species Act (CESA) Incidental Take Permit (ITP) for the long-term operations of the SWP. As a part of the analysis for the ITP, as well as for the associated CEQA environmental analysis, the proposed operations must be compared against baseline physical conditions.

One aspect of the baseline conditions is the manner in which the SWP and the CVP jointly operate to meet Delta regulatory requirements. The SWP and CVP share responsibility for these requirements as defined by the COA, which DWR and Reclamation executed in 1986 and subsequently modified in 2018 through an Addendum.

DWR has identified a baseline that includes the 2018 COA Addendum as opposed to the unmodified 1986 version of the COA. A baseline that includes the COA Addendum accurately represents the existing physical conditions in the Delta. In addition, CalSim II modeling results indicate that the flows entering and exiting the Delta are unaffected by execution of the 2018 COA Addendum. Therefore, using the 2018 COA Addendum as a baseline condition would sufficiently represent Delta conditions under D1641 and the 2008/2009 BiOps as well as under existing conditions.

CEQA Legal Requirements

Under CEQA, lead agencies refer to baseline physical conditions to determine whether a project's impact is significant. (CEQA Guidelines §15125). Similarly, the Director of CDFW makes CESA findings that take authorized by an ITP is consistent with statutory requirements, such as finding that the impacts of take will be minimized and fully mitigated. CDFW may refer to information in the Final Environmental Impact Report in making these findings. (Environmental Protection Information Center v. California Department of Fish and Wildlife (2008) 44 Cal.4th 459, 517).

The baseline consists of existing physical conditions and, generally, should consist of the conditions that exist at the time that the Notice of Preparation (NOP) is published. A lead agency may identify a different baseline "where existing conditions change or fluctuate over time, and where necessary to provide the most accurate picture practically possible of the project's impacts" so long as the different baseline is supported by substantial evidence. (CEQA Guidelines §15125(a)(1)).

The baseline that DWR has identified reflects the conditions at the time of NOP publication because DWR and Reclamation were operating under the 2018 COA Addendum before April 19, 2019. COA implementation is not a fluctuating condition in the Delta. The COA has been in place since 1986 and has been modified only once, through the 2018 COA Addendum. The COA Addendum was executed over four months before the NOP was published and will have been in effect for over a year before project implementation.

Tables 3 through 5 provide CalSim II modeling results that demonstrate that the physical condition in the Delta did not significantly change as a result of executing the 2018 COA Addendum.

Table 3. Delta Outflow (TAF), 1986 COA vs. 2018 COA Addendum

Study	Annual Average	Annual Average [Dry and Critical]	Spring Average [Mar – Jun]	Spring Average [Dry and Critical]
2018 Addendum	15,752	6,335	6,588	2,607
1986 COA	15,752	6,337	6,590	2,609
Change	0	-2	-2	-2

Table 4. SWP and CVP Exports (TAF), 1986 COA vs. 2018 COA Addendum

Study	Annual Average	Spring Average [Mar – Jun]	Annual Average [SWP]	Annual Average [CVP]
2018 Addendum	4,887	1,028	2,421	2,466
1986 COA	4,887	1,031	2,556	2,331
Change	0	-3	-135	135

Table 5. Old and Middle River Flows (CFS) in Late Spring, 1986 COA vs. 2018 COA Addendum

Study	Late Spring [Mar – Jun]	Late Spring [Dry and Critical]	Late Spring [Below Normal]	Late Spring [Above Normal]
2018 Addendum	-2,094	-2,805	-2,594	-2,252
1986 COA	-2,106	-2,817	-2,579	-2,256
Change	12	12	-15	4

Old and Middle River Flows

The following summary graphs present a selection of Delta related output in average monthly plots as well as exceedance plots. The comparison of OMR flows between the 1986 COA and the 2018 COA Addendum show that any differences are extremely small (Figures 20 to 26).

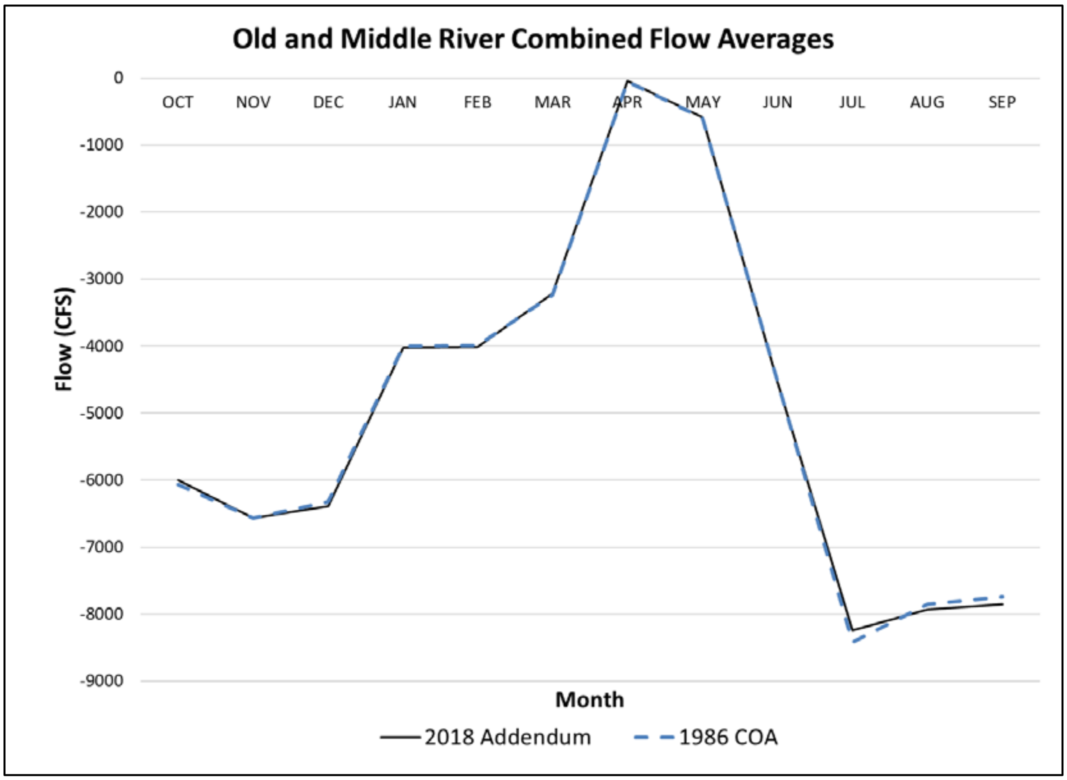

Figure 20. Monthly Average OMR Flow (CFS) for the 1986 COA and the 2018 COA Addendum

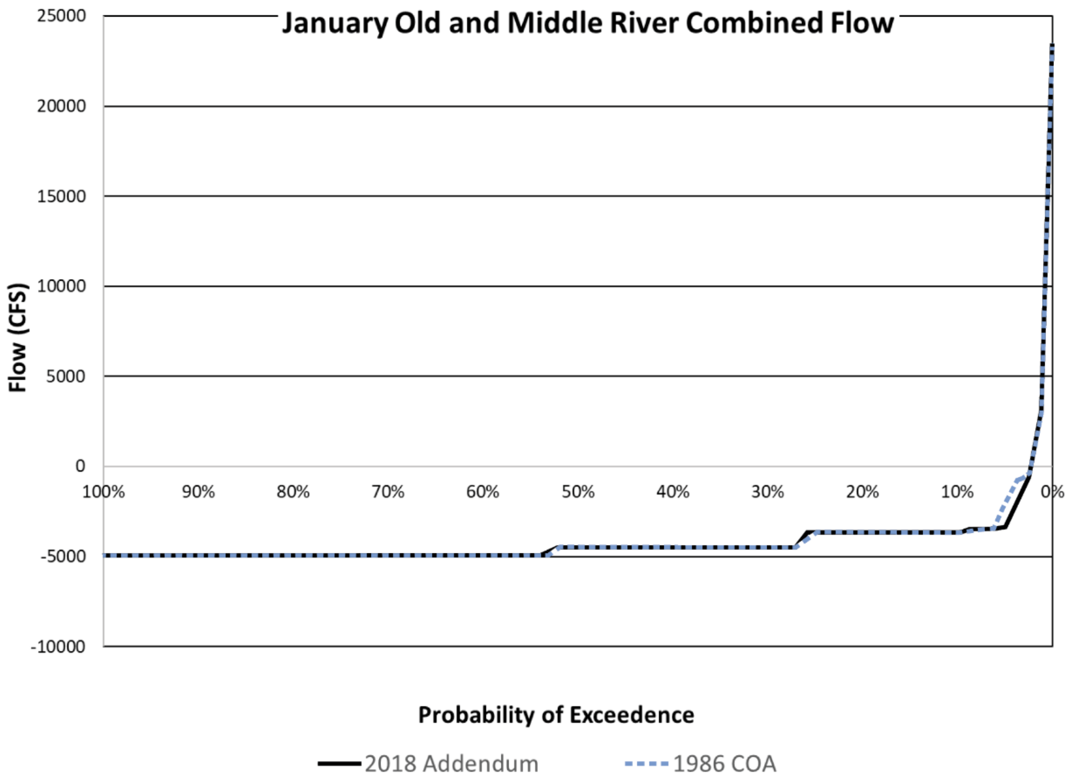

Figure 21. Exceedance Plot of OMR Flow (CFS) in January for the 1986 COA and the 2018 COA Addendum Shows Virtually No Difference Between the Two Scenarios

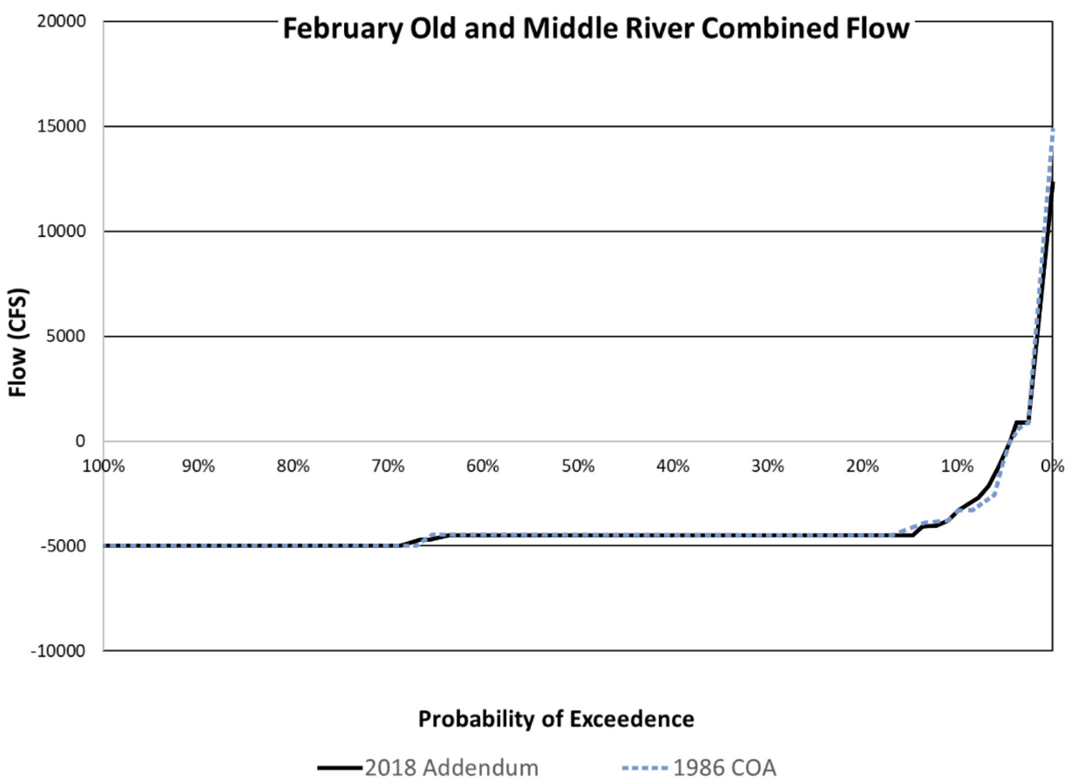

Figure 22. Exceedance Plot of OMR Flow (CFS) in February for the 1986 COA and the 2018 COA Addendum Shows Virtually No Difference Between the Two Scenarios

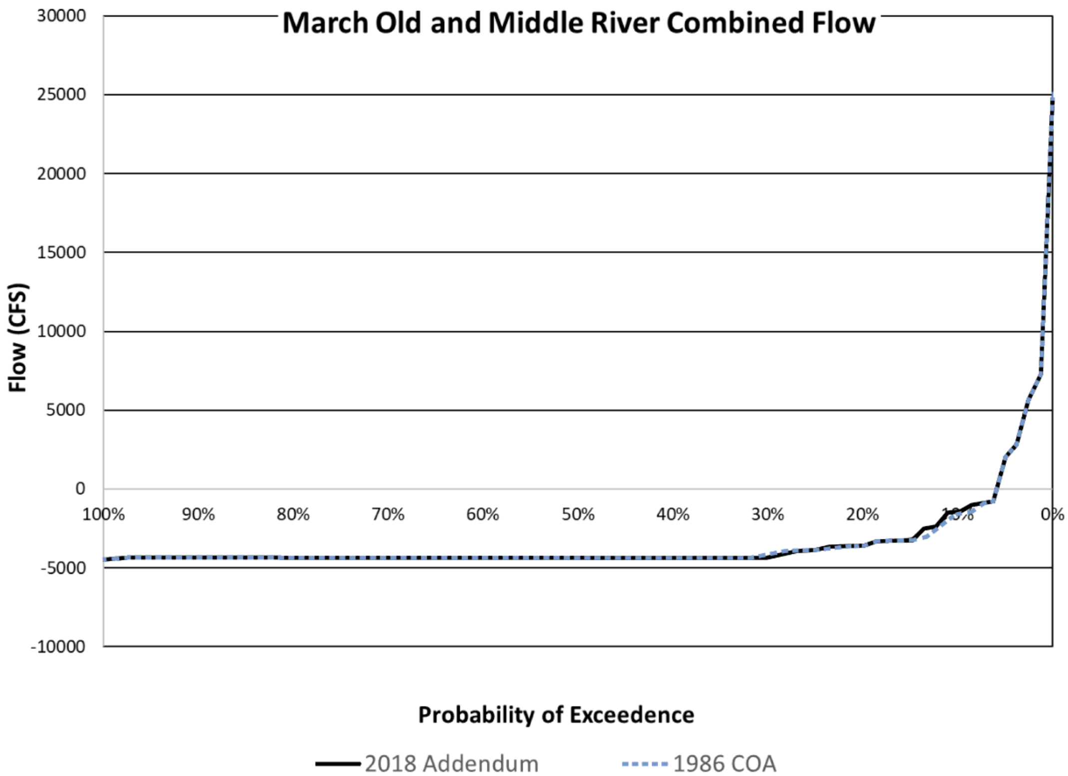

Figure 23. Exceedance Plot of OMR Flow (CFS) in March for the 1986 COA and the 2018 COA Addendum Shows Virtually No Difference Between the Two Scenarios

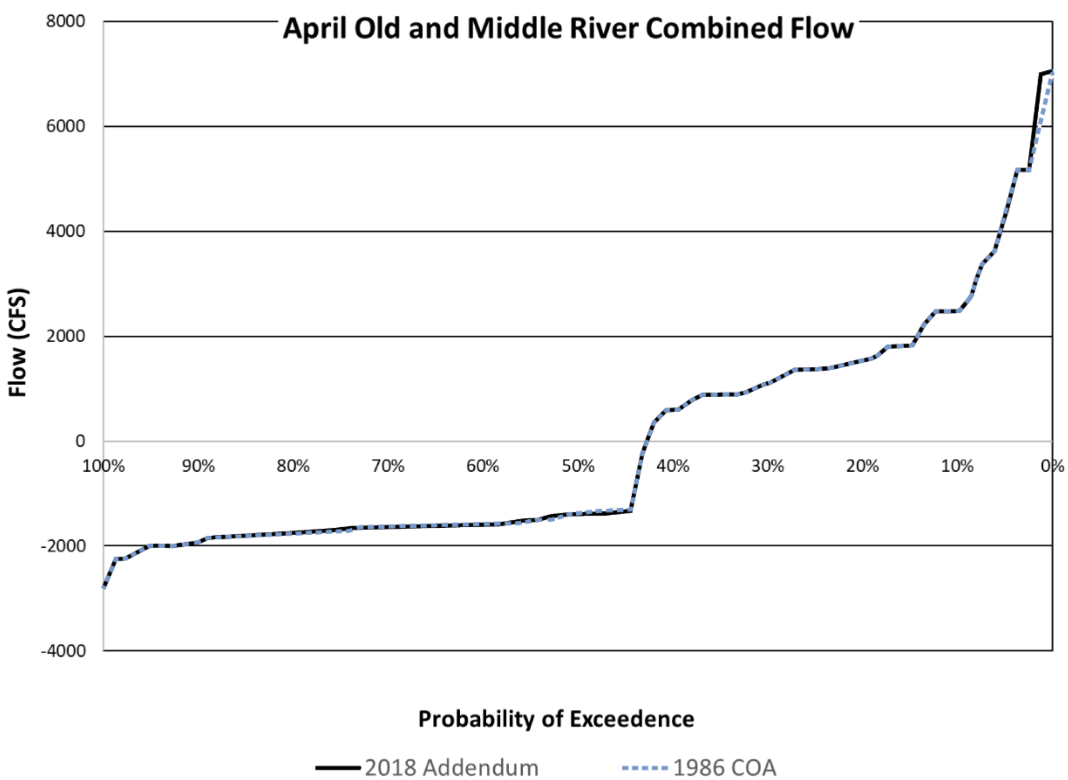

Figure 24. Exceedance Plot of OMR Flow (CFS) in April for the 1986 COA and the 2018 COA Addendum Shows Virtually No Difference Between the Two Scenarios

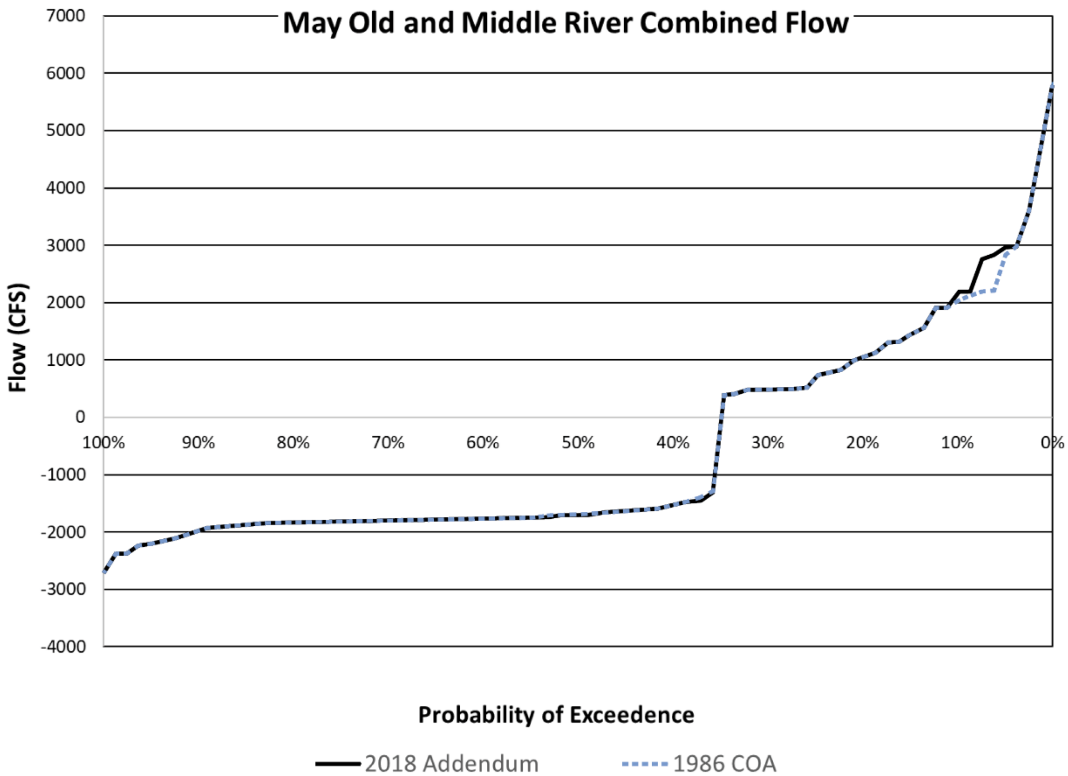

Figure 25. Exceedance Plot of OMR Flow (CFS) in May for the 1986 COA and the 2018 COA Addendum Shows Virtually No Difference Between the Two Scenarios

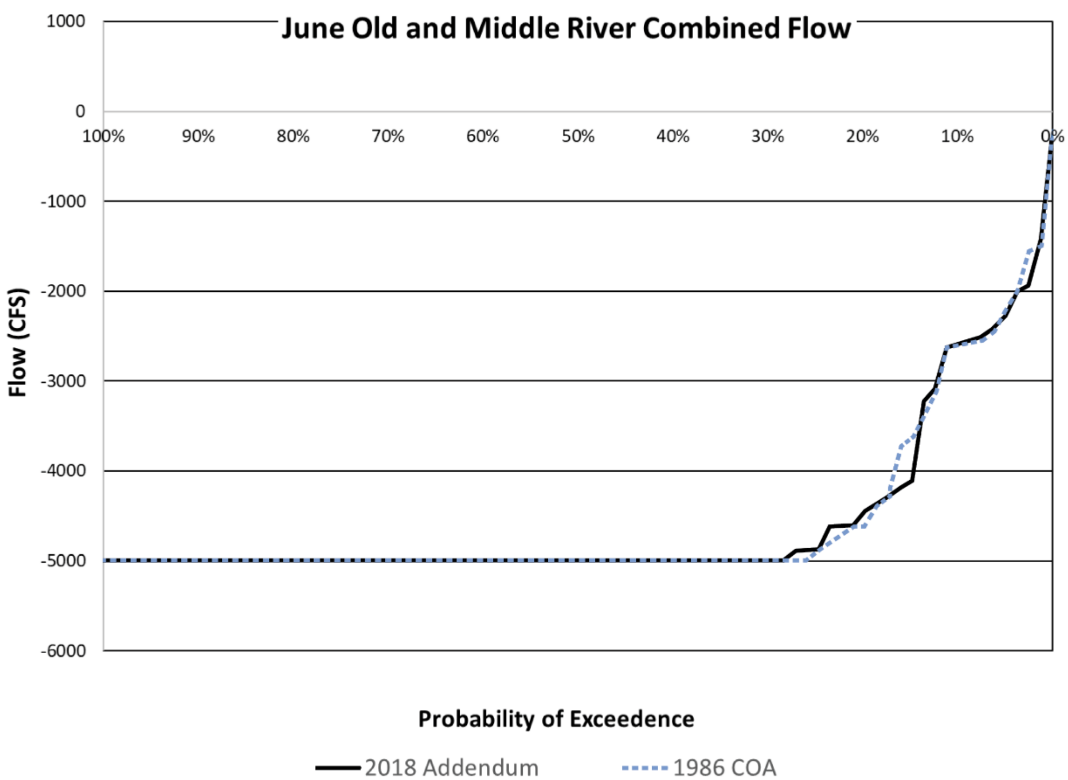

Figure 26. Exceedance Plot of OMR Flow (CFS) in June for the 1986 COA and the 2018 COA Addendum Shows Virtually No Difference Between the Two Scenarios

DELTA OUTFLOW

The following summary graphs present a selection of Delta related output in average monthly plots as well as exceedance plots. The comparison of OMR flows between the 1986 COA and the 2018 COA Addendum show that any differences are extremely small (Figures 27 to 31).

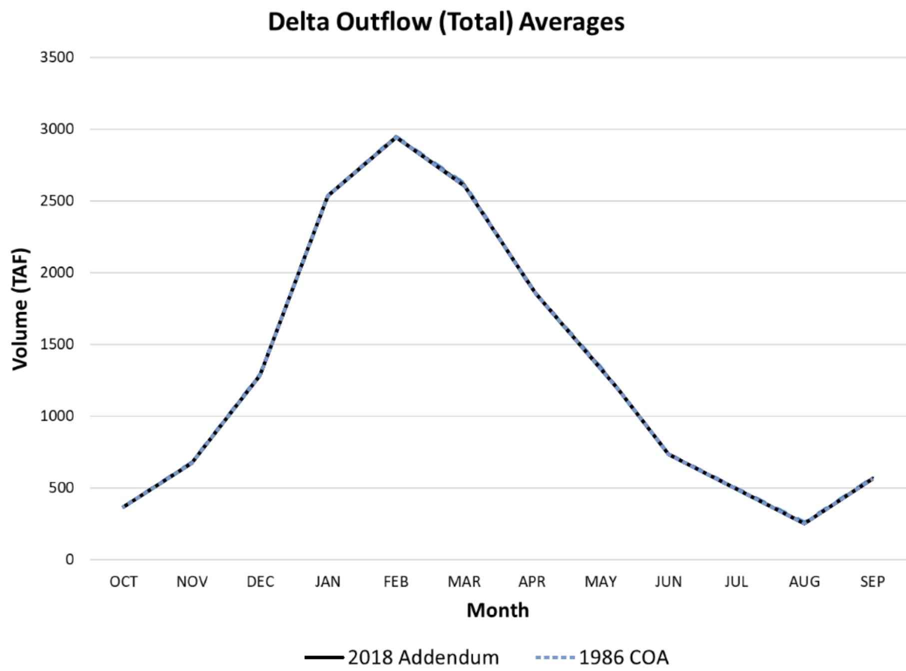

Figure 27. Monthly Average Delta Outflow Volume (TAF) for the 1986 COA and the 2018 COA Addendum

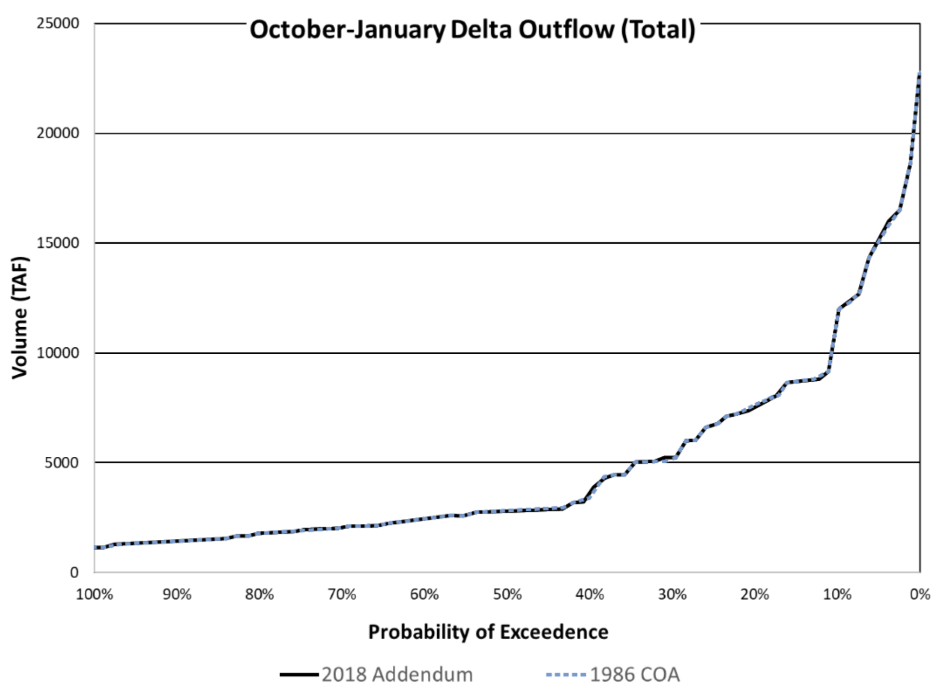

Figure 28. Exceedance Plot of Delta Outflow Volume (TAF) October to January for the 1986 COA and the 2018 COA Addendum Shows Virtually No Difference Between the Two Scenarios

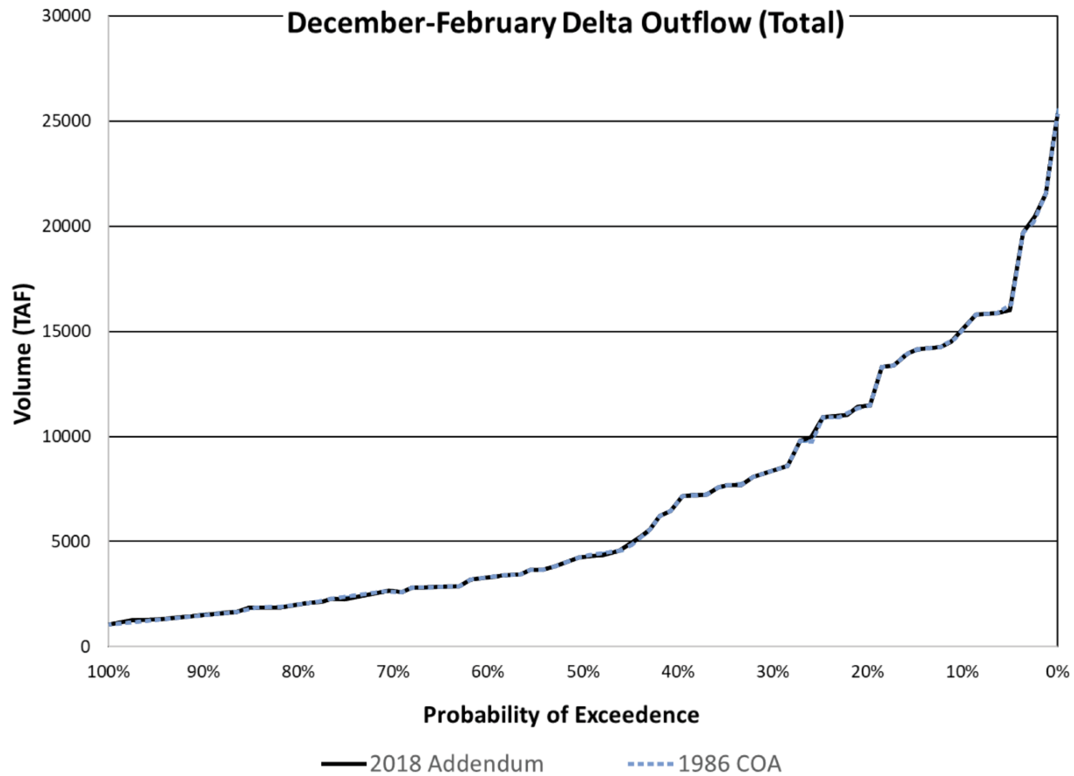

Figure 29. Exceedance Plot of Delta Outflow Volume (TAF) December to February for the 1986 COA and the 2018 COA Addendum Shows Virtually No Difference Between the Two Scenarios

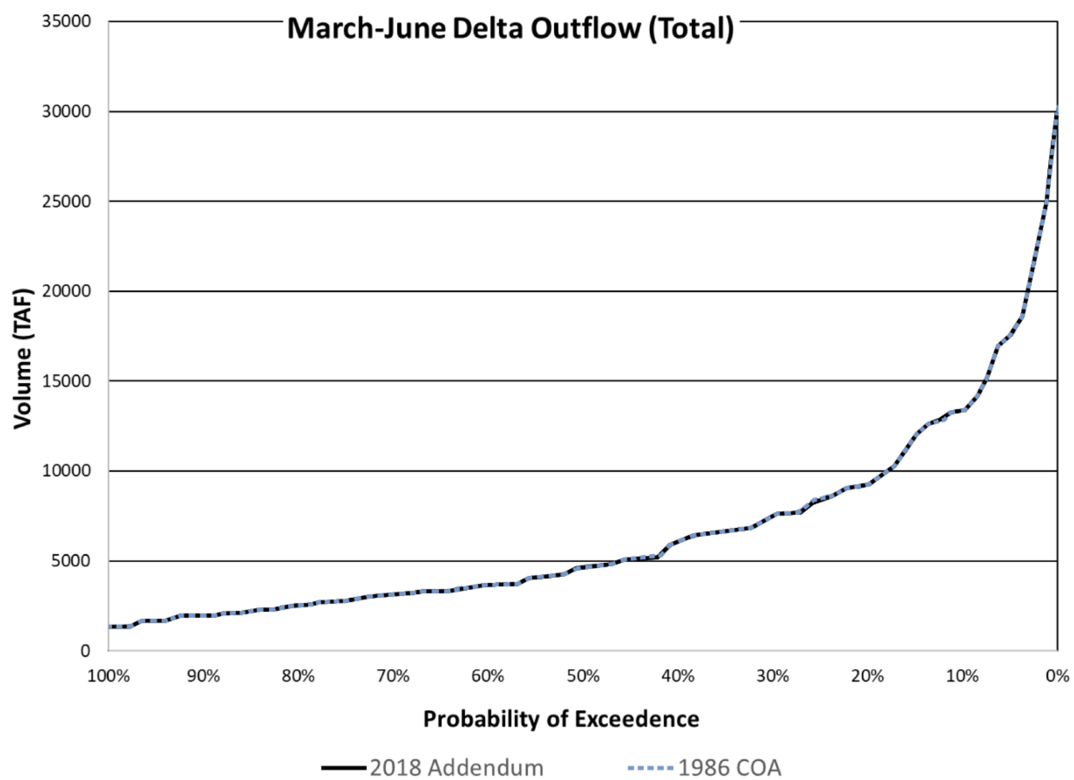

Figure 30. Exceedance Plot of Delta Outflow Volume (TAF) March to June for the 1986 COA and the 2018 COA Addendum Shows Virtually No Difference Between the Two Scenarios

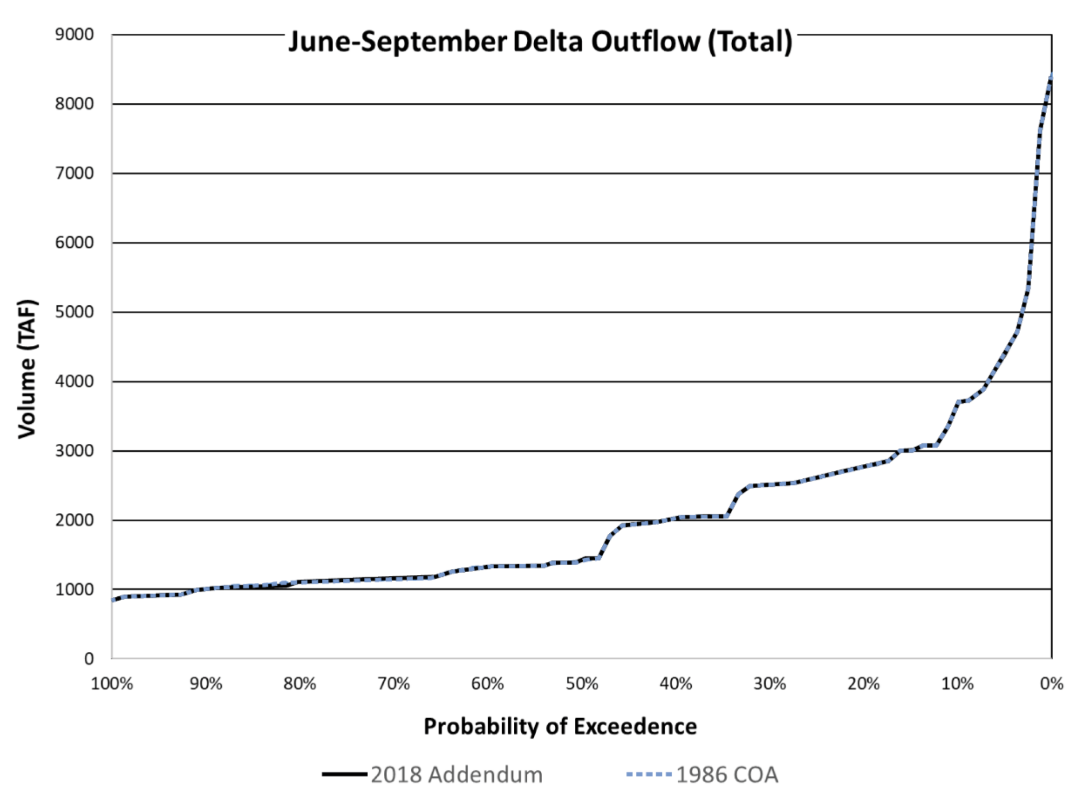

Figure 31. Exceedance Plot of Delta Outflow Volume (TAF) June to September for the 1986 COA and the 2018 COA Addendum Shows Virtually No Difference Between the Two Scenarios

CalSim II Modeling Output

Following an initial summary review of the modeling output described above, CDFW requested additional detail. The complete CalSim II model output for the 2018 COA Addendum and the 1986 COA studies are provided at https://d3.water.ca.gov/owncloud/index.php/s/kKiT64Ma5ATGeEf. Additionally, a compiled set of outputs can be found in Appendix A. Interpreting model output must be done so in the proper context, however, as explained below.

In order to better understand and correctly interpret CalSim II model results, it is extremely important that one be familiar with the proper use of the model and its limitations. A brief discussion on the proper use of CalSim II and DSM2 models and their limitations can be found in Nader-Tehrani (2017) (SWRCB DWR Exhibit 79; See pp. 29-43).

It is generally believed that the most appropriate format to present CalSim II model results are either in the form of:

- Long term average summary and year-type based summary tables and graphics showing monthly and/or annual statistics derived from the model results, or
- Cumulative exceedance probability monthly and/or annual model results shown only by rank/order or only by probability statistic.

Comparative statistics based on these two types of presentations are generally acceptable. Relying on absolute differences computed at a point in time between model results from an alternative and a baseline to evaluate impacts is an inappropriate use of model results (e.g. computing differences between the results from a baseline and an alternative for a particular day, month, or year within the period of record of simulation).

The modeling package in Appendix A and in the website identified above includes model results for a number of specific locations consistent with CDFW's request. CDFW also requested individual year comparisons, but those were not provided due to the reasons listed above. It is possible for CDFW or others to make those comparisons from the raw model output that is available at the provided link, but DWR has declined to provide such comparisons because drawing conclusions from absolute differences would be an inappropriate use of model results.

It is also important to note that, under extreme operational conditions, CalSim II will utilize a series of rules within the specified priority to reach a numerically feasible solution to allow for the continuation of the simulation. The outcome of these types of solutions in CalSim II may vary greatly depending upon the antecedent conditions from the previous time-step result. The model may reach a numerical solution, but the results of the simulation may not reflect a reasonably expected outcome (e.g., one that may occur following the exercise of judgment by authorized decision makers and coordination among appropriate agencies). In such cases, modeled flows may fall short of minimum flow criteria, salinities may exceed standards, diversions may fall short of allocated volumes and reservoir storages might reach extreme low levels, but actual flows may not reflect these conditions.

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Appendix C

Hydrology Model Results

Modeling Results

1. Introduction

The results of model simulations are provided for informational purposes. Please do not use any information contained in these products for any purpose other than this EIR process. If there are any questions regarding the results of these model simulations, please contact DWR.

Any use of results of model simulations should observe limitations of the models used as well as the limitations to the modeled alternatives. These results should only be used for comparative purposes. More information regarding limitations of the models used as well as the limitations to the modeled alternatives is included Appendix H Attachment 1-7 Model Limitations.

2. Modeled Alternatives

The following alternatives were prepared:

- Existing Conditions (EX)
- Proposed Project (PP)

Existing Conditions

The Existing Conditions represents CVP and SWP operations to comply with the "current" regulatory environment as of (April 22, 2019). The Existing Conditions assumptions include existing facilities and ongoing programs that existed as of April 22, 2019- publication date of the Notice of Preparation (NOP). The Existing Conditions assumptions also include facilities and programs that received approvals and permits by April, 2019 because those programs were consistent with existing management direction as of the NOP.

Proposed Project

The proposed project is the DWR on-going long-term operation of the State Water Project (SWP) consistent with existing regulatory requirements that address water rights, water quality, and the protection and conservation of designated species in compliance with California Endangered Species Act (CESA). The goal of the proposed project is to continue the long-term operation of the SWP for water supply and power generation, consistent with applicable laws, contractual obligations, and agreements, and to increase operational flexibility by focusing on nonoperational measures to avoid significant adverse effects. DWR proposes to store, divert, and convey water in accordance with existing water contracts and agreements up to full contract amounts and other deliveries, consistent with water rights and applicable laws and regulations.

The following model simulations were prepared for each alternative:

- CalSim II
- DSM2

3. Model Results for Modeled Alternatives

Model Results

The results for each alternative for each model are compiled in tables and charts in the following attachments:

- Appendix C Attachment 2-1 Storage and Elevation Results (CalSim II)
- Appendix C Attachment 2-2 Flow Results (CalSim II)
- Appendix C Attachment 2-3 Diversion Results (CalSim II)
- Appendix C Attachment 2-4 Water Supply Results (CalSim II)
- Appendix C Attachment 2-5 X2 Results (CalSim II)
- Appendix C Attachment 2-6 Stage Results (DSM2)
- Appendix C Attachment 2-7 EC Results (DSM2)
- Appendix C Attachment 2-8 Chloride Results (DSM2)
- Appendix C Attachment 2-9 D1641 Compliance Results (DSM2)
- Appendix C Attachment 2-10 D1641 Compliance Results (CalSim II)

Each attachment includes a catalog of results included.

As noted in the Introduction, any use of results of model simulations should observe limitations of the models used as well as the limitations to the modeled alternatives. These results should only be used for comparative purposes. More information regarding limitations of the models used as well as the limitations to the modeled alternatives is included Appendix C Attachment 1-7 Model Limitations.

Formats Provided

The following formats are provided:

- Monthly tables comparing two alternatives (exceedance values, long-term average, and average by water year type)
- Monthly pattern charts (long-term average and average by water year type) including all alternatives
- Monthly exceedance charts (all months) including all alternatives

4. References

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Appendix C – Modeling

Attachment 2-1 – Storage and Elevation Results (CalSim II)

The following results of the CalSim II model are included for reservoir storage conditions for the following alternatives:

- Existing Conditions
- Proposed Project

Table 2-1.1. Storage and Elevation Results (CalSim II)

Title	Model Parameter	Table Numbers	Figure Numbers
San Luis Reservoir Storage	S11+S12	1a-1	1a-1 to 1a-18
San Luis Reservoir Elevation	Post-processed	1b-1	1b-1 to 1b-18
SWP San Luis Reservoir Storage	S12	1c-1	1c-1 to 1c-18

Report formats

- Monthly tables comparing two scenarios (exceedance values, long-term average, and average by water year type)
- Monthly exceedance charts (all months) including all scenarios

Table 1a-1. San Luis Storage (CVP and SWP), End of Month Storage

Existing

Statistic	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	712	873	1,152	1,609	1,840	2,039	1,780	1,416	1,144	903	631	699
20%	599	734	1,065	1,375	1,637	1,930	1,724	1,284	958	712	515	607
30%	529	654	968	1,274	1,533	1,839	1,630	1,225	840	653	457	500
40%	485	618	902	1,198	1,492	1,712	1,496	1,148	810	597	398	449
50%	443	543	850	1,103	1,402	1,644	1,424	1,108	774	498	349	411
60%	362	463	762	1,022	1,291	1,507	1,347	1,021	708	469	322	353
70%	314	422	684	959	1,222	1,378	1,221	950	630	438	284	304
80%	255	393	574	884	1,124	1,306	1,173	860	567	398	215	240
90%	213	301	464	776	1,041	1,266	1,103	788	469	309	188	187
Long Term												
Full Simulation Period[a]	473	591	844	1,138	1,407	1,617	1,435	1,103	796	581	408	446
Water Year Types[b,c]												
Wet (32%)	546	675	896	1,223	1,521	1,790	1,576	1,207	909	707	564	639
Above Normal (15%)	479	599	912	1,200	1,471	1,682	1,443	1,034	689	482	390	489
Below Normal (17%)	416	542	803	1,076	1,367	1,587	1,378	1,013	664	523	409	418
Dry (22%)	448	572	844	1,130	1,359	1,546	1,400	1,102	801	586	280	293
Critical (15%)	410	489	711	976	1,212	1,316	1,244	1,057	807	469	276	246

Proposed Project

Statistic	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	1,113	1,366	1,639	1,848	2,039	2,039	1,994	1,890	1,590	1,264	1,015	1,056
20%	911	1,120	1,386	1,638	1,865	2,028	1,932	1,813	1,402	1,079	757	803
30%	731	977	1,297	1,506	1,702	1,907	1,858	1,580	1,179	896	628	677
40%	628	831	1,167	1,401	1,586	1,744	1,736	1,517	1,047	732	545	566
50%	501	713	944	1,271	1,509	1,682	1,614	1,422	966	675	464	491
60%	450	564	852	1,094	1,404	1,546	1,487	1,269	902	577	387	401
70%	331	486	717	1,002	1,299	1,404	1,372	1,162	781	494	309	319
80%	249	398	615	882	1,143	1,239	1,226	1,038	732	436	244	229
90%	209	314	479	793	972	1,141	1,117	918	598	397	185	202
Long Term												
Full Simulation Period[a]	611	795	1,024	1,274	1,498	1,619	1,583	1,401	1,040	761	548	565
Water Year Types[b,c]												
Wet (32%)	756	961	1,153	1,397	1,623	1,796	1,802	1,662	1,316	1,054	865	909
Above Normal (15%)	595	791	1,072	1,338	1,562	1,669	1,630	1,425	991	726	571	633
Below Normal (17%)	596	795	1,027	1,264	1,516	1,594	1,542	1,338	923	680	512	507
Dry (22%)	538	708	986	1,253	1,457	1,562	1,494	1,274	924	620	275	269
Critical (15%)	440	570	746	988	1,203	1,303	1,244	1,072	805	466	291	261

Proposed Project minus Existing

Statistic	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	401	494	487	239	199	0	214	474	447	361	384	357
20%	312	386	321	263	227	97	208	530	444	367	242	197
30%	202	323	328	233	168	68	229	355	339	243	171	177
40%	143	213	266	203	94	31	241	368	237	135	147	116
50%	59	170	94	168	107	38	190	315	192	177	115	80
60%	87	101	90	72	113	40	140	248	195	108	65	47
70%	16	65	32	43	77	26	150	212	151	56	25	15
80%	**-6**	5	42	**-2**	19	**-67**	53	178	164	38	29	**-11**
90%	**-4**	12	15	17	**-69**	**-125**	14	129	128	88	**-3**	15
Long Term												
Full Simulation Period[a]	138	203	180	136	91	3	148	297	244	179	140	118
Water Year Types[b,c]												
Wet (32%)	210	286	258	174	102	6	226	456	408	346	300	270
Above Normal (15%)	115	191	160	138	91	**-14**	187	391	302	243	181	144
Below Normal (17%)	180	252	223	188	149	7	164	326	258	157	103	88
Dry (22%)	90	136	142	122	98	15	94	172	123	34	**-5**	**-24**
Critical (15%)	30	81	35	12	**-10**	**-12**	0	15	**-2**	**-3**	15	15

a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.

Figure 1a-7. San Luis Storage (CVP and SWP), End of October Storage

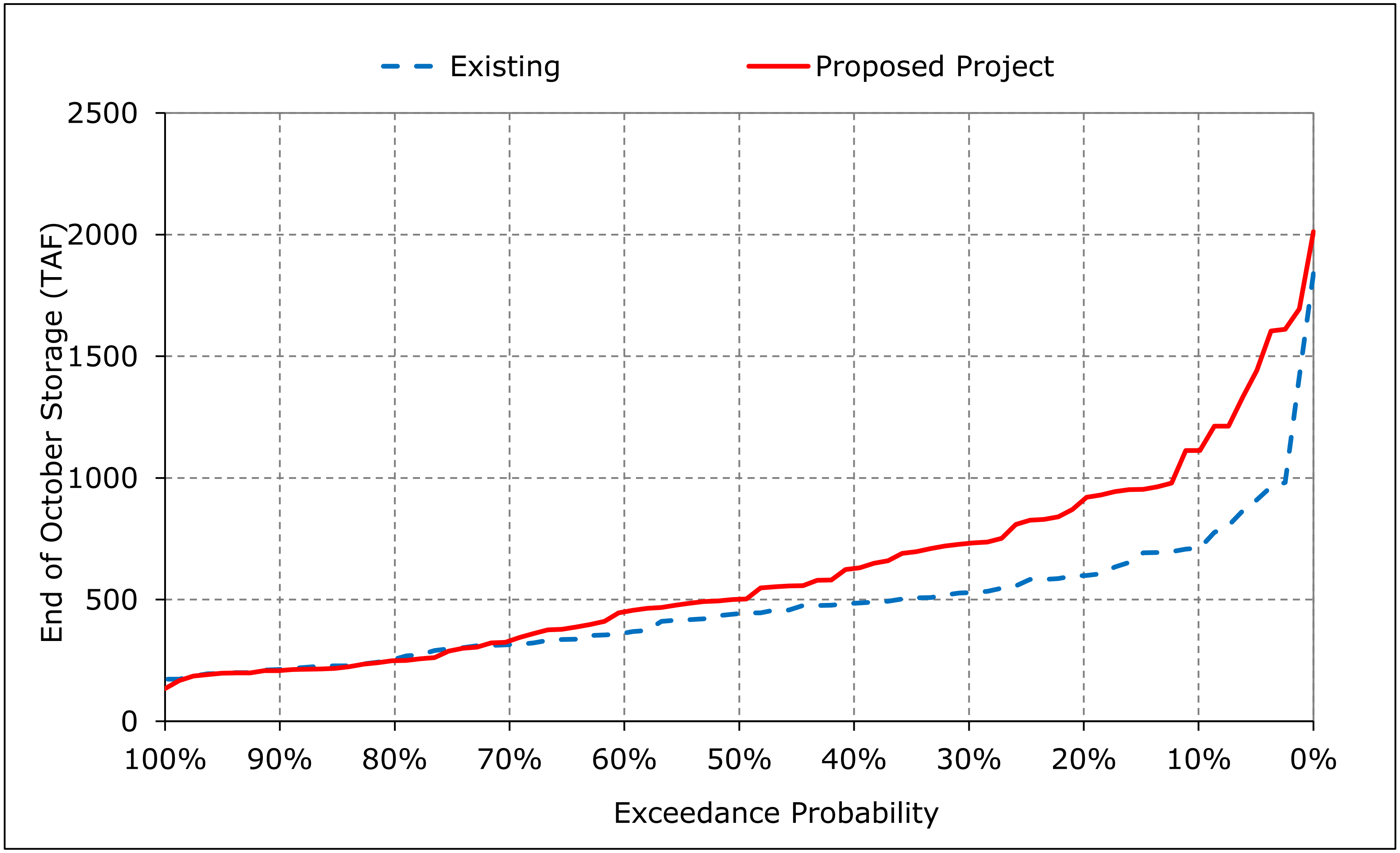


Figure 1a-8. San Luis Storage (CVP and SWP), End of November Storage

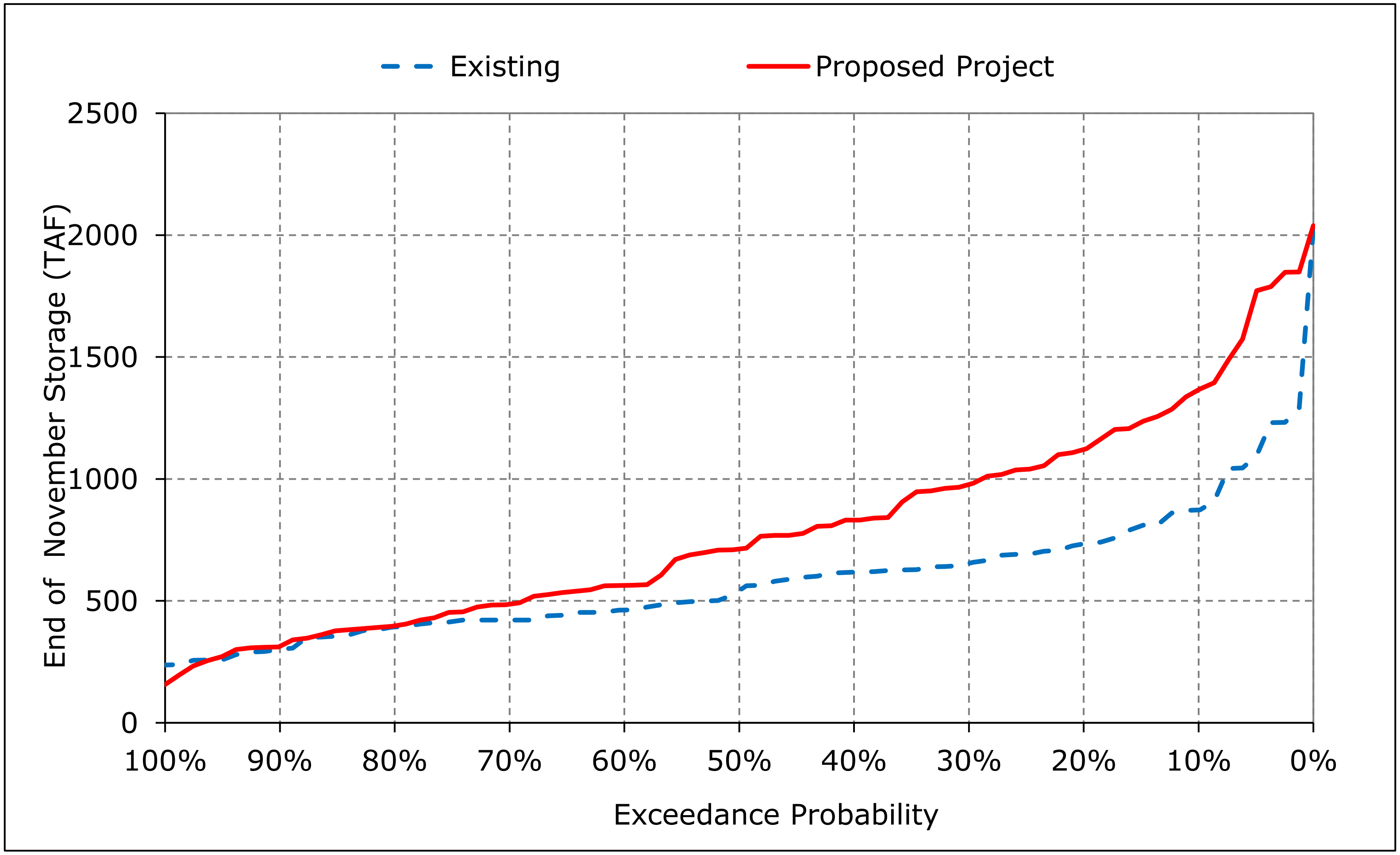


Figure 1a-9. San Luis Storage (CVP and SWP), End of December Storage

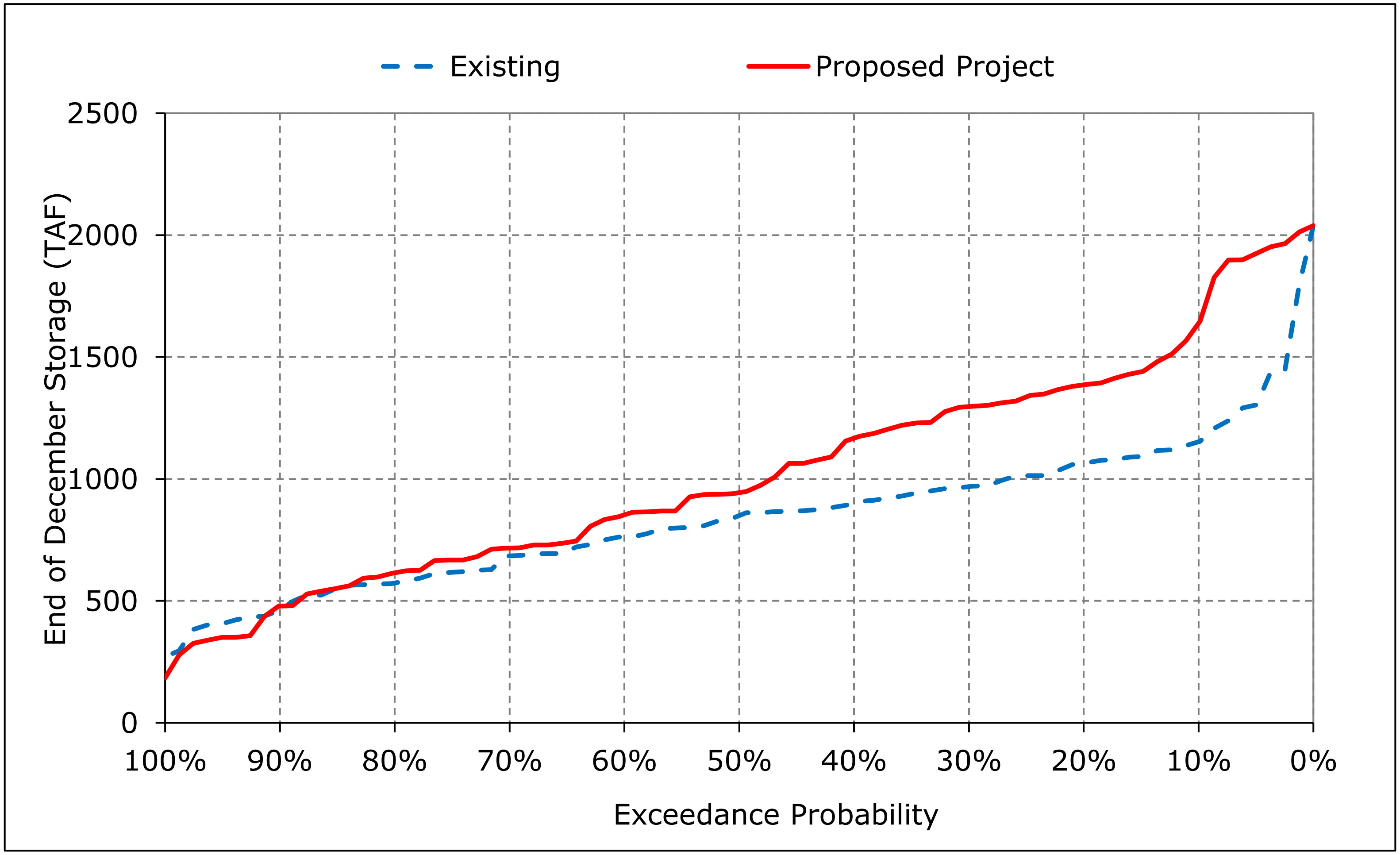


Figure 1a-10. San Luis Storage (CVP and SWP), End of January Storage

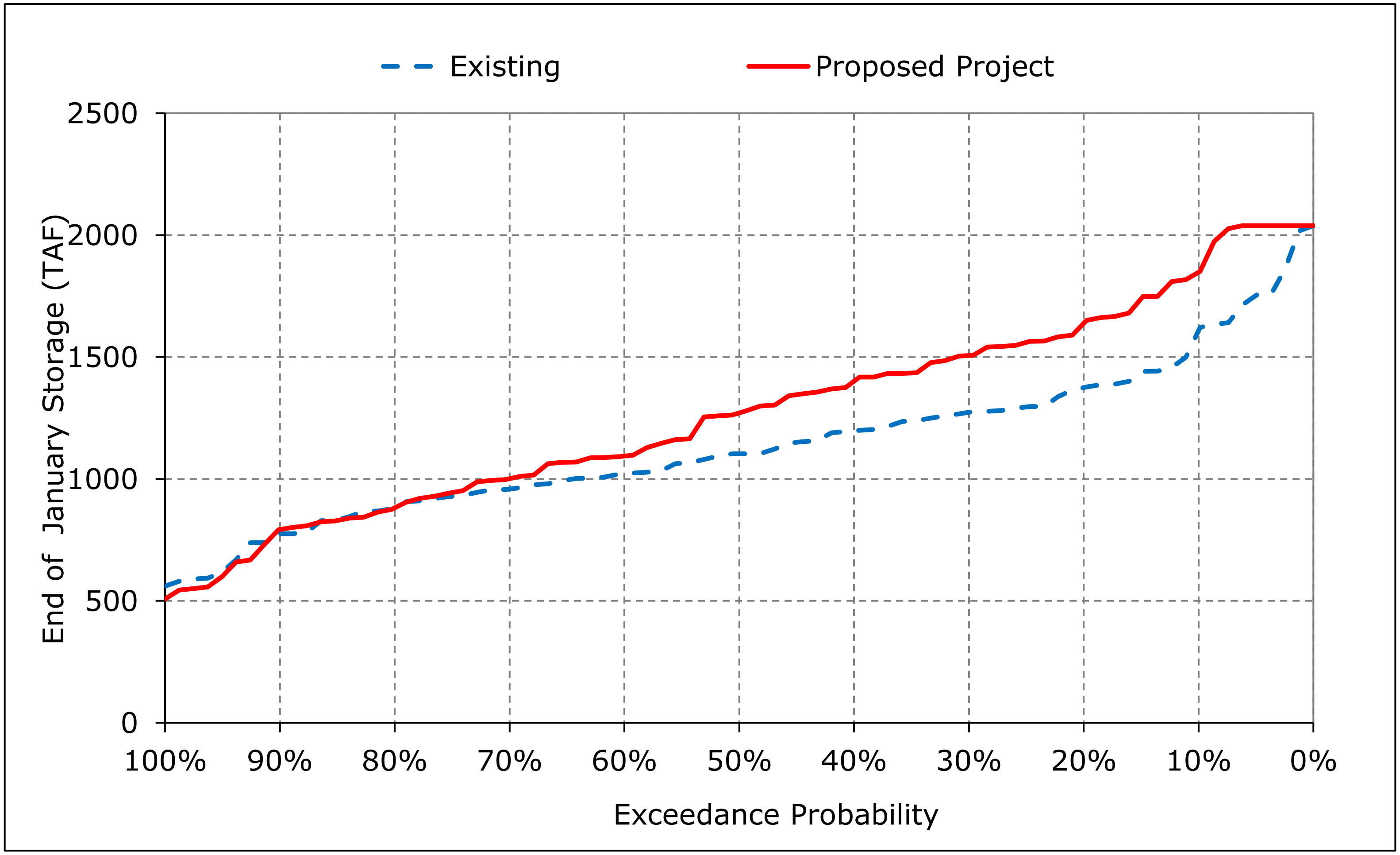


Figure 1a-11. San Luis Storage (CVP and SWP), End of February Storage

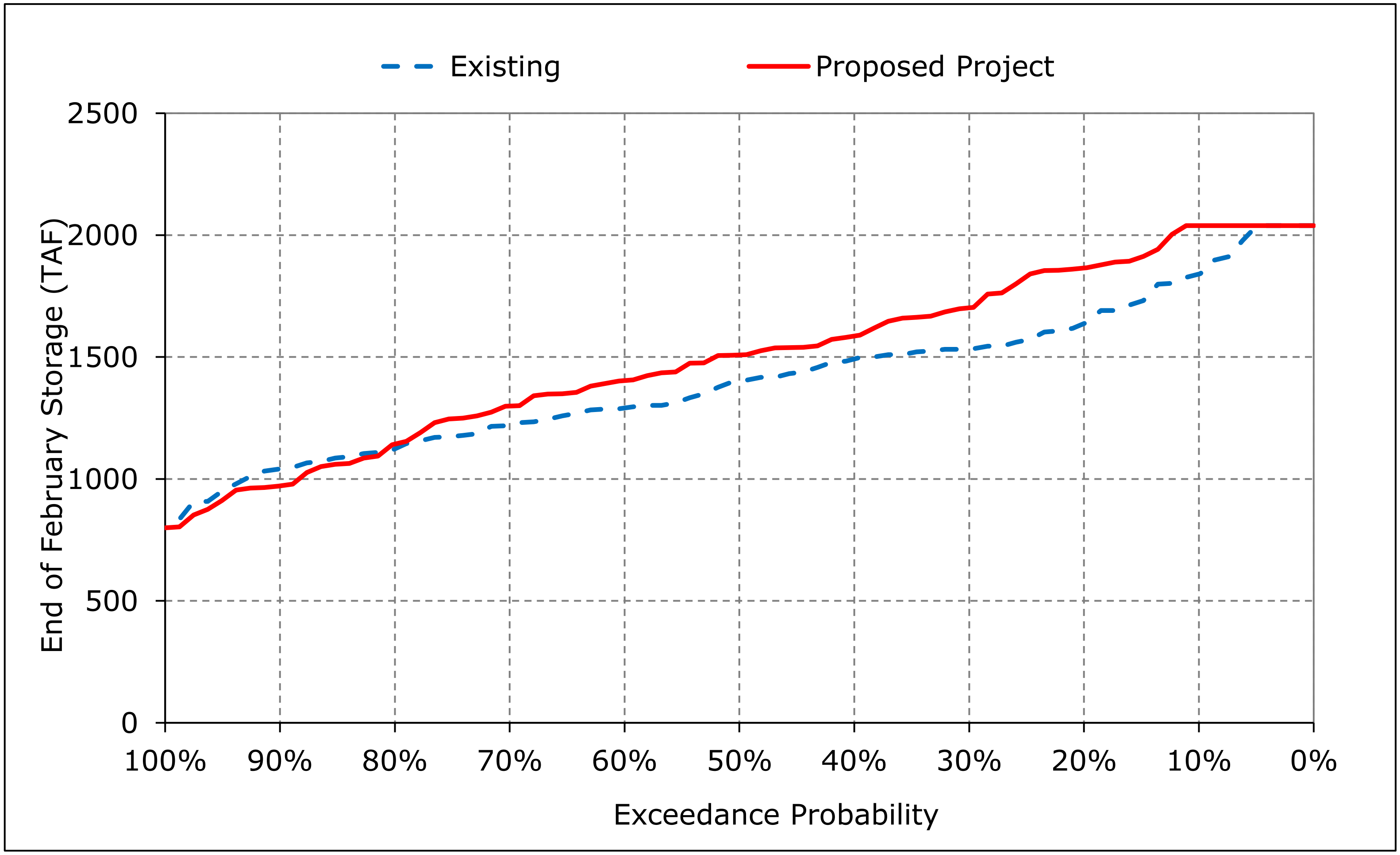


Figure 1a-12. San Luis Storage (CVP and SWP), End of March Storage

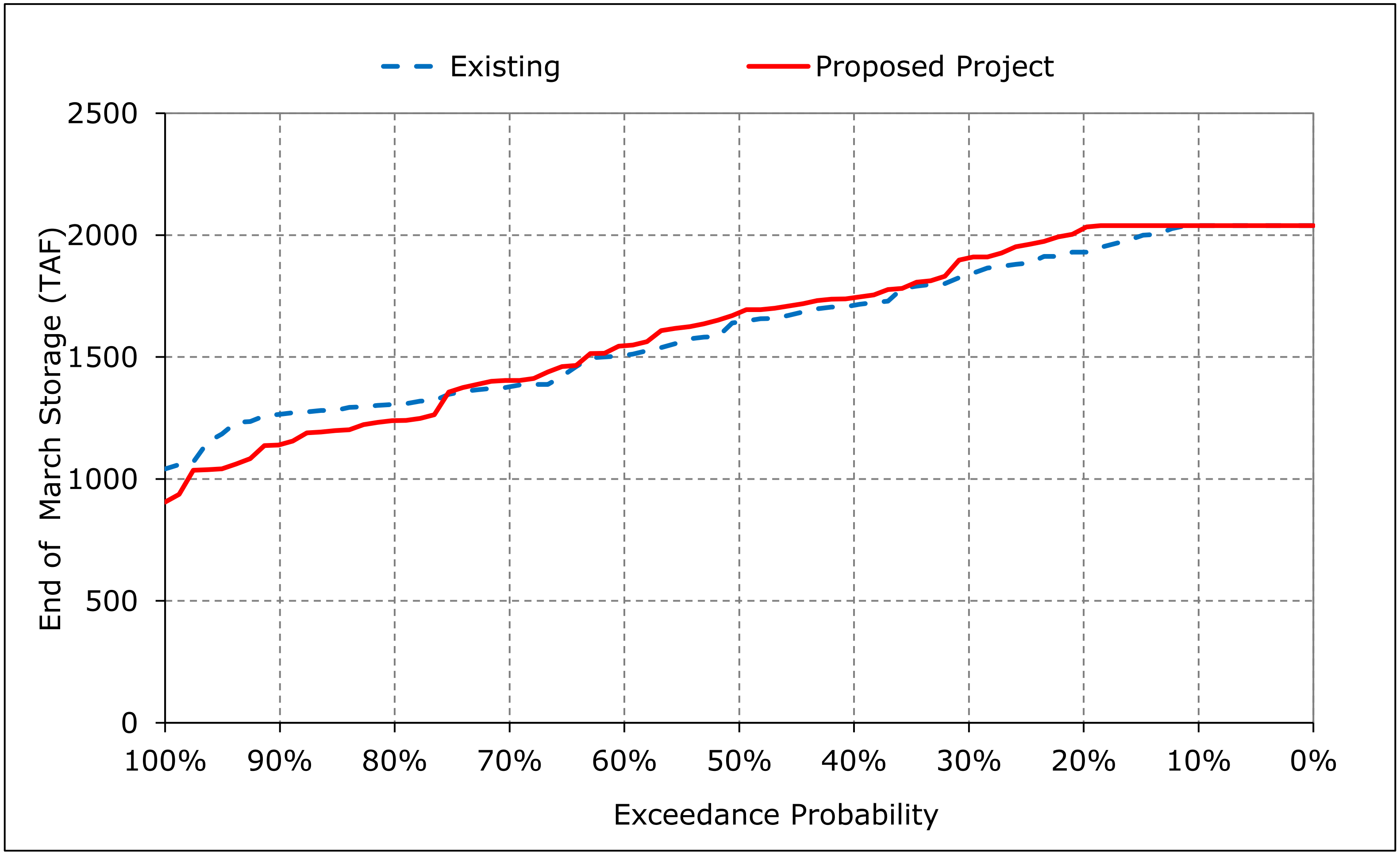


Figure 1a-13. San Luis Storage (CVP and SWP), End of April Storage

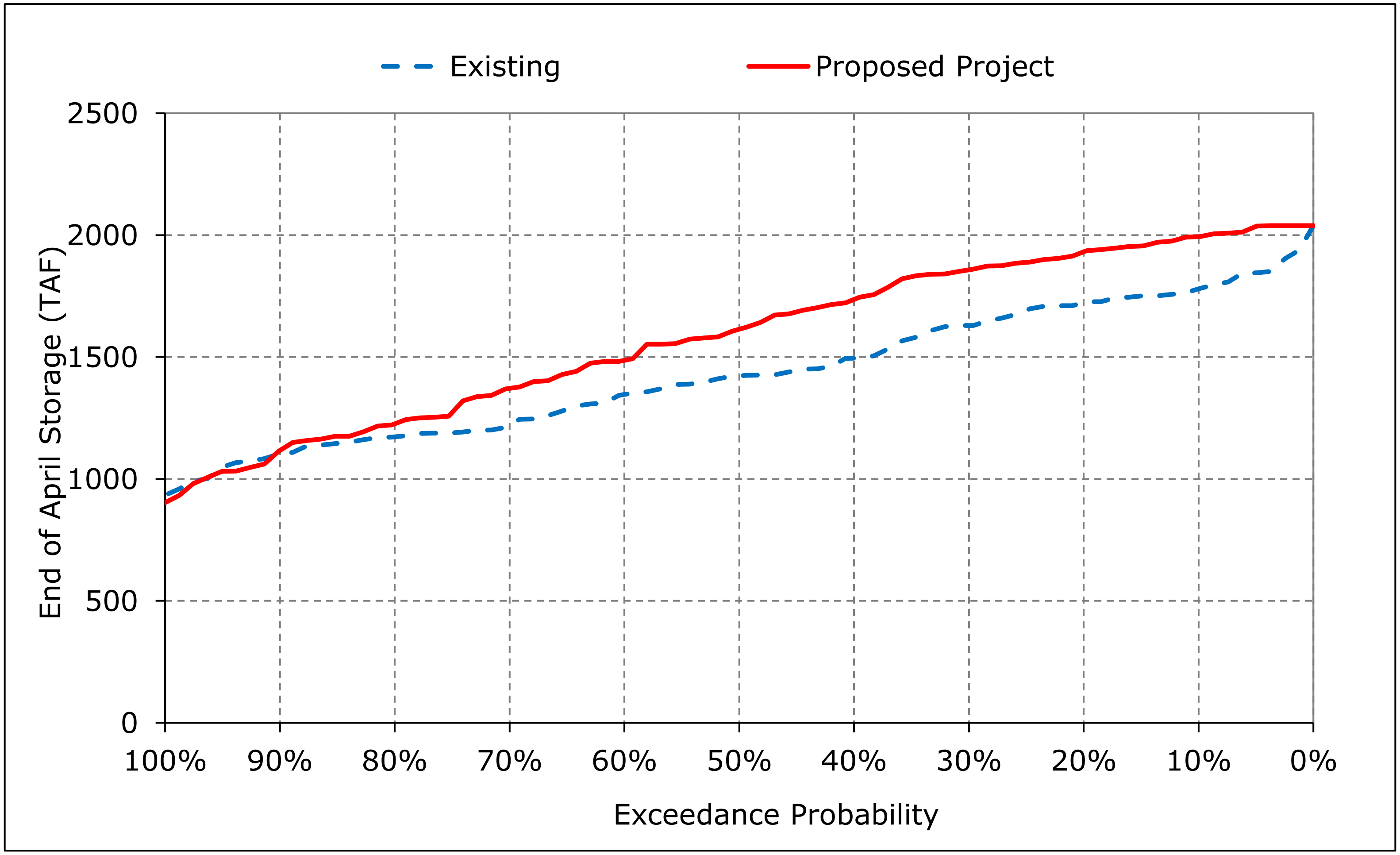


Figure 1a-14. San Luis Storage (CVP and SWP), End of May Storage

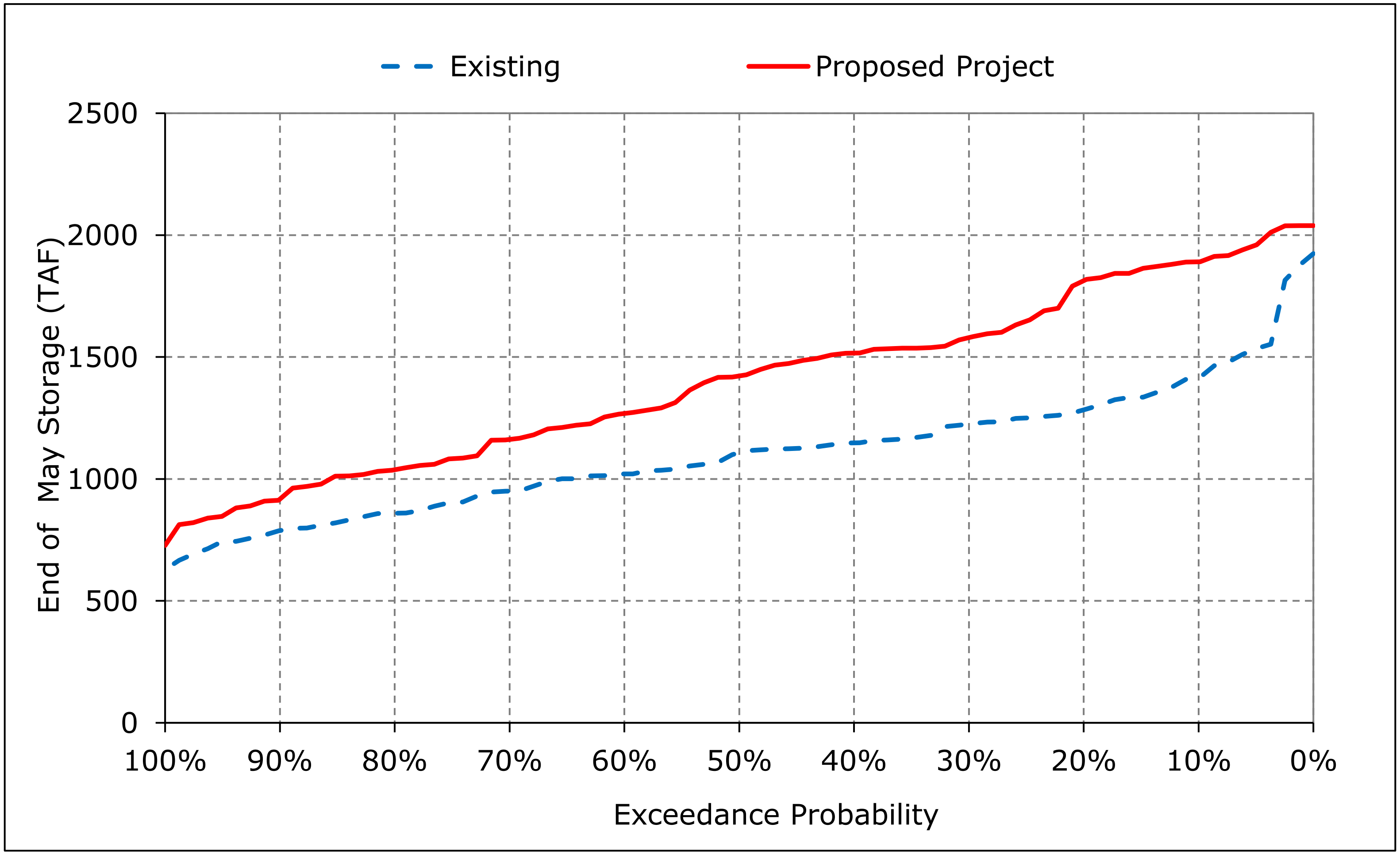


Figure 1a-15. San Luis Storage (CVP and SWP), End of June Storage

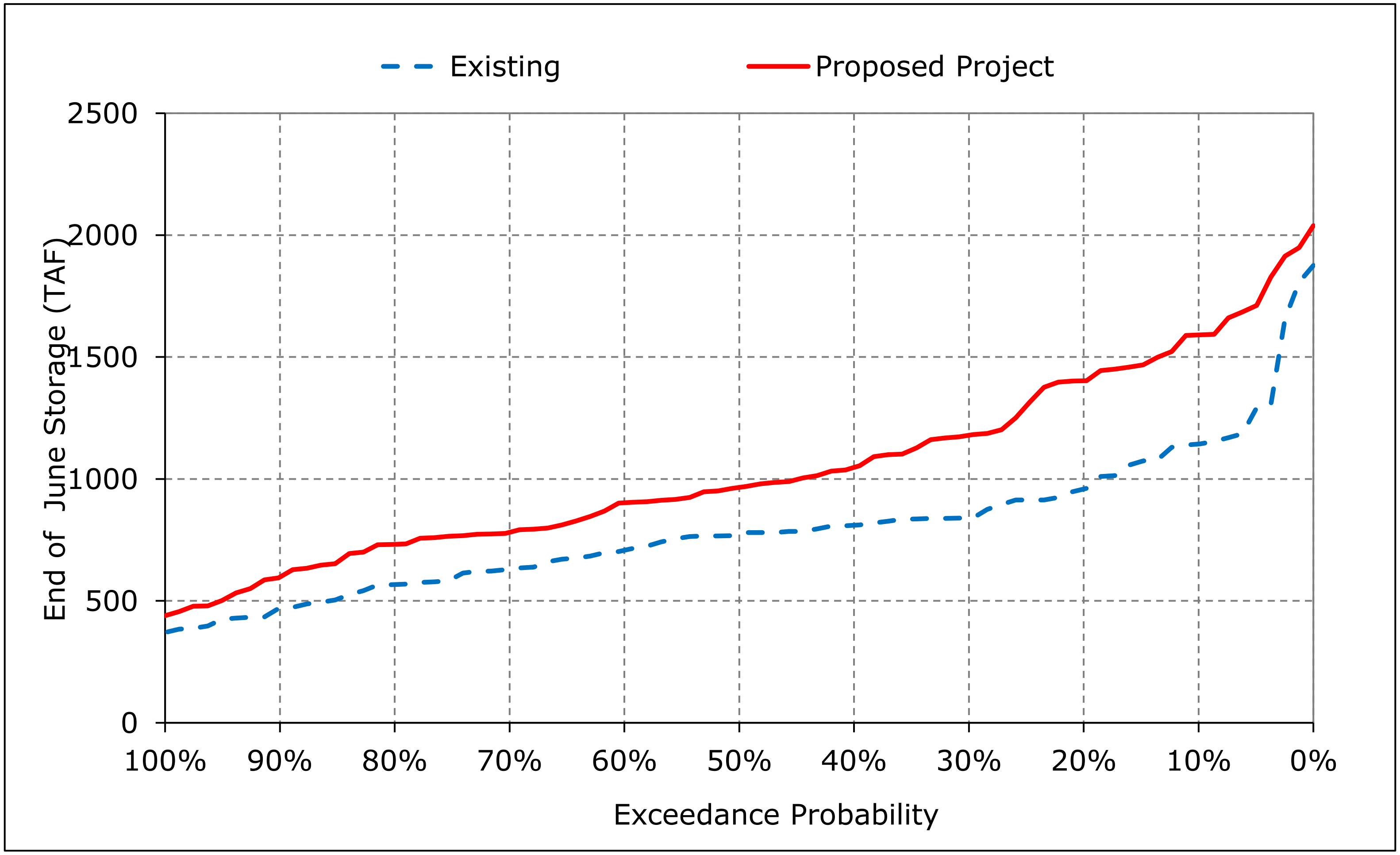


Figure 1a-16. San Luis Storage (CVP and SWP), End of July Storage

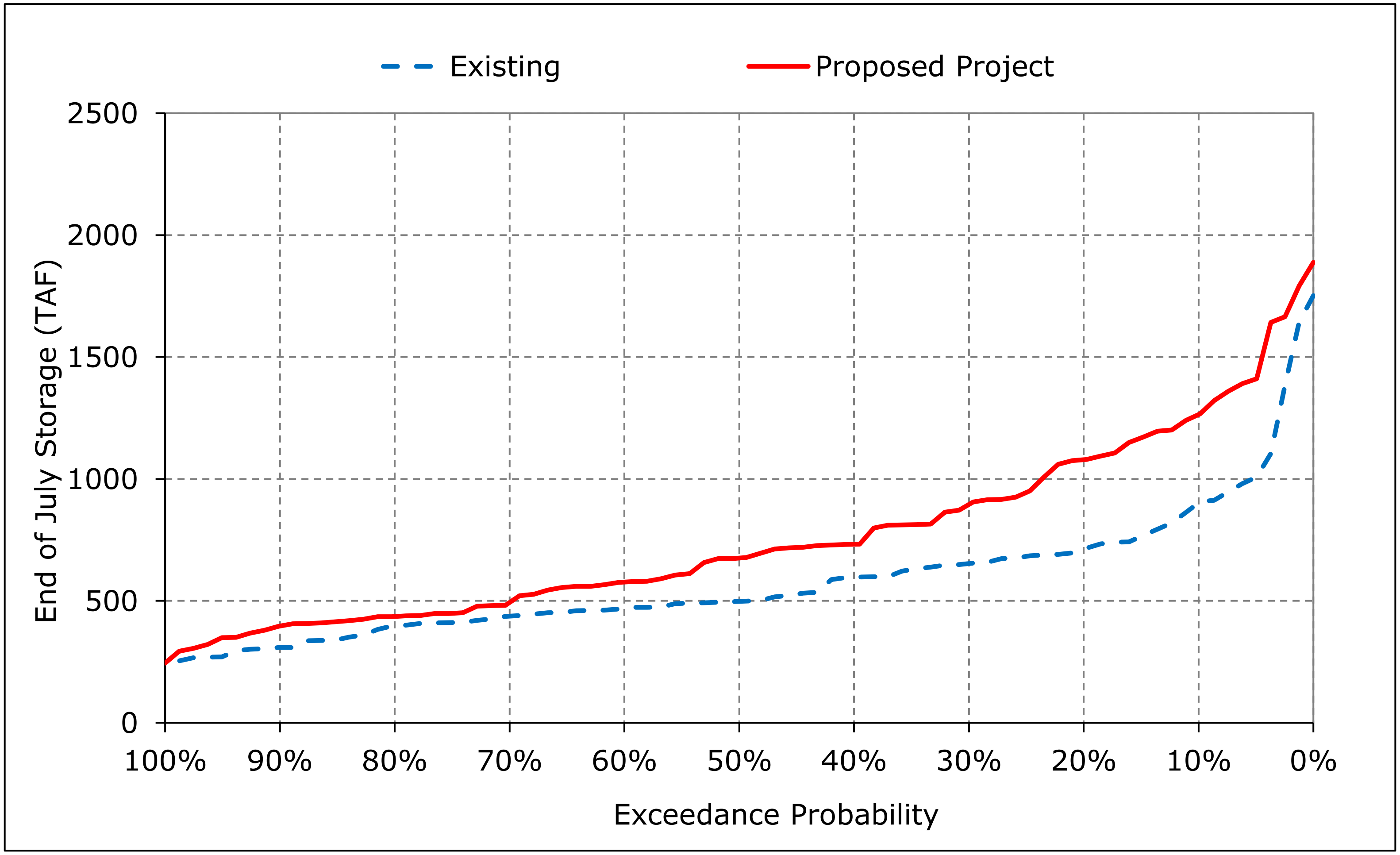


Figure 1a-17. San Luis Storage (CVP and SWP), End of August Storage

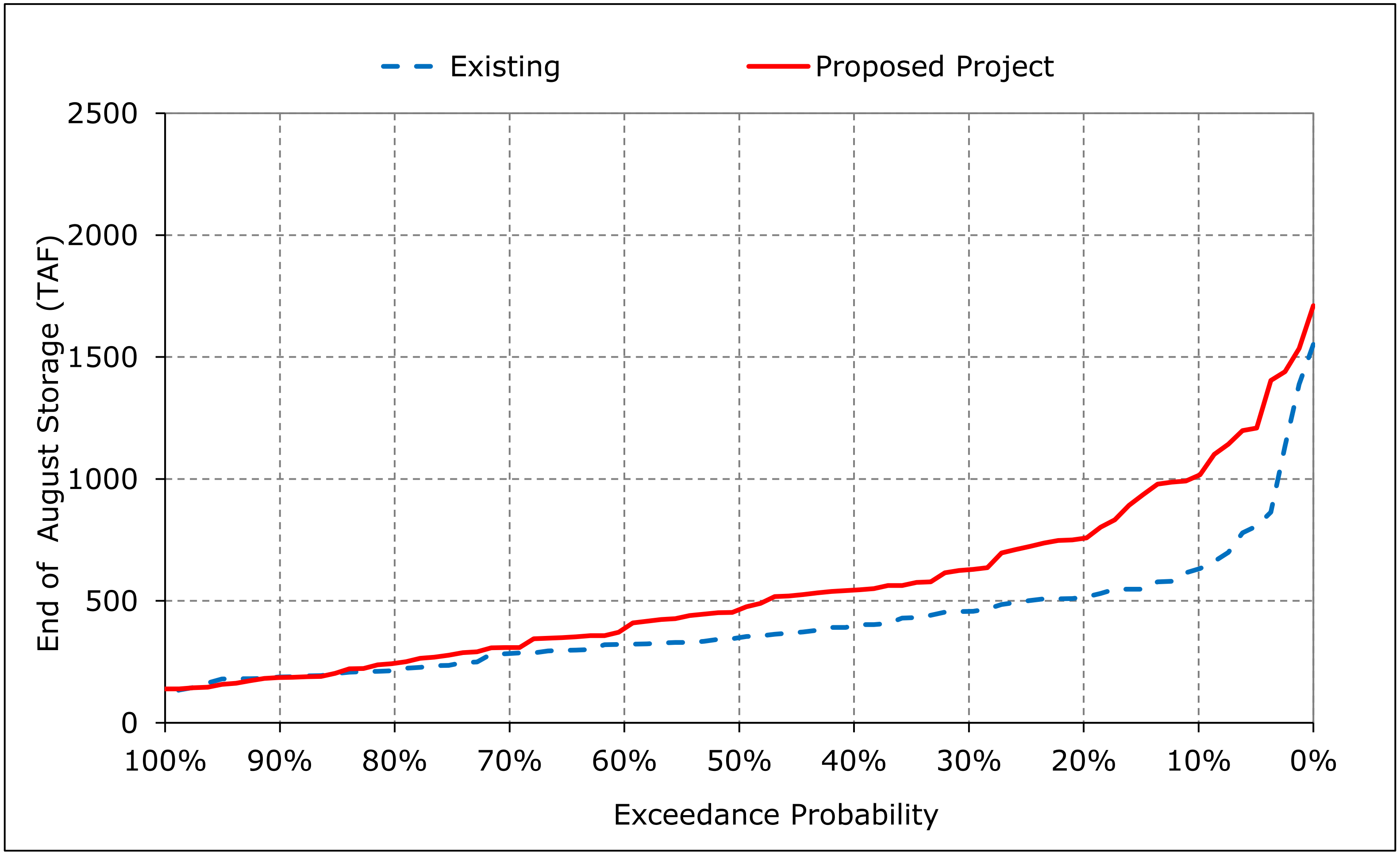


Figure 1a-18. San Luis Storage (CVP and SWP), End of September Storage

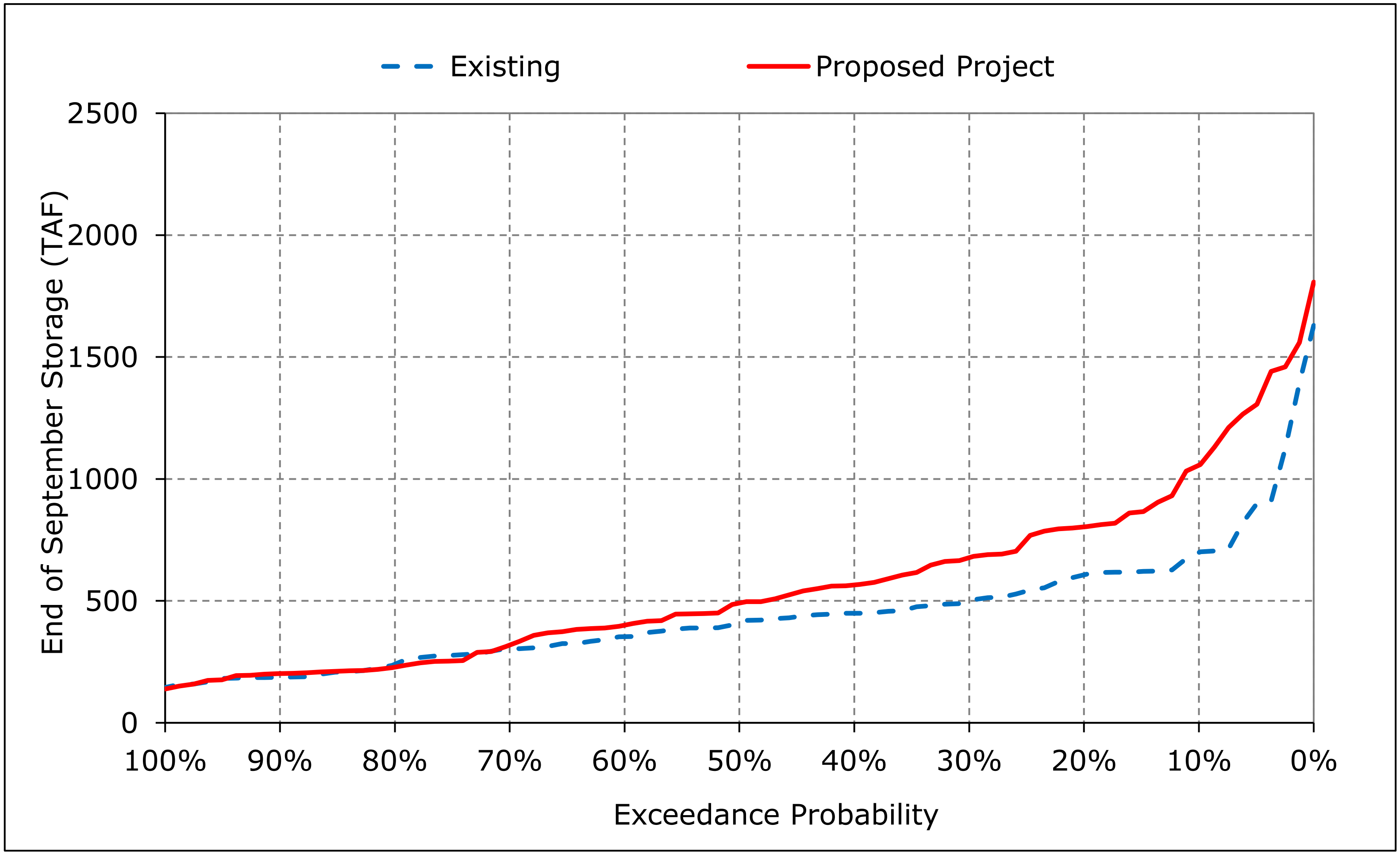


Table 1b-1. San Luis Reservoir (SWP and CVP), End of Month Elevation

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	End of Month Elevation (FEET)											
Probability of Exceedance												
10%	428	442	484	517	544	544	537	514	494	436	401	407
20%	409	429	471	504	534	544	526	502	472	421	390	390
30%	396	429	468	502	526	544	523	493	457	406	374	384
40%	388	429	468	495	520	540	521	487	454	403	363	376
50%	383	427	466	493	513	534	517	481	444	400	360	372
60%	381	418	459	486	506	529	513	476	435	394	356	367
70%	379	412	453	484	502	523	506	469	432	389	352	364
80%	376	397	437	472	497	516	500	463	430	382	345	358
90%	371	382	422	445	477	498	481	456	420	377	339	353
Long Term												
Full Simulation Period[a]	392	420	458	488	512	528	513	482	450	404	368	378
Water Year Types[b,c]												
Wet (32%)	397	426	465	496	520	538	525	496	467	419	380	389
Above Normal (15%)	385	415	456	488	513	533	516	479	446	393	358	372
Below Normal (17%)	393	422	458	487	512	528	510	475	442	399	359	376
Dry (22%)	392	418	458	488	509	524	508	474	440	396	357	369
Critical (15%)	389	411	444	475	499	507	494	474	443	397	377	374

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	End of Month Elevation (FEET)											
Probability of Exceedance												
10%	448	474	508	542	544	544	544	544	524	468	426	431
20%	427	458	491	518	544	544	544	540	504	449	409	409
30%	409	444	480	506	533	544	542	532	488	430	391	396
40%	402	433	470	499	522	540	536	517	471	419	381	386
50%	391	429	467	496	516	533	531	508	462	408	375	382
60%	382	422	461	491	511	523	520	497	458	403	364	374
70%	379	414	453	477	503	518	511	493	451	397	357	371
80%	374	402	435	473	489	505	503	484	443	392	351	361
90%	369	384	414	447	474	488	482	467	431	386	340	349
Long Term												
Full Simulation Period[a]	402	430	465	493	514	525	522	507	471	418	380	387
Water Year Types[b,c]												
Wet (32%)	411	438	474	501	521	535	538	529	495	439	397	402
Above Normal (15%)	394	424	460	490	512	528	528	513	472	412	370	377
Below Normal (17%)	406	437	468	495	518	526	521	508	471	418	375	390
Dry (22%)	395	423	460	488	508	516	508	487	452	404	365	374
Critical (15%)	396	424	456	481	502	510	499	481	447	401	382	380

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	End of Month Elevation (FEET)											
Probability of Exceedance												
10%	20	32	24	25	0	0	8	30	31	33	25	25
20%	18	29	20	13	10	0	18	38	32	28	19	19
30%	13	15	12	4	7	0	19	39	31	25	17	12
40%	14	4	2	4	2	0	14	30	17	17	18	10
50%	8	2	1	4	3	**0**	13	27	19	8	15	10
60%	1	4	2	5	5	**-6**	7	21	23	10	9	7
70%	**0**	2	**0**	**-7**	0	**-4**	5	24	20	8	5	6
80%	**-2**	5	**-2**	0	**-7**	**-12**	4	21	13	10	6	3
90%	**-1**	2	**-8**	2	**-2**	**-10**	1	11	11	9	1	**-4**
Long Term												
Full Simulation Period[a]	10	10	8	4	2	**-3**	9	25	21	15	12	9
Water Year Types[b,c]												
Wet (32%)	14	12	9	5	1	**-3**	13	32	28	20	17	13
Above Normal (15%)	9	9	5	2	**0**	**-5**	13	34	26	19	12	4
Below Normal (17%)	13	15	10	8	6	**-2**	11	32	29	19	16	14
Dry (22%)	3	4	2	0	**0**	**-8**	1	14	12	8	8	6
Critical (15%)	6	13	12	6	3	3	5	7	4	4	5	6

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

Figure 1b-7. San Luis Reservoir (SWP and CVP), Reservoir Pool Elevation, October

Figure 1b-8. San Luis Reservoir (SWP and CVP), Reservoir Pool Elevation, November

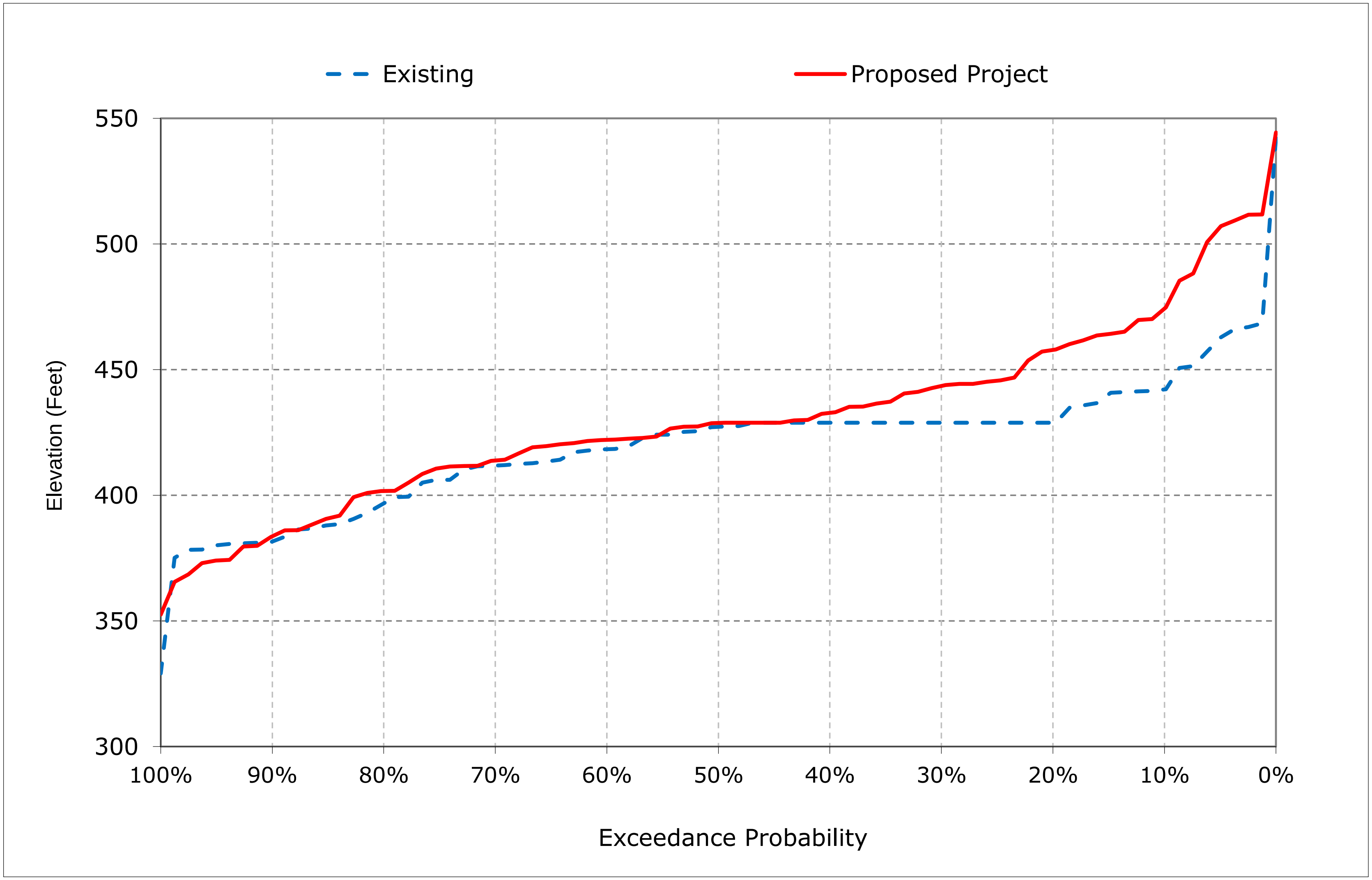


Figure 1b-9. San Luis Reservoir (SWP and CVP), Reservoir Pool Elevation, December

Figure 1b-10. San Luis Reservoir (SWP and CVP), Reservoir Pool Elevation, January

Figure 1b-11. San Luis Reservoir (SWP and CVP), Reservoir Pool Elevation, February

Figure 1b-12. San Luis Reservoir (SWP and CVP), Reservoir Pool Elevation, March

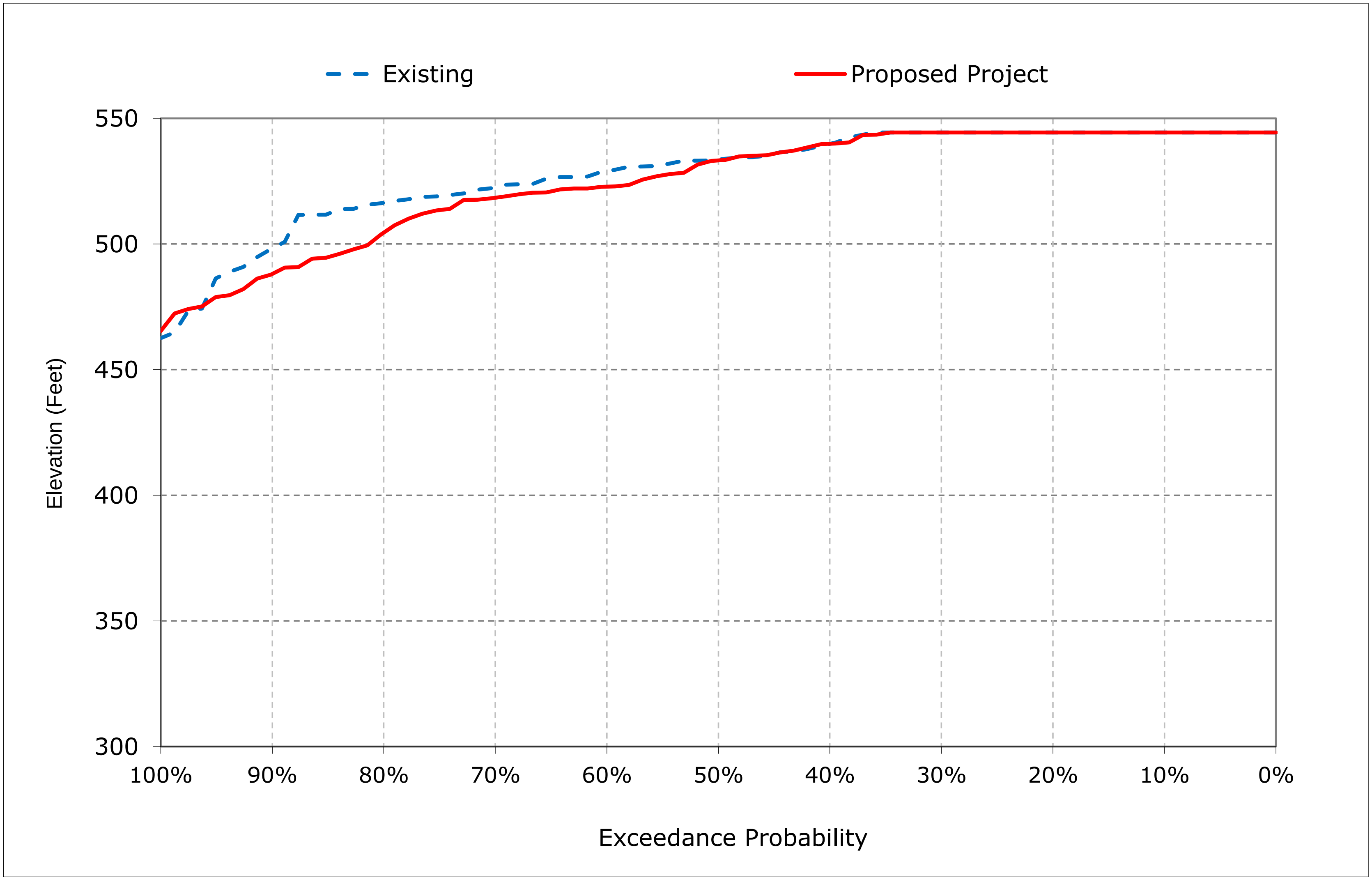


Figure 1b-13. San Luis Reservoir (SWP and CVP), Reservoir Pool Elevation, April

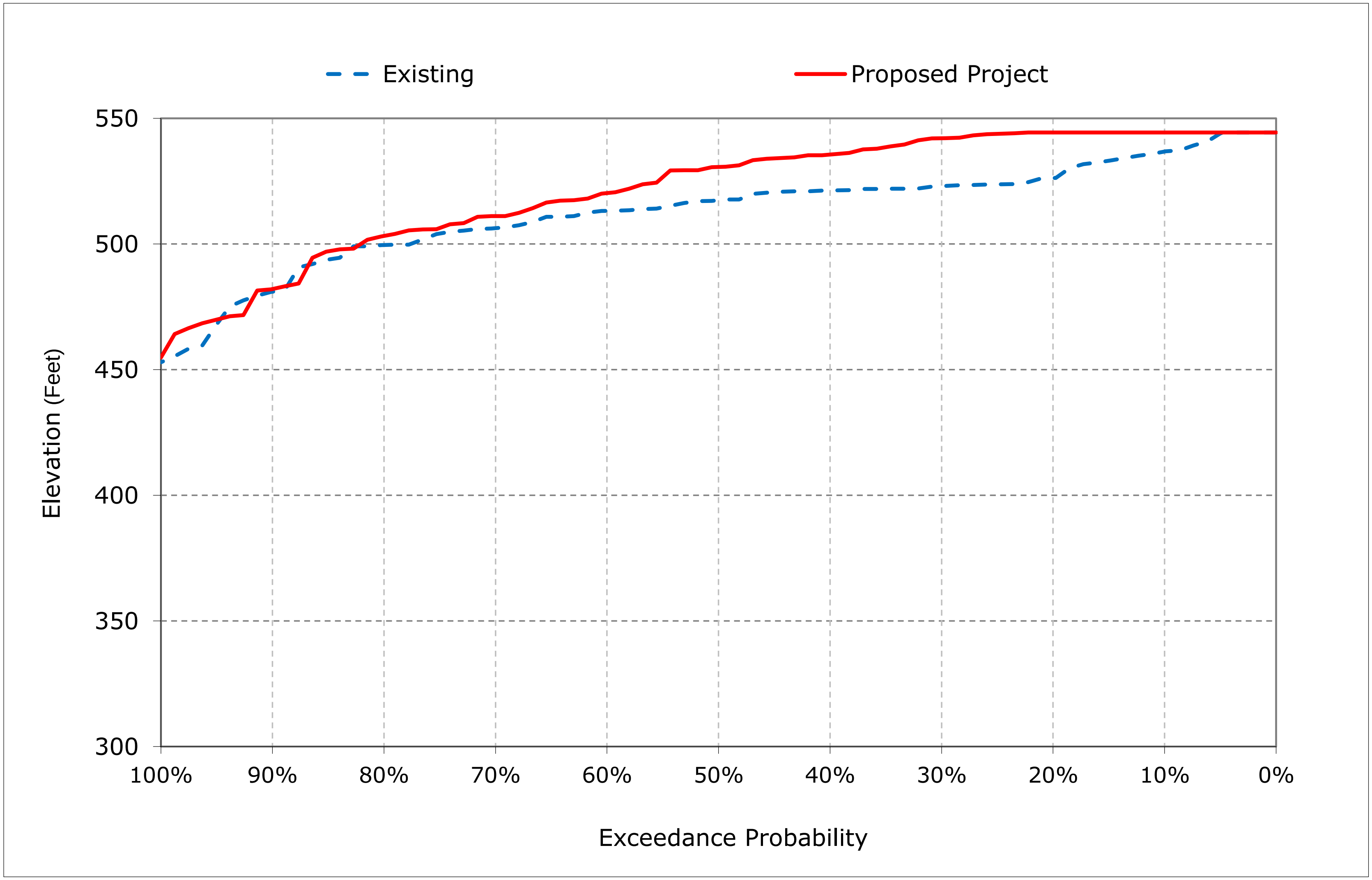


Figure 1b-14. San Luis Reservoir (SWP and CVP), Reservoir Pool Elevation, May

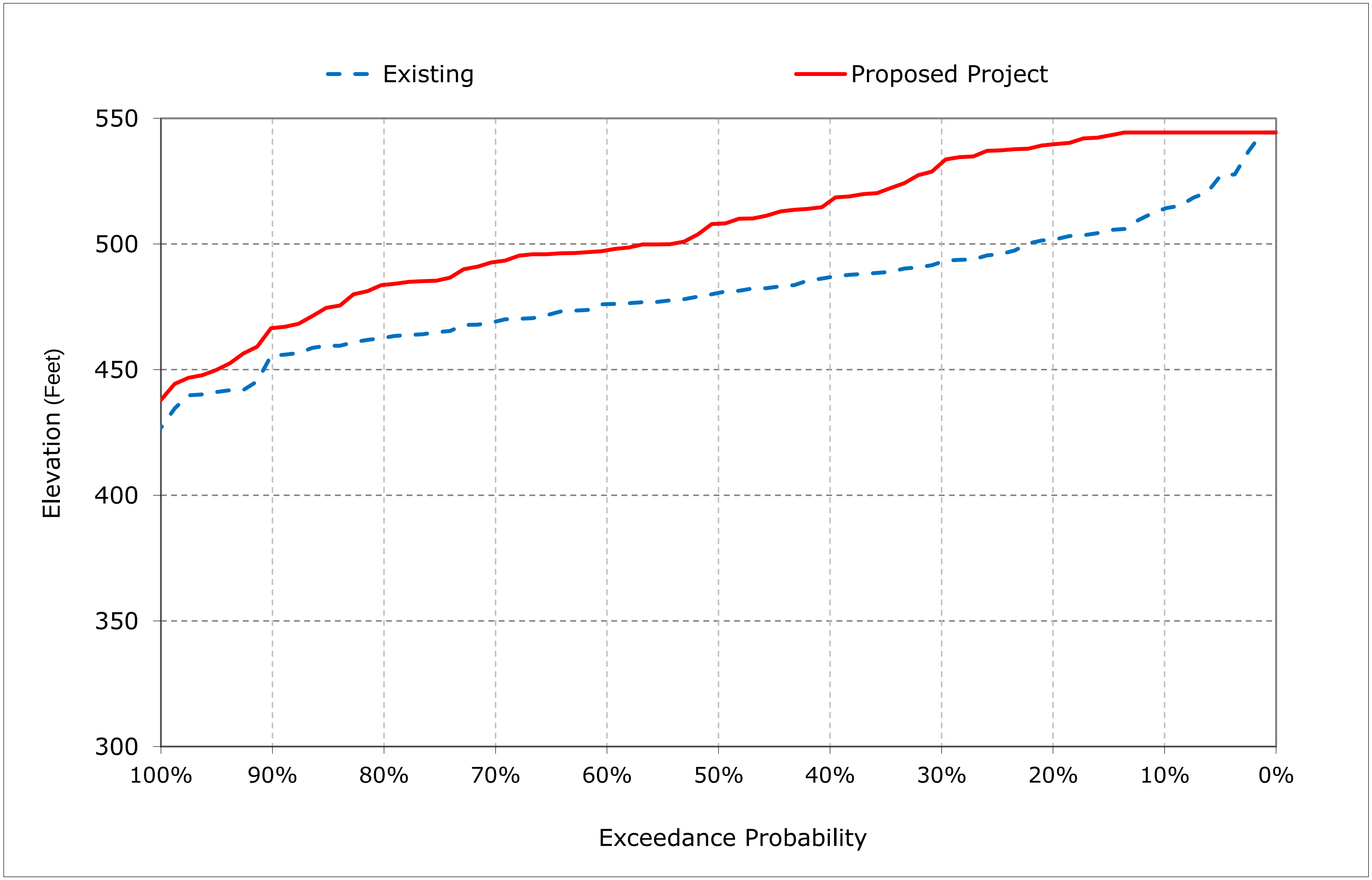


Figure 1b-15. San Luis Reservoir (SWP and CVP), Reservoir Pool Elevation, June

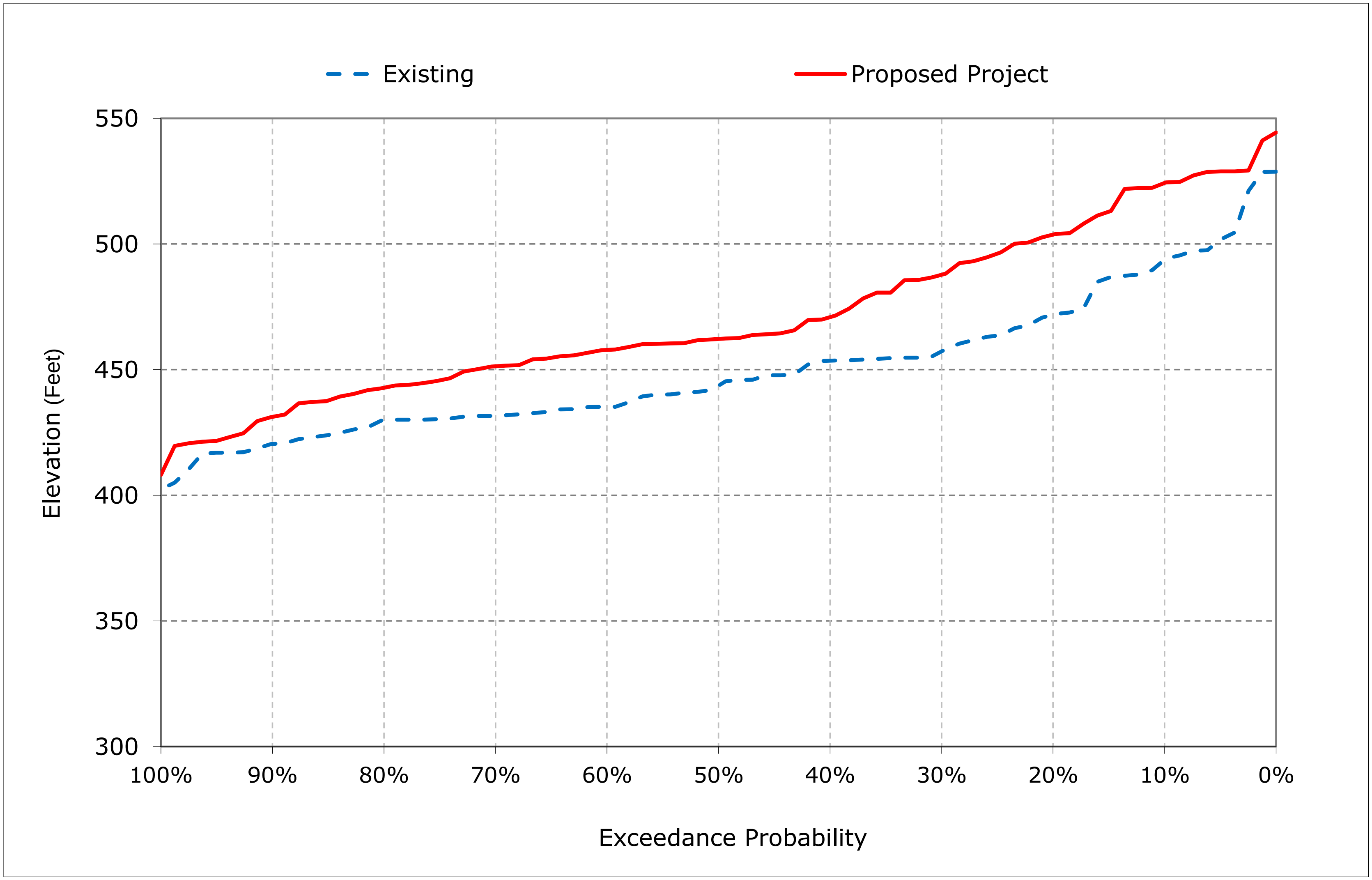


Figure 1b-16. San Luis Reservoir (SWP and CVP), Reservoir Pool Elevation, July

Figure 1b-17. San Luis Reservoir (SWP and CVP), Reservoir Pool Elevation, August

Figure 1b-18. San Luis Reservoir (SWP and CVP), Reservoir Pool Elevation, September

Table 1c-1. San Luis SWP Storage, End of Month Storage

Existing

Statistic	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	508	498	626	794	1,008	1,067	904	668	547	554	462	532
20%	372	396	539	676	843	1,020	877	638	455	427	385	426
30%	316	329	433	566	694	921	810	590	392	373	317	332
40%	269	252	352	486	655	809	725	531	361	315	258	285
50%	211	196	328	439	596	716	583	480	323	272	223	237
60%	153	145	275	383	542	659	565	398	256	234	195	188
70%	85	97	186	313	455	565	521	347	206	207	130	129
80%	55	55	85	230	379	507	447	318	156	158	84	55
90%	55	55	55	199	345	444	378	267	95	100	55	55
Long Term												
Full Simulation Period[a]	244	255	339	479	619	740	645	478	326	309	255	266
Water Year Types[b,c]												
Wet (32%)	297	310	357	525	687	856	718	505	355	365	365	414
Above Normal (15%)	276	279	414	545	681	779	638	425	242	249	268	330
Below Normal (17%)	187	201	295	422	579	709	601	421	233	275	290	251
Dry (22%)	225	246	342	476	593	692	638	521	383	349	166	147
Critical (15%)	190	191	268	383	497	554	552	475	372	227	98	77

Proposed Project

Statistic	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	704	841	972	1,042	1,067	1,067	1,023	944	748	712	660	689
20%	602	695	797	893	1,052	1,067	979	869	685	653	552	581
30%	512	568	686	811	889	973	940	807	606	555	518	540
40%	392	463	555	673	819	866	875	729	505	488	417	396
50%	298	361	448	559	702	805	783	636	431	422	330	311
60%	164	262	323	444	631	723	662	577	397	313	241	208
70%	92	170	233	340	475	555	593	476	320	237	138	121
80%	55	55	107	270	394	464	470	372	249	192	79	55
90%	55	55	55	199	321	420	400	328	158	156	55	55
Long Term												
Full Simulation Period[a]	342	409	476	590	701	761	742	641	467	426	353	349
Water Year Types[b,c]												
Wet (32%)	446	534	560	666	785	879	868	781	620	620	599	627
Above Normal (15%)	361	440	553	669	772	794	751	632	415	418	413	458
Below Normal (17%)	314	381	462	565	694	729	701	572	350	353	344	291
Dry (22%)	300	358	468	594	691	750	728	621	448	352	139	103
Critical (15%)	195	219	248	366	472	526	527	454	351	211	95	74

Proposed Project minus Existing

Statistic	End of Month Storage (TAF)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	196	343	347	249	59	0	118	277	202	158	198	156
20%	230	300	258	216	209	47	101	231	230	226	167	155
30%	196	239	254	245	195	51	130	217	214	182	200	207
40%	124	211	202	187	165	57	150	197	144	173	159	111
50%	87	166	120	120	106	89	200	156	109	150	107	73
60%	11	116	48	61	89	63	98	179	142	79	46	20
70%	8	73	47	26	20	**-10**	72	129	114	30	7	**-8**
80%	0	0	22	40	15	**-43**	23	54	93	34	**-5**	0
90%	0	0	0	**0**	**-24**	**-24**	22	62	63	56	0	0
Long Term												
Full Simulation Period[a]	99	154	138	111	82	22	97	163	140	117	98	83
Water Year Types[b,c]												
Wet (32%)	149	224	203	142	98	23	150	277	265	255	234	213
Above Normal (15%)	85	161	139	125	91	15	113	207	172	169	145	128
Below Normal (17%)	127	180	167	143	115	20	100	151	117	79	54	40
Dry (22%)	75	112	125	118	98	58	89	100	65	3	**-27**	**-44**
Critical (15%)	5	28	**-20**	**-17**	**-25**	**-28**	**-25**	**-21**	**-22**	**-16**	**-3**	**-2**

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

Figure 1c-7. San Luis SWP Storage, End of October Storage

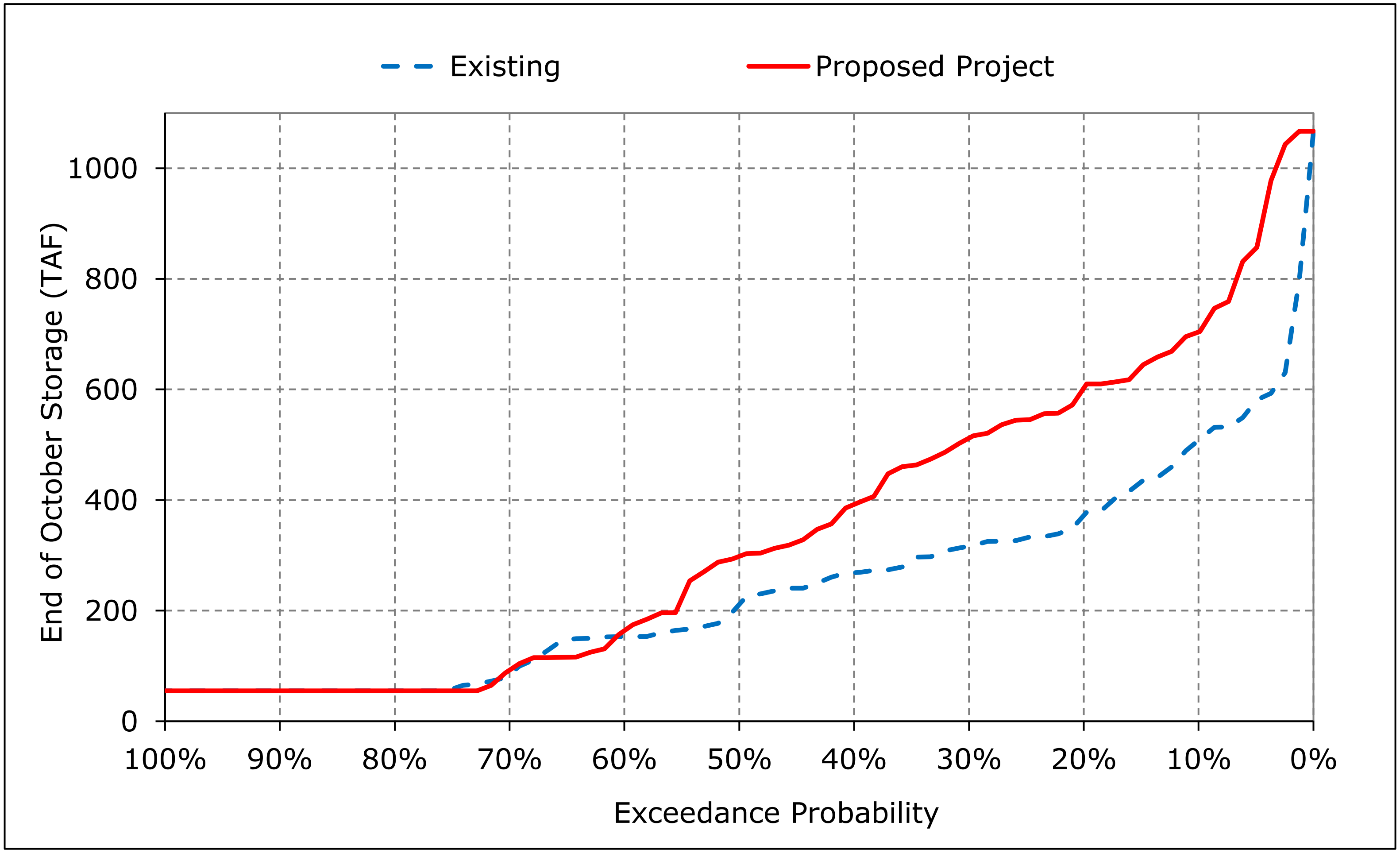


Figure 1c-8. San Luis SWP Storage, End of November Storage

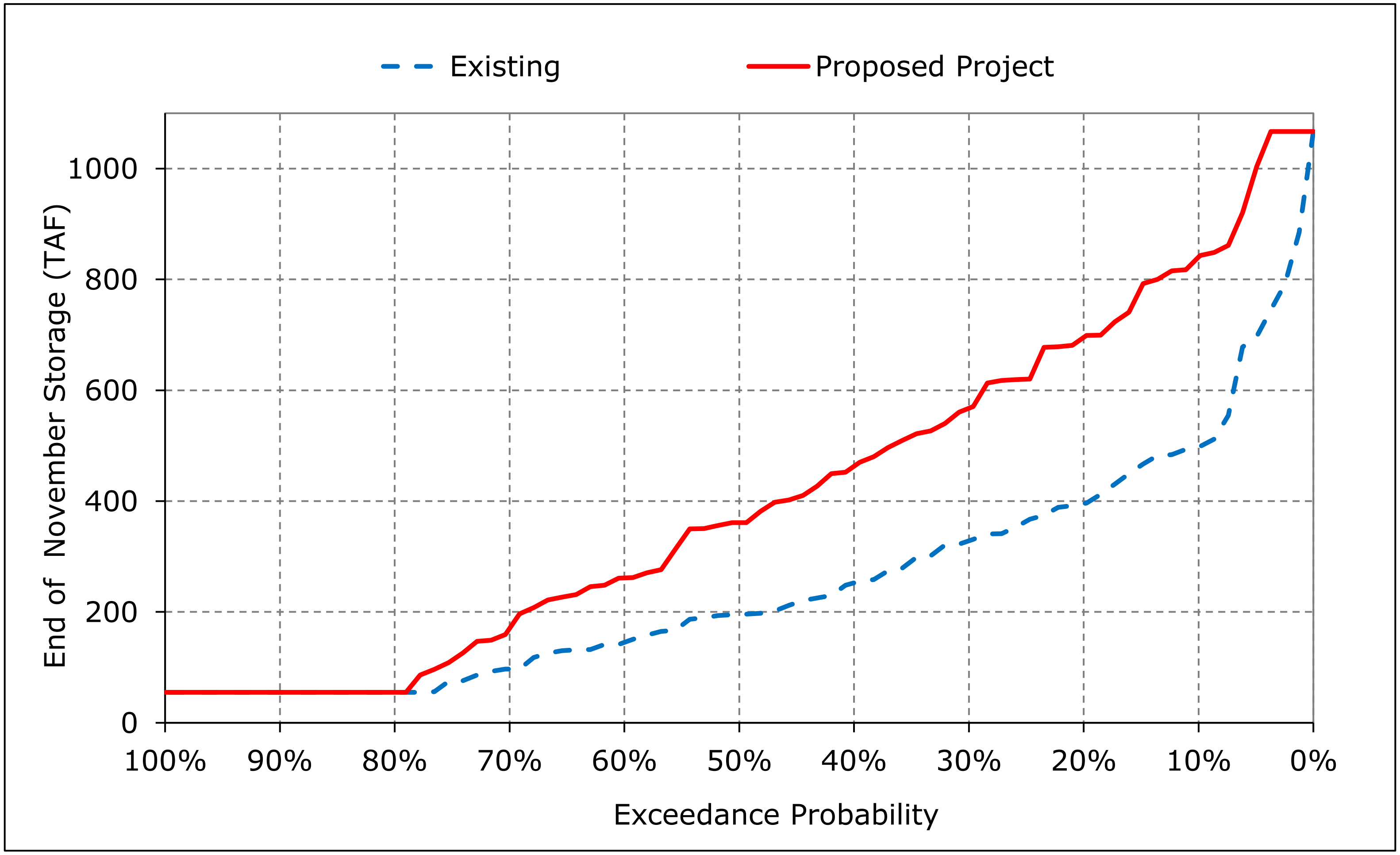


Figure 1c-9. San Luis SWP Storage, End of December Storage

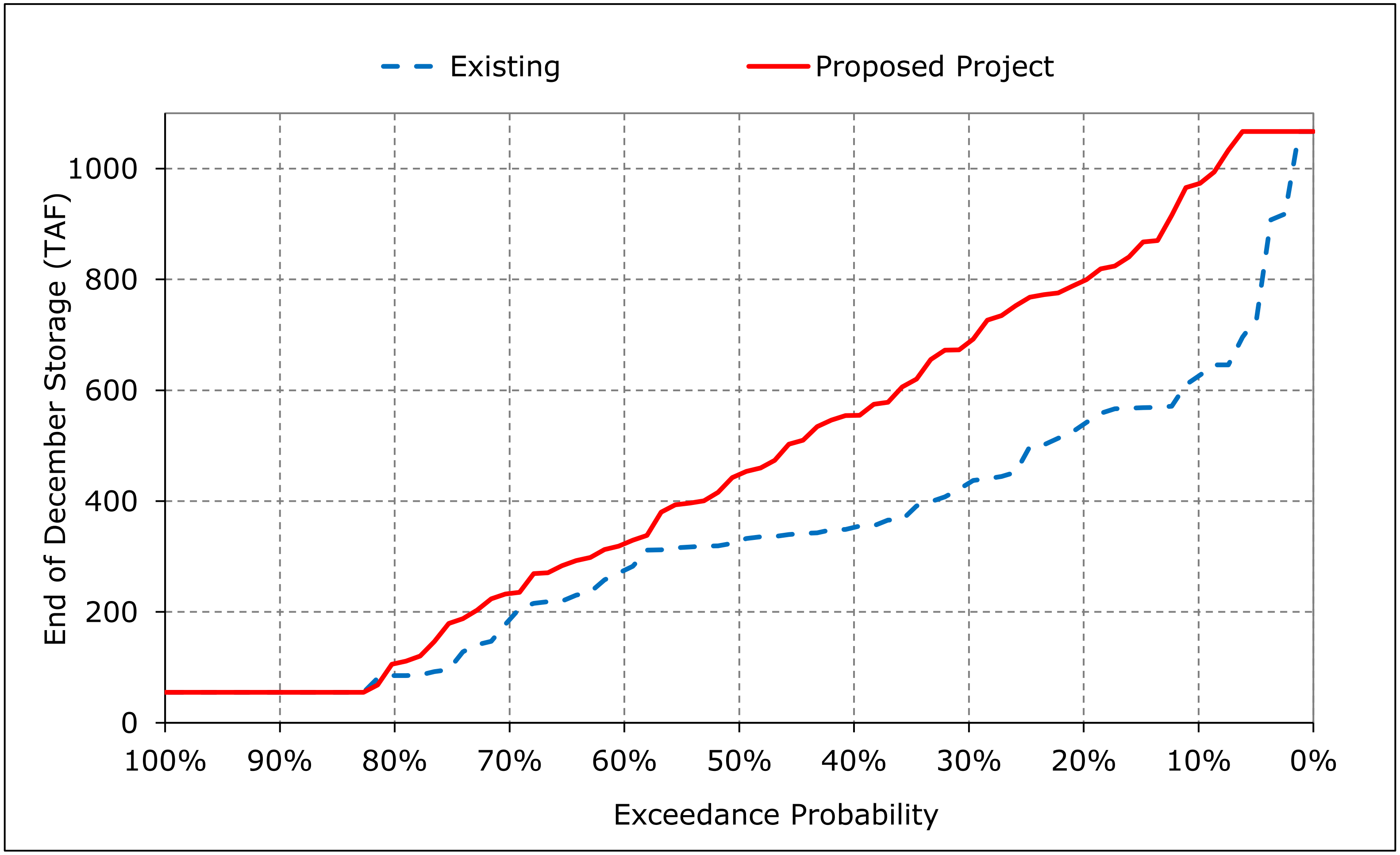


Figure 1c-10. San Luis SWP Storage, End of January Storage

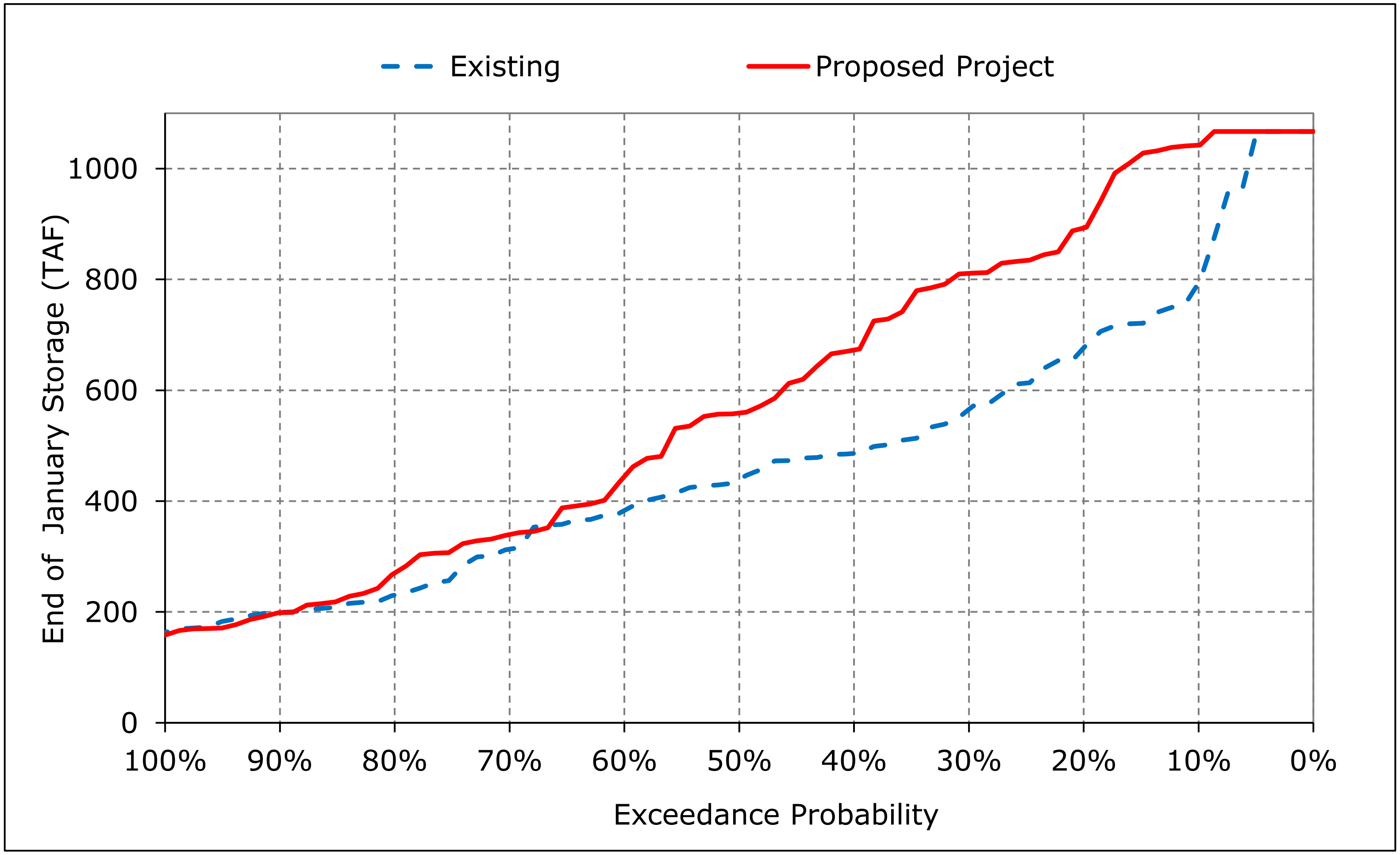


Figure 1c-11. San Luis SWP Storage, End of February Storage

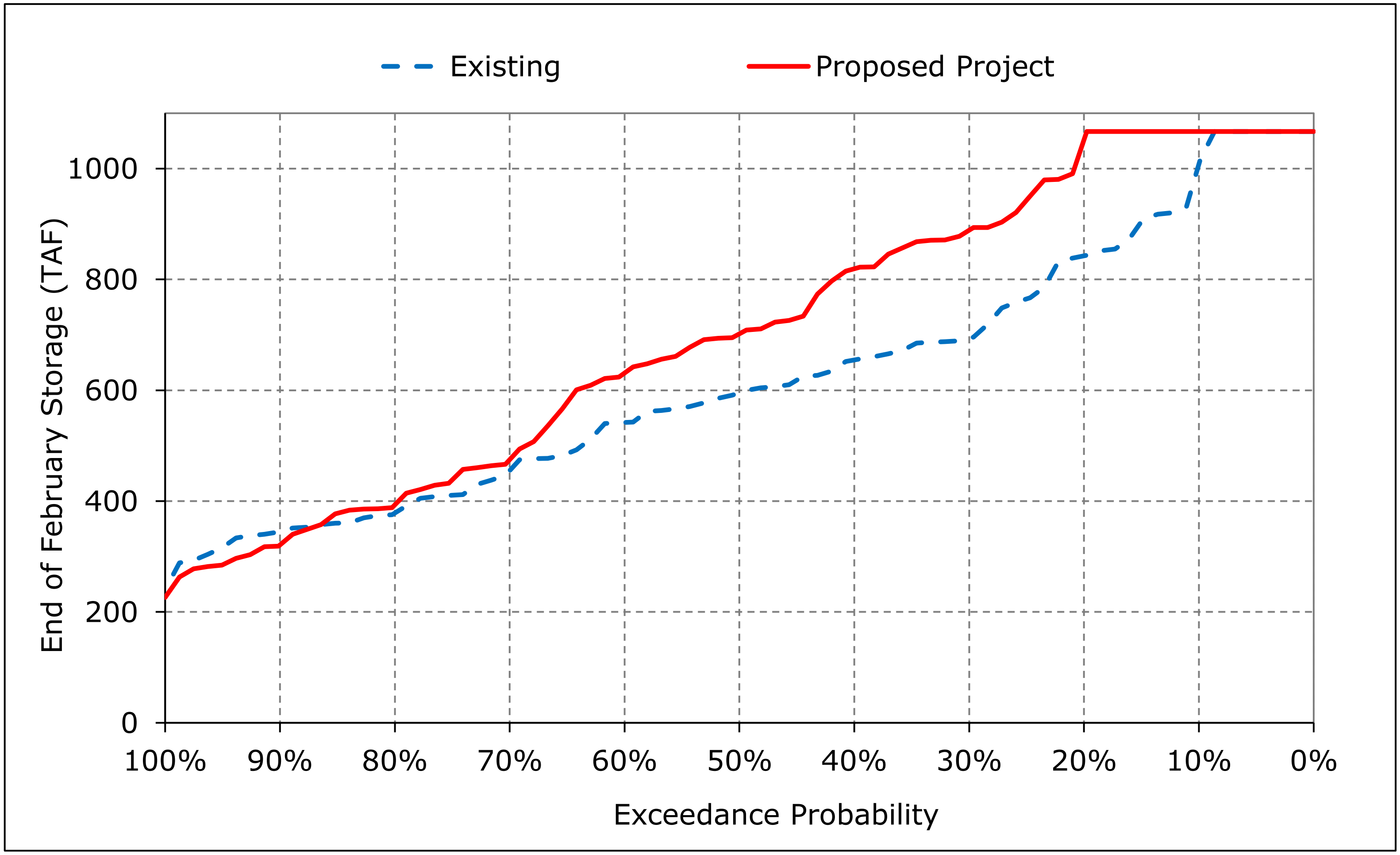


Figure 1c-12. San Luis SWP Storage, End of March Storage

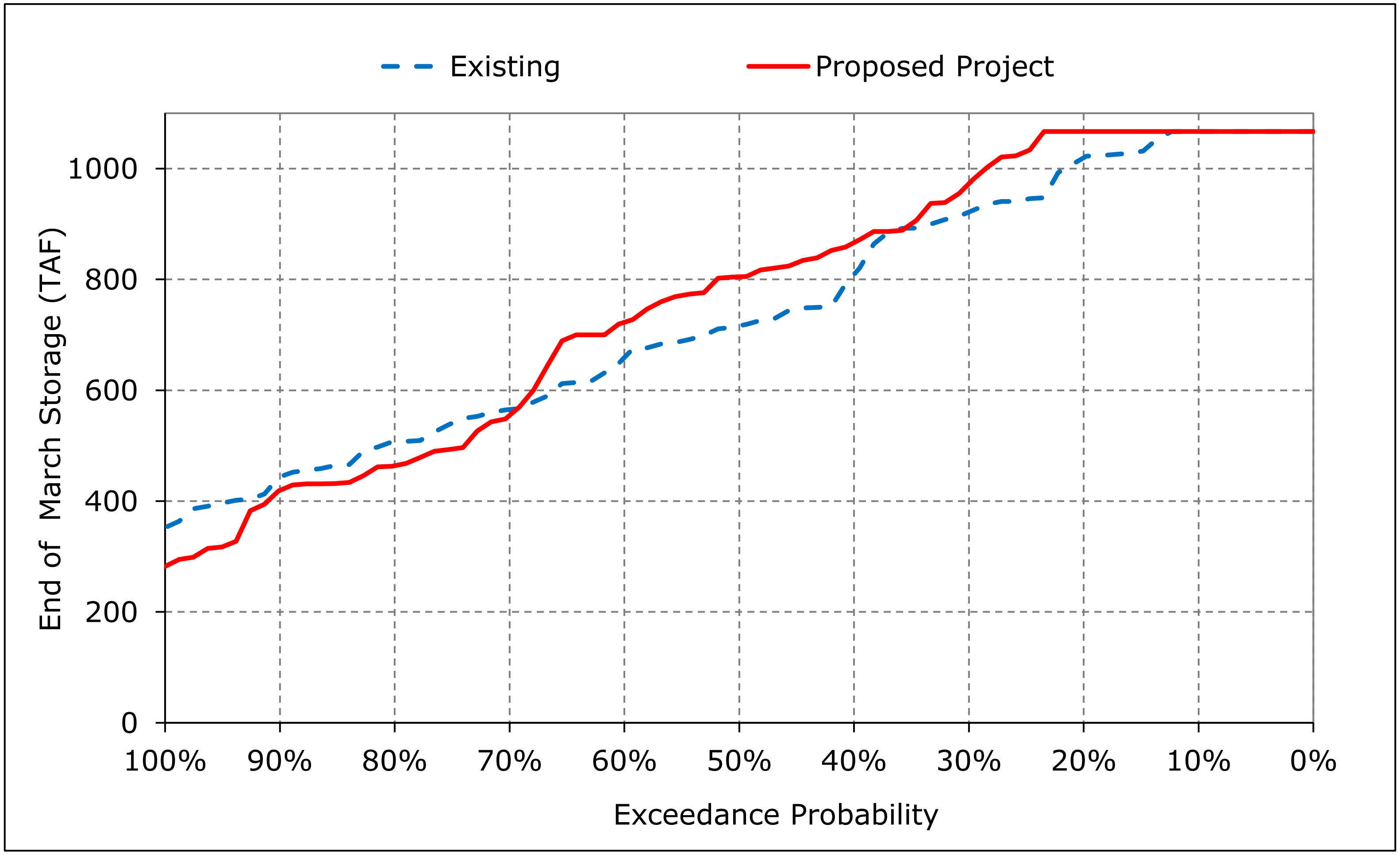


Figure 1c-13. San Luis SWP Storage, End of April Storage

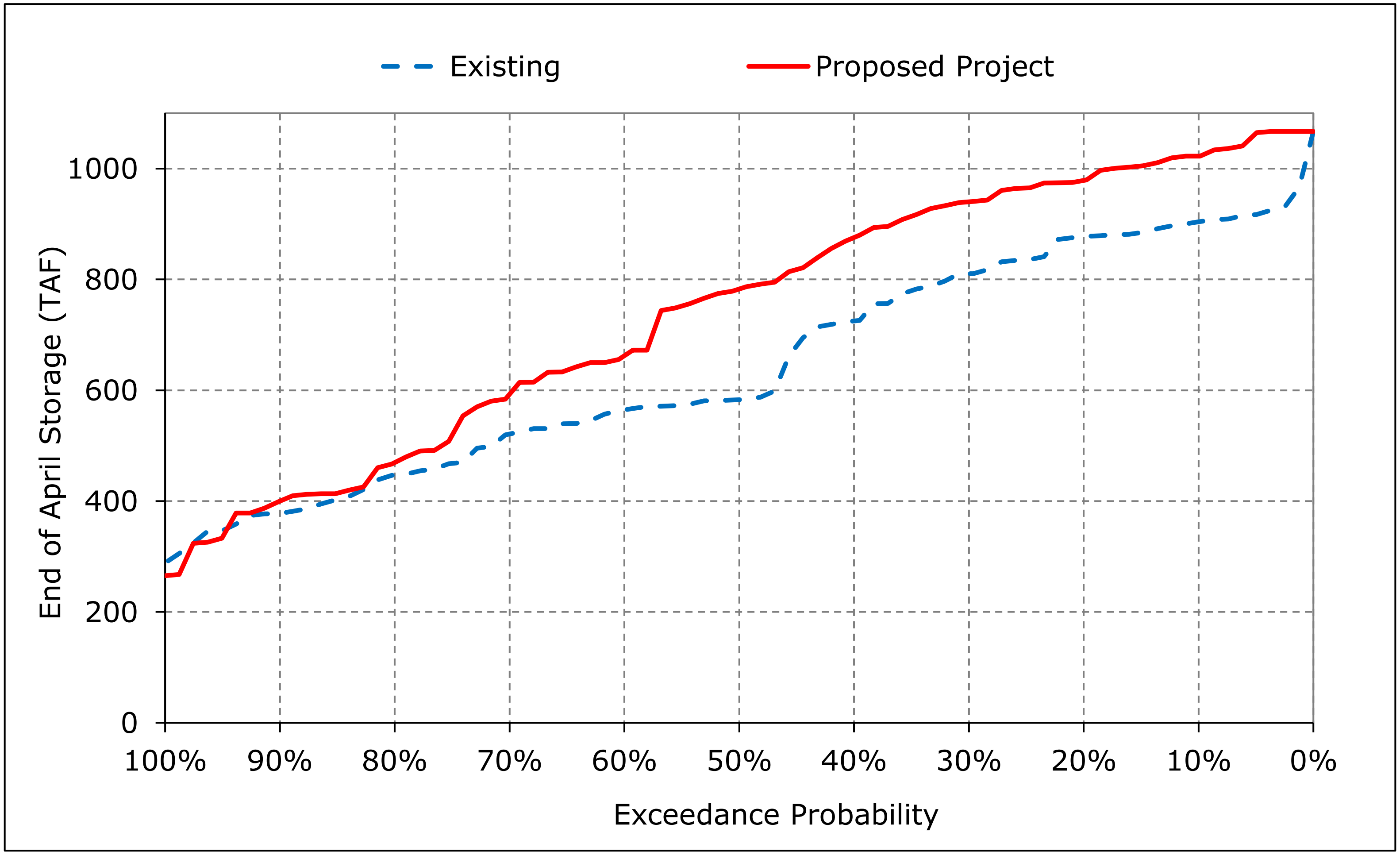


Figure 1c-14. San Luis SWP Storage, End of May Storage

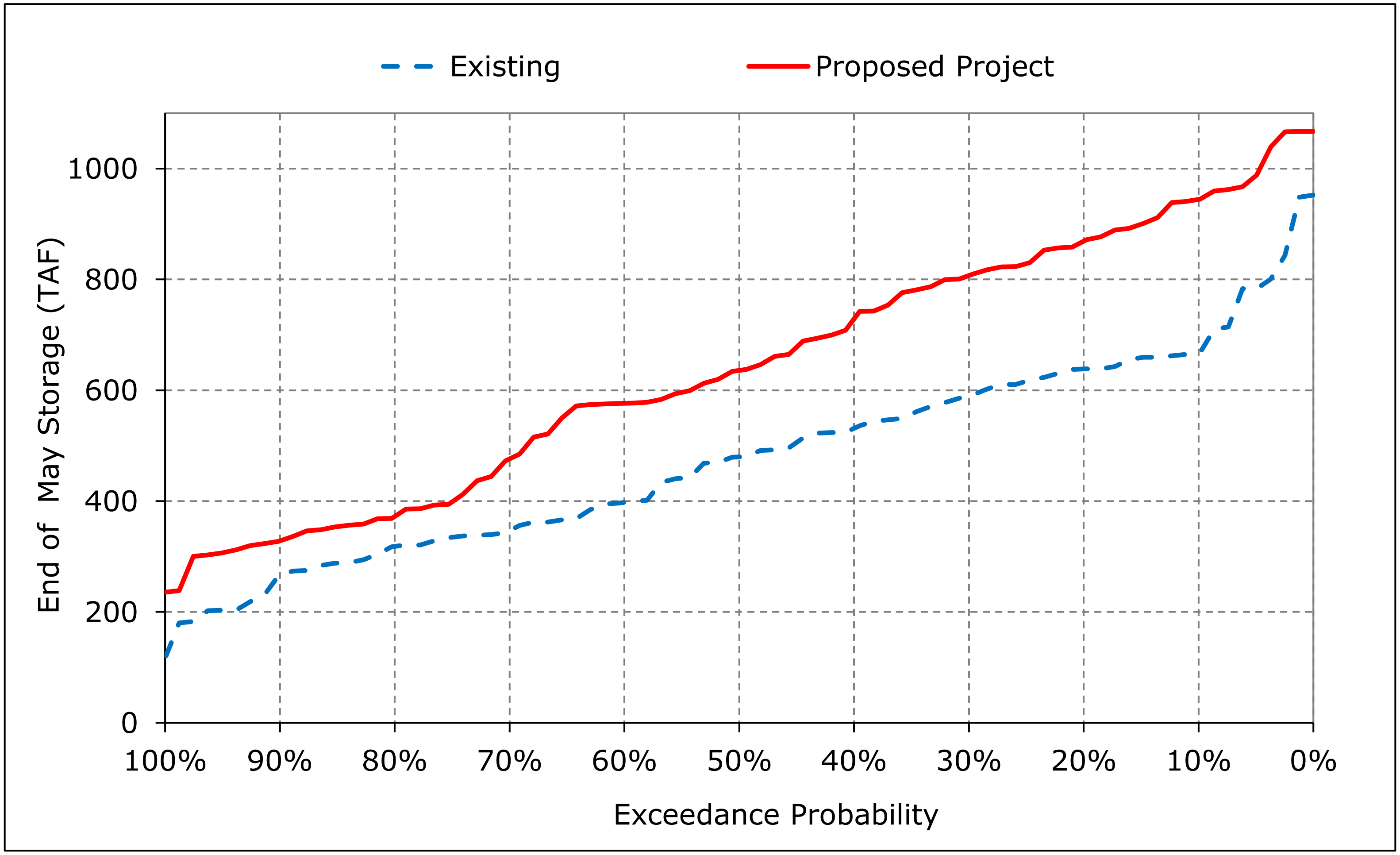


Figure 1c-15. San Luis SWP Storage, End of June Storage

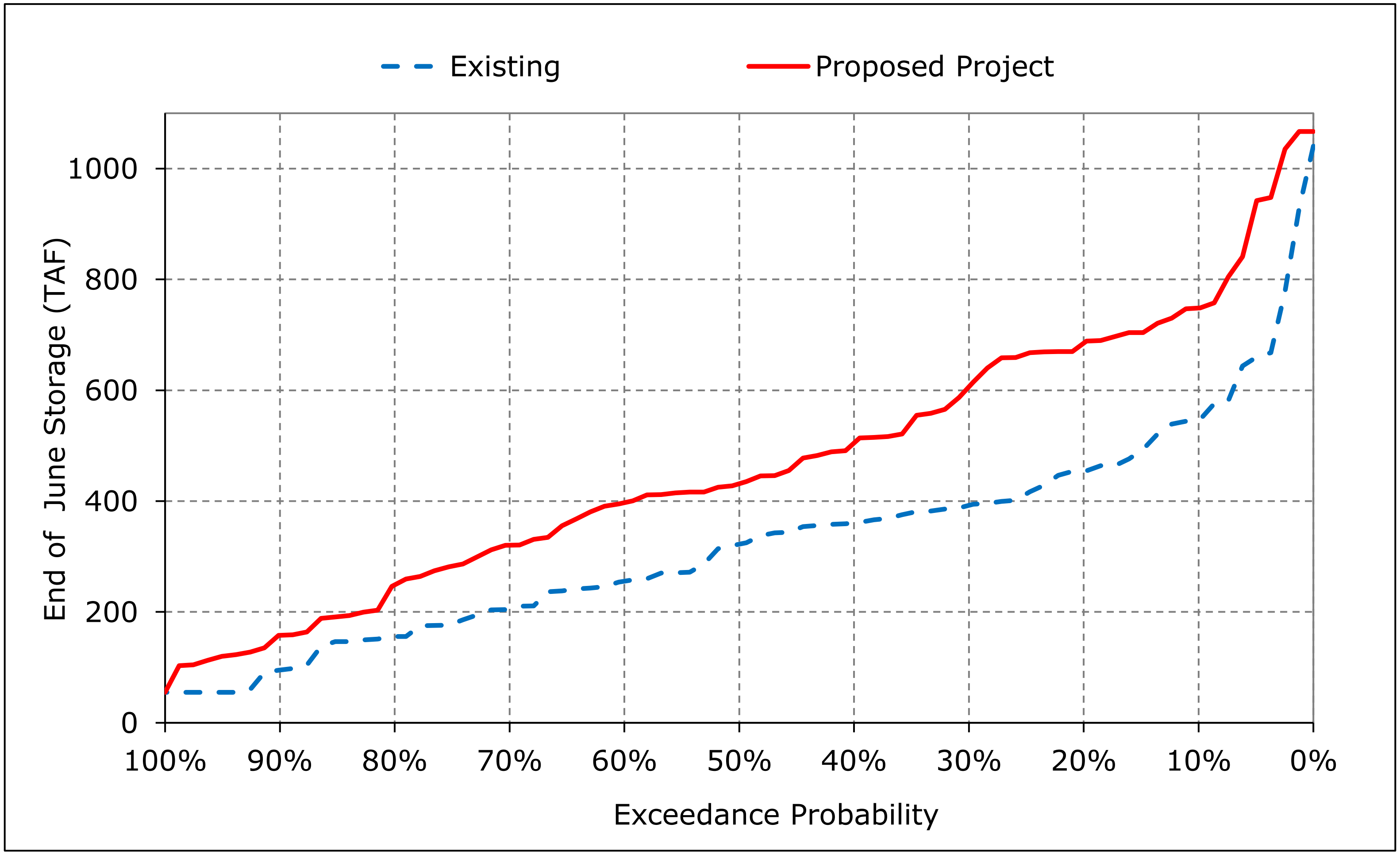


Figure 1c-16. San Luis SWP Storage, End of July Storage

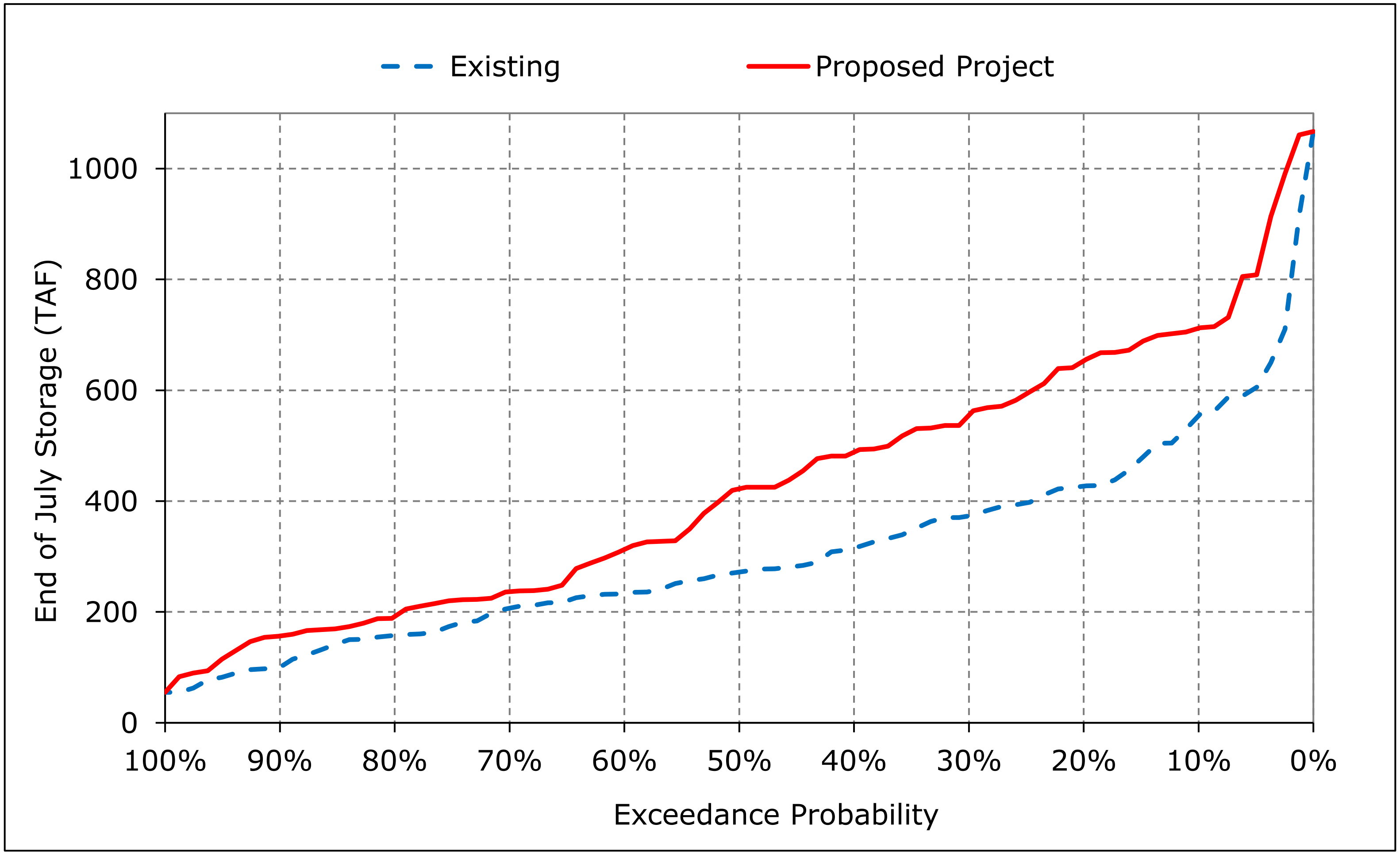


Figure 1c-17. San Luis SWP Storage, End of August Storage

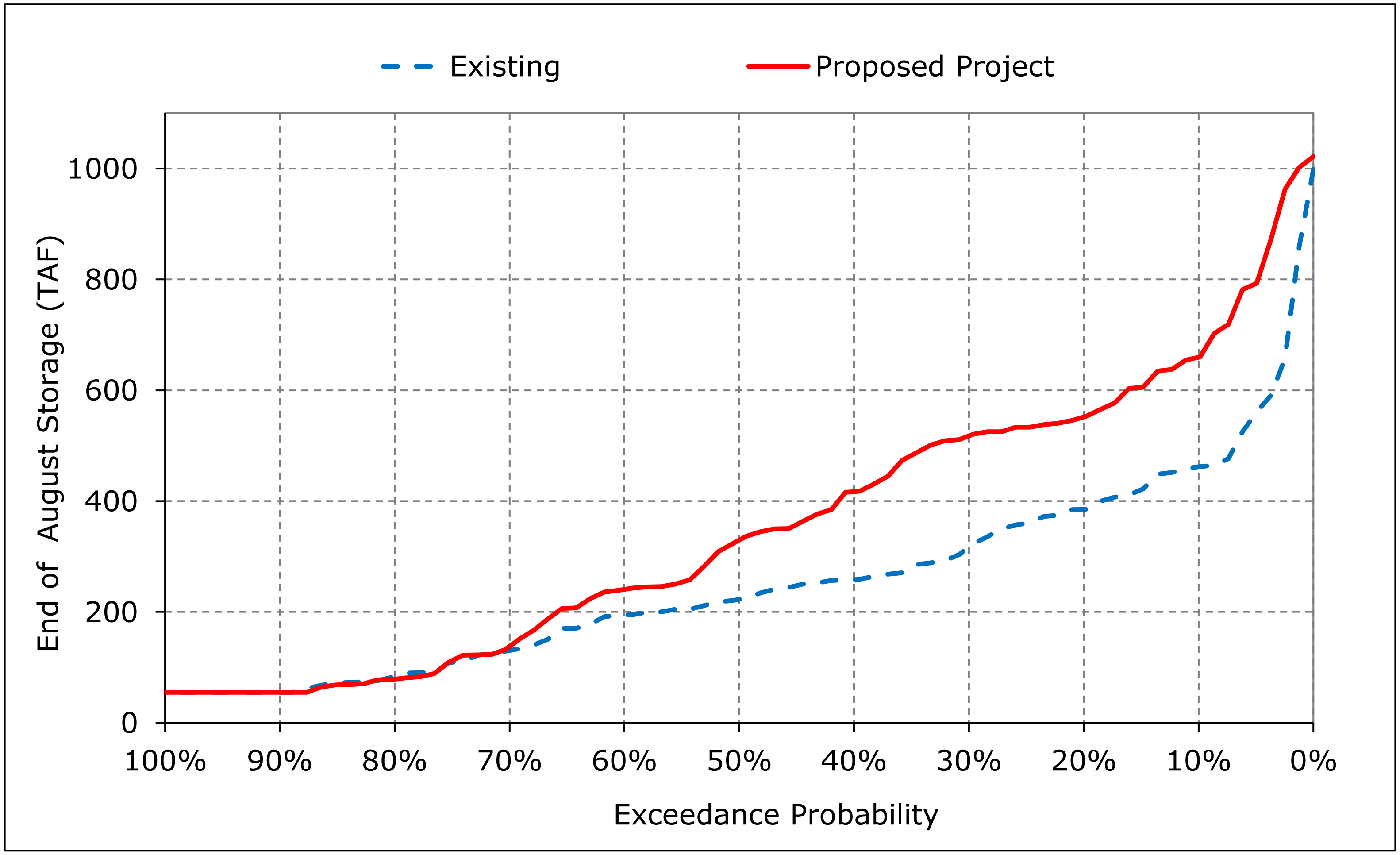
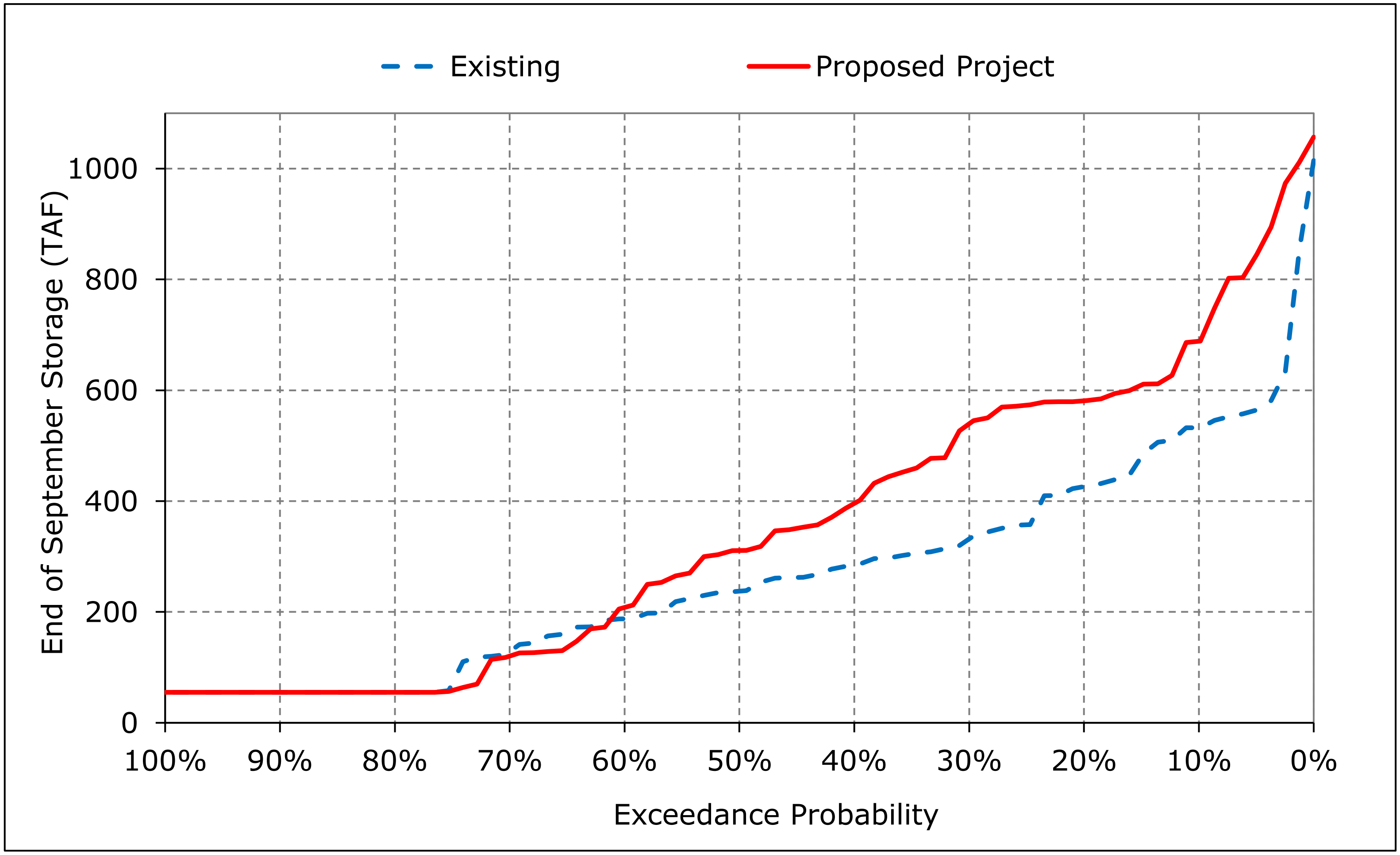


Figure 1c-18. San Luis SWP Storage, End of September Storage



Appendix C – Modeling

Attachment 2-2 – Flow Results (CalSim II)

The following results of the CalSim II model are included for river flow conditions for the following alternatives:

- Existing Conditions
- Proposed Project

Table 2-2.1. Flow Results (CalSim II)

Title	Model Parameter	Table Numbers	Figure Numbers
Sacramento River Flow at Freeport	C169	1-1	1-1 to 1-18
Georgiana Slough Flow	D401B_GEO	2-1	2-1 to 2-18
Yolo Bypass Flow	C157	3-1	3-1 to 3-18
Sacramento River Flow at Rio Vista	C405	4-1	4-1 to 4-18
San Joaquin River at Vernalis	C639	5-1	5-1 to 5-18
Mokelumne River Below Consumnes	C504	6-1	6-1 to 6-18
Old and Middle River Flow	C408	7-1	7-1 to 7-18
Qwest	C416A	8-1	8-1 to 8-18
Delta Outflow	C406	9-1	9-1 to 9-18

Report formats

- Monthly tables comparing two scenarios (exceedance values, long-term average, and average by water year type)
- Monthly pattern charts (long-term average and average by water year type) including all scenarios
- Monthly exceedance charts (all months) including all scenarios

Table 1-1. Sacramento River Flow at Freeport, Monthly Flow

Existing

Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	13,766	22,073	48,752	63,157	68,384	62,394	52,923	41,803	26,593	24,522	16,963	30,152
20%	13,332	19,621	32,185	55,411	60,806	52,865	40,600	29,832	19,988	22,968	16,238	29,429
30%	12,763	18,605	21,963	38,417	49,902	39,929	26,021	19,236	15,420	21,584	16,006	24,061
40%	11,546	16,220	18,343	26,706	45,009	33,941	23,119	14,886	14,831	19,917	15,770	21,992
50%	10,520	14,888	15,589	20,626	34,615	26,439	18,461	12,887	14,467	19,155	15,543	14,610
60%	9,213	12,135	15,117	18,712	26,295	21,695	15,302	11,820	14,035	17,518	14,469	11,310
70%	8,522	10,419	13,252	14,718	20,073	19,289	13,396	10,805	13,099	16,490	10,614	9,977
80%	8,051	9,021	10,982	13,213	16,888	15,732	11,576	10,231	12,322	14,778	9,349	9,445
90%	6,705	7,877	9,715	12,233	14,026	11,430	10,003	8,633	11,596	10,527	8,394	7,551
Long Term												
Full Simulation Period[a]	10,902	16,017	22,564	30,820	37,978	32,595	24,891	19,312	17,132	18,361	13,660	17,819
Water Year Types[b,c]												
Wet (32%)	12,658	21,062	36,113	50,121	57,672	49,926	40,193	31,908	23,827	20,207	16,271	28,817
Above Normal (15%)	10,615	16,983	22,363	37,320	45,427	43,052	27,490	21,850	16,431	21,886	16,401	22,366
Below Normal (17%)	10,453	14,106	16,596	21,953	32,254	22,985	19,573	14,371	14,588	20,870	15,568	12,979
Dry (22%)	10,048	13,410	15,147	16,518	23,267	20,656	14,489	10,764	14,050	16,782	9,809	9,645
Critical (15%)	9,190	10,263	11,497	14,298	16,601	13,704	10,947	8,065	10,921	10,281	8,813	7,354

Proposed Project

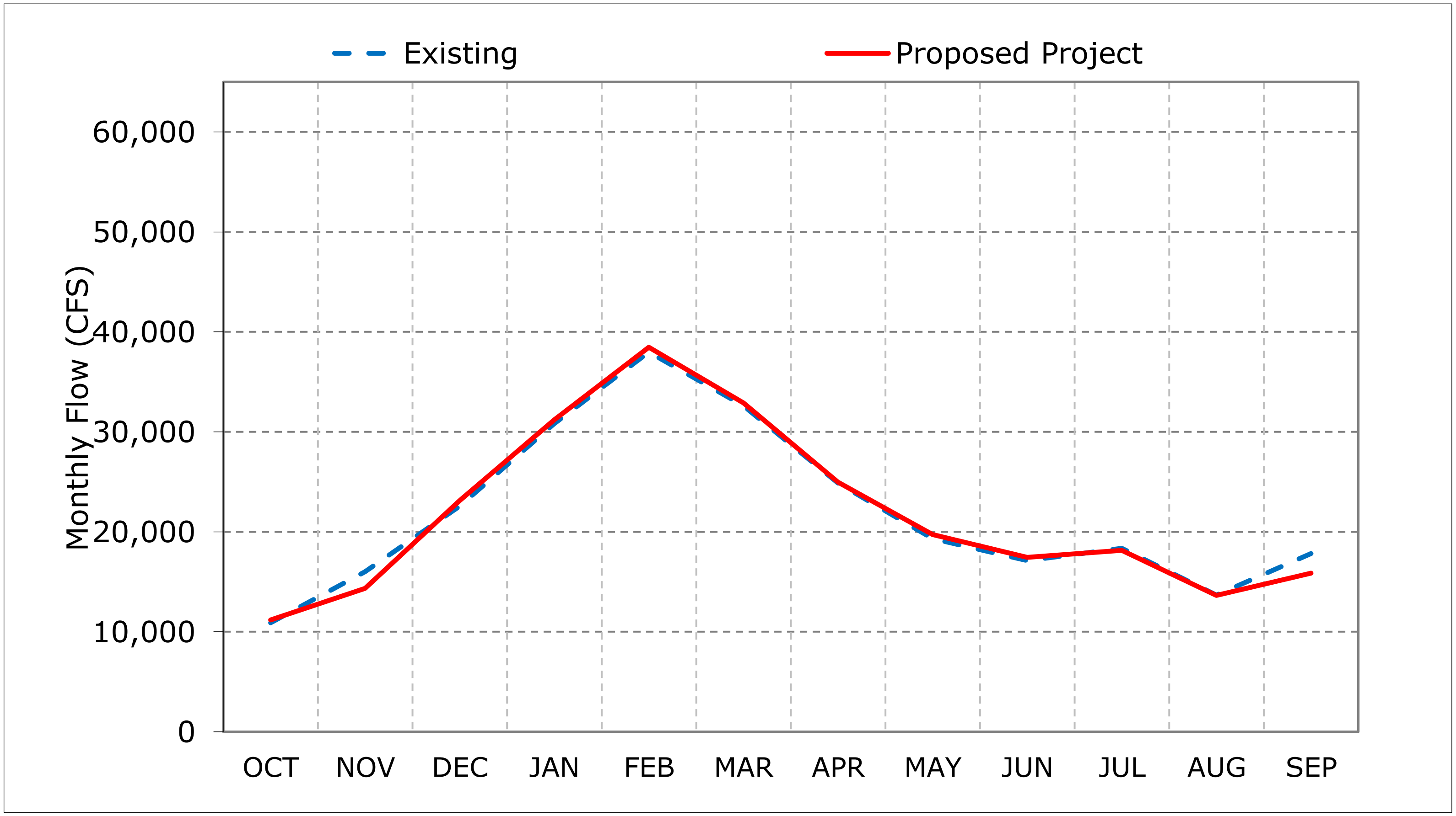
Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	14,579	21,983	50,342	63,821	68,500	62,720	52,922	41,633	26,579	24,388	16,949	23,785
20%	13,668	14,736	34,367	56,341	60,972	52,961	40,610	30,275	19,984	23,606	16,353	23,138
30%	12,876	13,914	22,492	40,731	51,407	41,411	25,847	19,232	15,561	21,872	16,088	22,442
40%	11,976	13,504	18,497	27,766	46,113	33,998	23,116	14,880	15,242	19,624	15,804	21,117
50%	11,366	12,870	15,651	24,206	34,576	26,432	18,443	14,135	14,912	18,583	15,099	14,655
60%	9,382	11,090	15,089	18,809	26,302	22,024	14,967	12,796	14,571	16,979	13,855	11,091
70%	8,393	10,514	13,953	15,191	21,628	19,329	13,279	11,520	13,743	15,871	10,684	9,899
80%	8,051	8,899	12,087	12,613	17,573	15,516	11,979	10,749	12,733	13,951	9,622	9,456
90%	6,939	7,611	9,698	11,643	14,471	11,722	10,428	9,369	11,311	10,603	9,031	7,600
Long Term												
Full Simulation Period[a]	11,184	14,330	23,129	31,210	38,462	32,897	24,958	19,719	17,441	18,162	13,655	15,851
Water Year Types[b,c]												
Wet (32%)	13,033	18,891	37,629	50,737	57,966	50,069	40,162	31,903	23,912	20,073	16,188	22,361
Above Normal (15%)	11,171	14,703	22,541	38,453	46,067	43,786	27,480	21,949	17,174	21,957	16,329	23,113
Below Normal (17%)	10,767	12,629	16,668	22,954	33,682	23,290	19,629	15,142	15,417	20,508	15,268	12,740
Dry (22%)	10,072	11,942	15,377	16,311	23,289	20,945	14,680	11,796	14,238	16,076	9,910	9,604
Critical (15%)	9,348	9,644	11,463	13,640	16,932	13,938	11,128	8,315	10,854	10,618	9,228	7,485

Proposed Project minus Existing

Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	812	-91	1,590	664	116	326	-1	-169	-14	-134	-14	-6,367
20%	336	-4,885	2,182	931	166	95	11	443	-3	638	115	-6,291
30%	112	-4,691	529	2,314	1,504	1,482	-174	-4	141	287	82	-1,619
40%	430	-2,716	154	1,061	1,105	57	-3	-6	410	-293	34	-874
50%	846	-2,017	62	3,581	-39	-7	-18	1,248	445	-573	-444	45
60%	169	-1,045	-27	97	7	329	-335	976	537	-539	-613	-219
70%	-129	95	701	473	1,555	40	-117	715	644	-619	70	-78
80%	0	-123	1,104	-600	684	-216	403	517	411	-827	273	11
90%	235	-266	-17	-590	445	292	426	736	-286	76	638	49
Long Term												
Full Simulation Period[a]	283	-1,687	564	391	484	302	67	407	308	-199	-5	-1,968
Water Year Types[b,c]												
Wet (32%)	375	-2,171	1,516	616	294	143	-31	-5	85	-134	-83	-6,457
Above Normal (15%)	556	-2,280	178	1,133	640	733	-10	98	743	71	-73	747
Below Normal (17%)	314	-1,476	72	1,002	1,427	305	56	771	829	-362	-300	-239
Dry (22%)	24	-1,467	230	-206	22	289	191	1,031	187	-705	101	-41
Critical (15%)	159	-620	-34	-658	331	234	181	249	-67	337	415	131

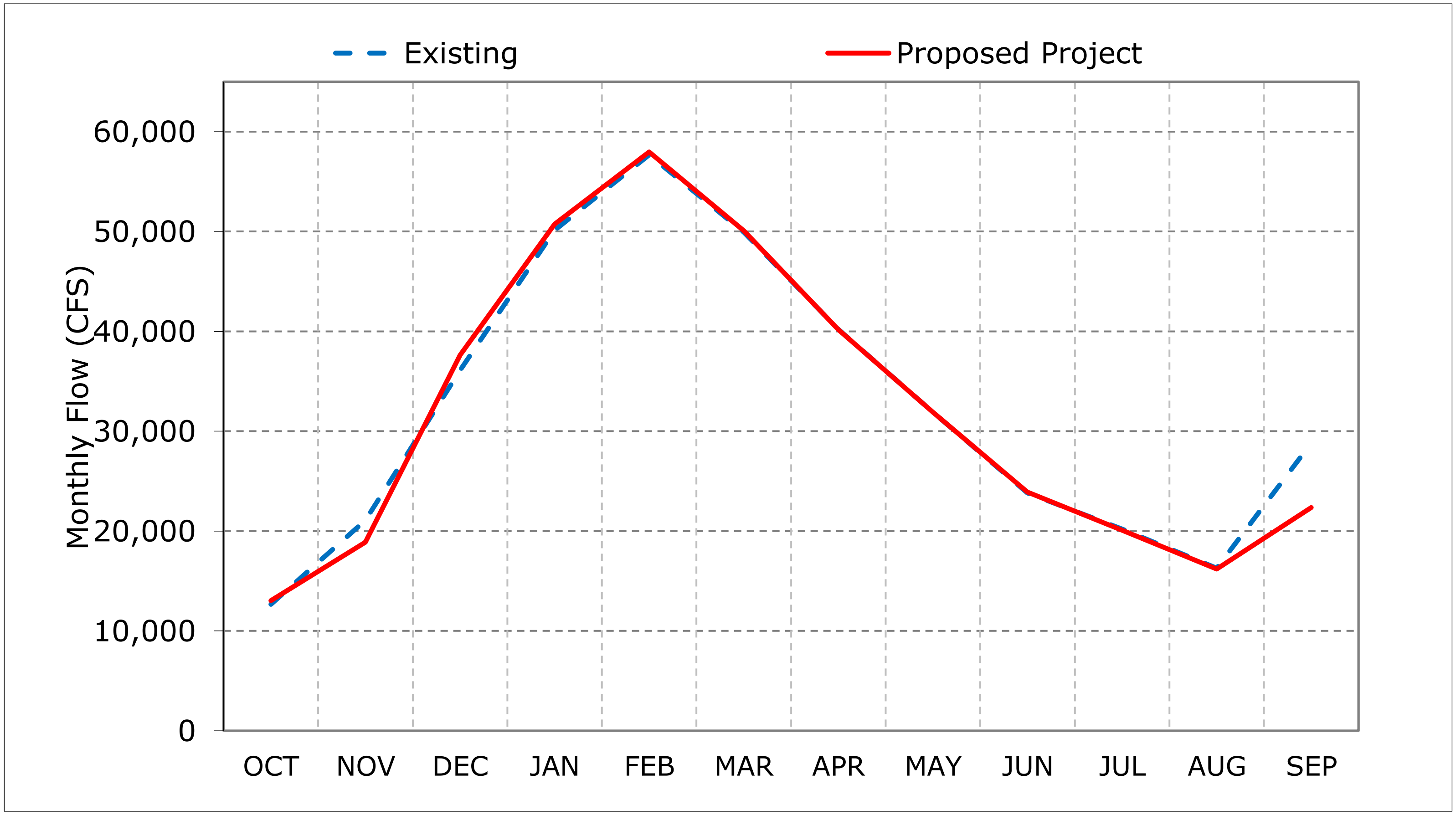
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.

Figure 1-1. Sacramento River Flow at Freeport, Long-Term Average Flow



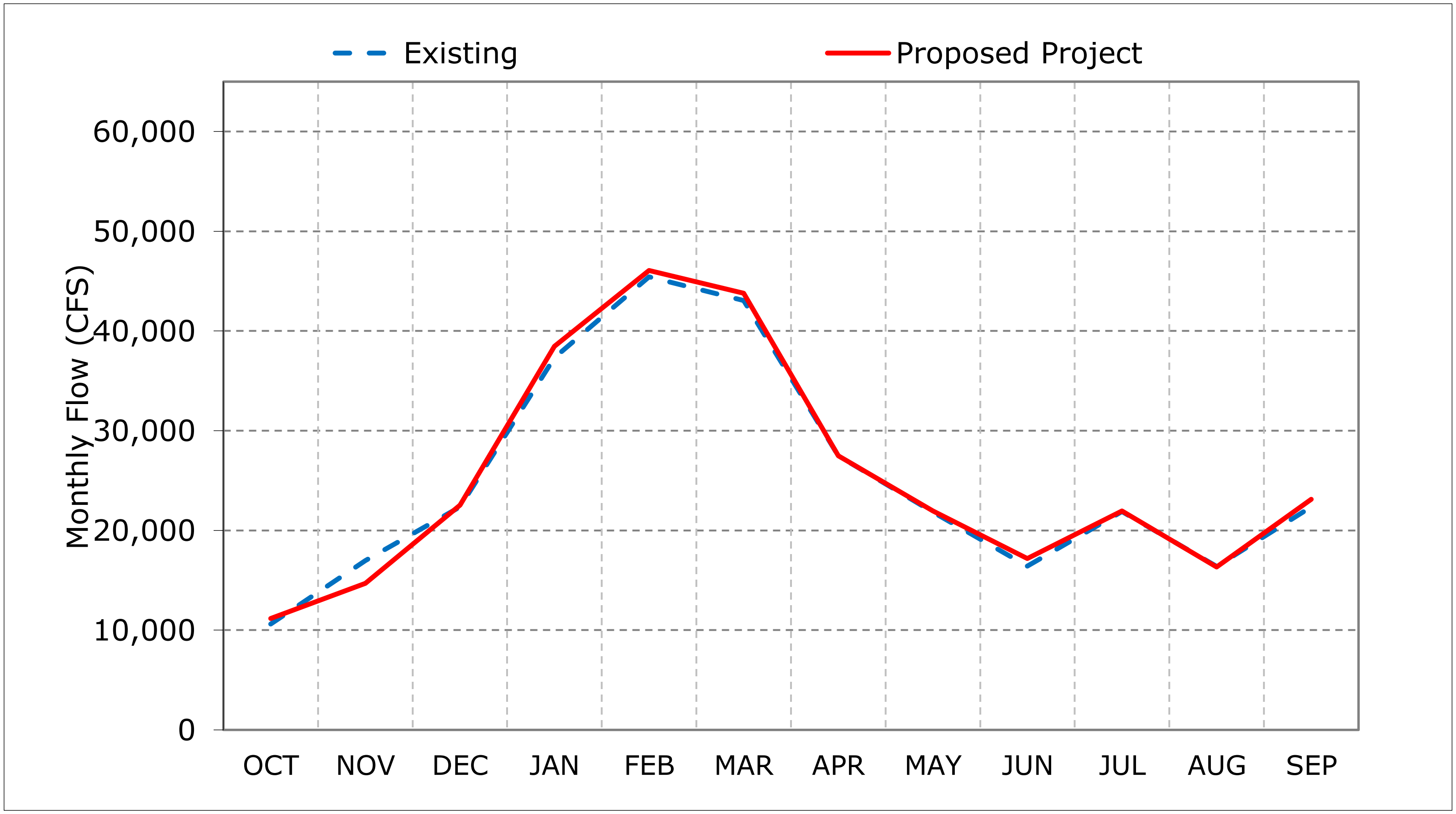
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-2. Sacramento River Flow at Freeport, Wet Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

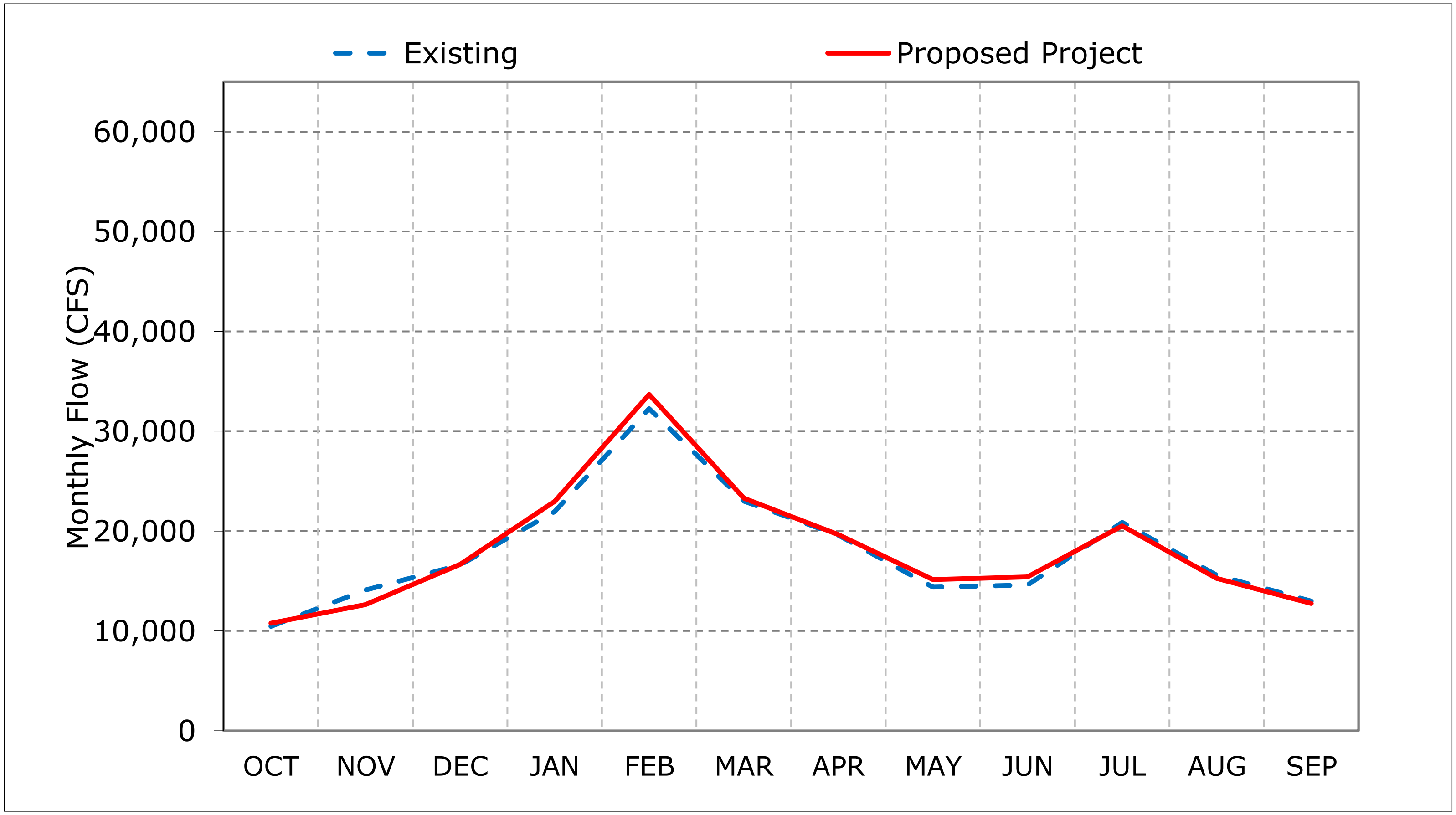
Figure 1-3. Sacramento River Flow at Freeport, Above Normal Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164

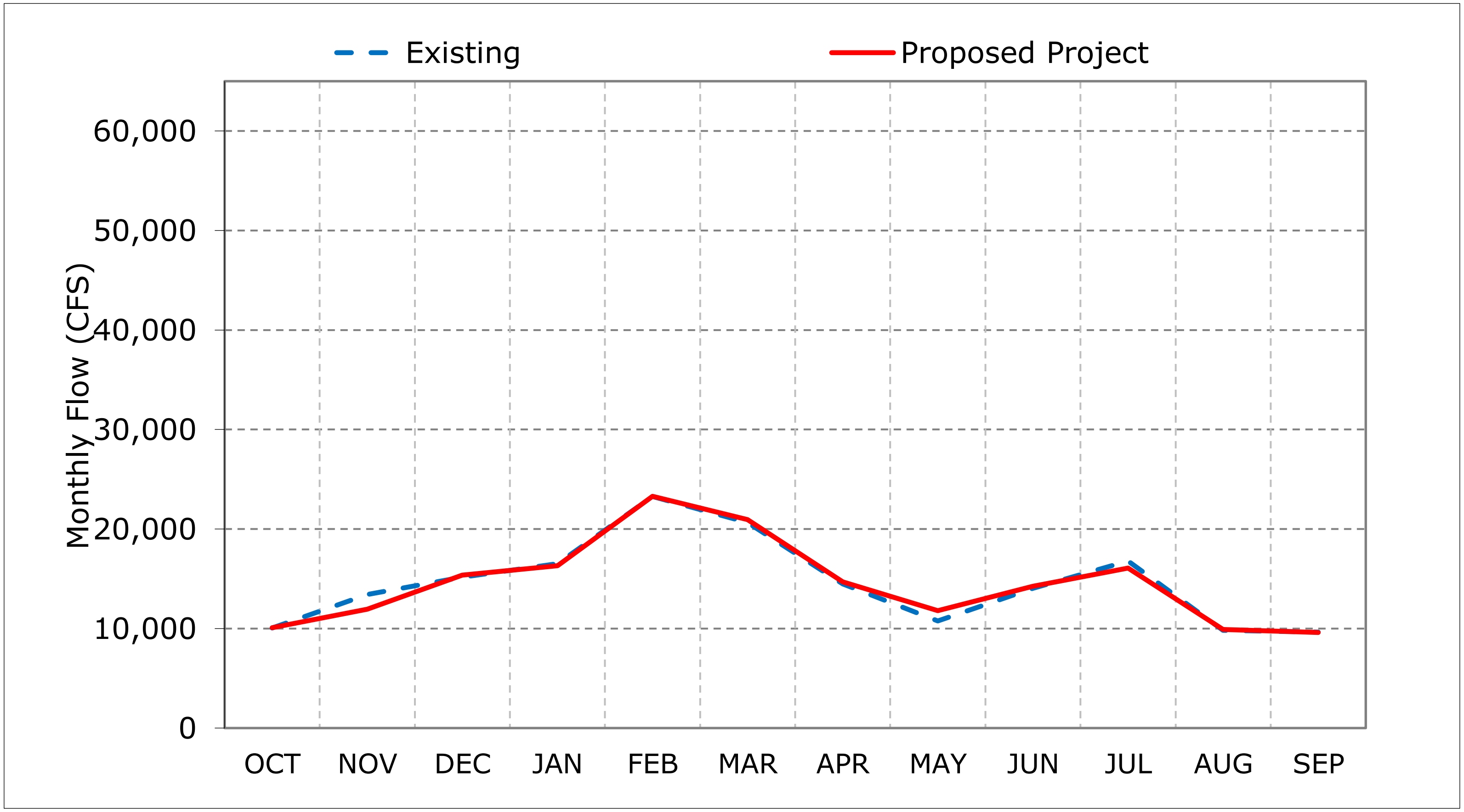
*These results are displayed with water year - year type sorting.

Figure 1-4. Sacramento River Flow at Freeport, Below Normal Year Average Flow



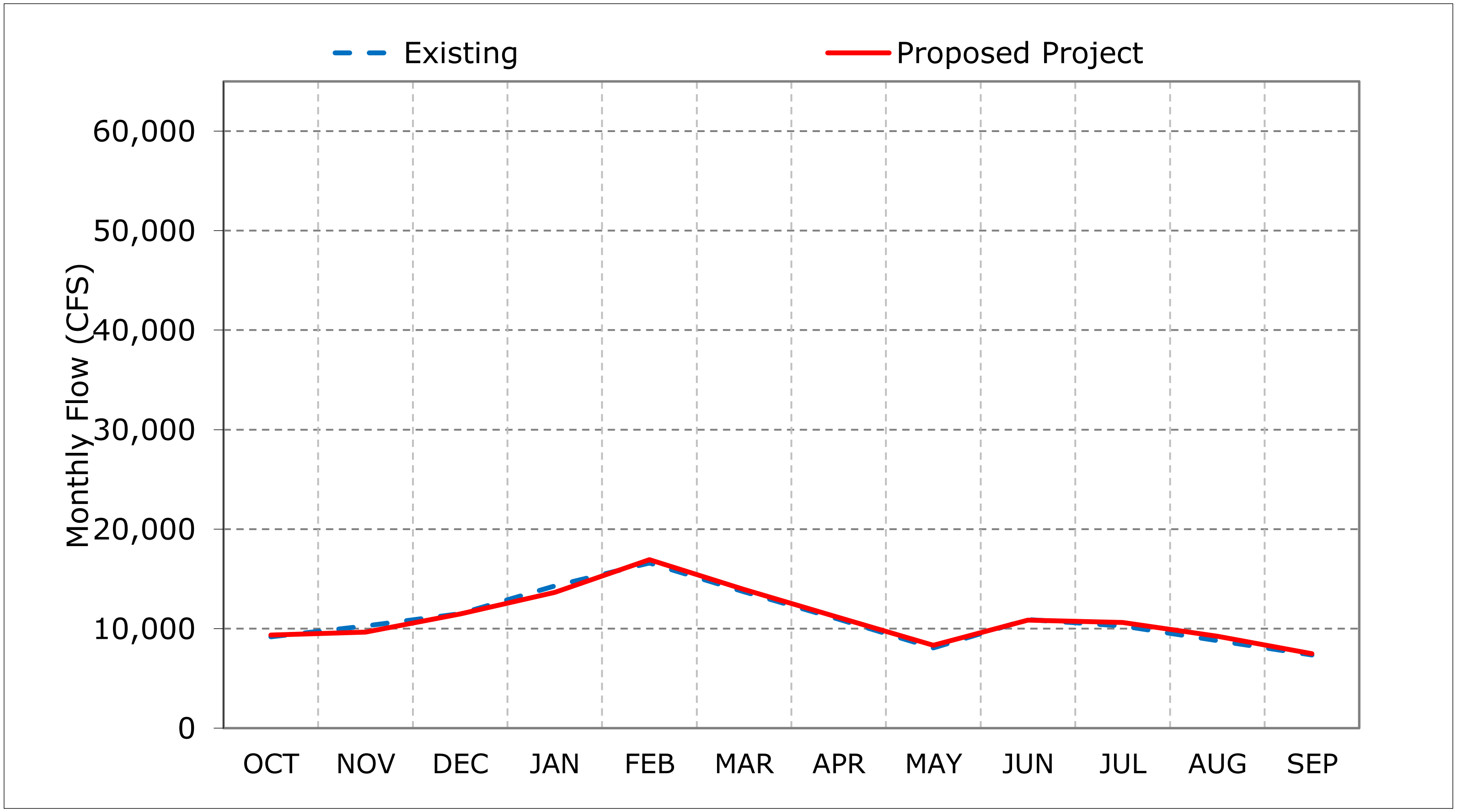
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-5. Sacramento River Flow at Freeport, Dry Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-6. Sacramento River Flow at Freeport, Critical Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-7. Sacramento River Flow at Freeport, October

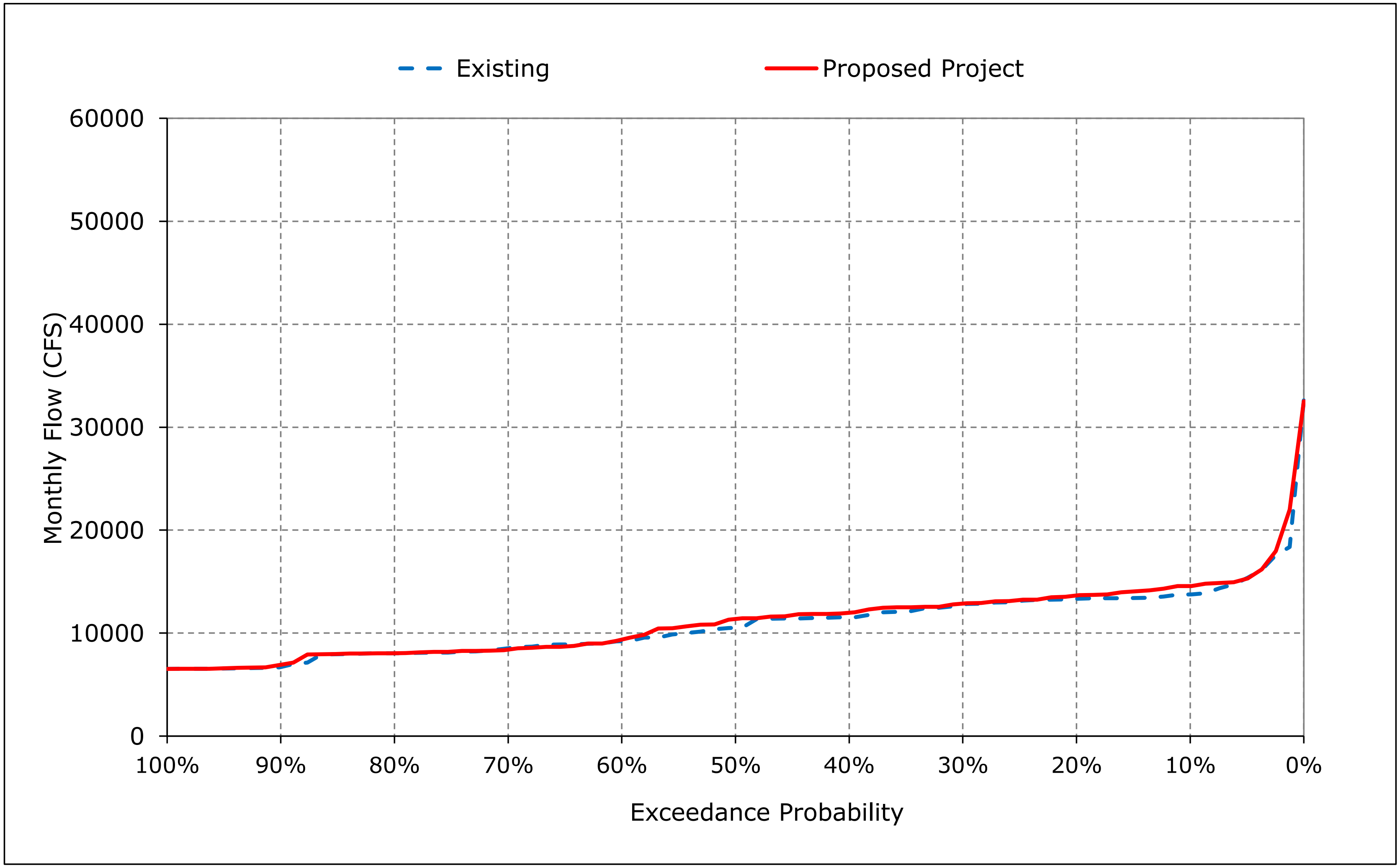


Figure 1-8. Sacramento River Flow at Freeport, November

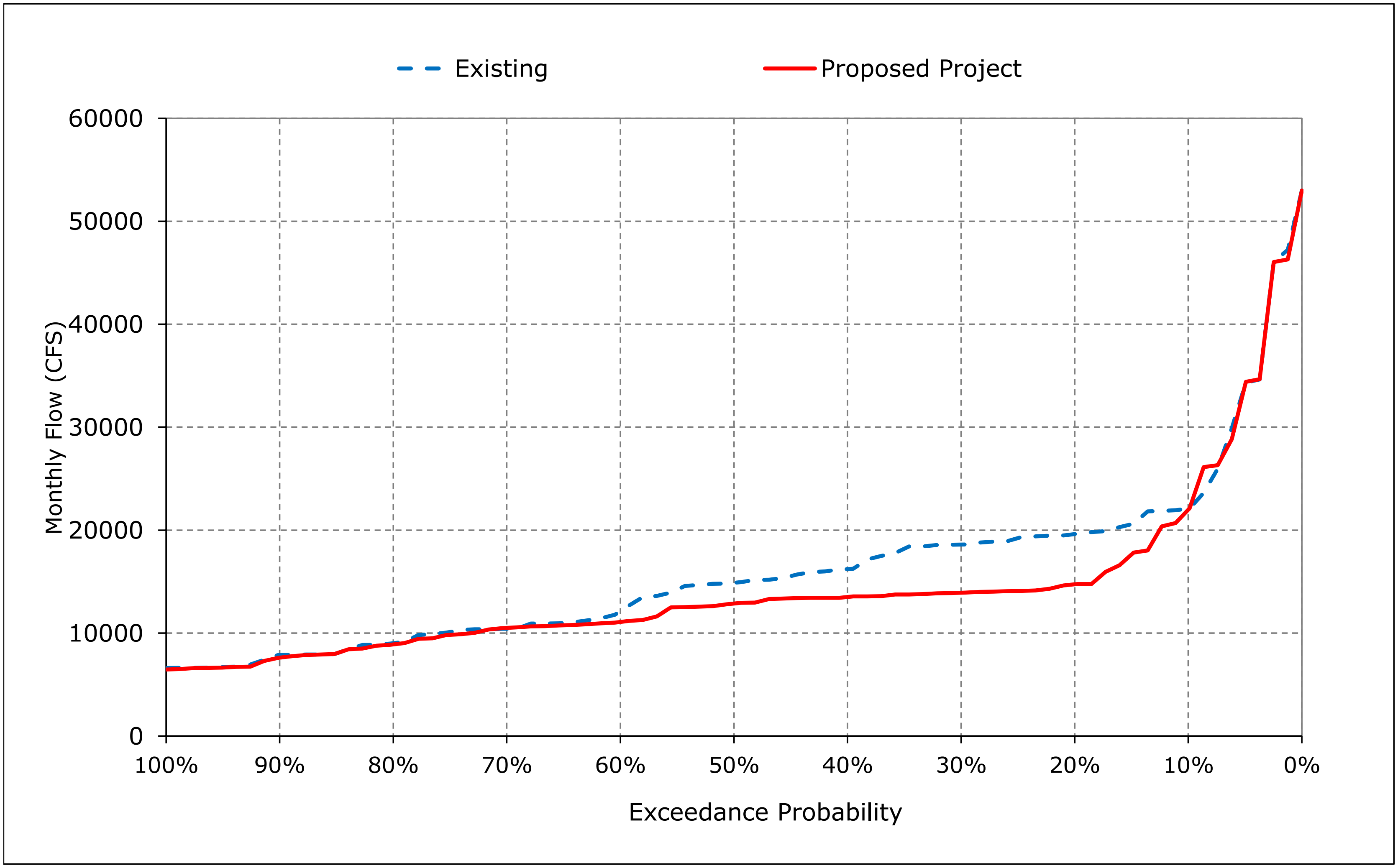


Figure 1-9. Sacramento River Flow at Freeport, December

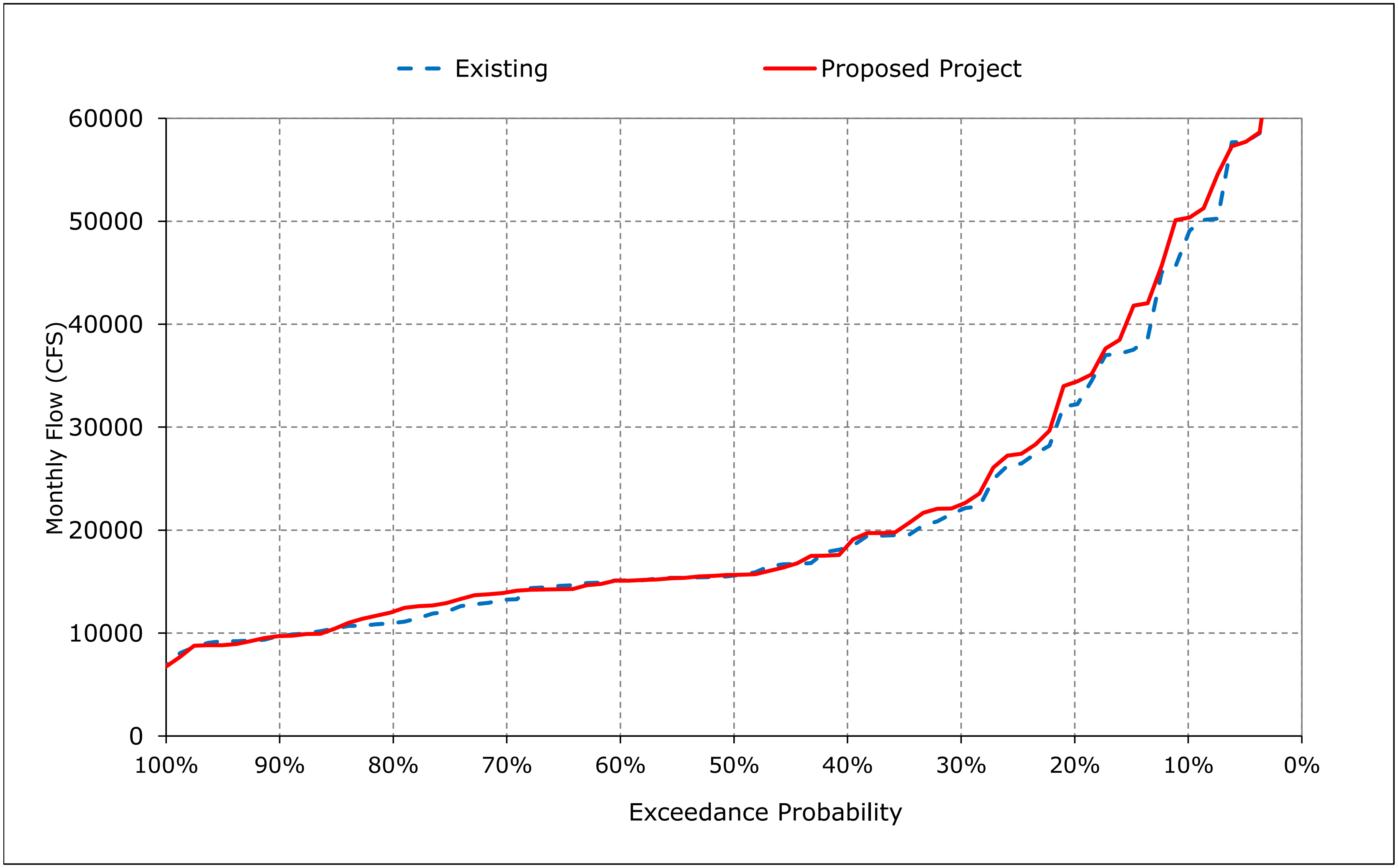


Figure 1-10. Sacramento River Flow at Freeport, January

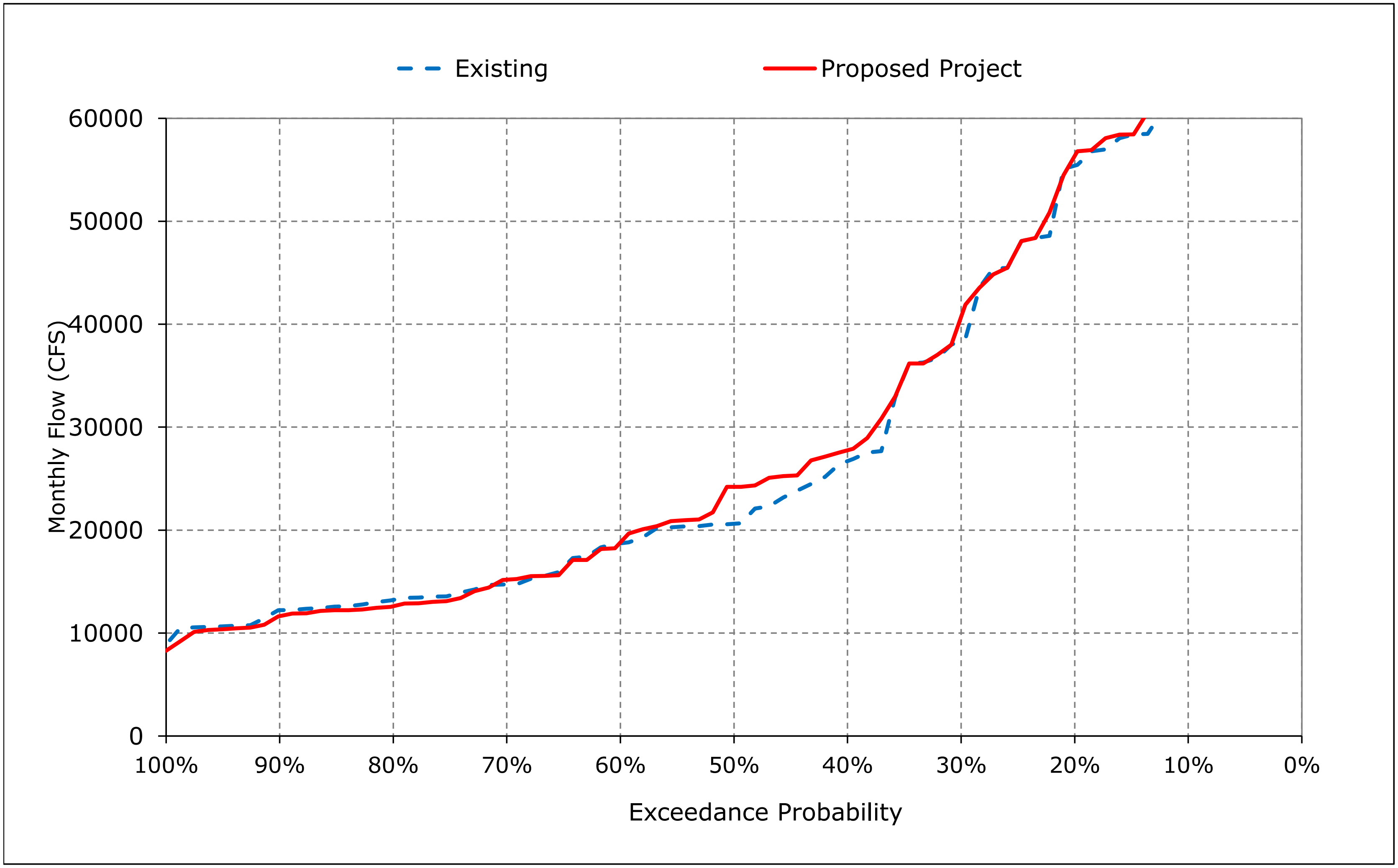


Figure 1-11. Sacramento River Flow at Freeport, February

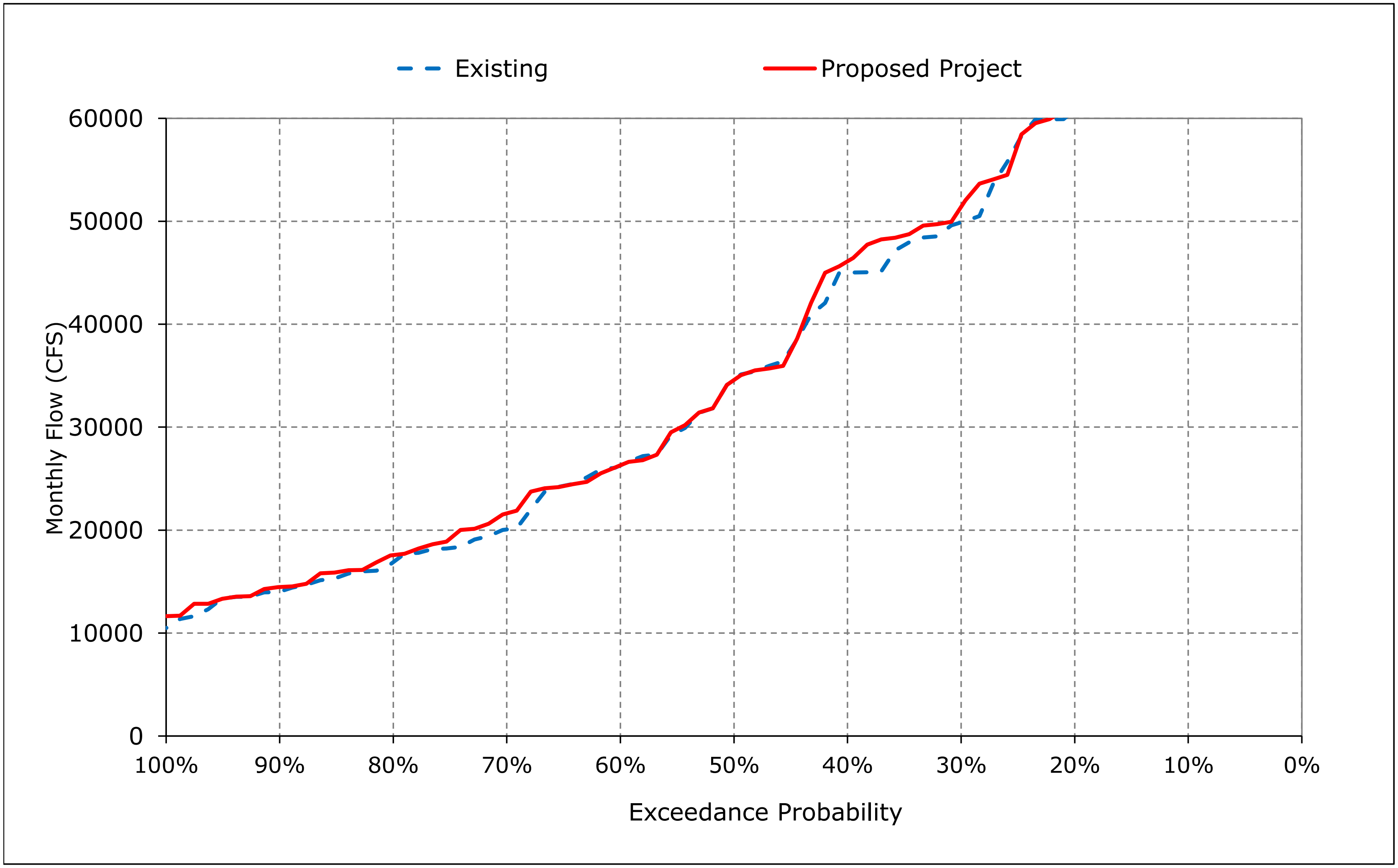


Figure 1-12. Sacramento River Flow at Freeport, March

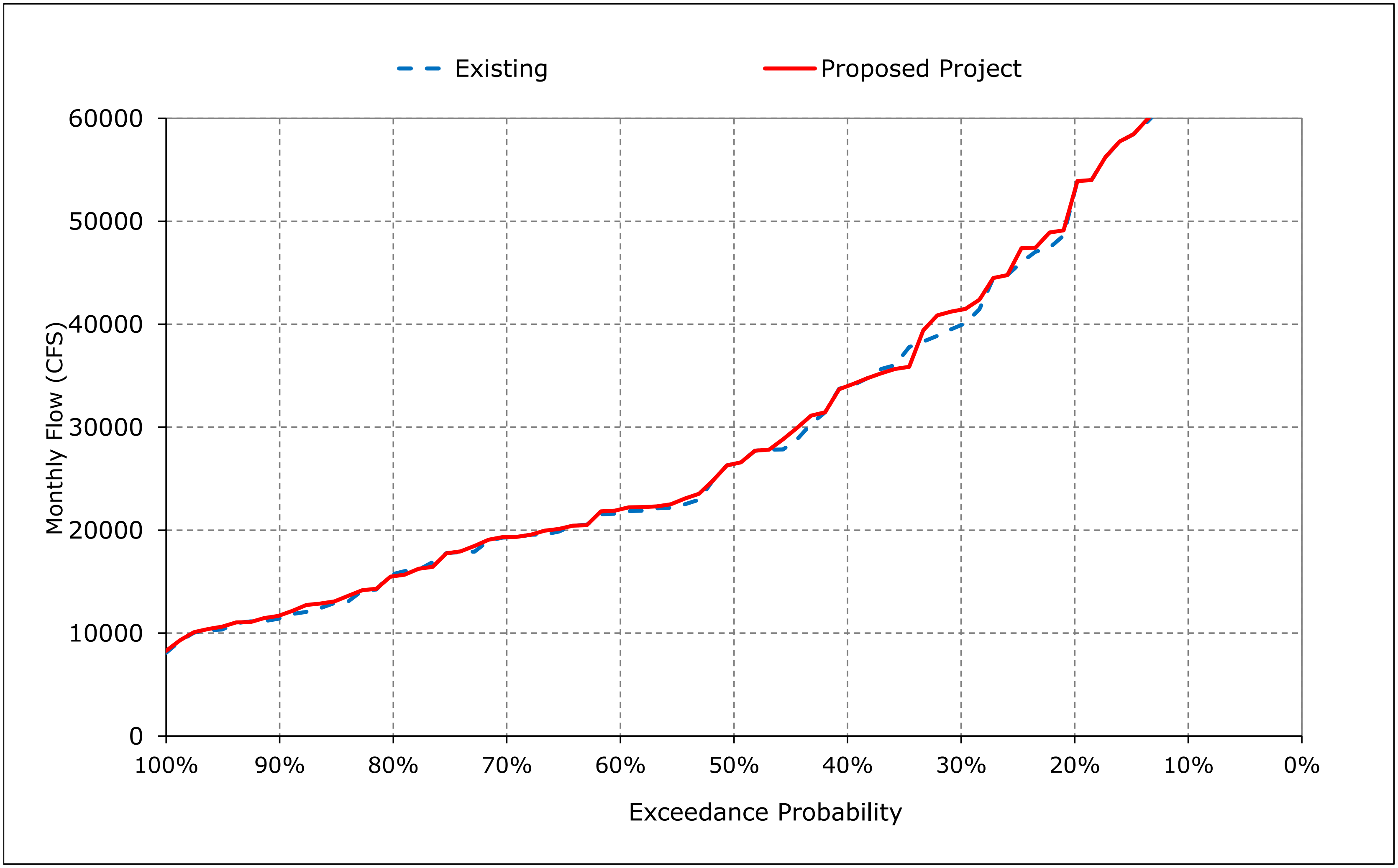


Figure 1-13. Sacramento River Flow at Freeport, April

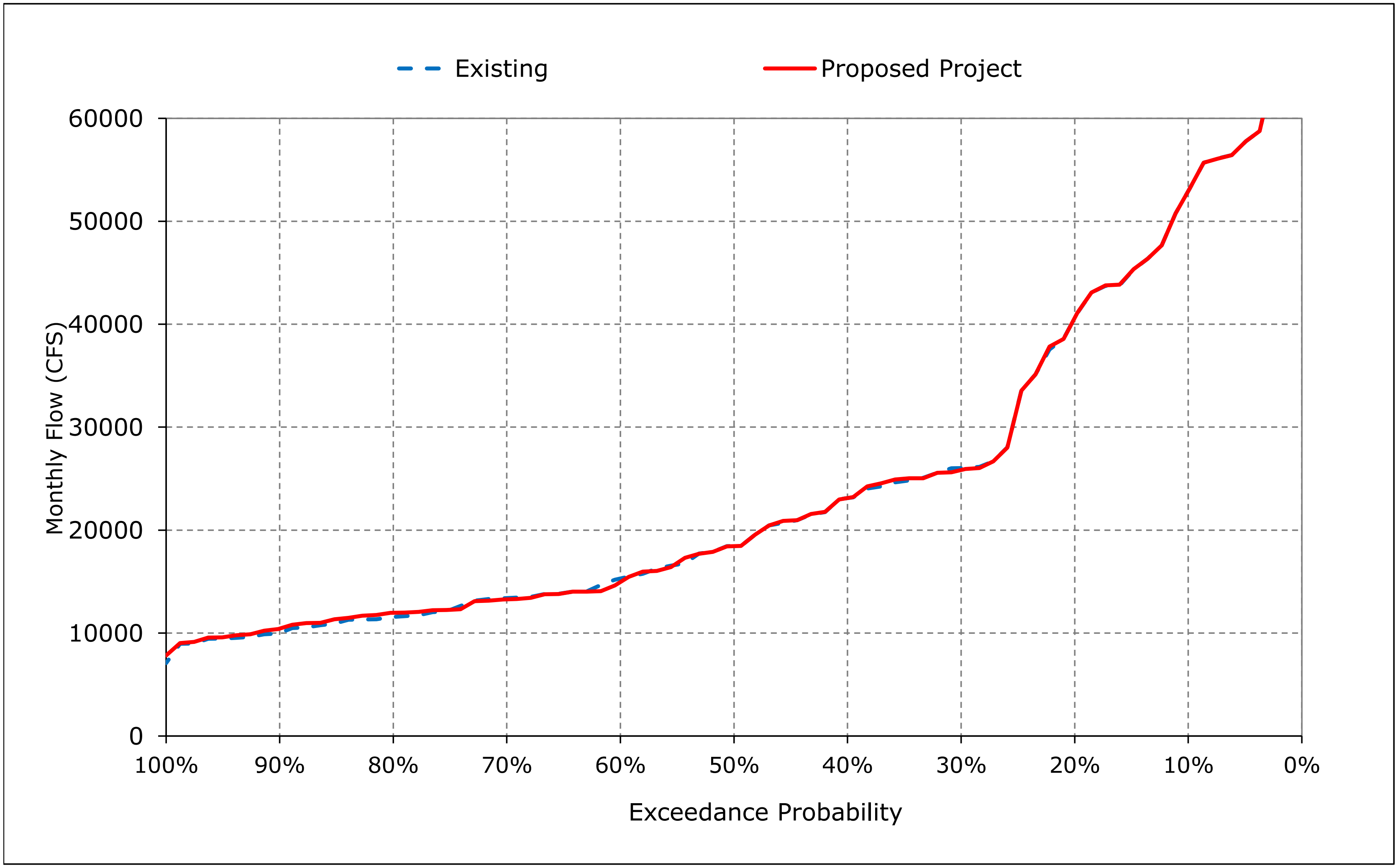


Figure 1-14. Sacramento River Flow at Freeport, May

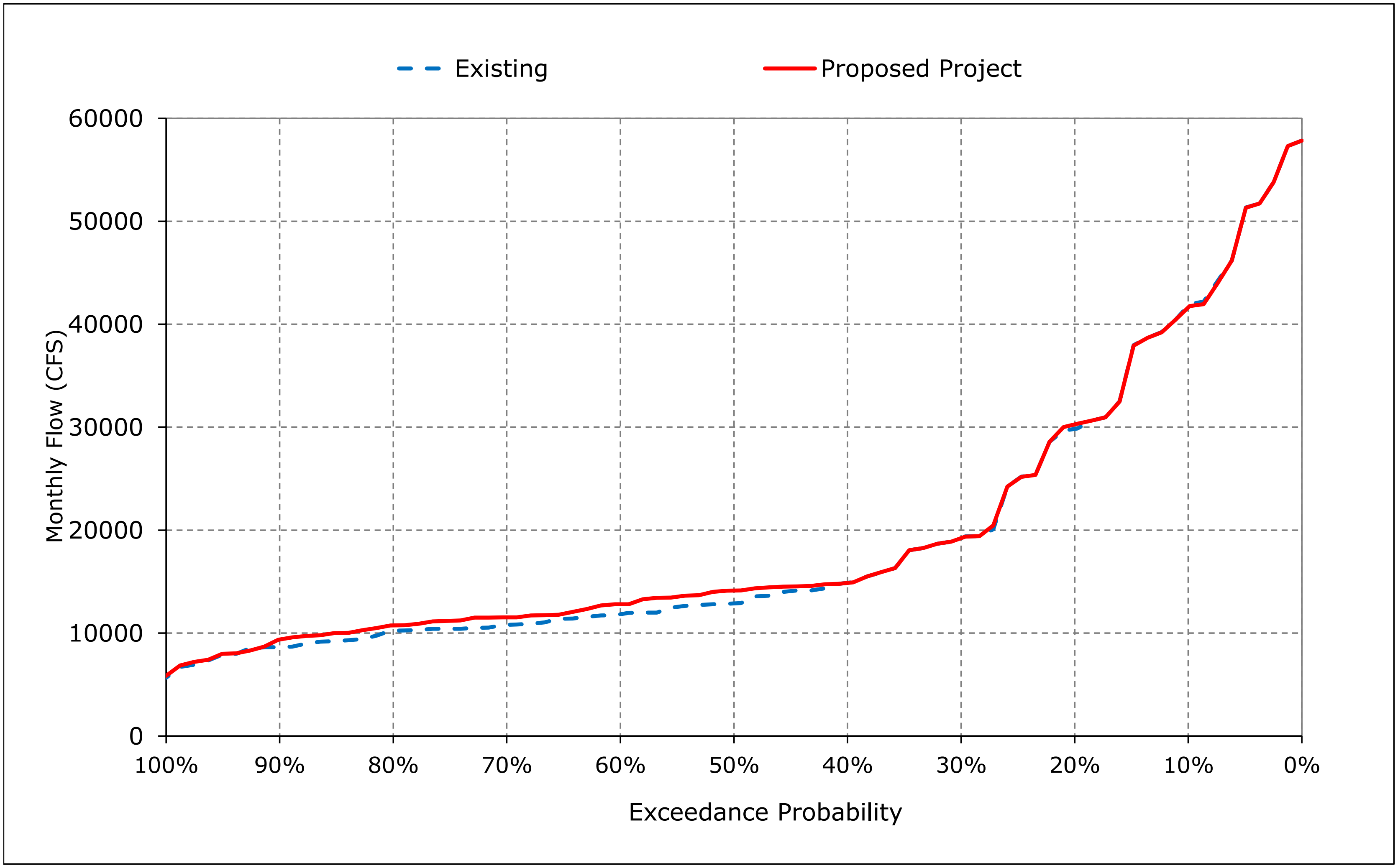


Figure 1-15. Sacramento River Flow at Freeport, June

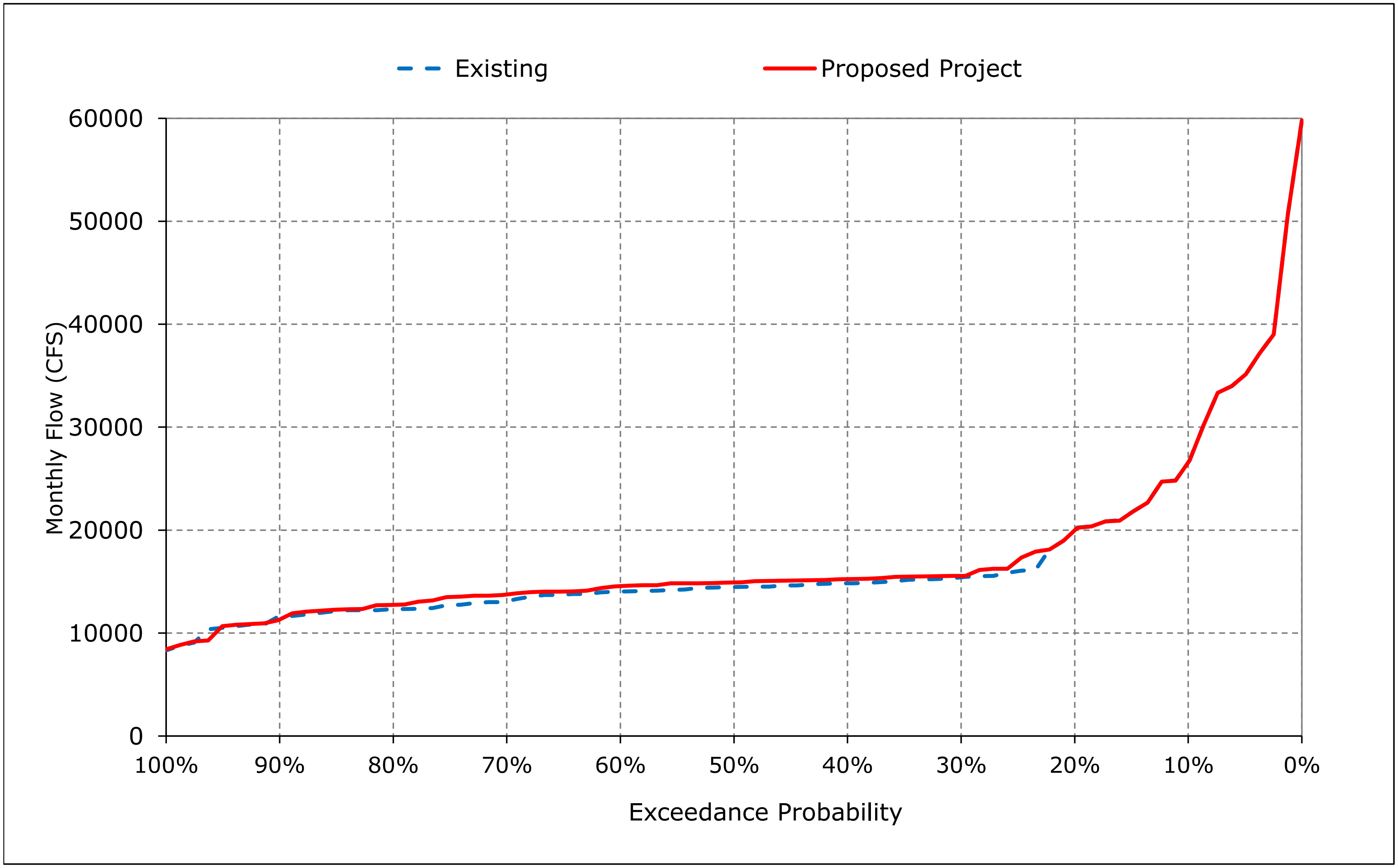


Figure 1-16. Sacramento River Flow at Freeport, July

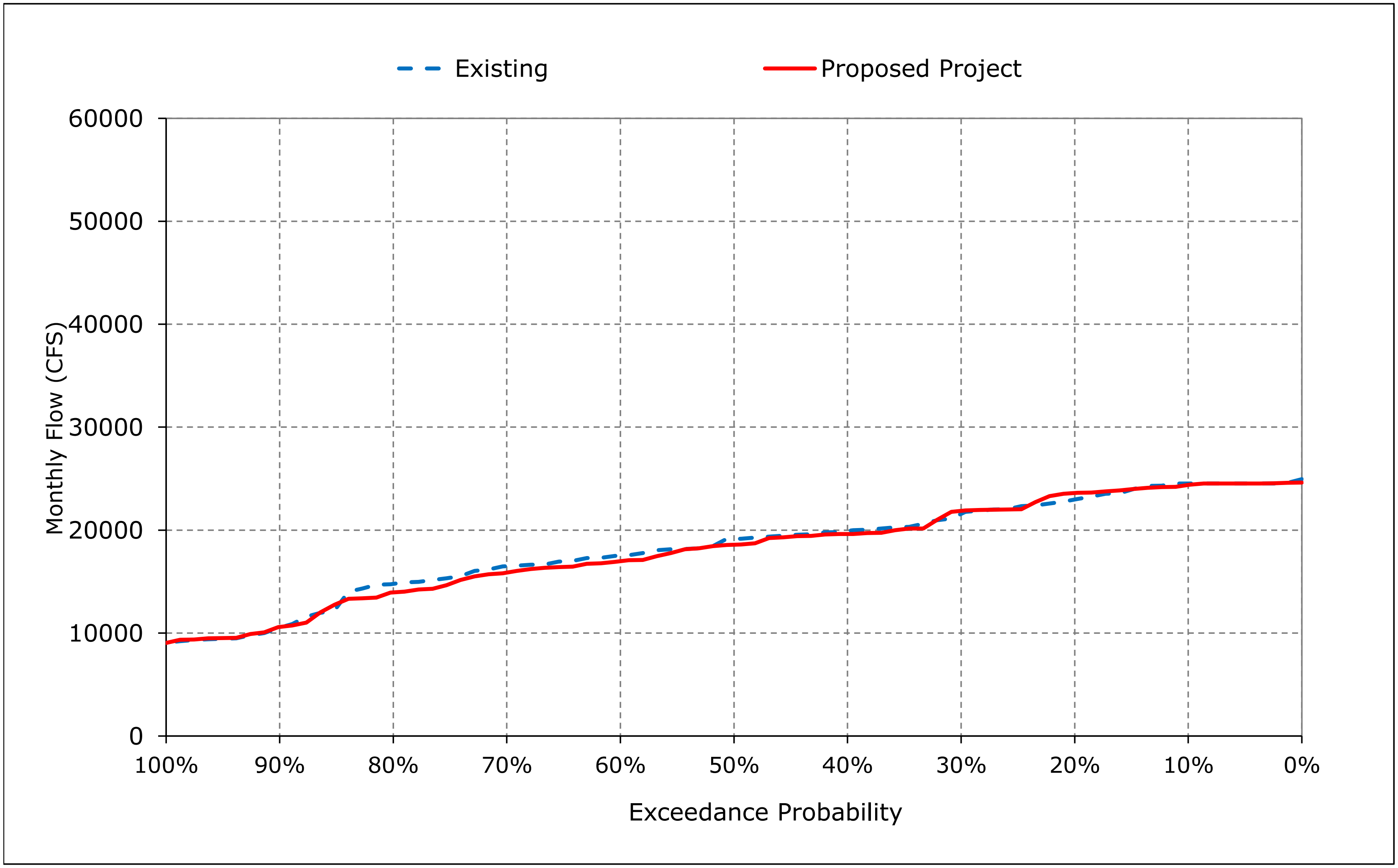


Figure 1-17. Sacramento River Flow at Freeport, August

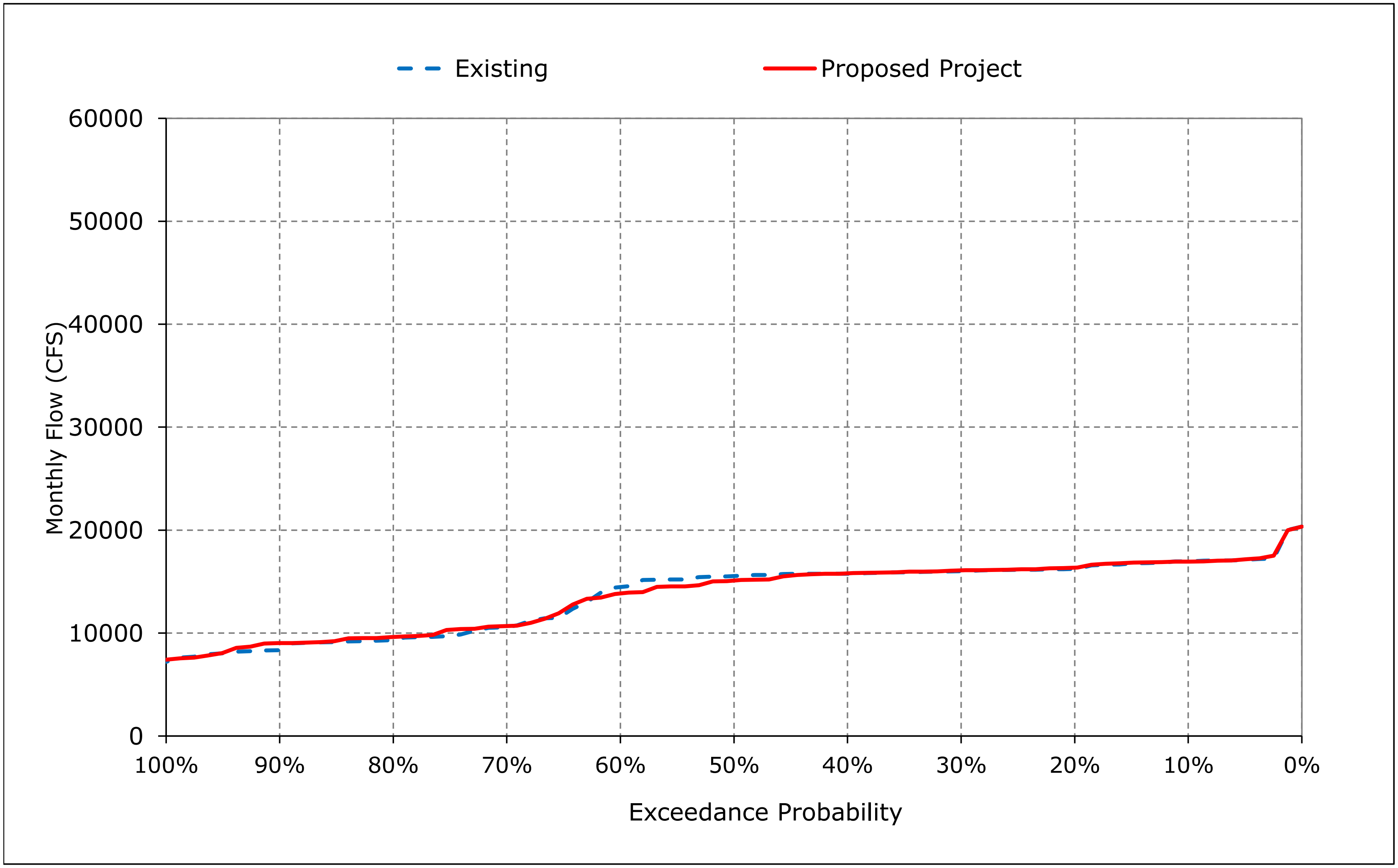


Figure 1-18. Sacramento River Flow at Freeport, September

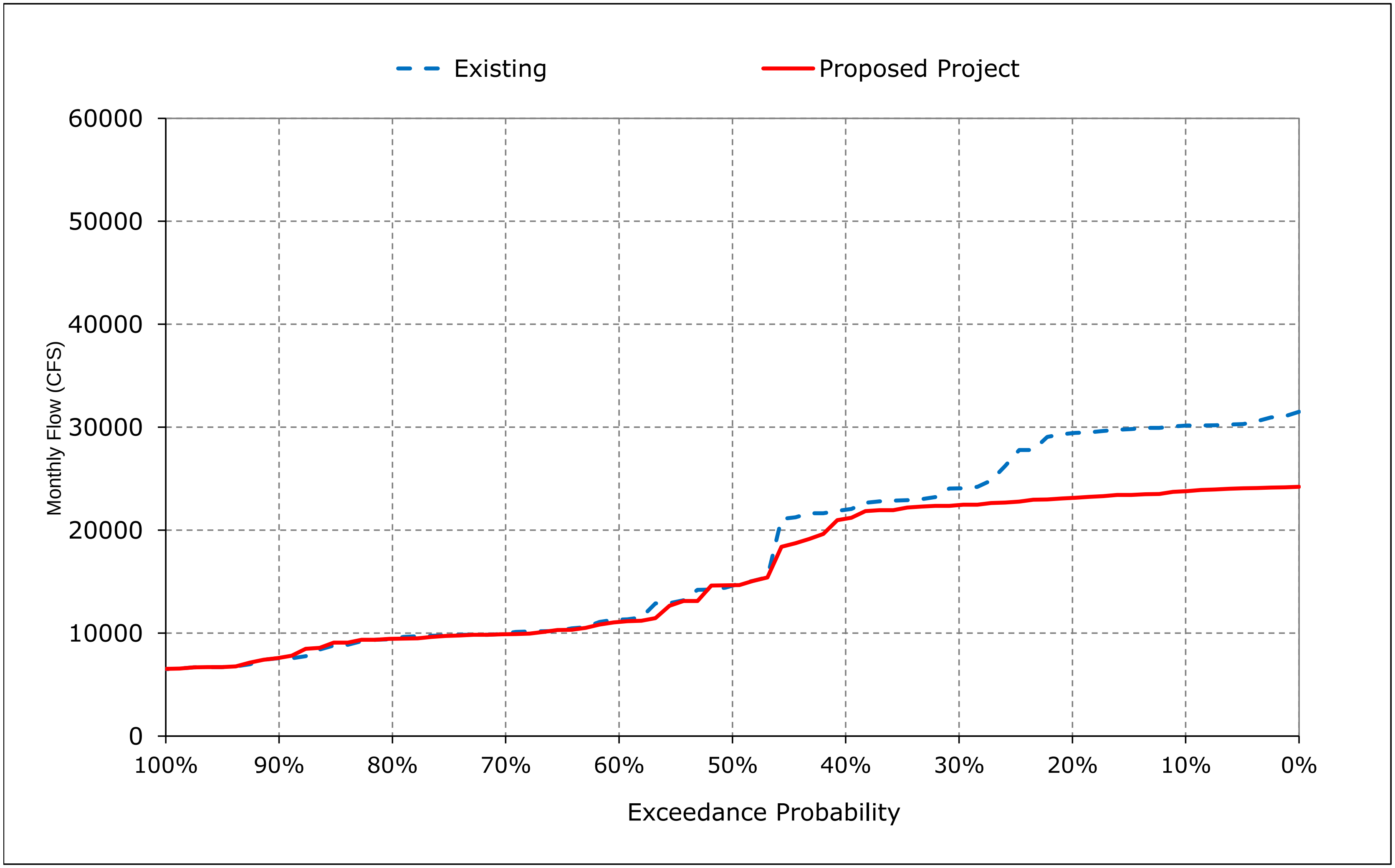


Table 2-1. Georgiana Slough, Monthly Flow

Existing

Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	2,894	4,016	7,532	9,442	10,171	9,326	8,070	6,594	4,577	4,298	3,309	5,056
20%	2,838	3,672	5,350	8,425	9,129	8,051	6,444	5,015	3,701	4,091	3,213	4,961
30%	2,761	3,549	3,984	6,172	7,686	6,360	4,518	3,610	3,093	3,908	3,181	4,254
40%	2,601	3,219	3,504	4,639	7,040	5,565	4,133	3,038	3,020	3,691	3,150	3,979
50%	2,467	3,047	3,144	3,834	5,668	4,581	3,519	2,772	2,970	3,588	3,122	3,004
60%	2,293	2,686	3,074	3,562	4,573	3,949	3,099	2,627	2,912	3,372	2,979	2,568
70%	2,203	2,455	2,835	3,037	3,735	3,629	2,844	2,491	2,789	3,236	2,469	2,395
80%	2,138	2,273	2,526	2,837	3,316	3,159	2,605	2,421	2,682	3,011	2,302	2,321
90%	1,960	2,118	2,364	2,700	2,935	2,586	2,397	2,213	2,592	2,441	2,176	2,071
Long Term												
Full Simulation Period[a]	2,516	3,197	4,067	5,171	6,112	5,389	4,366	3,621	3,321	3,483	2,872	3,428
Water Year Types[b,c]												
Wet (32%)	2,749	3,866	5,862	7,729	8,718	7,680	6,391	5,287	4,208	3,727	3,217	4,881
Above Normal (15%)	2,478	3,324	4,042	6,036	7,102	6,770	4,710	3,958	3,229	3,949	3,235	4,029
Below Normal (17%)	2,457	2,943	3,277	3,997	5,357	4,119	3,663	2,967	2,986	3,815	3,124	2,789
Dry (22%)	2,403	2,852	3,084	3,275	4,164	3,812	2,991	2,492	2,913	3,274	2,363	2,349
Critical (15%)	2,290	2,434	2,598	2,978	3,277	2,890	2,521	2,133	2,497	2,411	2,232	2,046

Proposed Project

Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	3,002	3,991	7,766	9,530	10,186	9,374	8,070	6,579	4,576	4,278	3,307	4,215
20%	2,882	3,024	5,622	8,537	9,149	8,065	6,446	5,074	3,701	4,175	3,227	4,130
30%	2,775	2,924	4,064	6,478	7,882	6,554	4,494	3,610	3,113	3,947	3,193	4,038
40%	2,658	2,861	3,547	4,764	7,186	5,573	4,132	3,037	3,071	3,650	3,154	3,863
50%	2,576	2,780	3,151	4,298	5,663	4,580	3,517	2,936	3,029	3,512	3,062	3,011
60%	2,317	2,546	3,072	3,578	4,574	3,993	3,054	2,761	2,985	3,298	2,897	2,539
70%	2,184	2,472	2,920	3,092	3,943	3,634	2,829	2,590	2,874	3,156	2,482	2,382
80%	2,138	2,253	2,674	2,757	3,408	3,128	2,657	2,487	2,739	2,900	2,340	2,325
90%	1,993	2,083	2,361	2,628	2,995	2,628	2,450	2,303	2,554	2,451	2,260	2,078
Long Term												
Full Simulation Period[a]	2,554	2,974	4,142	5,223	6,176	5,429	4,375	3,675	3,362	3,456	2,871	3,168
Water Year Types[b,c]												
Wet (32%)	2,798	3,580	6,062	7,811	8,757	7,699	6,387	5,286	4,219	3,710	3,206	4,028
Above Normal (15%)	2,552	3,023	4,066	6,186	7,187	6,867	4,709	3,971	3,327	3,959	3,225	4,127
Below Normal (17%)	2,498	2,748	3,287	4,130	5,546	4,160	3,671	3,069	3,095	3,767	3,084	2,758
Dry (22%)	2,406	2,658	3,115	3,248	4,167	3,850	3,016	2,628	2,938	3,181	2,377	2,343
Critical (15%)	2,310	2,352	2,593	2,891	3,321	2,921	2,544	2,166	2,488	2,456	2,287	2,063

Proposed Project minus Existing

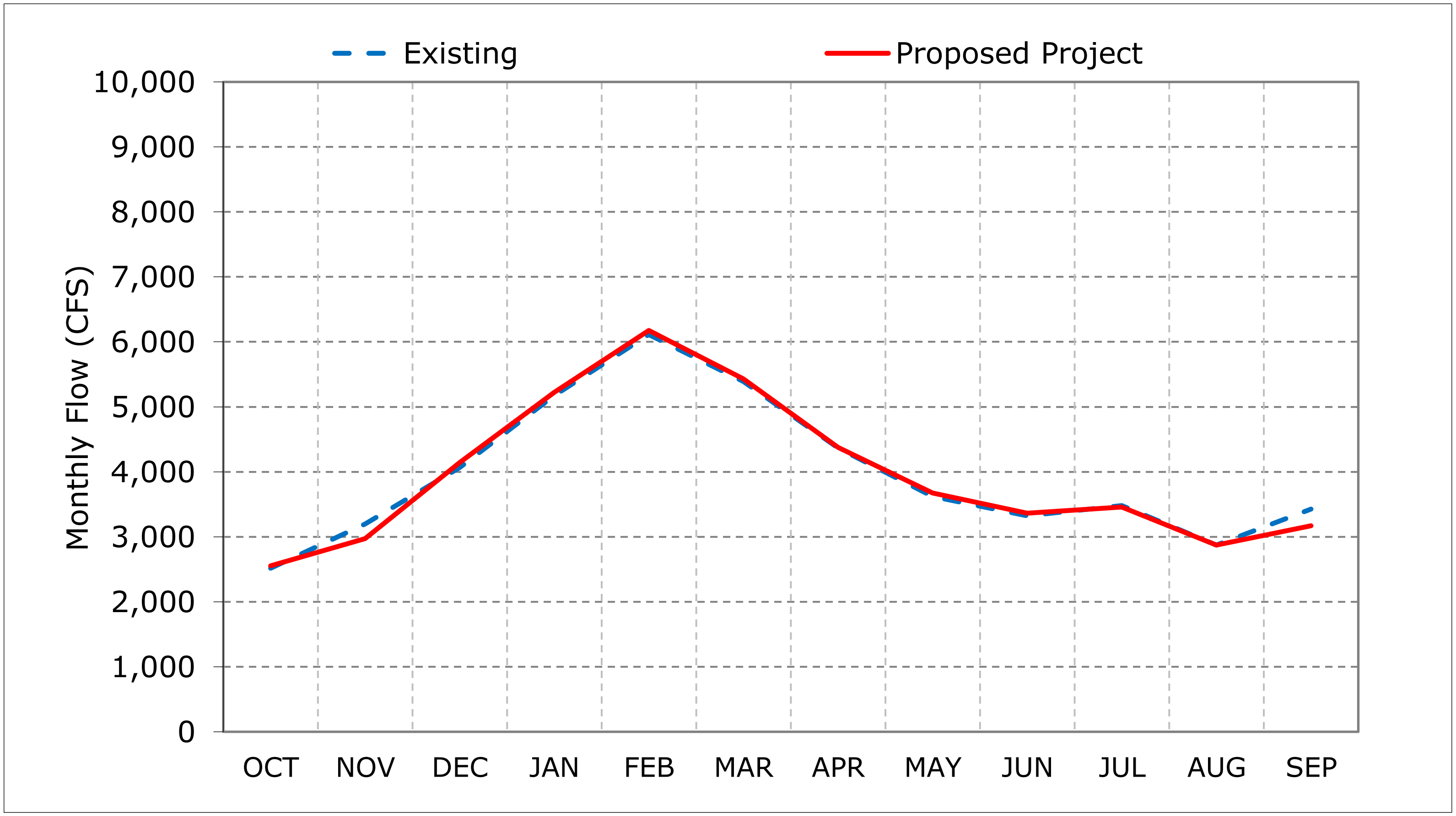
Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	108	**-25**	234	88	15	47	**0**	**-15**	**-2**	**-20**	**-2**	**-841**
20%	44	**-648**	272	113	20	14	1	58	**0**	84	14	**-831**
30%	15	**-625**	80	306	196	194	**-24**	**0**	21	38	12	**-216**
40%	58	**-358**	42	125	146	7	**0**	**-1**	52	**-41**	4	**-116**
50%	110	**-267**	7	465	**-5**	**-1**	**-2**	163	60	**-76**	**-60**	7
60%	24	**-140**	**-2**	16	1	44	**-44**	135	73	**-74**	**-82**	**-29**
70%	**-19**	18	85	56	208	5	**-15**	98	85	**-80**	14	**-13**
80%	0	**-20**	148	**-80**	92	**-31**	52	66	58	**-111**	38	4
90%	33	**-35**	**-3**	**-73**	61	42	52	90	**-38**	10	84	7
Long Term												
Full Simulation Period[a]	37	**-223**	75	52	64	40	9	54	41	**-26**	**-1**	**-260**
Water Year Types[b,c]												
Wet (32%)	50	**-287**	200	81	39	19	**-4**	**-1**	11	**-18**	**-11**	**-853**
Above Normal (15%)	73	**-301**	24	150	85	97	**-1**	13	98	9	**-10**	99
Below Normal (17%)	42	**-195**	9	132	189	40	7	102	110	**-48**	**-40**	**-32**
Dry (22%)	3	**-194**	30	**-27**	3	38	25	136	25	**-93**	13	**-5**
Critical (15%)	21	**-82**	**-4**	**-87**	44	31	24	33	**-9**	45	55	17

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

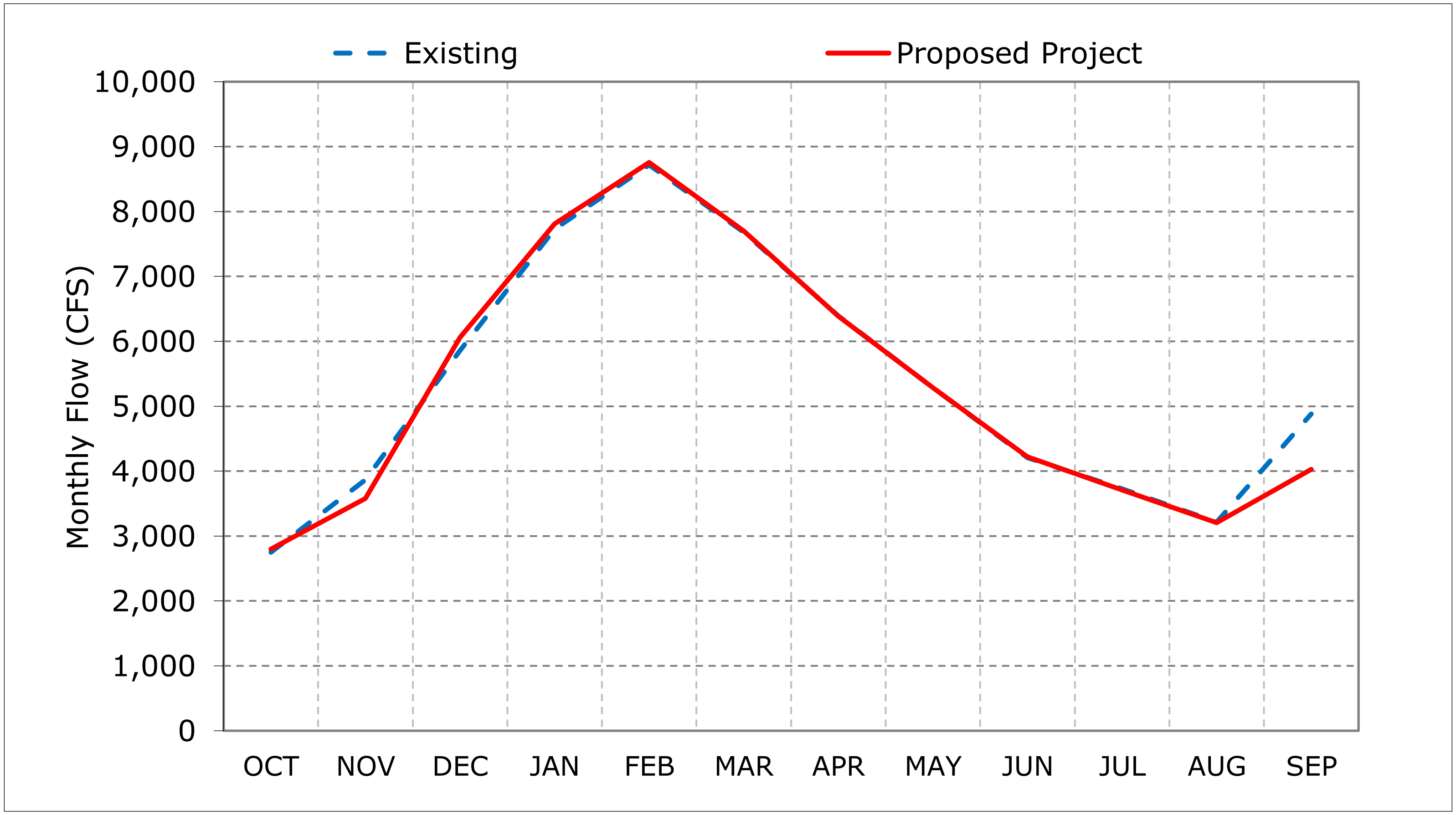
c These results are displayed with water year - year type sorting.

Figure 2-1. Georgiana Slough, Long-Term Average Flow



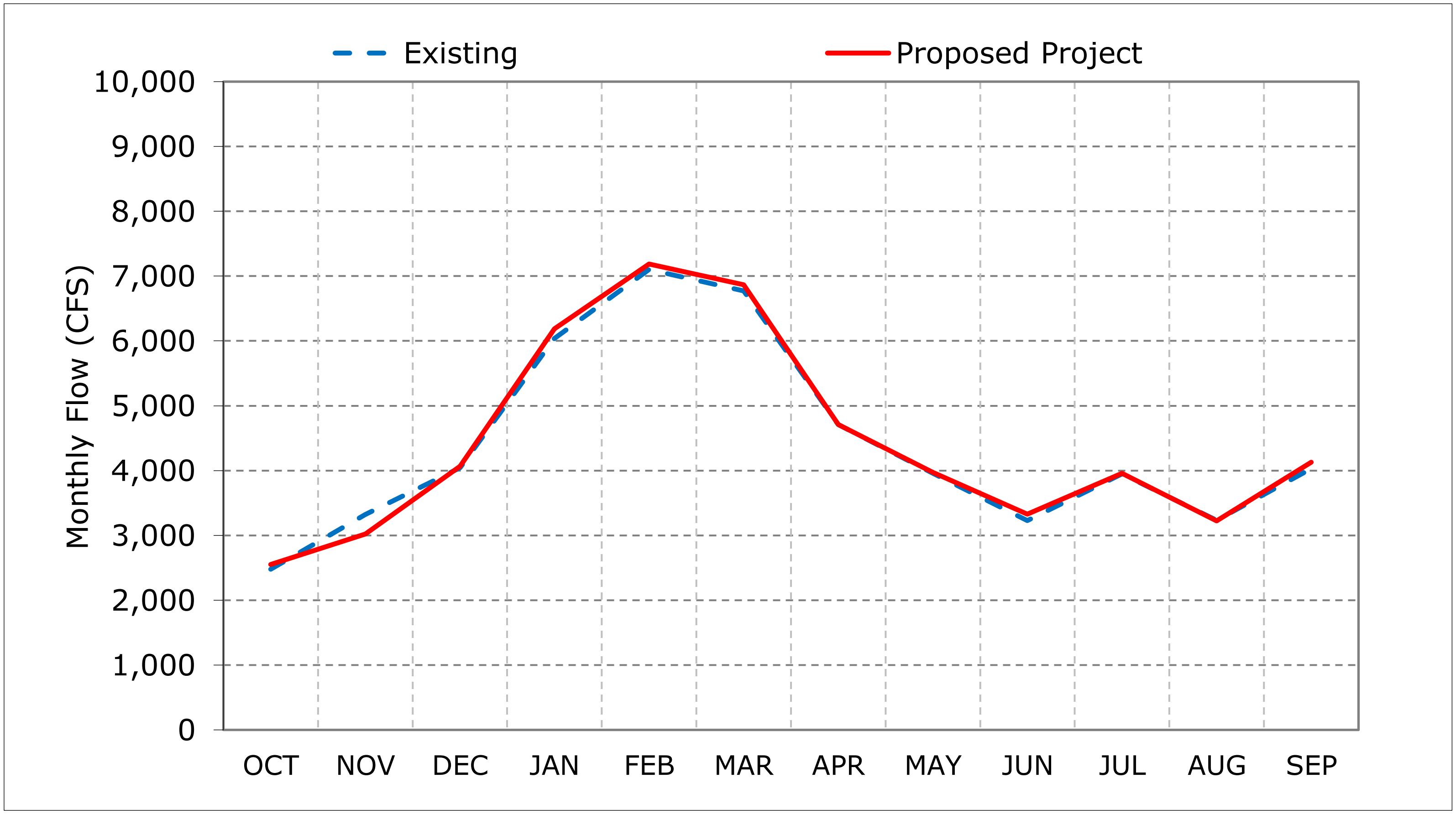
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 2-2. Georgiana Slough, Wet Year Average Flow



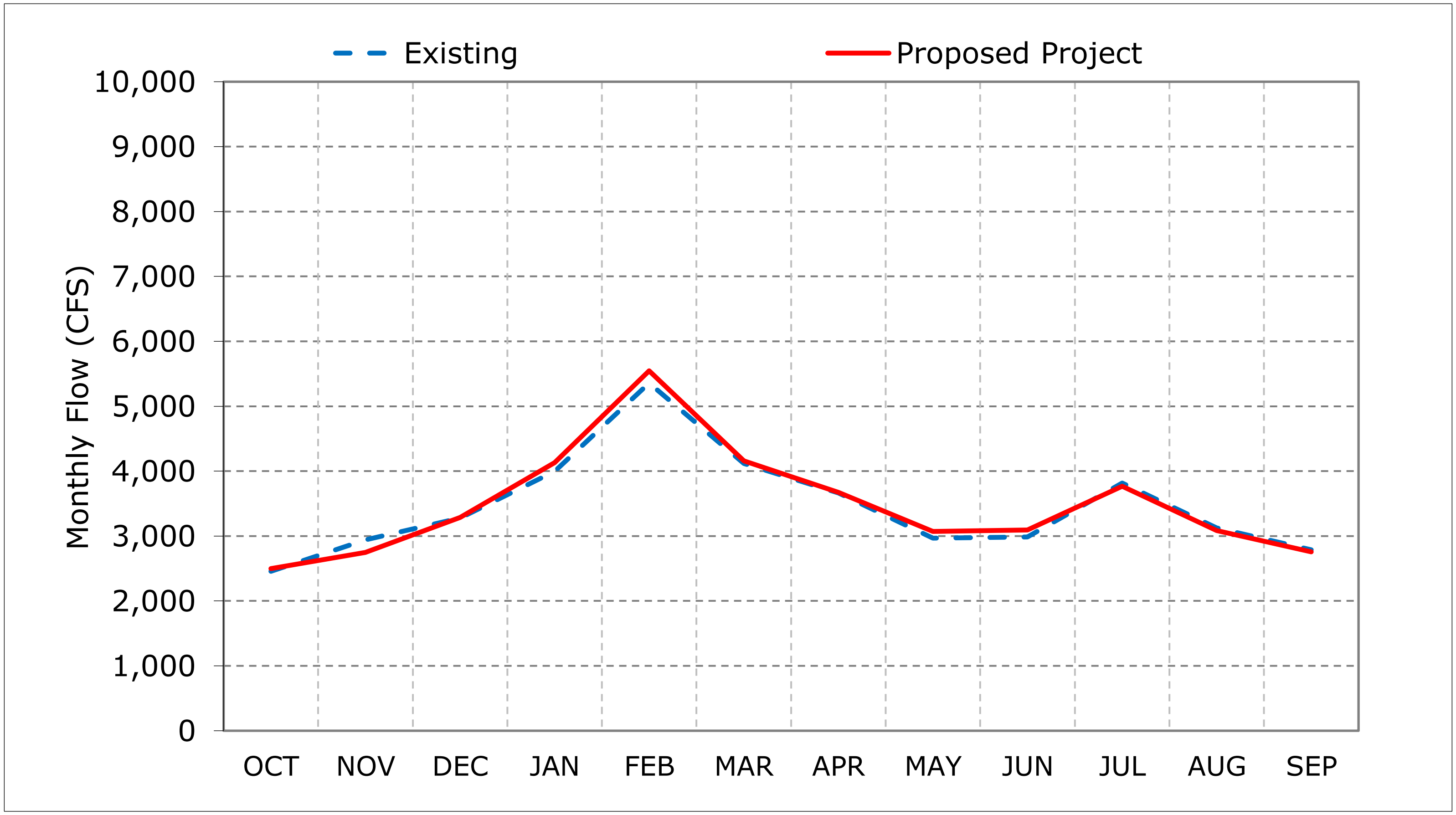
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 2-3. Georgiana Slough, Above Normal Year Average Flow



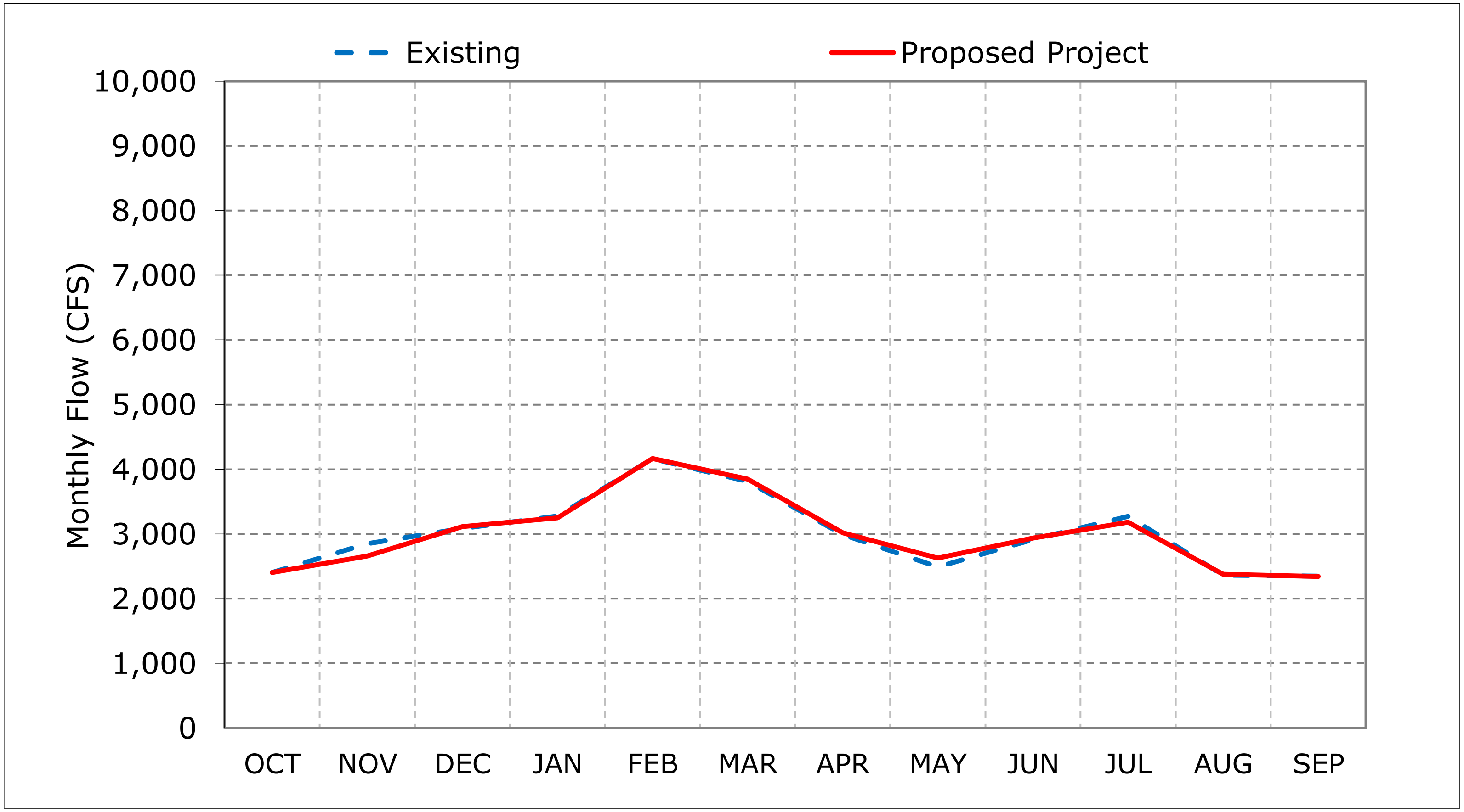
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 2-4. Georgiana Slough, Below Normal Year Average Flow



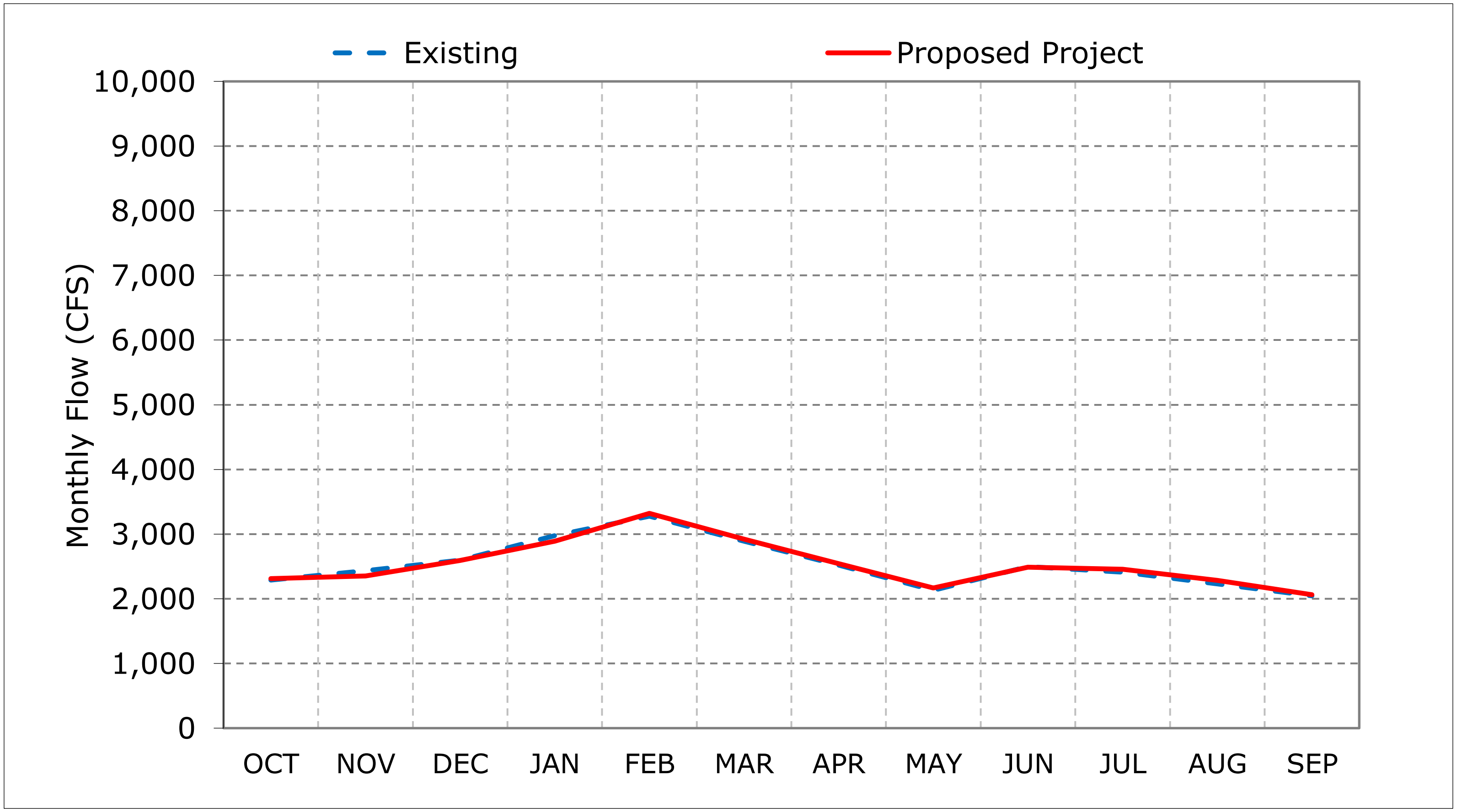
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 2-5. Georgiana Slough, Dry Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 2-6. Georgiana Slough, Critical Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 2-7. Georgiana Slough, October

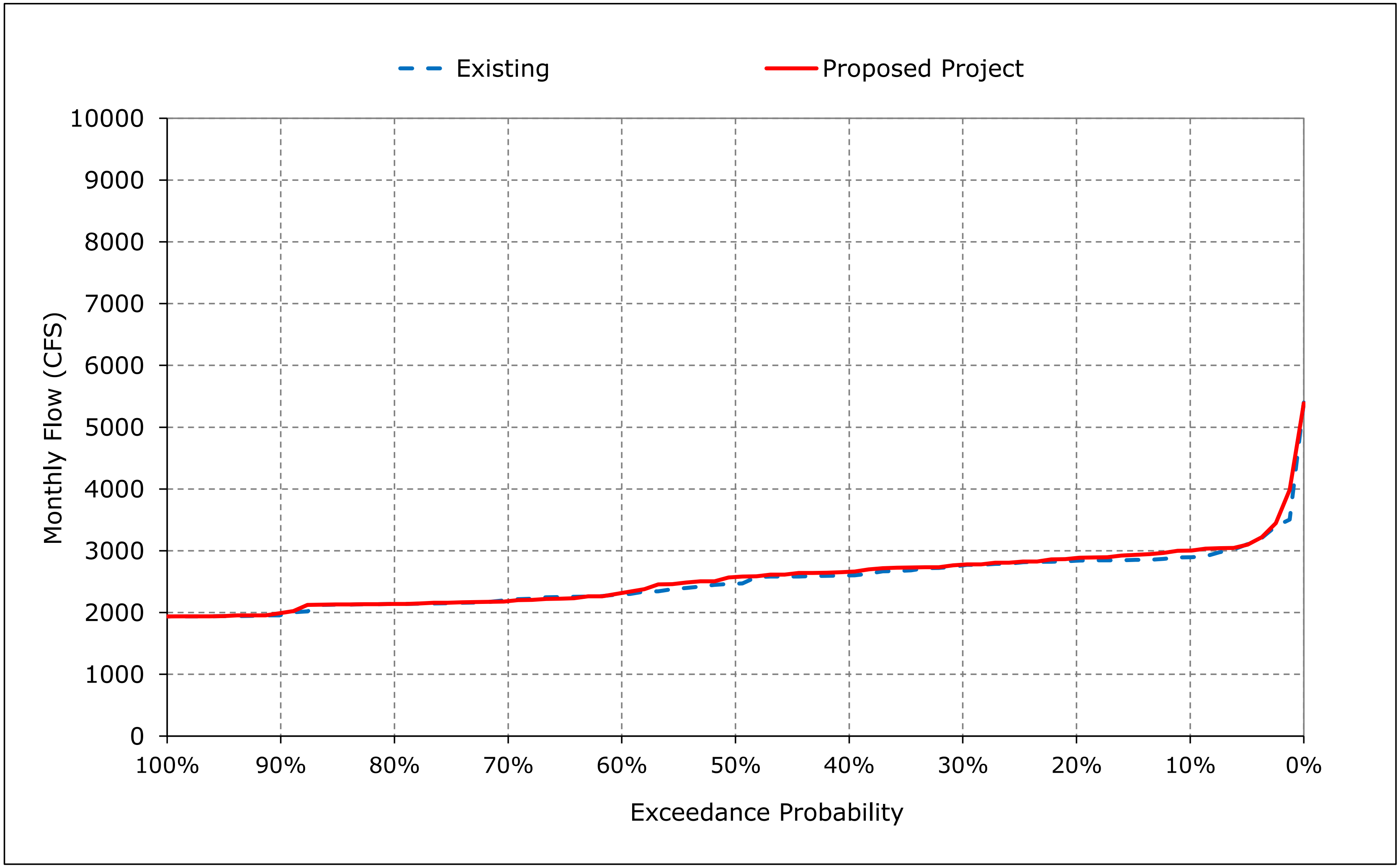


Figure 2-8. Georgiana Slough, November

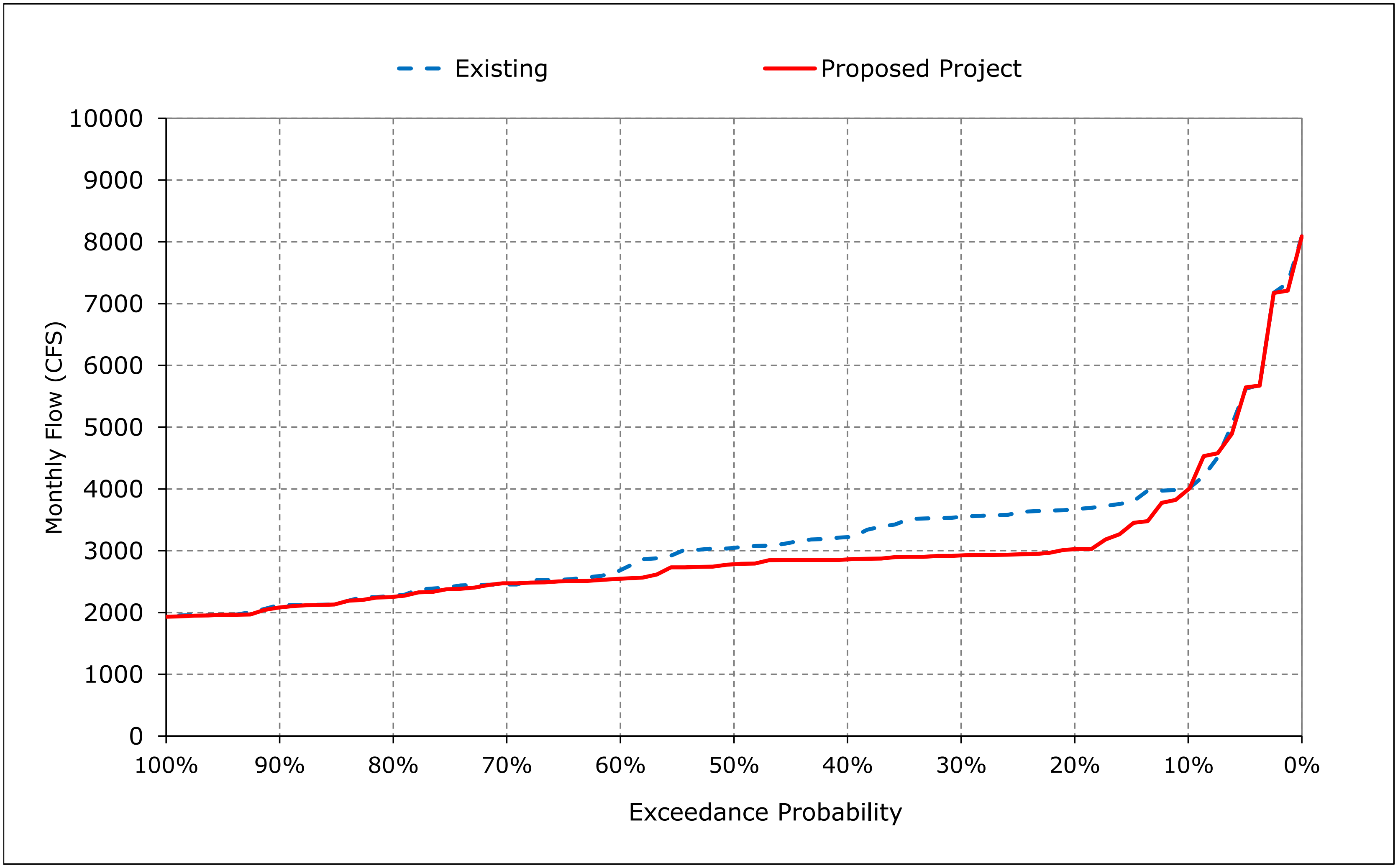


Figure 2-9. Georgiana Slough, December

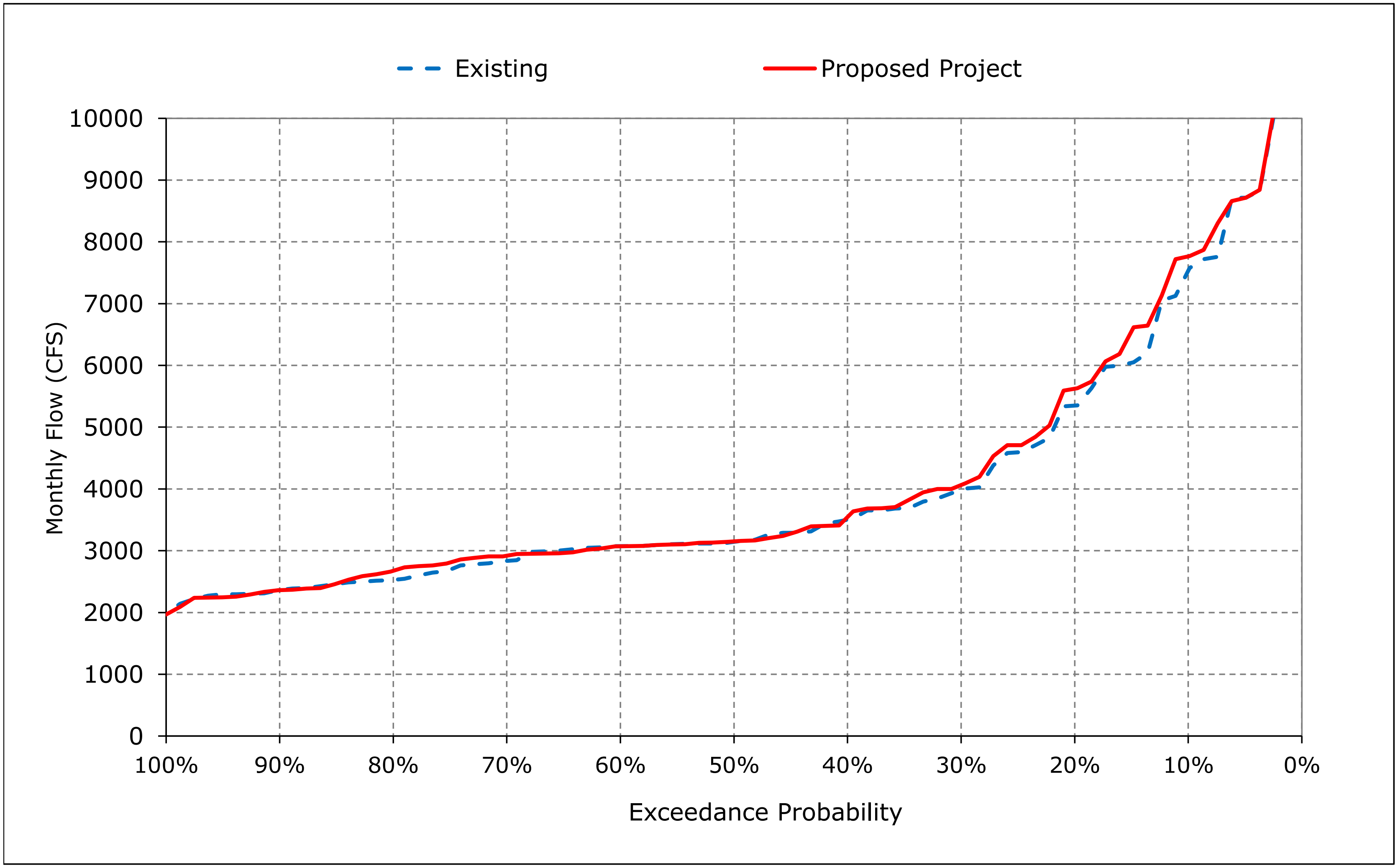


Figure 2-10. Georgiana Slough, January

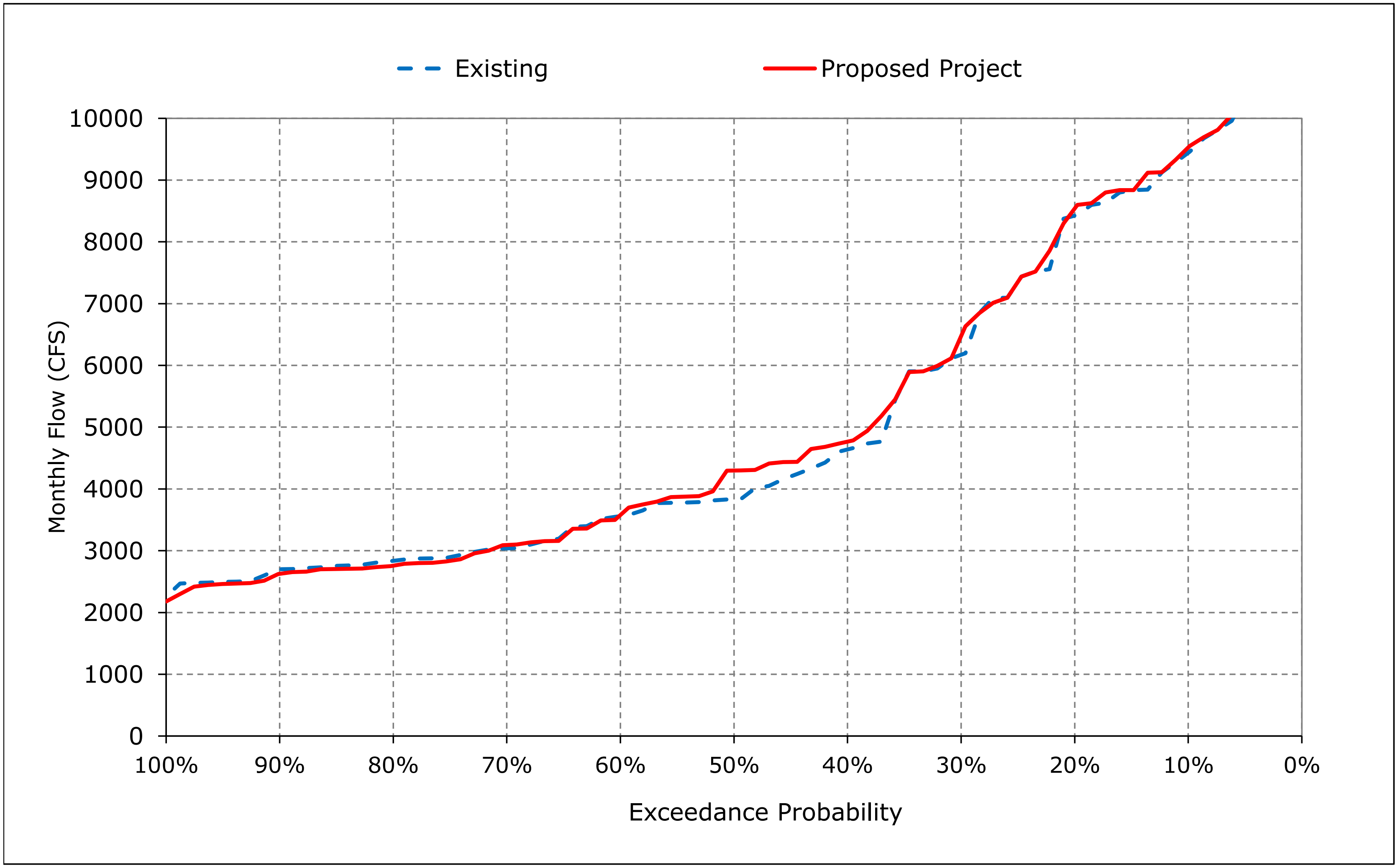


Figure 2-11. Georgiana Slough, February

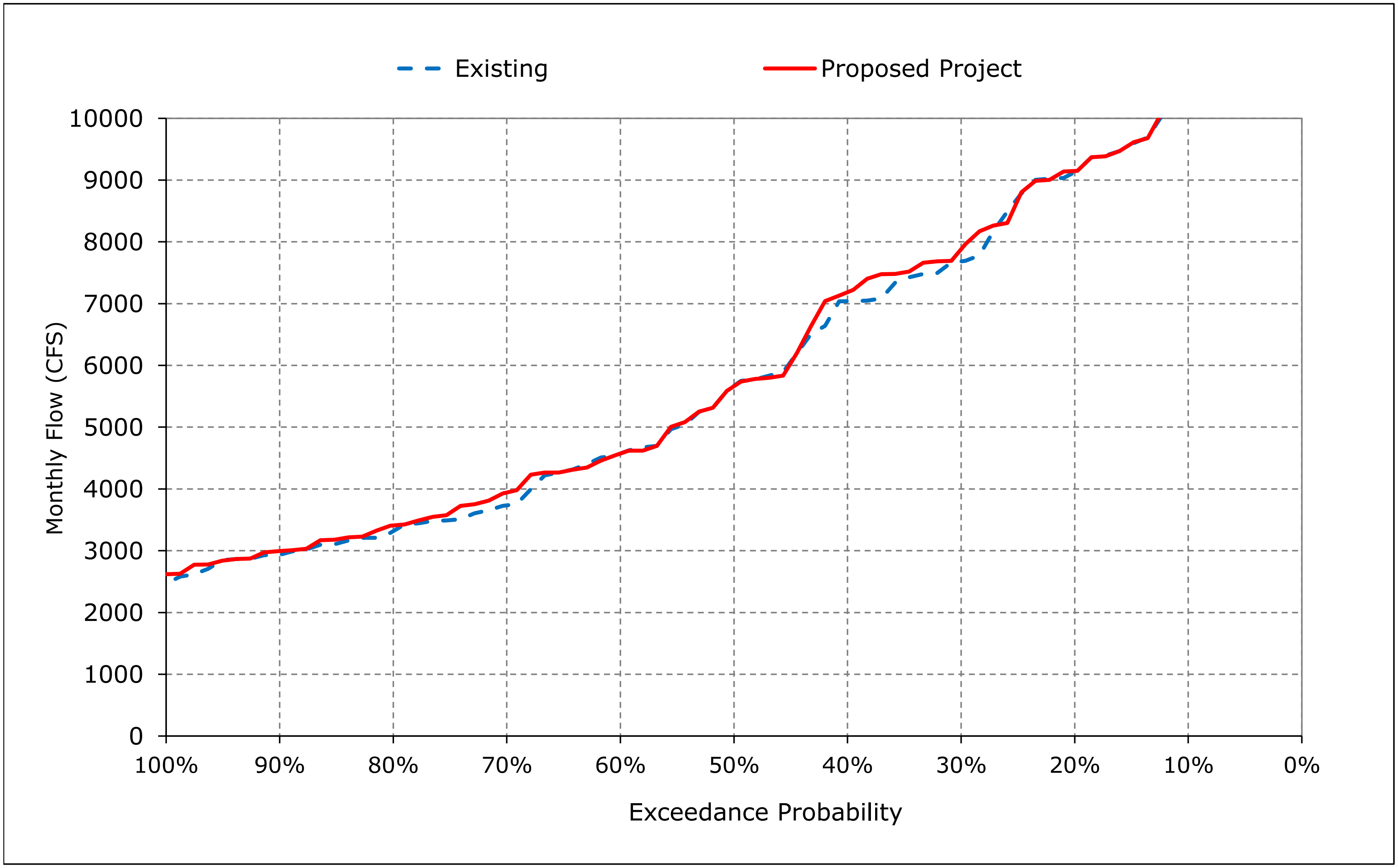


Figure 2-12. Georgiana Slough, March

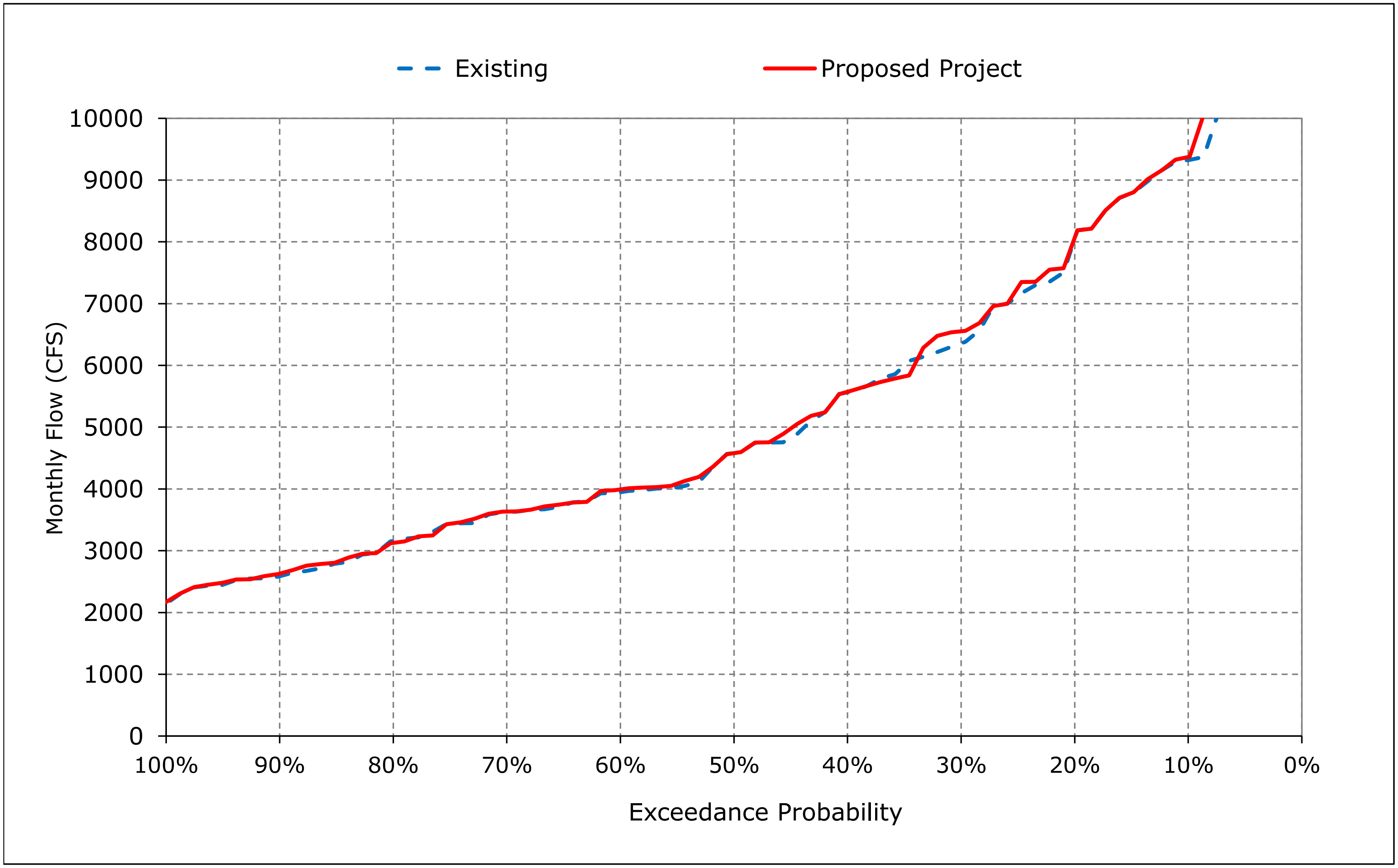


Figure 2-13. Georgiana Slough, April

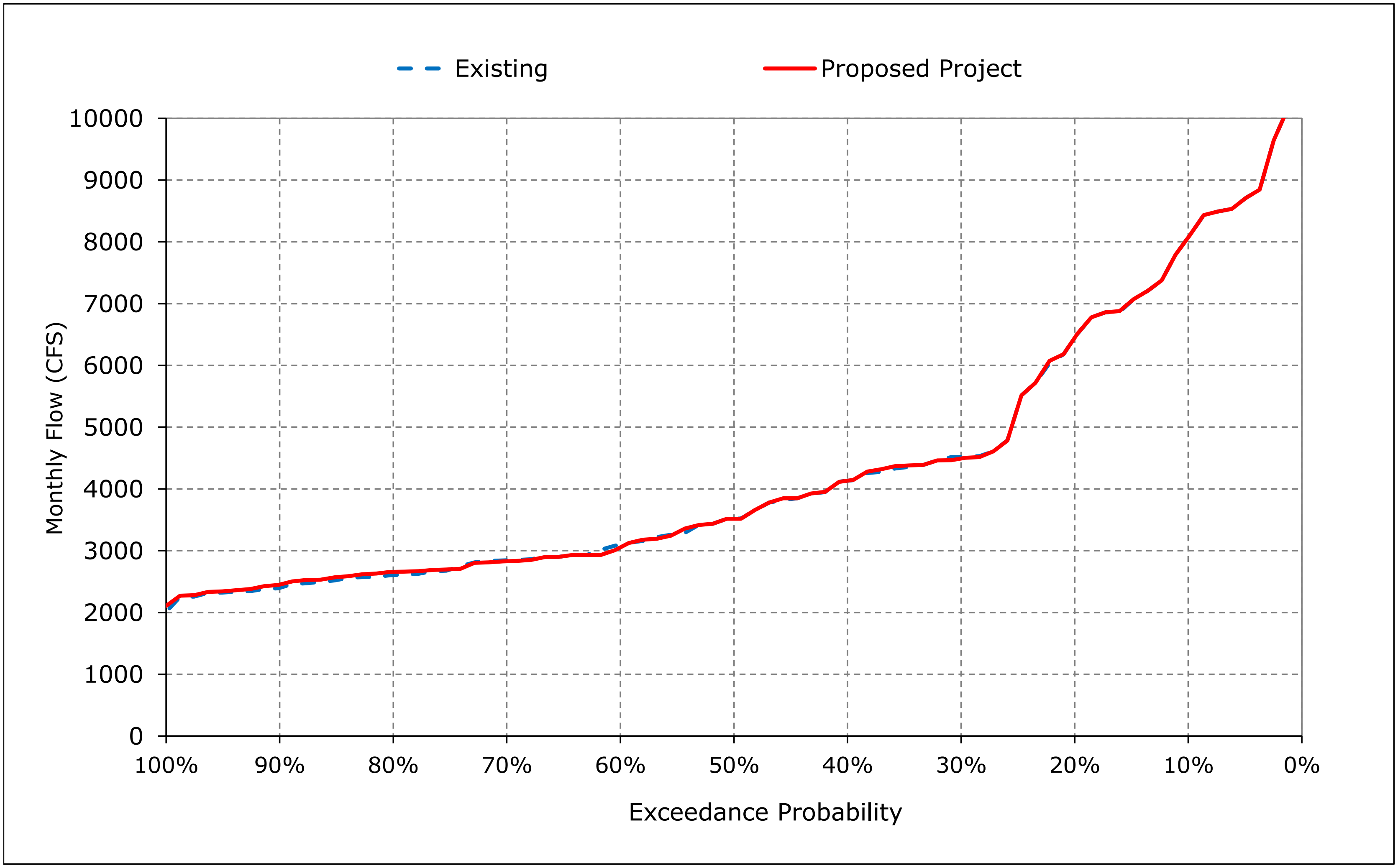


Figure 2-14. Georgiana Slough, May

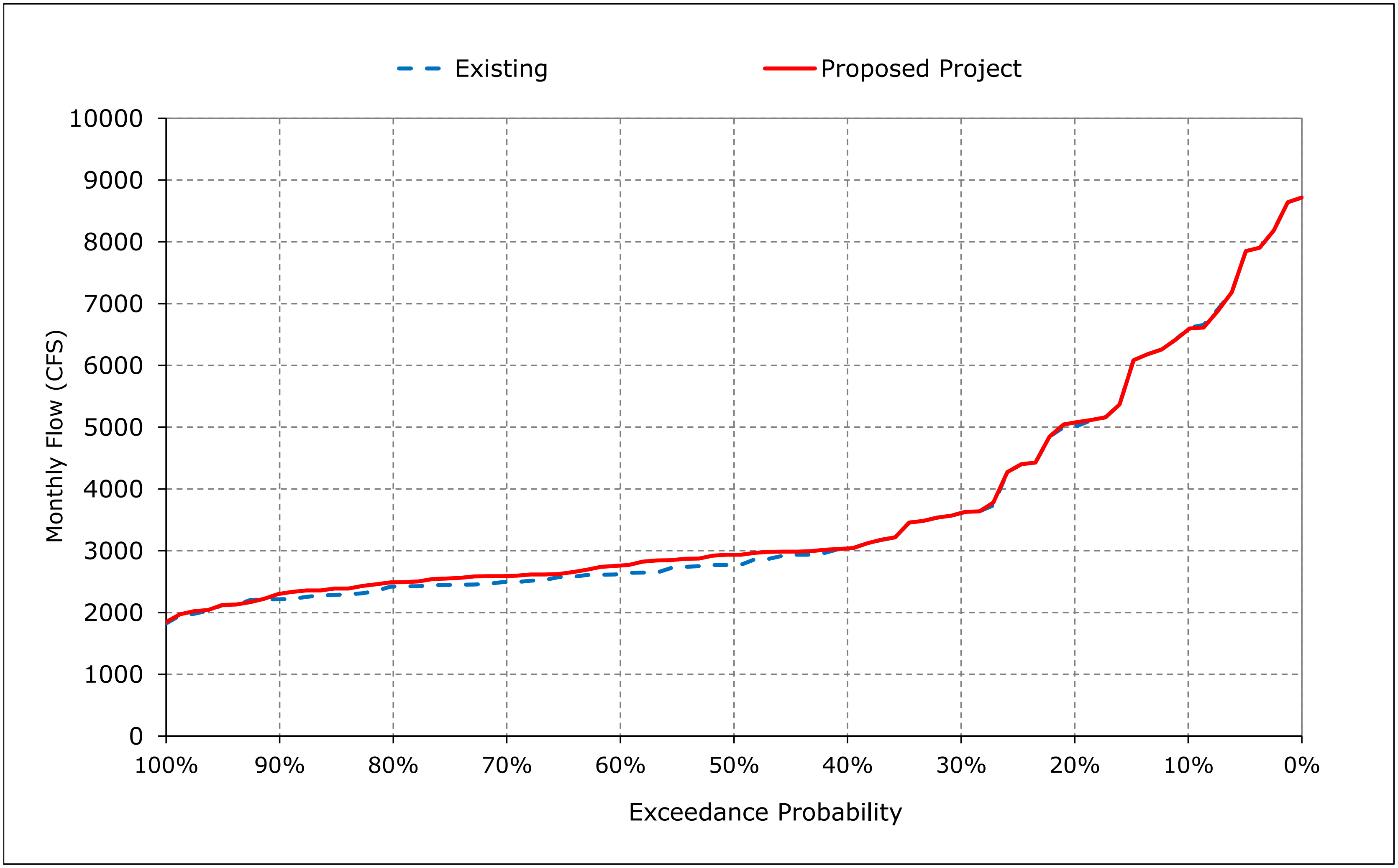


Figure 2-15. Georgiana Slough, June

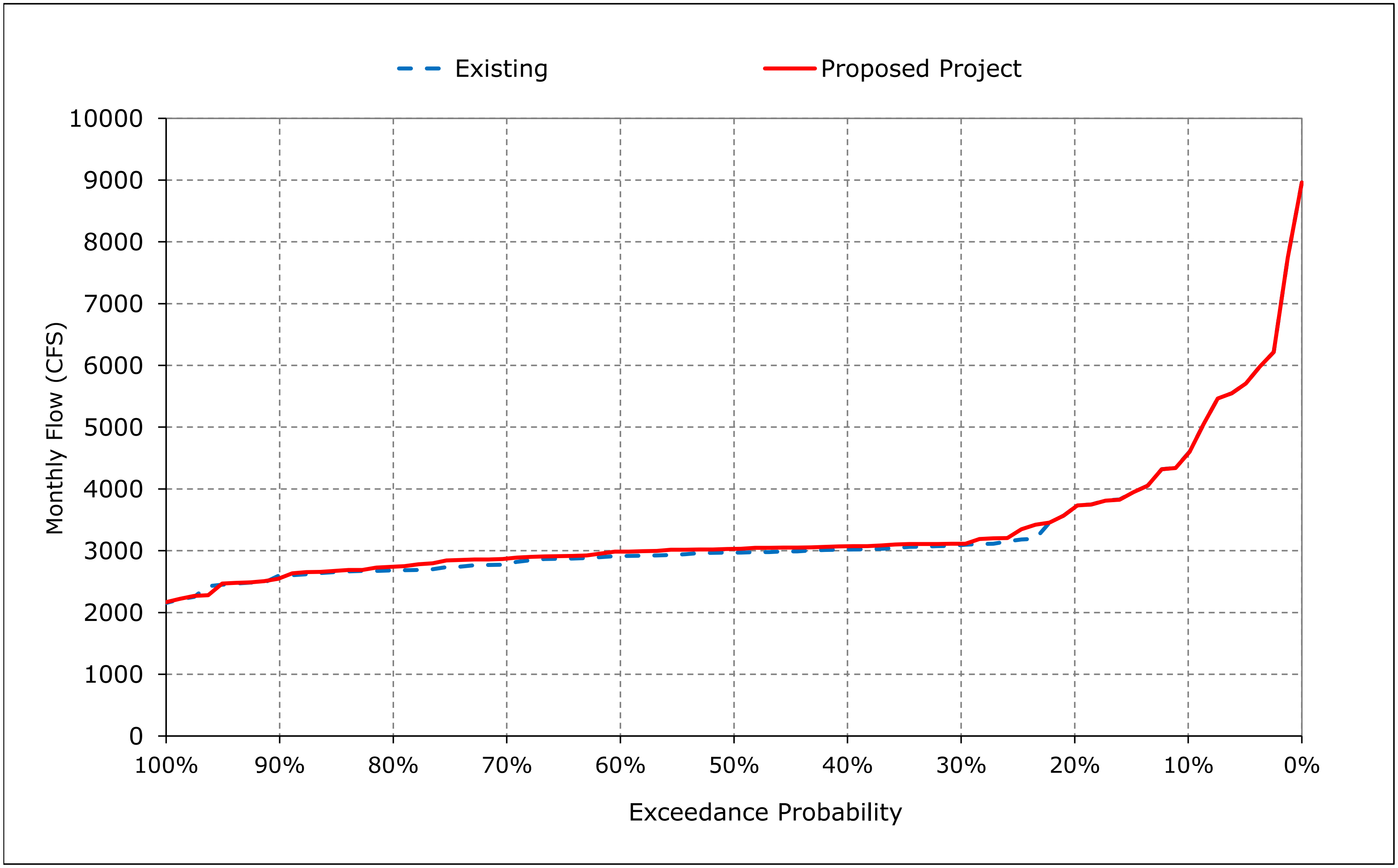


Figure 2-16. Georgiana Slough, July

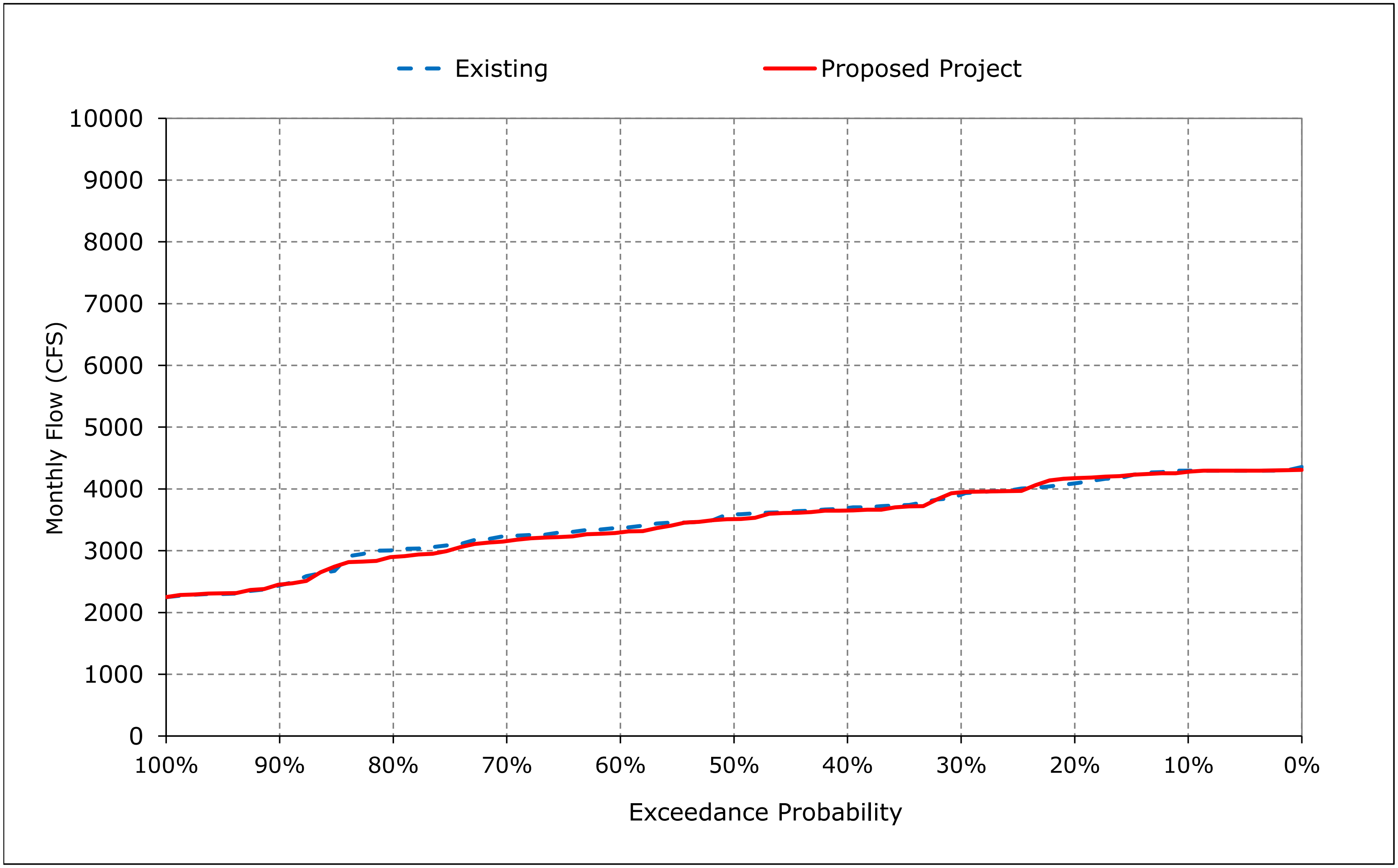


Figure 2-17. Georgiana Slough, August

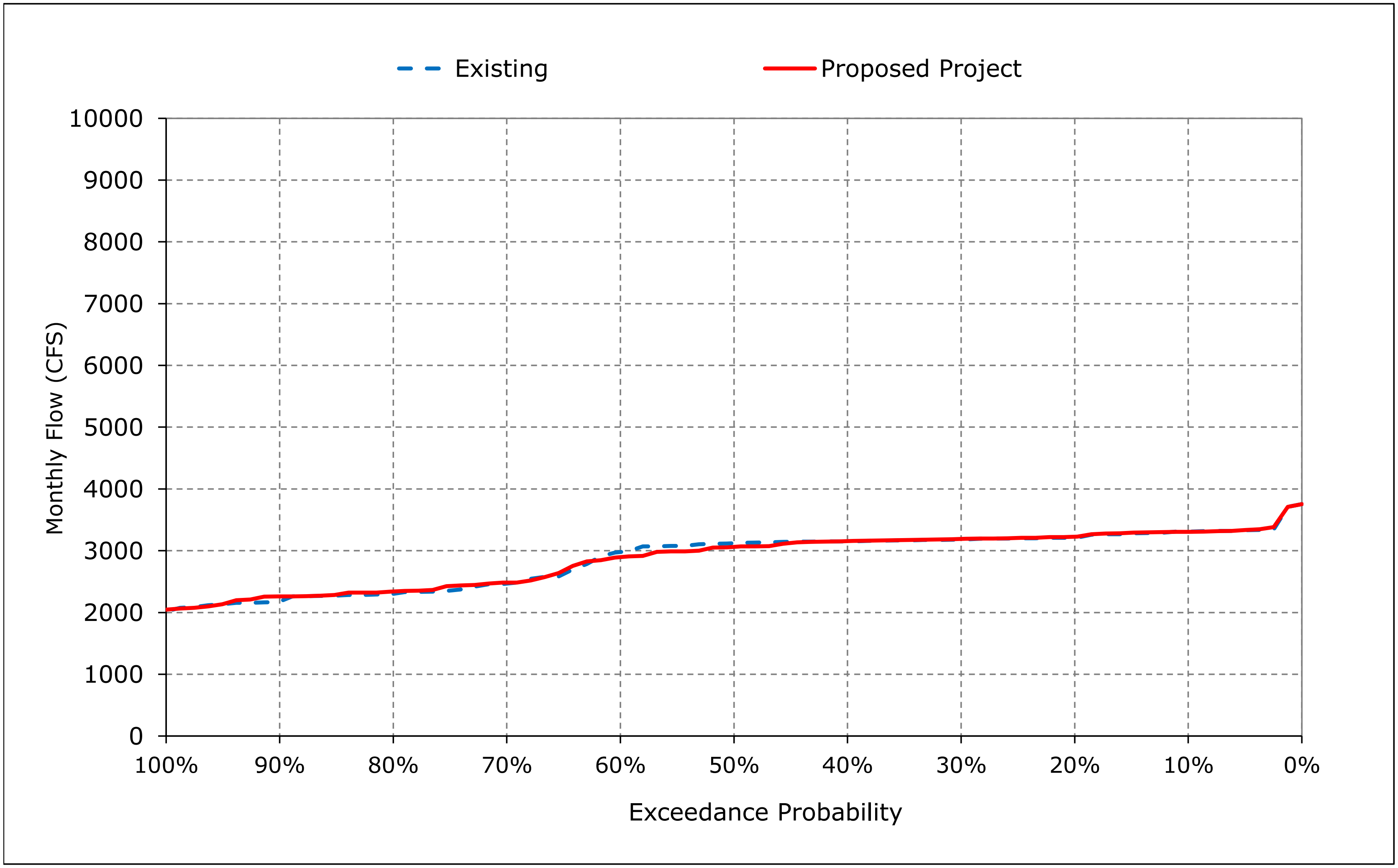


Figure 2-18. Georgiana Slough, September

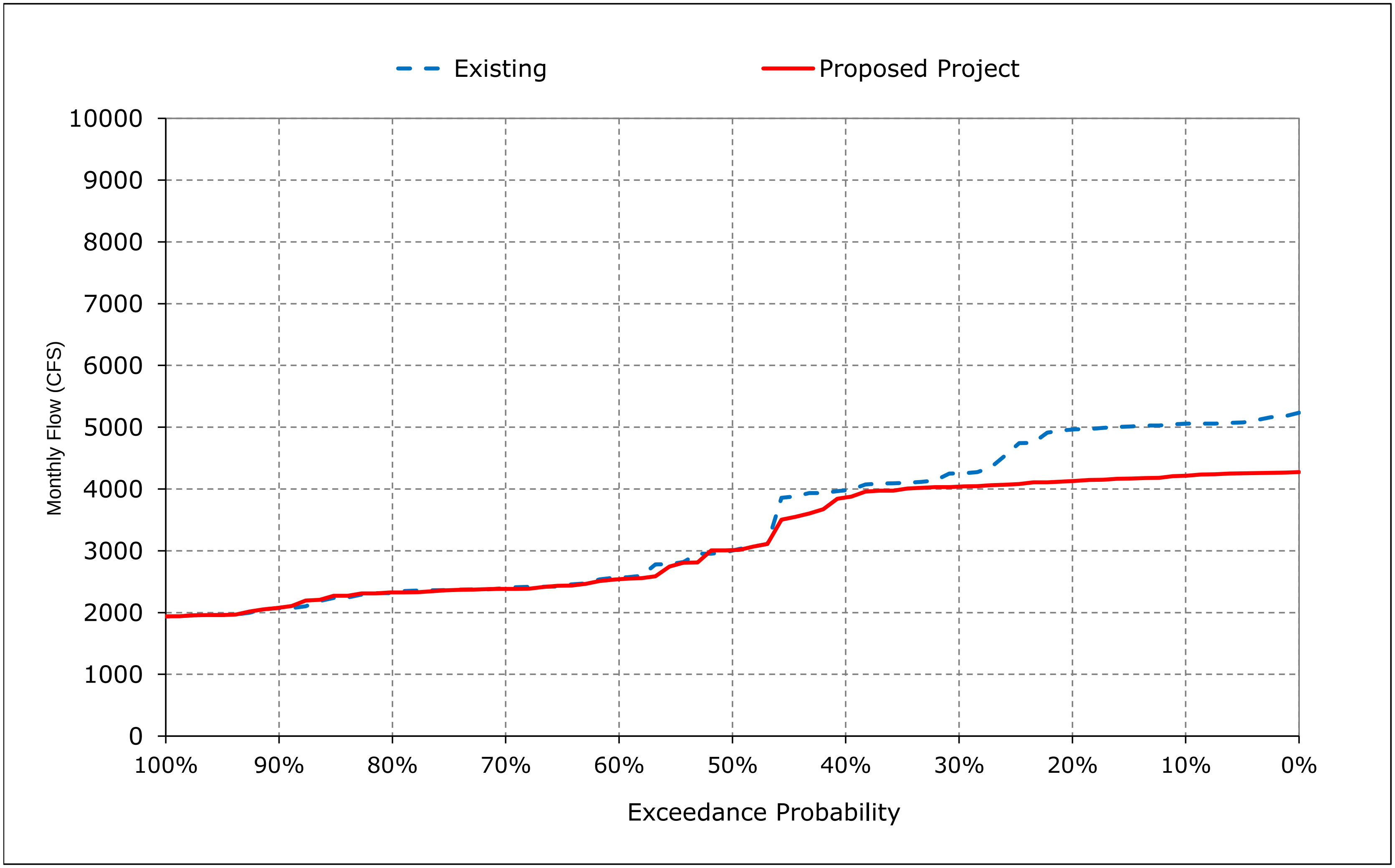


Table 3-1. Yolo Bypass Flow, Monthly Flow

Existing

	Monthly Flow (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	63	475	7,065	32,116	44,401	22,630	7,266	275	68	48	183	190
20%	61	145	2,778	10,983	16,552	8,079	3,162	78	68	48	55	110
30%	58	46	917	3,830	7,981	3,276	1,068	73	68	48	55	59
40%	53	10	316	1,912	4,787	1,767	229	70	68	48	55	59
50%	45	8	148	495	2,163	918	135	68	67	48	55	59
60%	40	5	60	269	609	279	111	65	67	48	55	59
70%	29	0	15	62	233	115	88	63	66	48	55	58
80%	16	0	0	27	82	45	78	59	64	48	55	56
90%	5	0	0	0	0	7	56	53	62	48	54	52
Long Term												
Full Simulation Period[a]	128	384	3,071	9,666	12,947	8,304	2,671	284	126	48	100	105
Water Year Types[b,c]												
Wet (32%)	263	1,057	8,104	26,331	32,235	21,722	7,047	684	255	48	143	177
Above Normal (15%)	32	176	1,191	6,758	11,720	7,440	1,747	194	66	48	95	65
Below Normal (17%)	47	33	1,415	932	3,239	704	574	67	66	48	114	85
Dry (22%)	116	68	331	557	1,842	751	308	77	67	48	62	65
Critical (15%)	41	19	89	317	365	292	107	68	64	48	54	70

Proposed Project

	Monthly Flow (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	63	475	8,674	32,255	45,986	23,519	7,266	275	68	48	183	127
20%	62	145	2,779	11,430	16,948	8,135	3,162	78	68	48	55	59
30%	59	50	974	3,877	8,111	3,320	1,068	73	68	48	55	59
40%	53	17	342	1,912	6,221	1,981	229	70	68	48	55	59
50%	46	9	148	509	2,328	1,005	135	68	67	48	55	59
60%	40	5	60	327	729	373	111	65	67	48	55	59
70%	31	0	15	80	261	122	88	63	66	48	55	58
80%	16	0	0	51	82	47	78	59	64	48	55	55
90%	5	0	0	13	0	7	56	53	62	48	54	52
Long Term												
Full Simulation Period[a]	130	373	3,315	9,834	13,249	8,460	2,671	279	126	48	100	73
Water Year Types[b,c]												
Wet (32%)	269	989	8,882	26,798	32,580	21,816	7,047	669	255	48	143	73
Above Normal (15%)	32	160	1,178	6,789	12,359	8,182	1,747	194	66	48	95	65
Below Normal (17%)	47	33	1,412	1,013	3,839	703	575	67	66	48	114	85
Dry (22%)	118	120	331	566	1,828	831	308	77	67	48	62	65
Critical (15%)	41	27	89	317	367	292	107	68	64	48	54	77

Proposed Project minus Existing

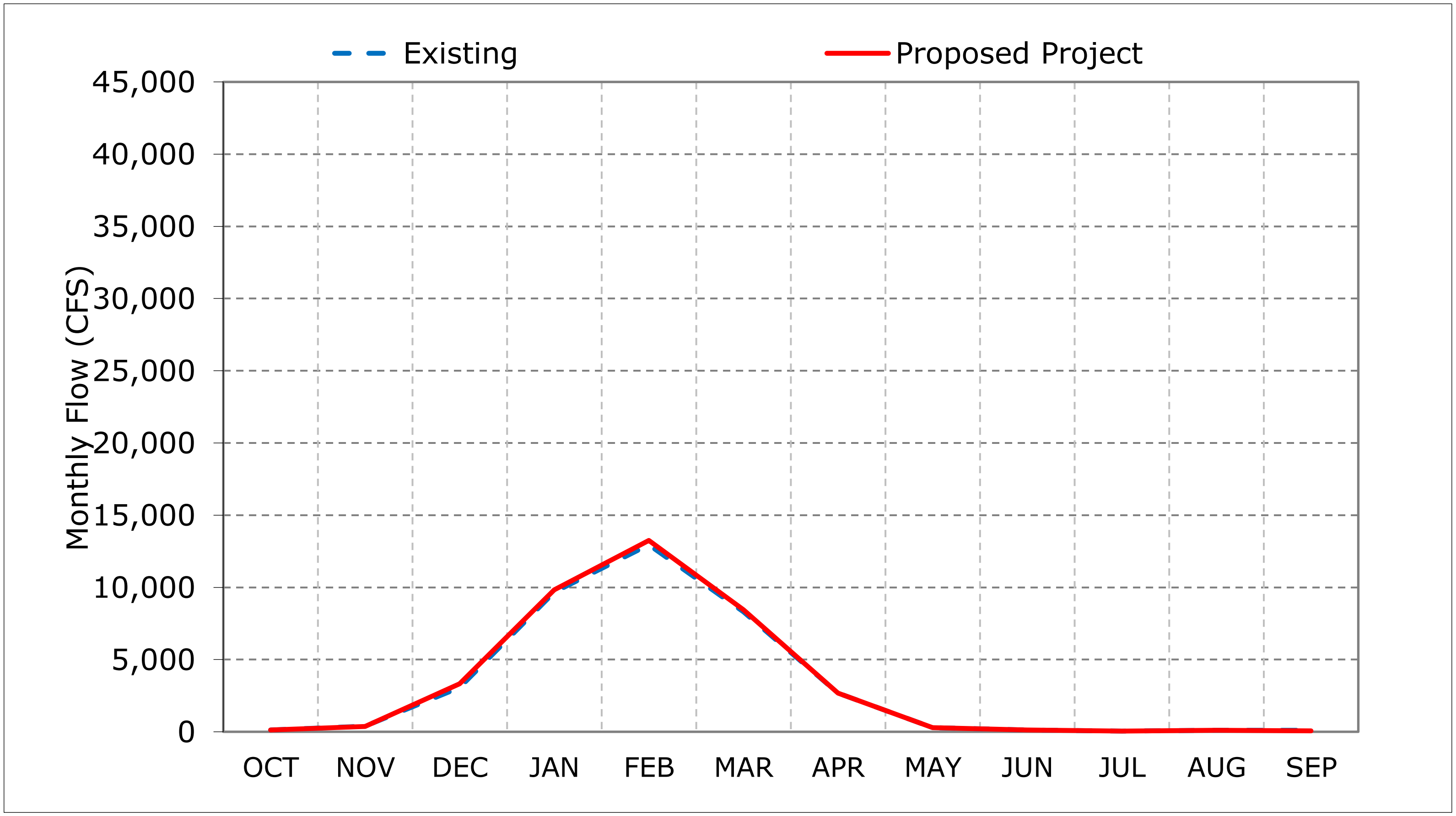
	Monthly Flow (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	0	0	1,609	140	1,585	889	**-1**	0	0	0	0	**-63**
20%	0	0	1	447	396	57	0	0	0	0	0	**-51**
30%	1	5	57	47	130	44	0	0	0	0	0	0
40%	0	7	26	0	1,433	215	0	0	0	0	0	0
50%	1	0	0	14	166	87	0	0	0	0	0	0
60%	0	1	0	57	120	94	0	0	0	0	0	**0**
70%	1	0	0	18	28	8	0	0	0	0	0	**-1**
80%	0	0	0	24	0	2	0	0	0	0	0	**-1**
90%	0	0	0	13	0	0	0	0	0	0	0	0
Long Term												
Full Simulation Period[a]	2	**-11**	244	168	302	156	**0**	**-5**	**0**	0	0	**-32**
Water Year Types[b,c]												
Wet (32%)	6	**-68**	778	467	344	93	**-1**	**-15**	**0**	0	0	**-105**
Above Normal (15%)	0	**-16**	**-13**	31	639	742	0	0	0	0	0	0
Below Normal (17%)	0	0	**-3**	81	600	**0**	0	0	0	0	0	0
Dry (22%)	2	53	0	9	**-14**	80	0	0	0	0	0	0
Critical (15%)	0	8	0	**-1**	2	0	0	0	0	0	0	7

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

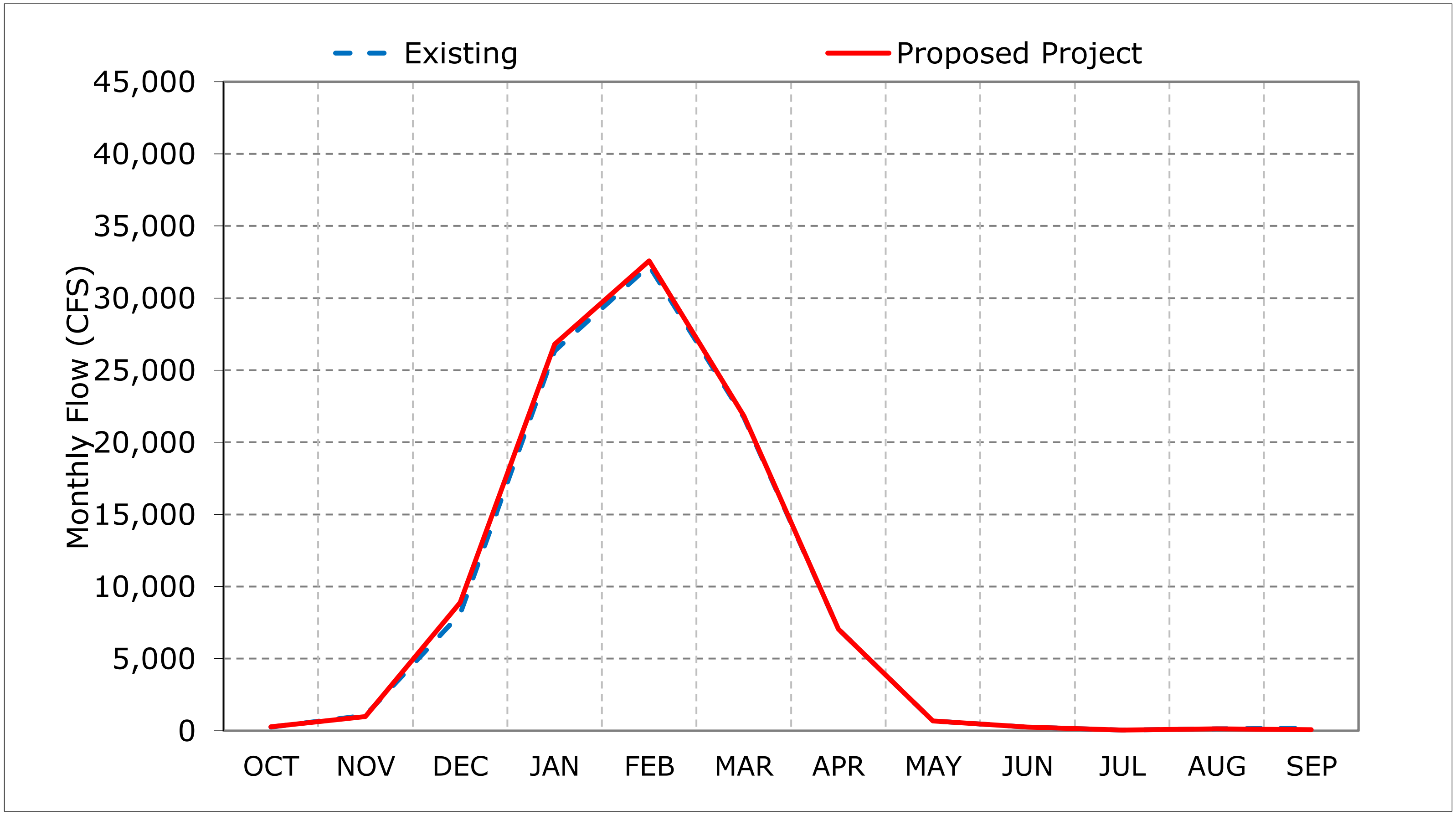
c These results are displayed with water year - year type sorting.

Figure 3-1. Yolo Bypass Flow, Long-Term Average Flow



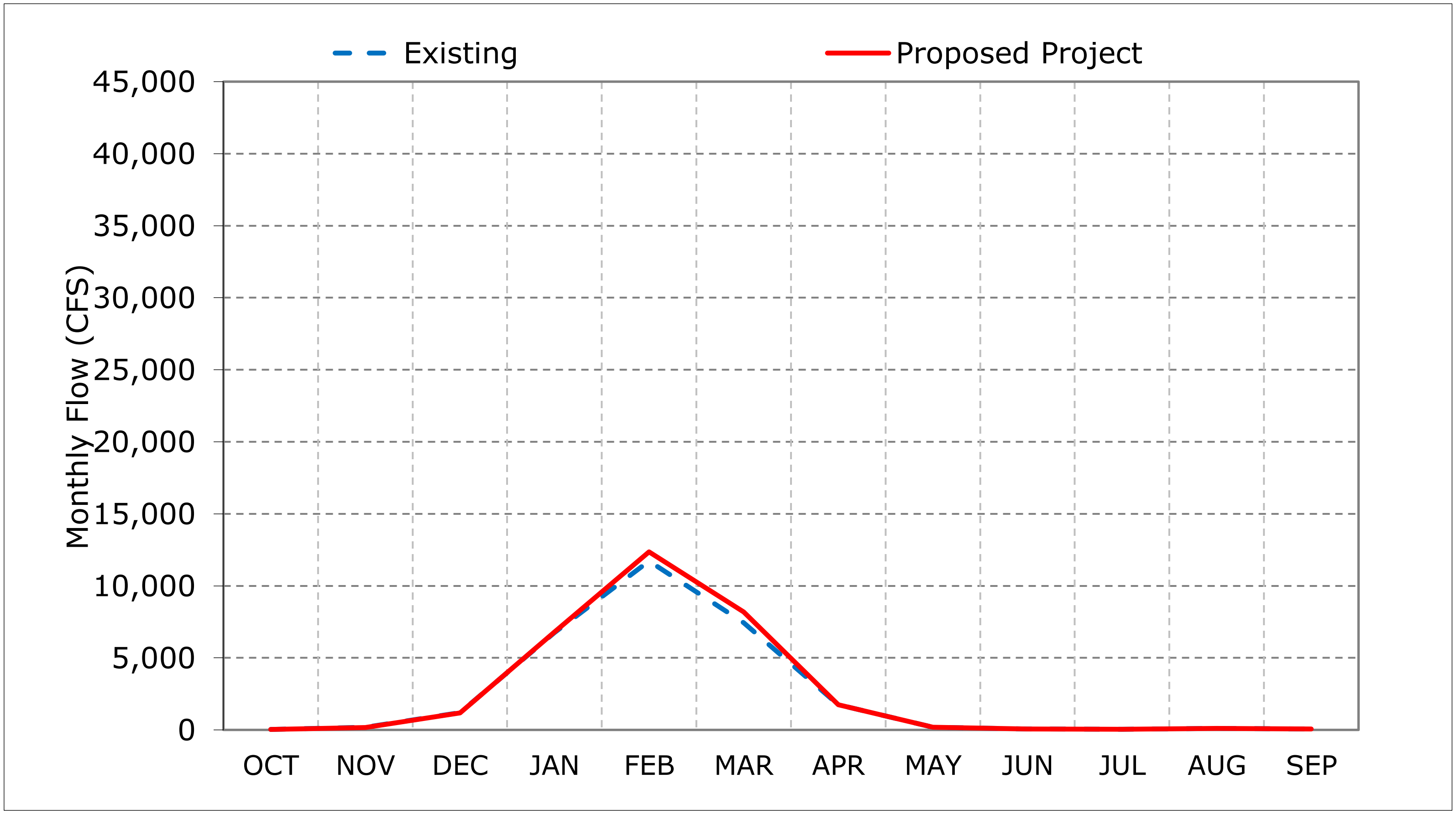
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 3-2. Yolo Bypass Flow, Wet Year Average Flow



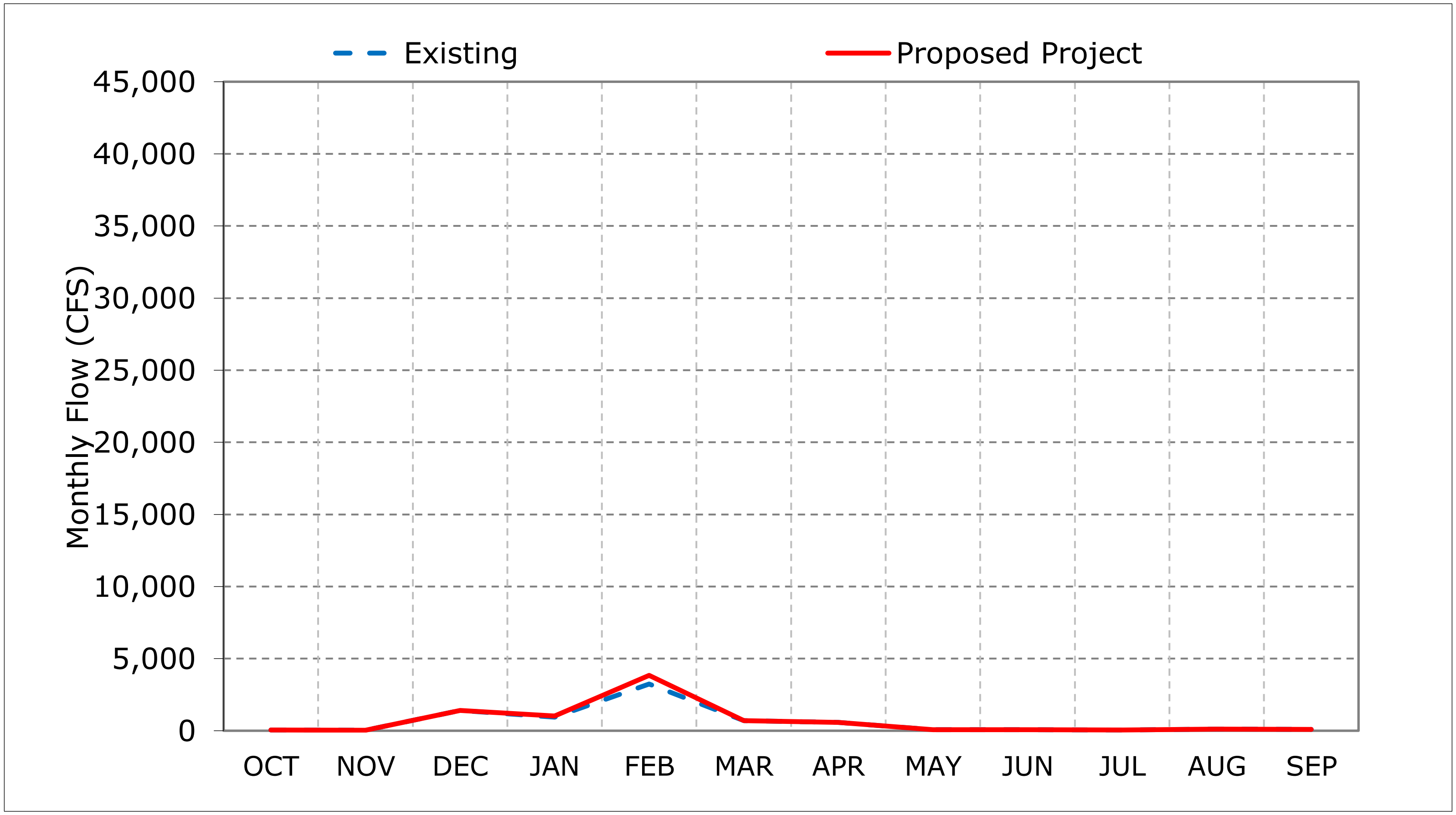
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 3-3. Yolo Bypass Flow, Above Normal Year Average Flow



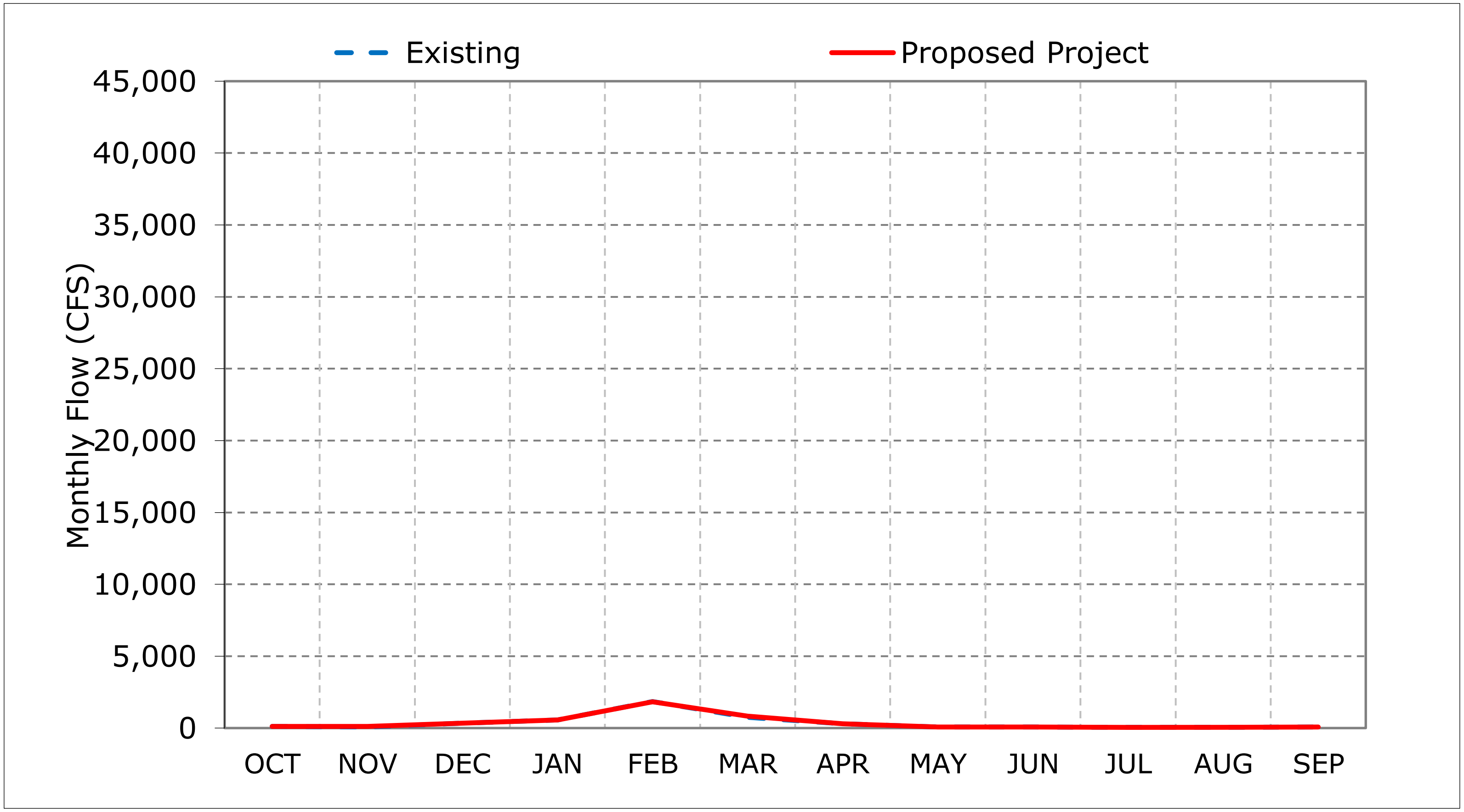
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 3-4. Yolo Bypass Flow, Below Normal Year Average Flow



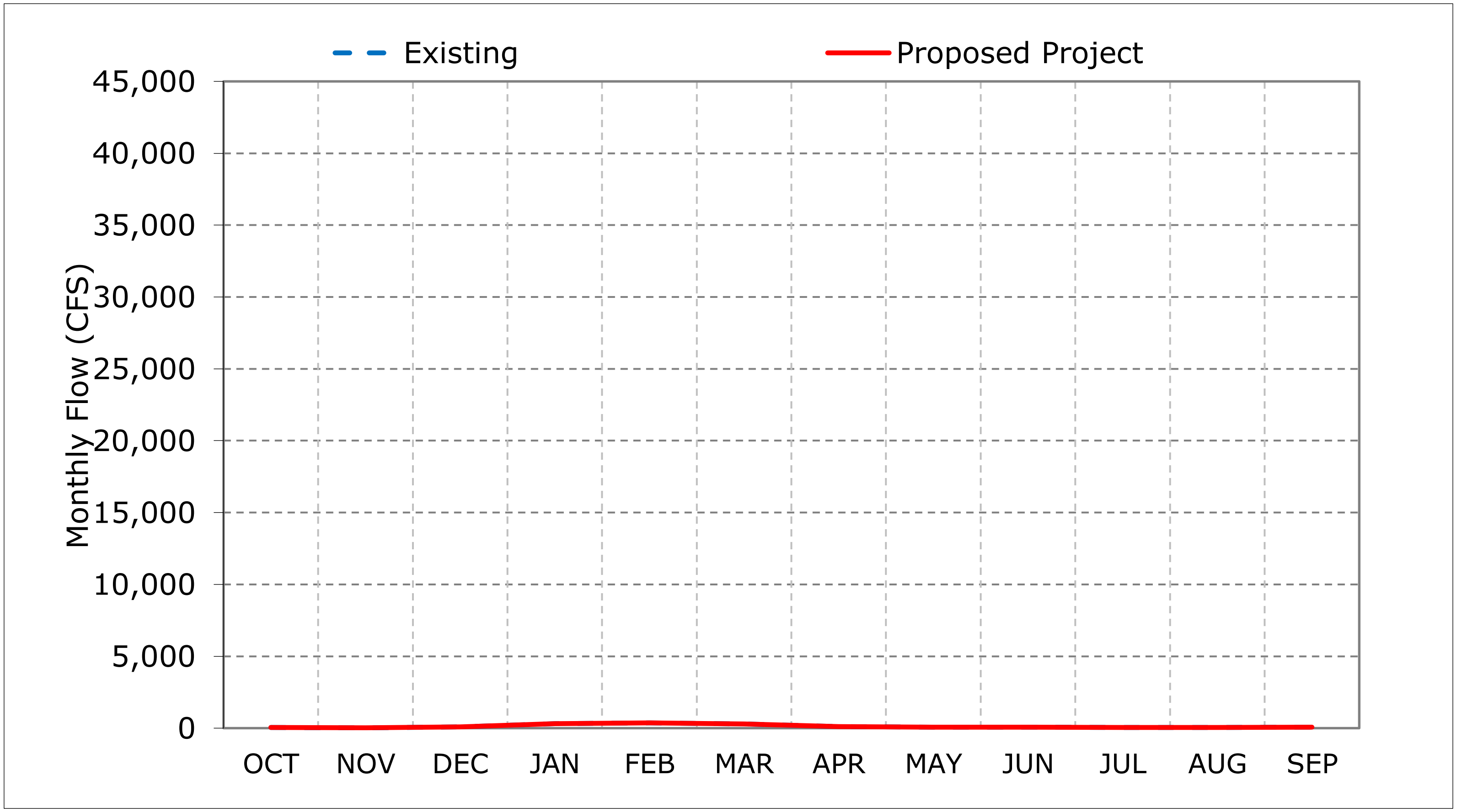
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 3-5. Yolo Bypass Flow, Dry Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 3-6. Yolo Bypass Flow, Critical Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 3-7. Yolo Bypass Flow, October

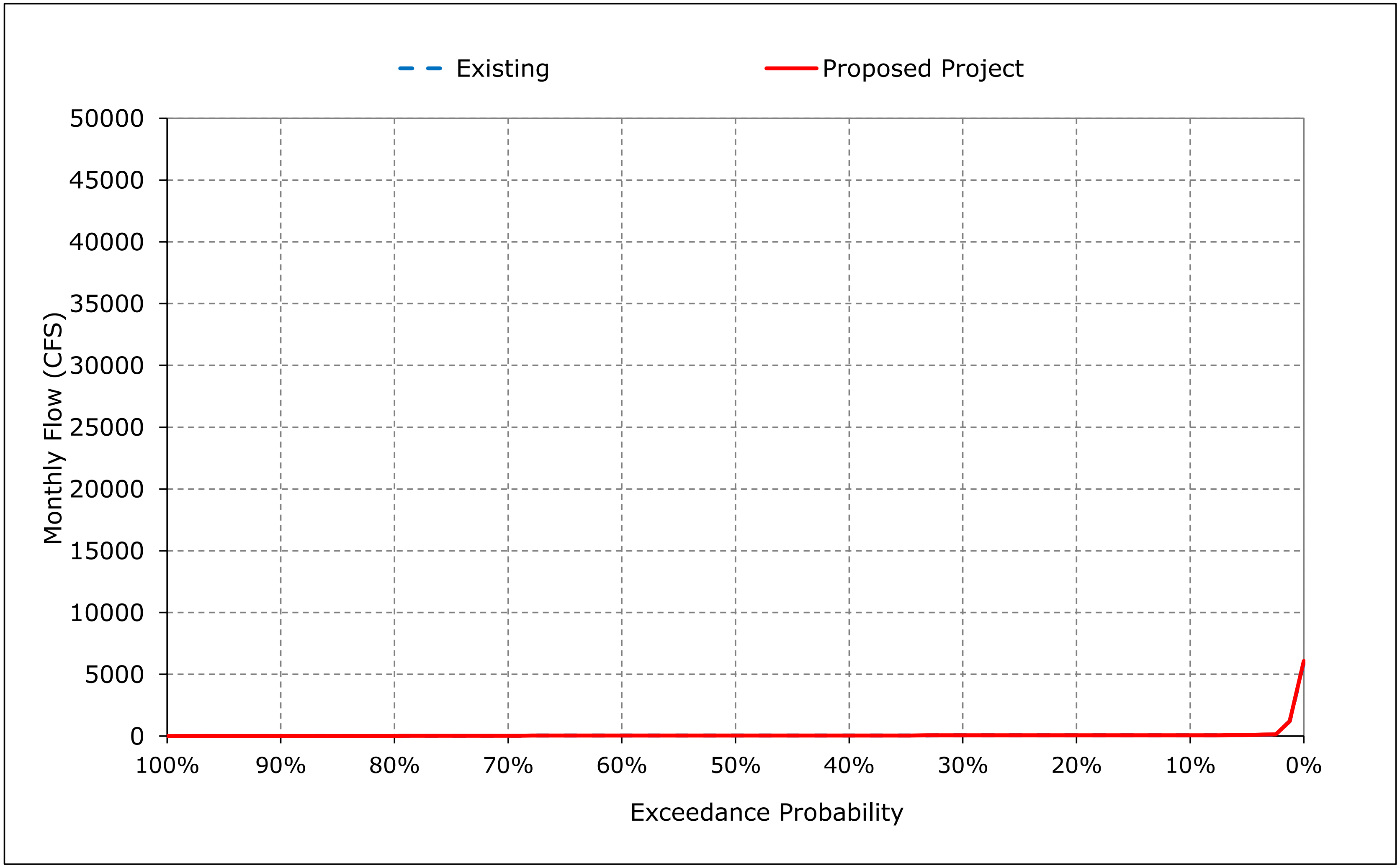


Figure 3-8. Yolo Bypass Flow, November

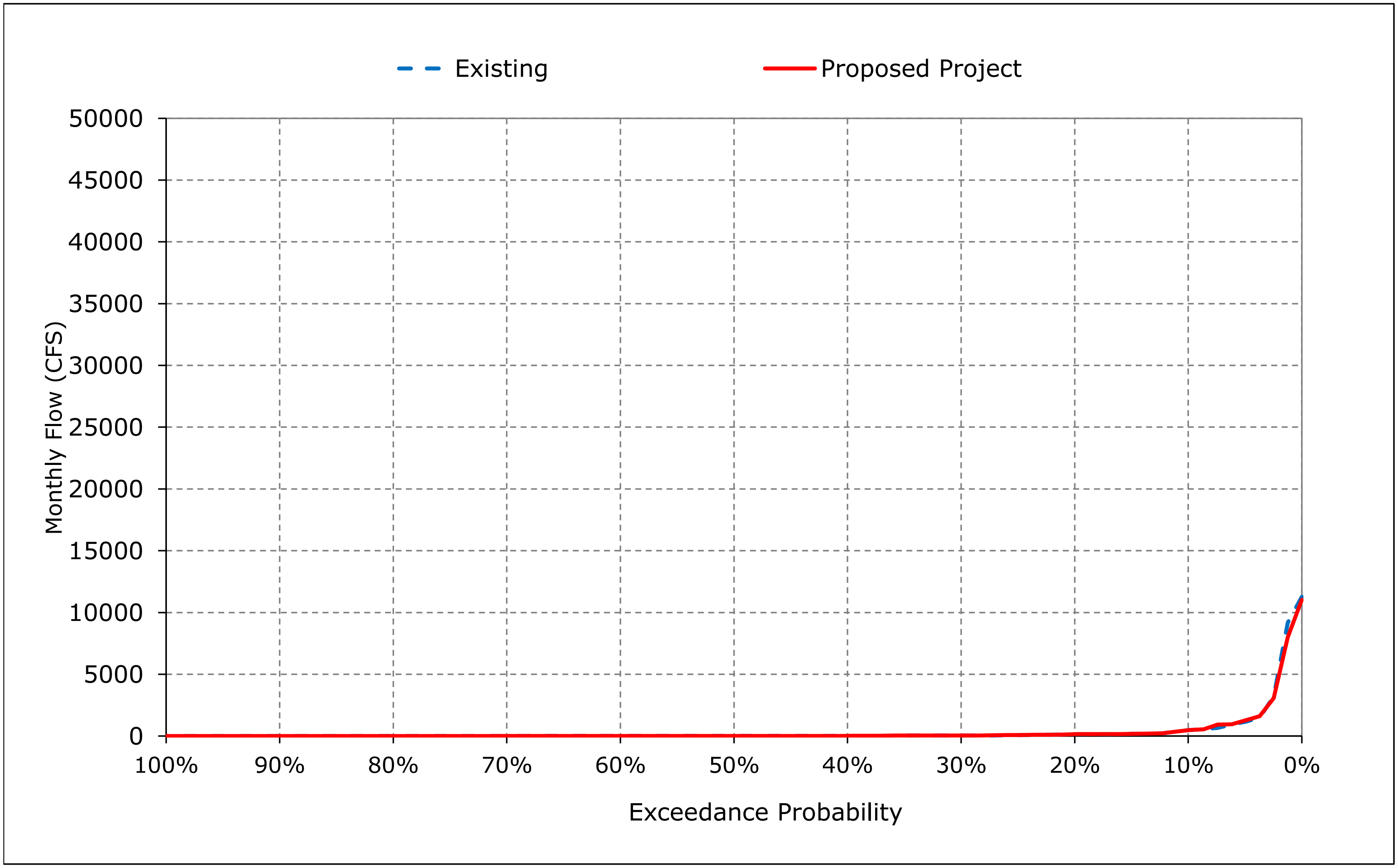


Figure 3-9. Yolo Bypass Flow, December

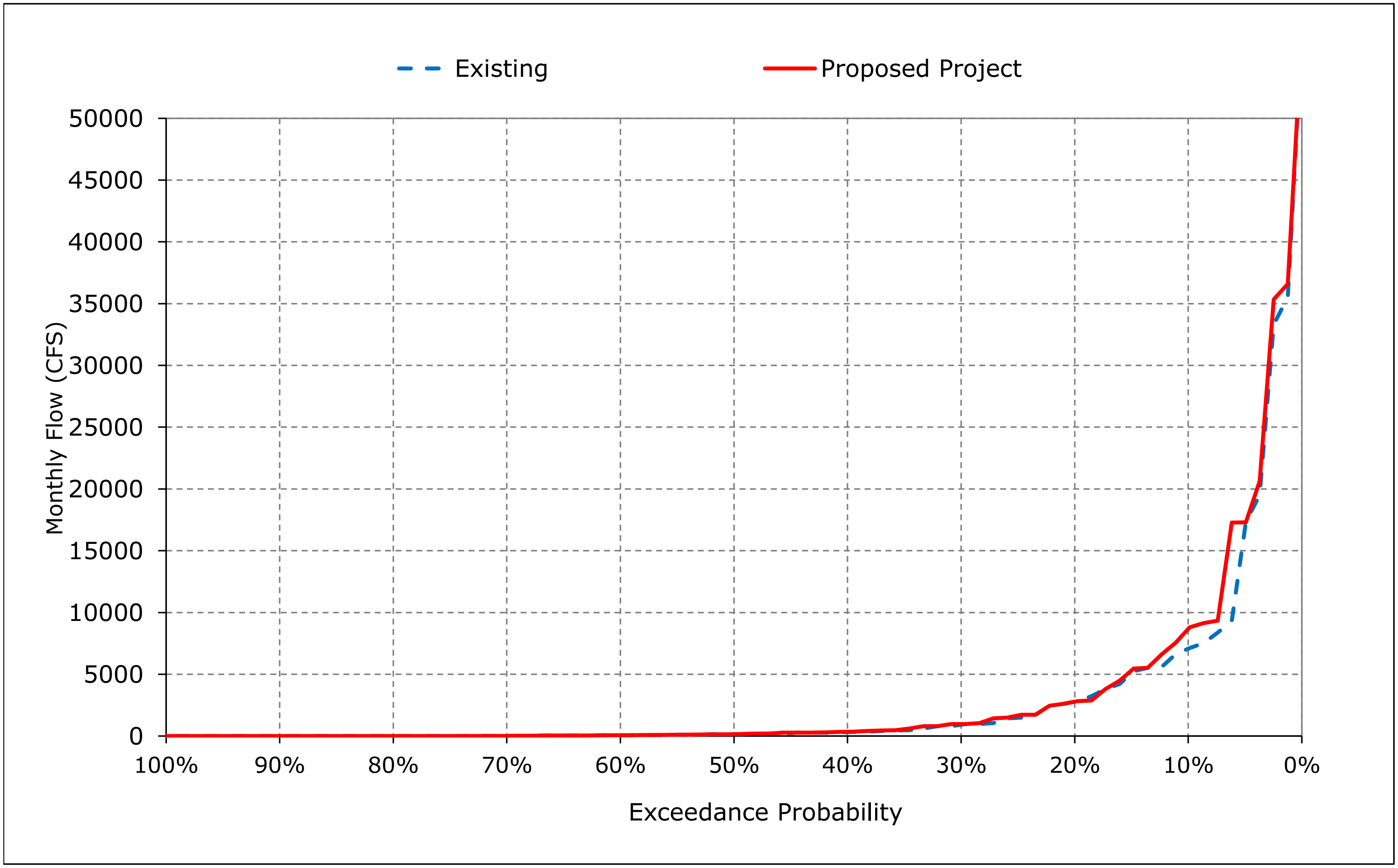


Figure 3-10. Yolo Bypass Flow, January

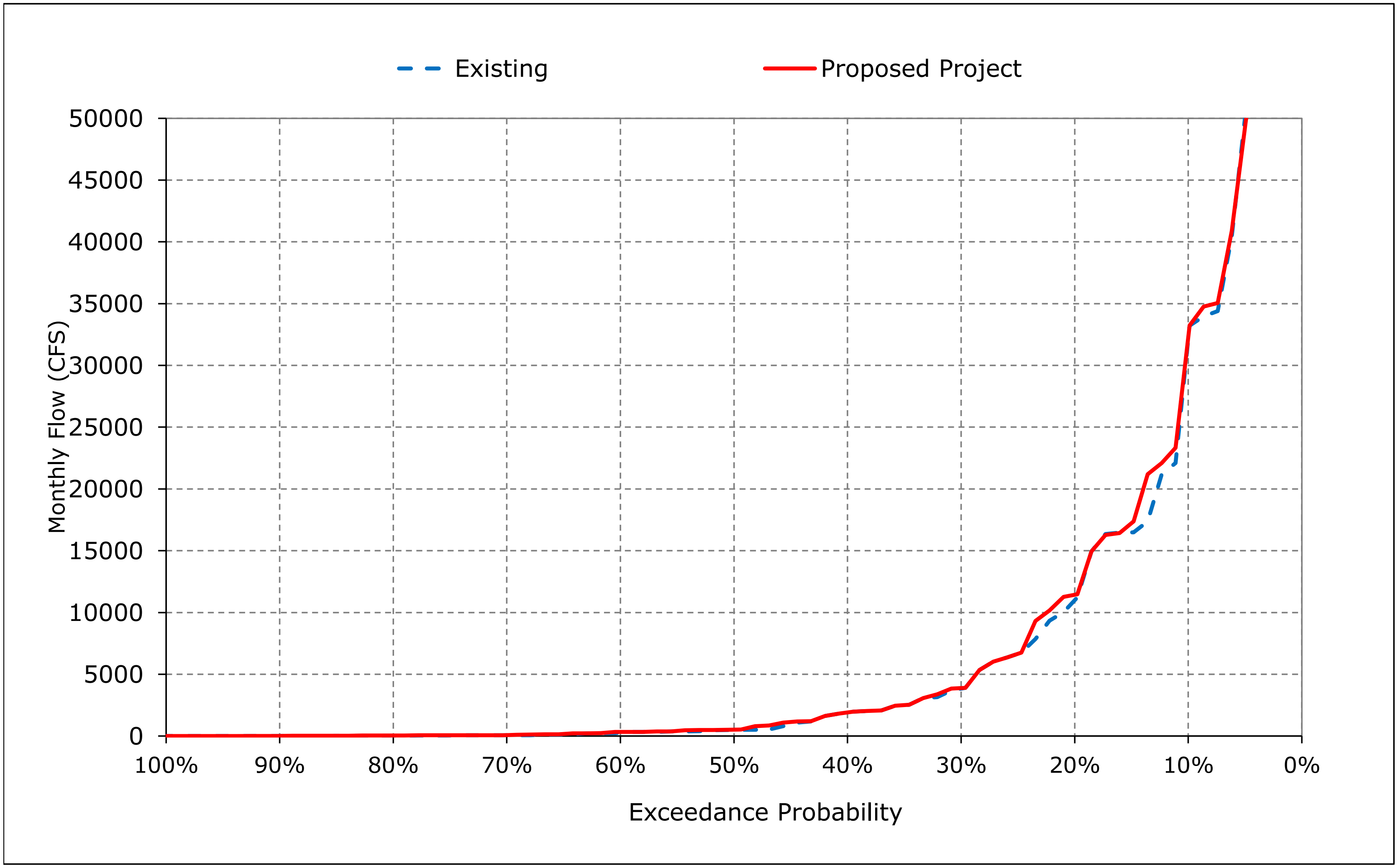


Figure 3-11. Yolo Bypass Flow, February

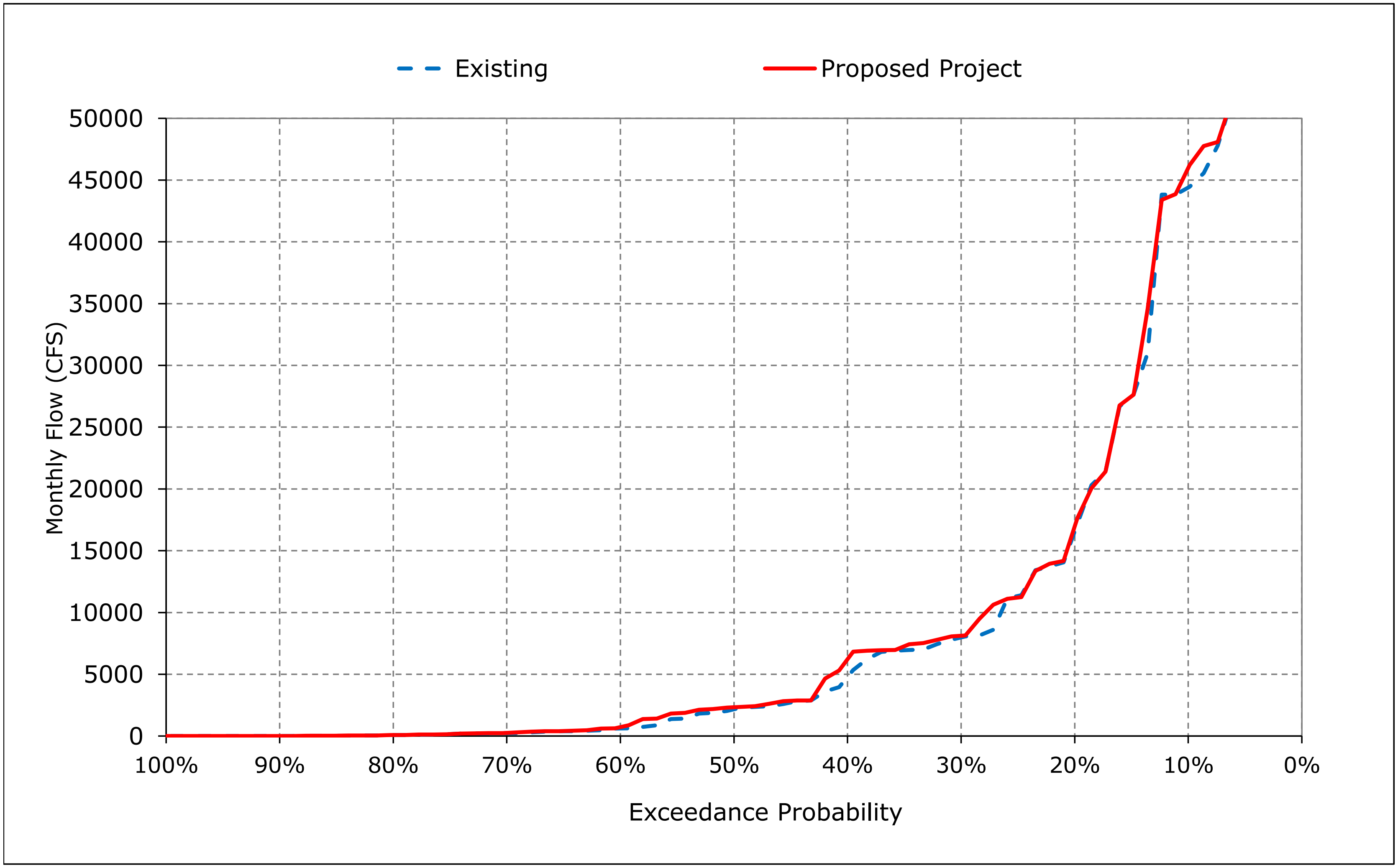


Figure 3-12. Yolo Bypass Flow, March

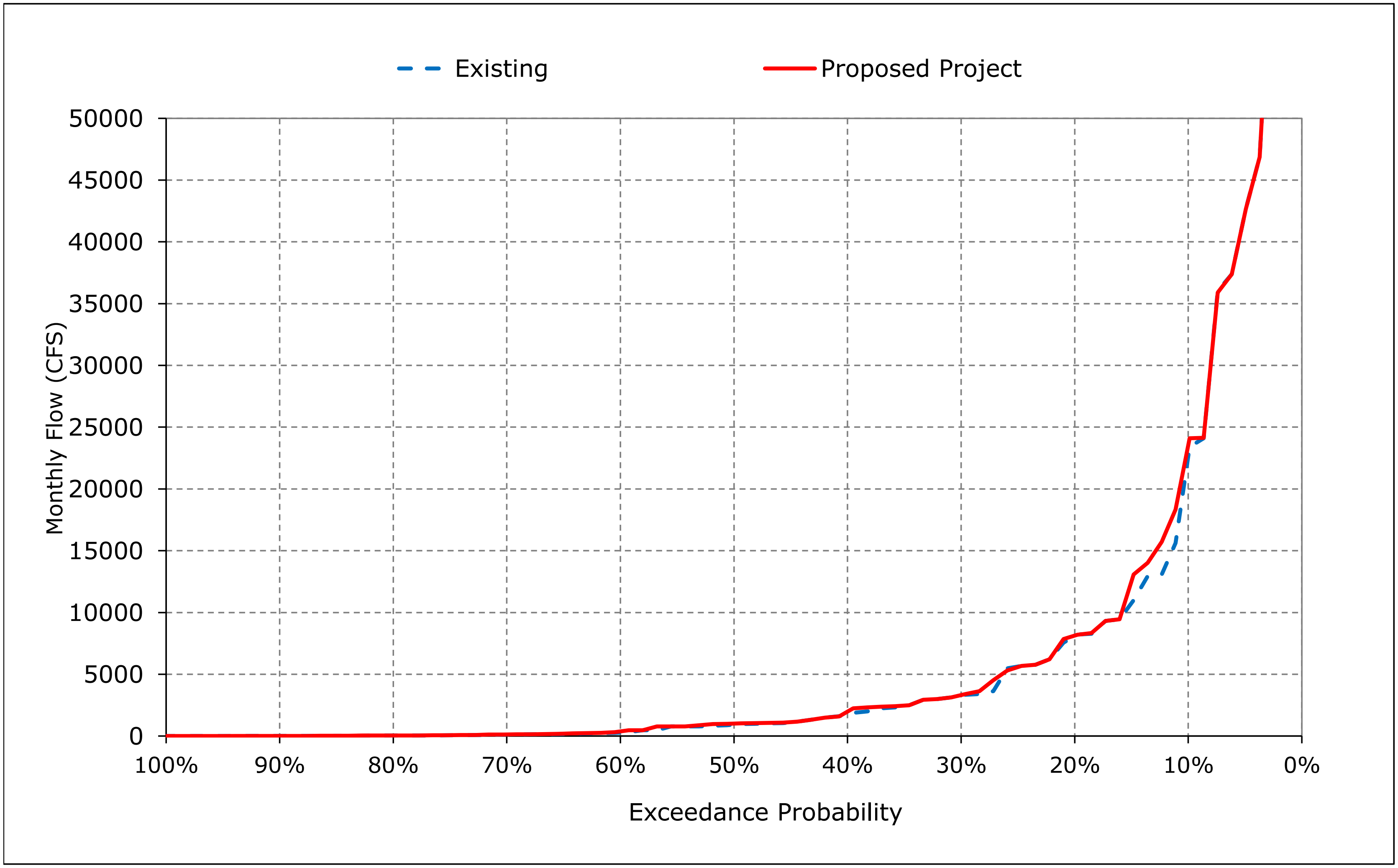


Figure 3-13. Yolo Bypass Flow, April

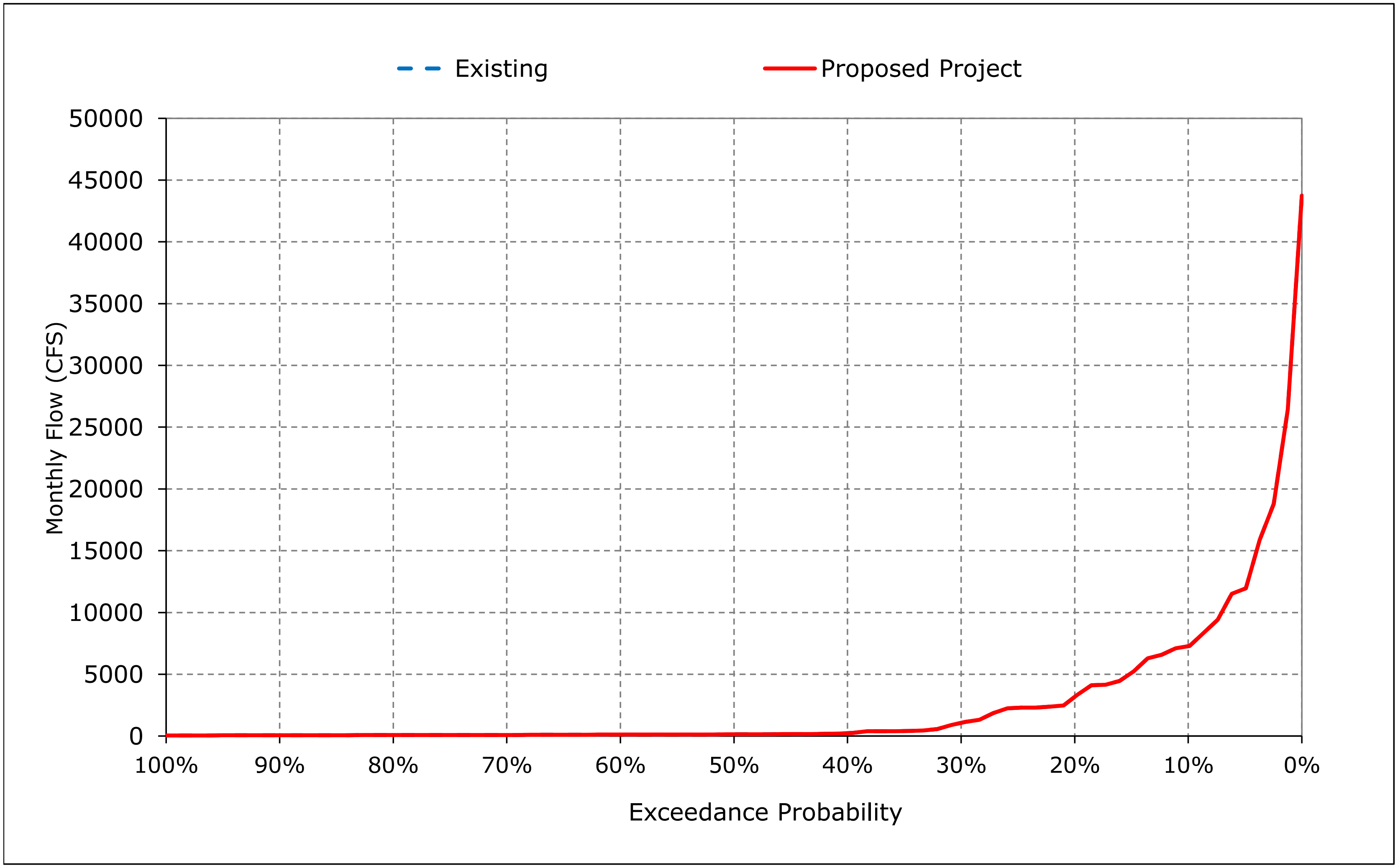


Figure 3-14. Yolo Bypass Flow, May

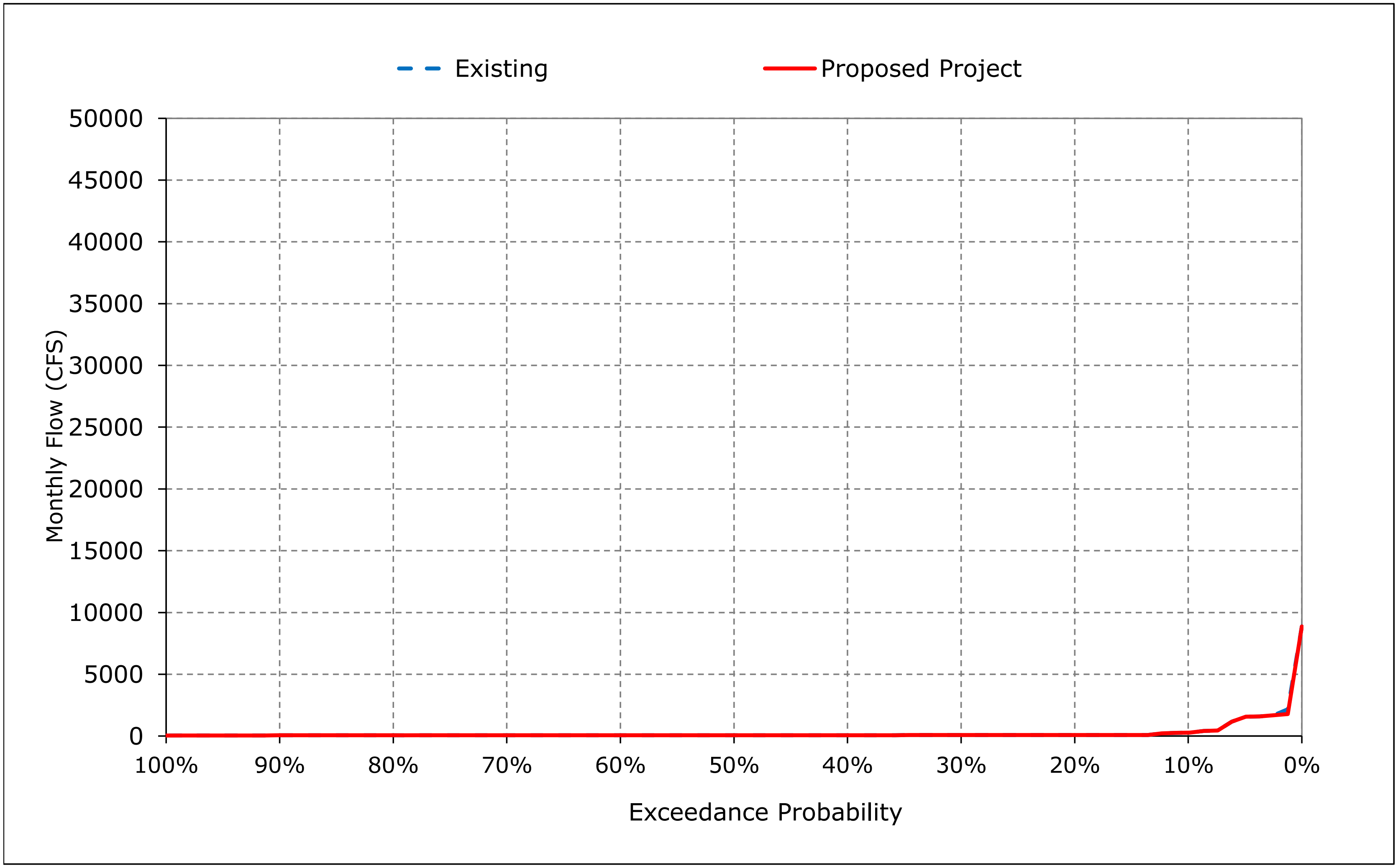


Figure 3-15. Yolo Bypass Flow, June

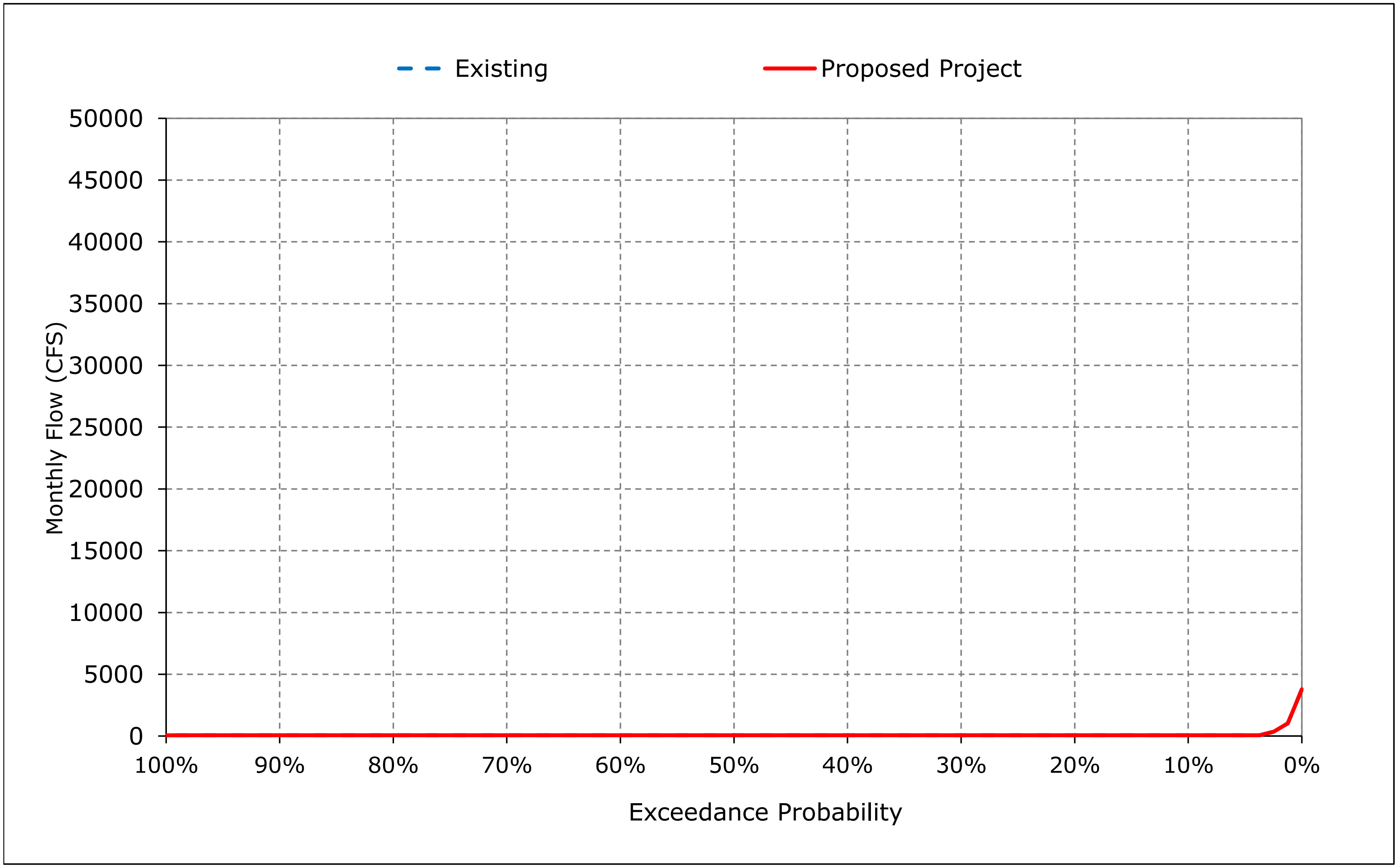


Figure 3-16. Yolo Bypass Flow, July

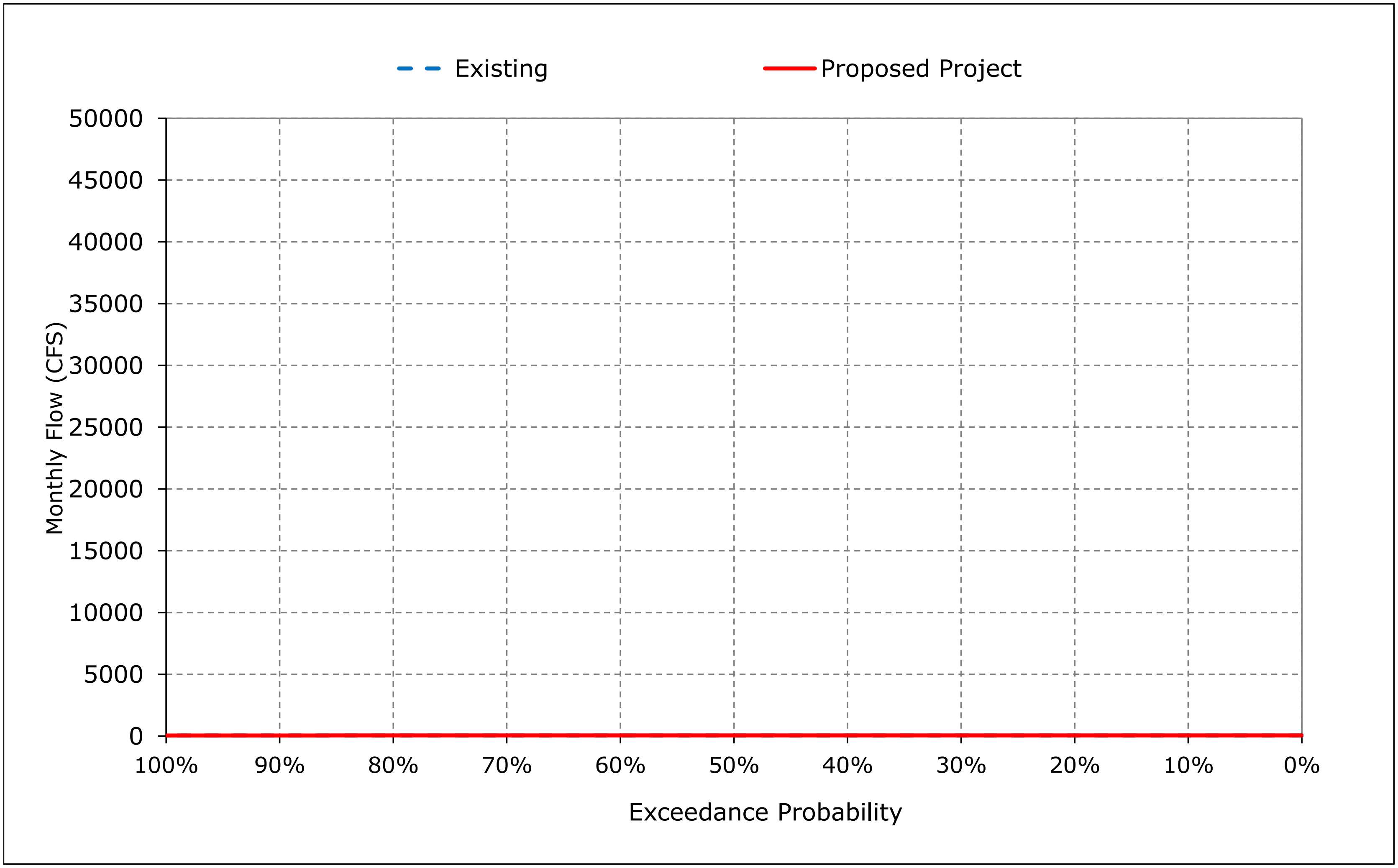


Figure 3-17. Yolo Bypass Flow, August

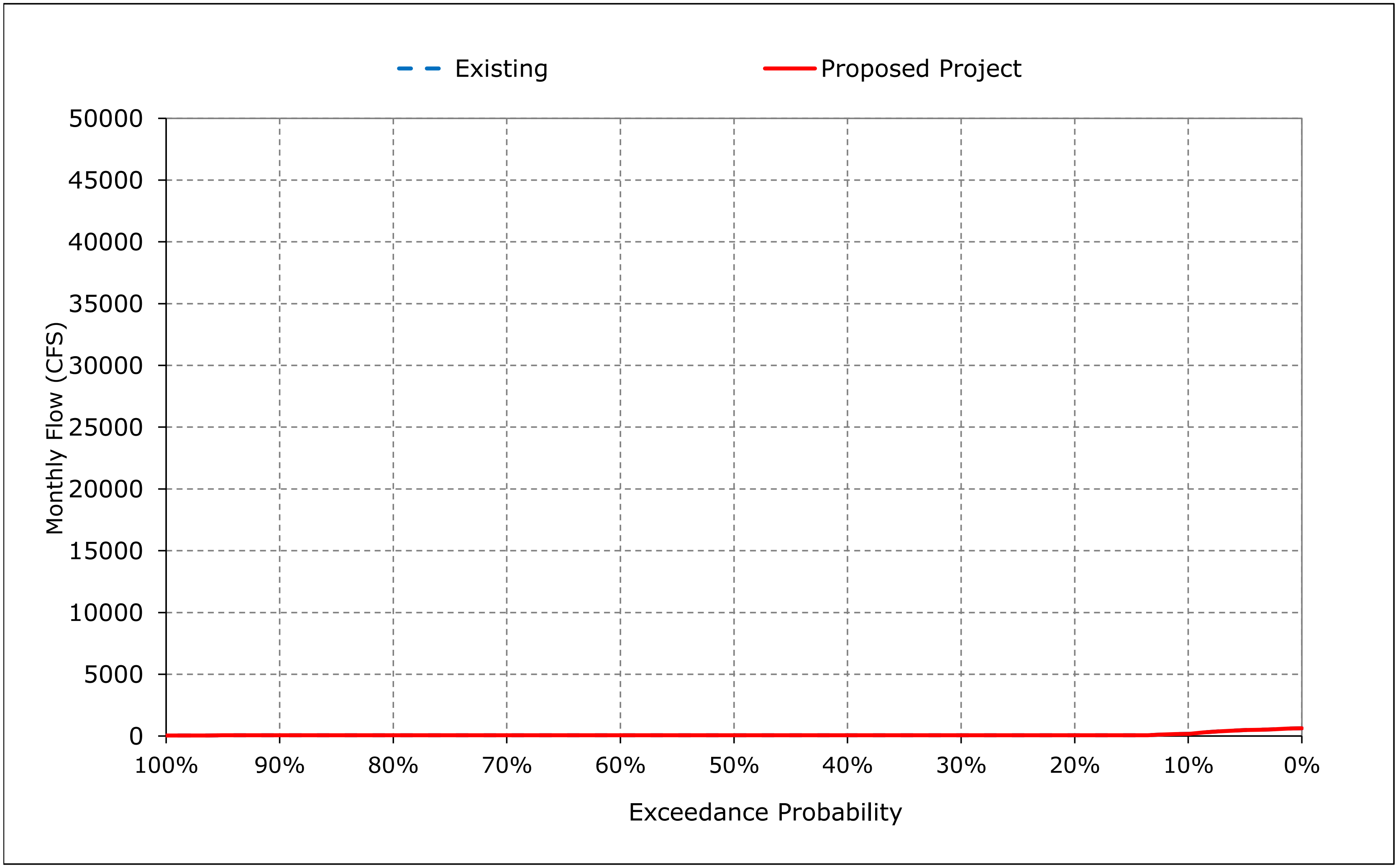


Figure 3-18. Yolo Bypass Flow, September

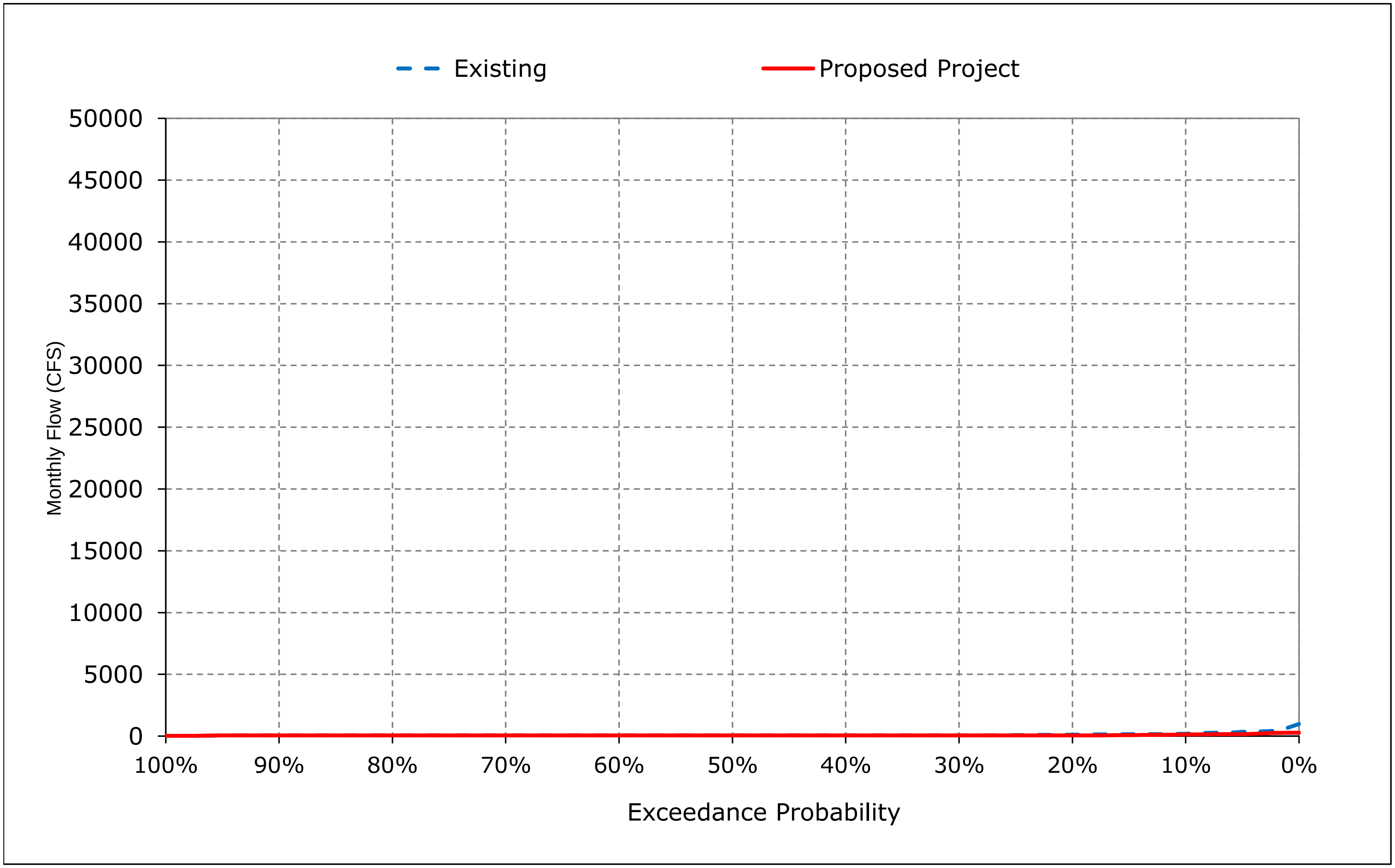


Table 4-1. Sacramento River Flow at Rio Vista, Monthly Flow

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Flow (CFS)											
Probability of Exceedance												
10%	9,140	18,806	52,284	86,457	105,186	73,918	54,112	34,926	20,648	14,280	9,718	24,620
20%	8,138	15,685	29,468	55,667	67,393	52,550	37,257	24,211	11,911	13,237	9,428	23,952
30%	7,537	14,649	18,168	40,343	52,127	35,838	21,850	14,901	8,567	12,292	9,053	14,756
40%	6,476	12,272	14,804	25,624	42,524	30,001	19,665	11,196	8,253	11,254	8,870	13,303
50%	5,940	10,585	12,150	18,372	30,086	22,487	14,597	9,601	7,982	10,683	8,695	8,343
60%	4,923	7,745	10,857	15,373	22,618	17,884	11,737	8,431	7,635	9,608	7,960	6,083
70%	4,401	6,657	9,754	12,155	16,358	15,500	10,094	7,427	6,990	8,871	5,327	5,285
80%	4,000	5,787	7,341	10,446	13,659	12,316	8,529	7,028	6,450	7,752	4,466	4,822
90%	3,039	4,471	6,370	9,425	11,071	8,460	7,156	5,787	6,145	4,765	3,992	3,521
Long Term												
Full Simulation Period[a]	6,443	12,240	21,031	35,843	45,193	35,436	22,760	15,220	10,618	10,157	7,442	12,045
Water Year Types[b,c]												
Wet (32%)	8,294	17,532	38,344	69,721	81,768	64,062	40,542	26,583	16,592	11,403	9,239	22,778
Above Normal (15%)	6,029	13,013	19,036	38,894	50,702	43,650	24,065	17,363	10,171	12,539	9,314	13,569
Below Normal (17%)	5,727	10,062	13,889	19,160	30,527	19,416	15,992	10,661	8,060	11,839	8,755	7,242
Dry (22%)	5,567	9,566	11,619	13,948	21,093	17,438	11,327	7,586	7,664	9,106	4,779	4,991
Critical (15%)	4,995	6,556	7,962	11,698	13,697	10,887	7,974	5,223	5,535	4,689	4,142	3,451

Proposed Project

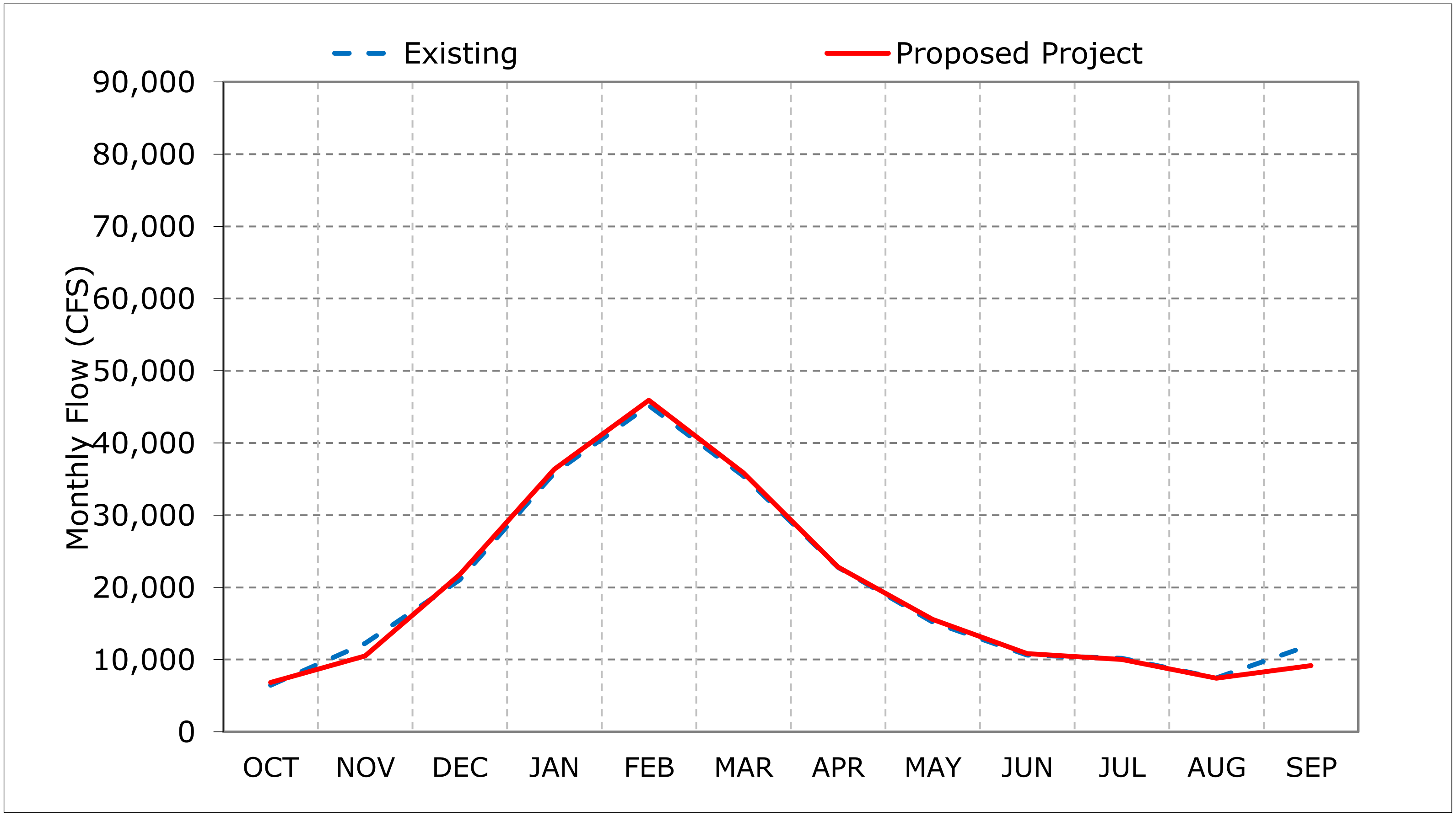
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Flow (CFS)											
Probability of Exceedance												
10%	9,937	17,954	56,836	86,691	105,510	76,139	54,110	34,923	20,636	14,174	9,685	14,502
20%	9,027	10,679	31,820	57,625	67,442	52,546	37,257	24,595	11,911	13,667	9,395	14,071
30%	7,780	9,424	19,243	40,753	54,662	38,414	21,618	14,898	8,754	12,506	9,156	13,611
40%	6,922	8,747	15,330	26,124	45,380	29,980	19,762	11,191	8,454	11,067	8,881	12,676
50%	6,264	8,425	11,736	20,661	30,078	22,481	14,582	10,449	8,321	10,295	8,392	8,418
60%	5,265	7,142	10,934	15,659	22,930	18,285	11,446	9,443	8,069	9,203	7,519	5,894
70%	4,323	6,598	9,655	12,166	17,577	15,546	10,031	8,270	7,478	8,558	5,467	5,180
80%	4,095	5,593	8,094	9,957	14,129	12,099	8,872	7,453	6,813	7,127	4,708	4,842
90%	3,283	4,334	6,288	9,119	11,419	8,804	7,457	6,288	5,965	4,816	4,226	3,564
Long Term												
Full Simulation Period[a]	6,829	10,495	21,780	36,351	45,915	35,853	22,820	15,570	10,834	10,021	7,439	9,182
Water Year Types[b,c]												
Wet (32%)	8,724	15,248	40,463	70,723	82,367	64,279	40,515	26,564	16,652	11,311	9,182	13,574
Above Normal (15%)	6,635	10,705	19,188	39,908	51,897	45,029	24,057	17,449	10,693	12,587	9,262	14,076
Below Normal (17%)	6,244	8,481	13,946	20,111	32,366	19,680	16,041	11,334	8,638	11,593	8,551	7,079
Dry (22%)	5,659	8,121	11,850	13,778	21,098	17,770	11,497	8,484	7,795	8,628	4,851	4,965
Critical (15%)	5,353	5,894	7,928	11,129	13,987	11,084	8,138	5,445	5,488	4,915	4,426	3,550

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Flow (CFS)											
Probability of Exceedance												
10%	797	**-852**	4,552	234	324	2,222	**-1**	**-3**	**-12**	**-106**	**-33**	**-10,118**
20%	890	**-5,006**	2,353	1,958	49	**-5**	**0**	384	**0**	430	**-32**	**-9,881**
30%	243	**-5,225**	1,075	410	2,536	2,576	**-233**	**-3**	187	214	103	**-1,145**
40%	446	**-3,525**	526	500	2,856	**-21**	98	**-5**	201	**-187**	11	**-628**
50%	324	**-2,159**	**-414**	2,289	**-8**	**-6**	**-15**	848	339	**-388**	**-304**	75
60%	342	**-602**	77	285	312	401	**-291**	1,012	434	**-405**	**-440**	**-189**
70%	**-78**	**-59**	**-99**	11	1,219	46	**-62**	842	488	**-314**	141	**-105**
80%	95	**-193**	753	**-489**	470	**-217**	343	425	364	**-625**	242	21
90%	243	**-137**	**-83**	**-306**	348	344	301	501	**-180**	52	234	42
Long Term												
Full Simulation Period[a]	386	**-1,746**	750	508	722	417	60	351	216	**-136**	**-3**	**-2,863**
Water Year Types[b,c]												
Wet (32%)	430	**-2,283**	2,119	1,002	599	217	**-27**	**-20**	59	**-91**	**-57**	**-9,203**
Above Normal (15%)	607	**-2,307**	151	1,015	1,195	1,379	**-8**	86	522	48	**-52**	507
Below Normal (17%)	517	**-1,581**	57	950	1,839	264	49	672	578	**-246**	**-203**	**-162**
Dry (22%)	93	**-1,445**	231	**-170**	5	331	170	898	131	**-478**	73	**-27**
Critical (15%)	358	**-663**	**-33**	**-569**	290	197	164	223	**-47**	226	284	99

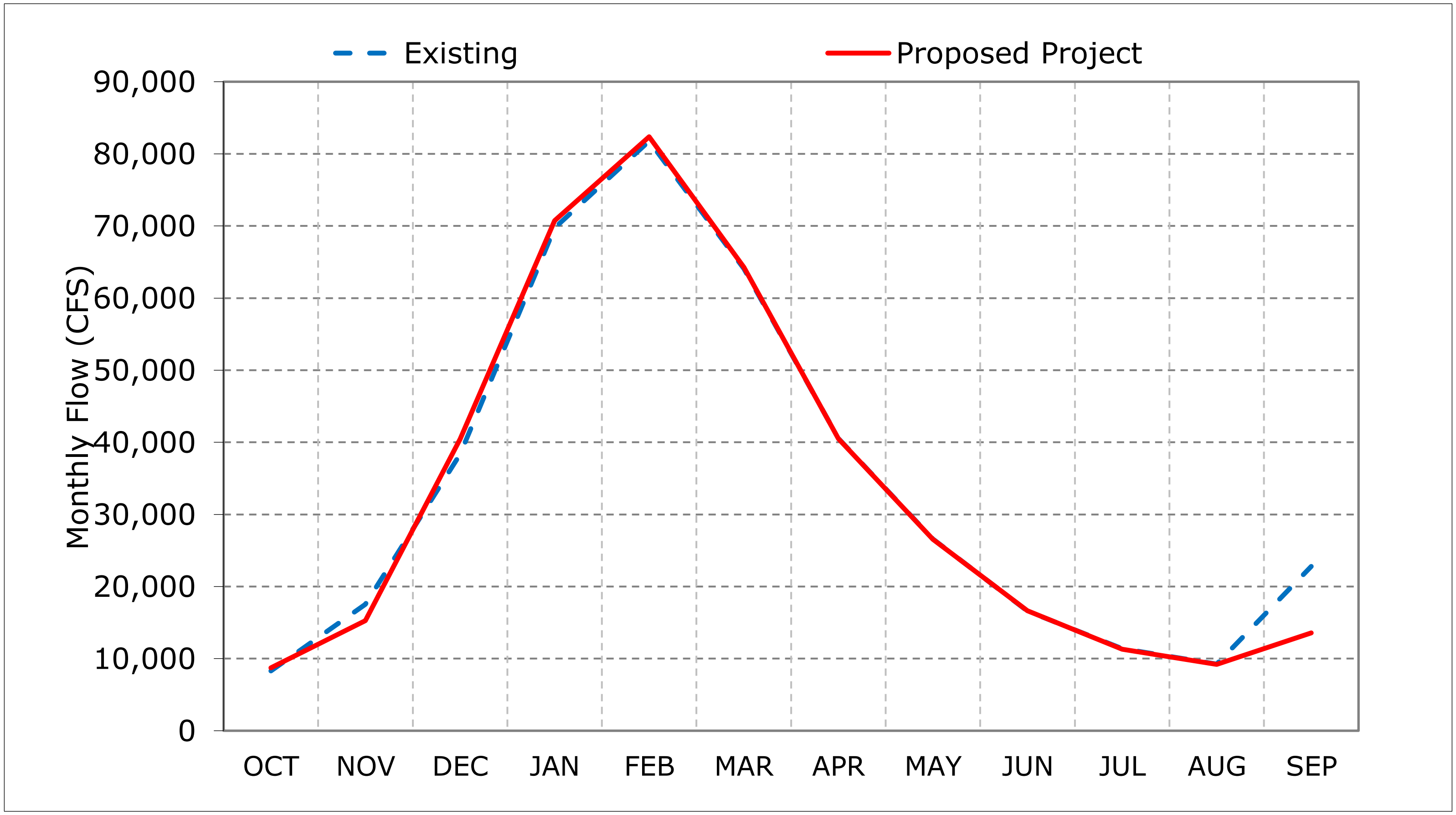
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.

Figure 4-1. Sacramento River Flow at Rio Vista, Long-Term Average Flow



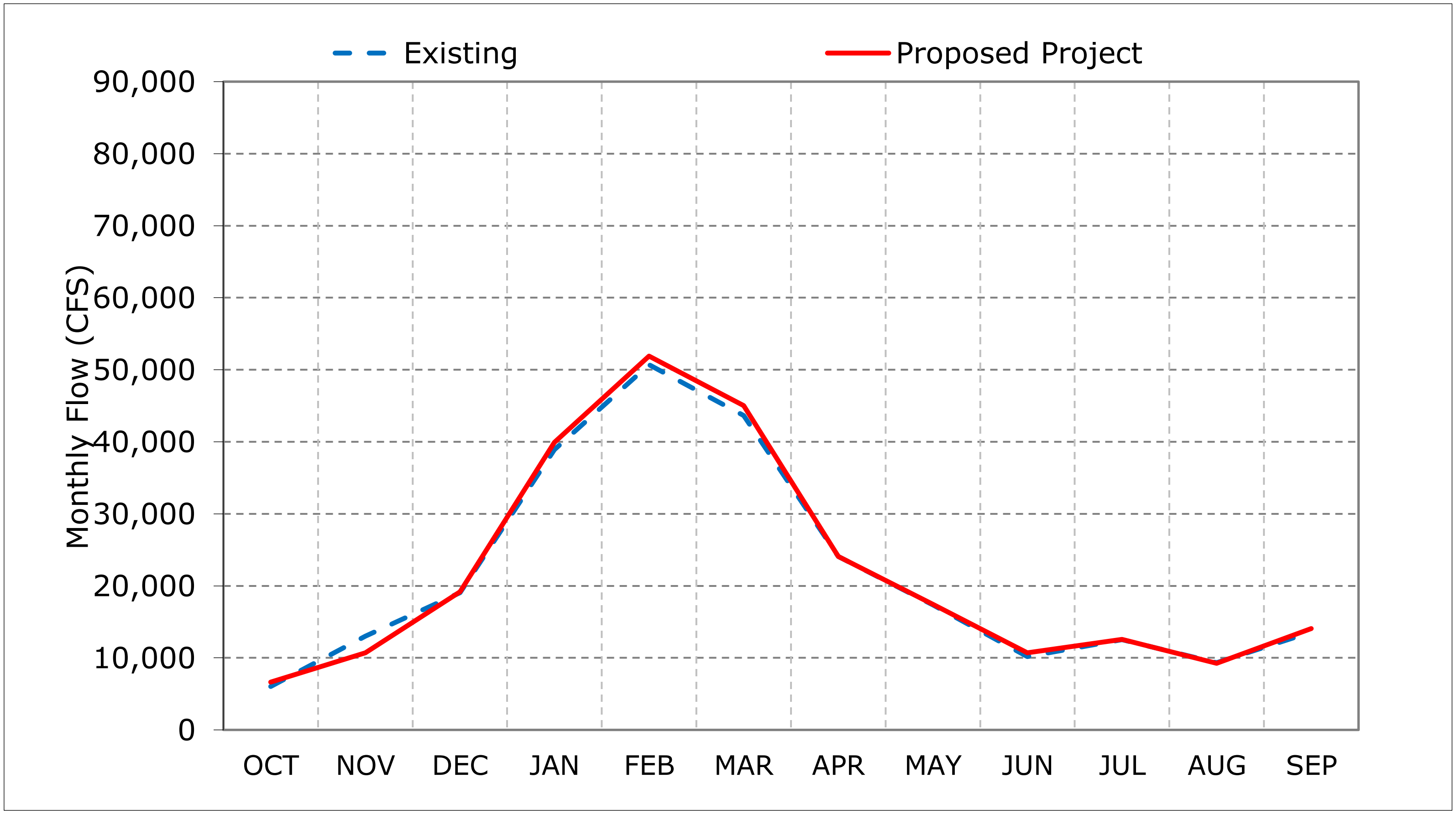
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 4-2. Sacramento River Flow at Rio Vista, Wet Year Average Flow



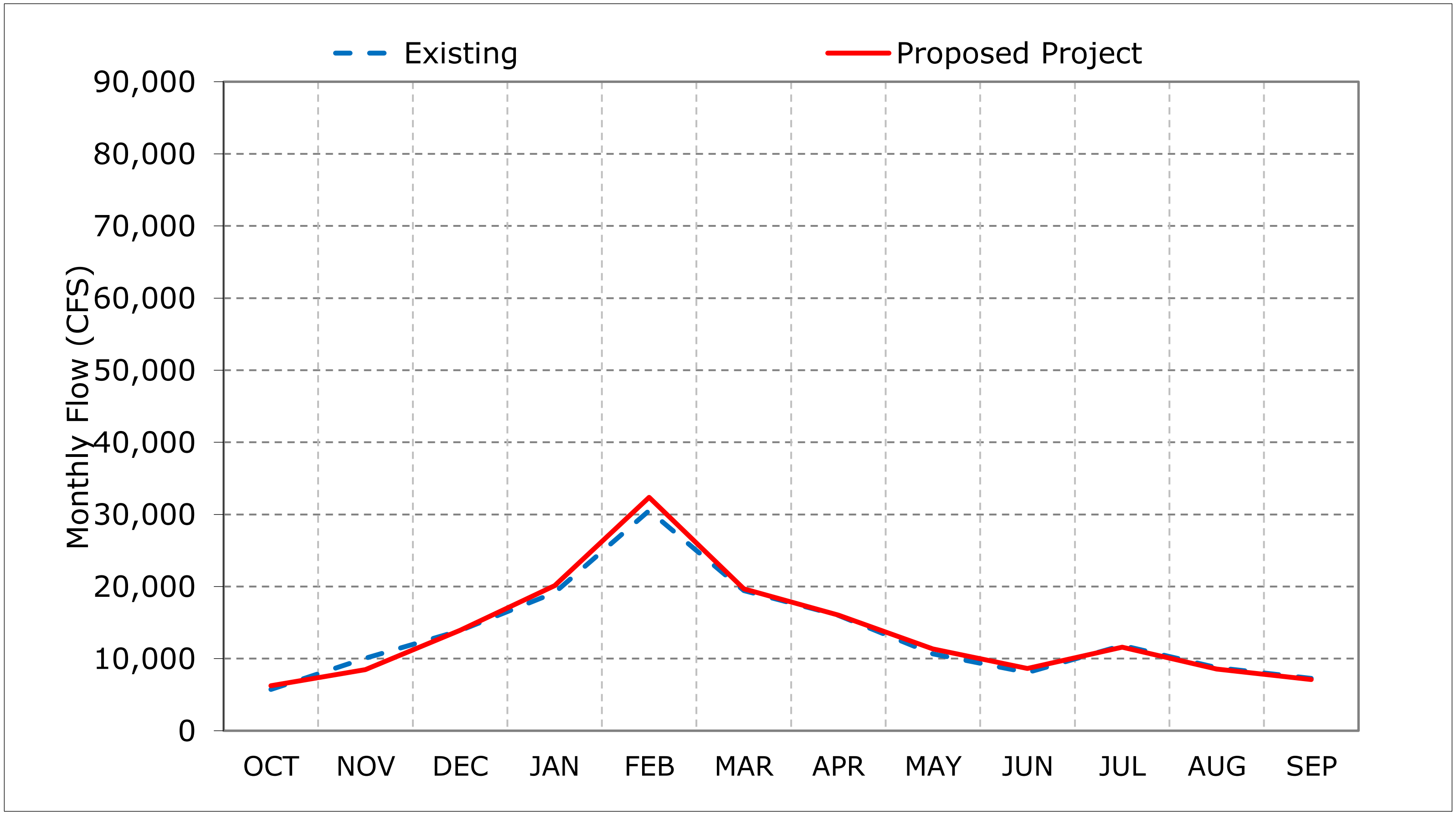
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 4-3. Sacramento River Flow at Rio Vista, Above Normal Year Average Flow



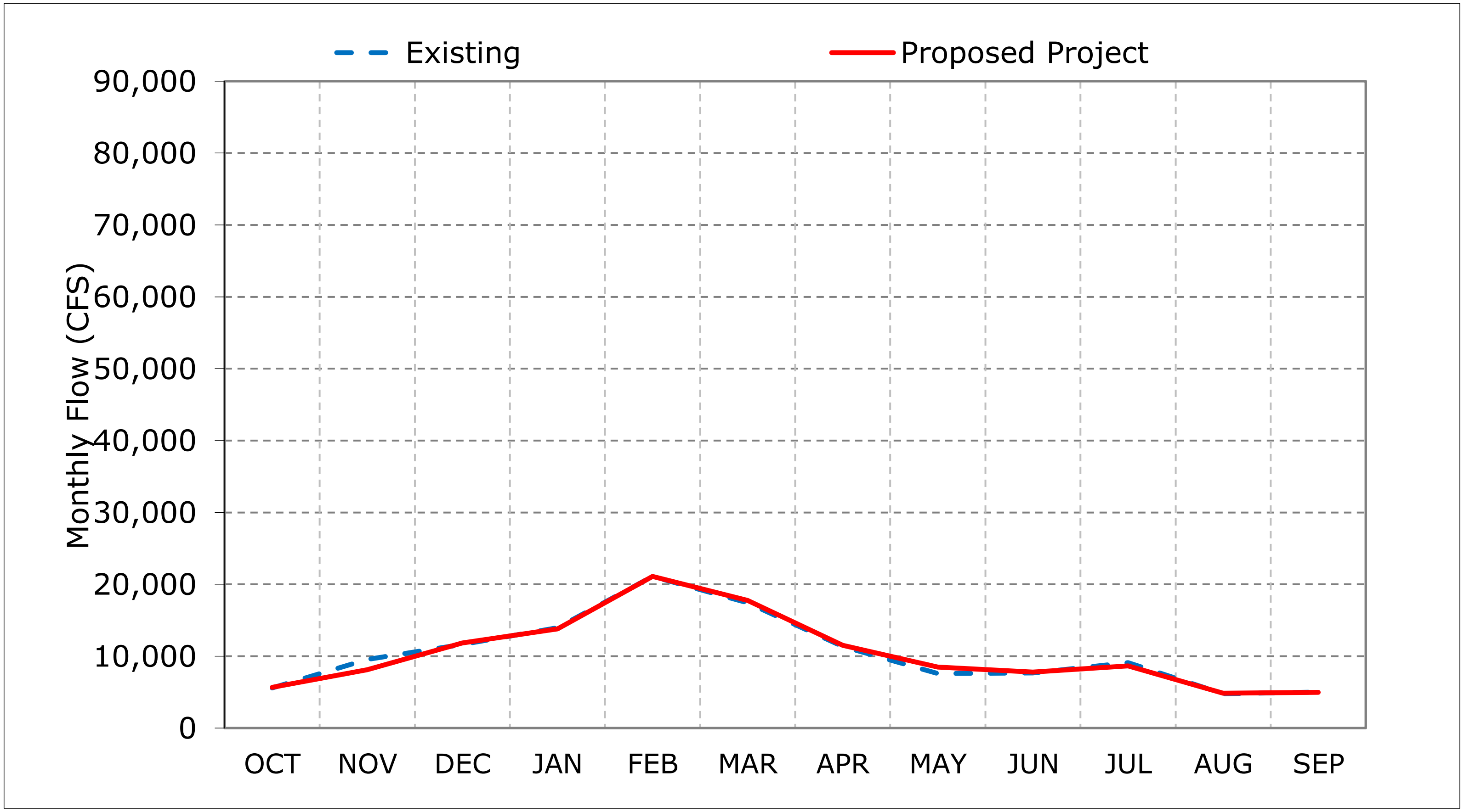
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 4-4. Sacramento River Flow at Rio Vista, Below Normal Year Average Flow



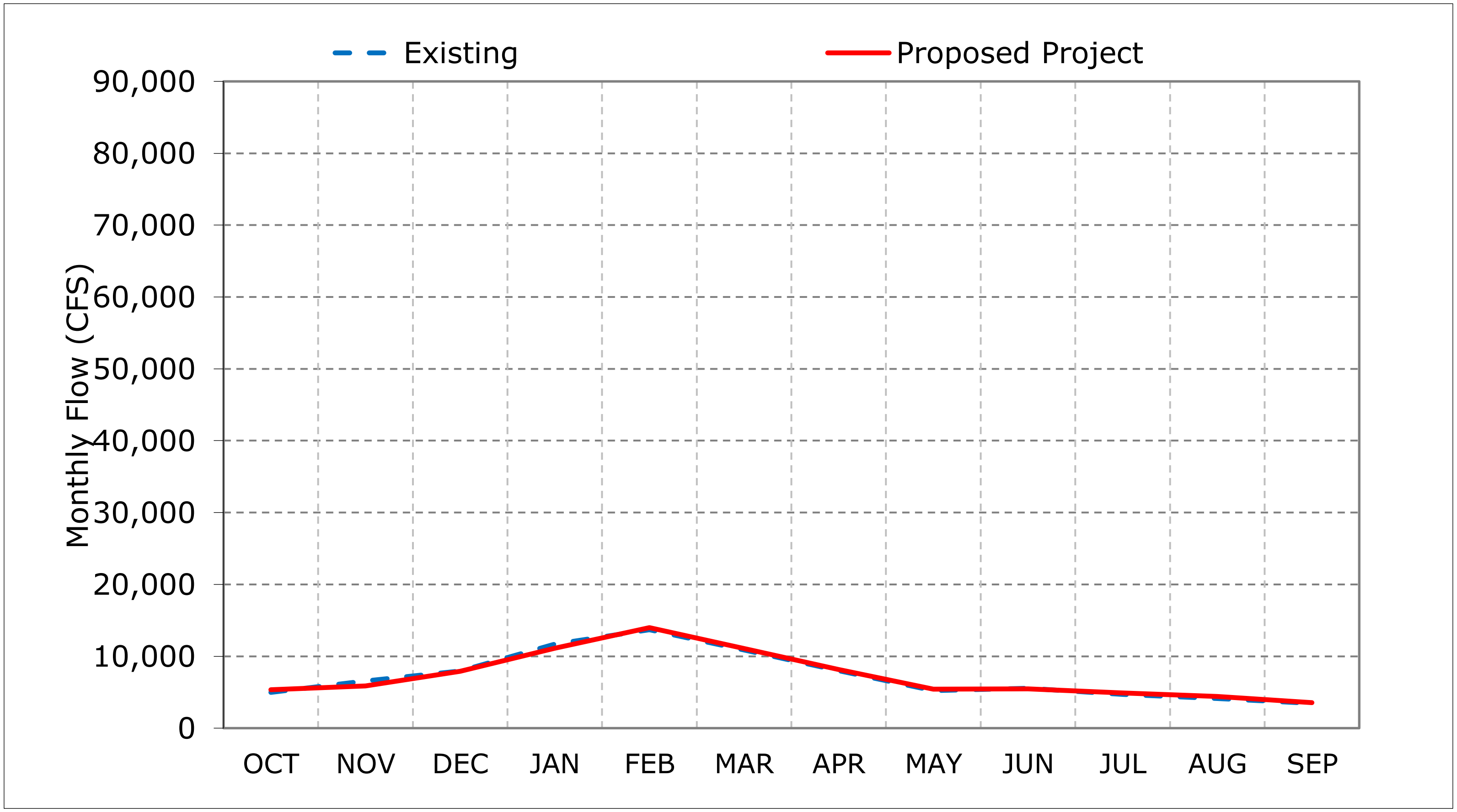
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 4-5. Sacramento River Flow at Rio Vista, Dry Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 4-6. Sacramento River Flow at Rio Vista, Critical Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 4-7. Sacramento River Flow at Rio Vista, October

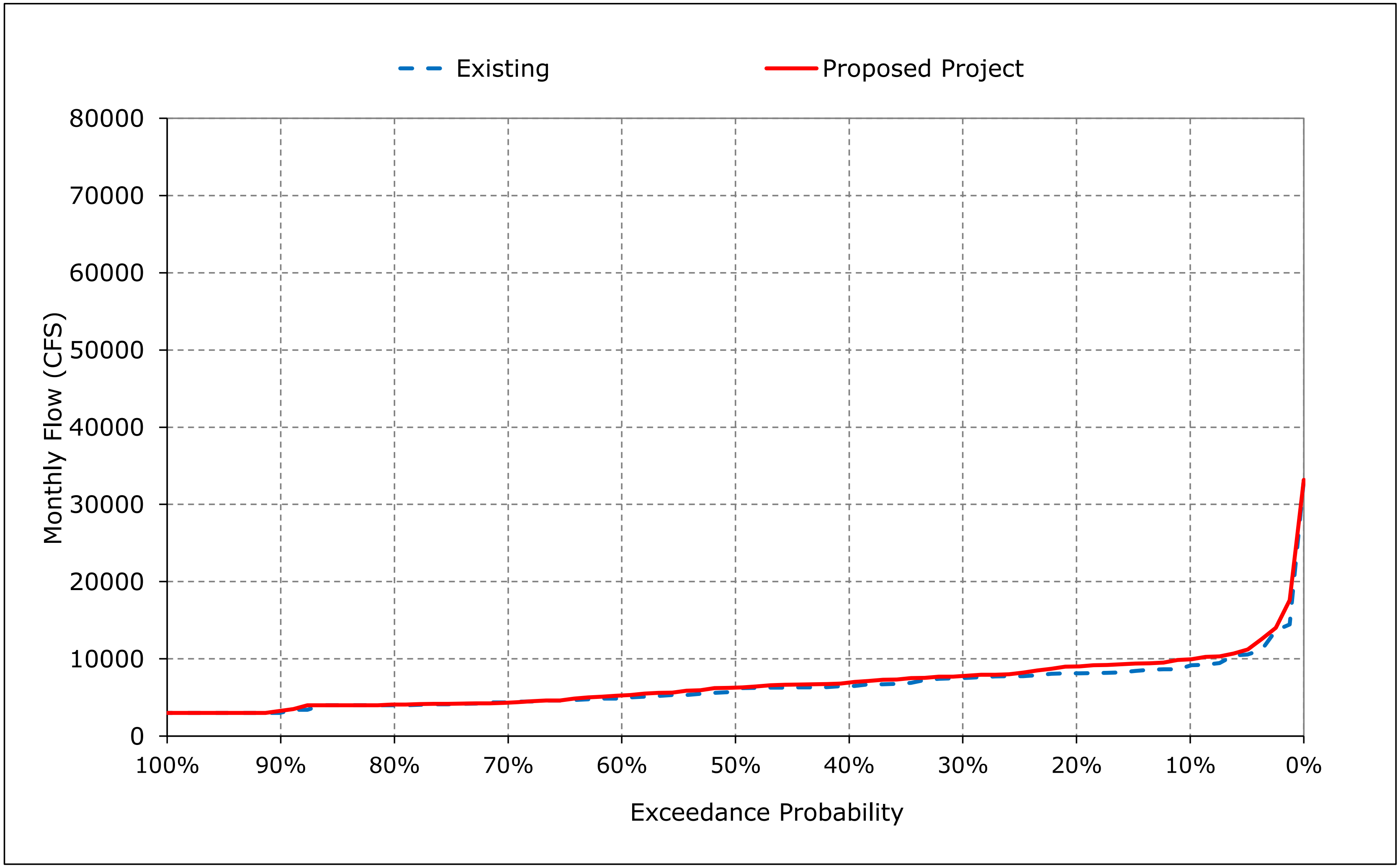


Figure 4-8. Sacramento River Flow at Rio Vista, November

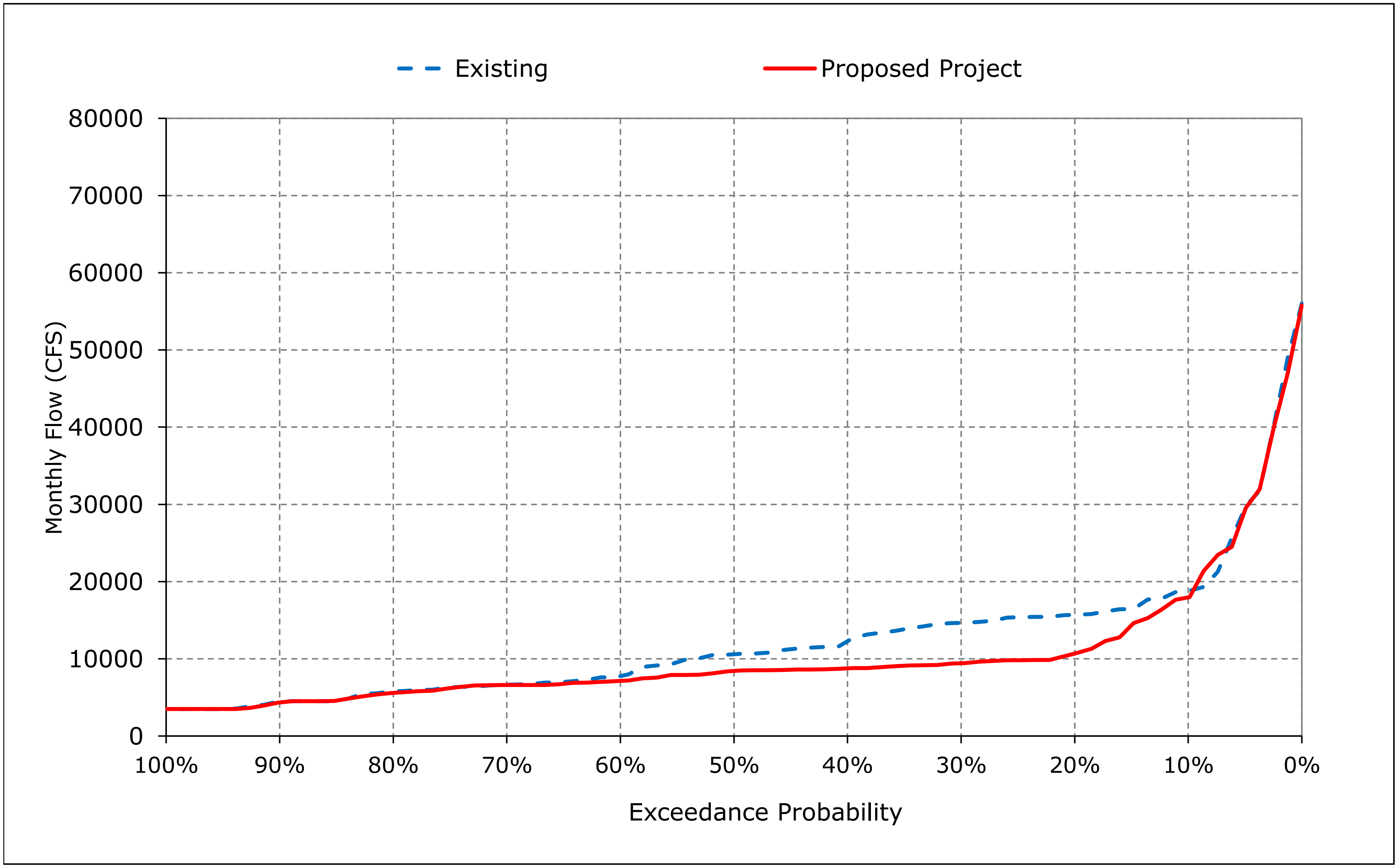


Figure 4-9. Sacramento River Flow at Rio Vista, December

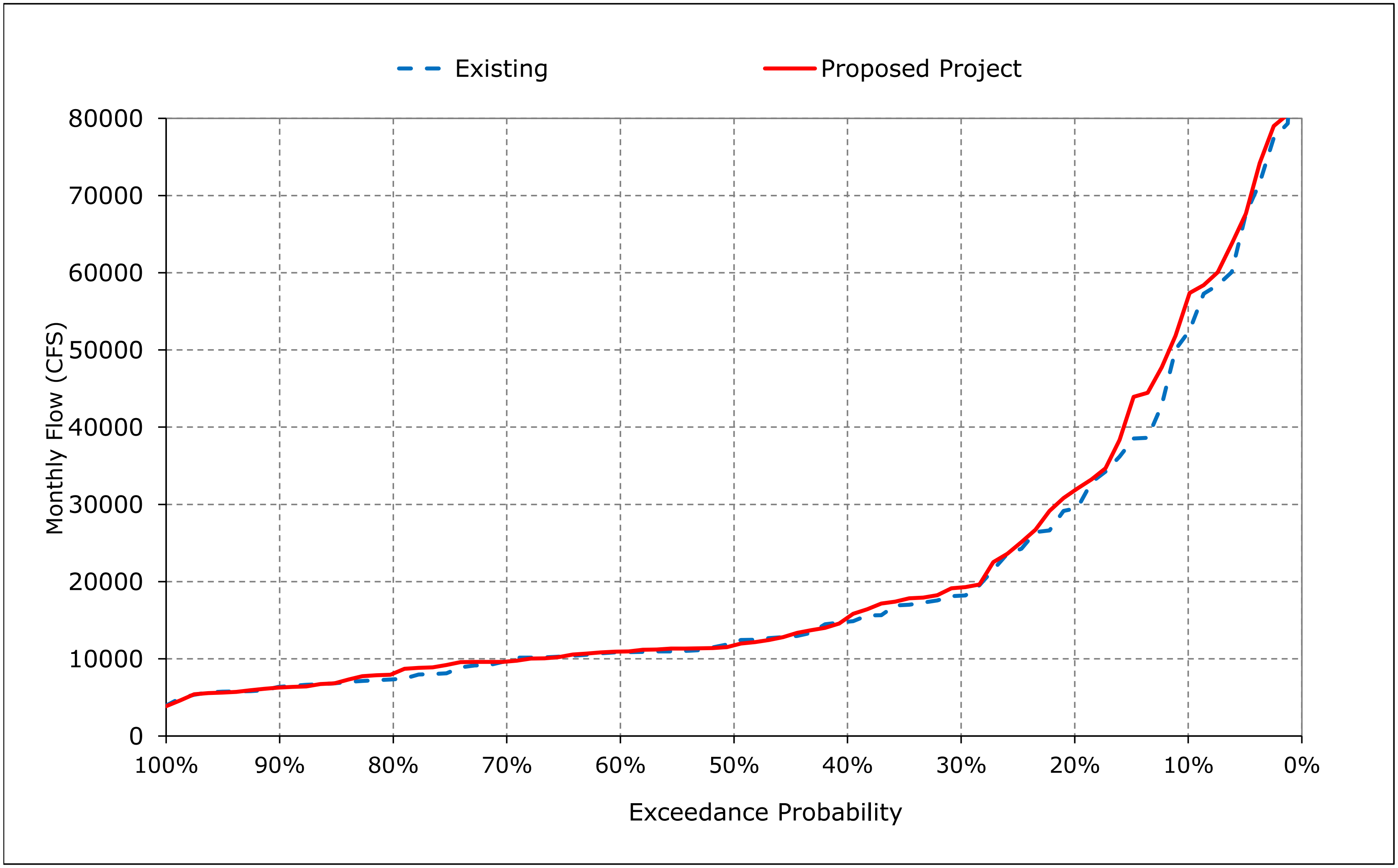


Figure 4-10. Sacramento River Flow at Rio Vista, January

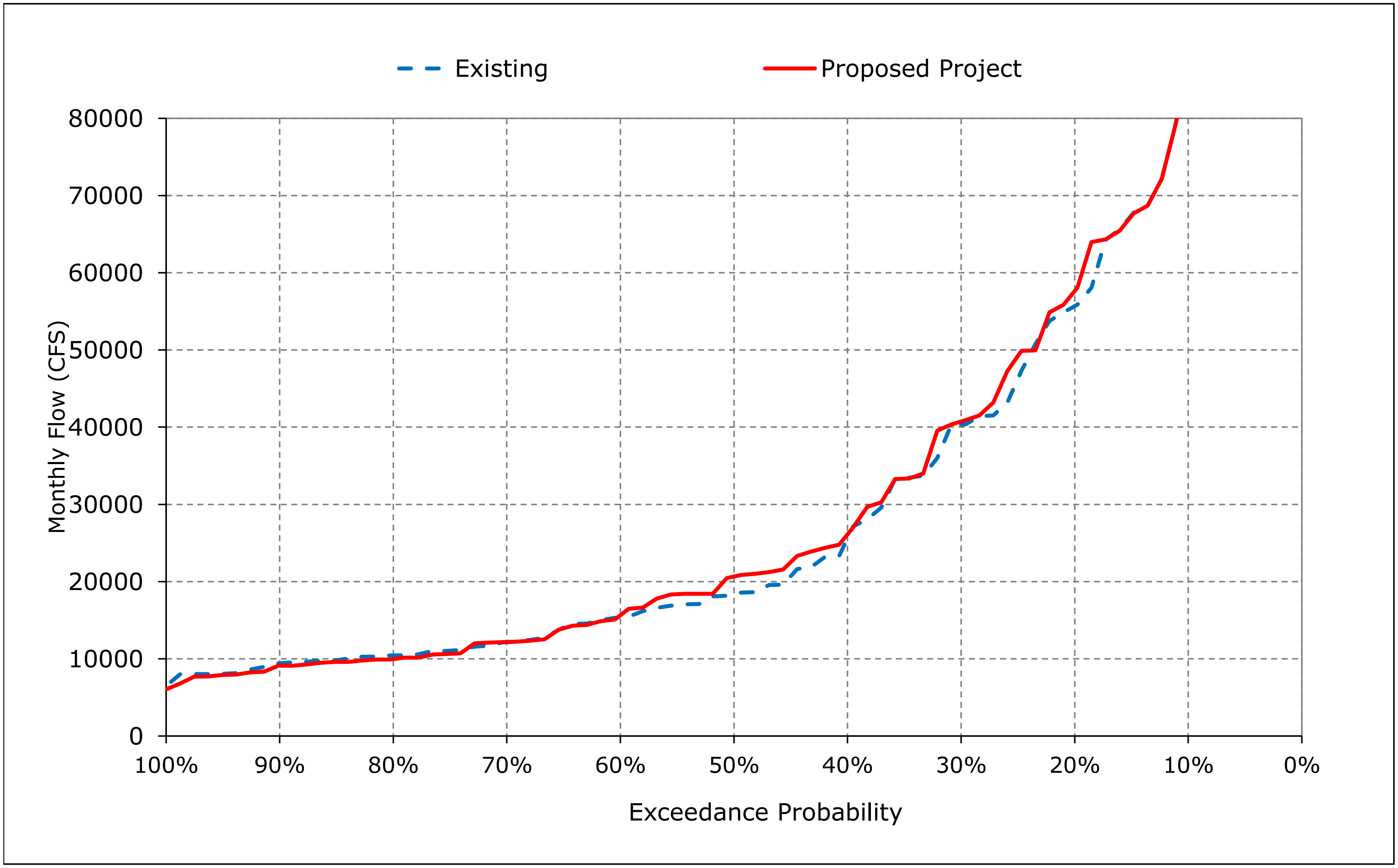


Figure 4-11. Sacramento River Flow at Rio Vista, February

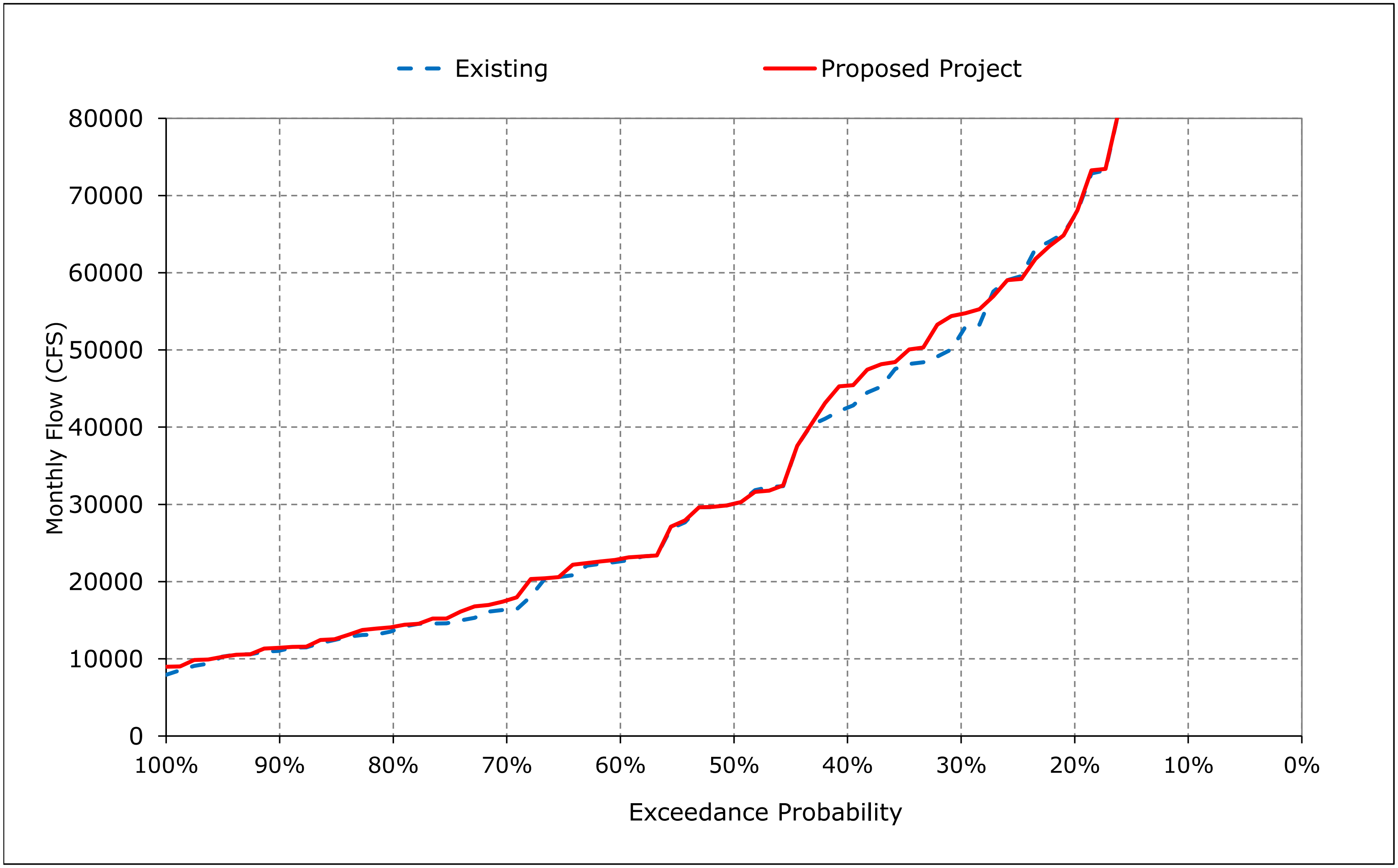


Figure 4-12. Sacramento River Flow at Rio Vista, March

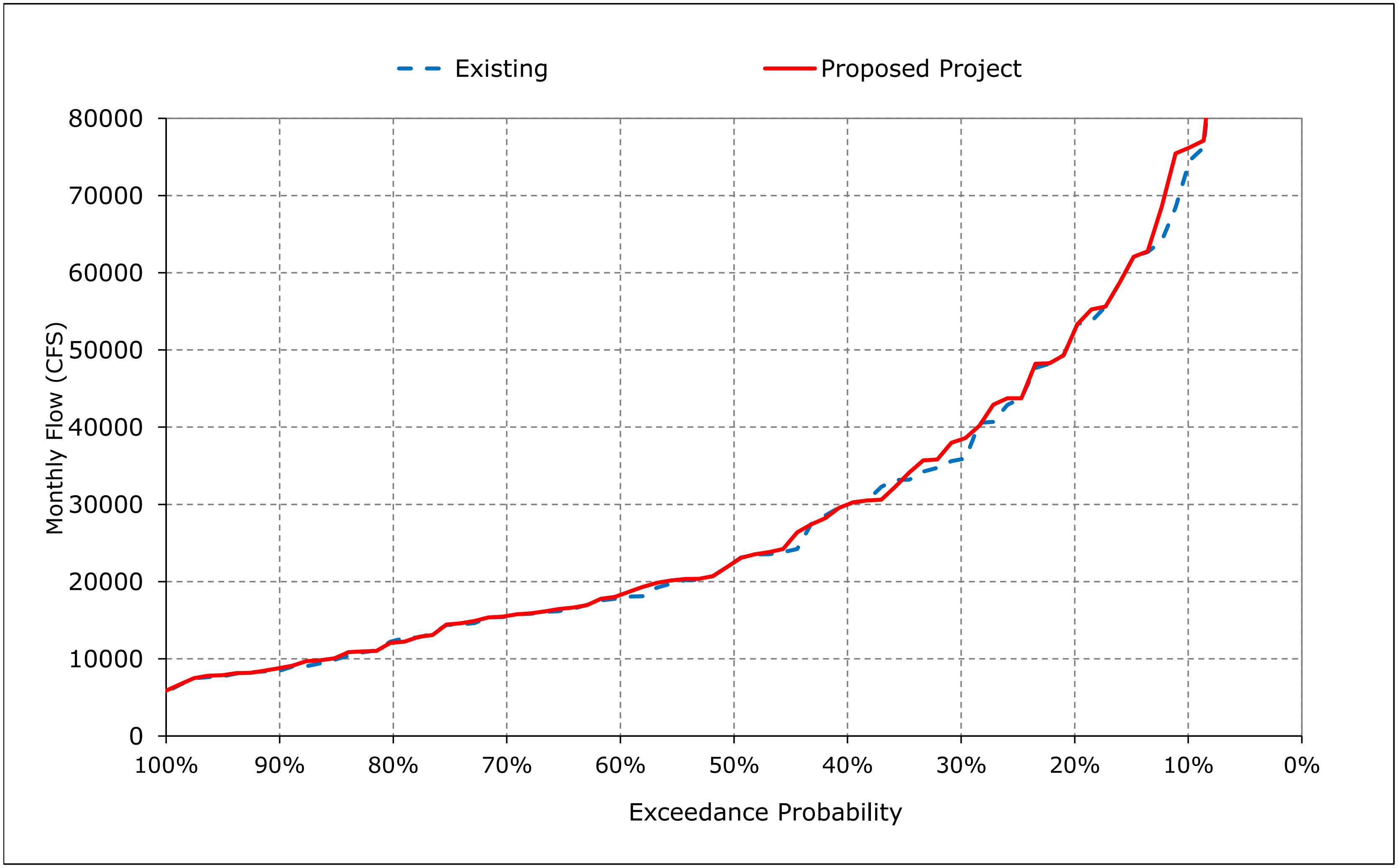


Figure 4-13. Sacramento River Flow at Rio Vista, April

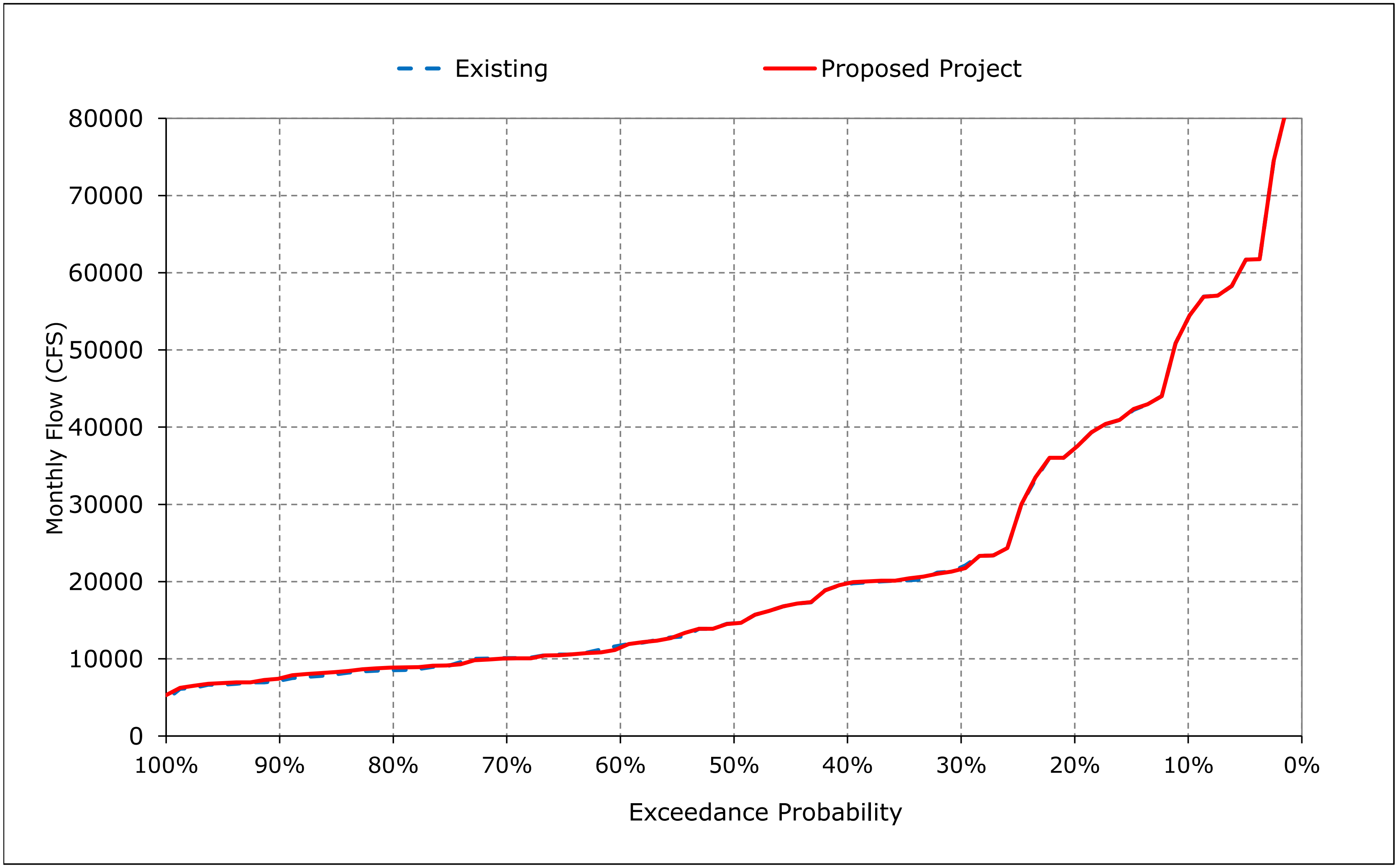


Figure 4-14. Sacramento River Flow at Rio Vista, May

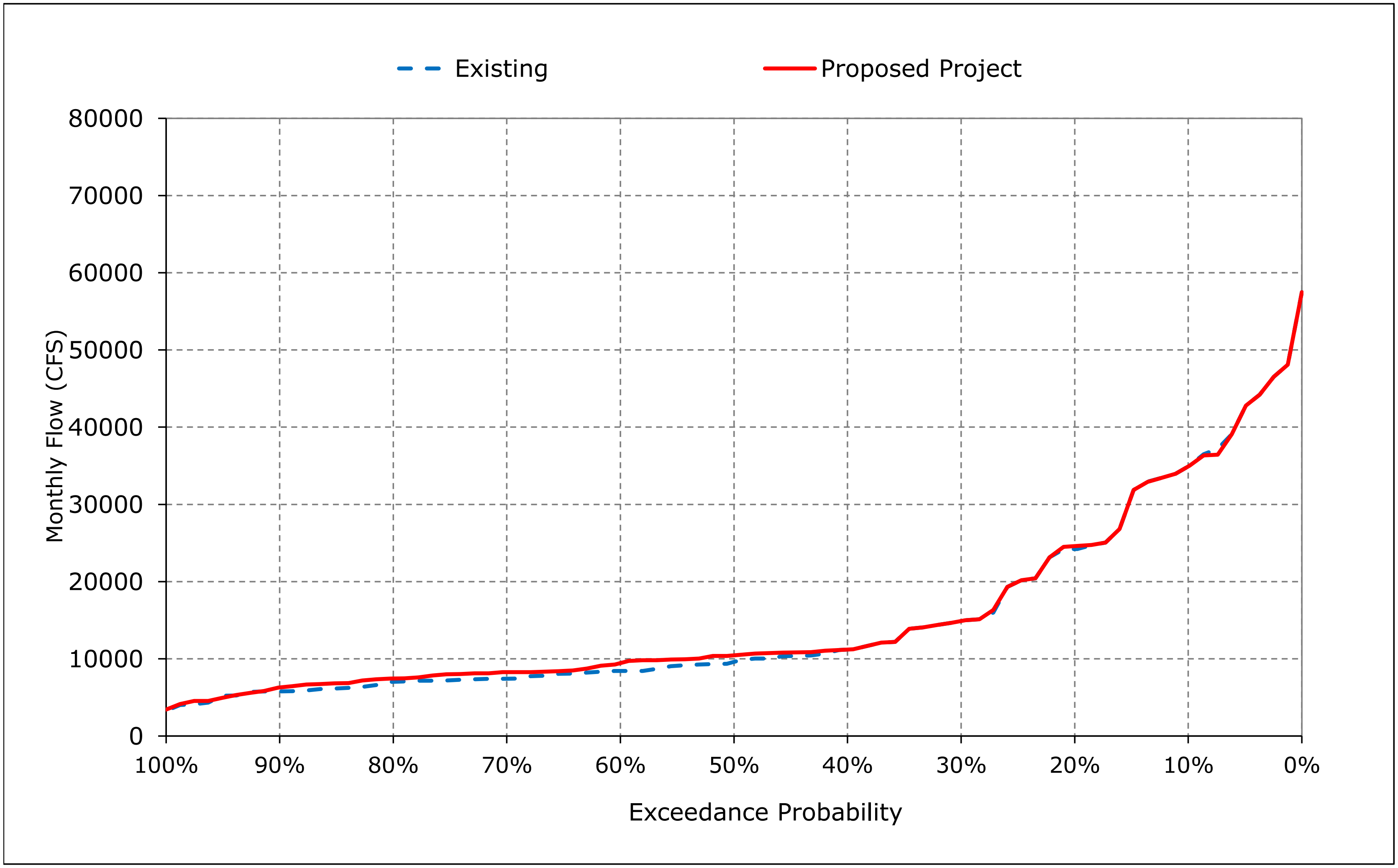


Figure 4-15. Sacramento River Flow at Rio Vista, June

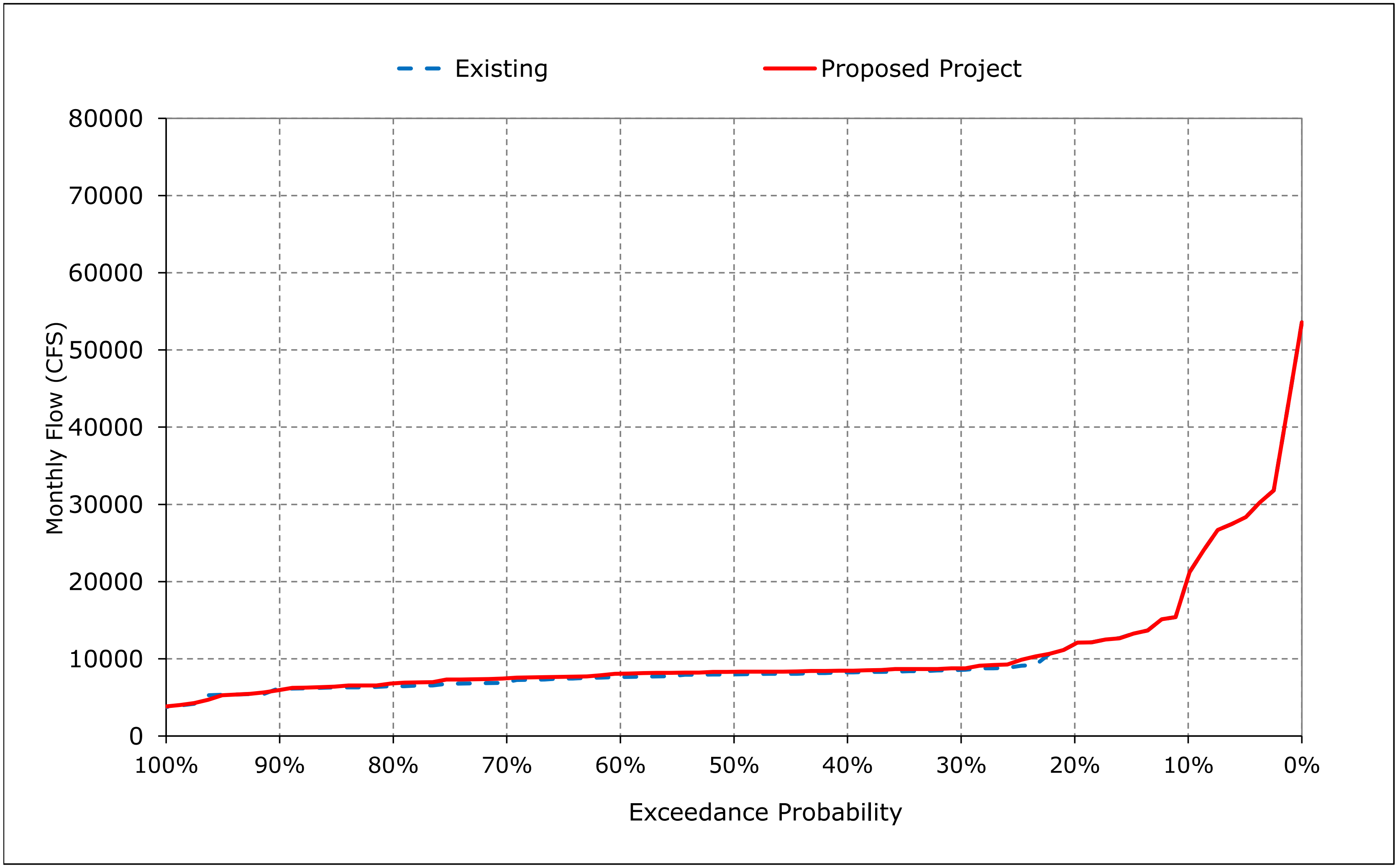


Figure 4-16. Sacramento River Flow at Rio Vista, July

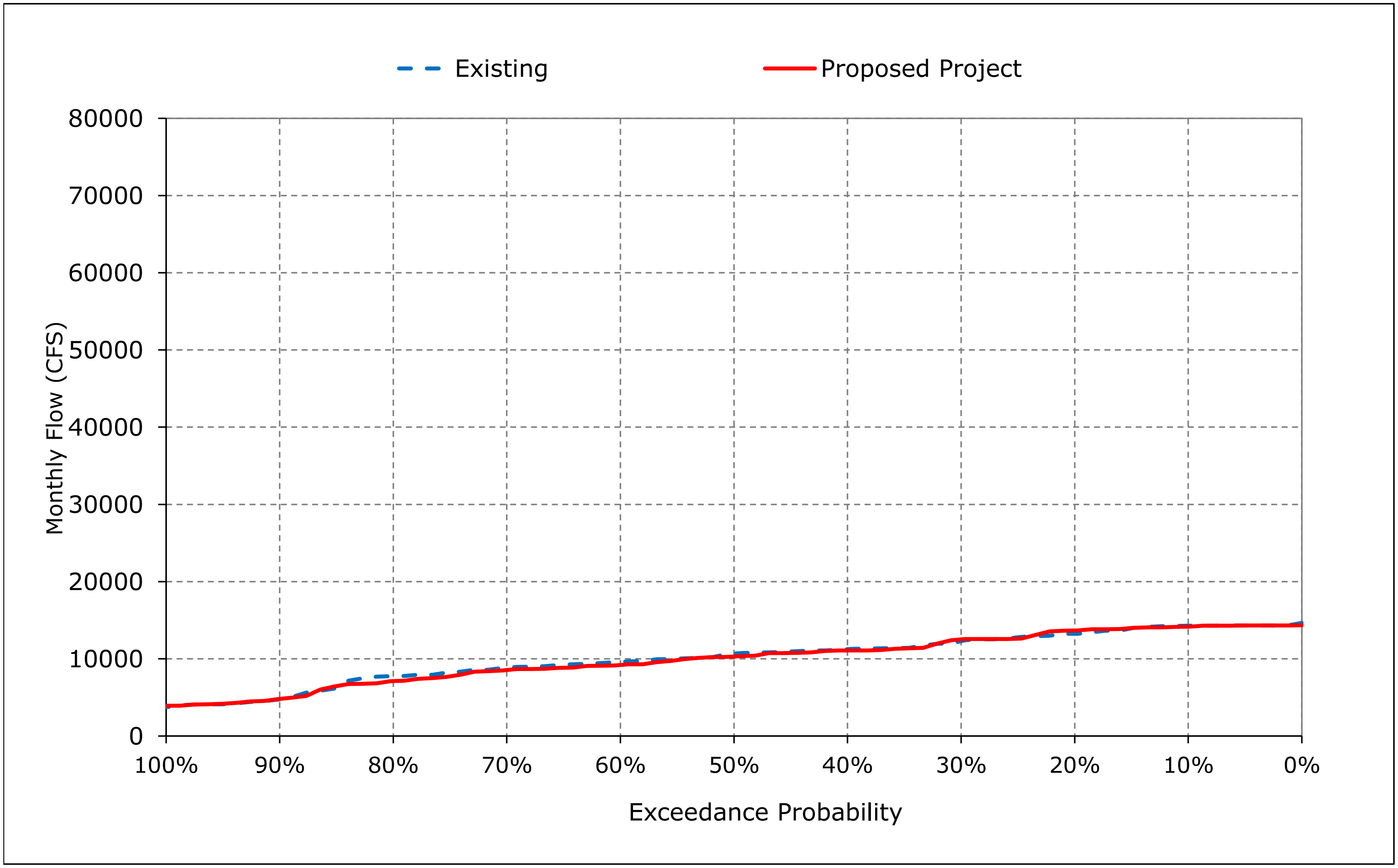


Figure 4-17. Sacramento River Flow at Rio Vista, August

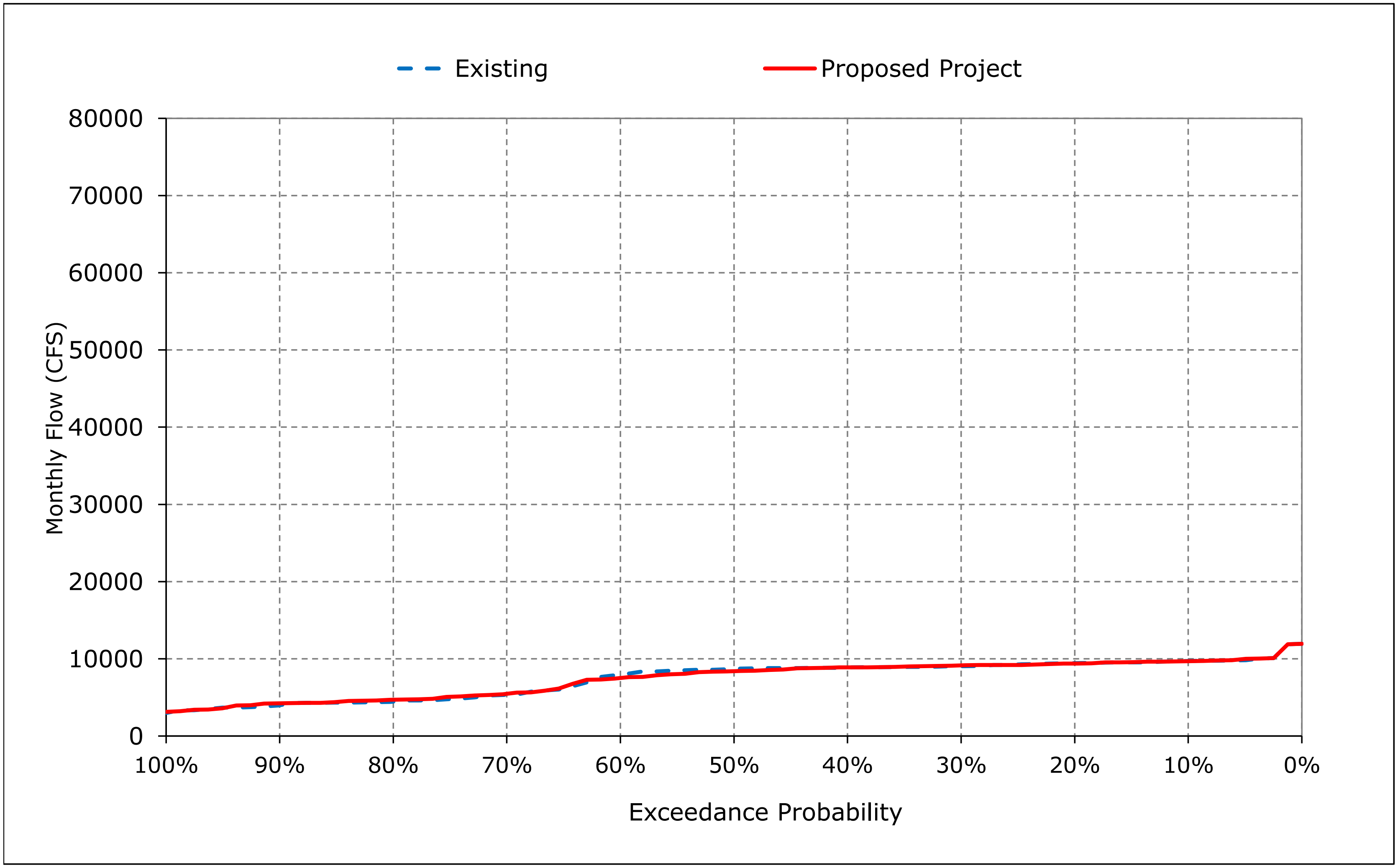


Figure 4-18. Sacramento River Flow at Rio Vista, September

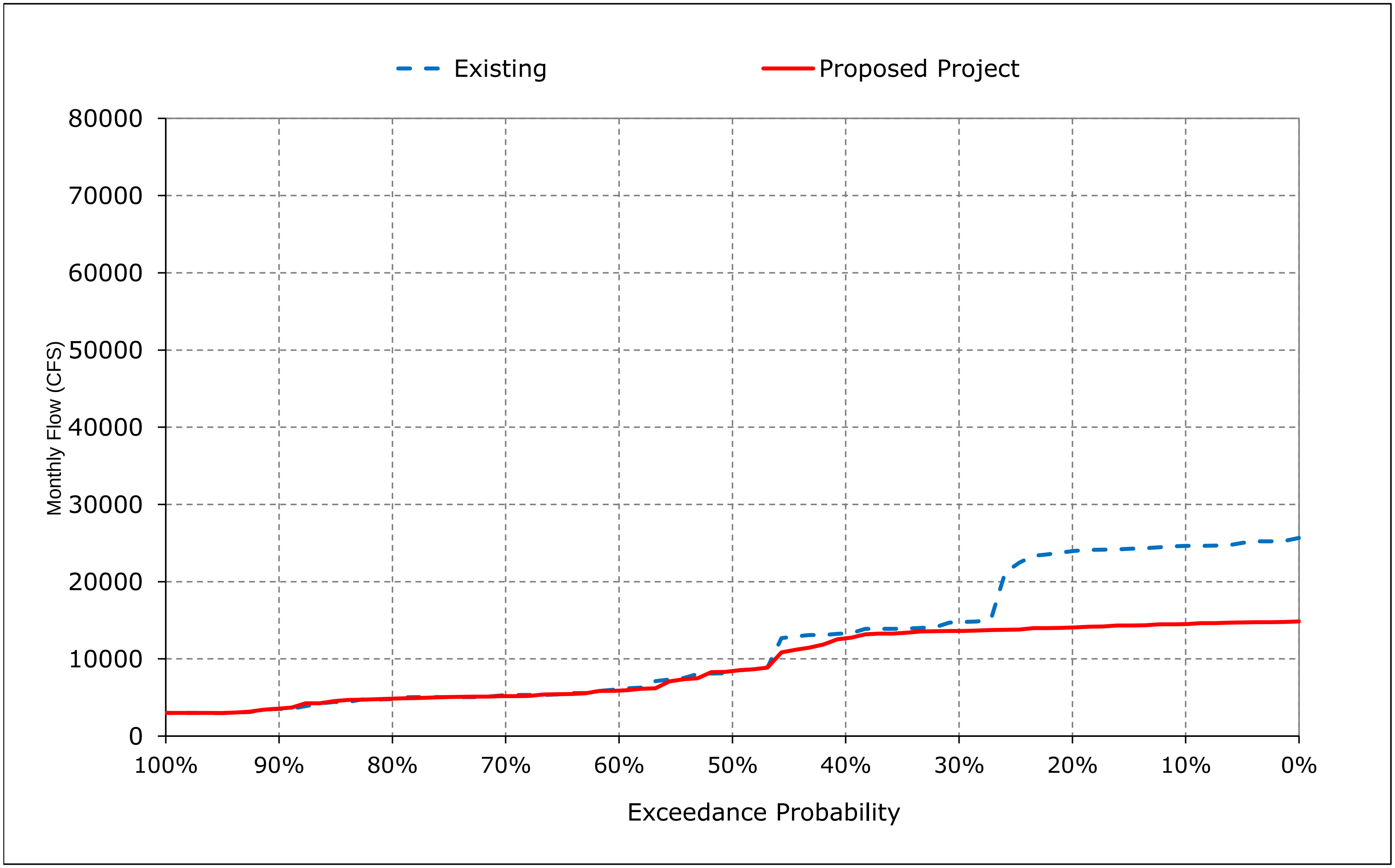


Table 5-1. San Joaquin River at Vernalis, Monthly Flow

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Flow (CFS)											
Probability of Exceedance												
10%	3,478	2,775	4,265	10,211	14,013	14,227	12,024	11,059	10,024	7,130	3,076	3,290
20%	3,115	2,561	2,816	5,121	9,911	9,351	7,937	7,369	6,949	3,529	2,780	2,817
30%	2,940	2,367	2,311	3,370	6,914	8,049	6,466	5,322	3,334	2,404	2,422	2,570
40%	2,757	2,182	2,116	2,572	4,292	6,202	5,382	4,426	2,962	1,783	1,880	2,321
50%	2,531	2,028	2,006	2,324	3,522	3,942	4,391	3,685	2,323	1,587	1,520	1,940
60%	2,405	1,957	1,936	2,179	2,808	3,420	3,513	2,937	1,845	1,393	1,437	1,842
70%	2,219	1,853	1,840	1,955	2,280	2,363	3,001	2,618	1,505	1,209	1,345	1,779
80%	2,049	1,746	1,740	1,749	2,228	1,888	2,262	2,176	1,426	1,140	1,265	1,670
90%	1,780	1,609	1,612	1,575	1,956	1,674	1,622	1,680	1,043	923	1,087	1,495
Long Term												
Full Simulation Period[a]	2,647	2,387	3,115	4,766	6,366	6,884	5,961	5,364	4,211	3,170	2,057	2,345
Water Year Types[b,c]												
Wet (32%)	2,976	3,062	4,916	9,348	11,567	13,134	10,528	9,615	8,281	6,511	3,177	3,318
Above Normal (15%)	2,337	1,975	2,828	4,077	6,178	7,223	5,874	5,054	4,541	2,744	2,026	2,377
Below Normal (17%)	2,623	2,191	2,628	3,008	5,667	4,920	4,897	4,380	2,478	1,779	1,840	2,096
Dry (22%)	2,632	2,157	2,036	2,065	2,477	2,650	3,125	2,672	1,589	1,220	1,330	1,767
Critical (15%)	2,293	1,907	1,686	1,627	1,937	1,643	1,646	1,652	1,021	907	1,004	1,358

Proposed Project

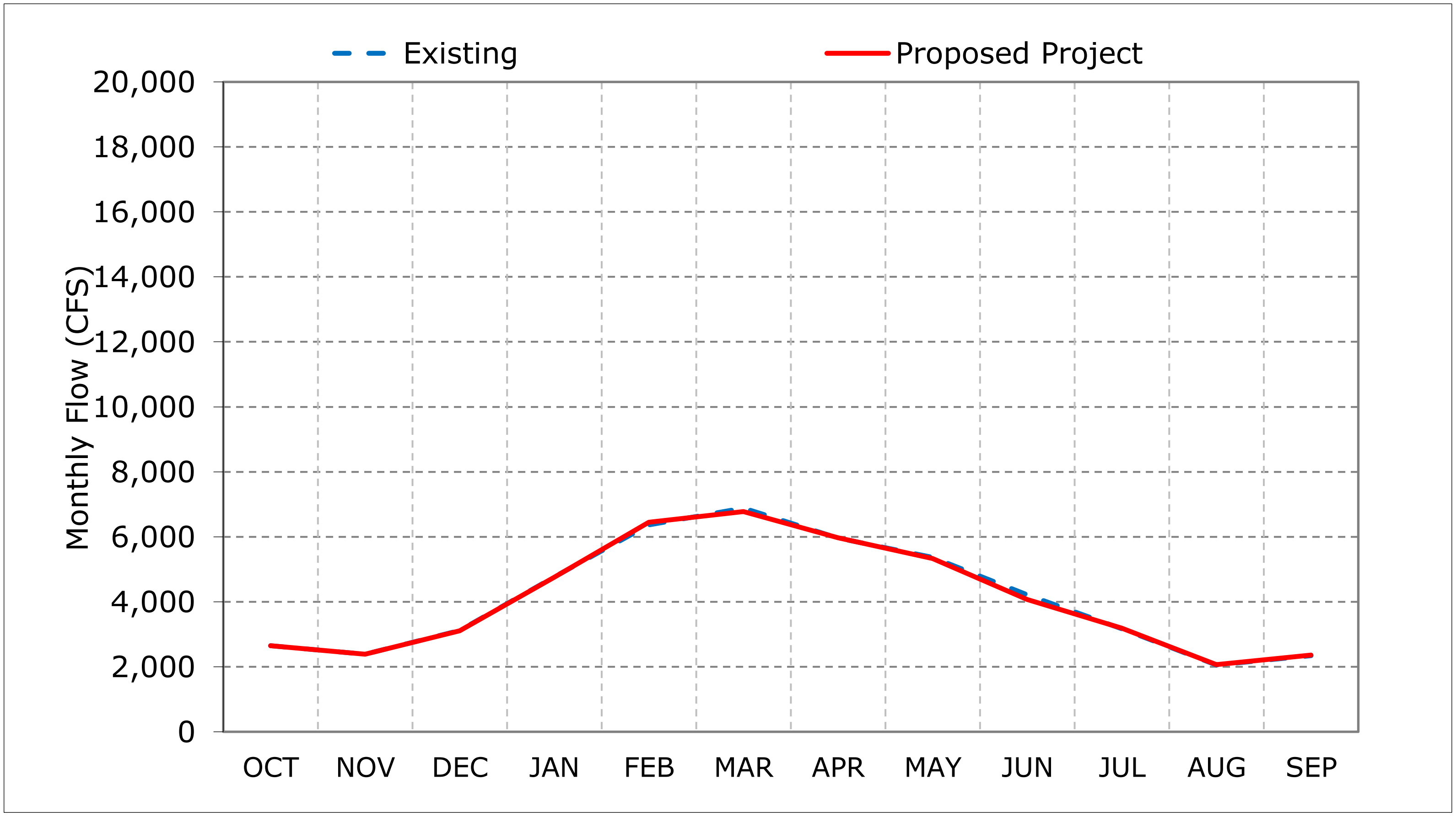
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Flow (CFS)											
Probability of Exceedance												
10%	3,479	2,776	4,265	10,216	14,903	14,724	12,153	11,839	10,077	7,137	3,464	3,511
20%	3,111	2,546	2,824	5,151	9,887	9,602	8,478	7,364	6,957	3,546	2,791	2,830
30%	2,941	2,353	2,290	3,541	7,093	7,868	6,633	5,277	2,856	2,422	2,432	2,528
40%	2,792	2,183	2,106	2,630	4,533	6,153	5,517	4,504	2,411	1,776	1,870	2,295
50%	2,556	2,028	2,006	2,407	3,486	3,942	4,456	3,532	2,101	1,578	1,517	1,943
60%	2,400	1,957	1,936	2,183	2,685	3,280	3,749	3,196	1,790	1,377	1,425	1,835
70%	2,197	1,853	1,840	1,941	2,272	2,363	2,799	2,355	1,438	1,202	1,345	1,747
80%	2,034	1,747	1,740	1,753	2,006	1,733	2,001	2,068	1,315	1,099	1,248	1,670
90%	1,759	1,609	1,612	1,569	1,768	1,499	1,515	1,523	999	908	1,079	1,479
Long Term												
Full Simulation Period[a]	2,650	2,383	3,103	4,759	6,447	6,777	5,970	5,328	4,070	3,189	2,067	2,360
Water Year Types[b,c]												
Wet (32%)	2,975	3,059	4,887	9,328	11,916	13,096	10,523	9,494	8,148	6,606	3,235	3,378
Above Normal (15%)	2,320	1,975	2,828	4,075	6,266	7,190	6,109	5,220	4,353	2,752	2,032	2,381
Below Normal (17%)	2,660	2,191	2,628	3,013	5,575	4,753	5,178	4,554	2,274	1,781	1,842	2,095
Dry (22%)	2,611	2,146	2,025	2,061	2,405	2,510	2,887	2,501	1,454	1,198	1,308	1,754
Critical (15%)	2,322	1,907	1,686	1,628	1,856	1,431	1,514	1,554	968	851	973	1,351

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Flow (CFS)											
Probability of Exceedance												
10%	0	0	0	5	889	496	129	780	54	8	388	222
20%	**-5**	**-15**	8	30	**-24**	251	541	**-6**	8	18	11	13
30%	2	**-14**	**-21**	171	179	**-181**	167	**-45**	**-478**	18	10	**-43**
40%	35	0	**-10**	58	241	**-49**	135	78	**-551**	**-7**	**-10**	**-27**
50%	25	0	0	82	**-36**	0	65	**-153**	**-222**	**-9**	**-3**	3
60%	**-5**	0	**0**	4	**-123**	**-140**	235	259	**-55**	**-16**	**-12**	**-7**
70%	**-22**	0	0	**-14**	**-8**	0	**-203**	**-263**	**-67**	**-7**	**0**	**-32**
80%	**-15**	0	**0**	3	**-223**	**-155**	**-261**	**-109**	**-111**	**-40**	**-16**	1
90%	**-21**	0	**0**	**-6**	**-187**	**-175**	**-107**	**-156**	**-43**	**-15**	**-7**	**-16**
Long Term												
Full Simulation Period[a]	3	**-3**	**-12**	**-7**	80	**-107**	9	**-36**	**-142**	18	10	15
Water Year Types[b,c]												
Wet (32%)	**-1**	**-3**	**-30**	**-20**	349	**-38**	**-5**	**-121**	**-133**	95	59	60
Above Normal (15%)	**-17**	0	0	**-2**	88	**-33**	235	167	**-188**	8	6	3
Below Normal (17%)	36	0	0	5	**-92**	**-167**	281	174	**-205**	2	2	**-2**
Dry (22%)	**-21**	**-11**	**-11**	**-4**	**-72**	**-140**	**-238**	**-171**	**-135**	**-22**	**-22**	**-13**
Critical (15%)	29	0	0	2	**-81**	**-212**	**-132**	**-98**	**-53**	**-57**	**-32**	**-7**

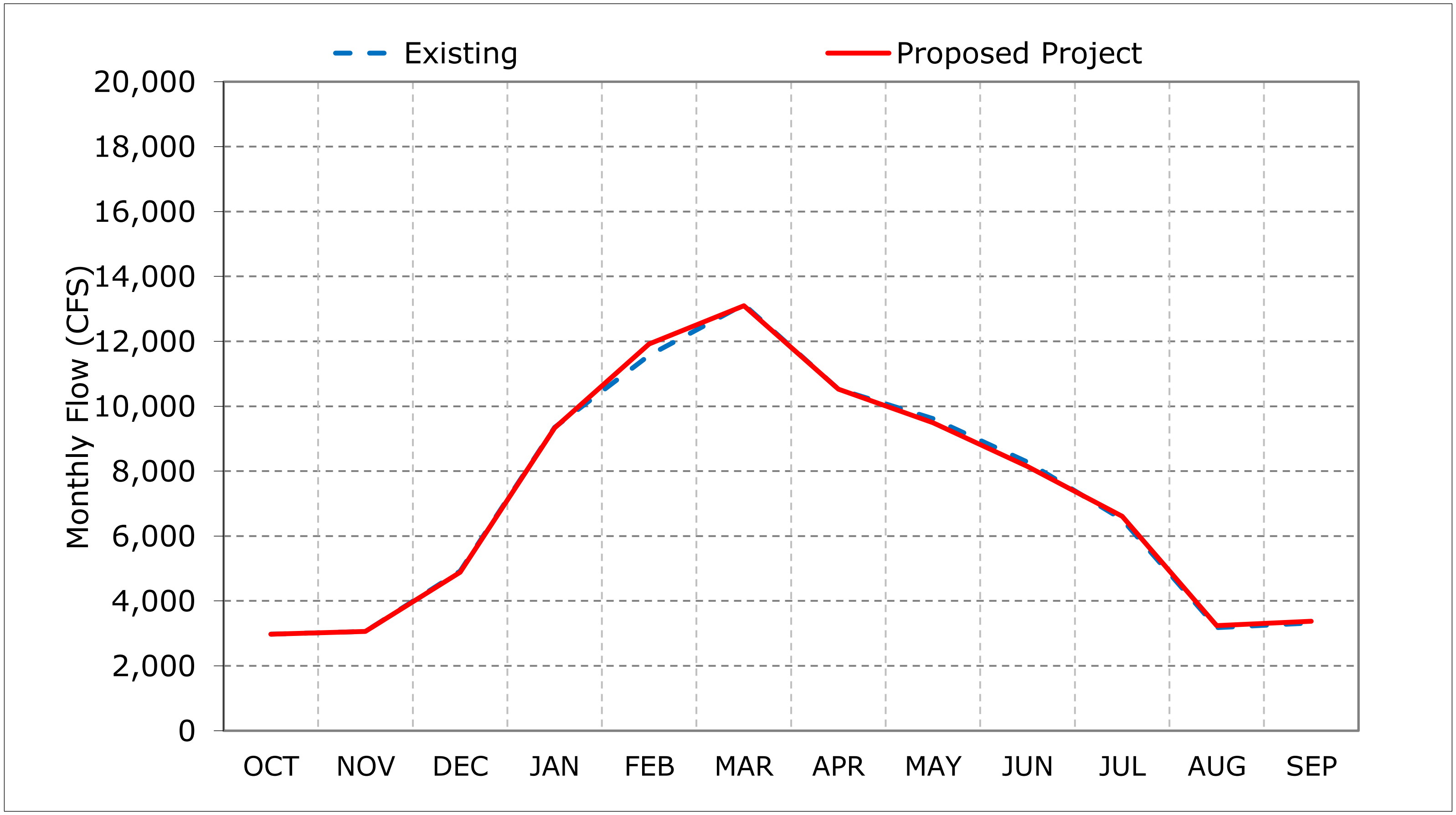
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.

Figure 5-1. San Joaquin River at Vernalis, Long-Term Average Flow



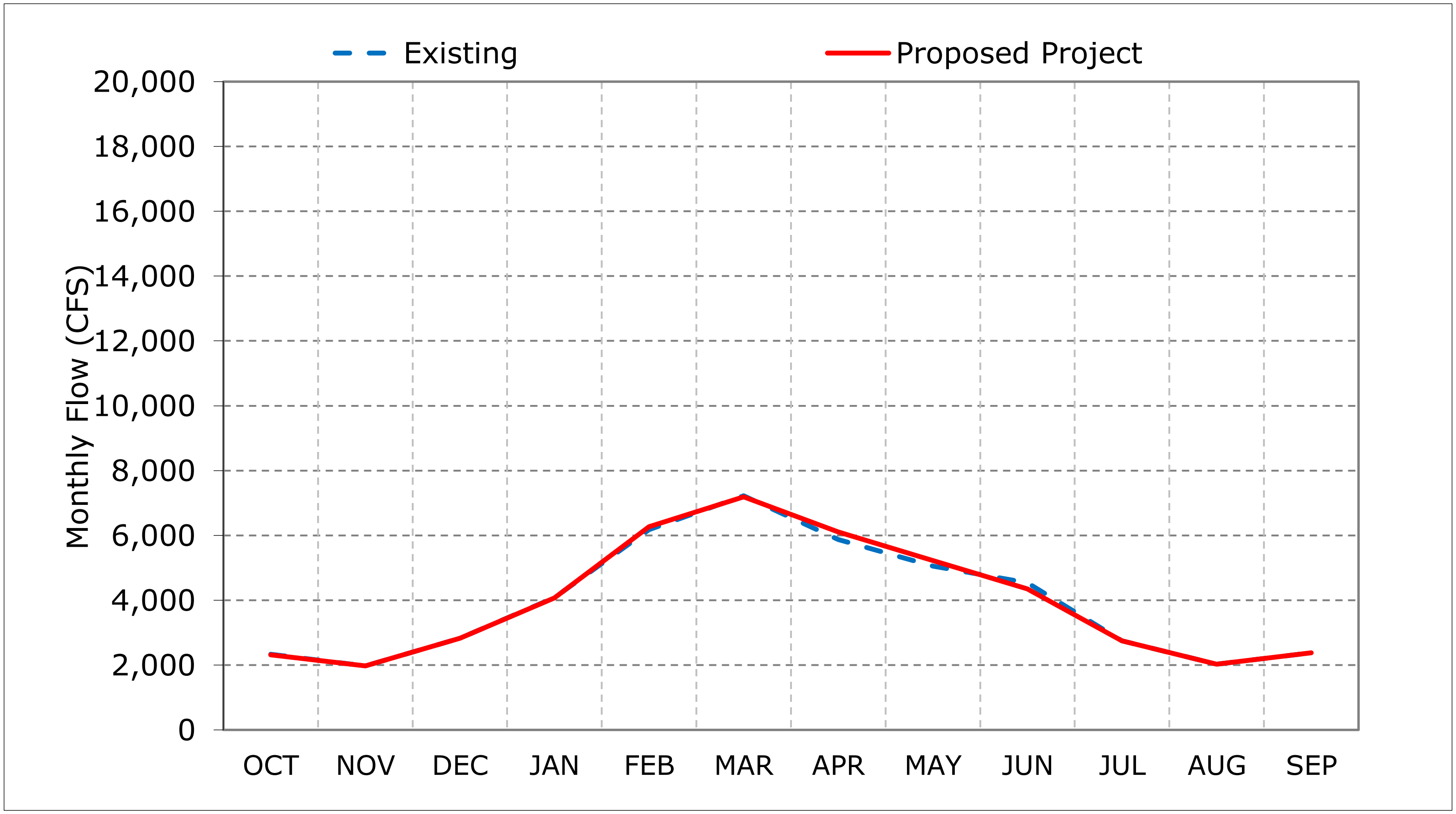
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 5-2. San Joaquin River at Vernalis, Wet Year Average Flow



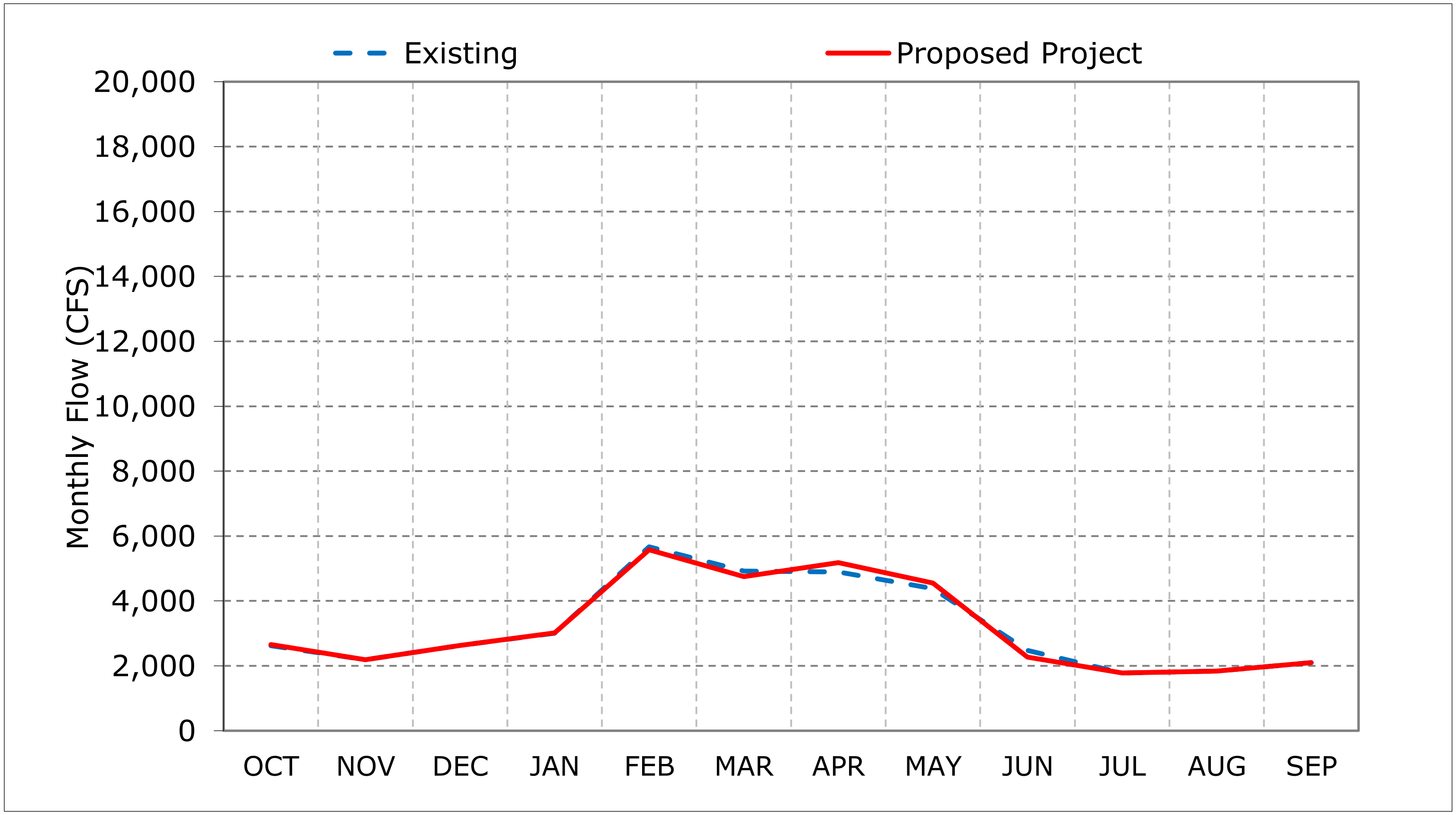
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 5-3. San Joaquin River at Vernalis, Above Normal Year Average Flow



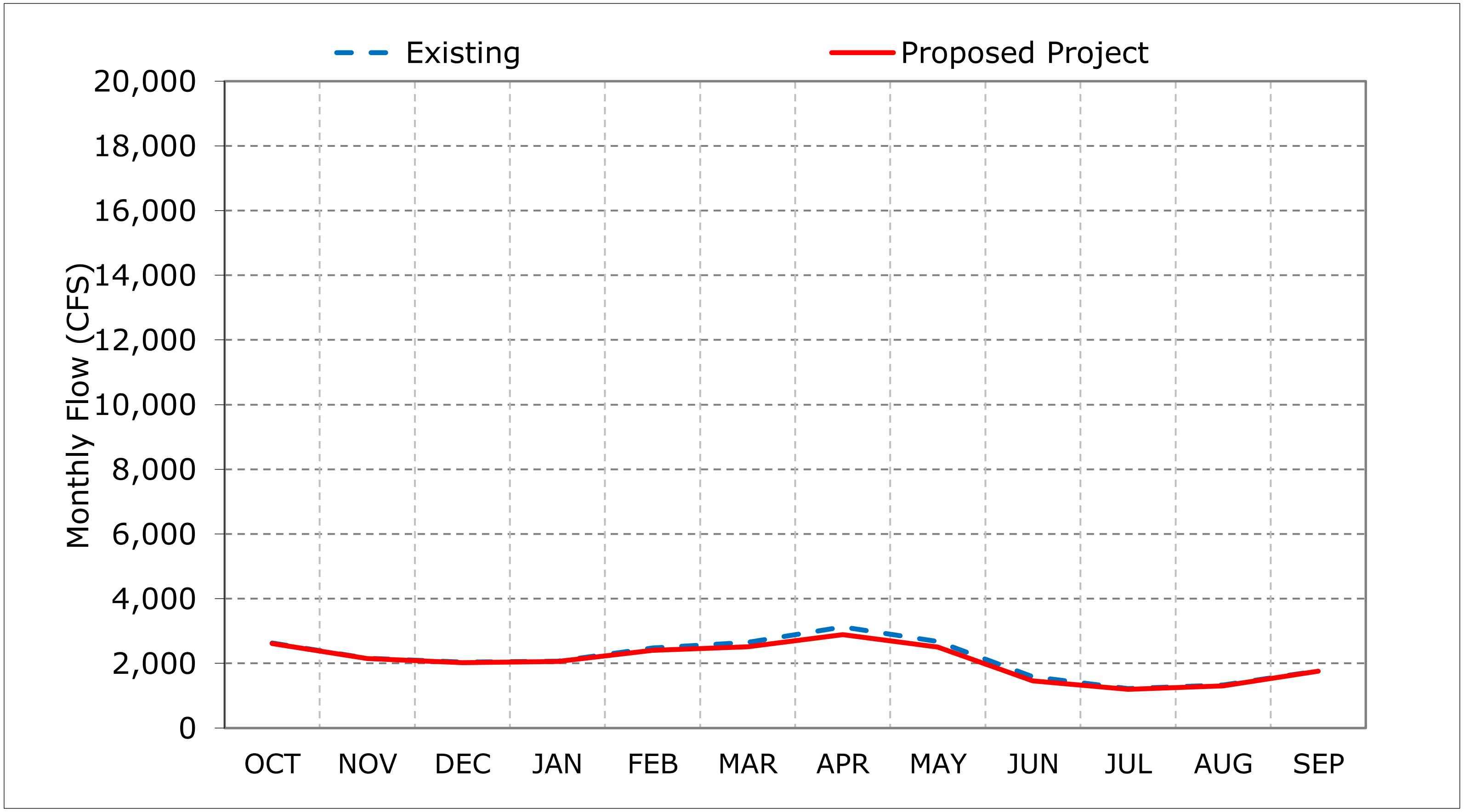
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 5-4. San Joaquin River at Vernalis, Below Normal Year Average Flow



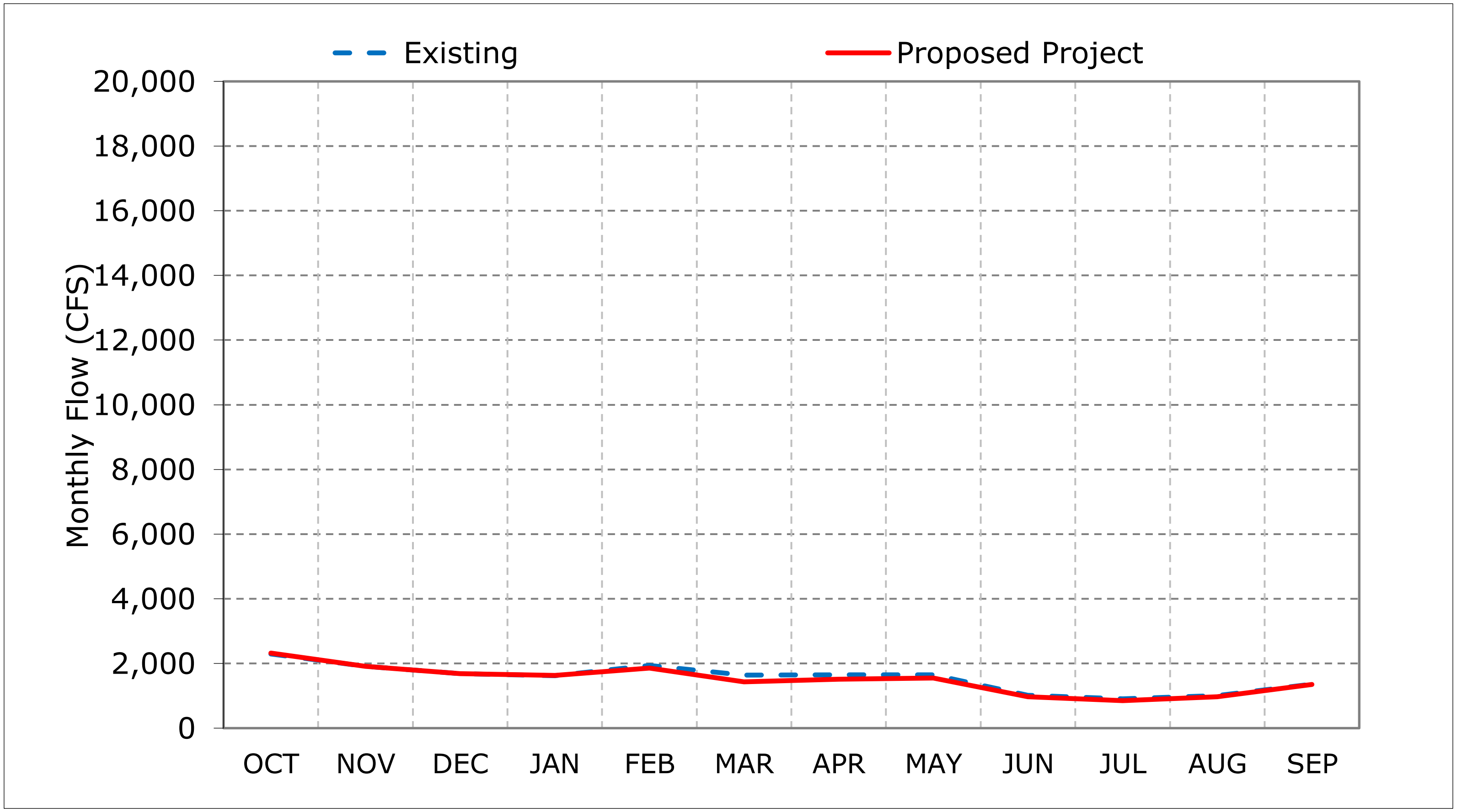
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 5-5. San Joaquin River at Vernalis, Dry Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 5-6. San Joaquin River at Vernalis, Critical Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 5-7. San Joaquin River at Vernalis, October

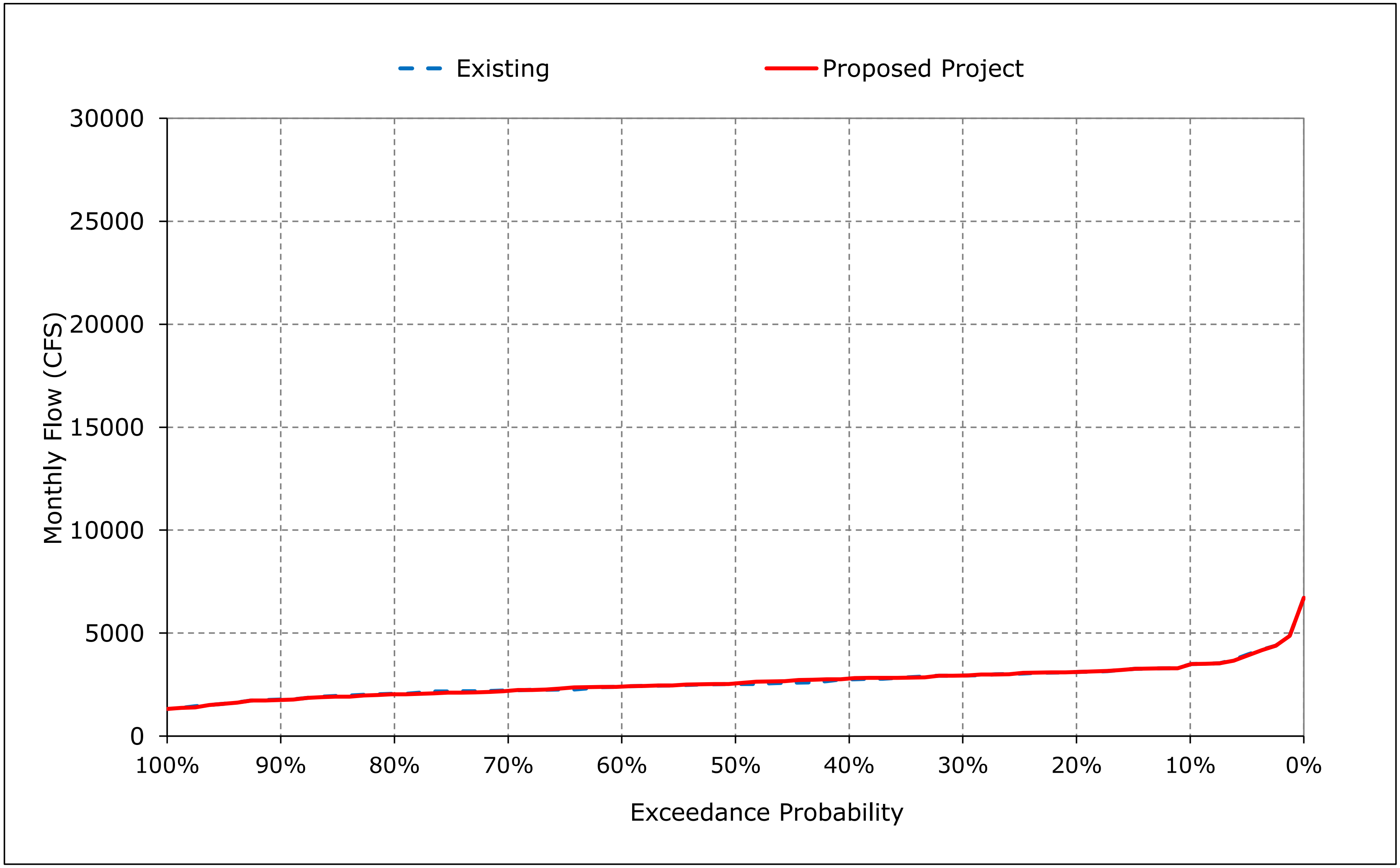


Figure 5-8. San Joaquin River at Vernalis, November

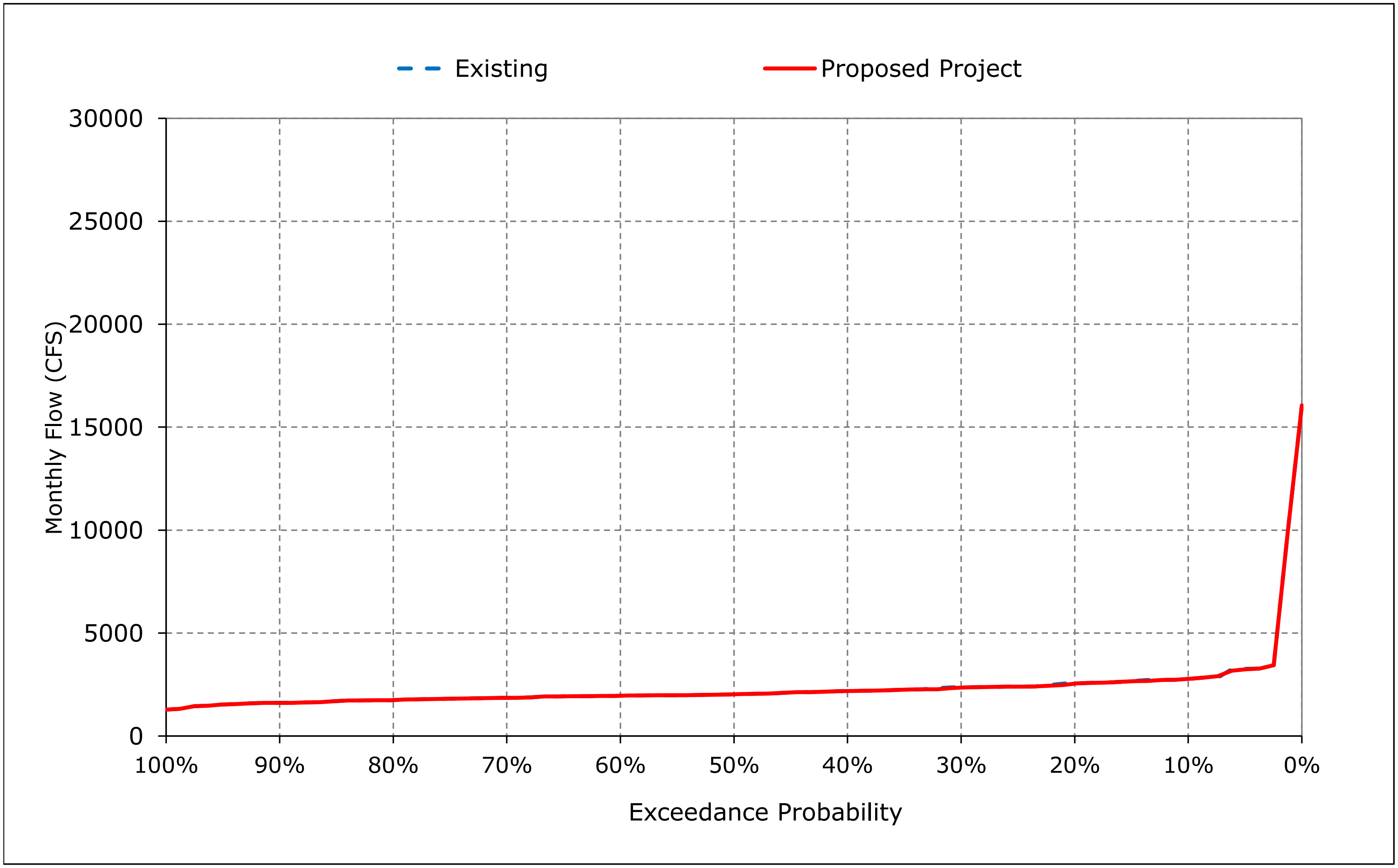


Figure 5-9. San Joaquin River at Vernalis, December

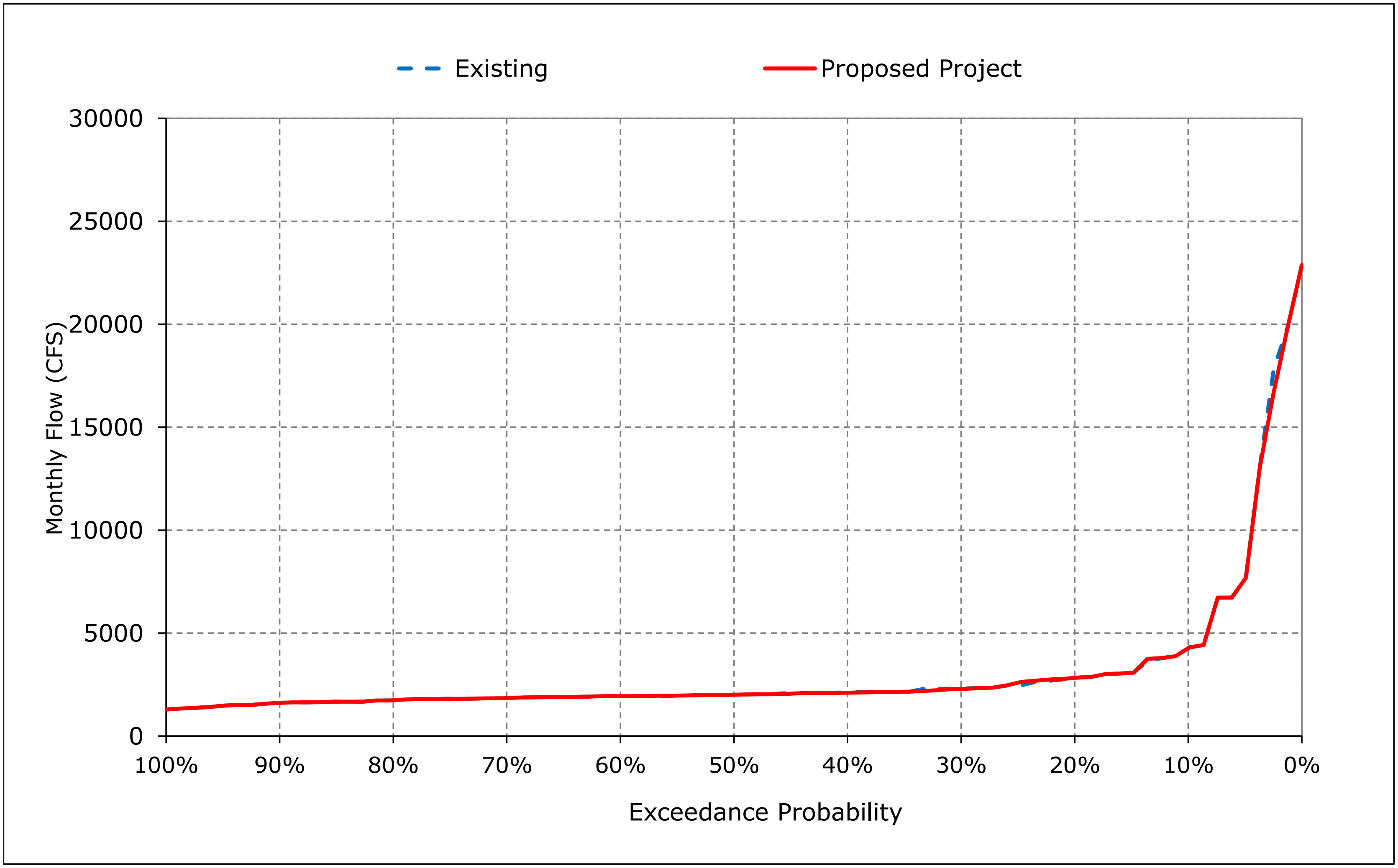


Figure 5-10. San Joaquin River at Vernalis, January

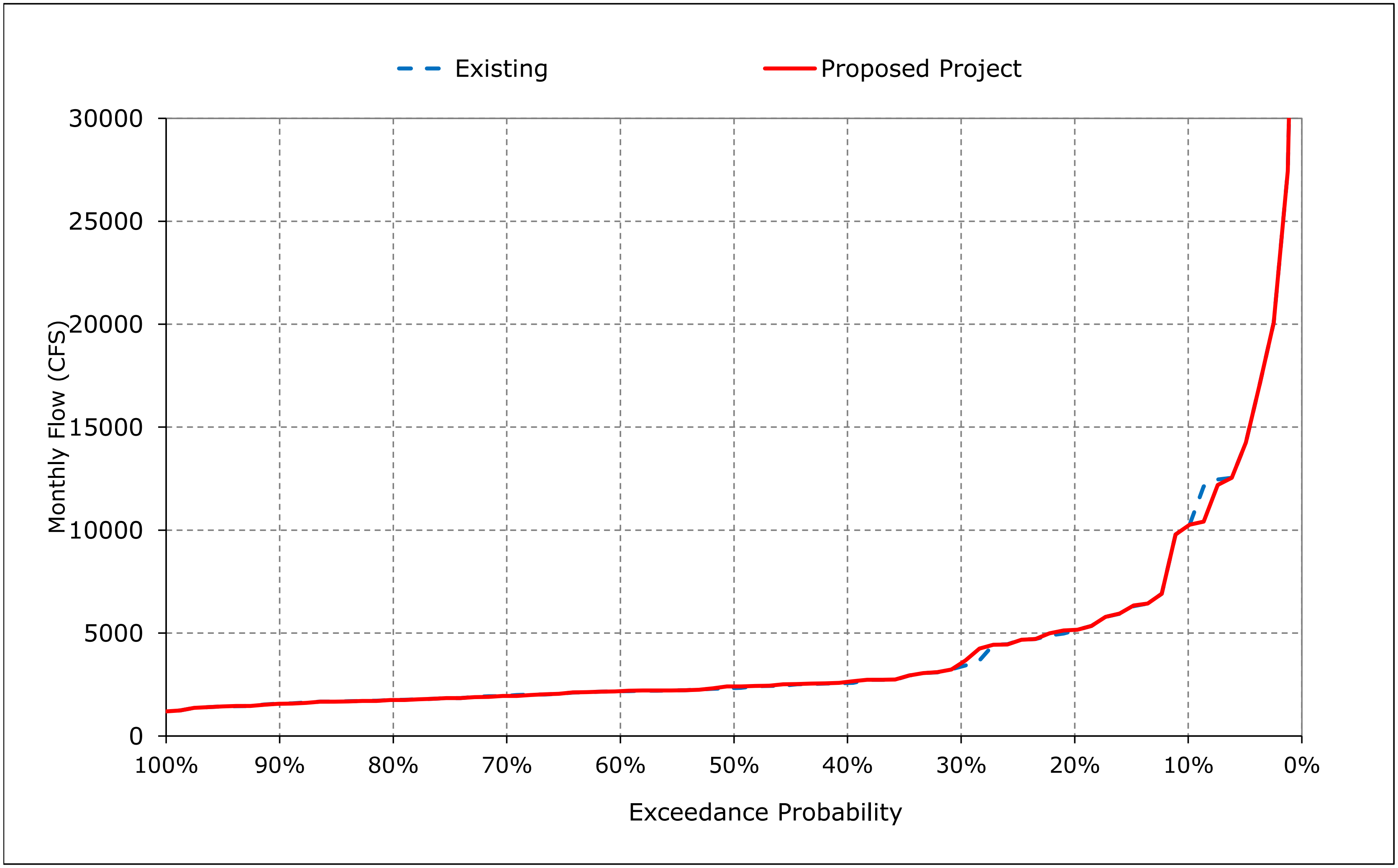


Figure 5-11. San Joaquin River at Vernalis, February

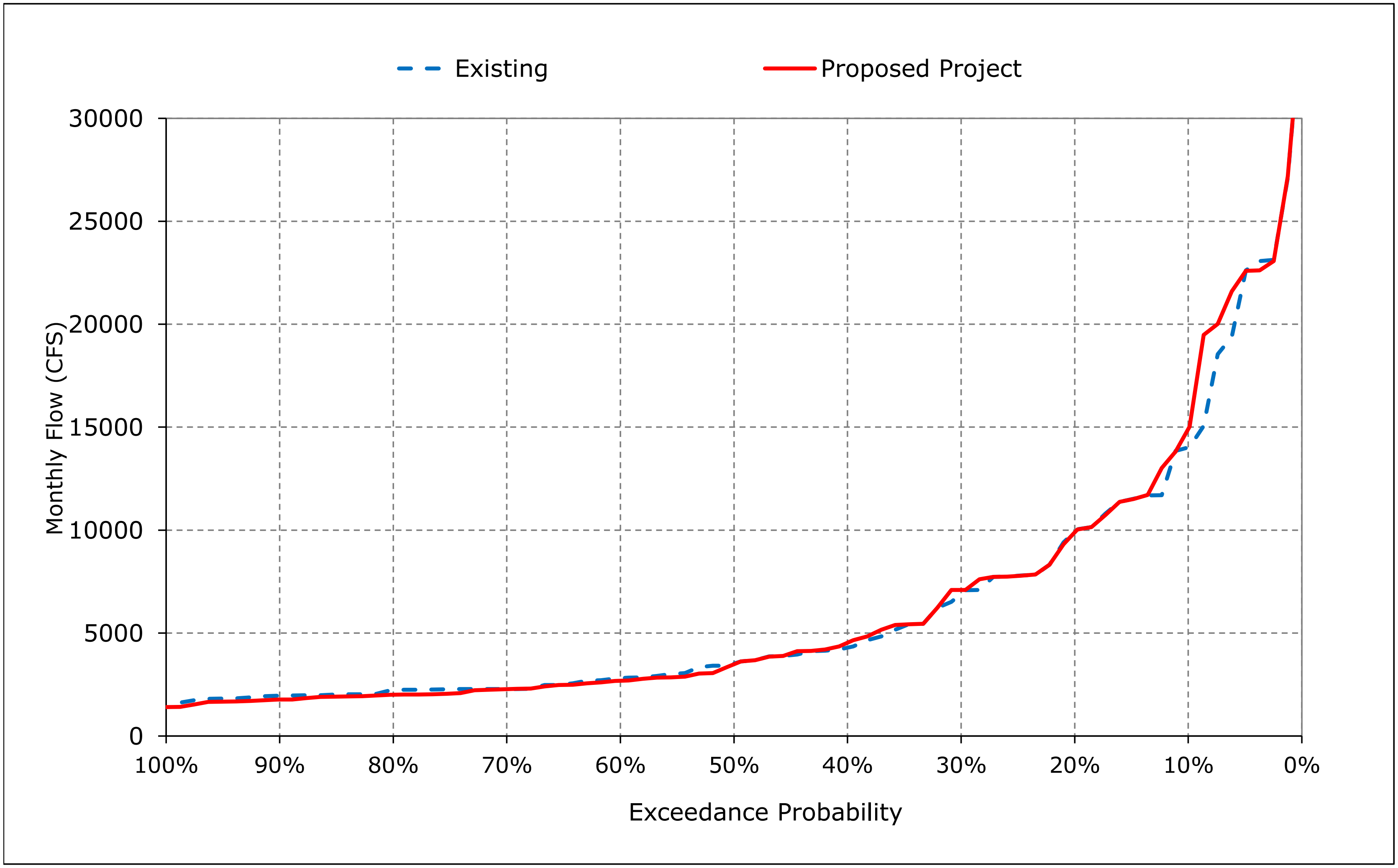


Figure 5-12. San Joaquin River at Vernalis, March

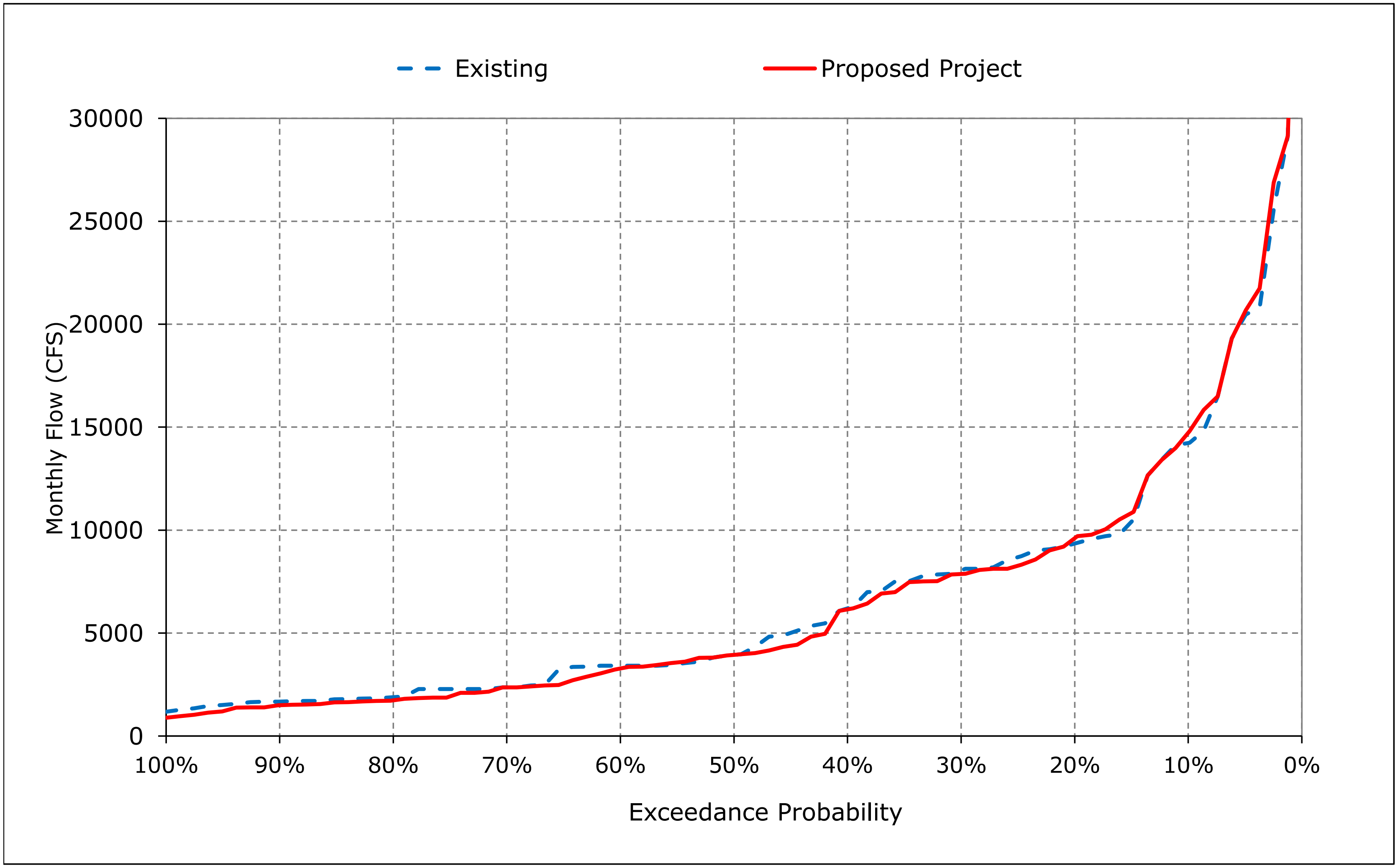


Figure 5-13. San Joaquin River at Vernalis, April

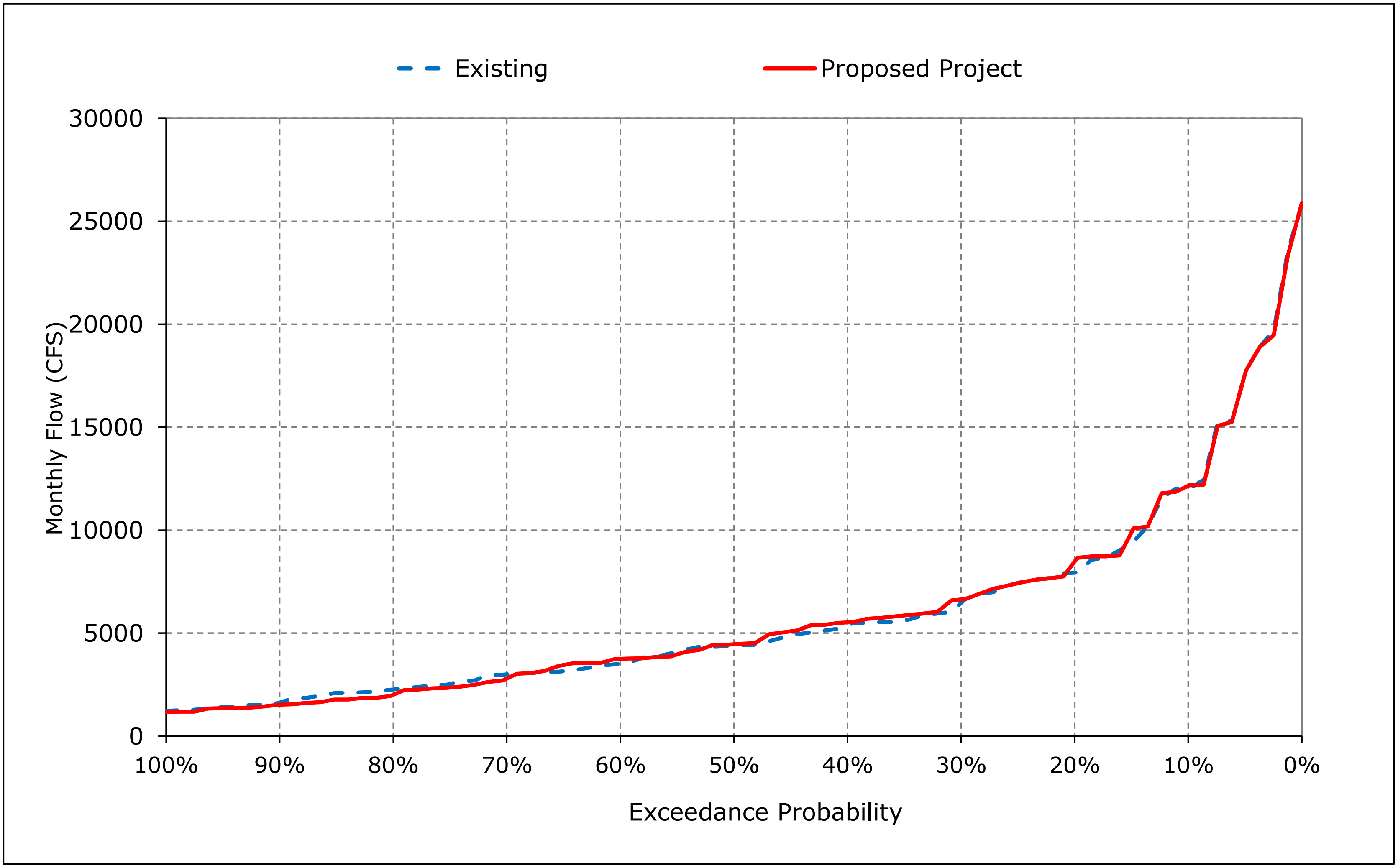


Figure 5-14. San Joaquin River at Vernalis, May

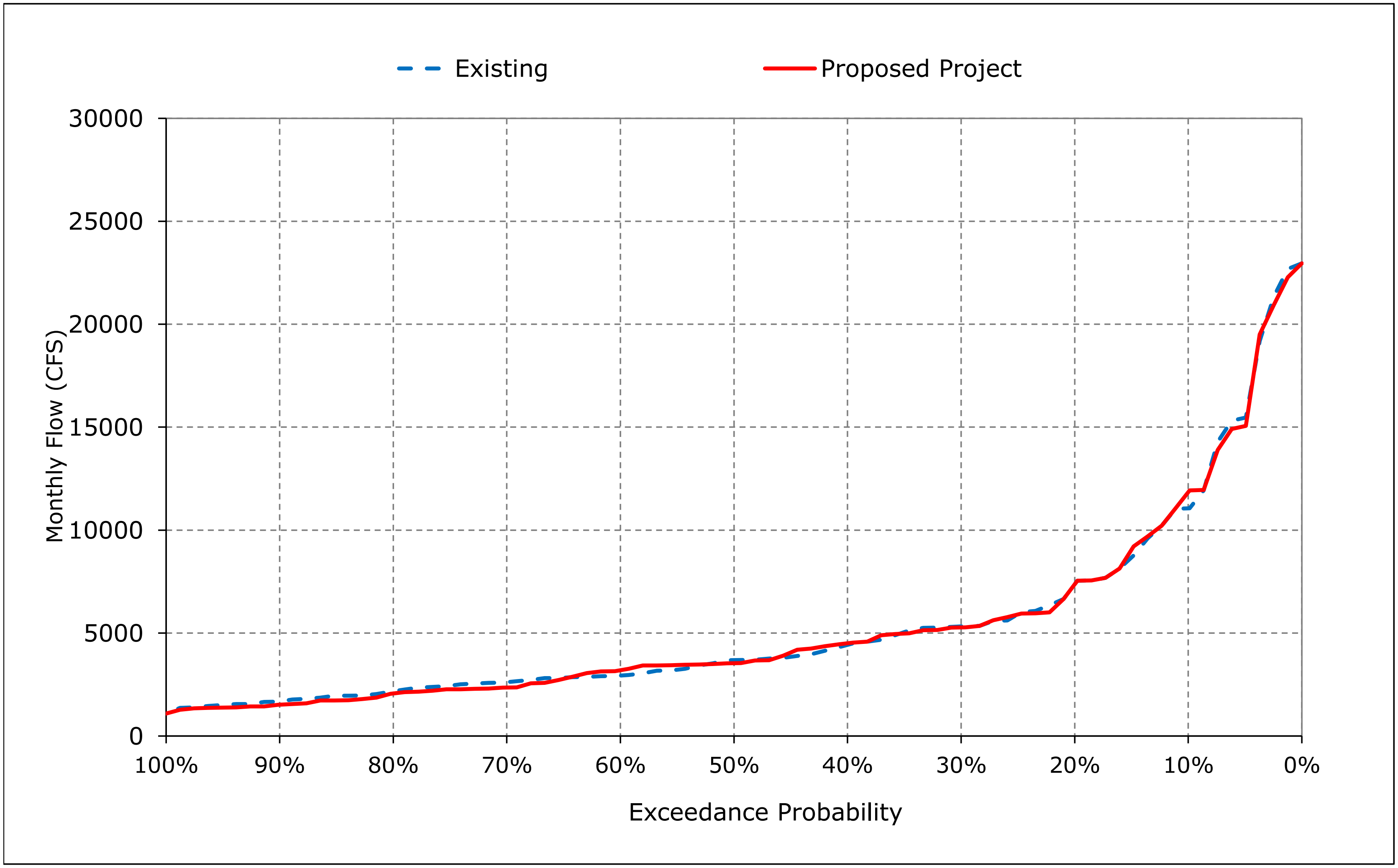


Figure 5-15. San Joaquin River at Vernalis, June

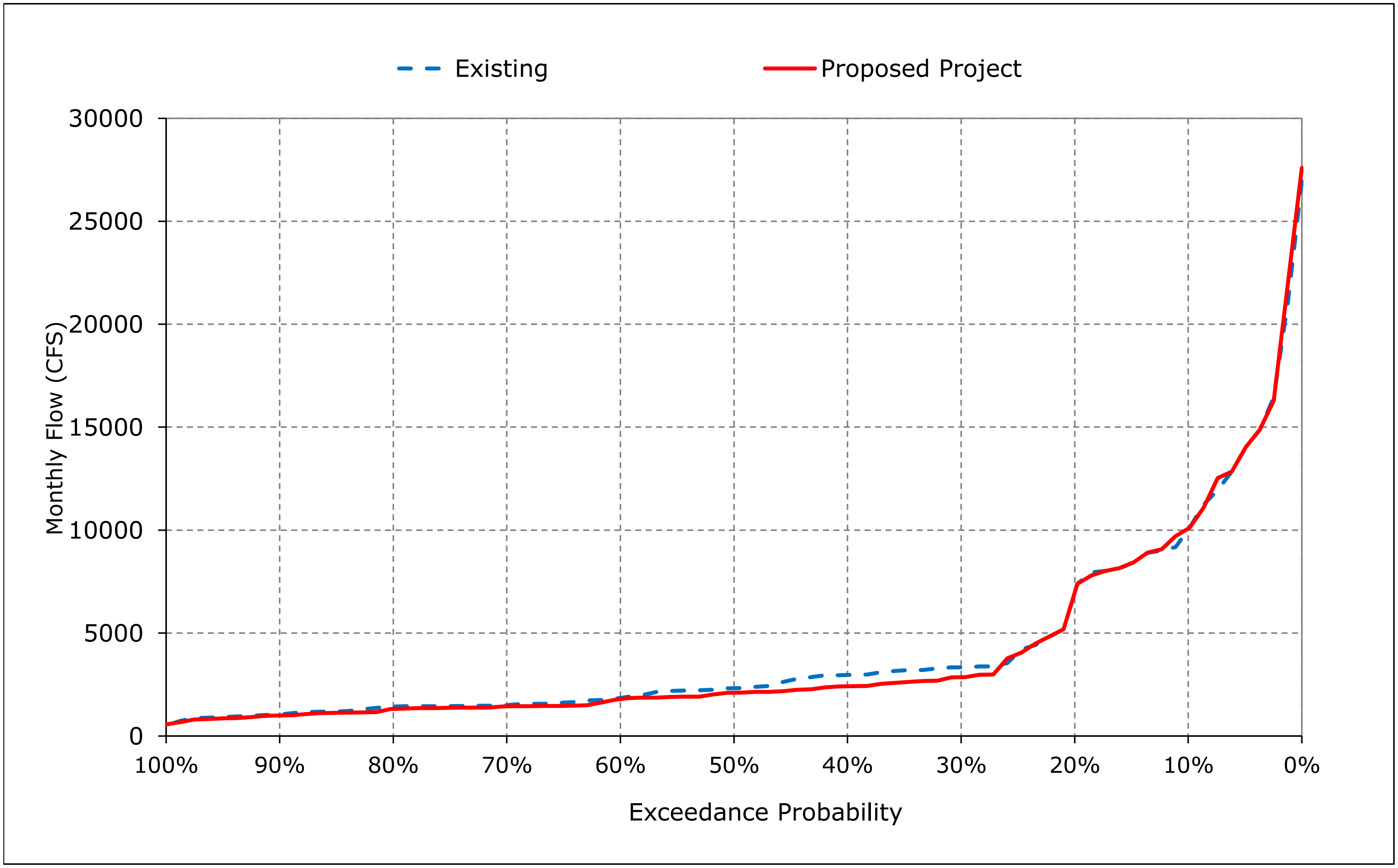


Figure 5-16. San Joaquin River at Vernalis, July

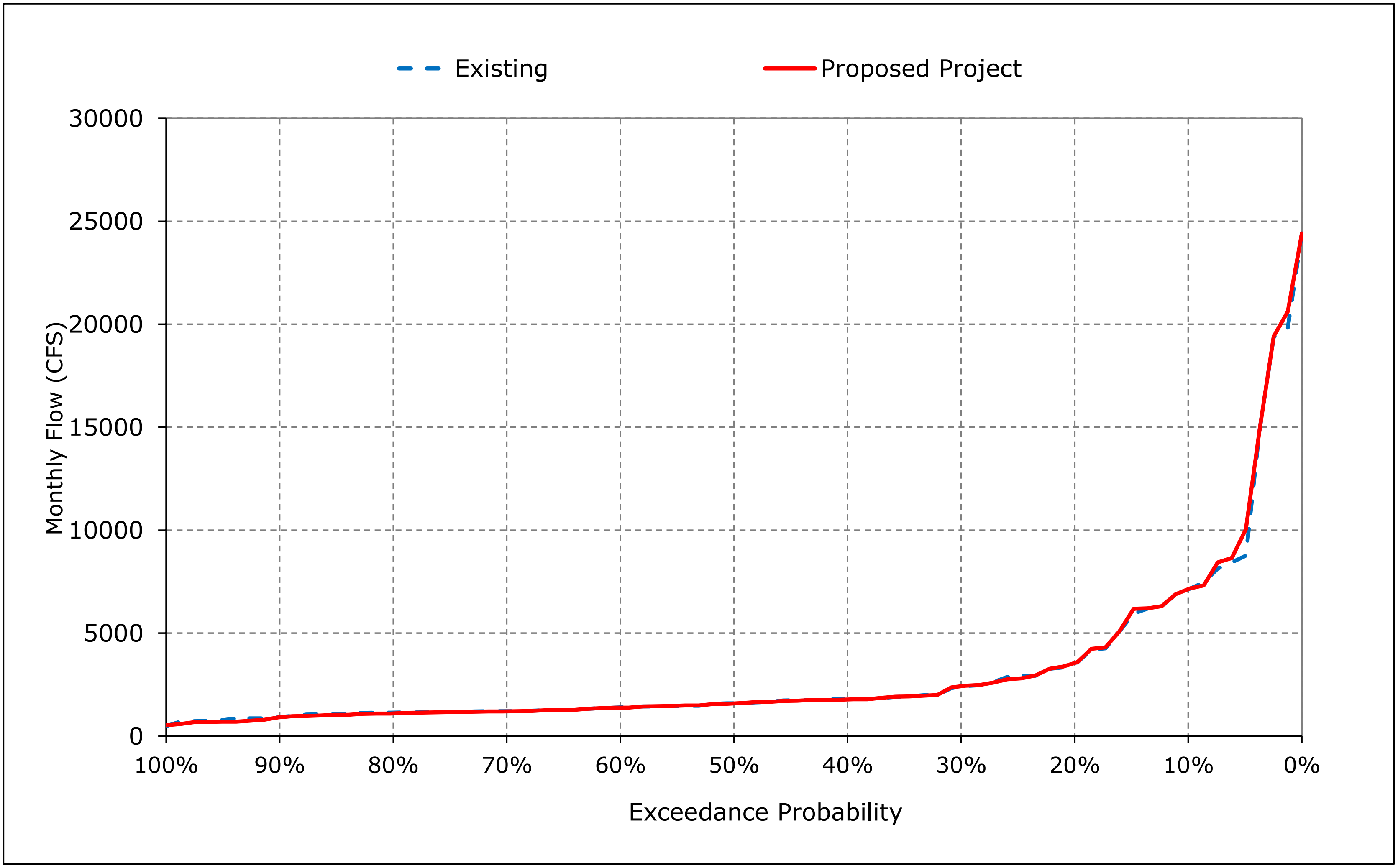


Figure 5-17. San Joaquin River at Vernalis, August

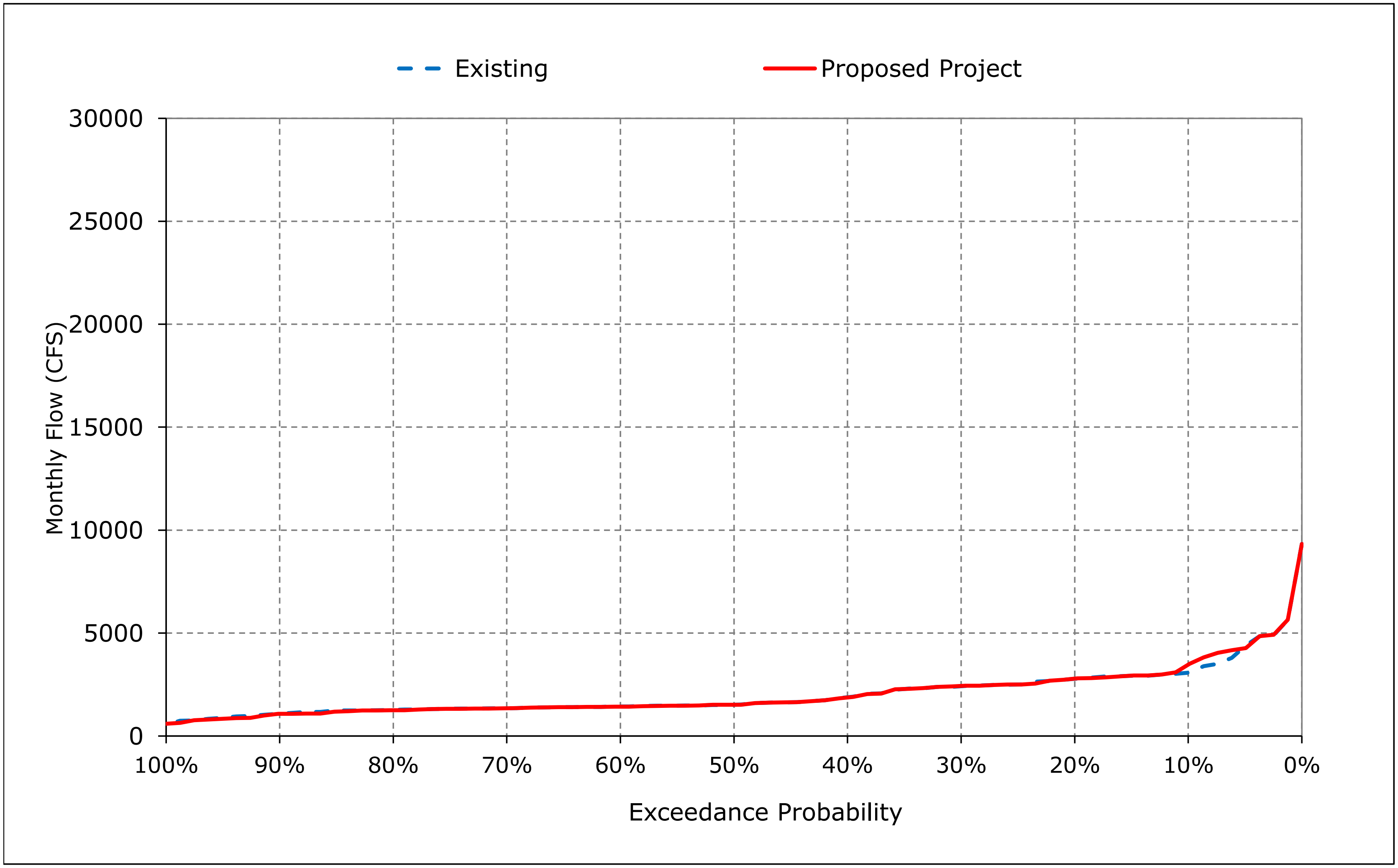


Figure 5-18. San Joaquin River at Vernalis, September

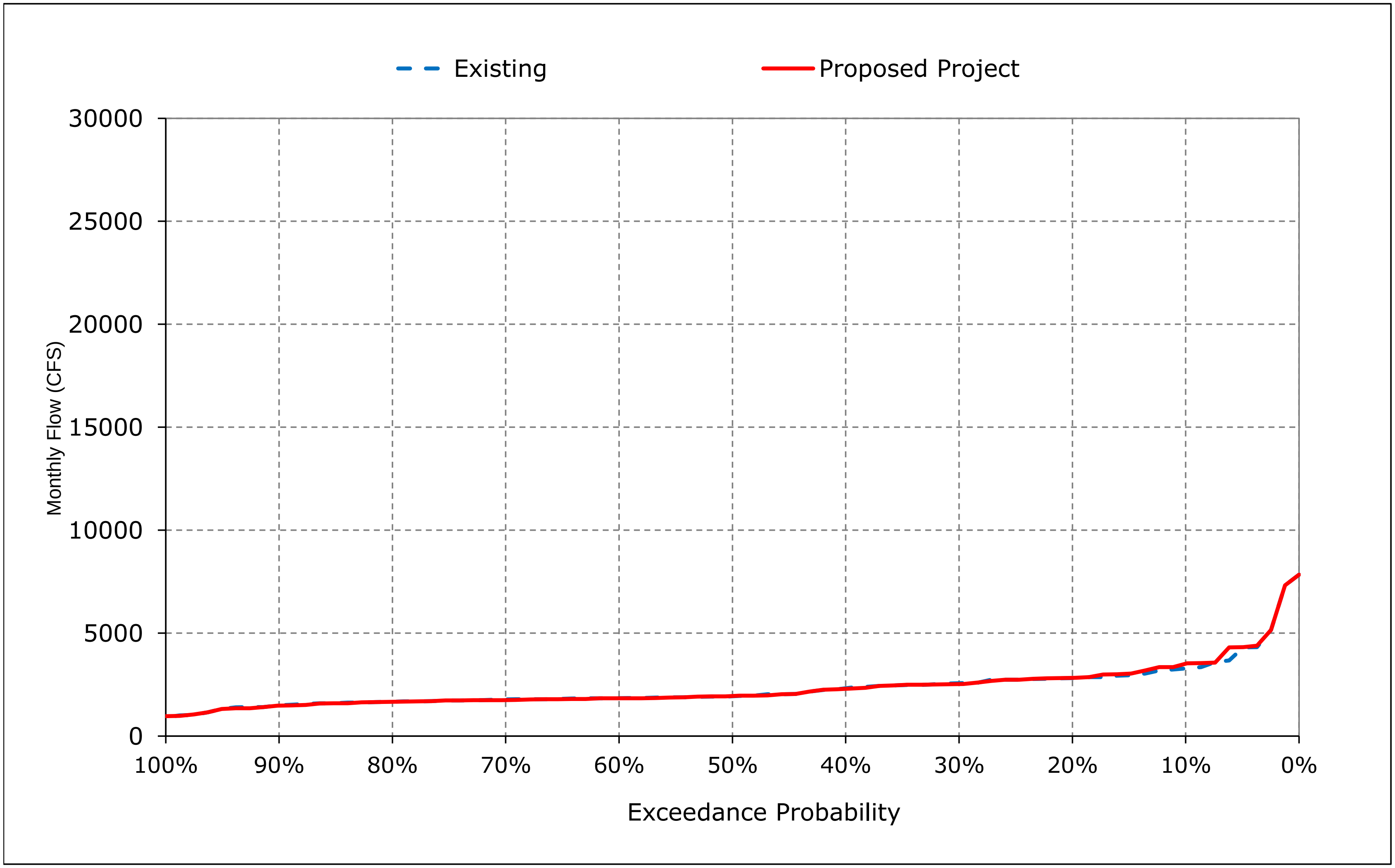


Table 6-1. Mokelumne River below Consumnes, Monthly Flow

Existing

Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	803	1,033	2,131	3,558	4,038	3,475	3,831	3,723	2,588	828	305	385
20%	631	714	879	2,337	3,063	2,618	2,518	2,729	1,706	578	237	282
30%	556	571	581	1,479	2,338	2,419	2,004	1,769	1,308	340	143	219
40%	475	509	488	886	1,605	1,704	1,592	1,406	713	268	73	164
50%	414	459	435	703	1,246	1,297	1,322	1,029	465	95	54	102
60%	321	407	388	520	868	1,018	923	790	349	56	46	85
70%	277	365	330	432	685	842	707	502	163	50	44	50
80%	222	241	265	355	509	687	607	354	83	46	41	42
90%	183	188	216	292	393	522	313	200	53	43	37	38
Long Term												
Full Simulation Period[a]	444	598	902	1,479	1,858	1,892	1,693	1,527	977	385	136	172
Water Year Types[b,c]												
Wet (32%)	545	831	1,643	2,918	3,368	3,357	2,962	2,824	2,025	905	276	318
Above Normal (15%)	398	773	966	1,811	2,019	2,280	1,836	1,627	1,083	331	129	174
Below Normal (17%)	464	529	702	833	1,536	1,325	1,596	1,314	670	151	72	107
Dry (22%)	404	413	377	455	775	889	739	620	215	79	46	68
Critical (15%)	305	280	257	315	422	495	345	225	103	44	50	85

Proposed Project

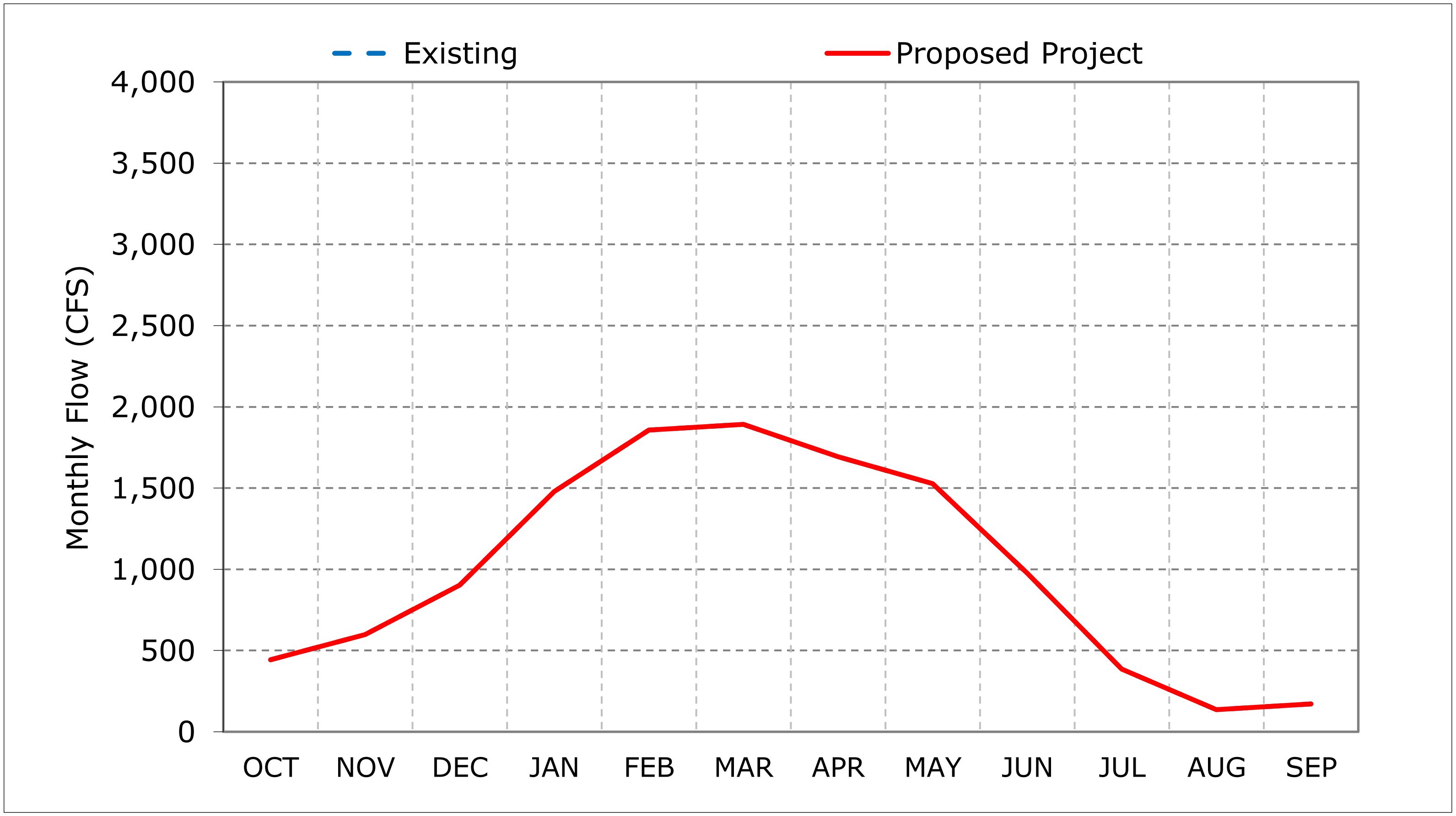
Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	803	1,033	2,131	3,558	4,038	3,475	3,831	3,723	2,588	828	305	385
20%	631	714	879	2,337	3,063	2,618	2,518	2,729	1,706	578	237	282
30%	556	571	581	1,479	2,339	2,419	2,004	1,769	1,309	341	143	219
40%	475	509	488	886	1,605	1,704	1,592	1,406	713	268	73	164
50%	414	459	435	703	1,246	1,297	1,322	1,029	465	94	54	102
60%	321	408	388	520	868	1,018	923	791	349	56	47	86
70%	277	365	331	433	685	842	707	502	163	50	44	50
80%	222	242	266	355	509	687	608	354	83	46	41	42
90%	183	188	217	292	393	522	313	200	53	43	38	38
Long Term												
Full Simulation Period[a]	444	599	903	1,479	1,858	1,892	1,693	1,527	977	385	136	172
Water Year Types[b,c]												
Wet (32%)	546	831	1,643	2,918	3,368	3,357	2,962	2,824	2,025	905	276	318
Above Normal (15%)	398	773	966	1,811	2,019	2,281	1,836	1,627	1,083	331	129	174
Below Normal (17%)	464	529	702	834	1,536	1,325	1,596	1,314	670	151	72	107
Dry (22%)	404	413	377	455	775	889	740	620	215	80	46	68
Critical (15%)	305	280	257	315	422	495	345	225	103	44	50	85

Proposed Project minus Existing

Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	0	0	0	0	0	0	0	0	0	0	0	0
20%	0	0	0	0	0	0	0	**0**	0	0	0	0
30%	0	**0**	0	0	1	0	**0**	0	0	0	0	0
40%	0	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	**0**	0	**0**
60%	0	0	0	0	0	**0**	0	1	0	0	1	1
70%	0	0	2	1	0	0	0	0	1	0	0	**0**
80%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
Long Term												
Full Simulation Period[a]	0	0	0	0	0	0	0	0	0	0	0	0
Water Year Types[b,c]												
Wet (32%)	0	0	0	0	0	**0**	**0**	0	0	0	0	0
Above Normal (15%)	0	0	0	0	0	0	0	0	0	0	0	0
Below Normal (17%)	0	0	0	0	0	0	0	0	0	0	0	0
Dry (22%)	0	0	0	0	0	0	0	0	0	0	0	0
Critical (15%)	0	0	0	0	0	0	0	0	0	0	0	0

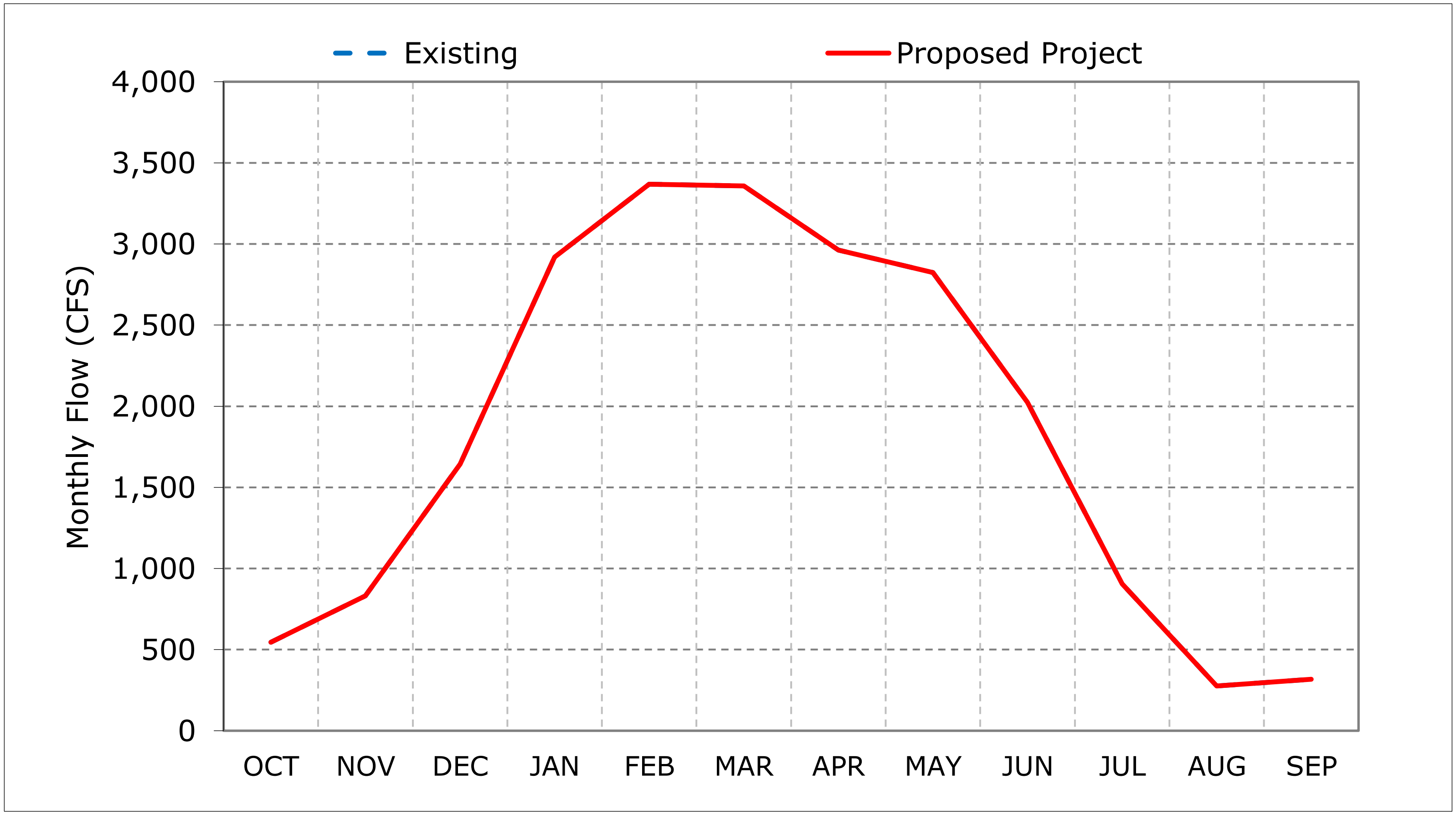
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.

Figure 6-1. Mokelumne River below Consumnes, Long-Term Average Flow



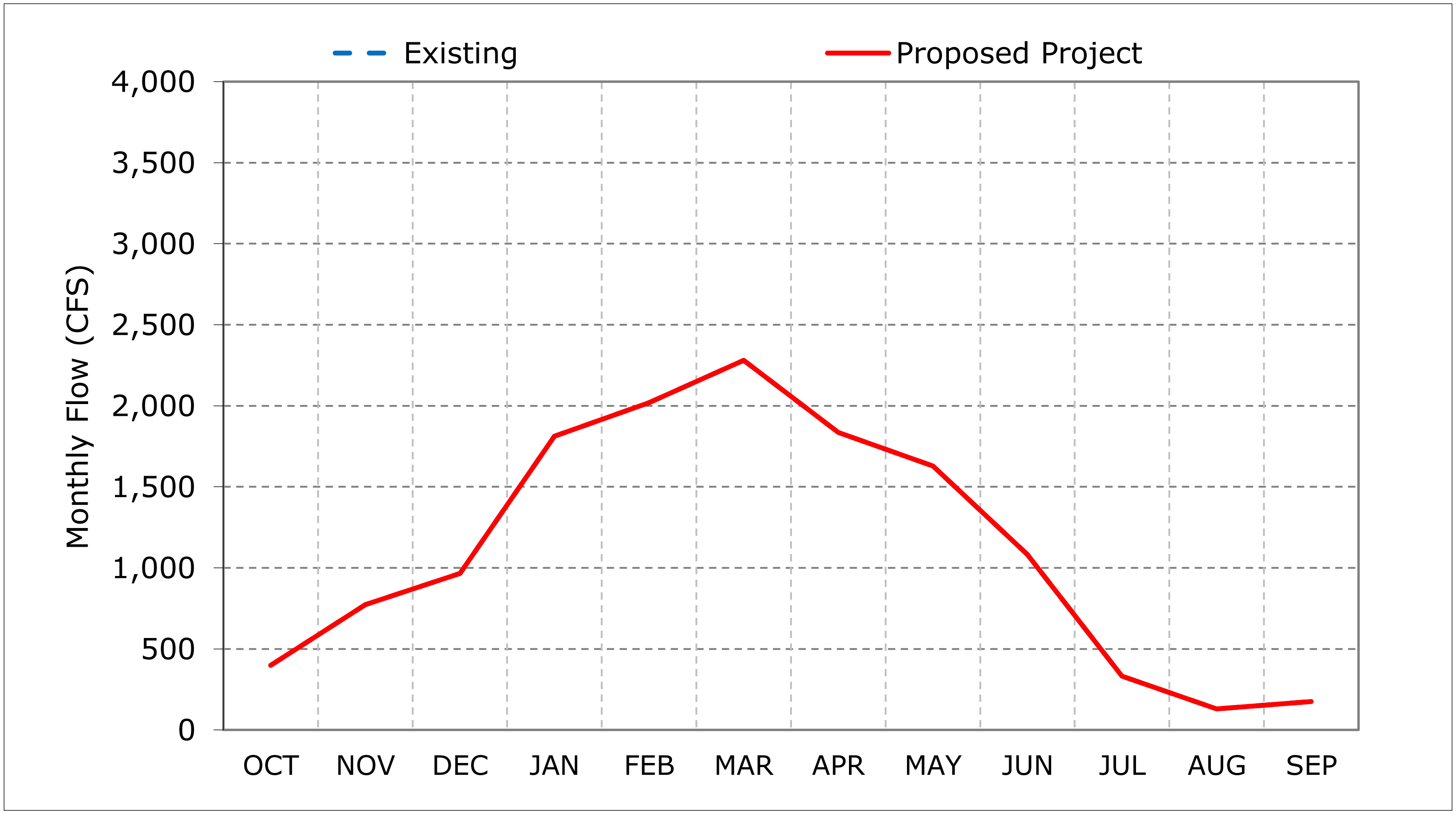
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 6-2. Mokelumne River below Consumnes, Wet Year Average Flow



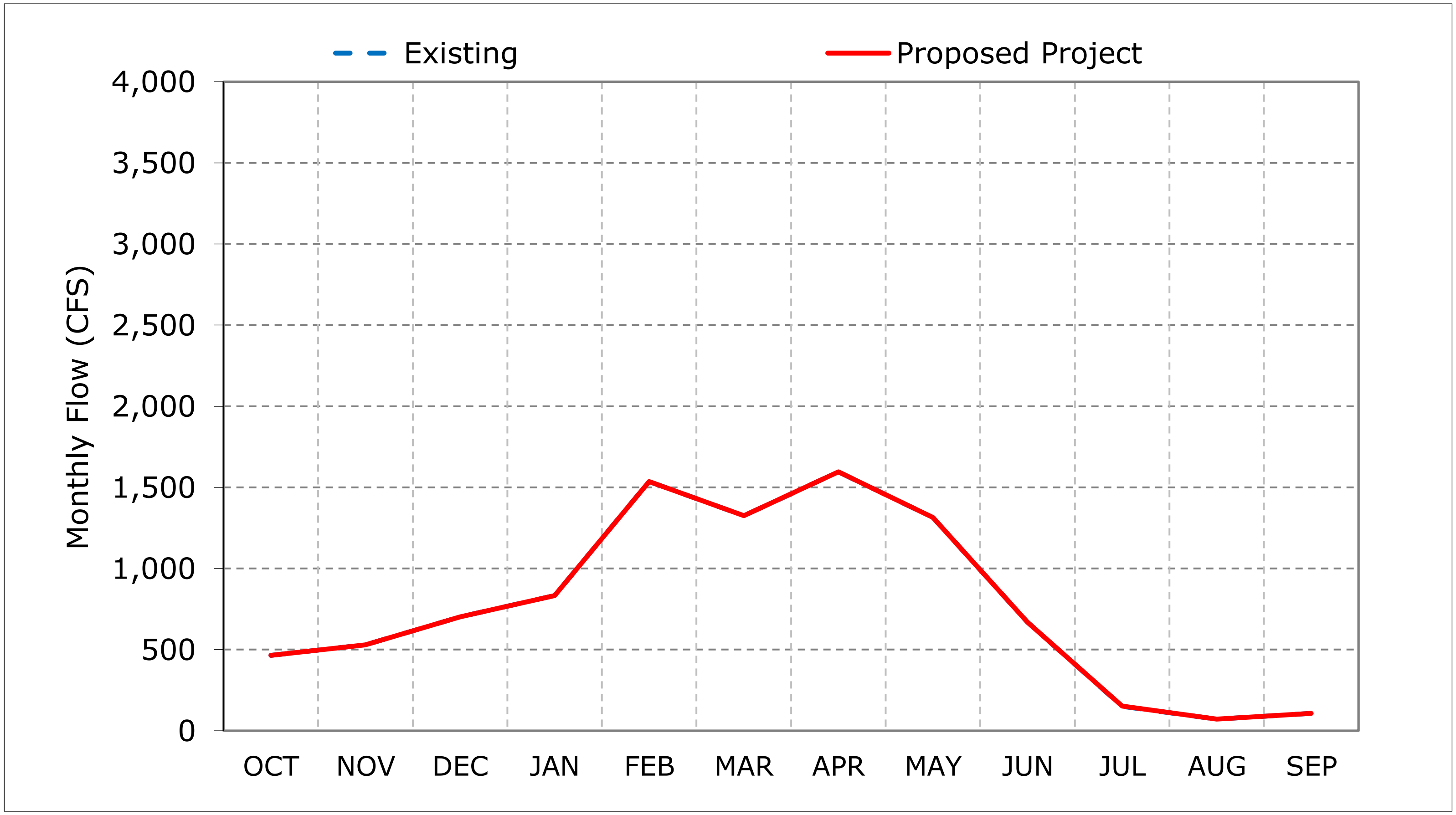
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 6-3. Mokelumne River below Consumnes, Above Normal Year Average Flow



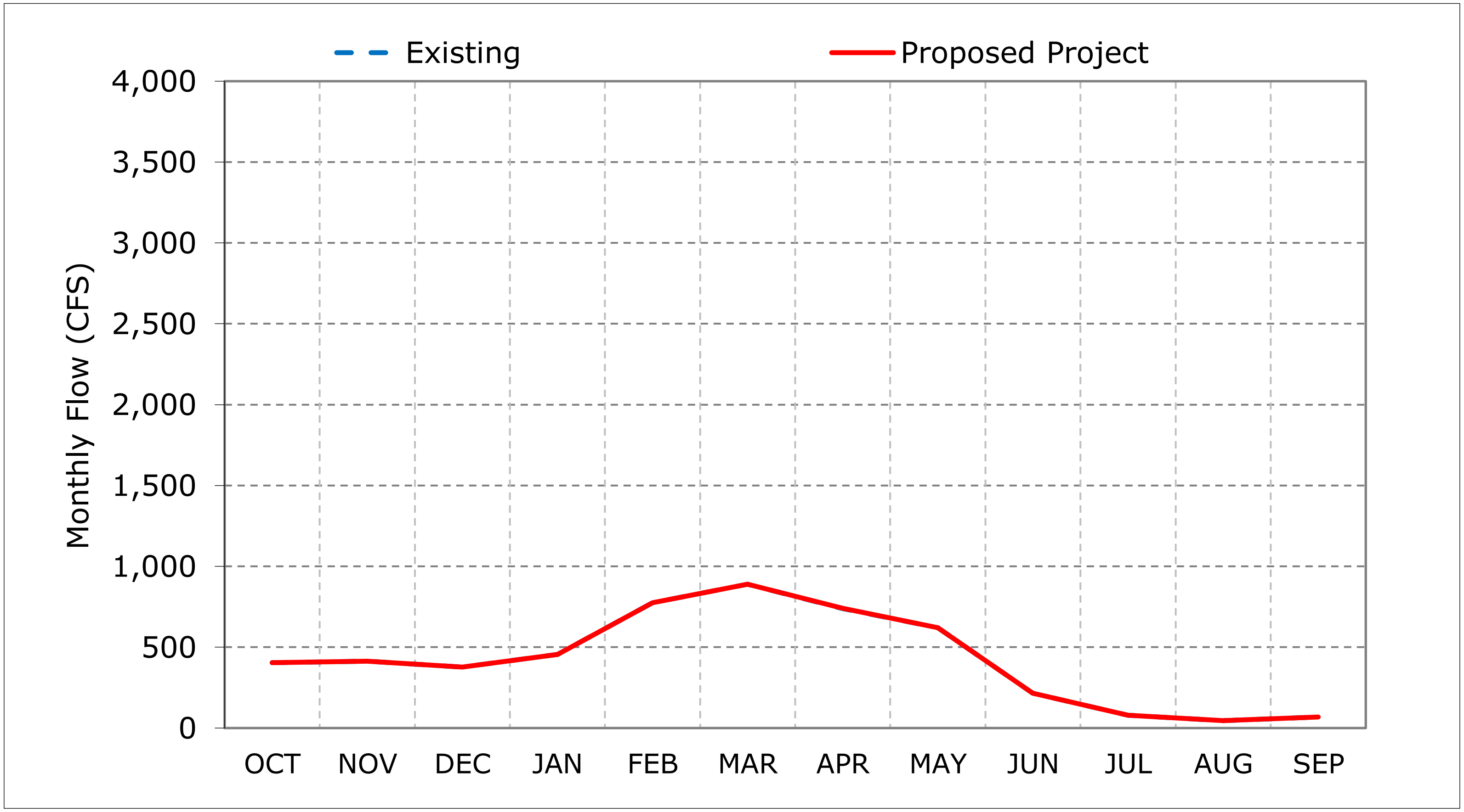
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 6-4. Mokelumne River below Consumnes, Below Normal Year Average Flow



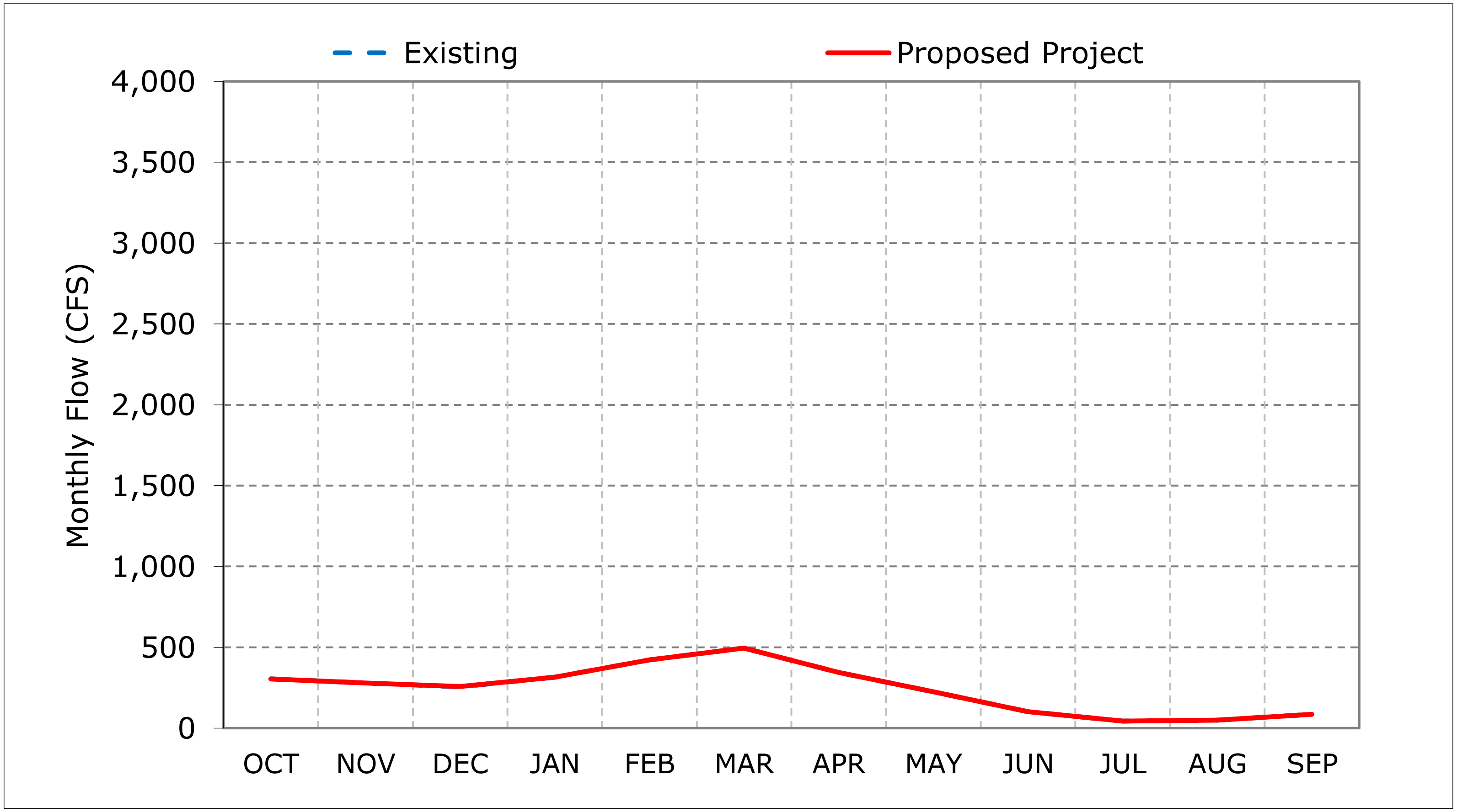
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 6-5. Mokelumne River below Consumnes, Dry Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 6-6. Mokelumne River below Consumnes, Critical Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 6-7. Mokelumne River below Consumnes, October

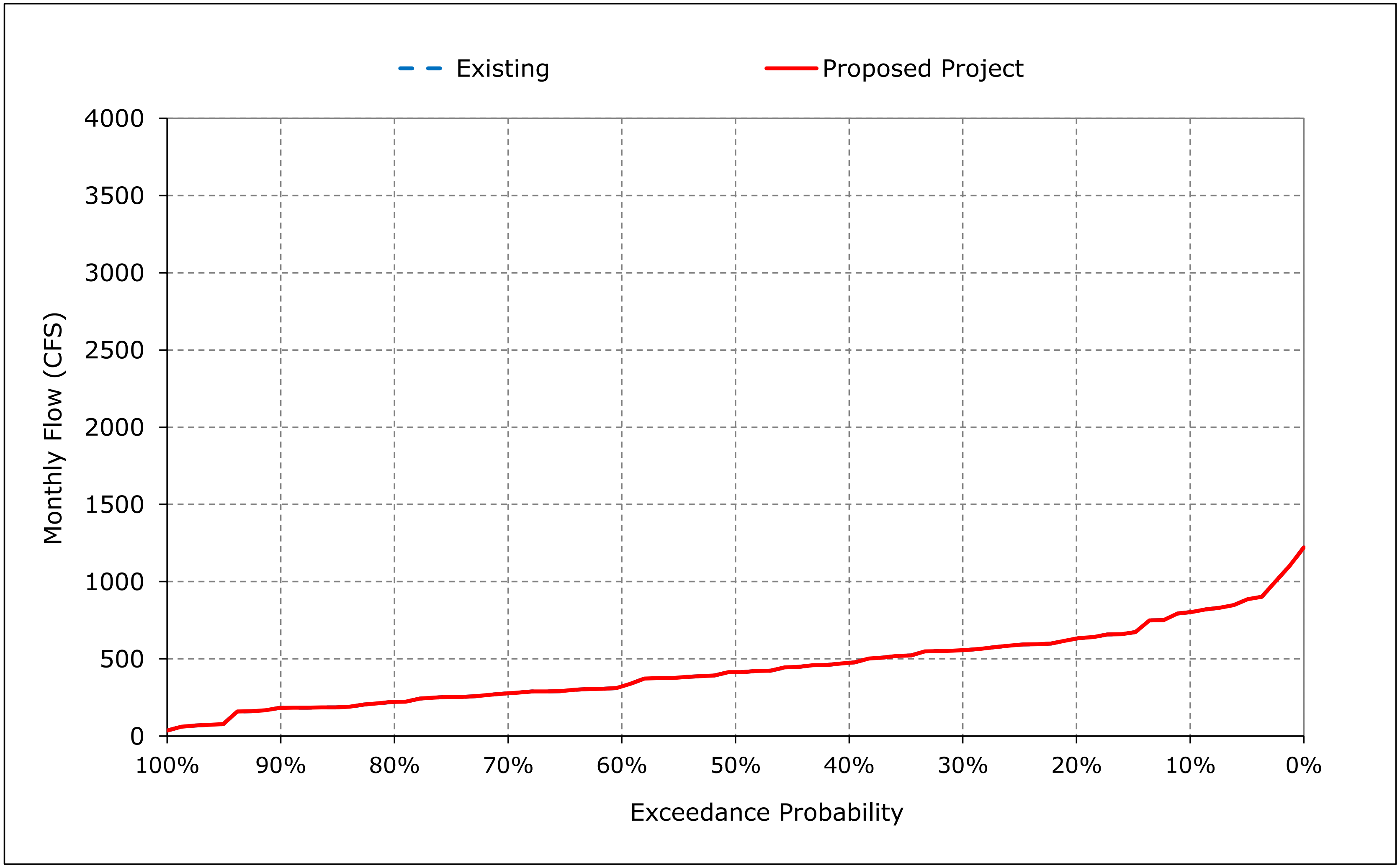


Figure 6-8. Mokelumne River below Consumnes, November

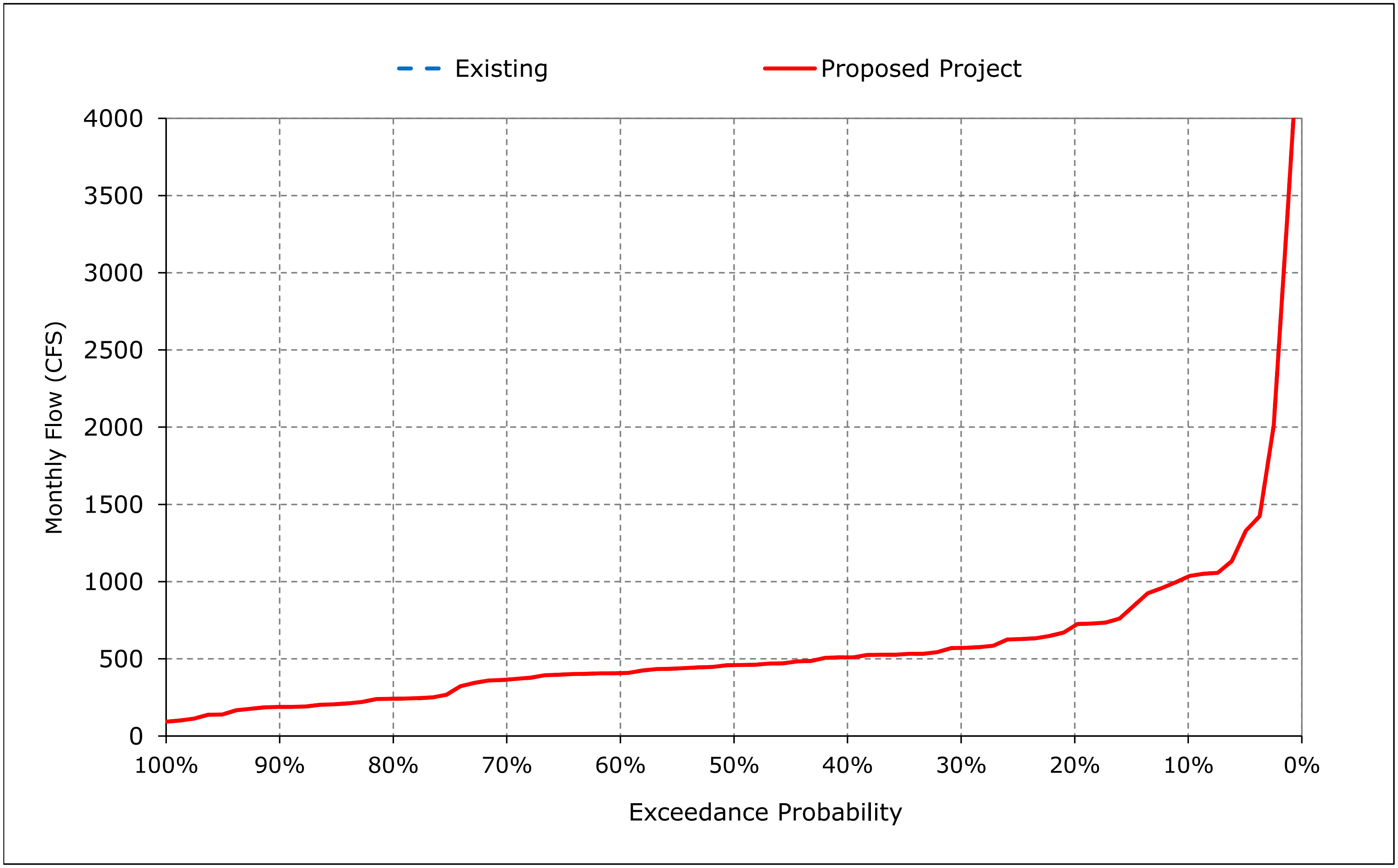


Figure 6-9. Mokelumne River below Consumnes, December

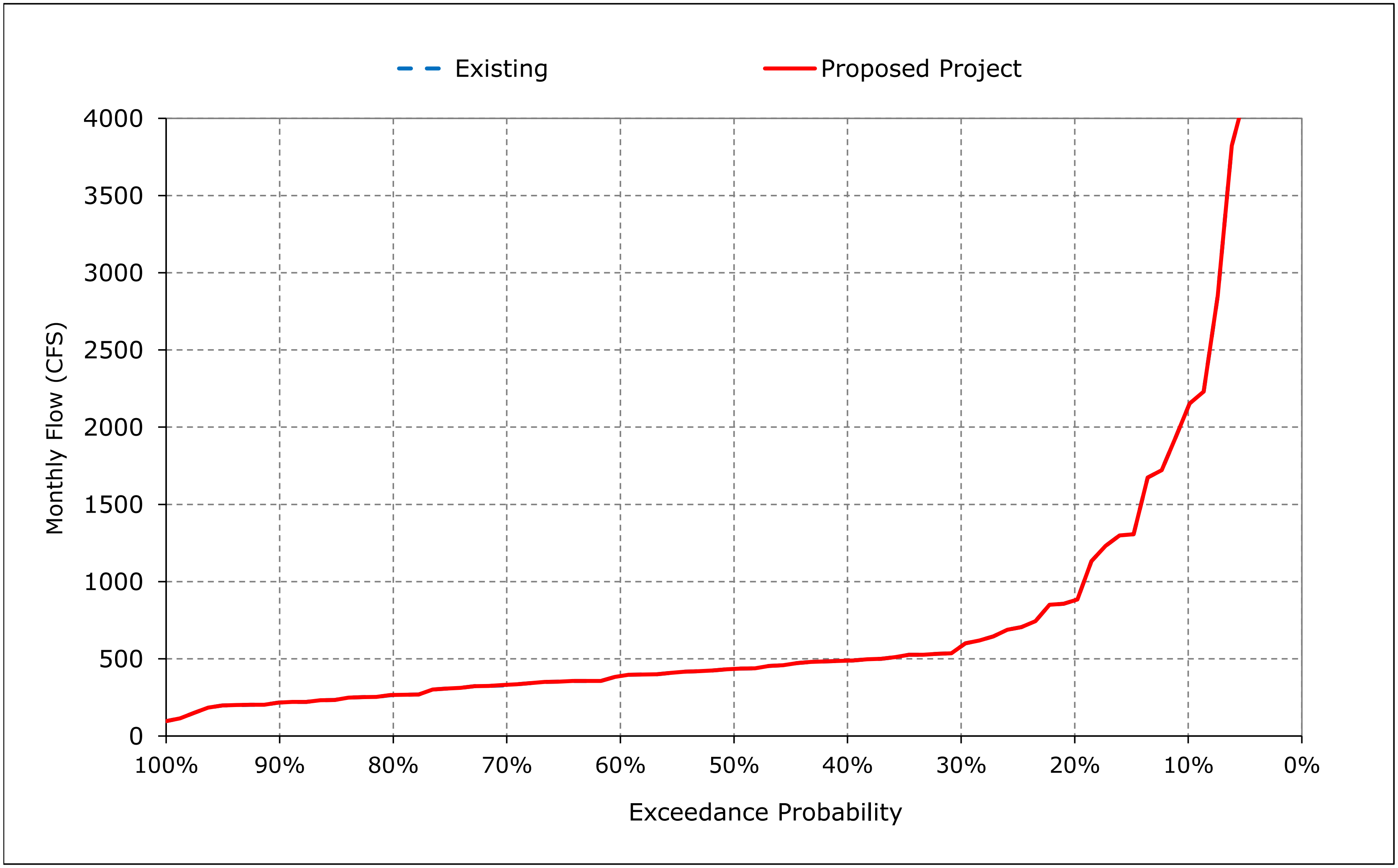


Figure 6-10. Mokelumne River below Consumnes, January

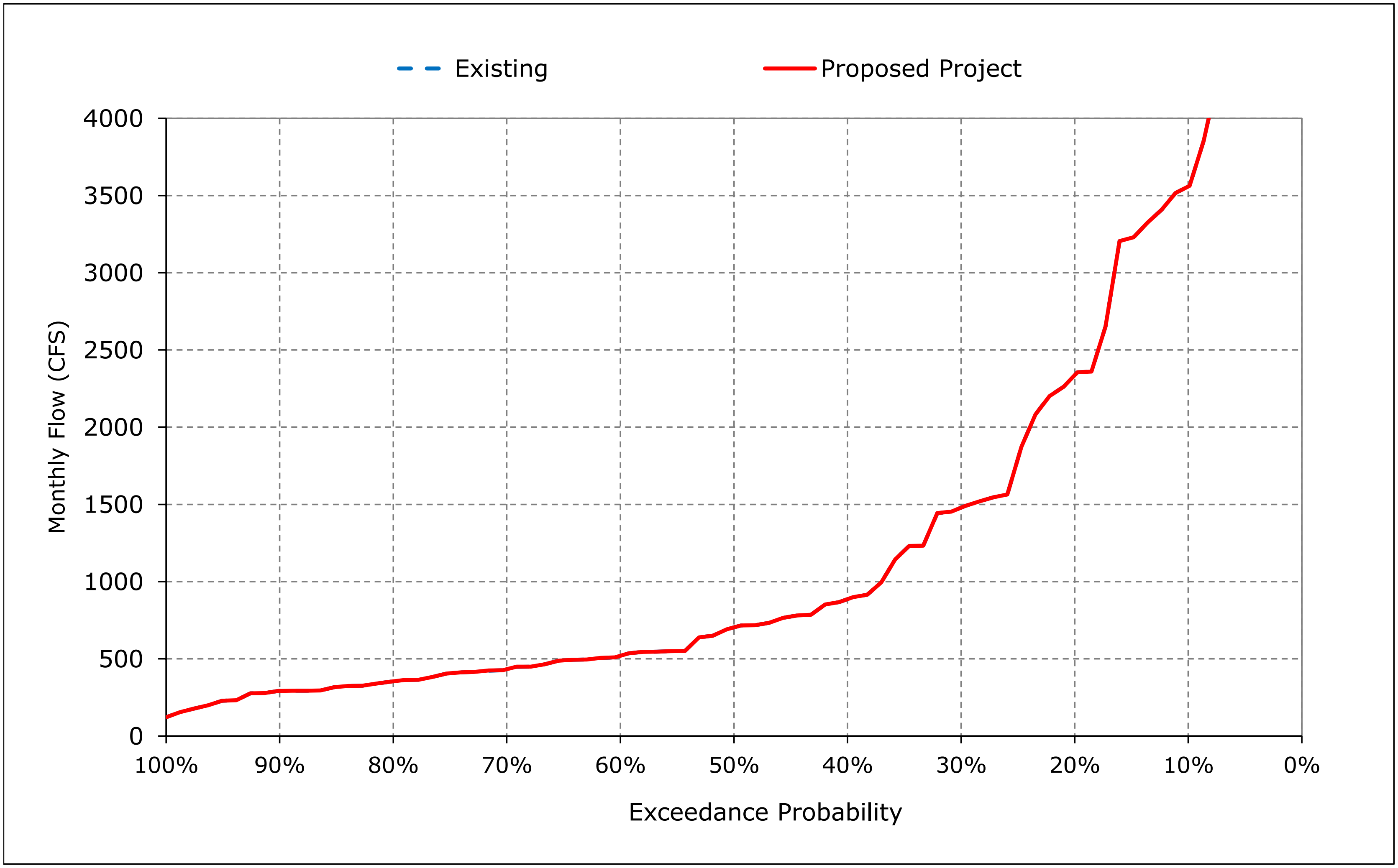


Figure 6-11. Mokelumne River below Consumnes, February

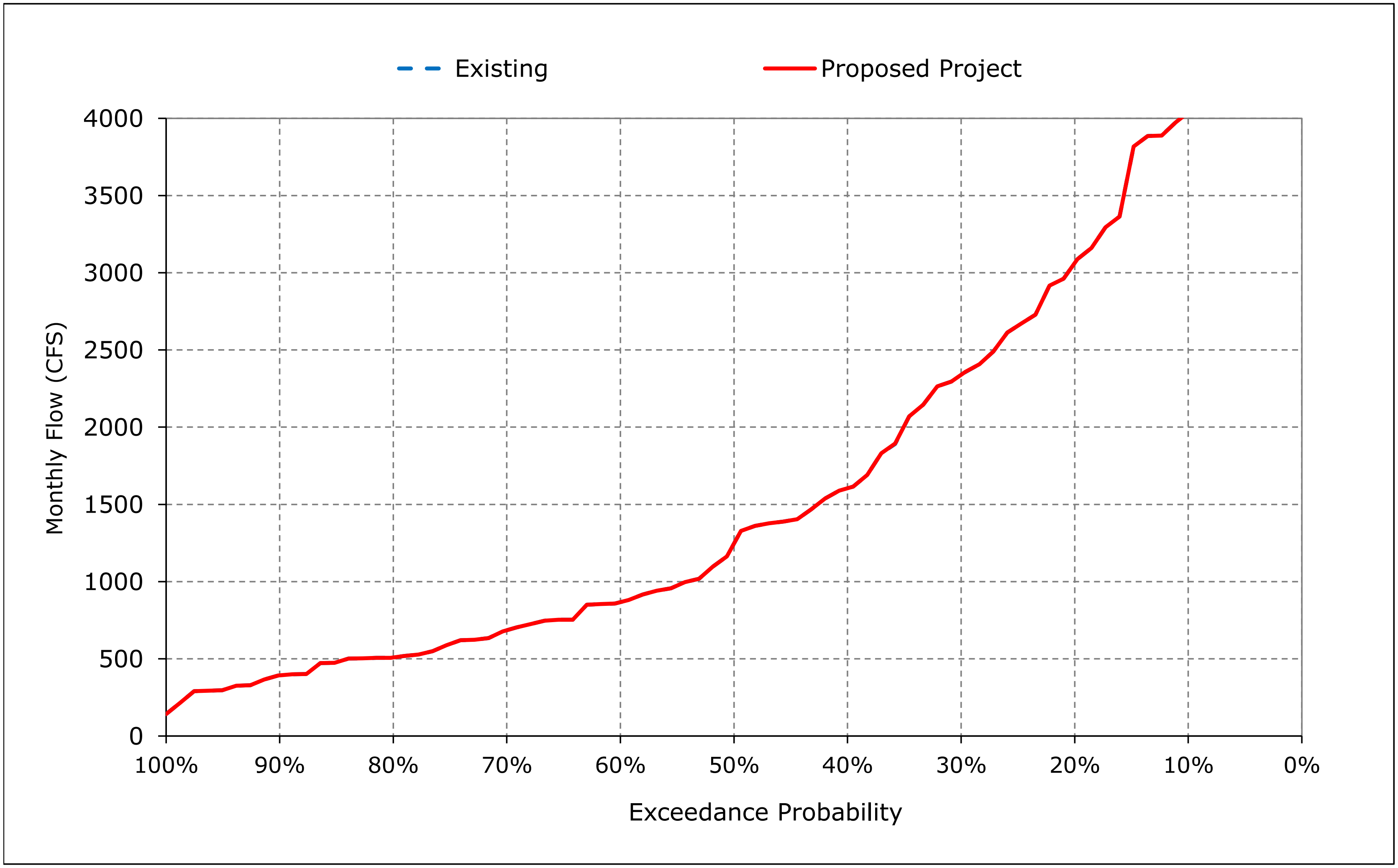


Figure 6-12. Mokelumne River below Consumnes, March

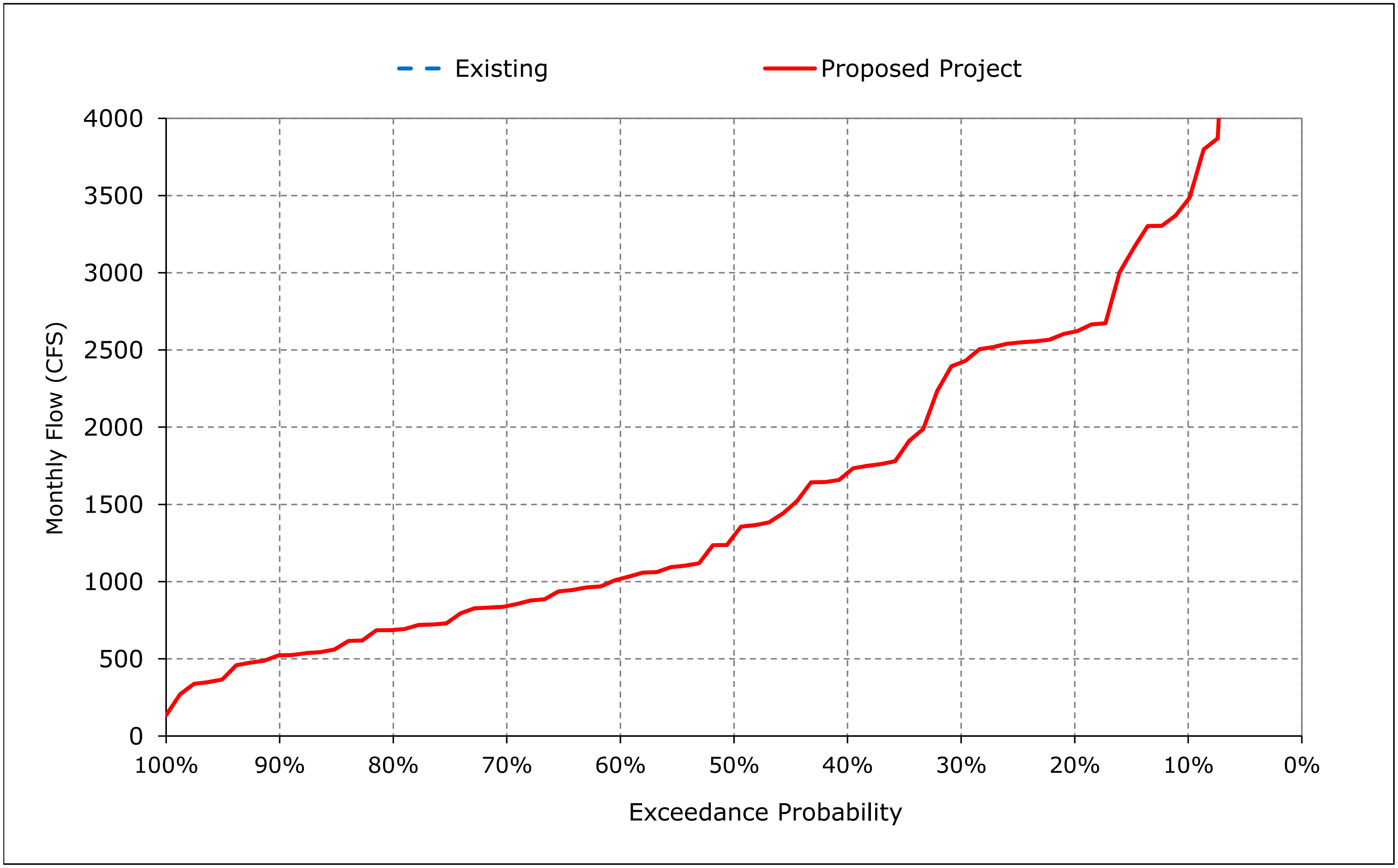


Figure 6-13. Mokelumne River below Consumnes, April

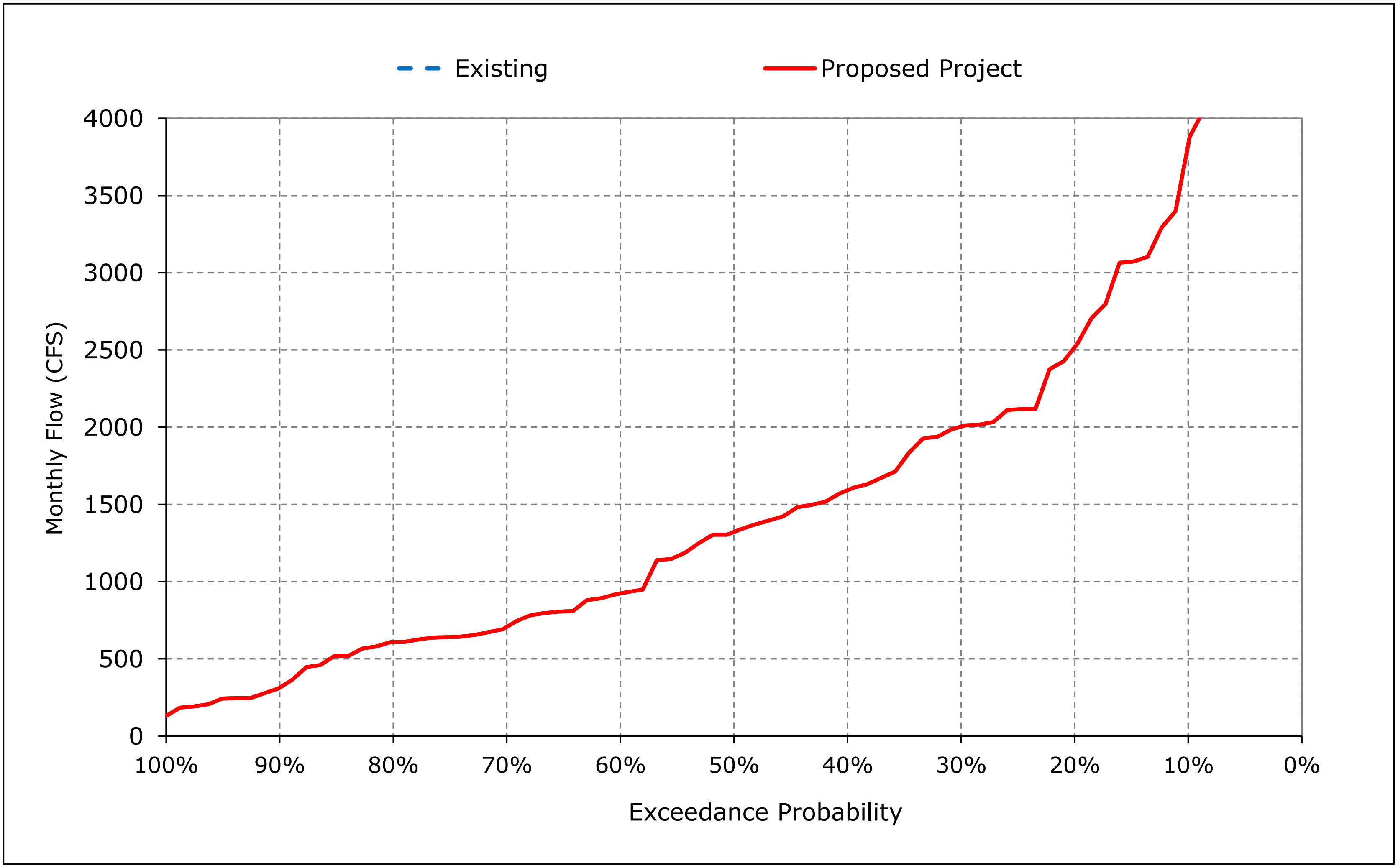


Figure 6-14. Mokelumne River below Consumnes, May

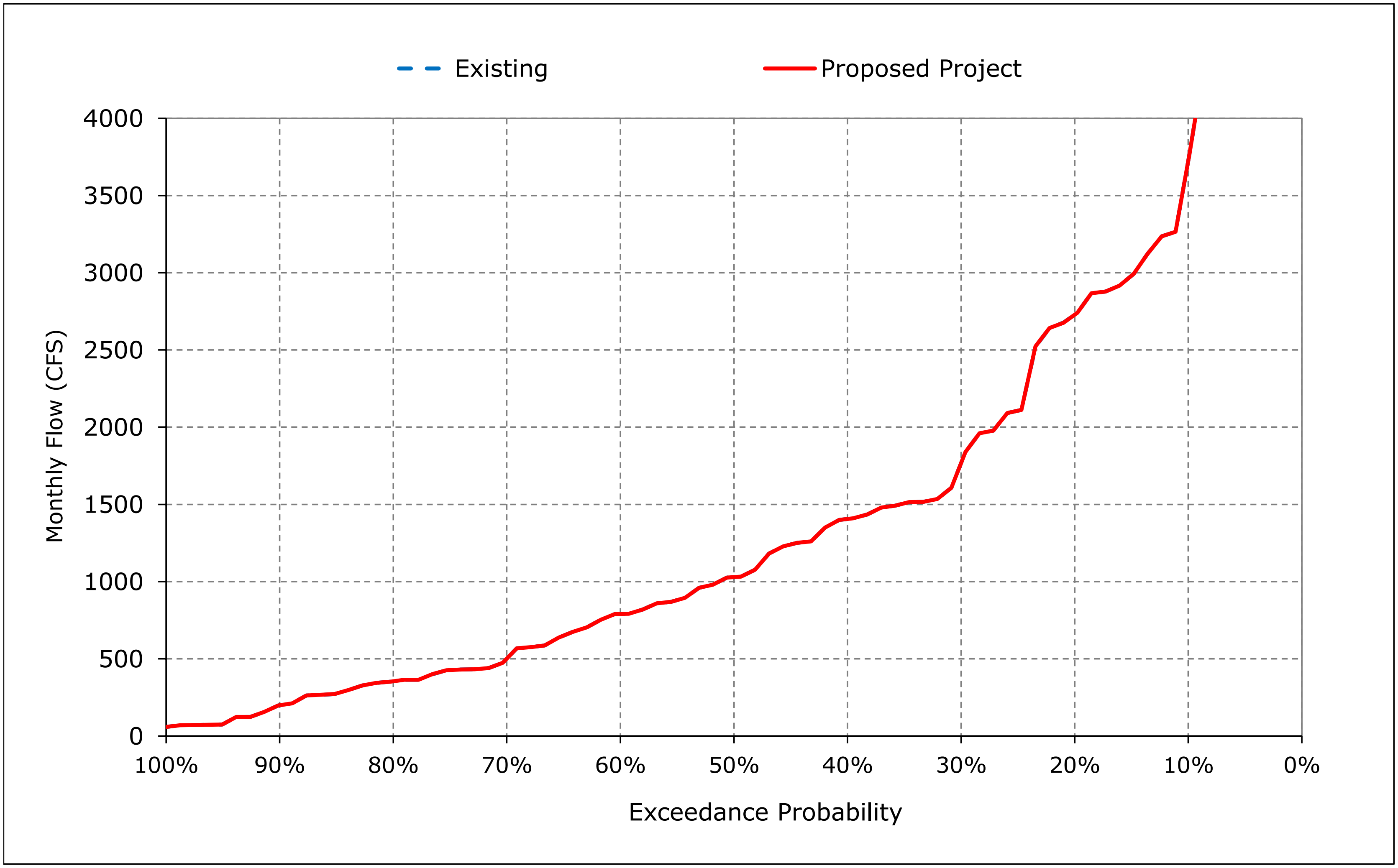


Figure 6-15. Mokelumne River below Consumnes, June

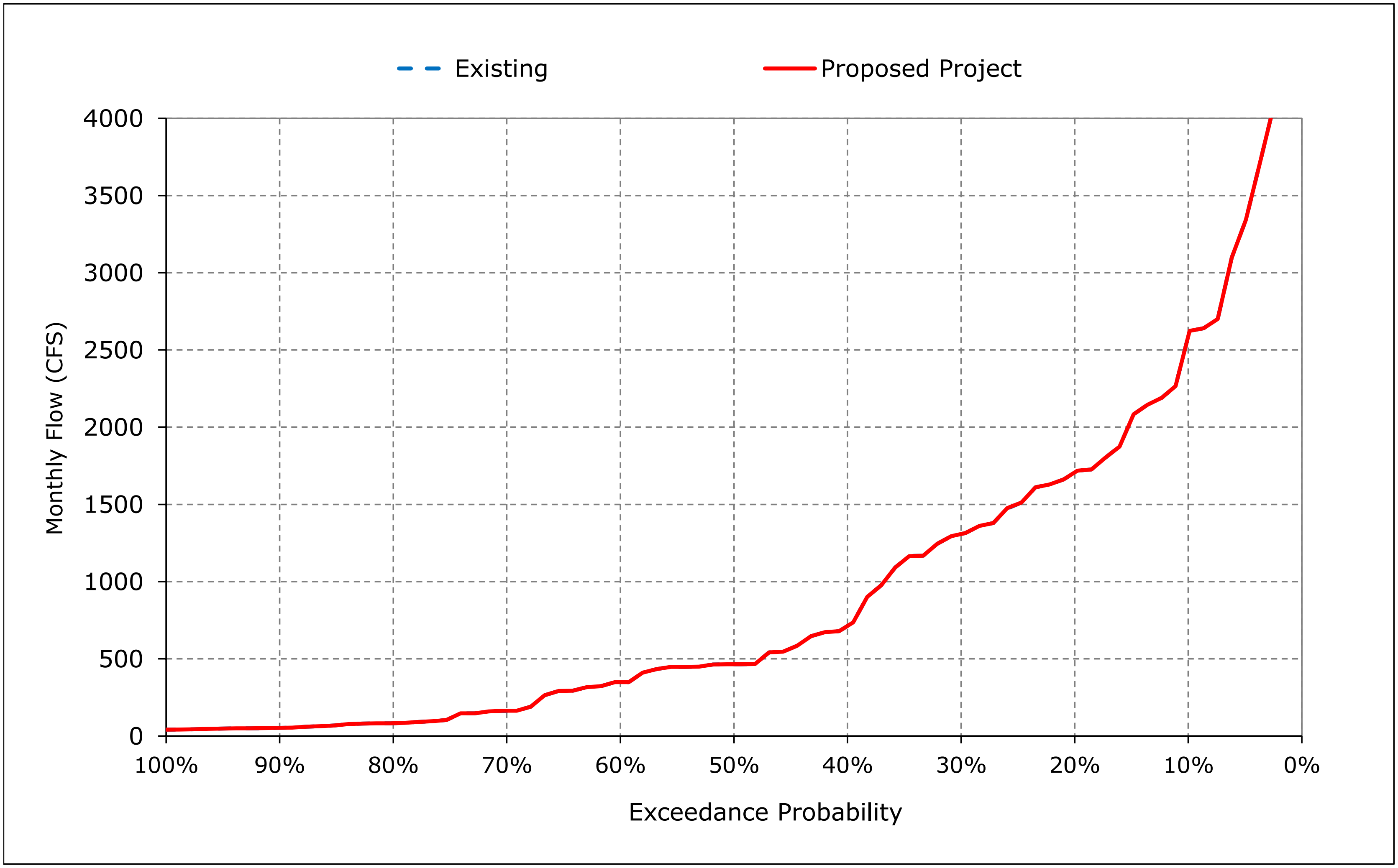


Figure 6-16. Mokelumne River below Consumnes, July

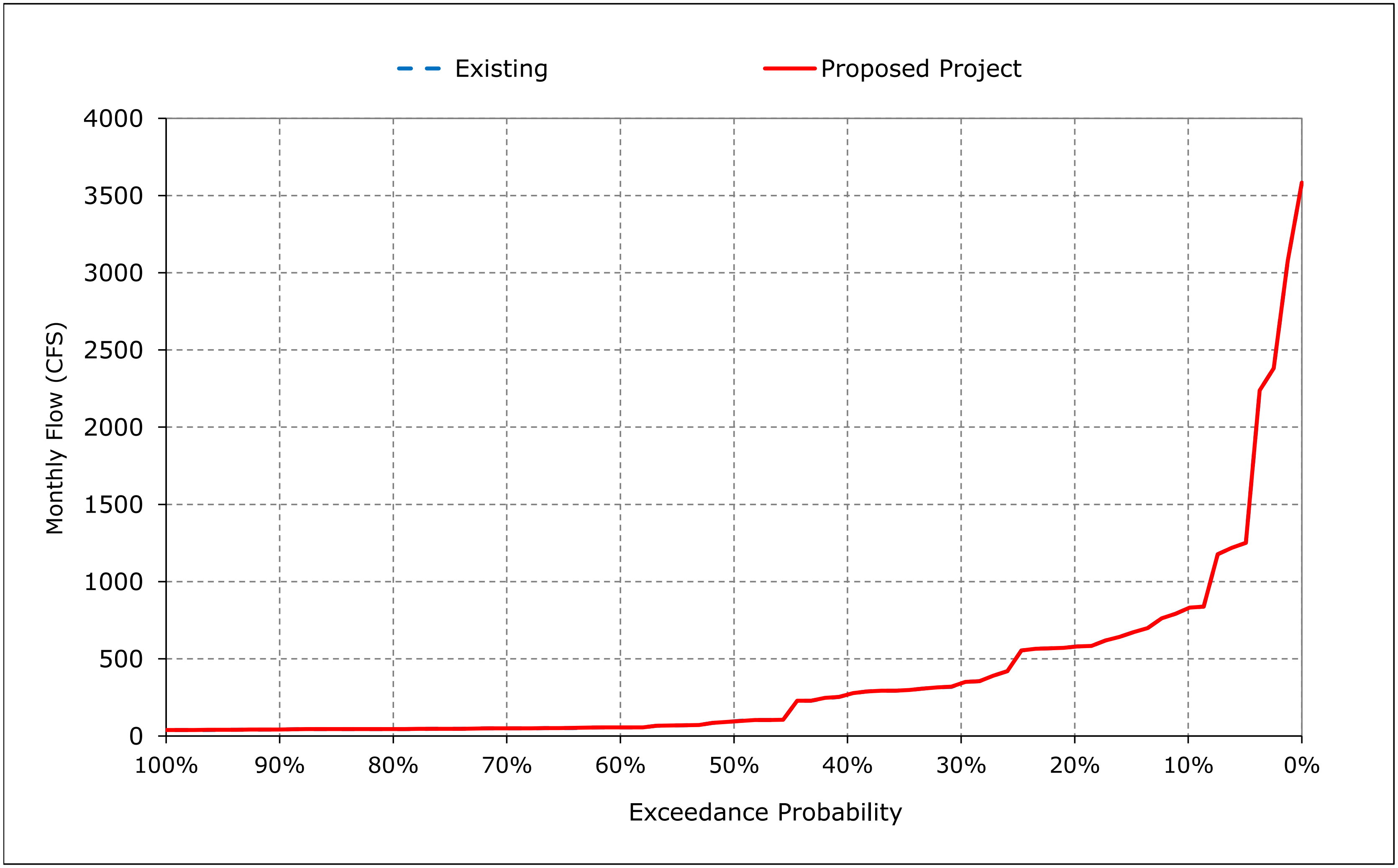


Figure 6-17. Mokelumne River below Consumnes, August

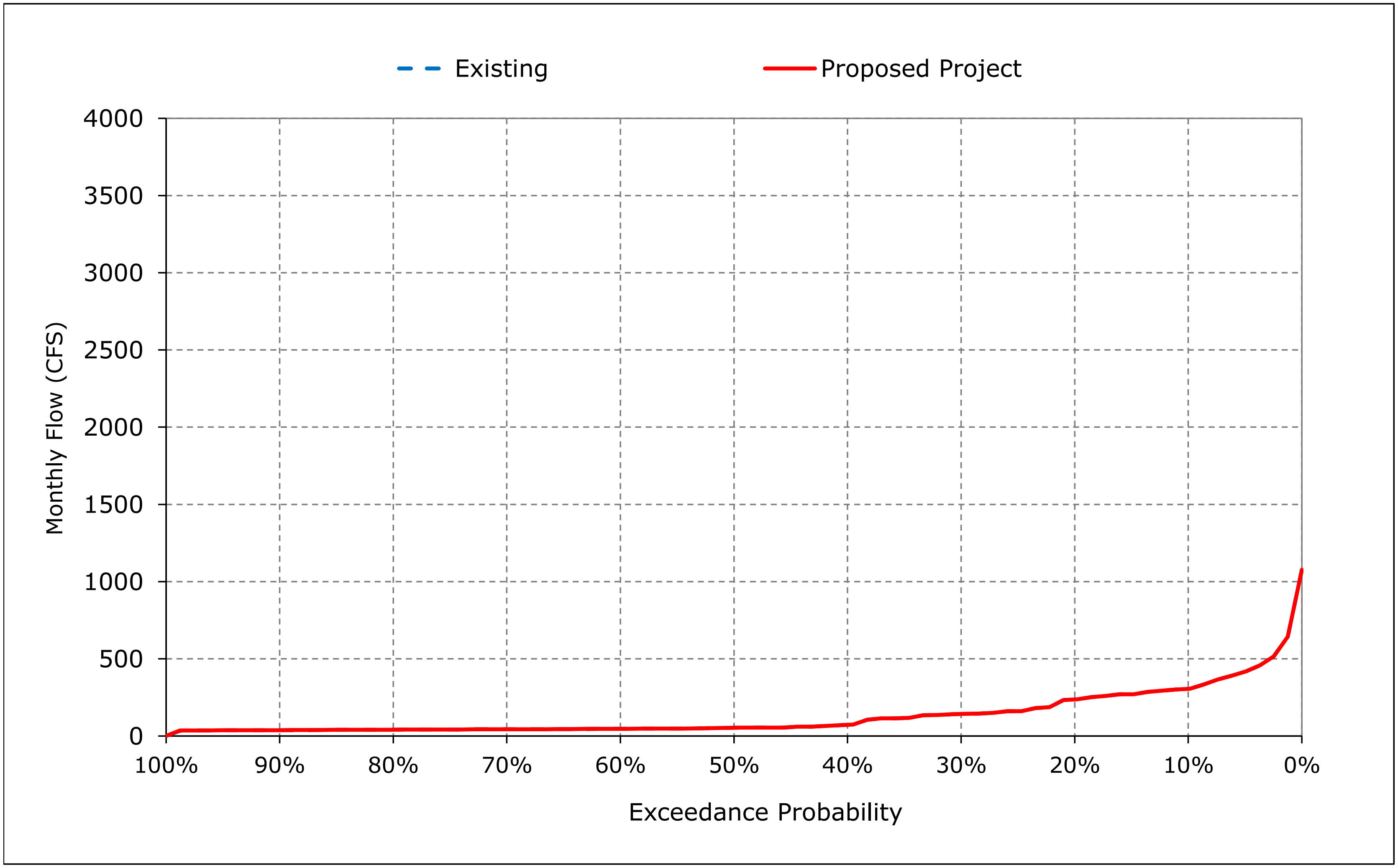


Figure 6-18. Mokelumne River below Consumnes, September

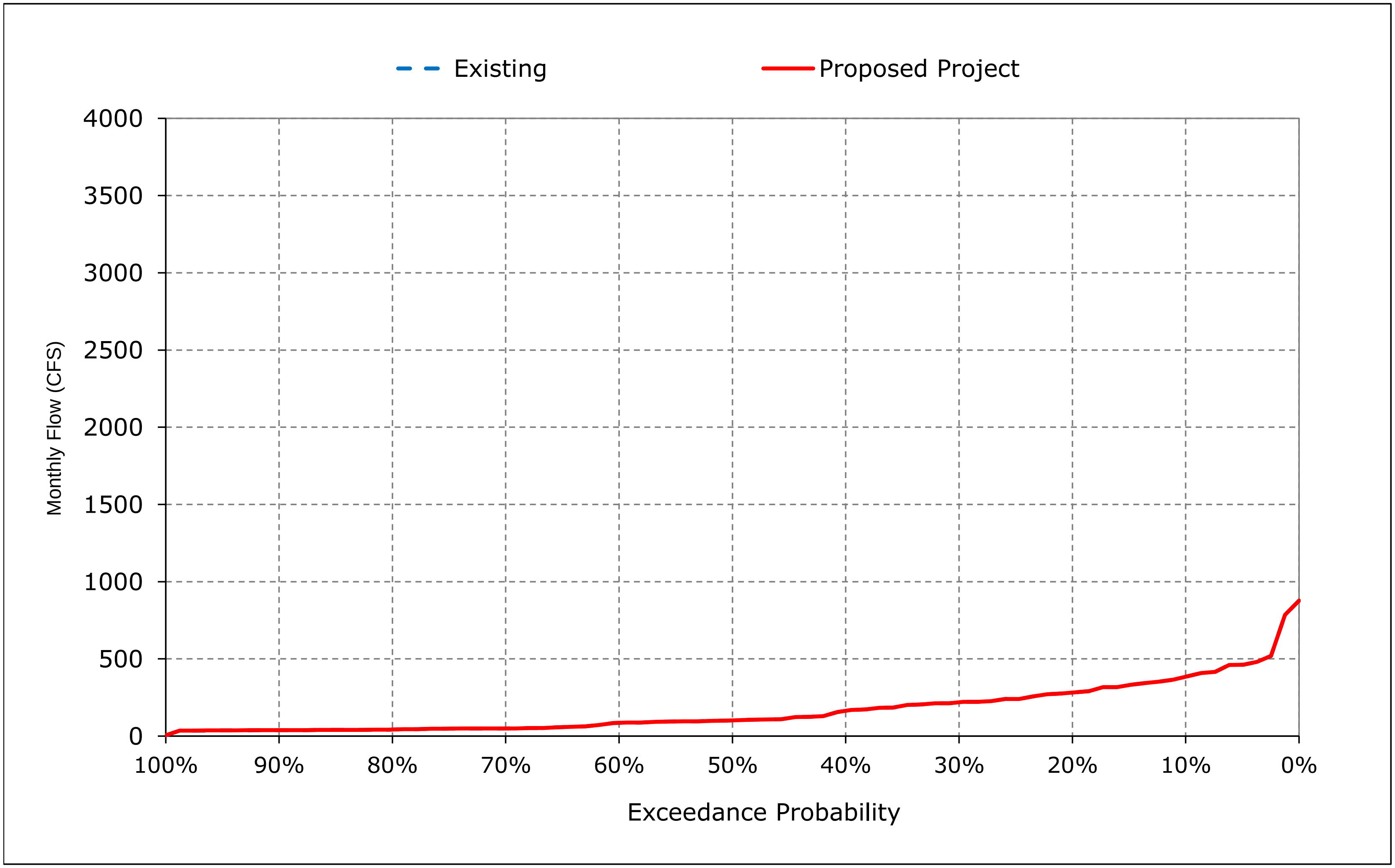


Table 7-1. Old and Middle River Flow, Monthly Flow (combined flows)

Existing

Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-3,881	-3,777	-4,457	-3,645	-3,332	-1,406	2,480	2,164	-2,590	-3,012	-3,262	-3,631
20%	-4,680	-4,317	-5,290	-3,645	-4,464	-3,539	1,530	1,037	-4,475	-5,673	-4,219	-5,827
30%	-5,019	-5,410	-5,290	-4,516	-4,464	-4,288	1,103	488	-5,000	-7,848	-5,410	-6,363
40%	-5,299	-5,958	-5,290	-4,516	-4,464	-4,371	594	-1,530	-5,000	-8,435	-8,514	-7,721
50%	-5,929	-6,405	-5,616	-4,516	-4,474	-4,371	-1,385	-1,706	-5,000	-9,287	-9,802	-8,906
60%	-6,394	-6,805	-6,374	-5,000	-4,483	-4,371	-1,592	-1,767	-5,000	-9,669	-10,268	-9,620
70%	-6,761	-7,651	-7,242	-5,000	-4,984	-4,371	-1,636	-1,796	-5,000	-10,199	-10,450	-9,841
80%	-7,446	-8,620	-9,502	-5,000	-5,000	-4,371	-1,743	-1,833	-5,000	-10,673	-10,558	-9,950
90%	-8,256	-10,054	-9,701	-5,000	-5,000	-4,371	-1,928	-1,977	-5,000	-10,901	-10,815	-10,152
Long Term												
Full Simulation Period[a]	-6,004	-6,570	-6,394	-4,029	-4,014	-3,219	-43	-582	-4,532	-8,245	-7,927	-7,854
Water Year Types[b,c]												
Wet (32%)	-6,495	-7,433	-5,515	-2,766	-2,728	-1,815	1,945	812	-4,667	-8,739	-10,214	-9,567
Above Normal (15%)	-5,955	-6,478	-7,343	-4,274	-4,248	-3,761	104	-383	-4,967	-9,553	-10,592	-9,992
Below Normal (17%)	-6,003	-6,910	-7,000	-4,578	-4,649	-4,294	-415	-695	-4,973	-10,256	-9,703	-8,760
Dry (22%)	-5,844	-6,372	-7,004	-4,889	-4,709	-4,151	-1,586	-1,773	-4,727	-8,401	-4,339	-6,036
Critical (15%)	-5,232	-4,692	-5,727	-4,588	-4,787	-3,067	-1,748	-1,881	-2,998	-3,286	-3,621	-3,678

Proposed Project

Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-3,159	-3,418	-4,037	-3,645	-2,977	-1,144	-838	-1,353	-2,588	-2,886	-3,402	-3,537
20%	-3,935	-4,497	-5,267	-3,645	-4,464	-3,258	-1,677	-1,792	-4,333	-4,885	-4,546	-5,432
30%	-4,264	-5,333	-5,290	-4,516	-4,464	-3,258	-1,888	-2,197	-5,000	-7,628	-5,633	-5,976
40%	-4,663	-6,337	-5,290	-4,516	-4,464	-3,258	-2,026	-2,571	-5,000	-8,136	-7,927	-6,740
50%	-6,059	-7,452	-5,320	-4,516	-4,466	-3,258	-2,352	-2,897	-5,000	-8,951	-9,532	-7,407
60%	-6,549	-8,886	-6,461	-5,000	-4,483	-3,258	-2,538	-3,241	-5,000	-9,552	-10,098	-8,662
70%	-6,933	-9,101	-7,976	-5,226	-5,000	-3,258	-2,926	-3,557	-5,000	-10,007	-10,441	-9,284
80%	-7,355	-9,253	-9,447	-5,226	-5,193	-3,258	-3,109	-3,760	-5,000	-10,414	-10,580	-9,507
90%	-8,244	-9,373	-9,699	-5,226	-5,250	-3,500	-3,260	-4,061	-5,000	-10,816	-10,844	-9,660
Long Term												
Full Simulation Period[a]	-5,655	-6,916	-6,413	-3,967	-3,901	-2,466	-1,948	-2,622	-4,491	-7,964	-7,929	-7,292
Water Year Types[b,c]												
Wet (32%)	-6,267	-7,818	-5,512	-2,373	-2,270	-955	-1,208	-2,388	-4,629	-8,548	-10,134	-8,733
Above Normal (15%)	-5,951	-6,950	-7,391	-4,331	-3,985	-2,755	-2,740	-3,585	-4,961	-9,713	-10,525	-9,339
Below Normal (17%)	-5,725	-7,415	-6,970	-4,707	-4,787	-3,238	-2,495	-3,268	-4,959	-9,485	-9,414	-8,182
Dry (22%)	-5,342	-6,276	-7,274	-5,061	-4,918	-3,289	-2,300	-2,548	-4,668	-7,739	-4,457	-5,653
Critical (15%)	-4,422	-5,307	-5,447	-4,553	-4,794	-3,316	-1,592	-1,522	-2,909	-3,512	-4,031	-3,545

Proposed Project minus Existing

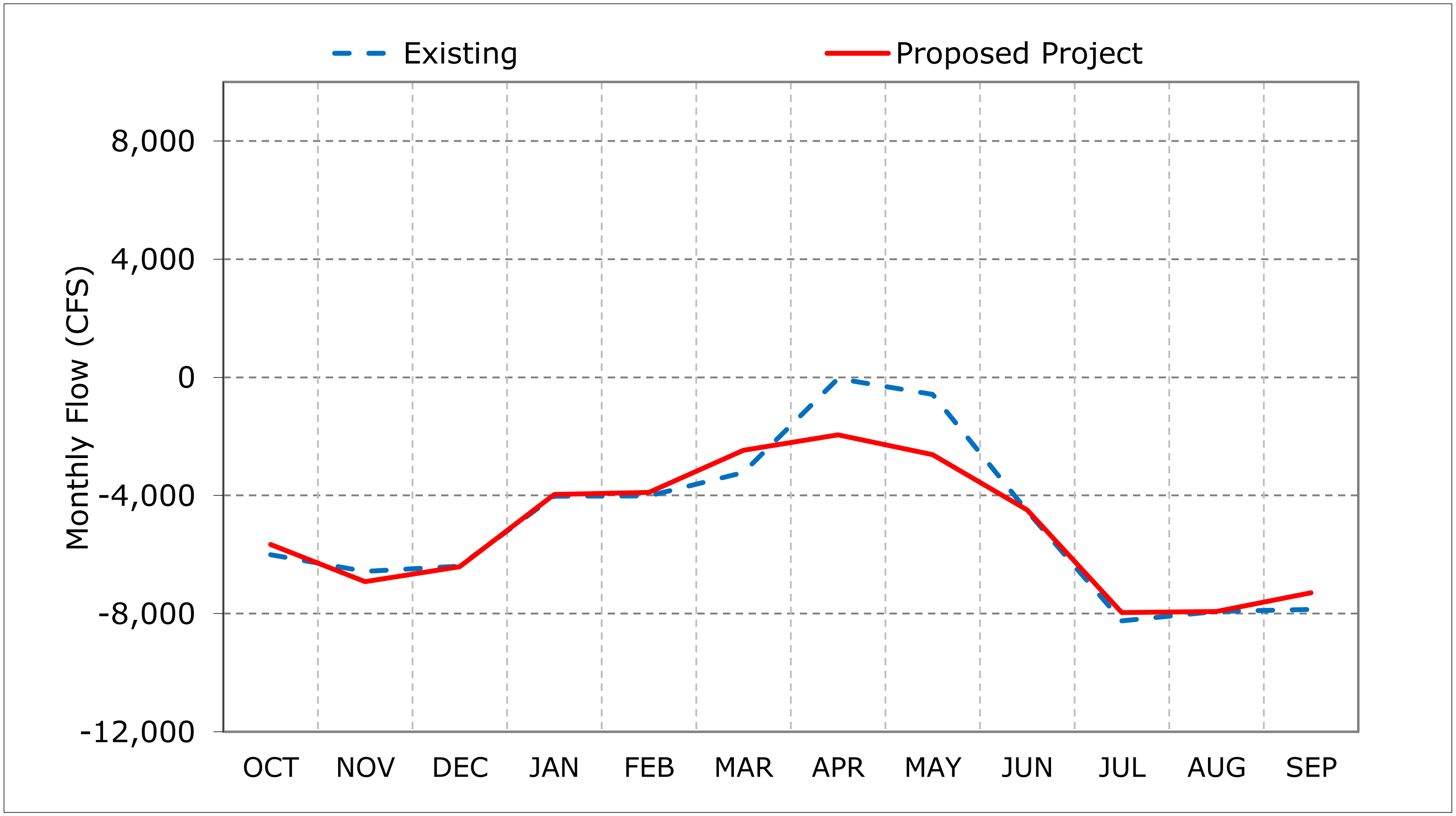
Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	722	358	420	0	354	262	**-3,318**	**-3,517**	2	126	**-141**	94
20%	745	**-180**	23	0	0	281	**-3,207**	**-2,830**	142	787	**-327**	395
30%	755	78	0	0	0	1,030	**-2,991**	**-2,685**	0	220	**-224**	387
40%	636	**-379**	0	0	0	1,113	**-2,620**	**-1,041**	0	300	587	981
50%	**-131**	**-1,046**	297	0	8	1,113	**-967**	**-1,191**	0	336	271	1,499
60%	**-155**	**-2,081**	**-87**	0	0	1,113	**-946**	**-1,475**	0	117	170	958
70%	**-172**	**-1,450**	**-734**	**-226**	**-16**	1,113	**-1,290**	**-1,762**	0	193	9	557
80%	91	**-633**	55	**-226**	**-193**	1,113	**-1,366**	**-1,928**	0	259	**-22**	443
90%	12	681	2	**-226**	**-250**	871	**-1,332**	**-2,084**	0	86	**-29**	492
Long Term												
Full Simulation Period[a]	349	**-346**	**-19**	61	113	753	**-1,905**	**-2,040**	41	281	**-2**	562
Water Year Types[b,c]												
Wet (32%)	228	**-385**	3	392	457	859	**-3,154**	**-3,200**	39	191	80	834
Above Normal (15%)	4	**-472**	**-48**	**-56**	262	1,005	**-2,844**	**-3,202**	6	**-159**	67	653
Below Normal (17%)	278	**-505**	30	**-129**	**-137**	1,056	**-2,080**	**-2,573**	13	772	289	579
Dry (22%)	503	96	**-270**	**-173**	**-209**	862	**-714**	**-775**	59	662	**-119**	383
Critical (15%)	810	**-615**	280	36	**-7**	**-250**	156	359	89	**-227**	**-411**	133

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

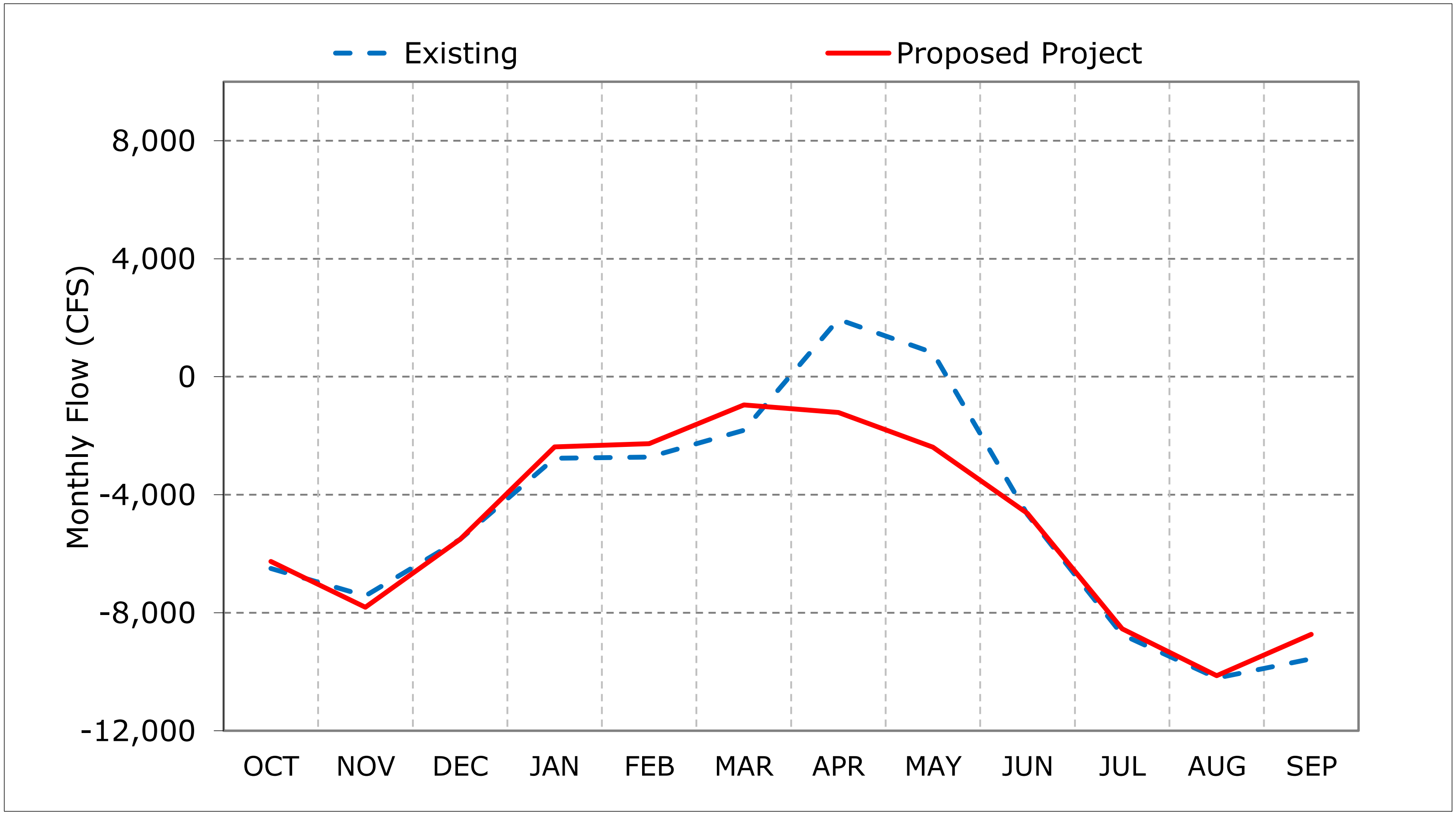
c These results are displayed with water year - year type sorting.

Figure 7-1. Old and Middle River Flow, Long-Term Average Flow



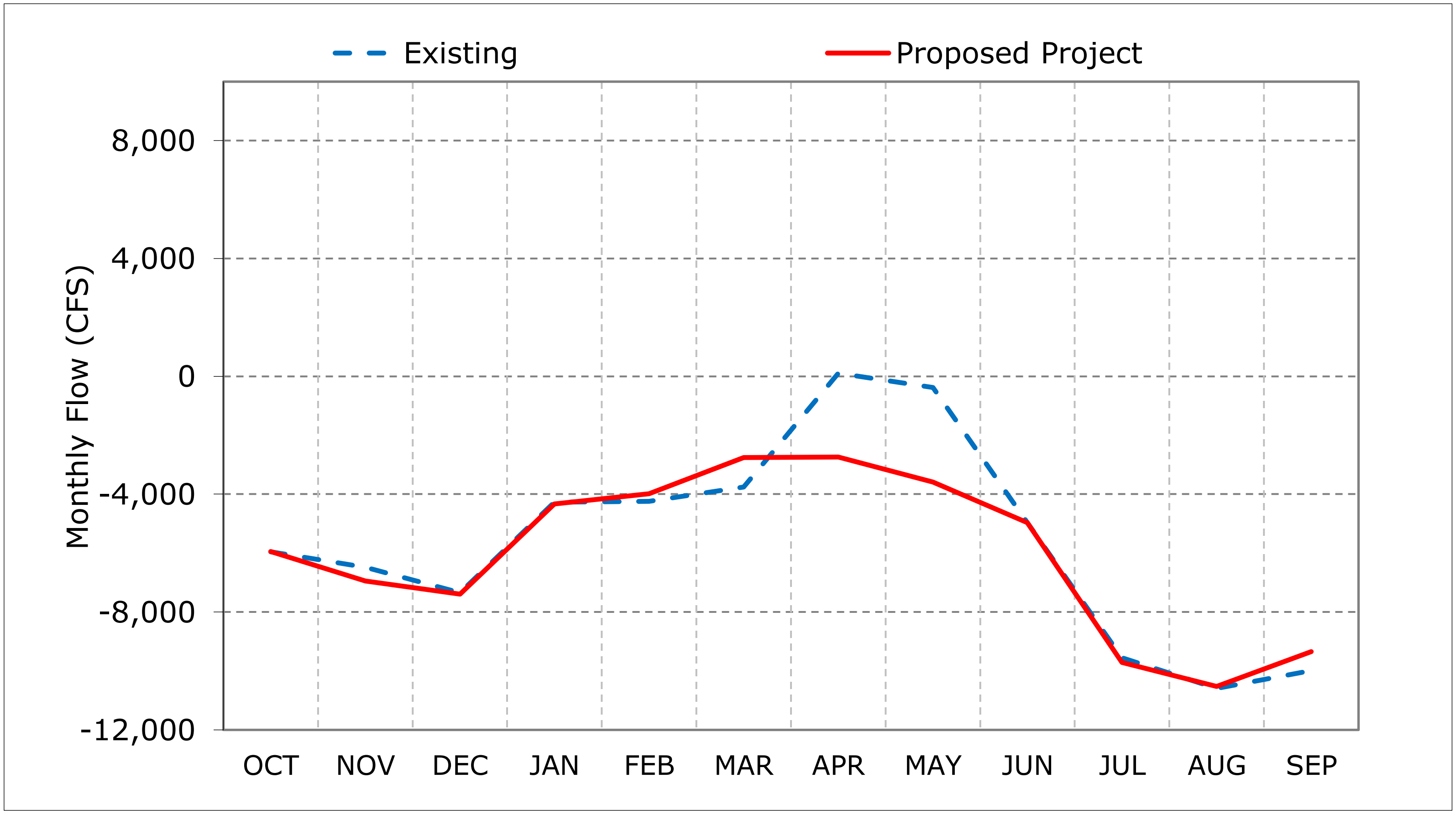
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 7-2. Old and Middle River Flow, Wet Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

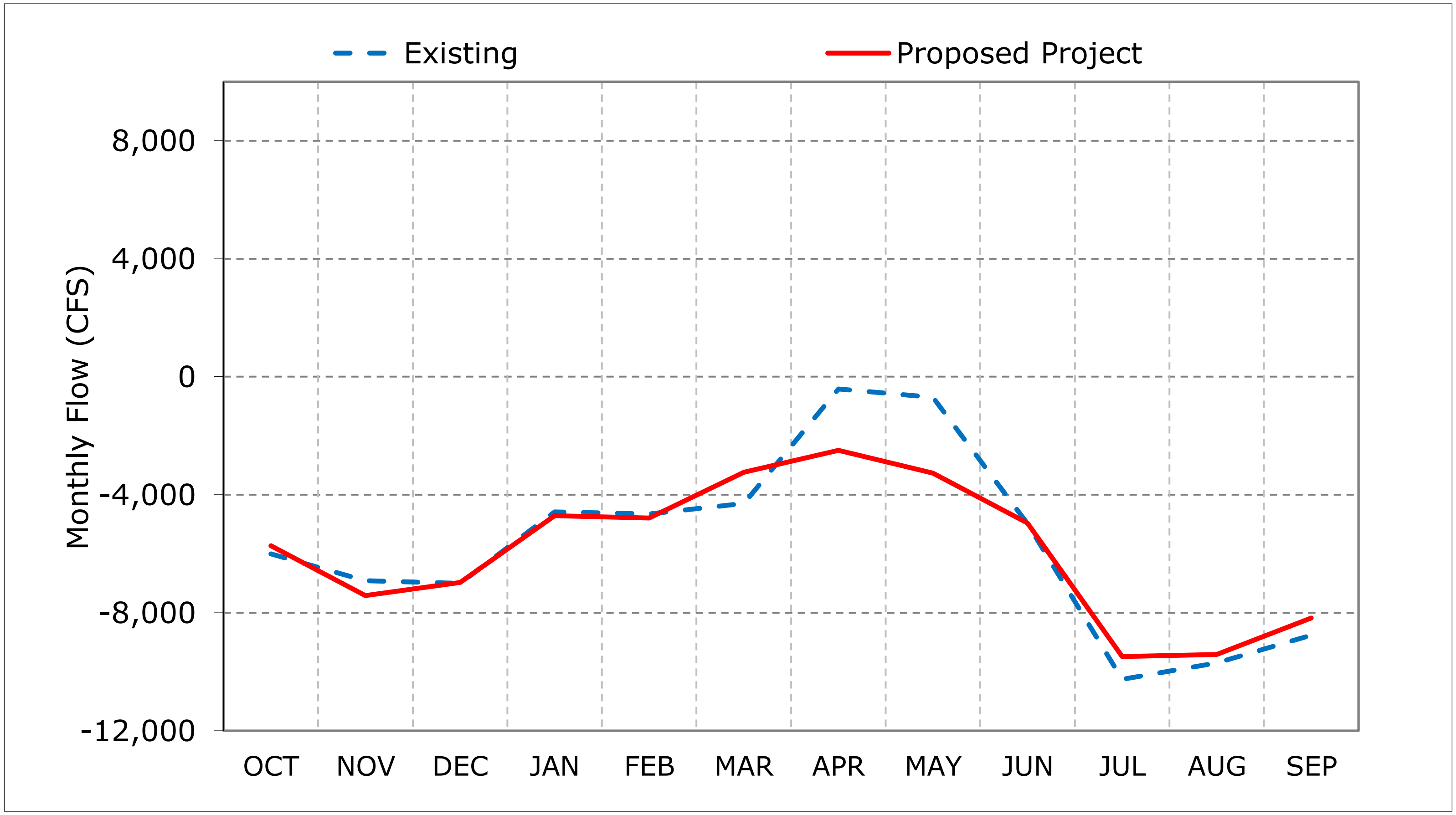
Figure 7-3. Old and Middle River Flow, Above Normal Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164

*These results are displayed with water year - year type sorting.

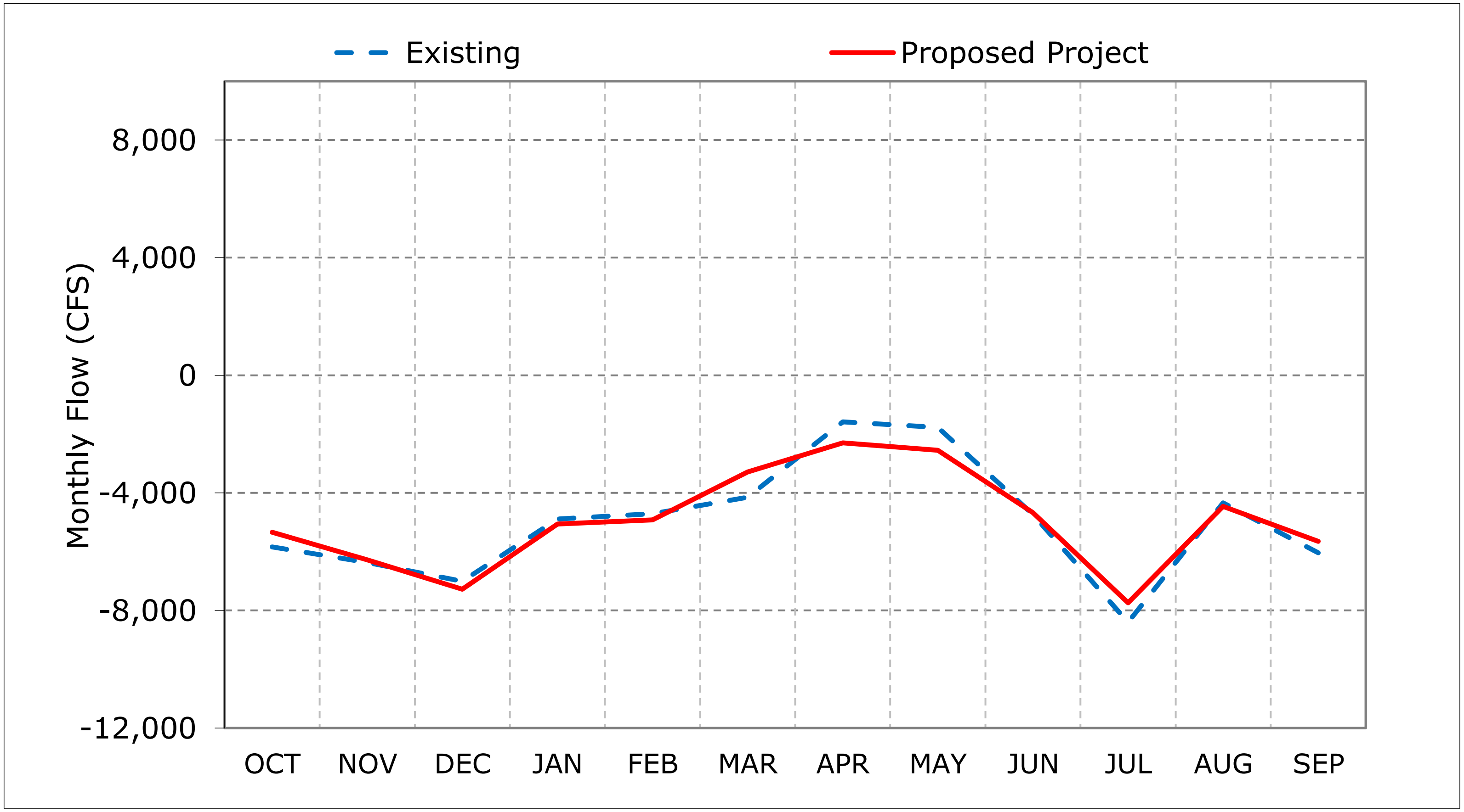
Figure 7-4. Old and Middle River Flow, Below Normal Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164

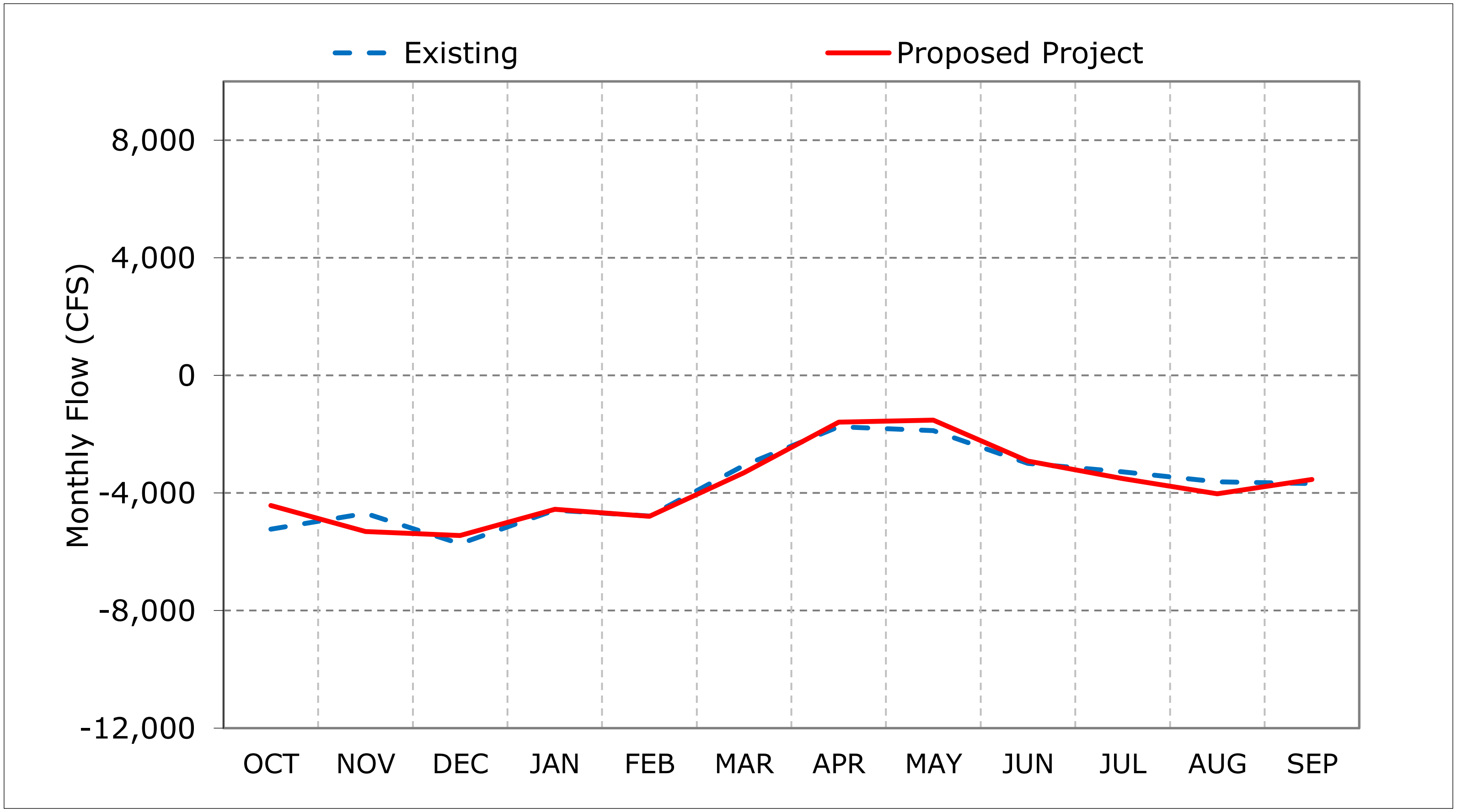
*These results are displayed with water year - year type sorting.

Figure 7-5. Old and Middle River Flow, Dry Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 7-6. Old and Middle River Flow, Critical Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 7-7. Old and Middle River Flow, October

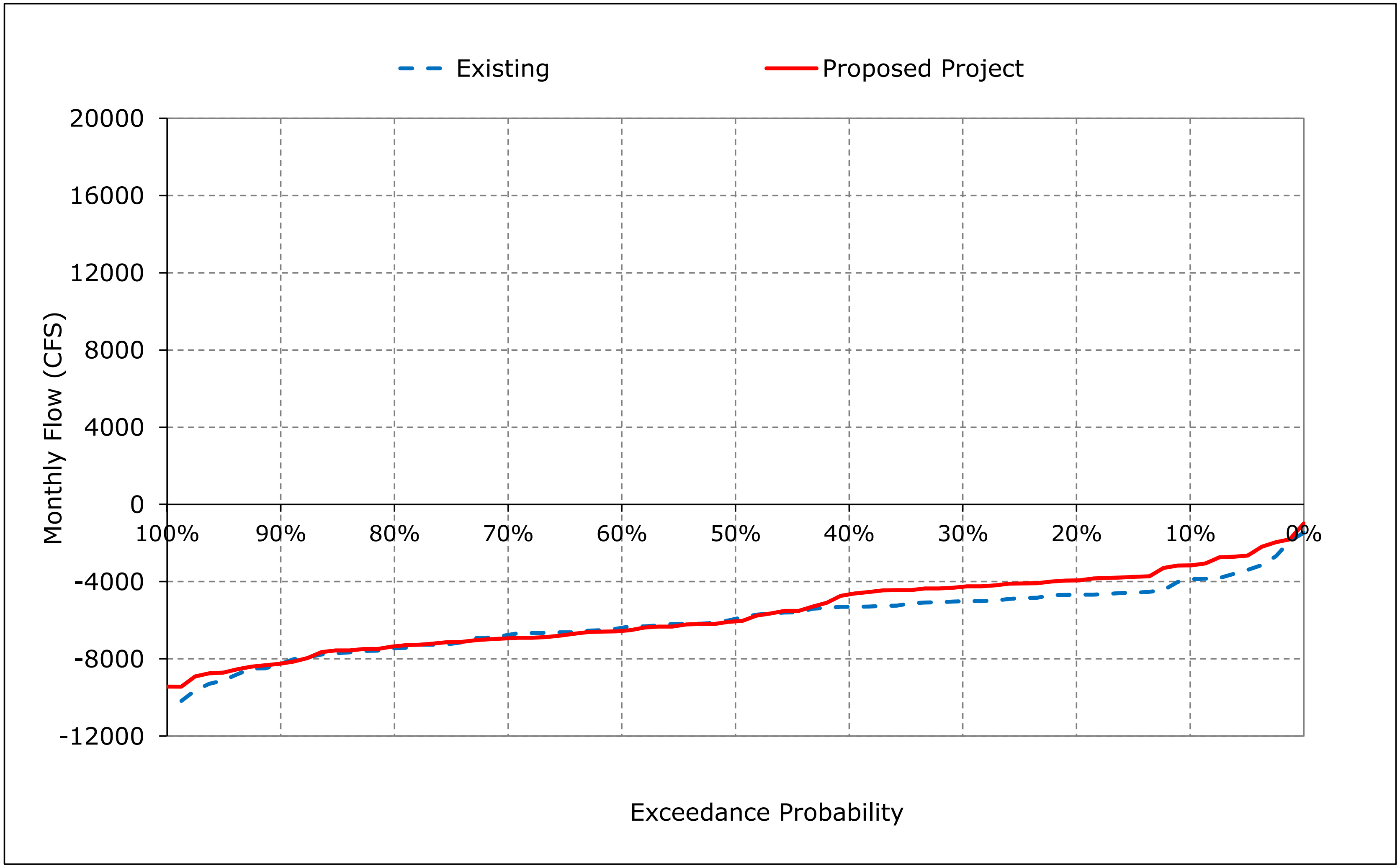


Figure 7-8. Old and Middle River Flow, November

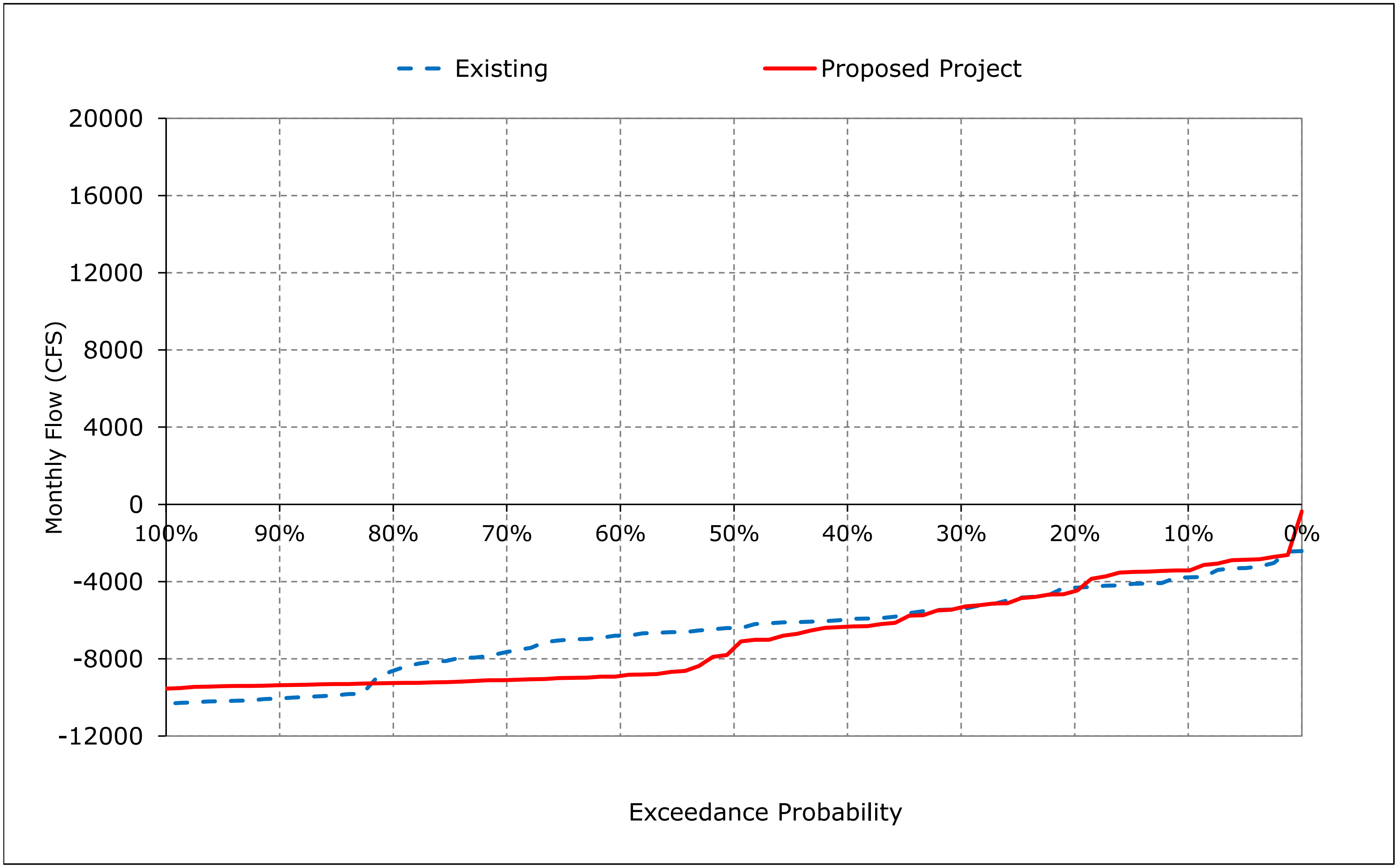


Figure 7-9. Old and Middle River Flow, December

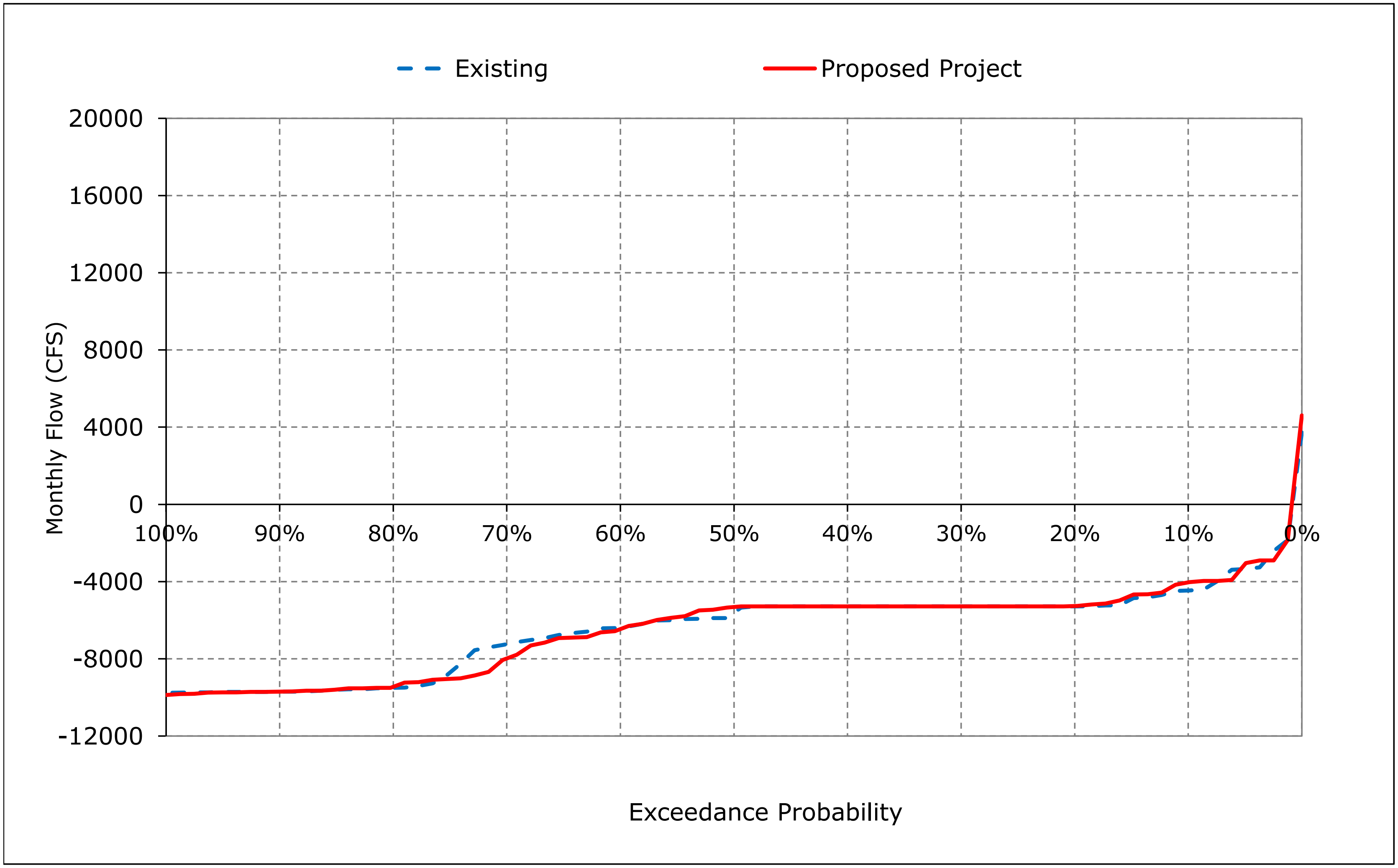


Figure 7-10. Old and Middle River Flow, January

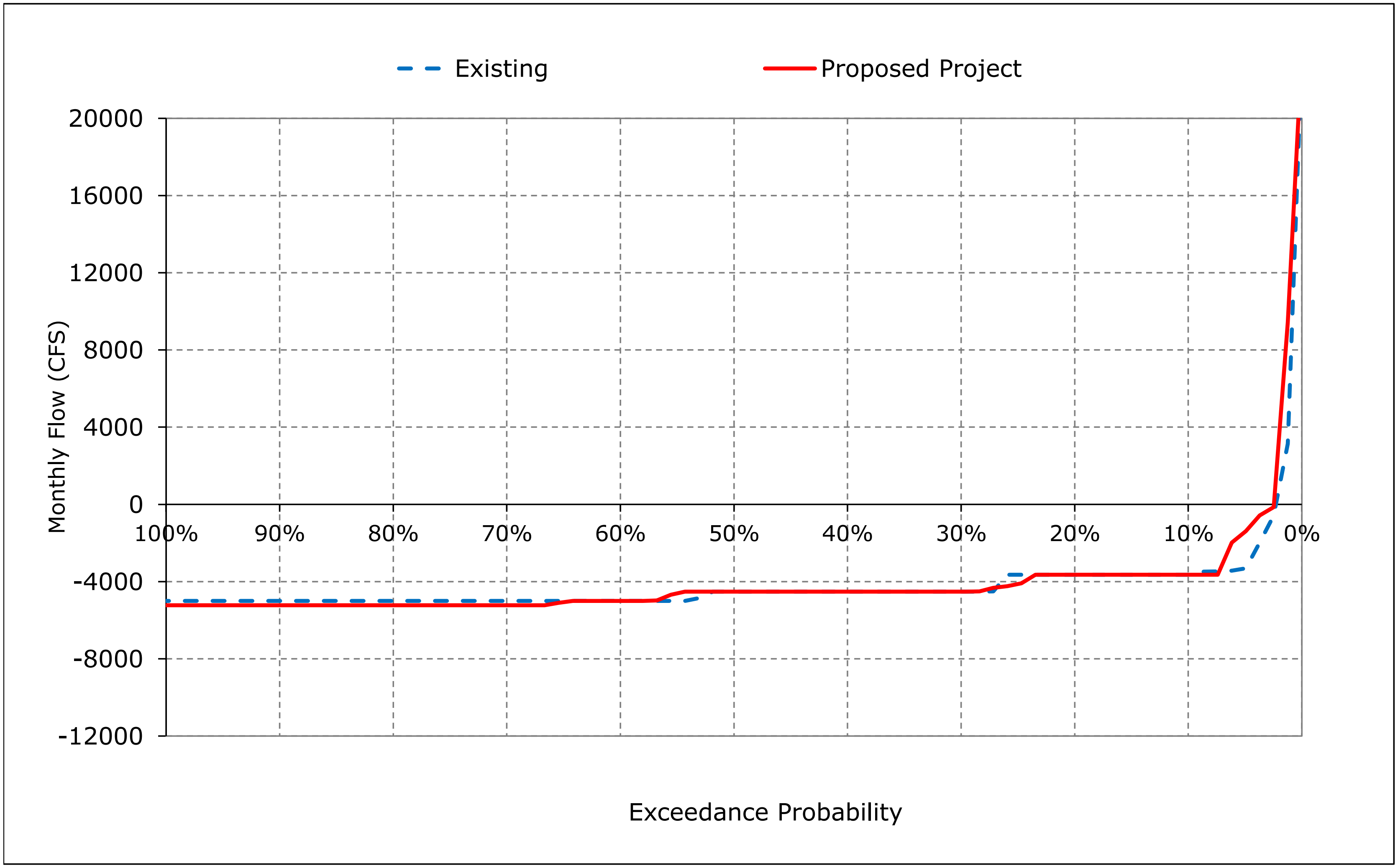


Figure 7-11. Old and Middle River Flow, February

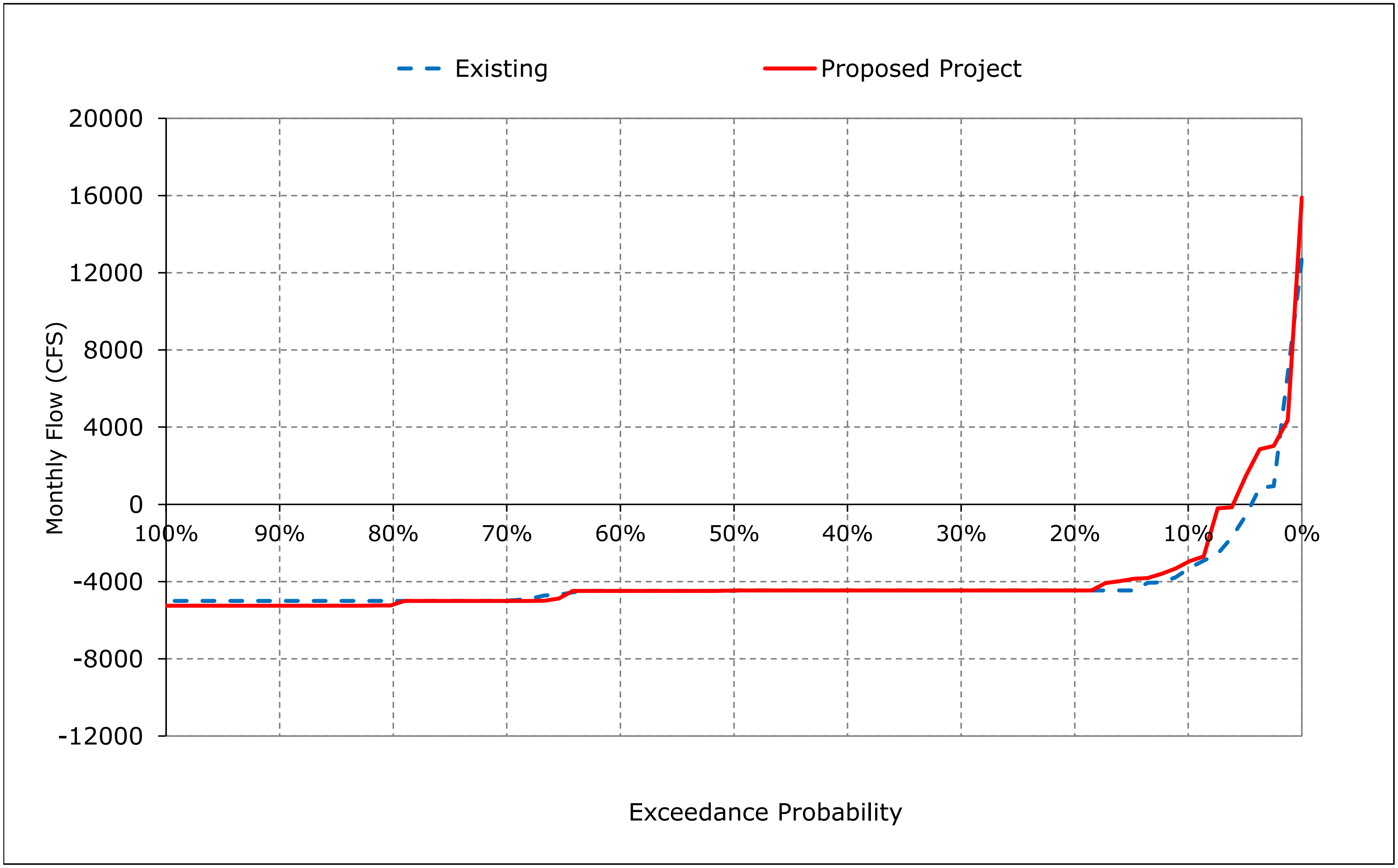


Figure 7-12. Old and Middle River Flow, March

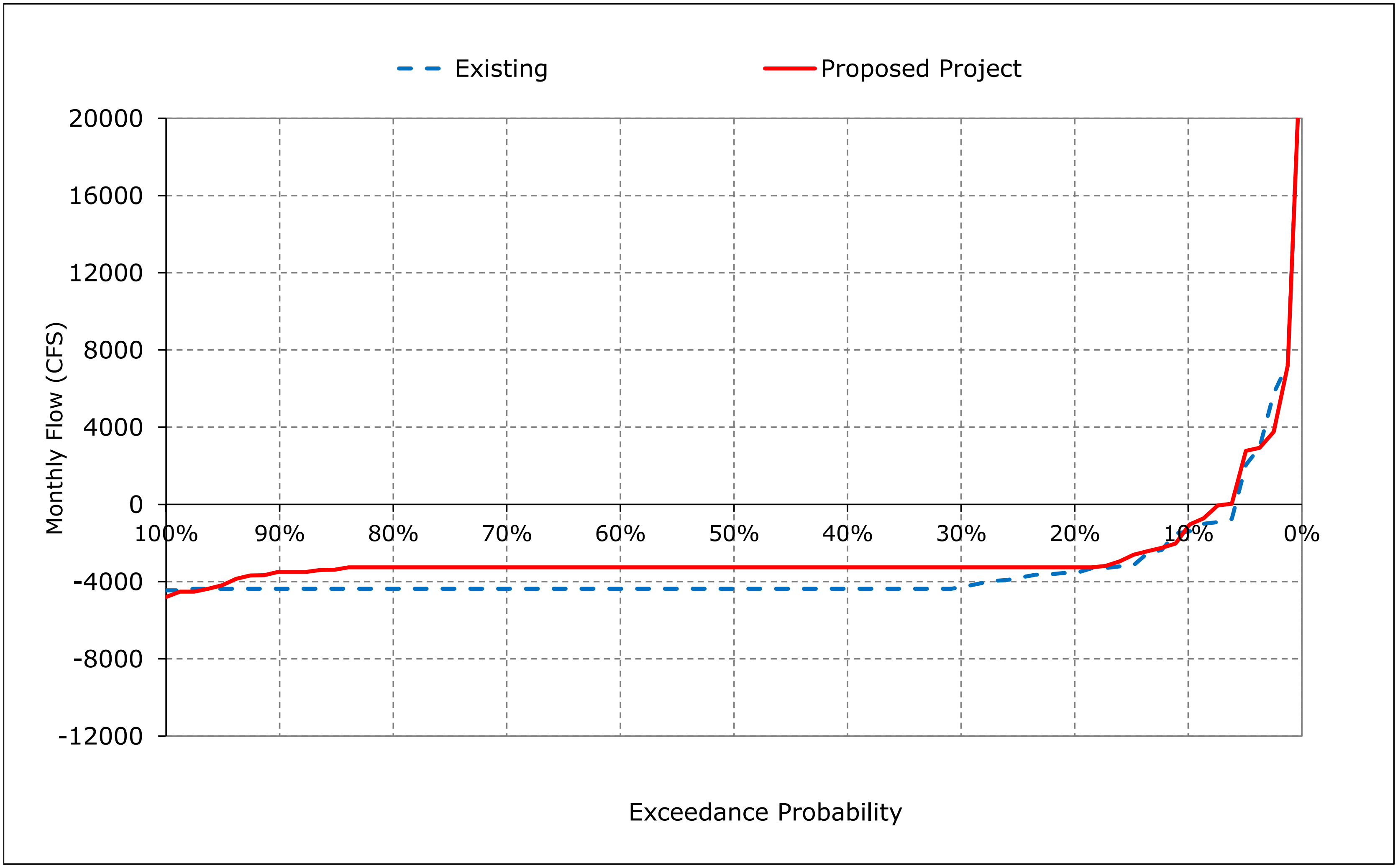


Figure 7-13. Old and Middle River Flow, April

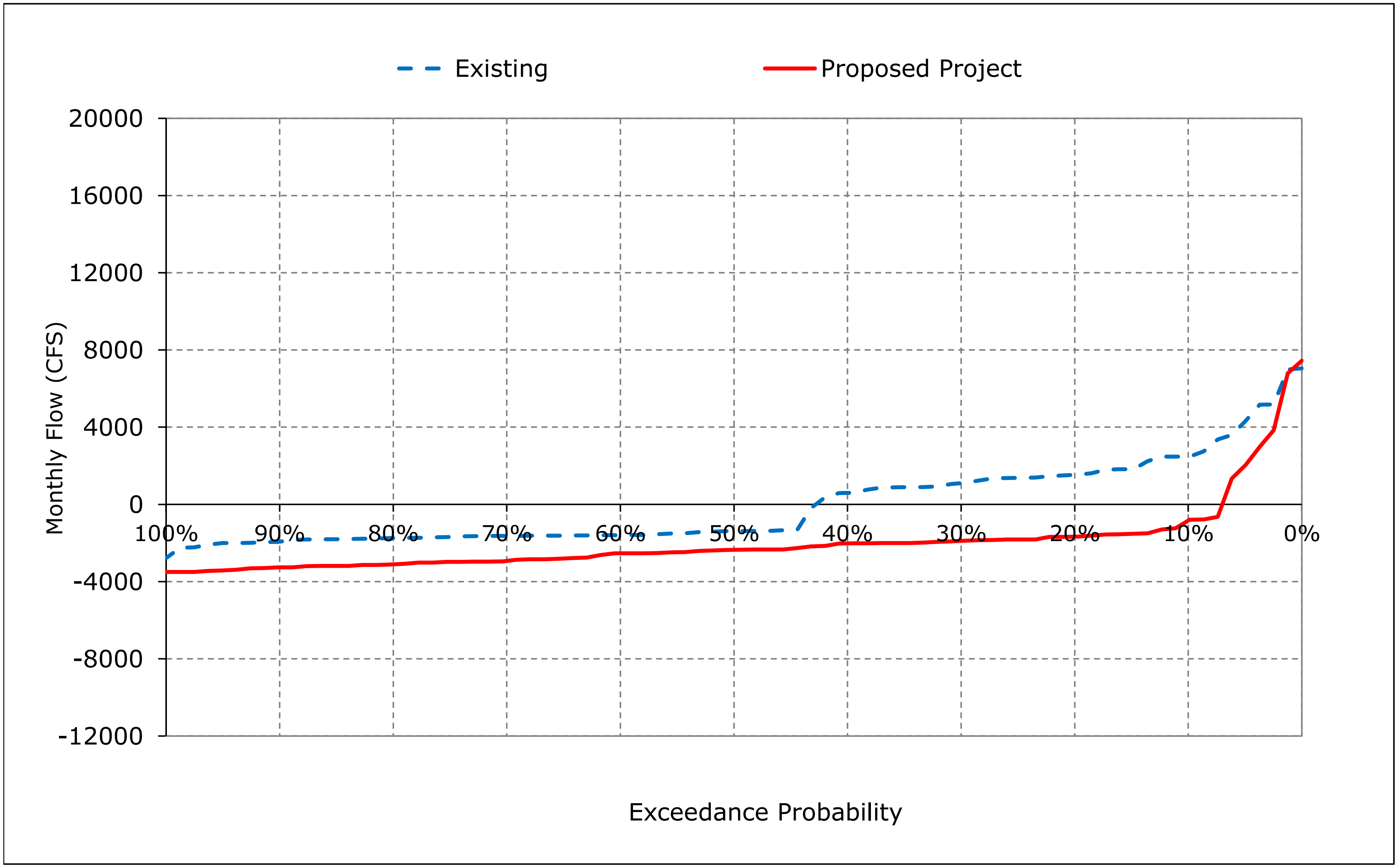


Figure 7-14. Old and Middle River Flow, May

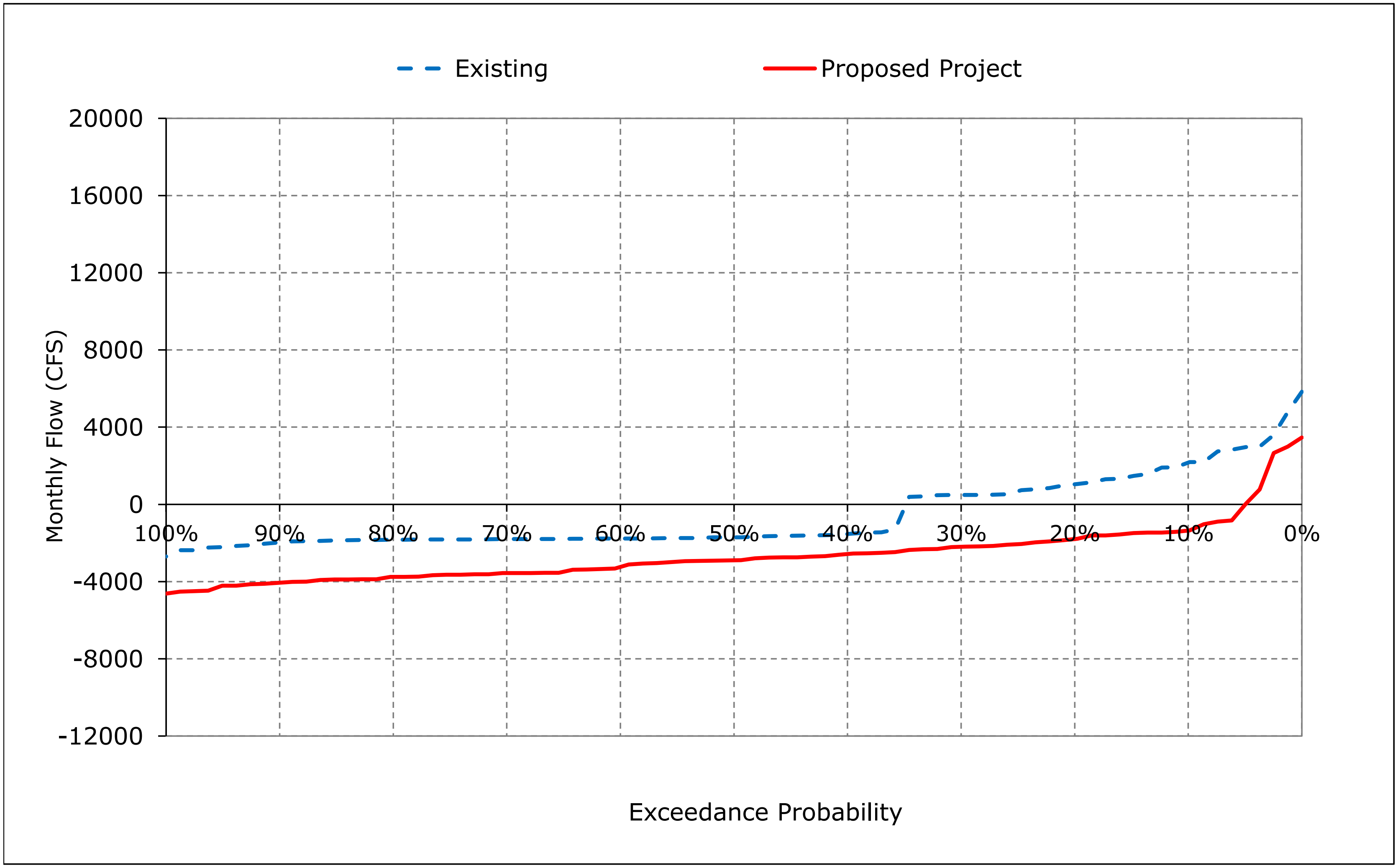


Figure 7-15. Old and Middle River Flow, June

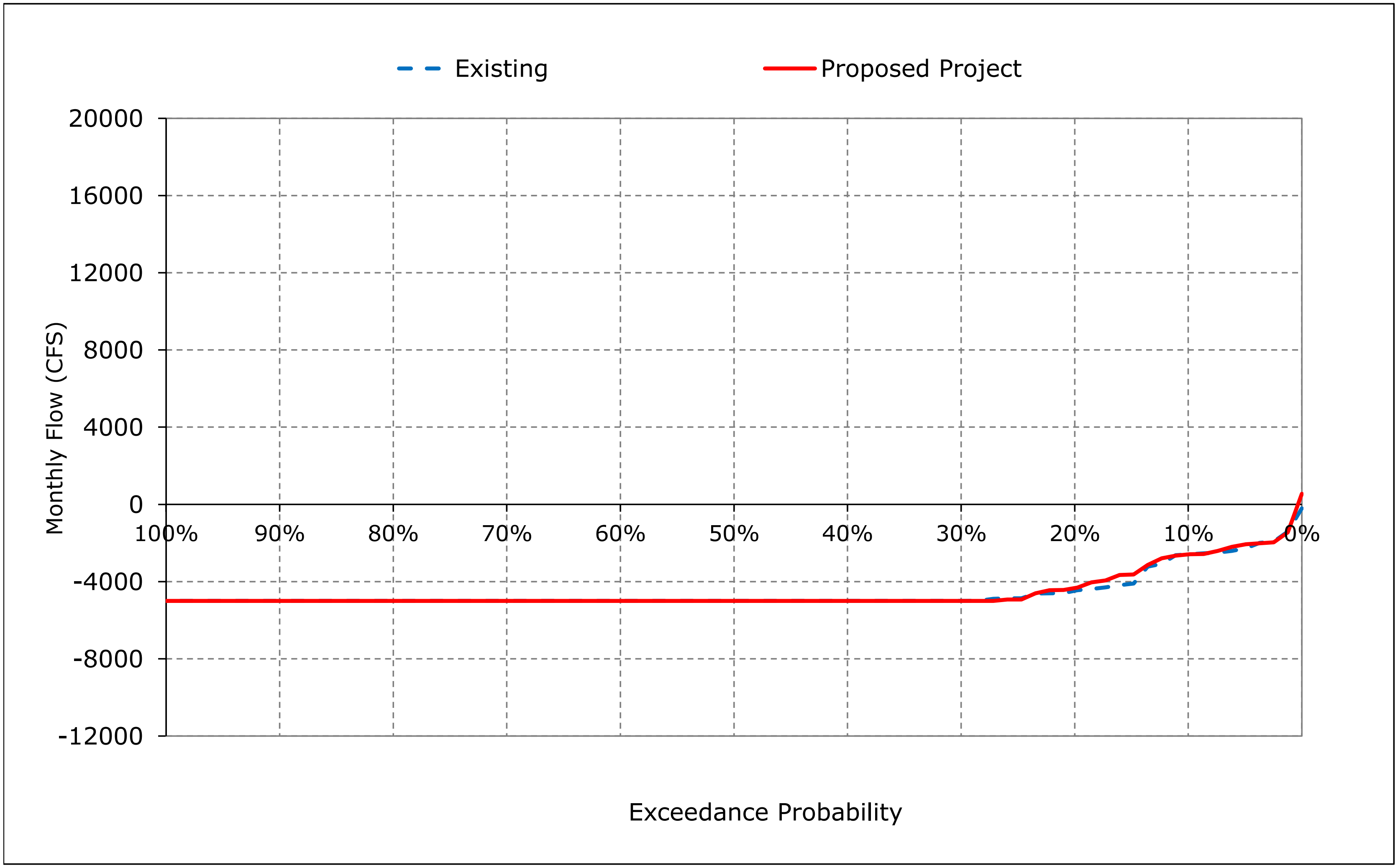


Figure 7-16. Old and Middle River Flow, July

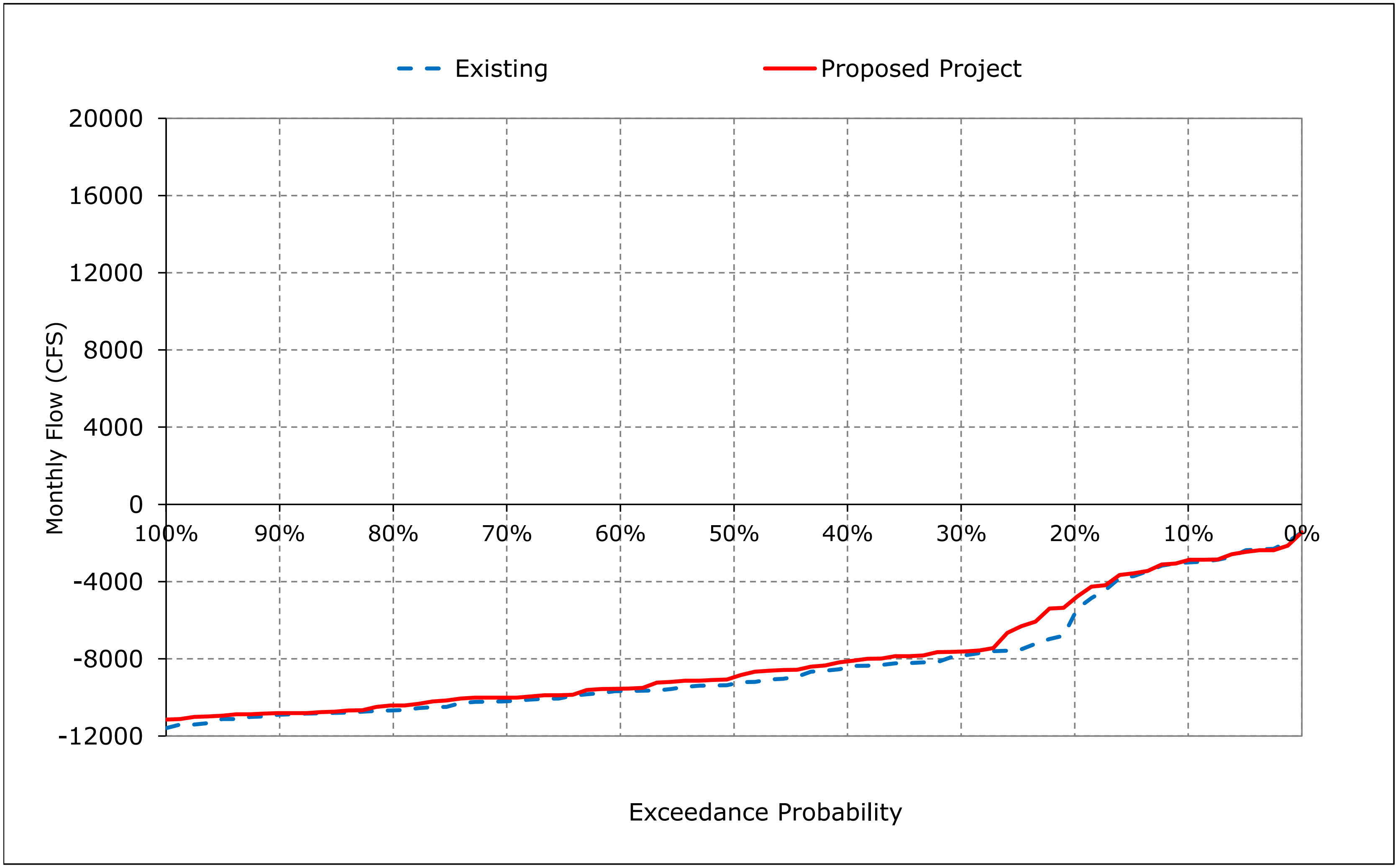


Figure 7-17. Old and Middle River Flow, August

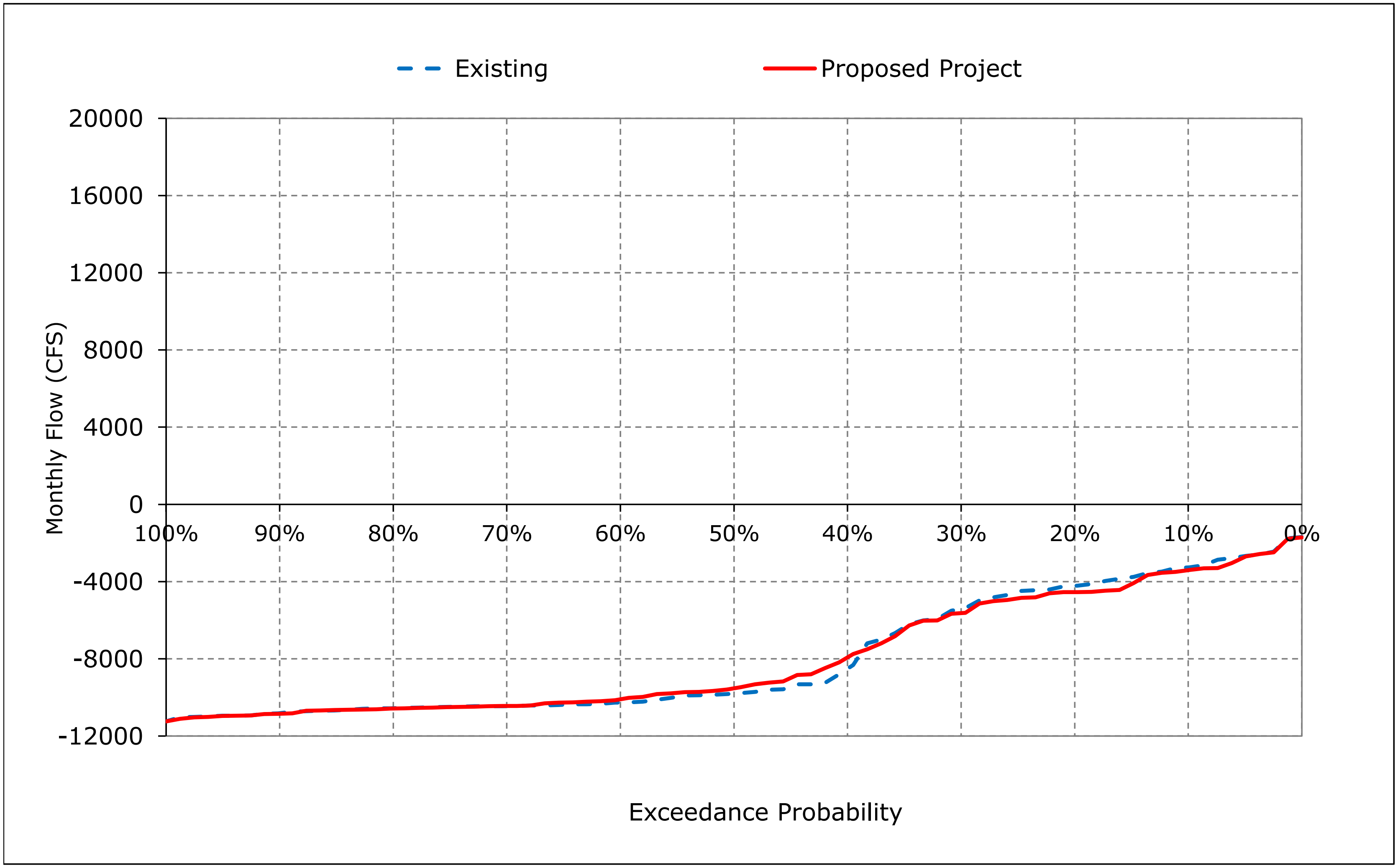


Figure 7-18. Old and Middle River Flow, September

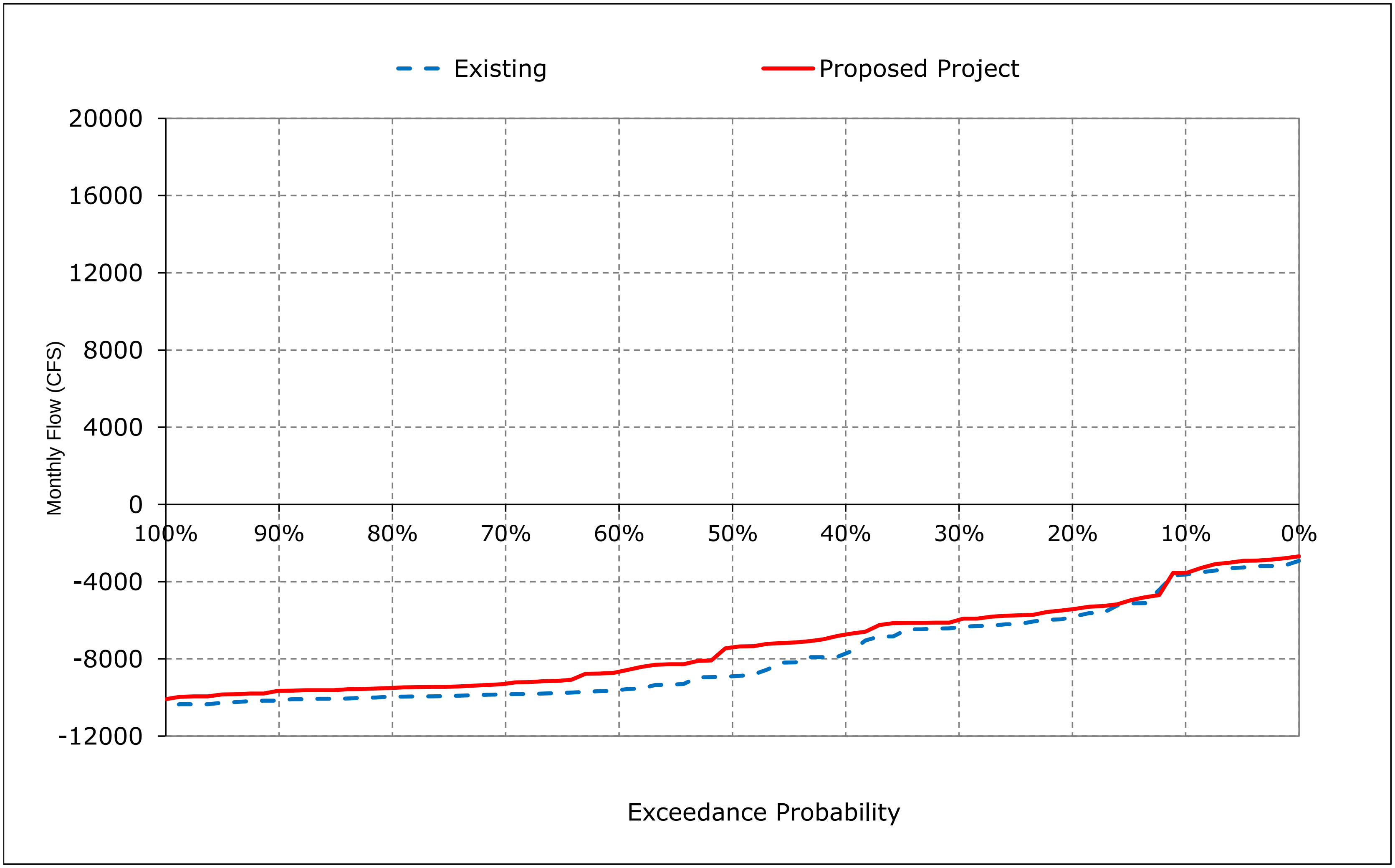


Table 8-1. Qwest, Monthly Flow

Existing

Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	1,101	1,598	7,499	14,692	18,541	18,228	20,508	16,658	7,874	362	245	35
20%	459	97	2,675	10,229	12,454	11,863	14,500	9,590	3,602	-285	-650	-1,012
30%	76	-77	-321	5,864	10,150	6,927	10,843	7,568	2,039	-1,323	-1,260	-1,568
40%	-10	-641	-1,310	3,159	7,473	5,169	8,593	6,449	1,054	-2,443	-2,321	-1,948
50%	-224	-923	-1,710	1,398	4,039	3,332	6,602	5,451	476	-2,799	-4,233	-2,266
60%	-371	-1,513	-2,422	261	1,931	2,051	4,740	3,606	51	-3,227	-4,588	-2,638
70%	-578	-1,990	-3,349	-189	730	1,470	3,805	2,374	-556	-3,787	-4,725	-3,631
80%	-1,237	-2,586	-4,822	-985	-18	684	2,559	1,691	-930	-4,236	-5,078	-4,095
90%	-1,696	-3,624	-5,504	-1,333	-908	-178	1,618	921	-1,123	-4,772	-5,296	-4,560
Long Term												
Full Simulation Period[a]	-375	-767	-53	5,395	7,422	7,194	8,963	6,858	2,054	-1,788	-3,008	-2,285
Water Year Types[b,c]												
Wet (32%)	-497	-233	4,357	13,707	15,795	15,802	16,456	13,289	6,129	542	-3,962	-3,120
Above Normal (15%)	-536	-877	-1,207	6,404	8,852	8,806	9,620	7,376	1,502	-2,434	-5,088	-1,665
Below Normal (17%)	-221	-1,429	-1,740	1,722	5,401	3,169	7,343	5,311	189	-4,172	-4,524	-3,501
Dry (22%)	-281	-1,341	-2,853	-309	1,266	1,312	3,890	2,496	-660	-3,778	-769	-1,874
Critical (15%)	-268	-182	-2,286	-781	-560	451	1,572	755	25	-425	-449	-295

Proposed Project

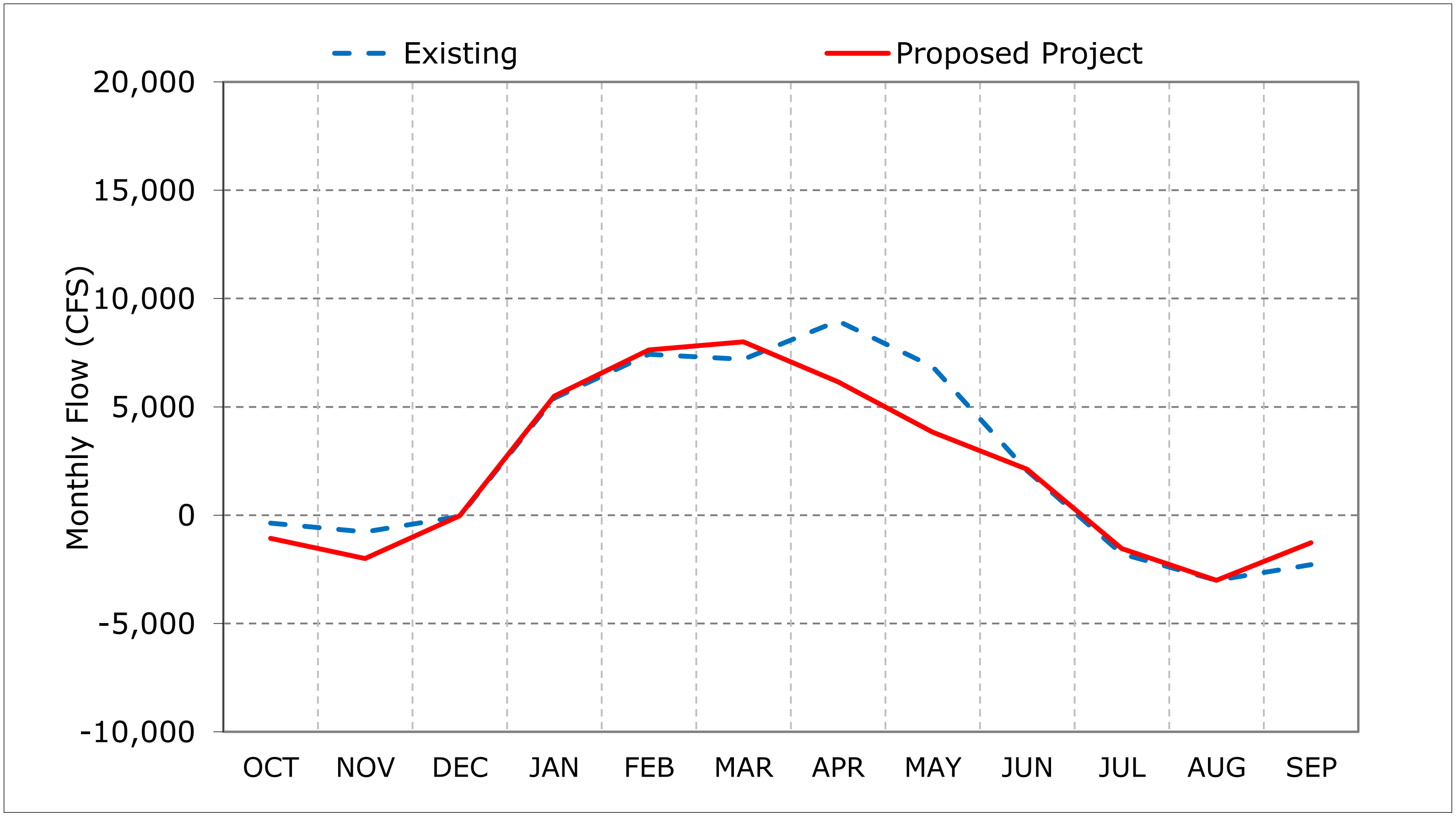
Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	485	60	7,406	14,759	19,661	18,842	14,629	10,860	7,870	362	-3	399
20%	66	-270	2,425	10,208	12,519	13,483	9,890	4,611	3,762	-104	-1,020	27
30%	-97	-1,185	-240	5,986	9,693	7,878	6,428	3,428	2,105	-1,053	-1,511	-588
40%	-309	-2,025	-1,146	3,492	7,430	6,540	4,573	2,225	1,187	-1,906	-2,476	-1,020
50%	-711	-2,389	-1,593	1,762	4,072	4,475	3,218	1,747	508	-2,622	-3,693	-1,491
60%	-1,306	-3,364	-2,365	132	1,825	2,886	2,086	1,086	11	-3,090	-4,271	-1,785
70%	-1,774	-3,628	-3,357	-653	575	1,911	1,772	650	-496	-3,428	-4,795	-1,981
80%	-2,216	-3,967	-4,945	-1,172	-401	1,302	1,321	264	-832	-3,999	-5,029	-2,266
90%	-3,033	-4,706	-5,426	-1,505	-1,033	-101	786	-36	-1,095	-4,290	-5,392	-3,078
Long Term												
Full Simulation Period[a]	-1,064	-2,007	-26	5,494	7,622	8,001	6,155	3,830	2,113	-1,540	-3,008	-1,268
Water Year Types[b,c]												
Wet (32%)	-1,362	-1,756	4,499	14,173	16,435	16,725	12,634	9,001	6,123	758	-3,870	-154
Above Normal (15%)	-1,489	-2,116	-1,245	6,427	9,208	9,991	5,917	3,228	1,626	-2,580	-5,036	-1,208
Below Normal (17%)	-1,067	-2,716	-1,691	1,736	5,440	4,290	4,354	1,905	337	-3,452	-4,306	-3,385
Dry (22%)	-772	-2,042	-3,154	-528	990	2,222	1,847	588	-615	-3,305	-890	-1,848
Critical (15%)	-430	-1,561	-1,979	-827	-564	106	914	339	72	-600	-778	-405

Proposed Project minus Existing

Statistic	Monthly Flow (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-615	-1,538	-94	67	1,120	614	-5,880	-5,799	-4	0	-248	364
20%	-393	-368	-251	-21	65	1,619	-4,610	-4,979	160	182	-370	1,039
30%	-173	-1,108	80	122	-458	951	-4,416	-4,140	66	270	-251	980
40%	-299	-1,383	165	333	-43	1,371	-4,020	-4,224	132	536	-154	928
50%	-488	-1,466	117	364	33	1,143	-3,384	-3,703	32	177	540	776
60%	-935	-1,851	57	-129	-105	835	-2,654	-2,520	-40	136	318	853
70%	-1,196	-1,637	-8	-465	-155	441	-2,033	-1,724	60	360	-69	1,650
80%	-980	-1,381	-122	-186	-383	618	-1,238	-1,428	99	237	49	1,829
90%	-1,337	-1,082	78	-172	-124	77	-832	-957	29	482	-96	1,481
Long Term												
Full Simulation Period[a]	-690	-1,240	27	99	200	806	-2,809	-3,028	59	248	0	1,017
Water Year Types[b,c]												
Wet (32%)	-865	-1,523	142	467	639	923	-3,822	-4,288	-6	216	92	2,966
Above Normal (15%)	-953	-1,239	-39	23	356	1,185	-3,703	-4,147	124	-145	52	457
Below Normal (17%)	-845	-1,287	49	15	39	1,121	-2,989	-3,406	148	720	218	116
Dry (22%)	-492	-701	-301	-219	-276	910	-2,042	-1,908	46	473	-121	26
Critical (15%)	-162	-1,378	307	-47	-3	-346	-658	-416	47	-175	-328	-110

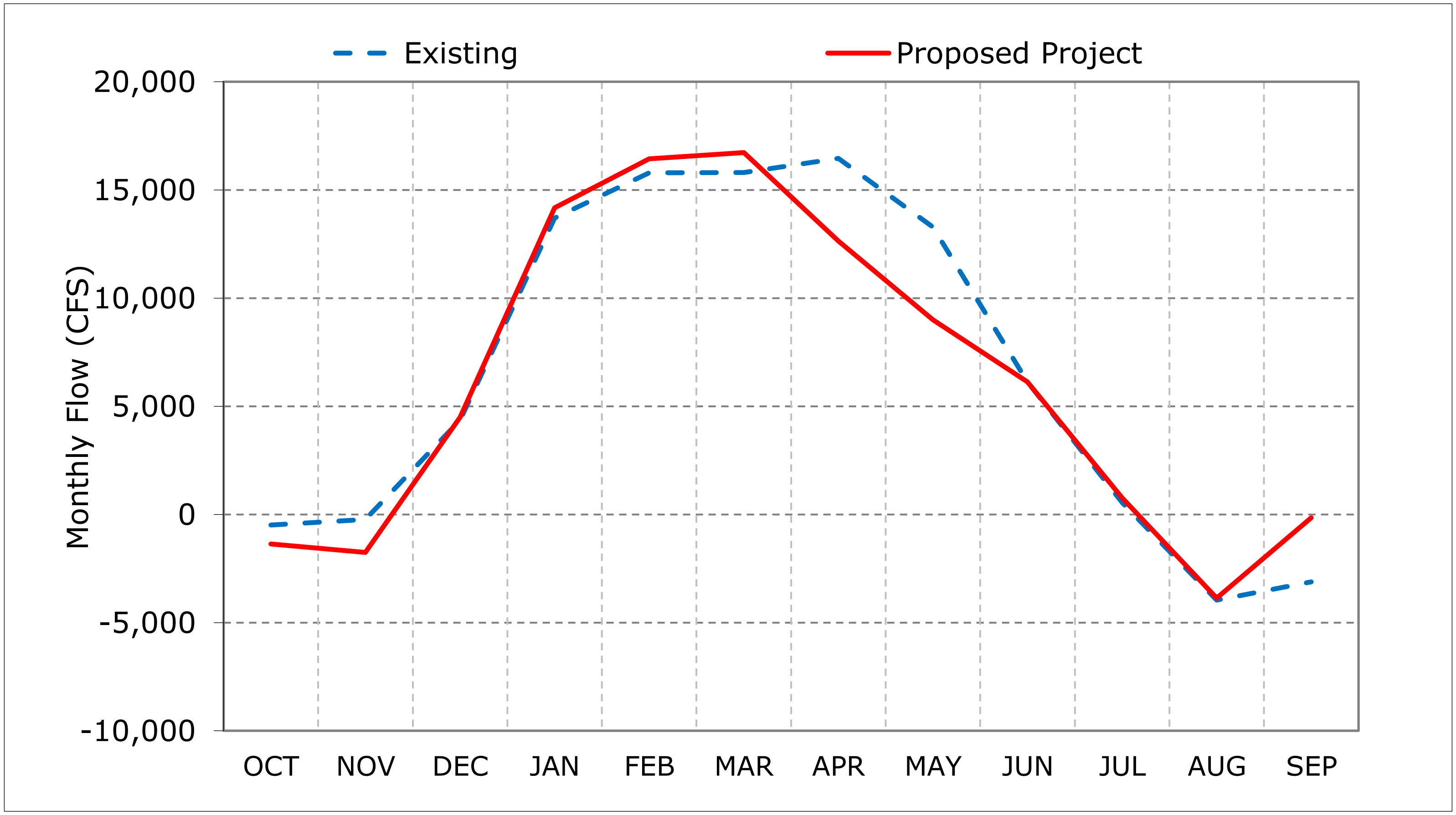
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.

Figure 8-1. Qwest, Long-Term Average Flow



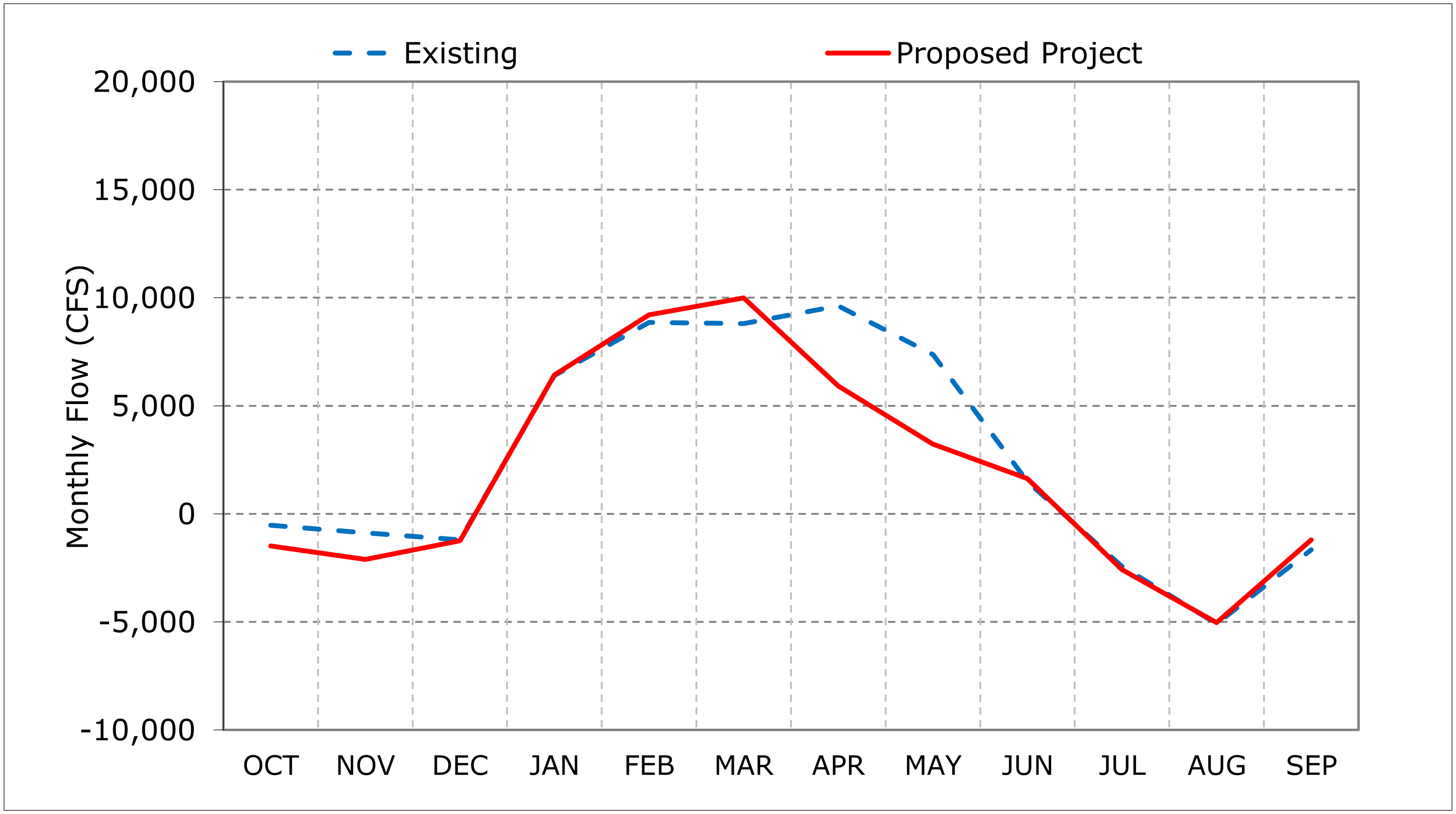
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 8-2. Qwest, Wet Year Average Flow



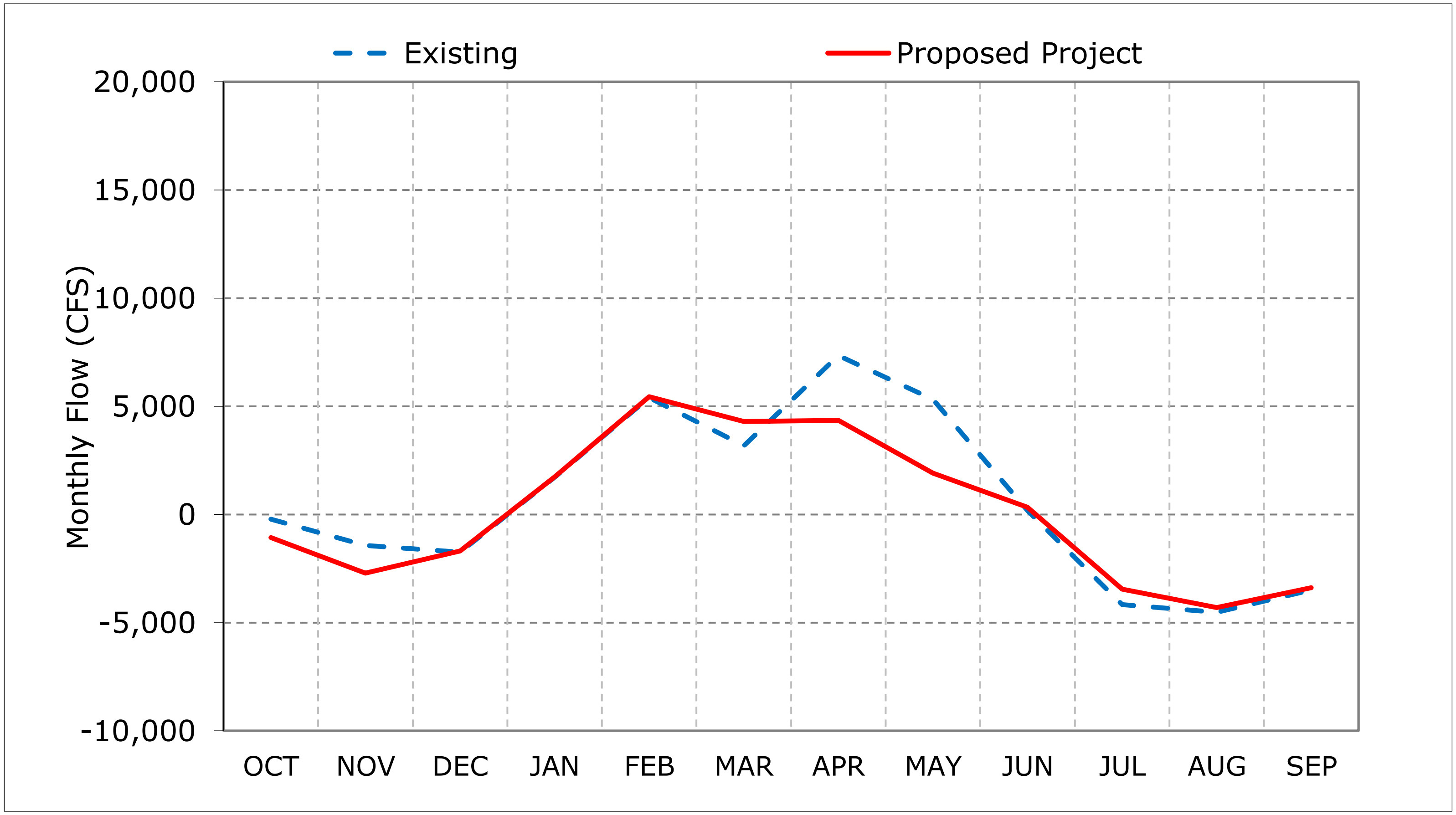
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 8-3. Qwest, Above Normal Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

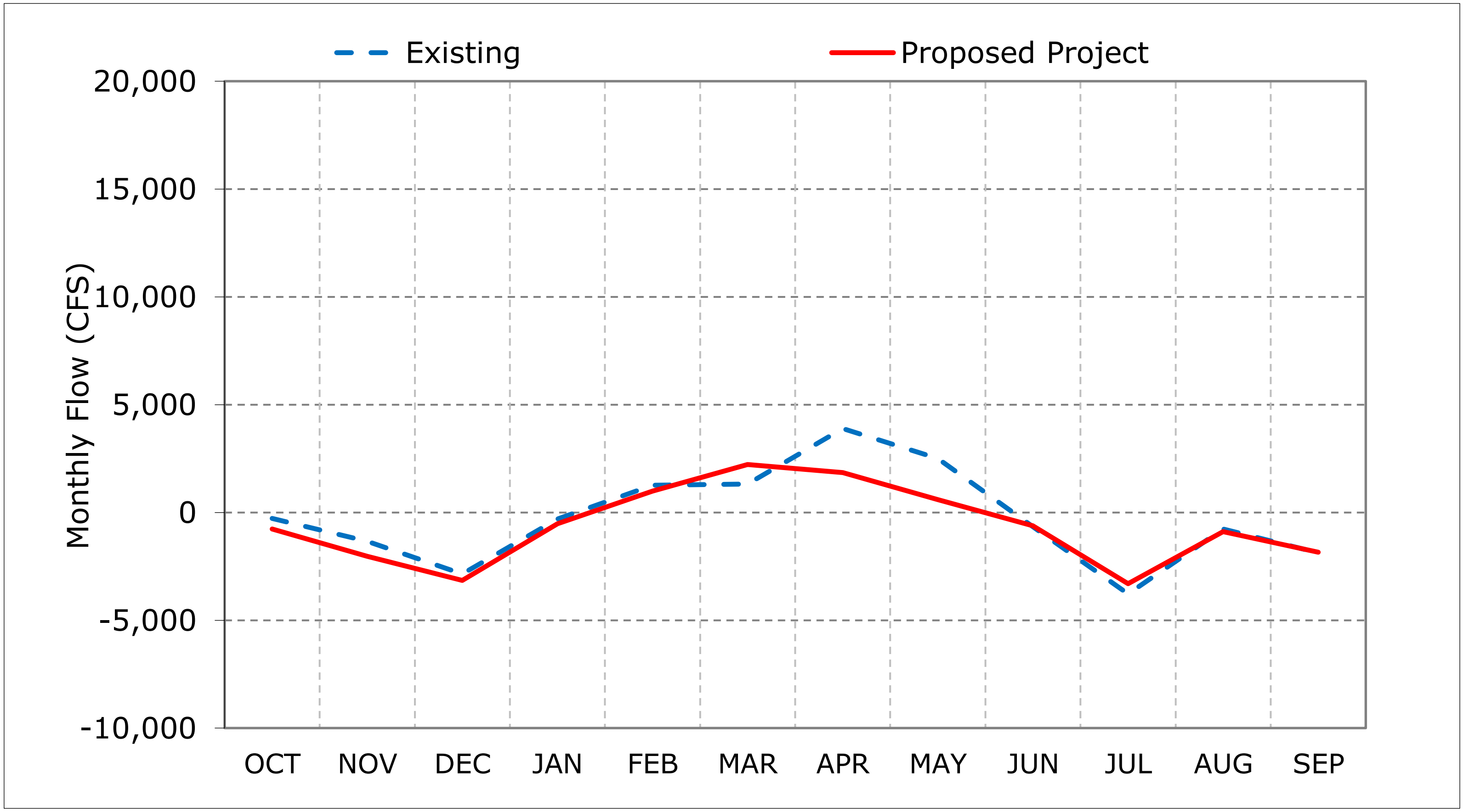
Figure 8-4. Qwest, Below Normal Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164

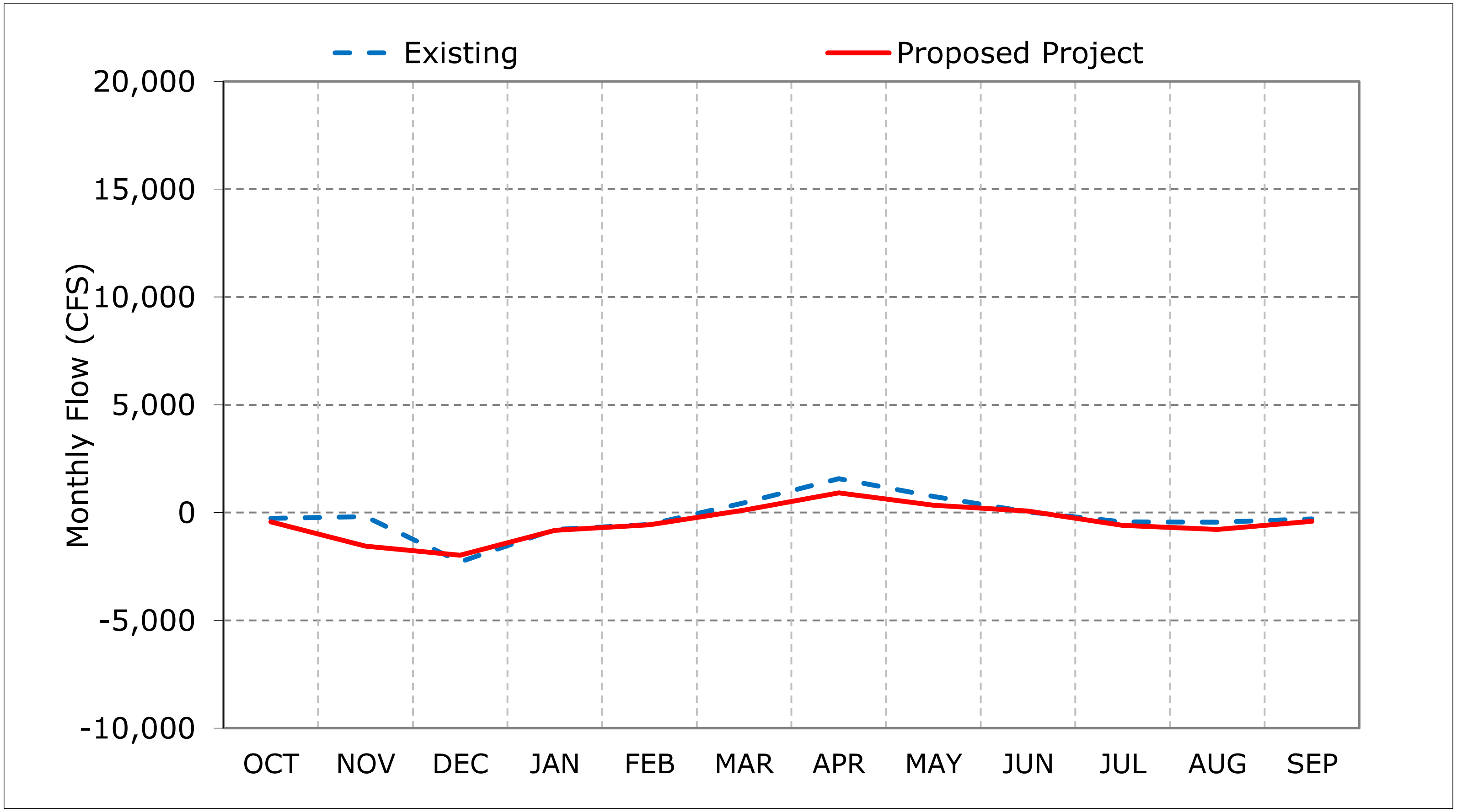
*These results are displayed with water year - year type sorting.

Figure 8-5. Qwest, Dry Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 8-6. Qwest, Critical Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 8-7. Qwest, October

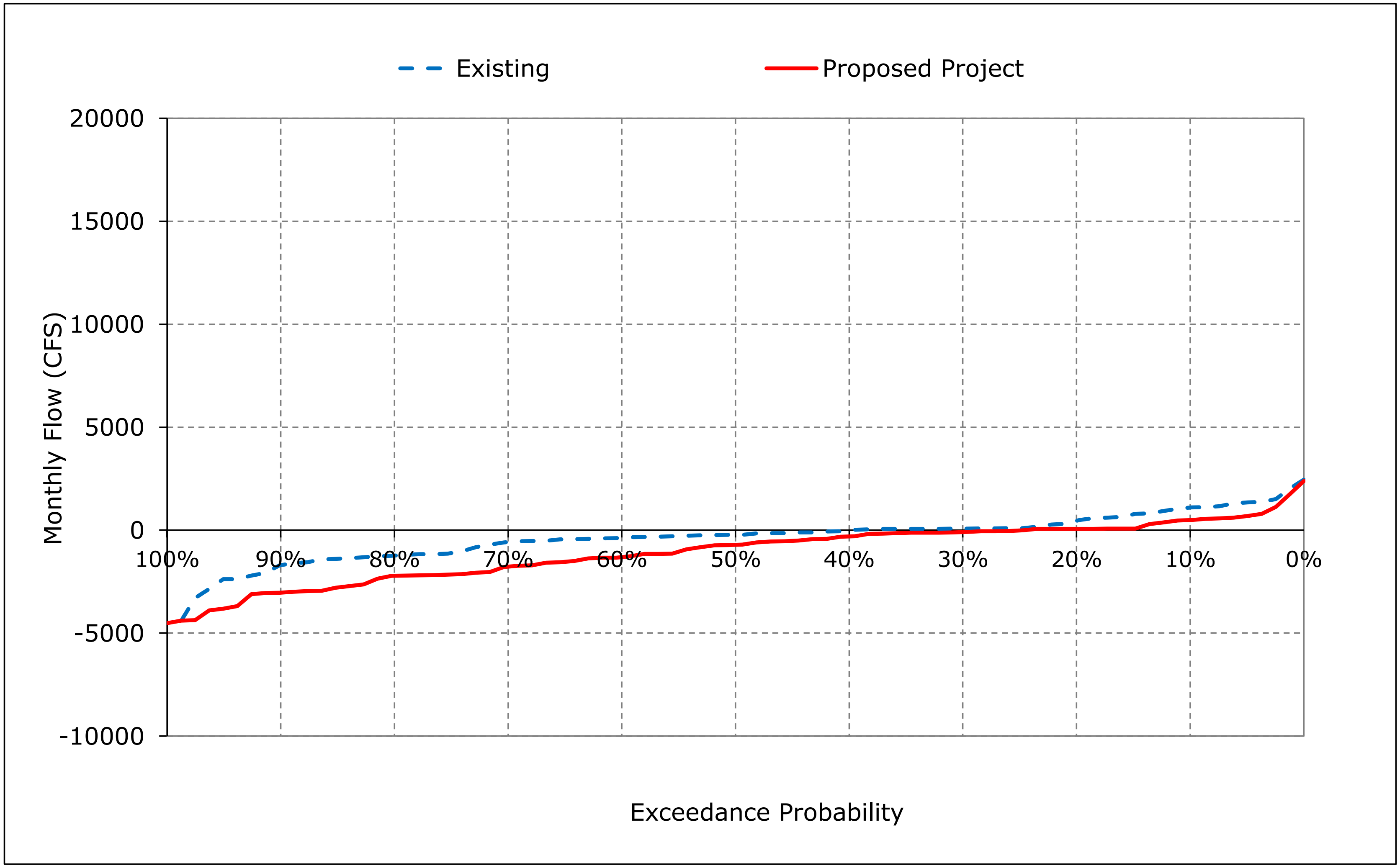


Figure 8-8. Qwest, November

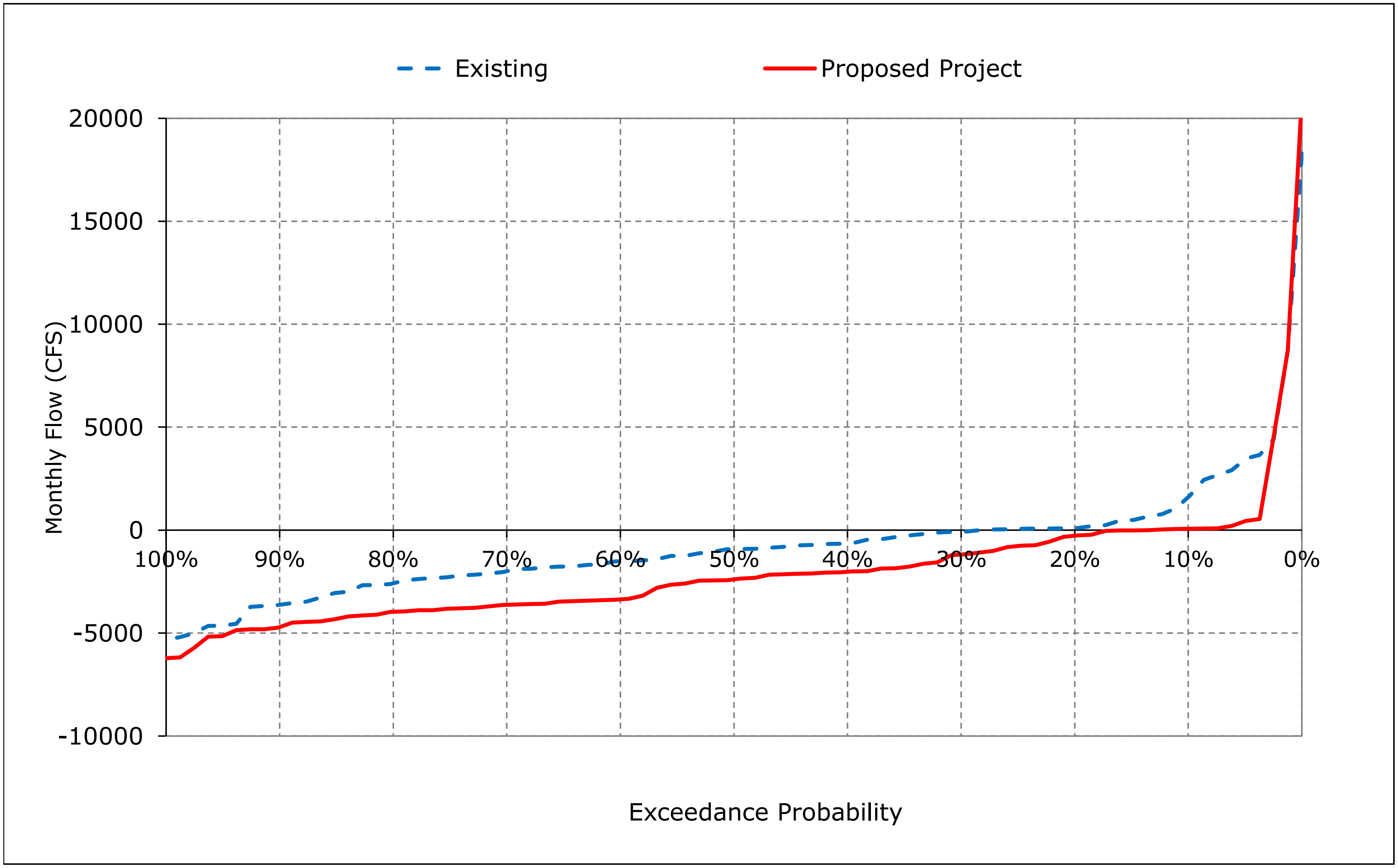


Figure 8-9. Qwest, December

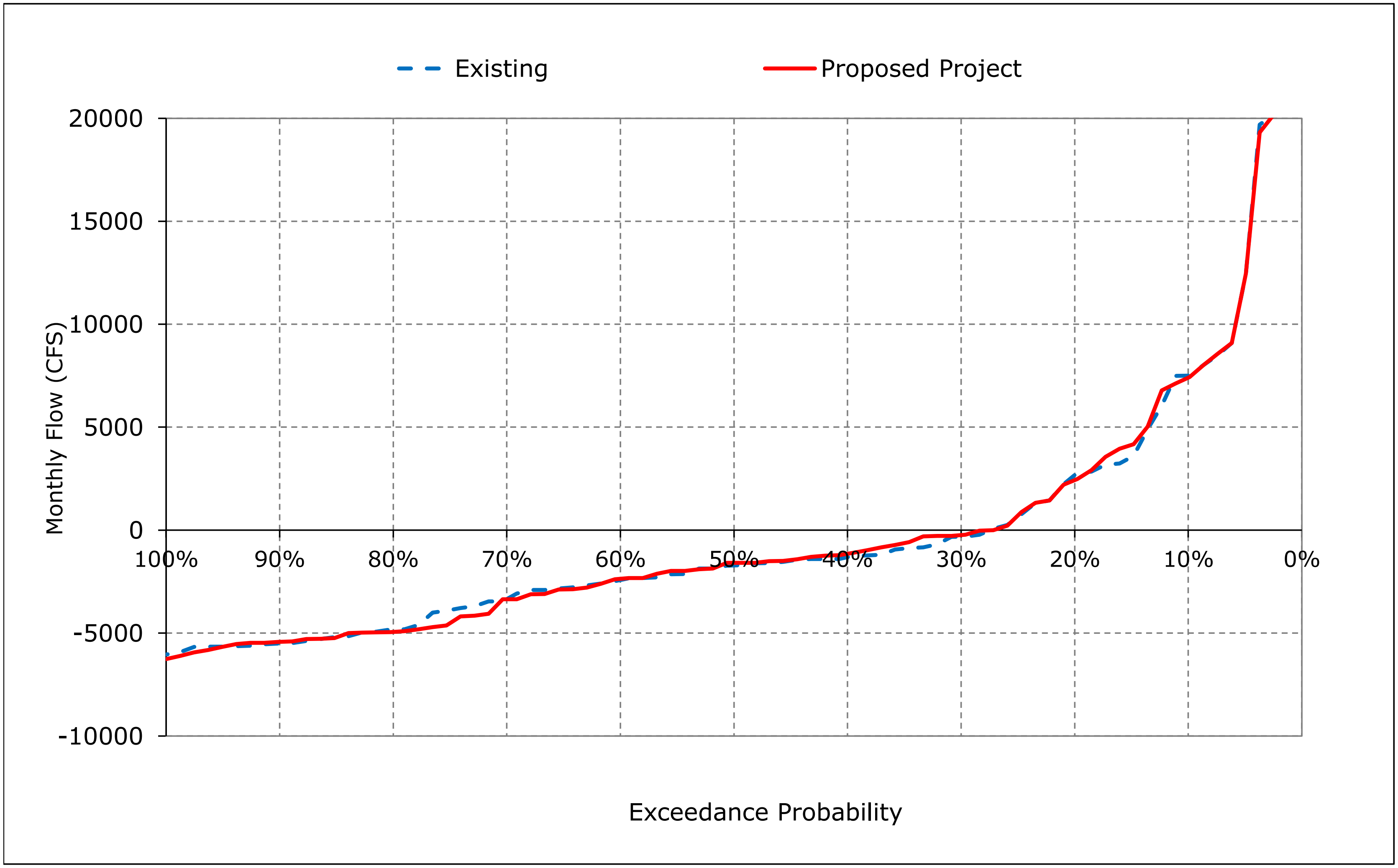


Figure 8-10. Qwest, January

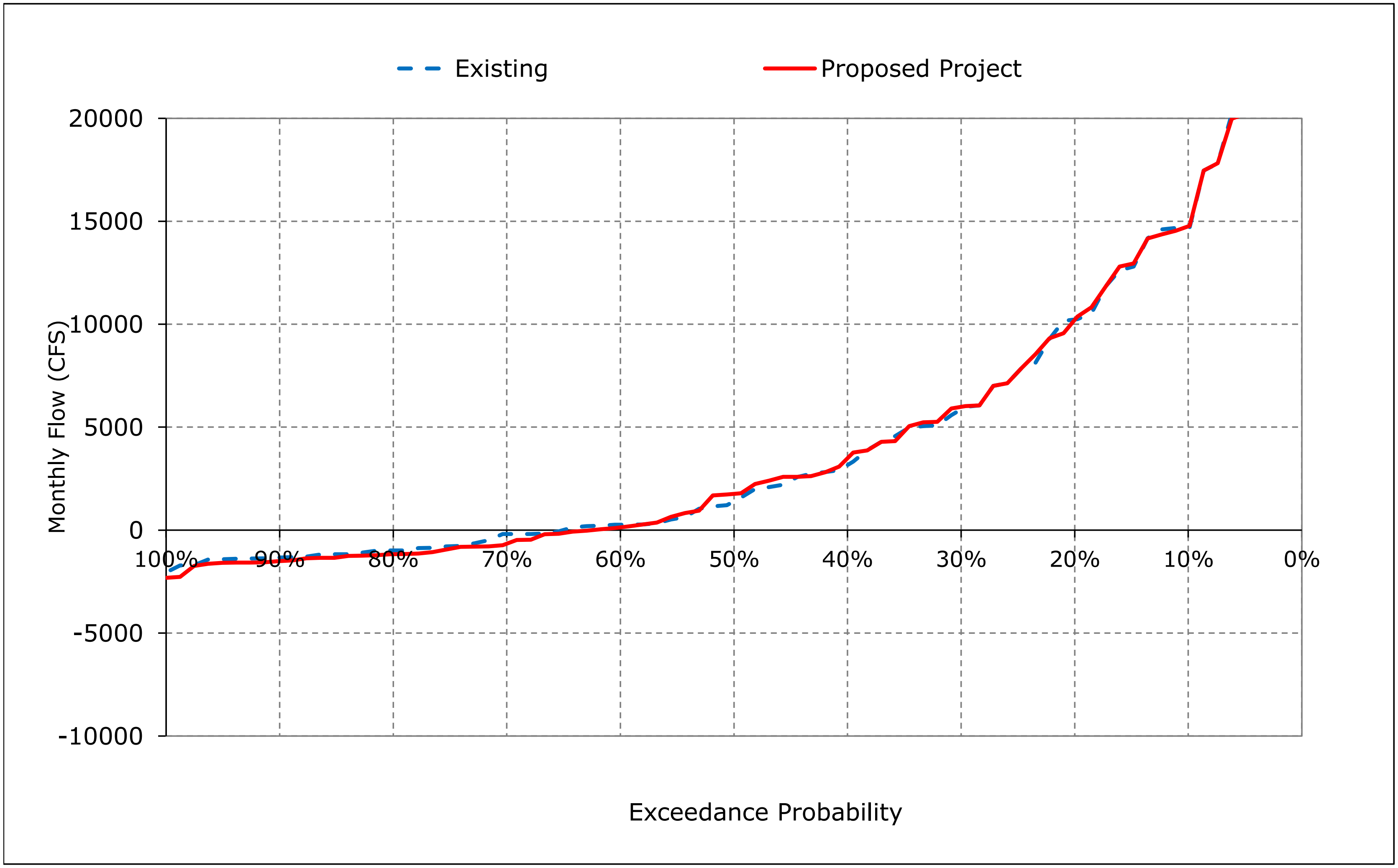


Figure 8-11. Qwest, February

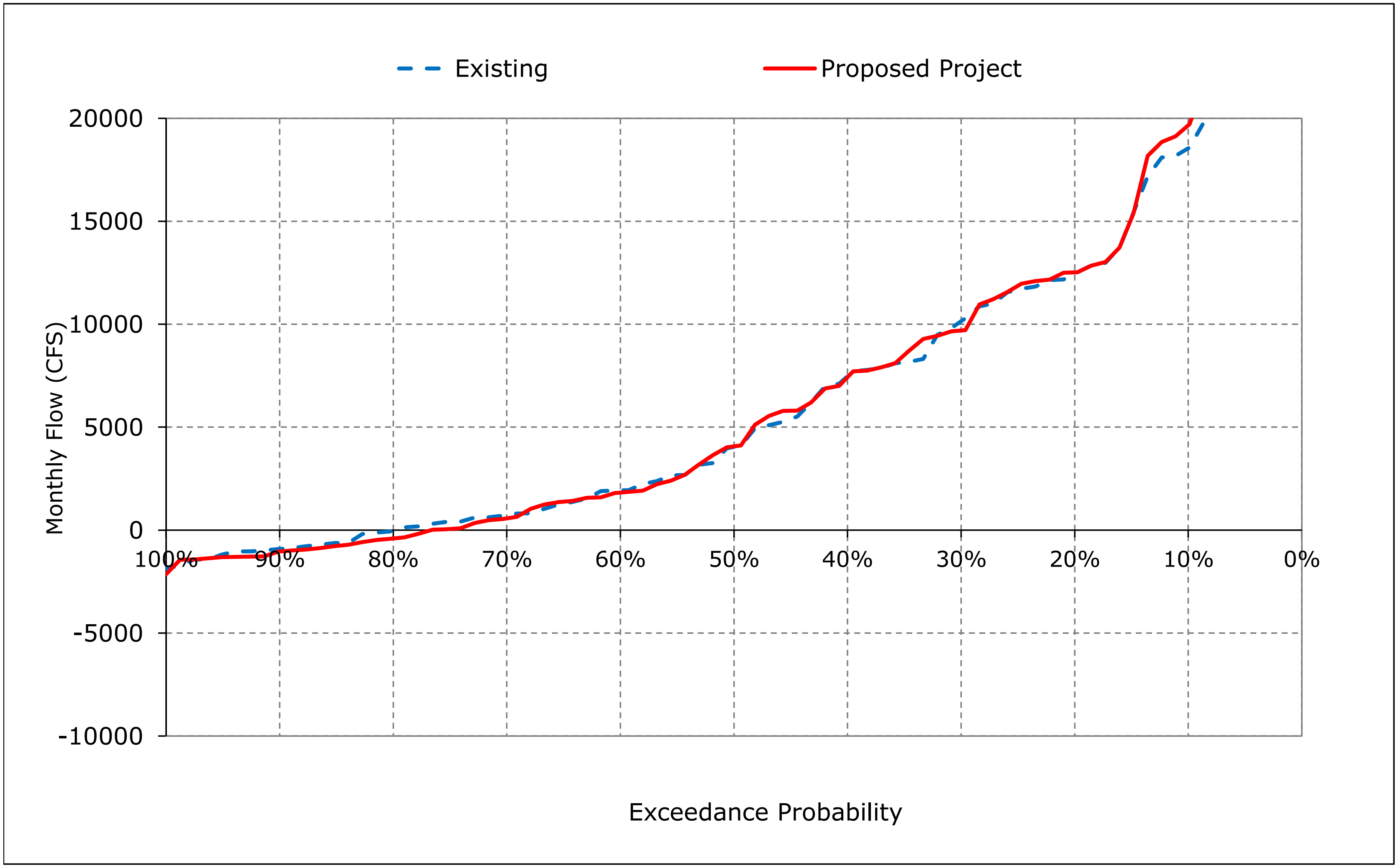


Figure 8-12. Qwest, March

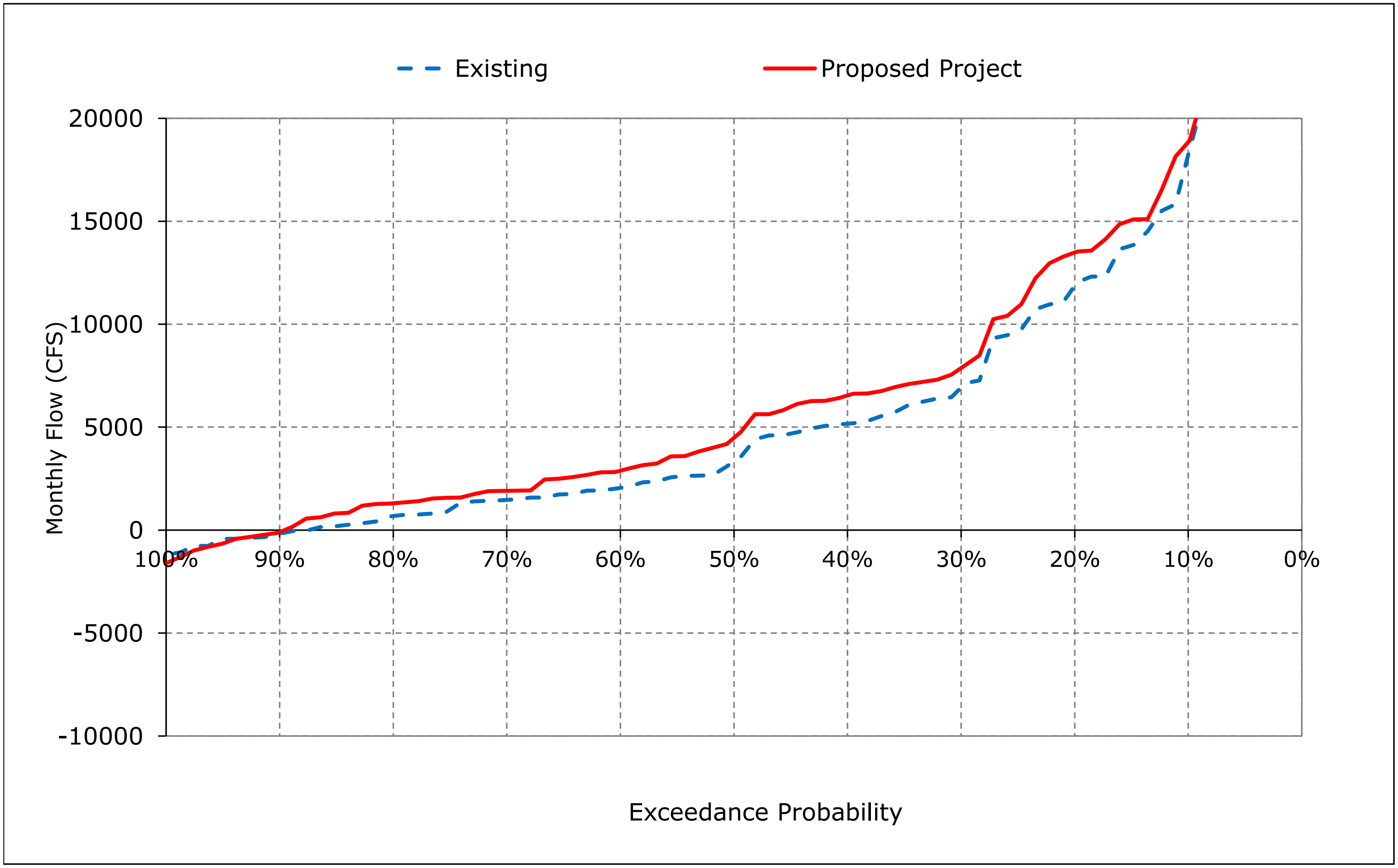


Figure 8-13. Qwest, April

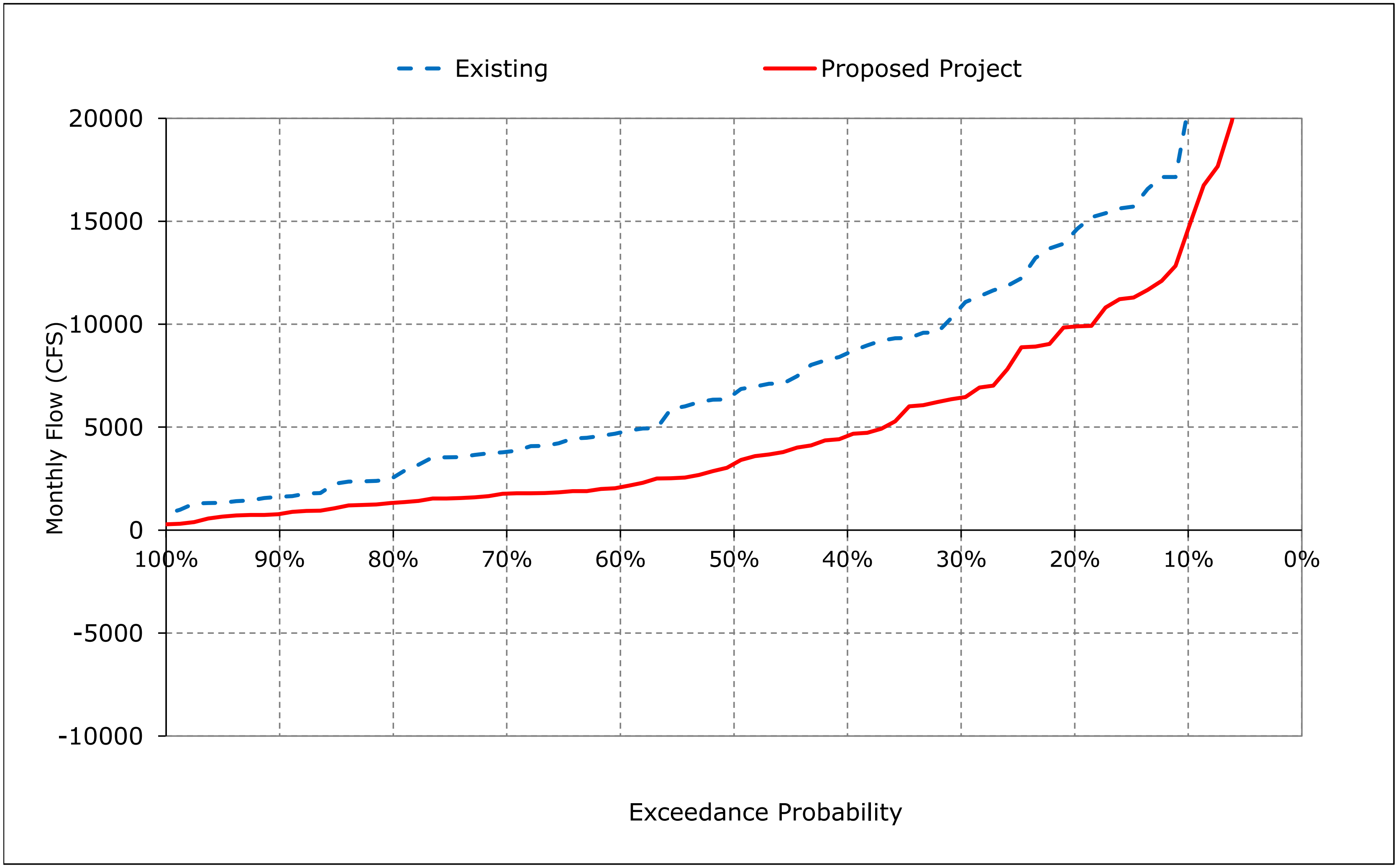


Figure 8-14. Qwest, May

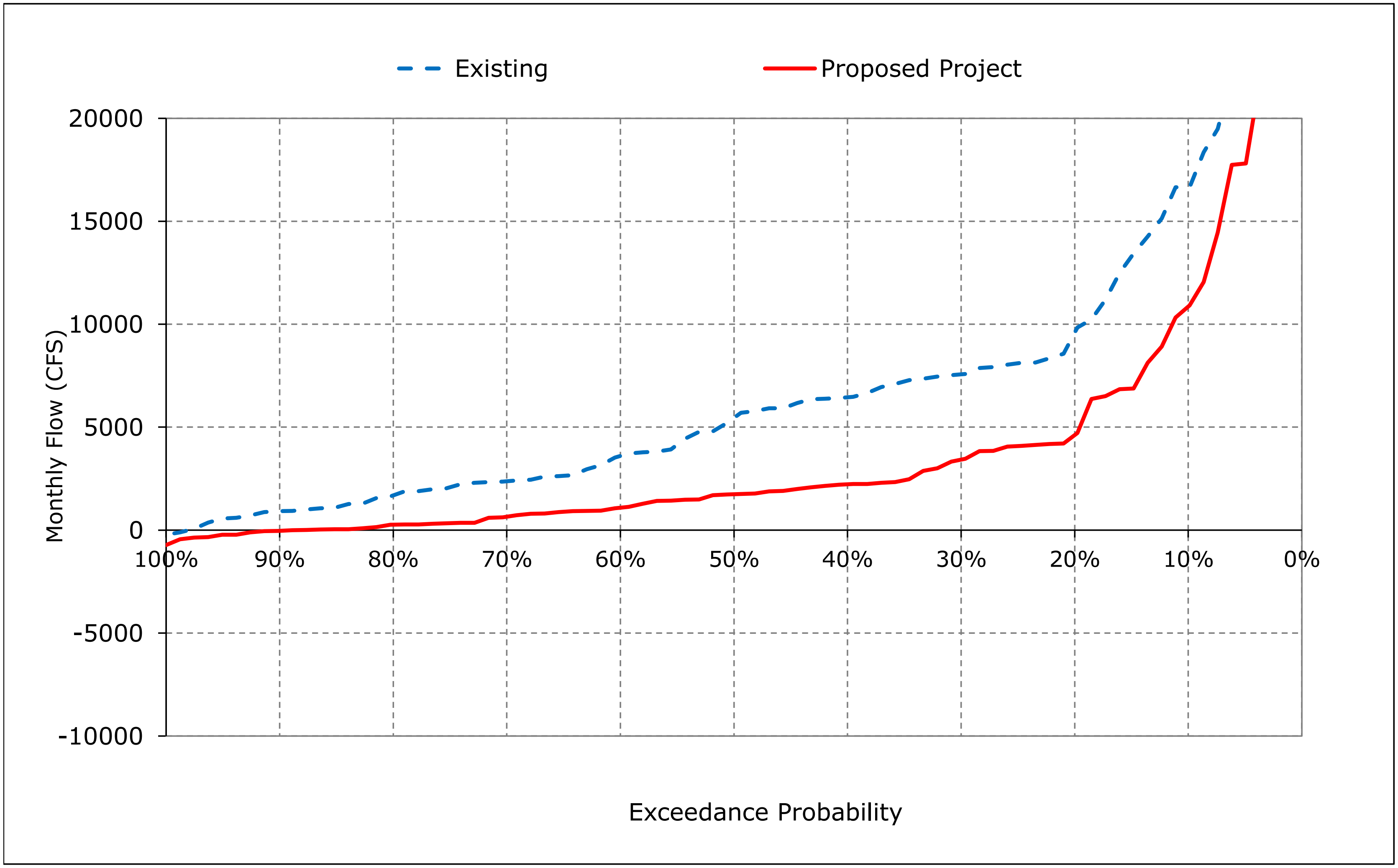


Figure 8-15. Qwest, June

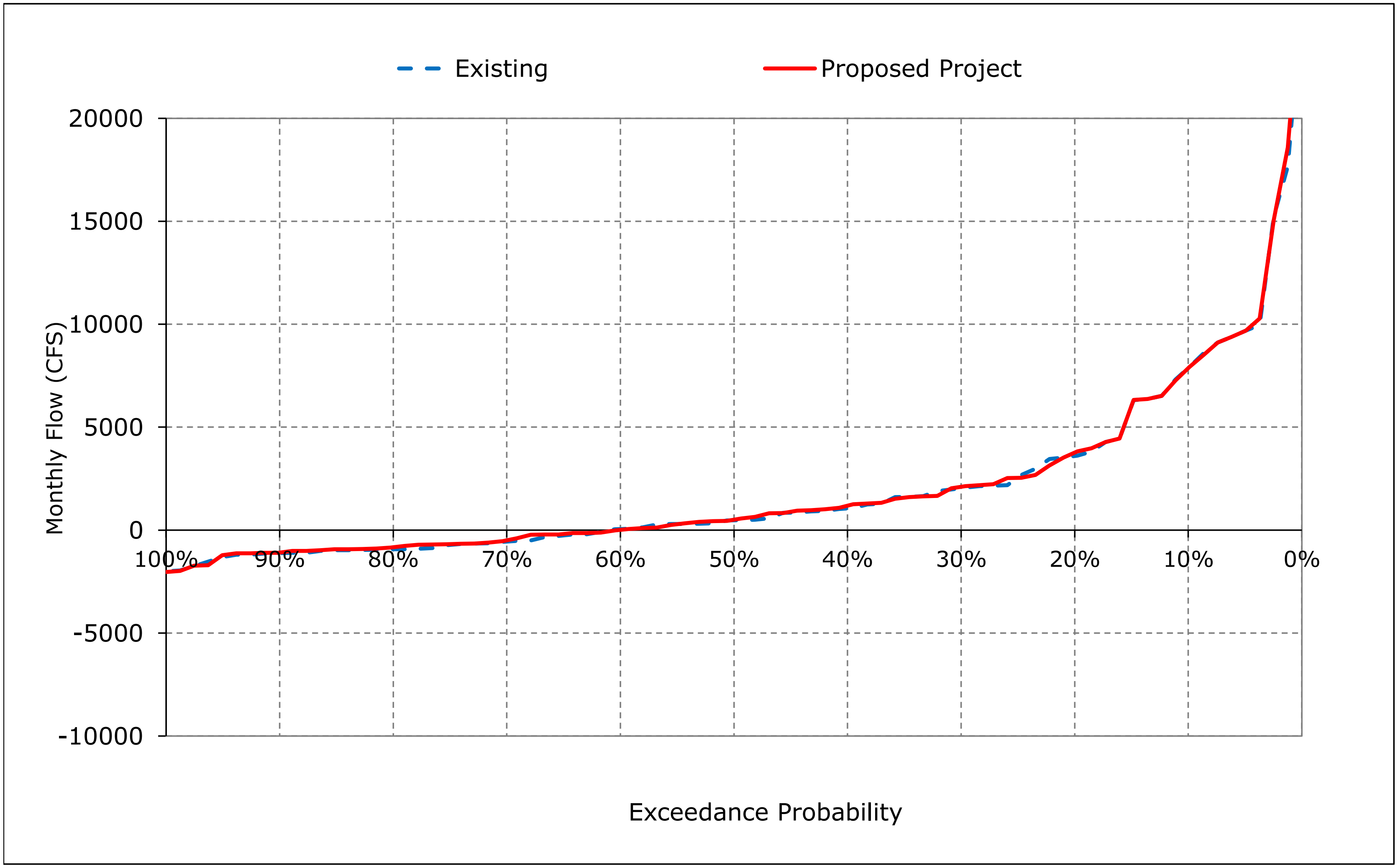


Figure 8-16. Qwest, July

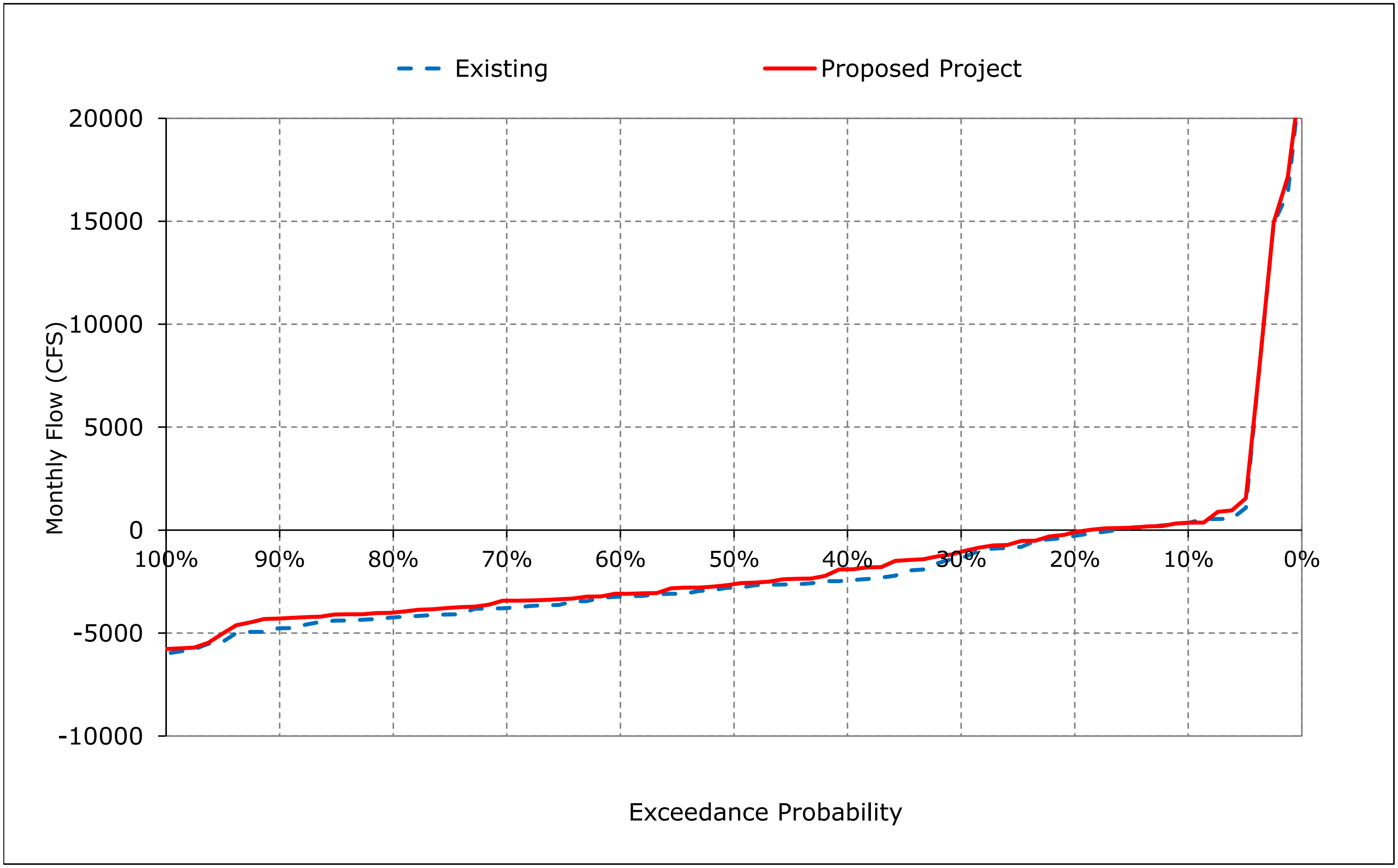


Figure 8-17. Qwest, August

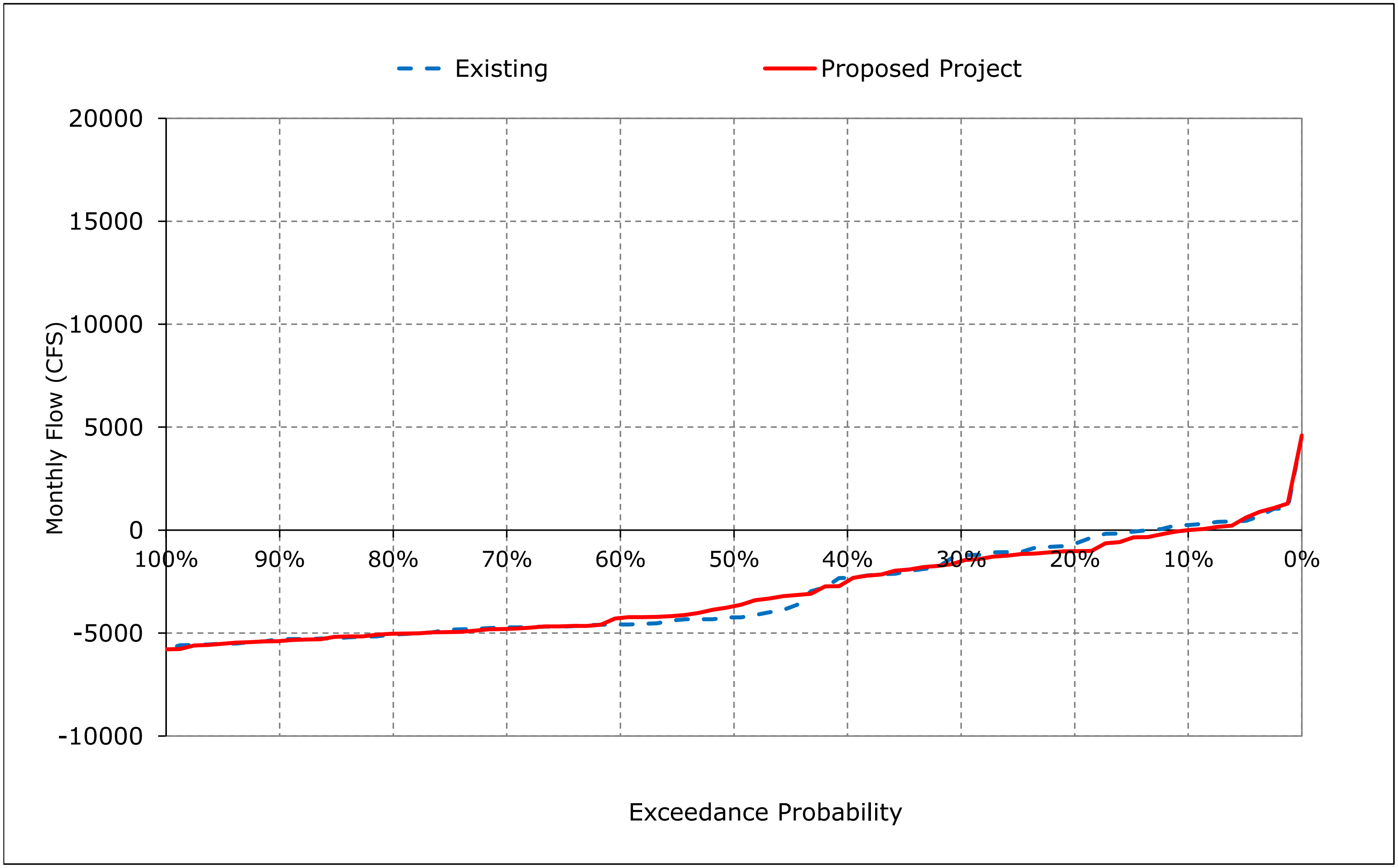


Figure 8-18. Qwest, September

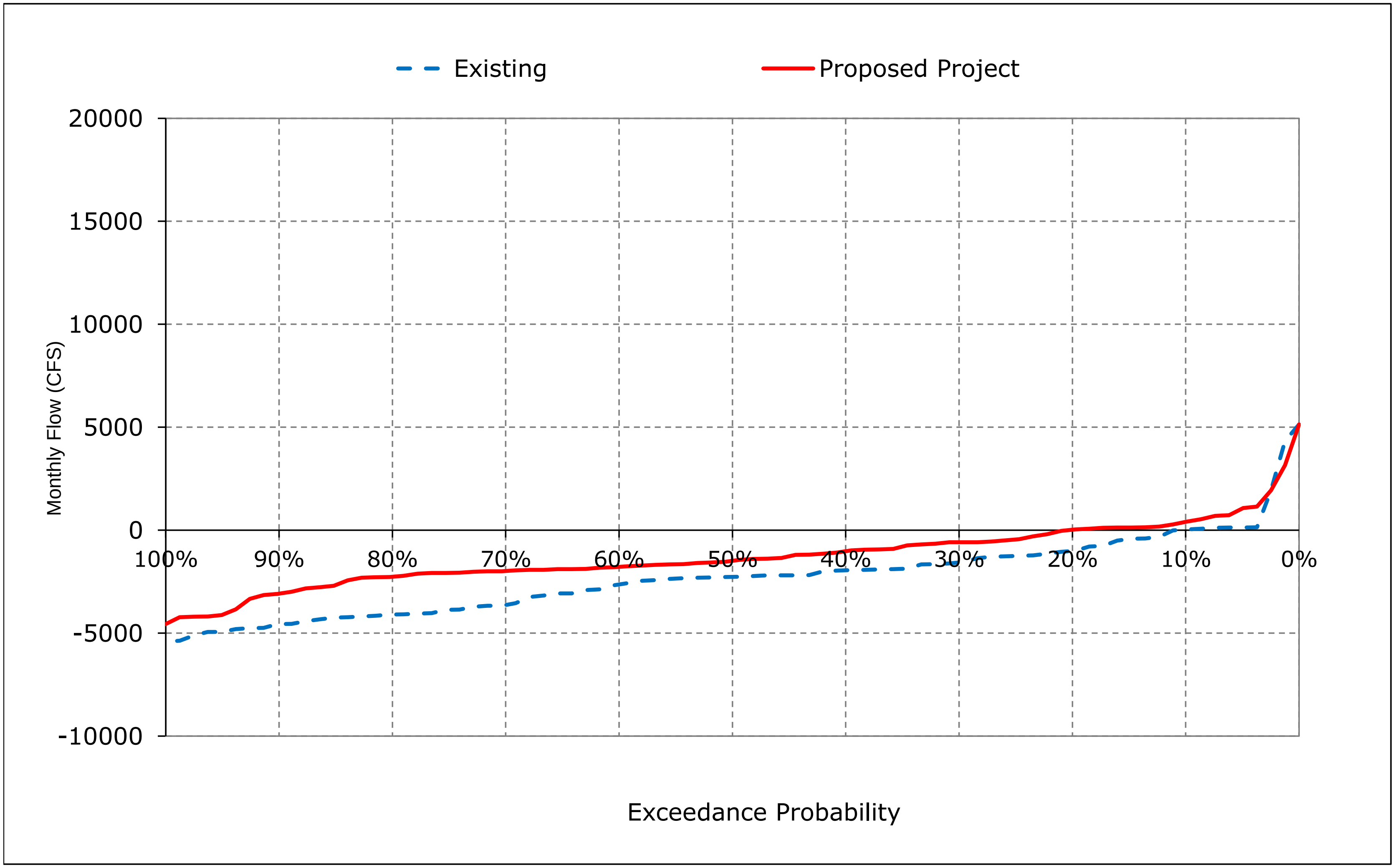


Table 9-1. Delta Outflow, Monthly Outflow

Existing

	Monthly Outflow (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	8,281	16,003	64,924	99,529	128,573	86,962	73,320	51,194	29,470	11,514	4,216	20,133
20%	7,813	15,281	32,439	66,067	79,799	65,200	53,523	31,419	14,524	9,504	4,000	19,500
30%	7,453	13,889	15,815	47,484	60,558	43,763	31,053	21,380	10,193	8,268	4,000	15,953
40%	6,031	11,000	12,583	28,238	51,342	35,194	28,456	18,465	7,993	8,000	4,000	11,563
50%	4,712	10,156	9,684	19,147	35,758	25,841	22,248	15,195	7,243	8,000	4,000	4,203
60%	4,000	5,463	5,579	16,356	24,017	20,399	16,601	11,910	7,100	6,500	4,000	3,055
70%	4,000	4,500	4,932	11,933	16,765	16,301	13,467	9,446	7,037	5,000	3,998	3,000
80%	4,000	4,500	4,506	9,402	14,140	12,437	11,550	8,237	6,119	5,000	3,838	3,000
90%	4,000	4,500	4,500	8,081	10,146	9,076	9,541	6,979	5,034	4,000	3,500	3,000
Long Term												
Full Simulation Period[a]	5,997	11,472	21,026	41,339	52,691	42,631	31,618	21,916	12,394	8,075	4,216	9,630
Water Year Types[b,c]												
Wet (32%)	7,724	17,334	42,783	83,568	97,663	79,915	56,933	39,709	22,444	11,645	5,047	19,510
Above Normal (15%)	5,432	12,125	17,901	45,449	59,682	52,471	33,562	24,582	11,383	9,804	4,000	11,758
Below Normal (17%)	5,429	8,622	12,186	20,966	36,006	22,558	23,217	15,806	7,964	7,360	4,000	3,625
Dry (22%)	5,213	8,210	8,791	13,693	22,405	18,720	15,097	9,920	6,717	5,036	3,801	3,006
Critical (15%)	4,657	6,332	5,673	10,968	13,155	11,295	9,410	5,821	5,316	4,004	3,506	3,040

Proposed Project

	Monthly Outflow (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	6,859	14,685	64,939	100,311	129,486	90,940	67,887	44,418	29,473	11,562	4,284	13,594
20%	6,406	6,932	32,897	66,826	80,337	65,797	48,067	28,298	14,459	9,830	4,000	12,656
30%	6,250	5,186	19,037	47,311	64,736	45,962	27,983	17,016	10,628	8,581	4,000	12,500
40%	6,010	4,997	12,289	28,203	53,411	36,137	23,971	13,637	8,509	8,000	4,000	12,125
50%	5,250	4,865	9,331	22,286	36,075	27,590	17,845	12,246	7,700	8,000	4,000	4,199
60%	4,196	4,500	6,400	15,901	24,348	22,213	13,221	10,391	7,197	6,500	4,000	3,000
70%	4,000	4,500	5,161	11,690	17,941	17,235	11,321	8,791	7,100	5,000	3,933	3,000
80%	4,000	4,500	4,613	8,949	14,002	12,990	9,673	7,241	6,915	5,000	3,722	3,000
90%	4,000	3,976	4,500	7,950	10,082	9,117	8,442	6,546	4,956	4,000	3,500	3,000
Long Term												
Full Simulation Period[a]	5,693	8,486	21,802	41,945	53,614	43,855	28,870	19,239	12,669	8,188	4,213	7,784
Water Year Types[b,c]												
Wet (32%)	7,288	13,528	45,045	85,036	98,901	81,055	53,084	35,402	22,498	11,770	5,082	13,273
Above Normal (15%)	5,086	8,579	18,014	46,486	61,233	55,035	29,851	20,521	12,029	9,707	4,000	12,721
Below Normal (17%)	5,100	5,755	12,292	21,931	37,884	23,943	20,278	13,073	8,690	7,835	4,014	3,579
Dry (22%)	4,814	6,064	8,722	13,304	22,134	19,961	13,225	8,909	6,894	5,030	3,753	3,006
Critical (15%)	4,854	4,291	5,946	10,352	13,442	11,146	8,916	5,628	5,316	4,056	3,462	3,028

Proposed Project minus Existing

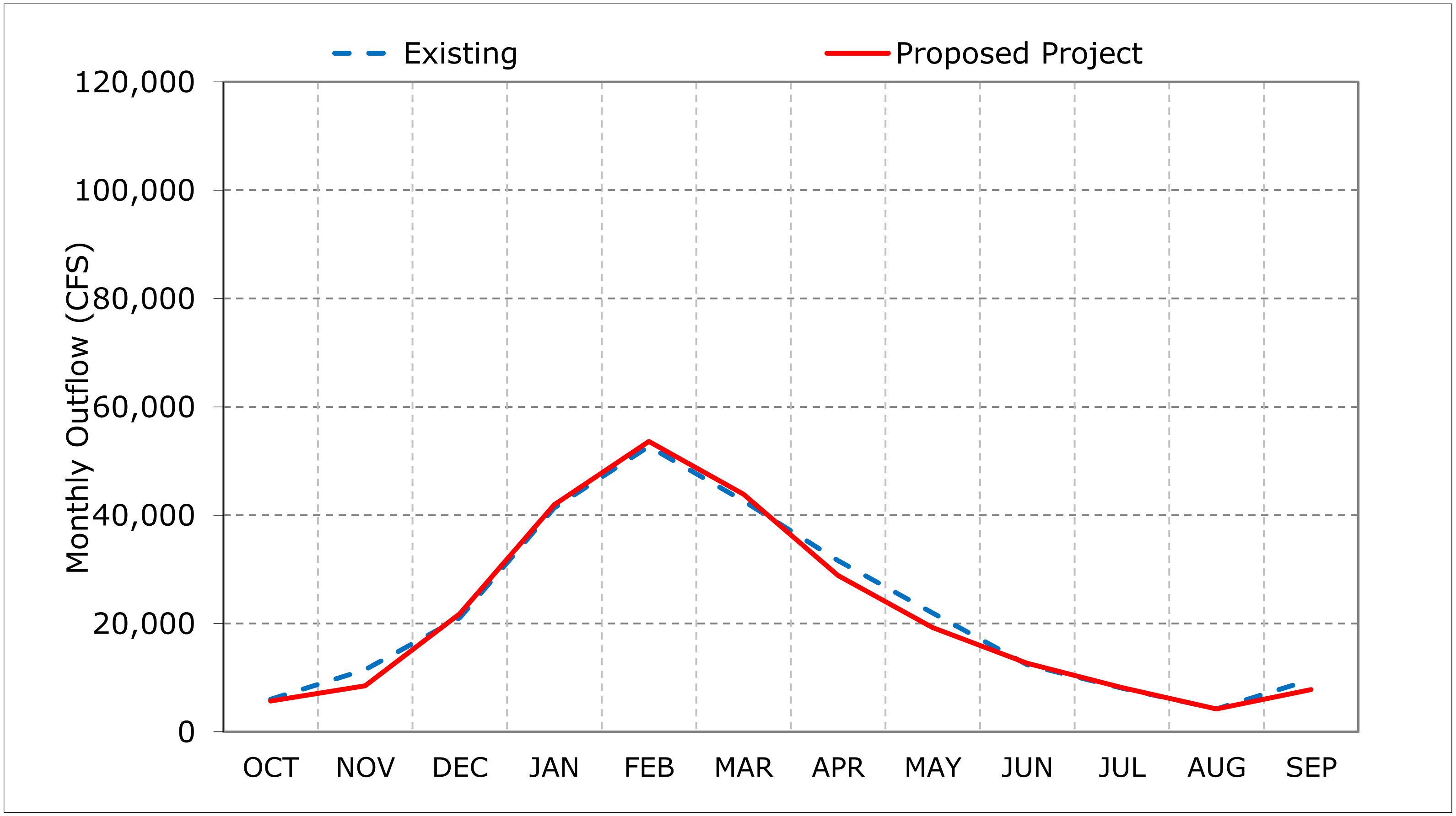
	Monthly Outflow (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	**-1,422**	**-1,318**	14	782	913	3,978	**-5,433**	**-6,777**	3	48	68	**-6,539**
20%	**-1,406**	**-8,349**	458	760	538	597	**-5,456**	**-3,121**	**-65**	326	0	**-6,844**
30%	**-1,203**	**-8,703**	3,222	**-174**	4,177	2,199	**-3,070**	**-4,364**	435	313	0	**-3,453**
40%	**-21**	**-6,003**	**-294**	**-35**	2,069	944	**-4,485**	**-4,828**	516	0	0	563
50%	537	**-5,291**	**-353**	3,139	317	1,749	**-4,403**	**-2,949**	457	0	0	**-4**
60%	196	**-963**	821	**-454**	330	1,813	**-3,380**	**-1,520**	97	0	0	**-55**
70%	0	0	229	**-243**	1,176	935	**-2,146**	**-655**	63	0	**-65**	0
80%	0	0	107	**-453**	**-137**	553	**-1,877**	**-997**	796	0	**-116**	0
90%	0	**-524**	0	**-130**	**-64**	41	**-1,100**	**-433**	**-77**	0	0	0
Long Term												
Full Simulation Period[a]	**-304**	**-2,985**	776	607	923	1,224	**-2,749**	**-2,677**	274	113	**-3**	**-1,846**
Water Year Types[b,c]												
Wet (32%)	**-436**	**-3,806**	2,261	1,468	1,238	1,140	**-3,849**	**-4,307**	54	125	35	**-6,237**
Above Normal (15%)	**-346**	**-3,546**	113	1,038	1,550	2,564	**-3,711**	**-4,061**	646	**-97**	0	964
Below Normal (17%)	**-329**	**-2,868**	106	965	1,878	1,385	**-2,940**	**-2,733**	726	474	14	**-46**
Dry (22%)	**-399**	**-2,146**	**-70**	**-389**	**-270**	1,241	**-1,873**	**-1,011**	177	**-6**	**-48**	**-1**
Critical (15%)	196	**-2,041**	273	**-616**	286	**-149**	**-494**	**-194**	**0**	51	**-44**	**-11**

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

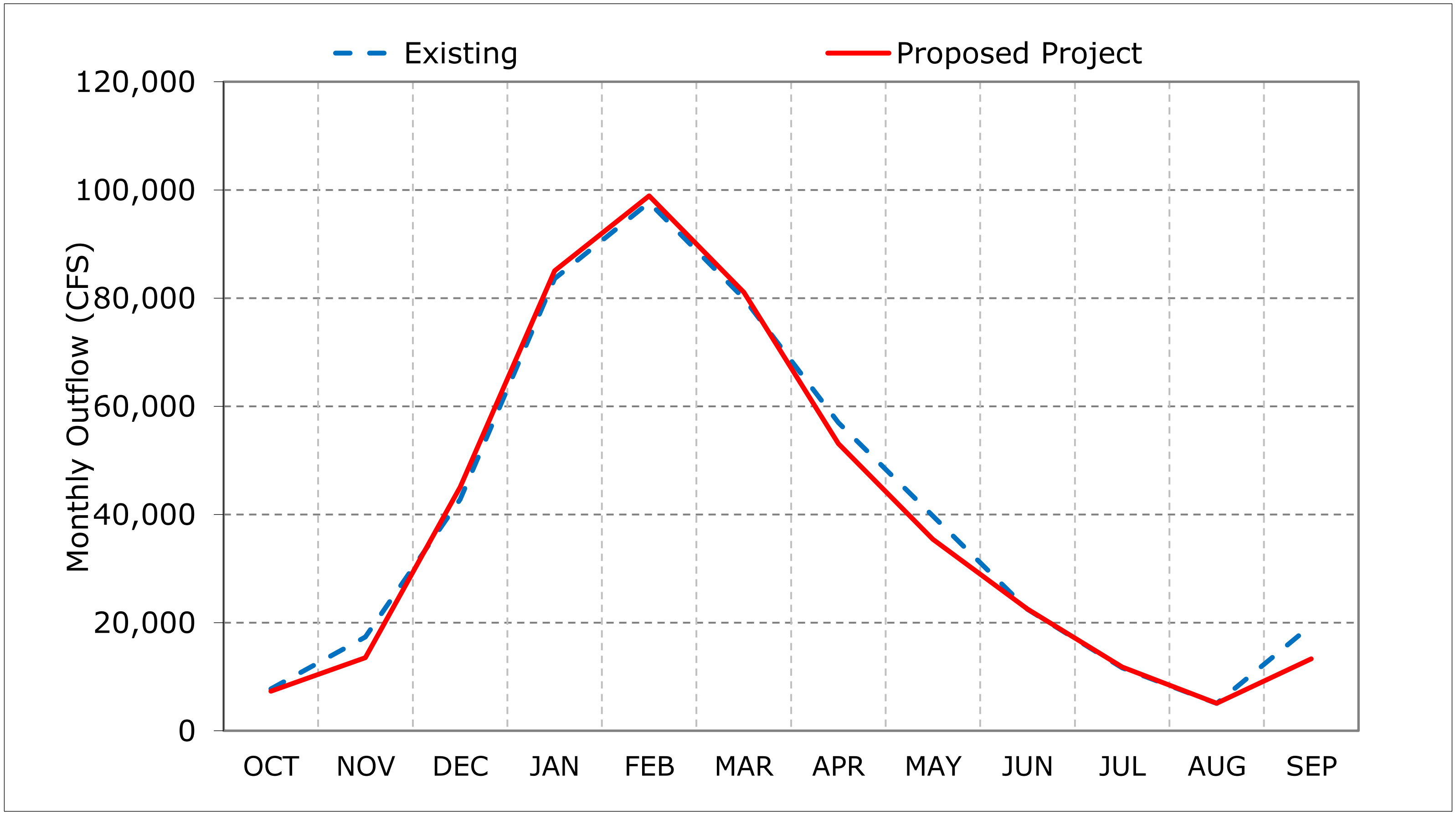
c These results are displayed with water year - year type sorting.

Figure 9-1. Delta Outflow, Long-Term Average Outflow



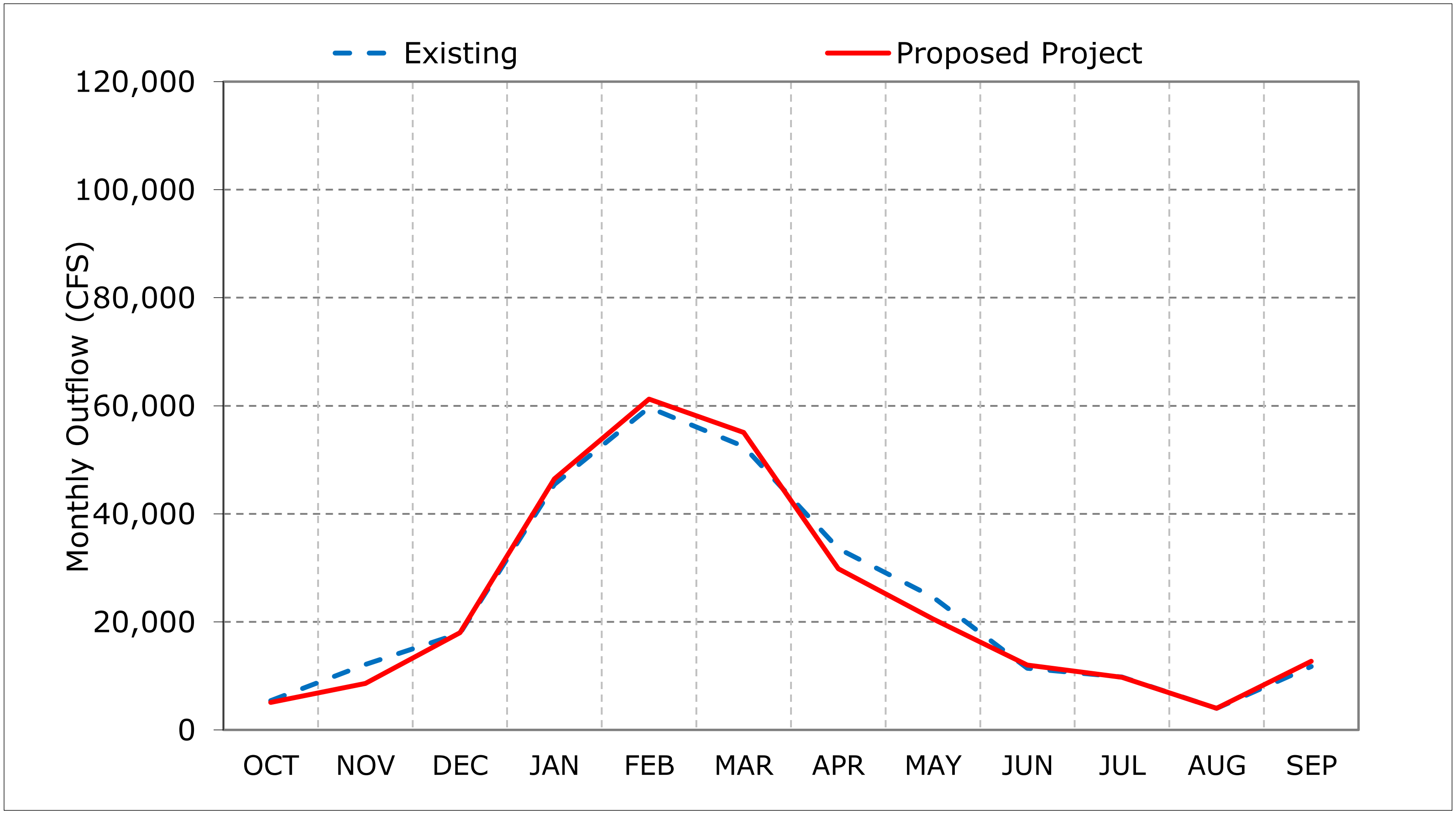
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 9-2. Delta Outflow, Wet Year Average Outflow



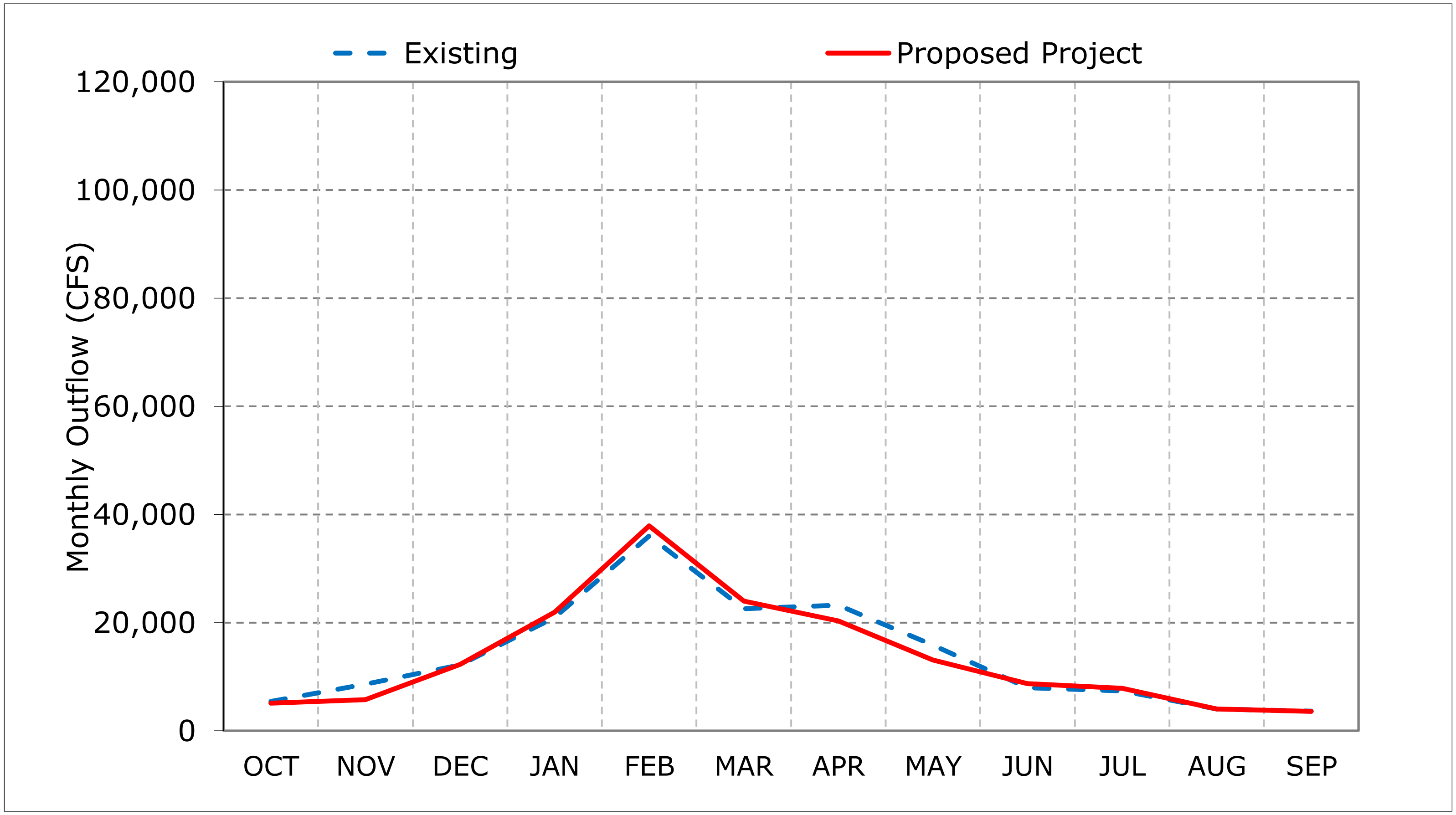
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 9-3. Delta Outflow, Above Normal Year Average Outflow



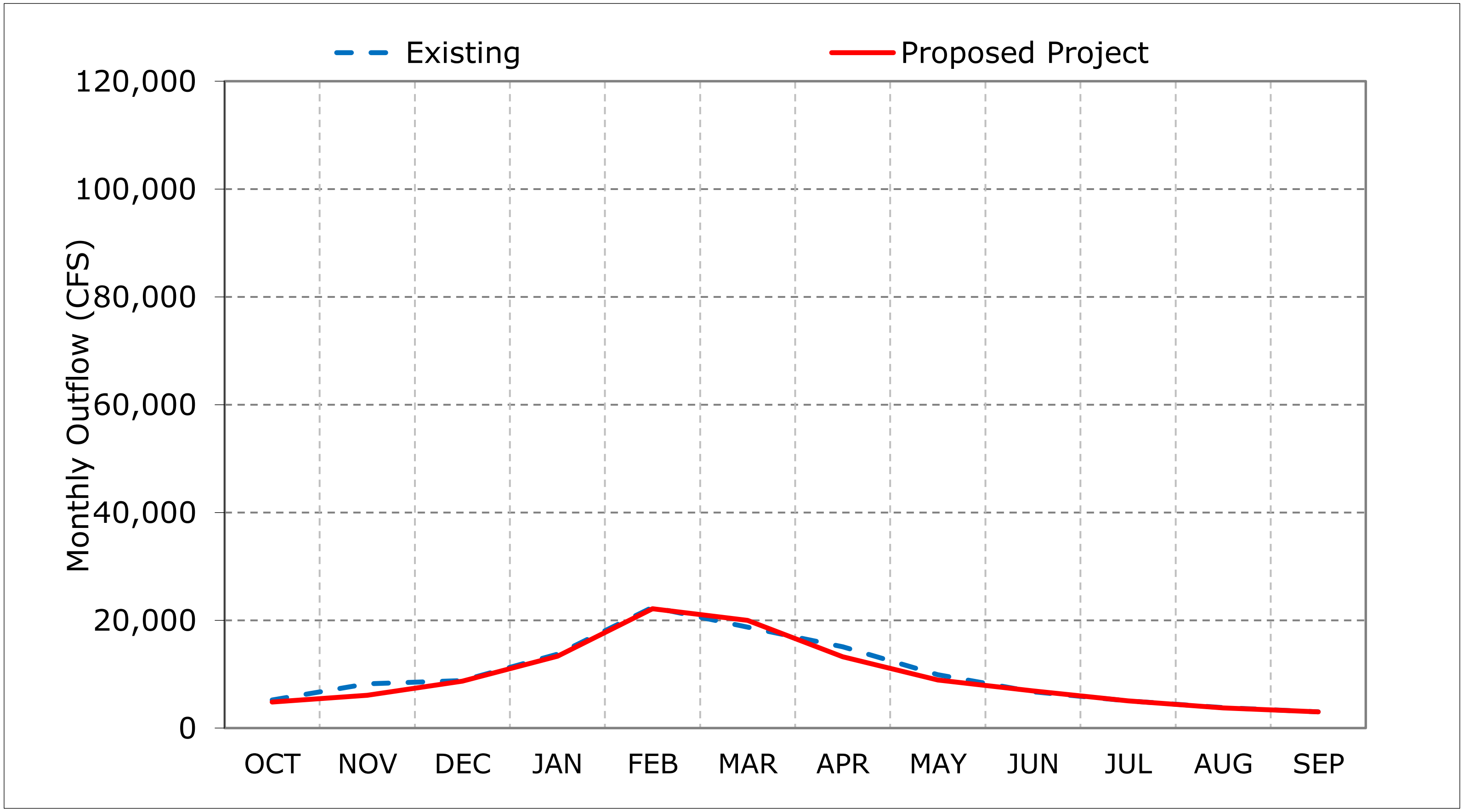
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 9-4. Delta Outflow, Below Normal Year Average Outflow



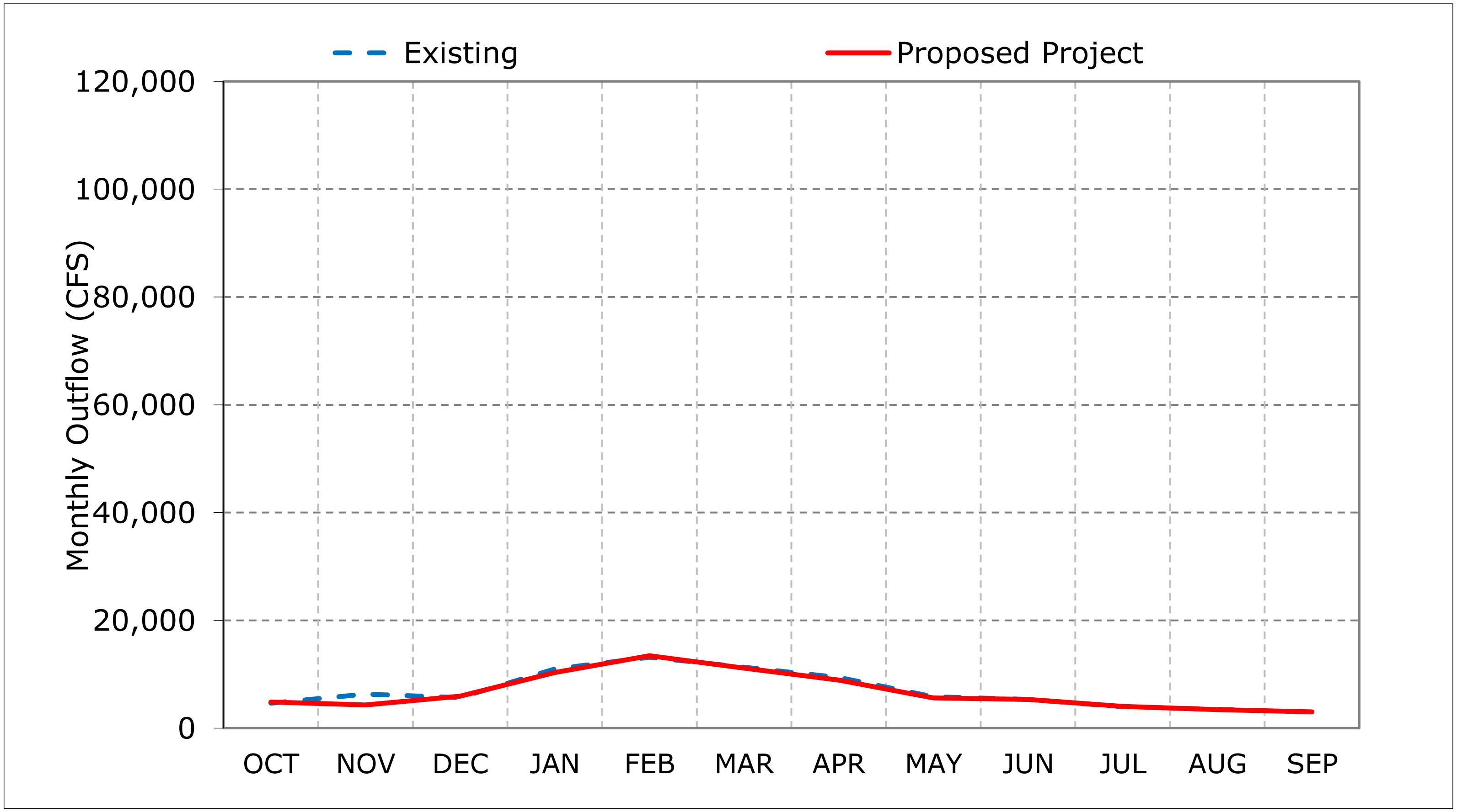
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 9-5. Delta Outflow, Dry Year Average Outflow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 9-6. Delta Outflow, Critical Year Average Outflow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 9-7. Delta Outflow, October

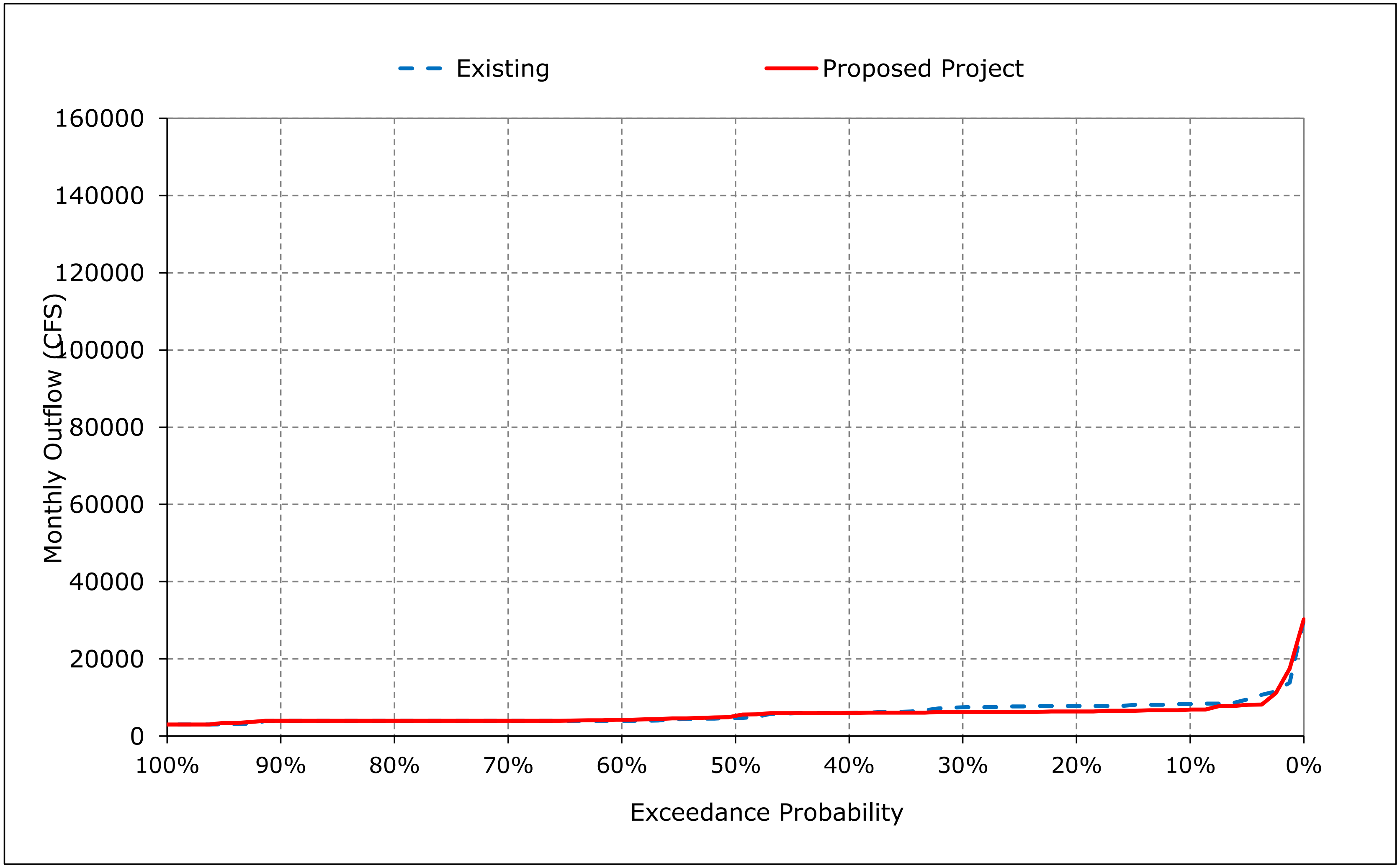


Figure 9-8. Delta Outflow, November

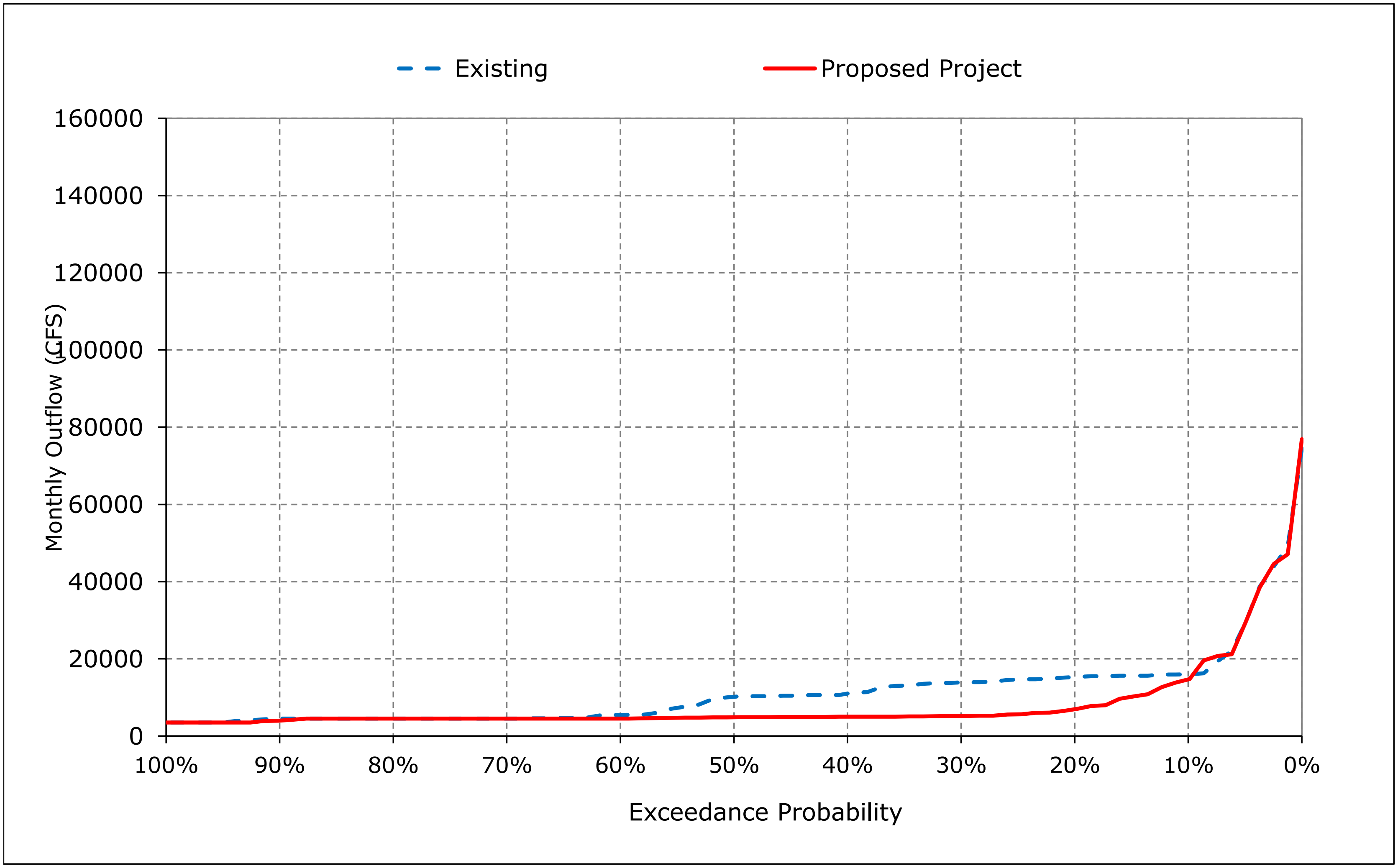


Figure 9-9. Delta Outflow, December

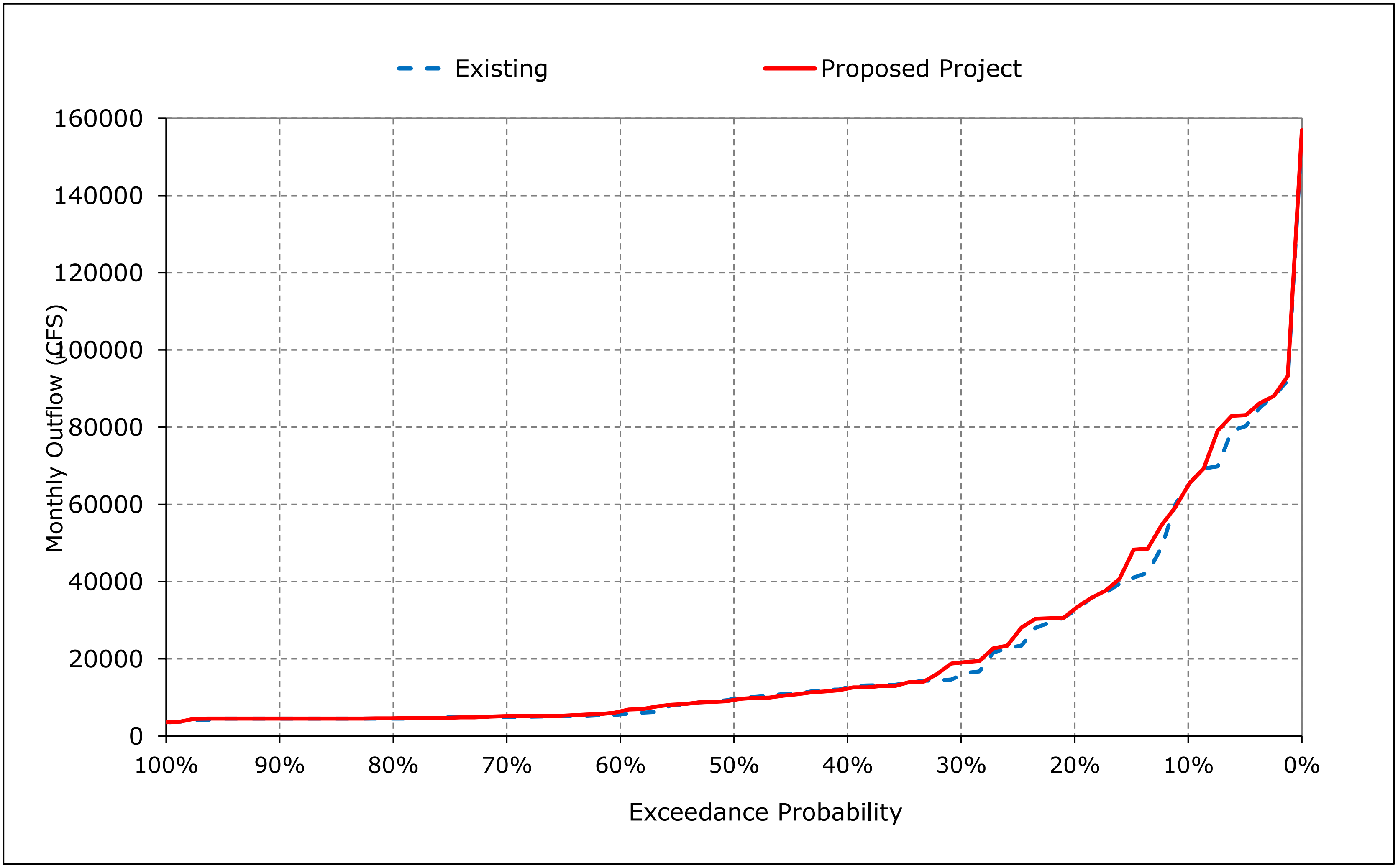


Figure 9-10. Delta Outflow, January

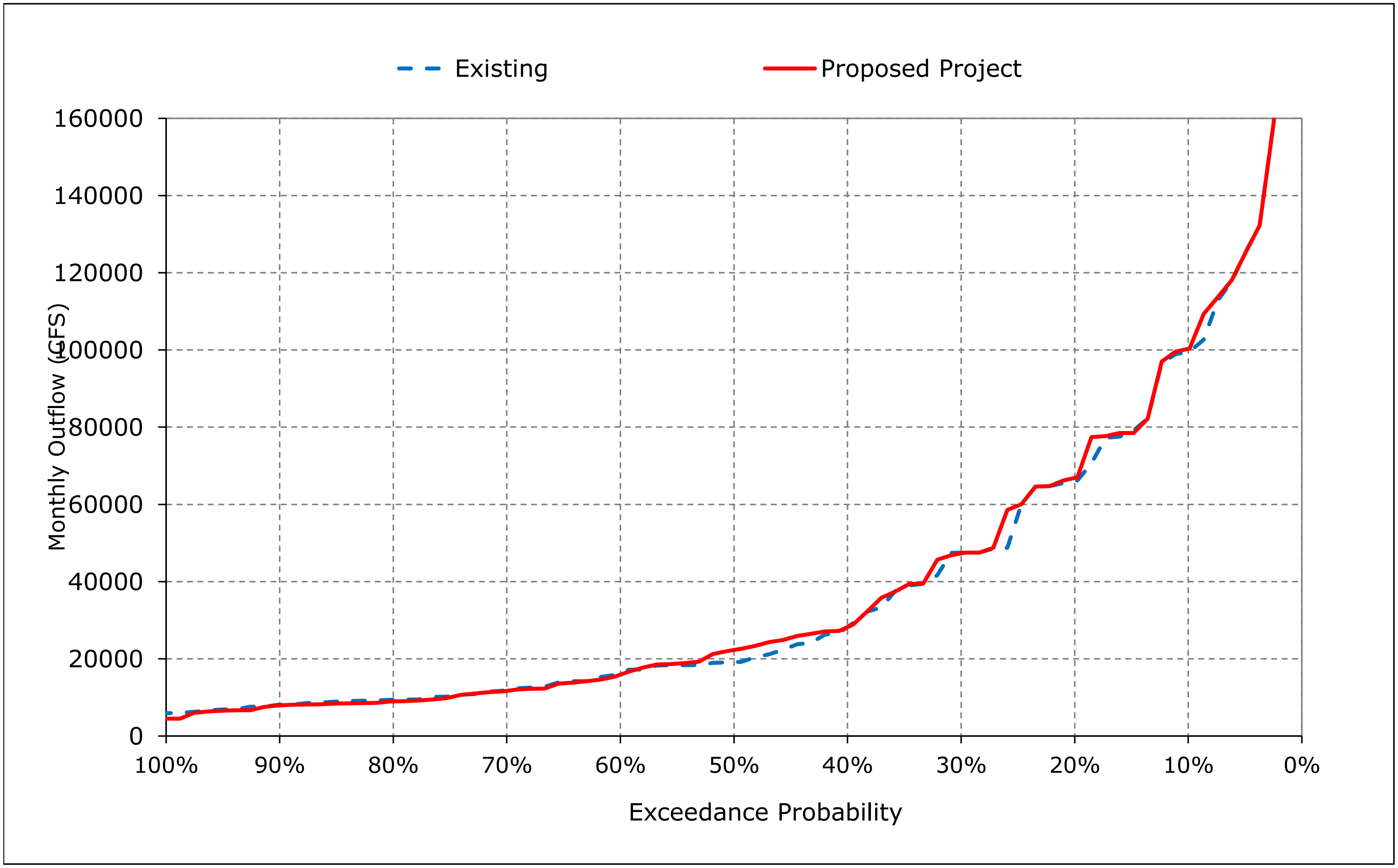


Figure 9-11. Delta Outflow, February

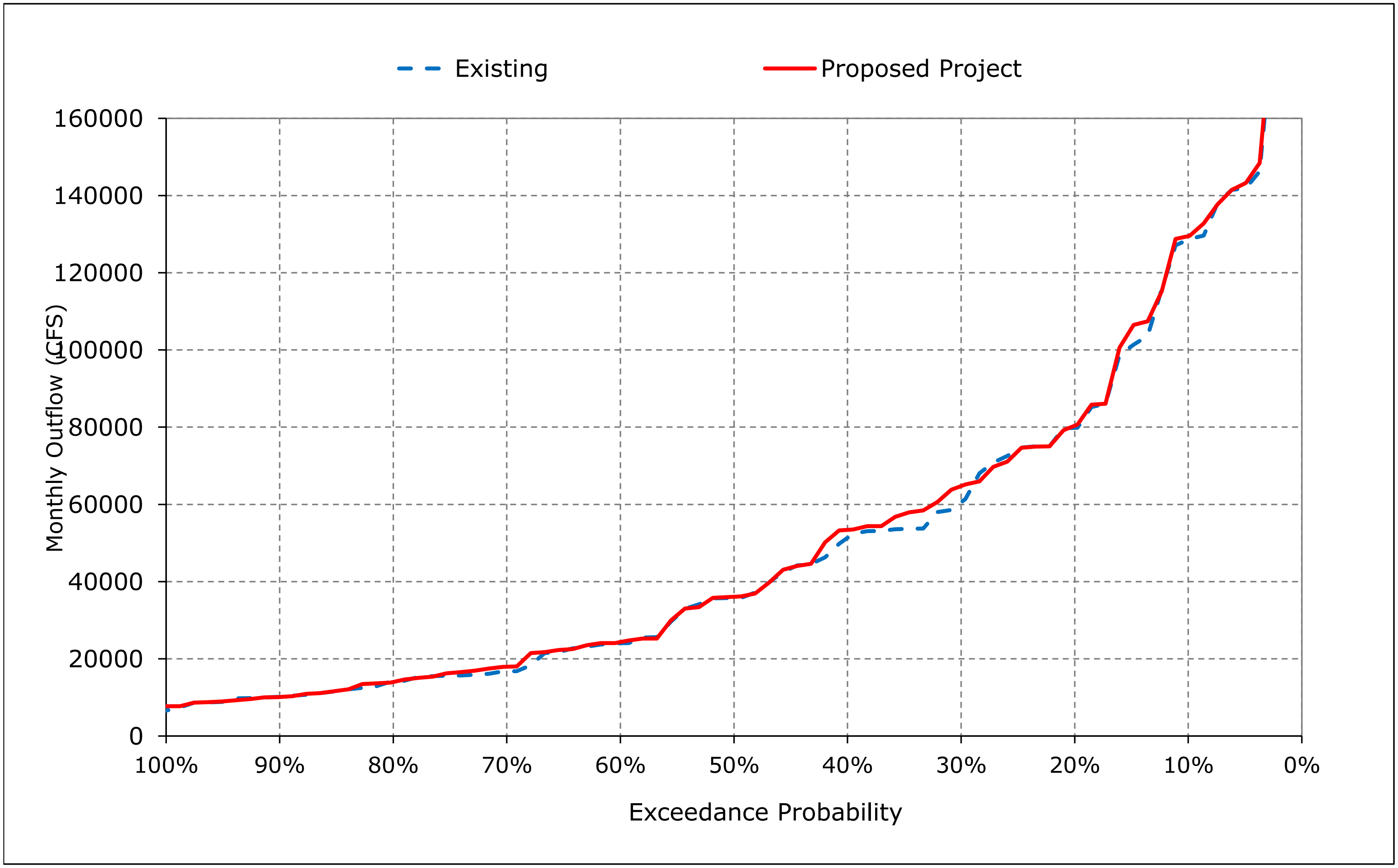


Figure 9-12. Delta Outflow, March

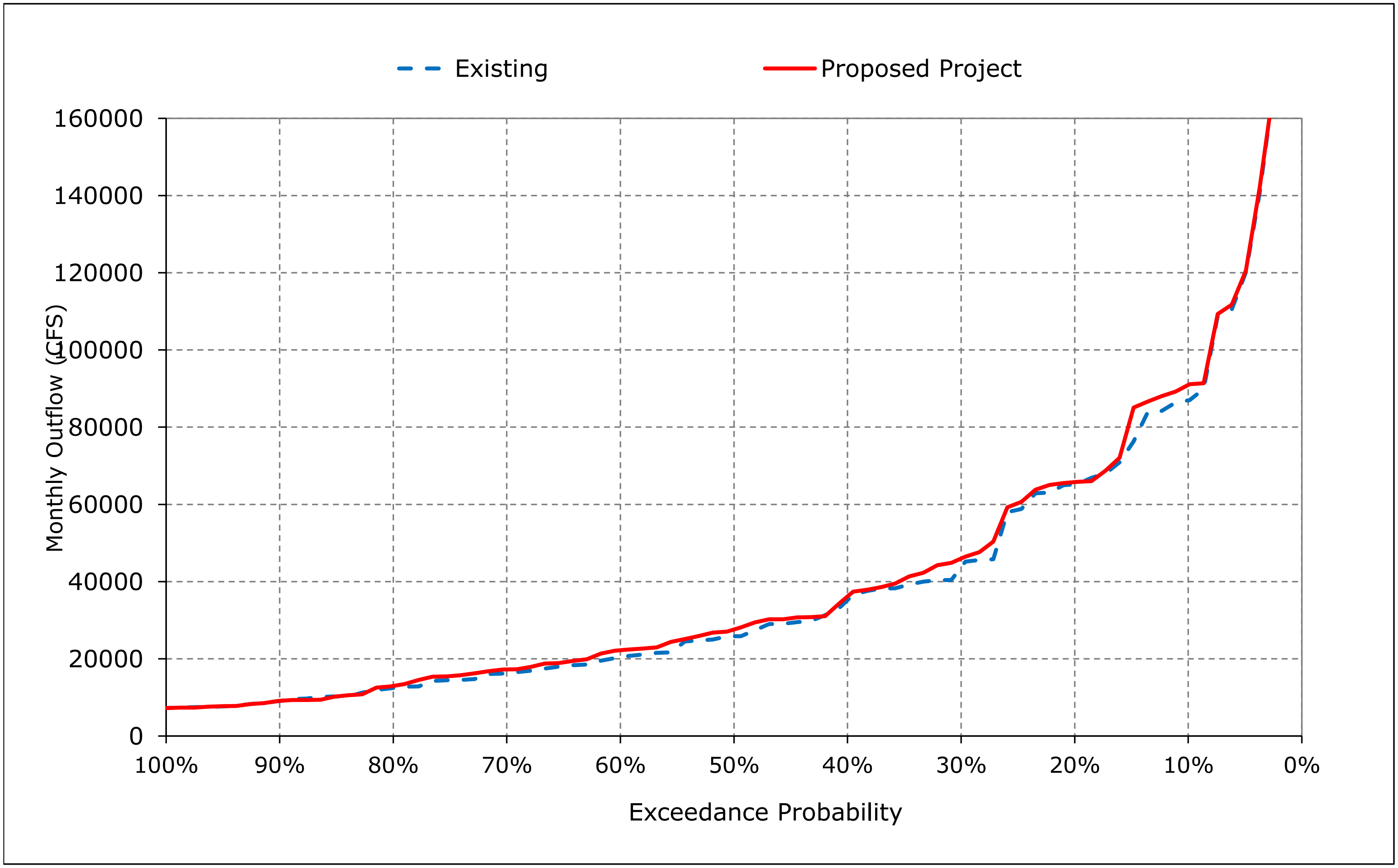


Figure 9-13. Delta Outflow, April

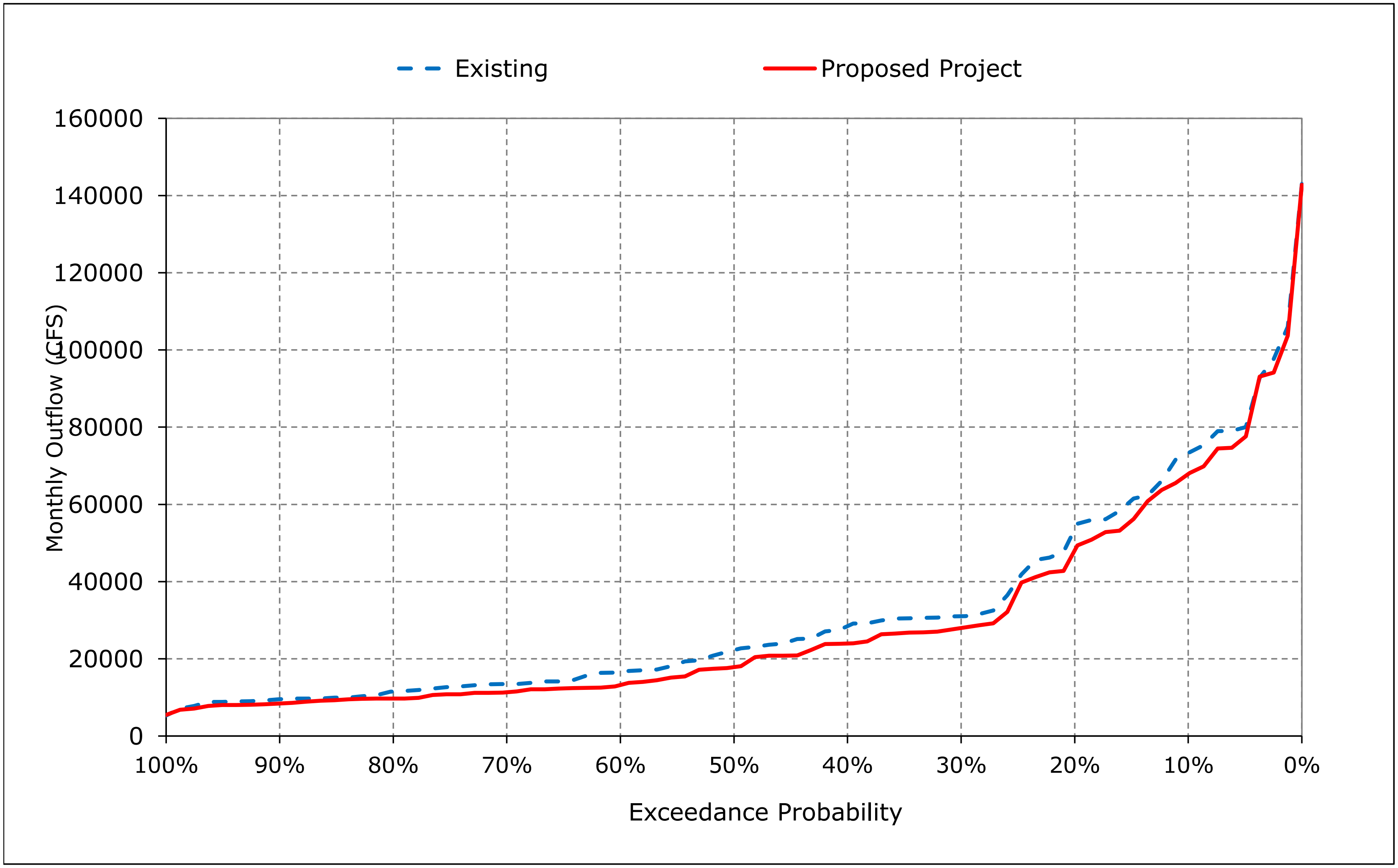


Figure 9-14. Delta Outflow, May

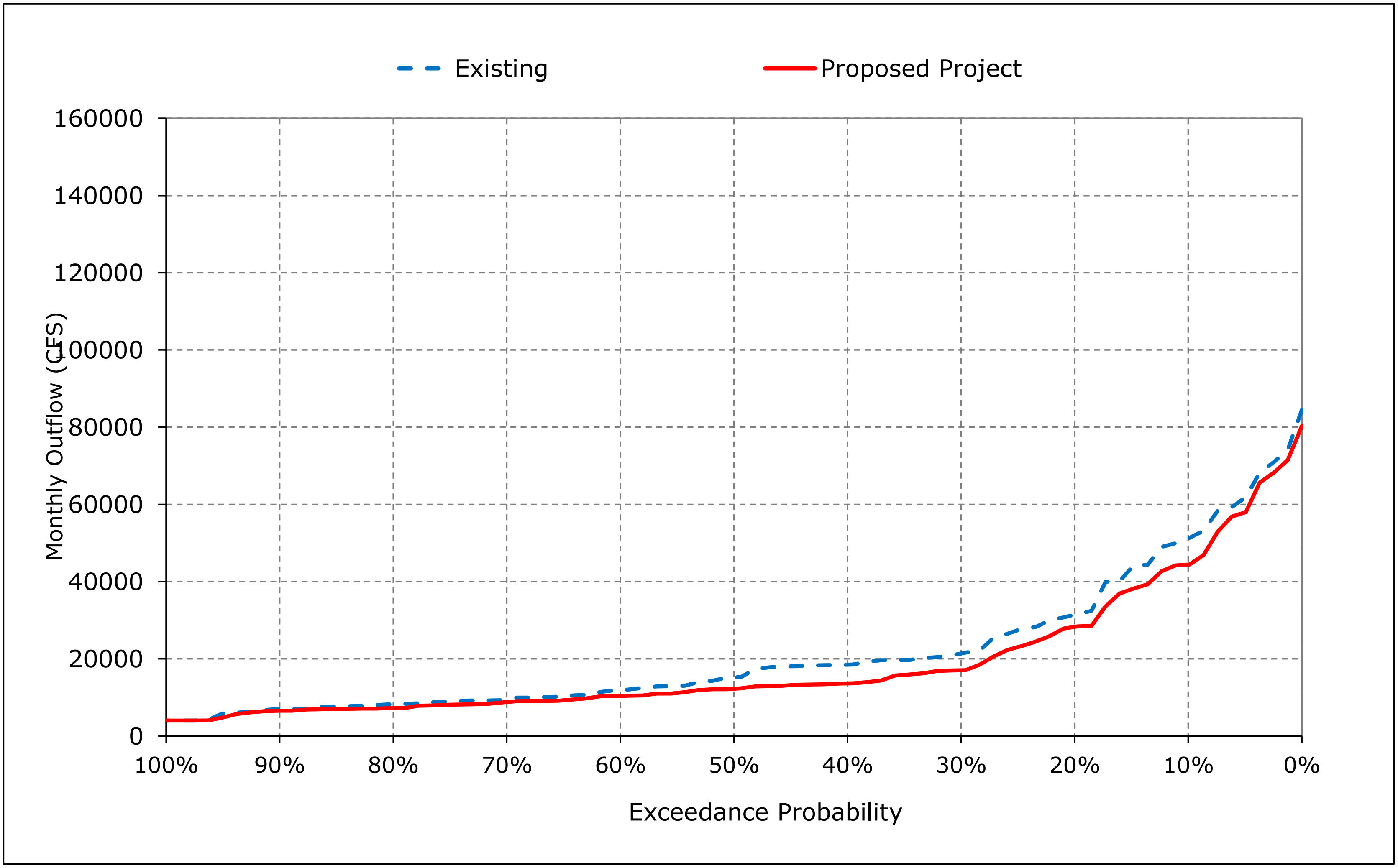


Figure 9-15. Delta Outflow, June

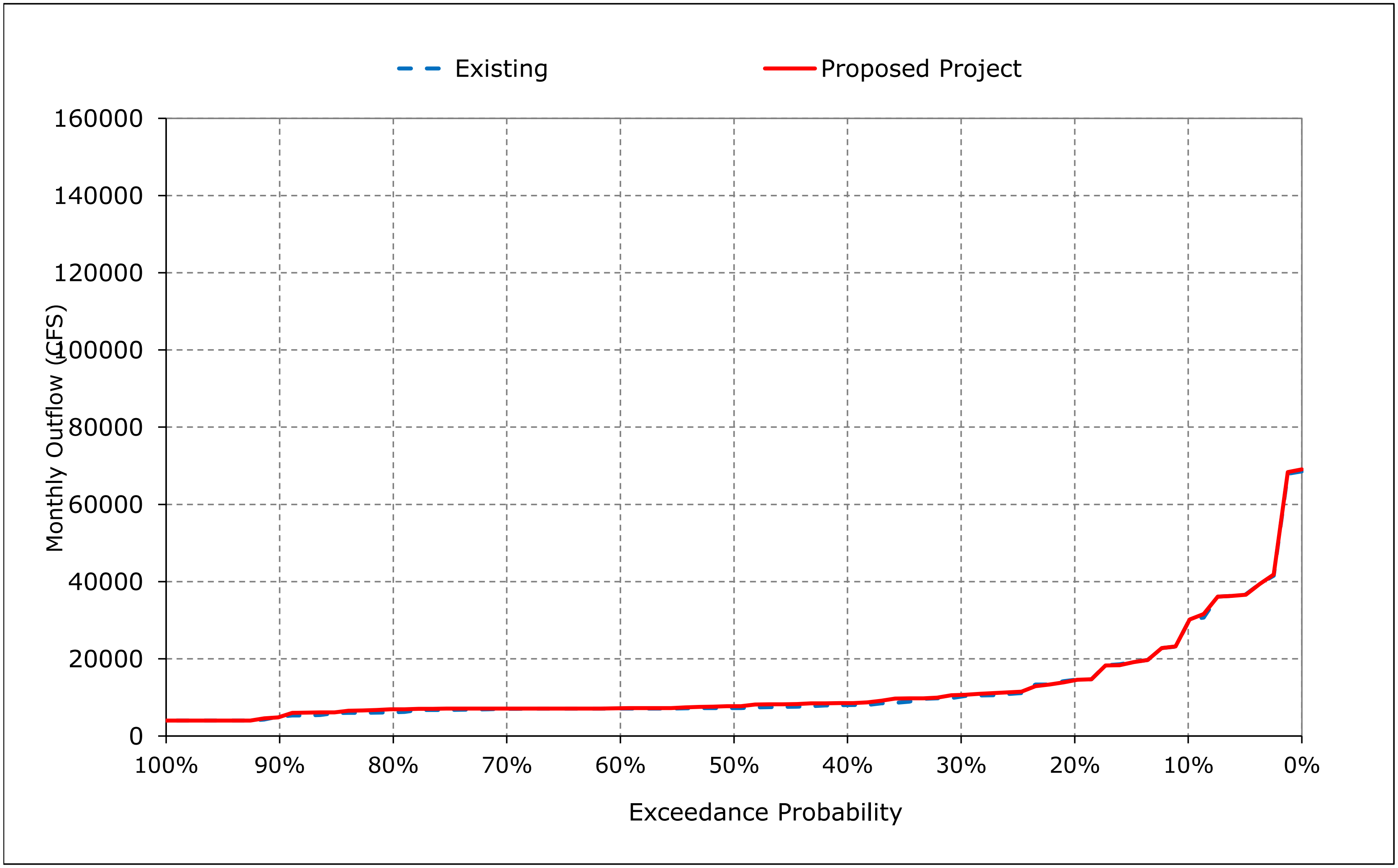


Figure 9-16. Delta Outflow, July

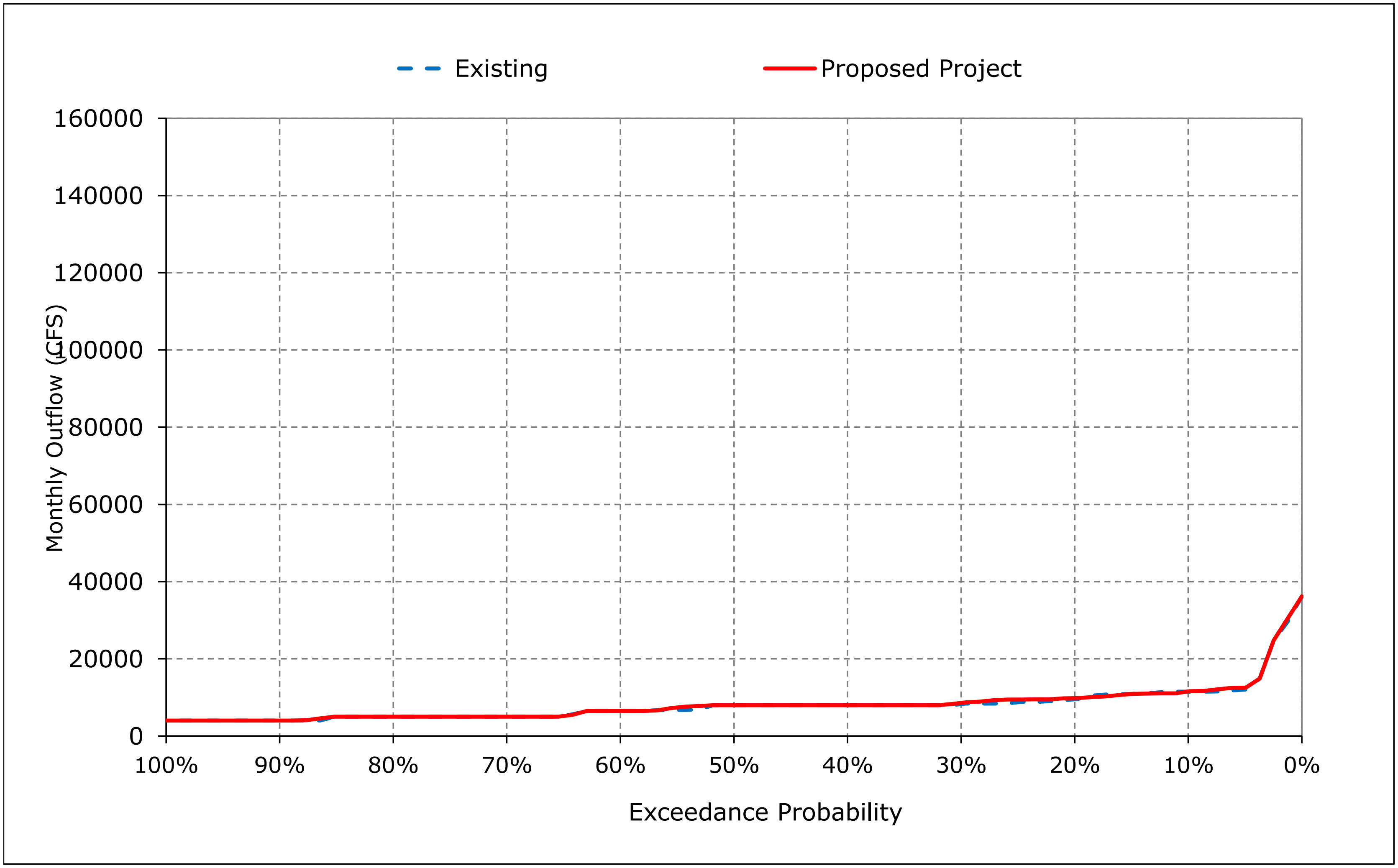


Figure 9-17. Delta Outflow, August

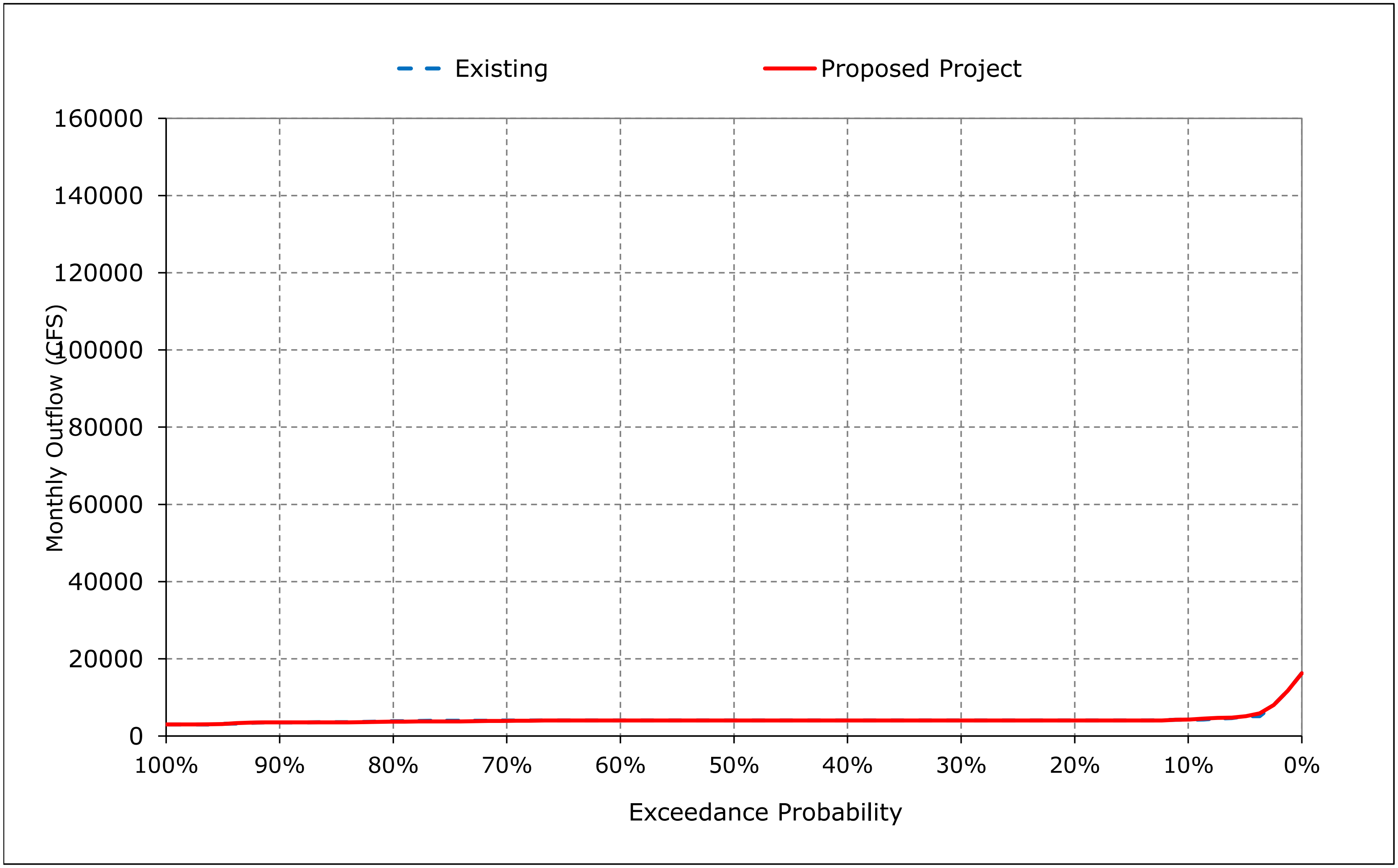
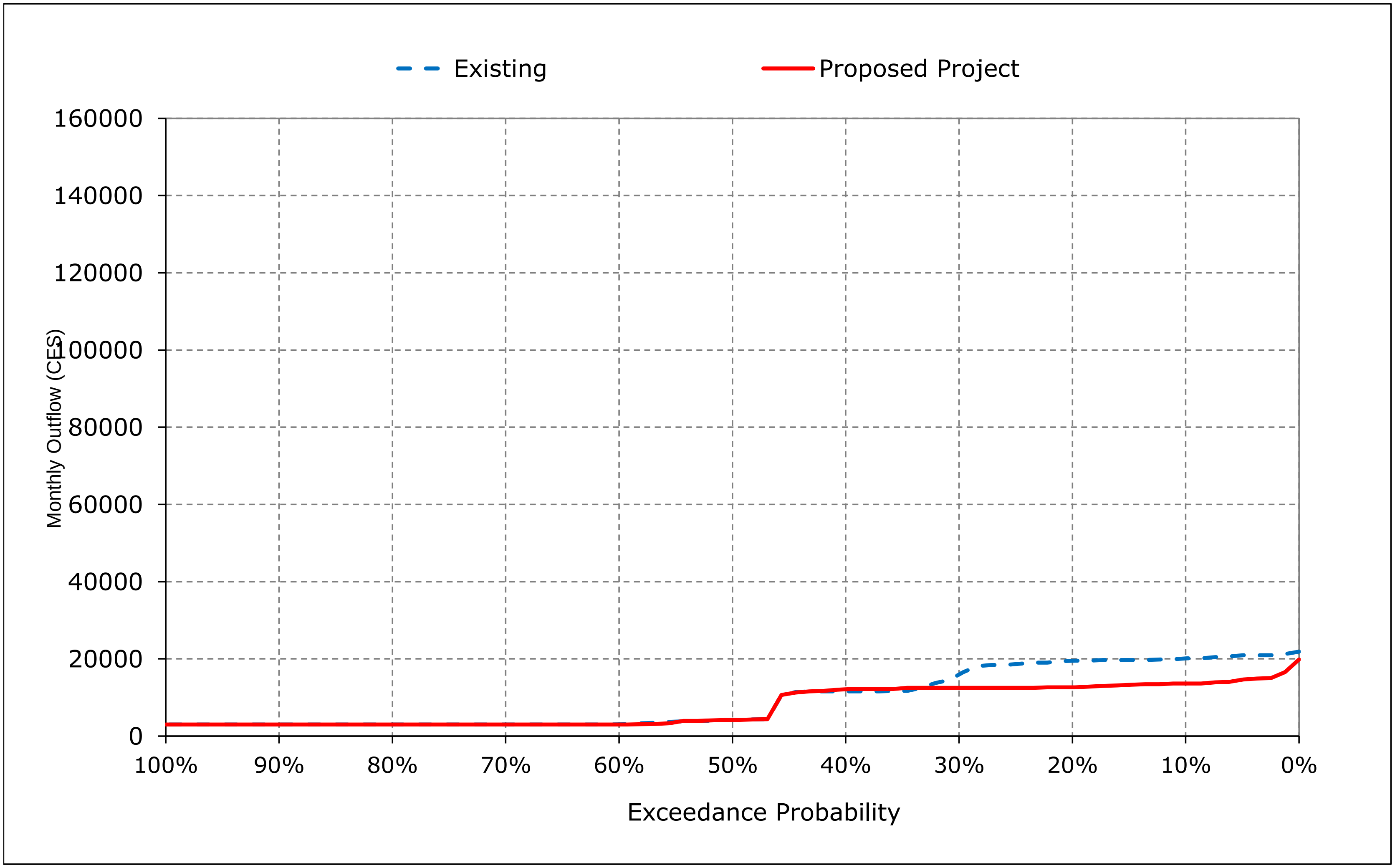


Figure 9-18. Delta Outflow, September



Appendix C – Modeling

Attachment 2-3 – Diversion Results (CalSim II)

The following results of the CalSim II model are included for diversions at key project locations for the following alternatives:

- Existing Conditions
- Proposed Project

Table 2-3.1. Diversion Results (CalSim II)

Title	Model Parameter	Table Numbers	Figure Numbers
North Bay Aqueduct Exports	D403B	1-1	1-1 to 1-18
DCC Flow	C401B_DXC	2-1	2-1 to 2-18
Total Delta Exports	TOTAL_EXP	3-1	3-1 to 3-18
SWP Banks PP Exports	D419_SWP	4-1	4-1 to 4-18
CVP Banks PP Exports	D419_CVP	5-1	5-1 to 5-18
Banks PP Exports	D419	6-1	6-1 to 6-18
Jones PP Exports	D418	7-1	7-1 to 7-18

Report formats

- Monthly tables comparing two scenarios (exceedance values, long-term average, and average by water year type)
- Monthly pattern charts (long-term average and average by water year type) including all scenarios
- Monthly exceedance charts (all months) including all scenarios

Table 1-1. North Bay Aqueduct, Monthly Diversion

Existing

	Monthly Diversion (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	74	72	67	33	37	33	87	66	70	92	83	66
20%	54	70	65	33	37	33	87	64	70	90	63	66
30%	54	63	65	33	37	33	86	63	69	89	63	66
40%	54	38	64	33	37	33	85	57	64	64	63	66
50%	53	38	64	33	37	33	84	57	61	64	63	62
60%	53	38	63	33	37	33	84	57	61	60	63	62
70%	51	38	60	33	37	33	63	57	36	37	60	52
80%	46	36	60	33	36	33	63	53	36	37	60	52
90%	41	32	32	33	36	33	35	32	2	3	35	41
Long Term												
Full Simulation Period[a]	54	47	58	33	35	31	70	53	51	59	61	59
Water Year Types[b,c]												
Wet (32%)	54	51	63	33	37	33	86	57	68	73	63	66
Above Normal (15%)	57	48	58	33	37	33	86	61	70	86	63	66
Below Normal (17%)	54	43	58	33	32	33	84	65	62	81	60	62
Dry (22%)	53	49	57	33	35	32	59	57	38	37	75	52
Critical (15%)	55	42	50	33	34	17	21	15	2	5	35	44

Proposed Project

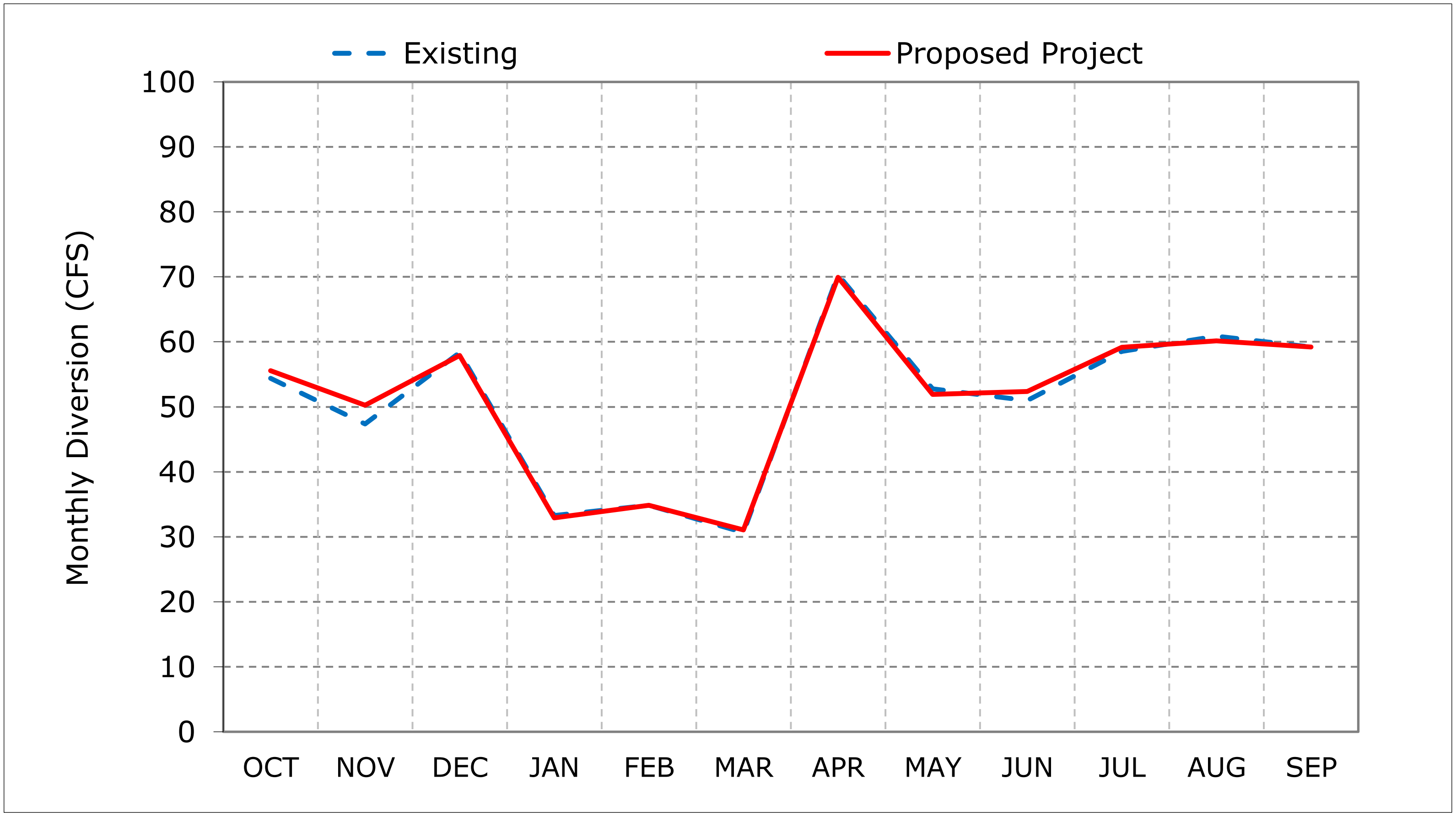
	Monthly Diversion (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	74	72	67	33	37	33	87	64	76	92	83	66
20%	58	70	65	33	37	33	87	64	70	90	63	66
30%	54	66	65	33	37	33	86	63	70	89	63	66
40%	54	49	64	33	37	33	85	57	64	64	63	66
50%	54	42	63	33	37	33	84	57	64	64	63	62
60%	53	39	63	33	37	33	84	57	61	60	61	62
70%	51	38	60	33	37	33	63	57	36	37	60	52
80%	51	38	60	33	36	33	63	53	36	37	50	52
90%	41	32	32	33	36	33	35	32	2	3	35	41
Long Term												
Full Simulation Period[a]	56	50	58	33	35	31	70	52	52	59	60	59
Water Year Types[b,c]												
Wet (32%)	54	56	63	33	37	33	86	57	68	74	64	66
Above Normal (15%)	62	48	58	33	37	33	86	61	68	86	65	66
Below Normal (17%)	54	49	56	33	32	33	84	63	70	81	60	62
Dry (22%)	53	52	55	33	35	32	57	57	39	37	70	52
Critical (15%)	58	39	53	31	34	20	21	13	2	8	32	44

Proposed Project minus Existing

	Monthly Diversion (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	0	0	0	0	0	0	0	**-2**	6	0	**0**	0
20%	4	0	**0**	0	0	0	0	0	0	0	**0**	0
30%	0	3	0	0	0	0	0	**0**	1	0	0	0
40%	0	10	**0**	0	0	0	0	**0**	0	0	0	0
50%	1	4	**-1**	0	0	0	0	0	3	0	**0**	0
60%	0	1	**0**	**0**	0	0	0	**0**	0	0	**-2**	0
70%	0	0	**0**	0	0	0	0	**0**	0	0	**0**	0
80%	5	1	0	0	0	0	0	0	0	0	**-9**	0
90%	0	0	**0**	0	0	0	0	**0**	0	0	0	0
Long Term												
Full Simulation Period[a]	1	3	**0**	**0**	0	0	**0**	**-1**	1	1	**-1**	0
Water Year Types[b,c]												
Wet (32%)	0	4	0	0	0	0	0	0	0	1	1	0
Above Normal (15%)	5	0	**-1**	0	0	0	0	**-1**	**-2**	0	3	0
Below Normal (17%)	0	6	**-2**	0	0	0	0	**-2**	8	0	0	0
Dry (22%)	0	3	**-2**	0	0	0	**-2**	0	1	0	**-4**	0
Critical (15%)	3	**-2**	3	**-3**	0	3	0	**-3**	0	3	**-3**	0

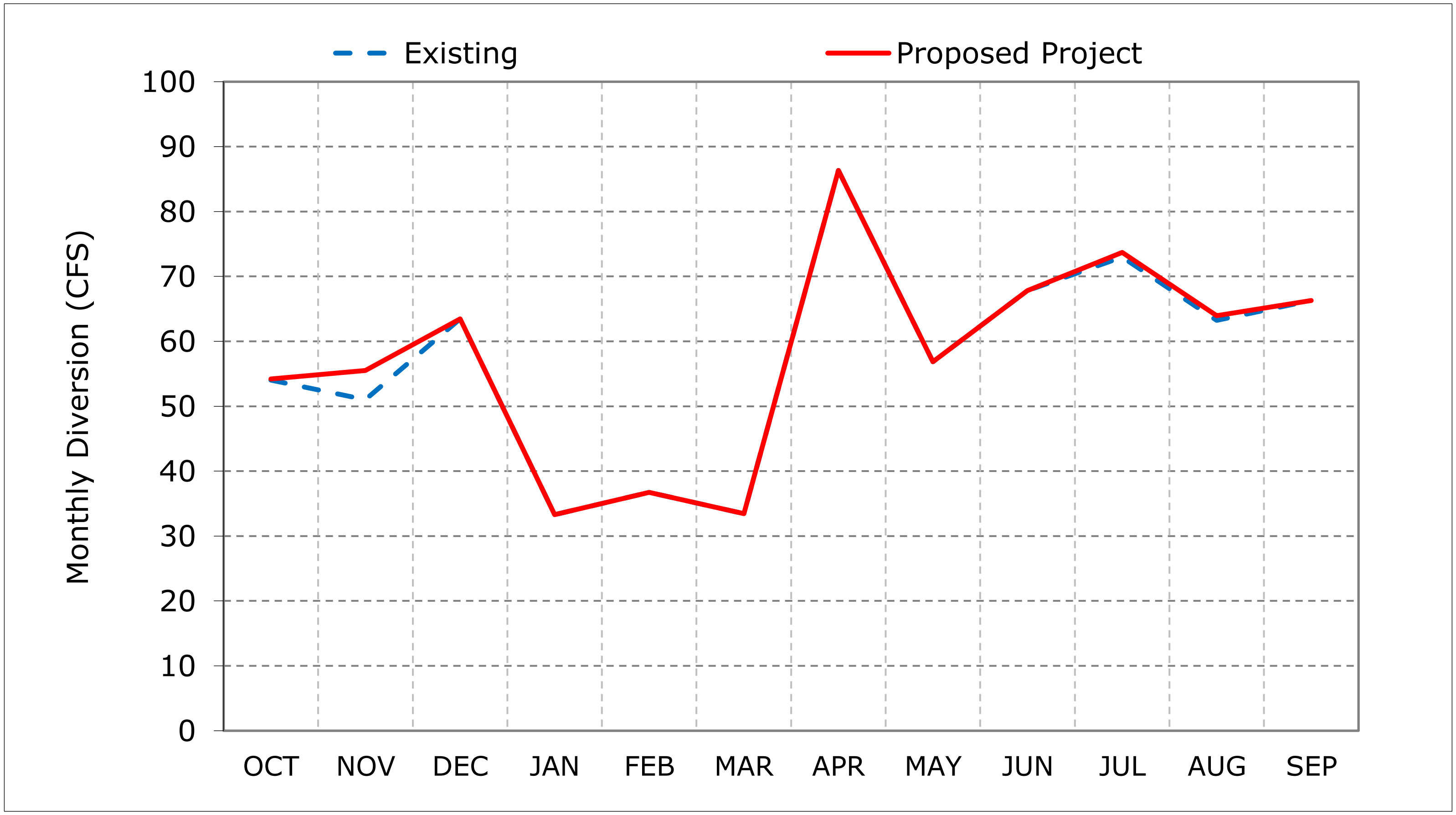
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.

Figure 1-1. North Bay Aqueduct, Long-Term Average Diversion



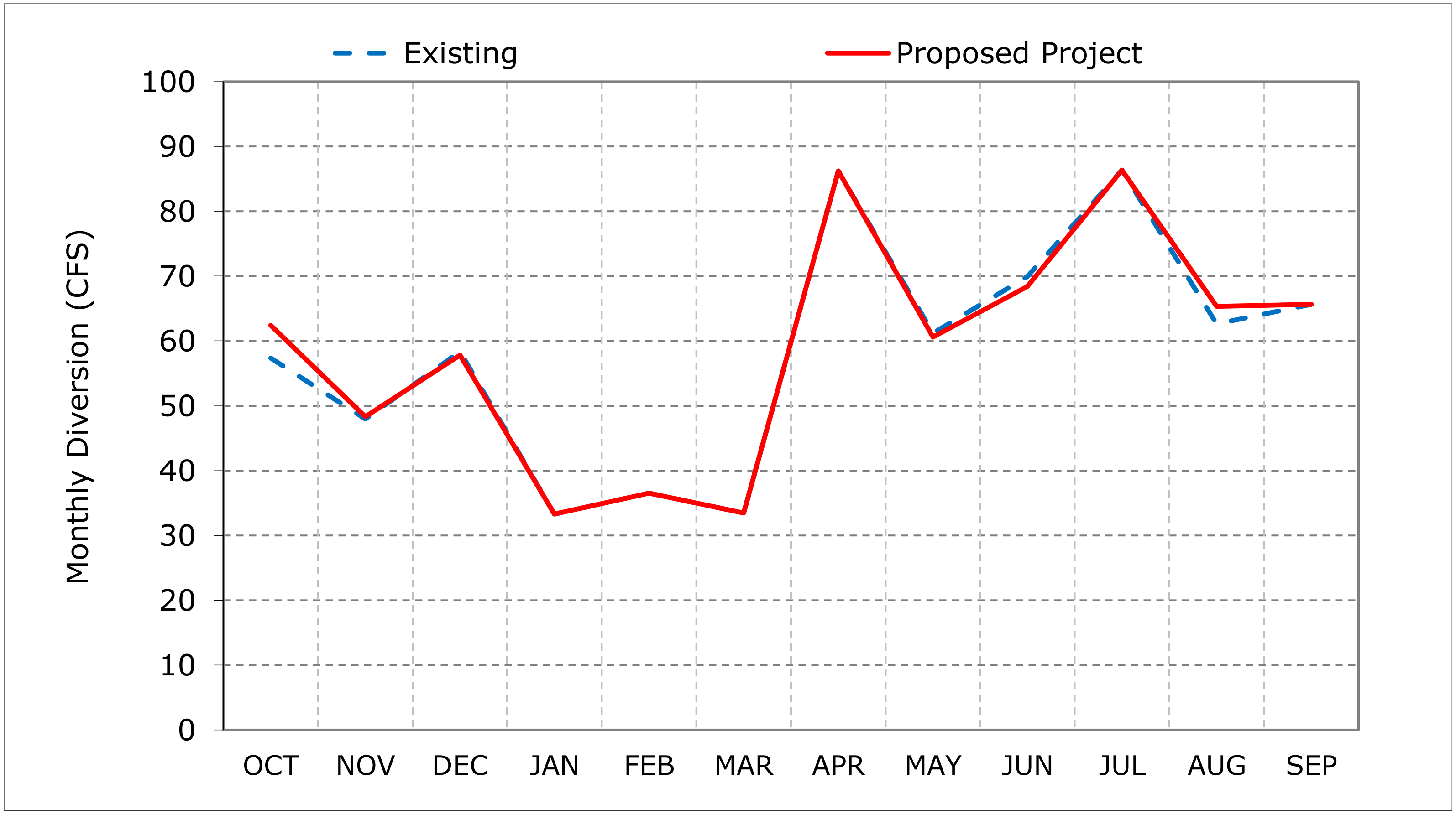
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-2. North Bay Aqueduct, Wet Year Average Diversion



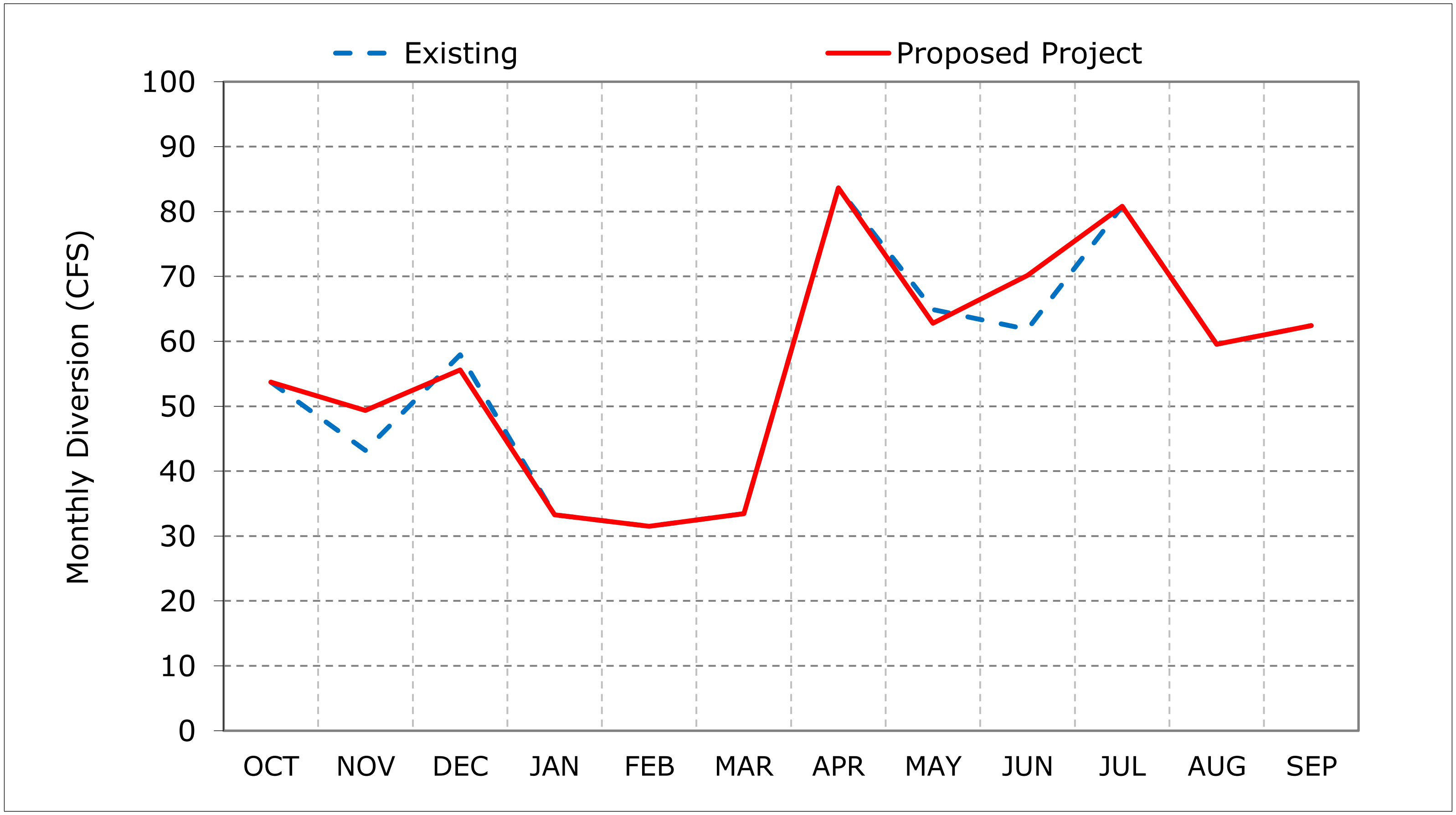
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-3. North Bay Aqueduct, Above Normal Year Average Diversion



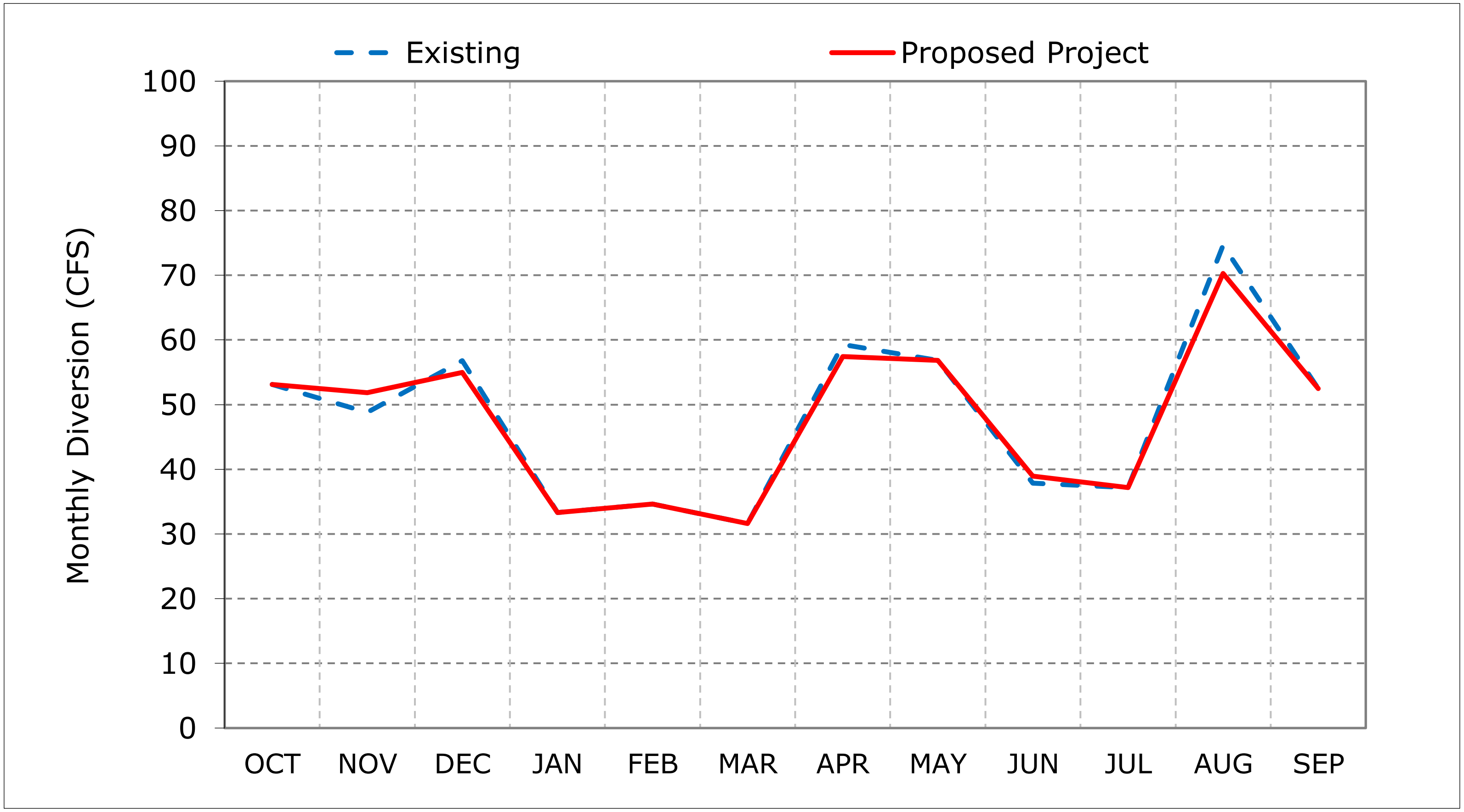
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-4. North Bay Aqueduct, Below Normal Year Average Diversion



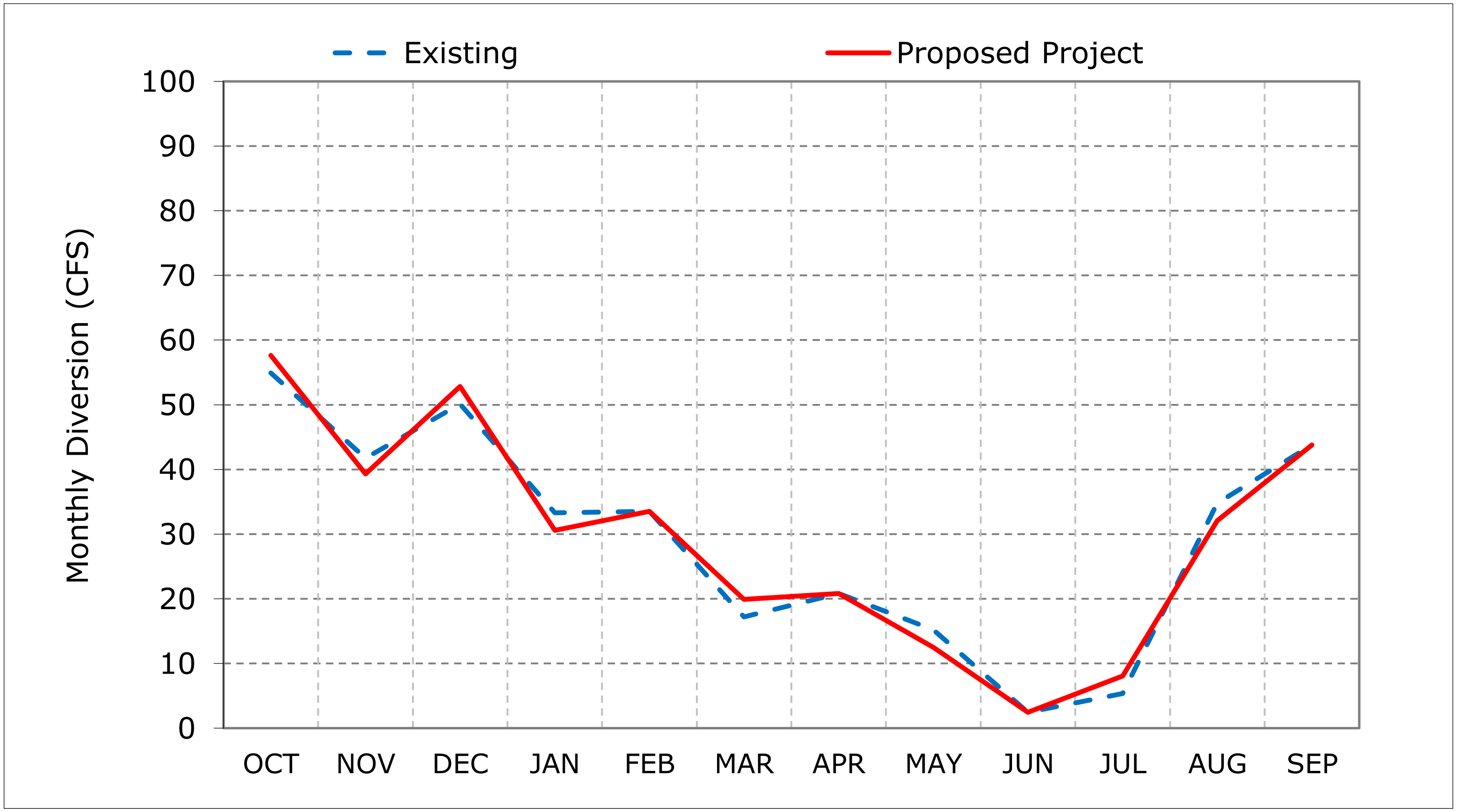
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-5. North Bay Aqueduct, Dry Year Average Diversion



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-6. North Bay Aqueduct, Critical Year Average Diversion



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-7. North Bay Aqueduct, October

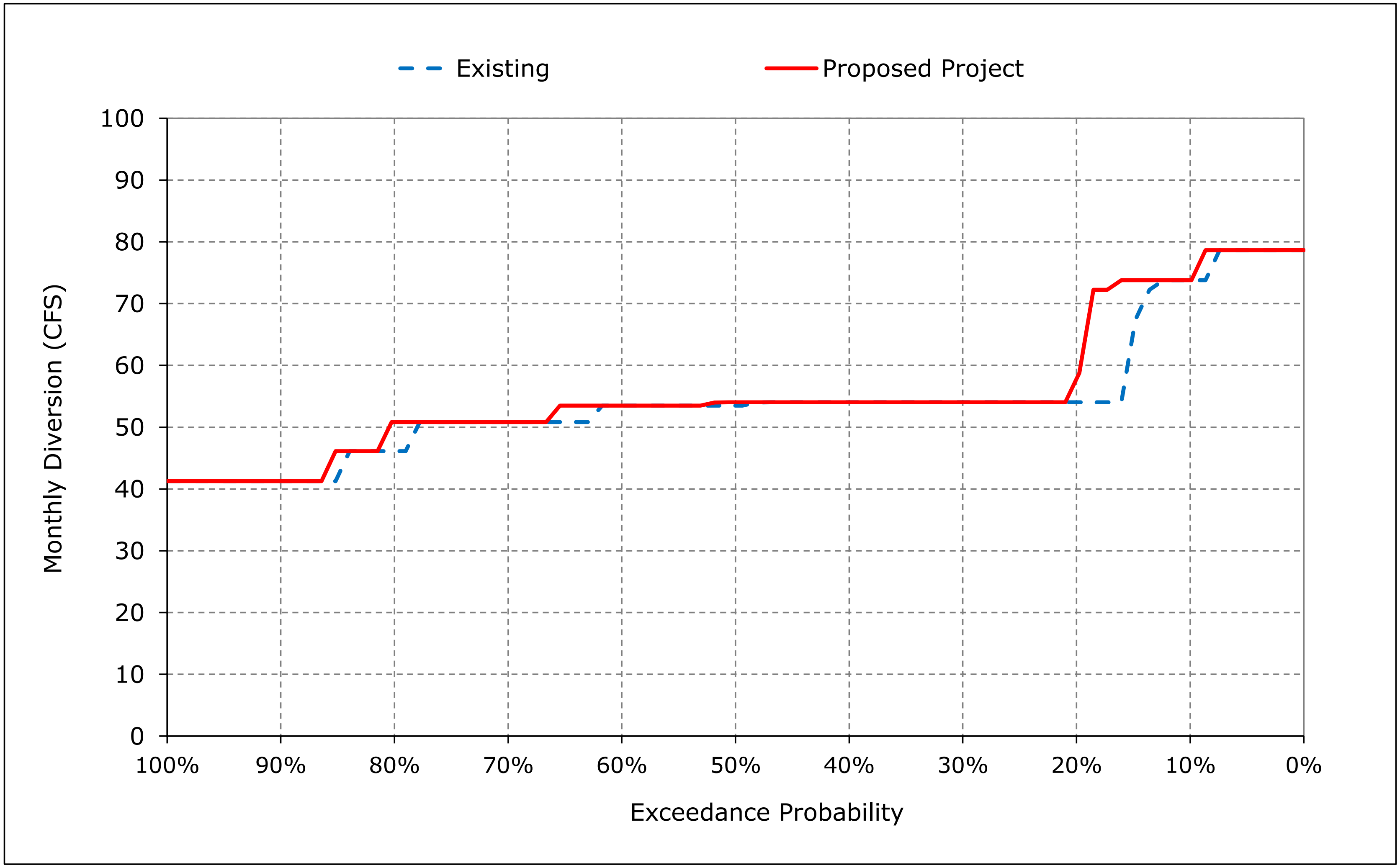


Figure 1-8. North Bay Aqueduct, November

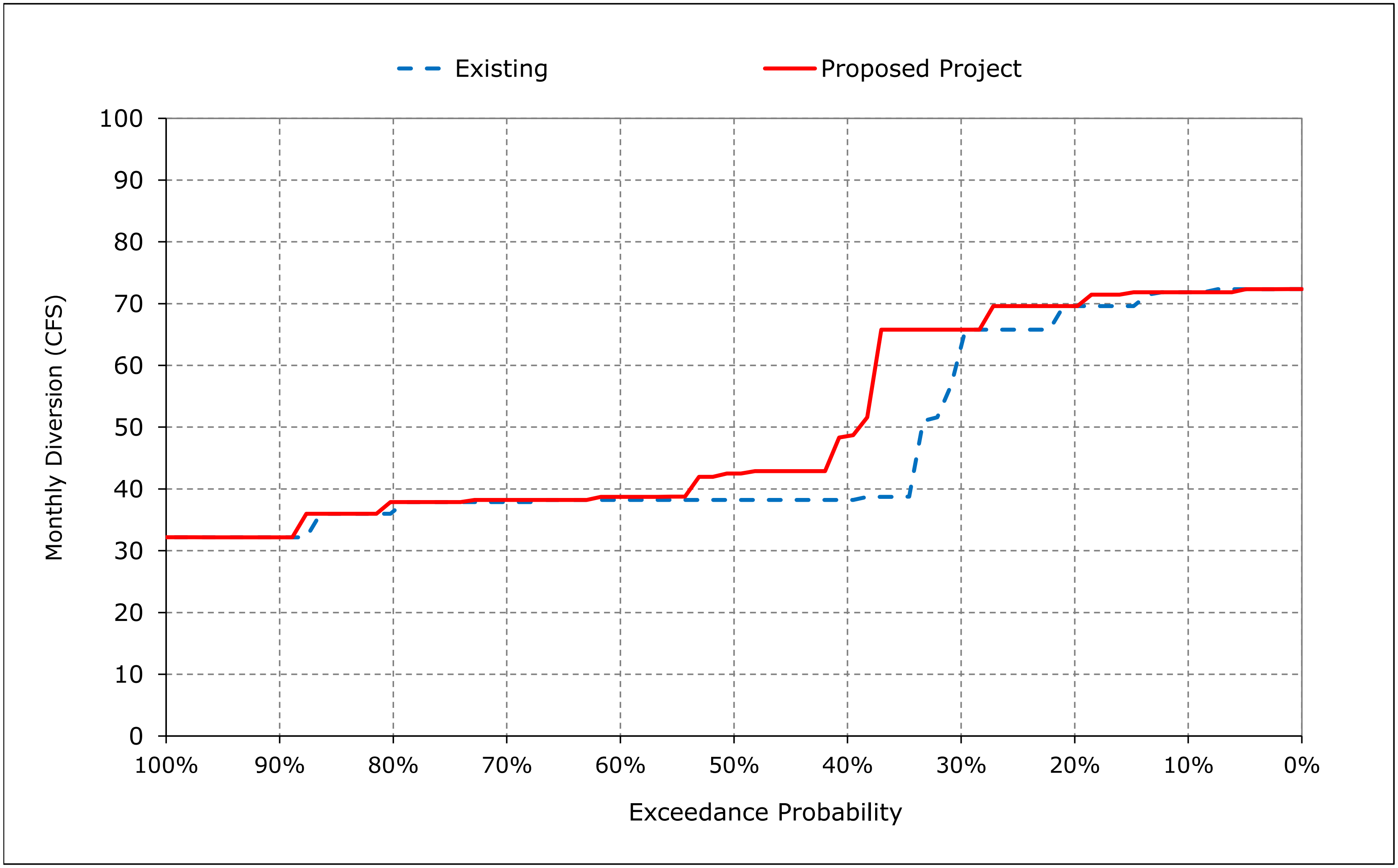


Figure 1-9. North Bay Aqueduct, December

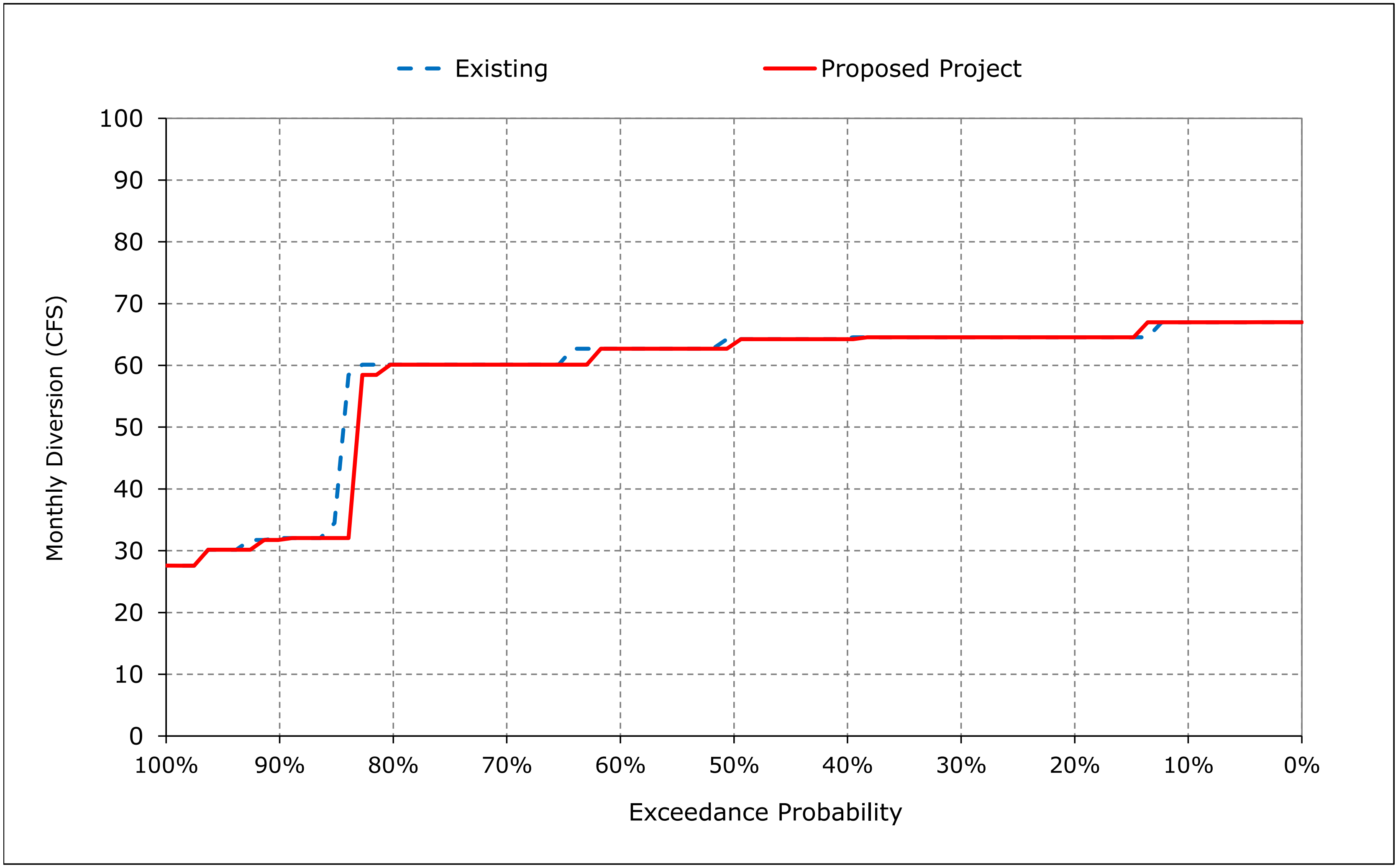


Figure 1-10. North Bay Aqueduct, January

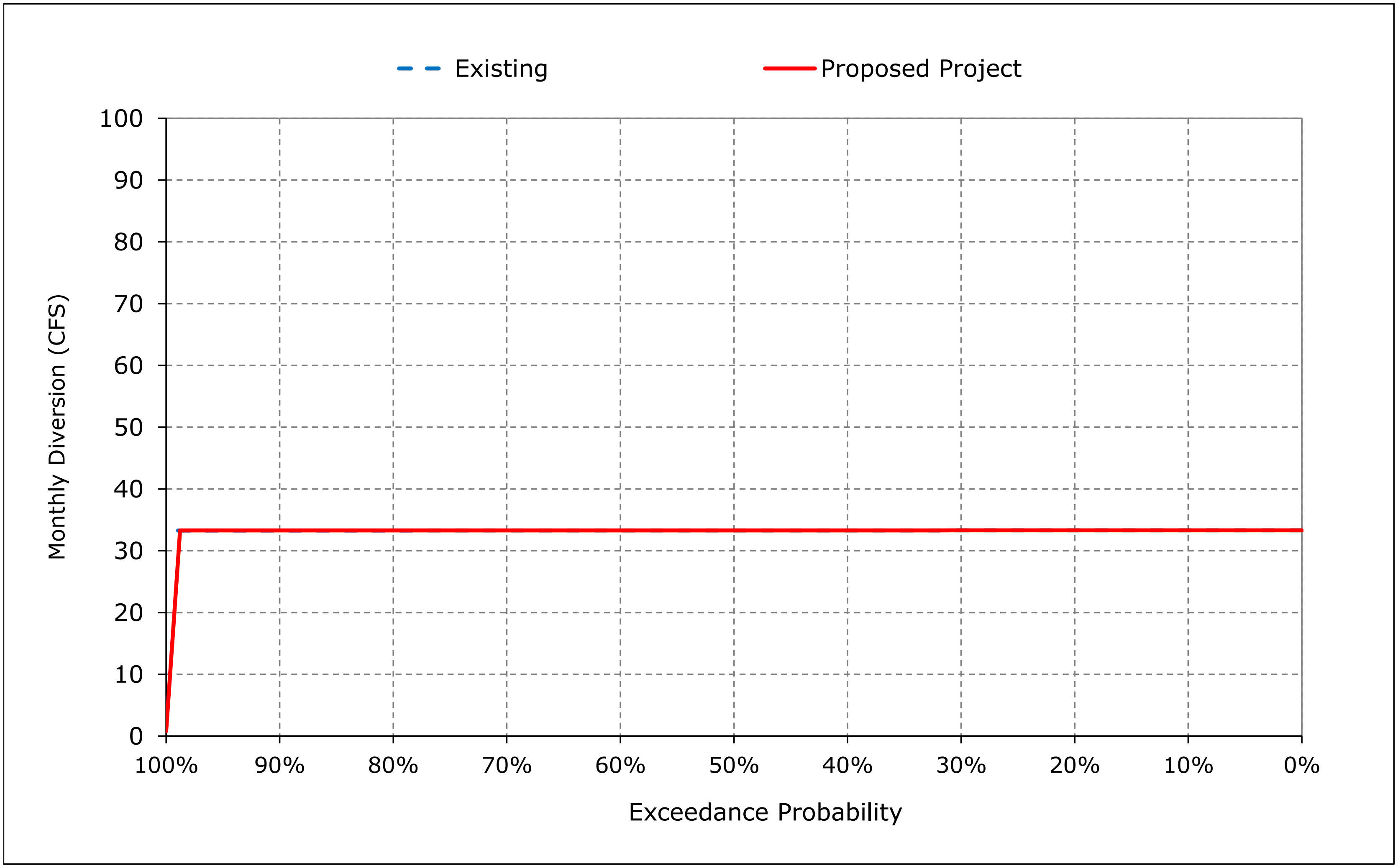


Figure 1-11. North Bay Aqueduct, February

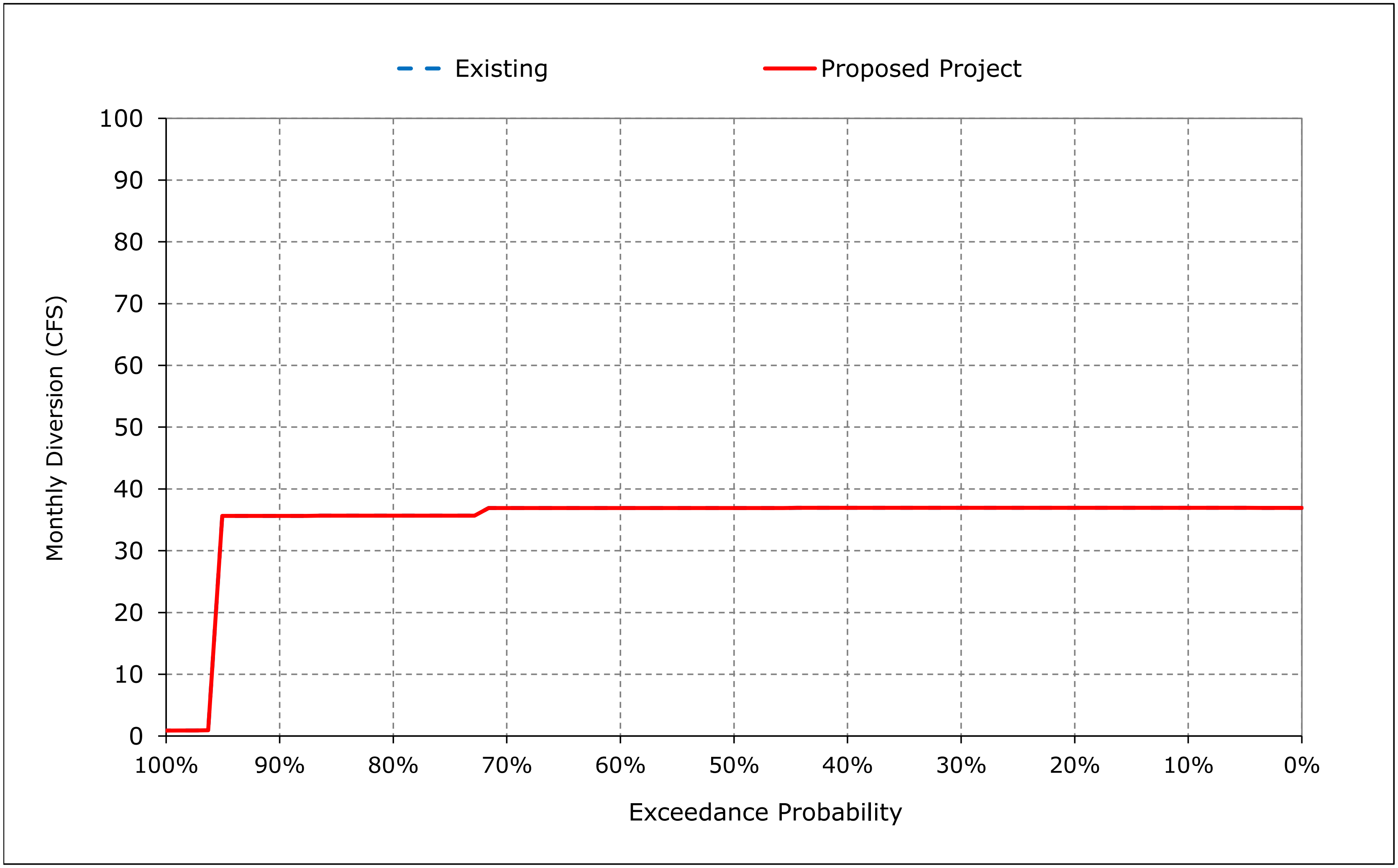


Figure 1-12. North Bay Aqueduct, March

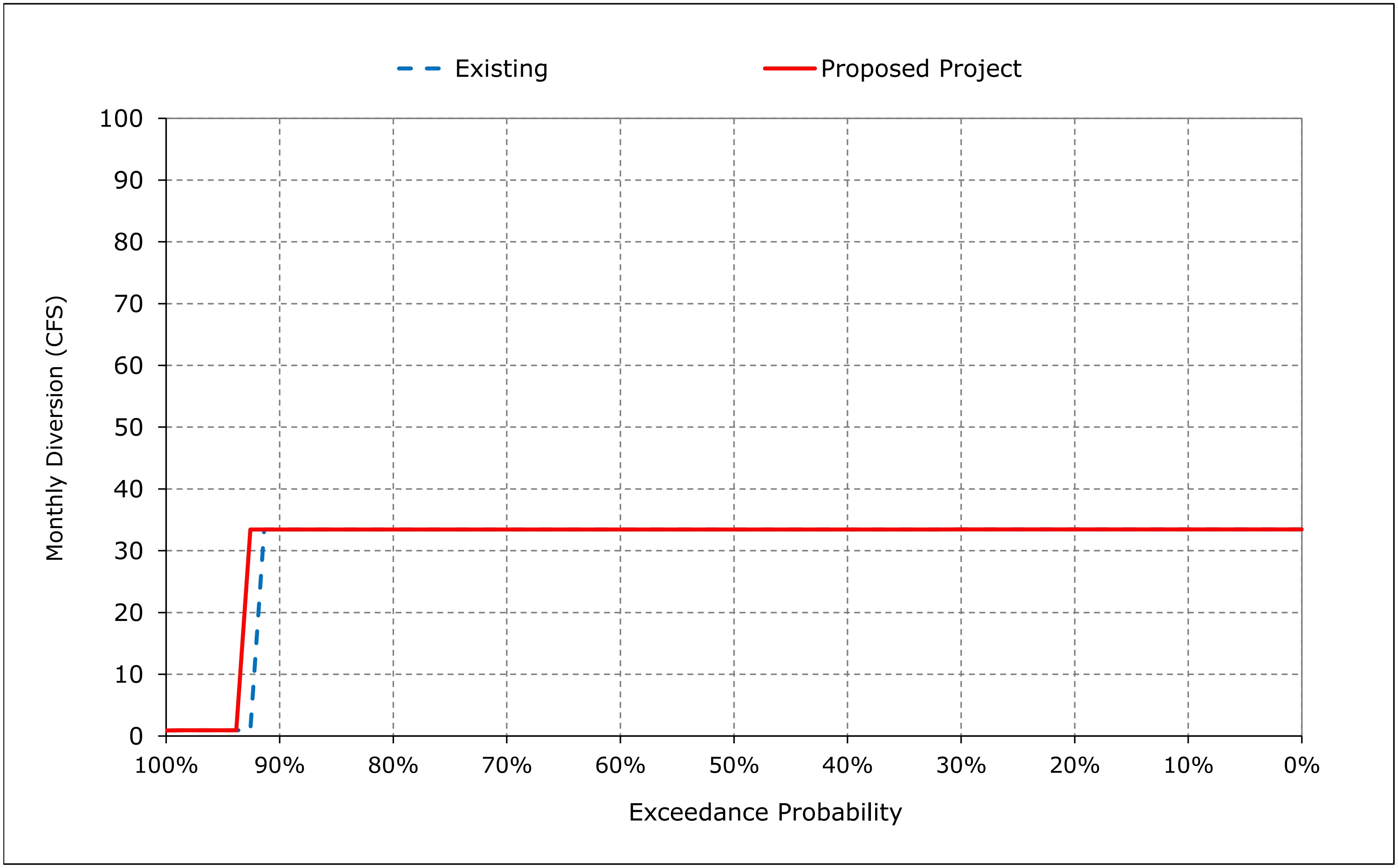


Figure 1-13. North Bay Aqueduct, April

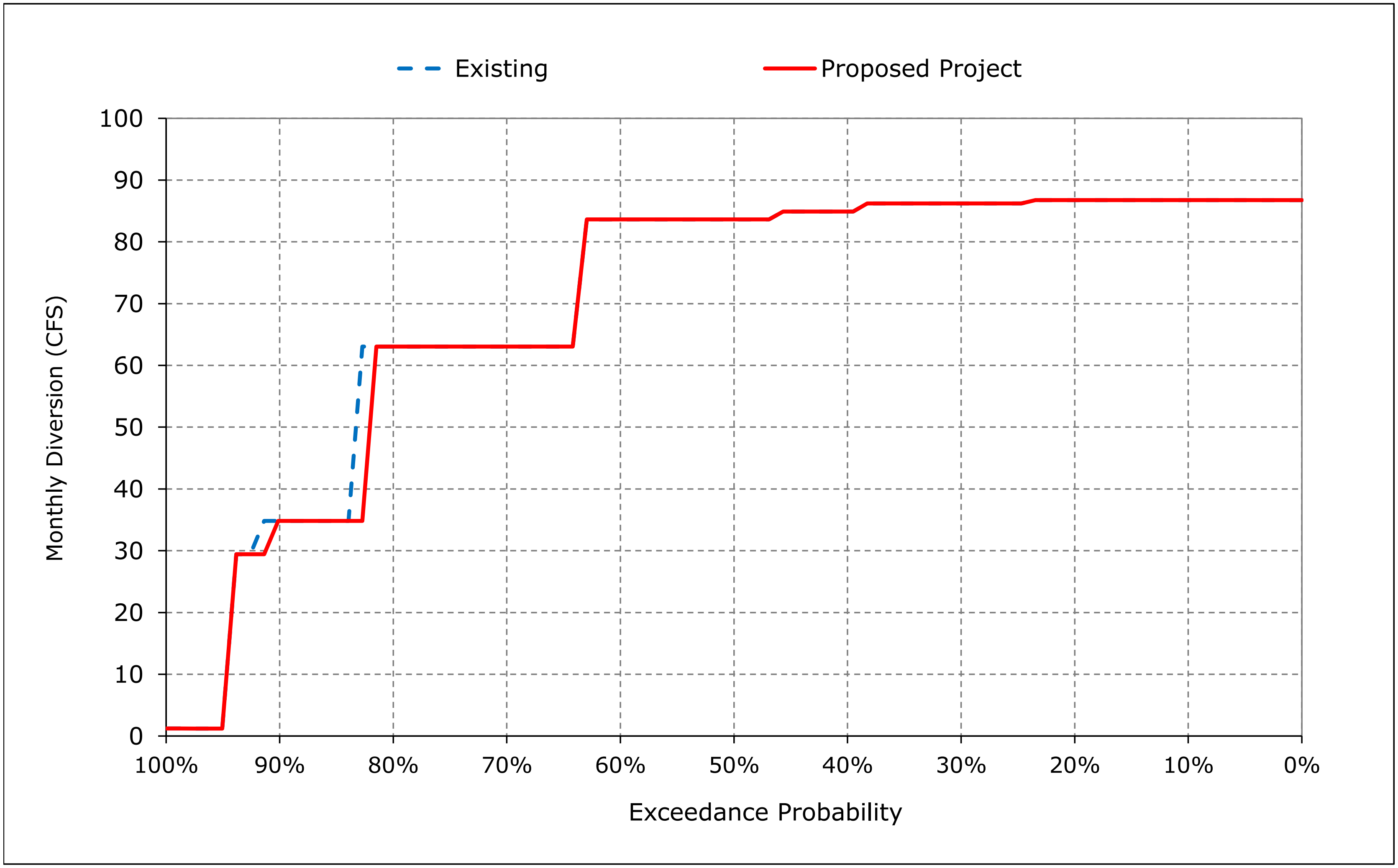


Figure 1-14. North Bay Aqueduct, May

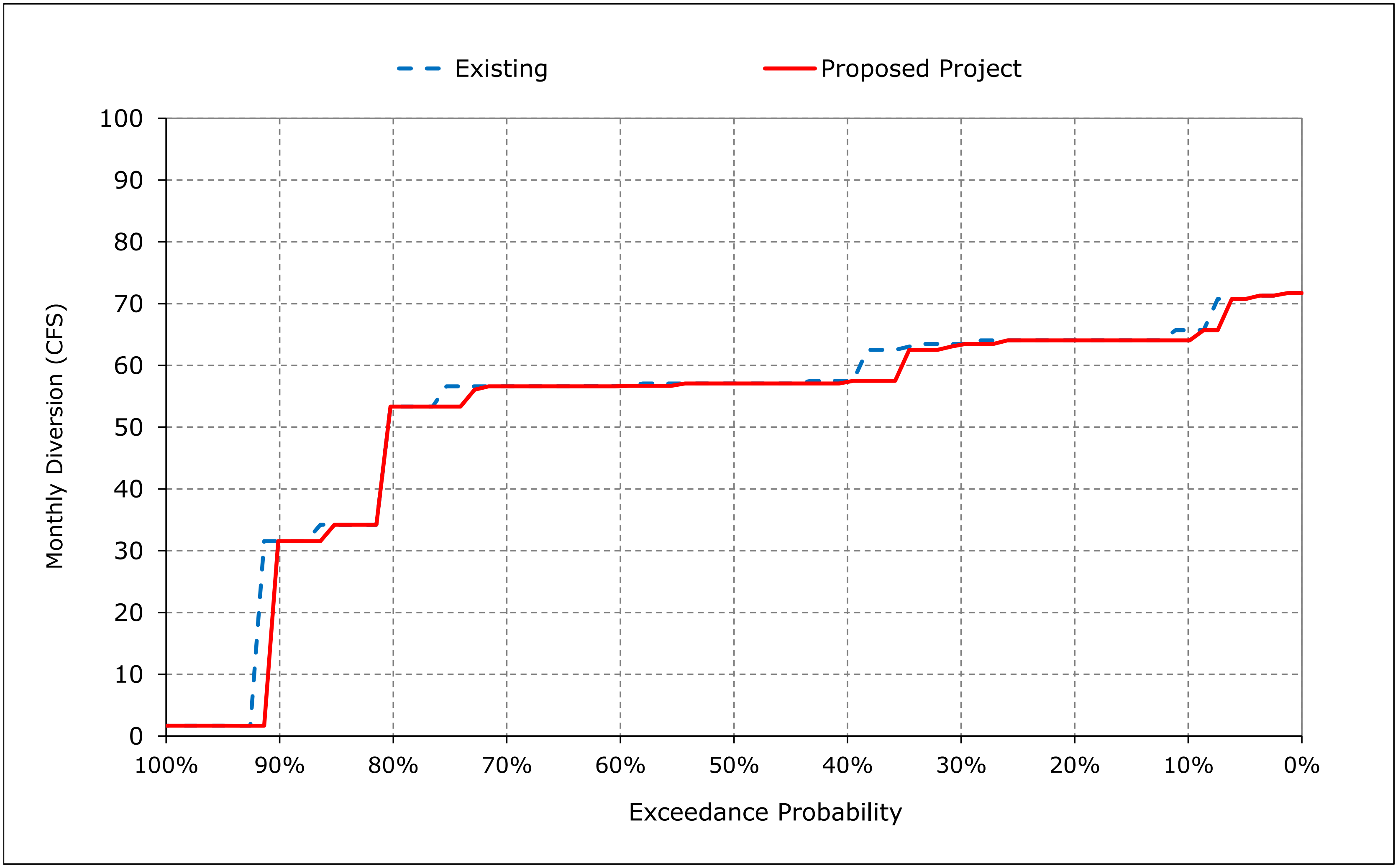


Figure 1-15. North Bay Aqueduct, June

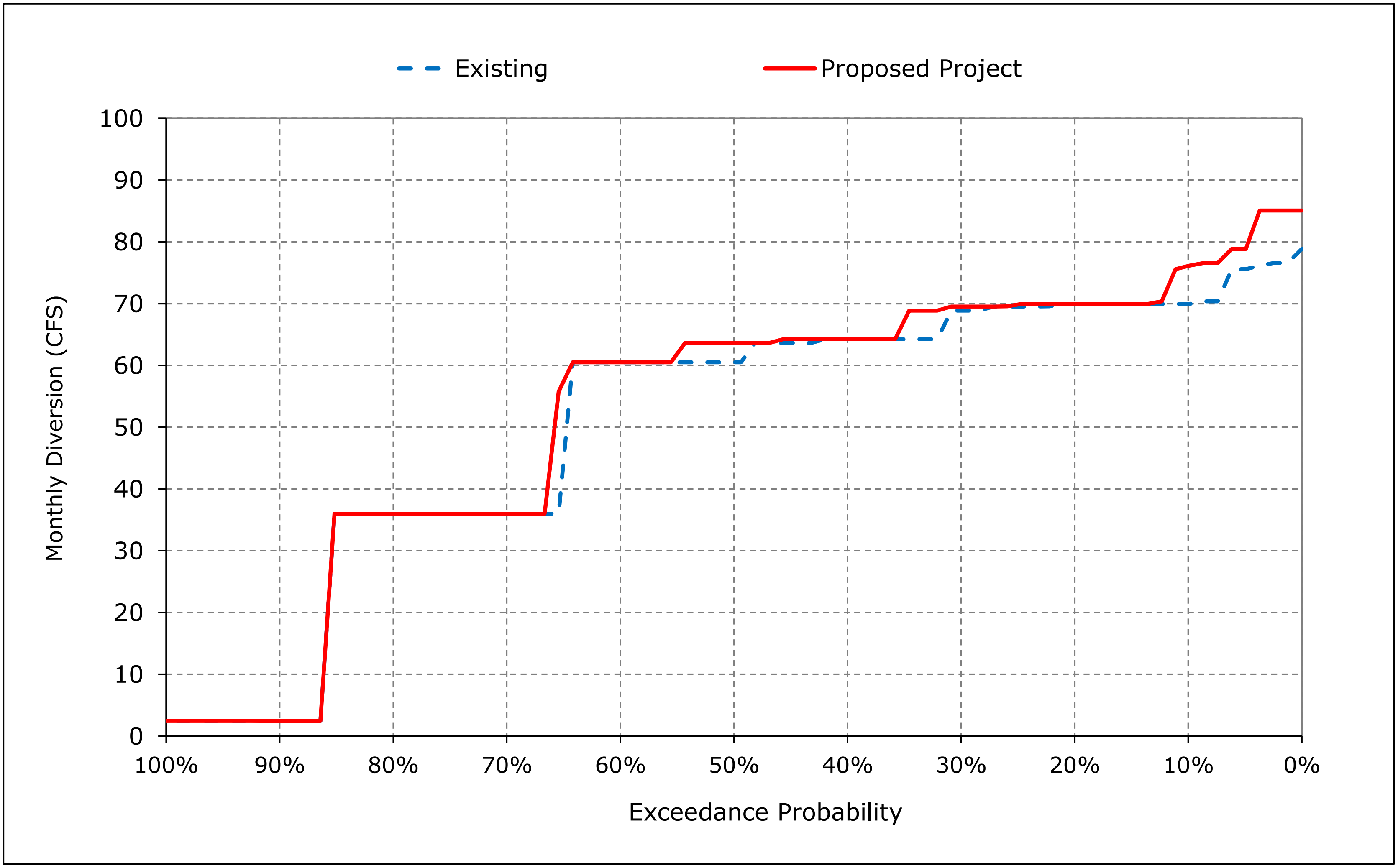


Figure 1-16. North Bay Aqueduct, July

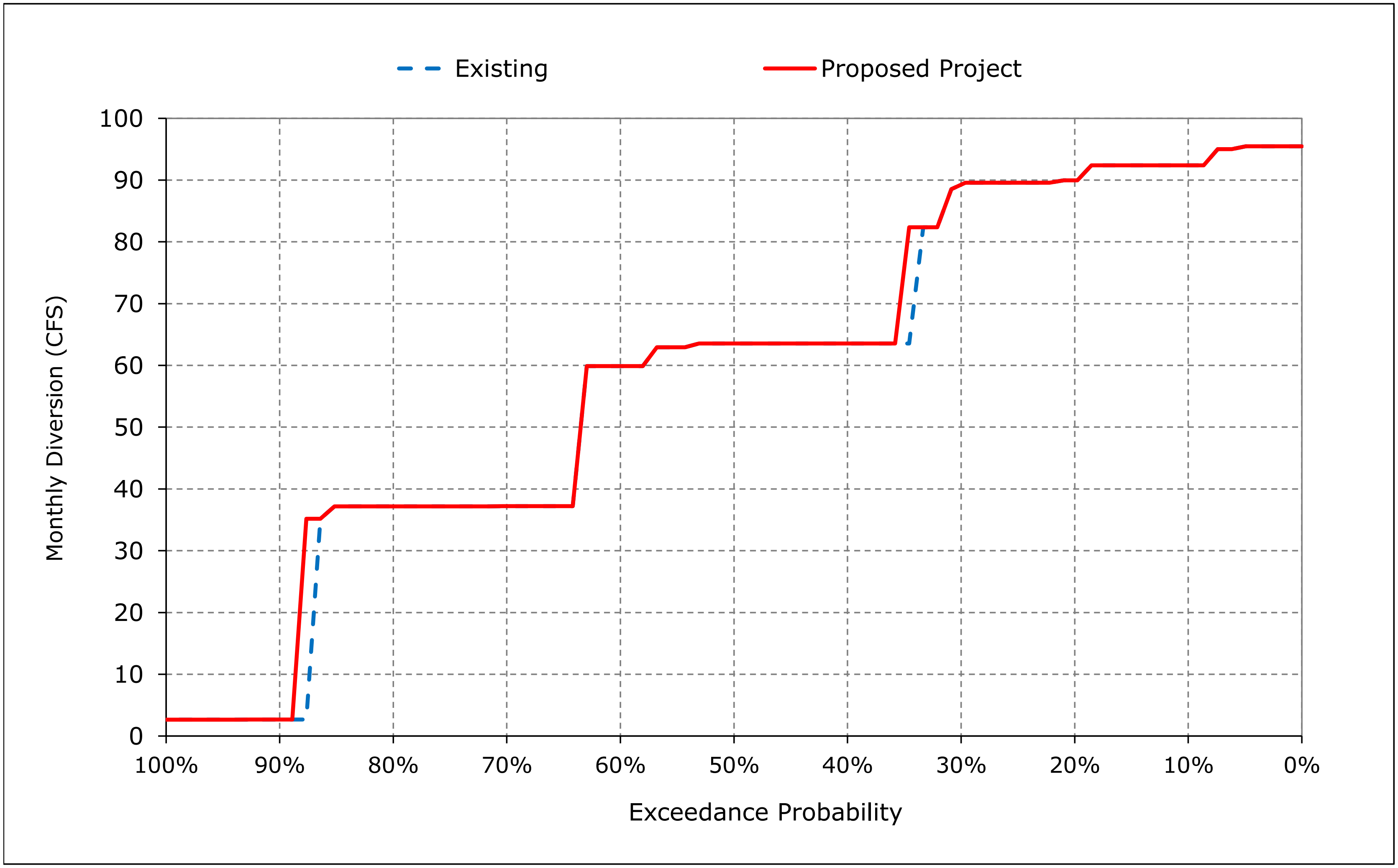


Figure 1-17. North Bay Aqueduct, August

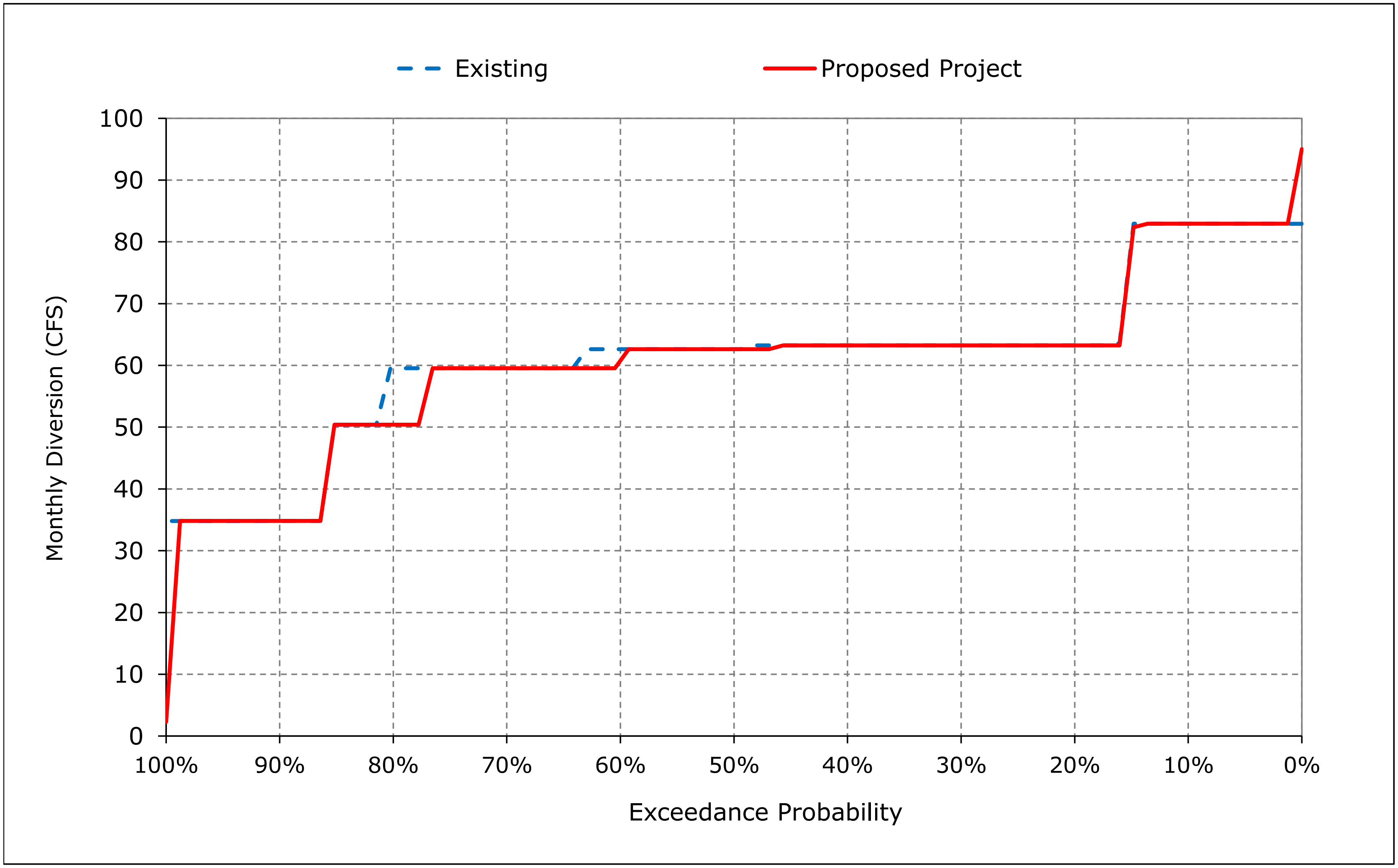


Figure 1-18. North Bay Aqueduct, September

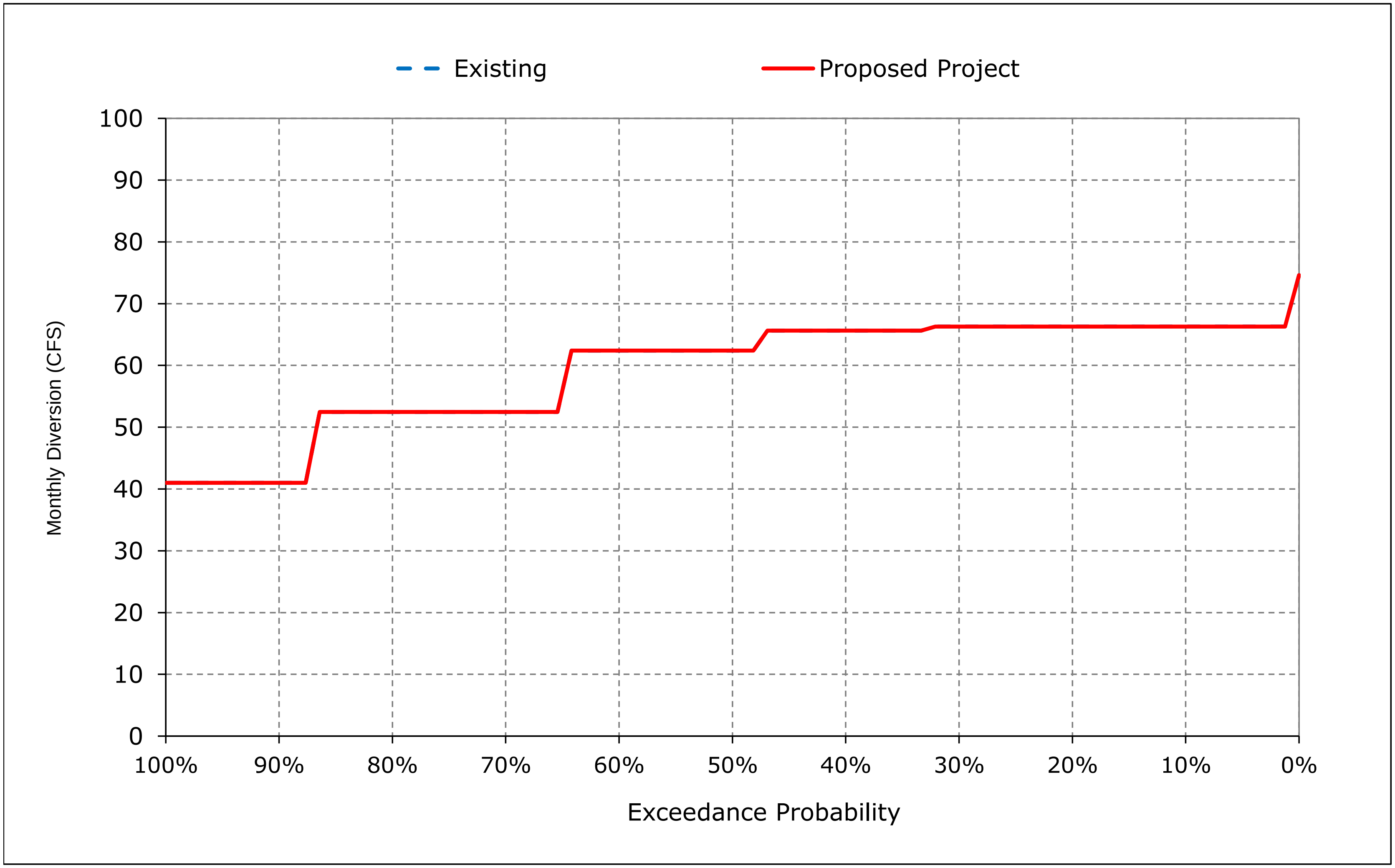


Table 2-1. DCC Flow, Monthly Flow

Existing

	Monthly Flow (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	2,148	1,277	922	0	0	0	0	0	3,039	4,572	3,153	4,268
20%	2,080	1,142	861	0	0	0	0	0	2,446	4,276	3,015	2,858
30%	1,881	1,008	776	0	0	0	0	0	2,368	4,013	2,970	2,314
40%	1,765	883	685	0	0	0	0	0	2,308	3,701	2,925	1,875
50%	1,613	797	485	0	0	0	0	0	2,230	3,553	2,885	1,789
60%	1,486	523	0	0	0	0	0	0	2,065	3,244	2,680	1,468
70%	1,446	30	0	0	0	0	0	0	1,944	3,049	1,947	1,213
80%	1,208	0	0	0	0	0	0	0	1,733	2,726	1,708	0
90%	1,157	0	0	0	0	0	0	0	130	1,907	1,527	0
Long Term												
Full Simulation Period[a]	1,596	645	436	0	0	0	0	0	2,061	3,402	2,526	1,828
Water Year Types[b,c]												
Wet (32%)	1,419	450	107	0	0	0	0	0	2,060	3,754	3,021	690
Above Normal (15%)	1,669	516	417	0	0	0	0	0	1,820	4,072	3,046	4,186
Below Normal (17%)	1,827	783	679	0	0	0	0	0	2,331	3,879	2,887	2,407
Dry (22%)	1,705	716	567	0	0	0	0	0	2,240	3,103	1,796	1,775
Critical (15%)	1,470	930	684	0	0	0	0	0	1,723	1,865	1,607	1,340

Proposed Project

	Monthly Flow (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	2,111	1,593	996	0	0	0	0	0	3,039	4,544	3,150	4,454
20%	1,935	1,461	830	0	0	0	0	0	2,486	4,397	3,035	4,332
30%	1,707	1,297	744	0	0	0	0	0	2,433	4,068	2,986	4,200
40%	1,592	1,113	645	0	0	0	0	0	2,380	3,643	2,931	3,948
50%	1,502	959	416	0	0	0	0	0	2,311	3,445	2,799	2,726
60%	1,424	832	0	0	0	0	0	0	2,176	3,137	2,562	2,047
70%	1,236	774	0	0	0	0	0	0	2,013	2,933	1,967	1,823
80%	1,186	190	0	0	0	0	0	0	1,745	2,566	1,762	1,741
90%	734	0	0	0	0	0	0	0	131	1,922	1,648	1,386
Long Term												
Full Simulation Period[a]	1,455	905	421	0	0	0	0	0	2,112	3,365	2,525	2,951
Water Year Types[b,c]												
Wet (32%)	1,321	763	82	0	0	0	0	0	2,074	3,729	3,005	4,185
Above Normal (15%)	1,536	828	407	0	0	0	0	0	1,943	4,086	3,033	4,328
Below Normal (17%)	1,582	1,063	684	0	0	0	0	0	2,467	3,810	2,831	2,362
Dry (22%)	1,633	935	537	0	0	0	0	0	2,271	2,969	1,815	1,767
Critical (15%)	1,246	1,058	685	0	0	0	0	0	1,712	1,928	1,686	1,365

Proposed Project minus Existing

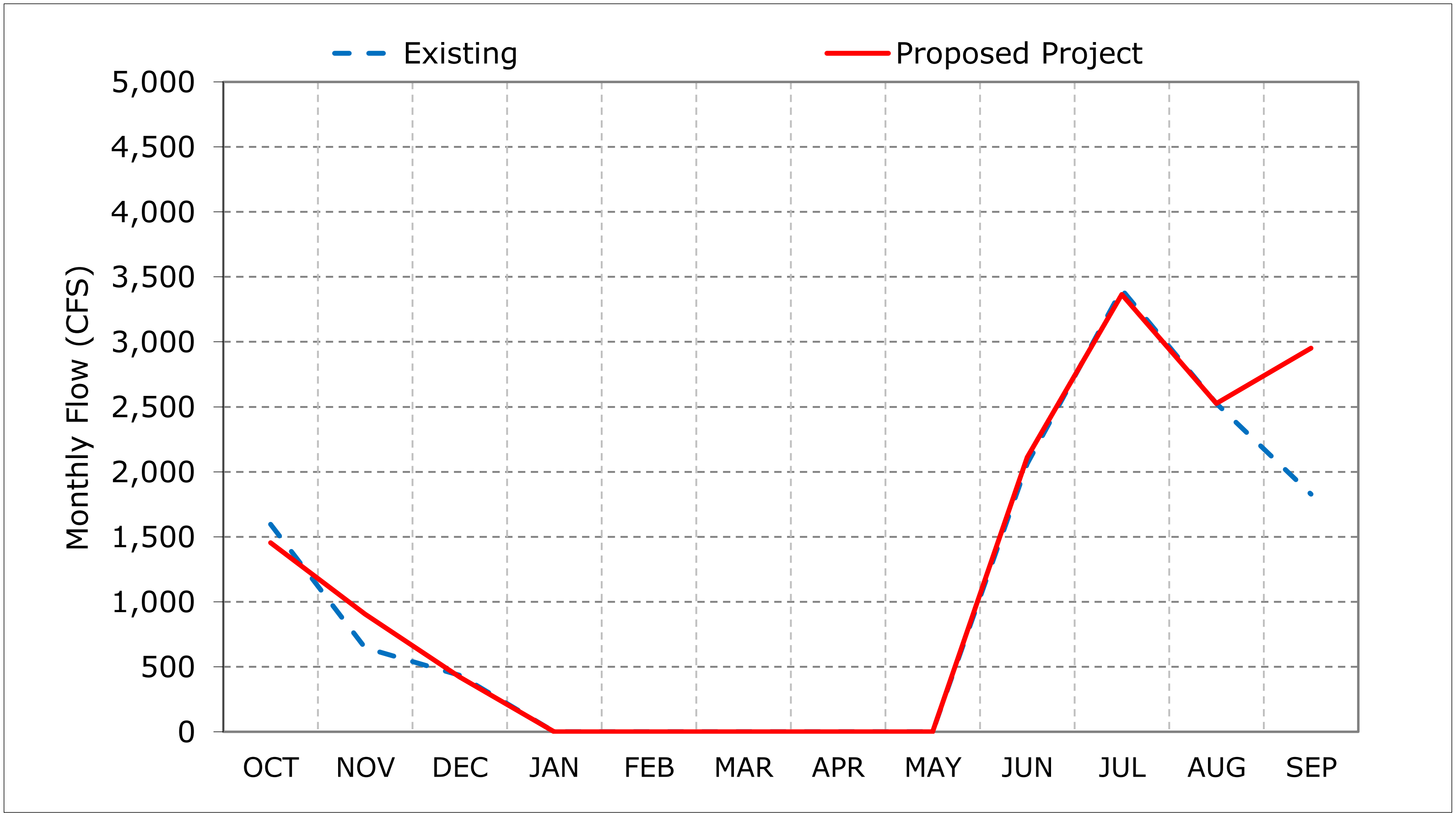
	Monthly Flow (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	**-38**	317	74	0	0	0	0	0	**0**	**-28**	**-3**	187
20%	**-145**	319	**-31**	0	0	0	0	0	41	121	21	1,474
30%	**-174**	289	**-32**	0	0	0	0	0	64	55	17	1,885
40%	**-173**	231	**-39**	0	0	0	0	0	72	**-58**	6	2,073
50%	**-111**	162	**-70**	0	0	0	0	0	81	**-109**	**-86**	936
60%	**-62**	309	0	0	0	0	0	0	111	**-107**	**-118**	580
70%	**-210**	744	0	0	0	0	0	0	69	**-115**	19	610
80%	**-22**	190	0	0	0	0	0	0	12	**-160**	54	1,741
90%	**-423**	0	0	0	0	0	0	0	2	14	120	1,386
Long Term												
Full Simulation Period[a]	**-141**	259	**-15**	0	0	0	0	0	51	**-38**	**-1**	1,123
Water Year Types[b,c]												
Wet (32%)	**-98**	313	**-25**	0	0	0	0	0	14	**-25**	**-16**	3,495
Above Normal (15%)	**-134**	311	**-10**	0	0	0	0	0	122	13	**-14**	142
Below Normal (17%)	**-244**	280	5	0	0	0	0	0	136	**-69**	**-57**	**-45**
Dry (22%)	**-72**	220	**-30**	0	0	0	0	0	31	**-134**	19	**-8**
Critical (15%)	**-223**	127	1	0	0	0	0	0	**-11**	64	79	25

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

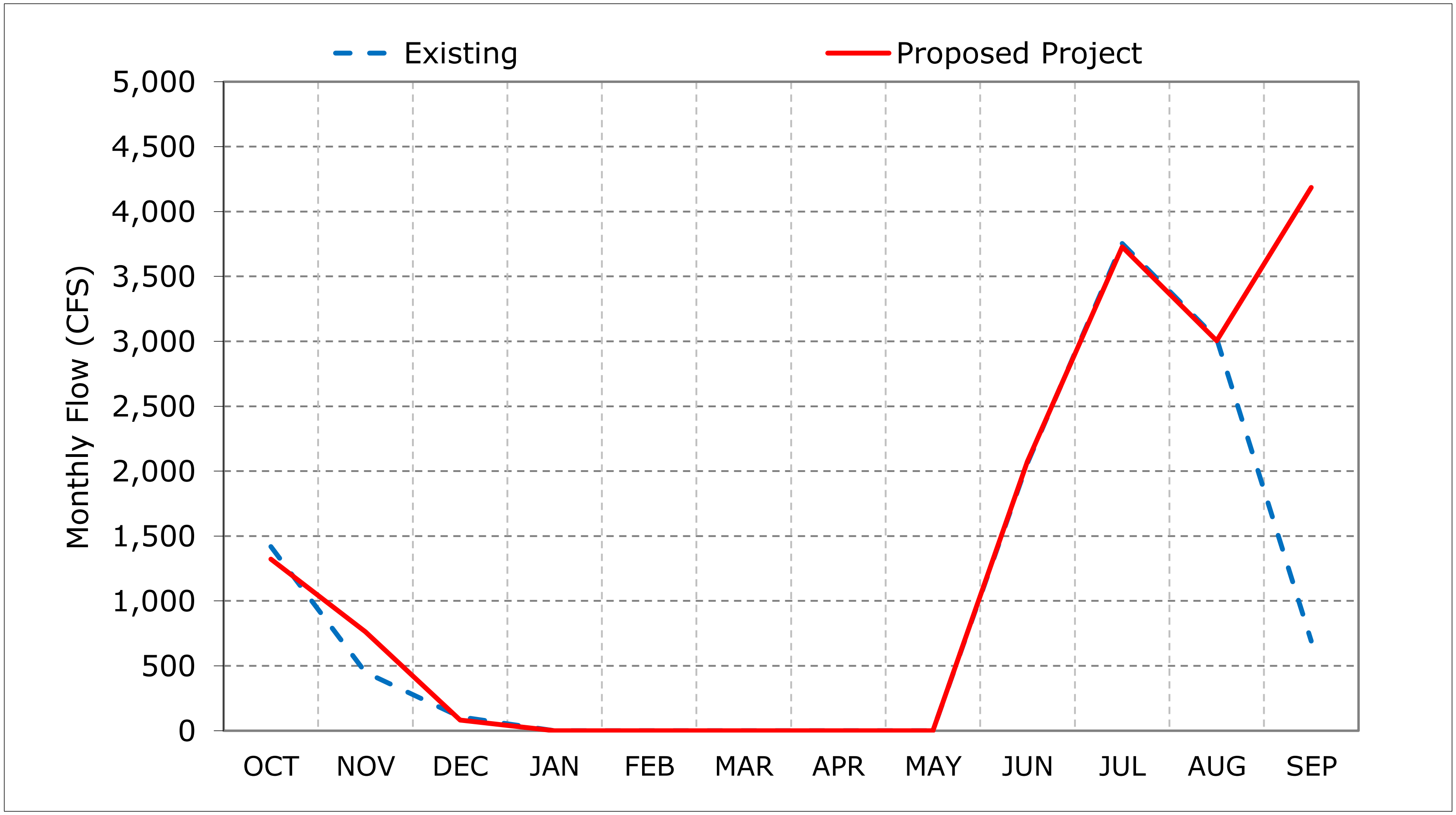
c These results are displayed with water year - year type sorting.

Figure 2-1. DCC Flow, Long-Term Average Flow



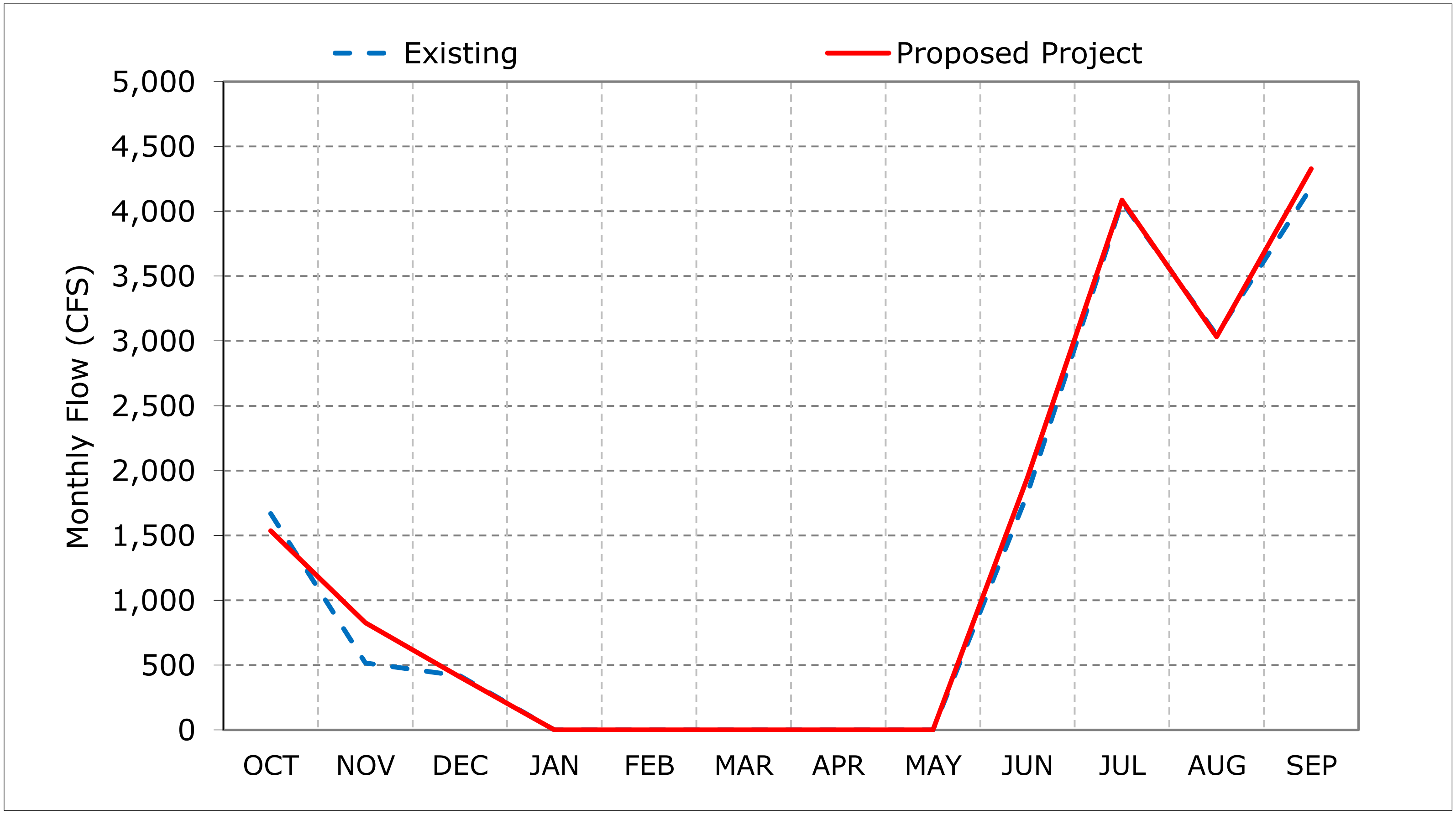
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 2-2. DCC Flow, Wet Year Average Flow



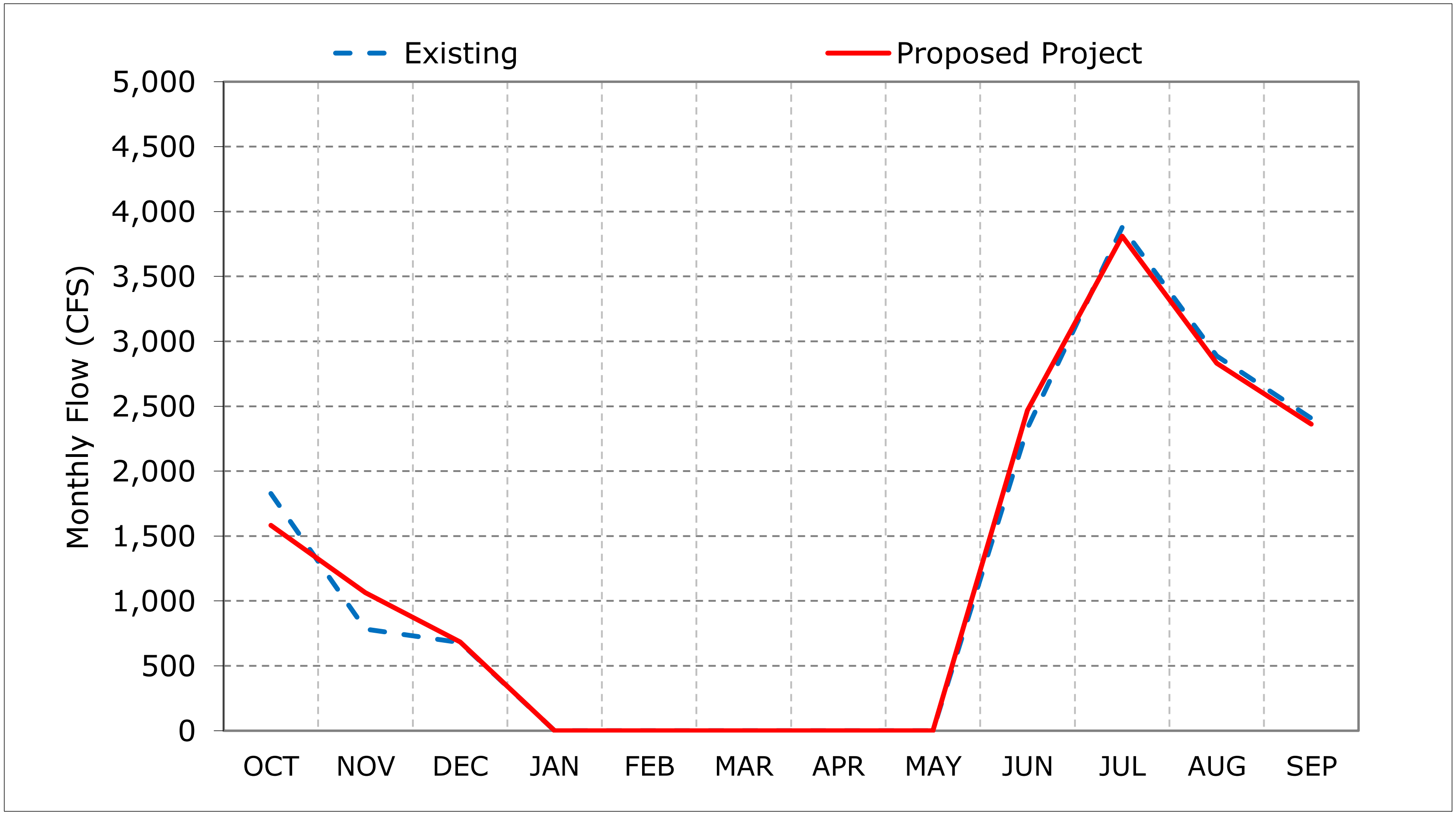
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 2-3. DCC Flow, Above Normal Year Average Flow



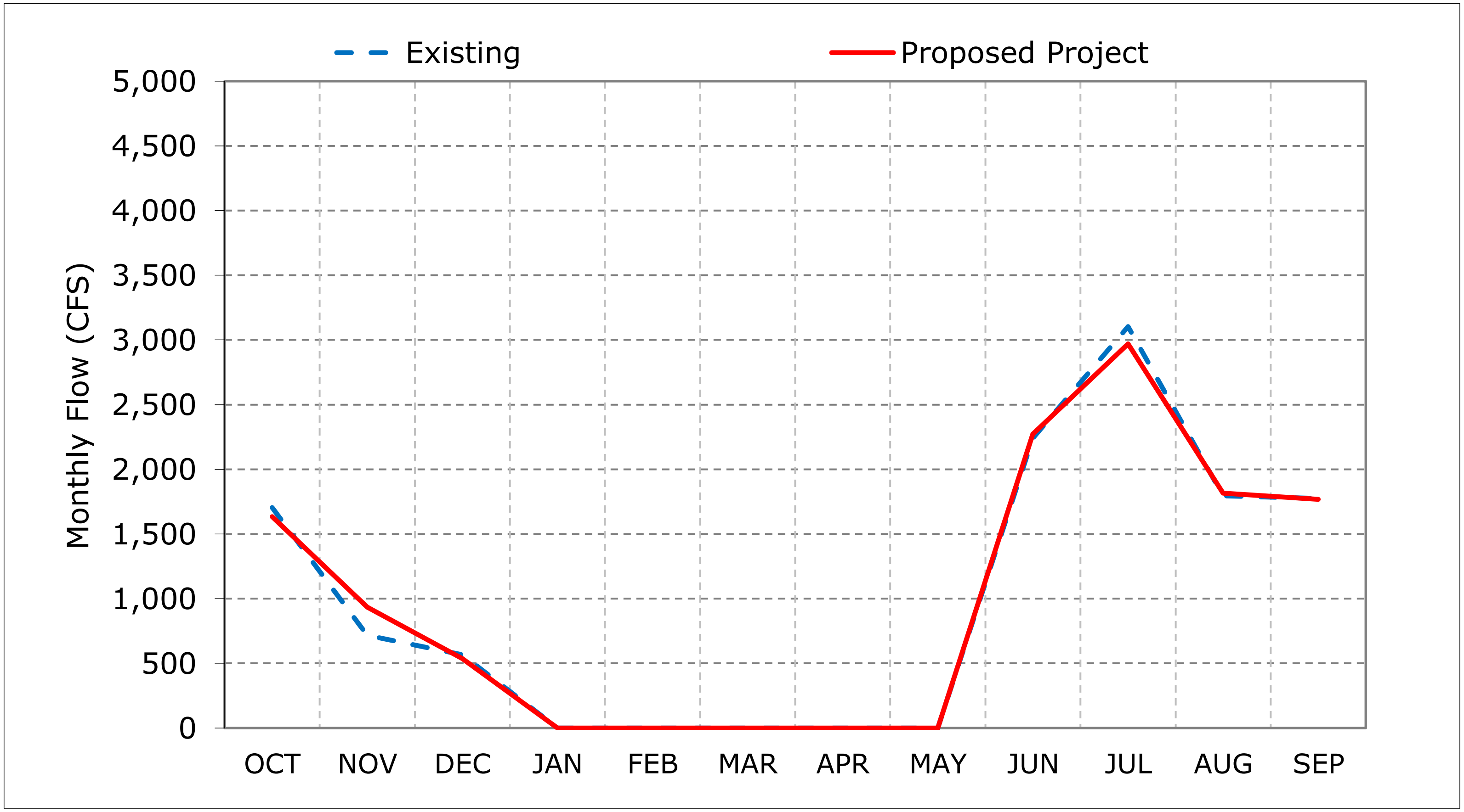
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 2-4. DCC Flow, Below Normal Year Average Flow



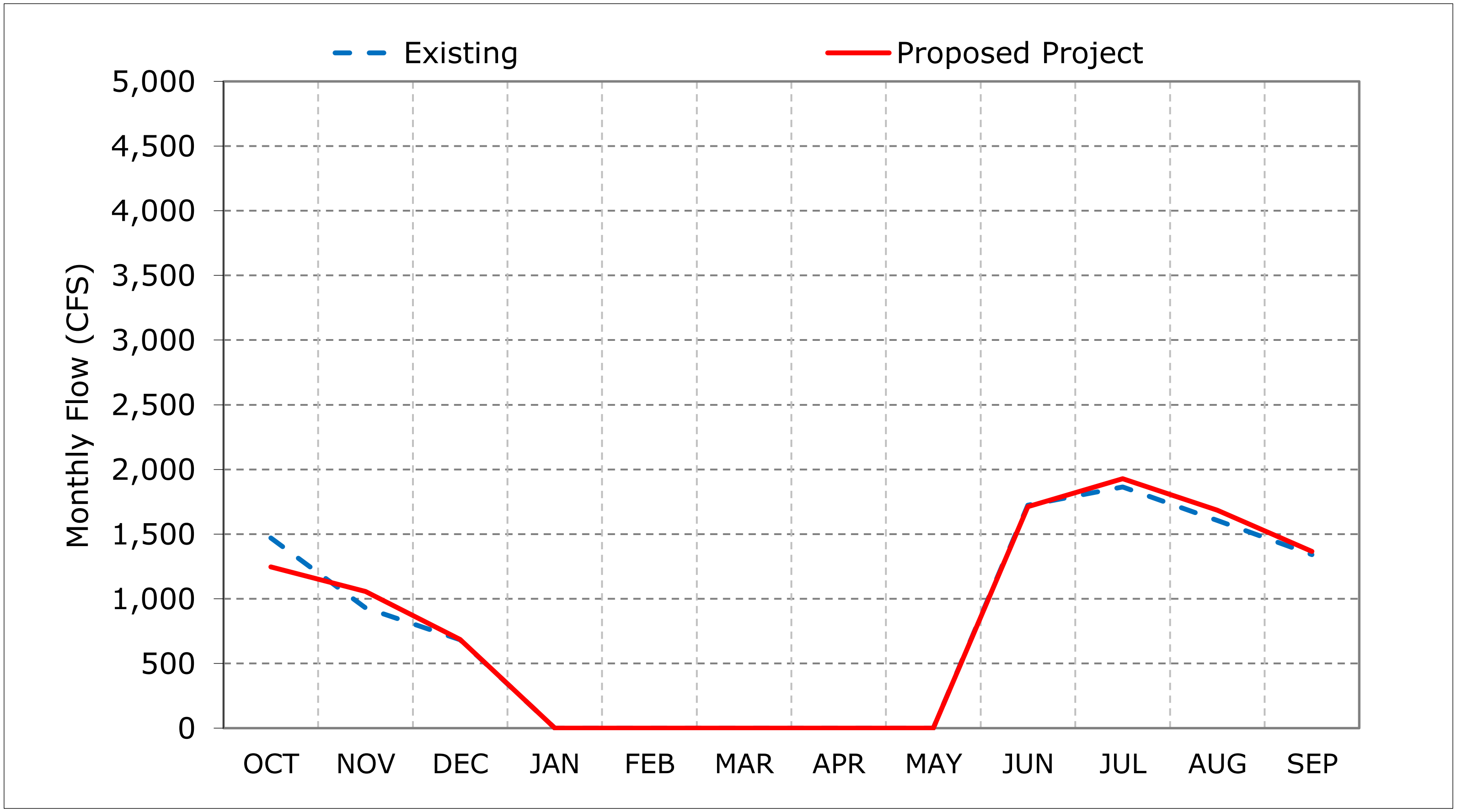
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 2-5. DCC Flow, Dry Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 2-6. DCC Flow, Critical Year Average Flow



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 2-7. DCC Flow, October

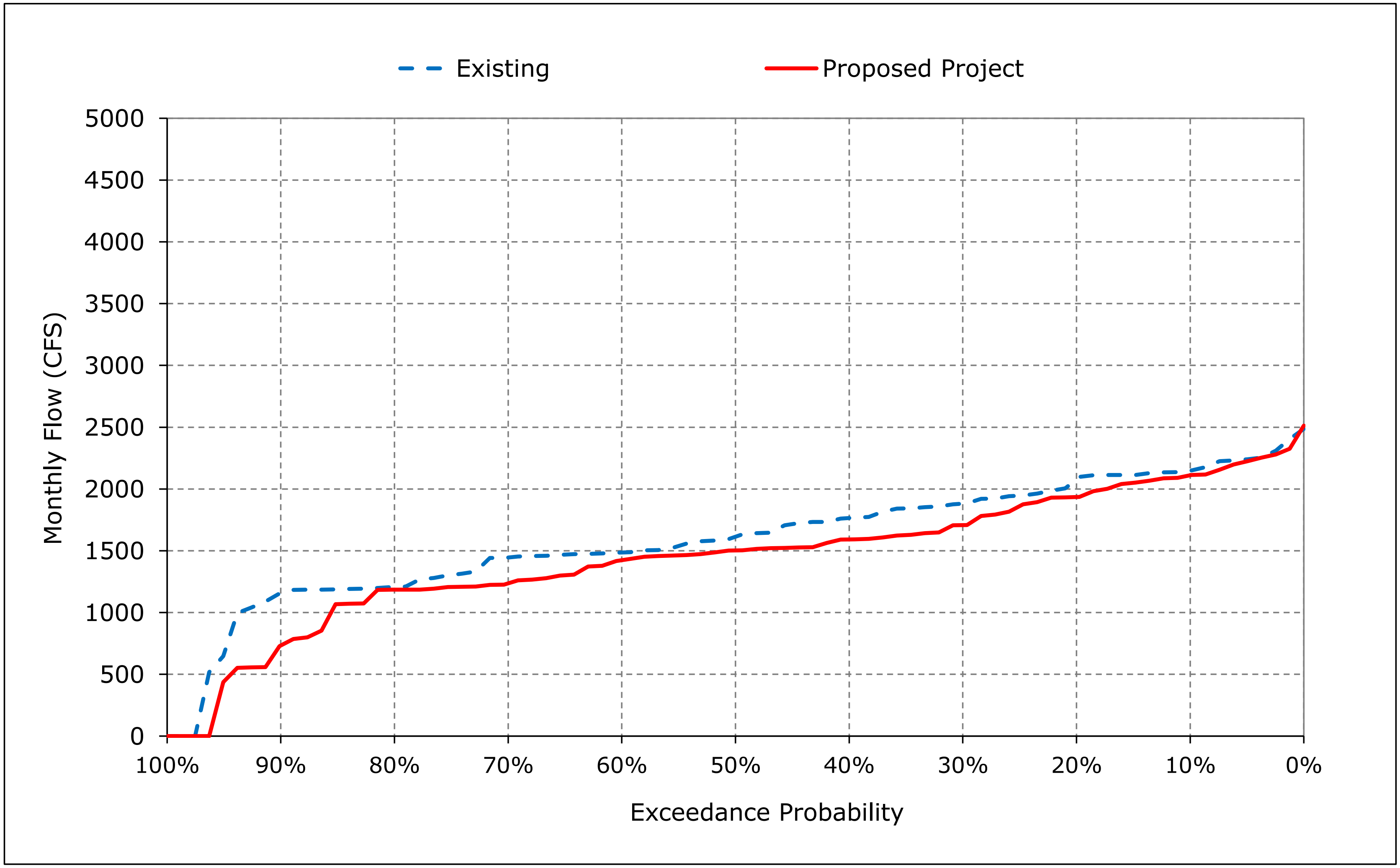


Figure 2-8. DCC Flow, November

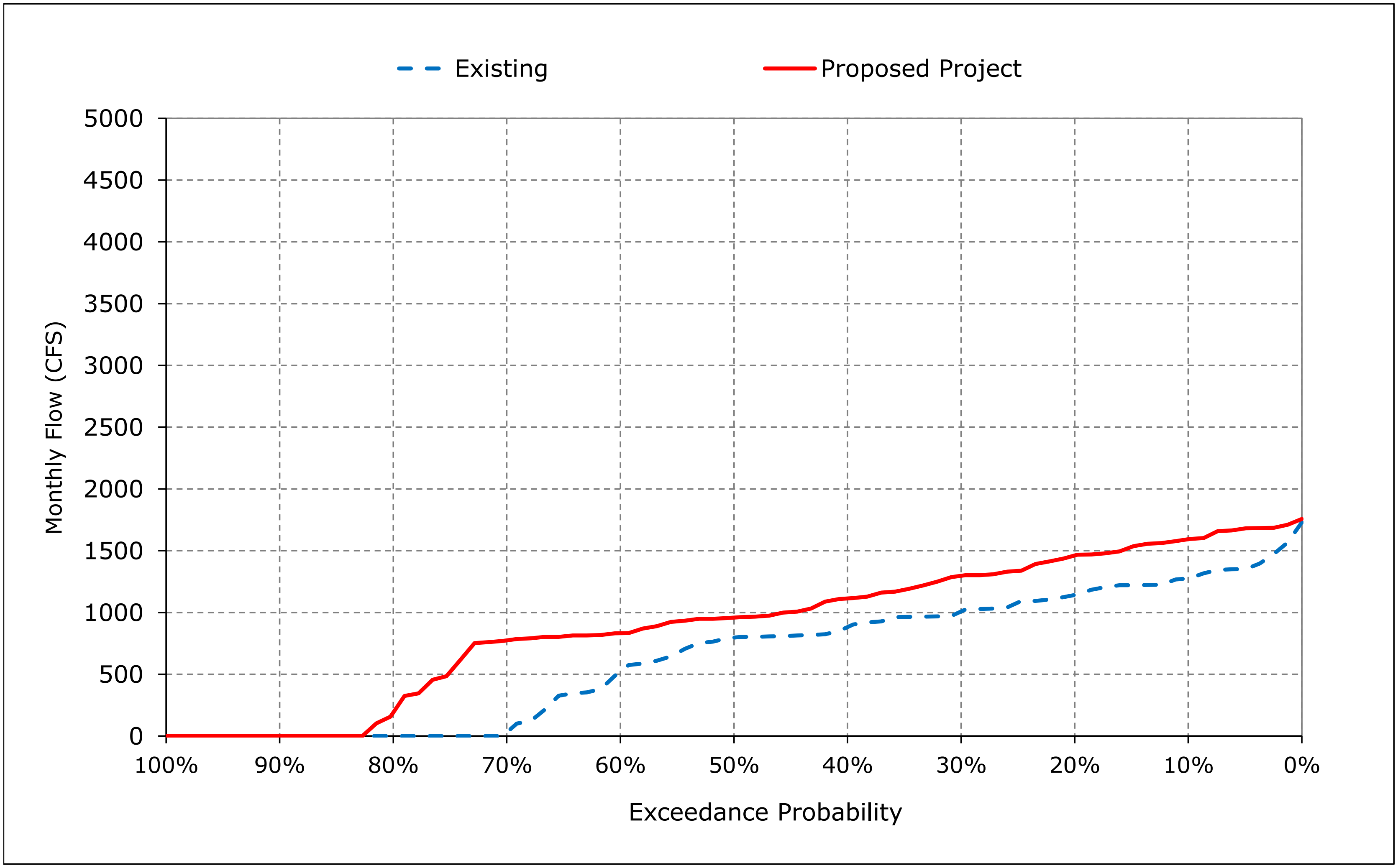


Figure 2-9. DCC Flow, December

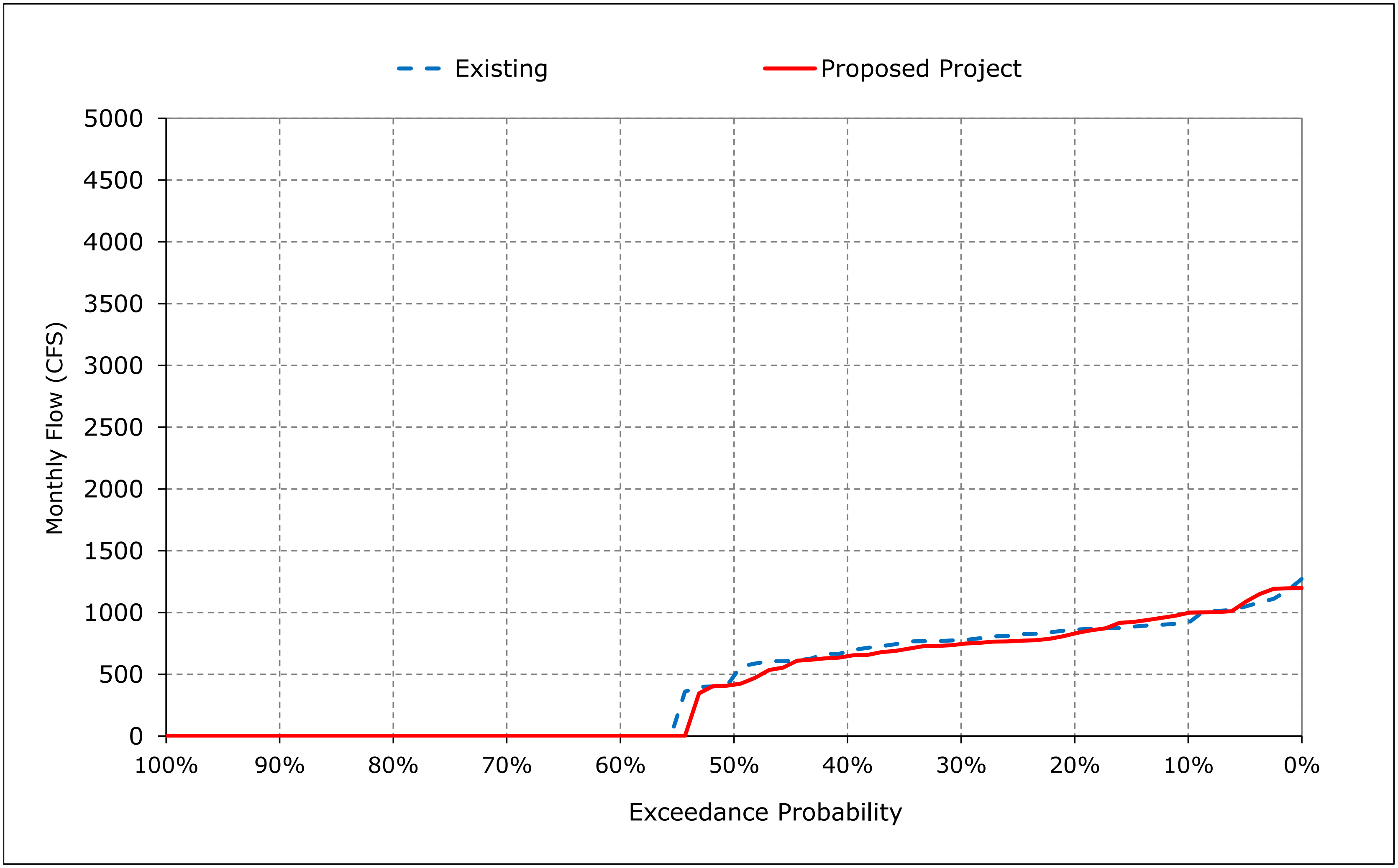


Figure 2-10. DCC Flow, January

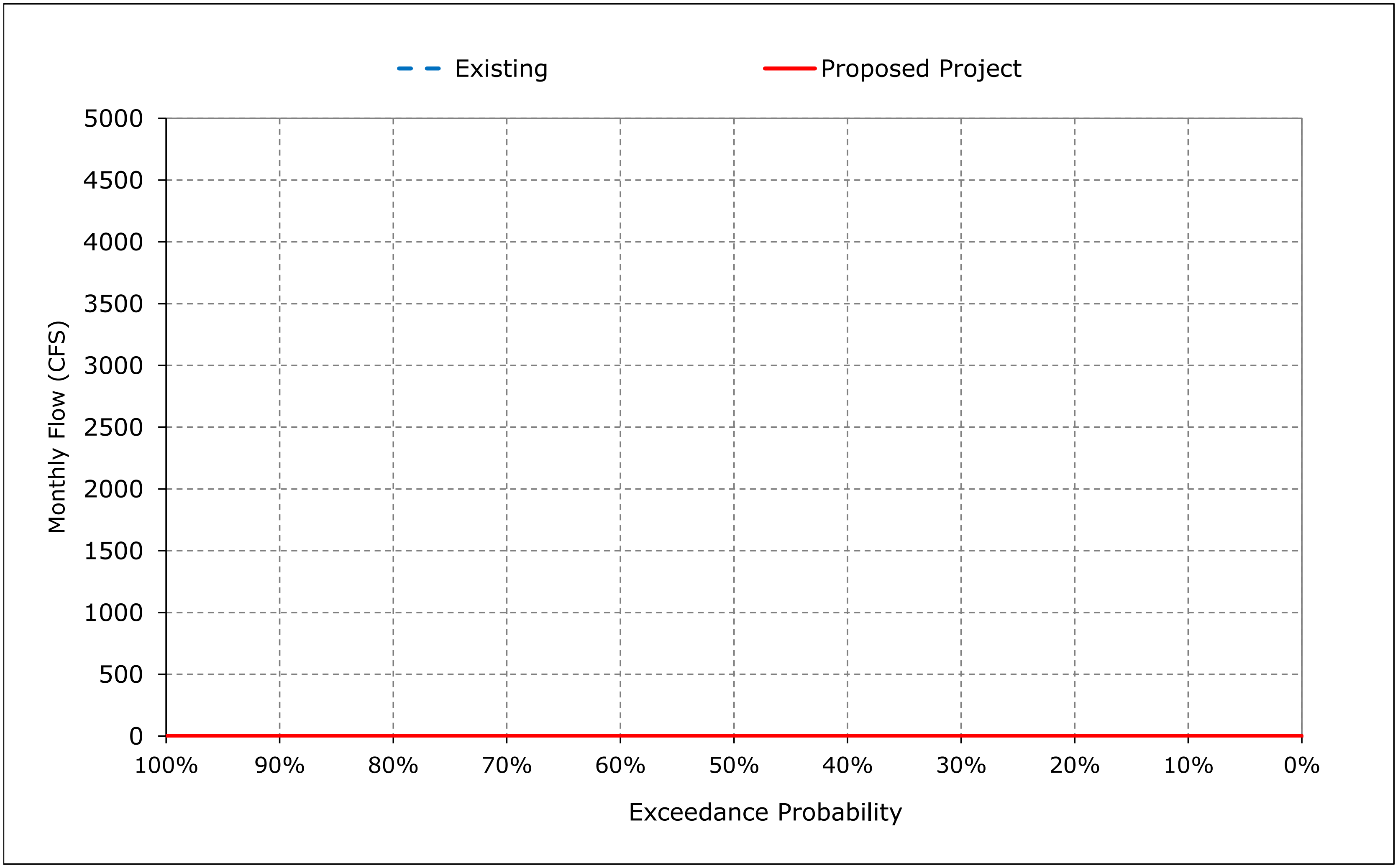


Figure 2-11. DCC Flow, February

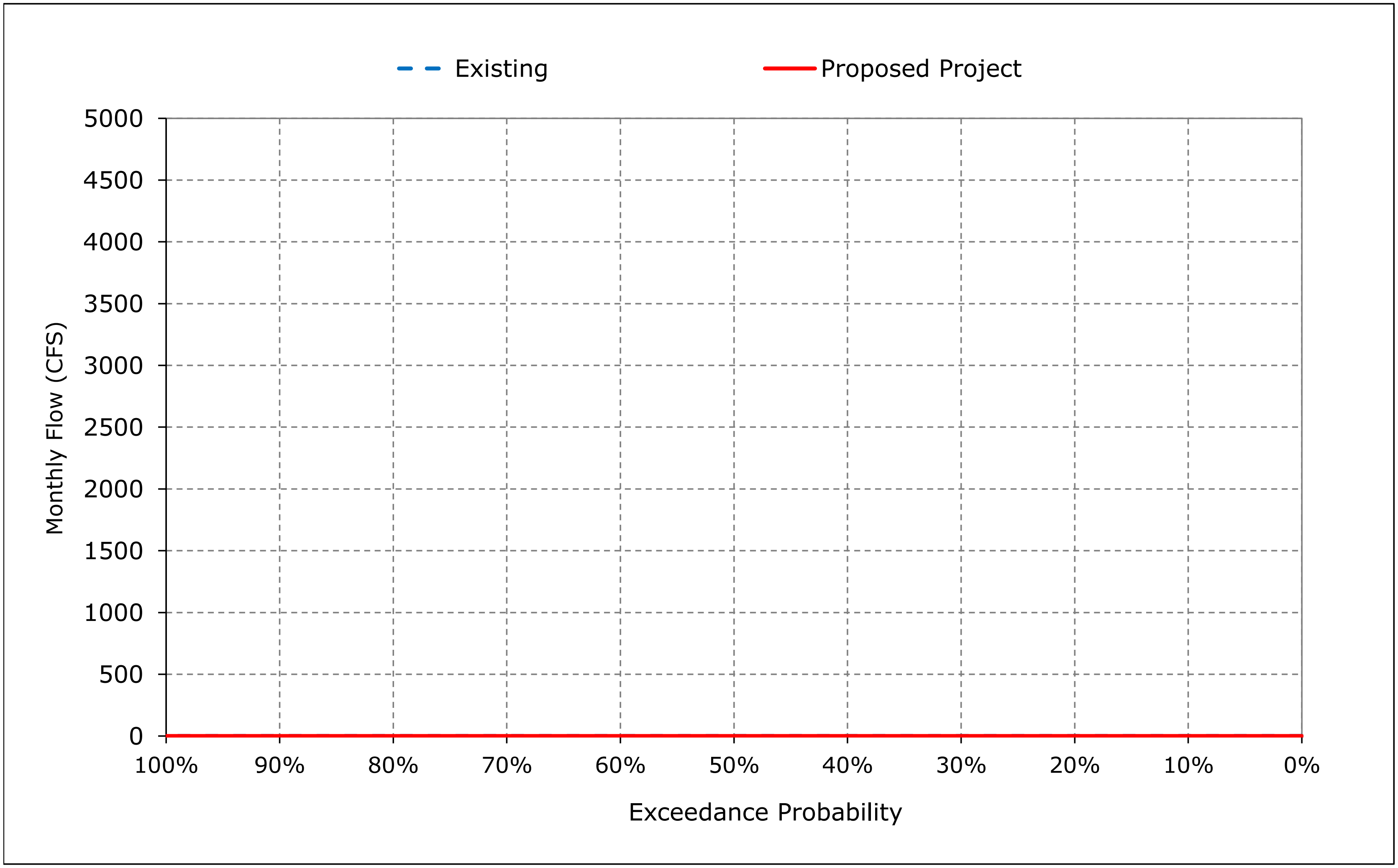


Figure 2-12. DCC Flow, March

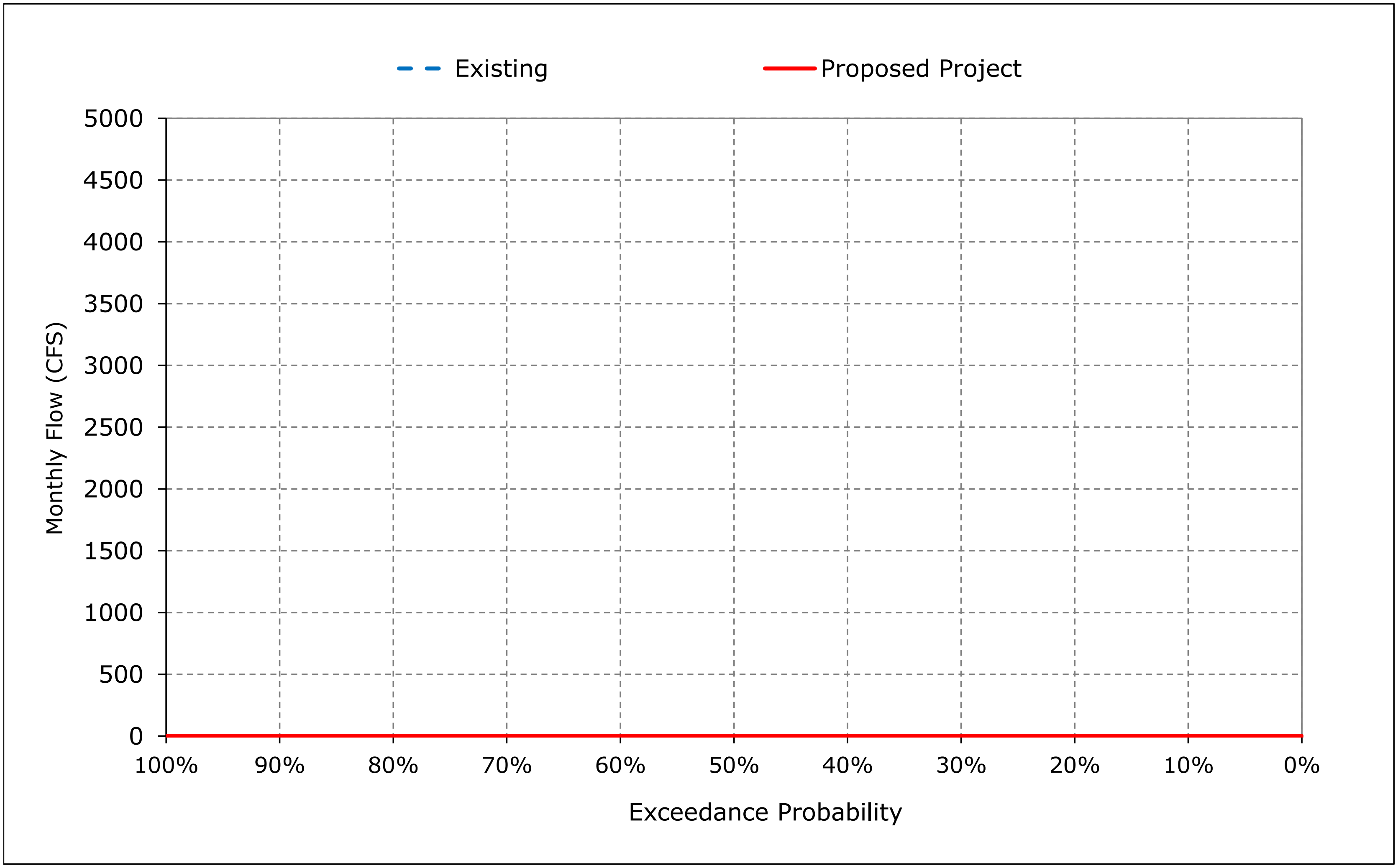


Figure 2-13. DCC Flow, April

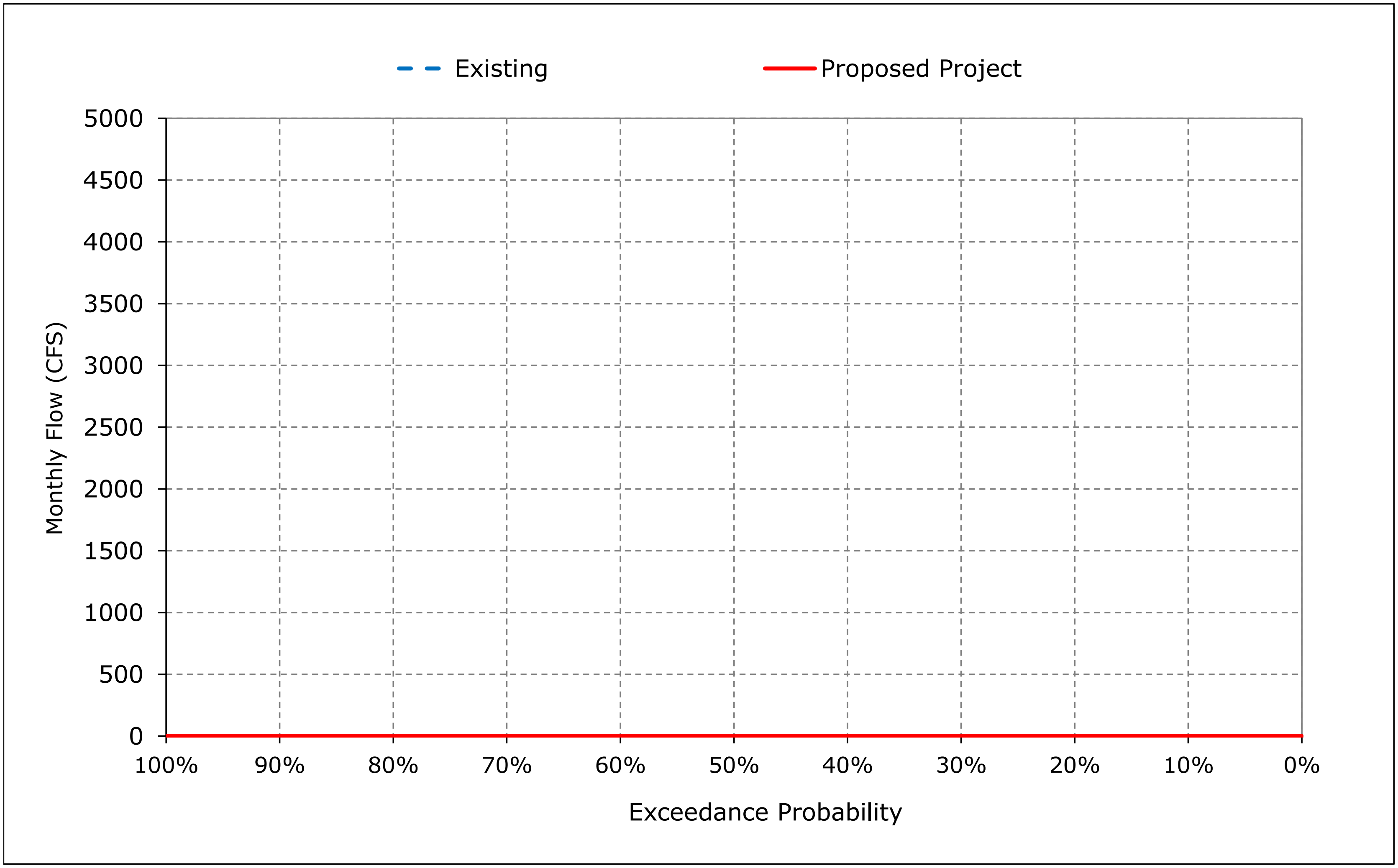


Figure 2-14. DCC Flow, May

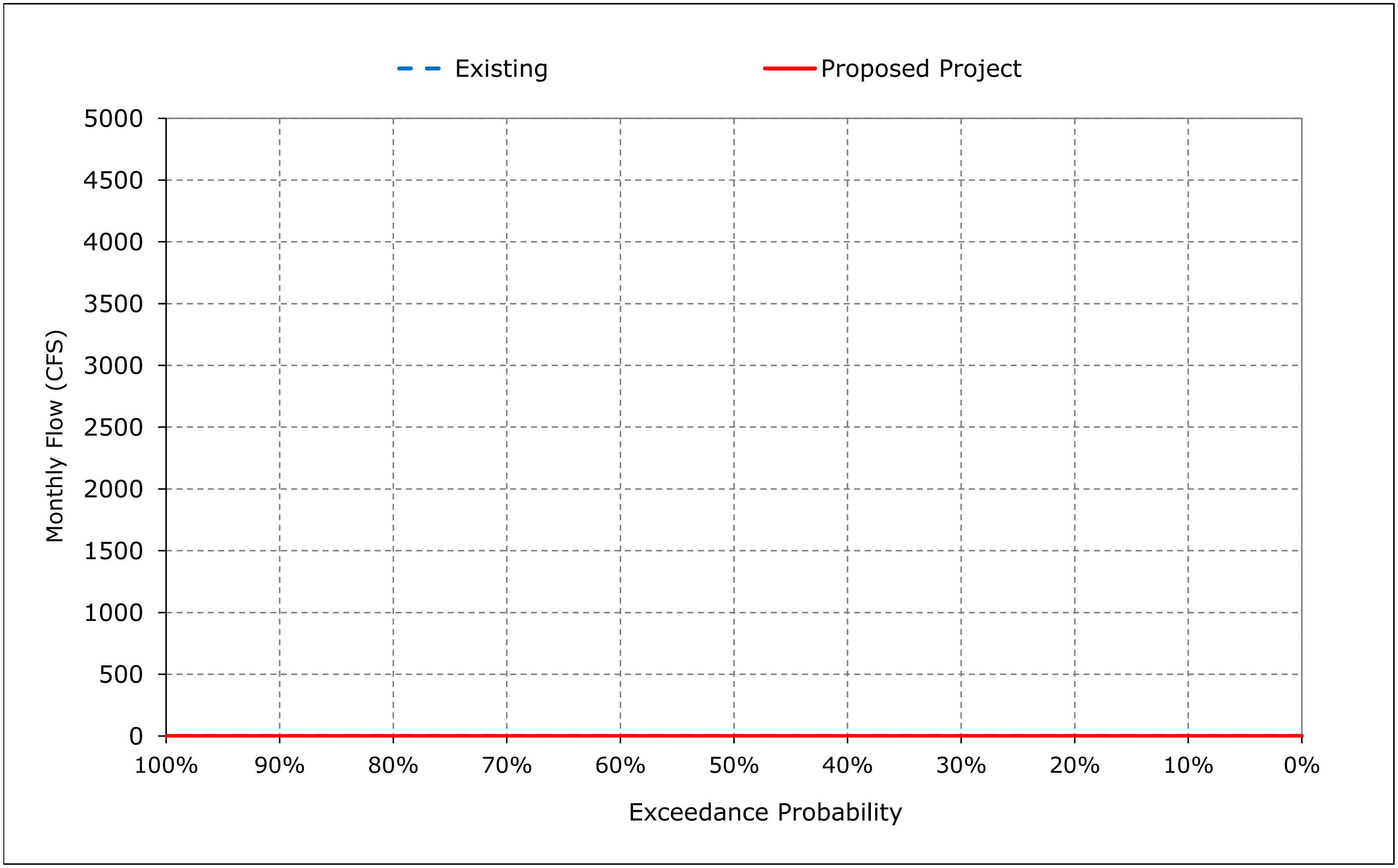


Figure 2-15. DCC Flow, June

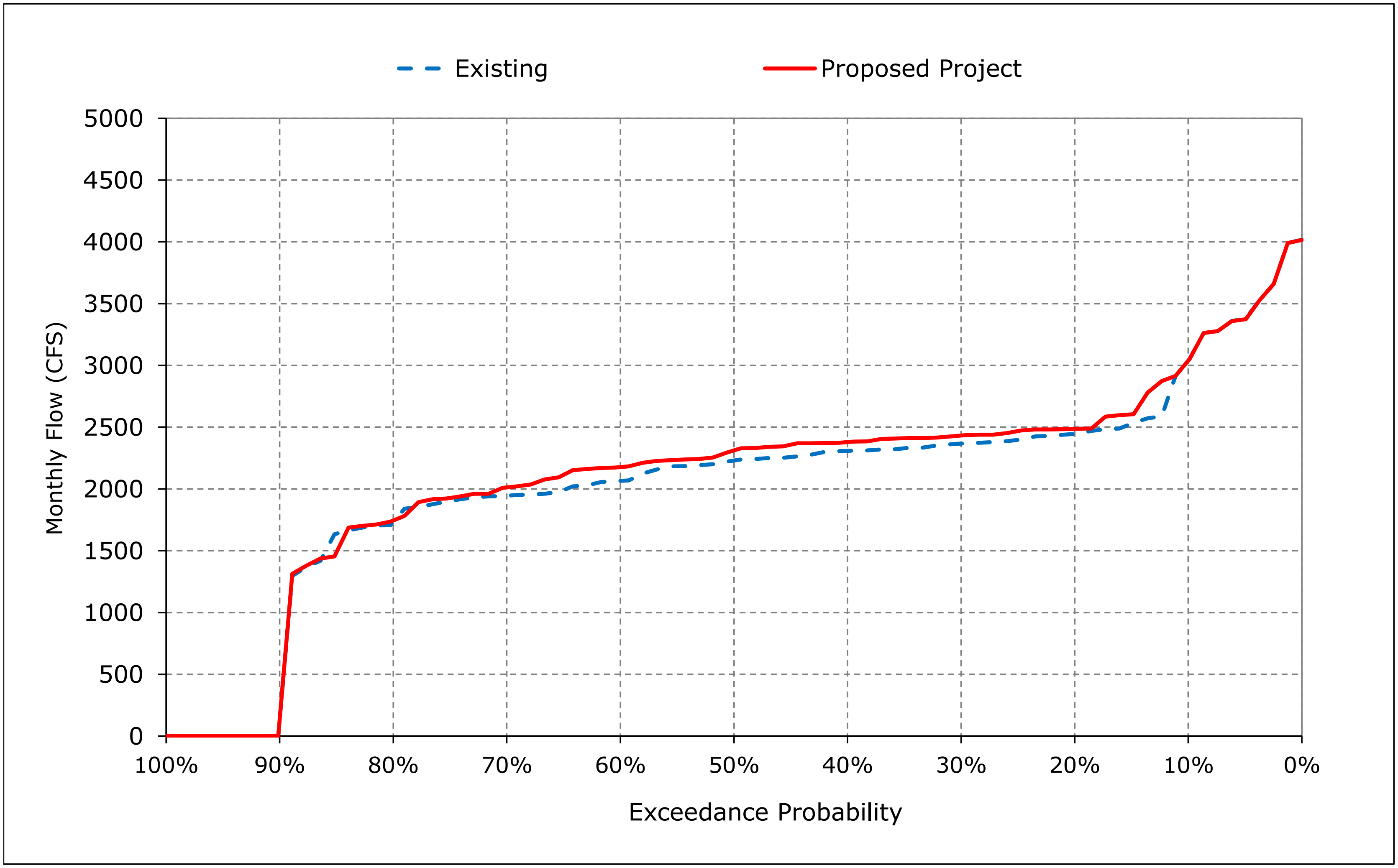


Figure 2-16. DCC Flow, July

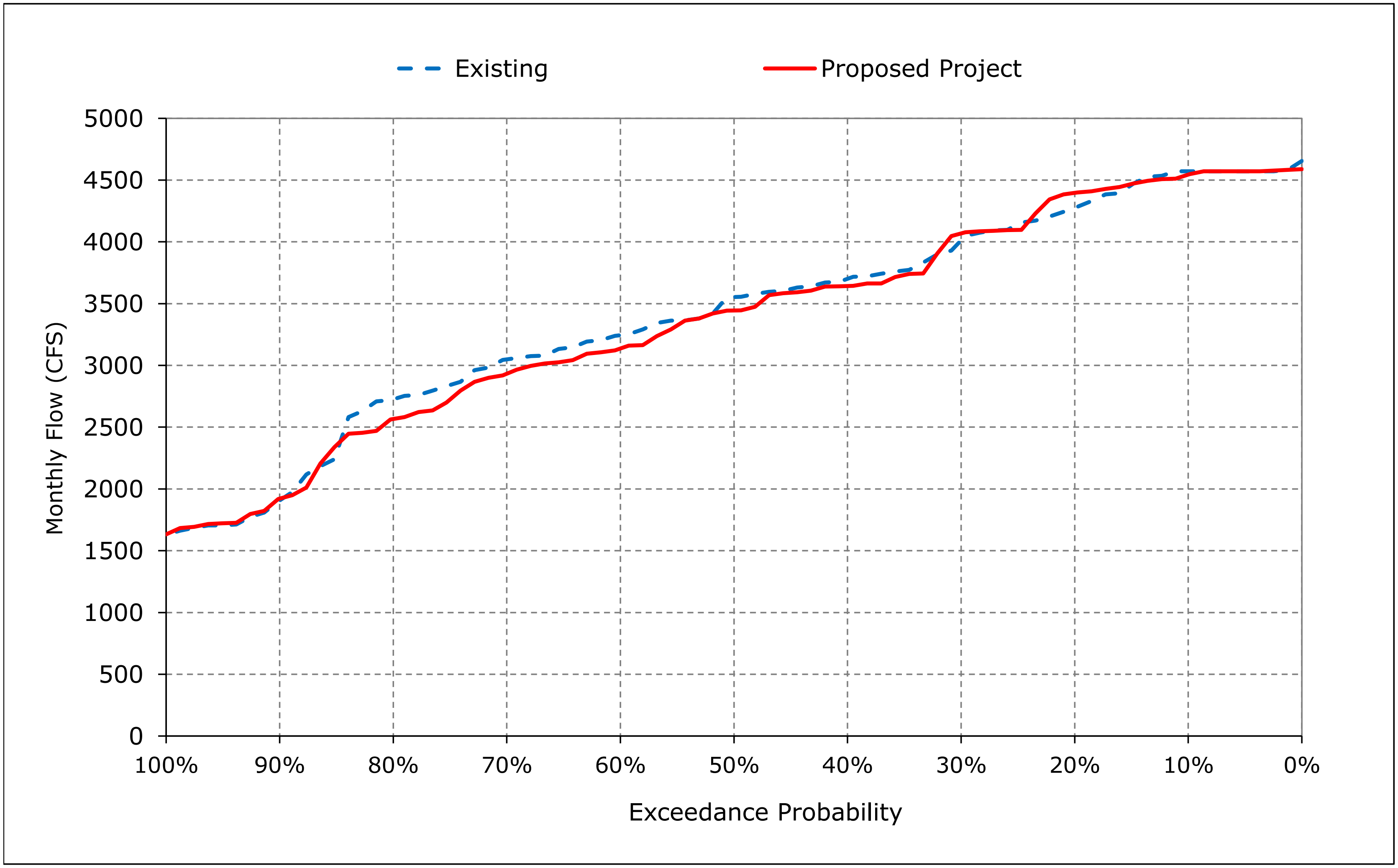


Figure 2-17. DCC Flow, August

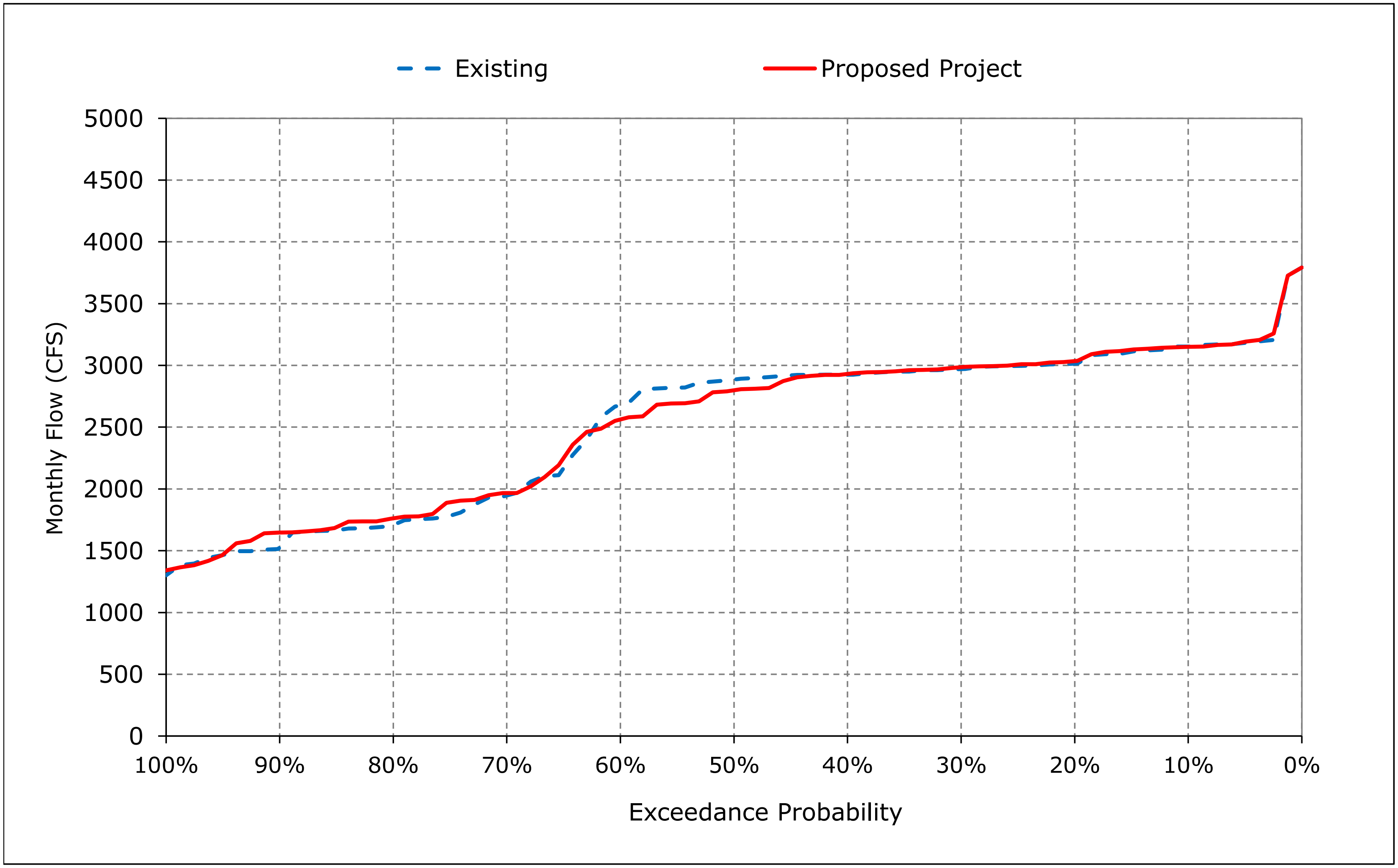


Figure 2-18. DCC Flow, September

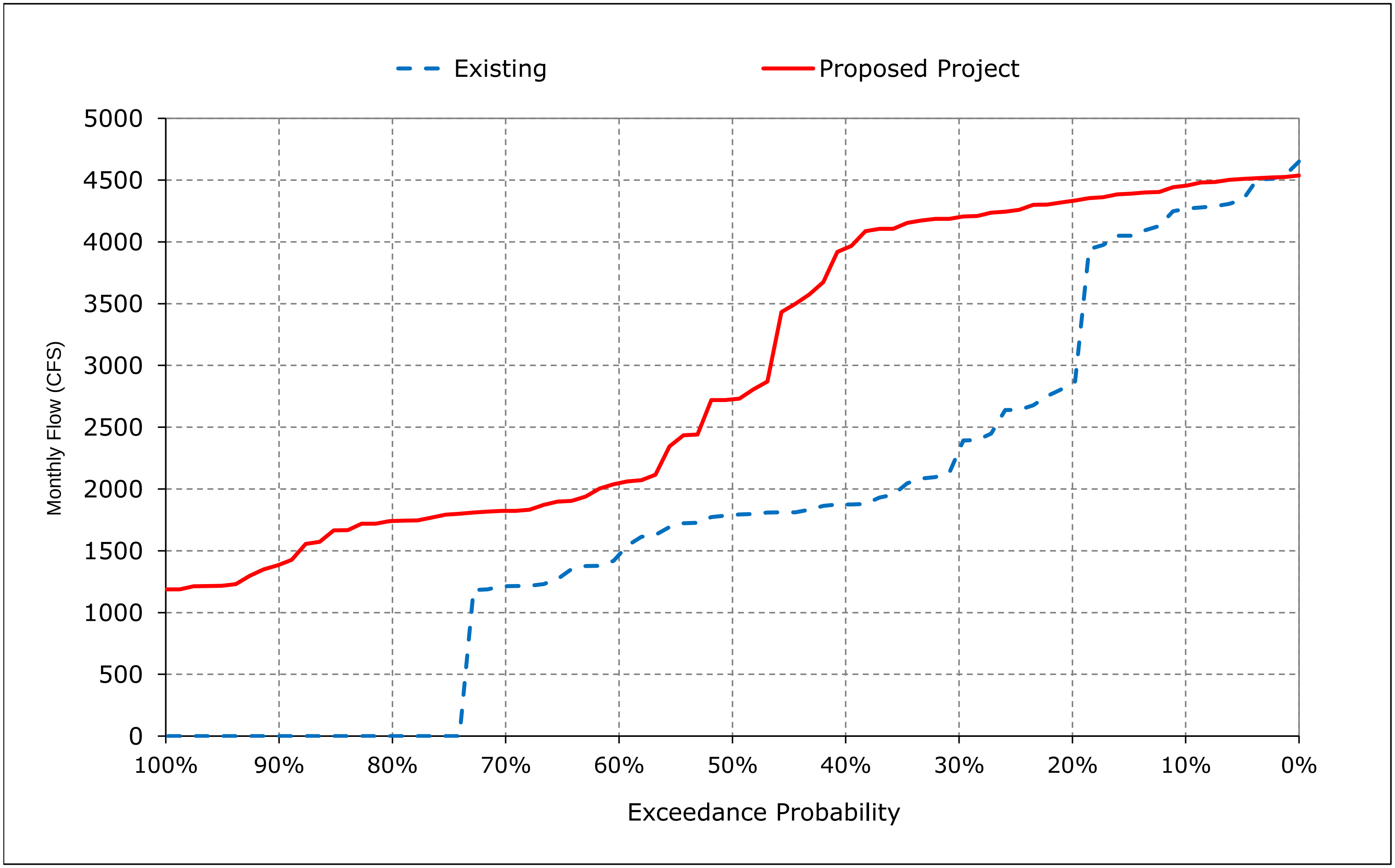


Table 3-1. Total Delta Exports, Monthly Delivery

Existing

	Monthly Delivery (CFS)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	9,505	11,280	11,672	10,061	12,003	10,316	3,006	2,765	8,910	11,483	11,629	11,280
20%	8,355	10,656	11,620	8,032	9,639	9,196	2,231	1,956	6,968	11,338	11,569	11,280
30%	7,633	8,681	10,027	7,159	8,359	8,719	1,970	1,698	5,734	11,280	11,363	11,206
40%	7,193	7,557	8,942	6,890	7,752	7,282	1,790	1,514	5,587	11,140	11,280	11,115
50%	6,672	7,183	8,016	6,749	7,108	6,587	1,625	1,500	5,319	10,475	10,858	10,419
60%	5,945	6,628	7,390	6,549	6,703	6,104	1,500	1,500	5,053	9,917	10,057	8,592
70%	5,628	6,008	7,197	6,453	6,576	5,823	1,500	1,500	4,907	8,976	5,344	7,062
80%	5,093	4,950	6,685	6,180	6,419	5,545	1,500	1,500	4,670	7,186	4,136	6,579
90%	4,332	4,216	5,939	5,204	6,063	4,720	1,500	1,500	2,900	2,468	3,201	3,927
Long Term												
Full Simulation Period[a]	6,738	7,386	8,593	7,274	8,058	7,232	2,053	2,013	5,677	9,053	8,537	8,885
Water Year Types[b,c]												
Wet (32%)	7,370	8,515	8,705	8,773	9,741	9,395	2,791	2,861	7,690	11,211	11,501	11,092
Above Normal (15%)	6,560	7,164	9,463	7,134	8,319	7,873	1,765	1,639	6,253	10,328	11,350	11,102
Below Normal (17%)	6,739	7,696	8,931	6,680	8,176	7,197	1,651	1,580	5,366	10,518	10,293	9,805
Dry (22%)	6,572	7,130	8,672	6,573	6,552	5,843	1,813	1,621	4,684	8,247	4,413	6,754
Critical (15%)	5,790	5,184	6,966	5,907	6,271	4,027	1,570	1,644	2,592	2,603	3,439	4,011

Proposed Project

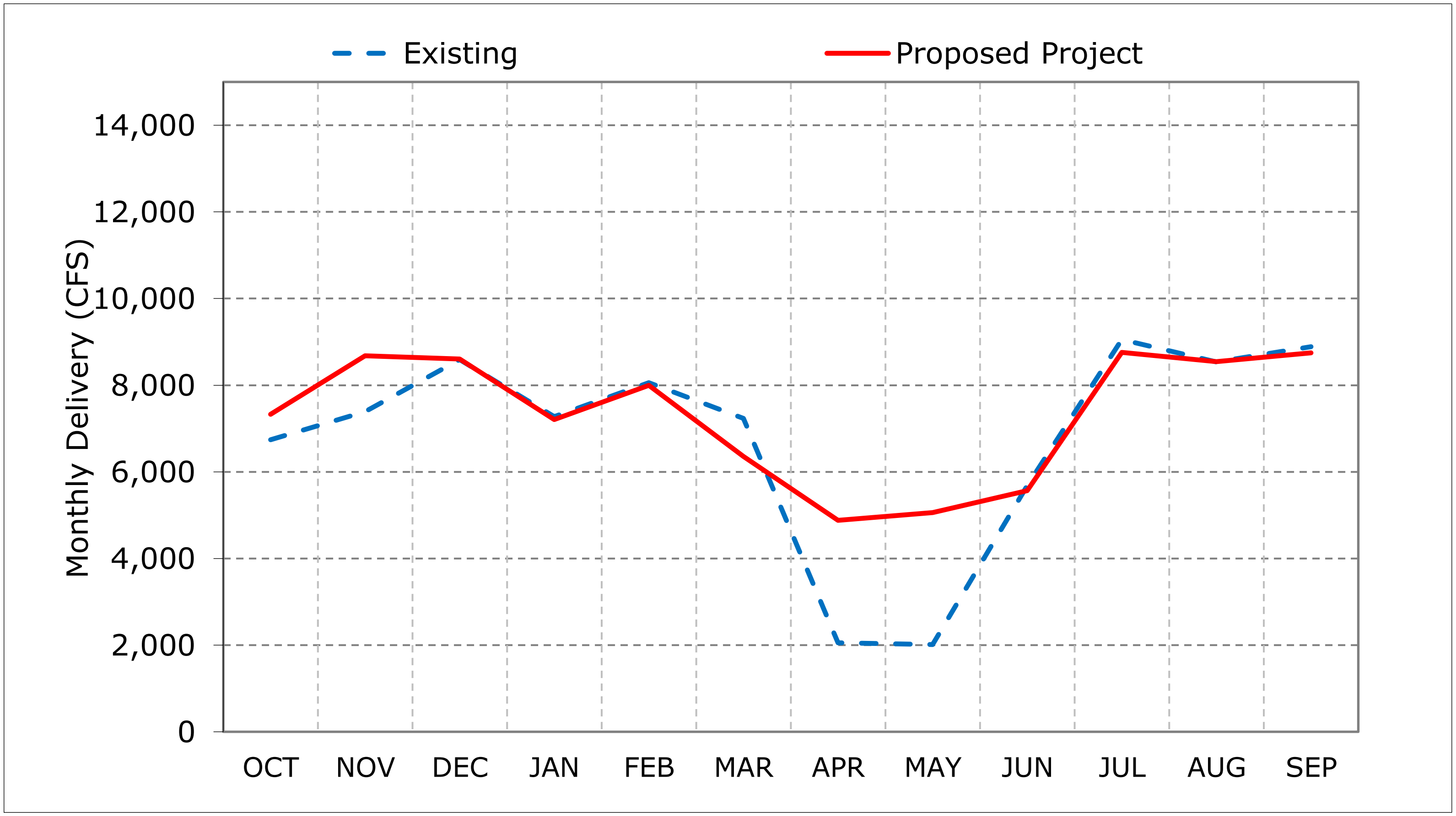
	Monthly Delivery (CFS)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	11,062	11,280	11,696	9,352	10,883	9,977	7,423	8,500	8,907	11,386	11,622	11,280
20%	9,229	11,280	11,627	8,004	9,226	7,874	6,315	7,417	6,925	11,280	11,531	11,280
30%	8,850	11,280	10,699	7,251	8,575	7,455	6,037	6,249	5,519	11,279	11,280	11,238
40%	8,362	10,980	9,039	7,093	7,875	6,172	5,542	5,686	5,372	10,675	11,258	10,925
50%	7,932	9,343	7,982	6,904	7,244	5,683	4,929	5,029	5,156	10,221	10,712	9,768
60%	6,427	8,271	7,347	6,738	6,737	5,348	4,347	4,211	5,019	9,560	8,870	8,316
70%	5,644	6,874	7,034	6,521	6,544	4,843	3,624	3,383	4,845	7,893	5,613	6,957
80%	5,100	5,798	6,634	6,108	6,294	4,611	2,923	2,762	4,603	6,037	4,632	6,434
90%	4,122	4,517	5,817	5,537	6,068	4,403	2,382	2,112	2,730	2,416	3,333	4,055
Long Term												
Full Simulation Period[a]	7,327	8,681	8,605	7,207	7,996	6,357	4,881	5,058	5,568	8,757	8,543	8,748
Water Year Types[b,c]												
Wet (32%)	8,188	10,049	8,678	8,346	9,476	8,453	6,606	7,027	7,588	11,047	11,441	10,828
Above Normal (15%)	7,437	8,489	9,515	7,195	8,096	6,752	5,702	5,966	6,162	10,504	11,280	10,886
Below Normal (17%)	7,418	9,123	8,898	6,824	8,279	5,951	4,931	5,258	5,259	9,684	9,981	9,618
Dry (22%)	6,973	7,871	8,962	6,761	6,745	4,824	3,643	3,495	4,560	7,520	4,532	6,702
Critical (15%)	5,777	6,609	6,660	5,868	6,236	4,191	2,121	1,996	2,472	2,823	3,869	4,156

Proposed Project minus Existing

	Monthly Delivery (CFS)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	1,556	0	24	**-708**	**-1,120**	**-339**	4,417	5,735	**-3**	**-97**	**-8**	0
20%	874	624	7	**-28**	**-413**	**-1,321**	4,084	5,461	**-43**	**-58**	**-38**	0
30%	1,217	2,599	671	92	216	**-1,264**	4,067	4,551	**-215**	**-1**	**-83**	32
40%	1,169	3,423	97	203	122	**-1,111**	3,752	4,172	**-216**	**-465**	**-22**	**-190**
50%	1,260	2,161	**-35**	155	136	**-904**	3,305	3,529	**-162**	**-255**	**-146**	**-652**
60%	482	1,643	**-43**	189	34	**-756**	2,847	2,711	**-33**	**-357**	**-1,187**	**-276**
70%	15	866	**-163**	69	**-32**	**-979**	2,124	1,883	**-62**	**-1,083**	269	**-105**
80%	7	848	**-51**	**-72**	**-125**	**-934**	1,423	1,262	**-67**	**-1,149**	495	**-145**
90%	**-210**	301	**-122**	333	5	**-317**	882	612	**-170**	**-52**	132	129
Long Term												
Full Simulation Period[a]	590	1,295	12	**-67**	**-62**	**-875**	2,828	3,045	**-109**	**-296**	6	**-138**
Water Year Types[b,c]												
Wet (32%)	818	1,534	**-27**	**-428**	**-265**	**-942**	3,815	4,166	**-102**	**-164**	**-60**	**-264**
Above Normal (15%)	876	1,325	53	61	**-222**	**-1,121**	3,937	4,327	**-91**	176	**-70**	**-217**
Below Normal (17%)	679	1,427	**-33**	144	103	**-1,246**	3,280	3,678	**-107**	**-834**	**-312**	**-186**
Dry (22%)	402	741	291	187	192	**-1,019**	1,830	1,874	**-125**	**-726**	118	**-52**
Critical (15%)	**-12**	1,425	**-307**	**-38**	**-34**	164	550	351	**-120**	220	430	145

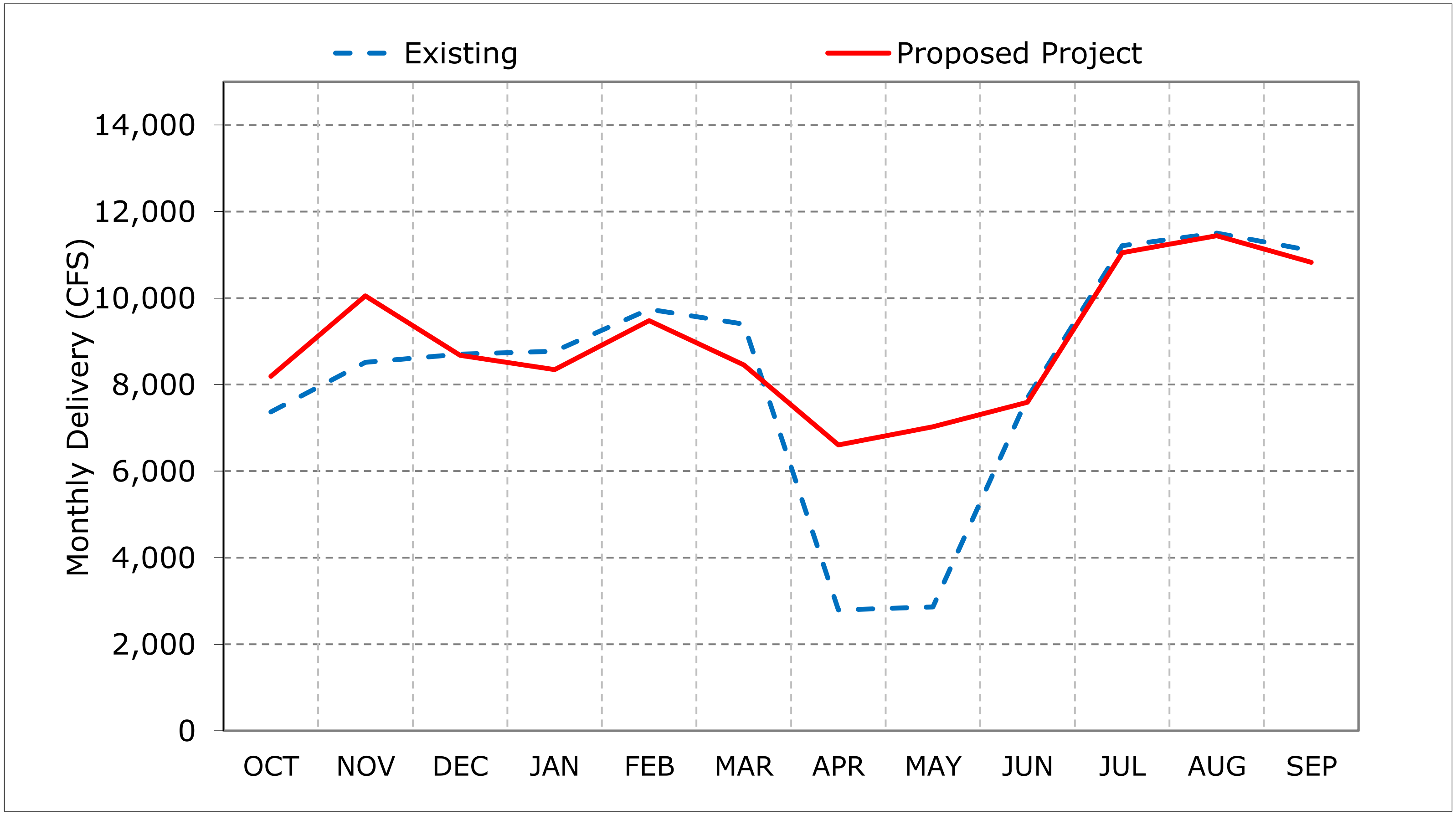
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.

Figure 3-1. Total Delta Exports, Long-Term Average Delivery



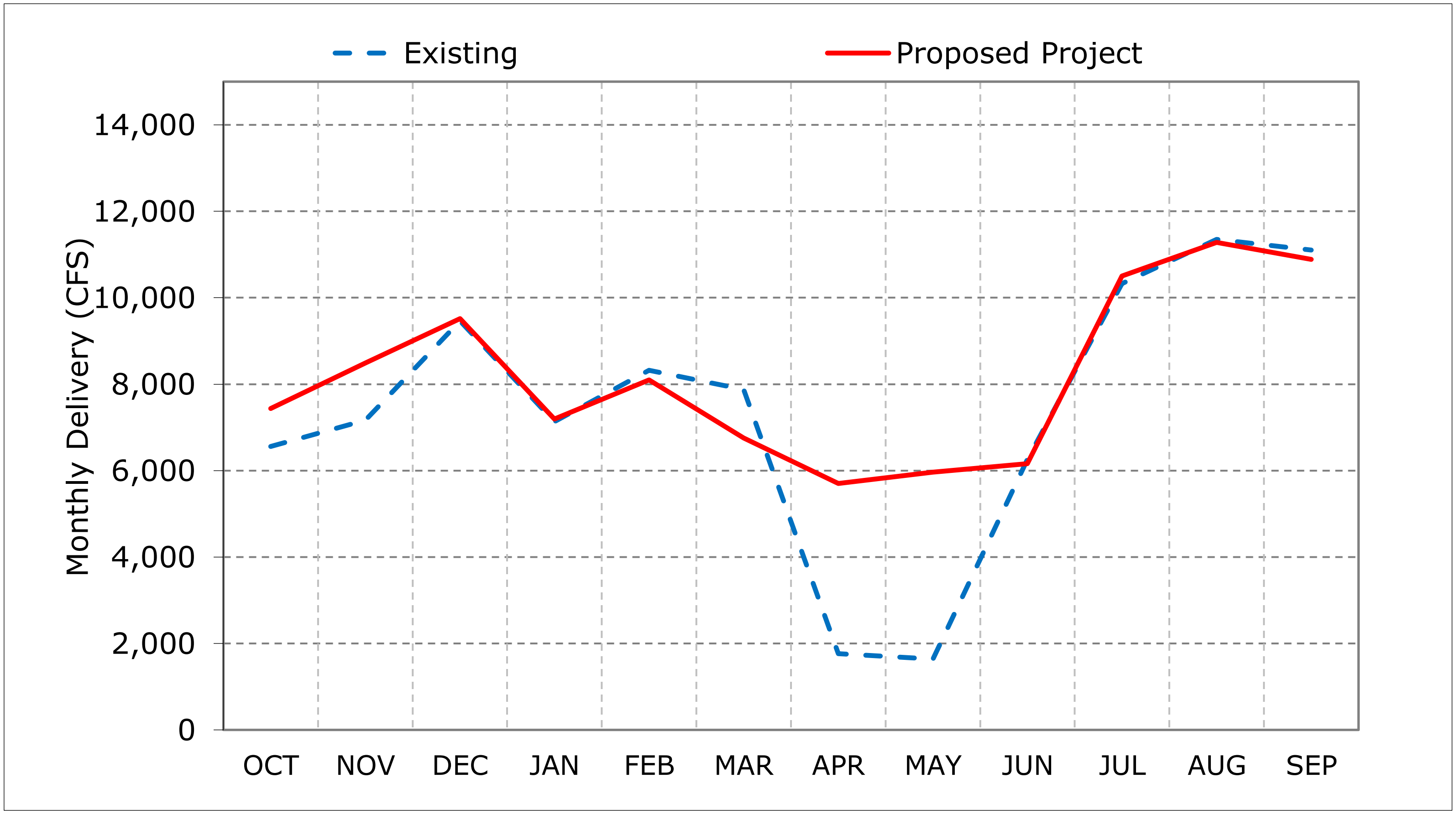
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 3-2. Total Delta Exports, Wet Year Average Delivery



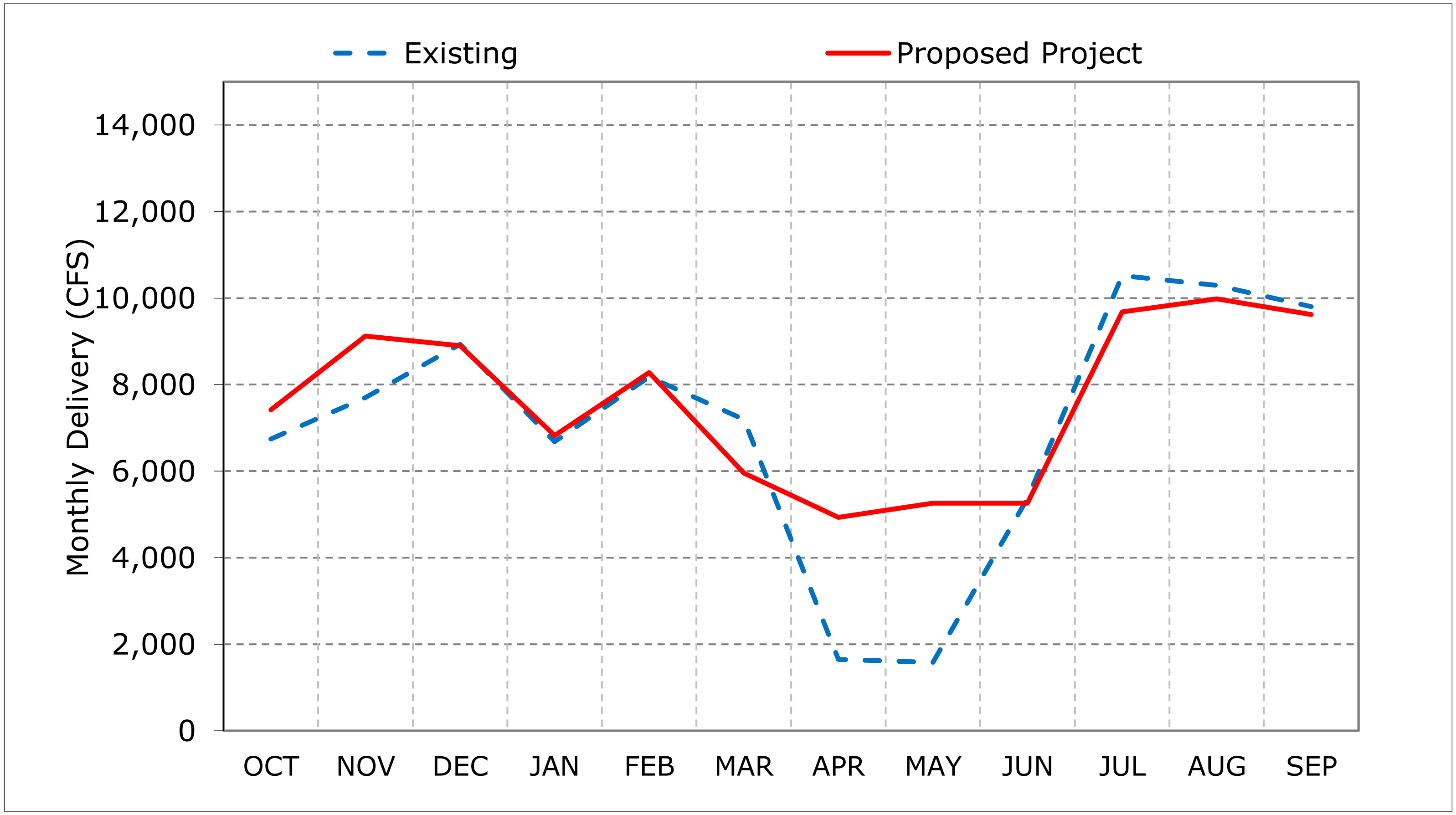
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 3-3. Total Delta Exports, Above Normal Year Average Delivery



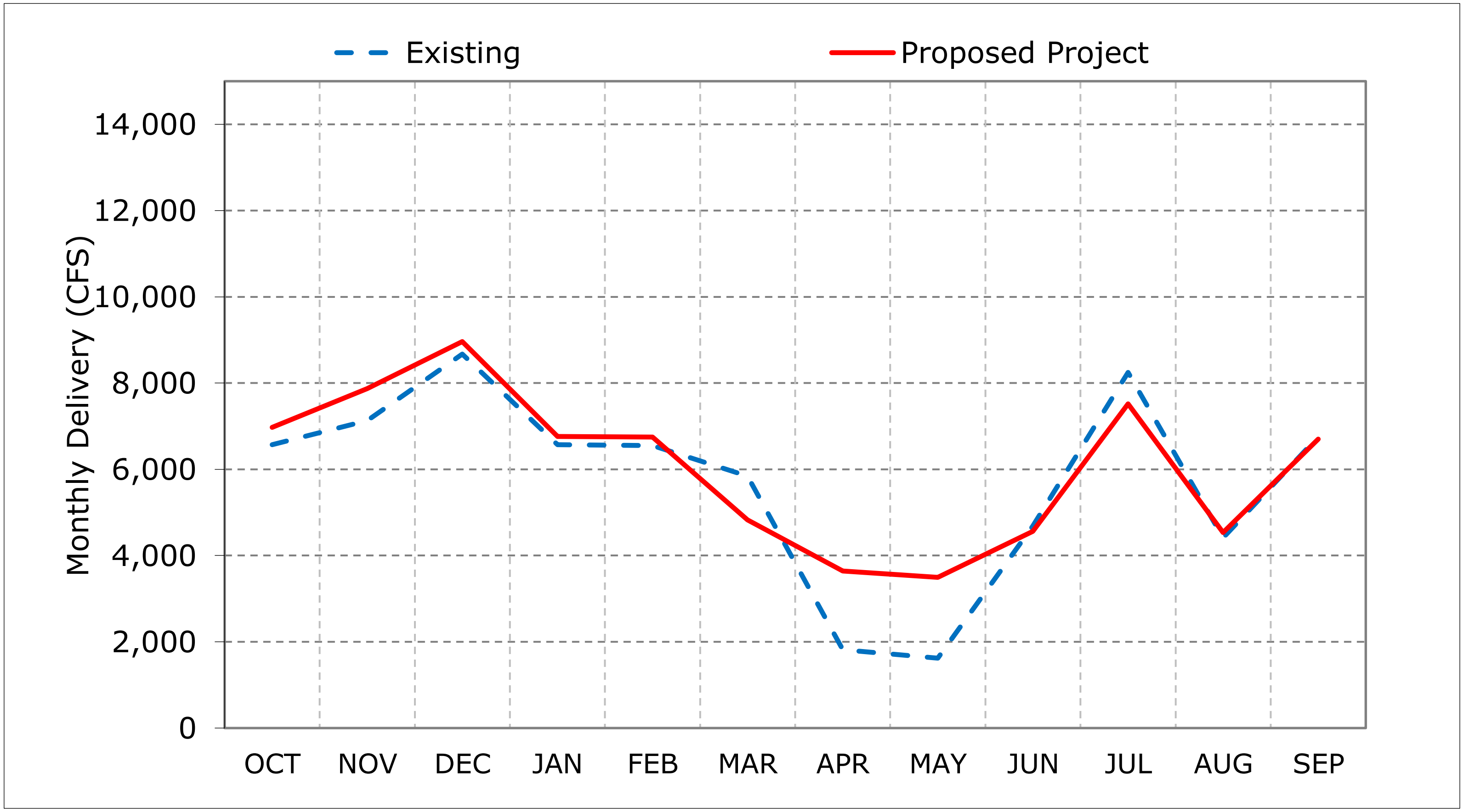
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 3-4. Total Delta Exports, Below Normal Year Average Delivery



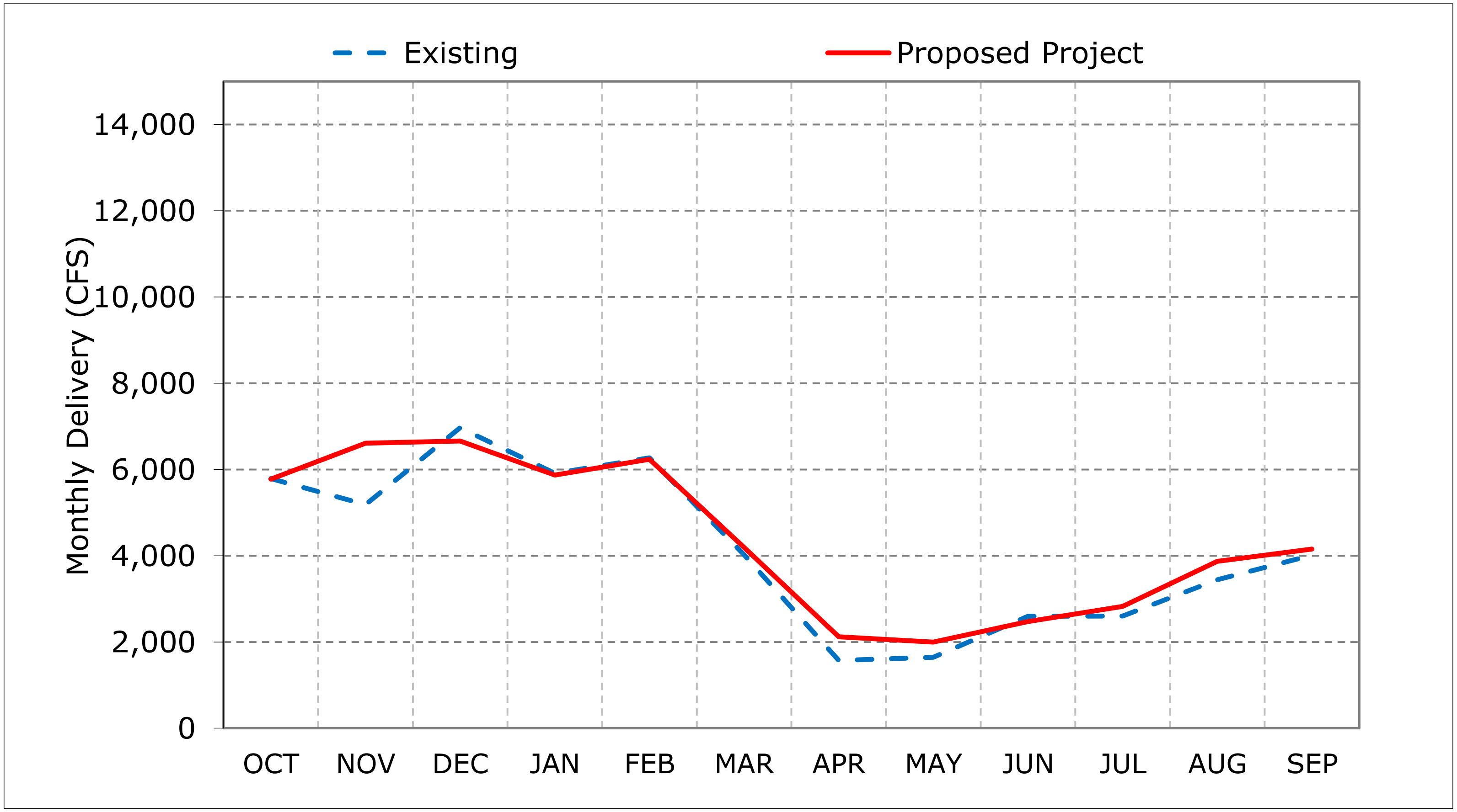
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 3-5. Total Delta Exports, Dry Year Average Delivery



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 3-6. Total Delta Exports, Critical Year Average Delivery



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 3-7. Total Delta Exports, October

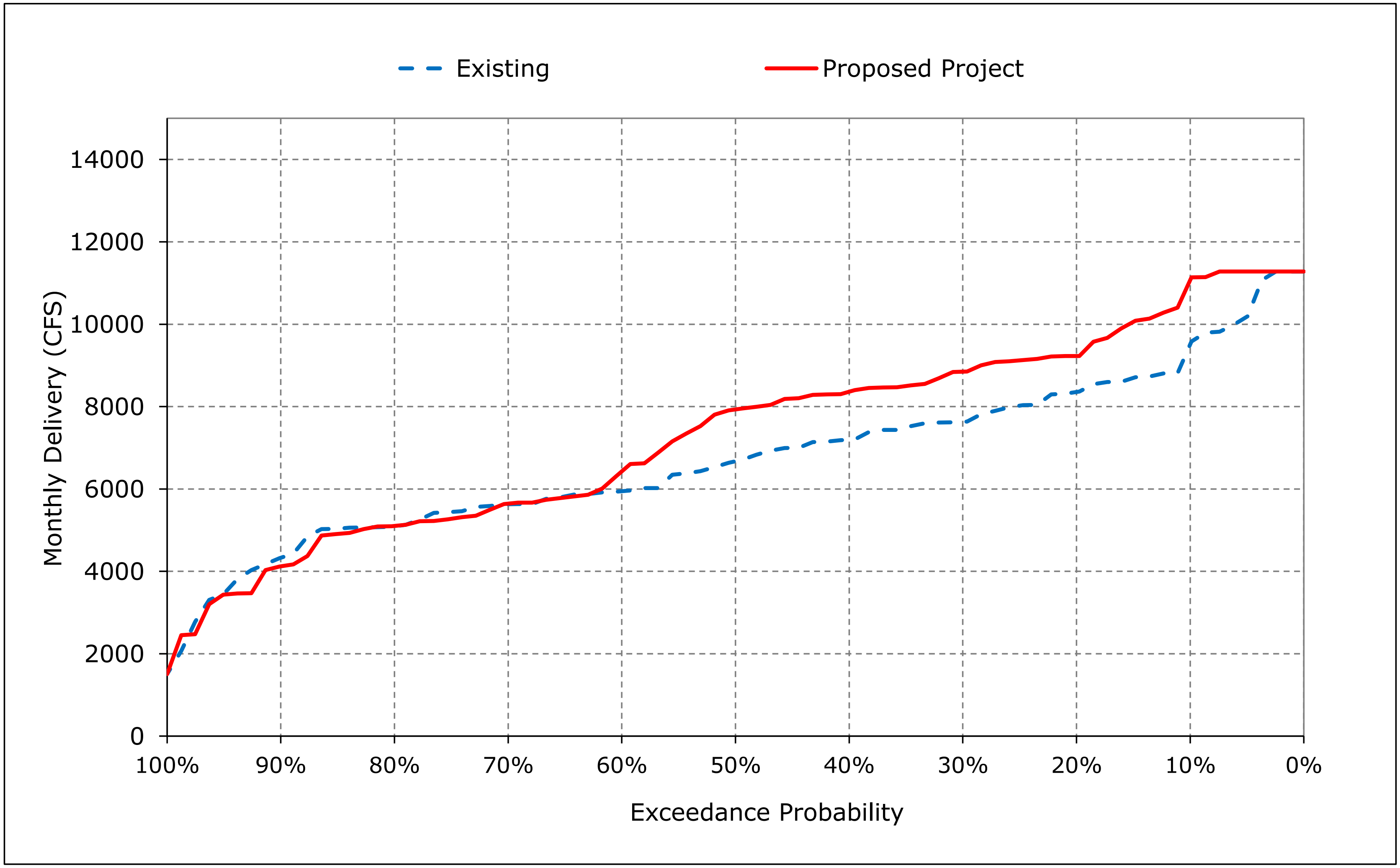


Figure 3-8. Total Delta Exports, November

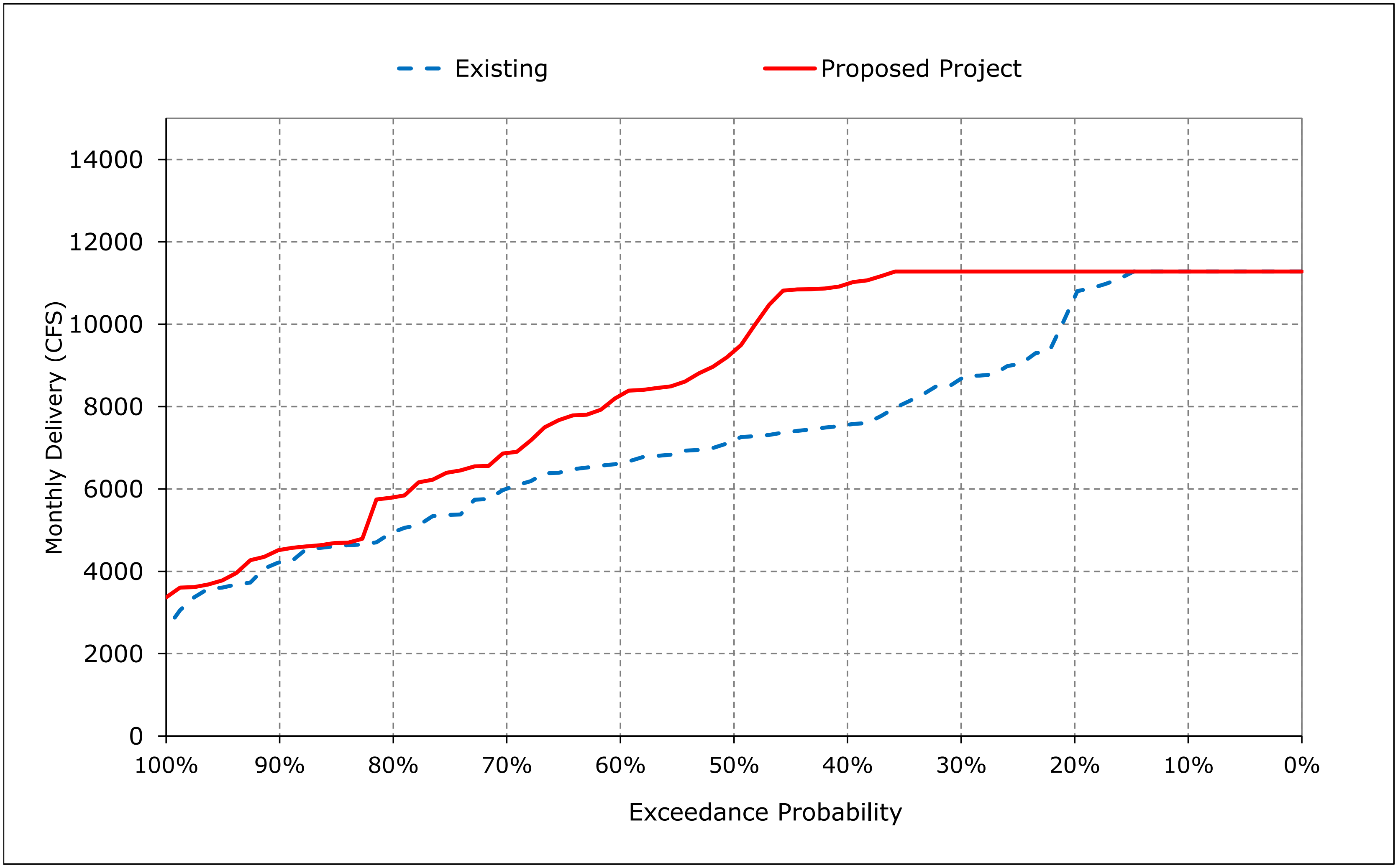


Figure 3-9. Total Delta Exports, December

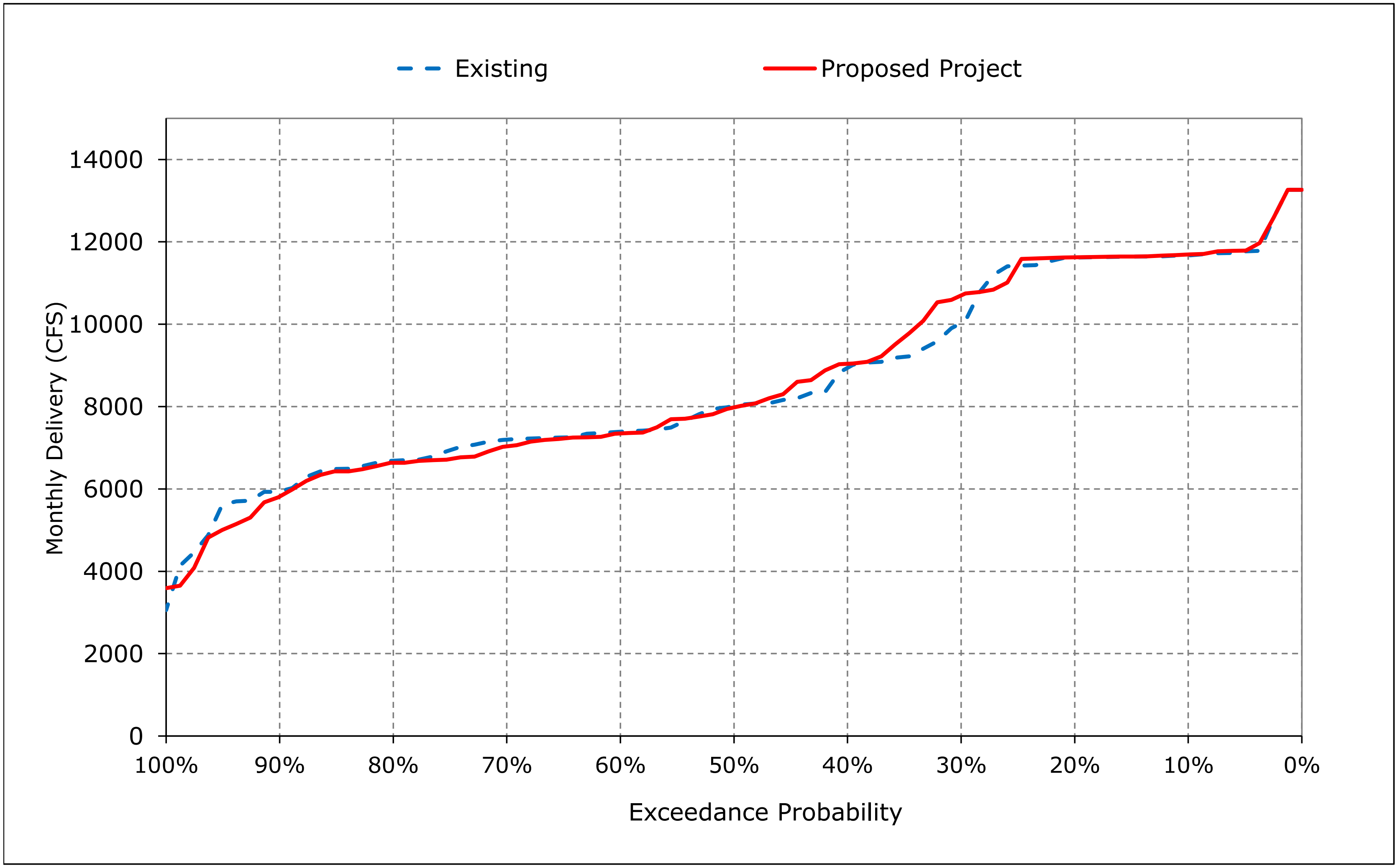


Figure 3-10. Total Delta Exports, January

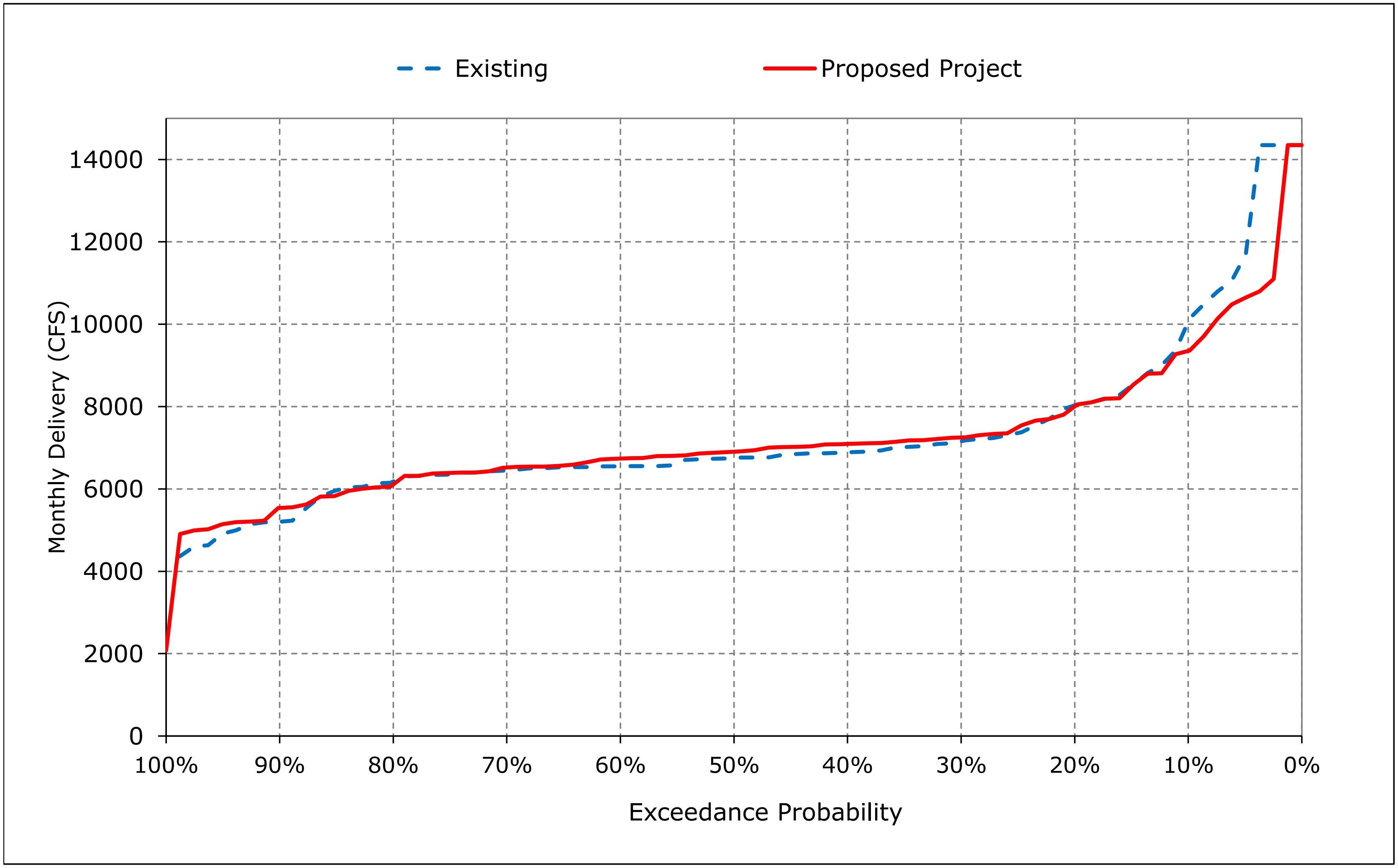


Figure 3-11. Total Delta Exports, February

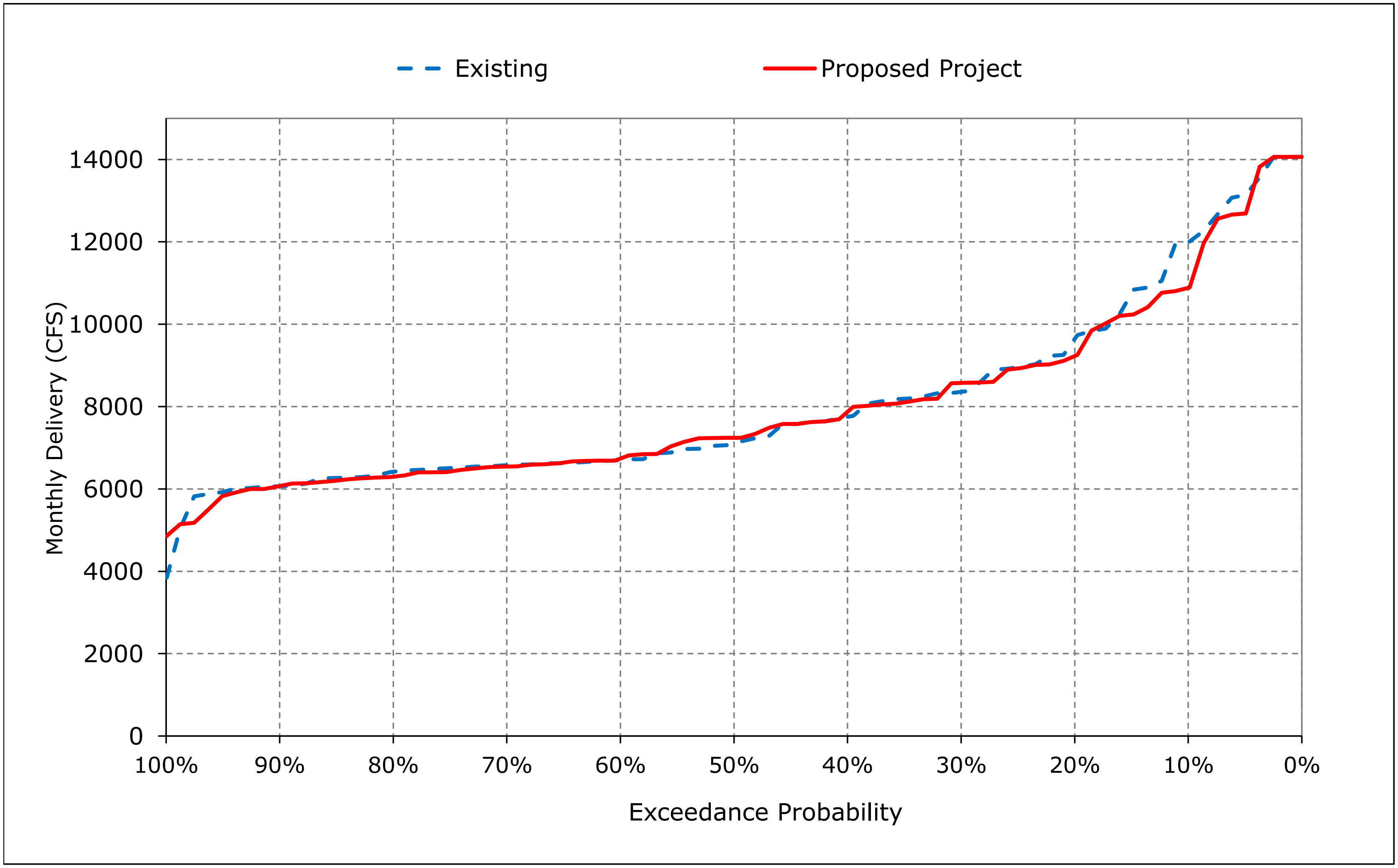


Figure 3-12. Total Delta Exports, March

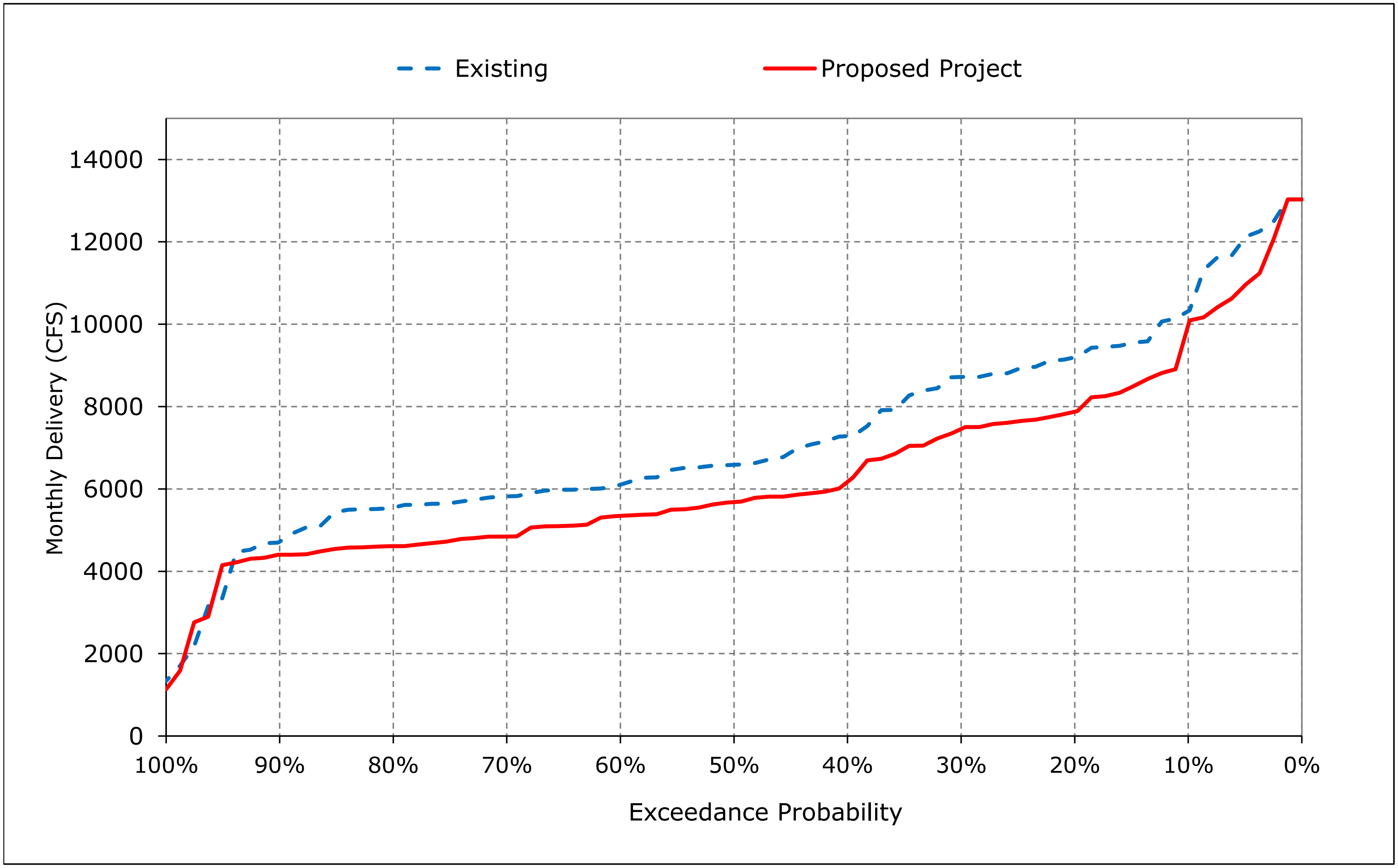


Figure 3-13. Total Delta Exports, April

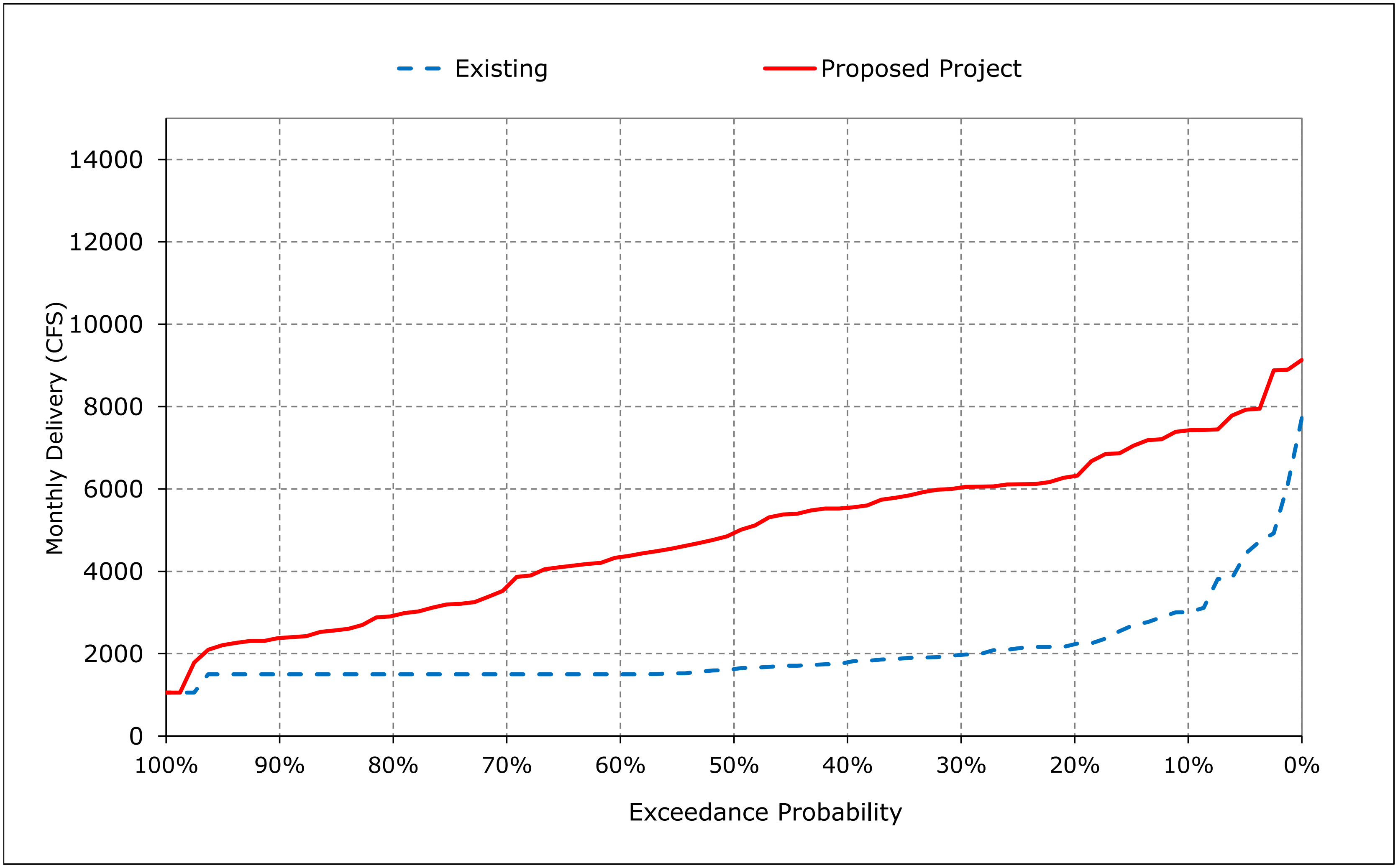


Figure 3-14. Total Delta Exports, May

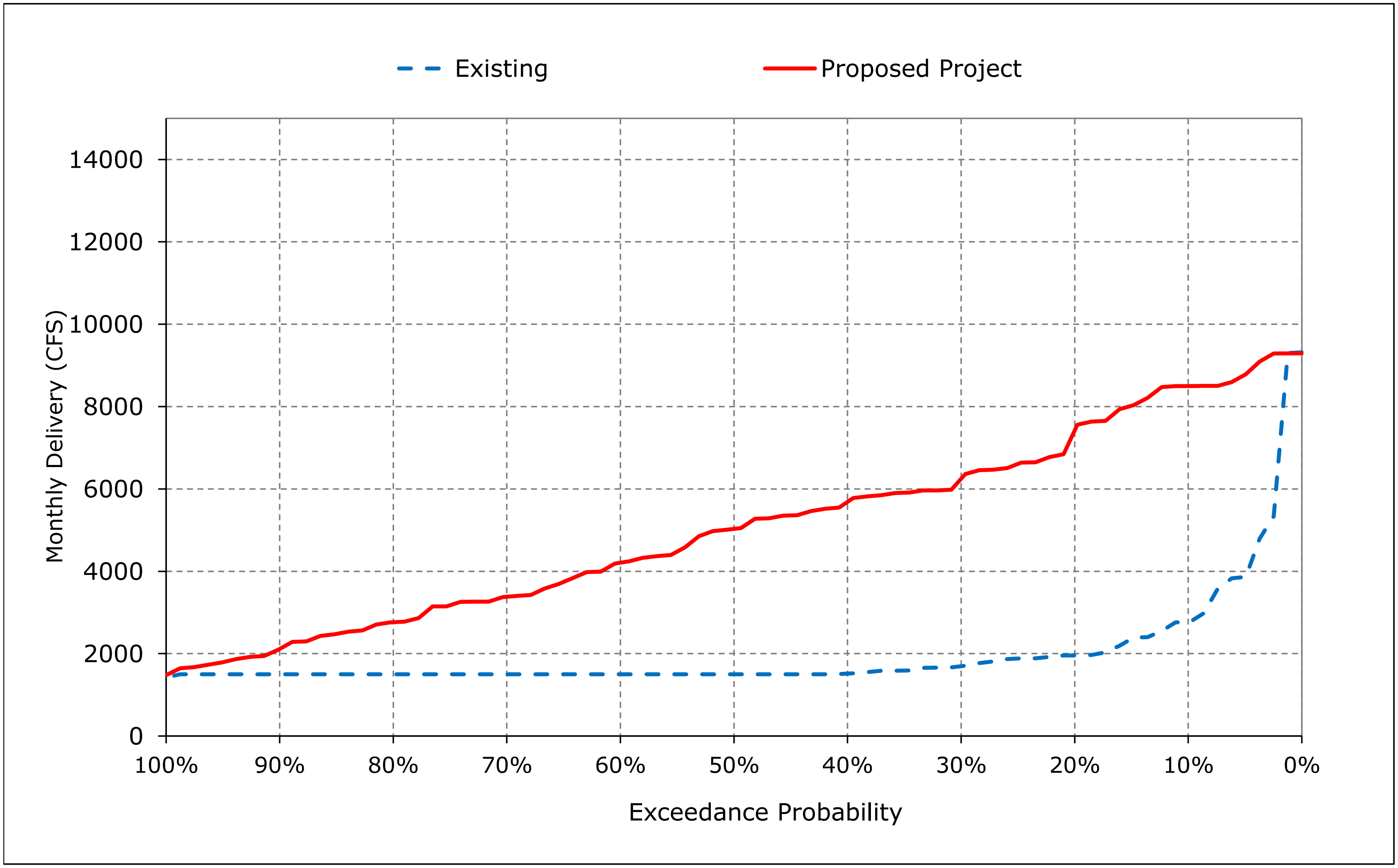


Figure 3-15. Total Delta Exports, June

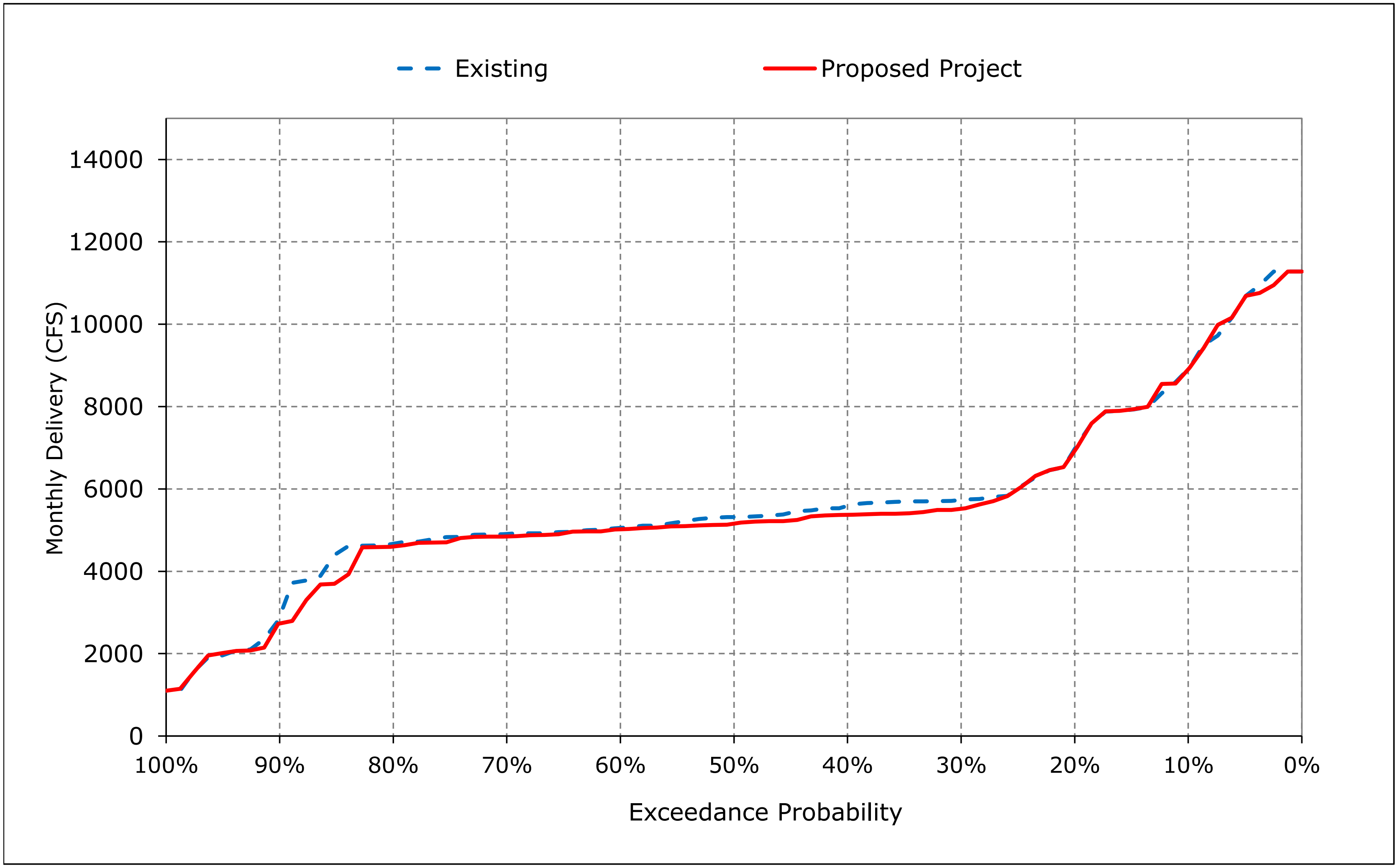


Figure 3-16. Total Delta Exports, July

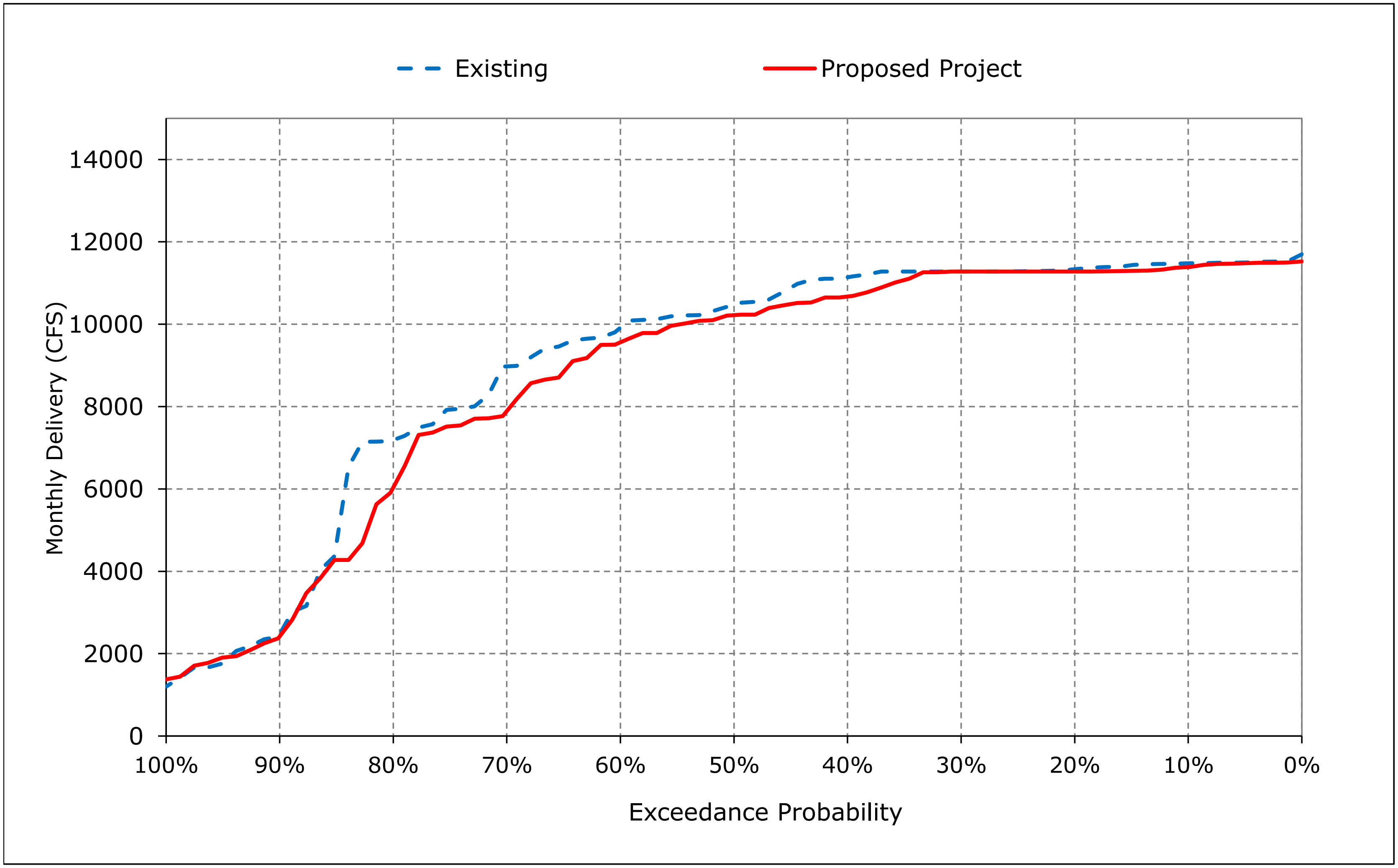


Figure 3-17. Total Delta Exports, August

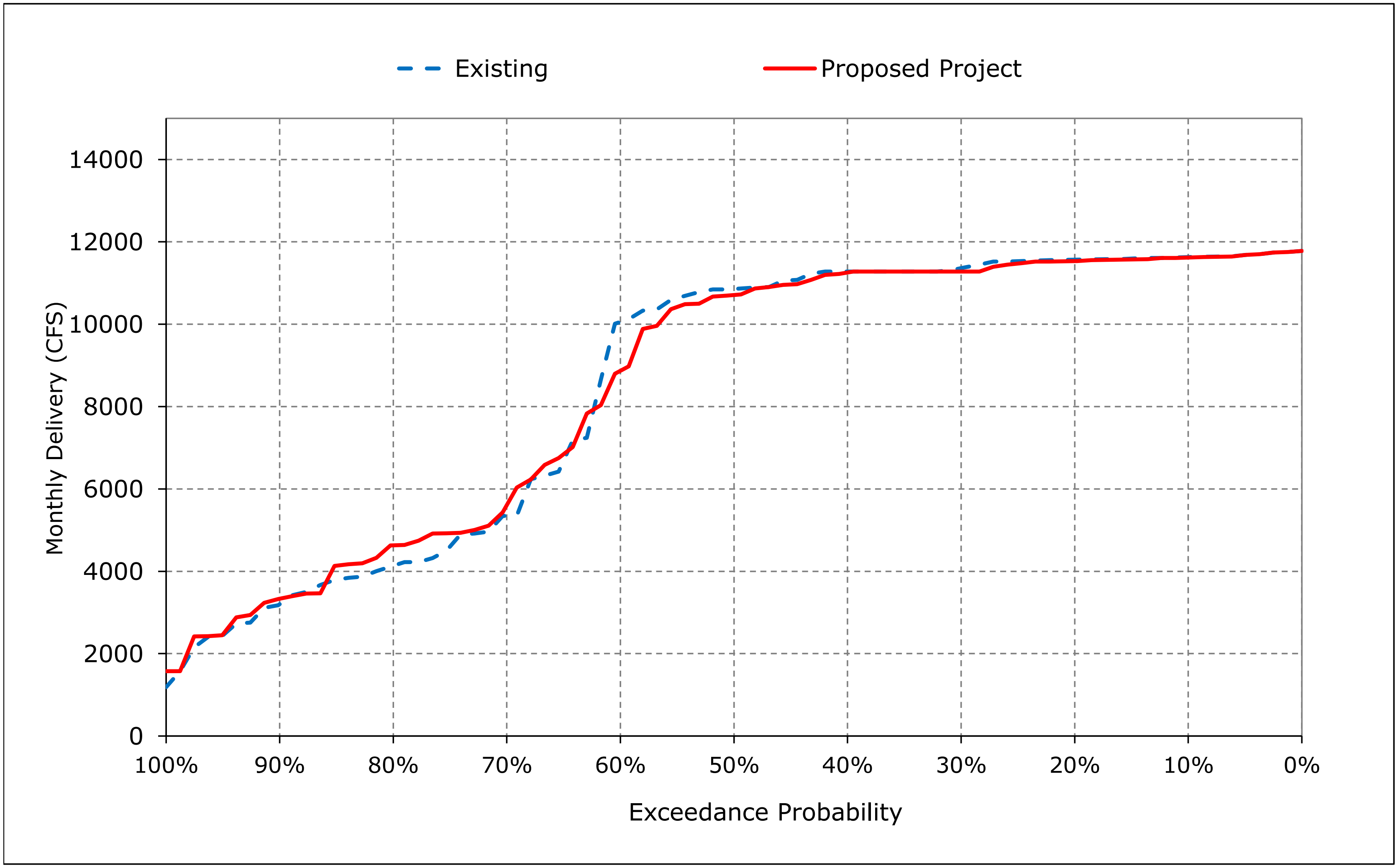


Figure 3-18. Total Delta Exports, September

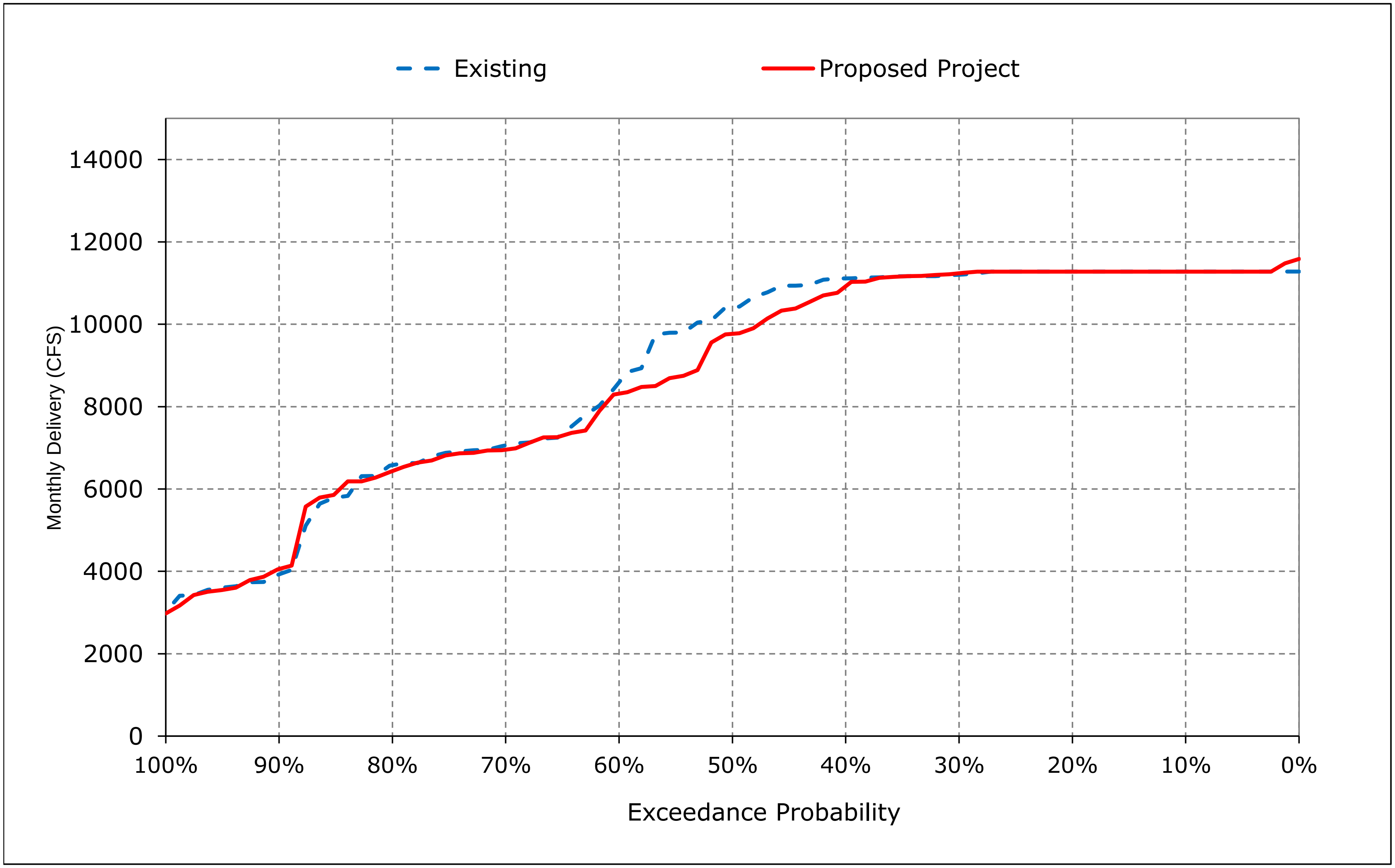


Table 4-1. SWP Banks PP Exports, Monthly Delivery

Existing

Statistic	Monthly Delivery (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	4,953	6,680	7,105	5,846	7,403	8,190	1,330	1,106	4,310	6,680	6,680	6,680
20%	4,110	5,508	7,043	3,432	5,331	5,223	935	766	3,083	6,680	6,680	6,680
30%	3,758	4,523	6,552	2,864	3,916	4,832	787	637	2,325	6,680	6,680	6,680
40%	3,419	3,519	4,565	2,770	3,313	3,773	712	600	2,119	6,680	6,680	6,680
50%	3,163	2,821	4,000	2,707	2,877	2,912	673	600	1,935	6,680	6,680	6,428
60%	2,882	2,225	3,485	2,621	2,689	2,634	606	600	1,848	6,626	6,680	3,197
70%	2,297	1,683	2,960	2,601	2,622	2,386	600	600	1,741	5,788	511	2,574
80%	1,813	1,337	2,774	2,485	2,559	2,249	600	600	1,635	2,943	300	2,416
90%	986	564	2,487	2,204	2,423	1,632	600	526	324	300	300	1,678
Long Term												
Full Simulation Period[a]	3,088	3,243	4,576	3,302	3,900	3,793	873	811	2,335	5,164	4,373	4,622
Water Year Types[b,c]												
Wet (32%)	3,680	4,067	4,520	4,574	5,340	5,783	1,264	1,270	3,555	6,602	6,680	6,617
Above Normal (15%)	3,044	2,865	5,335	3,151	4,114	3,956	706	656	2,482	6,411	6,680	6,680
Below Normal (17%)	3,114	3,394	4,908	2,768	3,839	3,682	672	632	2,049	6,676	6,404	4,657
Dry (22%)	2,775	3,074	4,599	2,692	2,683	2,383	695	628	1,687	4,089	515	2,581
Critical (15%)	2,289	1,911	3,514	2,234	2,464	1,566	692	454	852	650	483	1,264

Proposed Project

Statistic	Monthly Delivery (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	5,791	6,680	7,103	5,534	6,288	6,357	3,972	4,558	4,318	6,680	6,680	6,680
20%	5,062	6,680	7,040	3,861	5,596	4,169	3,189	3,539	3,243	6,680	6,680	6,680
30%	4,490	6,434	5,420	3,185	4,321	3,582	2,859	2,810	2,461	6,680	6,680	6,680
40%	3,961	5,531	4,831	2,914	3,517	3,065	2,523	2,390	2,003	6,680	6,680	6,680
50%	3,644	5,076	3,977	2,837	3,031	2,655	2,305	2,144	1,898	6,675	6,680	5,182
60%	3,095	4,095	3,476	2,748	2,874	2,243	1,999	1,602	1,795	6,239	3,915	3,157
70%	2,412	3,577	2,960	2,642	2,634	2,029	1,714	1,405	1,738	5,121	997	2,620
80%	1,933	2,899	2,817	2,526	2,518	1,821	1,453	904	1,644	1,395	300	2,455
90%	1,009	2,133	2,574	2,216	2,371	1,623	1,078	451	300	300	300	1,820
Long Term												
Full Simulation Period[a]	3,518	4,684	4,517	3,355	3,946	3,218	2,353	2,225	2,295	4,957	4,237	4,484
Water Year Types[b,c]												
Wet (32%)	4,245	5,995	4,558	4,352	5,403	4,945	3,241	3,393	3,449	6,490	6,382	6,318
Above Normal (15%)	3,646	4,424	5,264	3,184	3,934	3,092	2,669	2,702	2,477	6,473	6,378	6,555
Below Normal (17%)	3,483	4,784	4,900	2,946	3,974	3,046	2,515	2,221	2,023	6,175	6,050	4,372
Dry (22%)	3,100	4,043	4,759	2,931	2,801	1,965	1,636	1,334	1,666	3,537	694	2,599
Critical (15%)	2,484	2,949	2,870	2,480	2,486	1,678	999	559	870	831	646	1,400

Proposed Project minus Existing

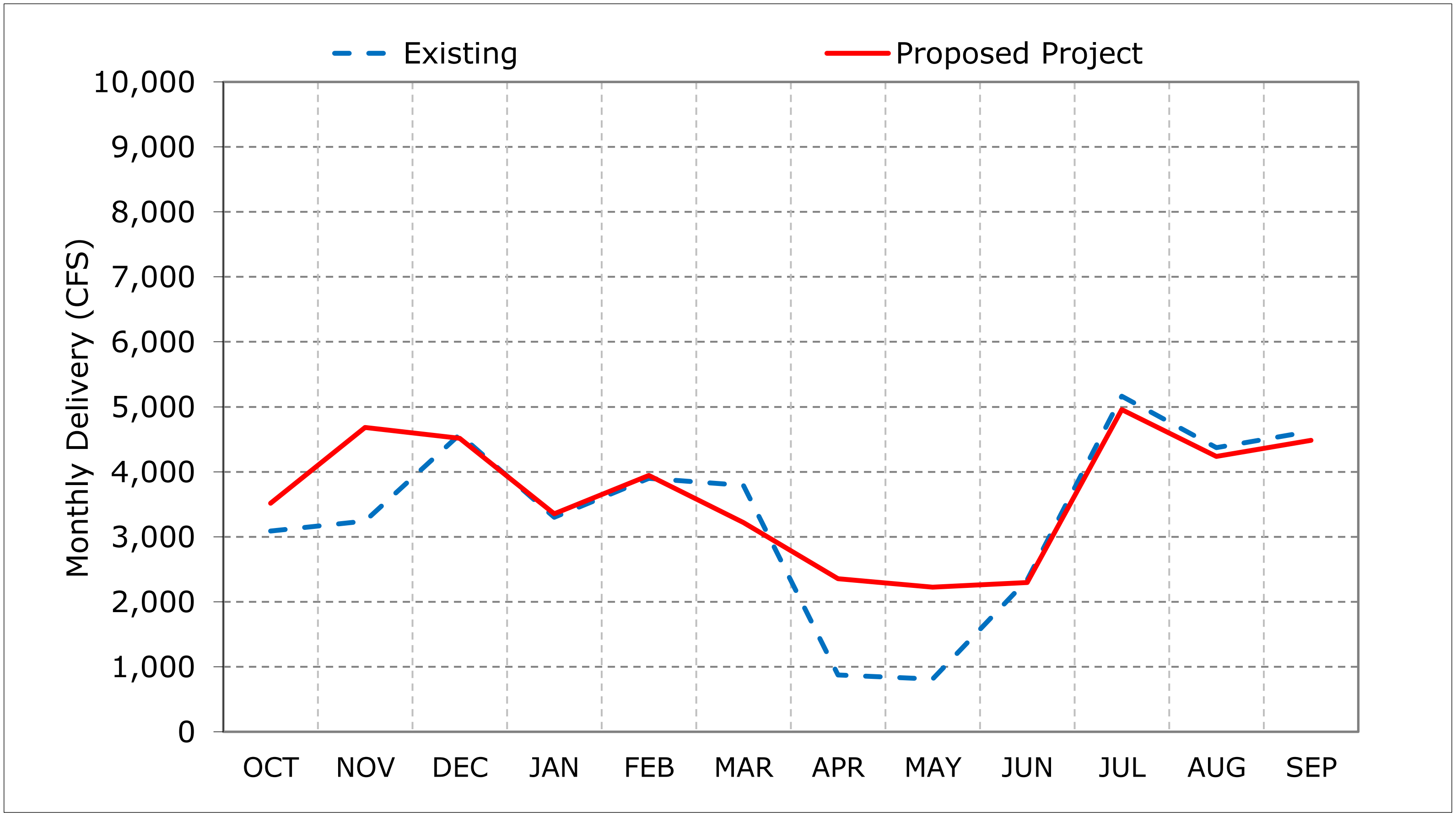
Statistic	Monthly Delivery (CFS)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	838	0	**-1**	**-312**	**-1,115**	**-1,834**	2,642	3,452	8	0	0	0
20%	952	1,172	**-3**	429	265	**-1,054**	2,254	2,773	161	0	0	0
30%	732	1,910	**-1,132**	321	405	**-1,250**	2,072	2,173	137	0	0	0
40%	542	2,013	266	144	204	**-707**	1,810	1,790	**-115**	0	0	0
50%	480	2,255	**-23**	130	154	**-257**	1,632	1,544	**-37**	**-5**	0	**-1,245**
60%	213	1,870	**-9**	126	185	**-391**	1,393	1,002	**-53**	**-387**	**-2,765**	**-40**
70%	115	1,894	0	41	11	**-356**	1,114	805	**-3**	**-667**	486	46
80%	120	1,562	43	42	**-42**	**-429**	853	304	9	**-1,547**	0	38
90%	23	1,569	88	12	**-52**	**-9**	478	**-76**	**-24**	0	0	141
Long Term												
Full Simulation Period[a]	430	1,442	**-59**	53	46	**-576**	1,480	1,414	**-41**	**-207**	**-136**	**-138**
Water Year Types[b,c]												
Wet (32%)	565	1,929	38	**-222**	63	**-837**	1,977	2,123	**-106**	**-111**	**-298**	**-300**
Above Normal (15%)	601	1,559	**-71**	33	**-180**	**-864**	1,963	2,046	**-5**	62	**-302**	**-125**
Below Normal (17%)	369	1,390	**-9**	178	135	**-636**	1,844	1,590	**-25**	**-501**	**-355**	**-285**
Dry (22%)	326	969	160	239	118	**-419**	941	706	**-21**	**-552**	179	17
Critical (15%)	195	1,039	**-644**	246	23	112	306	105	18	181	164	136

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

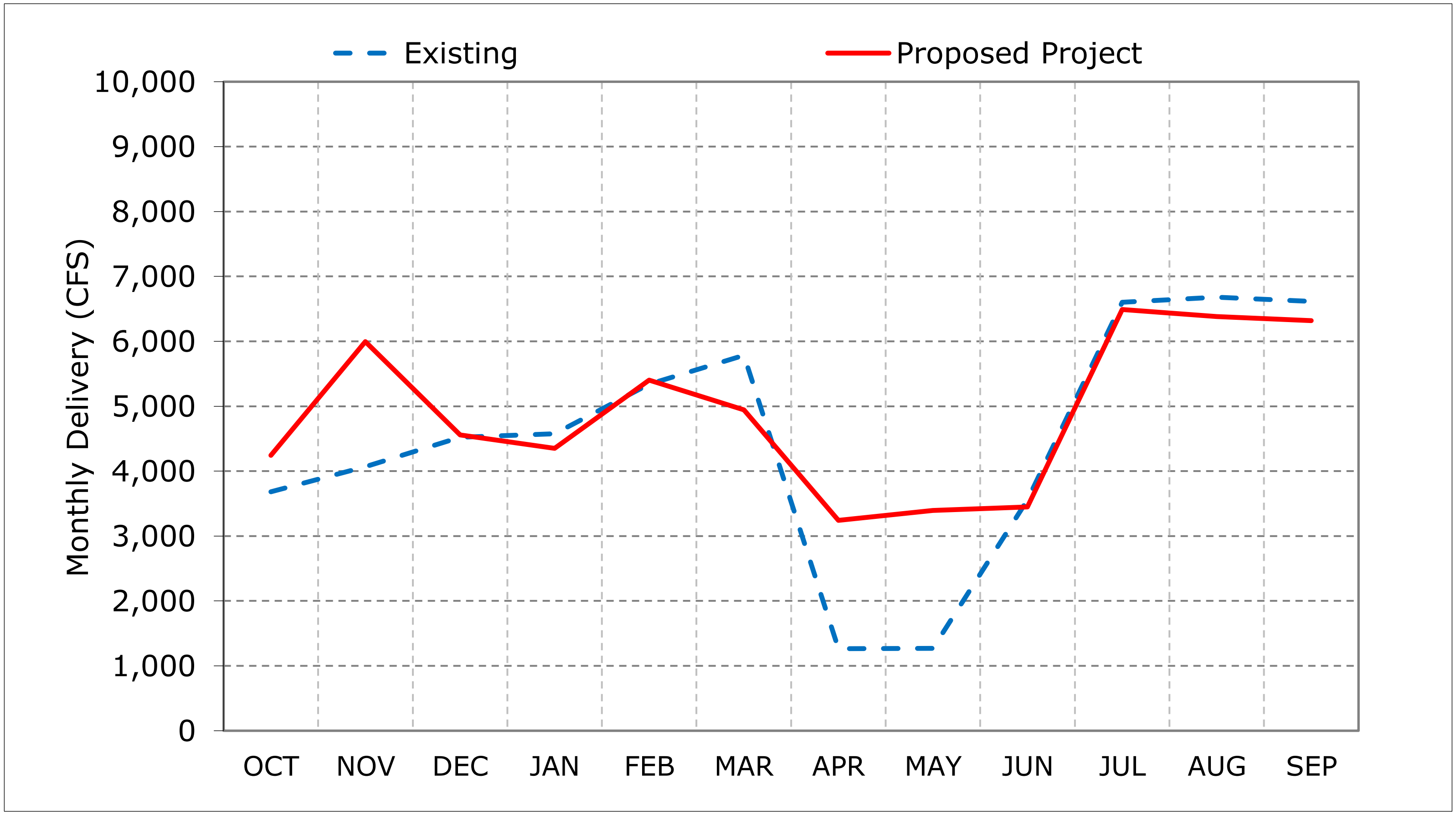
c These results are displayed with water year - year type sorting.

Figure 4-1. SWP Banks PP Exports, Long-Term Average Delivery



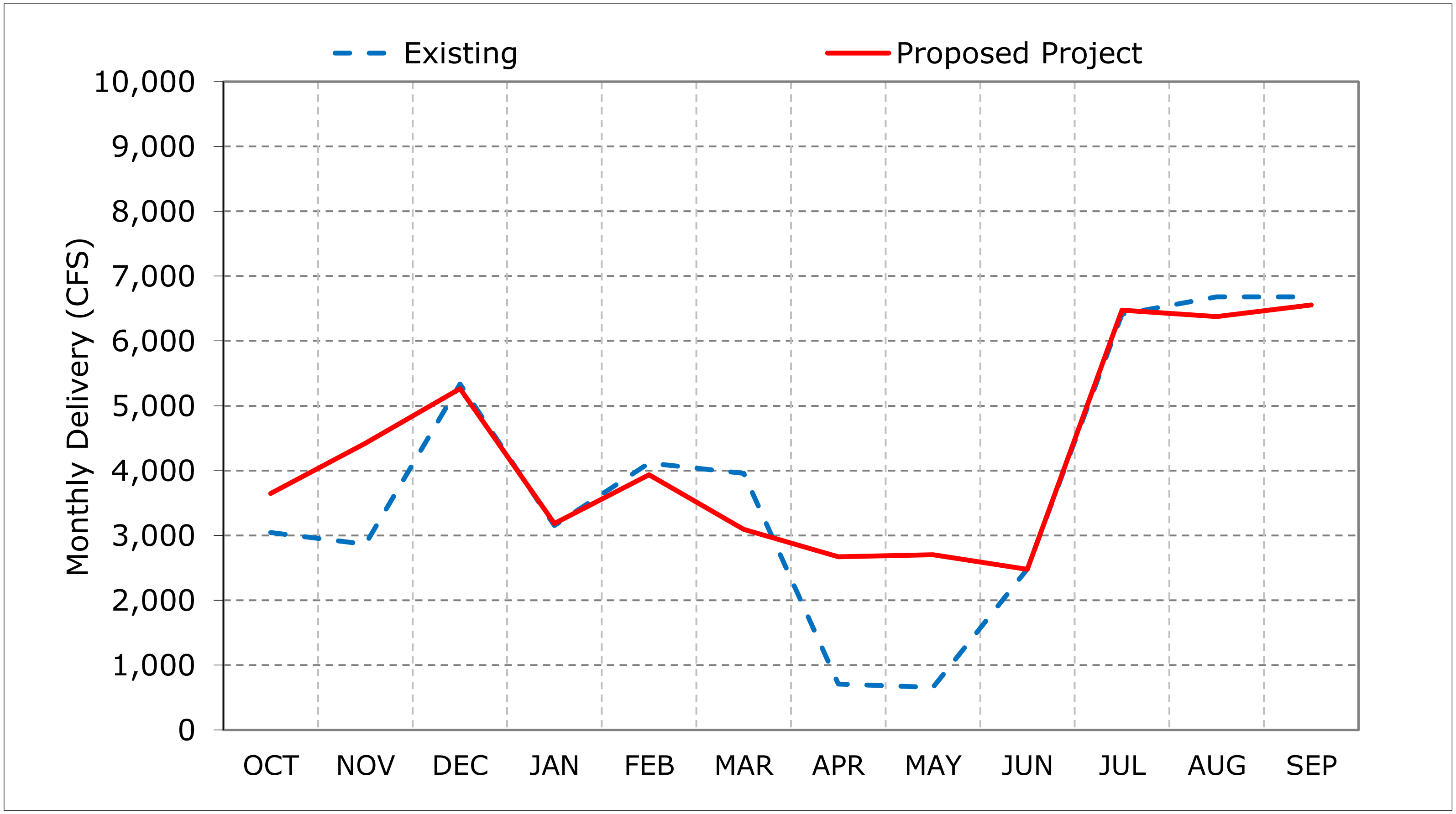
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 4-2. SWP Banks PP Exports, Wet Year Average Delivery



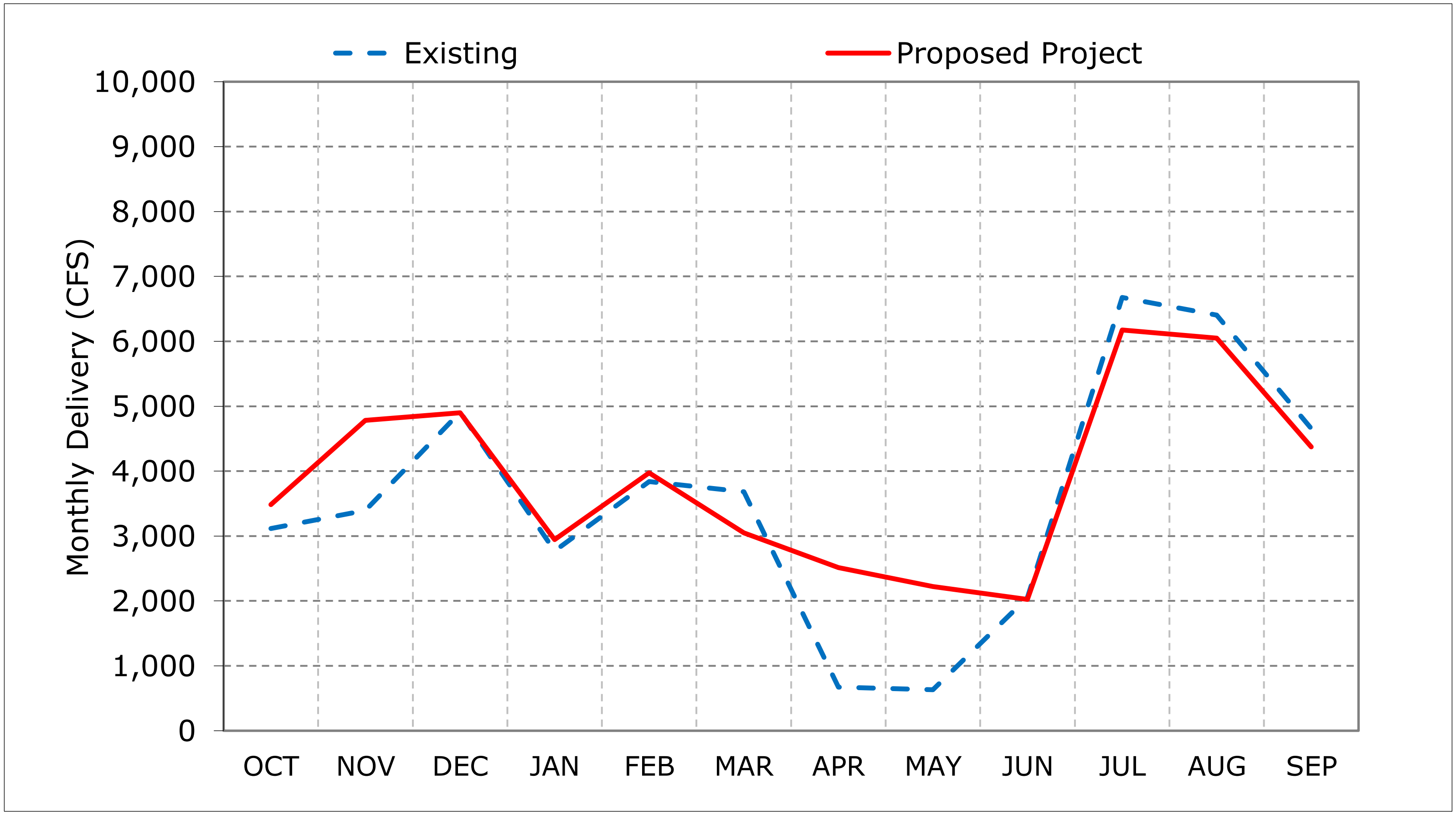
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 4-3. SWP Banks PP Exports, Above Normal Year Average Delivery



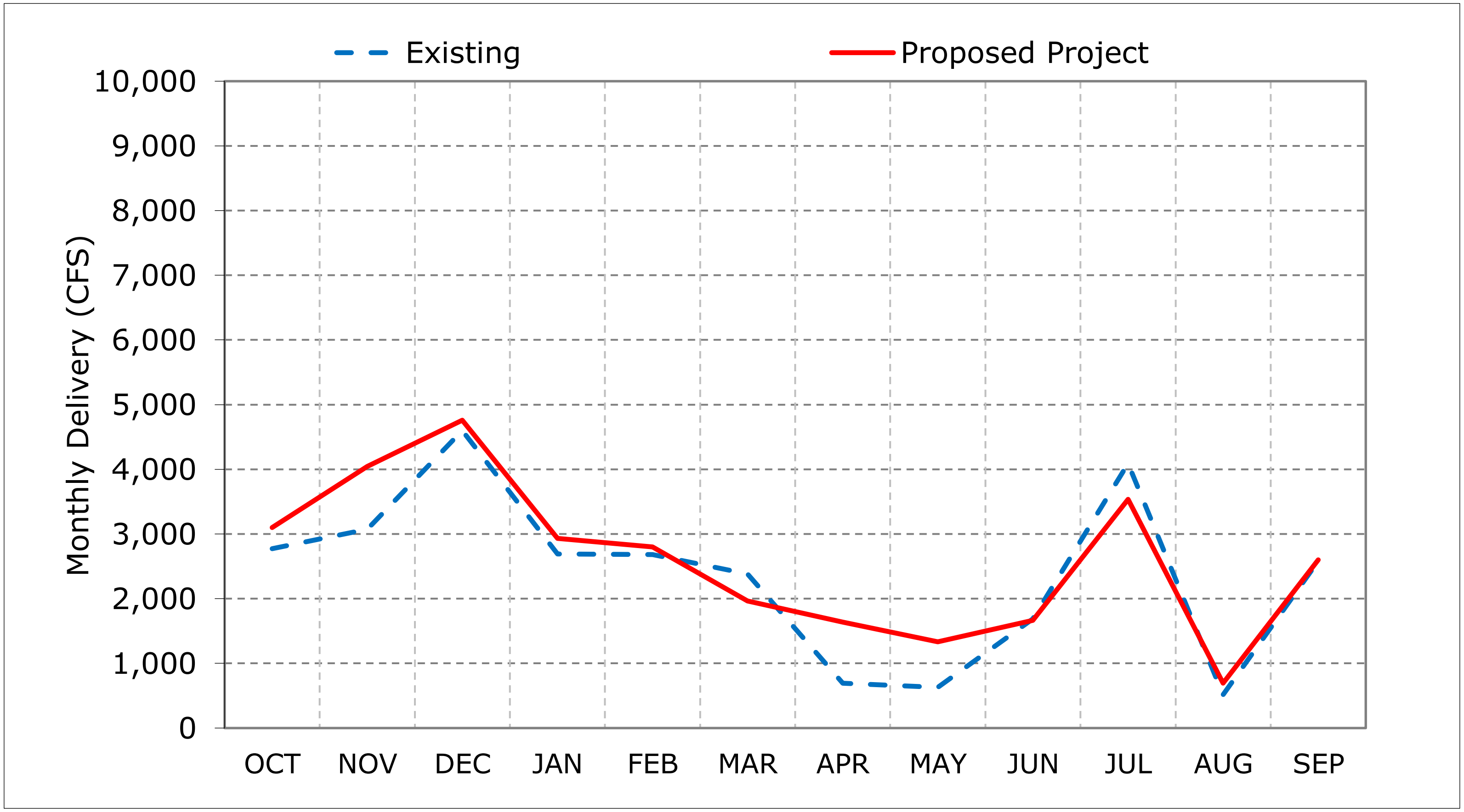
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 4-4. SWP Banks PP Exports, Below Normal Year Average Delivery



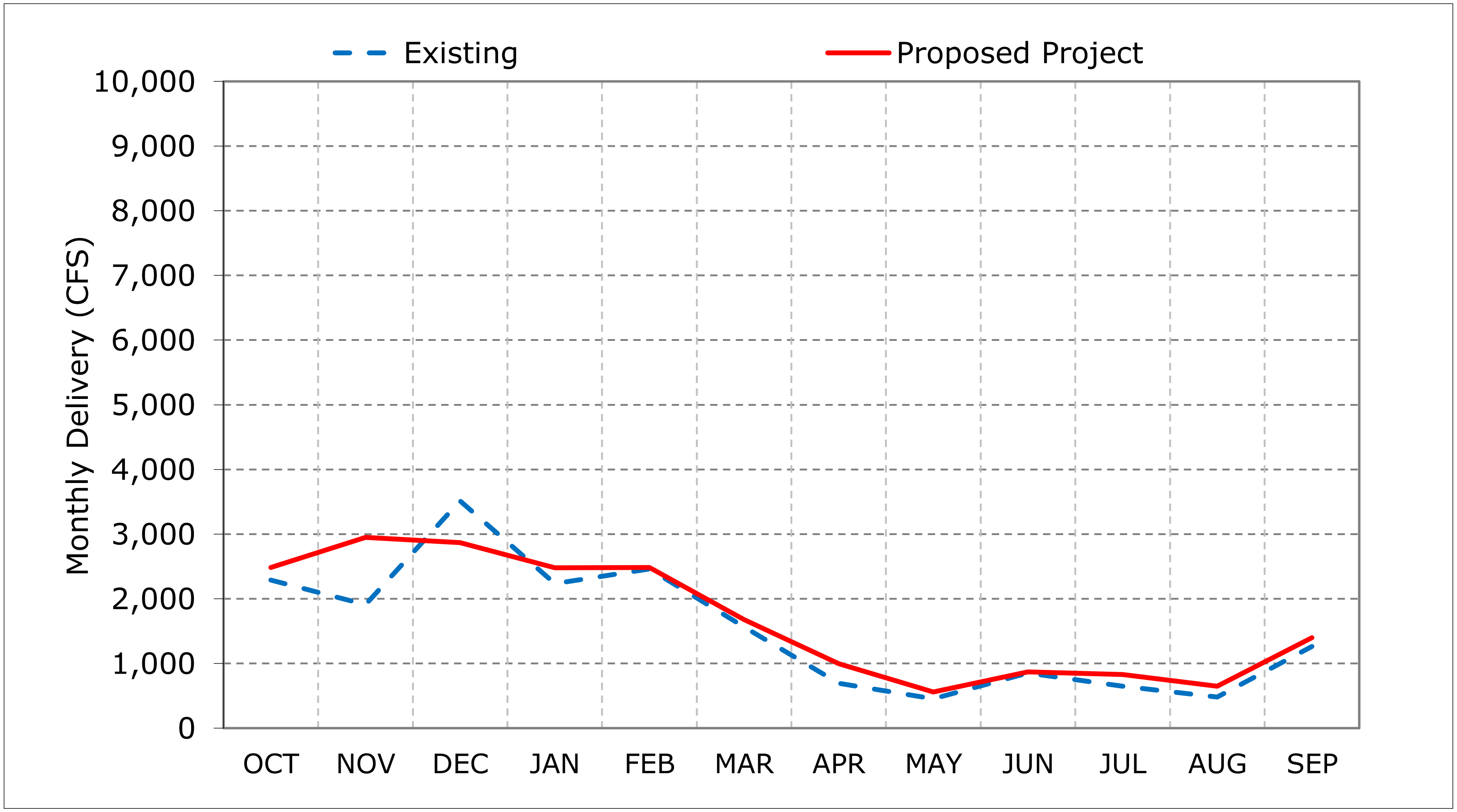
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 4-5. SWP Banks PP Exports, Dry Year Average Delivery



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 4-6. SWP Banks PP Exports, Critical Year Average Delivery



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 4-7. SWP Banks PP Exports, October

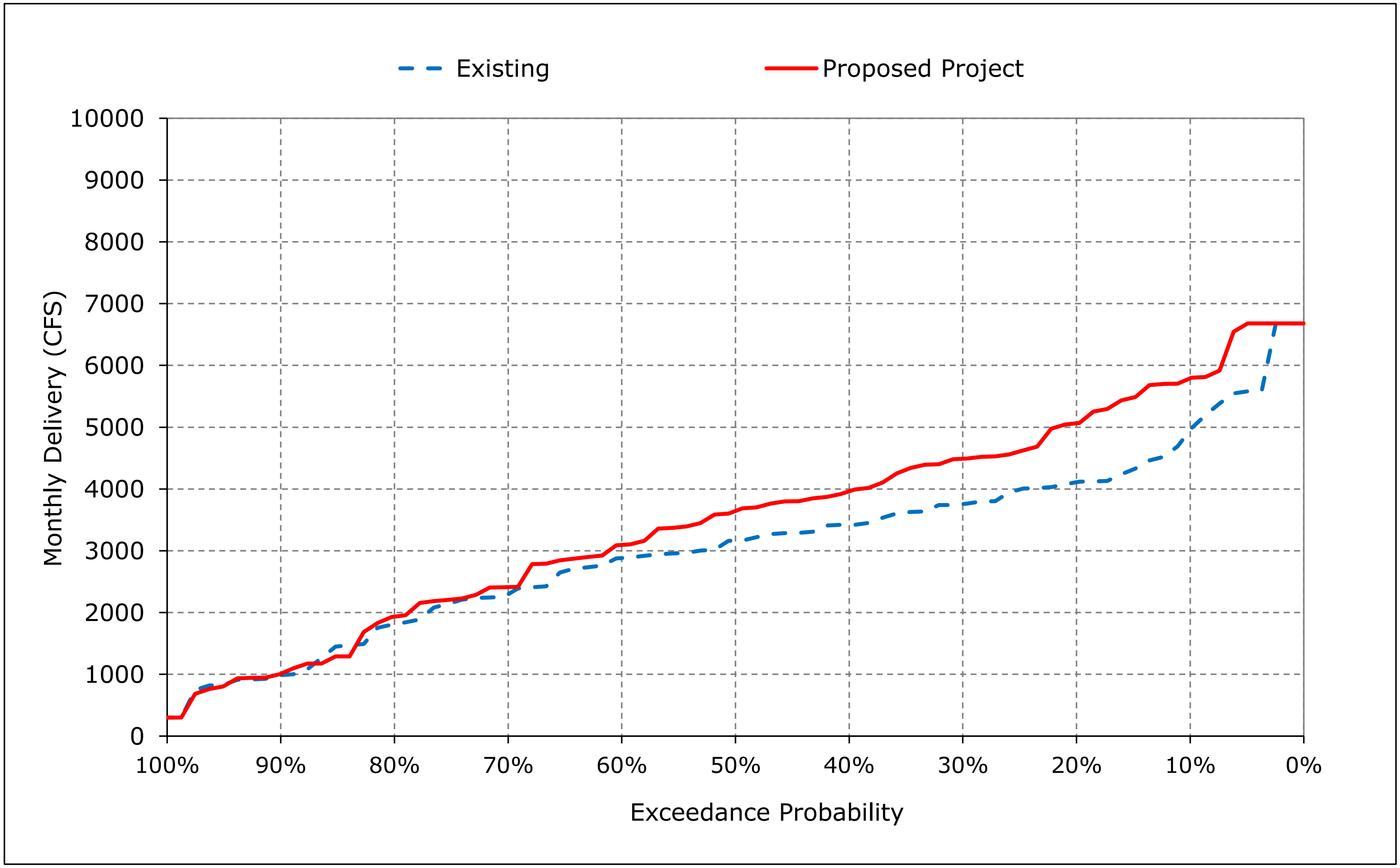


Figure 4-8. SWP Banks PP Exports, November

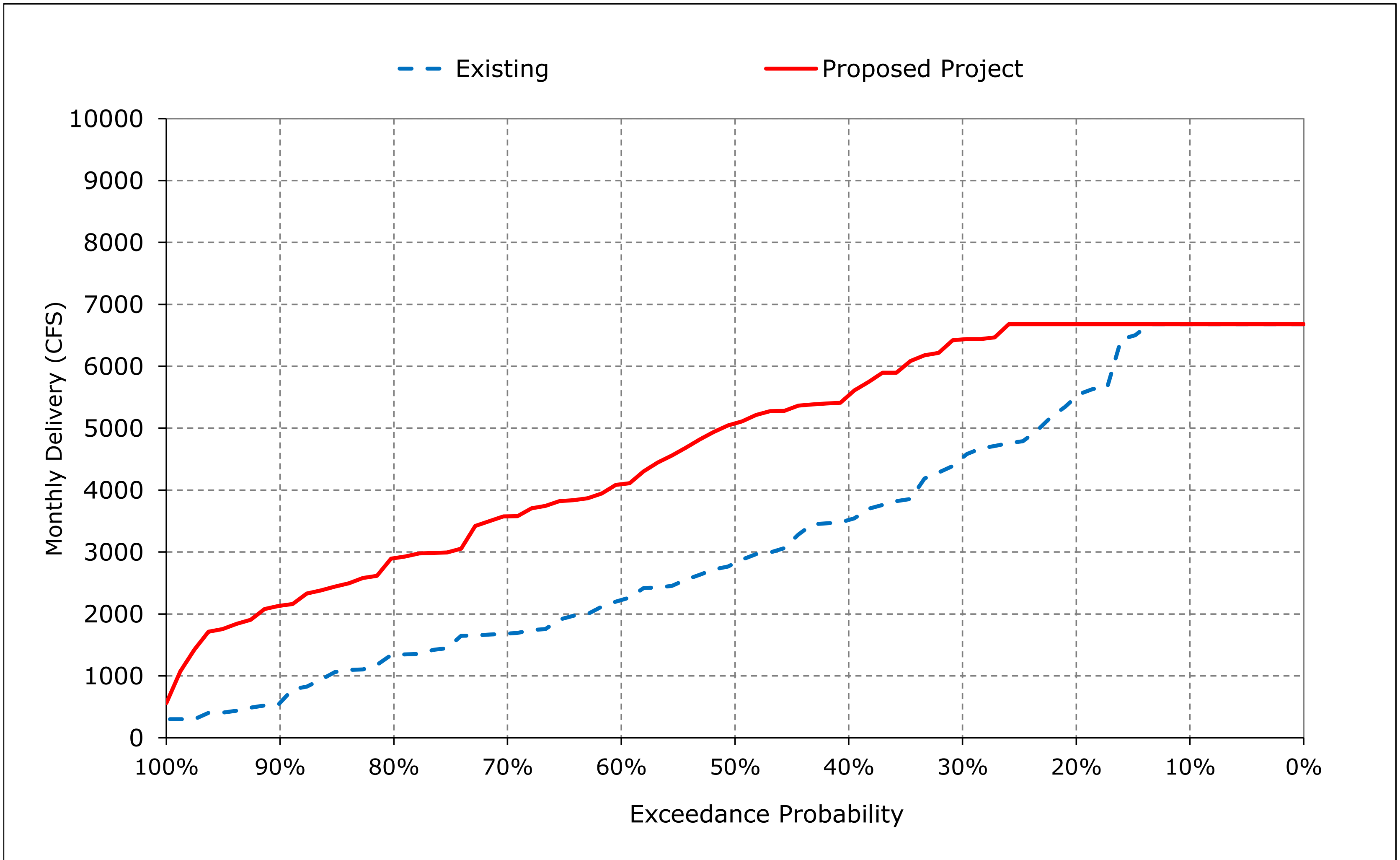


Figure 4-9. SWP Banks PP Exports, December

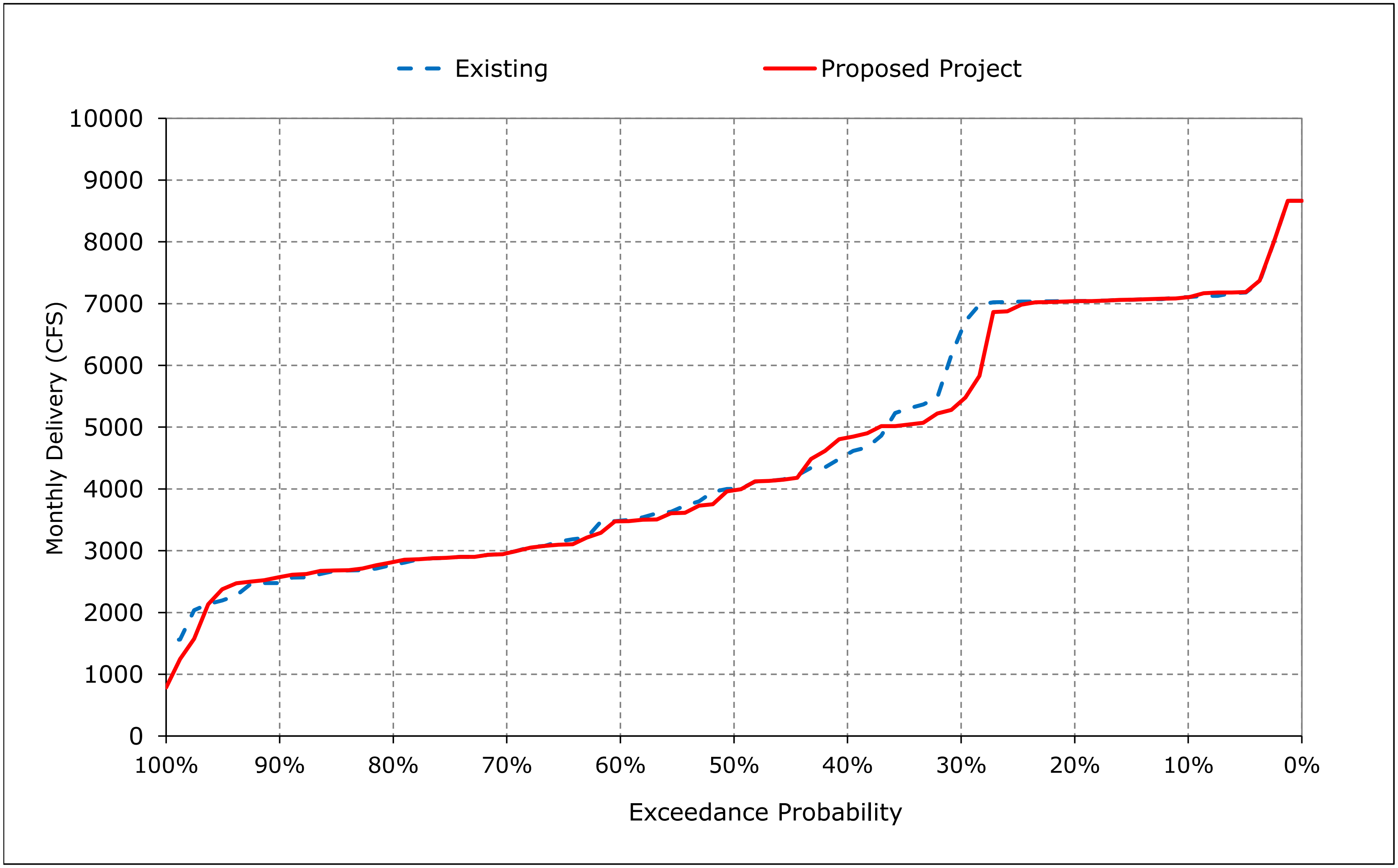


Figure 4-10. SWP Banks PP Exports, January

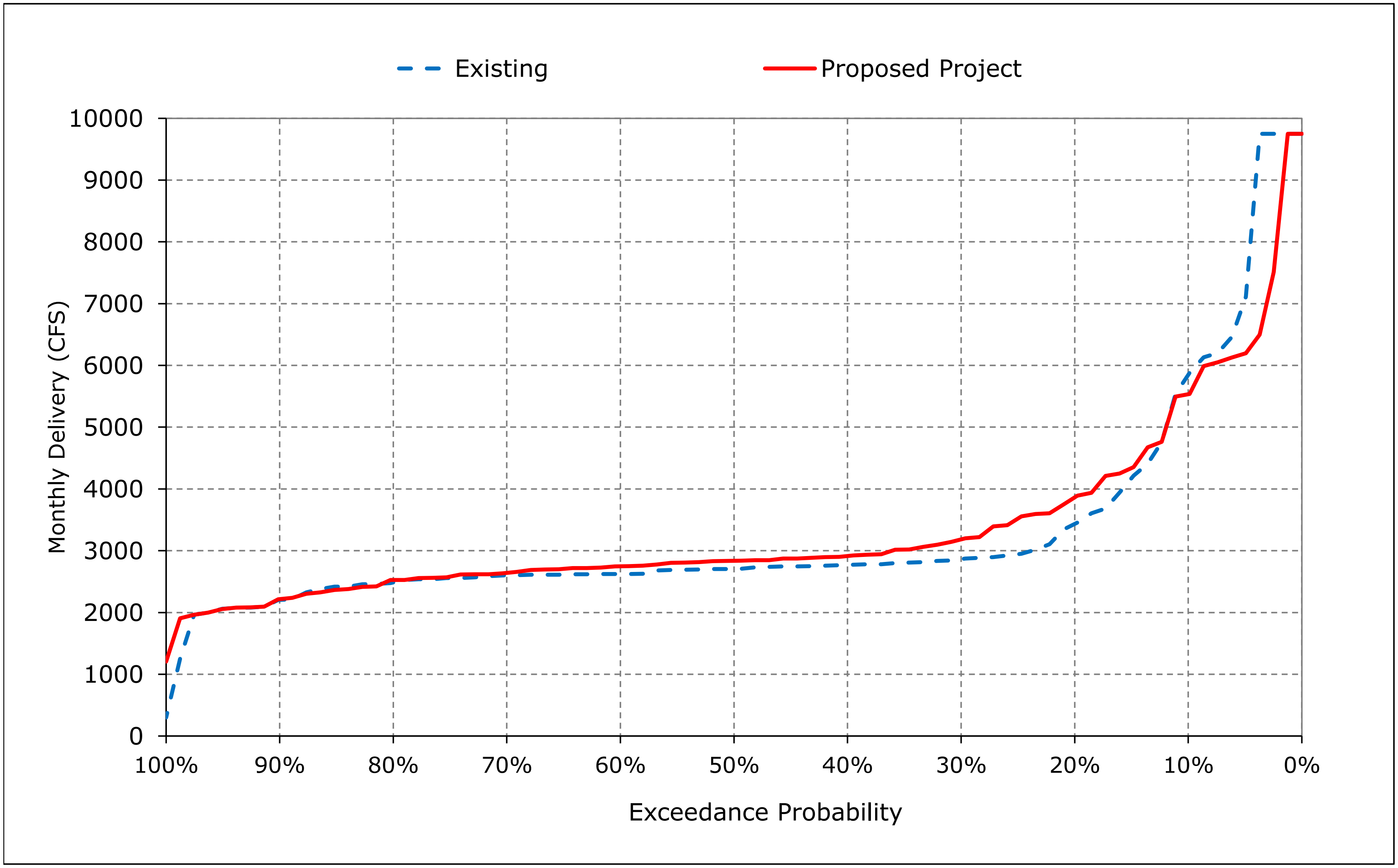


Figure 4-11. SWP Banks PP Exports, February

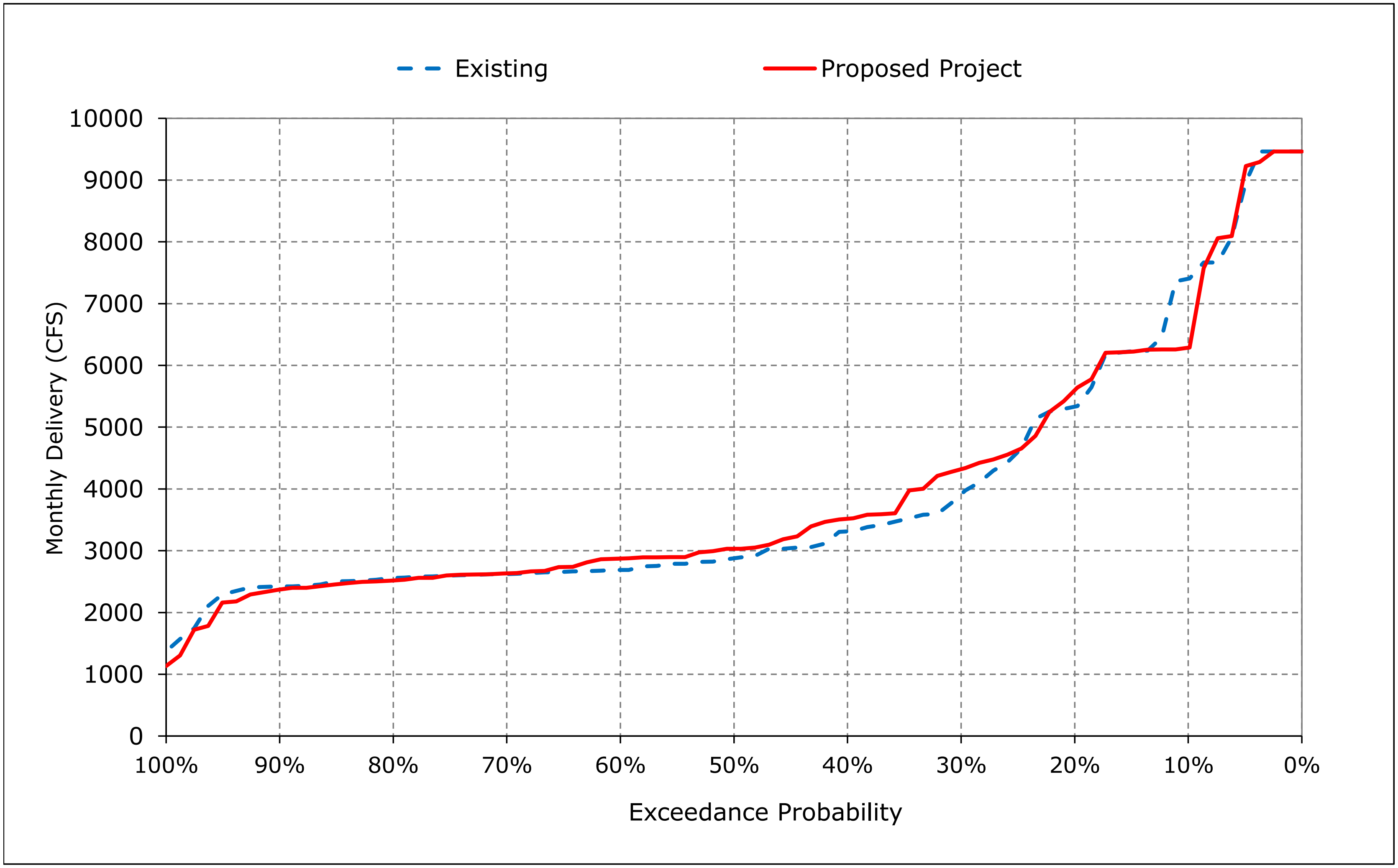


Figure 4-12. SWP Banks PP Exports, March

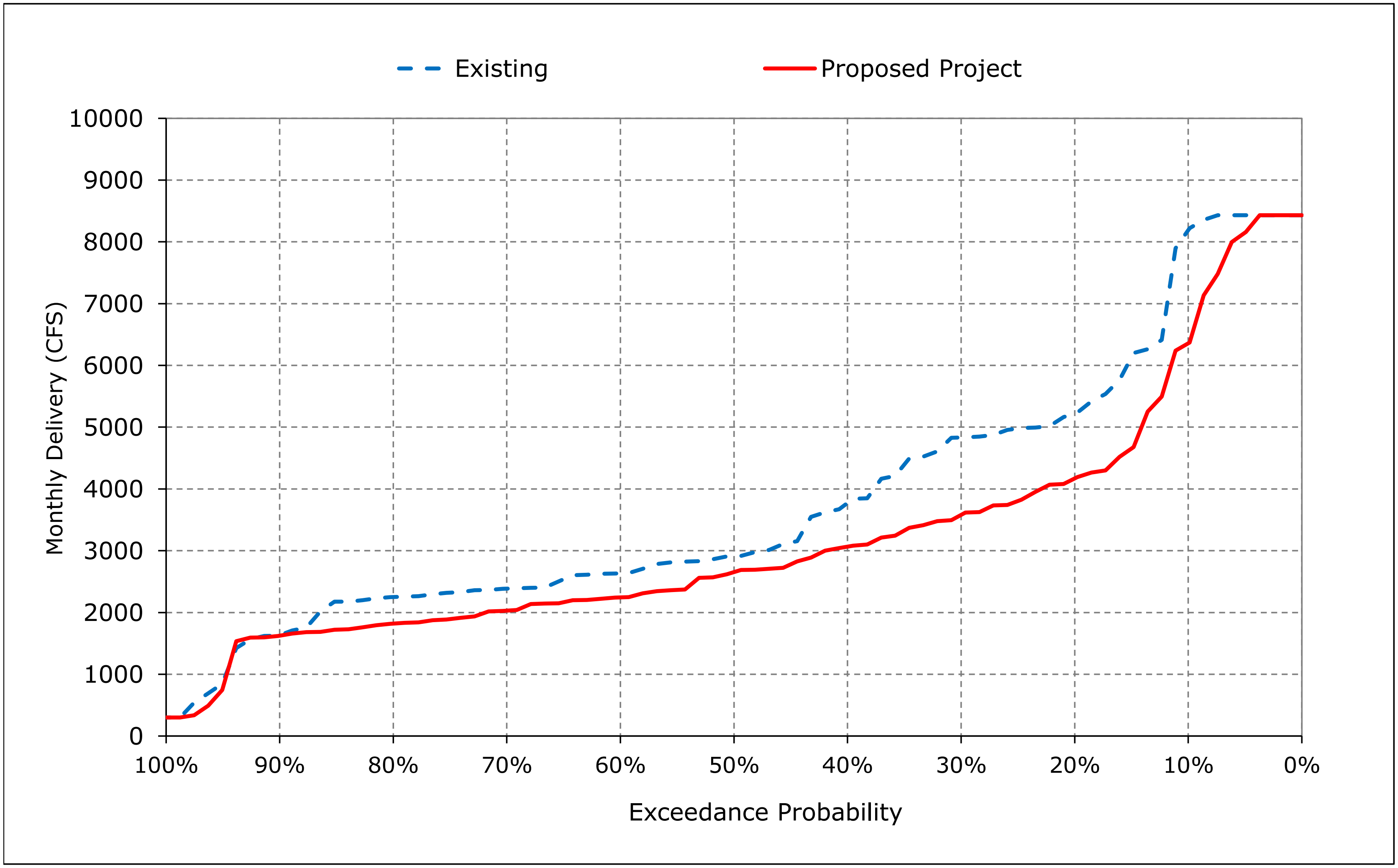


Figure 4-13. SWP Banks PP Exports, April

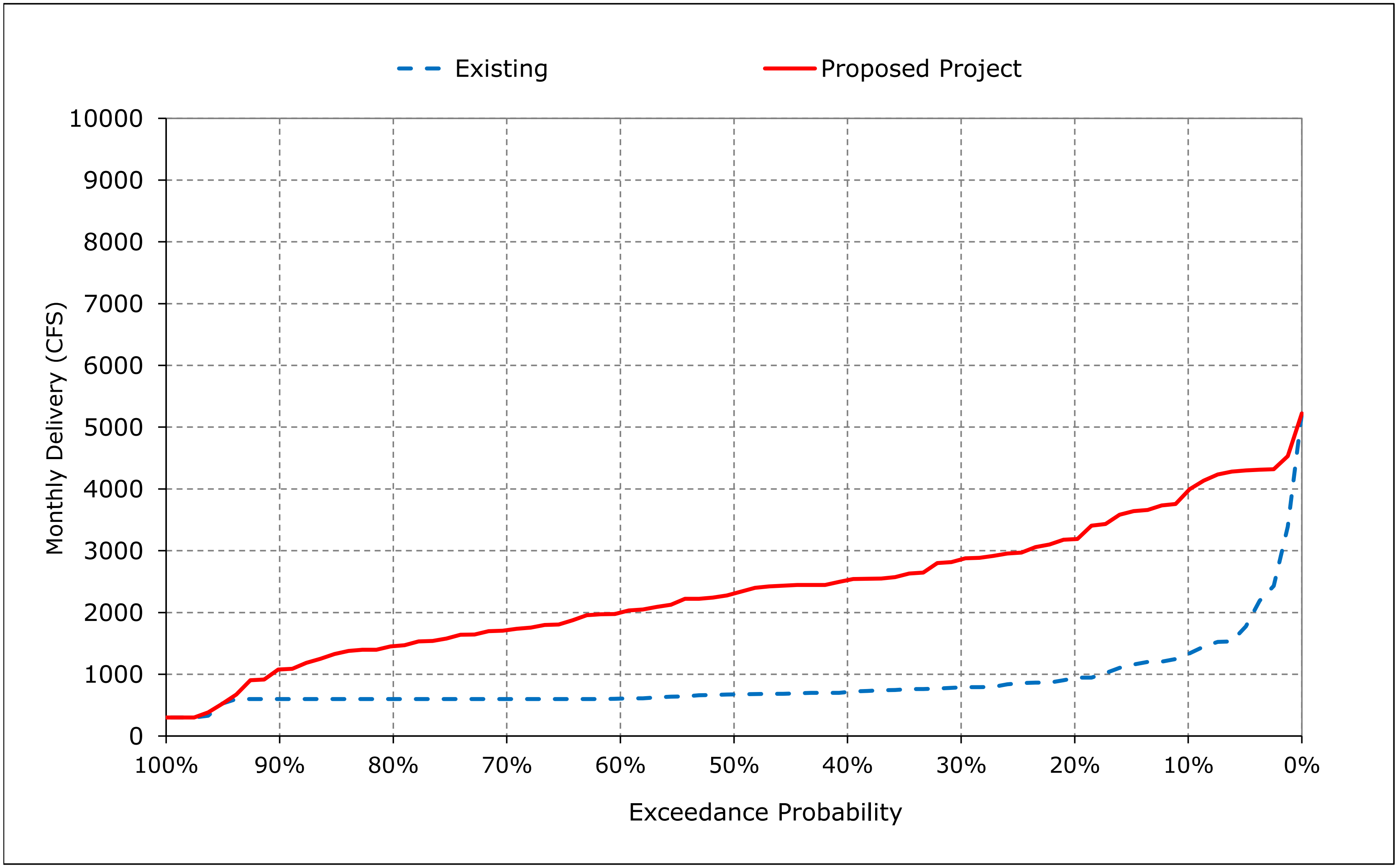


Figure 4-14. SWP Banks PP Exports, May

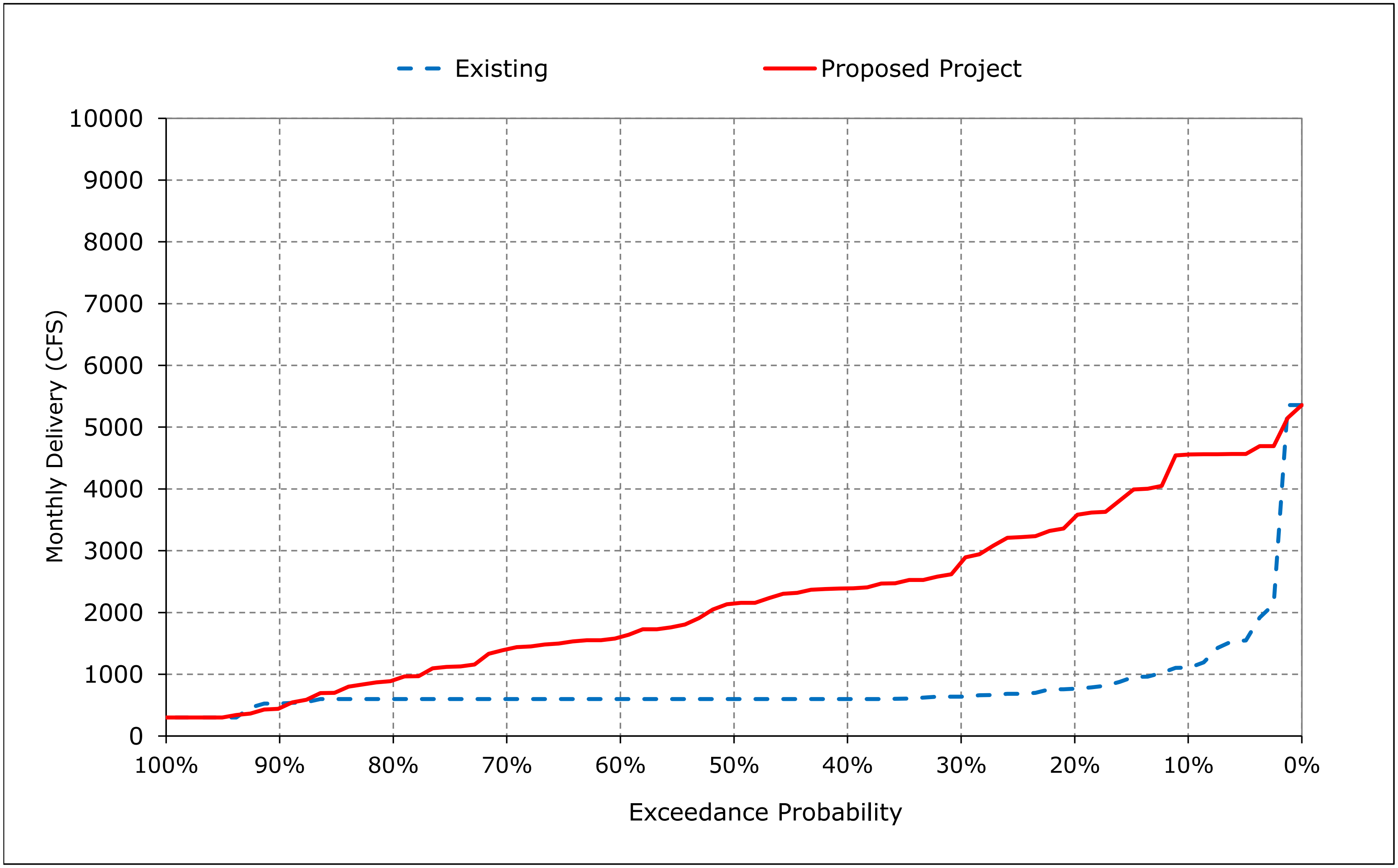


Figure 4-15. SWP Banks PP Exports, June

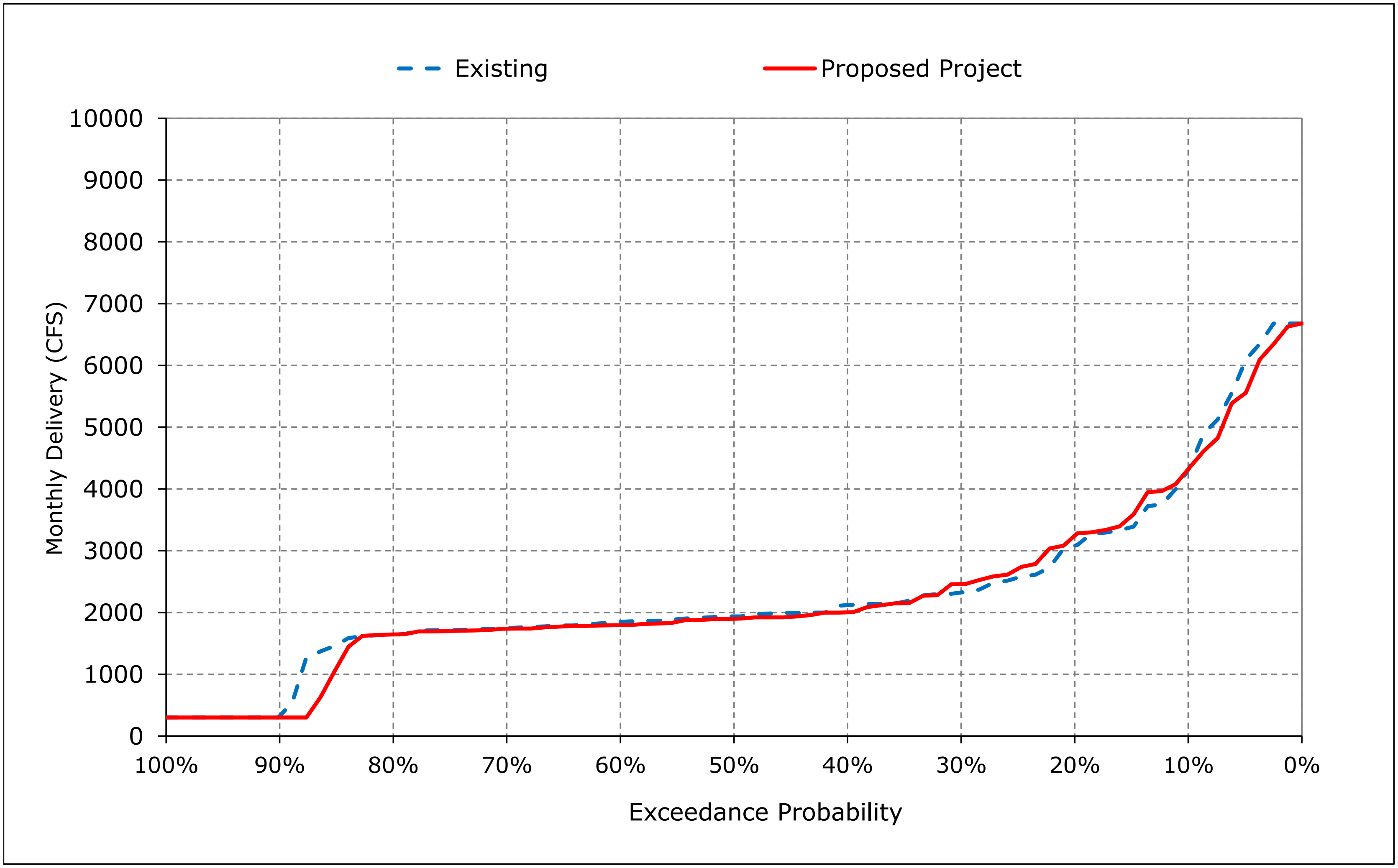


Figure 4-16. SWP Banks PP Exports, July

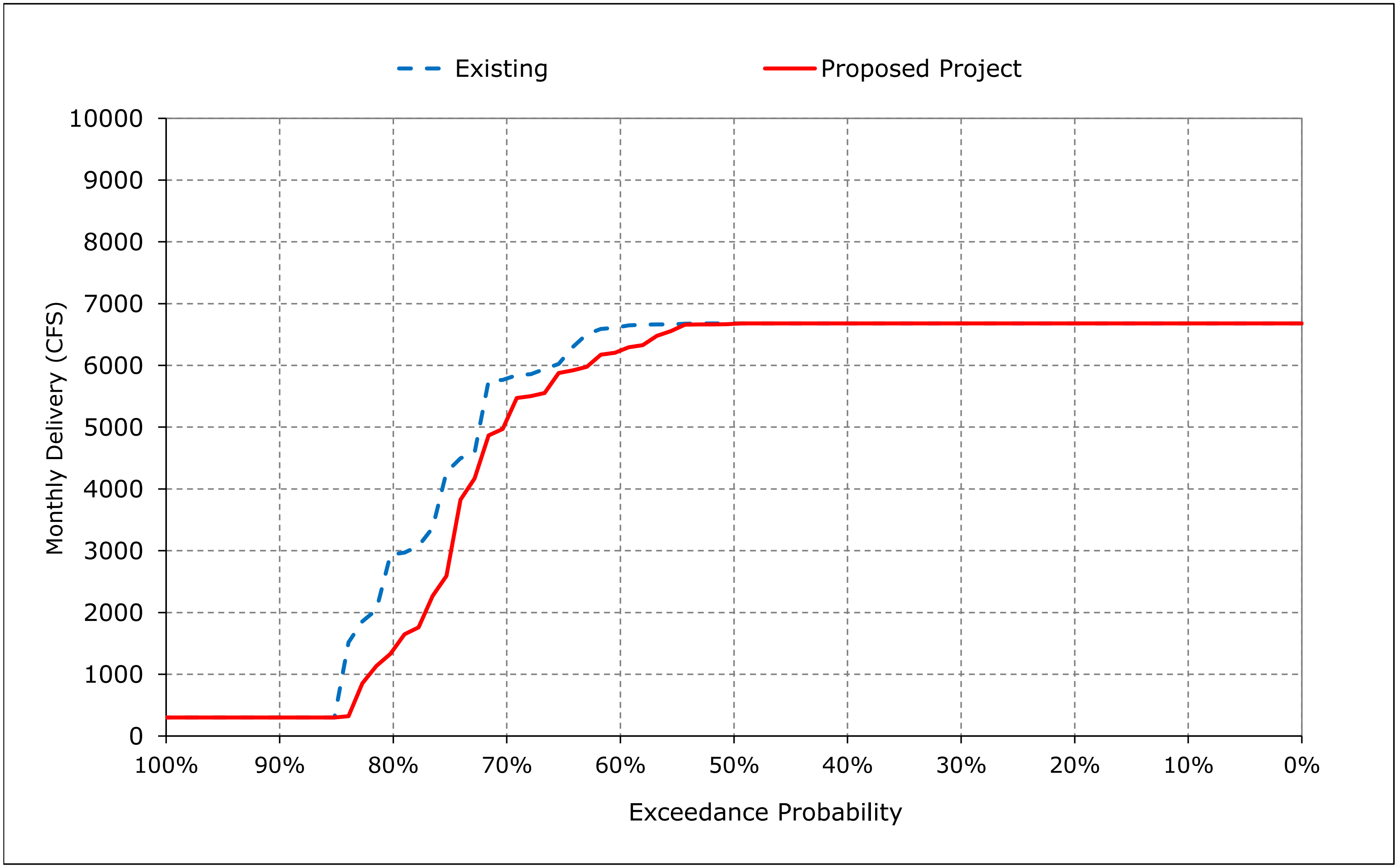


Figure 4-17. SWP Banks PP Exports, August

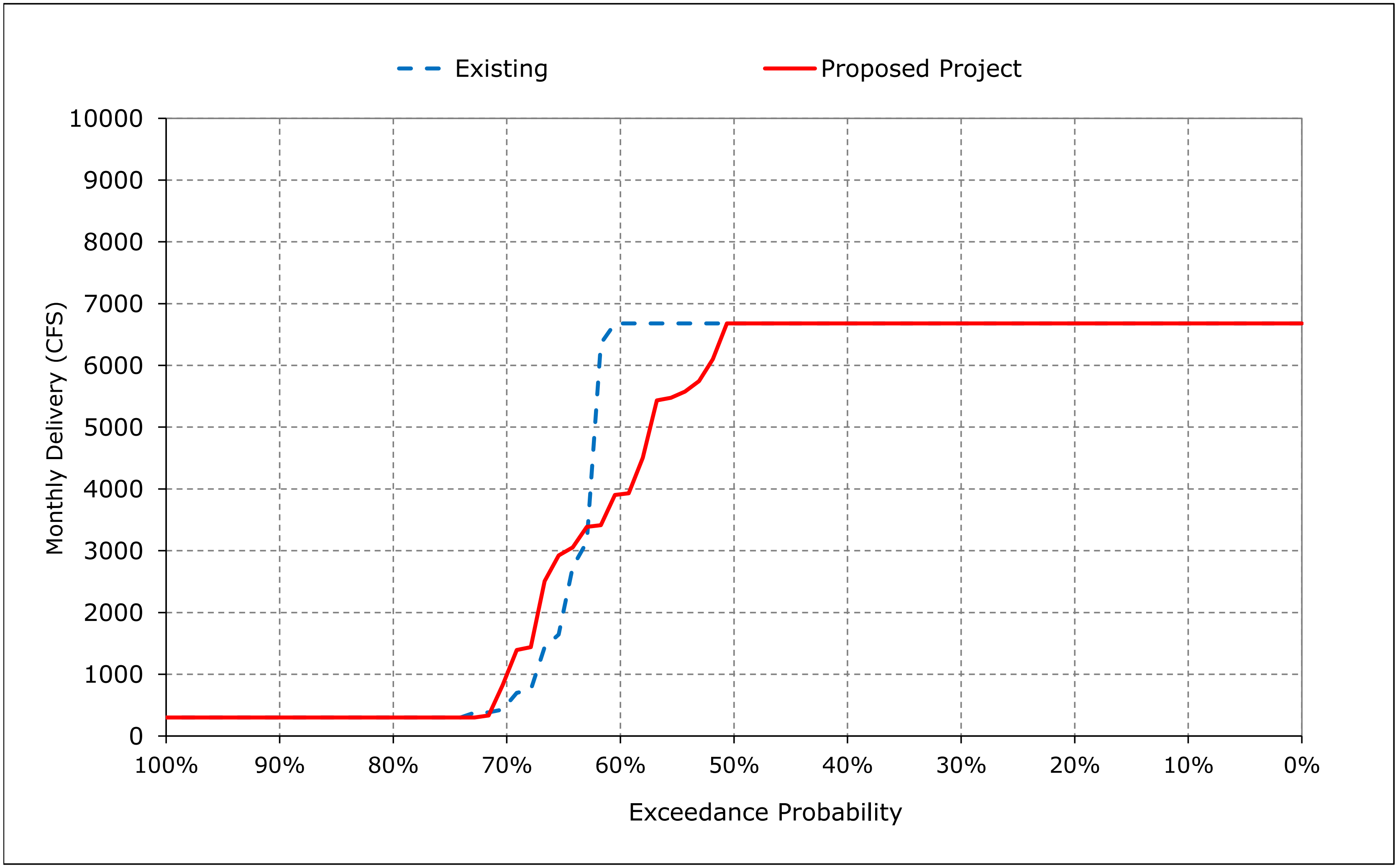


Figure 4-18. SWP Banks PP Exports, September

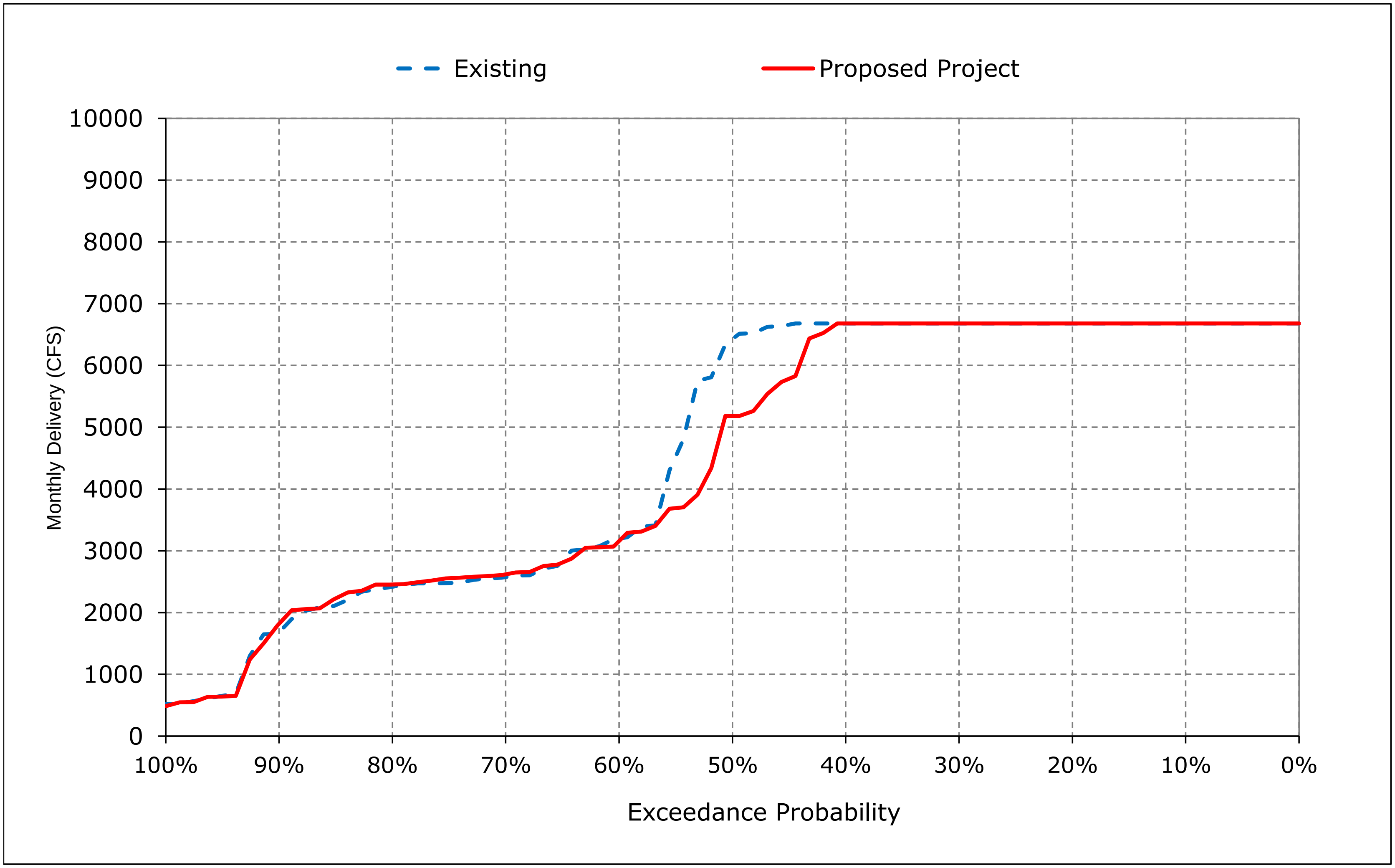


Table 5-1. CVP Banks PP Exports, Monthly Delivery

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Delivery (CFS)											
Probability of Exceedance												
10%	0	1,875	0	0	0	0	0	0	0	915	293	0
20%	0	1,705	0	0	0	0	0	0	0	622	0	0
30%	0	1,454	0	0	0	0	0	0	0	76	0	0
40%	0	163	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0
60%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
80%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
Long Term												
Full Simulation Period[a]	69	660	19	0	41	10	0	0	0	224	95	103
Water Year Types[b,c]												
Wet (32%)	8	715	21	0	73	0	0	0	0	33	0	0
Above Normal (15%)	74	740	0	0	73	0	0	0	0	0	0	0
Below Normal (17%)	84	759	0	0	41	0	0	0	0	1	107	602
Dry (22%)	113	647	0	0	0	44	0	0	0	632	347	0
Critical (15%)	111	361	85	0	0	0	0	0	0	513	1	0

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Delivery (CFS)											
Probability of Exceedance												
10%	0	1,297	211	0	0	0	0	0	0	1,074	975	14
20%	0	745	0	0	0	0	0	0	0	692	35	0
30%	0	91	0	0	0	0	0	0	0	235	0	0
40%	0	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0
60%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
80%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
Long Term												
Full Simulation Period[a]	74	322	134	0	60	15	0	0	20	276	212	114
Water Year Types[b,c]												
Wet (32%)	33	258	0	0	140	49	0	0	62	70	256	0
Above Normal (15%)	99	384	175	0	62	0	0	0	0	0	166	0
Below Normal (17%)	102	394	154	0	39	0	0	0	0	142	160	652
Dry (22%)	145	269	160	0	0	0	0	0	0	707	319	13
Critical (15%)	0	390	318	0	0	0	0	0	0	508	60	0

Proposed Project minus Existing

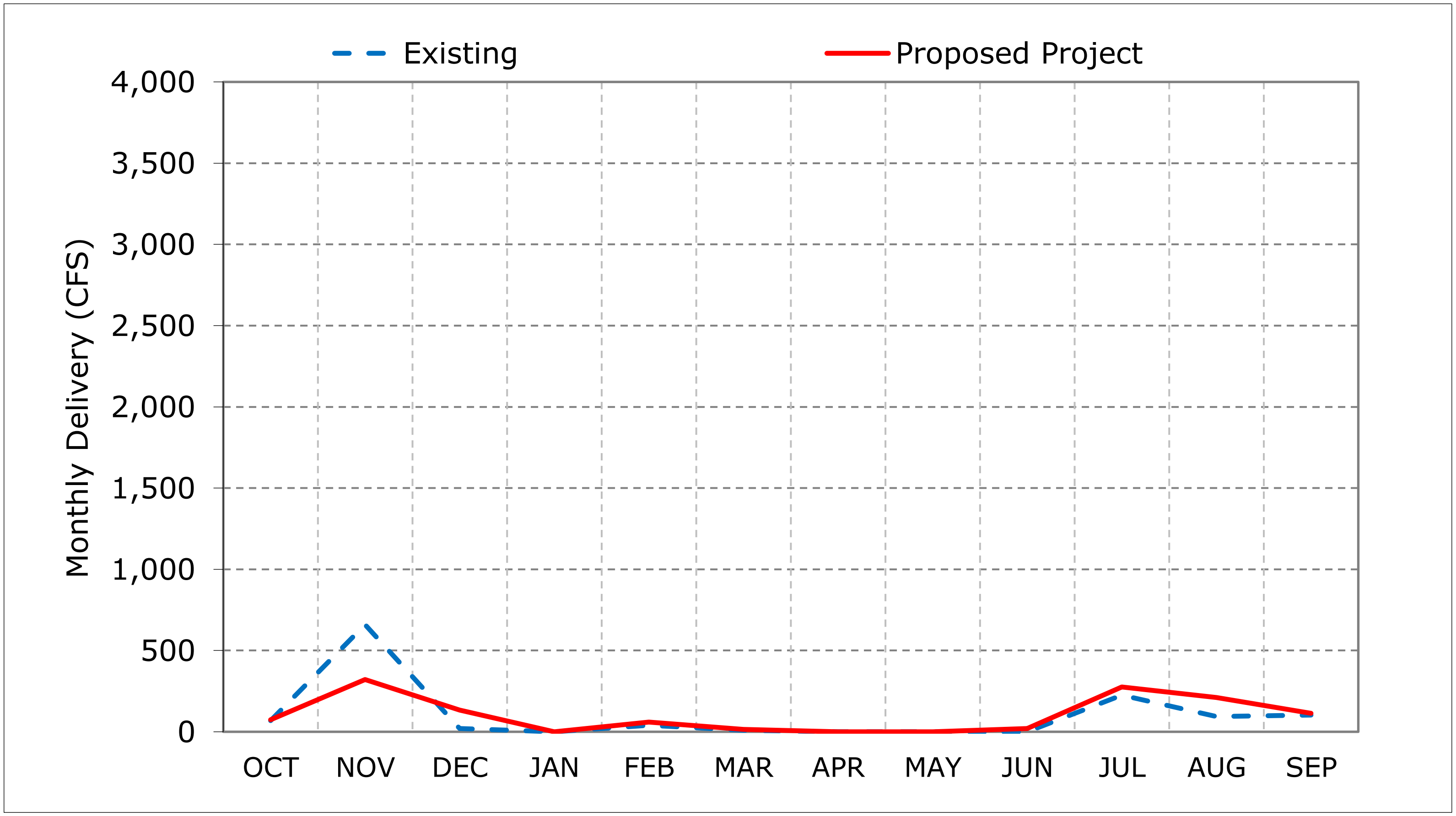
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Delivery (CFS)											
Probability of Exceedance												
10%	0	**-579**	211	0	0	0	0	0	0	159	683	14
20%	0	**-960**	0	0	0	0	0	0	0	70	35	0
30%	0	**-1,363**	0	0	0	0	0	0	0	159	0	0
40%	0	**-163**	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0
60%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
80%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
Long Term												
Full Simulation Period[a]	6	**-338**	114	0	19	6	0	0	20	52	117	11
Water Year Types[b,c]												
Wet (32%)	25	**-456**	**-21**	0	67	49	0	0	62	37	256	0
Above Normal (15%)	25	**-357**	175	0	**-11**	0	0	0	0	0	166	0
Below Normal (17%)	18	**-365**	154	0	**-2**	0	0	0	0	140	52	50
Dry (22%)	32	**-378**	160	0	0	**-44**	0	0	0	75	**-28**	13
Critical (15%)	**-111**	29	232	0	0	0	0	0	0	**-5**	59	0

a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

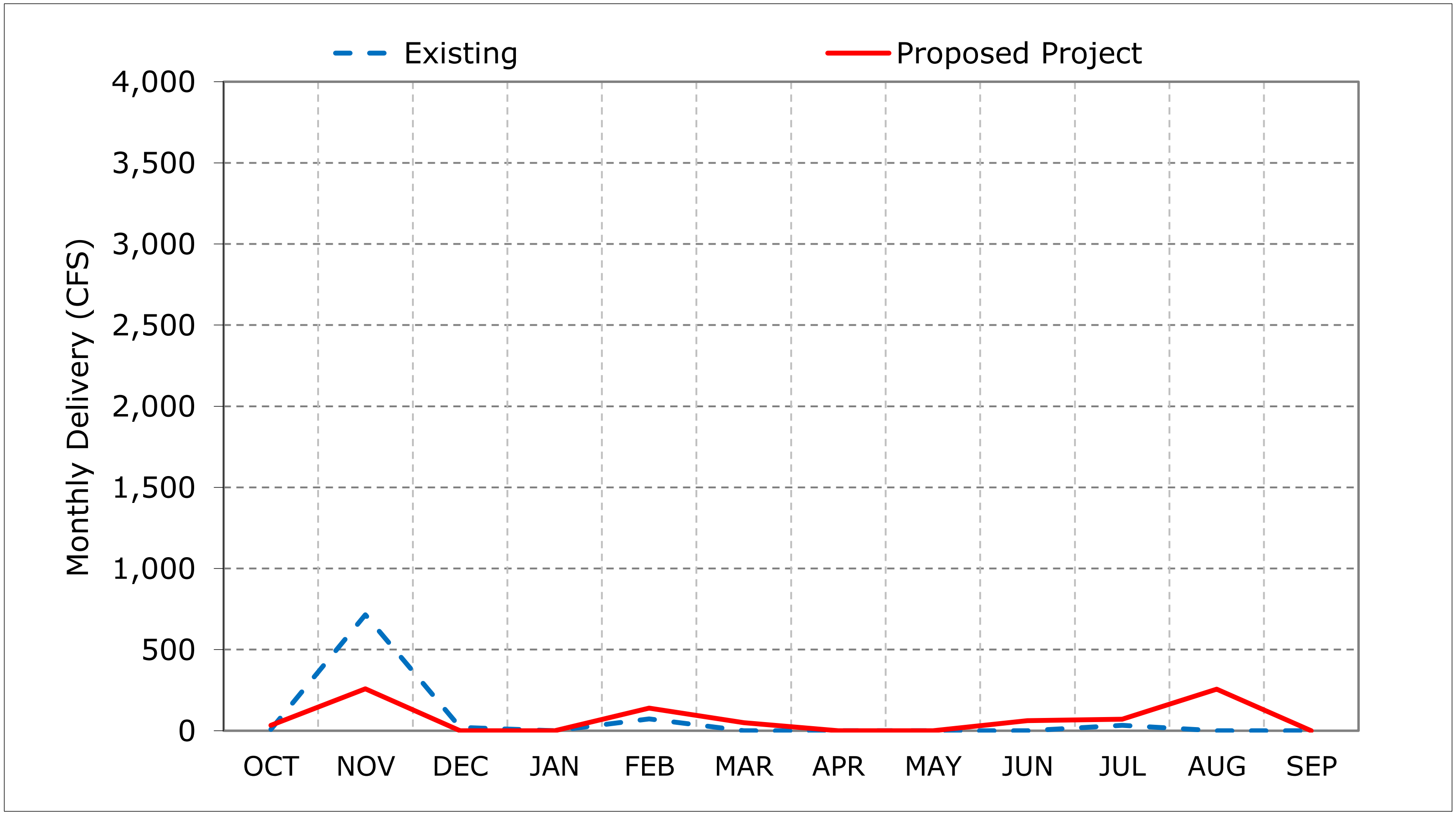
c These results are displayed with water year - year type sorting.

Figure 5-1. CVP Banks PP Exports, Long-Term Average Delivery



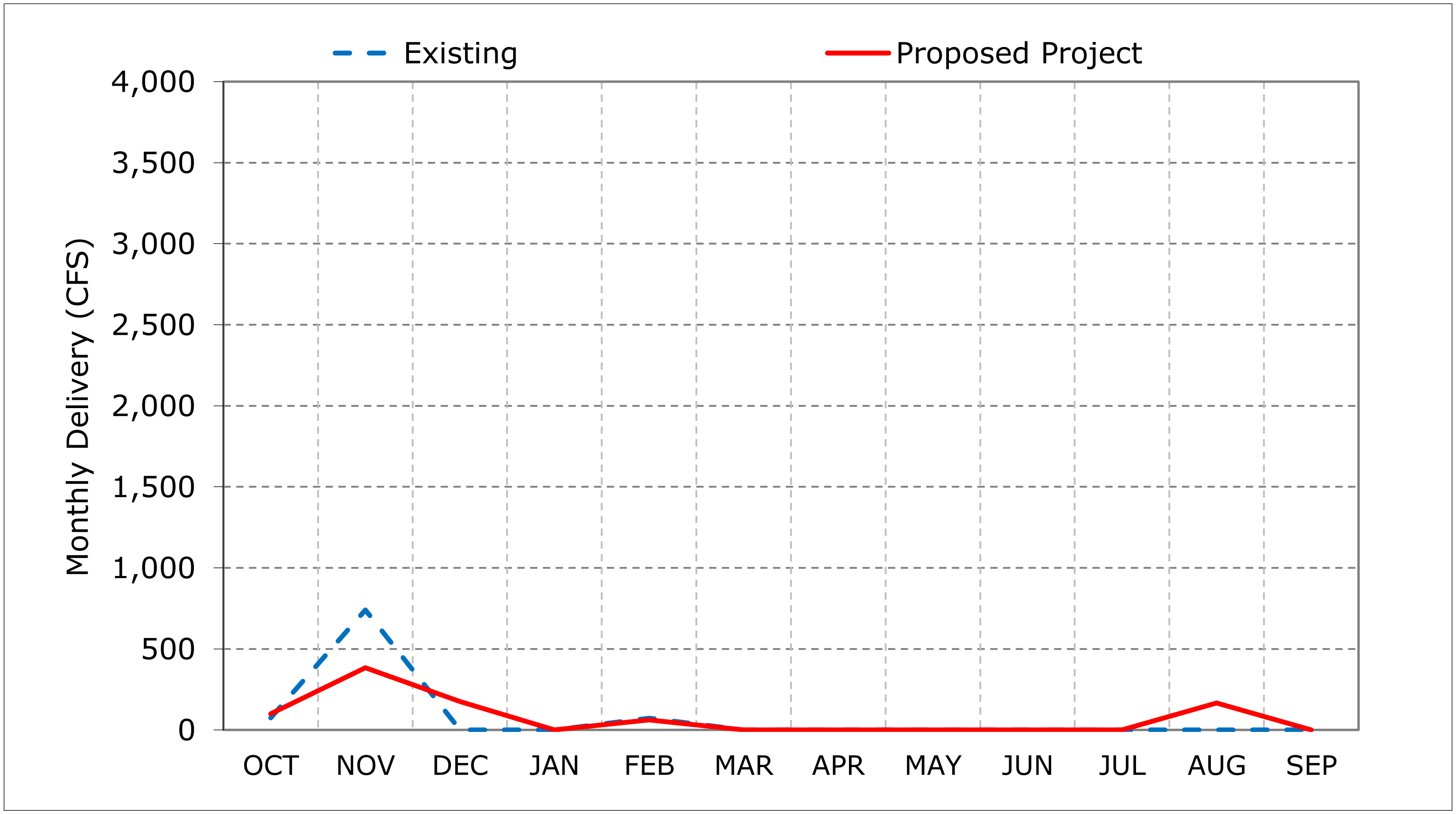
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 5-2. CVP Banks PP Exports, Wet Year Average Delivery



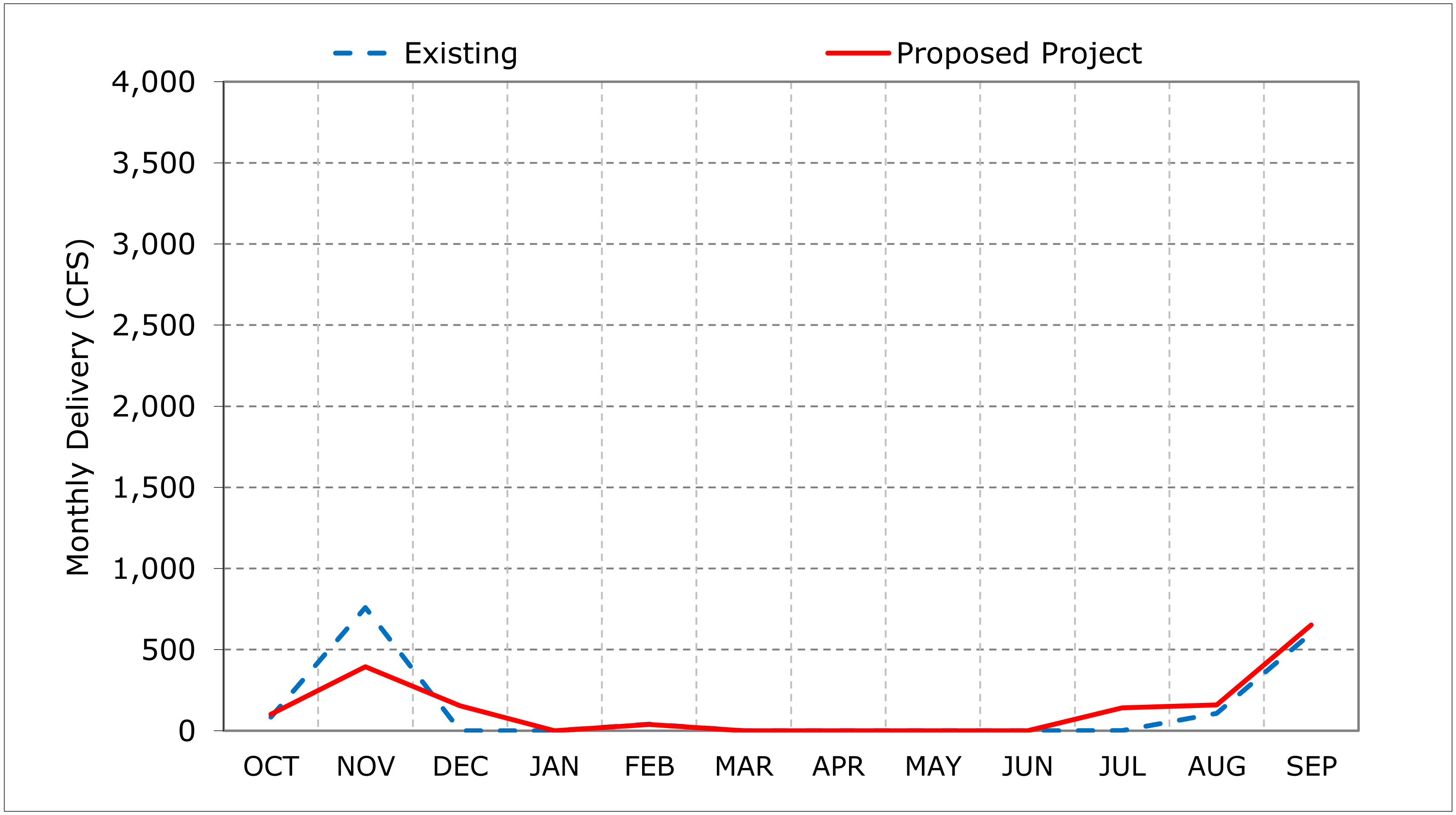
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 5-3. CVP Banks PP Exports, Above Normal Year Average Delivery



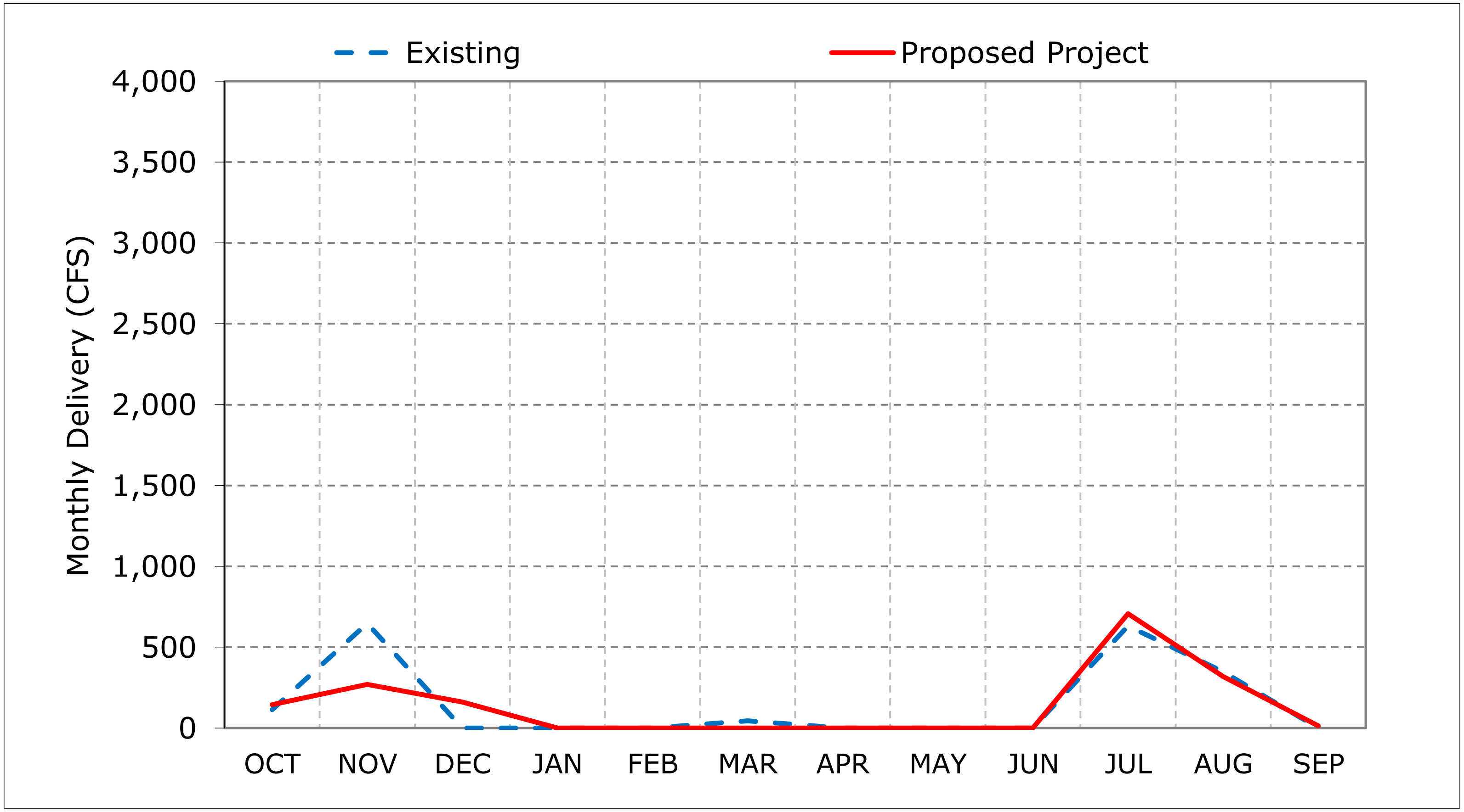
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 5-4. CVP Banks PP Exports, Below Normal Year Average Delivery



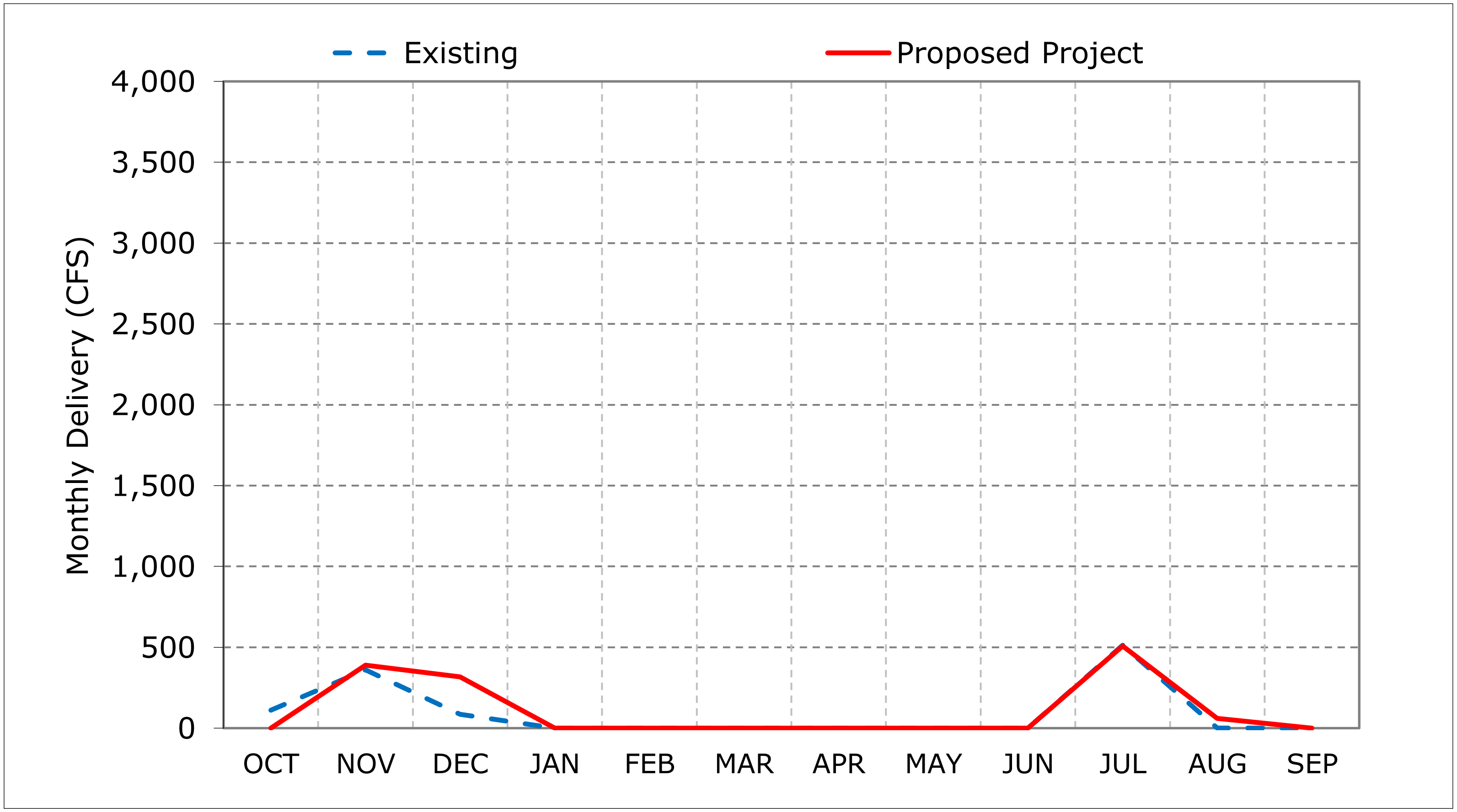
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 5-5. CVP Banks PP Exports, Dry Year Average Delivery



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 5-6. CVP Banks PP Exports, Critical Year Average Delivery



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 5-7. CVP Banks PP Exports, October

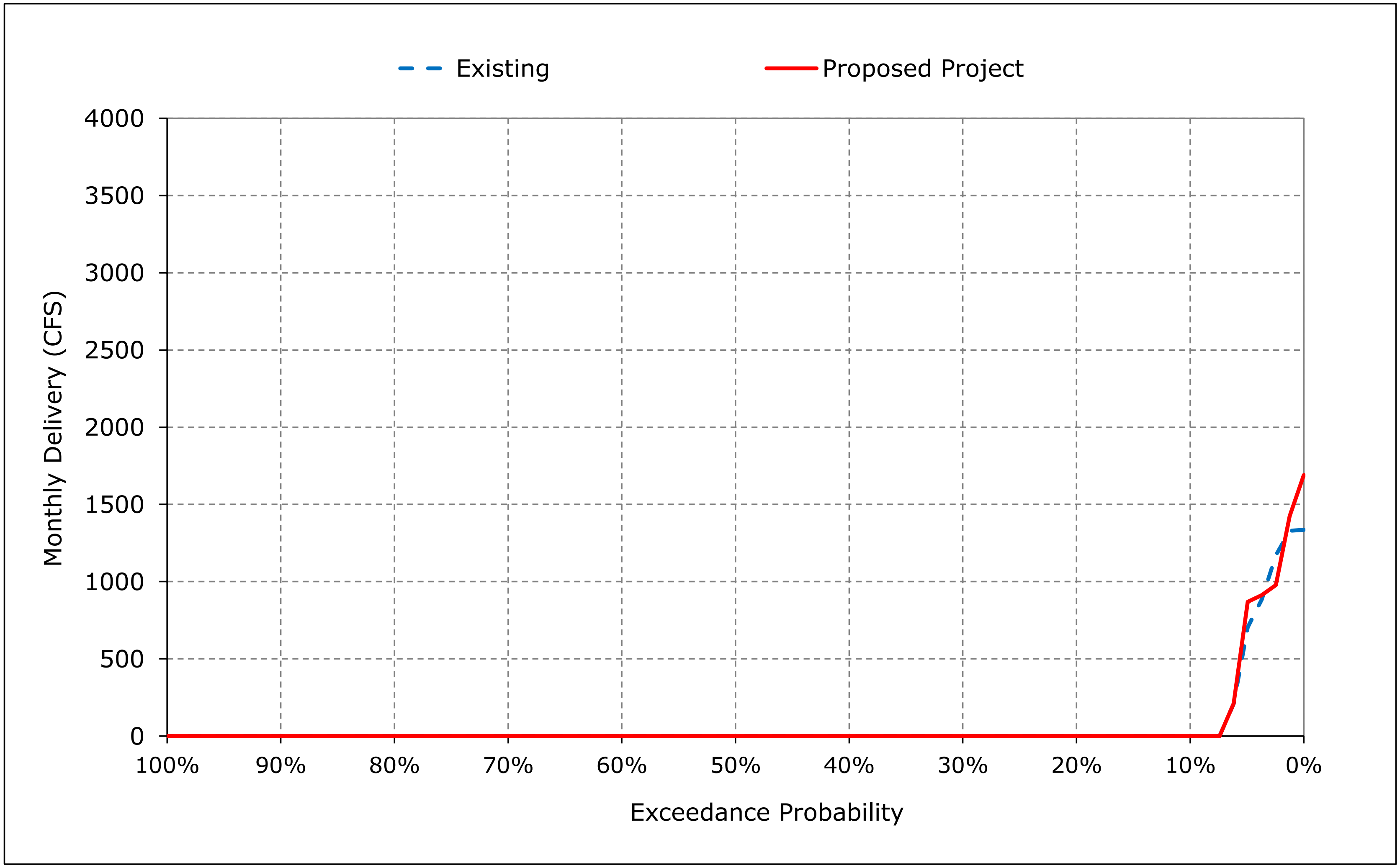


Figure 5-8. CVP Banks PP Exports, November

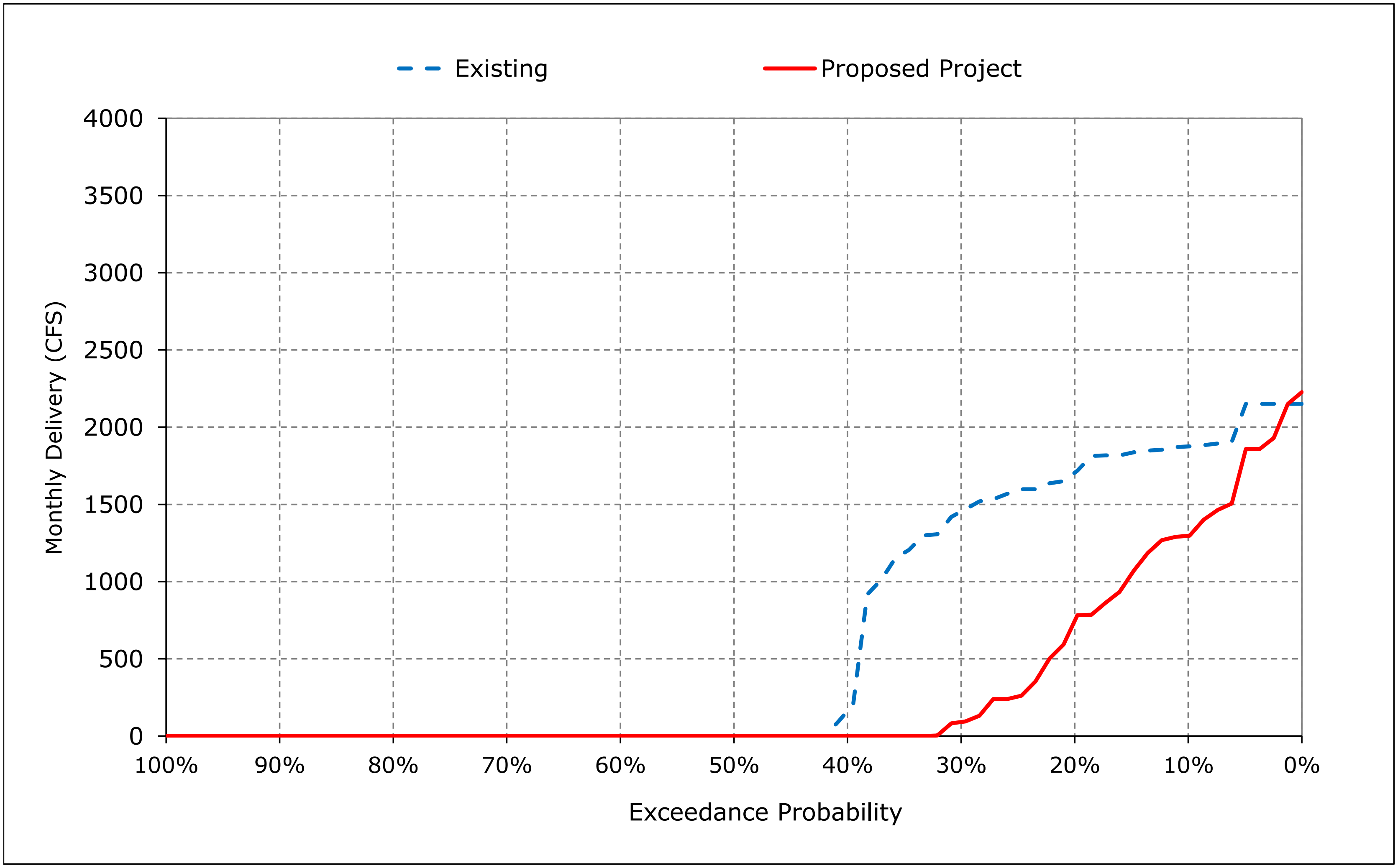


Figure 5-9. CVP Banks PP Exports, December

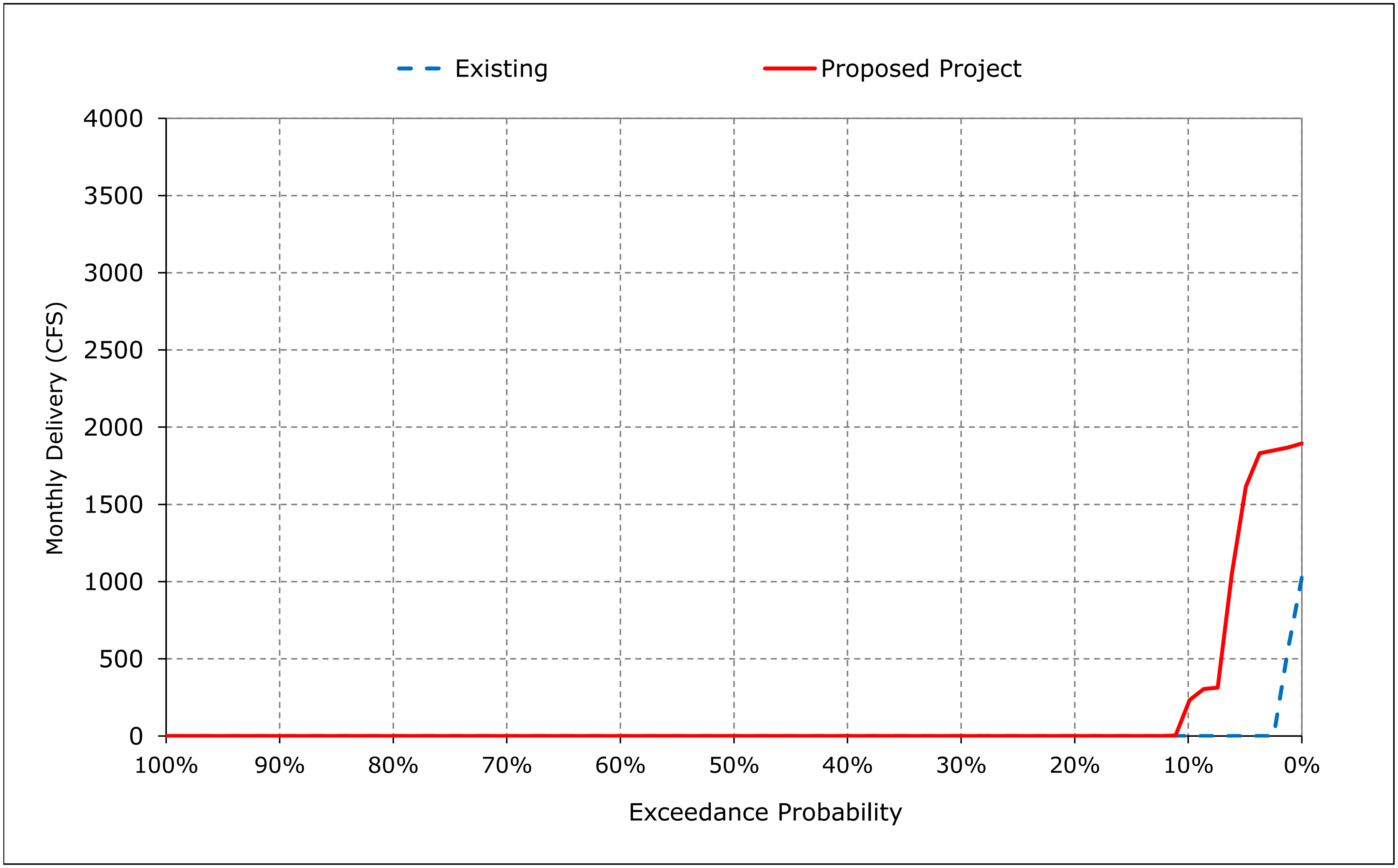


Figure 5-10. CVP Banks PP Exports, January

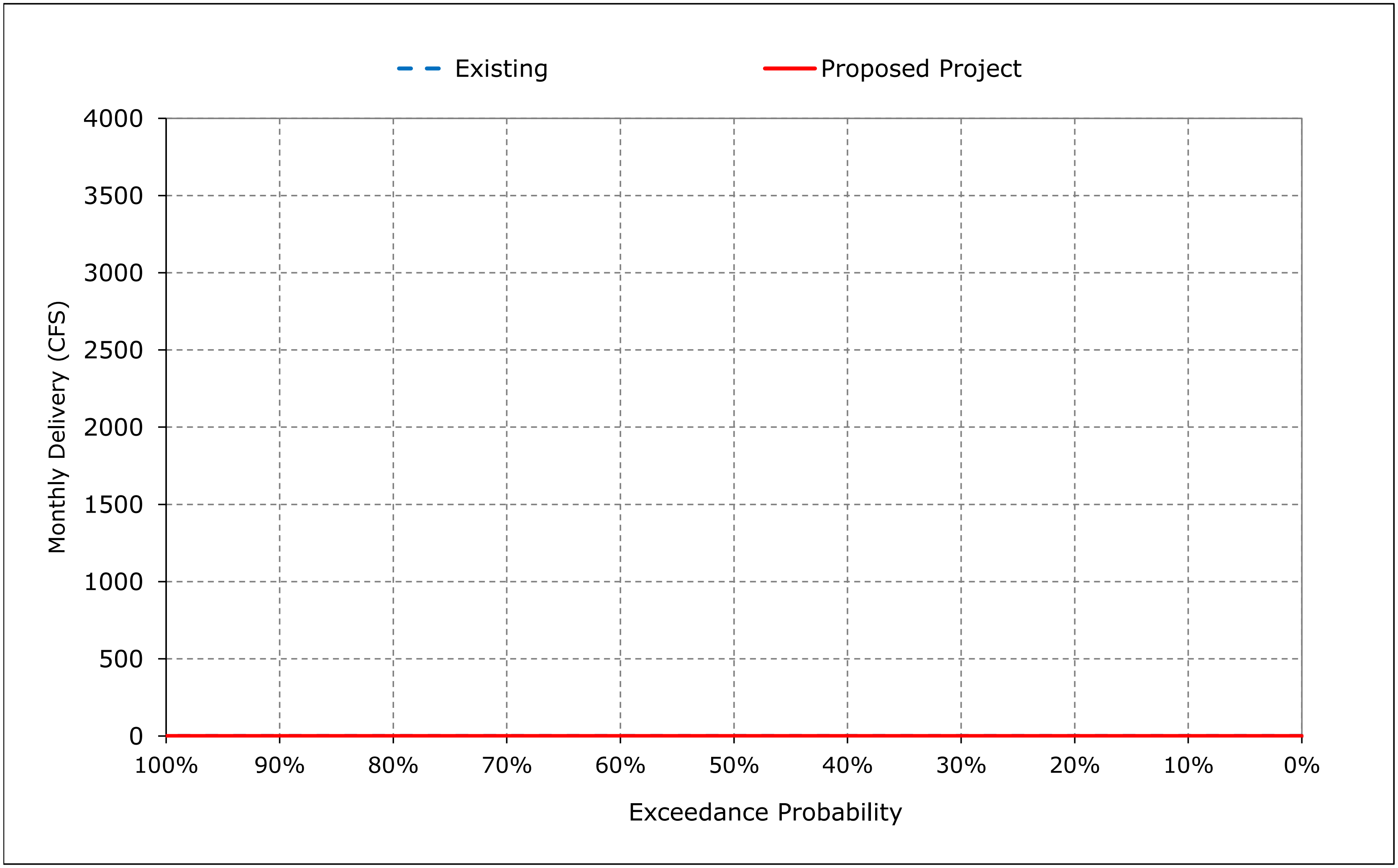


Figure 5-11. CVP Banks PP Exports, February

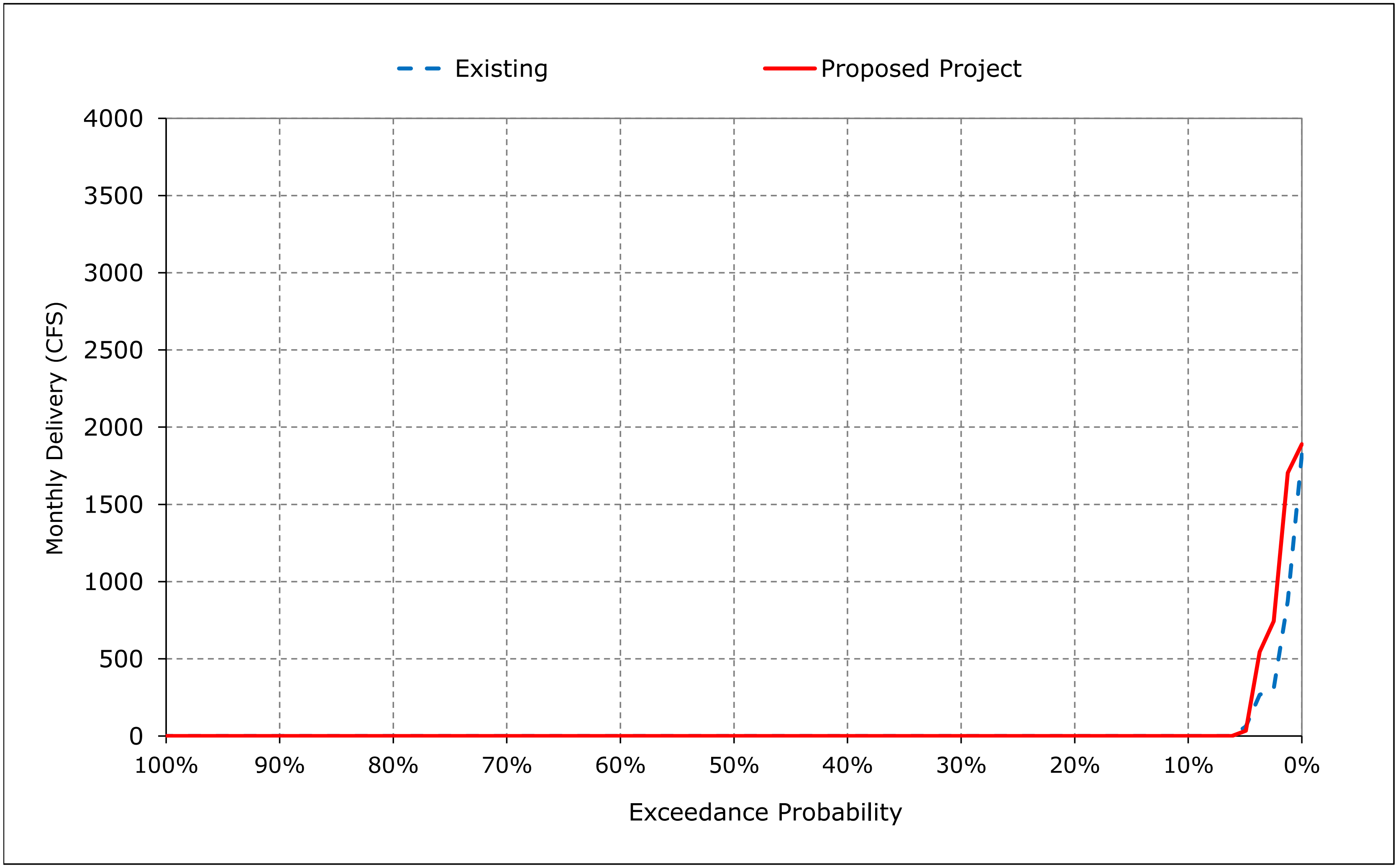


Figure 5-12. CVP Banks PP Exports, March

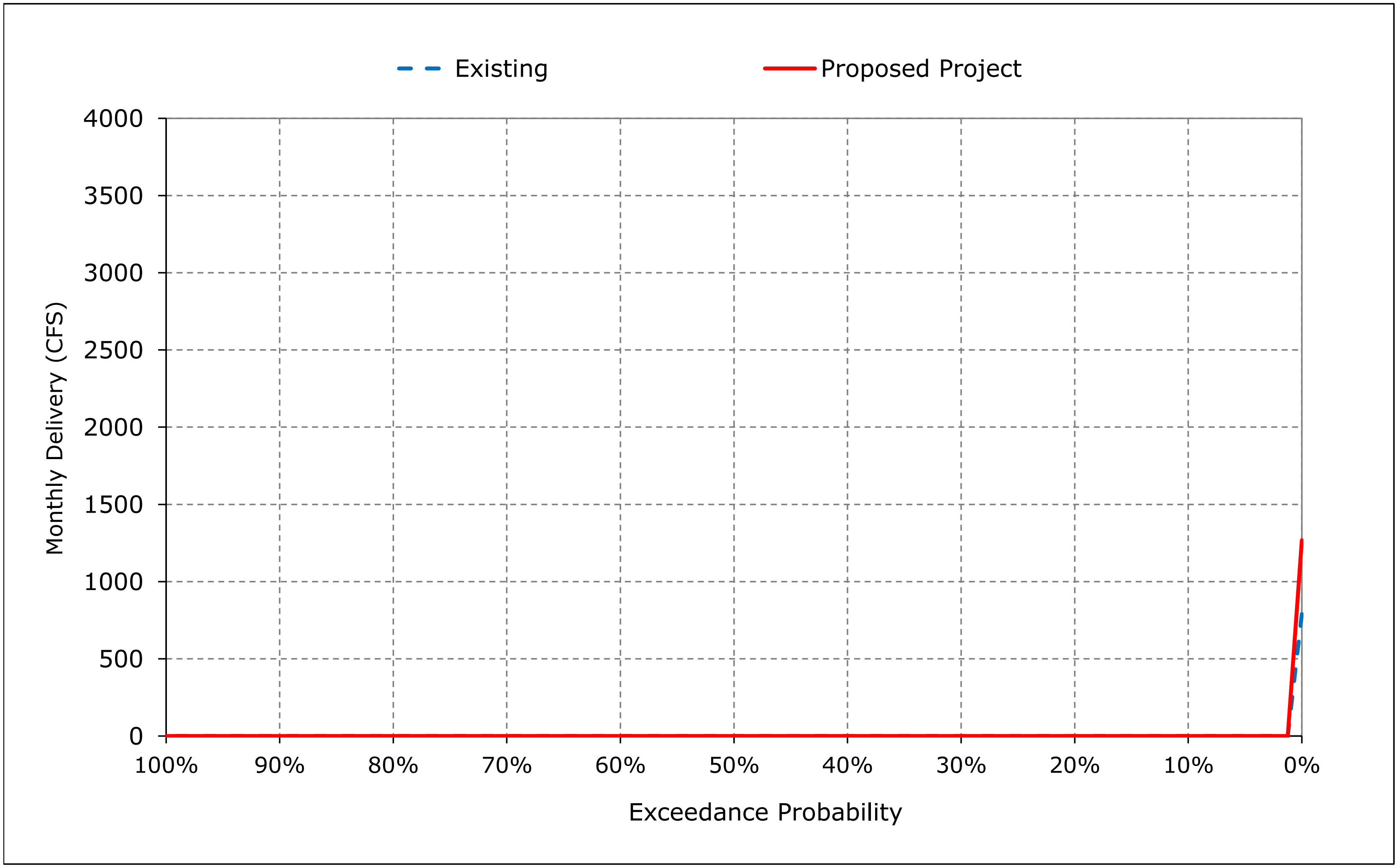


Figure 5-13. CVP Banks PP Exports, April

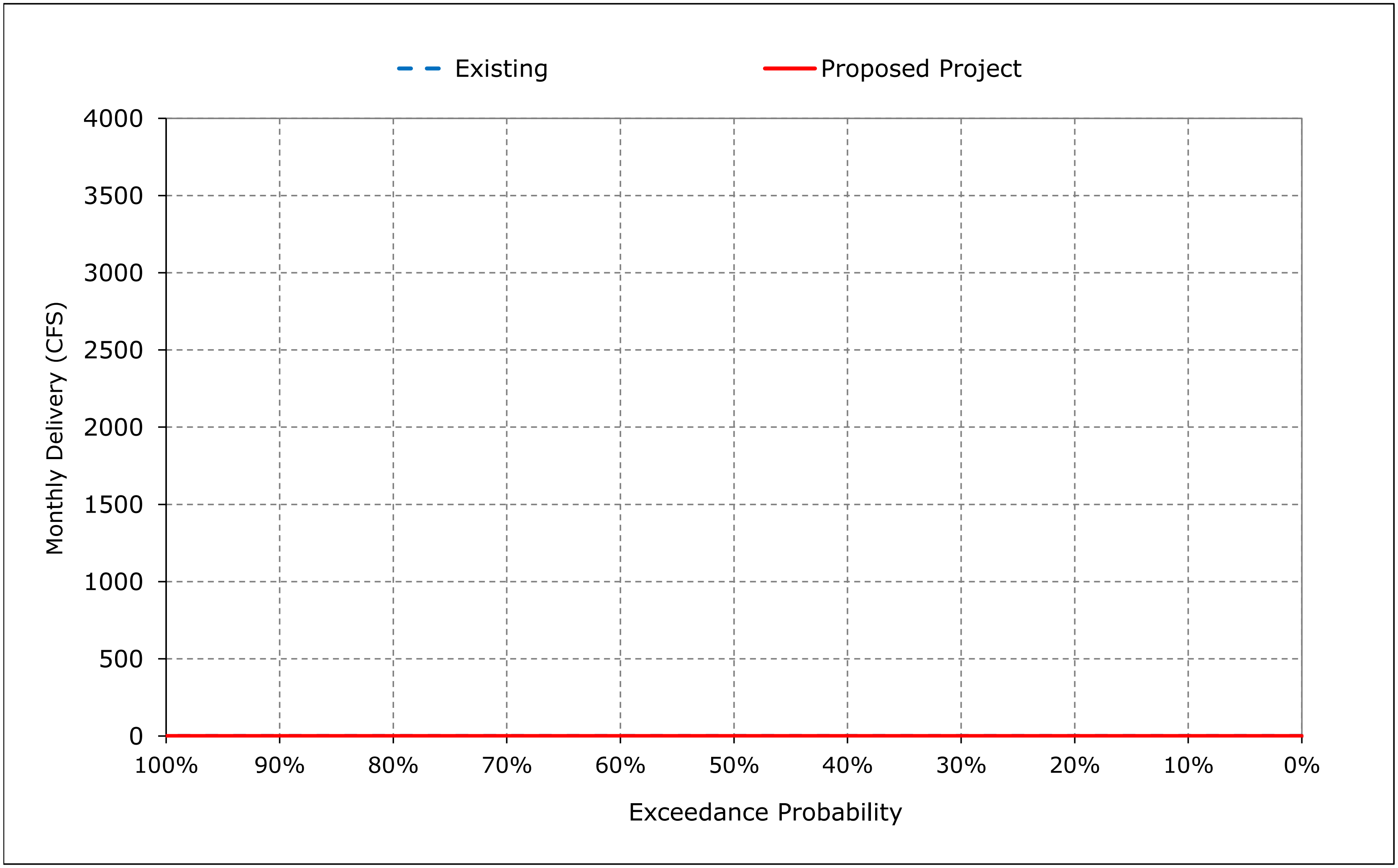


Figure 5-14. CVP Banks PP Exports, May

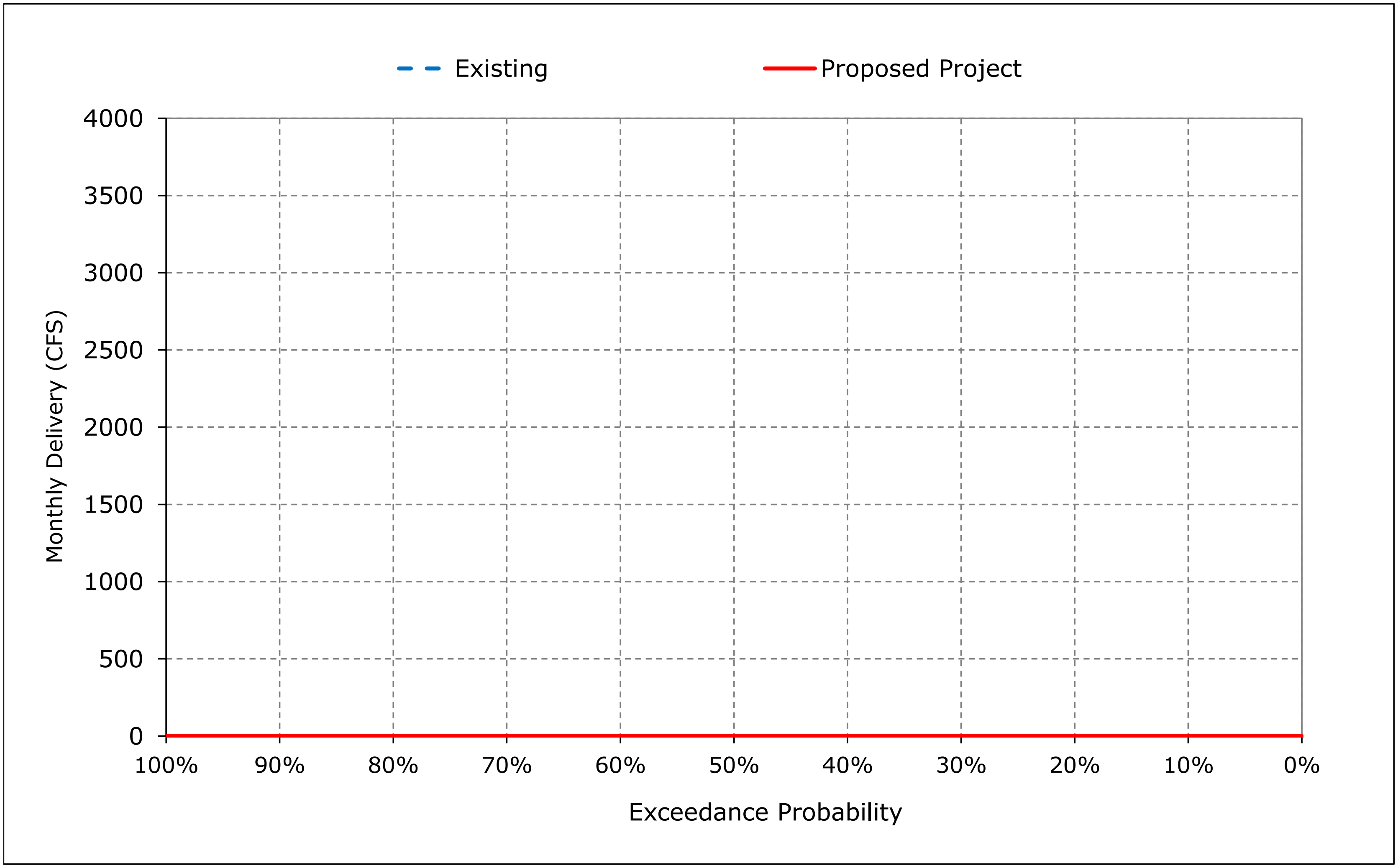


Figure 5-15. CVP Banks PP Exports, June

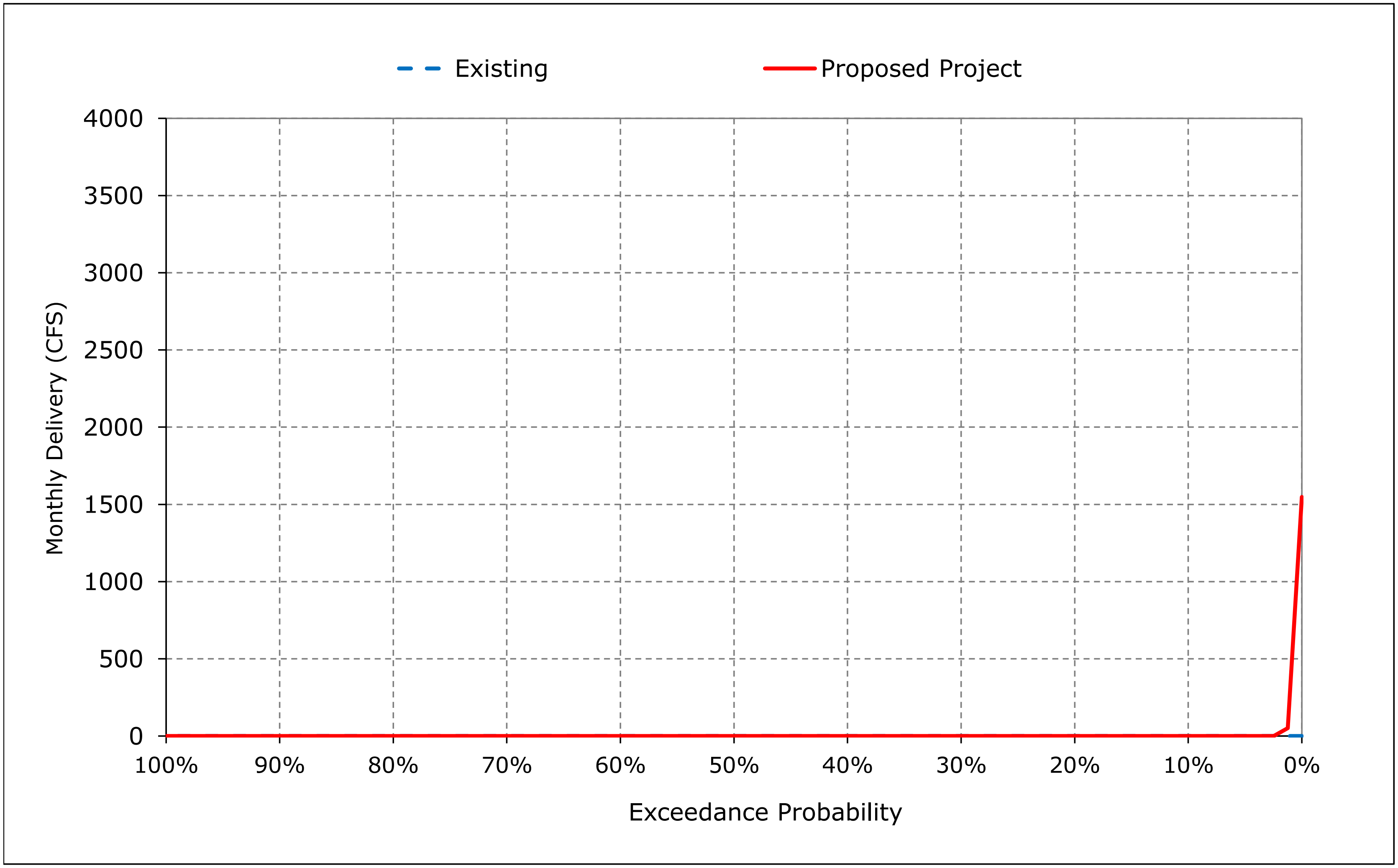


Figure 5-16. CVP Banks PP Exports, July

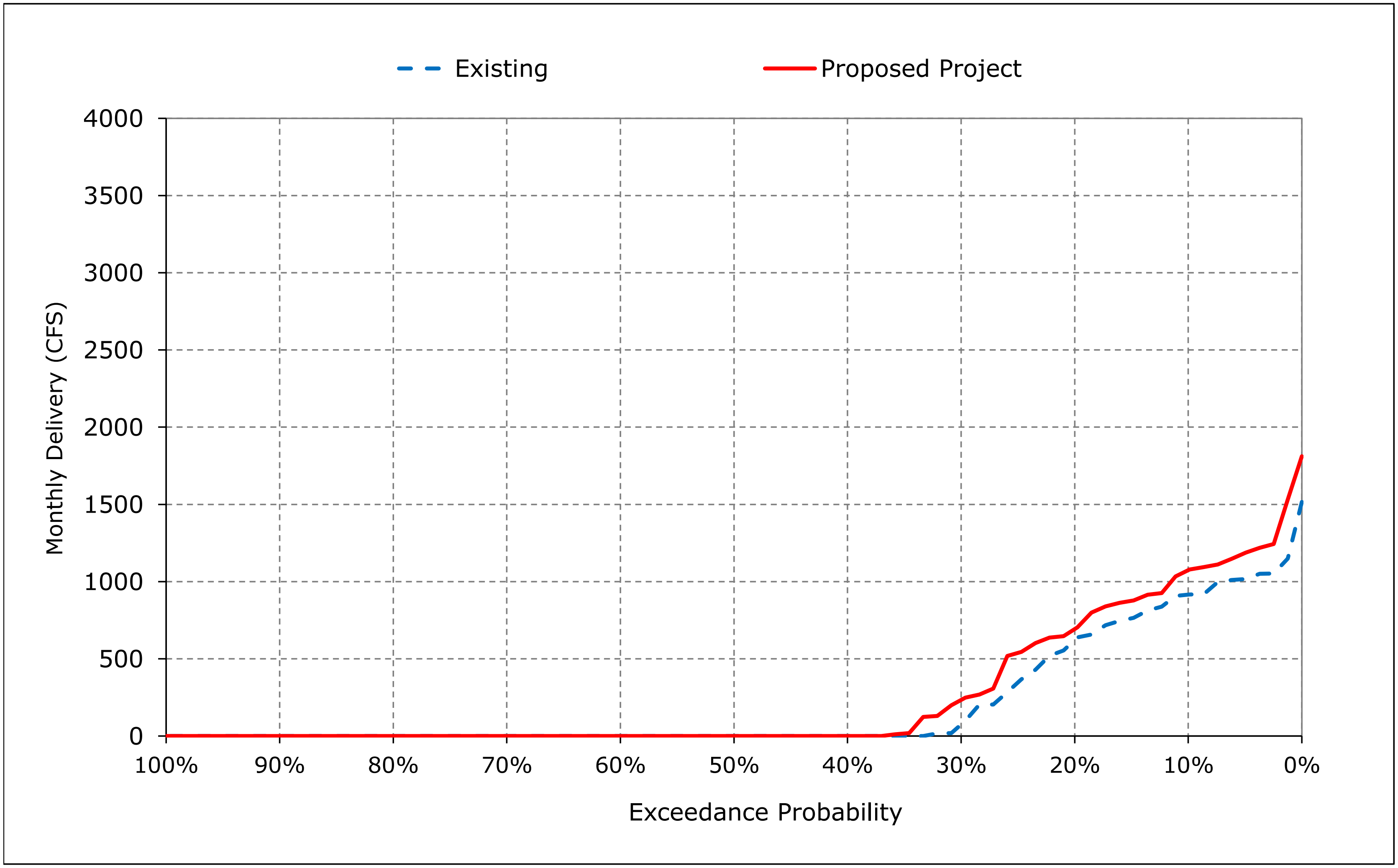


Figure 5-17. CVP Banks PP Exports, August

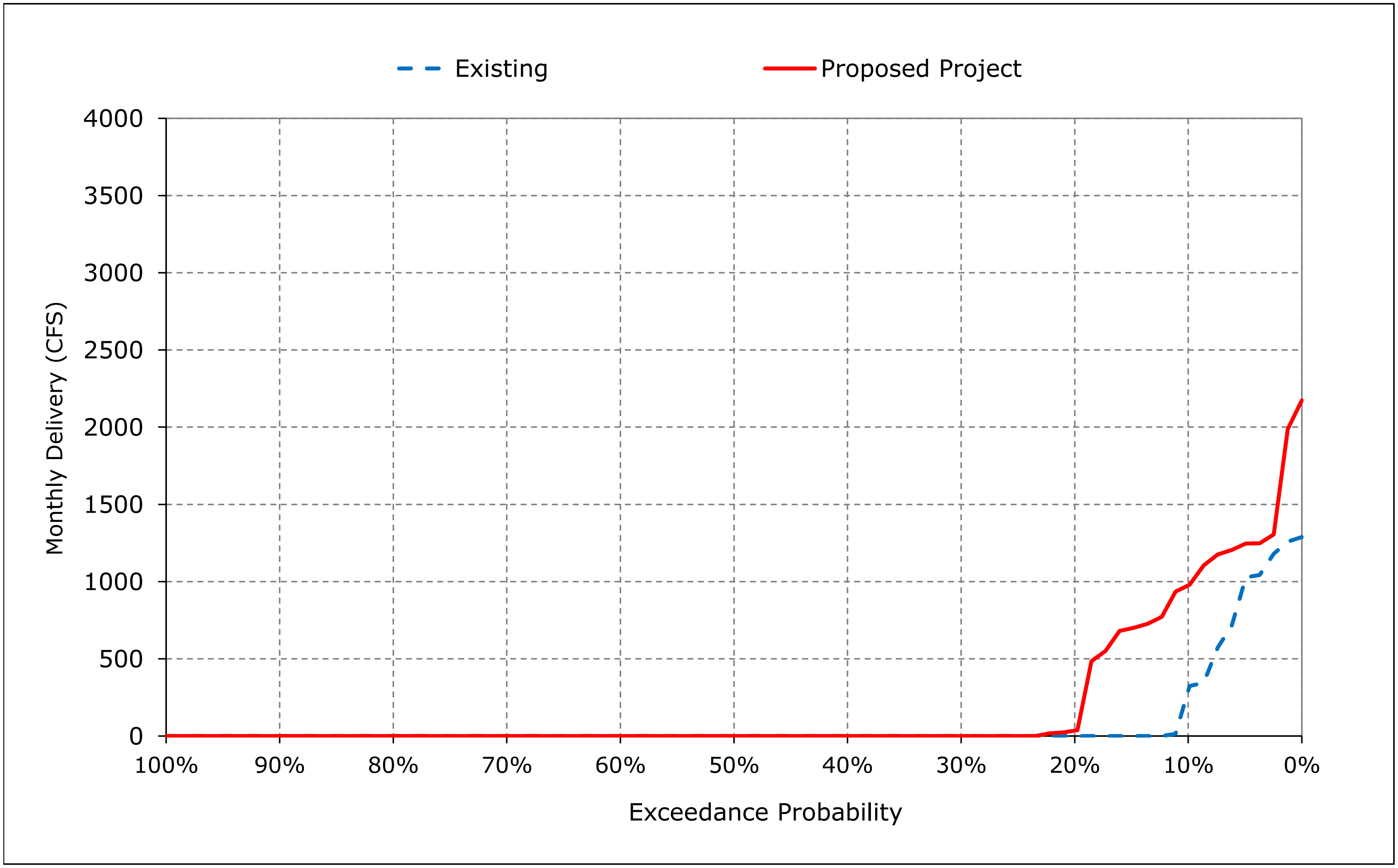


Figure 5-18. CVP Banks PP Exports, September

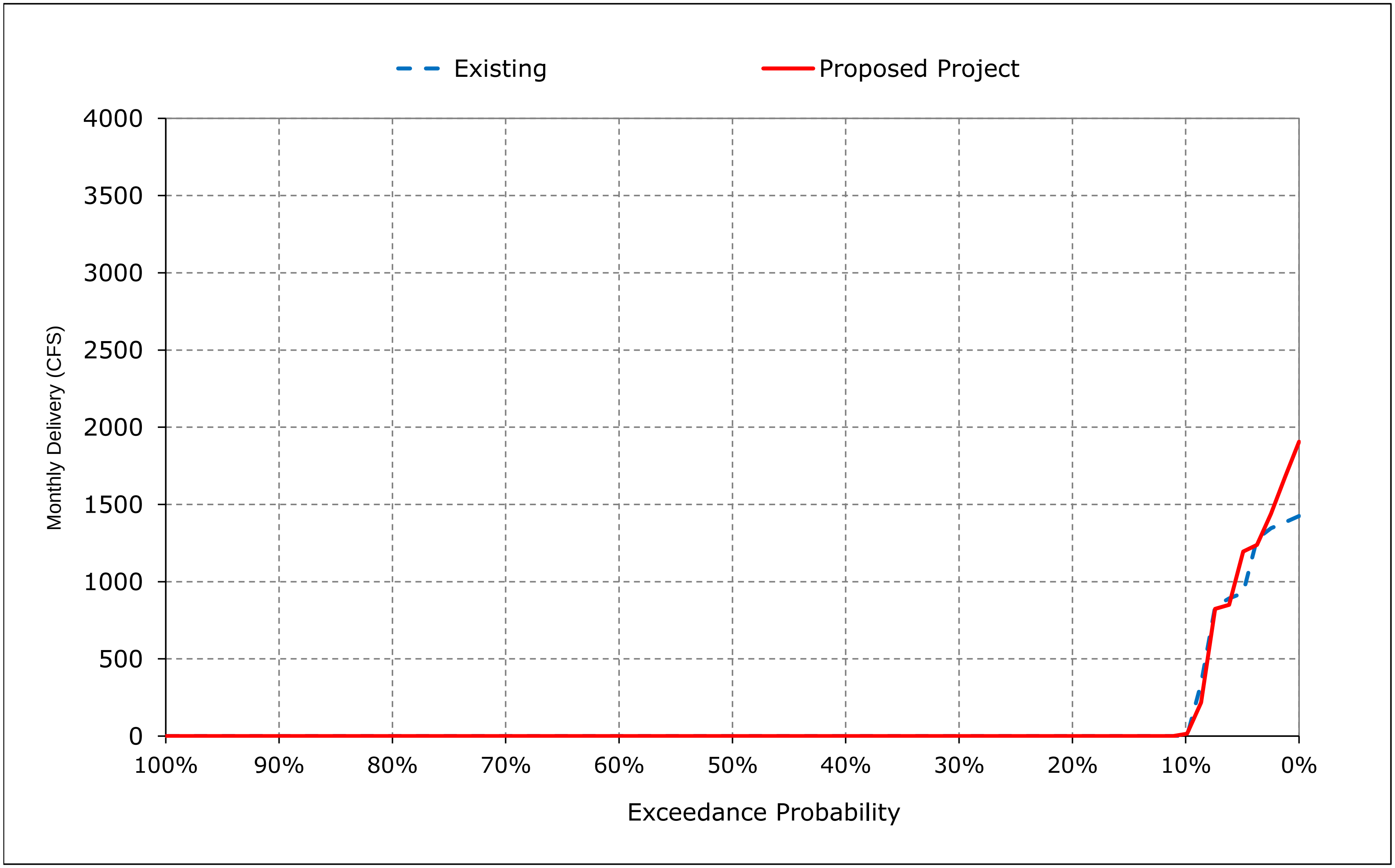


Table 6-1. Banks PP Exports, Monthly Delivery

Existing

	Monthly Delivery (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	5,172	6,680	7,105	5,846	7,403	8,190	1,330	1,106	4,310	6,930	7,042	6,680
20%	4,189	6,460	7,043	3,432	5,331	5,223	935	766	3,083	6,903	7,008	6,680
30%	3,988	4,842	6,672	2,864	4,069	4,832	787	637	2,325	6,873	6,965	6,680
40%	3,576	4,299	4,565	2,770	3,356	3,773	712	600	2,119	6,782	6,930	6,680
50%	3,193	3,504	4,000	2,707	2,877	2,912	673	600	1,935	6,680	6,774	6,519
60%	2,882	3,106	3,487	2,621	2,689	2,634	606	600	1,848	6,680	6,680	4,063
70%	2,297	2,691	3,017	2,601	2,622	2,386	600	600	1,757	5,793	1,588	2,826
80%	1,813	2,277	2,819	2,485	2,559	2,249	600	600	1,663	4,160	628	2,543
90%	986	1,765	2,565	2,204	2,423	1,632	600	526	549	1,076	305	1,903
Long Term												
Full Simulation Period[a]	3,165	3,956	4,602	3,302	3,943	3,803	873	811	2,349	5,543	4,684	4,802
Water Year Types[b,c]												
Wet (32%)	3,688	4,850	4,542	4,574	5,413	5,783	1,264	1,270	3,555	6,722	6,901	6,617
Above Normal (15%)	3,152	3,621	5,362	3,151	4,187	3,956	706	656	2,482	6,513	6,990	6,680
Below Normal (17%)	3,198	4,171	4,908	2,768	3,891	3,682	672	632	2,049	6,892	6,775	5,404
Dry (22%)	2,902	3,799	4,607	2,692	2,683	2,427	695	628	1,721	4,996	1,105	2,748
Critical (15%)	2,400	2,341	3,610	2,234	2,464	1,566	692	454	894	1,268	503	1,372

Proposed Project

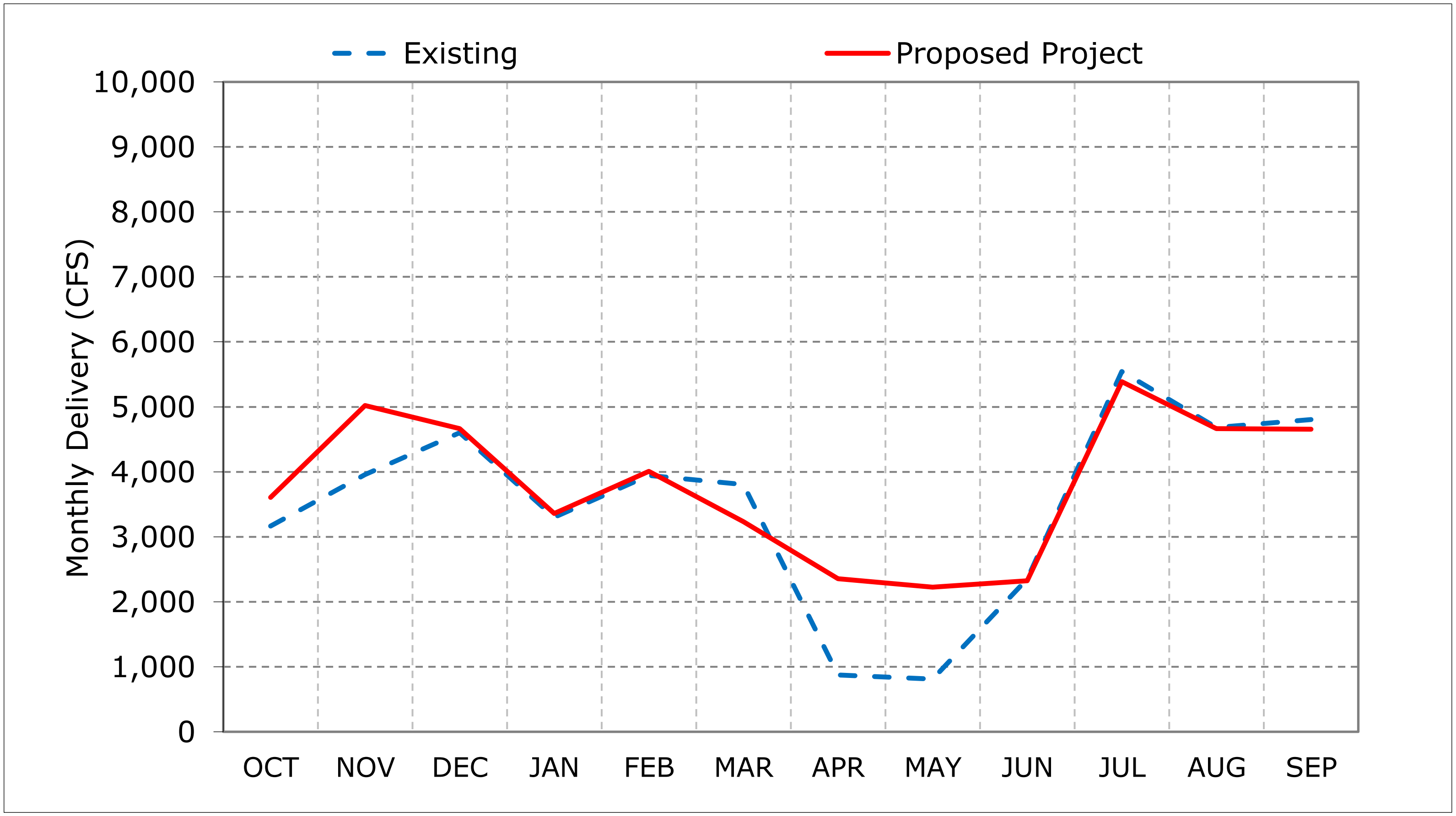
	Monthly Delivery (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	6,481	6,680	7,110	5,534	7,795	6,357	3,972	4,558	4,318	6,935	7,038	6,680
20%	5,257	6,680	7,048	3,861	5,633	4,169	3,189	3,539	3,243	6,903	6,977	6,680
30%	4,549	6,680	6,994	3,214	4,321	3,582	2,859	2,810	2,461	6,868	6,945	6,680
40%	4,070	6,680	5,049	2,914	3,517	3,065	2,523	2,390	2,003	6,692	6,902	6,680
50%	3,725	6,057	4,047	2,837	3,031	2,655	2,305	2,144	1,898	6,680	6,680	5,283
60%	3,095	5,079	3,476	2,748	2,874	2,243	1,999	1,602	1,795	6,612	5,567	3,888
70%	2,412	3,730	2,960	2,642	2,634	2,029	1,714	1,405	1,738	5,518	1,586	2,820
80%	1,933	2,979	2,817	2,526	2,518	1,821	1,453	904	1,656	3,077	594	2,519
90%	1,009	2,171	2,574	2,216	2,371	1,623	1,078	451	404	1,144	332	1,820
Long Term												
Full Simulation Period[a]	3,609	5,022	4,665	3,357	4,006	3,233	2,353	2,225	2,326	5,388	4,666	4,655
Water Year Types[b,c]												
Wet (32%)	4,279	6,280	4,558	4,358	5,543	4,994	3,241	3,393	3,511	6,648	6,841	6,337
Above Normal (15%)	3,833	4,808	5,458	3,184	3,996	3,092	2,669	2,702	2,477	6,611	6,854	6,555
Below Normal (17%)	3,585	5,194	5,066	2,946	4,013	3,046	2,515	2,221	2,023	6,501	6,514	5,119
Dry (22%)	3,259	4,327	4,941	2,931	2,801	1,965	1,636	1,334	1,692	4,522	1,244	2,710
Critical (15%)	2,484	3,354	3,221	2,480	2,486	1,678	999	559	911	1,433	746	1,483

Proposed Project minus Existing

	Monthly Delivery (CFS)											
Statistic	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Probability of Exceedance												
10%	1,309	0	5	**-312**	393	**-1,834**	2,642	3,452	8	6	**-5**	0
20%	1,068	220	5	429	302	**-1,054**	2,254	2,773	161	0	**-31**	0
30%	560	1,838	323	350	252	**-1,250**	2,072	2,173	137	**-6**	**-20**	0
40%	494	2,381	484	144	161	**-707**	1,810	1,790	**-115**	**-91**	**-28**	0
50%	532	2,553	47	130	154	**-257**	1,632	1,544	**-37**	0	**-94**	**-1,236**
60%	213	1,973	**-11**	126	185	**-391**	1,393	1,002	**-54**	**-68**	**-1,113**	**-175**
70%	115	1,039	**-56**	41	11	**-356**	1,114	805	**-20**	**-275**	**-2**	**-6**
80%	120	702	**-1**	42	**-42**	**-429**	853	304	**-8**	**-1,083**	**-35**	**-24**
90%	23	406	9	12	**-52**	**-9**	478	**-76**	**-145**	68	26	**-83**
Long Term												
Full Simulation Period[a]	444	1,066	63	55	63	**-570**	1,480	1,414	**-23**	**-156**	**-18**	**-148**
Water Year Types[b,c]												
Wet (32%)	591	1,430	16	**-216**	130	**-789**	1,977	2,123	**-44**	**-74**	**-60**	**-280**
Above Normal (15%)	682	1,186	96	33	**-190**	**-864**	1,963	2,046	**-5**	98	**-136**	**-125**
Below Normal (17%)	387	1,023	158	178	122	**-636**	1,844	1,590	**-25**	**-391**	**-262**	**-285**
Dry (22%)	357	528	334	239	118	**-462**	941	706	**-29**	**-474**	139	**-38**
Critical (15%)	84	1,013	**-389**	246	23	112	306	105	18	165	243	111

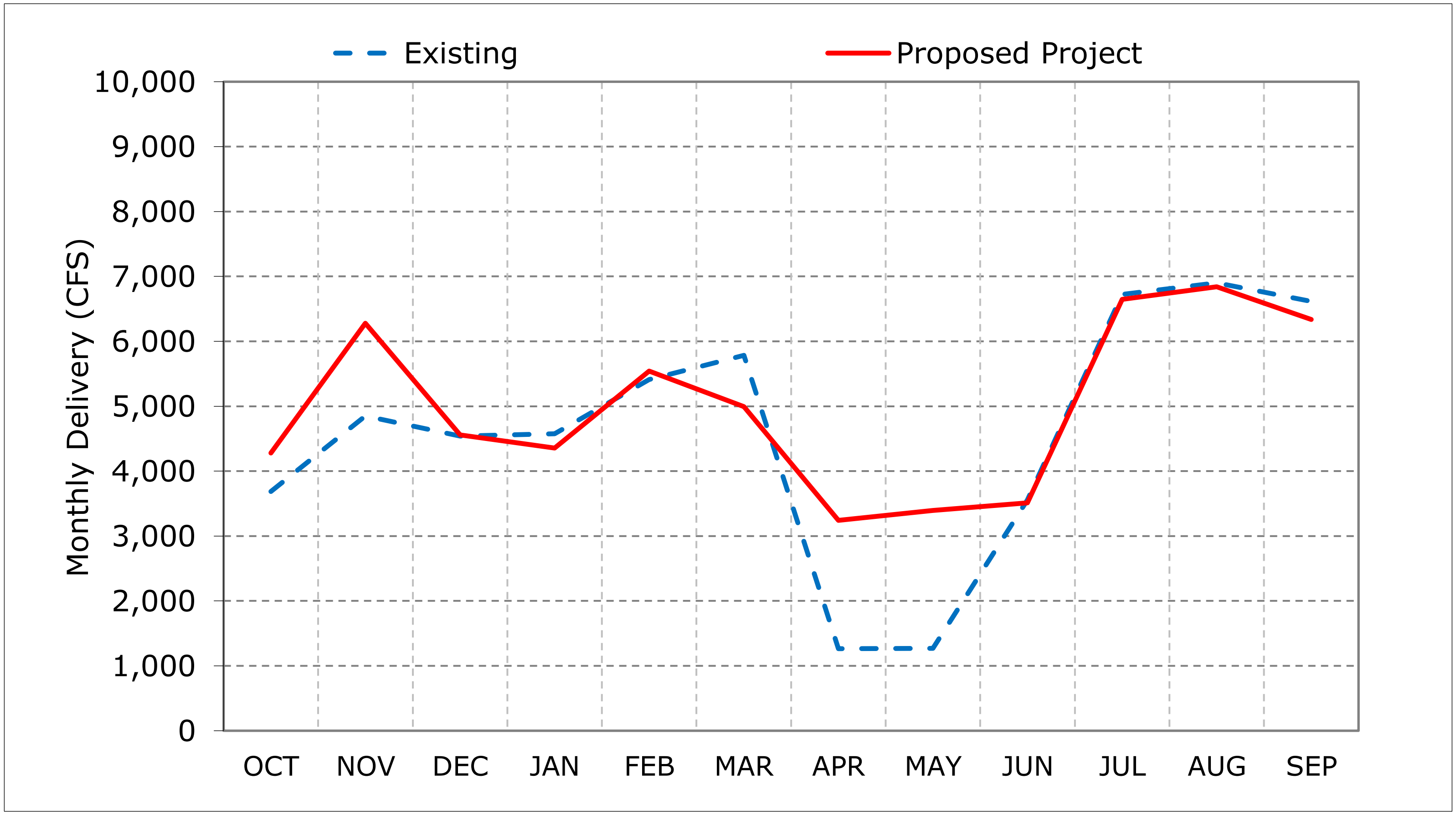
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.

Figure 6-1. Banks PP Exports, Long-Term Average Delivery



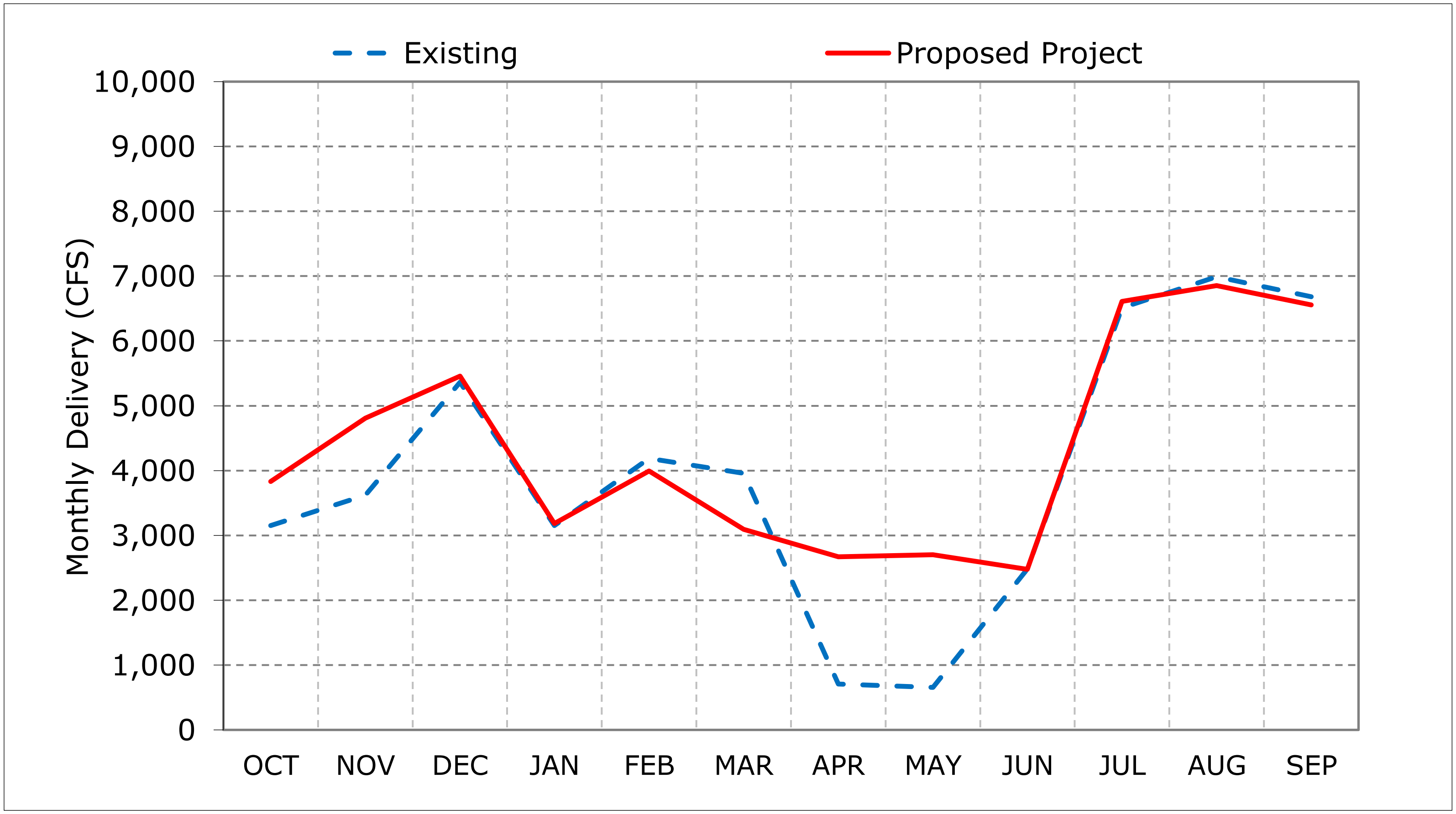
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 6-2. Banks PP Exports, Wet Year Average Delivery



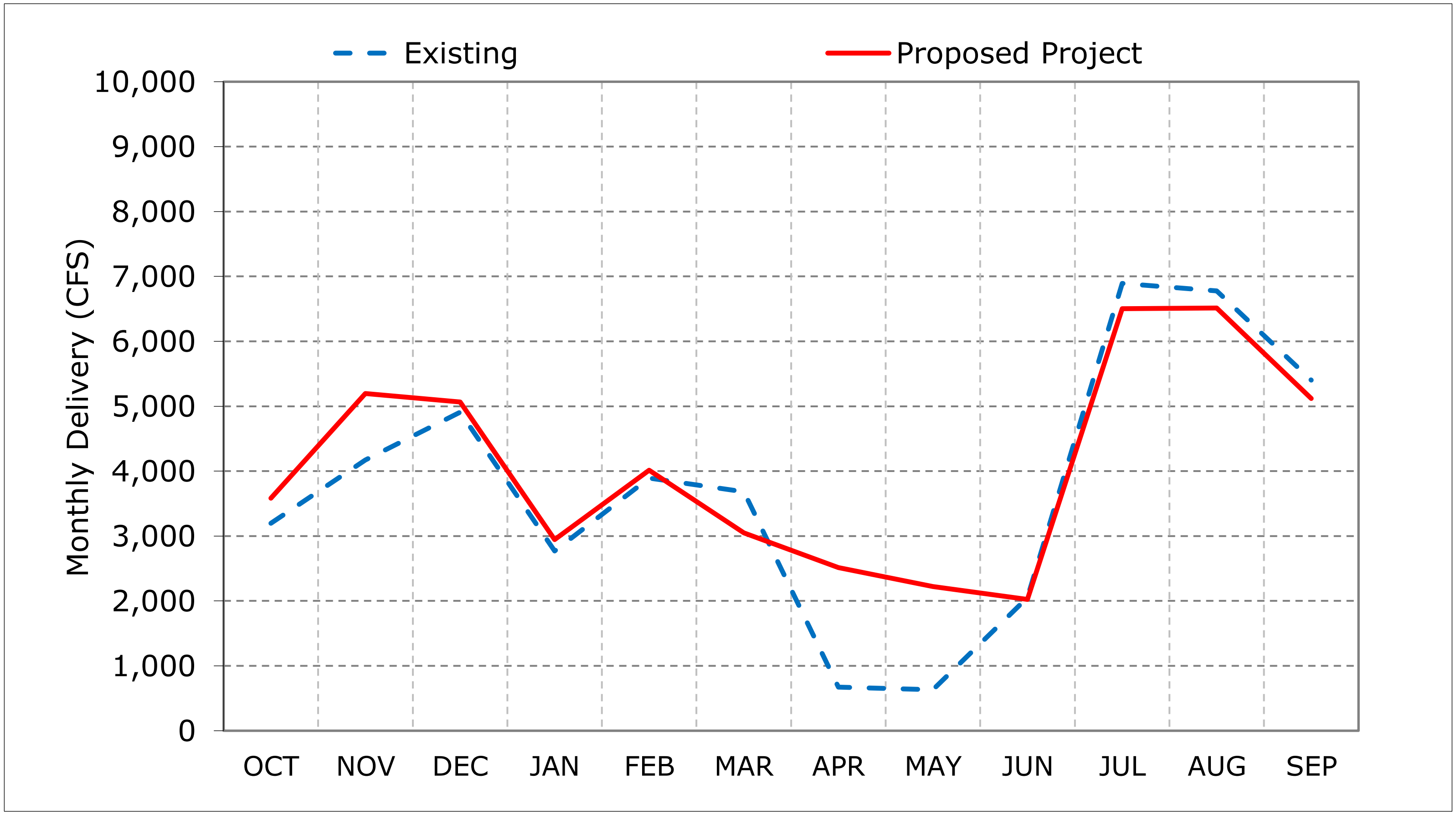
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 6-3. Banks PP Exports, Above Normal Year Average Delivery



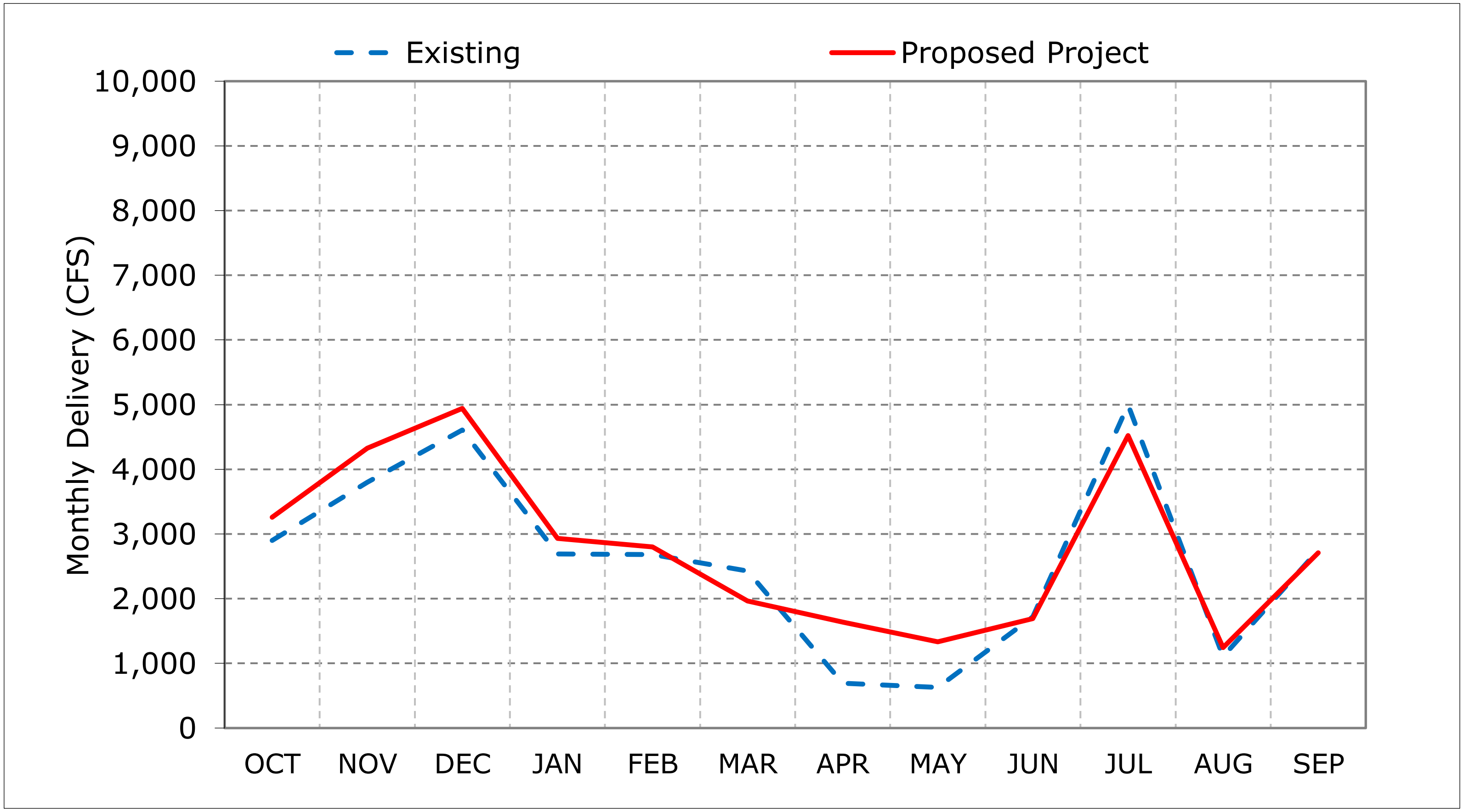
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 6-4. Banks PP Exports, Below Normal Year Average Delivery



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

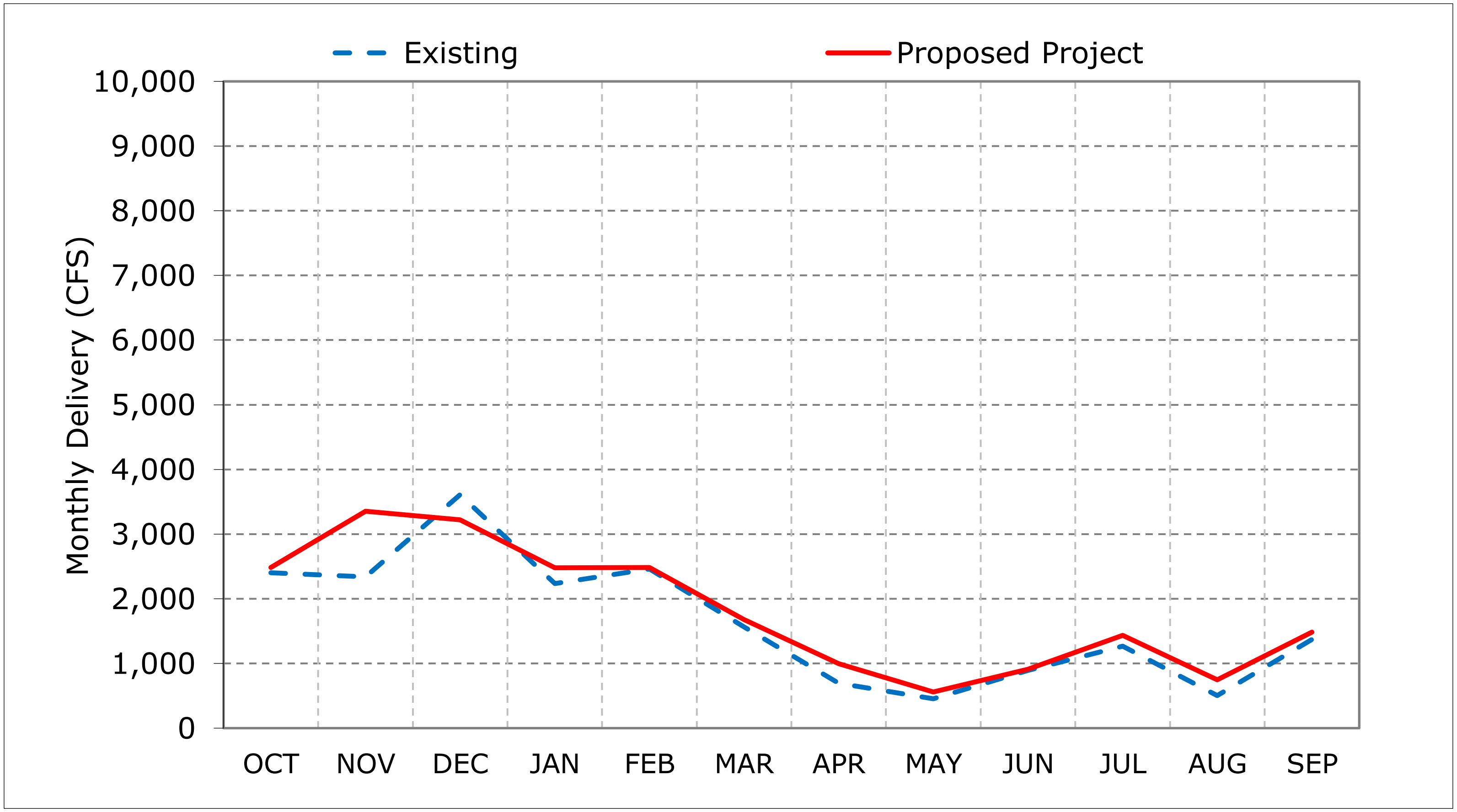
Figure 6-5. Banks PP Exports, Dry Year Average Delivery



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164

*These results are displayed with water year - year type sorting.

Figure 6-6. Banks PP Exports, Critical Year Average Delivery



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 6-7. Banks PP Exports, October

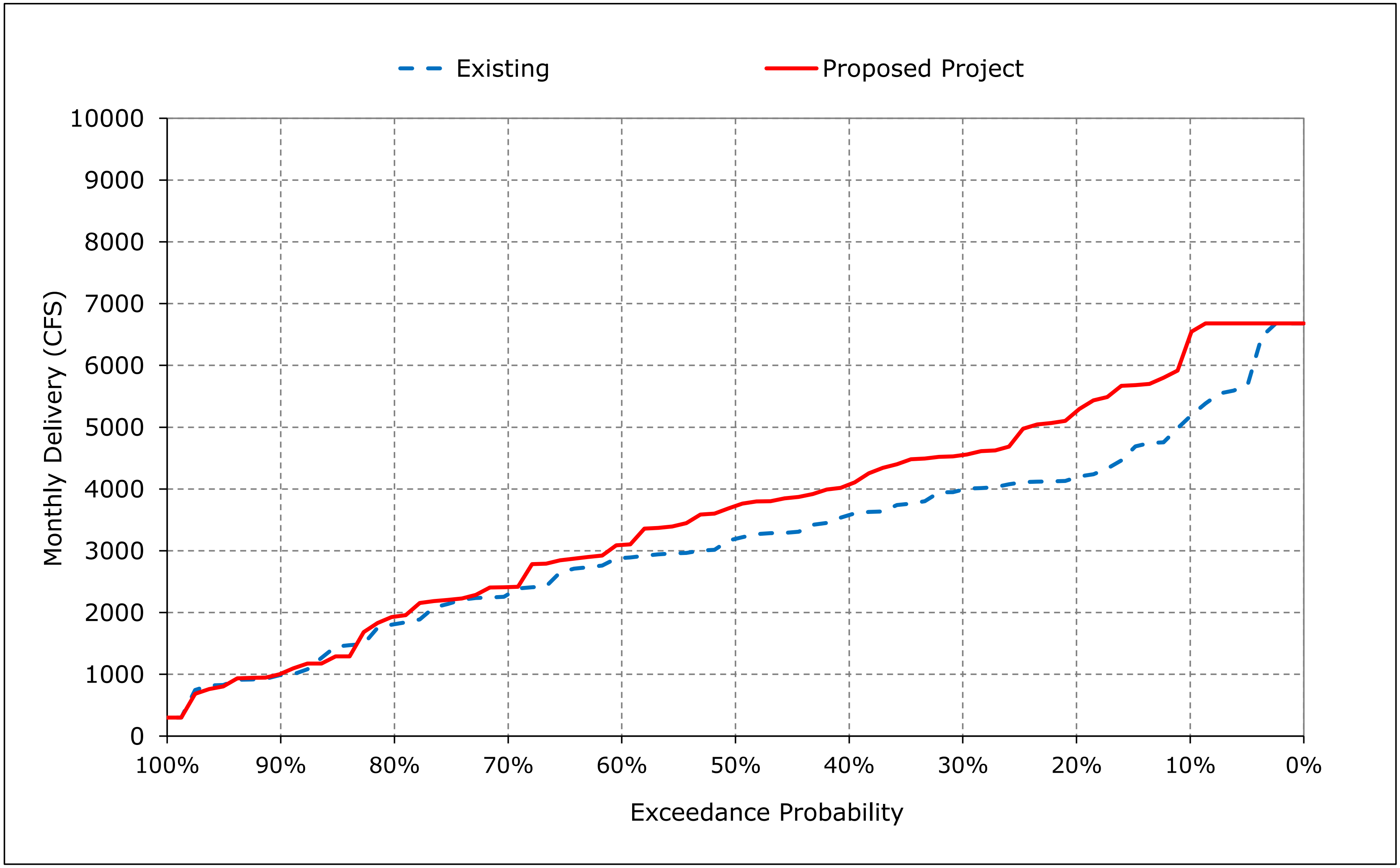


Figure 6-8. Banks PP Exports, November

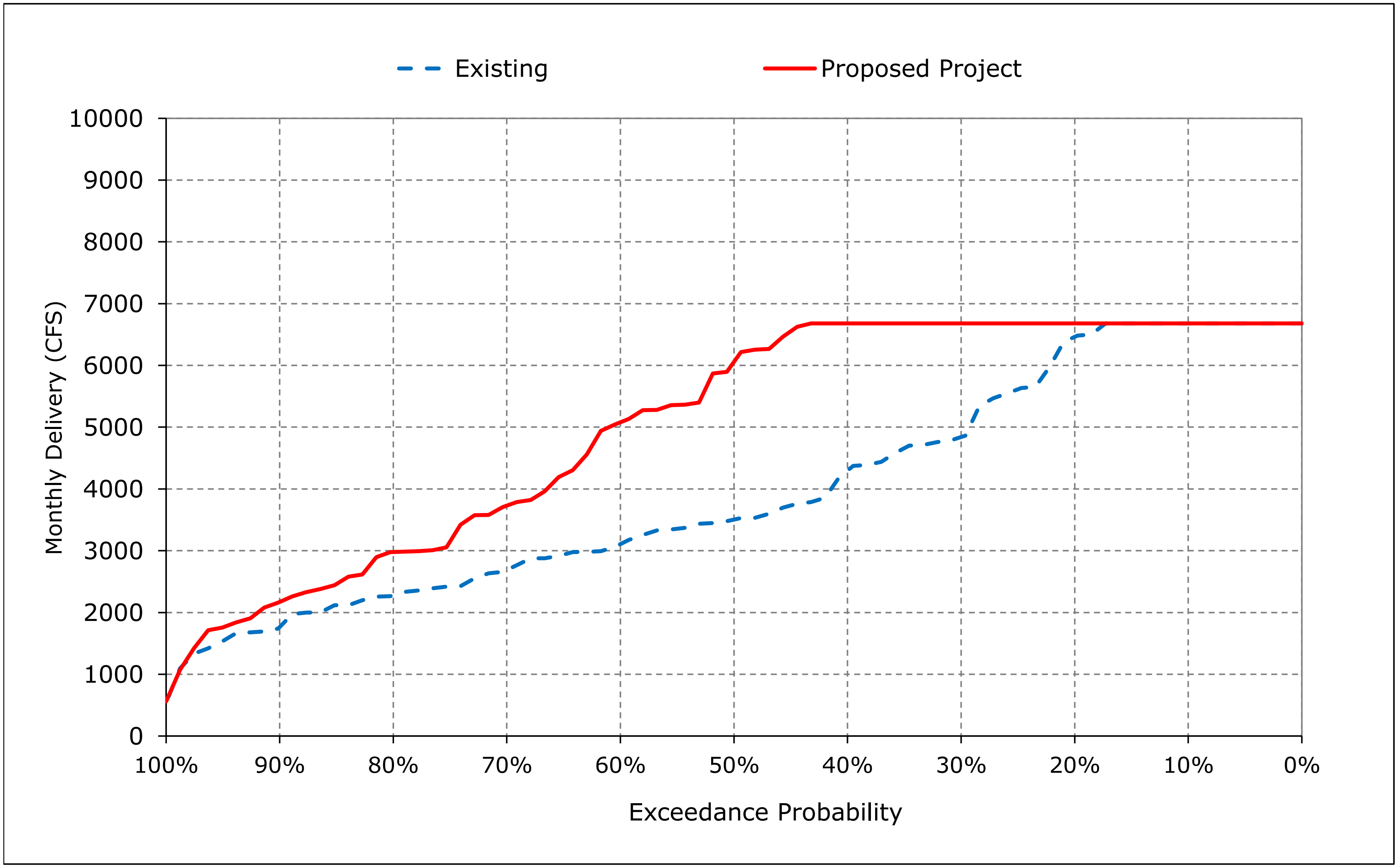


Figure 6-9. Banks PP Exports, December

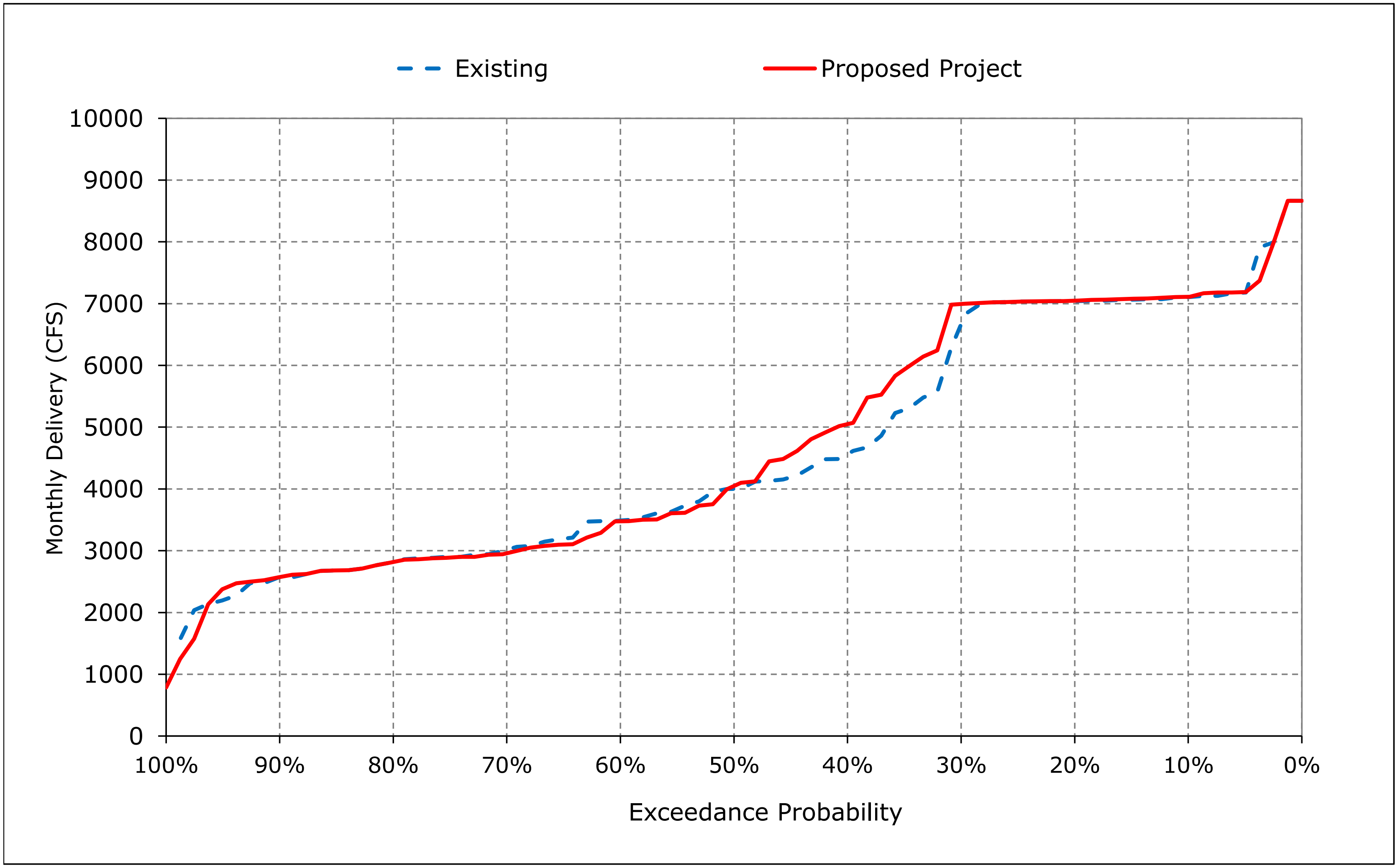


Figure 6-10. Banks PP Exports, January

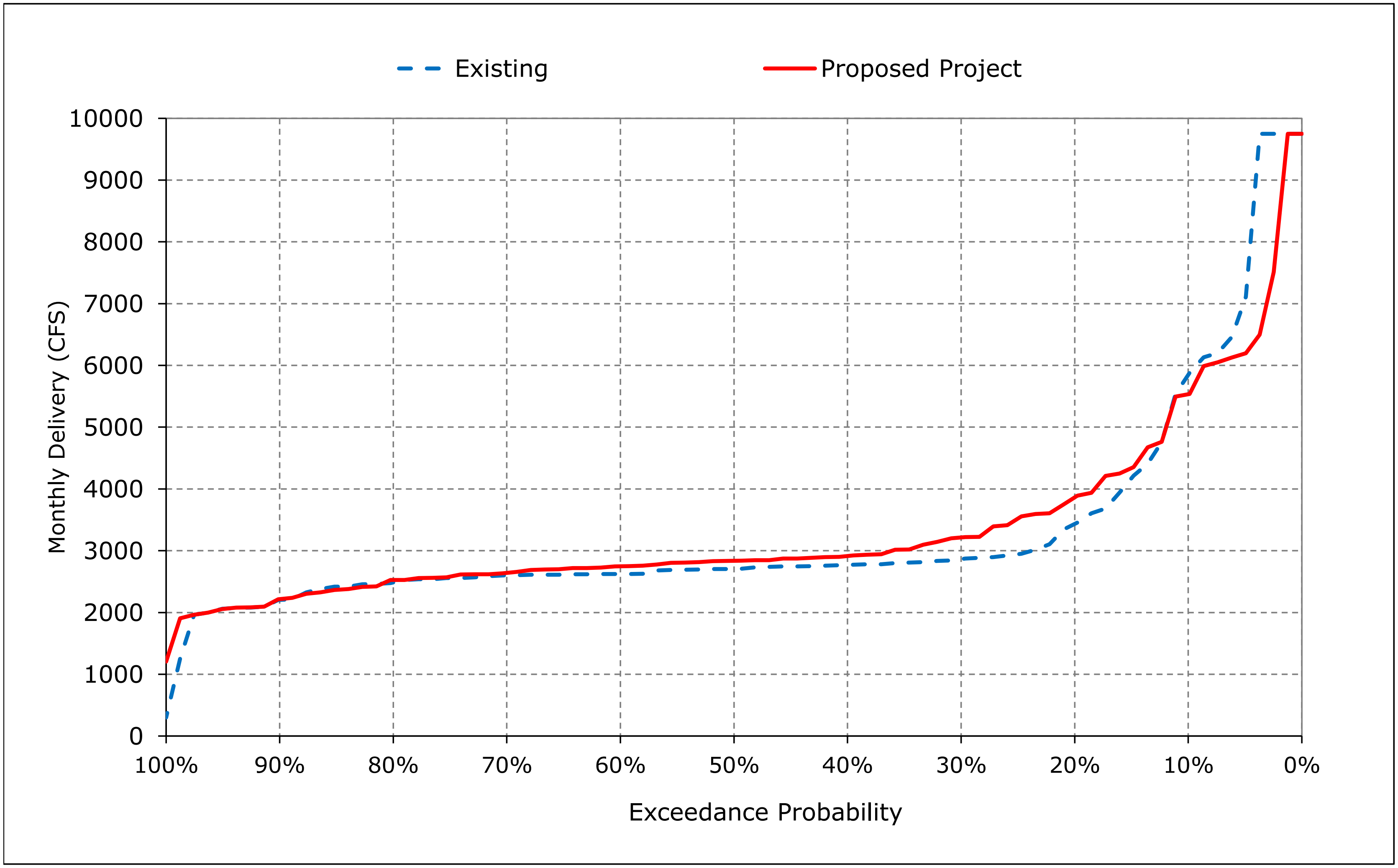


Figure 6-11. Banks PP Exports, February

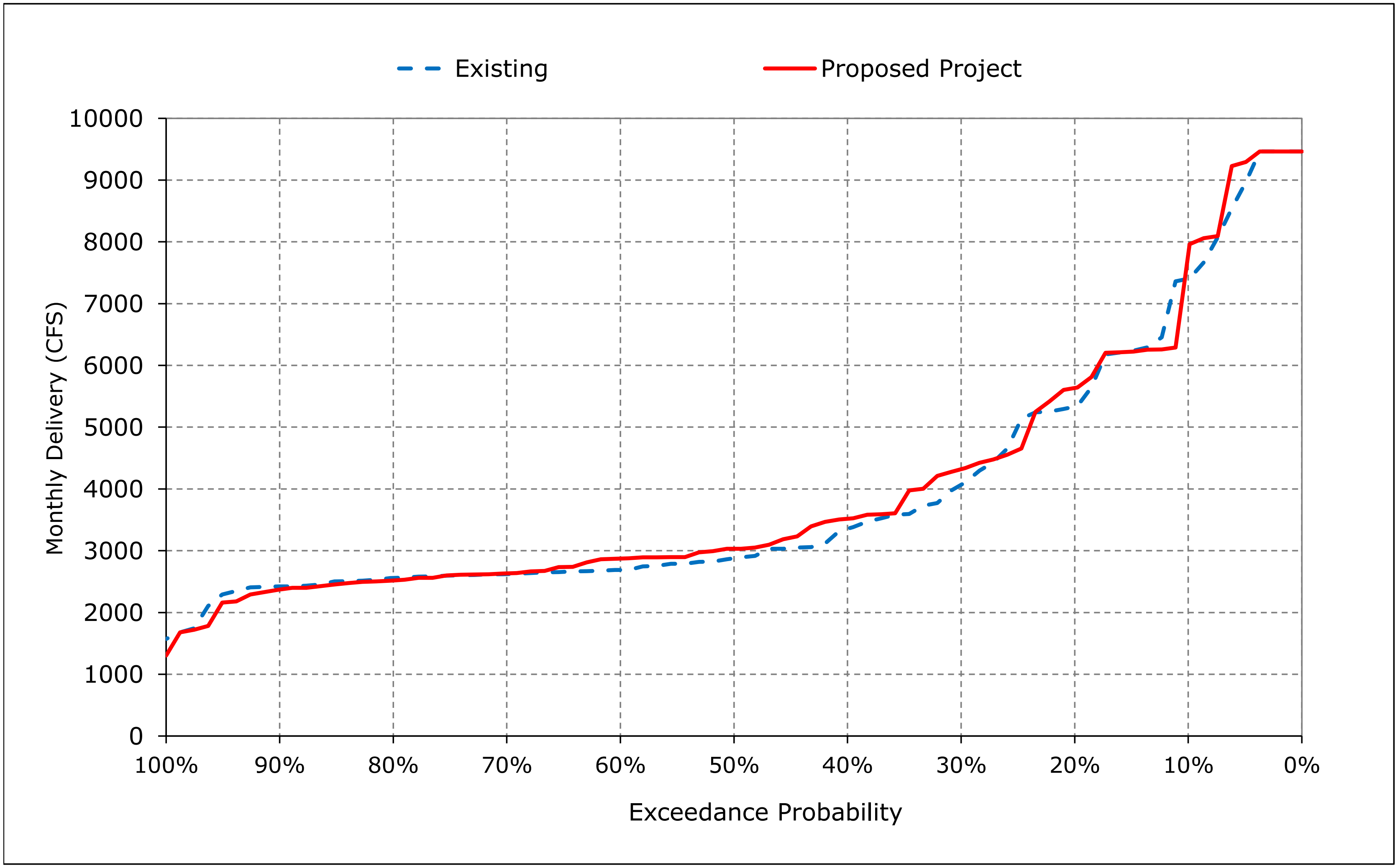


Figure 6-12. Banks PP Exports, March

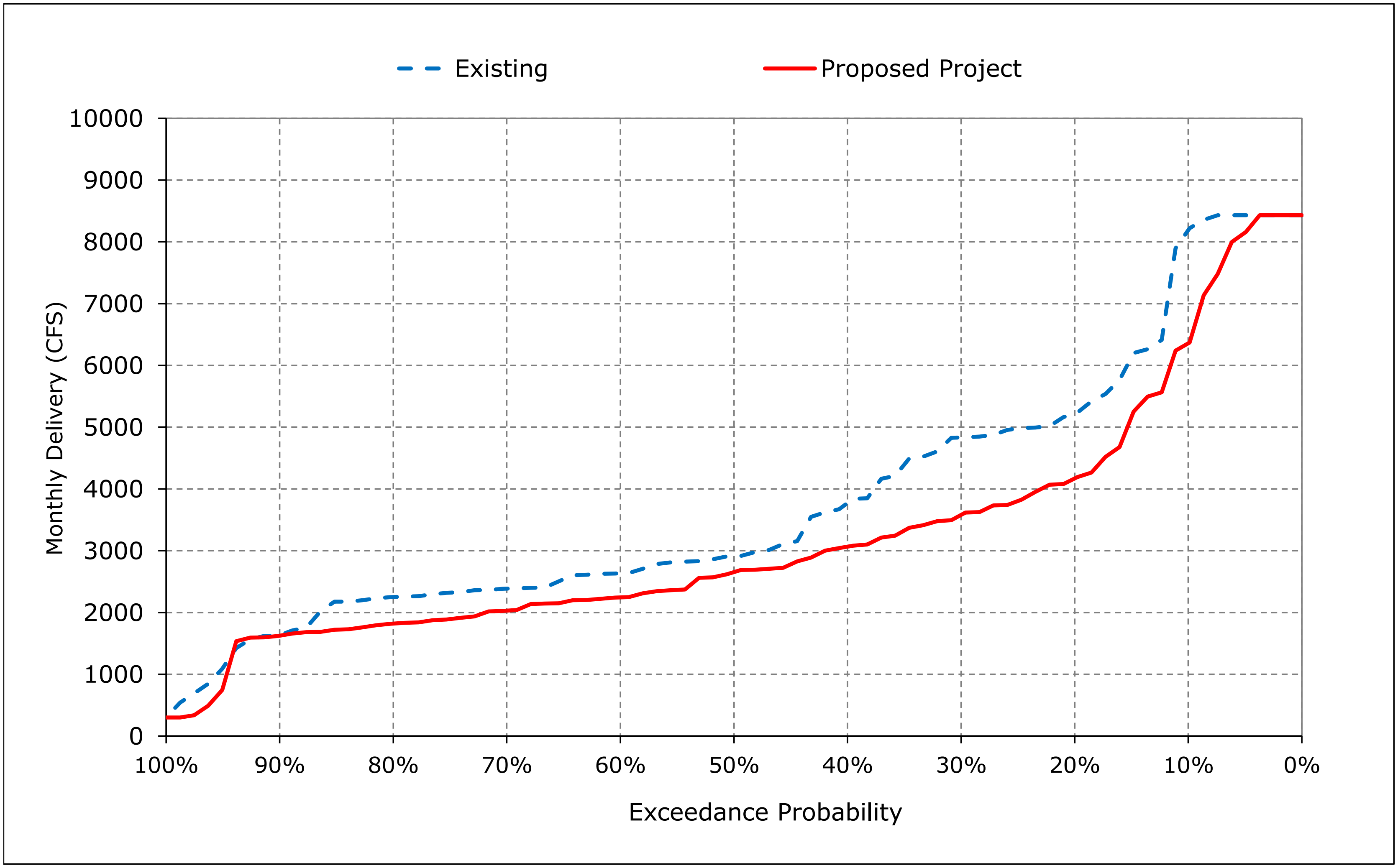


Figure 6-13. Banks PP Exports, April

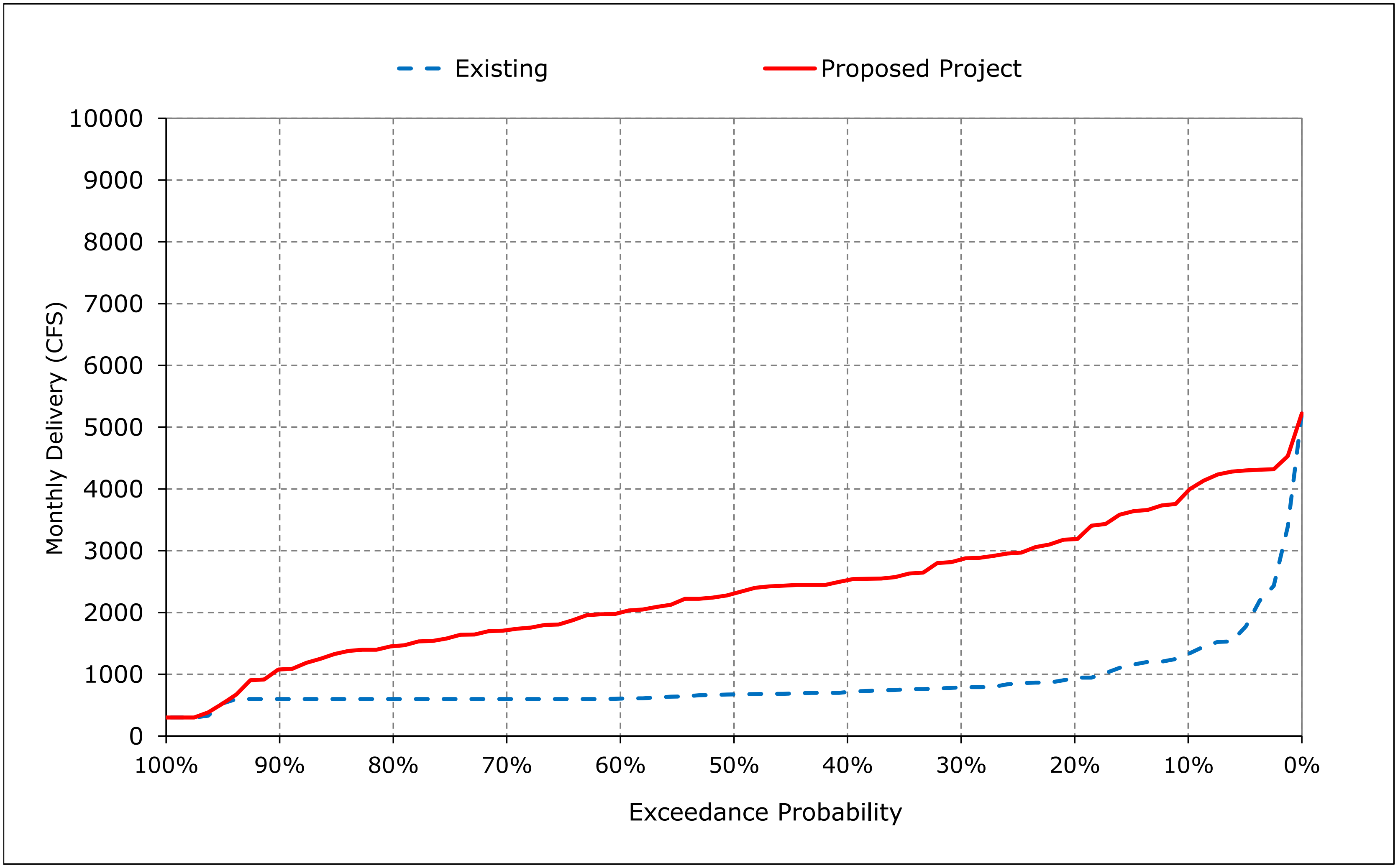


Figure 6-14. Banks PP Exports, May

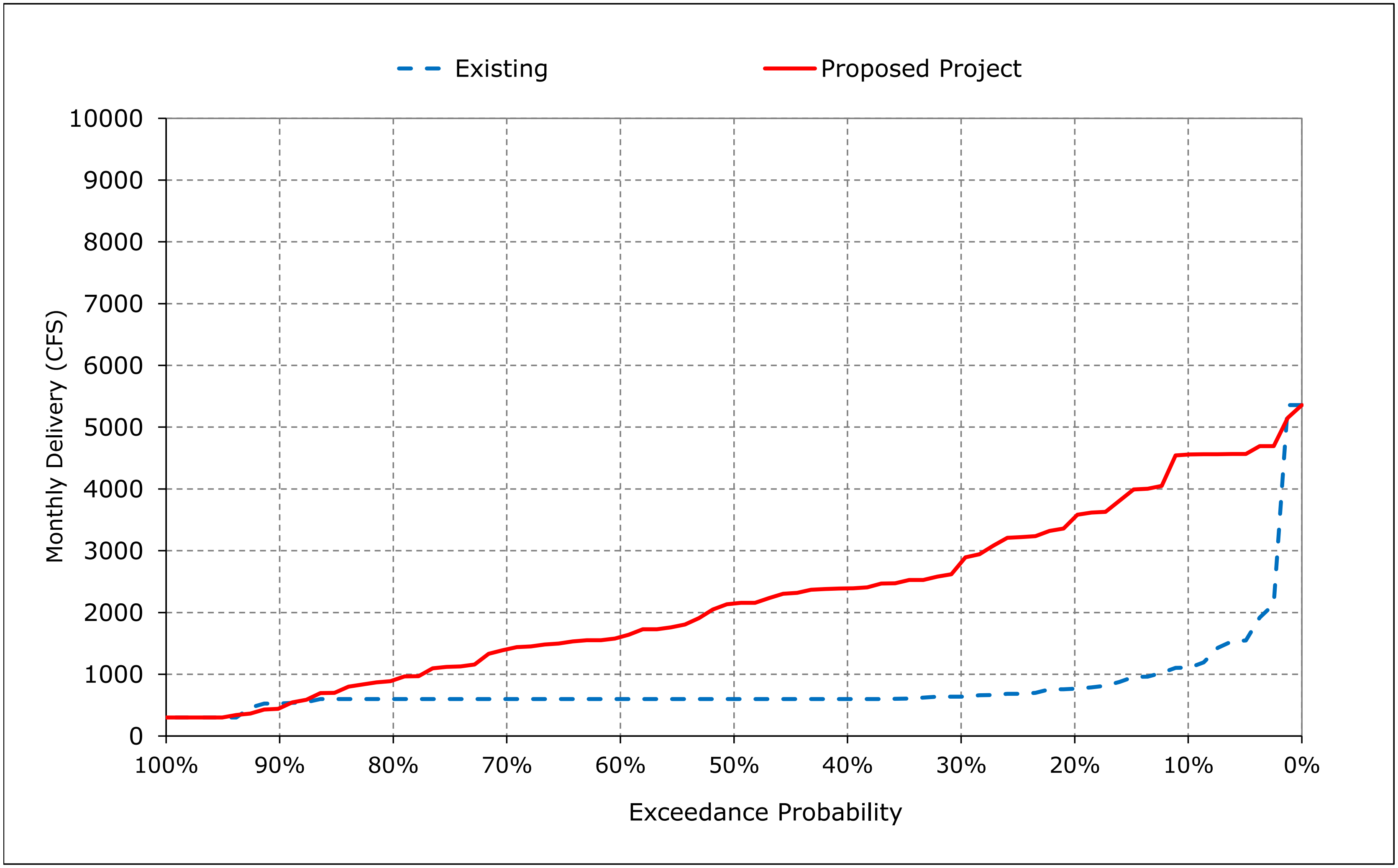


Figure 6-15. Banks PP Exports, June

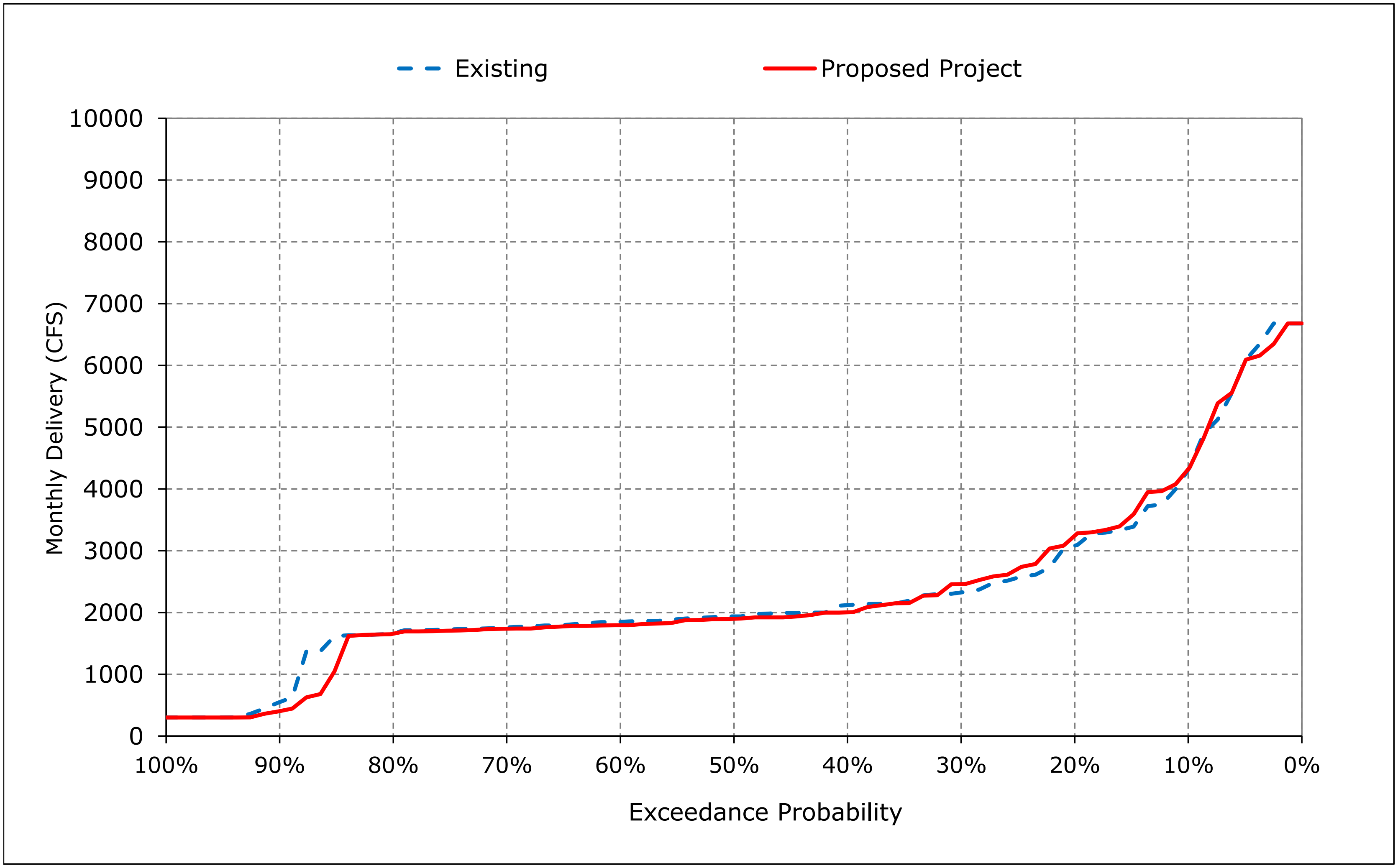


Figure 6-16. Banks PP Exports, July

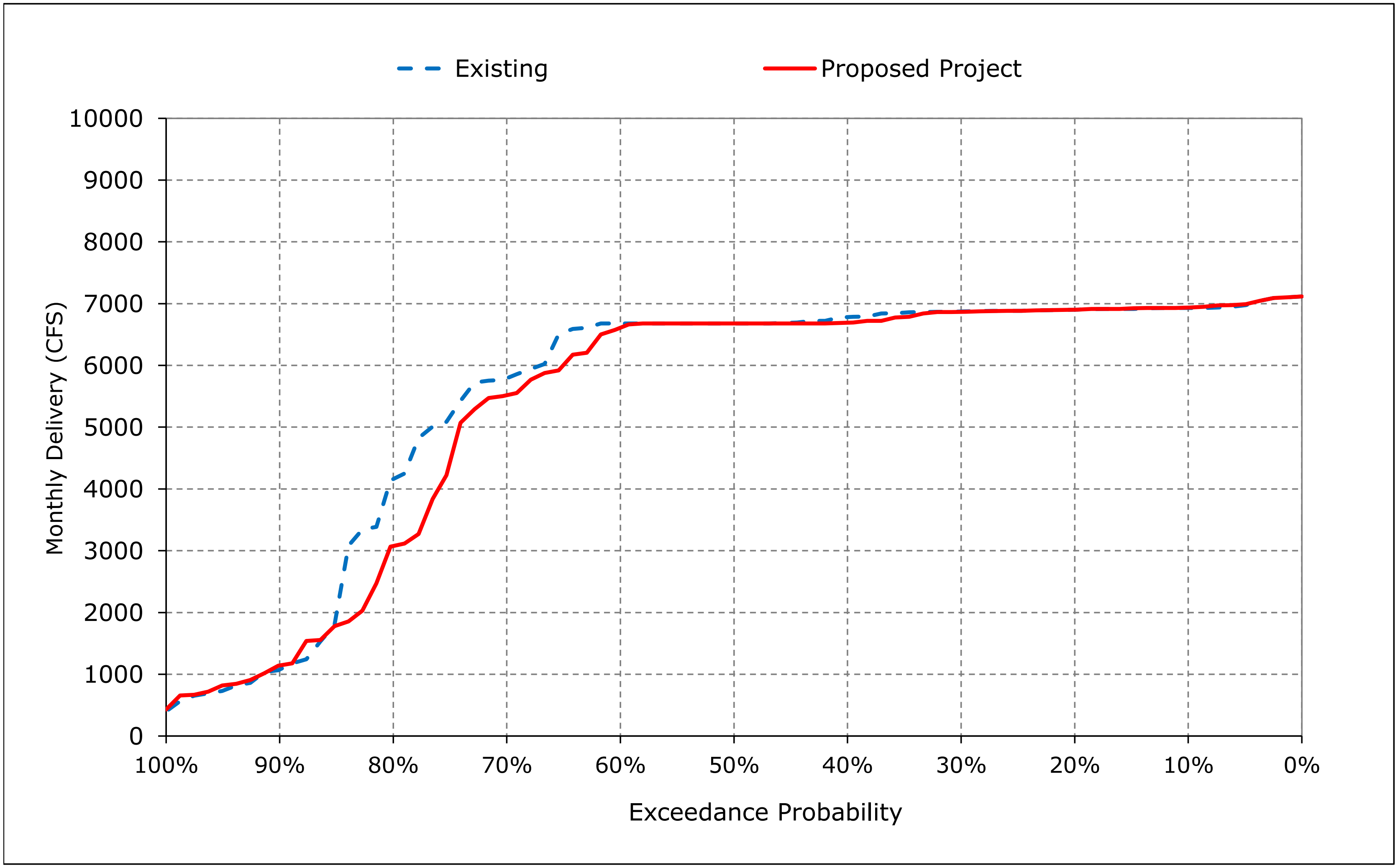


Figure 6-17. Banks PP Exports, August

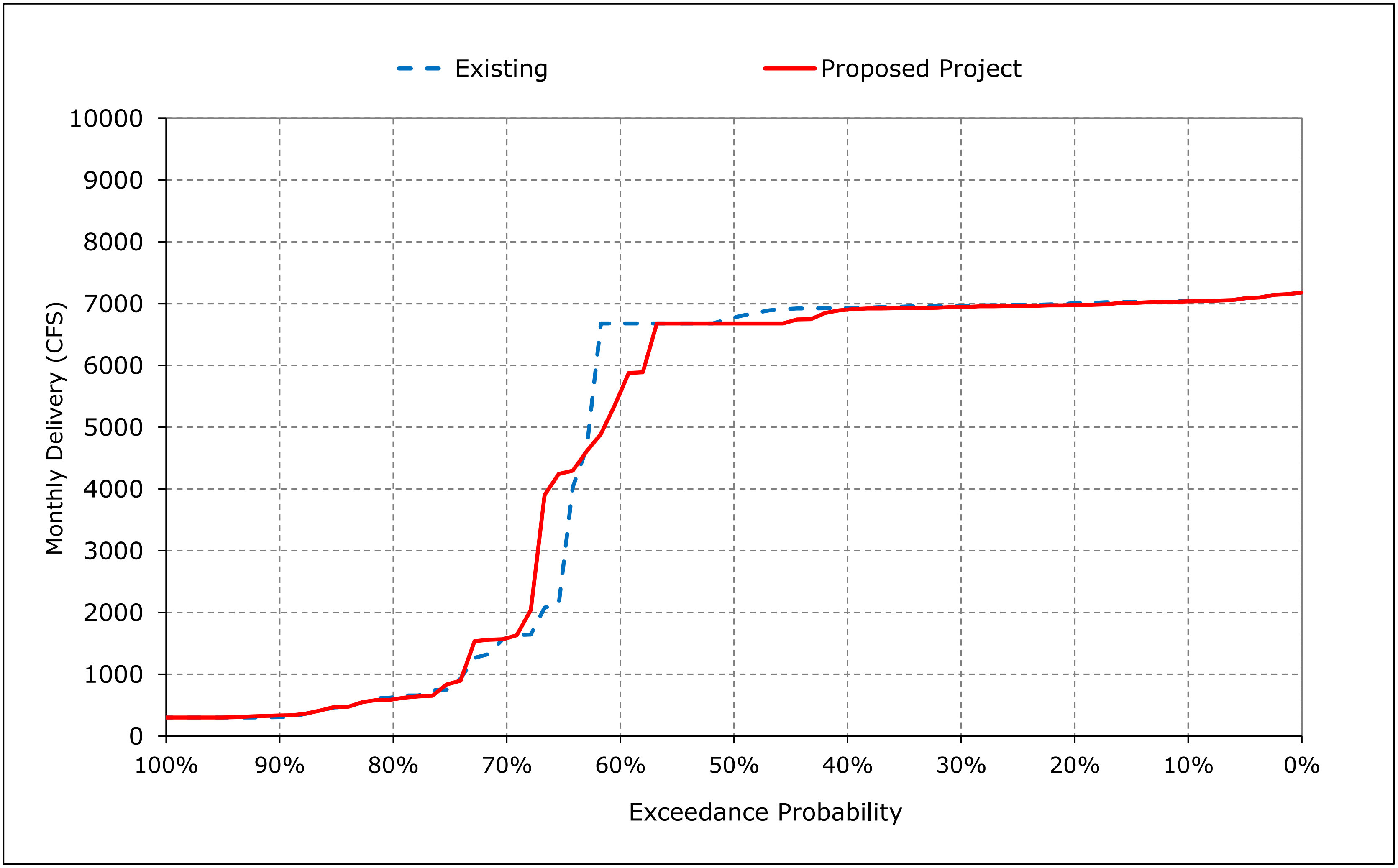


Figure 6-18. Banks PP Exports, September

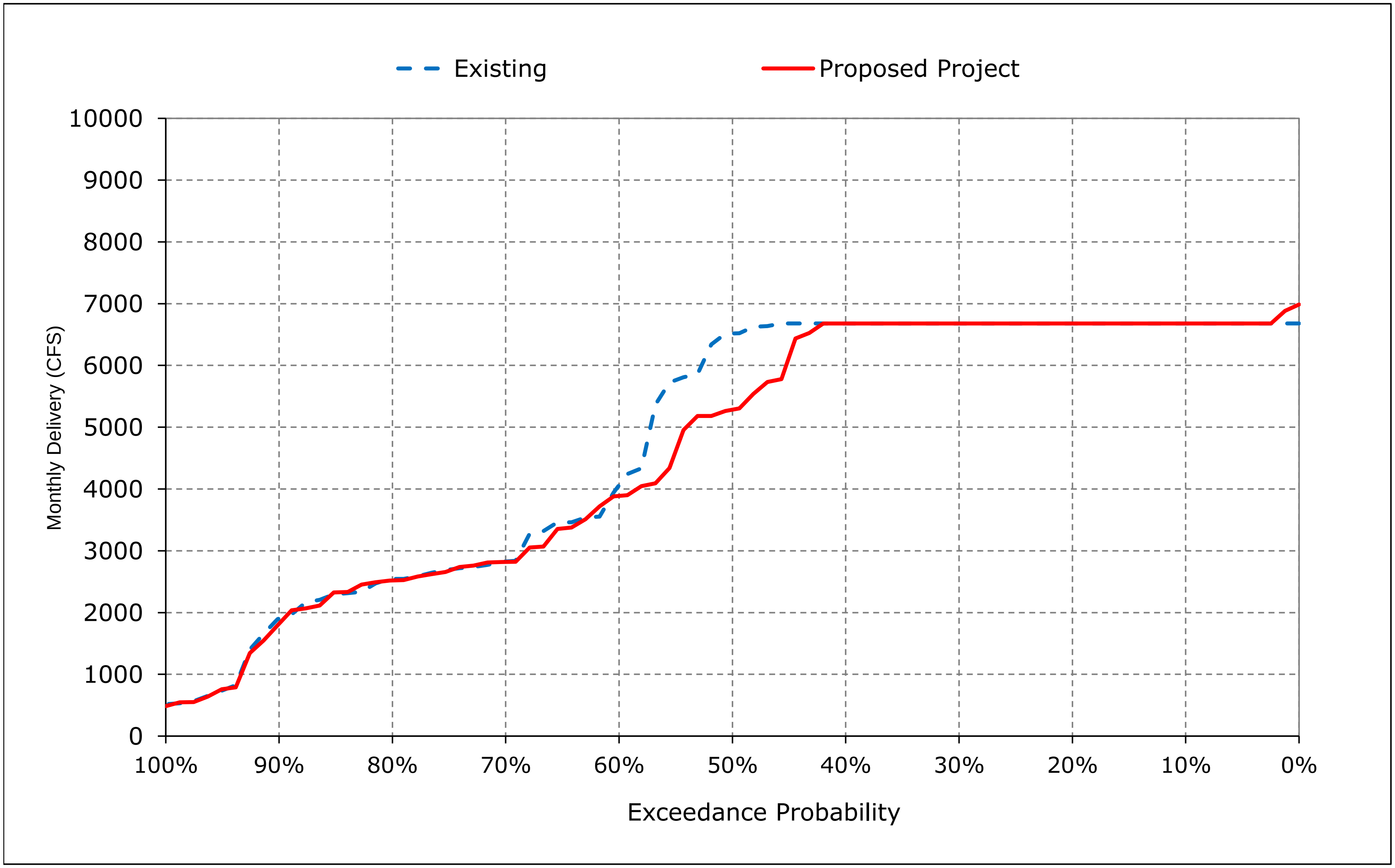


Table 7-1. Jones PP Exports, Monthly Delivery

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Delivery (CFS)											
Probability of Exceedance												
10%	4,600	4,600	4,600	4,600	4,600	4,600	1,804	1,659	4,600	4,600	4,600	4,600
20%	4,393	4,600	4,600	4,600	4,600	4,371	1,341	1,346	4,433	4,600	4,600	4,600
30%	4,114	4,579	4,600	4,287	4,600	4,031	1,165	1,172	3,703	4,600	4,600	4,600
40%	3,631	4,201	4,411	4,134	4,386	3,809	1,043	975	3,491	4,397	4,600	4,524
50%	3,499	3,913	4,327	4,049	4,184	3,534	948	900	3,408	3,972	4,241	4,443
60%	3,337	3,333	4,174	3,929	3,986	3,377	900	900	3,237	3,465	3,919	4,293
70%	3,189	2,639	3,987	3,864	3,896	3,115	900	900	3,179	3,235	3,650	3,979
80%	3,064	2,063	3,614	3,685	3,762	2,552	900	900	2,728	2,110	3,198	3,544
90%	2,878	1,760	2,571	3,122	3,607	1,913	820	900	1,820	1,385	2,175	3,088
Long Term												
Full Simulation Period[a]	3,573	3,430	3,990	3,972	4,115	3,429	1,180	1,202	3,328	3,510	3,853	4,083
Water Year Types[b,c]												
Wet (32%)	3,683	3,665	4,164	4,199	4,328	3,612	1,527	1,591	4,135	4,489	4,600	4,475
Above Normal (15%)	3,409	3,543	4,101	3,983	4,132	3,917	1,059	984	3,771	3,815	4,360	4,422
Below Normal (17%)	3,541	3,525	4,023	3,912	4,285	3,515	980	948	3,317	3,625	3,518	4,401
Dry (22%)	3,670	3,331	4,064	3,881	3,870	3,416	1,118	992	2,963	3,251	3,308	4,006
Critical (15%)	3,389	2,843	3,357	3,673	3,807	2,461	878	1,190	1,698	1,335	2,936	2,639

Proposed Project

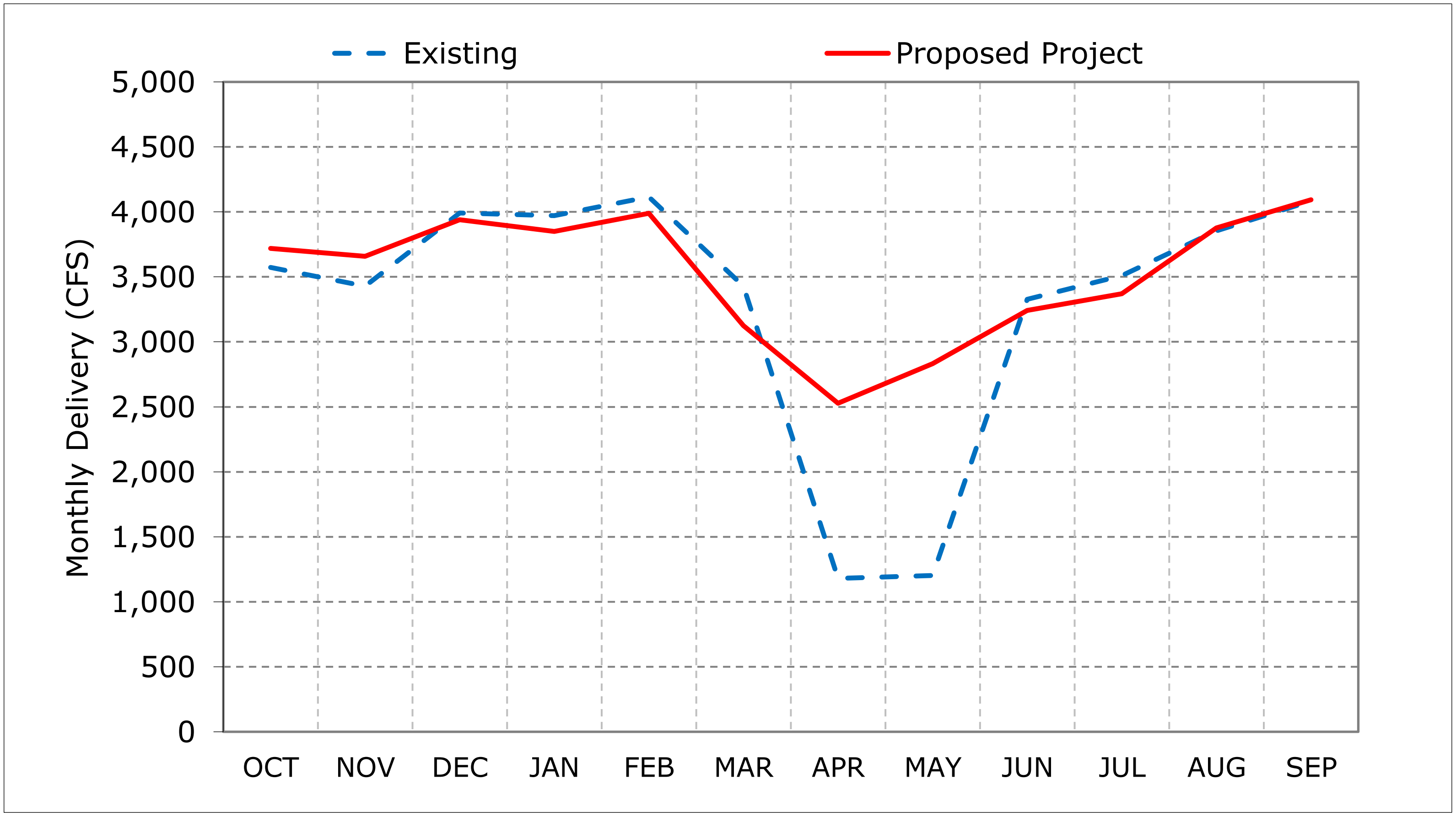
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Delivery (CFS)											
Probability of Exceedance												
10%	4,600	4,600	4,600	4,600	4,600	4,600	3,781	3,942	4,600	4,600	4,600	4,600
20%	4,600	4,600	4,600	4,479	4,600	4,139	3,501	3,901	4,430	4,600	4,600	4,600
30%	4,600	4,600	4,600	4,297	4,600	3,560	3,143	3,459	3,568	4,600	4,600	4,600
40%	4,400	4,600	4,509	4,209	4,390	3,274	2,733	3,241	3,410	4,174	4,600	4,600
50%	3,765	4,243	4,321	4,079	4,107	3,027	2,511	2,879	3,300	3,816	4,348	4,584
60%	3,439	3,929	4,214	3,924	3,935	2,819	2,114	2,581	3,201	3,309	3,950	4,480
70%	3,166	3,127	3,929	3,636	3,761	2,701	1,877	2,309	3,057	2,852	3,737	3,923
80%	2,966	2,430	3,354	3,250	3,587	2,423	1,599	1,673	2,554	1,897	3,082	3,449
90%	2,790	1,860	2,490	2,949	3,032	1,879	1,258	1,435	1,685	1,235	2,515	3,033
Long Term												
Full Simulation Period[a]	3,719	3,659	3,940	3,850	3,990	3,124	2,528	2,833	3,242	3,370	3,877	4,093
Water Year Types[b,c]												
Wet (32%)	3,909	3,770	4,120	3,988	3,933	3,459	3,364	3,634	4,078	4,399	4,600	4,491
Above Normal (15%)	3,603	3,682	4,057	4,011	4,100	3,660	3,033	3,264	3,685	3,893	4,427	4,330
Below Normal (17%)	3,833	3,929	3,832	3,878	4,266	2,905	2,416	3,037	3,235	3,182	3,468	4,499
Dry (22%)	3,715	3,544	4,021	3,829	3,943	2,860	2,007	2,161	2,867	2,999	3,288	3,992
Critical (15%)	3,293	3,255	3,439	3,389	3,750	2,513	1,122	1,436	1,561	1,390	3,123	2,673

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Delivery (CFS)											
Probability of Exceedance												
10%	0	0	0	0	0	0	1,978	2,283	0	0	0	0
20%	207	0	0	**-121**	0	**-232**	2,159	2,555	**-4**	0	0	0
30%	486	21	0	10	0	**-471**	1,978	2,286	**-134**	0	0	0
40%	769	399	98	76	4	**-536**	1,689	2,266	**-81**	**-223**	0	76
50%	266	330	**-6**	30	**-77**	**-507**	1,562	1,979	**-108**	**-156**	107	141
60%	102	597	40	**-6**	**-51**	**-558**	1,214	1,681	**-36**	**-157**	30	186
70%	**-23**	488	**-58**	**-228**	**-135**	**-414**	977	1,409	**-122**	**-384**	87	**-55**
80%	**-98**	367	**-260**	**-435**	**-175**	**-128**	699	773	**-174**	**-213**	**-116**	**-95**
90%	**-88**	100	**-80**	**-174**	**-576**	**-34**	438	535	**-135**	**-149**	340	**-55**
Long Term												
Full Simulation Period[a]	146	230	**-50**	**-122**	**-125**	**-305**	1,347	1,631	**-86**	**-140**	24	10
Water Year Types[b,c]												
Wet (32%)	227	105	**-44**	**-211**	**-395**	**-153**	1,837	2,043	**-58**	**-90**	0	16
Above Normal (15%)	195	139	**-44**	28	**-32**	**-257**	1,974	2,281	**-86**	78	67	**-92**
Below Normal (17%)	292	404	**-191**	**-34**	**-19**	**-610**	1,436	2,089	**-82**	**-443**	**-50**	99
Dry (22%)	44	213	**-44**	**-52**	74	**-556**	889	1,168	**-96**	**-252**	**-20**	**-14**
Critical (15%)	**-96**	412	82	**-284**	**-57**	52	244	246	**-137**	55	187	34

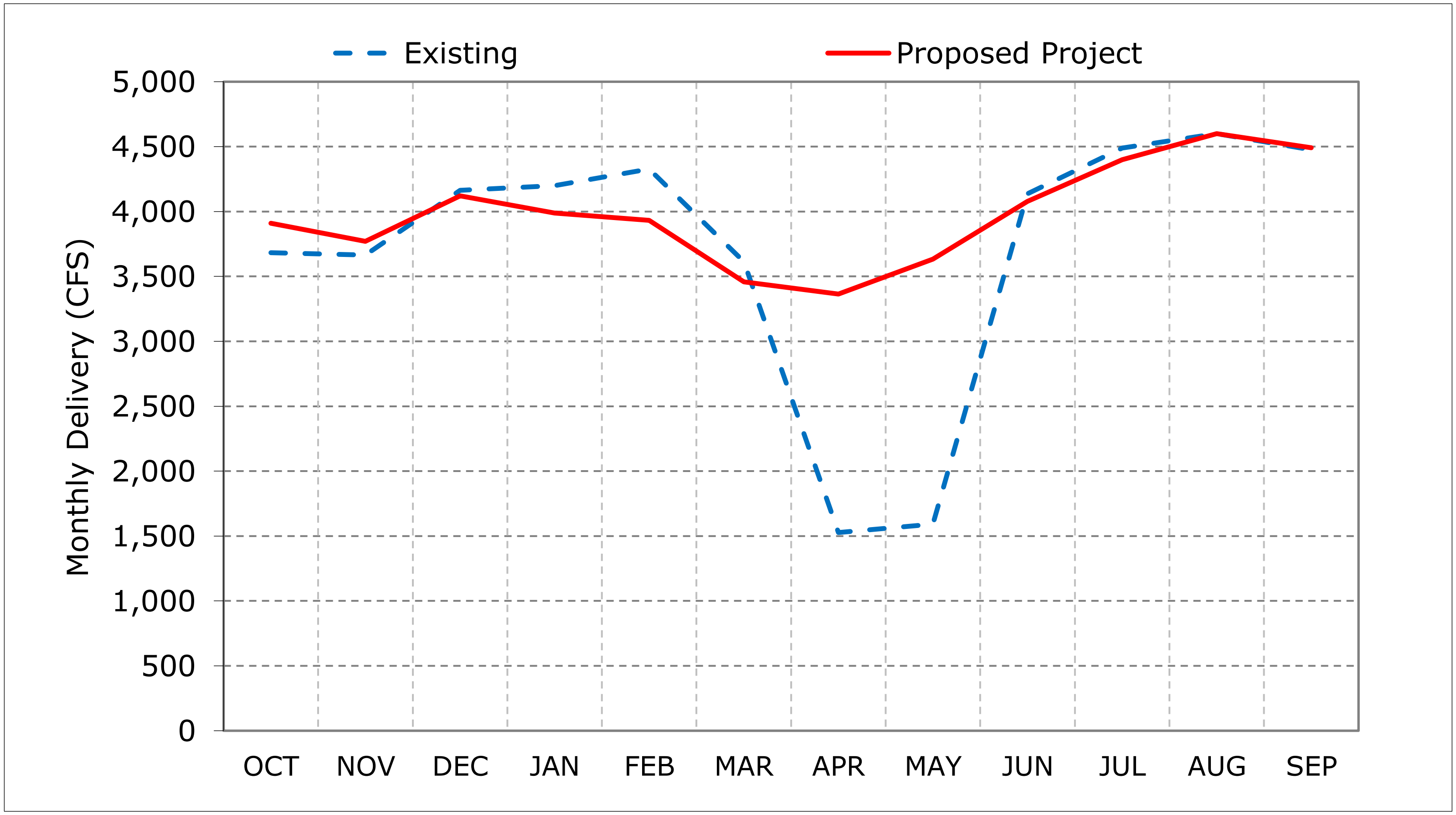
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.

Figure 7-1. Jones PP Exports, Long-Term Average Delivery



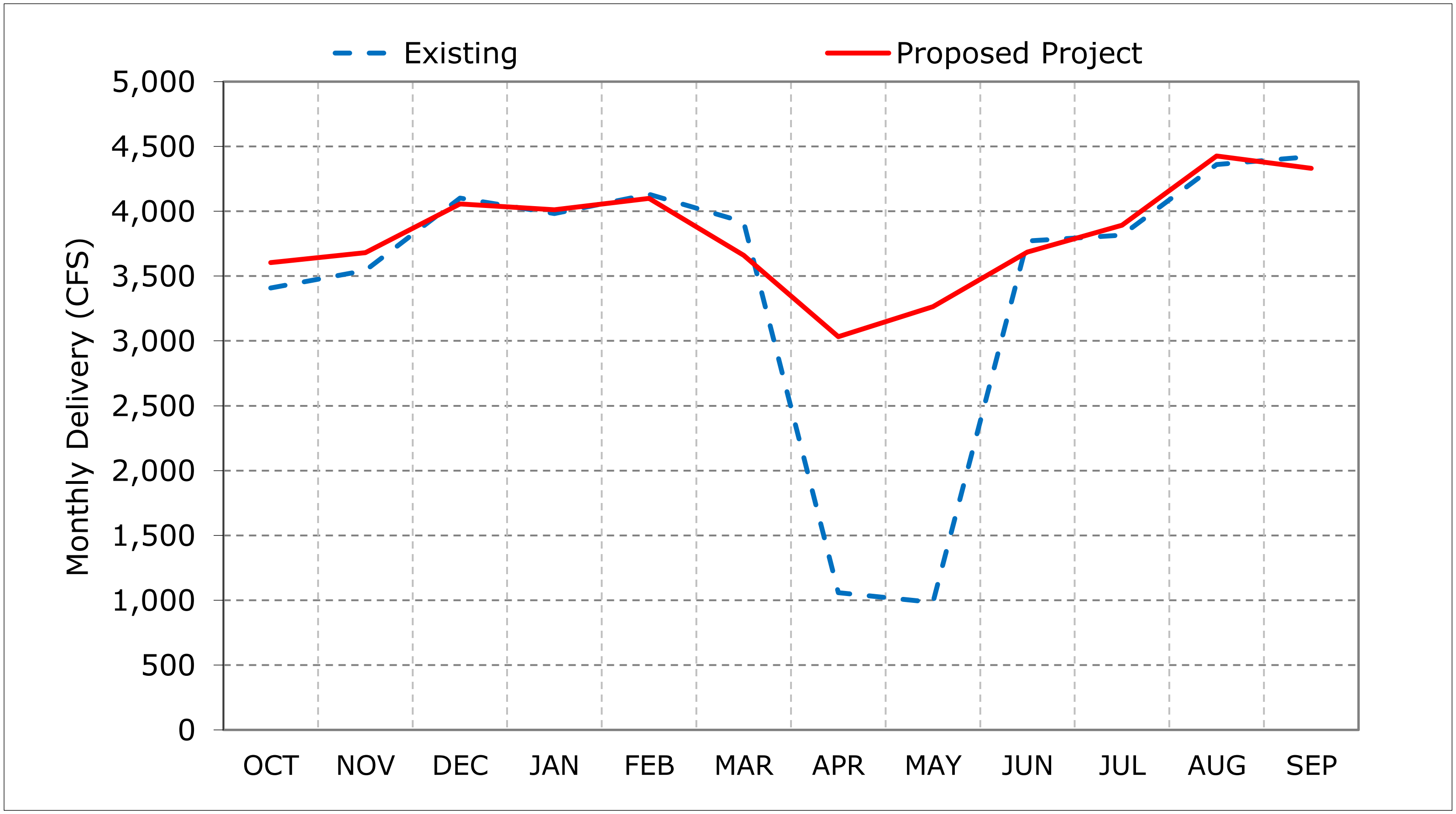
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 7-2. Jones PP Exports, Wet Year Average Delivery



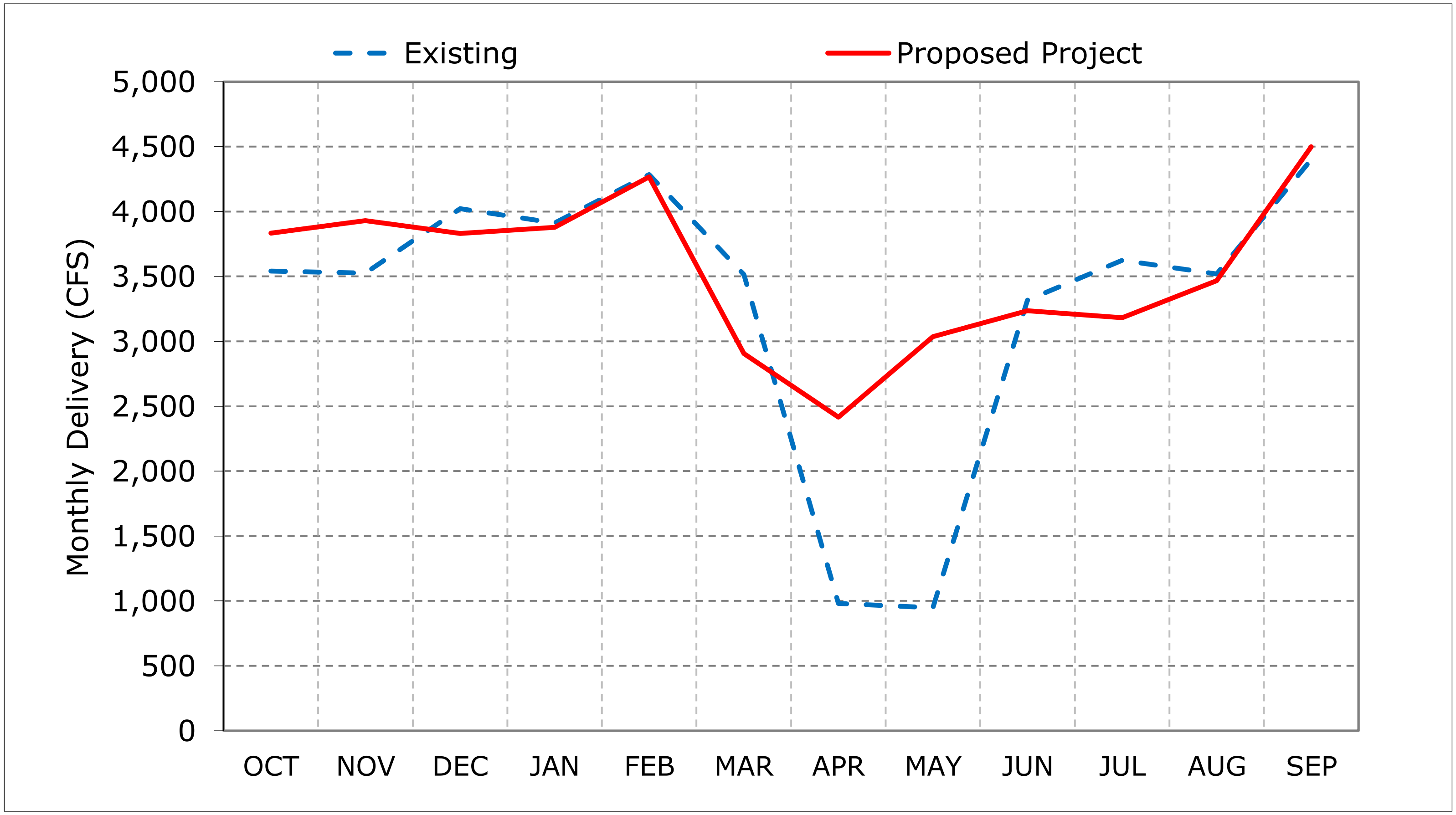
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 7-3. Jones PP Exports, Above Normal Year Average Delivery



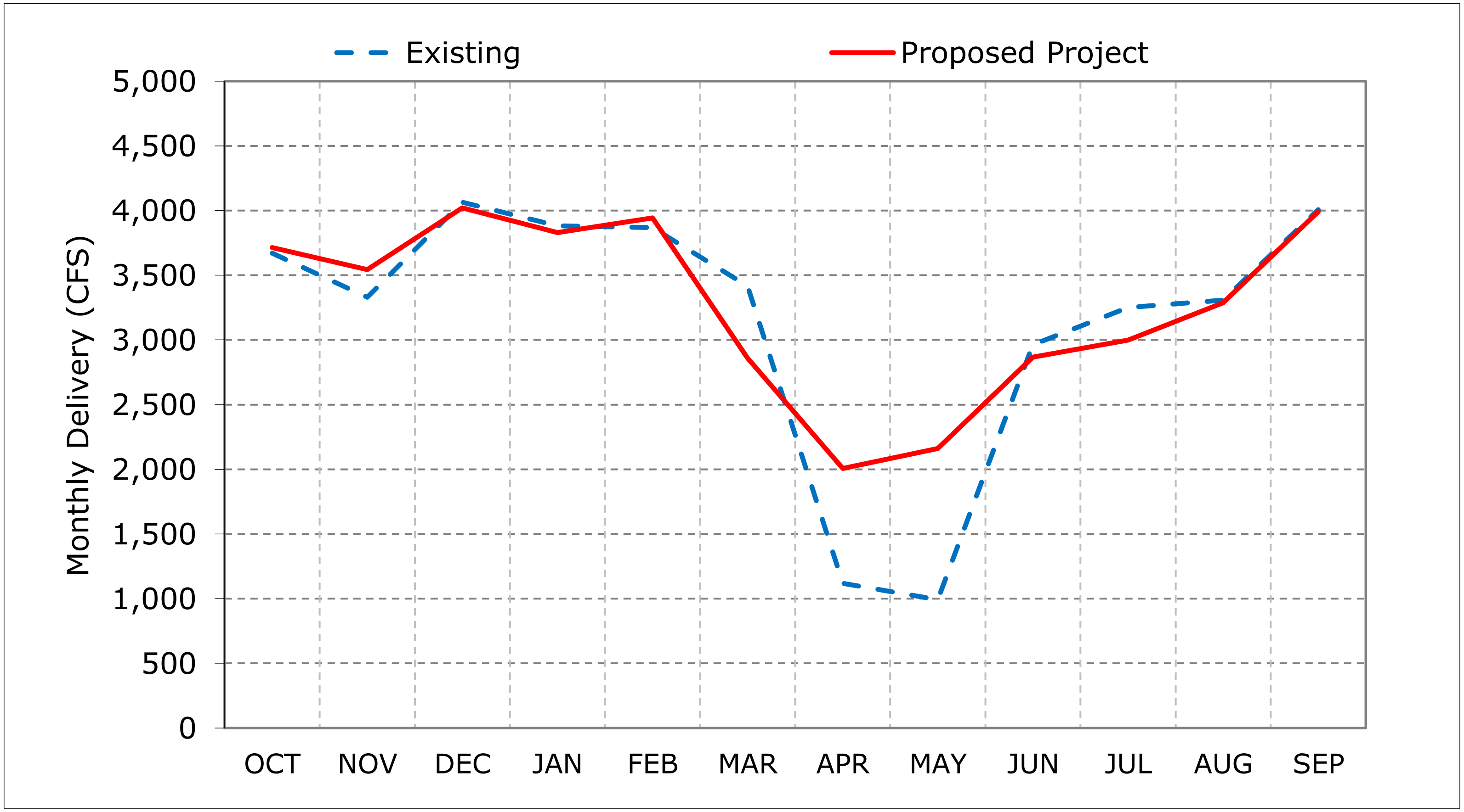
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 7-4. Jones PP Exports, Below Normal Year Average Delivery



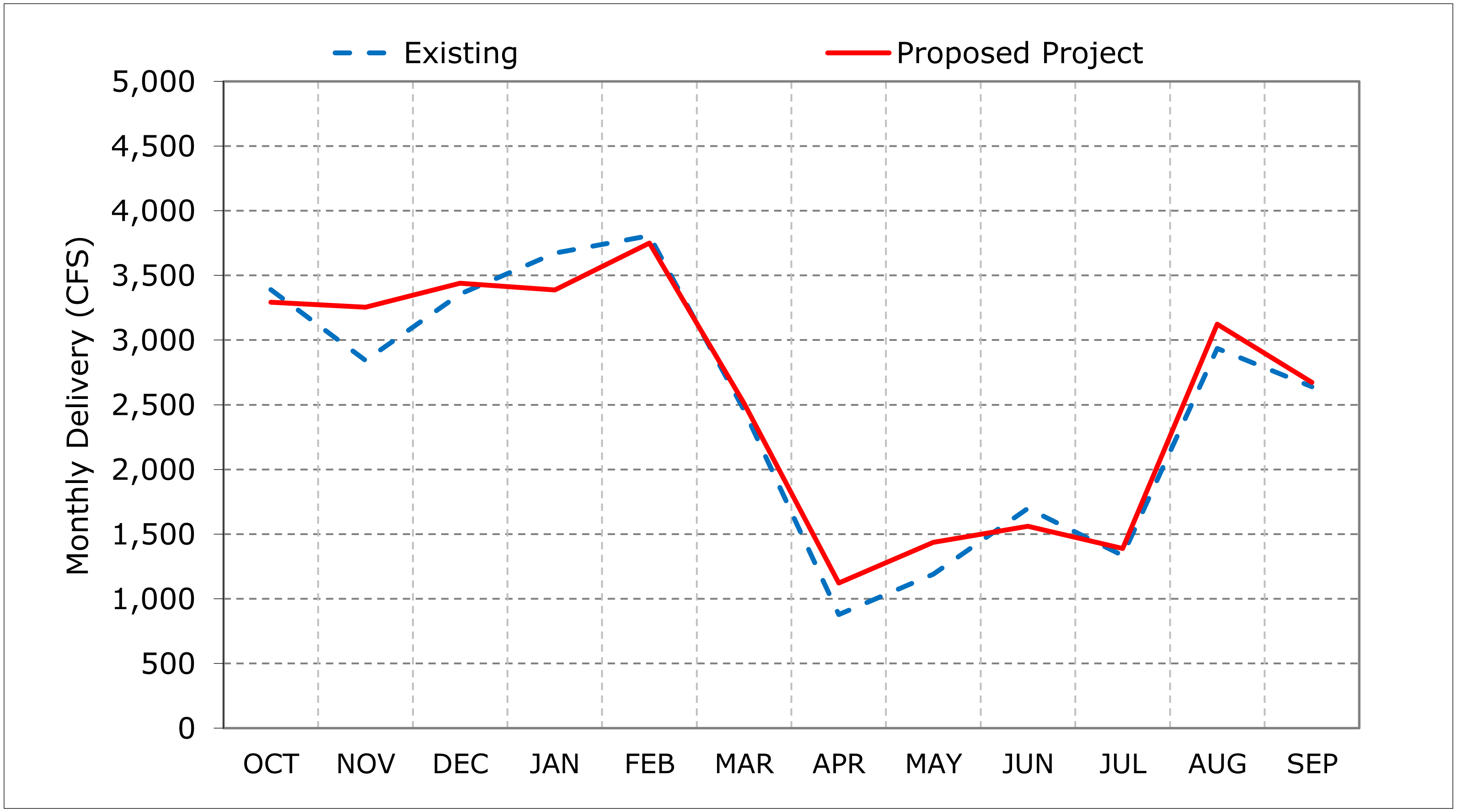
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 7-5. Jones PP Exports, Dry Year Average Delivery



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 7-6. Jones PP Exports, Critical Year Average Delivery



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 7-7. Jones PP Exports, October

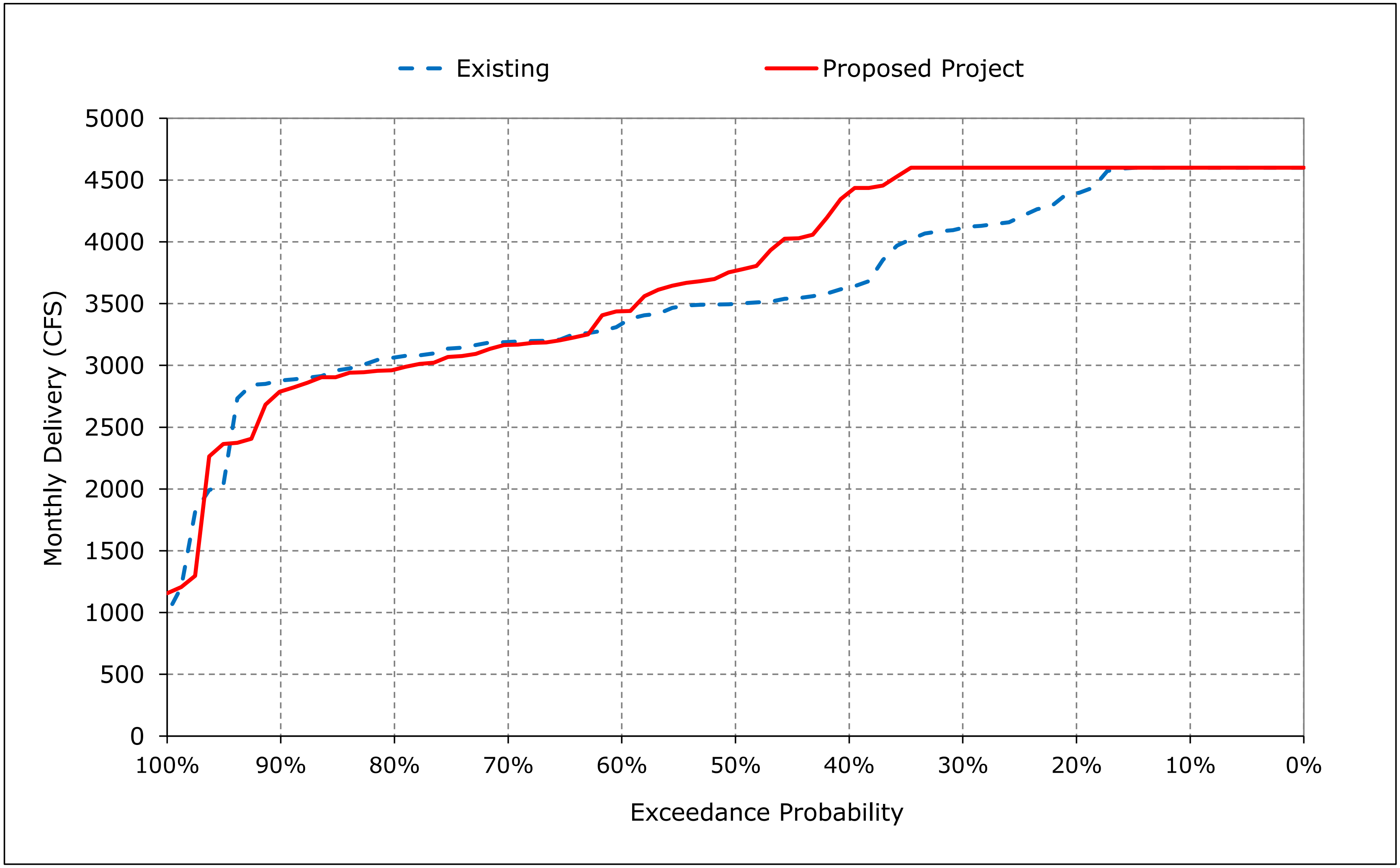


Figure 7-8. Jones PP Exports, November

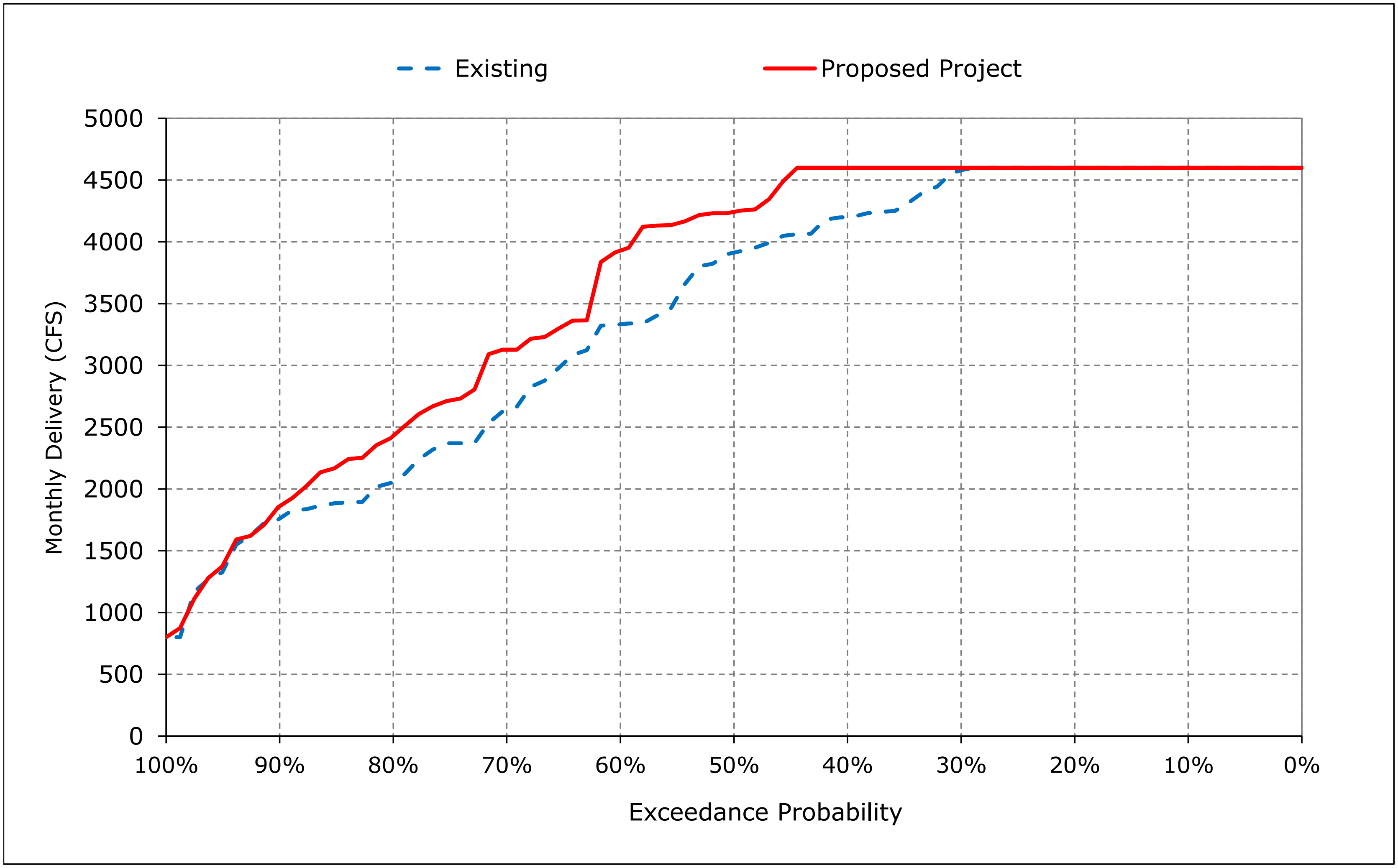


Figure 7-9. Jones PP Exports, December

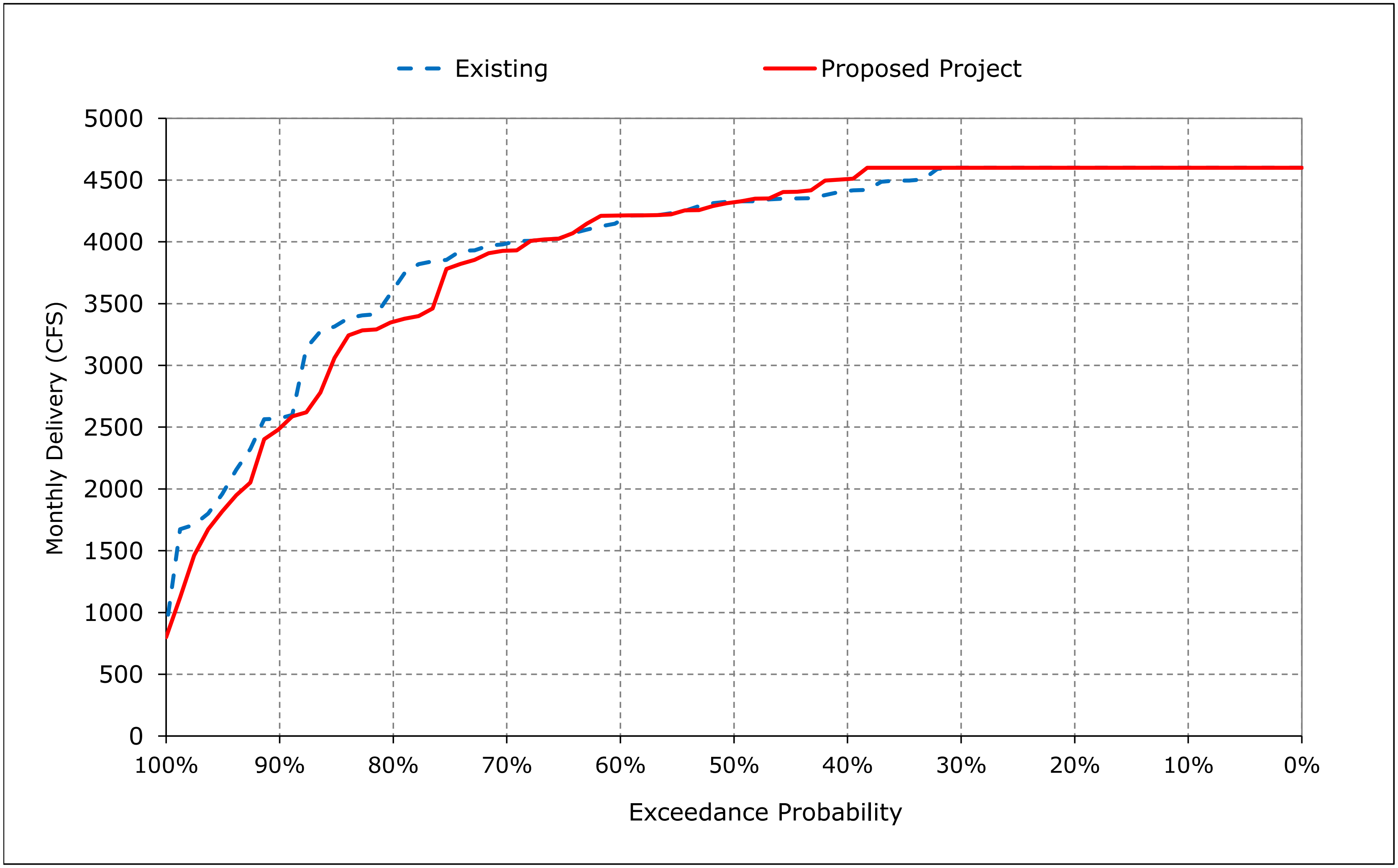


Figure 7-10. Jones PP Exports, January

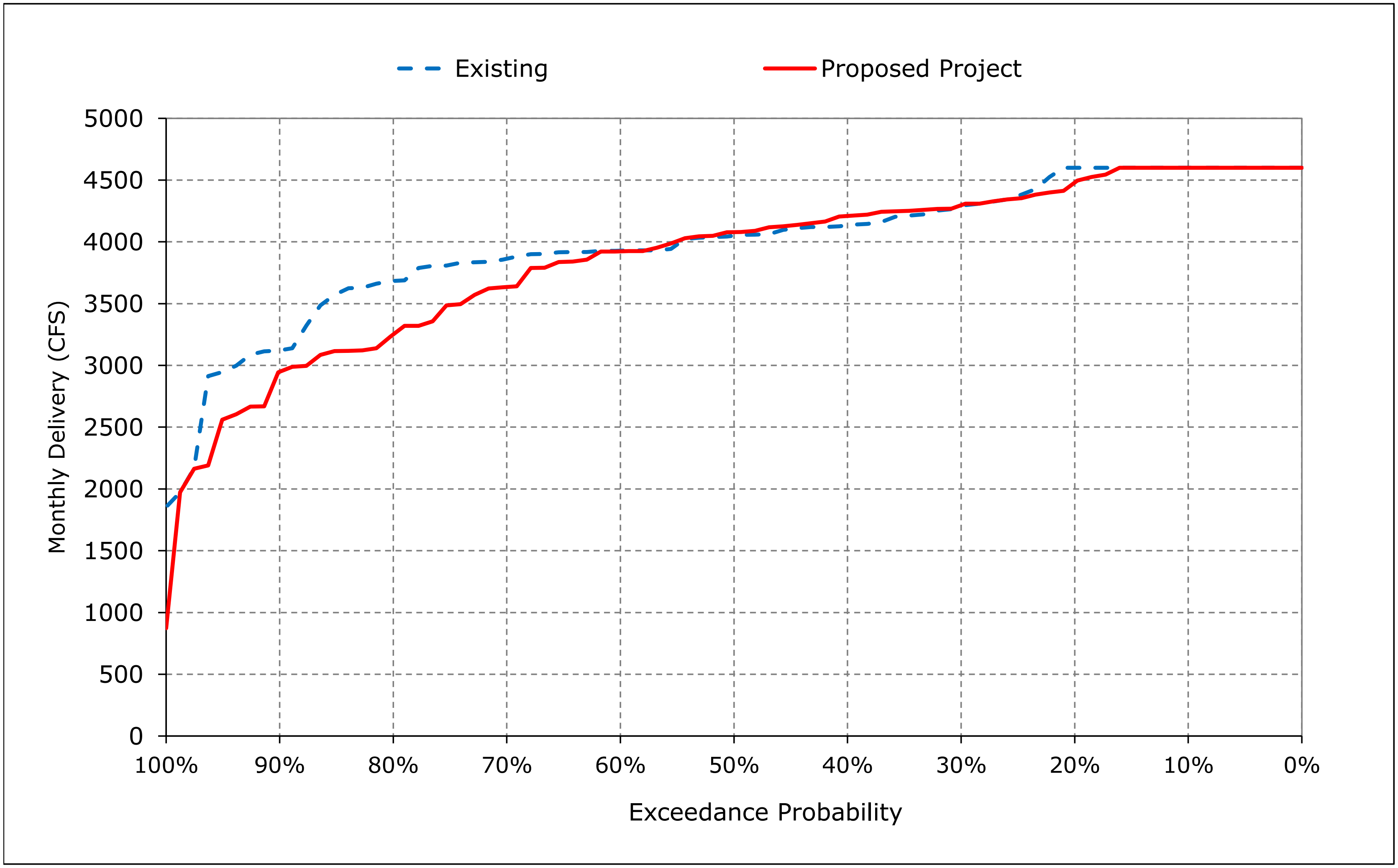


Figure 7-11. Jones PP Exports, February

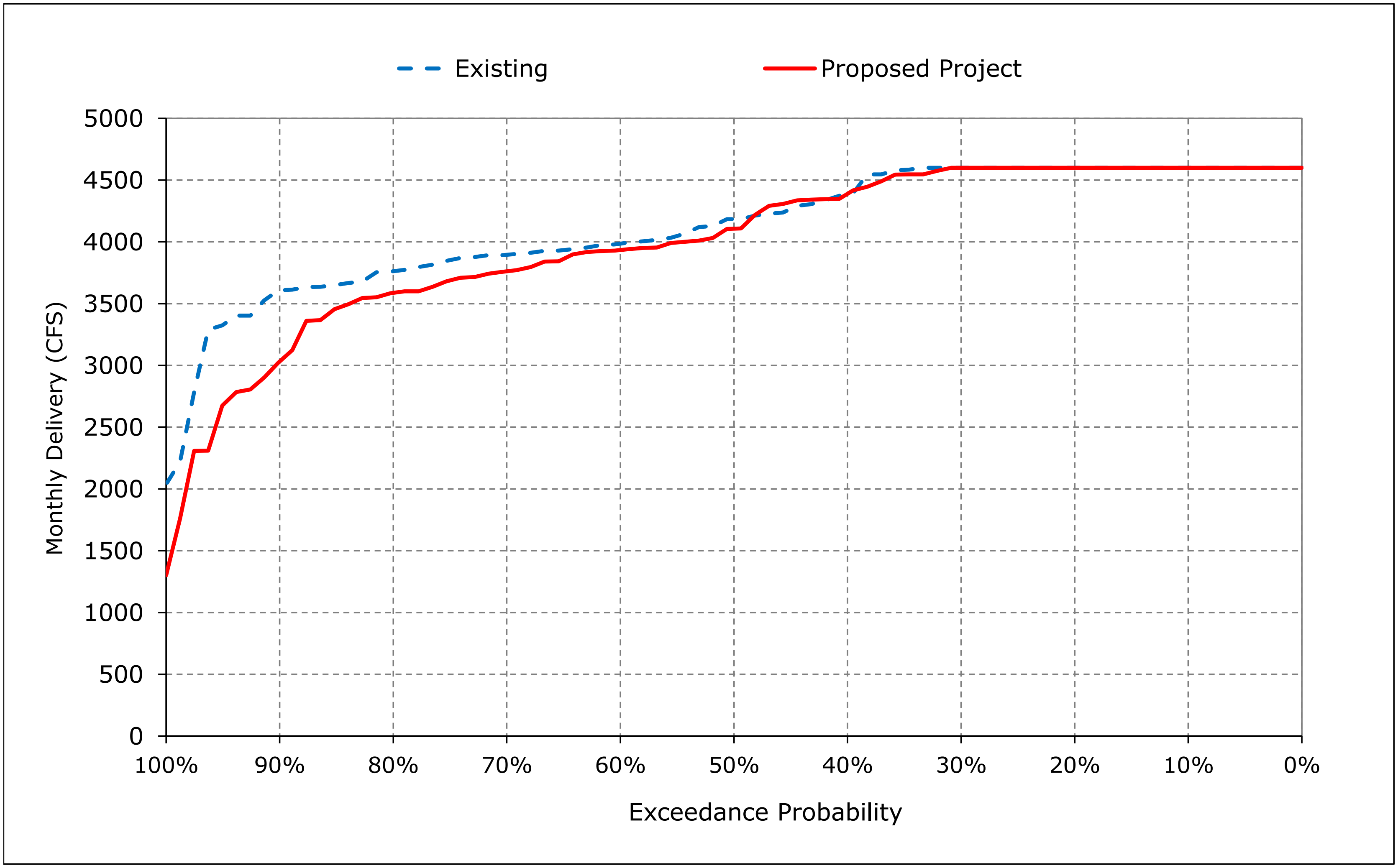


Figure 7-12. Jones PP Exports, March

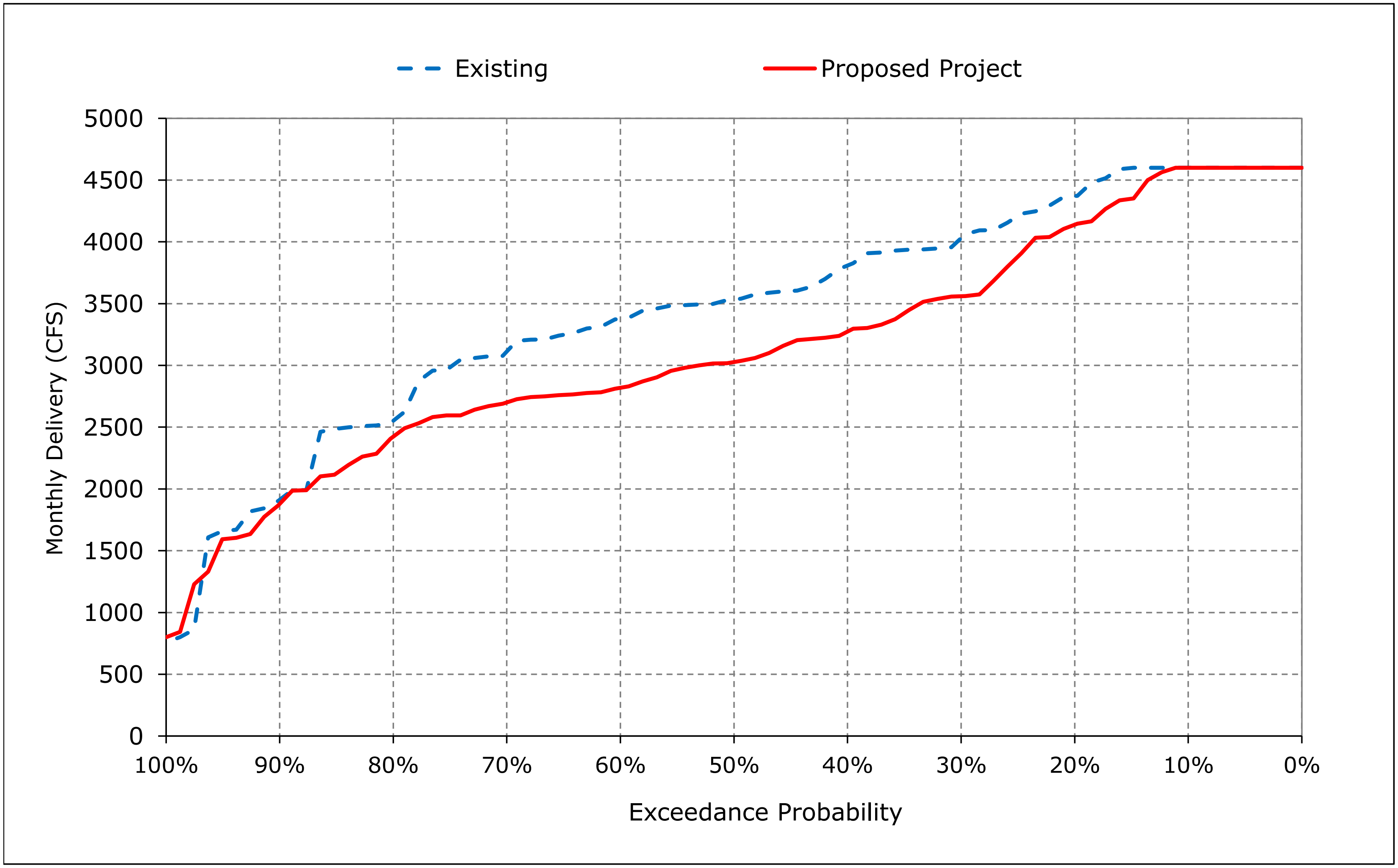


Figure 7-13. Jones PP Exports, April

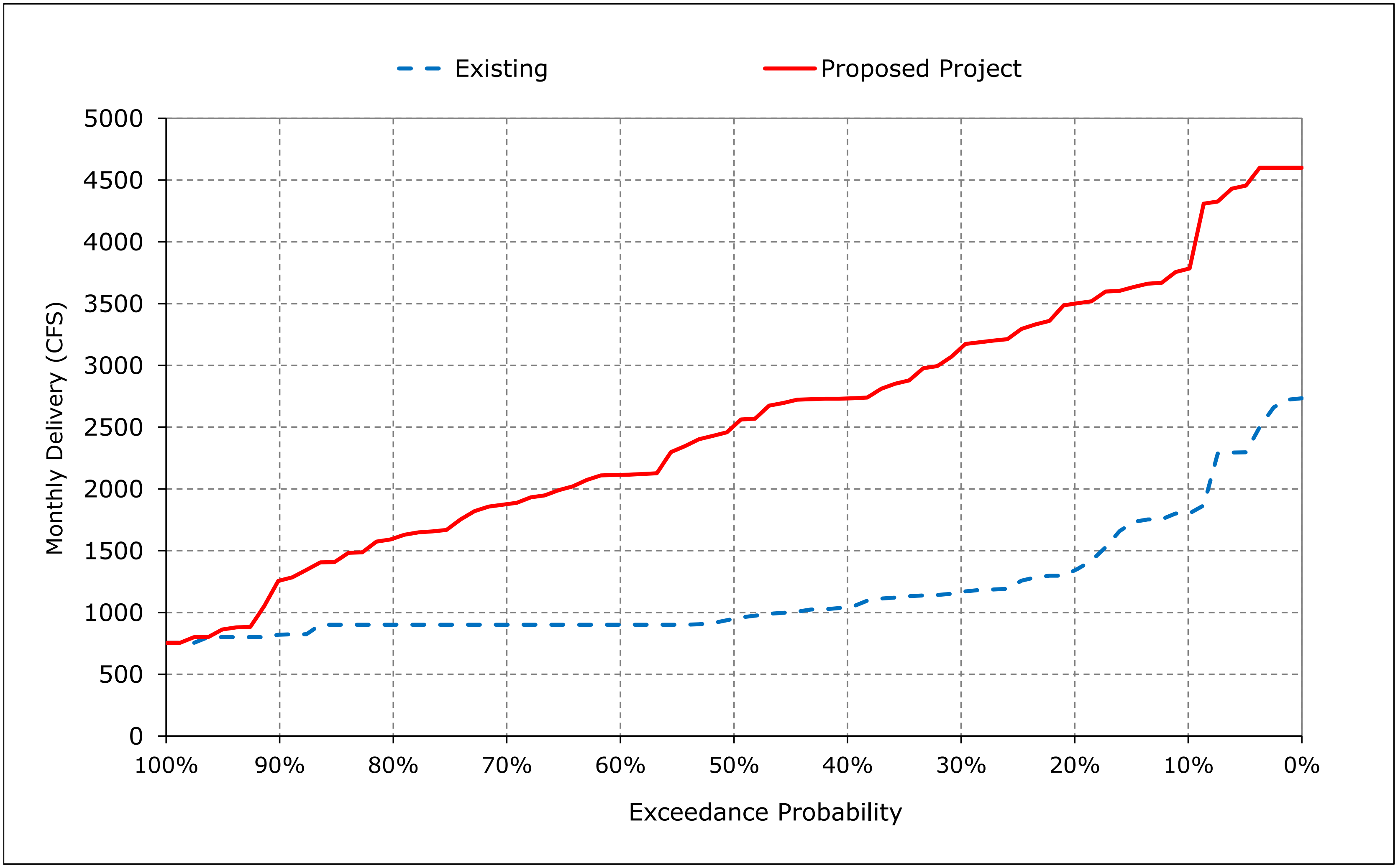


Figure 7-14. Jones PP Exports, May

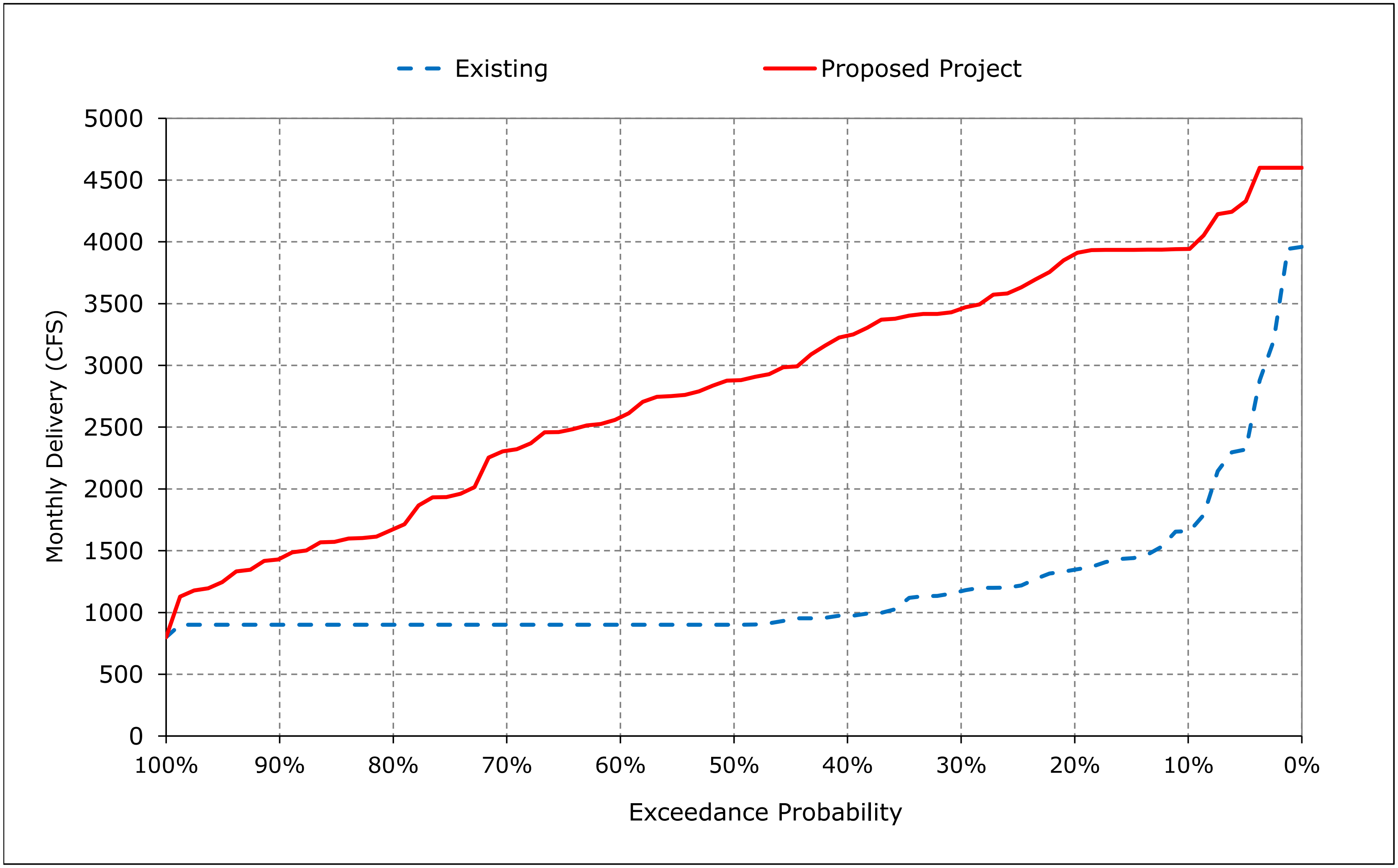


Figure 7-15. Jones PP Exports, June

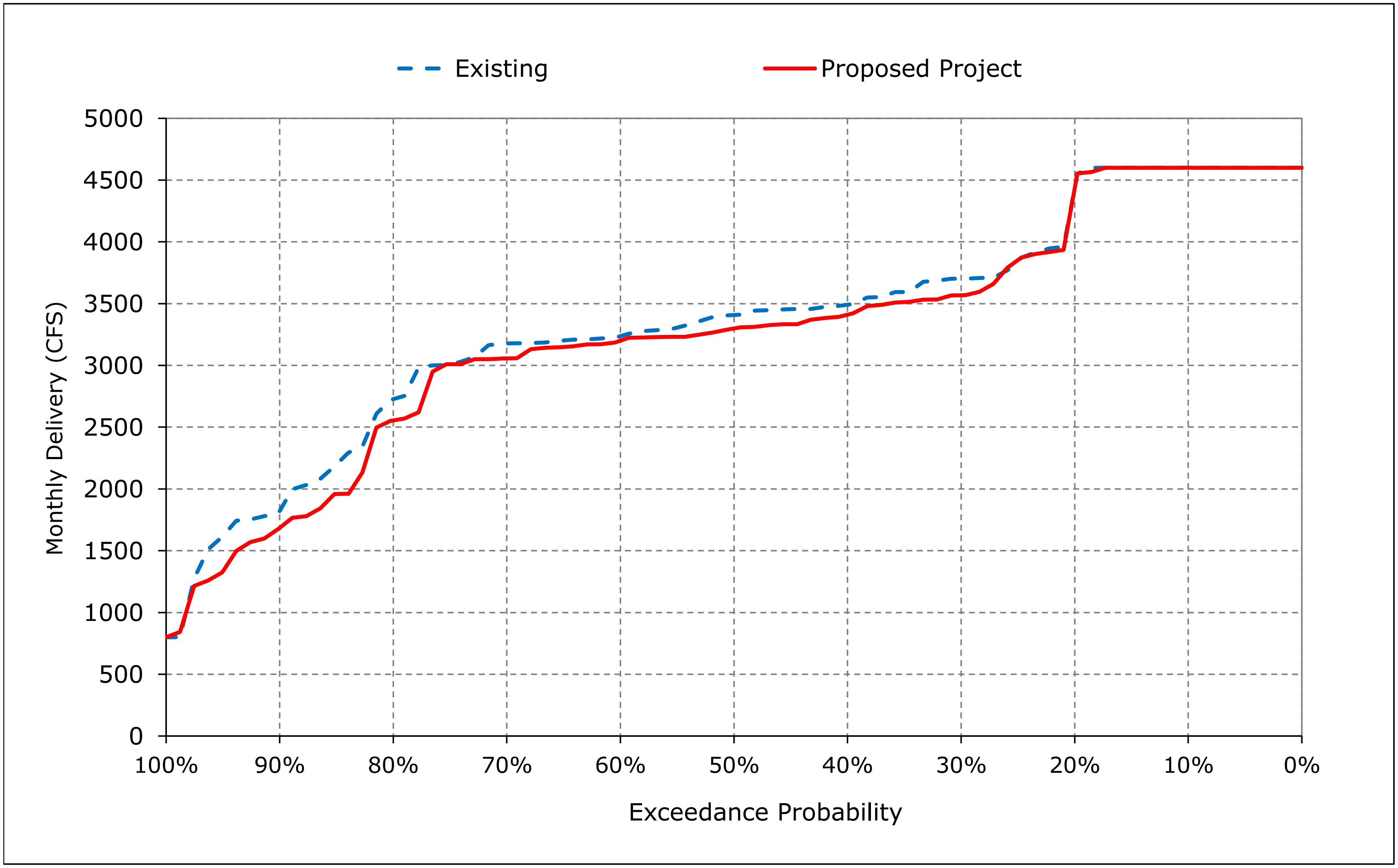


Figure 7-16. Jones PP Exports, July

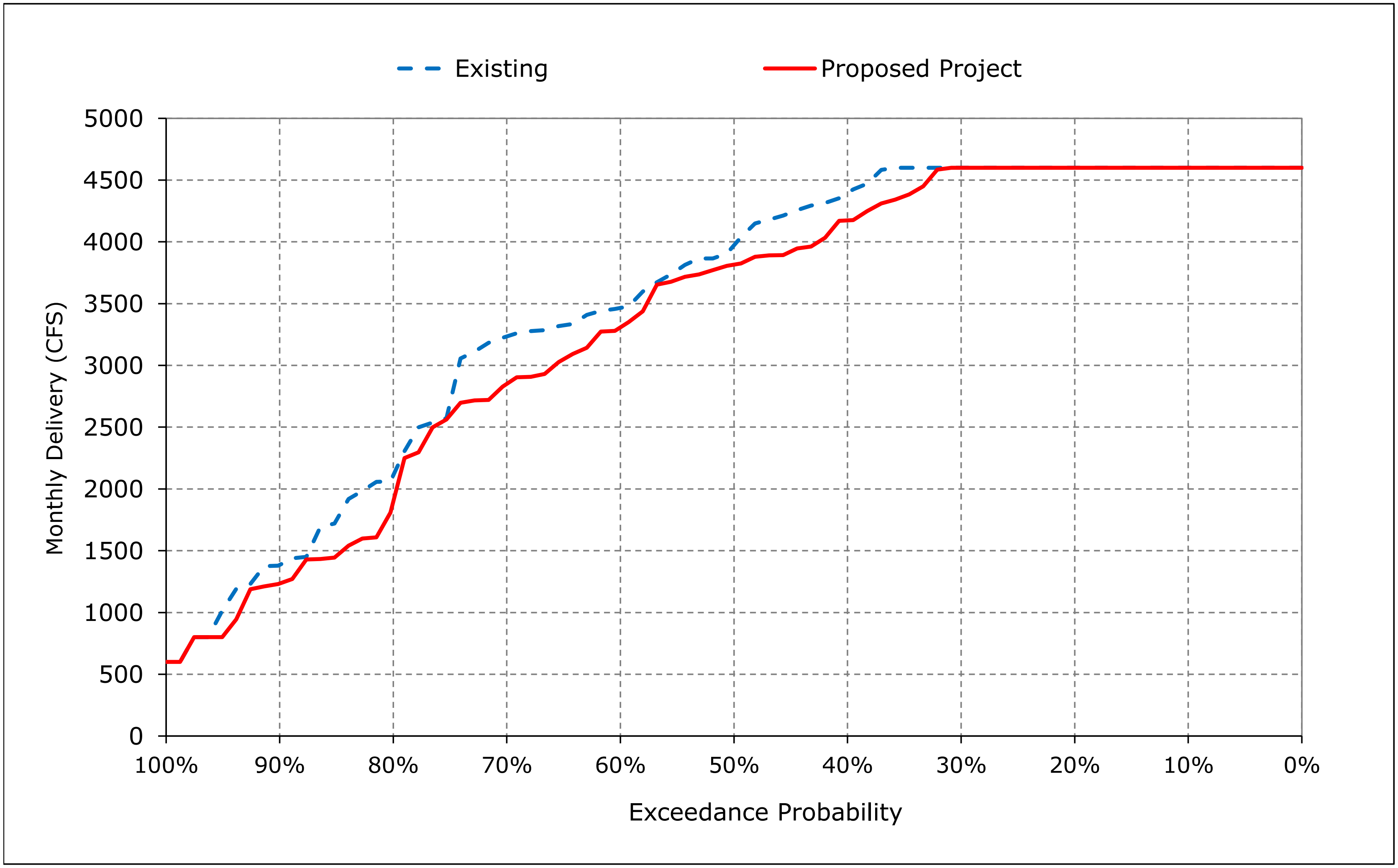


Figure 7-17. Jones PP Exports, August

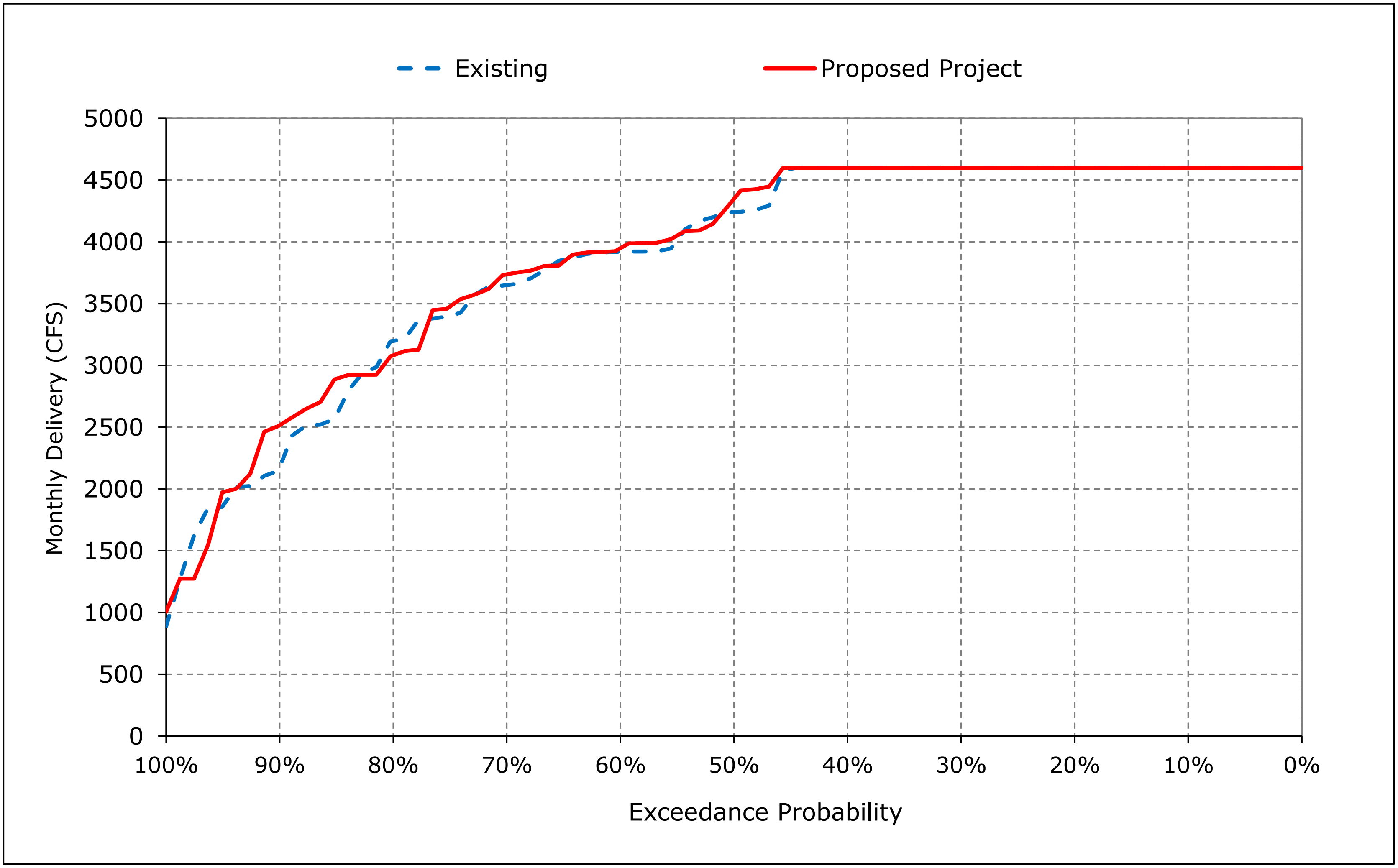
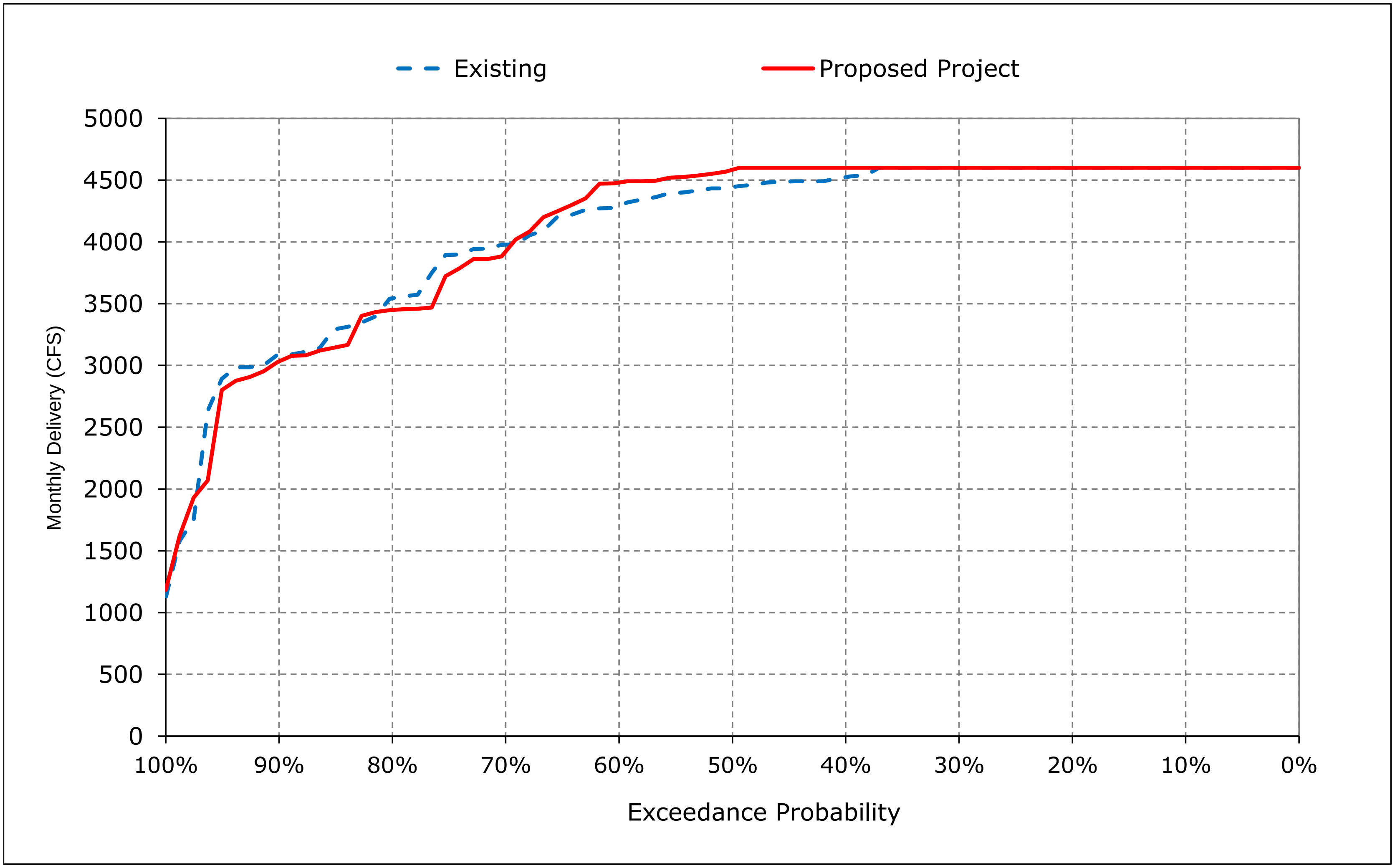


Figure 7-18. Jones PP Exports, September



Appendix C – Modeling

Attachment 2-4 – Water Supply Results (CalSim II)

The following water supply results of the CalSim II model are included for the following alternatives:

- Existing Conditions
- Proposed Project

Table 2-4.1. Water Supply Results (CalSim II)

Title	Model Parameter	Table Numbers	Figure Numbers
CalSim II Water Supply Summary Report	NA	1-1 to 1-8	1-1 to 1-9
Total Delta Exports	TOTAL_EXP	-	2-1

Note: "-" indicates blank cell

Report formats

- Tables comparing water supply of two scenarios (water supply by region and type, and water supply by type)
- Annual exceedance charts including all scenarios

Table 1-1. CALSIM II Water Summary Report, by Region and Type, Long-Term Average and Dry and Critical Year Averages

				Proposed Project	Existing	Proposed Project minus Existing
Water Supply Reliability						
Sacramento River Hydrologic Region						
CVP Settlement	Contract Delivery (annual average)	(TAF/year)	Long Term	1,600	1,610	-10
			Dry and Critical	1,576	1,585	-9
CVP Refuge Level 2	Contract Delivery (annual average)	(TAF/year)	Long Term	163	159	4
			Dry and Critical	144	140	3
CVP M&I	Contract Delivery (annual average)	(TAF/year)	Long Term	227	225	2
			Dry and Critical	201	199	3
CVP Ag	Contract Delivery (annual average - does not include Settlement	(TAF/year)	Long Term	280	275	5
			Dry and Critical	190	181	9
SWP FRSA	Contract Delivery (annual average)	(TAF/year)	Long Term	952	952	0
			Dry and Critical	908	908	0
SWP M&I	Contract Delivery (annual average)	(TAF/year)	Long Term	31	30	1
			Dry and Critical	22	20	2
San Joaquin River Hydrologic Region (not including Friant-Kern and Madera Canal water users)						
CVP Exchange	Contract Delivery (annual average)	(TAF/year)	Long Term	852	852	0
			Dry and Critical	814	814	0
CVP Refuge Level 2	Contract Delivery (annual average)	(TAF/year)	Long Term	261	261	0
			Dry and Critical	249	249	0
CVP M&I	Contract Delivery (annual average)	(TAF/year)	Long Term	18	17	1
			Dry and Critical	15	15	0
CVP Ag	Contract Delivery (annual average; does not include Exchange	(TAF/year)	Long Term	404	352	52
			Dry and Critical	243	226	17
SWP Ag	Contract Delivery (including Article 21) (annual average)	(TAF/year)	Long Term	4	3	0
			Dry and Critical	2	2	0
San Francisco Bay Hydrologic Region						
CVP M&I	Contract Delivery (annual average)	(TAF/year)	Long Term	263	259	5
			Dry and Critical	284	281	2
CVP Ag	Contract Delivery (annual average)	(TAF/year)	Long Term	50	44	6
			Dry and Critical	30	28	2
SWP M&I	Contract Delivery (including Article 21, includes transfers to SWP contractors) (annual average)	(TAF/year)	Long Term	215	202	13
			Dry and Critical	138	125	13
Central Coast Hydrologic Region						
SWP M&I	Contract Delivery (annual average)	(TAF/year)	Long Term	43	40	3
			Dry and Critical	24	22	2
Tulare Lake Hydrologic Region (not including Friant-Kern Canal water users)						
CVP Refuge Level 2	Contract Delivery (annual average)	(TAF/year)	Long Term	12	12	0
			Dry and Critical	11	11	0
CVP Ag	Contract Delivery (annual average - includes Cross Valley Canal)	(TAF/year)	Long Term	820	728	91
			Dry and Critical	509	474	35
SWP M&I	Contract Delivery (annual average)	(TAF/year)	Long Term	83	77	6
			Dry and Critical	47	42	4
SWP Ag	Contract Delivery (including Article 21) (annual average)	(TAF/year)	Long Term	639	585	54
			Dry and Critical	342	310	31
South Lahontan Hydrologic Region						
SWP M&I	Contract Delivery (including Article 21) (annual average)	(TAF/year)	Long Term	281	260	21
			Dry and Critical	175	155	20
South Coast Hydrologic Region						
SWP M&I	Contract Delivery (including Article 21, includes transfers to SWP contractors) (annual average)	(TAF/year)	Long Term	1,363	1,242	121
			Dry and Critical	884	763	121
SWP Ag	Contract Delivery (including Article 21) (annual average)	(TAF/year)	Long Term	8	7	1
			Dry and Critical	4	4	0
Total For All Regions						
Total Supplies	Contract Delivery (CVP, SWP and other) (annual average)	(TAF/year)	Long Term	8,568	8,193	375
			Dry and Critical	6,812	6,556	255

Notes:

1. Long Term is the average quantity for the period of Oct 1921 - Sep 2003.
2. Dry and Critical Years Average is the average quantity for the combination of the SWRCB D-1641 40-30-30 Dry and Critical years for the period of Oct 192

Table 1-2. CALSIM II Water Supply Summary Report, by Type, Long-Term Average and Dry and Critical Year Averages

				Proposed Project	Existing	Proposed Project minus Existing
Water Supply Reliability						
North of Delta						
CVP Ag	Contract Delivery (annual average; does not include Exchange	(TAF/year)	Long Term Dry and Critical	280 190	275 181	5 9
CVP M&I	Contract Delivery (annual average)	(TAF/year)	Long Term Dry and Critical	379 388	376 386	2 3
SWP Ag	Contract Delivery (including Article 21) (annual average)	(TAF/year)	Long Term Dry and Critical	0 0	0 0	0 0
SWP M&I	Contract Delivery (including Article 21, includes transfers to SWP contractors) (annual average)	(TAF/year)	Long Term Dry and Critical	102 70	101 68	1 2
Total CVP North of Delta						
Total CVP Ag and M&I NOD	Contract Delivery (CVP) (annual average)	(TAF/year)	Long Term Dry and Critical	658 578	651 567	7 11
Total SWP North of Delta						
Total SWP Ag and M&I NOD	Contract Delivery (SWP) (annual average)	(TAF/year)	Long Term Dry and Critical	102 70	101 68	1 2
Total North of Delta						
Total North of Delta Ag and M&I Deliveries	Contract Delivery (CVP, SWP and other) (annual average)	(TAF/year)	Long Term Dry and Critical	761 648	752 635	9 13
South of Delta						
CVP Ag	Contract Delivery (annual average; does not include Exchange	(TAF/year)	Long Term Dry and Critical	1,273 782	1,124 729	149 53
CVP M&I	Contract Delivery (annual average)	(TAF/year)	Long Term Dry and Critical	130 112	124 109	5 3
SWP Ag	Contract Delivery (including Article 21) (annual average)	(TAF/year)	Long Term Dry and Critical	650 348	596 316	55 32
SWP M&I	Contract Delivery (including Article 21, includes transfers to SWP contractors) (annual average)	(TAF/year)	Long Term Dry and Critical	1,914 1,220	1,750 1,060	163 160
Total CVP South of Delta						
Total CVP Ag and M&I SOD	Contract Delivery (CVP) (annual average)	(TAF/year)	Long Term Dry and Critical	1,403 894	1,248 838	155 56
Total SWP South of Delta						
Total SWP Ag and M&I SOD	Contract Delivery (SWP) (annual average)	(TAF/year)	Long Term Dry and Critical	2,564 1,568	2,346 1,377	218 192
Total South of Delta						
Total South of Delta Ag and M&I Deliveries	Contract Delivery (CVP, SWP and other) (annual average)	(TAF/year)	Long Term Dry and Critical	3,967 2,462	3,594 2,215	373 248

Notes:

1. Long Term is the average quantity for the period of Oct 1921 - Sep 2003.
2. Dry and Critical Years Average is the average quantity for the combination of the SWRCB D-1641 40-30-30 Dry and Critical years for the period of Oct 192

Figure 1-1. CVP North of Delta Agricultural Water Service Contract Deliveries, Annual (Mar-Feb)

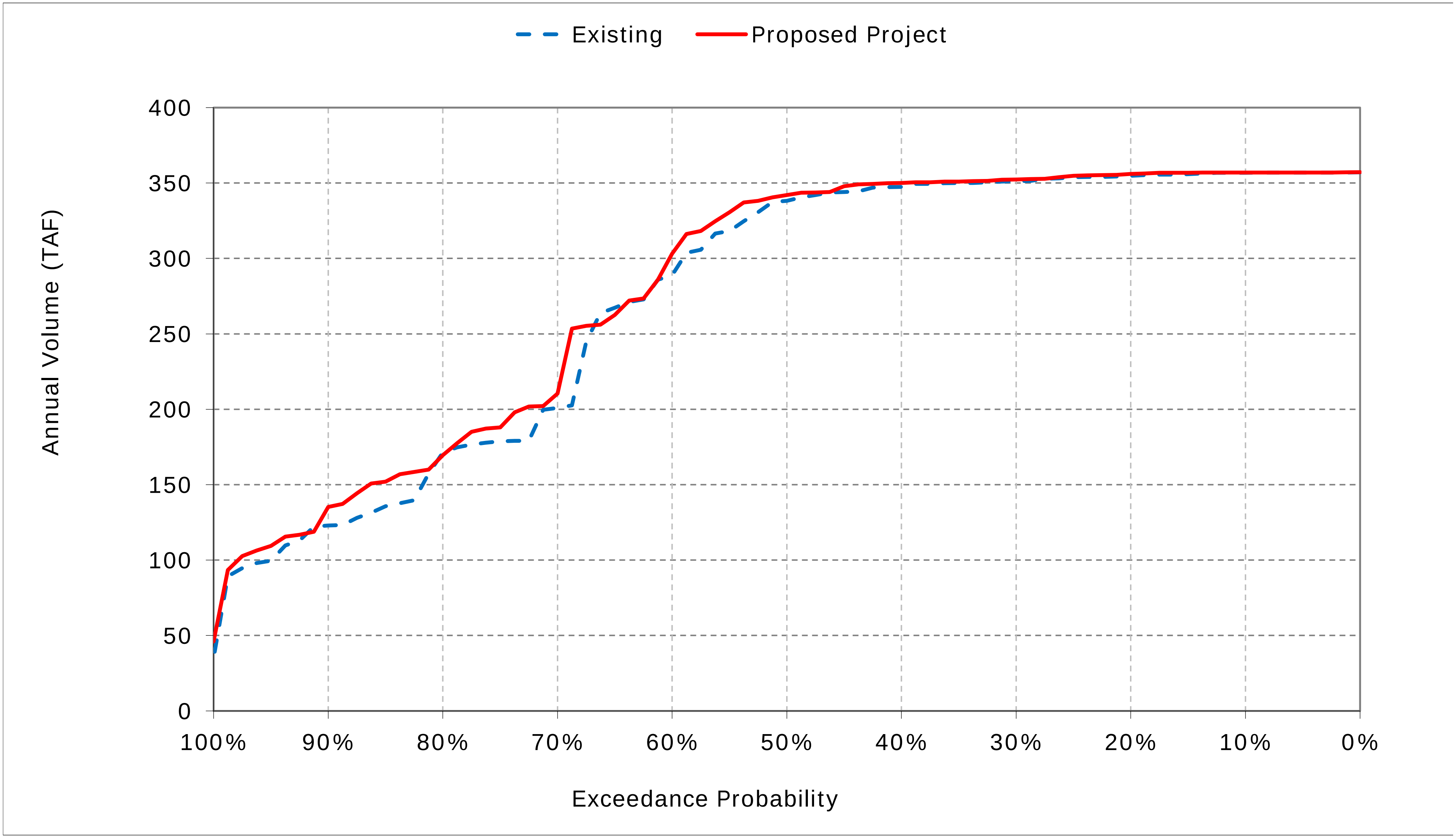


Figure 1-2. CVP South of Delta Agricultural Water Service Contract Deliveries, Annual (Mar-Feb)

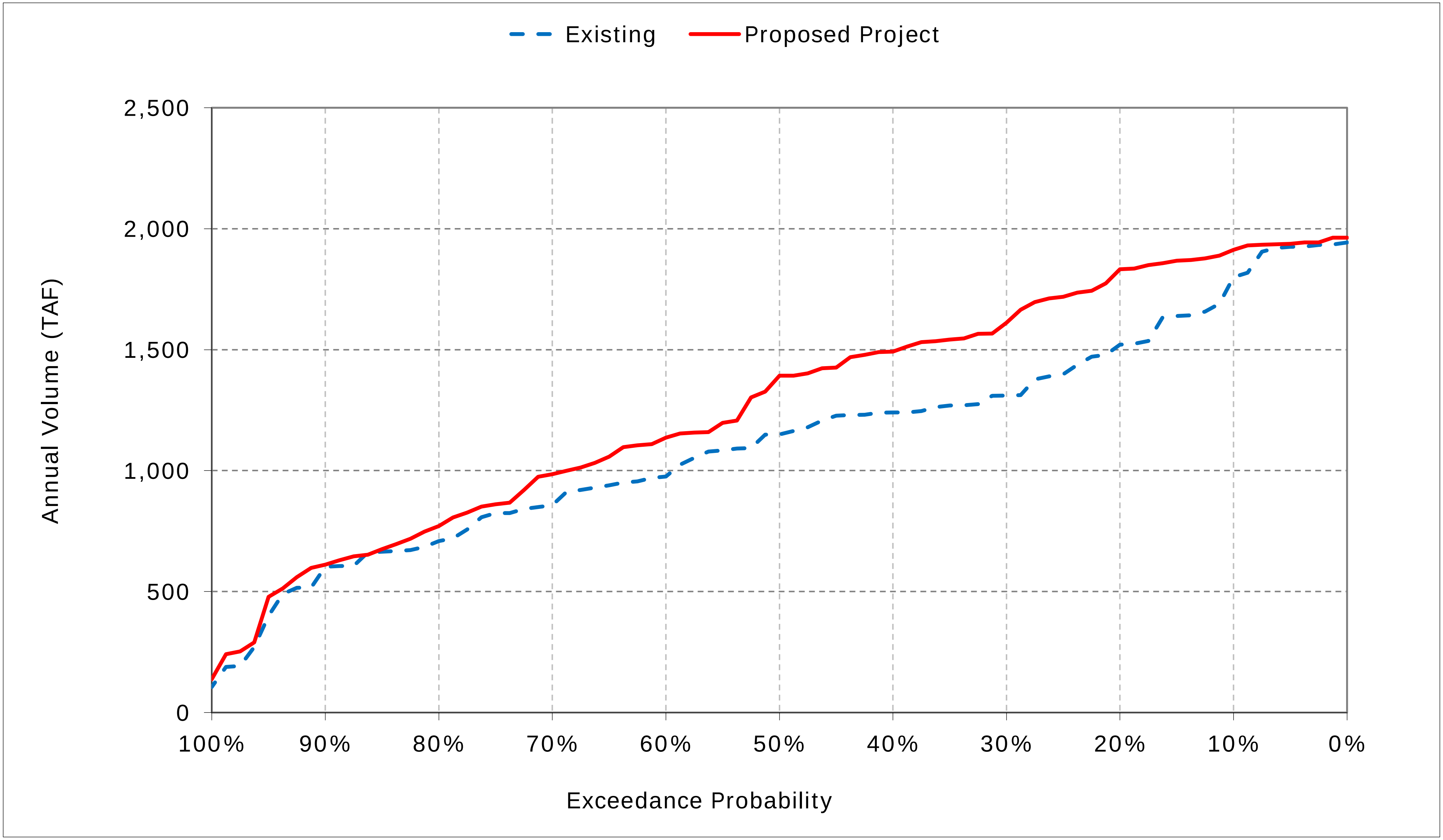


Figure 1-3. CVP North of Delta M&I Water Service Contract Deliveries, Annual (Mar-Feb)

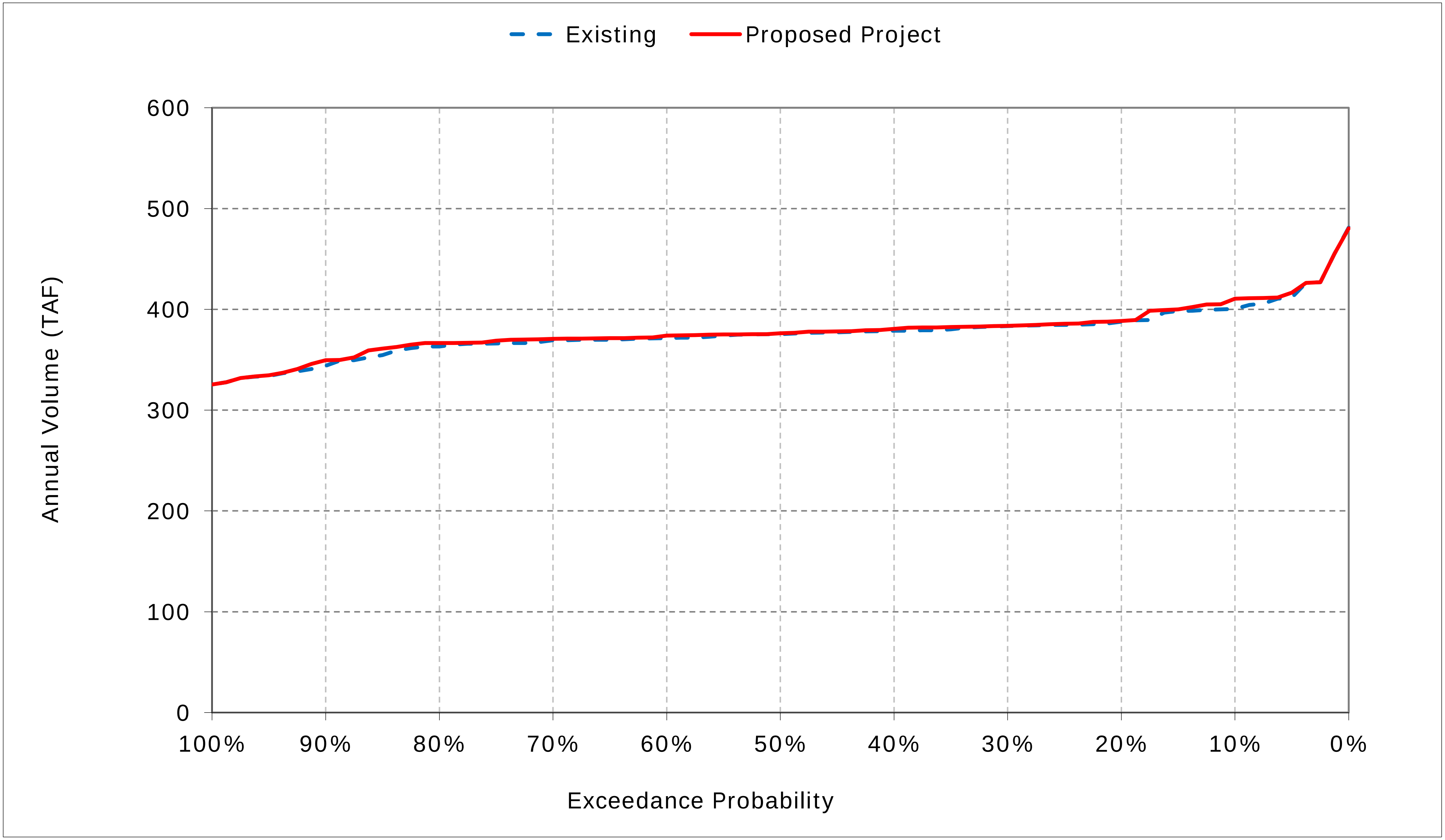


Figure 1-4. CVP South of Delta M&I Water Service Contract Deliveries, Annual (Mar-Feb)

Figure 1-5. Total SWP Deliveries, Annual (Jan-Dec)

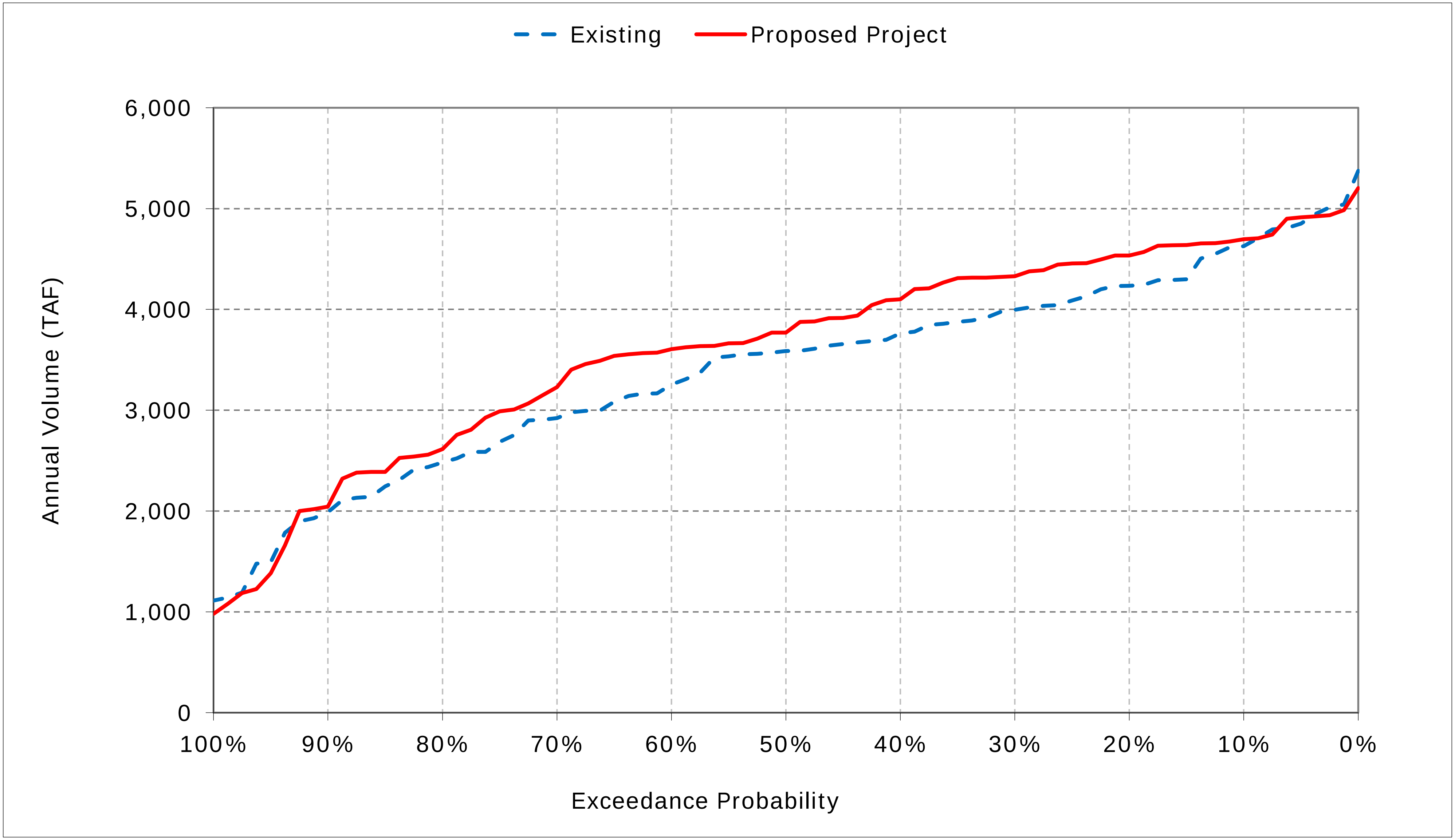


Figure 1-6. Total SWP South of Delta Deliveries including Article 21 and 56, Annual (Jan-Dec)

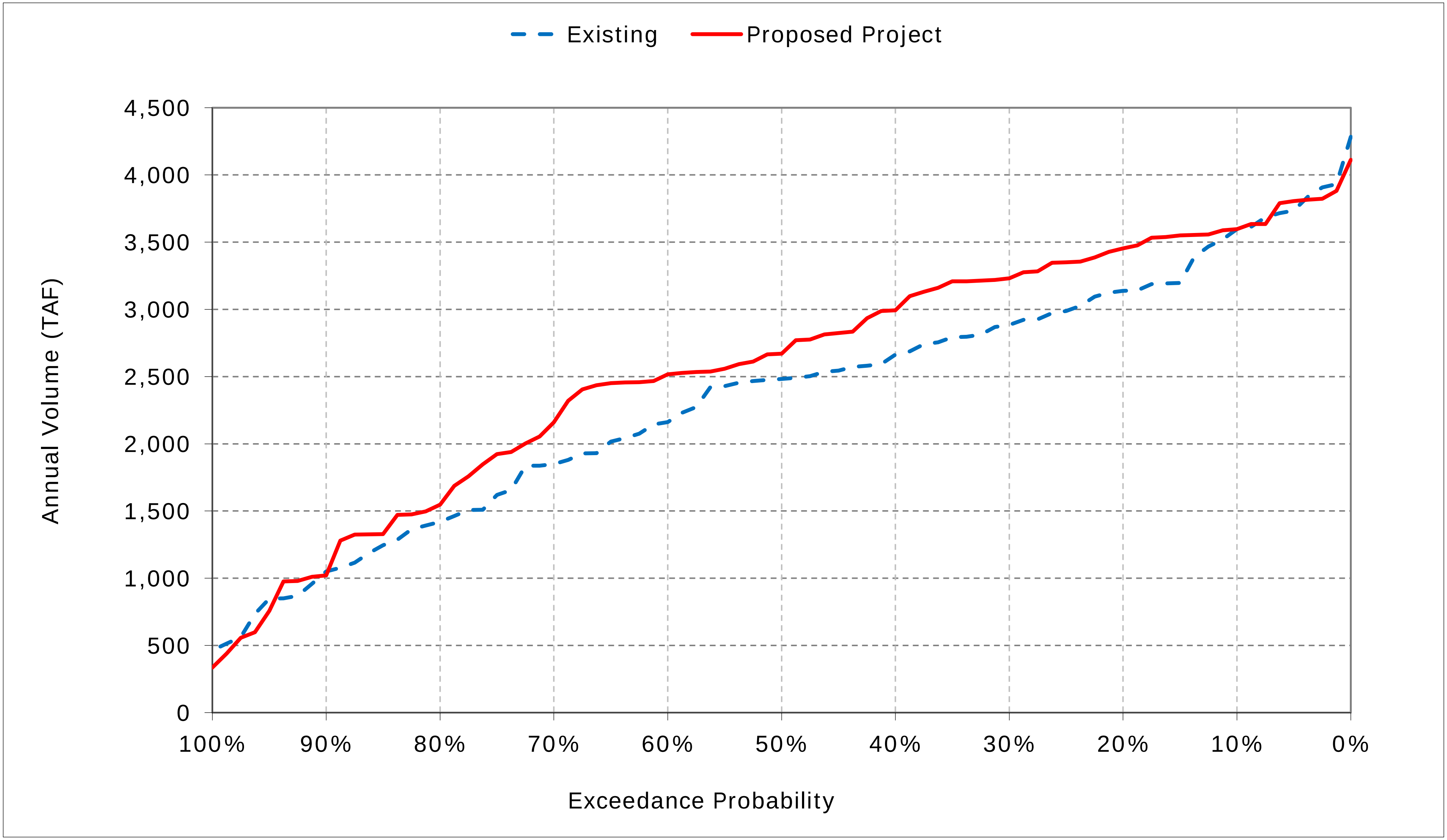


Figure 1-7. SWP Table A Deliveries with Article 56, Annual (Jan-Dec)

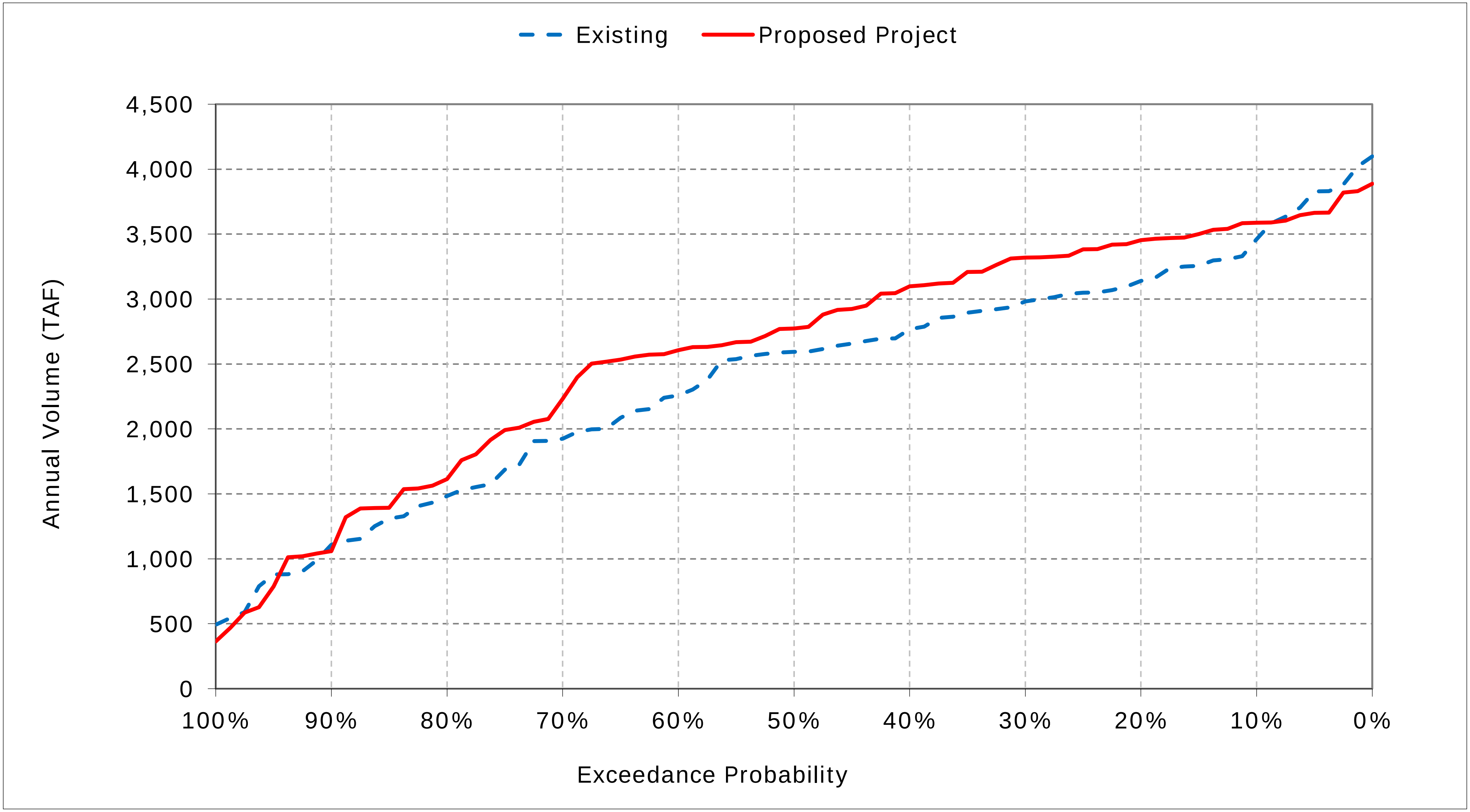


Figure 1-8. SWP South of Delta Table A Deliveries with Article 56, Annual (Jan-Dec)

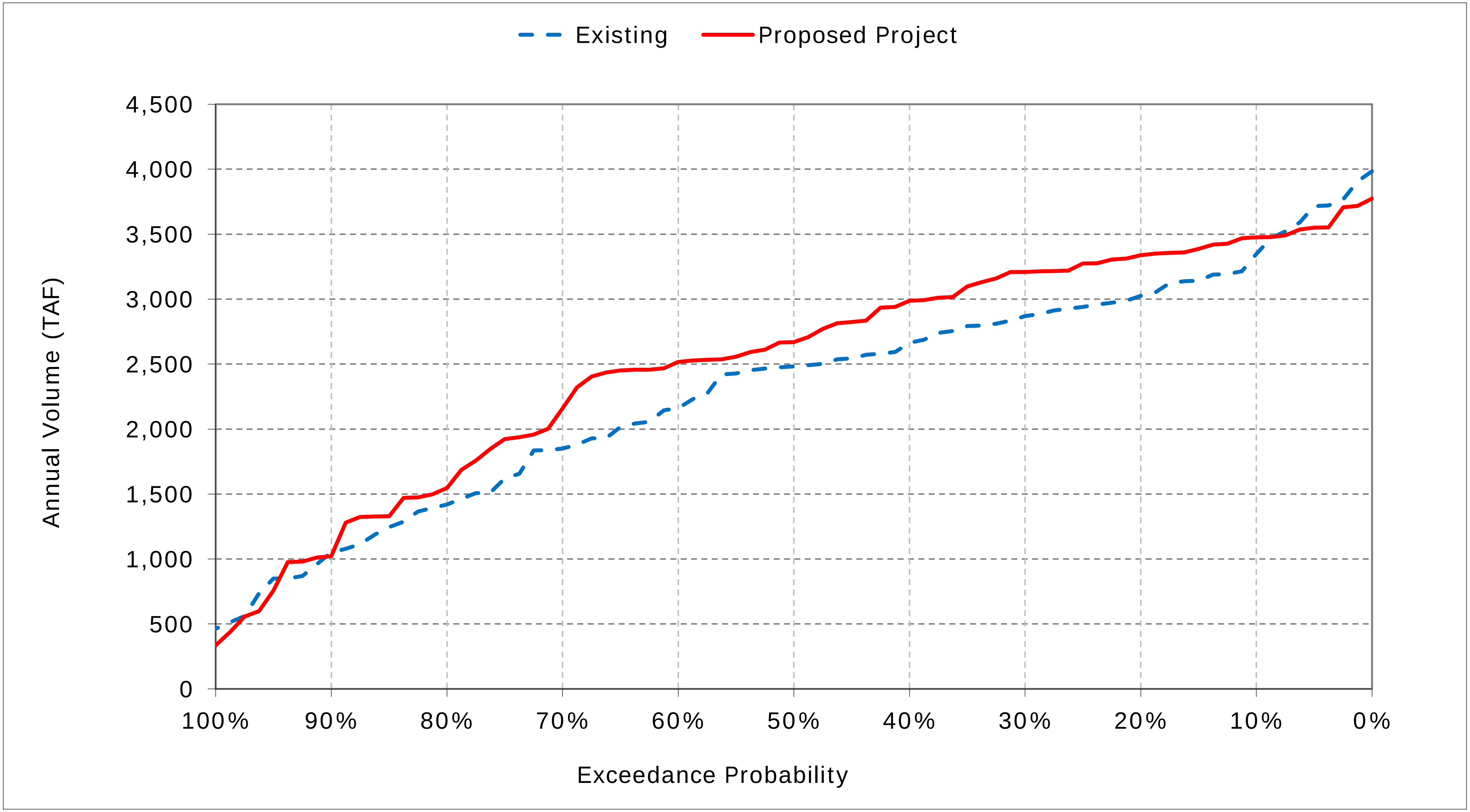


Figure 1-9. SWP Article 21 Deliveries, Annual (Jan-Dec)

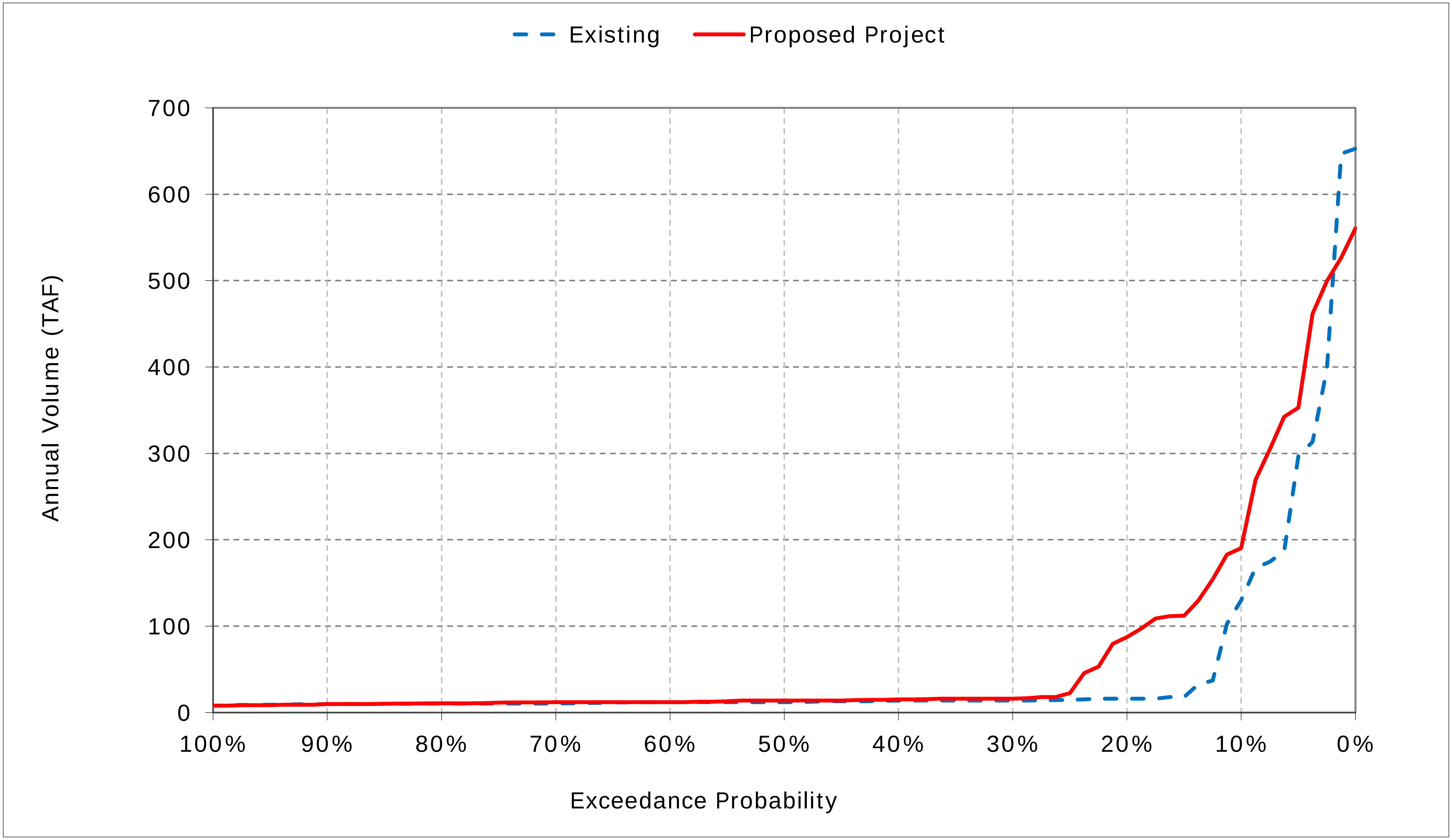
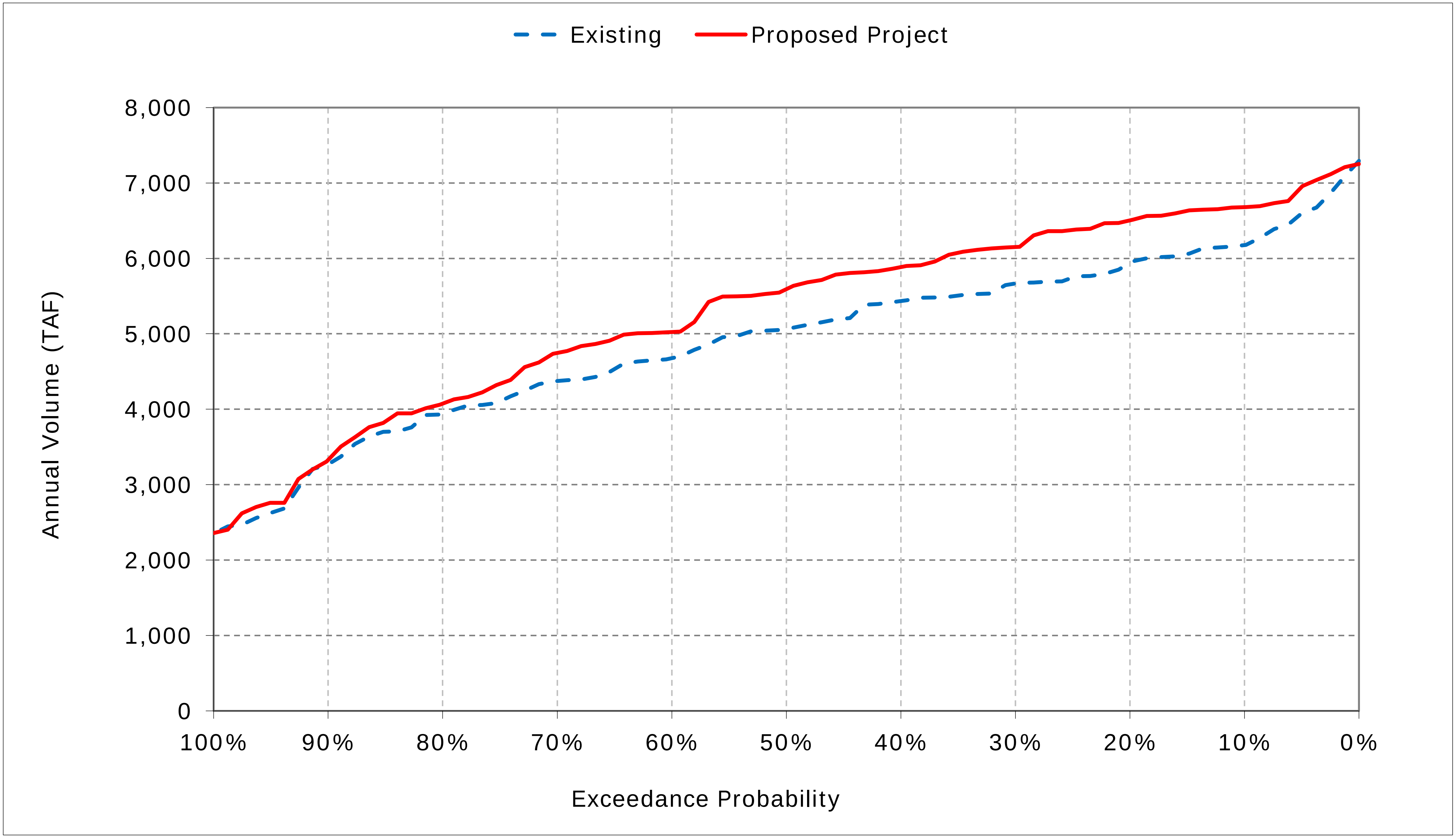


Figure 2-1. Total Delta Exports, Annual (Oct-Sep)



Appendix C – Modeling

Attachment 2-5 – X2 Position Results (CalSim II)

The following results of the CalSim II model are included for Delta X2 conditions for the following alternatives:

- Existing Conditions
- Proposed Project

Table 2-5.1. X2 Position Results (CalSim II)

Title	Model Parameter	Table Numbers	Figure Numbers
X2	X2_PRV_MOD	1-1	1-1 to 1-18

Report formats

- Monthly tables comparing two scenarios (exceedance values, long-term average, and average by water year type)
- Monthly pattern charts (long-term average and average by water year type) including all scenarios
- Monthly exceedance charts (all months) including all scenarios

Table 1-1. X2 Position, Monthly Position

Existing

Statistic	Monthly Position (KM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	92.8	91.8	90.7	84.5	78.2	77.3	78.1	80.9	83.4	86.4	90.3	92.3
20%	92.1	91.3	88.6	82.9	72.2	71.8	72.2	78.1	81.7	85.1	88.2	91.1
30%	91.7	90.9	84.0	79.8	67.4	65.1	67.8	75.1	81.0	84.5	87.7	90.6
40%	91.0	90.4	82.0	73.4	63.3	63.6	66.4	71.0	80.4	82.4	86.3	89.8
50%	89.9	81.1	80.1	71.5	58.9	60.3	62.4	66.9	77.0	80.9	85.7	88.5
60%	81.0	80.9	78.8	65.4	53.8	57.3	60.0	64.5	75.3	79.9	85.0	81.0
70%	74.0	75.4	71.5	55.4	51.0	54.0	57.9	62.0	72.2	78.6	84.6	74.1
80%	74.0	74.0	63.5	50.3	48.2	49.9	53.2	58.7	66.5	77.1	83.7	74.0
90%	74.0	73.3	52.5	48.4	47.7	48.1	49.1	53.1	59.7	73.9	82.4	74.0
Long Term												
Full Simulation Period[a]	84.1	82.4	76.3	67.9	60.7	60.9	63.2	67.7	74.9	80.5	85.6	83.9
Water Year Types[b,c]												
Wet (32%)	80.7	76.7	63.8	53.9	50.2	51.8	54.1	57.9	65.5	74.4	82.7	73.6
Above Normal (15%)	83.6	80.9	76.6	62.5	54.7	53.8	58.2	62.5	73.0	78.2	83.6	74.3
Below Normal (17%)	85.3	84.9	81.5	72.7	61.0	63.5	63.9	68.5	76.9	81.6	85.4	89.1
Dry (22%)	85.3	85.4	82.7	78.1	69.3	67.2	69.8	74.8	80.8	84.9	87.9	90.8
Critical (15%)	88.9	88.6	87.7	82.7	76.3	75.4	77.5	82.7	86.2	88.2	90.5	92.5

Proposed Project

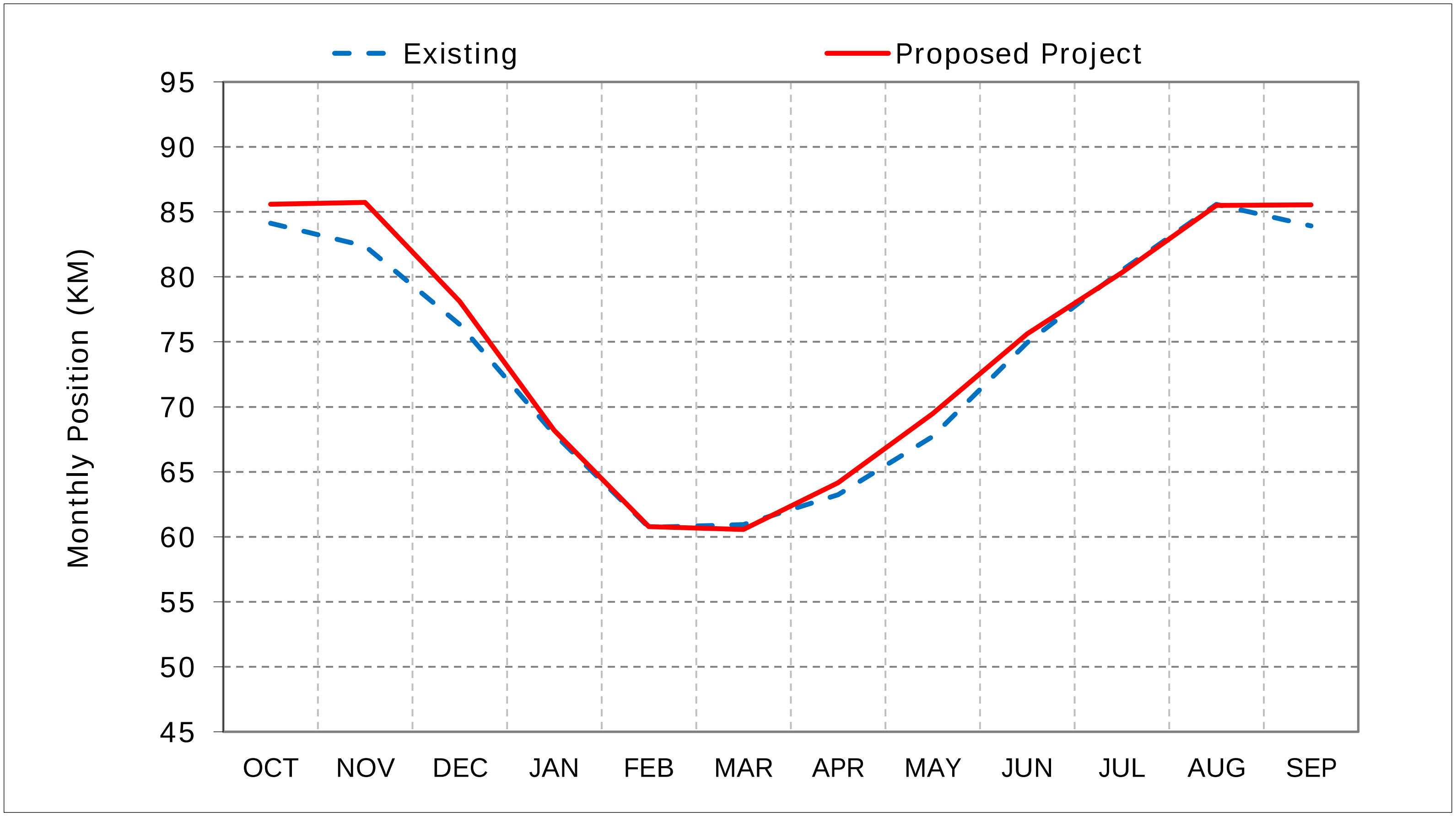
Statistic	Monthly Position (KM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	92.5	91.9	90.6	86.4	77.6	77.4	78.6	81.3	83.4	86.4	90.3	92.6
20%	92.1	91.4	88.8	84.1	71.7	71.1	73.7	79.6	82.8	85.2	88.4	91.3
30%	91.6	90.8	88.0	80.8	67.6	64.4	69.4	77.2	81.6	84.6	87.9	90.9
40%	91.1	90.3	87.3	74.6	63.9	62.8	67.5	73.3	81.0	81.4	85.8	89.7
50%	89.7	86.7	84.8	71.0	58.8	59.7	64.1	69.5	77.9	80.3	85.4	88.6
60%	80.1	86.4	81.0	64.7	53.5	56.7	61.1	67.4	76.6	79.6	84.7	80.1
70%	80.0	86.2	73.2	55.0	51.1	53.6	58.8	63.7	73.4	78.3	84.2	80.0
80%	80.0	84.7	64.7	50.1	48.2	49.3	54.2	59.8	66.9	77.1	83.4	80.0
90%	79.9	73.2	52.6	48.2	47.7	48.0	49.5	54.3	59.8	73.7	82.4	80.0
Long Term												
Full Simulation Period[a]	85.6	85.7	78.1	68.2	60.8	60.6	64.2	69.5	75.6	80.3	85.5	85.6
Water Year Types[b,c]												
Wet (32%)	82.6	81.0	65.0	53.8	50.1	51.6	54.9	59.6	66.3	74.3	82.5	79.0
Above Normal (15%)	85.4	84.9	79.4	62.6	54.3	53.3	59.2	64.7	73.9	77.9	83.5	73.3
Below Normal (17%)	86.8	88.1	83.7	72.5	60.5	62.8	65.2	71.1	77.6	80.8	85.0	89.1
Dry (22%)	86.7	88.1	84.7	79.1	69.9	66.6	70.8	76.4	81.5	84.9	88.1	91.0
Critical (15%)	89.0	90.5	89.0	83.5	77.0	75.6	78.0	83.3	86.4	88.3	90.6	92.6

Proposed Project minus Existing

Statistic	Monthly Position (KM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-0.3	0.1	-0.1	1.9	-0.5	0.1	0.5	0.3	0.0	0.0	-0.1	0.3
20%	0.0	0.1	0.1	1.1	-0.5	-0.7	1.5	1.5	1.2	0.0	0.2	0.2
30%	-0.1	-0.1	4.0	1.0	0.2	-0.7	1.6	2.1	0.6	0.1	0.2	0.2
40%	0.0	-0.2	5.3	1.1	0.6	-0.8	1.1	2.3	0.5	-0.9	-0.4	-0.1
50%	-0.2	5.6	4.6	-0.5	-0.1	-0.6	1.7	2.6	0.9	-0.6	-0.3	0.1
60%	-0.9	5.5	2.2	-0.6	-0.3	-0.5	1.1	2.9	1.4	-0.4	-0.3	-0.9
70%	6.0	10.7	1.7	-0.4	0.1	-0.4	0.9	1.8	1.2	-0.2	-0.4	5.9
80%	6.0	10.7	1.2	-0.1	0.0	-0.6	0.9	1.1	0.4	0.1	-0.3	6.0
90%	6.0	-0.1	0.1	-0.2	-0.1	-0.1	0.4	1.2	0.1	-0.1	0.0	6.0
Long Term												
Full Simulation Period[a]	1.5	3.4	1.8	0.3	0.1	-0.4	0.9	1.8	0.7	-0.2	-0.1	1.6
Water Year Types[b,c]												
Wet (32%)	1.9	4.3	1.2	-0.1	-0.1	-0.3	0.9	1.7	0.8	-0.1	-0.2	5.3
Above Normal (15%)	1.9	4.0	2.8	0.1	-0.4	-0.5	1.0	2.3	0.9	-0.3	-0.1	-0.9
Below Normal (17%)	1.6	3.2	2.1	-0.1	-0.5	-0.7	1.2	2.6	0.7	-0.8	-0.4	0.0
Dry (22%)	1.5	2.7	2.0	1.0	0.6	-0.6	1.0	1.6	0.6	0.0	0.2	0.2
Critical (15%)	0.1	1.9	1.3	0.8	0.7	0.2	0.6	0.6	0.3	0.1	0.1	0.1

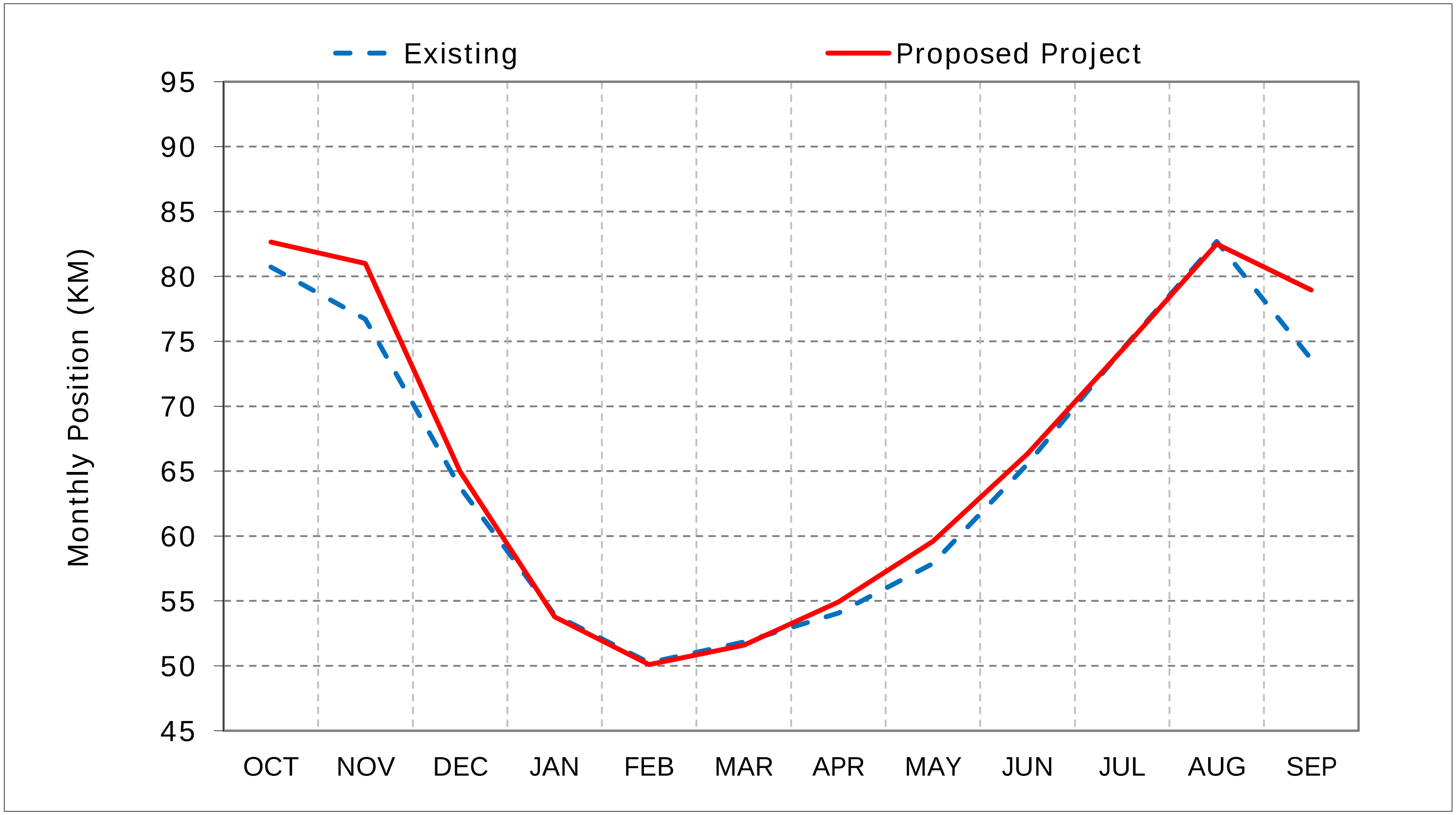
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.

Figure 1-1. X2 Position, Long-Term Average Position



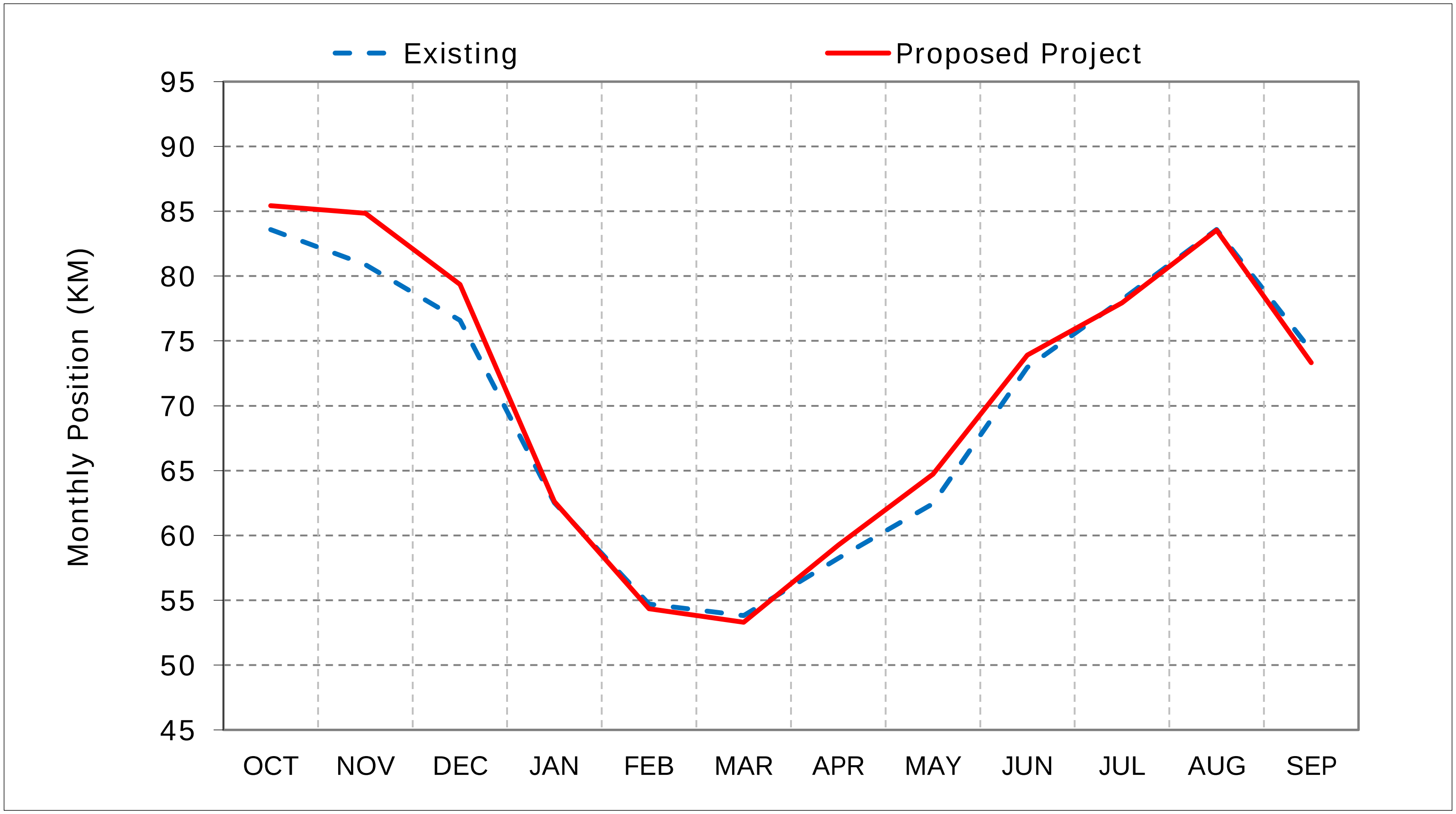
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-2. X2 Position, Wet Year Average Position



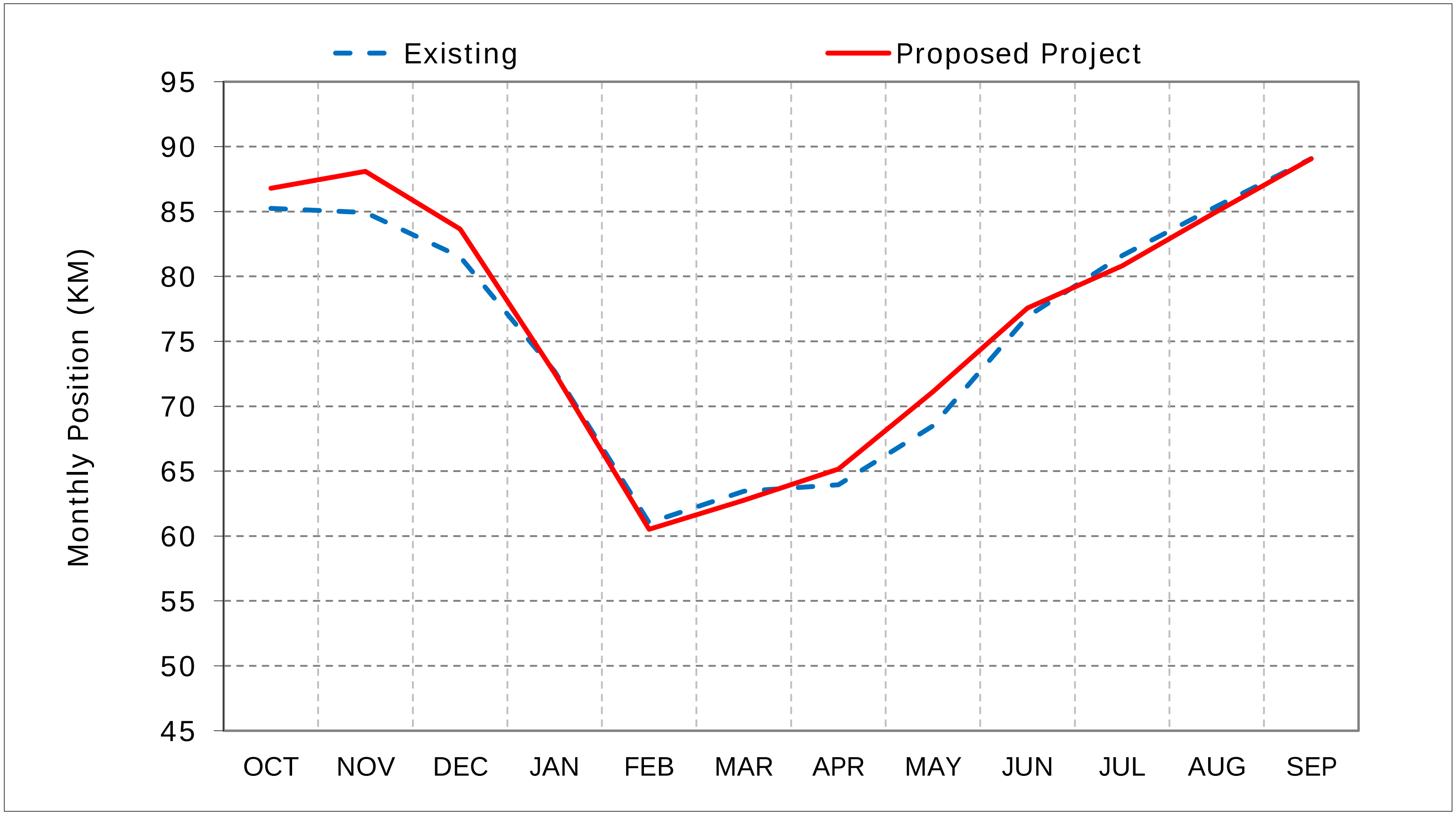
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-3. X2 Position, Above Normal Year Average Position



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

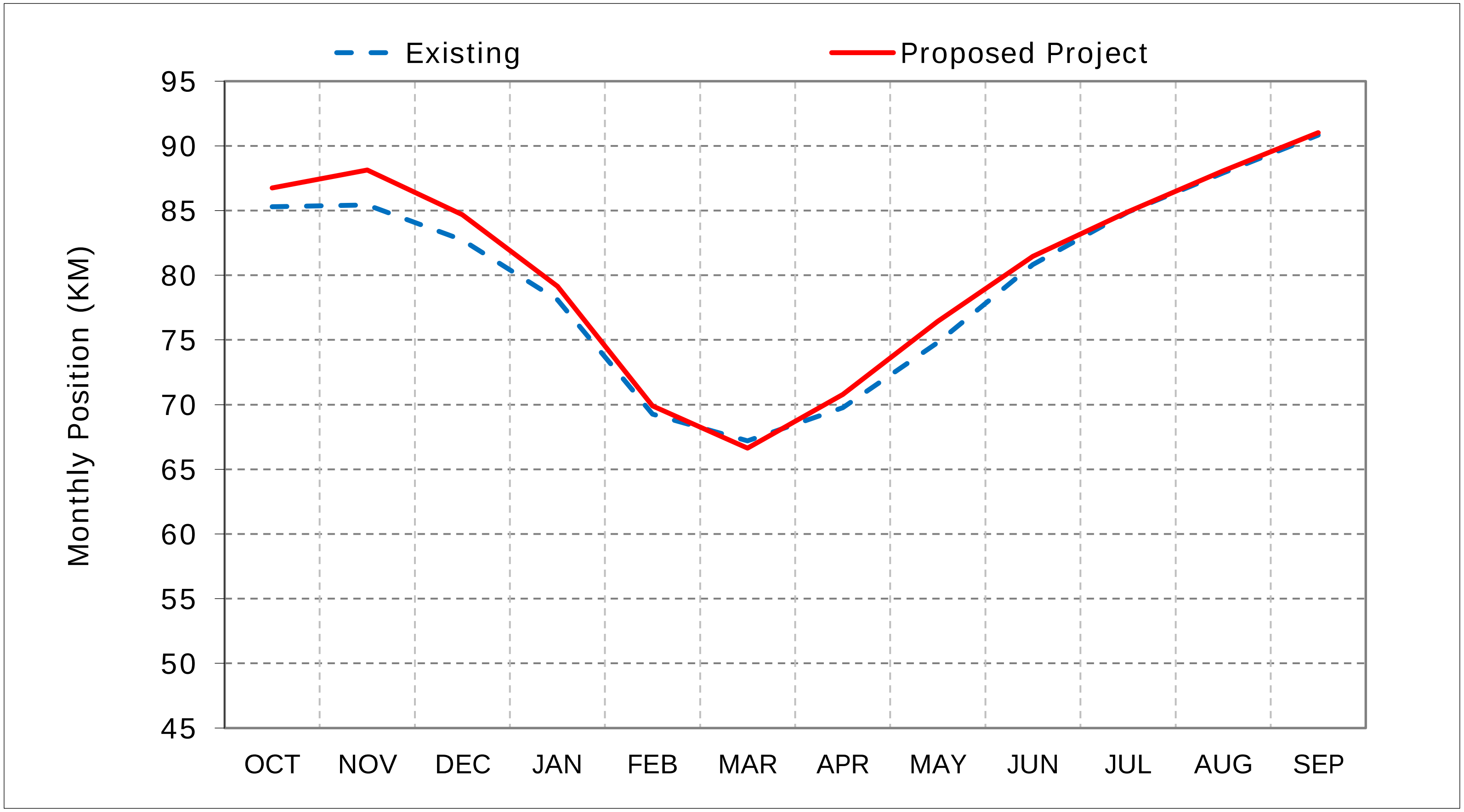
Figure 1-4. X2 Position, Below Normal Year Average Position



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164

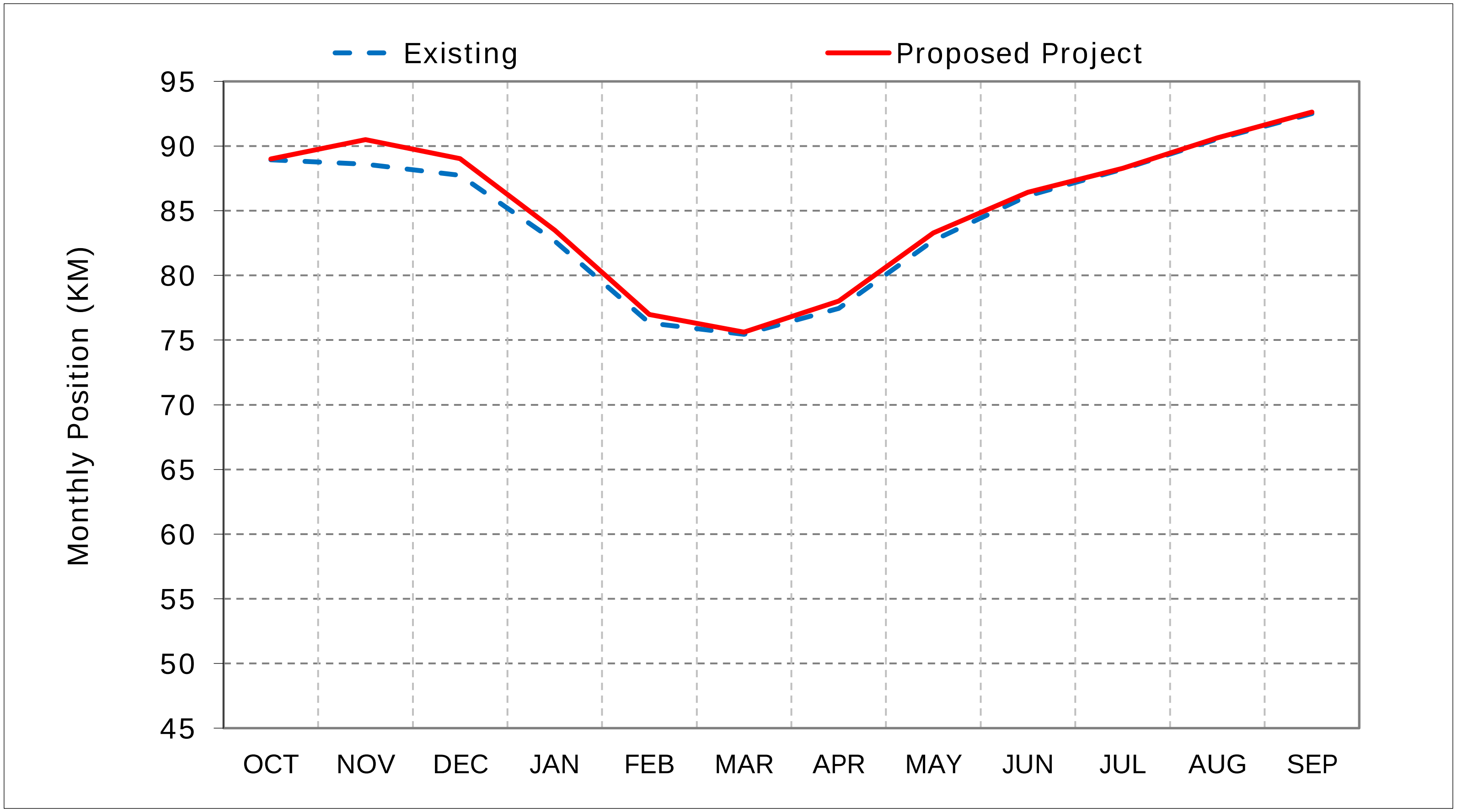
*These results are displayed with water year - year type sorting.

Figure 1-5. X2 Position, Dry Year Average Position



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-6. X2 Position, Critical Year Average Position



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-164
*These results are displayed with water year - year type sorting.

Figure 1-7. X2 Position, October

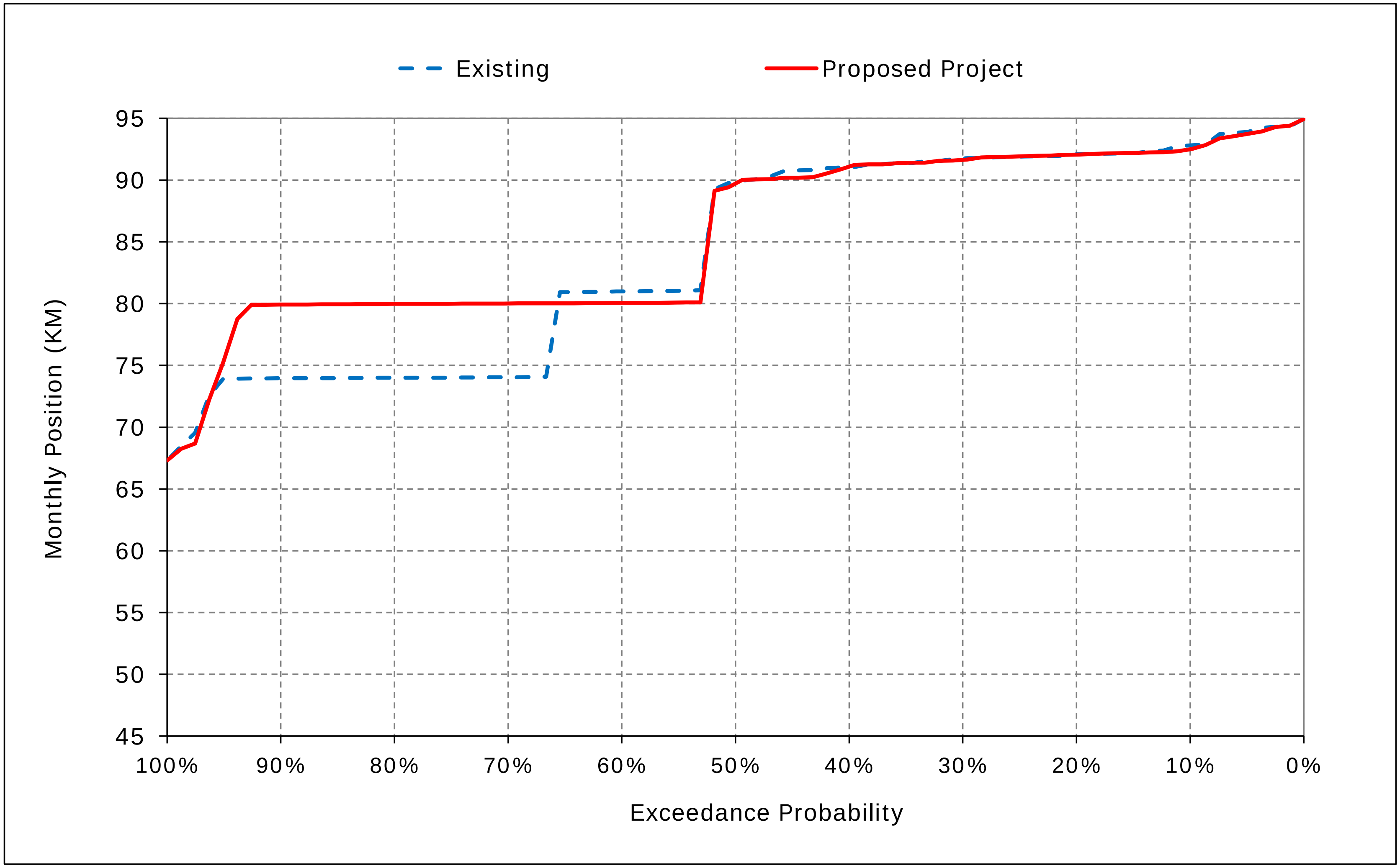


Figure 1-8. X2 Position, November

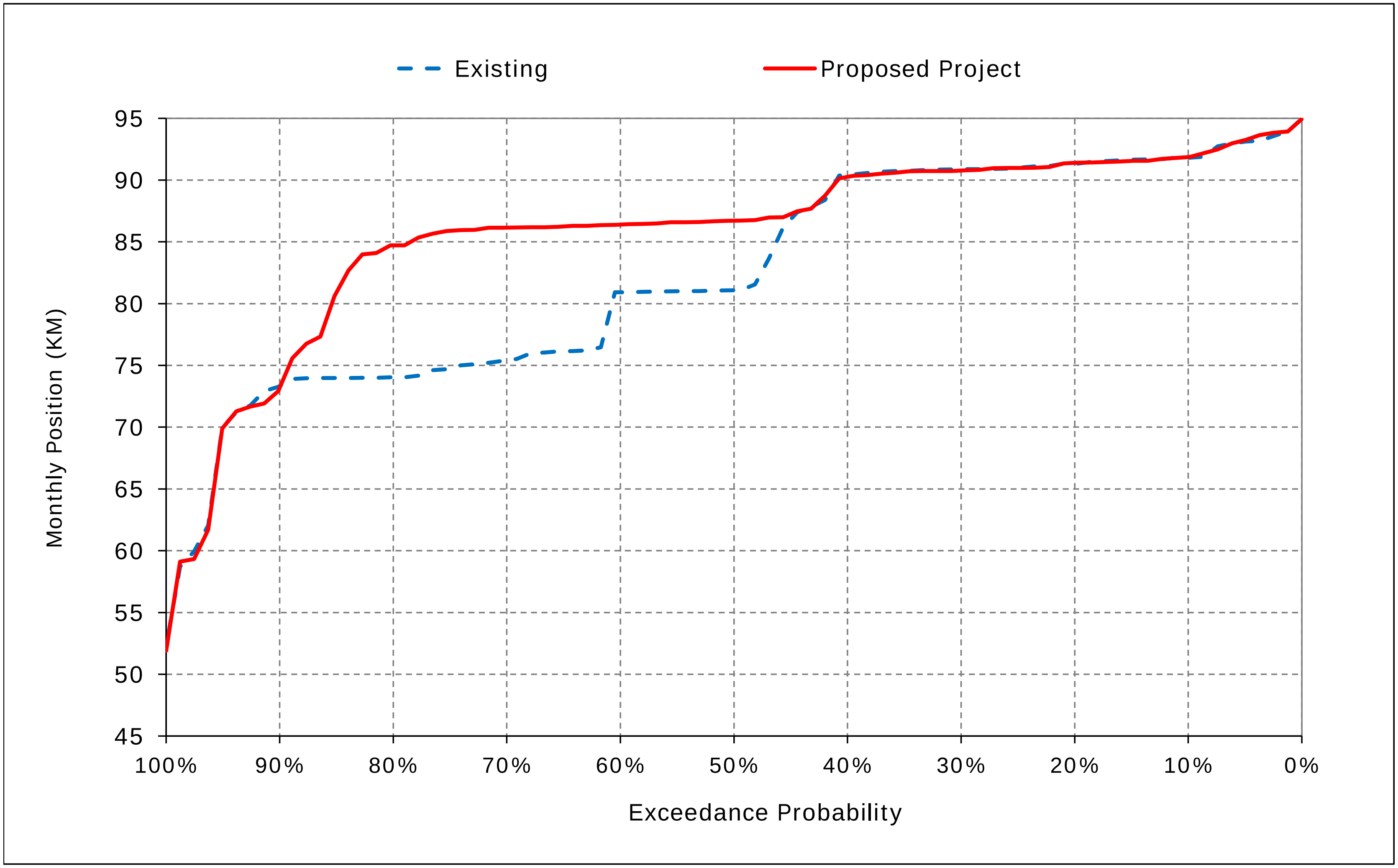


Figure 1-9. X2 Position, December

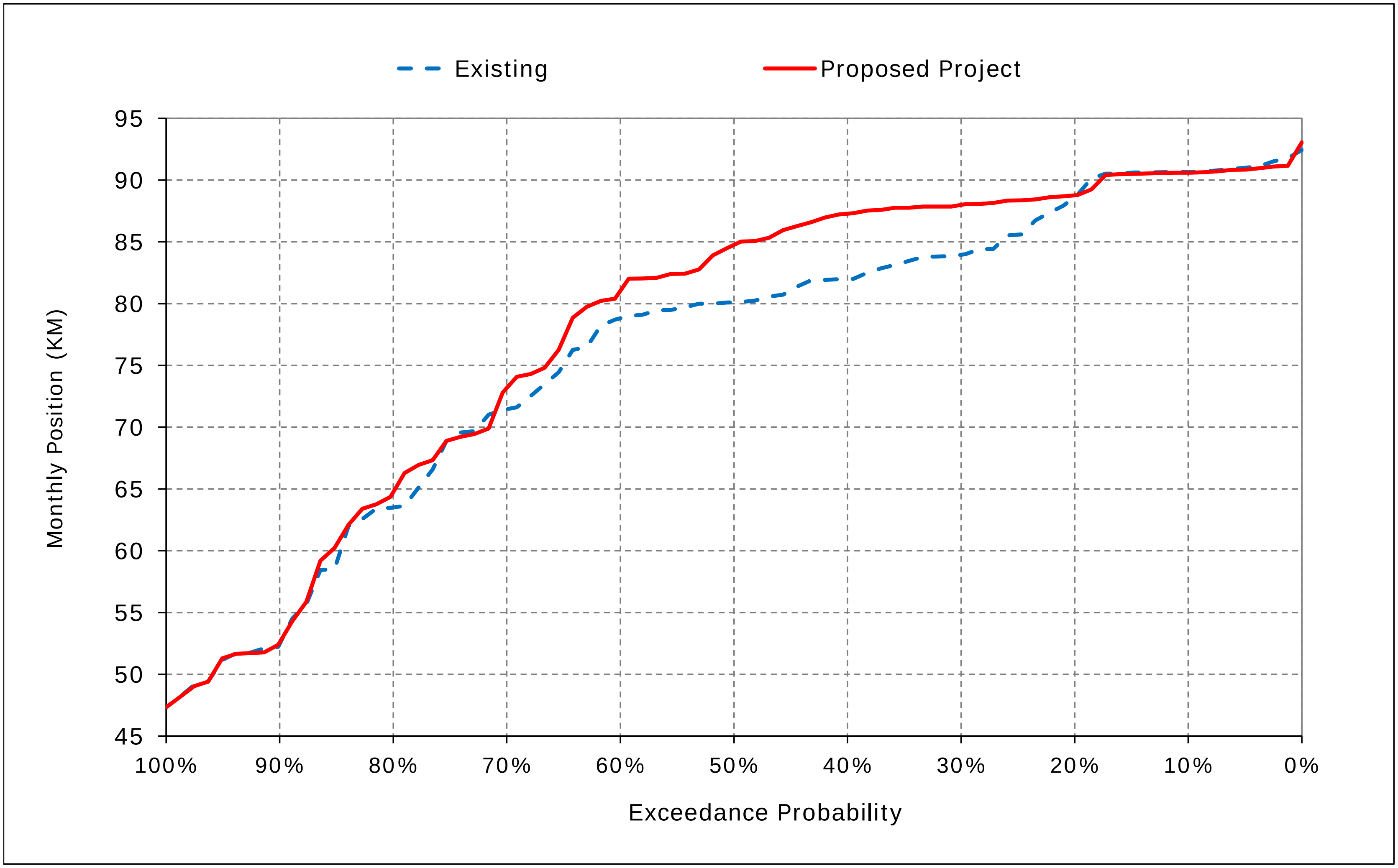


Figure 1-10. X2 Position, January

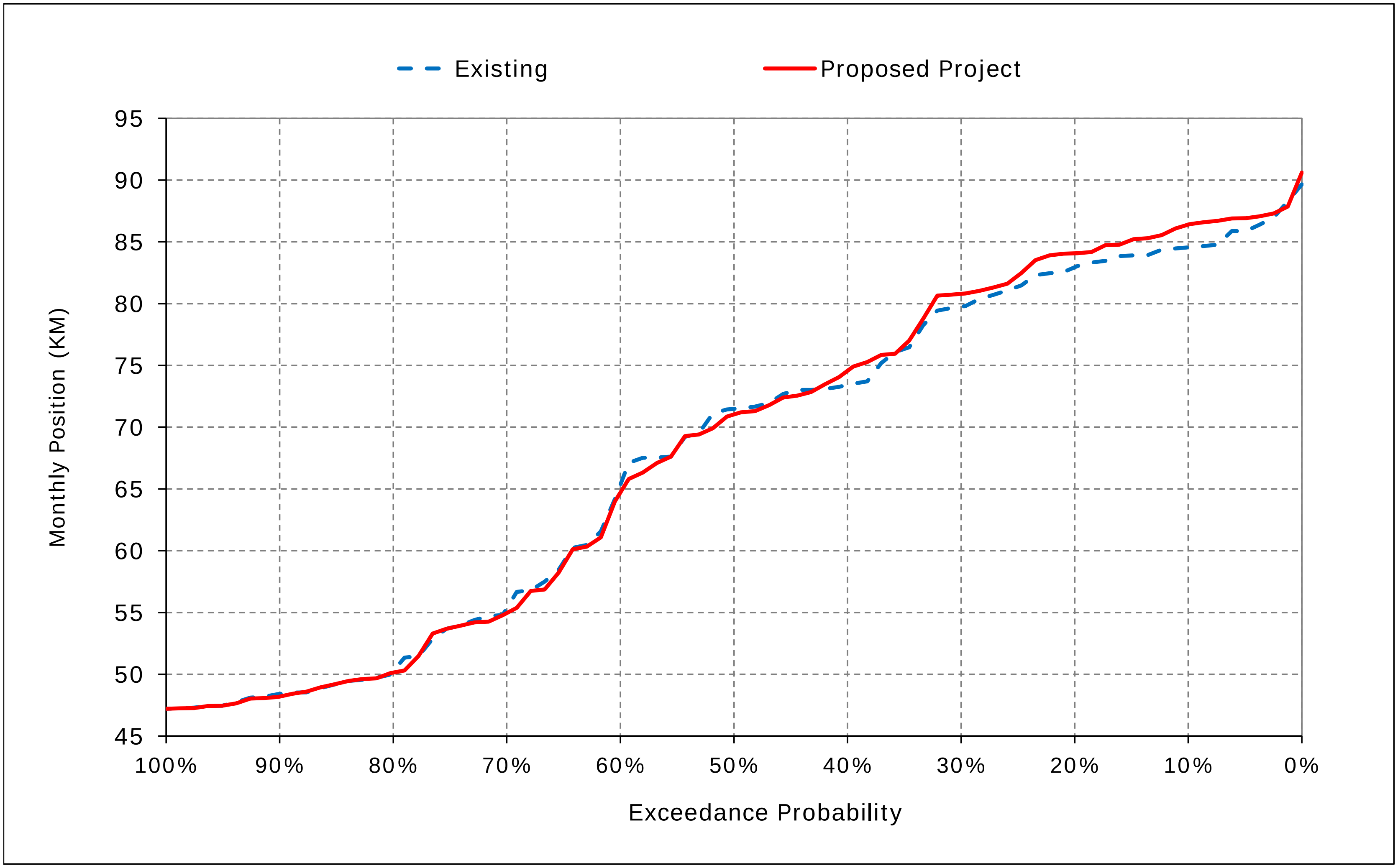


Figure 1-11. X2 Position, February

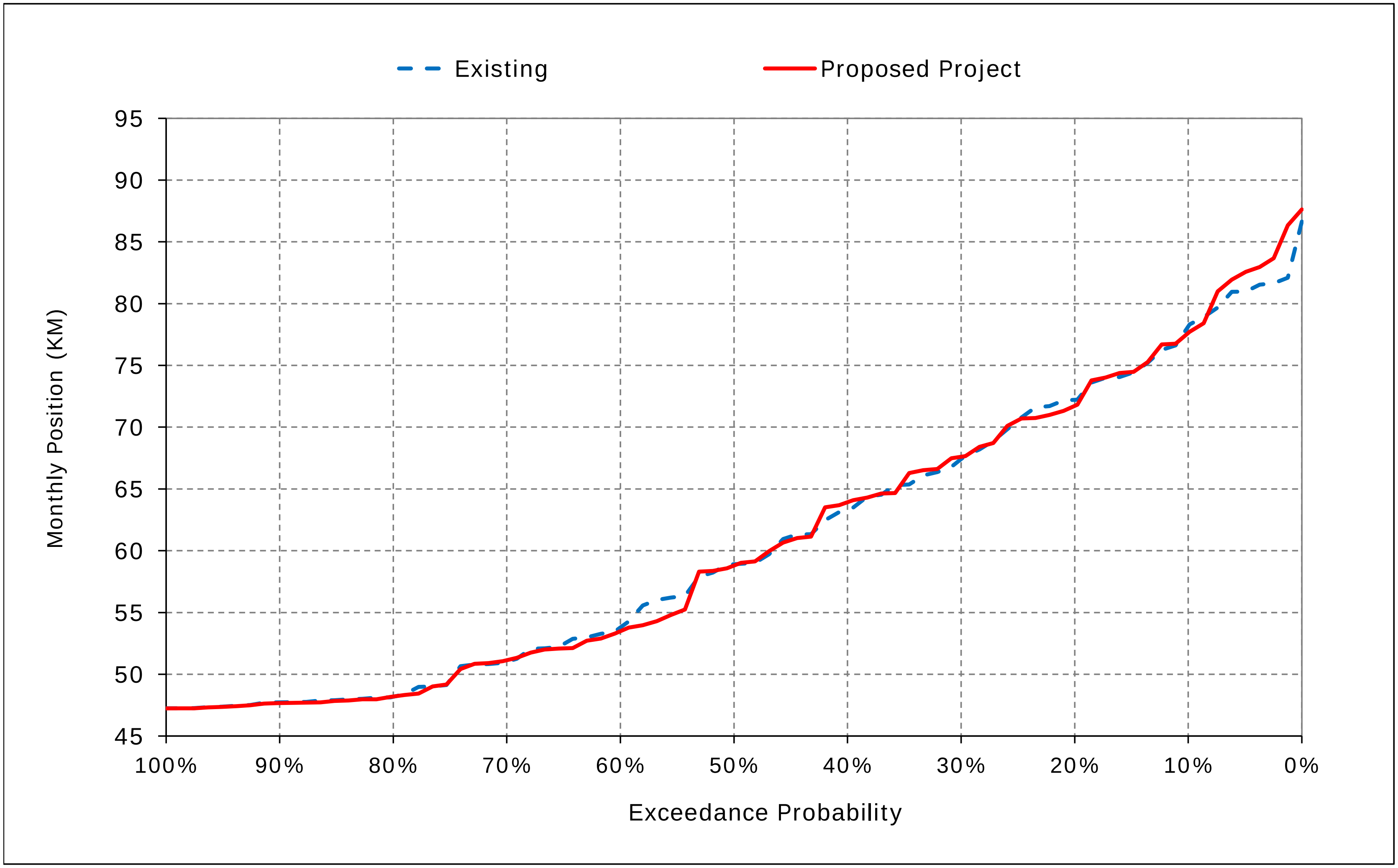


Figure 1-12. X2 Position, March

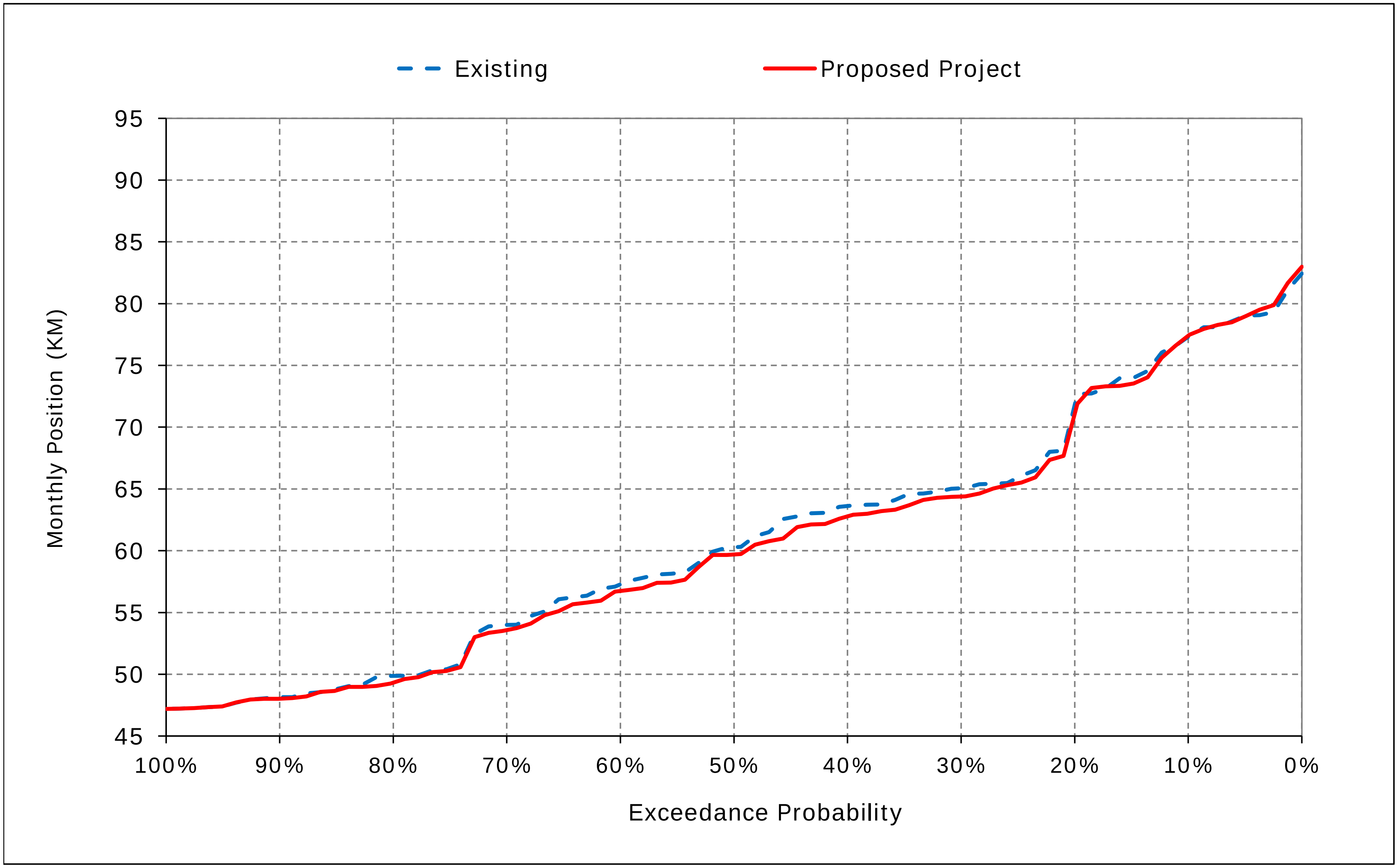


Figure 1-13. X2 Position, April

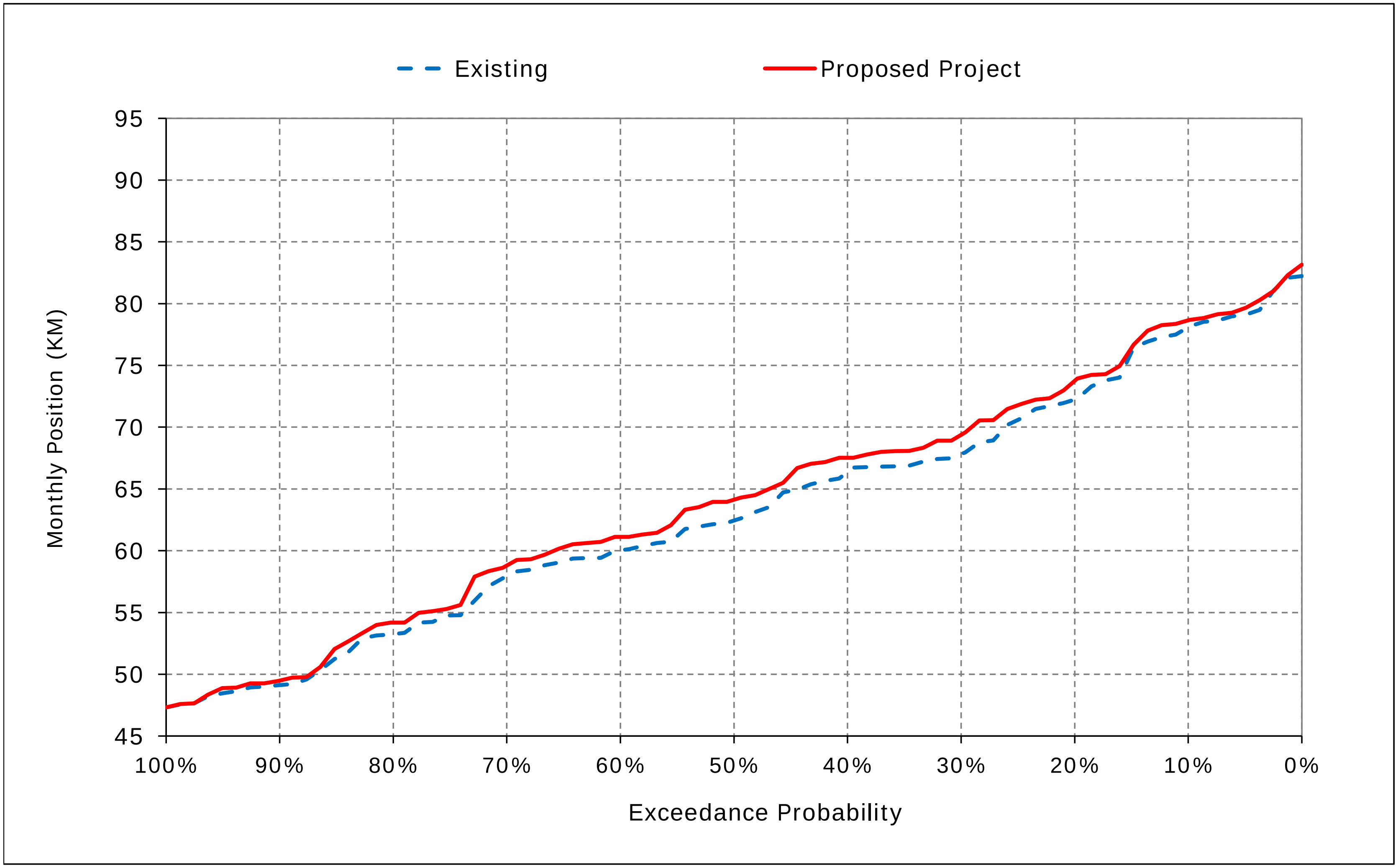


Figure 1-14. X2 Position, May

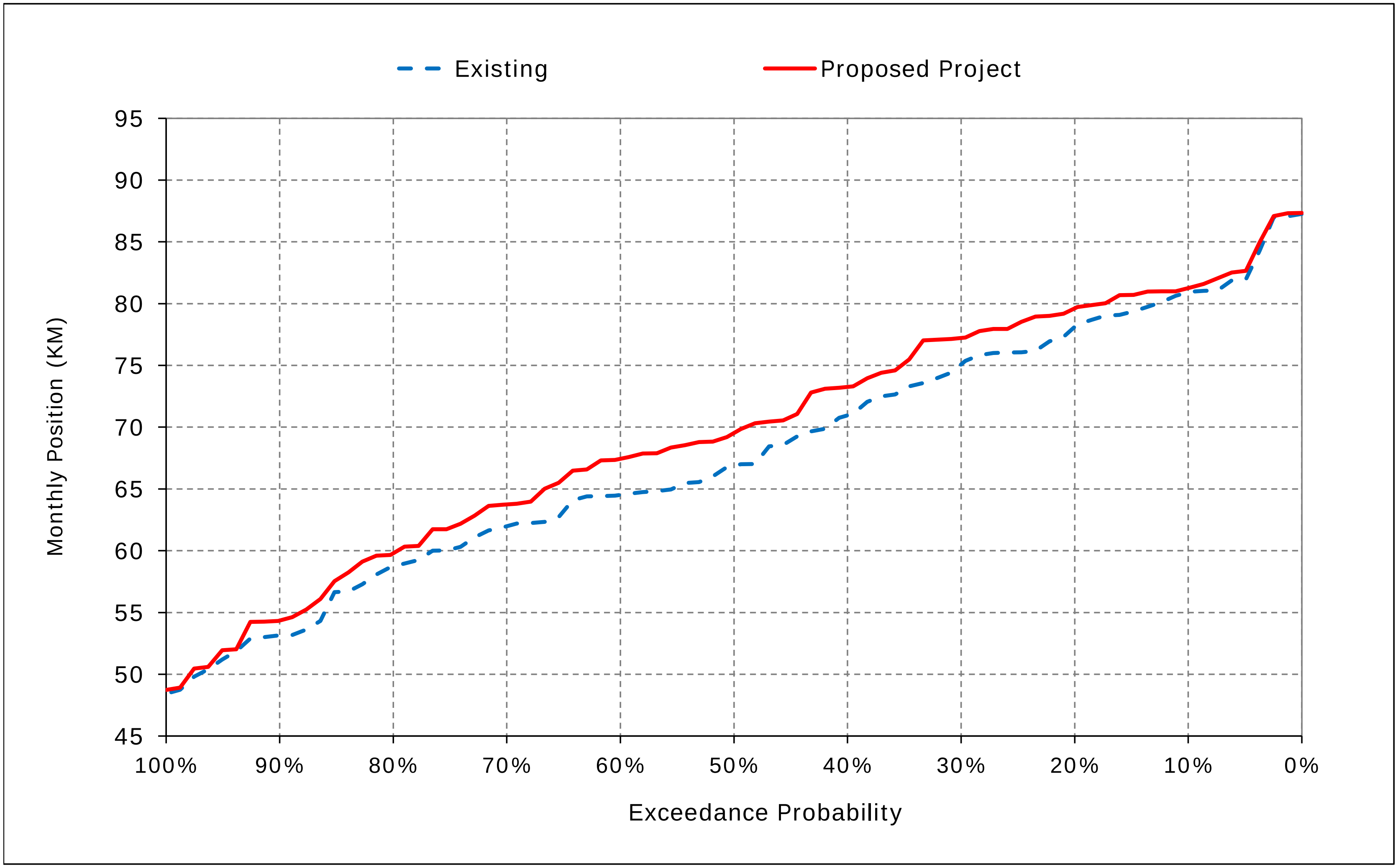


Figure 1-15. X2 Position, June

Figure 1-16. X2 Position, July

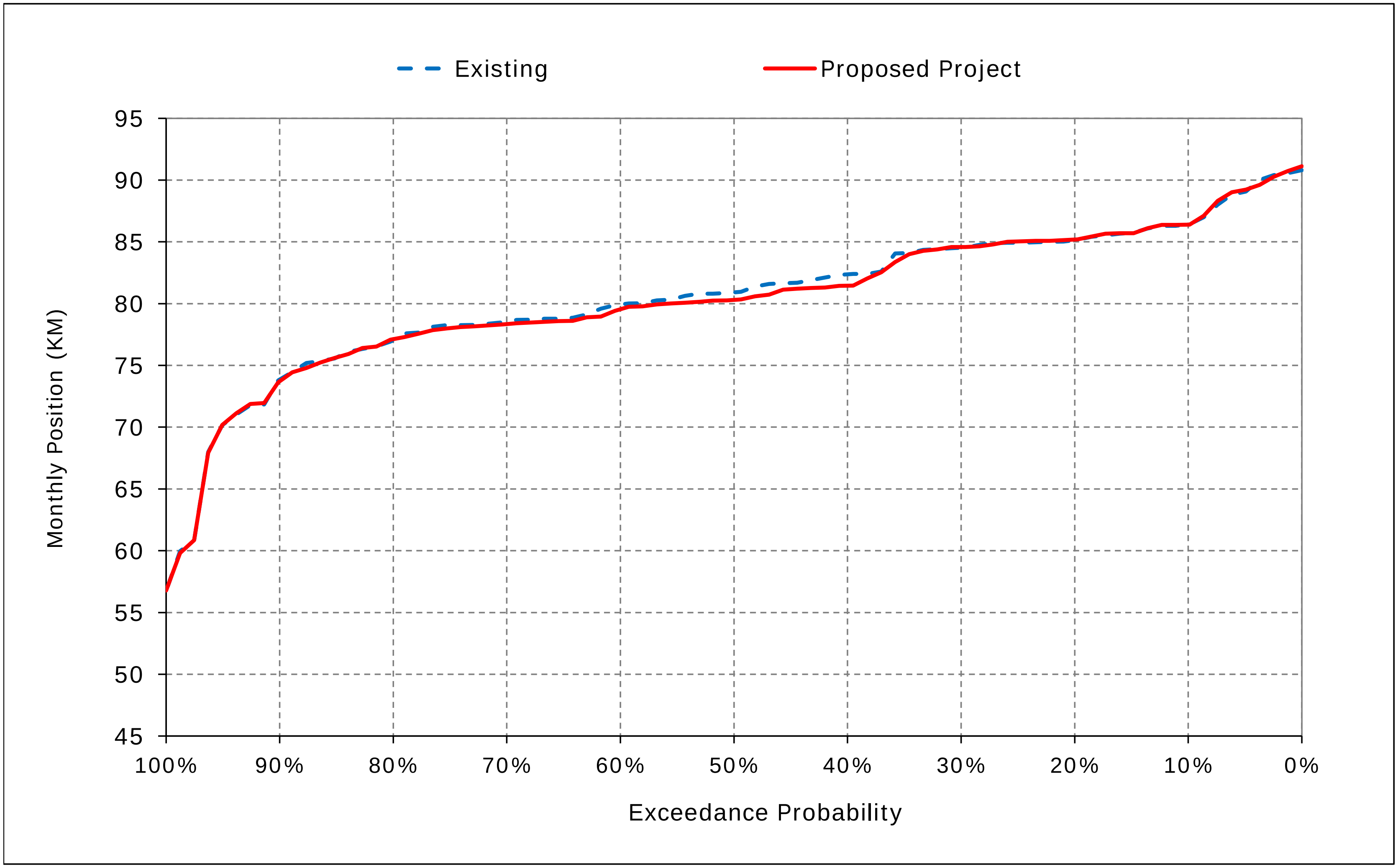


Figure 1-17. X2 Position, August

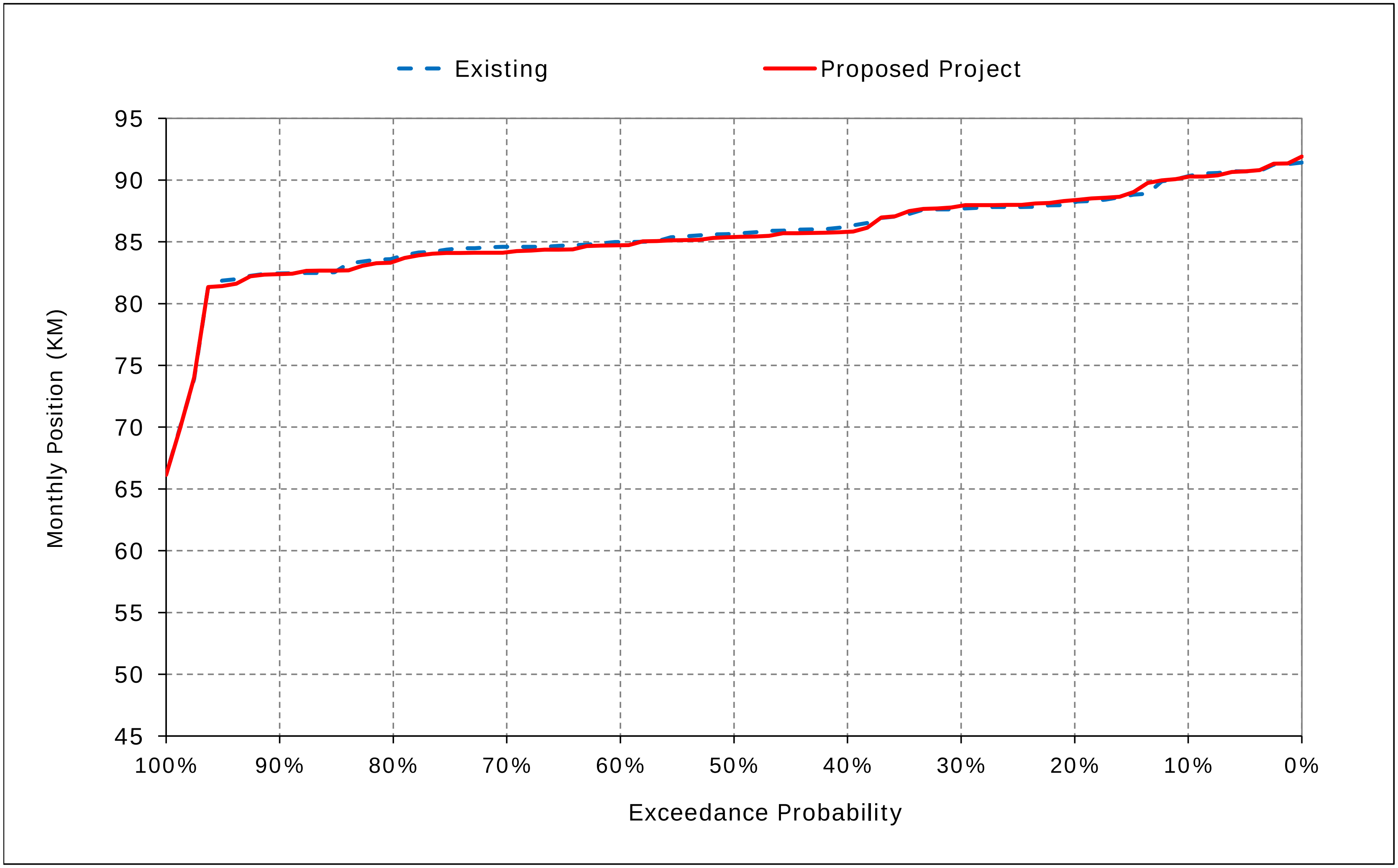
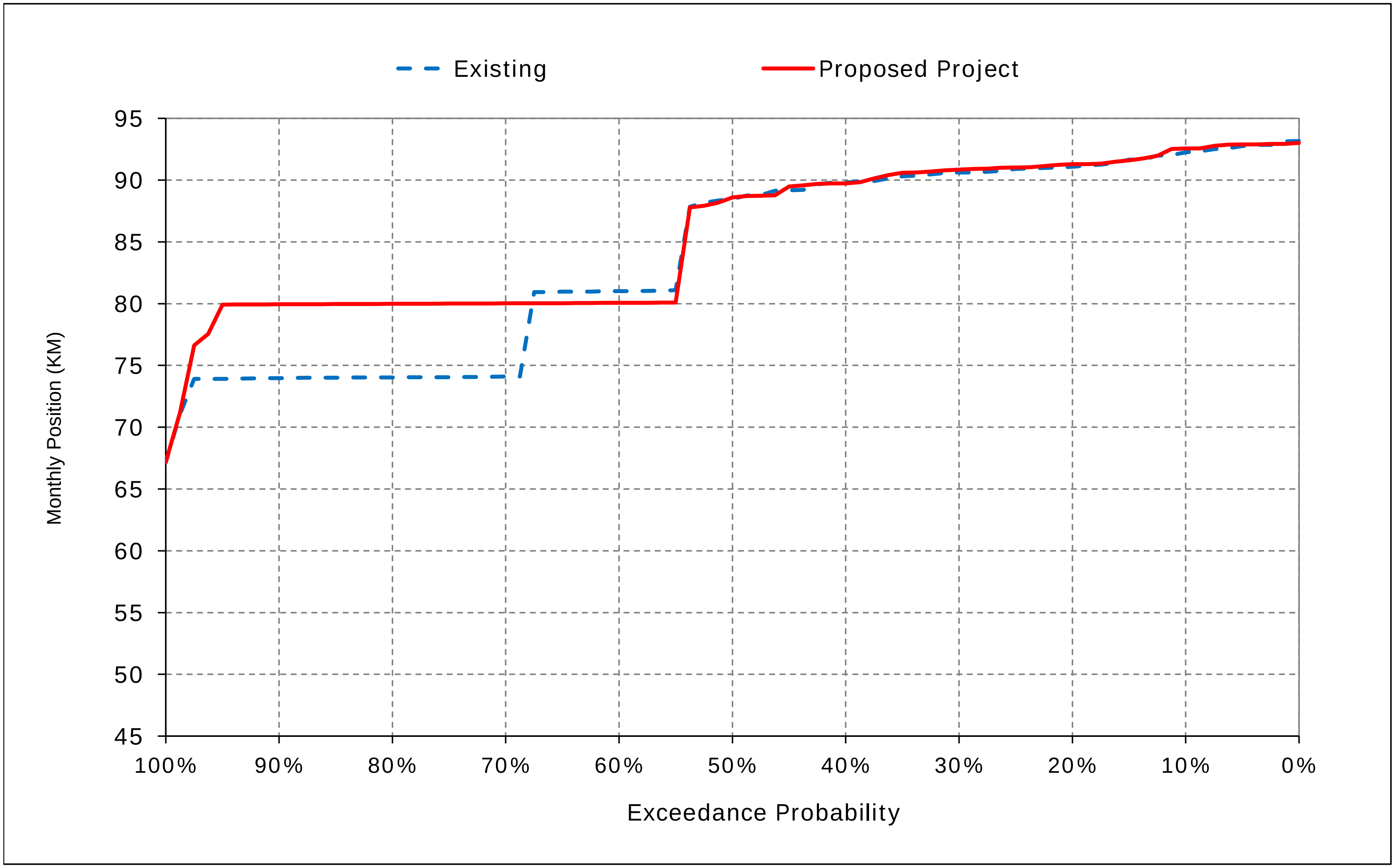


Figure 1-18. X2 Position, September



Appendix C – Modeling

Attachment 2-6 – Water Surface Elevation Results (DSM2-HYDRO)

The following results of the DSM2-HYDRO model are included for Delta water surface elevation conditions for the following alternatives:

- Existing Conditions
- Proposed Project

Table 2-6.1. Water Surface Elevation Results (DSM2-HYDRO)

Title	Model Parameter	Table Numbers	Figure Numbers
Sacramento River at Freeport Water Surface Elevation	RSAC155	1-1 to 1-2	NA
Sacramento River downstream of Steamboat Slough Water Surface Elevation	SAC_DS_STMBTSL	2-1 to 2-2	NA
Sacramento River at Rio Vista Water Surface Elevation	RSAC101	3-1 to 3-2	NA
San Joaquin River at Jersey Point Water Surface Elevation	RSAN018	4-1 to 4-2	NA
San Joaquin River at Prisoners Point Water Surface Elevation	RSAN037	5-1 to 5-2	NA
Old River at Tracy Boulevard Water Surface Elevation	ROLD059	6-1 to 6-2	NA

Report formats

- Monthly tables comparing two scenarios (exceedance values, long-term average, and average by water year type)

Table 1-1-1. Sacramento River at Freeport, Monthly Averaged Daily Maximum Elevation

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Maximum Elevation (FEET)											
Probability of Exceedance												
10%	3.8	5.6	5.9	7.5	15.0	12.0	10.8	5.7	4.7	5.3	4.6	6.5
20%	3.6	4.8	5.0	6.9	12.0	8.9	6.7	4.3	4.5	5.0	4.5	4.3
30%	3.6	4.0	4.6	6.0	9.0	7.5	6.1	4.3	4.4	4.9	4.3	4.0
40%	3.5	3.7	4.3	5.5	6.0	6.5	6.0	4.2	4.4	4.7	4.1	3.8
50%	3.5	3.7	3.9	5.1	5.0	4.8	5.6	4.0	4.2	4.6	4.0	3.8
60%	3.4	3.6	3.8	4.9	4.7	4.0	4.2	3.8	4.1	4.5	3.9	3.7
70%	3.3	3.4	3.8	4.3	4.5	3.8	3.7	3.8	3.9	4.2	3.9	3.6
80%	3.3	3.3	3.7	4.0	4.4	3.4	3.6	3.6	3.8	4.0	3.8	3.5
90%	3.2	3.3	3.7	3.9	4.2	3.3	3.4	3.4	3.8	3.9	3.7	3.5
Long Term												
Full Simulation Period[a]	3.5	4.1	4.9	5.5	7.7	6.6	6.0	4.6	4.4	4.6	4.1	4.3
Water Year Types[b]												
Wet (32%)	3.5	3.7	4.0	4.5	4.6	4.6	3.6	3.6	4.0	4.2	3.9	3.6
Above Normal (16%)	3.2	4.3	4.4	5.8	14.3	7.3	8.7	5.1	4.4	5.0	4.2	5.6
Below Normal (13%)	3.5	3.6	3.8	4.9	9.5	4.7	5.4	3.7	4.2	4.5	3.7	3.5
Dry (24%)	3.5	3.9	4.4	6.2	7.3	7.3	5.0	4.0	4.2	4.9	4.3	4.4
Critical (15%)	3.5	4.6	6.3	5.6	7.6	7.7	7.7	5.9	5.0	4.6	4.2	4.5

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Maximum Elevation (FEET)											
Probability of Exceedance												
10%	3.9	4.8	6.0	7.6	15.0	12.6	10.8	5.7	4.8	5.3	4.6	5.8
20%	3.7	4.0	5.1	6.8	11.5	8.8	6.7	4.3	4.5	5.0	4.5	4.3
30%	3.6	3.8	4.6	5.9	9.0	7.5	6.2	4.3	4.4	4.7	4.3	4.0
40%	3.6	3.6	4.3	5.6	6.1	6.5	6.0	4.2	4.4	4.6	4.0	3.8
50%	3.5	3.6	4.0	5.1	5.1	4.7	5.6	4.1	4.2	4.4	4.0	3.7
60%	3.5	3.5	3.9	4.8	4.8	4.0	4.2	3.8	4.1	4.3	3.9	3.7
70%	3.3	3.4	3.8	4.2	4.7	3.8	3.7	3.8	3.9	4.1	3.9	3.7
80%	3.3	3.3	3.7	4.0	4.5	3.6	3.6	3.6	3.9	4.0	3.8	3.5
90%	3.2	3.3	3.7	3.9	4.3	3.4	3.4	3.4	3.8	3.9	3.7	3.5
Long Term												
Full Simulation Period[a]	3.5	3.9	4.9	5.4	7.7	6.7	6.0	4.6	4.5	4.6	4.1	4.1
Water Year Types[b]												
Wet (32%)	3.5	3.6	4.0	4.5	4.6	4.6	3.6	3.5	4.0	4.2	3.9	3.6
Above Normal (16%)	3.2	4.2	4.4	5.8	14.1	7.3	8.7	5.1	4.4	4.9	4.3	4.8
Below Normal (13%)	3.5	3.5	3.9	4.8	9.5	4.5	5.4	4.2	4.1	4.5	3.7	3.4
Dry (24%)	3.5	3.5	4.4	6.1	7.3	7.6	5.0	4.0	4.3	4.8	4.3	4.4
Critical (15%)	3.6	4.4	6.3	5.6	7.7	7.7	7.8	5.9	5.1	4.5	4.1	4.1

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Maximum Elevation (FEET)											
Probability of Exceedance												
10%	0.1	-0.9	0.1	0.0	0.0	0.6	0.0	0.0	0.1	0.0	0.0	-0.7
20%	0.1	-0.8	0.1	0.0	-0.5	0.0	0.0	0.0	0.1	0.0	0.0	0.1
30%	0.0	-0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0	-0.2	-0.1	-0.1
40%	0.0	-0.1	-0.1	0.1	0.1	0.0	0.0	0.0	0.0	-0.1	-0.1	0.0
50%	0.0	0.0	0.1	-0.1	0.1	-0.1	0.0	0.2	0.0	-0.2	0.0	0.0
60%	0.0	0.0	0.0	-0.1	0.1	0.0	0.0	0.0	0.0	-0.2	0.0	0.0
70%	0.0	0.0	0.0	-0.1	0.2	0.0	0.0	0.0	0.0	-0.2	0.0	0.0
80%	0.0	0.0	0.0	0.0	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0
90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long Term												
Full Simulation Period[a]	0.0	-0.2	0.0	0.0	0.0	0.1	0.0	0.0	0.0	-0.1	0.0	-0.2
Water Year Types[b]												
Wet (32%)	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal (16%)	0.0	-0.1	0.0	0.0	-0.2	0.0	0.0	0.0	0.0	-0.1	0.0	-0.9
Below Normal (13%)	0.0	0.0	0.0	-0.1	0.0	-0.2	0.0	0.5	-0.1	0.0	0.0	0.0
Dry (24%)	0.0	-0.4	0.0	0.0	0.1	0.3	0.0	0.0	0.0	-0.1	0.0	0.1
Critical (15%)	0.1	-0.3	0.1	0.0	0.1	0.0	0.1	0.0	0.1	-0.1	0.0	-0.4

a Based on the 16-year simulation period

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999) at Early Long-Term

c The Elevations are based on National Geodetic Vertical Datum of 1929 (NGVD 29)

Table 1-2-1. Sacramento River at Freeport, Monthly Averaged Daily Minimum Elevation

Existing

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	2.1	4.7	5.0	6.8	14.6	11.5	10.4	4.7	3.3	4.1	3.2	5.7
20%	1.8	3.7	4.0	6.0	11.5	8.4	5.9	2.9	2.8	3.8	3.0	2.8
30%	1.6	2.3	3.2	5.2	8.5	6.9	5.5	2.7	2.8	3.5	2.8	2.4
40%	1.5	1.9	2.8	4.4	5.2	5.7	5.2	2.7	2.7	3.2	2.3	1.9
50%	1.4	1.7	2.1	4.1	4.0	3.7	4.7	2.3	2.5	3.0	1.7	1.8
60%	1.3	1.3	1.9	3.6	3.7	2.7	2.7	1.9	2.1	2.9	1.7	1.6
70%	1.1	1.2	1.8	2.7	3.3	2.3	2.1	1.8	2.0	2.2	1.6	1.3
80%	1.0	0.9	1.7	2.5	3.1	2.1	1.9	1.5	1.9	1.6	1.6	1.2
90%	0.9	0.9	1.6	2.3	2.8	1.9	1.6	1.2	1.6	1.6	1.4	1.1
Long Term												
Full Simulation Period[a]	1.5	2.3	3.3	4.3	6.8	5.6	4.9	3.0	2.7	2.9	2.2	2.5
Water Year Types[b]												
Wet (32%)	1.4	1.5	2.1	3.0	3.4	3.2	1.9	1.4	2.0	2.0	1.5	1.3
Above Normal (16%)	1.1	2.8	3.1	4.6	13.9	6.5	8.2	3.9	2.7	3.7	2.5	4.4
Below Normal (13%)	1.5	1.7	1.7	3.6	9.0	3.6	4.5	1.9	2.5	3.0	1.4	1.4
Dry (24%)	1.4	1.9	2.9	5.3	6.3	6.3	3.7	2.3	2.5	3.3	2.4	2.7
Critical (15%)	1.7	3.2	4.9	4.5	6.7	6.9	6.9	4.6	3.5	3.1	2.5	2.9

Proposed Project

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	2.3	3.5	5.1	6.8	14.6	12.1	10.4	4.7	3.4	4.2	3.2	4.9
20%	2.1	2.5	3.9	6.0	11.0	8.4	5.8	2.9	3.1	3.7	2.9	2.9
30%	1.8	2.2	3.2	5.1	8.5	6.9	5.5	2.8	2.8	3.2	2.8	2.3
40%	1.5	1.7	2.7	4.6	5.2	5.8	5.3	2.8	2.7	3.1	2.2	1.9
50%	1.4	1.5	2.2	4.0	4.1	3.6	4.7	2.6	2.5	2.9	1.7	1.8
60%	1.3	1.3	2.0	3.5	3.8	2.7	2.7	2.0	2.3	2.6	1.6	1.6
70%	1.1	1.2	1.8	2.6	3.6	2.4	2.1	1.7	2.0	1.8	1.6	1.3
80%	1.0	0.9	1.7	2.4	3.3	2.4	2.0	1.6	1.9	1.6	1.5	1.2
90%	0.9	0.9	1.6	2.3	2.8	1.9	1.6	1.2	1.6	1.6	1.3	1.1
Long Term												
Full Simulation Period[a]	1.5	2.0	3.3	4.3	6.9	5.7	4.9	3.0	2.7	2.8	2.1	2.3
Water Year Types[b]												
Wet (32%)	1.5	1.4	2.1	3.0	3.4	3.3	2.0	1.4	2.0	2.0	1.5	1.3
Above Normal (16%)	1.1	2.6	3.1	4.6	13.6	6.5	8.2	3.9	2.8	3.6	2.5	3.4
Below Normal (13%)	1.5	1.6	1.7	3.5	9.0	3.3	4.5	2.8	2.4	3.1	1.3	1.4
Dry (24%)	1.4	1.4	2.8	5.2	6.4	6.6	3.7	2.3	2.6	3.1	2.4	2.7
Critical (15%)	1.8	2.8	5.0	4.5	6.8	6.9	7.0	4.6	3.6	2.9	2.4	2.5

Proposed Project minus Existing

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	0.2	-1.2	0.1	0.0	0.0	0.6	0.0	0.0	0.0	0.1	0.0	-0.8
20%	0.4	-1.3	-0.1	0.0	-0.5	0.0	0.0	0.0	0.3	-0.1	-0.1	0.1
30%	0.1	-0.2	0.0	-0.1	0.0	0.0	0.1	0.0	0.0	-0.3	-0.1	-0.2
40%	0.0	-0.2	-0.1	0.2	0.1	0.0	0.1	0.1	0.0	-0.1	-0.1	-0.1
50%	0.0	-0.1	0.1	-0.1	0.2	-0.2	0.0	0.3	0.0	-0.2	0.1	0.0
60%	0.0	0.0	0.1	-0.1	0.1	0.0	0.0	0.0	0.2	-0.4	0.0	0.0
70%	0.0	0.0	0.0	-0.1	0.2	0.0	0.0	0.0	0.0	-0.4	0.0	0.0
80%	0.0	0.0	0.1	-0.1	0.2	0.3	0.1	0.1	0.0	0.0	-0.1	0.0
90%	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	-0.1	0.0
Long Term												
Full Simulation Period[a]	0.1	-0.3	0.0	0.0	0.1	0.1	0.0	0.1	0.1	-0.1	0.0	-0.2
Water Year Types[b]												
Wet (32%)	0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal (16%)	0.0	-0.2	0.0	0.0	-0.2	0.0	0.0	0.0	0.0	-0.1	0.1	-1.0
Below Normal (13%)	0.0	-0.1	0.1	-0.1	0.0	-0.3	0.0	0.8	-0.1	0.0	-0.1	0.0
Dry (24%)	0.0	-0.5	-0.1	-0.1	0.1	0.3	0.0	0.0	0.1	-0.2	0.0	0.1
Critical (15%)	0.1	-0.4	0.1	0.0	0.1	0.0	0.1	0.0	0.1	-0.2	-0.1	-0.5

a Based on the 16-year simulation period

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999) at Early Long-Term

c The Elevations are based on National Geodetic Vertical Datum of 1929 (NGVD 29)

Table 2-1-1. Sacramento River d/s of Steamboat Slough, Monthly Averaged Daily Maximum Elevation

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Maximum Elevation (FEET)											
Probability of Exceedance												
10%	3.3	4.1	4.2	4.9	9.1	7.1	6.4	4.1	3.9	4.1	3.9	4.3
20%	3.2	3.6	3.8	4.6	7.1	5.5	4.3	3.8	3.8	4.1	3.8	3.7
30%	3.2	3.4	3.8	4.2	5.6	4.7	4.1	3.7	3.8	4.0	3.7	3.6
40%	3.2	3.4	3.7	4.1	4.2	4.3	4.0	3.6	3.7	4.0	3.6	3.5
50%	3.2	3.3	3.5	4.0	3.9	3.7	3.9	3.5	3.7	3.9	3.6	3.4
60%	3.1	3.2	3.5	3.8	3.8	3.4	3.5	3.4	3.7	3.9	3.5	3.3
70%	3.0	3.1	3.4	3.7	3.7	3.3	3.3	3.4	3.5	3.7	3.5	3.3
80%	2.9	3.0	3.3	3.6	3.6	3.0	3.2	3.2	3.5	3.6	3.5	3.2
90%	2.9	2.9	3.3	3.5	3.6	3.0	3.1	3.1	3.5	3.6	3.3	3.1
Long Term												
Full Simulation Period[a]	3.1	3.4	3.9	4.1	5.2	4.5	4.2	3.7	3.8	3.9	3.6	3.5
Water Year Types[b]												
Wet (32%)	3.1	3.2	3.5	3.8	3.7	3.6	3.2	3.2	3.6	3.7	3.5	3.3
Above Normal (16%)	2.9	3.4	3.5	4.1	8.6	4.7	5.3	3.9	3.7	4.0	3.6	4.1
Below Normal (13%)	3.1	3.2	3.5	4.0	5.8	3.7	4.0	3.3	3.7	3.8	3.3	3.1
Dry (24%)	3.1	3.3	3.7	4.3	5.1	4.9	3.7	3.6	3.7	4.0	3.7	3.6
Critical (15%)	3.2	3.6	4.5	4.1	5.2	5.1	5.0	4.3	4.0	3.9	3.6	3.6

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Maximum Elevation (FEET)											
Probability of Exceedance												
10%	3.4	3.8	4.2	4.9	9.1	7.5	6.4	4.1	4.0	4.1	3.9	3.9
20%	3.2	3.4	3.8	4.6	6.9	5.4	4.3	3.8	3.8	4.0	3.8	3.7
30%	3.2	3.3	3.8	4.2	5.6	4.7	4.1	3.7	3.8	4.0	3.7	3.5
40%	3.2	3.3	3.7	4.0	4.2	4.3	4.0	3.6	3.7	3.9	3.6	3.5
50%	3.2	3.3	3.6	4.0	3.9	3.7	3.9	3.6	3.7	3.8	3.6	3.4
60%	3.1	3.2	3.5	3.8	3.8	3.4	3.5	3.5	3.6	3.8	3.5	3.3
70%	3.0	3.1	3.4	3.7	3.7	3.3	3.3	3.4	3.5	3.7	3.5	3.3
80%	2.9	3.0	3.3	3.6	3.6	3.1	3.3	3.2	3.5	3.6	3.5	3.2
90%	2.9	2.9	3.3	3.5	3.6	3.0	3.1	3.1	3.5	3.6	3.3	3.1
Long Term												
Full Simulation Period[a]	3.1	3.3	3.9	4.1	5.2	4.6	4.2	3.7	3.8	3.8	3.6	3.4
Water Year Types[b]												
Wet (32%)	3.2	3.2	3.5	3.8	3.7	3.6	3.2	3.2	3.6	3.7	3.5	3.3
Above Normal (16%)	2.9	3.4	3.5	4.1	8.5	4.7	5.3	3.9	3.8	3.9	3.7	3.6
Below Normal (13%)	3.1	3.2	3.5	4.0	5.9	3.6	4.0	3.5	3.6	3.8	3.3	3.1
Dry (24%)	3.1	3.1	3.7	4.3	5.1	5.1	3.7	3.6	3.8	3.9	3.7	3.6
Critical (15%)	3.2	3.5	4.6	4.1	5.2	5.1	5.0	4.3	4.0	3.8	3.6	3.4

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Maximum Elevation (FEET)											
Probability of Exceedance												
10%	0.0	-0.3	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	-0.4
20%	0.0	-0.2	0.0	0.0	-0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30%	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0
40%	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0
50%	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0
60%	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0
70%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long Term												
Full Simulation Period[a]	0.0	-0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	-0.1
Water Year Types[b]												
Wet (32%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal (16%)	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.4
Below Normal (13%)	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.2	0.0	0.0	0.0	0.0
Dry (24%)	0.0	-0.1	0.0	0.0	0.0	0.2	0.0	0.0	0.0	-0.1	0.0	0.0
Critical (15%)	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2

a Based on the 16-year simulation period

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999) at Early Long-Term

c The Elevations are based on National Geodetic Vertical Datum of 1929 (NGVD 29)

Table 2-2-1. Sacramento River d/s of Steamboat Slough, Monthly Averaged Daily Minimum Elevation

Existing

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	0.6	2.0	2.2	3.2	8.4	6.2	5.4	2.0	1.1	1.4	1.0	2.4
20%	0.5	1.4	1.6	2.8	6.2	4.3	2.7	1.1	0.9	1.2	1.0	0.9
30%	0.4	0.7	1.2	2.3	4.3	3.3	2.4	1.1	0.8	1.2	0.9	0.8
40%	0.3	0.5	1.0	1.9	2.3	2.7	2.3	1.0	0.8	1.0	0.7	0.6
50%	0.3	0.4	0.6	1.7	1.7	1.6	2.1	0.8	0.7	0.9	0.5	0.5
60%	0.3	0.3	0.5	1.5	1.5	0.9	1.0	0.6	0.5	0.9	0.5	0.5
70%	0.1	0.1	0.5	1.0	1.4	0.8	0.7	0.5	0.5	0.6	0.4	0.3
80%	0.1	0.0	0.4	0.9	1.2	0.6	0.5	0.3	0.5	0.4	0.4	0.3
90%	0.0	-0.1	0.3	0.8	1.1	0.5	0.4	0.2	0.3	0.4	0.3	0.2
Long Term												
Full Simulation Period[a]	0.3	0.7	1.3	1.9	3.5	2.7	2.2	1.2	0.8	0.9	0.6	0.9
Water Year Types[b]												
Wet (32%)	0.3	0.3	0.6	1.2	1.3	1.3	0.6	0.3	0.5	0.5	0.4	0.3
Above Normal (16%)	0.1	1.0	1.1	2.0	7.8	3.1	4.1	1.7	0.9	1.2	0.7	1.9
Below Normal (13%)	0.4	0.4	0.5	1.5	4.6	1.6	2.0	0.6	0.7	0.9	0.3	0.3
Dry (24%)	0.3	0.5	1.0	2.3	3.2	3.1	1.5	0.8	0.7	1.0	0.8	0.9
Critical (15%)	0.4	1.2	2.3	2.0	3.4	3.5	3.4	2.1	1.3	1.0	0.8	1.1

Proposed Project

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	0.7	1.4	2.2	3.2	8.4	6.6	5.4	2.0	1.1	1.4	1.0	1.8
20%	0.6	0.7	1.6	2.8	5.9	4.2	2.6	1.1	1.0	1.2	1.0	1.0
30%	0.4	0.6	1.2	2.3	4.3	3.3	2.5	1.1	0.8	1.0	0.9	0.7
40%	0.4	0.5	0.9	2.0	2.4	2.7	2.3	1.0	0.8	0.9	0.7	0.6
50%	0.3	0.3	0.6	1.6	1.7	1.5	2.1	1.0	0.7	0.9	0.5	0.5
60%	0.3	0.3	0.6	1.5	1.5	0.9	1.0	0.6	0.6	0.8	0.4	0.5
70%	0.1	0.1	0.5	1.0	1.5	0.8	0.7	0.5	0.6	0.5	0.4	0.3
80%	0.1	0.0	0.5	0.9	1.4	0.7	0.6	0.4	0.4	0.4	0.4	0.3
90%	0.0	-0.1	0.3	0.8	1.1	0.5	0.4	0.3	0.3	0.4	0.3	0.2
Long Term												
Full Simulation Period[a]	0.3	0.6	1.3	1.8	3.5	2.7	2.2	1.2	0.9	0.9	0.6	0.7
Water Year Types[b]												
Wet (32%)	0.3	0.3	0.6	1.2	1.3	1.3	0.6	0.3	0.5	0.5	0.4	0.3
Above Normal (16%)	0.1	0.9	1.1	2.0	7.7	3.1	4.1	1.6	0.9	1.1	0.8	1.1
Below Normal (13%)	0.4	0.3	0.6	1.5	4.6	1.4	2.0	1.0	0.6	0.9	0.3	0.3
Dry (24%)	0.3	0.2	1.0	2.3	3.2	3.3	1.5	0.8	0.7	1.0	0.7	0.9
Critical (15%)	0.5	1.0	2.3	2.0	3.5	3.5	3.5	2.1	1.4	0.9	0.7	0.8

Proposed Project minus Existing

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	0.0	-0.6	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	-0.7
20%	0.1	-0.7	0.0	0.0	-0.3	0.0	0.0	0.0	0.1	-0.1	0.0	0.0
30%	0.1	-0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	-0.1	0.0	-0.1
40%	0.1	0.0	-0.1	0.1	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0
50%	0.0	0.0	0.0	0.0	0.1	-0.1	0.0	0.2	0.0	-0.1	0.0	0.0
60%	0.0	0.0	0.1	-0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
70%	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	-0.2	0.0	0.0
80%	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long Term												
Full Simulation Period[a]	0.0	-0.2	0.0	0.0	0.0	0.1	0.0	0.0	0.0	-0.1	0.0	-0.2
Water Year Types[b]												
Wet (32%)	0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal (16%)	0.0	-0.1	0.0	0.0	-0.2	0.0	0.0	0.0	0.0	0.0	0.0	-0.8
Below Normal (13%)	0.0	0.0	0.0	0.0	0.0	-0.2	0.0	0.4	-0.1	0.0	0.0	0.0
Dry (24%)	0.0	-0.3	0.0	0.0	0.1	0.2	0.0	0.0	0.0	-0.1	0.0	0.0
Critical (15%)	0.0	-0.2	0.0	0.0	0.1	0.0	0.0	0.0	0.1	-0.1	0.0	-0.3

a Based on the 16-year simulation period

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999) at Early Long-Term

c The Elevations are based on National Geodetic Vertical Datum of 1929 (NGVD 29)

Table 3-1-1. Sacramento River at Rio Vista, Monthly Averaged Daily Maximum Elevation

Existing

Statistic	Monthly Averaged Daily Maximum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	3.3	3.4	3.5	3.6	4.0	3.5	3.4	3.5	3.6	3.7	3.6	3.5
20%	3.2	3.3	3.4	3.5	3.7	3.4	3.3	3.4	3.6	3.7	3.6	3.4
30%	3.2	3.3	3.4	3.5	3.6	3.3	3.2	3.4	3.6	3.7	3.6	3.4
40%	3.1	3.2	3.4	3.5	3.5	3.2	3.1	3.3	3.6	3.7	3.5	3.3
50%	3.1	3.2	3.4	3.4	3.4	3.1	3.1	3.3	3.5	3.7	3.5	3.3
60%	3.1	3.2	3.3	3.4	3.4	3.0	3.1	3.3	3.5	3.6	3.5	3.3
70%	3.1	3.1	3.3	3.3	3.3	3.0	3.0	3.2	3.5	3.6	3.5	3.3
80%	3.0	3.1	3.2	3.3	3.1	2.9	3.0	3.1	3.5	3.6	3.5	3.3
90%	3.0	3.0	3.1	3.2	3.1	2.7	2.9	3.0	3.4	3.5	3.4	3.2
Long Term												
Full Simulation Period[a]	3.1	3.2	3.4	3.4	3.5	3.1	3.1	3.3	3.5	3.6	3.5	3.3
Water Year Types[b]												
Wet (32%)	3.2	3.2	3.3	3.4	3.2	3.0	3.0	3.2	3.5	3.7	3.5	3.4
Above Normal (16%)	3.0	3.1	3.1	3.2	3.8	3.1	3.2	3.3	3.5	3.6	3.5	3.4
Below Normal (13%)	3.2	3.2	3.5	3.5	3.7	3.2	3.3	3.1	3.5	3.5	3.5	3.1
Dry (24%)	3.1	3.2	3.4	3.4	3.5	3.2	3.1	3.4	3.5	3.7	3.6	3.4
Critical (15%)	3.1	3.2	3.4	3.4	3.4	3.2	3.2	3.4	3.5	3.6	3.4	3.3

Proposed Project

Statistic	Monthly Averaged Daily Maximum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	3.3	3.4	3.5	3.6	4.0	3.5	3.4	3.5	3.6	3.7	3.6	3.5
20%	3.2	3.3	3.4	3.5	3.7	3.4	3.3	3.4	3.6	3.7	3.6	3.4
30%	3.2	3.3	3.4	3.5	3.6	3.3	3.2	3.4	3.6	3.7	3.6	3.4
40%	3.1	3.2	3.4	3.5	3.5	3.2	3.1	3.3	3.6	3.7	3.5	3.3
50%	3.1	3.2	3.4	3.4	3.4	3.1	3.1	3.3	3.5	3.7	3.5	3.3
60%	3.1	3.1	3.3	3.4	3.4	3.0	3.1	3.2	3.5	3.6	3.5	3.3
70%	3.1	3.1	3.3	3.3	3.3	3.0	3.0	3.2	3.5	3.6	3.5	3.3
80%	3.0	3.1	3.2	3.2	3.1	2.9	3.0	3.2	3.5	3.6	3.4	3.3
90%	3.0	3.0	3.1	3.2	3.1	2.7	2.9	3.0	3.4	3.5	3.4	3.2
Long Term												
Full Simulation Period[a]	3.1	3.2	3.4	3.4	3.5	3.1	3.1	3.3	3.5	3.6	3.5	3.3
Water Year Types[b]												
Wet (32%)	3.2	3.2	3.3	3.4	3.2	3.0	3.0	3.2	3.5	3.7	3.5	3.4
Above Normal (16%)	3.0	3.1	3.1	3.2	3.8	3.1	3.2	3.3	3.5	3.6	3.5	3.3
Below Normal (13%)	3.2	3.2	3.5	3.5	3.7	3.2	3.3	3.2	3.5	3.5	3.4	3.1
Dry (24%)	3.1	3.1	3.4	3.4	3.5	3.2	3.1	3.4	3.5	3.7	3.6	3.4
Critical (15%)	3.1	3.2	3.4	3.4	3.4	3.2	3.2	3.4	3.5	3.6	3.4	3.2

Proposed Project minus Existing

Statistic	Monthly Averaged Daily Maximum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long Term												
Full Simulation Period[a]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Water Year Types[b]												
Wet (32%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal (16%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
Below Normal (13%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dry (24%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Critical (15%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

a Based on the 16-year simulation period

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999) at Early Long-Term

c The Elevations are based on National Geodetic Vertical Datum of 1929 (NGVD 29)

Table 3-2-1. Sacramento River at Rio Vista, Monthly Averaged Daily Minimum Elevation

Existing

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-0.8	-0.9	-0.9	-0.8	0.3	-0.4	-0.5	-0.8	-0.9	-0.8	-0.7	-0.6
20%	-0.8	-0.9	-1.0	-0.9	-0.2	-0.6	-0.7	-0.9	-0.9	-0.8	-0.7	-0.6
30%	-0.9	-1.0	-1.1	-0.9	-0.4	-0.7	-0.8	-0.9	-1.0	-0.9	-0.8	-0.7
40%	-0.9	-1.1	-1.1	-1.0	-0.8	-0.8	-0.9	-1.1	-1.0	-0.9	-0.8	-0.8
50%	-1.0	-1.1	-1.2	-1.0	-0.8	-0.8	-1.0	-1.1	-1.0	-0.9	-0.8	-0.8
60%	-1.0	-1.2	-1.2	-1.1	-0.9	-0.9	-1.0	-1.1	-1.0	-0.9	-0.8	-0.8
70%	-1.1	-1.3	-1.2	-1.1	-0.9	-1.1	-1.1	-1.1	-1.0	-0.9	-0.9	-0.8
80%	-1.1	-1.3	-1.2	-1.1	-0.9	-1.2	-1.1	-1.2	-1.1	-1.0	-0.9	-0.8
90%	-1.1	-1.3	-1.3	-1.2	-1.1	-1.2	-1.2	-1.2	-1.1	-1.0	-0.9	-0.9
Long Term												
Full Simulation Period[a]	-1.0	-1.1	-1.1	-1.0	-0.6	-0.8	-0.9	-1.0	-1.0	-0.9	-0.8	-0.8
Water Year Types[b]												
Wet (32%)	-1.0	-1.2	-1.2	-1.1	-1.0	-1.1	-1.1	-1.2	-1.1	-0.9	-0.9	-0.8
Above Normal (16%)	-1.1	-1.1	-1.3	-1.1	0.2	-0.8	-0.7	-1.0	-0.9	-0.9	-0.8	-0.7
Below Normal (13%)	-0.8	-1.1	-1.0	-0.9	-0.3	-0.7	-0.7	-1.2	-1.0	-1.0	-0.9	-1.0
Dry (24%)	-1.0	-1.2	-1.1	-1.1	-0.7	-0.8	-1.0	-1.0	-1.0	-0.9	-0.8	-0.7
Critical (15%)	-0.9	-1.0	-0.9	-1.0	-0.5	-0.5	-0.7	-0.9	-0.9	-0.8	-0.8	-0.7

Proposed Project

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-0.8	-0.9	-0.9	-0.8	0.3	-0.3	-0.6	-0.9	-0.9	-0.8	-0.7	-0.6
20%	-0.8	-1.0	-1.0	-0.9	-0.2	-0.6	-0.7	-0.9	-0.9	-0.8	-0.7	-0.7
30%	-0.9	-1.0	-1.1	-0.9	-0.4	-0.7	-0.8	-0.9	-1.0	-0.9	-0.8	-0.7
40%	-0.9	-1.1	-1.1	-1.0	-0.8	-0.8	-0.9	-1.1	-1.0	-0.9	-0.8	-0.8
50%	-1.0	-1.1	-1.2	-1.1	-0.8	-0.8	-1.0	-1.1	-1.0	-0.9	-0.8	-0.8
60%	-1.0	-1.2	-1.2	-1.1	-0.9	-1.0	-1.1	-1.1	-1.0	-0.9	-0.8	-0.8
70%	-1.1	-1.3	-1.2	-1.1	-0.9	-1.1	-1.1	-1.1	-1.0	-0.9	-0.9	-0.8
80%	-1.1	-1.3	-1.2	-1.1	-0.9	-1.2	-1.1	-1.2	-1.1	-1.0	-0.9	-0.8
90%	-1.1	-1.3	-1.3	-1.2	-1.1	-1.2	-1.2	-1.2	-1.1	-1.0	-0.9	-0.9
Long Term												
Full Simulation Period[a]	-1.0	-1.1	-1.1	-1.0	-0.6	-0.8	-0.9	-1.0	-1.0	-0.9	-0.8	-0.8
Water Year Types[b]												
Wet (32%)	-1.0	-1.2	-1.2	-1.1	-1.0	-1.1	-1.1	-1.2	-1.1	-0.9	-0.9	-0.8
Above Normal (16%)	-1.1	-1.2	-1.3	-1.1	0.2	-0.8	-0.8	-1.0	-0.9	-0.9	-0.8	-0.8
Below Normal (13%)	-0.8	-1.1	-1.0	-0.9	-0.3	-0.7	-0.7	-1.1	-1.0	-1.0	-0.9	-1.0
Dry (24%)	-1.0	-1.2	-1.1	-1.1	-0.7	-0.8	-1.0	-1.0	-1.0	-0.9	-0.8	-0.7
Critical (15%)	-0.9	-1.0	-0.9	-1.0	-0.5	-0.5	-0.7	-0.9	-0.9	-0.8	-0.8	-0.7

Proposed Project minus Existing

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
20%	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
30%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long Term												
Full Simulation Period[a]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Water Year Types[b]												
Wet (32%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal (16%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Below Normal (13%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dry (24%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Critical (15%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

a Based on the 16-year simulation period

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999) at Early Long-Term

c The Elevations are based on National Geodetic Vertical Datum of 1929 (NGVD 29)

Table 4-1-1. San Joaquin River at Jersey Point, Monthly Averaged Daily Maximum Elevation

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Maximum Elevation (FEET)											
Probability of Exceedance												
10%	3.0	3.0	3.1	3.2	3.5	3.0	2.9	3.2	3.3	3.4	3.3	3.2
20%	2.9	2.9	3.1	3.1	3.2	3.0	2.8	3.1	3.3	3.4	3.3	3.1
30%	2.9	2.9	3.0	3.1	3.2	2.9	2.8	3.1	3.3	3.4	3.2	3.0
40%	2.8	2.9	3.0	3.0	3.1	2.8	2.8	3.0	3.2	3.3	3.2	3.0
50%	2.8	2.8	3.0	3.0	3.0	2.7	2.8	3.0	3.2	3.3	3.2	3.0
60%	2.8	2.8	3.0	3.0	3.0	2.7	2.7	2.8	3.1	3.3	3.2	3.0
70%	2.8	2.8	2.9	2.9	2.9	2.6	2.7	2.8	3.1	3.3	3.1	2.9
80%	2.7	2.8	2.9	2.9	2.8	2.6	2.7	2.8	3.1	3.2	3.1	2.9
90%	2.7	2.7	2.8	2.8	2.7	2.4	2.6	2.7	3.1	3.1	3.0	2.9
Long Term												
Full Simulation Period[a]	2.8	2.8	3.0	3.0	3.0	2.7	2.8	2.9	3.2	3.3	3.2	3.0
Water Year Types[b]												
Wet (32%)	2.9	2.9	3.0	3.1	2.9	2.7	2.7	2.9	3.2	3.4	3.2	3.1
Above Normal (16%)	2.6	2.7	2.7	2.8	3.3	2.7	2.8	2.9	3.2	3.2	3.2	3.0
Below Normal (13%)	2.9	2.8	3.1	3.1	3.2	2.8	2.9	2.8	3.1	3.1	3.1	2.8
Dry (24%)	2.8	2.8	3.0	3.0	3.1	2.8	2.7	3.0	3.2	3.3	3.3	3.1
Critical (15%)	2.8	2.9	3.0	3.0	3.0	2.8	2.8	3.0	3.2	3.3	3.1	2.9

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Maximum Elevation (FEET)											
Probability of Exceedance												
10%	3.0	3.0	3.1	3.2	3.5	3.1	2.9	3.1	3.3	3.4	3.3	3.2
20%	2.9	2.9	3.1	3.1	3.2	3.0	2.8	3.1	3.3	3.4	3.3	3.1
30%	2.9	2.9	3.0	3.1	3.1	2.9	2.8	3.1	3.3	3.4	3.2	3.0
40%	2.8	2.9	3.0	3.0	3.1	2.8	2.8	3.0	3.2	3.3	3.2	3.0
50%	2.8	2.8	3.0	3.0	3.0	2.7	2.7	3.0	3.2	3.3	3.2	3.0
60%	2.8	2.8	3.0	3.0	3.0	2.7	2.7	2.8	3.2	3.3	3.2	3.0
70%	2.8	2.8	2.9	2.9	2.9	2.6	2.7	2.8	3.1	3.3	3.1	2.9
80%	2.7	2.8	2.9	2.9	2.8	2.6	2.7	2.8	3.1	3.2	3.1	2.9
90%	2.7	2.6	2.8	2.8	2.7	2.4	2.6	2.7	3.1	3.1	3.0	2.8
Long Term												
Full Simulation Period[a]	2.8	2.8	3.0	3.0	3.0	2.7	2.7	2.9	3.2	3.3	3.2	3.0
Water Year Types[b]												
Wet (32%)	2.9	2.9	3.0	3.1	2.9	2.7	2.7	2.9	3.2	3.4	3.2	3.1
Above Normal (16%)	2.6	2.7	2.7	2.8	3.3	2.7	2.8	2.9	3.2	3.2	3.2	3.0
Below Normal (13%)	2.9	2.8	3.1	3.1	3.2	2.8	2.9	2.8	3.1	3.1	3.1	2.8
Dry (24%)	2.8	2.8	3.0	3.0	3.1	2.8	2.7	3.0	3.2	3.3	3.3	3.1
Critical (15%)	2.8	2.9	3.0	3.0	3.0	2.8	2.8	3.0	3.2	3.3	3.1	2.9

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Maximum Elevation (FEET)											
Probability of Exceedance												
10%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long Term												
Full Simulation Period[a]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Water Year Types[b]												
Wet (32%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal (16%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Below Normal (13%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dry (24%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Critical (15%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

a Based on the 16-year simulation period

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999) at Early Long-Term

c The Elevations are based on National Geodetic Vertical Datum of 1929 (NGVD 29)

Table 4-2-1. San Joaquin River at Jersey Point, Monthly Averaged Daily Minimum Elevation

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Minimum Elevation (FEET)											
Probability of Exceedance												
10%	-0.5	-0.6	-0.6	-0.5	0.2	-0.2	-0.3	-0.5	-0.5	-0.4	-0.3	-0.3
20%	-0.5	-0.6	-0.7	-0.6	-0.1	-0.3	-0.4	-0.5	-0.5	-0.5	-0.4	-0.3
30%	-0.5	-0.7	-0.7	-0.6	-0.2	-0.4	-0.5	-0.5	-0.6	-0.5	-0.4	-0.4
40%	-0.6	-0.7	-0.7	-0.7	-0.5	-0.5	-0.5	-0.7	-0.6	-0.5	-0.4	-0.4
50%	-0.6	-0.8	-0.8	-0.7	-0.5	-0.6	-0.7	-0.7	-0.6	-0.5	-0.5	-0.4
60%	-0.6	-0.8	-0.8	-0.7	-0.6	-0.7	-0.7	-0.7	-0.6	-0.6	-0.5	-0.4
70%	-0.7	-0.9	-0.9	-0.7	-0.6	-0.8	-0.7	-0.8	-0.7	-0.6	-0.5	-0.5
80%	-0.7	-0.9	-0.9	-0.8	-0.6	-0.8	-0.8	-0.8	-0.7	-0.6	-0.5	-0.5
90%	-0.7	-0.9	-0.9	-0.8	-0.7	-0.8	-0.8	-0.9	-0.7	-0.6	-0.5	-0.5
Long Term												
Full Simulation Period[a]	-0.6	-0.8	-0.7	-0.7	-0.4	-0.5	-0.6	-0.7	-0.6	-0.5	-0.4	-0.4
Water Year Types[b]												
Wet (32%)	-0.6	-0.8	-0.8	-0.7	-0.7	-0.7	-0.8	-0.8	-0.7	-0.5	-0.5	-0.4
Above Normal (16%)	-0.7	-0.8	-0.9	-0.8	0.0	-0.6	-0.5	-0.6	-0.5	-0.6	-0.5	-0.4
Below Normal (13%)	-0.4	-0.7	-0.6	-0.5	-0.1	-0.3	-0.3	-0.8	-0.7	-0.6	-0.5	-0.6
Dry (24%)	-0.7	-0.8	-0.8	-0.7	-0.4	-0.5	-0.7	-0.6	-0.6	-0.6	-0.4	-0.4
Critical (15%)	-0.5	-0.7	-0.6	-0.6	-0.3	-0.3	-0.4	-0.5	-0.5	-0.5	-0.4	-0.4

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Minimum Elevation (FEET)											
Probability of Exceedance												
10%	-0.5	-0.6	-0.6	-0.5	0.2	-0.2	-0.3	-0.5	-0.5	-0.4	-0.3	-0.3
20%	-0.5	-0.6	-0.7	-0.6	-0.1	-0.3	-0.4	-0.5	-0.5	-0.5	-0.4	-0.3
30%	-0.5	-0.7	-0.7	-0.6	-0.2	-0.4	-0.5	-0.6	-0.6	-0.5	-0.4	-0.4
40%	-0.6	-0.7	-0.8	-0.7	-0.5	-0.5	-0.6	-0.7	-0.6	-0.5	-0.4	-0.4
50%	-0.6	-0.8	-0.8	-0.7	-0.5	-0.6	-0.7	-0.7	-0.6	-0.5	-0.5	-0.4
60%	-0.6	-0.8	-0.8	-0.7	-0.6	-0.7	-0.7	-0.7	-0.6	-0.6	-0.5	-0.4
70%	-0.7	-0.9	-0.9	-0.7	-0.6	-0.8	-0.7	-0.8	-0.7	-0.6	-0.5	-0.5
80%	-0.7	-0.9	-0.9	-0.8	-0.6	-0.8	-0.8	-0.8	-0.7	-0.6	-0.5	-0.5
90%	-0.7	-0.9	-0.9	-0.8	-0.7	-0.8	-0.8	-0.8	-0.7	-0.6	-0.5	-0.5
Long Term												
Full Simulation Period[a]	-0.6	-0.8	-0.7	-0.7	-0.4	-0.5	-0.6	-0.7	-0.6	-0.5	-0.4	-0.4
Water Year Types[b]												
Wet (32%)	-0.6	-0.8	-0.8	-0.7	-0.7	-0.7	-0.8	-0.8	-0.7	-0.5	-0.5	-0.4
Above Normal (16%)	-0.7	-0.8	-0.9	-0.8	0.0	-0.5	-0.5	-0.6	-0.5	-0.6	-0.5	-0.4
Below Normal (13%)	-0.4	-0.7	-0.6	-0.5	-0.1	-0.3	-0.4	-0.8	-0.7	-0.6	-0.5	-0.6
Dry (24%)	-0.7	-0.9	-0.8	-0.7	-0.4	-0.5	-0.7	-0.6	-0.6	-0.5	-0.4	-0.4
Critical (15%)	-0.5	-0.7	-0.6	-0.6	-0.3	-0.3	-0.5	-0.6	-0.5	-0.5	-0.4	-0.4

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Averaged Daily Minimum Elevation (FEET)											
Probability of Exceedance												
10%	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
20%	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0
30%	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0
40%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long Term												
Full Simulation Period[a]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Water Year Types[b]												
Wet (32%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal (16%)	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0
Below Normal (13%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dry (24%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Critical (15%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

a Based on the 16-year simulation period

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999) at Early Long-Term

c The Elevations are based on National Geodetic Vertical Datum of 1929 (NGVD 29)

Table 5-1-1. San Joaquin River at Prisoners Point, Monthly Averaged Daily Maximum Elevation

Existing

Statistic	Monthly Averaged Daily Maximum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	3.1	3.1	3.2	3.3	3.7	3.2	3.1	3.3	3.4	3.5	3.4	3.3
20%	3.1	3.0	3.2	3.2	3.4	3.1	3.0	3.2	3.4	3.5	3.4	3.2
30%	3.0	3.0	3.1	3.2	3.3	3.0	3.0	3.2	3.4	3.5	3.4	3.2
40%	2.9	3.0	3.1	3.1	3.2	2.9	2.9	3.2	3.4	3.5	3.3	3.1
50%	2.9	2.9	3.1	3.1	3.2	2.8	2.9	3.1	3.3	3.4	3.3	3.1
60%	2.9	2.9	3.1	3.1	3.1	2.8	2.8	3.0	3.3	3.4	3.3	3.1
70%	2.9	2.9	3.0	3.0	3.0	2.7	2.8	2.9	3.2	3.4	3.3	3.1
80%	2.8	2.9	3.0	3.0	2.9	2.7	2.8	2.9	3.2	3.3	3.2	3.0
90%	2.8	2.8	2.9	2.9	2.8	2.5	2.7	2.8	3.2	3.2	3.1	3.0
Long Term												
Full Simulation Period[a]	2.9	2.9	3.1	3.1	3.2	2.9	2.9	3.1	3.3	3.4	3.3	3.1
Water Year Types[b]												
Wet (32%)	3.0	3.0	3.1	3.2	3.0	2.8	2.8	3.0	3.3	3.5	3.3	3.2
Above Normal (16%)	2.8	2.8	2.8	2.9	3.4	2.8	2.9	3.0	3.3	3.3	3.3	3.1
Below Normal (13%)	3.0	2.9	3.2	3.2	3.4	2.9	3.1	2.9	3.2	3.2	3.2	2.9
Dry (24%)	2.9	2.9	3.1	3.1	3.3	2.9	2.9	3.1	3.3	3.4	3.4	3.2
Critical (15%)	2.9	3.0	3.2	3.1	3.2	2.9	2.9	3.1	3.3	3.4	3.2	3.0

Proposed Project

Statistic	Monthly Averaged Daily Maximum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	3.1	3.1	3.2	3.3	3.7	3.2	3.1	3.2	3.4	3.5	3.4	3.3
20%	3.1	3.0	3.2	3.2	3.4	3.1	3.0	3.2	3.4	3.5	3.4	3.2
30%	3.0	3.0	3.1	3.2	3.3	3.0	2.9	3.1	3.4	3.5	3.4	3.2
40%	2.9	3.0	3.1	3.1	3.2	2.9	2.9	3.1	3.3	3.5	3.3	3.1
50%	2.9	2.9	3.1	3.1	3.2	2.8	2.9	3.1	3.3	3.5	3.3	3.1
60%	2.9	2.9	3.1	3.1	3.1	2.8	2.8	2.9	3.3	3.4	3.3	3.1
70%	2.9	2.9	3.0	3.0	3.0	2.8	2.8	2.9	3.2	3.4	3.3	3.1
80%	2.8	2.9	3.0	3.0	2.9	2.7	2.8	2.9	3.2	3.3	3.2	3.0
90%	2.8	2.8	2.9	2.9	2.8	2.5	2.7	2.8	3.2	3.2	3.1	3.0
Long Term												
Full Simulation Period[a]	2.9	2.9	3.1	3.1	3.2	2.9	2.9	3.0	3.3	3.4	3.3	3.1
Water Year Types[b]												
Wet (32%)	3.0	3.0	3.1	3.2	3.0	2.8	2.8	3.0	3.3	3.5	3.3	3.2
Above Normal (16%)	2.8	2.8	2.8	2.9	3.4	2.8	2.9	3.0	3.3	3.3	3.3	3.1
Below Normal (13%)	3.0	2.9	3.2	3.2	3.4	2.9	3.0	2.9	3.2	3.2	3.2	2.9
Dry (24%)	2.9	2.9	3.1	3.1	3.3	3.0	2.9	3.1	3.3	3.4	3.4	3.2
Critical (15%)	2.9	3.0	3.2	3.1	3.2	2.9	2.9	3.1	3.3	3.4	3.2	3.0

Proposed Project minus Existing

Statistic	Monthly Averaged Daily Maximum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long Term												
Full Simulation Period[a]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Water Year Types[b]												
Wet (32%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal (16%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Below Normal (13%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dry (24%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Critical (15%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

a Based on the 16-year simulation period

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999) at Early Long-Term

c The Elevations are based on National Geodetic Vertical Datum of 1929 (NGVD 29)

Table 5-2-1. San Joaquin River at Prisoners Point, Monthly Averaged Daily Minimum Elevation

Existing

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-0.6	-0.7	-0.6	-0.6	0.1	-0.3	-0.3	-0.5	-0.6	-0.5	-0.5	-0.4
20%	-0.6	-0.7	-0.8	-0.6	-0.2	-0.4	-0.4	-0.6	-0.6	-0.6	-0.5	-0.4
30%	-0.6	-0.8	-0.8	-0.7	-0.3	-0.5	-0.5	-0.6	-0.7	-0.6	-0.5	-0.5
40%	-0.6	-0.8	-0.8	-0.7	-0.6	-0.5	-0.6	-0.7	-0.7	-0.6	-0.5	-0.5
50%	-0.7	-0.9	-0.9	-0.8	-0.6	-0.6	-0.7	-0.8	-0.7	-0.6	-0.5	-0.5
60%	-0.7	-0.9	-0.9	-0.8	-0.7	-0.7	-0.7	-0.8	-0.7	-0.6	-0.5	-0.5
70%	-0.7	-0.9	-0.9	-0.8	-0.7	-0.9	-0.8	-0.8	-0.7	-0.6	-0.6	-0.6
80%	-0.8	-1.0	-0.9	-0.9	-0.7	-0.9	-0.8	-0.8	-0.7	-0.7	-0.6	-0.6
90%	-0.8	-1.0	-1.0	-0.9	-0.8	-0.9	-0.9	-0.9	-0.8	-0.7	-0.6	-0.6
Long Term												
Full Simulation Period[a]	-0.7	-0.9	-0.8	-0.7	-0.4	-0.6	-0.6	-0.7	-0.7	-0.6	-0.5	-0.5
Water Year Types[b]												
Wet (32%)	-0.7	-0.9	-0.9	-0.8	-0.8	-0.8	-0.8	-0.9	-0.7	-0.6	-0.6	-0.5
Above Normal (16%)	-0.8	-0.9	-1.0	-0.9	0.0	-0.6	-0.5	-0.6	-0.6	-0.7	-0.6	-0.5
Below Normal (13%)	-0.5	-0.8	-0.7	-0.6	-0.2	-0.4	-0.4	-0.8	-0.7	-0.7	-0.5	-0.7
Dry (24%)	-0.7	-0.9	-0.9	-0.8	-0.4	-0.6	-0.7	-0.7	-0.7	-0.6	-0.5	-0.5
Critical (15%)	-0.6	-0.8	-0.7	-0.7	-0.4	-0.4	-0.5	-0.6	-0.6	-0.6	-0.5	-0.5

Proposed Project

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-0.6	-0.7	-0.6	-0.6	0.1	-0.2	-0.4	-0.6	-0.6	-0.5	-0.4	-0.4
20%	-0.6	-0.7	-0.8	-0.6	-0.2	-0.4	-0.5	-0.6	-0.6	-0.5	-0.5	-0.4
30%	-0.6	-0.8	-0.8	-0.7	-0.3	-0.5	-0.6	-0.6	-0.7	-0.6	-0.5	-0.5
40%	-0.6	-0.8	-0.8	-0.7	-0.6	-0.5	-0.6	-0.7	-0.7	-0.6	-0.5	-0.5
50%	-0.7	-0.9	-0.9	-0.8	-0.6	-0.6	-0.7	-0.8	-0.7	-0.6	-0.5	-0.5
60%	-0.7	-0.9	-0.9	-0.8	-0.7	-0.7	-0.7	-0.8	-0.7	-0.6	-0.5	-0.5
70%	-0.8	-1.0	-0.9	-0.8	-0.7	-0.9	-0.8	-0.9	-0.7	-0.6	-0.6	-0.5
80%	-0.8	-1.0	-0.9	-0.9	-0.7	-0.9	-0.8	-0.9	-0.7	-0.6	-0.6	-0.6
90%	-0.8	-1.0	-1.0	-0.9	-0.8	-0.9	-0.9	-0.9	-0.8	-0.7	-0.6	-0.6
Long Term												
Full Simulation Period[a]	-0.7	-0.9	-0.8	-0.8	-0.4	-0.6	-0.7	-0.7	-0.7	-0.6	-0.5	-0.5
Water Year Types[b]												
Wet (32%)	-0.7	-0.9	-0.9	-0.8	-0.8	-0.8	-0.8	-0.9	-0.7	-0.6	-0.6	-0.5
Above Normal (16%)	-0.8	-0.9	-1.0	-0.9	0.0	-0.6	-0.6	-0.7	-0.6	-0.7	-0.6	-0.5
Below Normal (13%)	-0.5	-0.8	-0.7	-0.6	-0.2	-0.4	-0.5	-0.9	-0.7	-0.7	-0.5	-0.7
Dry (24%)	-0.7	-0.9	-0.9	-0.8	-0.4	-0.6	-0.7	-0.7	-0.7	-0.6	-0.5	-0.5
Critical (15%)	-0.6	-0.8	-0.7	-0.7	-0.4	-0.4	-0.5	-0.6	-0.6	-0.5	-0.5	-0.5

Proposed Project minus Existing

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	0.0	0.0	0.0	0.0	0.0	0.1	0.0	-0.1	0.0	0.0	0.0	0.0
20%	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0
30%	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0
40%	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0
50%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long Term												
Full Simulation Period[a]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Water Year Types[b]												
Wet (32%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Above Normal (16%)	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0
Below Normal (13%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dry (24%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Critical (15%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

a Based on the 16-year simulation period

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999) at Early Long-Term

c The Elevations are based on National Geodetic Vertical Datum of 1929 (NGVD 29)

Table 6-1-1. Old River at Tracy Blvd, Monthly Averaged Daily Maximum Elevation

Existing

Statistic	Monthly Averaged Daily Maximum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	2.4	2.4	2.8	2.8	3.6	3.1	3.3	3.2	2.8	2.8	2.7	2.7
20%	2.4	2.3	2.8	2.8	3.3	2.8	3.2	3.1	2.8	2.7	2.7	2.6
30%	2.4	2.3	2.6	2.7	2.9	2.7	3.1	2.8	2.7	2.6	2.6	2.6
40%	2.3	2.3	2.5	2.7	2.7	2.5	3.0	2.8	2.7	2.6	2.6	2.4
50%	2.3	2.2	2.4	2.6	2.7	2.5	2.8	2.7	2.7	2.5	2.5	2.4
60%	2.2	2.2	2.4	2.5	2.6	2.4	2.6	2.6	2.7	2.4	2.5	2.3
70%	2.2	2.1	2.3	2.5	2.5	2.3	2.5	2.4	2.6	2.3	2.5	2.3
80%	2.2	2.1	2.3	2.5	2.5	2.3	2.5	2.4	2.5	2.3	2.5	2.3
90%	2.2	2.0	2.2	2.4	2.2	2.2	2.4	2.3	2.4	2.1	2.3	2.2
Long Term												
Full Simulation Period[a]	2.3	2.2	2.5	2.6	2.9	2.7	2.8	2.8	2.7	2.5	2.5	2.4
Water Year Types[b]												
Wet (32%)	2.4	2.4	2.5	2.7	2.4	2.4	2.5	2.5	2.6	2.6	2.7	2.6
Above Normal (16%)	2.2	2.1	2.2	2.4	3.0	2.3	3.1	2.8	2.7	2.2	2.4	2.3
Below Normal (13%)	2.4	2.1	2.8	2.7	3.0	2.4	3.0	2.4	2.2	2.0	2.6	2.3
Dry (24%)	2.3	2.3	2.4	2.6	2.9	2.7	2.7	2.7	2.7	2.4	2.5	2.4
Critical (15%)	2.2	2.1	2.6	2.6	3.1	3.2	3.1	3.1	2.8	2.7	2.5	2.3

Proposed Project

Statistic	Monthly Averaged Daily Maximum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	2.7	2.6	2.8	2.8	3.5	3.3	3.1	2.9	2.8	2.8	2.8	2.8
20%	2.6	2.6	2.7	2.7	3.3	2.8	2.9	2.8	2.7	2.8	2.7	2.8
30%	2.5	2.5	2.6	2.7	2.9	2.8	2.7	2.7	2.7	2.7	2.6	2.7
40%	2.5	2.5	2.5	2.7	2.7	2.7	2.7	2.7	2.7	2.6	2.6	2.5
50%	2.5	2.4	2.4	2.6	2.7	2.5	2.6	2.6	2.7	2.5	2.5	2.5
60%	2.5	2.4	2.3	2.5	2.6	2.4	2.6	2.5	2.6	2.4	2.5	2.5
70%	2.5	2.4	2.3	2.5	2.5	2.4	2.6	2.4	2.6	2.3	2.5	2.4
80%	2.4	2.3	2.3	2.5	2.4	2.4	2.6	2.3	2.4	2.3	2.5	2.4
90%	2.4	2.2	2.2	2.4	2.2	2.1	2.5	2.3	2.4	2.1	2.3	2.3
Long Term												
Full Simulation Period[a]	2.5	2.4	2.5	2.6	2.9	2.7	2.7	2.7	2.7	2.6	2.6	2.5
Water Year Types[b]												
Wet (32%)	2.6	2.5	2.5	2.7	2.4	2.4	2.6	2.6	2.6	2.6	2.7	2.7
Above Normal (16%)	2.4	2.3	2.2	2.3	3.0	2.4	2.6	2.5	2.7	2.2	2.4	2.4
Below Normal (13%)	2.6	2.4	2.7	2.7	3.0	2.7	2.7	2.3	2.2	2.0	2.7	2.4
Dry (24%)	2.5	2.5	2.4	2.6	2.9	2.7	2.7	2.6	2.7	2.5	2.6	2.6
Critical (15%)	2.5	2.4	2.6	2.6	3.1	3.2	3.0	2.9	2.8	2.7	2.5	2.5

Proposed Project minus Existing

Statistic	Monthly Averaged Daily Maximum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	0.3	0.2	0.0	0.0	0.0	0.2	-0.2	-0.2	0.0	0.1	0.0	0.1
20%	0.2	0.2	0.0	0.0	0.0	0.0	-0.3	-0.3	0.0	0.1	0.0	0.1
30%	0.2	0.2	0.0	0.0	0.0	0.1	-0.4	-0.2	0.0	0.1	0.0	0.1
40%	0.2	0.3	0.0	0.0	0.0	0.1	-0.4	-0.1	0.0	0.0	-0.1	0.1
50%	0.2	0.2	0.0	0.0	0.0	0.0	-0.2	-0.1	0.0	0.0	0.0	0.1
60%	0.3	0.2	-0.1	0.0	0.0	0.1	0.0	-0.1	0.0	0.0	0.0	0.1
70%	0.2	0.2	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.1
80%	0.2	0.3	0.0	0.0	0.0	0.1	0.1	-0.1	0.0	0.1	0.0	0.1
90%	0.2	0.2	0.0	0.0	0.0	-0.1	0.1	0.0	0.0	0.0	0.0	0.1
Long Term												
Full Simulation Period[a]	0.2	0.2	0.0	0.0	0.0	0.1	-0.1	-0.1	0.0	0.0	0.0	0.1
Water Year Types[b]												
Wet (32%)	0.2	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1
Above Normal (16%)	0.2	0.3	0.0	0.0	0.0	0.1	-0.5	-0.3	0.0	0.0	-0.1	0.1
Below Normal (13%)	0.2	0.3	0.0	0.0	0.0	0.3	-0.3	-0.1	0.0	0.0	0.0	0.1
Dry (24%)	0.2	0.2	0.0	0.0	0.0	0.1	0.0	-0.1	0.0	0.1	0.0	0.1
Critical (15%)	0.3	0.3	0.0	0.0	0.0	0.0	-0.1	-0.2	0.0	0.0	0.0	0.1

a Based on the 16-year simulation period

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999) at Early Long-Term

c The Elevations are based on National Geodetic Vertical Datum of 1929 (NGVD 29)

Table 6-2-1. Old River at Tracy Blvd, Monthly Averaged Daily Minimum Elevation

Existing

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	1.5	1.4	-0.2	-0.2	1.1	0.4	0.4	0.6	1.7	1.5	1.6	1.5
20%	1.4	1.3	-0.5	-0.4	0.3	0.0	0.4	0.3	1.7	1.5	1.6	1.5
30%	1.4	1.3	-0.6	-0.4	-0.1	-0.3	0.3	0.0	1.6	1.4	1.5	1.5
40%	1.4	1.3	-0.6	-0.5	-0.1	-0.4	0.1	-0.1	1.5	1.2	1.4	1.5
50%	1.4	1.3	-0.7	-0.5	-0.3	-0.4	-0.2	-0.3	1.2	1.2	1.4	1.4
60%	1.3	1.3	-0.7	-0.6	-0.4	-0.4	-0.5	-0.4	1.2	1.2	1.3	1.4
70%	1.3	1.2	-0.7	-0.6	-0.4	-0.5	-0.6	-0.4	1.1	1.2	1.3	1.4
80%	1.3	1.2	-0.7	-0.6	-0.5	-0.6	-0.7	-0.4	1.1	1.1	1.3	1.4
90%	1.3	1.2	-0.8	-0.7	-0.6	-0.7	-0.7	-0.5	1.1	1.1	1.3	1.4
Long Term												
Full Simulation Period[a]	1.4	1.3	-0.5	-0.5	0.1	0.0	-0.1	0.0	1.4	1.4	1.4	1.4
Water Year Types[b]												
Wet (32%)	1.4	1.3	-0.6	-0.6	-0.6	-0.6	-0.7	-0.4	1.2	1.2	1.3	1.4
Above Normal (16%)	1.3	1.2	-0.7	-0.7	0.1	-0.5	0.2	0.0	1.6	1.2	1.4	1.4
Below Normal (13%)	1.5	1.3	-0.3	-0.4	-0.1	-0.4	0.1	-0.4	1.0	1.0	1.3	1.4
Dry (24%)	1.4	1.3	-0.7	-0.6	0.0	-0.2	-0.3	-0.1	1.4	1.3	1.4	1.4
Critical (15%)	1.4	1.3	-0.4	-0.3	0.6	0.8	0.5	0.6	1.5	1.7	1.5	1.5

Proposed Project

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	1.7	1.5	-0.3	-0.2	1.1	0.6	0.4	0.4	1.6	1.6	1.6	1.7
20%	1.7	1.5	-0.4	-0.4	0.3	0.1	0.2	0.1	1.5	1.5	1.6	1.6
30%	1.6	1.5	-0.6	-0.5	-0.1	-0.3	0.1	0.0	1.5	1.4	1.5	1.6
40%	1.6	1.4	-0.6	-0.5	-0.1	-0.3	-0.1	-0.1	1.4	1.2	1.4	1.5
50%	1.6	1.4	-0.7	-0.6	-0.3	-0.4	-0.2	-0.2	1.2	1.2	1.4	1.5
60%	1.5	1.4	-0.7	-0.6	-0.4	-0.5	-0.3	-0.3	1.2	1.2	1.3	1.4
70%	1.5	1.4	-0.7	-0.6	-0.5	-0.5	-0.5	-0.3	1.1	1.1	1.3	1.4
80%	1.4	1.3	-0.7	-0.6	-0.5	-0.6	-0.6	-0.4	1.1	1.1	1.3	1.4
90%	1.4	1.3	-0.7	-0.7	-0.6	-0.7	-0.6	-0.4	1.0	1.1	1.2	1.4
Long Term												
Full Simulation Period[a]	1.5	1.4	-0.6	-0.5	0.1	0.0	-0.1	0.0	1.3	1.4	1.4	1.5
Water Year Types[b]												
Wet (32%)	1.5	1.4	-0.6	-0.6	-0.6	-0.6	-0.6	-0.4	1.1	1.2	1.3	1.5
Above Normal (16%)	1.4	1.4	-0.7	-0.7	0.1	-0.4	0.0	0.0	1.5	1.2	1.4	1.5
Below Normal (13%)	1.6	1.4	-0.4	-0.4	-0.1	-0.4	-0.1	-0.4	1.0	1.0	1.4	1.4
Dry (24%)	1.5	1.4	-0.7	-0.6	0.0	-0.2	-0.2	-0.1	1.3	1.3	1.4	1.5
Critical (15%)	1.6	1.4	-0.4	-0.3	0.6	0.8	0.4	0.6	1.4	1.7	1.5	1.6

Proposed Project minus Existing

Statistic	Monthly Averaged Daily Minimum Elevation (FEET)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	0.2	0.2	0.0	0.0	0.0	0.2	-0.1	-0.1	-0.1	0.1	0.0	0.1
20%	0.2	0.2	0.0	0.0	0.0	0.1	-0.2	-0.2	-0.2	0.0	0.0	0.1
30%	0.2	0.2	0.0	0.0	0.0	0.0	-0.2	0.0	-0.2	0.0	0.0	0.1
40%	0.2	0.1	0.0	0.0	0.0	0.1	-0.2	0.0	0.0	0.0	0.0	0.1
50%	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
60%	0.2	0.1	0.0	0.0	0.0	-0.1	0.2	0.1	0.0	0.0	0.0	0.1
70%	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.1
80%	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1
90%	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
Long Term												
Full Simulation Period[a]	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.1
Water Year Types[b]												
Wet (32%)	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
Above Normal (16%)	0.1	0.1	0.0	0.0	0.0	0.1	-0.3	-0.1	-0.1	0.0	0.0	0.1
Below Normal (13%)	0.2	0.2	0.0	0.0	0.0	0.0	-0.2	0.0	0.0	0.0	0.0	0.1
Dry (24%)	0.2	0.1	0.0	0.0	0.0	0.0	0.1	0.0	-0.1	0.0	0.0	0.1
Critical (15%)	0.2	0.2	0.0	0.0	0.0	0.0	-0.1	0.0	-0.1	0.0	0.0	0.1

a Based on the 16-year simulation period

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999) at Early Long-Term

c The Elevations are based on National Geodetic Vertical Datum of 1929 (NGVD 29)

Appendix C – Modeling

Attachment 2-7 – Salinity Results (DSM2-QUAL)

The following results of the DSM2-QUAL model are included for Delta salinity conditions for the following alternatives:

- Existing Conditions
- Proposed Project

Table 2-7.1. Salinity Results (DSM2-QUAL)

Title	Model Parameter	Table Numbers	Figure Numbers
Sacramento River downstream of Steamboat Slough Salinity	SAC_DS_STMBTSL	1-1	1-1 to 1-18
Cache Slough at Ryer Island Salinity	CACHE_RYER	2-1	2-1 to 2-18
Sacramento River downstream of Georgiana Slough Salinity	RSAC123	3-1	3-1 to 3-18
Sacramento River at Rio Vista Salinity	RSAC101	4-1	4-1 to 4-18
Sacramento River at Emmaton Salinity	RSAC092	5-1	5-1 to 5-18
Sacramento River at Collinsville Salinity	RSAC081	6-1	6-1 to 6-18
Sacramento River at Mallard Slough Salinity	RSAC075	7-1	7-1 to 7-18
Chipps Island North Channel Salinity	CHIPS_N_437	8-1	8-1 to 8-18
Chipps Island South Channel Salinity	CHIPS_S_442	9-1	9-1 to 9-18
Sacramento River at Port Chicago Salinity	RSAC064	10-1	10-1 to 10-18
San Joaquin River at Antioch Salinity	RSAN007	11-1	11-1 to 11-18
San Joaquin River at Jersey Point Salinity	RSAN018	12-1	12-1 to 12-18
San Joaquin River at San Andreas Salinity	RSAN032	13-1	13-1 to 13-18
San Joaquin River at Prisoners Point Salinity	RSAN037	14-1	14-1 to 14-18
Old River at Rock Slough Salinity	ROLD024	15-1	15-1 to 15-18
Banks Pumping Plant South Delta Exports Salinity	CLIFTON_COURT	16-1	16-1 to 16-18
Jones Pumping Plant South Delta Exports Salinity	CHDMC006	17-1	17-1 to 17-18
Old River at Highway 4	ROLD034	18-1	18-1 to 18-18
Victoria Canal	CHVCT000	19-1	19-1 to 19-18

Title	Model Parameter	Table Numbers	Figure Numbers
Montezuma Slough at Hunter Cut	SLMZU003	20-1	20-1 to 20-18
Montezuma Slough at Beldons Landing	SLMZU011	21-1	21-1 to 21-18
Montezuma Slough at National Steel	SLMZU025	22-1	22-1 to 22-18
Suisun Bay near Ryer	RYC	24-1	24-1 to 24-18
Goodyear Slough Outfall at Naval Fleet	GYS	25-1	25-1 to 25-18

Report formats

- Monthly tables comparing two scenarios (exceedance values, long-term average, and average by water year type)
- Monthly pattern charts (long-term average and average by water year type) including all scenarios
- Monthly exceedance charts (all months) including all scenarios

Table 1-1. Sacramento River downstream of Steamboat Slough Salinity, Monthly EC

Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	176	177	179	181	179	177	176	176	176	176	176	176
20%	176	176	178	180	178	176	176	176	176	176	176	176
30%	176	176	177	179	177	176	176	176	176	176	176	176
40%	176	176	177	178	177	176	176	176	176	175	176	176
50%	176	176	176	178	177	176	176	176	176	175	176	175
60%	176	176	176	178	176	176	176	176	176	175	176	175
70%	176	175	176	177	176	176	175	175	176	175	176	175
80%	175	175	175	177	176	176	175	175	176	175	175	175
90%	175	175	175	177	176	175	175	175	175	175	175	175
Long Term												
Full Simulation Period[a]	176	176	177	178	177	176	176	176	176	176	176	176
Water Year Types[b]												
Wet (32%)	176	176	177	178	176	176	175	175	176	175	176	175
Above Normal (15%)	176	176	177	178	177	176	176	175	176	175	175	175
Below Normal (17%)	176	176	177	179	177	176	176	176	176	175	176	176
Dry (22%)	176	176	177	179	177	176	176	176	176	176	176	176
Critical (15%)	176	176	176	178	177	176	176	176	176	176	176	176

Proposed Project

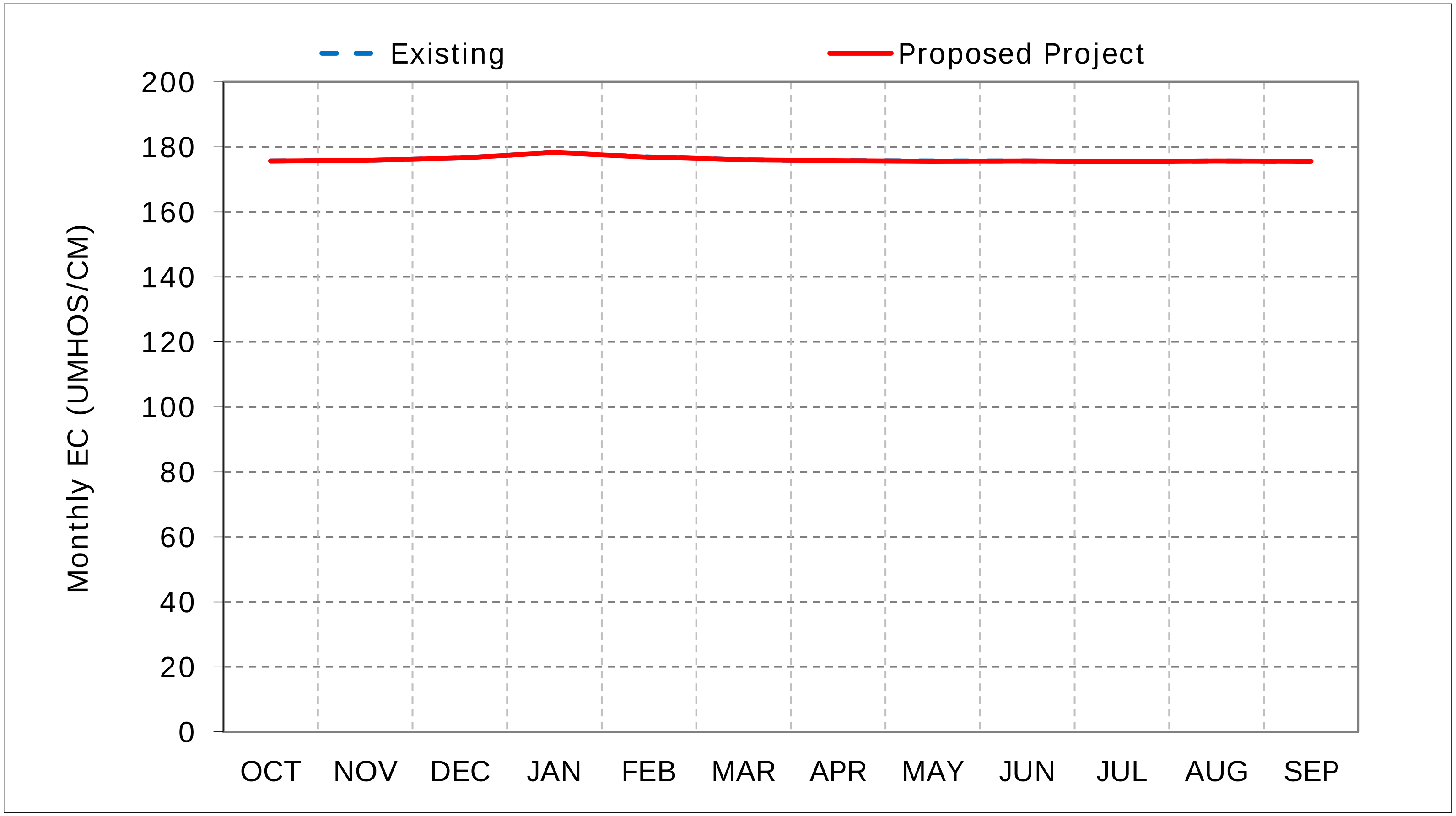
Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	176	177	178	181	179	177	176	176	176	176	176	176
20%	176	176	177	180	178	176	176	176	176	176	176	176
30%	176	176	177	179	177	176	176	176	176	176	176	176
40%	176	176	177	178	177	176	176	176	176	175	176	176
50%	176	176	176	178	177	176	176	176	176	175	176	175
60%	176	176	176	178	176	176	176	176	176	175	176	175
70%	176	175	176	177	176	176	175	175	176	175	176	175
80%	175	175	176	177	176	176	175	175	176	175	176	175
90%	175	175	175	177	176	175	175	175	175	175	175	175
Long Term												
Full Simulation Period[a]	176	176	177	178	177	176	176	176	176	176	176	176
Water Year Types[b]												
Wet (32%)	176	176	177	178	176	176	175	175	176	175	176	175
Above Normal (15%)	176	176	177	178	177	176	176	175	176	175	176	175
Below Normal (17%)	176	176	177	179	177	176	176	176	176	175	176	176
Dry (22%)	176	176	177	179	177	176	176	176	176	176	176	176
Critical (15%)	176	176	176	179	177	176	176	176	176	176	176	176

Proposed Project minus Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	0	0	0	0	0	0	0	0	0	0	0	0
20%	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0
40%	0	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0
60%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
80%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
Long Term												
Full Simulation Period[a]	0	0	0	0	0	0	0	0	0	0	0	0
Water Year Types[b]												
Wet (32%)	0	0	0	0	0	0	0	0	0	0	0	0
Above Normal (15%)	0	0	0	0	0	0	0	0	0	0	0	0
Below Normal (17%)	0	0	0	0	0	0	0	0	0	0	0	0
Dry (22%)	0	0	0	0	0	0	0	0	0	0	0	0
Critical (15%)	0	0	0	0	0	0	0	0	0	0	0	0

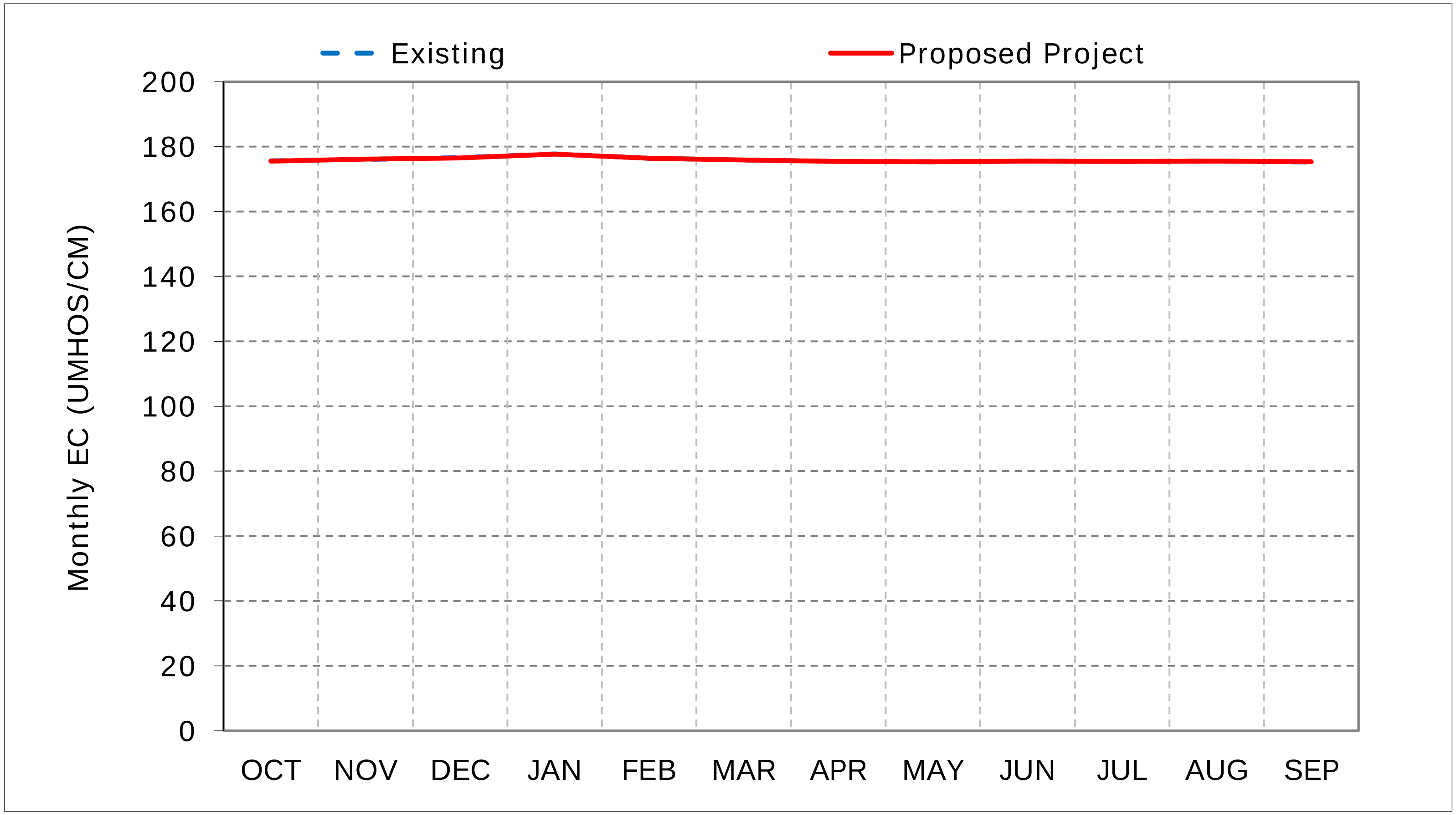
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 1-1. Sacramento River downstream of Steamboat Slough Salinity, Long-Ter



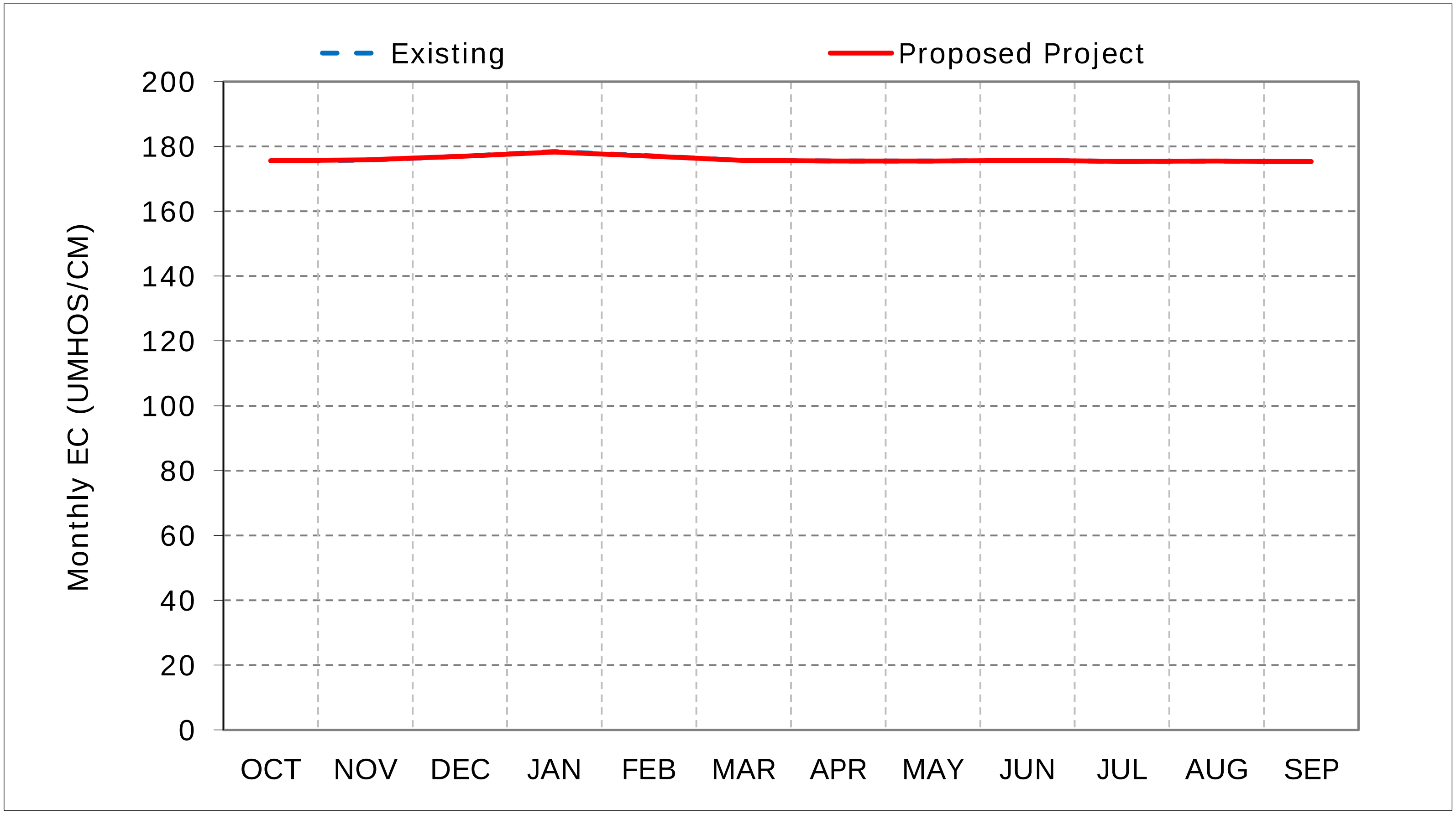
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 1-2. Sacramento River downstream of Steamboat Slough Salinity, Wet Year



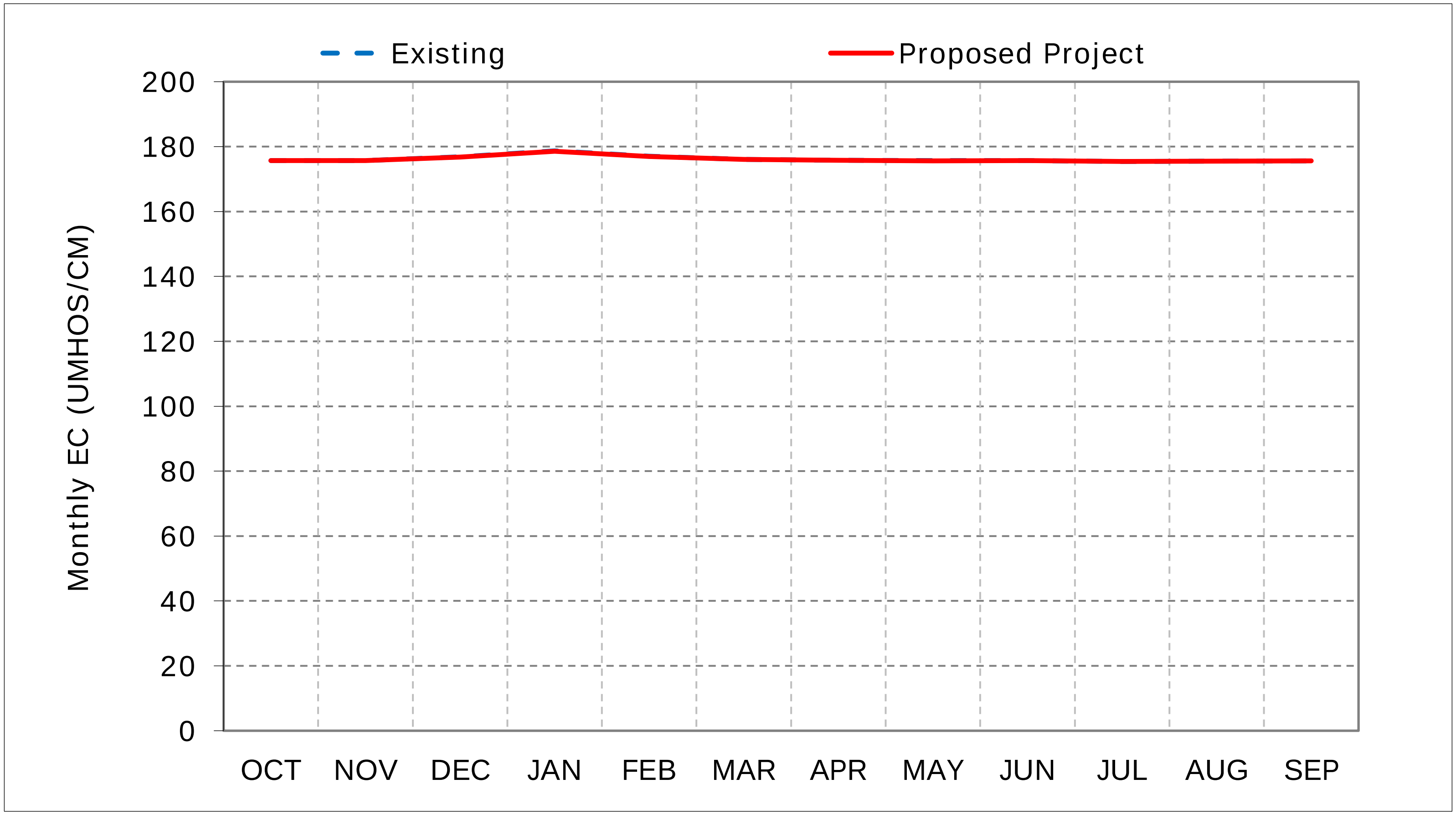
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 1-3. Sacramento River downstream of Steamboat Slough Salinity, Above N



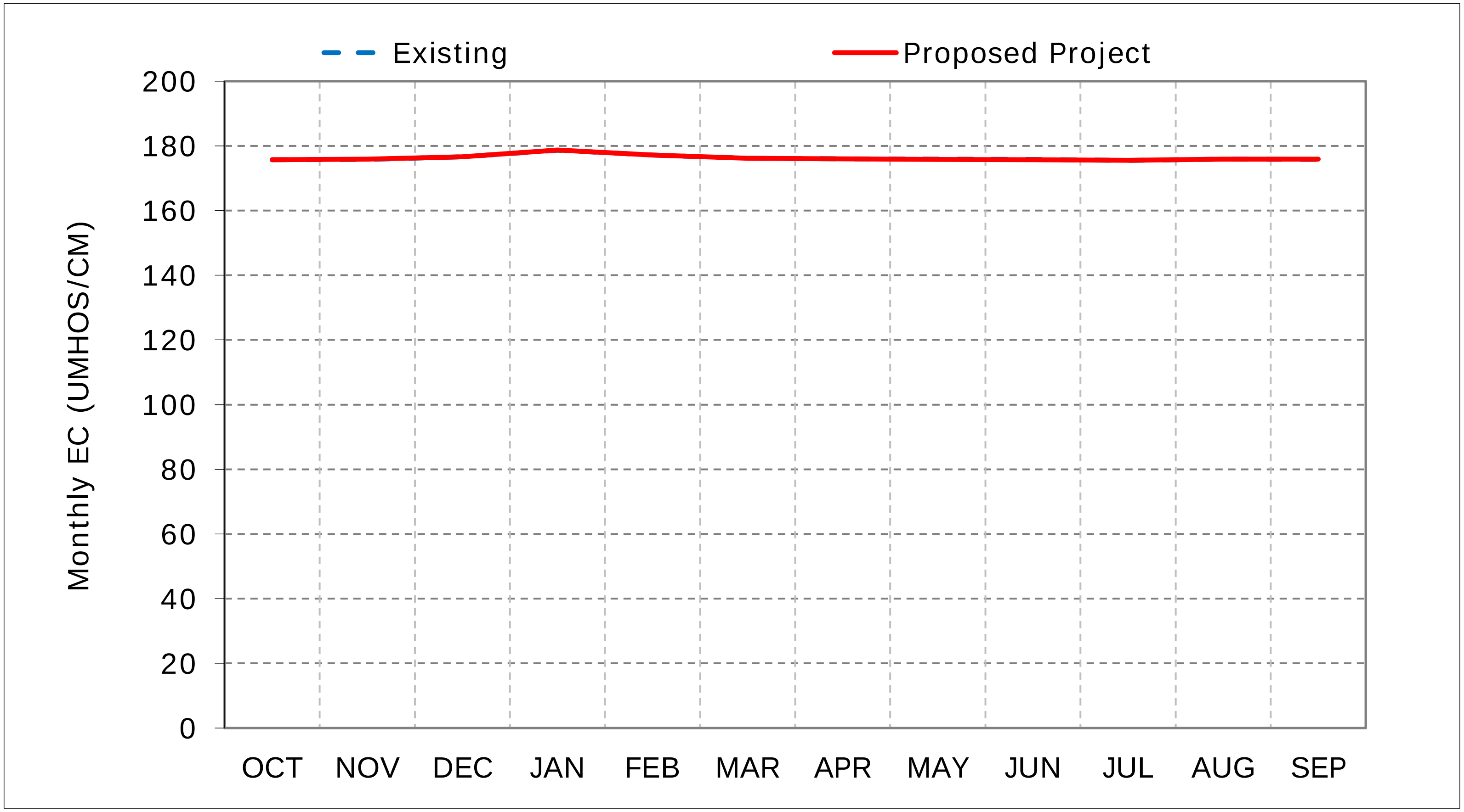
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 1-4. Sacramento River downstream of Steamboat Slough Salinity, Below N



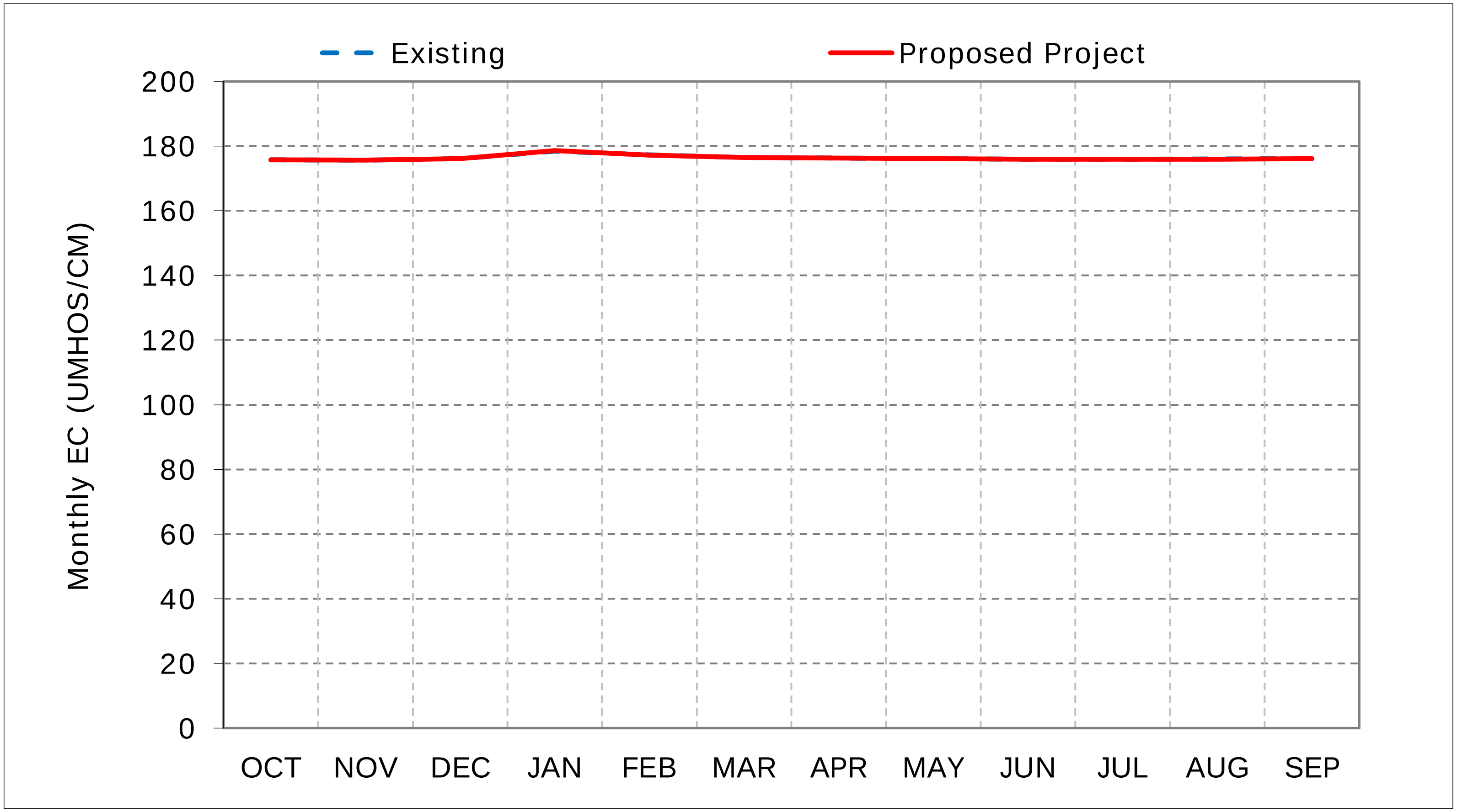
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 1-5. Sacramento River downstream of Steamboat Slough Salinity, Dry Year



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 1-6. Sacramento River downstream of Steamboat Slough Salinity, Critical Y



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 1-7. Sacramento River downstream of Steamboat Slough Salinity, January EC

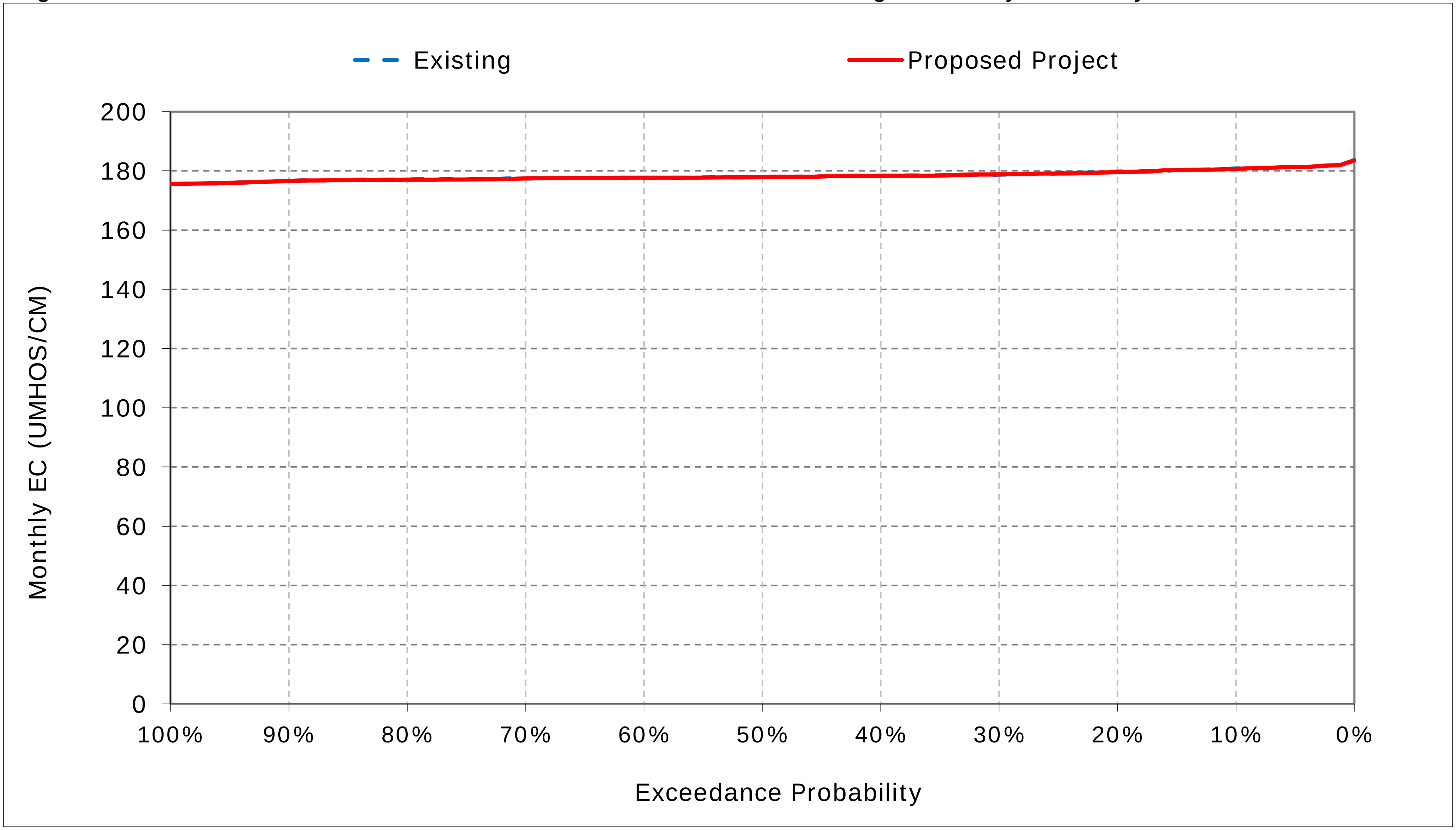


Figure 1-8. Sacramento River downstream of Steamboat Slough Salinity, February EC

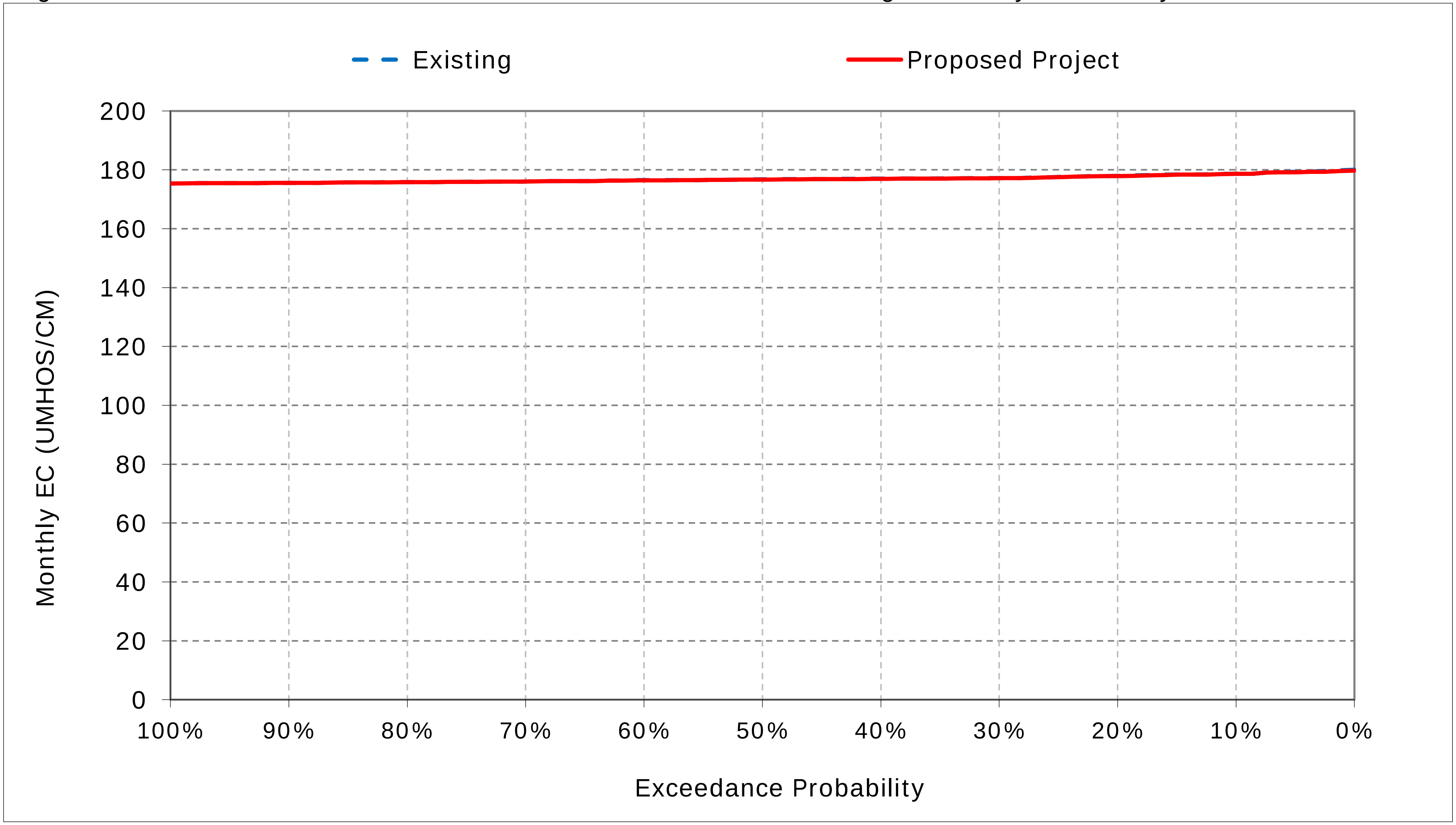


Figure 1-9. Sacramento River downstream of Steamboat Slough Salinity, March EC

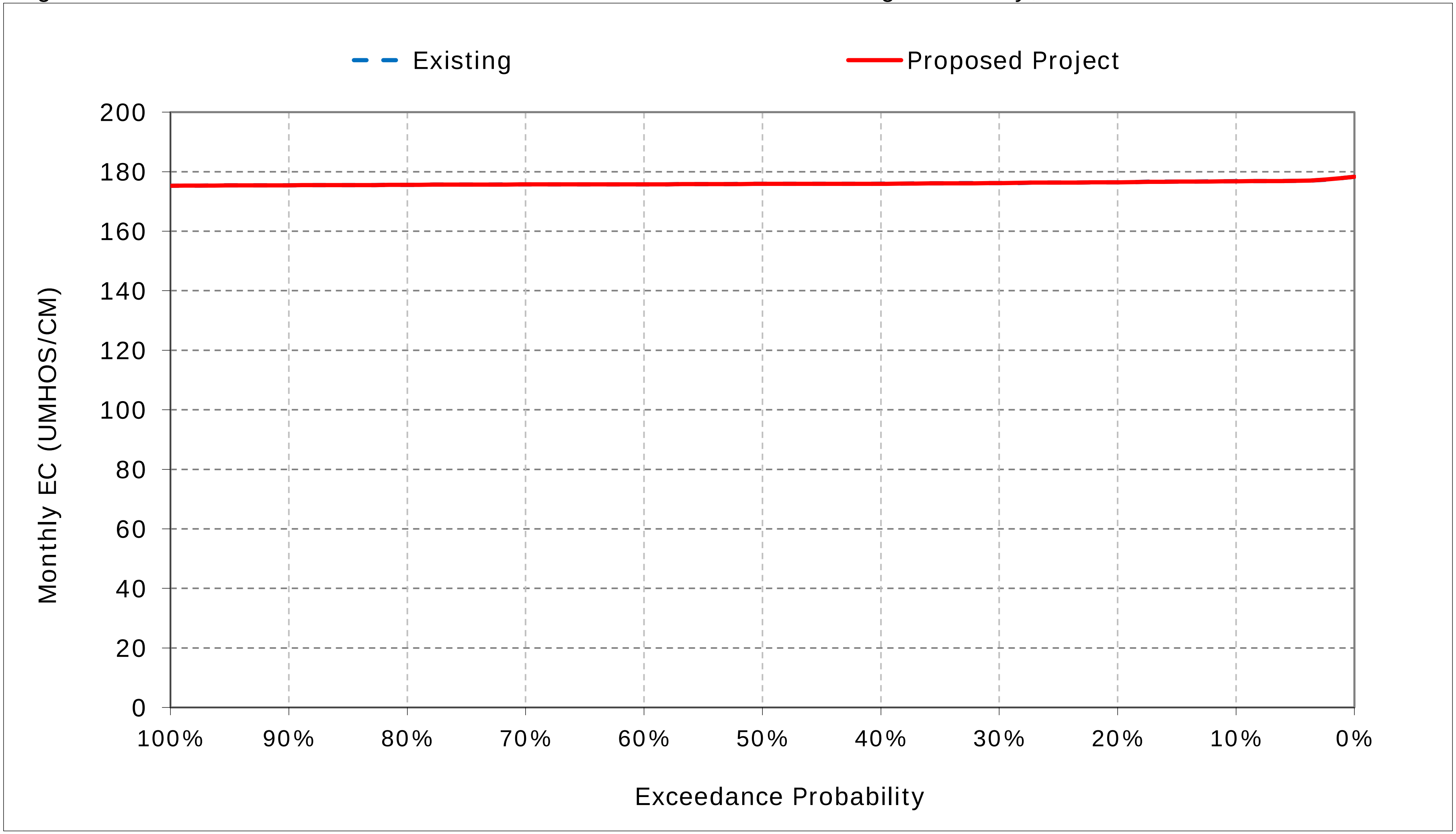


Figure 1-10. Sacramento River downstream of Steamboat Slough Salinity, April EC

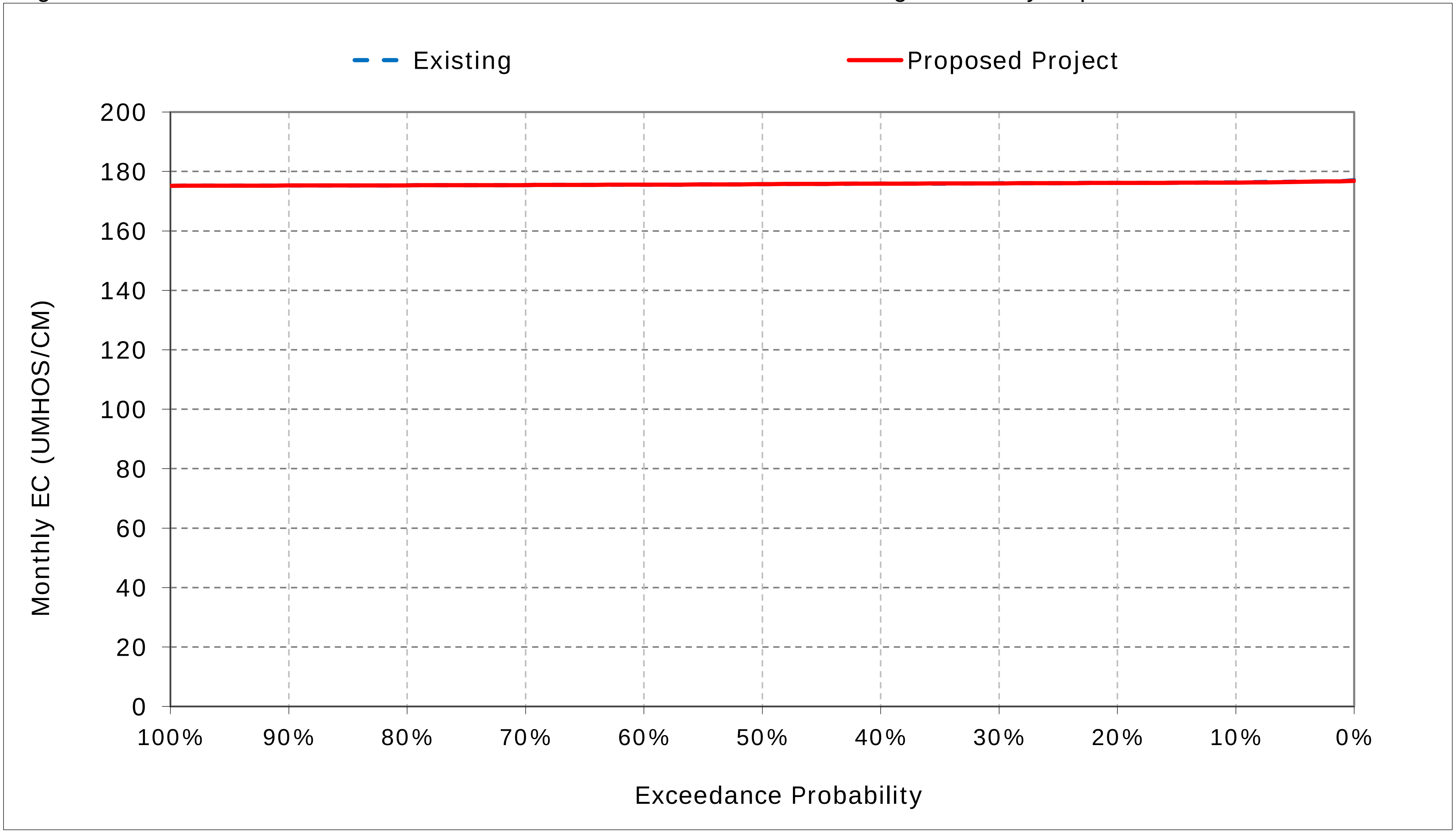


Figure 1-11. Sacramento River downstream of Steamboat Slough Salinity, May EC

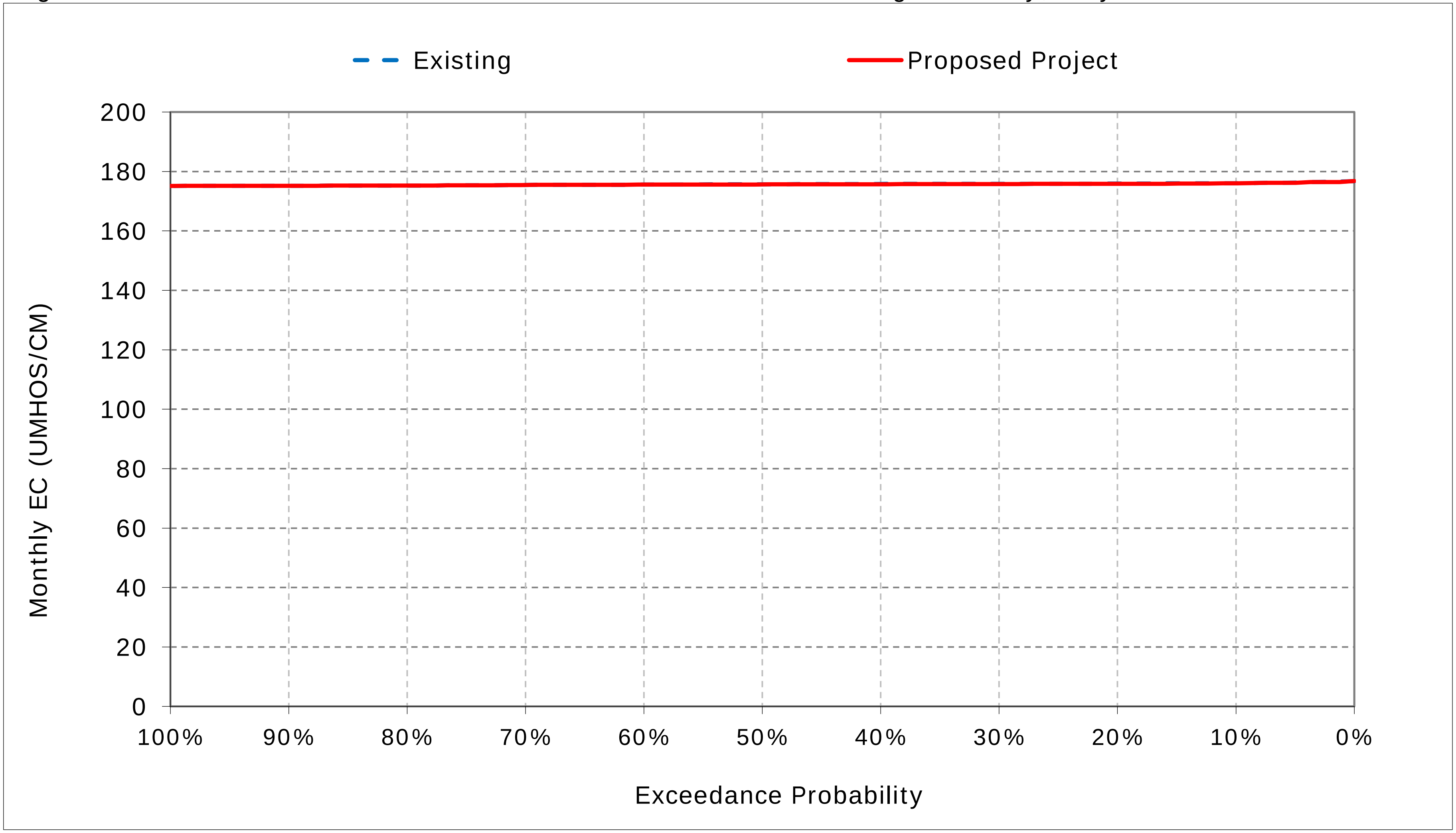


Figure 1-12. Sacramento River downstream of Steamboat Slough Salinity, June EC

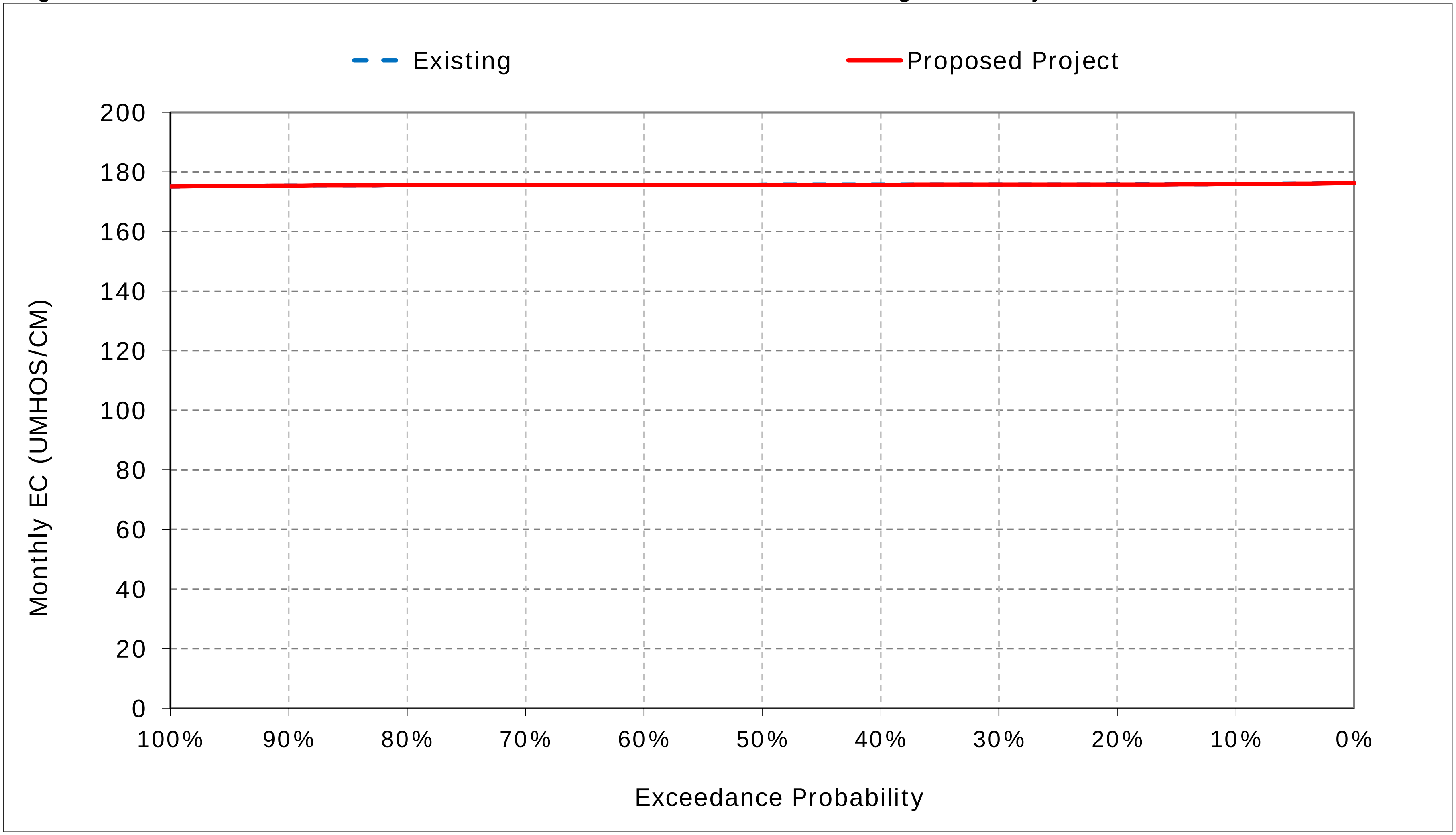


Figure 1-13. Sacramento River downstream of Steamboat Slough Salinity, July EC

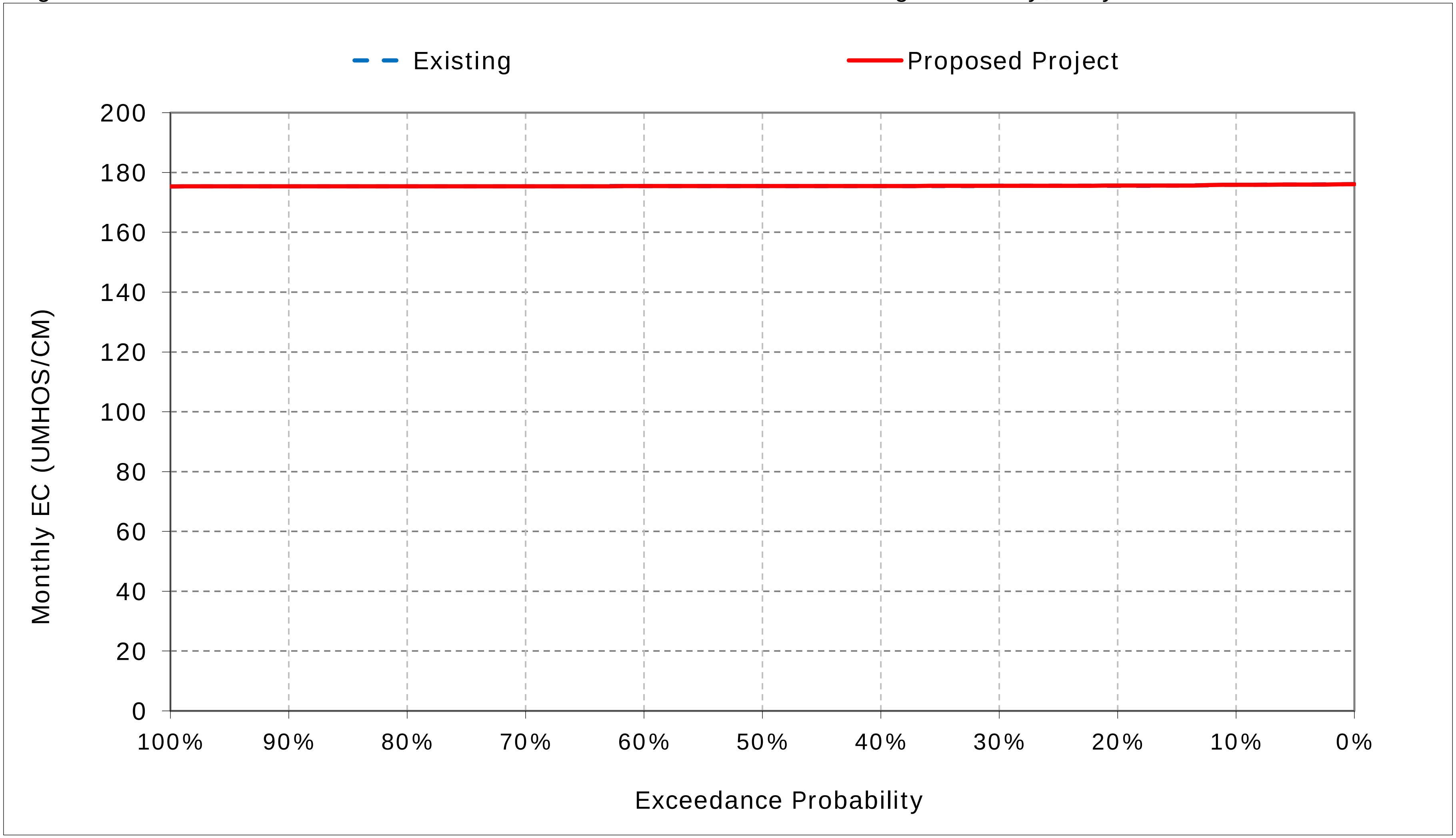


Figure 1-14. Sacramento River downstream of Steamboat Slough Salinity, August EC

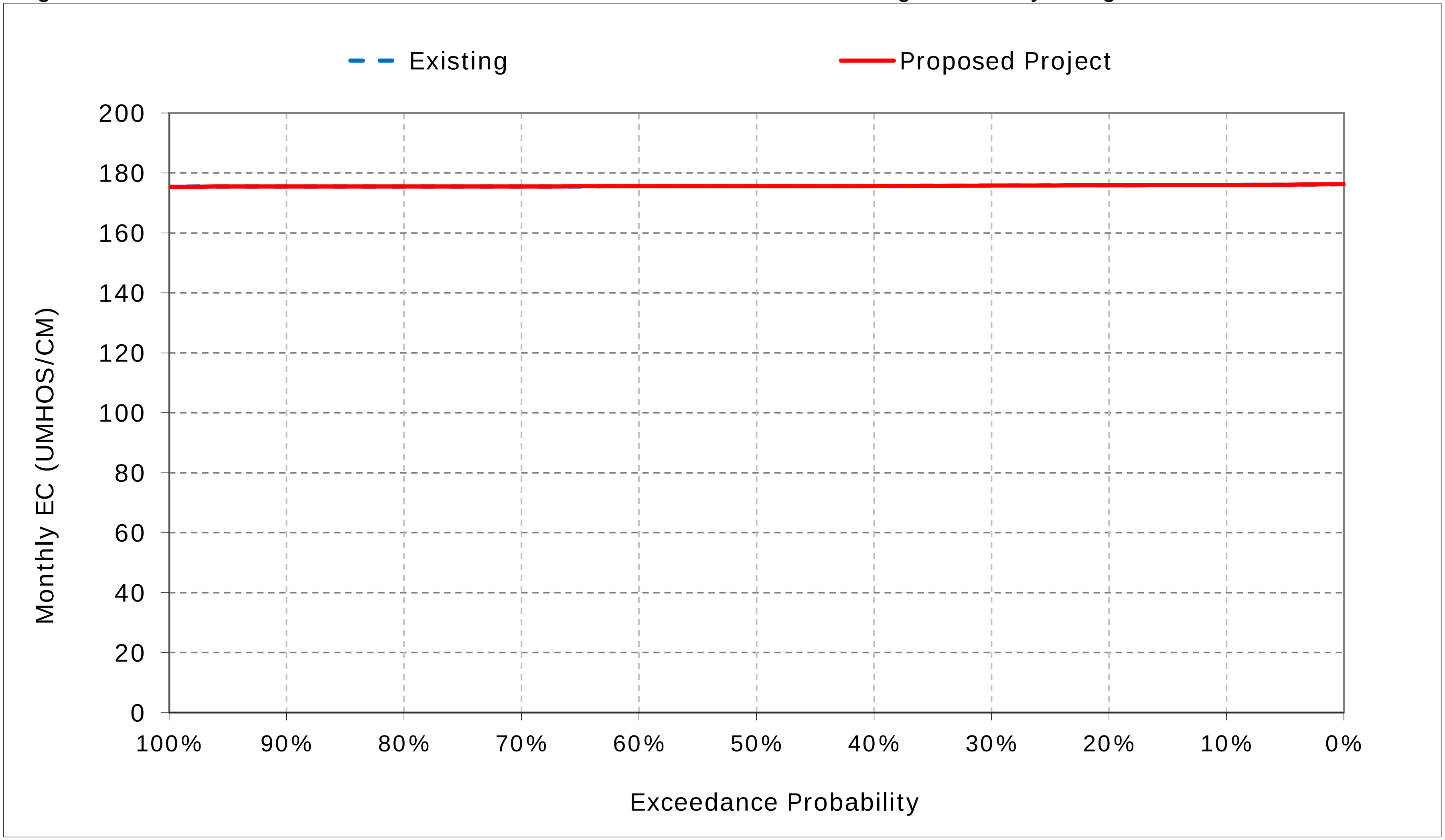


Figure 1-15. Sacramento River downstream of Steamboat Slough Salinity, September EC

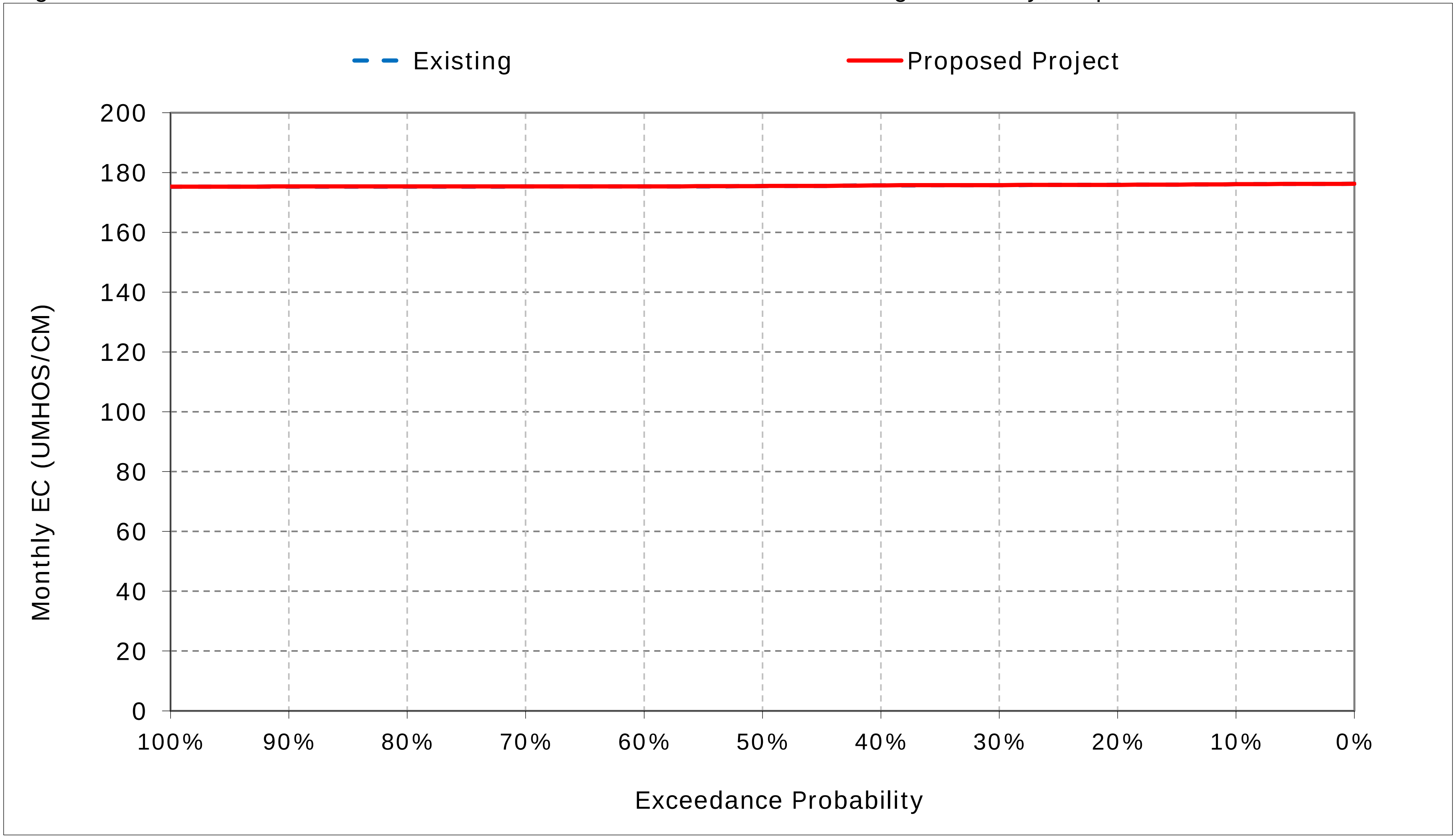


Figure 1-16. Sacramento River downstream of Steamboat Slough Salinity, October EC

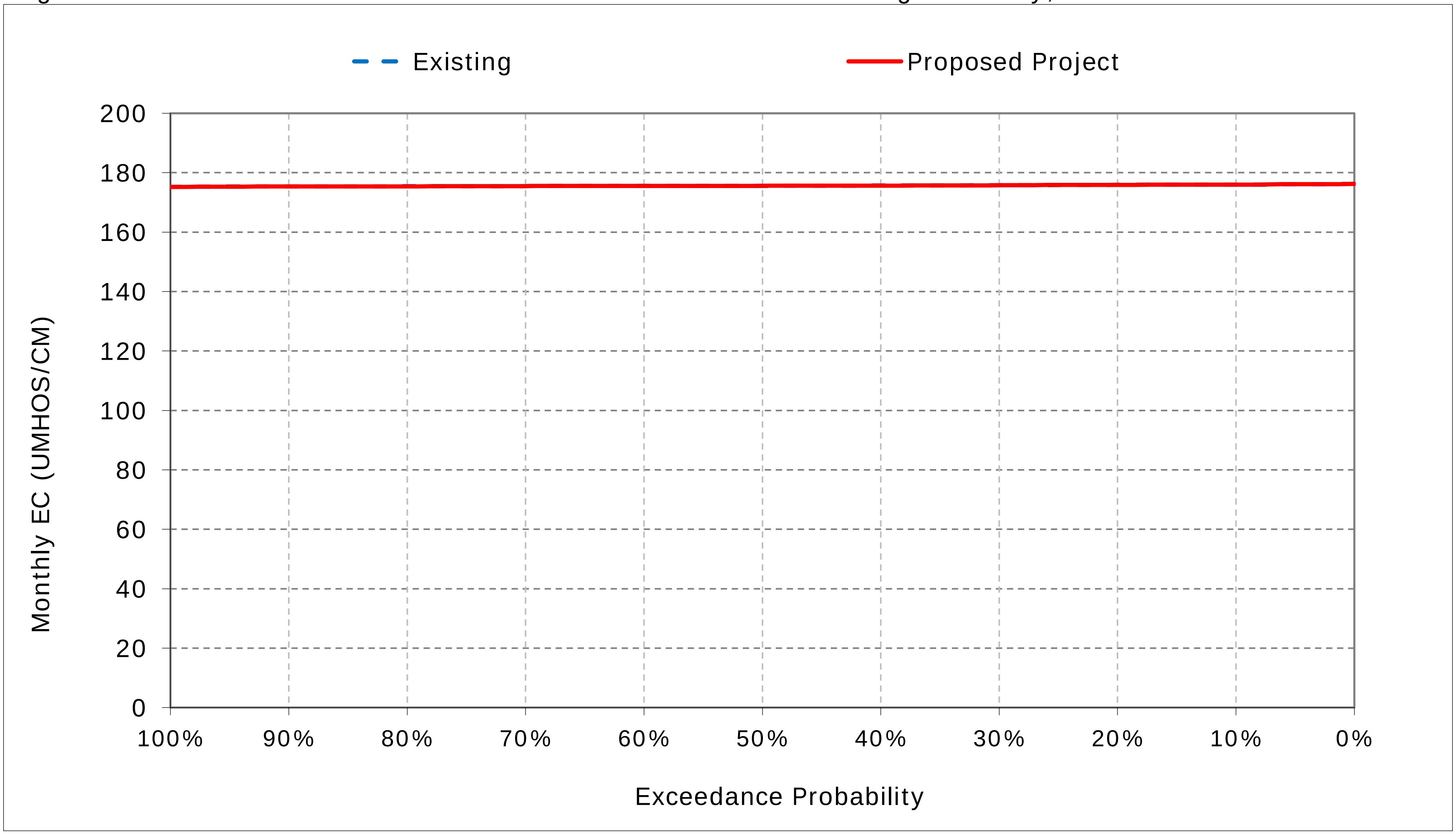


Figure 1-17. Sacramento River downstream of Steamboat Slough Salinity, November EC

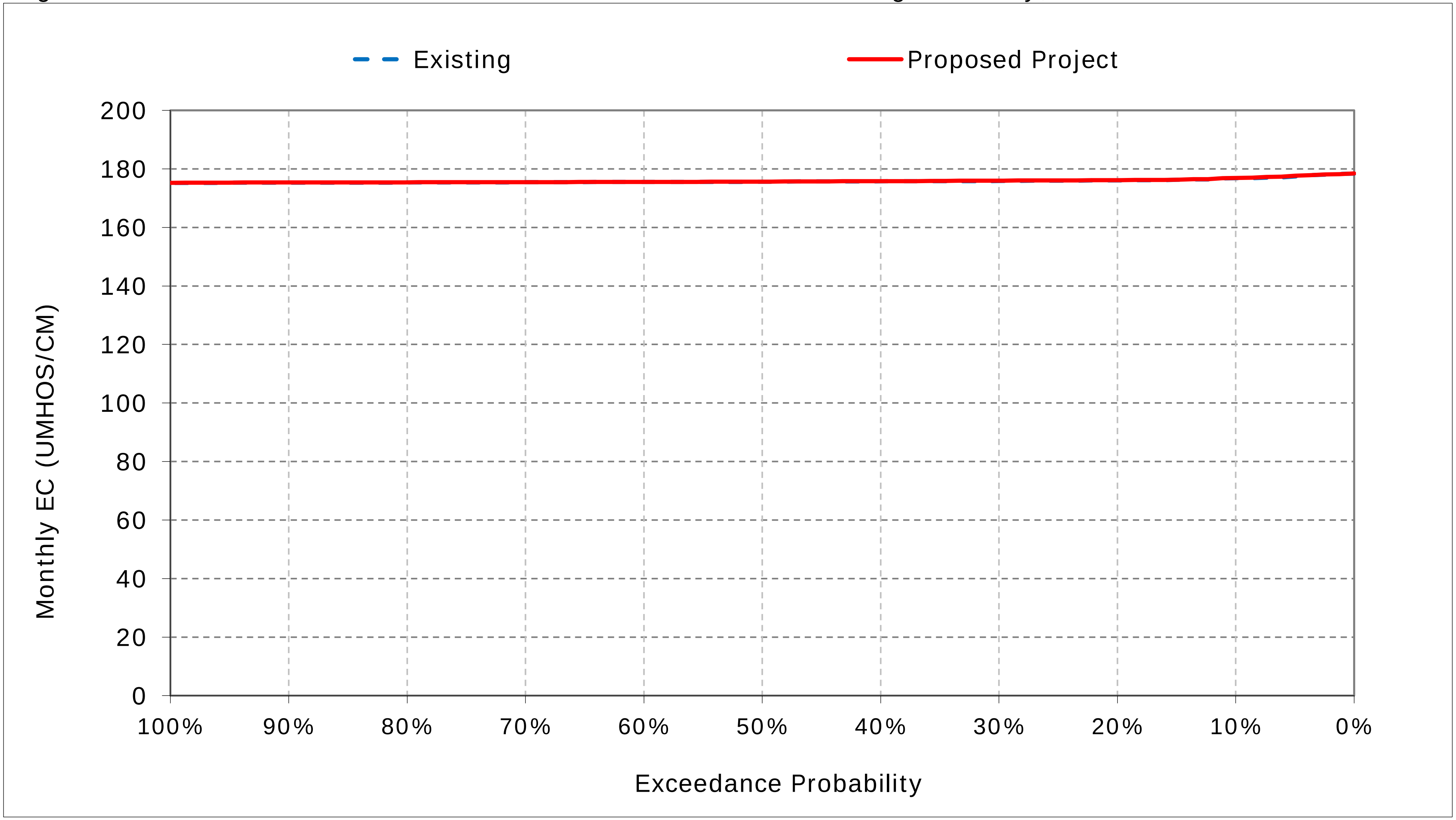


Figure 1-18. Sacramento River downstream of Steamboat Slough Salinity, December EC

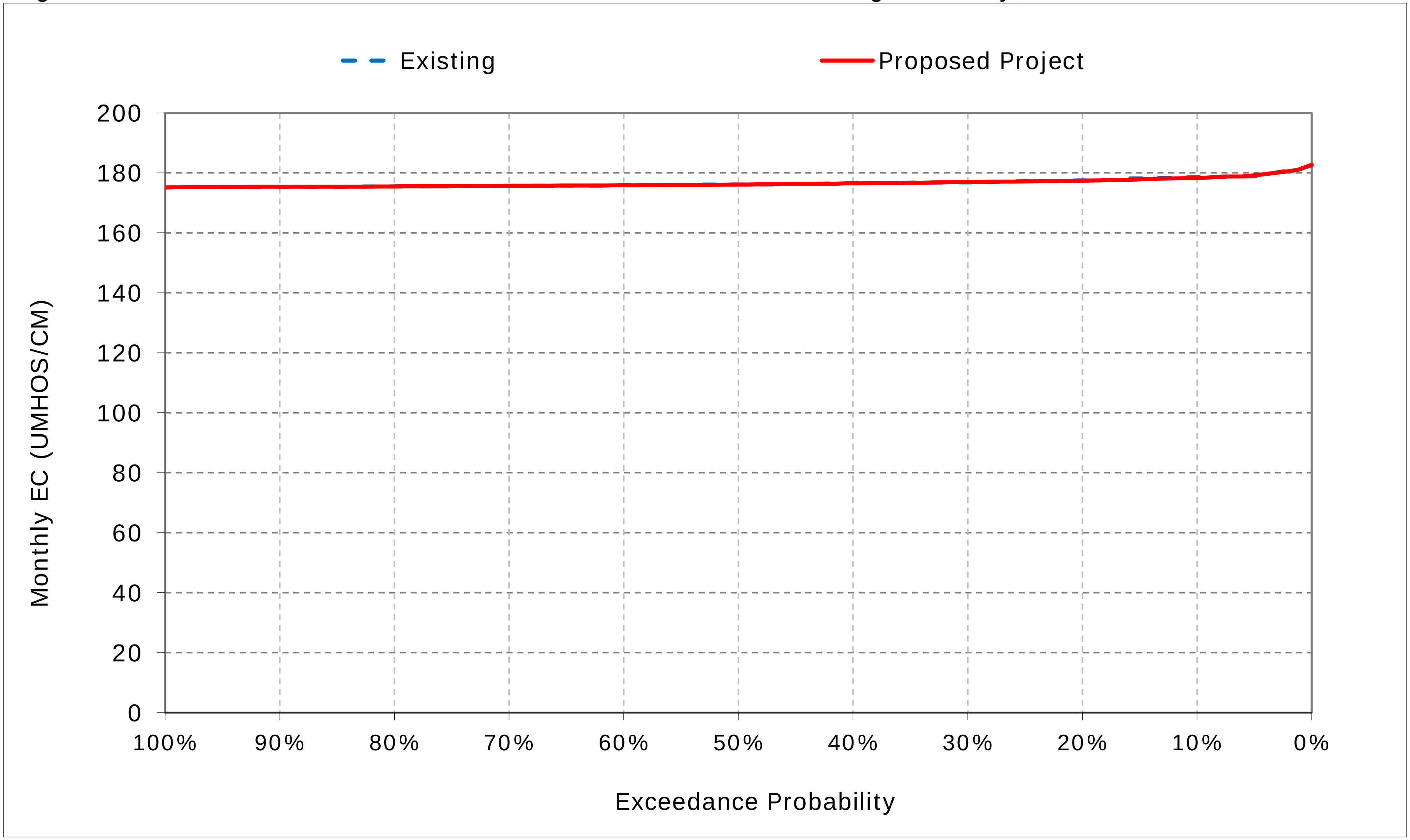


Table 2-1. Cache Slough at Ryer Island Salinity, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	189	190	191	203	201	194	187	184	184	185	186	187
20%	185	186	188	197	197	192	186	183	183	181	184	183
30%	184	184	186	193	192	190	185	183	182	181	183	182
40%	183	183	185	191	189	186	184	182	182	180	181	181
50%	181	181	184	190	188	185	183	182	182	180	180	180
60%	180	180	182	189	187	184	183	181	181	180	180	179
70%	180	180	181	187	185	183	182	180	181	180	180	179
80%	180	179	180	186	184	182	181	179	180	179	180	178
90%	179	179	180	184	182	181	180	178	179	179	179	178
Long Term												
Full Simulation Period[a]	183	183	185	192	190	187	184	181	182	181	182	181
Water Year Types[b]												
Wet (32%)	181	181	183	190	184	183	182	180	180	180	180	178
Above Normal (15%)	183	183	185	194	192	185	182	180	181	180	180	179
Below Normal (17%)	183	182	186	193	193	189	184	182	181	180	180	180
Dry (22%)	184	185	185	193	193	188	185	183	182	181	184	183
Critical (15%)	185	187	186	191	193	190	186	184	185	186	186	188

Proposed Project

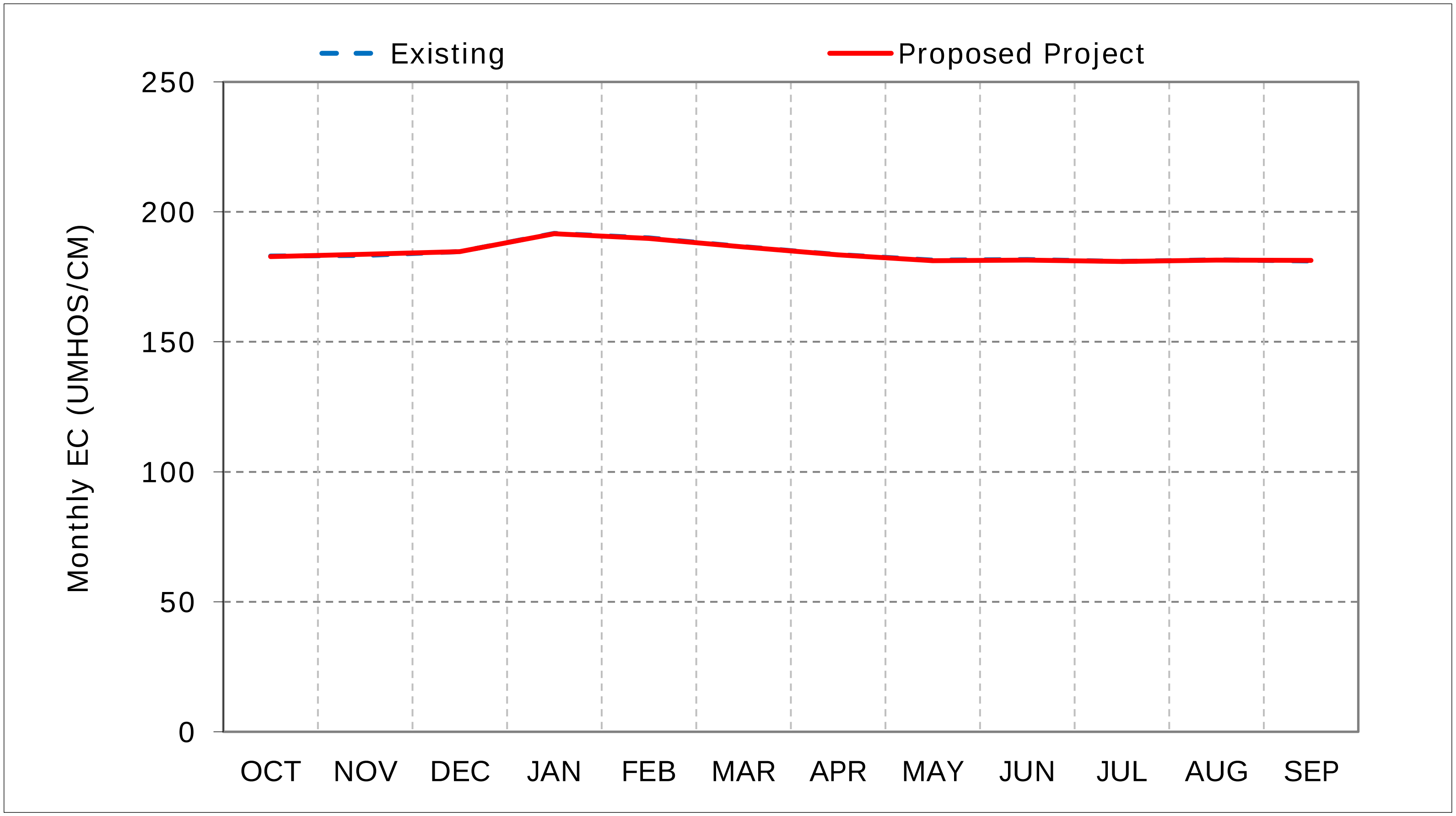
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	188	190	191	202	200	194	187	184	184	185	185	187
20%	185	186	188	197	197	192	186	183	182	181	184	183
30%	184	184	186	193	192	190	185	182	182	181	182	182
40%	182	183	185	191	188	186	184	182	182	180	181	181
50%	181	182	184	190	187	185	183	181	181	180	180	180
60%	180	181	182	188	187	184	182	181	181	180	180	179
70%	180	181	181	187	185	183	182	180	181	180	180	179
80%	180	180	180	186	184	182	181	179	180	179	179	179
90%	179	179	180	183	182	180	180	178	179	179	179	179
Long Term												
Full Simulation Period[a]	183	184	185	192	190	187	183	181	181	181	181	181
Water Year Types[b]												
Wet (32%)	181	182	183	189	184	183	182	180	180	180	180	179
Above Normal (15%)	182	184	185	193	192	185	182	180	181	180	180	179
Below Normal (17%)	183	182	186	192	192	189	184	181	181	180	180	181
Dry (22%)	184	185	186	193	193	188	185	182	182	181	184	183
Critical (15%)	185	187	187	191	193	190	186	184	186	186	185	188

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	0	0	0	-1	-1	0	0	-1	0	0	0	0
20%	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0
40%	0	0	0	0	-1	0	0	0	0	0	0	0
50%	0	1	0	0	-1	0	0	0	0	0	0	0
60%	0	1	0	0	0	0	0	0	0	0	0	0
70%	0	1	0	0	0	0	0	0	0	0	0	0
80%	0	1	0	0	0	0	0	0	0	0	0	1
90%	0	1	0	-1	0	-1	0	0	0	0	0	1
Long Term												
Full Simulation Period[a]	0	0	0	0	0	0	0	0	0	0	0	0
Water Year Types[b]												
Wet (32%)	0	1	0	0	0	0	0	0	0	0	0	1
Above Normal (15%)	0	0	0	0	-1	0	0	0	0	0	0	0
Below Normal (17%)	0	0	0	0	-1	0	0	0	0	0	0	0
Dry (22%)	0	0	0	0	0	0	0	-1	0	0	0	0
Critical (15%)	0	0	0	1	0	0	0	0	0	0	-1	0

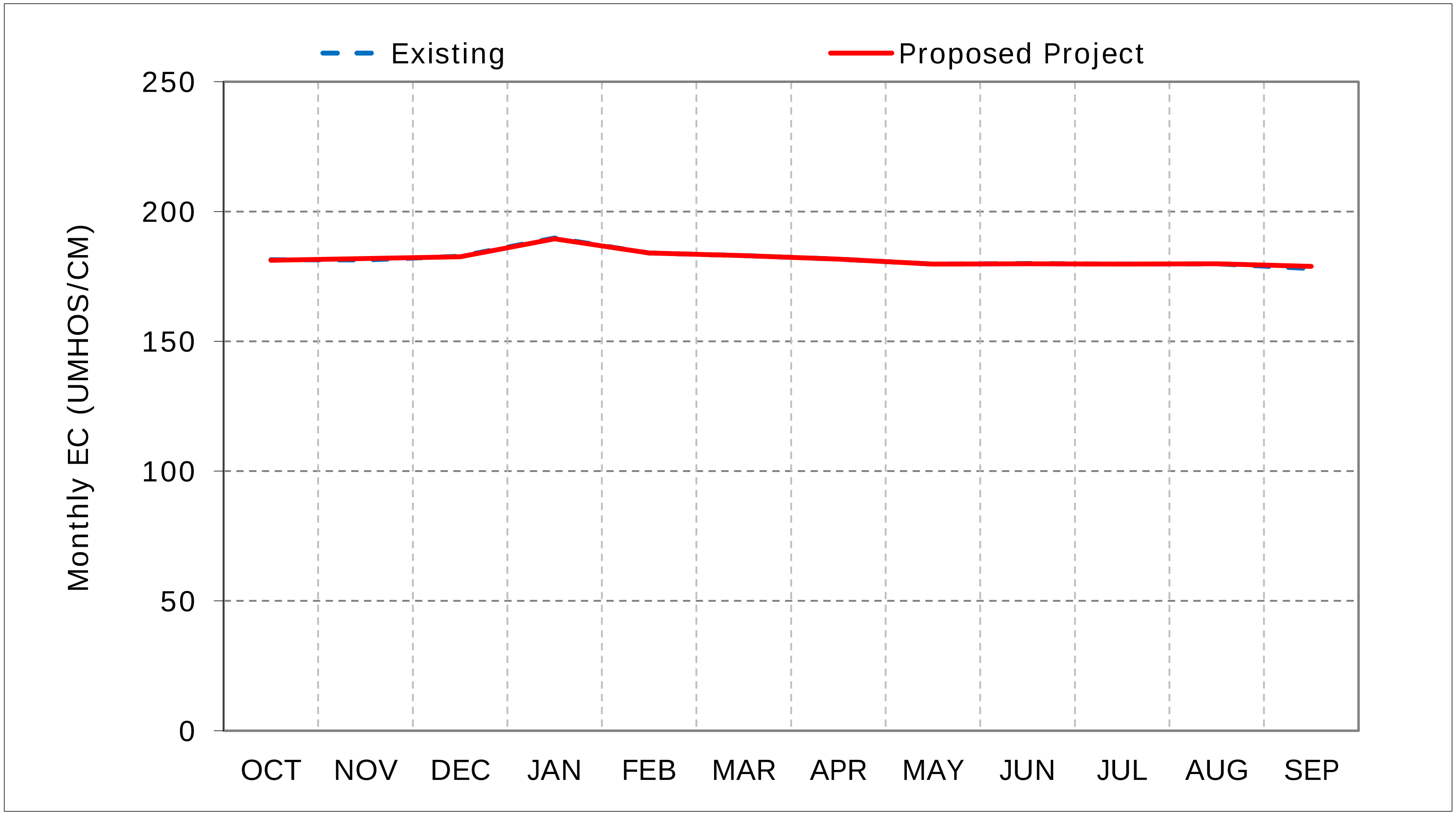
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 2-1. Cache Slough at Ryer Island Salinity, Long-Term Average EC



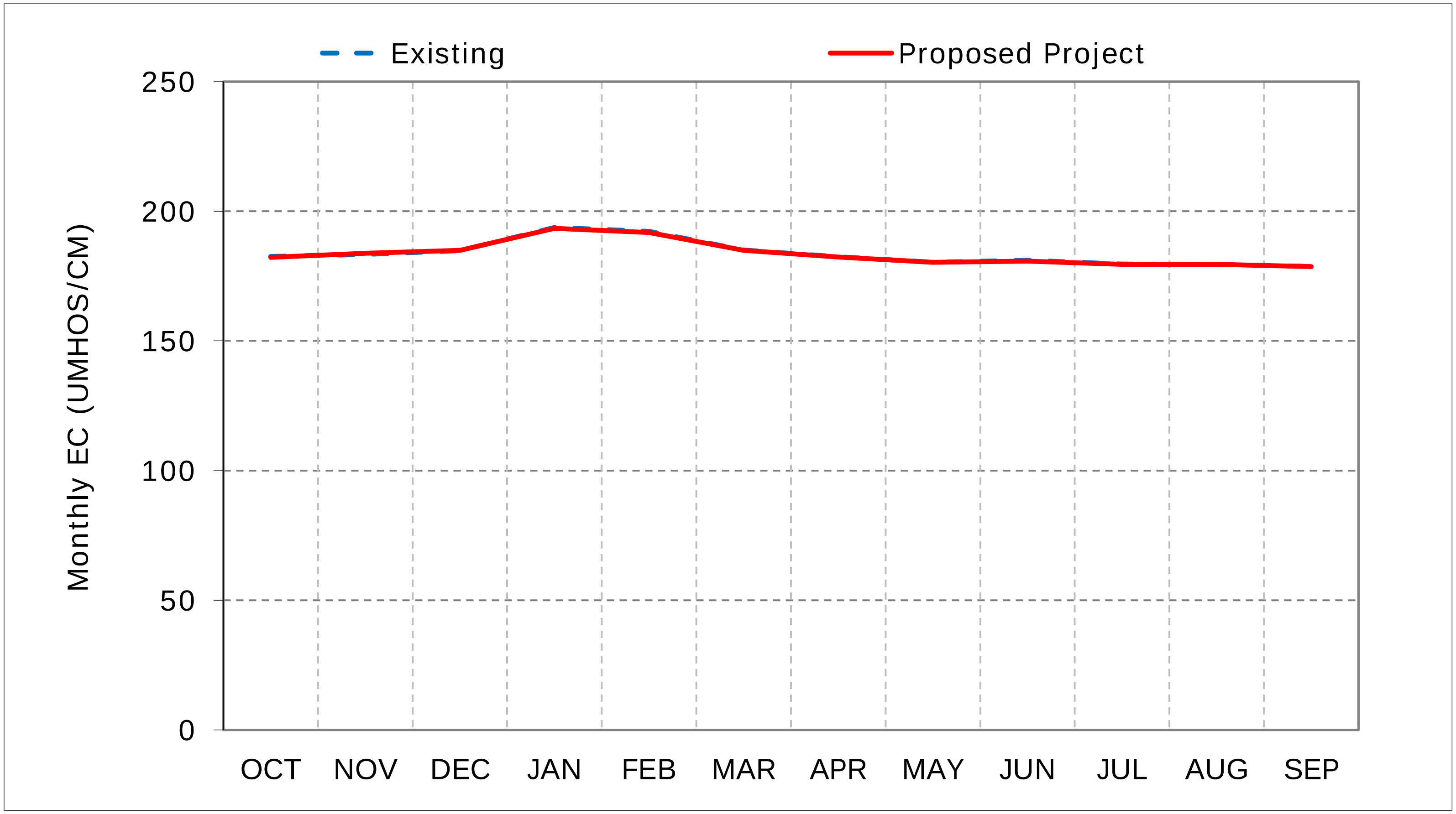
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 2-2. Cache Slough at Ryer Island Salinity, Wet Year Average EC



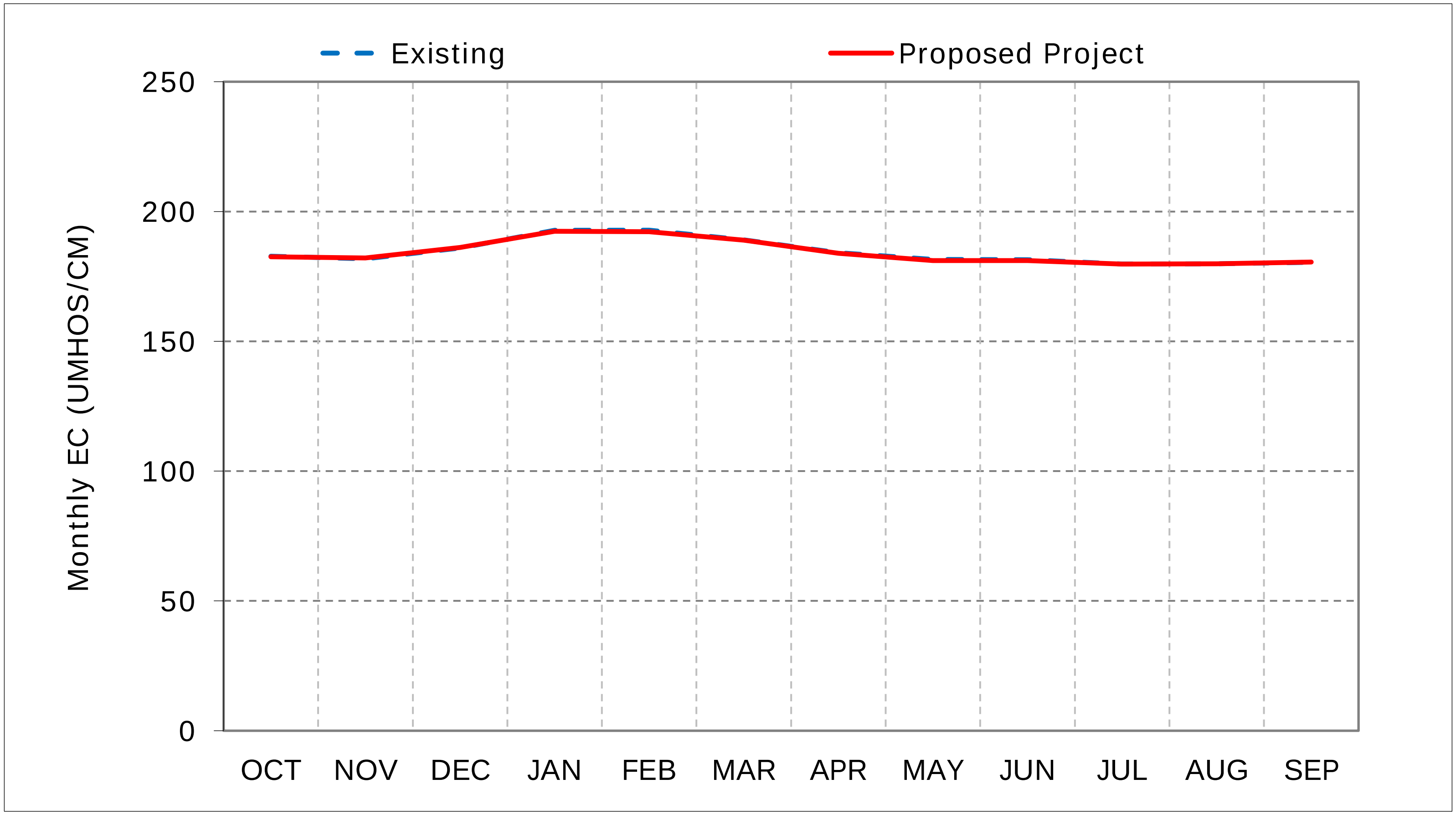
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 2-3. Cache Slough at Ryer Island Salinity, Above Normal Year Average EC



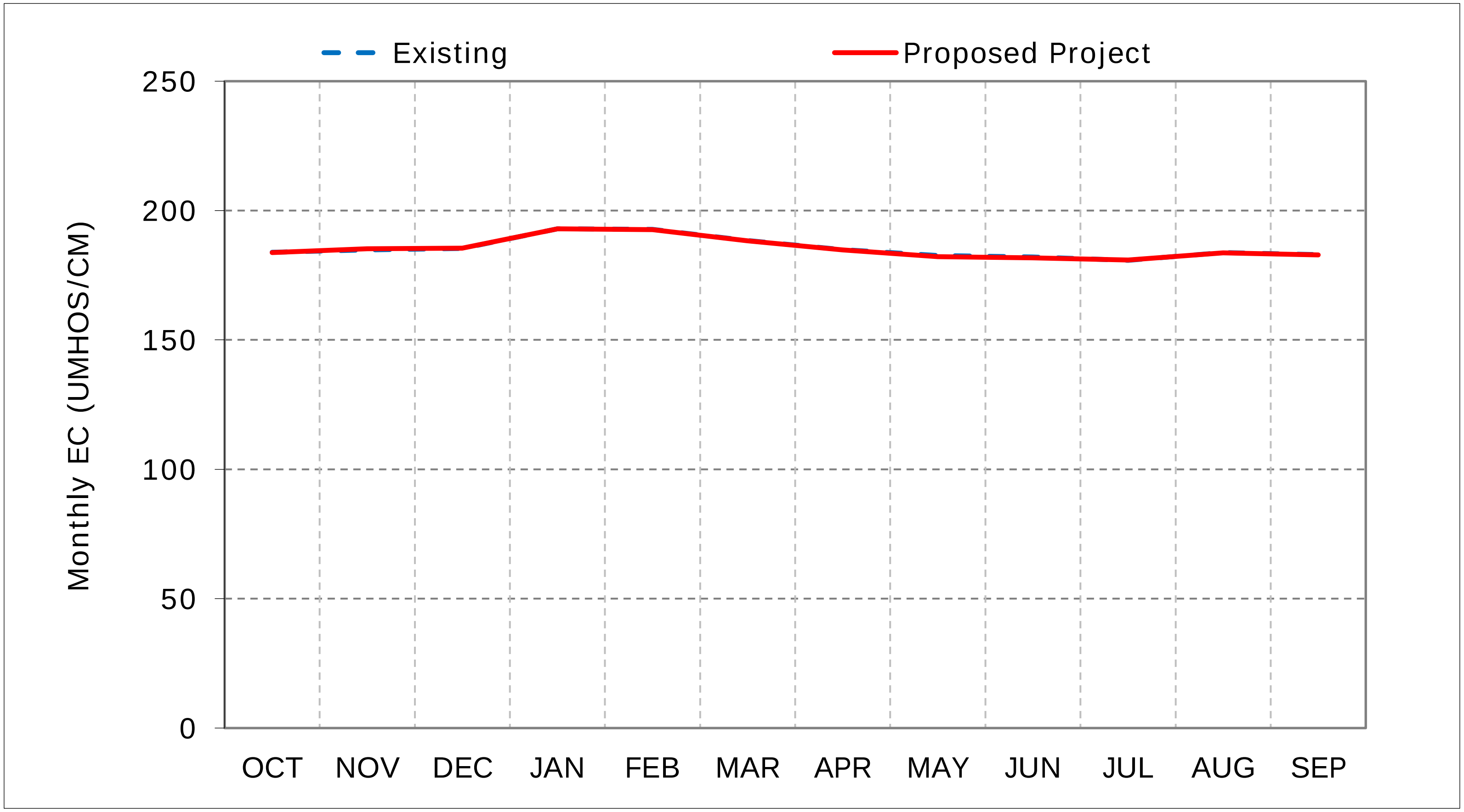
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 2-4. Cache Slough at Ryer Island Salinity, Below Normal Year Average EC



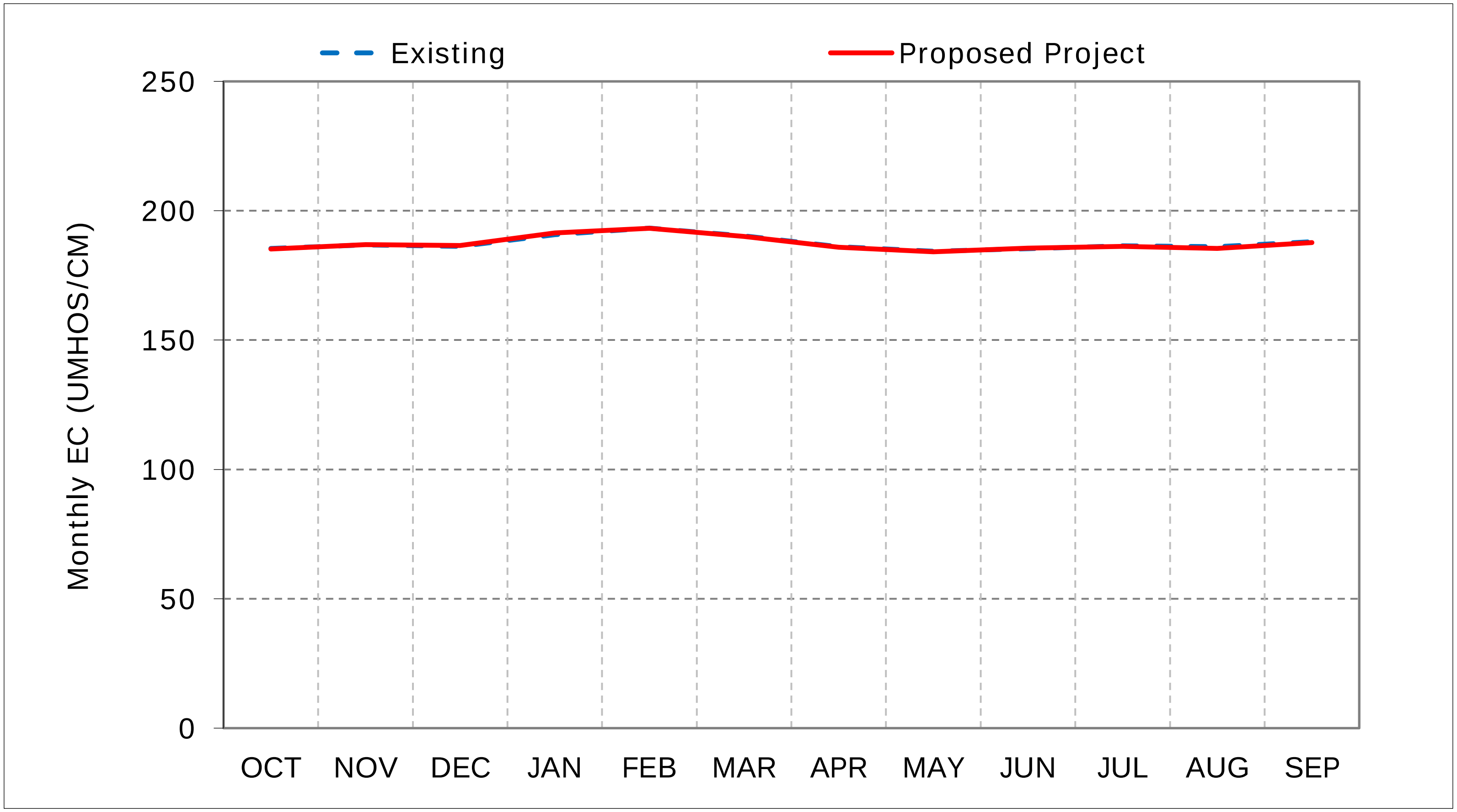
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 2-5. Cache Slough at Ryer Island Salinity, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 2-6. Cache Slough at Ryer Island Salinity, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 2-7. Cache Slough at Ryer Island Salinity, January EC

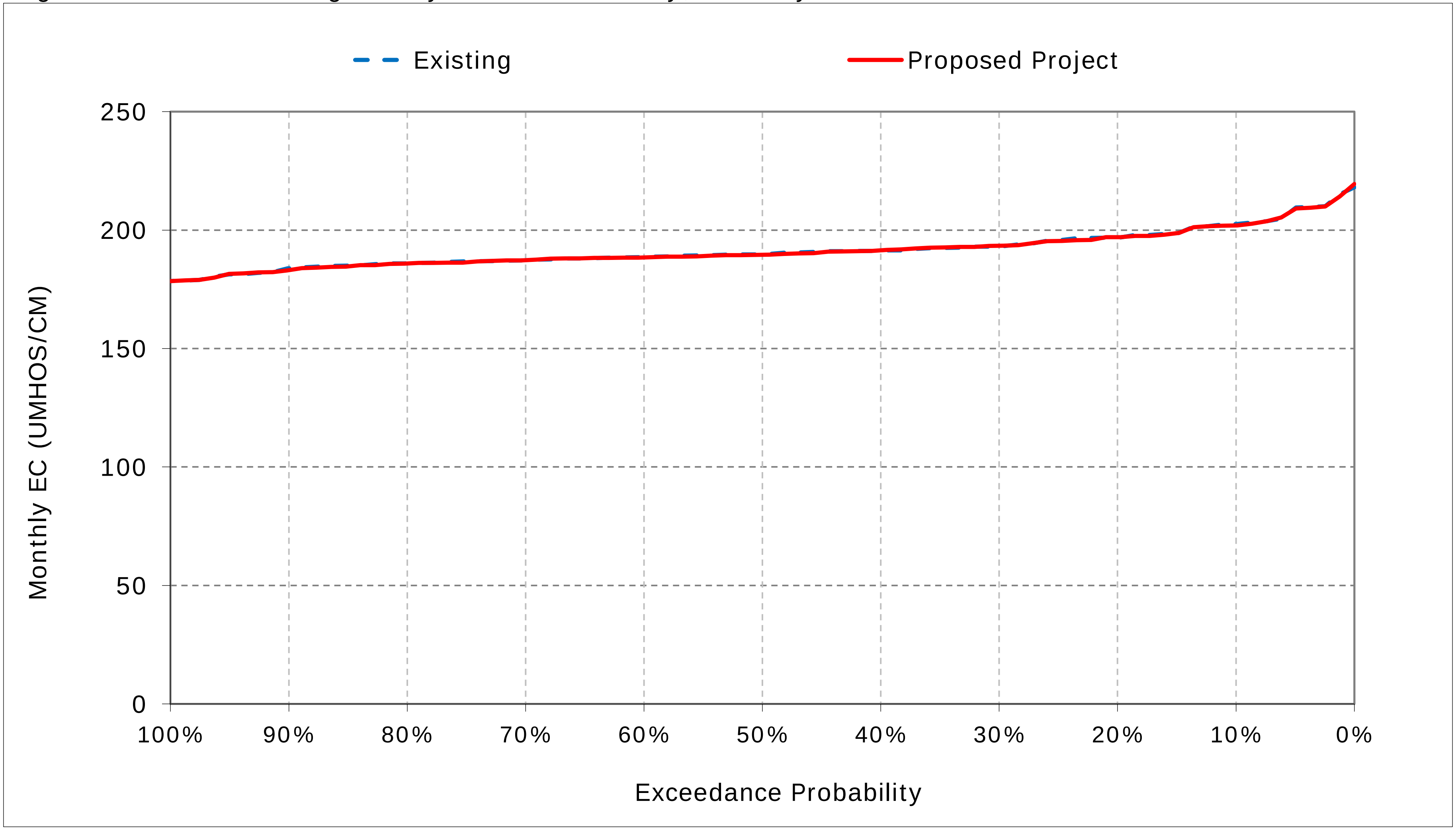


Figure 2-8. Cache Slough at Ryer Island Salinity, February EC

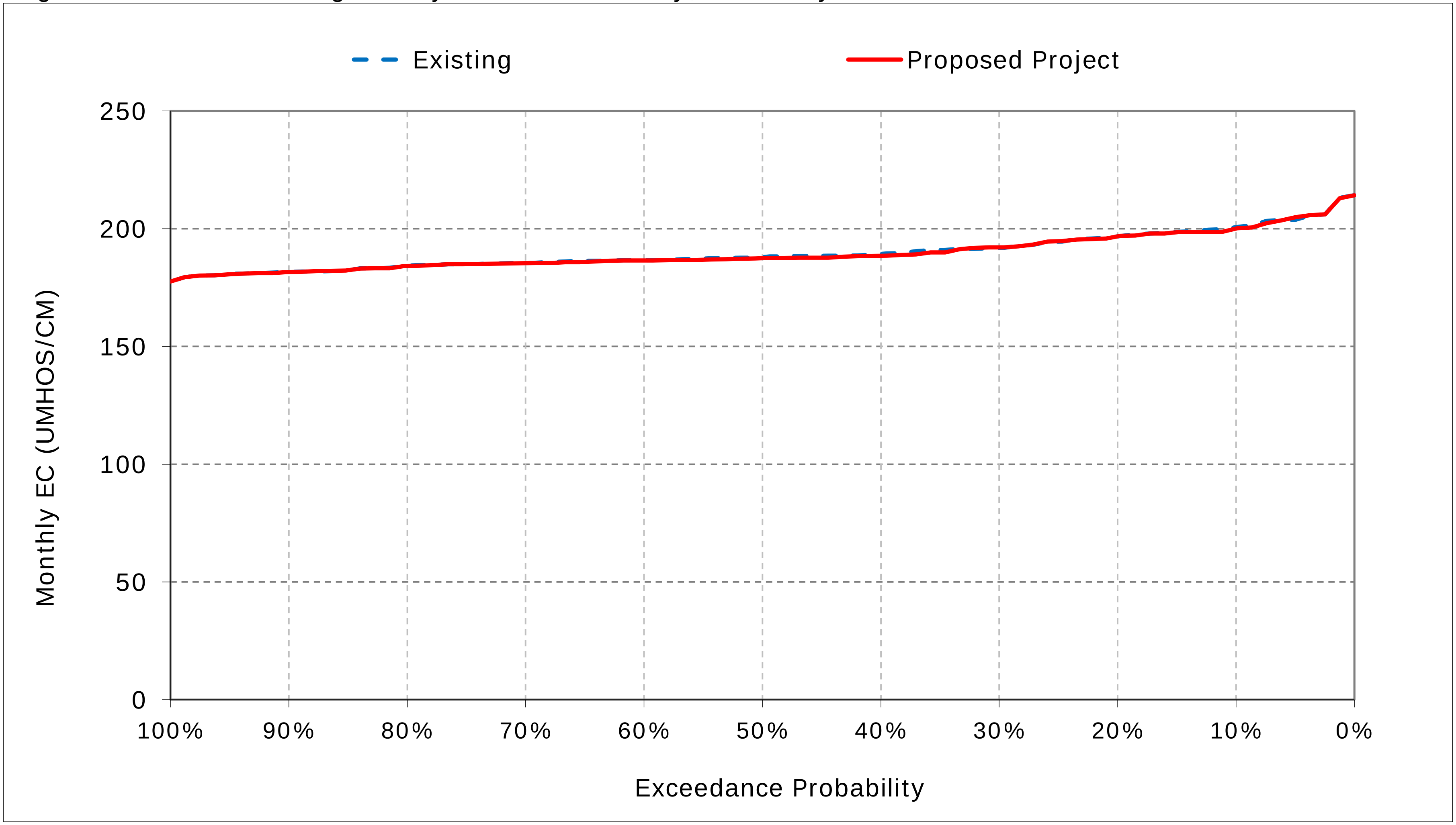


Figure 2-9. Cache Slough at Ryer Island Salinity, March EC

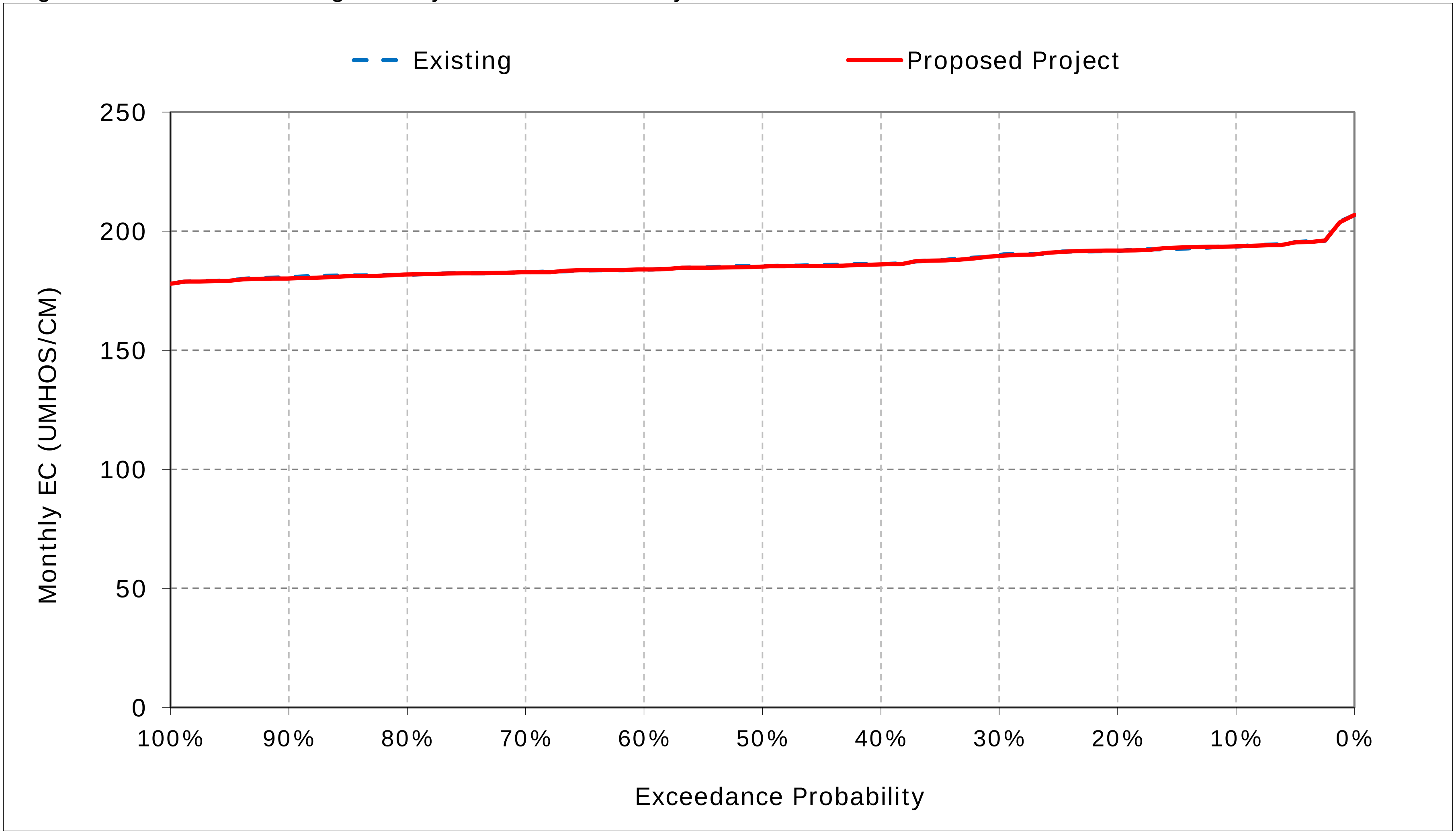


Figure 2-10. Cache Slough at Ryer Island Salinity, April EC

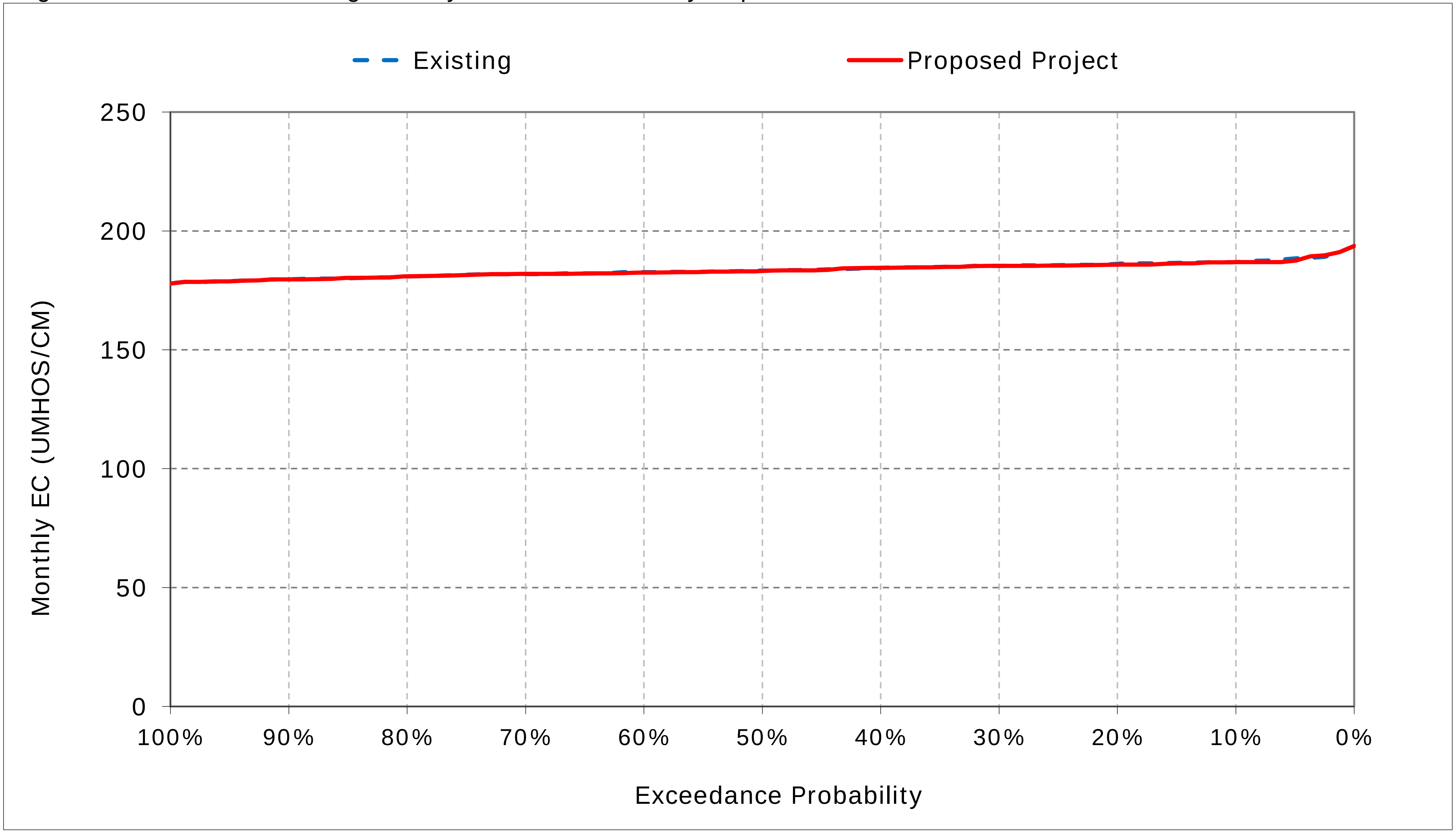


Figure 2-11. Cache Slough at Ryer Island Salinity, May EC

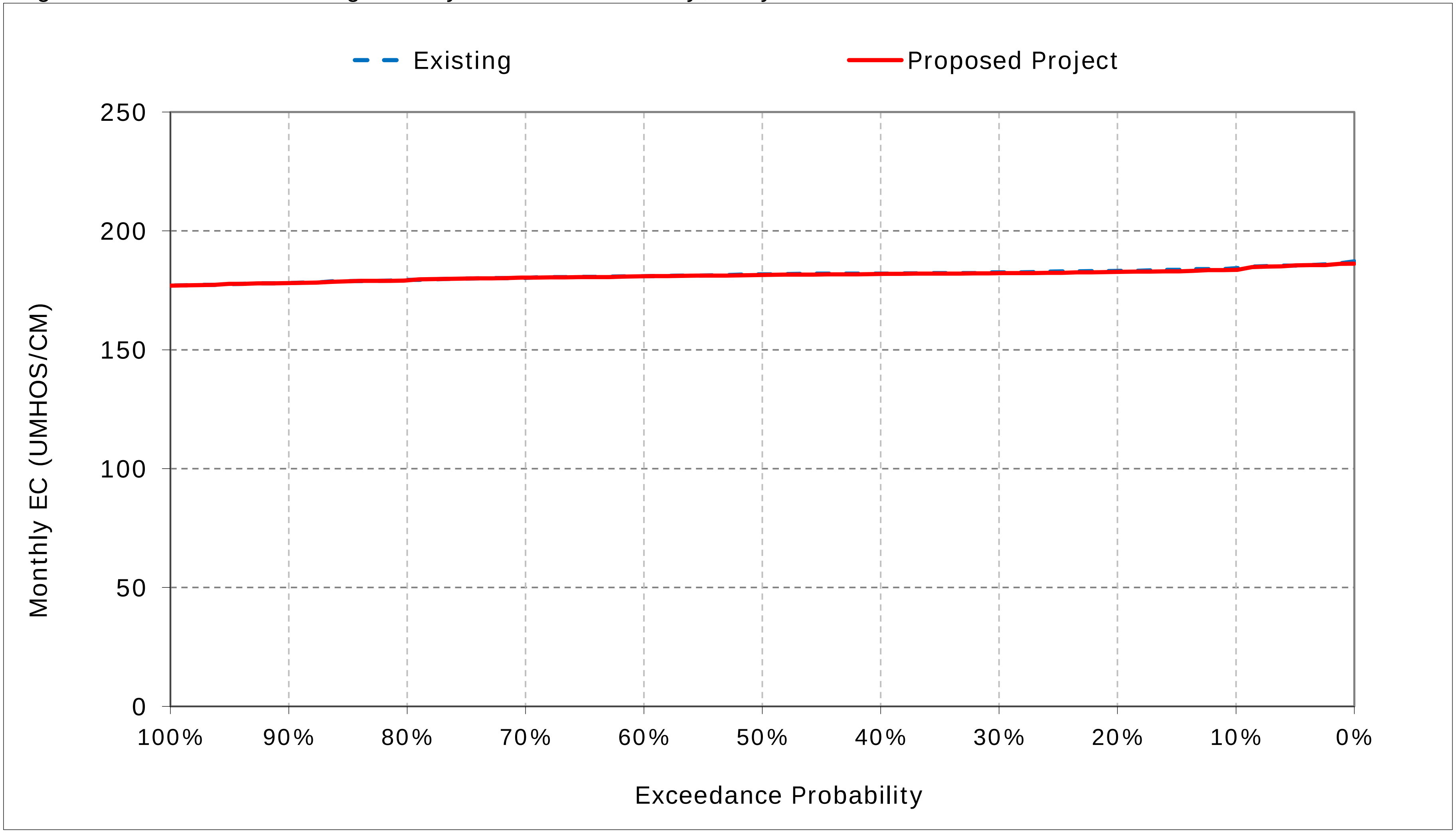


Figure 2-12. Cache Slough at Ryer Island Salinity, June EC

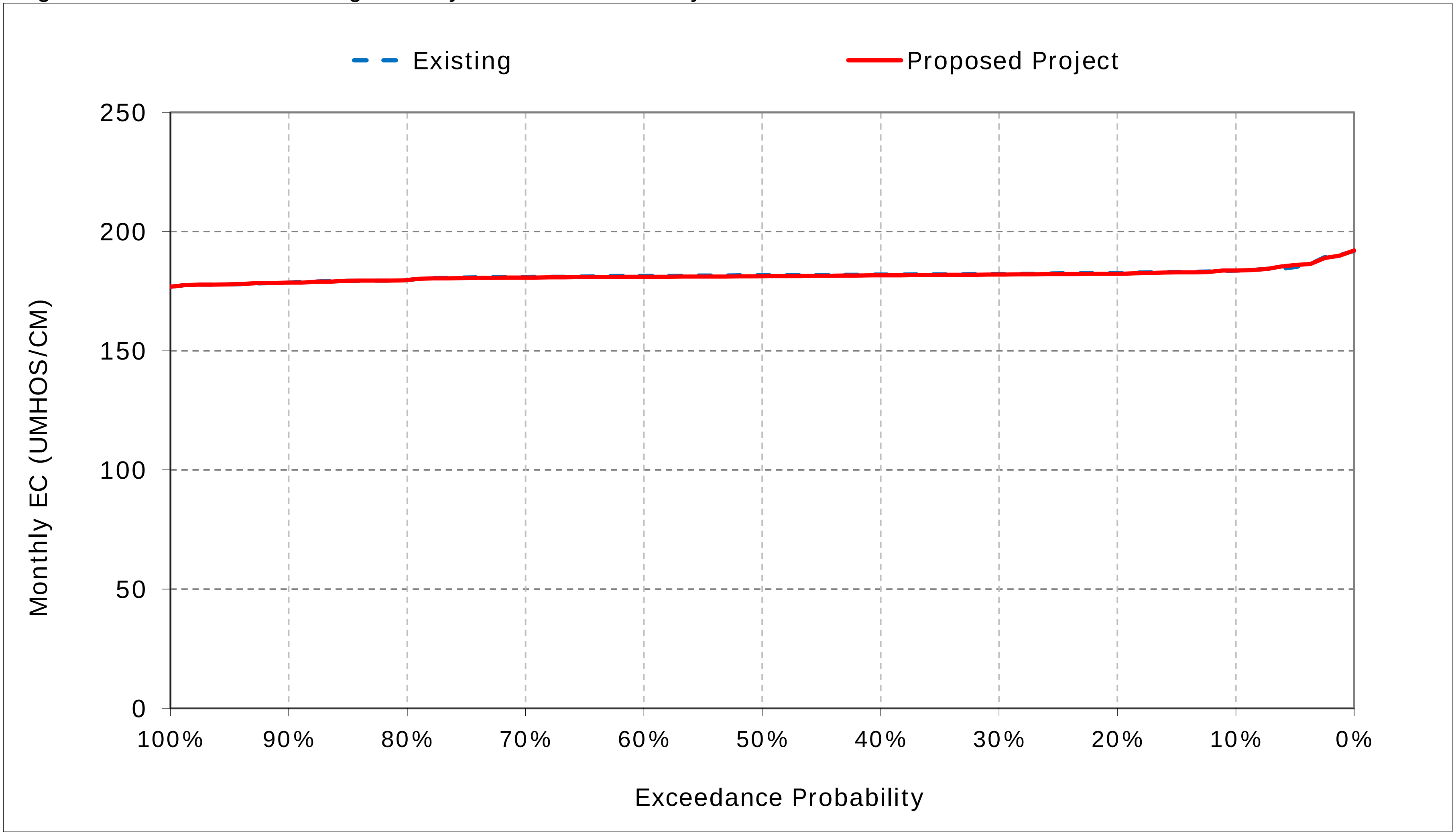


Figure 2-13. Cache Slough at Ryer Island Salinity, July EC

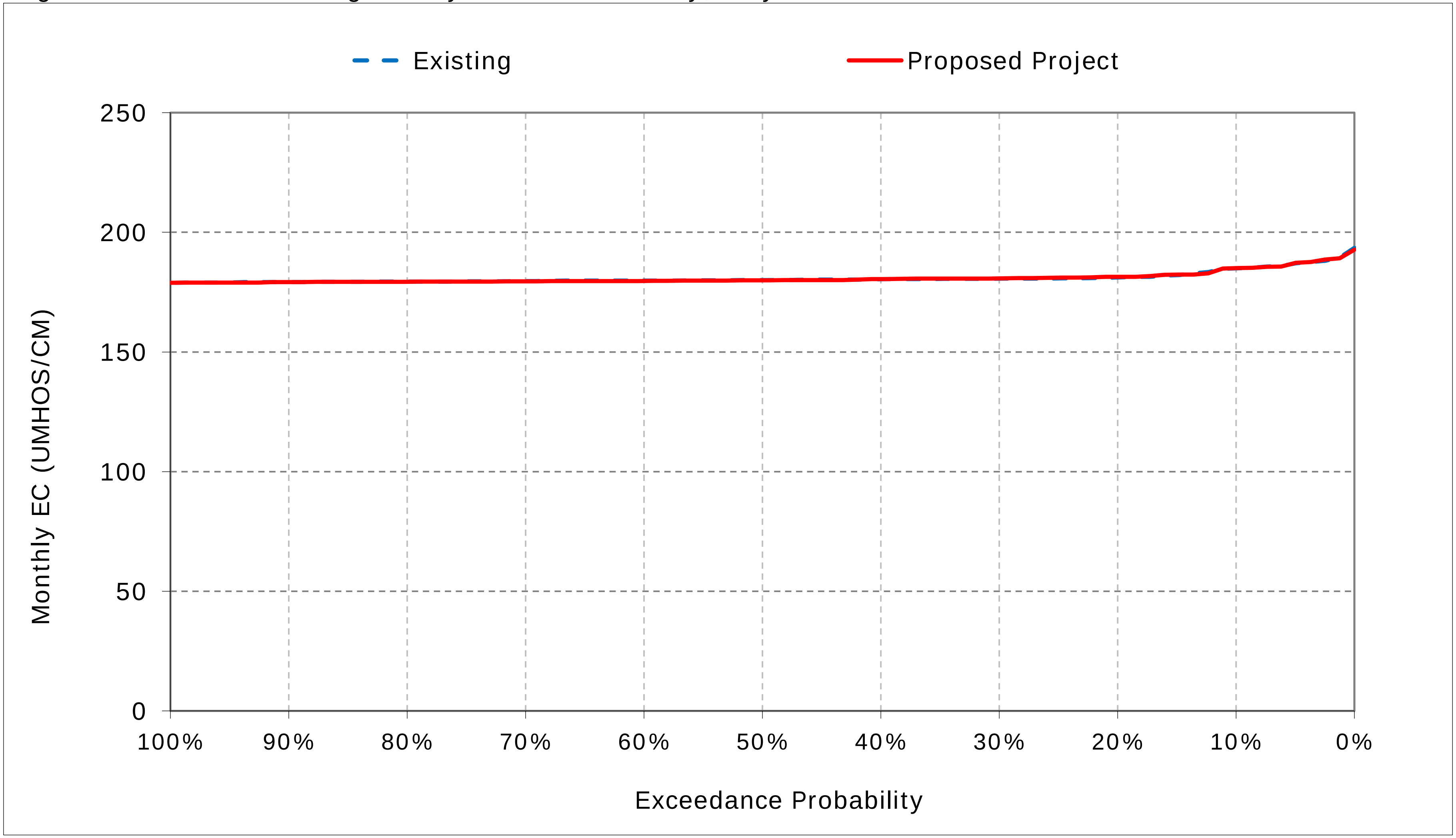


Figure 2-14. Cache Slough at Ryer Island Salinity, August EC

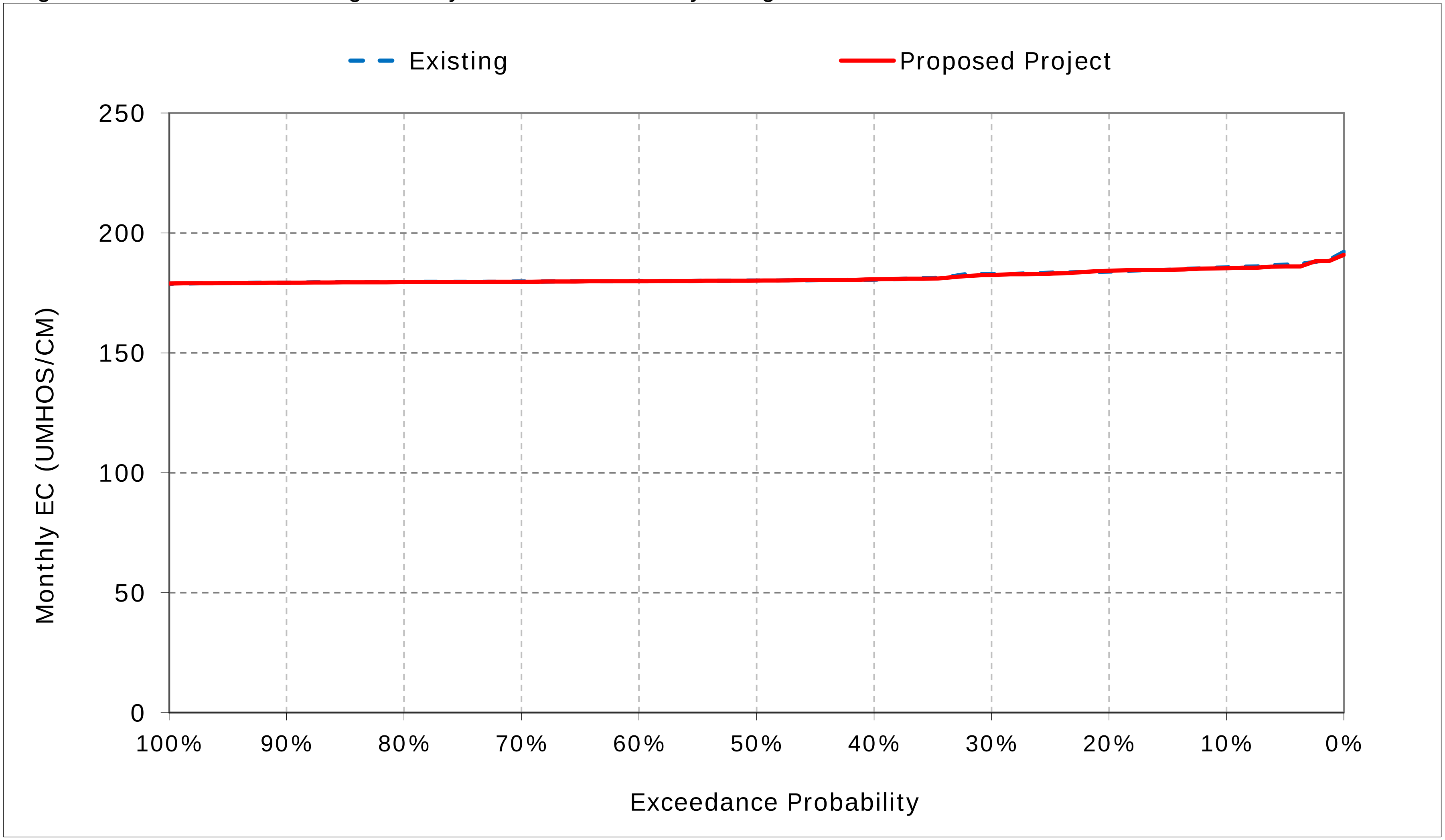


Figure 2-15. Cache Slough at Ryer Island Salinity, September EC

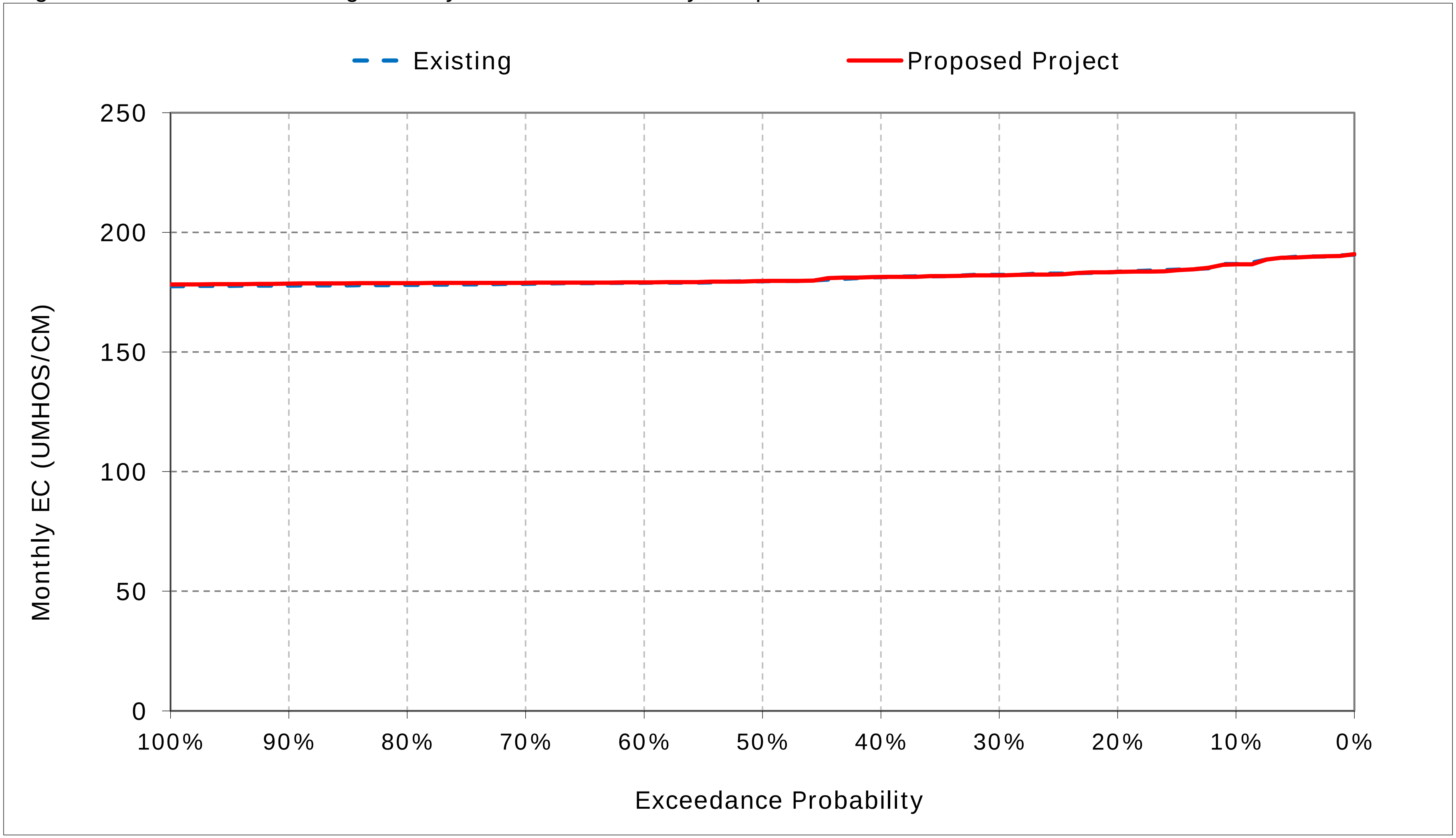


Figure 2-16. Cache Slough at Ryer Island Salinity, October EC

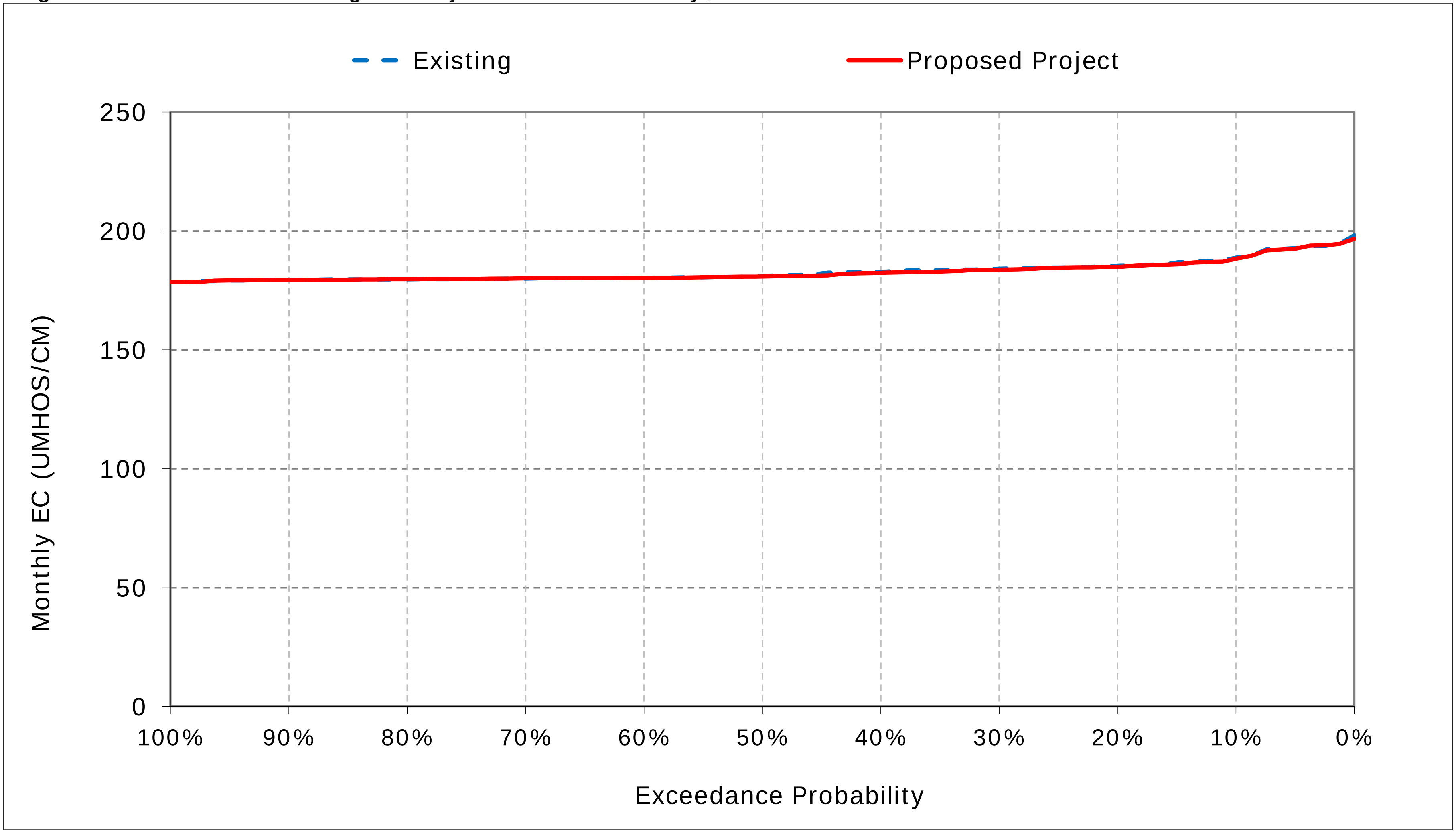


Figure 2-17. Cache Slough at Ryer Island Salinity, November EC

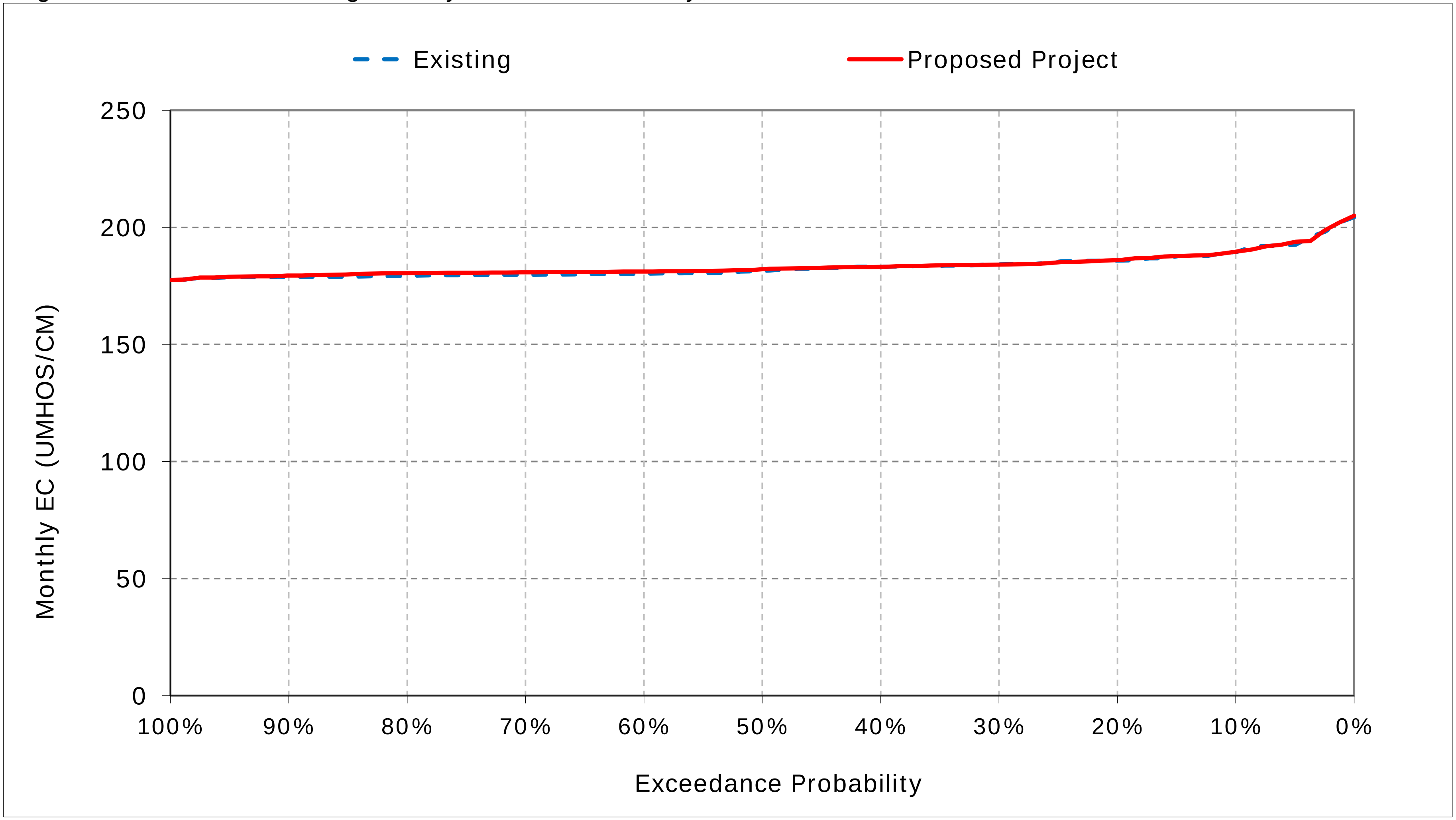


Figure 2-18. Cache Slough at Ryer Island Salinity, December EC

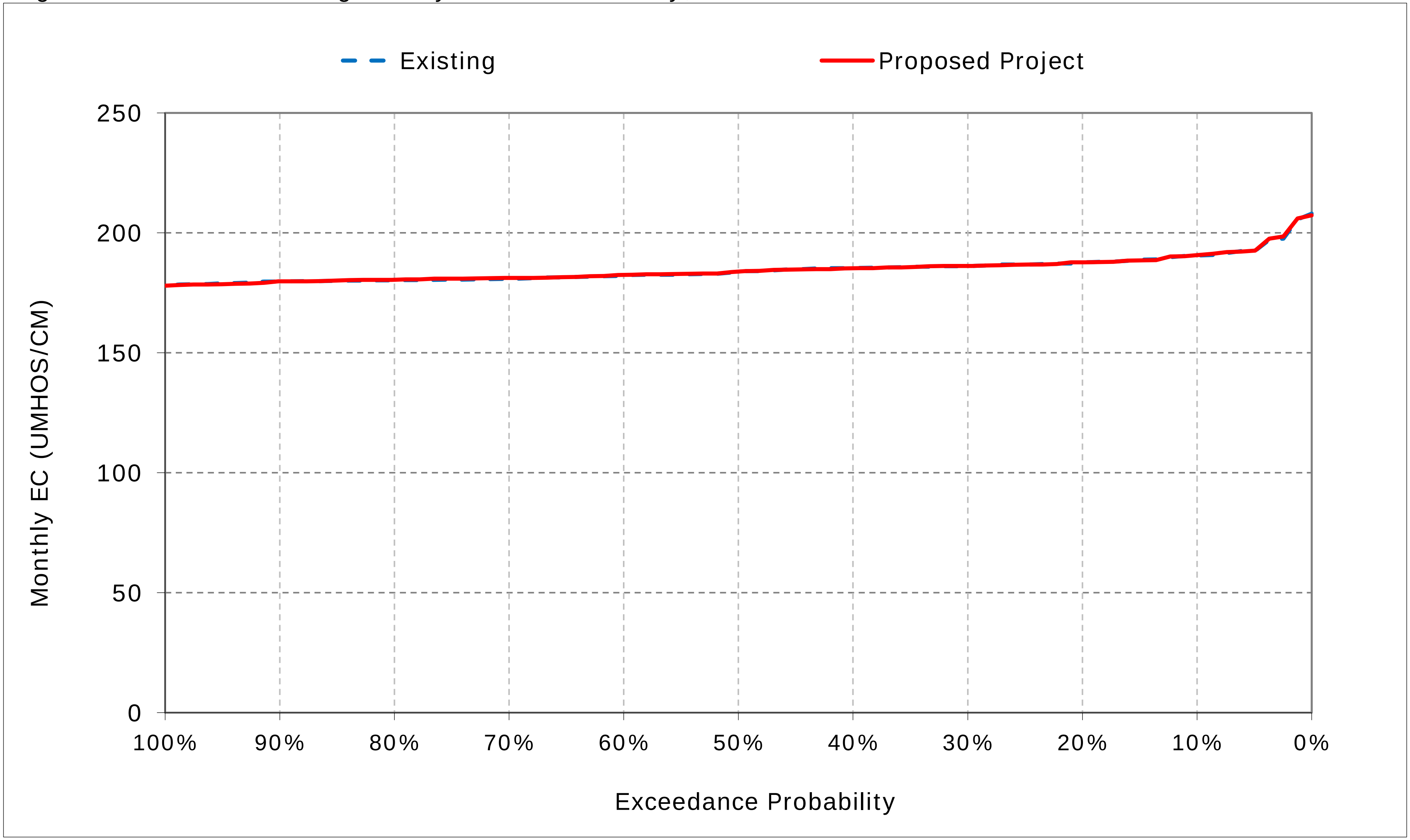


Table 3-1. Sacramento River downstream of Georgiana Slough Salinity, Monthly EC

Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	176	177	179	181	179	177	176	176	176	176	176	176
20%	176	176	178	180	178	177	176	176	176	176	176	176
30%	176	176	177	179	177	176	176	176	176	176	176	176
40%	176	176	177	179	177	176	176	176	176	176	176	176
50%	176	176	176	178	177	176	176	176	176	175	176	176
60%	176	176	176	178	177	176	176	176	176	175	176	175
70%	176	175	176	178	176	176	176	175	176	175	176	175
80%	176	175	176	177	176	176	175	175	176	175	176	175
90%	175	175	175	177	176	175	175	175	175	175	176	175
Long Term												
Full Simulation Period[a]	176	176	177	179	177	176	176	176	176	176	176	176
Water Year Types[b]												
Wet (32%)	176	176	177	178	177	176	176	175	176	175	176	175
Above Normal (15%)	176	176	177	179	177	176	176	176	176	175	176	175
Below Normal (17%)	176	176	177	179	177	176	176	176	176	175	176	176
Dry (22%)	176	176	177	179	177	176	176	176	176	176	176	176
Critical (15%)	176	176	176	179	177	177	176	176	176	176	176	176

Proposed Project

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	176	177	178	181	179	177	176	176	176	176	176	176
20%	176	176	178	180	178	177	176	176	176	176	176	176
30%	176	176	177	179	177	176	176	176	176	176	176	176
40%	176	176	177	179	177	176	176	176	176	176	176	176
50%	176	176	176	178	177	176	176	176	176	176	176	176
60%	176	176	176	178	177	176	176	176	176	175	176	175
70%	176	176	176	178	176	176	176	175	176	175	176	175
80%	175	175	176	177	176	176	175	175	176	175	176	175
90%	175	175	175	177	176	175	175	175	175	175	176	175
Long Term												
Full Simulation Period[a]	176	176	177	178	177	176	176	176	176	176	176	176
Water Year Types[b]												
Wet (32%)	176	176	177	178	177	176	176	175	176	175	176	175
Above Normal (15%)	176	176	177	178	177	176	176	176	176	175	176	175
Below Normal (17%)	176	176	177	179	177	176	176	176	176	175	176	176
Dry (22%)	176	176	177	179	177	176	176	176	176	176	176	176
Critical (15%)	176	176	176	179	177	177	176	176	176	176	176	176

Proposed Project minus Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	0	0	0	0	0	0	0	0	0	0	0	0
20%	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0
40%	0	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0
60%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
80%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
Long Term												
Full Simulation Period[a]	0	0	0	0	0	0	0	0	0	0	0	0
Water Year Types[b]												
Wet (32%)	0	0	0	0	0	0	0	0	0	0	0	0
Above Normal (15%)	0	0	0	0	0	0	0	0	0	0	0	0
Below Normal (17%)	0	0	0	0	0	0	0	0	0	0	0	0
Dry (22%)	0	0	0	0	0	0	0	0	0	0	0	0
Critical (15%)	0	0	0	0	0	0	0	0	0	0	0	0

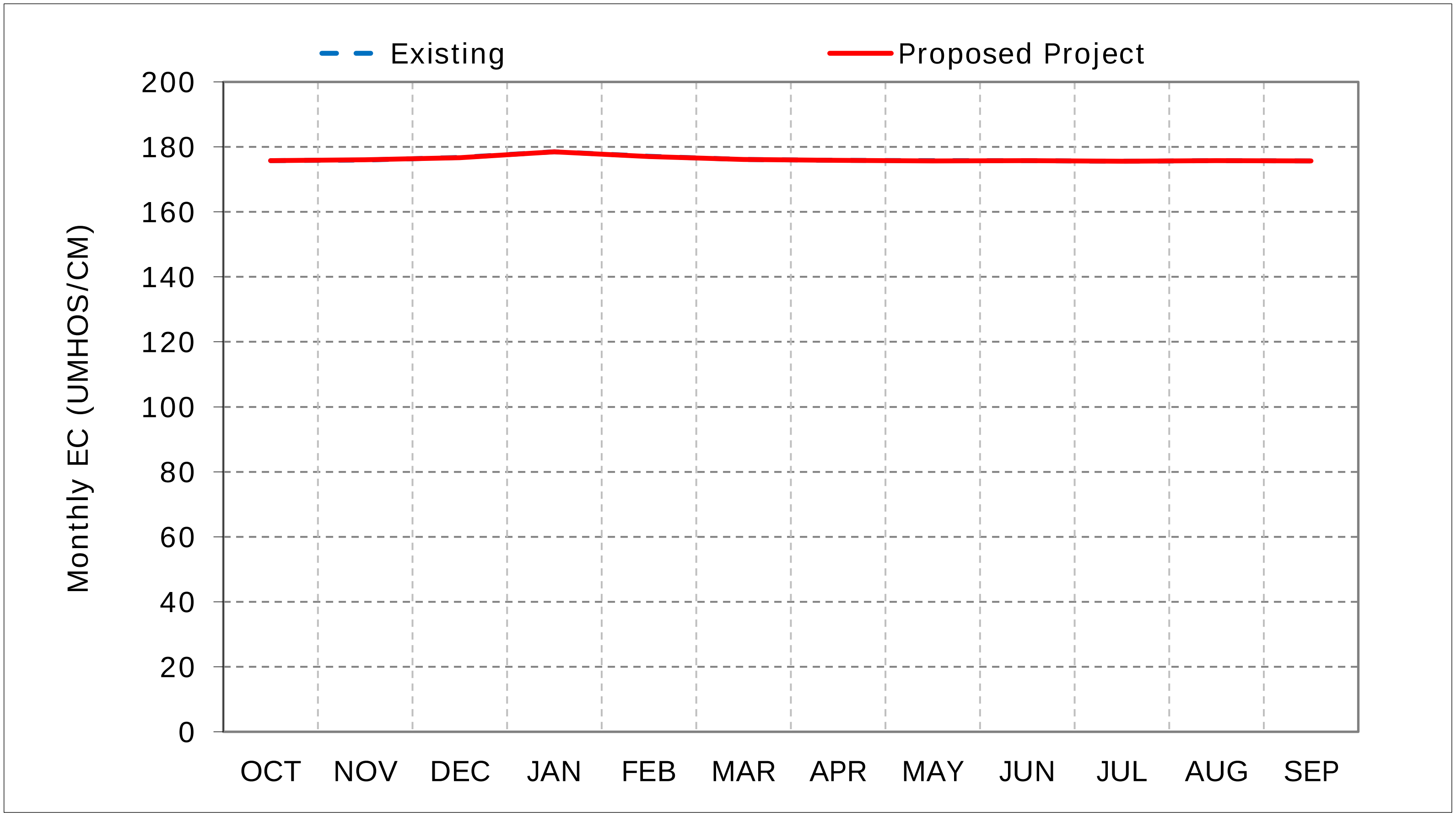
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

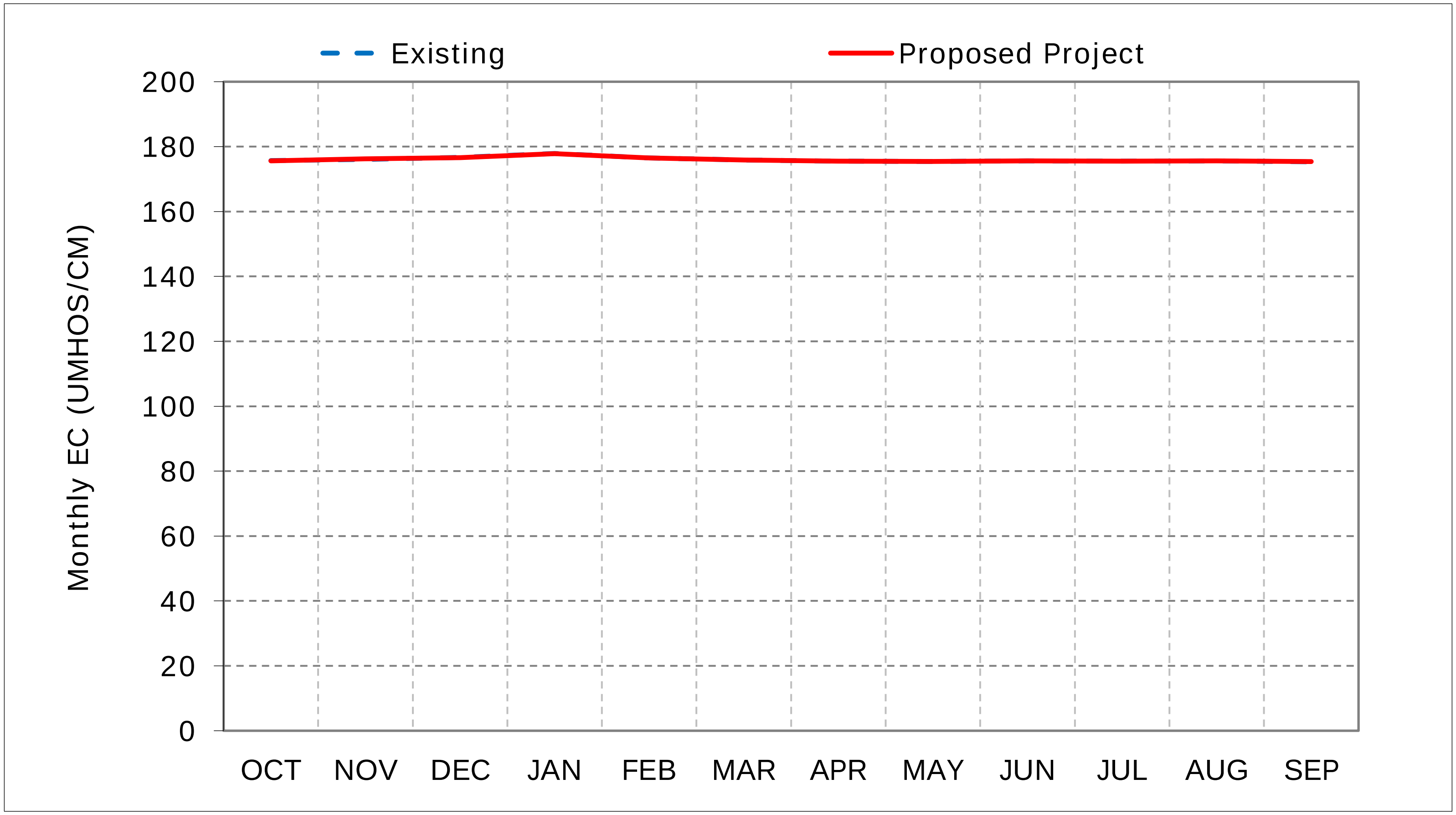
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 3-1. Sacramento River downstream of Georgiana Slough Salinity, Long-Ter



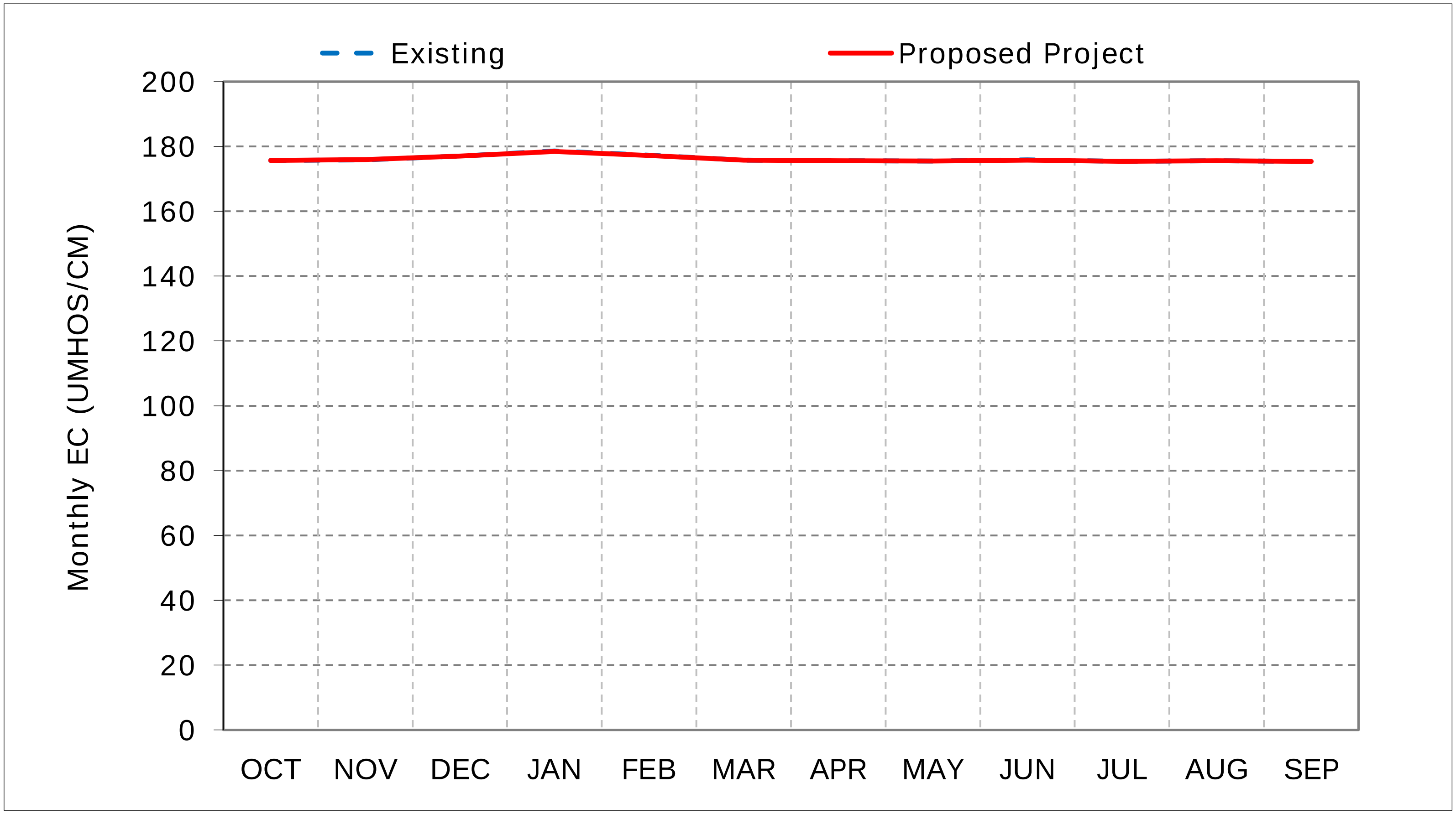
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 3-2. Sacramento River downstream of Georgiana Slough Salinity, Wet Year



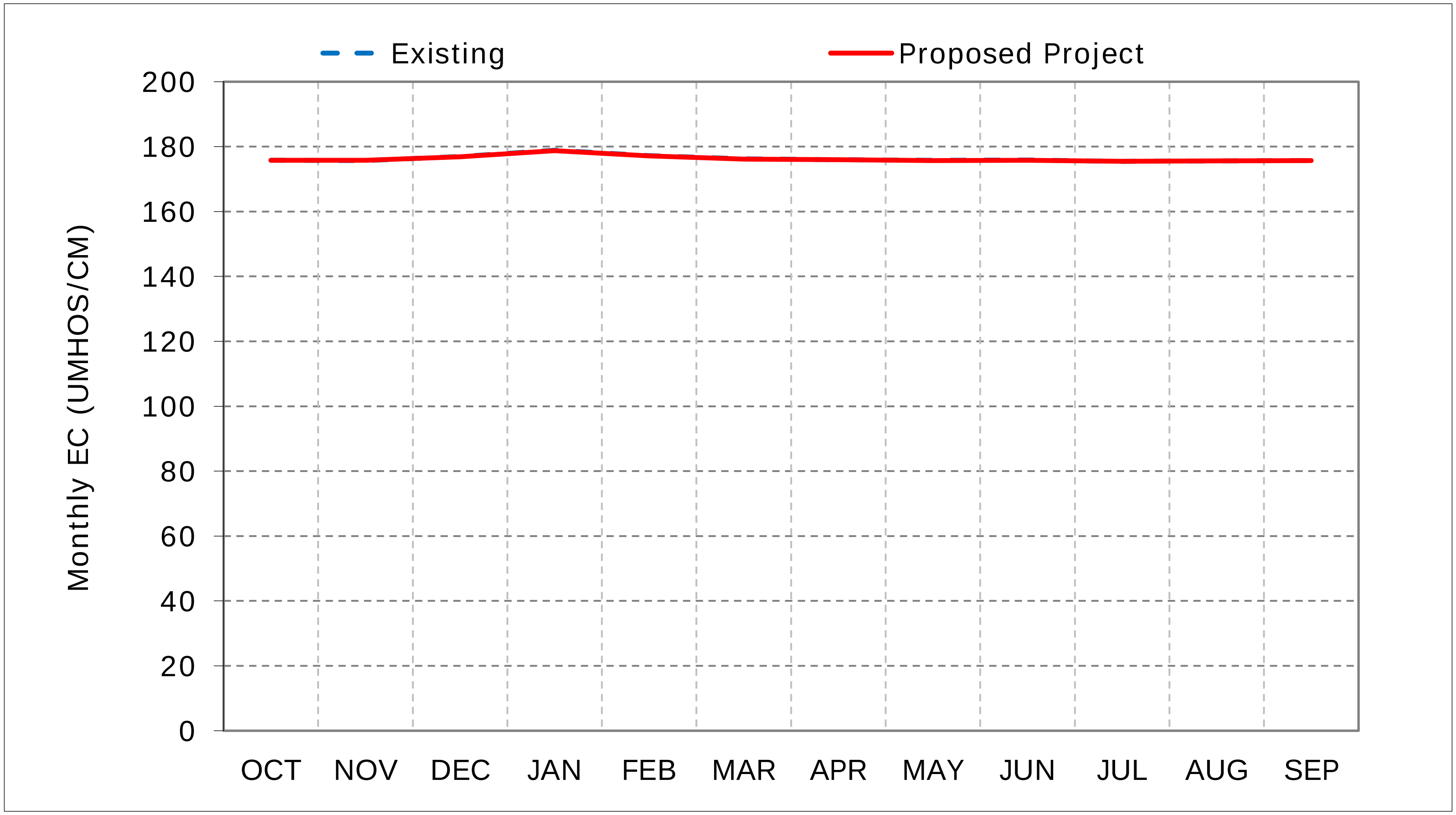
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 3-3. Sacramento River downstream of Georgiana Slough Salinity, Above No



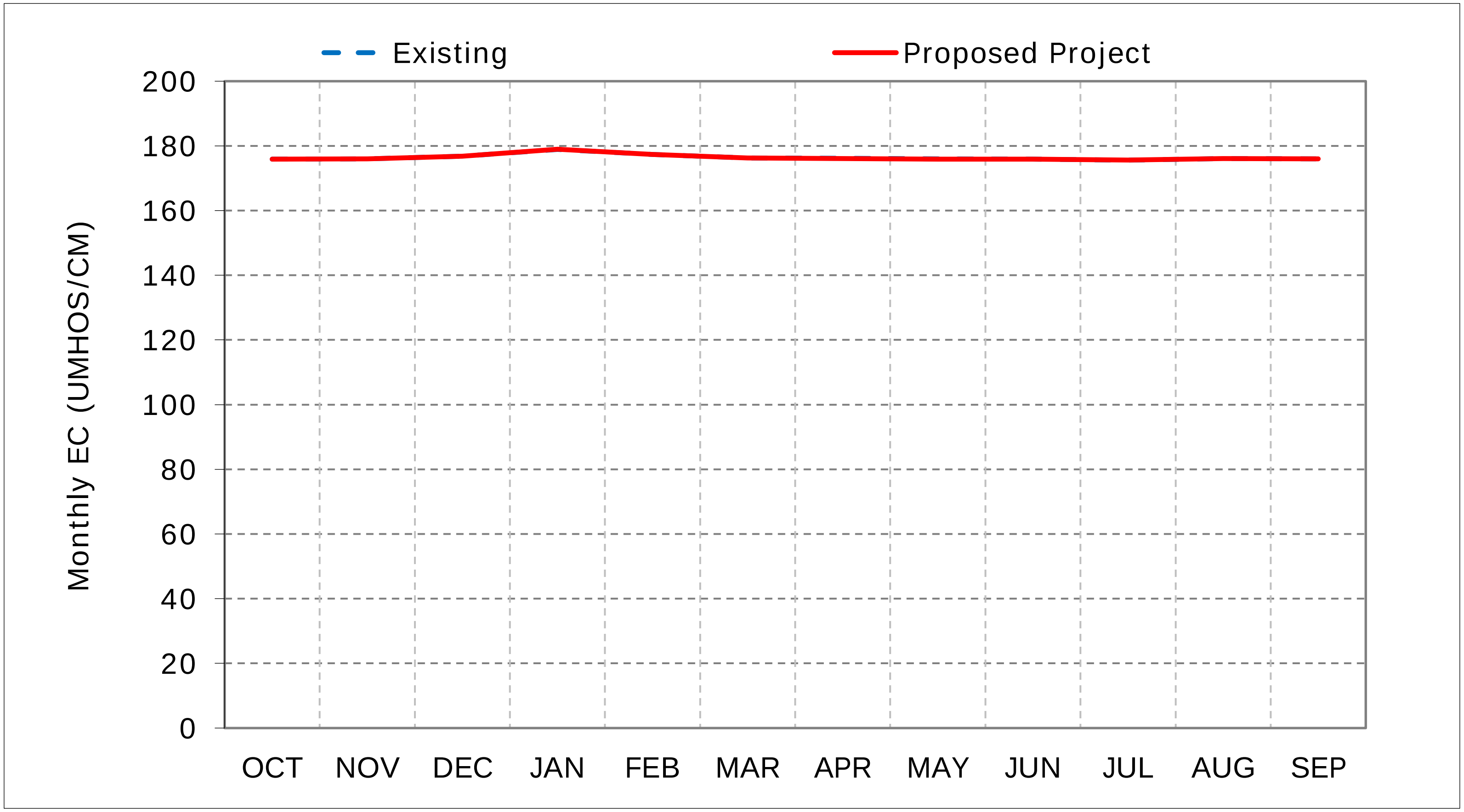
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 3-4. Sacramento River downstream of Georgiana Slough Salinity, Below No



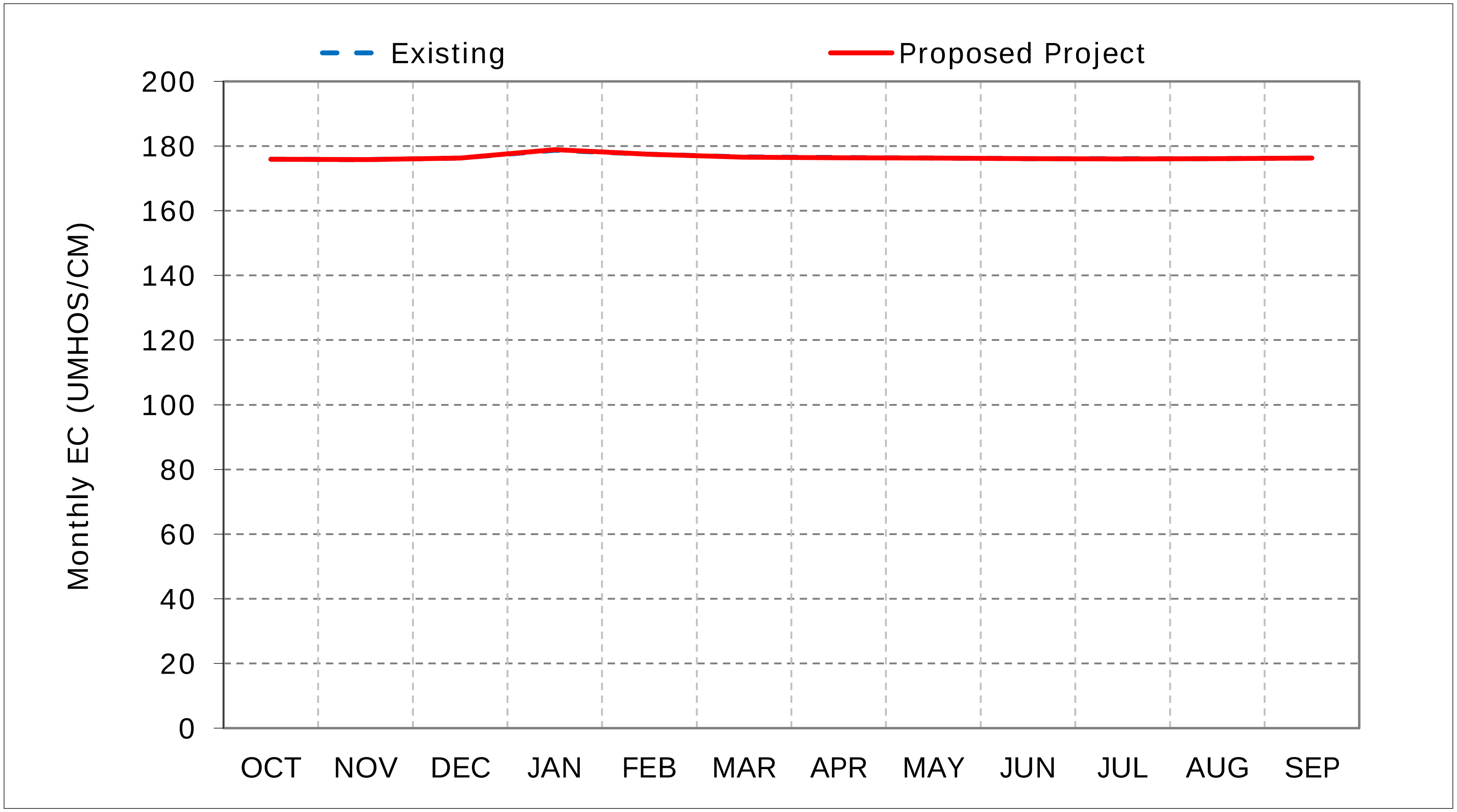
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 3-5. Sacramento River downstream of Georgiana Slough Salinity, Dry Year



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 3-6. Sacramento River downstream of Georgiana Slough Salinity, Critical Y



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 3-7. Sacramento River downstream of Georgiana Slough Salinity, January EC

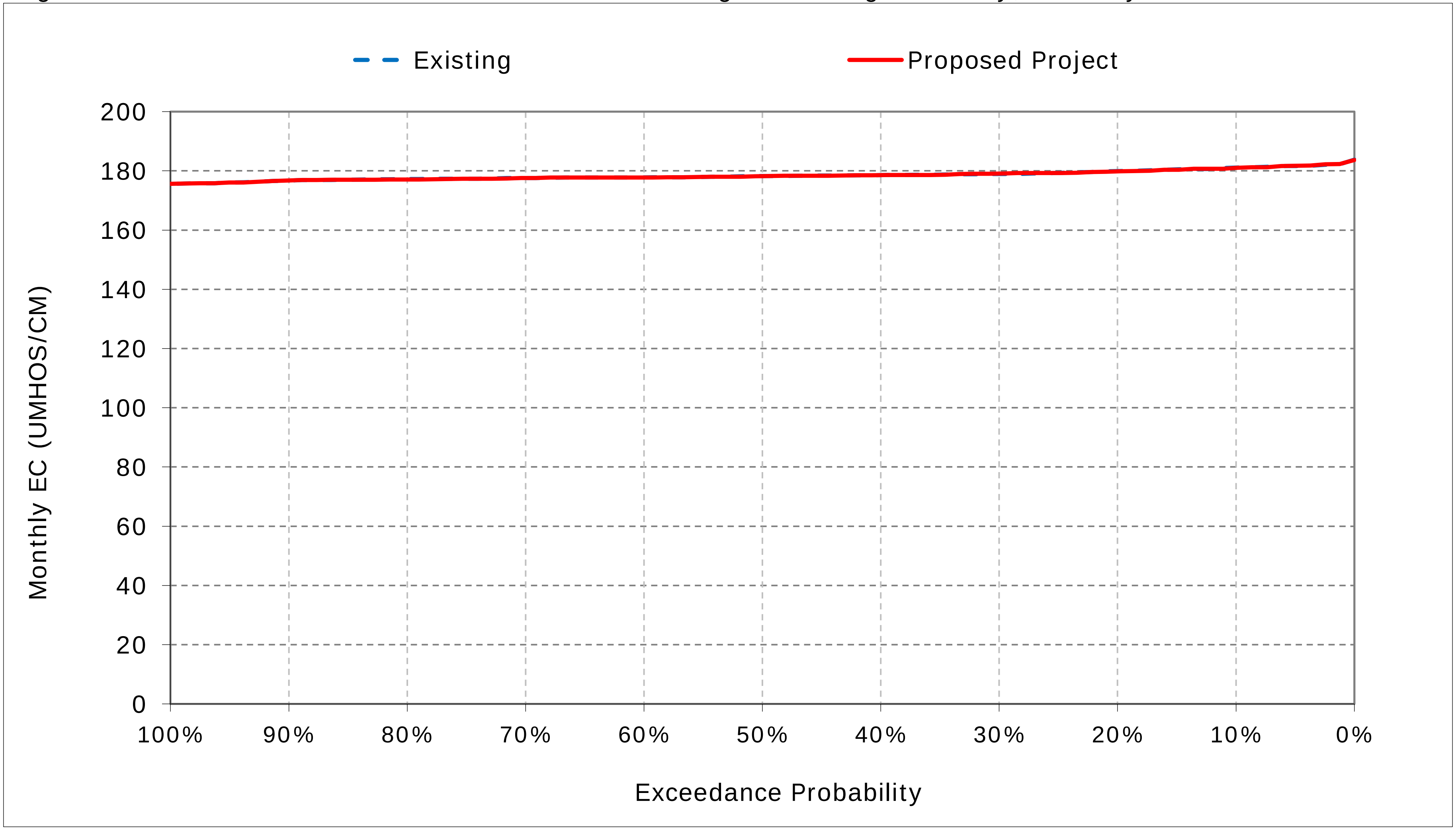


Figure 3-8. Sacramento River downstream of Georgiana Slough Salinity, February EC

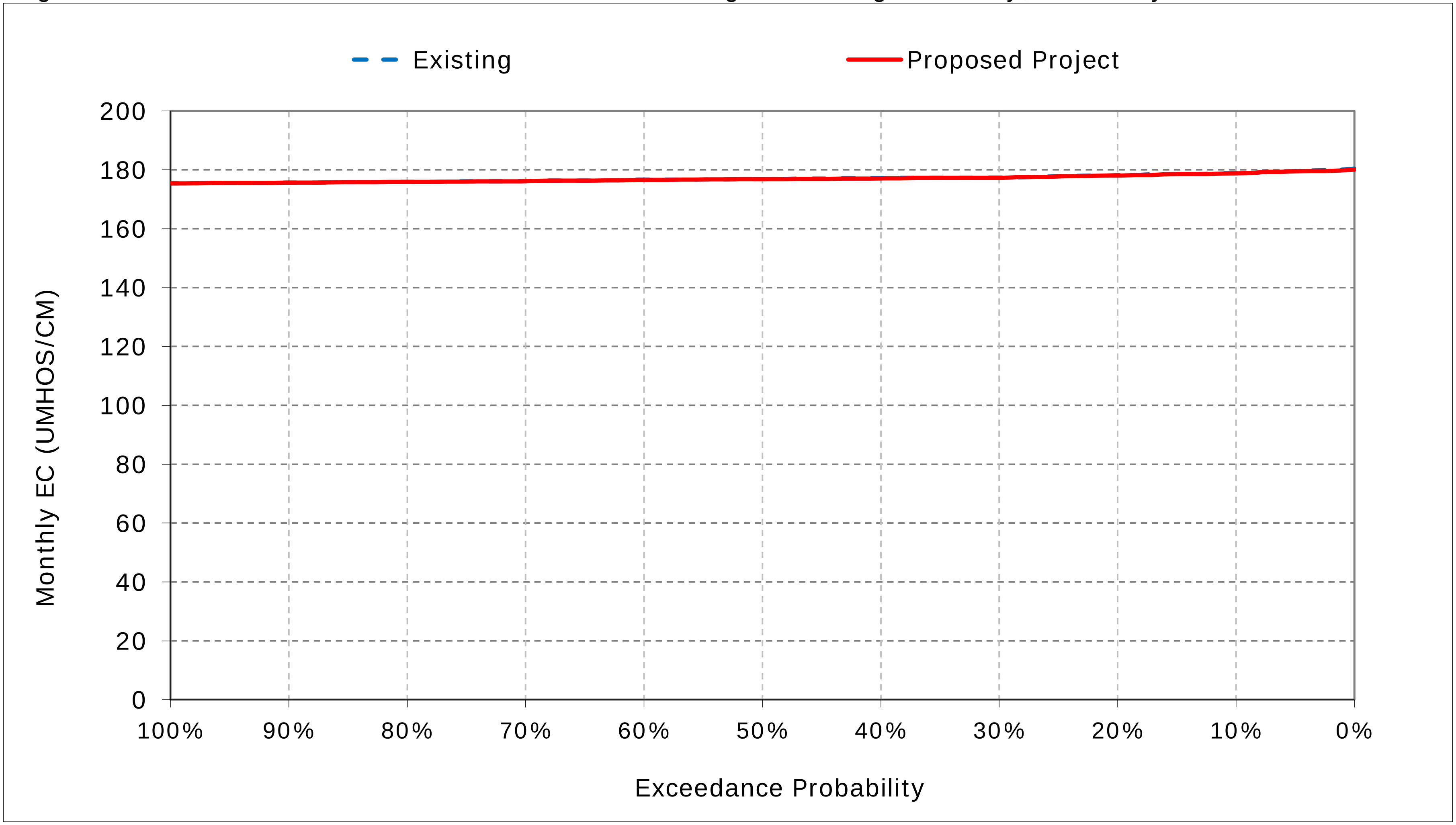


Figure 3-9. Sacramento River downstream of Georgiana Slough Salinity, March EC

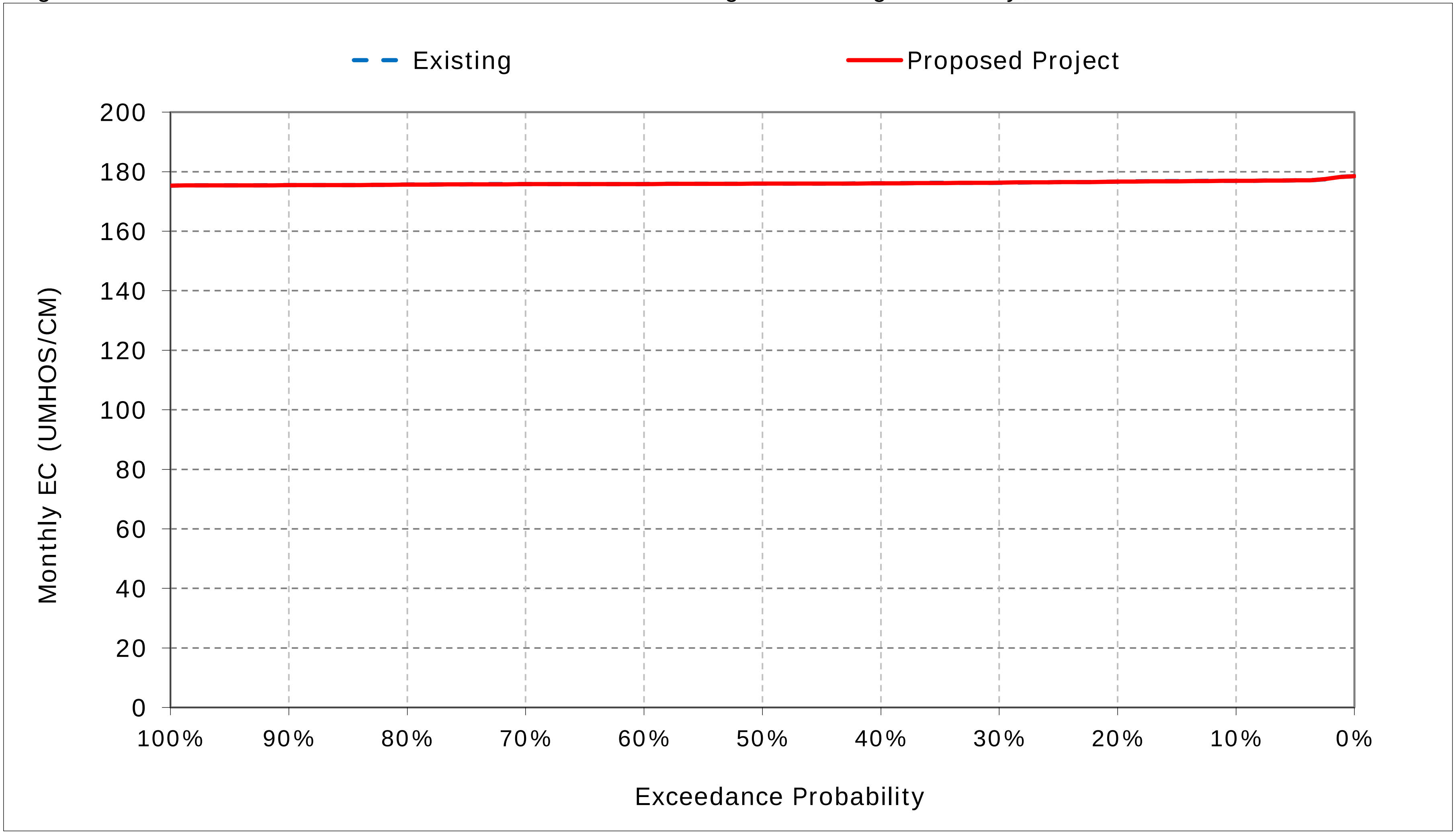


Figure 3-10. Sacramento River downstream of Georgiana Slough Salinity, April EC

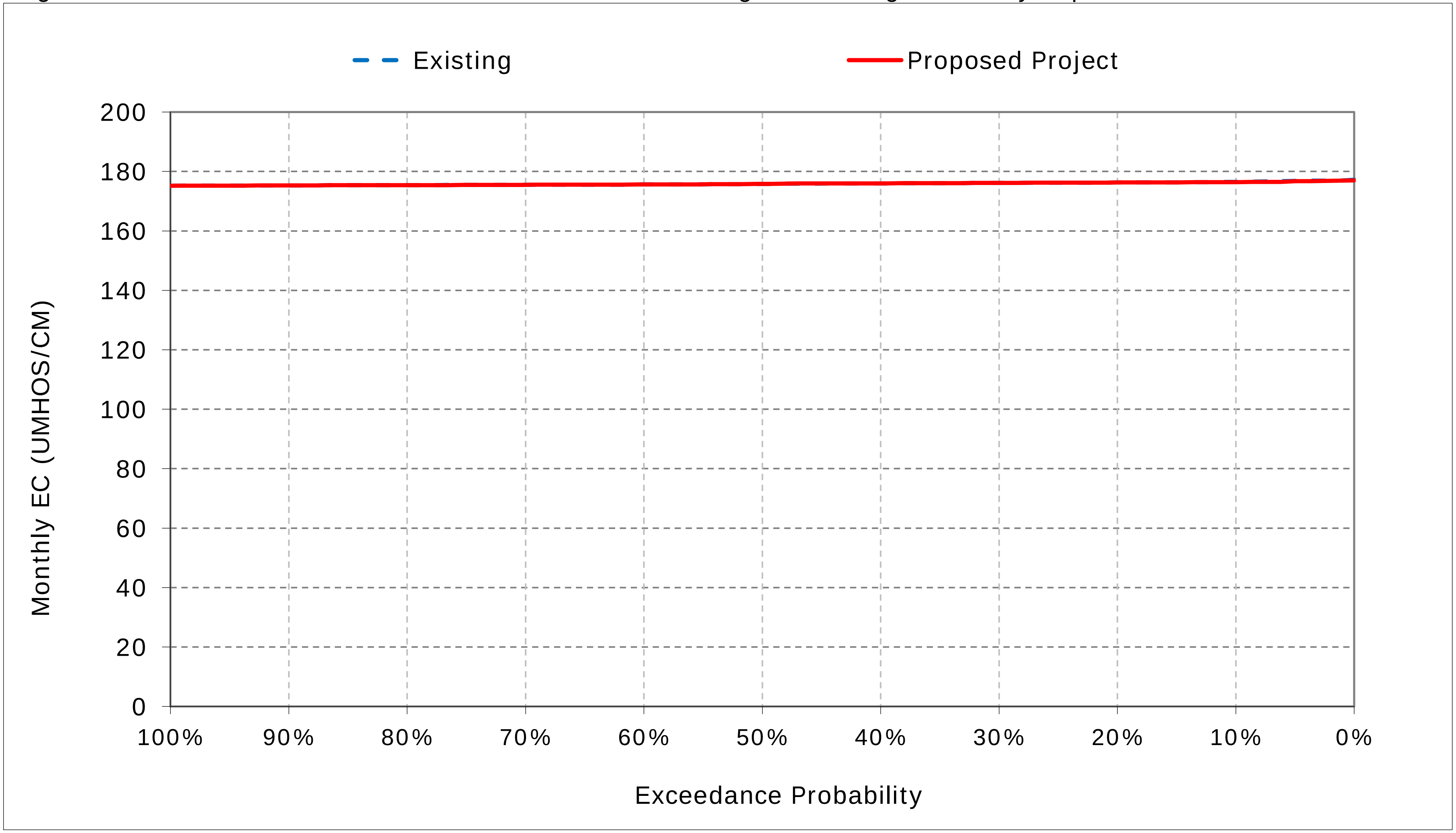


Figure 3-11. Sacramento River downstream of Georgiana Slough Salinity, May EC

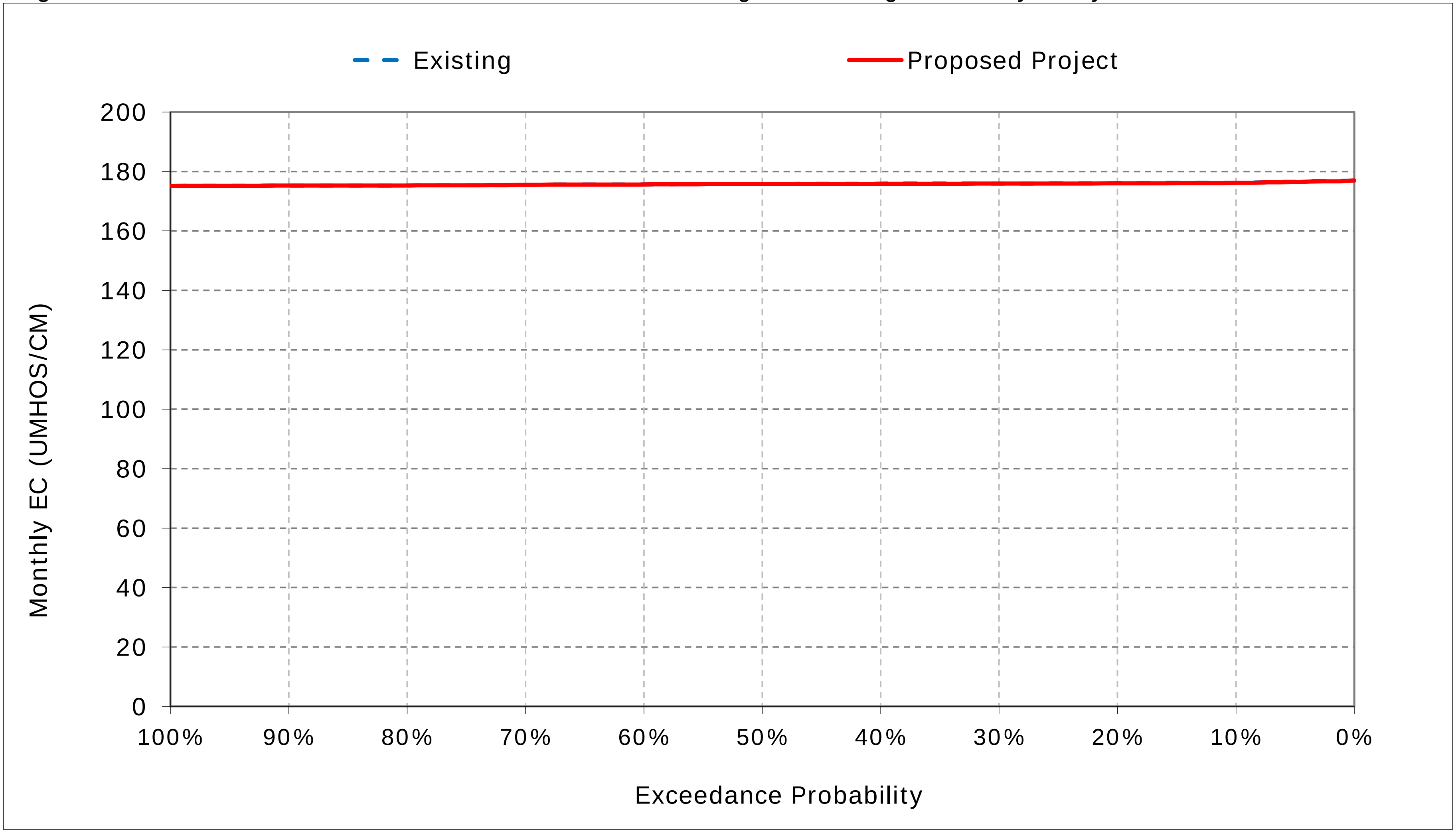


Figure 3-12. Sacramento River downstream of Georgiana Slough Salinity, June EC

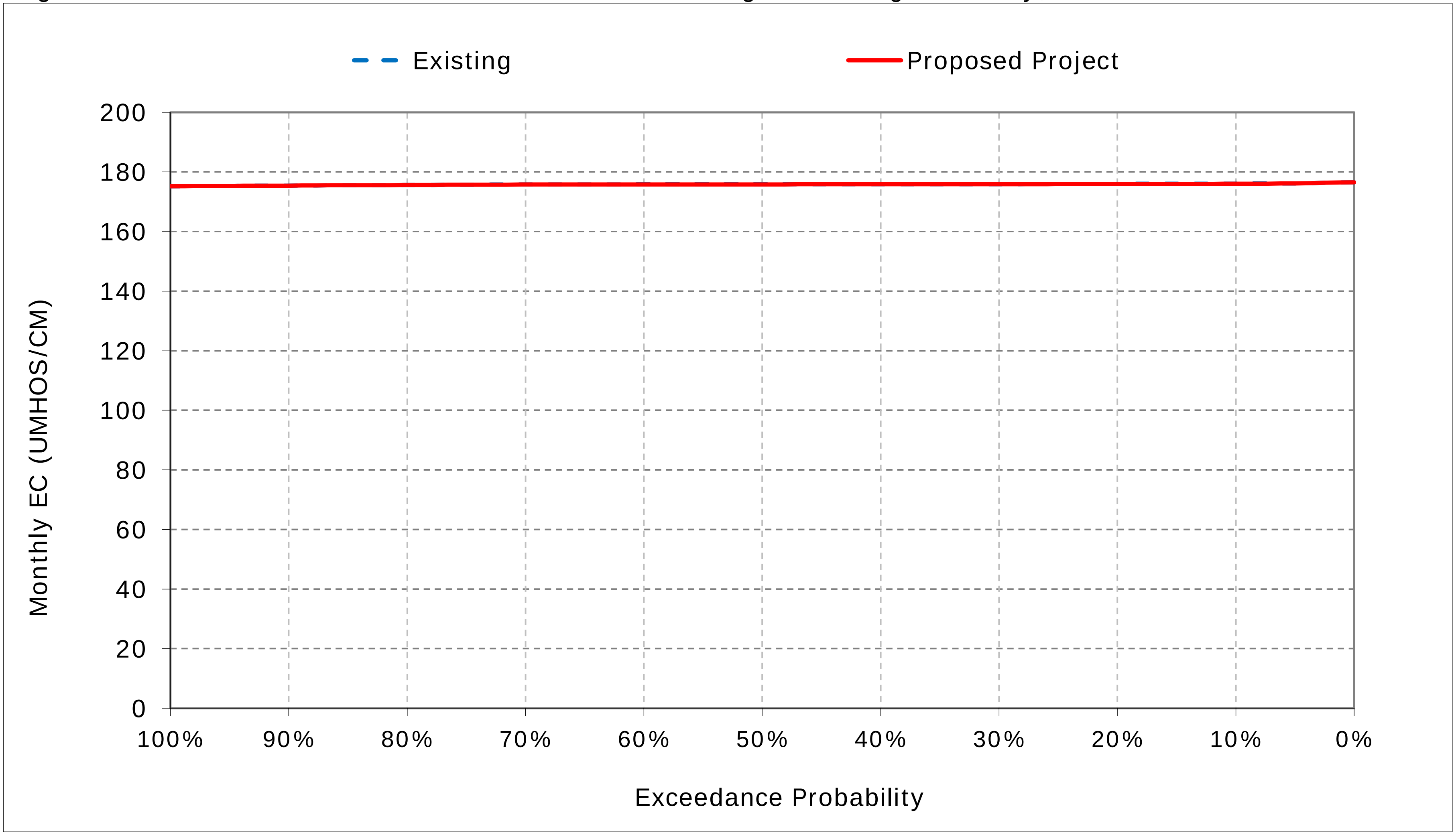


Figure 3-13. Sacramento River downstream of Georgiana Slough Salinity, July EC

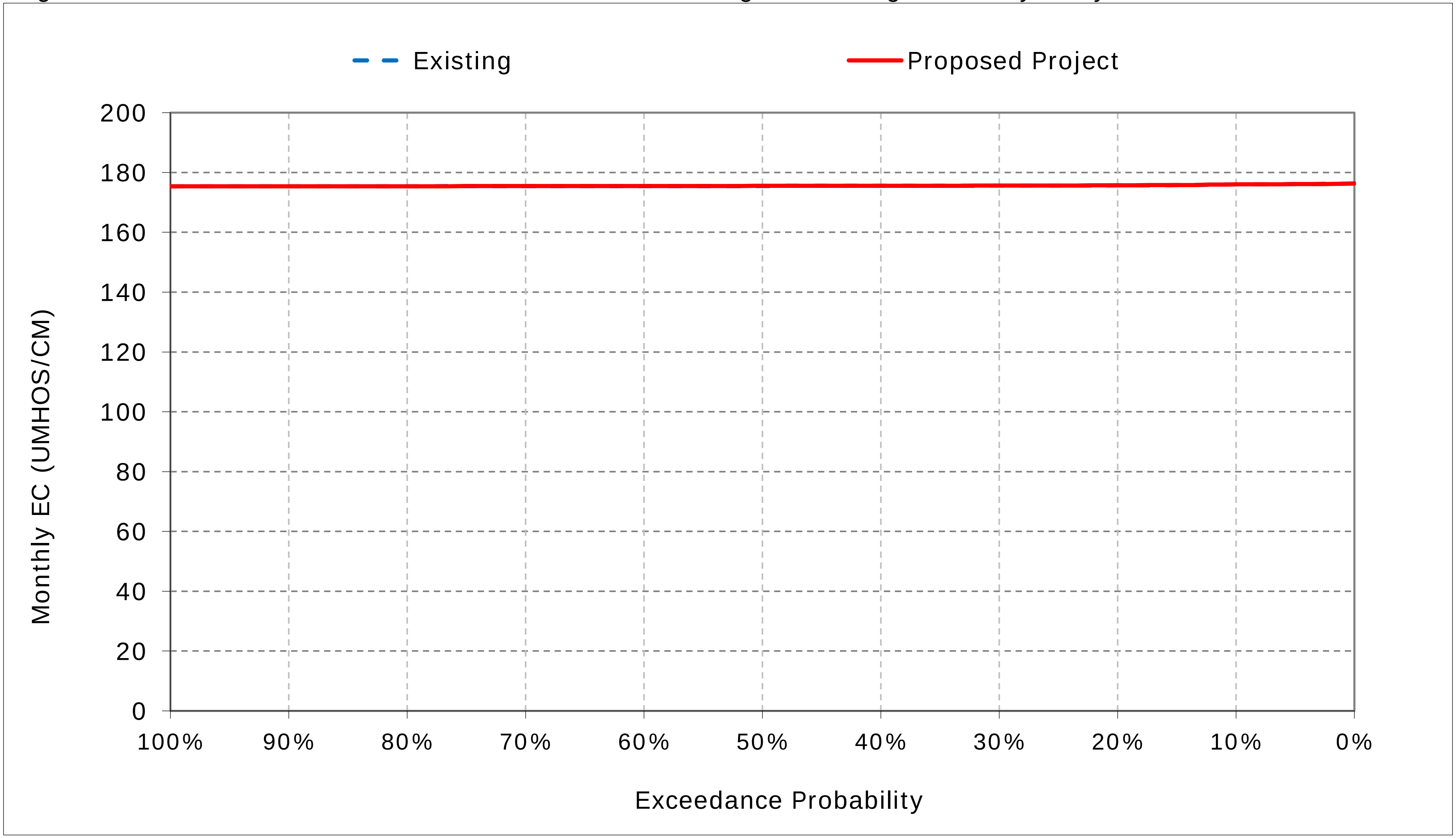


Figure 3-14. Sacramento River downstream of Georgiana Slough Salinity, August EC

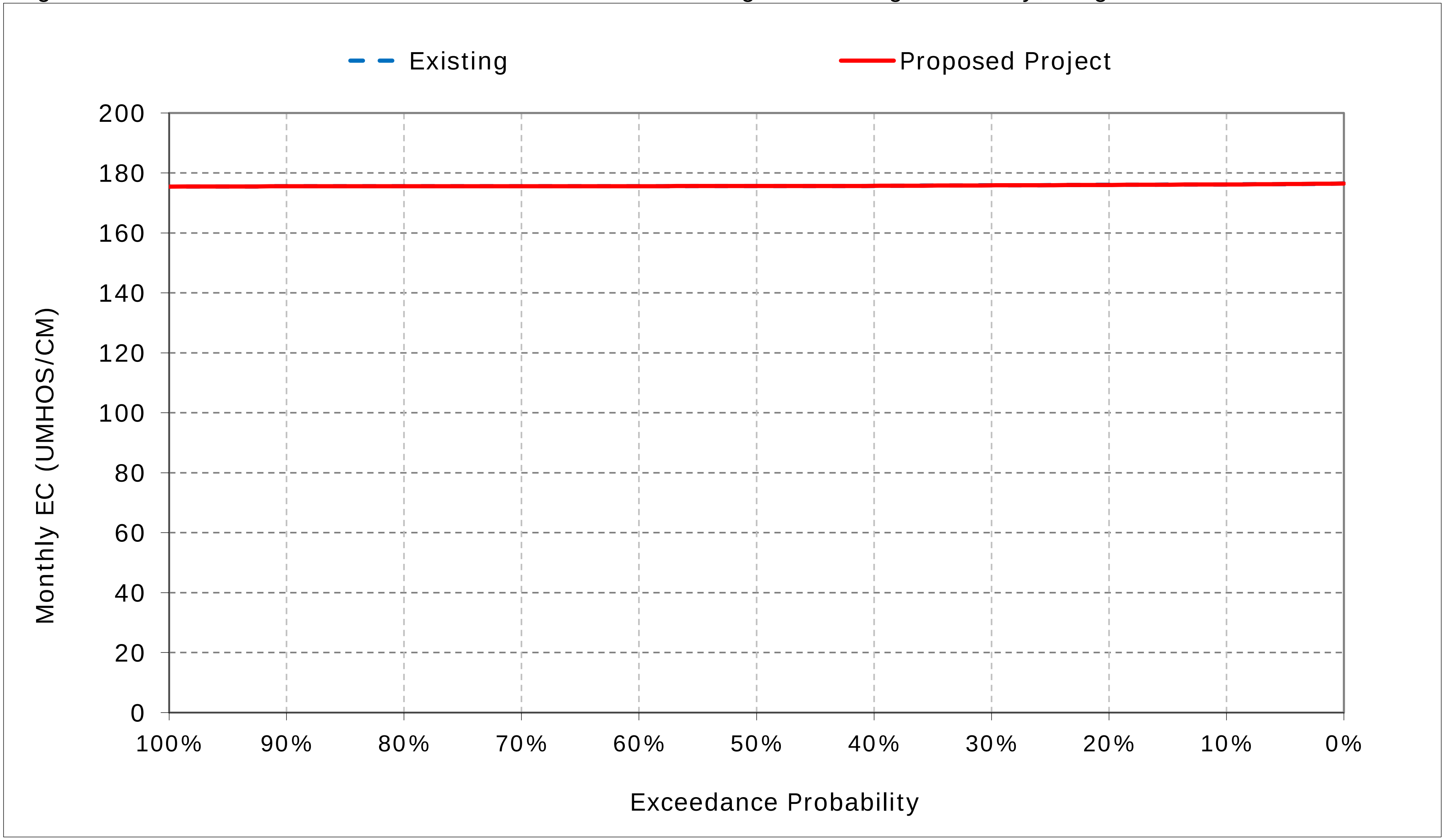


Figure 3-15. Sacramento River downstream of Georgiana Slough Salinity, September EC

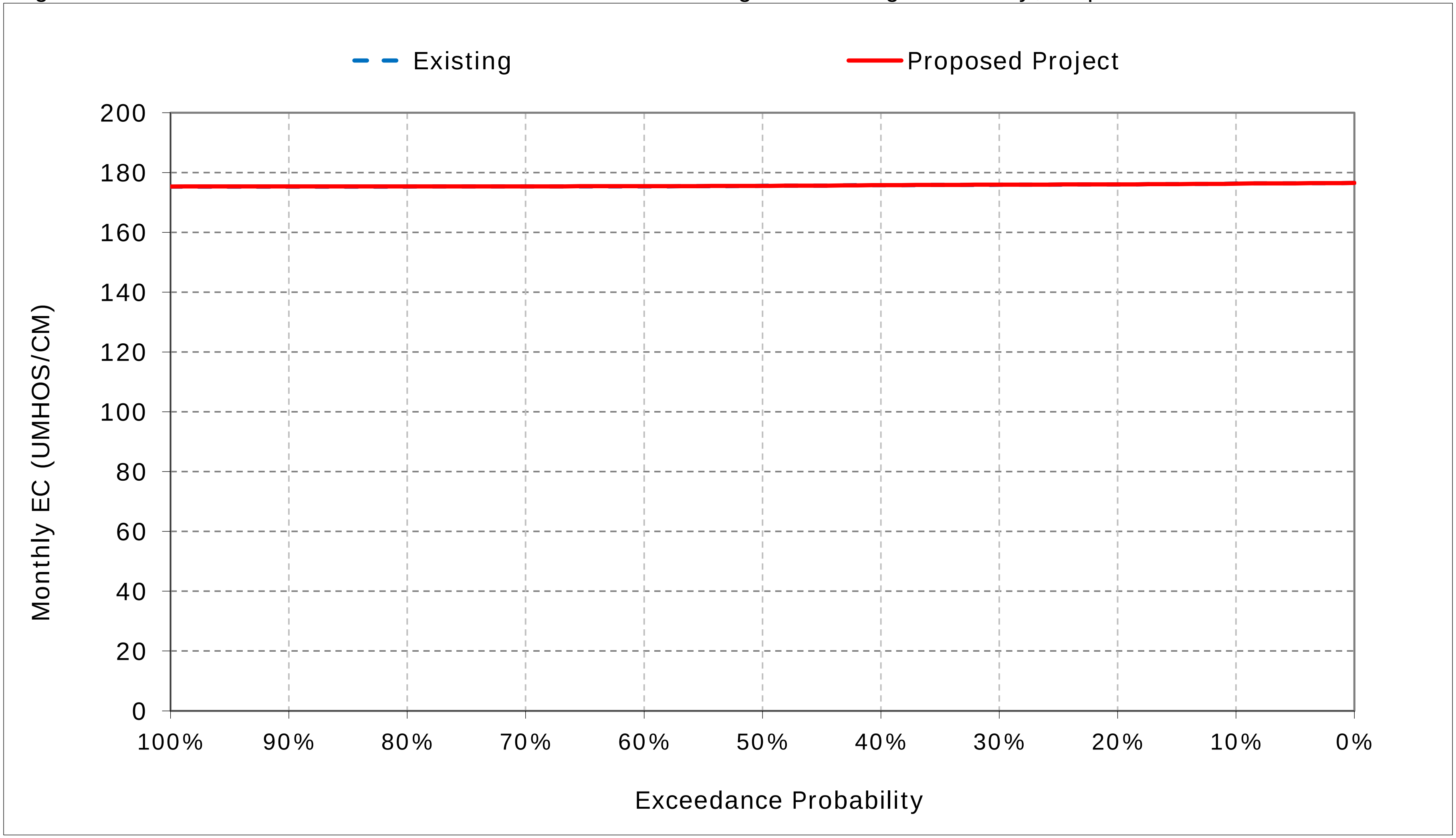


Figure 3-16. Sacramento River downstream of Georgiana Slough Salinity, October EC

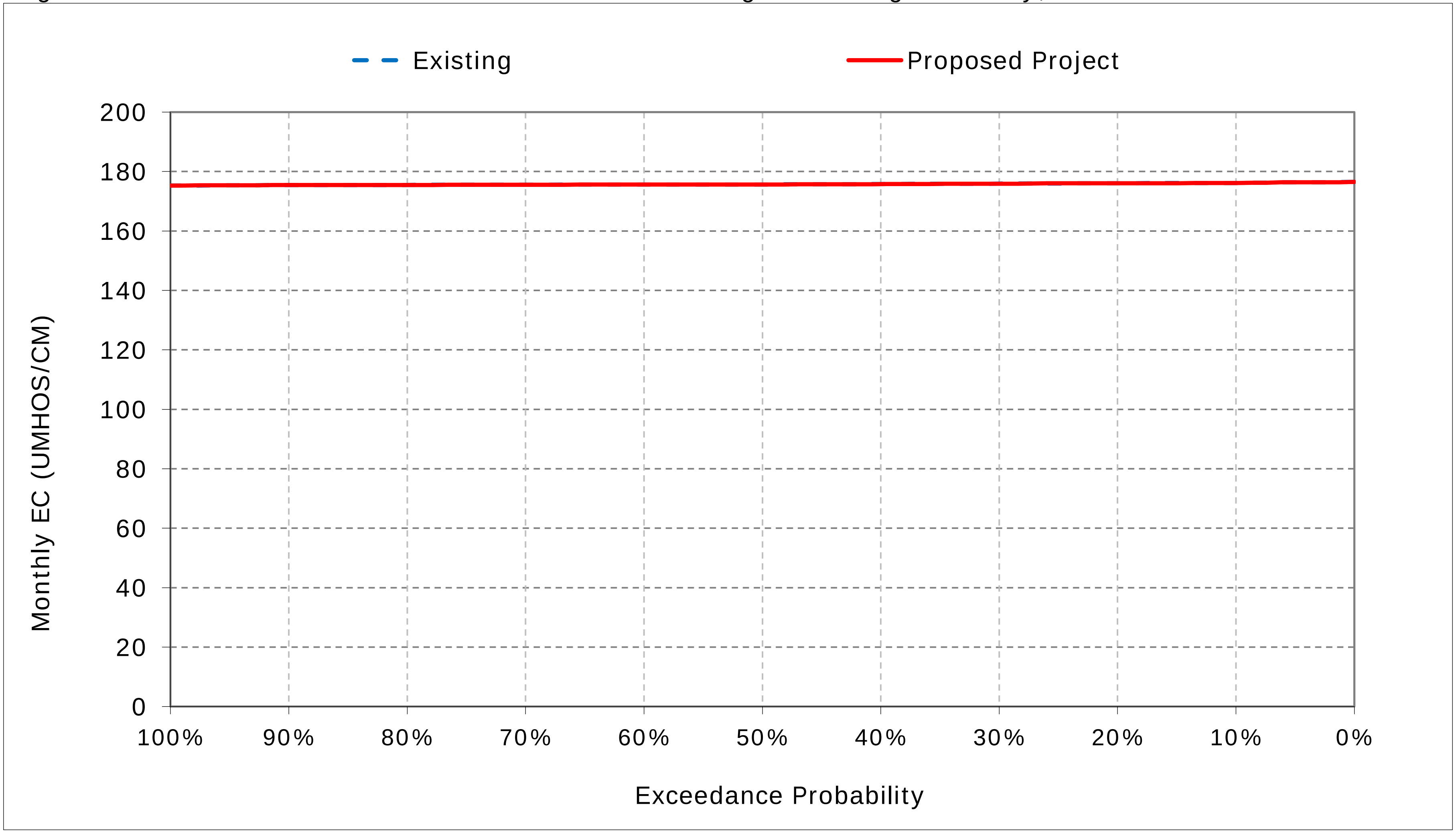


Figure 3-17. Sacramento River downstream of Georgiana Slough Salinity, November EC

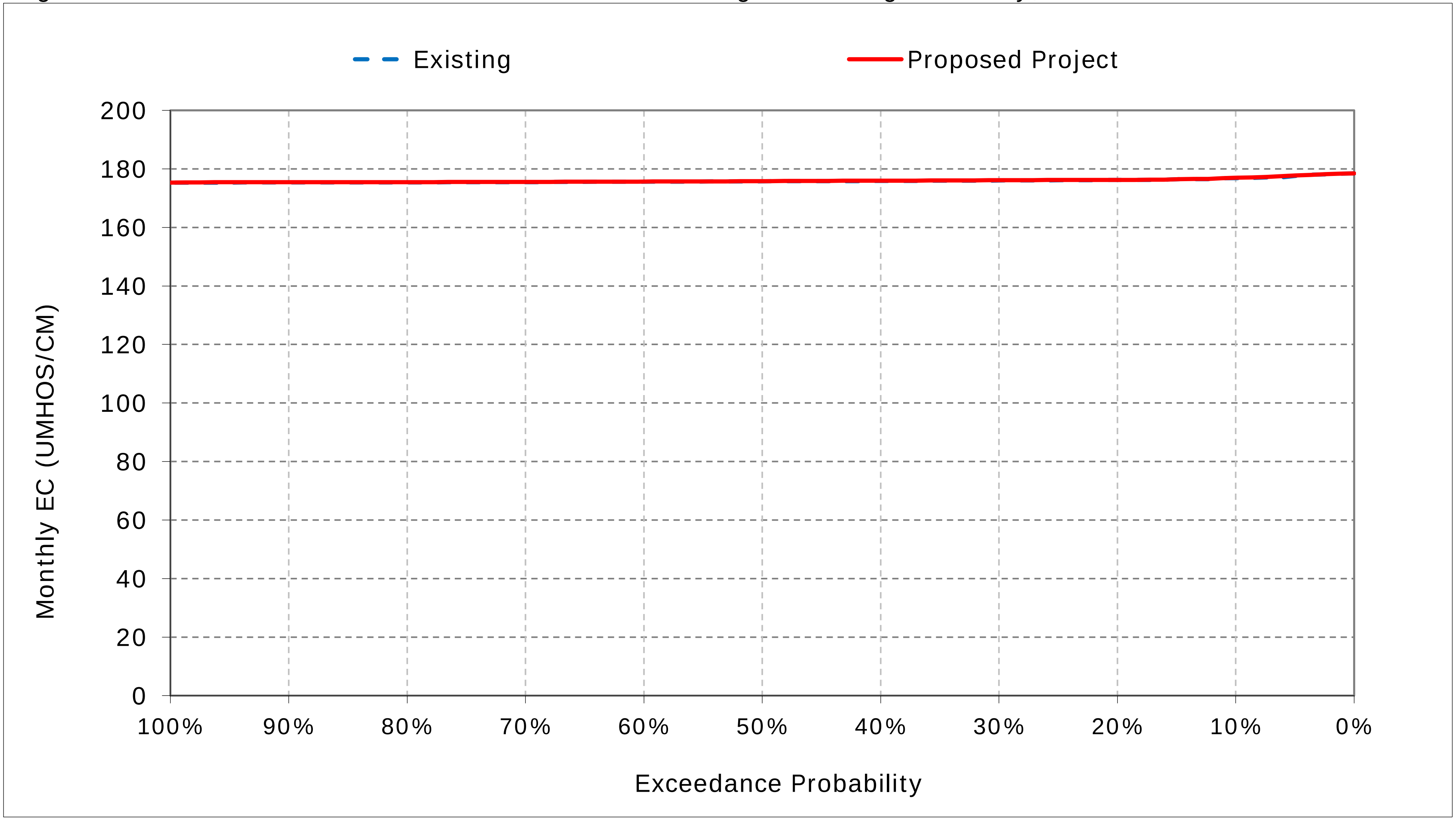


Figure 3-18. Sacramento River downstream of Georgiana Slough Salinity, December EC

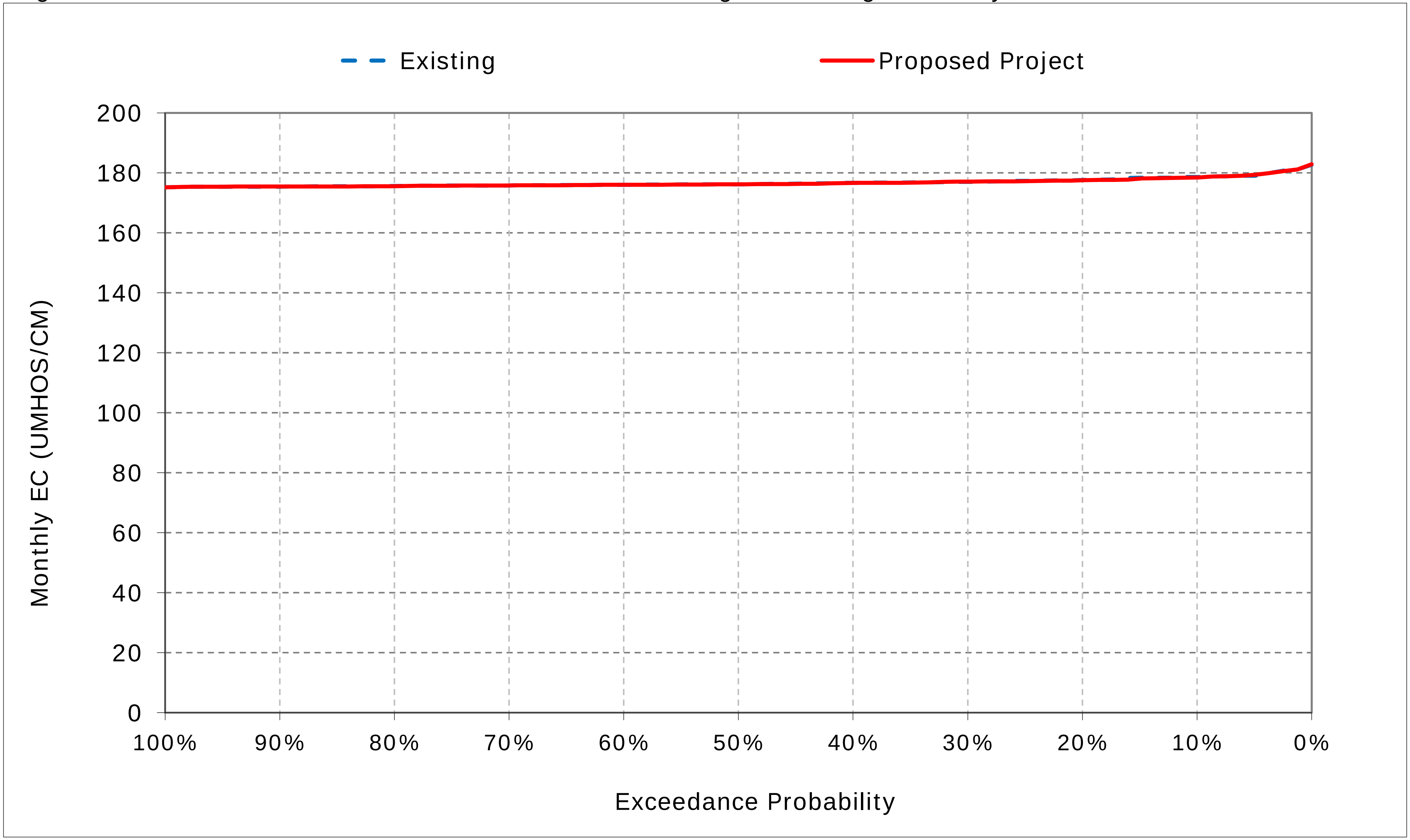


Table 4-1. Sacramento River at Rio Vista Salinity, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	491	422	367	244	201	195	191	198	215	278	369	457
20%	420	359	295	227	196	189	188	192	199	233	329	387
30%	401	337	234	213	193	187	186	188	195	221	314	371
40%	371	300	217	204	191	185	184	186	192	198	240	330
50%	322	201	204	198	186	183	183	184	190	194	233	282
60%	198	189	198	194	184	182	181	183	187	186	226	195
70%	188	182	187	190	183	180	180	181	184	185	221	183
80%	186	181	185	185	182	180	179	178	180	184	215	180
90%	185	180	180	181	180	179	178	177	178	182	212	180
Long Term												
Full Simulation Period[a]	311	274	239	207	190	185	184	189	200	216	267	291
Water Year Types[b]												
Wet (32%)	264	217	190	188	182	181	180	179	182	183	213	180
Above Normal (15%)	317	277	221	197	188	181	181	181	187	185	218	194
Below Normal (17%)	311	264	263	206	189	186	184	185	190	196	236	309
Dry (22%)	331	308	246	218	194	187	186	189	197	225	321	376
Critical (15%)	379	358	323	242	204	195	194	220	271	330	387	480

Proposed Project

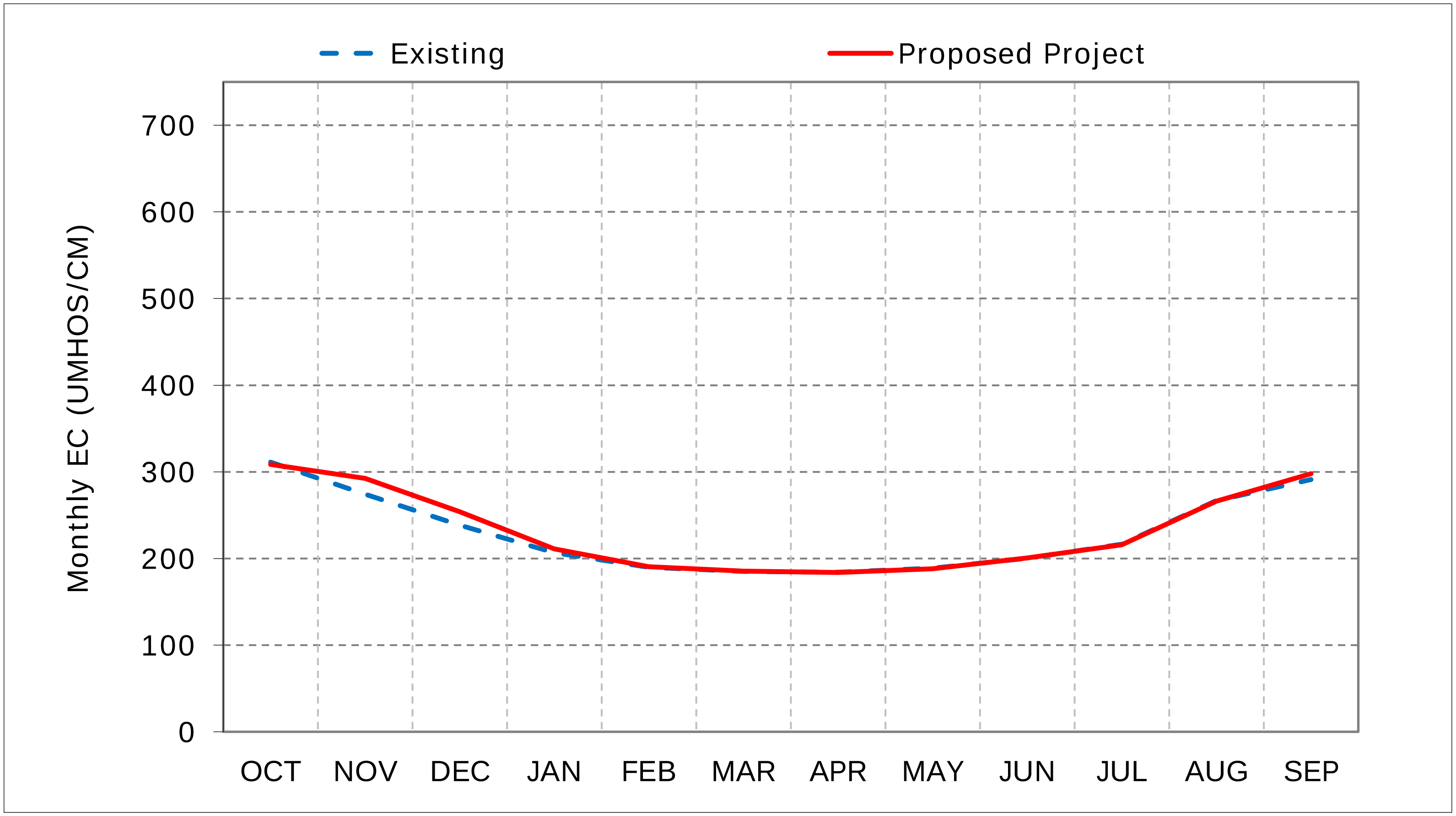
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	468	420	365	261	201	196	191	199	217	277	370	446
20%	422	361	309	236	196	189	188	190	202	234	327	385
30%	397	339	279	218	193	187	185	187	197	221	311	373
40%	353	303	261	203	190	185	184	183	192	196	249	355
50%	310	243	234	199	186	183	182	182	187	191	237	297
60%	195	237	216	193	184	182	181	181	185	186	224	195
70%	193	232	191	190	183	180	180	179	182	185	219	193
80%	192	220	185	184	182	180	179	178	180	184	215	190
90%	189	187	180	181	180	179	178	177	178	182	211	187
Long Term												
Full Simulation Period[a]	309	292	254	211	190	185	184	188	201	216	266	298
Water Year Types[b]												
Wet (32%)	262	238	195	188	182	181	180	179	181	183	211	190
Above Normal (15%)	309	296	243	200	187	181	181	180	184	185	219	192
Below Normal (17%)	310	280	284	207	189	185	183	183	188	194	241	327
Dry (22%)	330	326	267	227	195	187	186	188	198	226	319	380
Critical (15%)	375	369	338	253	208	196	194	222	277	328	380	482

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	-23	-2	-2	17	0	1	1	0	2	-2	2	-11
20%	1	2	14	9	0	0	0	-2	3	1	-2	-2
30%	-5	2	44	5	0	0	0	-1	2	0	-3	2
40%	-18	3	45	0	0	0	0	-3	-1	-2	9	25
50%	-12	43	31	1	0	0	0	-2	-3	-3	5	15
60%	-3	48	18	-1	0	0	-1	-2	-2	0	-2	0
70%	5	50	3	0	0	0	0	-1	-2	0	-2	10
80%	5	39	0	-1	0	0	0	0	0	0	0	10
90%	4	6	-1	0	0	0	0	0	0	0	-1	8
Long Term												
Full Simulation Period[a]	-3	18	15	4	1	0	0	-1	0	-1	-1	7
Water Year Types[b]												
Wet (32%)	-2	22	5	0	0	0	0	0	0	0	-2	10
Above Normal (15%)	-8	19	22	3	-1	0	0	-1	-2	0	1	-3
Below Normal (17%)	-1	17	21	1	-1	0	0	-2	-2	-2	6	18
Dry (22%)	-1	18	22	9	1	0	-1	-1	1	1	-2	3
Critical (15%)	-4	11	15	11	4	1	0	2	6	-2	-7	1

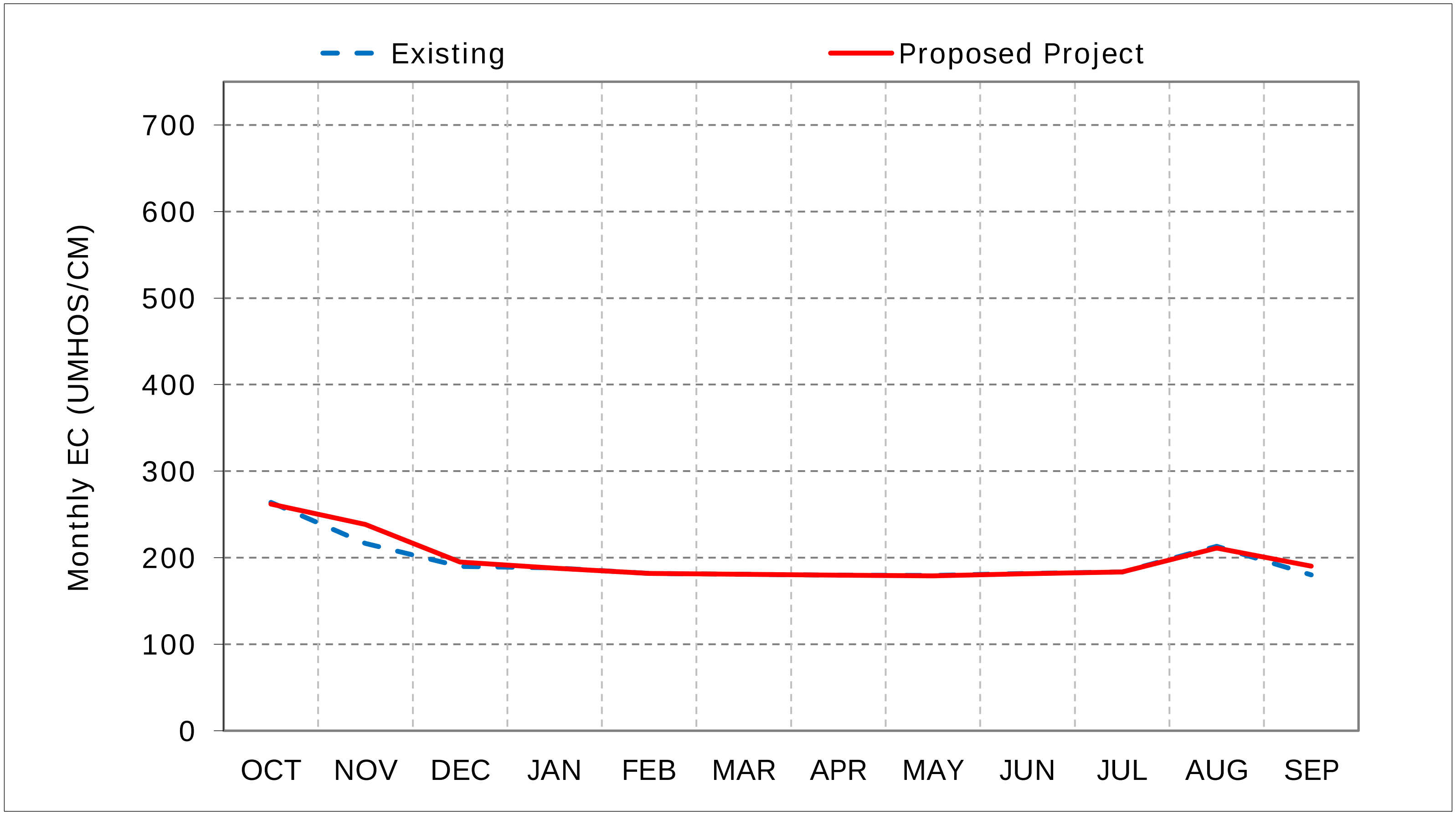
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 4-1. Sacramento River at Rio Vista Salinity, Long-Term Average EC



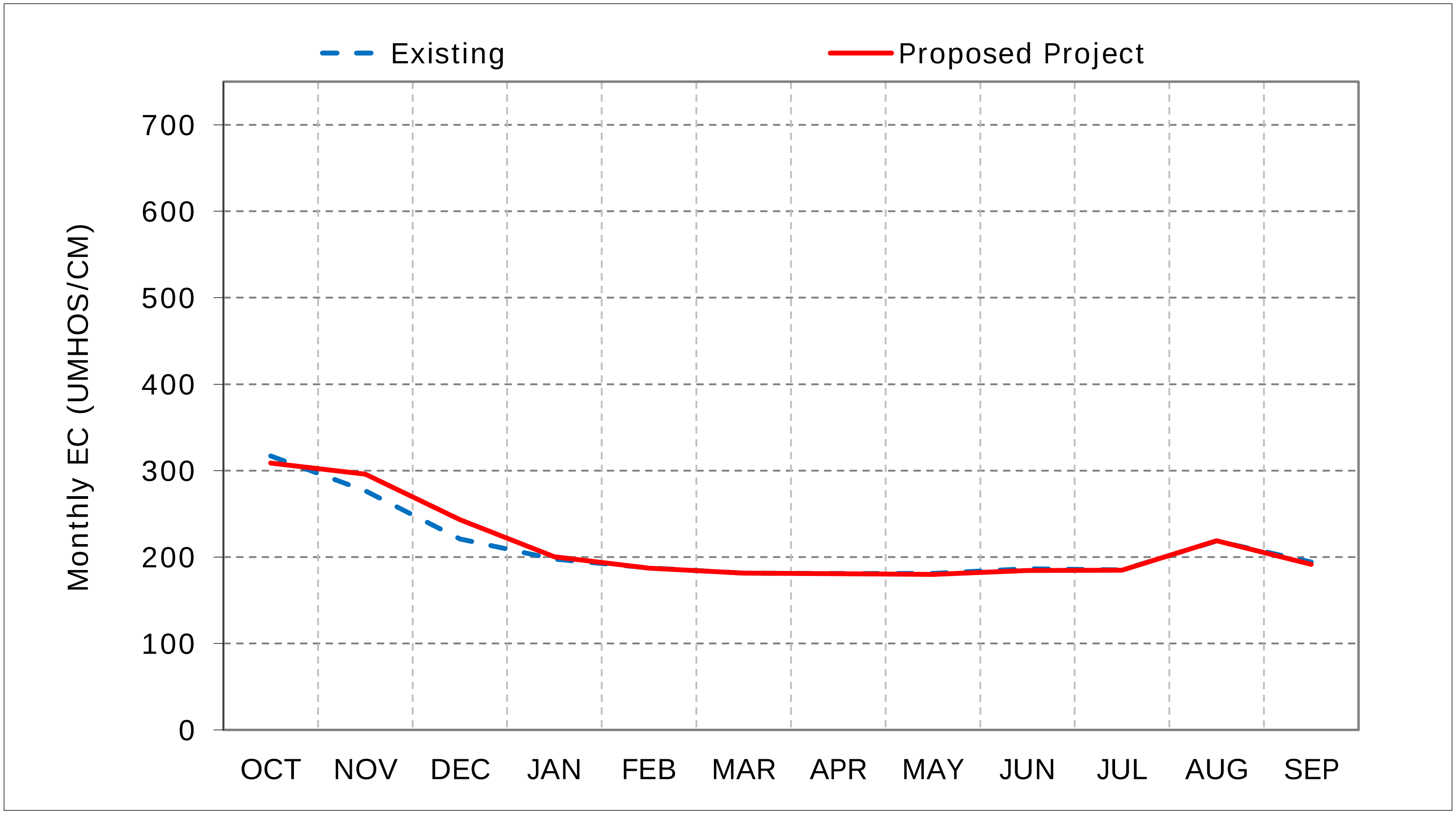
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 4-2. Sacramento River at Rio Vista Salinity, Wet Year Average EC



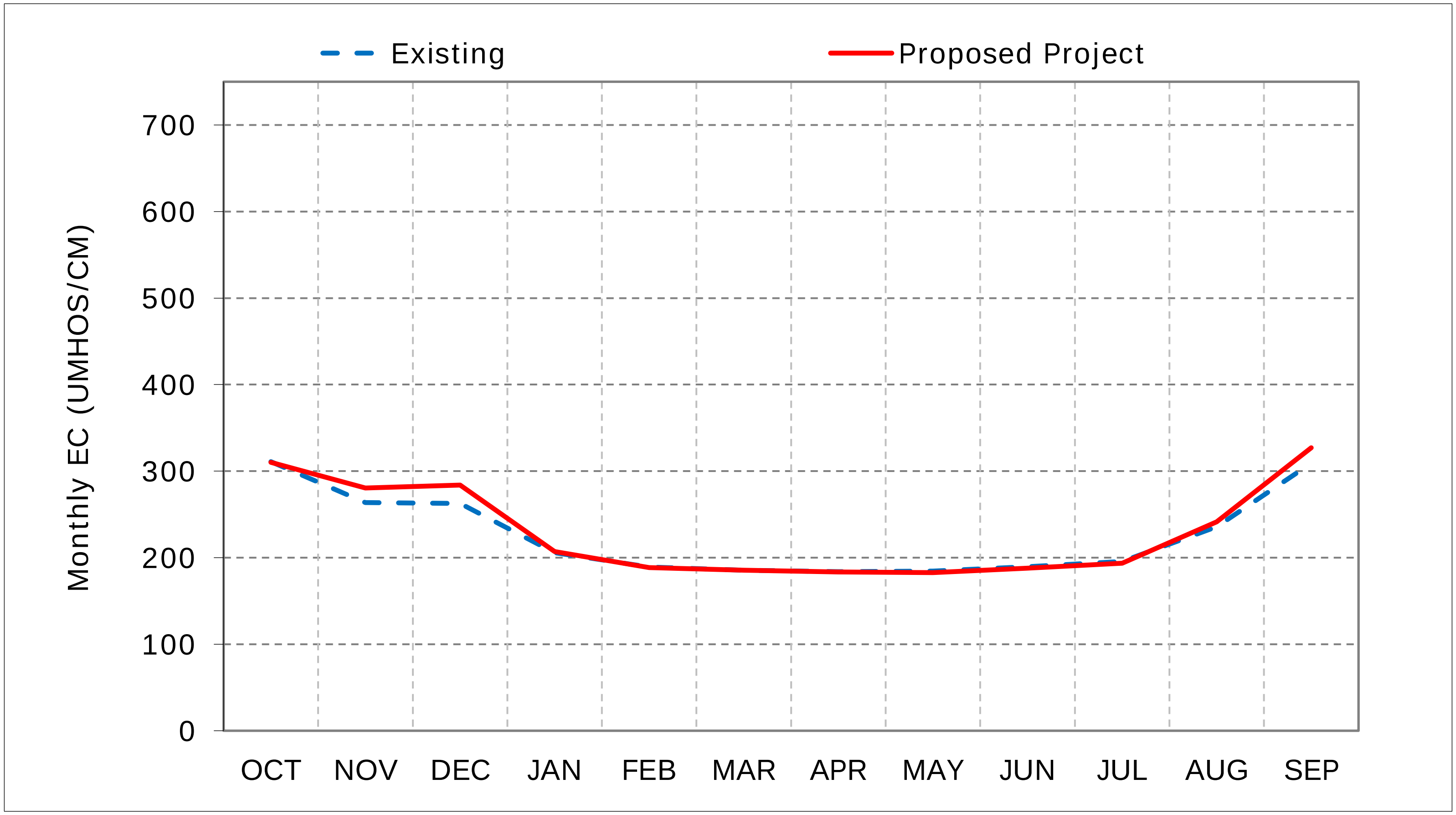
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 4-3. Sacramento River at Rio Vista Salinity, Above Normal Year Average EC



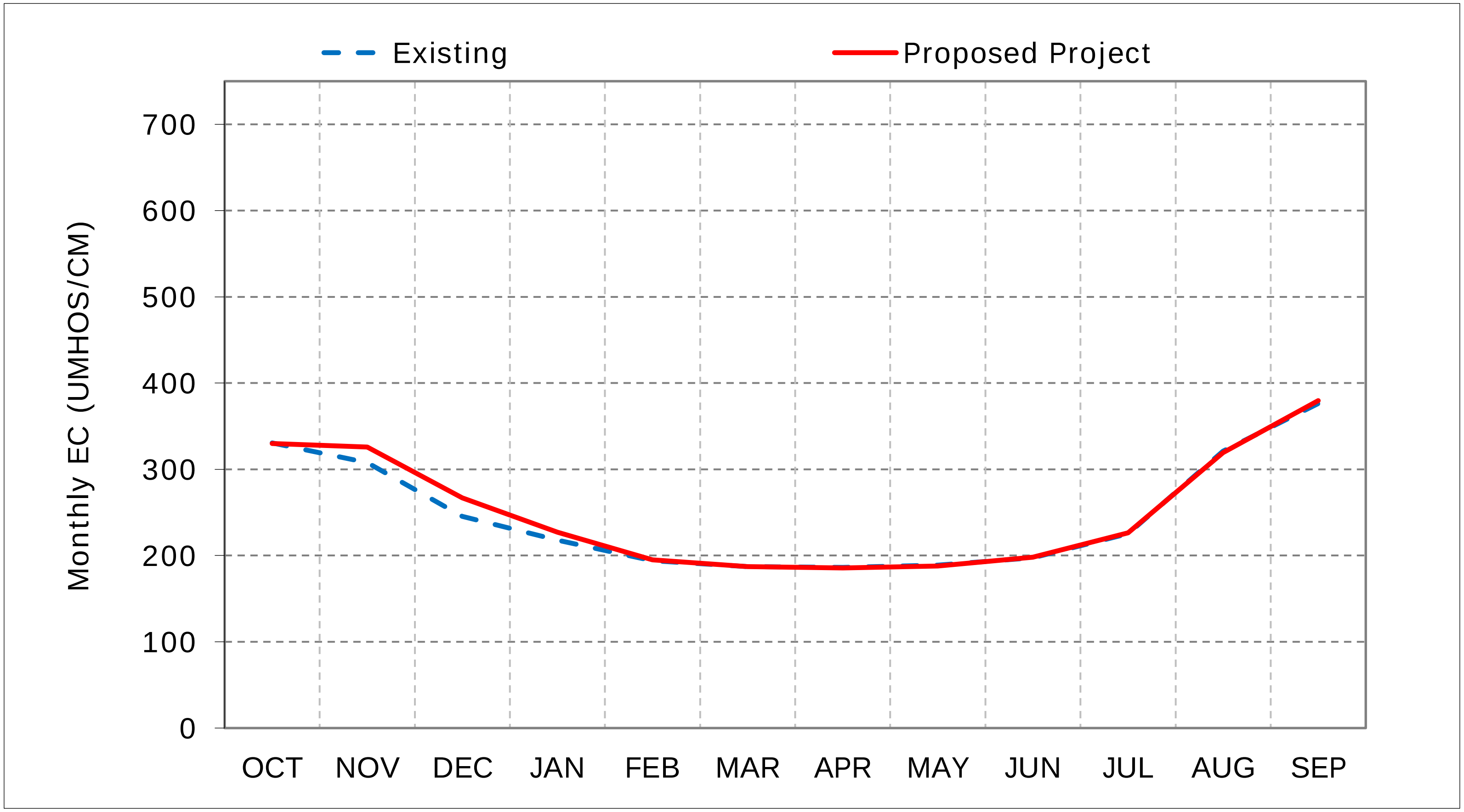
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 4-4. Sacramento River at Rio Vista Salinity, Below Normal Year Average EC



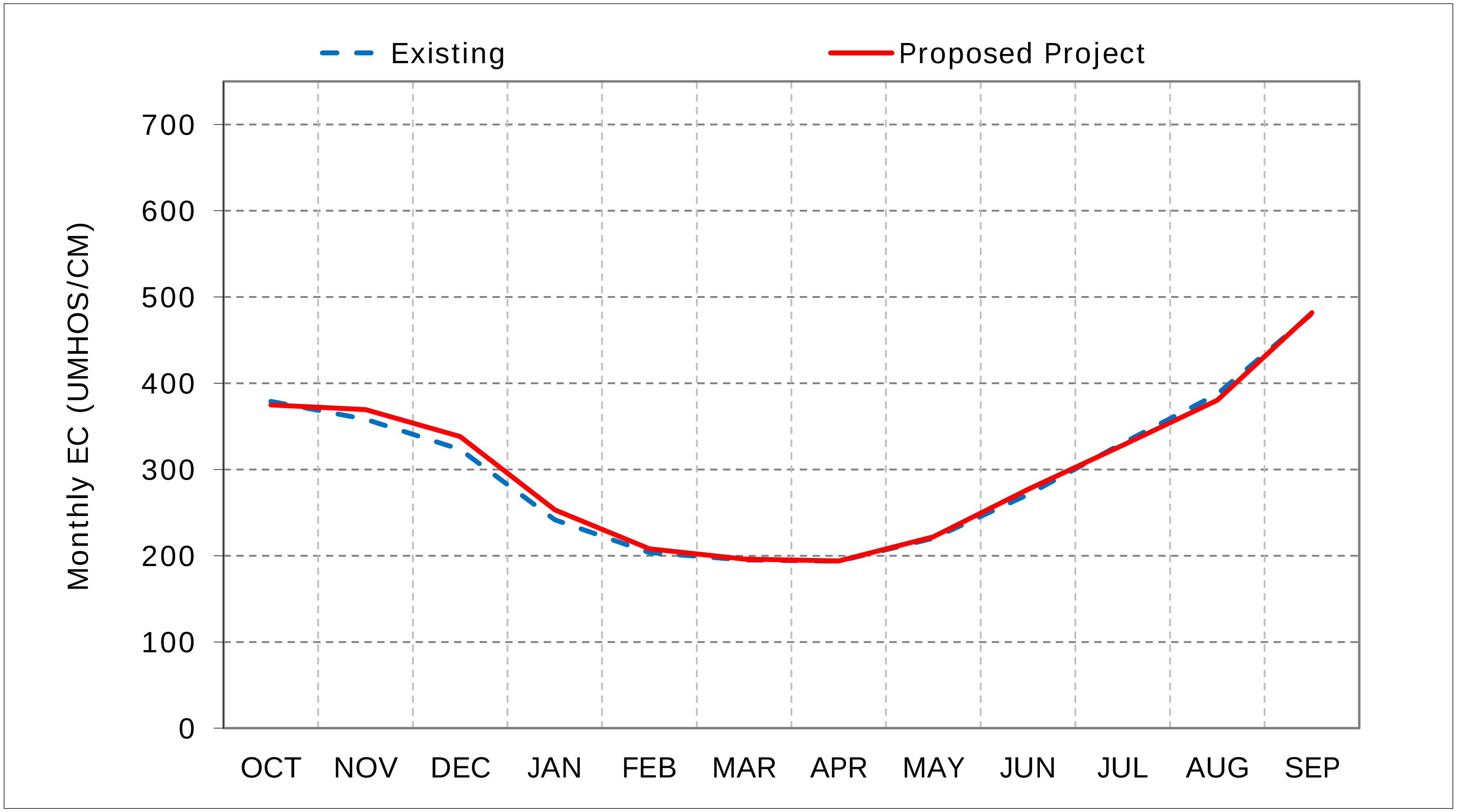
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 4-5. Sacramento River at Rio Vista Salinity, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 4-6. Sacramento River at Rio Vista Salinity, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 4-7. Sacramento River at Rio Vista Salinity, January EC

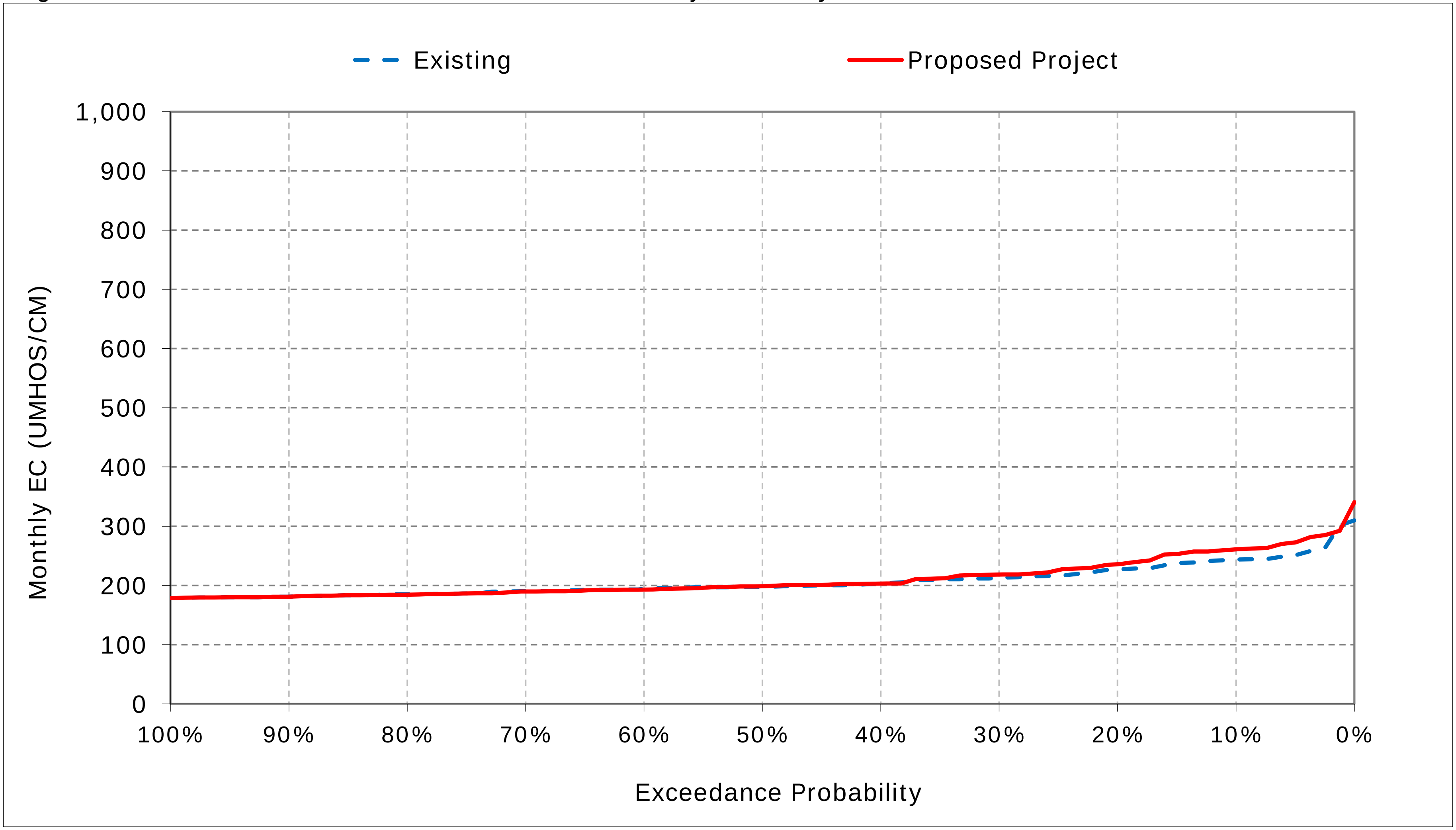


Figure 4-8. Sacramento River at Rio Vista Salinity, February EC

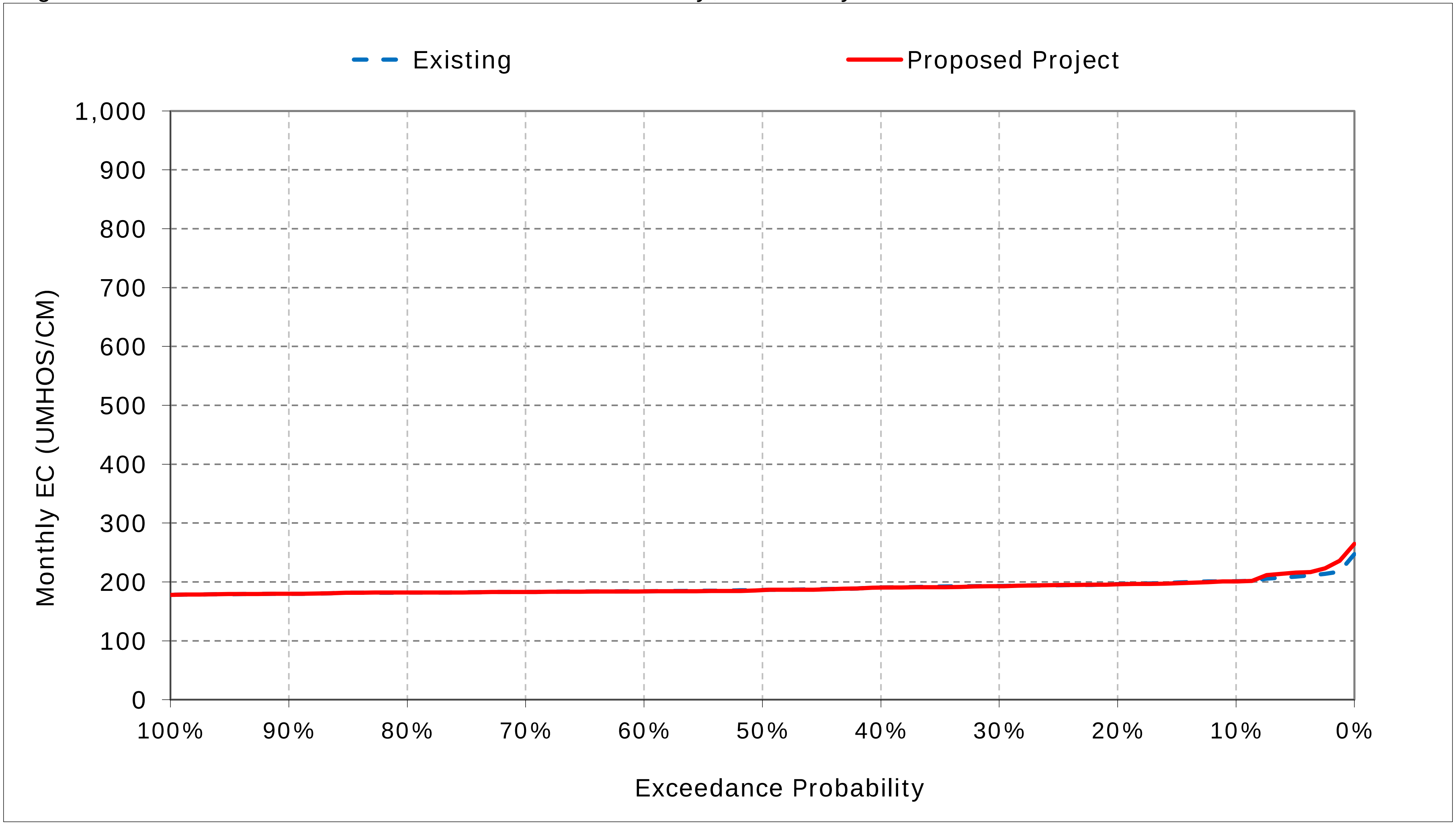


Figure 4-9. Sacramento River at Rio Vista Salinity, March EC

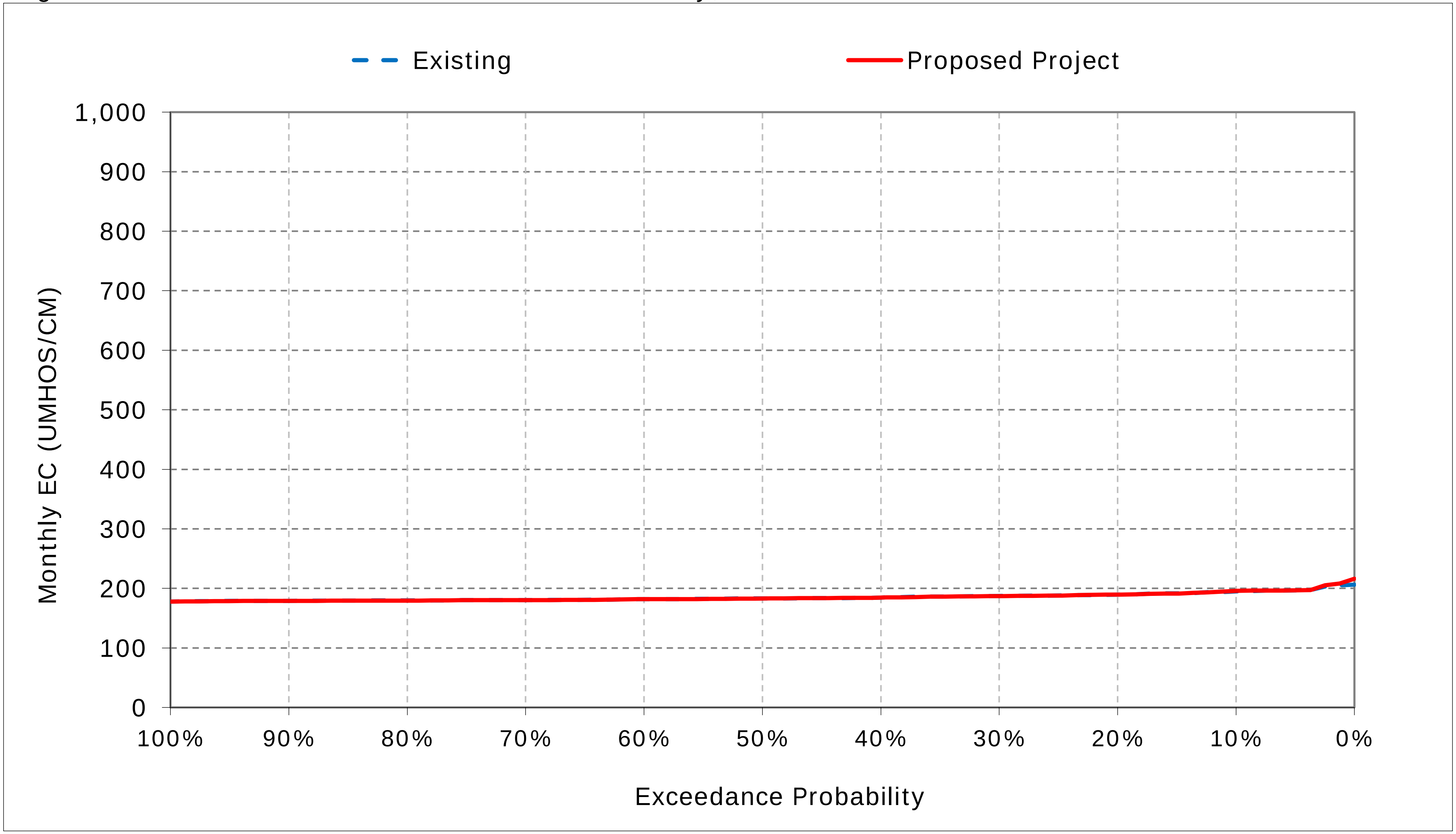


Figure 4-10. Sacramento River at Rio Vista Salinity, April EC

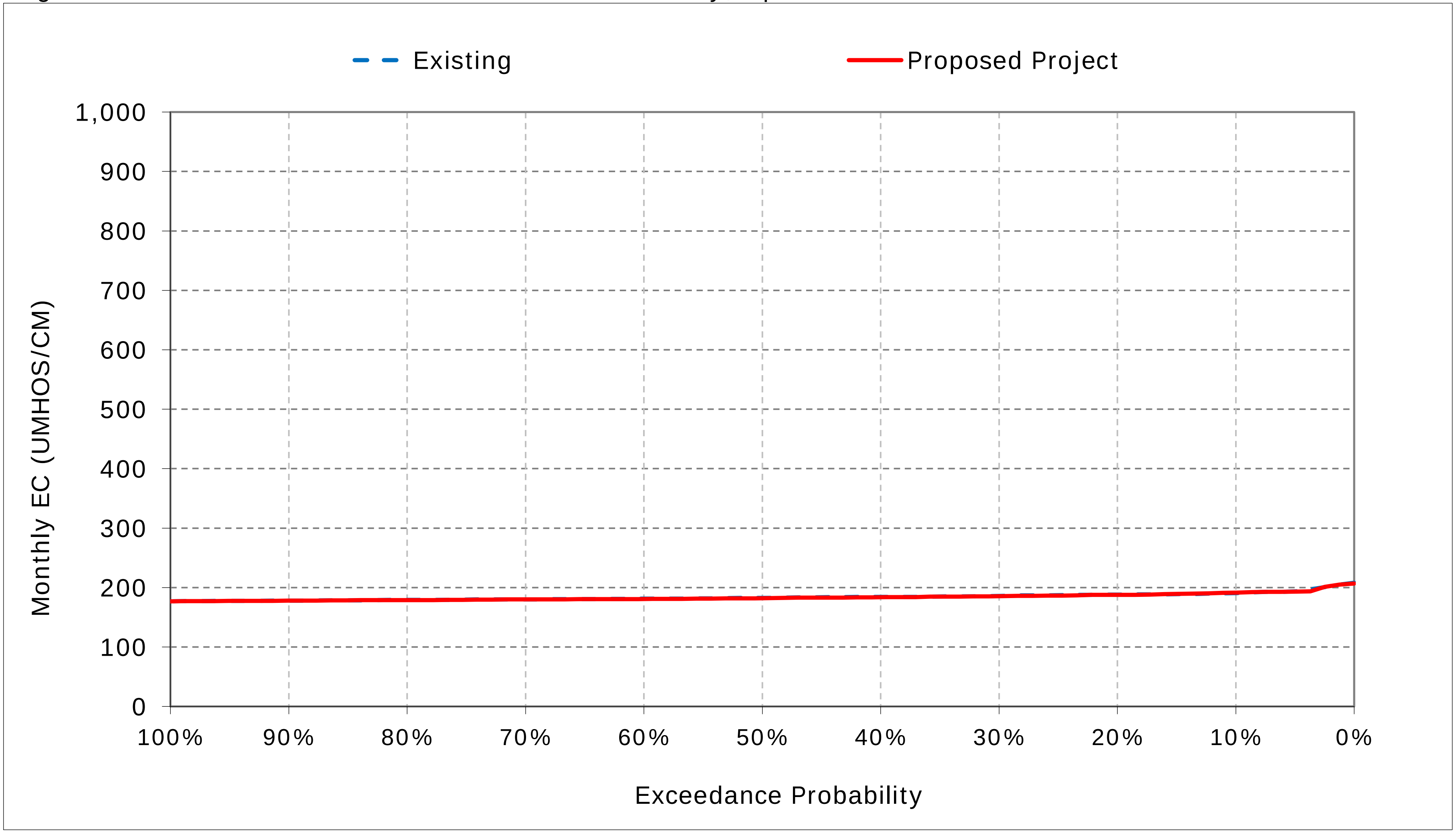


Figure 4-11. Sacramento River at Rio Vista Salinity, May EC

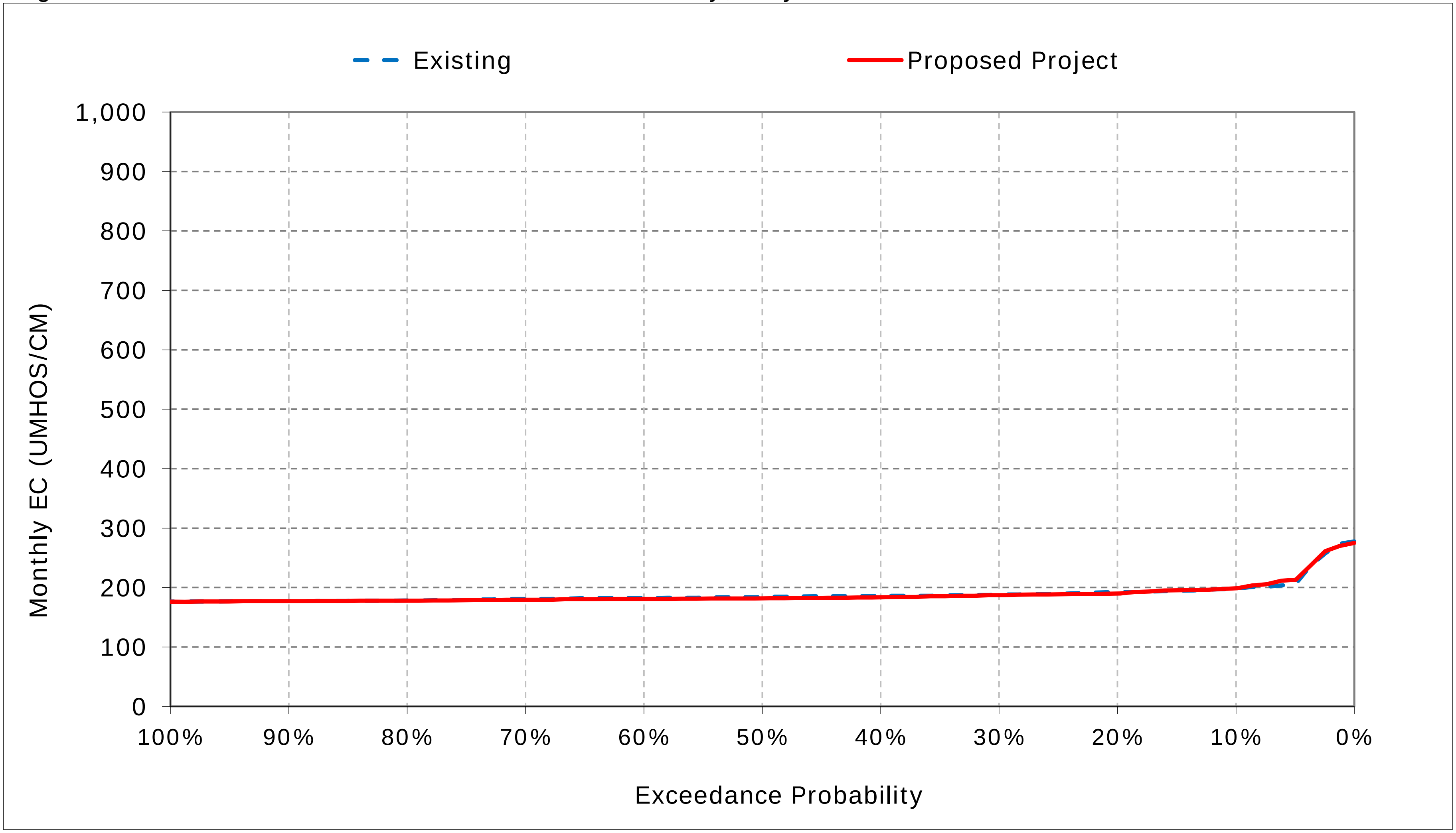


Figure 4-12. Sacramento River at Rio Vista Salinity, June EC

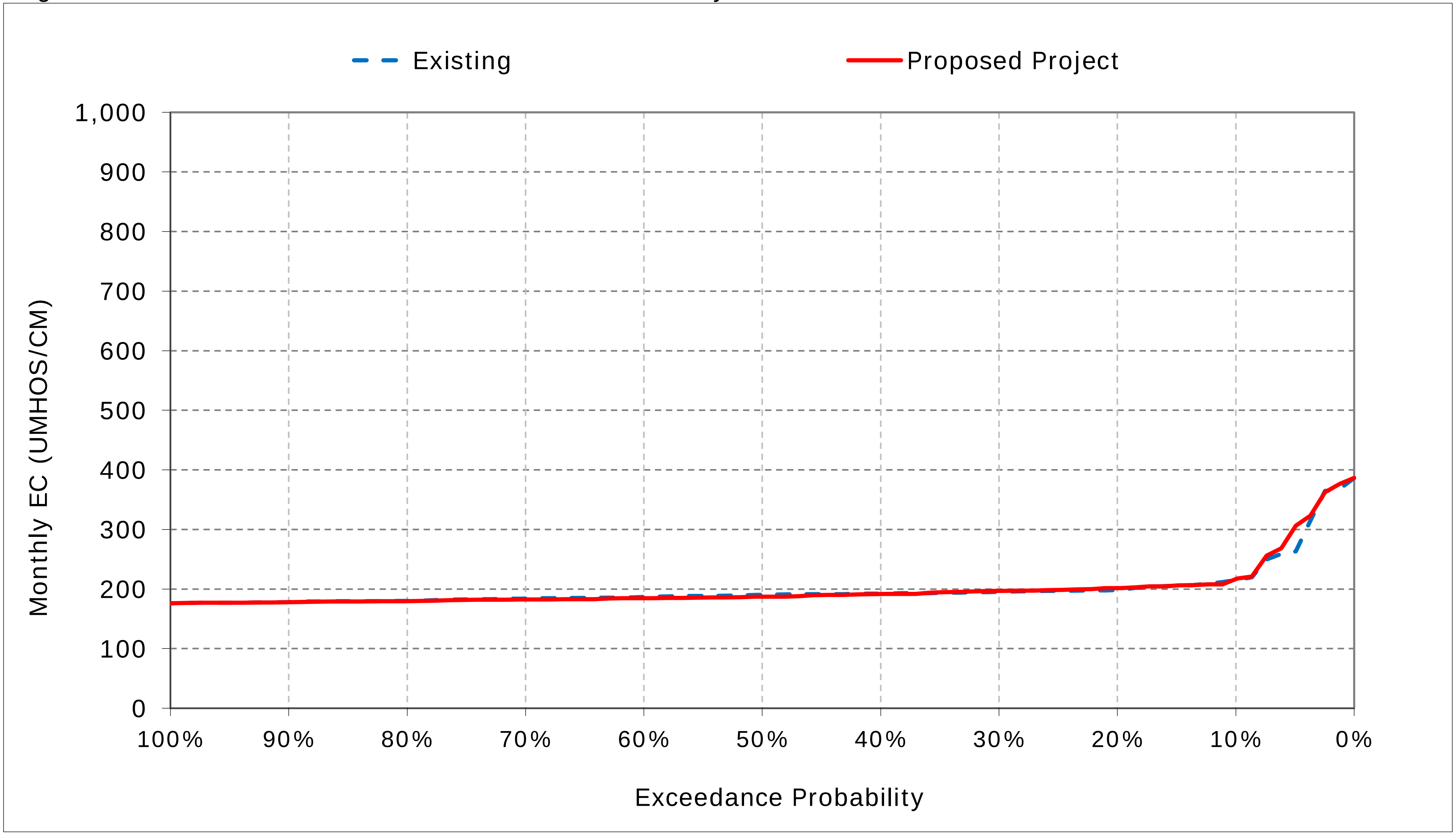


Figure 4-13. Sacramento River at Rio Vista Salinity, July EC

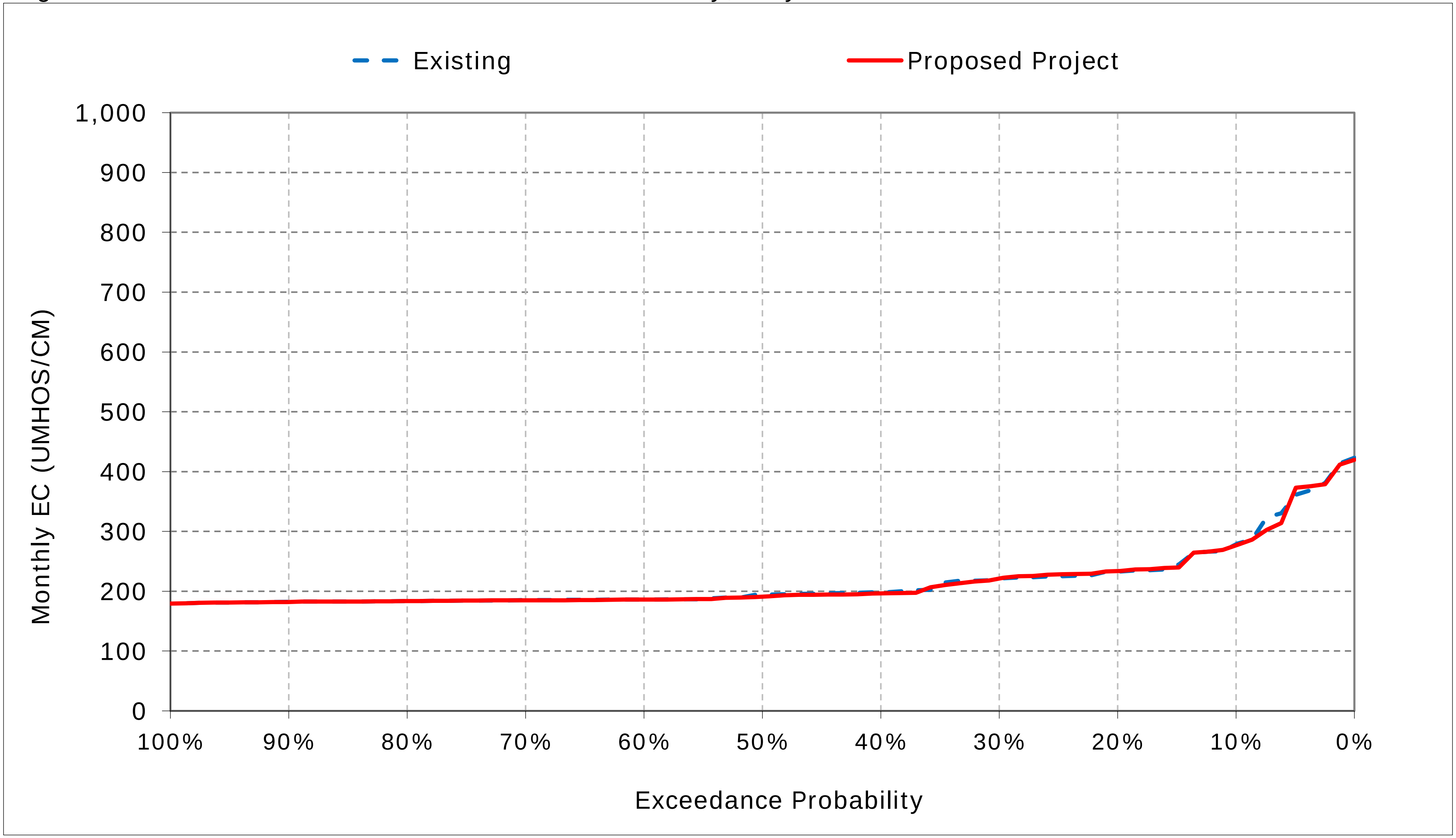


Figure 4-14. Sacramento River at Rio Vista Salinity, August EC

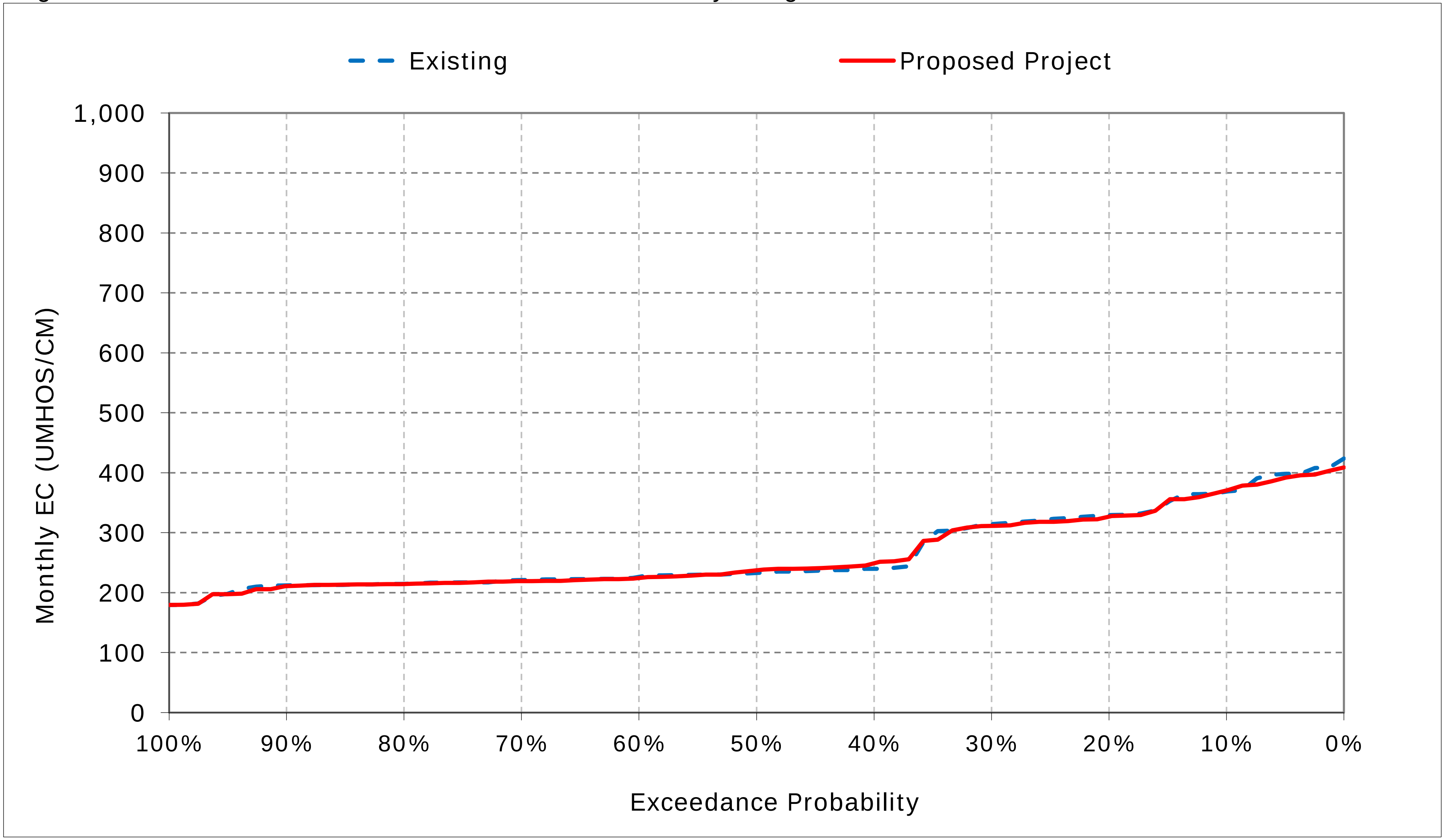


Figure 4-15. Sacramento River at Rio Vista Salinity, September EC

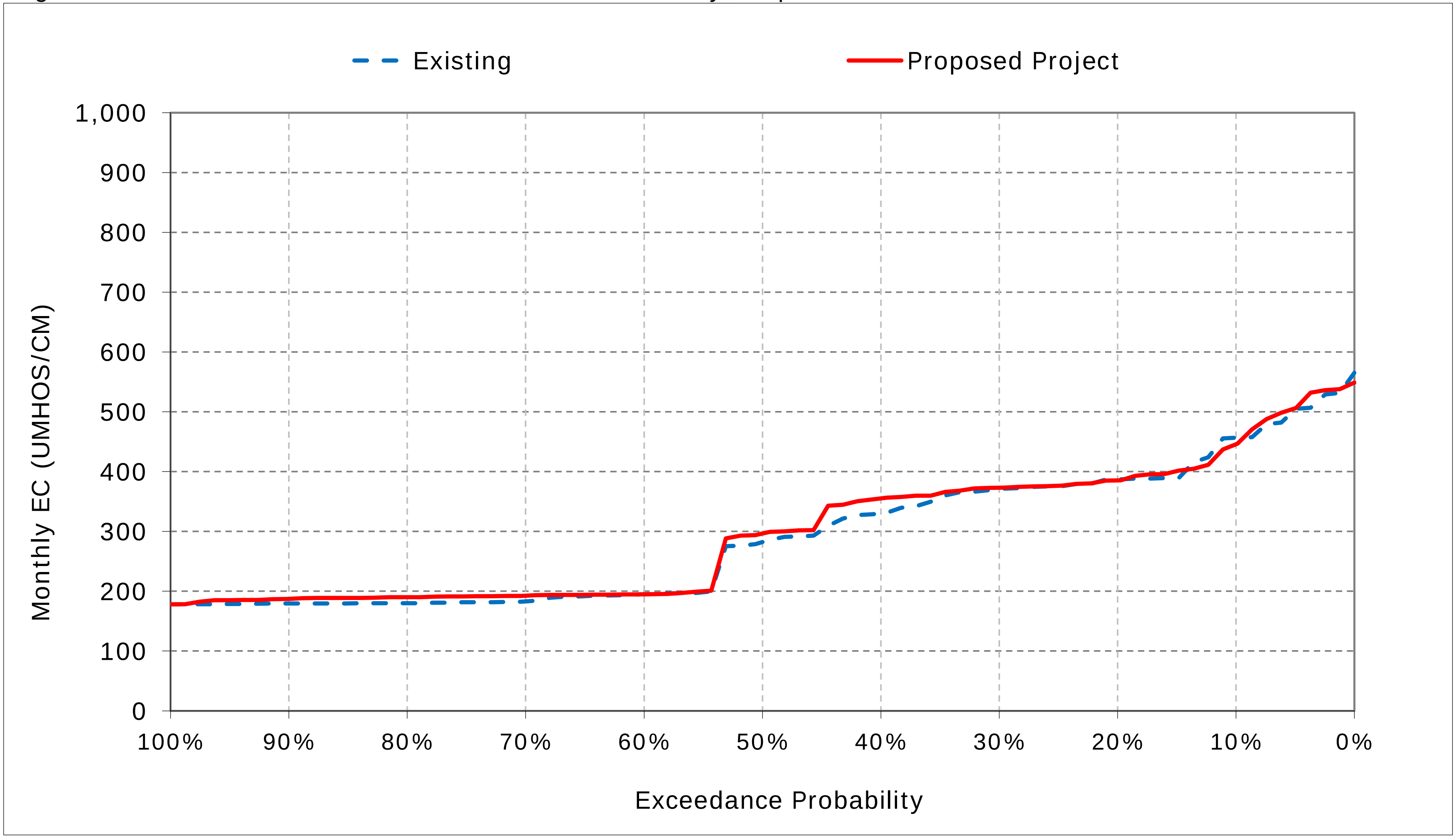


Figure 4-16. Sacramento River at Rio Vista Salinity, October EC

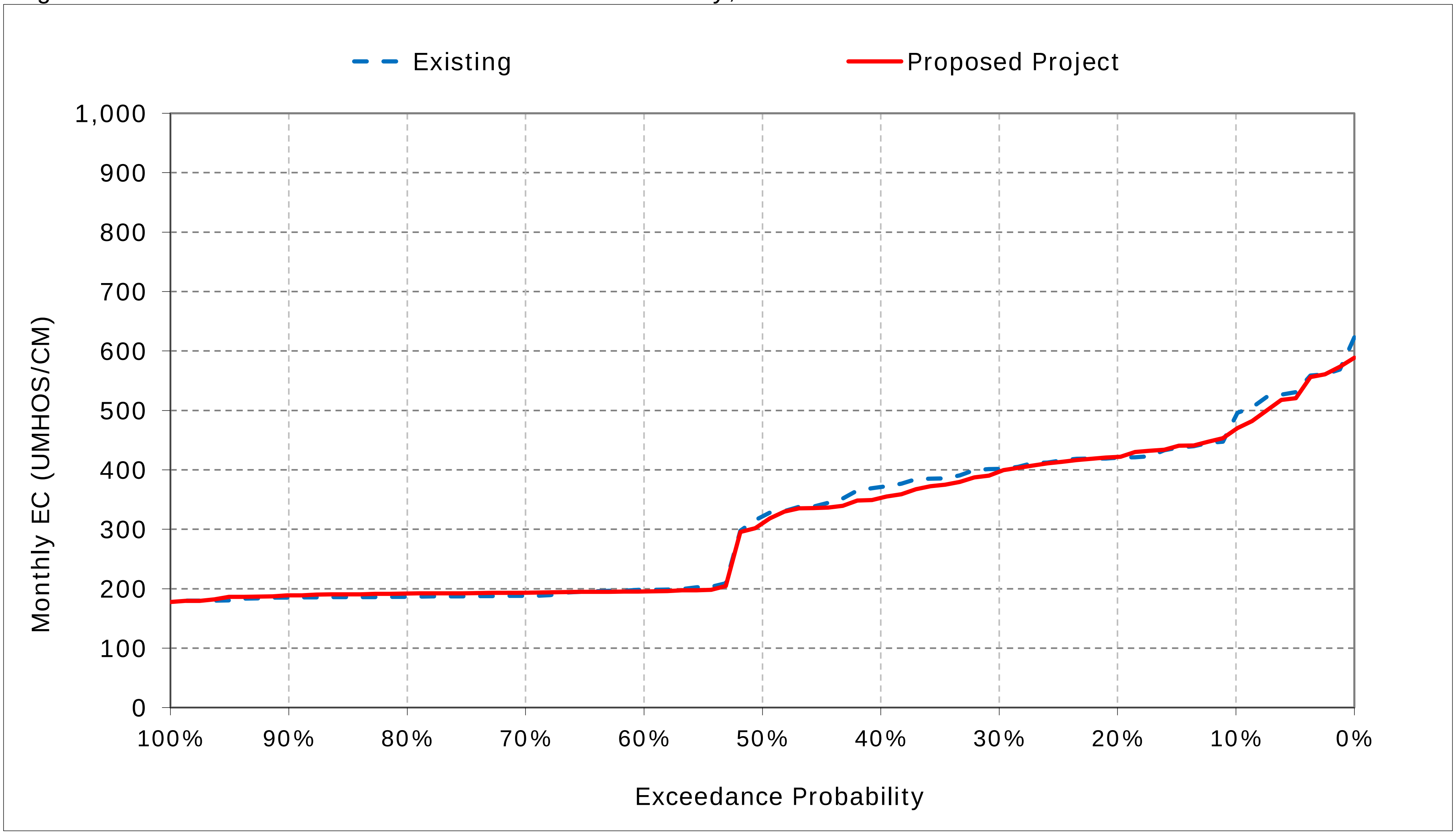


Figure 4-17. Sacramento River at Rio Vista Salinity, November EC

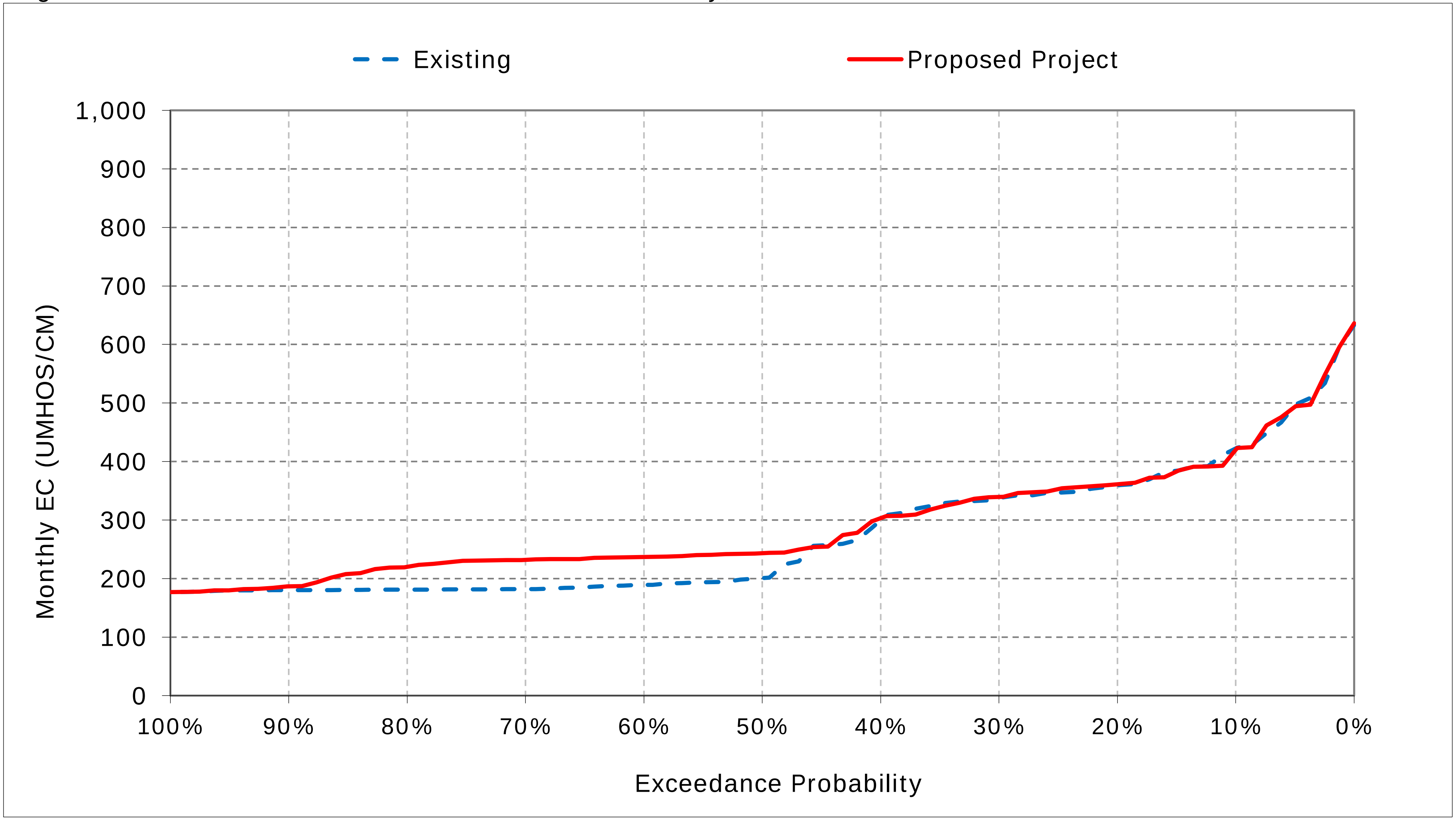


Figure 4-18. Sacramento River at Rio Vista Salinity, December EC

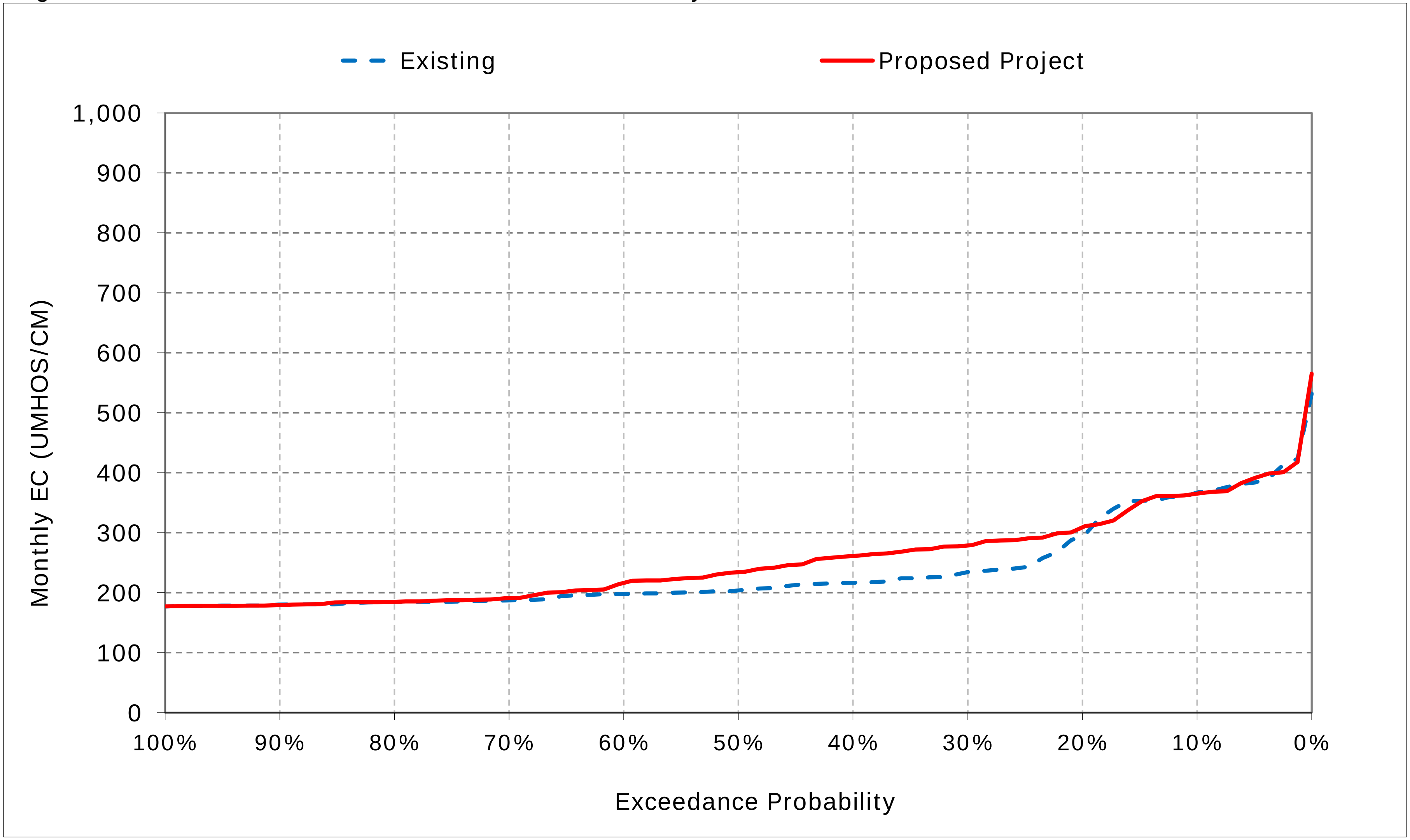


Table 5-1. Sacramento River at Emmaton Salinity, Monthly EC

Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	3,495	2,968	2,416	934	343	312	348	559	832	1,536	2,564	3,311
20%	3,015	2,476	1,573	736	252	238	247	399	595	1,007	2,001	2,732
30%	2,933	2,366	878	518	226	197	207	304	555	814	1,887	2,644
40%	2,724	1,968	712	352	206	193	198	232	461	535	1,085	2,188
50%	2,082	539	533	288	195	189	193	206	391	442	957	1,544
60%	644	426	493	227	190	187	189	198	300	348	912	472
70%	385	275	252	196	185	183	186	192	253	317	840	321
80%	342	247	211	188	183	181	182	183	194	293	796	302
90%	314	238	182	182	182	181	181	180	182	266	731	278
Long Term												
Full Simulation Period[a]	1,787	1,370	891	448	249	222	234	323	514	712	1,345	1,561
Water Year Types[b]												
Wet (32%)	1,273	710	302	209	184	183	185	190	230	281	748	283
Above Normal (15%)	1,870	1,412	735	301	199	184	188	195	316	328	809	464
Below Normal (17%)	1,848	1,367	1,153	437	211	199	206	235	390	485	1,020	1,843
Dry (22%)	1,958	1,695	1,017	590	285	233	240	326	562	901	1,951	2,694
Critical (15%)	2,492	2,273	1,828	913	432	353	408	839	1,398	2,011	2,644	3,399

Proposed Project

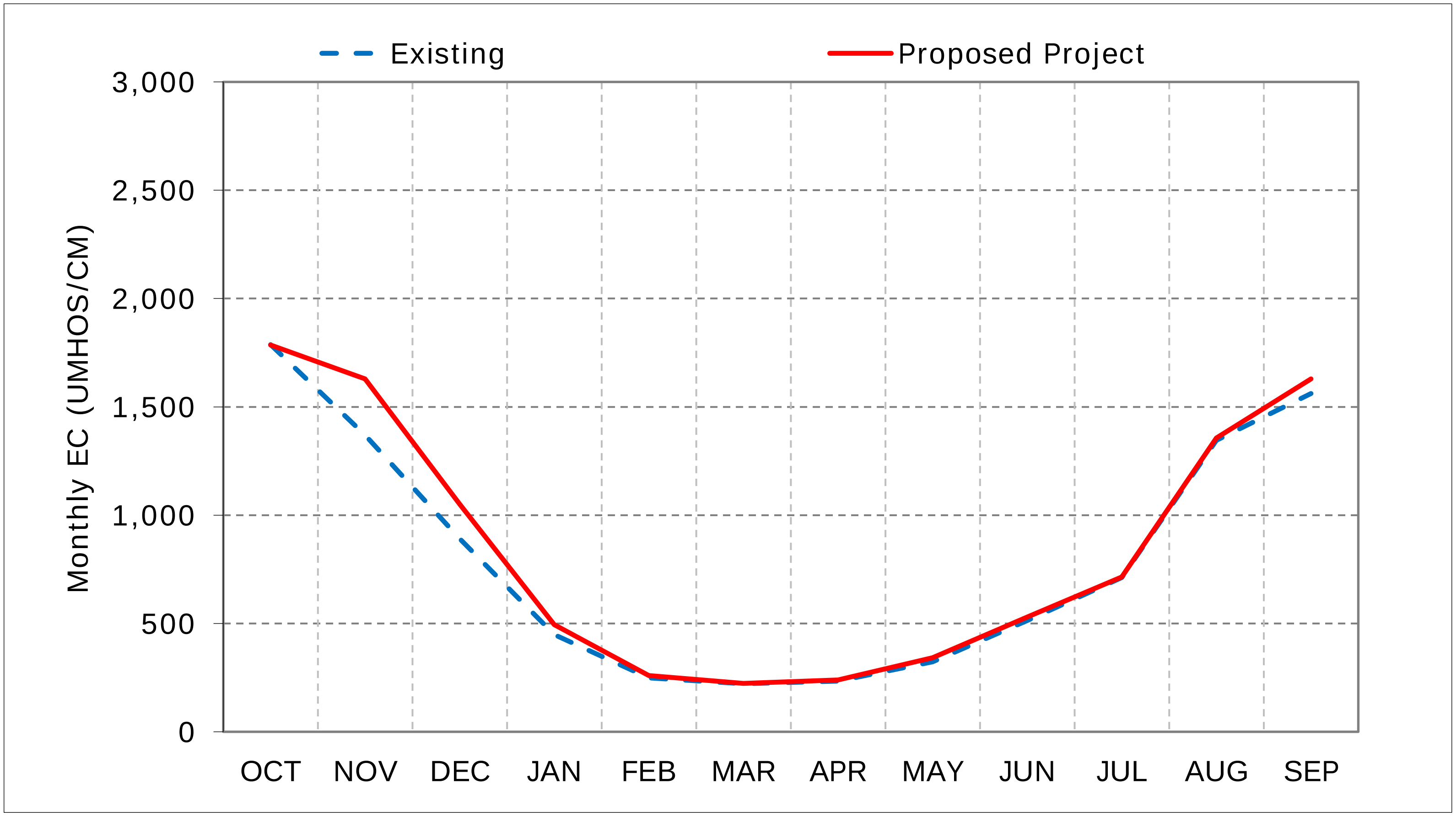
Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	3,471	2,889	2,408	1,126	344	315	388	588	851	1,517	2,470	3,171
20%	3,051	2,554	1,627	844	262	230	267	428	651	1,065	2,004	2,775
30%	2,909	2,336	1,423	578	227	196	216	372	584	838	1,938	2,639
40%	2,452	1,938	1,191	378	205	193	199	251	475	525	1,315	2,409
50%	1,894	1,228	873	300	196	189	191	211	375	429	1,046	1,672
60%	615	1,086	602	221	189	187	186	197	302	338	907	461
70%	556	1,023	316	196	185	183	183	187	247	314	818	444
80%	492	837	246	189	183	181	182	180	192	288	777	413
90%	413	340	188	182	182	181	180	178	181	267	704	376
Long Term												
Full Simulation Period[a]	1,785	1,630	1,051	495	260	223	239	341	530	714	1,356	1,630
Water Year Types[b]												
Wet (32%)	1,293	1,034	371	209	184	183	184	195	240	282	727	398
Above Normal (15%)	1,822	1,661	966	338	196	185	187	197	304	320	818	426
Below Normal (17%)	1,859	1,607	1,372	456	209	199	212	251	386	486	1,151	2,027
Dry (22%)	1,985	1,967	1,233	682	300	233	250	365	593	929	1,956	2,719
Critical (15%)	2,430	2,409	1,959	1,037	486	363	422	874	1,456	1,988	2,597	3,403

Proposed Project minus Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-23	-79	-8	192	1	2	40	29	20	-19	-94	-140
20%	36	79	54	108	10	-8	20	29	56	58	3	43
30%	-24	-31	545	61	1	-1	9	69	29	23	51	-5
40%	-273	-30	479	26	-1	0	1	19	14	-10	230	221
50%	-188	689	339	13	1	0	-2	5	-16	-14	89	128
60%	-29	660	109	-6	-1	1	-3	-2	1	-10	-5	-11
70%	171	748	64	1	0	0	-2	-5	-6	-3	-22	122
80%	150	590	35	1	0	0	-1	-4	-2	-4	-19	111
90%	98	102	6	0	0	0	-1	-2	-2	2	-27	99
Long Term												
Full Simulation Period[a]	-2	260	160	47	11	2	5	18	16	2	11	69
Water Year Types[b]												
Wet (32%)	20	323	69	0	0	0	0	5	10	1	-21	115
Above Normal (15%)	-49	249	232	37	-3	0	-1	1	-12	-8	10	-38
Below Normal (17%)	11	240	218	19	-2	0	7	16	-4	2	131	183
Dry (22%)	27	273	216	92	16	0	10	39	31	28	6	26
Critical (15%)	-62	136	130	124	55	10	13	35	58	-22	-47	4

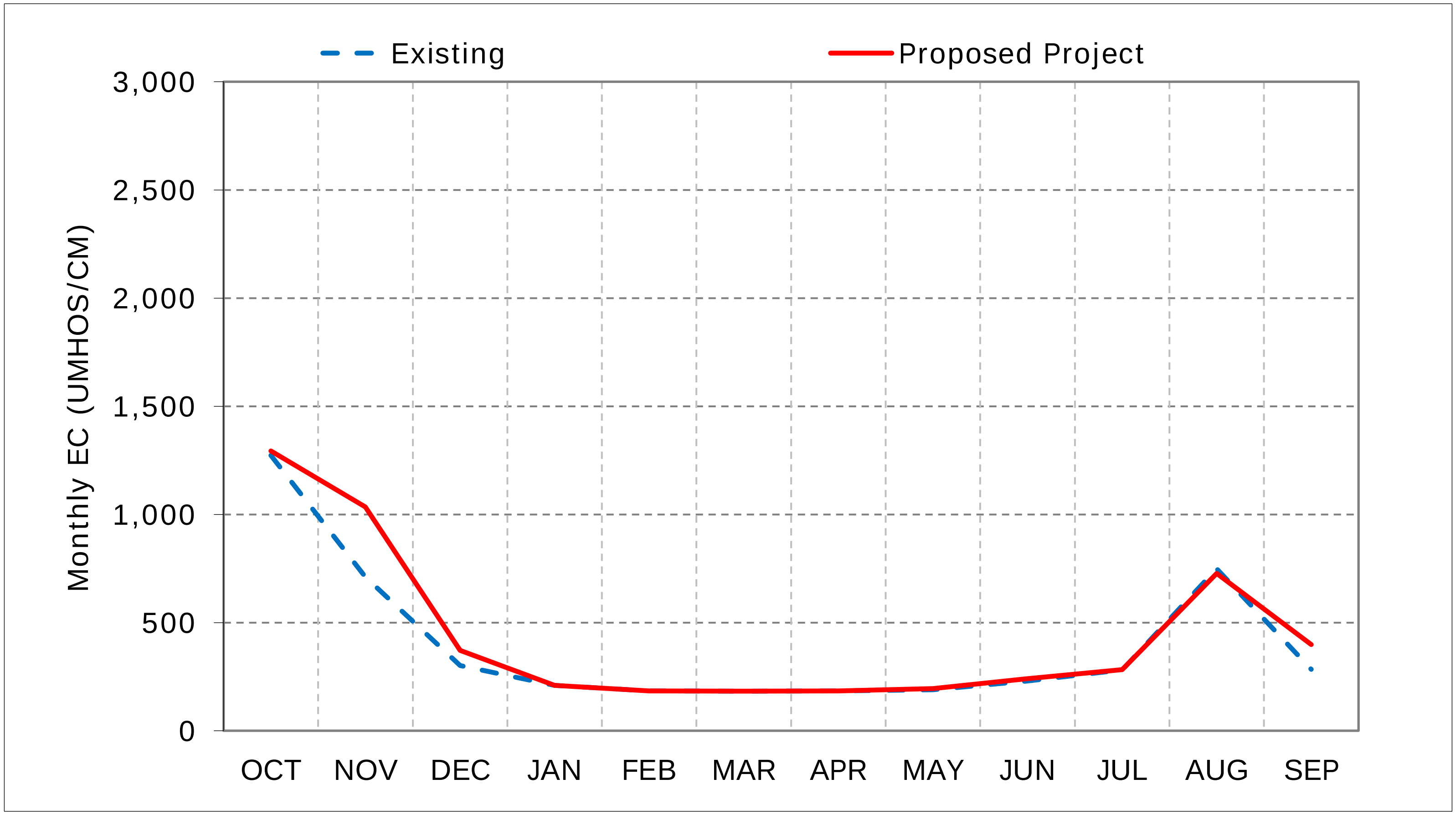
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 5-1. Sacramento River at Emmaton Salinity, Long-Term Average EC



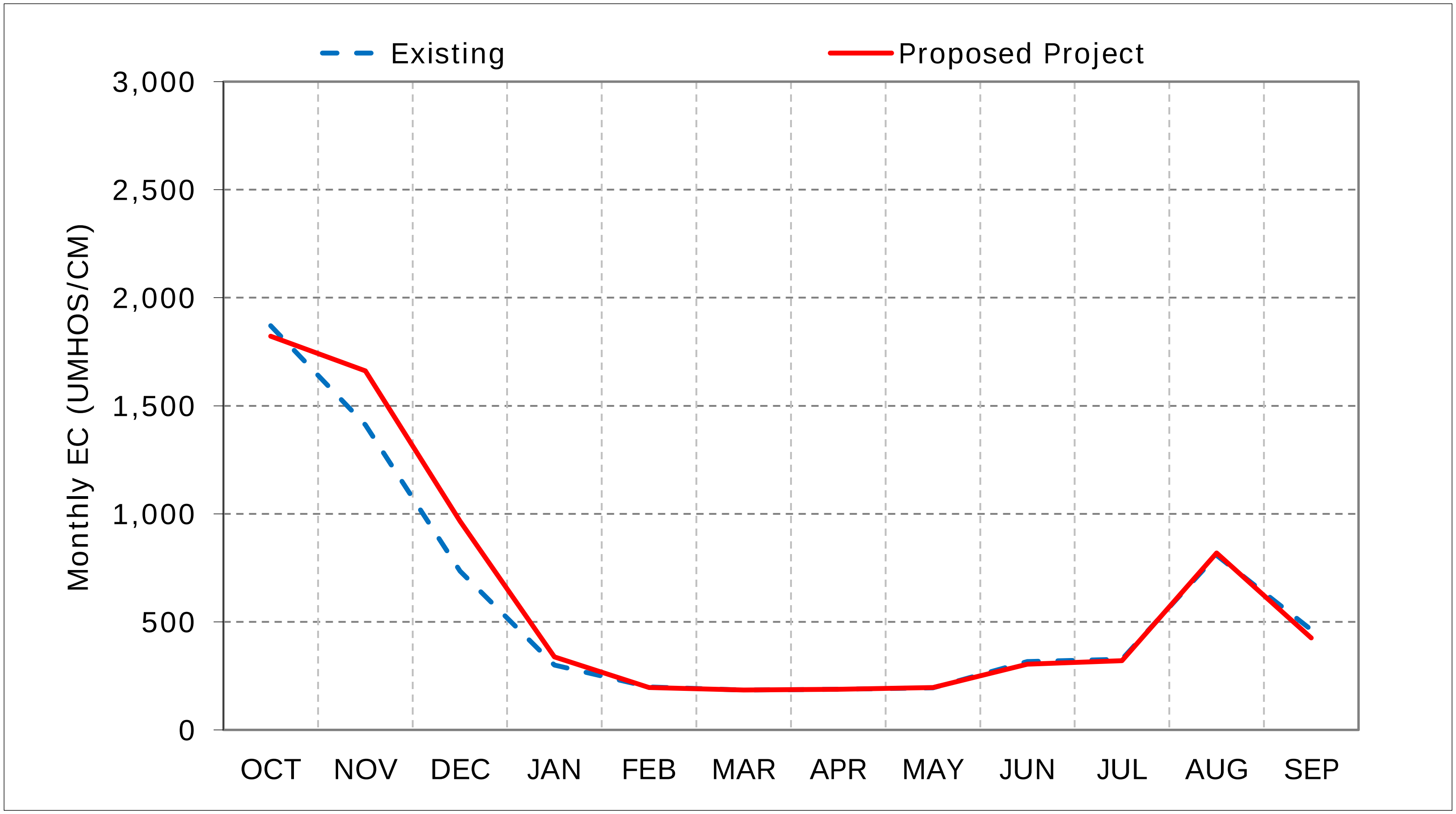
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 5-2. Sacramento River at Emmaton Salinity, Wet Year Average EC



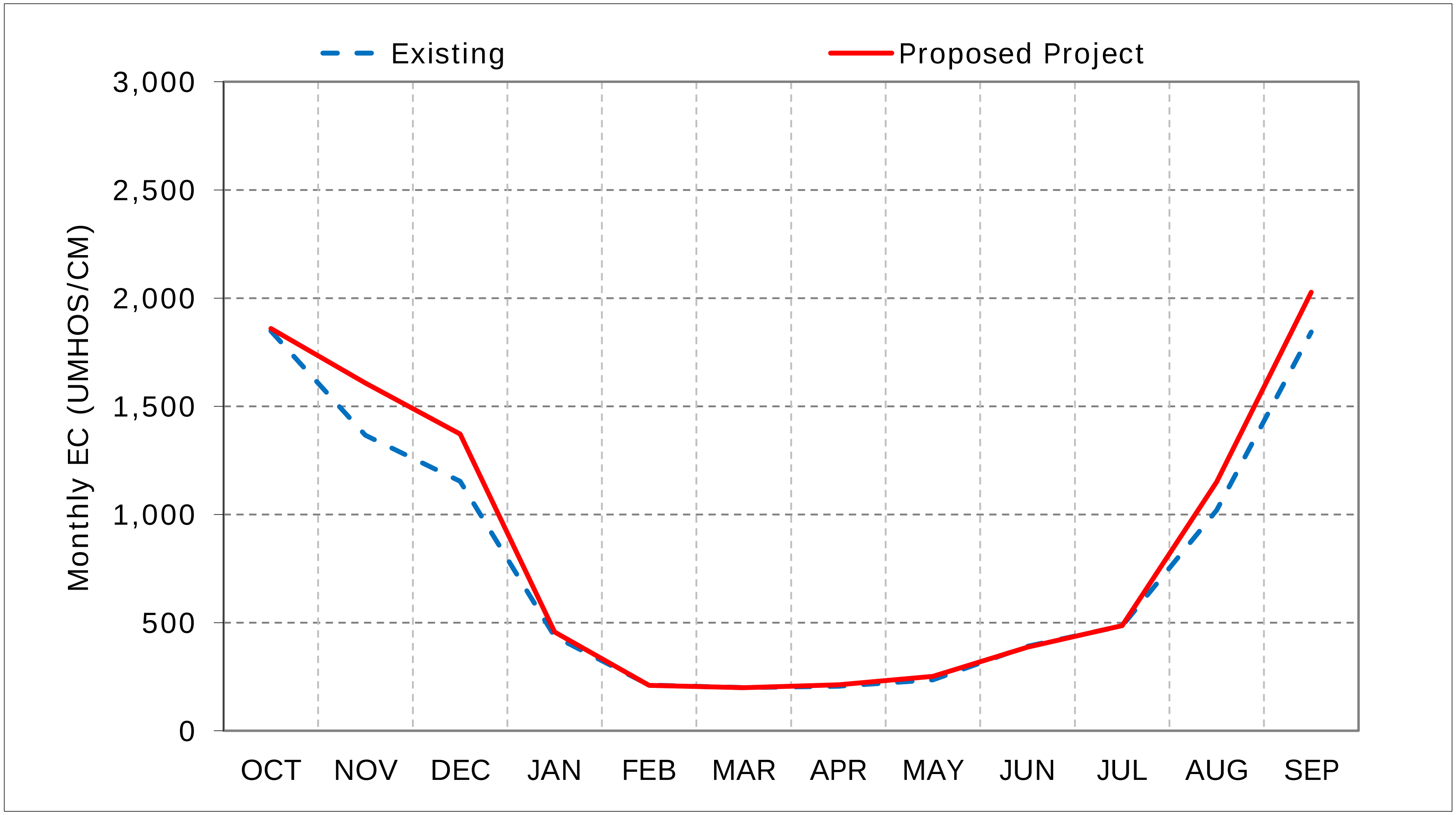
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 5-3. Sacramento River at Emmaton Salinity, Above Normal Year Average EC



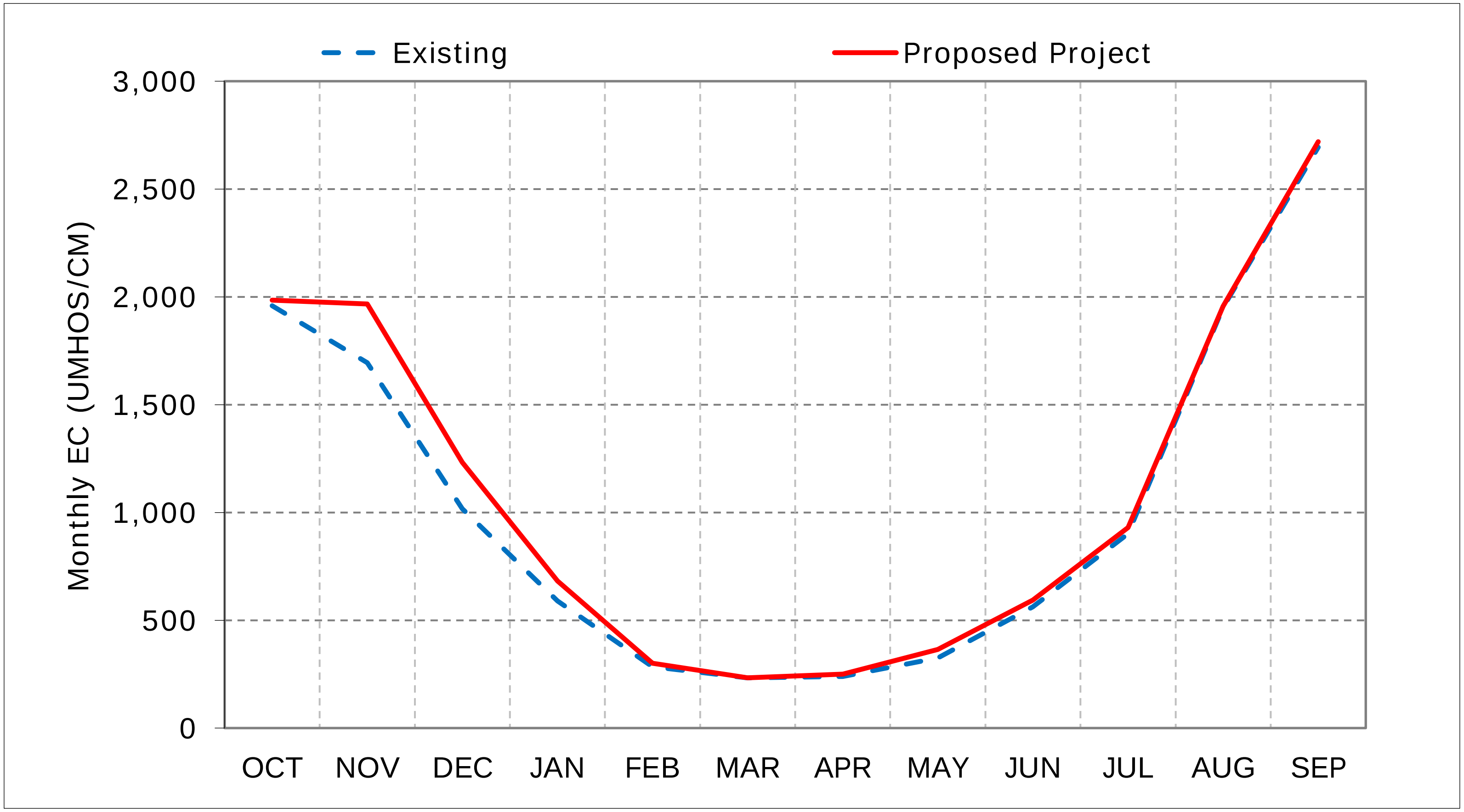
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 5-4. Sacramento River at Emmaton Salinity, Below Normal Year Average EC



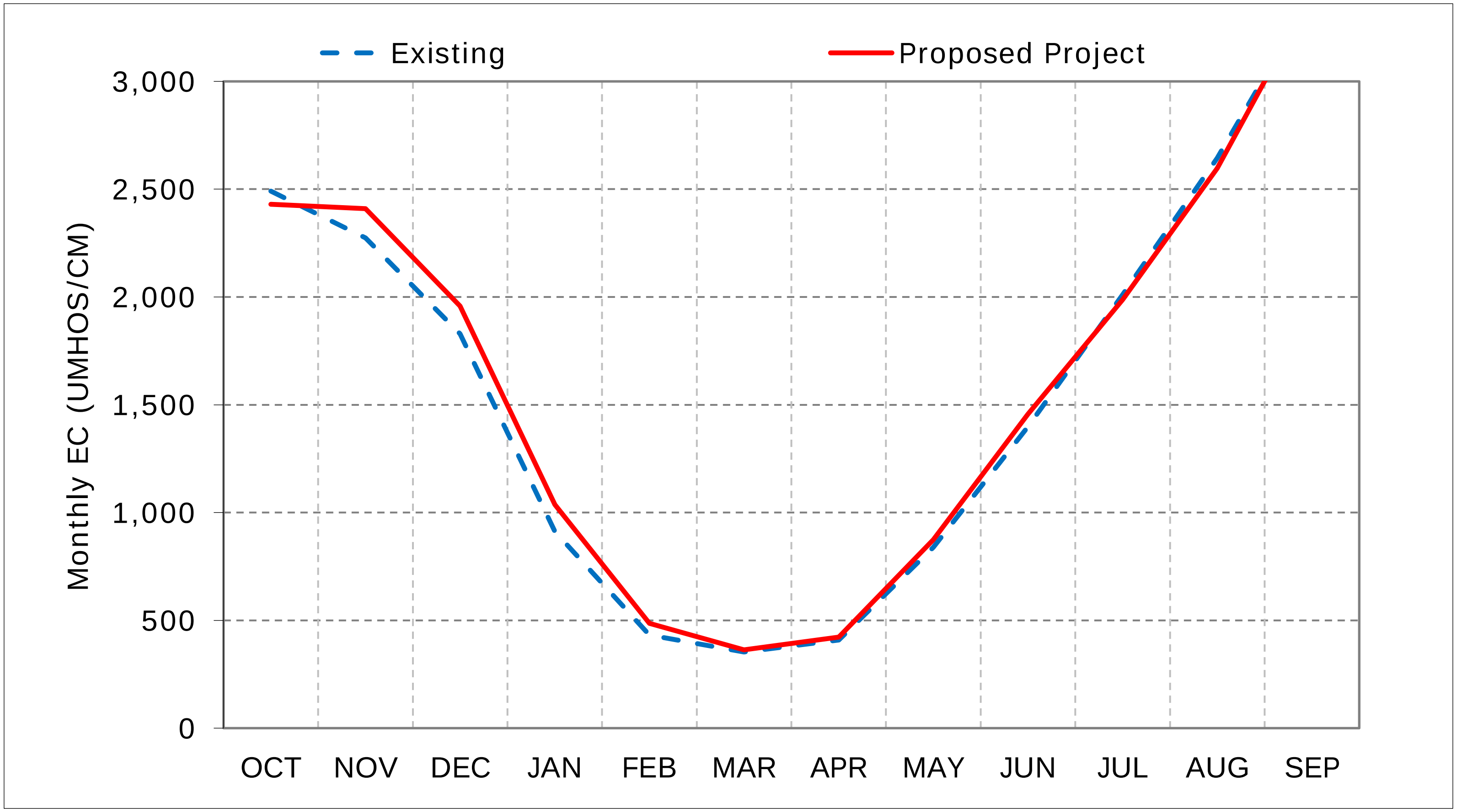
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 5-5. Sacramento River at Emmaton Salinity, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 5-6. Sacramento River at Emmaton Salinity, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 5-7. Sacramento River at Emmaton Salinity, January EC

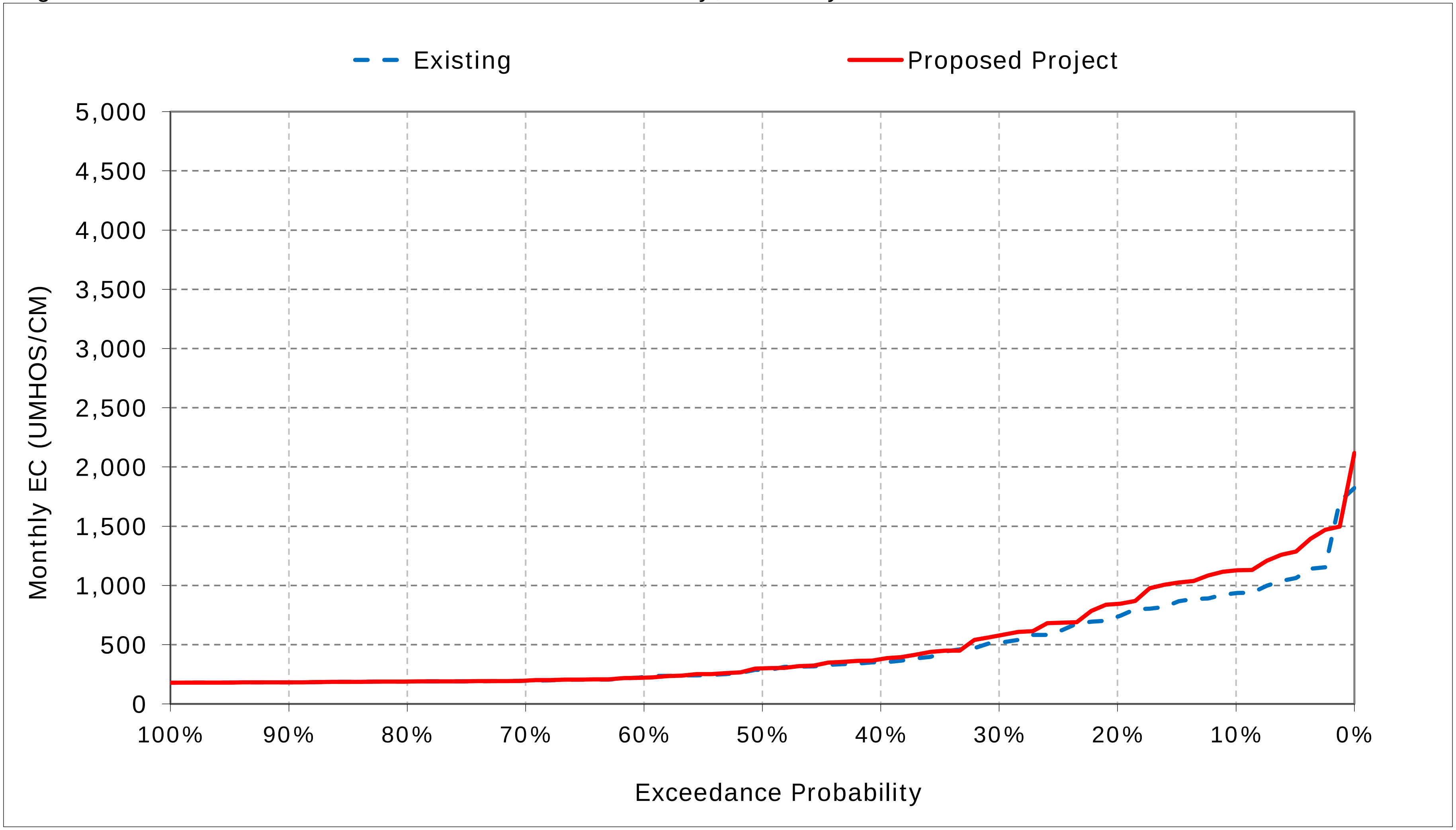


Figure 5-8. Sacramento River at Emmaton Salinity, February EC

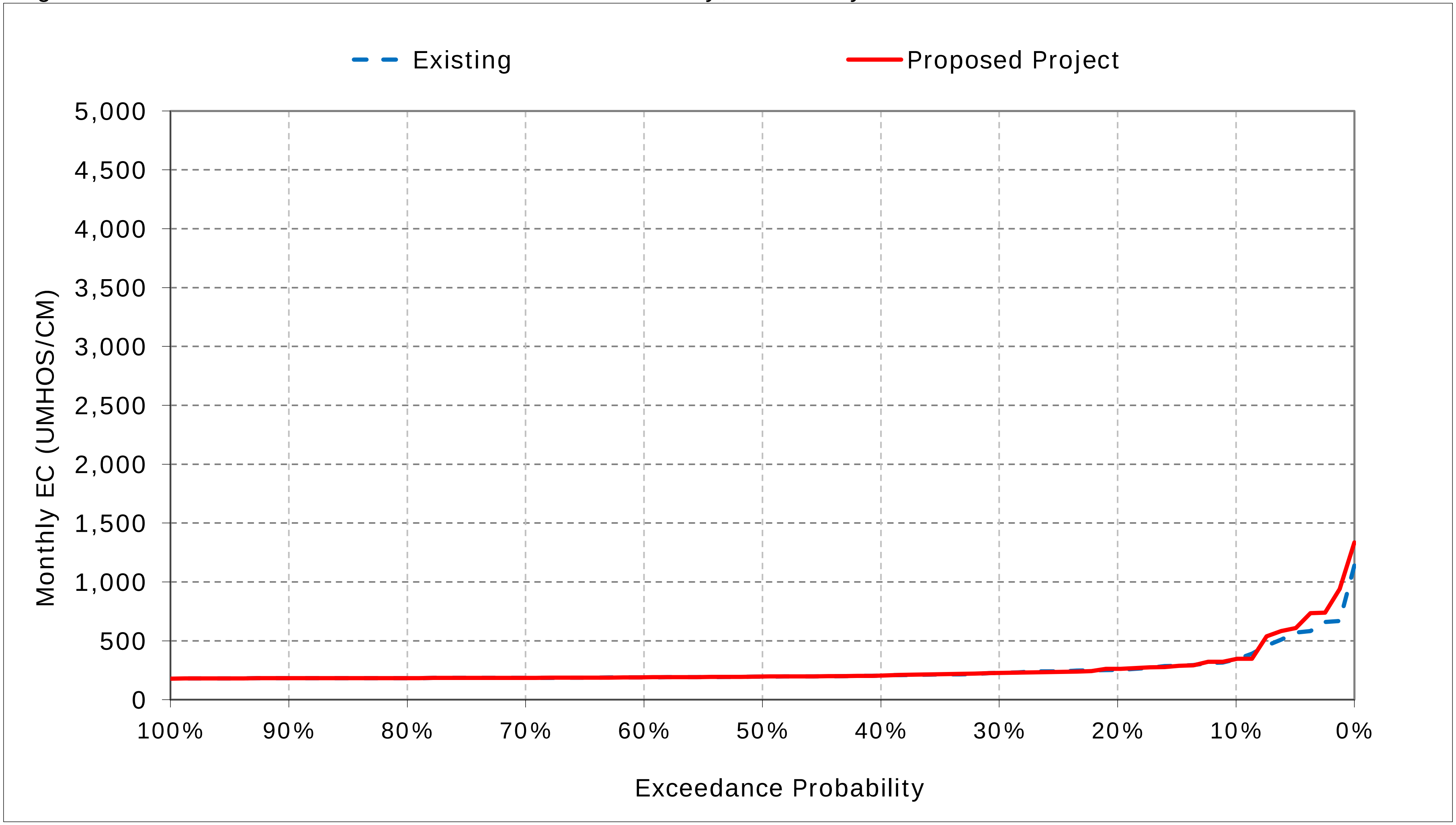


Figure 5-9. Sacramento River at Emmaton Salinity, March EC

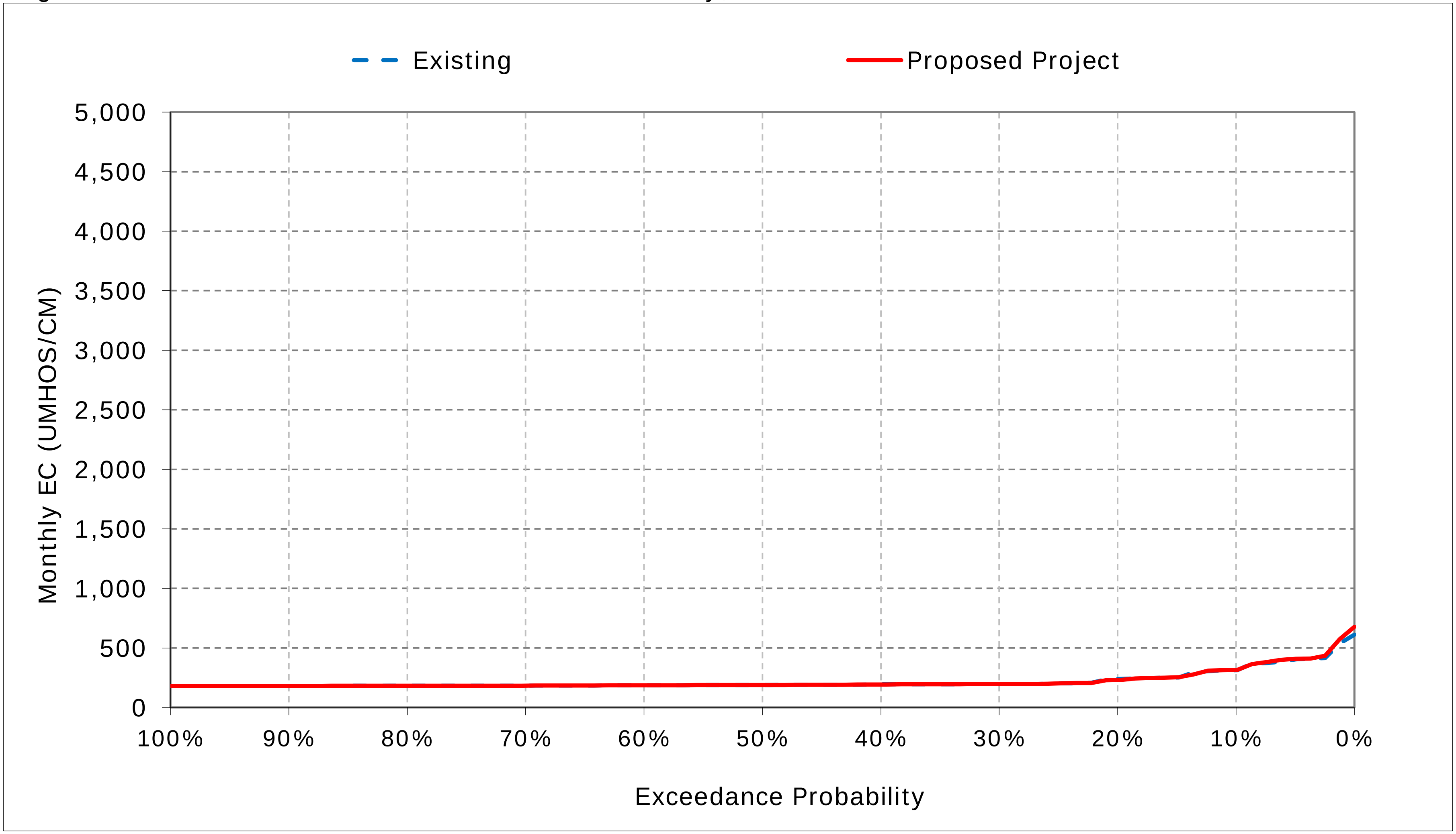


Figure 5-10. Sacramento River at Emmaton Salinity, April EC

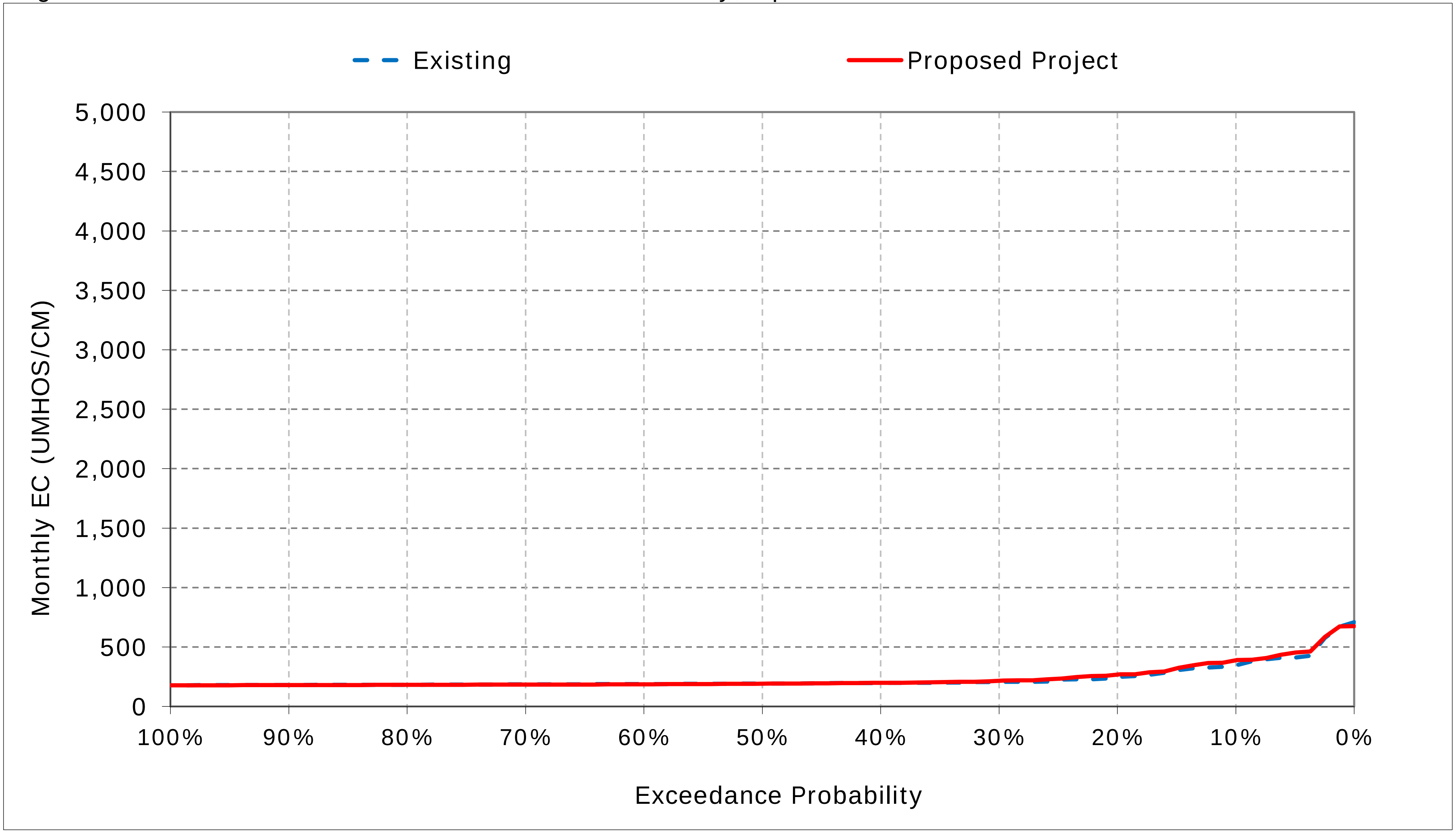


Figure 5-11. Sacramento River at Emmaton Salinity, May EC

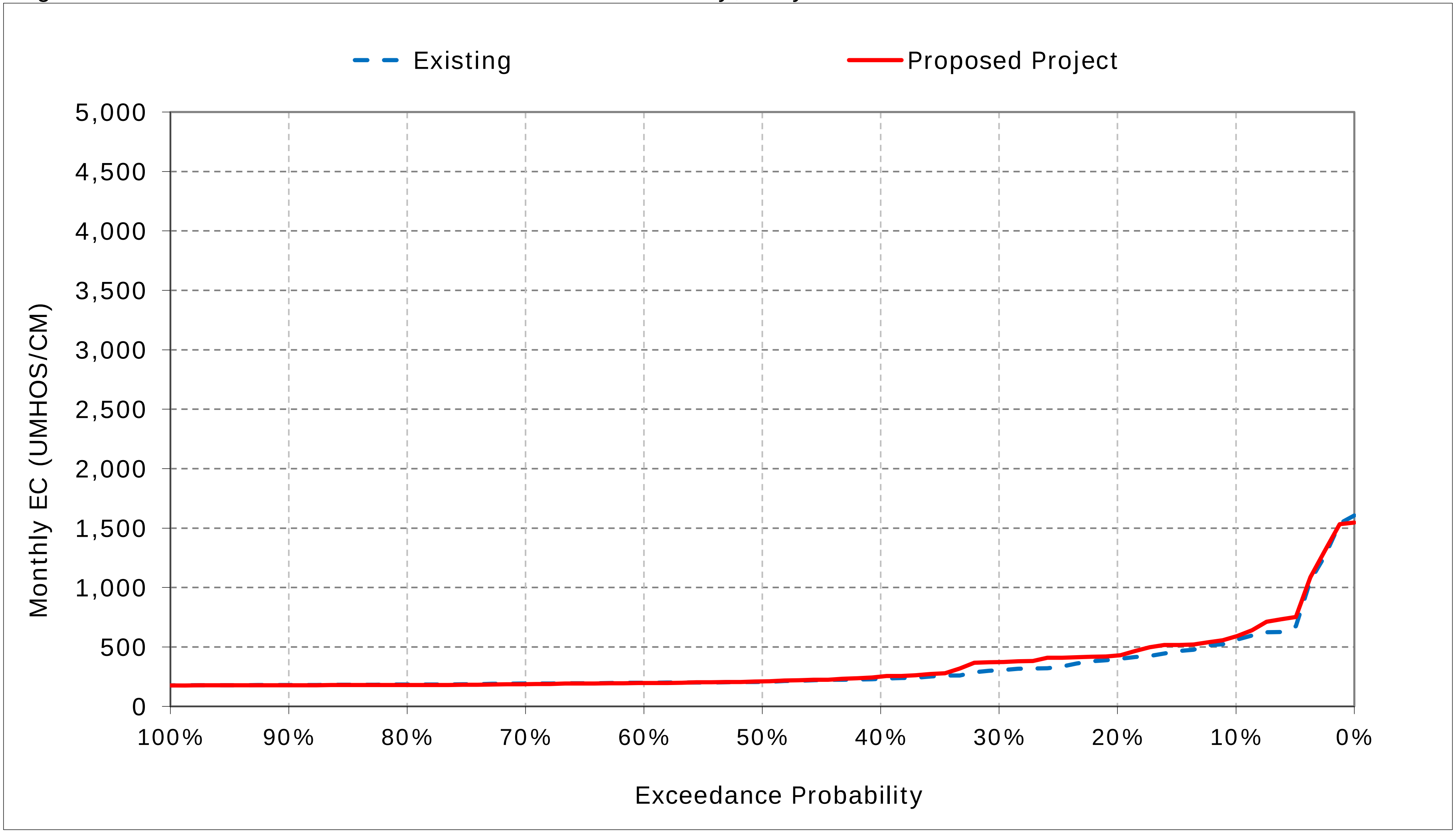


Figure 5-12. Sacramento River at Emmaton Salinity, June EC

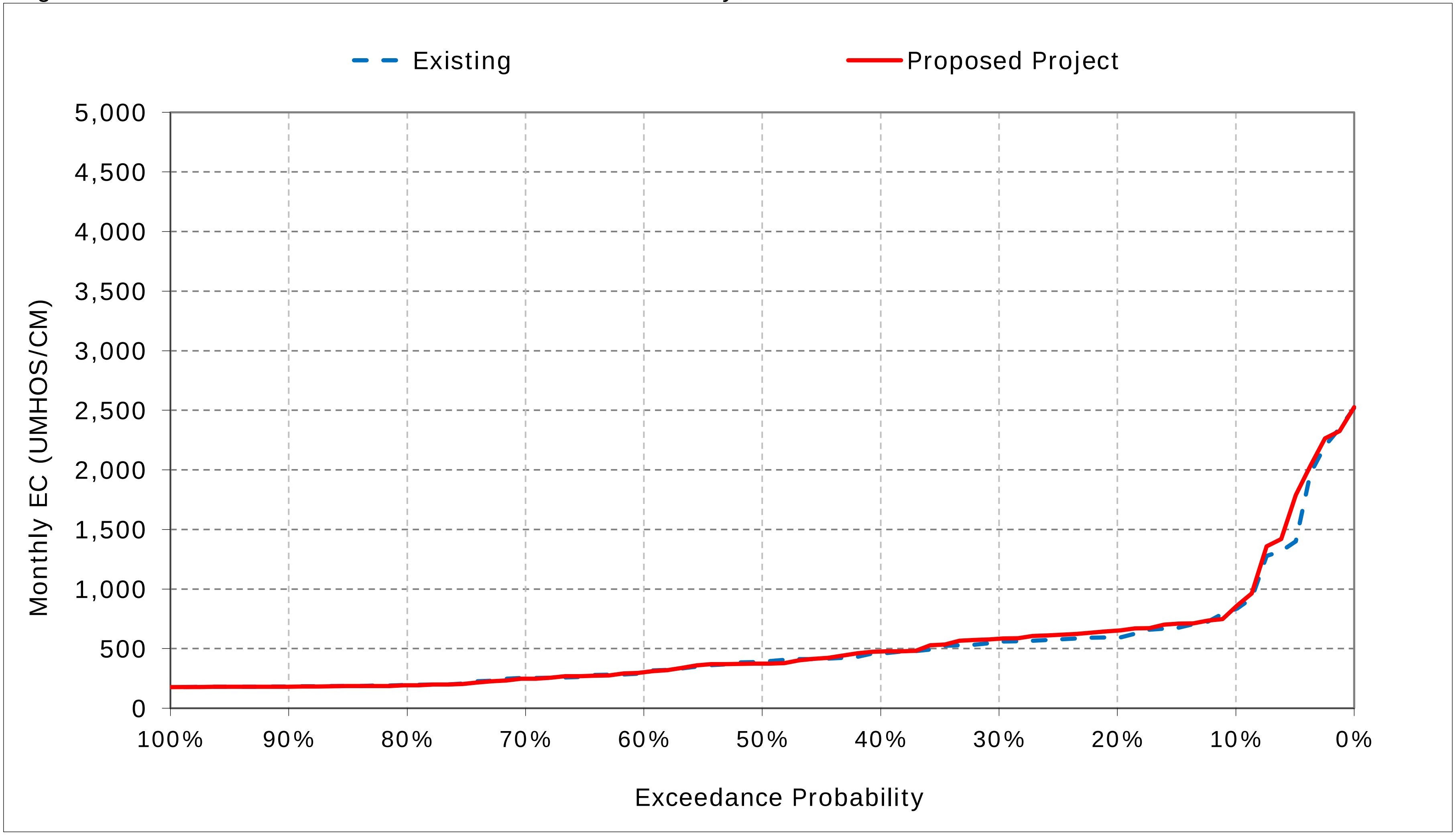


Figure 5-13. Sacramento River at Emmaton Salinity, July EC

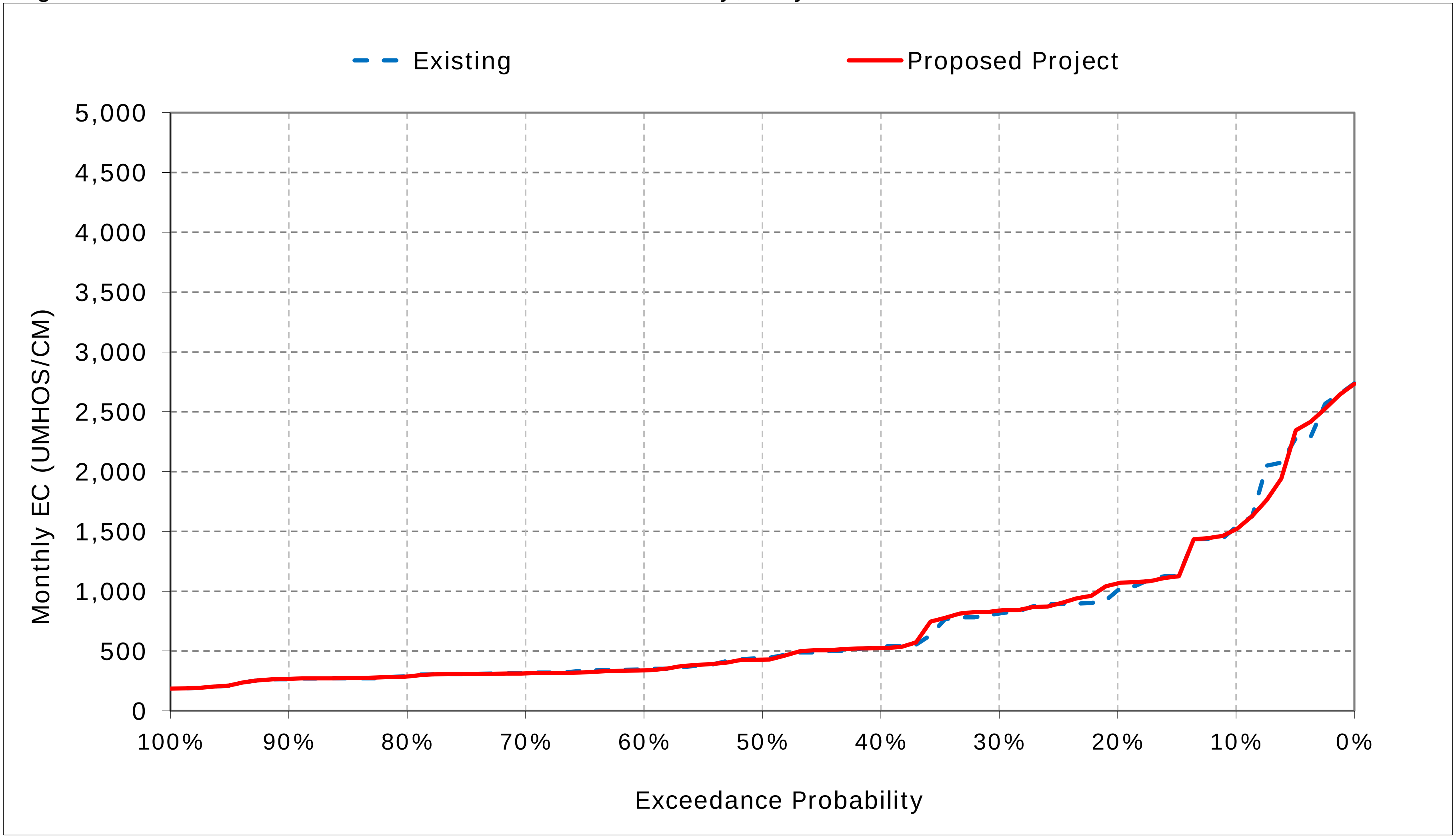


Figure 5-14. Sacramento River at Emmaton Salinity, August EC

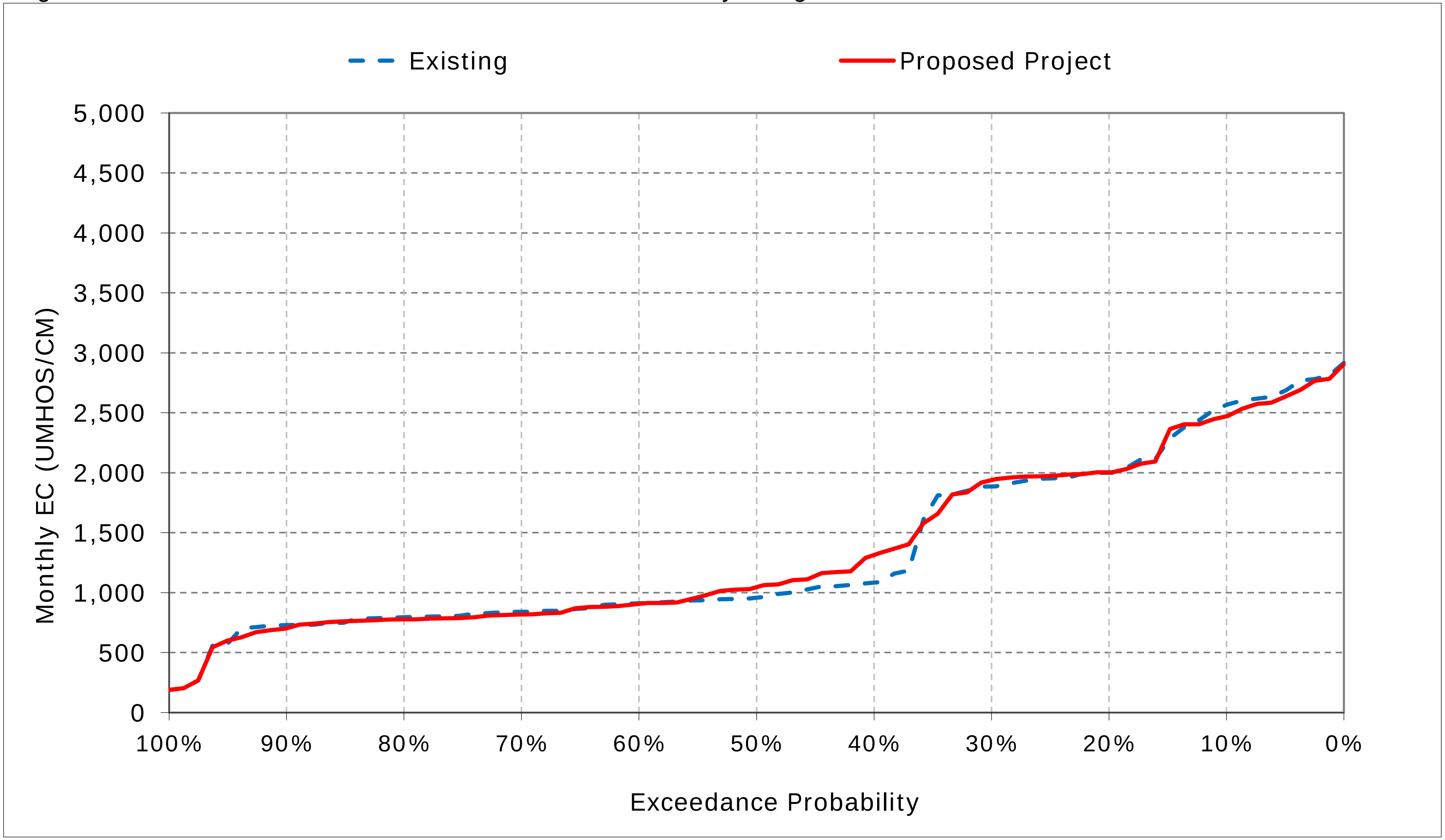


Figure 5-15. Sacramento River at Emmaton Salinity, September EC

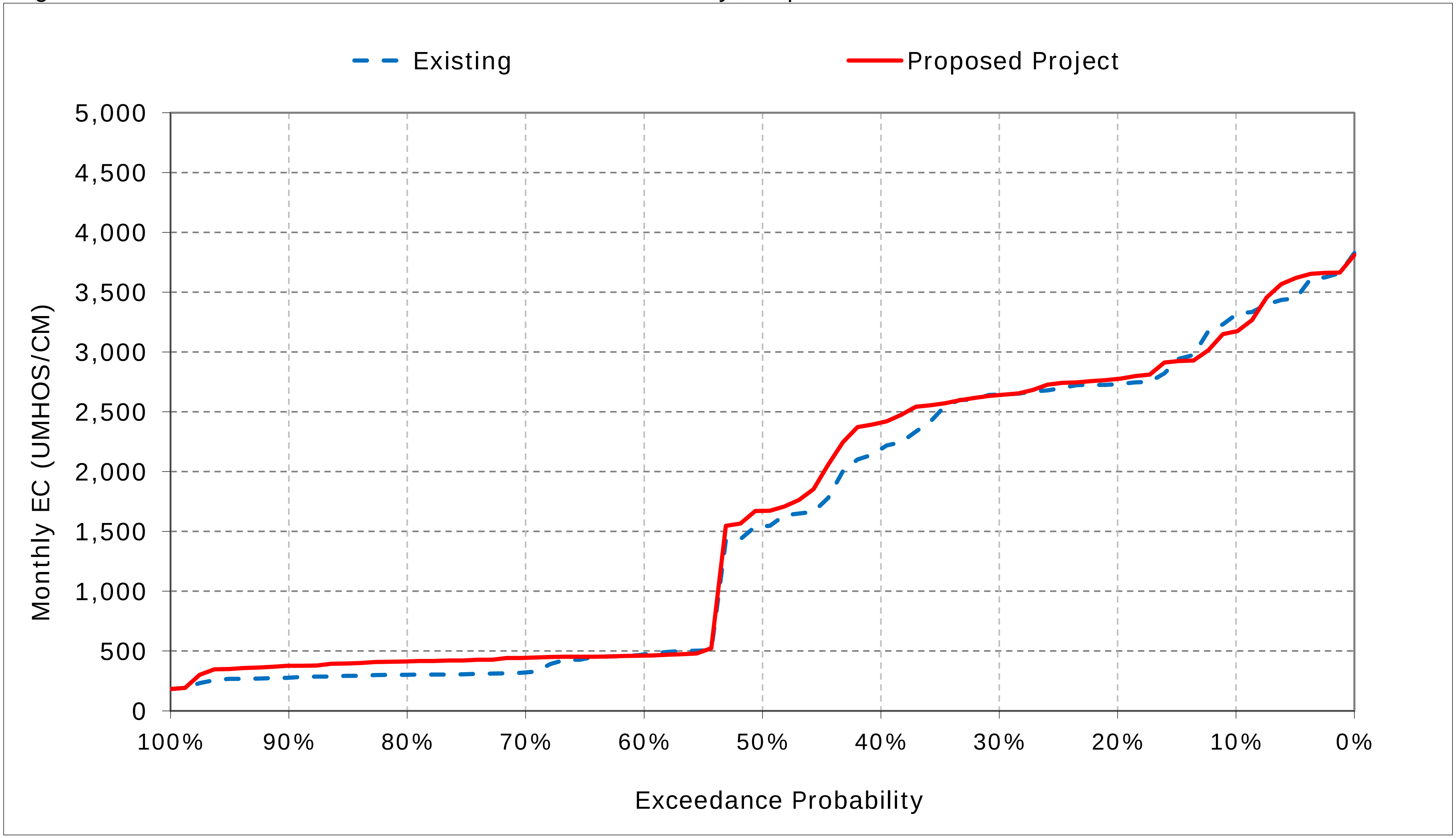


Figure 5-16. Sacramento River at Emmaton Salinity, October EC

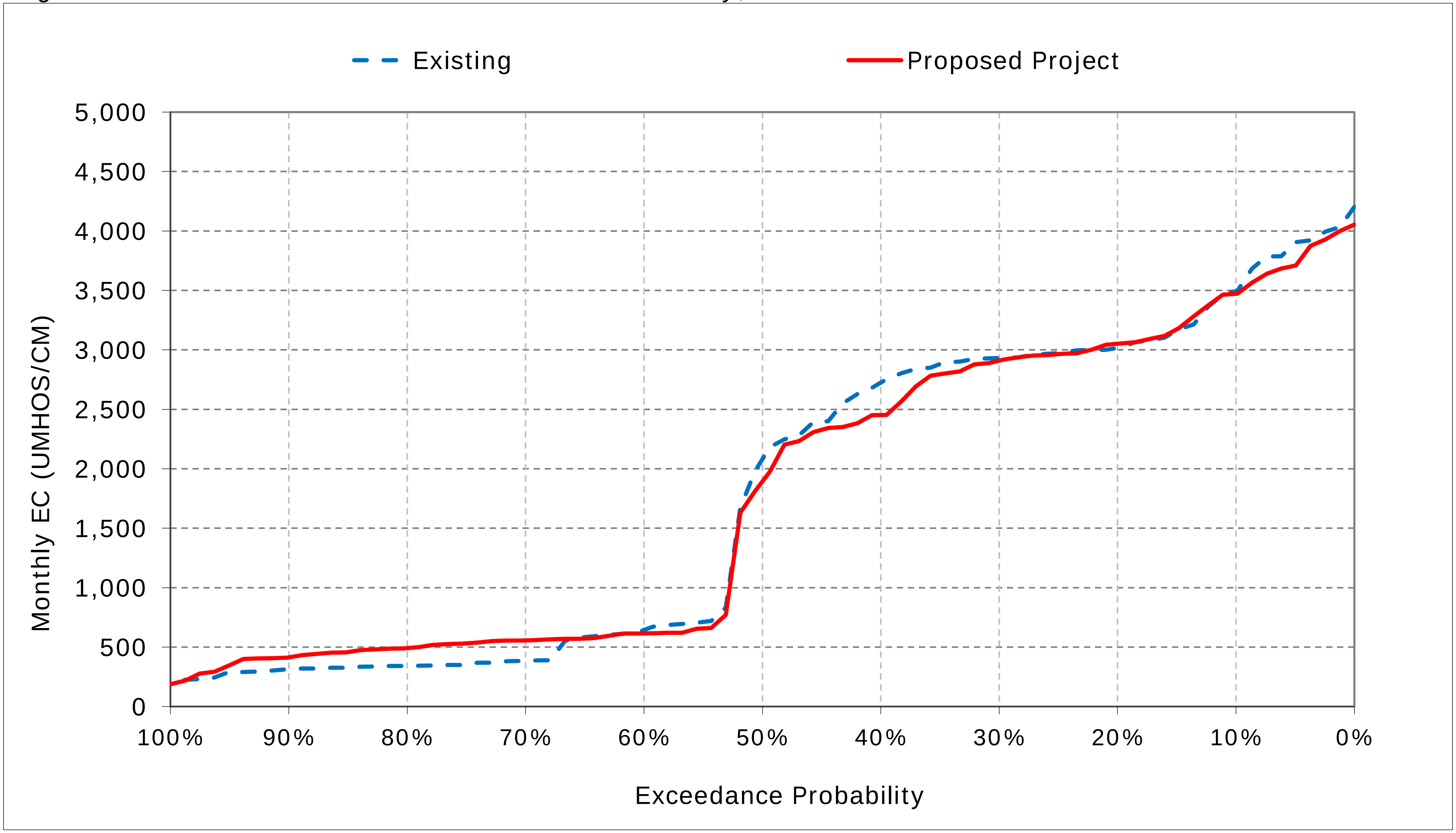


Figure 5-17. Sacramento River at Emmaton Salinity, November EC

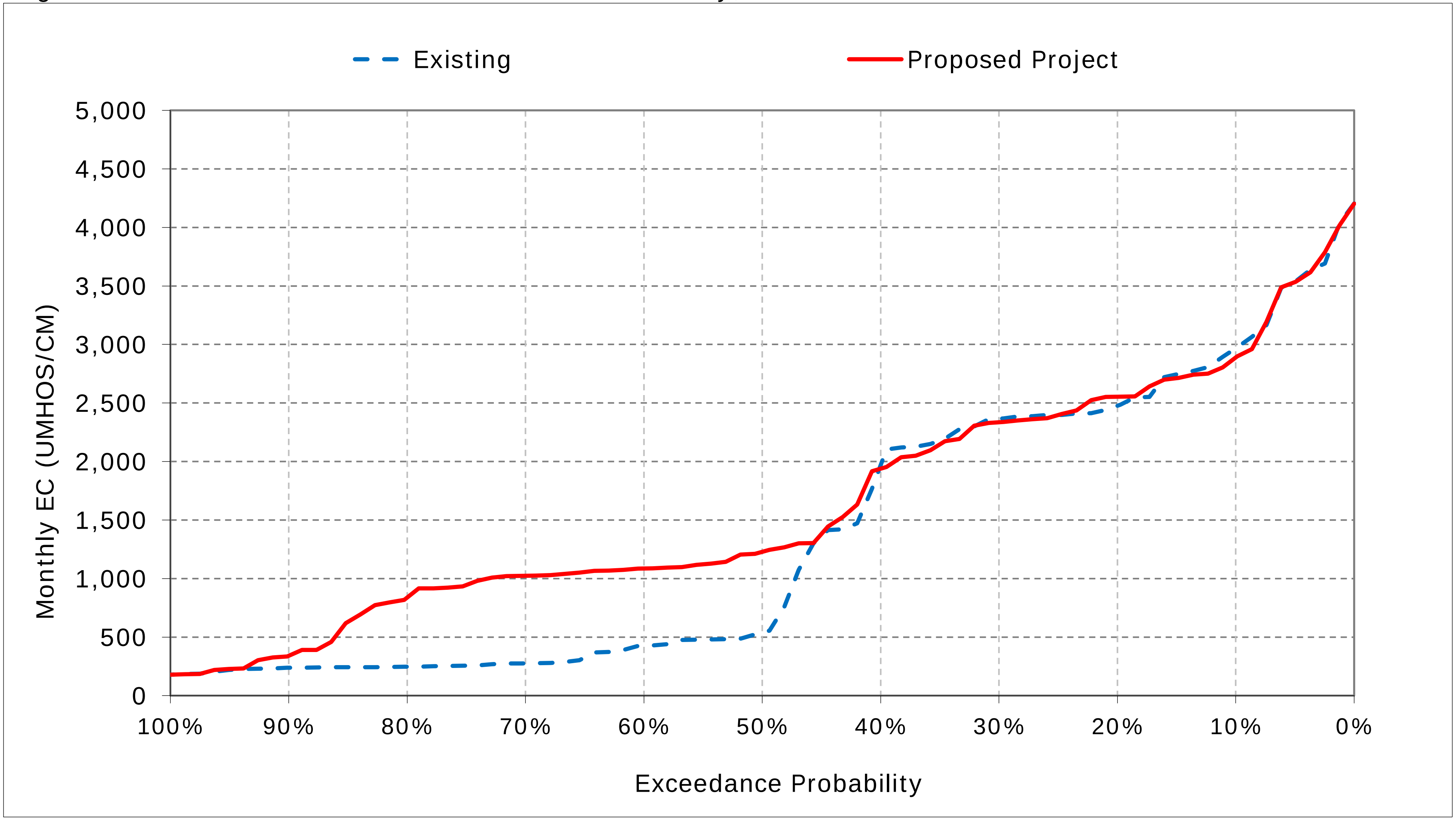


Figure 5-18. Sacramento River at Emmaton Salinity, December EC

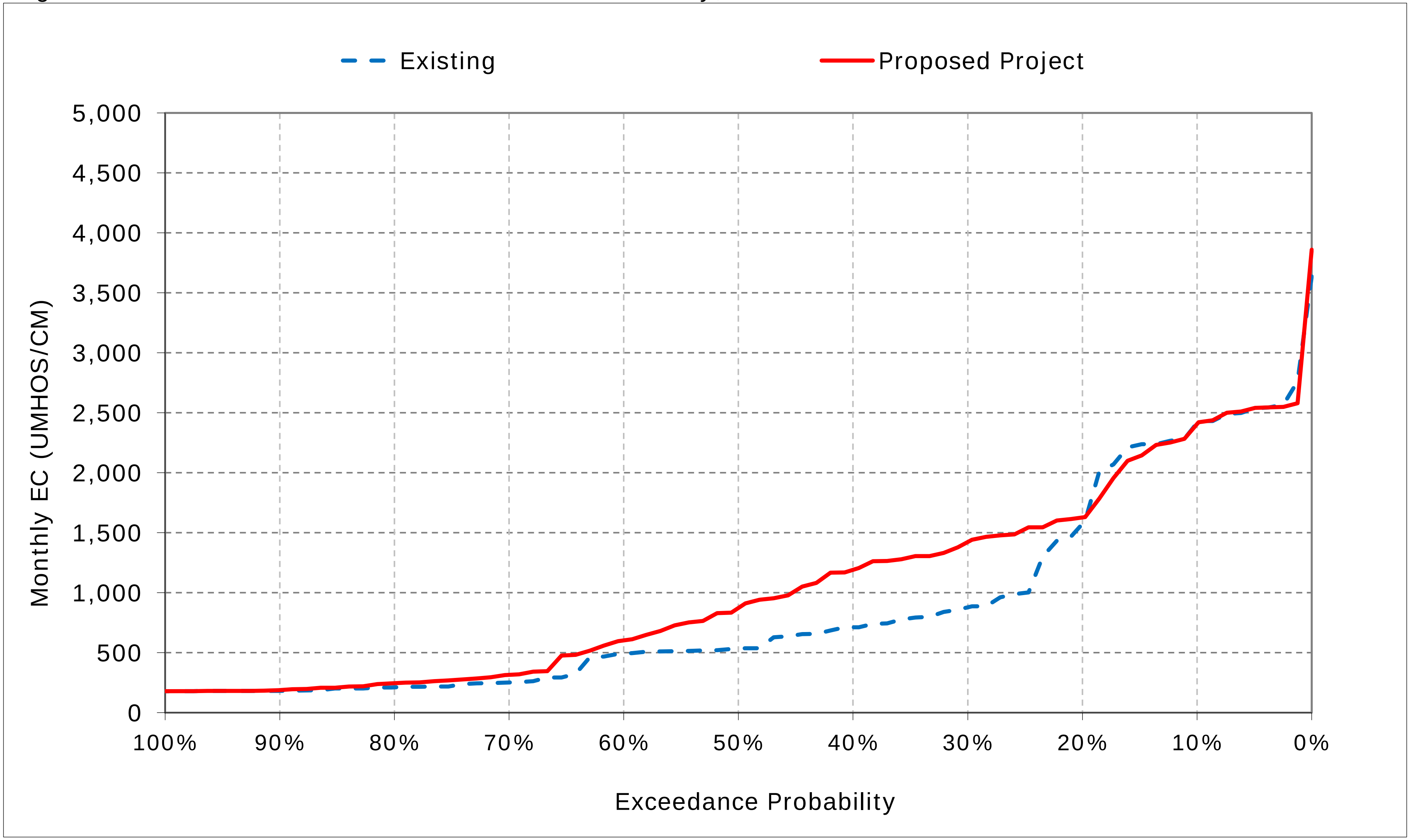


Table 6-1. Sacramento River at Collinsville Salinity, Monthly EC

Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	10,576	9,848	9,110	5,105	2,153	1,842	2,026	3,079	4,154	6,137	8,347	9,582
20%	9,842	9,273	7,373	4,259	1,341	965	1,027	2,112	3,307	5,010	7,170	8,936
30%	9,646	9,043	4,970	3,105	672	409	536	1,575	3,161	4,557	6,921	8,738
40%	9,323	8,431	4,102	1,656	393	313	407	851	2,547	3,240	5,285	7,855
50%	8,256	3,431	3,308	1,242	307	241	282	507	2,124	2,813	4,844	6,723
60%	3,721	2,939	3,073	649	215	209	221	349	1,490	2,140	4,720	2,769
70%	1,999	1,622	1,015	236	200	193	205	258	1,082	1,957	4,400	1,435
80%	1,856	1,375	518	205	192	189	195	200	468	1,696	4,159	1,261
90%	1,734	1,254	228	189	188	187	188	188	202	1,244	3,922	1,150
Long Term												
Full Simulation Period[a]	6,225	5,334	3,898	2,034	825	598	694	1,198	2,287	3,353	5,506	5,364
Water Year Types[b]												
Wet (32%)	4,702	3,187	1,148	404	202	200	220	295	726	1,457	3,869	1,153
Above Normal (15%)	6,525	5,298	3,716	1,157	344	206	239	342	1,446	1,943	4,256	2,698
Below Normal (17%)	6,541	5,825	5,091	2,147	511	414	447	787	2,047	3,006	5,064	7,241
Dry (22%)	6,655	6,322	4,797	3,160	1,238	759	877	1,623	3,094	4,725	7,025	8,834
Critical (15%)	8,210	7,970	7,294	4,624	2,401	1,826	2,188	3,854	5,577	7,217	8,538	9,762

Proposed Project

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	10,439	9,621	9,107	5,883	2,047	1,861	2,202	3,282	4,219	6,086	8,218	9,547
20%	9,793	9,299	7,403	4,723	1,312	896	1,291	2,579	3,594	5,118	7,184	8,992
30%	9,615	9,068	6,897	3,477	690	366	719	2,184	3,262	4,508	6,964	8,759
40%	8,944	8,377	6,353	1,821	378	289	513	1,187	2,832	3,513	6,273	8,297
50%	7,945	6,073	5,110	1,210	314	229	343	753	2,148	2,980	5,421	6,850
60%	3,501	5,702	3,633	590	215	206	229	547	1,722	2,104	4,669	2,638
70%	3,281	5,530	1,351	240	199	194	209	332	1,261	1,929	4,375	2,518
80%	3,097	4,846	855	201	193	189	191	199	484	1,721	4,096	2,358
90%	2,779	2,000	297	189	188	187	186	183	201	1,248	3,877	2,114
Long Term												
Full Simulation Period[a]	6,476	6,615	4,596	2,202	868	596	775	1,413	2,405	3,404	5,618	5,744
Water Year Types[b]												
Wet (32%)	5,073	4,815	1,527	399	199	198	244	400	834	1,462	3,785	2,222
Above Normal (15%)	6,786	6,662	4,783	1,266	285	203	275	508	1,497	1,905	4,284	2,443
Below Normal (17%)	6,811	7,029	5,973	2,194	489	395	554	1,084	2,123	3,246	5,806	7,611
Dry (22%)	6,954	7,488	5,682	3,544	1,343	737	1,021	1,983	3,283	4,794	7,073	8,879
Critical (15%)	8,096	8,673	7,822	5,044	2,628	1,874	2,315	4,040	5,727	7,211	8,519	9,796

Proposed Project minus Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-138	-228	-3	778	-106	20	176	203	65	-51	-129	-35
20%	-48	26	29	464	-29	-68	264	467	287	108	14	57
30%	-31	24	1,928	372	18	-43	183	610	101	-49	43	21
40%	-379	-54	2,251	165	-14	-23	105	336	285	273	988	442
50%	-311	2,642	1,802	-32	7	-13	61	246	25	167	577	127
60%	-219	2,764	561	-59	0	-4	7	198	232	-36	-51	-131
70%	1,282	3,909	336	5	-1	1	3	74	179	-28	-25	1,083
80%	1,241	3,471	337	-4	0	0	-4	-1	16	25	-63	1,097
90%	1,046	746	70	0	1	1	-2	-5	-1	4	-46	965
Long Term												
Full Simulation Period[a]	251	1,280	699	168	43	-2	81	215	118	51	112	380
Water Year Types[b]												
Wet (32%)	371	1,628	379	-5	-3	-2	24	104	108	5	-84	1,069
Above Normal (15%)	261	1,364	1,067	109	-58	-3	36	166	51	-39	28	-255
Below Normal (17%)	270	1,204	882	47	-22	-19	107	297	76	240	742	370
Dry (22%)	299	1,166	885	384	105	-22	145	360	189	69	49	45
Critical (15%)	-114	703	528	420	227	48	126	186	151	-6	-19	33

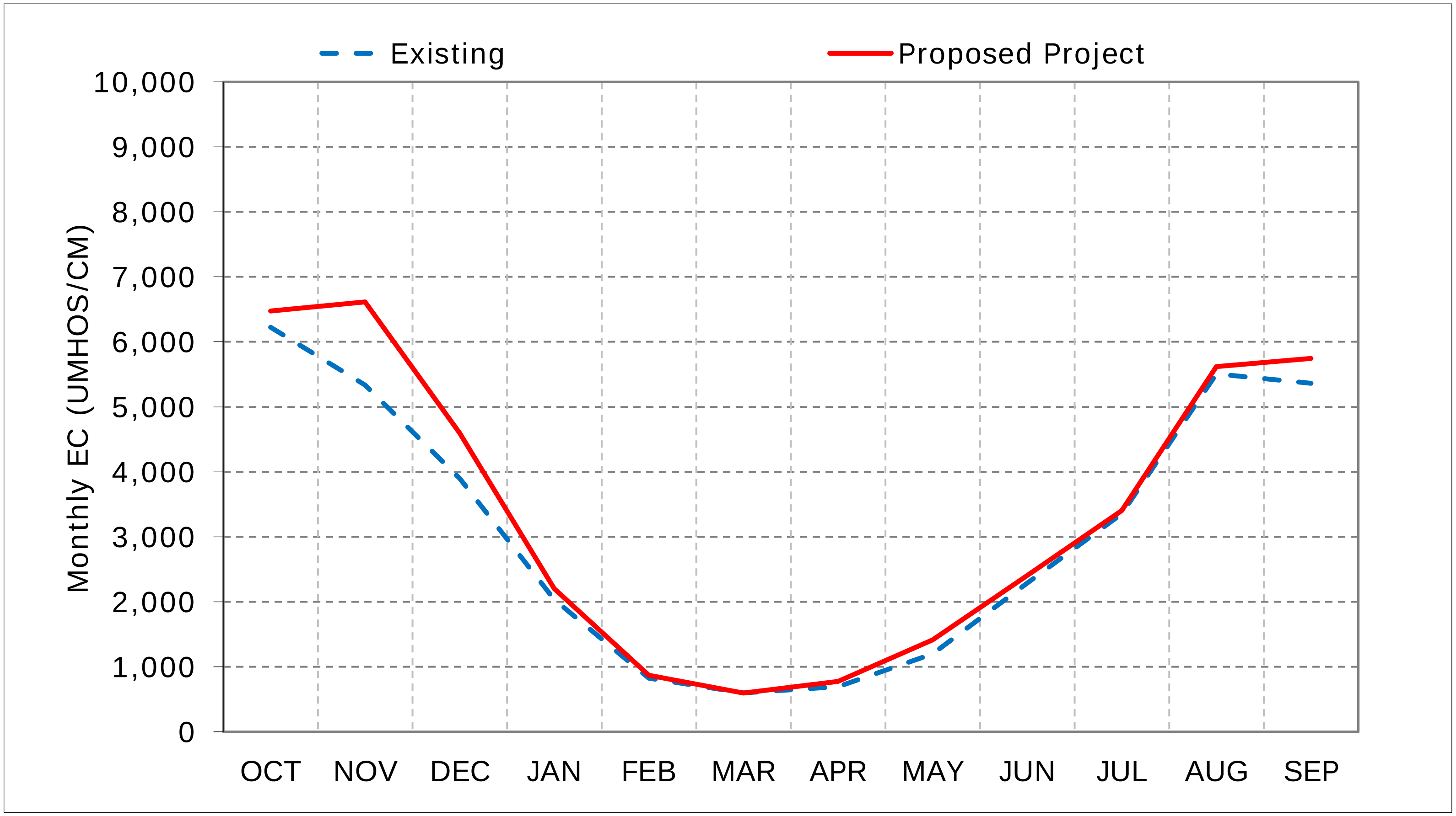
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

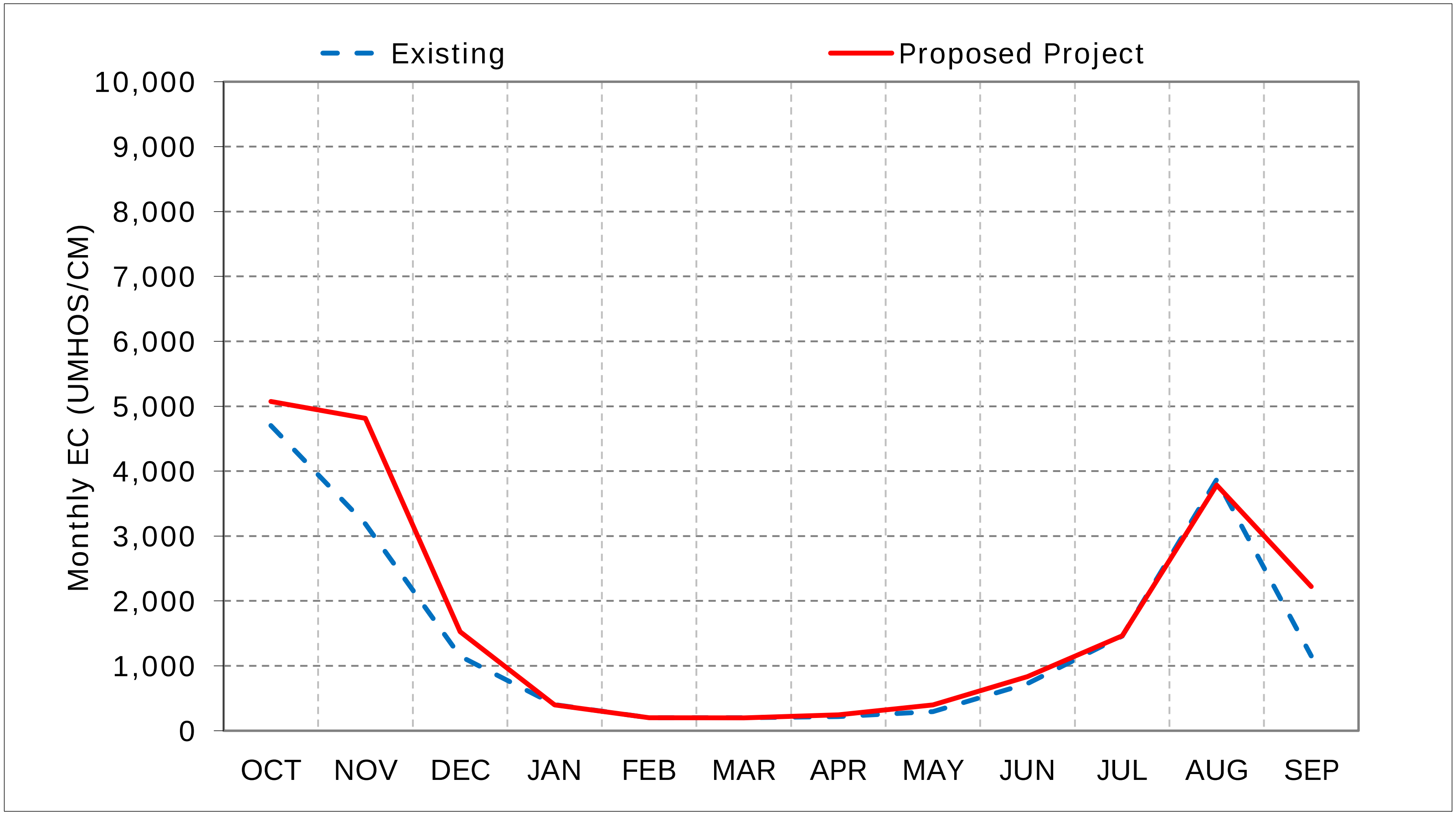
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 6-1. Sacramento River at Collinsville Salinity, Long-Term Average EC



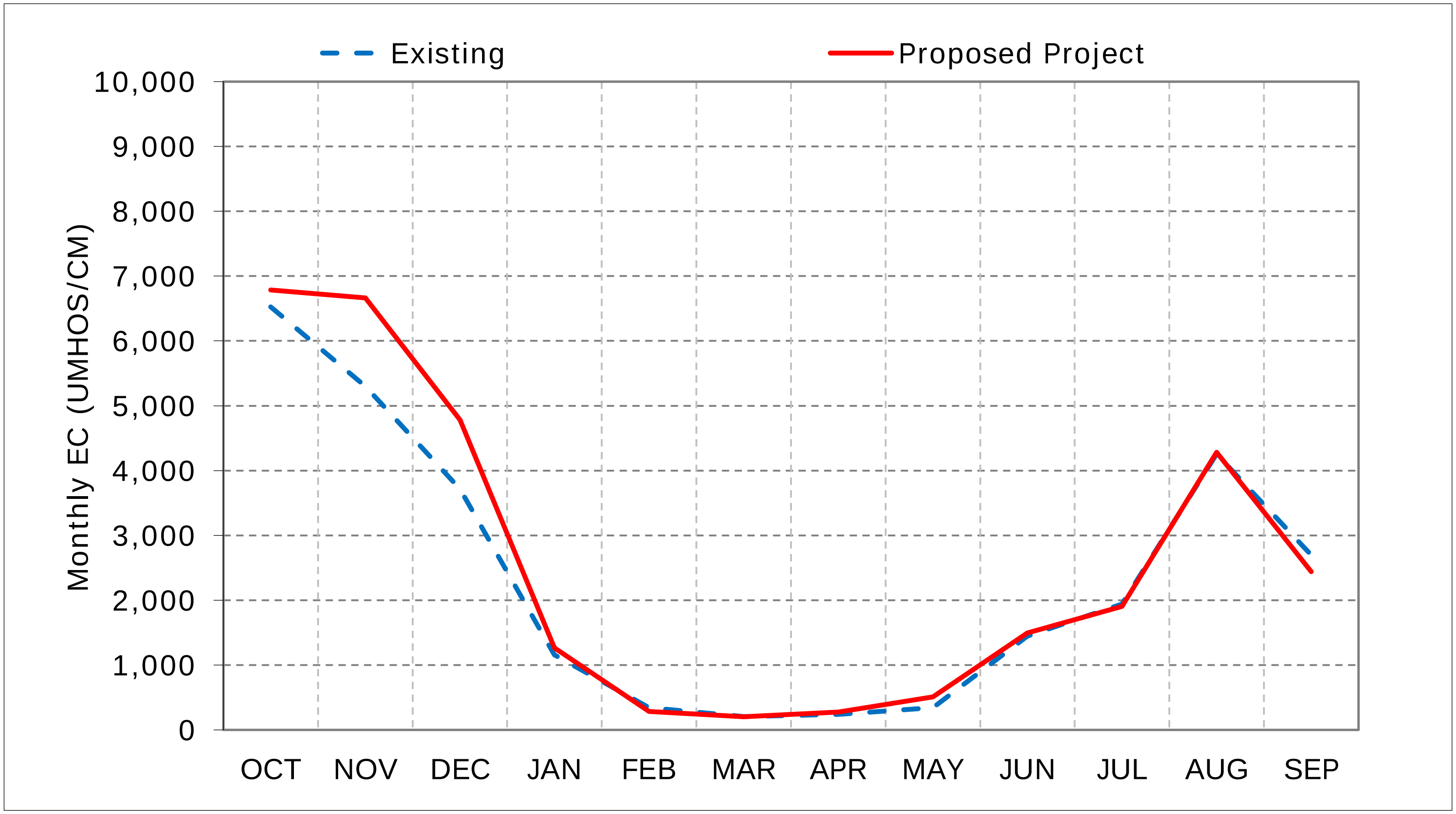
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 6-2. Sacramento River at Collinsville Salinity, Wet Year Average EC



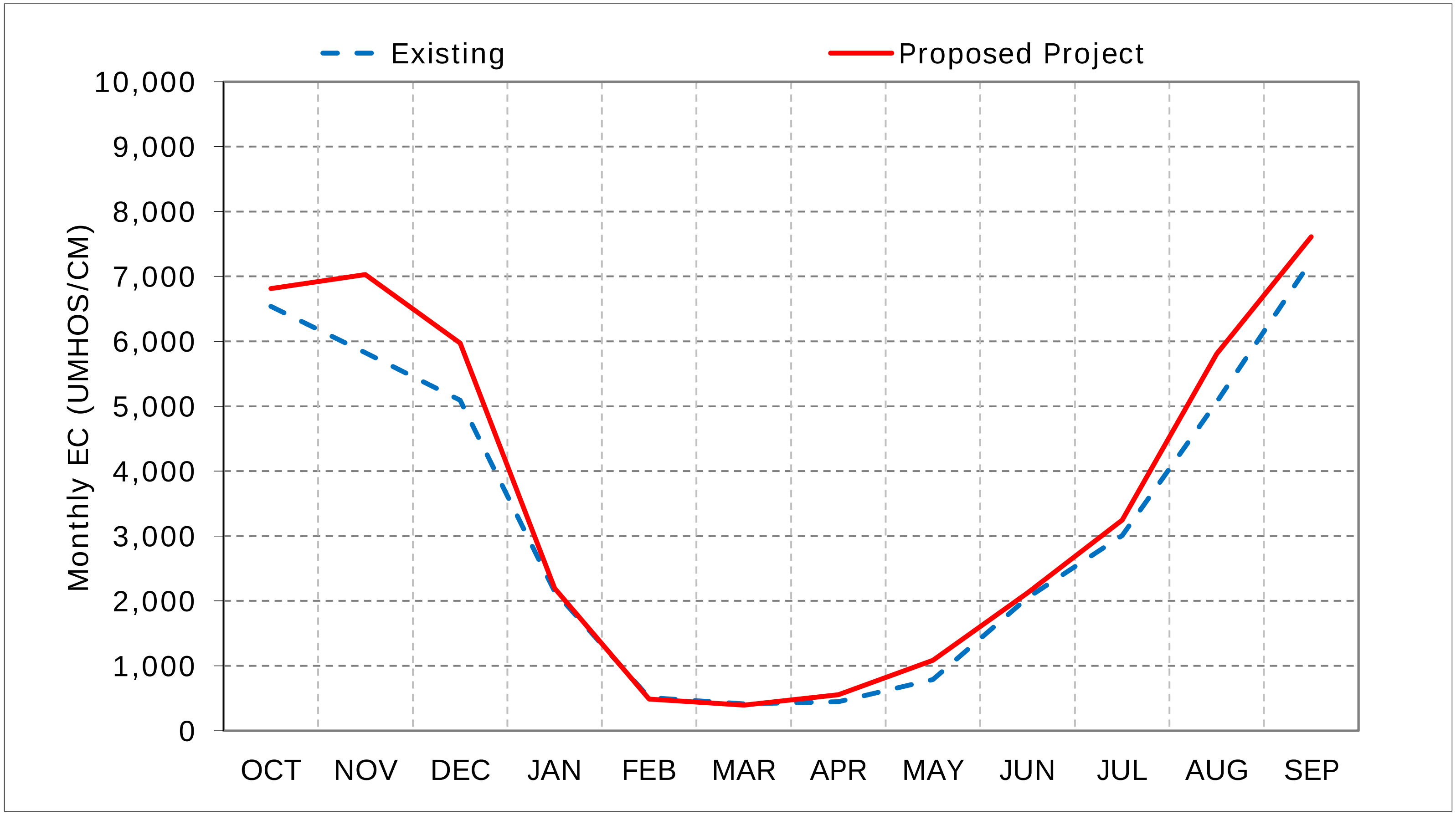
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 6-3. Sacramento River at Collinsville Salinity, Above Normal Year Average E



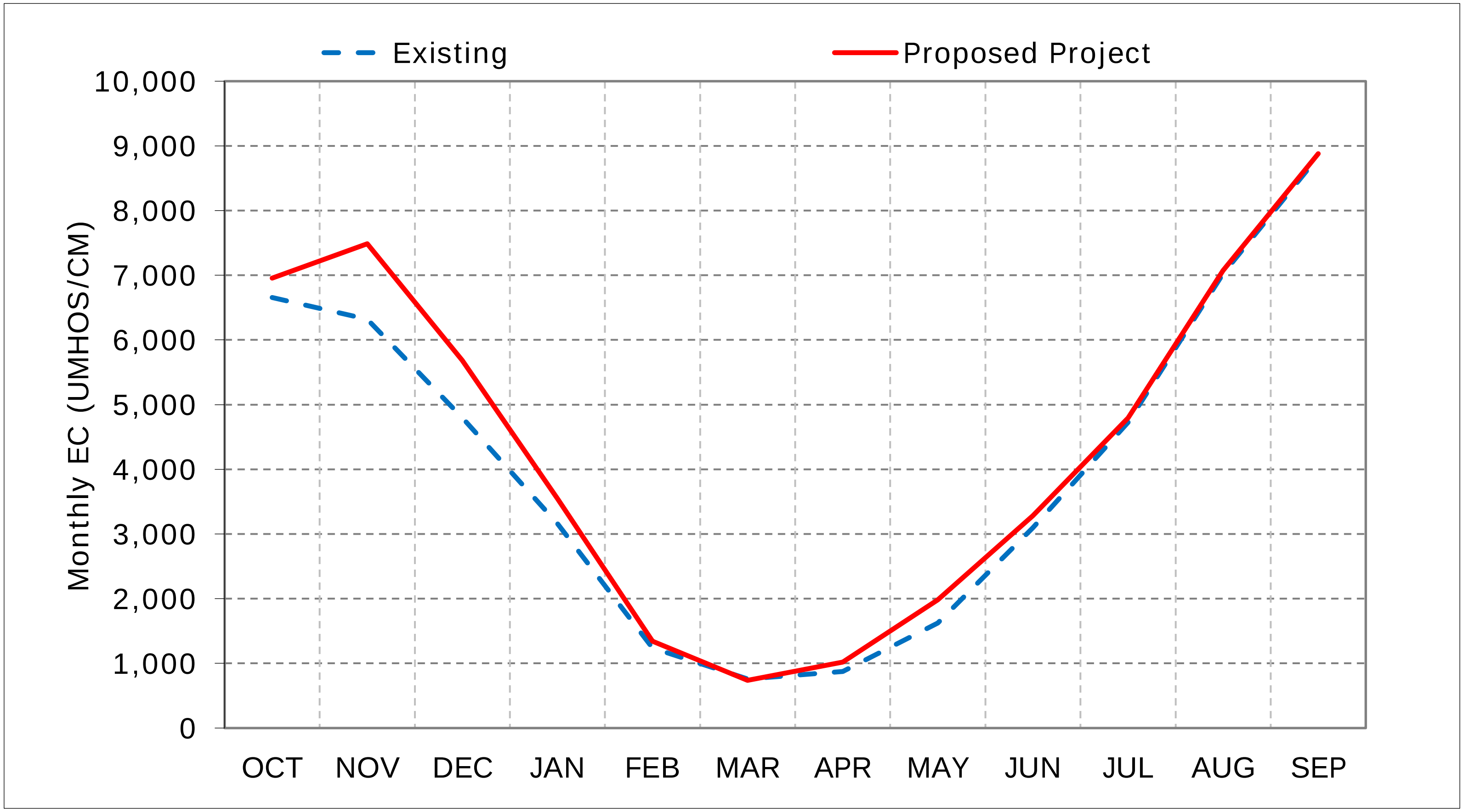
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 6-4. Sacramento River at Collinsville Salinity, Below Normal Year Average E



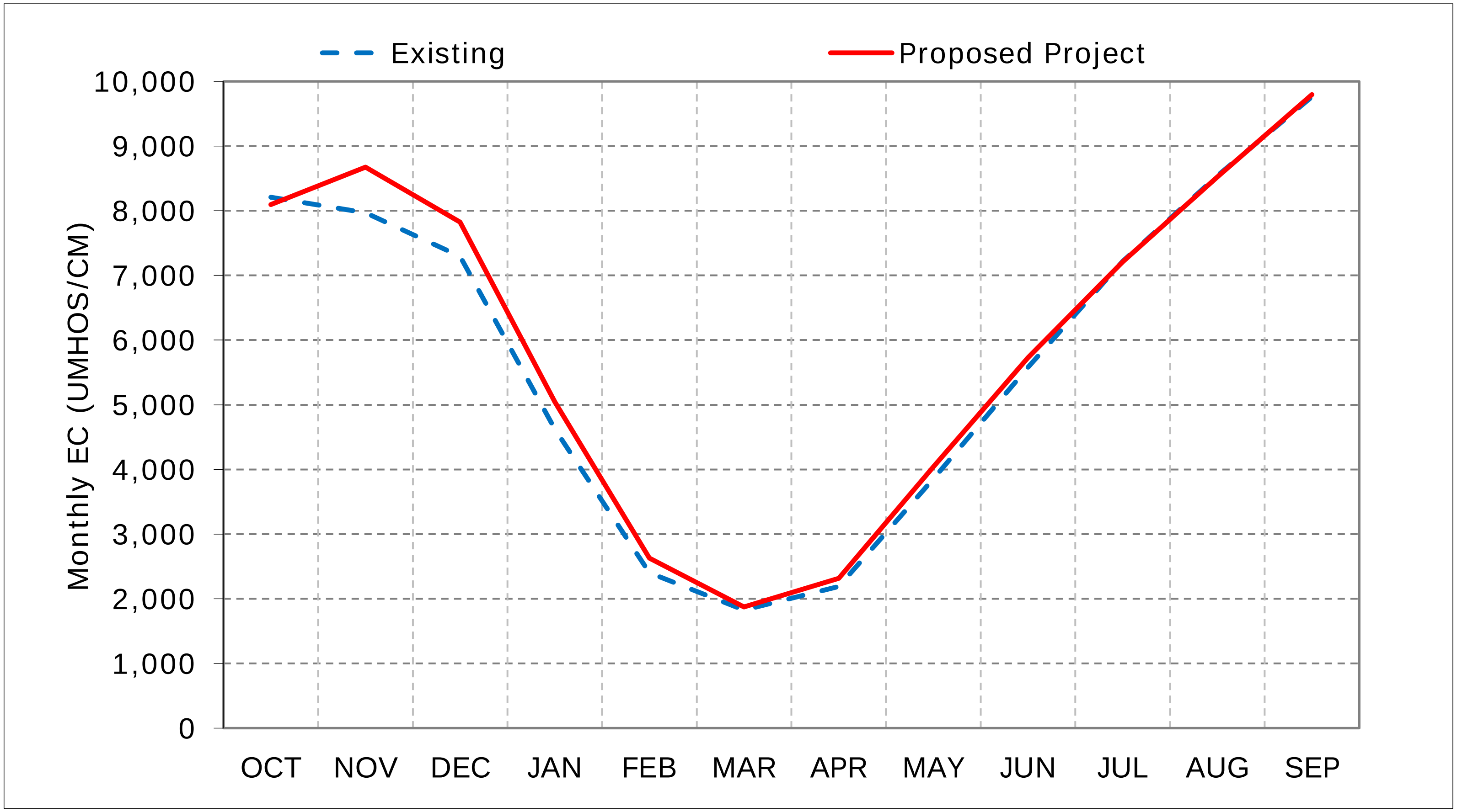
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 6-5. Sacramento River at Collinsville Salinity, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 6-6. Sacramento River at Collinsville Salinity, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 6-7. Sacramento River at Collinsville Salinity, January EC

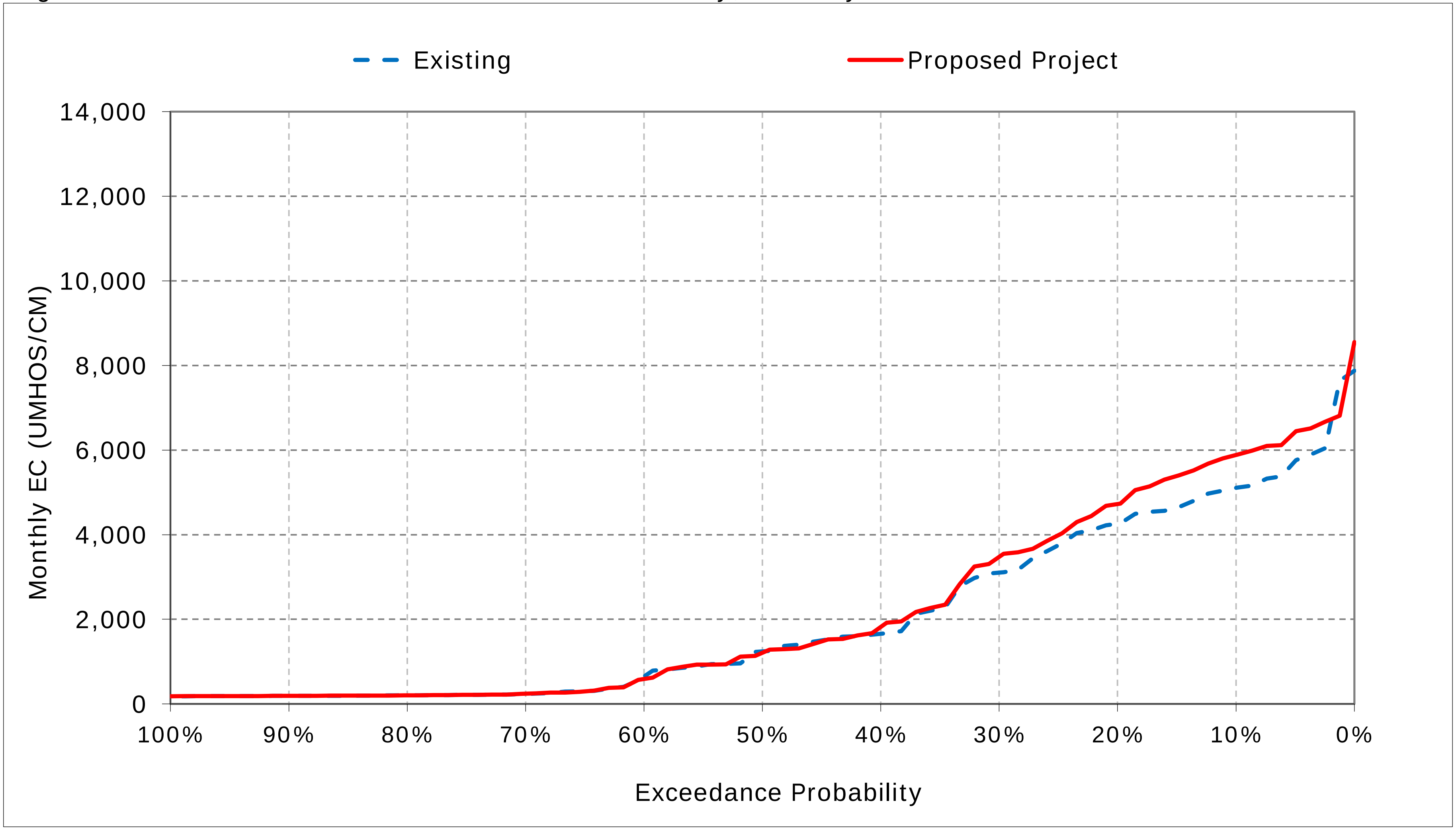


Figure 6-8. Sacramento River at Collinsville Salinity, February EC

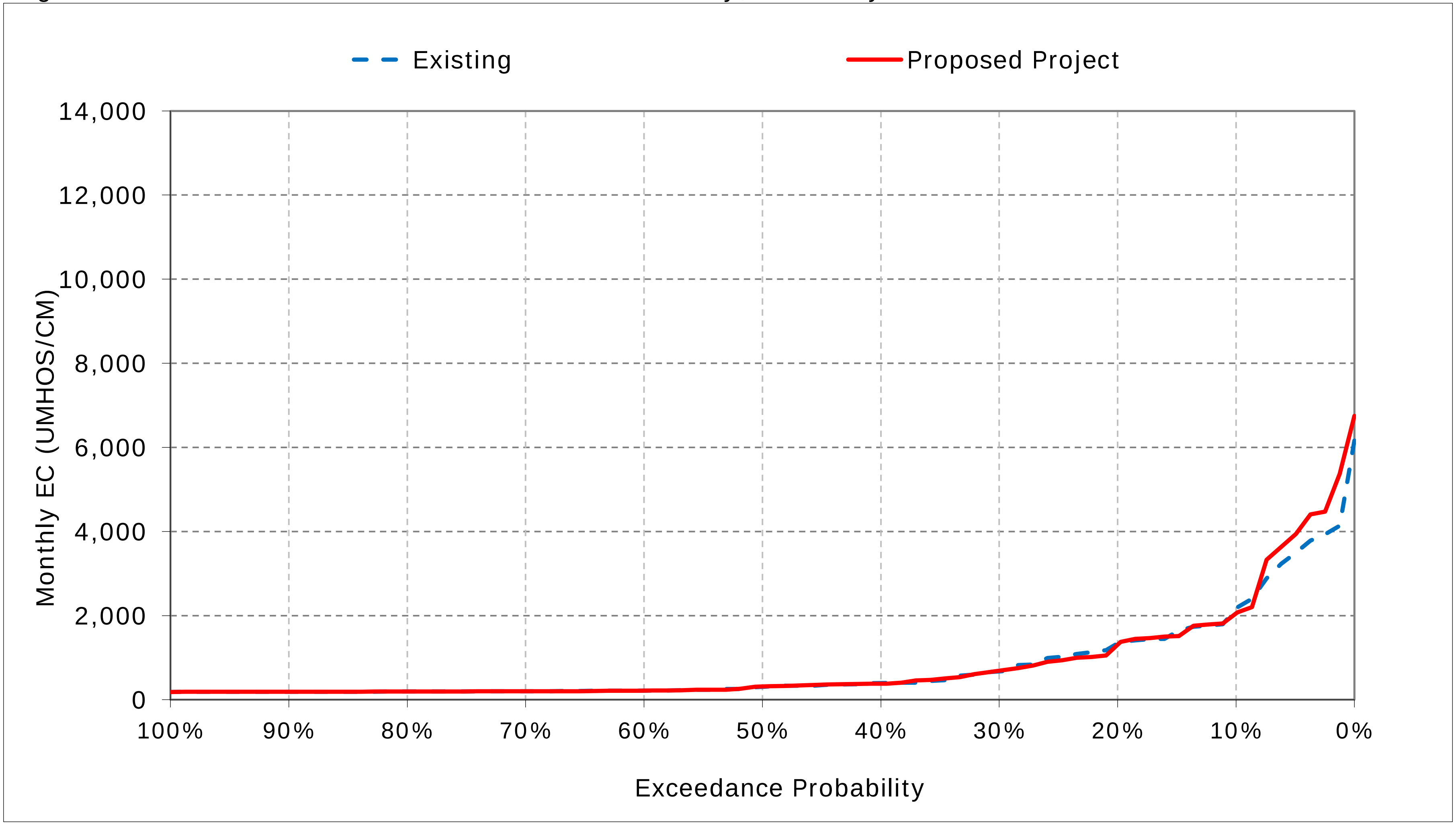


Figure 6-9. Sacramento River at Collinsville Salinity, March EC

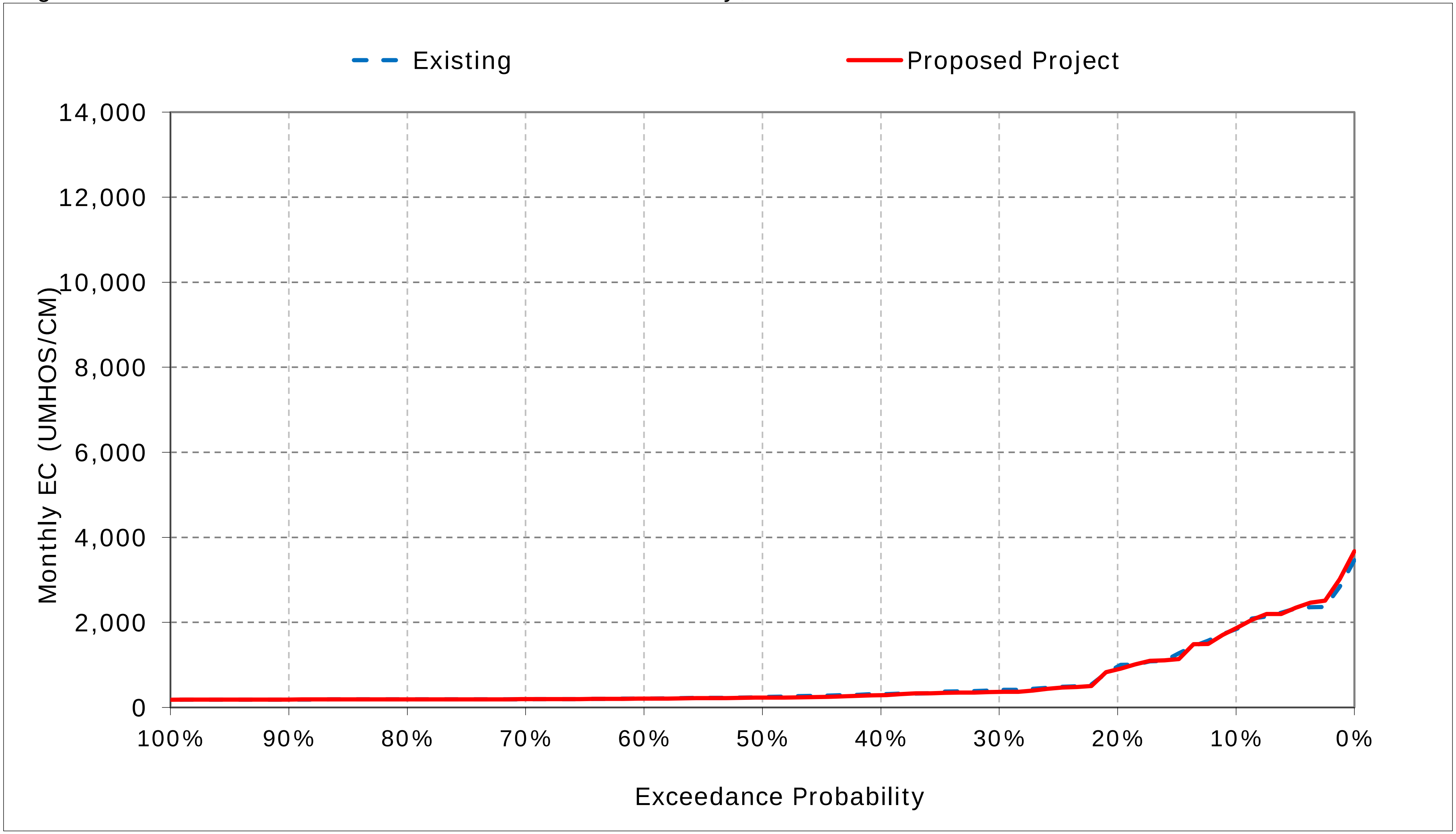


Figure 6-10. Sacramento River at Collinsville Salinity, April EC

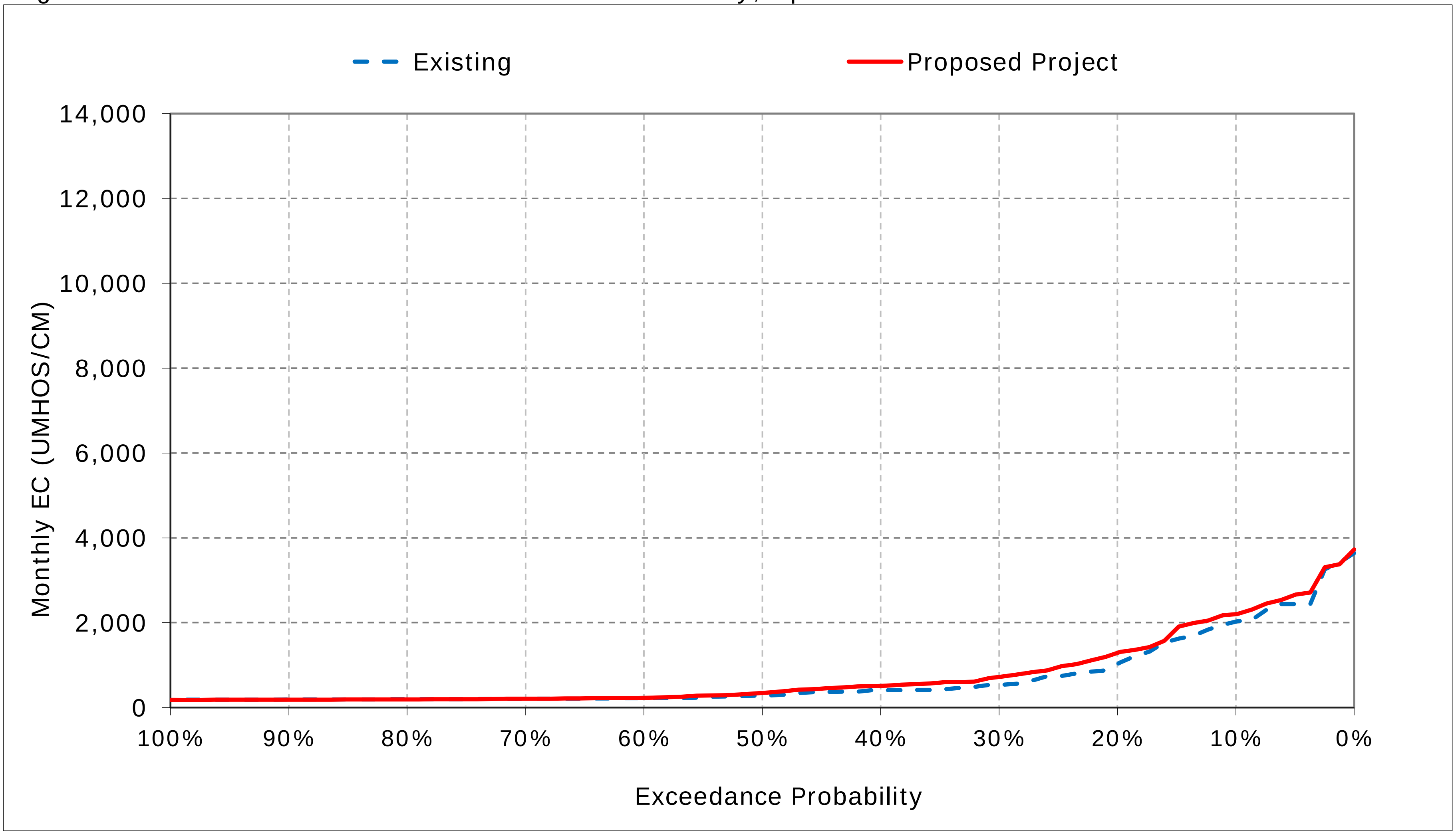


Figure 6-11. Sacramento River at Collinsville Salinity, May EC

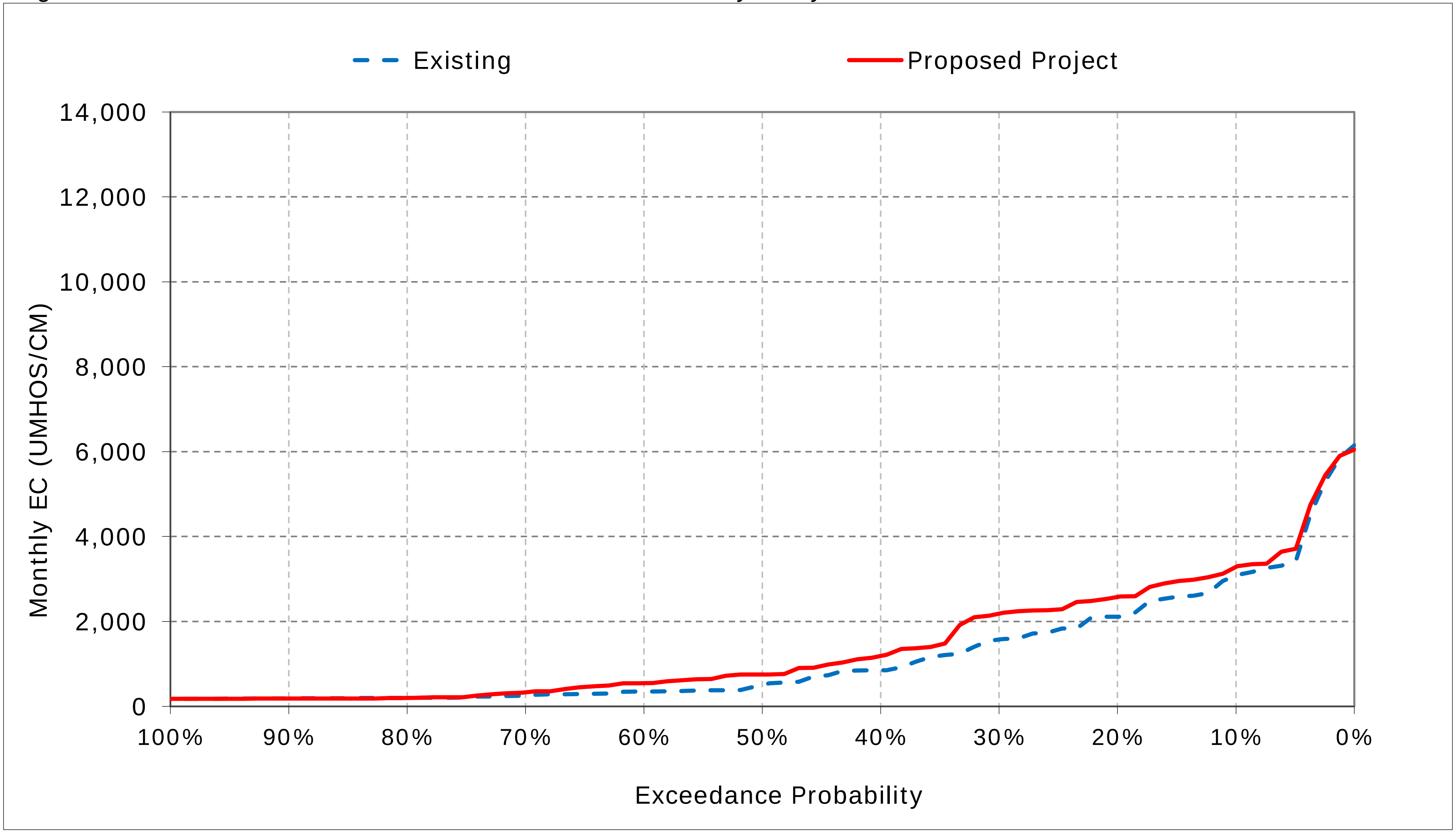


Figure 6-12. Sacramento River at Collinsville Salinity, June EC

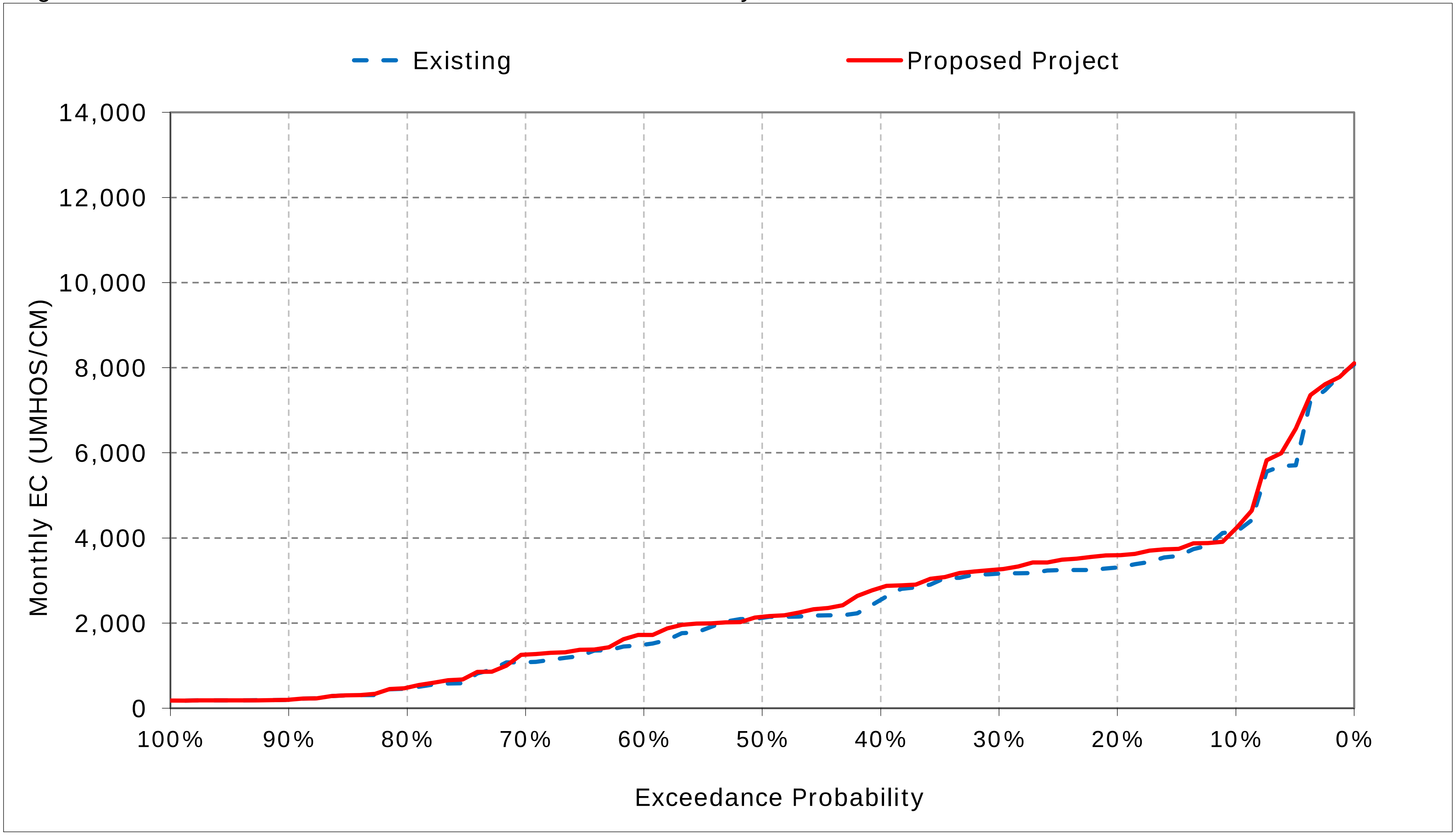


Figure 6-13. Sacramento River at Collinsville Salinity, July EC

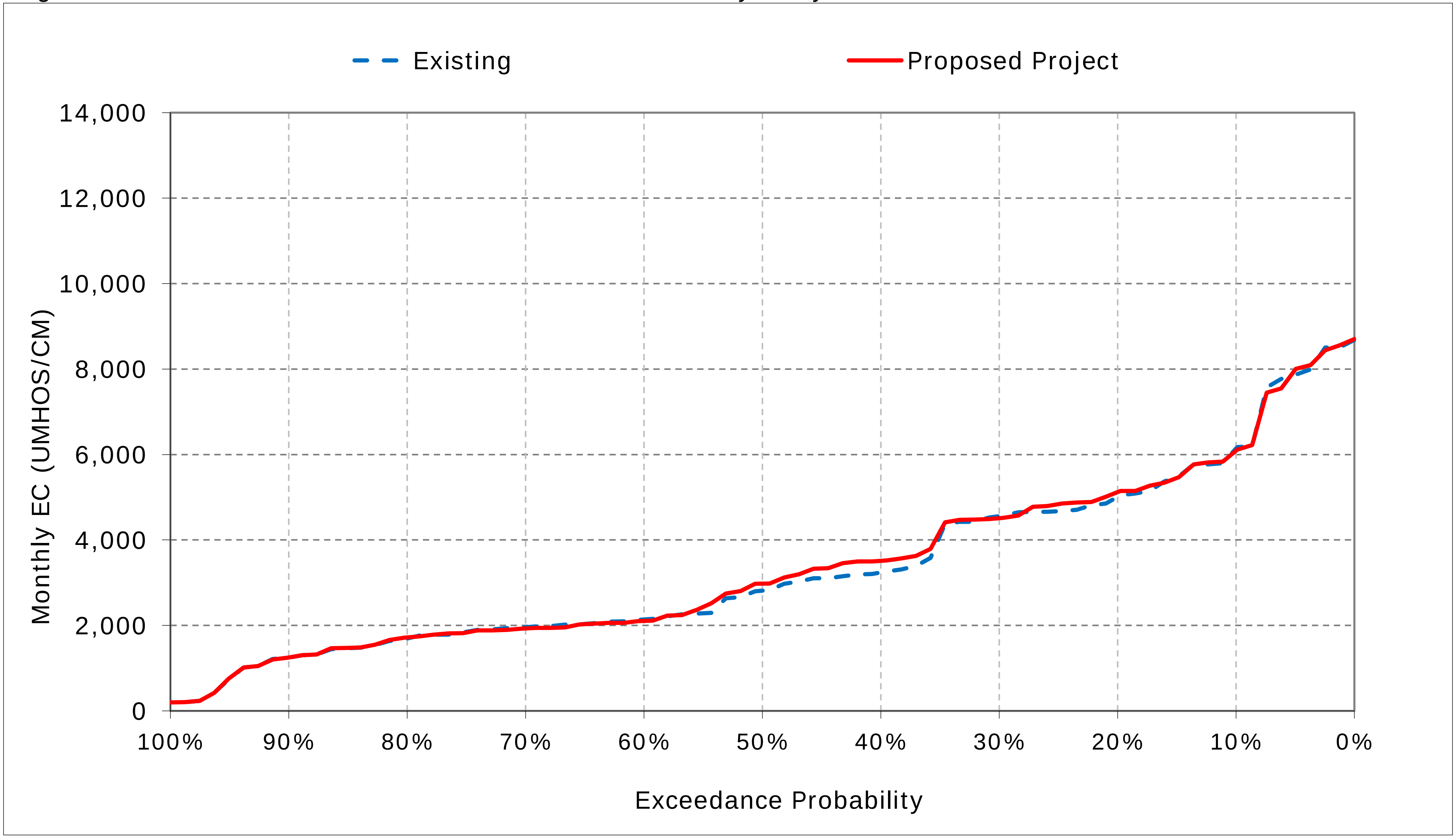


Figure 6-14. Sacramento River at Collinsville Salinity, August EC

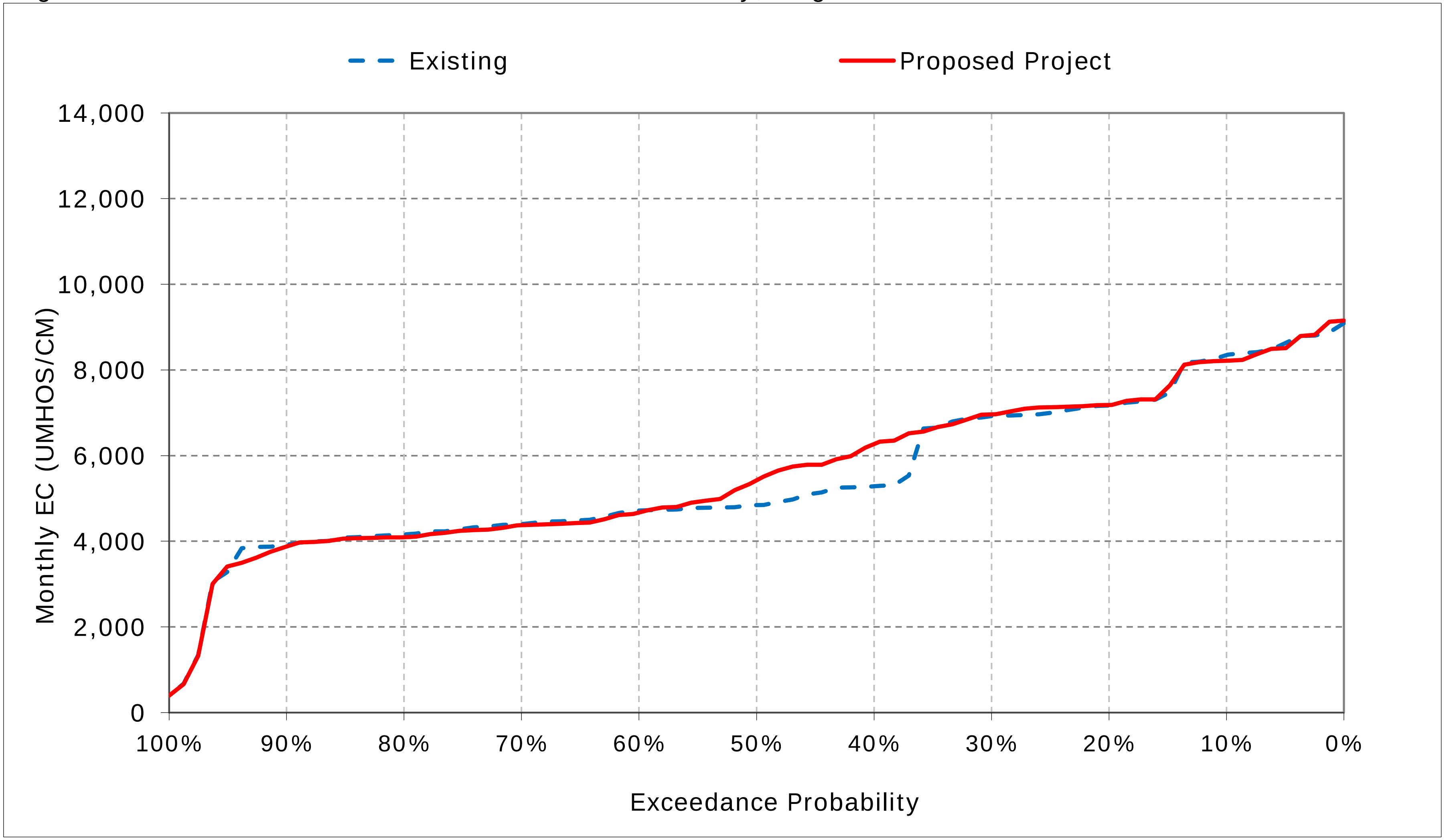


Figure 6-15. Sacramento River at Collinsville Salinity, September EC

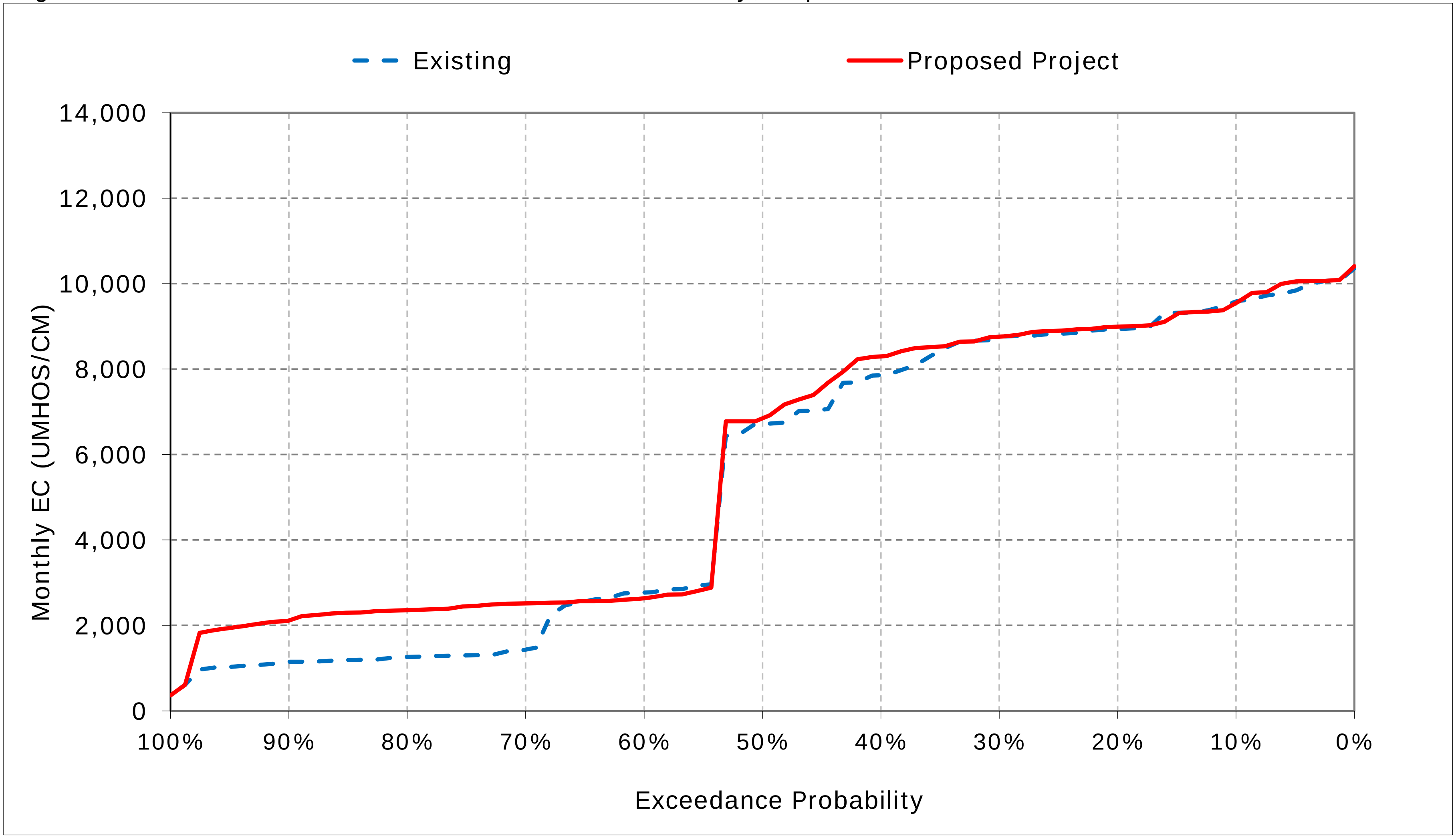


Figure 6-16. Sacramento River at Collinsville Salinity, October EC

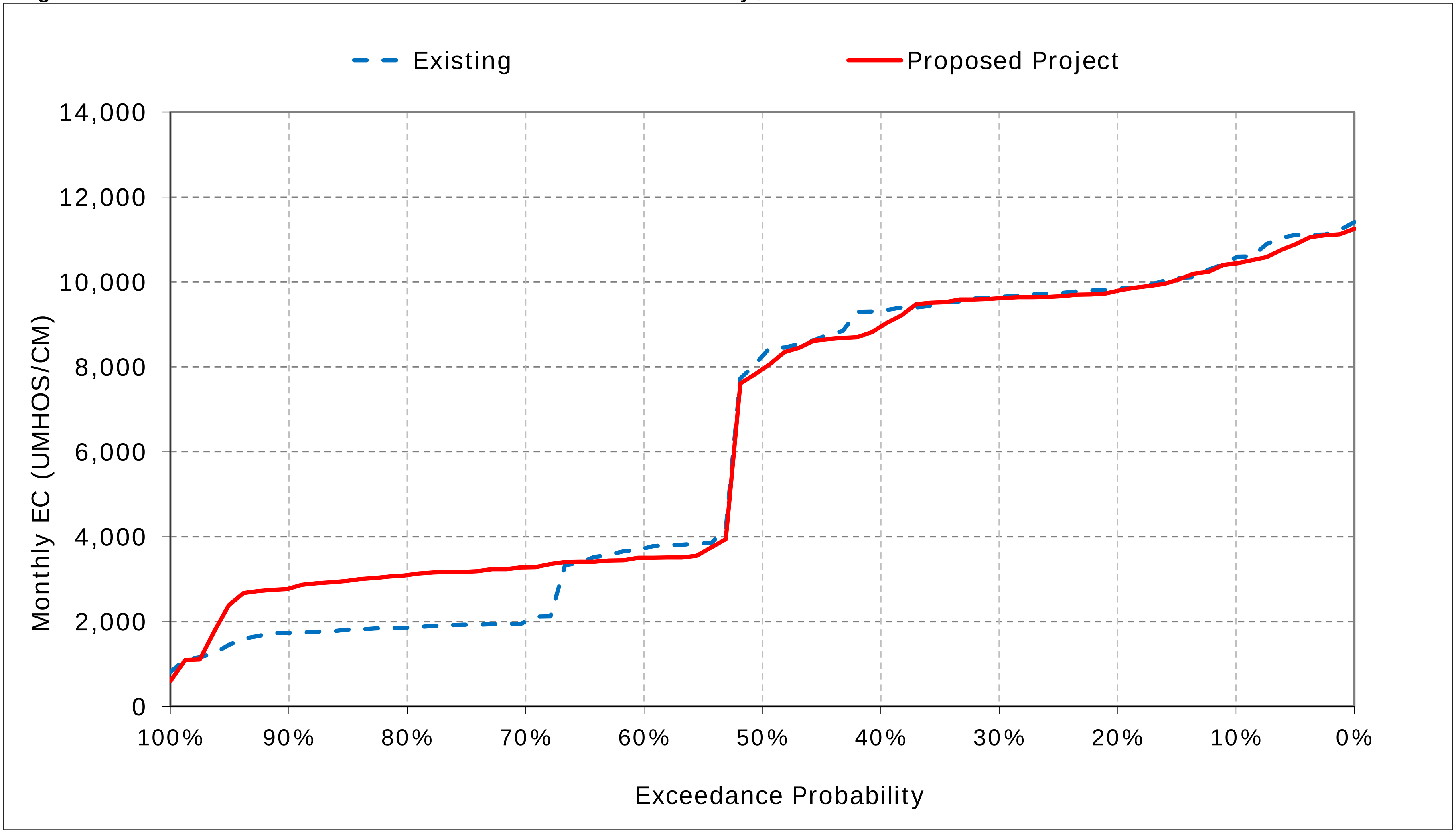


Figure 6-17. Sacramento River at Collinsville Salinity, November EC

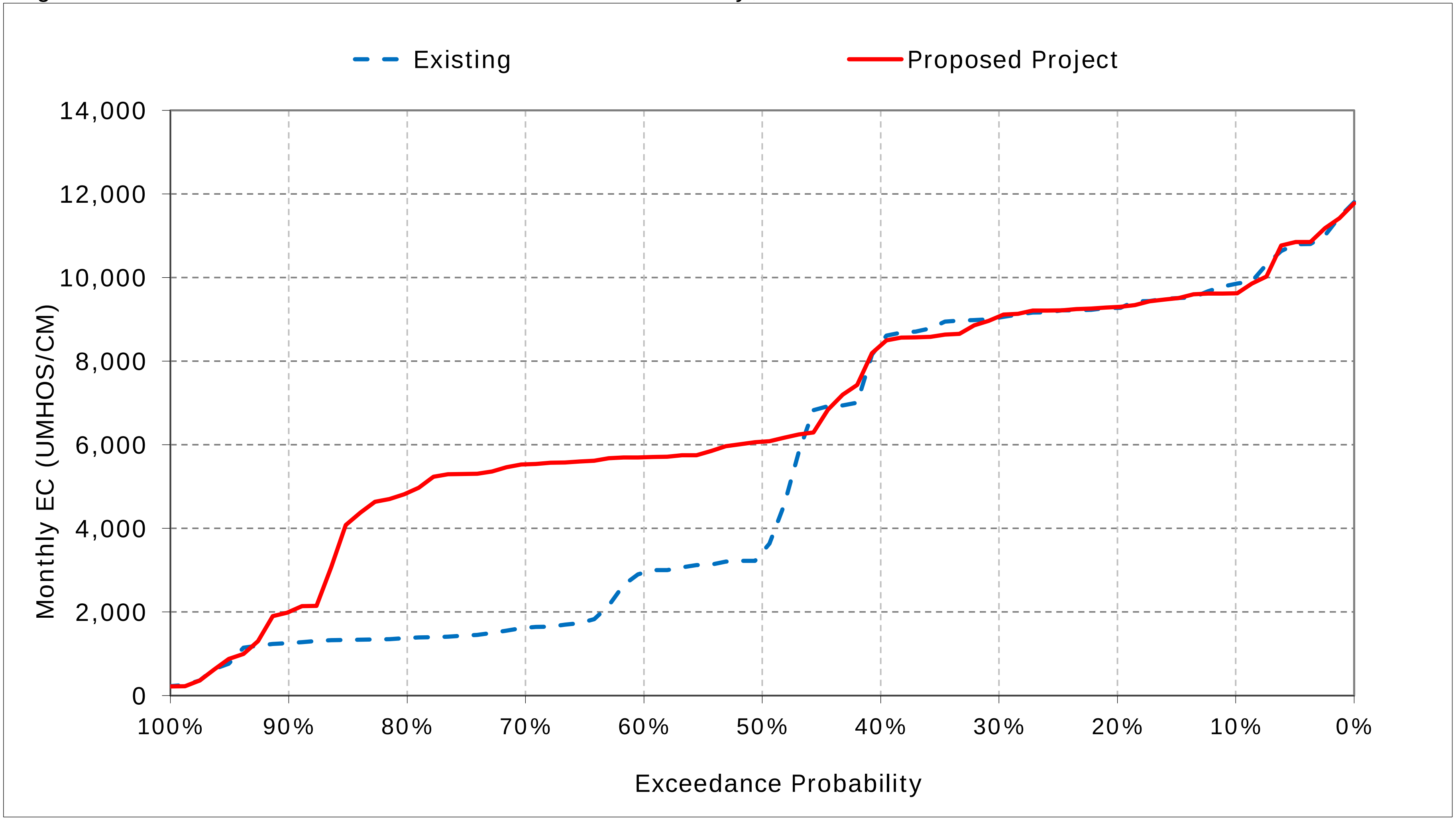


Figure 6-18. Sacramento River at Collinsville Salinity, December EC

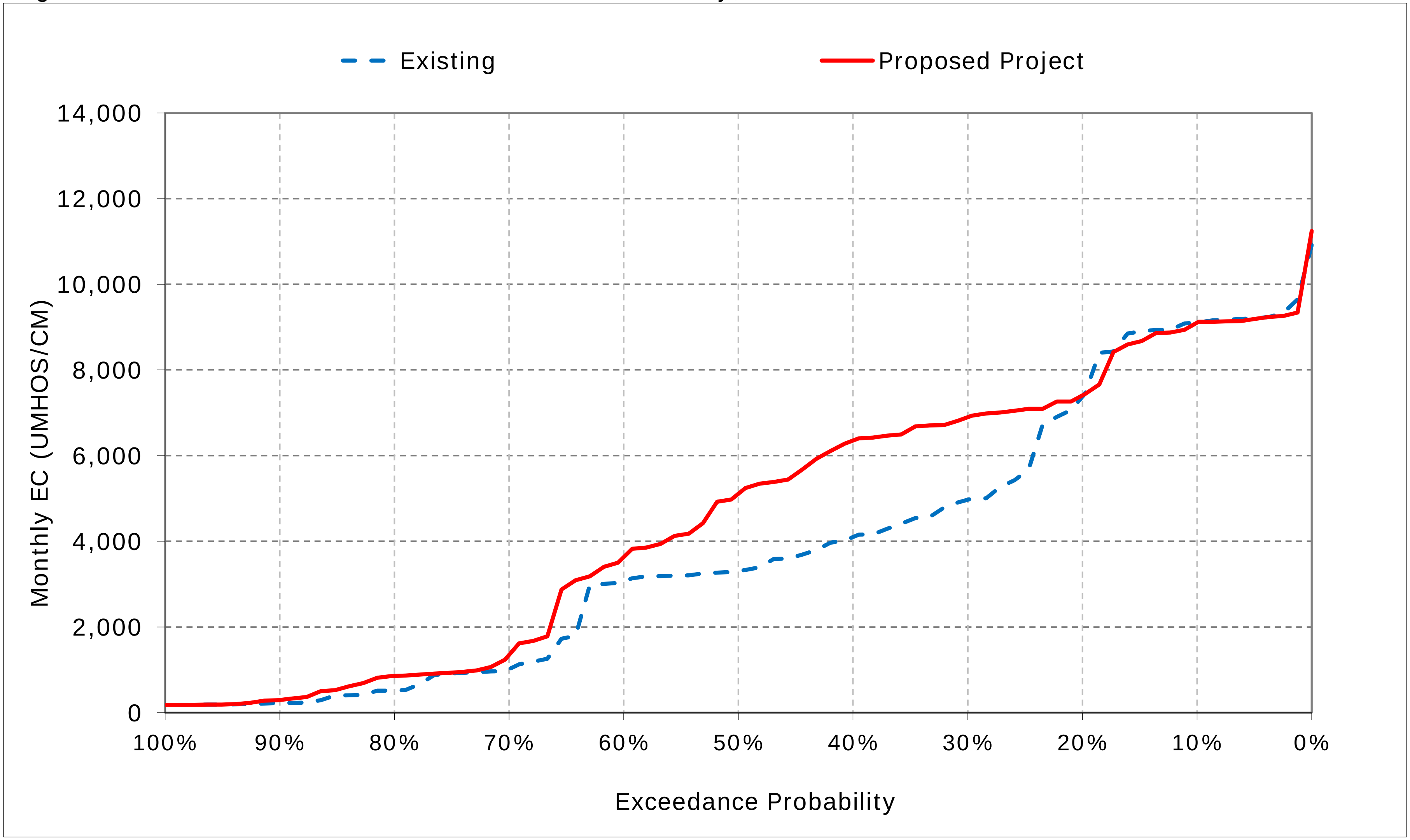


Table 7-1. Sacramento River at Mallard Slough Salinity, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	14,262	13,585	12,936	8,639	4,597	4,012	4,293	5,596	7,222	9,482	11,982	13,224
20%	13,605	13,227	11,331	7,673	2,924	2,247	2,342	4,309	6,033	8,280	10,695	12,609
30%	13,388	12,855	8,414	5,940	1,630	956	1,284	3,384	5,771	7,879	10,412	12,378
40%	13,120	12,345	7,099	3,495	809	700	1,005	2,083	4,919	6,131	8,722	11,515
50%	11,995	6,547	6,098	2,570	524	423	620	1,253	4,066	5,622	8,129	10,390
60%	6,582	5,724	5,568	1,463	286	274	361	814	3,217	4,474	7,926	5,456
70%	3,923	3,483	2,369	359	220	207	271	503	2,397	4,191	7,475	3,107
80%	3,688	3,152	1,073	220	202	199	207	270	1,164	3,700	7,186	2,793
90%	3,532	2,842	366	195	193	193	194	194	276	2,619	6,877	2,535
Long Term												
Full Simulation Period[a]	9,174	8,173	6,269	3,607	1,579	1,187	1,403	2,289	4,126	5,905	8,730	8,173
Water Year Types[b]												
Wet (32%)	7,268	5,420	2,138	668	239	254	318	527	1,492	3,090	6,675	2,582
Above Normal (15%)	9,562	8,069	6,277	2,184	595	270	393	736	2,907	4,100	7,318	5,343
Below Normal (17%)	9,602	8,995	7,981	3,998	1,044	902	977	1,745	4,029	5,789	8,430	10,918
Dry (22%)	9,695	9,431	7,836	5,709	2,550	1,656	1,989	3,398	5,703	8,040	10,550	12,495
Critical (15%)	11,632	11,396	10,864	7,790	4,638	3,754	4,381	6,633	8,800	10,742	12,212	13,430

Proposed Project

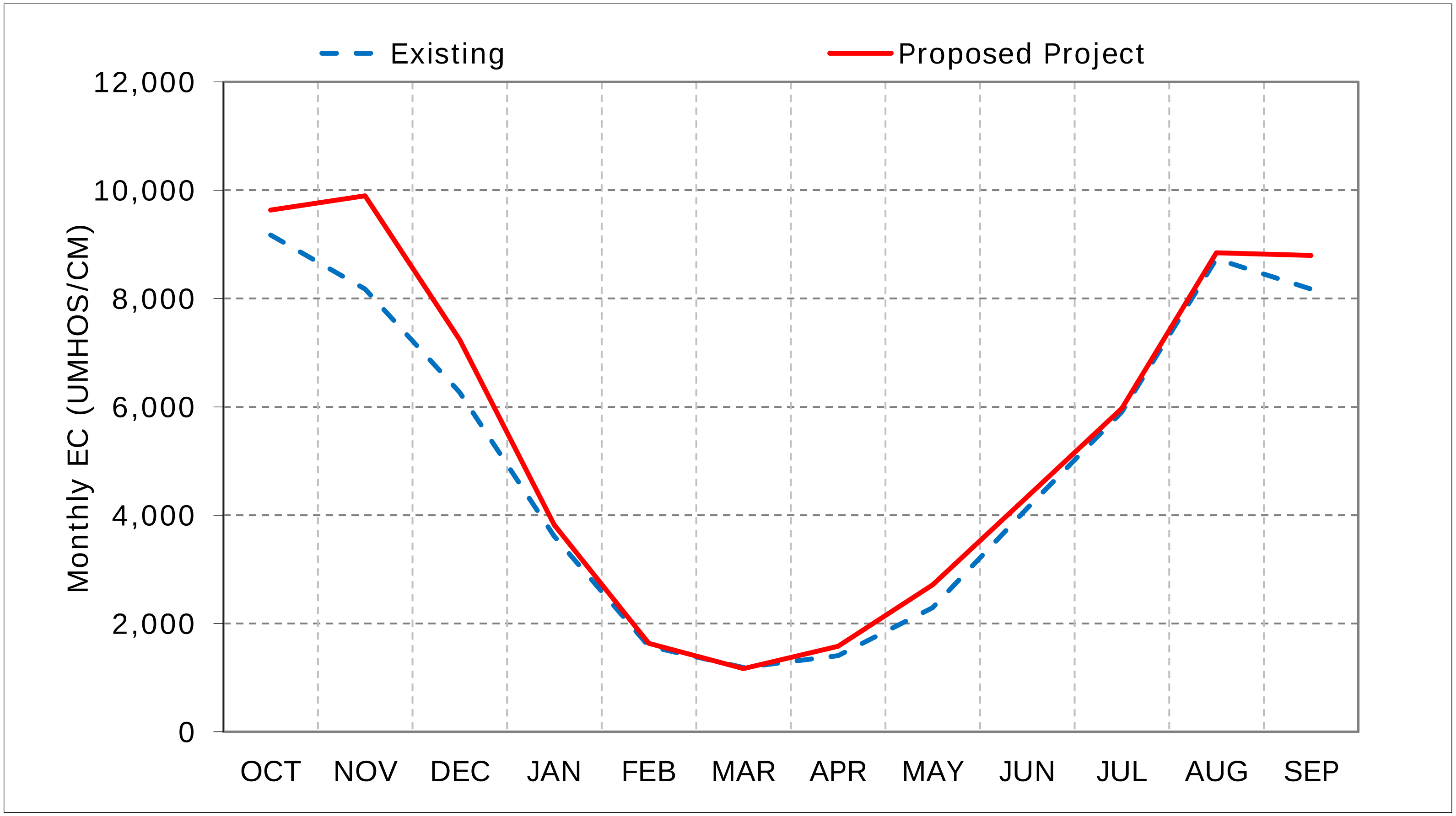
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	14,167	13,475	12,852	9,668	4,399	4,044	4,553	5,852	7,281	9,478	11,896	13,216
20%	13,526	13,199	11,287	8,238	2,774	2,127	2,831	5,042	6,493	8,387	10,732	12,663
30%	13,333	12,839	10,716	6,425	1,558	829	1,773	4,310	5,961	7,815	10,452	12,433
40%	12,771	12,181	10,045	3,735	881	647	1,280	2,708	5,425	6,457	9,678	11,923
50%	11,774	9,464	8,812	2,603	509	374	802	1,842	4,266	5,757	8,735	10,520
60%	6,200	9,080	6,833	1,379	248	246	424	1,373	3,708	4,427	7,864	5,219
70%	5,974	8,875	2,870	366	218	207	303	761	2,691	4,152	7,433	5,051
80%	5,690	8,159	1,730	218	203	197	206	325	1,226	3,734	7,136	4,805
90%	5,367	3,977	454	197	193	192	190	192	277	2,624	6,832	4,429
Long Term												
Full Simulation Period[a]	9,634	9,897	7,242	3,821	1,633	1,166	1,576	2,711	4,339	5,969	8,845	8,794
Water Year Types[b]												
Wet (32%)	7,895	7,635	2,722	662	233	245	391	771	1,700	3,100	6,568	4,511
Above Normal (15%)	10,105	9,984	7,765	2,299	469	254	506	1,178	3,072	4,049	7,353	4,932
Below Normal (17%)	10,089	10,632	9,169	4,033	992	834	1,223	2,377	4,216	6,083	9,202	11,231
Dry (22%)	10,196	10,915	9,025	6,243	2,728	1,587	2,267	4,007	5,997	8,113	10,610	12,543
Critical (15%)	11,558	12,330	11,589	8,312	4,938	3,830	4,591	6,897	8,978	10,758	12,208	13,469

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	-95	-109	-84	1,029	-198	31	260	256	59	-4	-86	-8
20%	-79	-28	-44	565	-149	-120	489	733	460	108	37	54
30%	-55	-17	2,302	485	-72	-127	489	927	190	-64	40	55
40%	-349	-163	2,946	240	72	-53	275	625	506	326	955	408
50%	-221	2,917	2,714	33	-15	-50	181	590	199	135	606	130
60%	-381	3,356	1,265	-84	-39	-27	63	558	491	-47	-63	-238
70%	2,051	5,392	500	8	-2	0	33	258	294	-39	-42	1,944
80%	2,002	5,007	657	-2	1	-1	-1	54	62	35	-50	2,012
90%	1,835	1,135	89	2	0	0	-4	-2	1	5	-45	1,894
Long Term												
Full Simulation Period[a]	461	1,724	973	214	54	-21	174	422	212	64	115	621
Water Year Types[b]												
Wet (32%)	627	2,215	584	-7	-6	-9	74	244	208	11	-108	1,929
Above Normal (15%)	543	1,914	1,488	115	-125	-16	113	442	165	-52	35	-411
Below Normal (17%)	487	1,637	1,188	35	-52	-68	246	632	187	294	772	313
Dry (22%)	501	1,483	1,188	533	178	-69	278	608	294	74	61	49
Critical (15%)	-75	934	725	522	300	76	210	264	178	15	-4	38

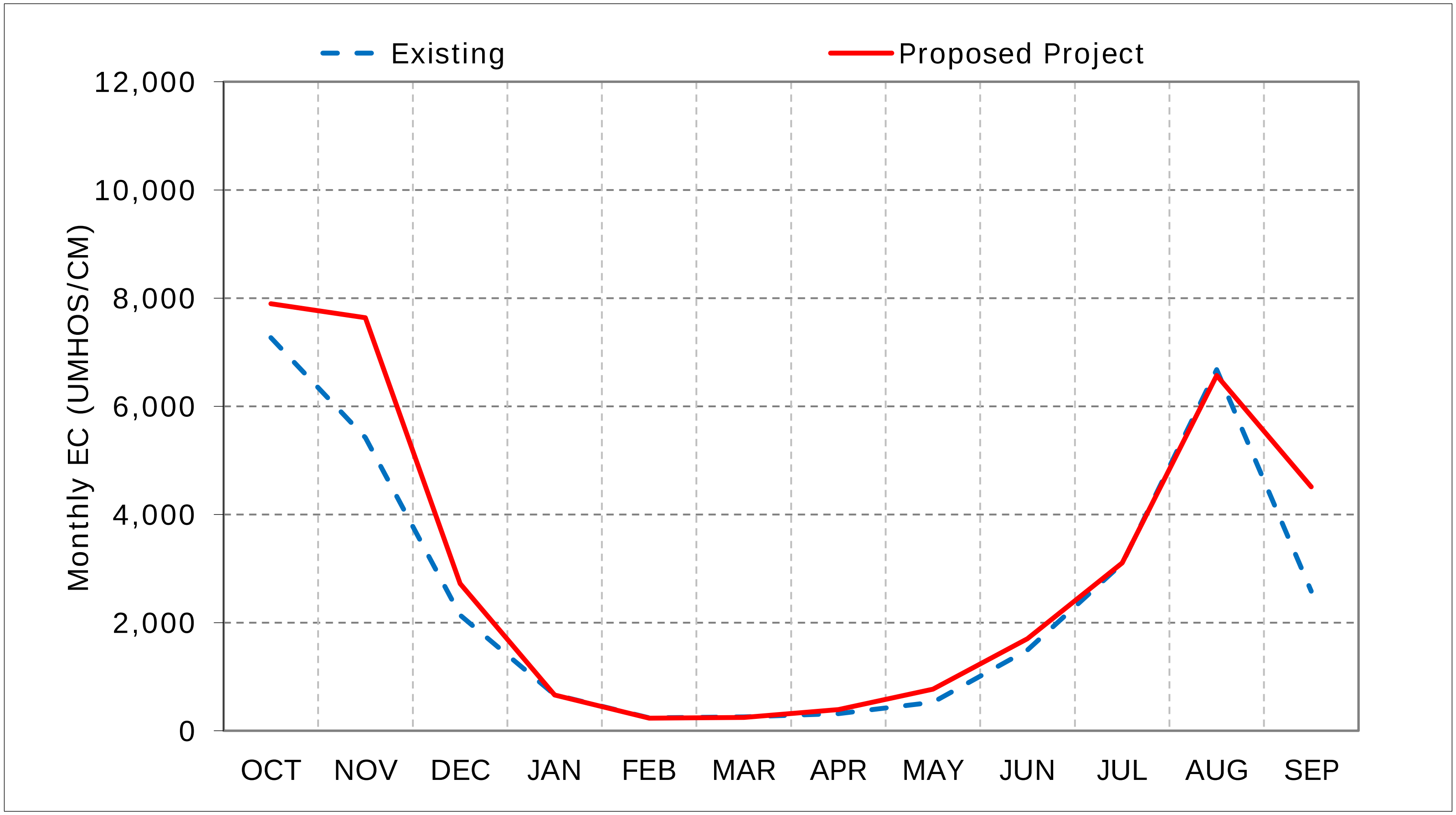
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 7-1. Sacramento River at Mallard Slough Salinity, Long-Term Average EC



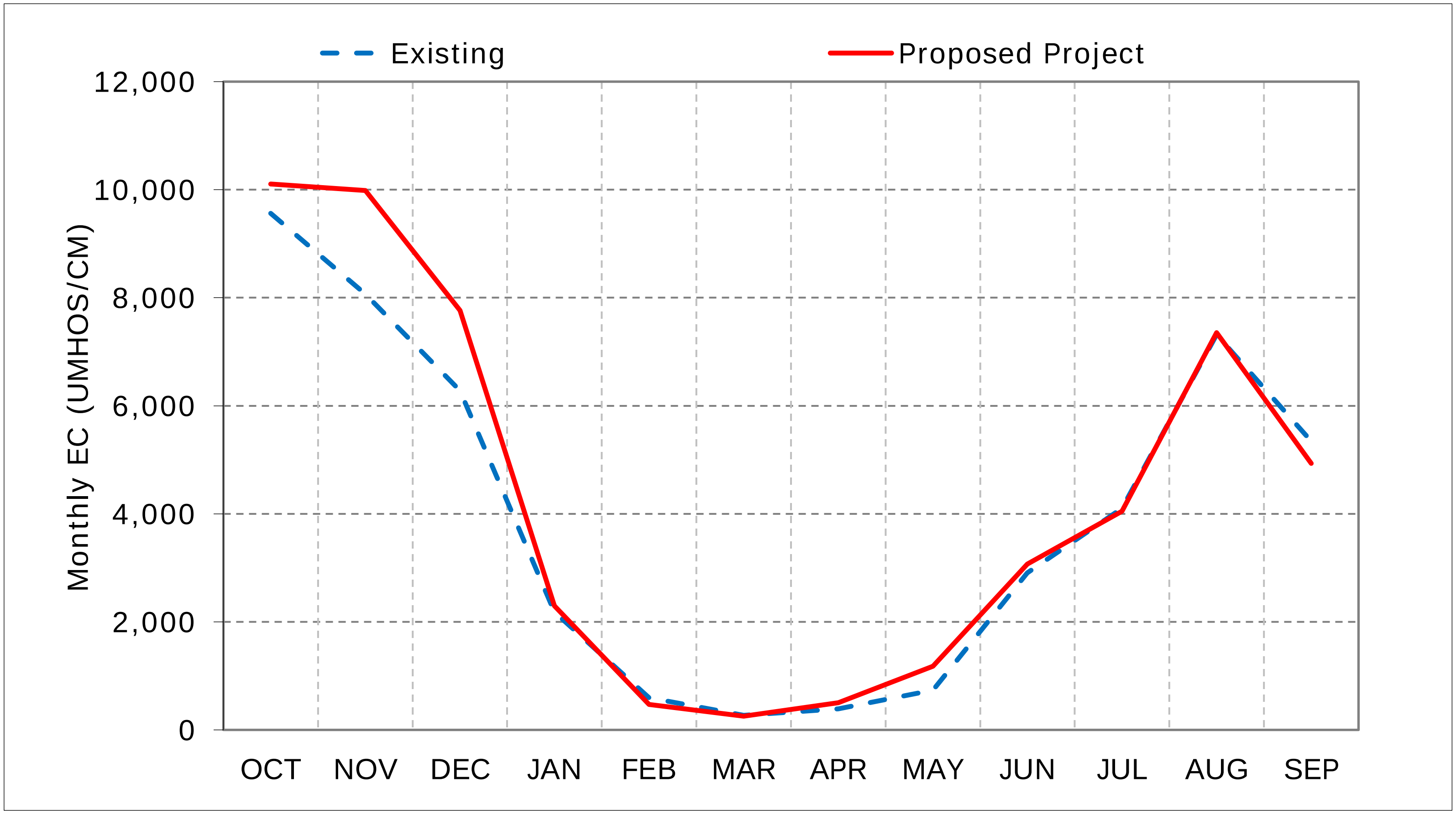
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 7-2. Sacramento River at Mallard Slough Salinity, Wet Year Average EC



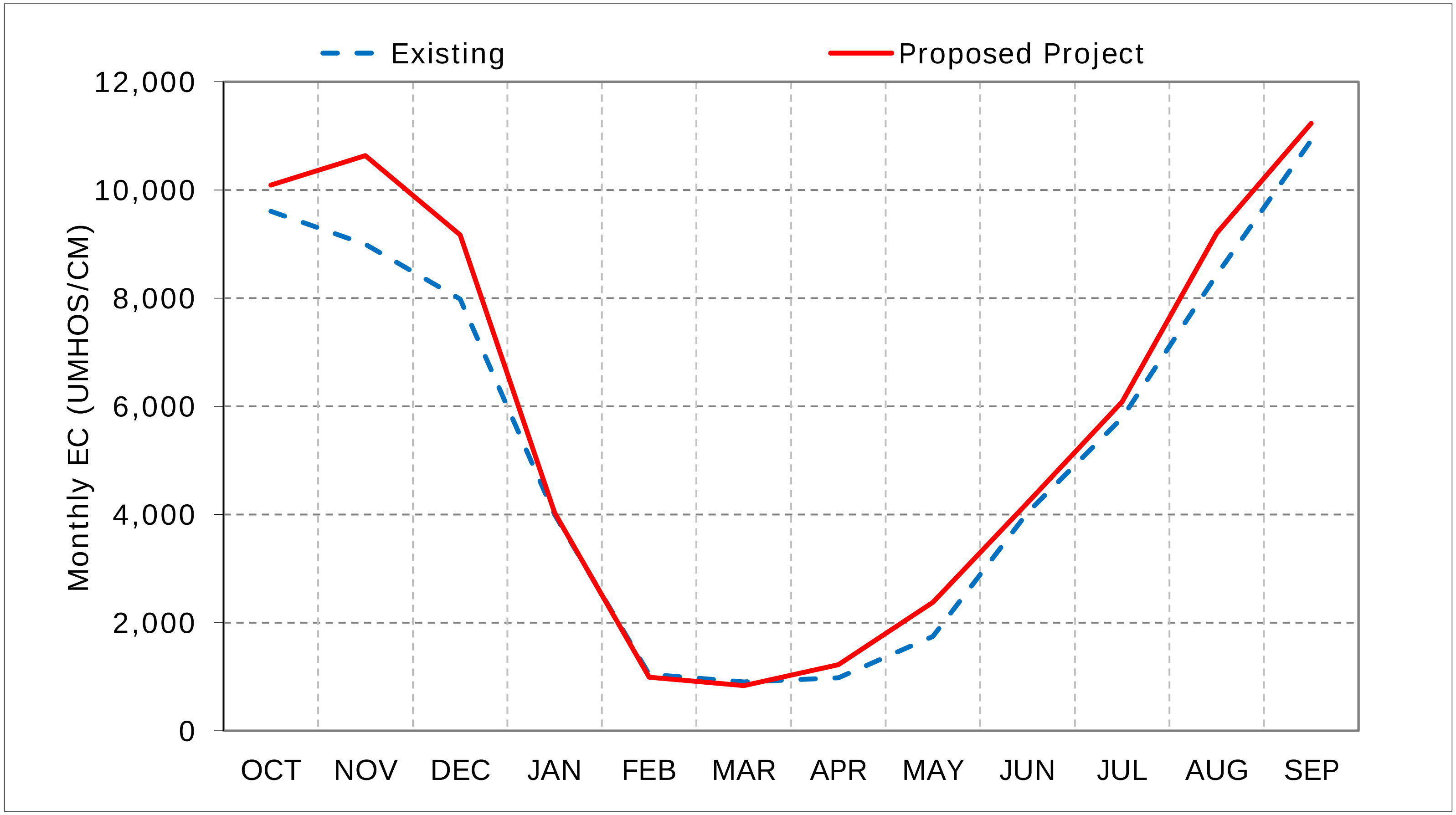
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 7-3. Sacramento River at Mallard Slough Salinity, Above Normal Year Avera



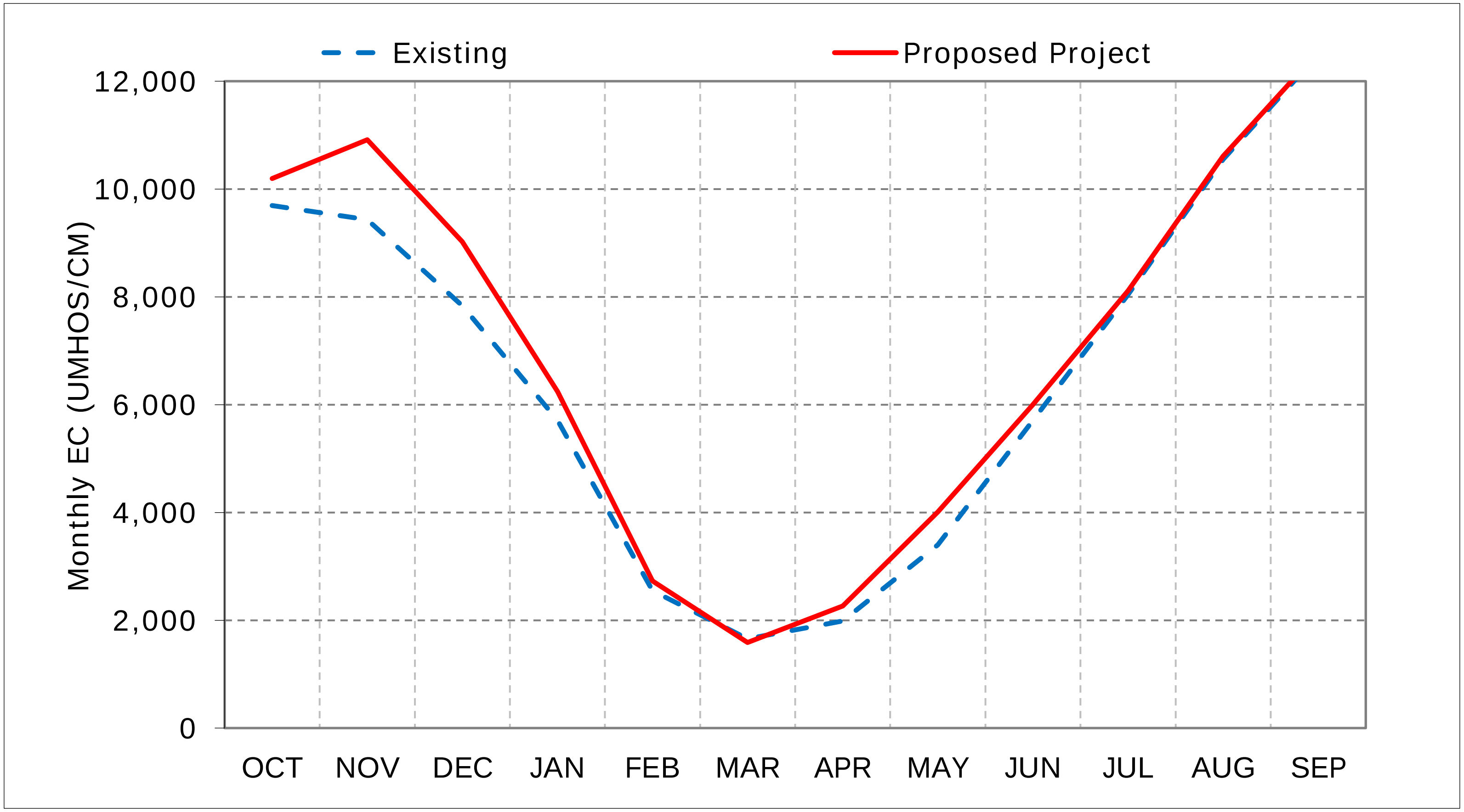
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 7-4. Sacramento River at Mallard Slough Salinity, Below Normal Year Avera



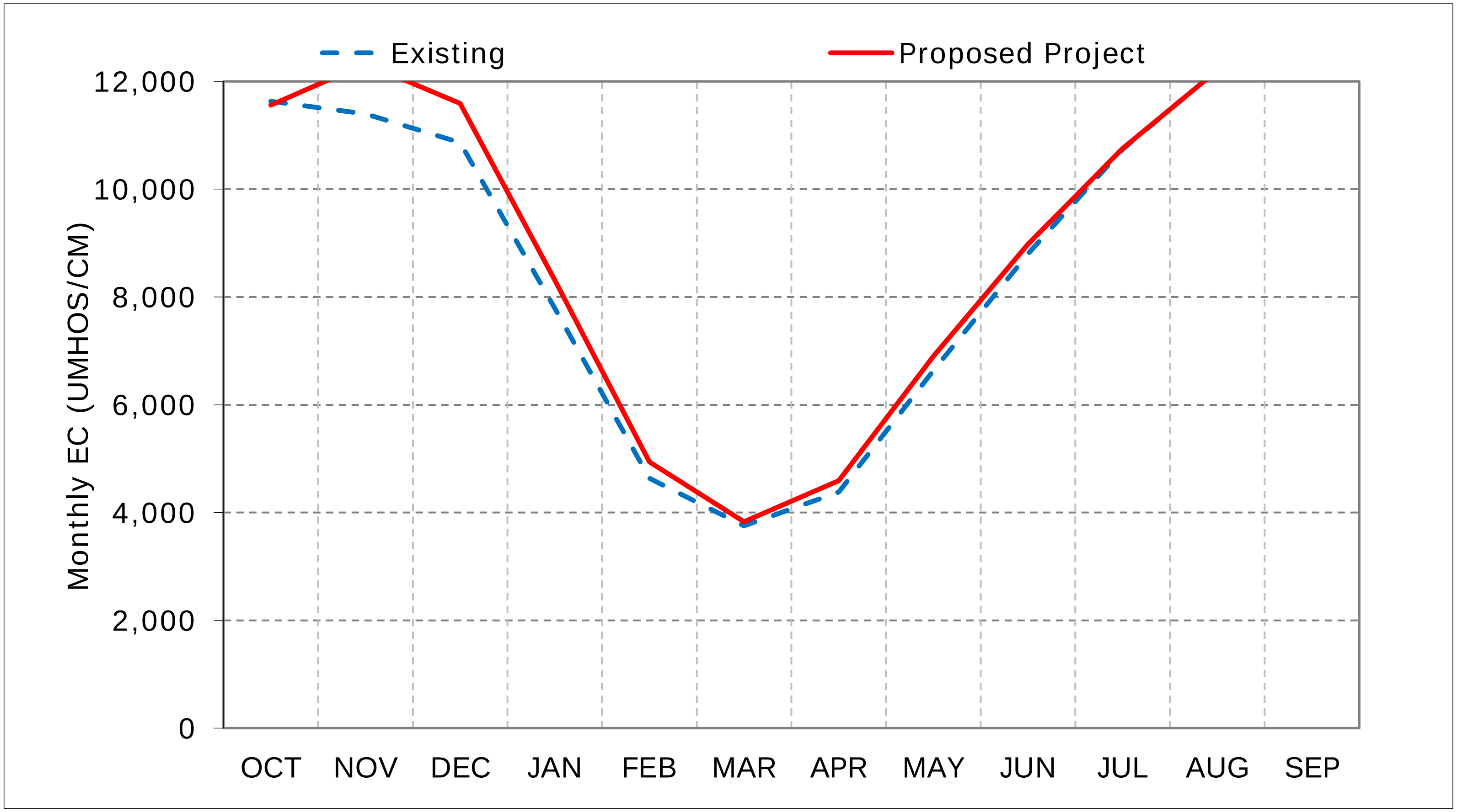
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 7-5. Sacramento River at Mallard Slough Salinity, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 7-6. Sacramento River at Mallard Slough Salinity, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 7-7. Sacramento River at Mallard Slough Salinity, January EC

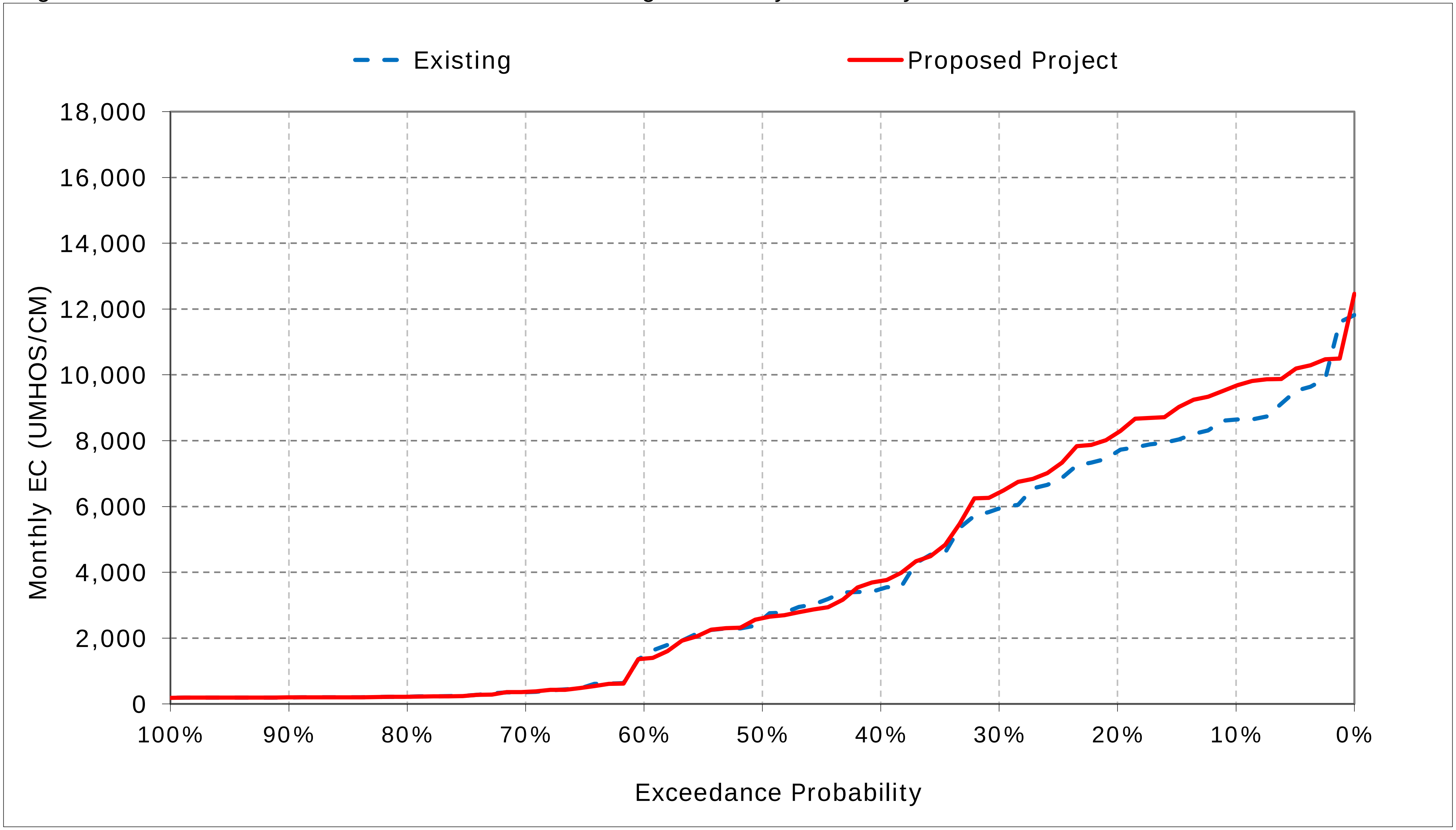


Figure 7-8. Sacramento River at Mallard Slough Salinity, February EC

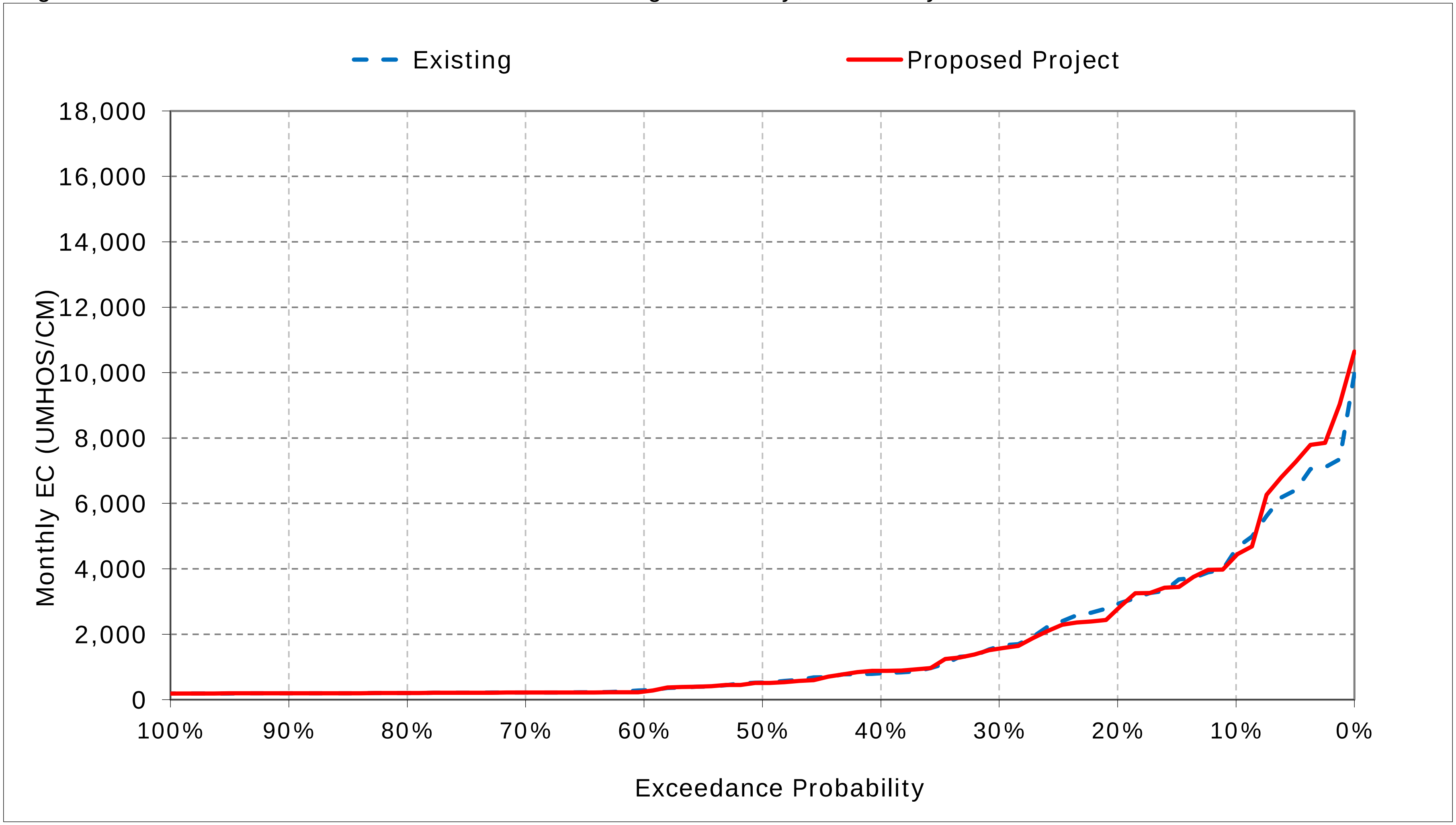


Figure 7-9. Sacramento River at Mallard Slough Salinity, March EC

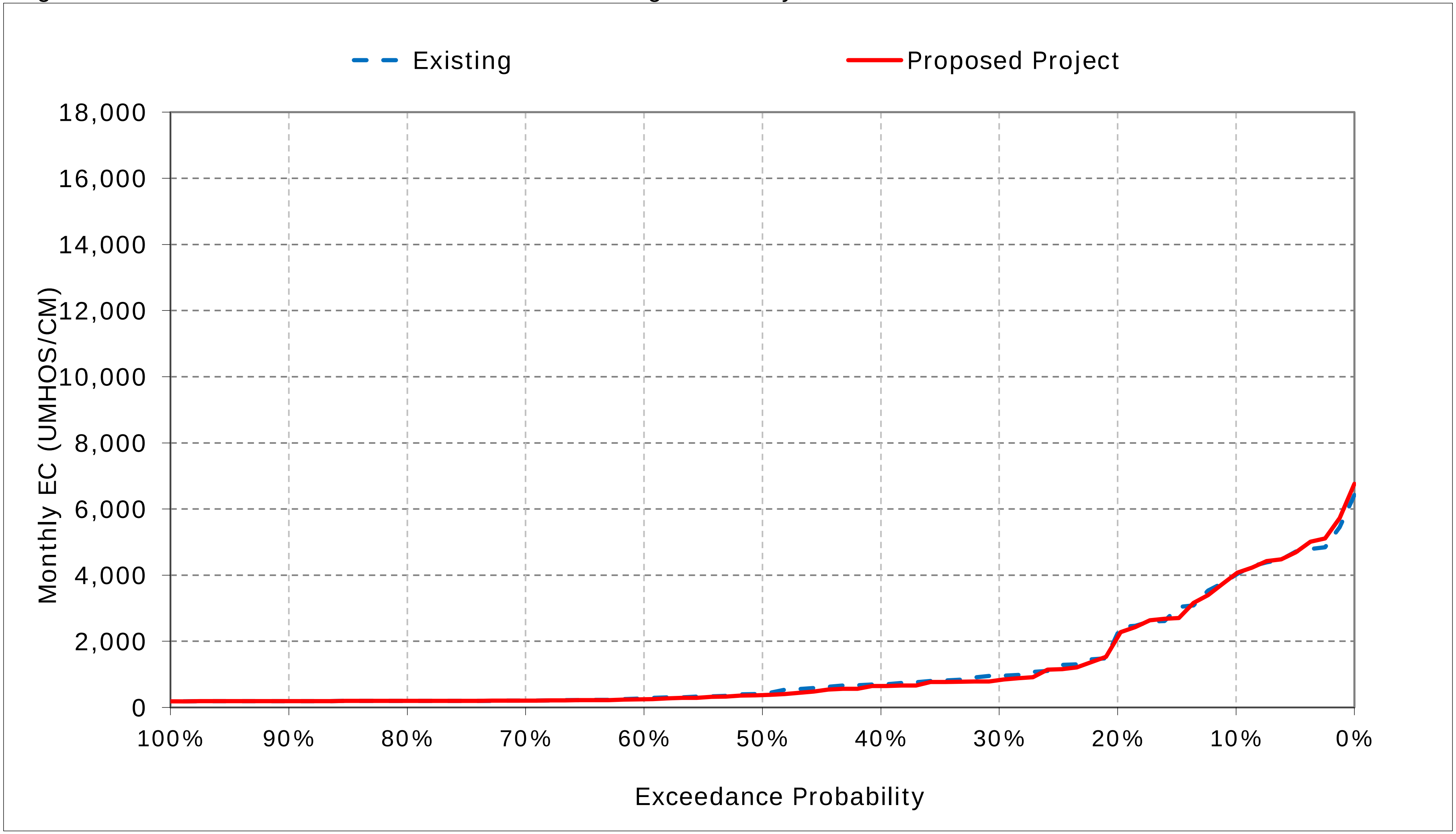


Figure 7-10. Sacramento River at Mallard Slough Salinity, April EC

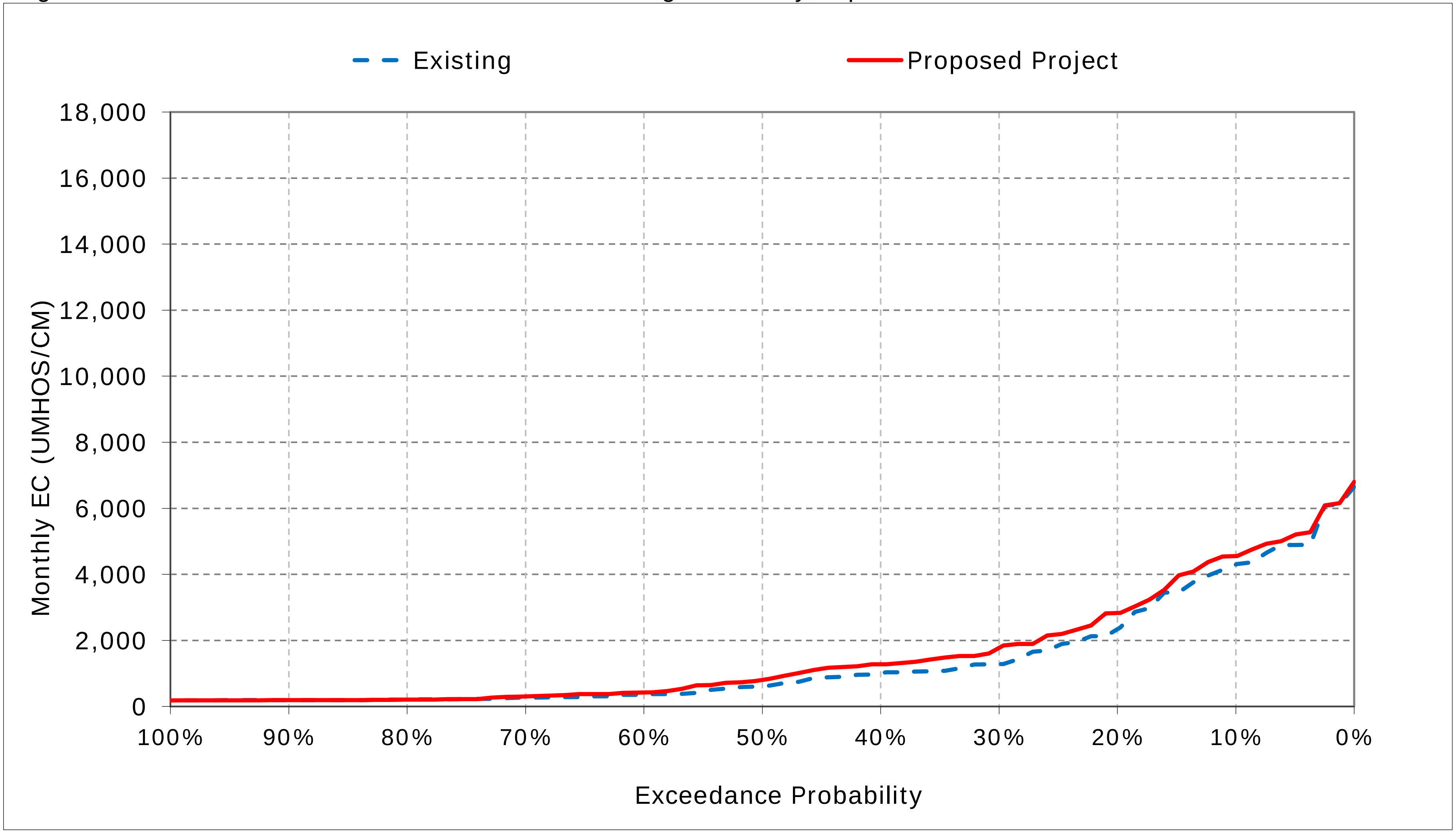


Figure 7-11. Sacramento River at Mallard Slough Salinity, May EC

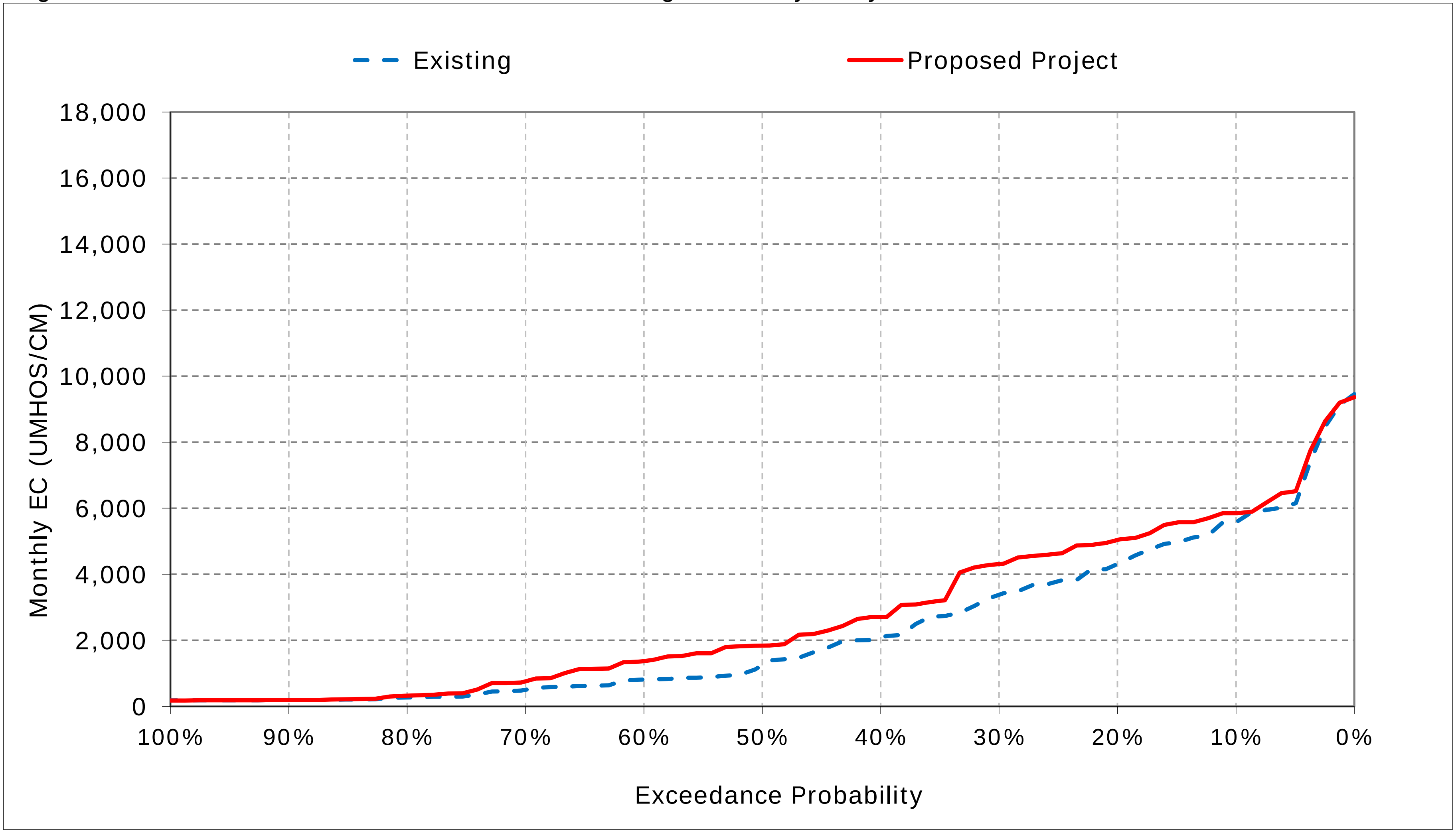


Figure 7-12. Sacramento River at Mallard Slough Salinity, June EC

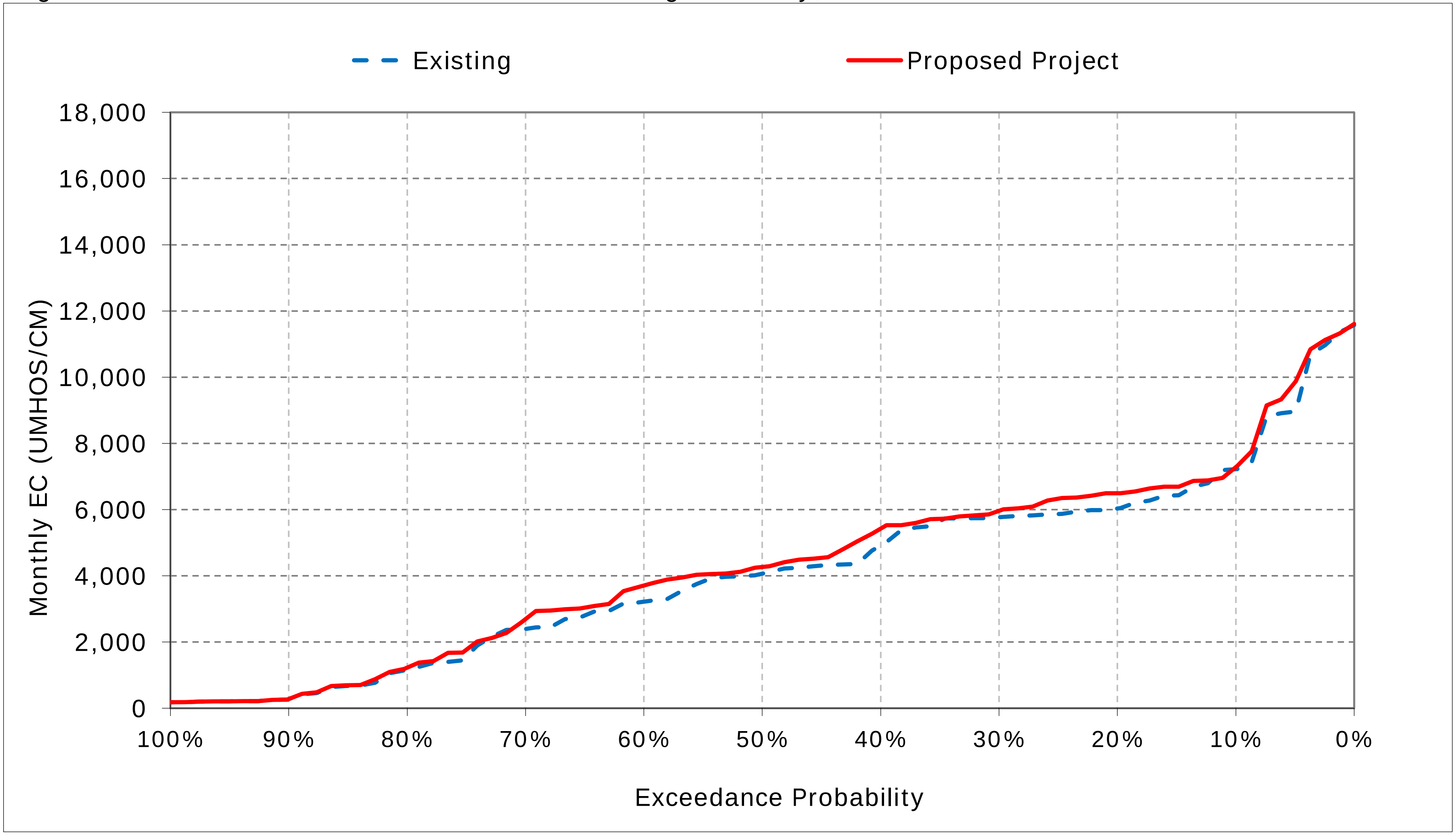


Figure 7-13. Sacramento River at Mallard Slough Salinity, July EC

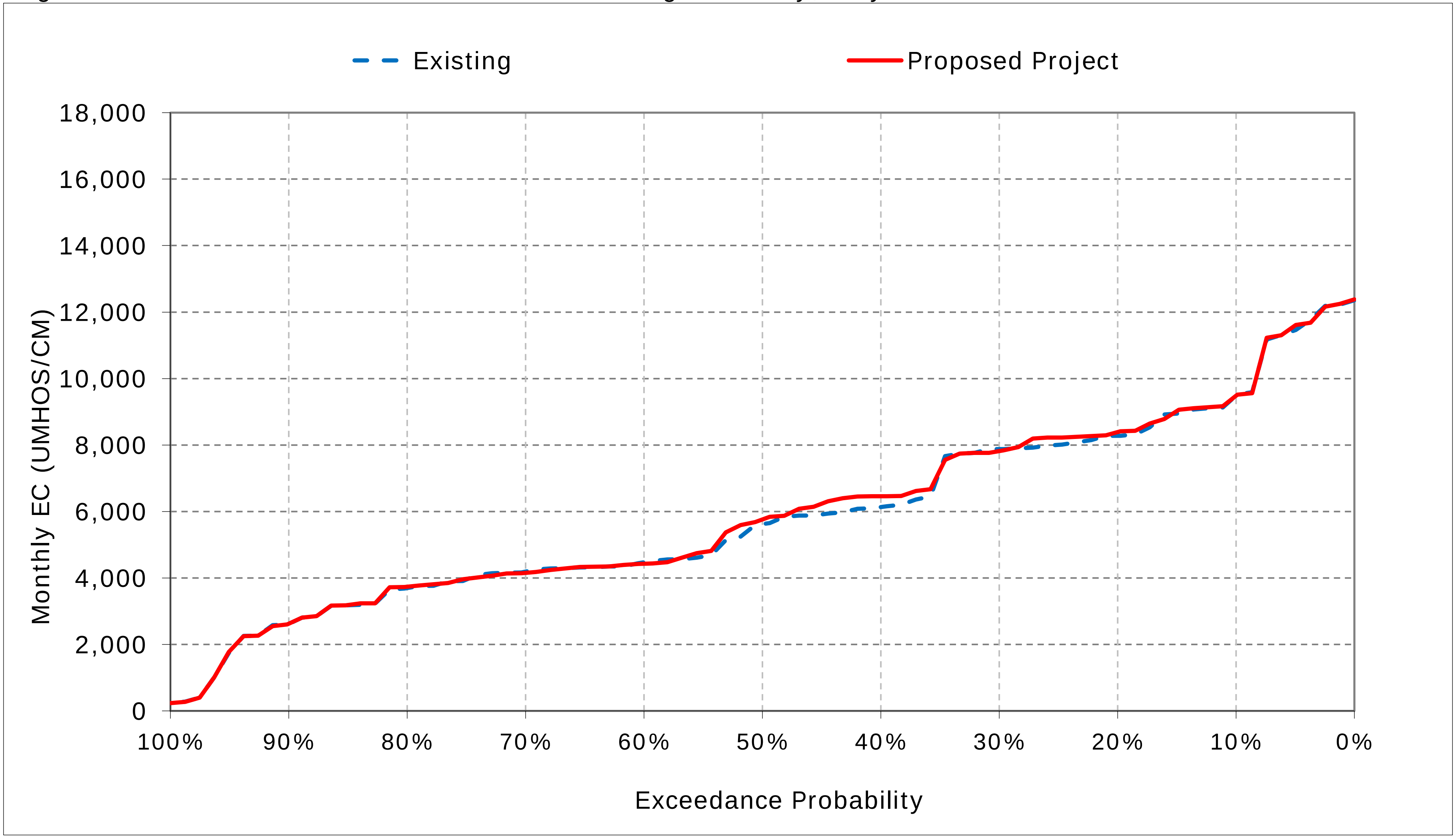


Figure 7-14. Sacramento River at Mallard Slough Salinity, August EC

Figure 7-15. Sacramento River at Mallard Slough Salinity, September EC

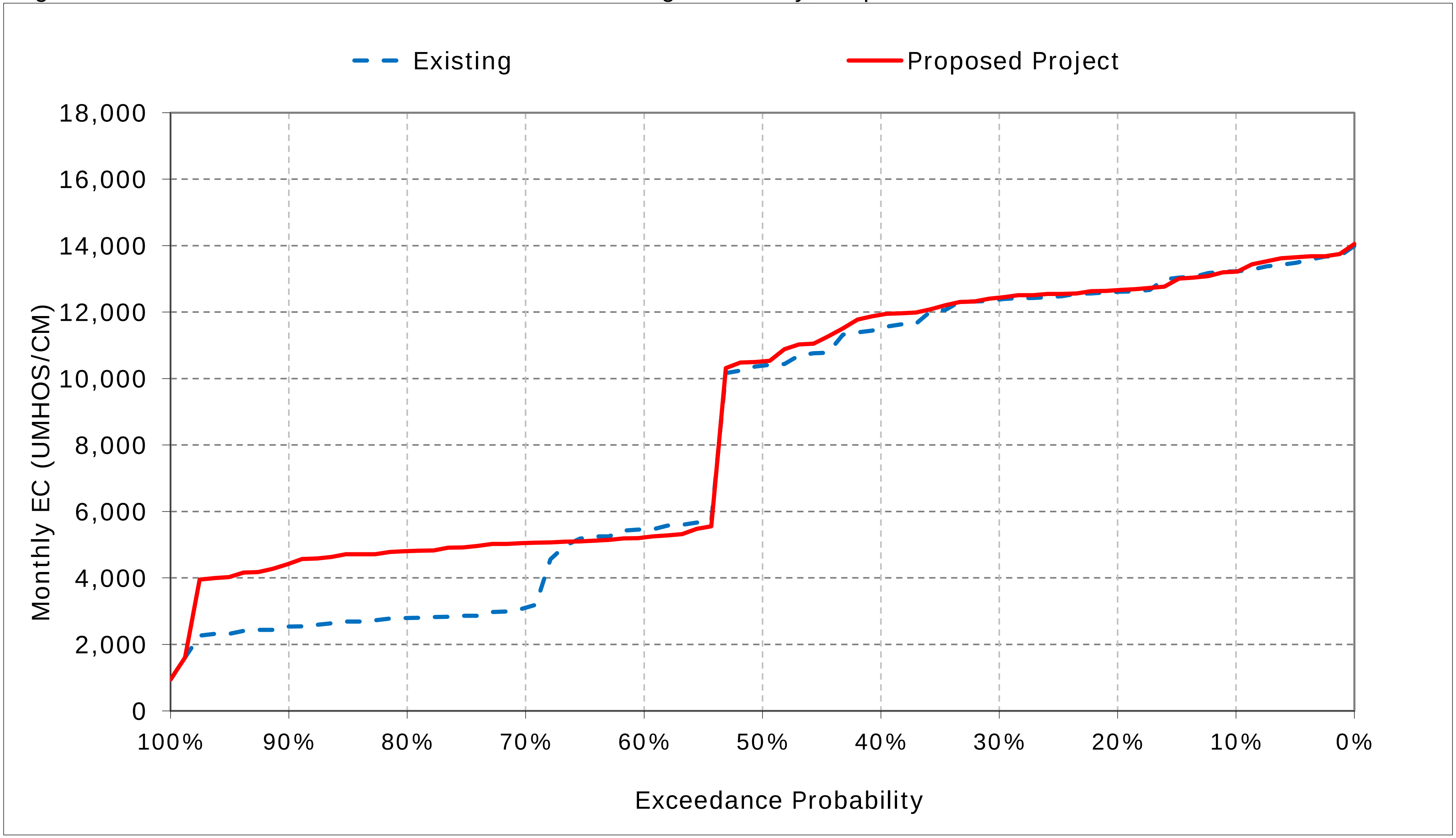


Figure 7-16. Sacramento River at Mallard Slough Salinity, October EC

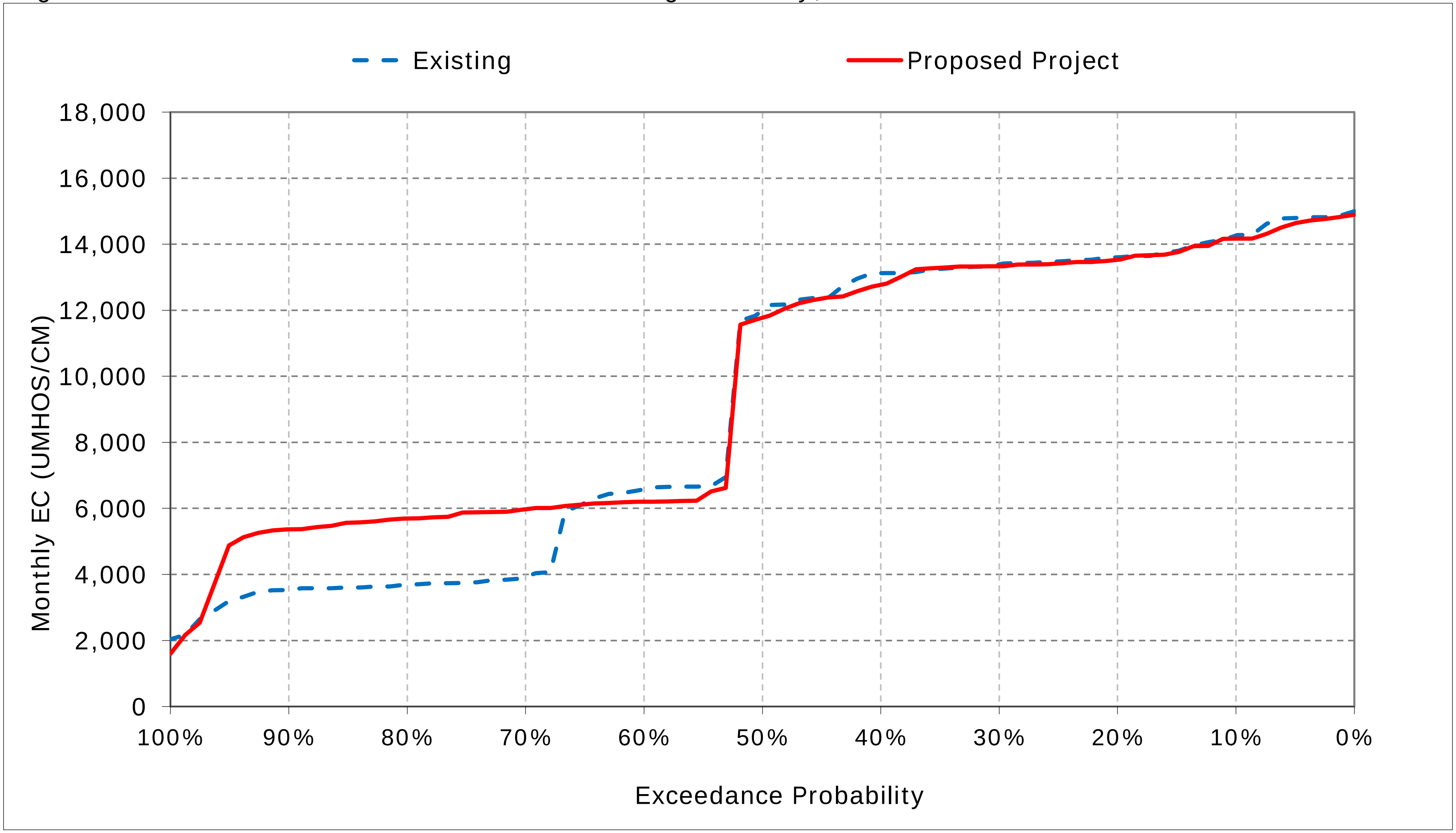


Figure 7-17. Sacramento River at Mallard Slough Salinity, November EC

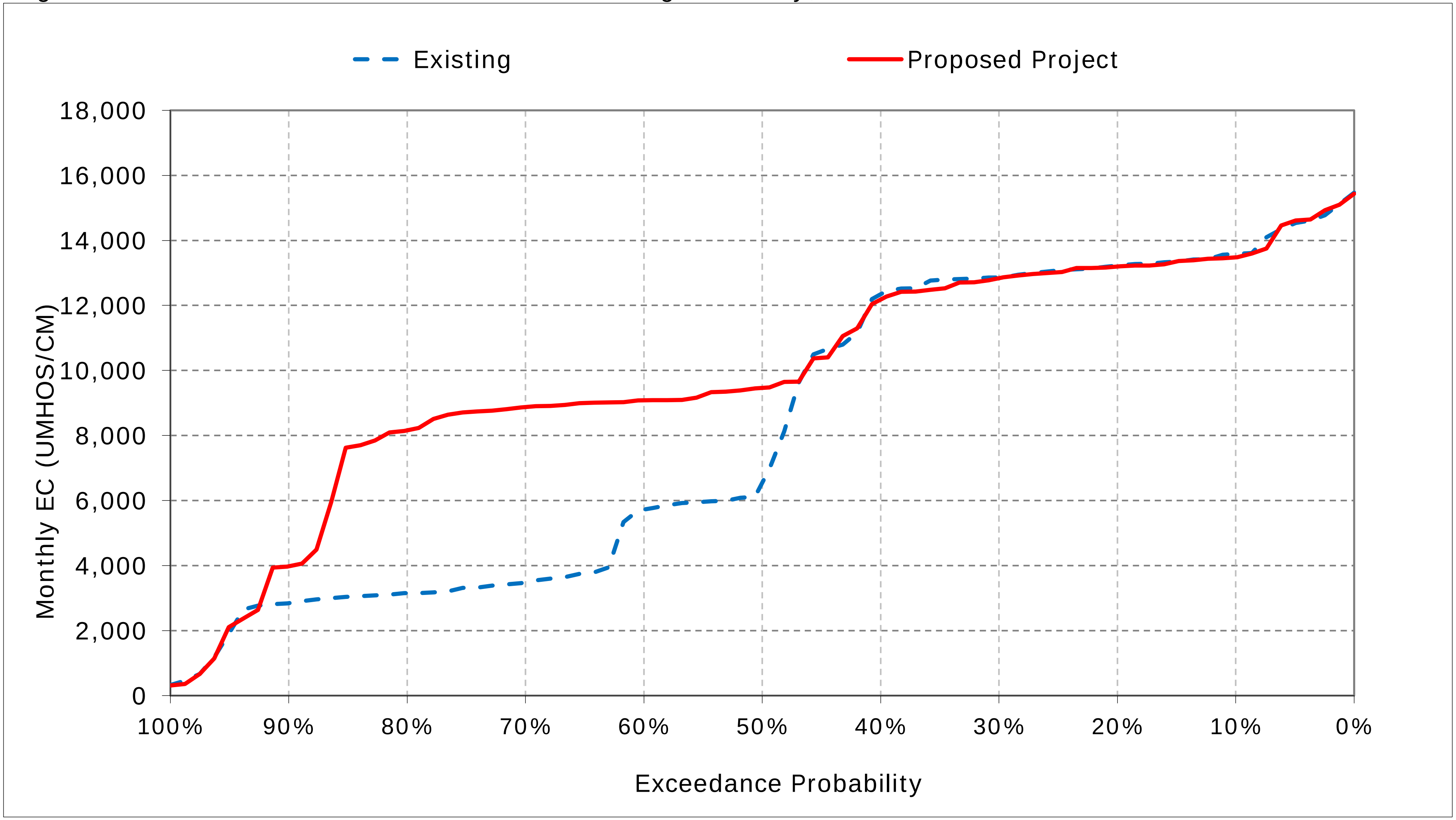


Figure 7-18. Sacramento River at Mallard Slough Salinity, December EC

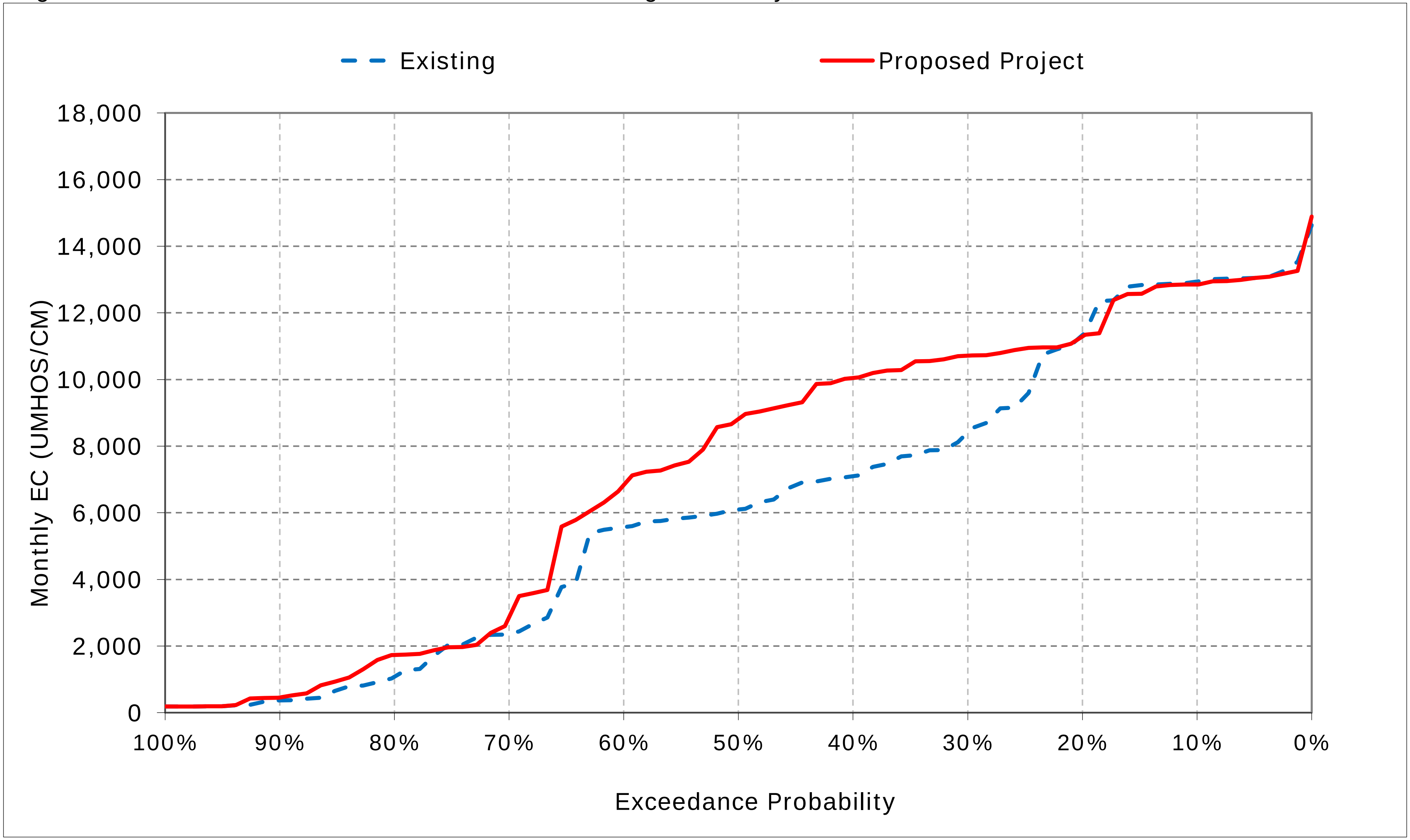


Table 8-1. Chipps Island North Channel Salinity, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	15,139	14,489	13,877	9,532	5,409	4,772	5,053	6,361	8,135	10,388	12,932	14,201
20%	14,525	14,158	12,320	8,644	3,435	2,748	2,823	5,030	6,871	9,219	11,638	13,565
30%	14,305	13,845	9,373	6,782	1,972	1,203	1,605	3,990	6,566	8,803	11,372	13,321
40%	14,060	13,301	8,053	4,143	1,005	902	1,261	2,549	5,667	6,999	9,694	12,485
50%	12,935	7,466	6,810	3,056	635	523	799	1,562	4,672	6,498	9,035	11,383
60%	7,398	6,550	6,264	1,784	321	316	446	1,033	3,816	5,231	8,836	6,341
70%	4,524	4,091	2,848	434	222	214	304	625	2,841	4,928	8,368	3,730
80%	4,248	3,742	1,294	227	203	200	215	317	1,451	4,385	8,047	3,386
90%	4,118	3,425	450	197	194	192	194	198	321	3,086	7,737	3,074
Long Term												
Full Simulation Period[a]	9,960	8,946	6,919	4,087	1,838	1,408	1,666	2,659	4,697	6,669	9,627	8,996
Water Year Types[b]												
Wet (32%)	7,986	6,081	2,461	761	253	280	364	625	1,765	3,635	7,485	3,140
Above Normal (15%)	10,362	8,828	6,983	2,528	692	305	468	909	3,388	4,812	8,193	6,219
Below Normal (17%)	10,414	9,840	8,741	4,591	1,252	1,113	1,204	2,106	4,665	6,641	9,377	11,904
Dry (22%)	10,498	10,257	8,668	6,472	3,009	2,003	2,412	3,999	6,494	8,973	11,500	13,449
Critical (15%)	12,501	12,262	11,767	8,686	5,345	4,410	5,103	7,452	9,701	11,681	13,181	14,387

Proposed Project

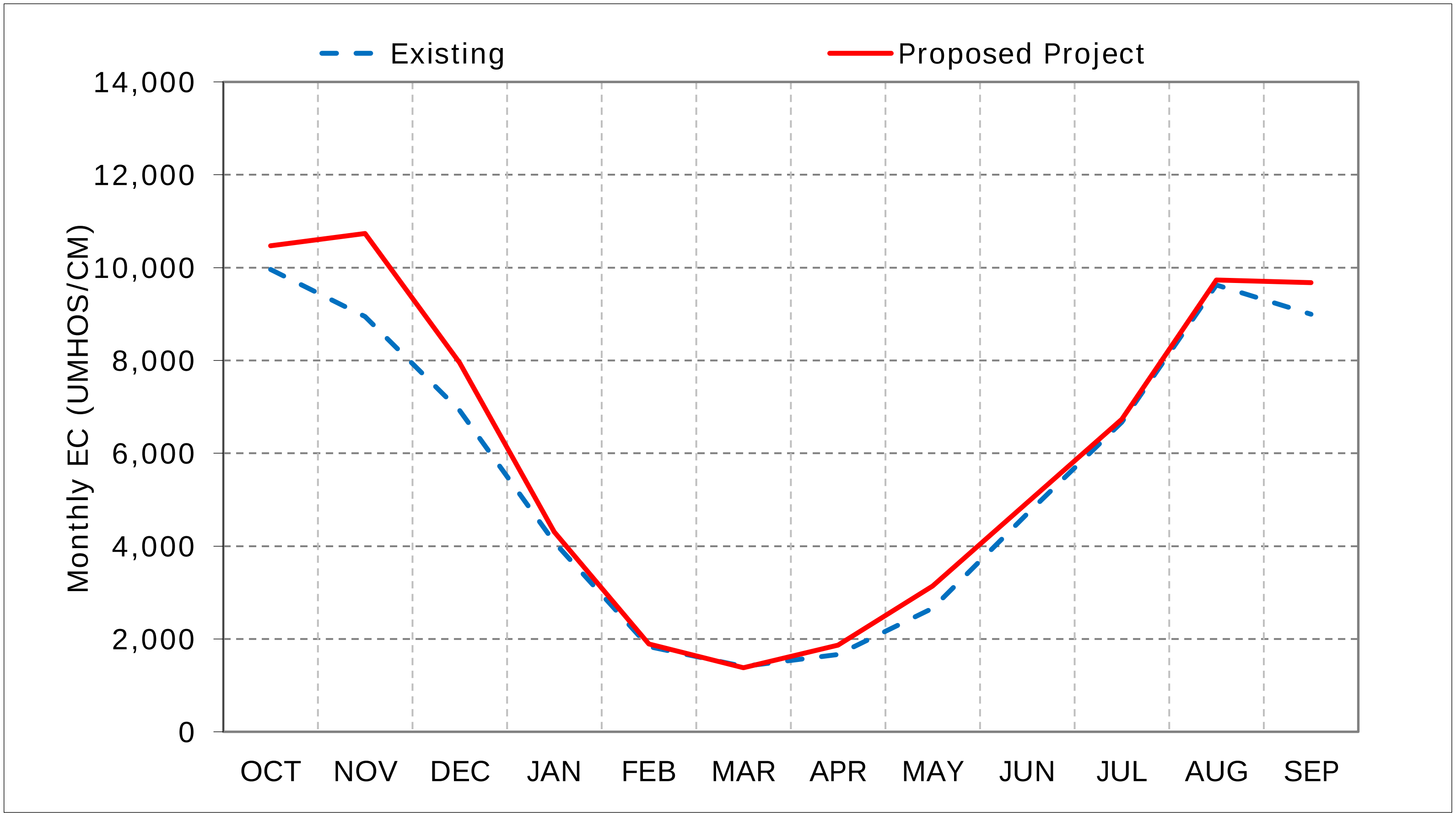
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	15,070	14,400	13,806	10,696	5,193	4,805	5,348	6,648	8,162	10,405	12,917	14,179
20%	14,457	14,127	12,193	9,232	3,267	2,606	3,415	5,836	7,368	9,305	11,690	13,612
30%	14,274	13,789	11,685	7,293	1,920	1,052	2,167	4,977	6,750	8,756	11,404	13,393
40%	13,717	13,105	10,971	4,412	1,101	812	1,597	3,259	6,222	7,297	10,559	12,833
50%	12,744	10,308	9,824	3,117	595	464	1,012	2,258	4,933	6,563	9,587	11,497
60%	6,979	9,948	7,769	1,710	270	277	533	1,711	4,384	5,183	8,769	6,083
70%	6,758	9,727	3,471	435	220	212	361	961	3,171	4,900	8,314	5,901
80%	6,446	9,036	2,023	222	205	200	216	404	1,531	4,429	8,002	5,648
90%	6,121	4,658	537	197	194	193	190	199	327	3,091	7,695	5,237
Long Term												
Full Simulation Period[a]	10,473	10,735	7,950	4,308	1,894	1,380	1,867	3,142	4,939	6,731	9,730	9,678
Water Year Types[b]												
Wet (32%)	8,674	8,385	3,099	754	246	268	456	916	2,003	3,648	7,374	5,294
Above Normal (15%)	10,975	10,832	8,556	2,642	550	282	610	1,442	3,594	4,757	8,228	5,776
Below Normal (17%)	10,954	11,543	9,990	4,621	1,190	1,024	1,494	2,838	4,891	6,907	10,080	12,183
Dry (22%)	11,048	11,778	9,912	7,036	3,207	1,917	2,724	4,668	6,816	9,048	11,562	13,498
Critical (15%)	12,442	13,222	12,534	9,219	5,661	4,493	5,331	7,732	9,883	11,702	13,181	14,426

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	-70	-89	-71	1,164	-216	34	295	288	28	17	-15	-22
20%	-68	-31	-127	588	-167	-142	592	806	497	85	52	47
30%	-31	-56	2,311	511	-52	-151	562	986	184	-47	32	73
40%	-344	-196	2,918	269	96	-90	336	710	556	298	864	348
50%	-191	2,843	3,014	61	-40	-59	212	697	261	66	552	114
60%	-419	3,399	1,505	-74	-52	-39	87	678	569	-48	-67	-259
70%	2,233	5,636	623	1	-2	-2	57	336	330	-28	-54	2,171
80%	2,198	5,293	729	-5	2	0	1	88	80	44	-45	2,262
90%	2,003	1,233	87	0	0	1	-3	1	7	5	-43	2,163
Long Term												
Full Simulation Period[a]	512	1,789	1,031	221	56	-29	201	483	242	61	104	682
Water Year Types[b]												
Wet (32%)	689	2,304	638	-7	-7	-12	92	291	238	13	-111	2,154
Above Normal (15%)	614	2,004	1,573	113	-143	-23	142	533	206	-55	36	-443
Below Normal (17%)	540	1,702	1,249	30	-62	-88	290	732	226	267	702	279
Dry (22%)	549	1,521	1,244	564	199	-85	311	669	322	75	62	49
Critical (15%)	-59	960	767	533	316	83	228	280	182	21	0	39

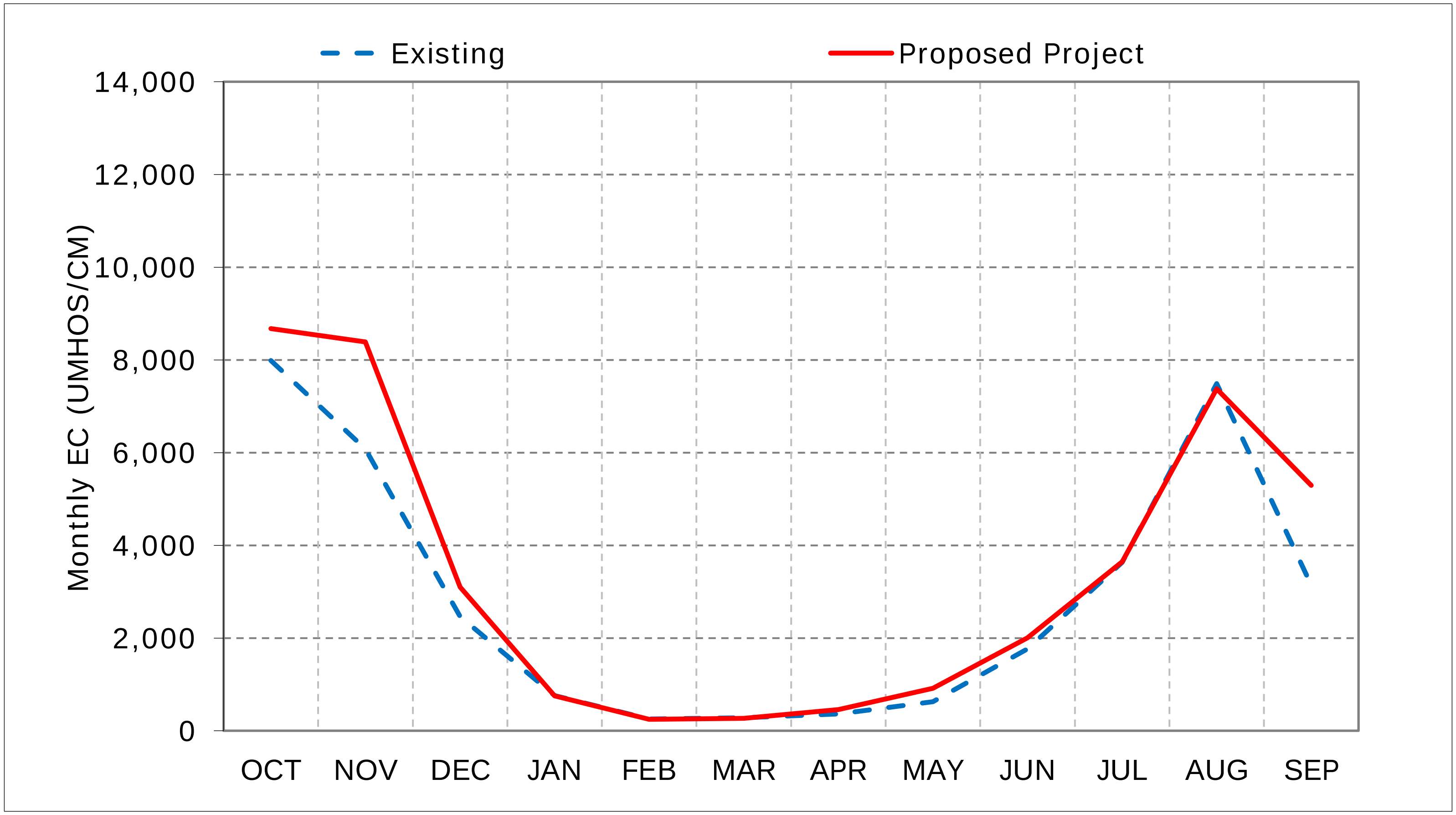
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 8-1. Chipps Island North Channel Salinity, Long-Term Average EC



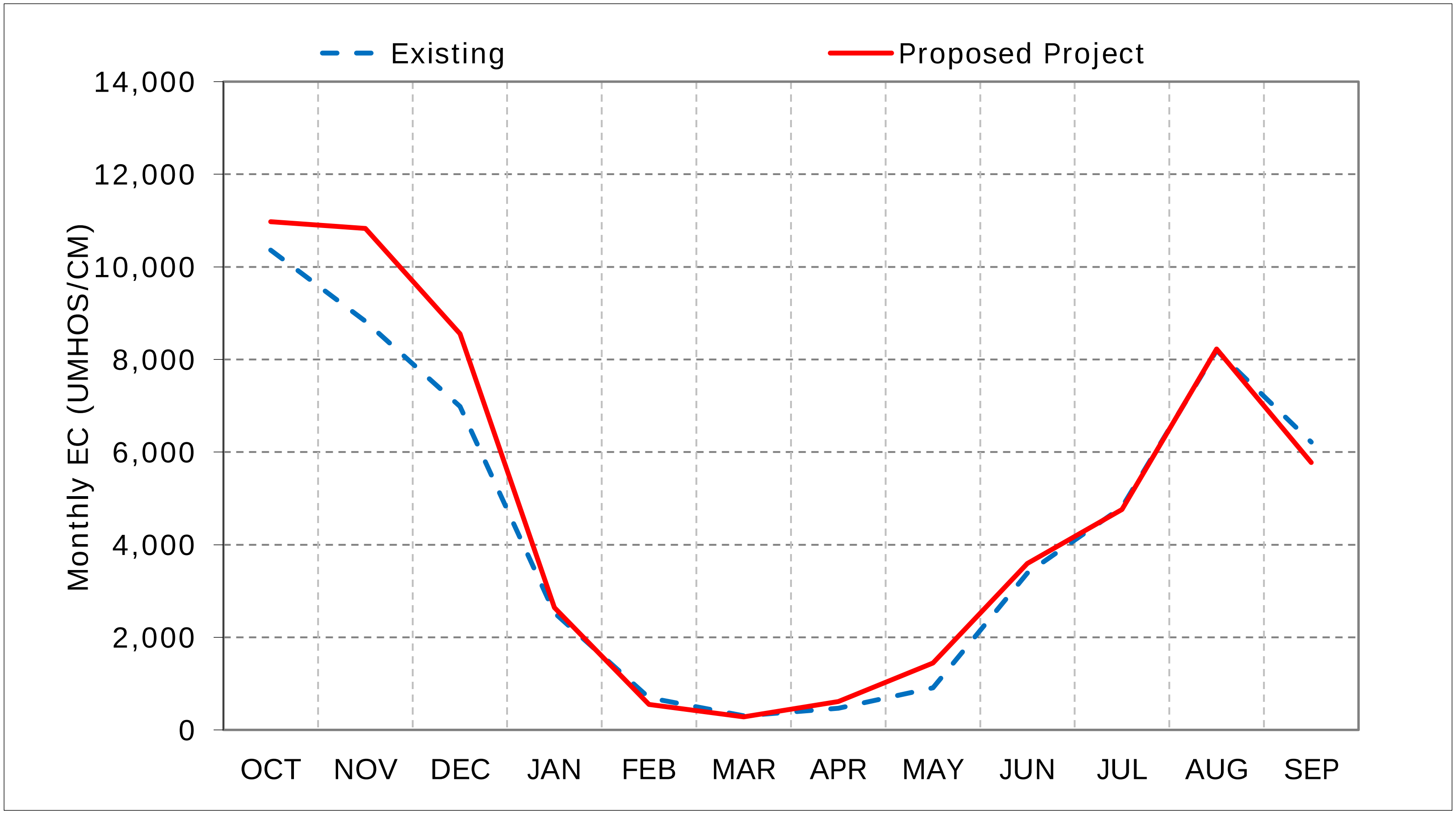
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 8-2. Chipps Island North Channel Salinity, Wet Year Average EC



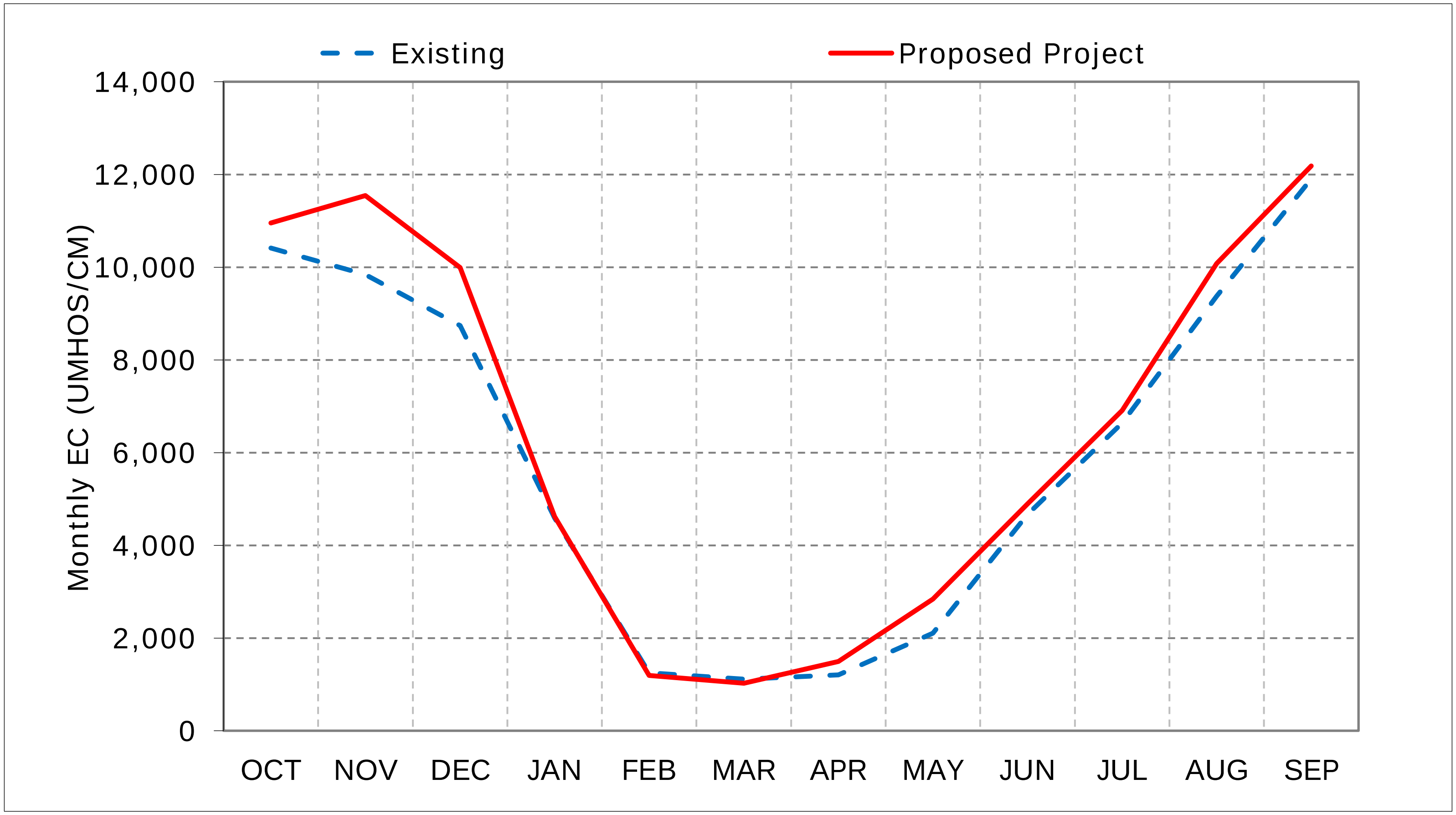
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 8-3. Chipps Island North Channel Salinity, Above Normal Year Average EC



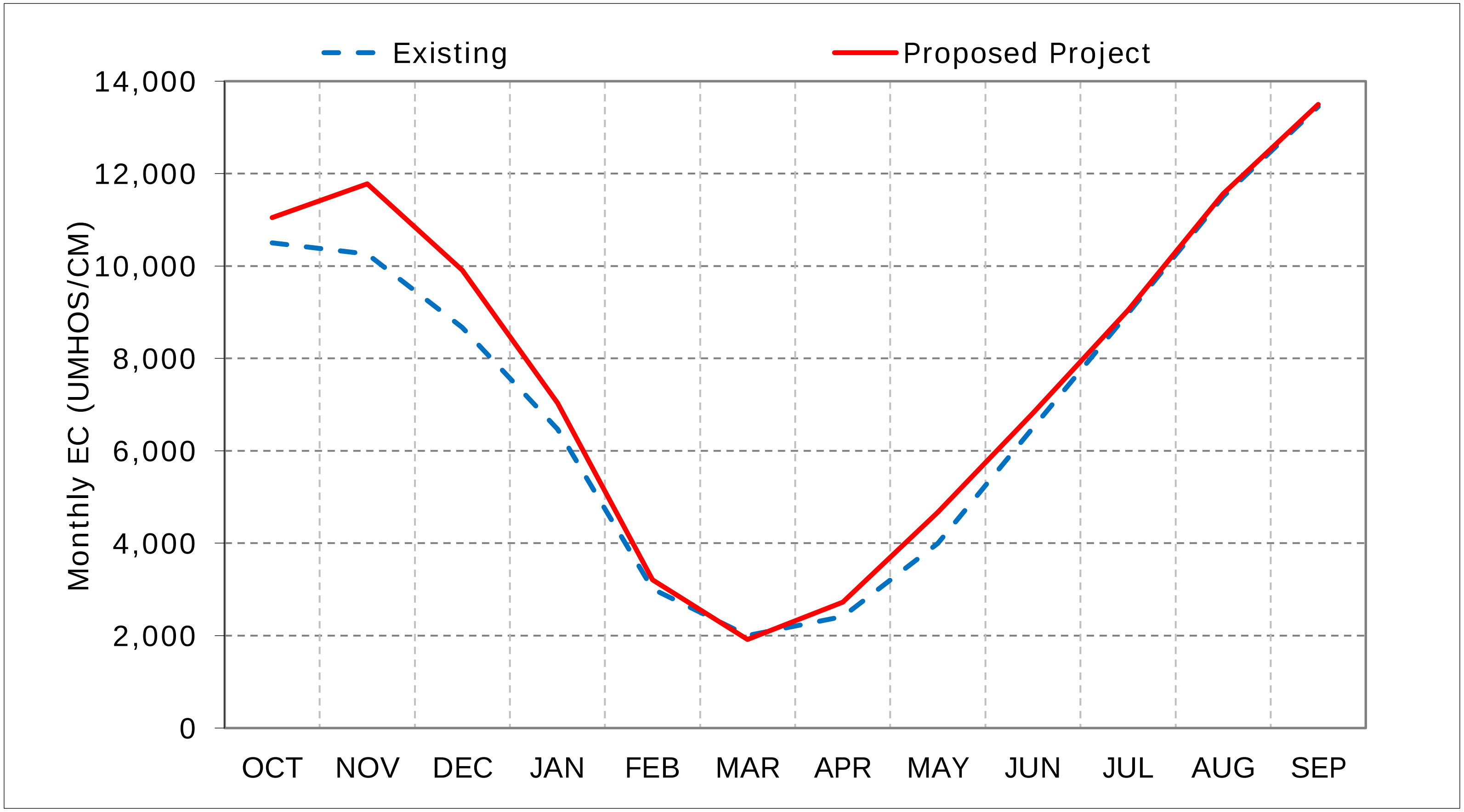
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 8-4. Chipps Island North Channel Salinity, Below Normal Year Average EC



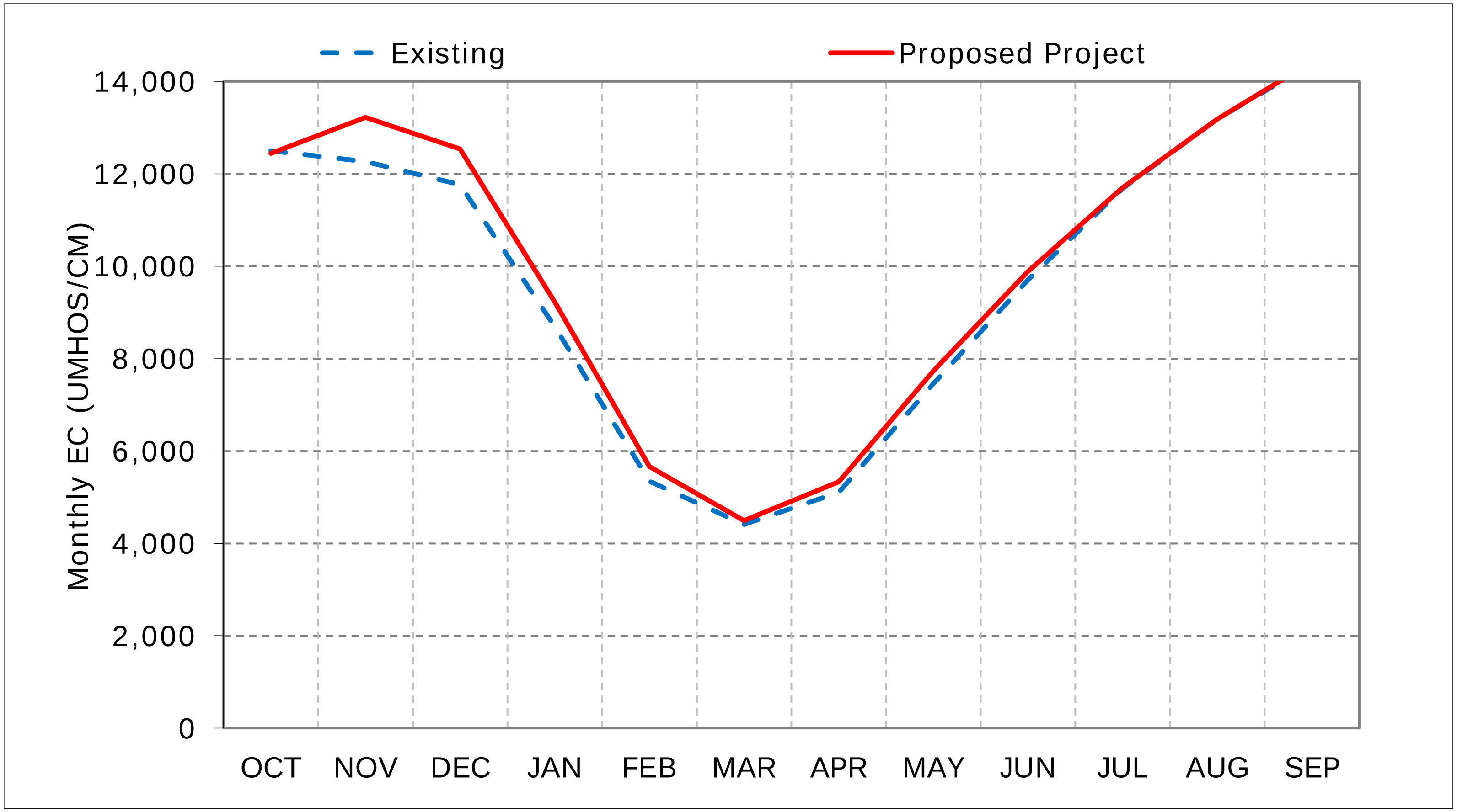
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 8-5. Chipps Island North Channel Salinity, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 8-6. Chipps Island North Channel Salinity, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 8-7. Chipps Island North Channel Salinity, January EC

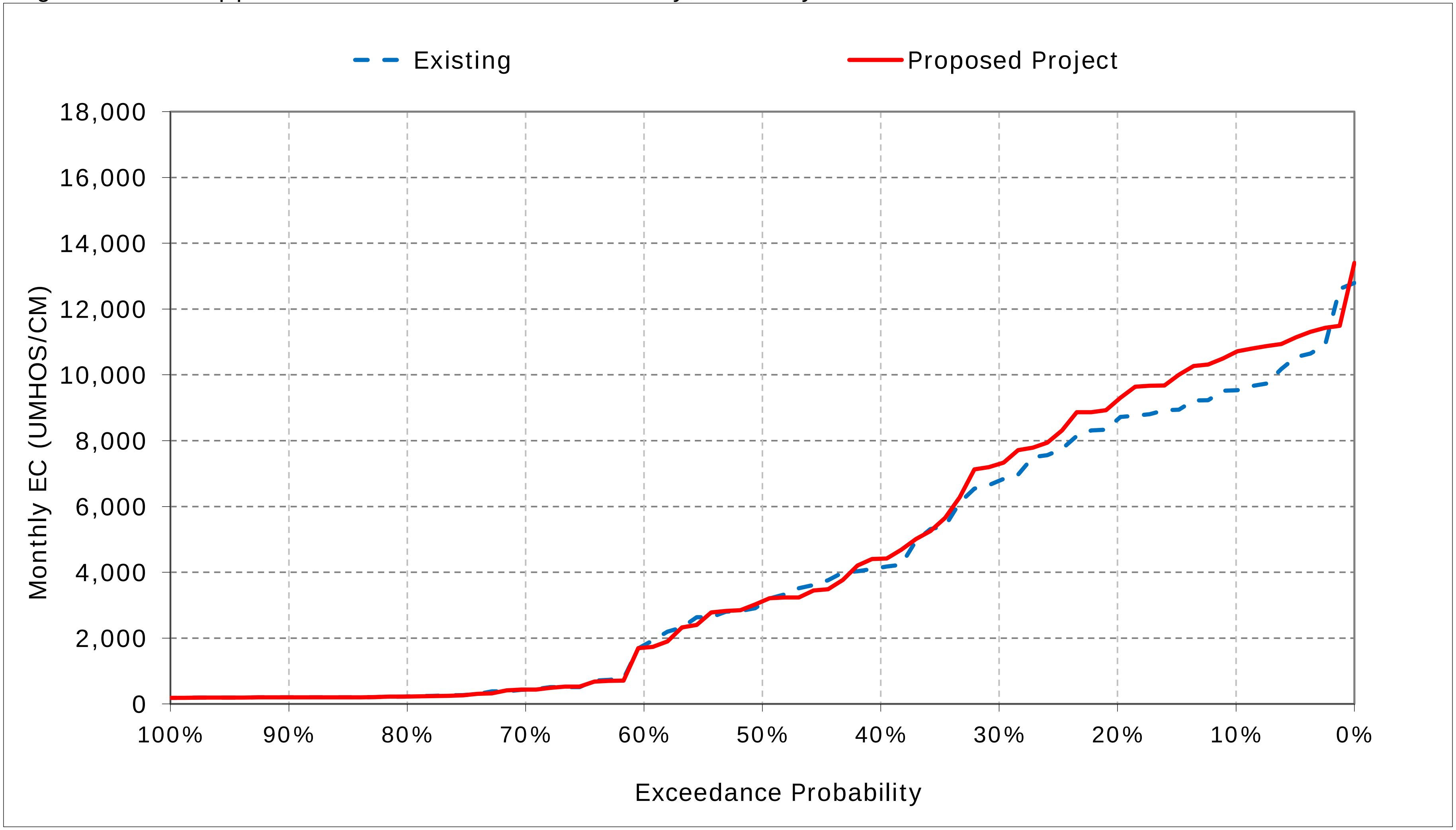


Figure 8-8. Chipps Island North Channel Salinity, February EC

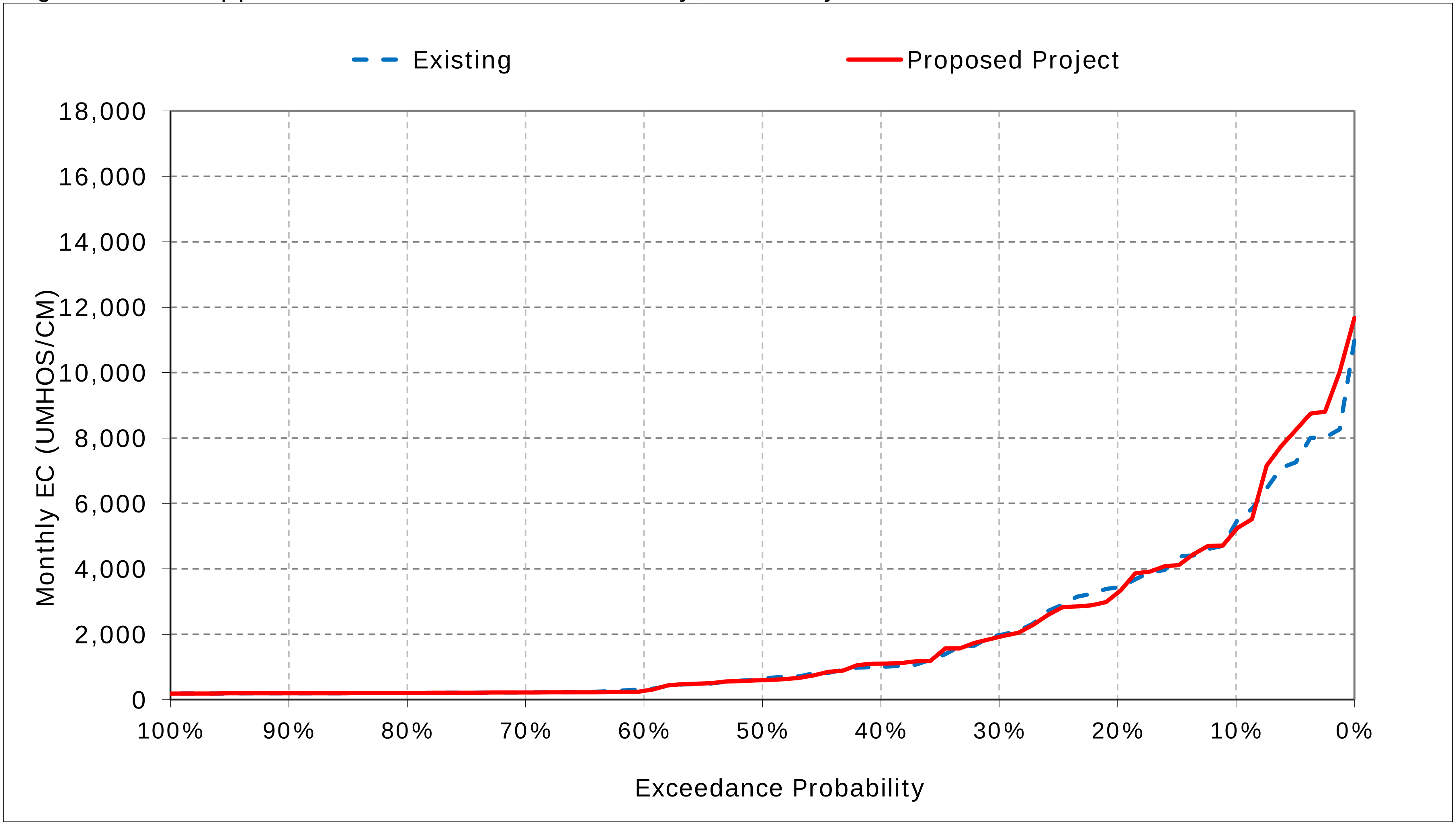


Figure 8-9. Chipps Island North Channel Salinity, March EC

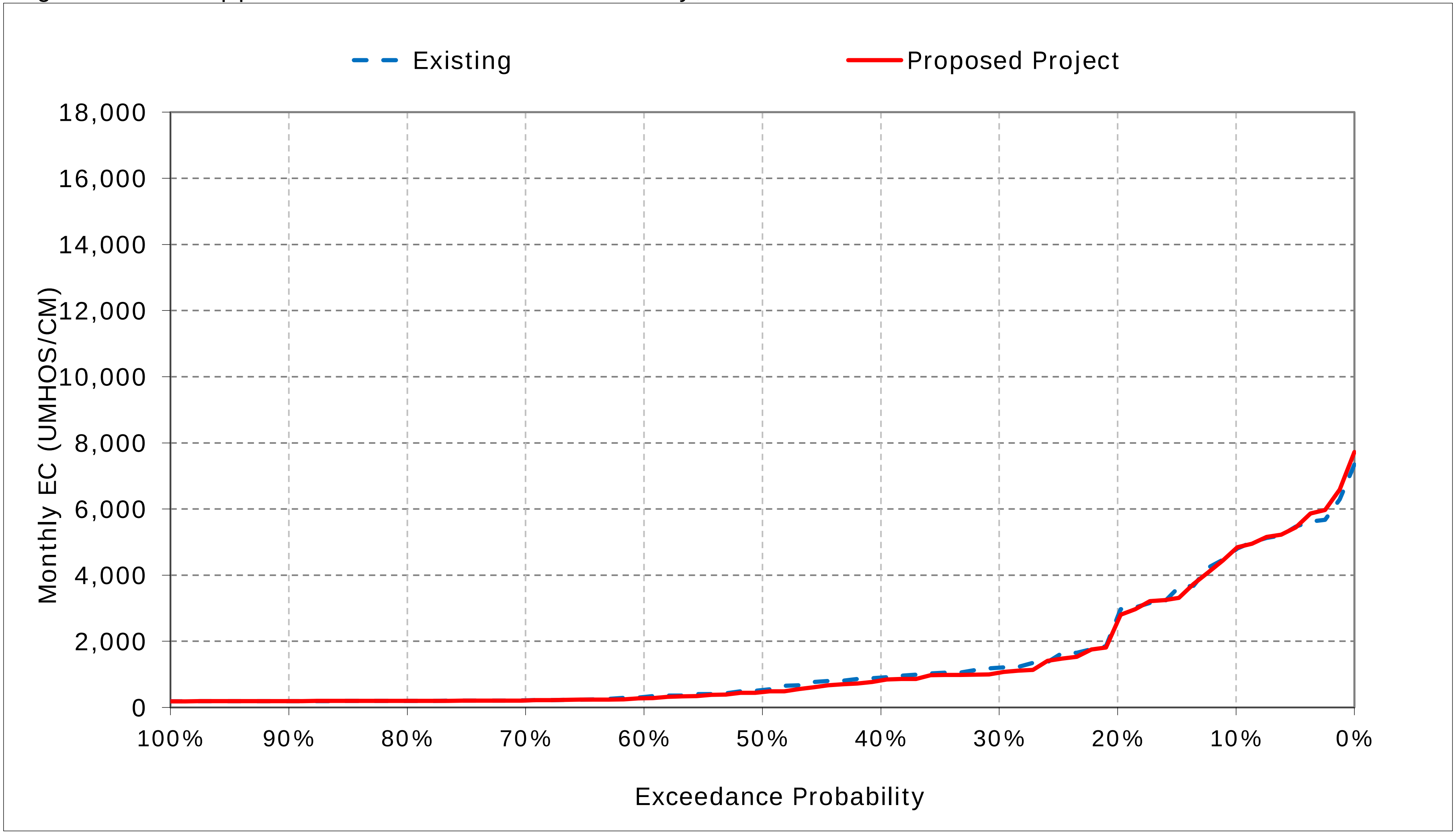


Figure 8-10. Chipps Island North Channel Salinity, April EC

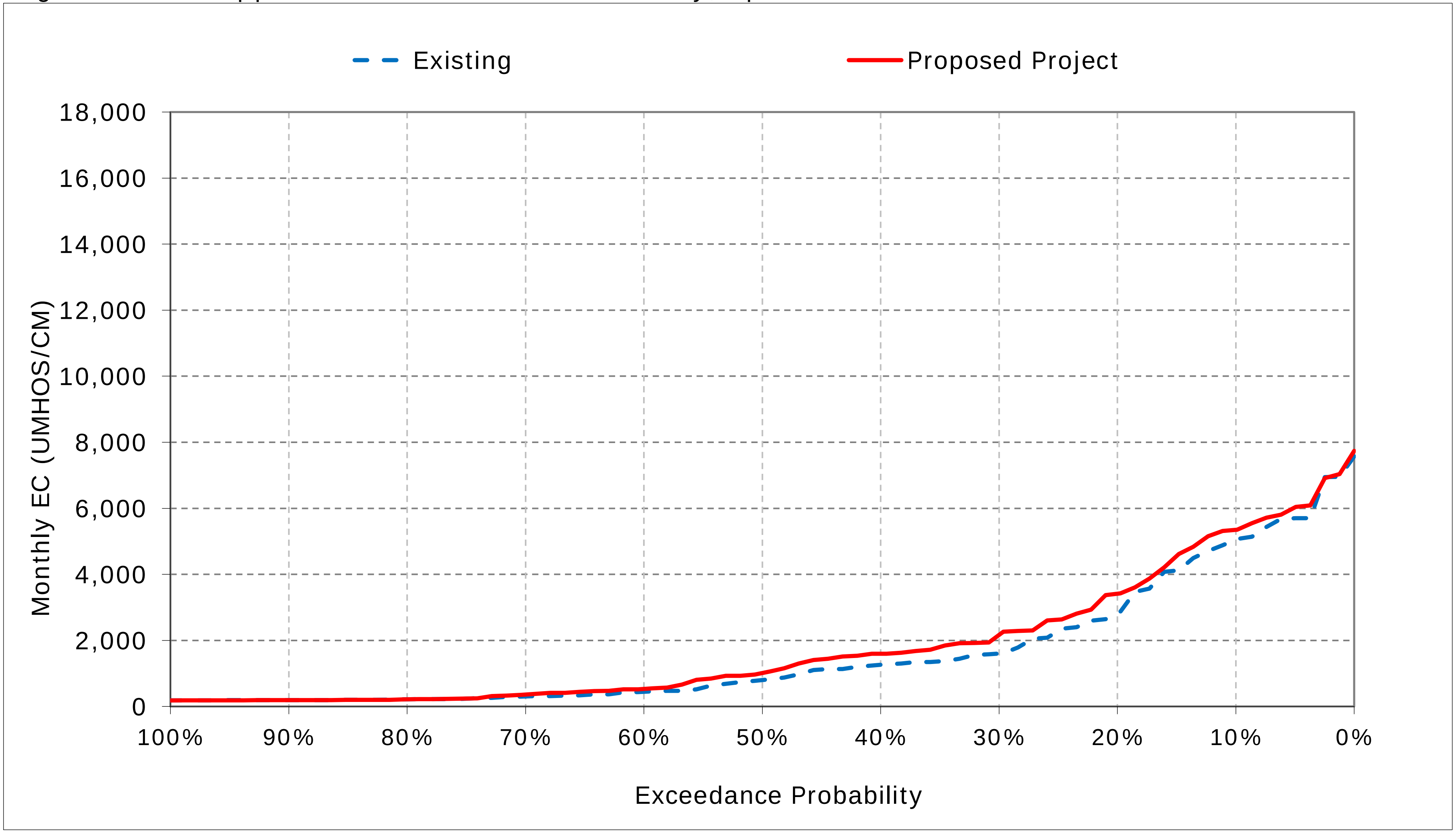


Figure 8-11. Chipps Island North Channel Salinity, May EC

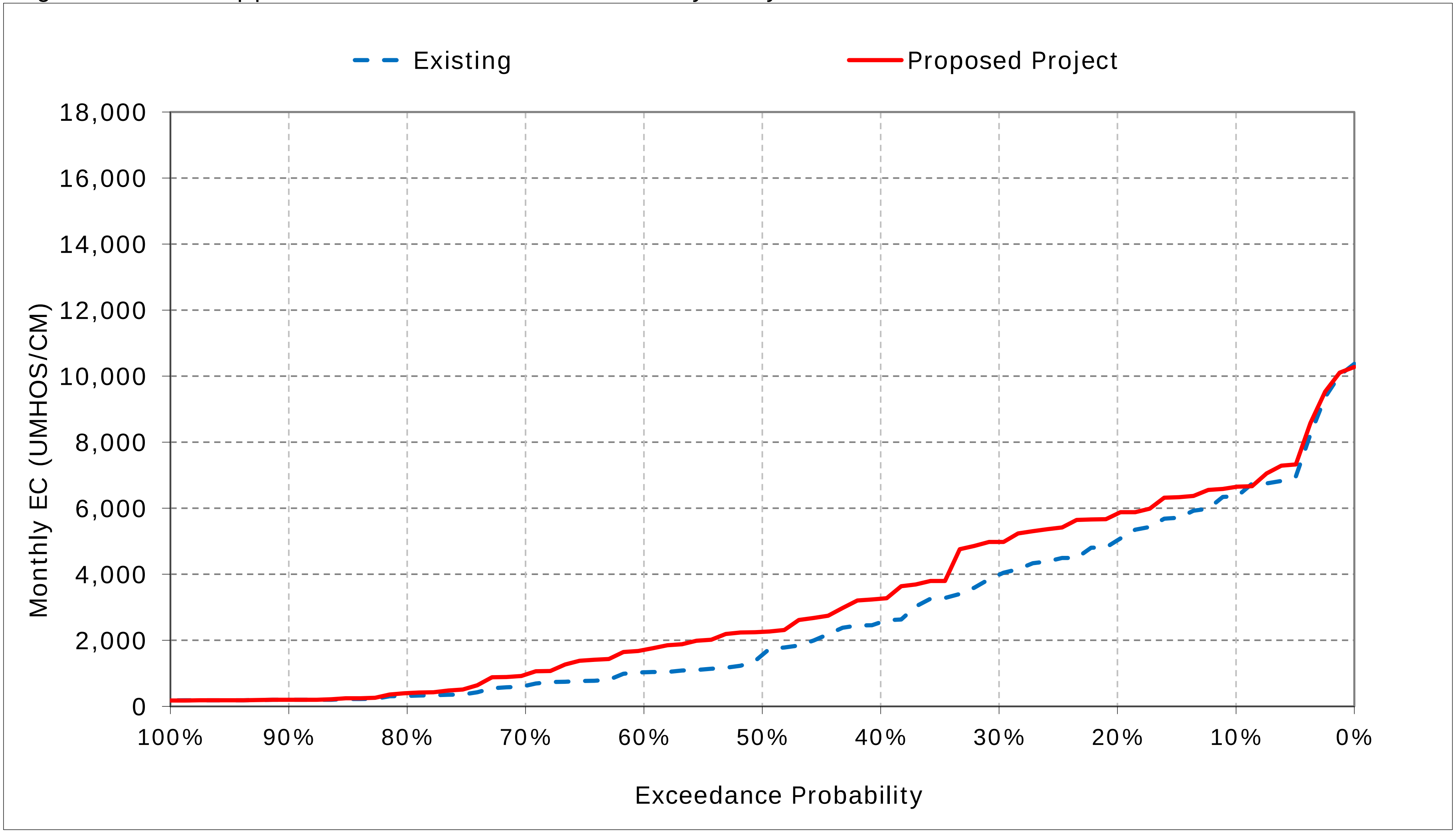


Figure 8-12. Chipps Island North Channel Salinity, June EC

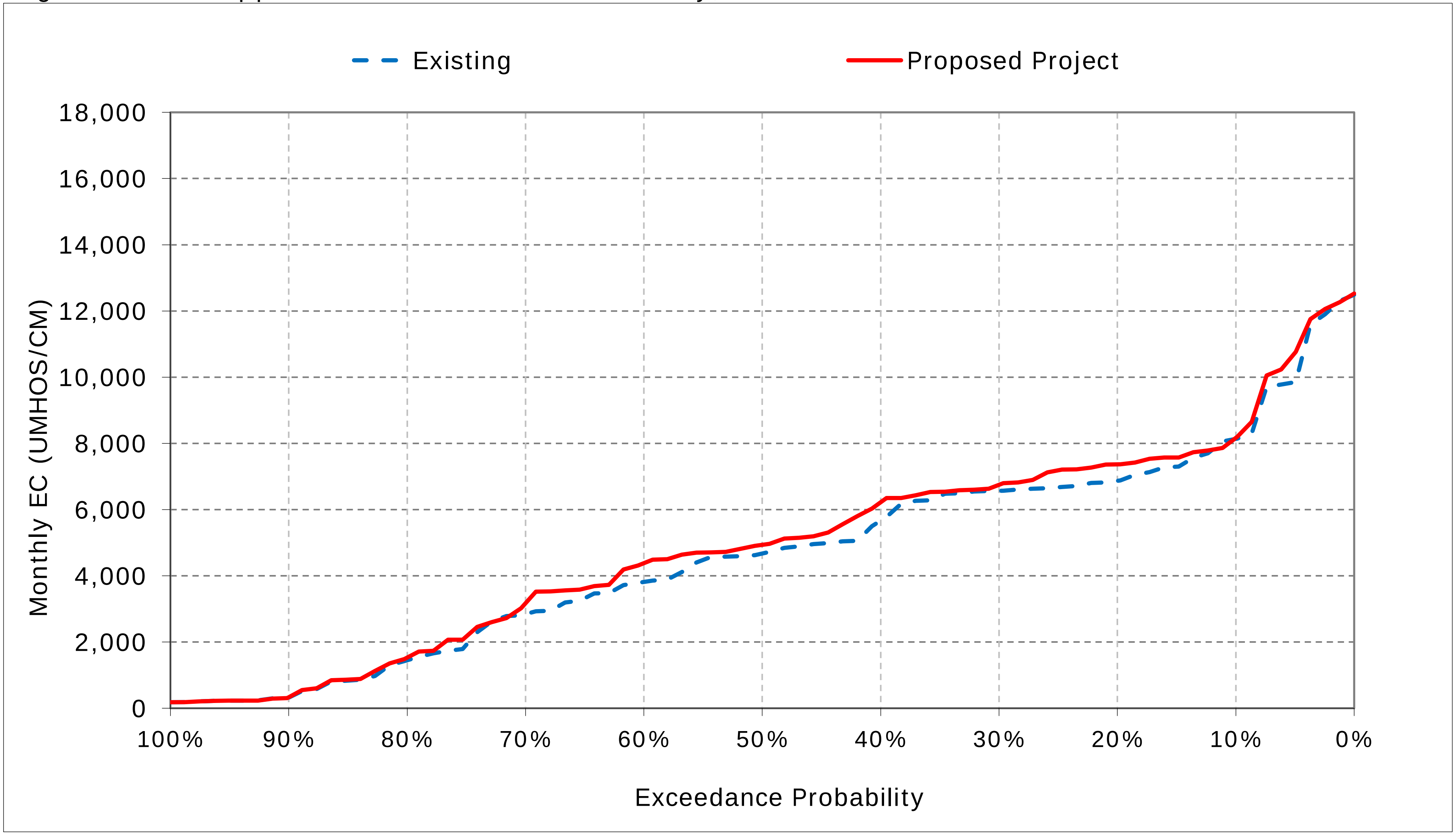


Figure 8-13. Chipps Island North Channel Salinity, July EC

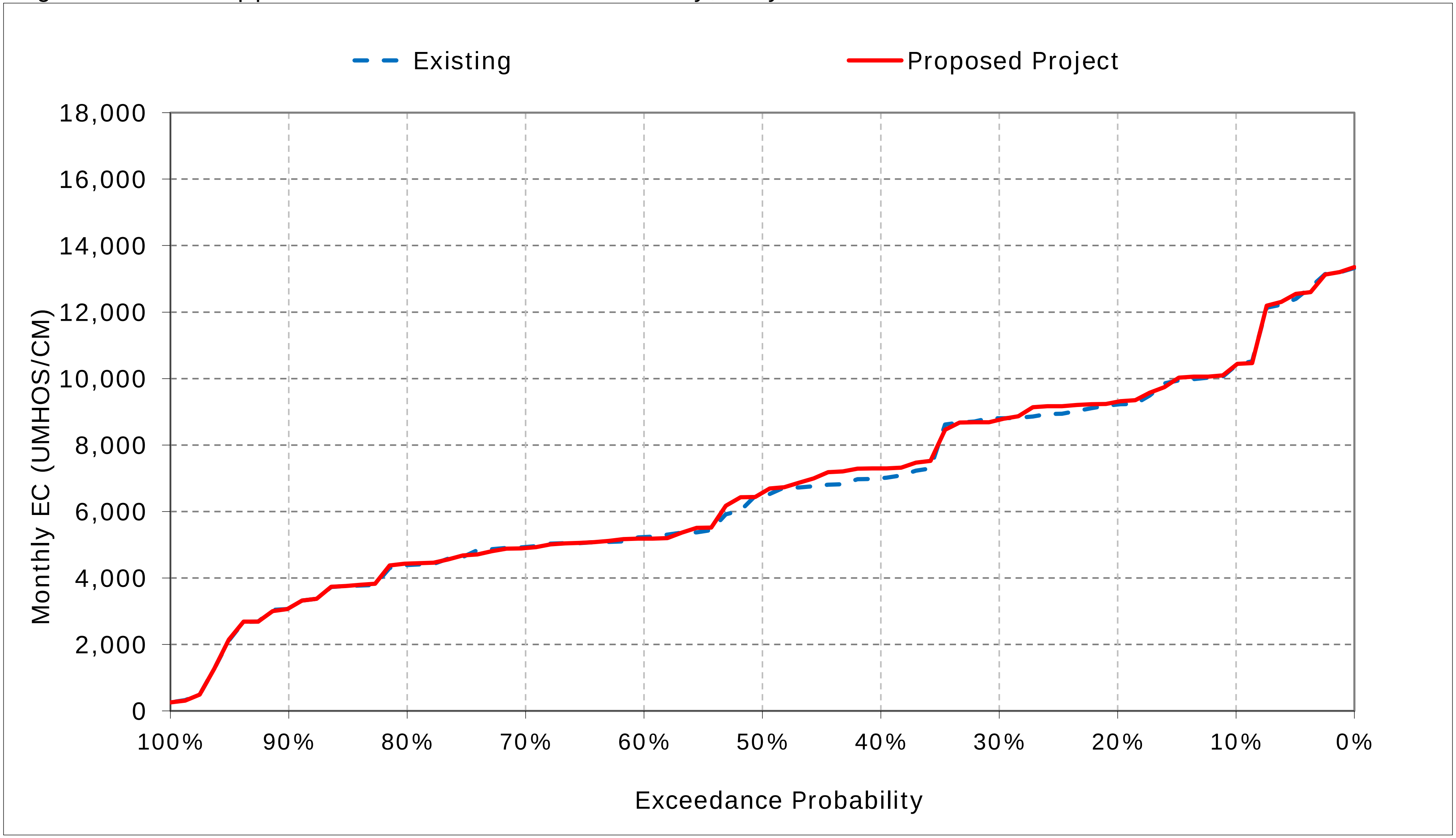


Figure 8-14. Chipps Island North Channel Salinity, August EC

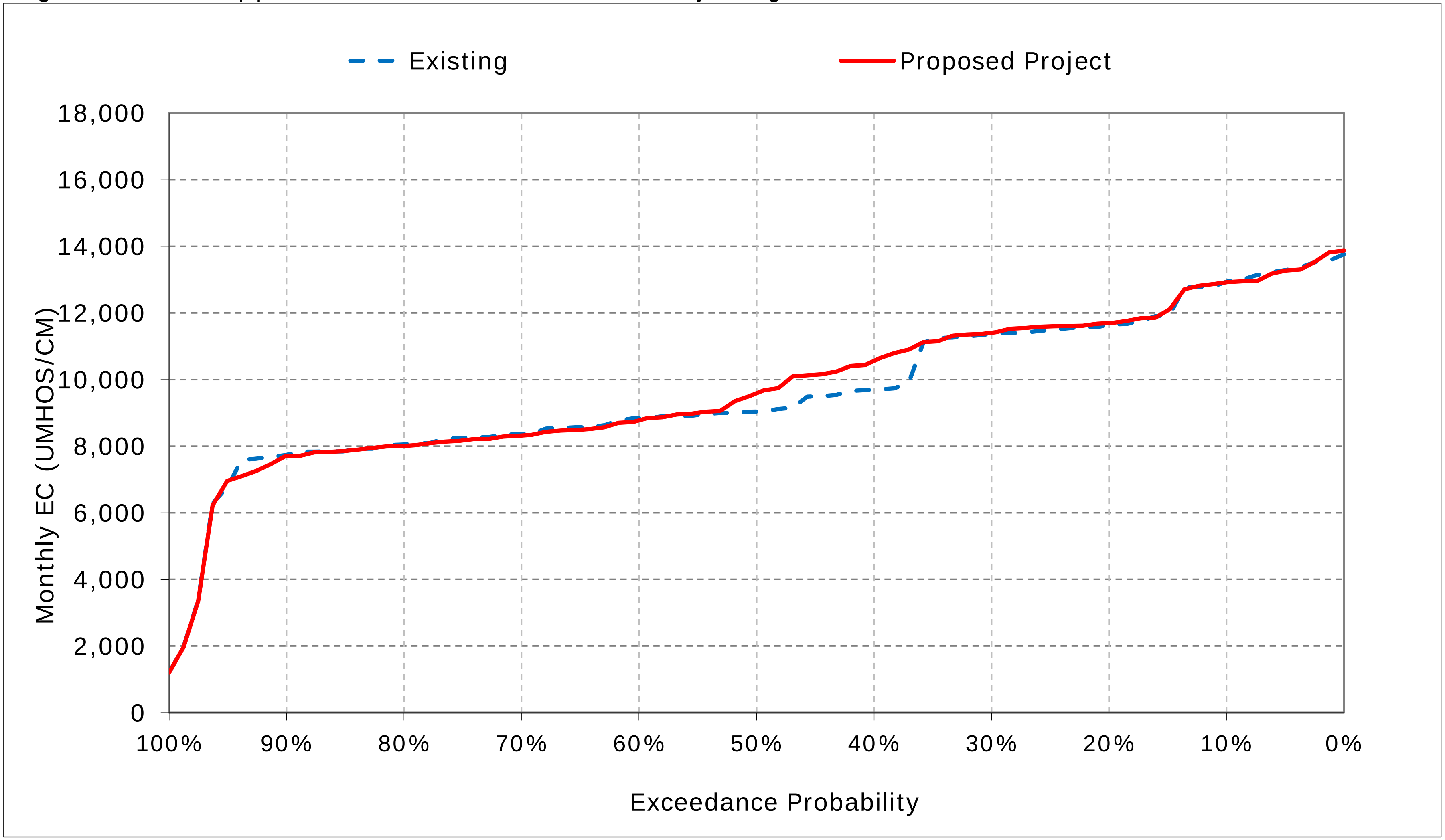


Figure 8-15. Chipps Island North Channel Salinity, September EC

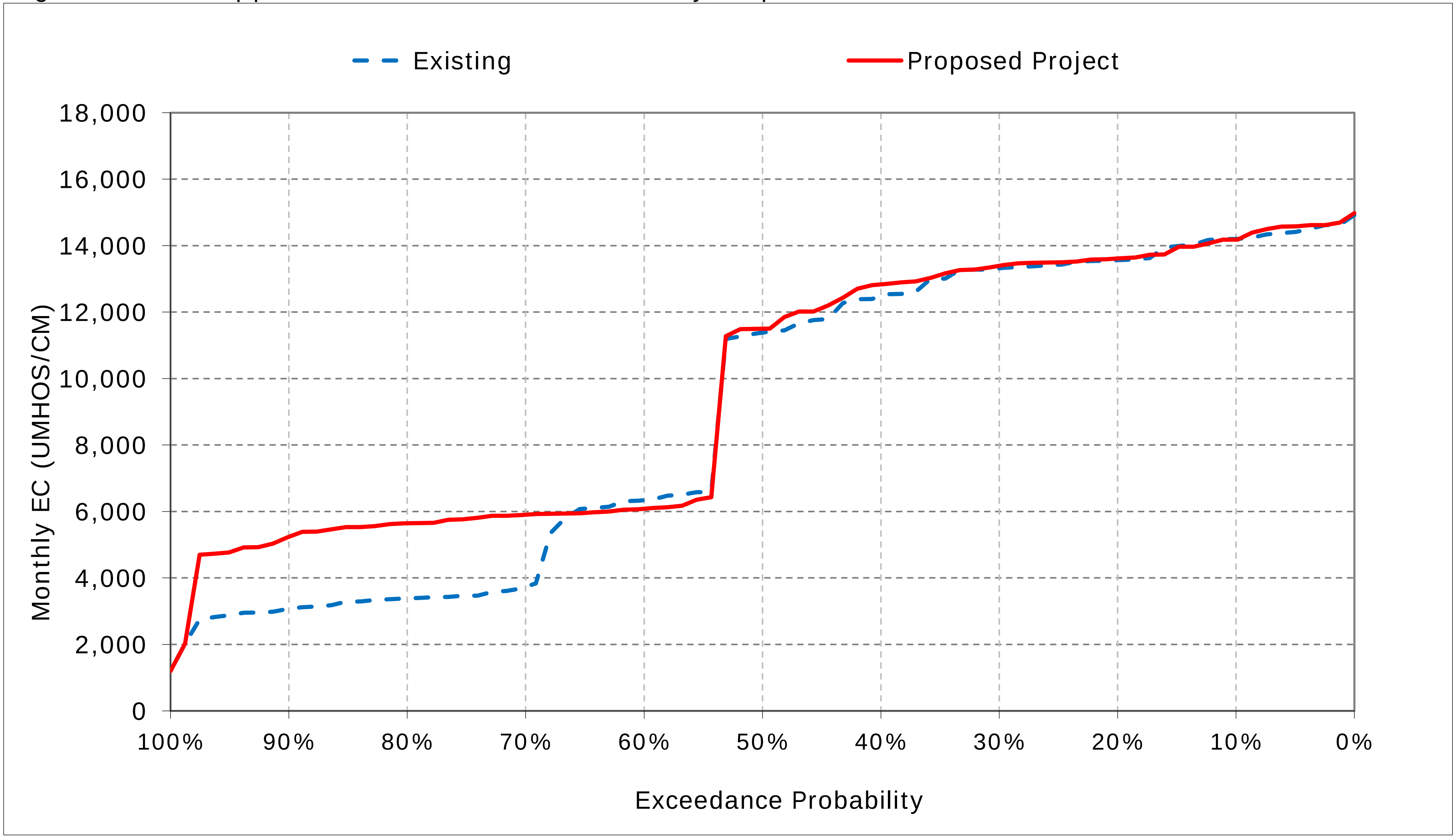


Figure 8-16. Chipps Island North Channel Salinity, October EC

Figure 8-17. Chipps Island North Channel Salinity, November EC

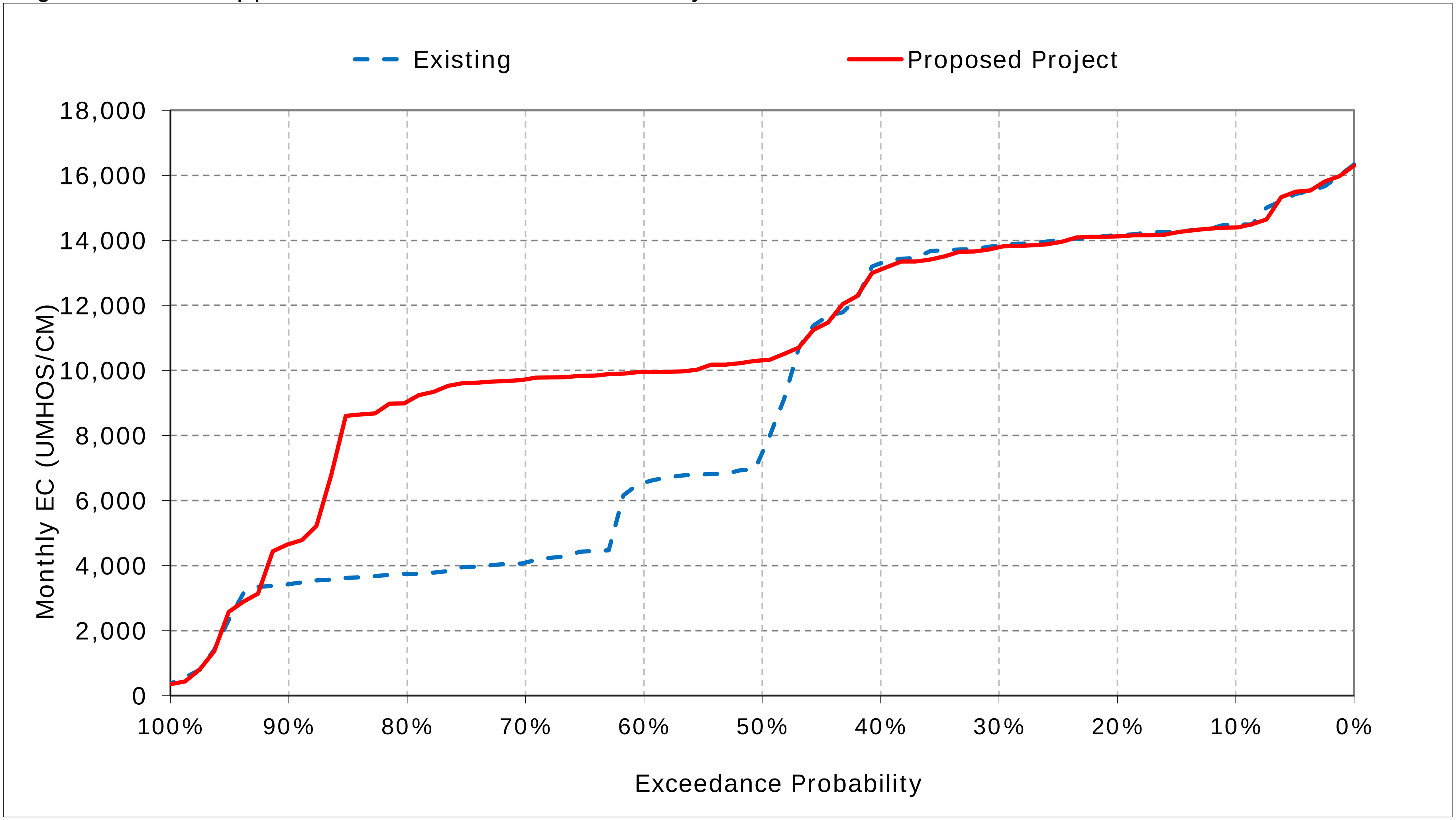


Figure 8-18. Chipps Island North Channel Salinity, December EC

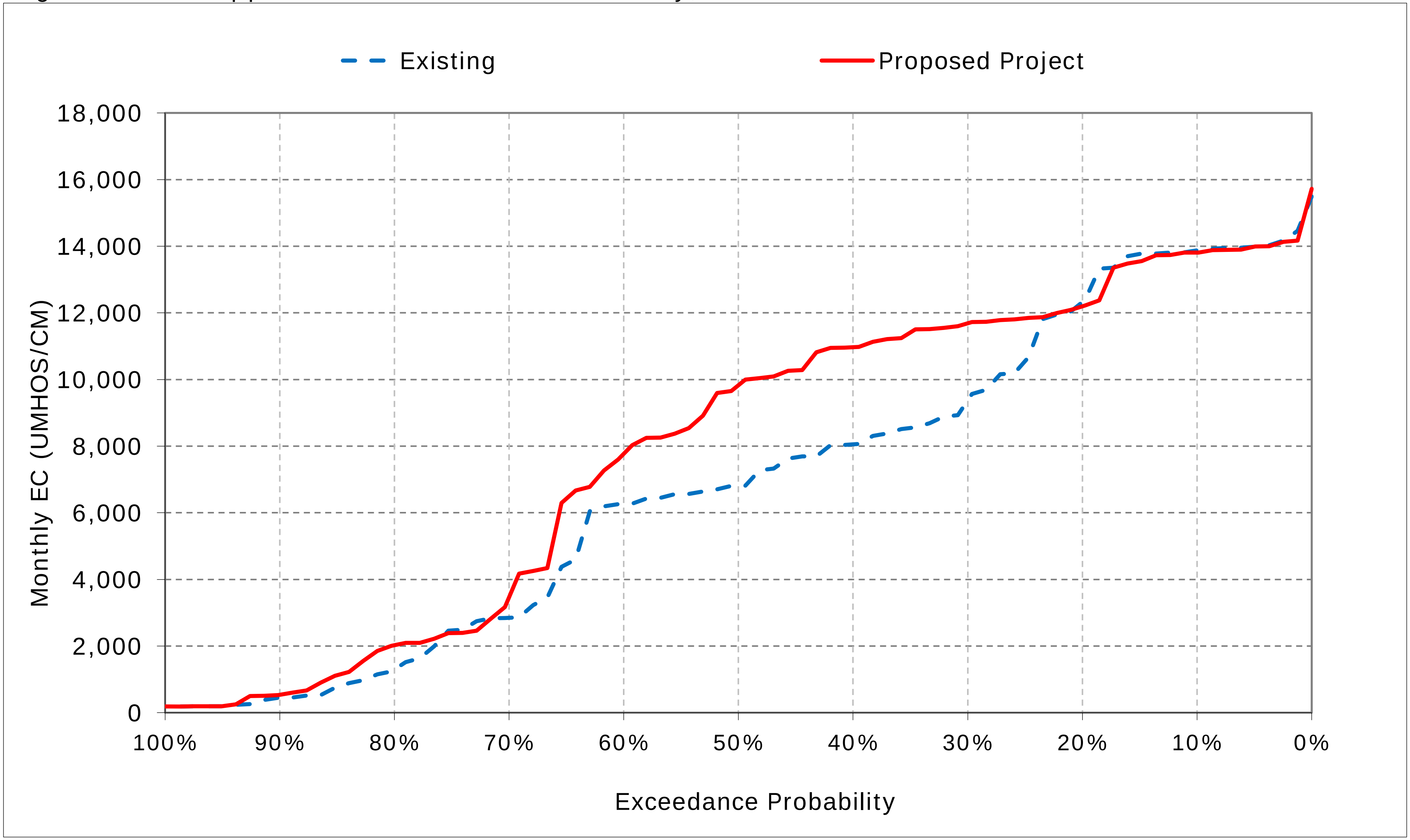


Table 9-1. Chipps Island South Channel Salinity, Monthly EC

Existing

	Monthly EC (UMHOS/CM)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	13,978	13,281	12,537	8,210	4,174	3,630	3,937	5,048	6,637	8,894	11,521	12,903
20%	13,320	12,805	10,920	7,295	2,547	2,037	1,966	3,919	5,526	7,692	10,241	12,247
30%	13,059	12,586	7,941	5,657	1,420	798	1,039	2,897	5,203	7,284	9,931	12,001
40%	12,865	11,999	6,732	3,264	795	605	808	1,734	4,277	5,564	8,261	11,115
50%	11,653	6,265	5,558	2,491	589	363	557	980	3,568	5,114	7,589	9,980
60%	6,184	5,367	5,069	1,335	295	244	307	646	2,720	4,060	7,427	5,219
70%	3,557	3,197	2,145	339	219	203	239	387	2,007	3,715	6,995	3,003
80%	3,334	2,863	1,040	216	201	196	205	238	897	3,268	6,690	2,663
90%	3,161	2,617	355	196	192	191	192	193	232	2,248	6,353	2,473
Long Term												
Full Simulation Period[a]	8,840	7,881	5,965	3,432	1,483	1,073	1,242	2,017	3,701	5,422	8,251	7,901
Water Year Types[b]												
Wet (32%)	6,948	5,172	2,013	631	240	236	282	448	1,259	2,703	6,196	2,473
Above Normal (15%)	9,230	7,827	5,961	2,122	564	251	336	595	2,502	3,646	6,818	5,100
Below Normal (17%)	9,261	8,675	7,599	3,803	972	781	836	1,470	3,527	5,266	7,910	10,521
Dry (22%)	9,348	9,098	7,430	5,383	2,376	1,474	1,734	2,962	5,139	7,459	10,075	12,122
Critical (15%)	11,294	11,051	10,428	7,453	4,354	3,446	3,964	6,062	8,235	10,217	11,797	13,075

Proposed Project

	Monthly EC (UMHOS/CM)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	13,914	13,142	12,458	9,361	4,157	3,658	4,141	5,232	6,727	8,834	11,506	12,877
20%	13,210	12,827	10,831	7,924	2,416	1,914	2,454	4,565	5,956	7,829	10,256	12,305
30%	13,042	12,504	10,368	6,055	1,509	728	1,454	3,837	5,355	7,258	9,968	12,060
40%	12,425	11,822	9,593	3,535	777	536	1,028	2,261	4,818	5,950	9,289	11,514
50%	11,422	9,081	8,412	2,438	617	333	663	1,480	3,761	5,297	8,243	10,131
60%	5,783	8,604	6,501	1,225	270	232	362	1,127	3,223	3,969	7,369	4,987
70%	5,517	8,426	2,623	336	217	205	261	584	2,231	3,715	6,945	4,772
80%	5,277	7,794	1,673	219	201	195	201	268	946	3,336	6,636	4,597
90%	4,950	3,727	612	197	193	192	190	188	234	2,255	6,234	4,347
Long Term												
Full Simulation Period[a]	9,288	9,559	6,973	3,651	1,543	1,058	1,392	2,399	3,910	5,492	8,376	8,491
Water Year Types[b]												
Wet (32%)	7,561	7,329	2,653	629	233	230	340	657	1,455	2,715	6,086	4,278
Above Normal (15%)	9,757	9,678	7,477	2,255	450	236	425	970	2,660	3,588	6,851	4,703
Below Normal (17%)	9,734	10,274	8,815	3,857	927	726	1,045	2,036	3,716	5,596	8,752	10,872
Dry (22%)	9,833	10,551	8,644	5,912	2,557	1,421	1,977	3,537	5,434	7,532	10,137	12,171
Critical (15%)	11,220	11,949	11,177	7,964	4,674	3,517	4,162	6,320	8,417	10,232	11,786	13,112

Proposed Project minus Existing

	Monthly EC (UMHOS/CM)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-64	-139	-79	1,151	-17	29	205	184	90	-60	-16	-26
20%	-111	22	-89	629	-131	-123	488	646	429	137	16	58
30%	-18	-83	2,427	398	90	-71	415	941	152	-27	36	59
40%	-440	-176	2,861	271	-17	-69	220	527	540	385	1,029	399
50%	-232	2,816	2,853	-53	28	-31	106	500	193	183	654	151
60%	-400	3,238	1,431	-110	-25	-12	55	481	503	-91	-58	-232
70%	1,960	5,229	479	-3	-2	2	22	197	224	0	-50	1,769
80%	1,942	4,931	633	3	0	-1	-4	30	49	68	-55	1,933
90%	1,789	1,110	258	0	1	1	-2	-5	2	6	-119	1,874
Long Term												
Full Simulation Period[a]	448	1,678	1,008	219	60	-15	150	382	209	70	126	590
Water Year Types[b]												
Wet (32%)	613	2,157	640	-2	-7	-6	58	209	196	12	-110	1,805
Above Normal (15%)	527	1,852	1,515	133	-114	-15	89	374	158	-58	33	-398
Below Normal (17%)	473	1,599	1,216	54	-44	-55	209	565	189	330	842	351
Dry (22%)	485	1,453	1,214	528	181	-53	243	575	295	74	62	50
Critical (15%)	-74	898	749	511	320	72	198	258	182	14	-11	37

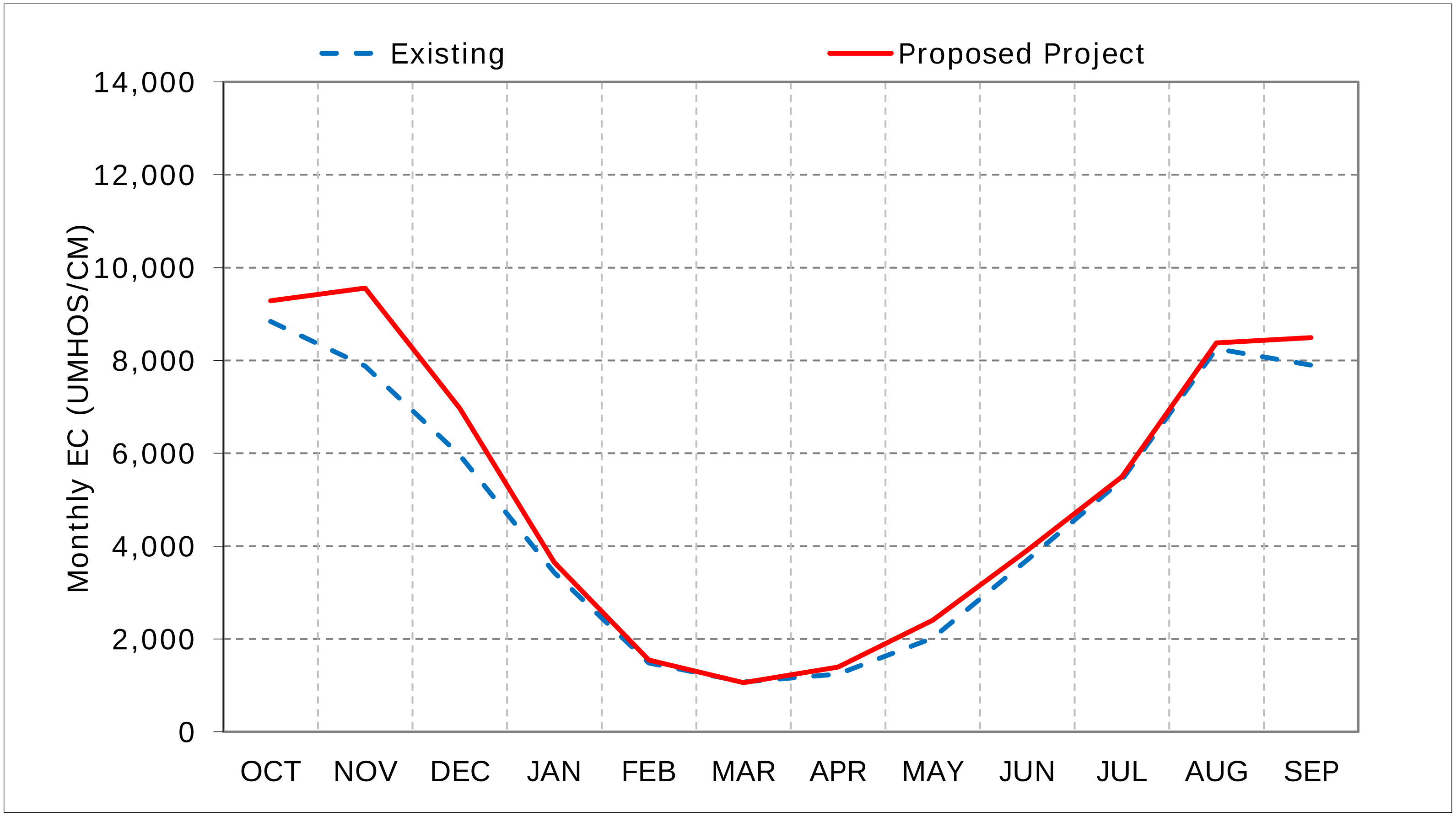
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

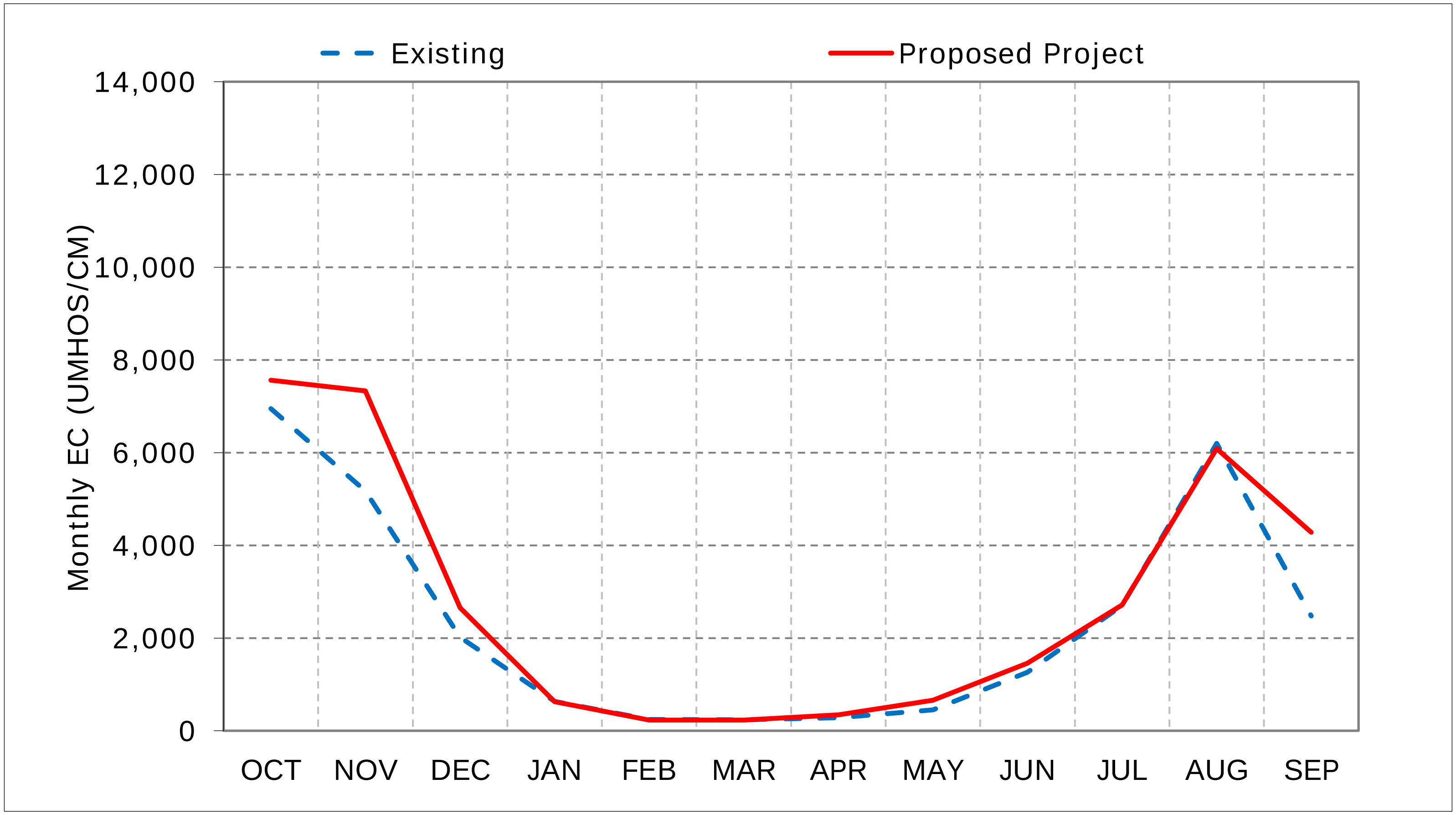
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 9-1. Chipps Island South Channel Salinity, Long-Term Average EC



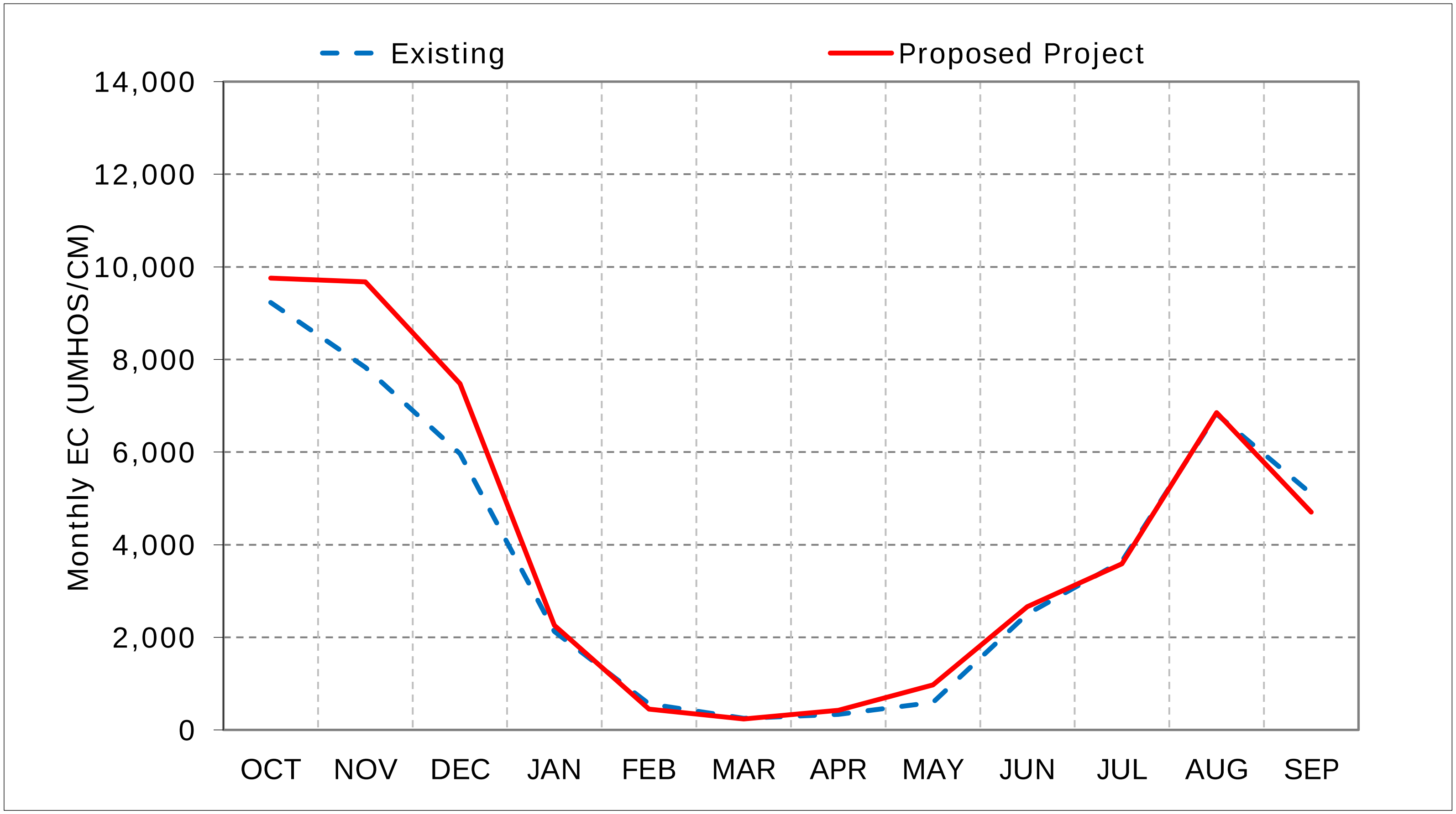
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 9-2. Chipps Island South Channel Salinity, Wet Year Average EC



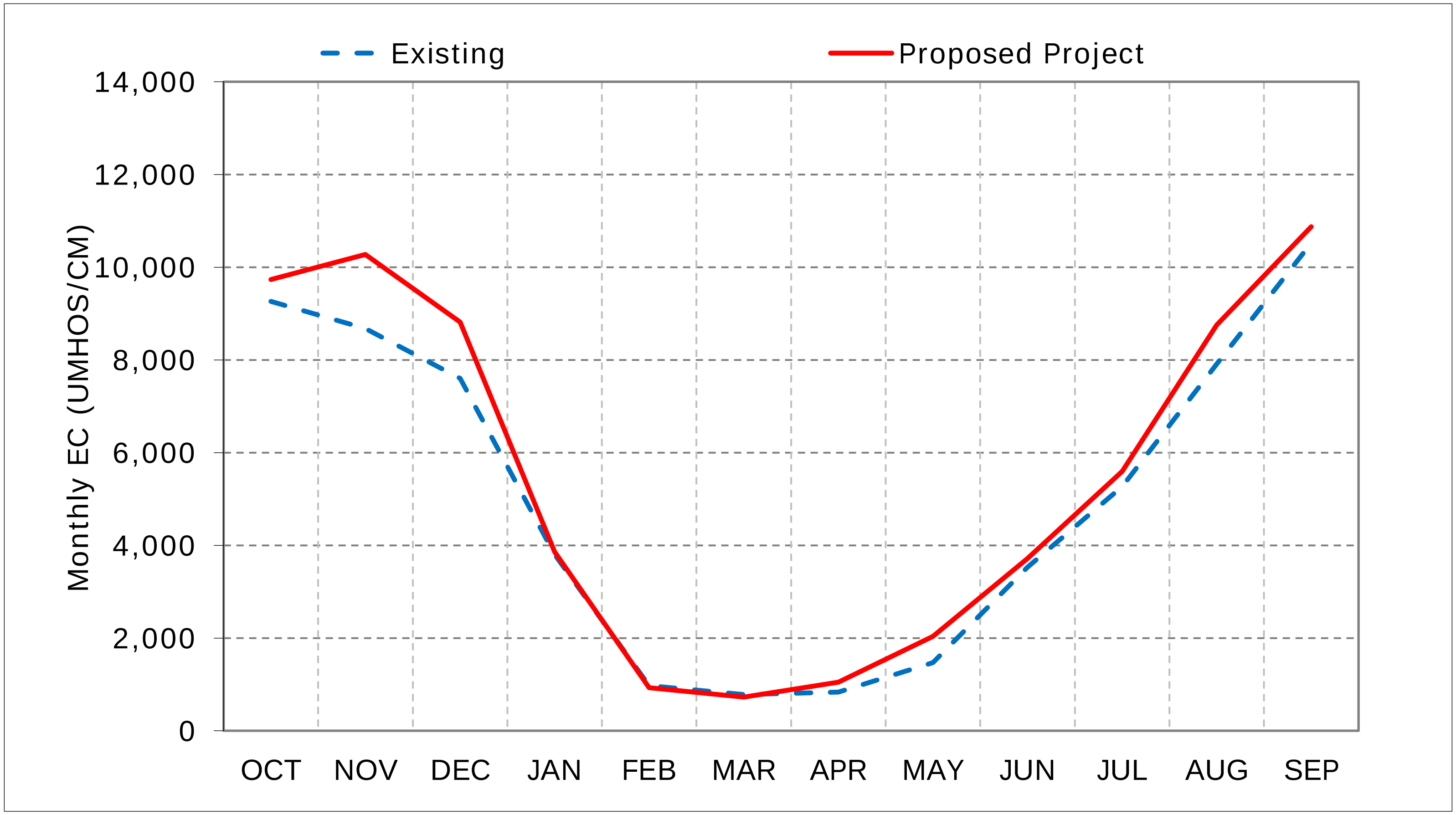
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 9-3. Chipps Island South Channel Salinity, Above Normal Year Average EC



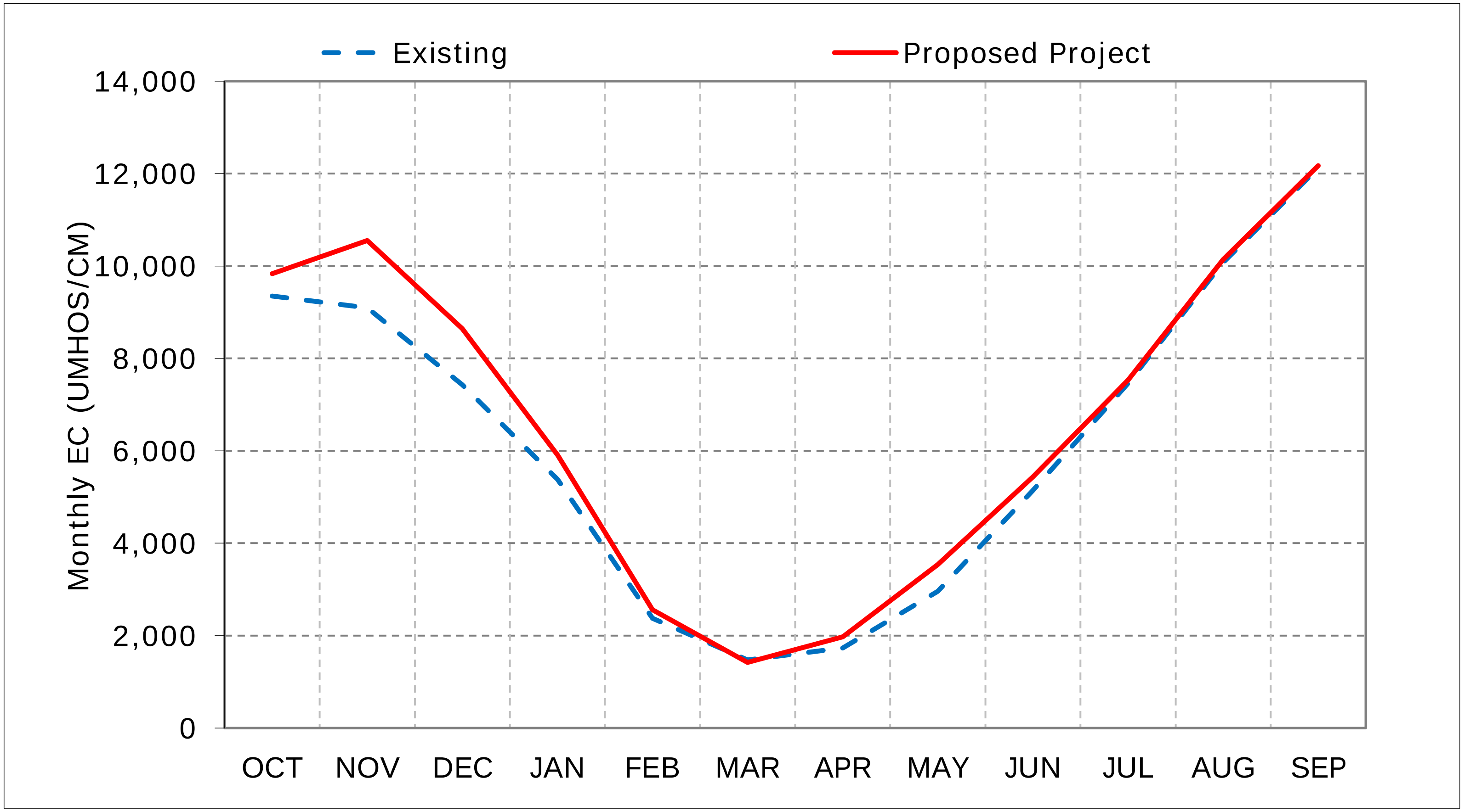
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 9-4. Chipps Island South Channel Salinity, Below Normal Year Average EC



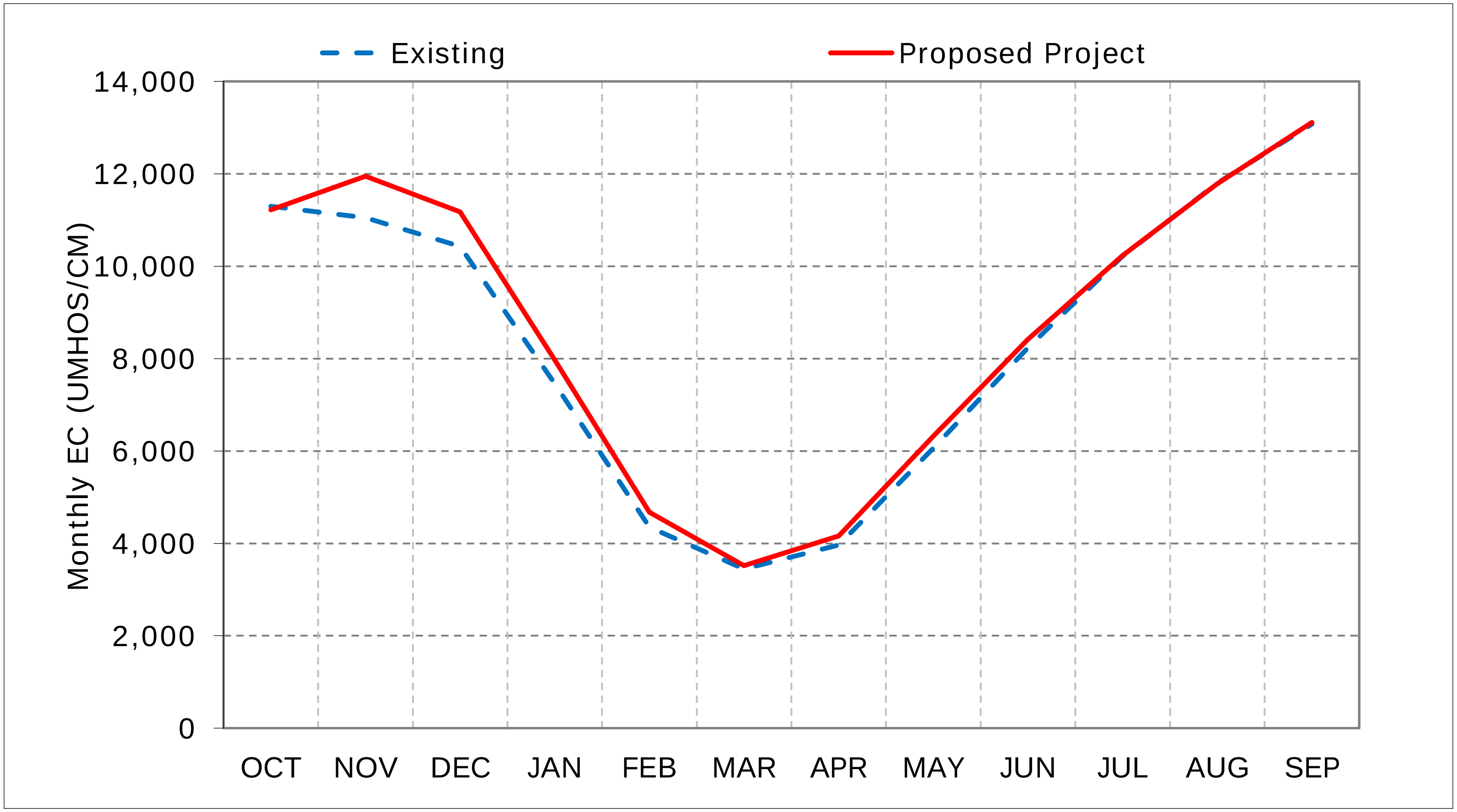
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 9-5. Chipps Island South Channel Salinity, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 9-6. Chipps Island South Channel Salinity, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 9-7. Chipps Island South Channel Salinity, January EC

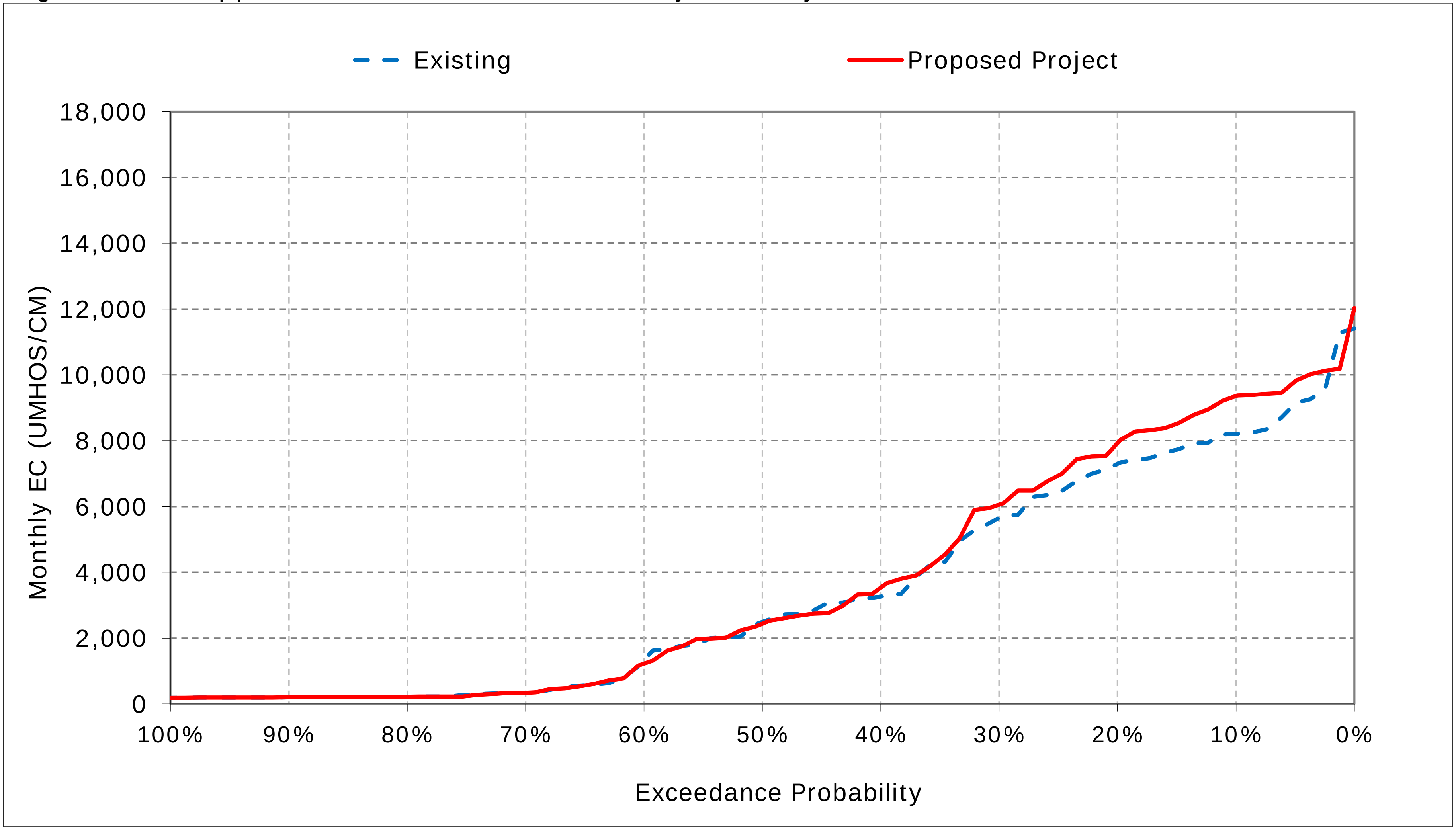


Figure 9-8. Chipps Island South Channel Salinity, February EC

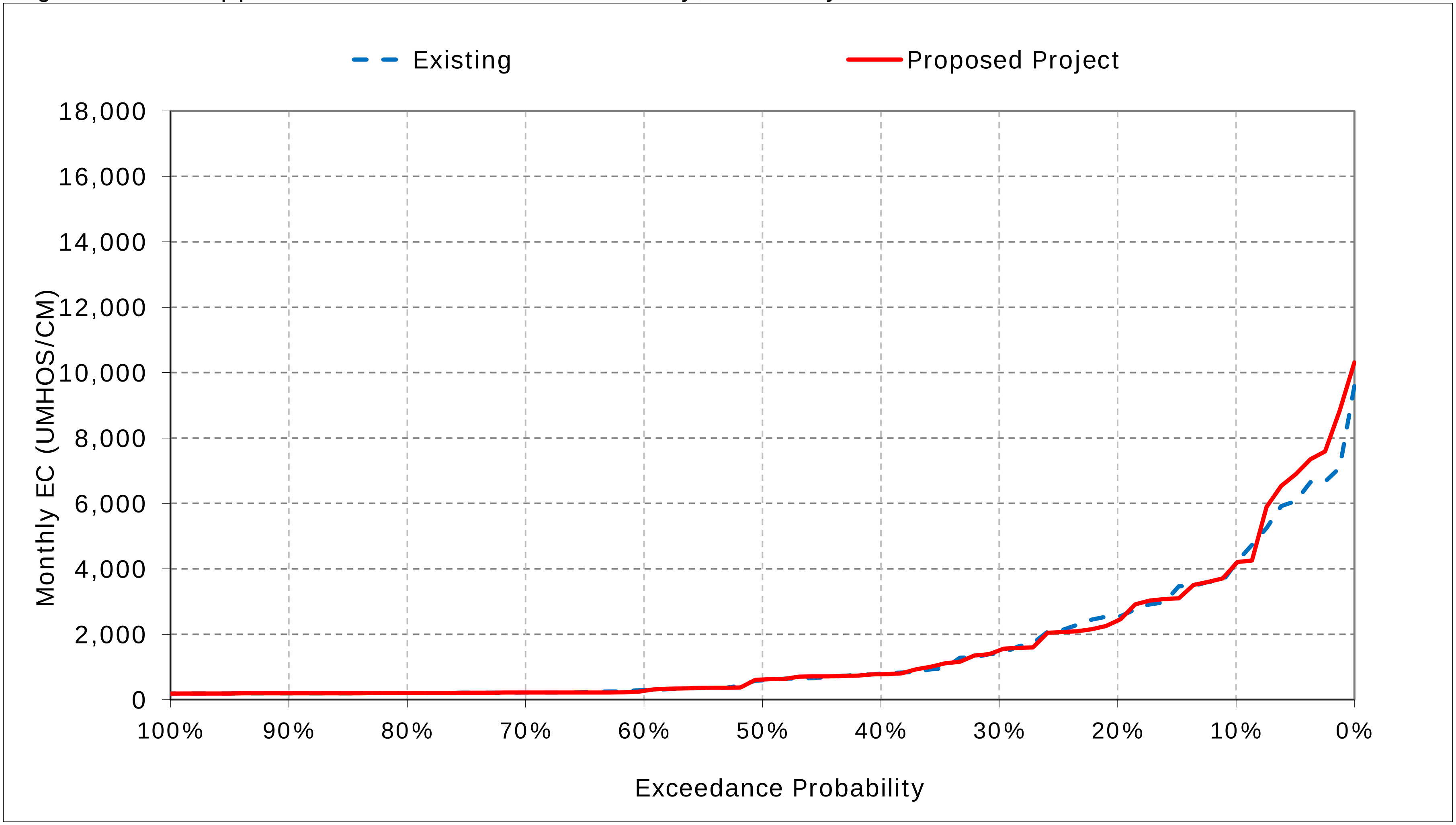


Figure 9-9. Chipps Island South Channel Salinity, March EC

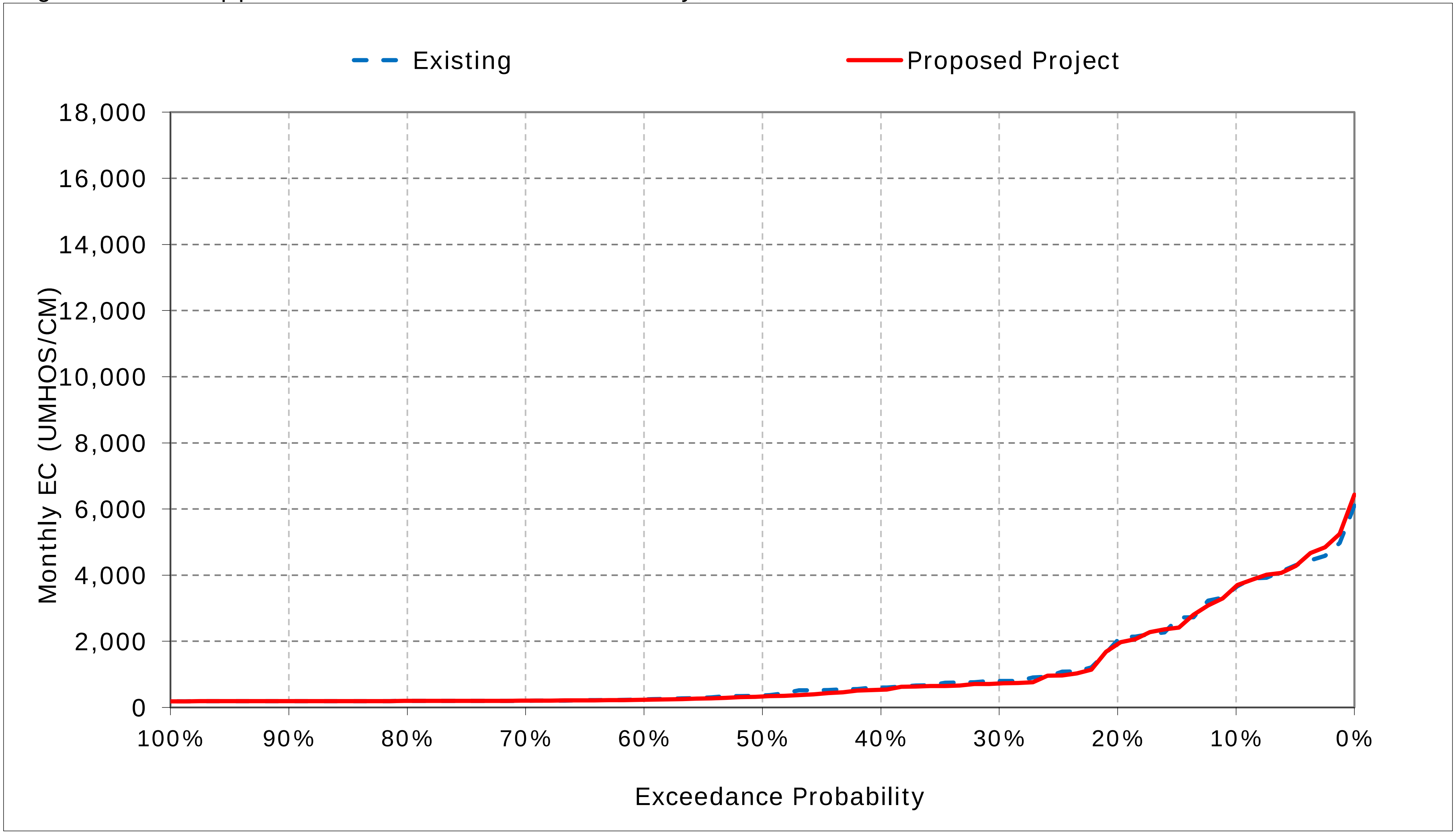


Figure 9-10. Chipps Island South Channel Salinity, April EC

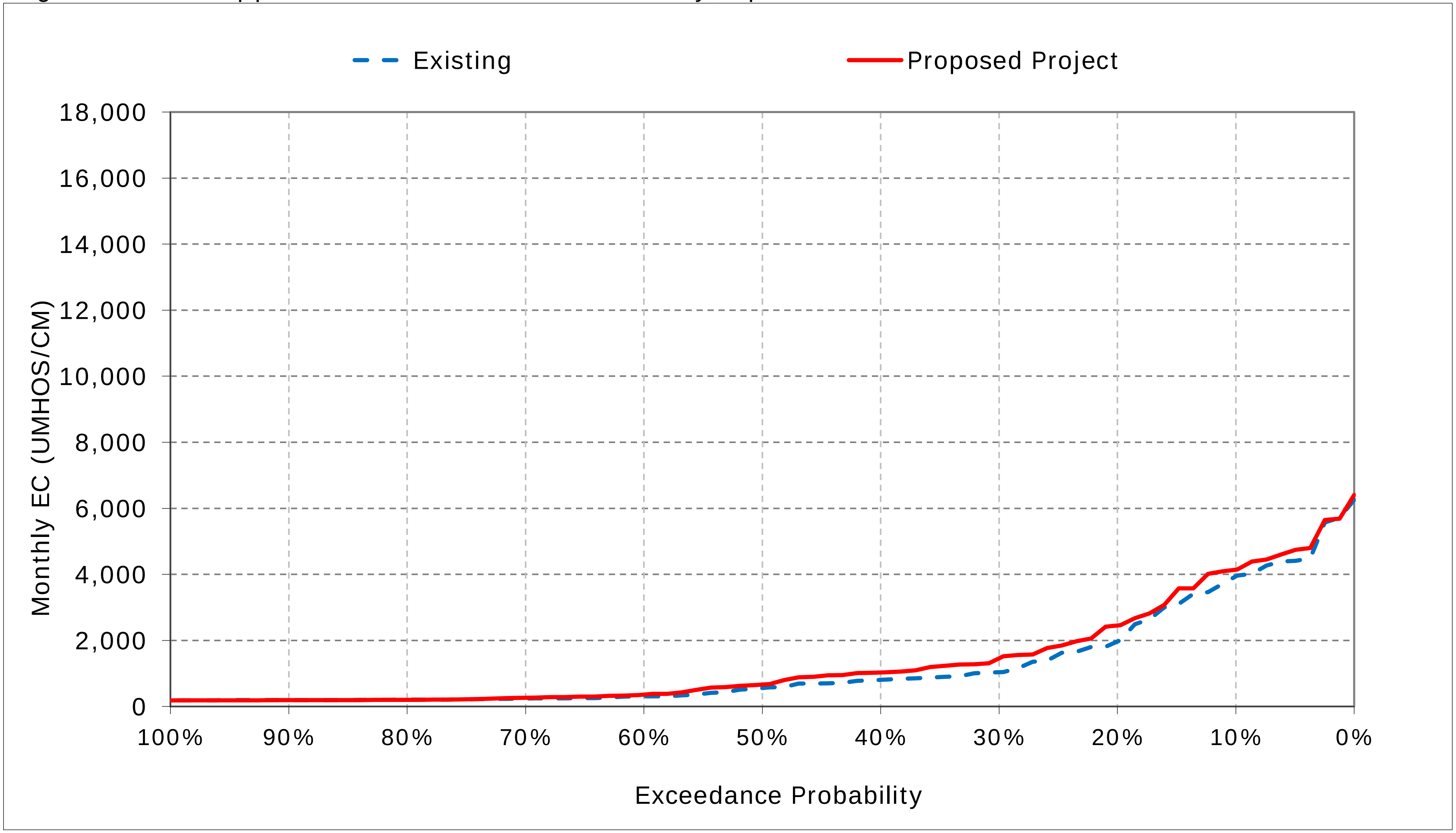


Figure 9-11. Chipps Island South Channel Salinity, May EC

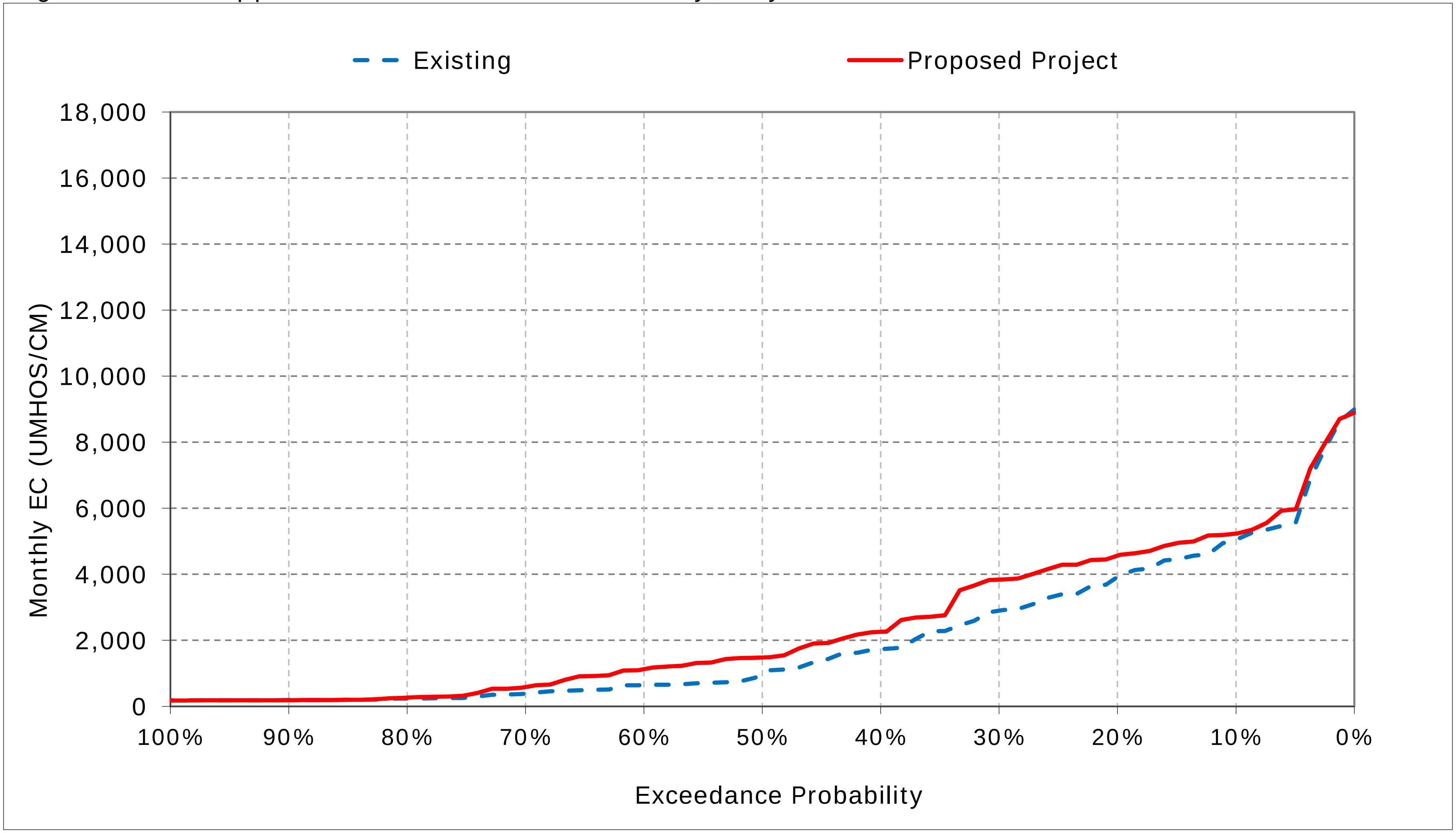


Figure 9-12. Chipps Island South Channel Salinity, June EC

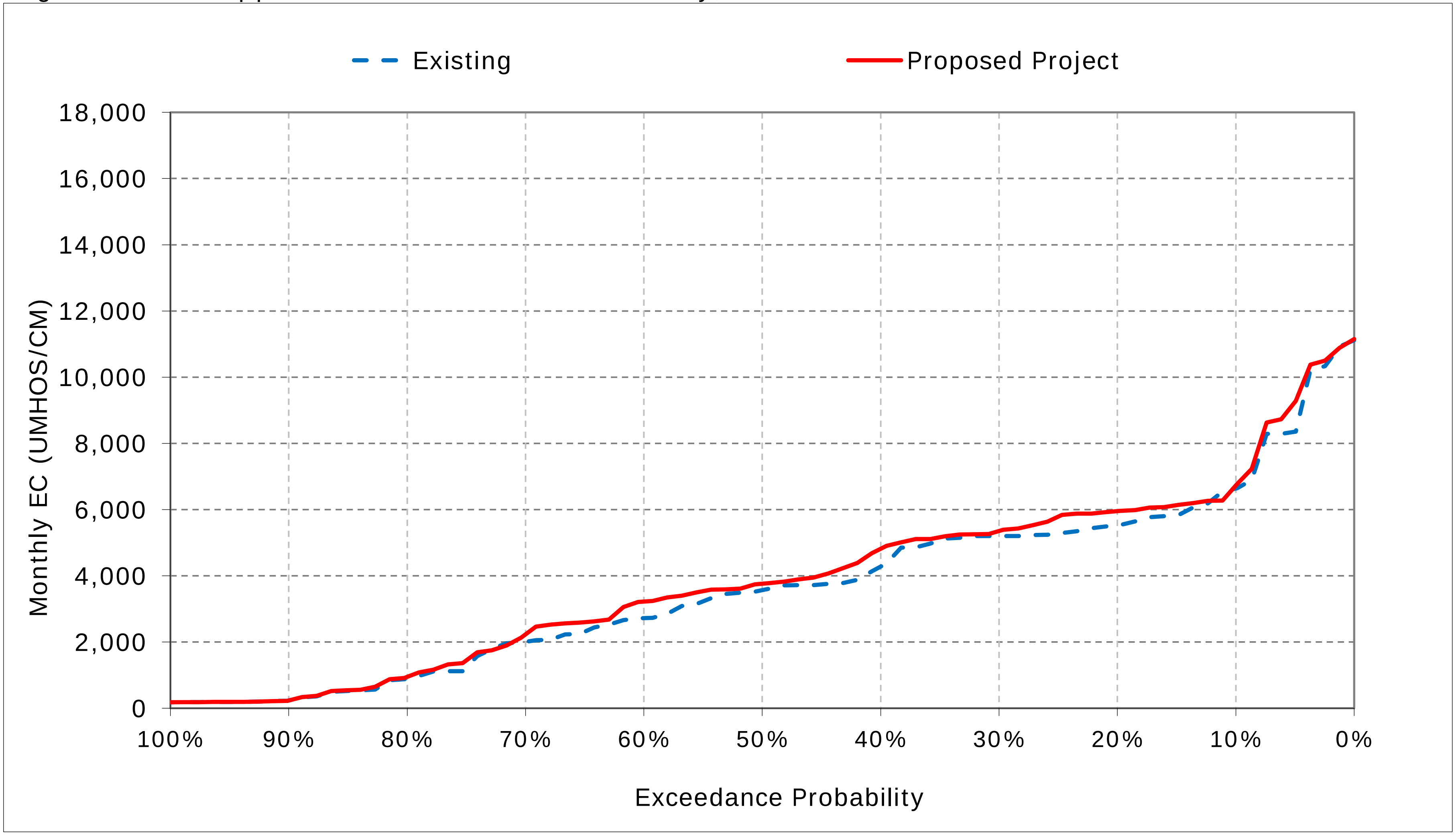


Figure 9-13. Chipps Island South Channel Salinity, July EC

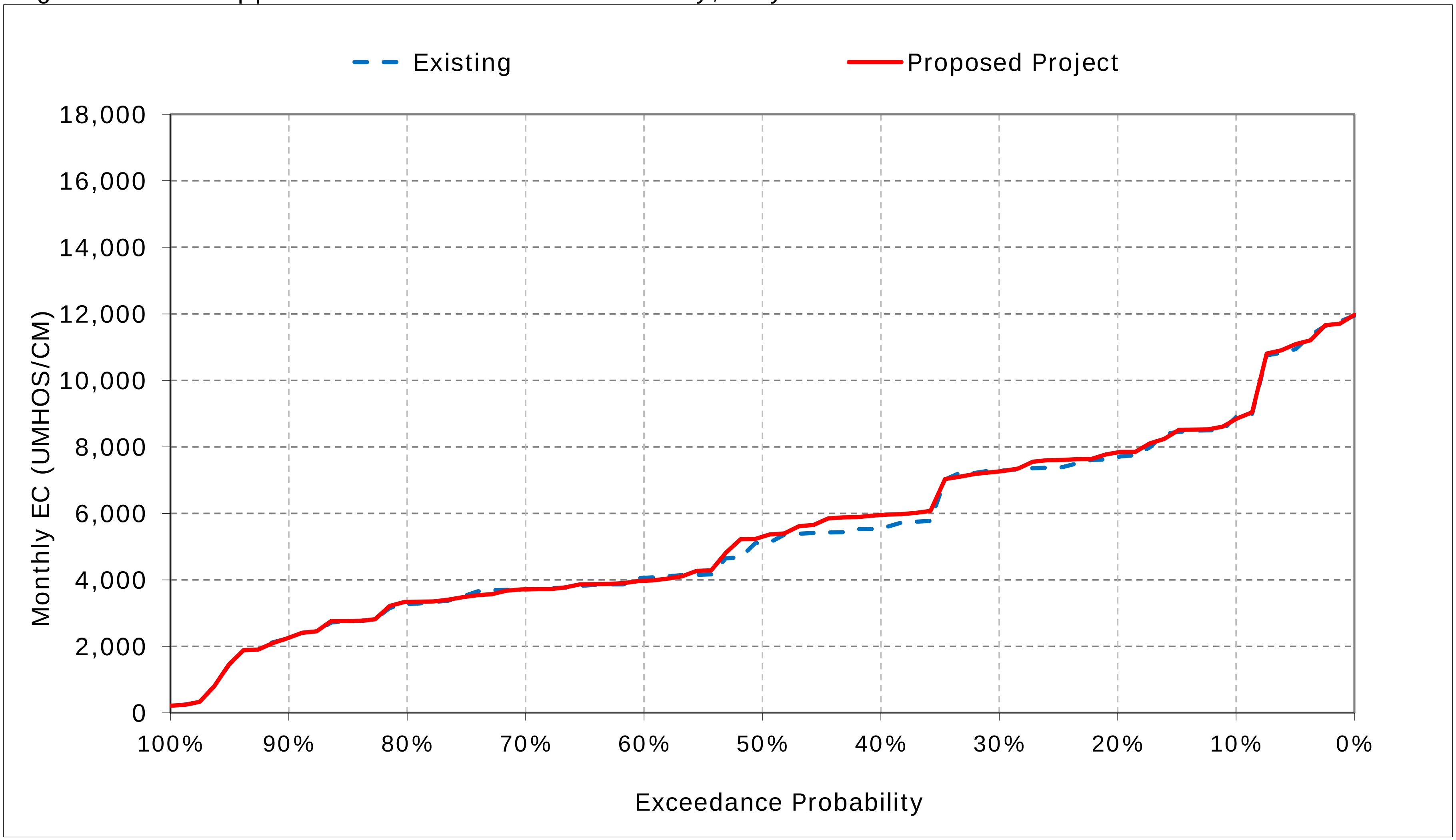


Figure 9-14. Chipps Island South Channel Salinity, August EC

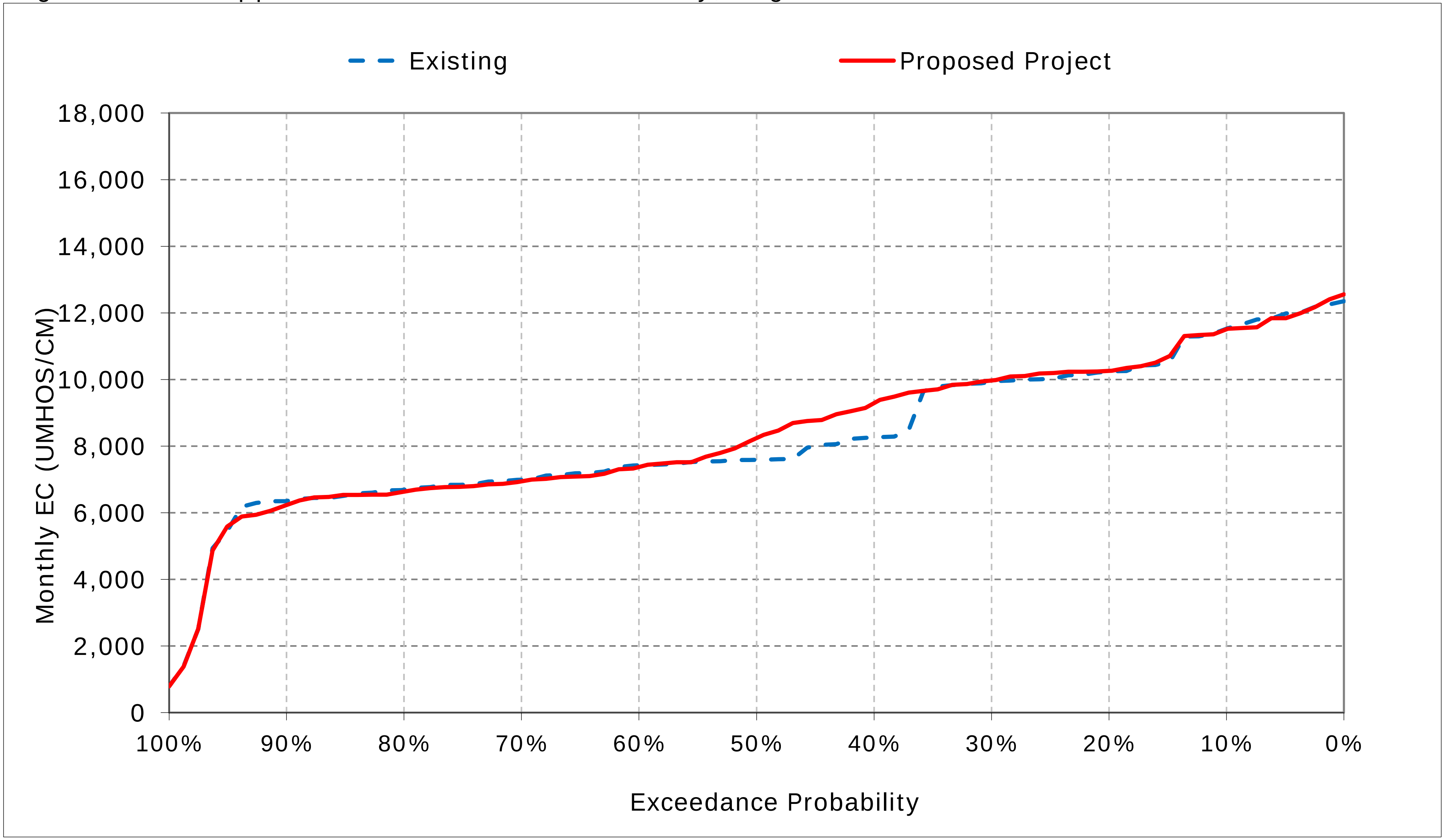


Figure 9-15. Chipps Island South Channel Salinity, September EC

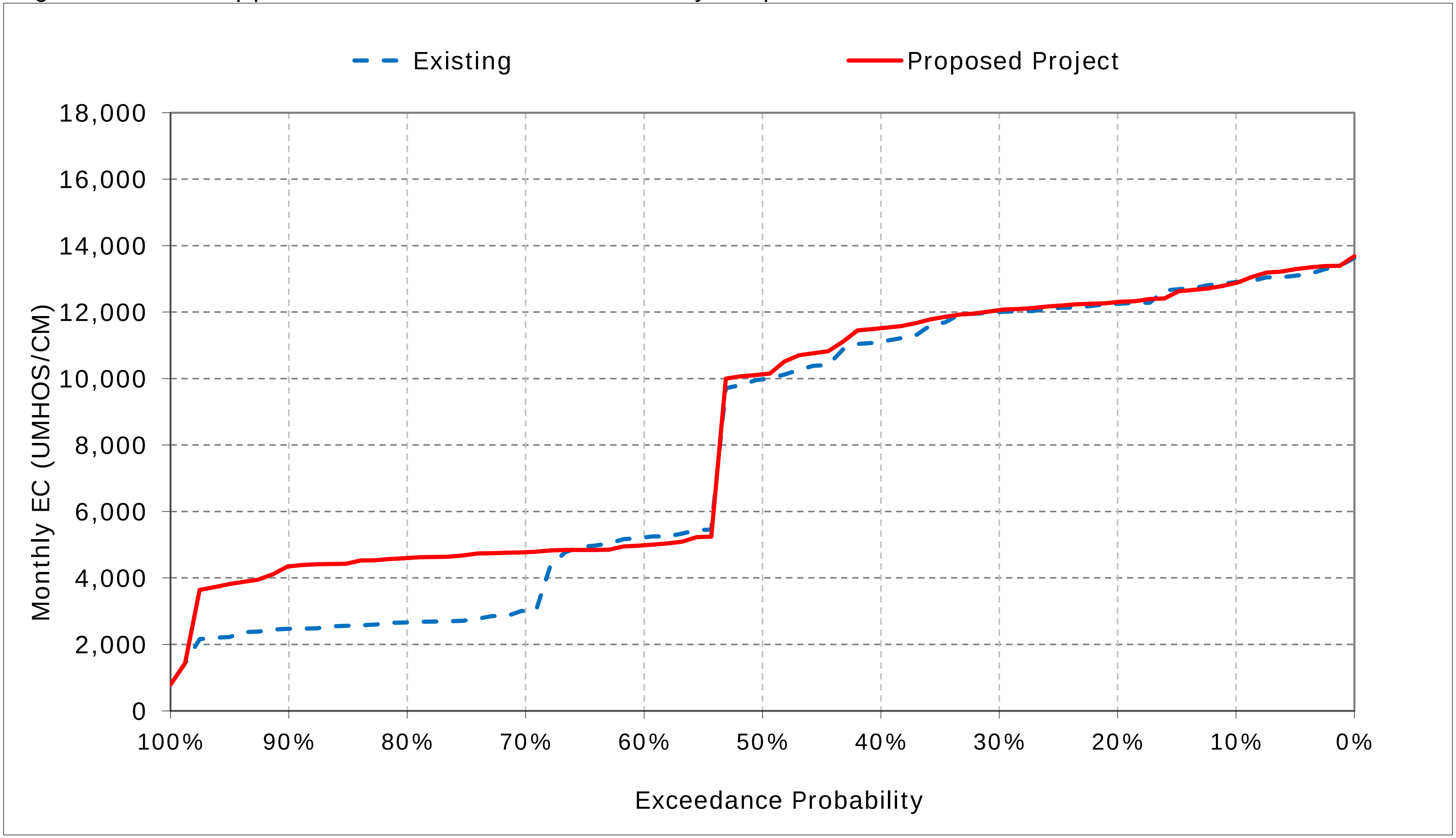


Figure 9-16. Chipps Island South Channel Salinity, October EC

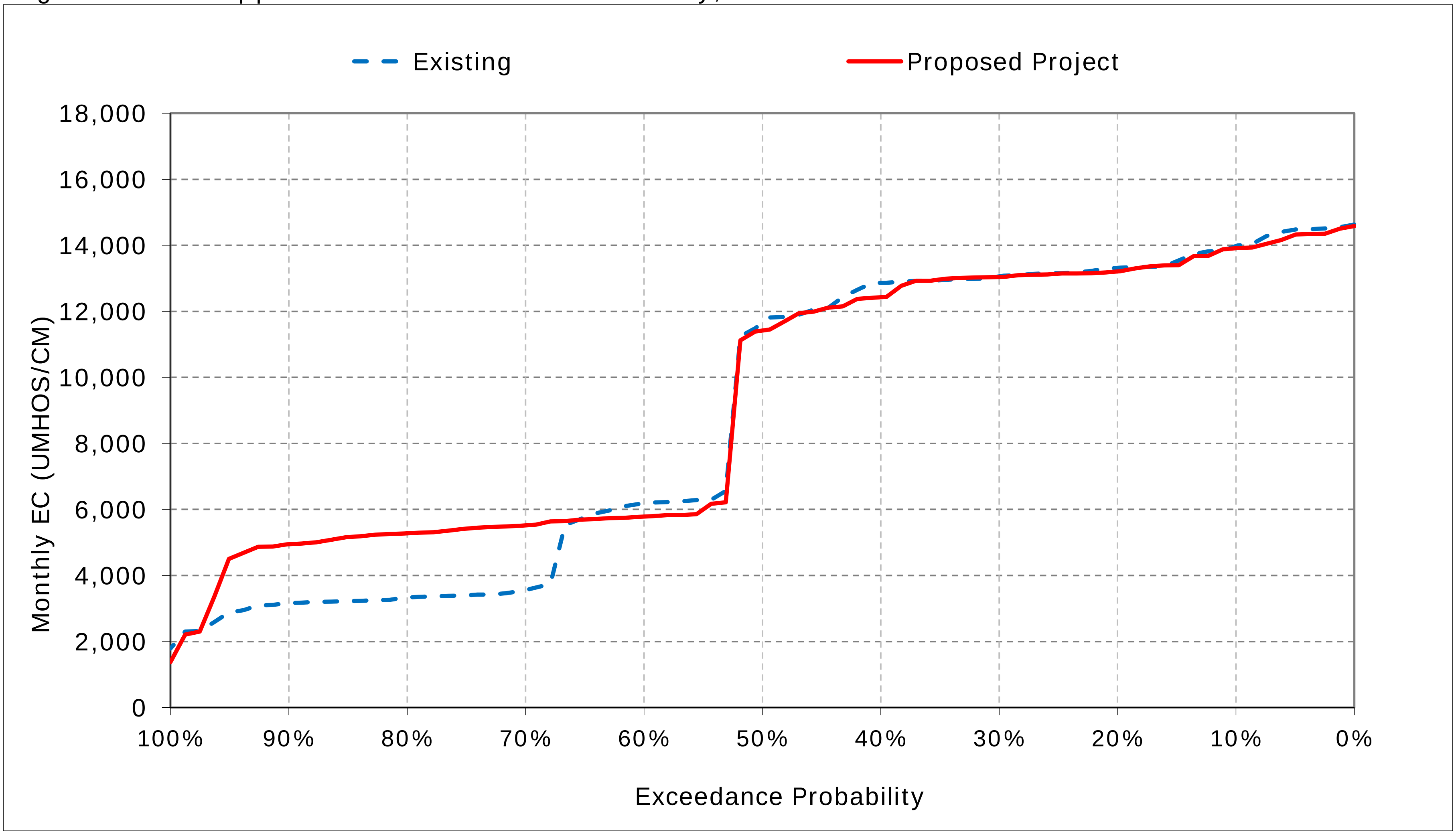


Figure 9-17. Chipps Island South Channel Salinity, November EC

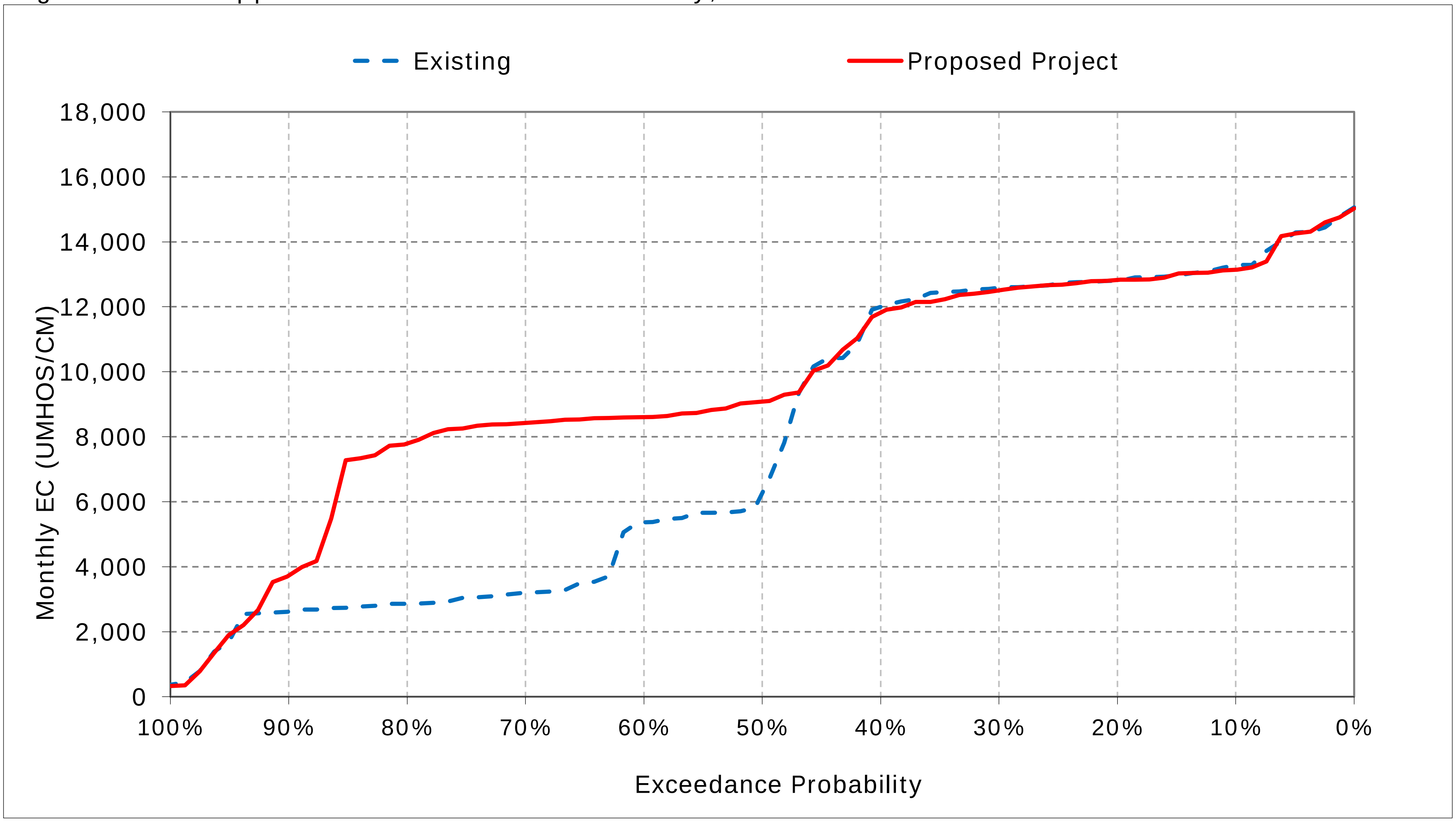


Figure 9-18. Chipps Island South Channel Salinity, December EC

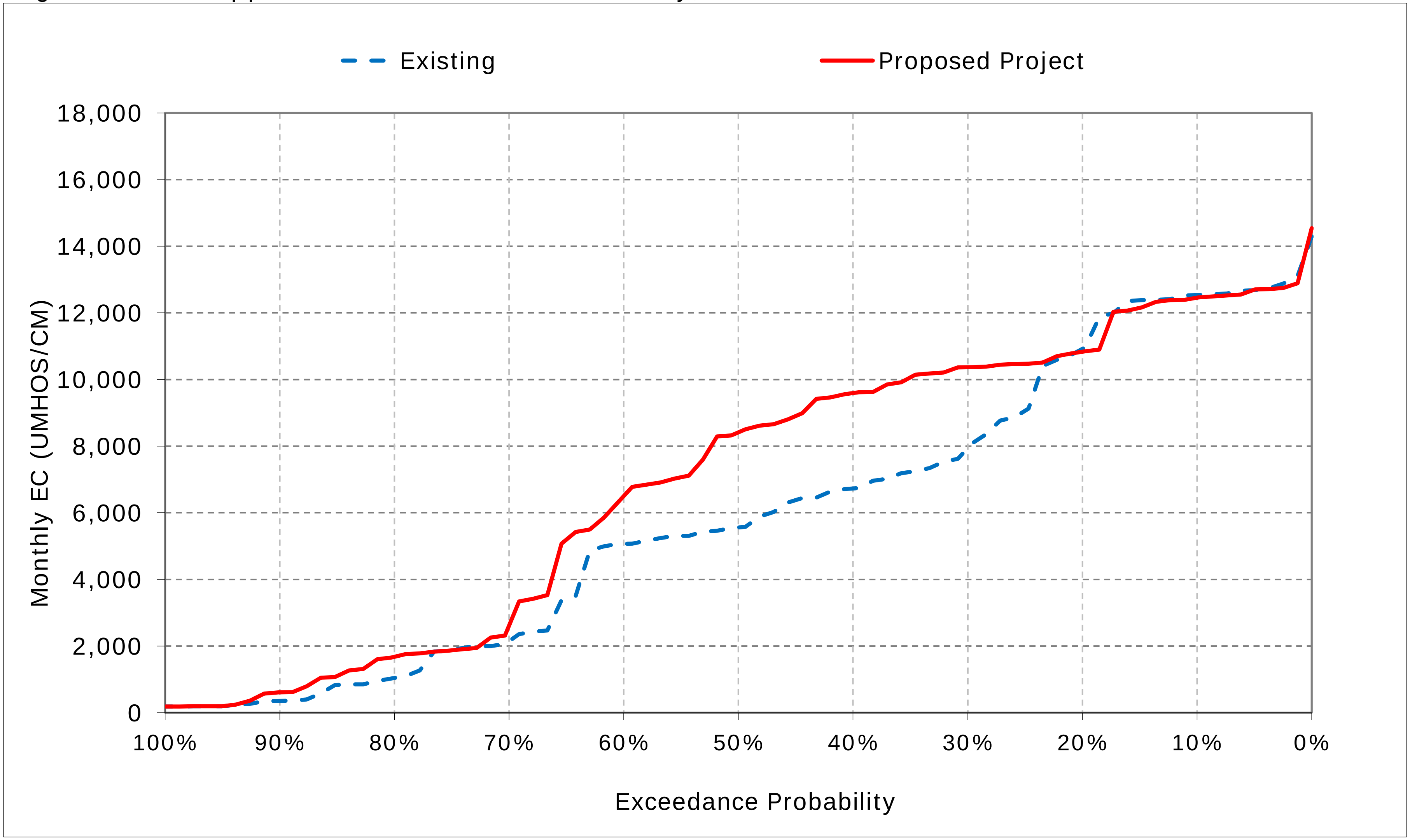


Table 10-1. Sacramento River at Port Chicago Salinity, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	18,857	18,301	17,944	14,027	10,103	9,246	9,508	11,032	12,944	14,993	17,328	18,408
20%	18,400	18,165	16,789	13,182	7,217	6,495	6,436	9,365	11,577	13,939	16,159	17,802
30%	18,221	17,817	14,104	11,188	4,890	3,578	4,510	8,038	11,116	13,675	15,975	17,592
40%	17,970	17,430	12,867	8,181	3,174	3,172	3,785	5,955	10,199	11,892	14,473	16,800
50%	17,153	12,186	11,009	6,774	1,756	1,883	2,627	4,393	8,819	11,353	13,884	16,050
60%	11,800	10,970	10,426	4,299	841	1,177	1,714	3,296	7,874	9,842	13,497	11,219
70%	8,403	8,017	6,384	1,127	341	539	1,041	2,304	6,353	9,483	13,064	7,842
80%	8,112	7,581	3,290	417	223	231	430	1,171	4,138	8,677	12,744	7,338
90%	7,934	7,173	1,022	227	205	201	219	337	1,237	6,634	12,410	6,785
Long Term												
Full Simulation Period[a]	13,892	12,807	10,348	6,775	3,582	3,140	3,701	5,288	8,305	11,058	14,210	13,231
Water Year Types[b]												
Wet (32%)	11,865	9,727	4,560	1,509	462	663	946	1,654	4,040	7,375	11,990	6,980
Above Normal (15%)	14,288	12,609	10,702	4,607	1,512	812	1,482	2,737	6,817	9,286	12,891	11,049
Below Normal (17%)	14,379	13,928	12,606	8,063	2,946	3,101	3,357	5,013	8,800	11,464	14,189	16,435
Dry (22%)	14,459	14,253	12,965	10,586	6,057	4,745	5,613	7,981	11,081	13,821	16,074	17,695
Critical (15%)	16,472	16,198	15,972	13,130	9,441	8,475	9,421	11,992	14,294	16,194	17,566	18,520

Proposed Project

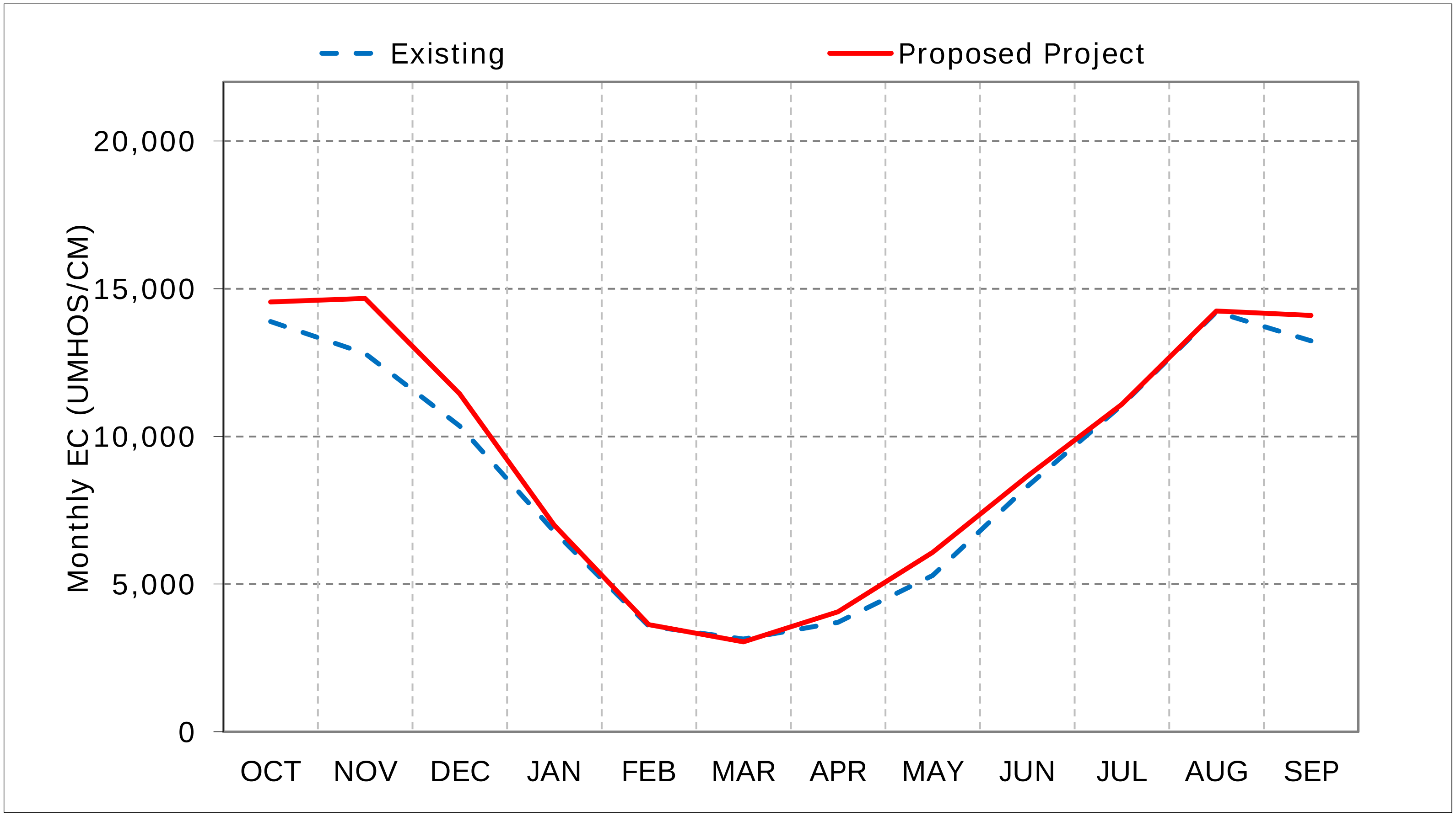
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	18,807	18,364	17,930	15,275	9,733	9,189	9,988	11,273	12,972	15,024	17,357	18,381
20%	18,405	18,122	16,529	14,037	6,813	6,374	7,403	10,357	12,141	14,132	16,249	17,837
30%	18,208	17,757	15,920	11,990	4,783	3,379	5,337	9,248	11,297	13,652	16,010	17,655
40%	17,806	17,203	15,464	8,671	3,283	2,839	4,433	7,278	10,866	11,916	14,852	17,013
50%	16,991	14,487	14,493	6,707	1,740	1,688	3,260	5,648	9,276	11,117	14,028	16,078
60%	11,336	14,200	12,571	4,163	641	981	1,943	4,608	8,564	9,821	13,451	10,855
70%	11,175	13,963	7,579	990	343	471	1,381	3,248	6,684	9,531	13,012	10,665
80%	10,827	13,519	4,094	400	222	232	507	1,556	4,307	8,733	12,790	10,439
90%	10,471	8,783	1,270	220	206	199	217	443	1,292	6,638	12,283	9,904
Long Term												
Full Simulation Period[a]	14,553	14,670	11,441	6,990	3,628	3,043	4,065	6,071	8,644	11,081	14,242	14,098
Water Year Types[b]												
Wet (32%)	12,723	12,151	5,319	1,484	444	619	1,180	2,252	4,405	7,395	11,882	9,851
Above Normal (15%)	15,103	14,760	12,346	4,689	1,303	721	1,847	3,793	7,182	9,230	12,924	10,538
Below Normal (17%)	15,073	15,716	13,907	8,052	2,808	2,859	3,903	6,213	9,156	11,489	14,463	16,535
Dry (22%)	15,145	15,761	14,213	11,207	6,330	4,546	6,074	8,844	11,463	13,893	16,132	17,739
Critical (15%)	16,472	17,181	16,768	13,658	9,751	8,581	9,705	12,299	14,468	16,227	17,577	18,556

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	-50	63	-15	1,248	-369	-57	480	242	28	32	30	-27
20%	5	-43	-259	855	-403	-121	967	992	564	193	90	35
30%	-13	-59	1,816	802	-107	-198	827	1,210	182	-24	35	64
40%	-164	-227	2,597	490	108	-333	648	1,323	667	23	379	213
50%	-162	2,301	3,484	-67	-16	-196	634	1,255	457	-236	144	29
60%	-464	3,230	2,145	-136	-199	-196	229	1,312	691	-21	-47	-364
70%	2,772	5,946	1,195	-137	2	-68	340	944	331	48	-52	2,823
80%	2,715	5,937	804	-17	0	2	77	385	169	56	46	3,101
90%	2,536	1,610	248	-7	1	-2	-2	105	55	5	-127	3,119
Long Term												
Full Simulation Period[a]	660	1,863	1,094	215	46	-97	364	783	339	23	32	867
Water Year Types[b]												
Wet (32%)	858	2,424	758	-25	-17	-44	234	598	365	19	-107	2,870
Above Normal (15%)	815	2,151	1,644	82	-210	-91	365	1,056	365	-56	33	-511
Below Normal (17%)	694	1,788	1,301	-12	-138	-242	545	1,200	356	25	273	100
Dry (22%)	686	1,507	1,249	621	273	-199	461	863	381	72	58	44
Critical (15%)	0	983	795	527	311	106	284	307	174	32	11	36

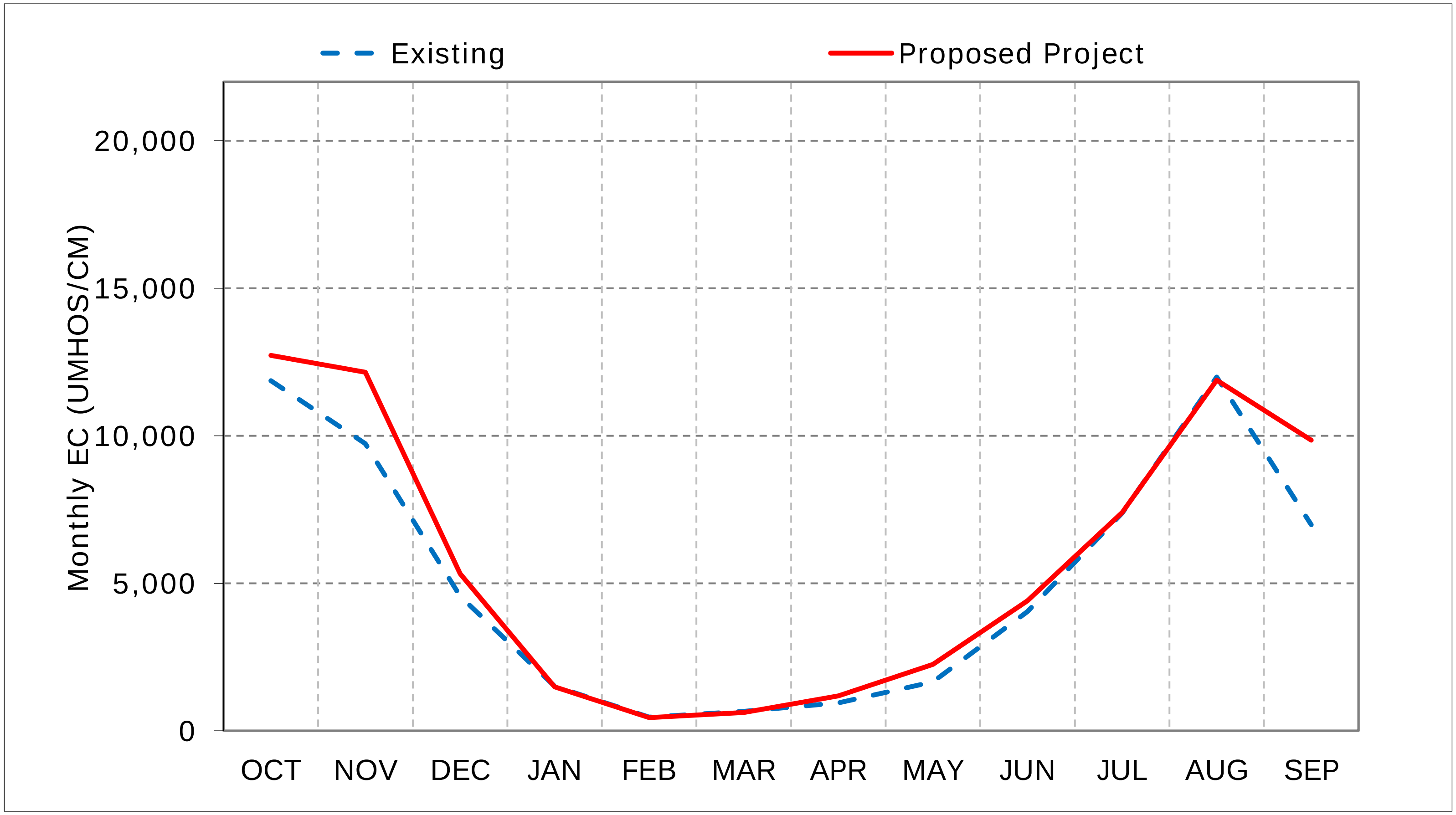
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 10-1. Sacramento River at Port Chicago Salinity, Long-Term Average EC



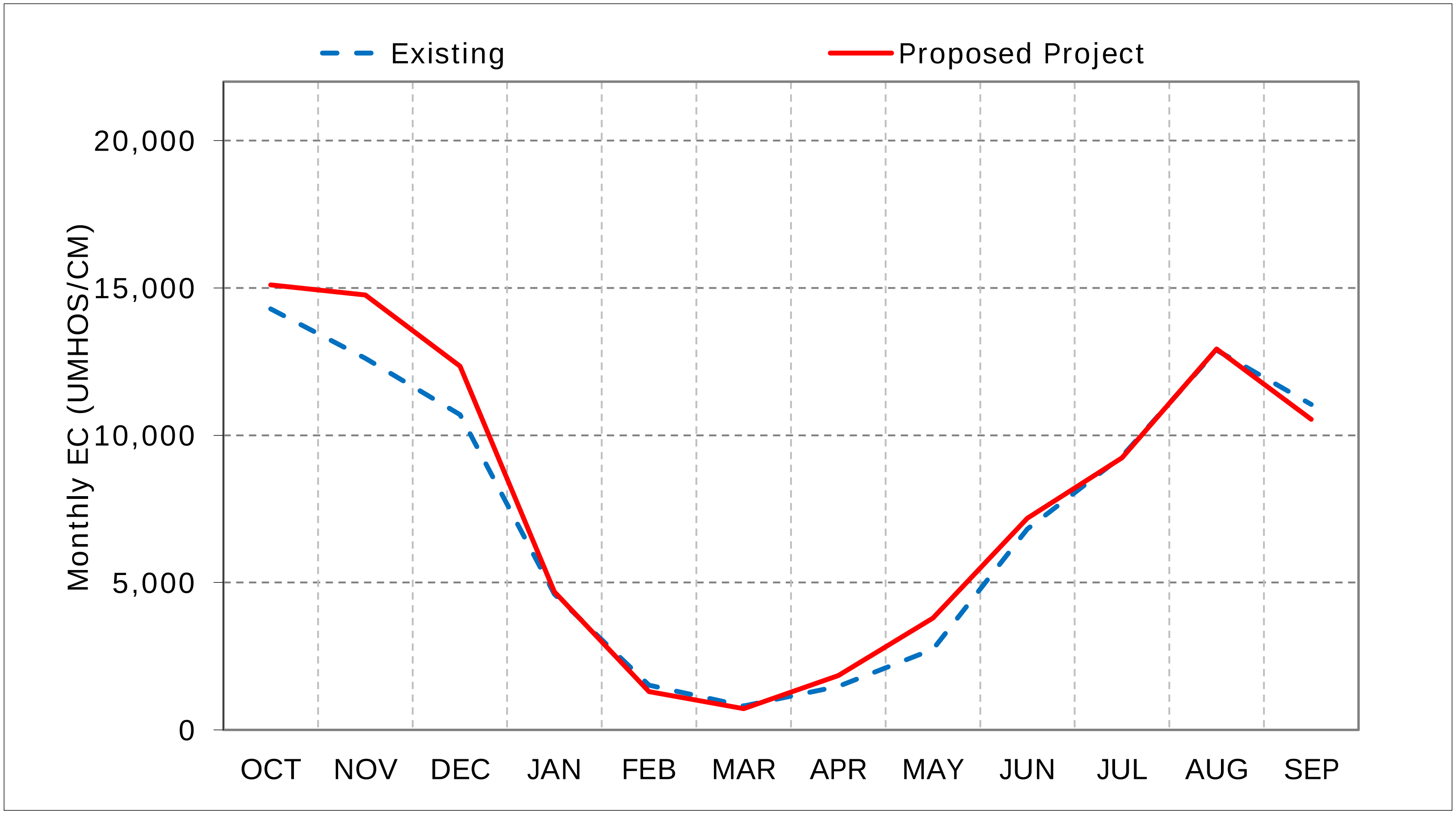
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 10-2. Sacramento River at Port Chicago Salinity, Wet Year Average EC



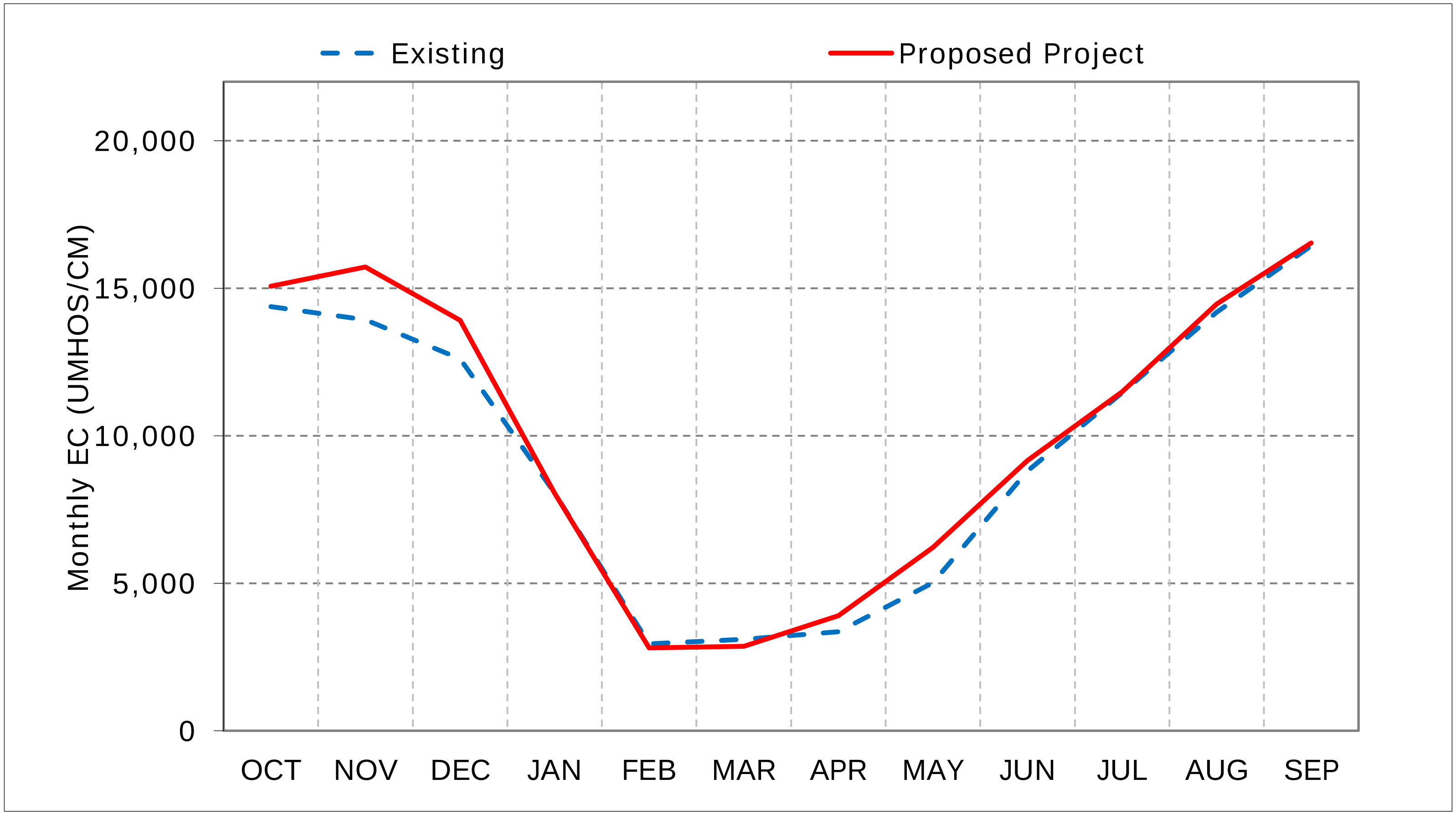
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 10-3. Sacramento River at Port Chicago Salinity, Above Normal Year Averag



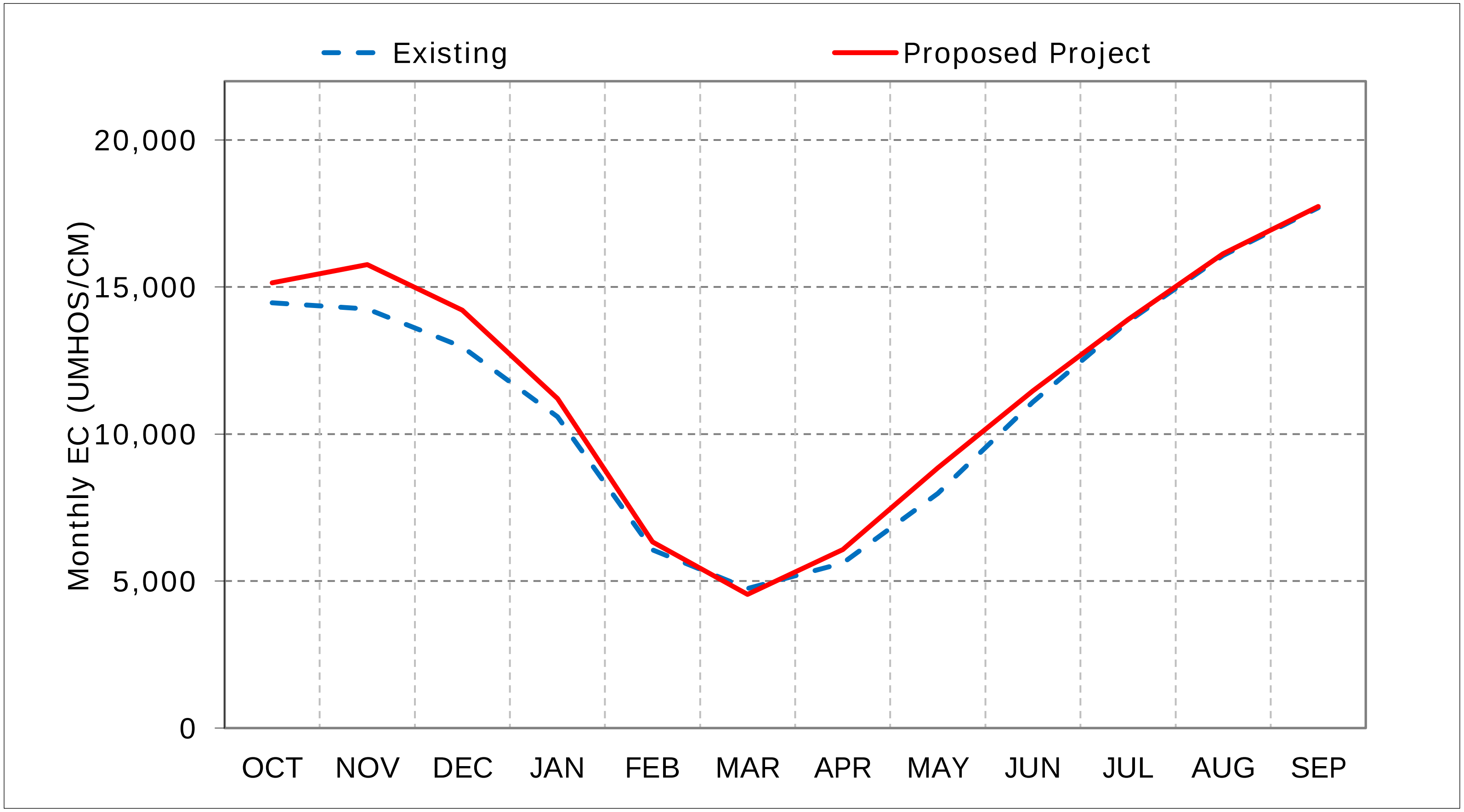
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 10-4. Sacramento River at Port Chicago Salinity, Below Normal Year Averag



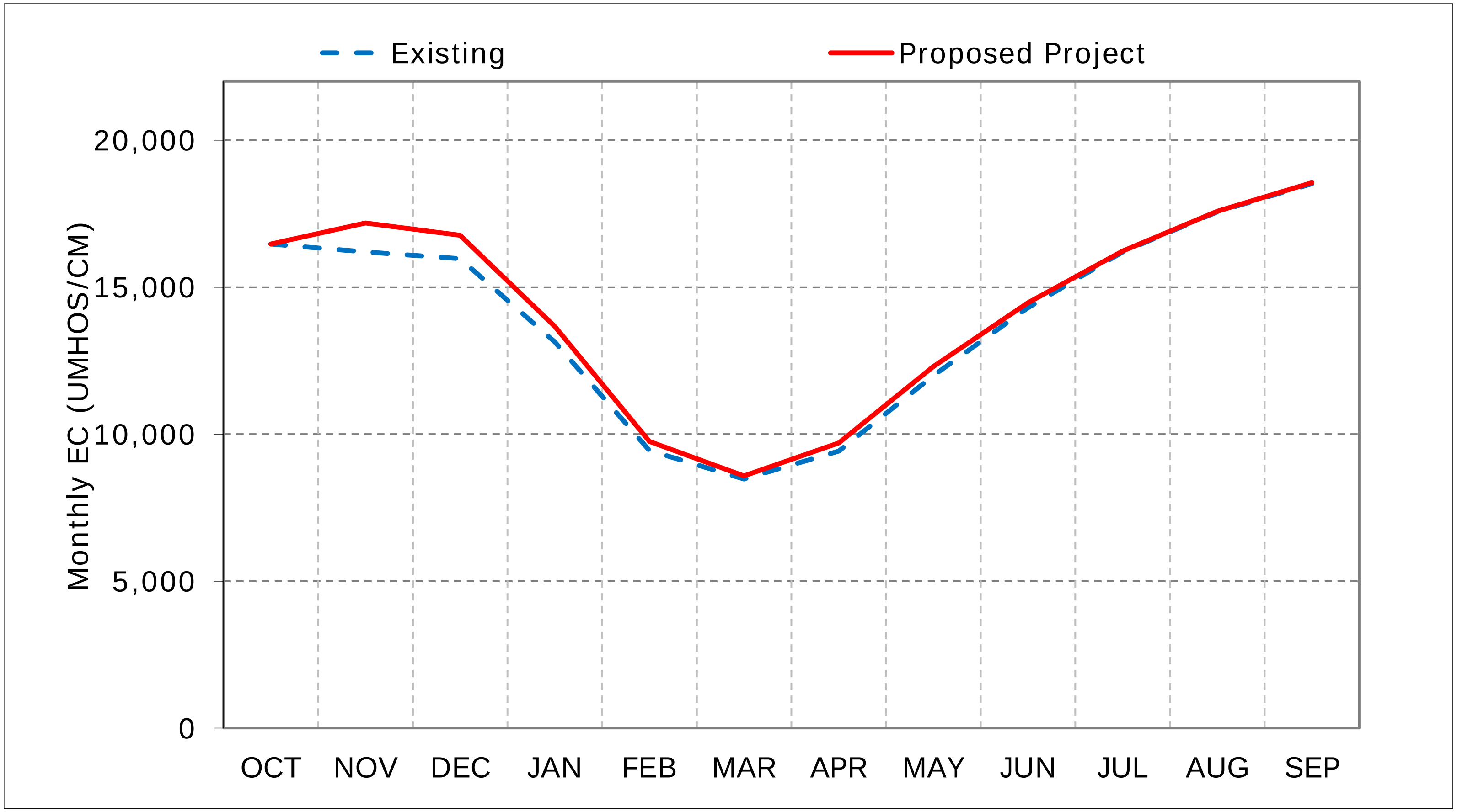
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 10-5. Sacramento River at Port Chicago Salinity, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 10-6. Sacramento River at Port Chicago Salinity, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 10-7. Sacramento River at Port Chicago Salinity, January EC

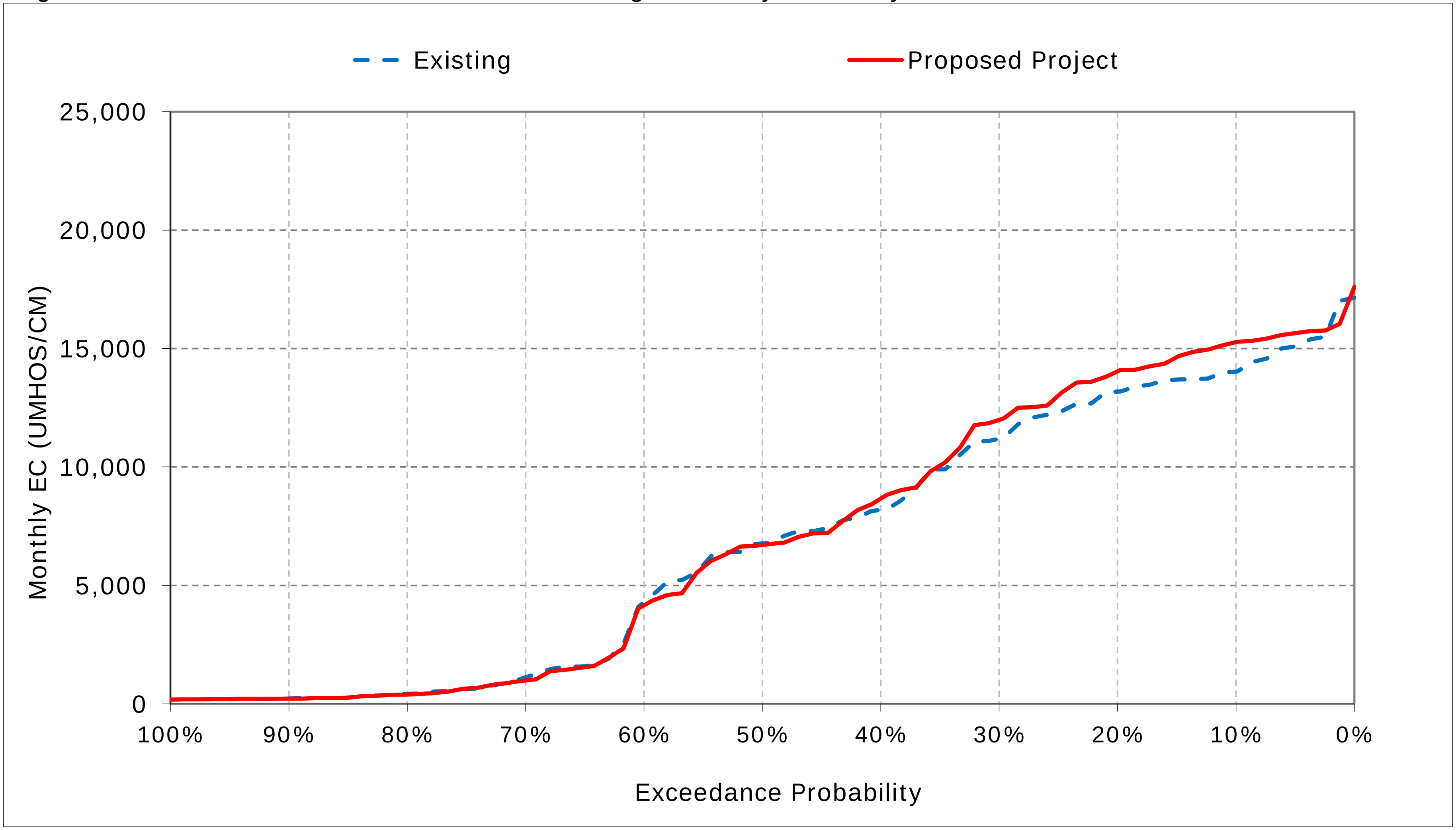


Figure 10-8. Sacramento River at Port Chicago Salinity, February EC

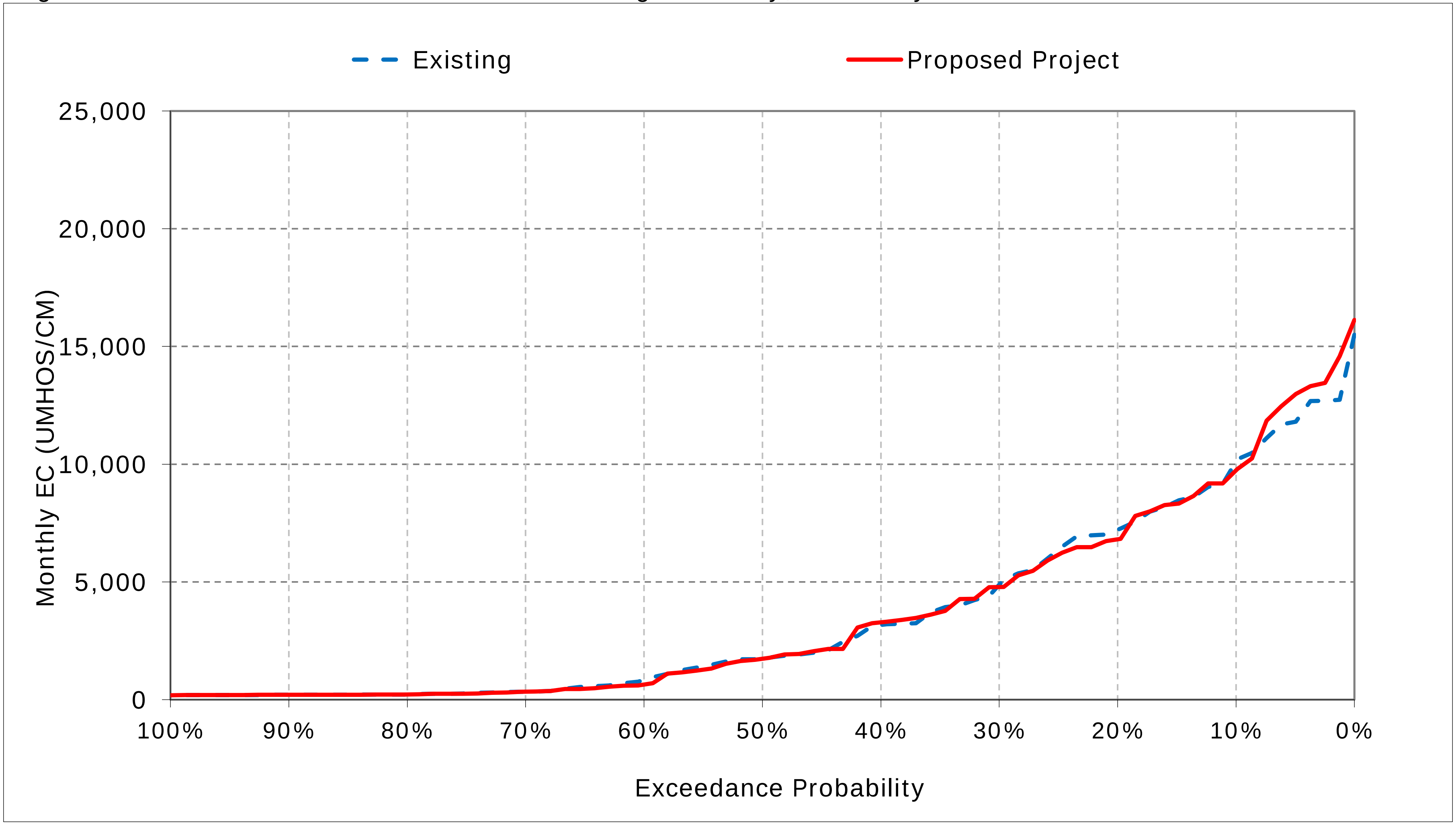


Figure 10-9. Sacramento River at Port Chicago Salinity, March EC

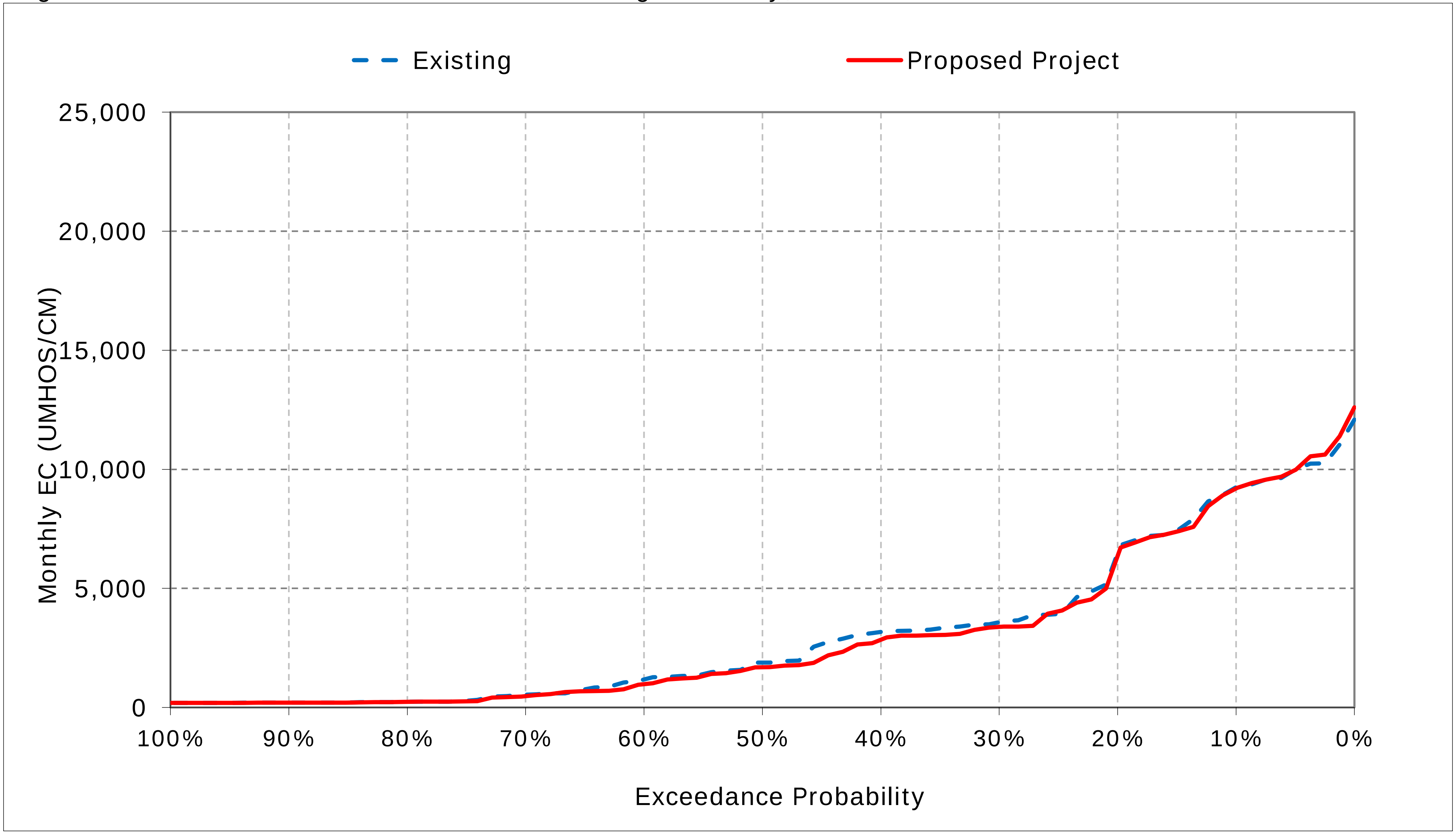


Figure 10-10. Sacramento River at Port Chicago Salinity, April EC

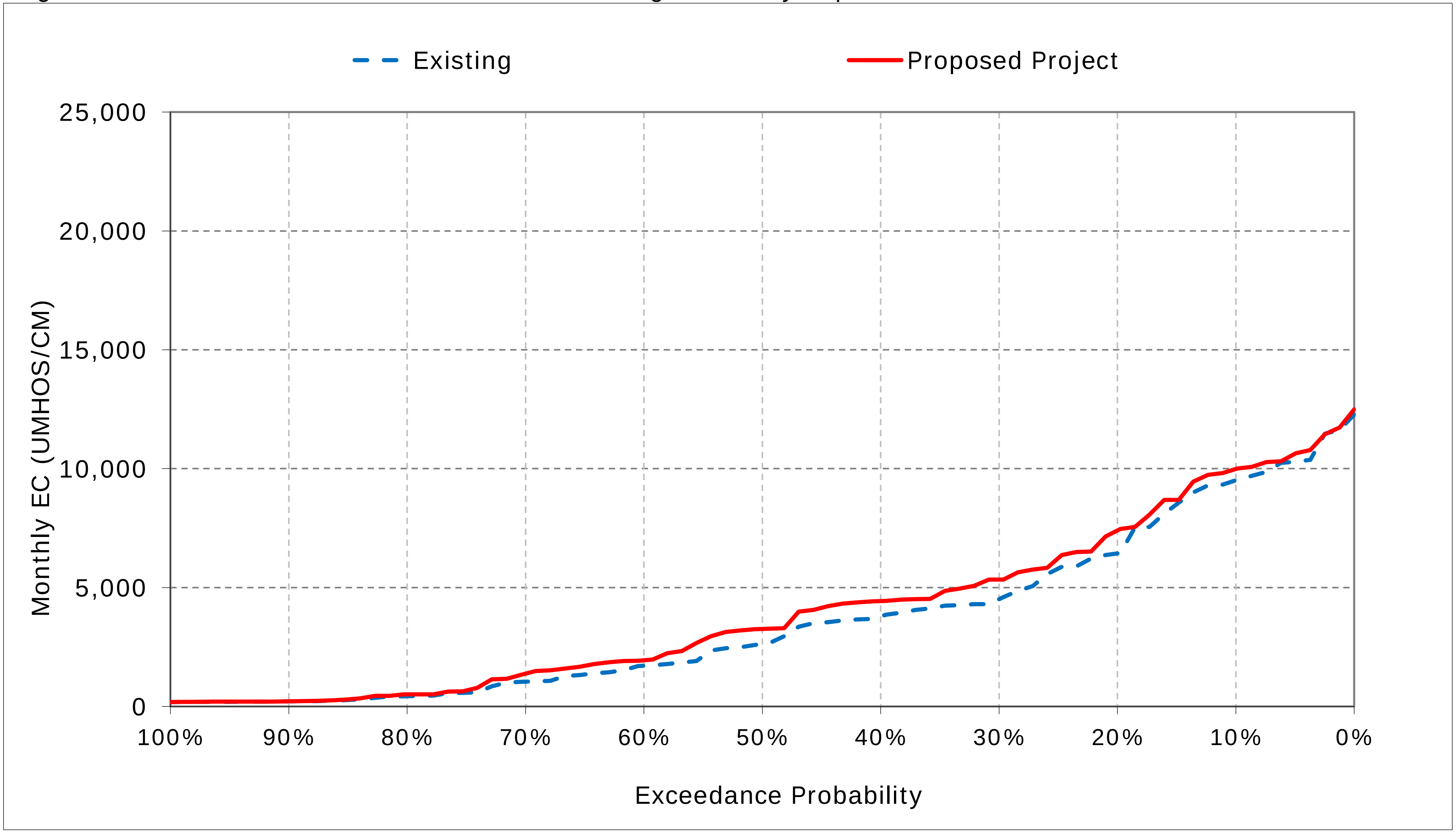


Figure 10-11. Sacramento River at Port Chicago Salinity, May EC

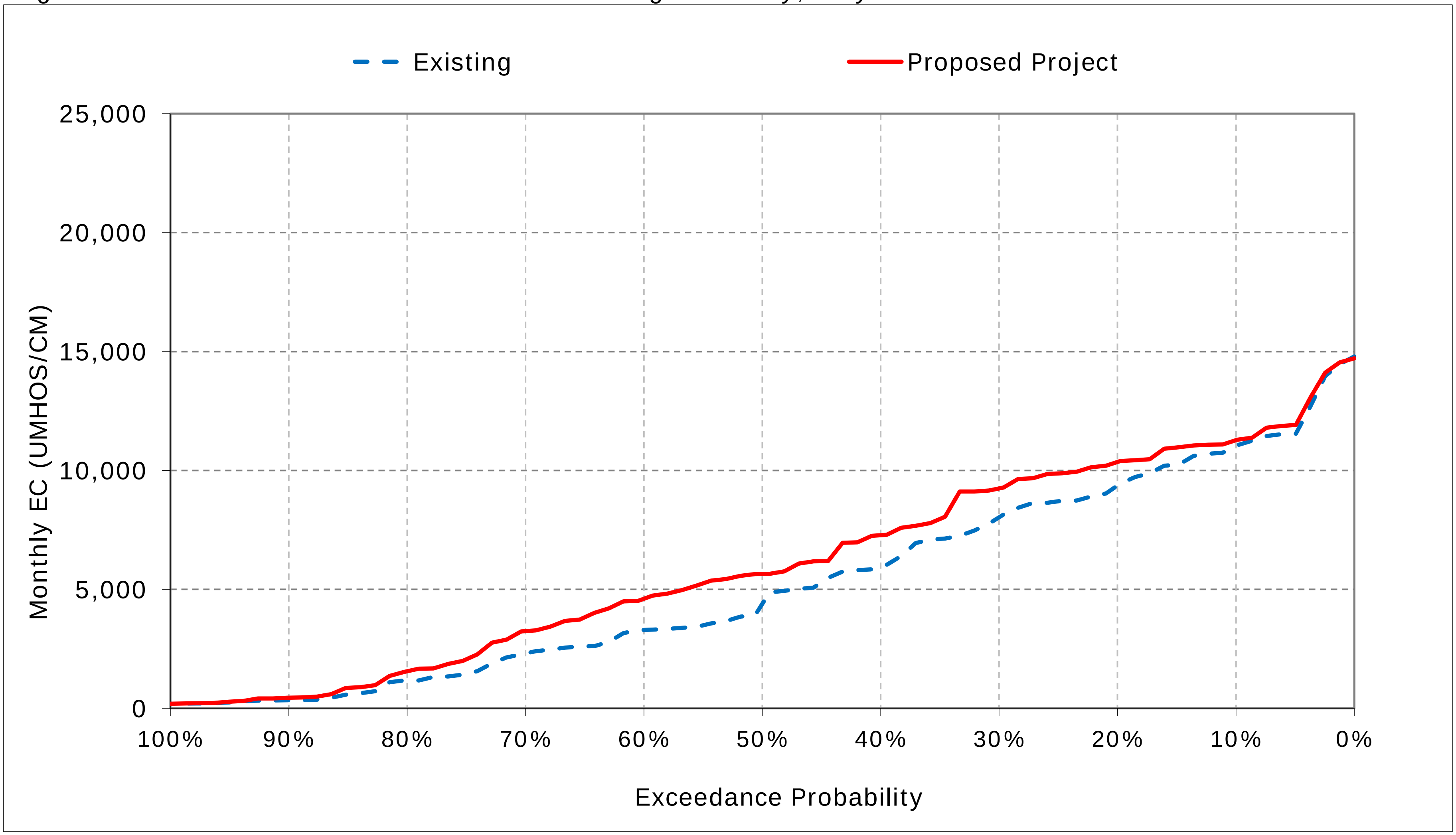


Figure 10-12. Sacramento River at Port Chicago Salinity, June EC

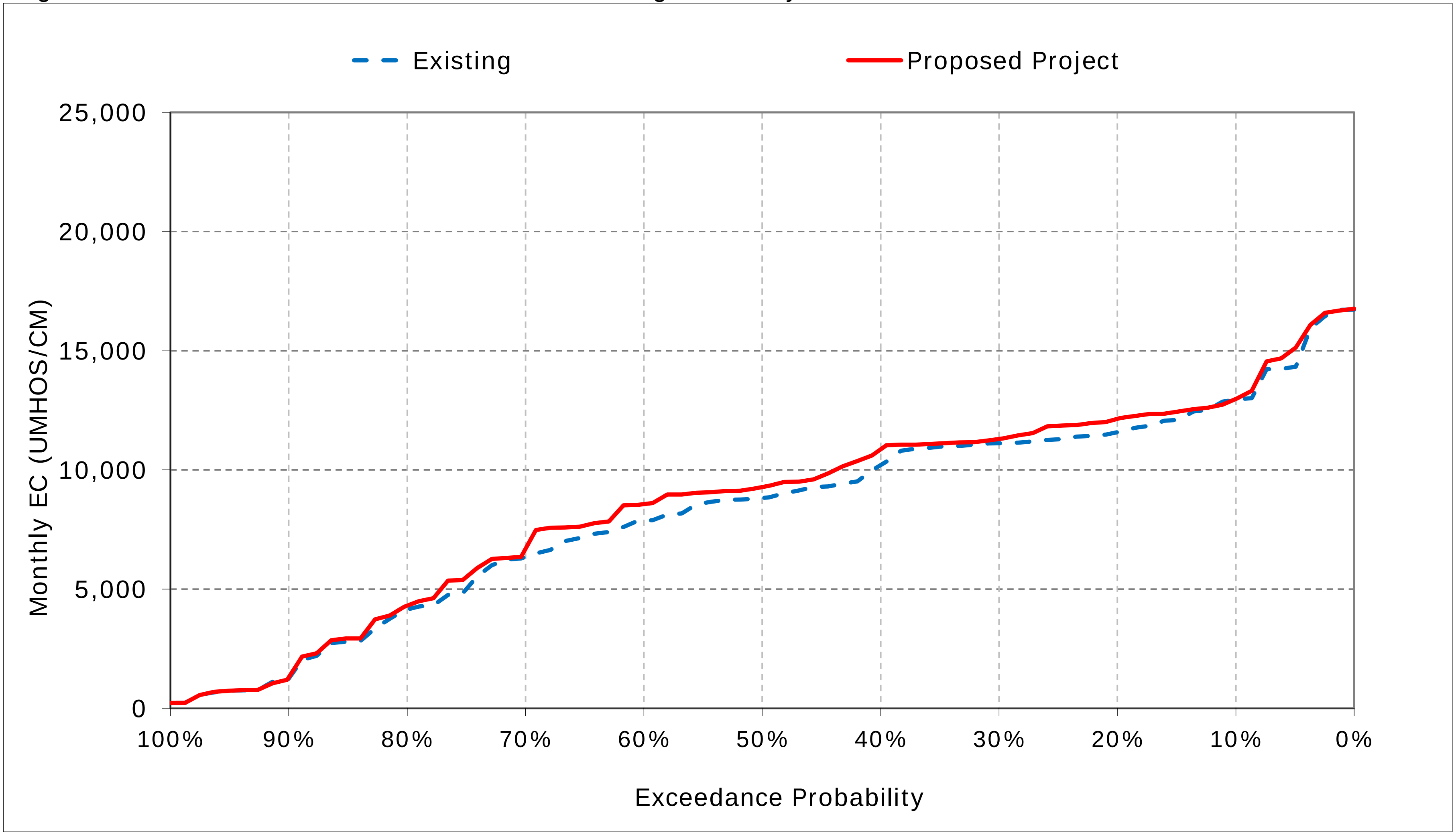


Figure 10-13. Sacramento River at Port Chicago Salinity, July EC

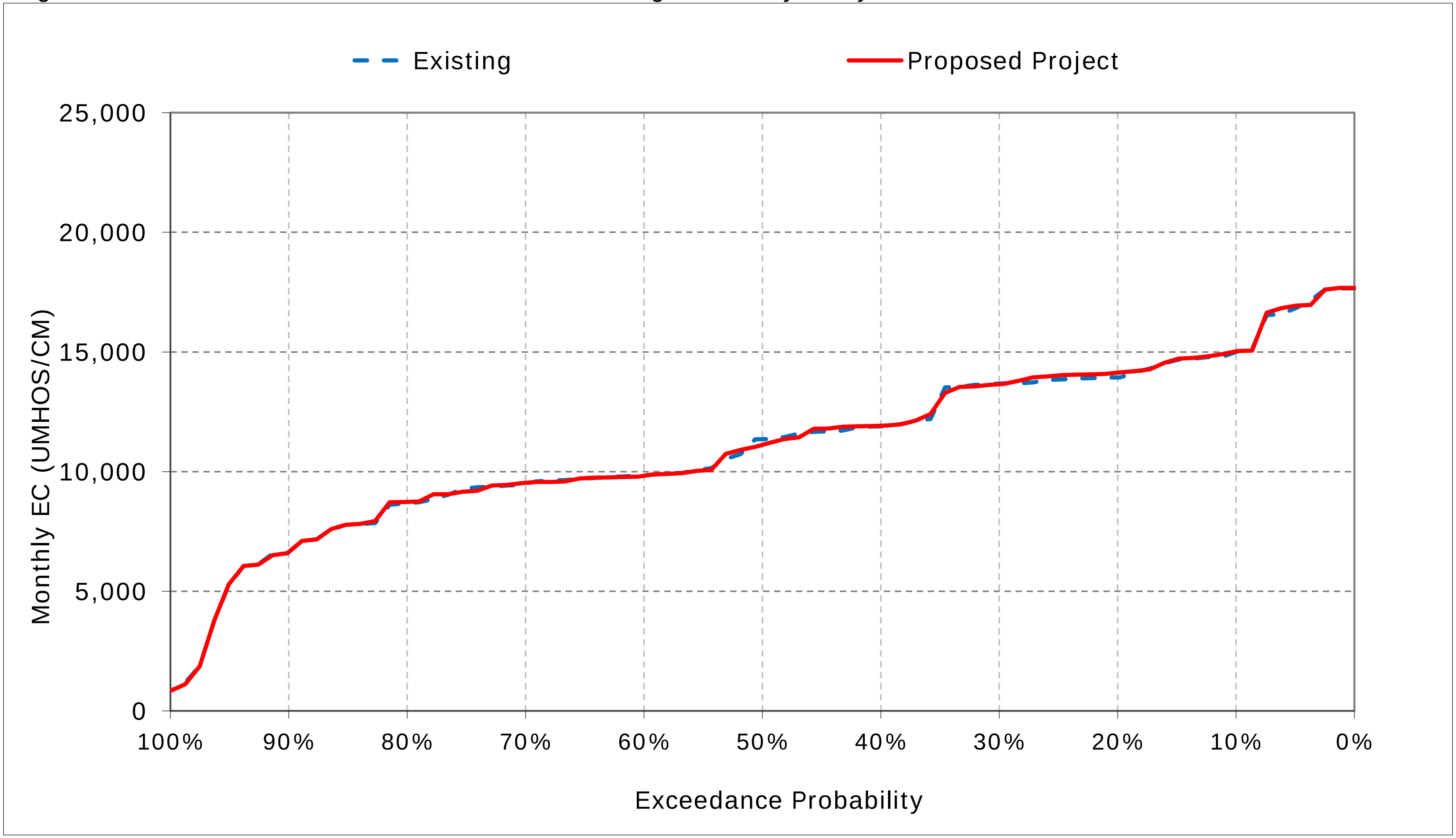


Figure 10-14. Sacramento River at Port Chicago Salinity, August EC

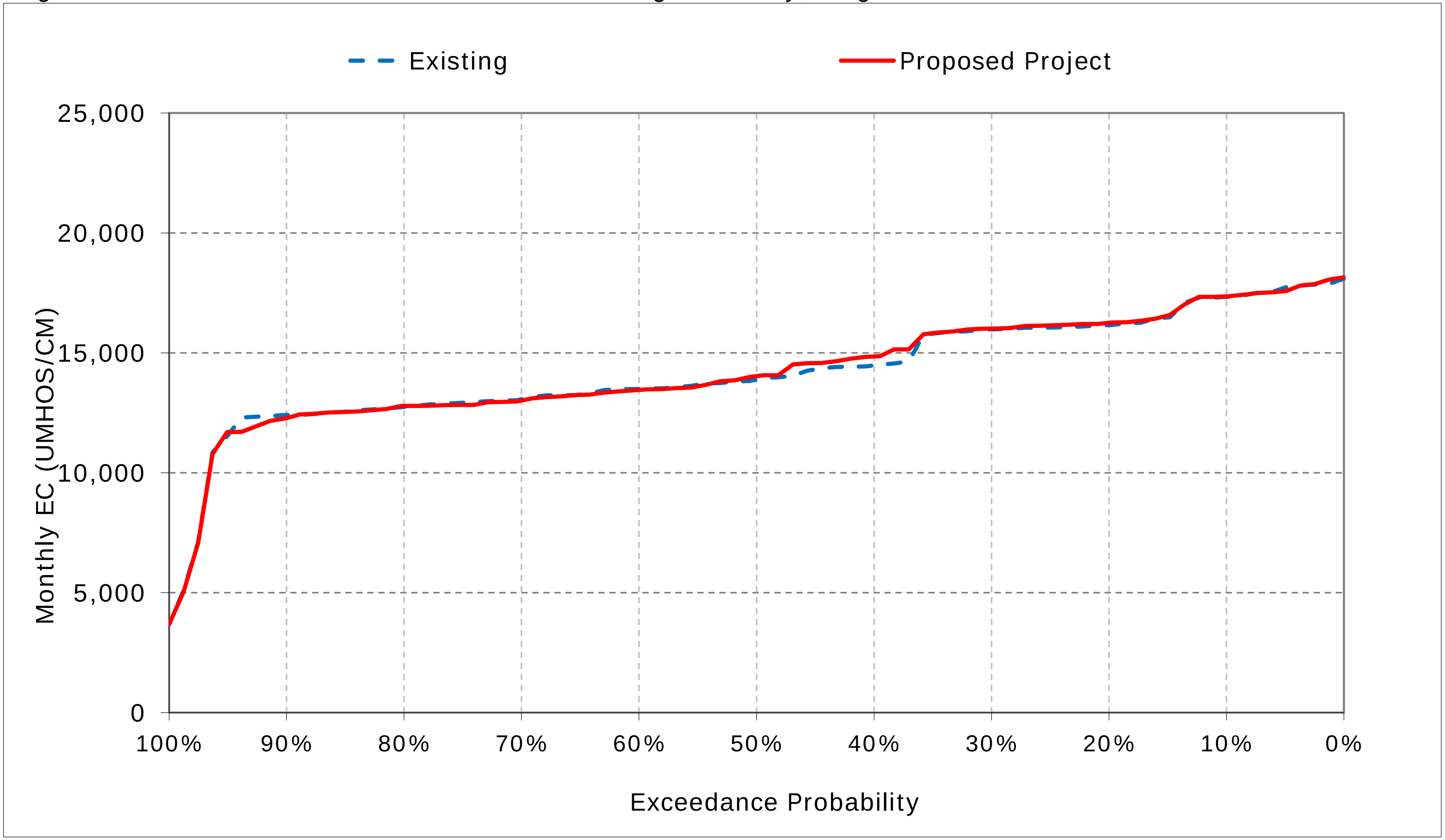


Figure 10-15. Sacramento River at Port Chicago Salinity, September EC

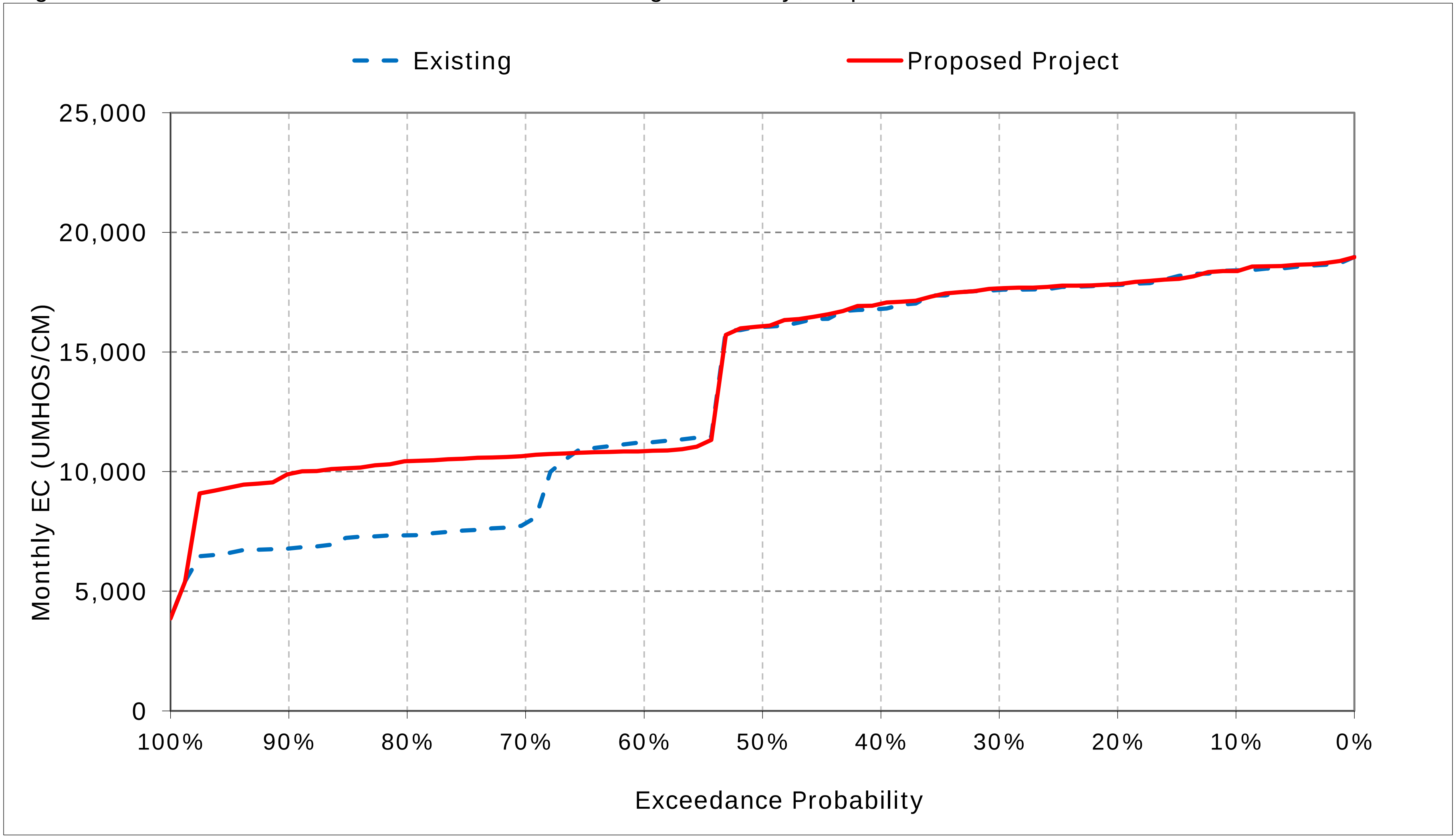


Figure 10-16. Sacramento River at Port Chicago Salinity, October EC

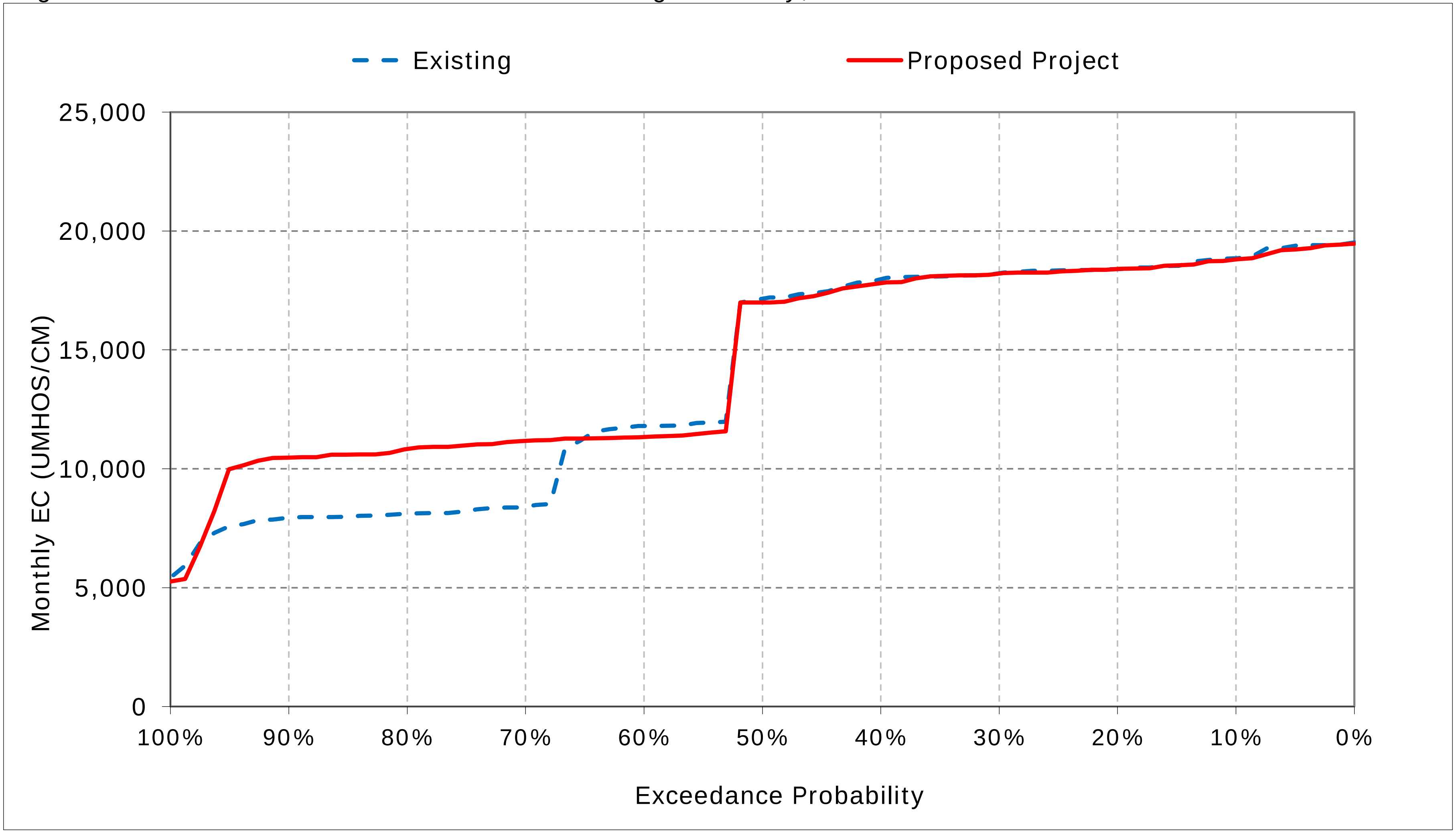


Figure 10-17. Sacramento River at Port Chicago Salinity, November EC

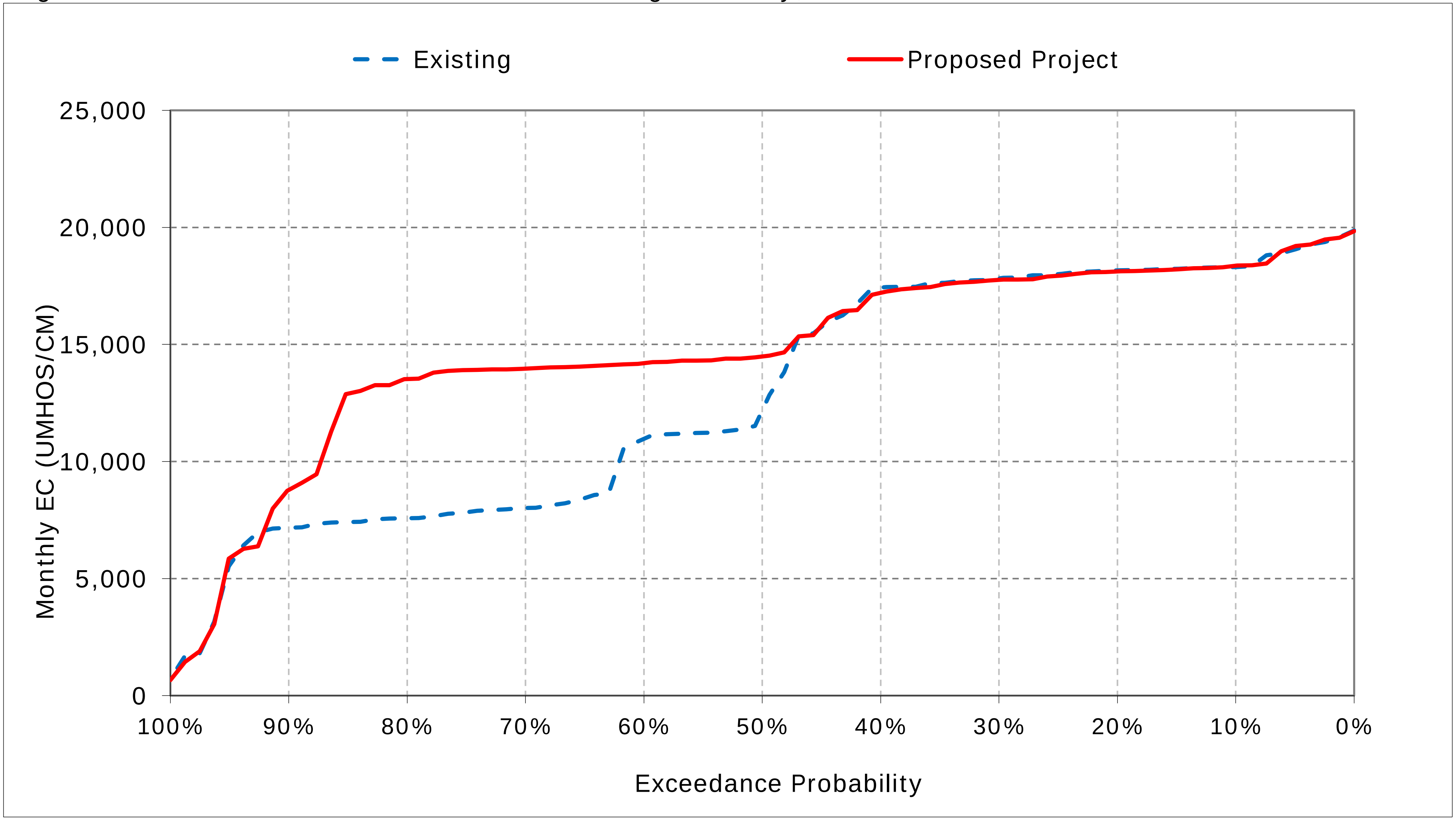


Figure 10-18. Sacramento River at Port Chicago Salinity, December EC

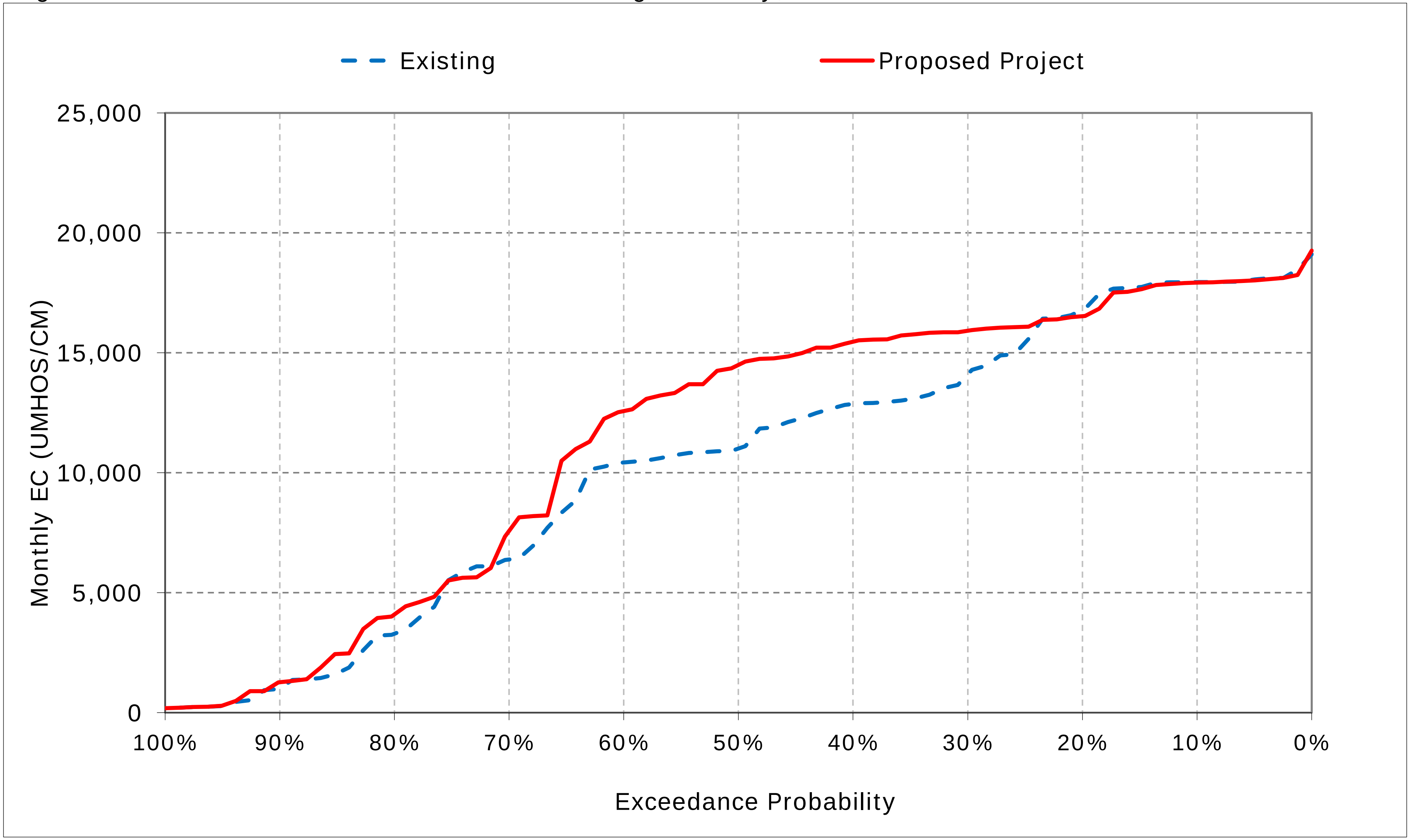


Table 11-1. San Joaquin River at Antioch Salinity, Monthly EC

Existing

	Monthly EC (UMHOS/CM)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	7,250	6,676	6,398	3,358	1,223	1,035	961	1,609	2,307	3,749	5,519	6,896
20%	6,792	6,518	5,164	2,829	758	498	505	1,020	1,833	3,160	4,834	6,480
30%	6,690	6,190	3,327	2,078	520	294	297	720	1,708	2,987	4,528	6,264
40%	6,284	5,969	2,785	1,274	370	260	262	422	1,303	2,013	3,709	5,800
50%	5,773	2,464	2,170	1,002	283	239	244	291	1,087	1,813	3,305	4,925
60%	2,050	1,730	1,872	491	255	229	227	252	689	1,232	3,199	2,032
70%	1,128	914	751	260	243	222	219	232	525	1,151	2,996	1,321
80%	952	798	486	235	225	216	213	216	270	955	2,779	1,199
90%	846	731	228	220	213	199	208	204	205	659	2,565	1,144
Long Term												
Full Simulation Period[a]	4,134	3,633	2,705	1,426	595	407	417	667	1,286	2,113	3,696	3,952
Water Year Types[b]												
Wet (32%)	3,066	2,178	843	354	240	220	220	236	408	827	2,568	1,081
Above Normal (15%)	4,383	3,637	2,584	908	319	223	224	251	755	1,128	2,849	2,005
Below Normal (17%)	4,353	3,978	3,531	1,536	399	296	293	422	1,065	1,884	3,469	5,337
Dry (22%)	4,420	4,312	3,284	2,079	808	464	454	785	1,686	3,078	4,668	6,380
Critical (15%)	5,515	5,357	5,024	3,155	1,547	1,040	1,123	2,128	3,379	4,706	5,797	6,863

Proposed Project

	Monthly EC (UMHOS/CM)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	7,178	6,644	6,230	4,058	1,249	1,047	1,110	1,754	2,368	3,799	5,530	6,973
20%	6,813	6,497	5,224	3,210	817	501	621	1,359	1,994	3,261	4,845	6,491
30%	6,621	6,139	5,010	2,234	538	284	376	1,112	1,786	2,980	4,623	6,268
40%	6,284	5,751	4,557	1,467	375	256	297	555	1,471	2,099	4,135	6,009
50%	5,636	4,014	3,616	1,024	296	241	244	372	1,065	1,800	3,675	5,149
60%	1,956	3,811	2,553	510	262	228	222	305	803	1,231	3,158	1,933
70%	1,802	3,730	1,140	271	242	219	212	228	593	1,124	2,954	1,849
80%	1,753	3,309	758	242	225	215	206	196	266	969	2,731	1,798
90%	1,622	1,396	364	220	214	201	201	192	199	659	2,502	1,571
Long Term												
Full Simulation Period[a]	4,301	4,564	3,319	1,577	645	413	457	785	1,355	2,125	3,776	4,170
Water Year Types[b]												
Wet (32%)	3,331	3,353	1,244	366	239	221	221	271	457	826	2,491	1,591
Above Normal (15%)	4,551	4,615	3,476	1,061	307	225	228	298	760	1,095	2,867	1,835
Below Normal (17%)	4,546	4,860	4,270	1,631	397	290	337	568	1,100	1,949	3,962	5,712
Dry (22%)	4,602	5,148	4,045	2,388	910	461	535	1,022	1,816	3,092	4,713	6,418
Critical (15%)	5,413	5,912	5,461	3,437	1,754	1,088	1,222	2,280	3,498	4,725	5,845	6,925

Proposed Project minus Existing

	Monthly EC (UMHOS/CM)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-72	-32	-168	700	27	12	148	146	61	50	10	77
20%	21	-20	60	381	60	2	116	338	161	101	11	11
30%	-69	-52	1,683	156	18	-10	80	392	78	-7	95	5
40%	0	-217	1,773	193	5	-3	35	133	167	86	426	209
50%	-136	1,550	1,446	23	13	3	0	81	-22	-12	370	224
60%	-94	2,080	681	19	7	-1	-6	53	114	-2	-40	-99
70%	674	2,816	389	11	-1	-3	-7	-4	68	-28	-41	528
80%	801	2,510	272	7	1	0	-8	-20	-4	14	-48	599
90%	777	665	136	0	1	2	-7	-12	-5	0	-63	426
Long Term												
Full Simulation Period[a]	167	931	615	151	50	6	41	117	68	12	79	218
Water Year Types[b]												
Wet (32%)	265	1,175	401	12	-1	1	1	35	49	0	-77	510
Above Normal (15%)	168	978	892	153	-12	2	4	47	5	-33	18	-170
Below Normal (17%)	193	882	738	95	-2	-6	44	146	35	65	494	375
Dry (22%)	182	836	761	309	102	-3	80	238	130	14	45	38
Critical (15%)	-102	555	437	282	207	48	99	152	119	19	48	62

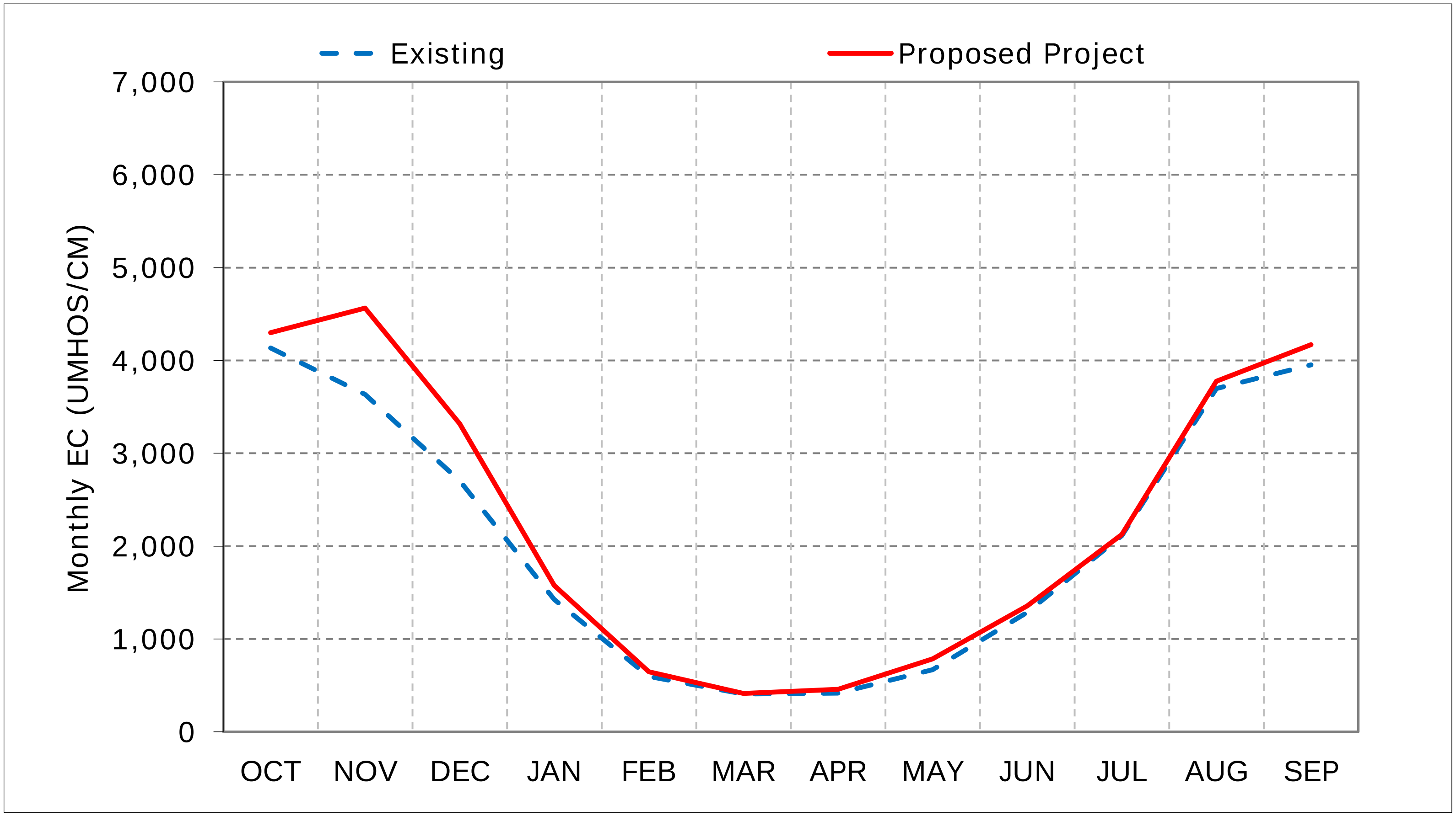
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

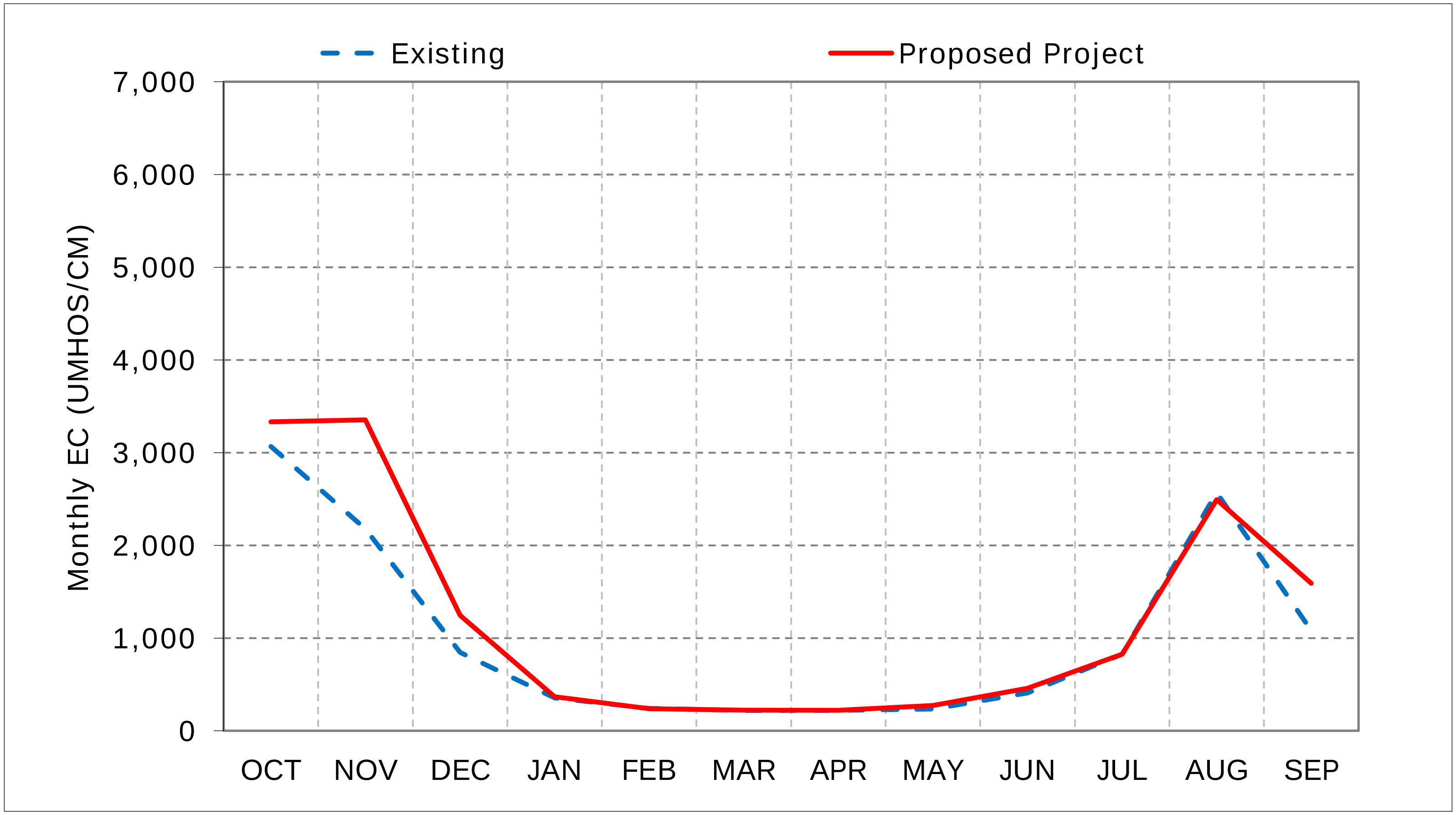
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 11-1. San Joaquin River at Antioch Salinity, Long-Term Average EC



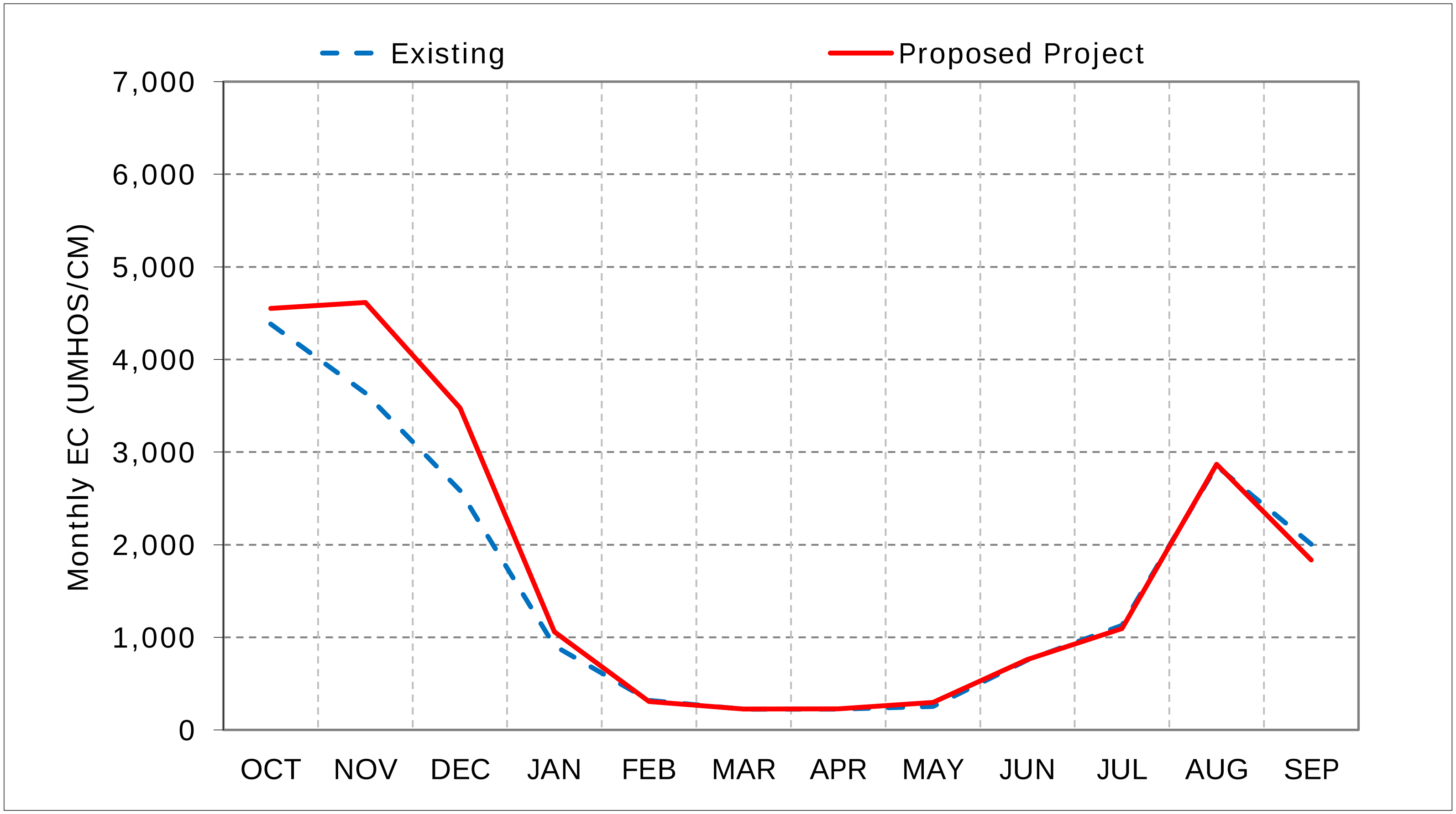
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 11-2. San Joaquin River at Antioch Salinity, Wet Year Average EC



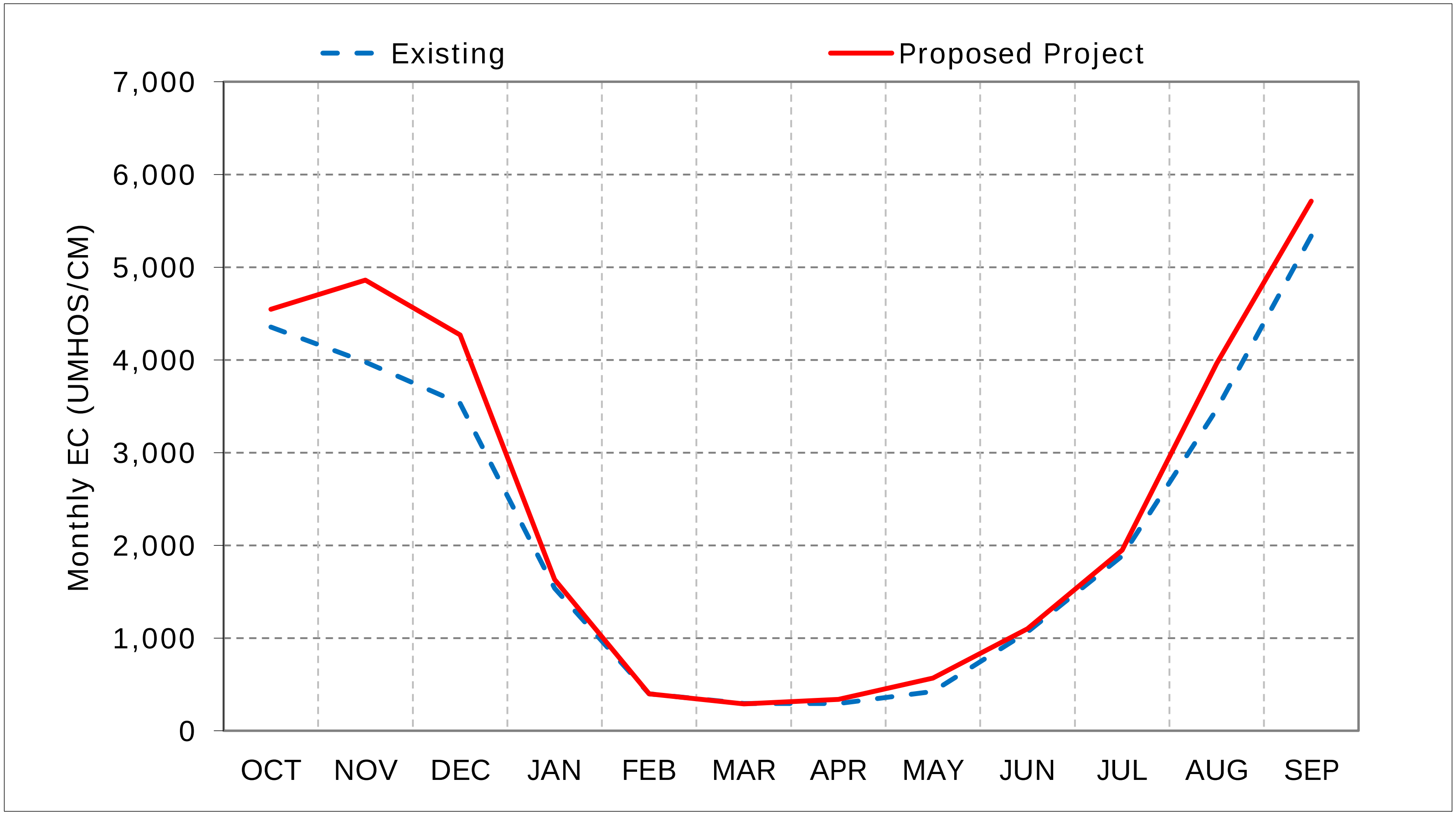
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 11-3. San Joaquin River at Antioch Salinity, Above Normal Year Average EC



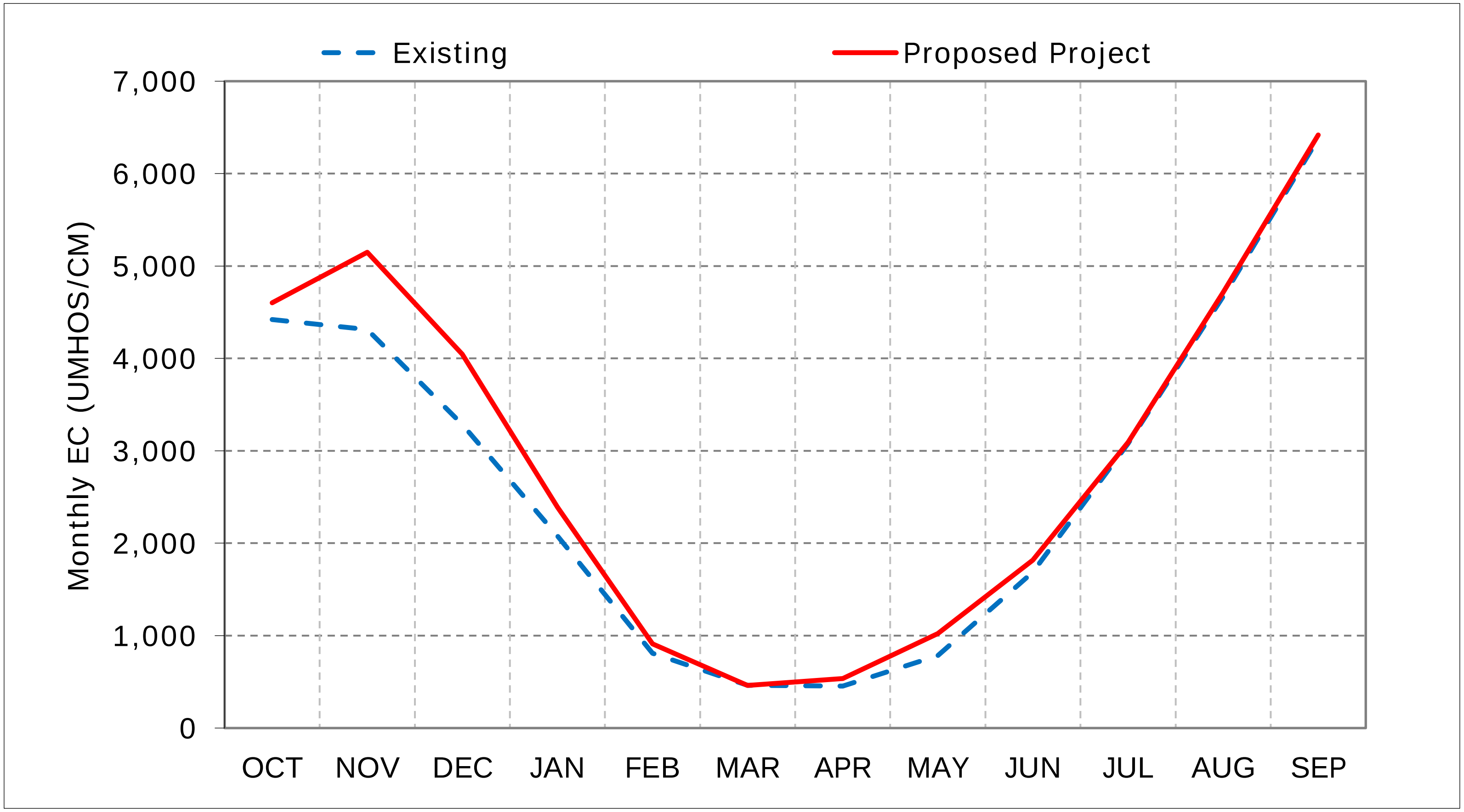
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 11-4. San Joaquin River at Antioch Salinity, Below Normal Year Average EC



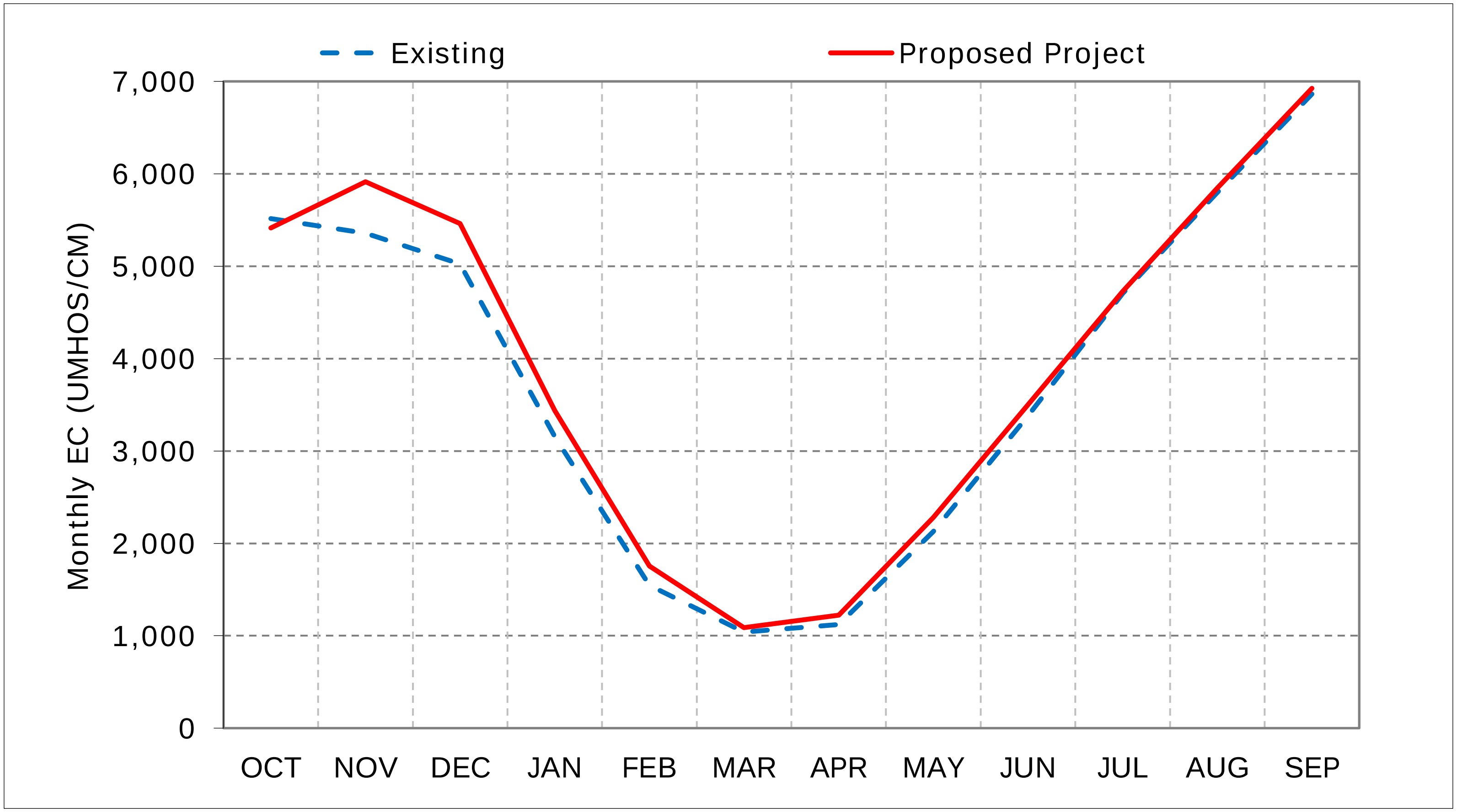
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 11-5. San Joaquin River at Antioch Salinity, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 11-6. San Joaquin River at Antioch Salinity, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 11-7. San Joaquin River at Antioch Salinity, January EC

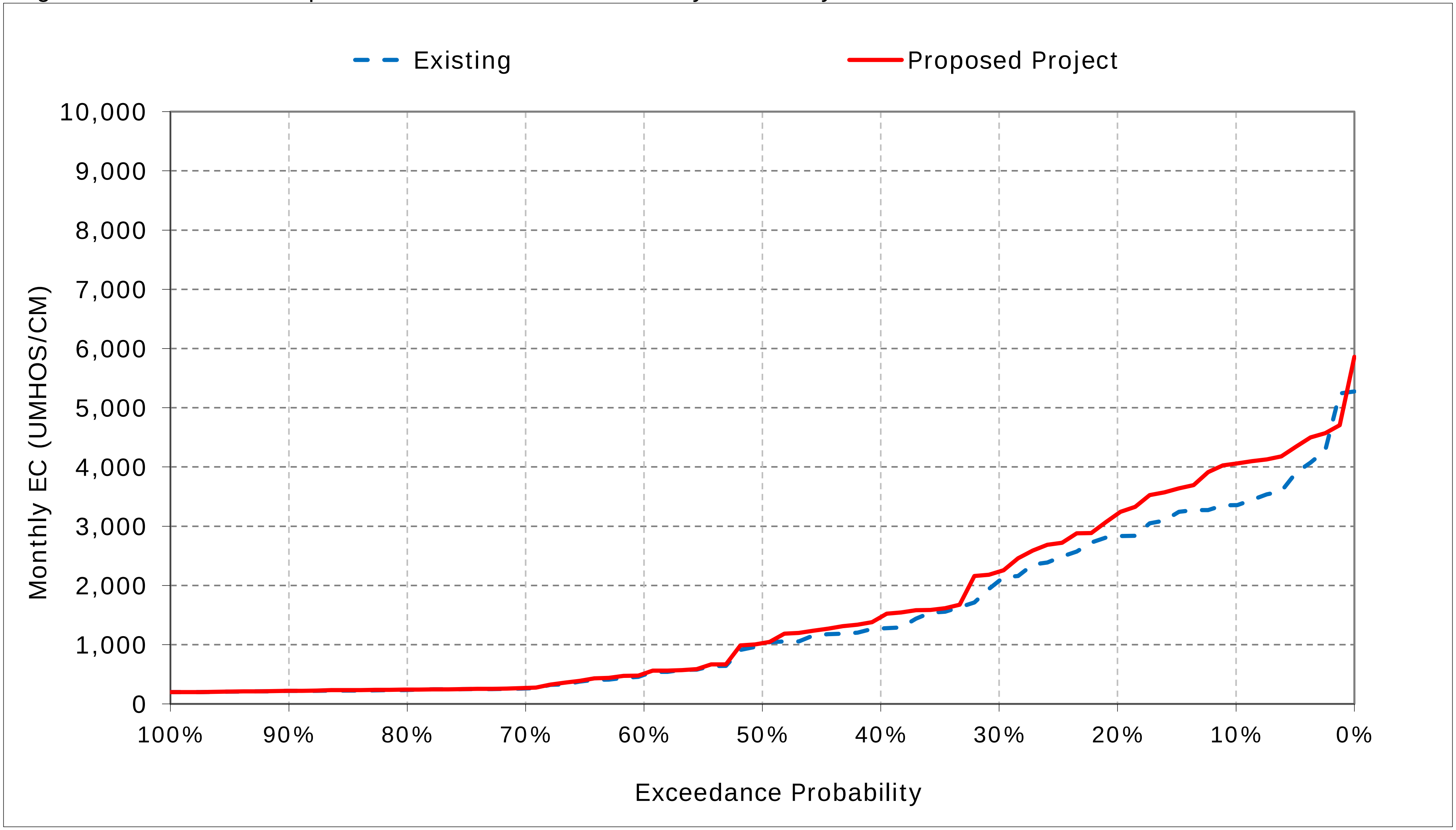


Figure 11-8. San Joaquin River at Antioch Salinity, February EC

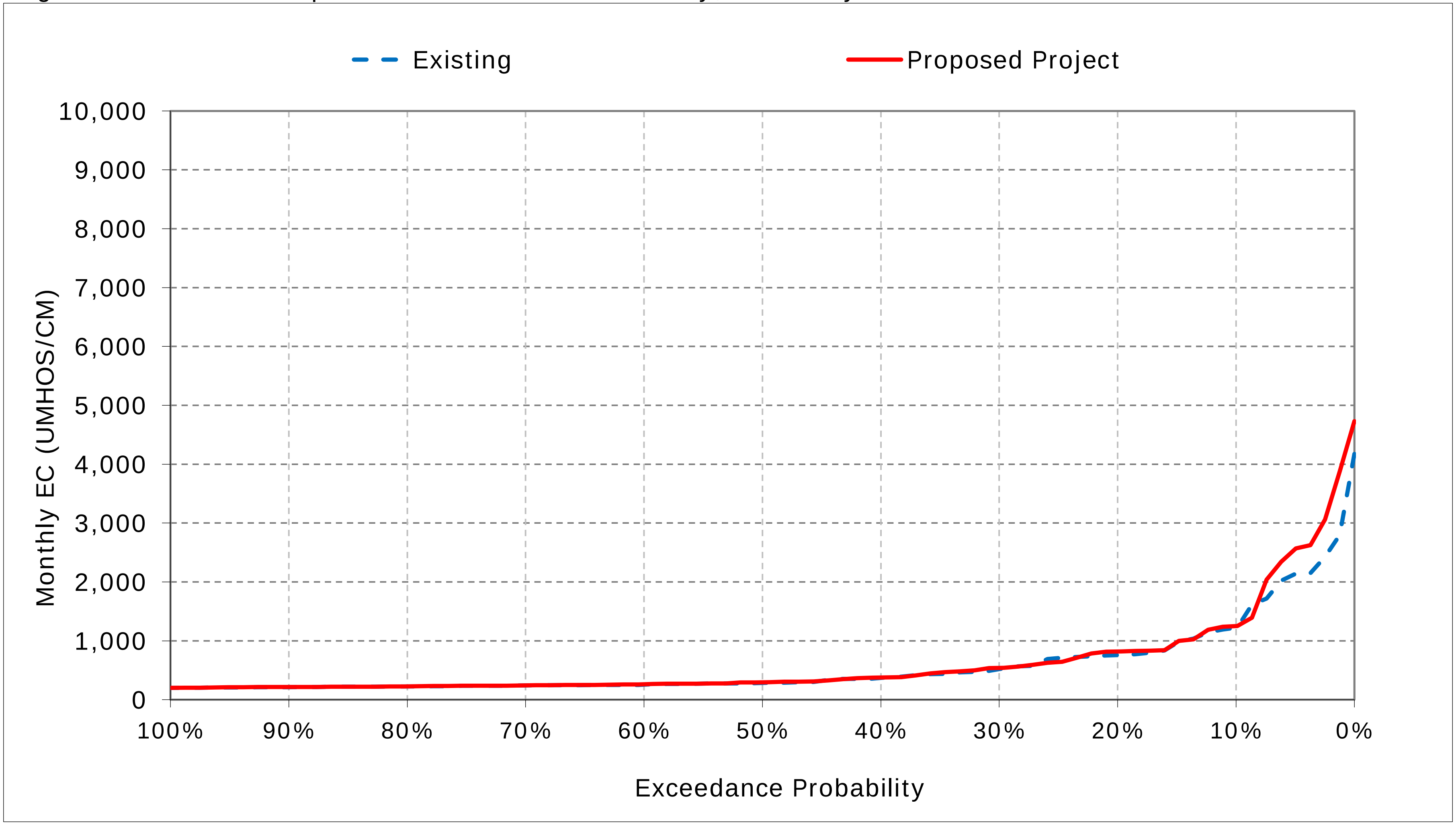


Figure 11-9. San Joaquin River at Antioch Salinity, March EC

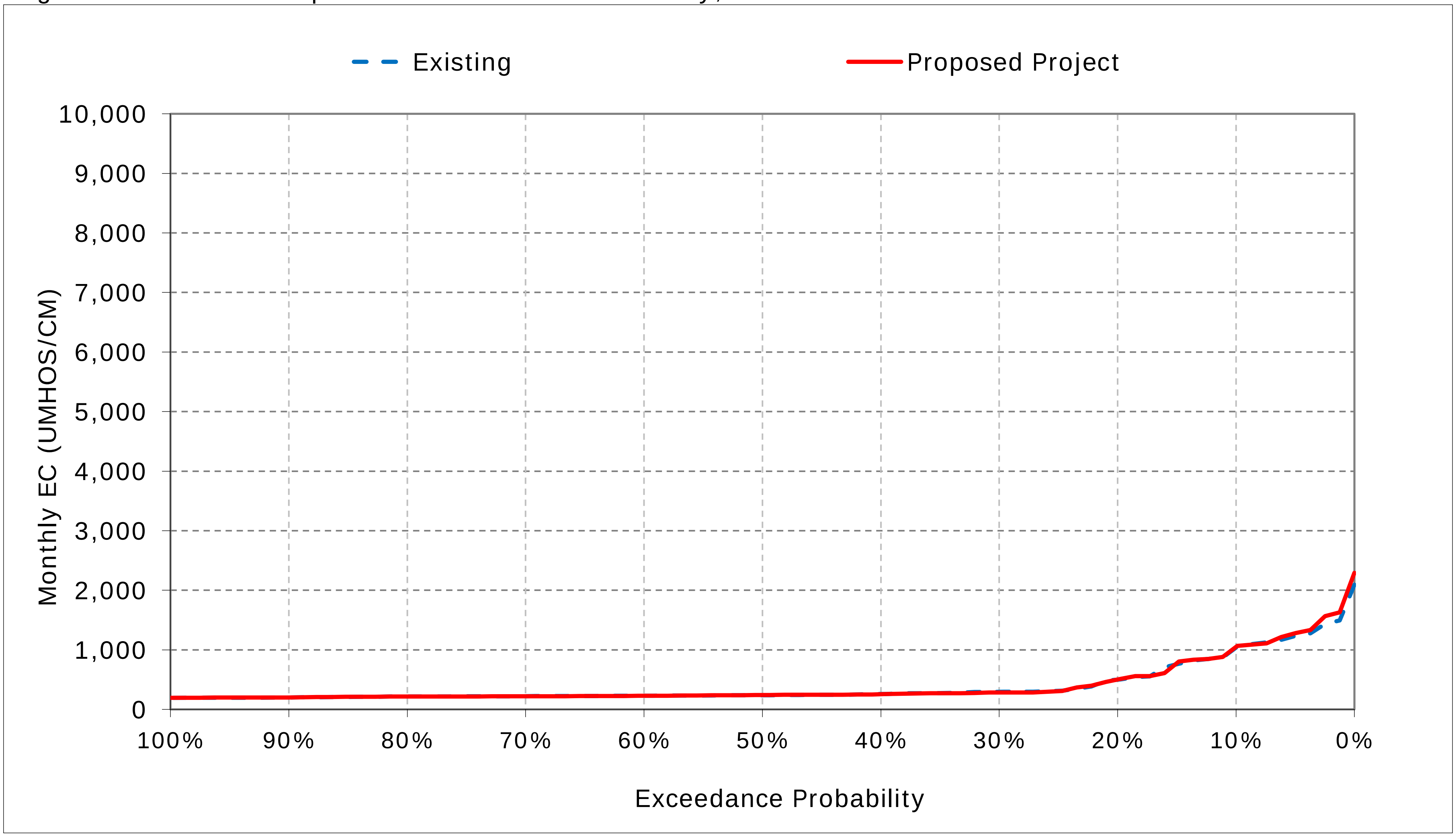


Figure 11-10. San Joaquin River at Antioch Salinity, April EC

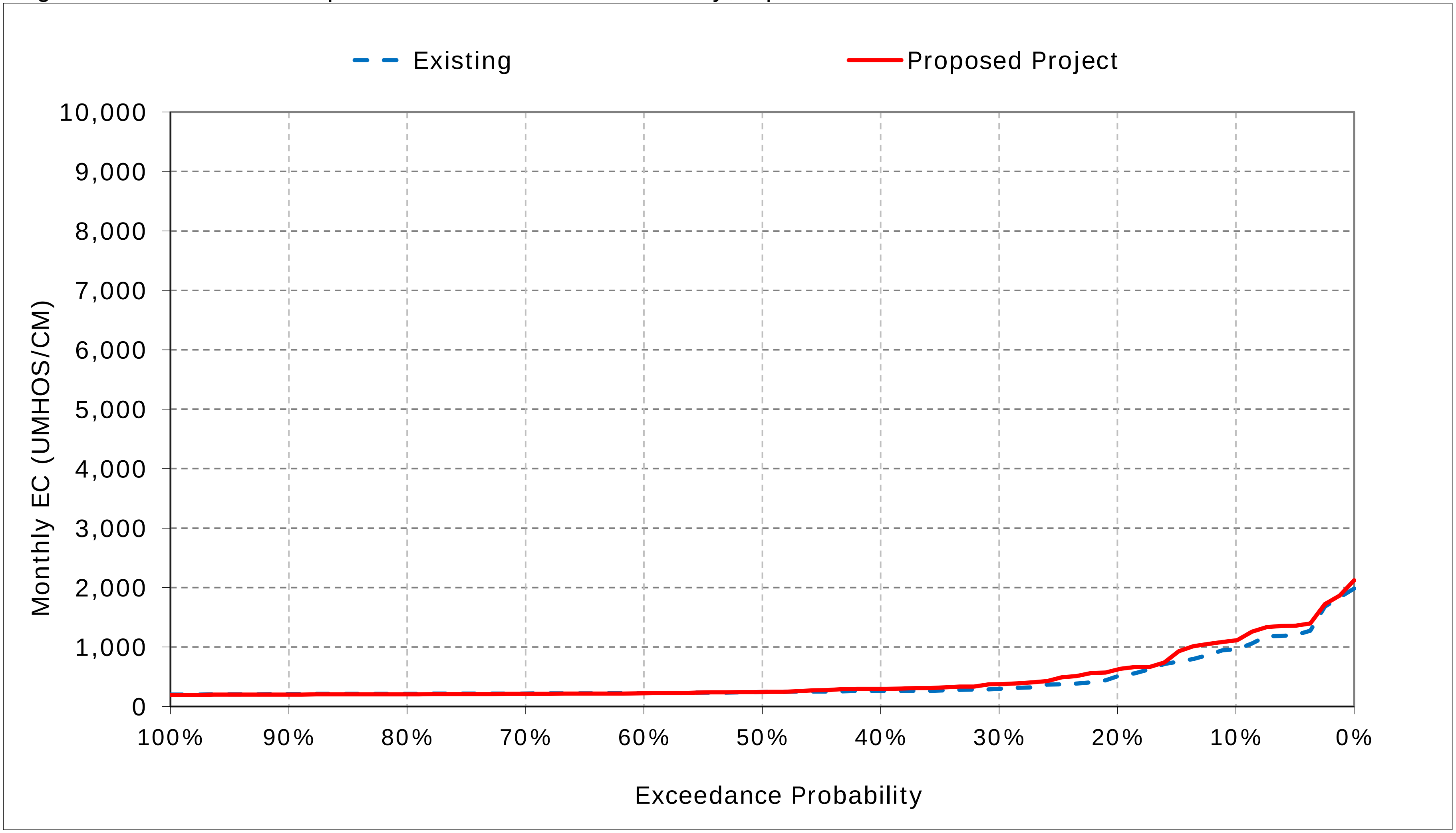


Figure 11-11. San Joaquin River at Antioch Salinity, May EC

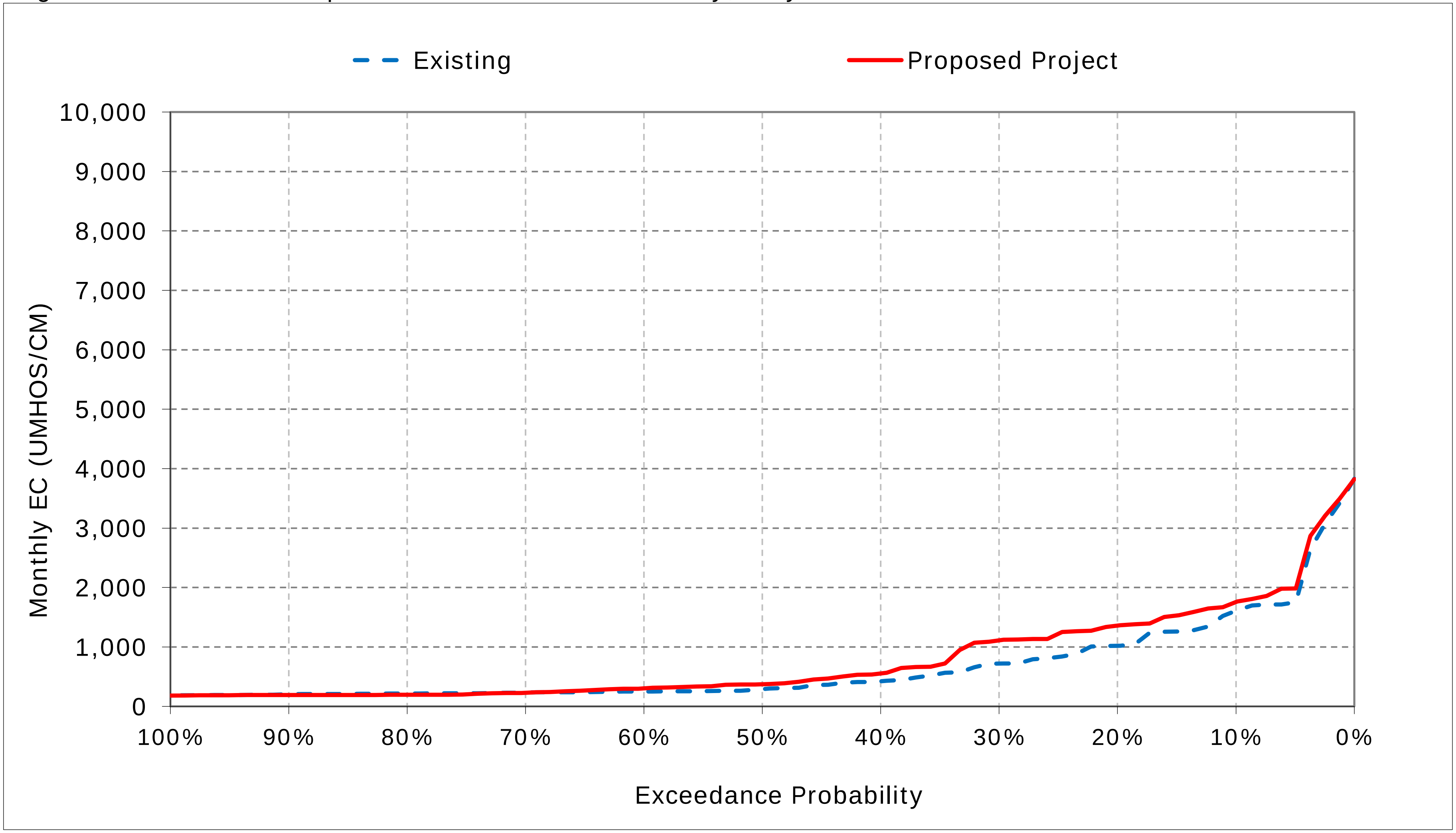


Figure 11-12. San Joaquin River at Antioch Salinity, June EC

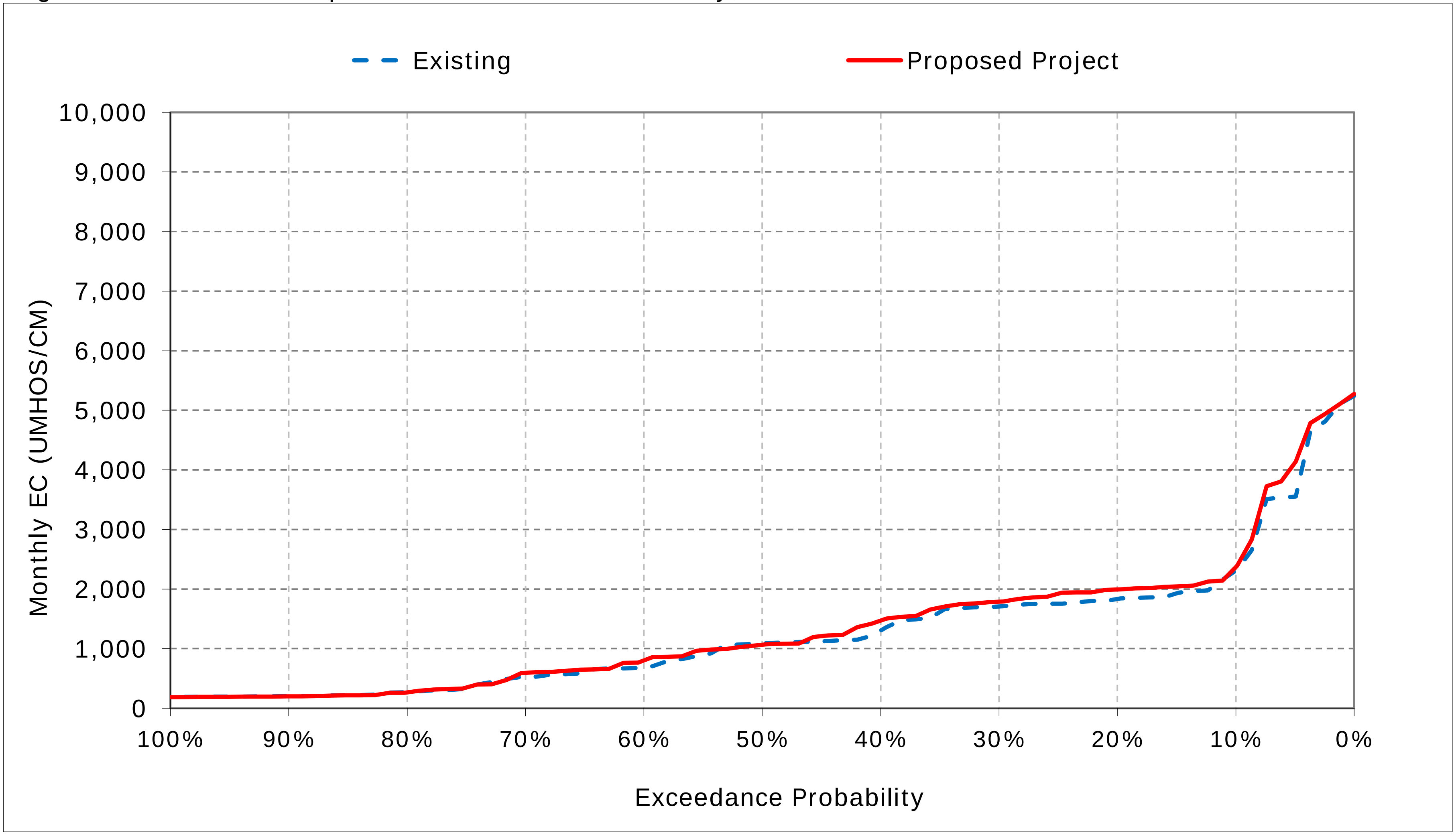


Figure 11-13. San Joaquin River at Antioch Salinity, July EC

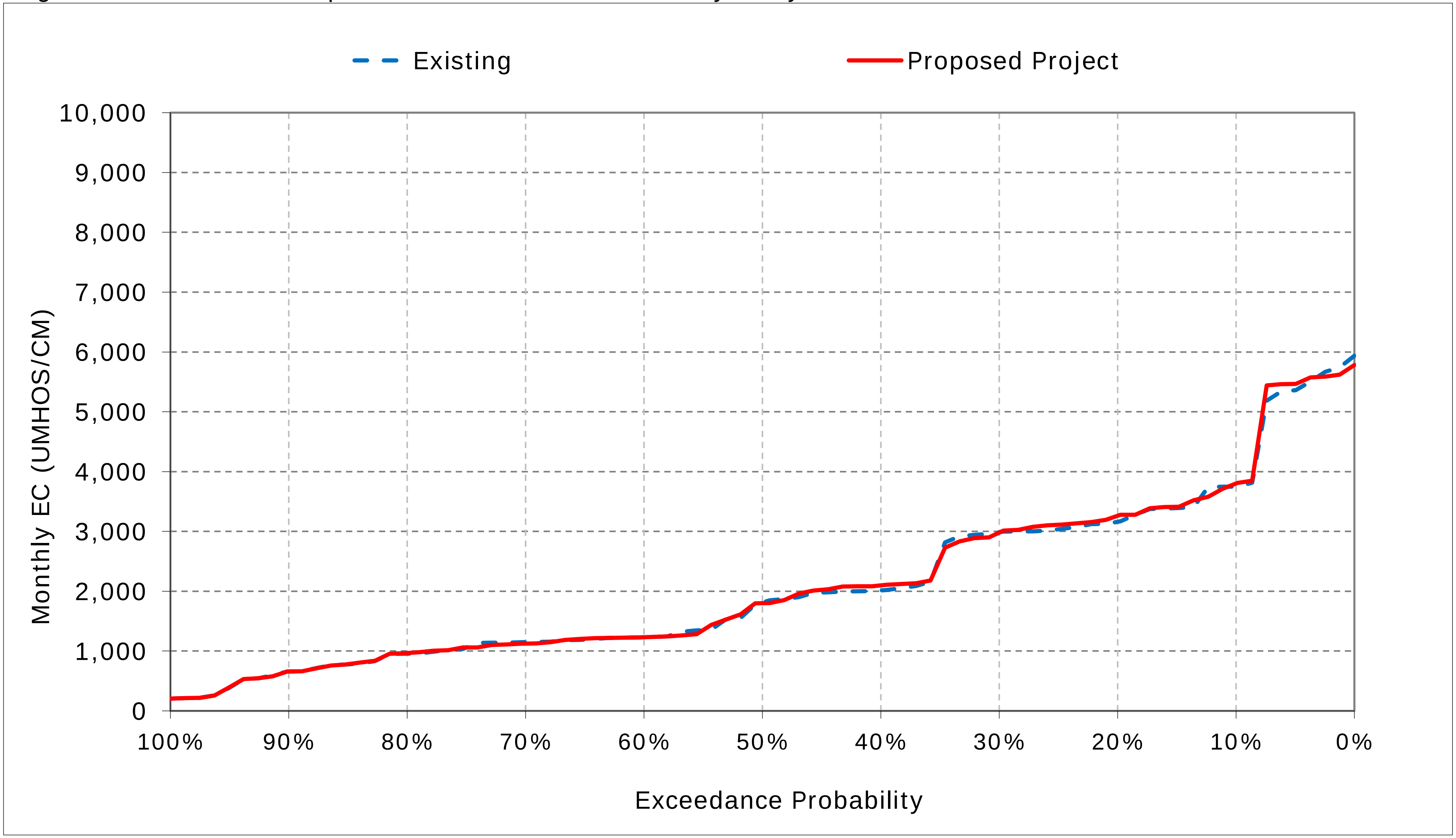


Figure 11-14. San Joaquin River at Antioch Salinity, August EC

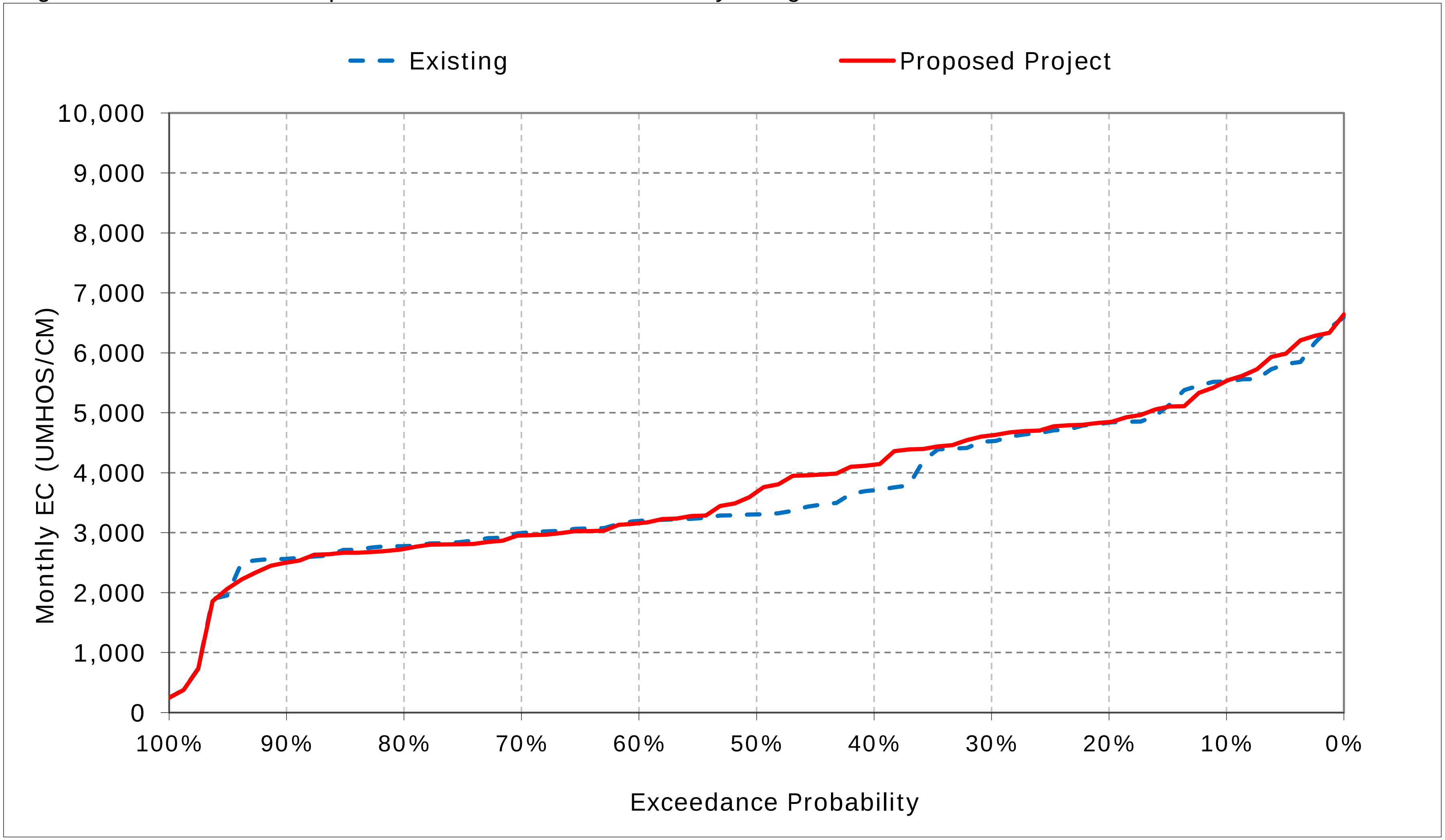


Figure 11-15. San Joaquin River at Antioch Salinity, September EC

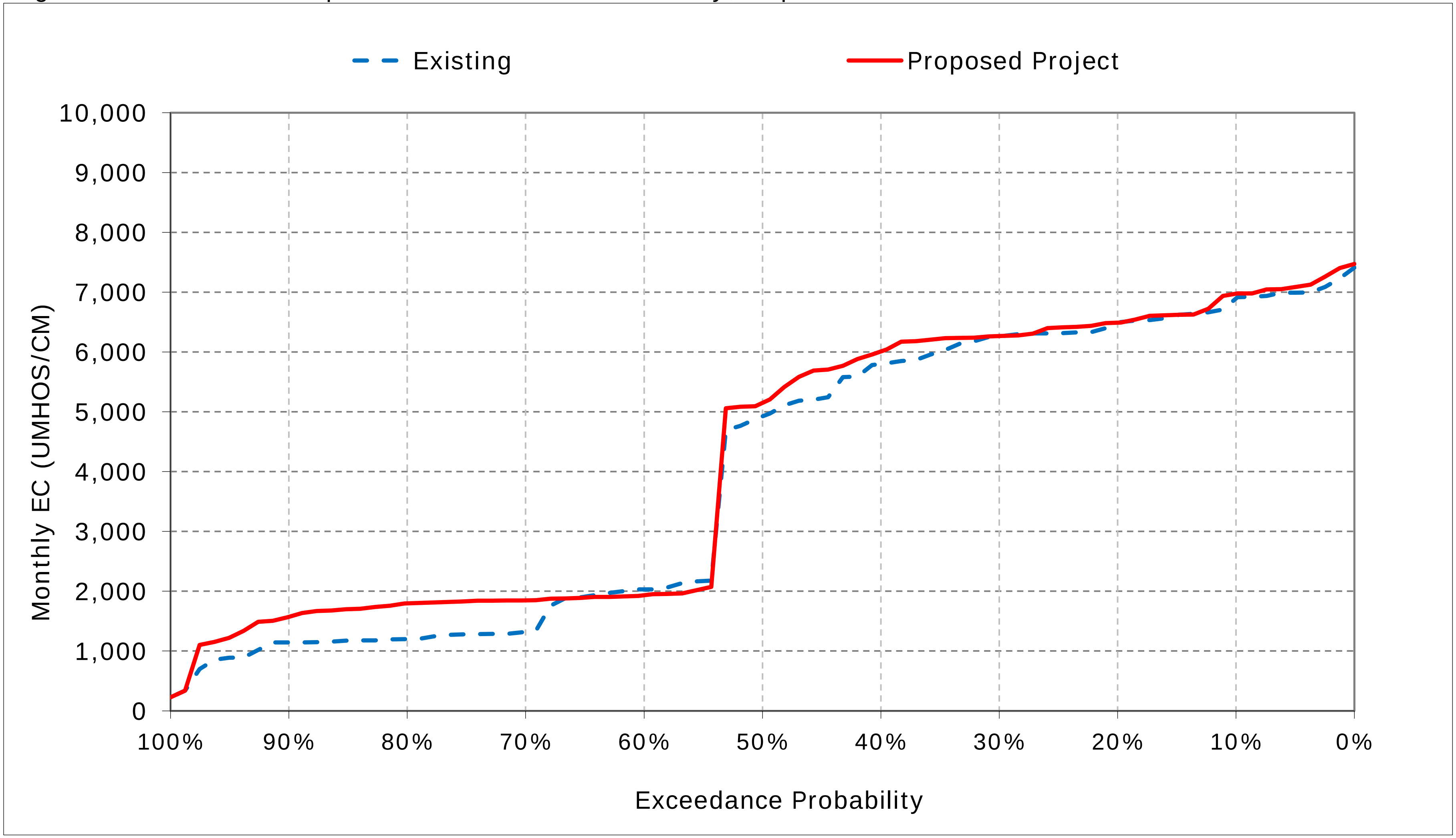


Figure 11-16. San Joaquin River at Antioch Salinity, October EC

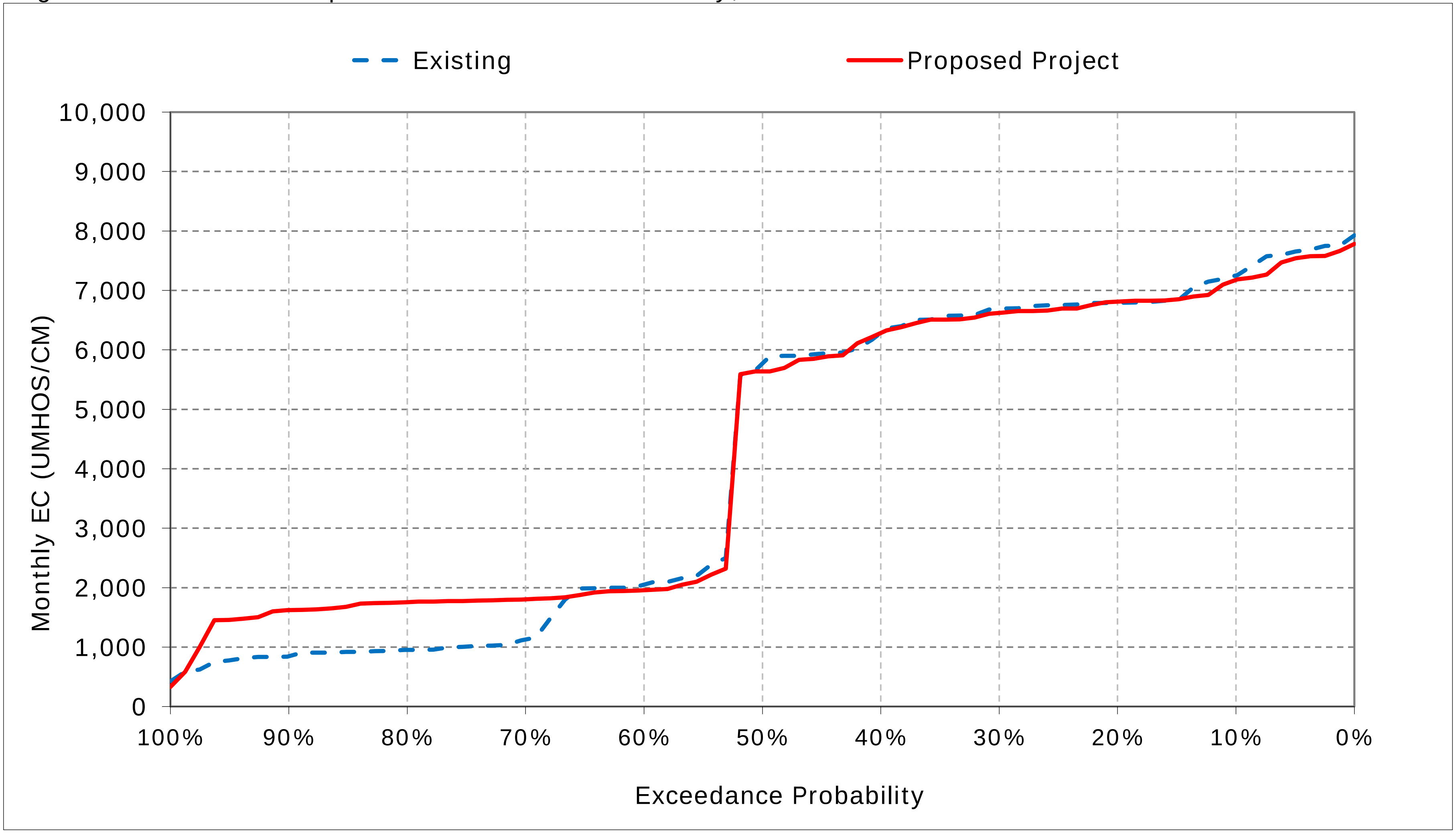


Figure 11-17. San Joaquin River at Antioch Salinity, November EC

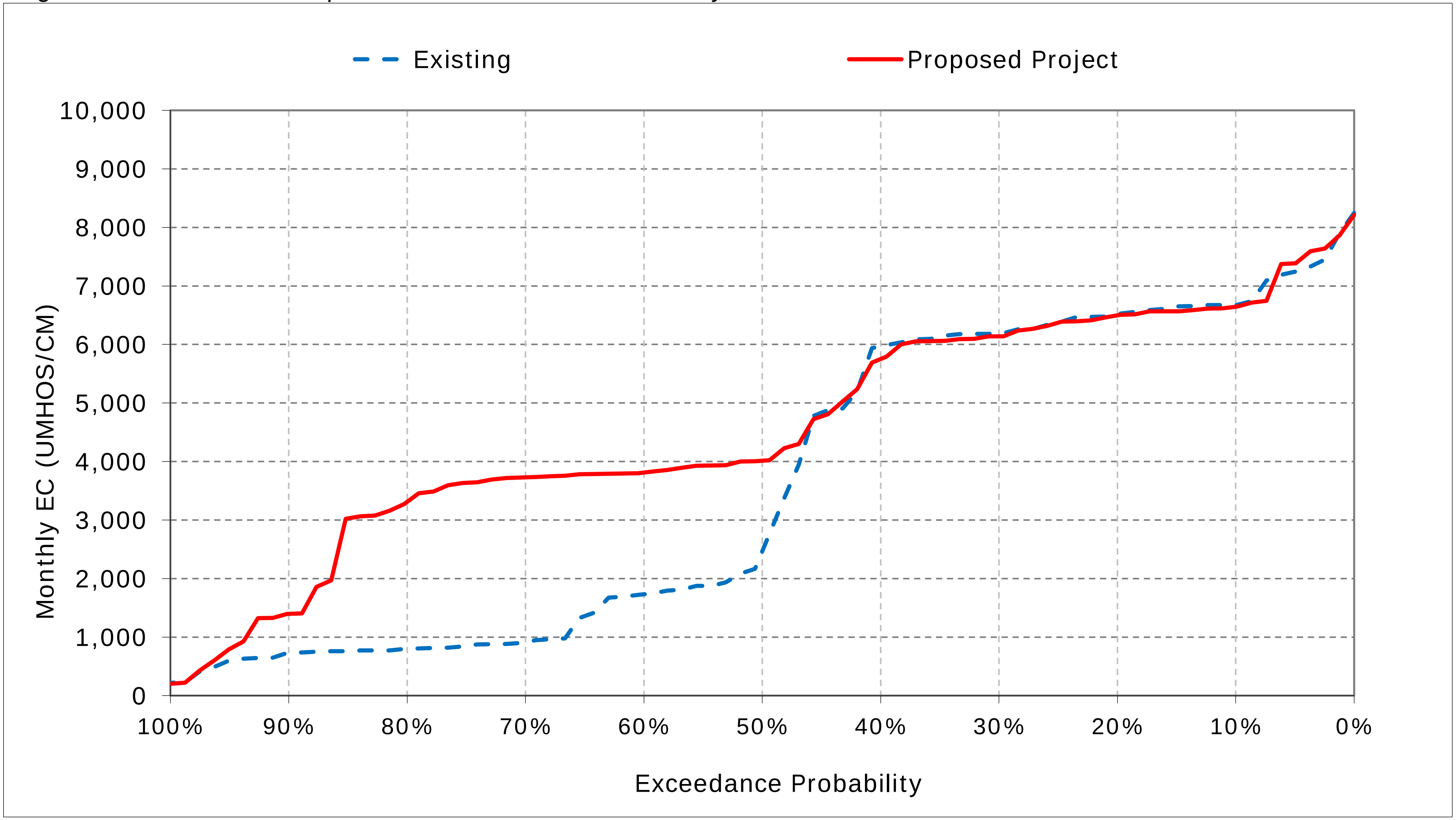


Figure 11-18. San Joaquin River at Antioch Salinity, December EC

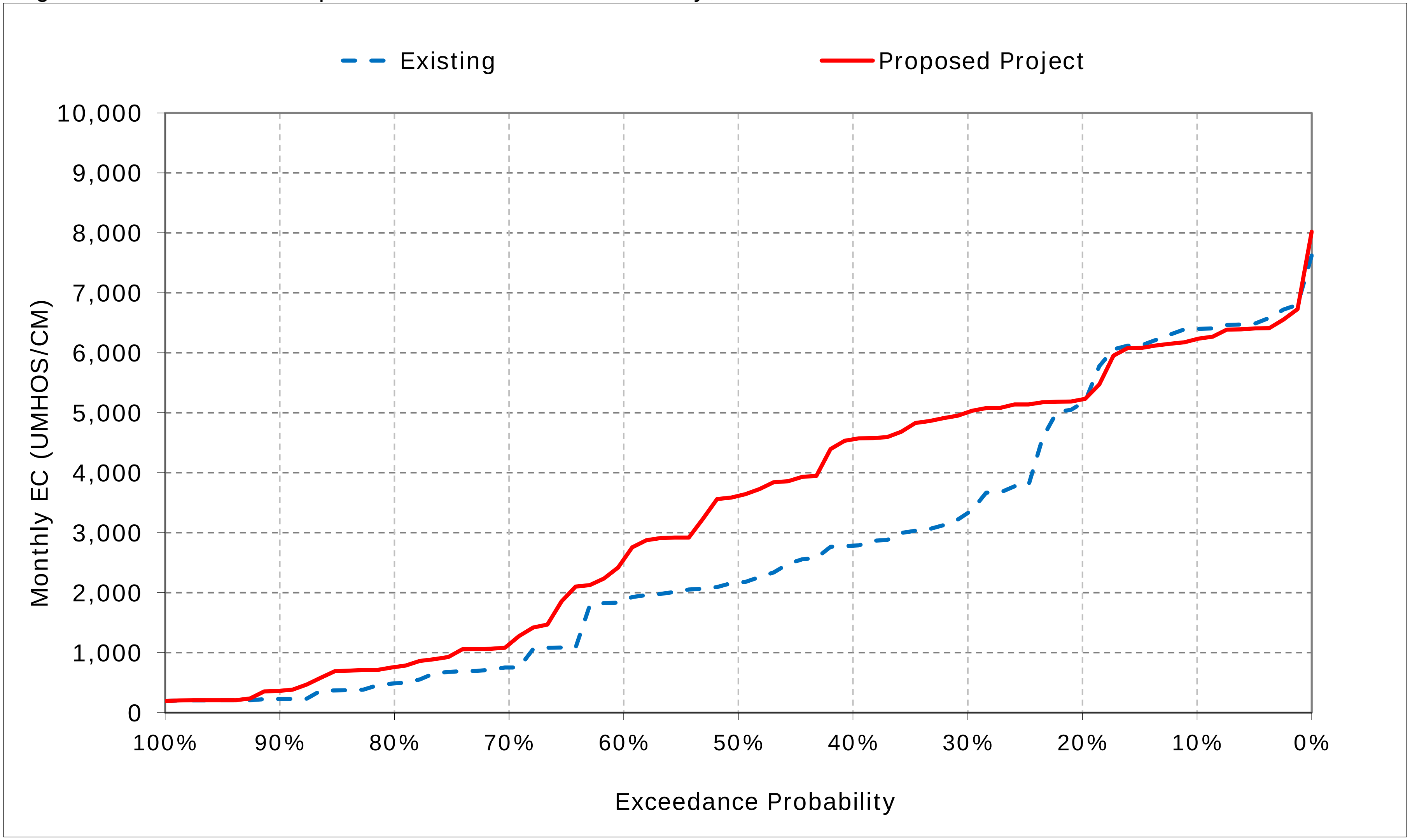


Table 12-1. San Joaquin River at Jersey Point Salinity, Monthly EC

Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	2,437	2,408	2,326	1,362	568	339	307	395	562	1,431	1,744	2,423
20%	2,258	2,253	2,053	1,126	397	274	249	303	470	1,136	1,546	2,323
30%	2,157	2,128	1,532	889	309	244	236	266	446	888	1,473	2,249
40%	2,064	1,889	1,271	674	290	236	230	247	365	808	1,374	2,127
50%	1,775	1,285	831	515	270	228	224	240	311	595	1,300	1,910
60%	562	637	743	352	252	222	221	233	256	491	1,208	1,028
70%	369	399	507	264	237	214	219	227	231	442	1,148	967
80%	312	322	308	234	219	209	214	222	209	337	1,065	909
90%	287	267	215	218	213	200	209	207	203	246	1,000	876
Long Term												
Full Simulation Period[a]	1,354	1,310	1,133	668	342	255	243	283	401	754	1,304	1,613
Water Year Types[b]												
Wet (32%)	1,021	898	480	277	234	219	218	215	223	335	990	819
Above Normal (15%)	1,495	1,286	1,114	516	267	222	224	229	276	429	1,124	942
Below Normal (17%)	1,417	1,465	1,437	744	289	233	232	247	328	746	1,402	2,286
Dry (22%)	1,430	1,529	1,355	865	391	256	239	277	449	1,141	1,475	2,261
Critical (15%)	1,747	1,716	1,876	1,282	637	387	332	534	923	1,413	1,795	2,248

Proposed Project

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	2,418	2,437	2,461	1,628	622	337	328	451	588	1,452	1,808	2,544
20%	2,262	2,267	2,327	1,287	413	275	249	367	521	1,019	1,640	2,480
30%	2,187	2,074	2,186	1,067	326	246	228	309	453	820	1,520	2,338
40%	2,021	1,877	1,951	879	294	239	220	235	381	754	1,420	2,160
50%	1,775	1,744	1,630	536	273	232	215	217	299	558	1,305	1,953
60%	619	1,507	1,358	381	258	225	211	207	247	465	1,181	935
70%	561	1,441	688	268	236	217	207	201	223	422	1,134	867
80%	488	1,223	525	240	220	209	205	195	200	340	1,047	792
90%	412	704	274	225	214	204	201	192	196	245	933	662
Long Term												
Full Simulation Period[a]	1,409	1,687	1,493	760	372	261	242	290	411	739	1,322	1,613
Water Year Types[b]												
Wet (32%)	1,109	1,363	724	295	235	221	208	202	223	330	946	708
Above Normal (15%)	1,570	1,723	1,647	644	276	226	211	205	260	418	1,127	865
Below Normal (17%)	1,488	1,822	1,844	829	293	233	224	246	324	691	1,511	2,479
Dry (22%)	1,474	1,822	1,806	1,038	445	262	243	313	482	1,102	1,487	2,281
Critical (15%)	1,712	1,989	2,123	1,383	745	417	364	584	968	1,453	1,863	2,311

Proposed Project minus Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-19	29	135	266	54	-2	21	56	26	21	64	122
20%	4	15	275	161	16	1	-1	64	51	-117	93	157
30%	29	-54	654	178	17	2	-8	44	7	-68	47	90
40%	-43	-12	679	206	5	3	-10	-11	15	-54	46	33
50%	0	460	798	21	3	3	-9	-23	-12	-38	5	44
60%	57	871	614	30	6	4	-10	-25	-9	-25	-27	-93
70%	192	1,042	180	5	0	3	-12	-26	-8	-21	-15	-100
80%	175	901	217	6	0	0	-10	-26	-9	3	-18	-117
90%	125	437	59	6	1	3	-8	-15	-7	-1	-67	-214
Long Term												
Full Simulation Period[a]	56	377	360	92	30	7	-1	7	10	-15	17	0
Water Year Types[b]												
Wet (32%)	88	465	244	18	1	2	-10	-13	-1	-4	-45	-111
Above Normal (15%)	75	437	533	128	9	4	-13	-24	-16	-10	3	-77
Below Normal (17%)	71	357	406	86	4	0	-8	-1	-4	-55	110	193
Dry (22%)	44	293	451	173	54	6	4	36	33	-39	12	20
Critical (15%)	-35	273	247	100	108	29	31	50	44	40	68	63

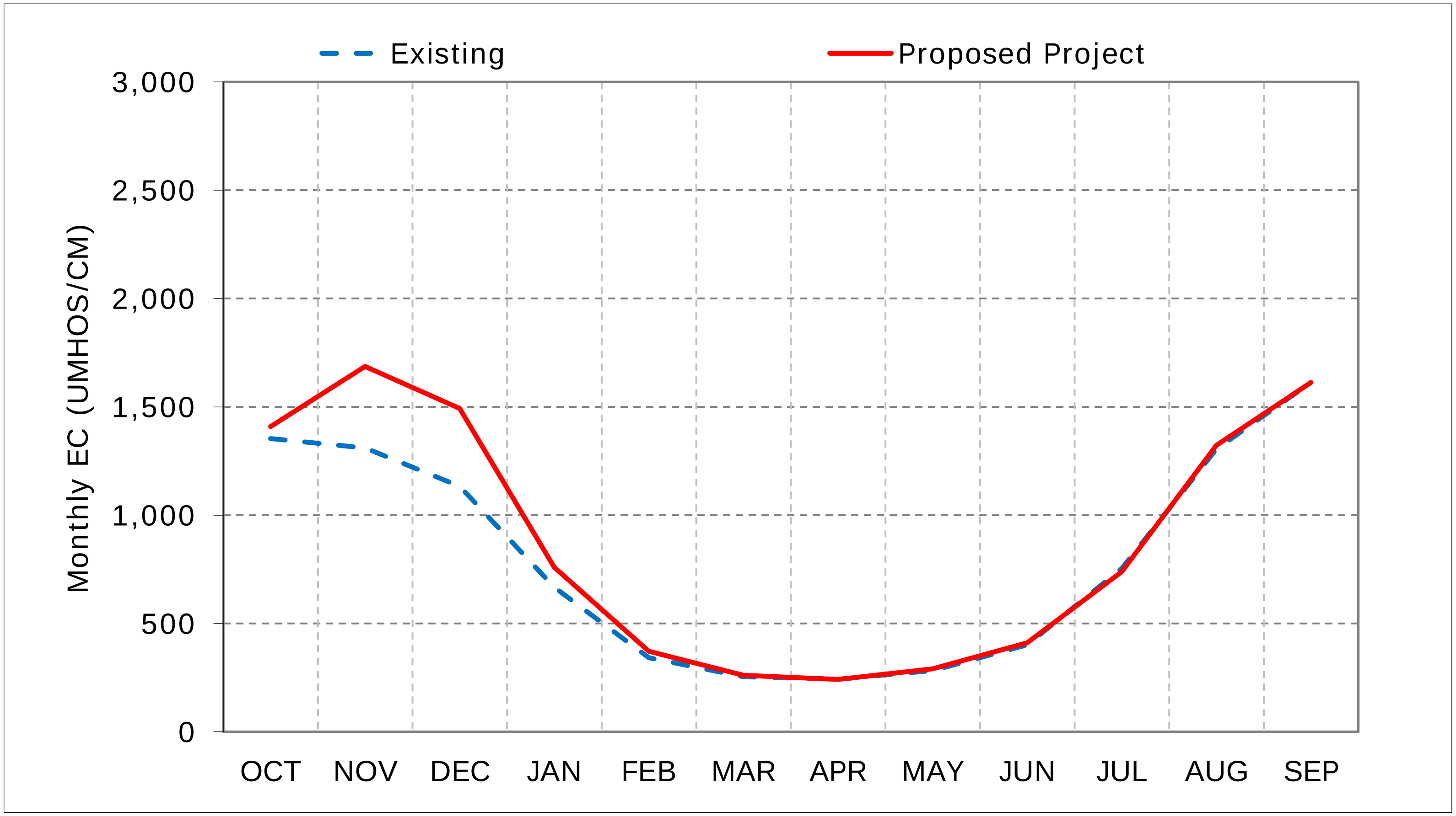
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

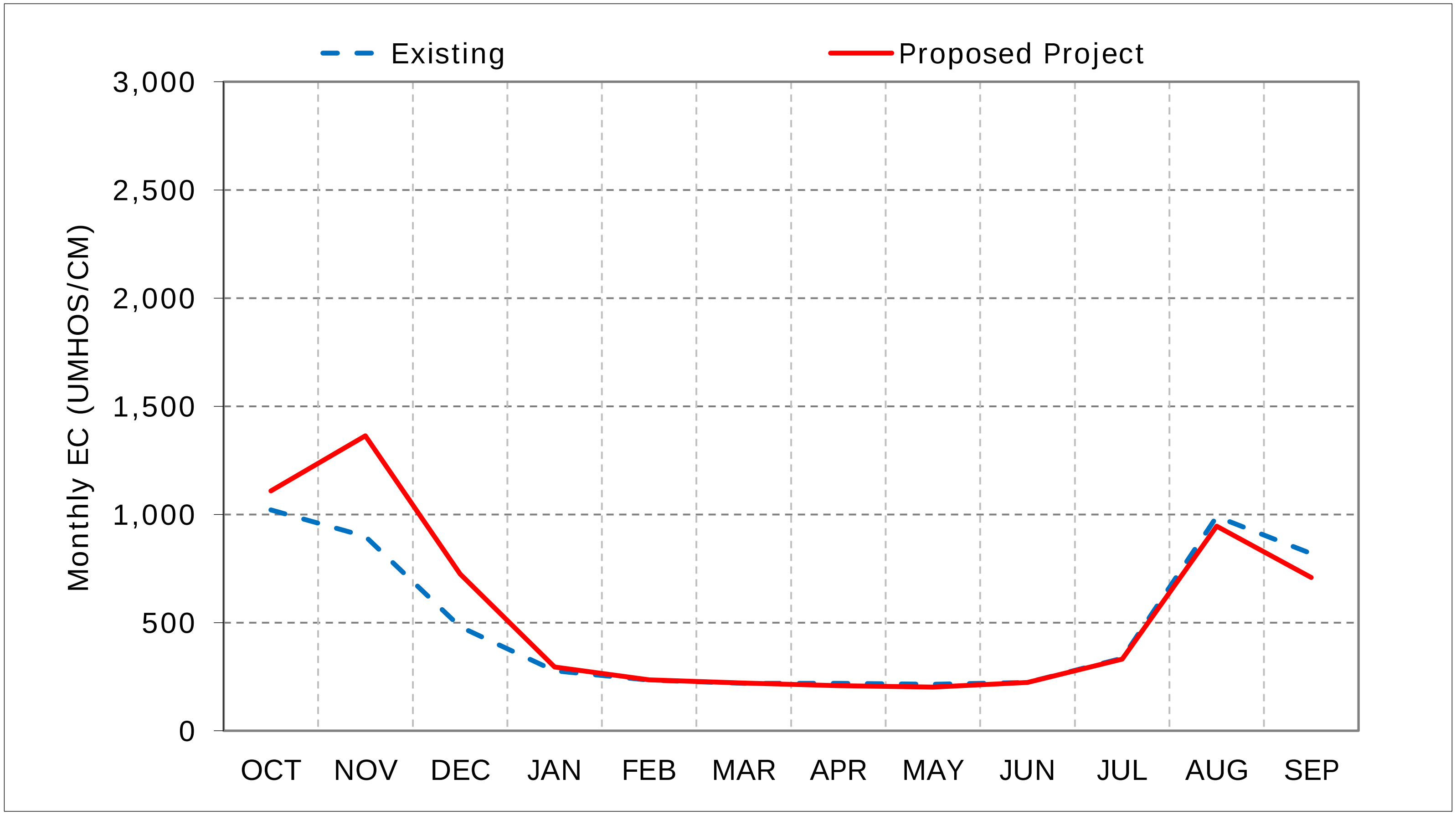
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 12-1. San Joaquin River at Jersey Point Salinity, Long-Term Average EC



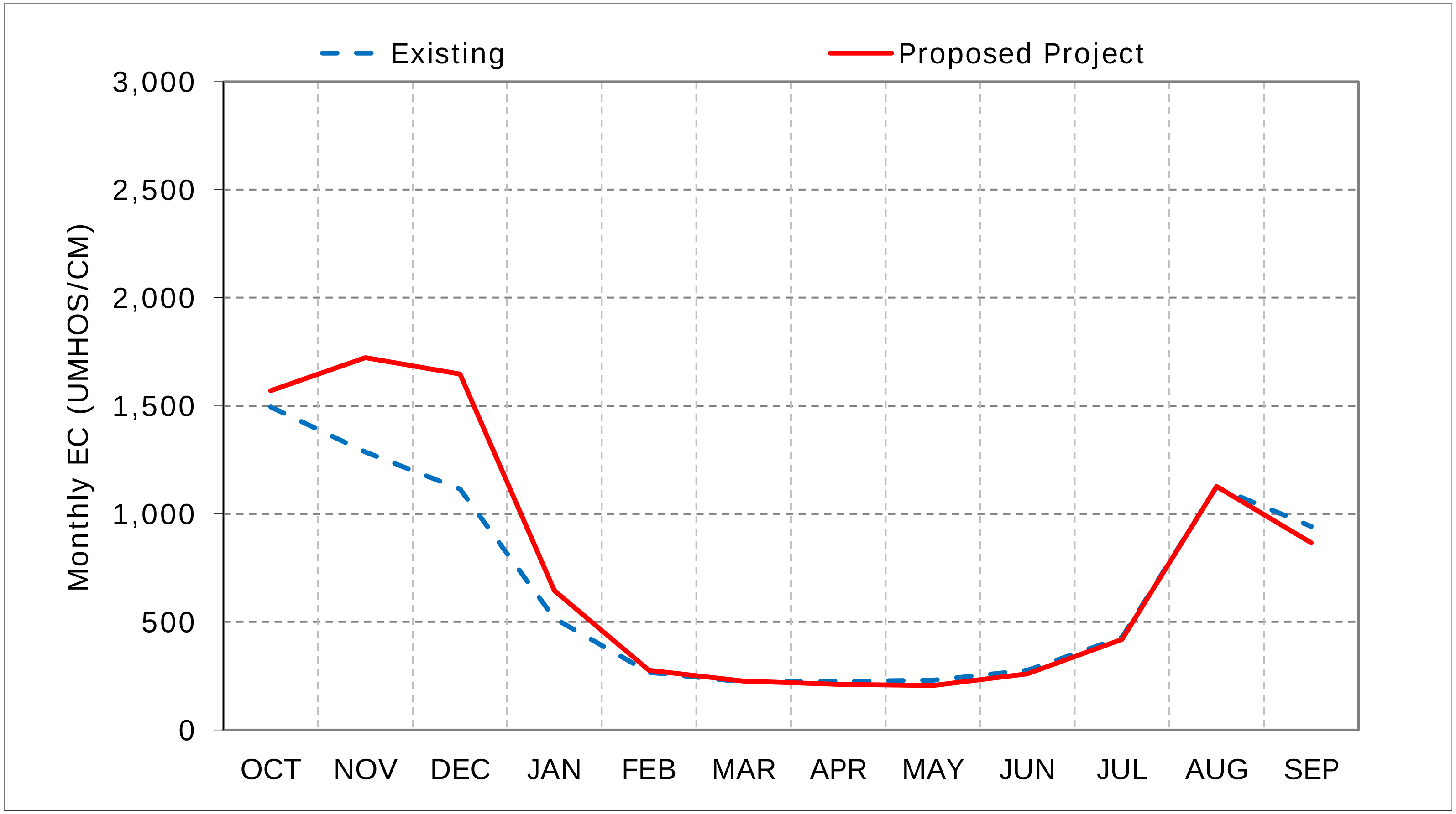
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 12-2. San Joaquin River at Jersey Point Salinity, Wet Year Average EC



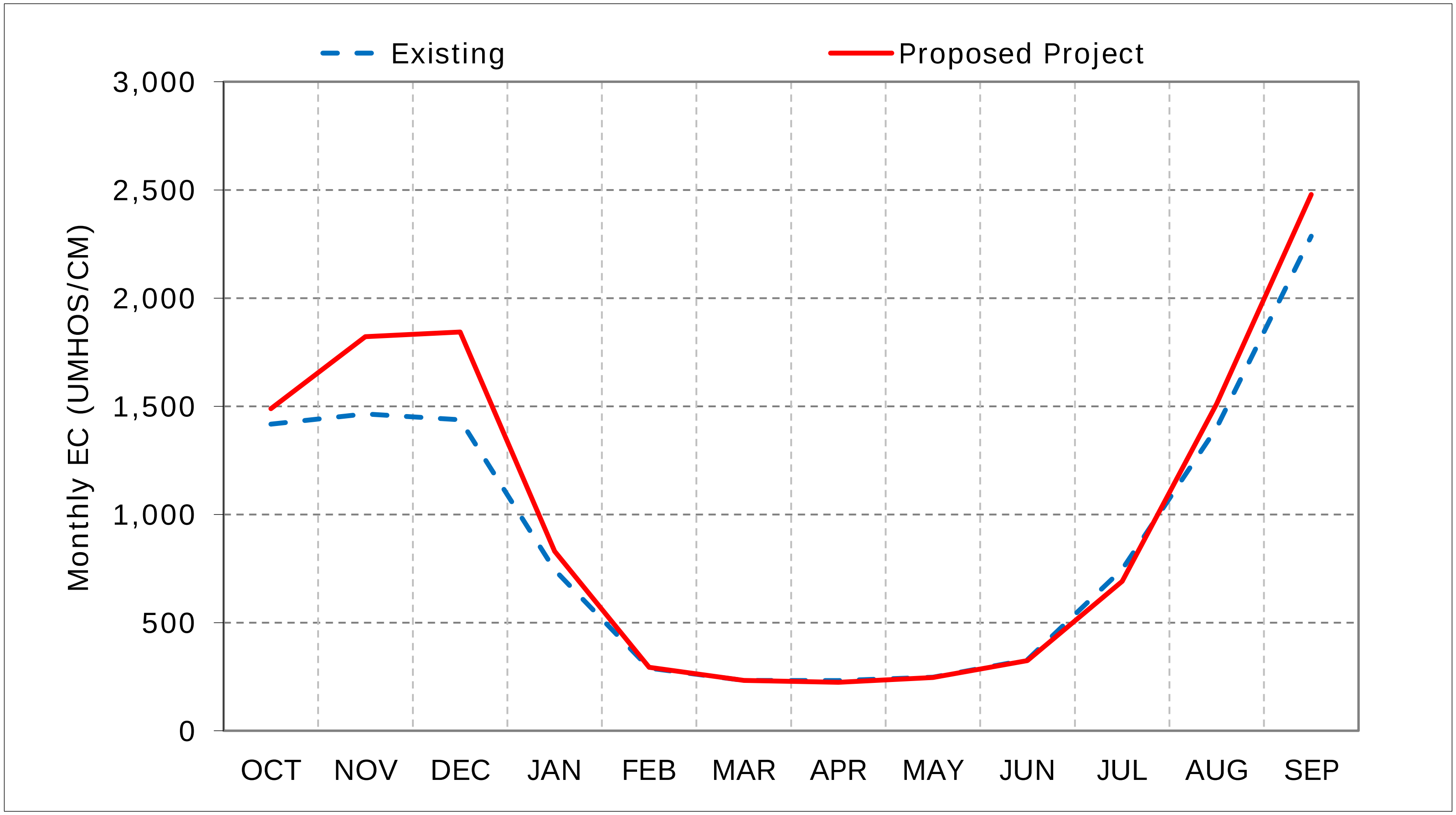
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 12-3. San Joaquin River at Jersey Point Salinity, Above Normal Year Averag



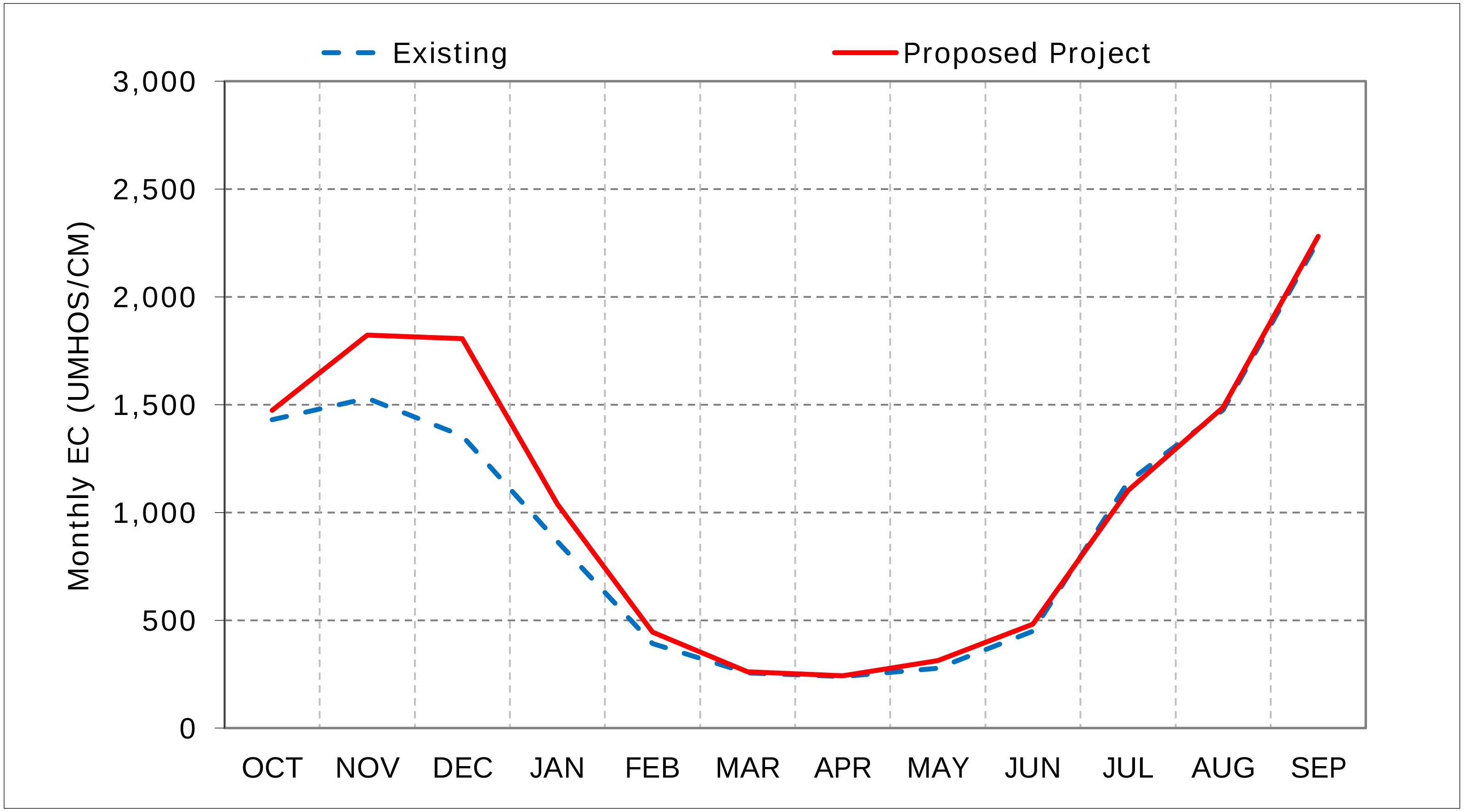
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 12-4. San Joaquin River at Jersey Point Salinity, Below Normal Year Averag



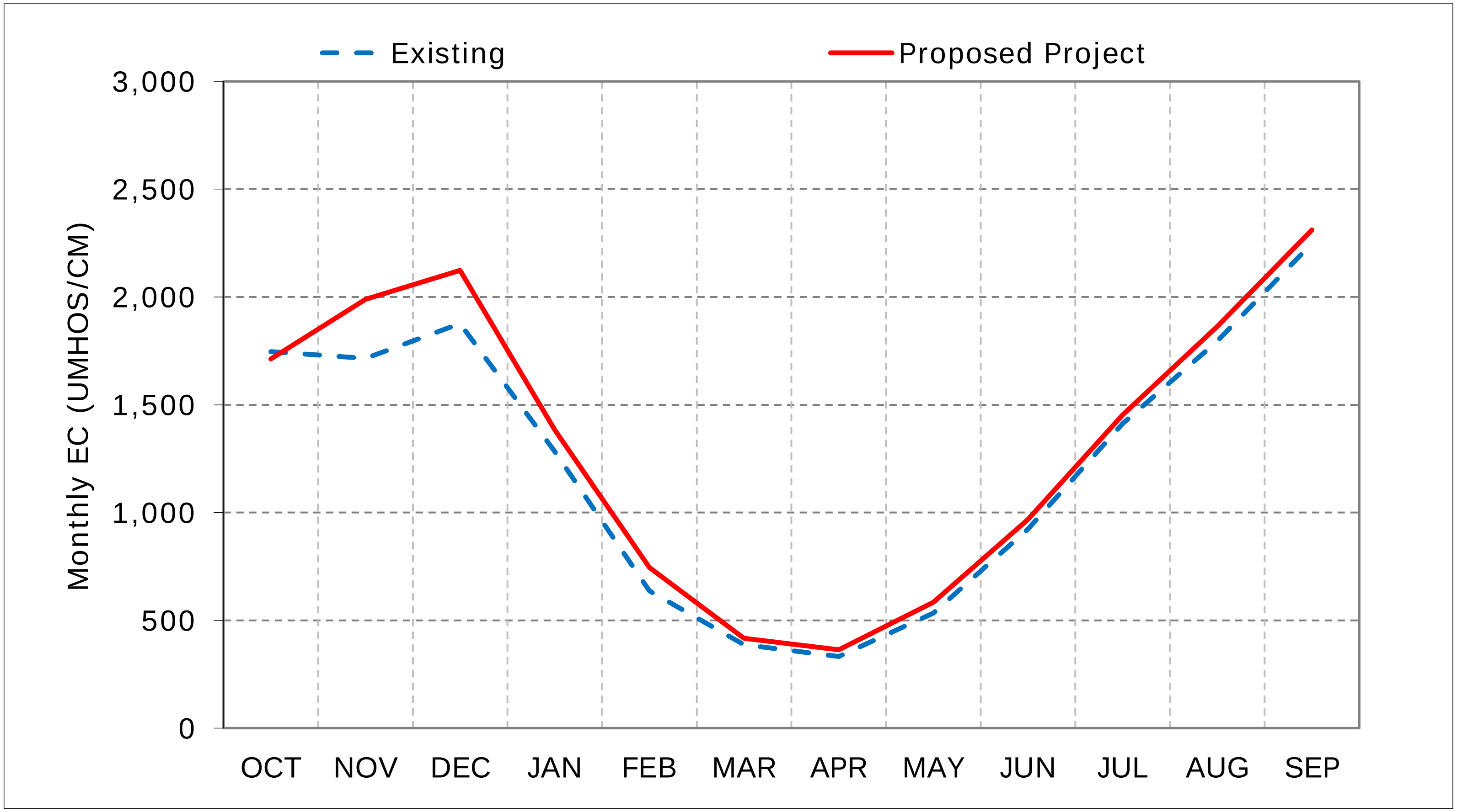
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 12-5. San Joaquin River at Jersey Point Salinity, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 12-6. San Joaquin River at Jersey Point Salinity, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 12-7. San Joaquin River at Jersey Point Salinity, January EC

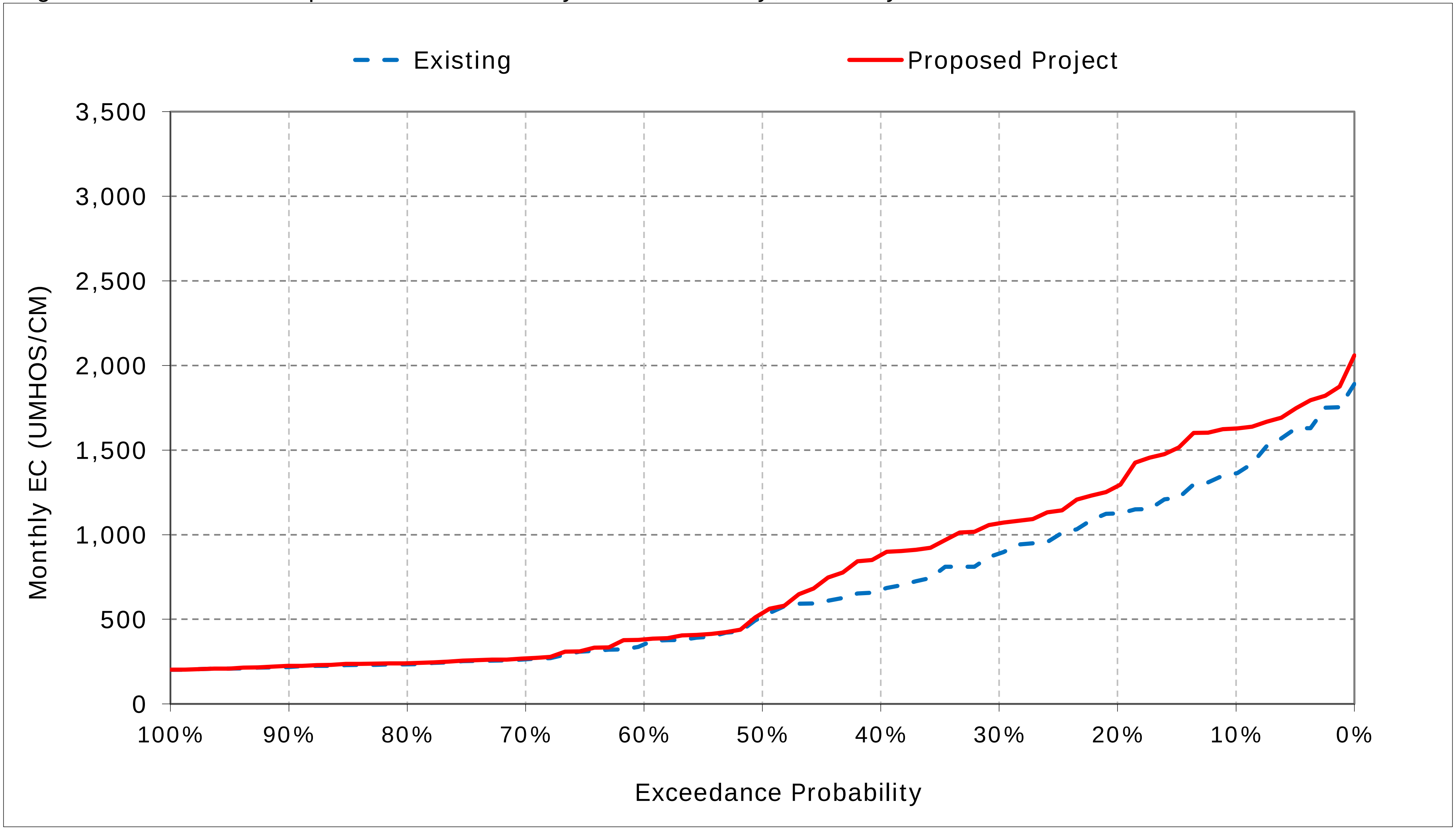


Figure 12-8. San Joaquin River at Jersey Point Salinity, February EC

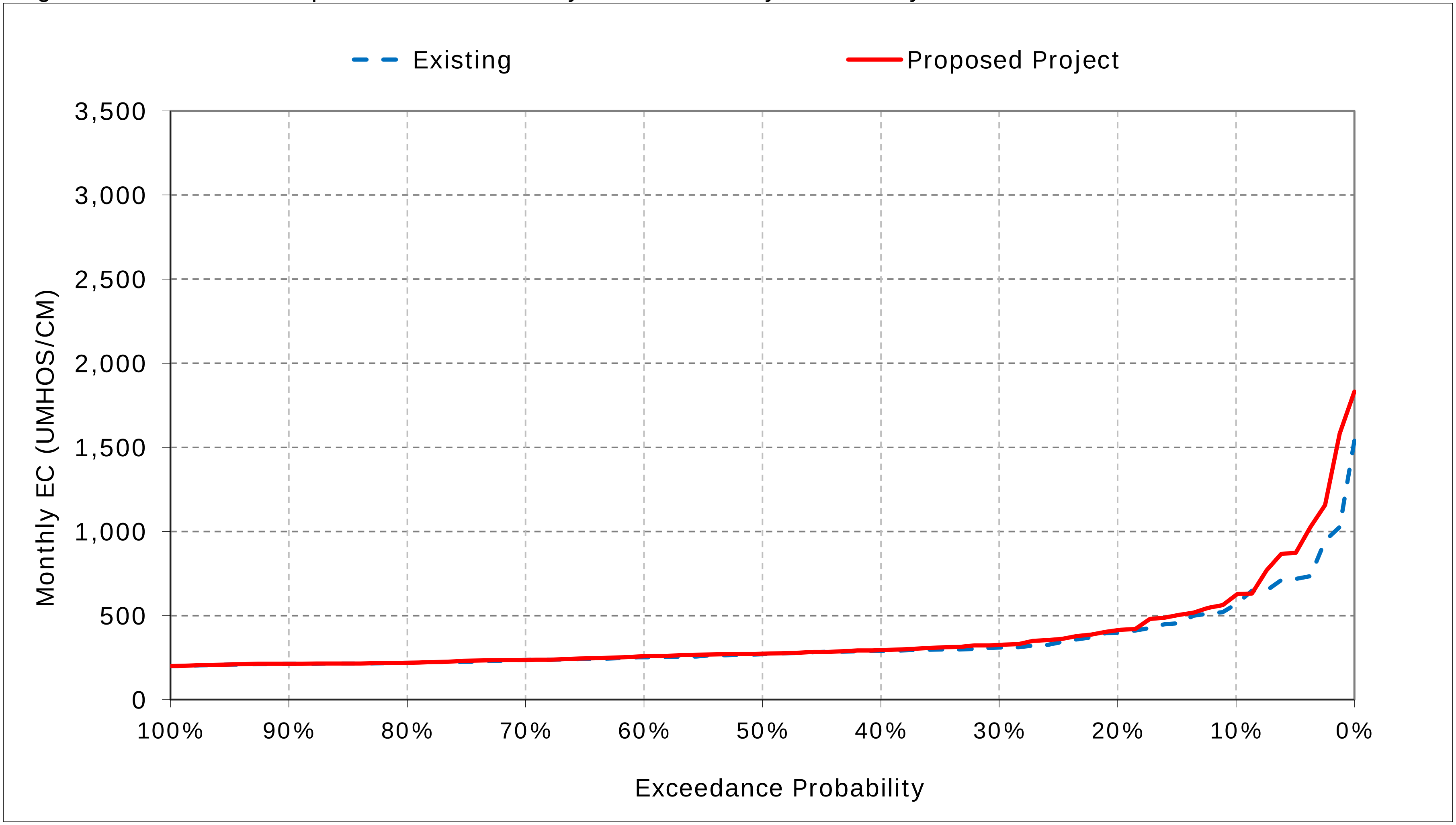


Figure 12-9. San Joaquin River at Jersey Point Salinity, March EC

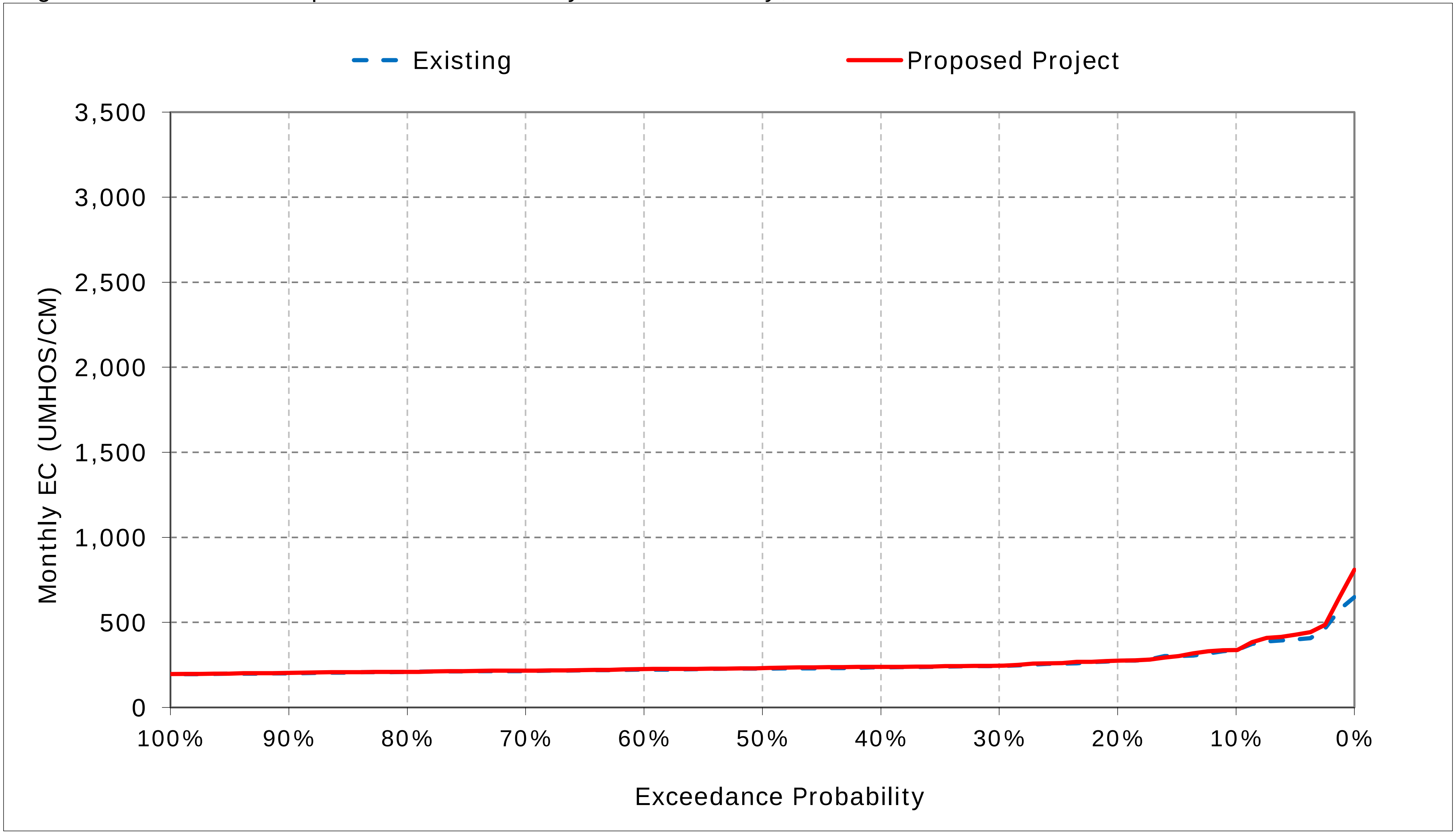


Figure 12-10. San Joaquin River at Jersey Point Salinity, April EC

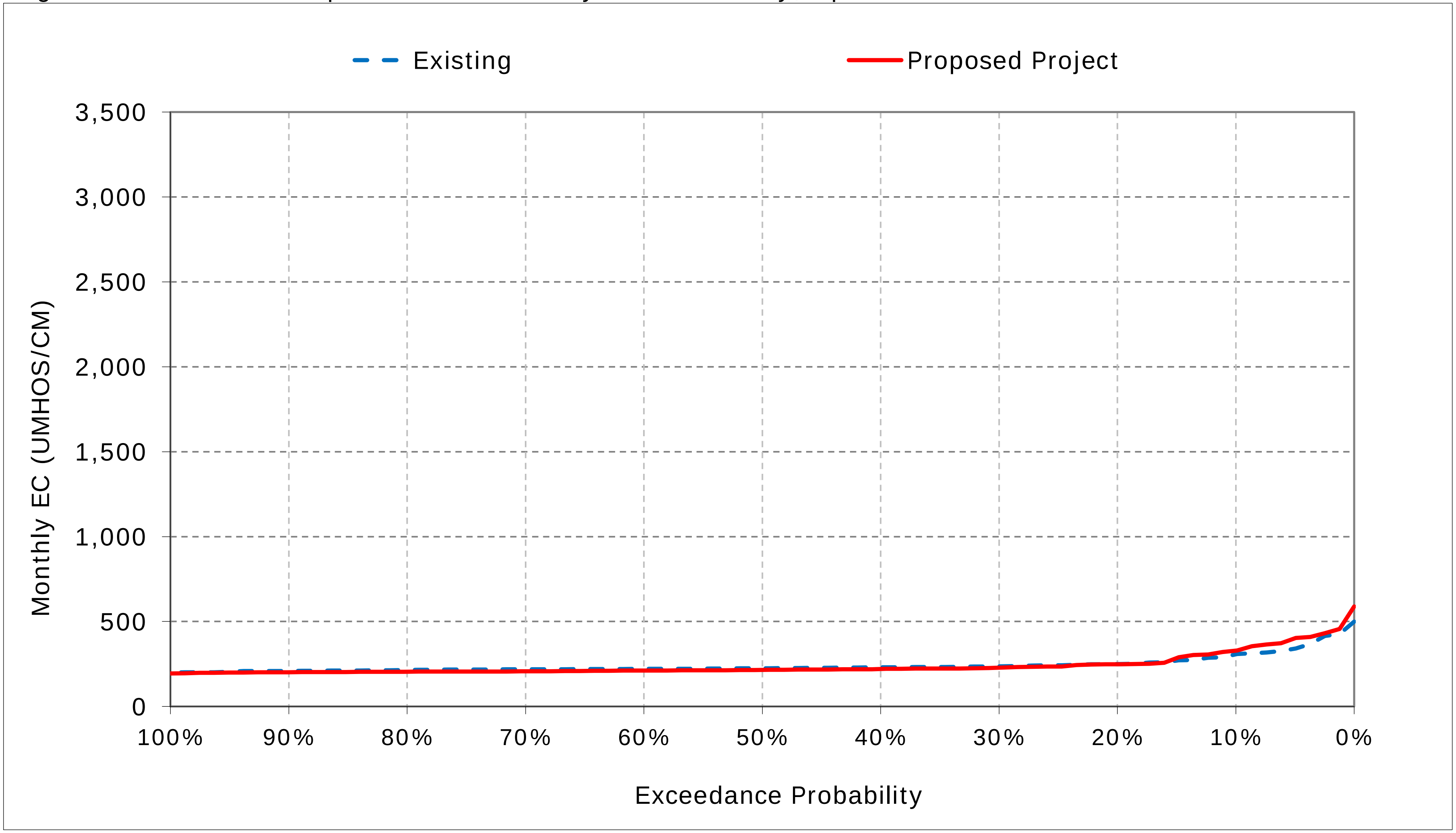


Figure 12-11. San Joaquin River at Jersey Point Salinity, May EC

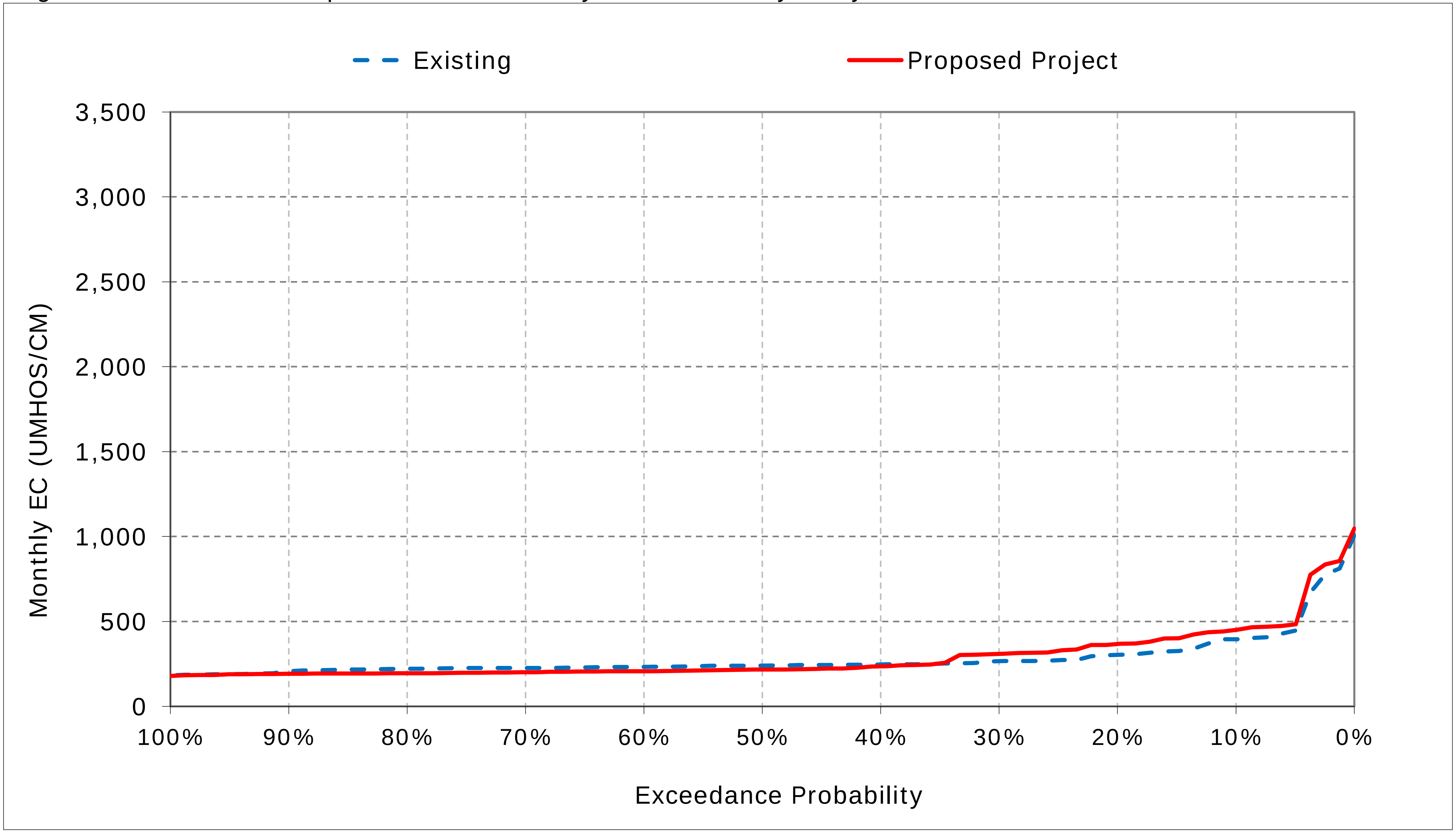


Figure 12-12. San Joaquin River at Jersey Point Salinity, June EC

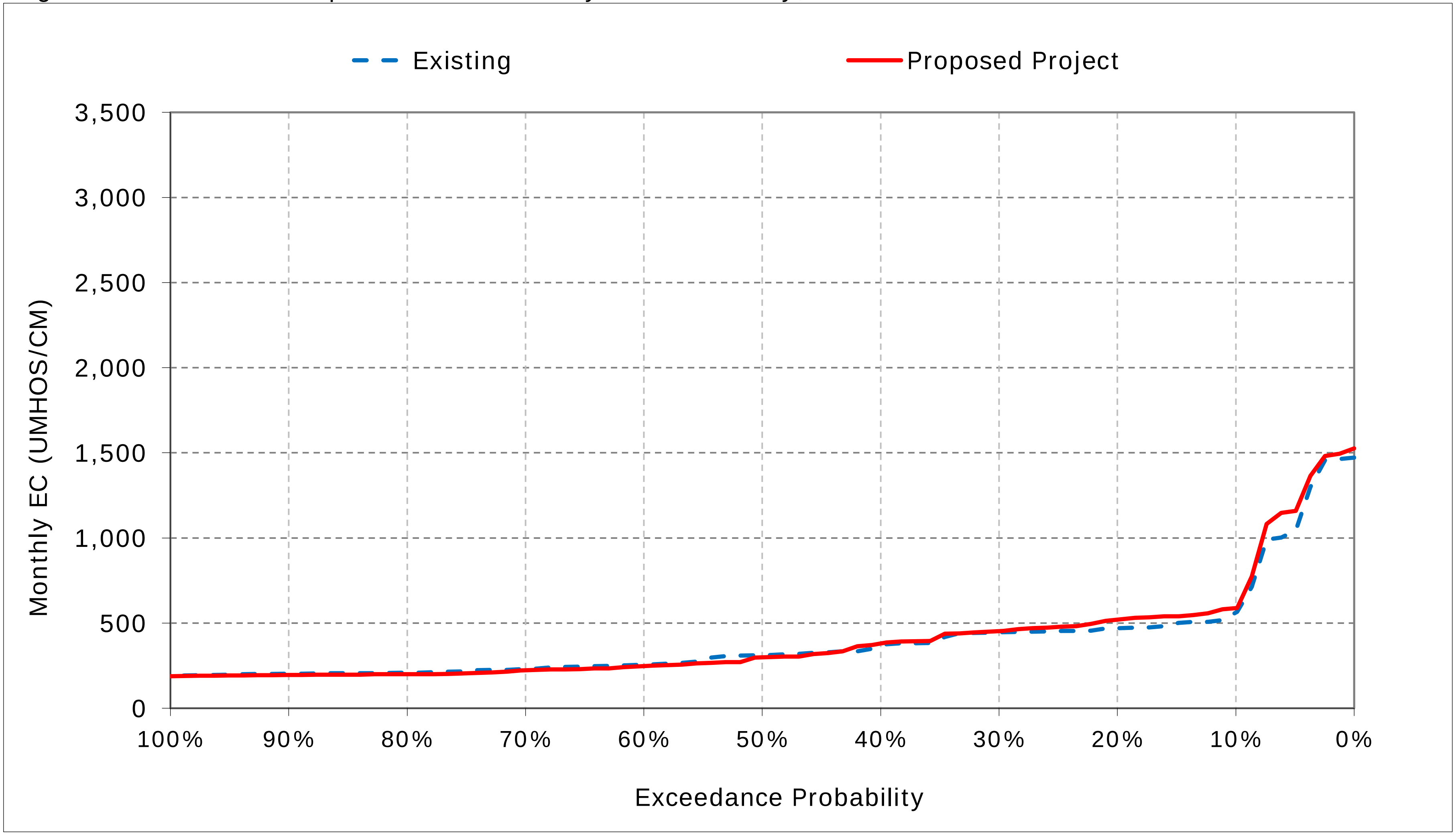


Figure 12-13. San Joaquin River at Jersey Point Salinity, July EC

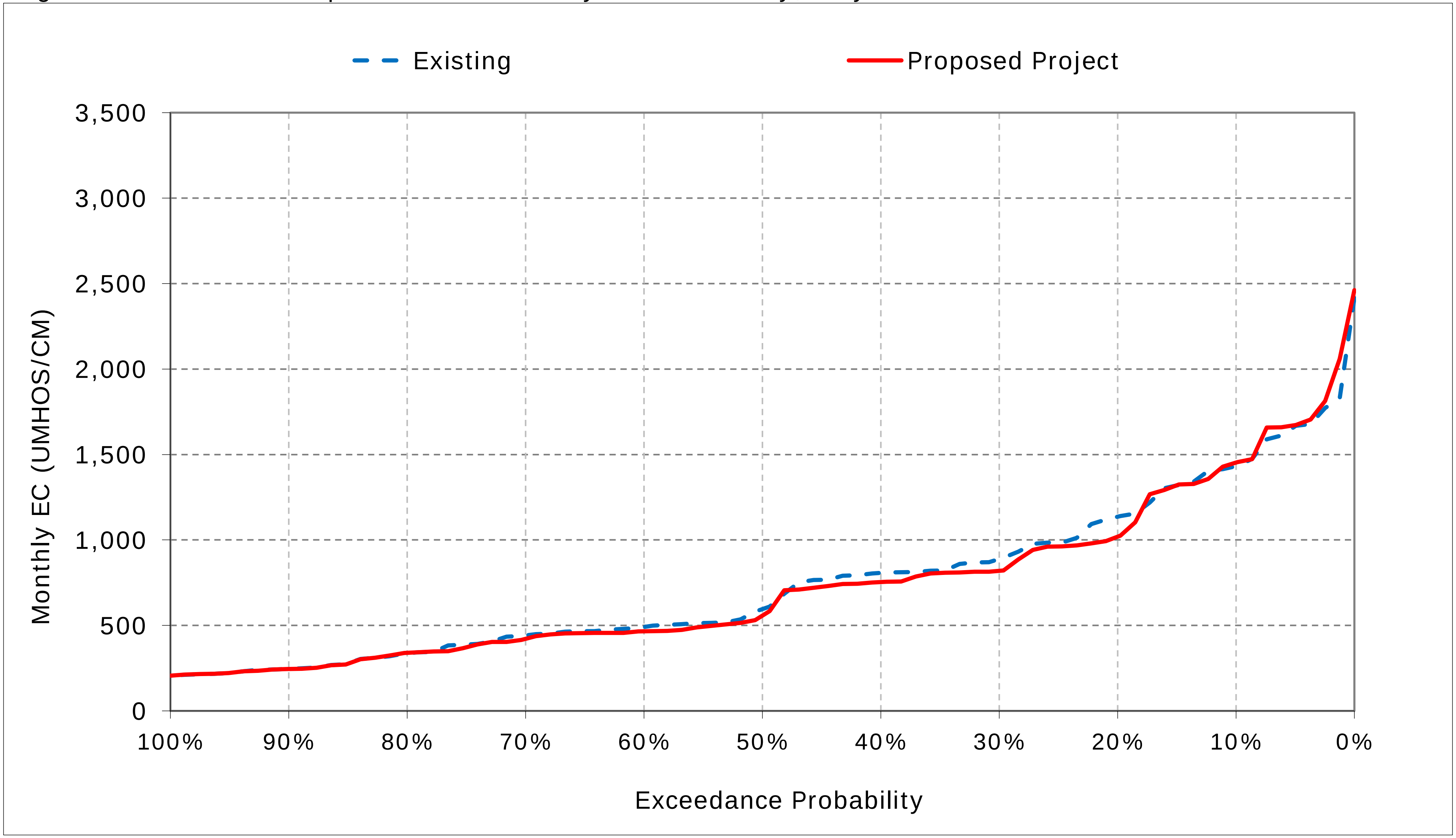


Figure 12-14. San Joaquin River at Jersey Point Salinity, August EC

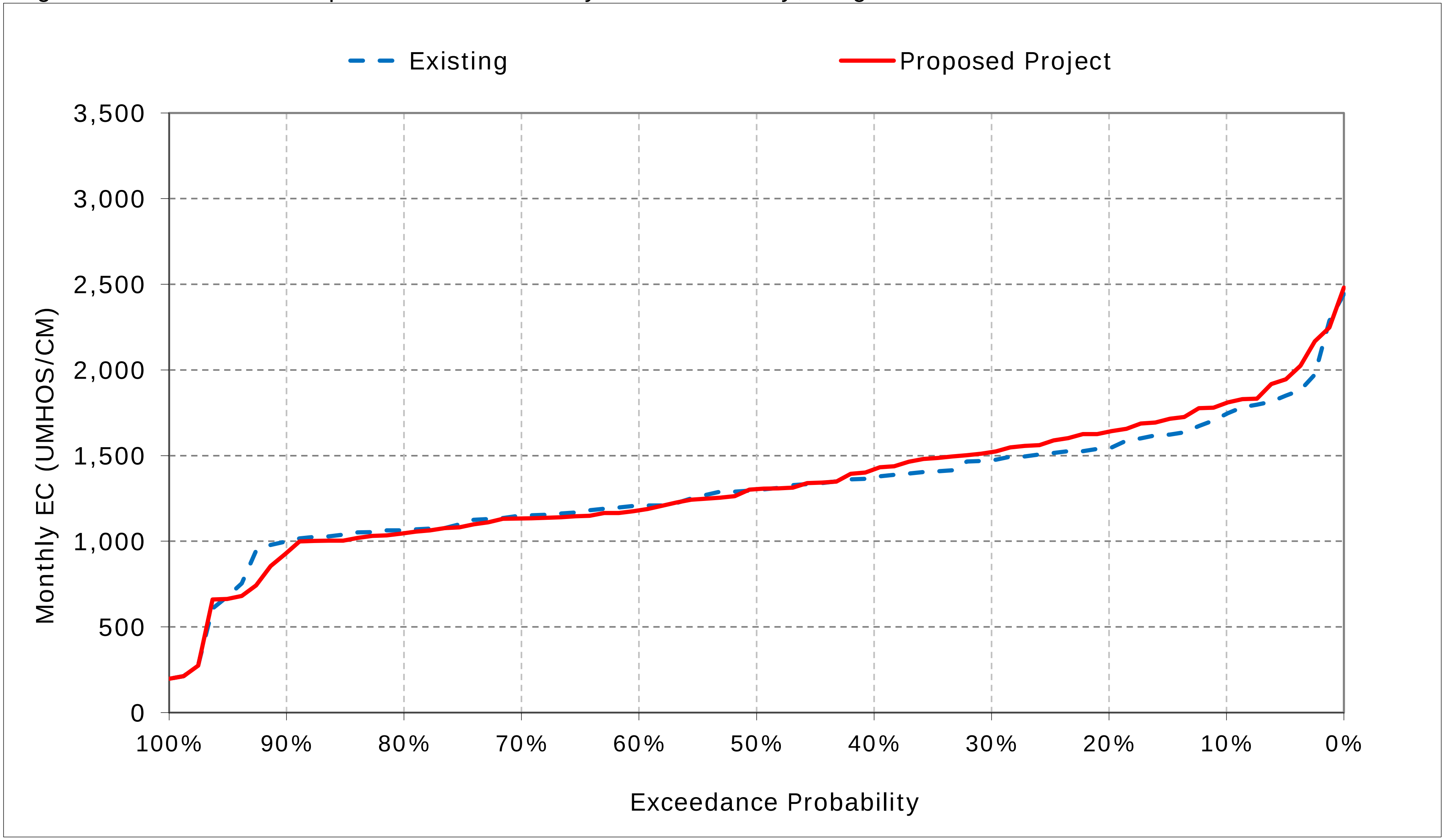


Figure 12-15. San Joaquin River at Jersey Point Salinity, September EC

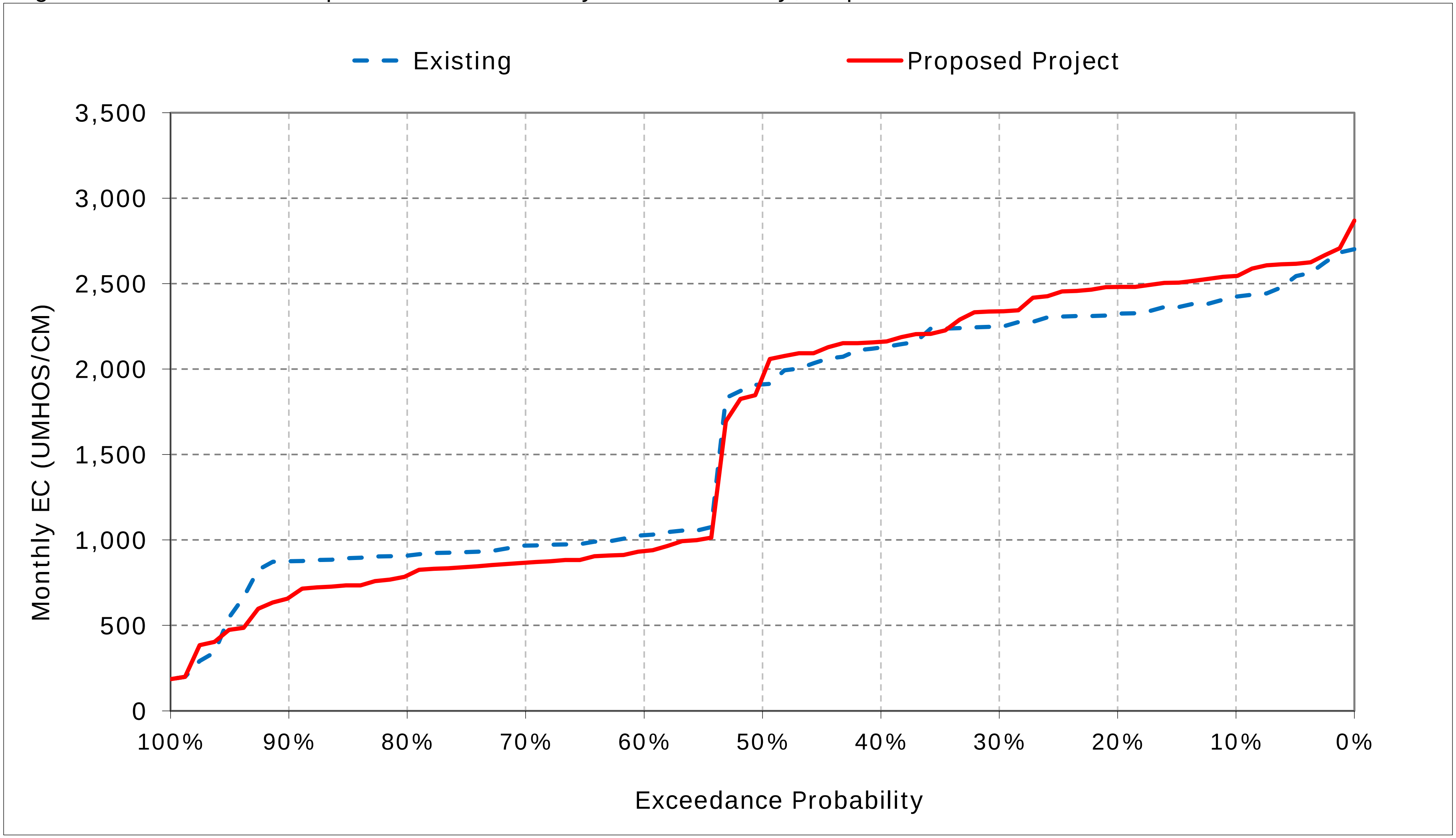


Figure 12-16. San Joaquin River at Jersey Point Salinity, October EC

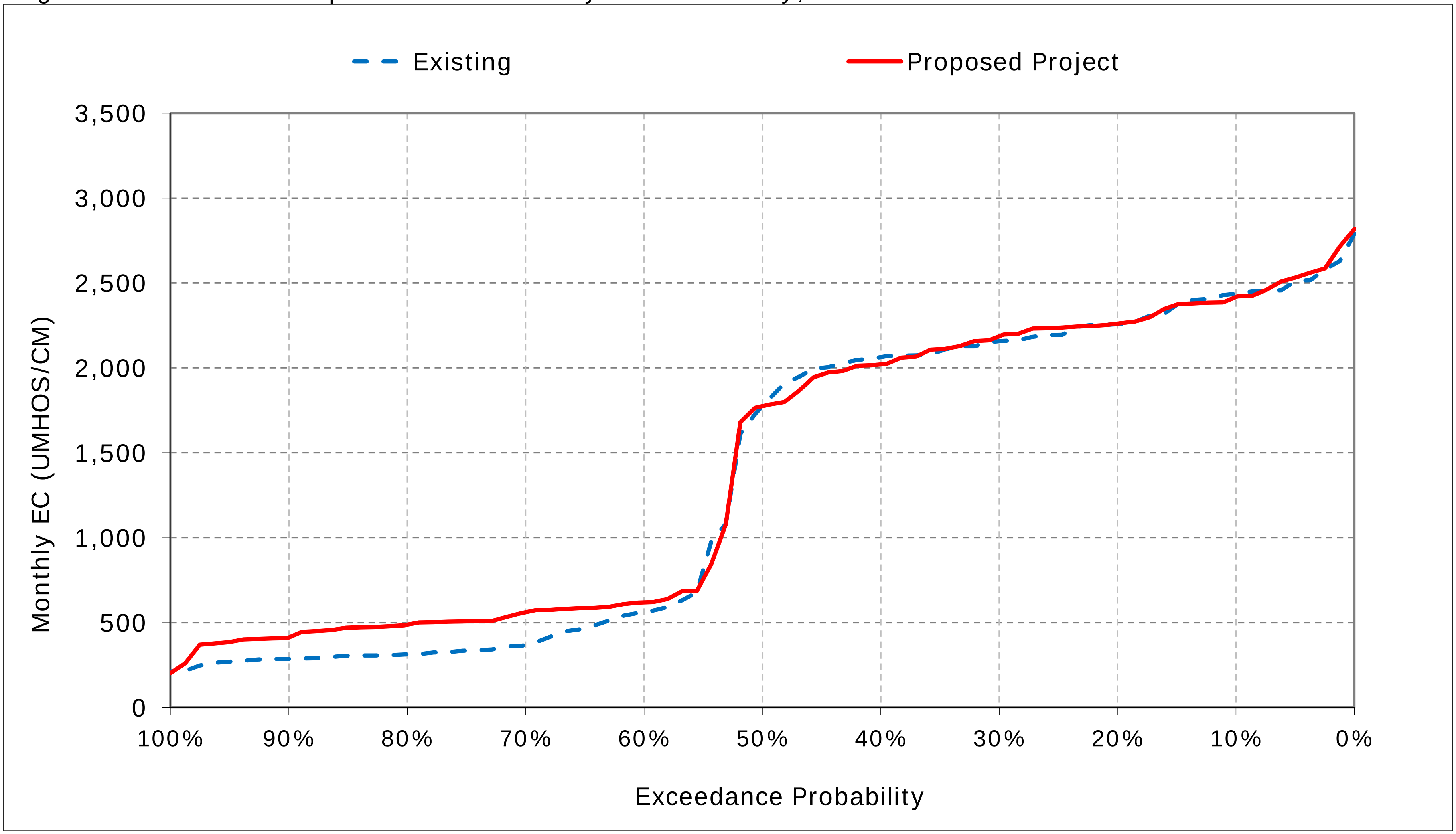


Figure 12-17. San Joaquin River at Jersey Point Salinity, November EC

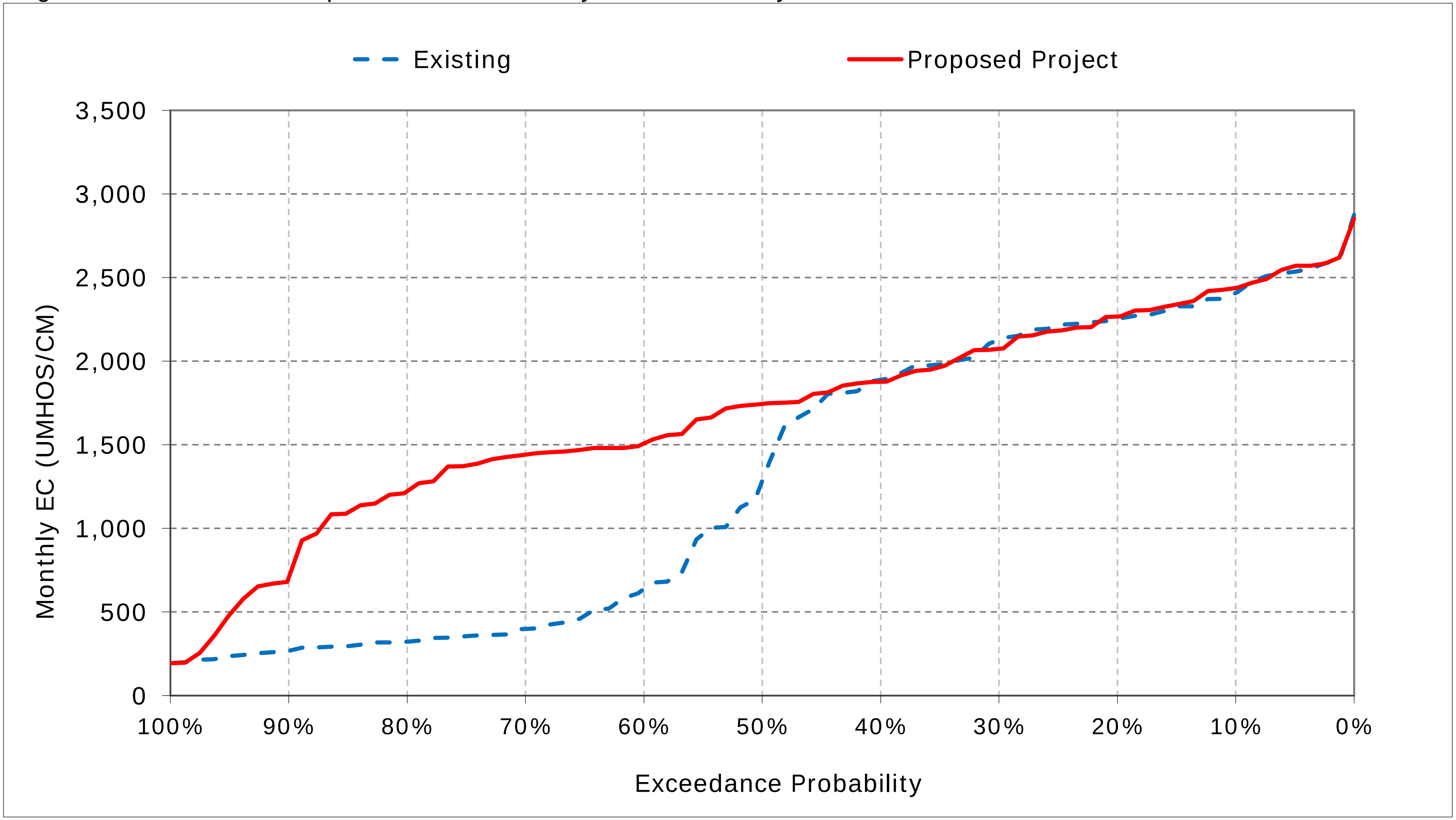


Figure 12-18. San Joaquin River at Jersey Point Salinity, December EC

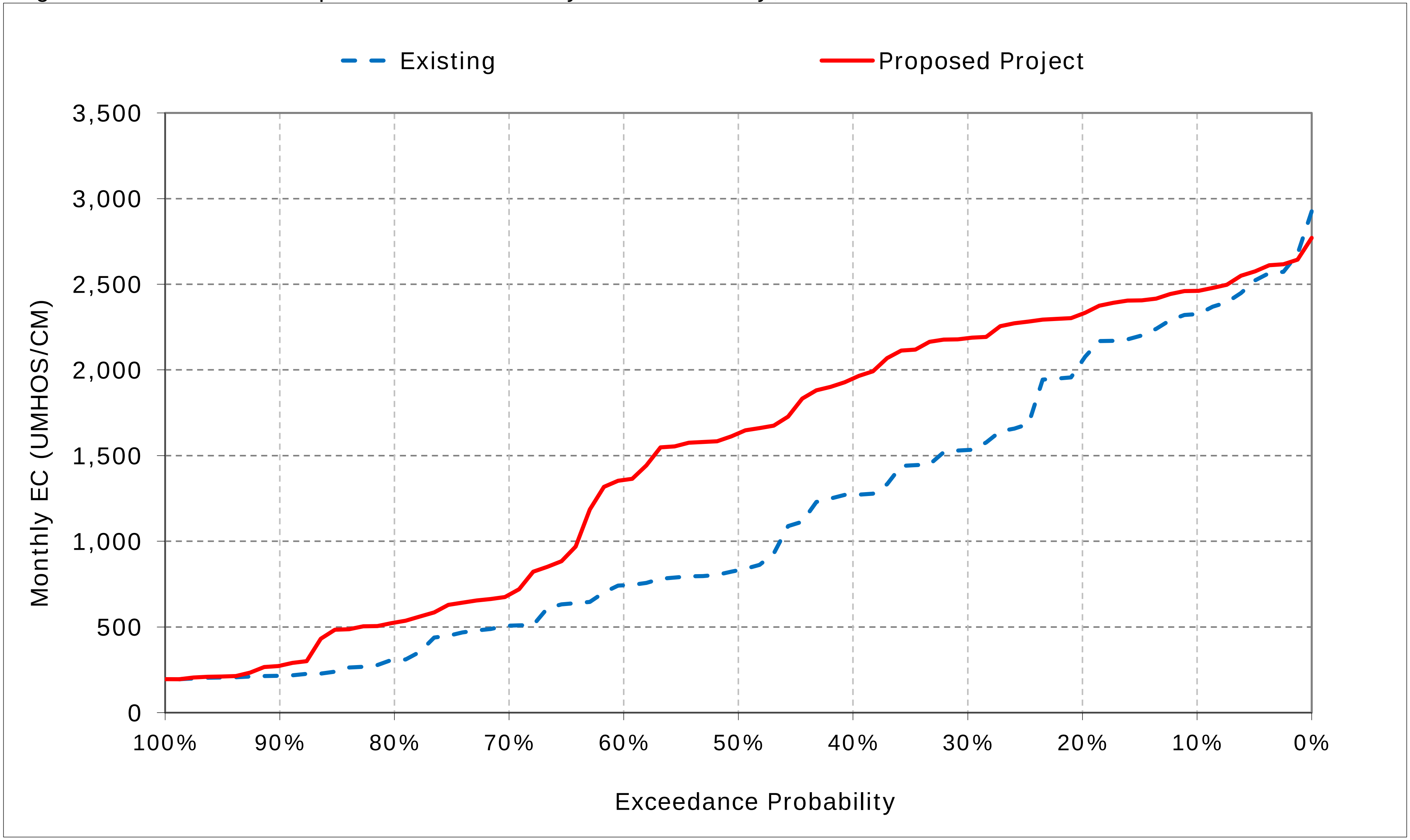


Table 13-1. San Joaquin River at San Andreas, Monthly EC

Existing

Statistic	Monthly EC (UMHOS/CM) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	652	638	694	569	318	233	241	246	236	360	470	586
20%	584	586	652	496	274	227	232	241	219	301	424	567
30%	564	560	581	414	245	217	226	237	215	267	391	539
40%	544	523	470	362	232	211	222	232	210	255	359	516
50%	500	422	322	308	227	206	217	224	206	220	341	470
60%	219	258	290	258	219	202	212	217	202	210	322	411
70%	213	215	263	230	208	197	208	214	194	204	292	372
80%	207	204	223	212	199	194	205	203	192	197	284	304
90%	203	198	195	202	195	191	192	185	188	193	272	272
Long Term												
Full Simulation Period[a]	410	409	419	353	244	212	218	225	217	259	351	448
Water Year Types[b]												
Wet (32%)	340	325	268	226	205	198	202	201	193	198	276	349
Above Normal (15%)	448	408	416	307	225	203	213	217	202	206	295	282
Below Normal (17%)	412	428	482	384	235	212	223	228	205	244	355	532
Dry (22%)	424	453	472	411	261	214	228	235	216	306	412	527
Critical (15%)	498	499	593	551	331	250	235	265	303	389	478	609

Proposed Project

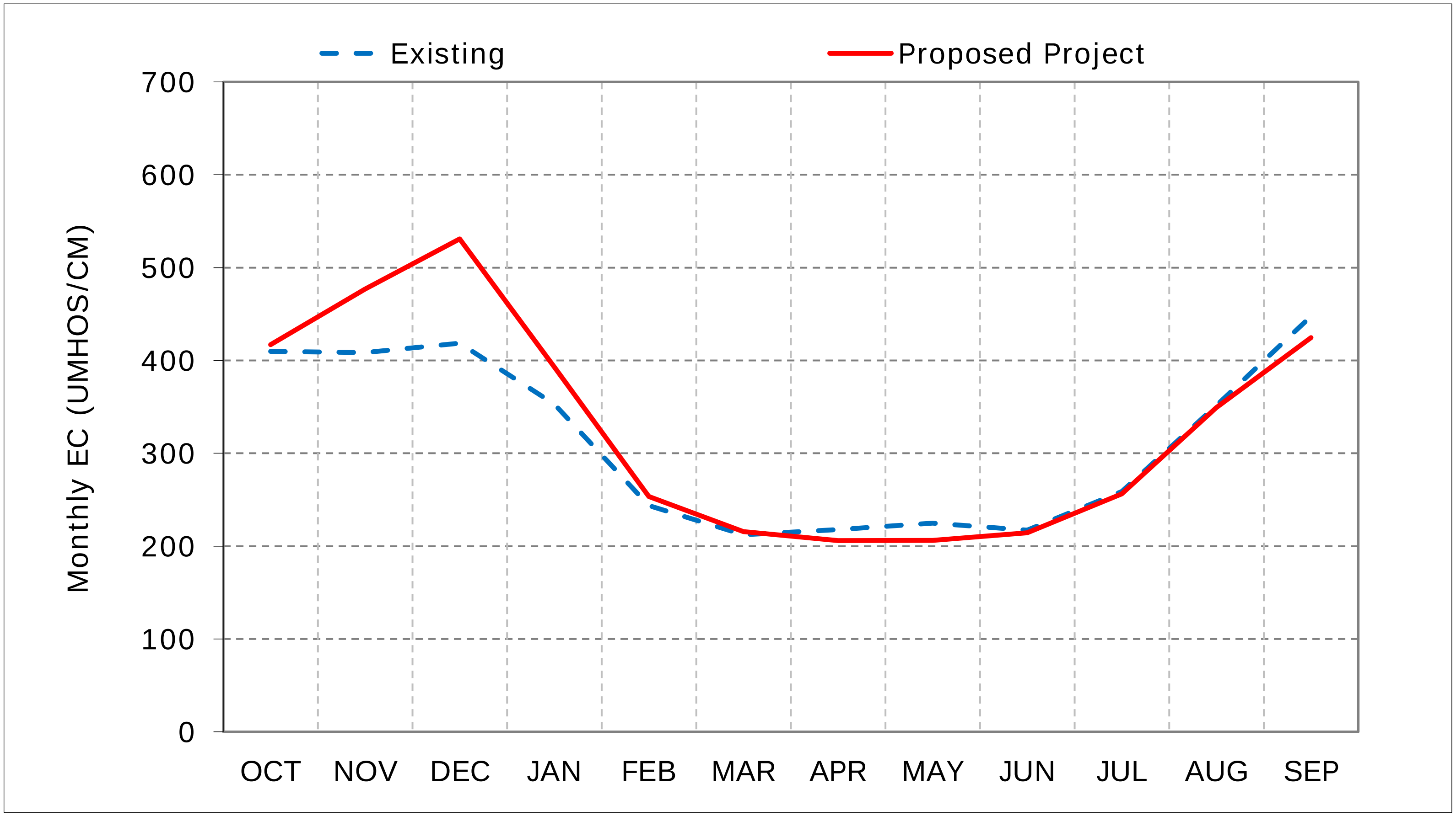
Statistic	Monthly EC (UMHOS/CM) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	638	664	756	681	338	235	224	231	239	364	465	620
20%	608	613	710	566	278	228	219	220	218	289	418	585
30%	575	572	695	502	250	219	212	211	213	264	386	566
40%	548	532	637	433	233	214	205	204	204	241	366	523
50%	527	491	608	309	229	208	203	200	195	217	336	476
60%	240	410	545	259	221	203	199	193	192	208	313	284
70%	218	375	337	232	208	199	196	190	189	202	289	268
80%	210	338	283	213	201	196	193	185	188	198	281	260
90%	201	278	209	202	195	193	188	179	185	193	256	246
Long Term												
Full Simulation Period[a]	417	477	531	393	253	216	206	206	214	256	349	425
Water Year Types[b]												
Wet (32%)	348	408	344	235	205	199	193	186	189	198	268	248
Above Normal (15%)	455	502	587	365	230	206	199	192	193	204	295	271
Below Normal (17%)	420	489	599	421	235	213	206	201	197	232	358	572
Dry (22%)	429	504	611	487	278	218	211	212	214	300	406	534
Critical (15%)	505	548	679	589	367	261	234	261	310	397	483	625

Proposed Project minus Existing

Statistic	Monthly EC (UMHOS/CM) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-14	26	62	112	21	2	-18	-16	3	4	-4	34
20%	23	27	58	70	4	1	-14	-21	0	-11	-6	18
30%	11	12	114	88	5	2	-15	-27	-2	-3	-5	27
40%	4	9	167	72	2	3	-16	-28	-6	-14	7	7
50%	27	69	286	1	2	2	-14	-23	-11	-3	-5	6
60%	20	152	254	1	2	1	-13	-24	-10	-2	-9	-126
70%	5	161	74	2	0	3	-12	-25	-4	-2	-3	-104
80%	3	134	60	0	2	2	-11	-19	-5	0	-4	-44
90%	-2	80	14	0	0	2	-4	-5	-4	0	-16	-26
Long Term												
Full Simulation Period[a]	7	68	112	40	10	4	-12	-19	-3	-3	-2	-23
Water Year Types[b]												
Wet (32%)	8	82	76	9	0	1	-9	-15	-3	0	-7	-101
Above Normal (15%)	7	94	172	58	4	3	-15	-24	-9	-1	1	-11
Below Normal (17%)	8	60	116	37	0	1	-17	-28	-7	-13	3	40
Dry (22%)	5	50	140	76	17	4	-17	-23	-2	-6	-6	7
Critical (15%)	6	50	86	38	36	11	-1	-4	7	7	6	15

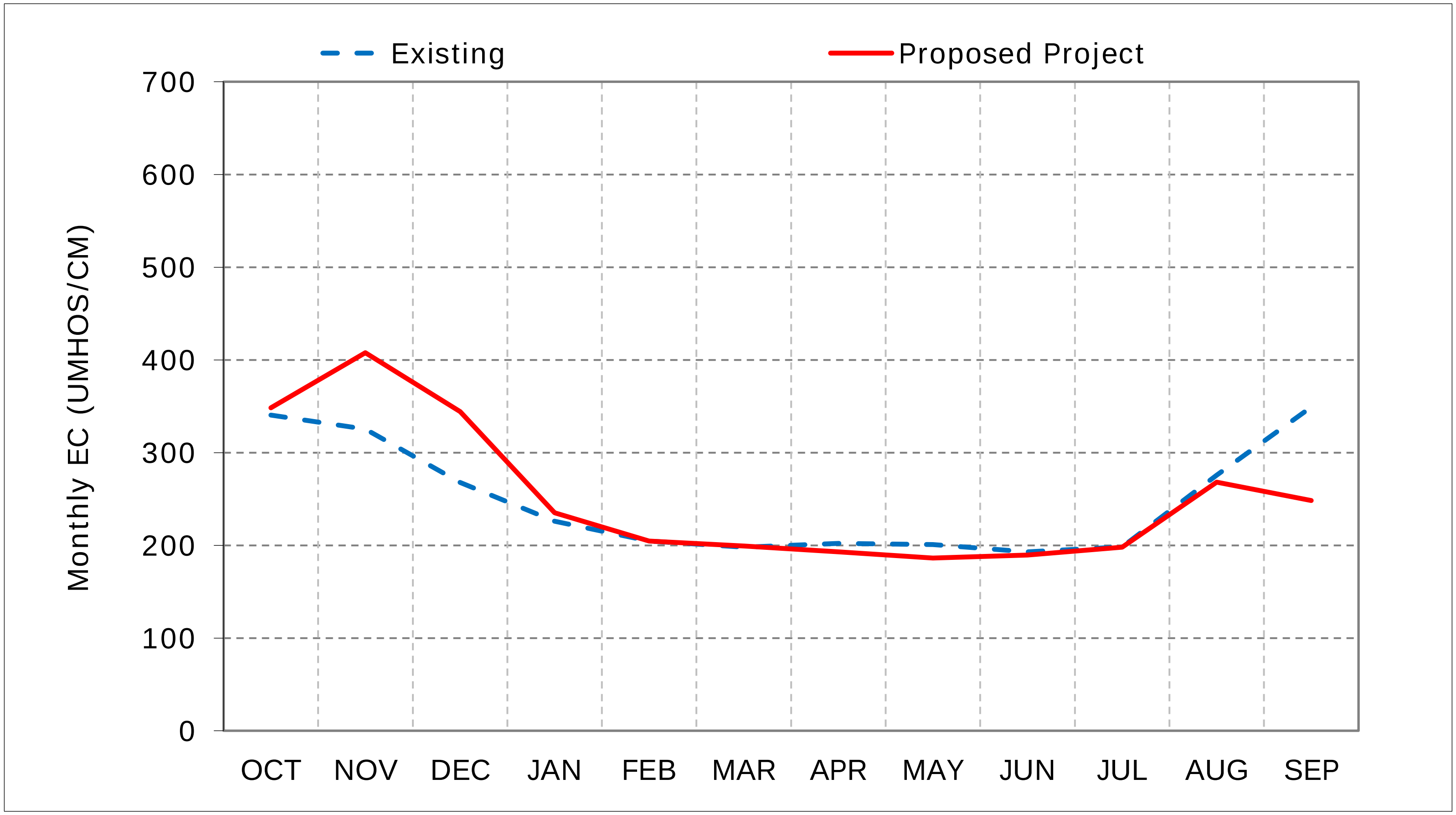
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 13-1. San Joaquin River at San Andreas, Long-Term Average EC



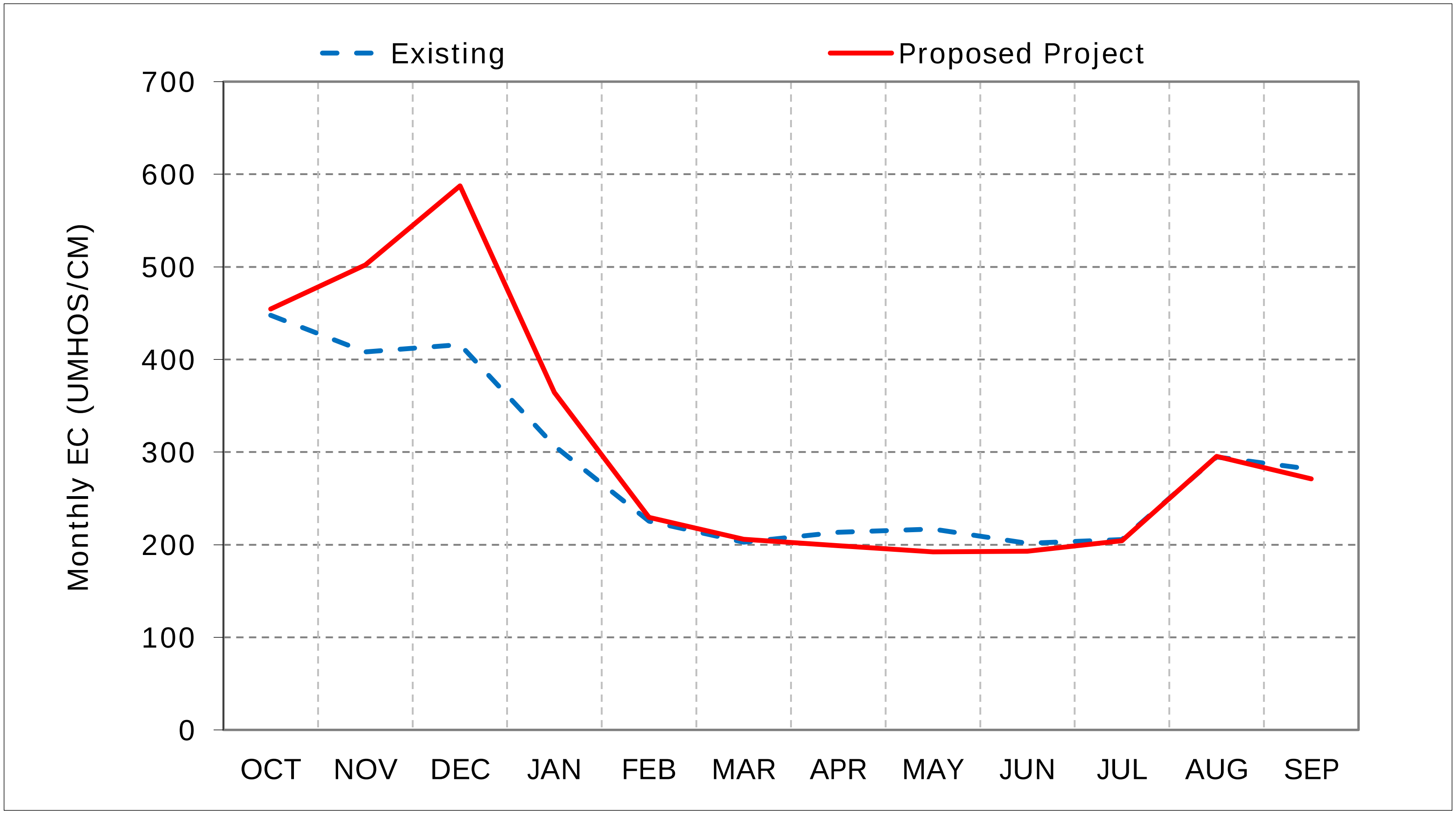
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 13-2. San Joaquin River at San Andreas, Wet Year Average EC



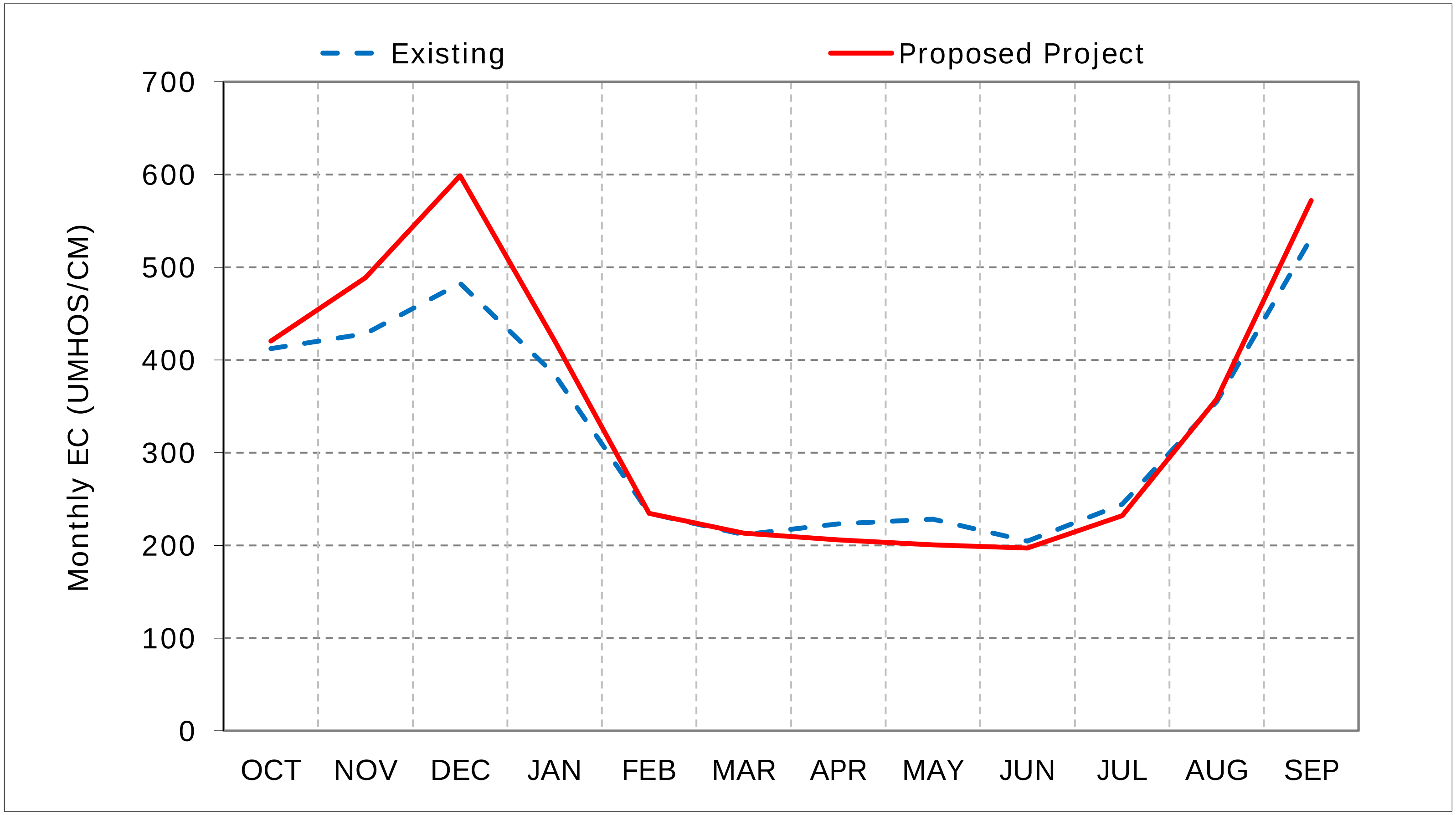
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 13-3. San Joaquin River at San Andreas, Above Normal Year Average EC



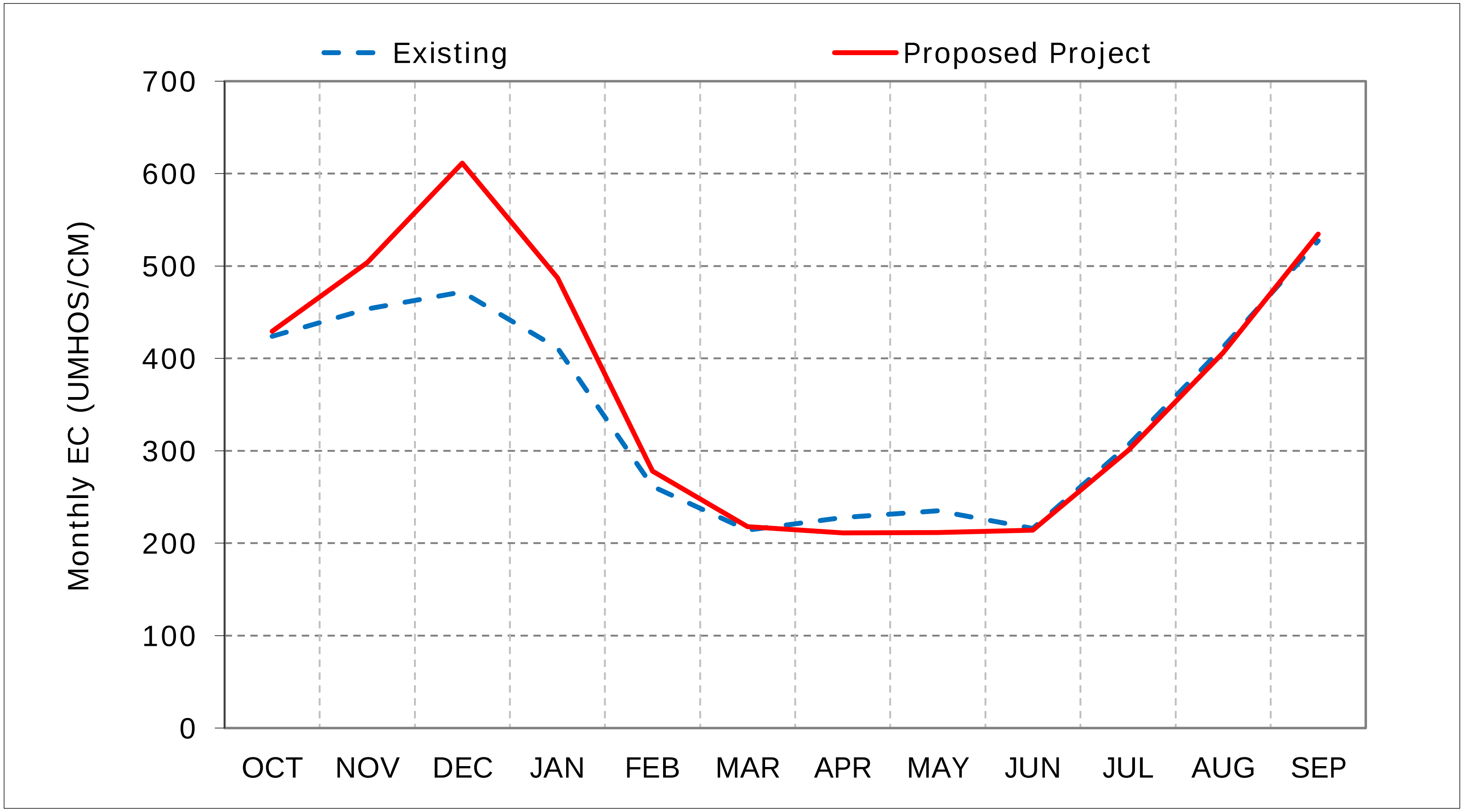
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 13-4. San Joaquin River at San Andreas, Below Normal Year Average EC



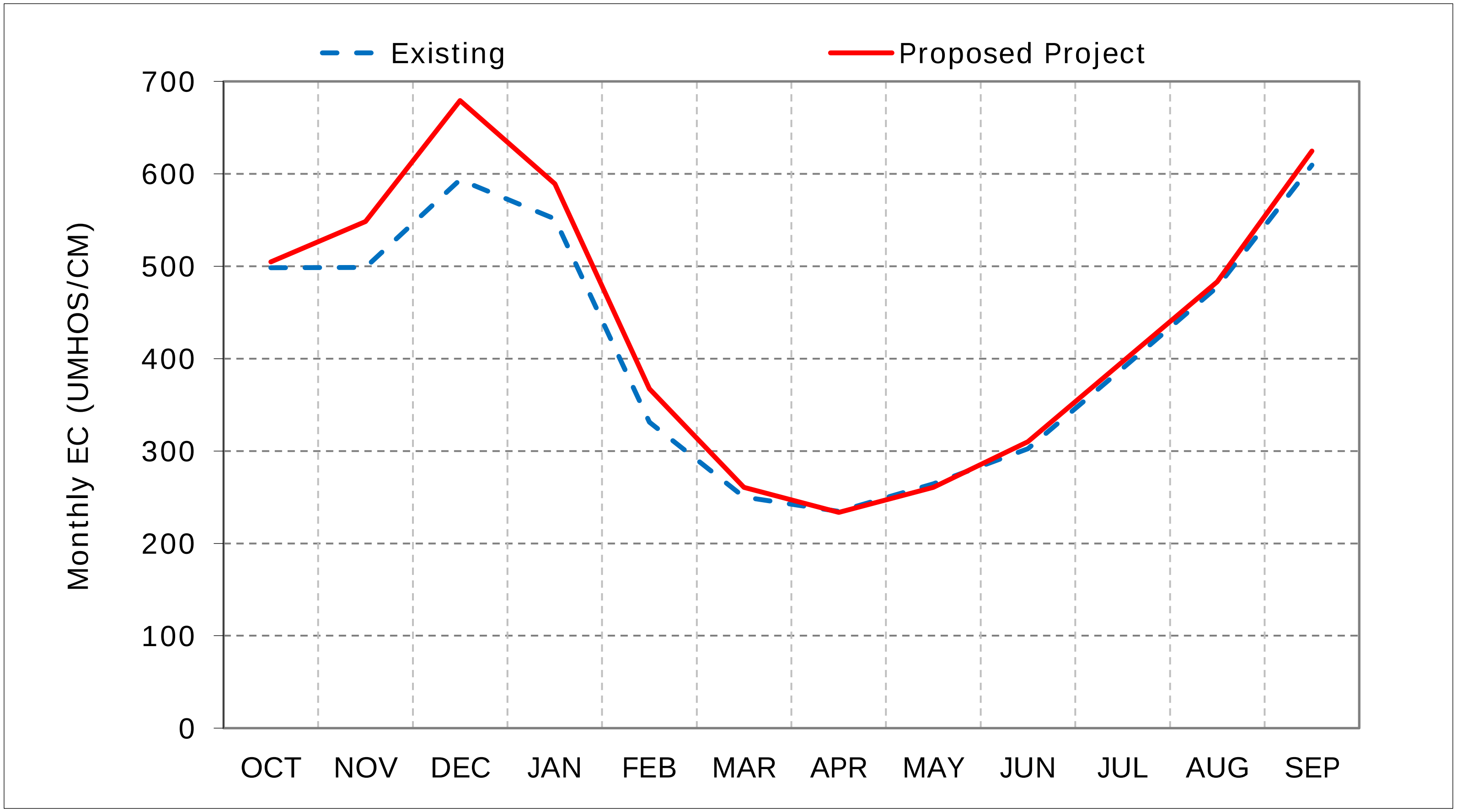
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 13-5. San Joaquin River at San Andreas, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 13-6. San Joaquin River at San Andreas, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 13-7. San Joaquin River at San Andreas, January EC

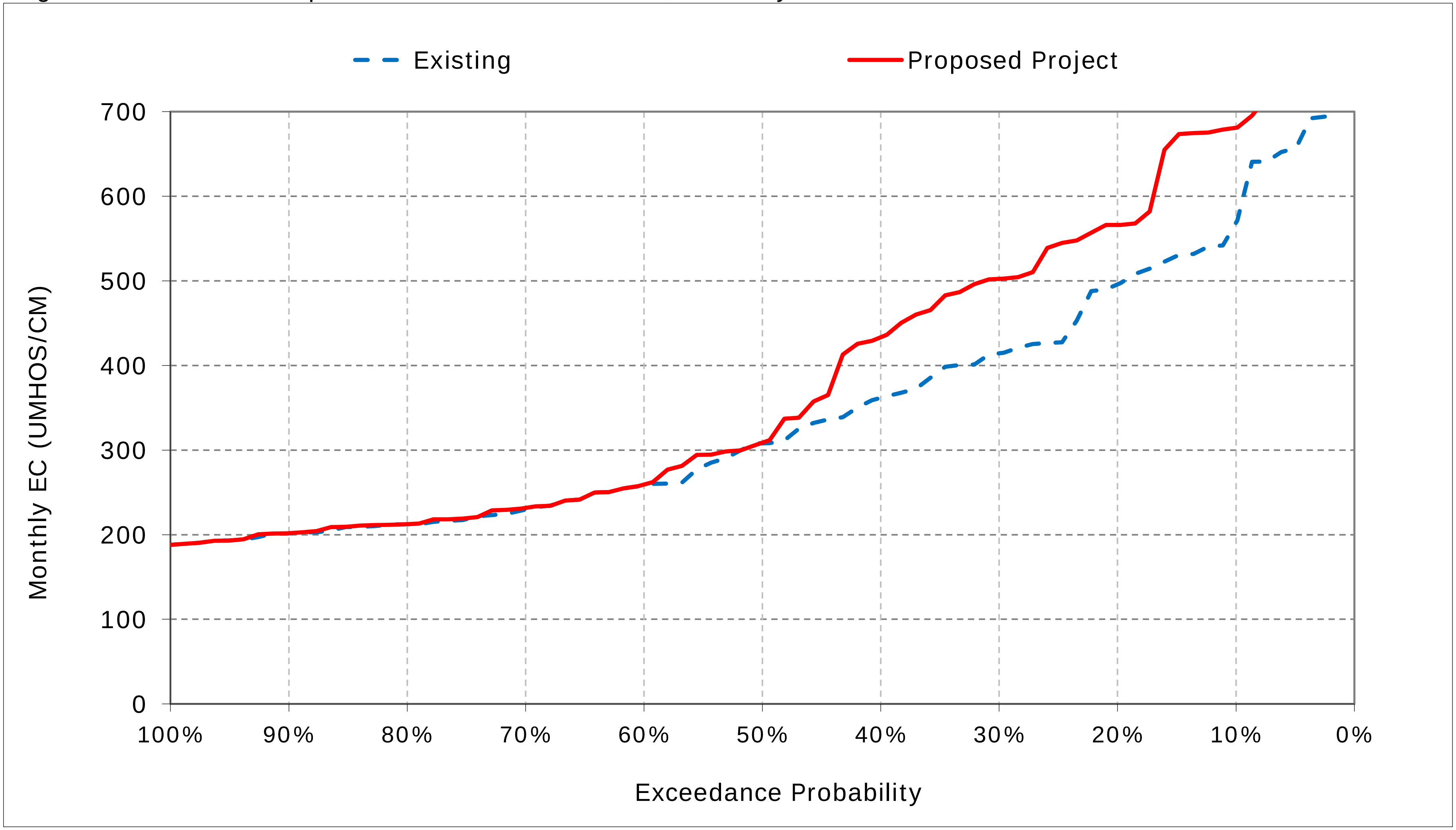


Figure 13-8. San Joaquin River at San Andreas, February EC

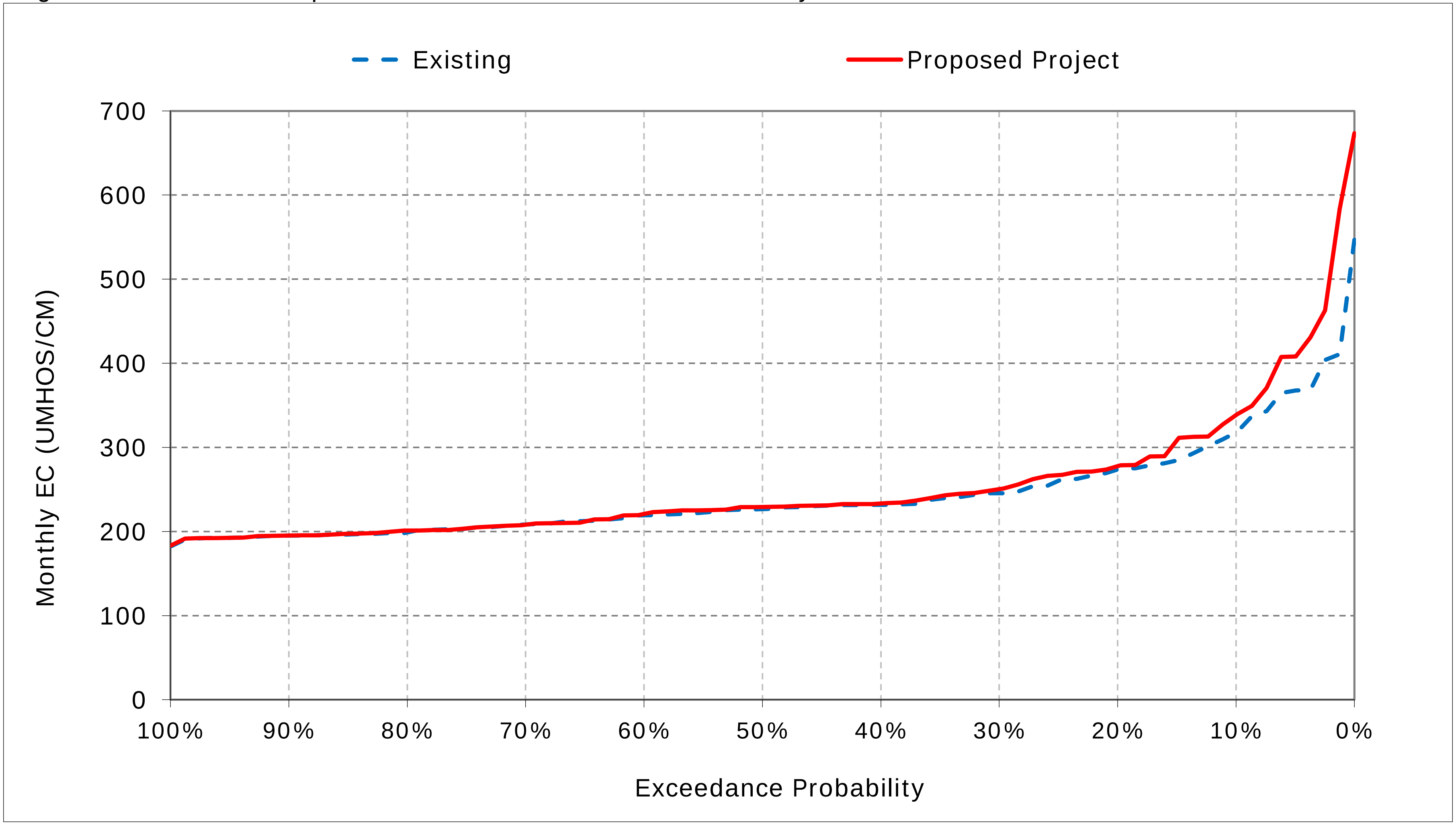


Figure 13-9. San Joaquin River at San Andreas, March EC

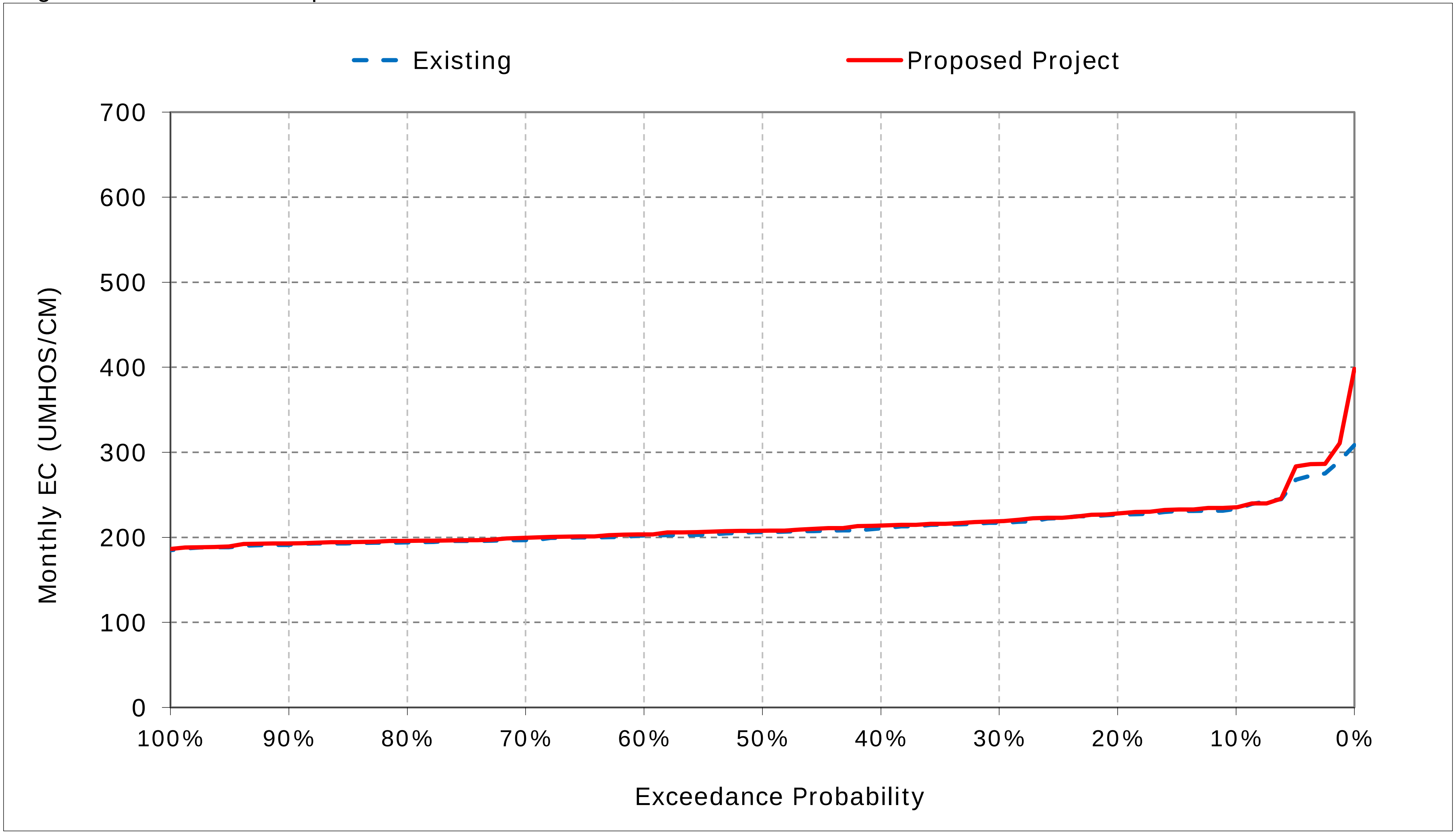


Figure 13-10. San Joaquin River at San Andreas, April EC

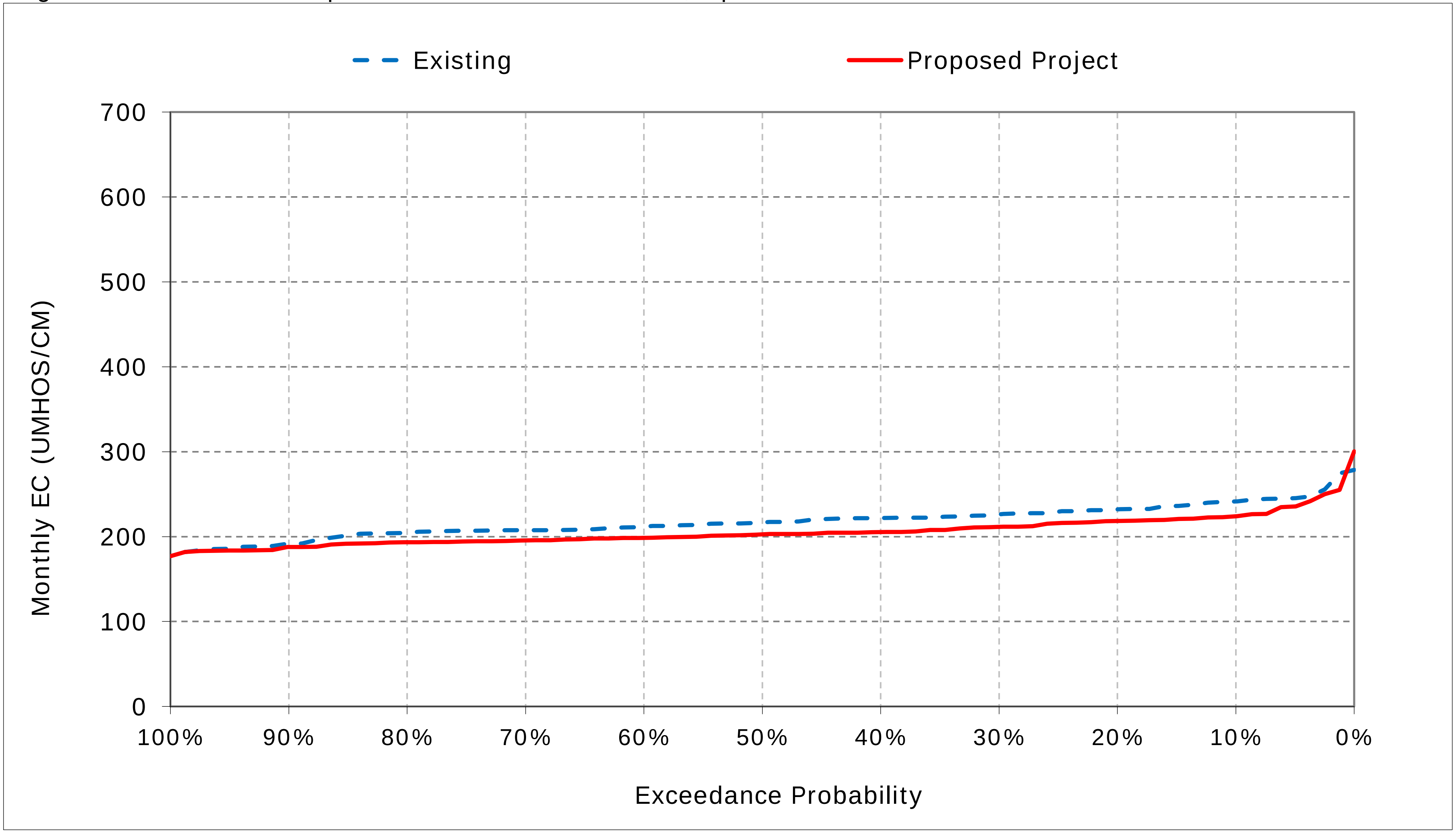


Figure 13-11. San Joaquin River at San Andreas, May EC

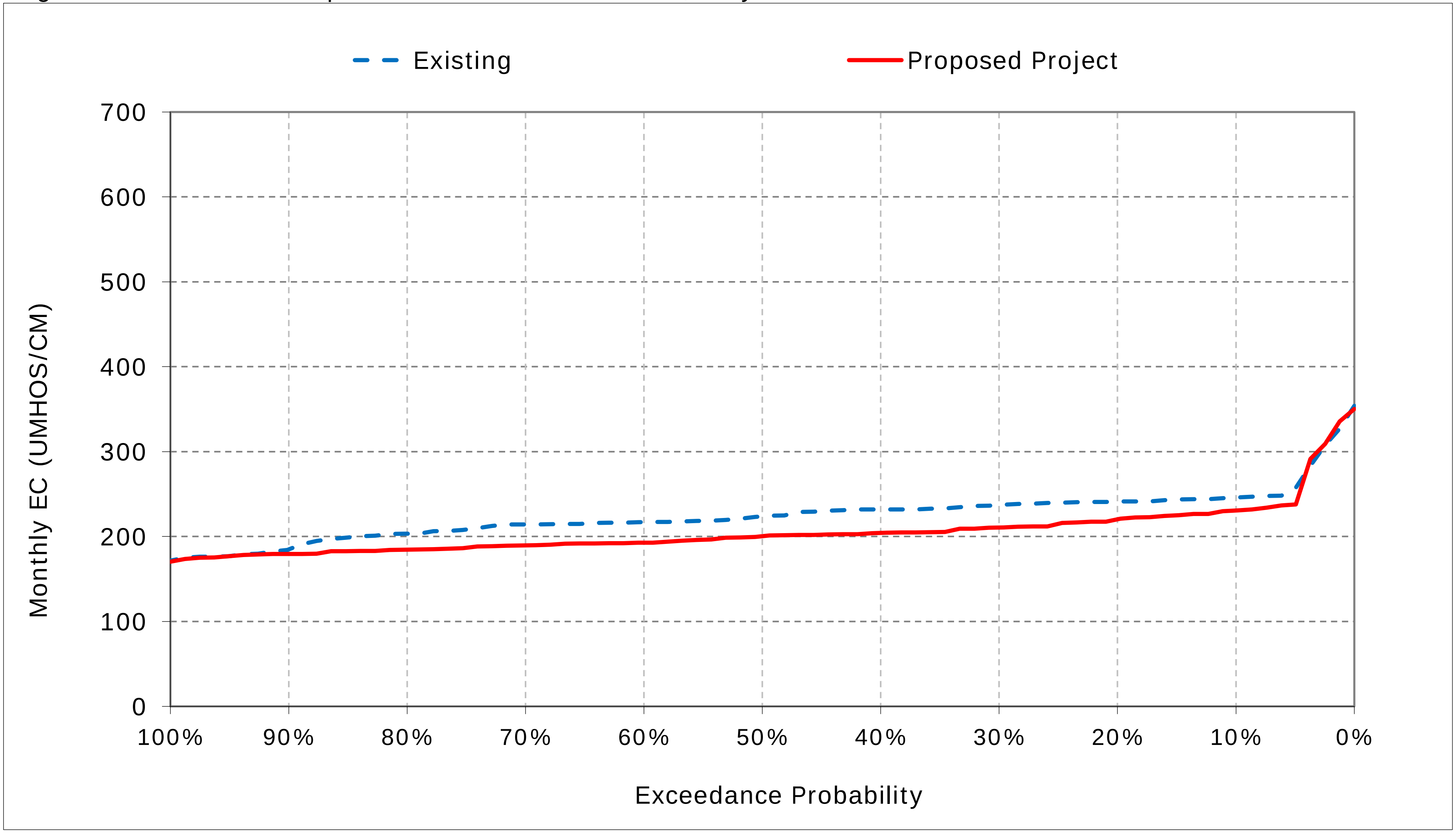


Figure 13-12. San Joaquin River at San Andreas, June EC

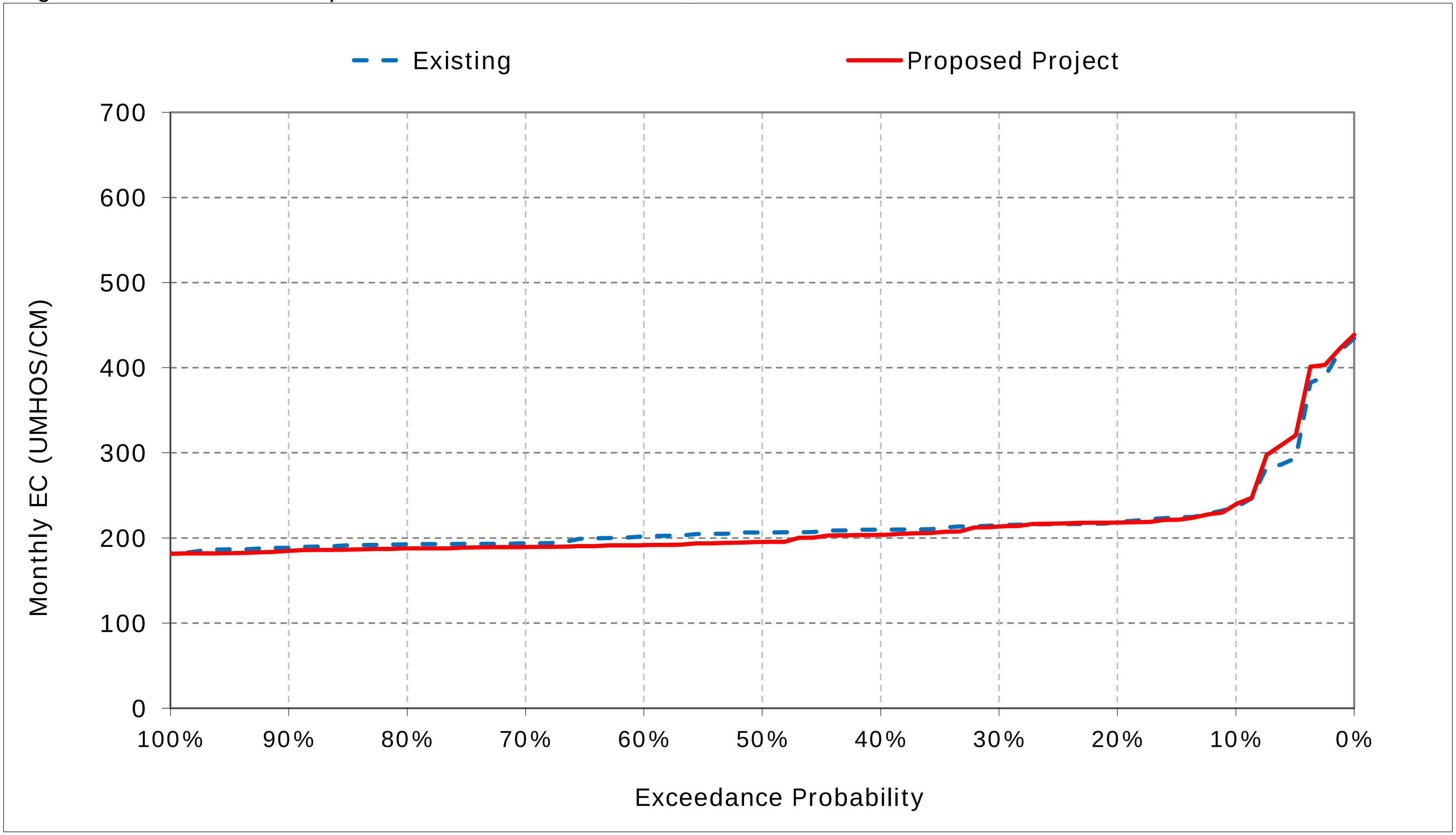


Figure 13-13. San Joaquin River at San Andreas, July EC

Figure 13-14. San Joaquin River at San Andreas, August EC

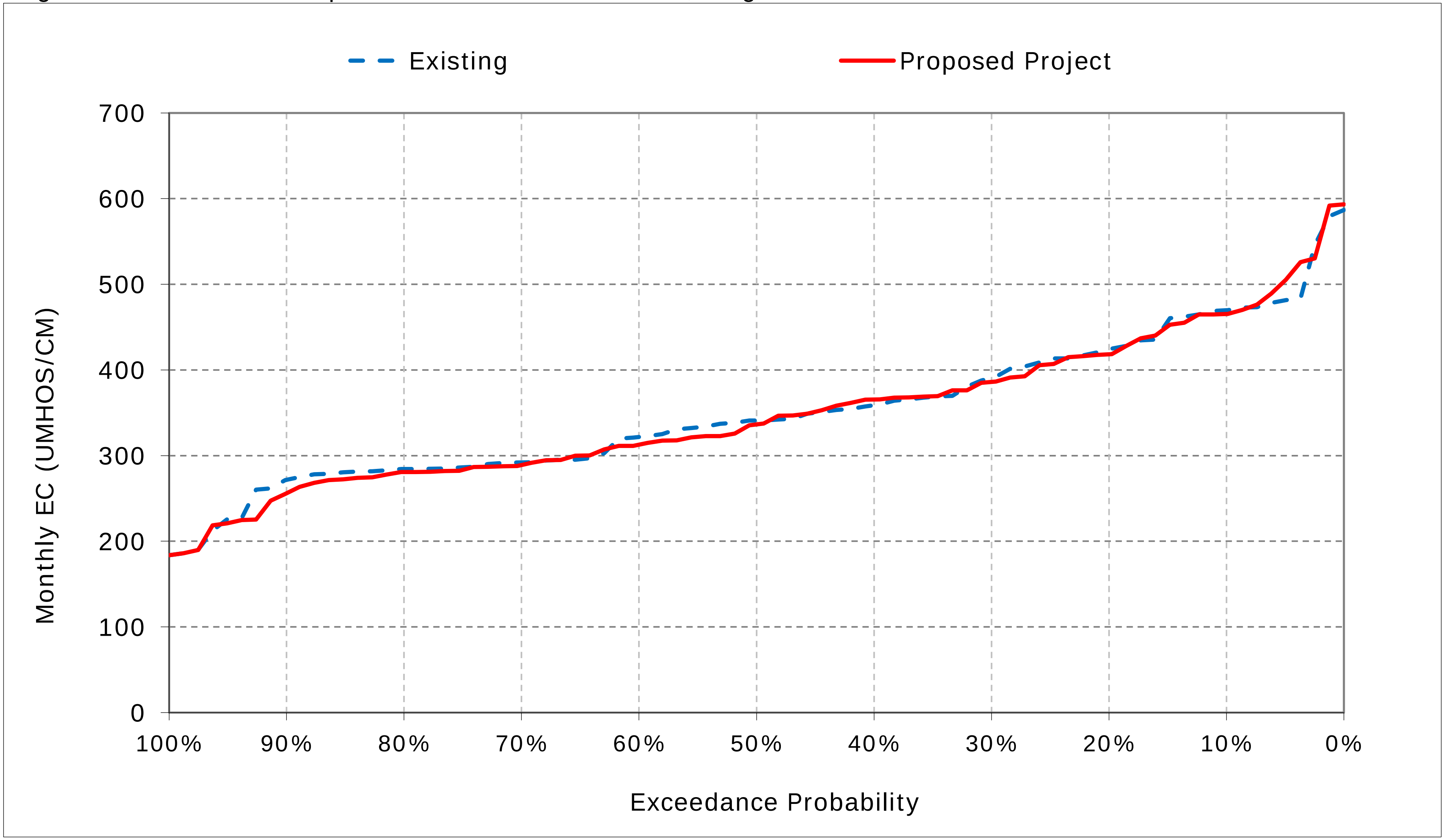


Figure 13-15. San Joaquin River at San Andreas, September EC

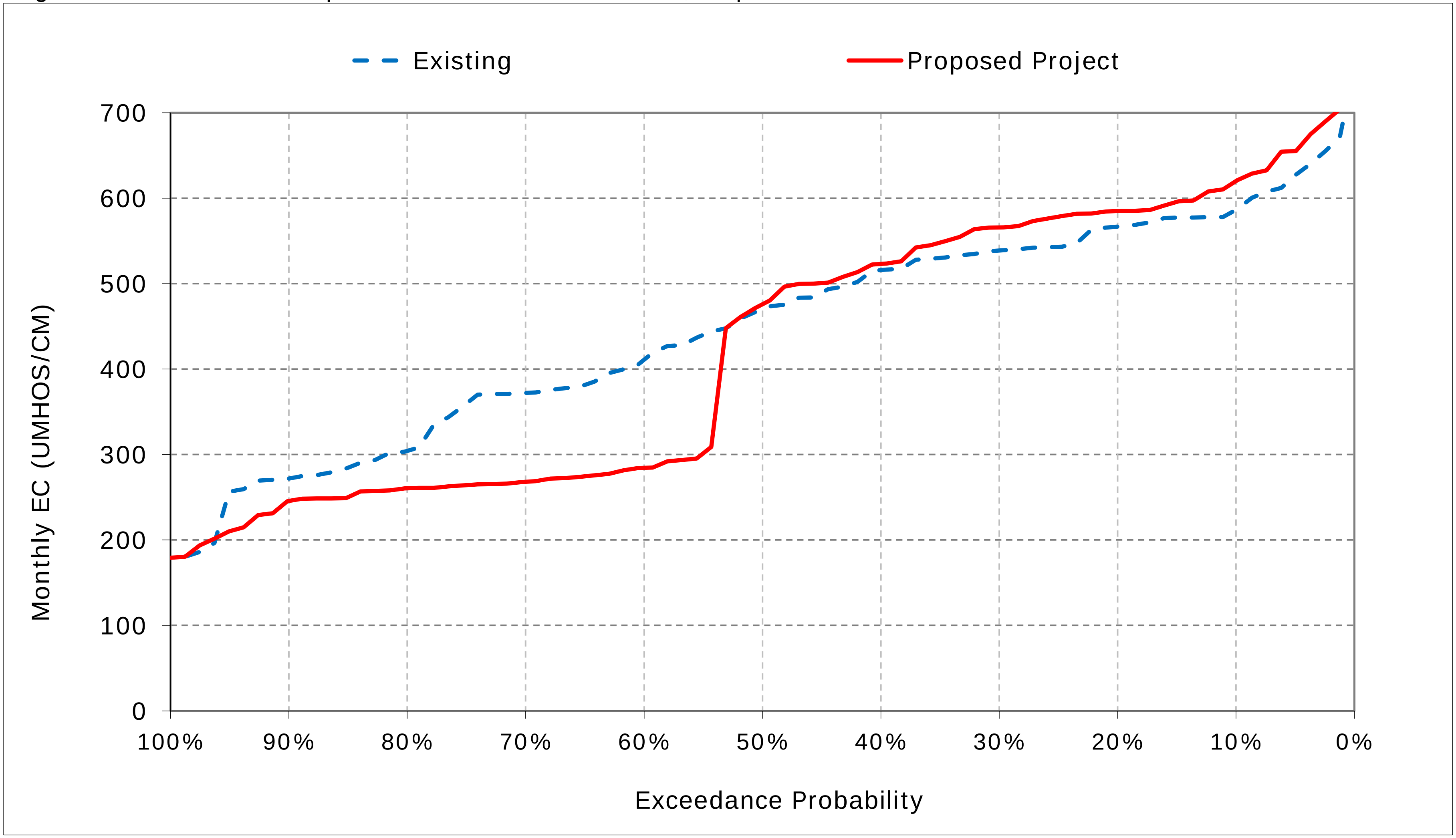


Figure 13-16. San Joaquin River at San Andreas, October EC

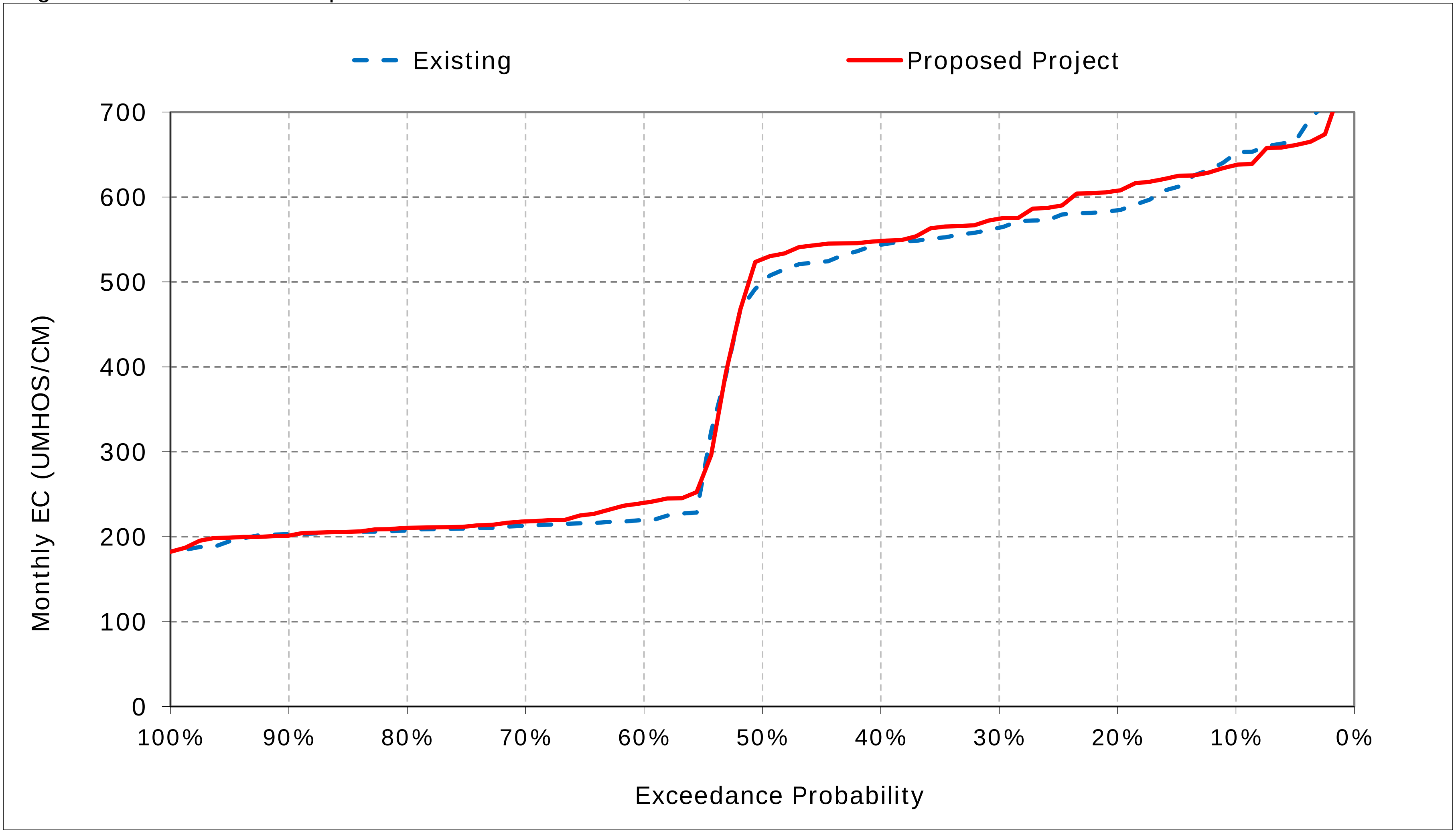


Figure 13-17. San Joaquin River at San Andreas, November EC

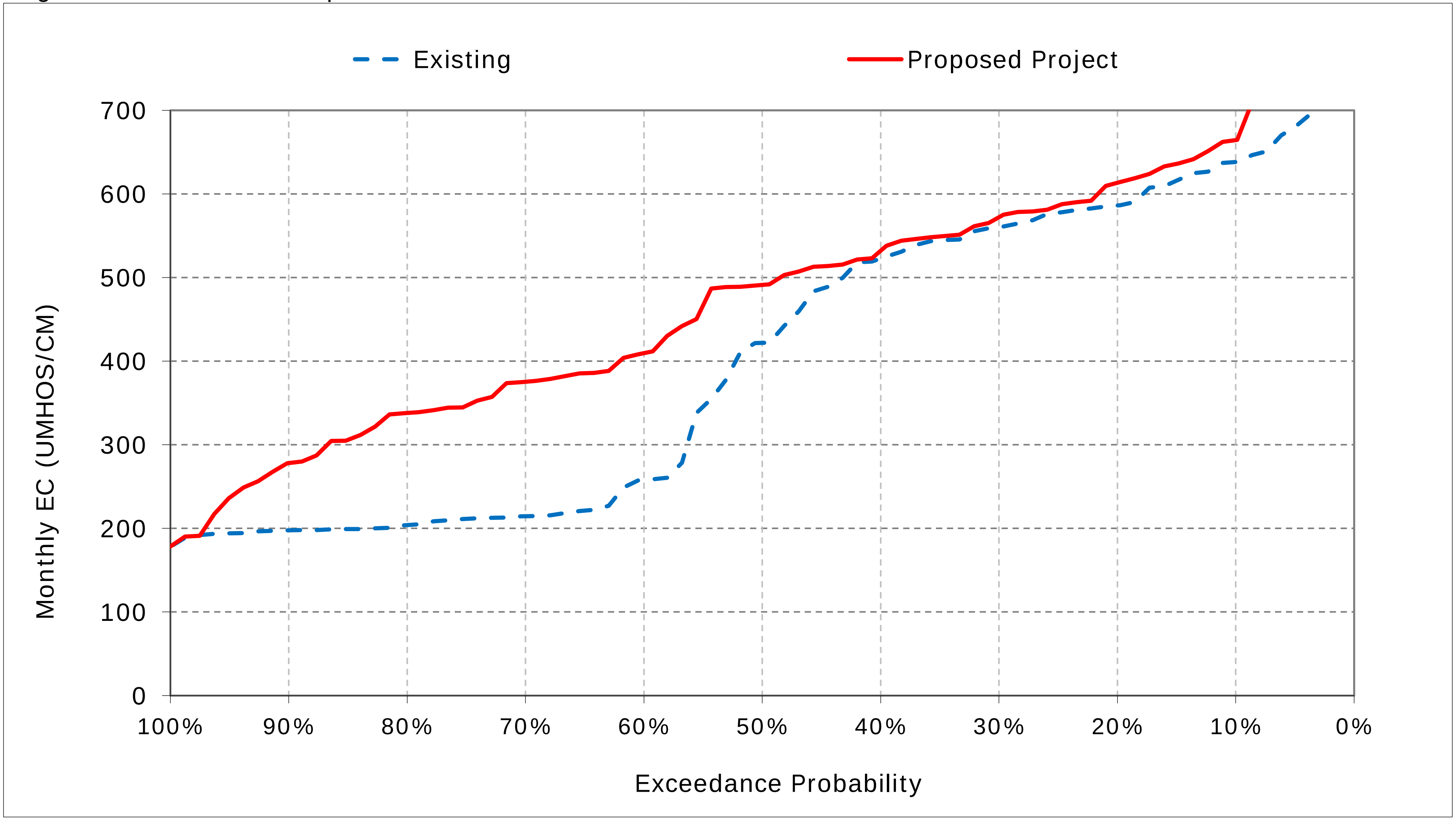


Figure 13-18. San Joaquin River at San Andreas, December EC

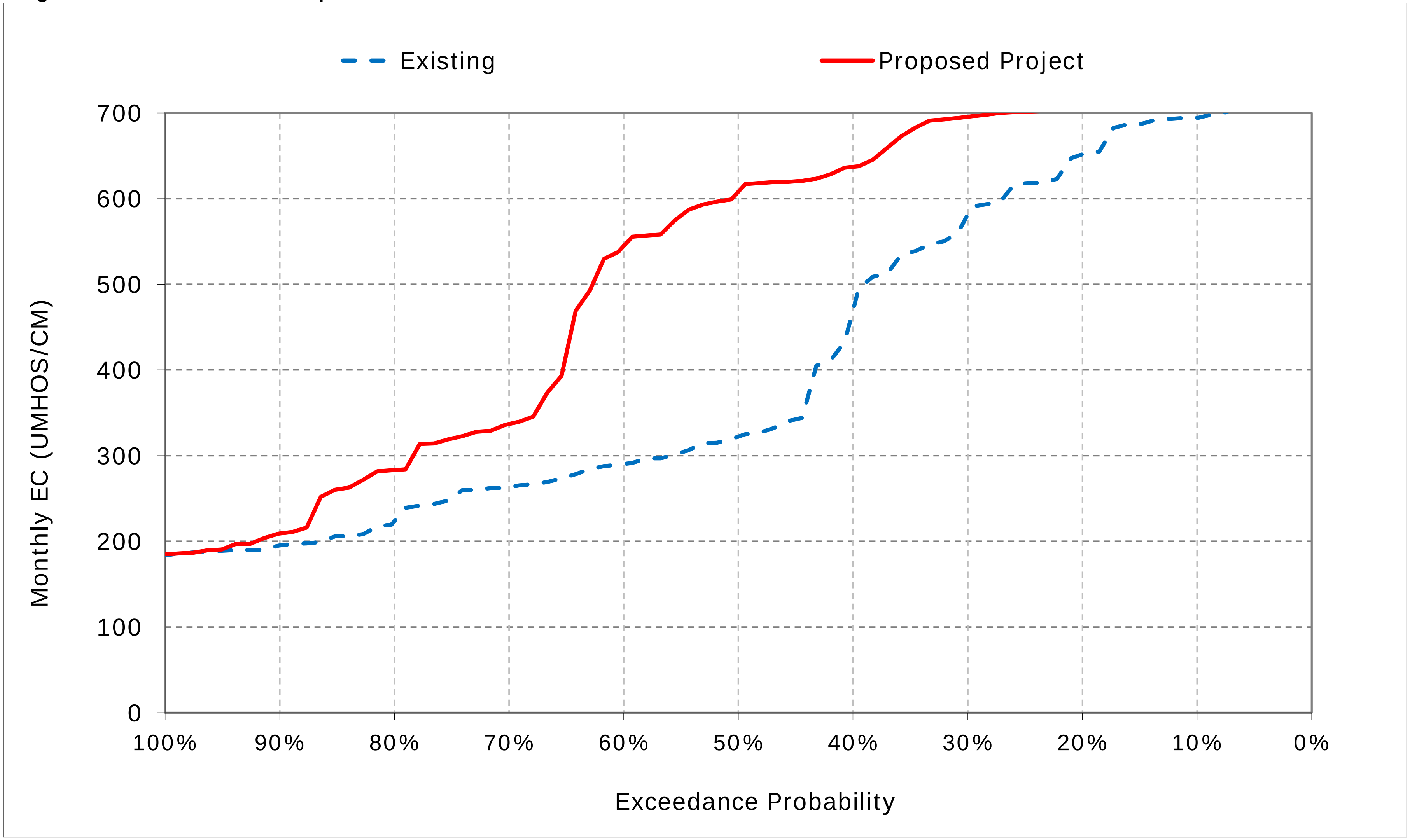


Table 14-1. San Joaquin River at Prisoners Point, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	599	595	688	651	443	341	366	352	292	375	473	569
20%	565	550	649	545	396	323	353	336	274	301	407	549
30%	550	524	588	507	382	308	341	328	264	278	379	519
40%	534	484	505	423	355	298	329	322	253	262	359	495
50%	495	450	374	402	335	282	317	316	247	253	338	463
60%	261	275	308	376	315	276	313	307	243	231	314	433
70%	247	242	284	346	287	269	294	300	241	224	287	410
80%	236	231	253	318	278	254	275	283	235	219	280	358
90%	227	224	237	286	265	240	257	226	228	208	271	322
Long Term												
Full Simulation Period[a]	410	402	438	438	340	290	313	306	259	271	347	453
Water Year Types[b]												
Wet (23%)	394	388	401	362	337	298	261	248	266	237	264	339
Above Normal (24%)	421	418	429	417	348	302	321	314	245	223	318	452
Below Normal (10%)	374	333	344	389	325	293	340	316	233	237	323	438
Dry (16%)	386	365	413	446	310	278	350	338	246	290	396	523
Critical (27%)	441	445	526	536	360	278	320	325	282	347	426	515

Proposed Project

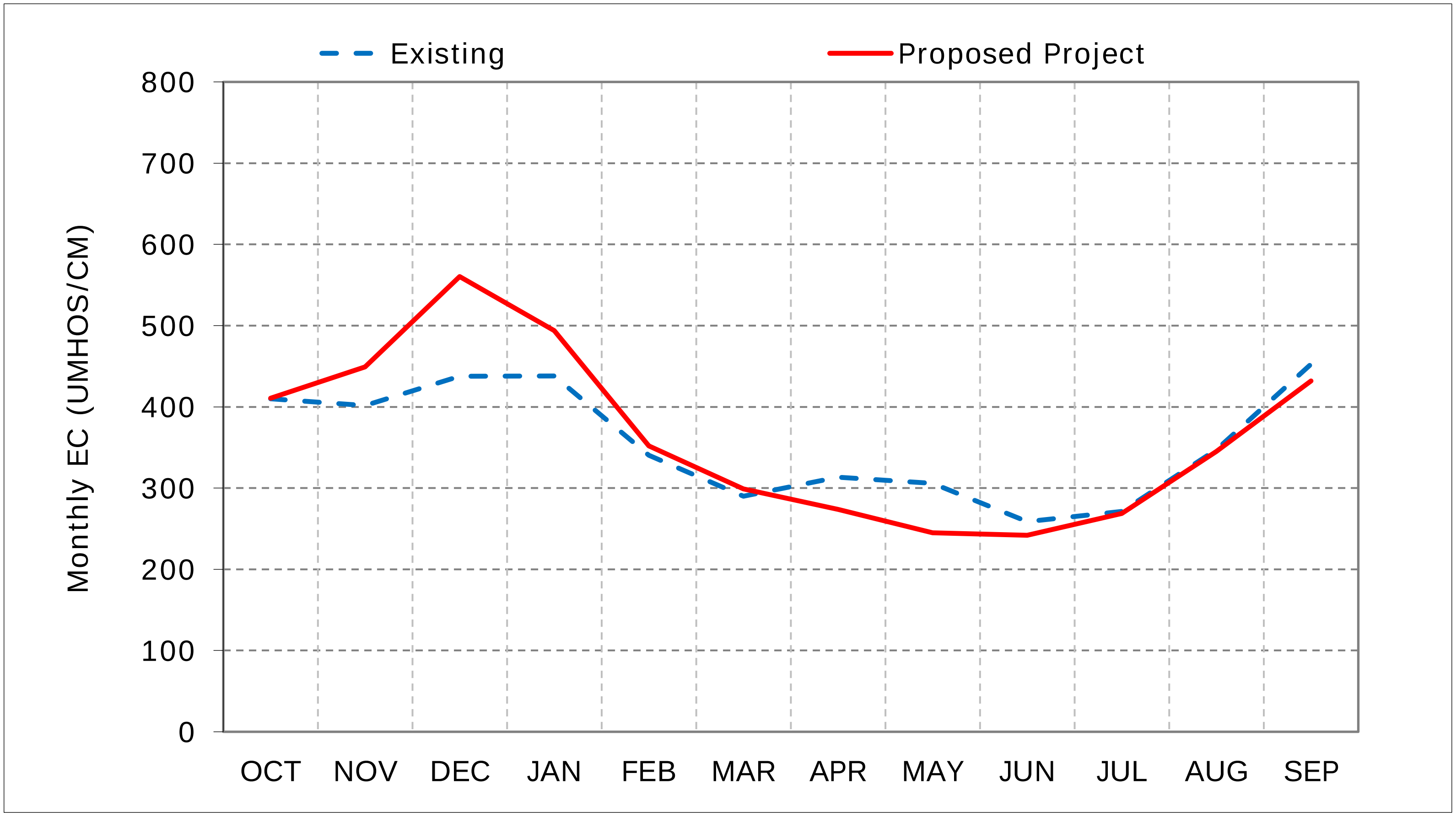
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	603	618	748	748	444	355	319	266	288	375	474	614
20%	584	569	706	681	417	336	304	260	266	290	398	575
30%	562	539	677	621	393	315	287	256	250	266	375	546
40%	546	508	649	531	367	302	282	249	236	257	353	491
50%	509	465	626	433	344	290	275	247	229	243	339	435
60%	235	401	577	384	315	283	266	242	223	229	307	340
70%	224	351	432	349	295	270	255	235	218	221	285	319
80%	217	310	388	325	280	261	245	230	211	216	275	309
90%	214	268	296	296	264	243	234	213	203	207	255	288
Long Term												
Full Simulation Period[a]	411	449	560	494	352	299	274	245	242	269	345	432
Water Year Types[b]												
Wet (23%)	396	429	480	372	334	298	248	227	261	238	256	272
Above Normal (24%)	426	459	518	450	346	307	287	246	217	217	313	411
Below Normal (10%)	362	438	550	525	347	314	299	241	209	227	313	408
Dry (16%)	377	419	597	543	323	293	284	248	222	281	395	546
Critical (27%)	446	480	650	598	391	290	270	260	272	351	433	530

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	5	23	59	97	1	14	-47	-85	-4	0	0	45
20%	19	19	57	136	20	13	-49	-76	-9	-11	-8	25
30%	13	14	89	113	11	7	-54	-72	-14	-12	-5	28
40%	12	24	145	108	12	4	-47	-73	-18	-5	-6	-4
50%	15	15	252	31	9	8	-42	-69	-19	-10	2	-28
60%	-27	126	269	8	0	7	-47	-64	-20	-2	-7	-93
70%	-23	110	148	3	8	1	-39	-65	-23	-3	-1	-91
80%	-19	78	135	7	3	8	-30	-53	-23	-2	-5	-49
90%	-13	44	59	10	-1	3	-23	-13	-24	-1	-16	-35
Long Term												
Full Simulation Period[a]	1	48	123	56	11	9	-40	-61	-17	-3	-2	-21
Water Year Types[b]												
Wet (23%)	2	40	79	10	-3	0	-13	-21	-6	1	-8	-67
Above Normal (24%)	5	41	90	34	-2	5	-34	-68	-27	-5	-4	-41
Below Normal (10%)	-12	105	206	136	22	22	-41	-76	-24	-11	-10	-29
Dry (16%)	-9	54	184	97	13	16	-66	-90	-24	-9	-1	23
Critical (27%)	5	36	124	62	31	12	-51	-65	-10	4	6	15

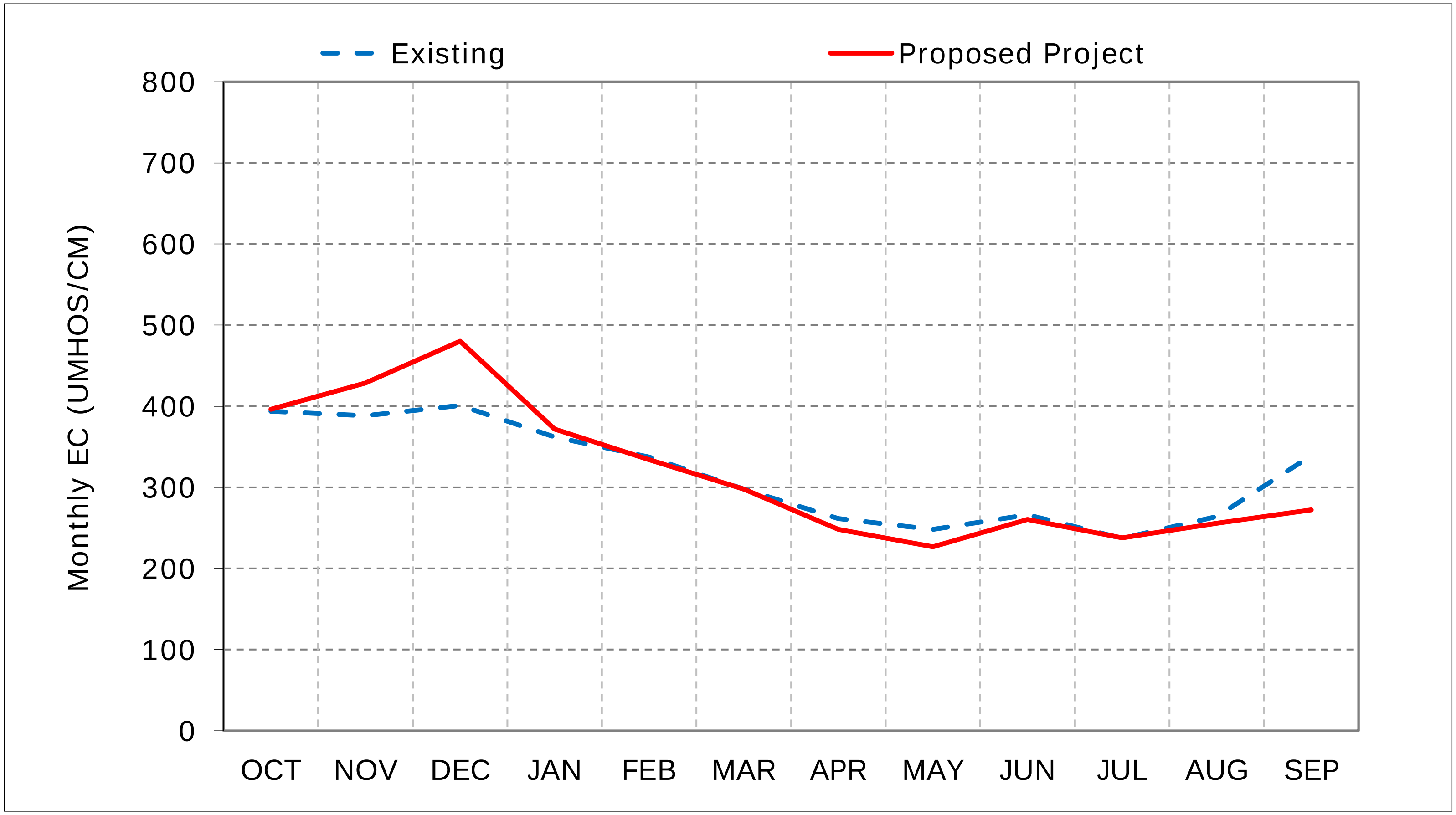
a Based on the 82-year simulation period.
b As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 14-1. San Joaquin River at Prisoners Point, Long-Term Average EC



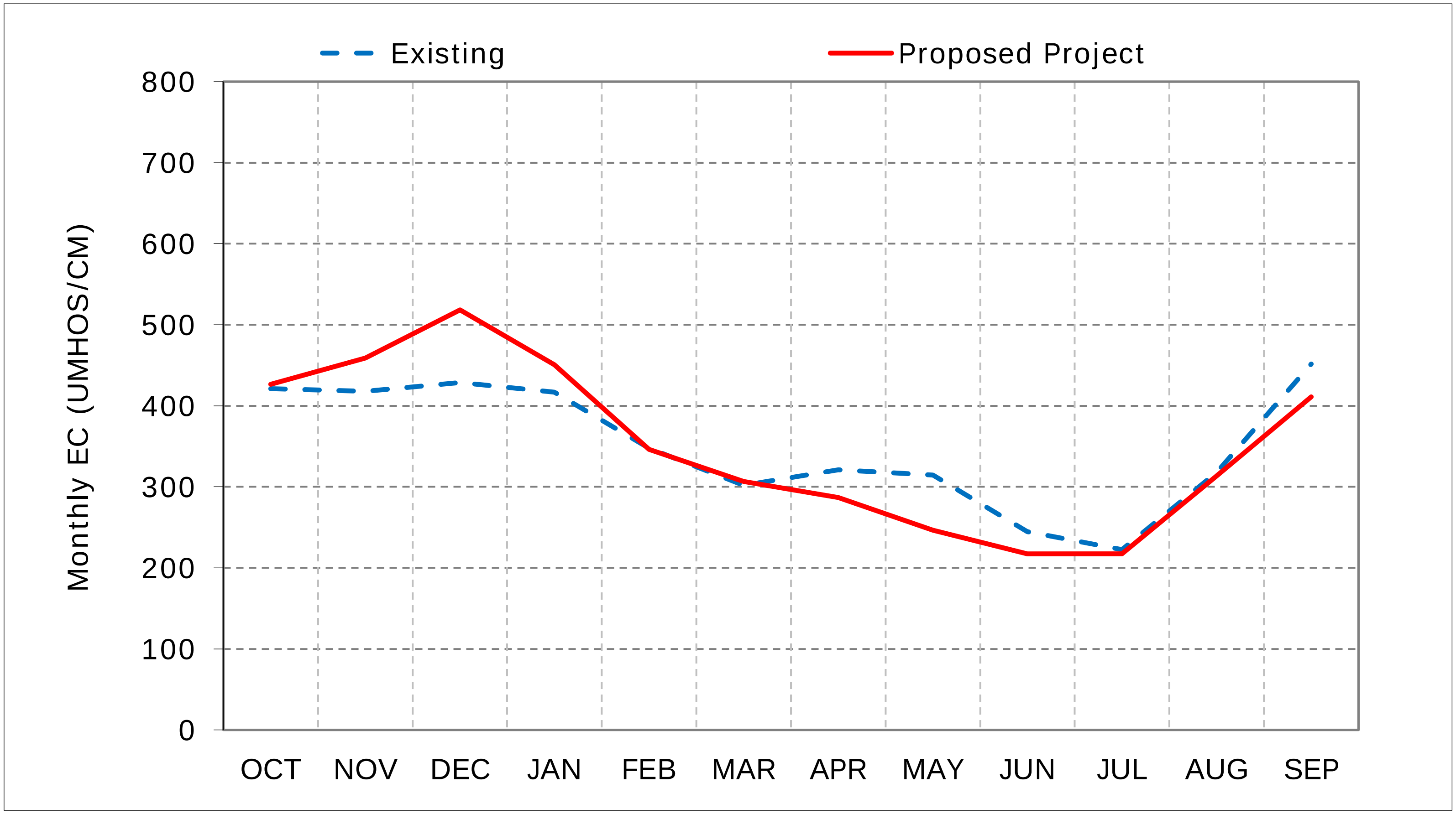
*As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 14-2. San Joaquin River at Prisoners Point, Wet Year Average EC



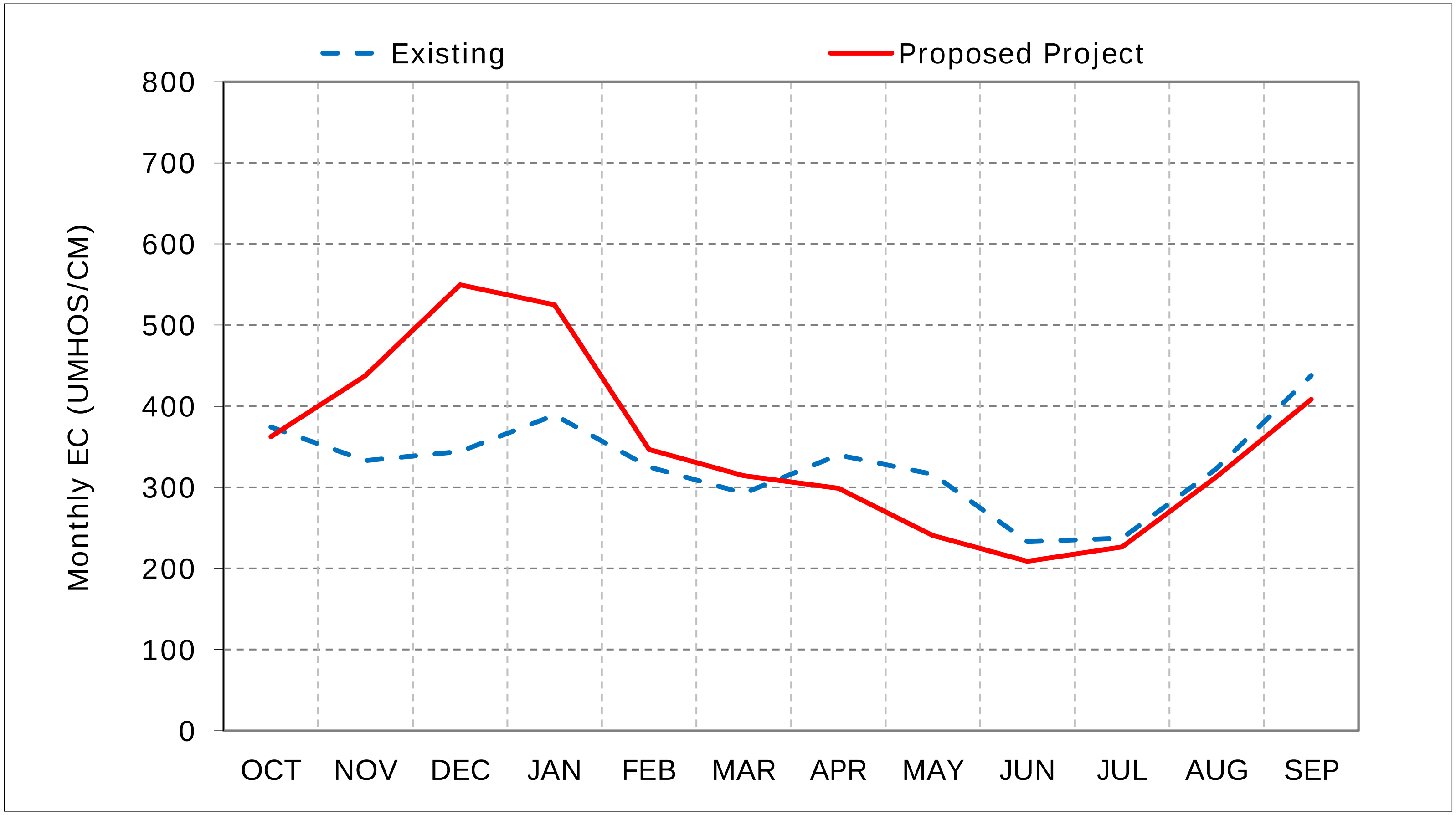
*As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 14-3. San Joaquin River at Prisoners Point, Above Normal Year Average EC



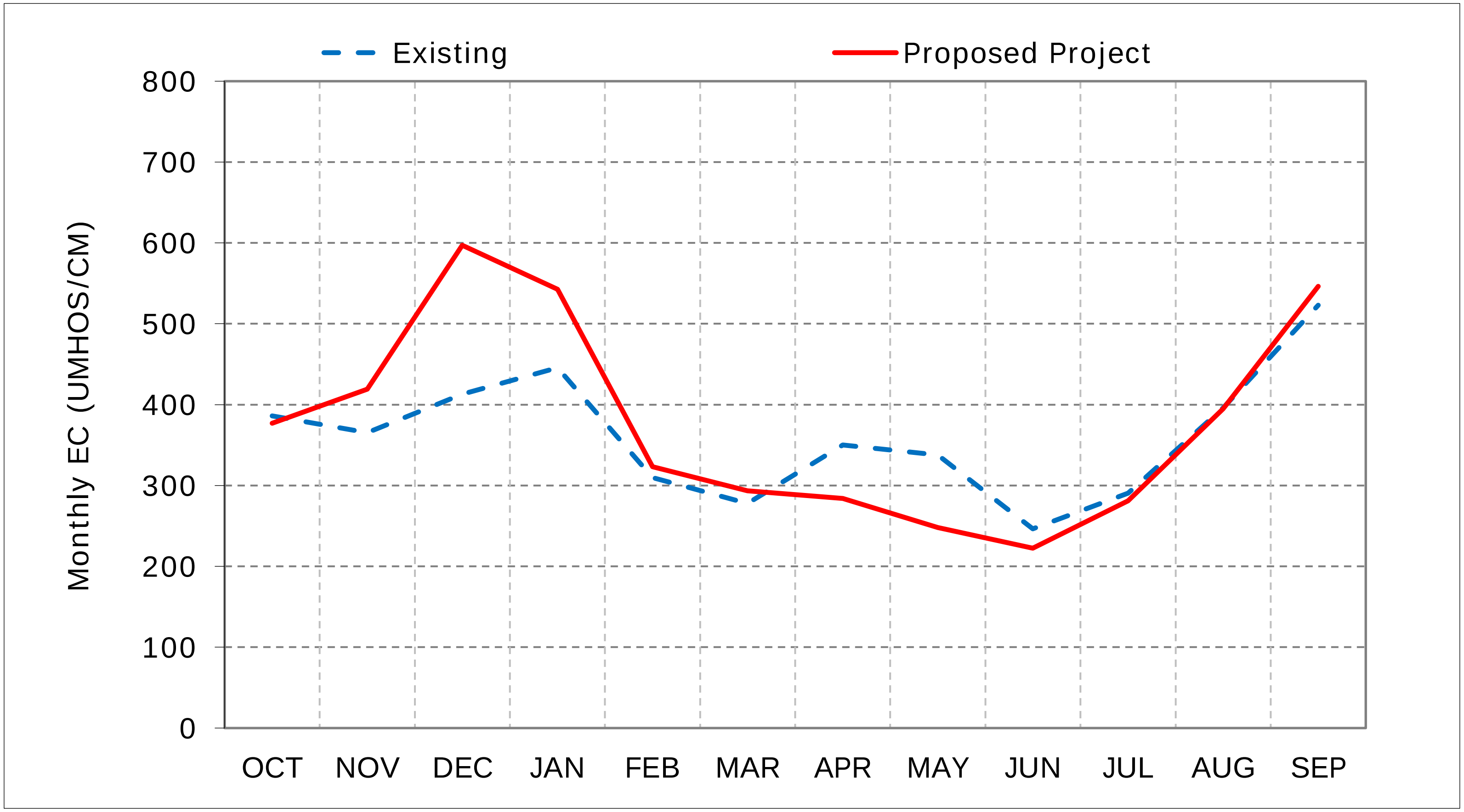
*As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 14-4. San Joaquin River at Prisoners Point, Below Normal Year Average EC



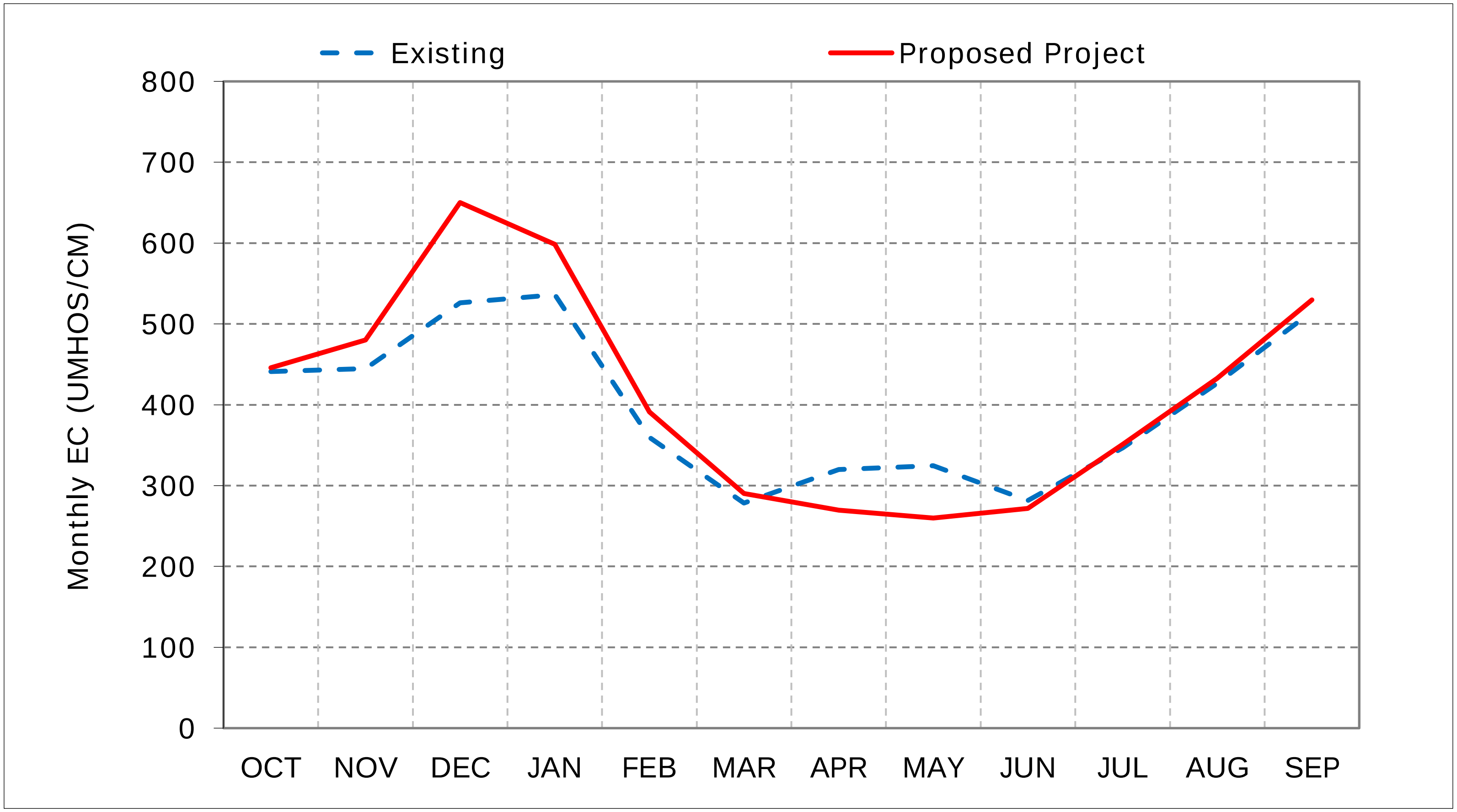
*As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 14-5. San Joaquin River at Prisoners Point, Dry Year Average EC



*As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 14-6. San Joaquin River at Prisoners Point, Critical Year Average EC



*As defined by the San Joaquin Valley 60-20-20 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 14-7. San Joaquin River at Prisoners Point, January EC

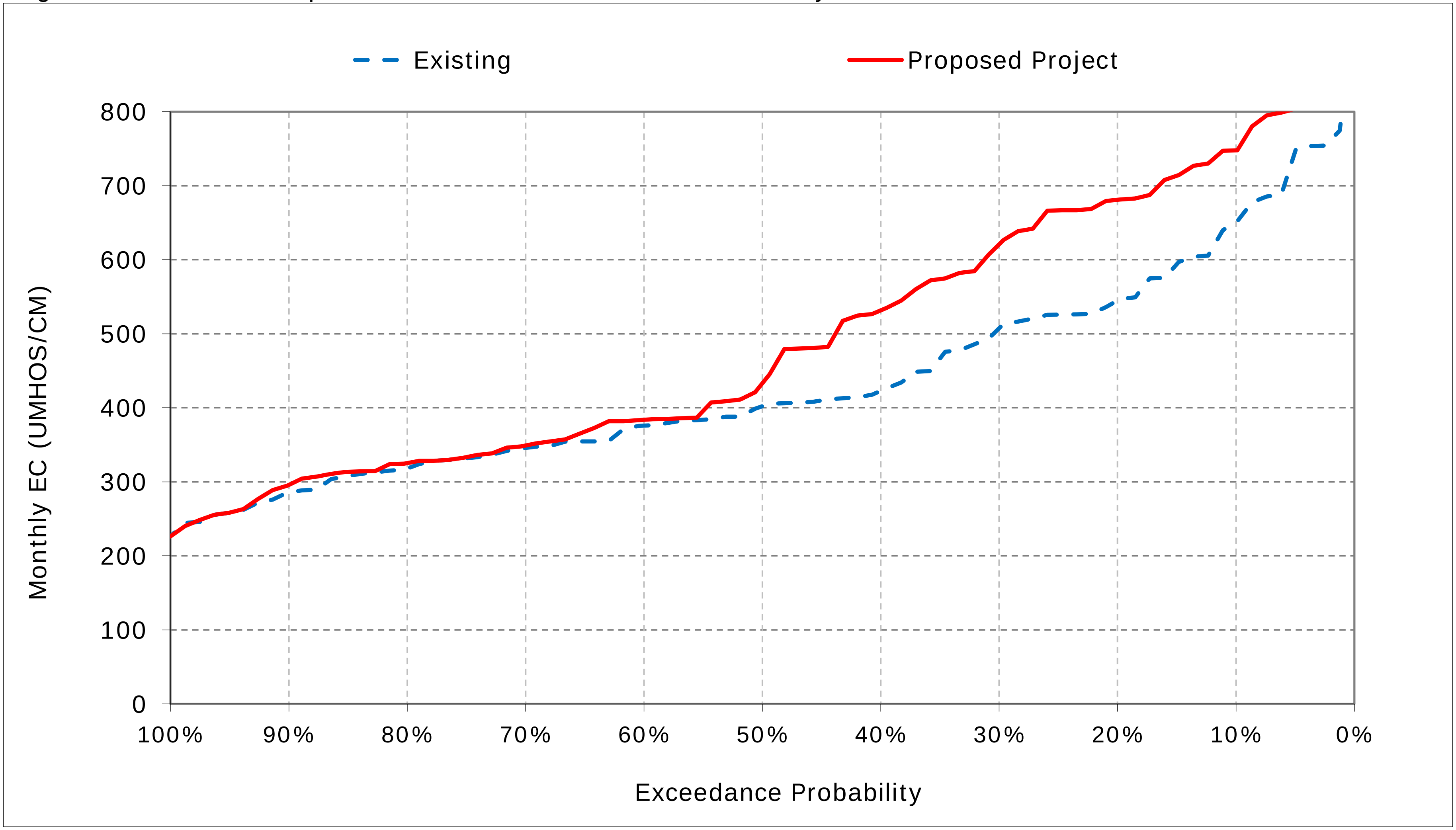


Figure 14-8. San Joaquin River at Prisoners Point, February EC

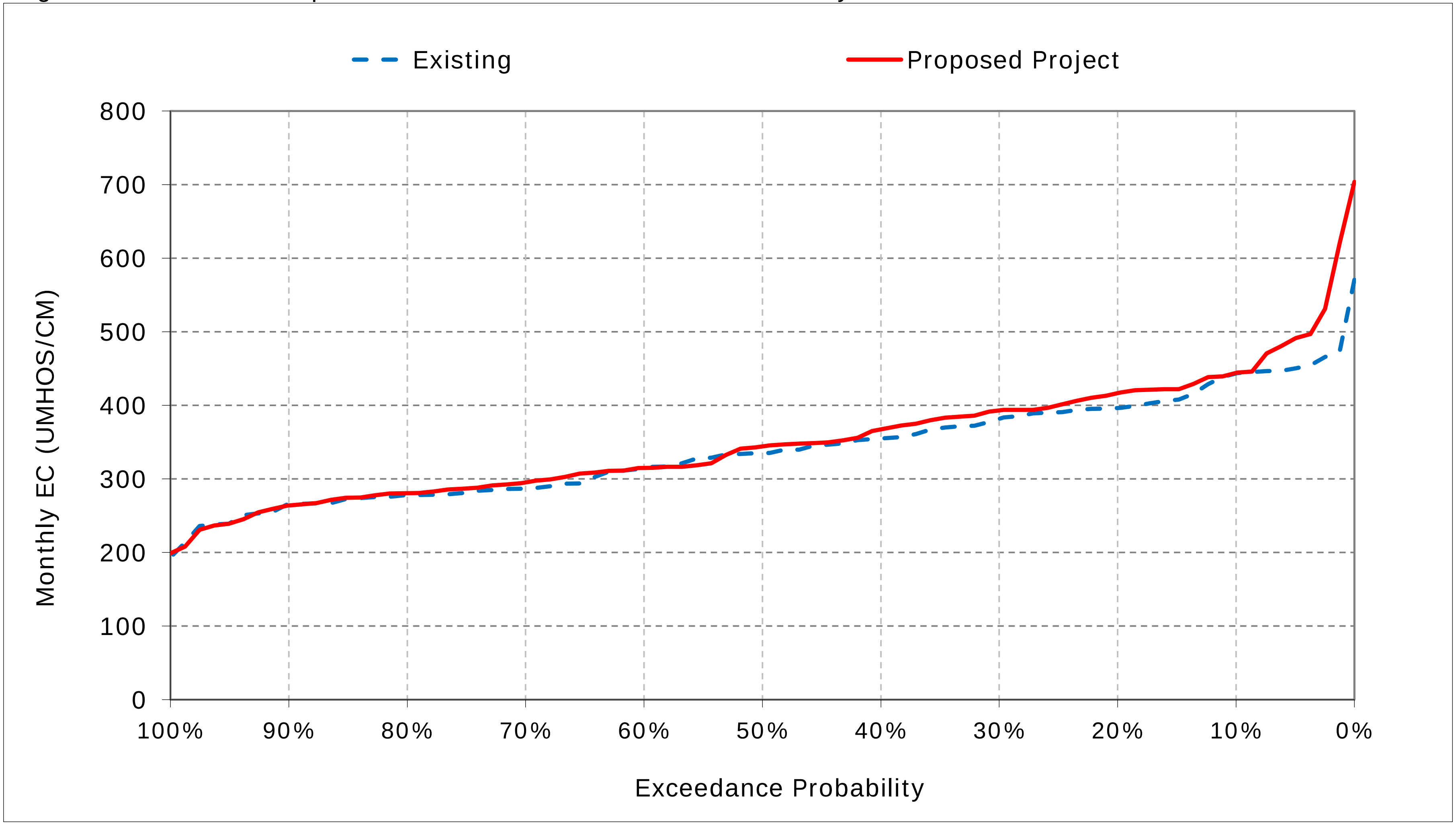


Figure 14-9. San Joaquin River at Prisoners Point, March EC

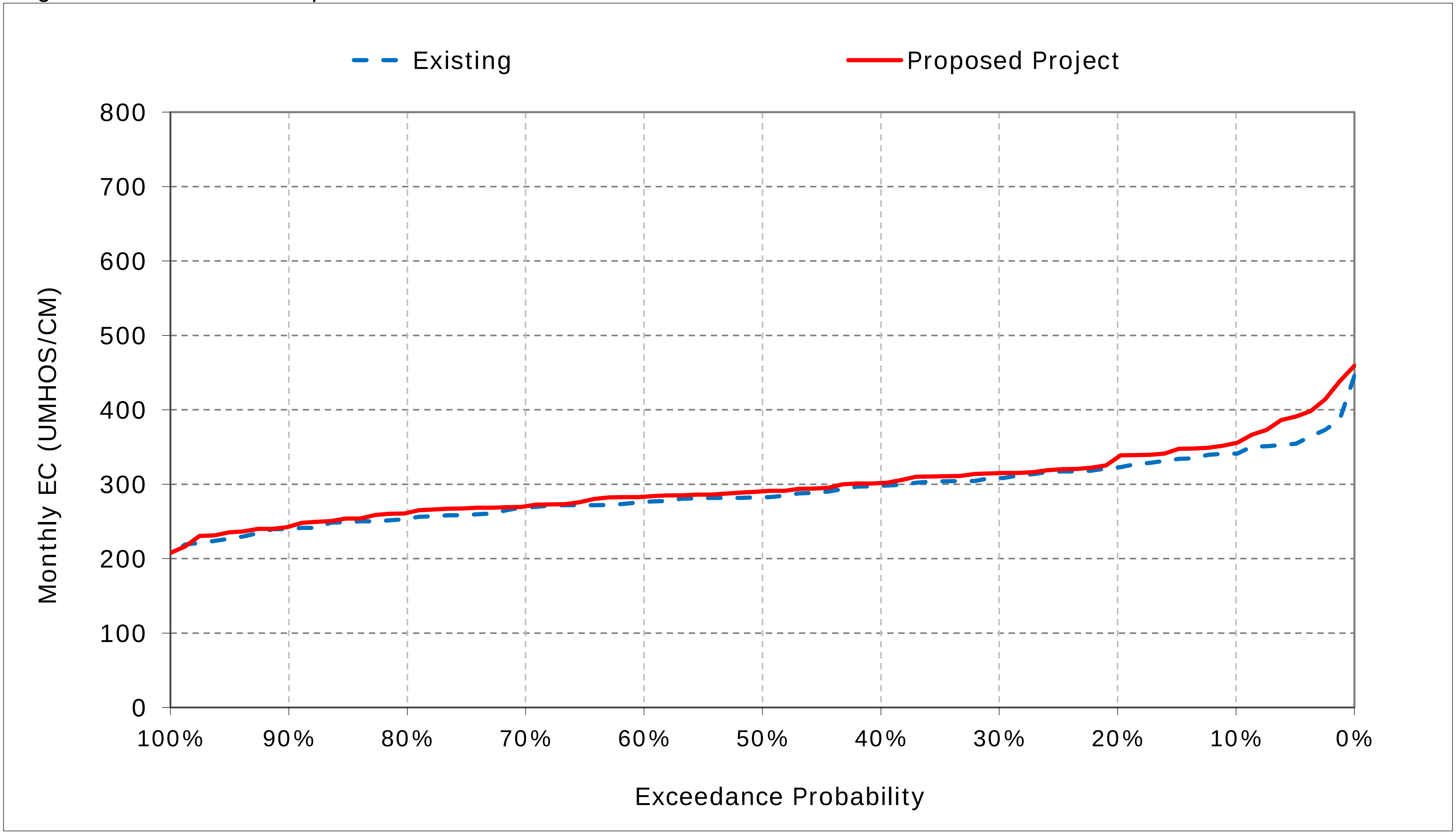


Figure 14-10. San Joaquin River at Prisoners Point, April EC

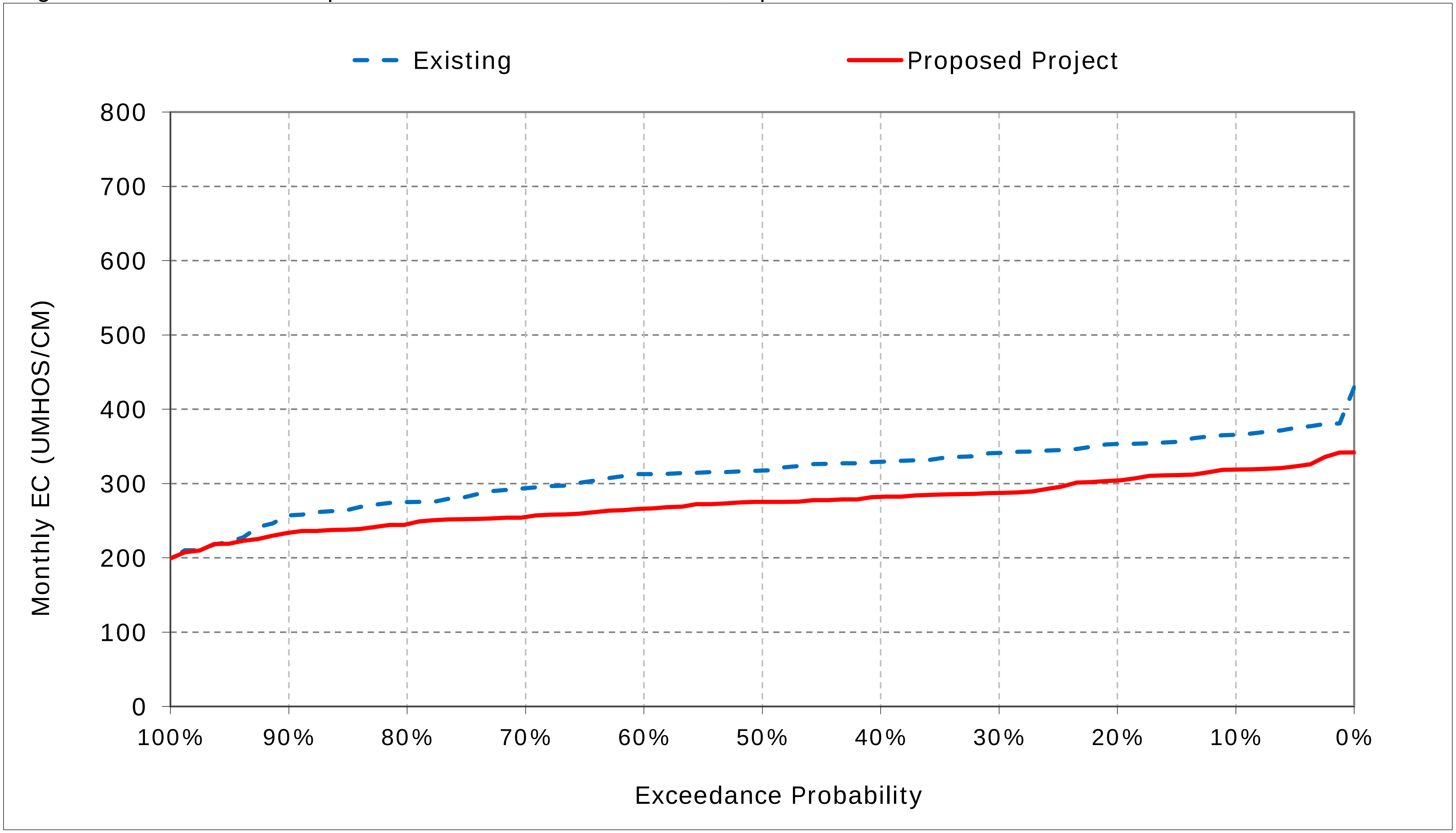


Figure 14-11. San Joaquin River at Prisoners Point, May EC

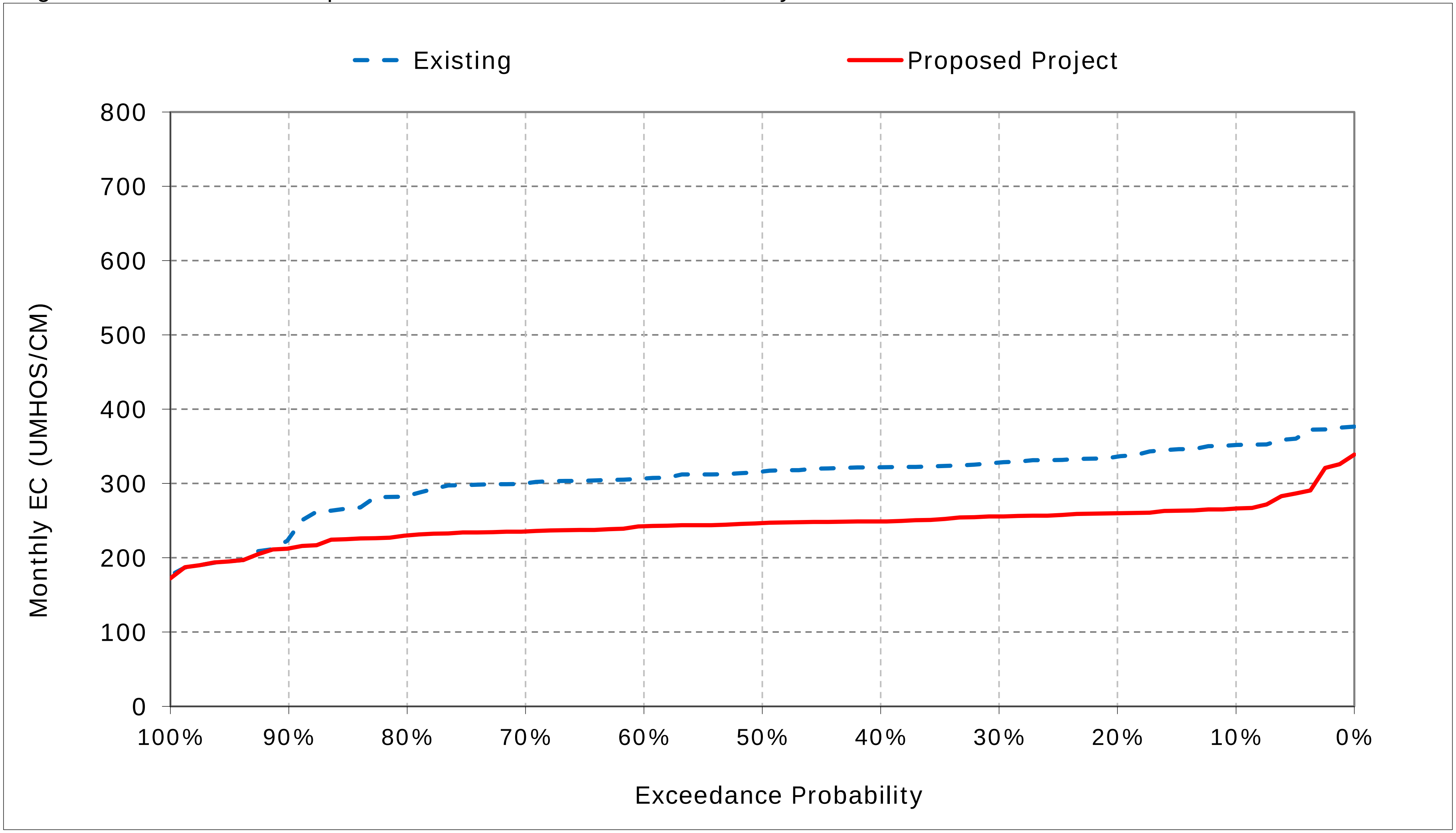


Figure 14-12. San Joaquin River at Prisoners Point, June EC

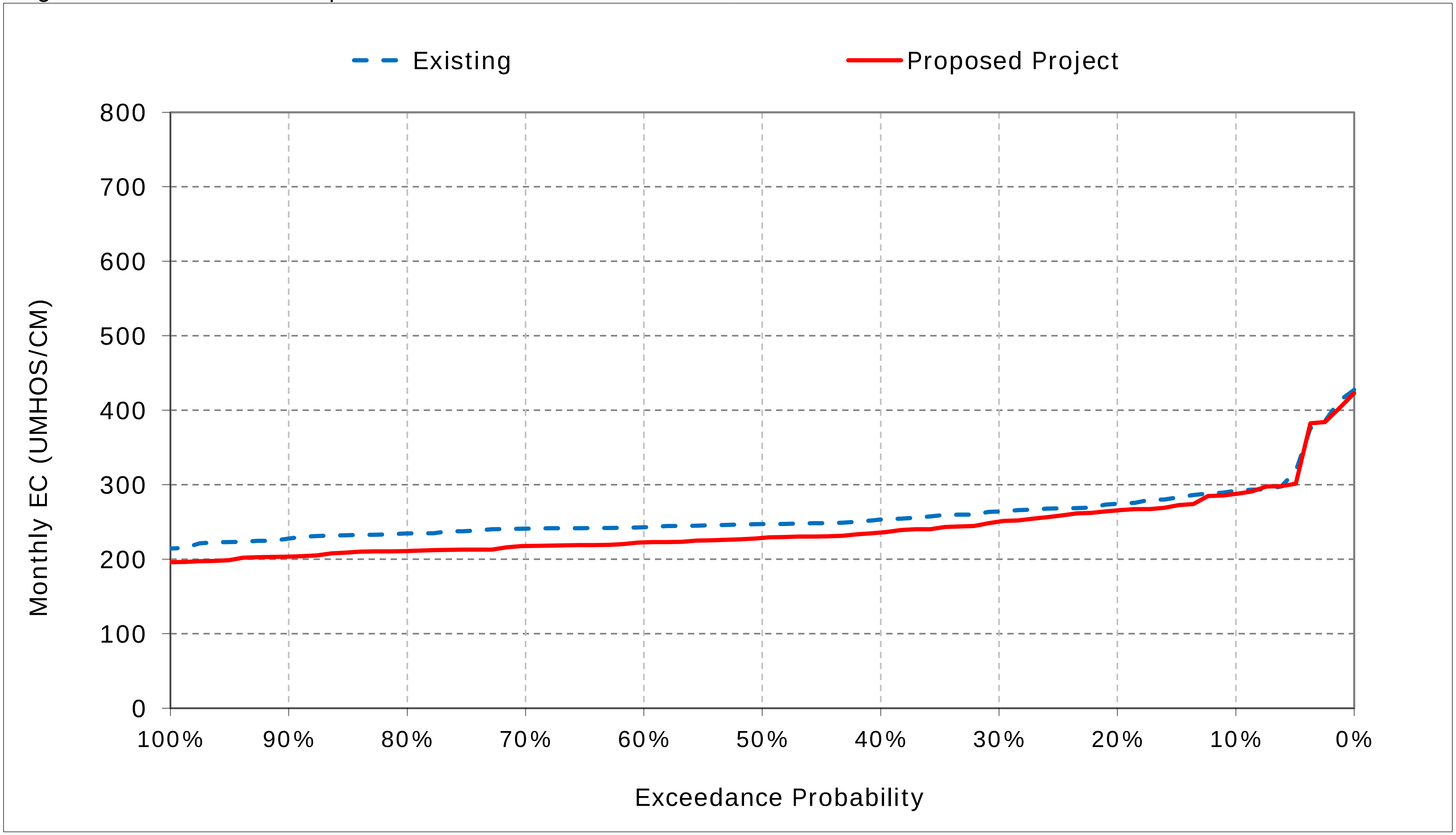


Figure 14-13. San Joaquin River at Prisoners Point, July EC

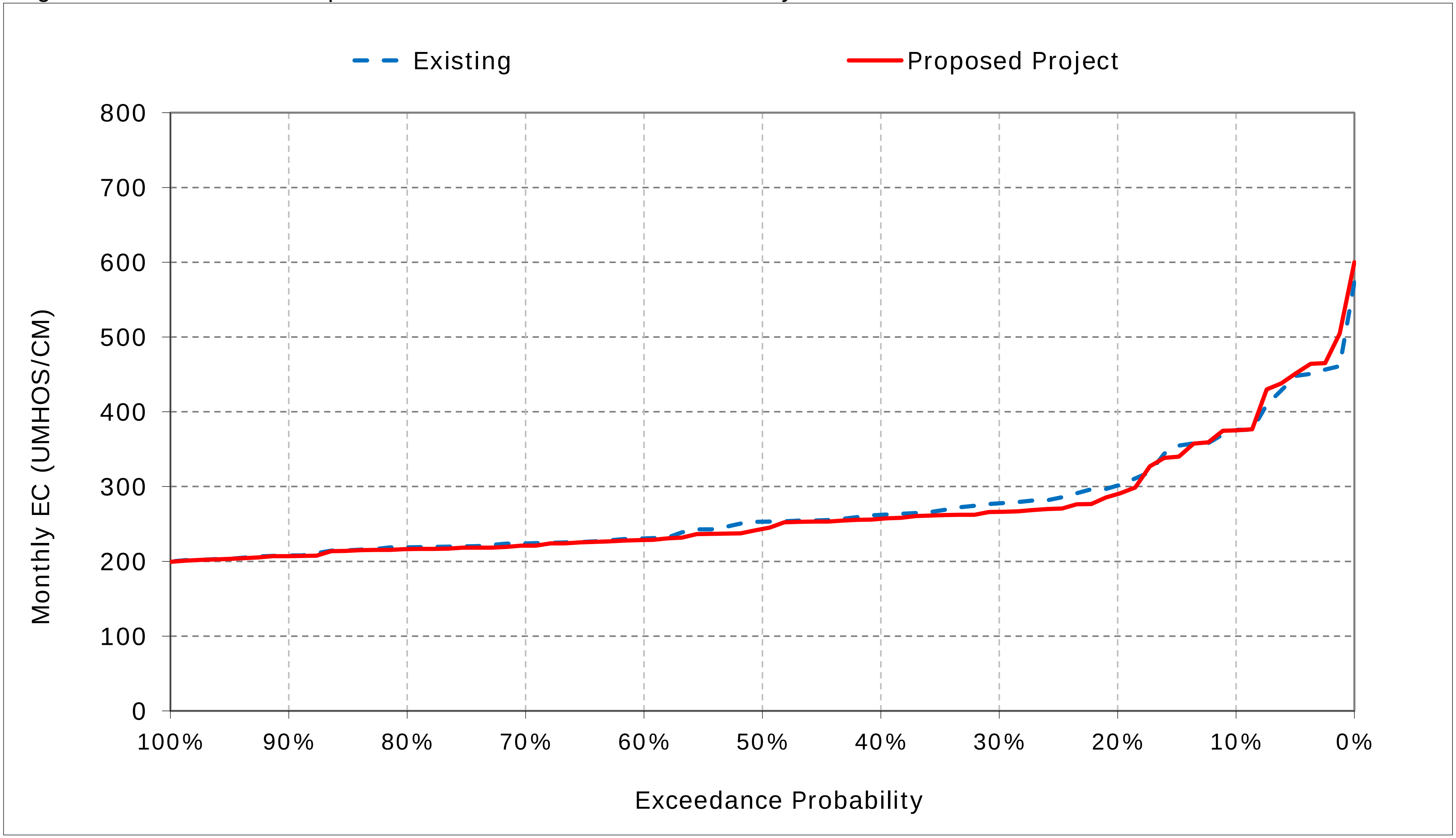


Figure 14-14. San Joaquin River at Prisoners Point, August EC

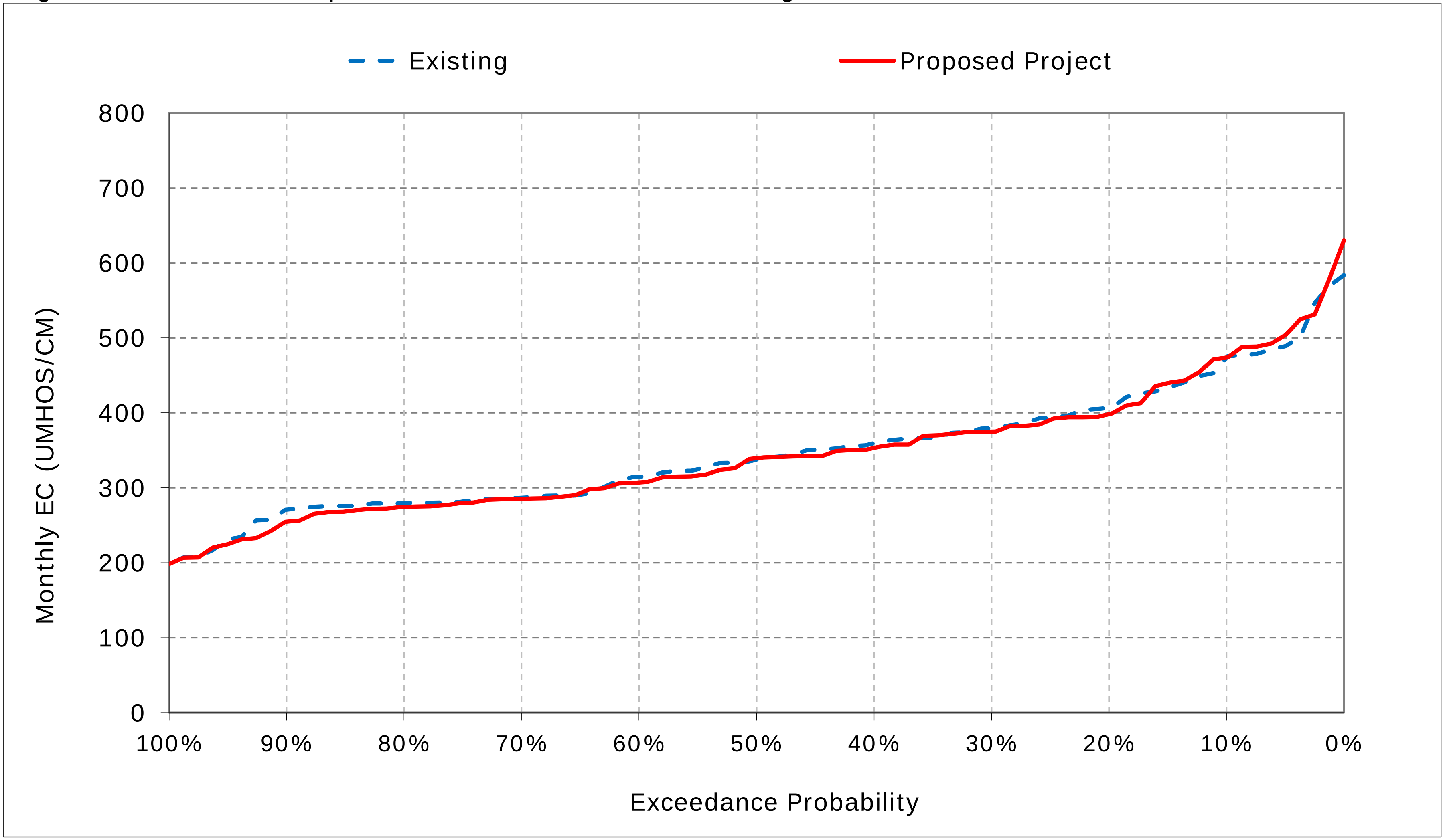


Figure 14-15. San Joaquin River at Prisoners Point, September EC

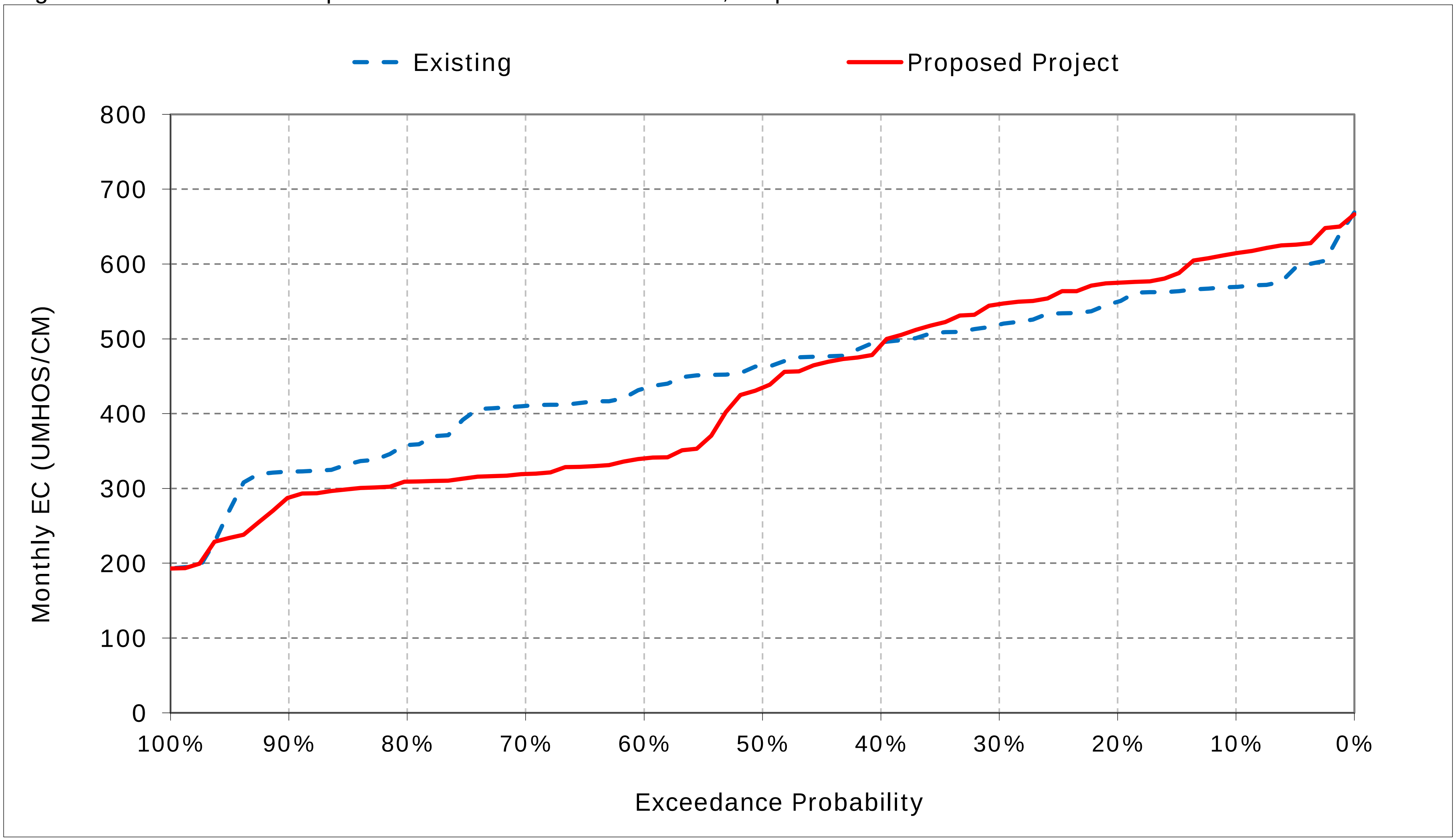


Figure 14-16. San Joaquin River at Prisoners Point, October EC

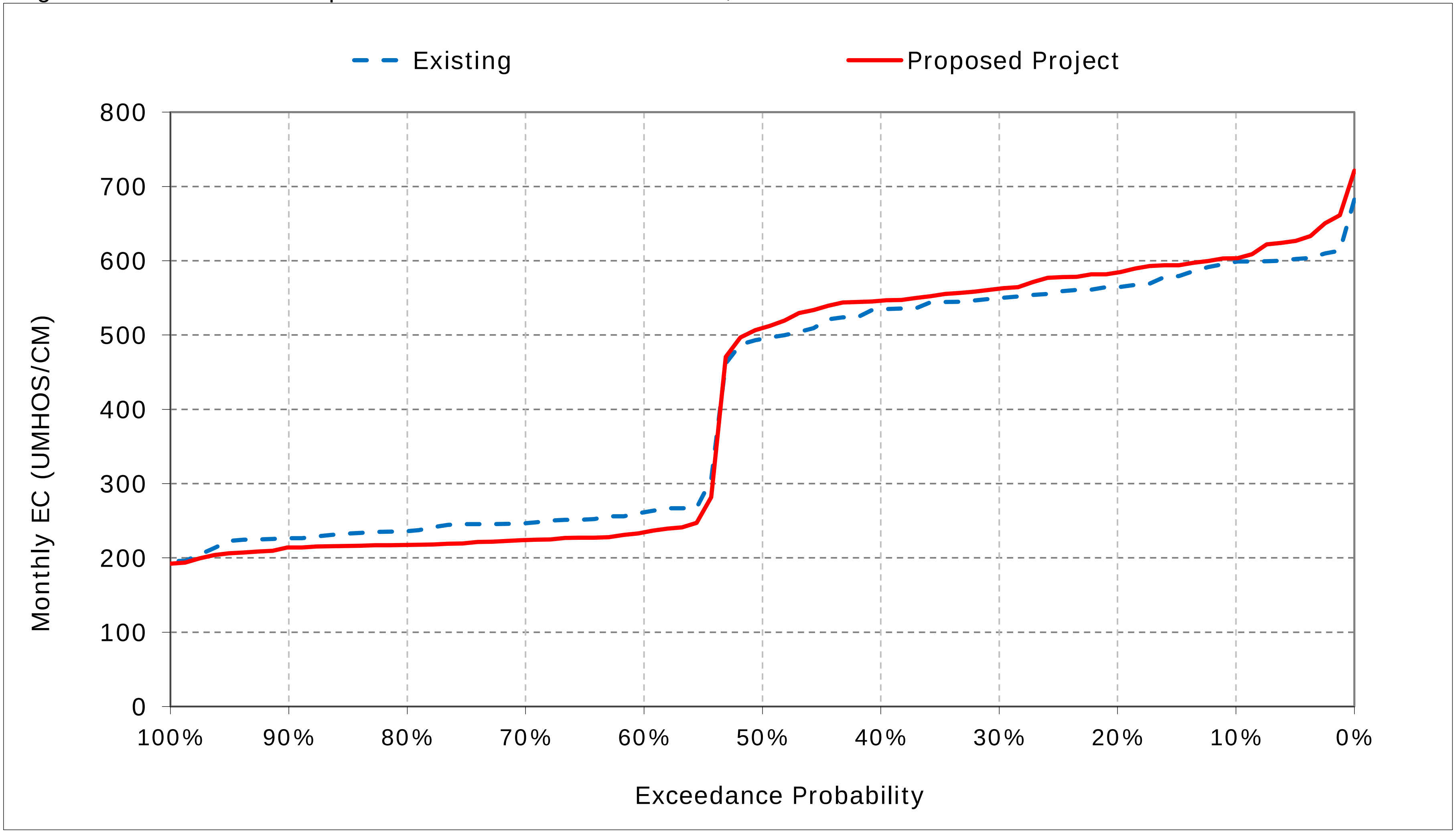


Figure 14-17. San Joaquin River at Prisoners Point, November EC

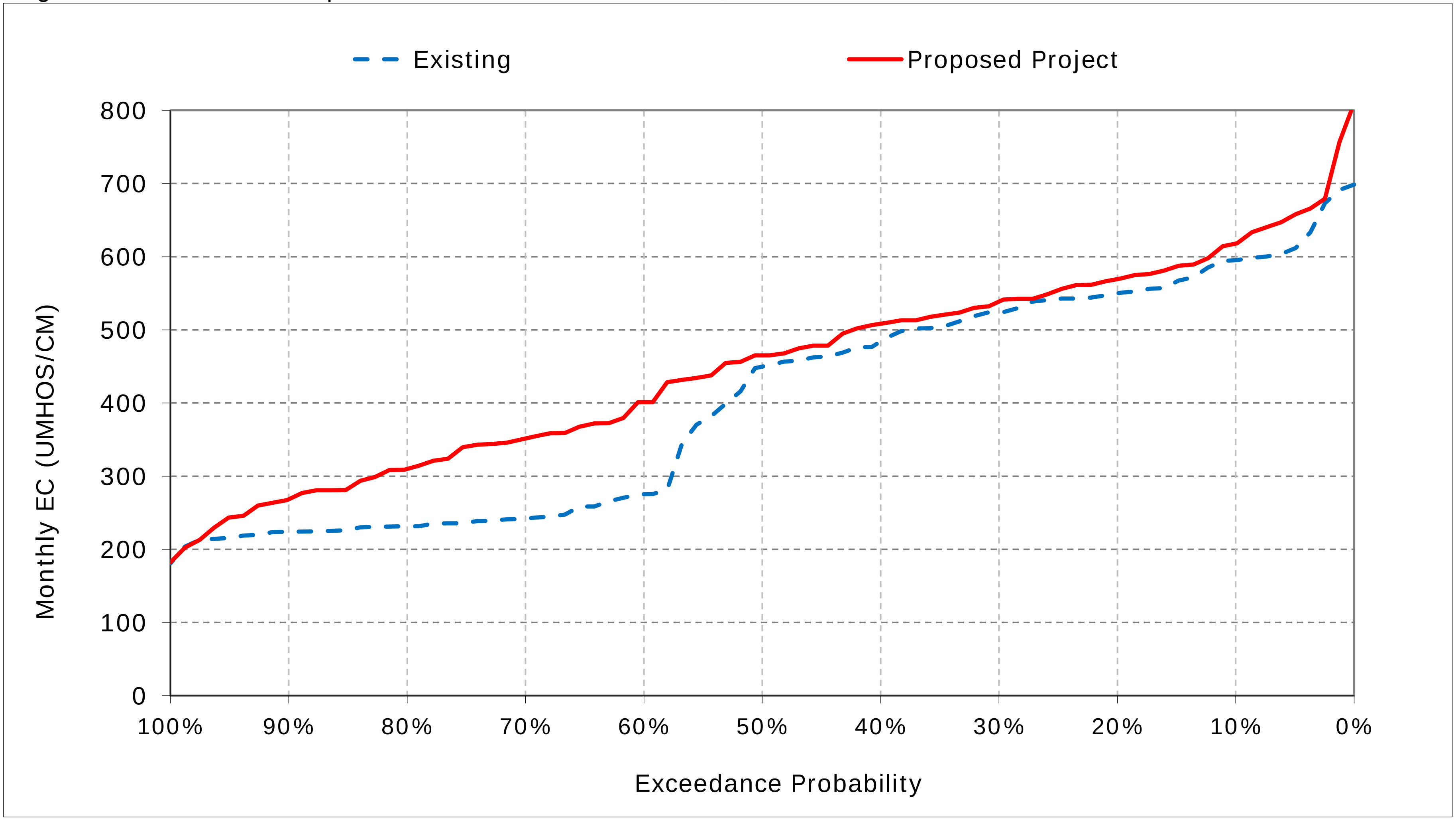


Figure 14-18. San Joaquin River at Prisoners Point, December EC

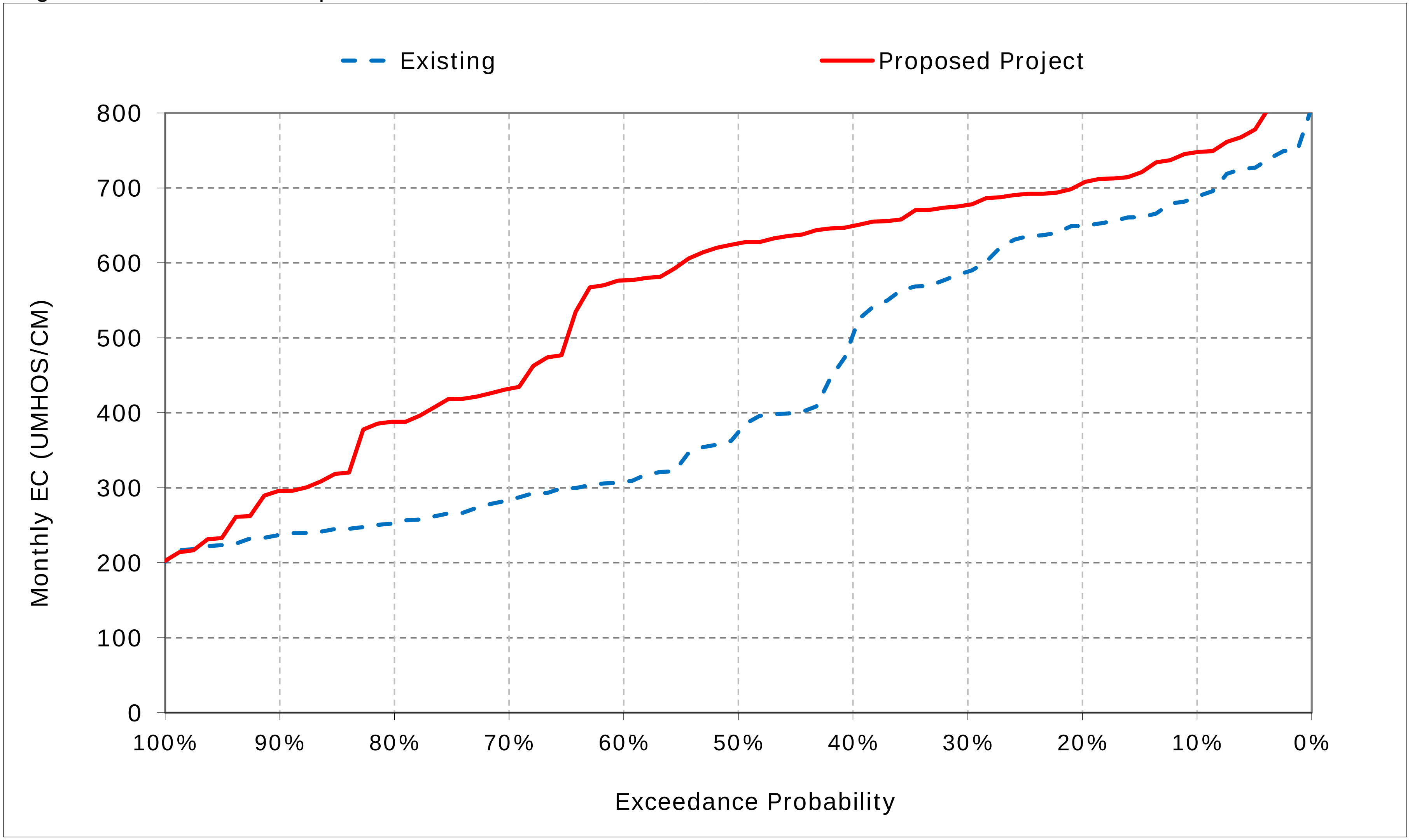


Table 15-1. Old River at Rock Slough Salinity, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	871	839	912	833	508	361	357	375	301	483	645	799
20%	831	768	869	699	418	316	339	352	273	374	544	774
30%	806	729	787	610	394	295	324	325	263	338	495	722
40%	776	673	627	524	360	287	309	314	259	303	471	664
50%	714	588	444	459	341	273	301	308	256	272	432	622
60%	275	310	342	419	306	264	288	298	252	254	397	571
70%	263	251	299	342	289	254	283	293	248	245	357	535
80%	259	236	272	312	275	243	270	282	240	230	344	476
90%	249	223	243	275	262	233	247	247	233	220	324	436
Long Term												
Full Simulation Period[a]	555	522	544	517	360	285	302	308	270	319	449	614
Water Year Types[b]												
Wet (32%)	459	415	371	343	331	285	289	280	243	235	335	492
Above Normal (15%)	618	541	542	485	345	286	321	328	252	244	361	454
Below Normal (17%)	573	549	617	591	338	270	317	335	252	305	470	762
Dry (22%)	560	571	617	566	361	268	296	309	264	389	545	686
Critical (15%)	668	632	729	769	459	330	301	315	373	487	613	755

Proposed Project

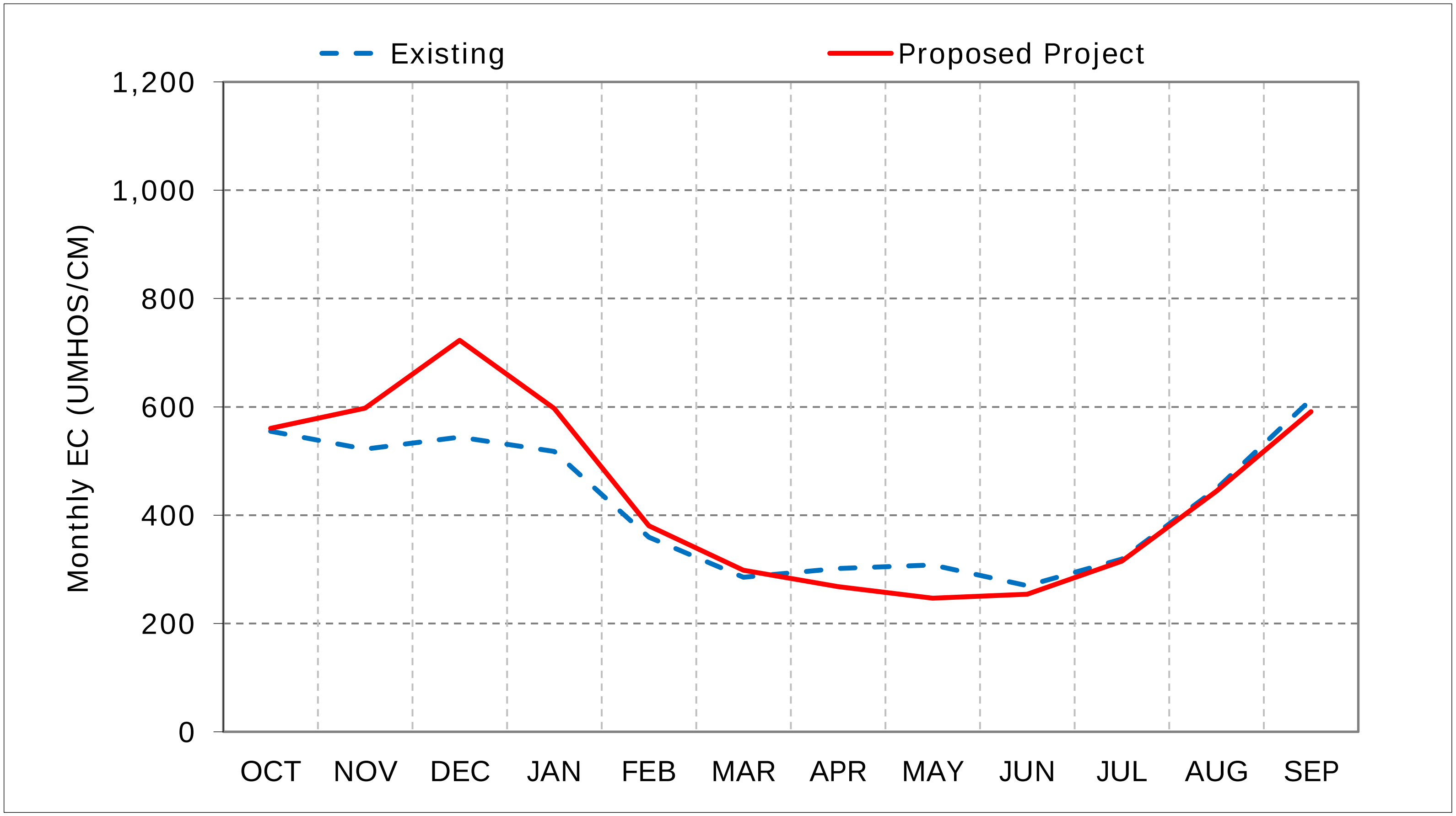
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	888	843	976	1,020	531	385	298	277	285	489	644	863
20%	857	797	924	884	489	338	281	262	264	345	527	804
30%	823	731	891	810	408	303	276	254	251	320	498	761
40%	787	703	857	694	378	295	273	243	241	297	463	676
50%	731	628	823	523	350	285	265	238	236	268	433	587
60%	266	528	763	449	320	270	257	234	230	249	389	468
70%	251	447	556	350	300	263	252	230	223	239	352	433
80%	242	394	494	325	283	251	243	227	218	228	336	411
90%	230	321	304	284	265	244	237	222	213	220	299	380
Long Term												
Full Simulation Period[a]	560	598	723	597	380	298	268	247	254	315	444	591
Water Year Types[b]												
Wet (32%)	463	510	521	372	332	295	257	230	228	235	324	378
Above Normal (15%)	628	649	792	617	371	302	264	231	225	240	362	439
Below Normal (17%)	575	619	793	679	344	280	270	242	228	283	467	822
Dry (22%)	562	622	810	694	395	284	266	252	252	380	532	695
Critical (15%)	683	673	879	822	513	347	297	298	375	503	628	779

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	18	4	64	188	24	24	-59	-98	-16	6	-1	63
20%	26	28	54	185	71	22	-58	-90	-9	-29	-17	30
30%	17	2	105	201	14	9	-48	-71	-12	-19	3	39
40%	11	30	230	171	18	8	-37	-71	-19	-6	-8	13
50%	17	40	379	64	10	13	-35	-70	-20	-3	1	-35
60%	-9	218	421	29	13	6	-31	-65	-23	-5	-9	-103
70%	-12	196	258	8	12	9	-30	-63	-25	-6	-4	-102
80%	-17	157	222	13	8	8	-26	-55	-21	-2	-8	-65
90%	-19	98	60	8	2	11	-9	-25	-20	0	-25	-56
Long Term												
Full Simulation Period[a]	6	75	179	79	21	13	-33	-61	-16	-4	-4	-23
Water Year Types[b]												
Wet (32%)	4	95	150	29	1	11	-31	-50	-15	0	-11	-114
Above Normal (15%)	9	108	250	131	26	15	-57	-97	-27	-4	1	-15
Below Normal (17%)	2	71	176	88	6	10	-47	-93	-25	-21	-3	60
Dry (22%)	1	52	193	128	34	16	-30	-57	-12	-10	-13	8
Critical (15%)	14	41	150	53	55	17	-4	-17	2	15	16	24

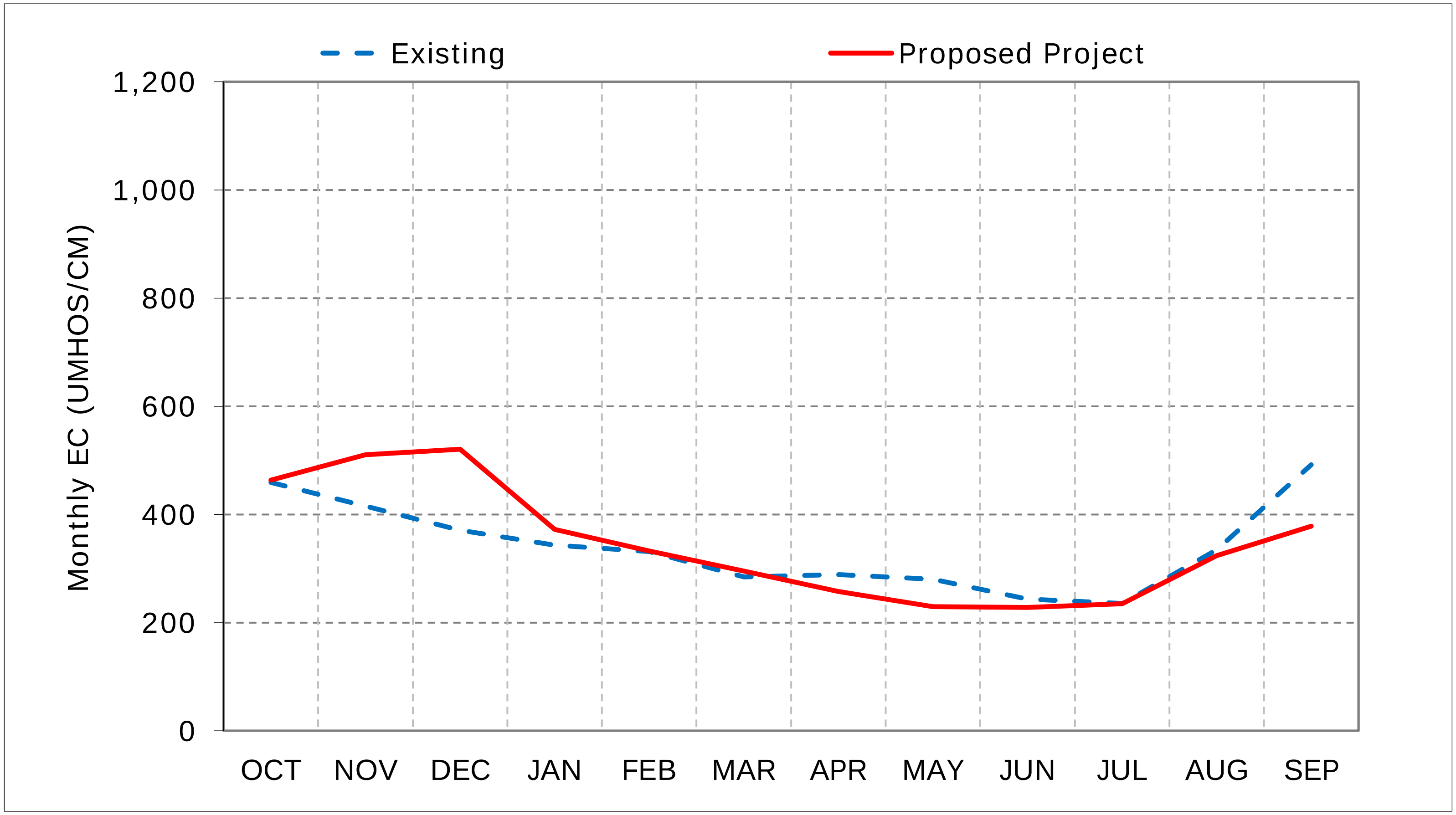
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 15-1. Old River at Rock Slough Salinity, Long-Term Average EC



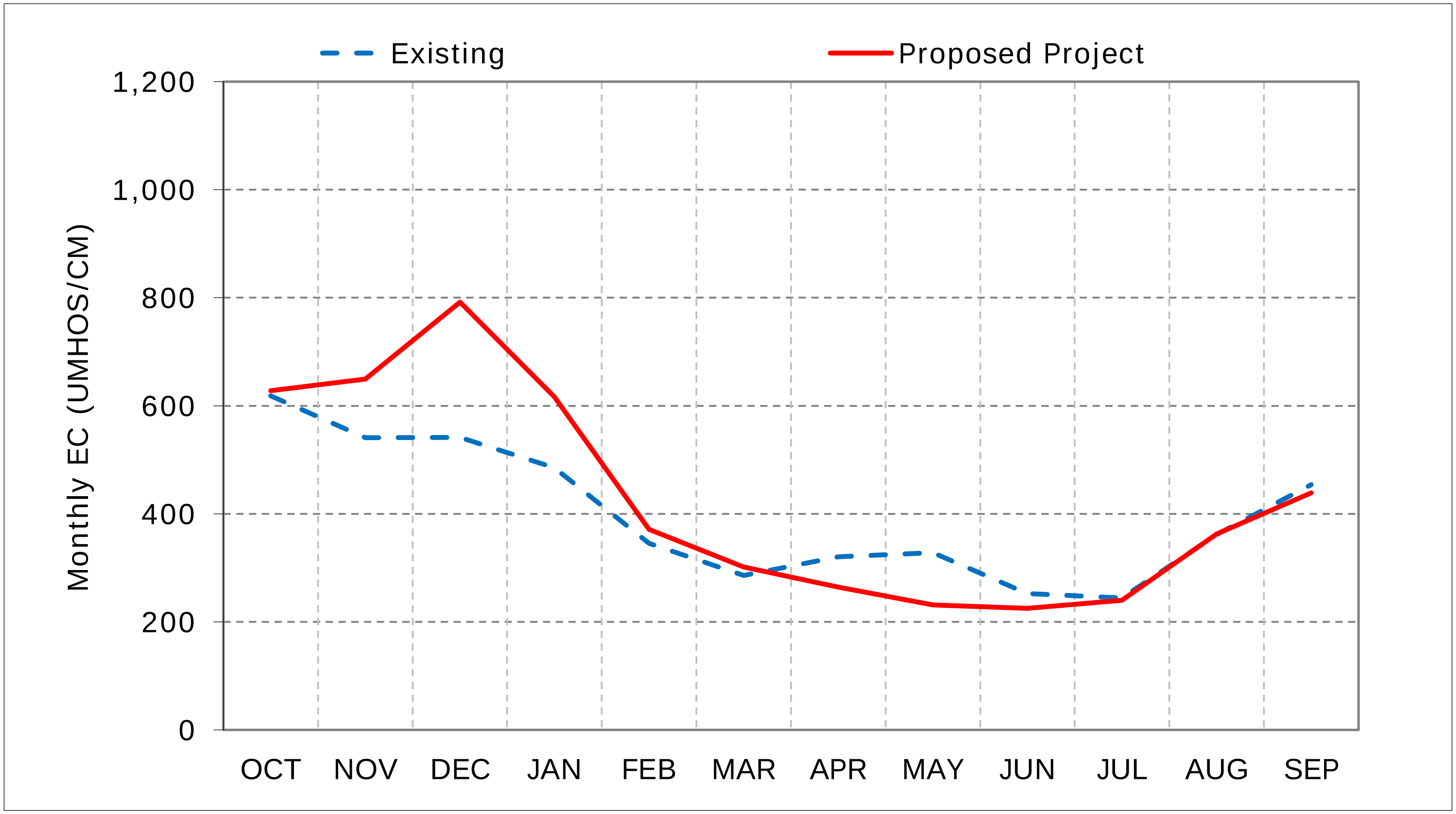
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 15-2. Old River at Rock Slough Salinity, Wet Year Average EC



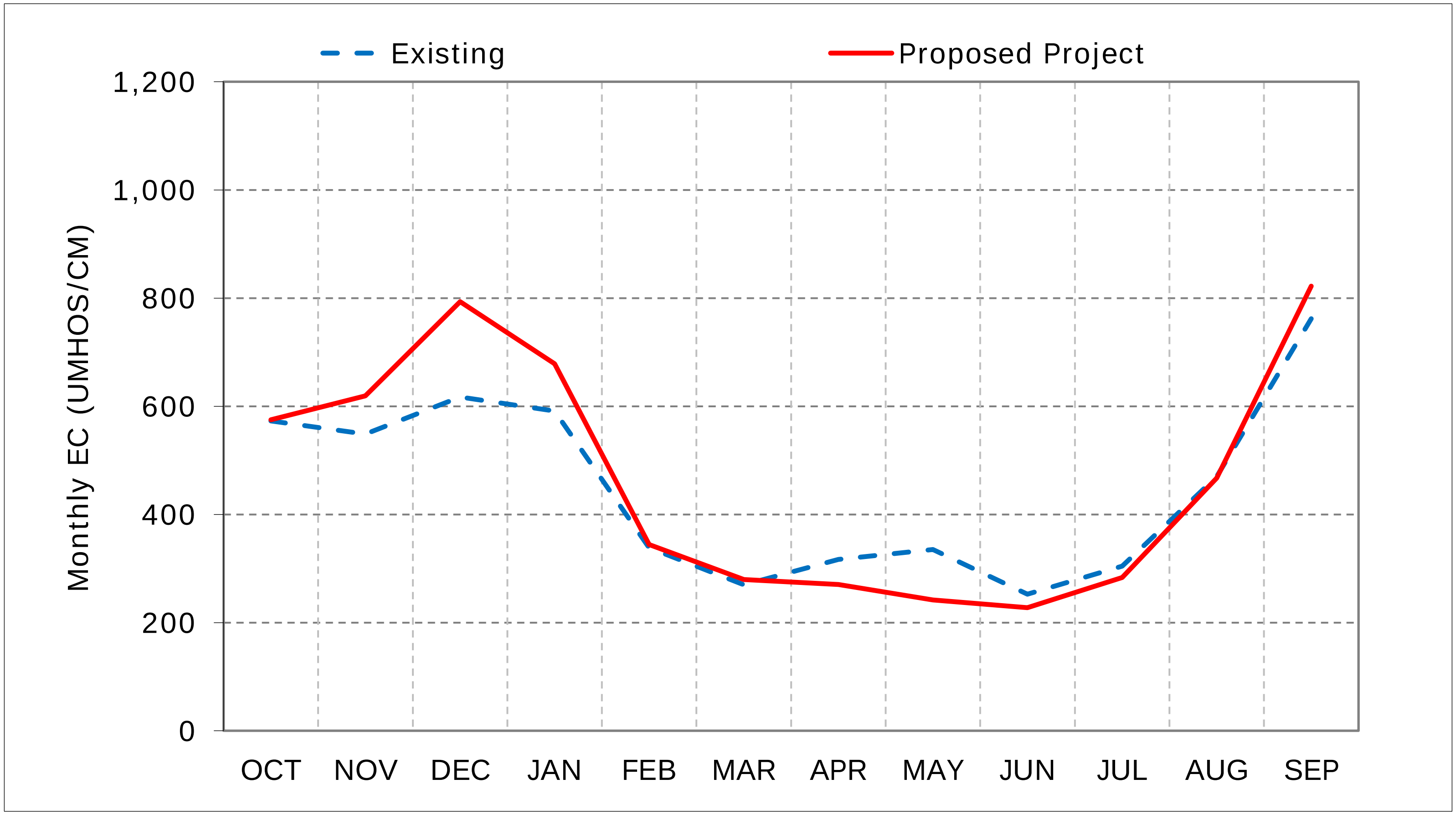
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 15-3. Old River at Rock Slough Salinity, Above Normal Year Average EC



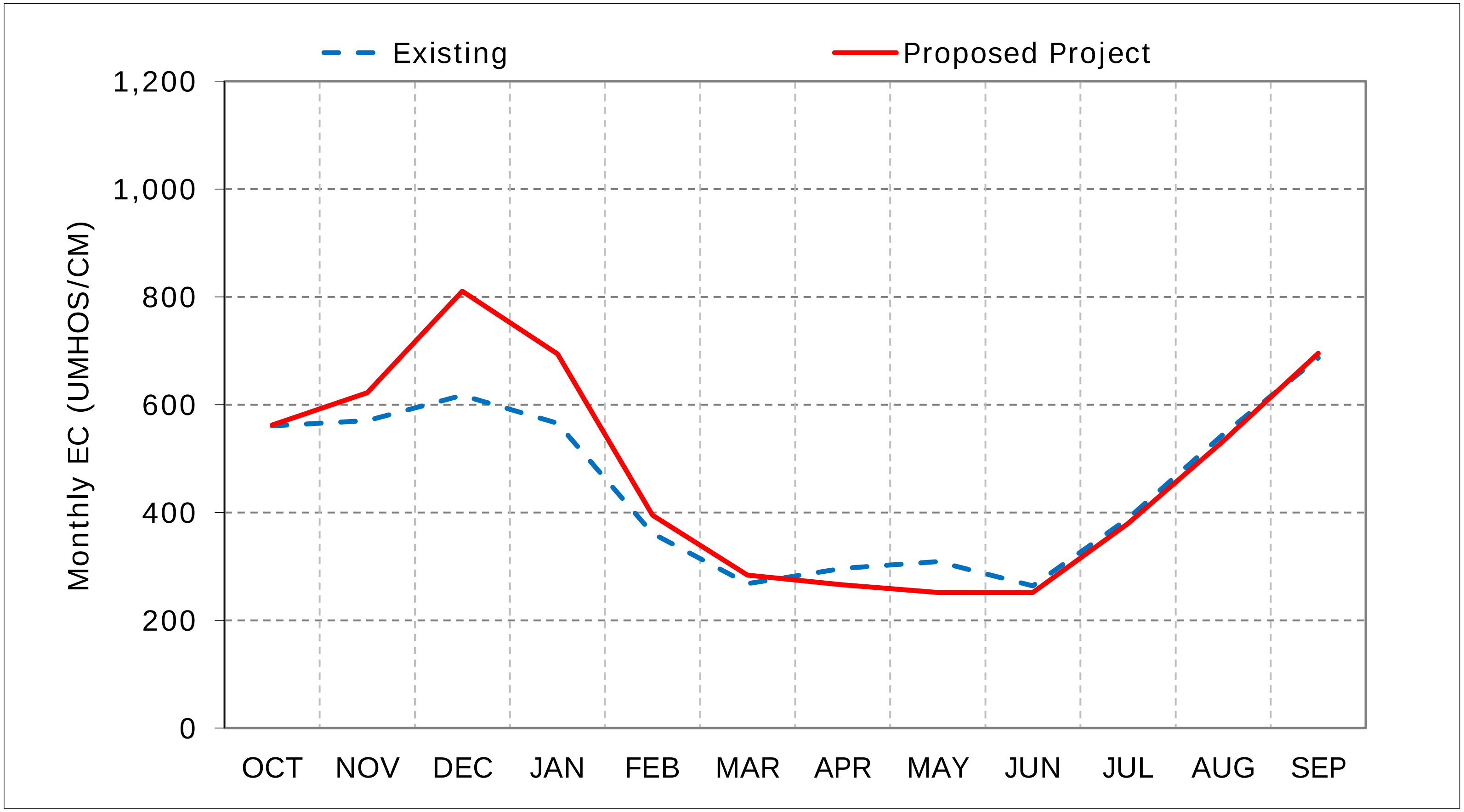
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 15-4. Old River at Rock Slough Salinity, Below Normal Year Average EC



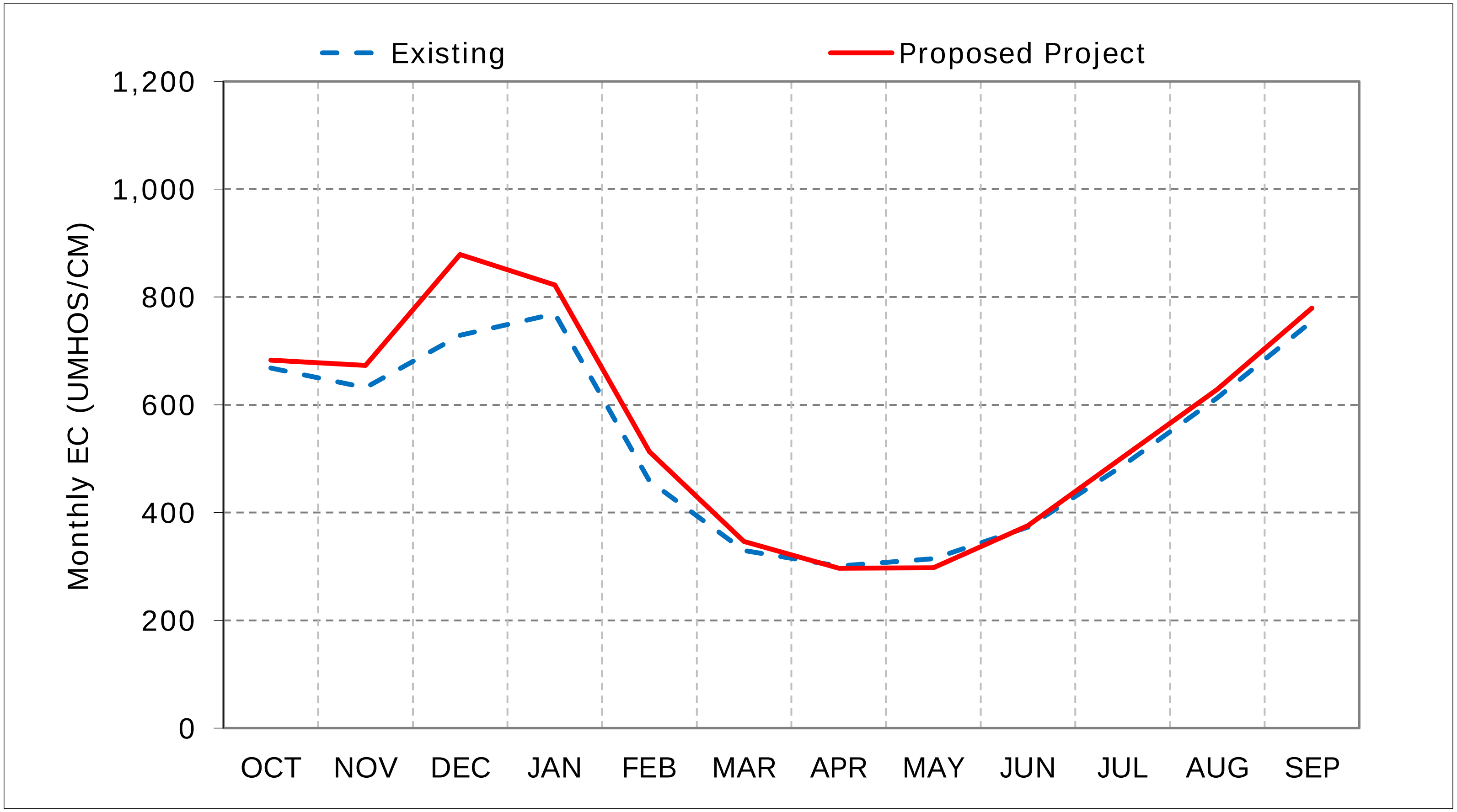
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 15-5. Old River at Rock Slough Salinity, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 15-6. Old River at Rock Slough Salinity, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 15-7. Old River at Rock Slough Salinity, January EC

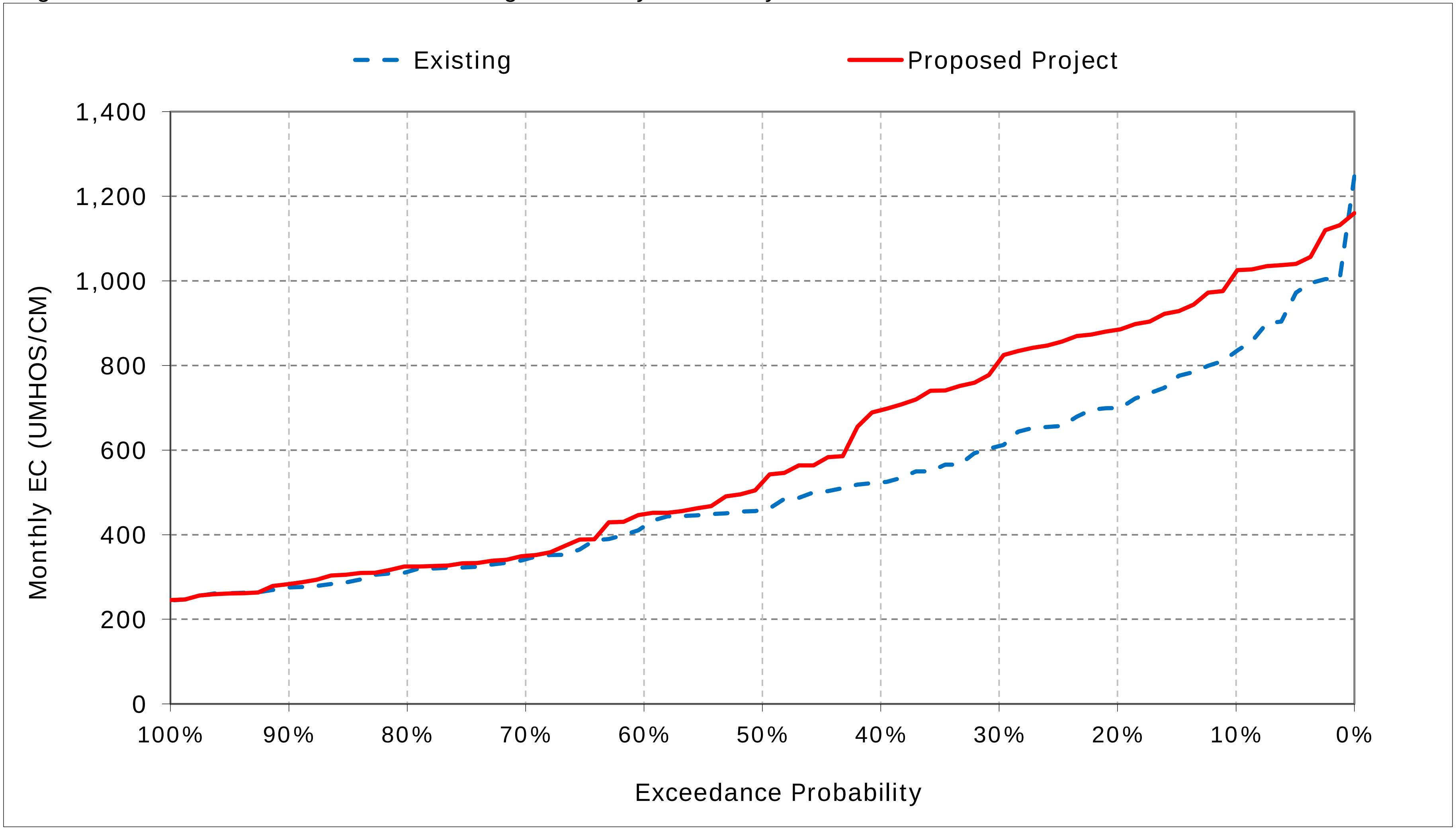


Figure 15-8. Old River at Rock Slough Salinity, February EC

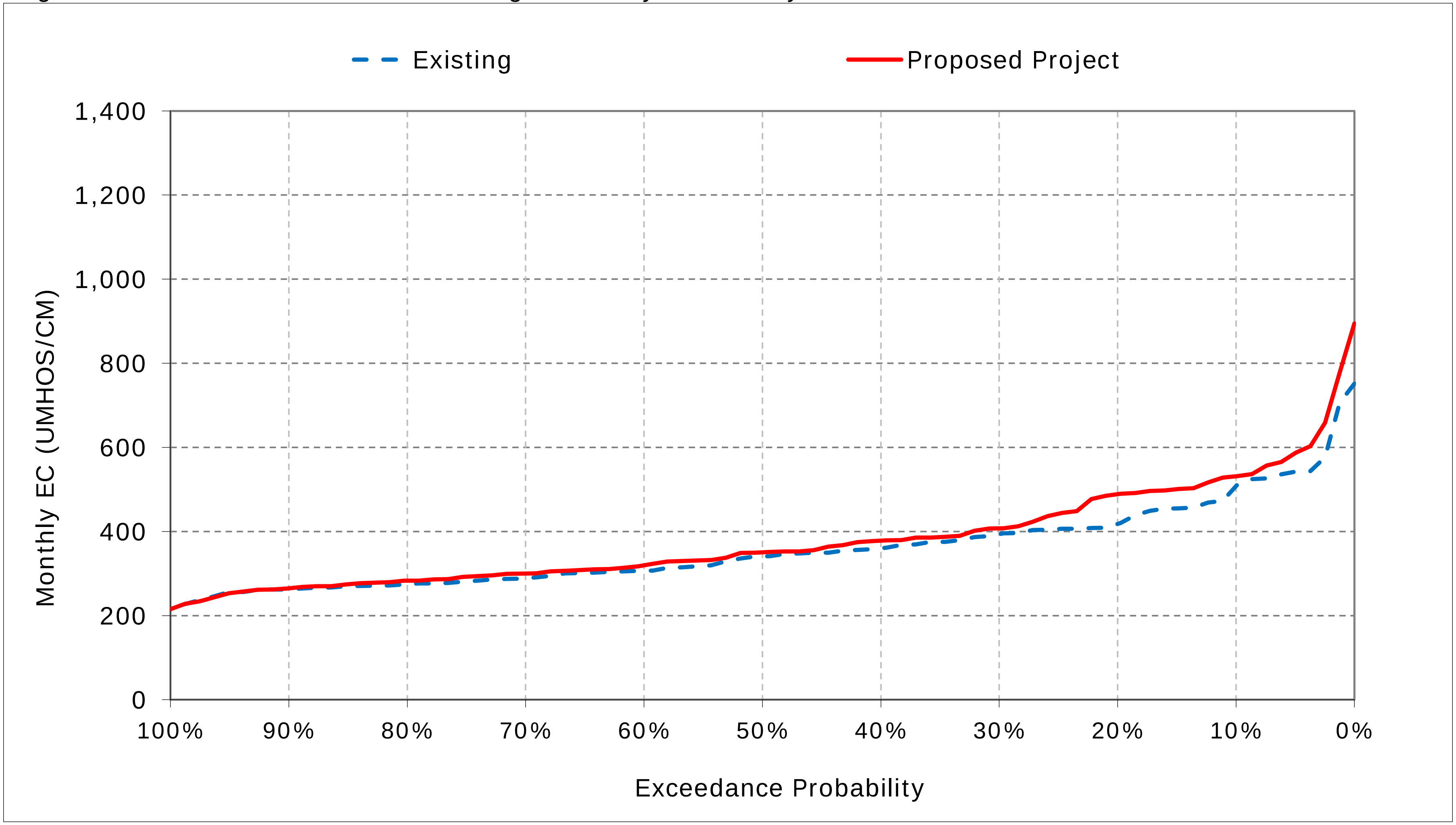


Figure 15-9. Old River at Rock Slough Salinity, March EC

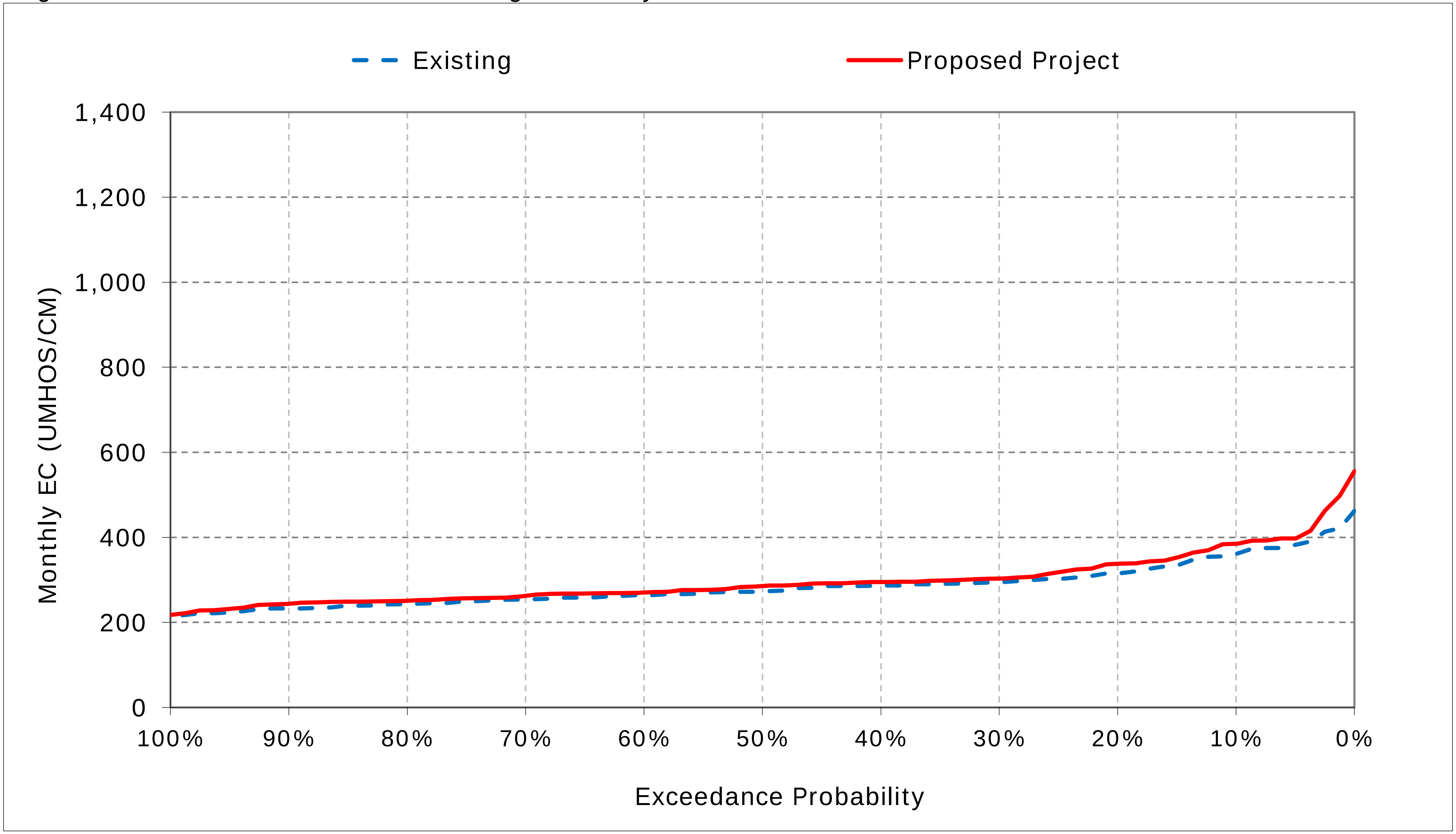


Figure 15-10. Old River at Rock Slough Salinity, April EC

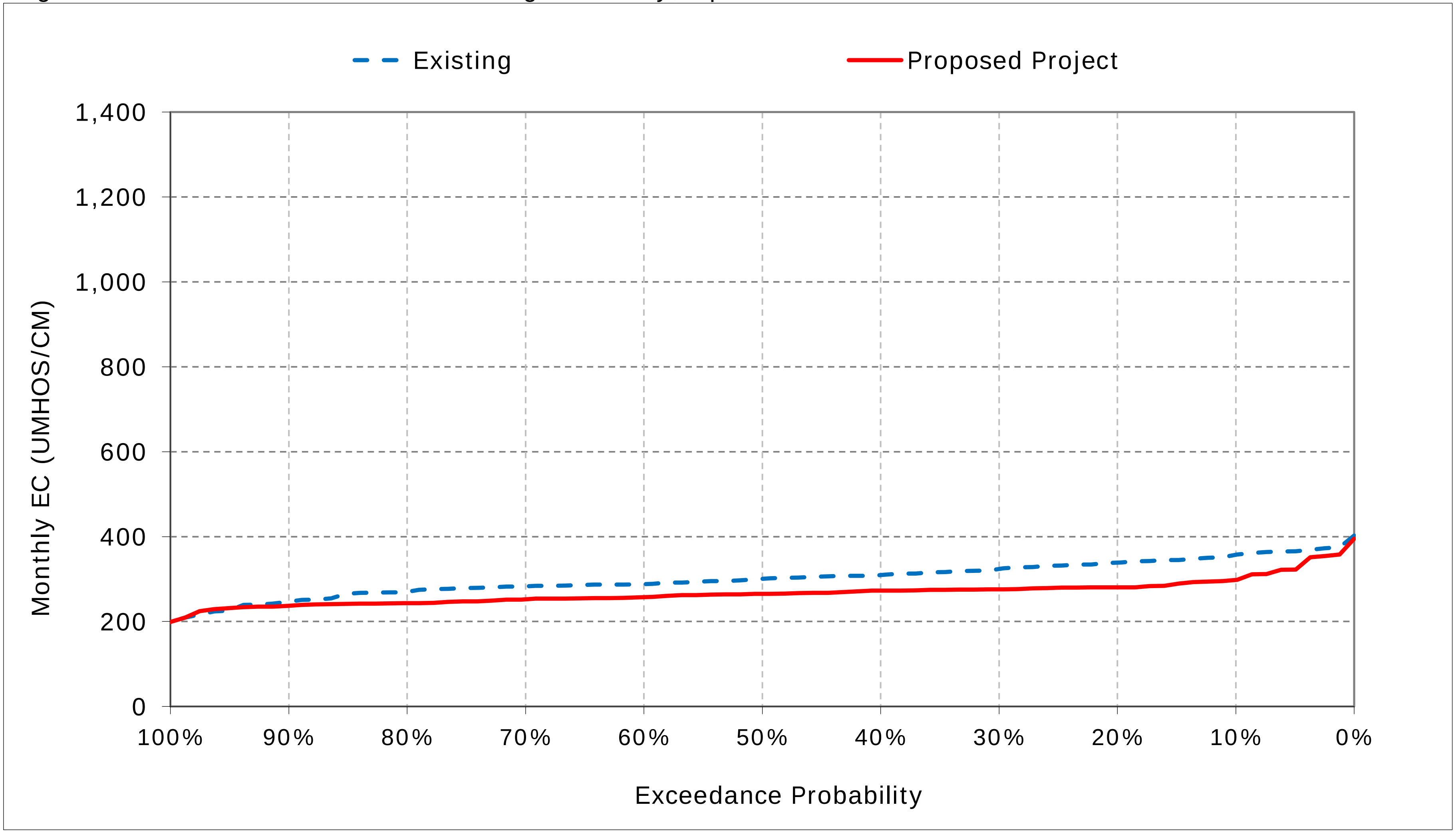


Figure 15-11. Old River at Rock Slough Salinity, May EC

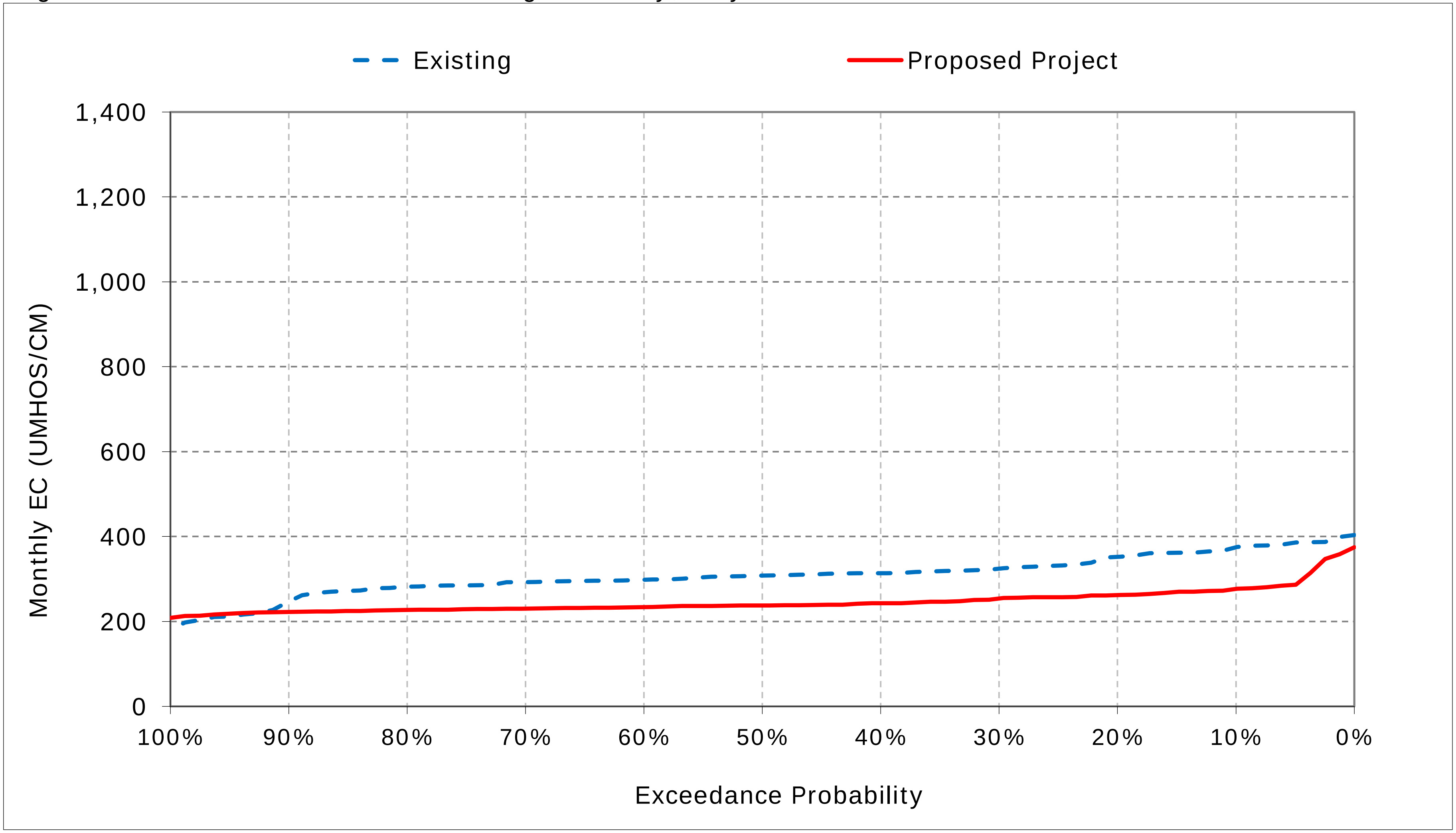


Figure 15-12. Old River at Rock Slough Salinity, June EC

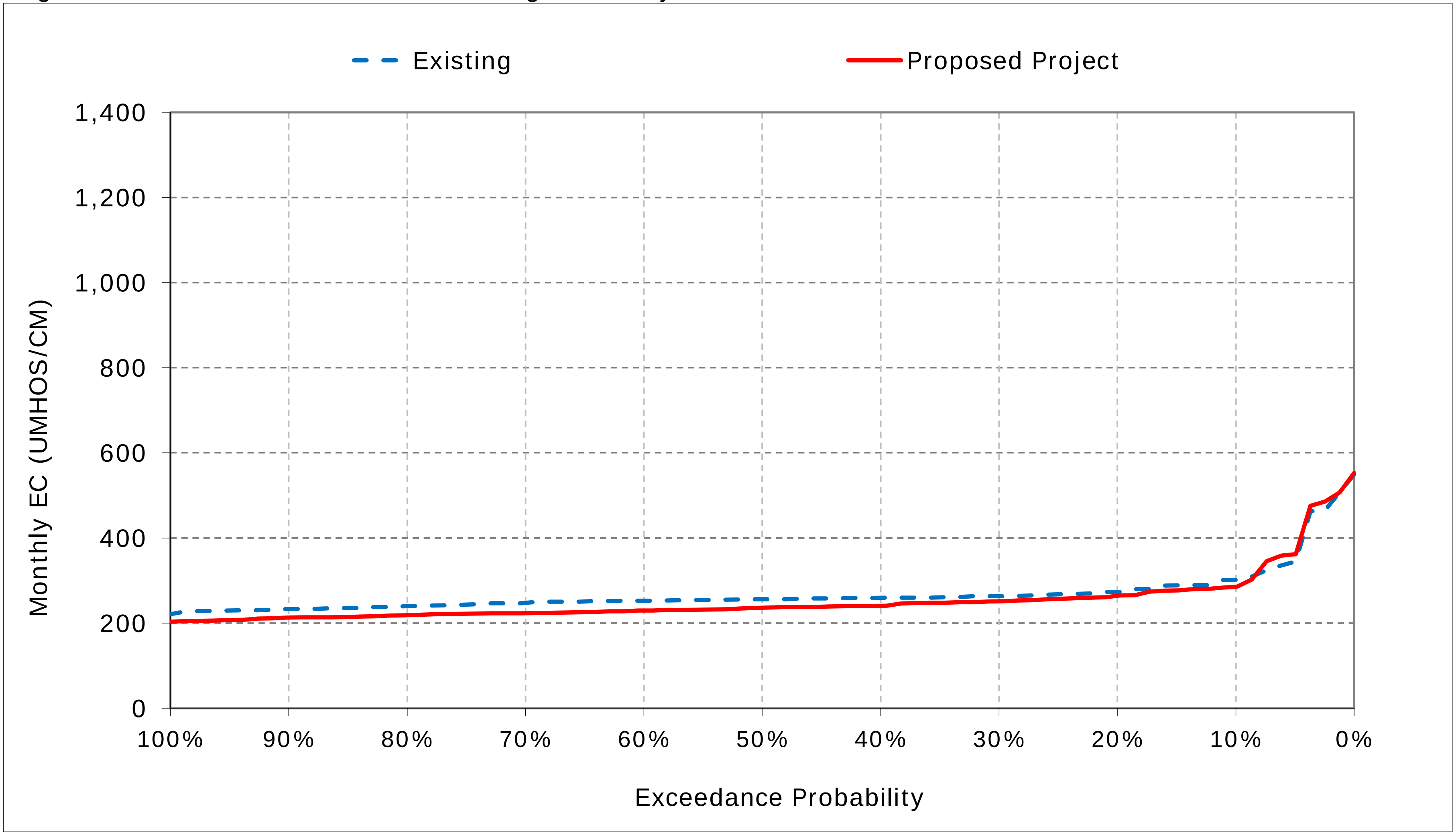


Figure 15-13. Old River at Rock Slough Salinity, July EC

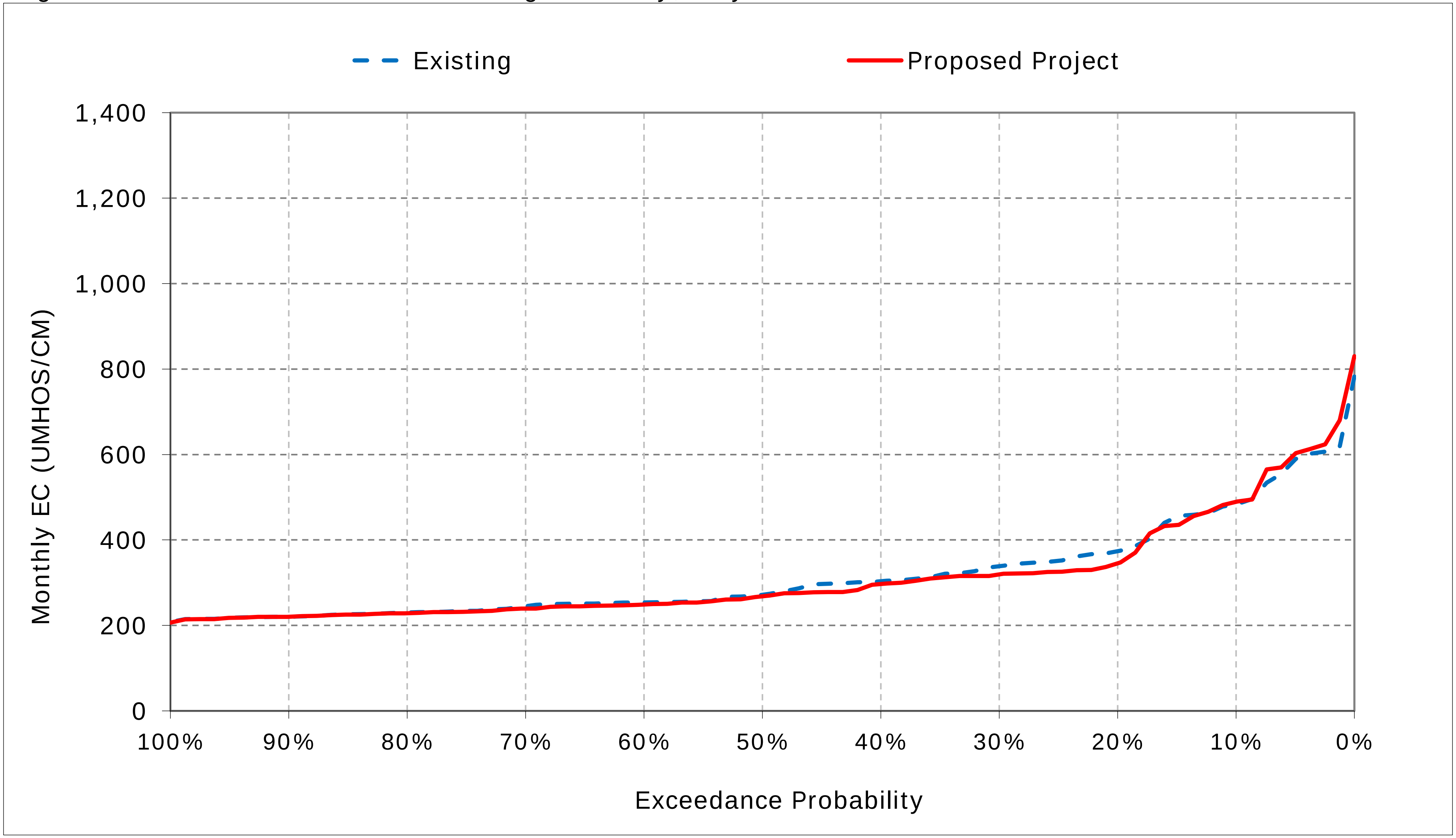


Figure 15-14. Old River at Rock Slough Salinity, August EC

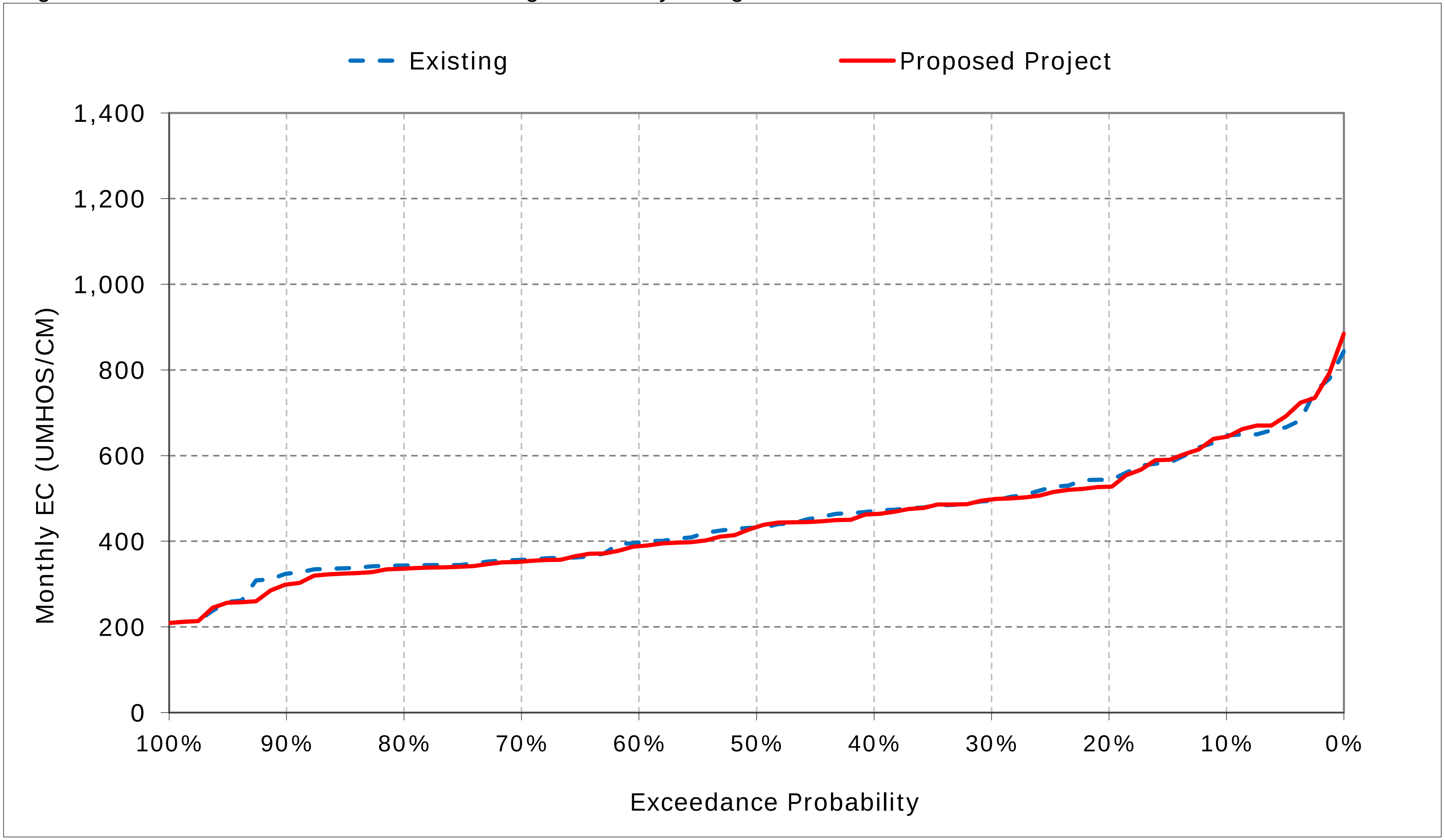


Figure 15-15. Old River at Rock Slough Salinity, September EC

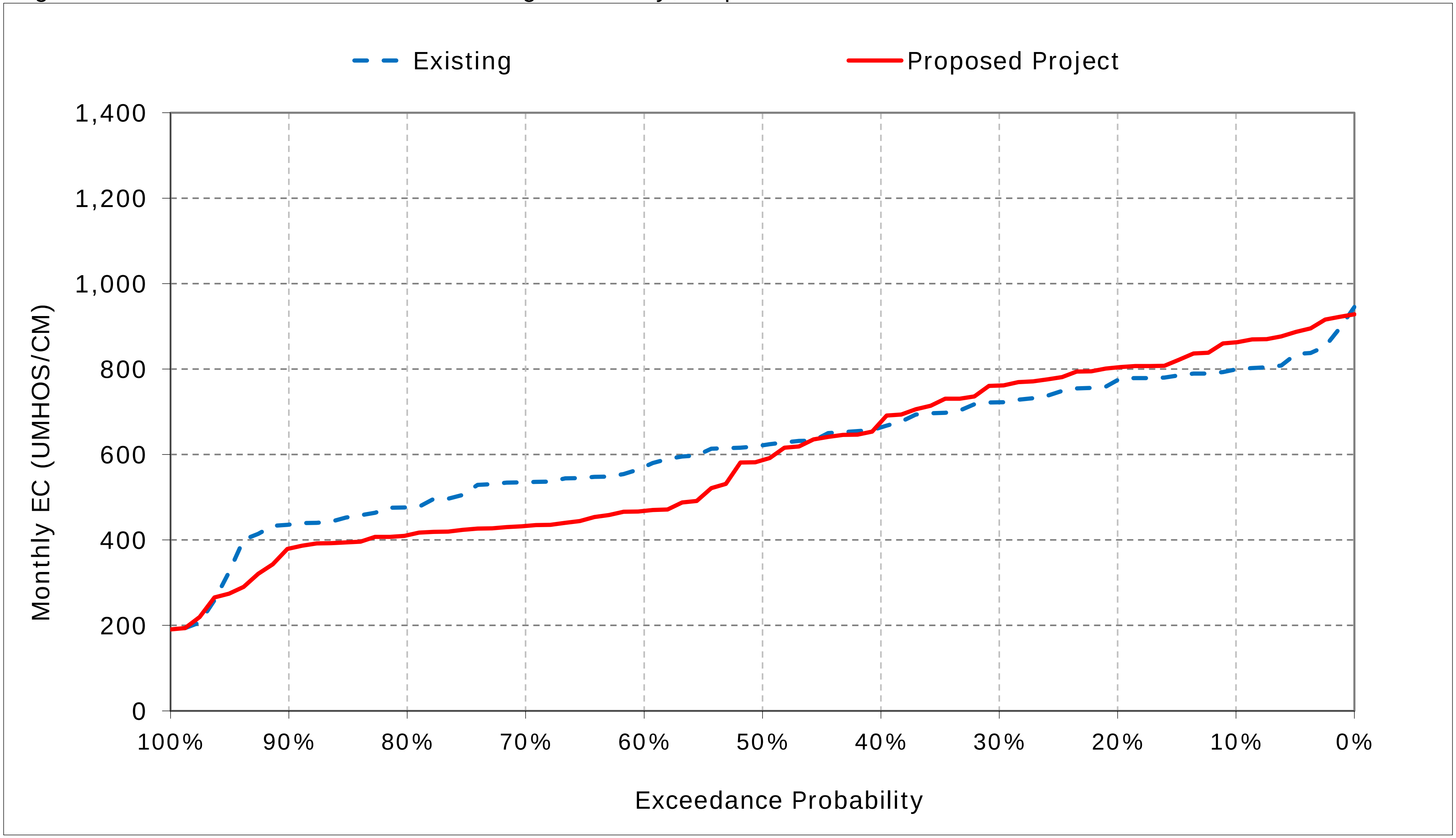


Figure 15-16. Old River at Rock Slough Salinity, October EC

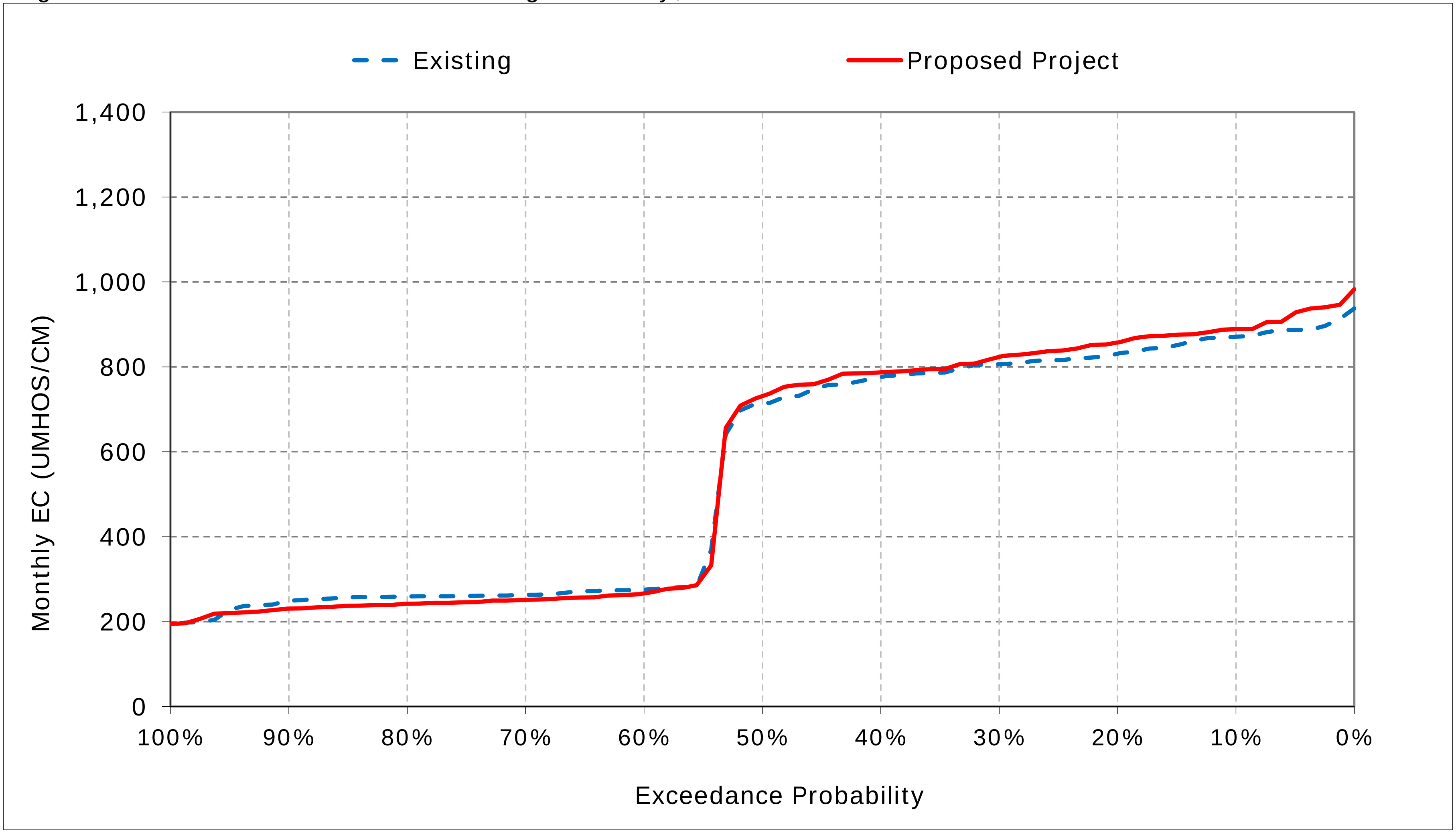


Figure 15-17. Old River at Rock Slough Salinity, November EC

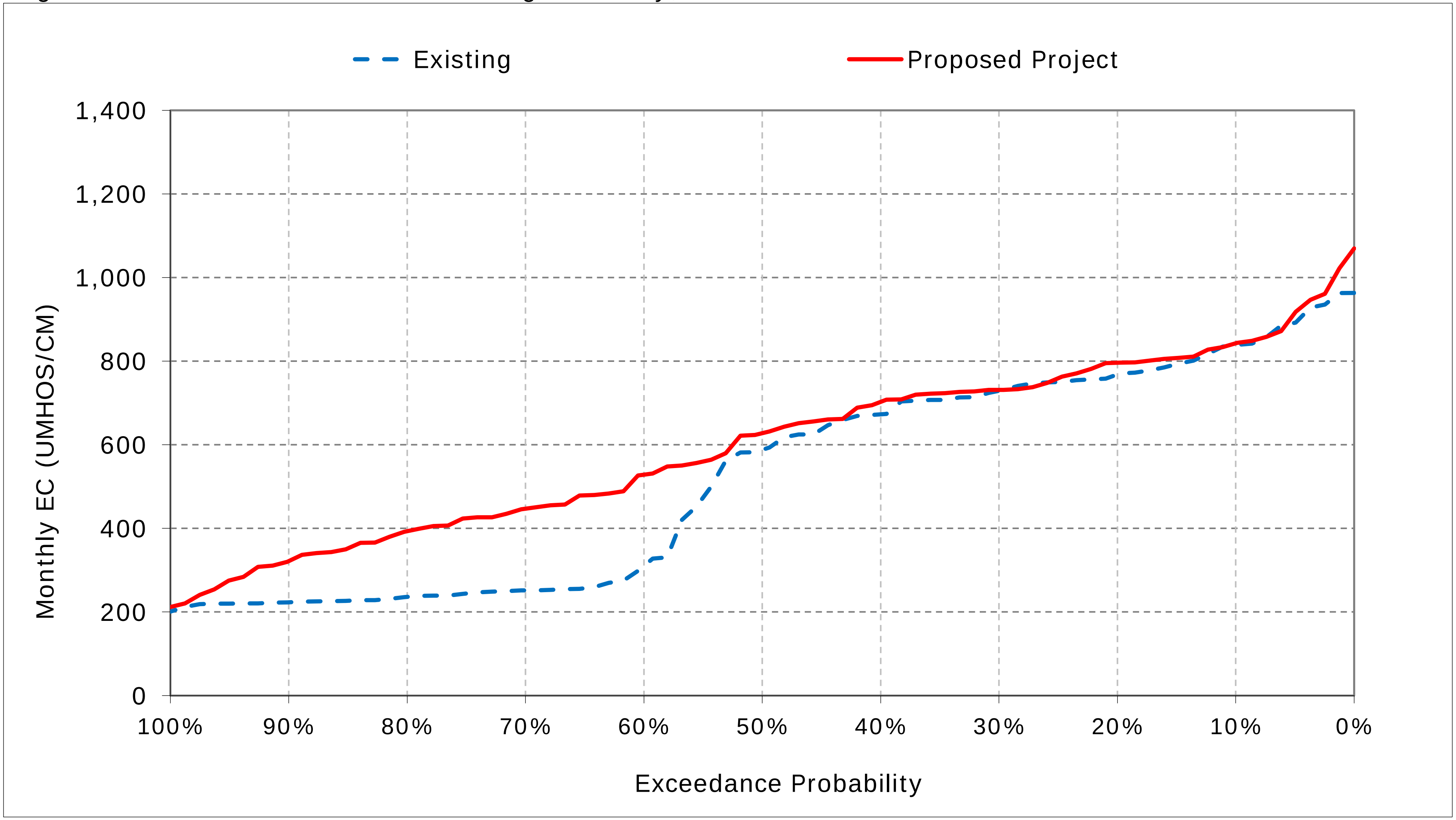


Figure 15-18. Old River at Rock Slough Salinity, December EC

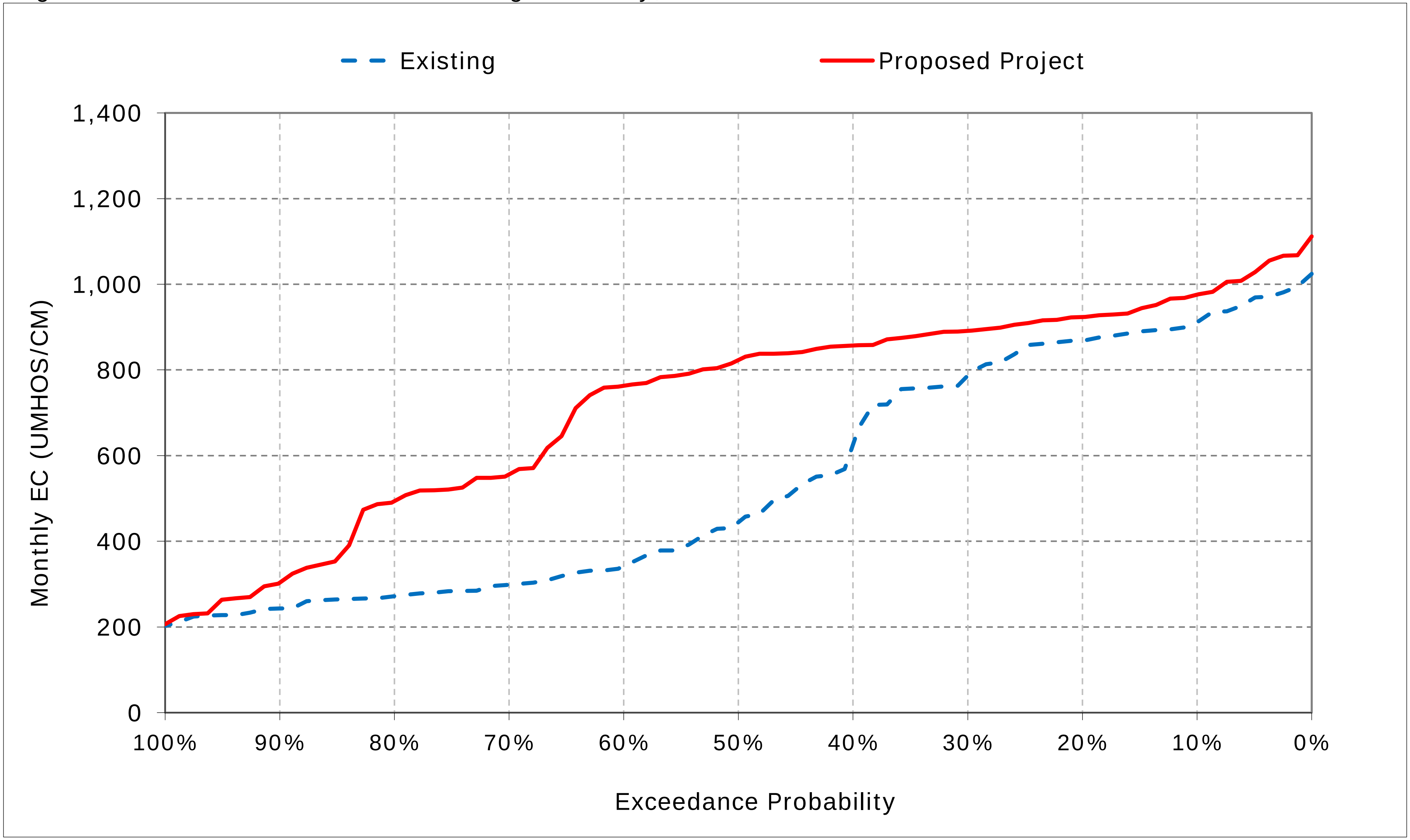


Table 16-1. Banks Pumping Plant South Delta Exports Salinity, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	667	668	727	769	621	518	467	469	430	401	532	593
20%	641	604	685	726	567	454	433	442	384	367	435	566
30%	625	592	660	604	520	432	407	427	370	322	393	545
40%	599	570	603	561	503	409	390	414	364	315	380	530
50%	572	549	441	516	461	392	377	397	354	310	351	496
60%	357	336	371	491	443	380	360	385	347	300	328	472
70%	336	311	329	455	418	361	346	360	341	282	311	456
80%	314	301	305	418	398	336	310	334	325	274	304	427
90%	296	294	294	384	346	311	267	230	294	266	293	401
Long Term												
Full Simulation Period[a]	486	469	499	555	477	401	372	381	358	323	376	490
Water Year Types[b]												
Wet (32%)	433	403	409	434	393	337	299	300	312	282	303	437
Above Normal (15%)	528	500	500	554	494	396	362	374	348	285	310	412
Below Normal (17%)	500	478	533	618	483	404	384	398	354	298	382	565
Dry (22%)	484	489	540	582	510	434	420	433	377	341	445	518
Critical (15%)	546	545	589	706	586	487	458	462	447	451	488	555

Proposed Project

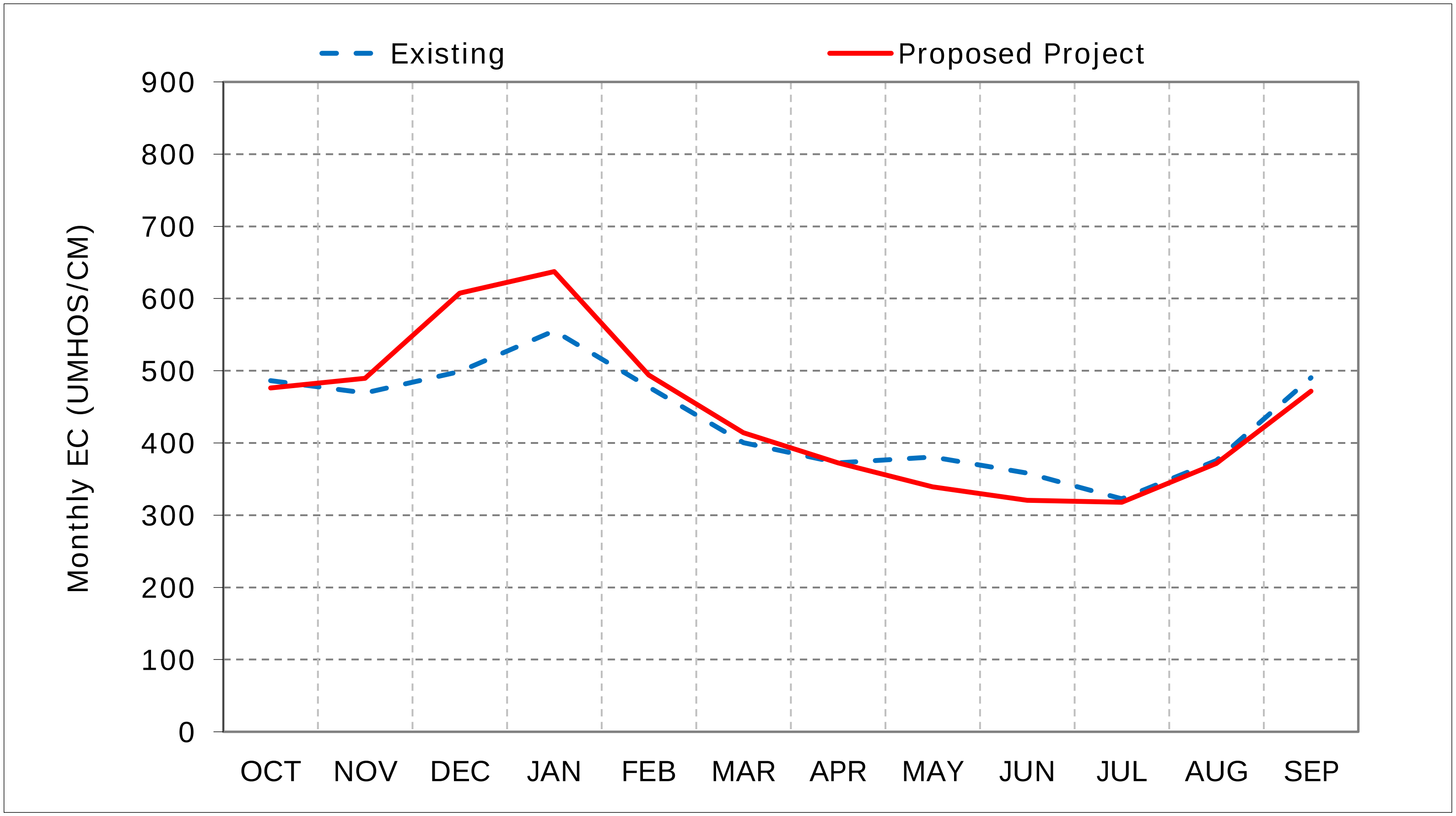
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	699	653	750	912	684	524	452	423	378	399	533	608
20%	660	630	708	850	615	484	434	391	338	357	416	585
30%	636	591	694	764	558	461	410	376	324	320	389	549
40%	598	580	666	721	518	430	396	347	313	312	373	497
50%	588	558	644	600	502	404	384	332	308	301	348	456
60%	295	395	626	531	444	391	350	320	305	295	328	424
70%	287	363	579	494	419	368	333	311	294	280	310	399
80%	280	331	499	432	388	337	311	302	287	265	303	386
90%	274	310	347	399	337	321	283	257	281	260	284	361
Long Term												
Full Simulation Period[a]	476	490	607	637	494	414	372	339	321	318	371	472
Water Year Types[b]												
Wet (32%)	418	428	507	469	390	342	297	272	288	280	298	361
Above Normal (15%)	520	543	657	698	520	415	356	315	300	277	310	405
Below Normal (17%)	483	495	632	705	495	416	382	340	303	288	375	596
Dry (22%)	473	499	648	701	543	456	427	383	328	336	434	519
Critical (15%)	554	549	685	766	619	503	457	443	421	448	494	565

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	32	-15	23	143	63	6	-16	-47	-52	-3	1	15
20%	19	26	23	124	48	30	1	-51	-46	-10	-19	19
30%	11	-1	34	160	38	29	3	-52	-46	-3	-4	5
40%	-2	10	64	160	15	21	5	-67	-51	-3	-7	-32
50%	16	8	202	84	41	12	7	-64	-47	-8	-2	-40
60%	-62	59	255	39	1	11	-10	-65	-43	-5	1	-47
70%	-49	52	250	39	0	6	-13	-49	-47	-2	-1	-56
80%	-34	30	194	14	-11	0	2	-32	-38	-9	0	-41
90%	-22	16	53	15	-9	11	16	26	-13	-6	-9	-40
Long Term												
Full Simulation Period[a]	-10	20	109	82	17	13	0	-41	-38	-5	-4	-18
Water Year Types[b]												
Wet (32%)	-15	25	98	35	-3	4	-1	-28	-23	-1	-5	-76
Above Normal (15%)	-9	43	156	145	26	19	-6	-59	-47	-8	1	-8
Below Normal (17%)	-16	17	100	87	12	12	-2	-59	-51	-11	-7	31
Dry (22%)	-11	11	109	119	33	22	8	-50	-49	-4	-11	1
Critical (15%)	9	4	96	60	33	16	-1	-19	-26	-3	5	10

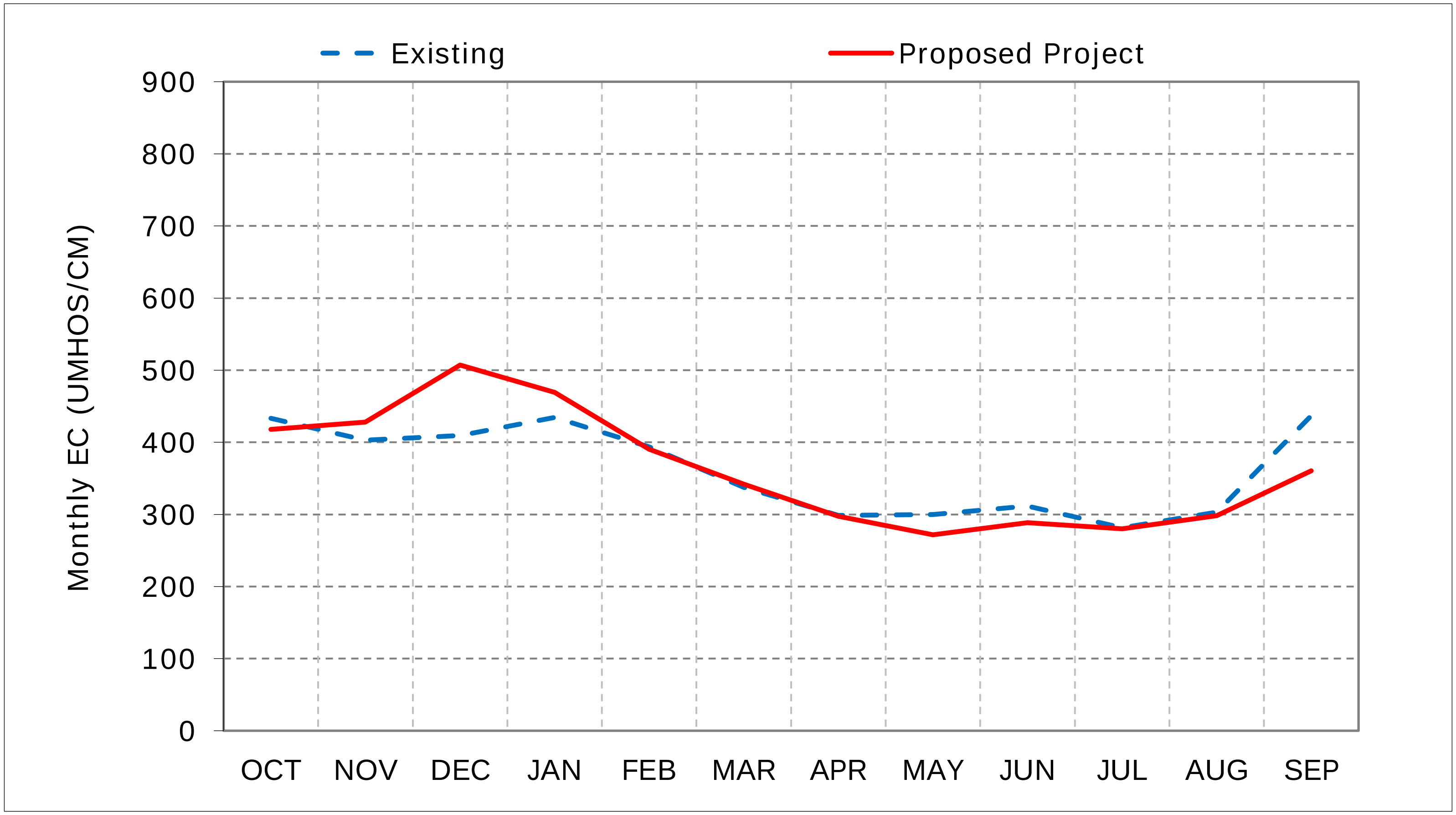
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 16-1. Banks Pumping Plant South Delta Exports Salinity, Long-Term Averag



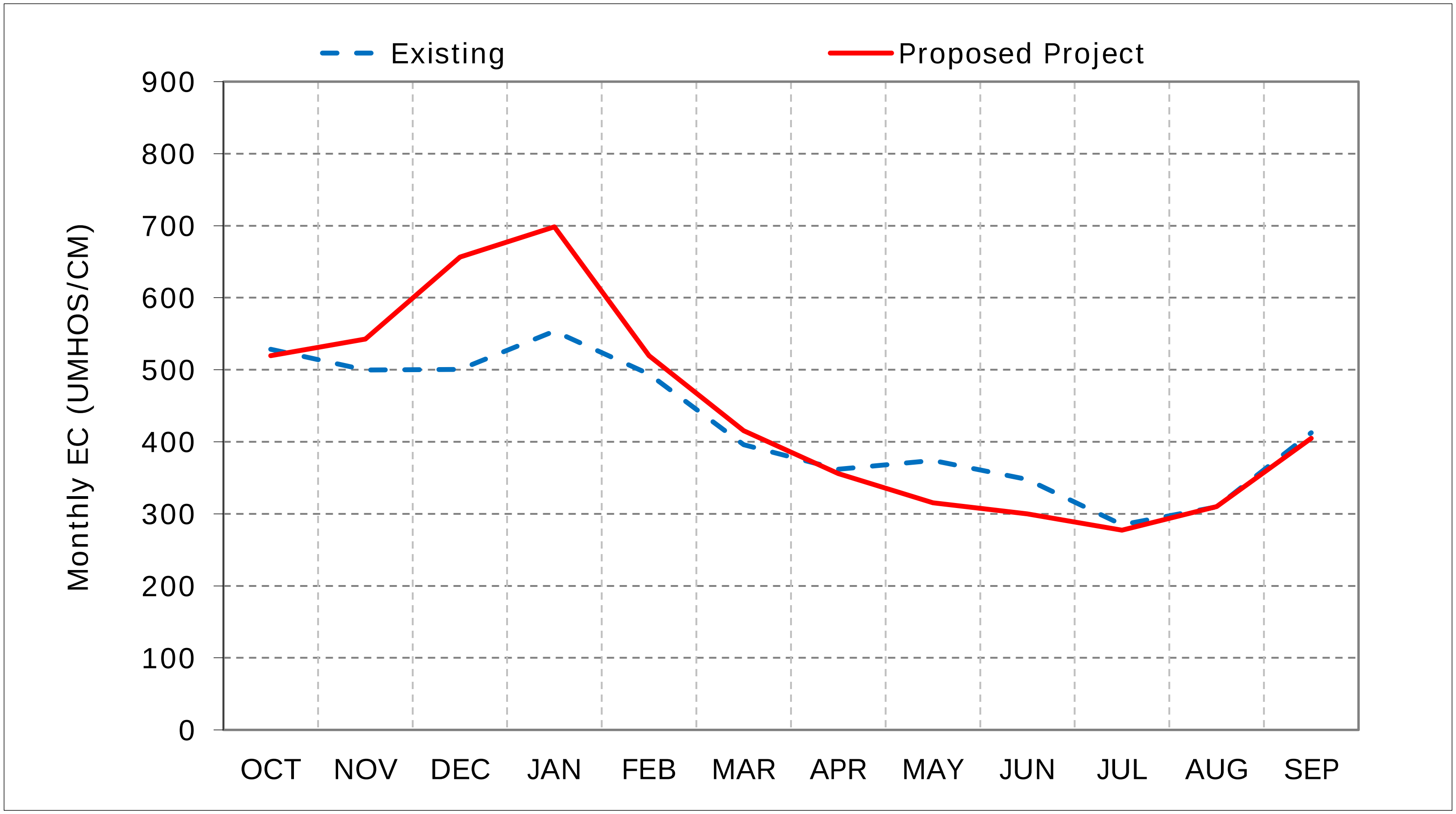
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 16-2. Banks Pumping Plant South Delta Exports Salinity, Wet Year Average



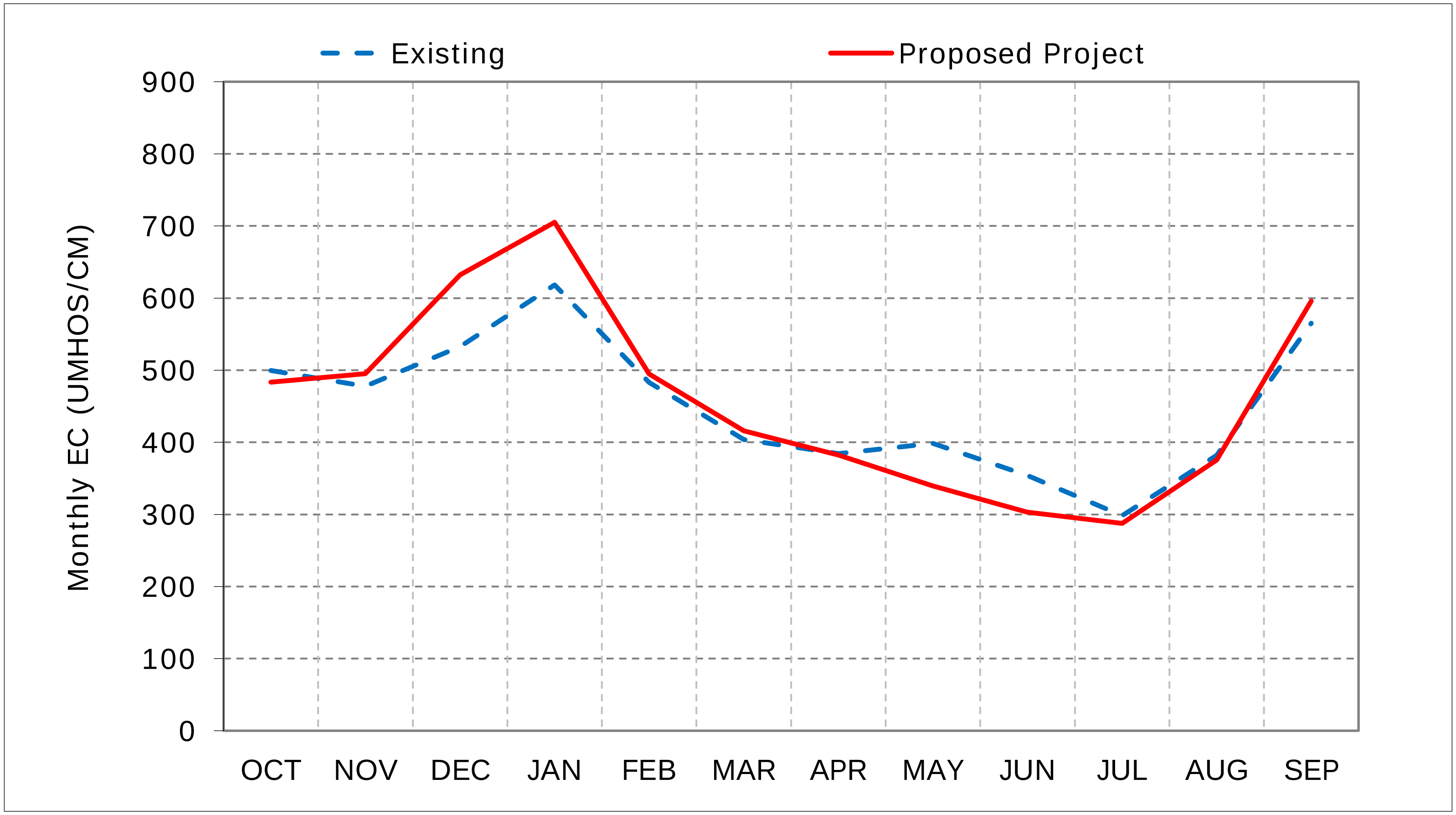
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 16-3. Banks Pumping Plant South Delta Exports Salinity, Above Normal Yea



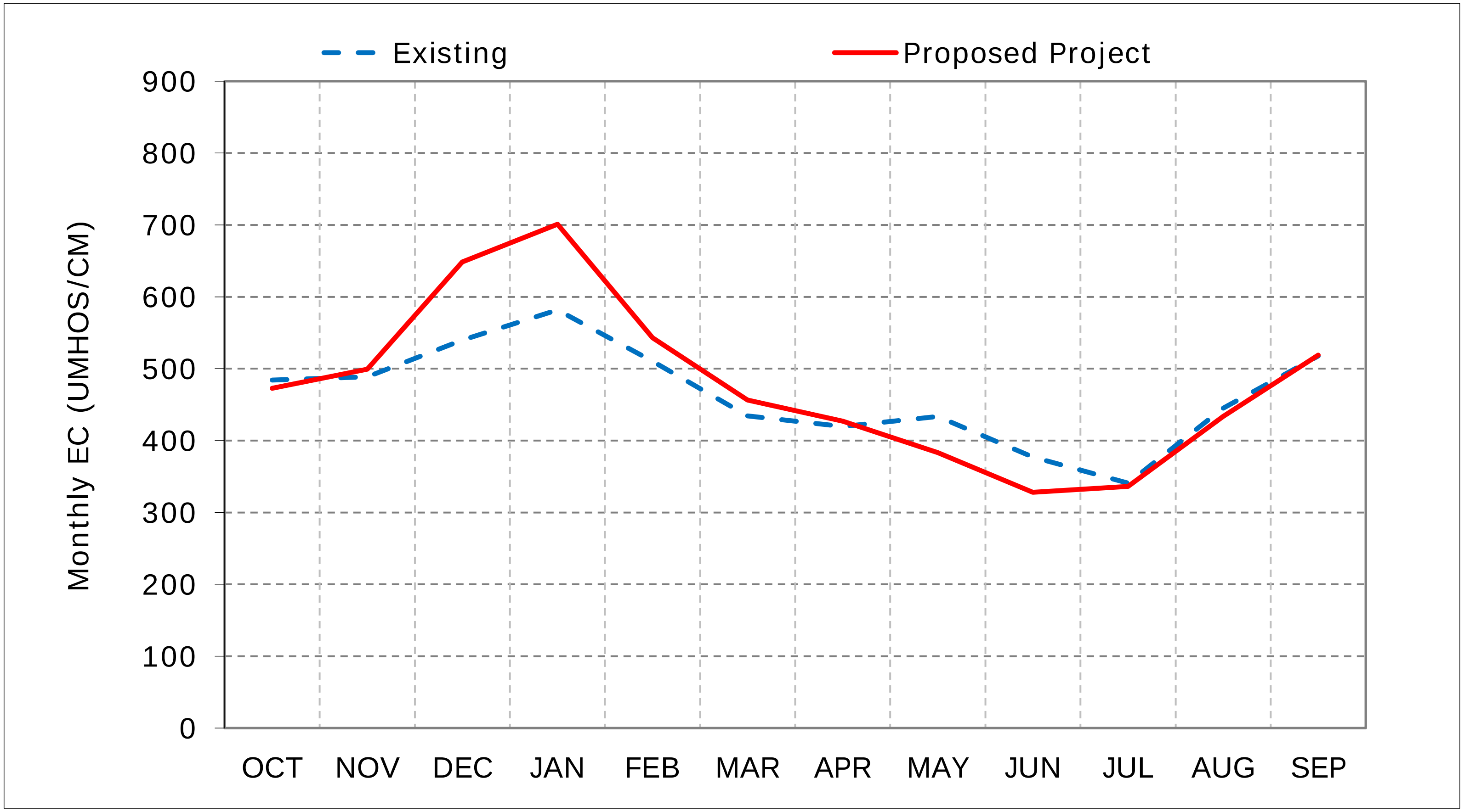
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 16-4. Banks Pumping Plant South Delta Exports Salinity, Below Normal Yea



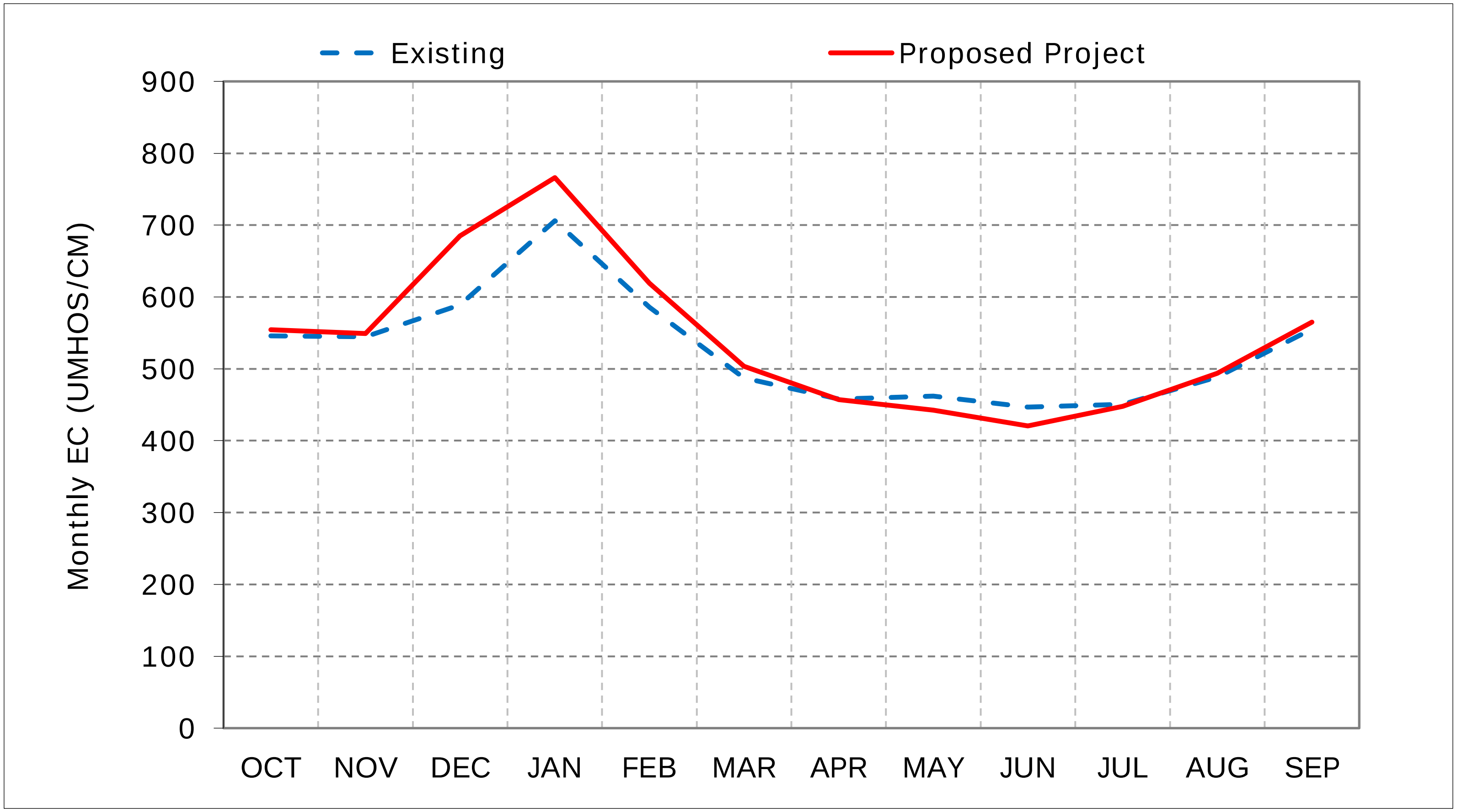
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 16-5. Banks Pumping Plant South Delta Exports Salinity, Dry Year Average



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 16-6. Banks Pumping Plant South Delta Exports Salinity, Critical Year Avera



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 16-7. Banks Pumping Plant South Delta Exports Salinity, January EC

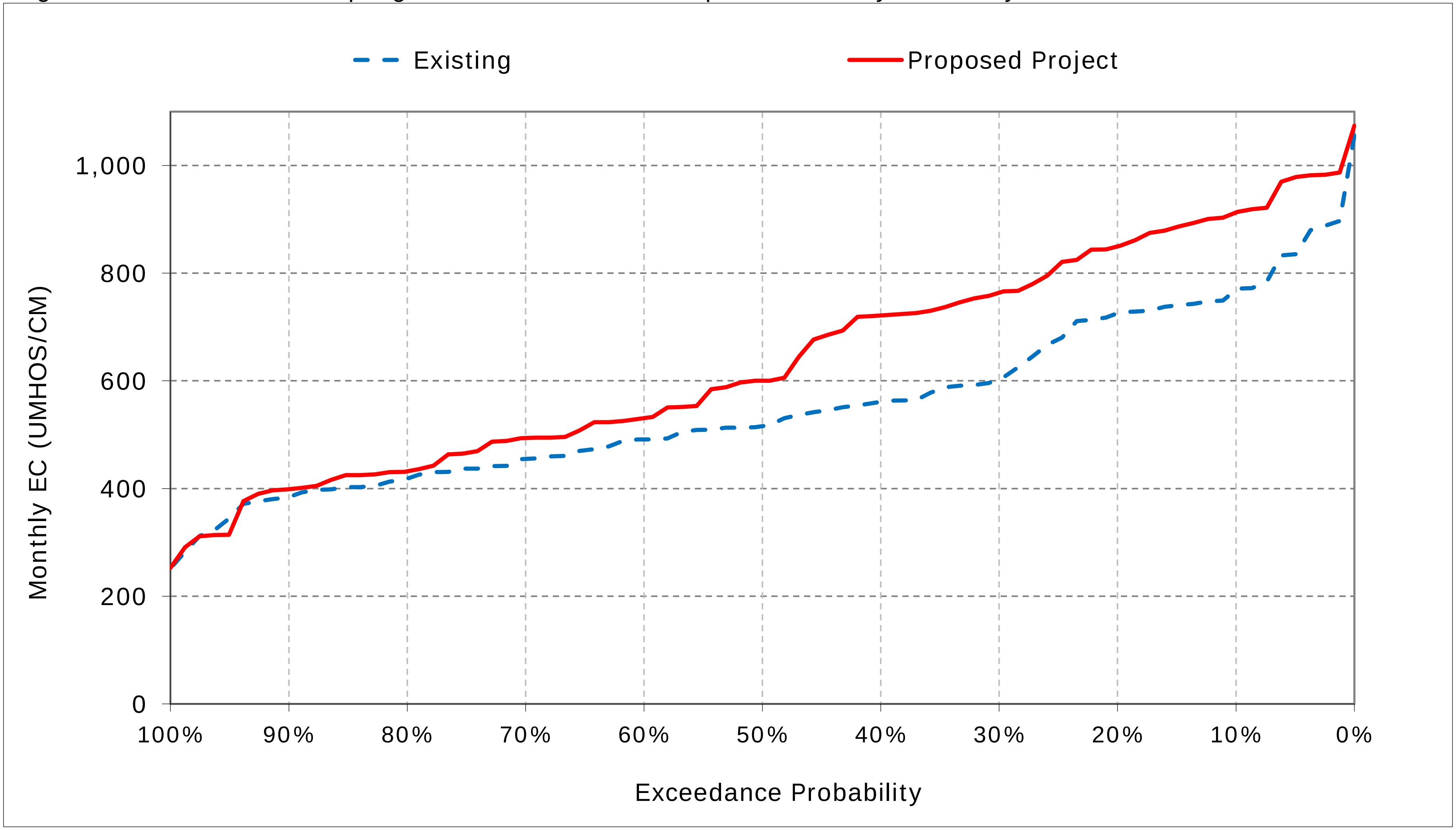


Figure 16-8. Banks Pumping Plant South Delta Exports Salinity, February EC

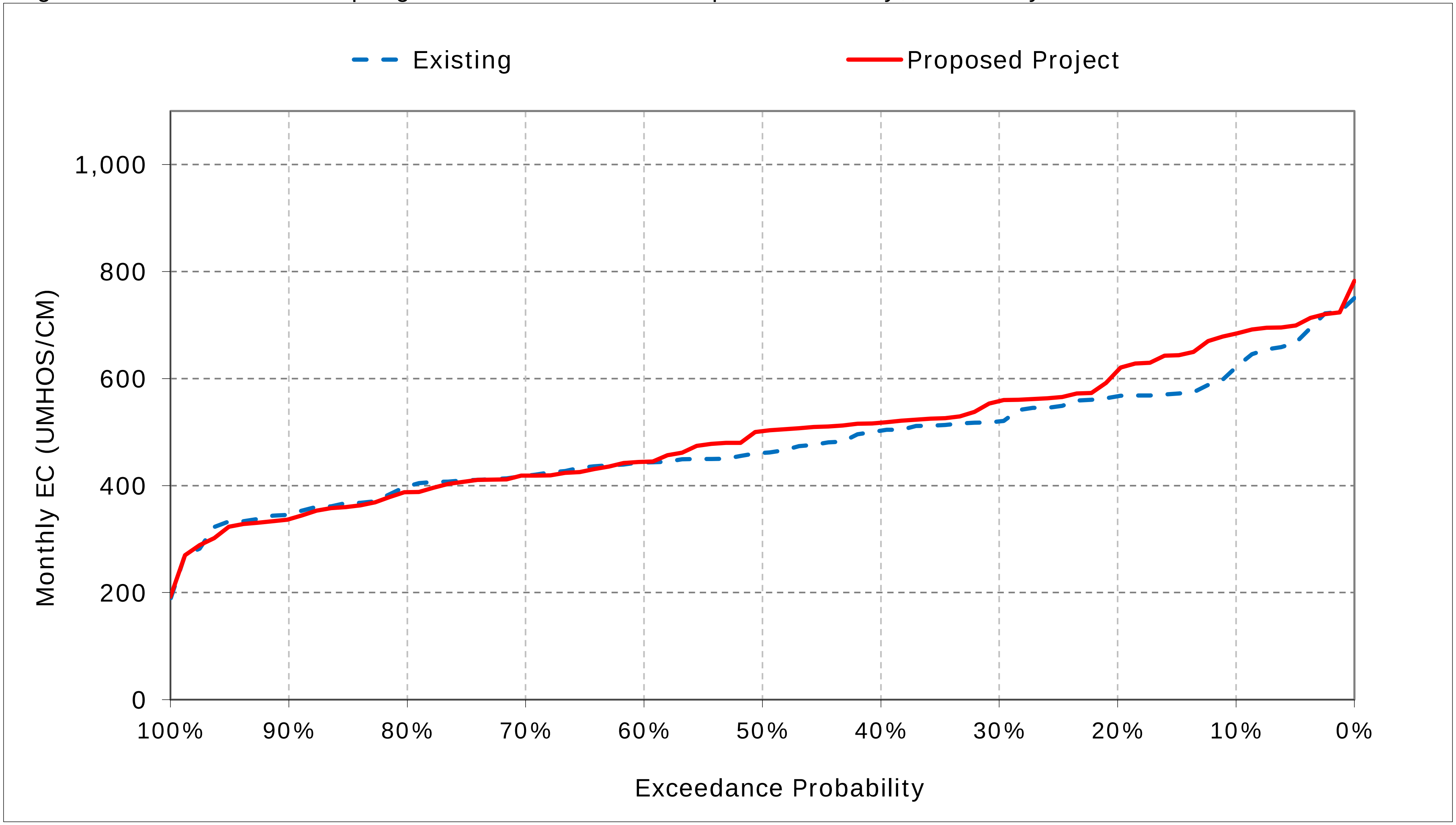


Figure 16-9. Banks Pumping Plant South Delta Exports Salinity, March EC

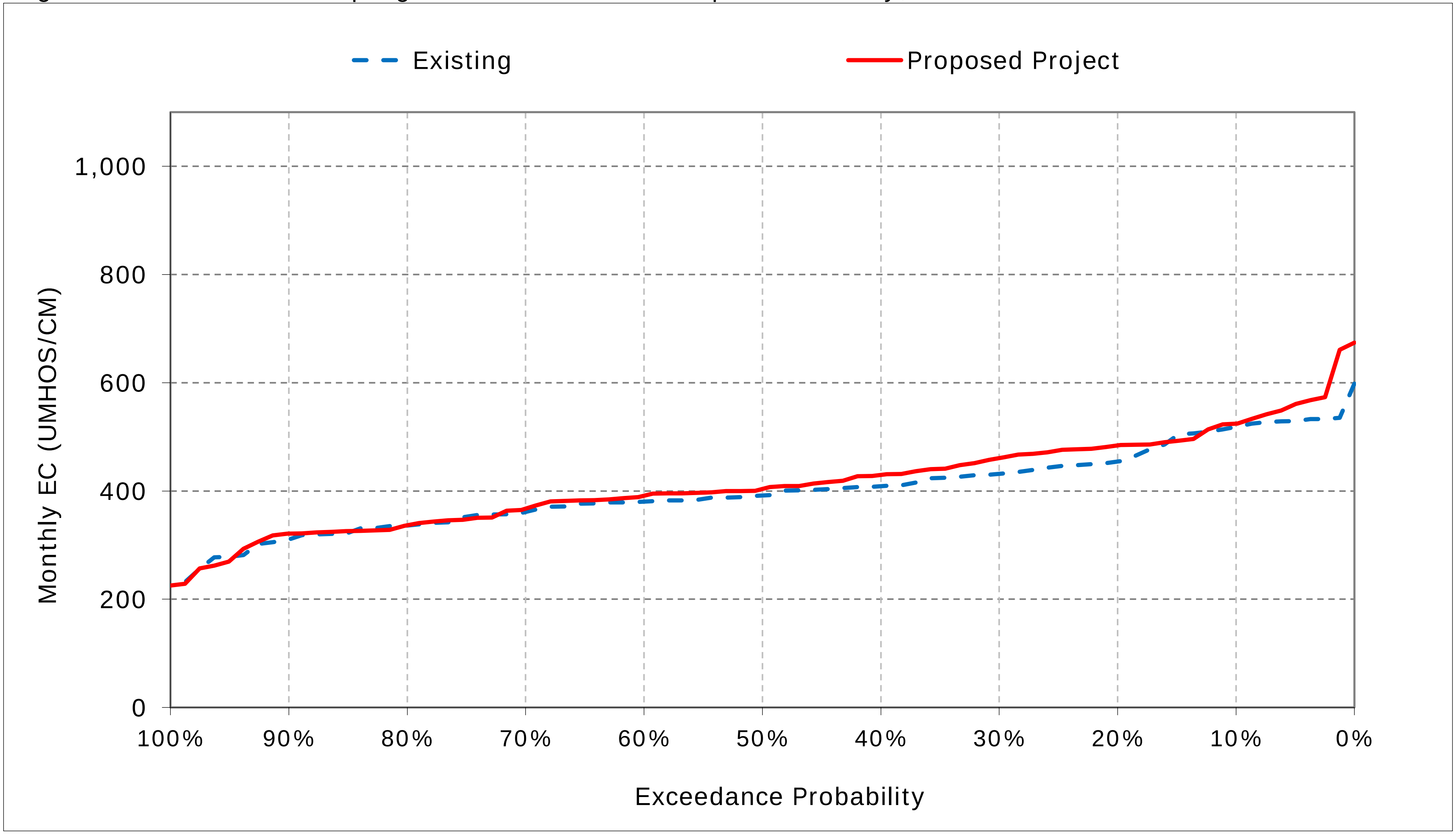


Figure 16-10. Banks Pumping Plant South Delta Exports Salinity, April EC

Figure 16-11. Banks Pumping Plant South Delta Exports Salinity, May EC

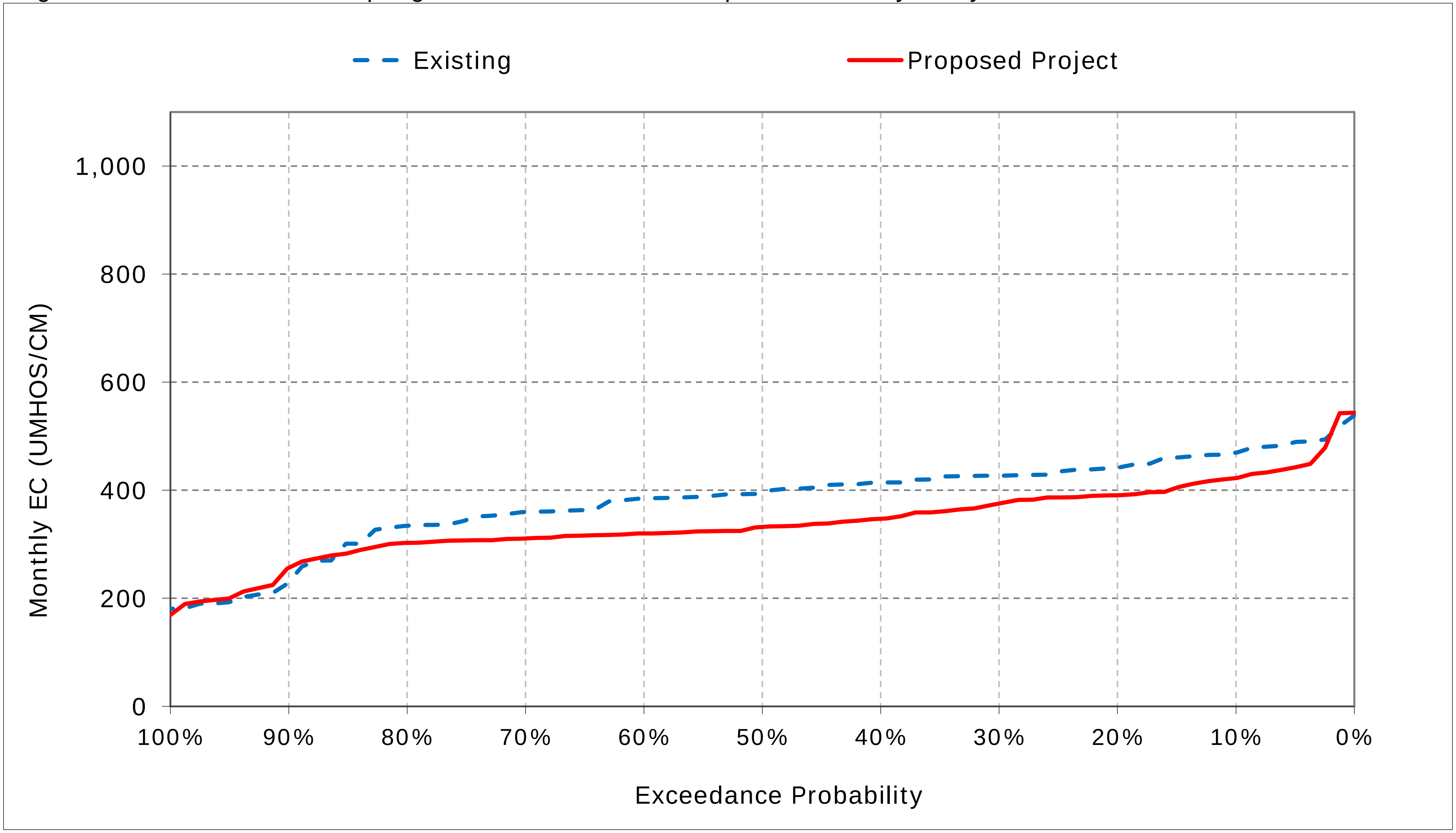


Figure 16-12. Banks Pumping Plant South Delta Exports Salinity, June EC

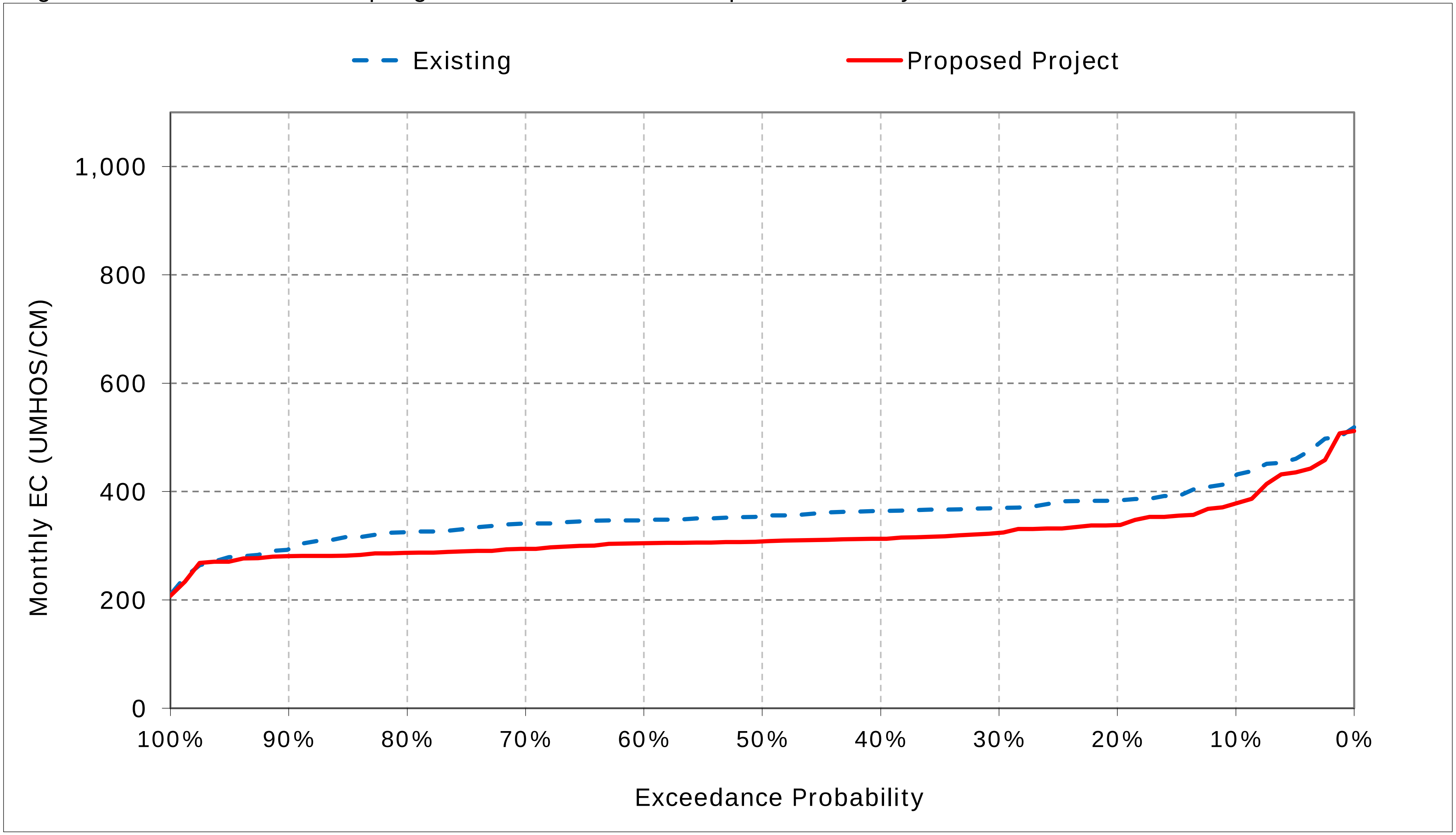


Figure 16-13. Banks Pumping Plant South Delta Exports Salinity, July EC

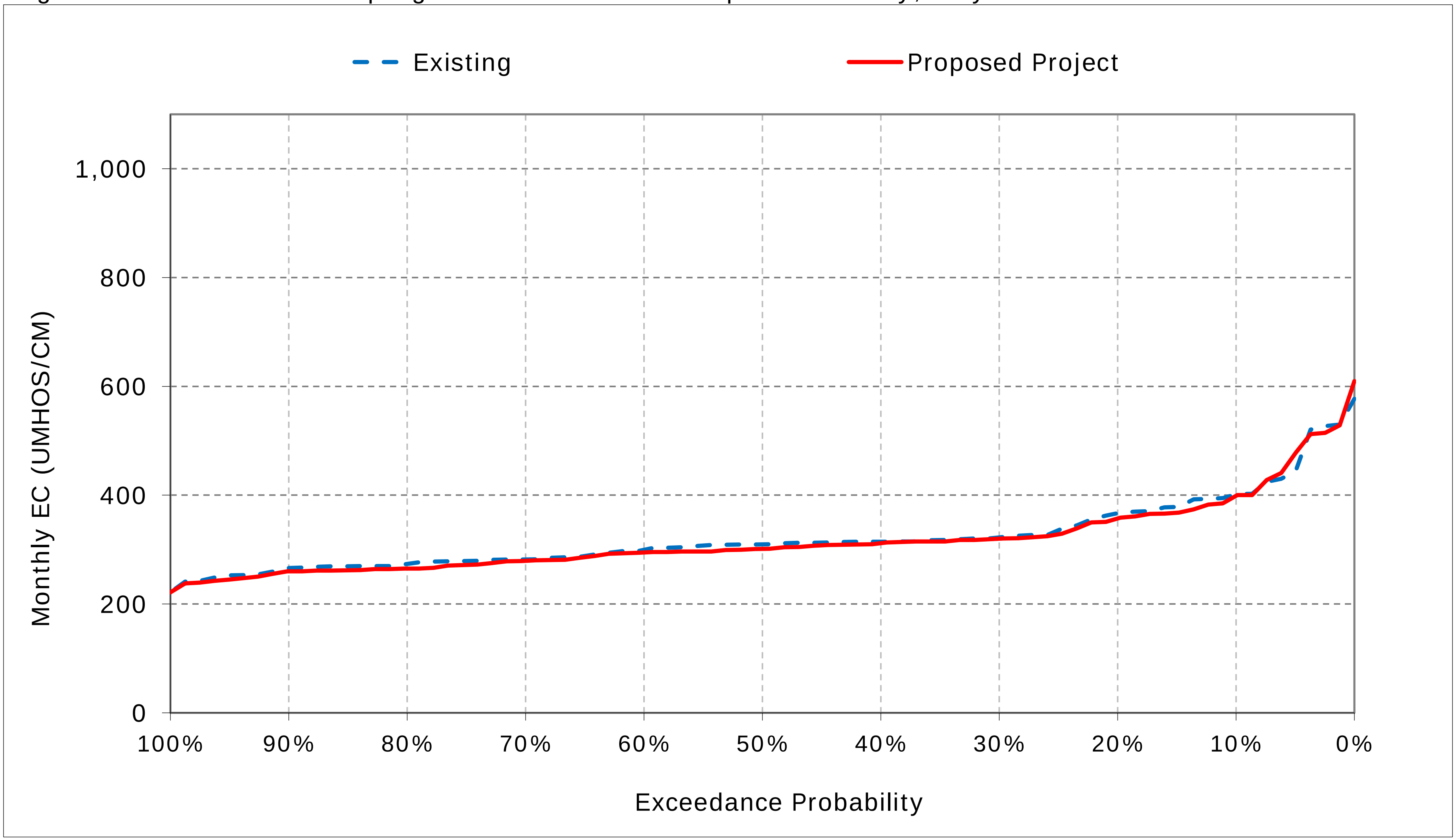


Figure 16-14. Banks Pumping Plant South Delta Exports Salinity, August EC

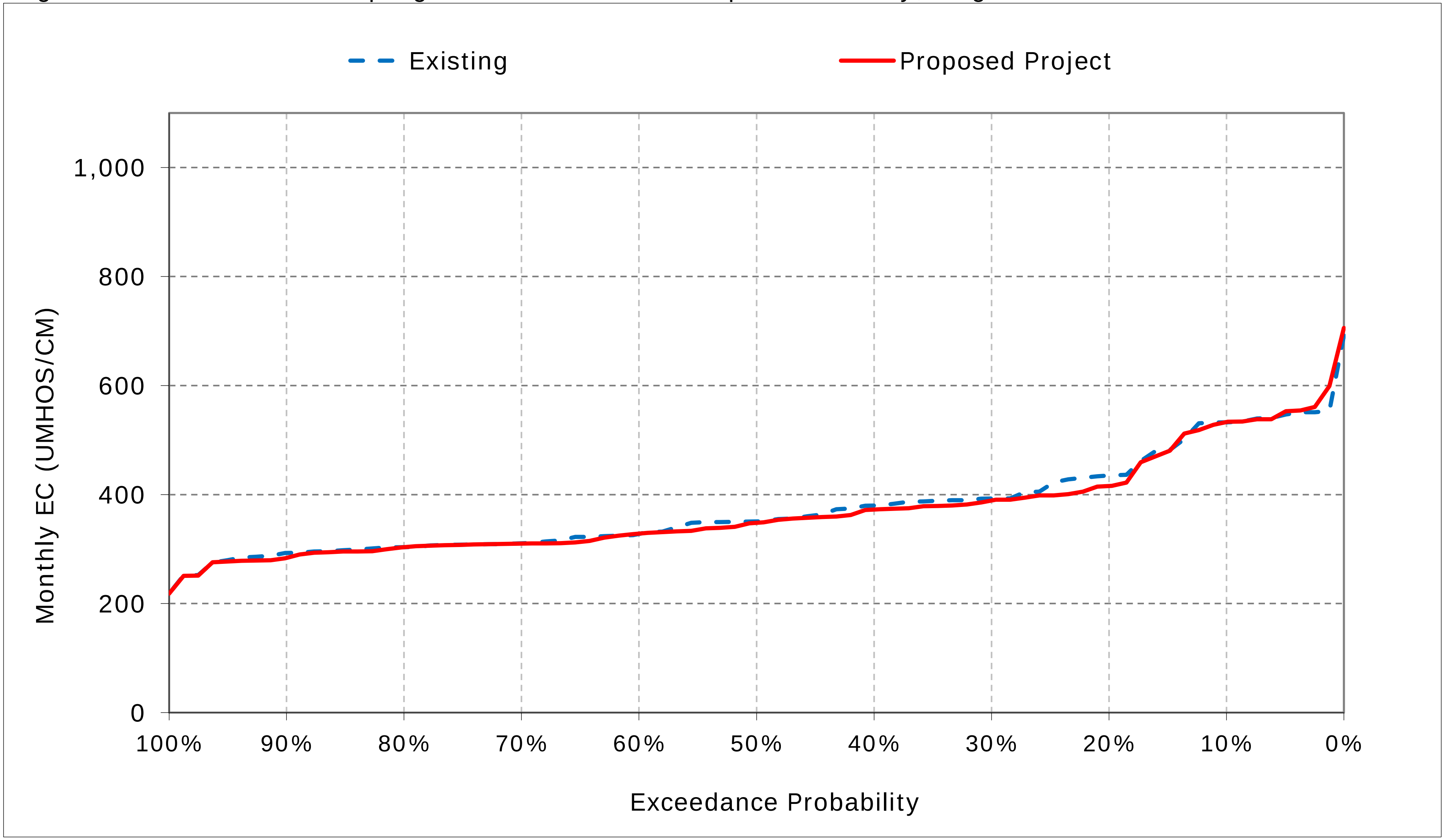


Figure 16-15. Banks Pumping Plant South Delta Exports Salinity, September EC

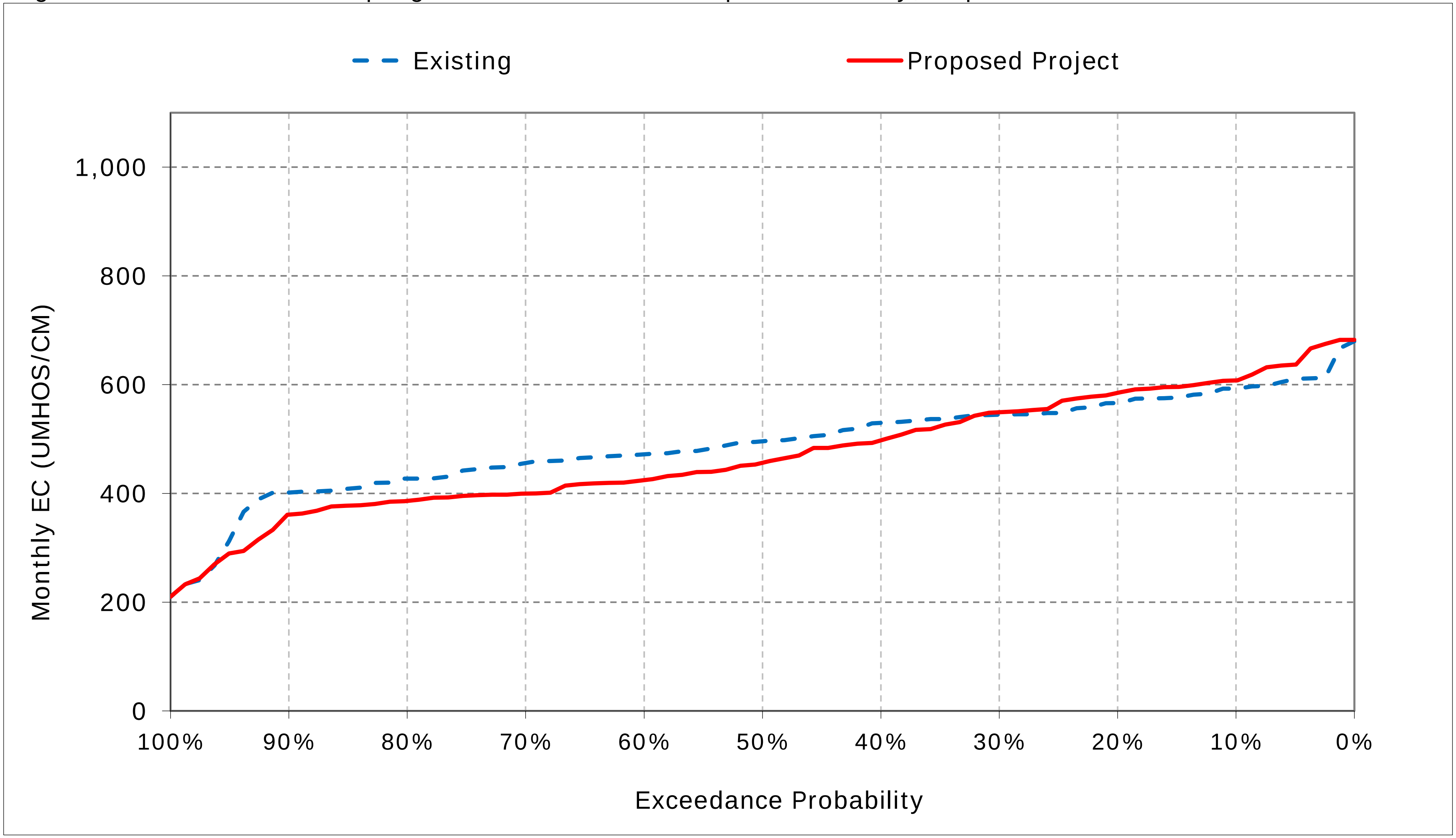


Figure 16-16. Banks Pumping Plant South Delta Exports Salinity, October EC

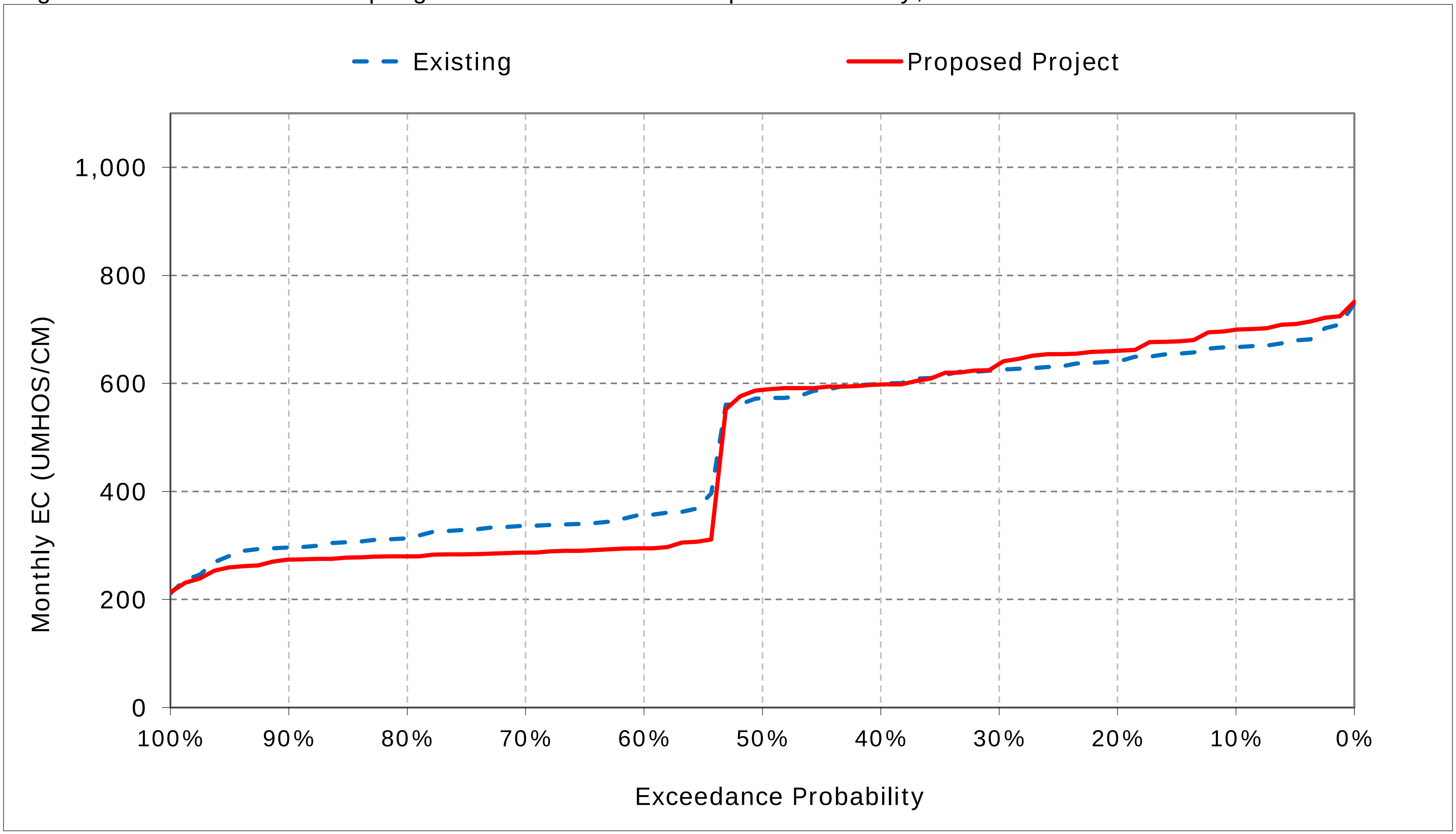


Figure 16-17. Banks Pumping Plant South Delta Exports Salinity, November EC

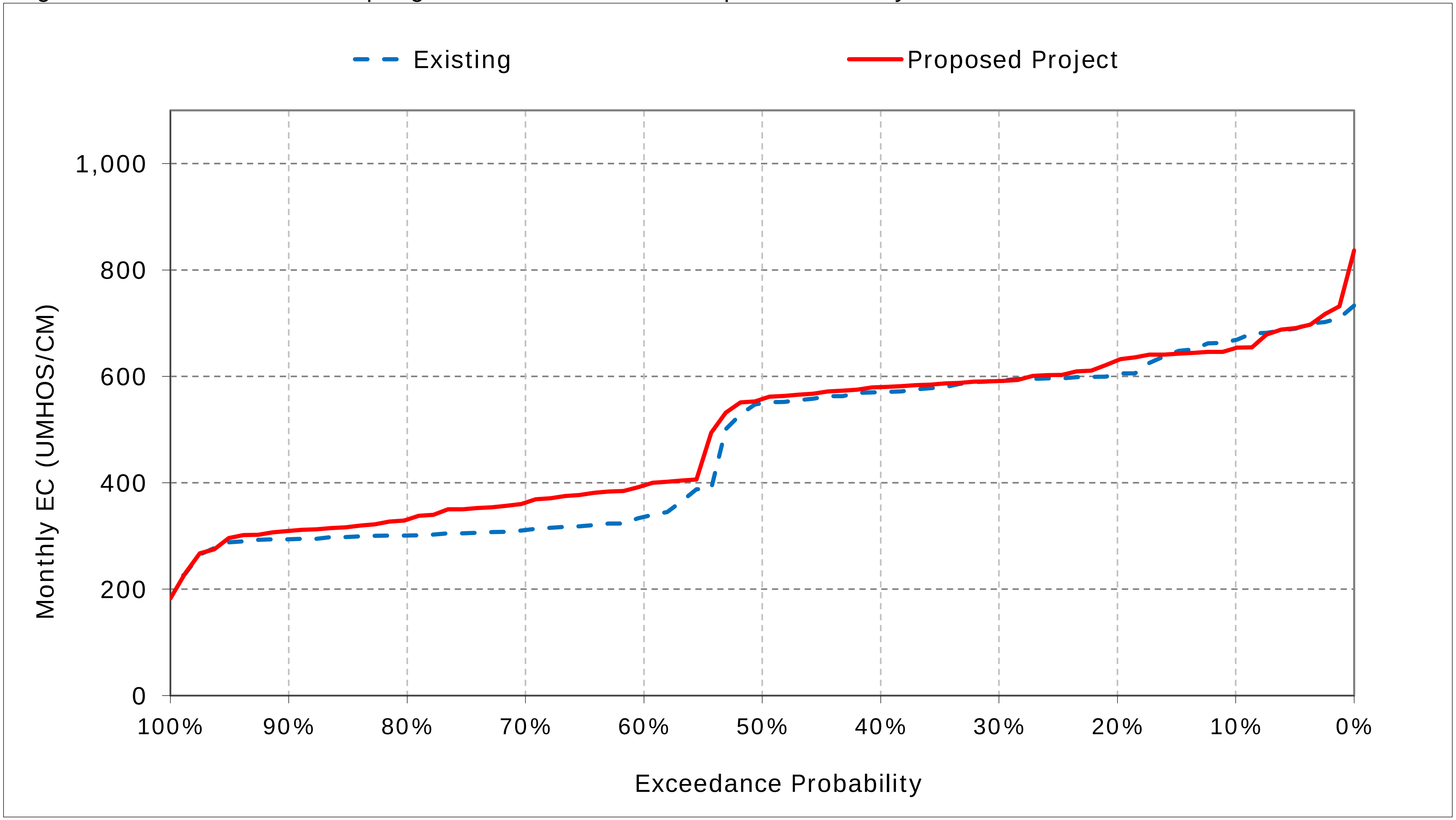


Figure 16-18. Banks Pumping Plant South Delta Exports Salinity, December EC

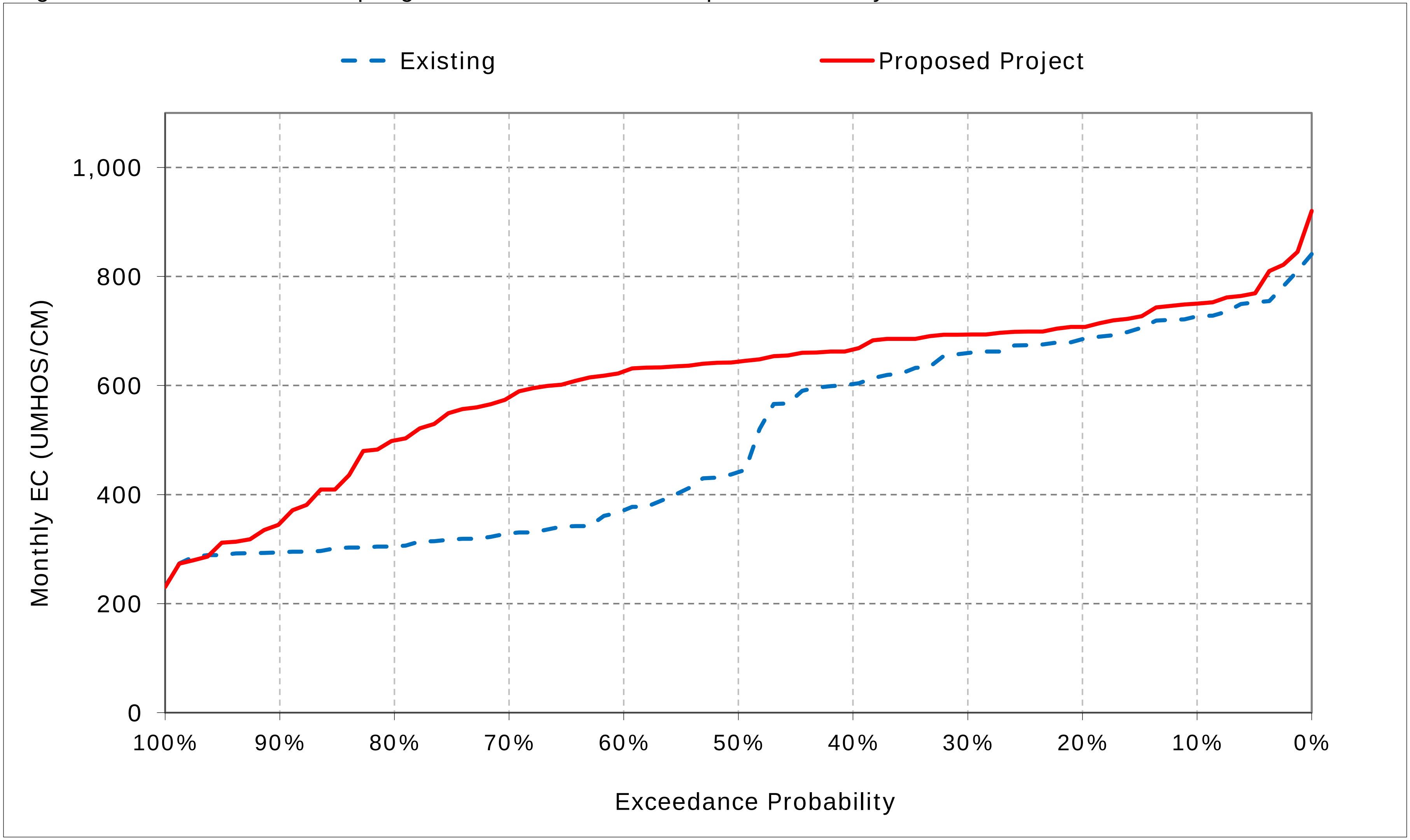


Table 17-1. Jones Pumping Plant South Delta Exports Salinity, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	652	661	764	777	681	619	511	463	409	413	537	597
20%	633	604	726	752	660	591	487	445	384	385	464	580
30%	618	593	699	674	617	552	459	431	377	377	425	556
40%	596	572	654	643	592	530	437	420	370	365	413	546
50%	566	548	543	613	569	490	403	392	366	345	392	516
60%	372	405	497	580	523	415	375	376	360	338	369	484
70%	358	359	453	547	470	362	341	363	354	323	347	456
80%	343	339	433	522	399	323	304	333	342	309	338	434
90%	330	329	426	427	331	299	251	226	329	291	329	403
Long Term												
Full Simulation Period[a]	492	489	577	614	534	472	393	380	368	355	404	501
Water Year Types[b]												
Wet (32%)	440	430	502	503	406	343	295	299	343	324	330	436
Above Normal (15%)	531	508	575	615	544	413	377	375	366	330	347	422
Below Normal (17%)	502	500	599	653	523	464	409	399	363	340	416	571
Dry (22%)	494	509	610	651	627	566	458	433	367	369	471	537
Critical (15%)	548	556	663	750	679	680	505	458	433	447	504	585

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	662	653	775	851	735	675	573	497	385	413	542	620
20%	626	621	742	823	680	616	516	462	366	392	446	589
30%	611	595	725	767	634	579	469	428	352	378	426	565
40%	589	583	712	734	605	540	415	377	339	358	408	539
50%	568	564	694	665	563	508	379	355	333	338	385	489
60%	355	443	677	610	518	443	352	342	328	328	366	440
70%	341	416	633	554	460	365	332	334	320	316	347	419
80%	335	392	547	522	400	327	306	312	311	305	338	402
90%	326	360	466	427	336	296	246	222	296	286	316	377
Long Term												
Full Simulation Period[a]	485	512	655	659	543	489	400	370	341	354	401	489
Water Year Types[b]												
Wet (32%)	435	460	565	519	401	350	284	280	328	323	325	375
Above Normal (15%)	522	553	693	695	551	417	349	335	332	324	347	423
Below Normal (17%)	488	517	674	700	524	489	392	362	327	336	412	596
Dry (22%)	491	523	692	723	641	598	479	437	331	365	462	540
Critical (15%)	548	563	734	780	713	698	591	509	407	452	514	597

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	10	-8	11	74	55	56	62	34	-24	1	5	23
20%	-7	17	16	71	20	25	29	17	-18	7	-18	9
30%	-6	3	25	92	17	27	10	-3	-24	1	1	10
40%	-6	10	58	92	13	11	-22	-43	-30	-7	-5	-7
50%	1	17	151	51	-6	18	-24	-37	-33	-7	-6	-27
60%	-18	38	180	31	-6	28	-23	-34	-32	-10	-4	-44
70%	-17	57	180	7	-10	2	-9	-29	-34	-7	0	-36
80%	-8	54	114	0	1	5	1	-21	-31	-4	0	-32
90%	-4	31	41	0	5	-3	-5	-4	-33	-5	-13	-26
Long Term												
Full Simulation Period[a]	-6	23	78	45	8	17	7	-10	-27	-2	-3	-13
Water Year Types[b]												
Wet (32%)	-5	30	62	16	-4	7	-11	-19	-15	0	-5	-61
Above Normal (15%)	-10	46	118	80	7	3	-28	-40	-34	-6	0	1
Below Normal (17%)	-14	16	74	48	2	24	-17	-37	-36	-4	-4	24
Dry (22%)	-4	14	82	71	14	33	21	4	-36	-4	-9	3
Critical (15%)	-1	7	71	30	34	18	86	51	-26	5	9	12

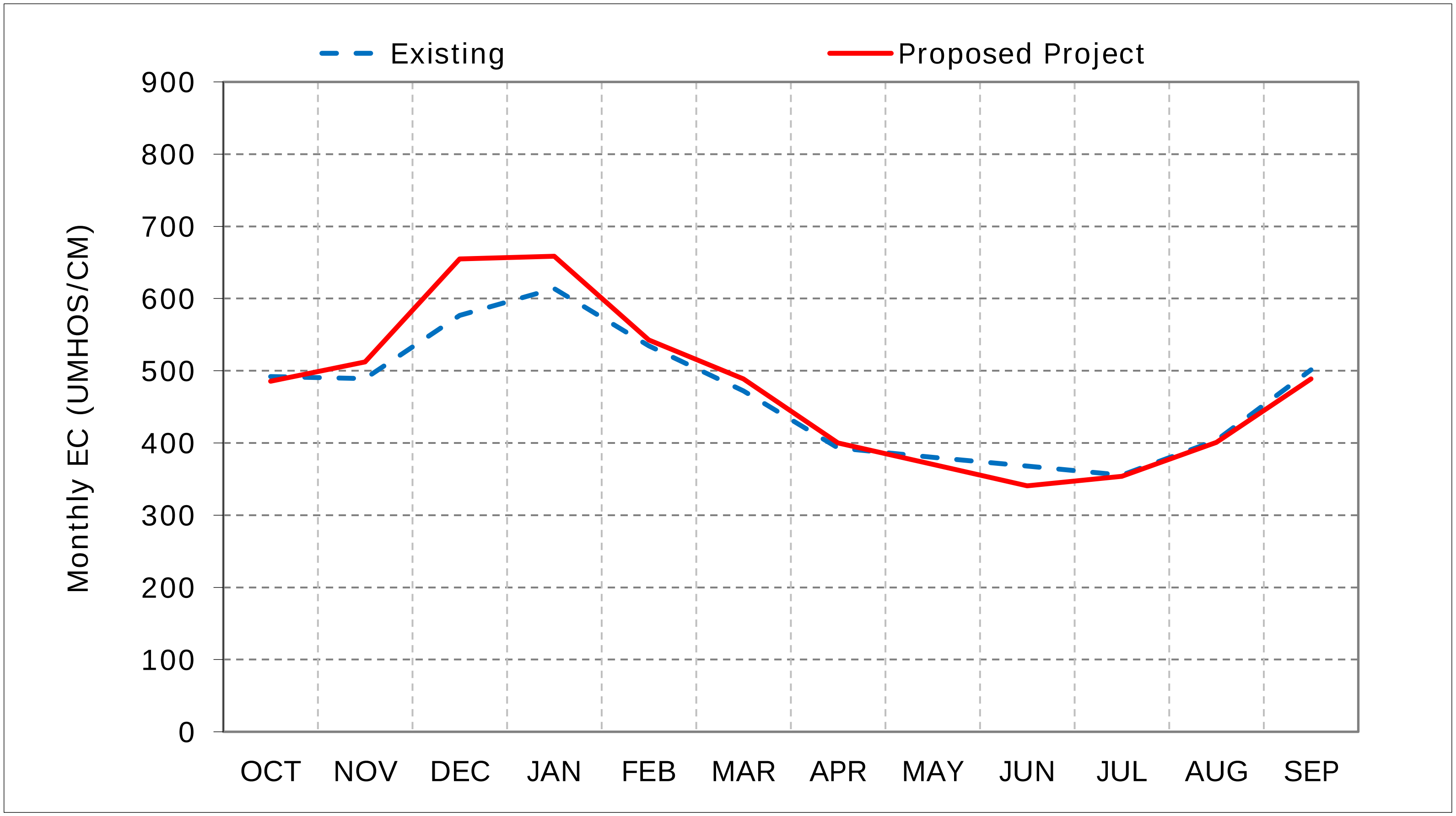
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

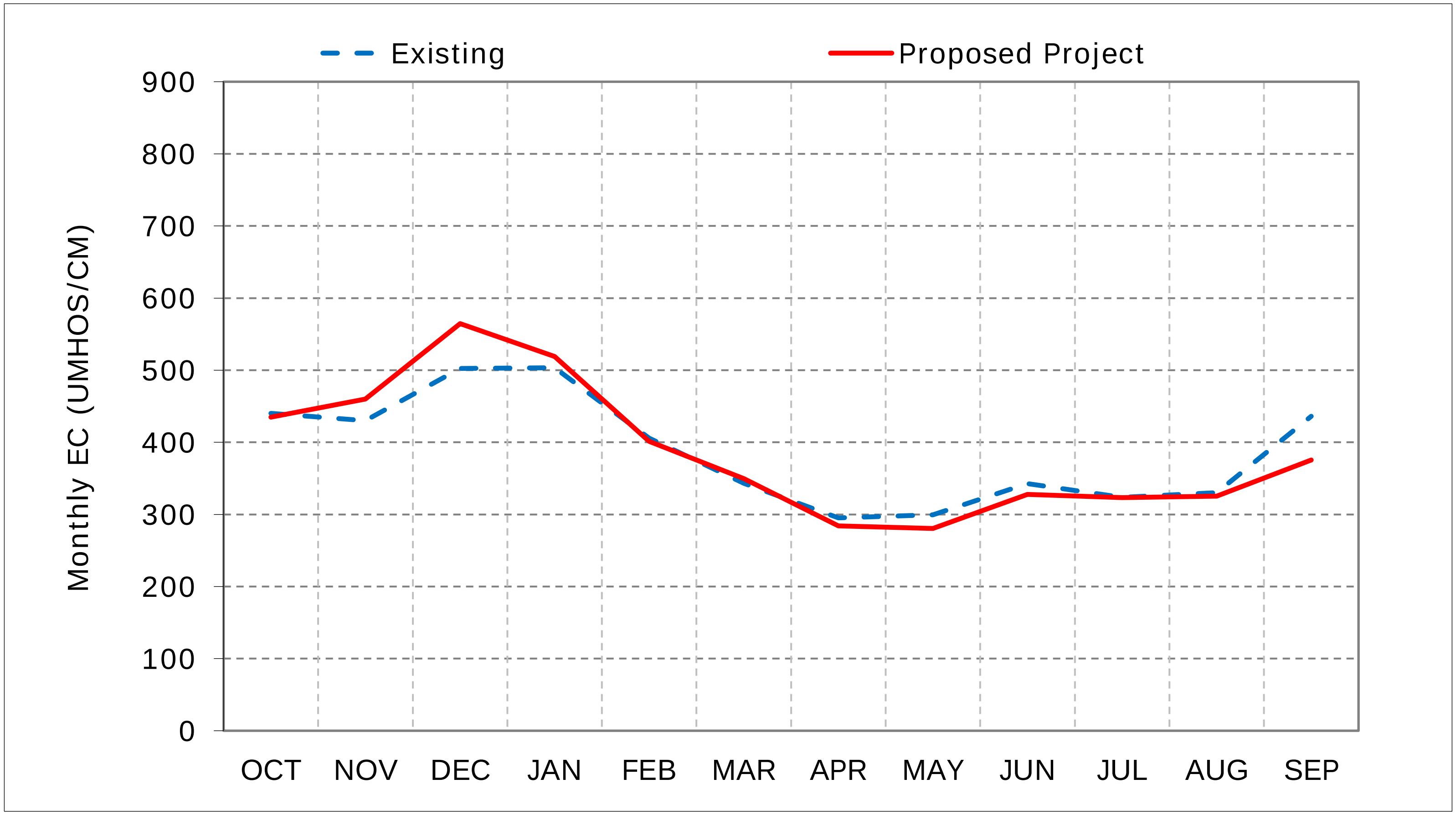
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 17-1. Jones Pumping Plant South Delta Exports Salinity, Long-Term Averag



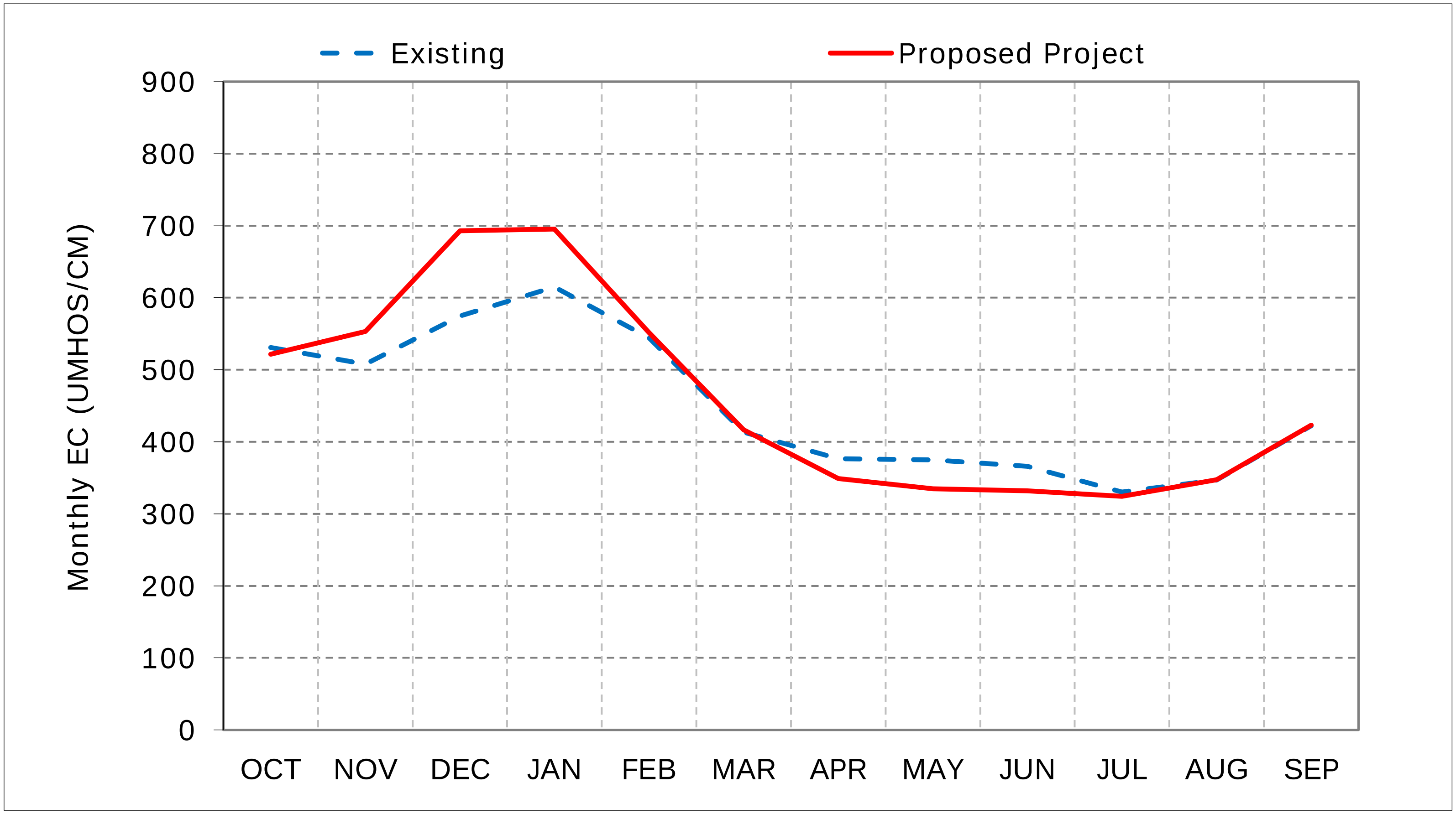
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 17-2. Jones Pumping Plant South Delta Exports Salinity, Wet Year Average



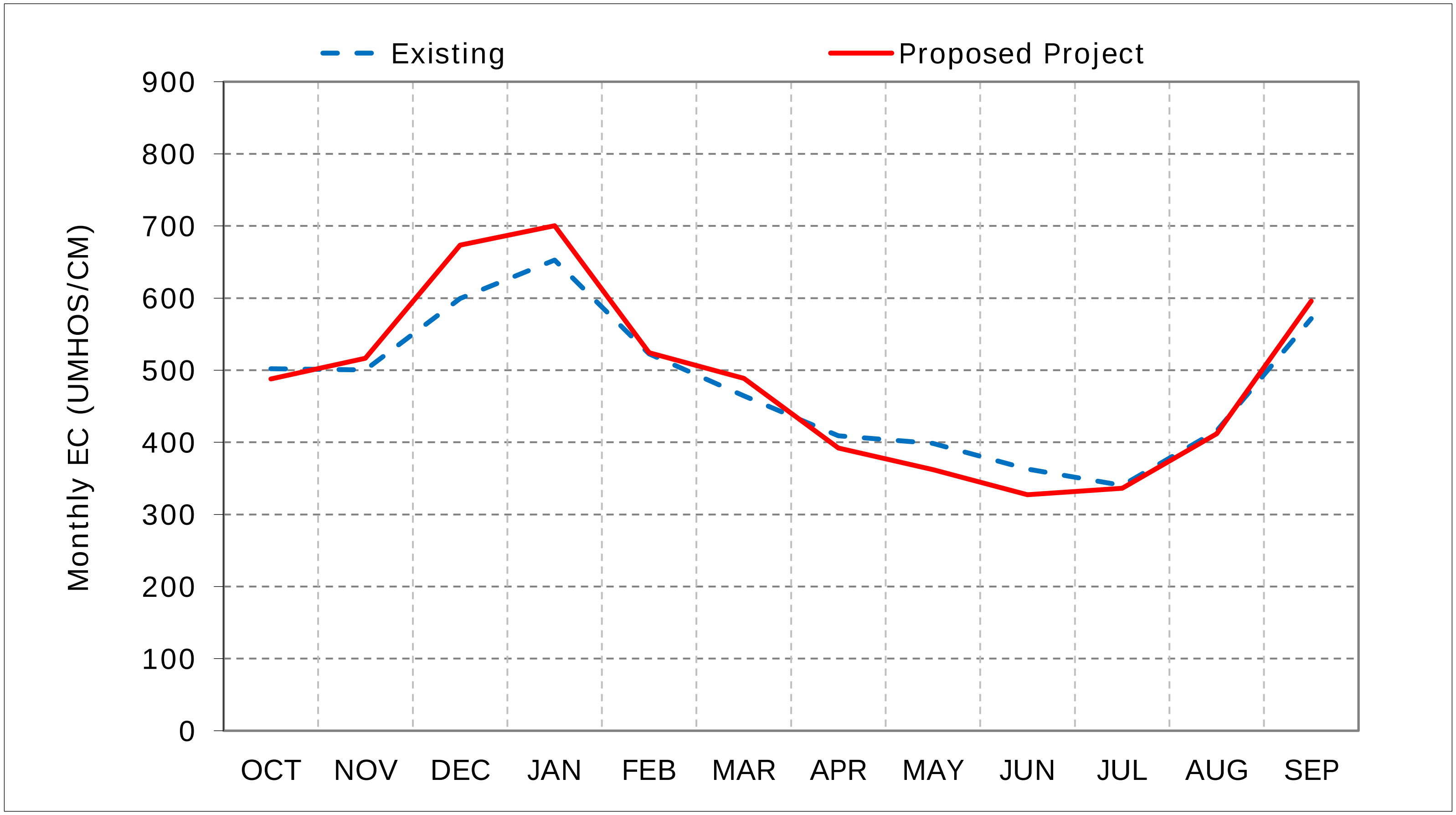
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 17-3. Jones Pumping Plant South Delta Exports Salinity, Above Normal Yea



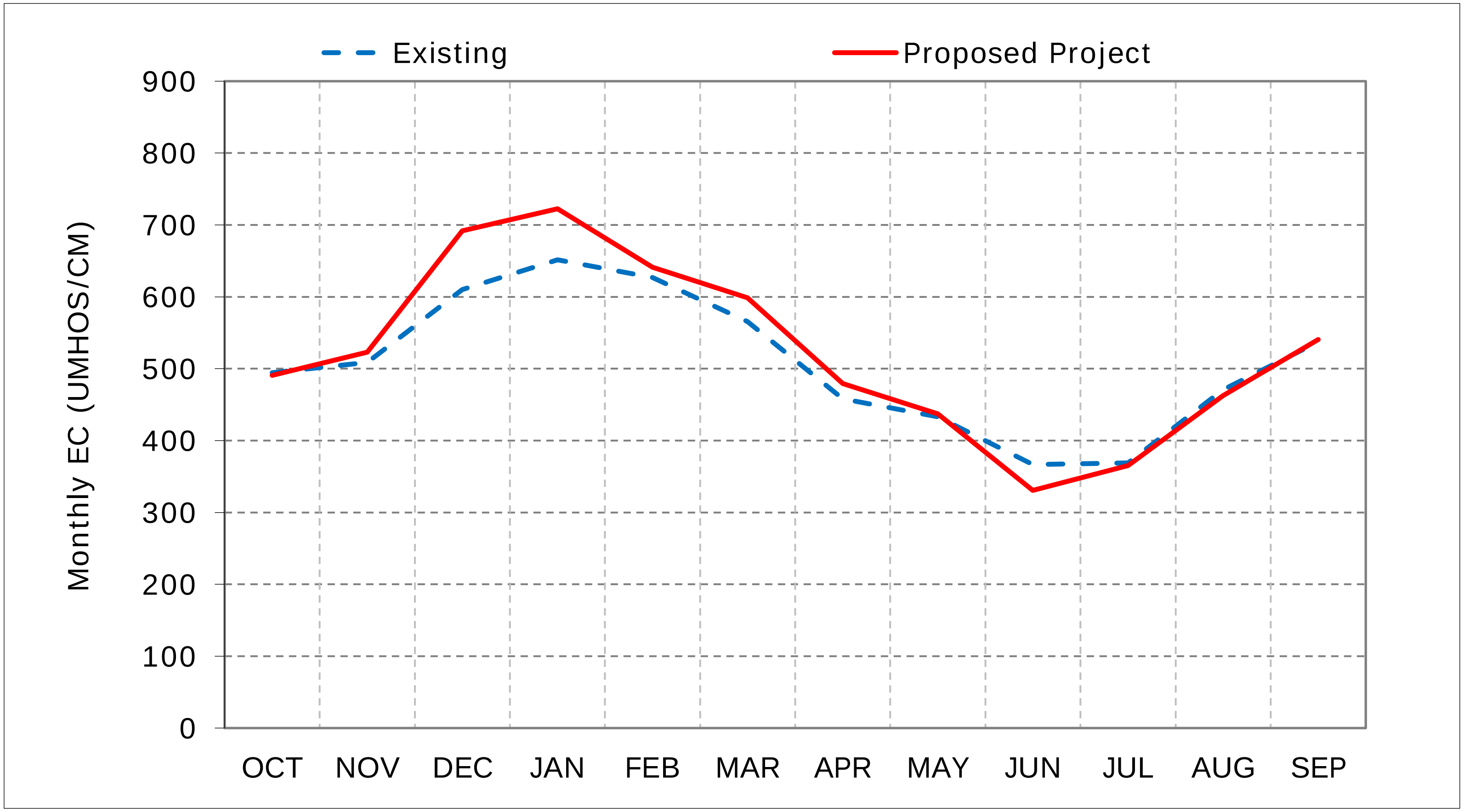
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 17-4. Jones Pumping Plant South Delta Exports Salinity, Below Normal Yea



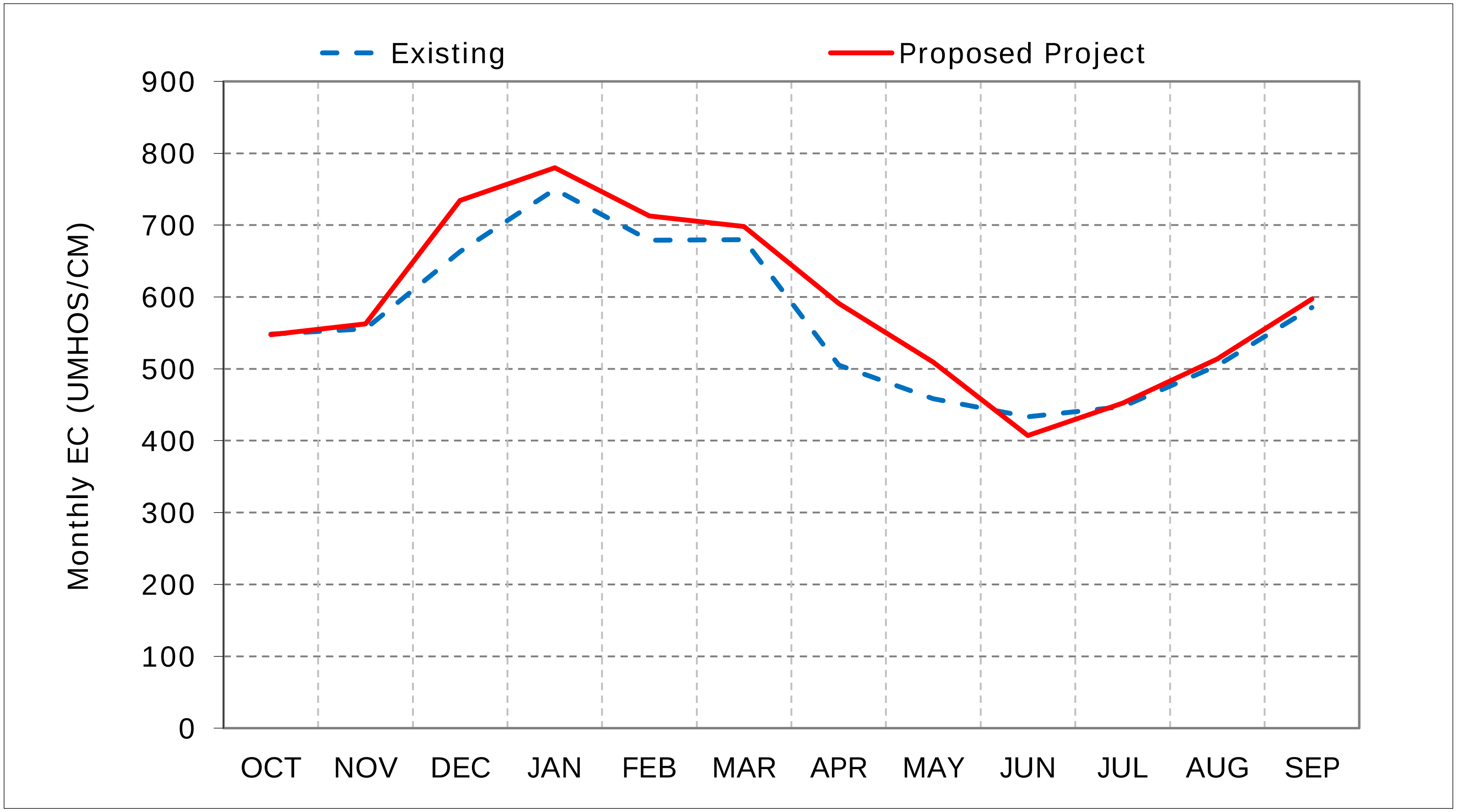
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 17-5. Jones Pumping Plant South Delta Exports Salinity, Dry Year Average



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 17-6. Jones Pumping Plant South Delta Exports Salinity, Critical Year Avera



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 17-7. Jones Pumping Plant South Delta Exports Salinity, January EC

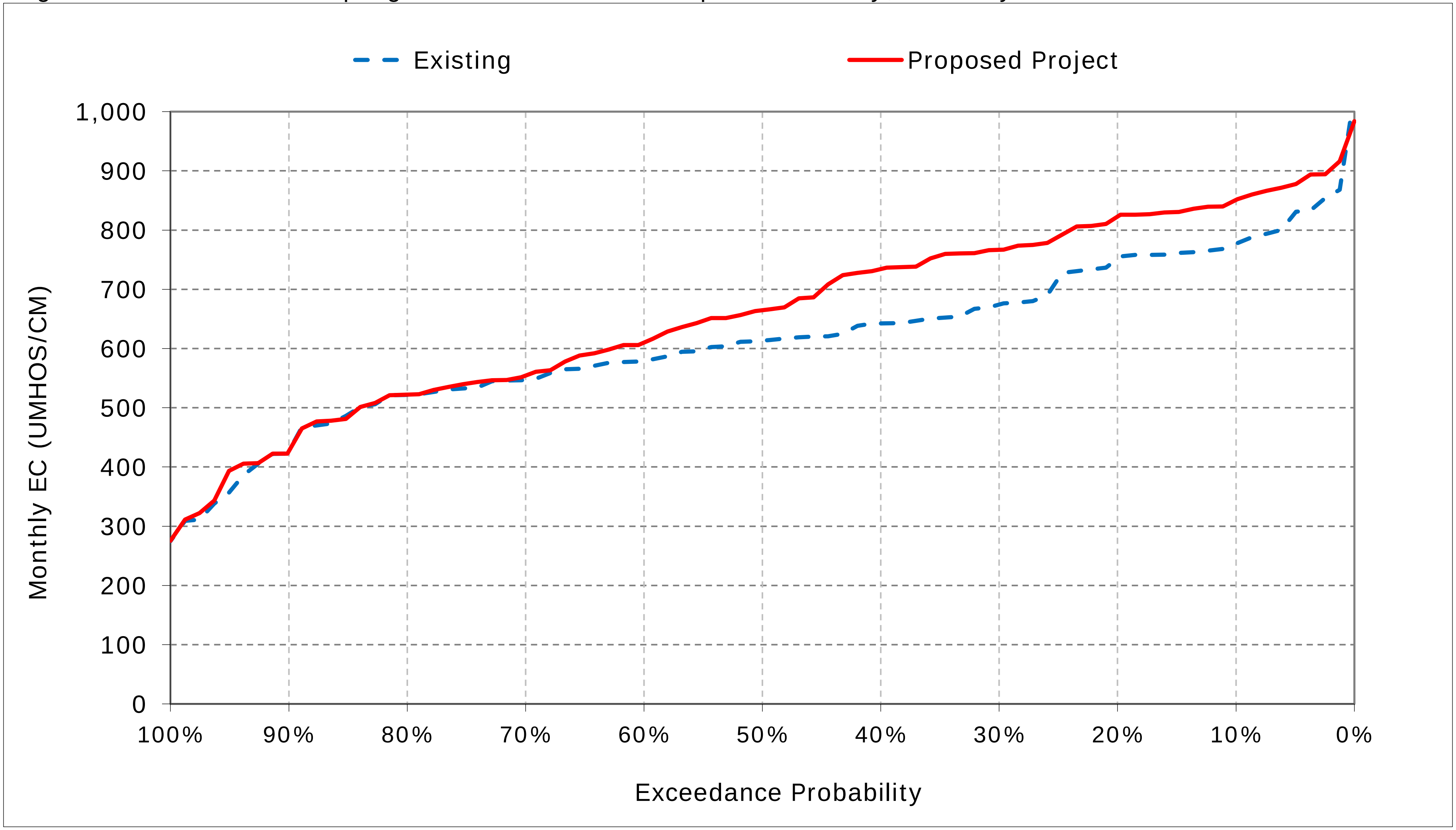


Figure 17-8. Jones Pumping Plant South Delta Exports Salinity, February EC

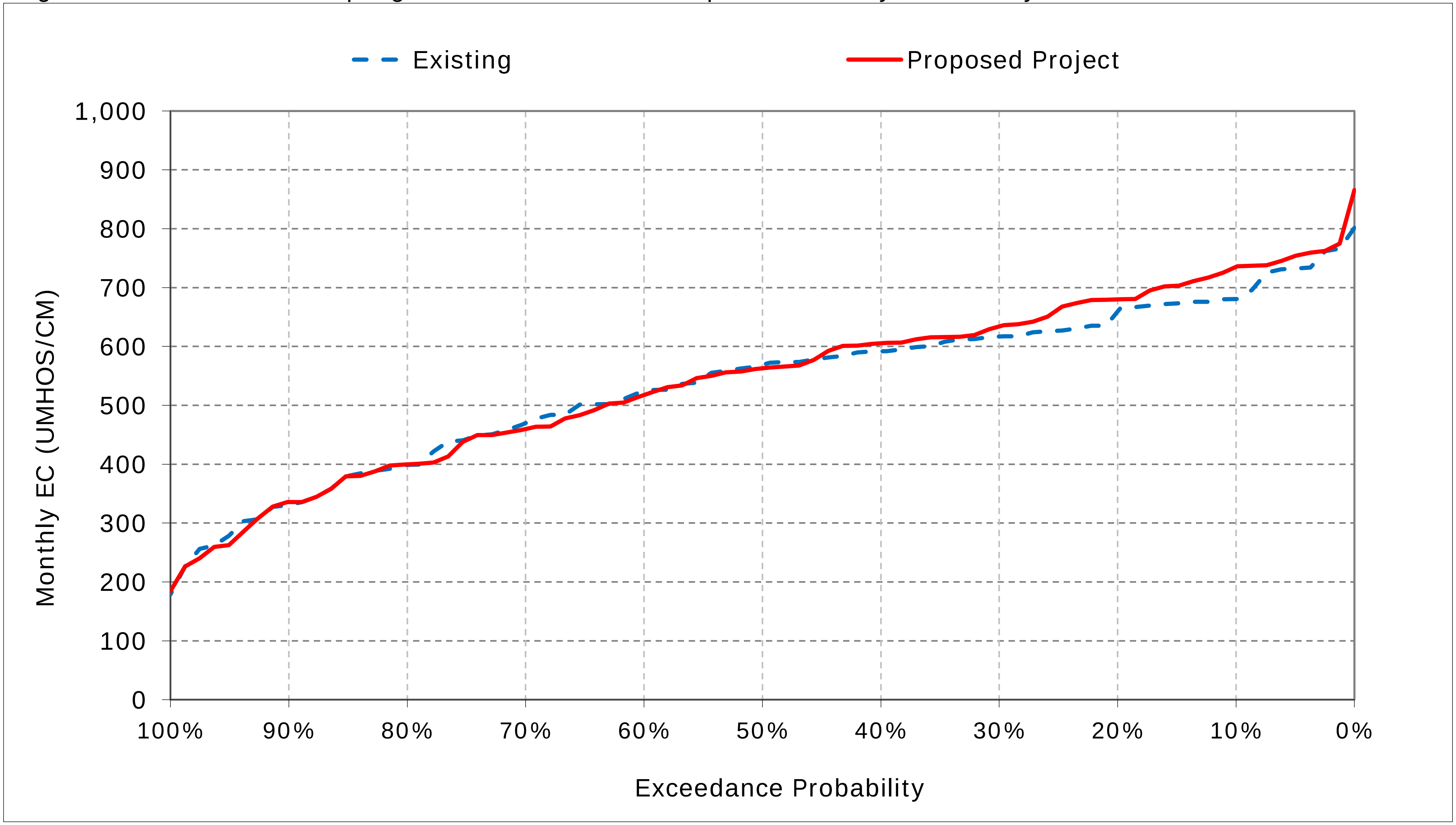


Figure 17-9. Jones Pumping Plant South Delta Exports Salinity, March EC

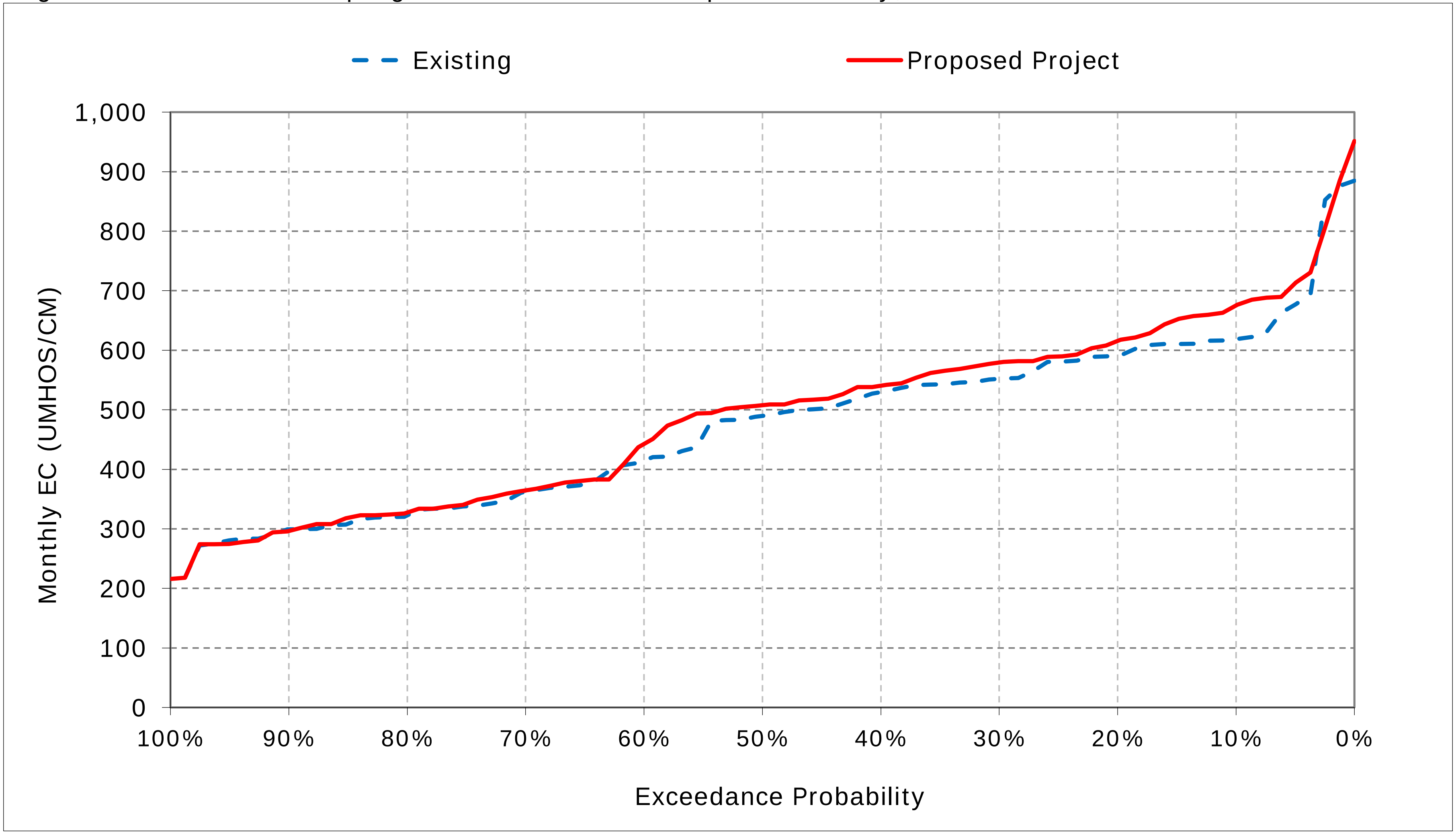


Figure 17-10. Jones Pumping Plant South Delta Exports Salinity, April EC

Figure 17-11. Jones Pumping Plant South Delta Exports Salinity, May EC

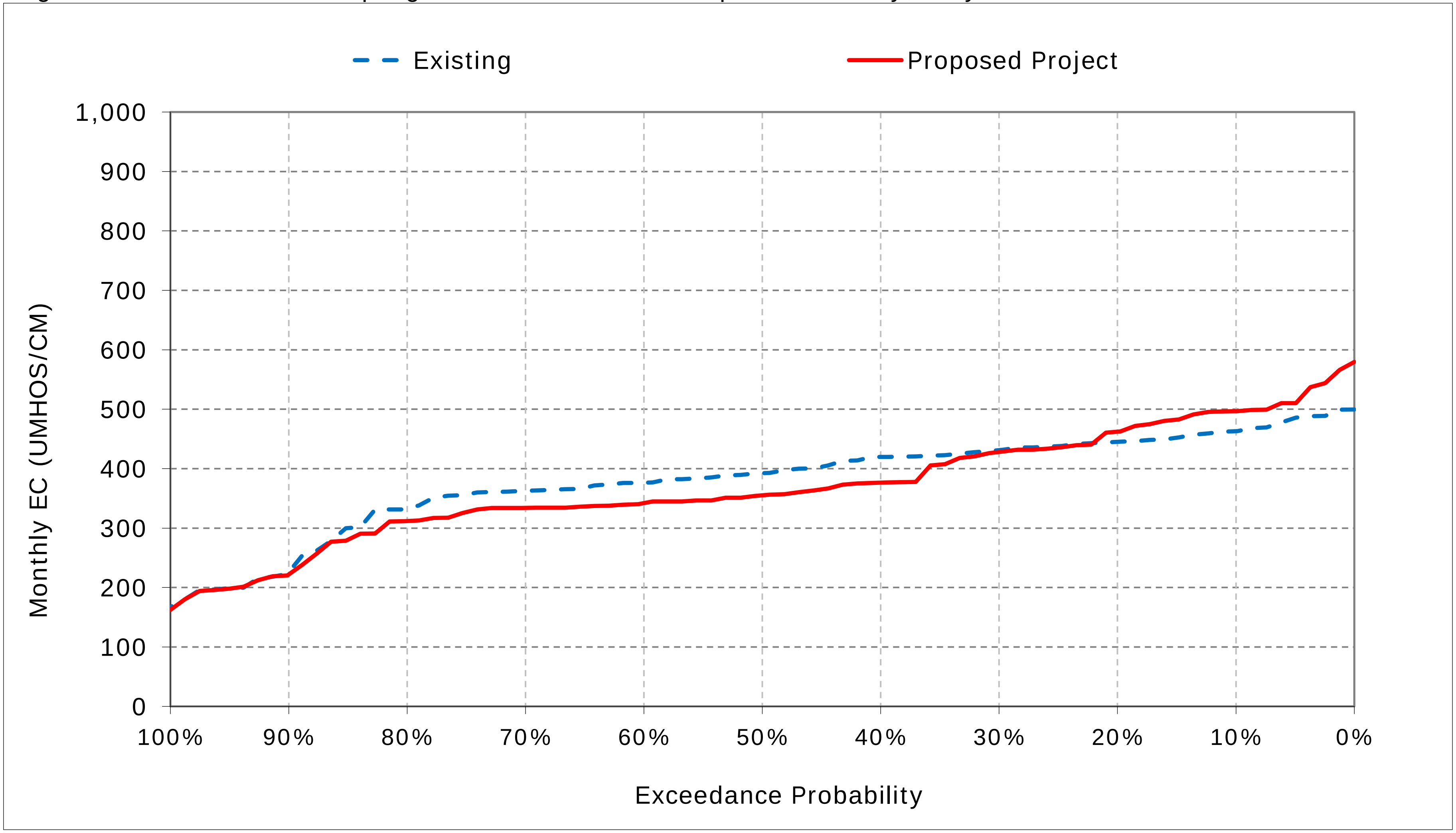


Figure 17-12. Jones Pumping Plant South Delta Exports Salinity, June EC

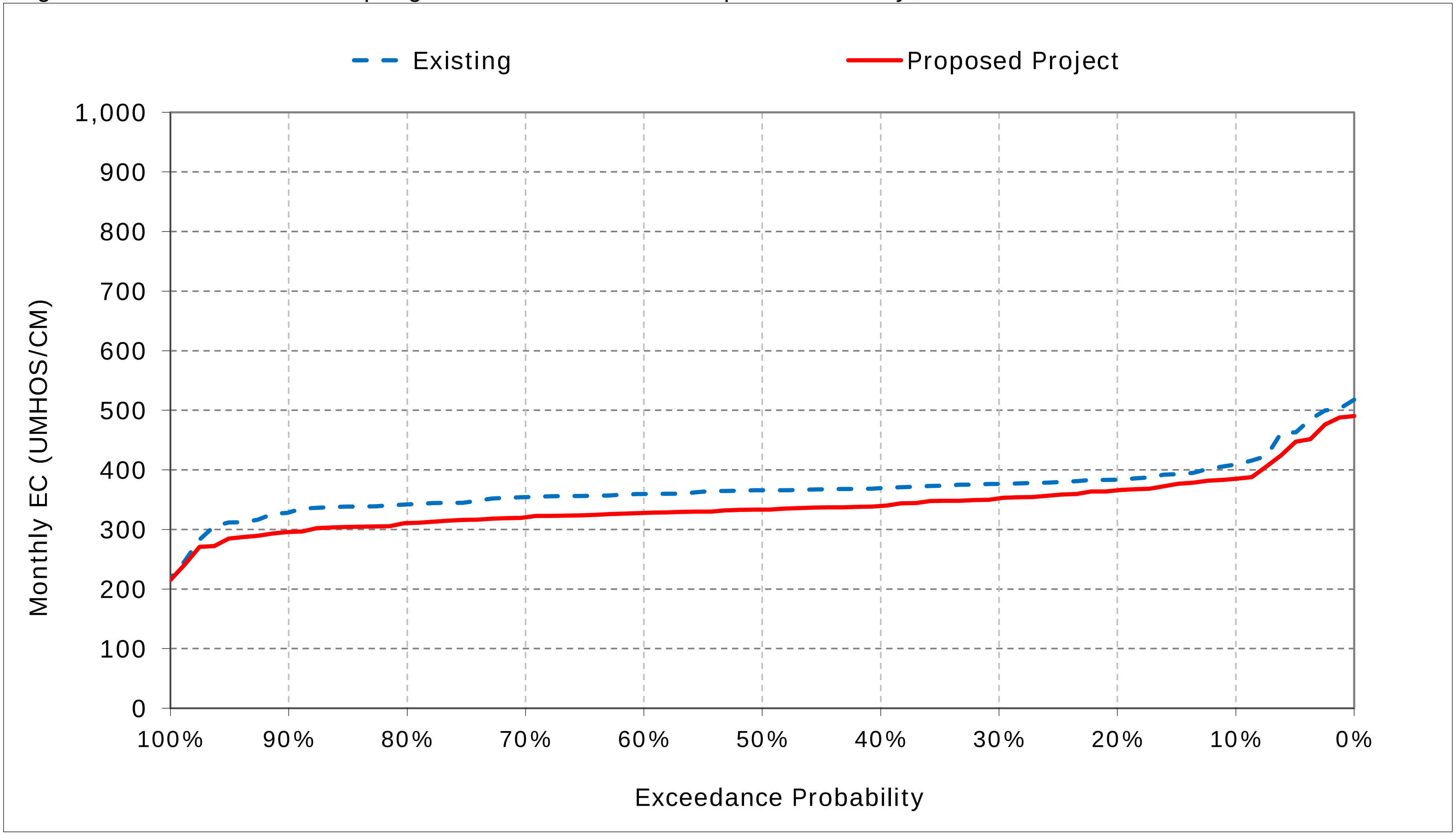


Figure 17-13. Jones Pumping Plant South Delta Exports Salinity, July EC

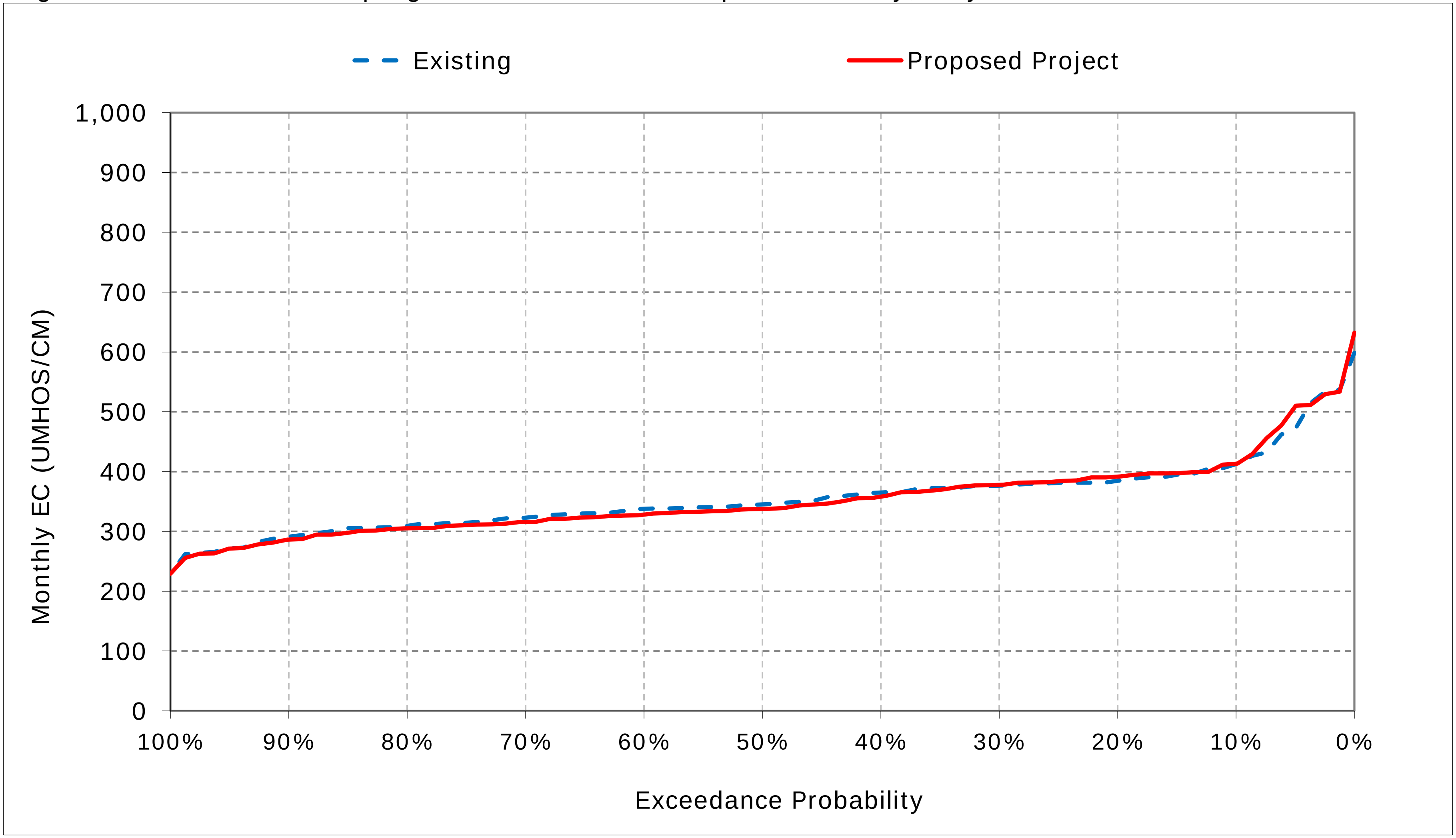


Figure 17-14. Jones Pumping Plant South Delta Exports Salinity, August EC

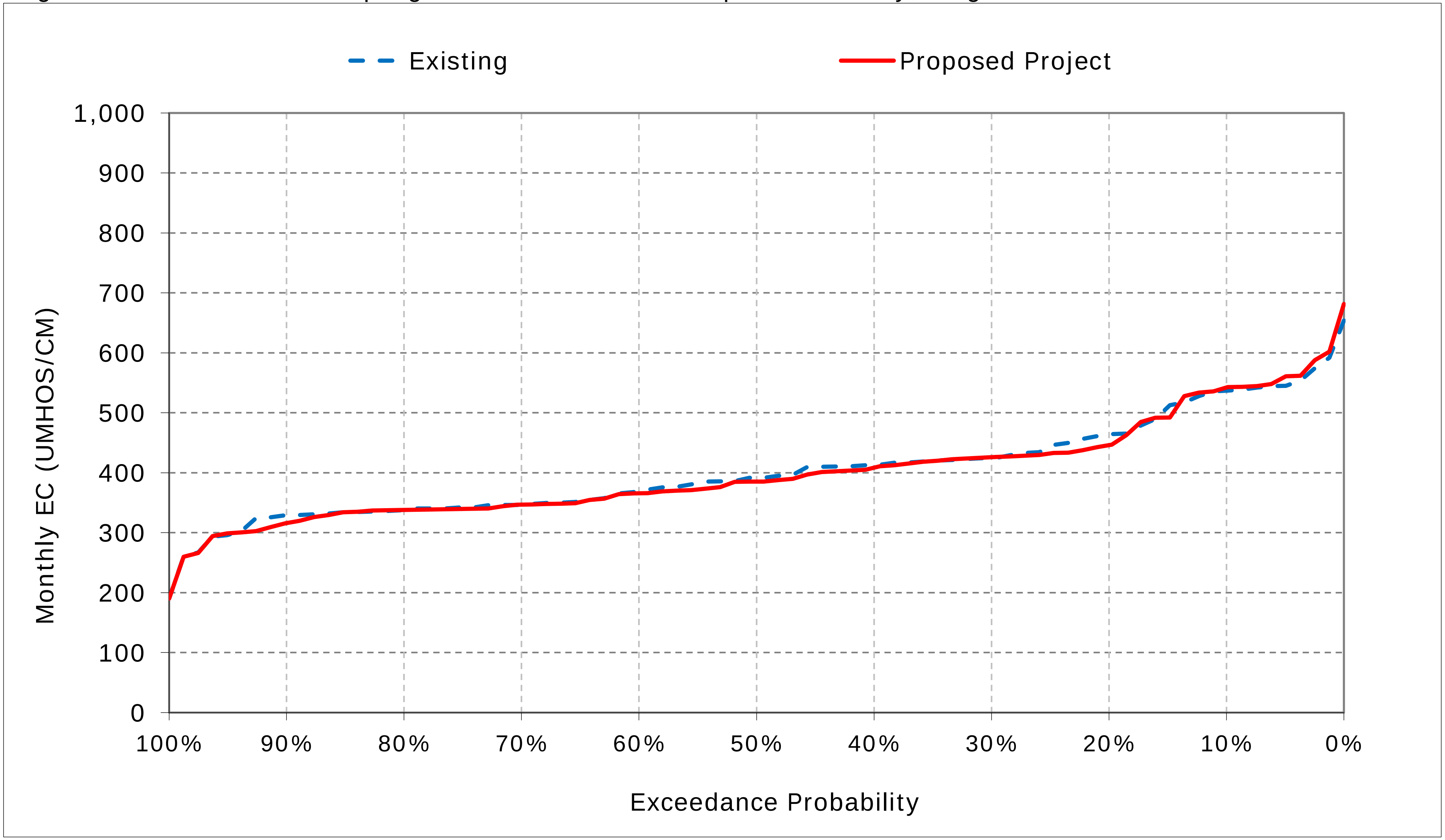


Figure 17-15. Jones Pumping Plant South Delta Exports Salinity, September EC

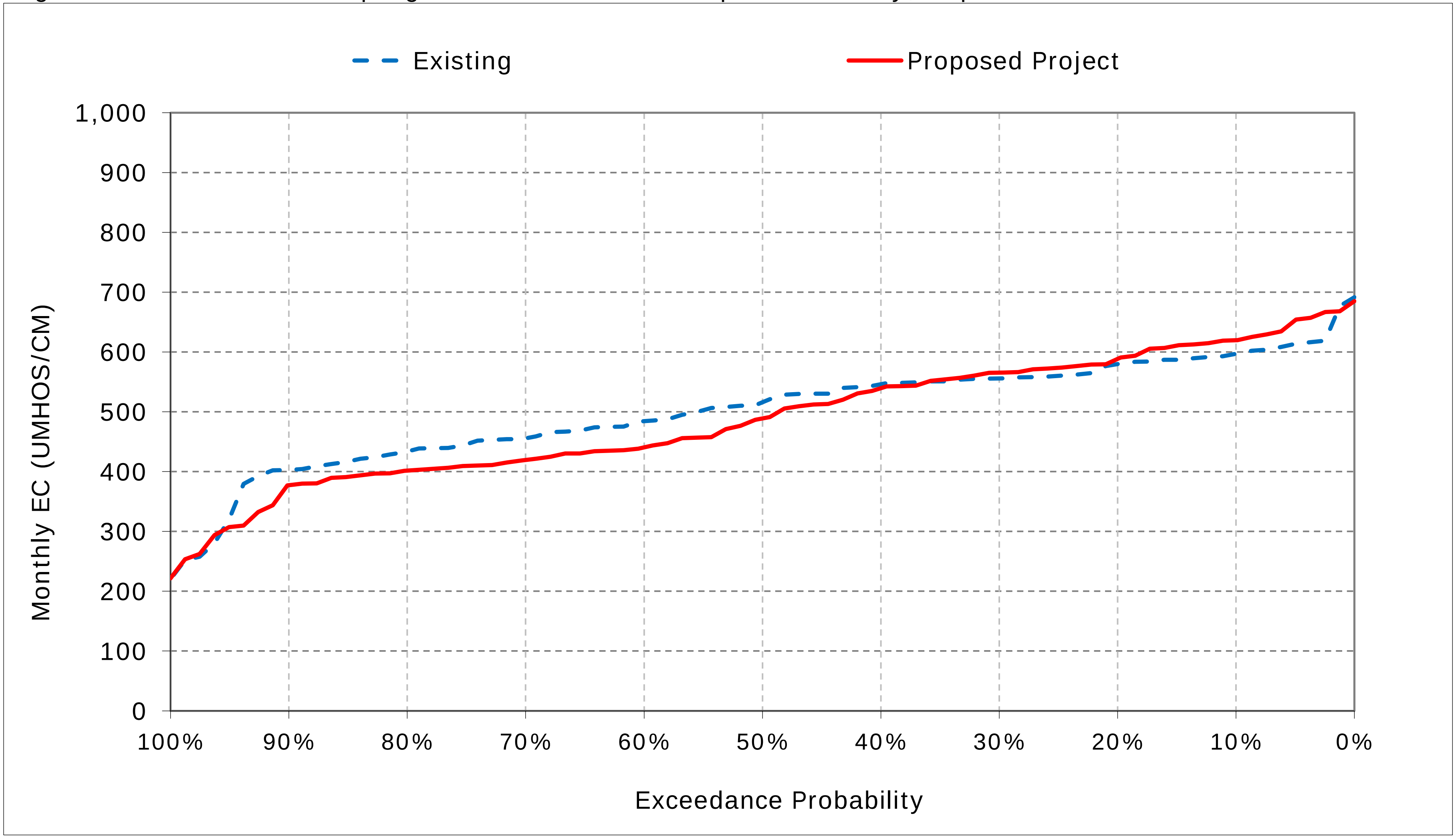


Figure 17-16. Jones Pumping Plant South Delta Exports Salinity, October EC

Figure 17-17. Jones Pumping Plant South Delta Exports Salinity, November EC

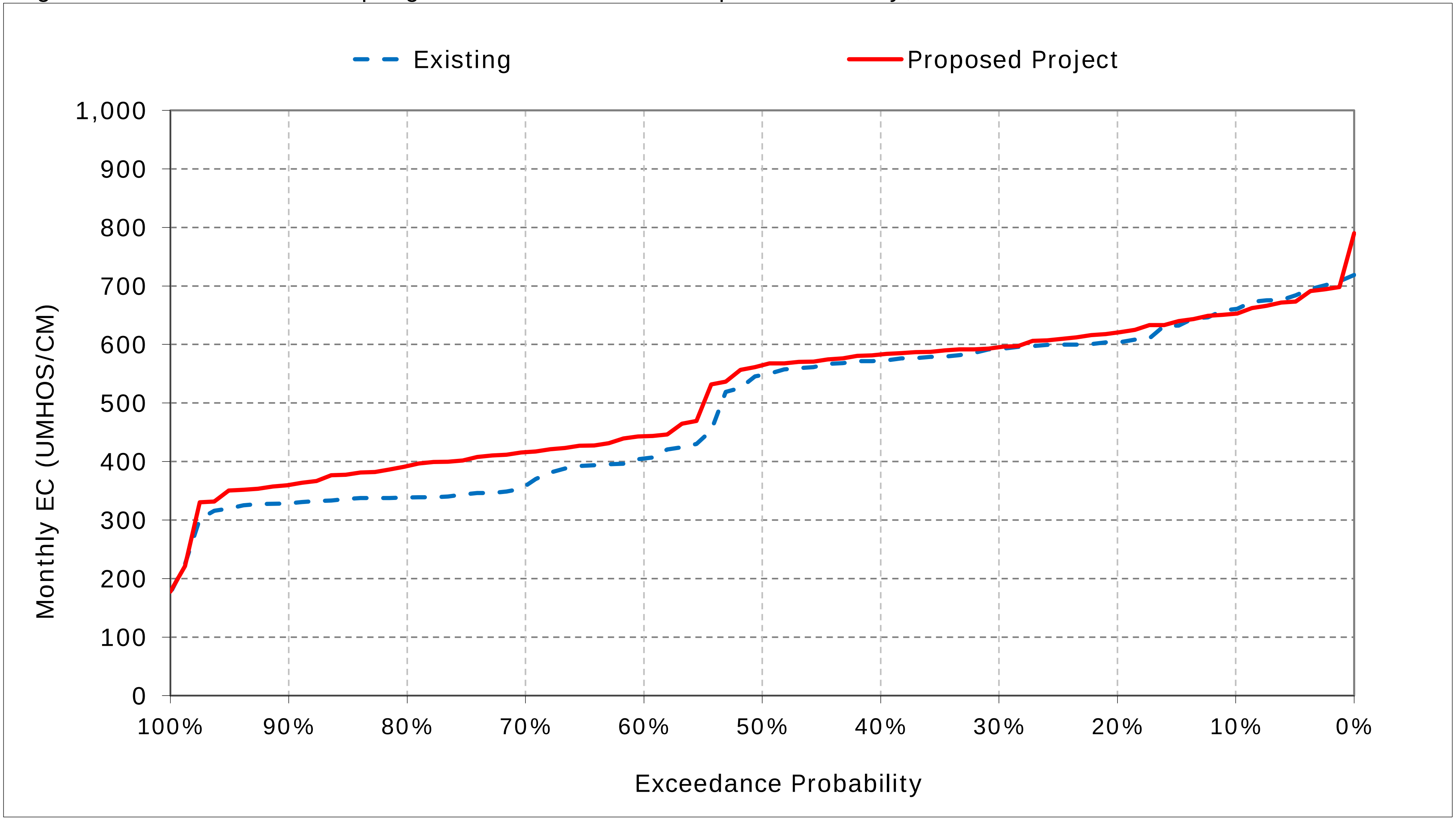


Figure 17-18. Jones Pumping Plant South Delta Exports Salinity, December EC

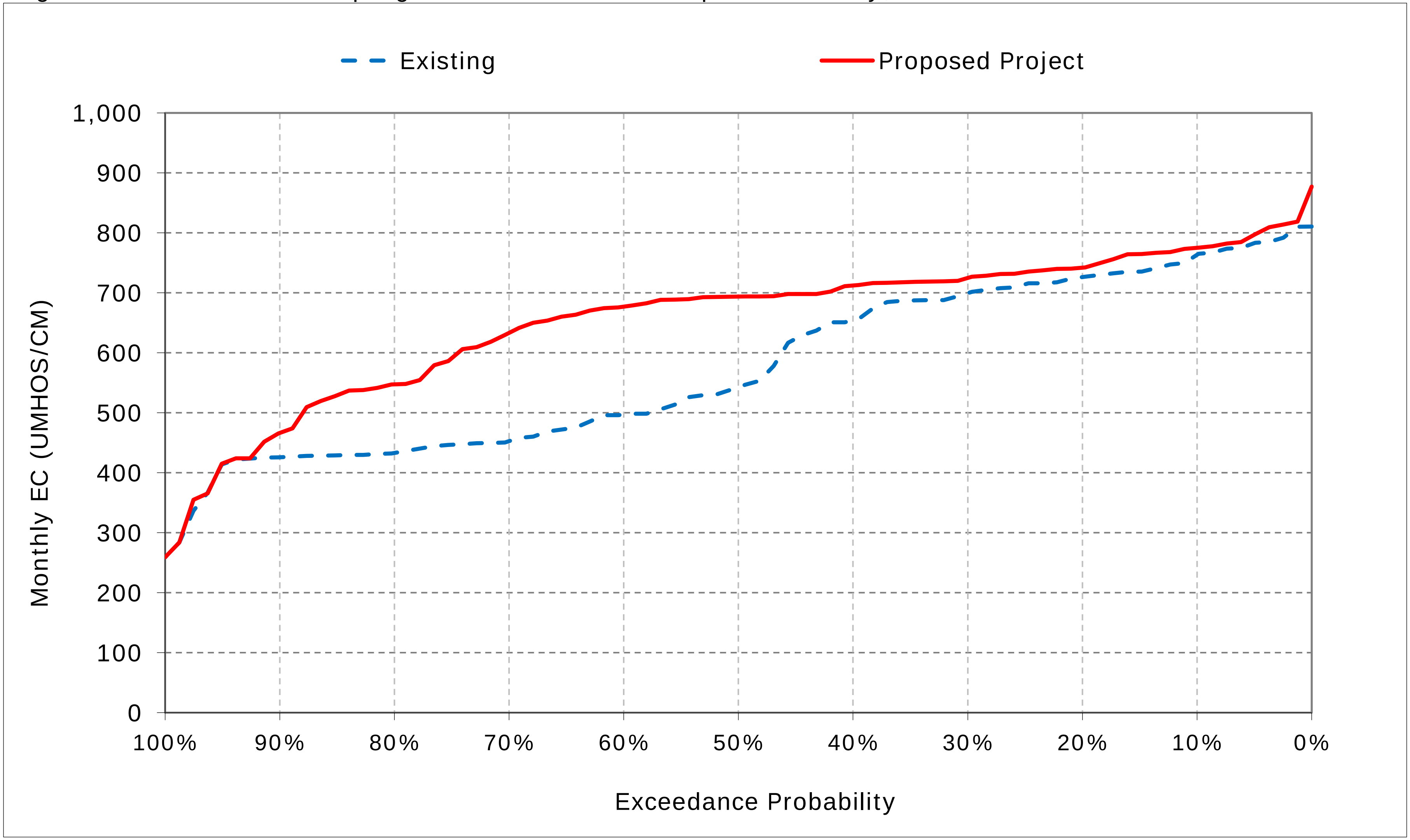


Table 18-1. Old River at Highway 4, Monthly EC

Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	753	741	807	782	558	435	417	418	360	425	570	689
20%	725	677	768	719	512	406	401	402	327	352	482	660
30%	710	650	722	612	487	370	380	391	315	332	442	624
40%	678	620	613	561	458	359	374	385	310	315	423	590
50%	634	580	424	518	421	347	363	377	307	290	387	559
60%	319	322	368	471	387	338	351	367	303	275	364	516
70%	303	286	313	429	366	324	336	354	297	268	330	496
80%	292	273	286	373	348	314	299	331	286	261	320	448
90%	278	266	280	351	327	288	246	220	273	252	309	418
Long Term												
Full Simulation Period[a]	516	492	519	552	435	356	350	357	315	321	408	547
Water Year Types[b]												
Wet (32%)	444	410	395	417	389	331	288	293	283	265	317	464
Above Normal (15%)	566	513	517	540	450	351	352	363	303	266	333	433
Below Normal (17%)	533	510	570	612	422	346	364	381	304	301	422	656
Dry (22%)	518	525	575	581	443	359	390	394	316	362	492	596
Critical (15%)	599	580	649	741	523	419	409	407	408	457	541	644

Proposed Project

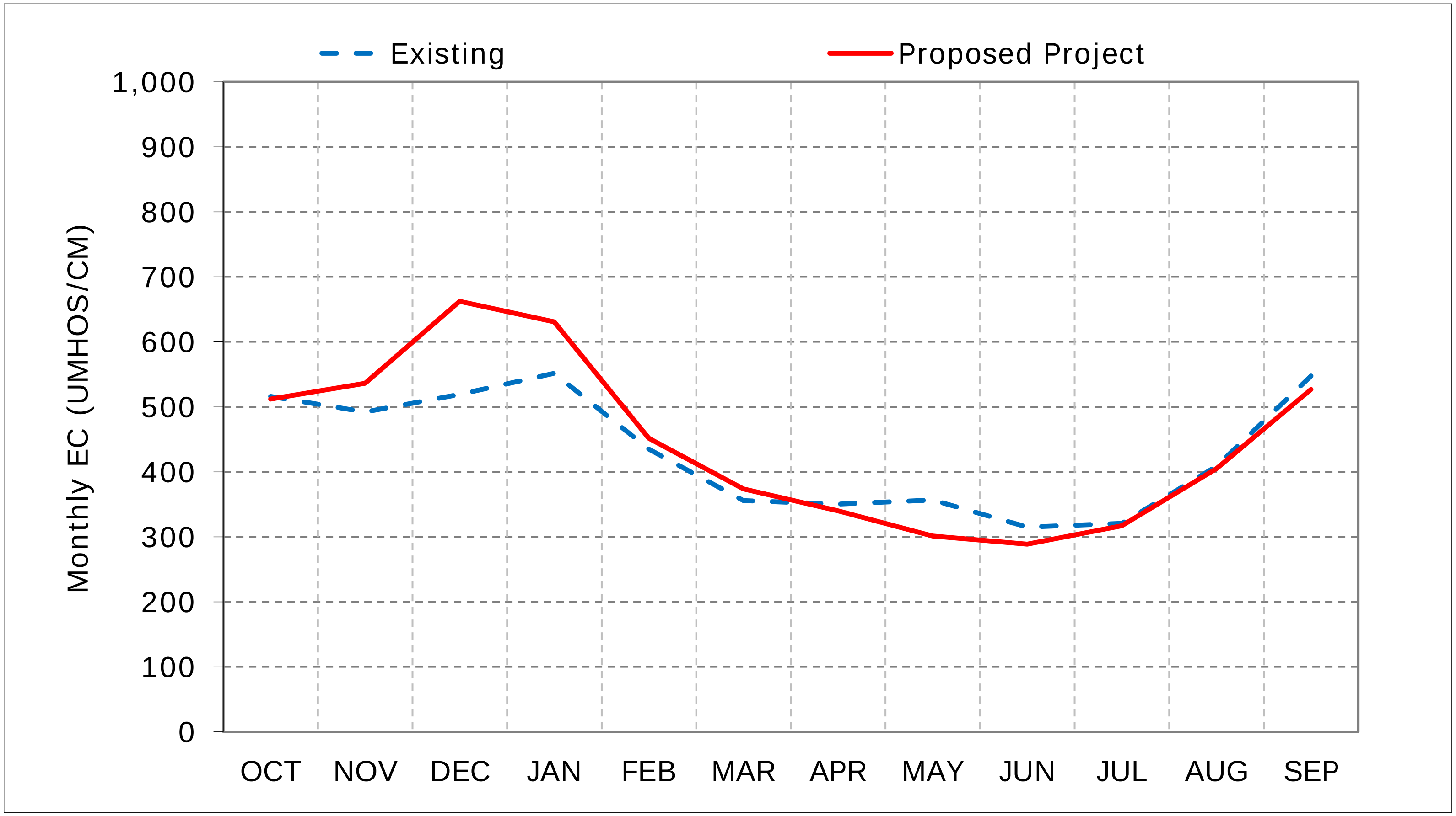
Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	774	732	831	956	612	477	406	355	345	431	577	731
20%	748	687	812	874	546	414	383	334	303	342	468	684
30%	715	650	777	774	488	394	368	321	286	323	443	640
40%	680	632	761	704	457	376	348	306	281	305	417	584
50%	647	587	739	582	428	367	337	292	275	282	384	524
60%	282	454	676	508	412	348	330	283	271	273	356	443
70%	270	398	586	449	382	337	319	278	264	262	328	415
80%	262	358	511	405	353	323	306	271	259	258	316	397
90%	257	316	329	359	328	303	282	261	249	251	296	370
Long Term												
Full Simulation Period[a]	512	536	662	631	451	374	340	301	289	317	405	527
Water Year Types[b]												
Wet (32%)	437	467	518	451	388	344	292	261	265	264	310	369
Above Normal (15%)	564	585	720	675	467	376	330	281	267	261	334	421
Below Normal (17%)	524	550	708	698	429	366	353	299	267	286	417	701
Dry (22%)	512	552	725	701	473	384	368	325	287	356	481	601
Critical (15%)	607	598	771	792	567	429	395	377	389	467	554	661

Proposed Project minus Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	21	-9	24	174	53	42	-11	-62	-15	6	7	42
20%	24	10	44	155	34	8	-17	-68	-24	-10	-14	24
30%	5	0	55	162	0	24	-12	-70	-29	-9	2	16
40%	2	12	148	143	-1	18	-26	-79	-30	-10	-5	-7
50%	13	8	314	64	8	20	-25	-85	-33	-9	-3	-35
60%	-37	132	308	37	25	10	-22	-83	-31	-3	-8	-73
70%	-33	113	273	20	16	13	-17	-76	-33	-7	-1	-81
80%	-29	85	225	32	5	9	7	-60	-27	-3	-4	-51
90%	-21	50	50	8	0	14	36	42	-24	-1	-13	-48
Long Term												
Full Simulation Period[a]	-4	44	143	79	16	18	-11	-55	-26	-3	-4	-20
Water Year Types[b]												
Wet (32%)	-7	57	123	33	-1	12	4	-31	-18	-1	-8	-95
Above Normal (15%)	-2	71	202	135	17	25	-22	-82	-36	-6	1	-12
Below Normal (17%)	-9	40	137	86	6	20	-11	-82	-36	-15	-5	45
Dry (22%)	-7	27	151	121	30	25	-22	-69	-29	-6	-11	5
Critical (15%)	8	18	123	51	44	10	-14	-29	-19	9	13	17

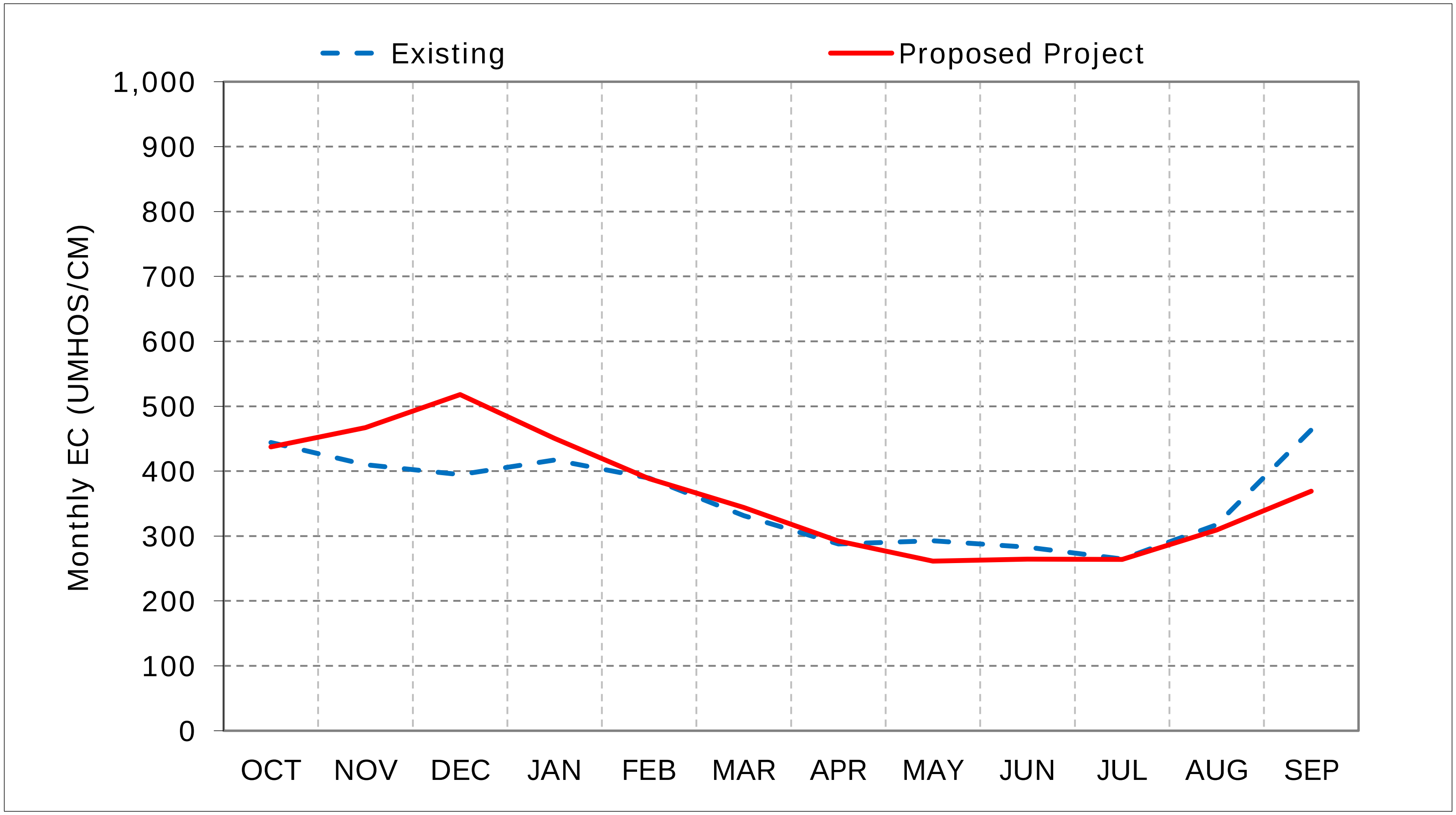
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 18-1. Old River at Highway 4, Long-Term Average EC



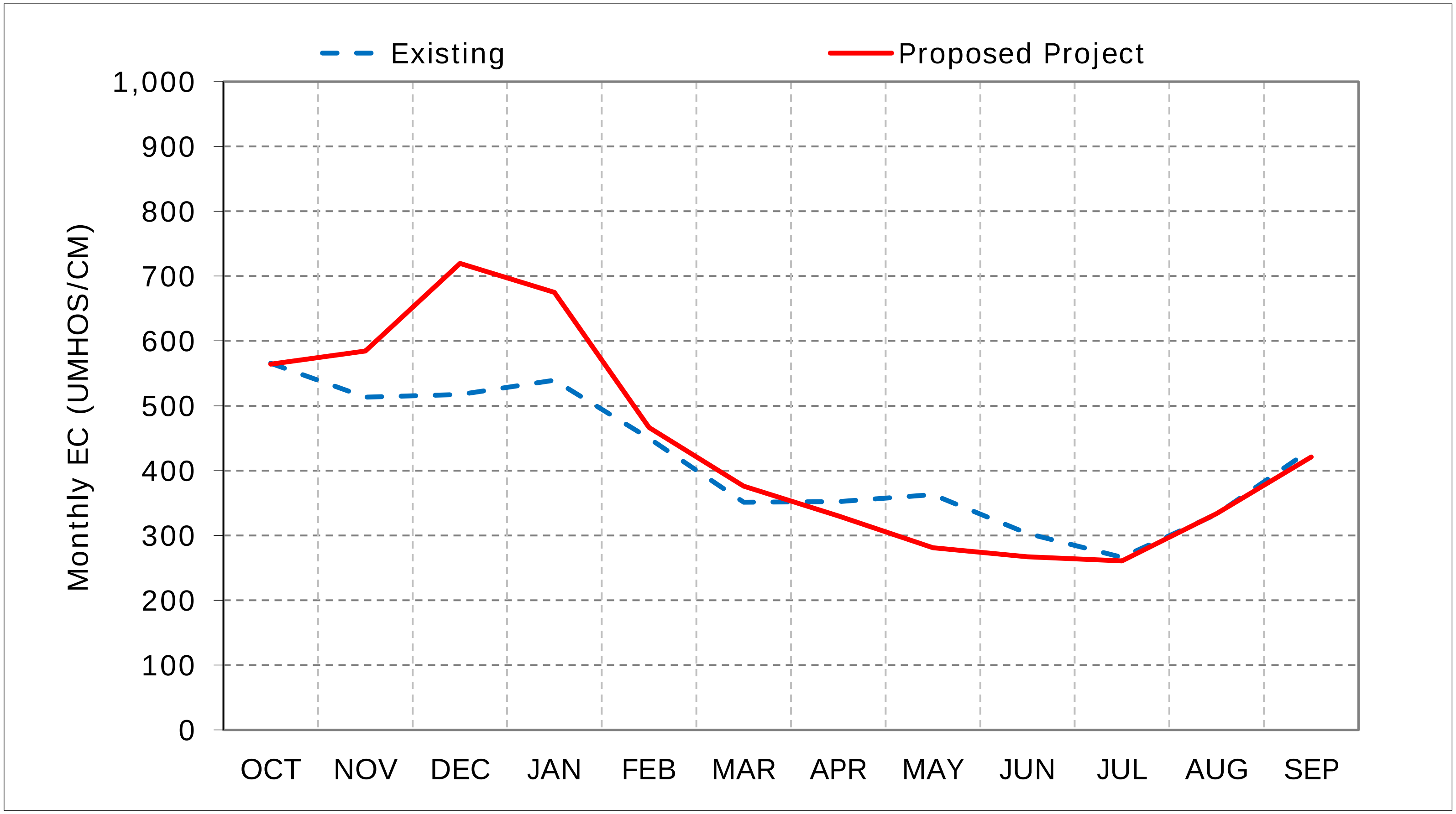
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 18-2. Old River at Highway 4, Wet Year Average EC



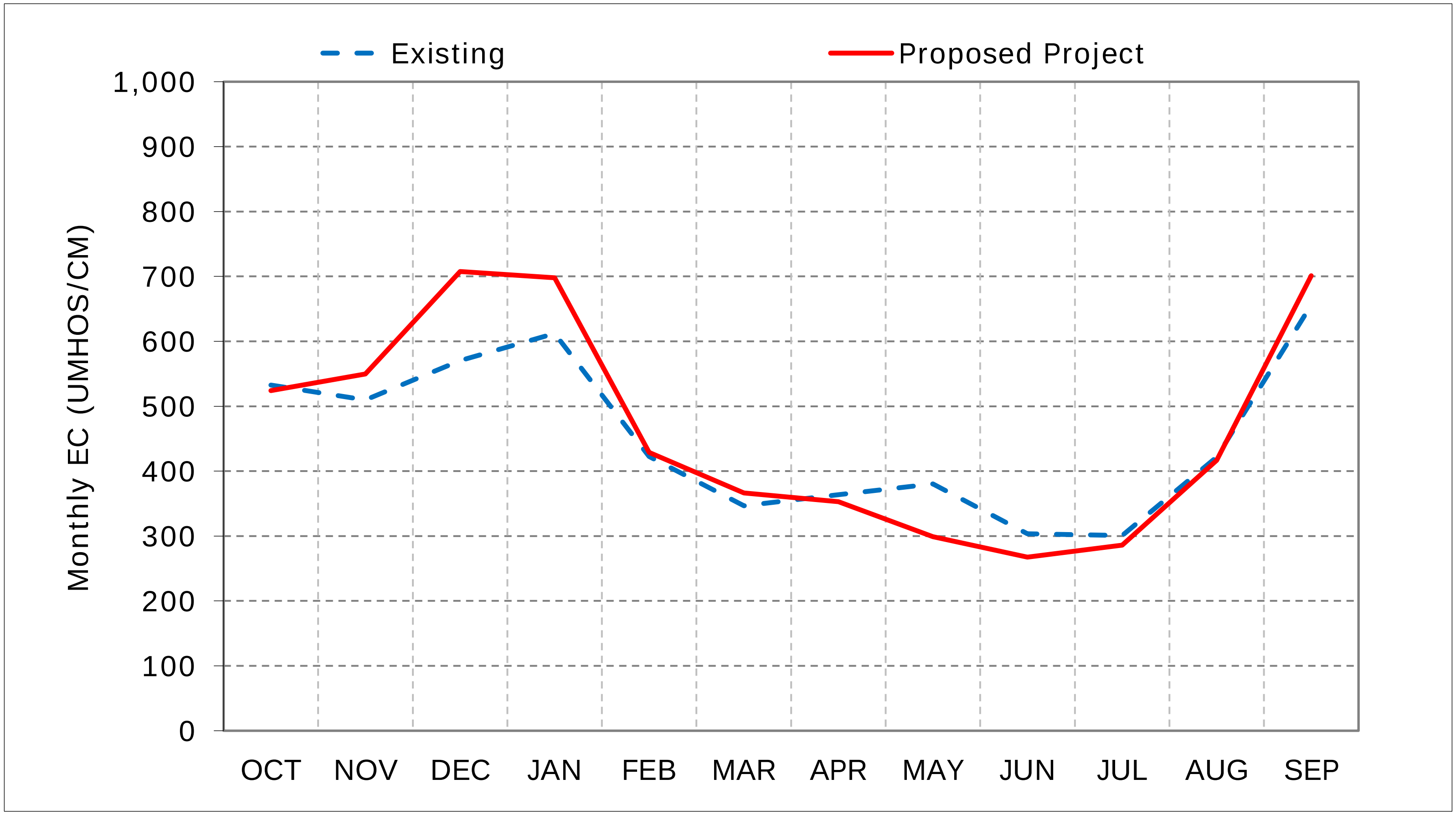
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 18-3. Old River at Highway 4, Above Normal Year Average EC



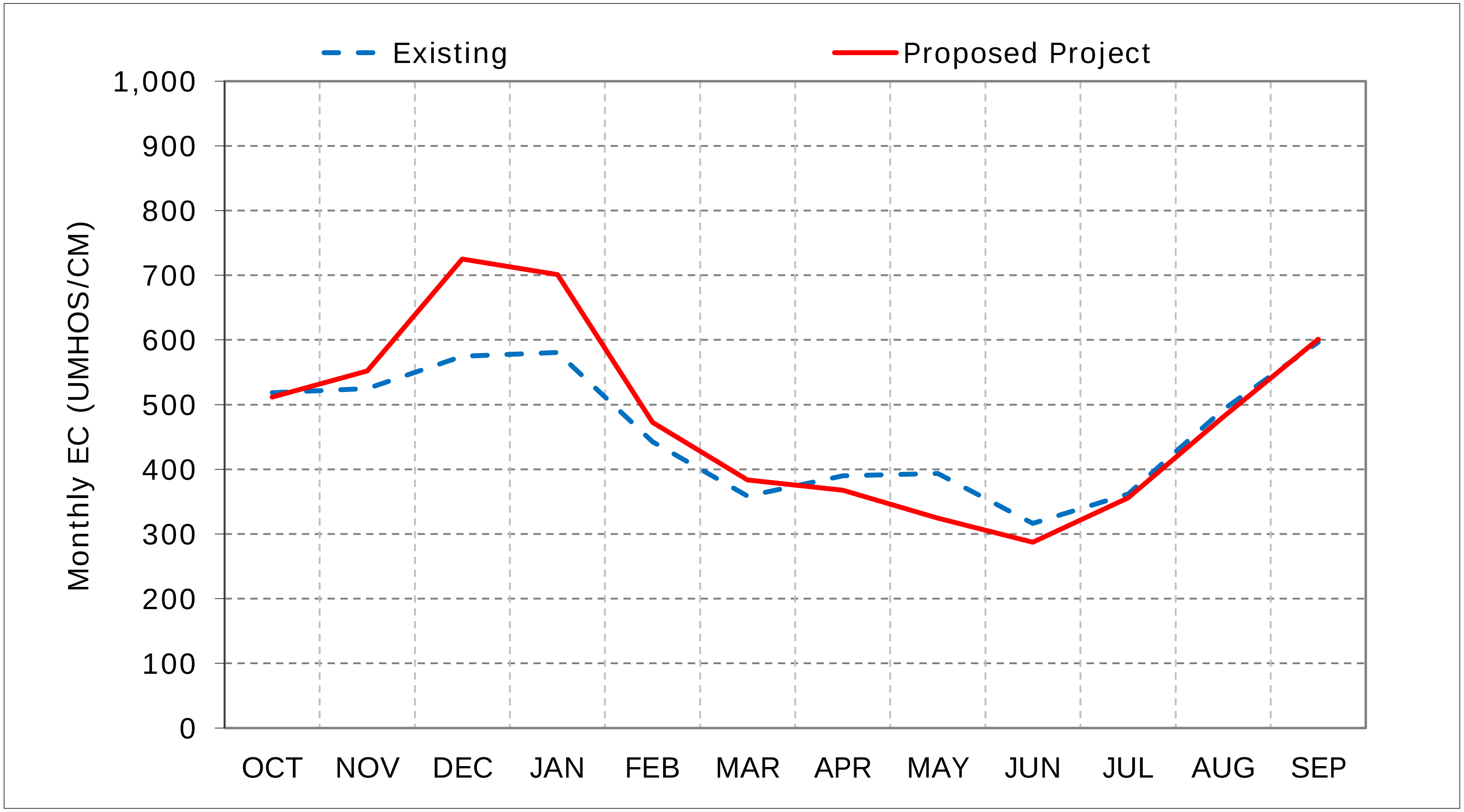
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 18-4. Old River at Highway 4, Below Normal Year Average EC



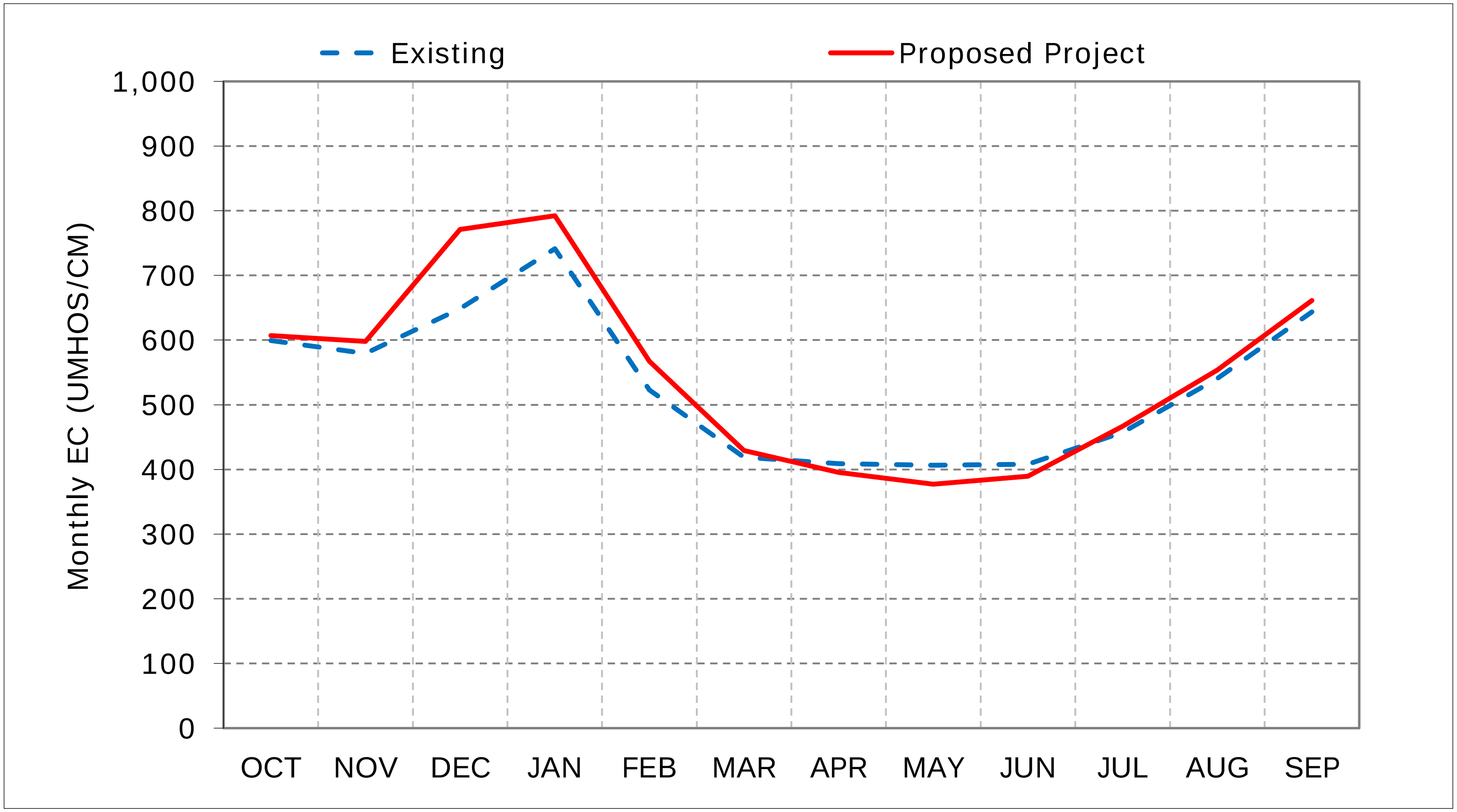
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 18-5. Old River at Highway 4, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 18-6. Old River at Highway 4, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 18-7. Old River at Highway 4, January EC

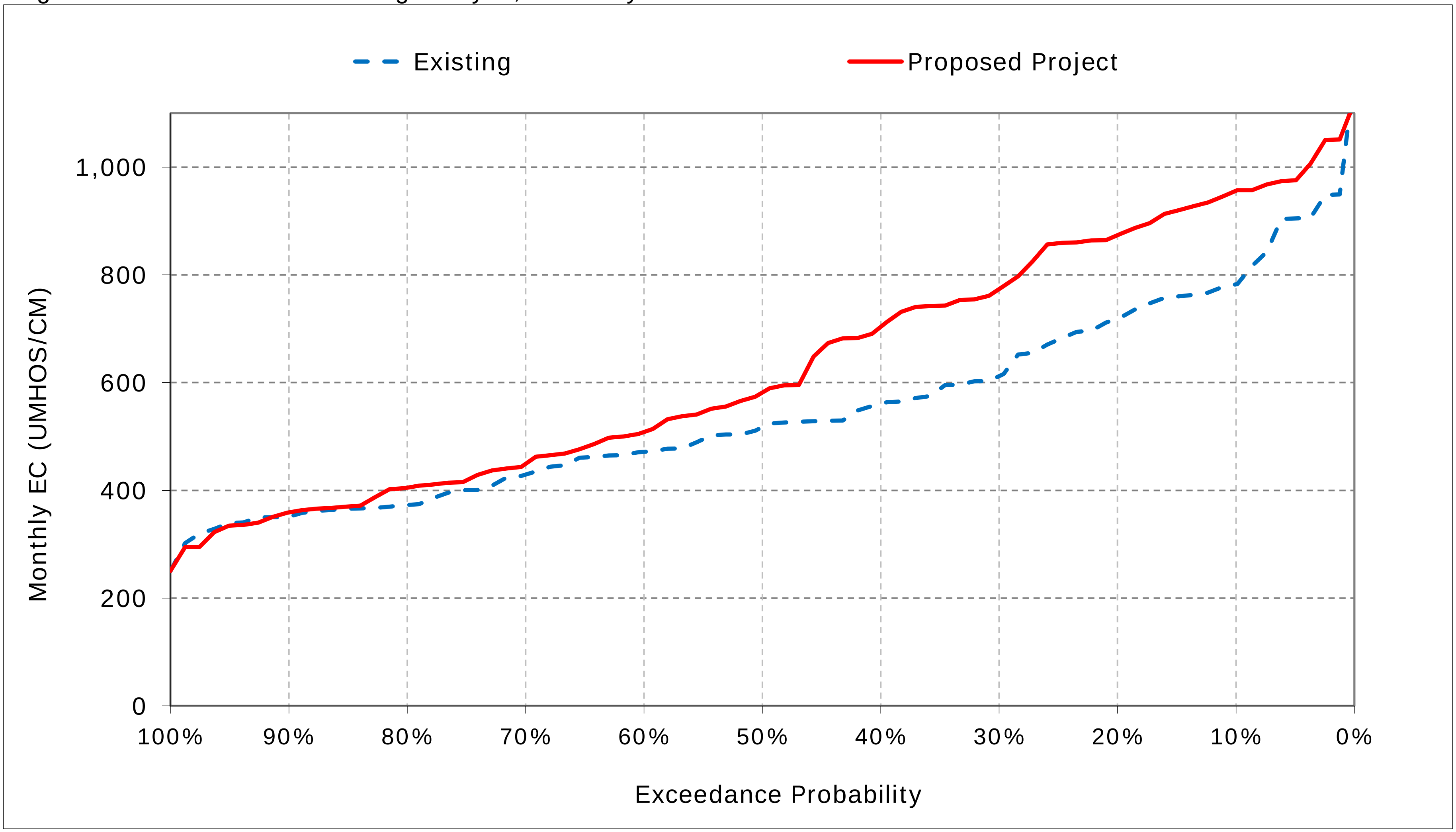


Figure 18-8. Old River at Highway 4, February EC

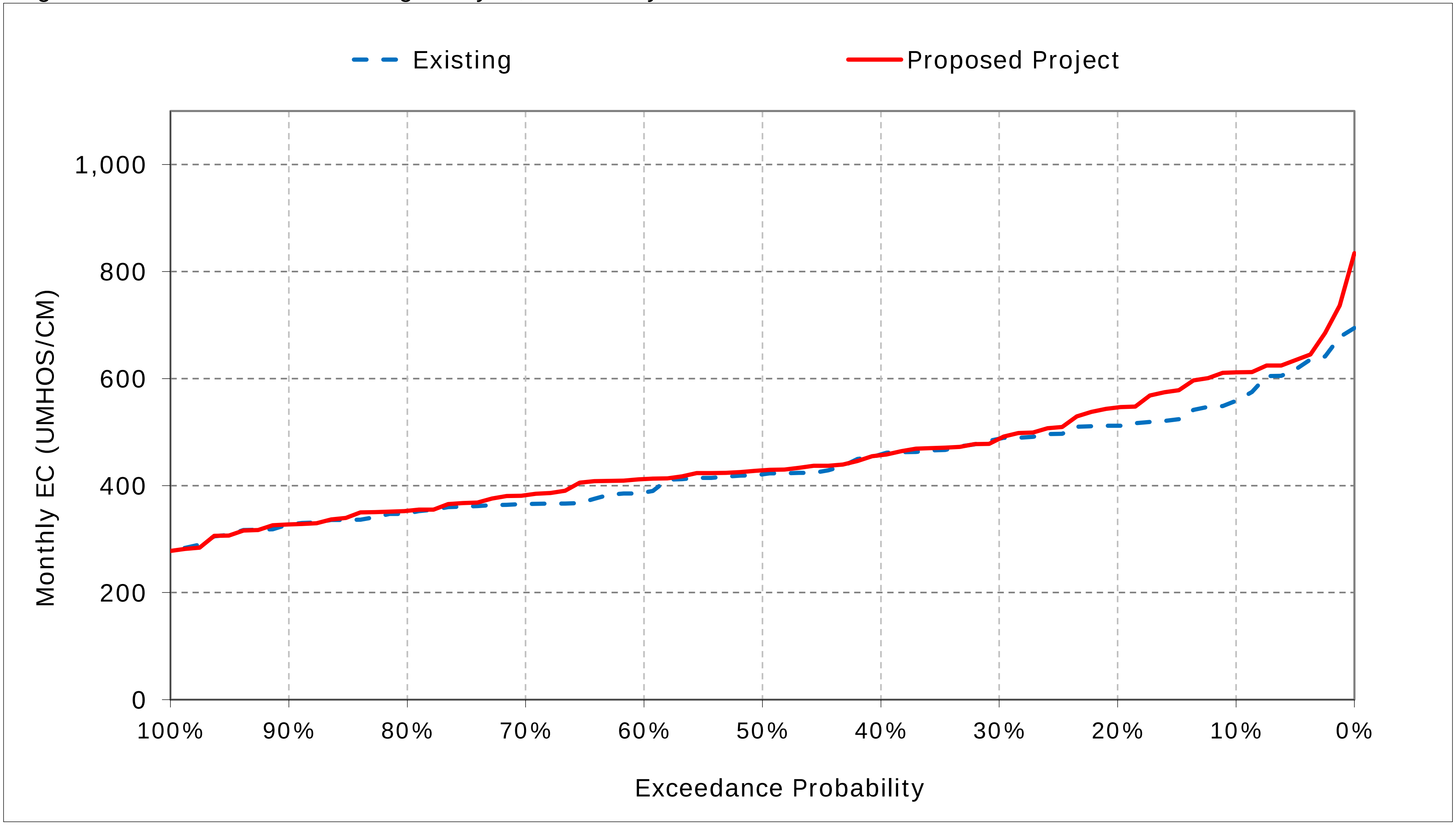


Figure 18-9. Old River at Highway 4, March EC

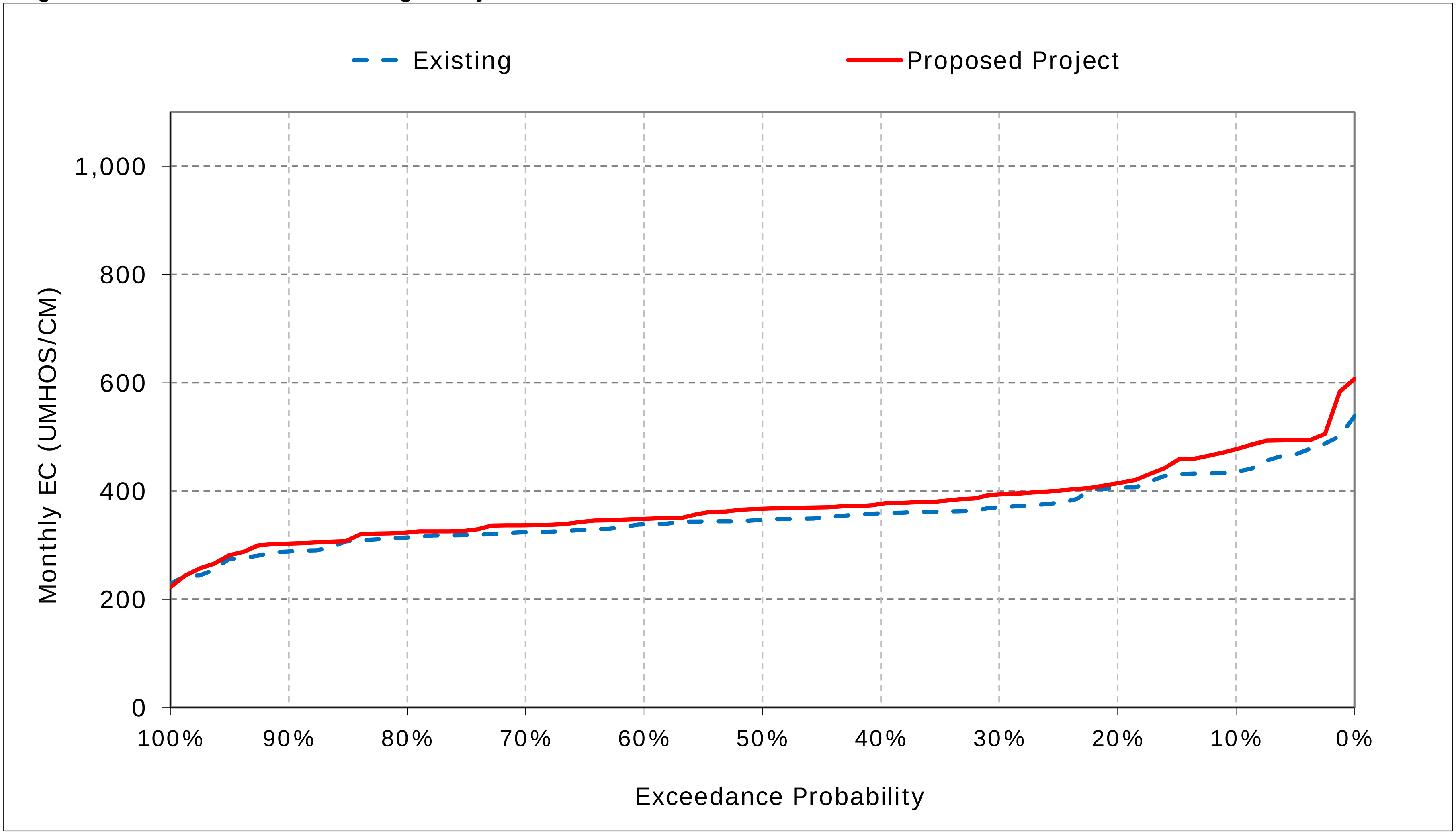


Figure 18-10. Old River at Highway 4, April EC

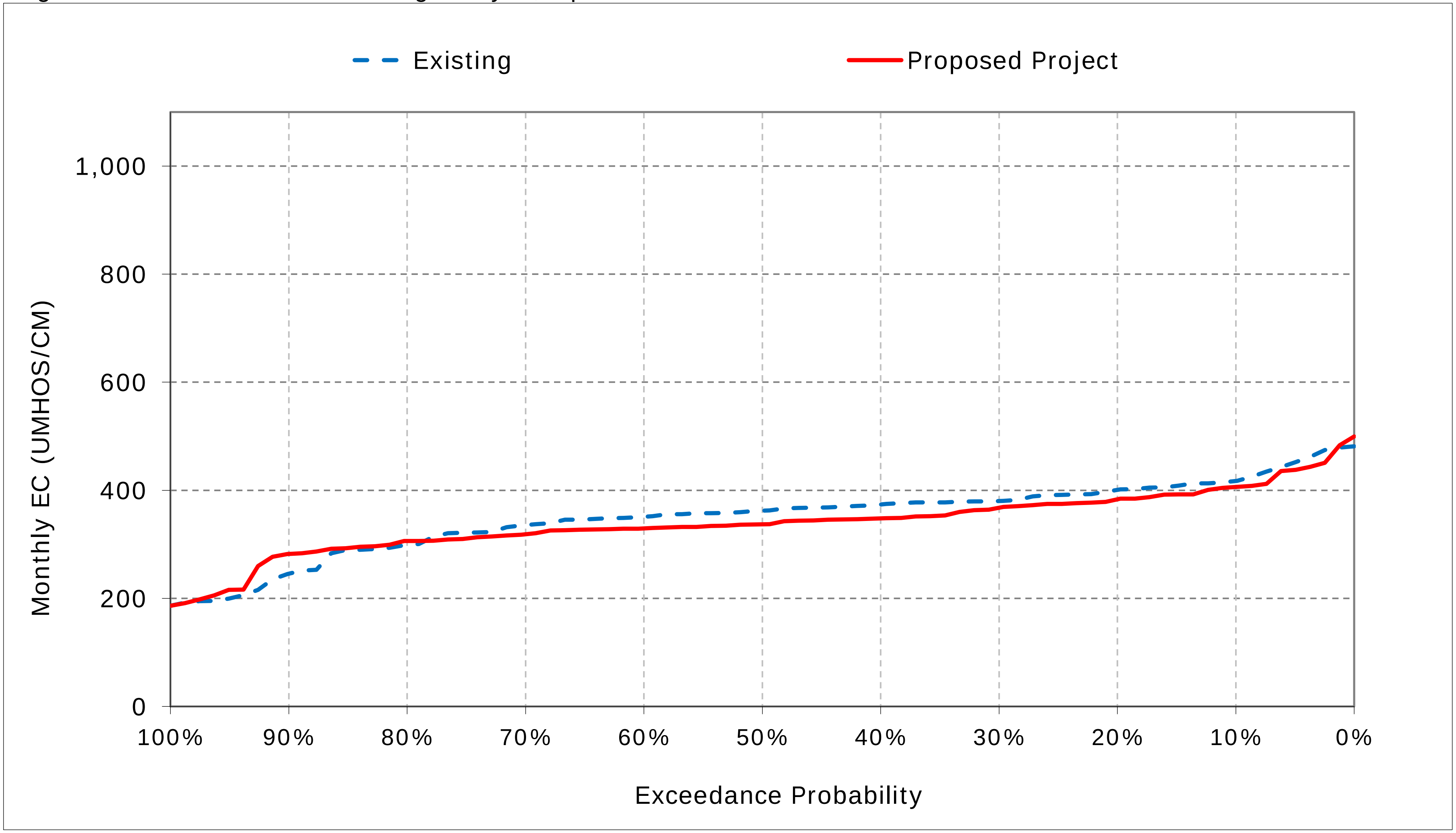


Figure 18-11. Old River at Highway 4, May EC

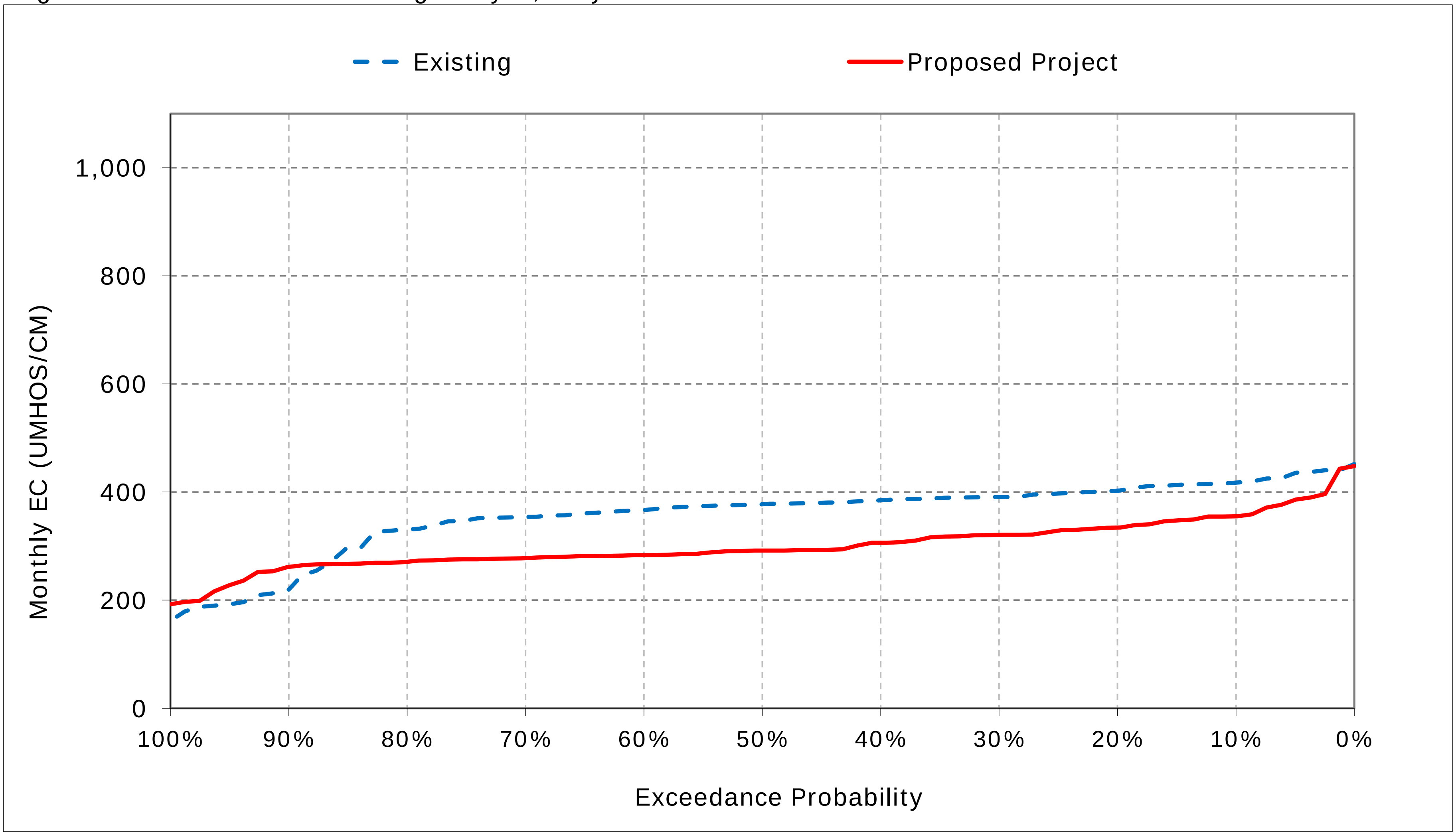


Figure 18-12. Old River at Highway 4, June EC

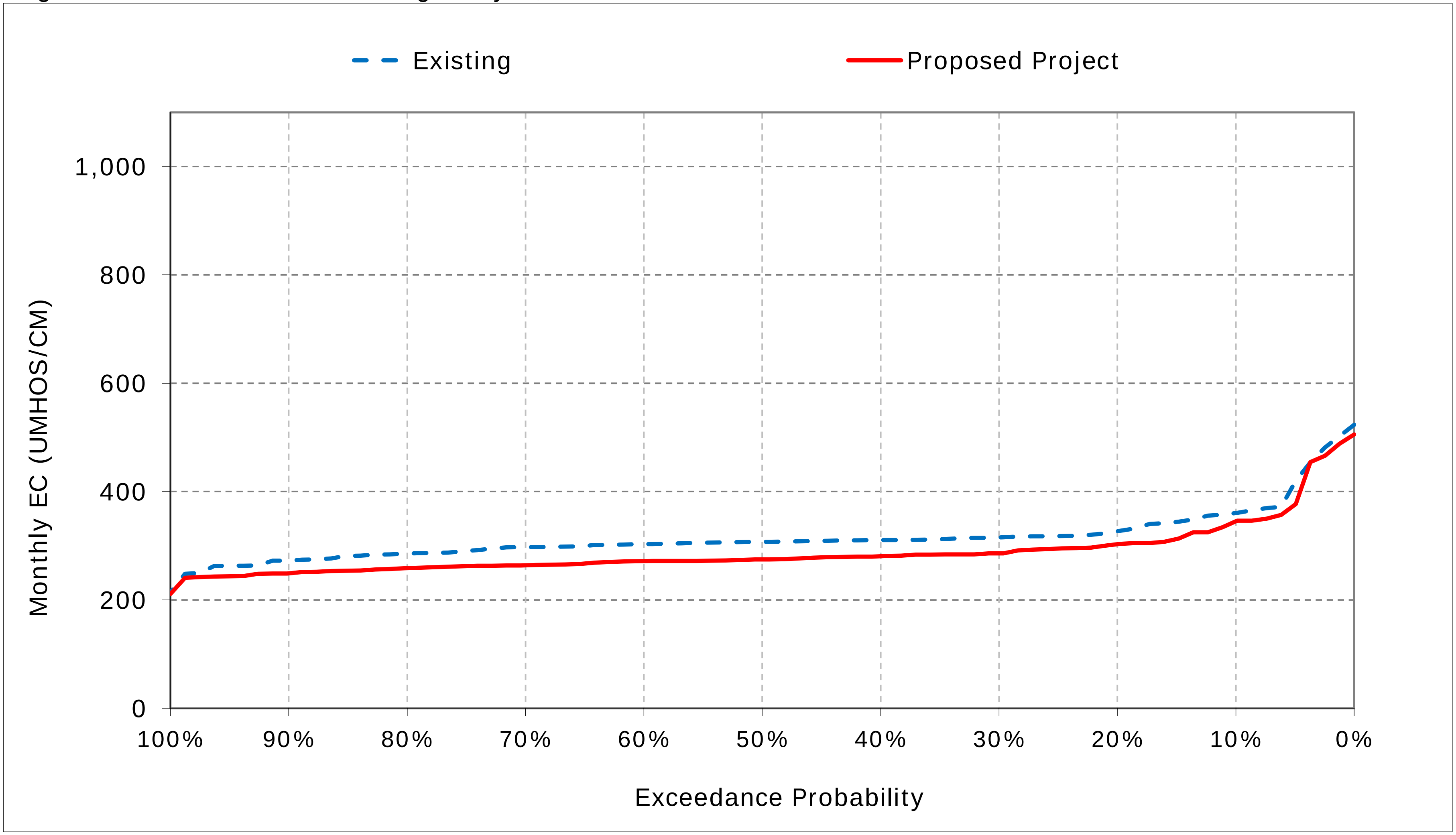


Figure 18-13. Old River at Highway 4, July EC

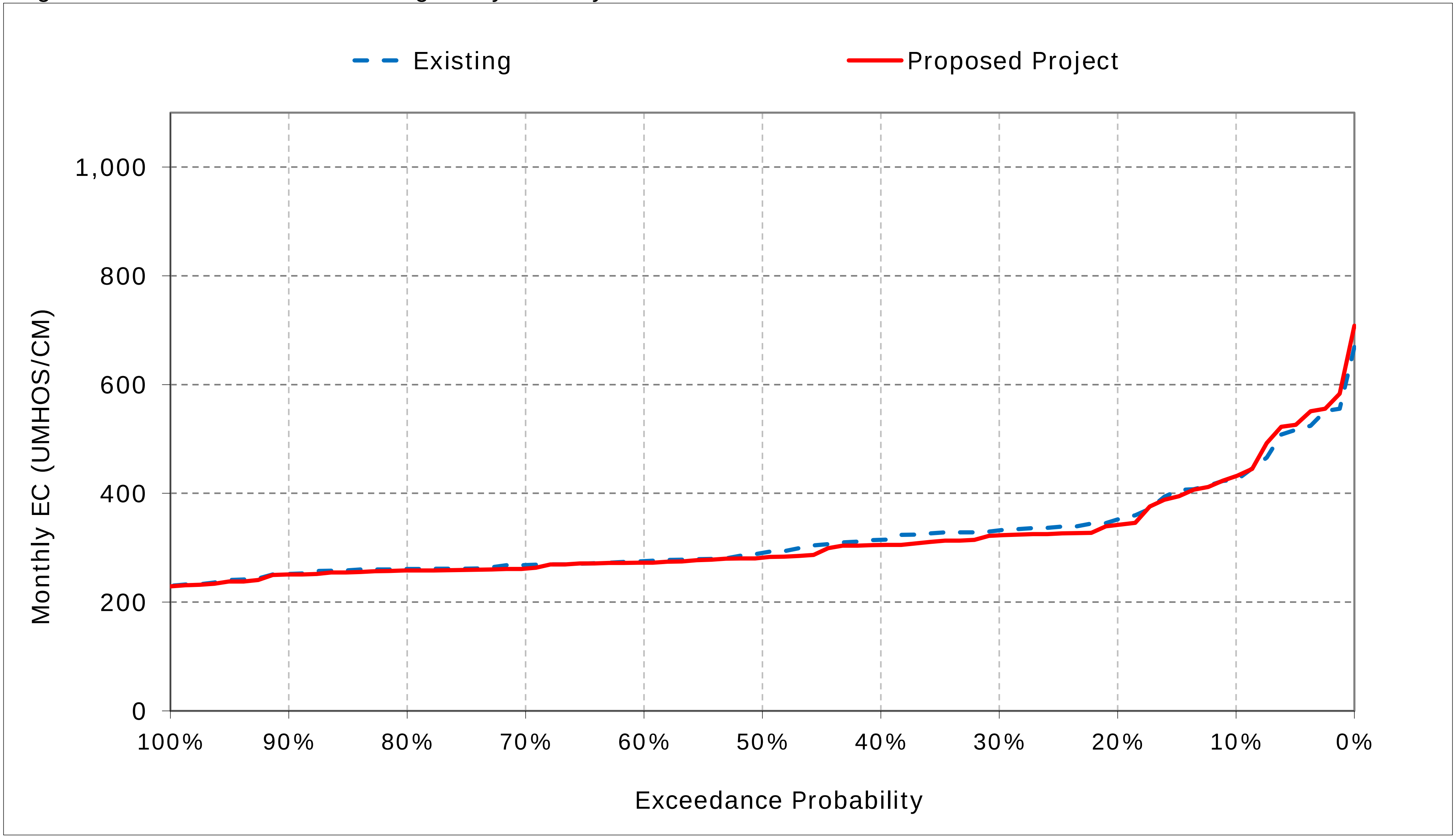


Figure 18-14. Old River at Highway 4, August EC

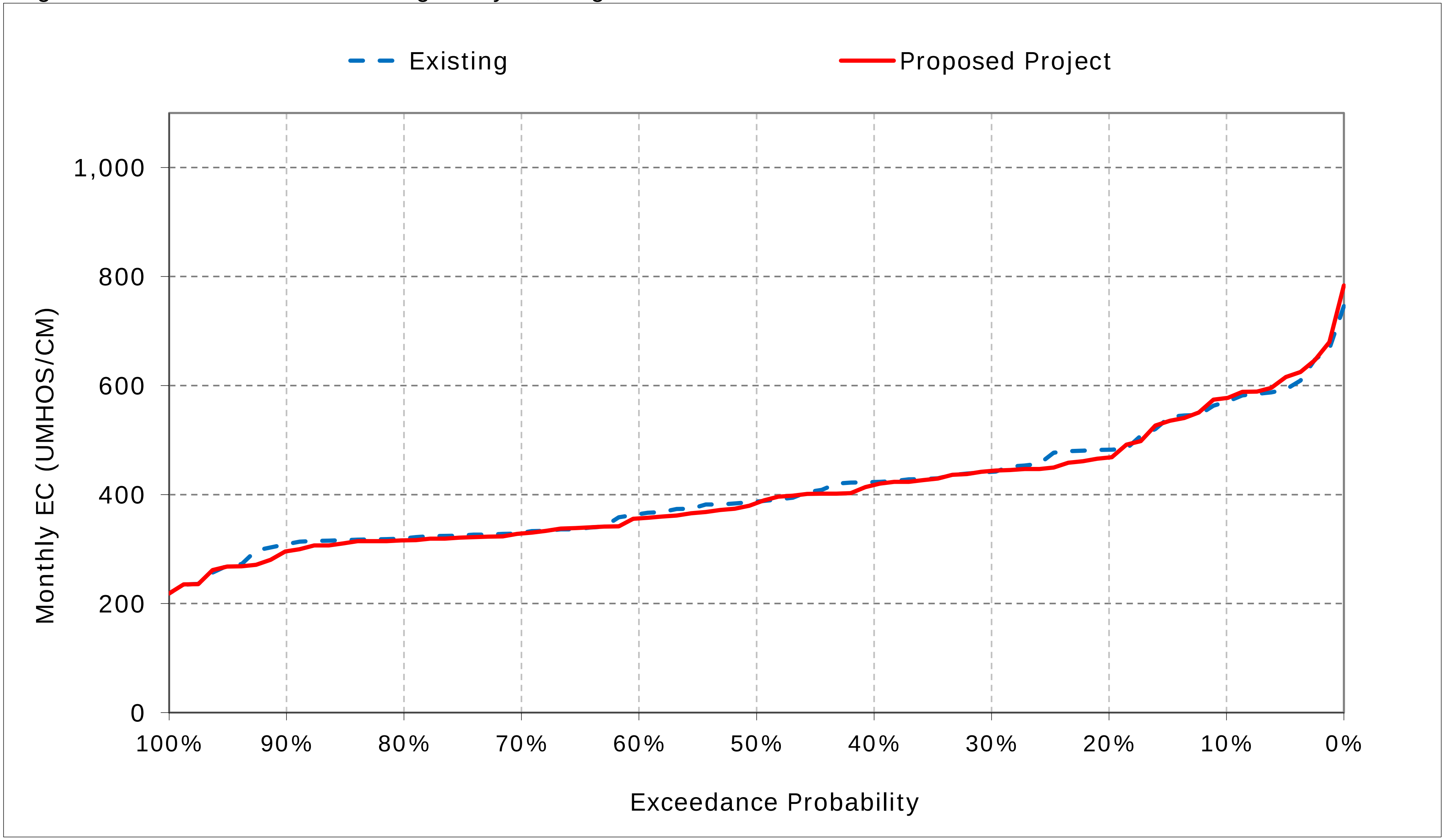


Figure 18-15. Old River at Highway 4, September EC

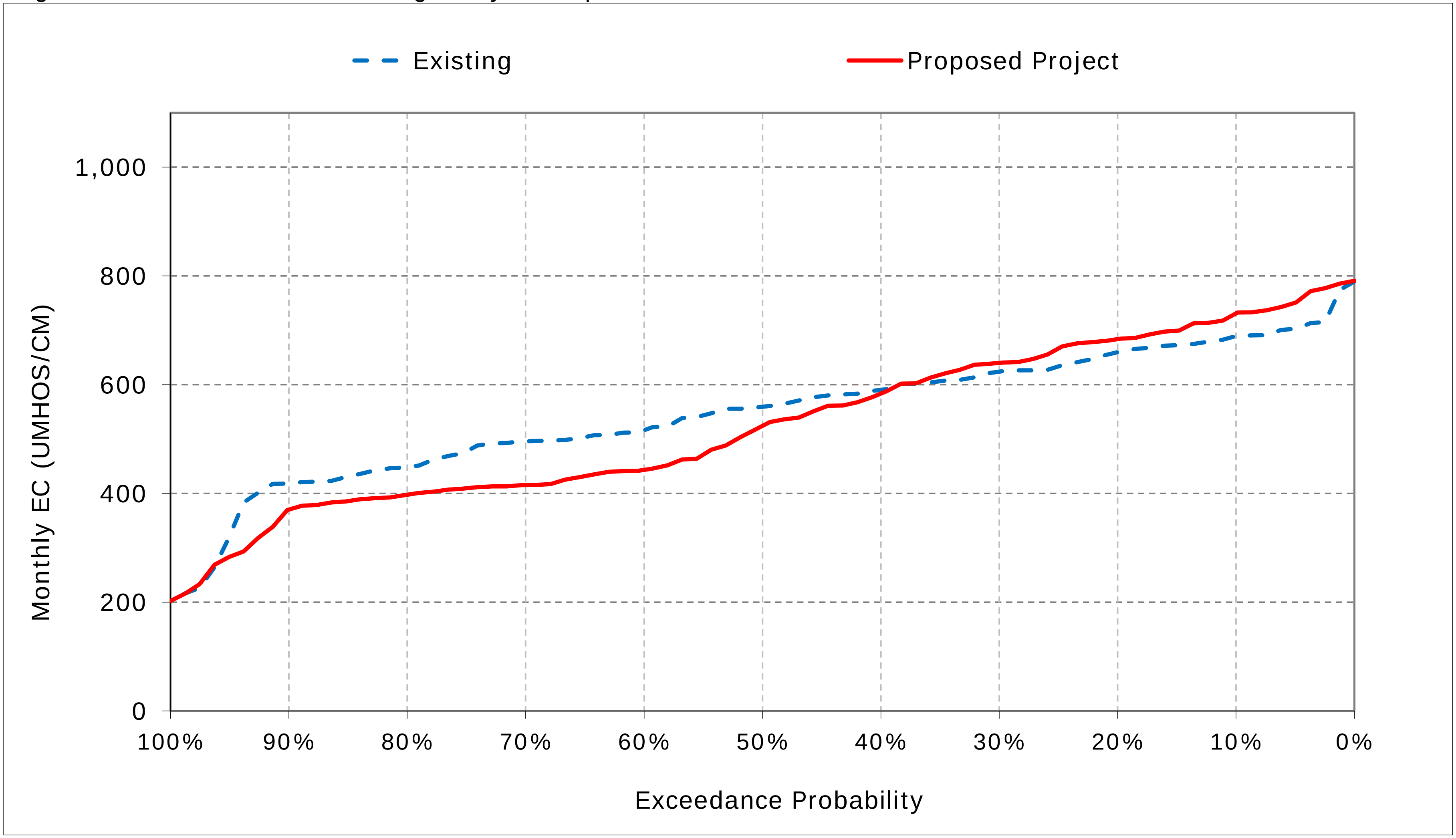


Figure 18-16. Old River at Highway 4, October EC

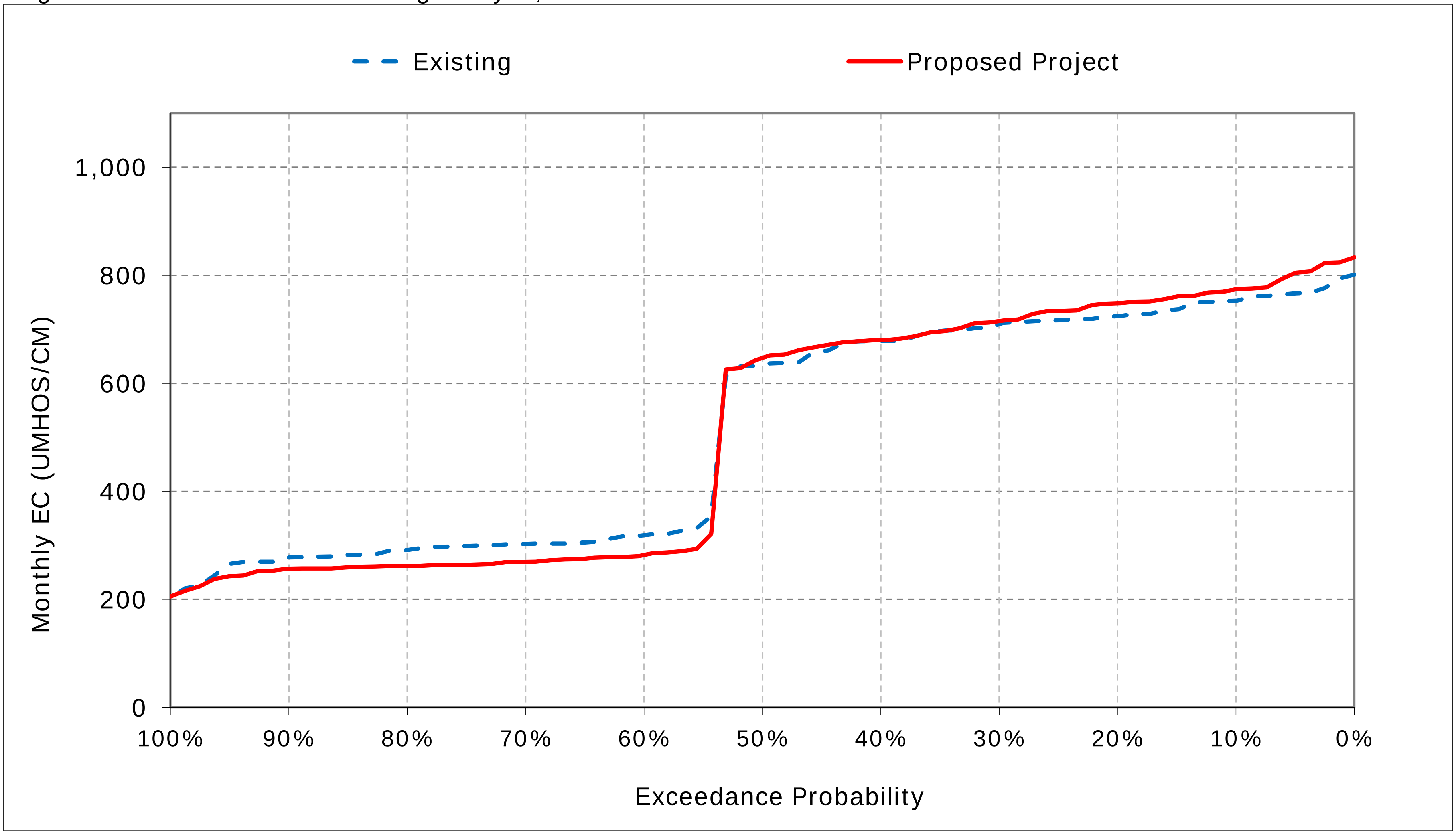


Figure 18-17. Old River at Highway 4, November EC

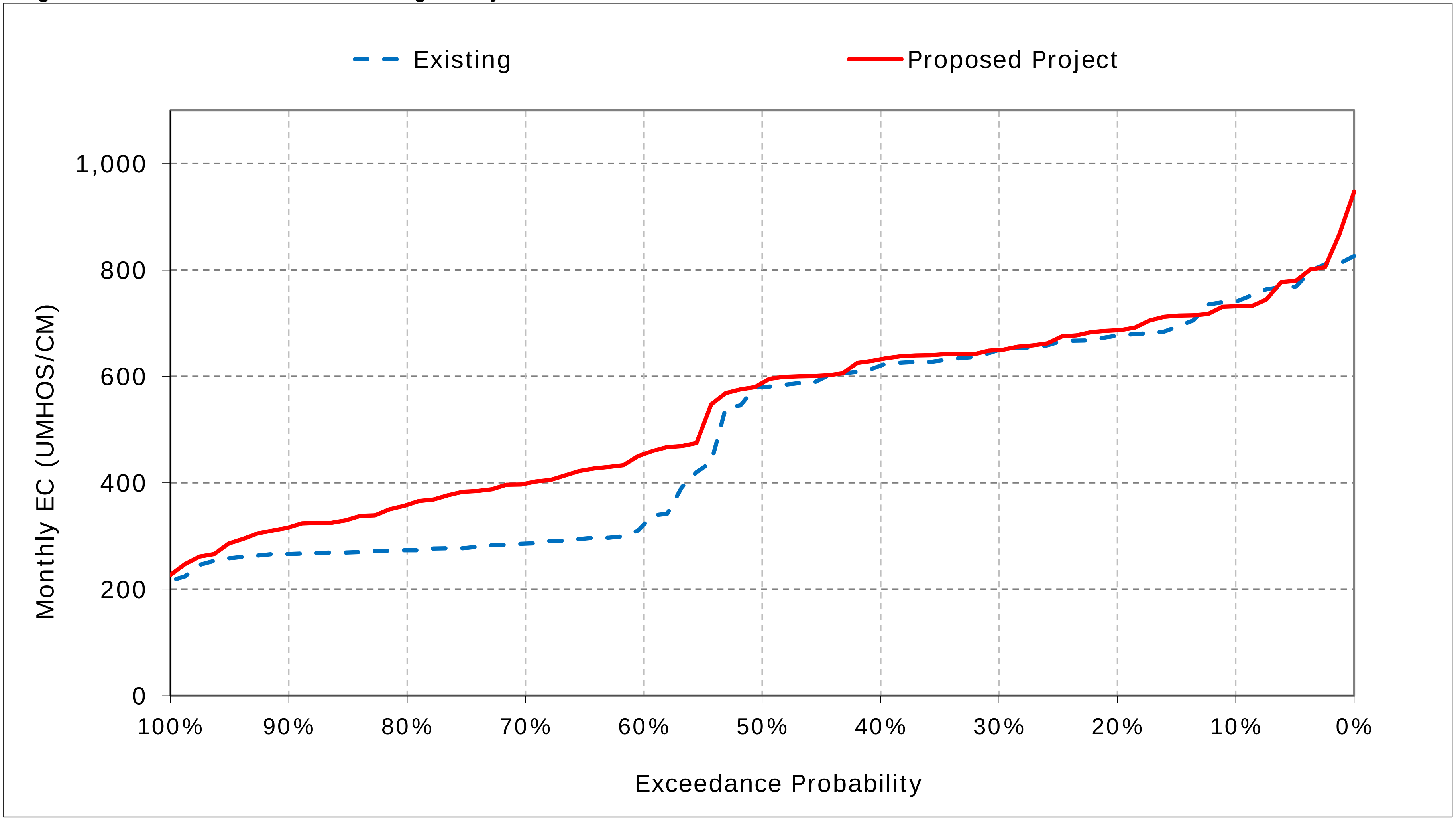


Figure 18-18. Old River at Highway 4, December EC

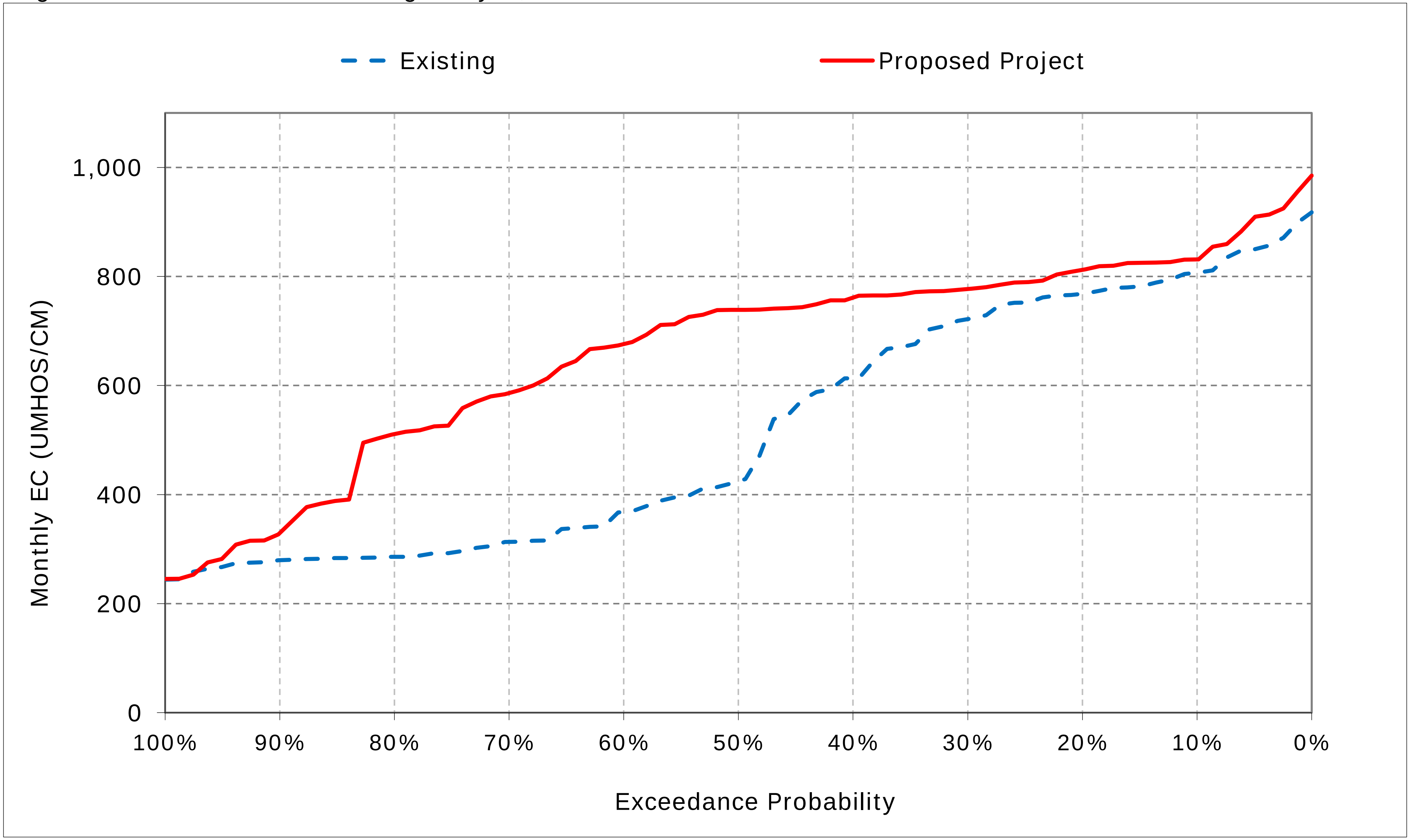


Table 19-1. Victoria Canal Salinity, Monthly EC

Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	512	528	585	672	620	535	496	471	426	368	427	458
20%	490	483	556	646	576	497	470	453	386	356	378	446
30%	477	467	538	583	550	481	450	438	375	327	350	439
40%	467	453	514	553	537	464	430	420	369	310	330	427
50%	446	431	436	526	503	440	410	389	363	298	308	412
60%	368	359	377	502	482	419	369	374	358	289	301	394
70%	354	348	337	481	469	395	333	359	348	280	293	386
80%	333	341	318	448	432	347	302	327	336	271	284	355
90%	320	330	295	427	368	323	246	215	322	258	270	338
Long Term												
Full Simulation Period[a]	418	414	443	541	501	433	387	379	365	311	330	401
Water Year Types[b]												
Wet (32%)	388	377	400	477	428	362	292	293	330	303	285	374
Above Normal (15%)	440	433	440	544	528	427	375	370	360	295	281	344
Below Normal (17%)	421	414	455	572	513	447	402	398	360	282	321	425
Dry (22%)	420	424	463	549	535	488	462	438	376	301	380	418
Critical (15%)	451	463	498	628	568	492	471	466	432	391	416	465

Proposed Project

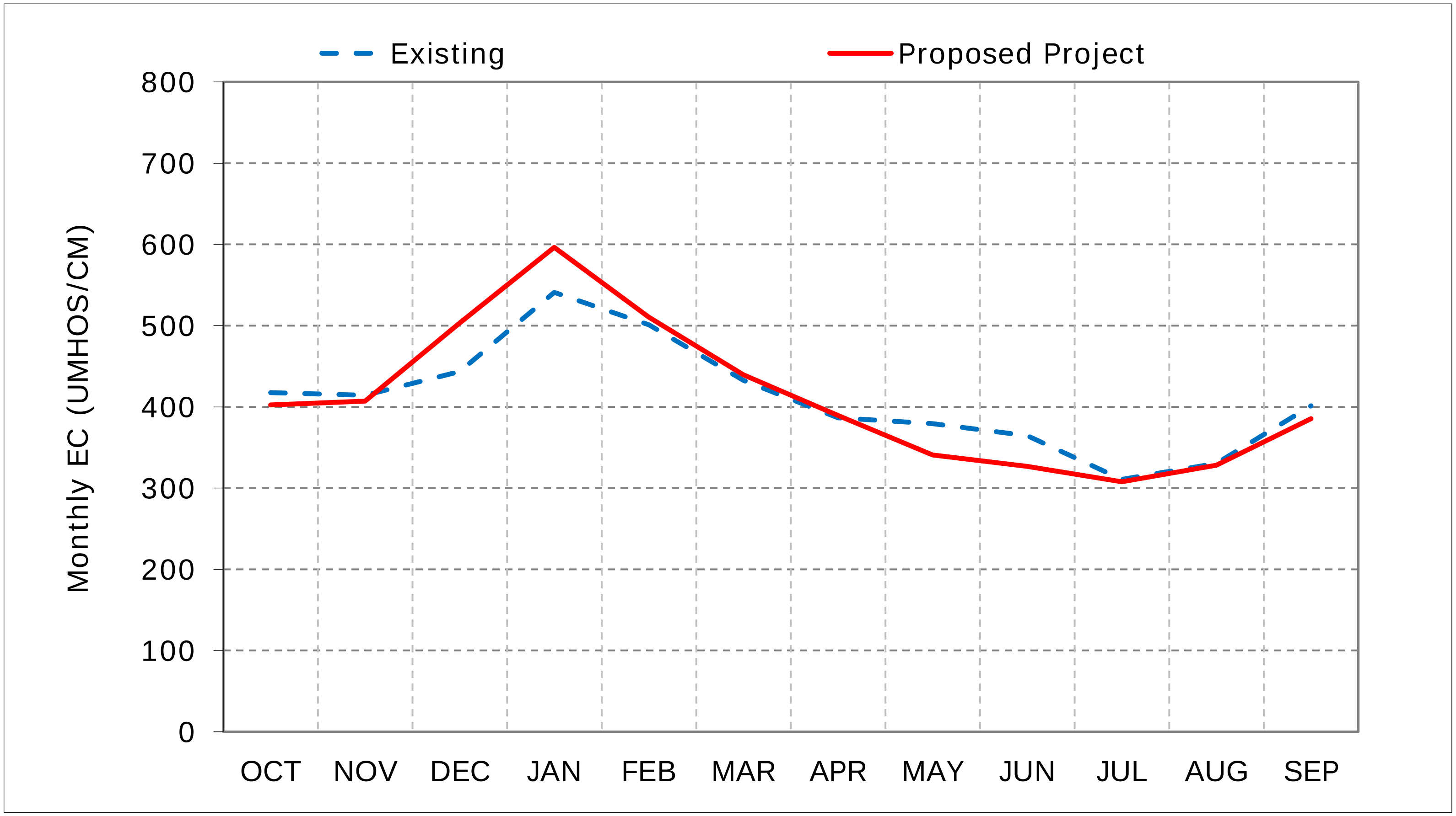
Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	527	522	619	770	655	548	483	411	365	371	426	464
20%	498	501	572	720	609	509	462	388	350	356	363	453
30%	484	469	552	674	567	486	441	375	335	328	343	434
40%	470	448	542	646	533	470	425	354	329	307	325	419
50%	457	436	519	582	511	446	407	344	322	296	306	391
60%	310	338	500	556	484	424	378	336	317	284	299	353
70%	301	326	471	516	465	384	346	327	310	274	291	337
80%	295	313	426	481	441	359	319	317	301	260	283	330
90%	287	305	357	434	370	327	289	253	290	254	271	313
Long Term												
Full Simulation Period[a]	402	407	503	596	510	439	389	341	327	308	328	386
Water Year Types[b]												
Wet (32%)	366	368	449	494	427	366	309	283	313	302	283	314
Above Normal (15%)	426	439	536	648	546	434	372	328	321	287	282	339
Below Normal (17%)	402	401	506	630	515	454	417	348	315	277	317	441
Dry (22%)	406	417	524	633	551	500	462	381	323	299	373	419
Critical (15%)	453	450	553	672	590	495	439	410	382	390	418	471

Proposed Project minus Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	16	-6	34	99	35	13	-13	-60	-60	4	-1	7
20%	8	18	16	74	34	12	-8	-65	-37	-1	-15	7
30%	7	2	14	90	16	5	-9	-63	-40	1	-7	-5
40%	2	-5	29	93	-4	7	-4	-66	-40	-3	-5	-8
50%	11	5	83	57	8	5	-3	-44	-41	-2	-2	-21
60%	-58	-21	123	54	2	4	9	-38	-41	-4	-2	-41
70%	-53	-22	133	35	-3	-11	13	-32	-39	-6	-2	-49
80%	-38	-28	109	32	9	12	17	-9	-34	-11	0	-25
90%	-32	-25	62	6	2	4	43	38	-31	-4	1	-25
Long Term												
Full Simulation Period[a]	-15	-7	60	55	9	7	3	-38	-38	-3	-2	-16
Water Year Types[b]												
Wet (32%)	-22	-9	49	17	-1	4	17	-10	-17	-2	-2	-59
Above Normal (15%)	-14	7	96	104	18	8	-2	-42	-39	-7	1	-5
Below Normal (17%)	-19	-12	50	58	1	7	15	-49	-45	-5	-4	16
Dry (22%)	-14	-7	61	84	17	12	0	-57	-53	-1	-7	1
Critical (15%)	2	-13	55	45	22	3	-31	-56	-50	-1	2	6

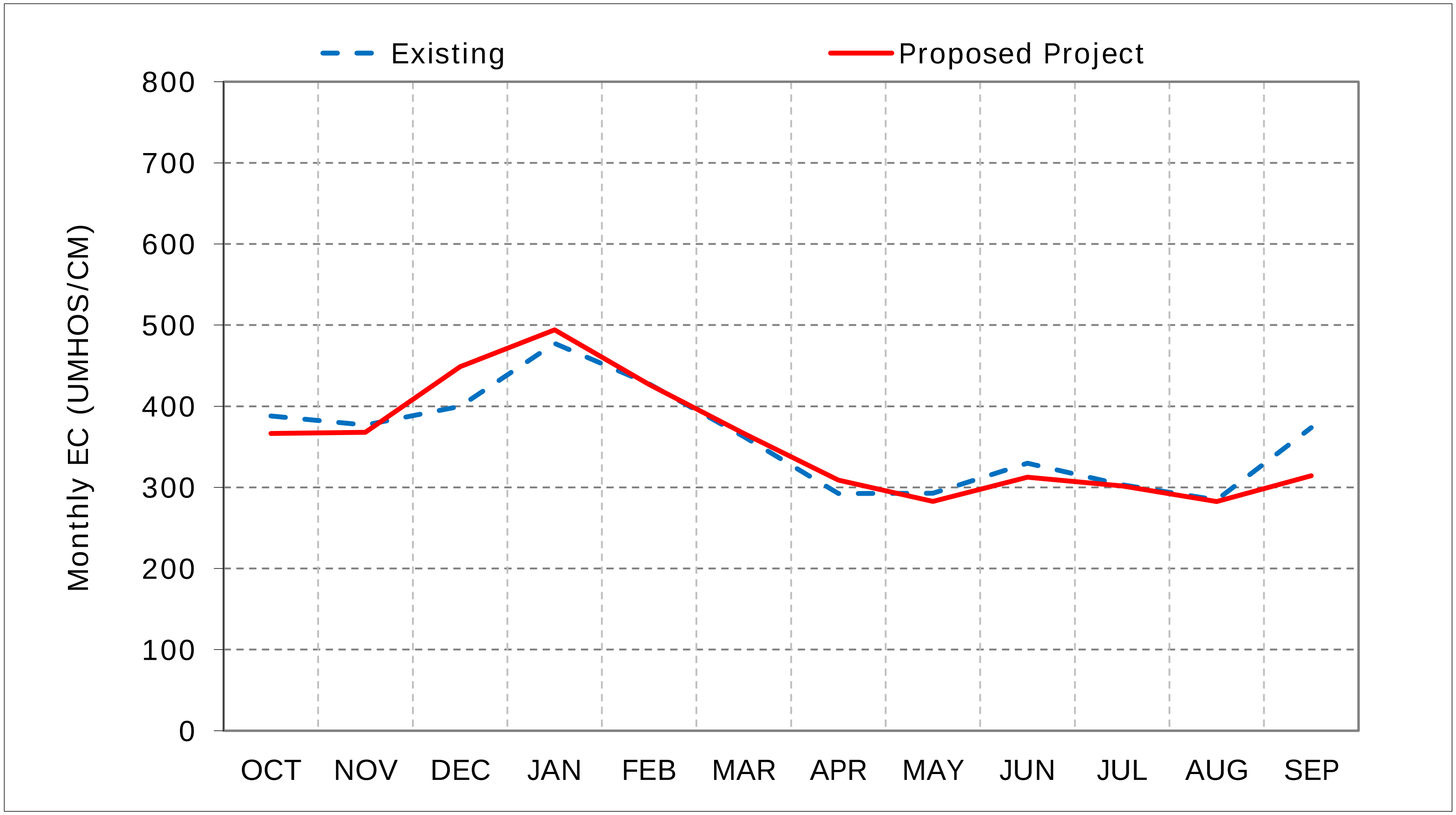
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 19-1. Victoria Canal Salinity, Long-Term Average EC



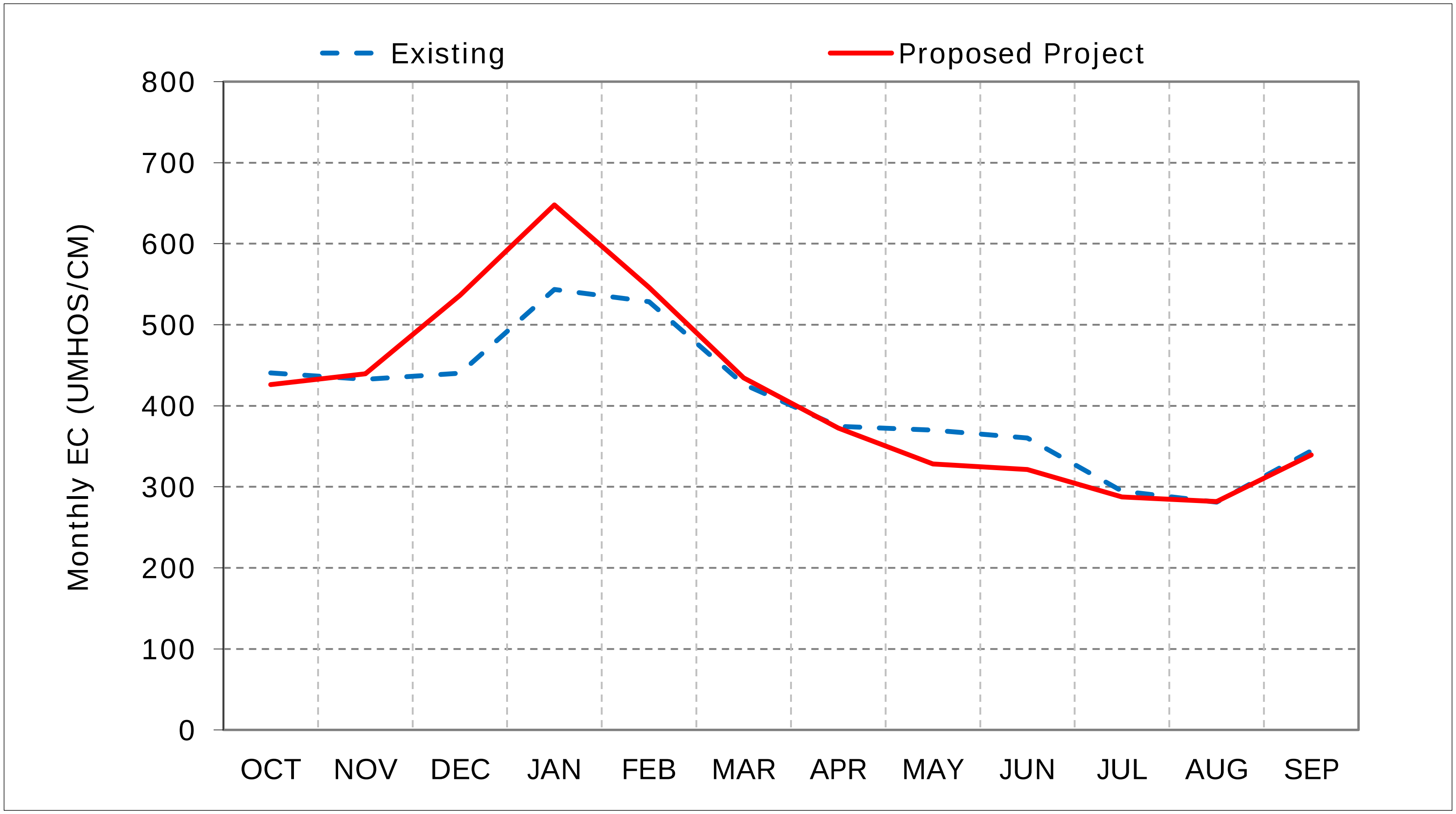
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 19-2. Victoria Canal Salinity, Wet Year Average EC



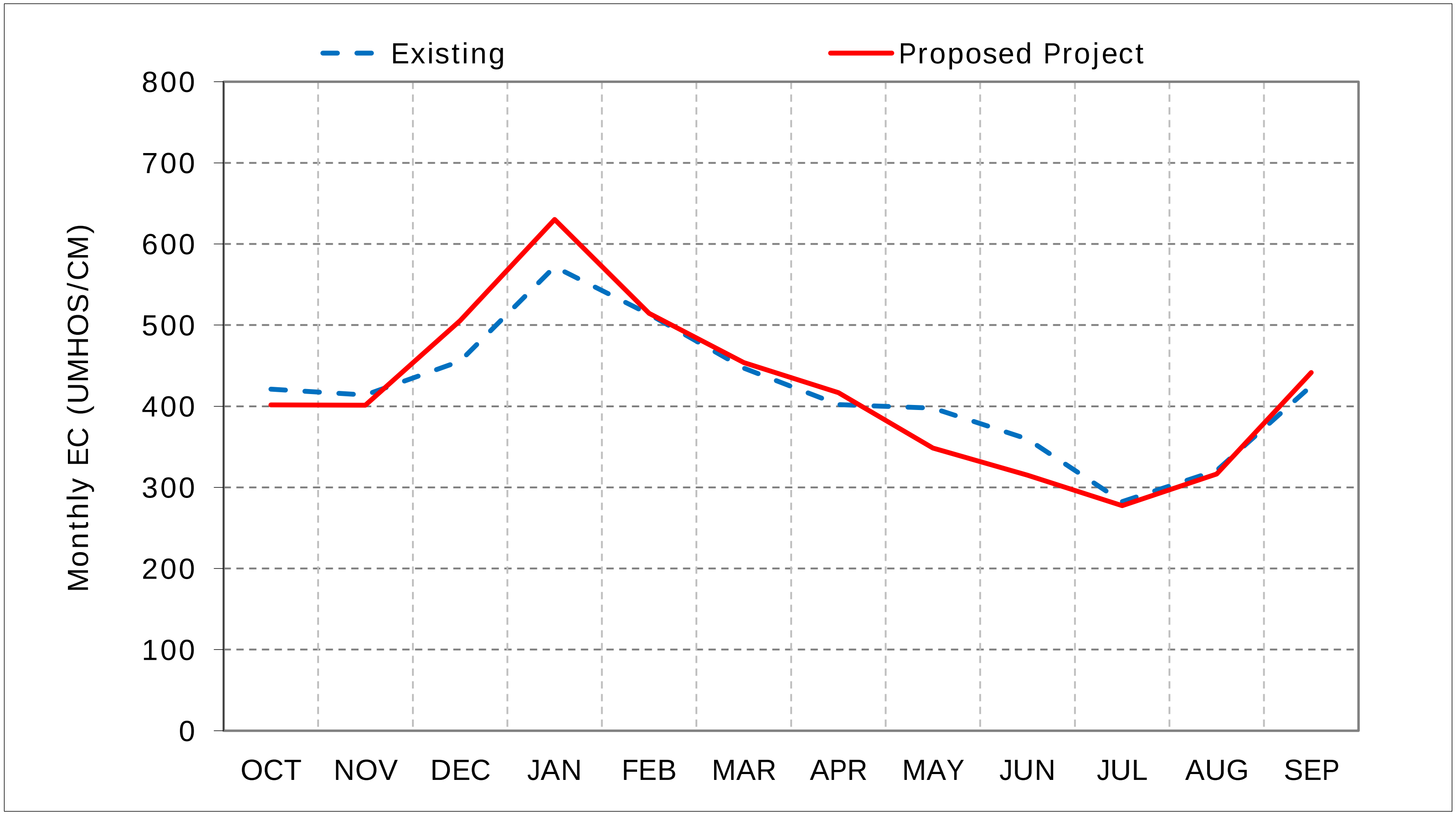
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 19-3. Victoria Canal Salinity, Above Normal Year Average EC



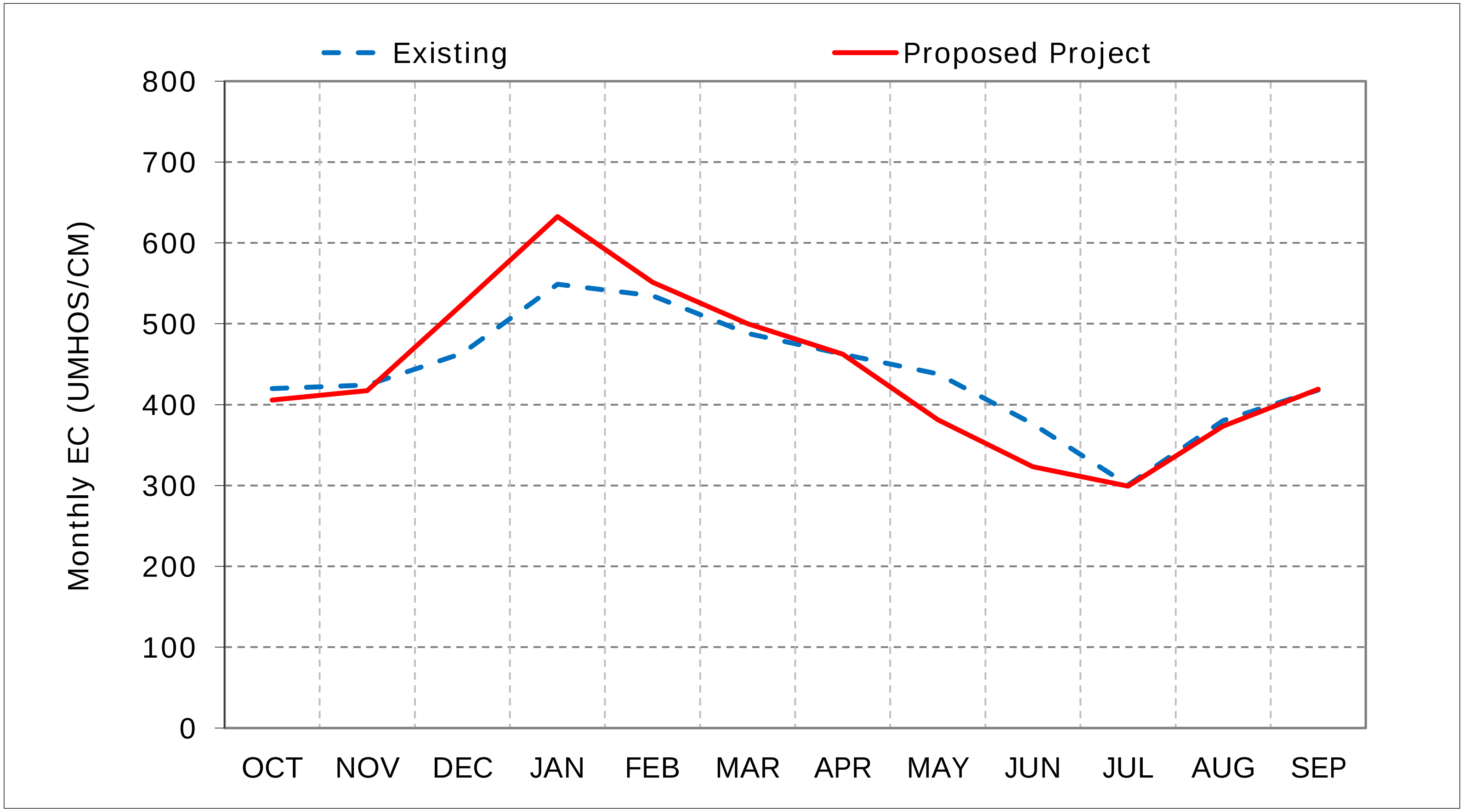
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 19-4. Victoria Canal Salinity, Below Normal Year Average EC



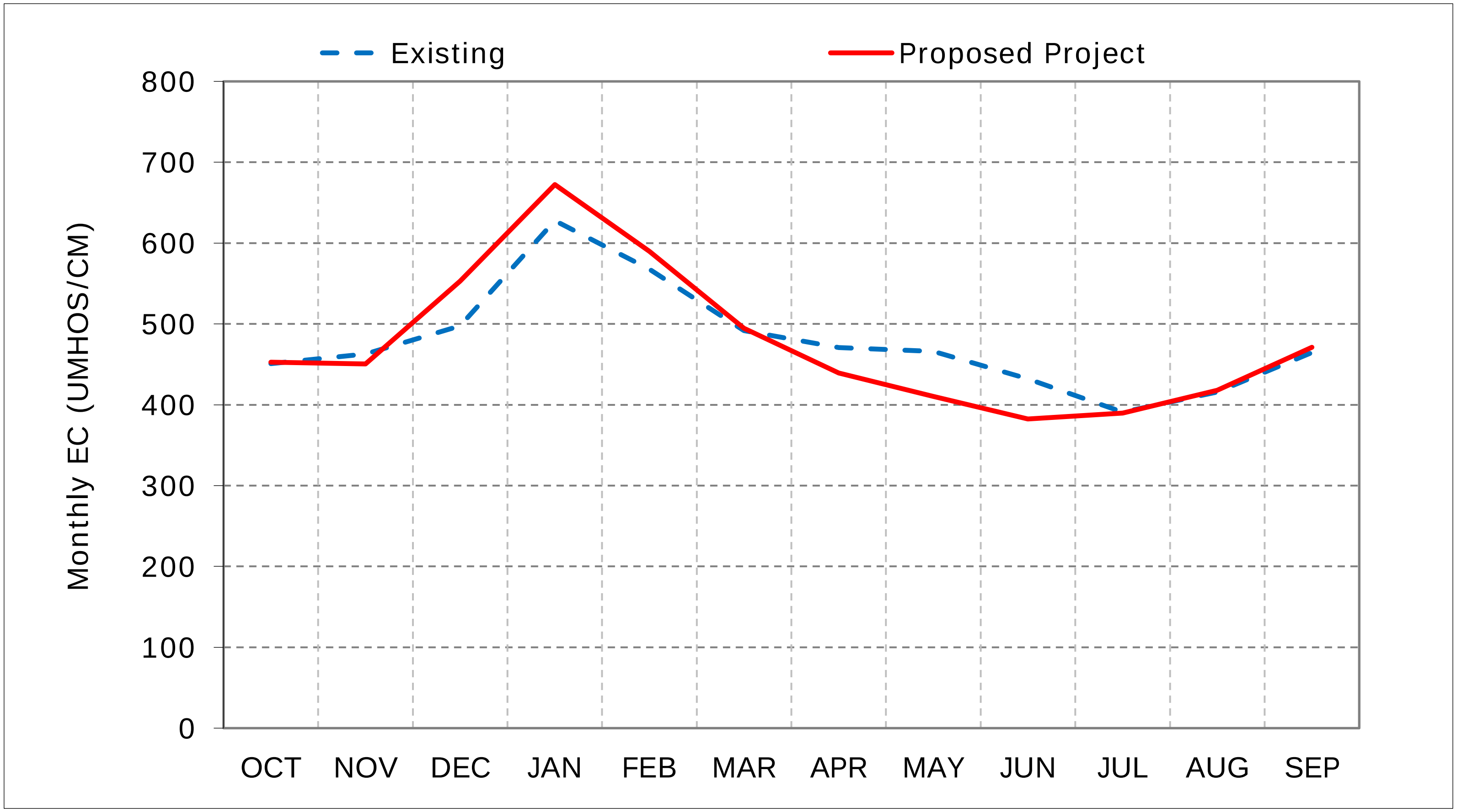
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 19-5. Victoria Canal Salinity, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 19-6. Victoria Canal Salinity, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 19-7. Victoria Canal Salinity, January EC

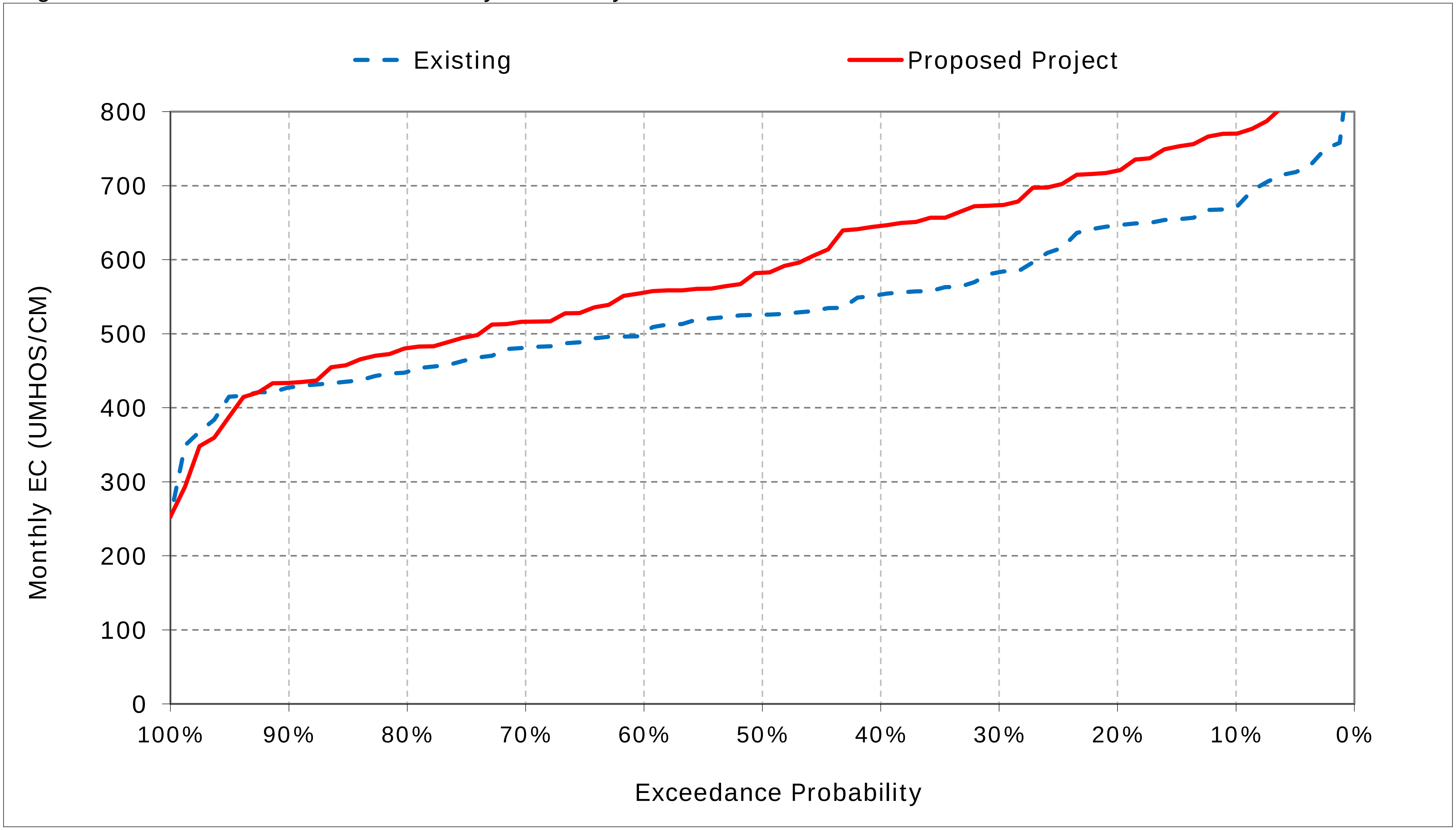


Figure 19-8. Victoria Canal Salinity, February EC

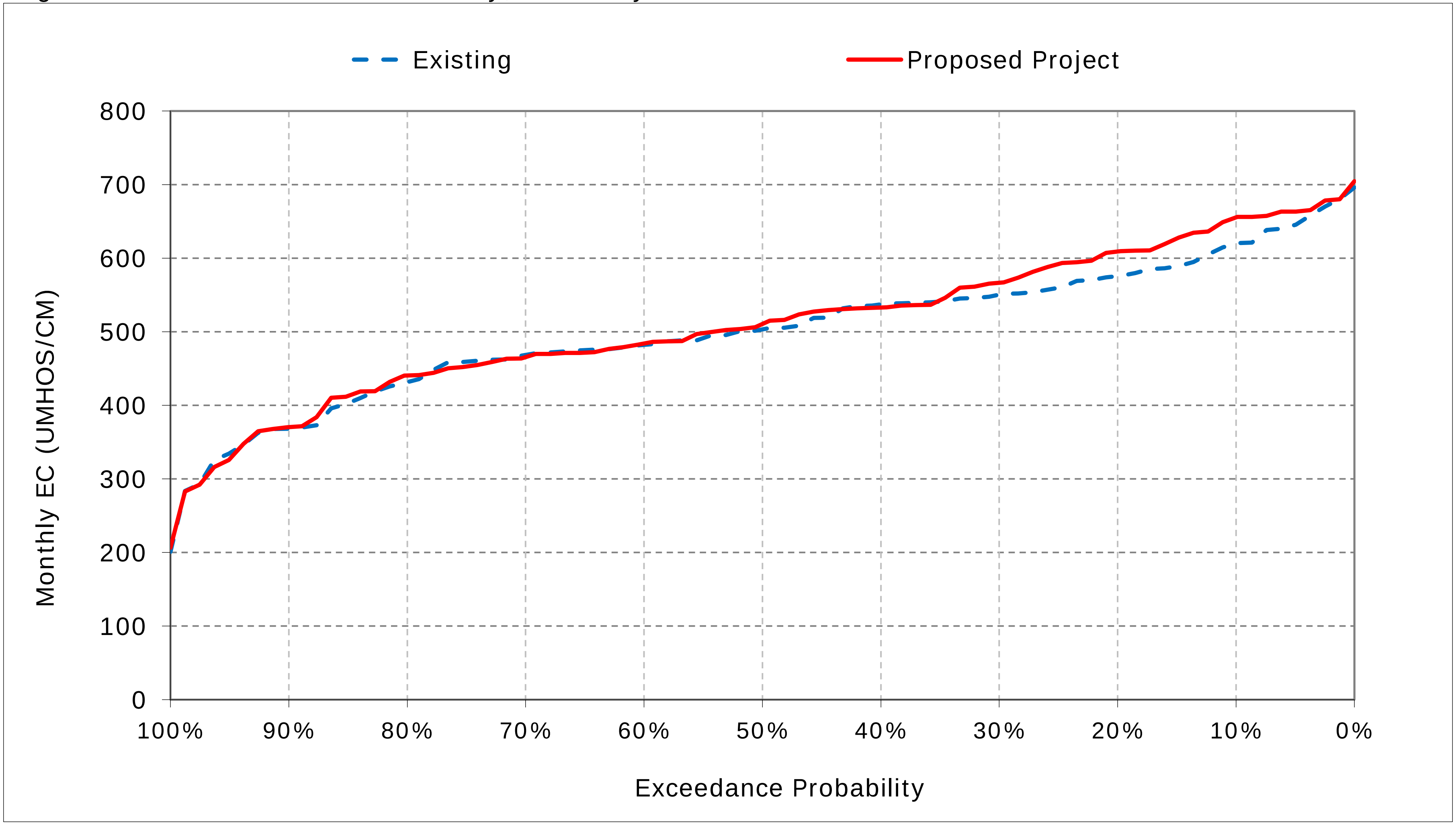


Figure 19-9. Victoria Canal Salinity, March EC

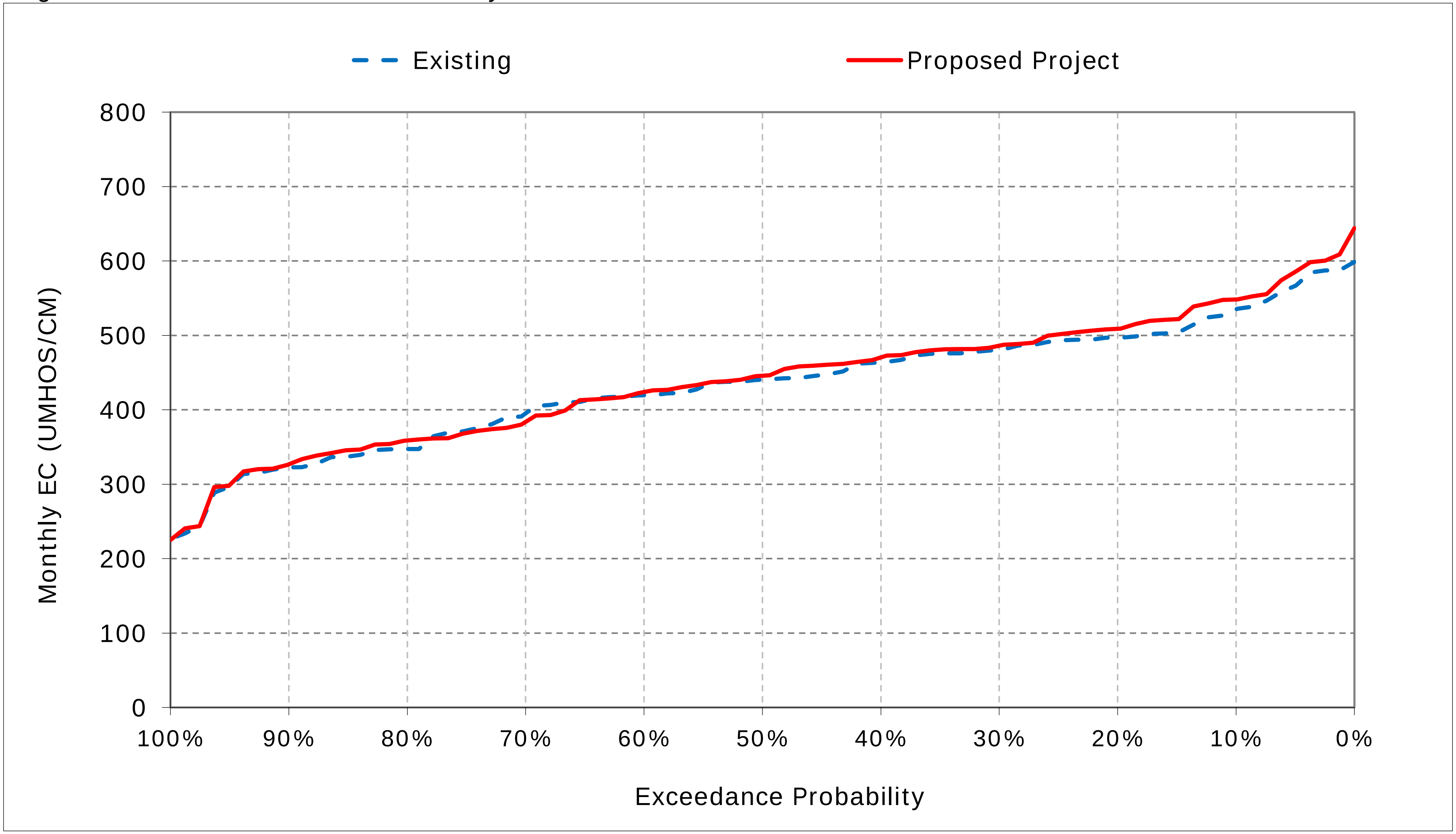


Figure 19-10. Victoria Canal Salinity, April EC

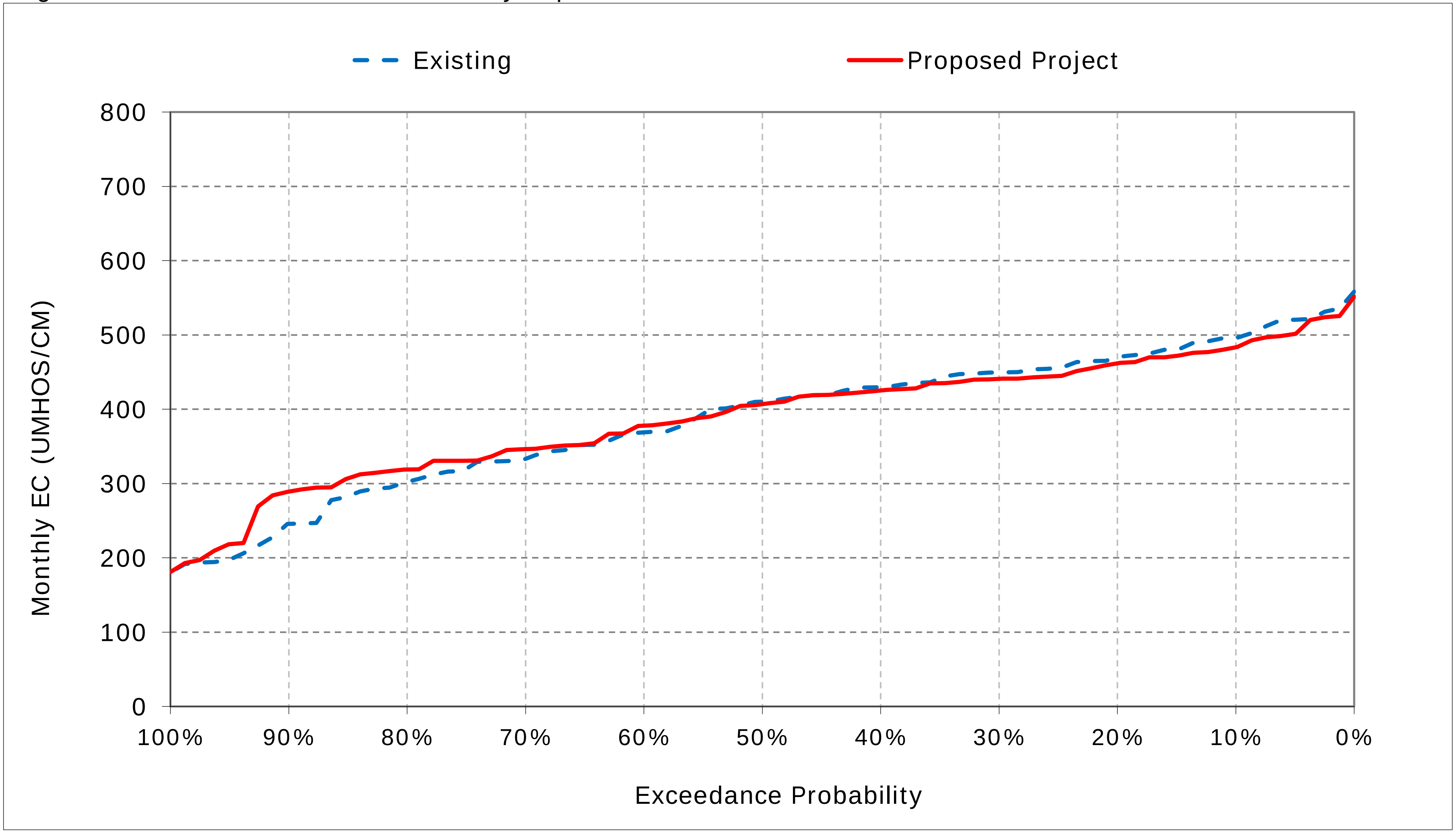


Figure 19-11. Victoria Canal Salinity, May EC

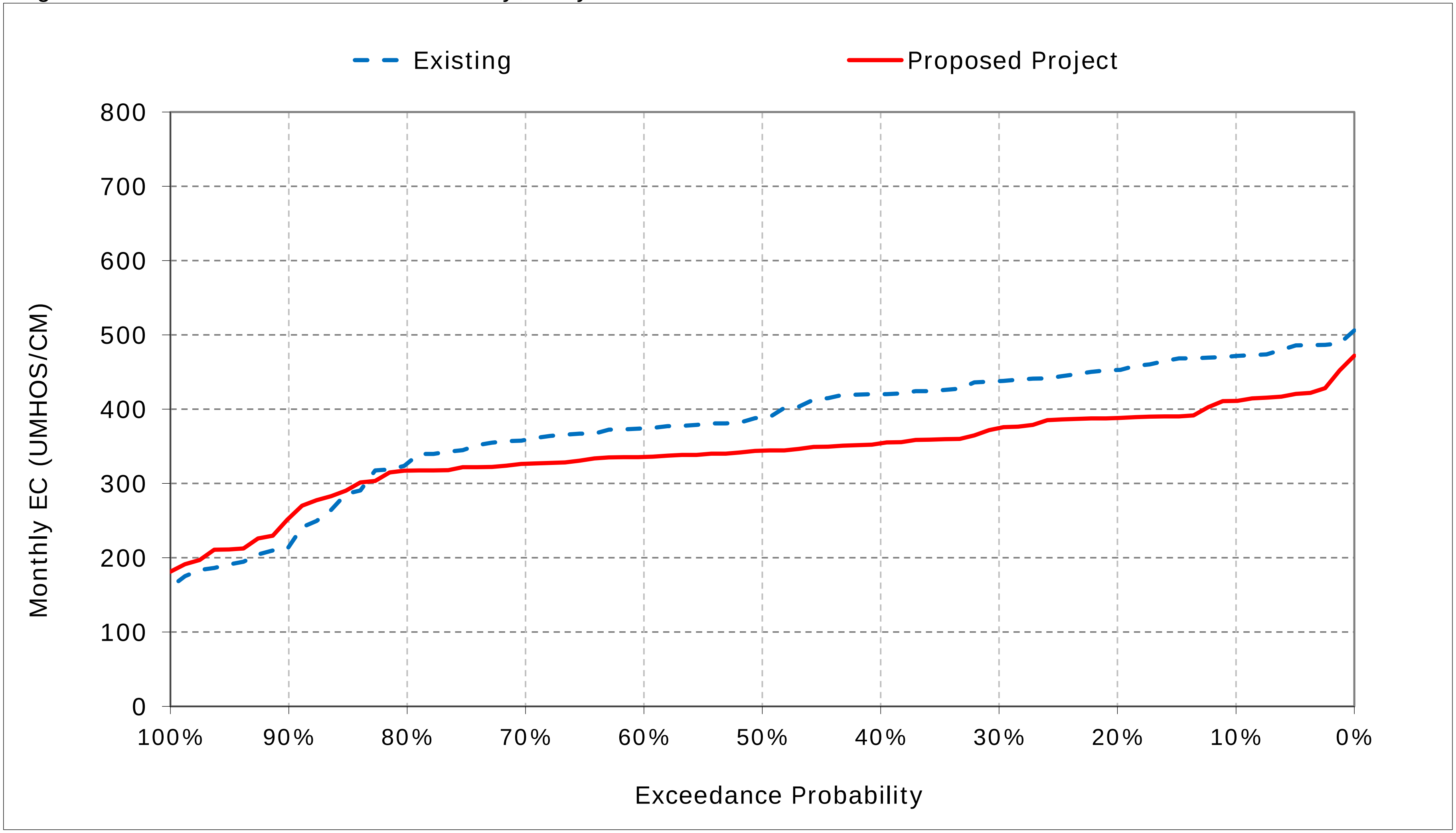


Figure 19-12. Victoria Canal Salinity, June EC

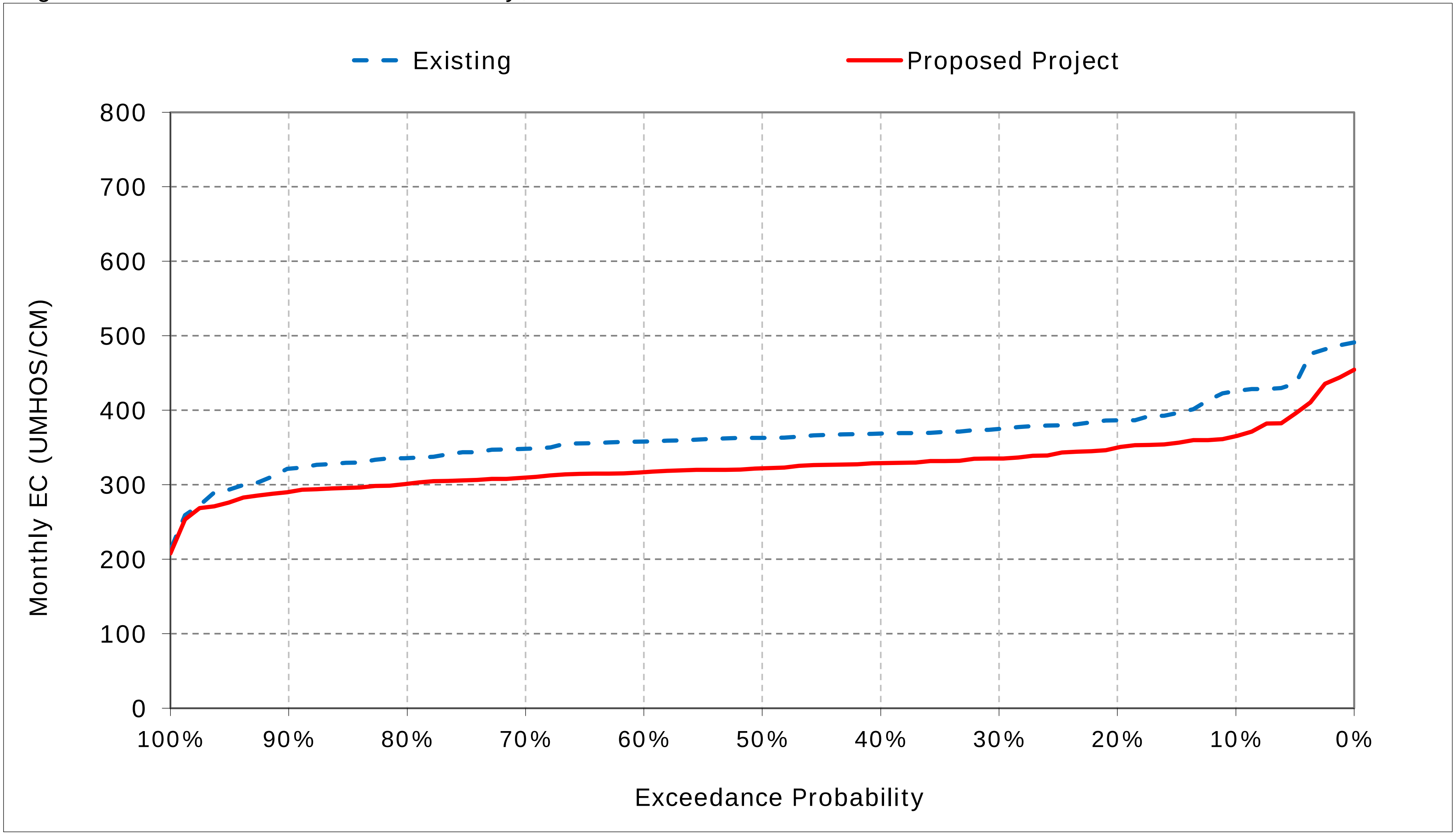


Figure 19-13. Victoria Canal Salinity, July EC

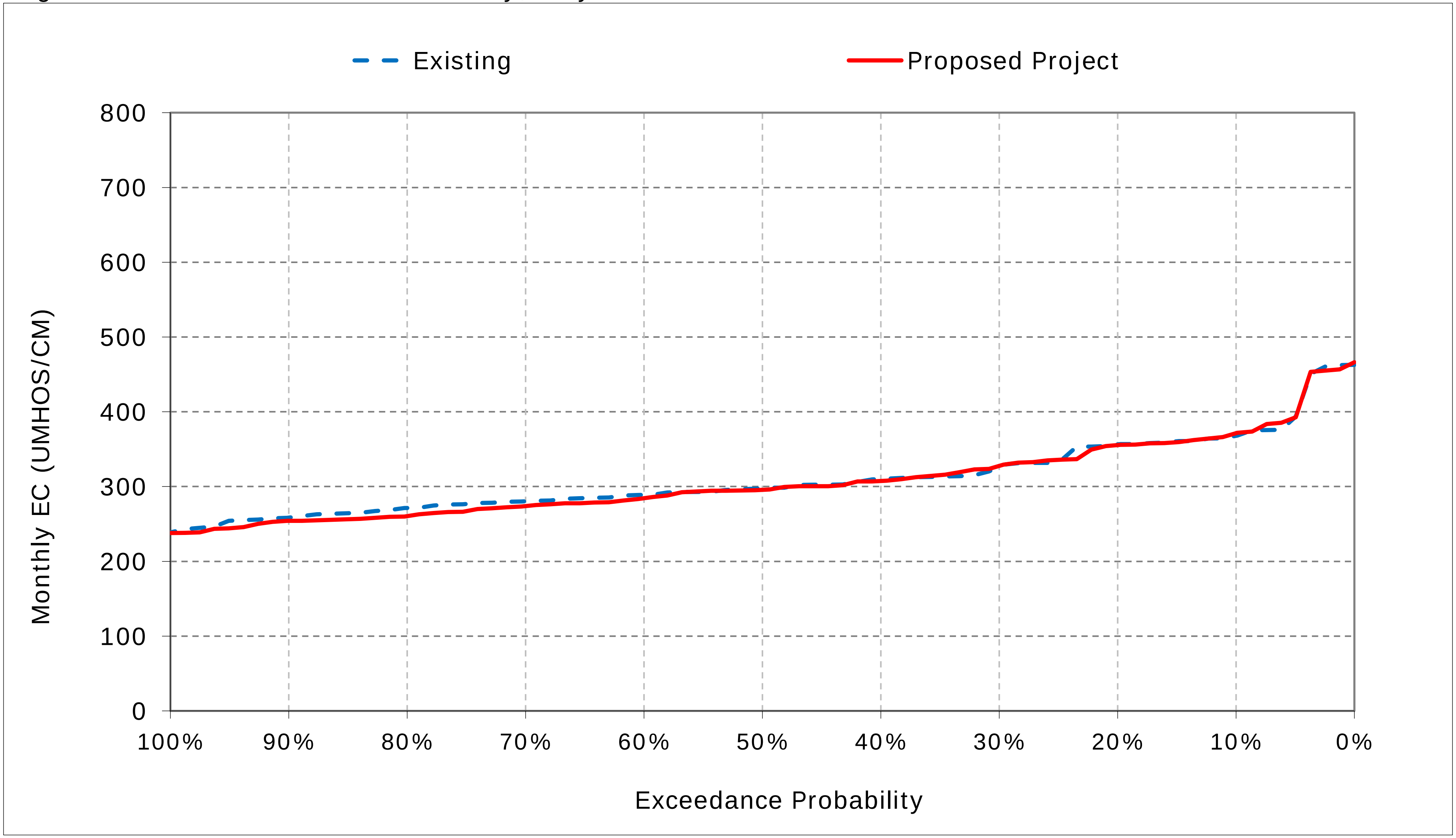


Figure 19-14. Victoria Canal Salinity, August EC

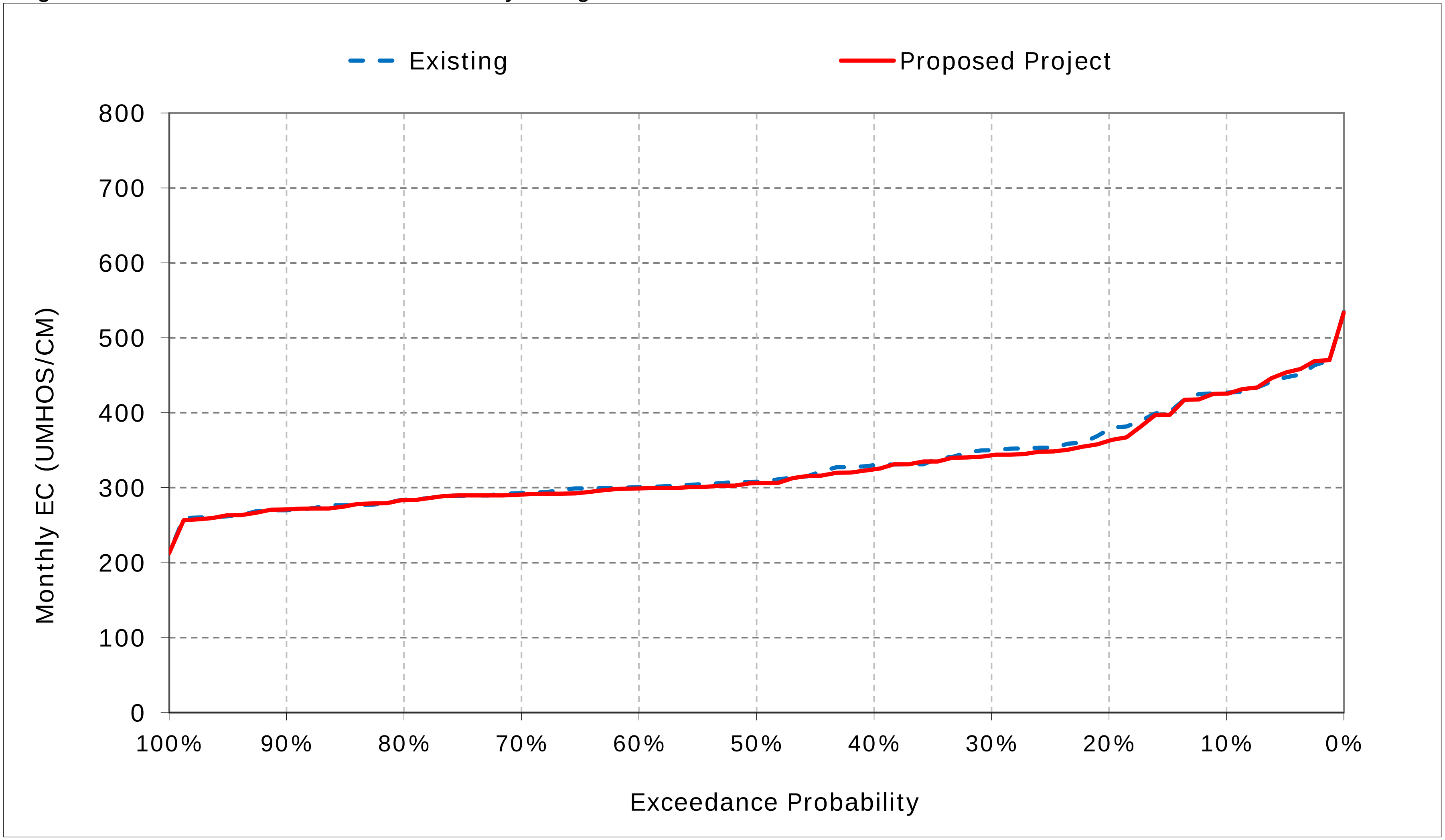


Figure 19-15. Victoria Canal Salinity, September EC

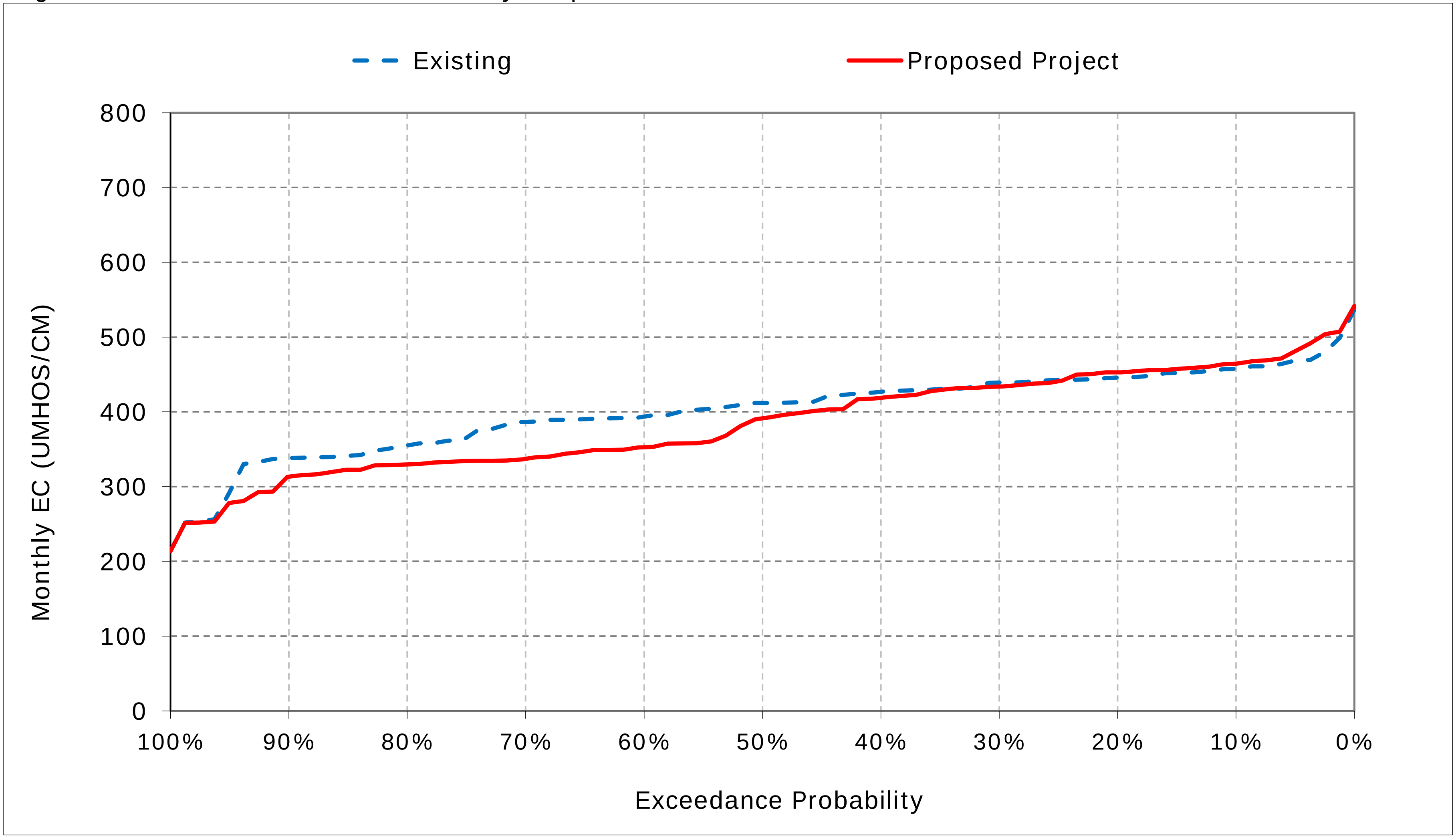


Figure 19-16. Victoria Canal Salinity, October EC

Figure 19-17. Victoria Canal Salinity, November EC

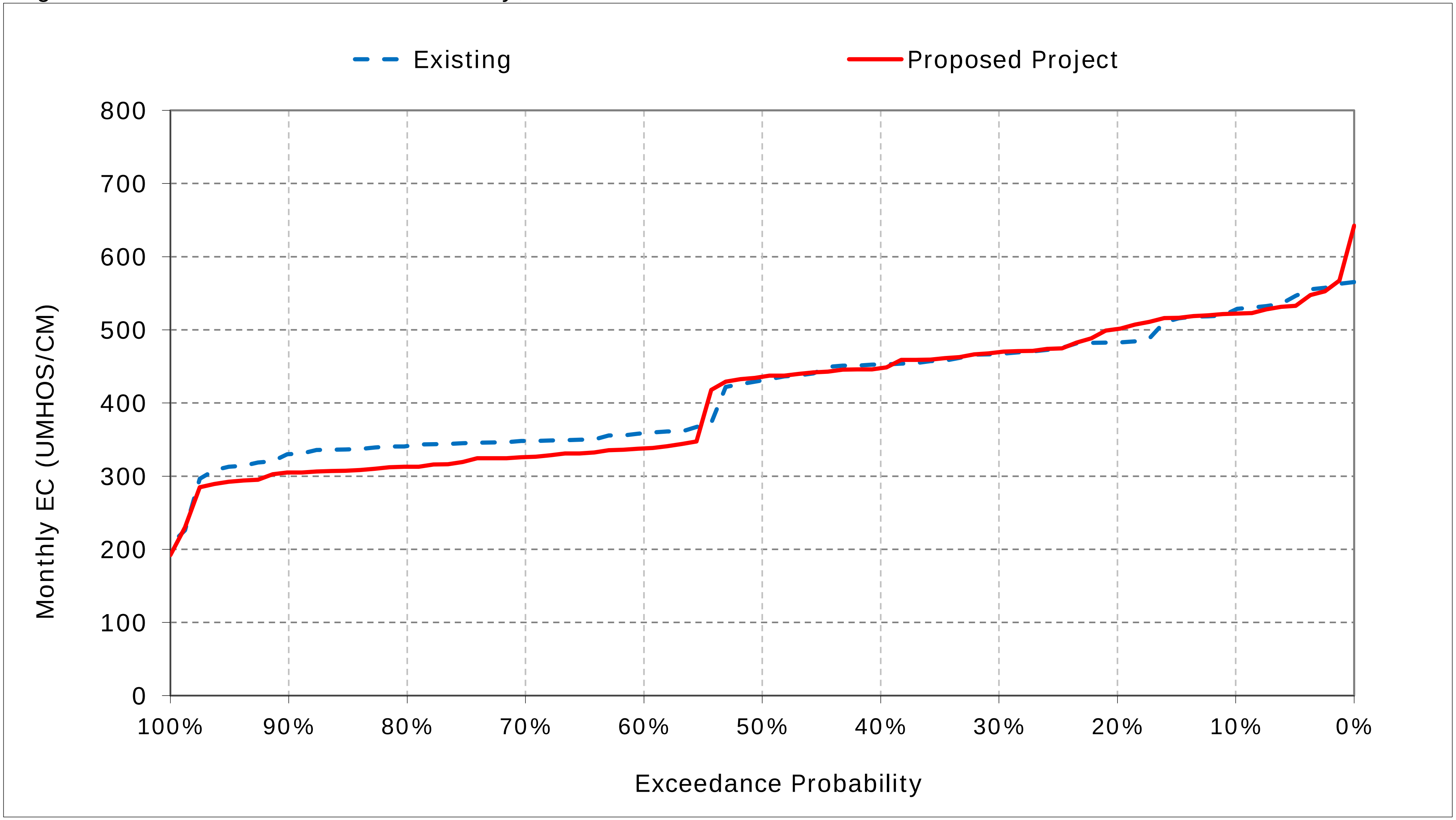


Figure 19-18. Victoria Canal Salinity, December EC

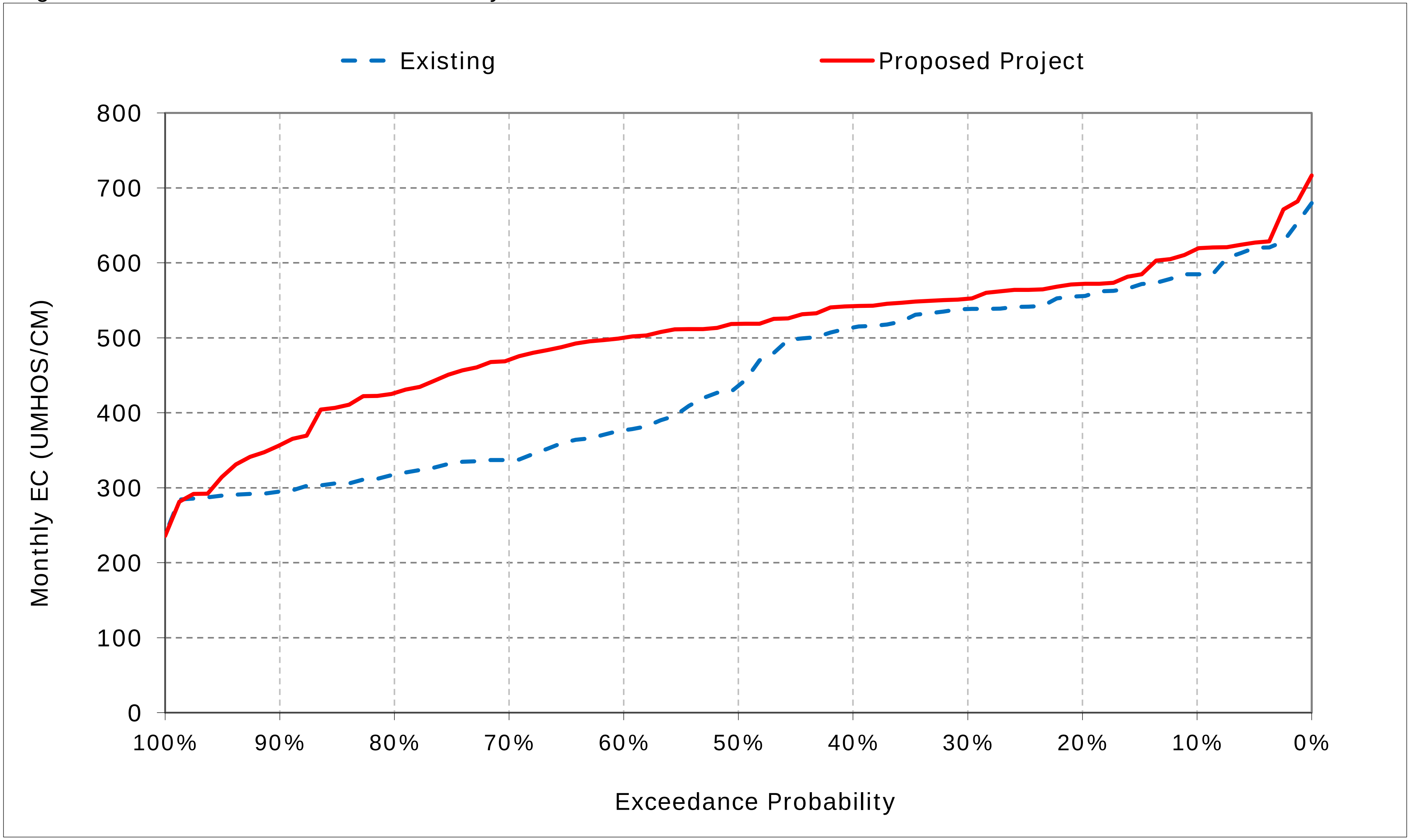


Table 20-1. Montezuma Slough at Hunter Cut, Monthly EC

Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	14,303	13,057	12,428	8,885	5,277	7,041	8,378	9,233	11,109	13,262	15,769	17,520
20%	13,613	12,740	11,353	7,778	3,597	4,779	5,007	7,390	9,703	12,148	14,600	16,623
30%	13,446	12,375	9,063	6,661	2,354	2,382	3,009	6,006	8,988	11,691	14,302	16,320
40%	13,049	11,875	7,384	4,663	1,667	1,942	2,465	4,098	7,777	10,014	12,642	15,391
50%	11,963	7,496	5,410	4,054	1,009	1,394	2,116	2,838	6,228	9,244	11,794	14,703
60%	6,829	6,147	5,020	2,313	587	578	895	1,861	5,217	8,225	11,379	10,866
70%	4,377	4,057	3,532	783	380	345	568	1,202	4,086	7,598	10,682	8,378
80%	4,087	3,878	2,109	425	256	267	294	537	2,288	6,285	10,276	8,012
90%	3,952	3,596	826	267	225	214	220	223	513	4,037	10,092	7,606
Long Term												
Full Simulation Period[a]	9,361	8,338	6,453	4,148	1,994	2,333	2,847	3,994	6,400	9,152	12,245	12,699
Water Year Types[b]												
Wet (32%)	7,609	5,949	2,748	930	345	428	588	1,023	2,551	5,354	9,579	7,450
Above Normal (15%)	9,683	8,294	6,445	2,967	906	587	851	1,651	4,553	7,411	10,619	10,803
Below Normal (17%)	9,724	9,042	7,837	4,942	1,574	2,075	2,419	3,513	6,467	9,511	12,205	15,013
Dry (22%)	9,817	9,417	7,993	6,187	3,273	3,494	4,332	6,146	8,990	11,860	14,461	16,483
Critical (15%)	11,730	11,119	10,564	8,319	5,223	6,765	8,012	10,109	12,627	14,640	16,371	17,592

Proposed Project

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	14,267	13,064	12,423	9,696	5,334	6,969	8,787	9,519	11,291	13,287	15,774	17,469
20%	13,593	12,688	11,261	8,620	3,574	4,844	5,411	8,580	10,312	12,358	14,720	16,632
30%	13,413	12,273	10,122	7,310	2,605	2,361	3,487	7,209	9,543	11,724	14,373	16,444
40%	12,985	11,609	9,739	5,072	1,656	1,670	2,800	5,326	8,507	8,505	11,416	14,546
50%	11,598	8,831	9,178	4,098	1,017	1,138	2,474	3,849	6,957	8,078	10,738	13,770
60%	6,488	8,429	7,615	2,319	556	542	1,158	2,758	6,197	7,073	10,379	10,748
70%	6,389	8,173	4,518	805	375	325	658	1,757	4,479	6,513	10,068	10,430
80%	6,138	7,821	3,122	424	255	268	320	740	2,424	5,534	8,677	10,341
90%	5,659	5,038	1,322	310	232	222	222	252	552	4,043	7,852	9,734
Long Term												
Full Simulation Period[a]	9,828	9,575	7,532	4,396	2,080	2,286	3,065	4,642	6,859	8,672	11,542	13,181
Water Year Types[b]												
Wet (32%)	8,230	7,563	3,600	973	342	410	716	1,454	2,965	5,438	9,501	9,550
Above Normal (15%)	10,244	9,670	7,946	3,195	835	515	1,047	2,446	5,107	7,388	10,660	10,439
Below Normal (17%)	10,213	10,224	9,072	5,089	1,532	1,921	2,731	4,514	7,053	6,334	8,084	14,146
Dry (22%)	10,299	10,501	9,192	6,711	3,514	3,401	4,601	6,949	9,511	11,993	14,538	16,540
Critical (15%)	11,721	11,695	11,353	8,732	5,577	6,877	8,258	10,431	12,844	14,711	16,385	17,628

Proposed Project minus Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-36	7	-5	811	57	-72	409	286	182	25	6	-51
20%	-20	-52	-92	842	-23	65	405	1,190	609	210	121	9
30%	-33	-102	1,059	648	251	-21	478	1,203	555	33	71	125
40%	-63	-265	2,355	409	-11	-272	335	1,227	730	-1,509	-1,226	-845
50%	-364	1,335	3,767	44	8	-256	357	1,011	729	-1,166	-1,056	-934
60%	-340	2,282	2,595	7	-32	-37	264	897	981	-1,152	-1,000	-118
70%	2,013	4,115	987	21	-5	-20	90	556	393	-1,085	-614	2,051
80%	2,050	3,944	1,012	0	-1	1	26	204	137	-750	-1,599	2,328
90%	1,707	1,442	496	43	7	7	2	29	39	6	-2,240	2,128
Long Term												
Full Simulation Period[a]	467	1,237	1,079	247	86	-46	218	647	459	-479	-704	482
Water Year Types[b]												
Wet (32%)	621	1,614	852	42	-4	-18	127	431	414	84	-78	2,100
Above Normal (15%)	561	1,376	1,501	228	-70	-72	196	795	554	-23	41	-364
Below Normal (17%)	488	1,183	1,234	147	-42	-153	311	1,000	586	-3,177	-4,122	-867
Dry (22%)	482	1,084	1,199	523	241	-92	270	803	521	133	77	57
Critical (15%)	-9	576	789	413	354	112	247	322	217	71	13	35

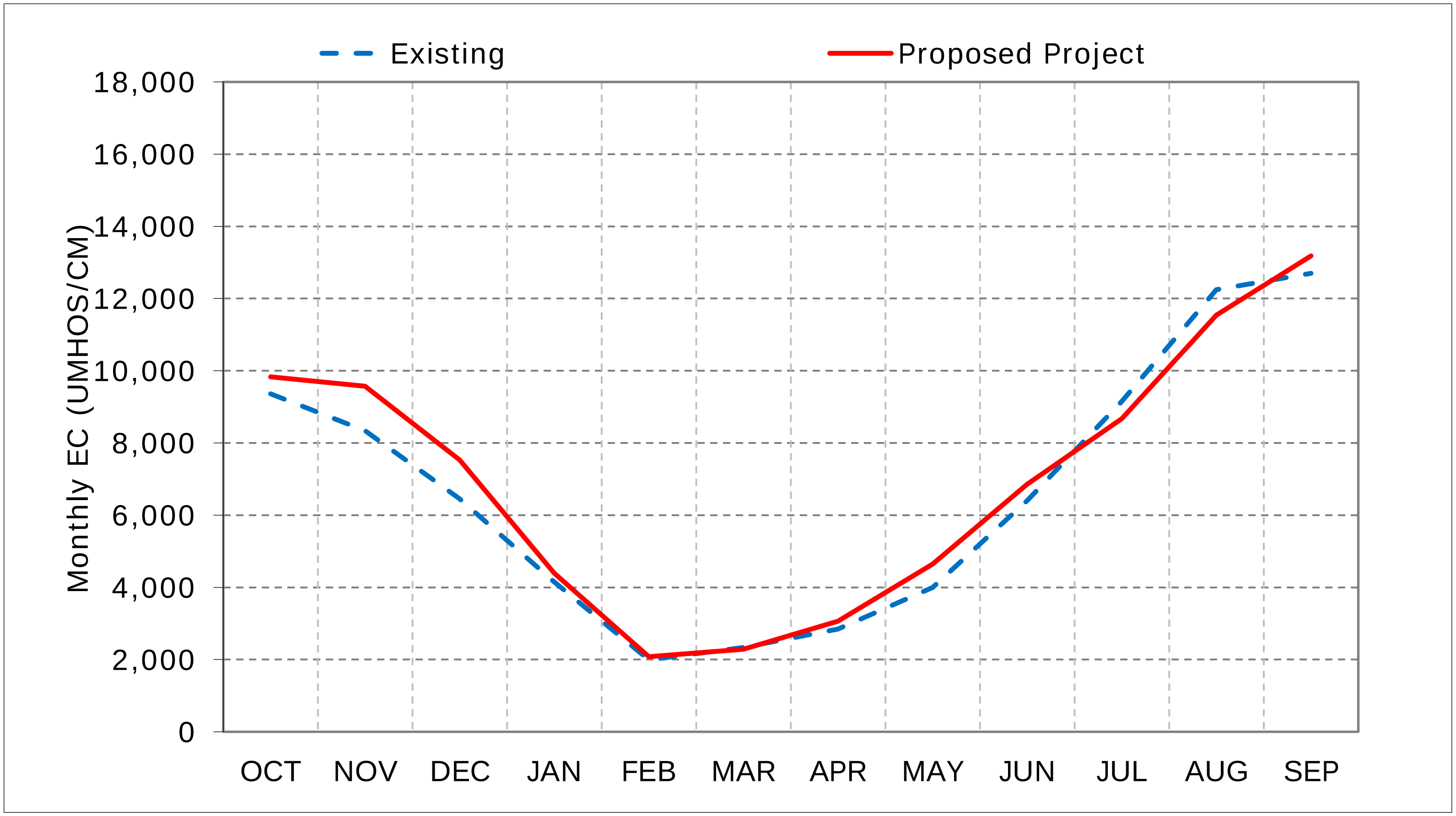
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

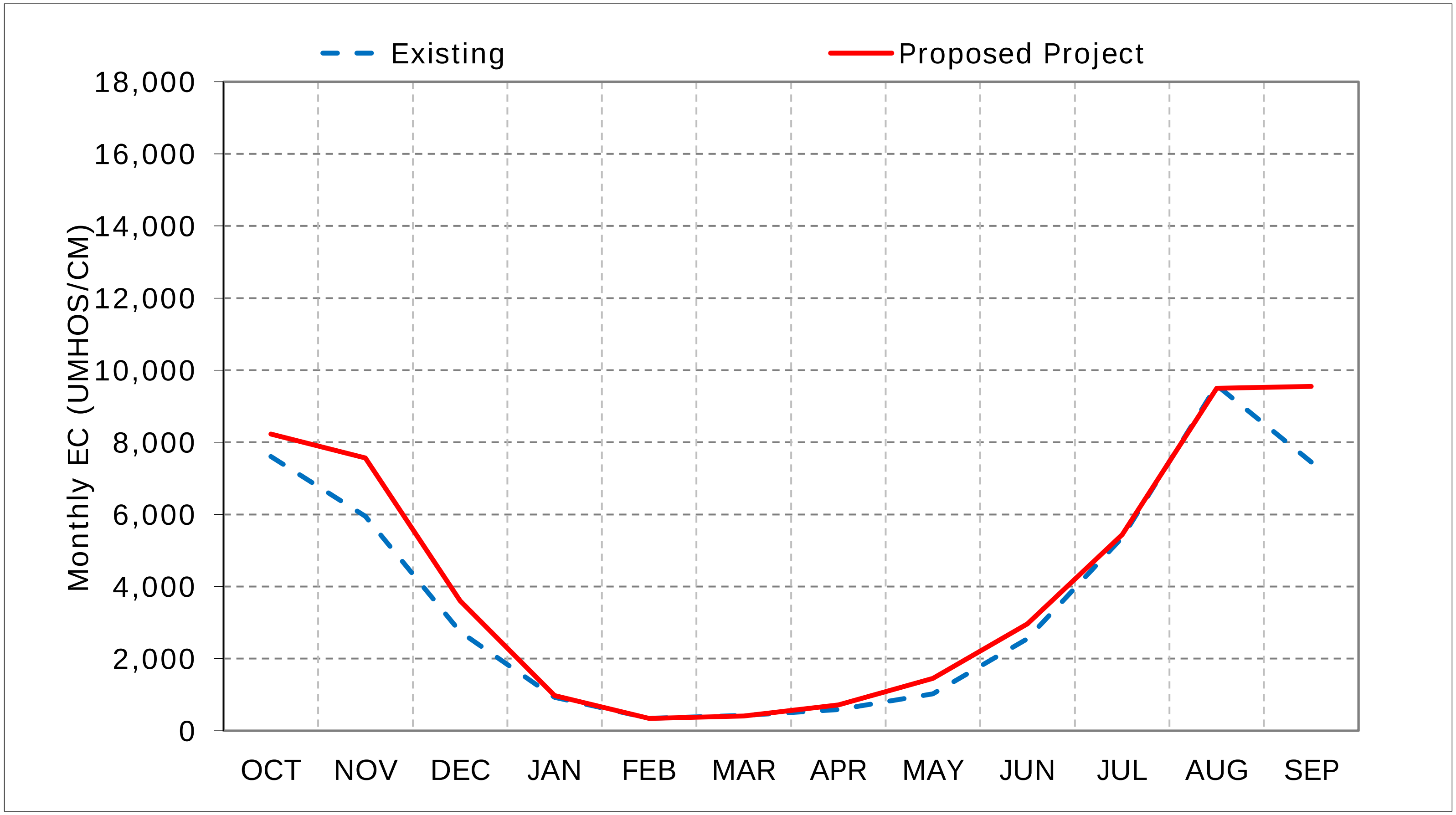
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 20-1. Montezuma Slough at Hunter Cut, Long-Term Average EC



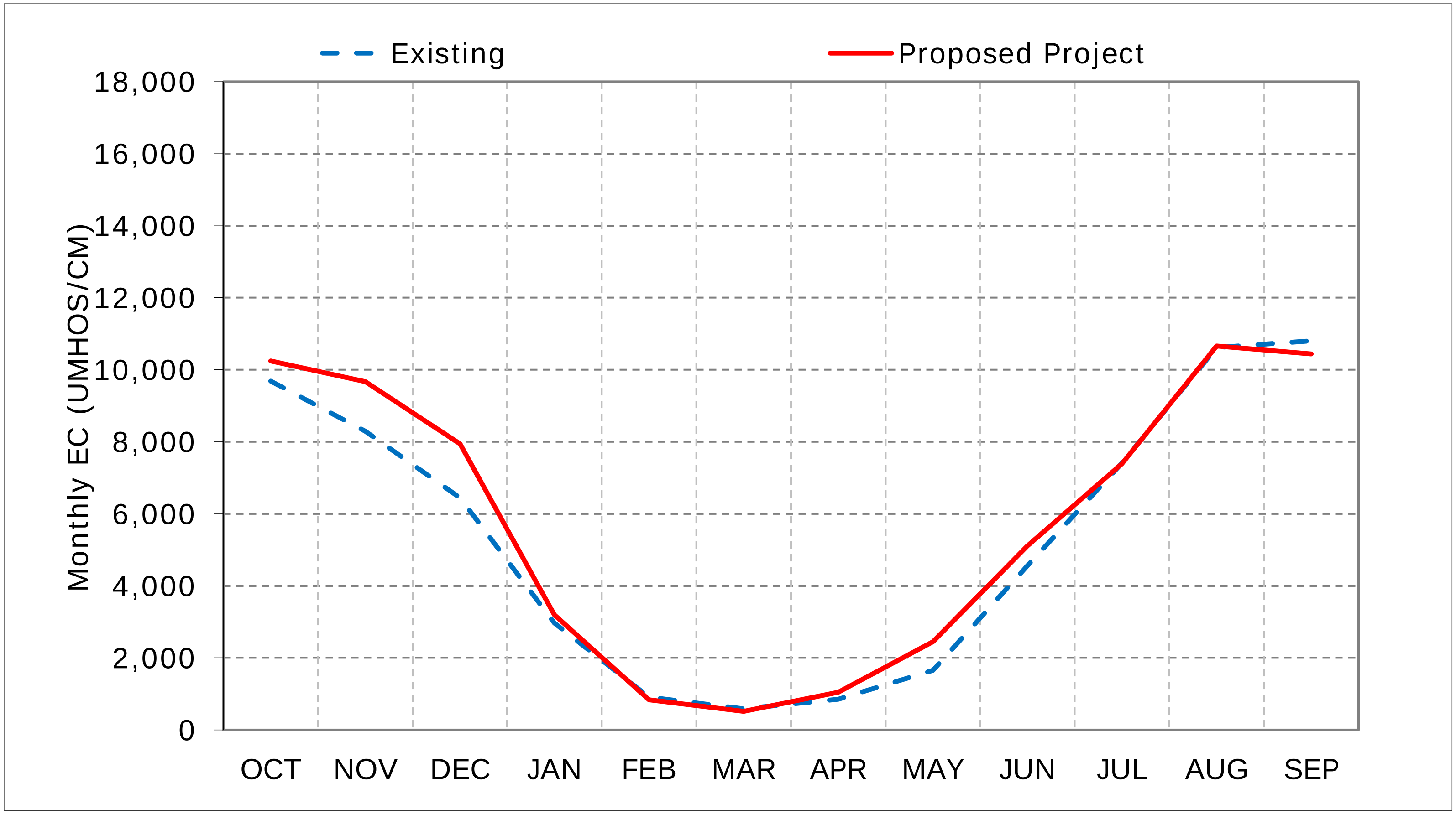
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 20-2. Montezuma Slough at Hunter Cut, Wet Year Average EC



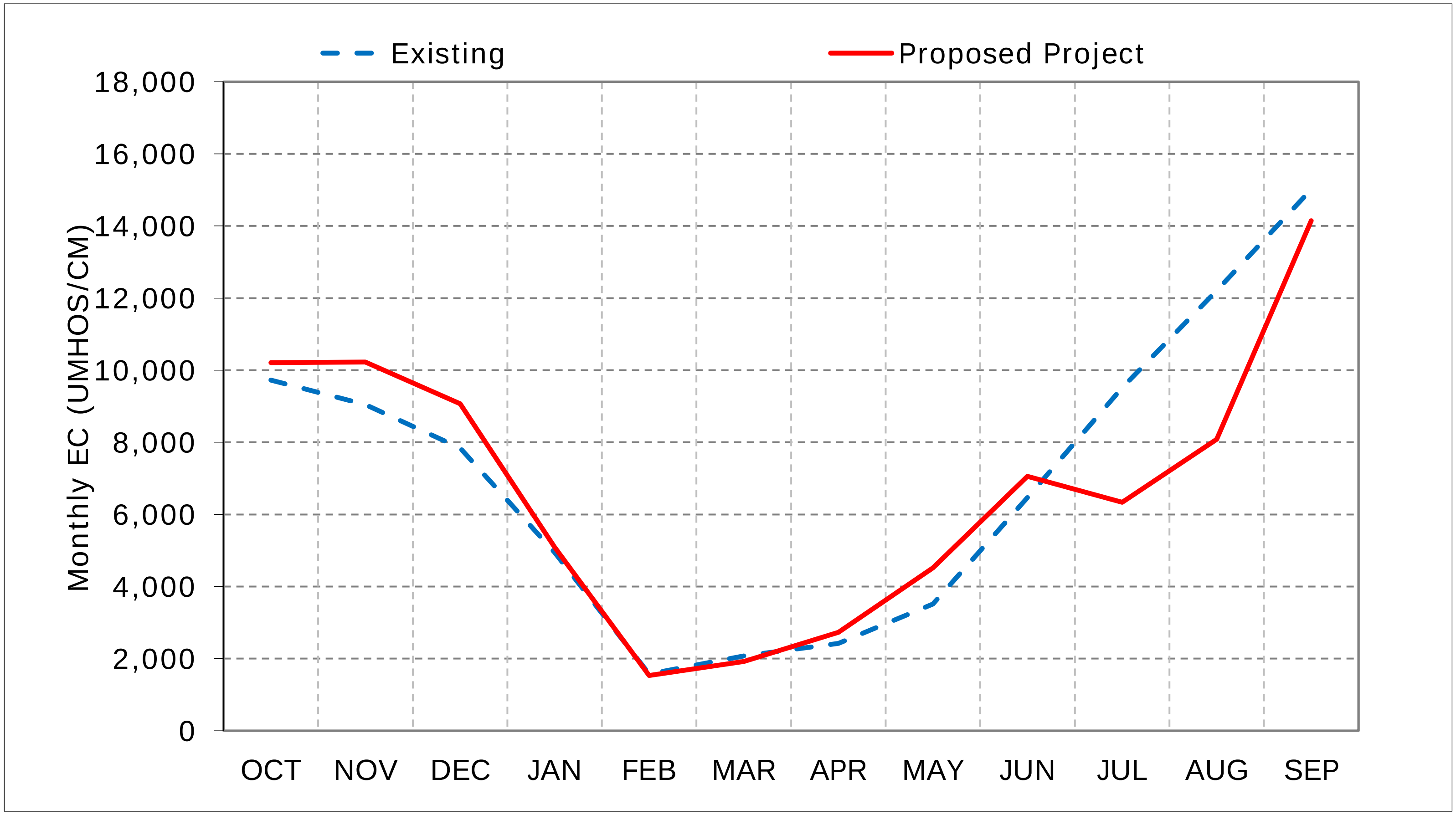
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 20-3. Montezuma Slough at Hunter Cut, Above Normal Year Average EC



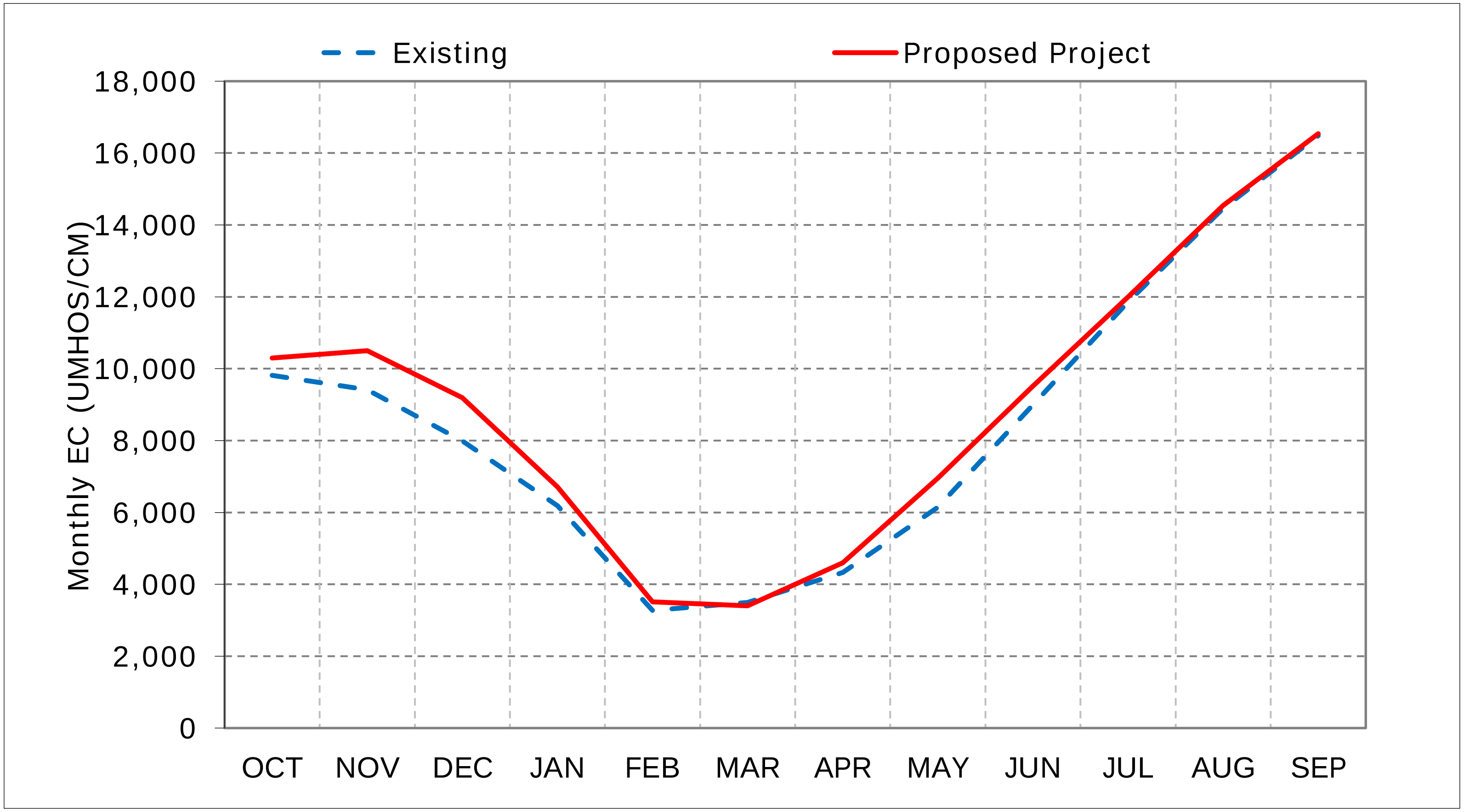
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 20-4. Montezuma Slough at Hunter Cut, Below Normal Year Average EC



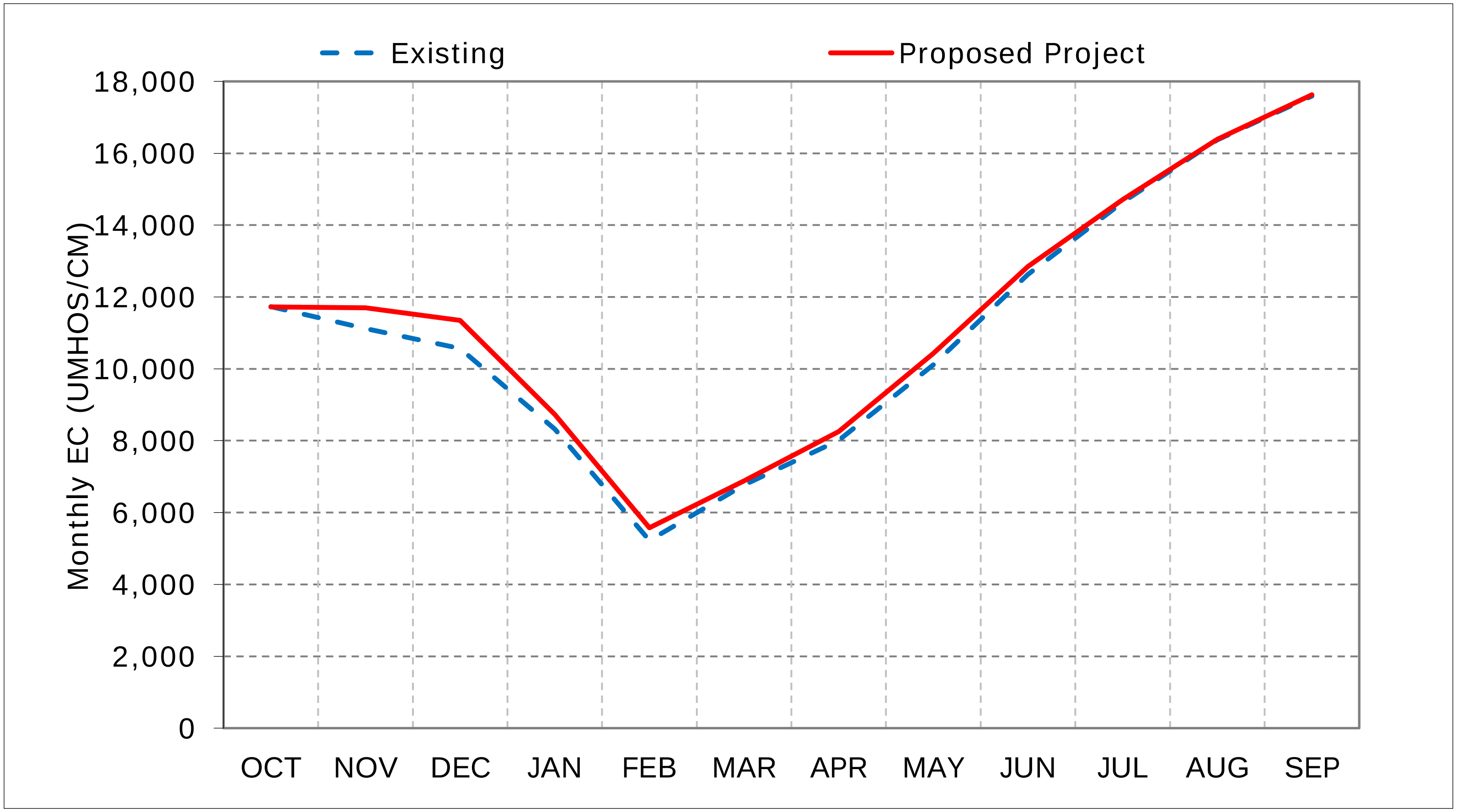
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 20-5. Montezuma Slough at Hunter Cut, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 20-6. Montezuma Slough at Hunter Cut, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 20-7. Montezuma Slough at Hunter Cut, January EC

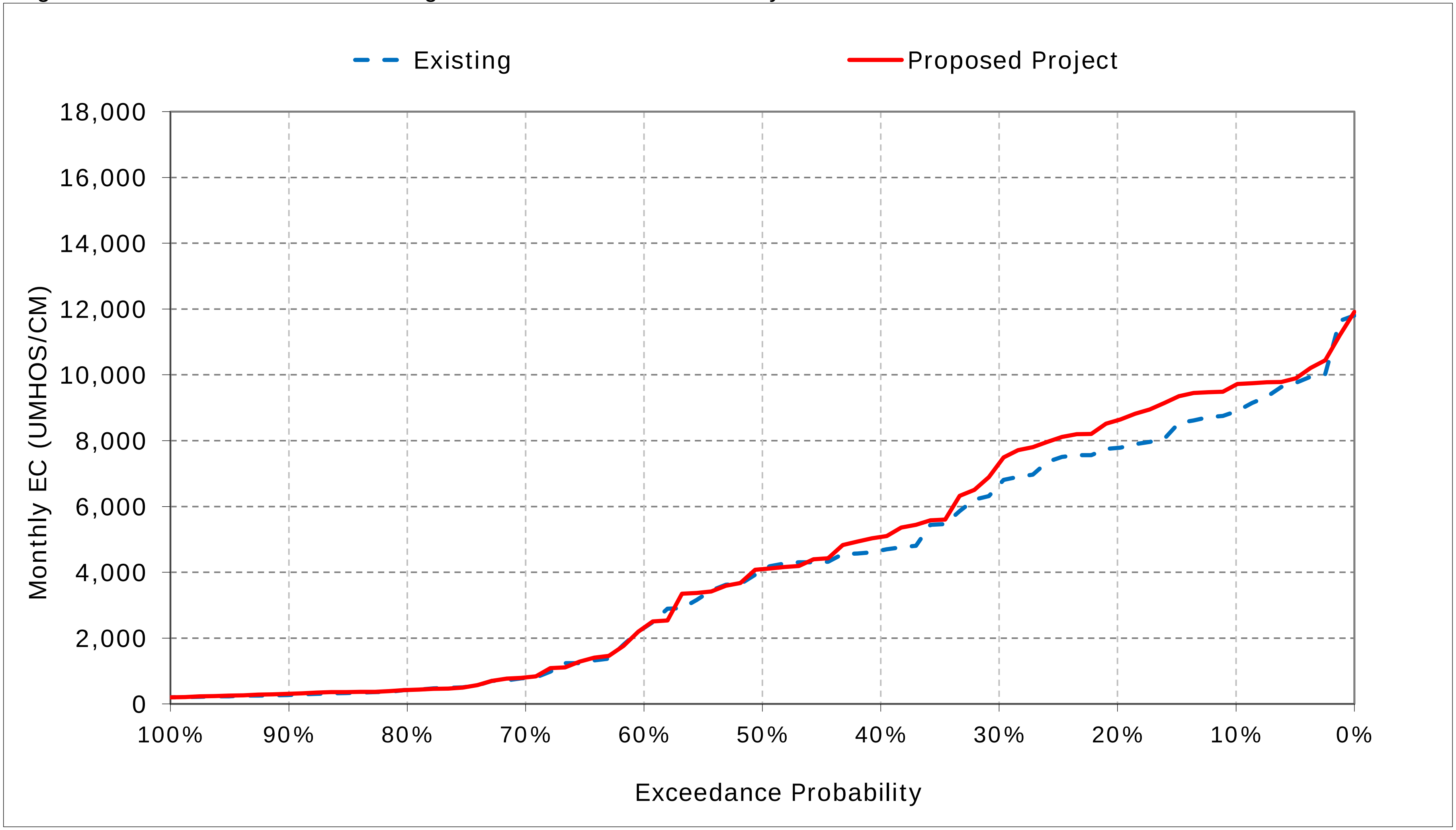


Figure 20-8. Montezuma Slough at Hunter Cut, February EC

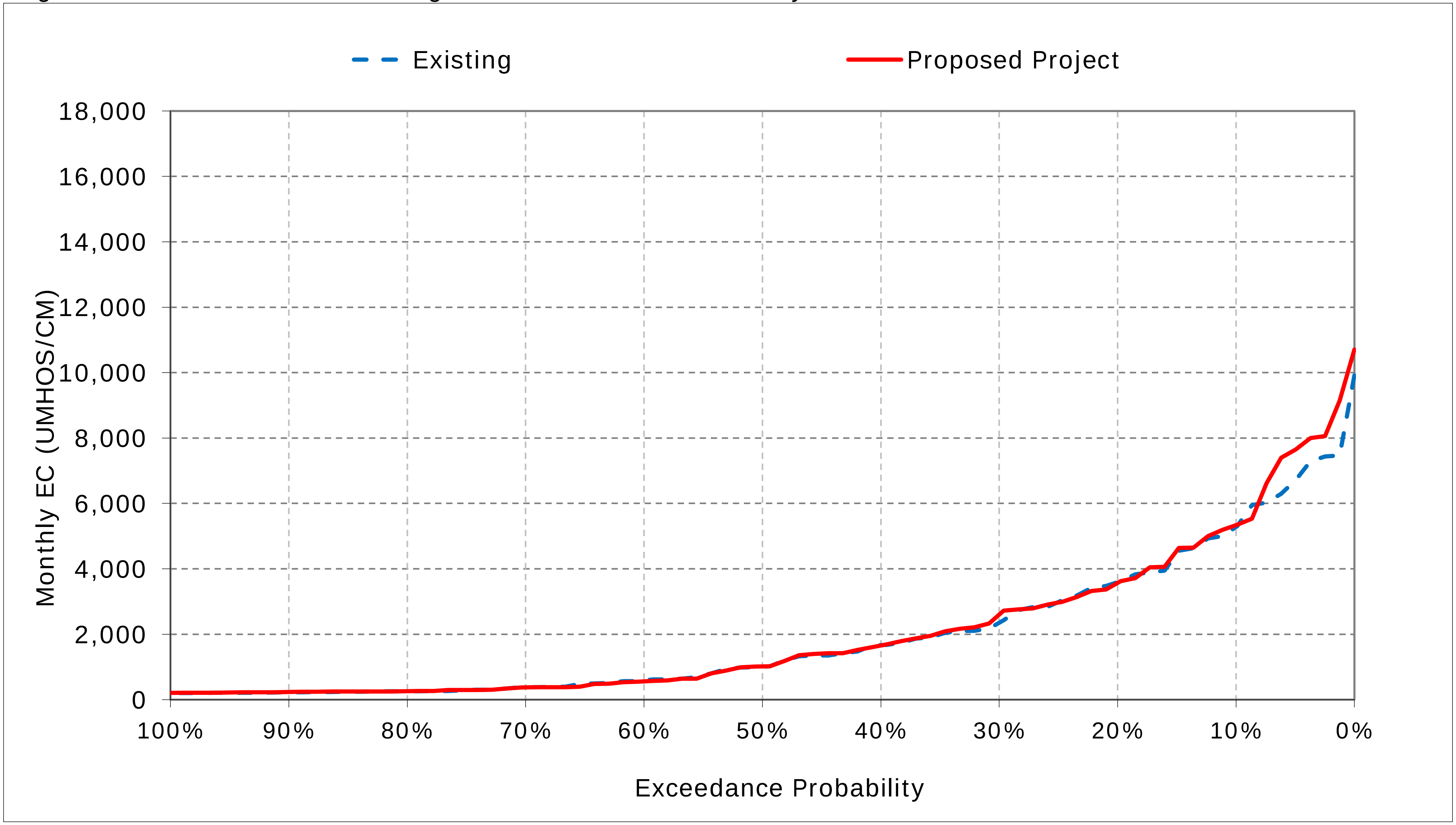


Figure 20-9. Montezuma Slough at Hunter Cut, March EC

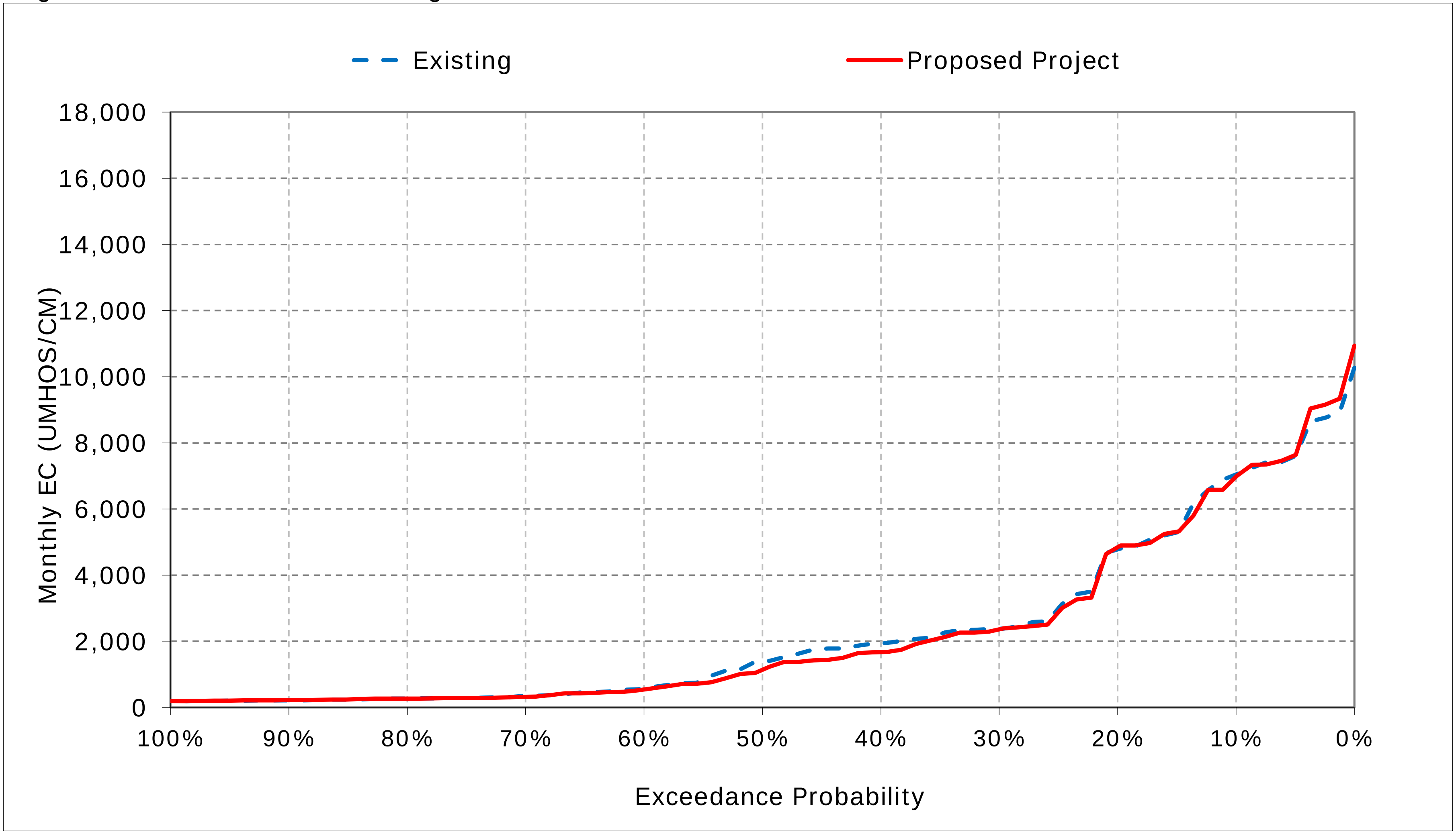


Figure 20-10. Montezuma Slough at Hunter Cut, April EC

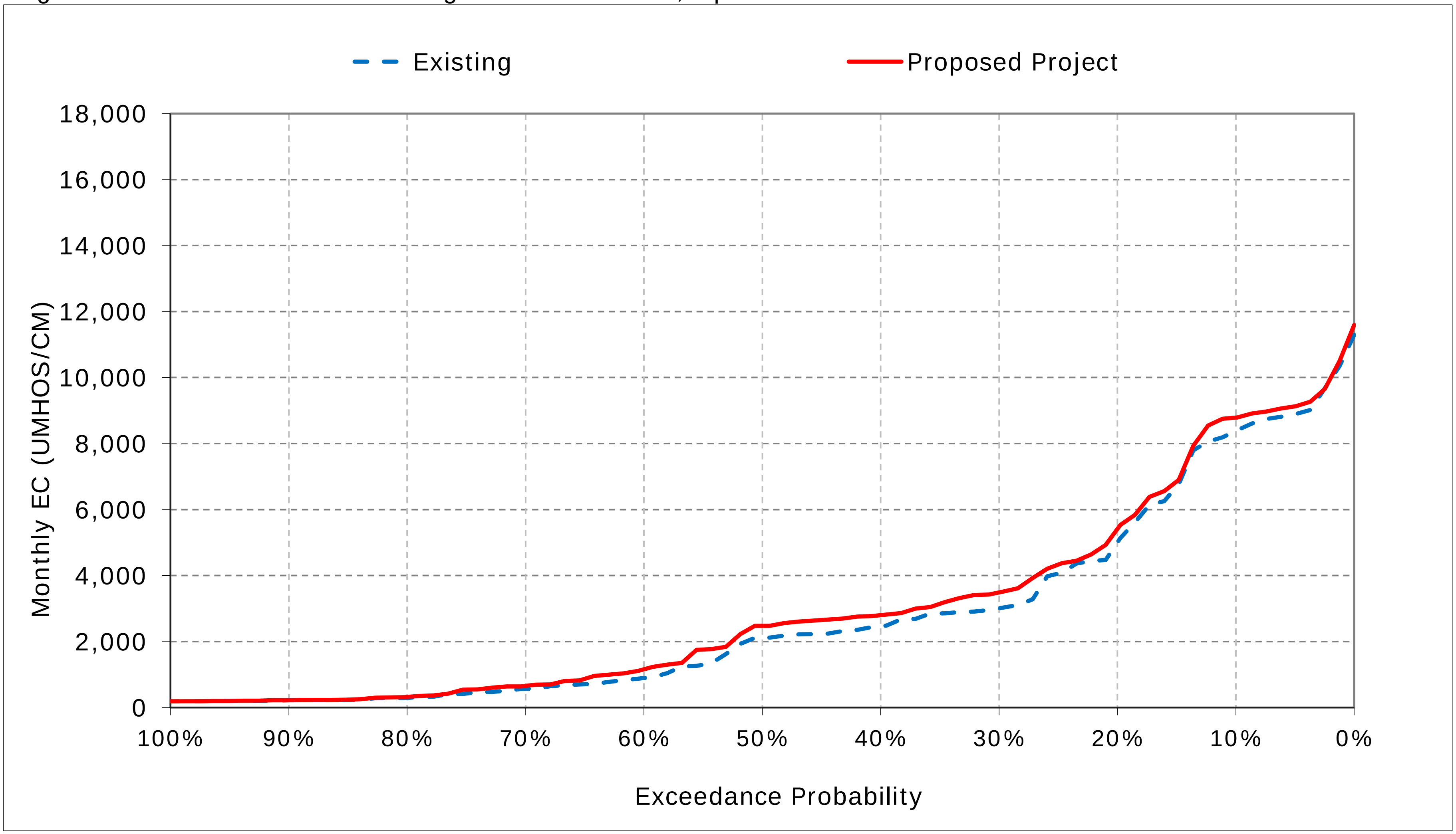


Figure 20-11. Montezuma Slough at Hunter Cut, May EC

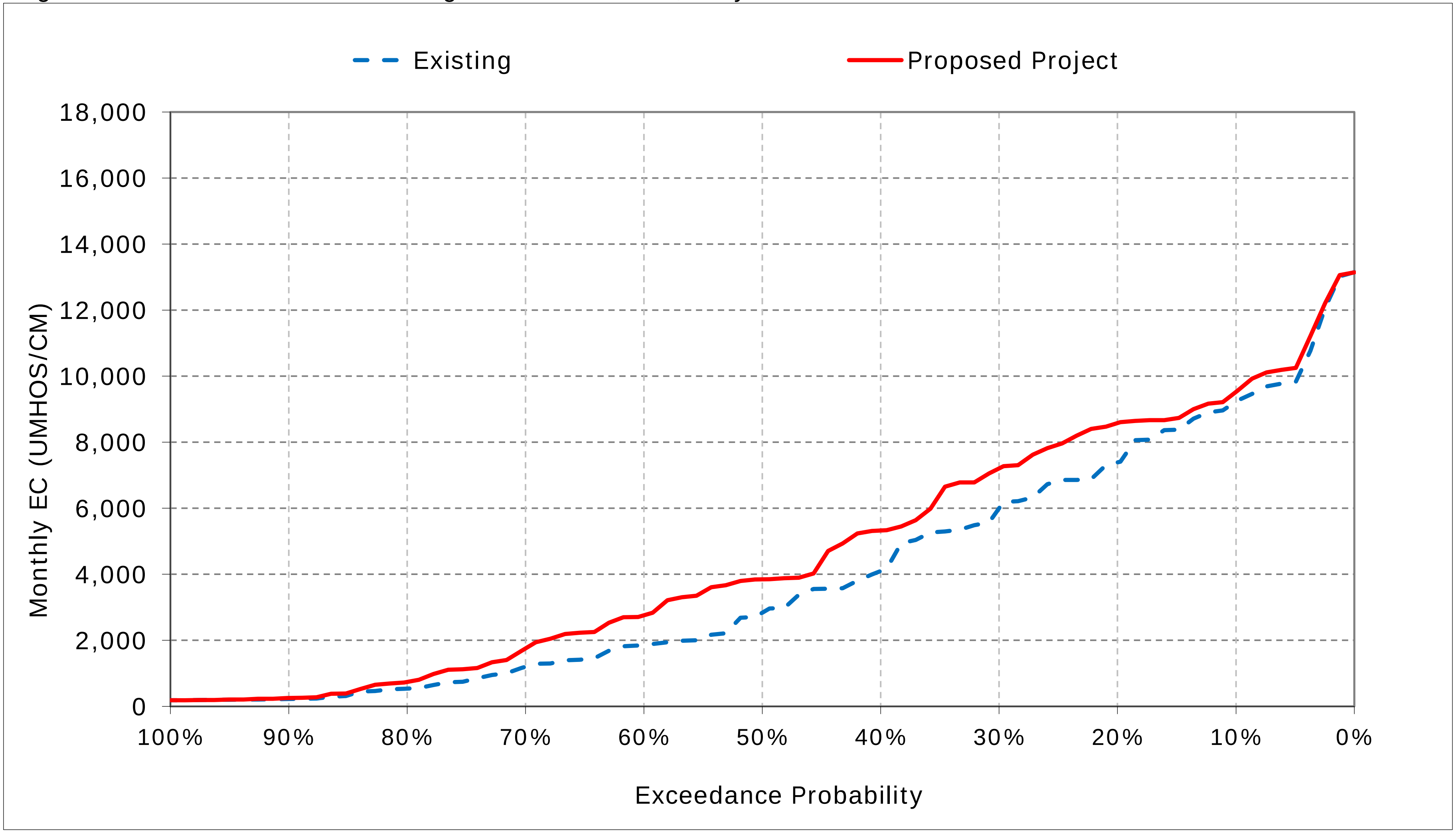


Figure 20-12. Montezuma Slough at Hunter Cut, June EC

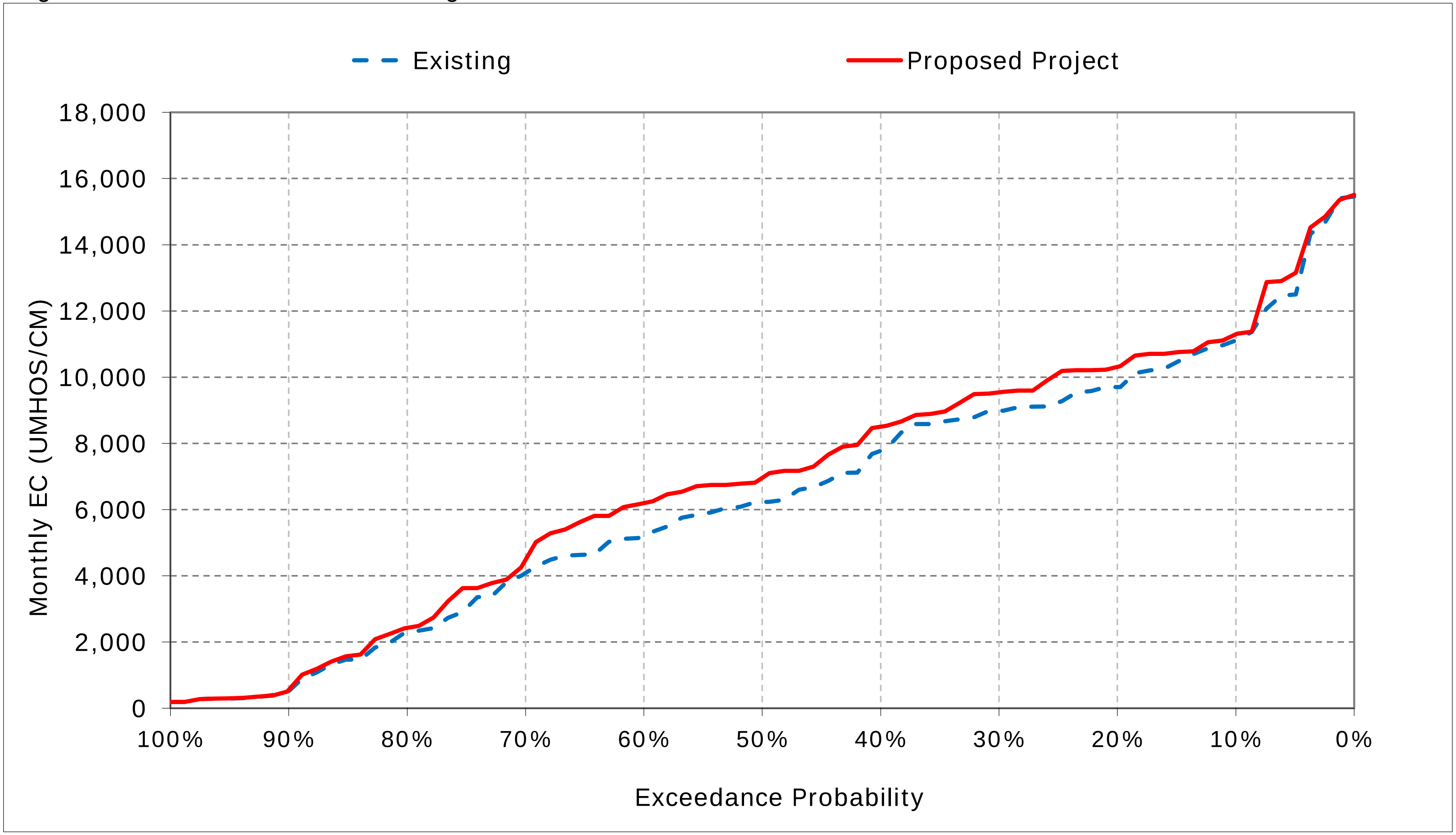


Figure 20-13. Montezuma Slough at Hunter Cut, July EC

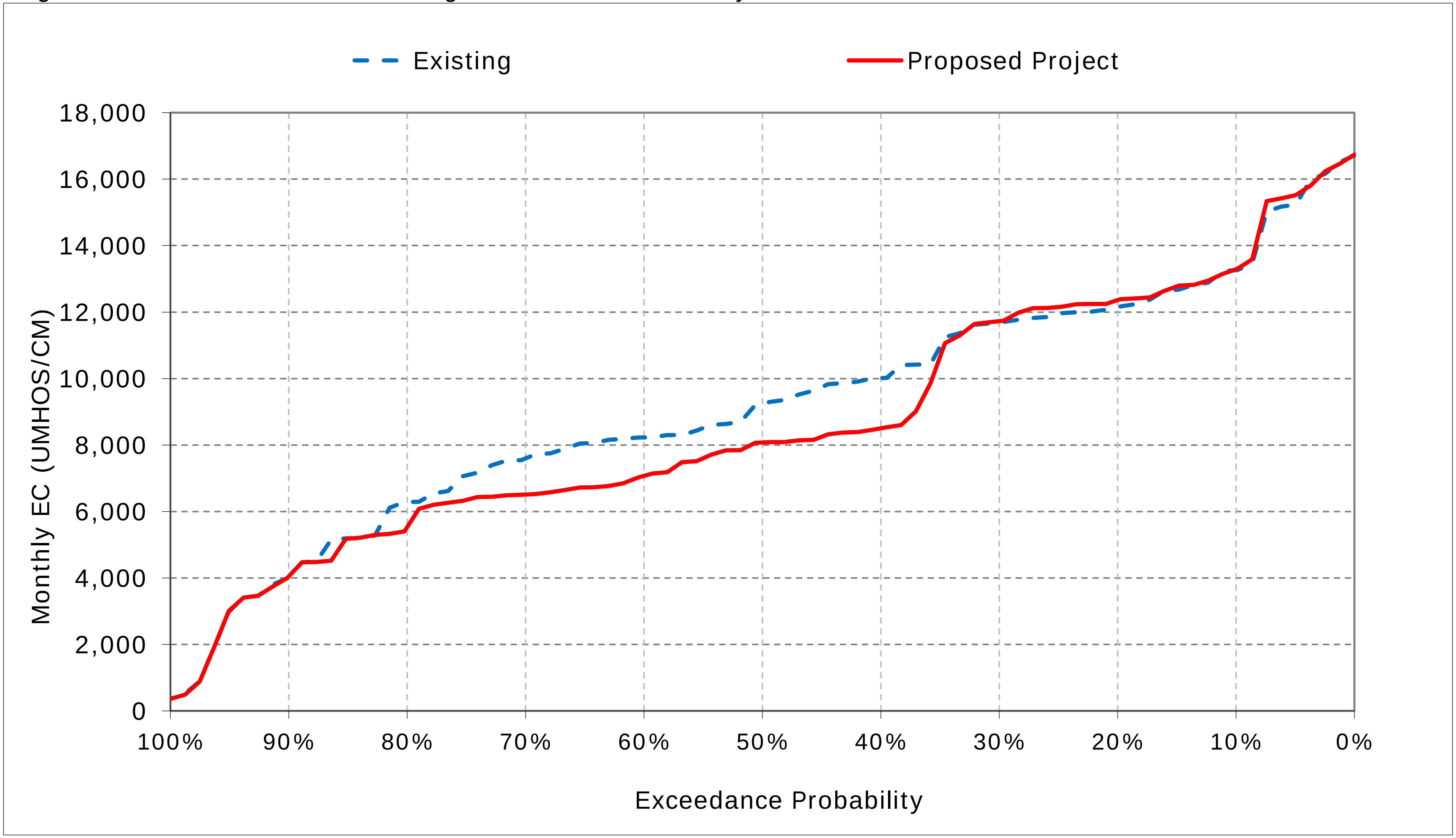


Figure 20-14. Montezuma Slough at Hunter Cut, August EC

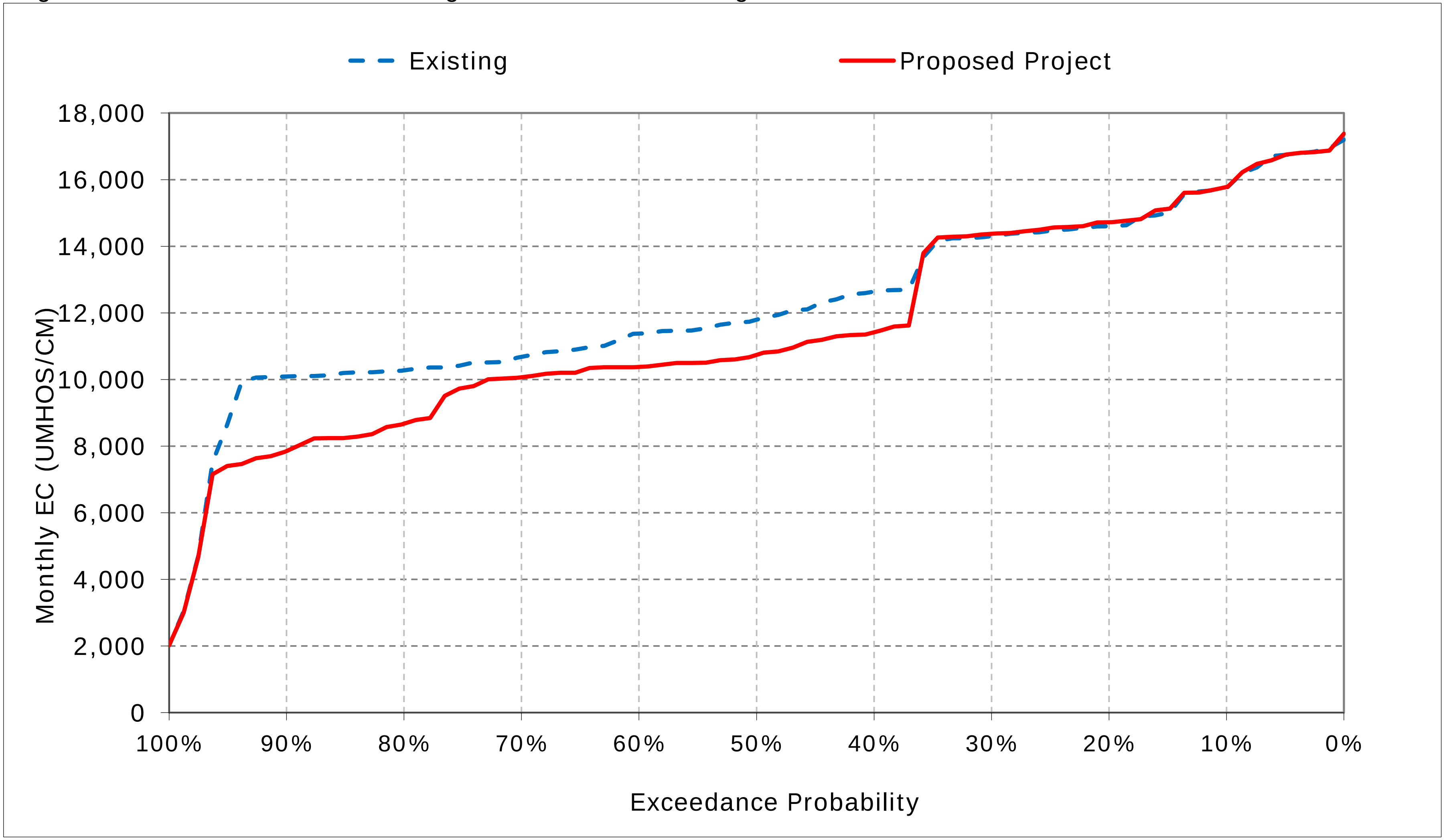


Figure 20-15. Montezuma Slough at Hunter Cut, September EC

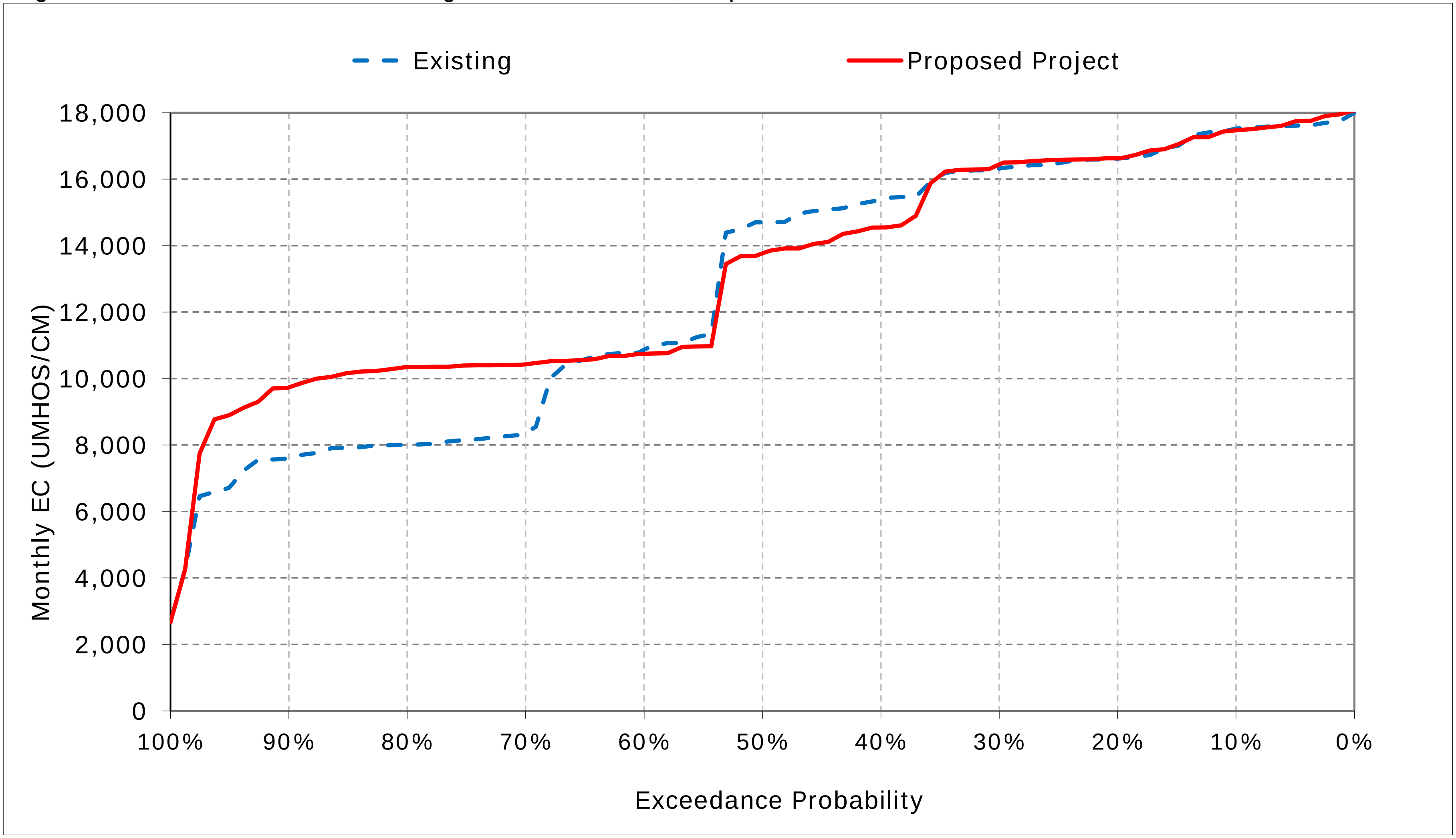


Figure 20-16. Montezuma Slough at Hunter Cut, October EC

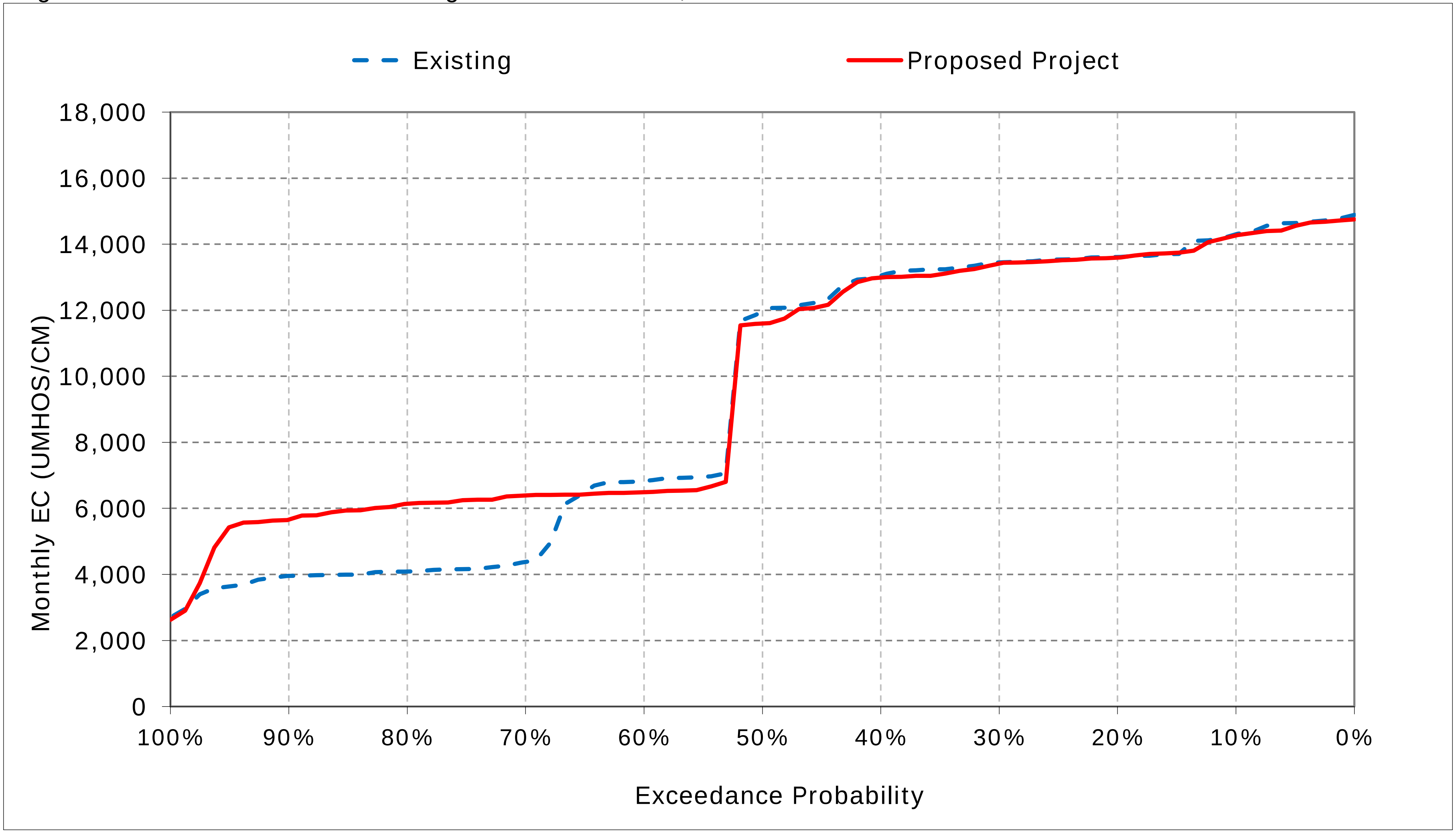


Figure 20-17. Montezuma Slough at Hunter Cut, November EC

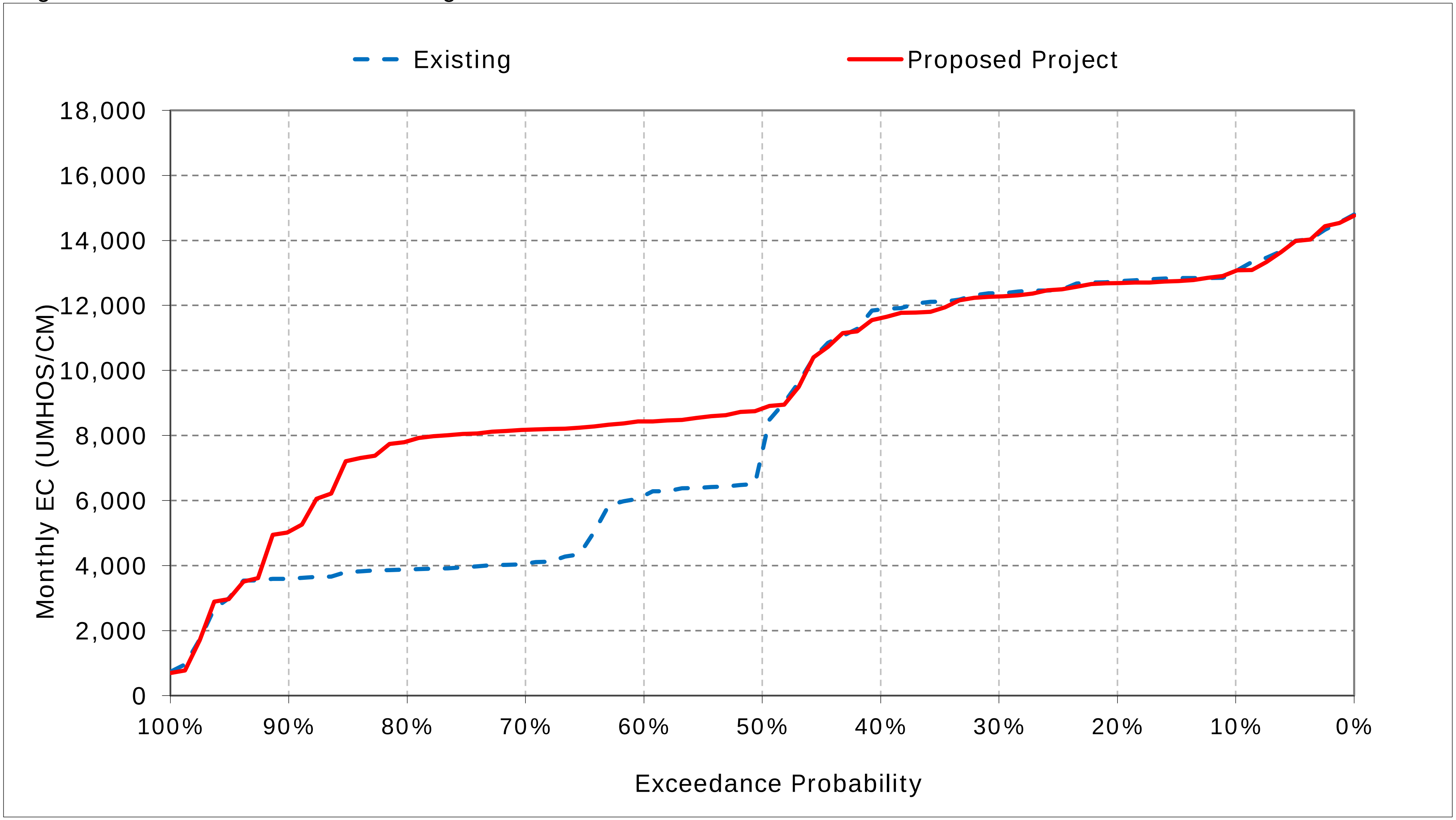


Figure 20-18. Montezuma Slough at Hunter Cut, December EC

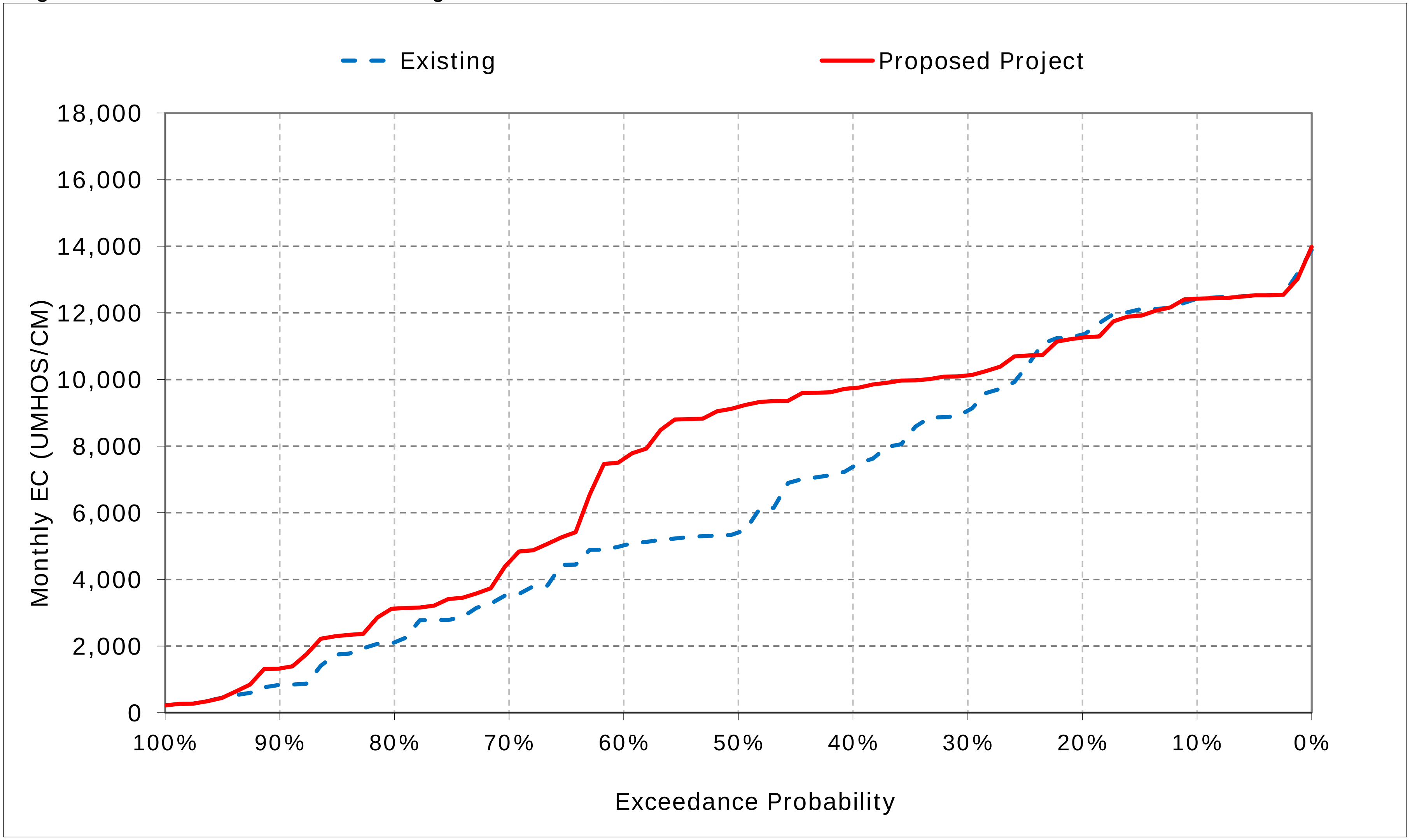


Table 21-1. Montezuma Slough at Beldons Landing, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	10,397	9,185	8,459	4,859	1,913	4,528	6,910	7,642	9,408	11,291	13,926	16,150
20%	9,726	8,768	6,977	4,038	1,247	2,844	3,734	5,911	7,904	10,245	12,836	15,110
30%	9,507	8,484	4,779	3,185	773	1,475	2,438	4,408	6,998	9,651	12,376	14,722
40%	9,254	7,931	3,817	1,903	557	1,021	1,574	2,715	5,707	8,399	10,521	13,462
50%	7,993	3,576	2,678	1,632	309	853	1,248	1,882	4,248	7,091	9,759	12,895
60%	3,553	2,817	2,383	718	232	347	586	1,126	3,297	6,637	9,000	9,885
70%	1,942	1,552	1,139	269	208	236	365	672	2,535	5,545	8,218	8,353
80%	1,727	1,379	809	210	198	210	239	366	1,132	4,226	8,042	7,889
90%	1,622	1,278	280	196	191	195	195	200	293	2,201	7,617	7,573
Long Term												
Full Simulation Period[a]	6,094	5,097	3,652	2,040	821	1,517	2,173	3,003	4,836	7,331	10,172	11,631
Water Year Types[b]												
Wet (32%)	4,627	3,136	1,198	410	220	288	391	672	1,598	3,726	7,266	7,212
Above Normal (15%)	6,377	5,107	3,446	1,297	368	370	528	1,022	2,874	5,632	8,335	9,858
Below Normal (17%)	6,393	5,547	4,642	2,292	548	1,255	1,742	2,463	4,577	7,545	10,081	13,190
Dry (22%)	6,458	5,971	4,487	3,024	1,240	2,210	3,276	4,600	7,033	9,806	12,571	14,904
Critical (15%)	8,098	7,502	6,769	4,543	2,264	4,595	6,530	8,271	10,822	12,880	14,817	16,249

Proposed Project

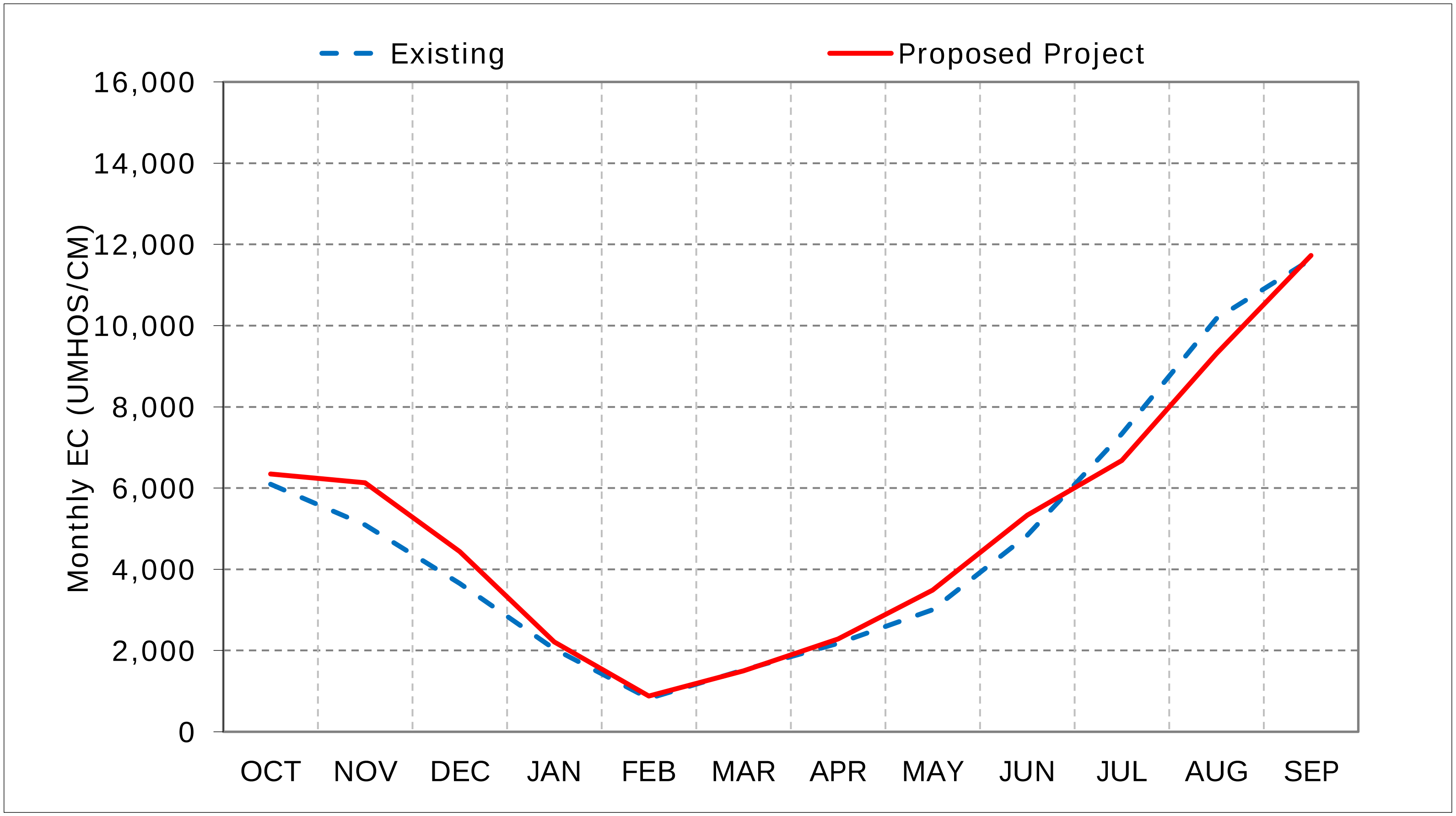
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	10,353	9,191	8,452	5,543	1,985	4,477	7,275	7,861	9,547	11,359	13,927	16,052
20%	9,690	8,738	6,987	4,531	1,232	2,829	3,663	6,531	8,622	10,406	12,964	15,064
30%	9,432	8,419	6,315	3,429	829	1,496	2,622	5,458	7,890	9,703	12,467	14,832
40%	8,912	7,831	5,745	2,107	554	888	1,778	3,810	6,151	7,127	9,181	11,493
50%	7,649	5,324	4,938	1,672	311	680	1,456	2,352	4,851	6,365	8,350	10,787
60%	3,289	4,936	3,689	728	222	335	674	1,822	4,295	4,818	8,101	9,977
70%	3,129	4,761	1,862	270	207	230	410	1,022	2,902	3,286	7,713	9,627
80%	2,951	4,480	1,131	213	200	208	243	442	1,457	3,109	5,547	9,406
90%	2,655	2,226	564	195	192	195	197	205	316	2,070	4,839	8,928
Long Term												
Full Simulation Period[a]	6,349	6,130	4,440	2,213	880	1,499	2,285	3,488	5,333	6,676	9,308	11,727
Water Year Types[b]												
Wet (32%)	4,995	4,471	1,731	420	214	279	449	957	1,990	3,863	7,223	8,666
Above Normal (15%)	6,650	6,190	4,562	1,453	333	326	613	1,543	3,476	5,673	8,378	9,617
Below Normal (17%)	6,664	6,523	5,580	2,384	533	1,167	1,886	3,206	5,266	3,068	4,920	11,149
Dry (22%)	6,744	6,926	5,435	3,390	1,370	2,173	3,399	5,265	7,628	10,007	12,667	14,970
Critical (15%)	8,018	8,011	7,368	4,892	2,538	4,688	6,729	8,579	11,071	12,986	14,833	16,282

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	-44	6	-6	684	72	-51	365	219	139	68	1	-98
20%	-35	-29	10	493	-15	-15	-72	620	719	161	128	-46
30%	-76	-65	1,536	244	55	21	184	1,050	891	52	90	110
40%	-342	-100	1,927	204	-3	-134	204	1,095	444	-1,272	-1,339	-1,968
50%	-344	1,747	2,261	41	3	-172	208	470	603	-726	-1,408	-2,108
60%	-264	2,118	1,306	10	-10	-12	87	696	998	-1,819	-899	92
70%	1,187	3,209	723	1	-1	-7	45	350	367	-2,259	-505	1,275
80%	1,224	3,101	322	3	2	-2	3	76	325	-1,117	-2,496	1,516
90%	1,033	948	284	0	0	0	2	5	23	-131	-2,778	1,355
Long Term												
Full Simulation Period[a]	254	1,032	788	173	59	-19	112	484	497	-655	-865	96
Water Year Types[b]												
Wet (32%)	369	1,334	533	10	-6	-9	58	284	392	138	-43	1,454
Above Normal (15%)	273	1,083	1,116	156	-34	-44	85	521	602	41	43	-241
Below Normal (17%)	271	976	937	92	-15	-88	144	743	689	-4,476	-5,160	-2,041
Dry (22%)	285	955	948	366	130	-37	123	665	595	200	97	66
Critical (15%)	-80	509	599	350	273	93	200	308	249	106	16	33

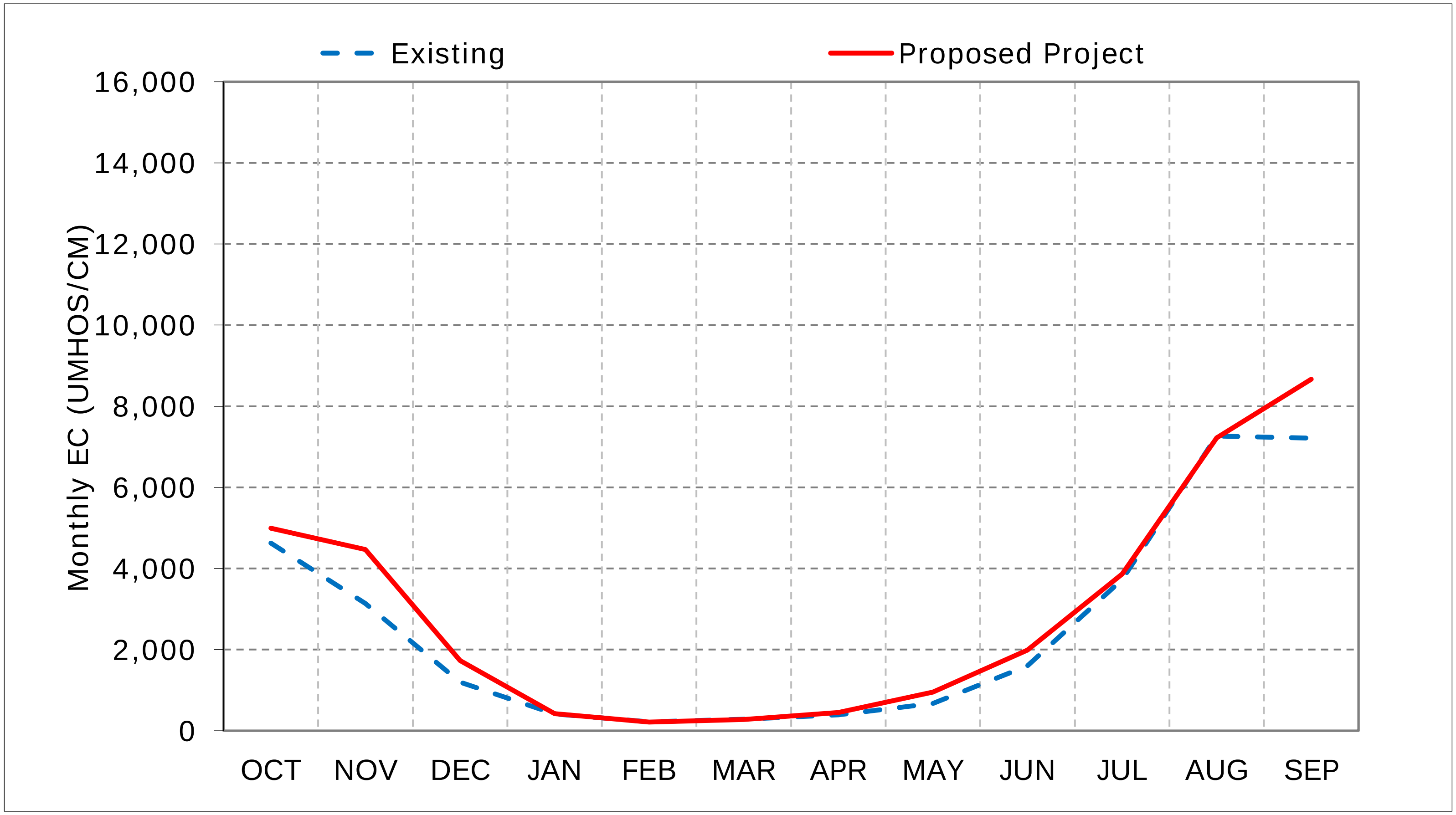
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 21-1. Montezuma Slough at Beldons Landing, Long-Term Average EC



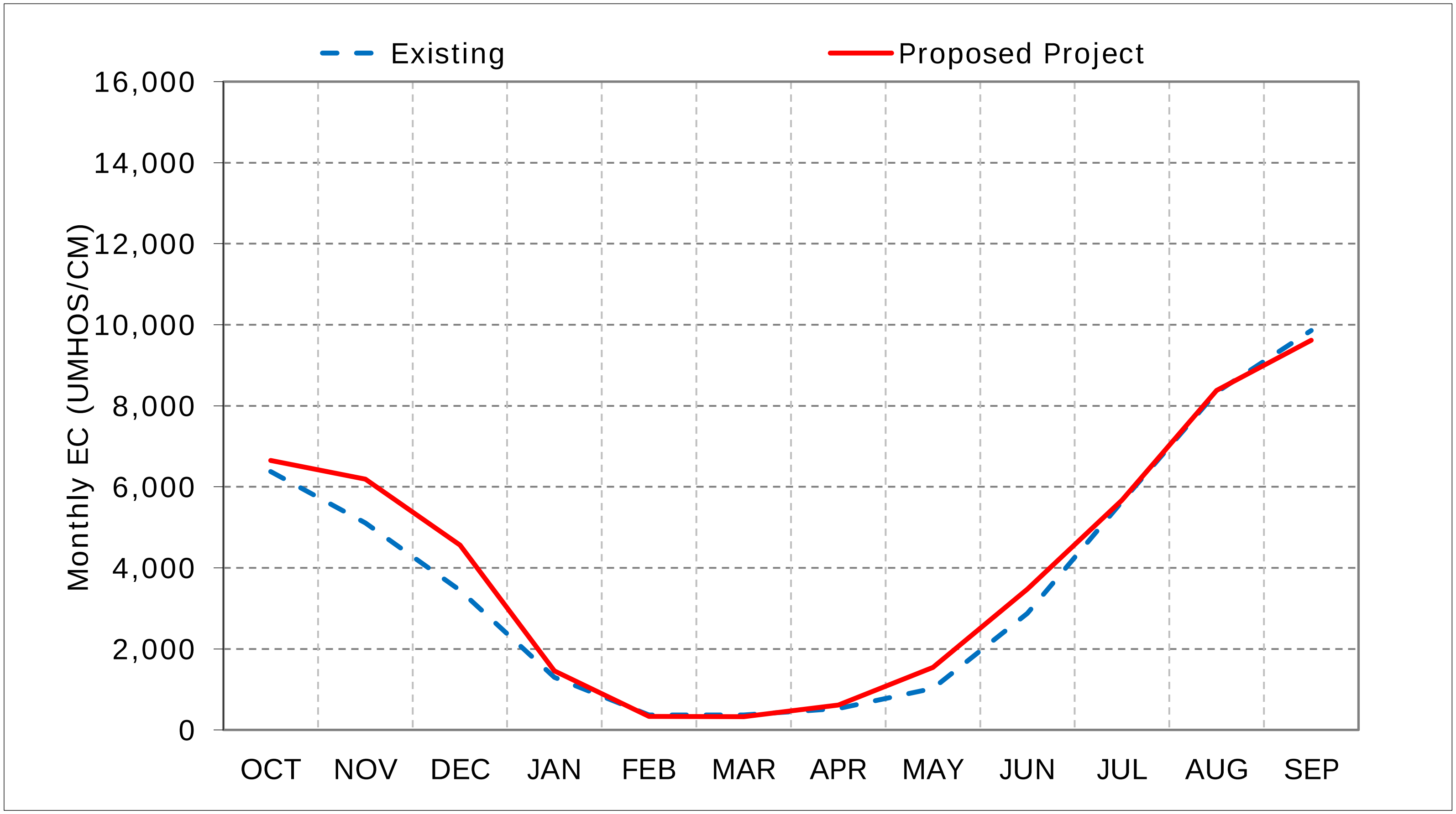
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 21-2. Montezuma Slough at Beldons Landing, Wet Year Average EC



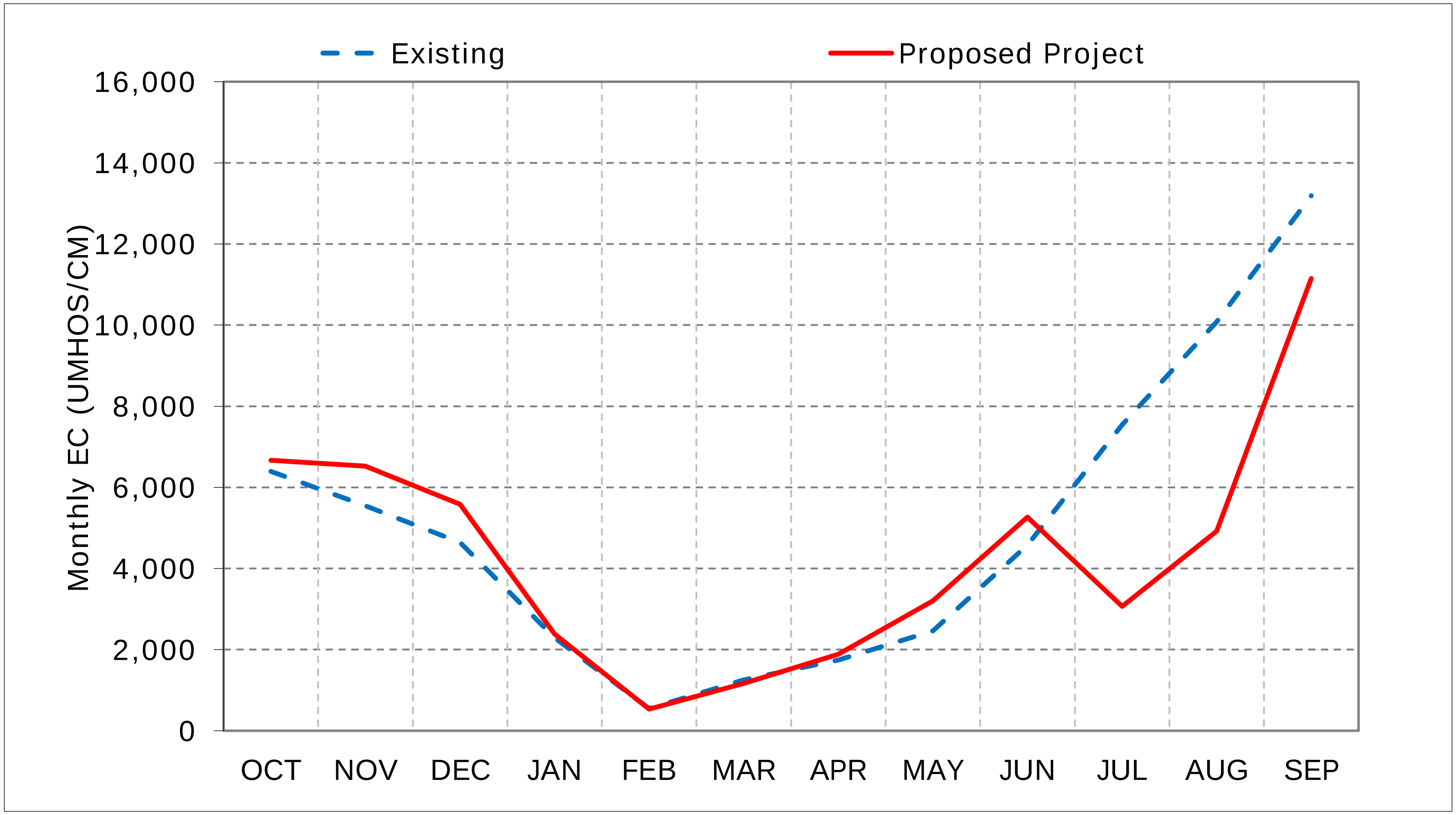
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 21-3. Montezuma Slough at Beldons Landing, Above Normal Year Average I



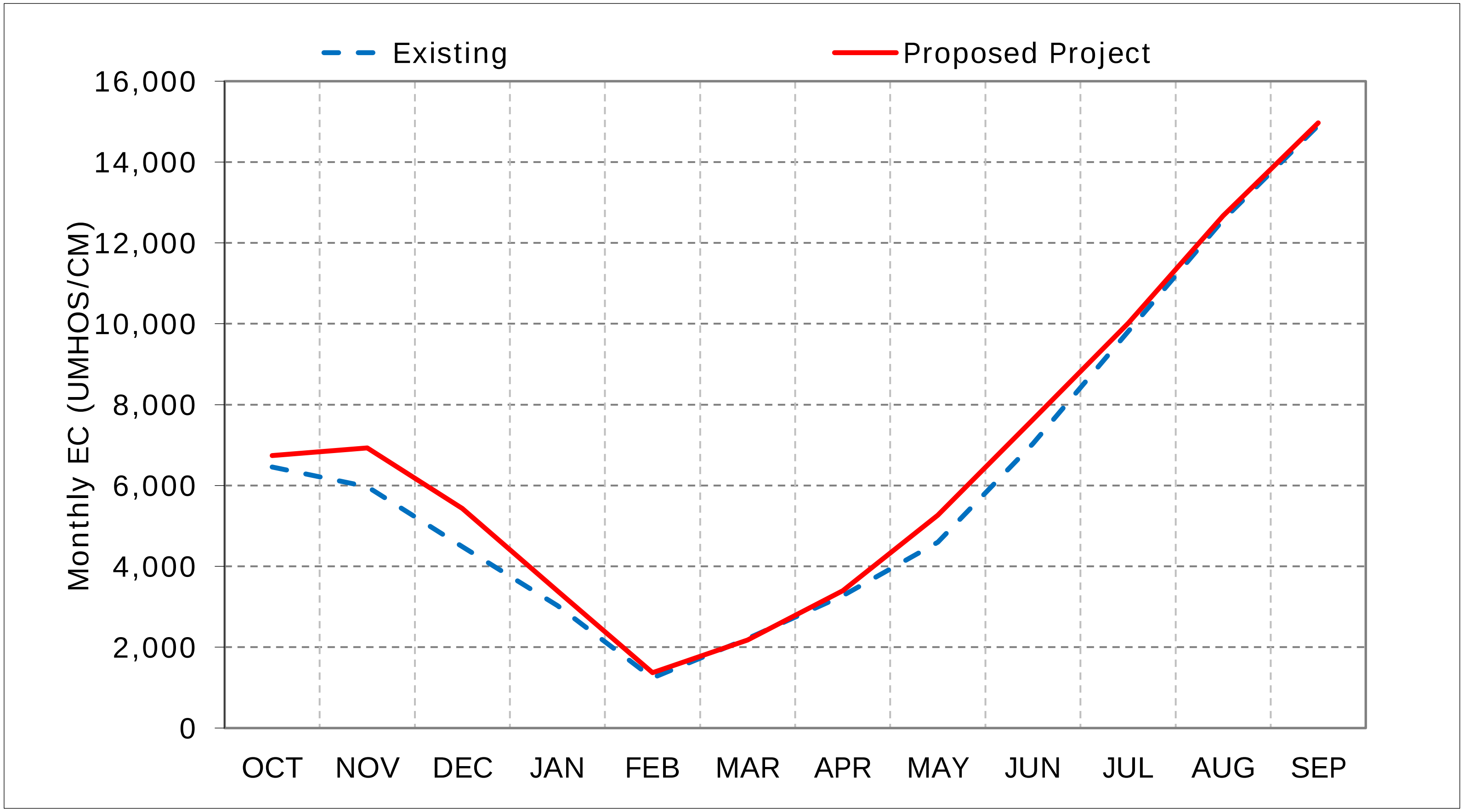
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 21-4. Montezuma Slough at Beldons Landing, Below Normal Year Average E



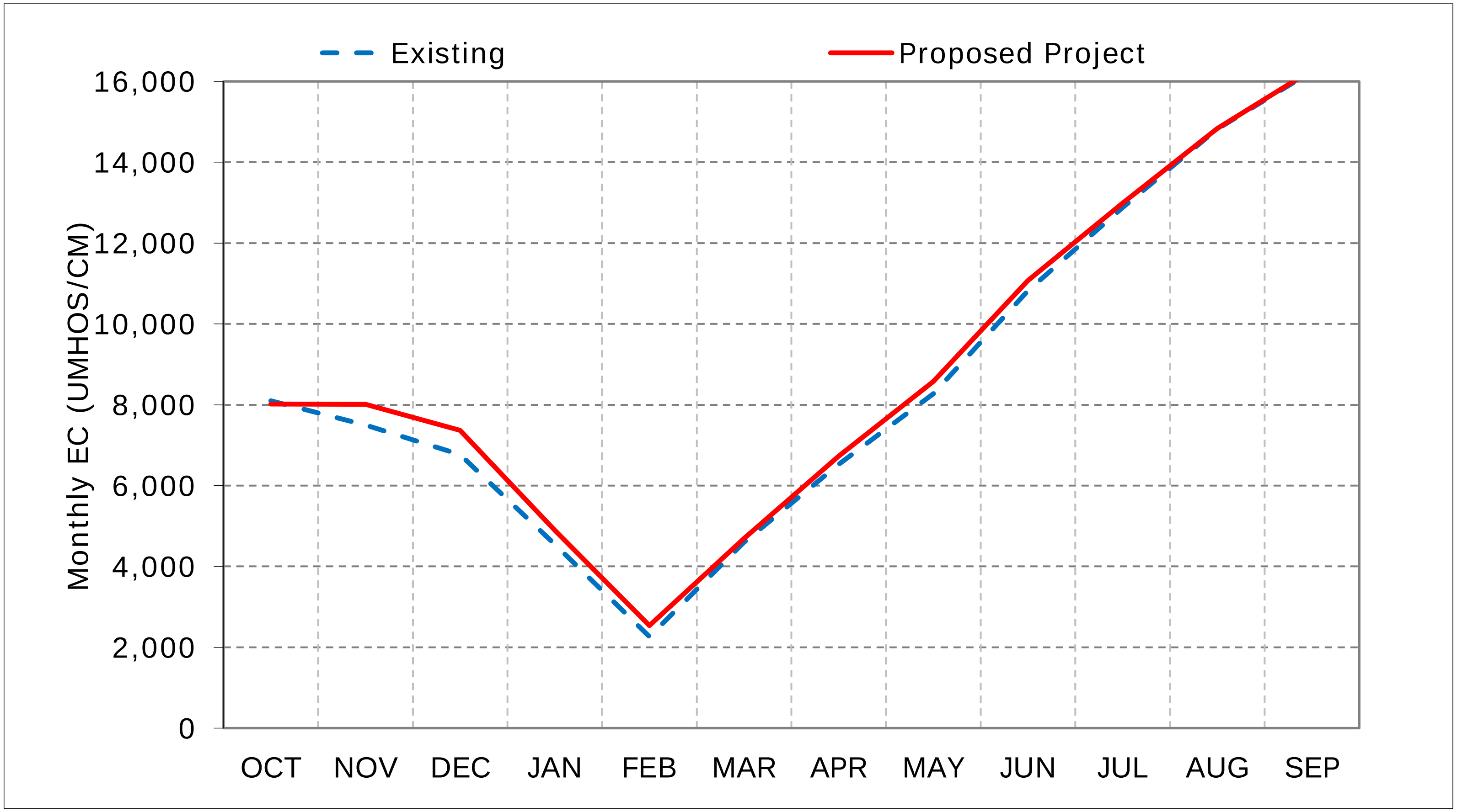
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 21-5. Montezuma Slough at Beldons Landing, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 21-6. Montezuma Slough at Beldons Landing, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 21-7. Montezuma Slough at Beldons Landing, January EC

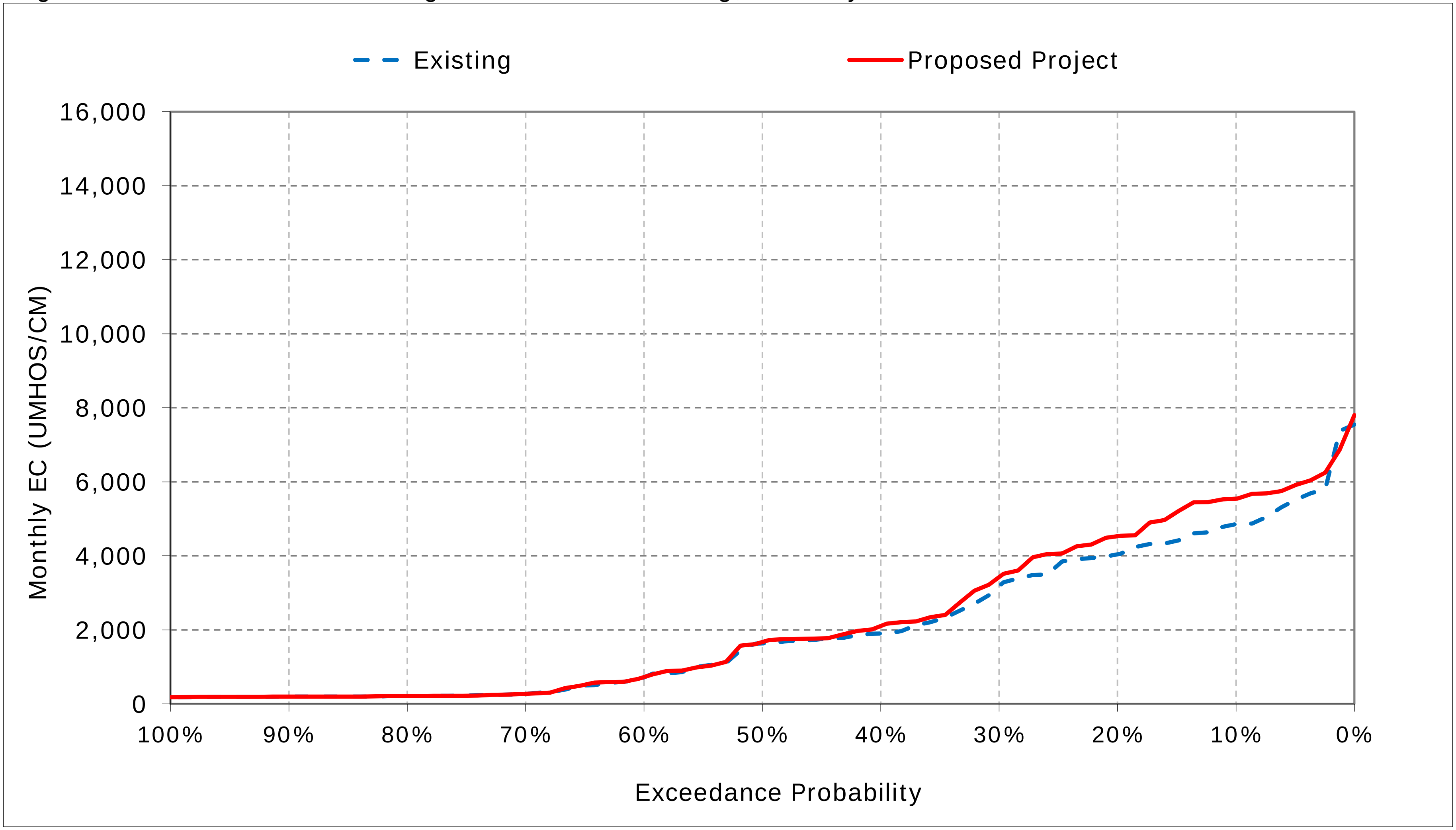


Figure 21-8. Montezuma Slough at Beldons Landing, February EC

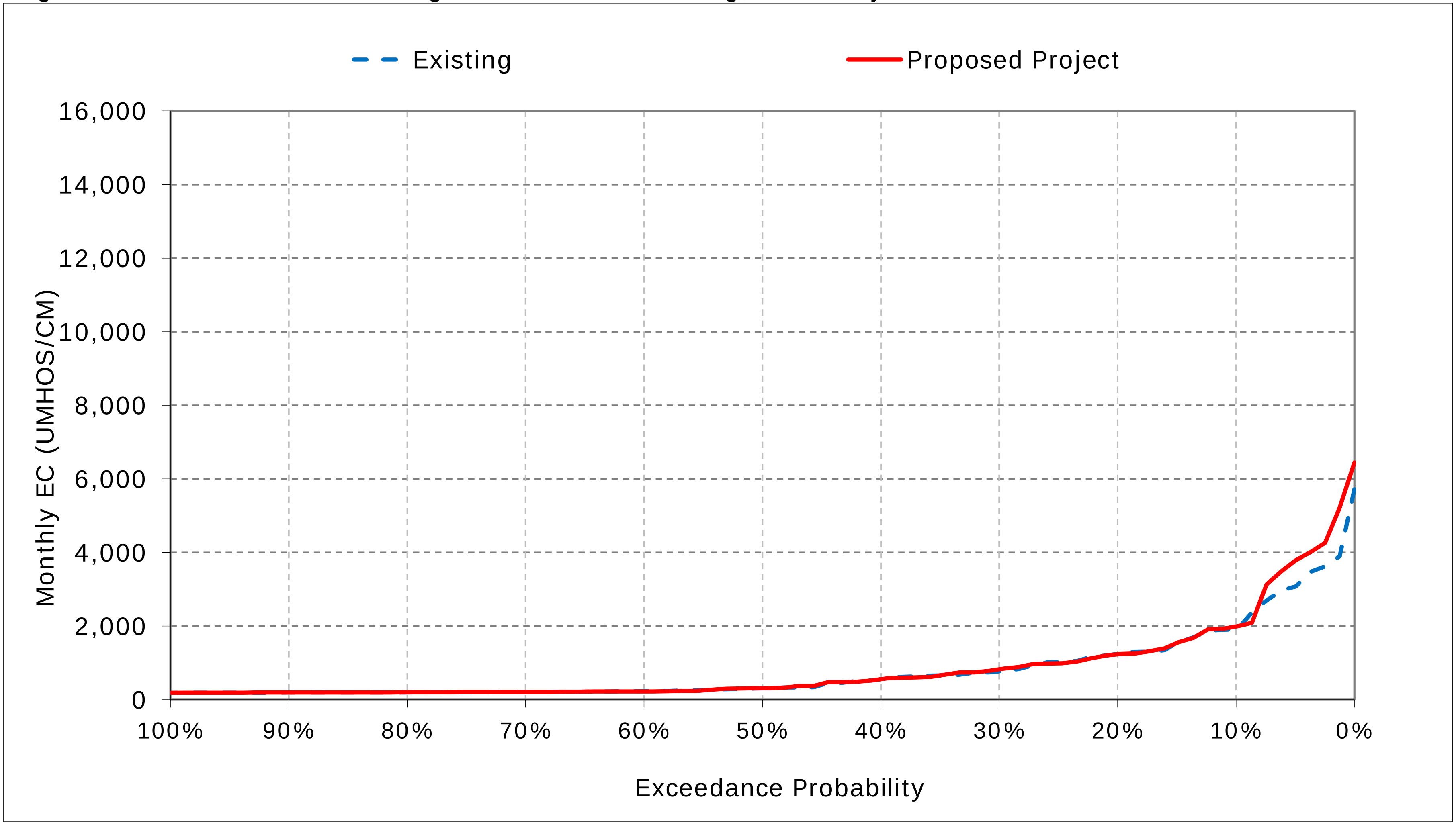


Figure 21-9. Montezuma Slough at Beldons Landing, March EC

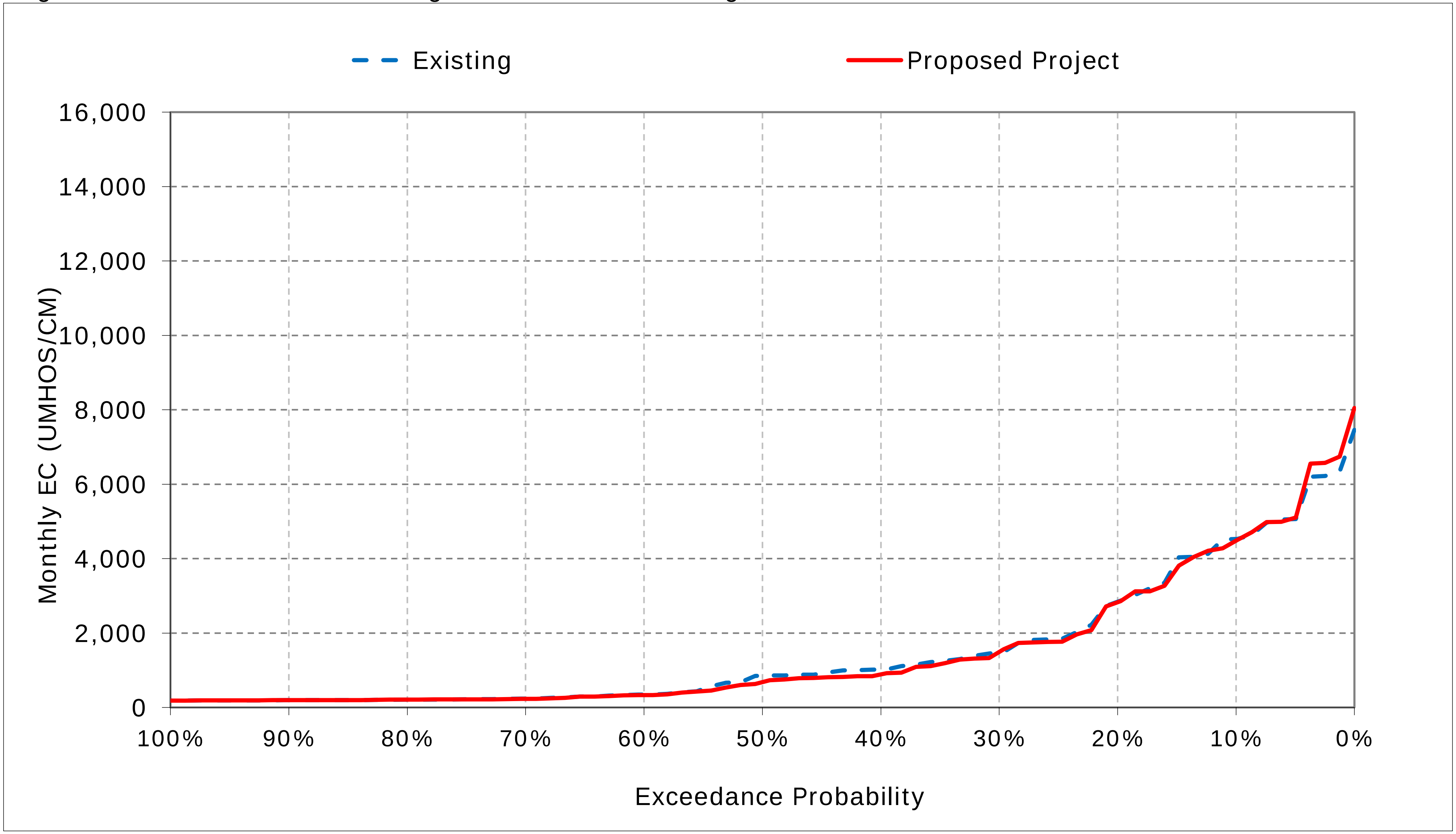


Figure 21-10. Montezuma Slough at Beldons Landing, April EC

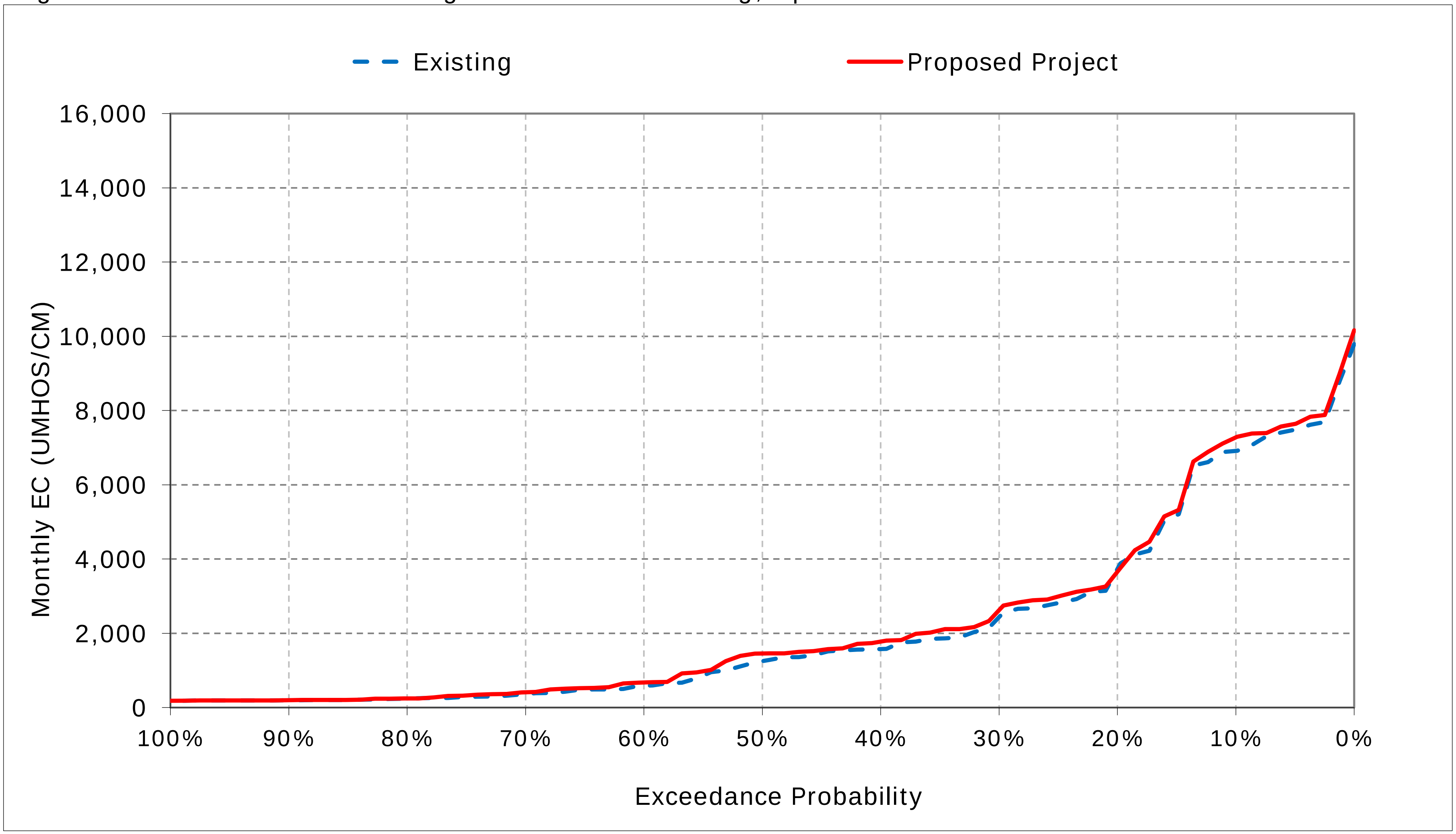


Figure 21-11. Montezuma Slough at Beldons Landing, May EC

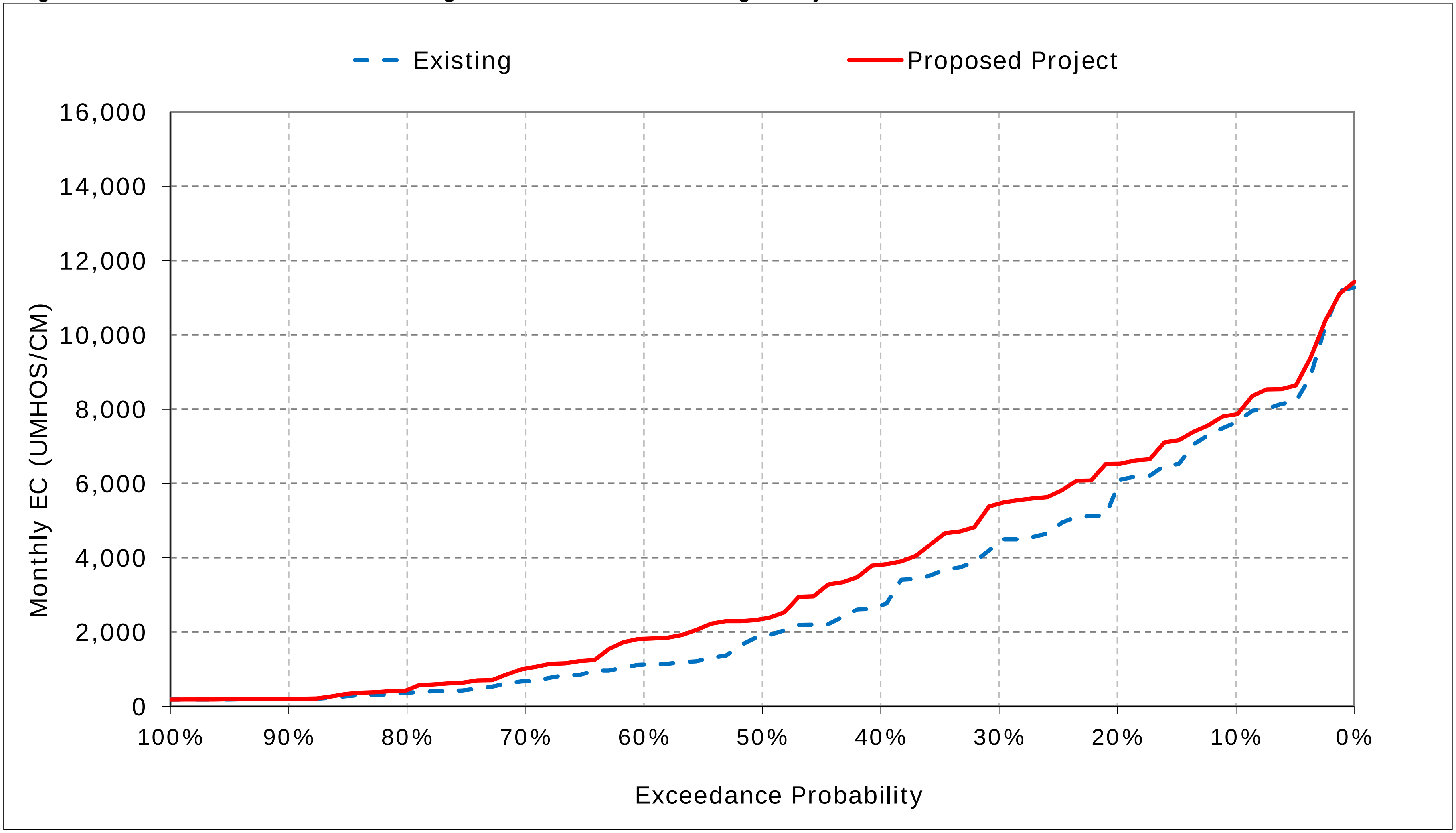


Figure 21-12. Montezuma Slough at Beldons Landing, June EC

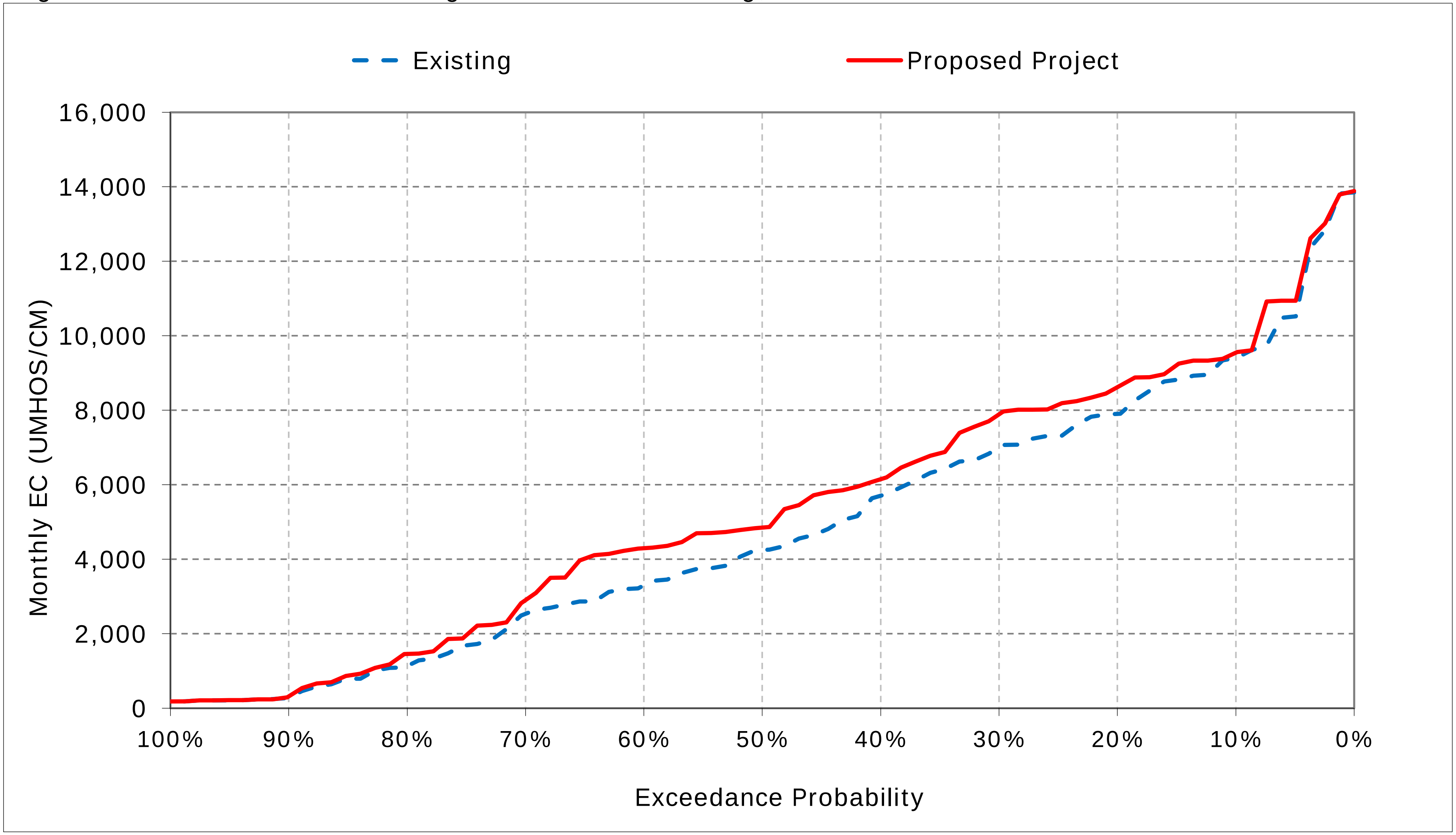


Figure 21-13. Montezuma Slough at Beldons Landing, July EC

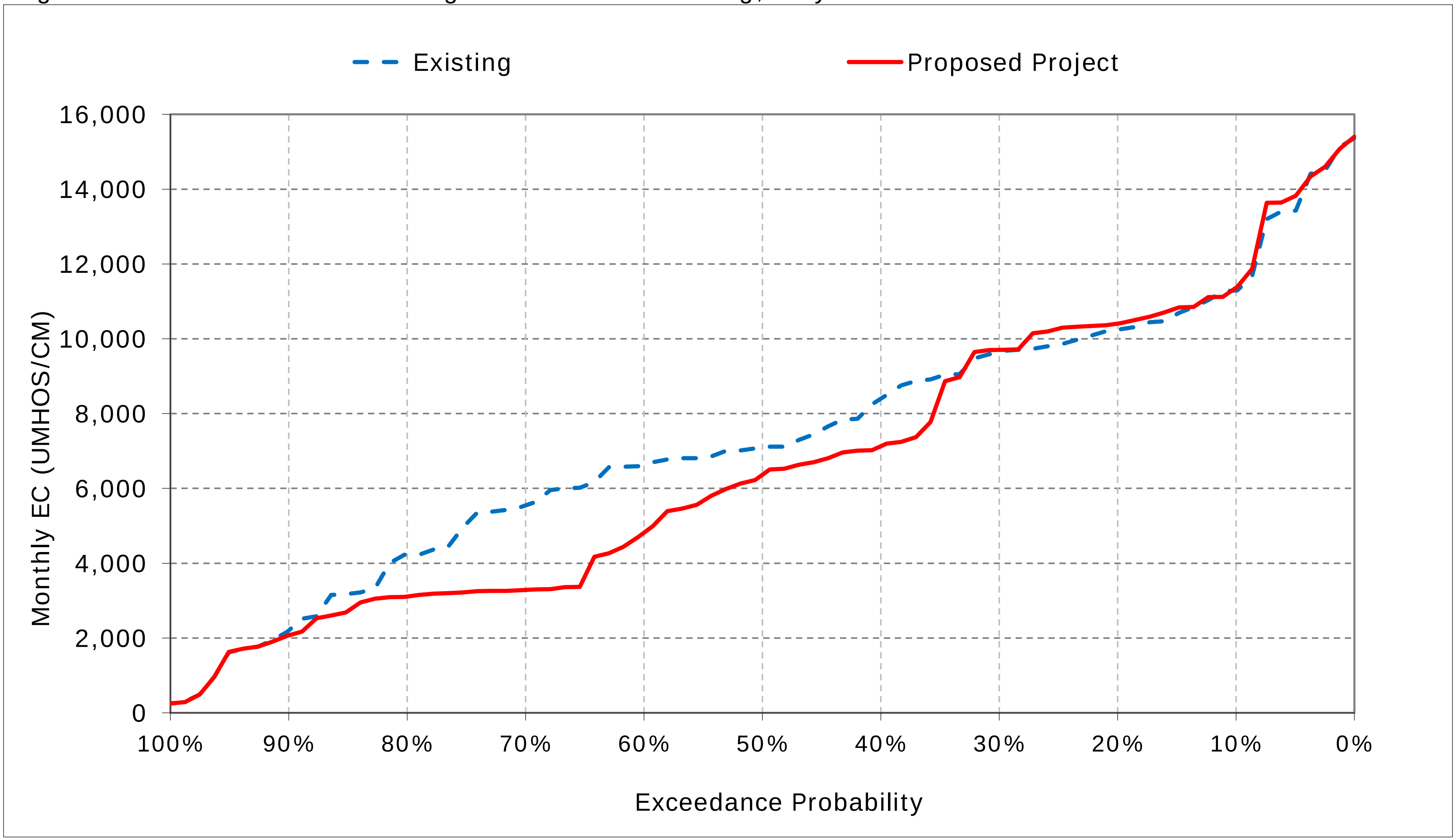


Figure 21-14. Montezuma Slough at Beldons Landing, August EC

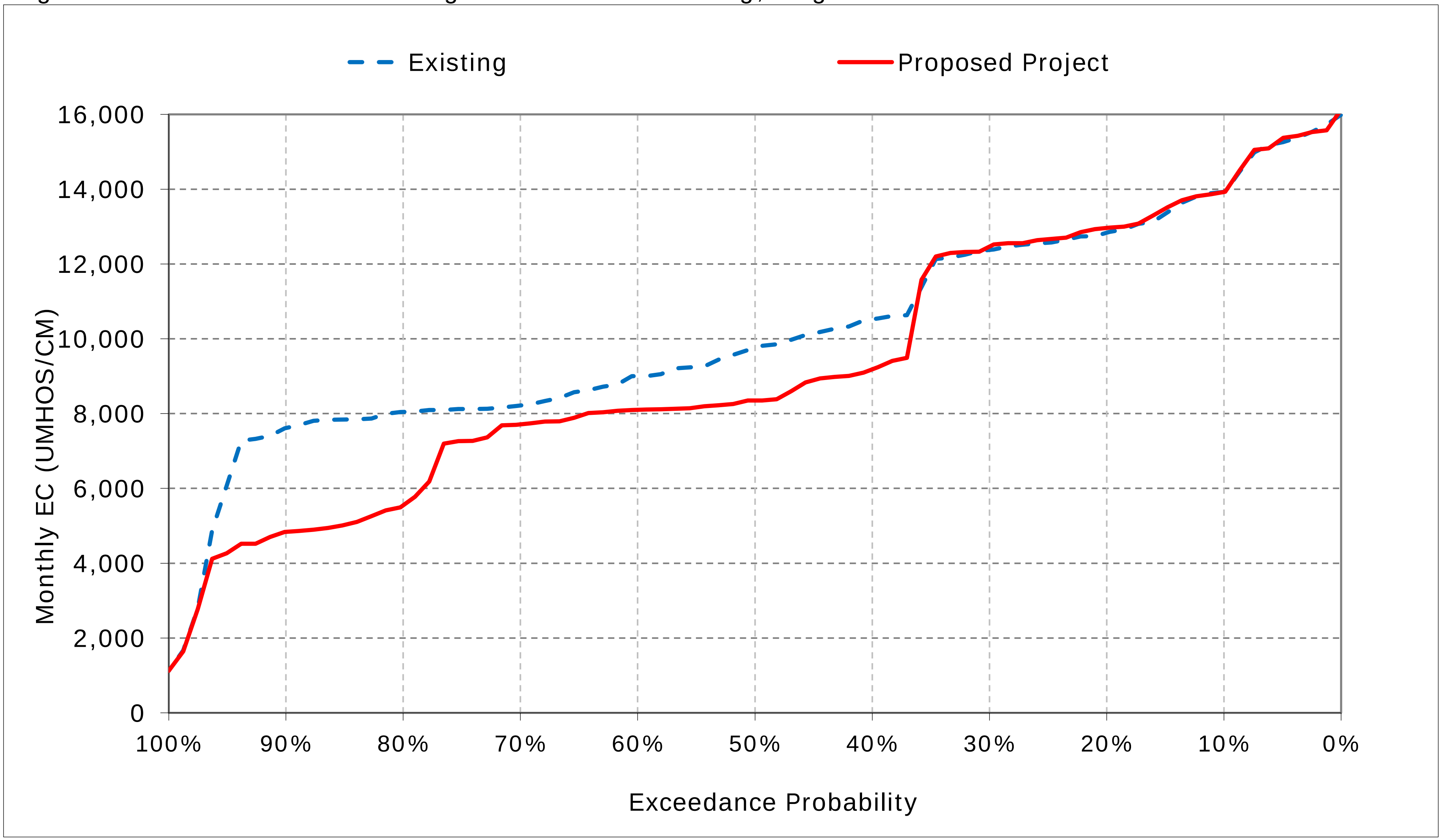


Figure 21-15. Montezuma Slough at Beldons Landing, September EC

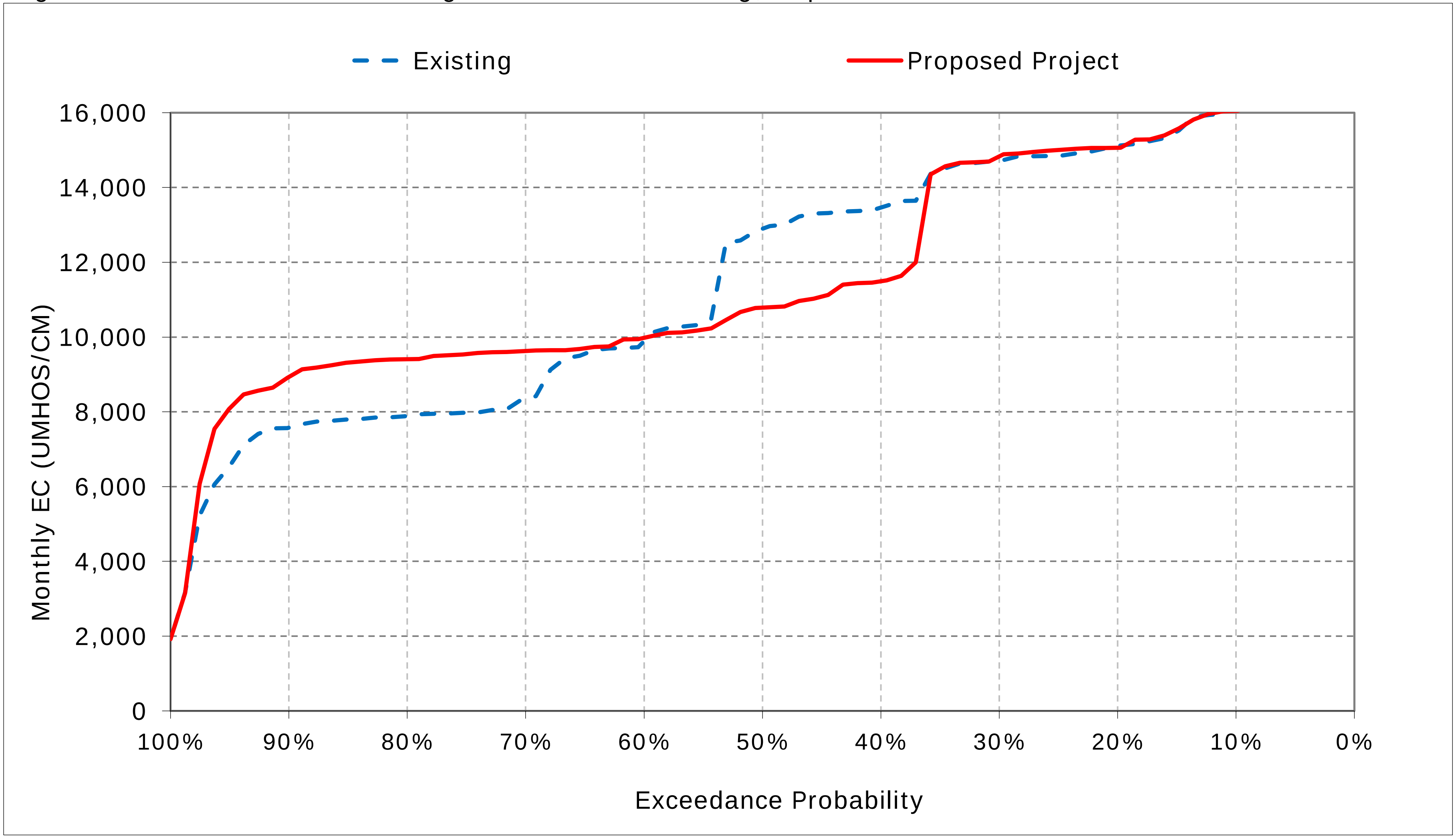


Figure 21-16. Montezuma Slough at Beldons Landing, October EC

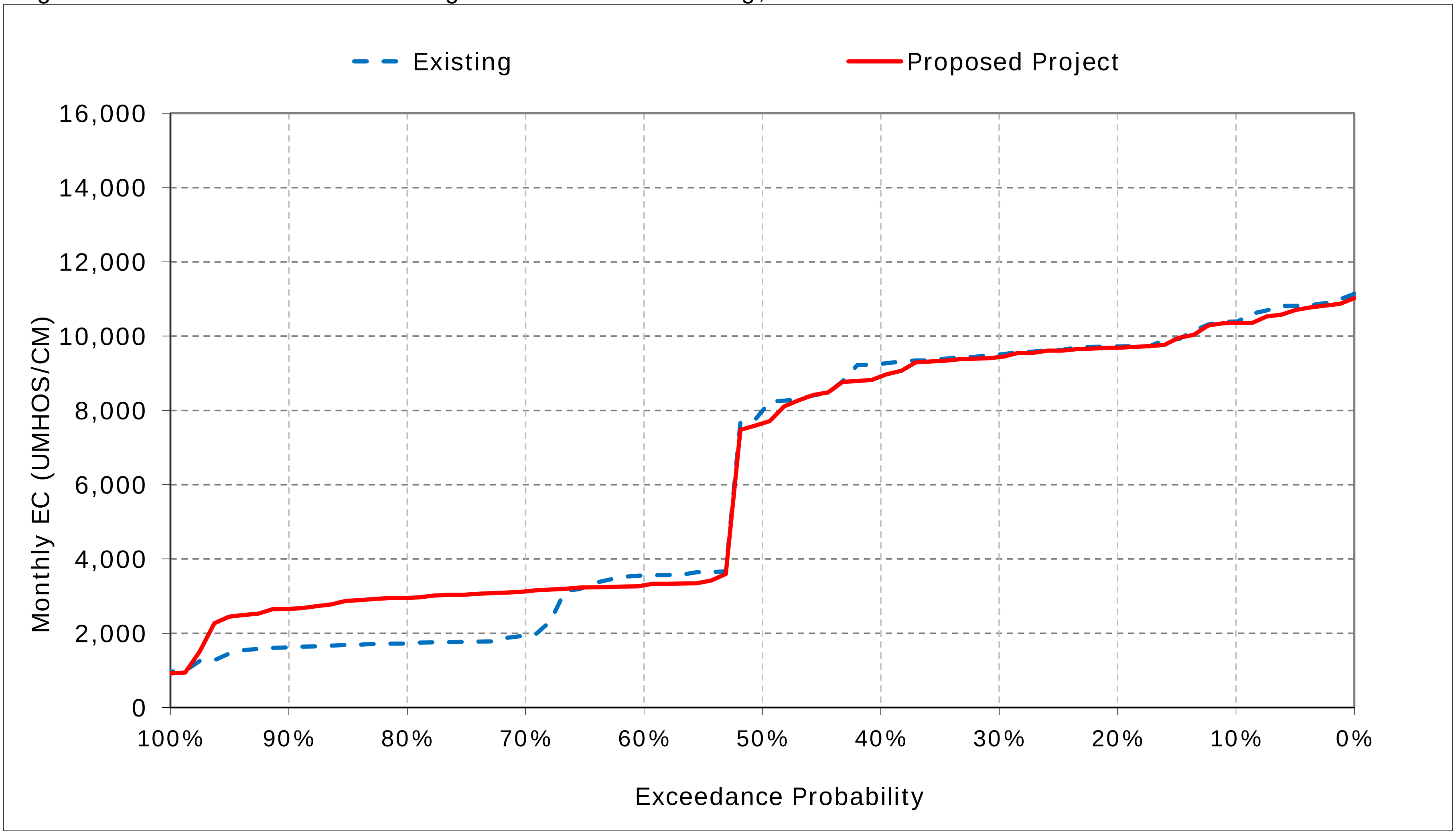


Figure 21-17. Montezuma Slough at Beldons Landing, November EC

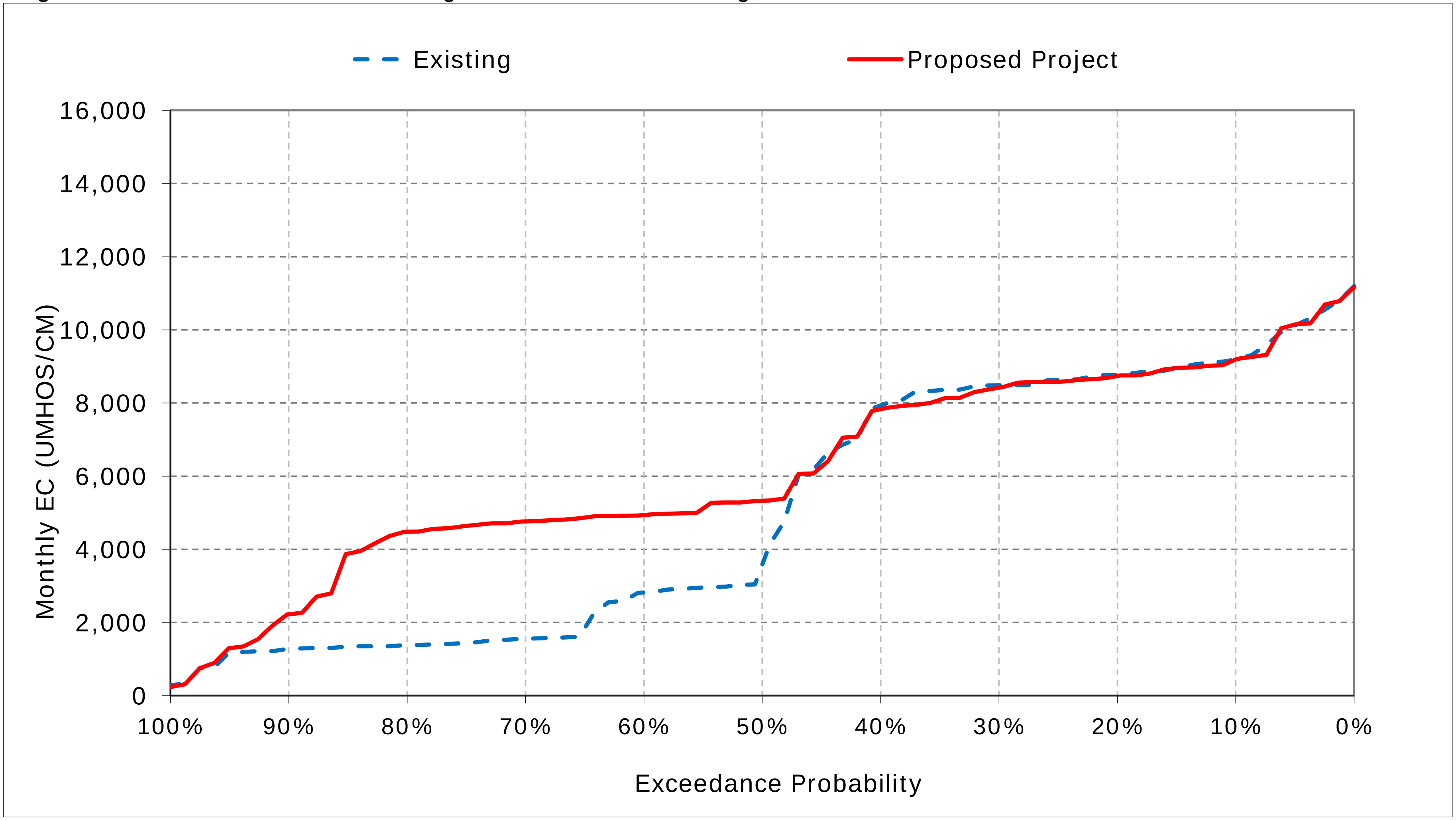


Figure 21-18. Montezuma Slough at Beldons Landing, December EC

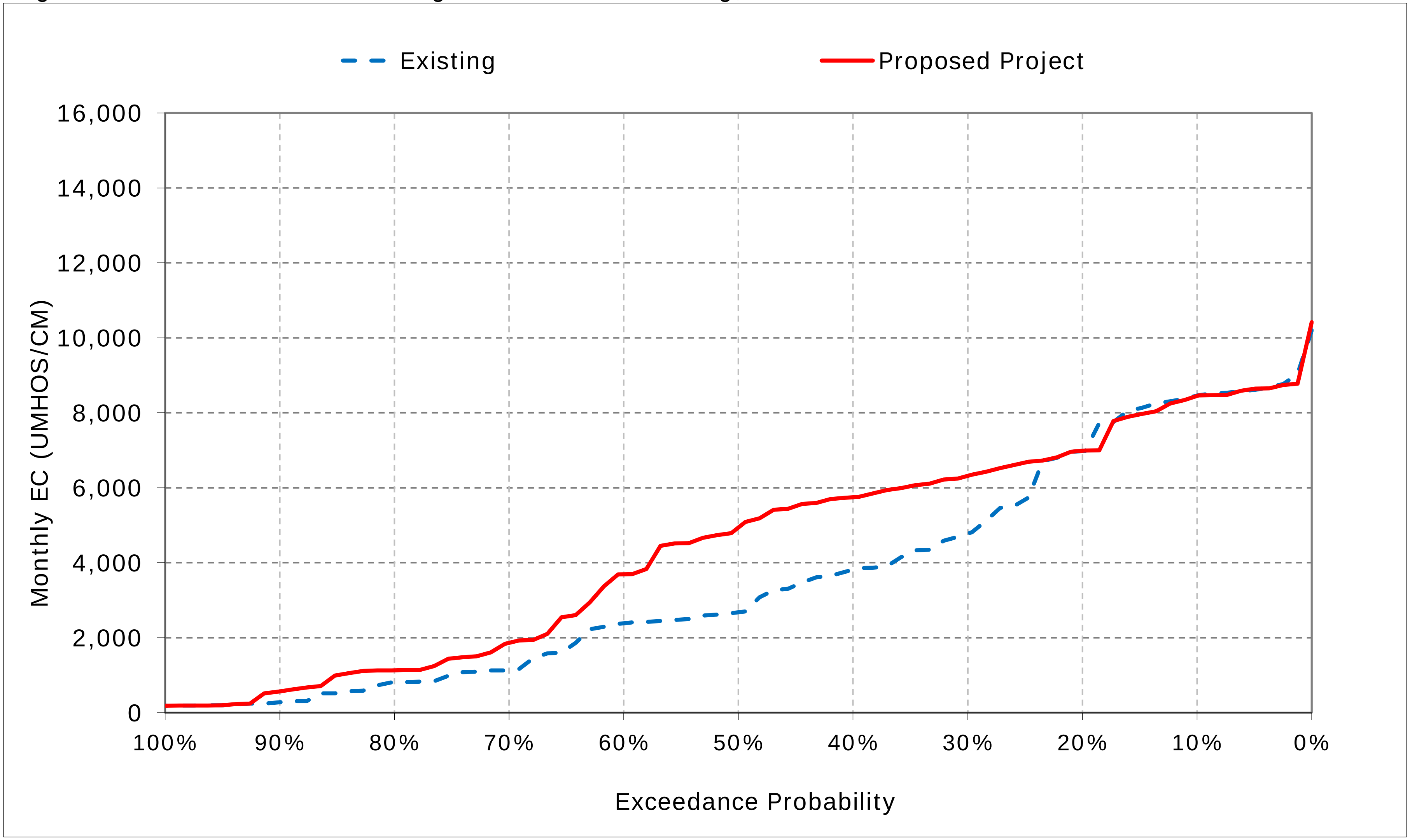


Table 22-1. Montezuma Slough at National Steel, Monthly EC

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	9,954	9,125	8,457	4,653	1,816	2,545	3,804	4,644	6,213	8,195	10,808	12,703
20%	9,229	8,637	6,804	3,899	1,124	1,367	1,768	3,345	4,995	7,041	9,632	11,765
30%	9,052	8,374	4,484	2,833	652	572	901	2,305	4,418	6,564	9,202	11,431
40%	8,727	7,798	3,679	1,533	404	420	647	1,272	3,512	5,011	7,333	10,280
50%	7,640	3,102	2,891	1,212	294	314	517	795	2,474	4,376	6,703	9,444
60%	3,261	2,578	2,661	560	216	219	258	476	1,892	3,681	6,260	5,782
70%	1,713	1,418	984	234	201	197	219	317	1,279	3,211	5,581	3,969
80%	1,581	1,192	526	206	196	192	198	215	583	2,384	5,361	3,625
90%	1,454	1,079	216	194	190	188	190	191	202	1,260	5,181	3,495
Long Term												
Full Simulation Period[a]	5,761	4,915	3,553	1,861	748	792	1,141	1,755	3,112	4,810	7,313	7,990
Water Year Types[b]												
Wet (32%)	4,322	2,914	1,051	377	206	212	243	368	902	2,087	4,915	3,315
Above Normal (15%)	6,040	4,890	3,344	1,082	327	225	276	462	1,698	3,150	5,651	5,655
Below Normal (17%)	6,054	5,358	4,640	1,977	471	564	734	1,238	2,758	4,649	7,004	9,832
Dry (22%)	6,143	5,820	4,349	2,849	1,103	1,044	1,594	2,553	4,454	6,716	9,368	11,615
Critical (15%)	7,687	7,403	6,723	4,237	2,133	2,501	3,744	5,458	7,717	9,698	11,446	12,866

Proposed Project

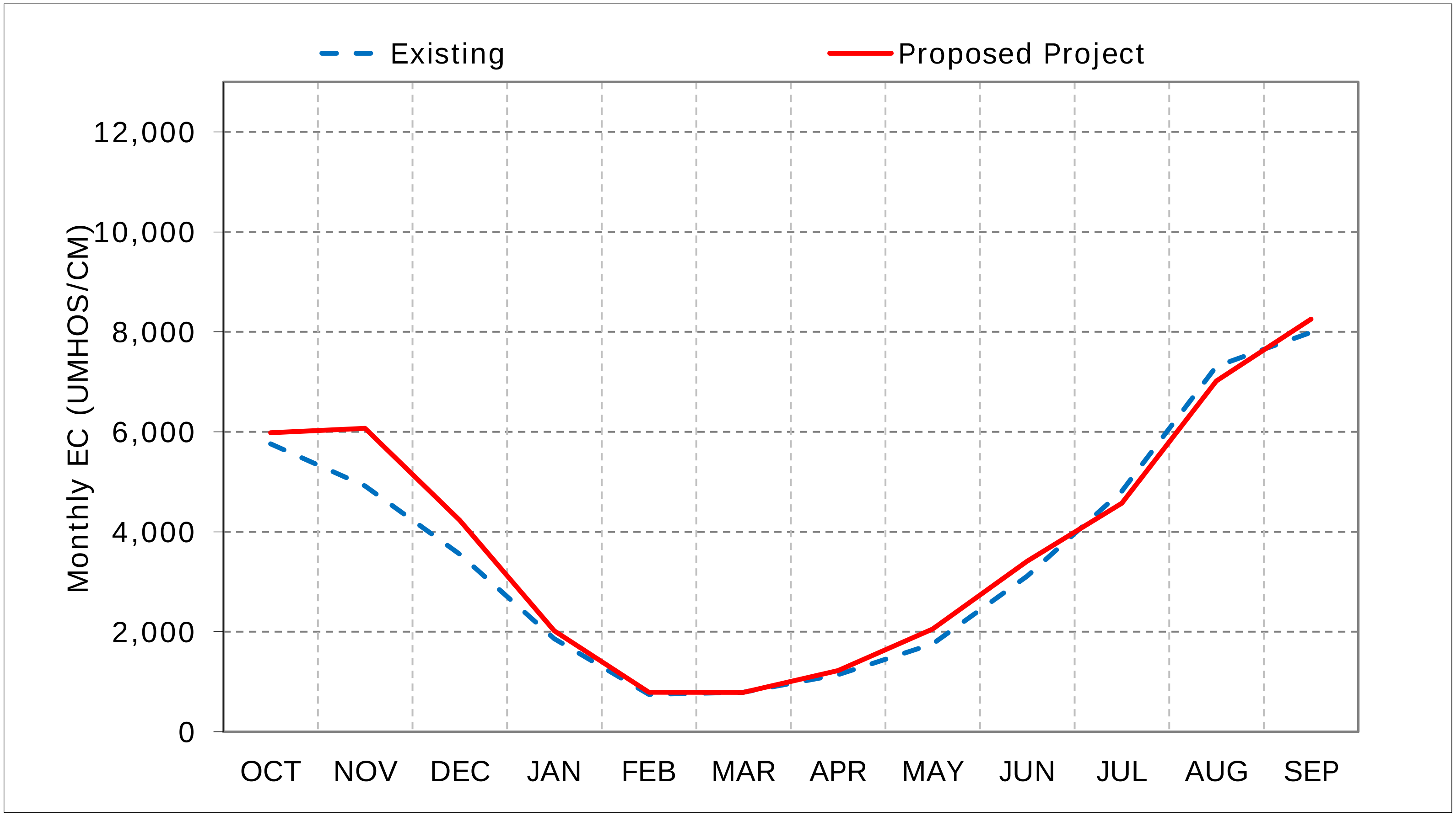
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	9,819	8,963	8,417	5,355	1,785	2,510	4,092	4,875	6,381	8,226	10,816	12,711
20%	9,224	8,644	6,803	4,345	1,111	1,341	1,880	3,926	5,486	7,243	9,698	11,745
30%	9,032	8,295	6,289	3,075	667	563	1,047	3,029	4,919	6,571	9,234	11,579
40%	8,379	7,795	5,692	1,684	393	361	756	1,899	3,984	3,904	6,355	9,242
50%	7,333	5,475	4,672	1,217	319	288	617	1,150	2,926	3,539	5,783	8,306
60%	3,039	5,127	3,284	549	216	215	295	806	2,428	3,122	5,483	5,679
70%	2,869	4,919	1,298	237	203	196	227	427	1,454	2,857	5,386	5,418
80%	2,691	4,303	789	203	196	192	198	228	614	2,325	5,216	5,240
90%	2,416	1,794	344	194	190	189	188	184	203	1,266	4,843	4,991
Long Term												
Full Simulation Period[a]	5,982	6,073	4,232	2,023	793	788	1,223	2,057	3,412	4,572	7,020	8,254
Water Year Types[b]												
Wet (32%)	4,654	4,390	1,438	375	203	209	270	514	1,123	2,156	4,858	4,814
Above Normal (15%)	6,262	6,110	4,358	1,199	281	215	313	715	1,999	3,155	5,686	5,364
Below Normal (17%)	6,295	6,448	5,488	2,034	454	530	837	1,684	3,131	2,876	5,260	8,743
Dry (22%)	6,409	6,883	5,205	3,208	1,205	1,026	1,719	3,036	4,863	6,865	9,451	11,675
Critical (15%)	7,576	8,028	7,236	4,624	2,359	2,561	3,906	5,708	7,931	9,763	11,446	12,898

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly EC (UMHOS/CM)											
Probability of Exceedance												
10%	-135	-162	-39	702	-32	-34	288	231	168	31	8	9
20%	-5	7	-1	446	-13	-26	112	581	491	202	66	-20
30%	-20	-79	1,804	242	16	-9	146	724	501	7	32	148
40%	-348	-3	2,013	151	-11	-60	109	628	472	-1,107	-978	-1,038
50%	-307	2,373	1,781	6	25	-26	101	355	451	-838	-921	-1,138
60%	-221	2,549	623	-10	0	-4	37	329	536	-559	-777	-103
70%	1,156	3,501	314	4	2	-1	9	110	175	-354	-196	1,449
80%	1,111	3,110	263	-4	1	0	0	14	31	-59	-144	1,615
90%	962	715	128	0	0	0	-2	-7	1	5	-338	1,496
Long Term												
Full Simulation Period[a]	221	1,158	679	162	45	-3	82	302	299	-238	-293	265
Water Year Types[b]												
Wet (32%)	333	1,476	387	-2	-3	-3	26	146	222	69	-58	1,499
Above Normal (15%)	222	1,220	1,014	117	-46	-10	37	254	302	5	35	-291
Below Normal (17%)	240	1,090	848	57	-18	-34	103	446	373	-1,773	-1,744	-1,089
Dry (22%)	266	1,063	856	360	102	-19	125	483	409	149	83	60
Critical (15%)	-112	625	512	387	226	60	162	249	214	65	0	32

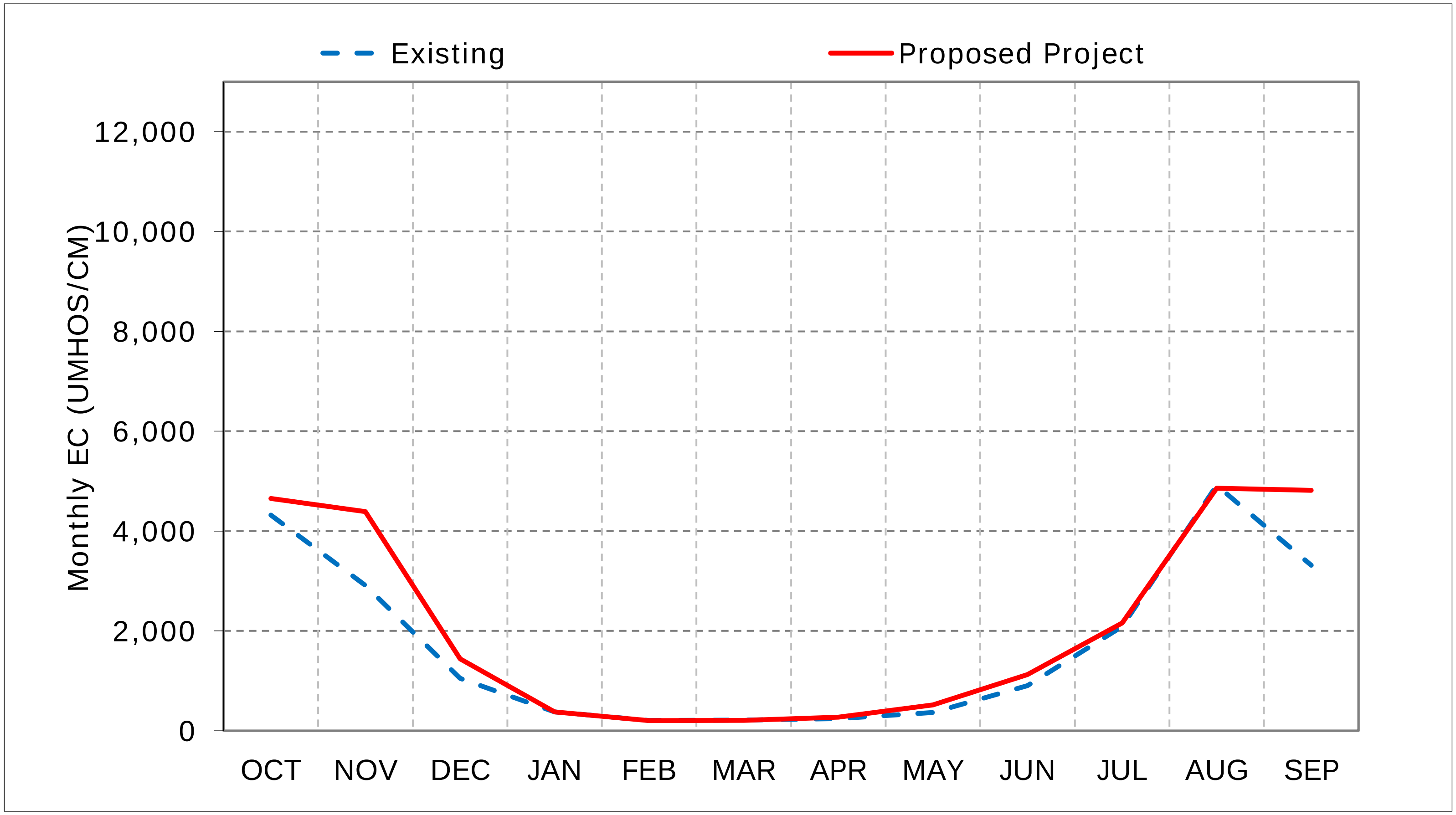
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 22-1. Montezuma Slough at National Steel, Long-Term Average EC



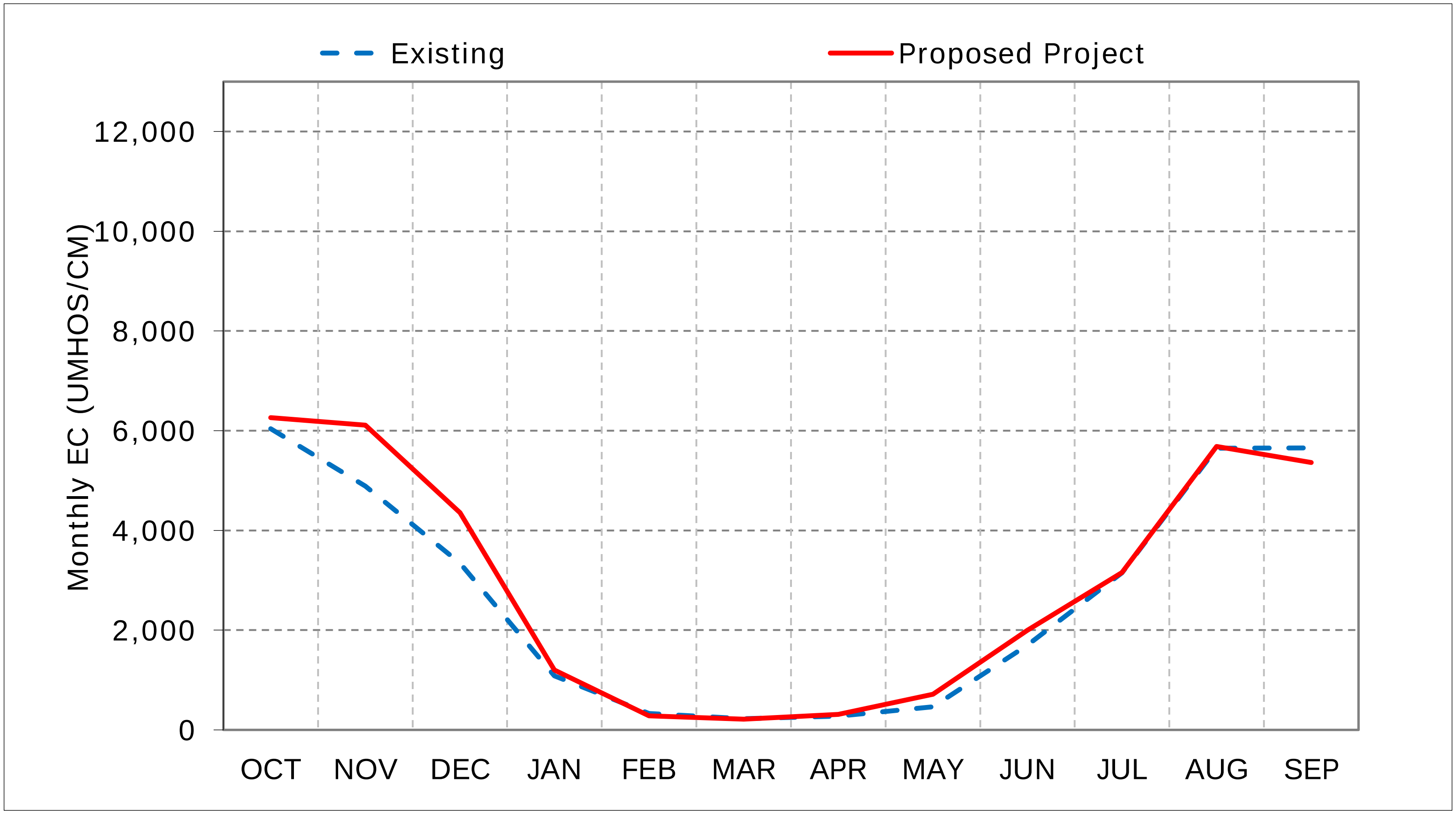
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 22-2. Montezuma Slough at National Steel, Wet Year Average EC



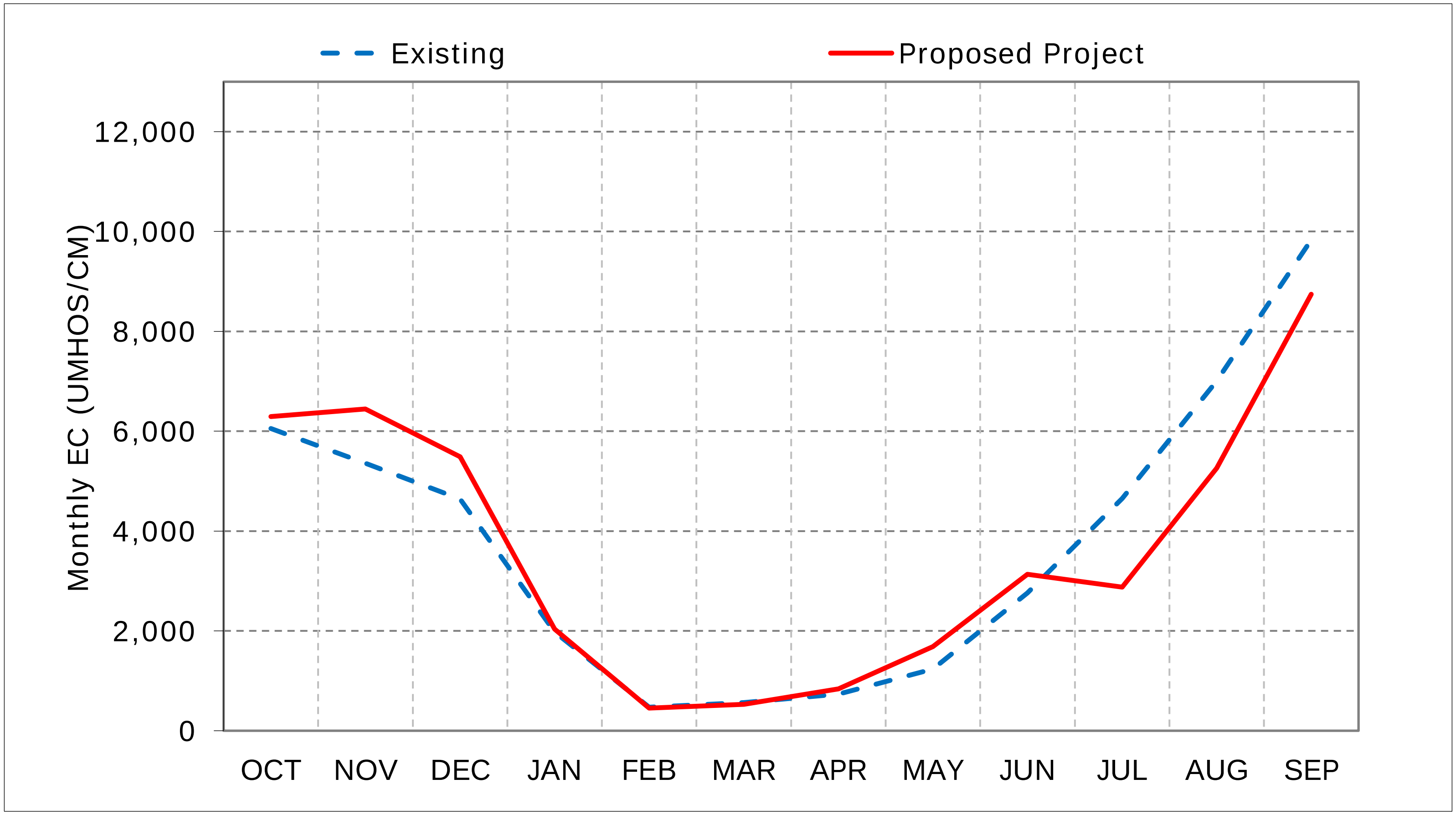
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 22-3. Montezuma Slough at National Steel, Above Normal Year Average EC



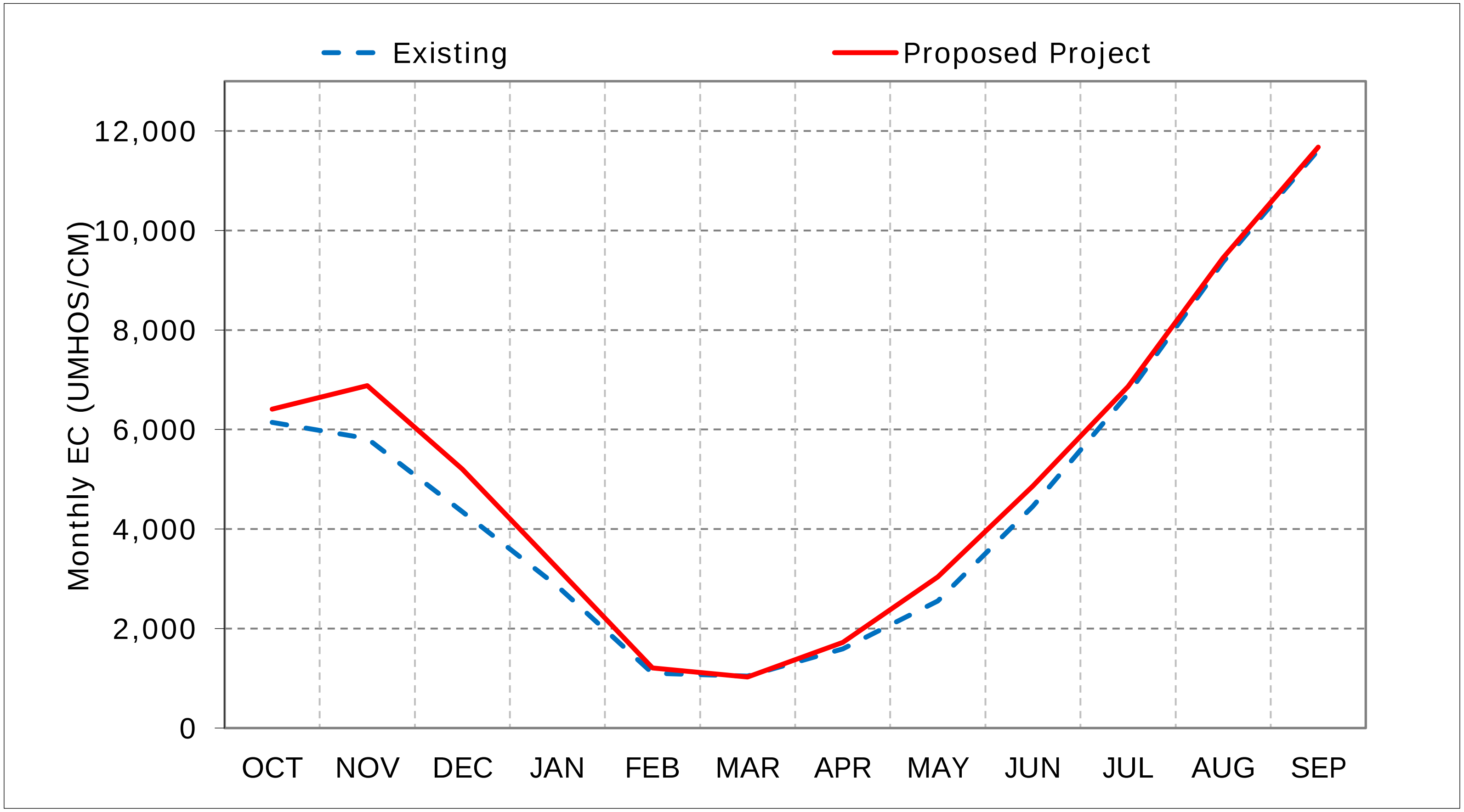
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 22-4. Montezuma Slough at National Steel, Below Normal Year Average EC



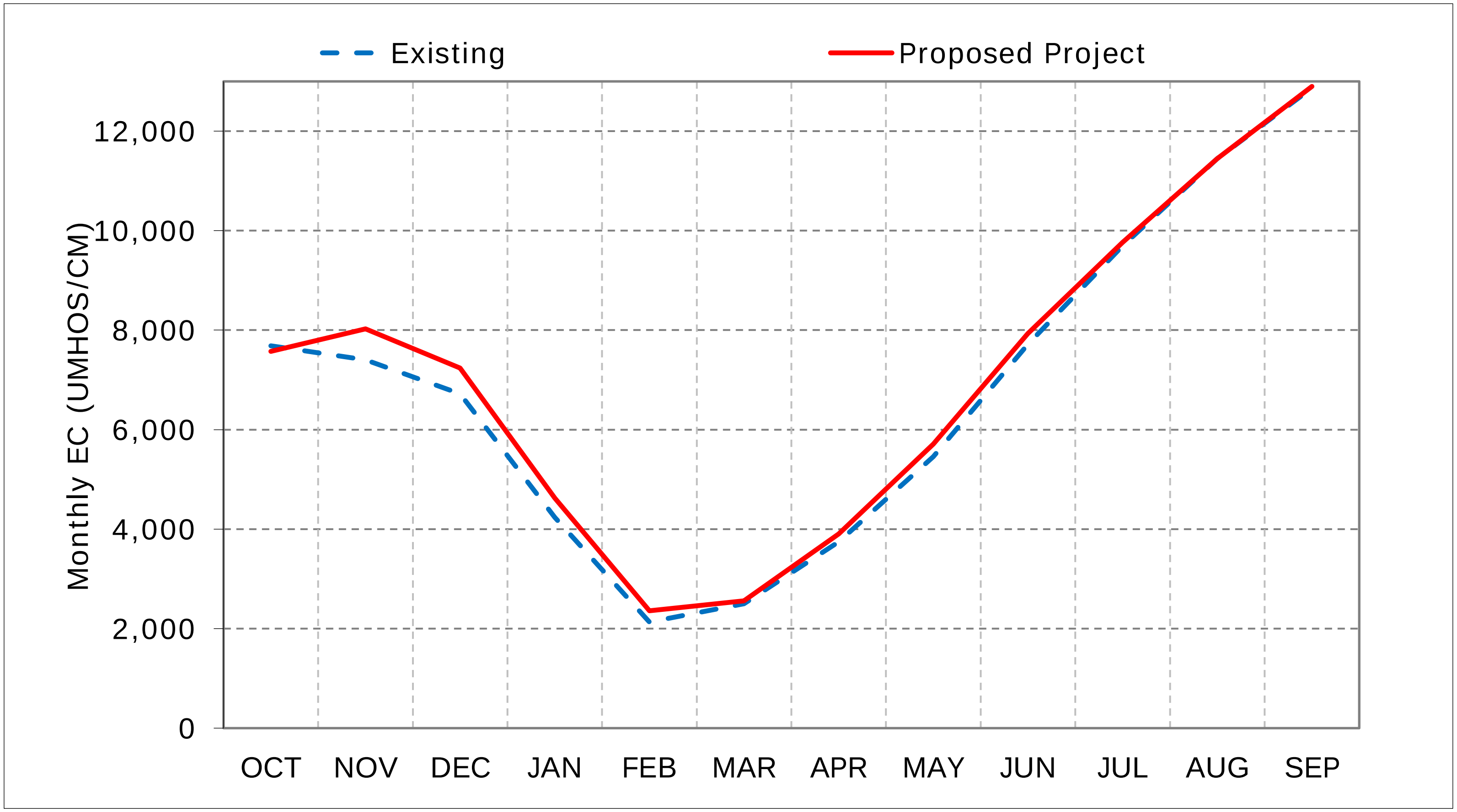
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 22-5. Montezuma Slough at National Steel, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 22-6. Montezuma Slough at National Steel, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 22-7. Montezuma Slough at National Steel, January EC

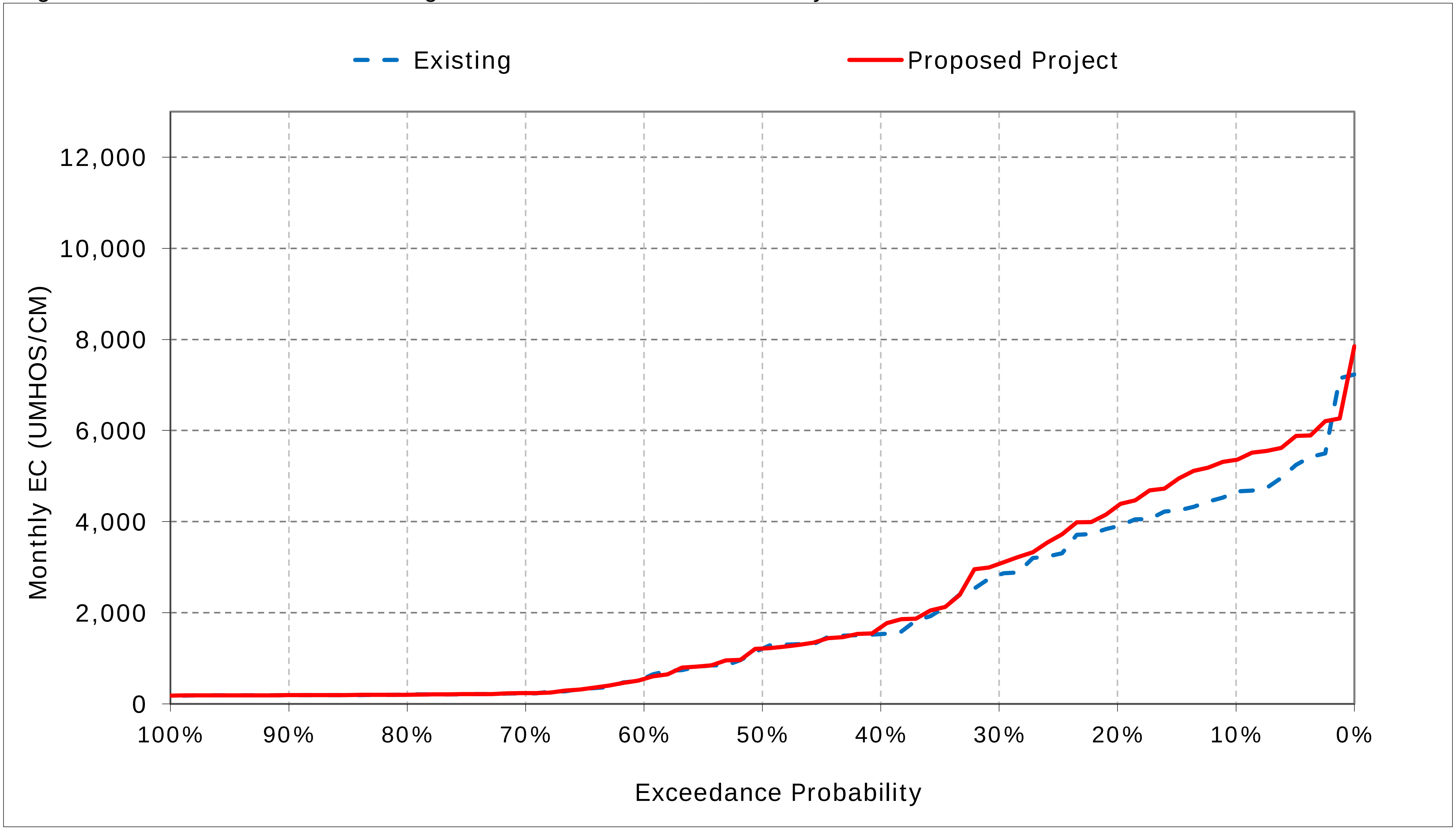


Figure 22-8. Montezuma Slough at National Steel, February EC

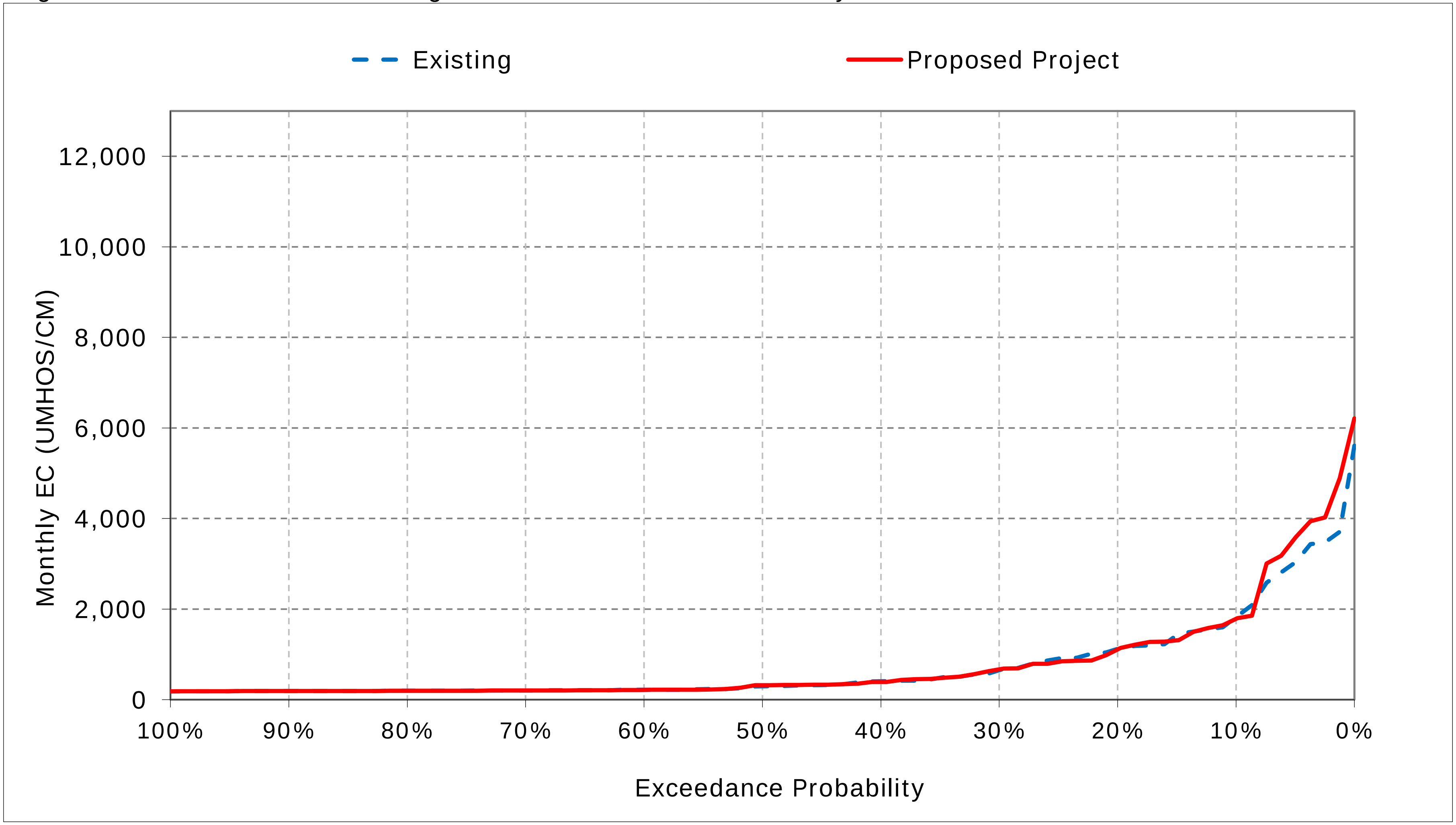


Figure 22-9. Montezuma Slough at National Steel, March EC

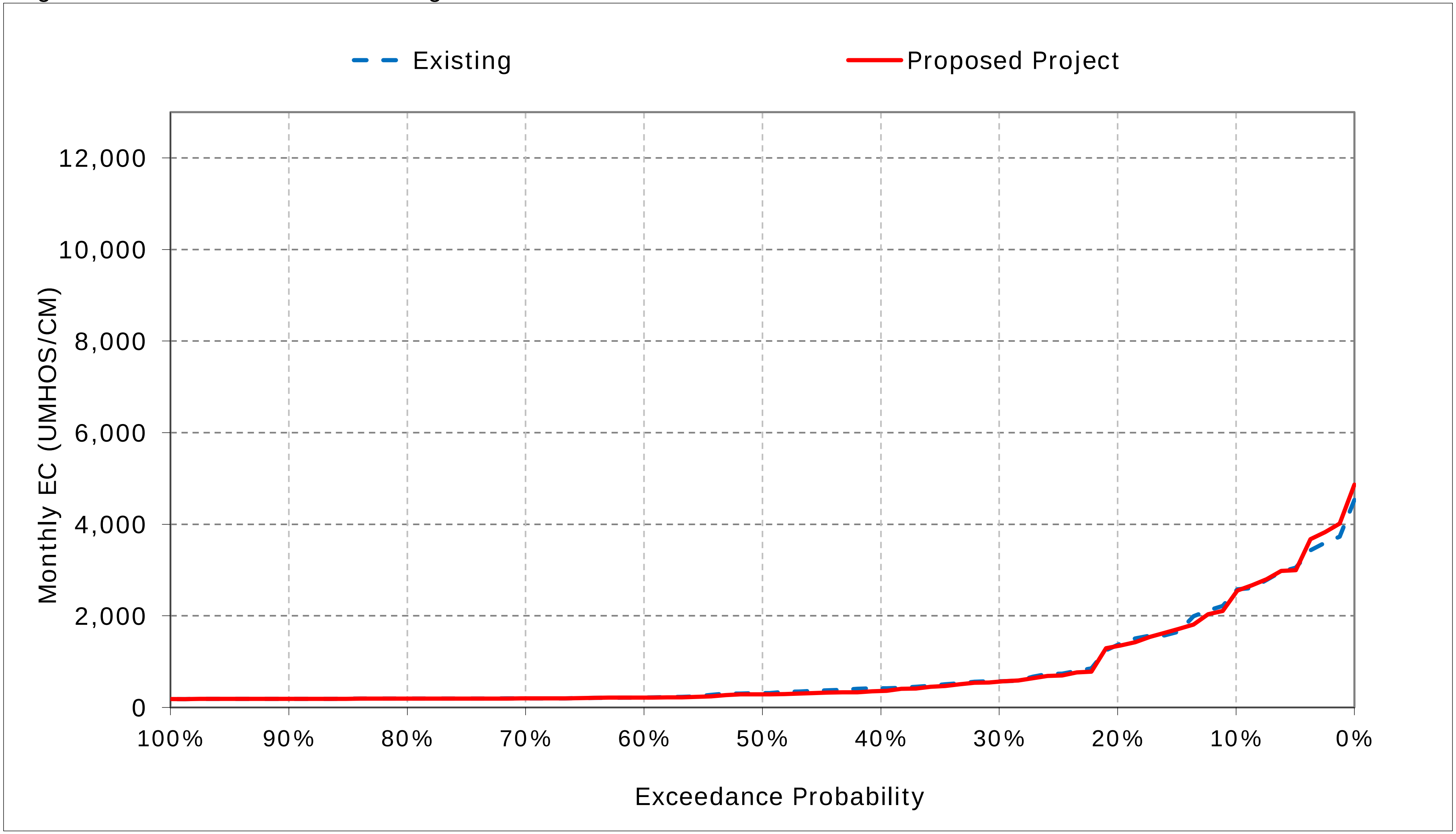


Figure 22-10. Montezuma Slough at National Steel, April EC

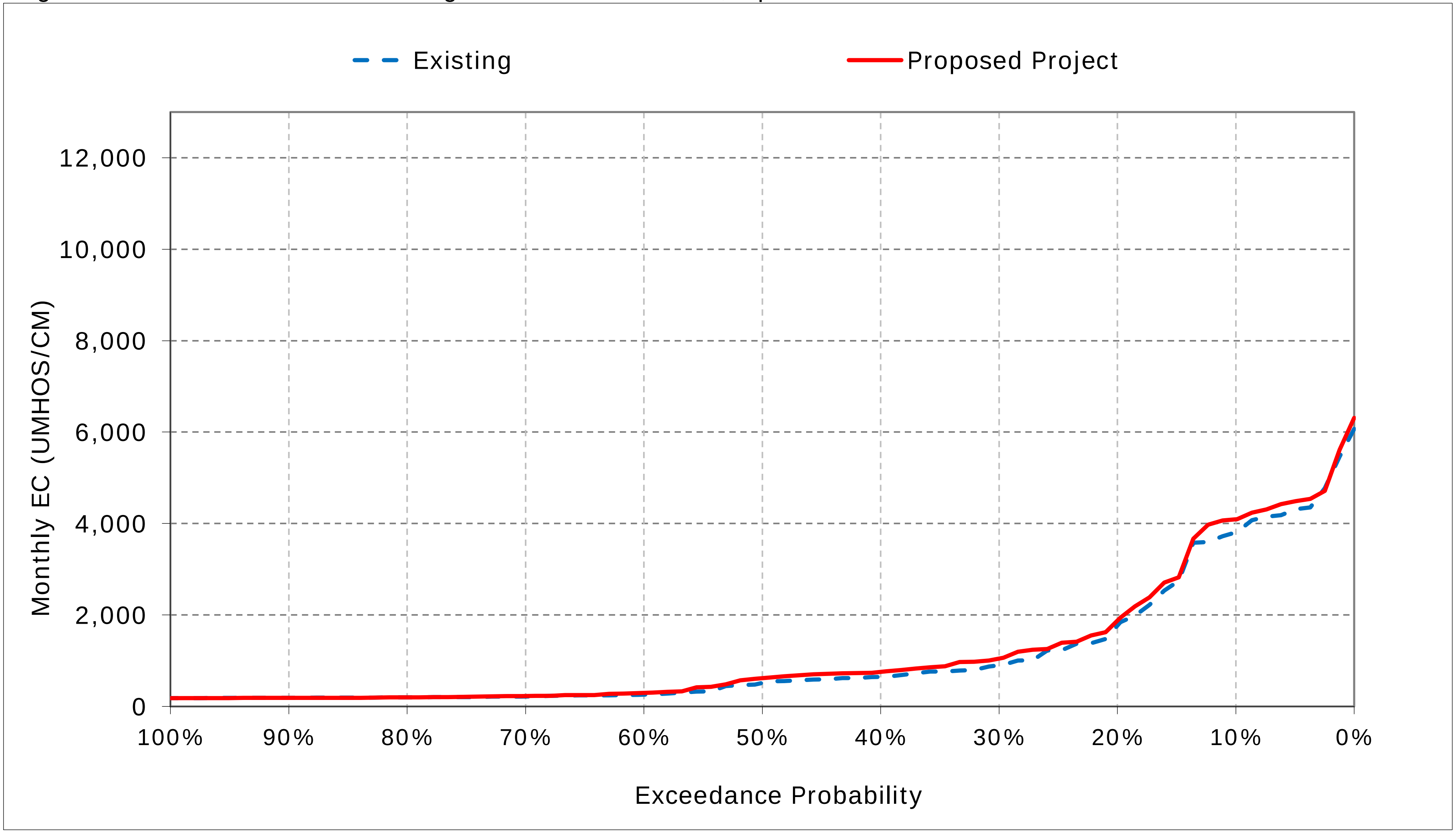


Figure 22-11. Montezuma Slough at National Steel, May EC

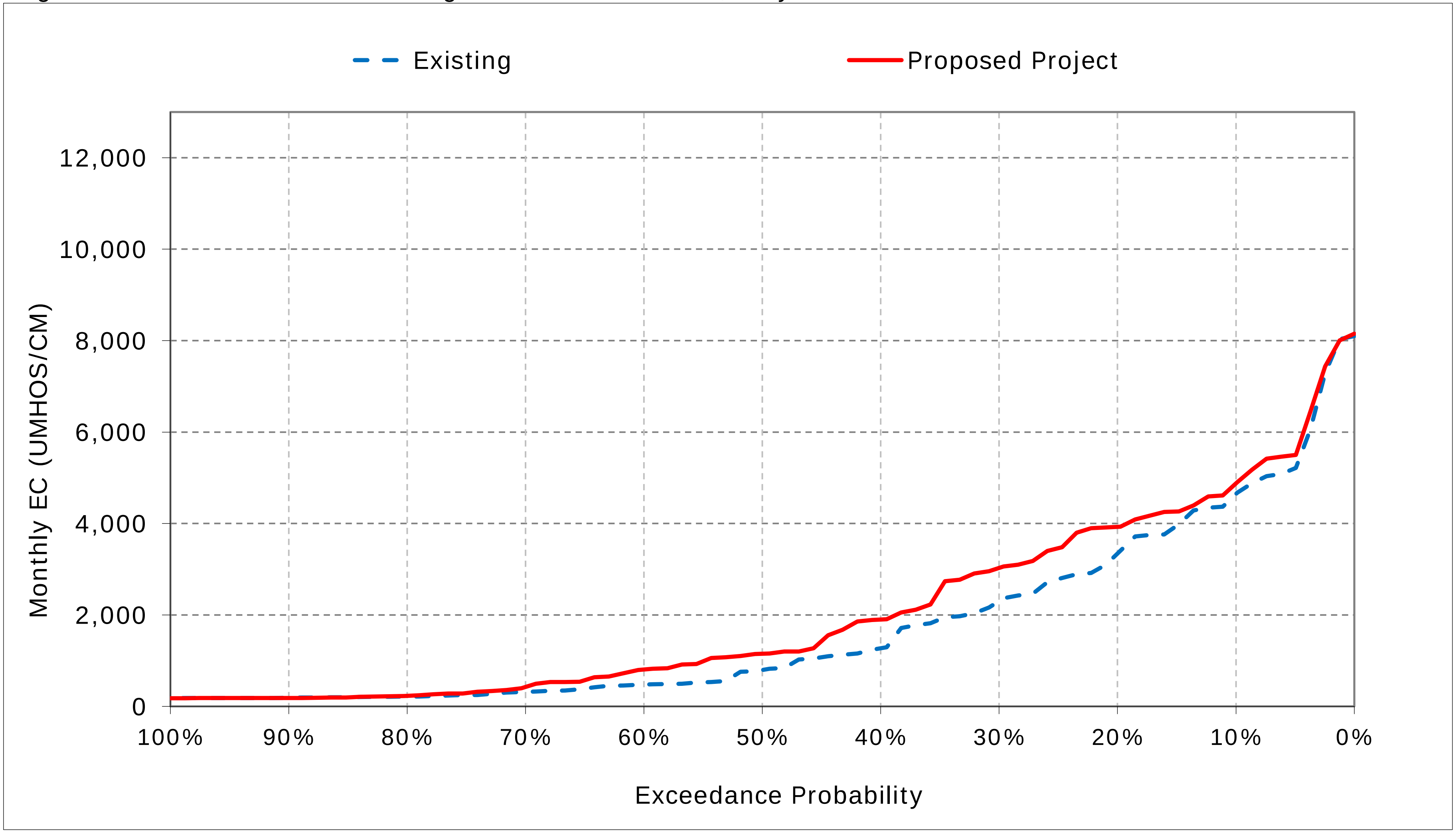


Figure 22-12. Montezuma Slough at National Steel, June EC

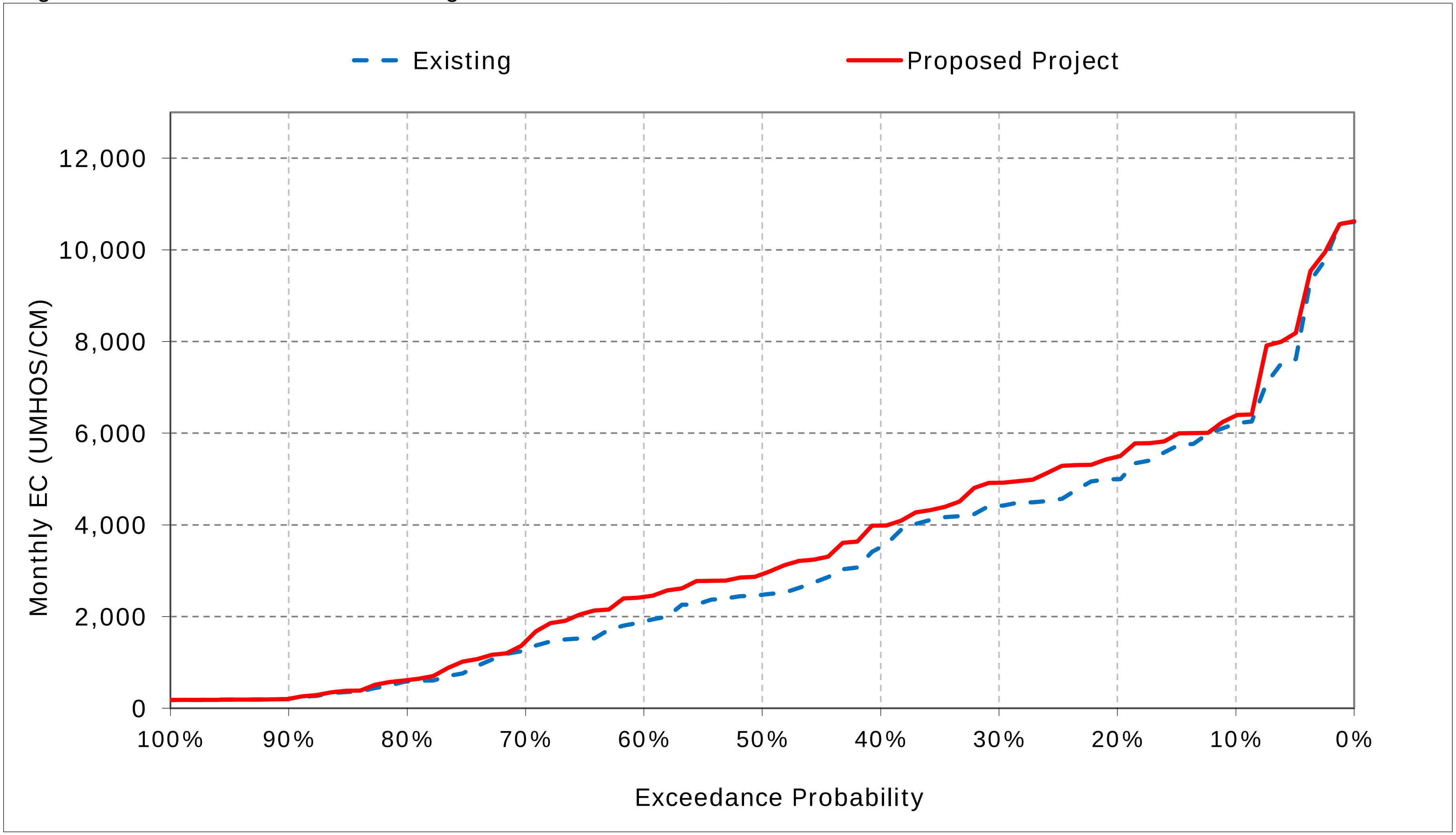


Figure 22-13. Montezuma Slough at National Steel, July EC

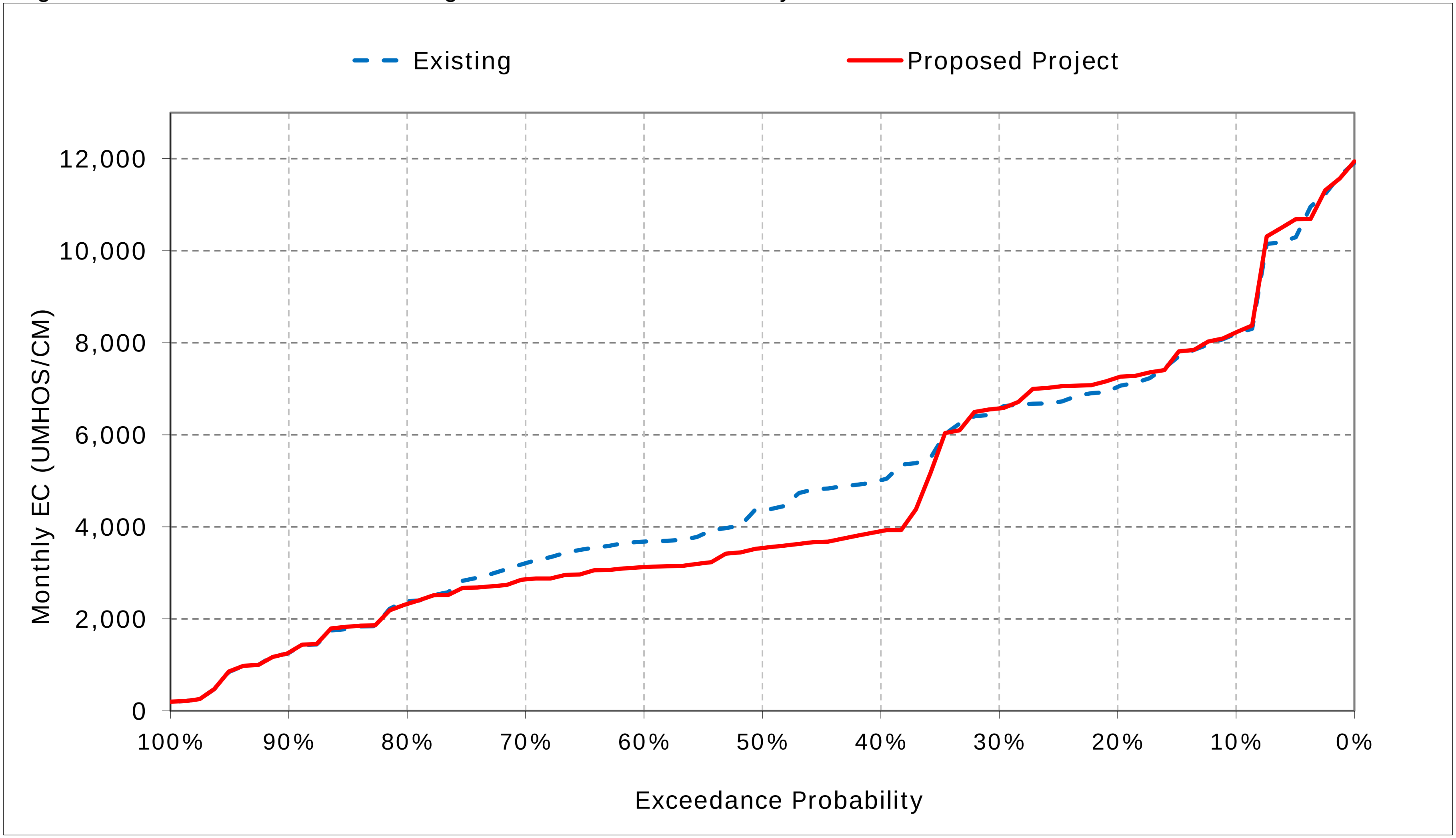


Figure 22-14. Montezuma Slough at National Steel, August EC

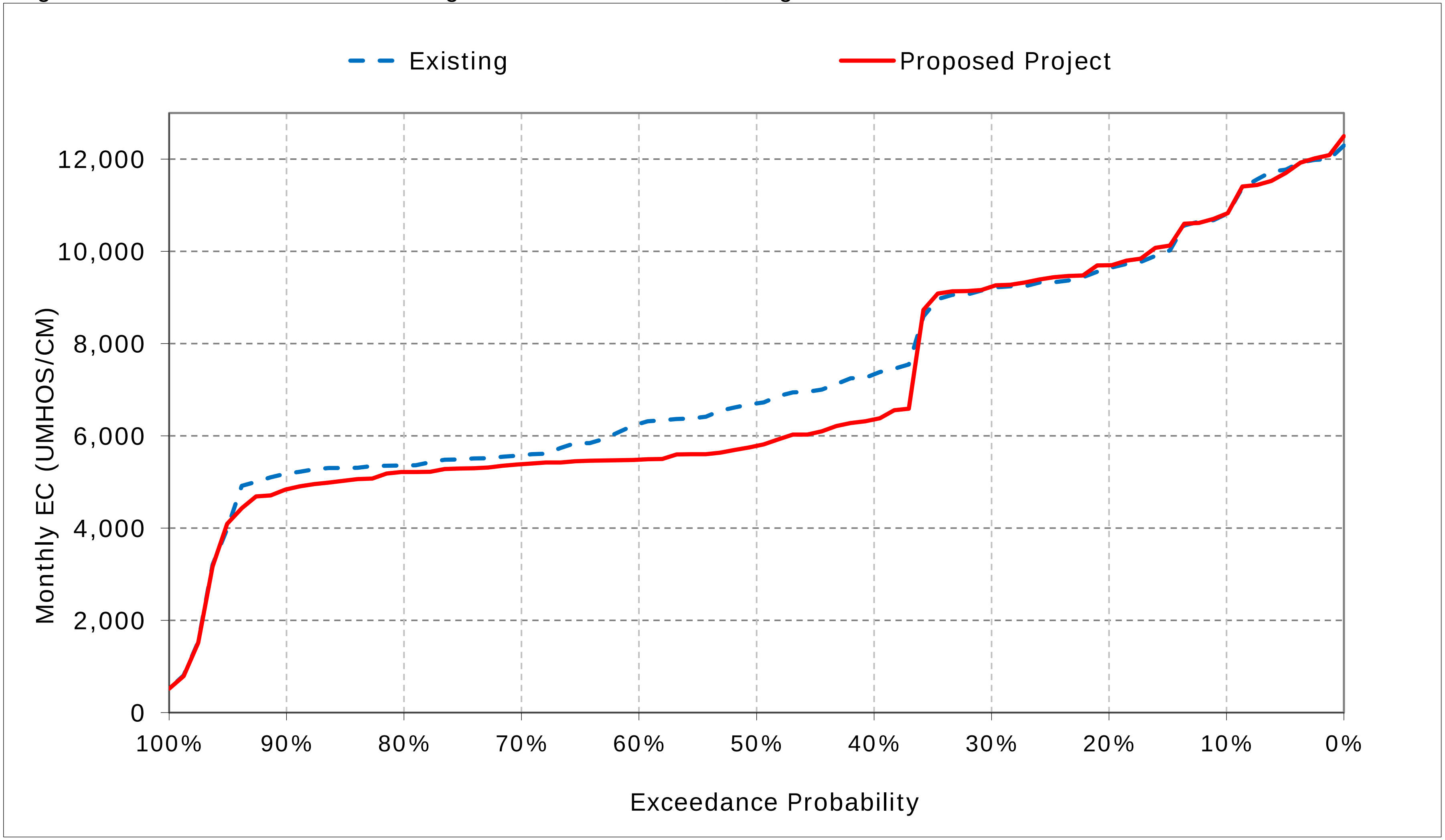


Figure 22-15. Montezuma Slough at National Steel, September EC

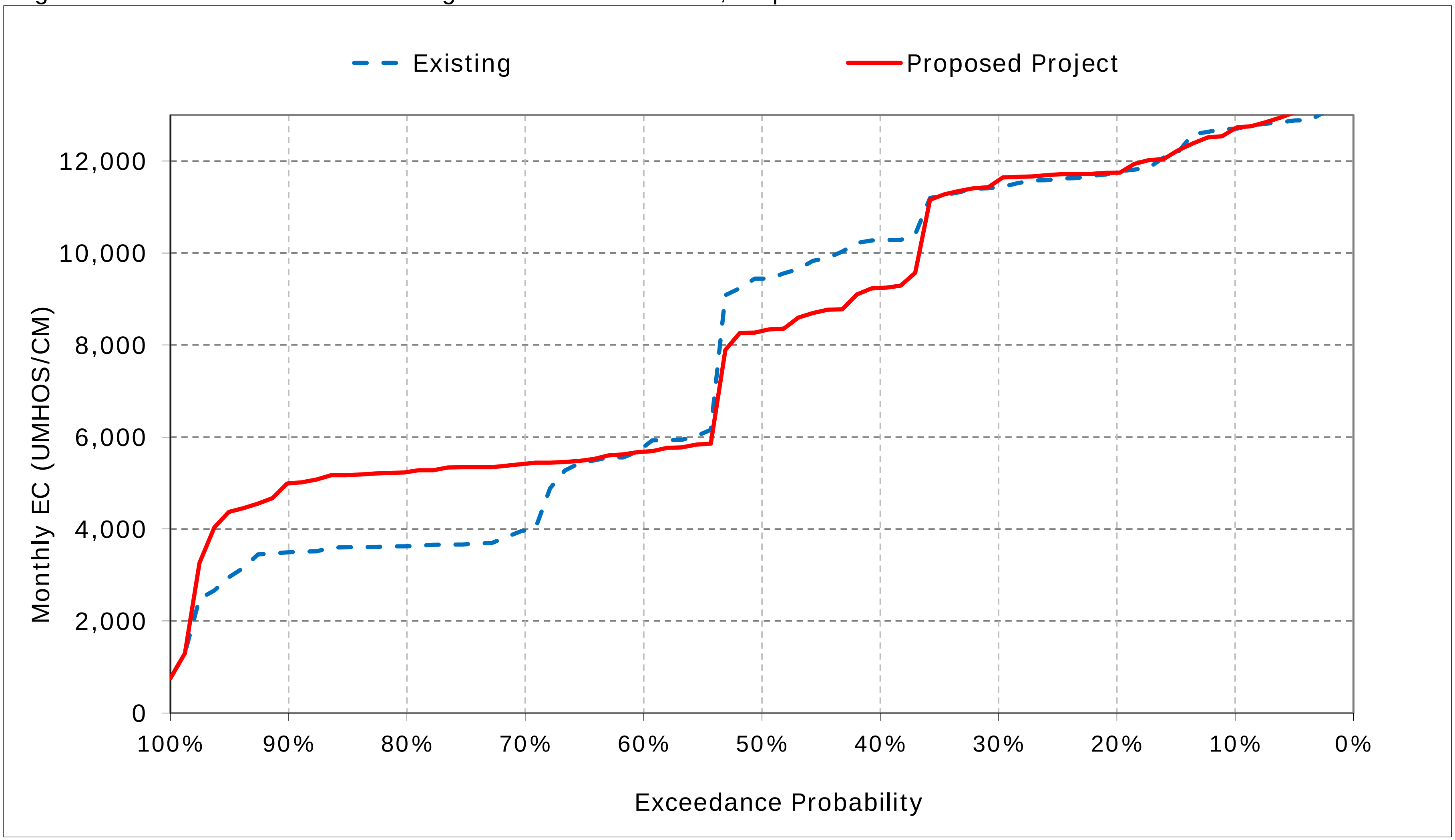


Figure 22-16. Montezuma Slough at National Steel, October EC

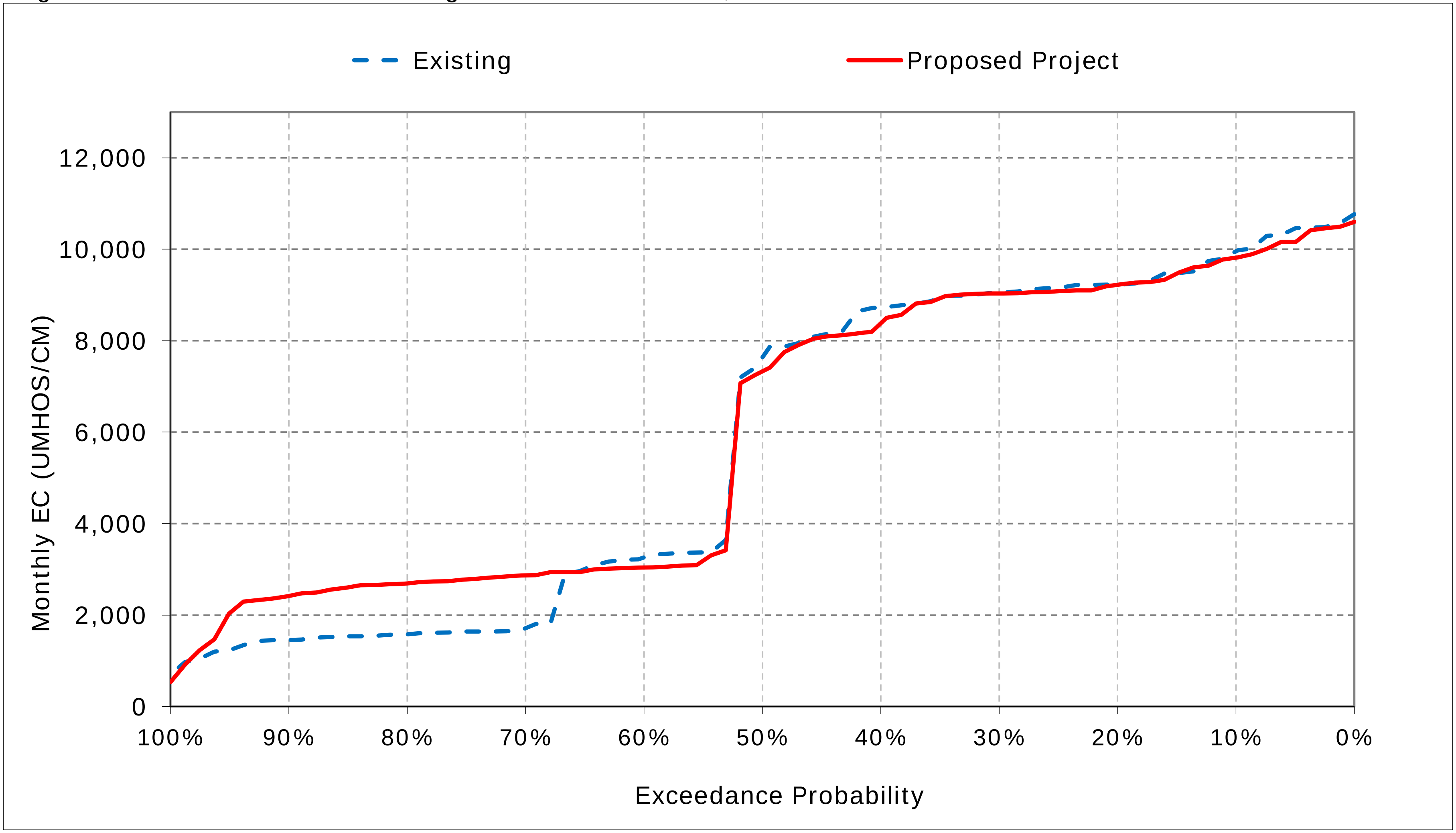


Figure 22-17. Montezuma Slough at National Steel, November EC

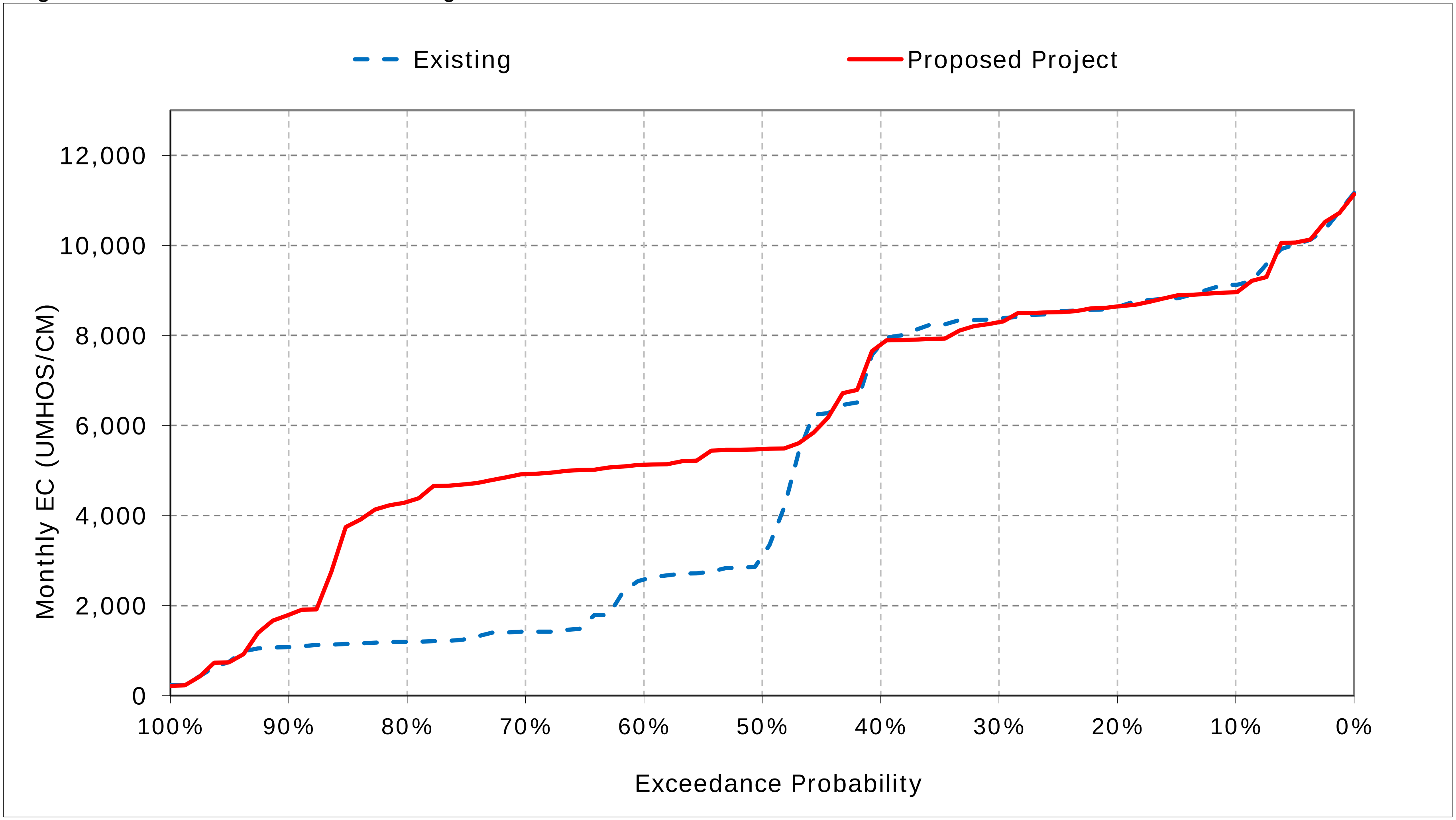


Figure 22-18. Montezuma Slough at National Steel, December EC

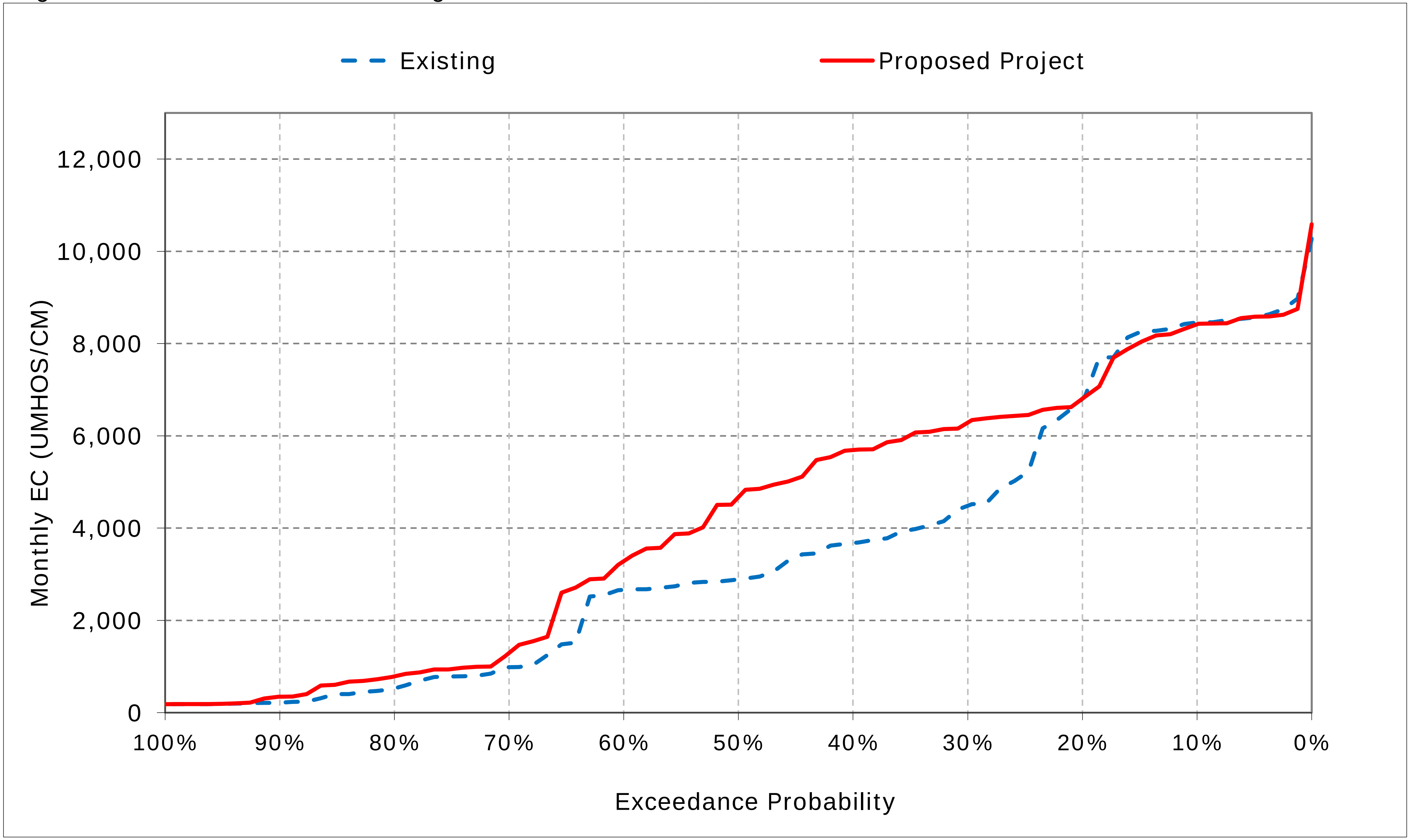


Table 24-1. Suisun Bay near Ryer, Monthly EC

Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	16,703	16,015	15,488	11,386	7,089	6,452	6,809	8,008	10,019	12,230	14,812	16,142
20%	16,148	15,774	14,171	10,495	4,725	3,858	3,849	6,638	8,637	11,068	13,505	15,448
30%	15,916	15,470	11,450	8,581	2,917	1,699	2,338	5,281	8,222	10,697	13,287	15,185
40%	15,735	14,990	9,986	5,728	1,498	1,354	1,874	3,479	7,141	8,868	11,631	14,351
50%	14,602	9,441	8,019	4,311	971	778	1,301	2,191	5,868	8,434	10,884	13,391
60%	8,926	8,249	7,489	2,674	460	410	657	1,505	4,956	6,859	10,648	8,464
70%	5,620	5,430	3,989	611	227	232	375	901	3,747	6,559	10,126	5,357
80%	5,344	5,115	1,942	256	209	200	235	424	2,021	5,757	9,751	4,985
90%	5,183	4,760	700	200	195	193	194	203	408	3,978	9,429	4,569
Long Term												
Full Simulation Period[a]	11,389	10,451	8,186	5,114	2,419	1,908	2,260	3,446	5,856	8,256	11,405	10,801
Water Year Types[b]												
Wet (32%)	9,330	7,468	3,198	977	293	340	467	836	2,318	4,779	9,075	4,646
Above Normal (15%)	11,798	10,318	8,360	3,352	937	390	637	1,293	4,323	6,367	9,917	8,307
Below Normal (17%)	11,868	11,458	10,147	5,928	1,744	1,595	1,737	2,893	5,947	8,438	11,257	13,867
Dry (22%)	11,938	11,818	10,281	8,042	4,052	2,794	3,382	5,287	8,126	10,864	13,402	15,325
Critical (15%)	14,060	13,820	13,391	10,499	6,844	5,860	6,696	9,139	11,546	13,558	15,118	16,271

Proposed Project

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	16,640	16,023	15,483	12,591	7,000	6,423	7,154	8,388	10,051	12,236	14,822	16,123
20%	16,110	15,757	14,007	11,228	4,178	3,775	4,671	7,478	9,177	11,175	13,611	15,482
30%	15,918	15,377	13,297	9,190	2,893	1,587	2,964	6,411	8,300	10,711	13,337	15,297
40%	15,481	14,734	12,738	6,090	1,592	1,231	2,245	4,483	7,908	8,938	12,004	14,543
50%	14,449	11,770	11,732	4,377	904	688	1,506	3,181	6,299	8,257	11,007	13,456
60%	8,422	11,447	9,765	2,589	358	343	775	2,396	5,674	6,815	10,509	8,117
70%	8,246	11,267	4,902	613	226	225	488	1,442	4,031	6,612	10,053	7,946
80%	7,940	10,794	2,896	249	211	202	245	574	2,136	5,791	9,718	7,686
90%	7,593	6,276	819	200	196	193	193	211	426	3,984	9,291	7,269
Long Term												
Full Simulation Period[a]	12,004	12,244	9,347	5,350	2,483	1,862	2,509	4,055	6,180	8,286	11,435	11,576
Water Year Types[b]												
Wet (32%)	10,137	9,796	3,991	973	282	322	594	1,225	2,634	4,804	8,963	7,183
Above Normal (15%)	12,551	12,361	10,093	3,477	770	348	835	2,021	4,655	6,305	9,954	7,821
Below Normal (17%)	12,515	13,173	11,523	5,965	1,660	1,462	2,104	3,834	6,295	8,485	11,523	14,012
Dry (22%)	12,578	13,312	11,625	8,655	4,302	2,678	3,739	6,076	8,522	10,944	13,466	15,374
Critical (15%)	14,045	14,747	14,250	11,030	7,199	5,957	6,957	9,449	11,739	13,592	15,122	16,309

Proposed Project minus Existing

Statistic	Monthly EC (UMHOS/CM)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-63	8	-4	1,205	-89	-29	345	379	32	7	10	-19
20%	-37	-17	-164	733	-546	-84	822	840	540	107	106	34
30%	2	-93	1,847	609	-24	-112	626	1,130	77	14	50	112
40%	-254	-256	2,752	362	93	-123	371	1,004	767	71	373	192
50%	-154	2,329	3,713	66	-67	-91	205	989	432	-177	123	65
60%	-504	3,197	2,276	-85	-102	-68	117	892	718	-44	-139	-347
70%	2,626	5,838	913	2	-2	-7	113	541	285	53	-73	2,588
80%	2,596	5,679	954	-7	1	2	10	150	115	34	-33	2,701
90%	2,410	1,517	120	0	1	0	-1	9	18	5	-139	2,700
Long Term												
Full Simulation Period[a]	615	1,794	1,161	236	64	-46	249	609	323	29	30	775
Water Year Types[b]												
Wet (32%)	806	2,329	793	-4	-11	-19	127	389	316	25	-112	2,537
Above Normal (15%)	754	2,043	1,733	125	-167	-42	198	728	332	-62	37	-486
Below Normal (17%)	647	1,715	1,375	37	-84	-134	367	940	348	47	266	145
Dry (22%)	640	1,494	1,344	614	250	-116	358	789	395	80	64	49
Critical (15%)	-15	927	859	530	355	97	260	310	193	34	4	38

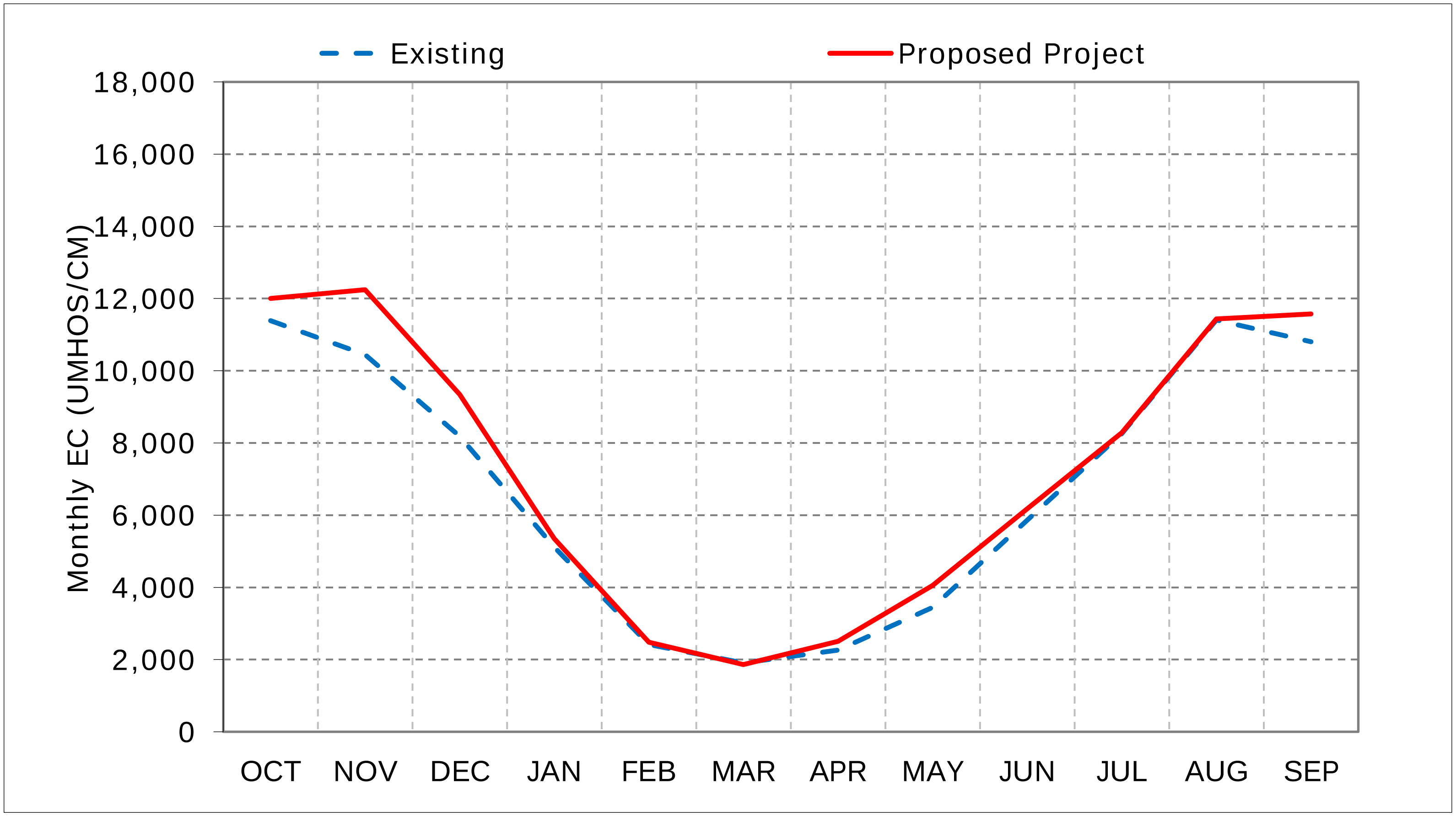
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

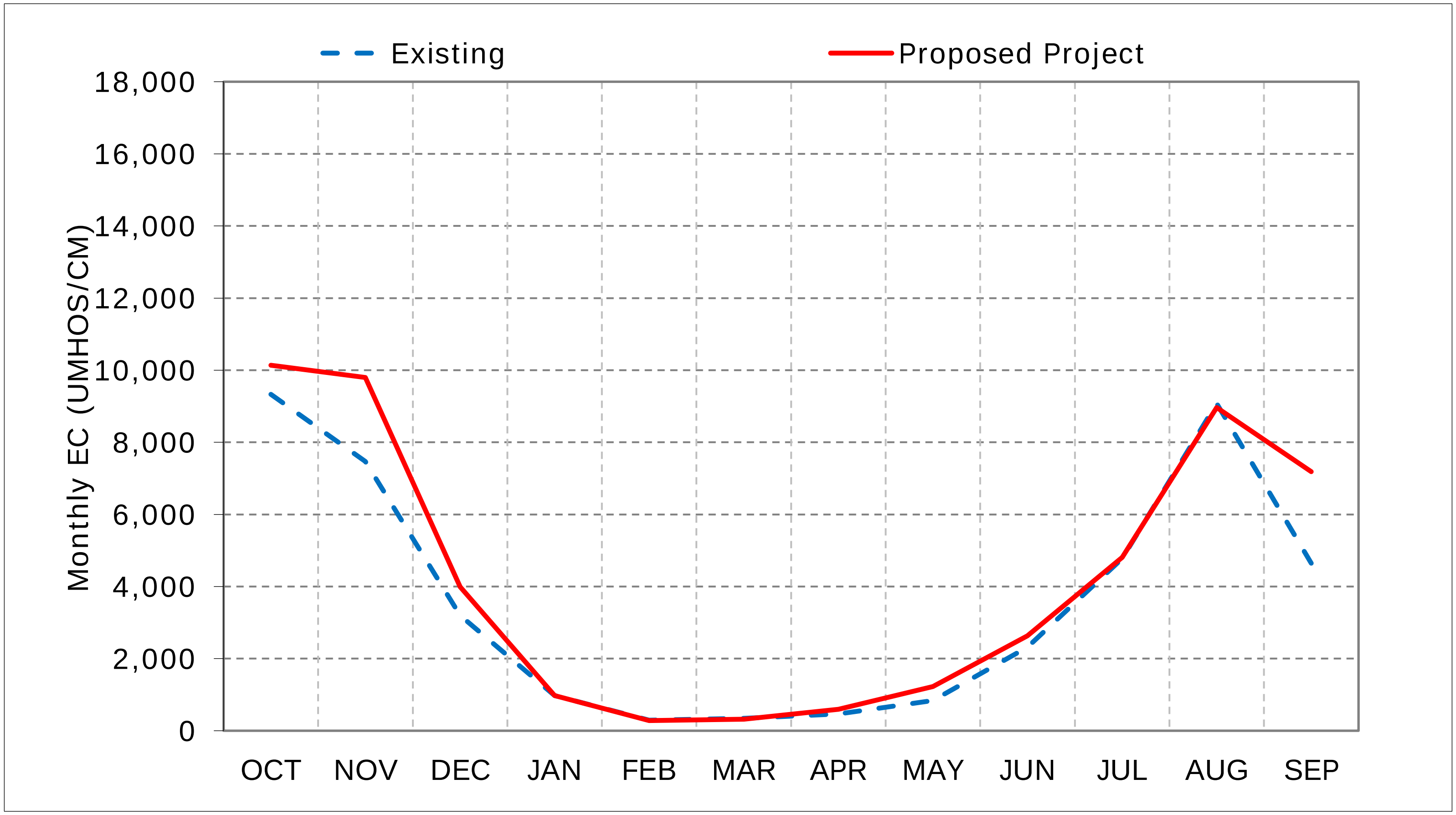
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 24-1. Suisun Bay near Ryer, Long-Term Average EC



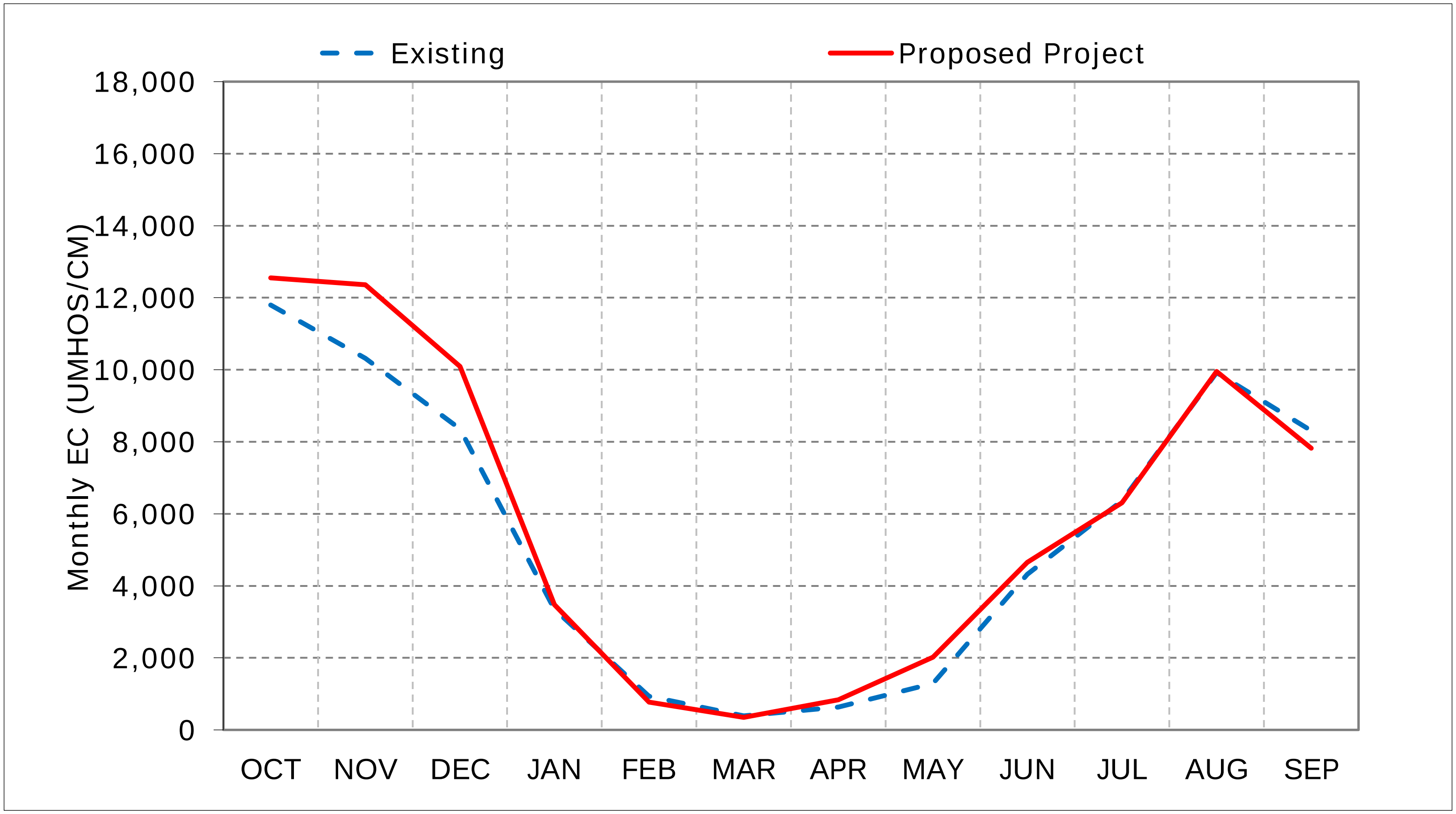
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 24-2. Suisun Bay near Ryer, Wet Year Average EC



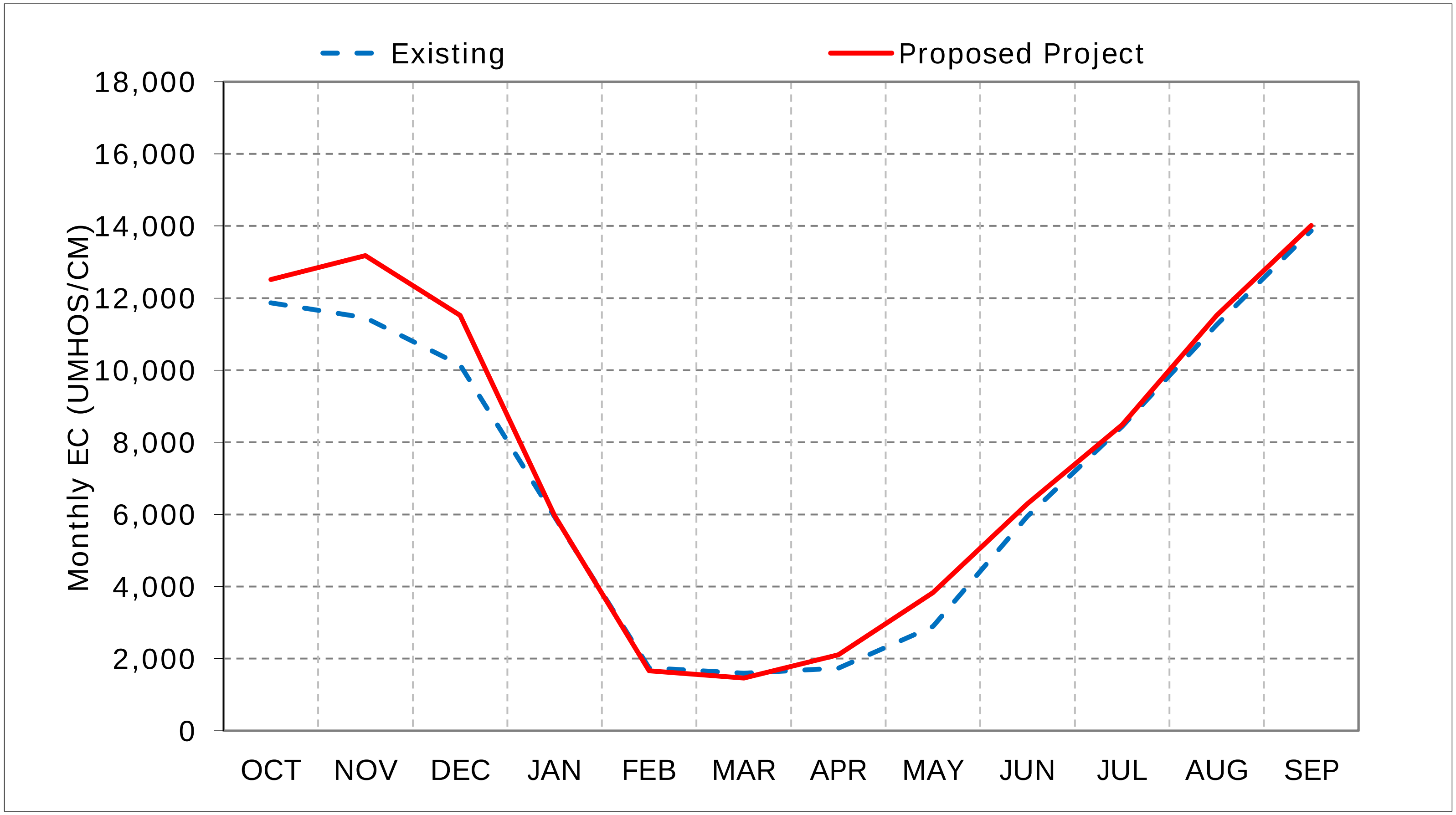
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 24-3. Suisun Bay near Ryer, Above Normal Year Average EC



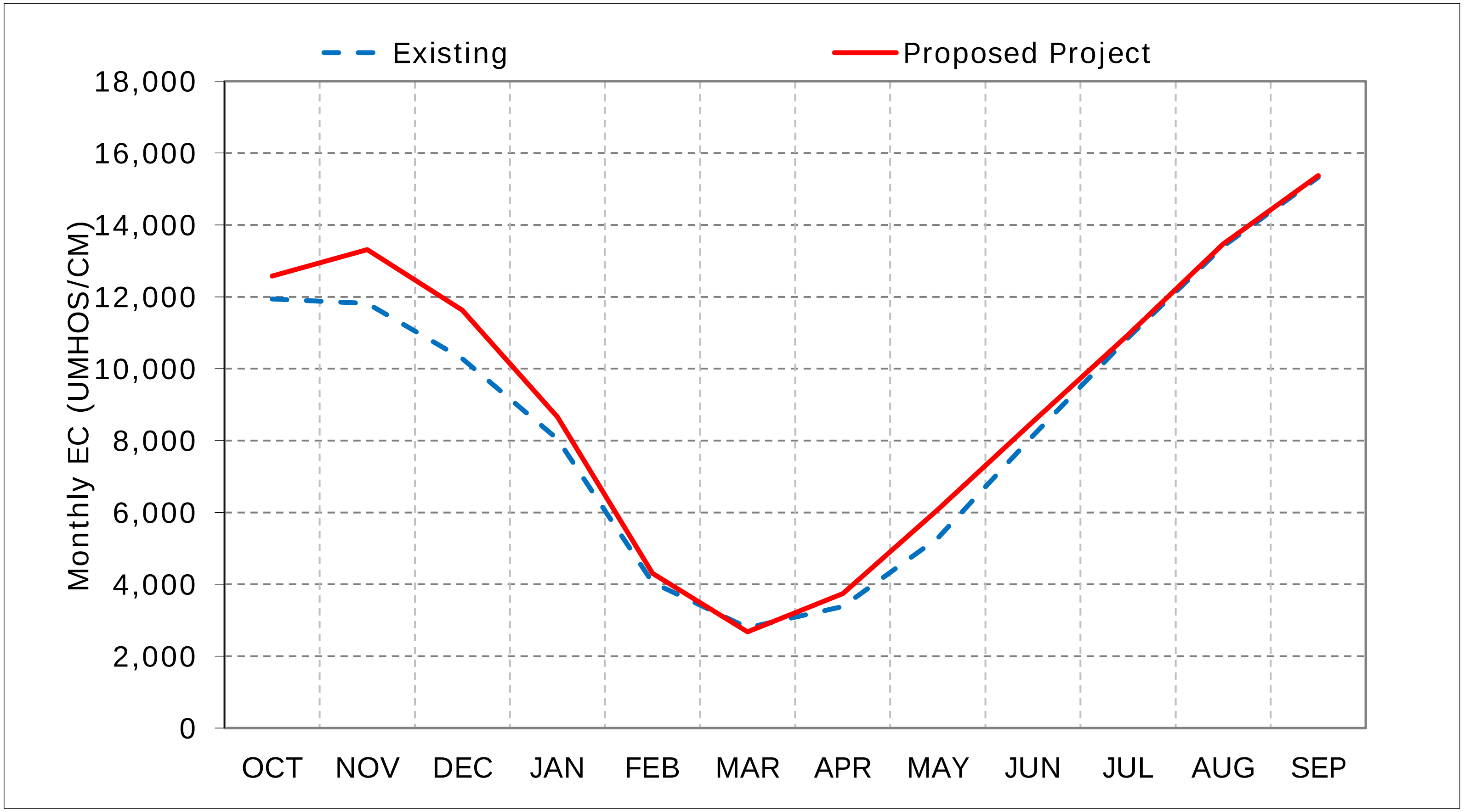
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 24-4. Suisun Bay near Ryer, Below Normal Year Average EC



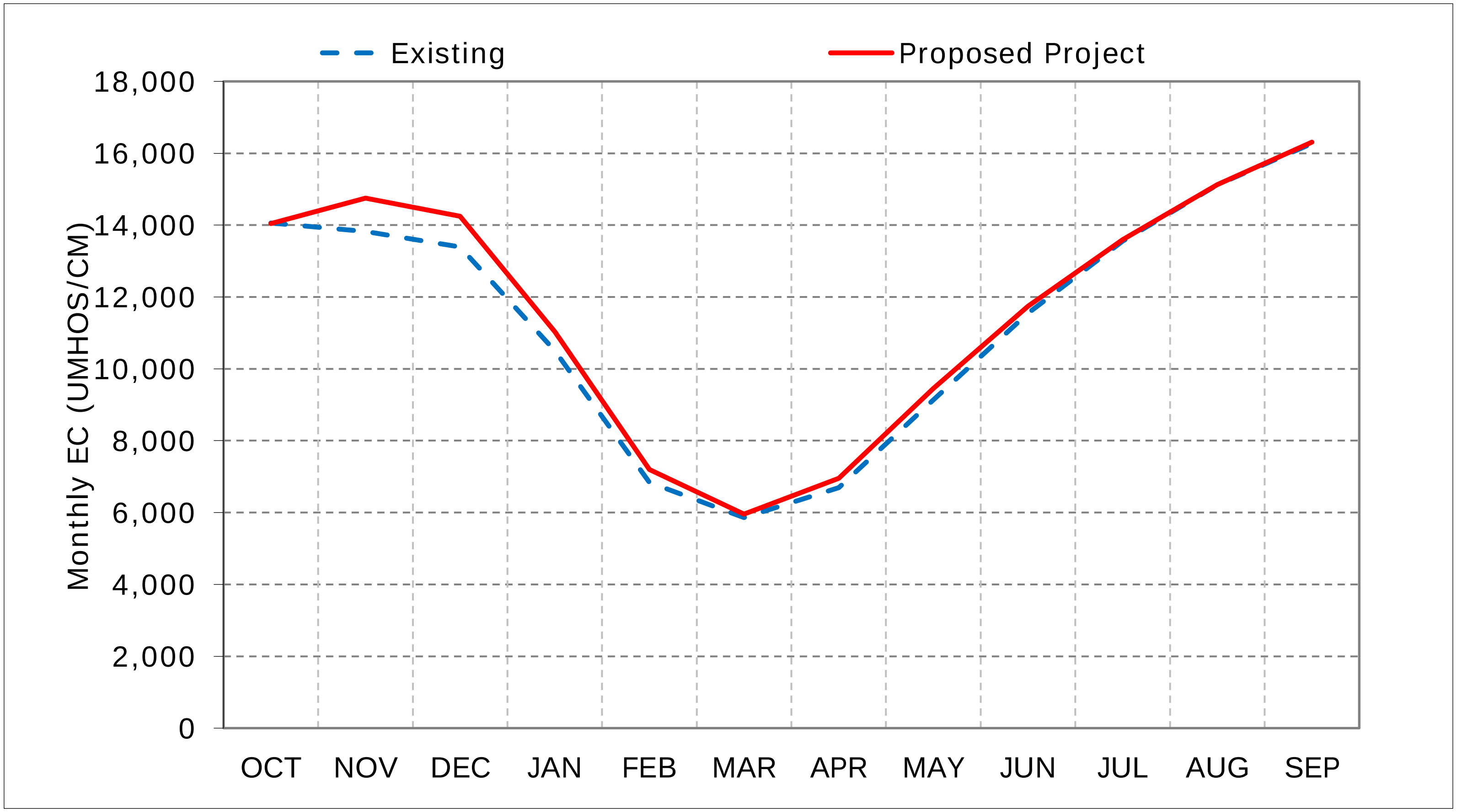
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 24-5. Suisun Bay near Ryer, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 24-6. Suisun Bay near Ryer, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 24-7. Suisun Bay near Ryer, January EC

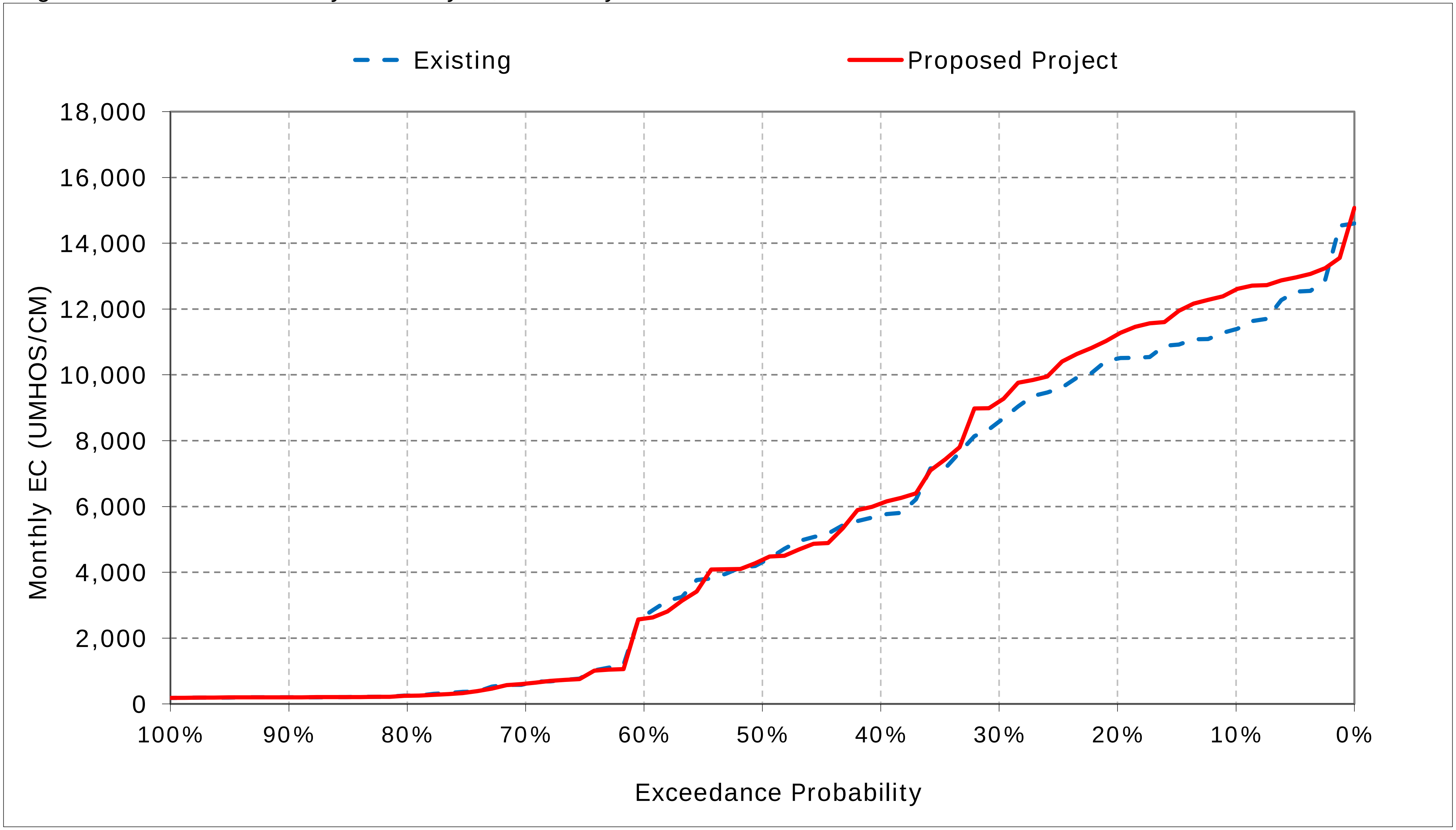


Figure 24-8. Suisun Bay near Ryer, February EC

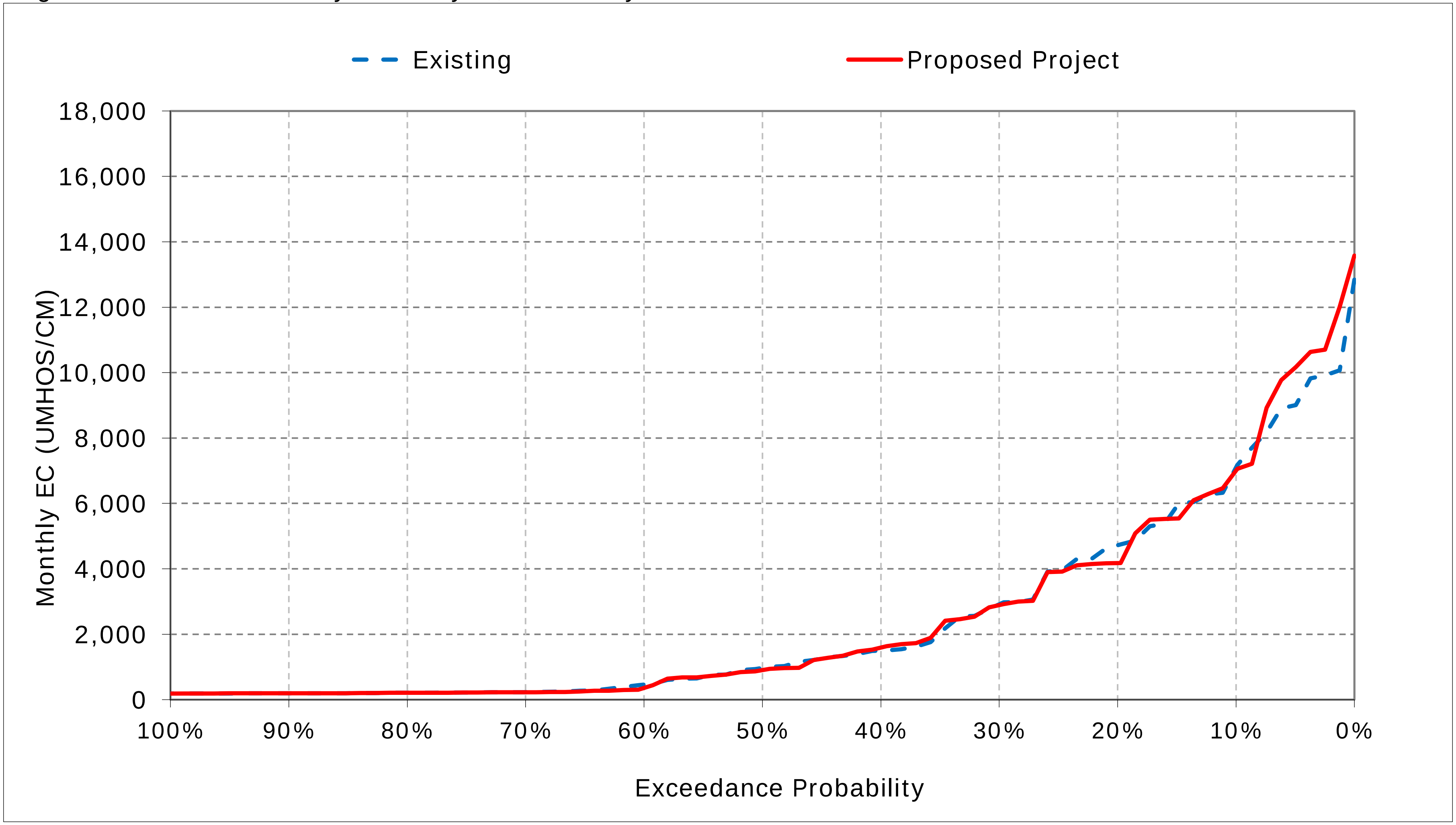


Figure 24-9. Suisun Bay near Ryer, March EC

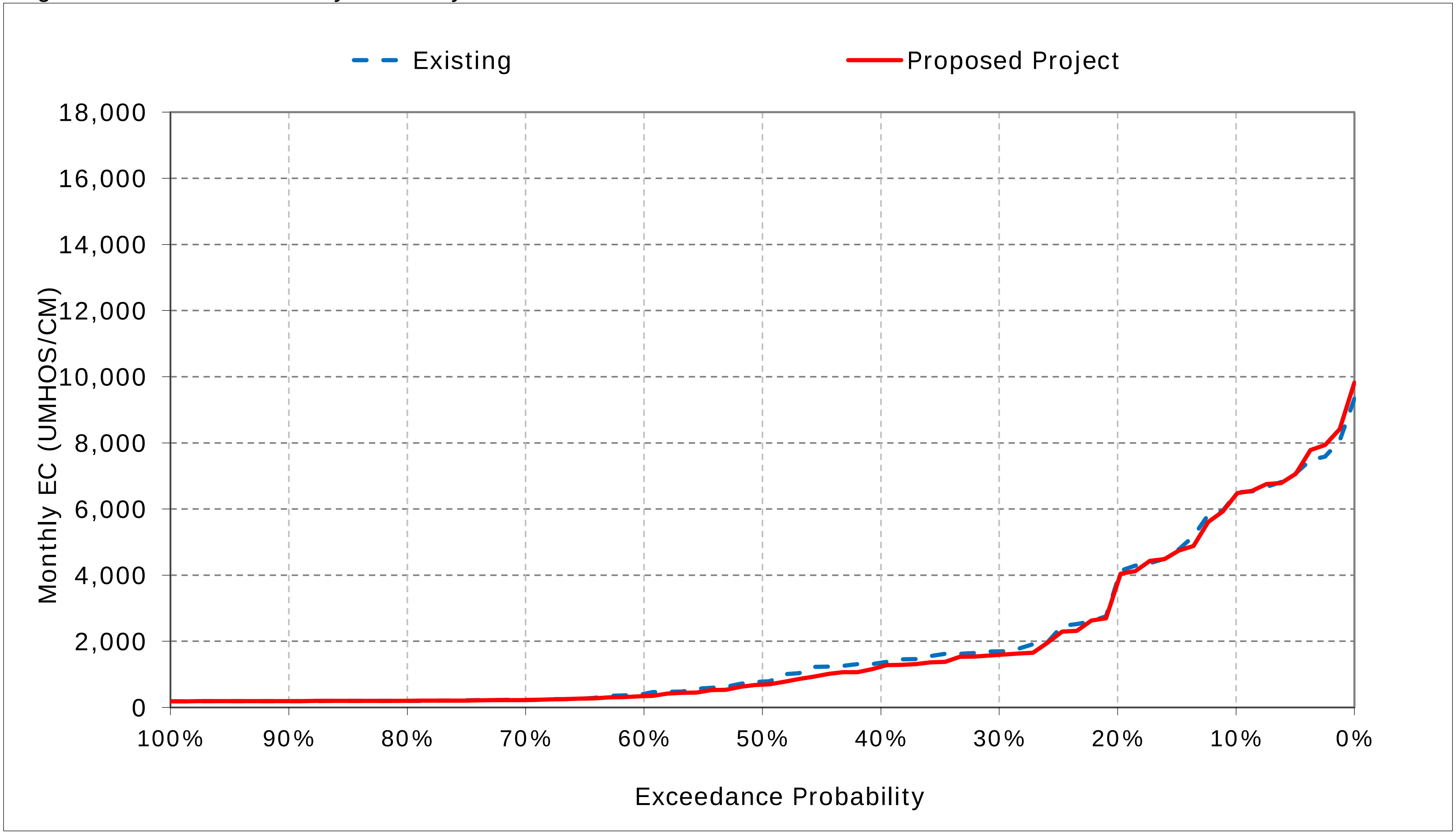


Figure 24-10. Suisun Bay near Ryer, April EC

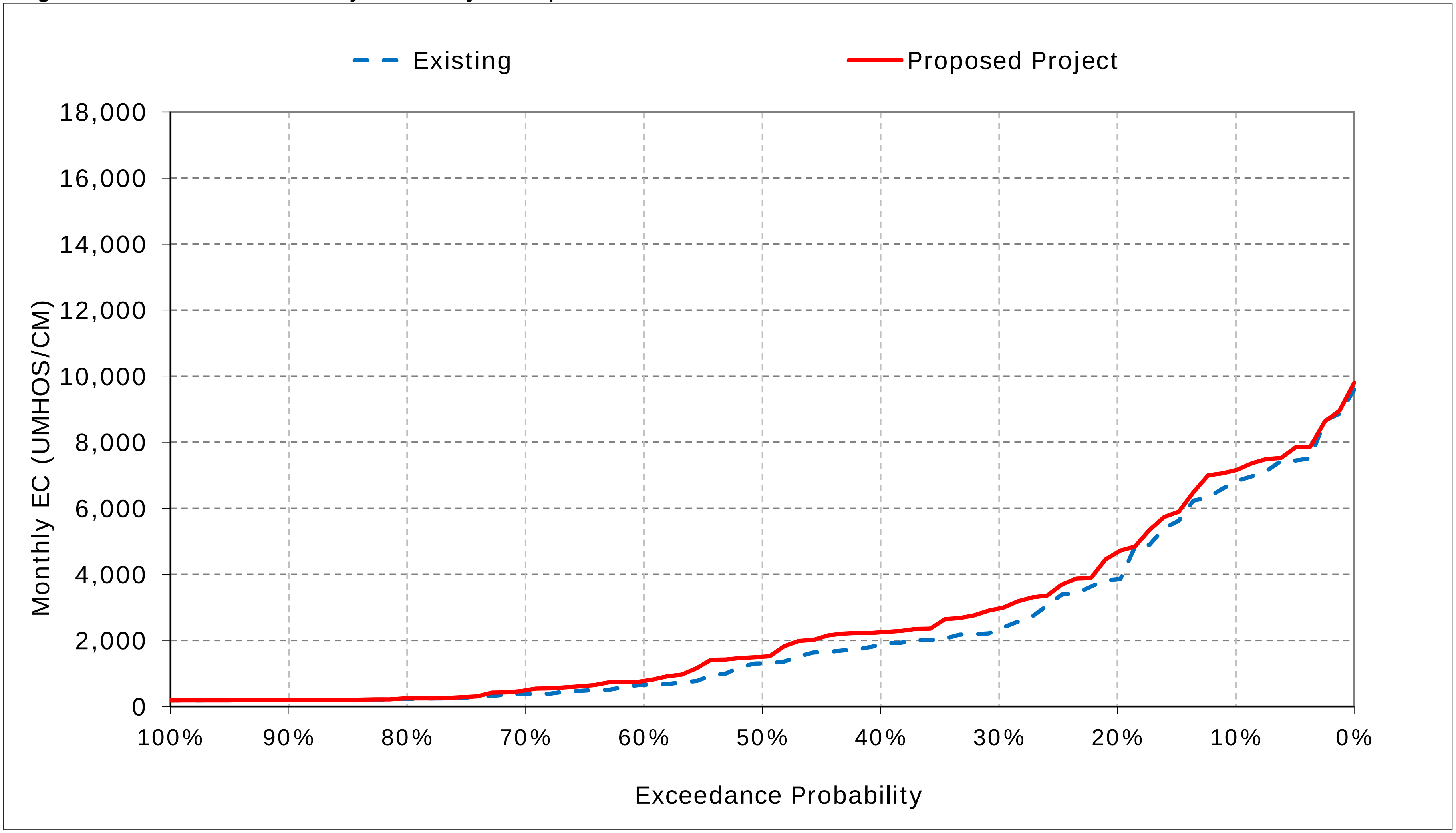


Figure 24-11. Suisun Bay near Ryer, May EC

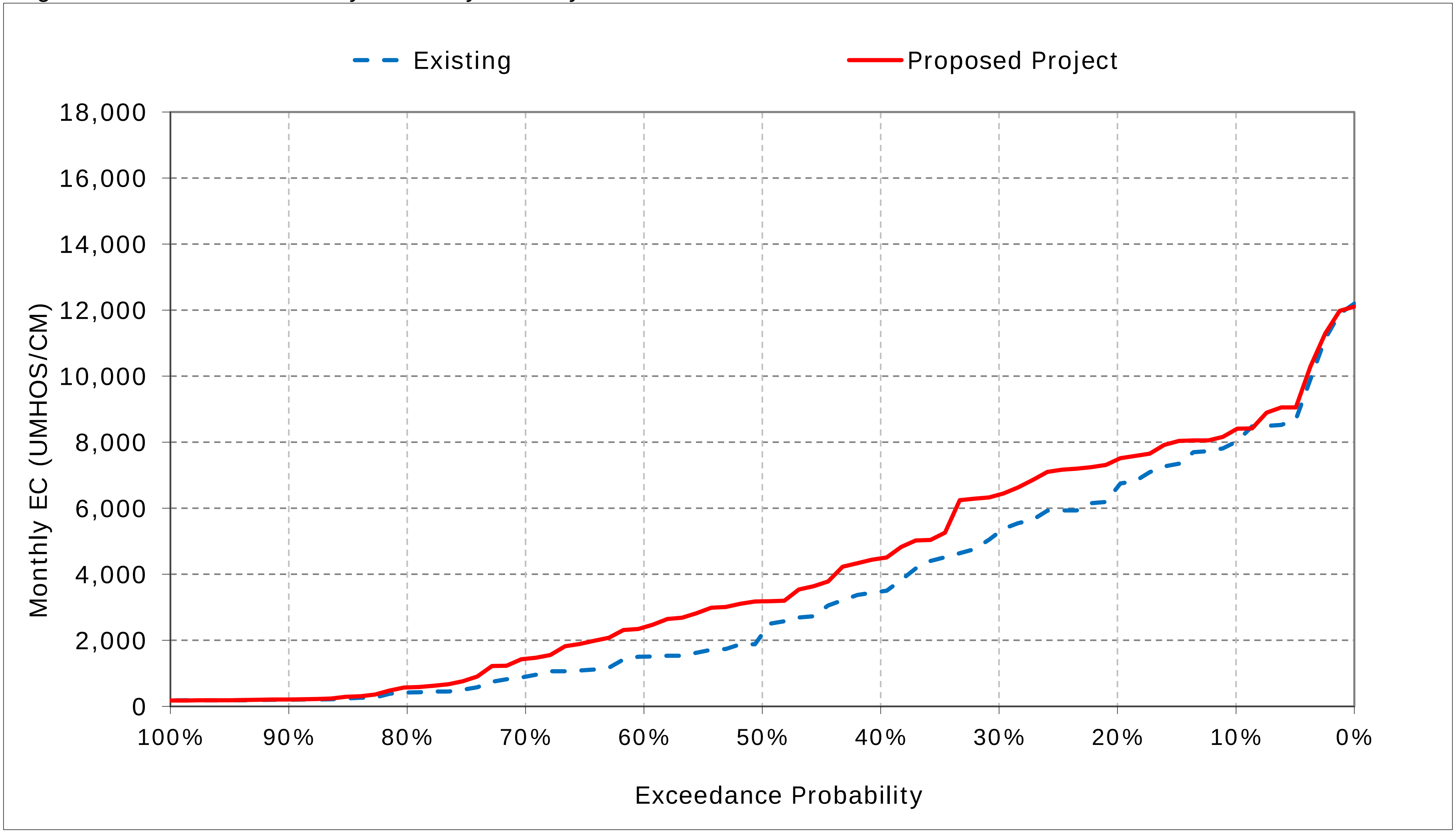


Figure 24-12. Suisun Bay near Ryer, June EC

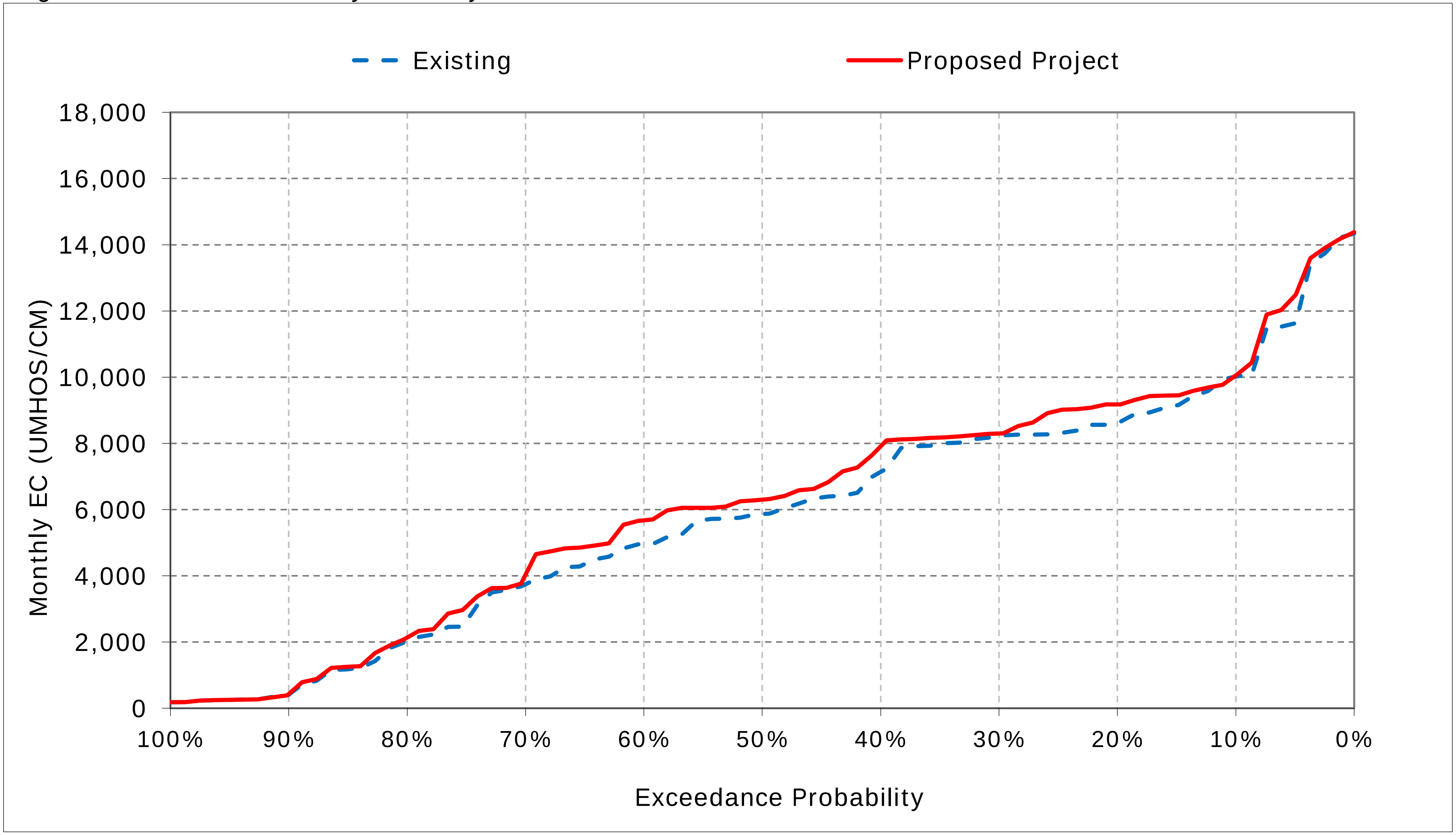


Figure 24-13. Suisun Bay near Ryer, July EC

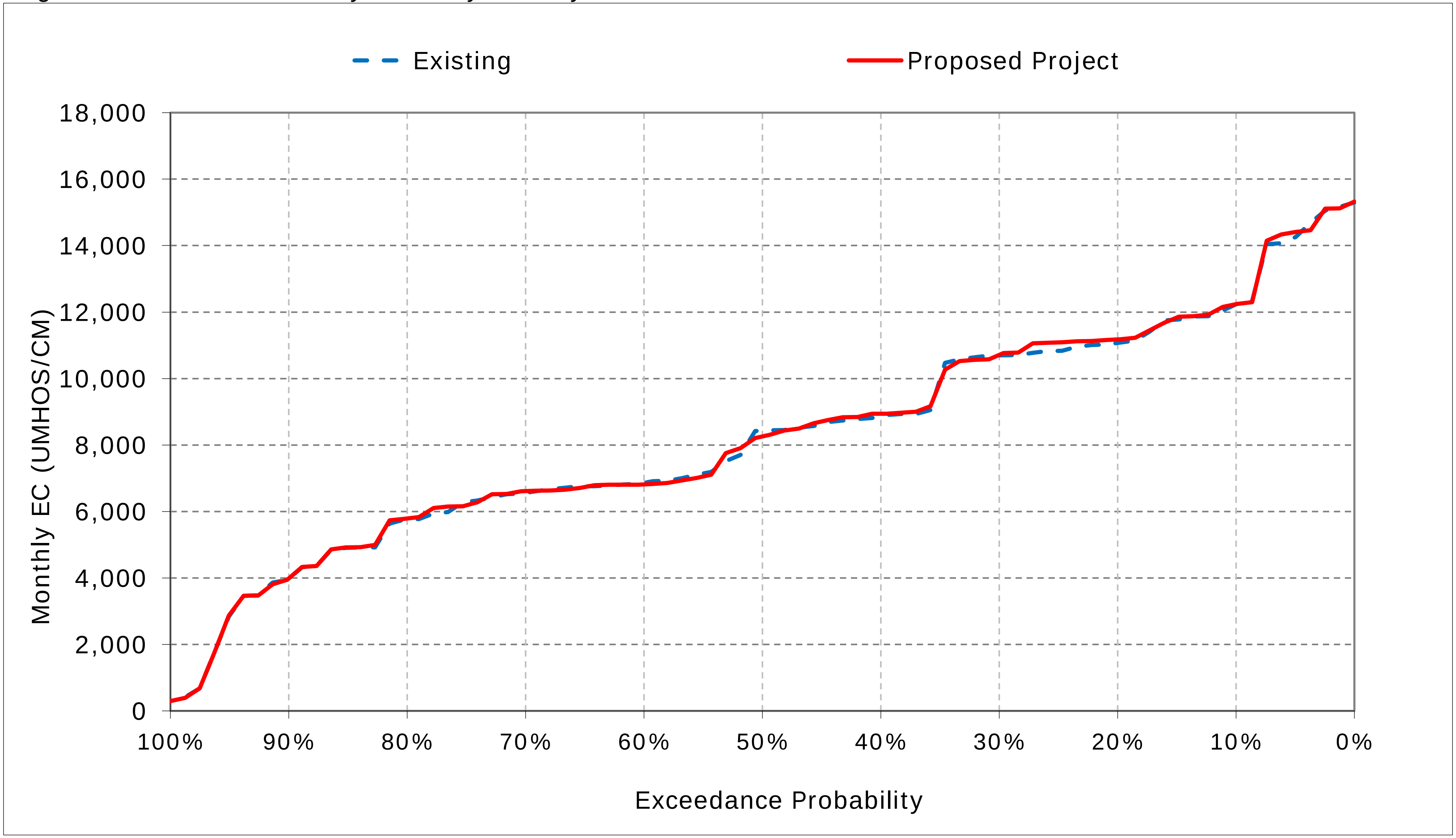


Figure 24-14. Suisun Bay near Ryer, August EC

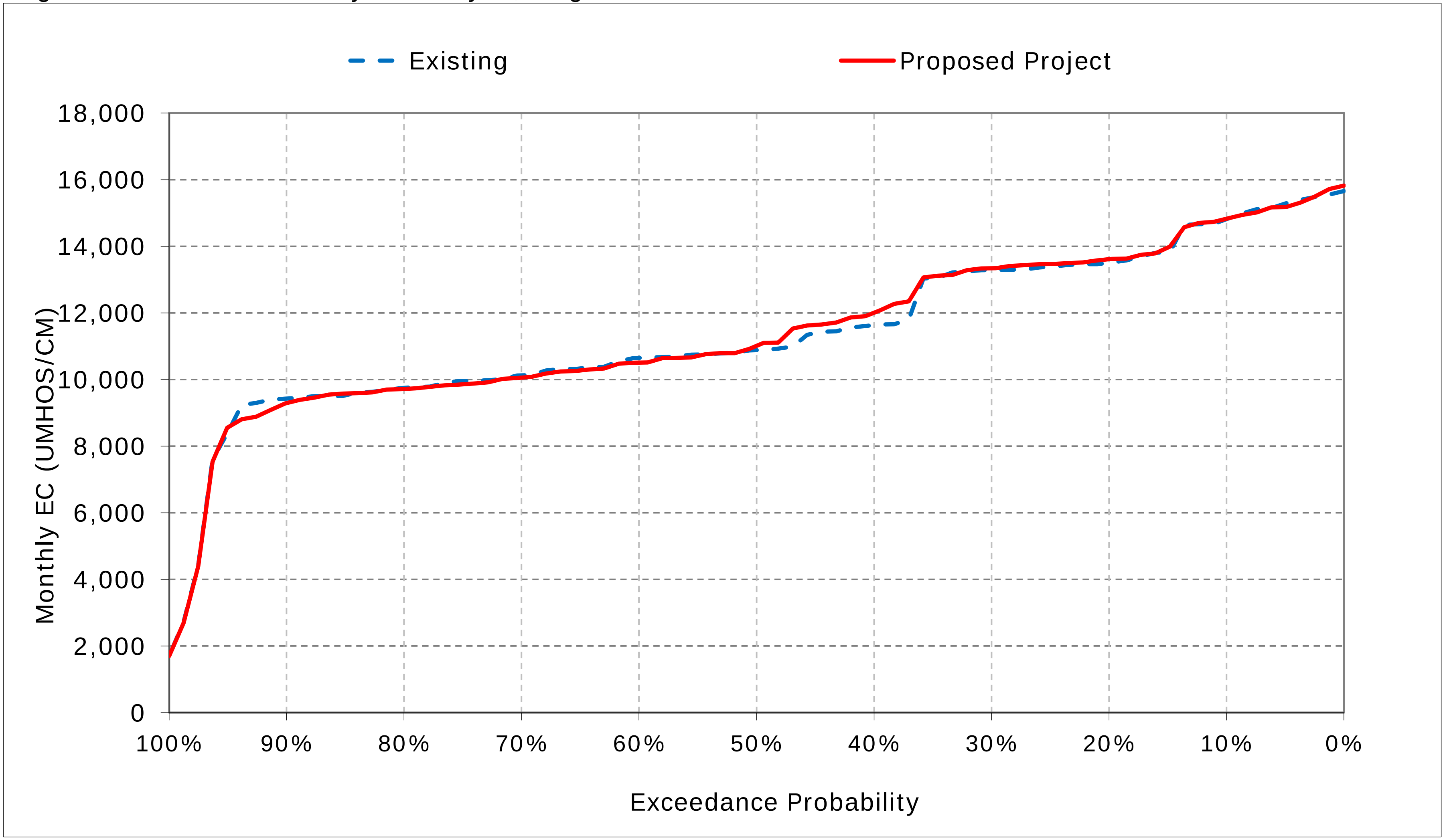


Figure 24-15. Suisun Bay near Ryer, September EC

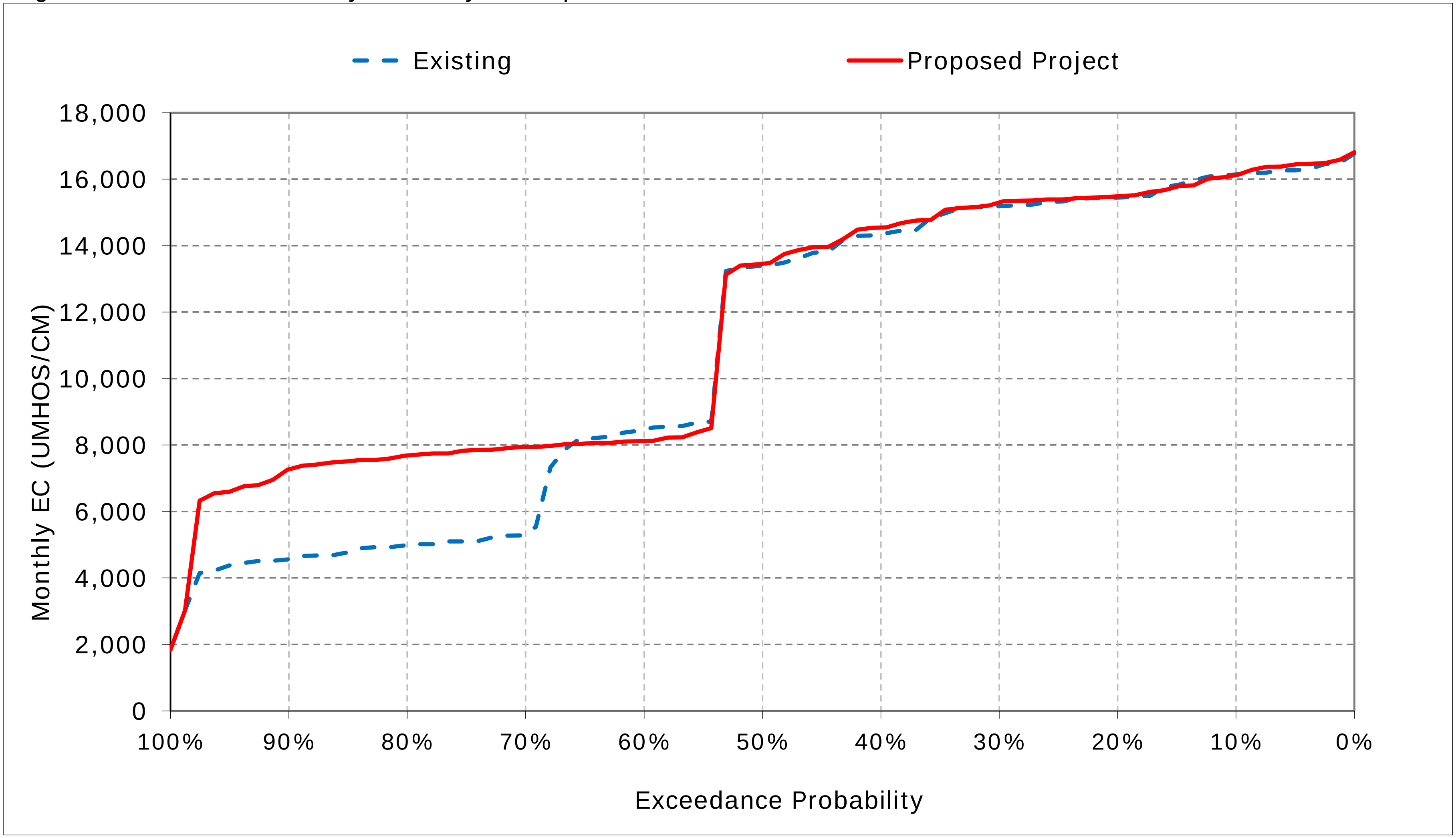


Figure 24-16. Suisun Bay near Ryer, October EC

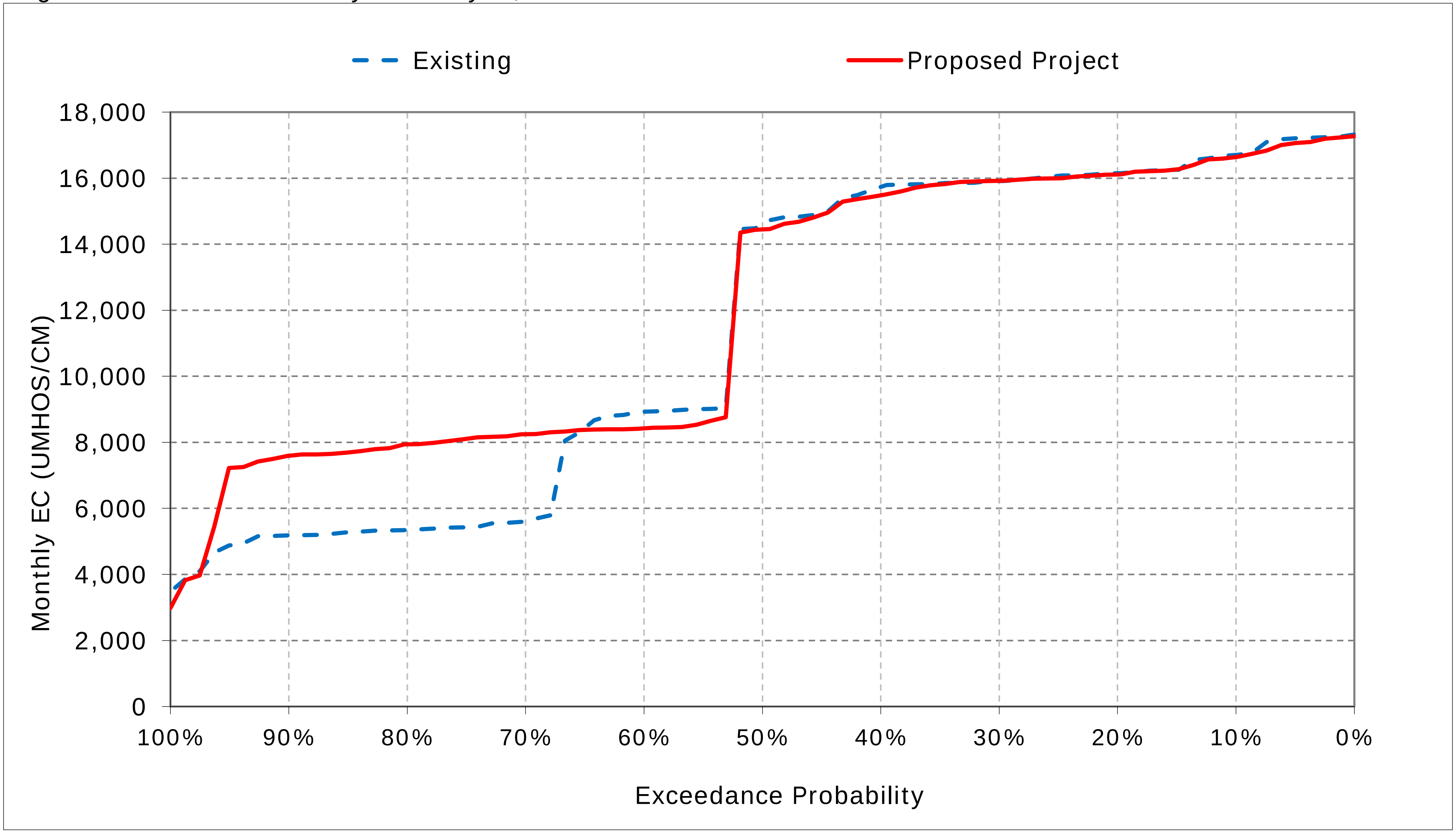


Figure 24-17. Suisun Bay near Ryer, November EC

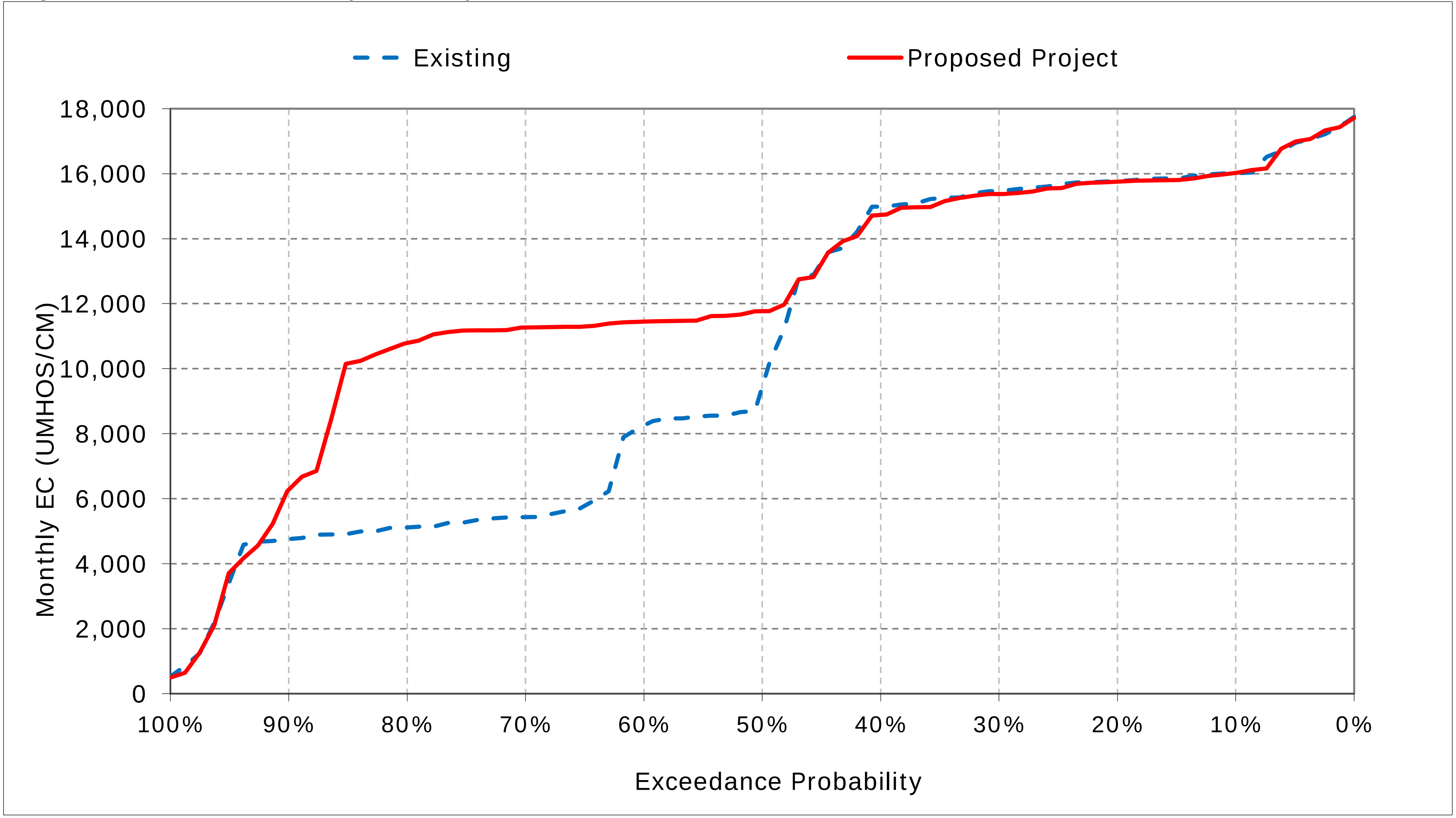


Figure 24-18. Suisun Bay near Ryer, December EC

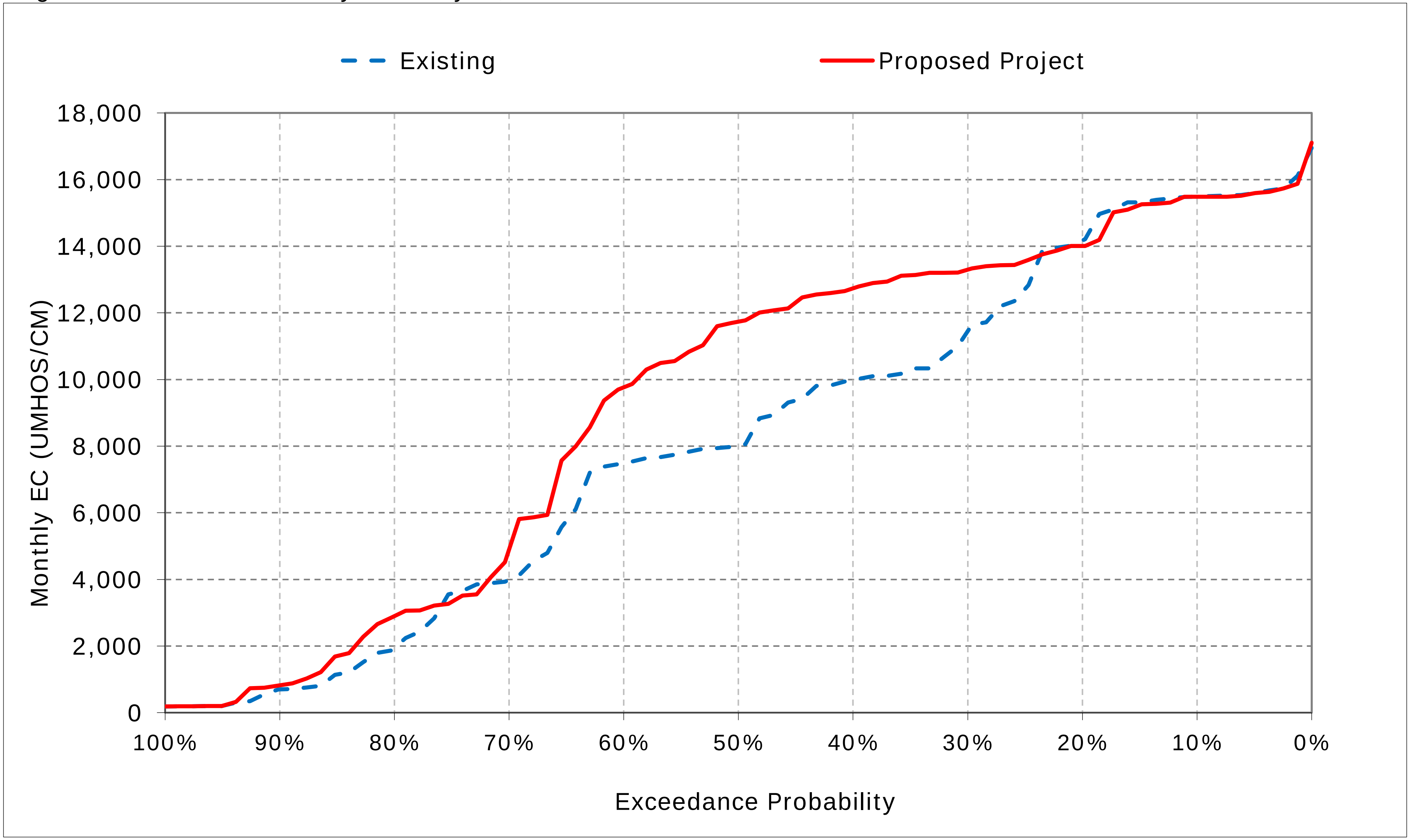


Table 25-1. Goodyear Slough Outfall at Naval Fleet, Monthly EC

Existing

	Monthly EC (UMHOS/CM)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	15,892	14,512	13,771	11,027	6,751	6,925	8,314	9,177	10,969	13,003	15,505	17,386
20%	15,210	14,126	13,187	9,217	5,084	4,597	5,072	7,317	9,558	11,956	14,356	16,448
30%	15,018	13,803	11,361	8,298	3,298	2,680	3,253	5,694	8,748	11,430	14,002	16,127
40%	14,589	13,202	8,662	6,455	2,889	1,936	2,477	3,954	7,467	9,981	12,348	15,121
50%	13,454	9,486	6,219	5,439	1,454	1,551	1,999	2,768	5,876	8,944	11,483	14,507
60%	8,092	7,681	5,684	3,477	1,052	651	917	1,705	4,846	8,278	10,936	11,184
70%	5,206	5,149	4,838	1,426	591	444	622	1,129	3,773	7,413	10,196	9,021
80%	4,926	5,008	3,536	719	389	349	343	539	1,971	5,929	9,848	8,689
90%	4,779	4,733	1,399	394	273	269	243	238	470	3,501	9,518	8,221
Long Term												
Full Simulation Period[a]	10,631	9,660	7,630	5,272	2,747	2,402	2,853	3,891	6,149	8,927	11,897	12,834
Water Year Types[b]												
Wet (32%)	8,799	7,246	3,710	1,360	541	465	598	999	2,365	5,094	9,112	8,043
Above Normal (15%)	10,954	9,676	7,687	4,170	1,394	717	857	1,601	4,190	7,257	10,188	11,099
Below Normal (17%)	11,001	10,398	9,021	6,431	2,384	2,126	2,465	3,412	6,121	9,317	11,872	14,786
Dry (22%)	11,093	10,708	9,331	7,590	4,475	3,591	4,329	5,975	8,734	11,602	14,206	16,297
Critical (15%)	13,156	12,445	11,890	10,023	6,709	6,824	7,974	9,880	12,462	14,438	16,208	17,477

Proposed Project

	Monthly EC (UMHOS/CM)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	15,872	14,389	13,763	11,145	6,962	6,751	8,822	9,348	11,112	13,007	15,501	17,339
20%	15,220	14,048	13,044	10,570	5,202	4,518	5,115	8,343	10,225	12,168	14,495	16,450
30%	15,038	13,724	11,491	9,027	3,520	2,672	3,389	6,933	9,403	11,478	14,085	16,253
40%	14,378	12,959	11,215	6,883	2,808	1,677	2,680	5,173	8,166	8,620	11,003	14,116
50%	13,073	10,051	10,768	5,540	1,553	1,228	2,323	3,625	6,597	8,184	10,248	13,418
60%	7,735	9,368	9,556	3,388	937	628	1,157	2,629	5,875	7,818	9,949	11,075
70%	7,570	9,097	6,021	1,499	626	436	703	1,587	4,201	7,145	9,706	10,821
80%	7,281	8,865	4,614	779	393	359	370	747	2,225	5,957	9,301	10,643
90%	6,955	6,708	2,527	515	326	271	274	269	516	3,508	8,597	10,143
Long Term												
Full Simulation Period[a]	11,199	10,813	8,921	5,602	2,871	2,372	3,029	4,511	6,657	8,692	11,407	13,210
Water Year Types[b]												
Wet (32%)	9,541	8,764	4,879	1,471	551	457	703	1,406	2,808	5,199	9,046	9,857
Above Normal (15%)	11,652	10,977	9,395	4,518	1,348	638	1,017	2,345	4,825	7,242	10,232	10,797
Below Normal (17%)	11,588	11,503	10,438	6,693	2,351	1,991	2,704	4,366	6,803	7,492	8,968	13,771
Dry (22%)	11,656	11,722	10,678	8,211	4,805	3,541	4,532	6,759	9,300	11,751	14,288	16,358
Critical (15%)	13,199	12,918	12,800	10,449	7,129	6,948	8,204	10,203	12,691	14,521	16,223	17,513

Proposed Project minus Existing

	Monthly EC (UMHOS/CM)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-20	-123	-8	118	211	-174	509	171	143	3	-3	-47
20%	10	-78	-142	1,354	118	-79	43	1,026	667	212	139	2
30%	20	-79	130	729	222	-8	136	1,239	655	47	84	126
40%	-212	-243	2,553	428	-81	-259	203	1,219	699	-1,361	-1,346	-1,005
50%	-381	566	4,550	101	99	-323	325	856	721	-760	-1,234	-1,089
60%	-357	1,687	3,872	-89	-115	-22	241	924	1,029	-459	-987	-109
70%	2,365	3,948	1,183	73	35	-8	80	458	428	-268	-490	1,801
80%	2,355	3,857	1,078	60	4	10	27	208	253	28	-547	1,955
90%	2,176	1,976	1,128	121	52	3	31	31	46	8	-921	1,922
Long Term												
Full Simulation Period[a]	568	1,152	1,292	329	125	-30	176	620	508	-235	-490	376
Water Year Types[b]												
Wet (32%)	742	1,518	1,169	111	10	-8	105	407	444	106	-65	1,814
Above Normal (15%)	698	1,301	1,708	348	-47	-79	160	744	635	-15	44	-302
Below Normal (17%)	587	1,105	1,417	261	-33	-136	239	954	682	-1,825	-2,904	-1,015
Dry (22%)	564	1,015	1,347	621	330	-50	202	784	566	150	82	61
Critical (15%)	43	474	910	427	420	124	231	323	229	83	15	36

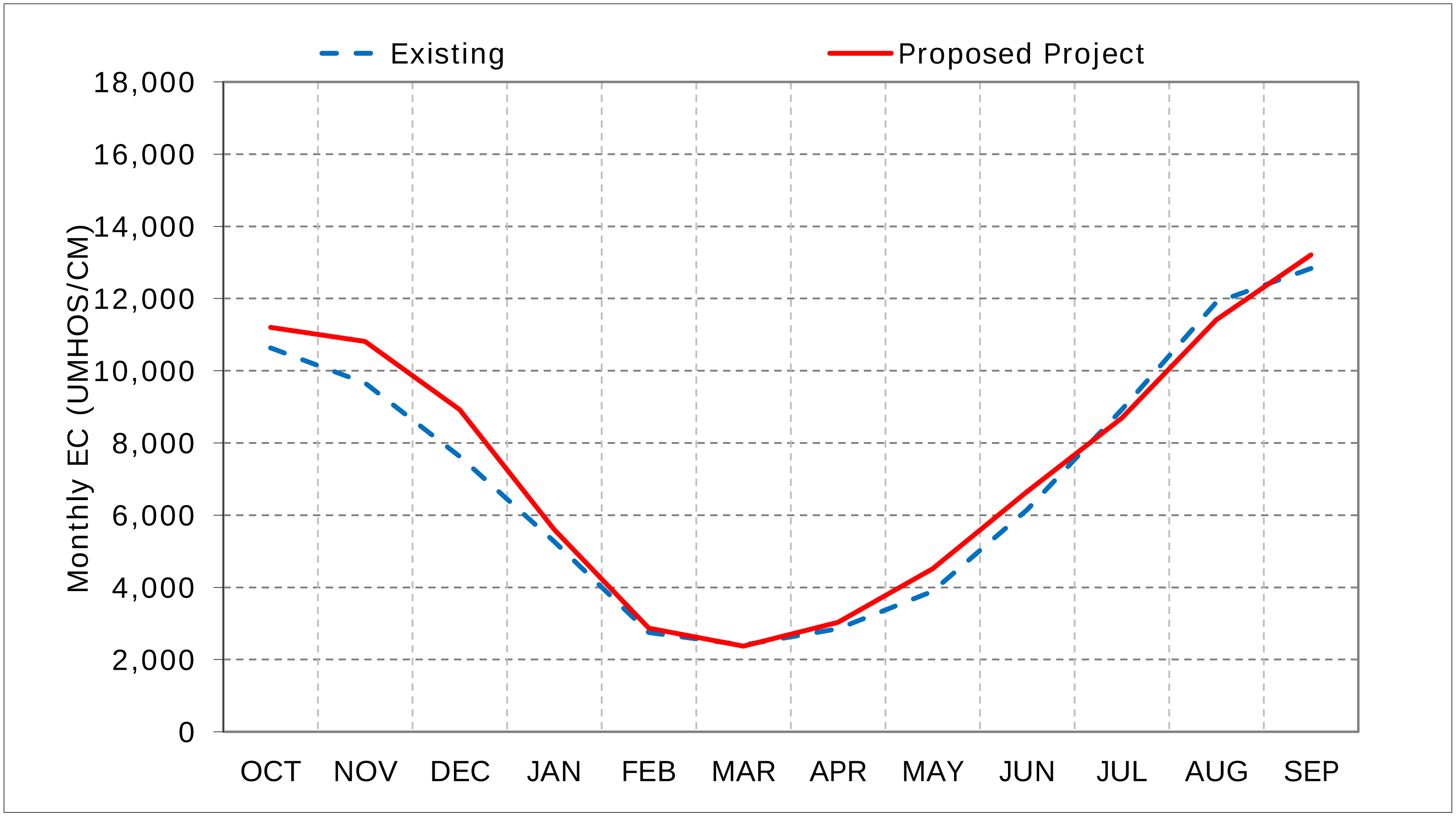
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

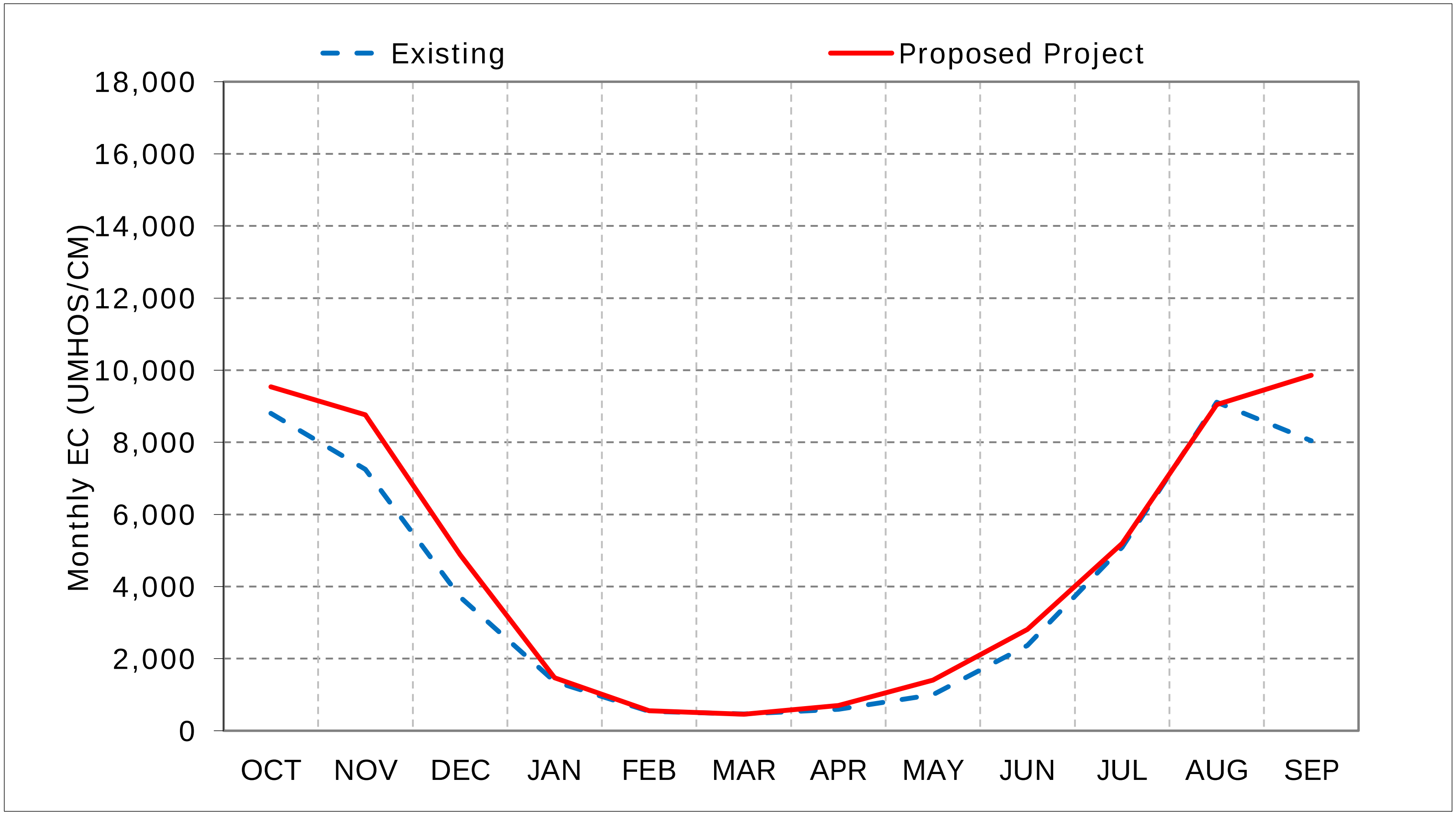
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 25-1. Goodyear Slough Outfall at Naval Fleet, Long-Term Average EC



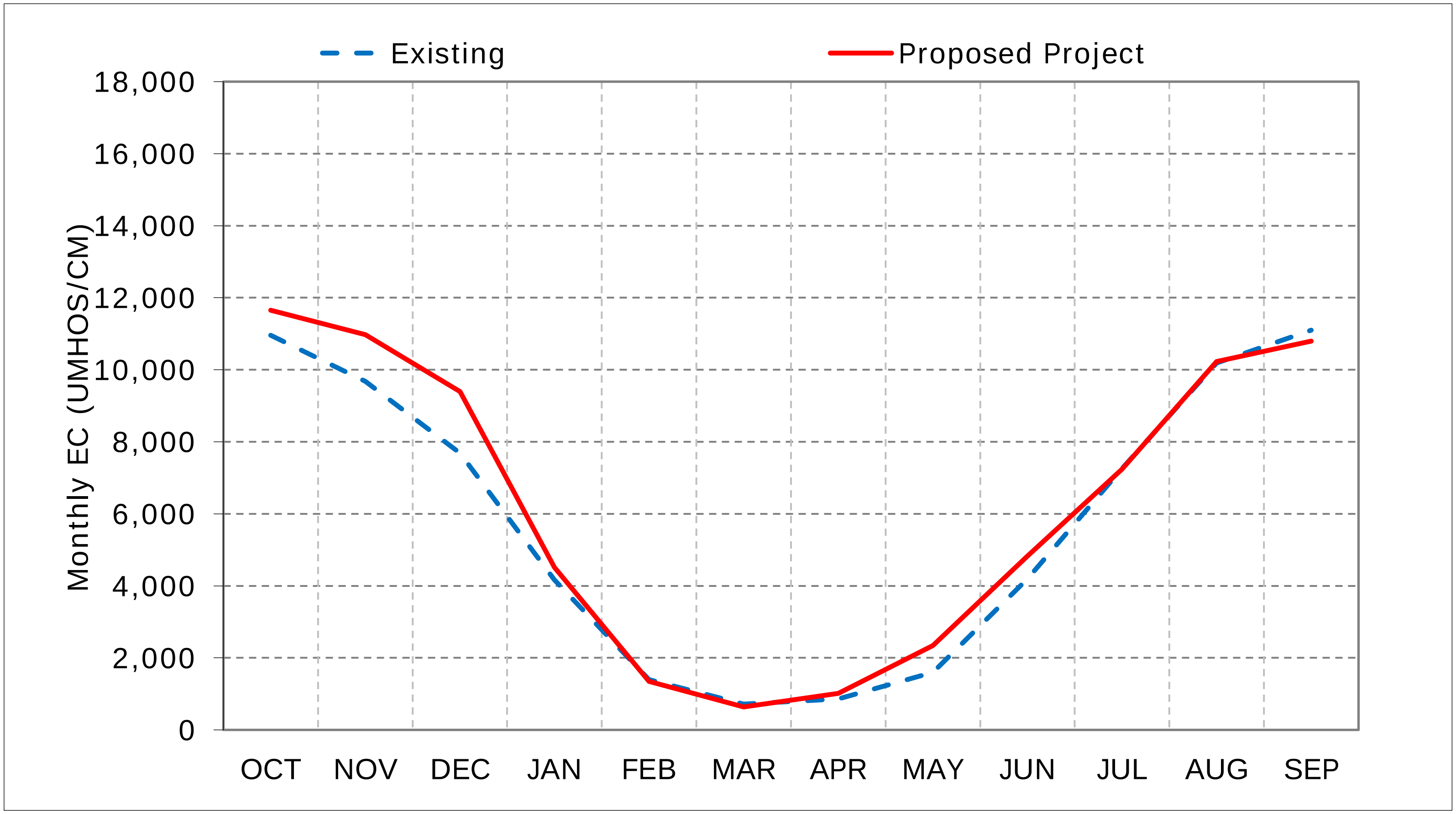
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 25-2. Goodyear Slough Outfall at Naval Fleet, Wet Year Average EC



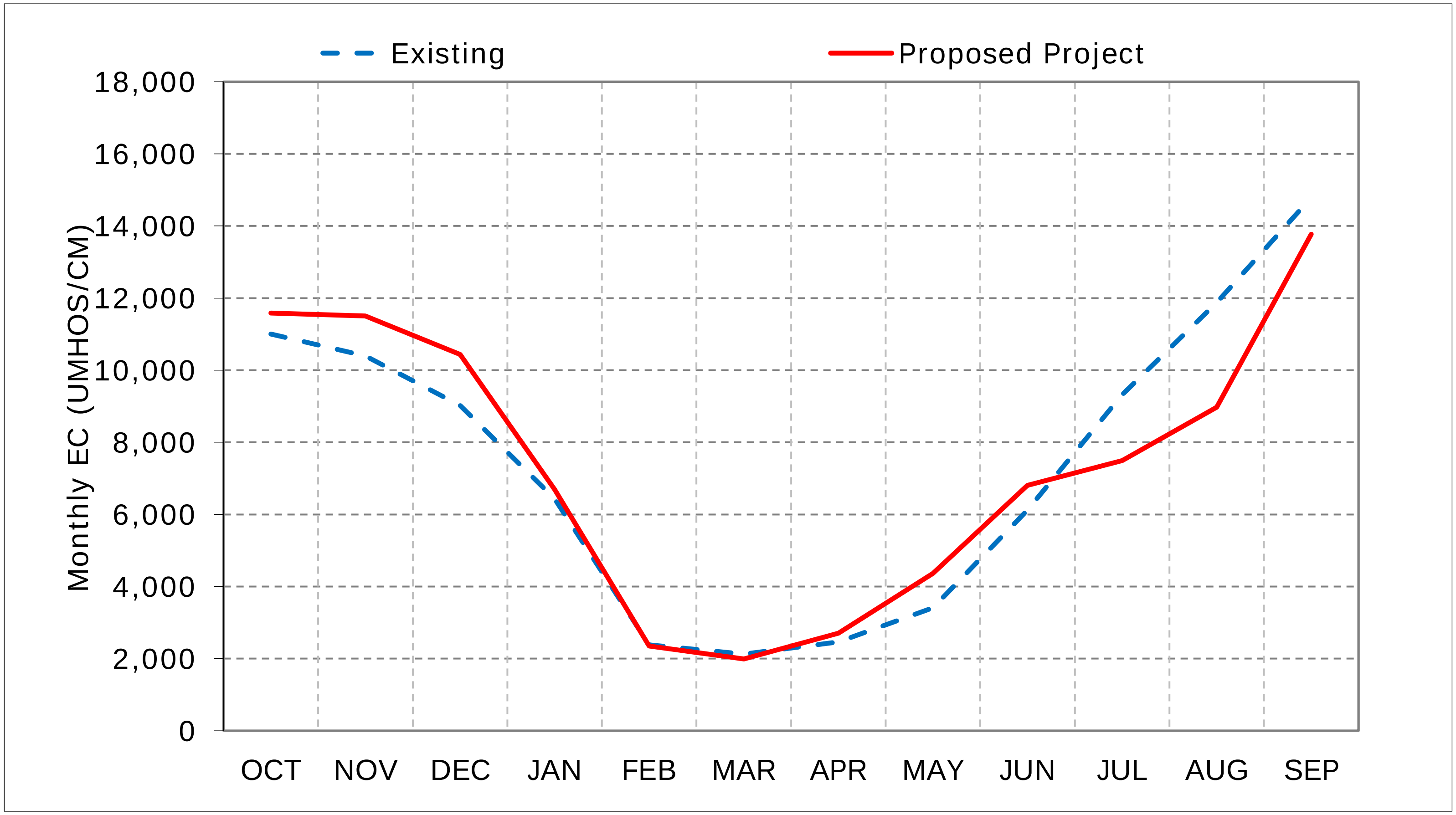
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 25-3. Goodyear Slough Outfall at Naval Fleet, Above Normal Year Average I



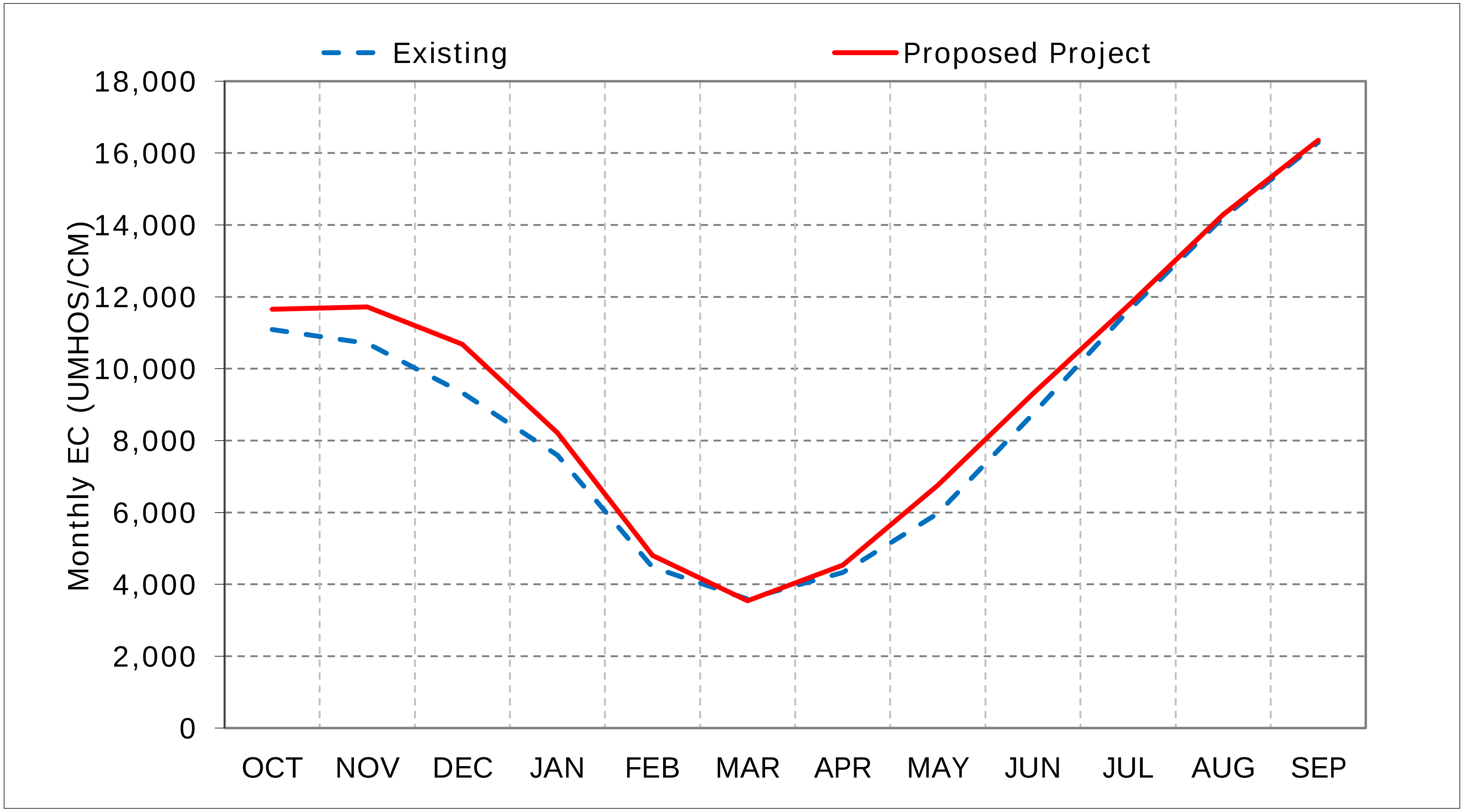
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 25-4. Goodyear Slough Outfall at Naval Fleet, Below Normal Year Average E



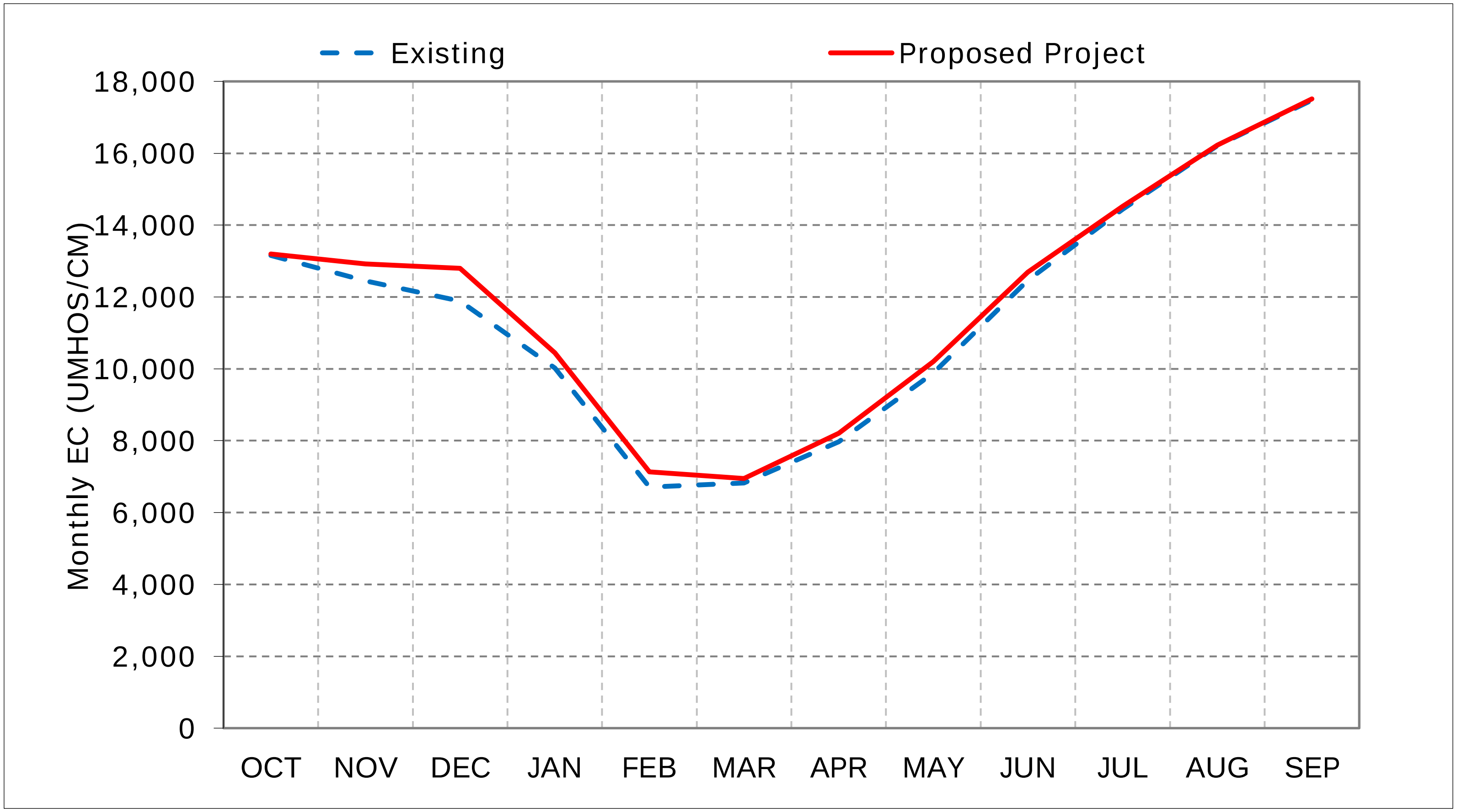
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 25-5. Goodyear Slough Outfall at Naval Fleet, Dry Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 25-6. Goodyear Slough Outfall at Naval Fleet, Critical Year Average EC



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 25-7. Goodyear Slough Outfall at Naval Fleet, January EC

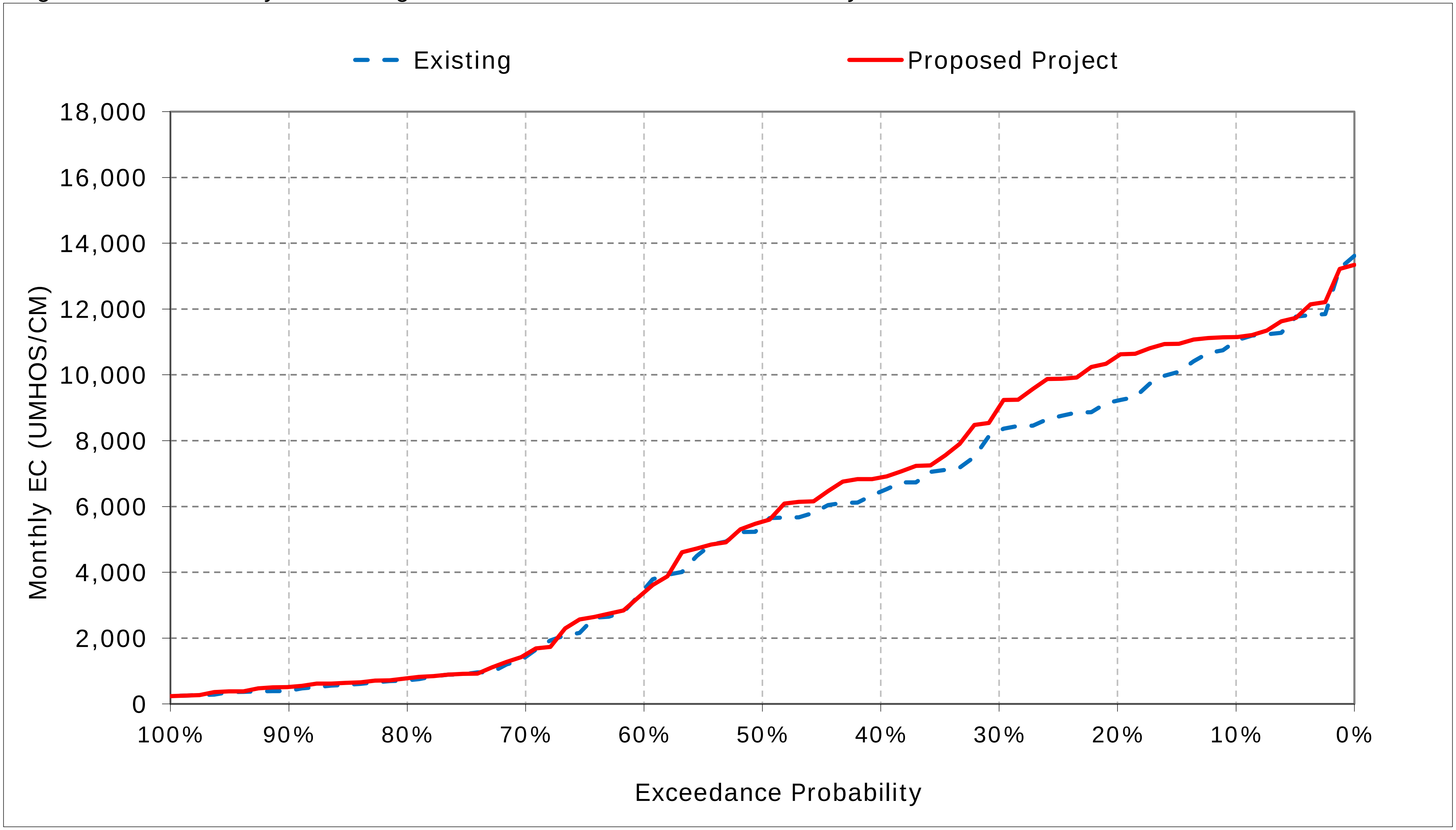


Figure 25-8. Goodyear Slough Outfall at Naval Fleet, February EC

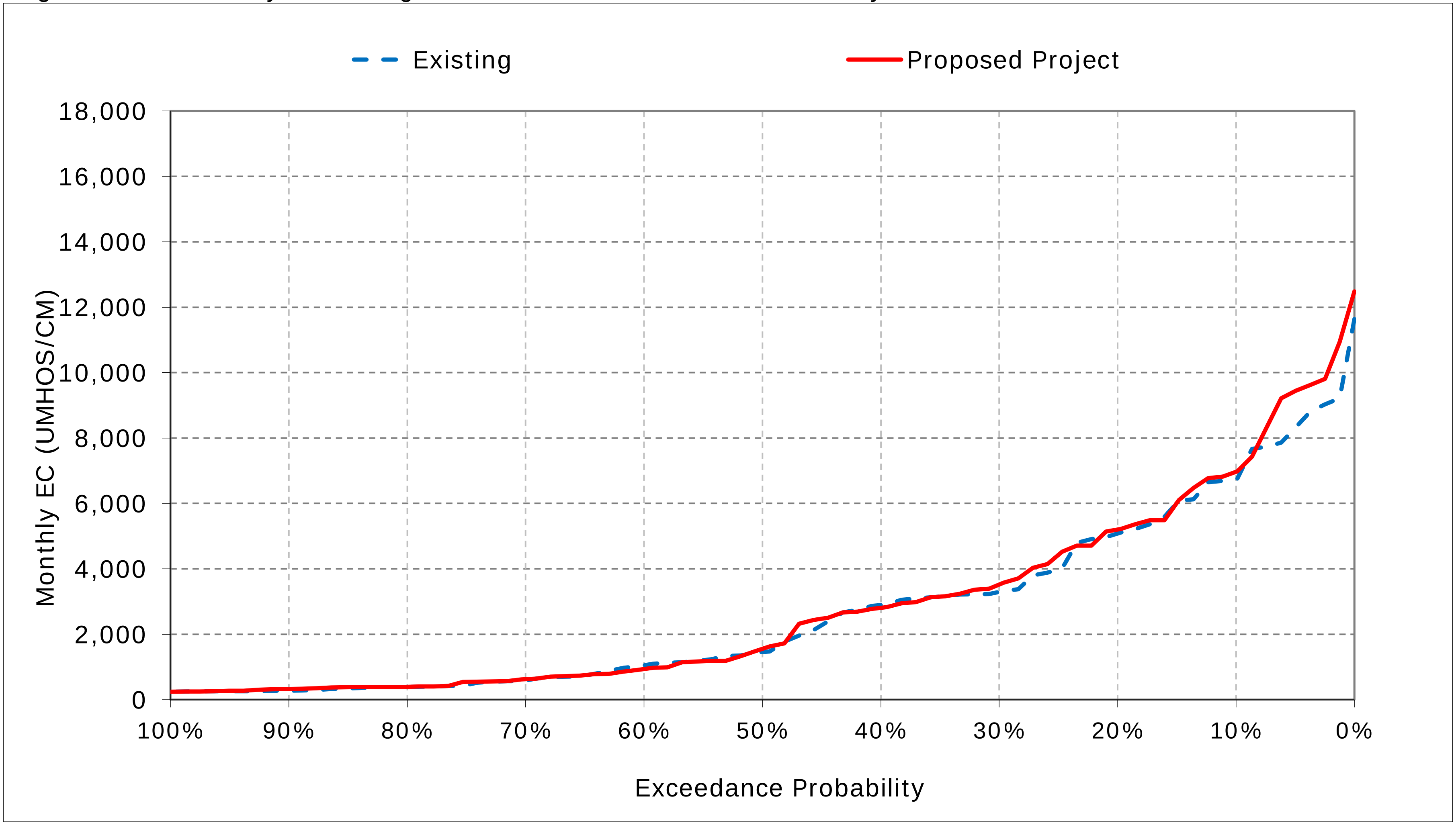


Figure 25-9. Goodyear Slough Outfall at Naval Fleet, March EC

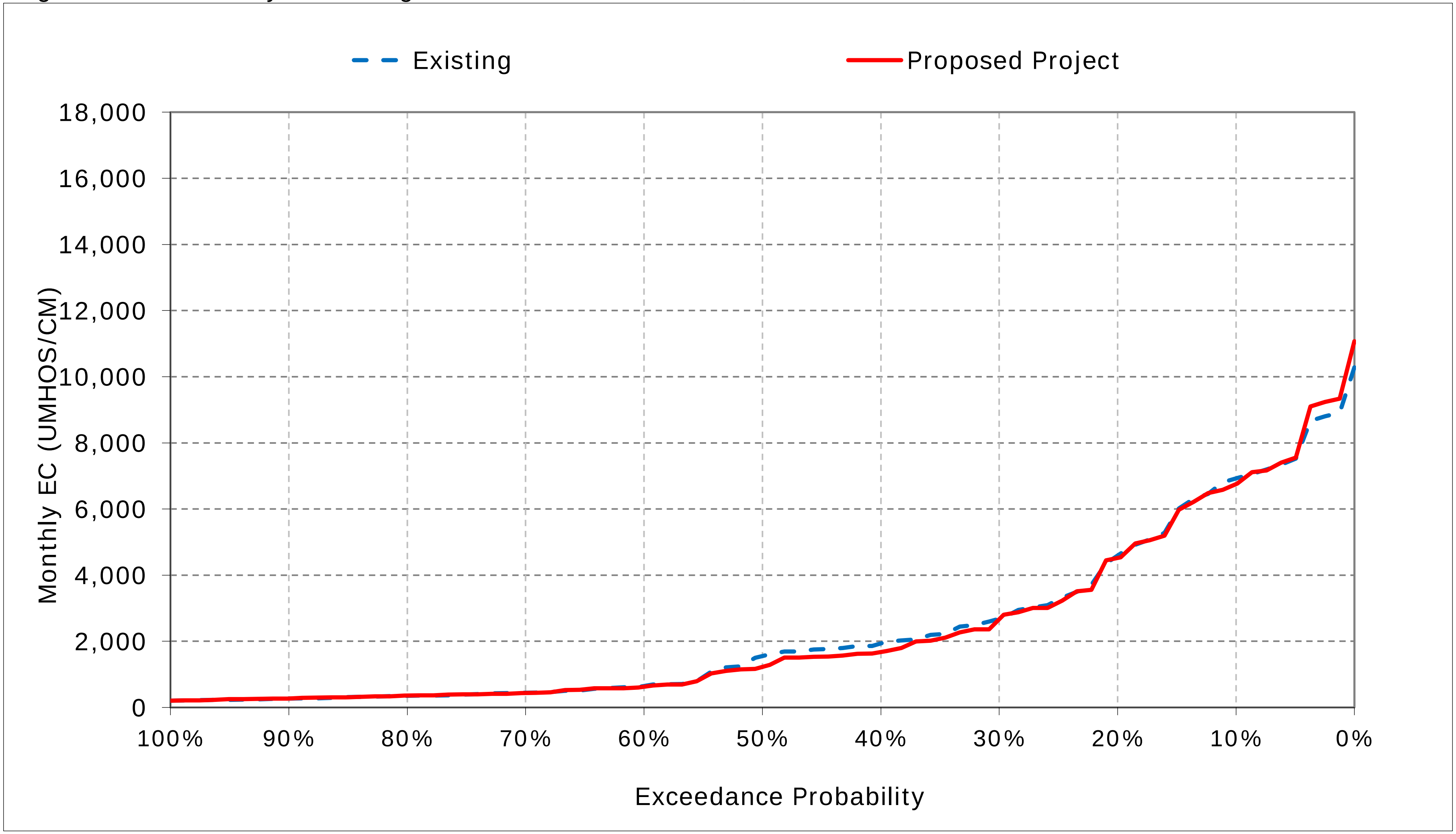


Figure 25-10. Goodyear Slough Outfall at Naval Fleet, April EC

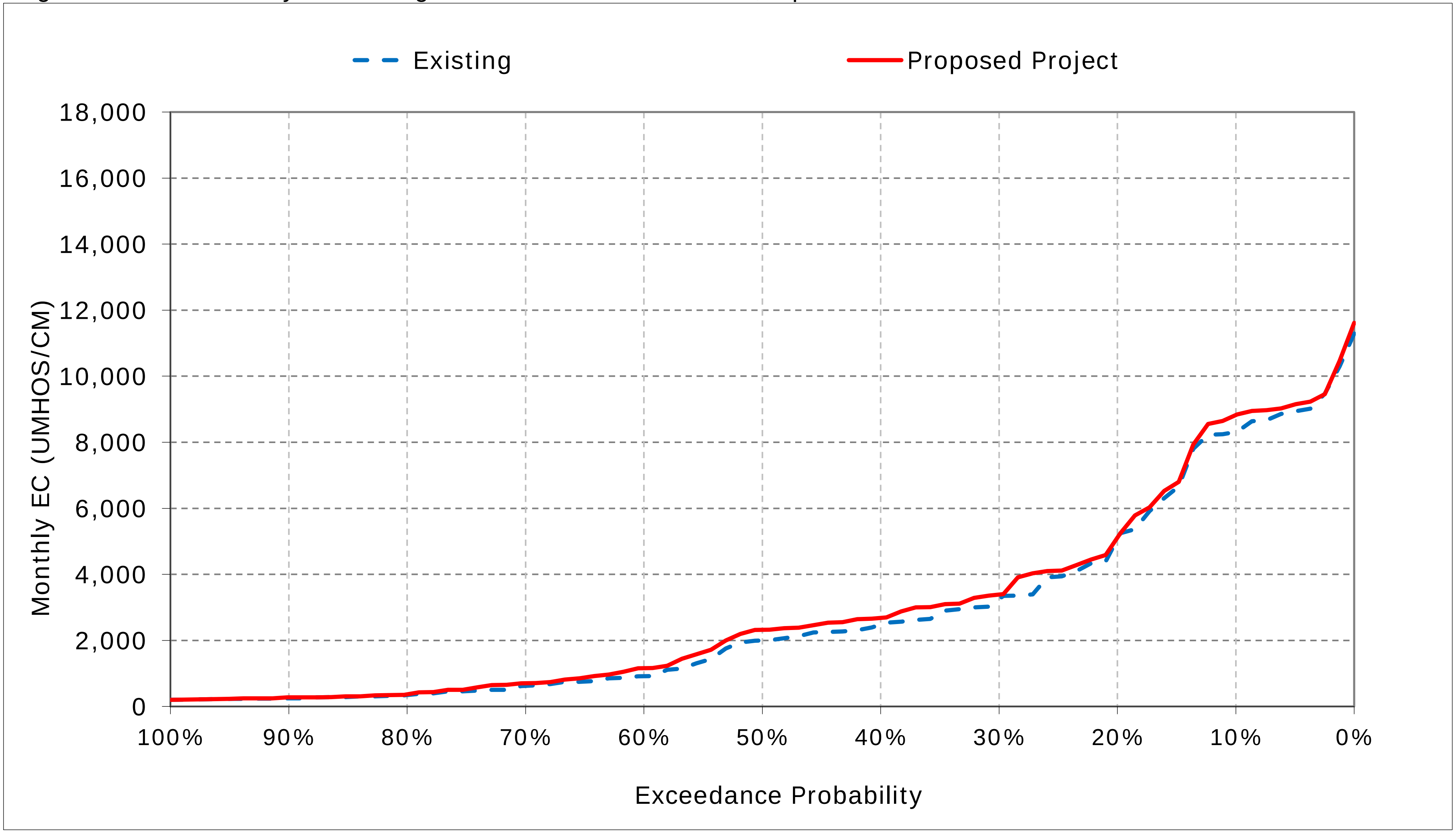


Figure 25-11. Goodyear Slough Outfall at Naval Fleet, May EC

Figure 25-12. Goodyear Slough Outfall at Naval Fleet, June EC

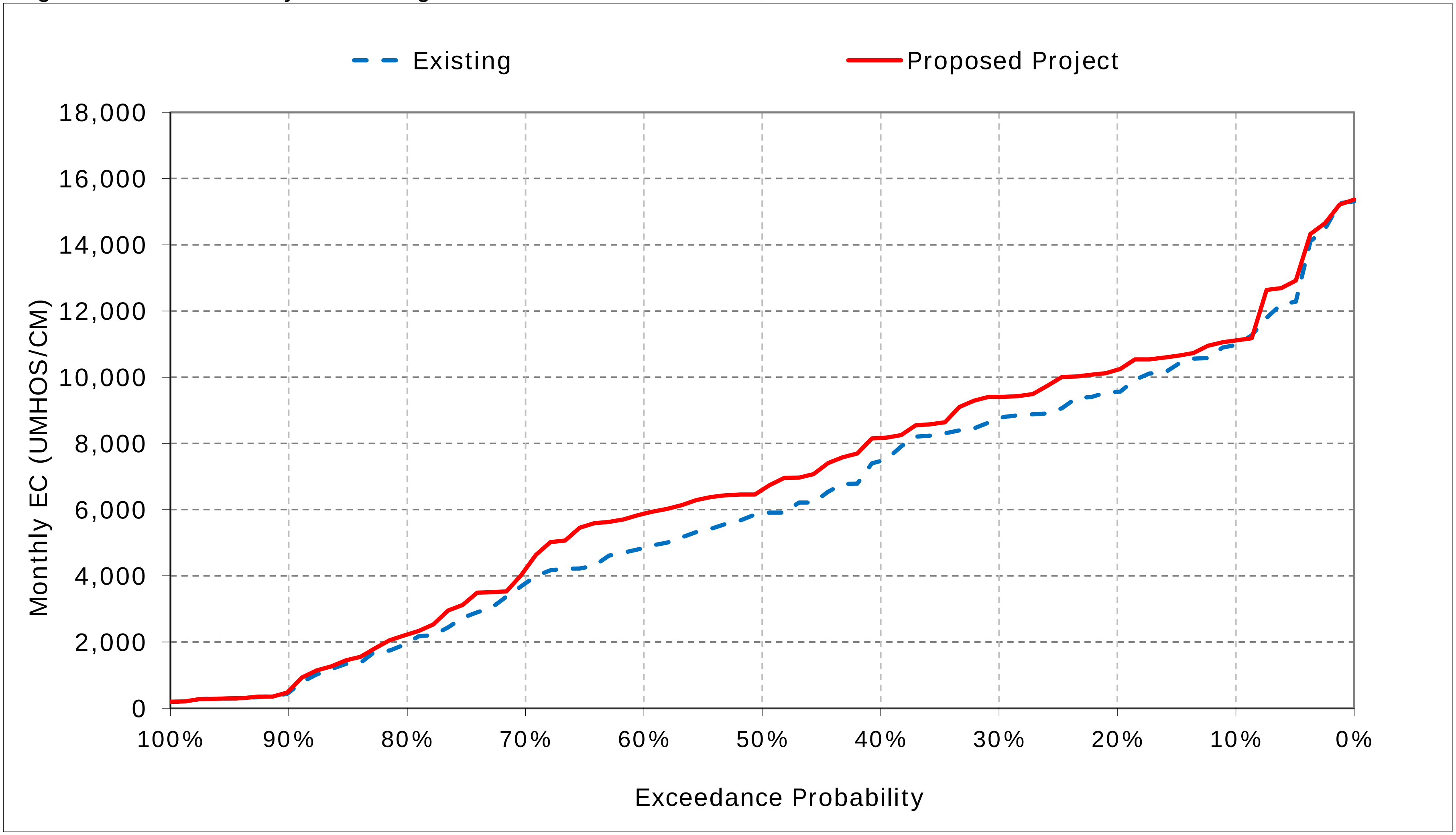


Figure 25-13. Goodyear Slough Outfall at Naval Fleet, July EC

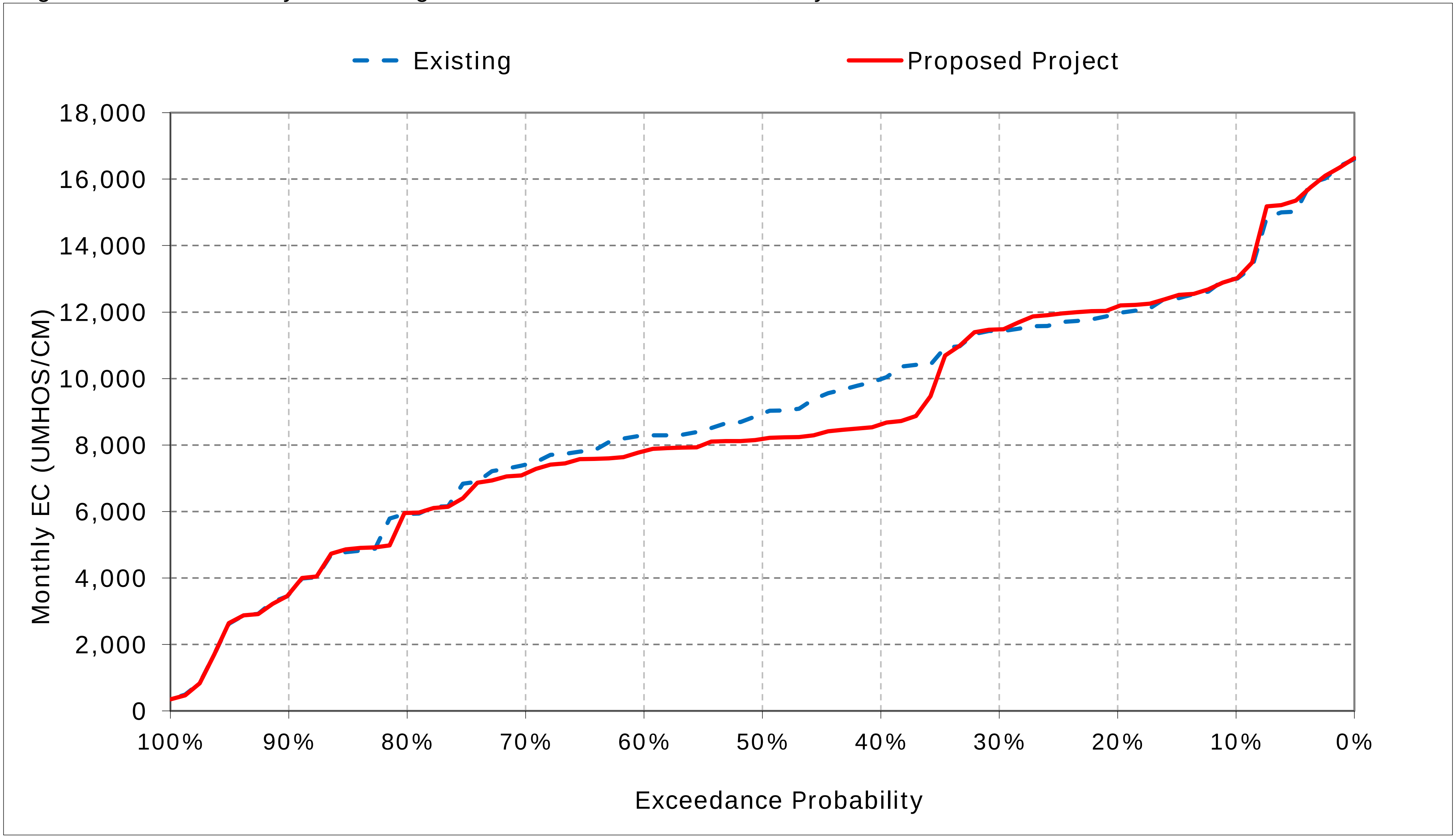


Figure 25-14. Goodyear Slough Outfall at Naval Fleet, August EC

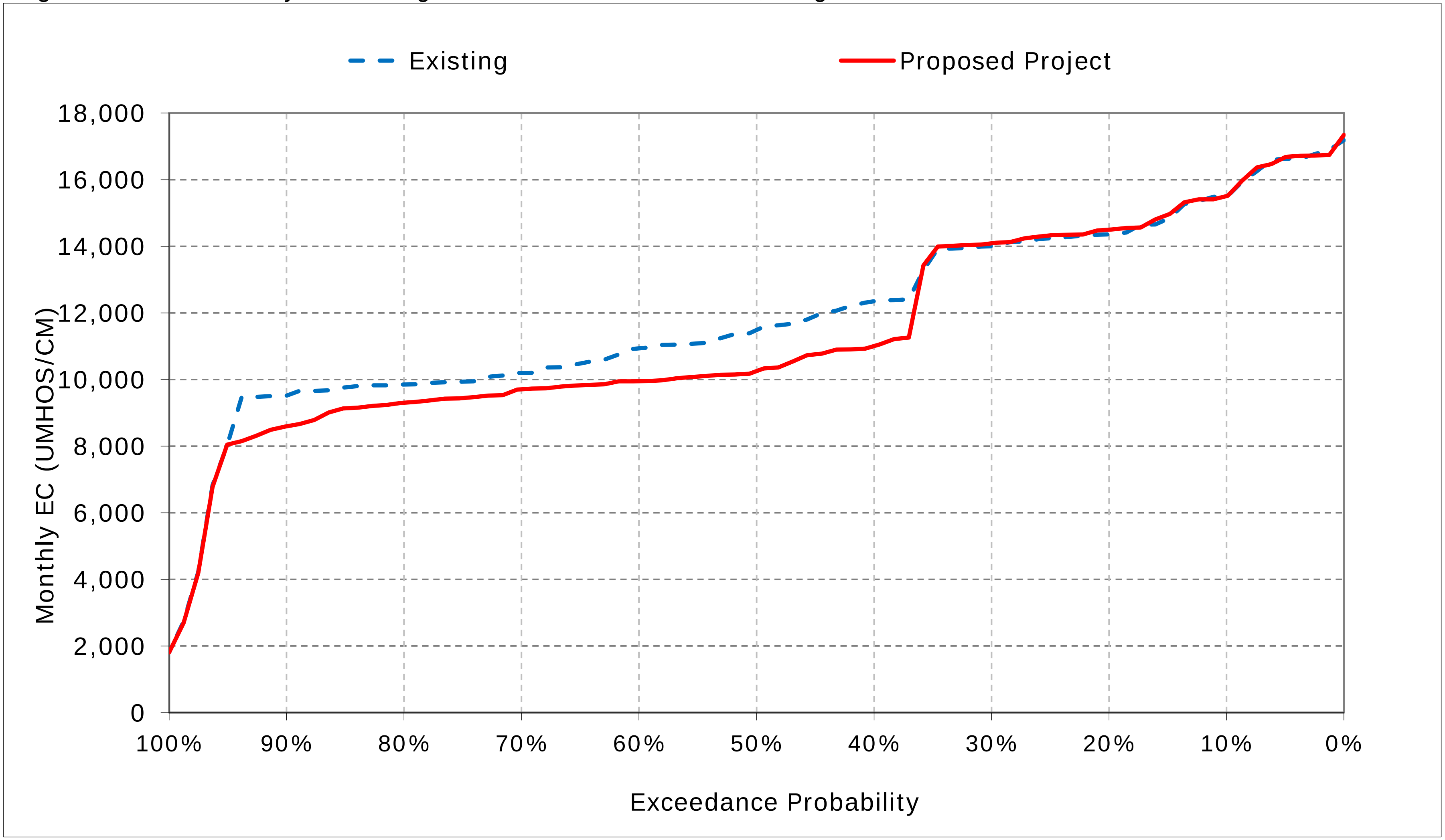


Figure 25-15. Goodyear Slough Outfall at Naval Fleet, September EC

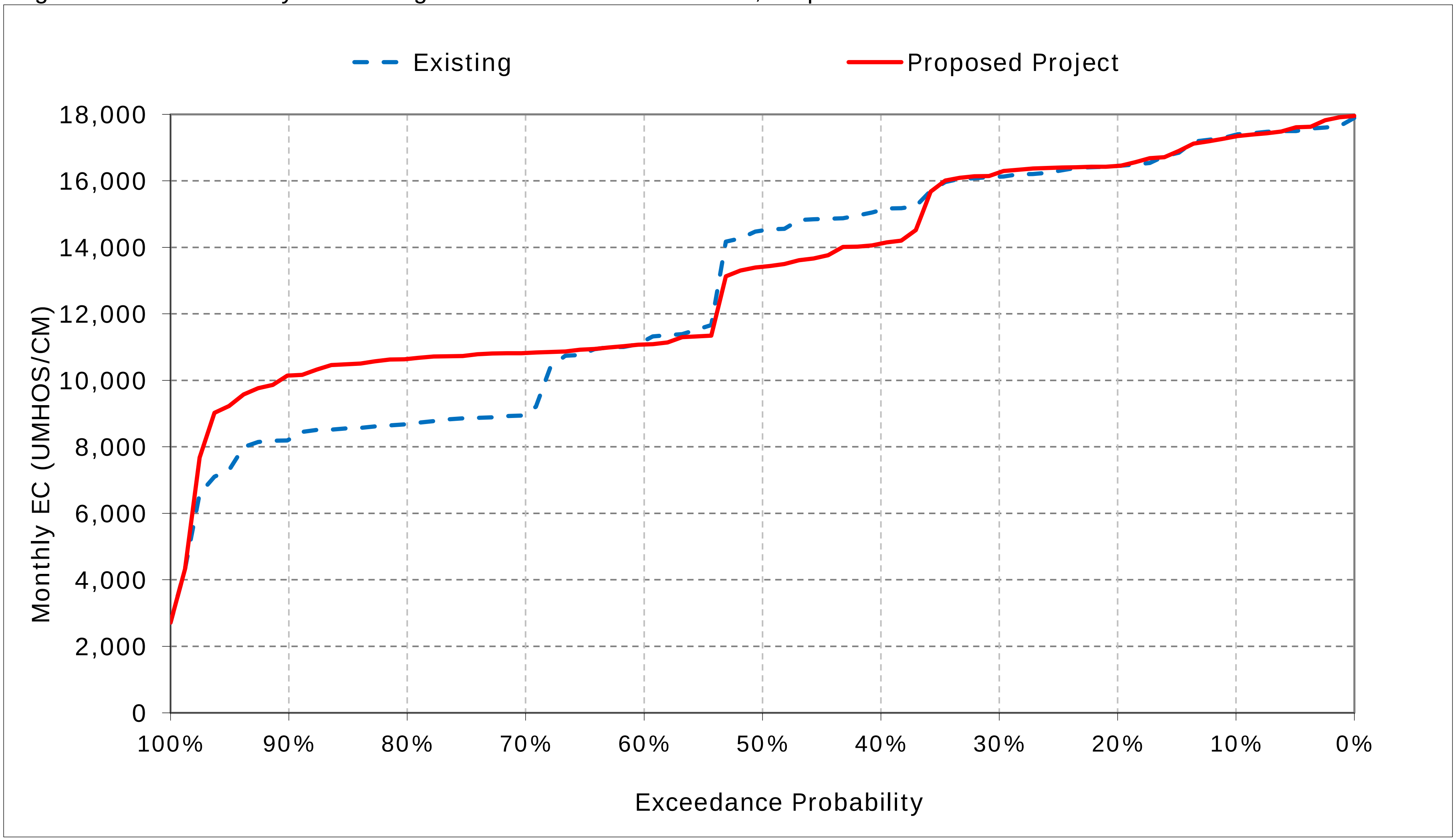


Figure 25-16. Goodyear Slough Outfall at Naval Fleet, October EC

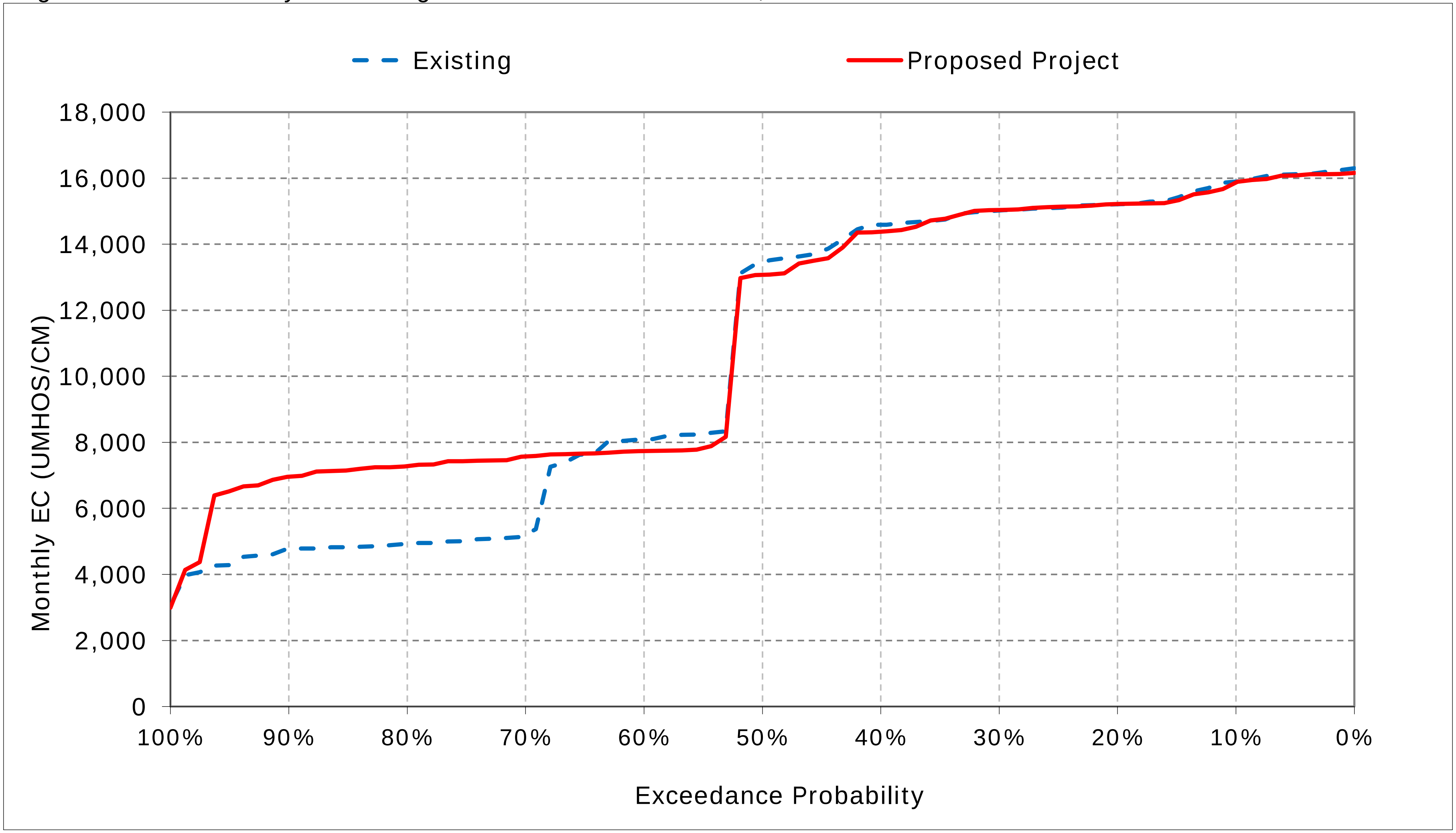


Figure 25-17. Goodyear Slough Outfall at Naval Fleet, November EC

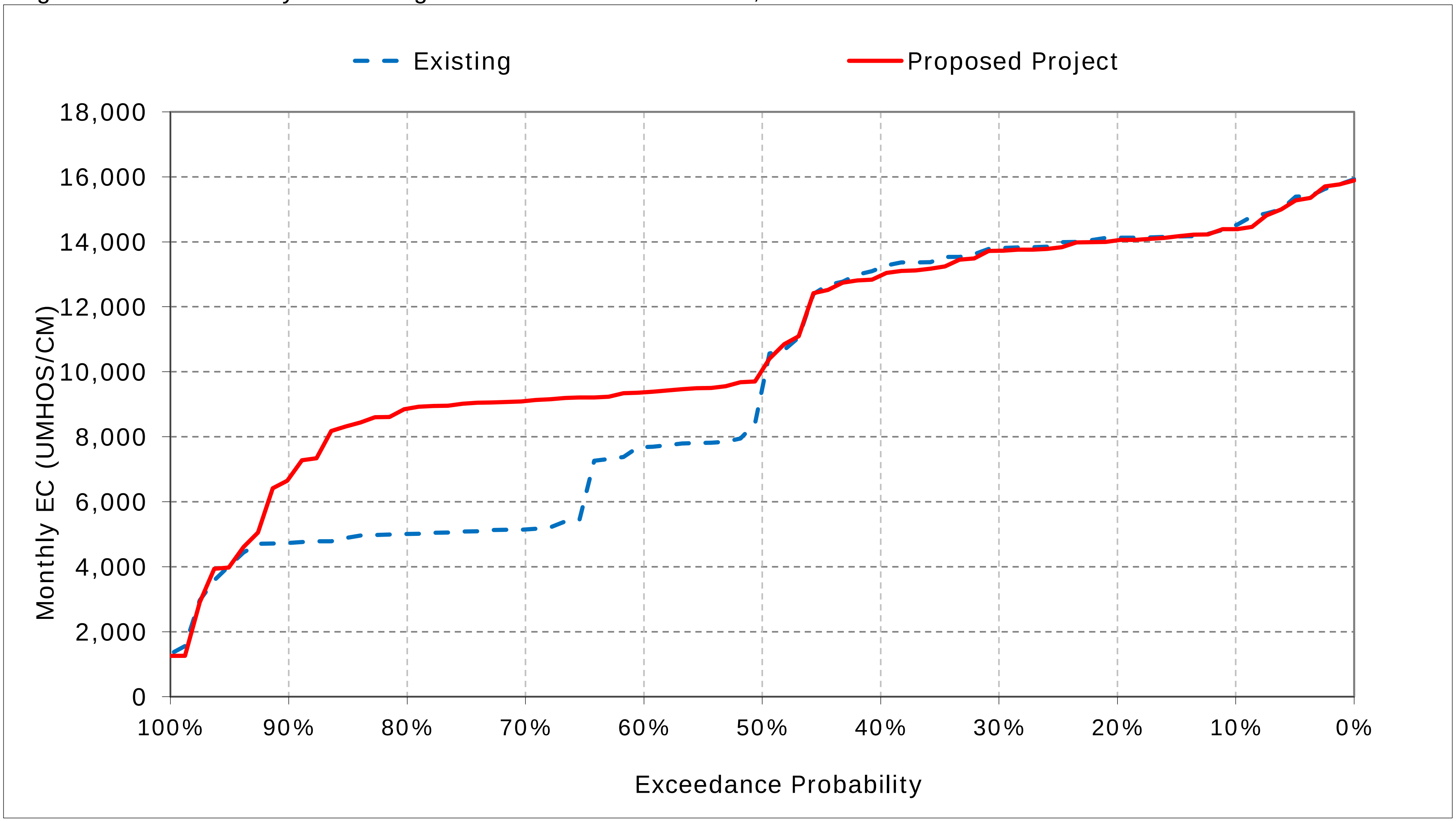
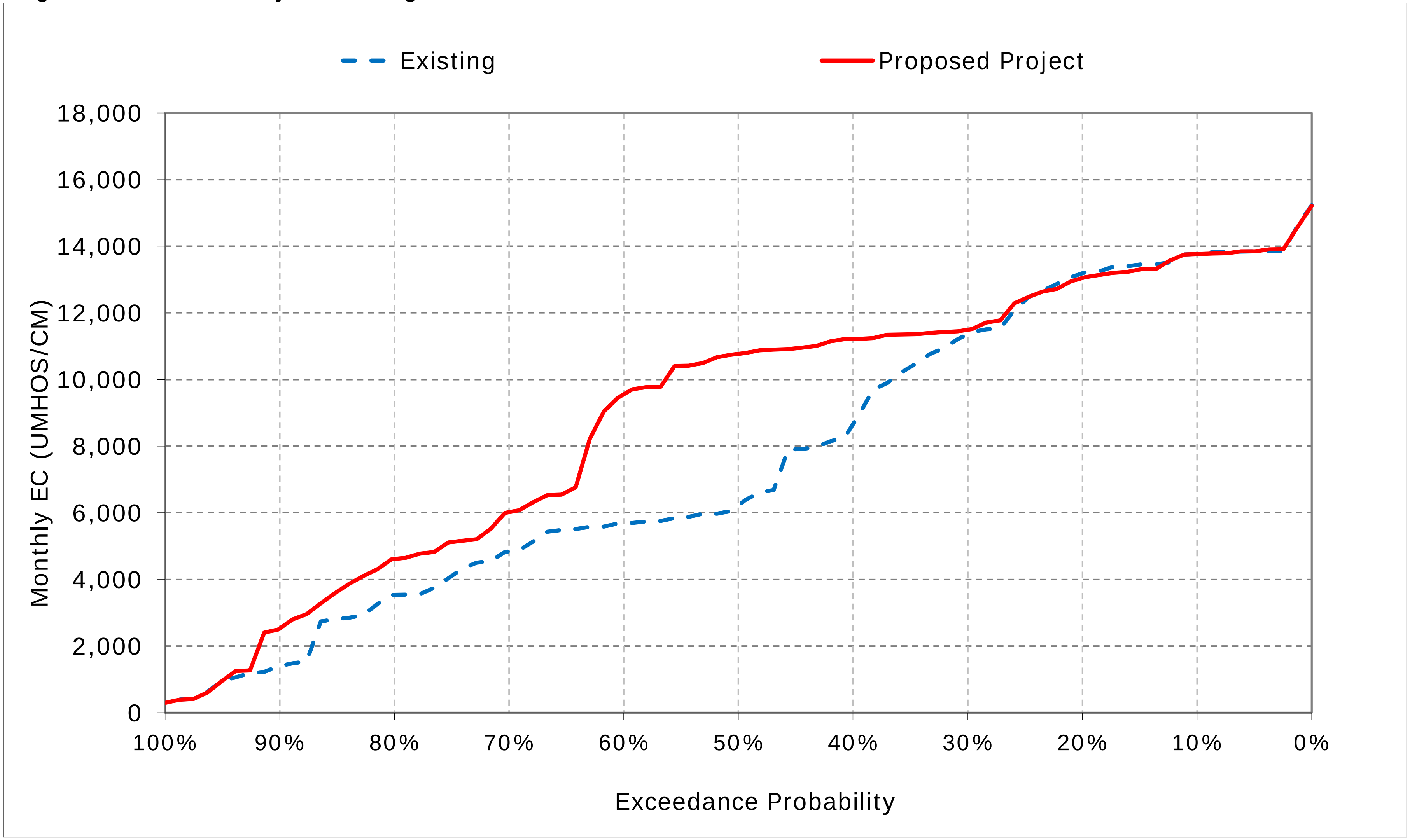


Figure 25-18. Goodyear Slough Outfall at Naval Fleet, December EC



Appendix C – Modeling

Attachment 2-8 – Chloride Results (DSM2-QUAL)

The following results of the DSM2-QUAL model are included for Delta chloride conditions for the following alternatives:

- Existing Conditions
- Proposed Project

Table 2-8.1. Chloride Results (DSM2-QUAL)

Title	Model Parameter	Table Numbers	Figure Numbers
Sacramento River at Mallard Slough Salinity	RSAC075	1-1	1-1 to 1-18
Sacramento River at Rio Vista Salinity	RSAC101	2-1	2-1 to 2-18
Sacramento River at Collinsville Salinity	RSAC081	3-1	3-1 to 3-18
San Joaquin River at Jersey Point Salinity	RSAN018	4-1	4-1 to 4-18
San Joaquin River at San Andreas Salinity	RSAN032	5-1	5-1 to 5-18
San Joaquin River at Prisoners Point Salinity	RSAN037	6-1	6-1 to 6-18
Old River at Highway 4	ROLD034	7-1	7-1 to 7-18
Victoria Canal	CHVCT000	8-1	8-1 to 8-18
Contra Costa Pumping Plant Chloride	ROLD024	9-1	9-1 to 9-18
San Joaquin River at Antioch Chloride	RSAN007	10-1	10-1 to 10-18
Banks Pumping Plant South Delta Exports Chloride	CLIFTON_COURT	11-1	11-1 to 11-18
Jones Pumping Plant South Delta Exports Chloride	CHDMC006	12-1	12-1 to 12-18
North Bay Aqueduct Chloride	SLBAR002	13-1	13-1 to 13-18

Report formats

- Monthly tables comparing two scenarios (exceedance values, long-term average, and average by water year type)
- Monthly pattern charts (long-term average and average by water year type) including all scenarios
- Monthly exceedance charts (all months) including all scenarios

Table 1-1. Sacramento River at Mallard Slough Chloride, Monthly Cl

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	4,015	3,822	3,637	2,412	1,260	1,094	1,174	1,545	2,008	2,652	3,365	3,719
20%	3,828	3,720	3,179	2,137	783	590	617	1,178	1,669	2,310	2,998	3,544
30%	3,766	3,614	2,348	1,643	415	223	316	914	1,595	2,196	2,917	3,478
40%	3,689	3,468	1,973	946	181	149	236	544	1,352	1,697	2,436	3,232
50%	3,369	1,816	1,688	682	99	71	127	307	1,109	1,552	2,267	2,911
60%	1,826	1,581	1,537	367	32	29	53	182	867	1,225	2,209	1,505
70%	1,068	943	625	52	21	19	29	93	633	1,144	2,080	835
80%	1,001	848	256	21	18	18	19	29	282	1,004	1,998	746
90%	957	760	54	17	17	17	17	17	31	696	1,910	672
Long Term												
Full Simulation Period[a]	2,564	2,279	1,738	981	404	292	353	605	1,127	1,633	2,438	2,279
Water Year Types[b]												
Wet (32%)	2,021	1,495	562	147	27	31	48	106	378	831	1,852	686
Above Normal (15%)	2,675	2,250	1,740	575	125	35	66	162	779	1,119	2,036	1,473
Below Normal (17%)	2,687	2,514	2,225	1,090	249	208	229	447	1,098	1,600	2,353	3,062
Dry (22%)	2,713	2,638	2,183	1,578	677	422	517	919	1,575	2,241	2,957	3,511
Critical (15%)	3,265	3,198	3,046	2,170	1,272	1,020	1,199	1,840	2,458	3,012	3,430	3,778

Proposed Project

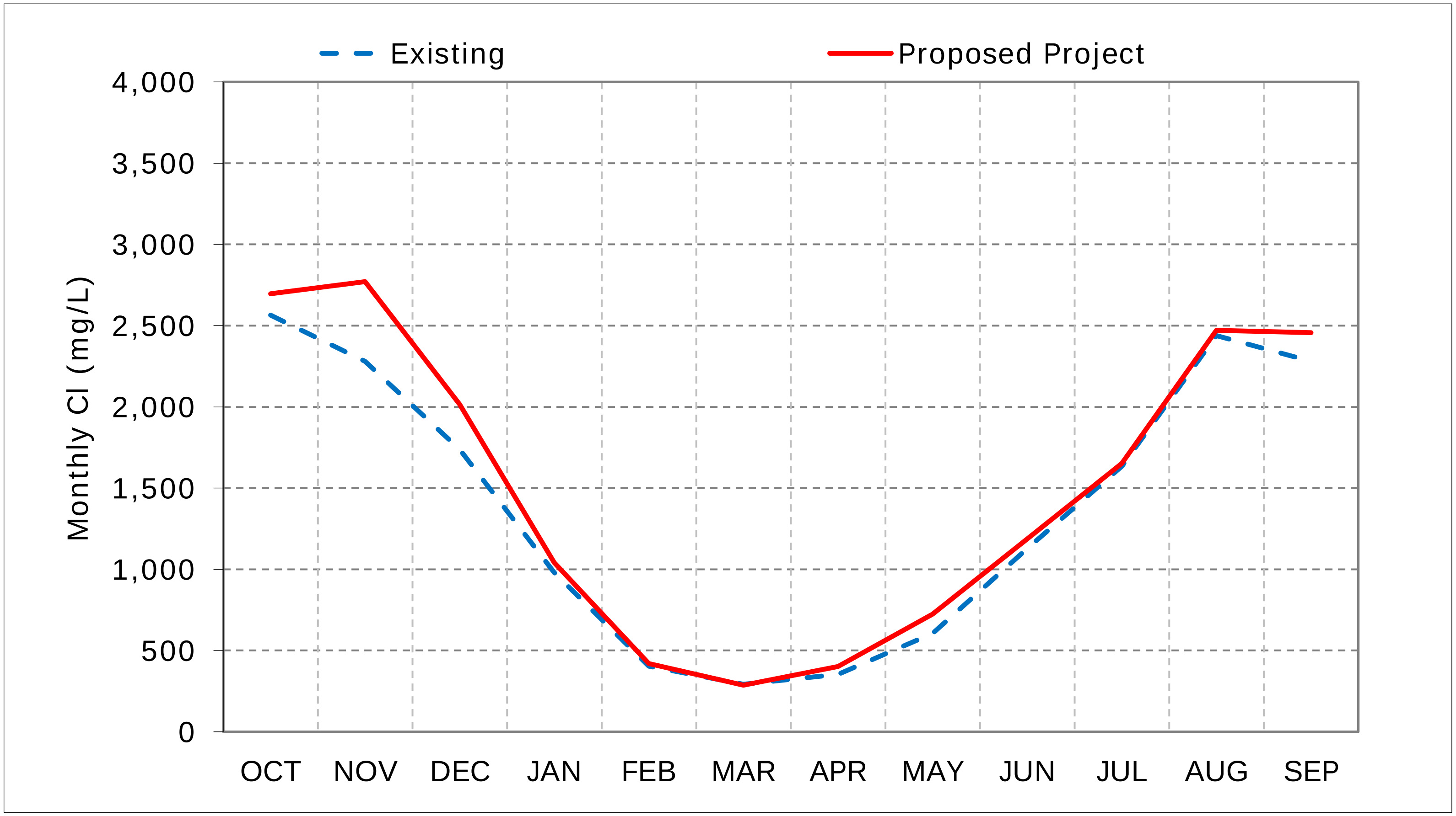
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	3,988	3,790	3,613	2,705	1,204	1,102	1,248	1,618	2,025	2,651	3,340	3,717
20%	3,805	3,712	3,167	2,298	741	556	757	1,387	1,801	2,340	3,009	3,559
30%	3,750	3,609	3,004	1,781	394	186	455	1,178	1,649	2,177	2,929	3,493
40%	3,590	3,422	2,813	1,014	201	134	315	722	1,496	1,790	2,708	3,348
50%	3,305	2,647	2,461	692	95	56	179	475	1,166	1,591	2,439	2,948
60%	1,717	2,538	1,898	343	25	25	71	341	1,007	1,212	2,191	1,437
70%	1,652	2,479	768	54	21	19	36	167	717	1,133	2,069	1,390
80%	1,572	2,275	443	21	18	18	19	43	299	1,014	1,984	1,320
90%	1,480	1,083	80	18	17	17	17	17	32	698	1,897	1,212
Long Term												
Full Simulation Period[a]	2,696	2,771	2,015	1,042	420	287	402	725	1,187	1,651	2,471	2,456
Water Year Types[b]												
Wet (32%)	2,200	2,126	728	145	26	29	69	176	437	834	1,822	1,236
Above Normal (15%)	2,830	2,795	2,164	608	90	31	98	287	826	1,104	2,046	1,356
Below Normal (17%)	2,825	2,980	2,563	1,100	234	189	299	627	1,151	1,684	2,573	3,151
Dry (22%)	2,856	3,061	2,522	1,730	727	402	596	1,092	1,659	2,262	2,974	3,525
Critical (15%)	3,244	3,464	3,253	2,319	1,357	1,041	1,258	1,916	2,509	3,016	3,429	3,789

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	-27	-31	-24	293	-56	9	74	73	17	-1	-25	-2
20%	-23	-8	-13	161	-43	-34	139	209	131	31	10	15
30%	-16	-5	656	138	-20	-36	139	264	54	-18	11	16
40%	-99	-47	840	68	20	-15	78	178	144	93	272	116
50%	-63	831	773	9	-4	-14	52	168	57	39	173	37
60%	-109	956	361	-24	-6	-4	18	159	140	-13	-18	-68
70%	585	1,537	143	2	0	0	8	73	84	-11	-12	554
80%	571	1,427	187	0	0	0	0	14	18	10	-14	573
90%	523	323	25	0	0	0	-1	0	0	1	-13	540
Long Term												
Full Simulation Period[a]	131	491	277	61	16	-6	49	120	61	18	33	177
Water Year Types[b]												
Wet (32%)	179	631	166	-2	-2	-2	21	69	59	3	-31	550
Above Normal (15%)	155	546	424	33	-35	-4	32	126	47	-15	10	-117
Below Normal (17%)	139	466	338	10	-14	-19	70	180	53	84	220	89
Dry (22%)	143	423	339	152	51	-20	79	173	84	21	17	14
Critical (15%)	-21	266	207	149	86	22	60	75	51	4	-1	11

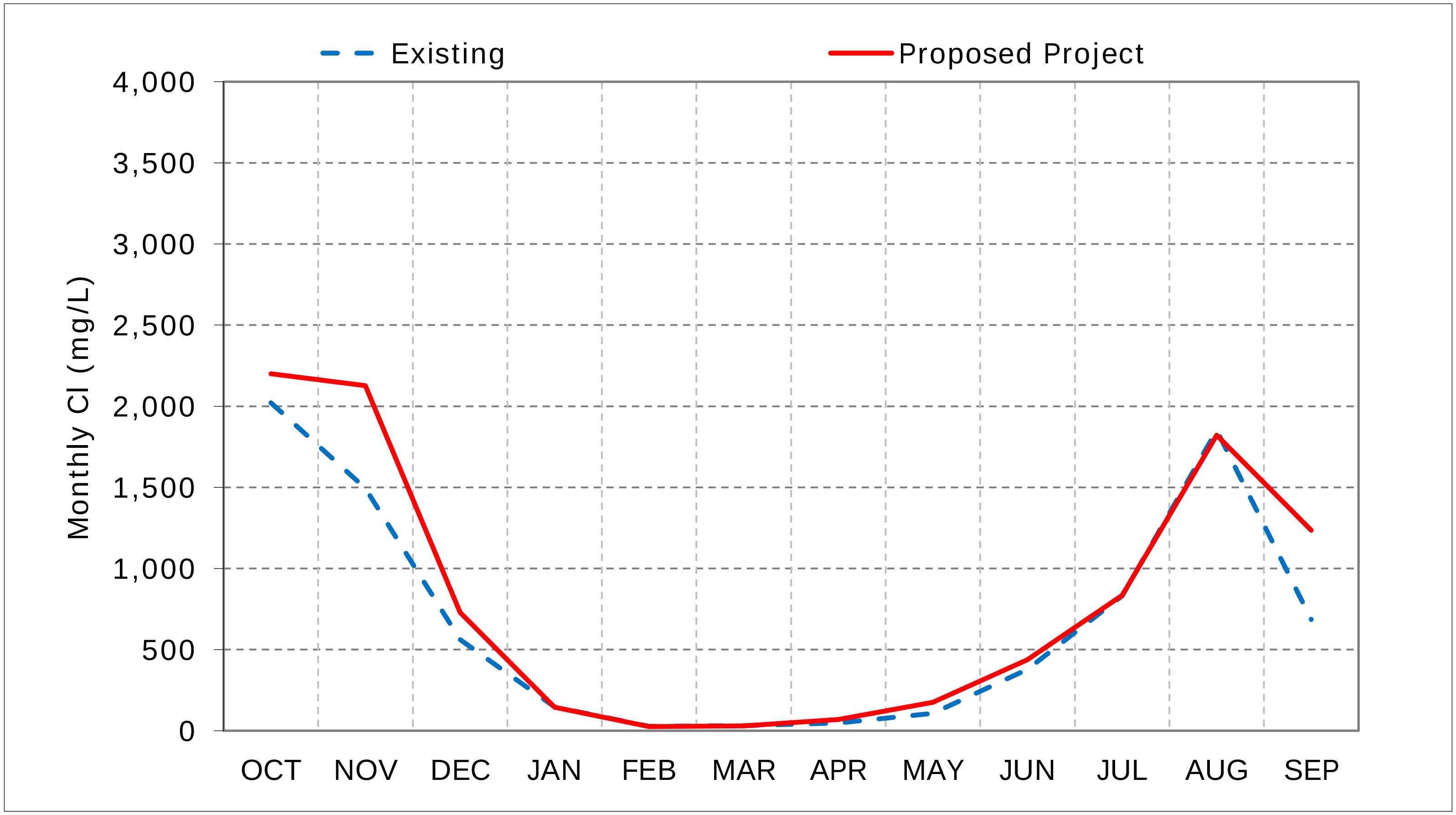
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 1-1. Sacramento River at Mallard Slough Chloride, Long-Term Average Cl



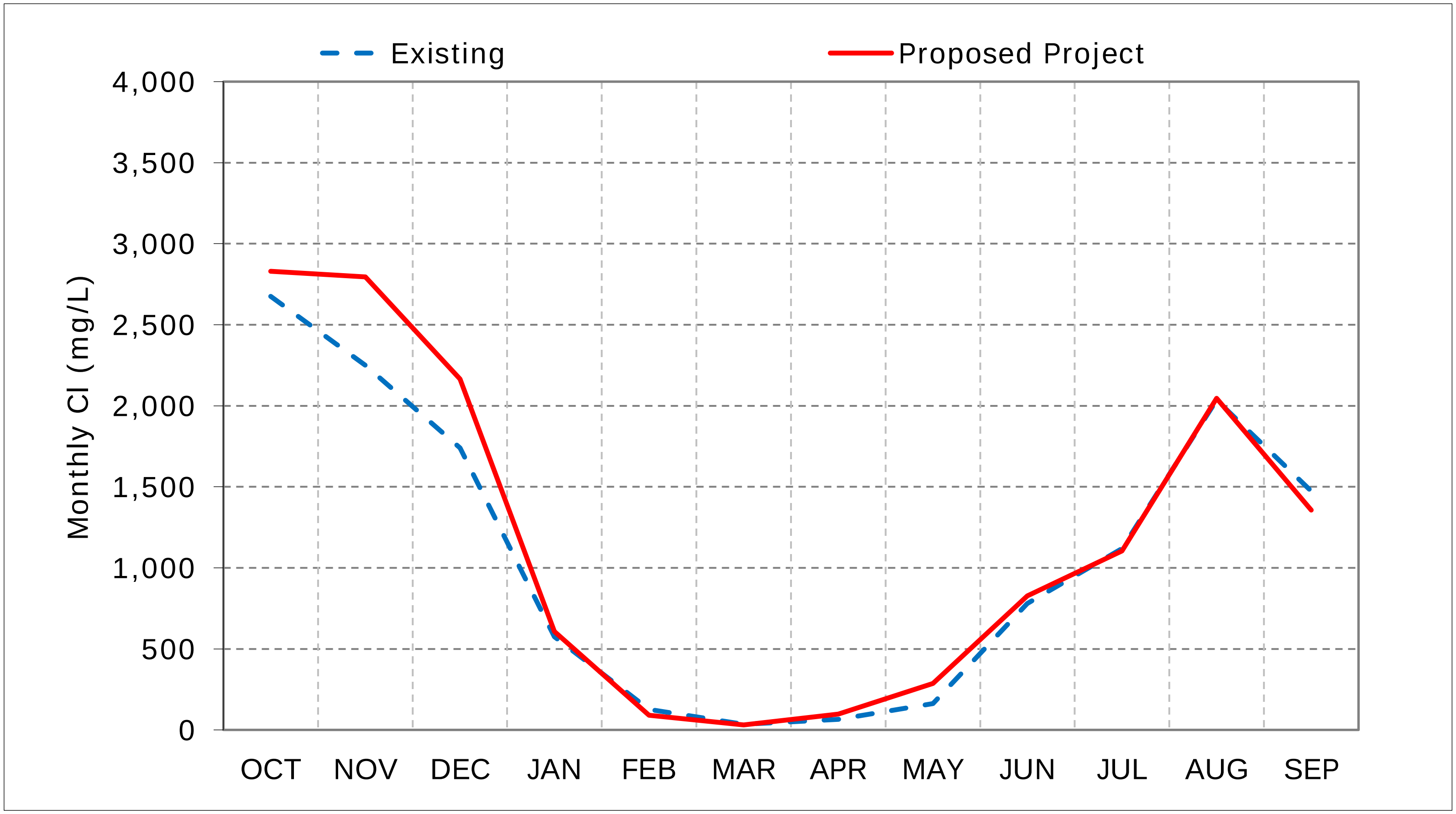
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 1-2. Sacramento River at Mallard Slough Chloride, Wet Year Average Cl



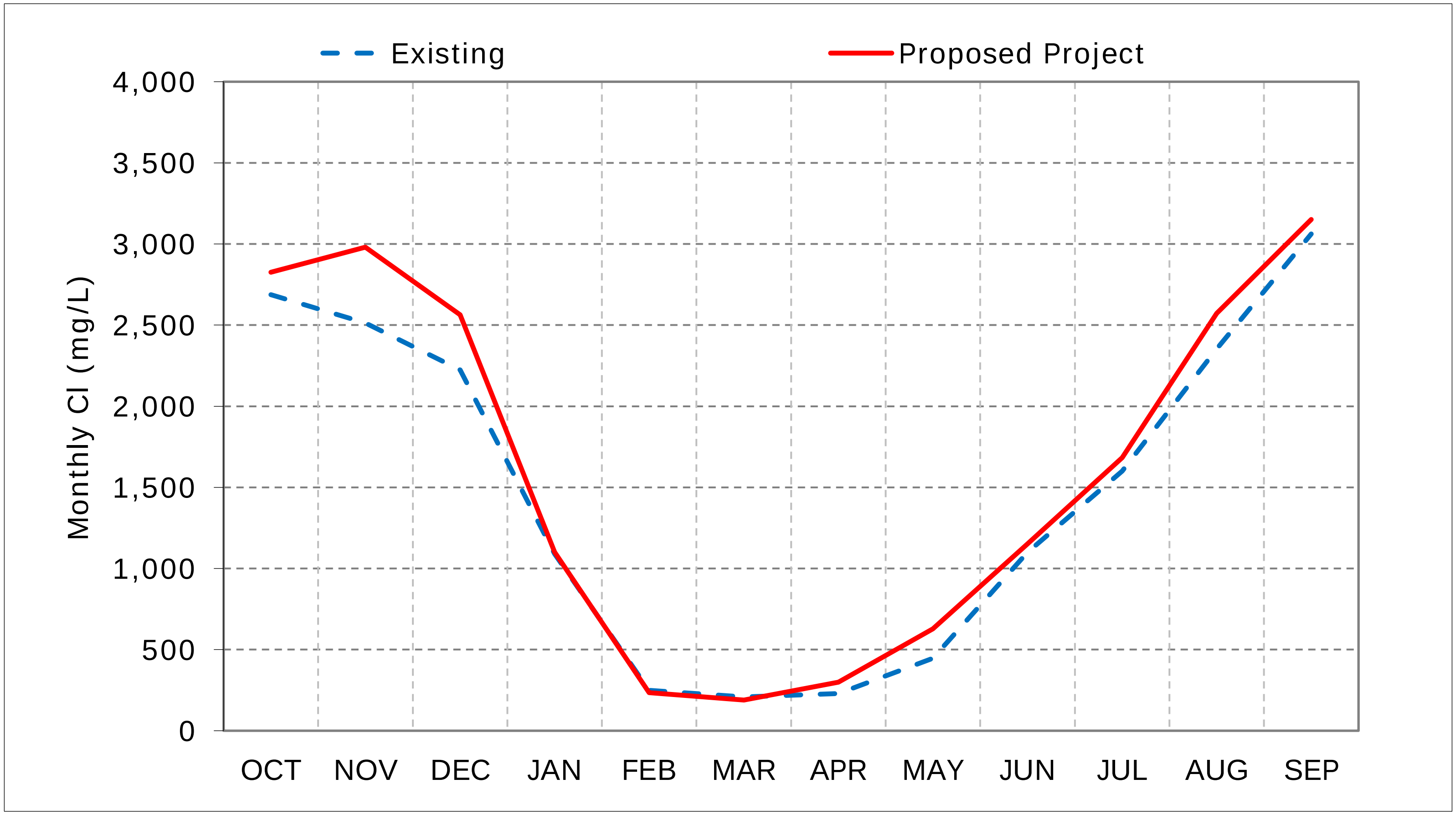
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 1-3. Sacramento River at Mallard Slough Chloride, Above Normal Year Aver



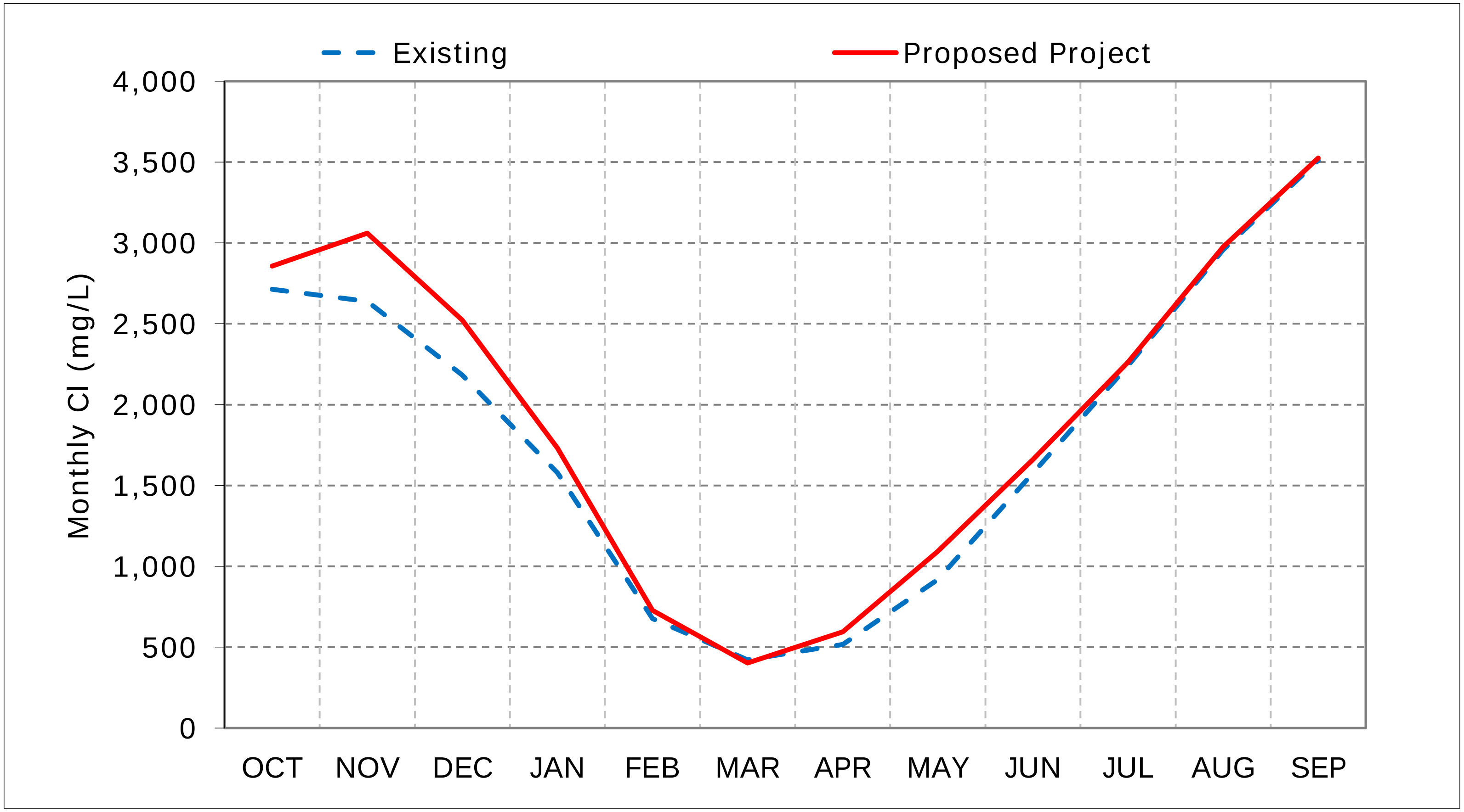
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 1-4. Sacramento River at Mallard Slough Chloride, Below Normal Year Aver



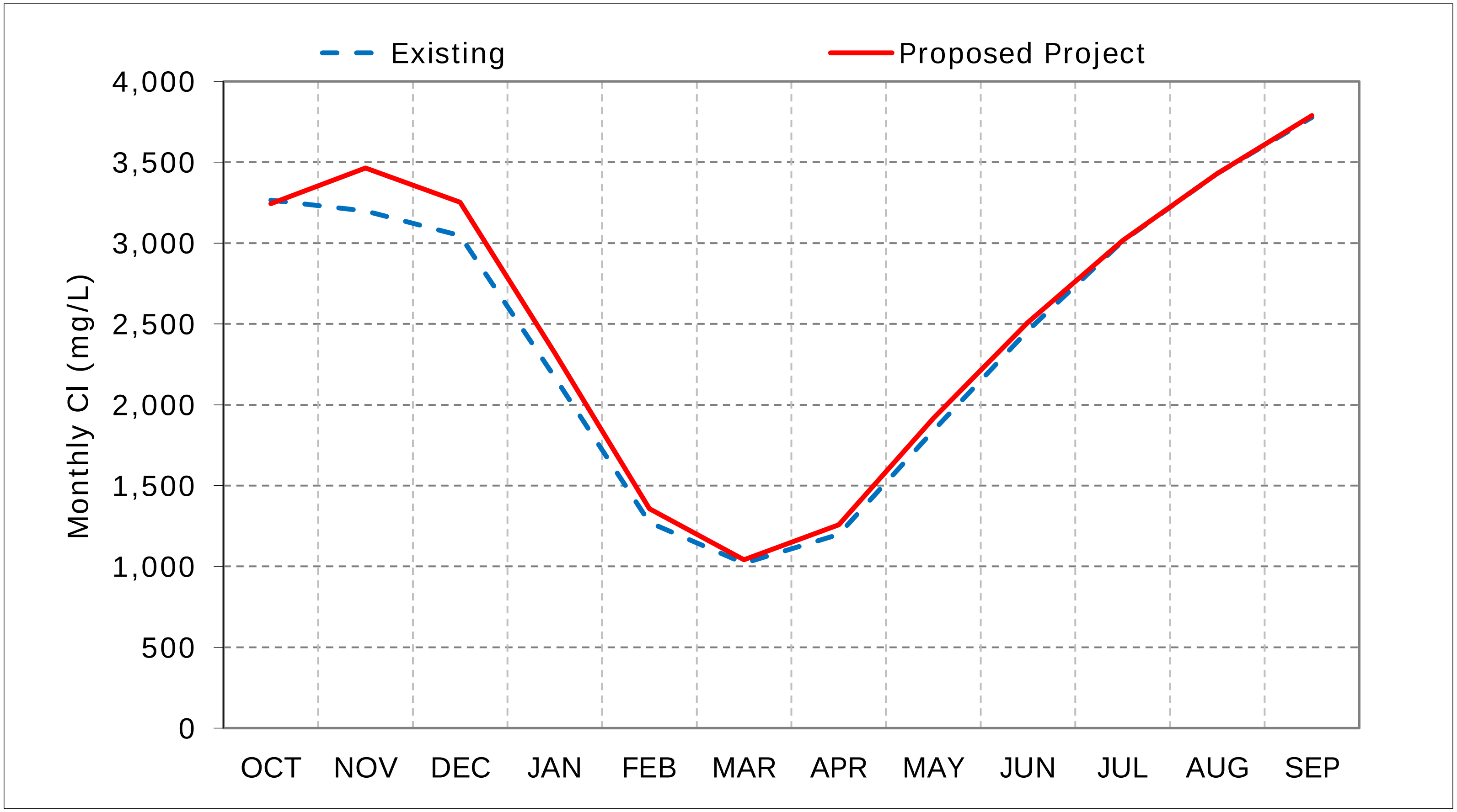
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 1-5. Sacramento River at Mallard Slough Chloride, Dry Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 1-6. Sacramento River at Mallard Slough Chloride, Critical Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 1-7. Sacramento River at Mallard Slough Chloride, January Cl

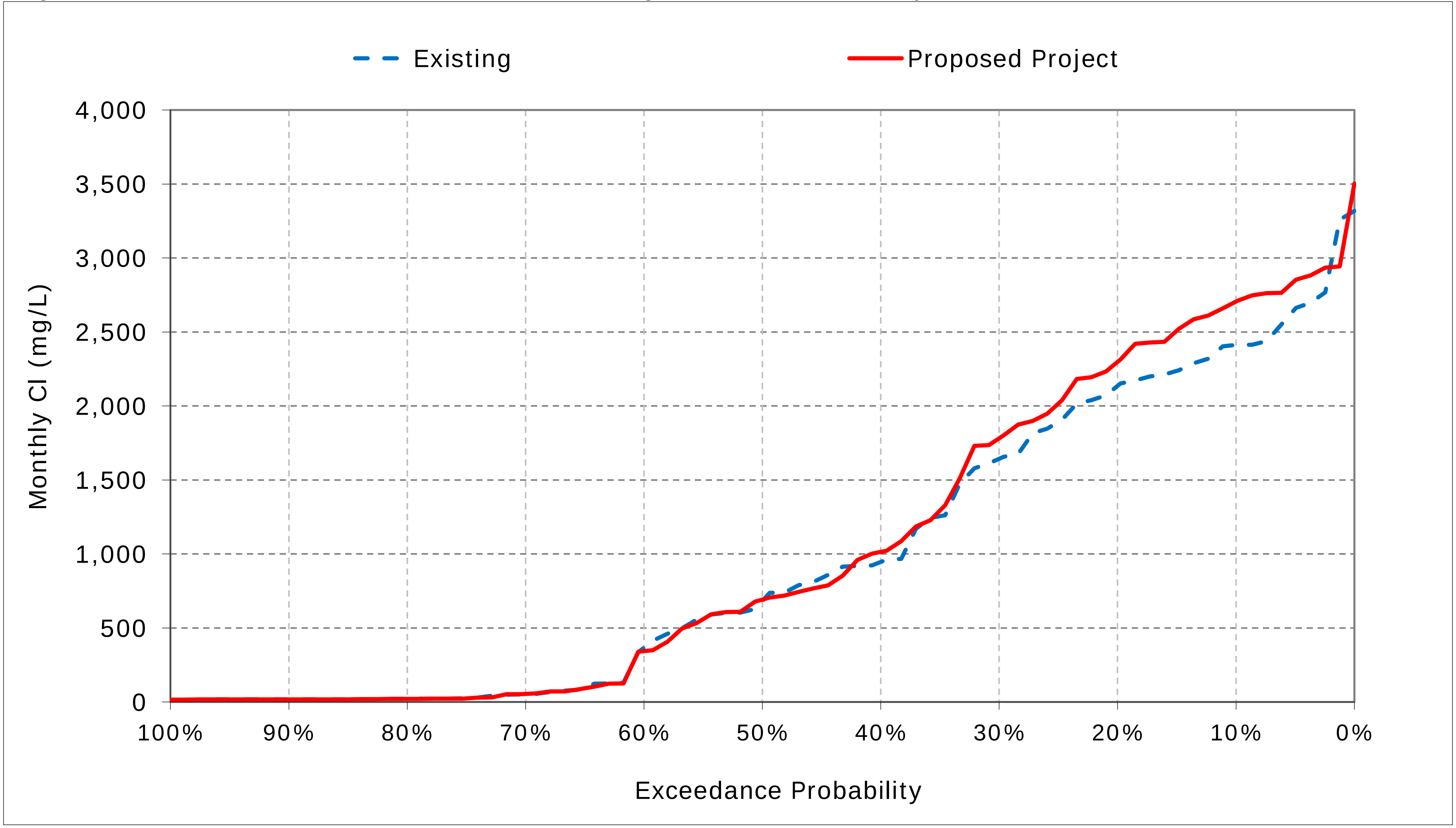


Figure 1-8. Sacramento River at Mallard Slough Chloride, February Cl

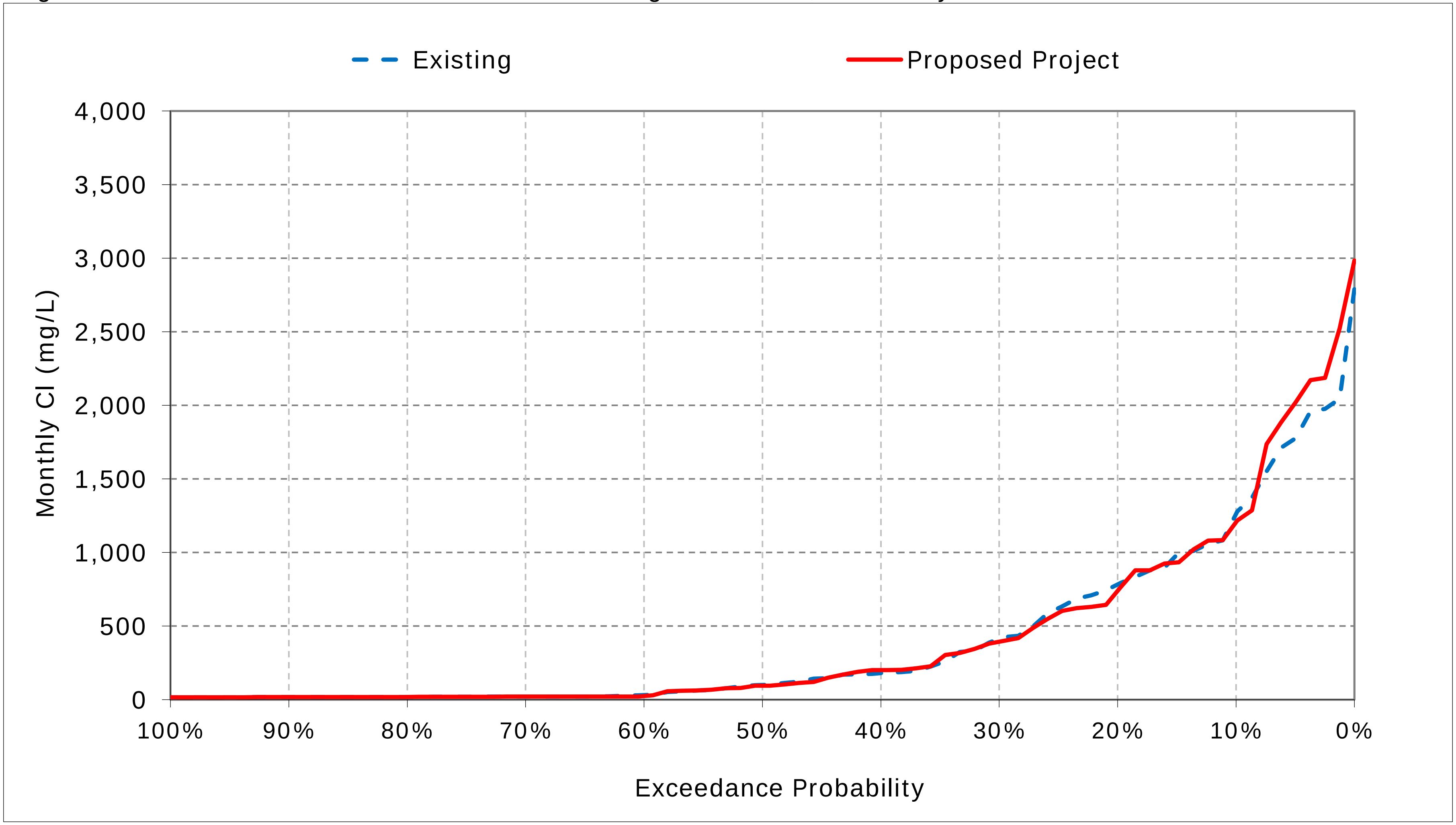


Figure 1-9. Sacramento River at Mallard Slough Chloride, March Cl

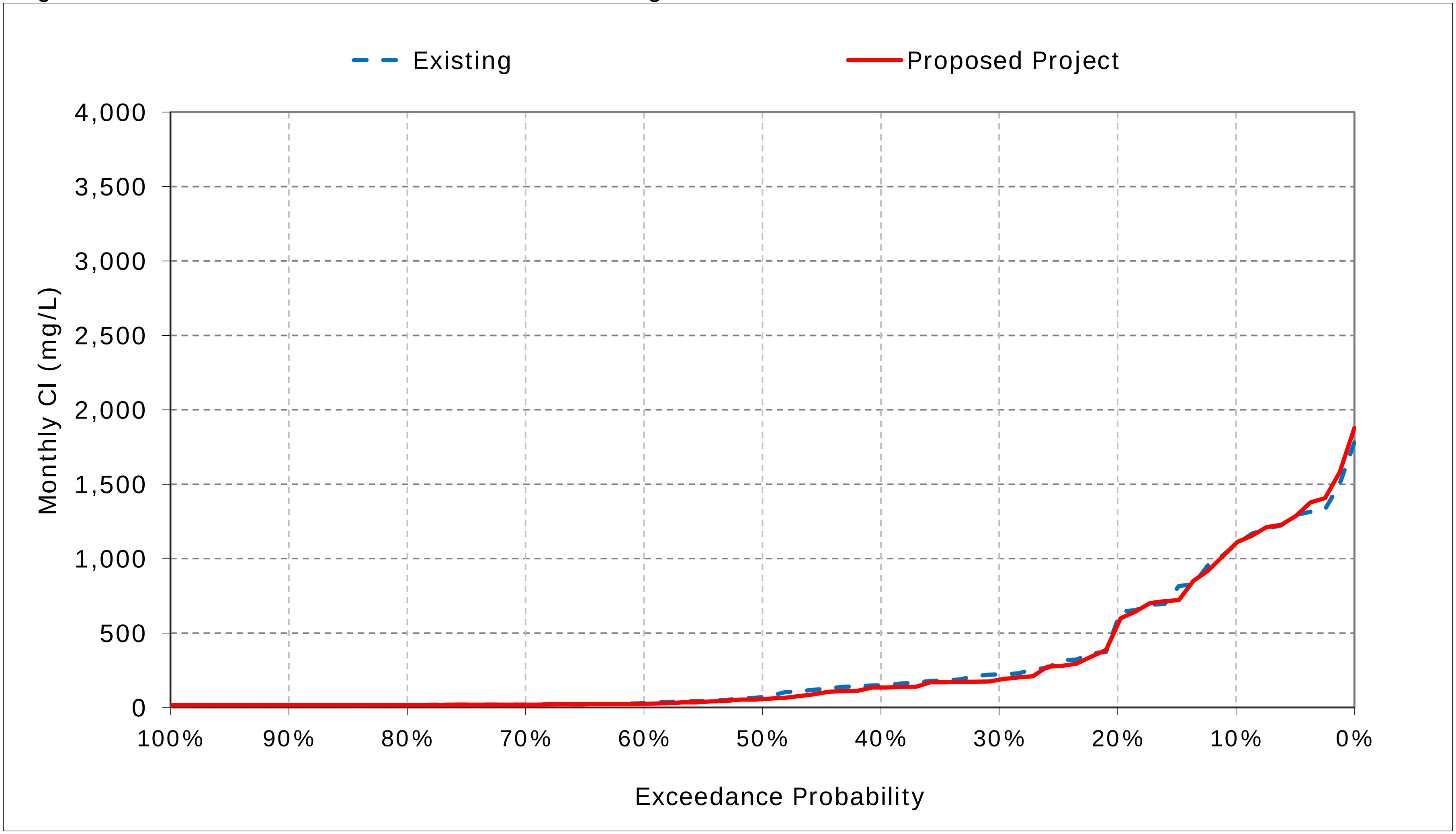


Figure 1-10. Sacramento River at Mallard Slough Chloride, April Cl

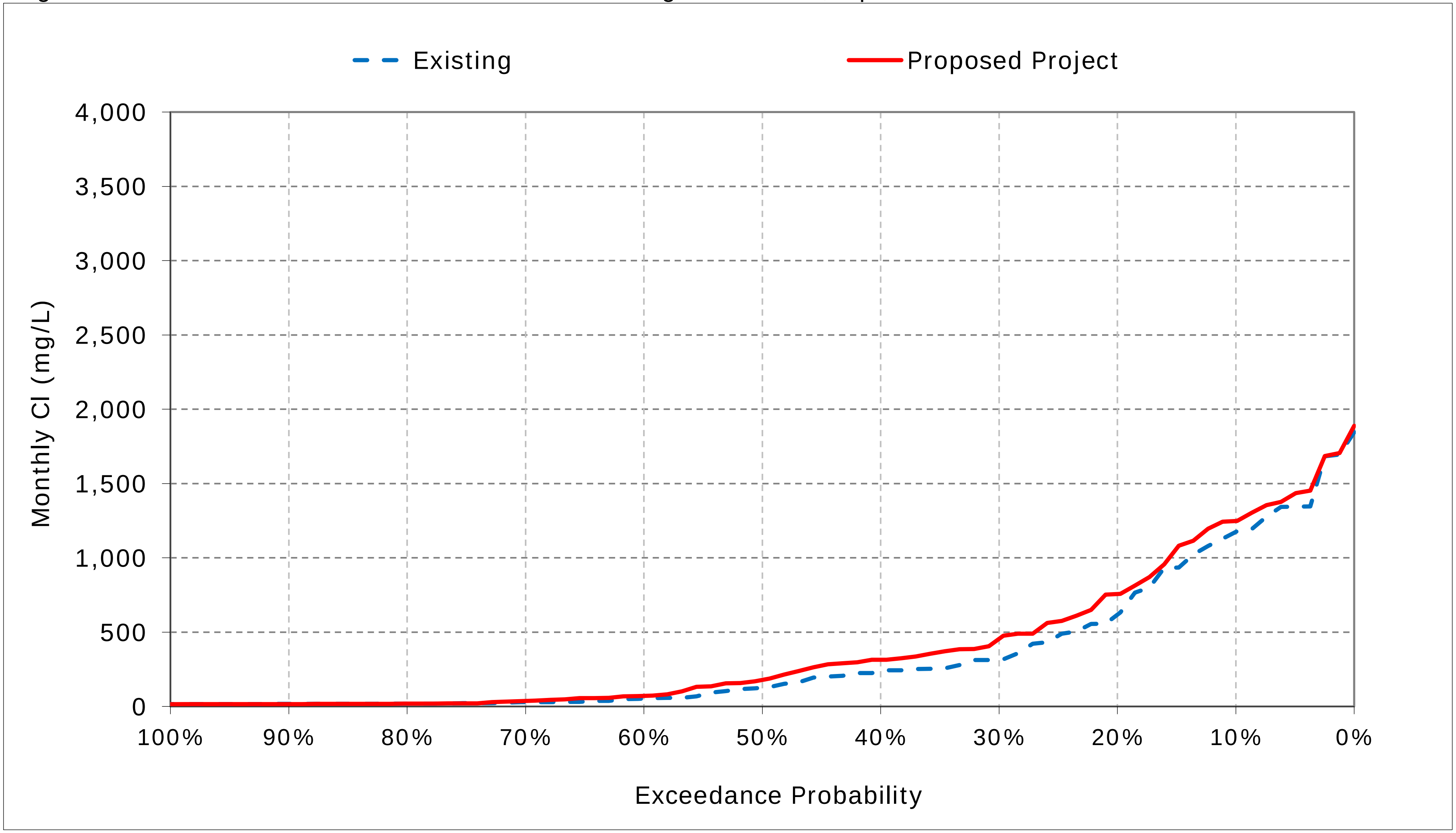


Figure 1-11. Sacramento River at Mallard Slough Chloride, May Cl

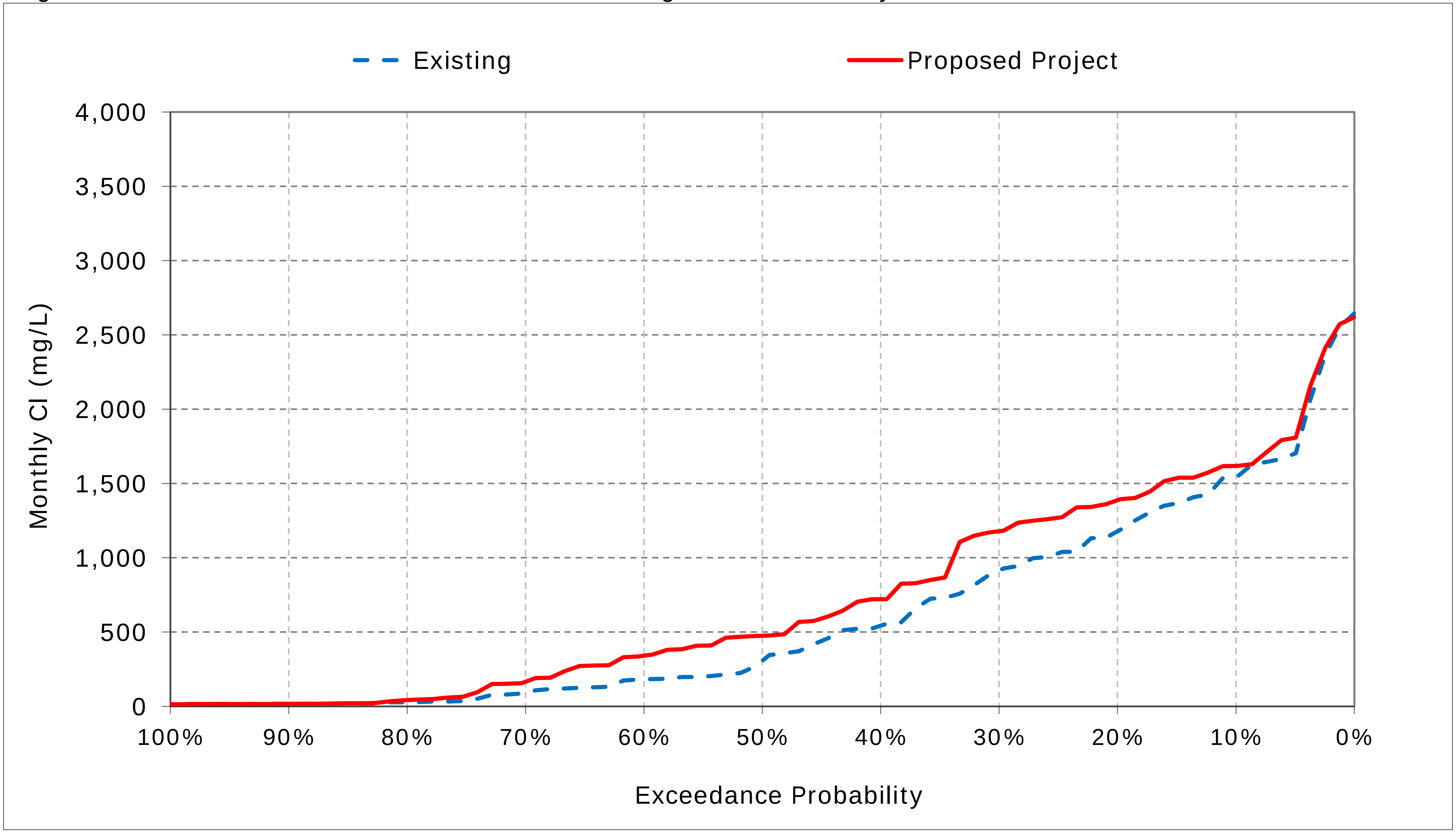


Figure 1-12. Sacramento River at Mallard Slough Chloride, June Cl

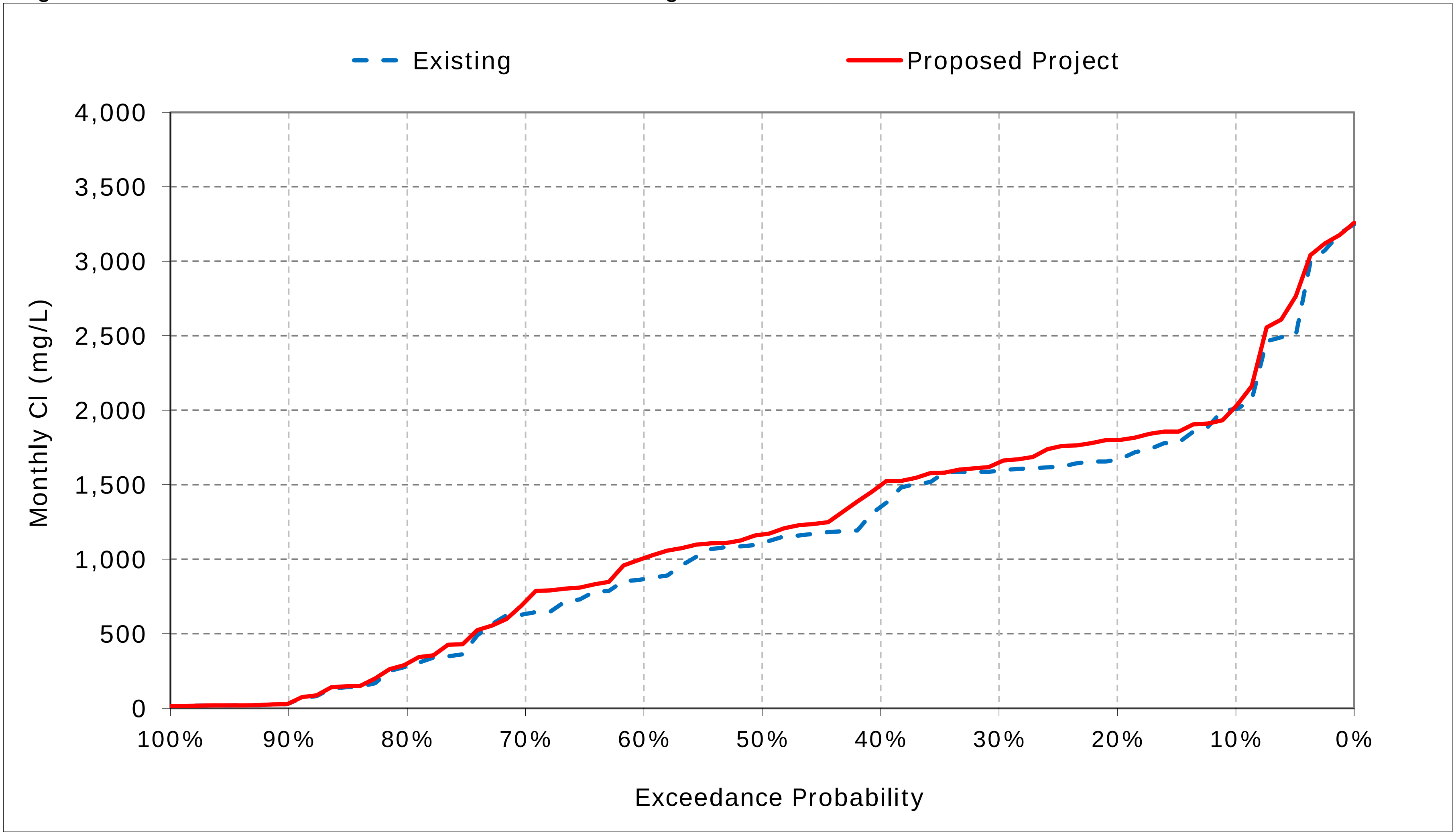


Figure 1-13. Sacramento River at Mallard Slough Chloride, July Cl

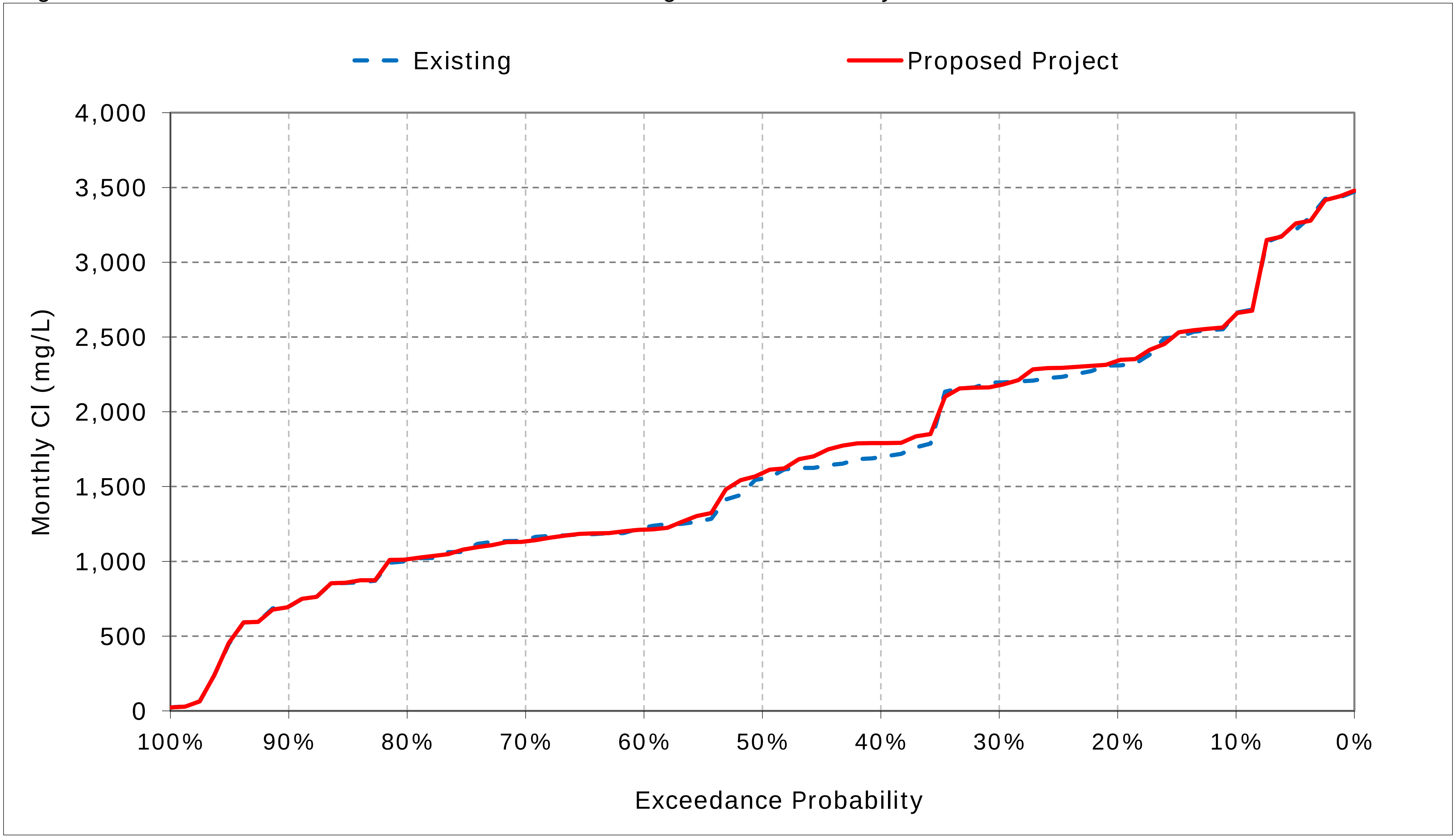


Figure 1-14. Sacramento River at Mallard Slough Chloride, August Cl

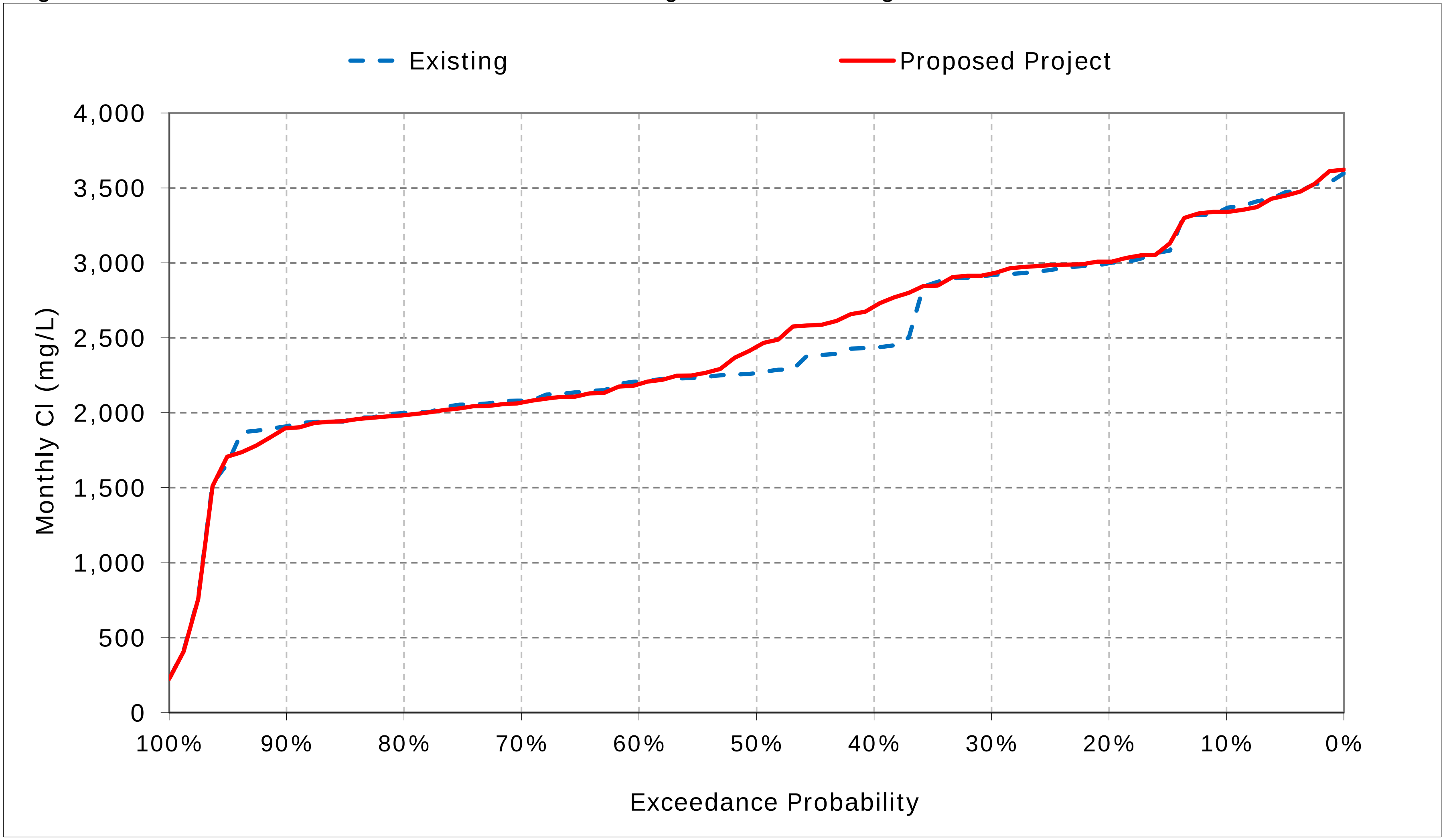


Figure 1-15. Sacramento River at Mallard Slough Chloride, September Cl

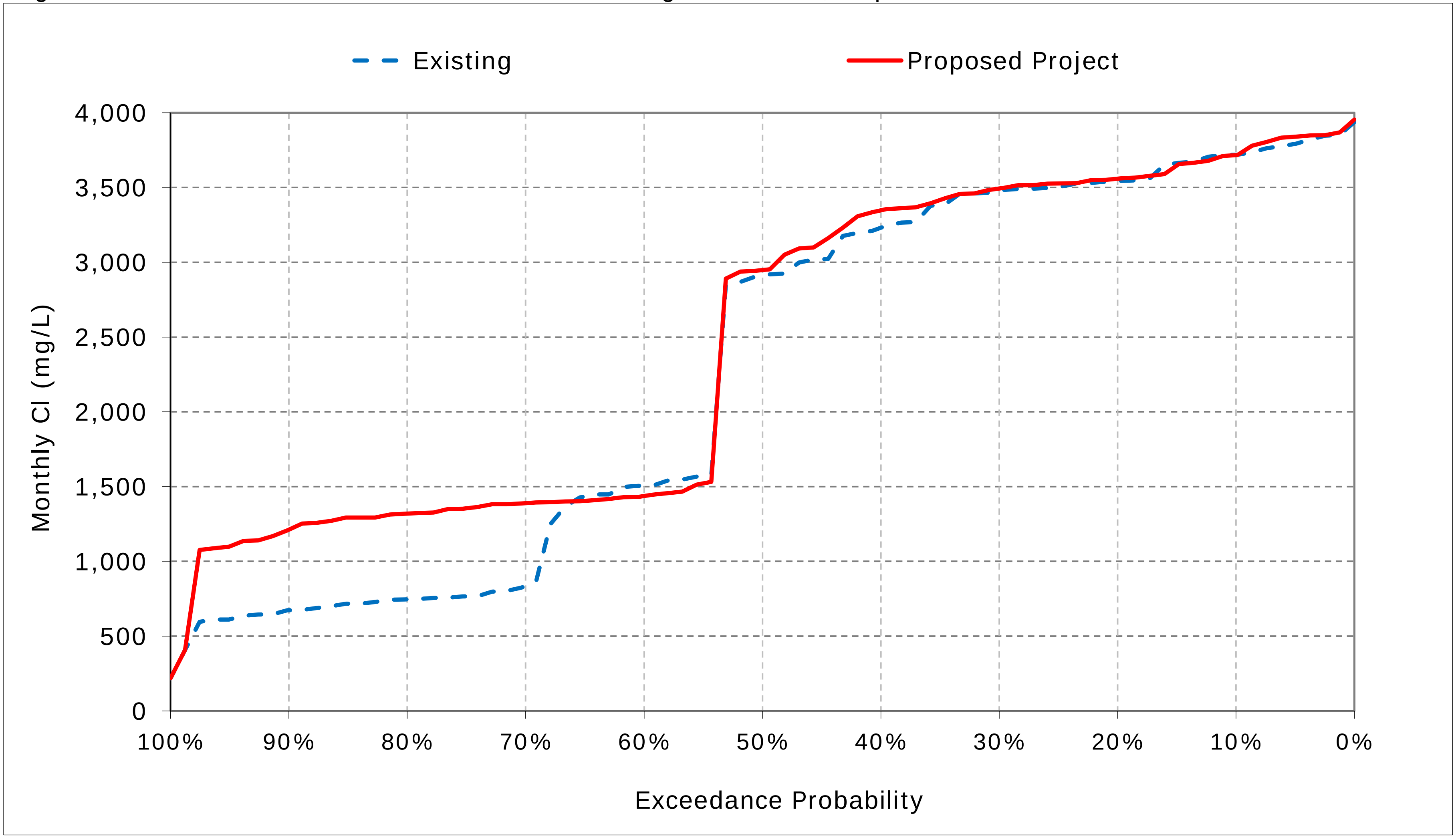


Figure 1-16. Sacramento River at Mallard Slough Chloride, October Cl

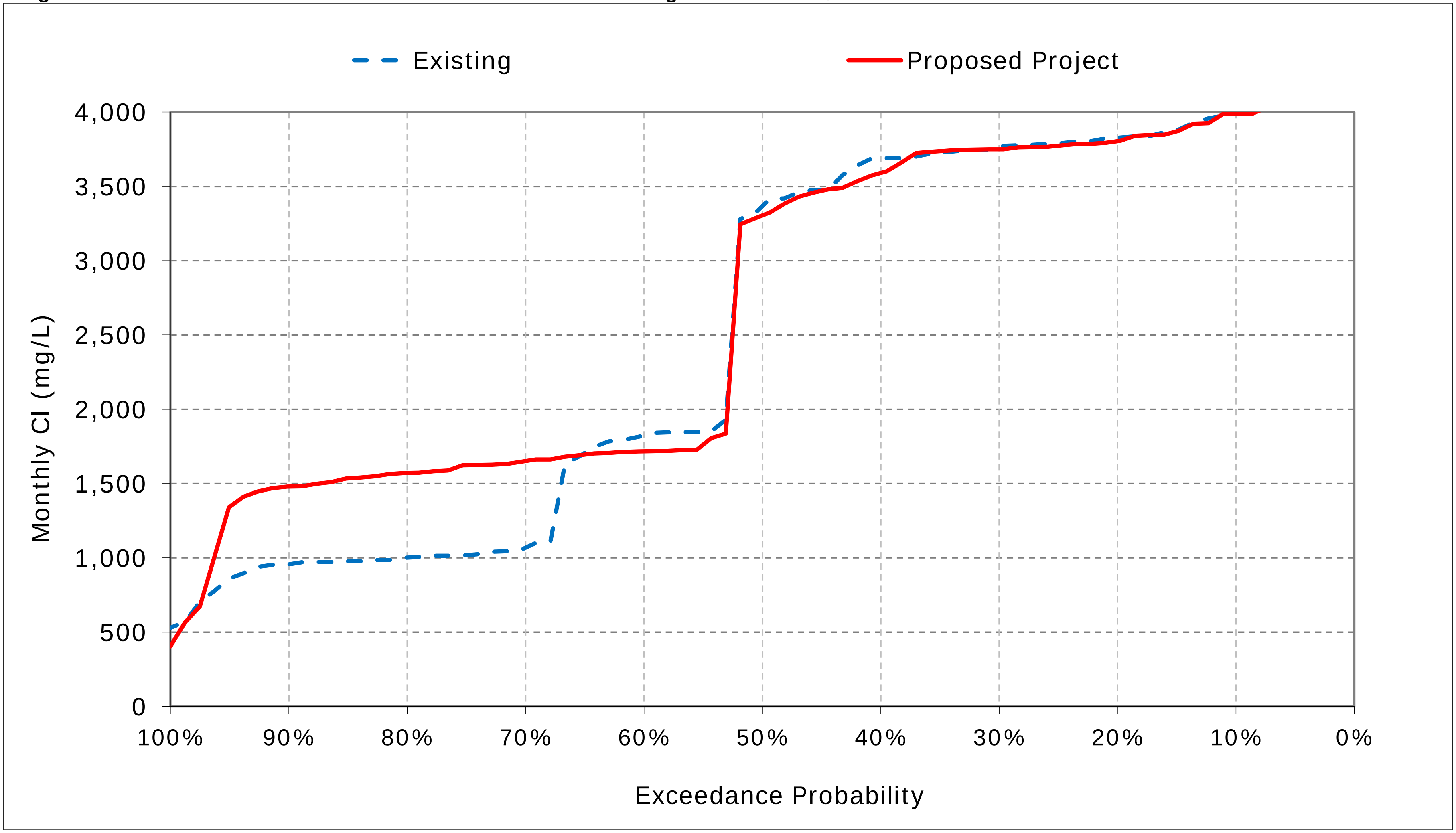


Figure 1-17. Sacramento River at Mallard Slough Chloride, November Cl

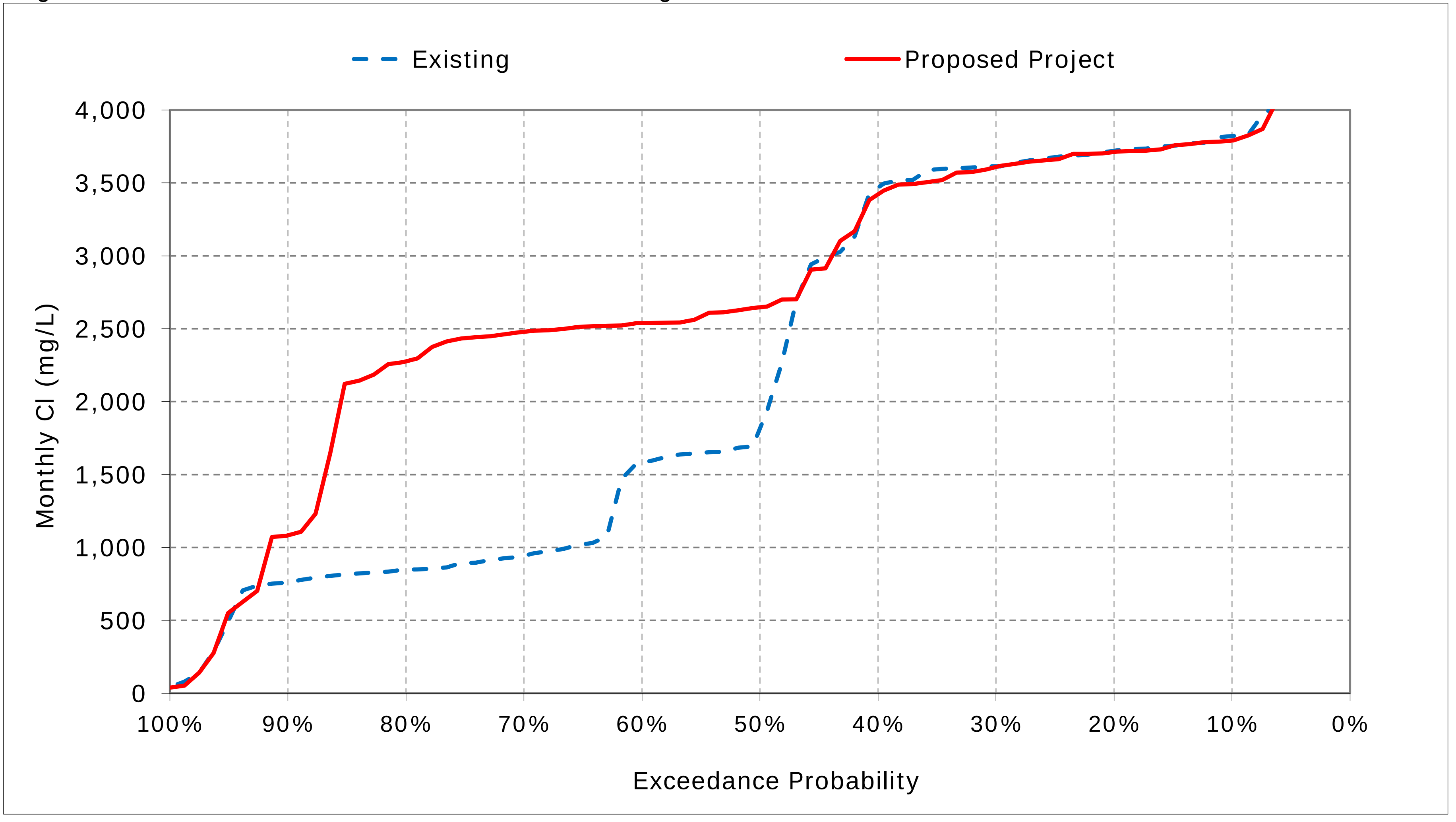


Figure 1-18. Sacramento River at Mallard Slough Chloride, December Cl

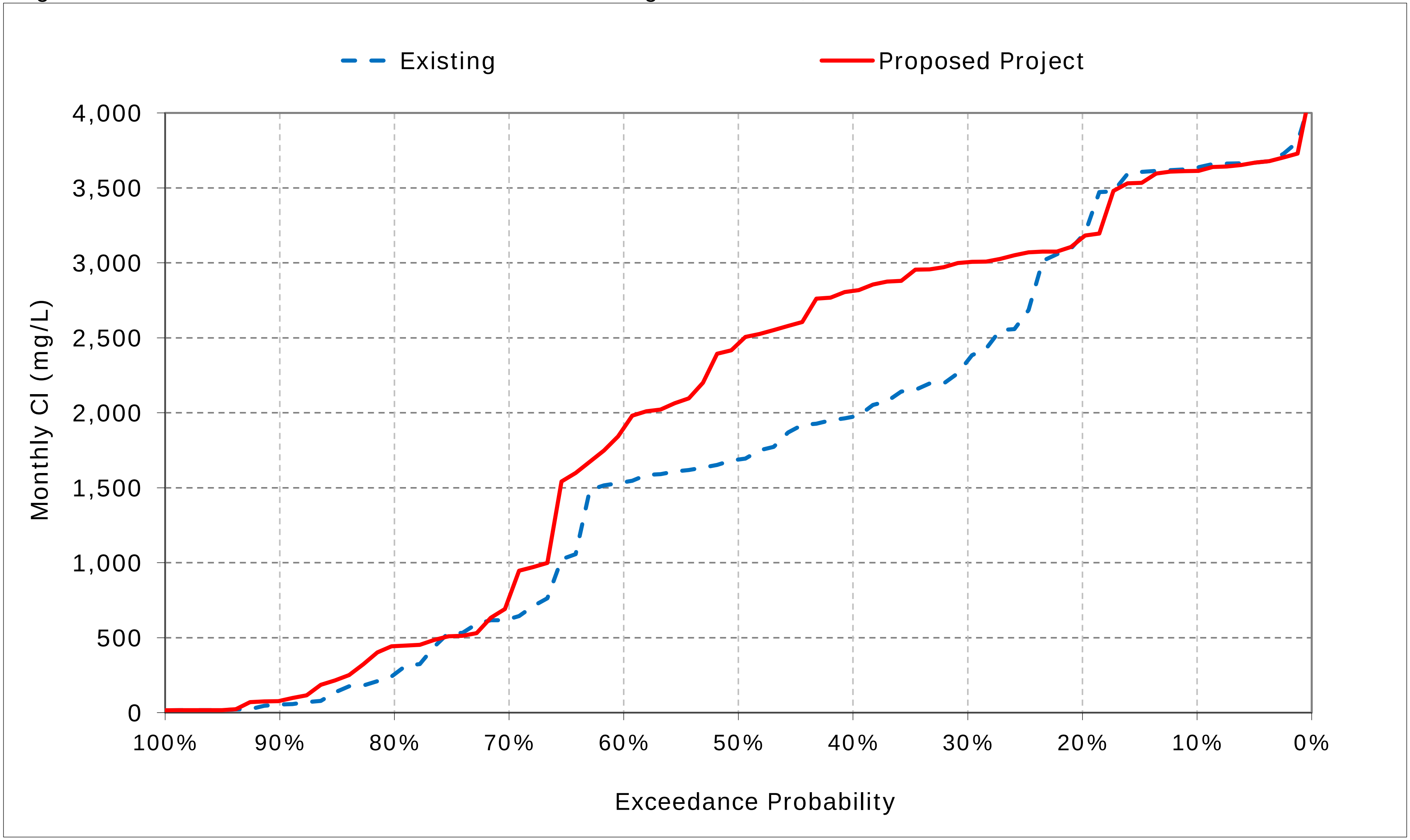


Table 2-1. Sacramento River at Rio Vista Chloride, Monthly Cl

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	90	70	55	25	18	17	17	18	20	30	55	80
20%	70	52	34	22	17	16	16	17	18	23	44	60
30%	64	46	23	20	17	16	16	16	17	21	40	56
40%	56	35	20	19	17	16	16	16	17	18	24	44
50%	42	18	19	18	16	15	15	16	17	17	23	31
60%	18	16	18	17	16	15	15	15	16	16	22	17
70%	16	15	16	17	15	15	15	15	16	16	21	15
80%	16	15	16	16	15	15	15	15	15	16	20	15
90%	16	15	15	15	15	15	15	15	15	15	20	15
Long Term												
Full Simulation Period[a]	45	35	26	19	16	16	16	16	19	22	31	39
Water Year Types[b]												
Wet (32%)	34	22	17	16	15	15	15	15	15	16	20	15
Above Normal (15%)	45	36	22	18	16	15	15	15	16	16	21	17
Below Normal (17%)	44	31	32	19	16	16	16	16	16	17	23	38
Dry (22%)	50	43	27	21	17	16	16	16	18	22	41	57
Critical (15%)	61	55	45	25	19	17	17	21	32	45	60	87

Proposed Project

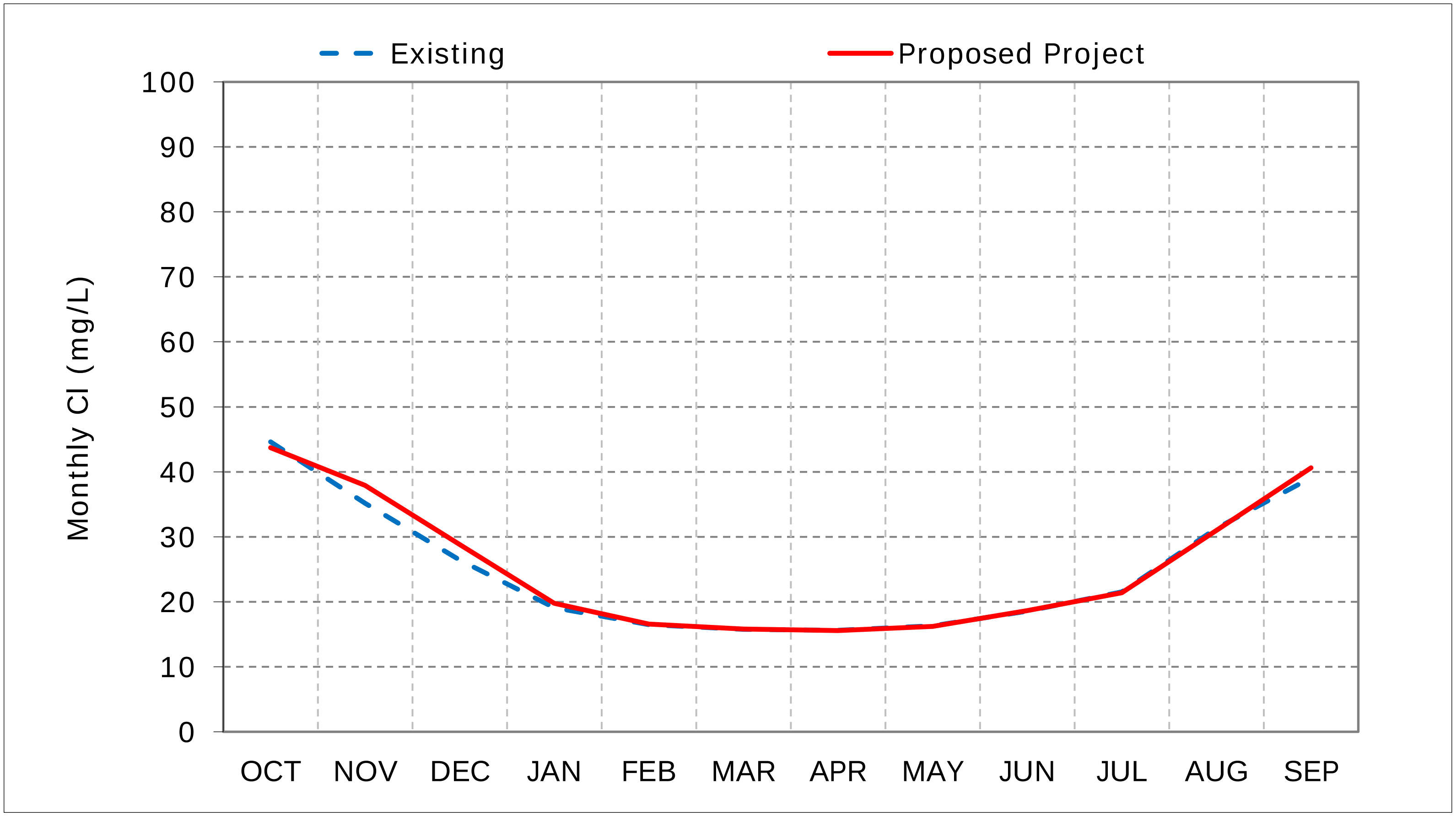
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	84	70	54	27	18	17	17	18	20	29	56	77
20%	70	53	38	23	17	16	16	17	18	23	43	60
30%	63	47	30	21	17	16	16	16	18	21	39	56
40%	50	36	27	18	17	16	16	16	17	17	25	51
50%	38	24	23	18	16	15	15	15	16	17	24	35
60%	17	24	20	17	16	15	15	15	16	16	22	17
70%	17	23	17	16	15	15	15	15	15	16	21	17
80%	17	21	16	16	15	15	15	15	15	16	20	17
90%	16	16	15	15	15	15	15	15	15	15	20	16
Long Term												
Full Simulation Period[a]	44	38	29	20	17	16	16	16	19	21	31	41
Water Year Types[b]												
Wet (32%)	33	25	17	16	15	15	15	15	15	16	20	17
Above Normal (15%)	43	39	25	18	16	15	15	15	16	16	21	17
Below Normal (17%)	44	34	35	19	16	16	15	15	16	17	24	43
Dry (22%)	49	46	31	22	17	16	16	16	18	22	41	58
Critical (15%)	60	57	48	27	19	17	17	21	33	44	58	87

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	-7	-1	0	3	0	0	0	0	0	0	0	-3
20%	0	1	4	1	0	0	0	0	0	0	-1	0
30%	-1	1	7	1	0	0	0	0	0	0	-1	1
40%	-5	1	7	0	0	0	0	0	0	0	1	7
50%	-3	6	5	0	0	0	0	0	0	0	1	4
60%	0	7	3	0	0	0	0	0	0	0	0	0
70%	1	8	0	0	0	0	0	0	0	0	0	1
80%	1	6	0	0	0	0	0	0	0	0	0	2
90%	1	1	0	0	0	0	0	0	0	0	0	1
Long Term												
Full Simulation Period[a]	-1	3	2	1	0	0	0	0	0	0	0	2
Water Year Types[b]												
Wet (32%)	-1	3	1	0	0	0	0	0	0	0	0	1
Above Normal (15%)	-3	3	3	0	0	0	0	0	0	0	0	0
Below Normal (17%)	0	3	3	0	0	0	0	0	0	0	1	5
Dry (22%)	0	3	4	1	0	0	0	0	0	0	0	1
Critical (15%)	-1	2	2	2	1	0	0	0	1	-1	-2	0

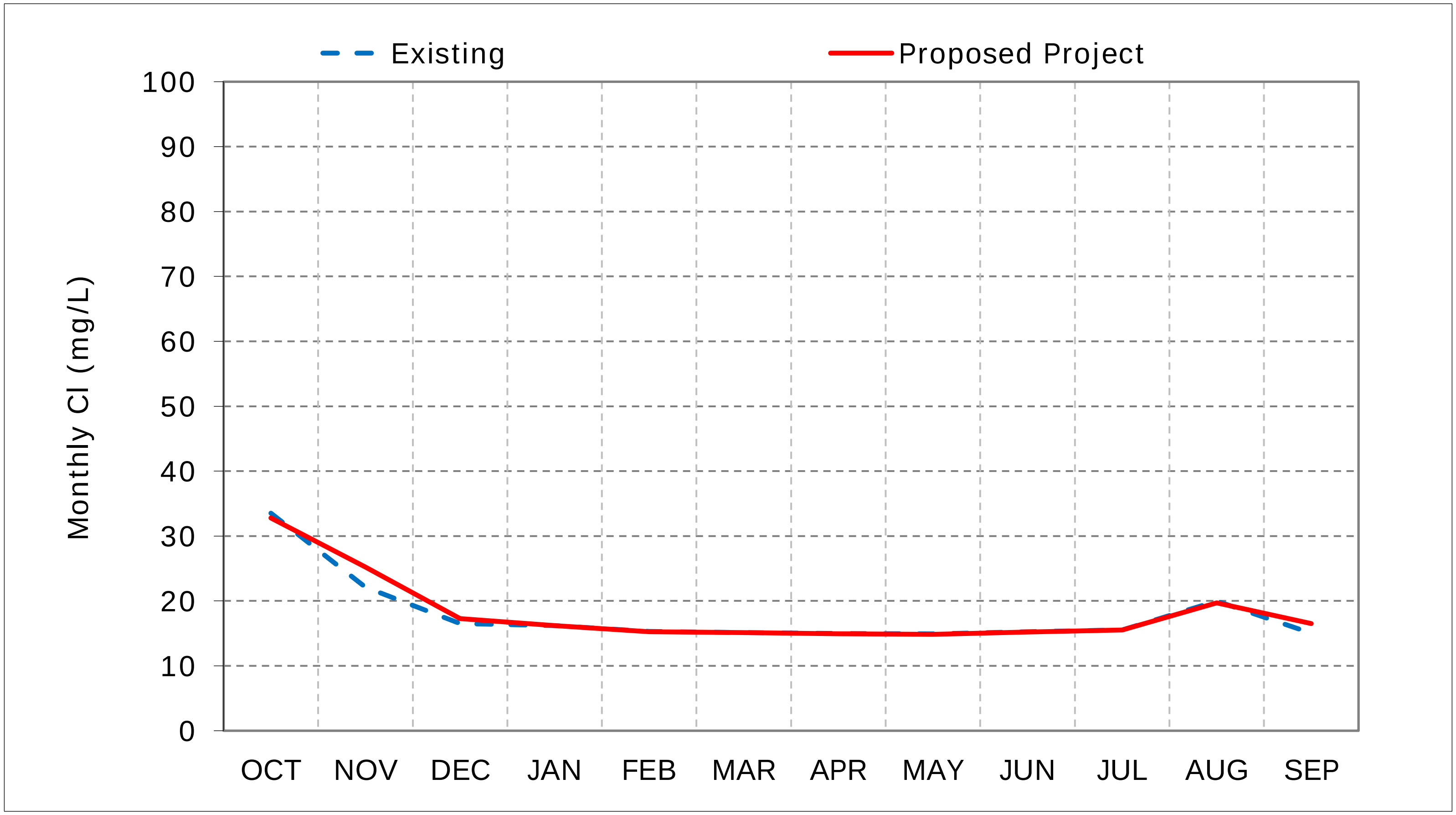
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 2-1. Sacramento River at Rio Vista Chloride, Long-Term Average Cl



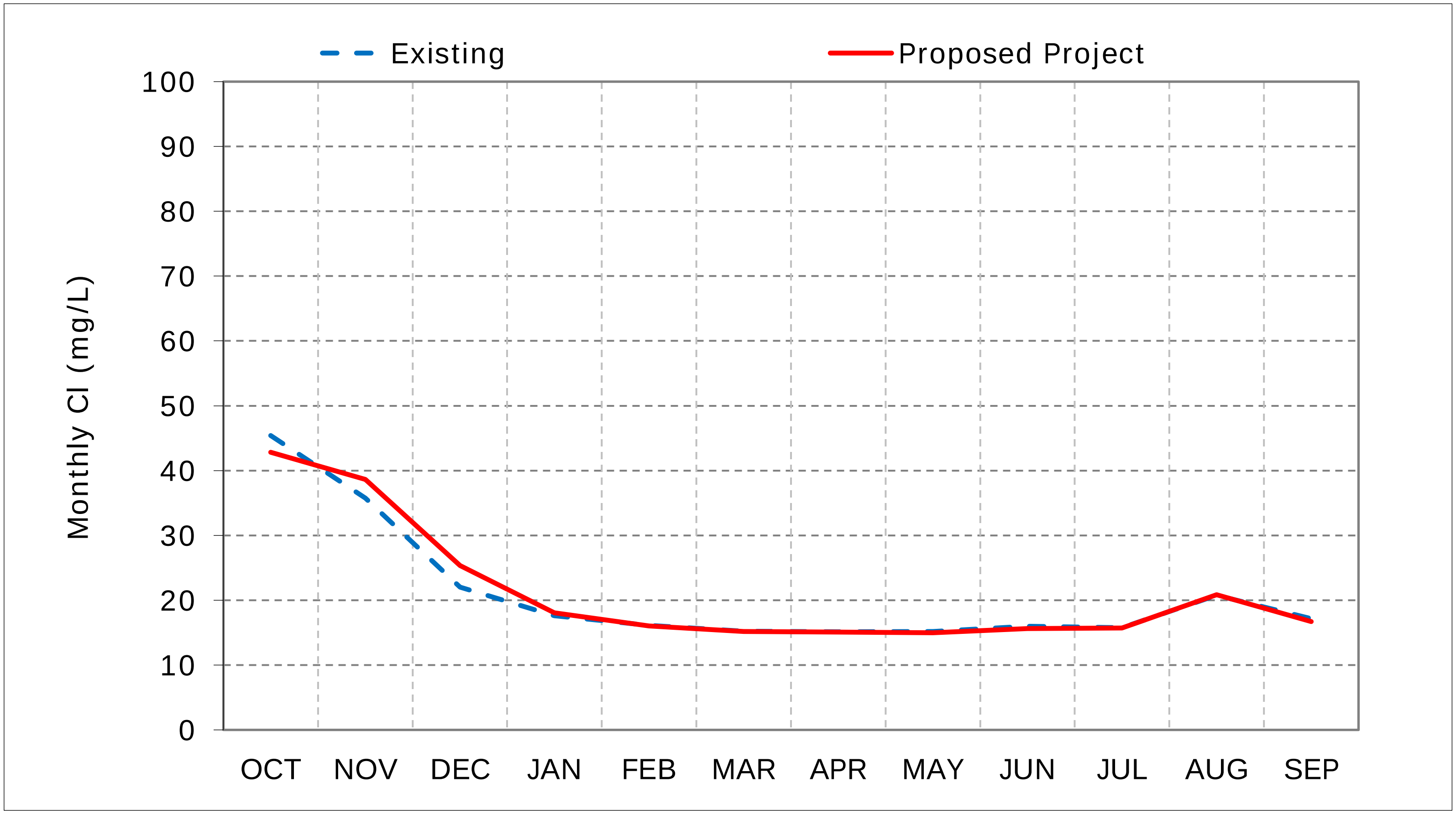
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 2-2. Sacramento River at Rio Vista Chloride, Wet Year Average Cl



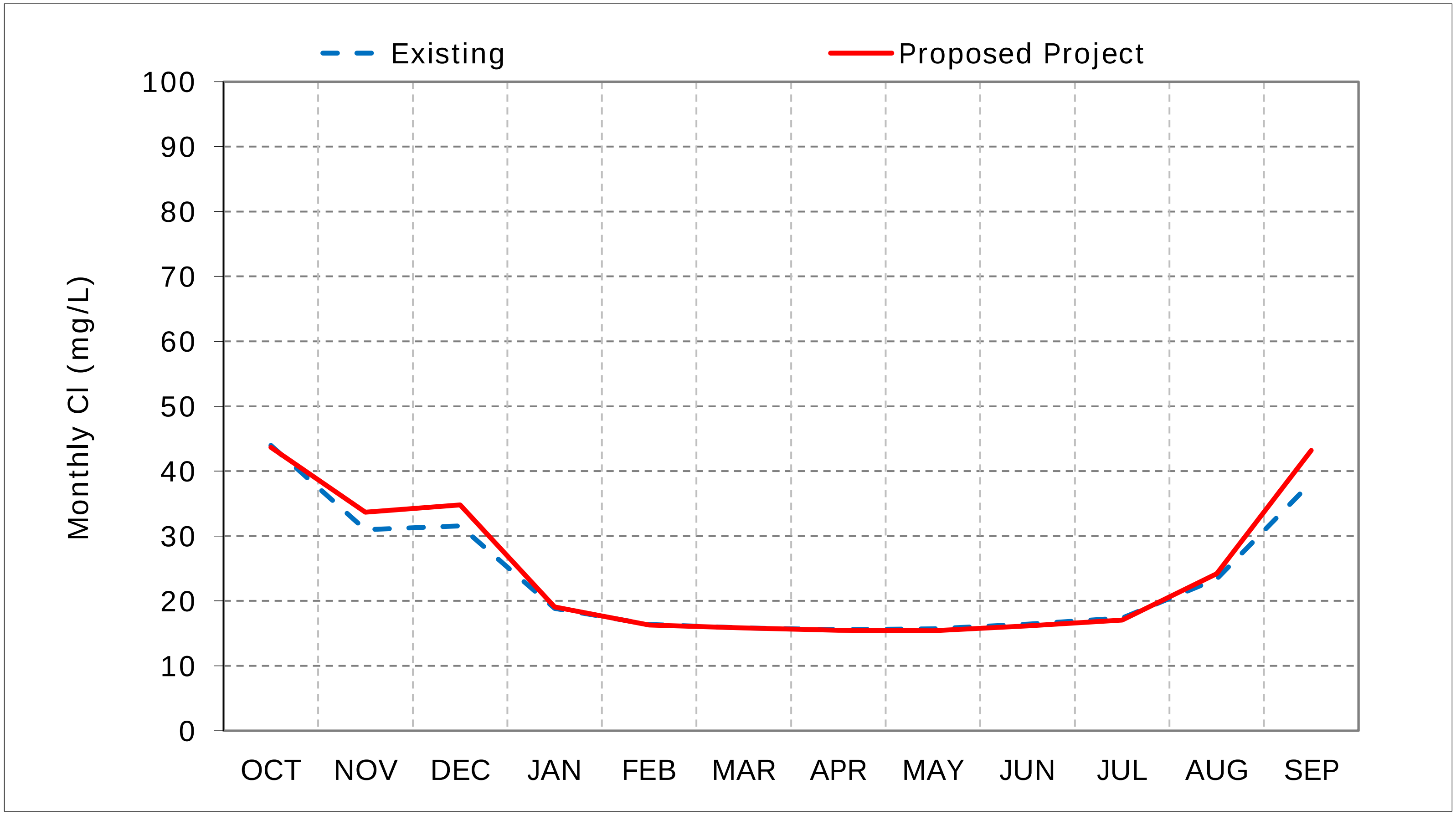
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 2-3. Sacramento River at Rio Vista Chloride, Above Normal Year Average Cl



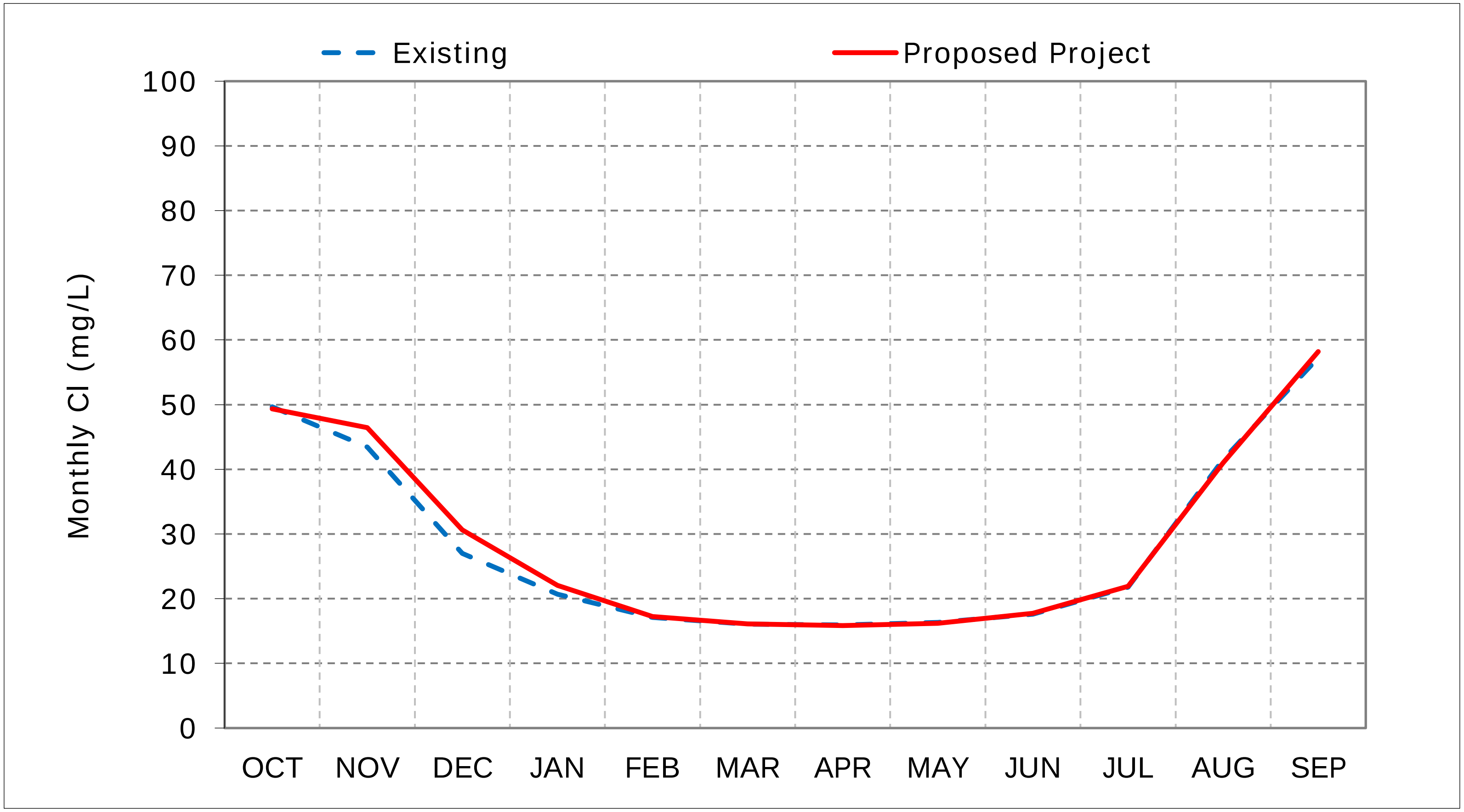
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 2-4. Sacramento River at Rio Vista Chloride, Below Normal Year Average Cl



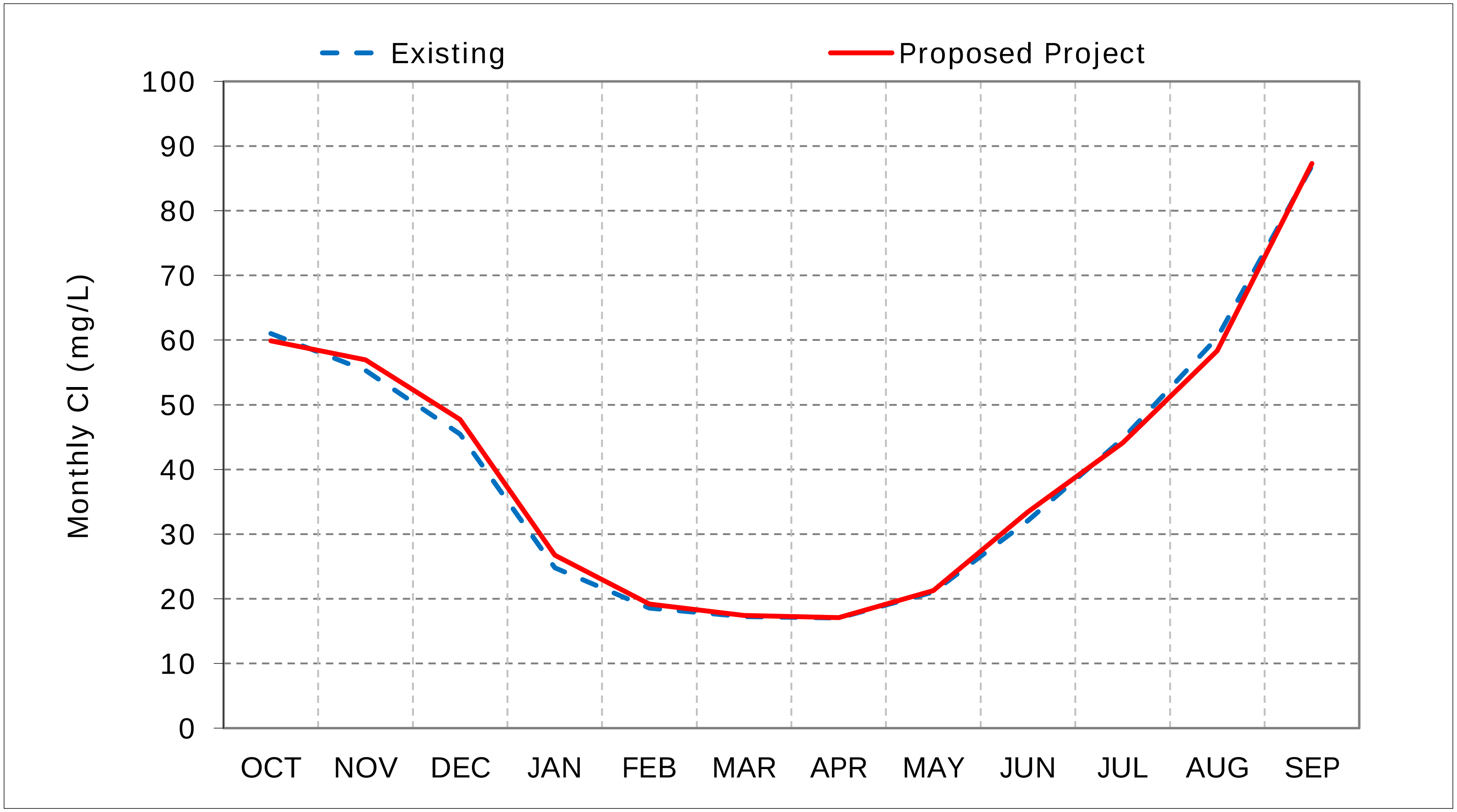
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 2-5. Sacramento River at Rio Vista Chloride, Dry Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 2-6. Sacramento River at Rio Vista Chloride, Critical Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 2-7. Sacramento River at Rio Vista Chloride, January Cl

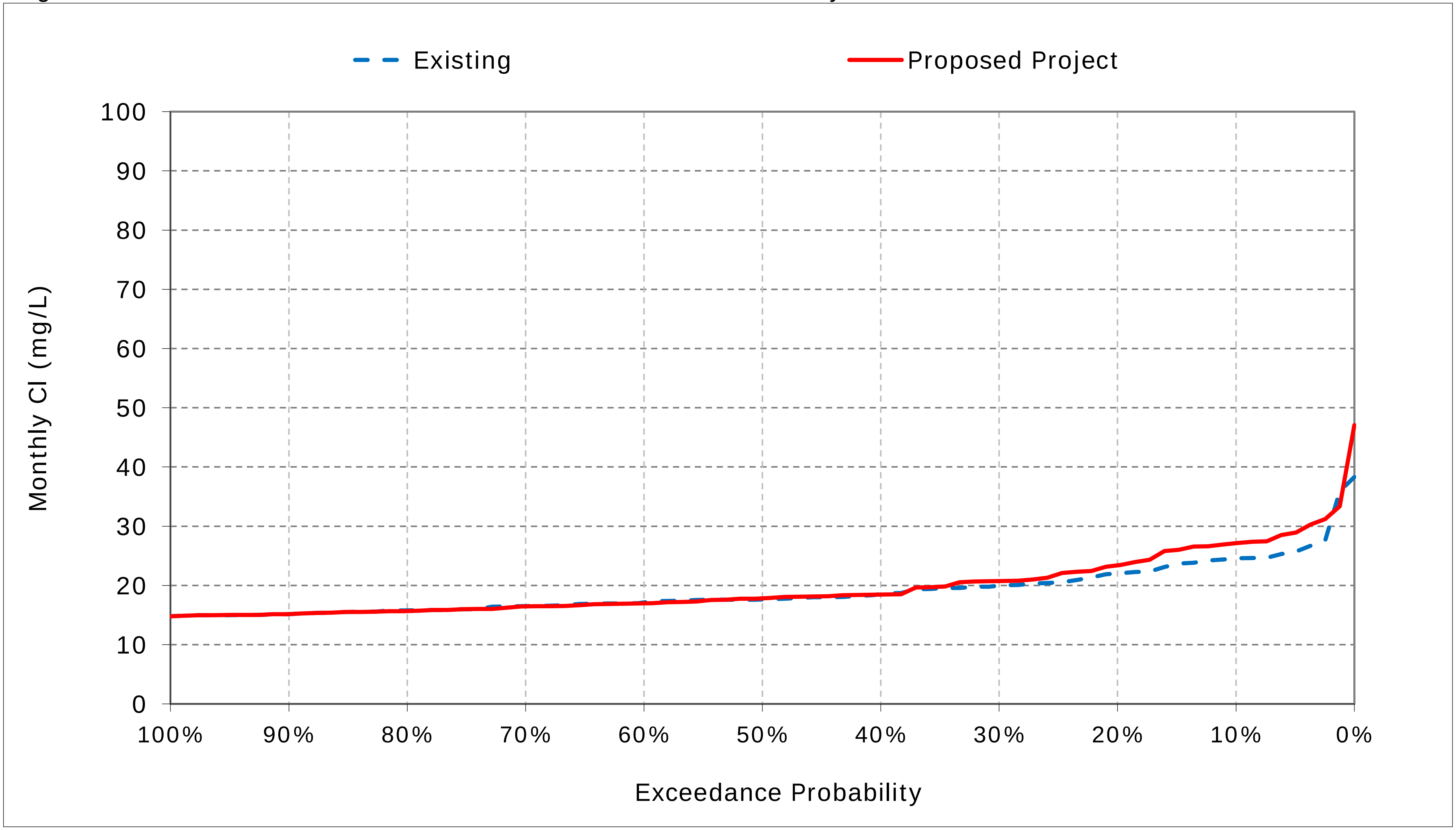


Figure 2-8. Sacramento River at Rio Vista Chloride, February Cl

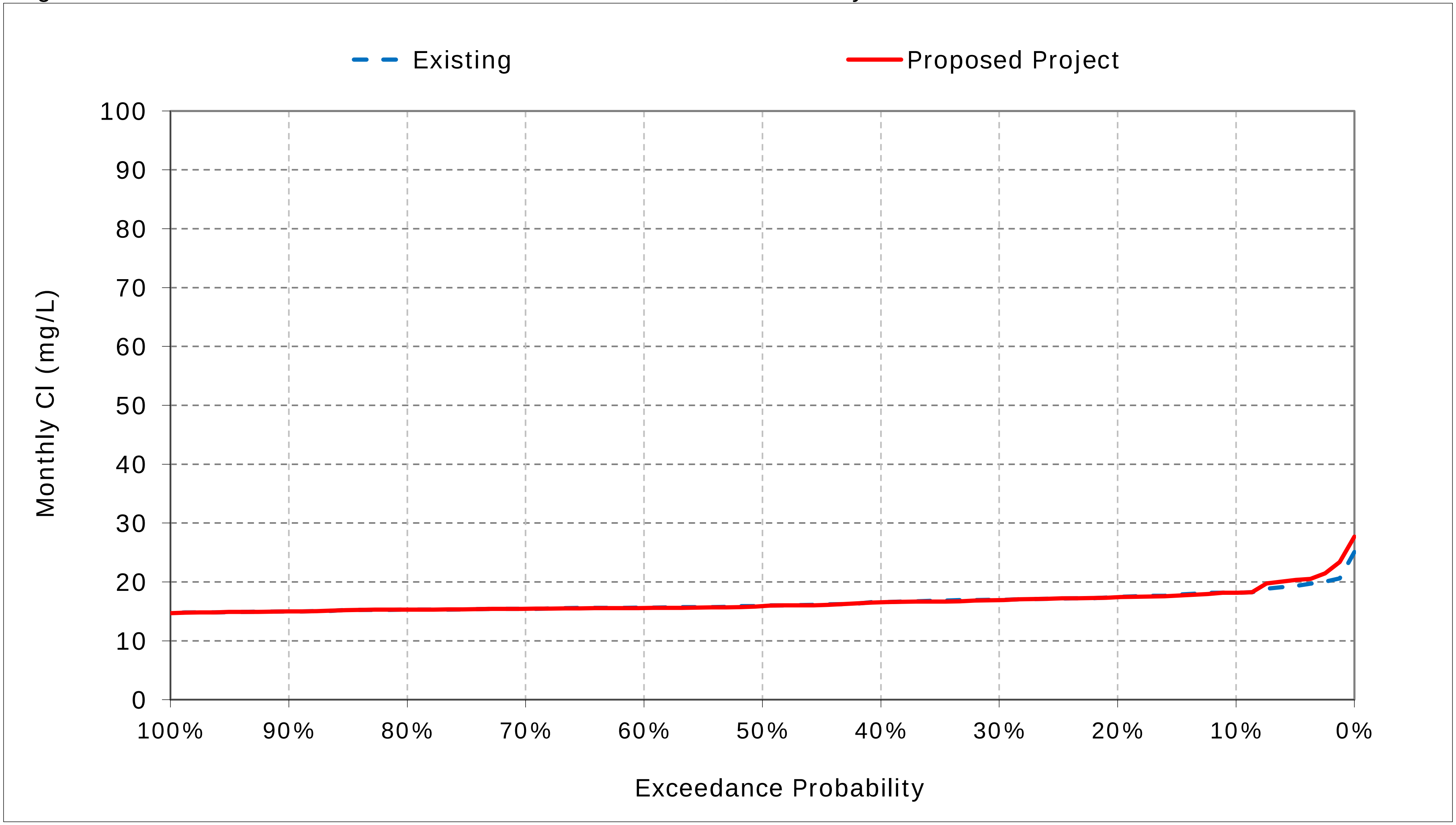


Figure 2-9. Sacramento River at Rio Vista Chloride, March Cl

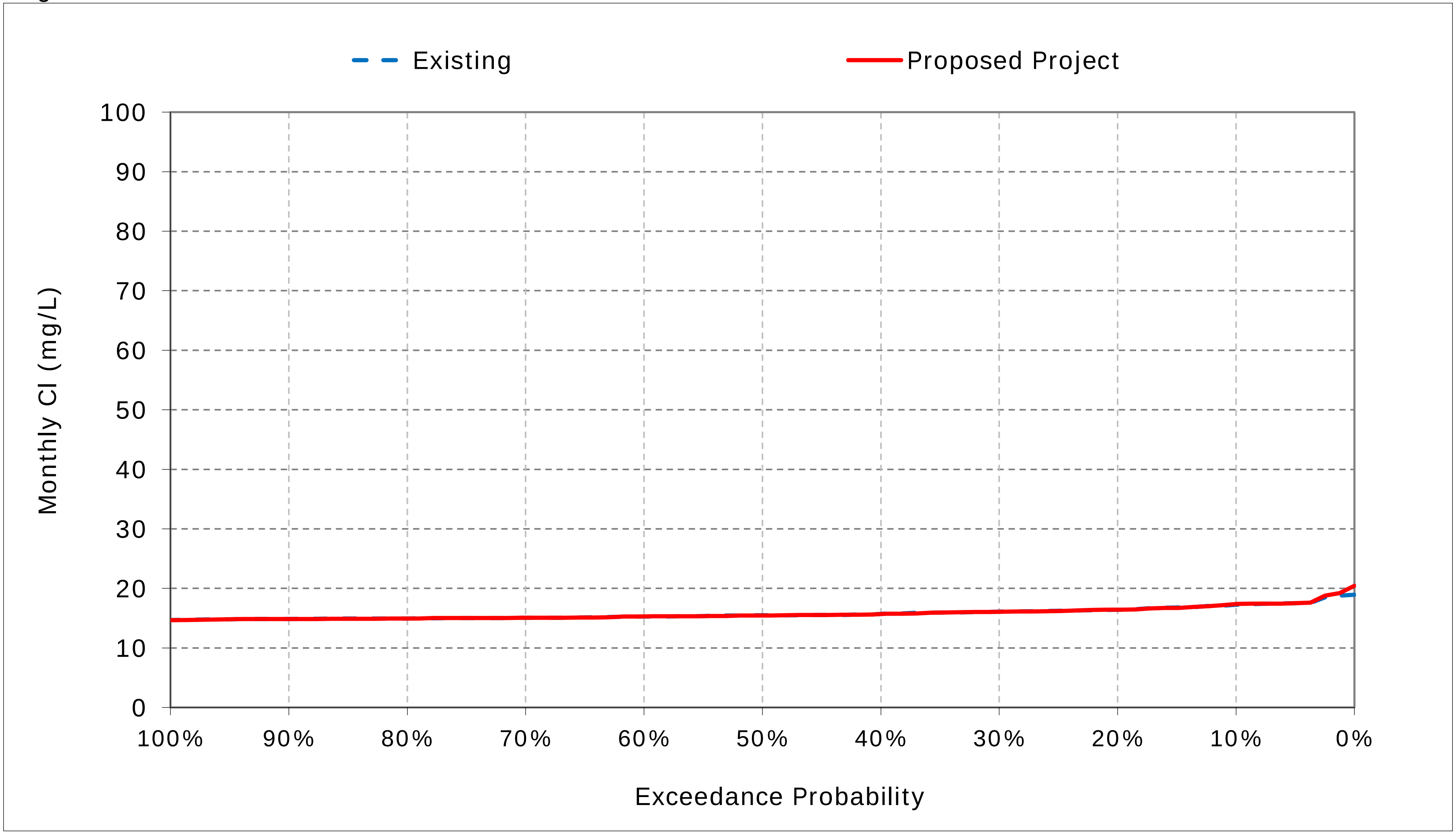


Figure 2-10. Sacramento River at Rio Vista Chloride, April Cl

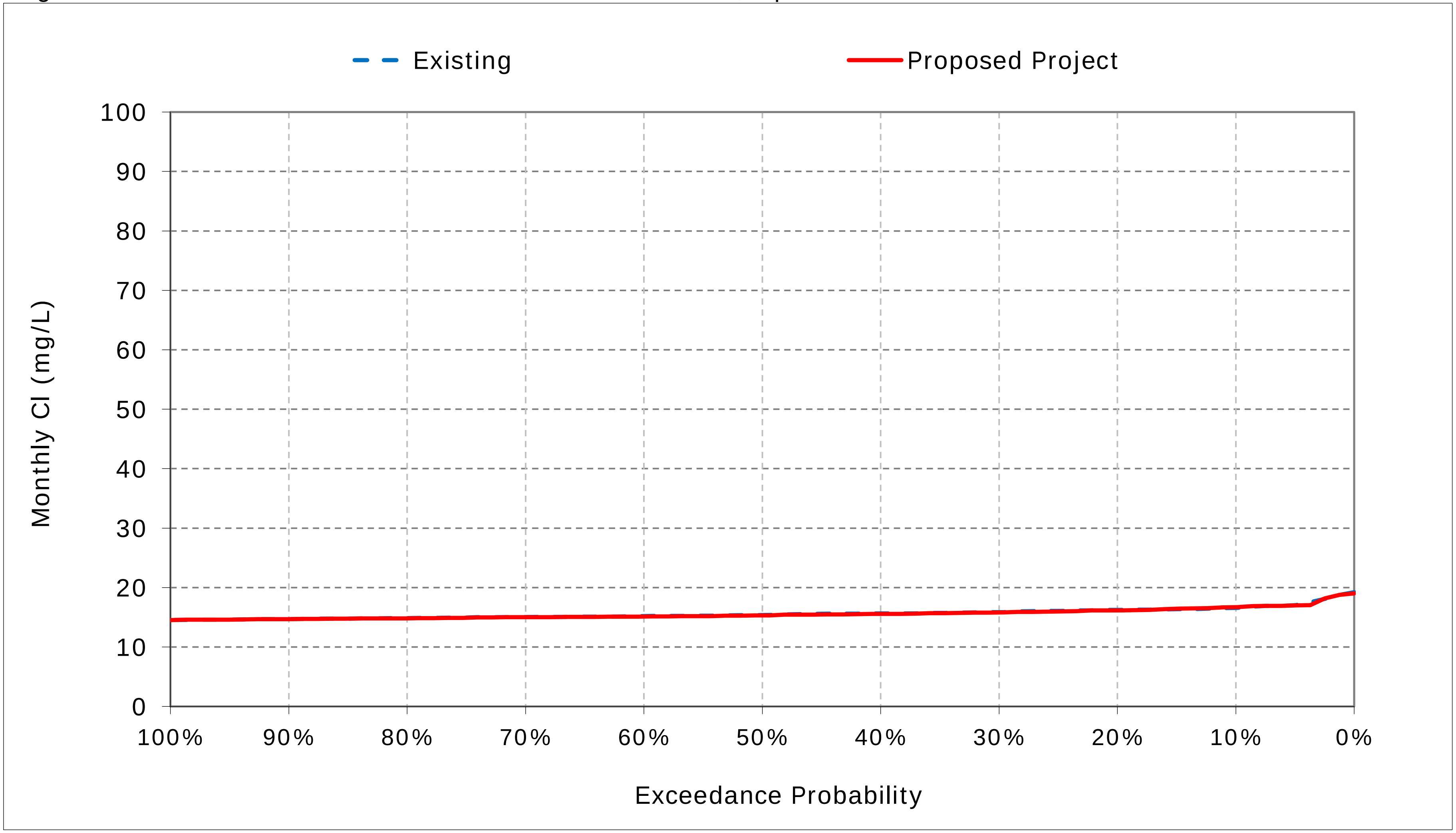


Figure 2-11. Sacramento River at Rio Vista Chloride, May Cl

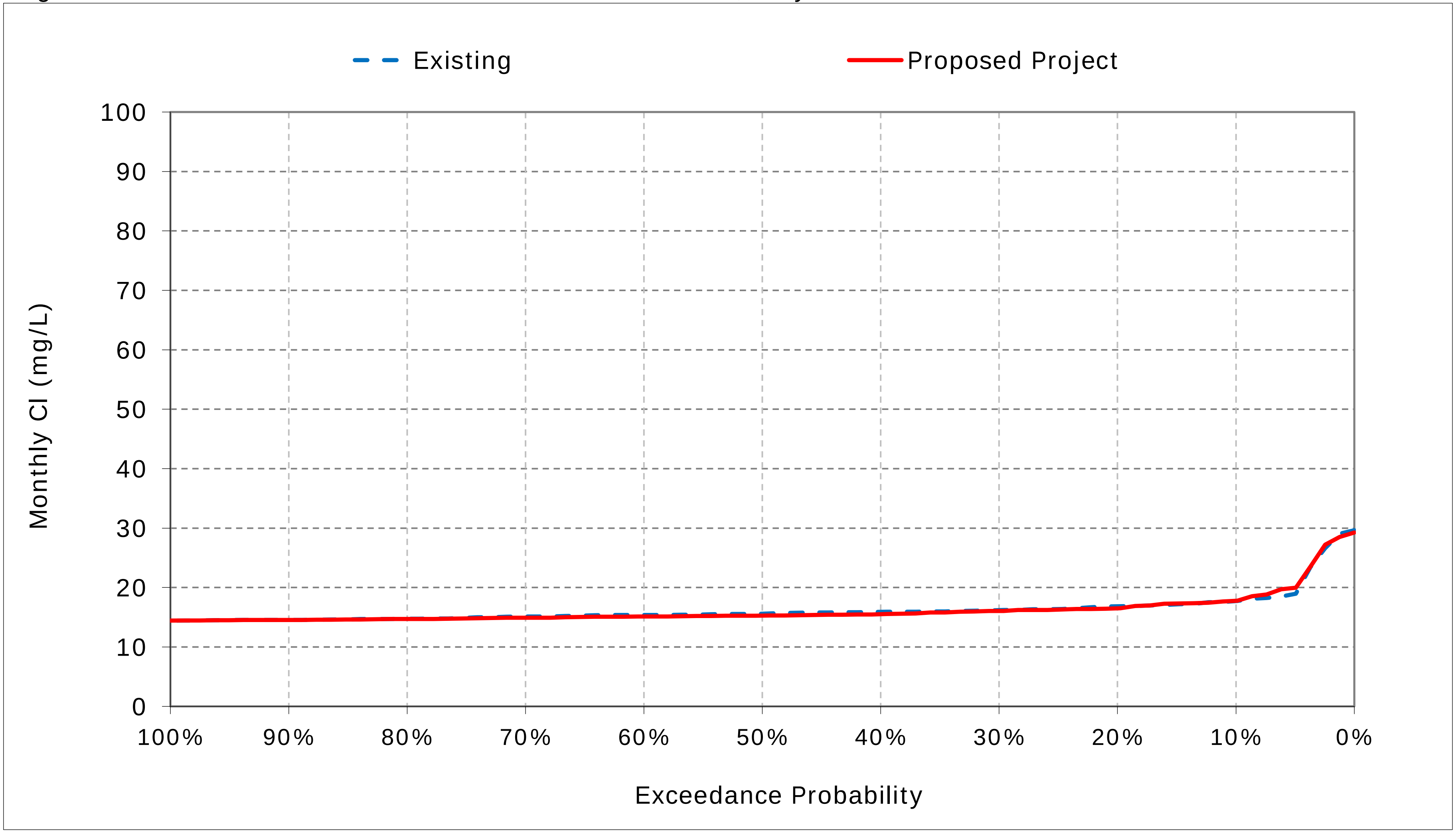


Figure 2-12. Sacramento River at Rio Vista Chloride, June Cl

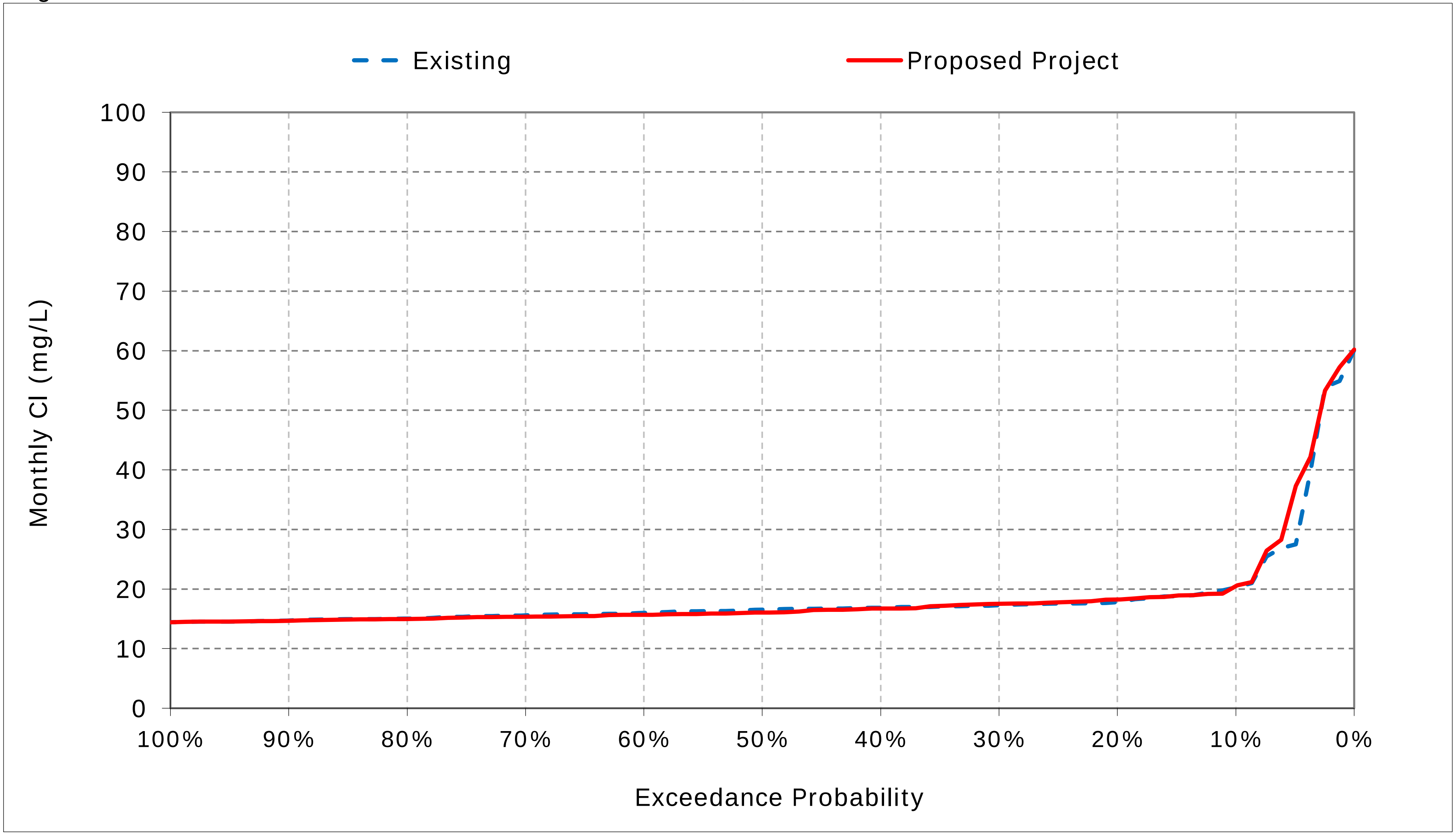


Figure 2-13. Sacramento River at Rio Vista Chloride, July Cl

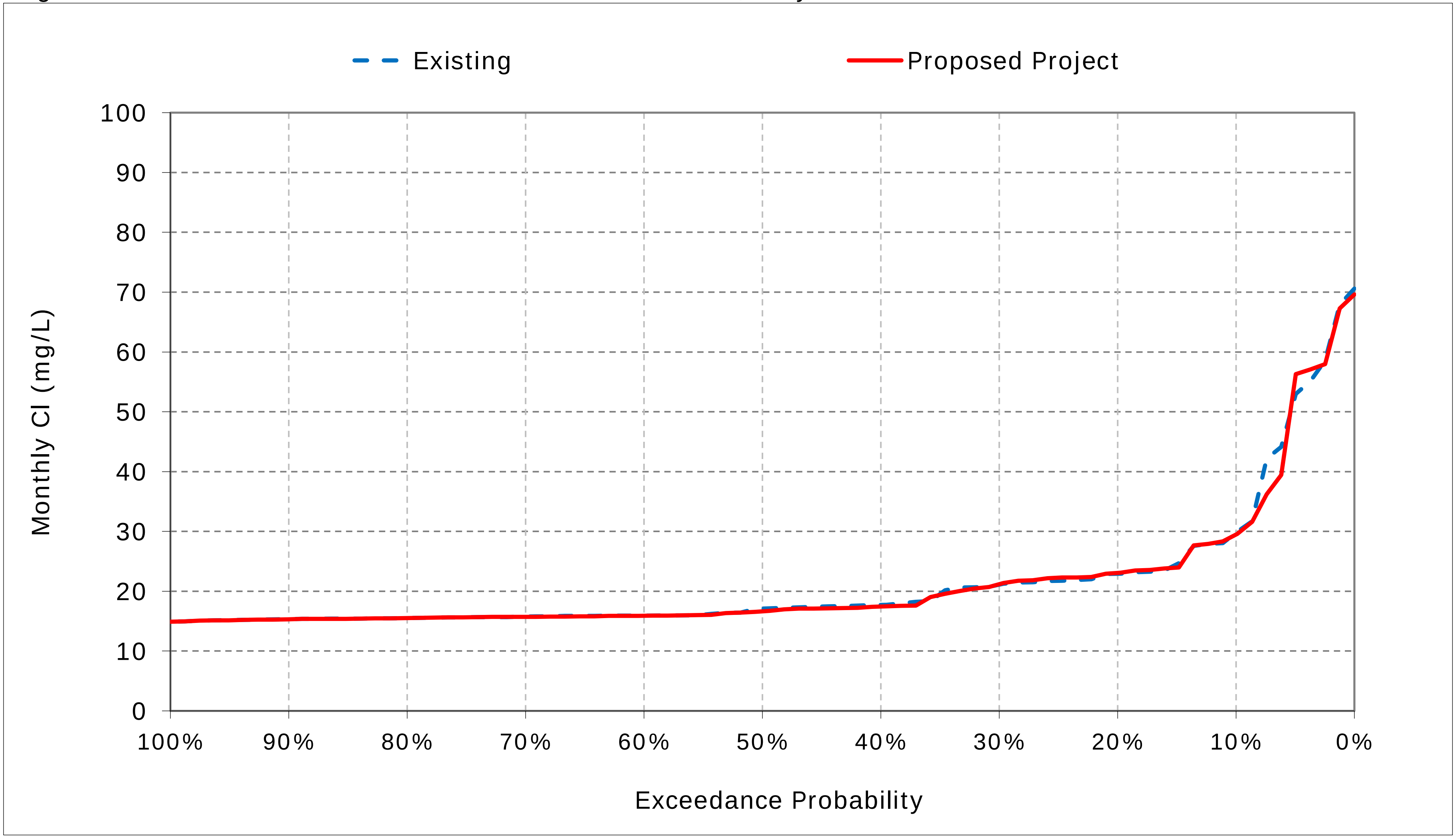


Figure 2-14. Sacramento River at Rio Vista Chloride, August Cl

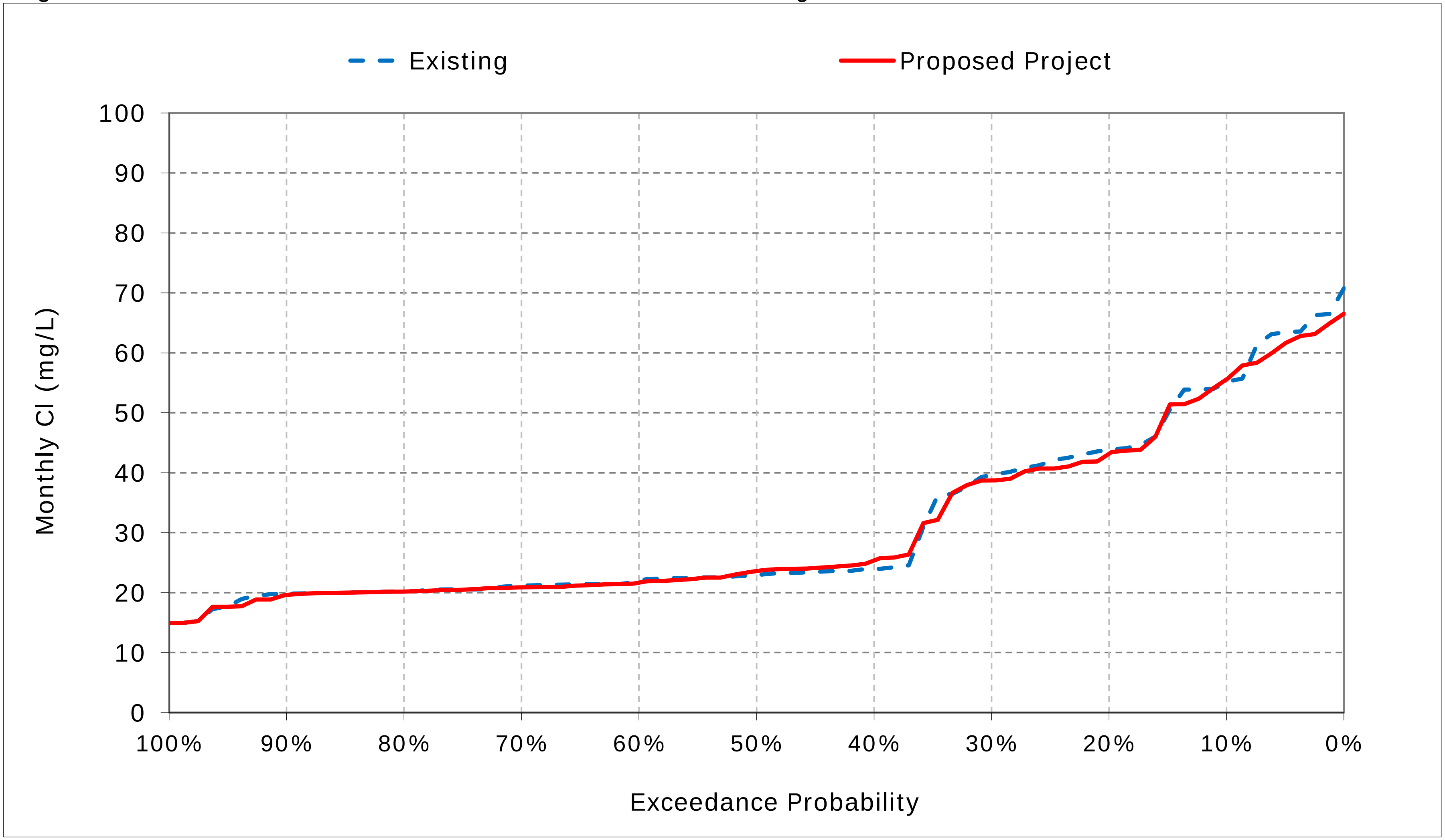


Figure 2-15. Sacramento River at Rio Vista Chloride, September Cl

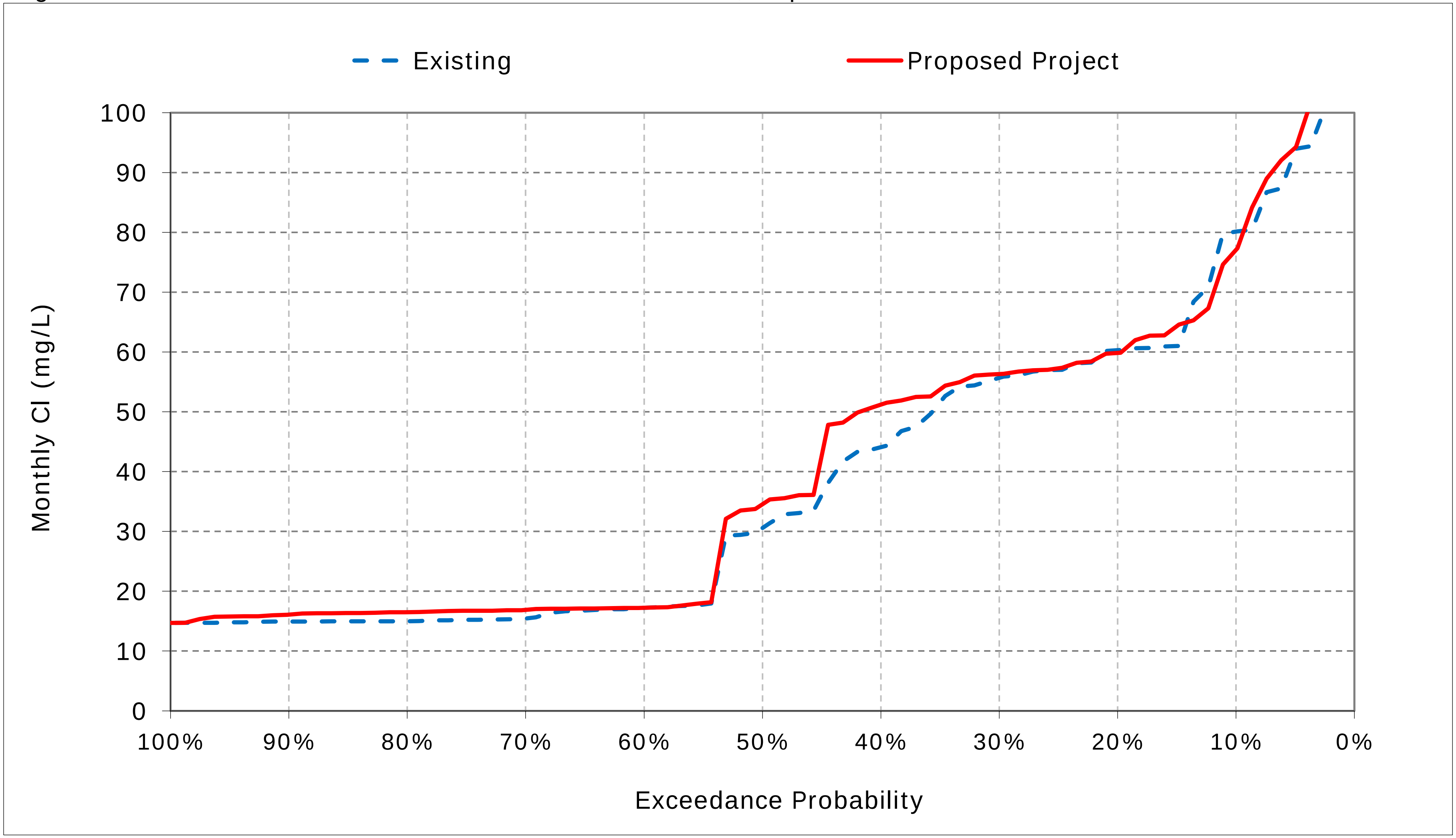


Figure 2-16. Sacramento River at Rio Vista Chloride, October Cl

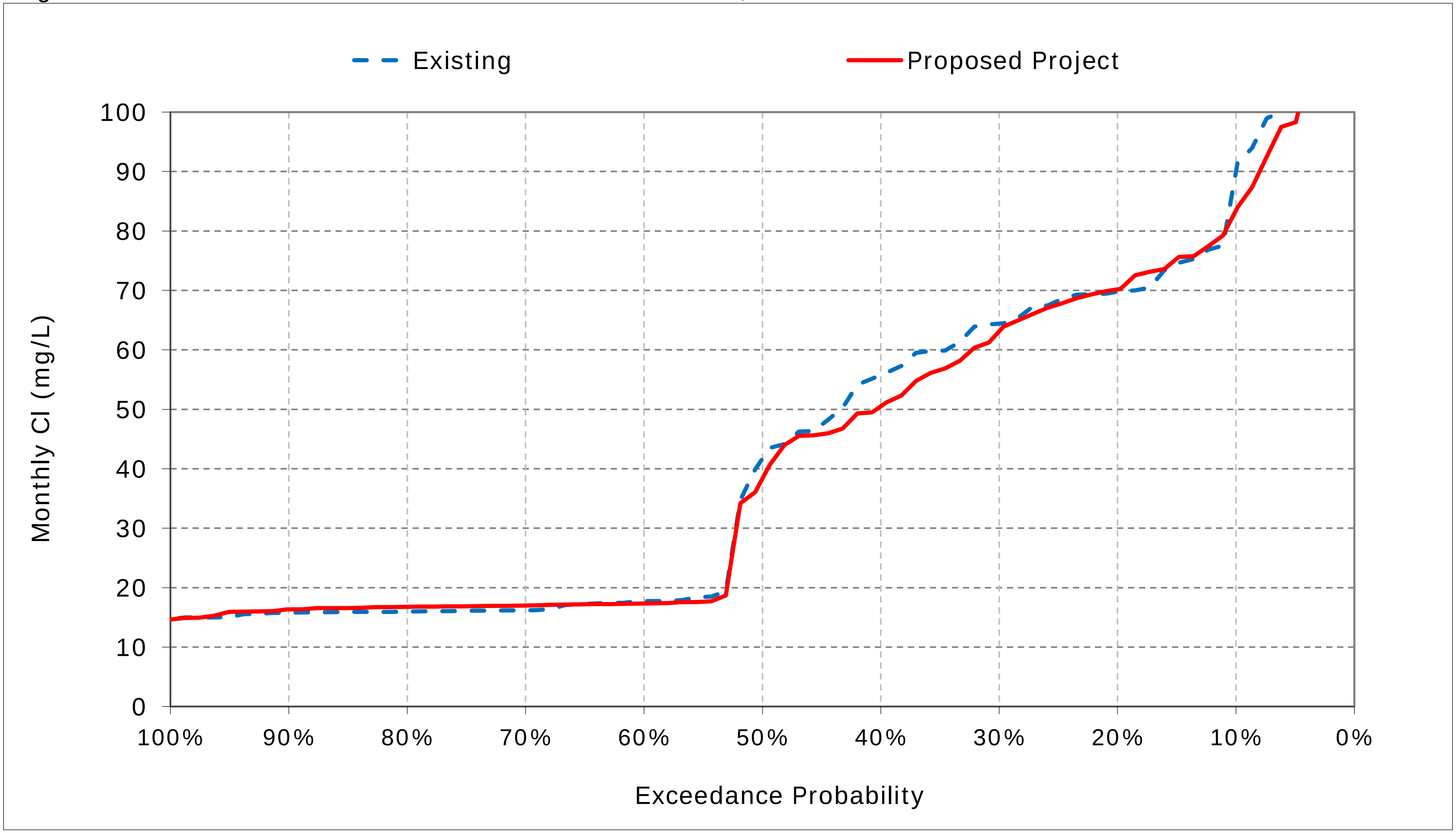


Figure 2-17. Sacramento River at Rio Vista Chloride, November Cl

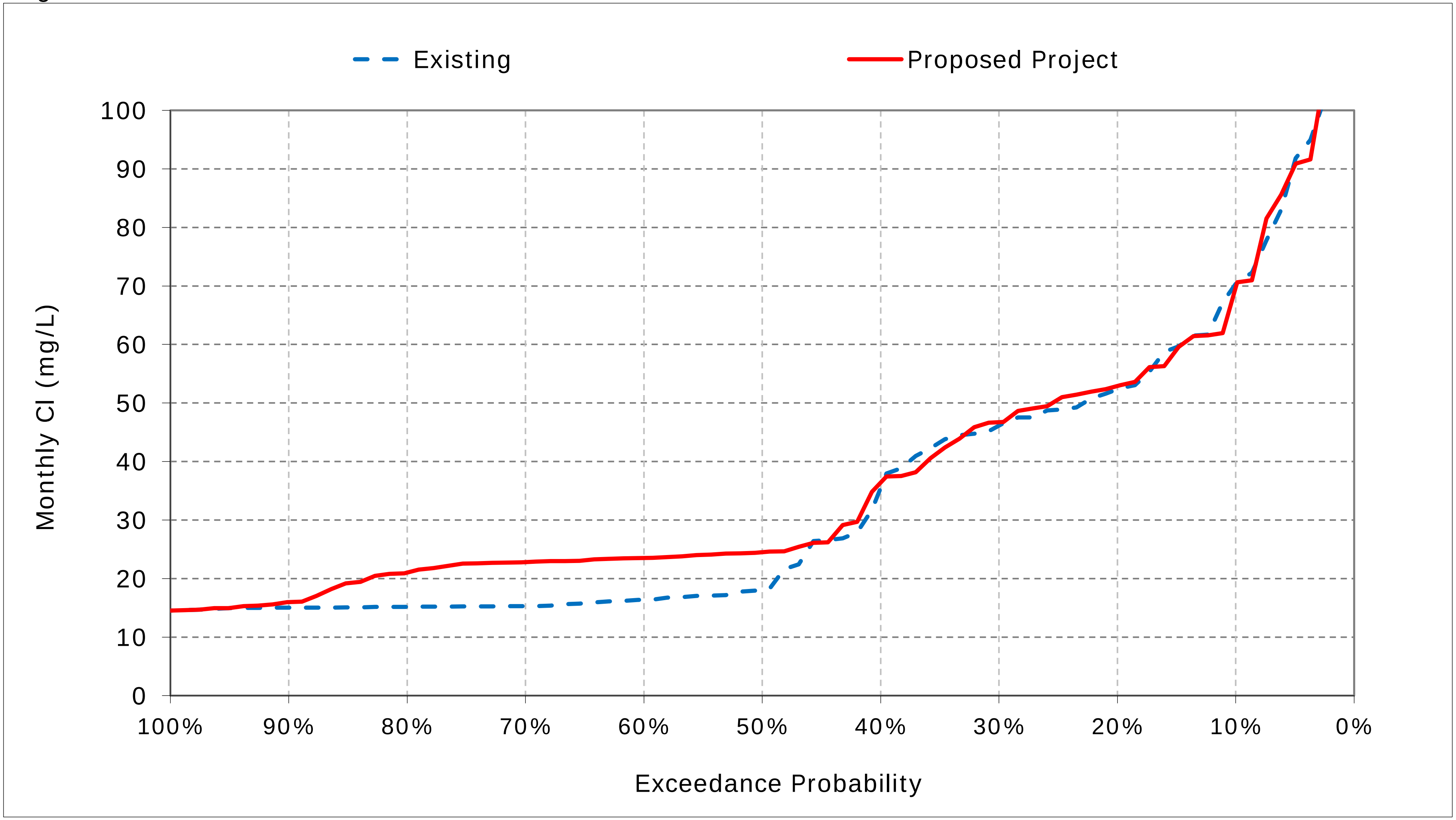


Figure 2-18. Sacramento River at Rio Vista Chloride, December Cl

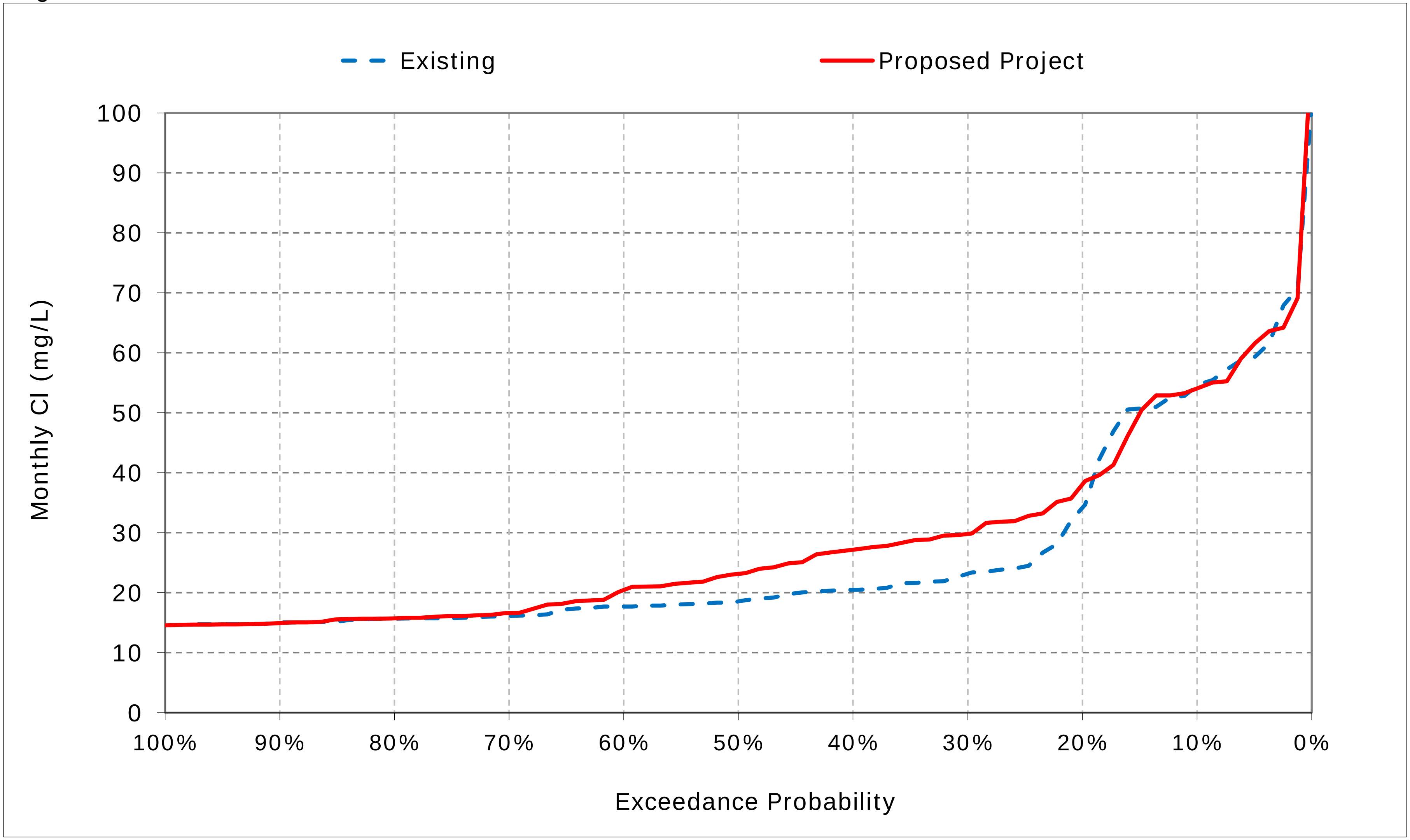


Table 3-1. Sacramento River at Collinsville Chloride, Monthly Cl

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	2,964	2,757	2,546	1,405	564	475	527	828	1,134	1,699	2,329	2,681
20%	2,755	2,593	2,051	1,164	332	225	243	552	893	1,378	1,993	2,497
30%	2,699	2,527	1,366	835	142	67	103	399	851	1,249	1,923	2,440
40%	2,607	2,353	1,119	422	62	39	66	193	676	874	1,456	2,189
50%	2,303	928	893	304	37	24	30	94	555	752	1,331	1,866
60%	1,010	788	826	135	20	19	21	49	375	560	1,295	739
70%	520	412	239	23	18	17	19	27	258	508	1,204	359
80%	479	342	98	19	17	16	17	18	83	433	1,135	309
90%	444	307	22	16	16	16	16	16	18	304	1,068	278
Long Term												
Full Simulation Period[a]	1,724	1,470	1,062	533	190	126	153	295	603	906	1,519	1,479
Water Year Types[b]												
Wet (32%)	1,290	859	281	74	19	18	23	43	161	366	1,053	279
Above Normal (15%)	1,810	1,460	1,010	283	56	19	27	51	364	504	1,163	719
Below Normal (17%)	1,814	1,610	1,401	563	99	72	80	175	533	807	1,393	2,014
Dry (22%)	1,847	1,752	1,317	851	303	167	201	413	832	1,297	1,952	2,468
Critical (15%)	2,290	2,221	2,029	1,268	634	471	574	1,048	1,539	2,007	2,383	2,732

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	2,925	2,692	2,545	1,627	533	480	578	885	1,153	1,684	2,292	2,671
20%	2,741	2,600	2,060	1,296	324	205	318	685	974	1,409	1,997	2,513
30%	2,690	2,534	1,916	941	147	54	155	572	880	1,235	1,935	2,446
40%	2,499	2,337	1,761	469	58	32	96	288	757	951	1,738	2,315
50%	2,214	1,681	1,406	295	39	22	48	165	562	799	1,495	1,902
60%	948	1,575	985	118	20	19	22	106	441	550	1,281	702
70%	885	1,526	335	24	18	17	19	44	310	500	1,197	668
80%	833	1,331	194	18	17	16	17	18	88	440	1,117	622
90%	742	520	35	16	16	16	16	16	18	306	1,055	553
Long Term												
Full Simulation Period[a]	1,796	1,835	1,261	581	203	126	176	356	637	921	1,551	1,587
Water Year Types[b]												
Wet (32%)	1,396	1,323	388	72	18	18	29	72	192	368	1,029	583
Above Normal (15%)	1,884	1,849	1,314	314	39	18	36	98	378	493	1,171	646
Below Normal (17%)	1,891	1,953	1,652	577	93	67	110	260	555	875	1,605	2,119
Dry (22%)	1,932	2,084	1,569	961	333	161	242	515	886	1,316	1,966	2,481
Critical (15%)	2,257	2,422	2,179	1,387	699	484	610	1,101	1,582	2,005	2,378	2,742

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	-39	-65	-1	222	-30	6	50	58	19	-15	-37	-10
20%	-14	7	8	132	-8	-20	75	133	82	31	4	16
30%	-9	7	549	106	5	-12	52	174	29	-14	12	6
40%	-108	-16	641	47	-4	-7	30	96	81	78	282	126
50%	-89	753	513	-9	2	-2	17	70	7	48	164	36
60%	-63	788	160	-17	0	-1	1	57	66	-10	-14	-37
70%	365	1,114	96	1	0	0	0	18	51	-8	-7	309
80%	354	989	96	-1	0	0	-1	0	5	7	-18	313
90%	298	213	13	0	0	0	0	-1	0	1	-13	275
Long Term												
Full Simulation Period[a]	72	365	199	48	12	0	23	61	34	15	32	108
Water Year Types[b]												
Wet (32%)	106	464	107	-1	-1	0	7	29	31	2	-24	305
Above Normal (15%)	74	389	304	31	-17	-1	9	47	15	-11	8	-73
Below Normal (17%)	77	343	251	13	-6	-5	30	84	22	68	211	106
Dry (22%)	85	332	252	109	30	-6	41	103	54	20	14	13
Critical (15%)	-32	200	151	120	65	14	36	53	43	-2	-5	9

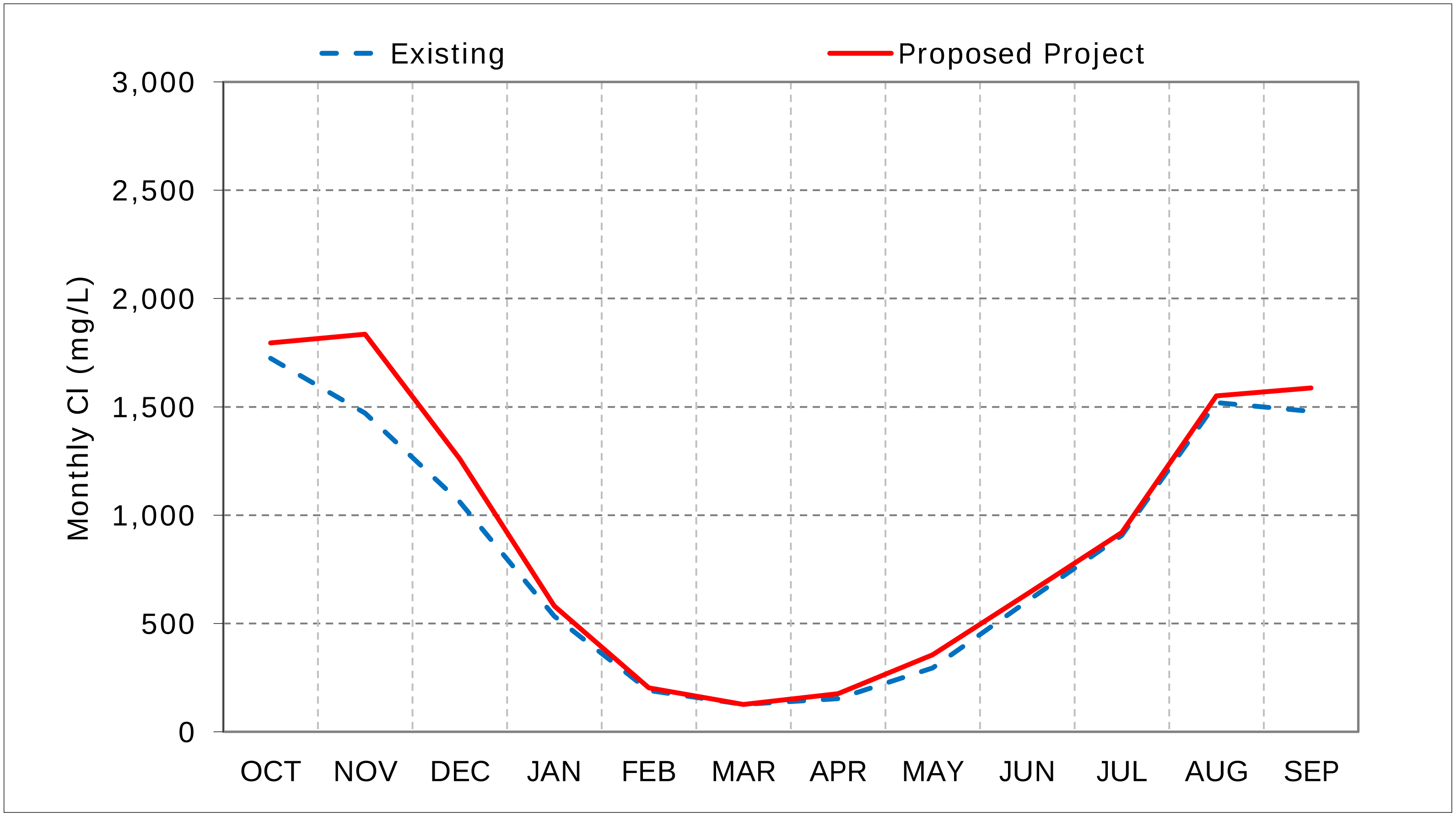
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

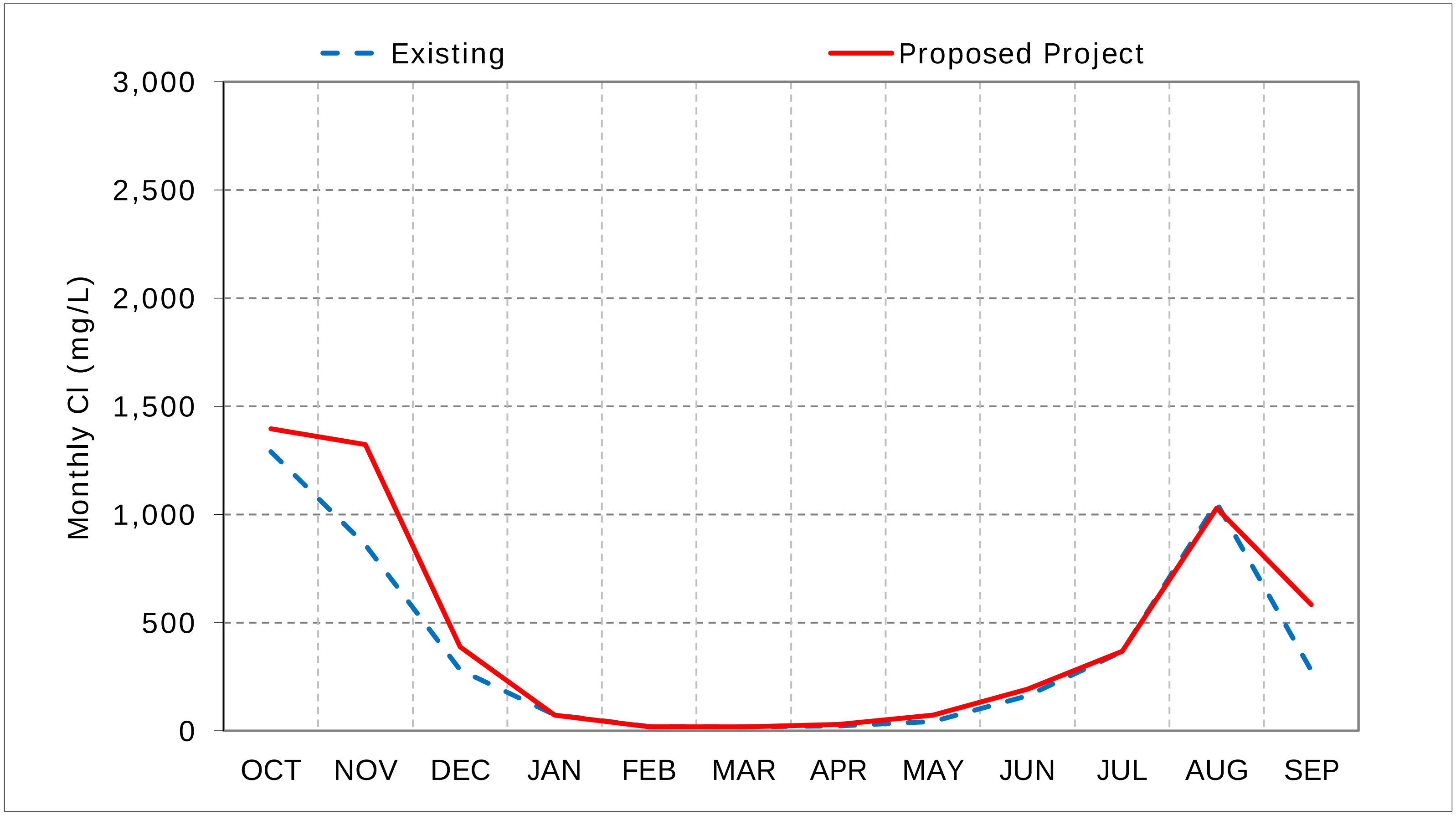
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 3-1. Sacramento River at Collinsville Chloride, Long-Term Average Cl



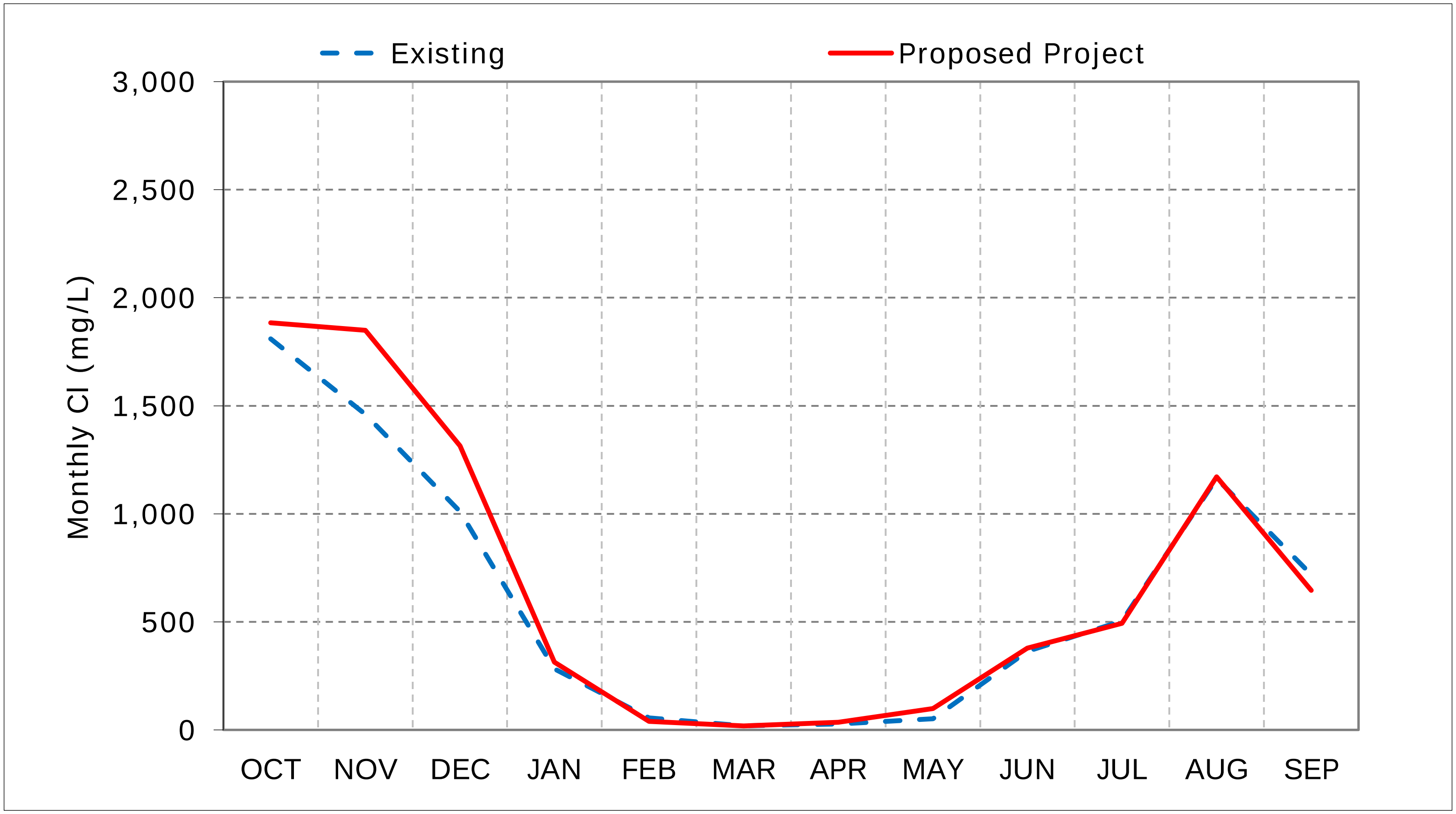
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 3-2. Sacramento River at Collinsville Chloride, Wet Year Average Cl



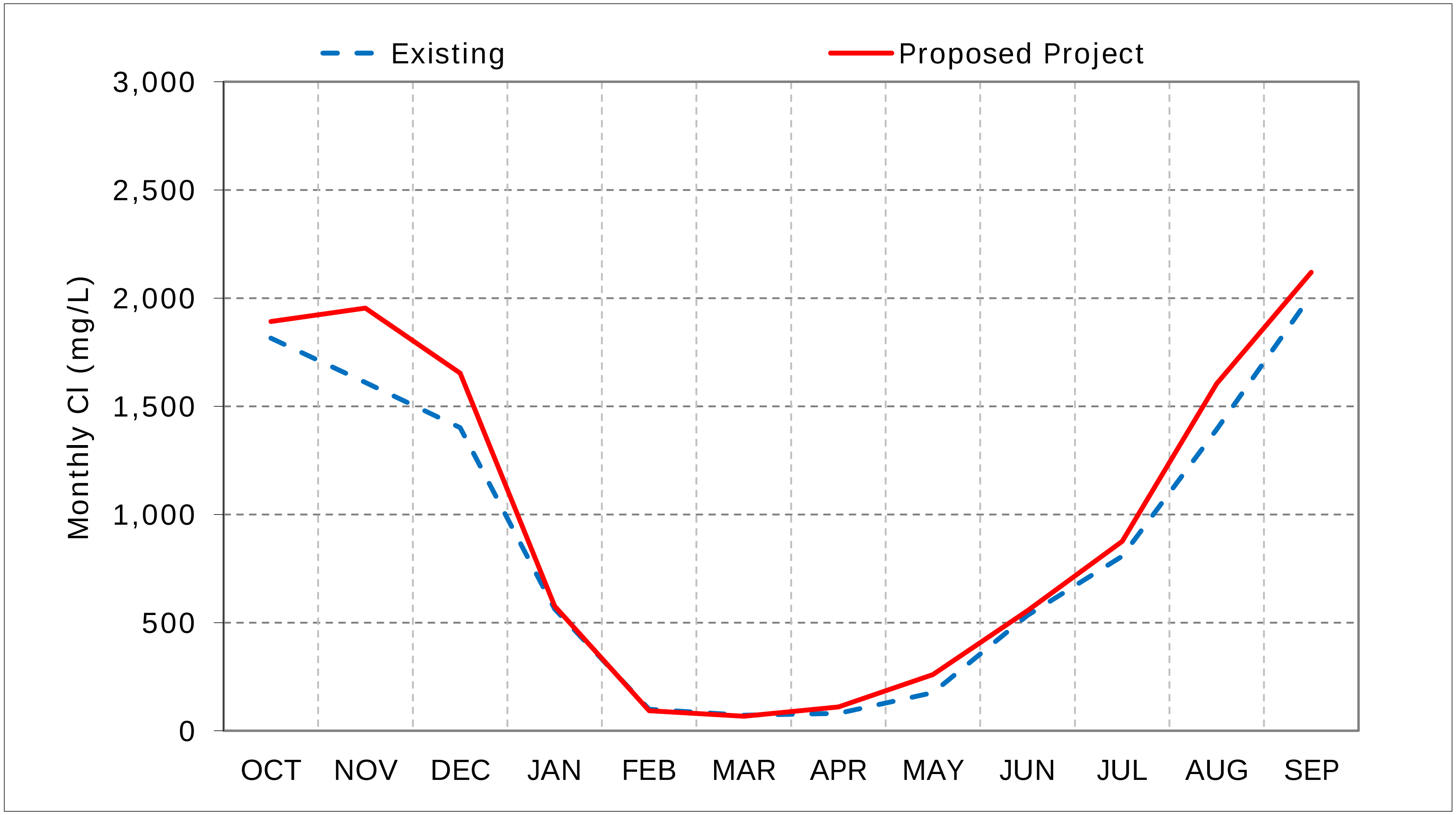
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 3-3. Sacramento River at Collinsville Chloride, Above Normal Year Average



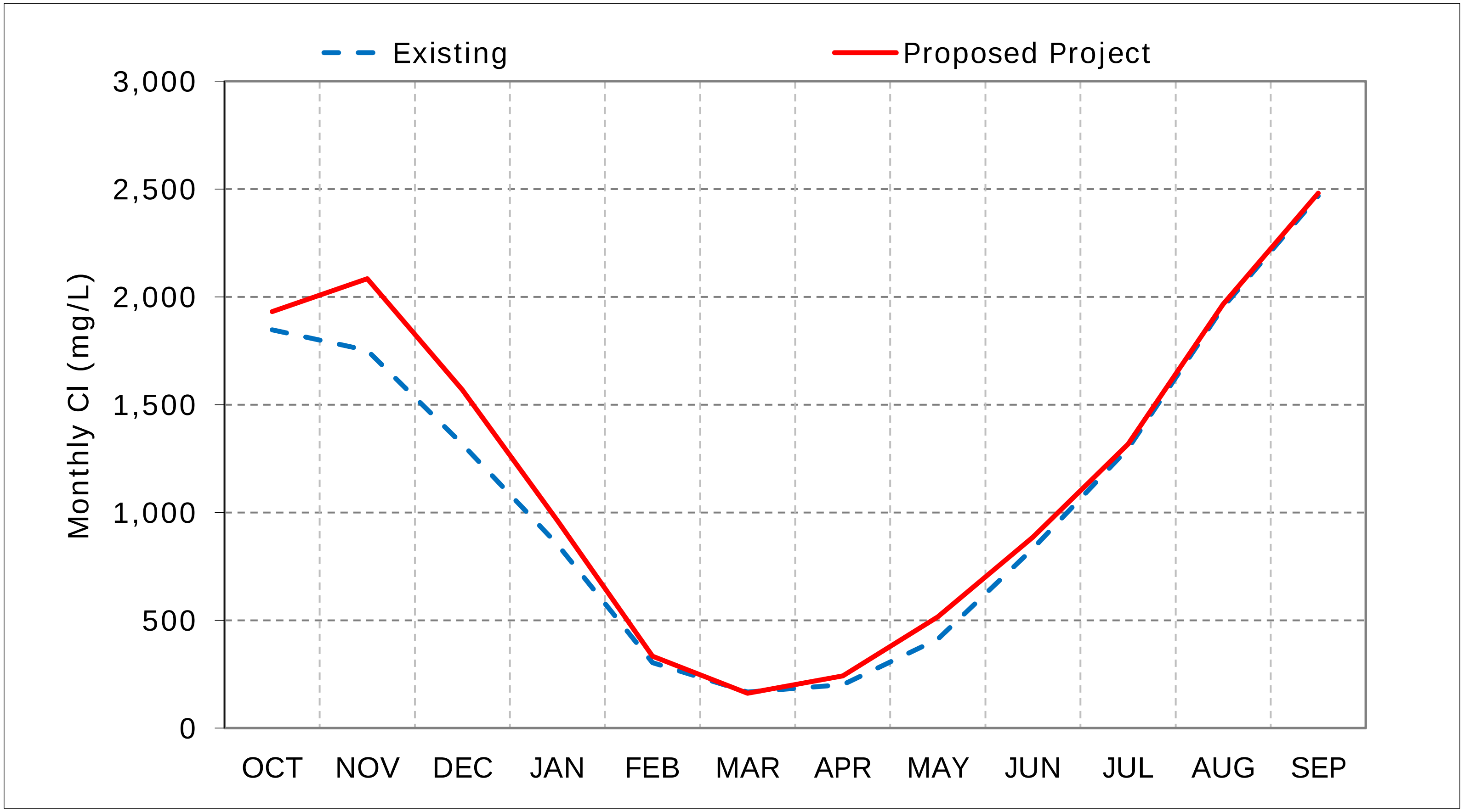
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 3-4. Sacramento River at Collinsville Chloride, Below Normal Year Average



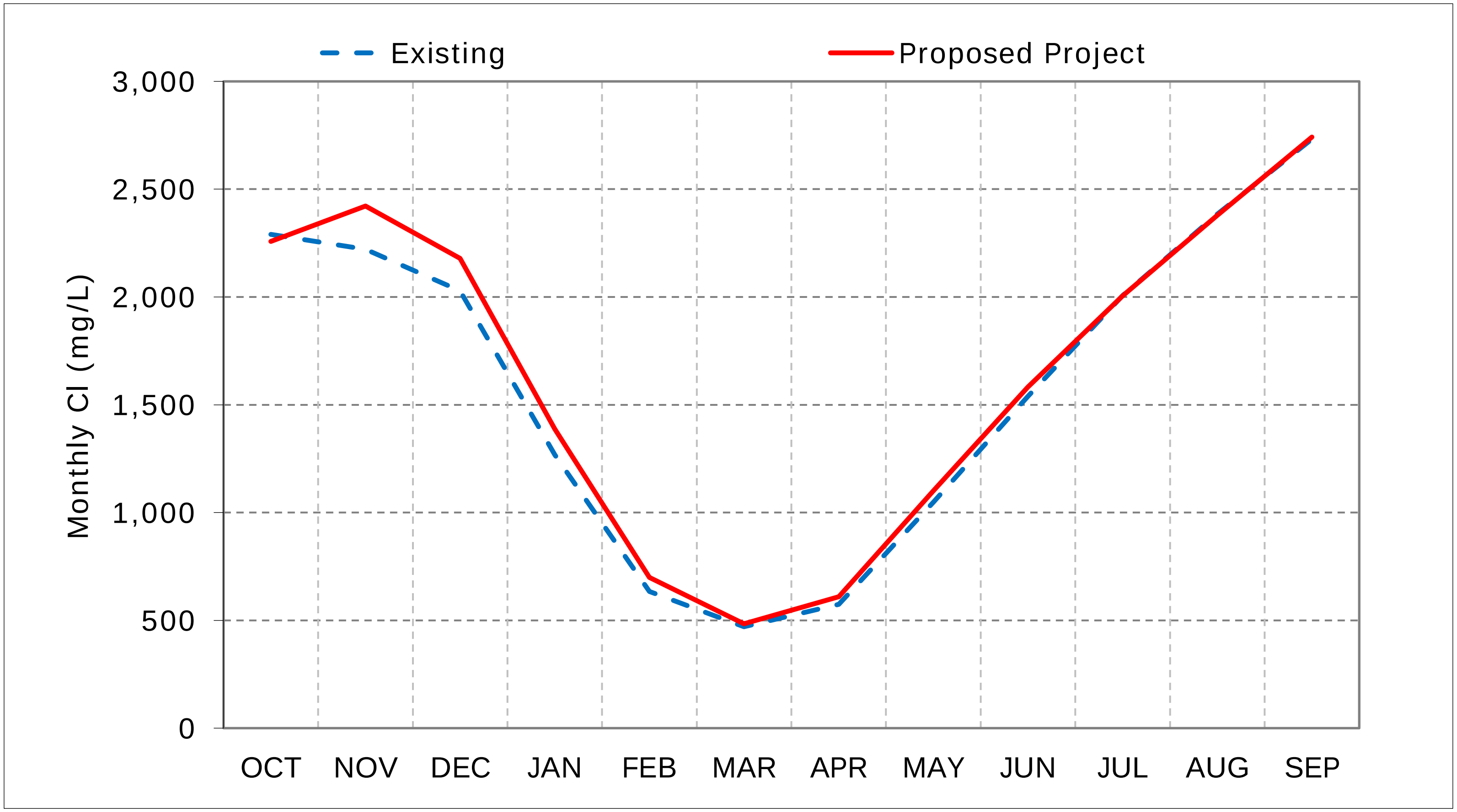
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 3-5. Sacramento River at Collinsville Chloride, Dry Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 3-6. Sacramento River at Collinsville Chloride, Critical Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 3-7. Sacramento River at Collinsville Chloride, January Cl

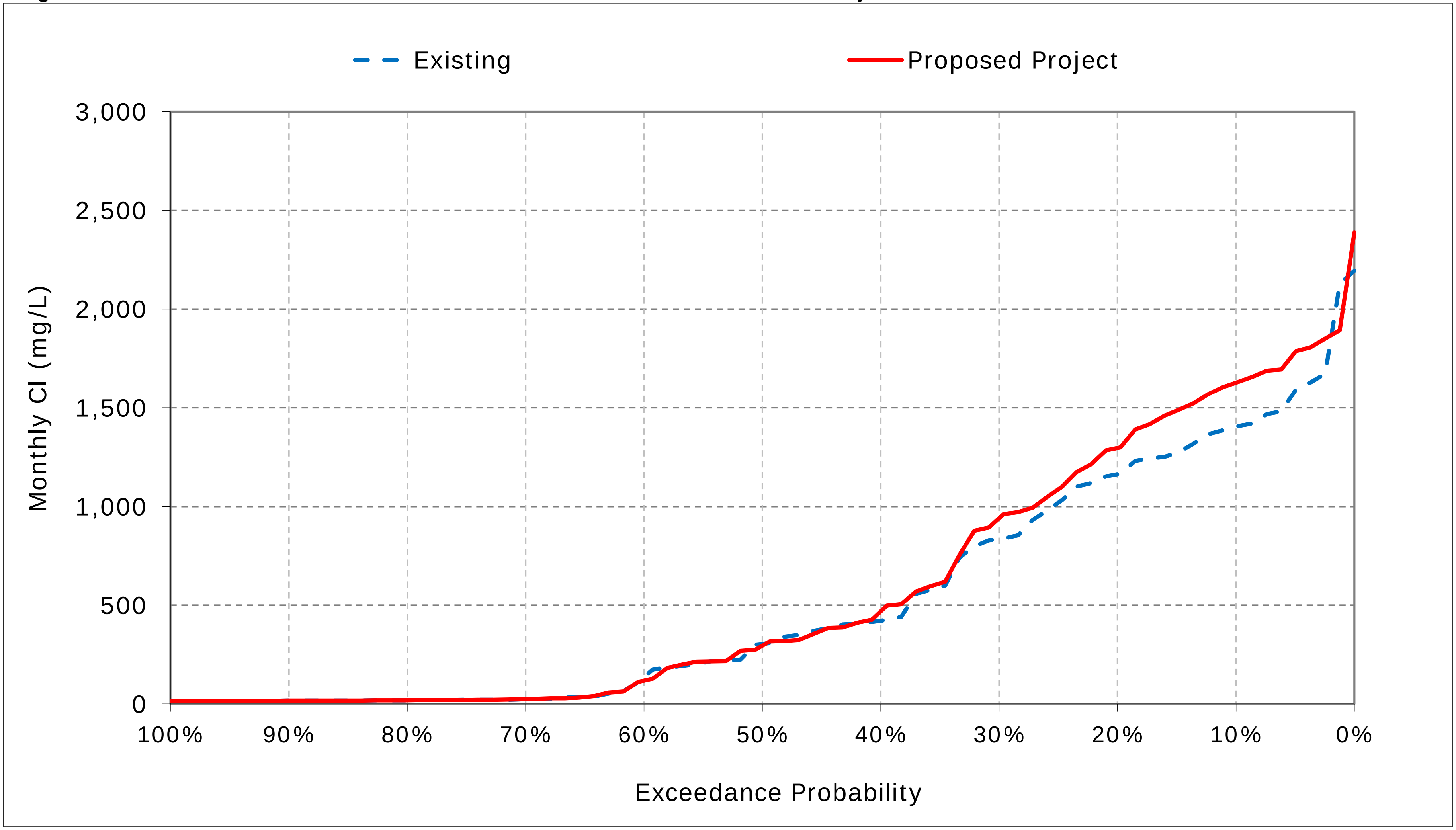


Figure 3-8. Sacramento River at Collinsville Chloride, February Cl

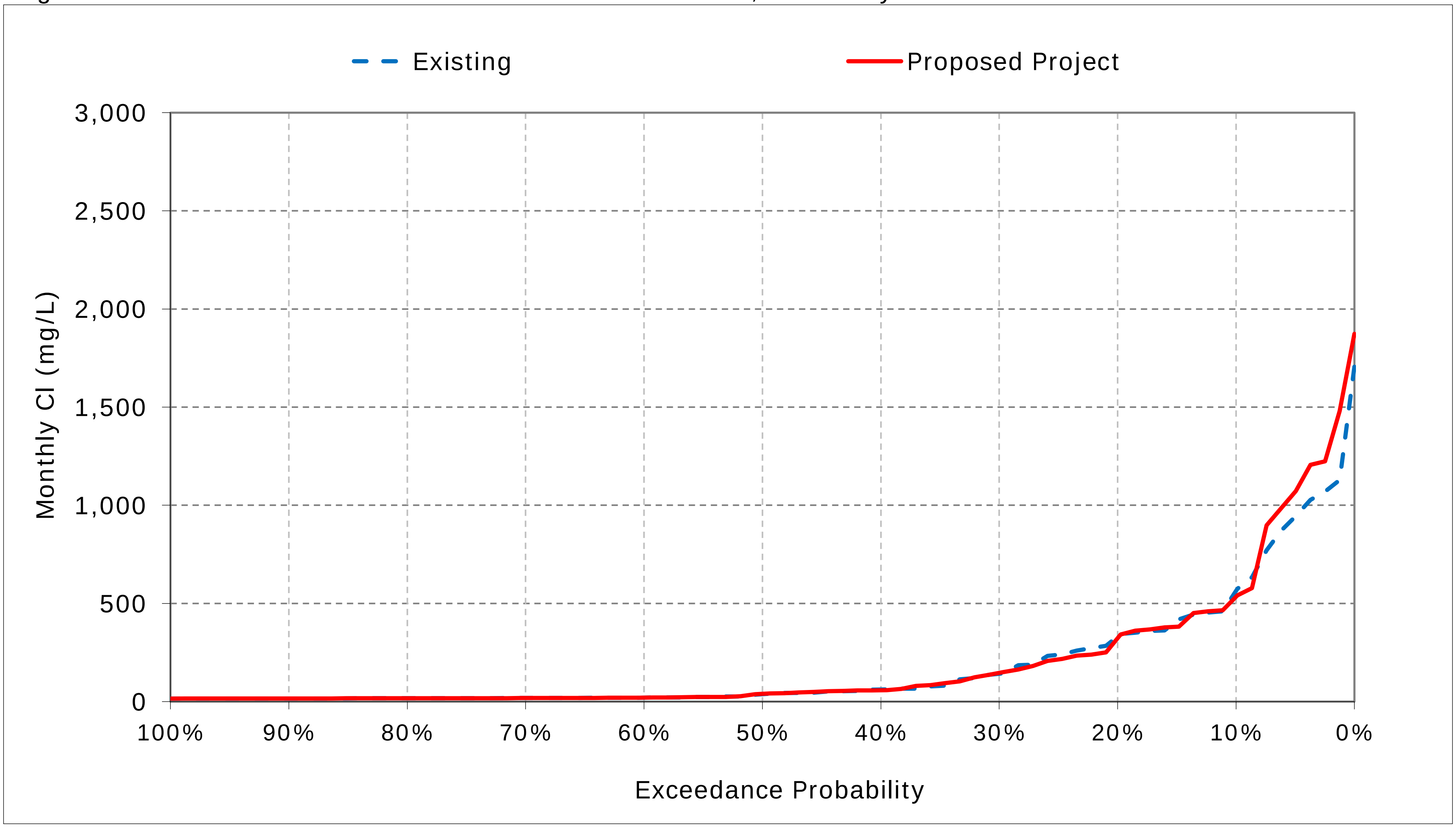


Figure 3-9. Sacramento River at Collinsville Chloride, March Cl

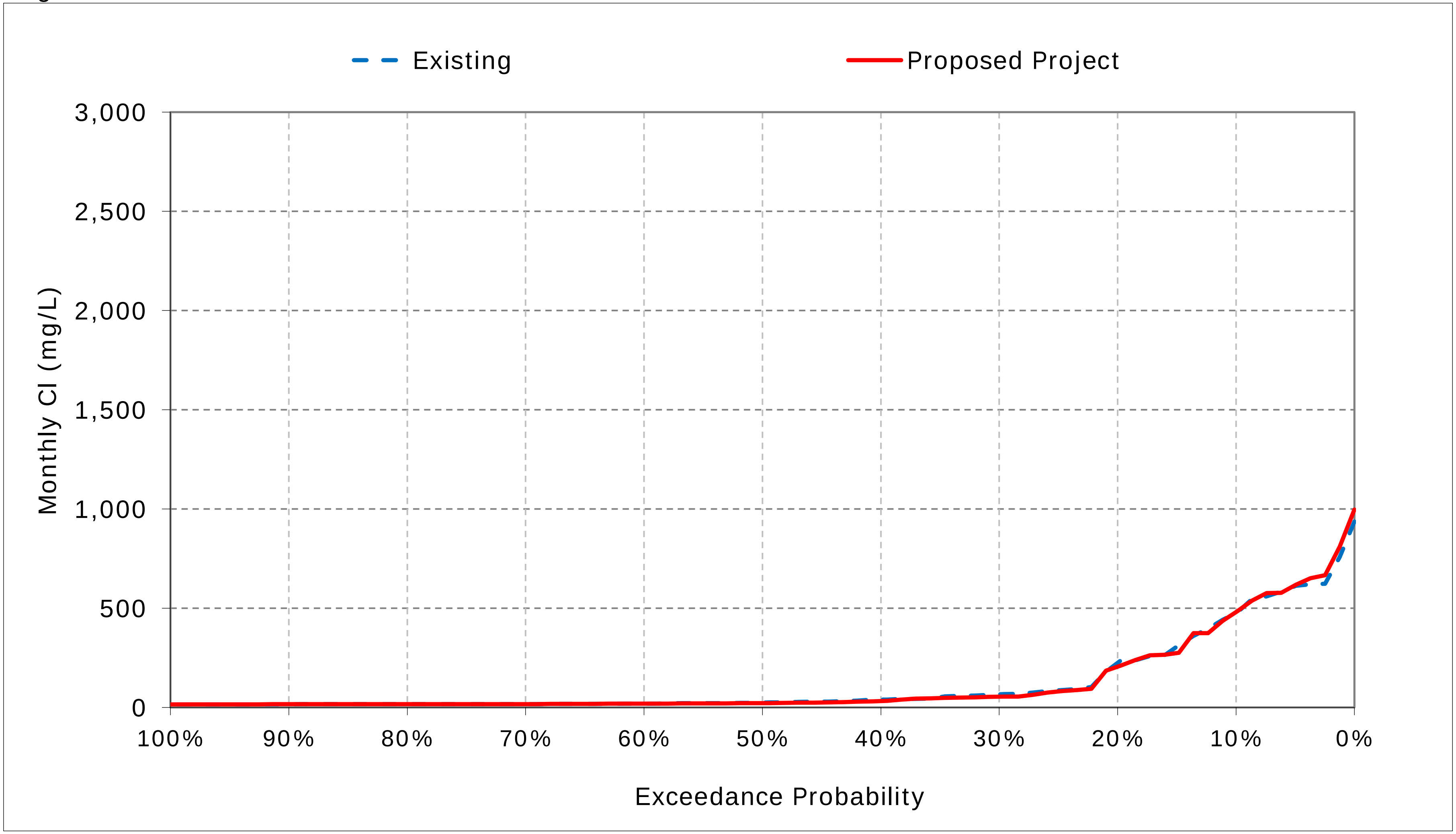


Figure 3-10. Sacramento River at Collinsville Chloride, April Cl

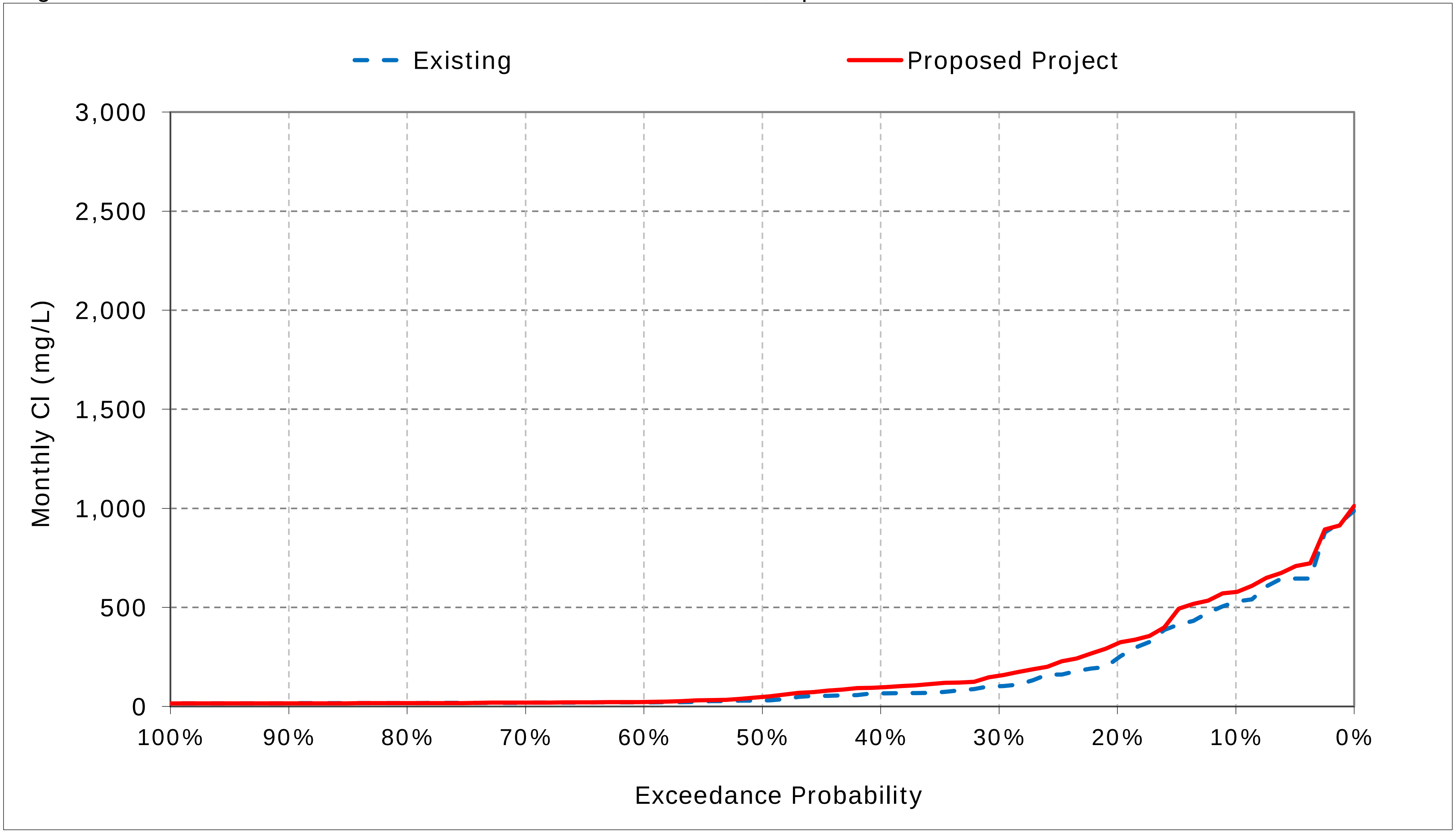


Figure 3-11. Sacramento River at Collinsville Chloride, May Cl

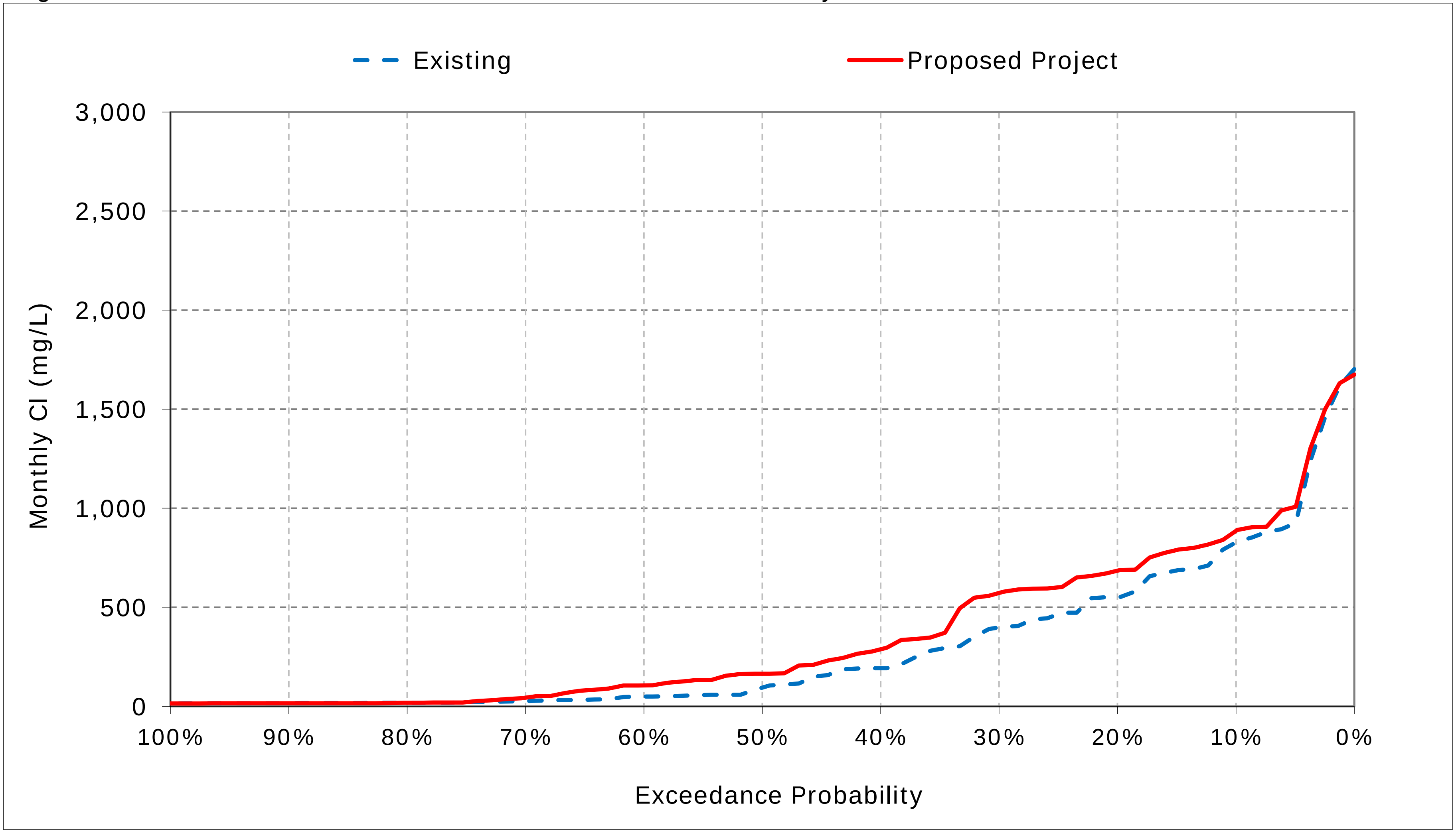


Figure 3-12. Sacramento River at Collinsville Chloride, June Cl

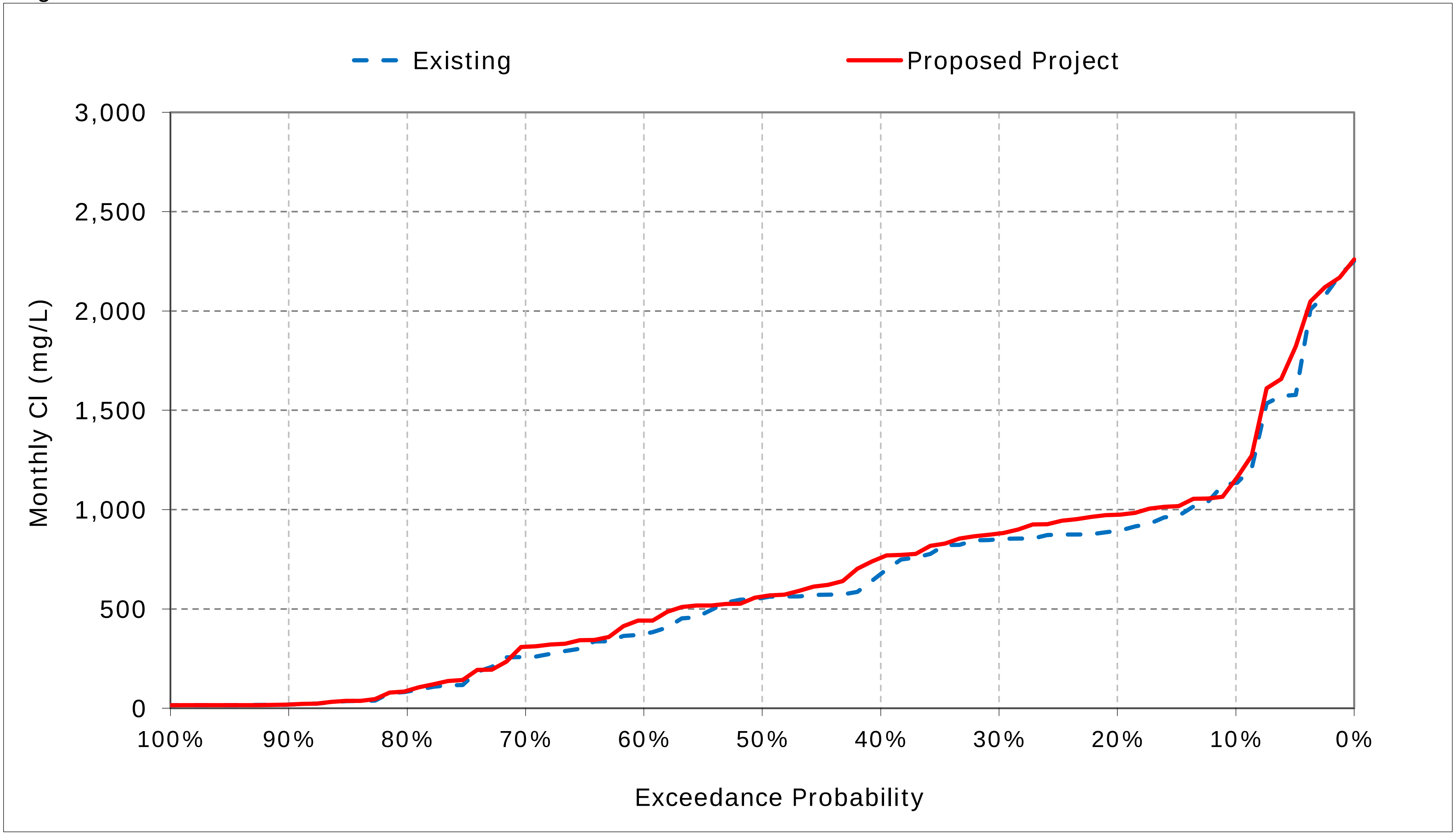


Figure 3-13. Sacramento River at Collinsville Chloride, July Cl

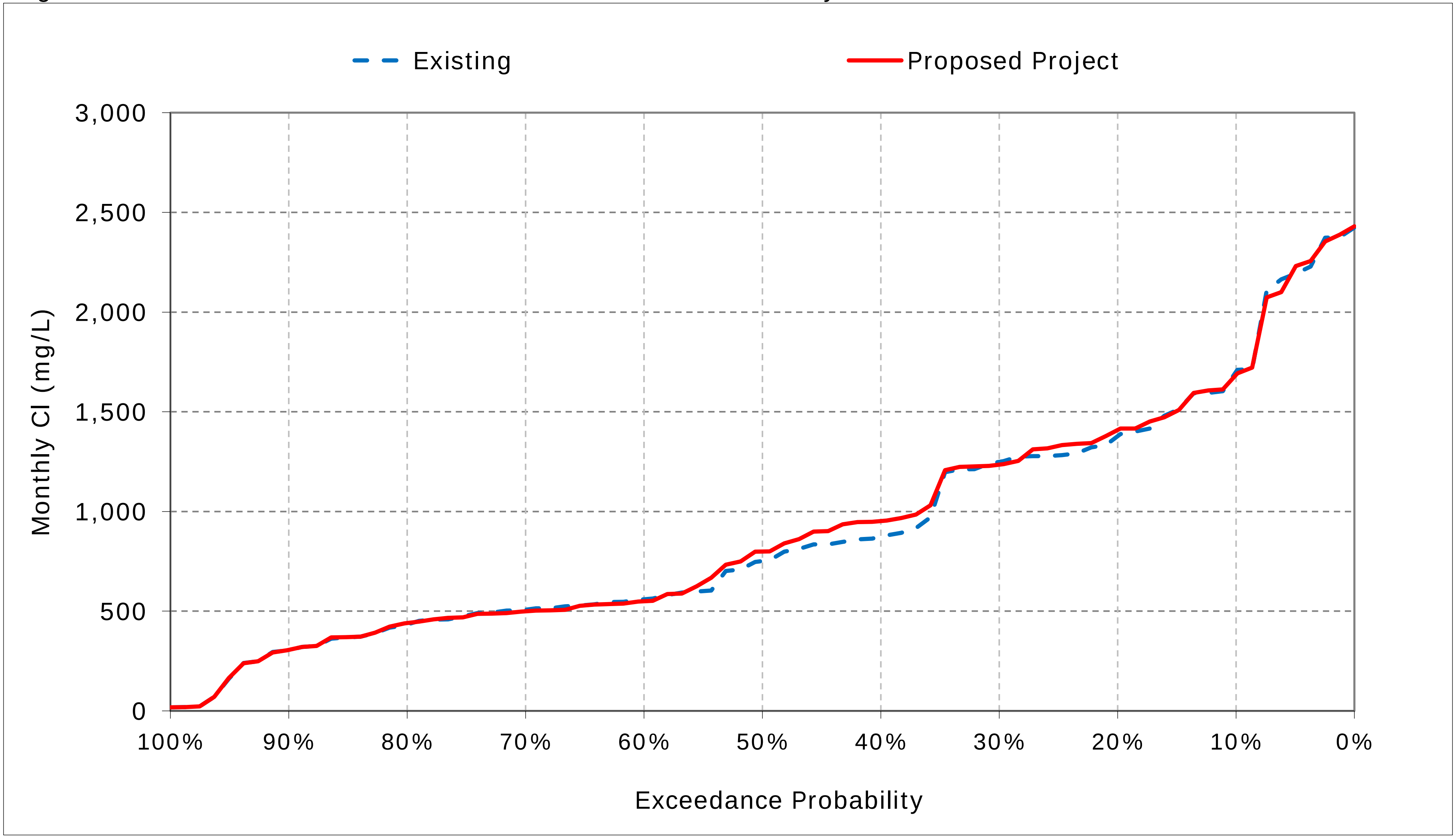


Figure 3-14. Sacramento River at Collinsville Chloride, August Cl

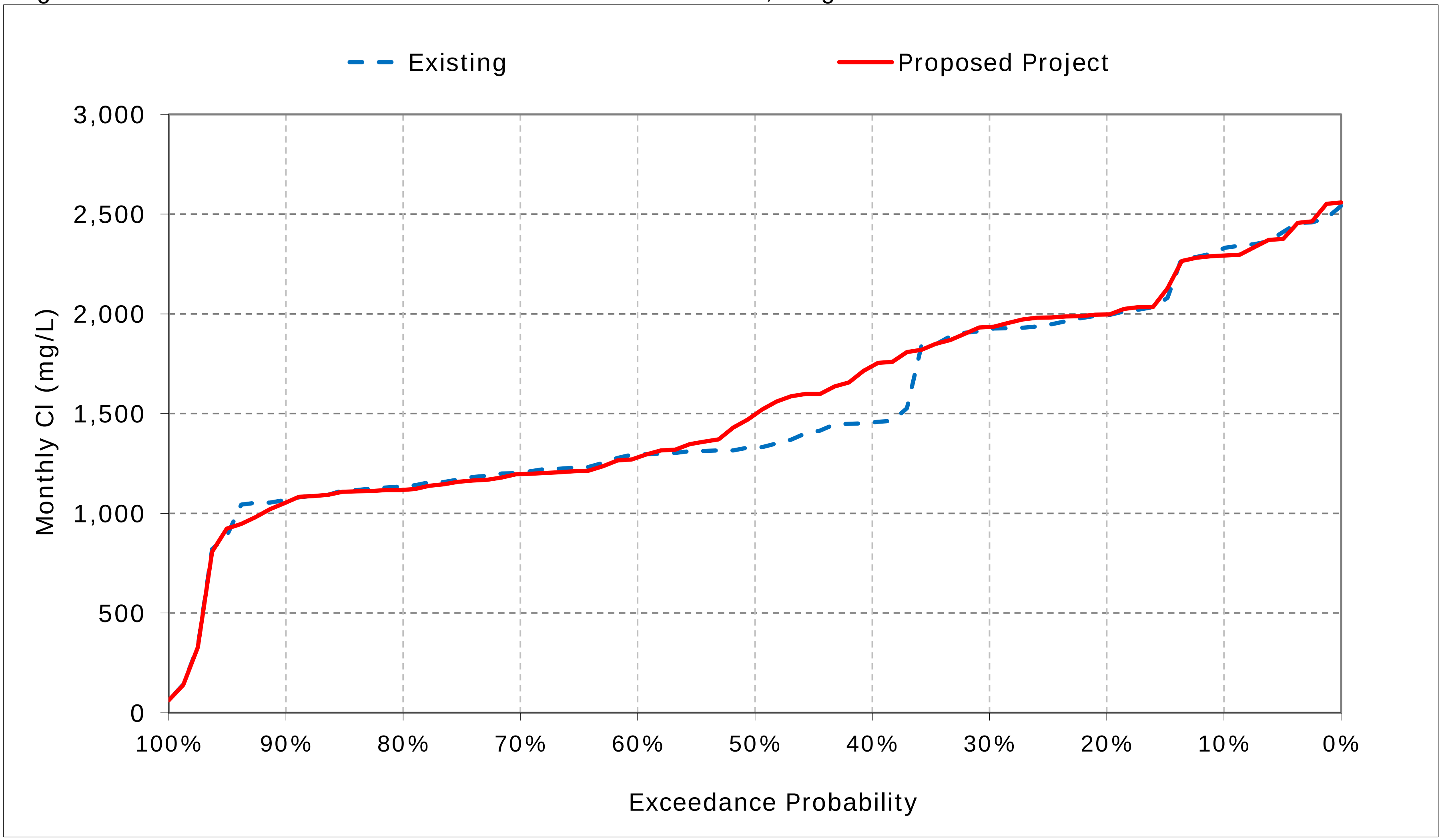


Figure 3-15. Sacramento River at Collinsville Chloride, September Cl

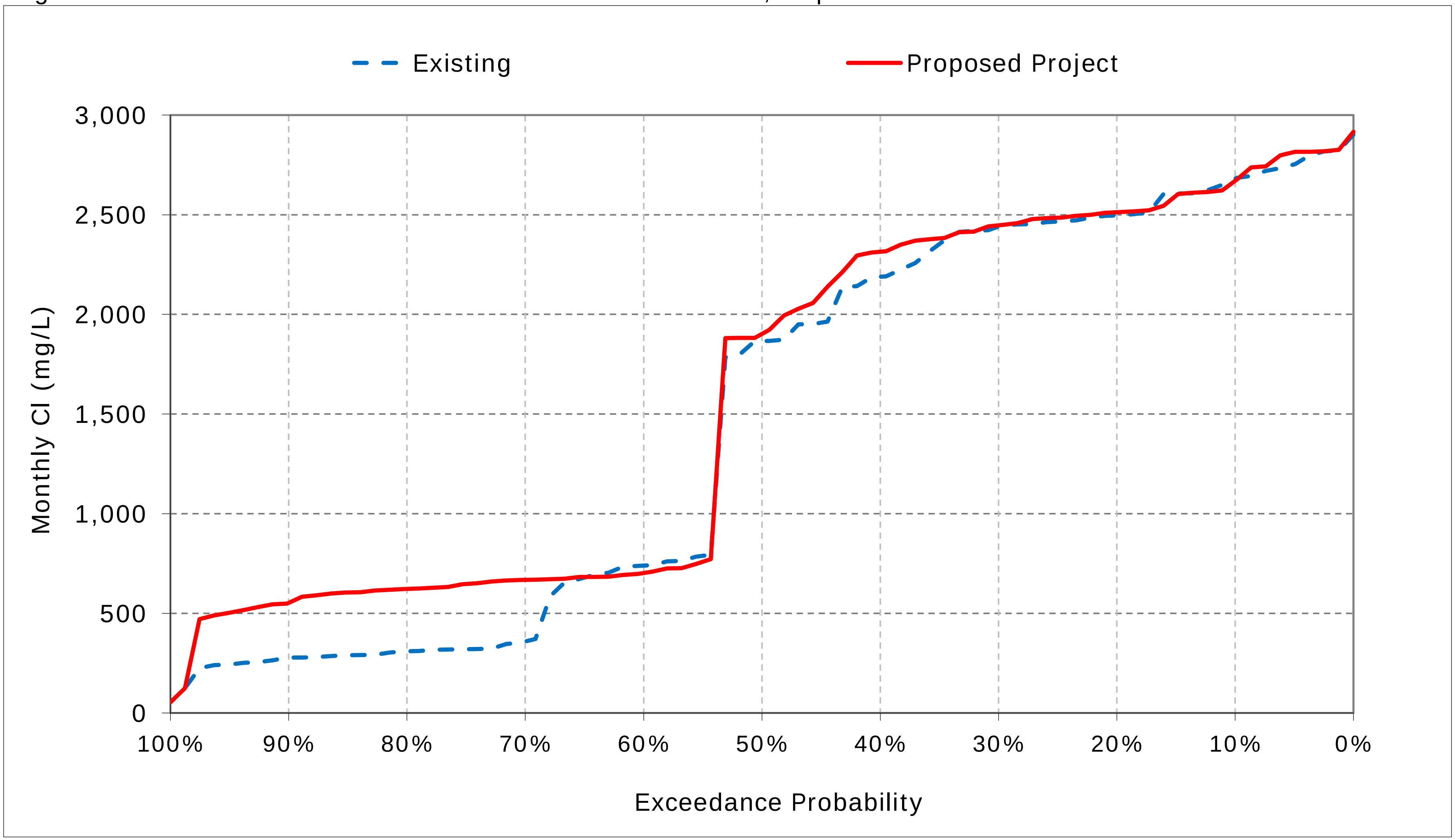


Figure 3-16. Sacramento River at Collinsville Chloride, October Cl

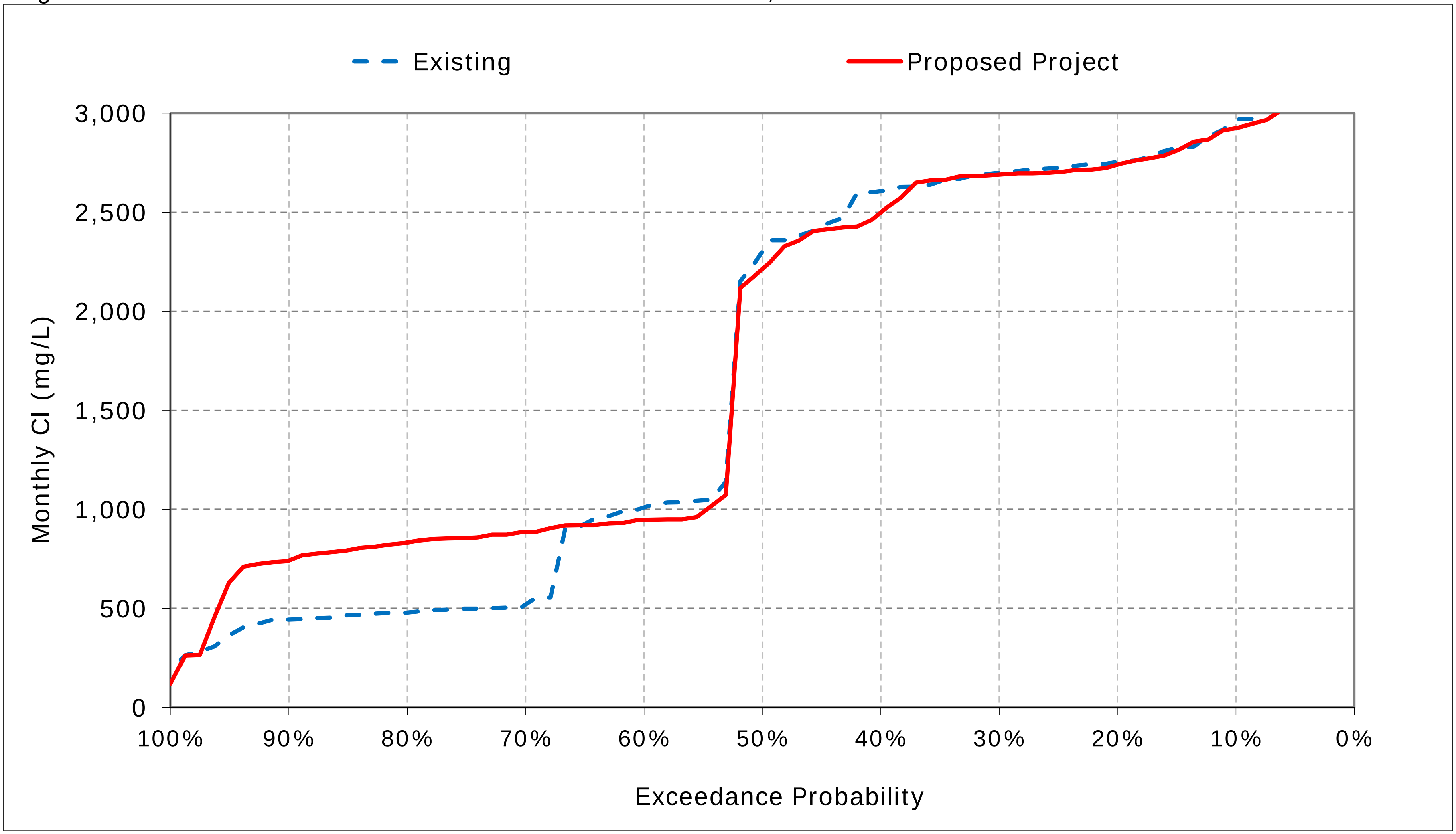


Figure 3-17. Sacramento River at Collinsville Chloride, November Cl

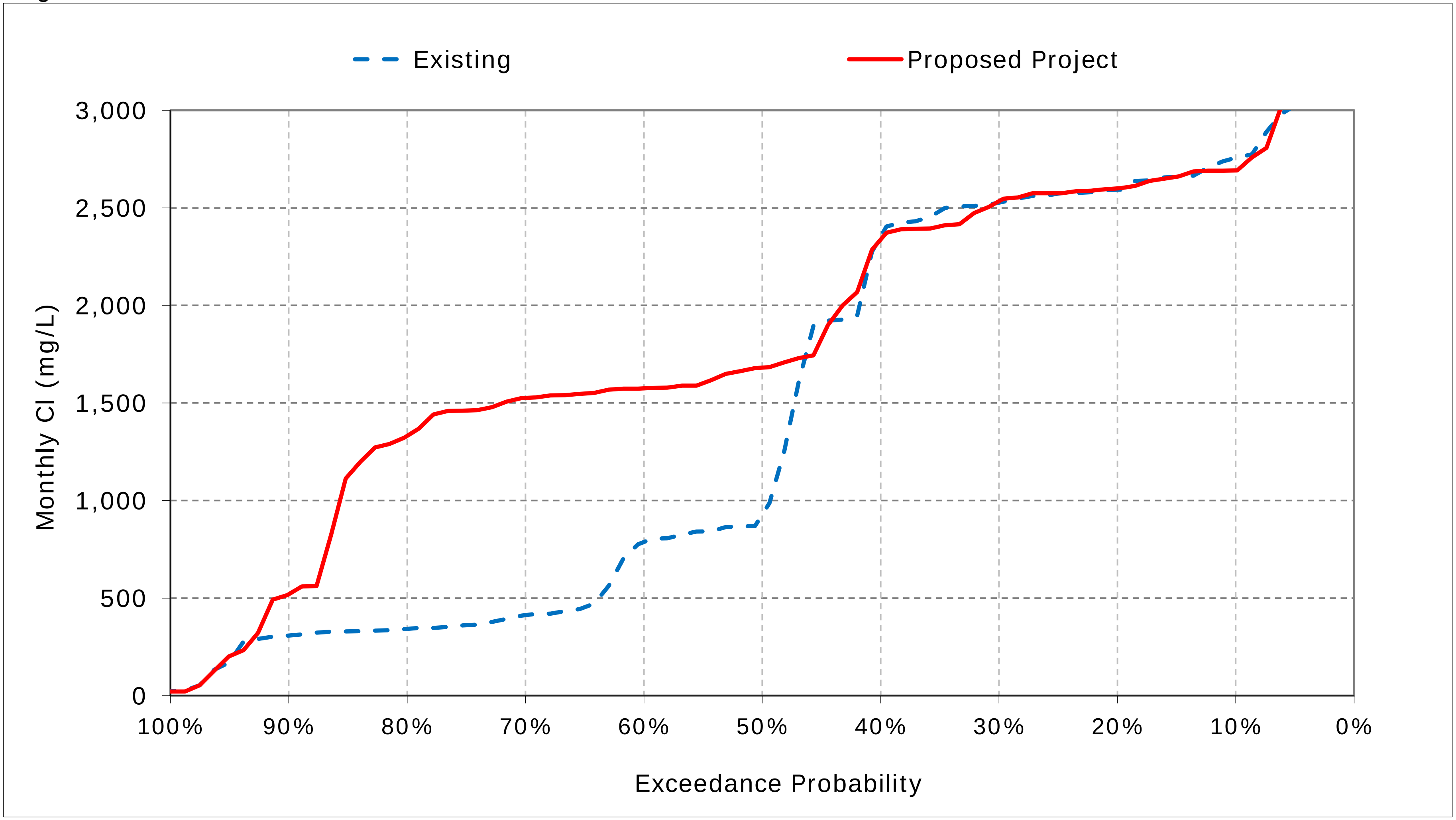


Figure 3-18. Sacramento River at Collinsville Chloride, December Cl

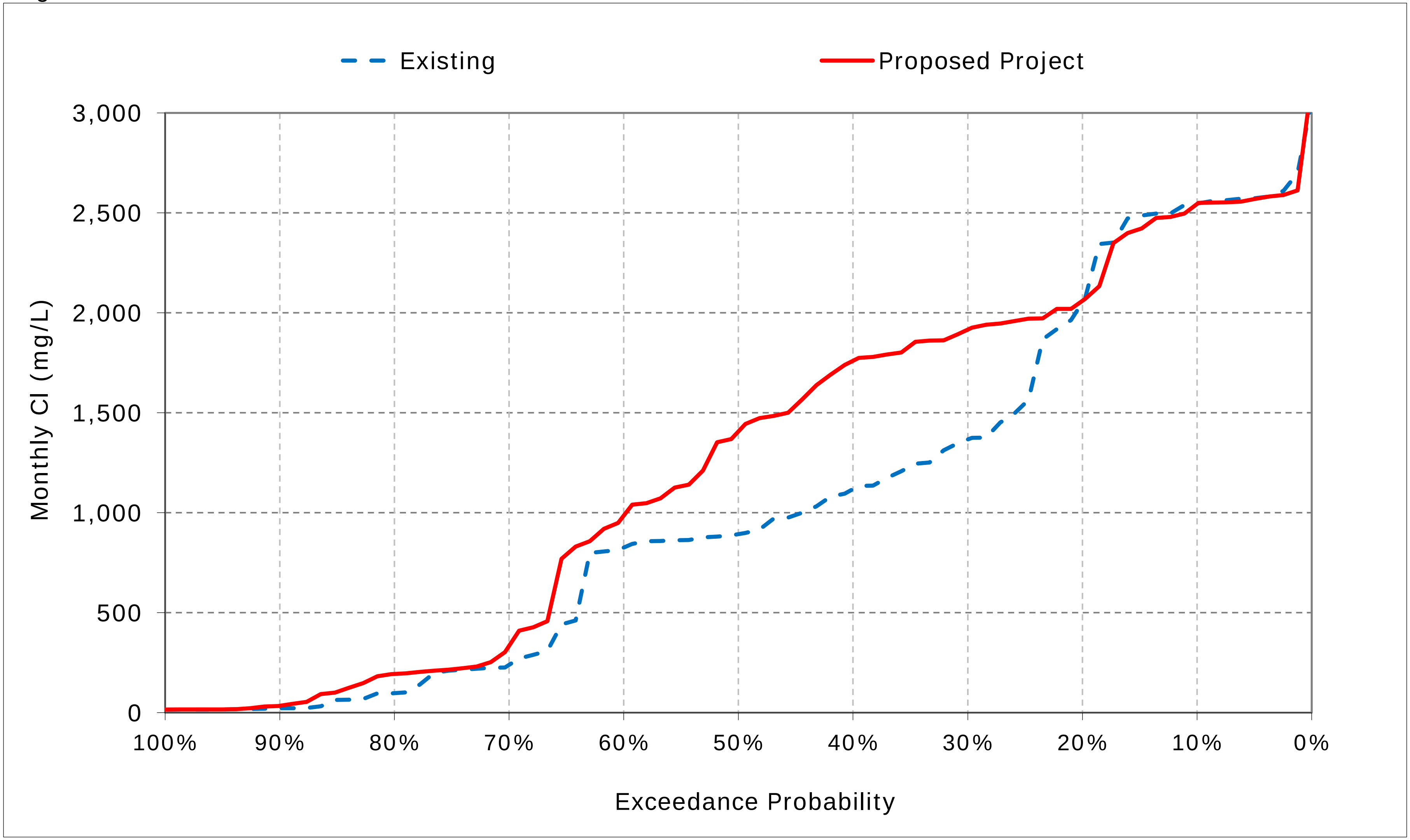


Table 4-1. San Joaquin River at Jersey Point Chloride, Monthly Cl

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	645	636	613	338	112	47	37	63	110	358	447	640
20%	593	592	535	271	63	29	25	36	84	274	391	612
30%	565	557	387	203	38	25	23	28	77	203	370	591
40%	538	488	312	142	33	23	23	25	54	180	342	556
50%	456	316	187	97	29	22	22	24	39	120	320	494
60%	110	132	162	50	26	21	21	23	26	90	294	243
70%	55	64	95	28	24	20	21	22	23	76	277	226
80%	39	42	38	23	21	19	20	21	19	46	254	209
90%	32	28	20	21	20	18	19	19	18	25	235	200
Long Term												
Full Simulation Period[a]	336	324	274	143	51	29	26	36	68	166	322	410
Water Year Types[b]												
Wet (32%)	242	208	91	34	23	21	21	20	22	48	233	184
Above Normal (15%)	376	317	268	99	30	21	22	22	32	73	270	219
Below Normal (17%)	354	368	360	163	35	23	23	25	46	163	349	602
Dry (22%)	357	386	336	197	63	28	24	31	78	275	370	594
Critical (15%)	448	439	485	315	132	61	46	102	213	353	461	591

Proposed Project

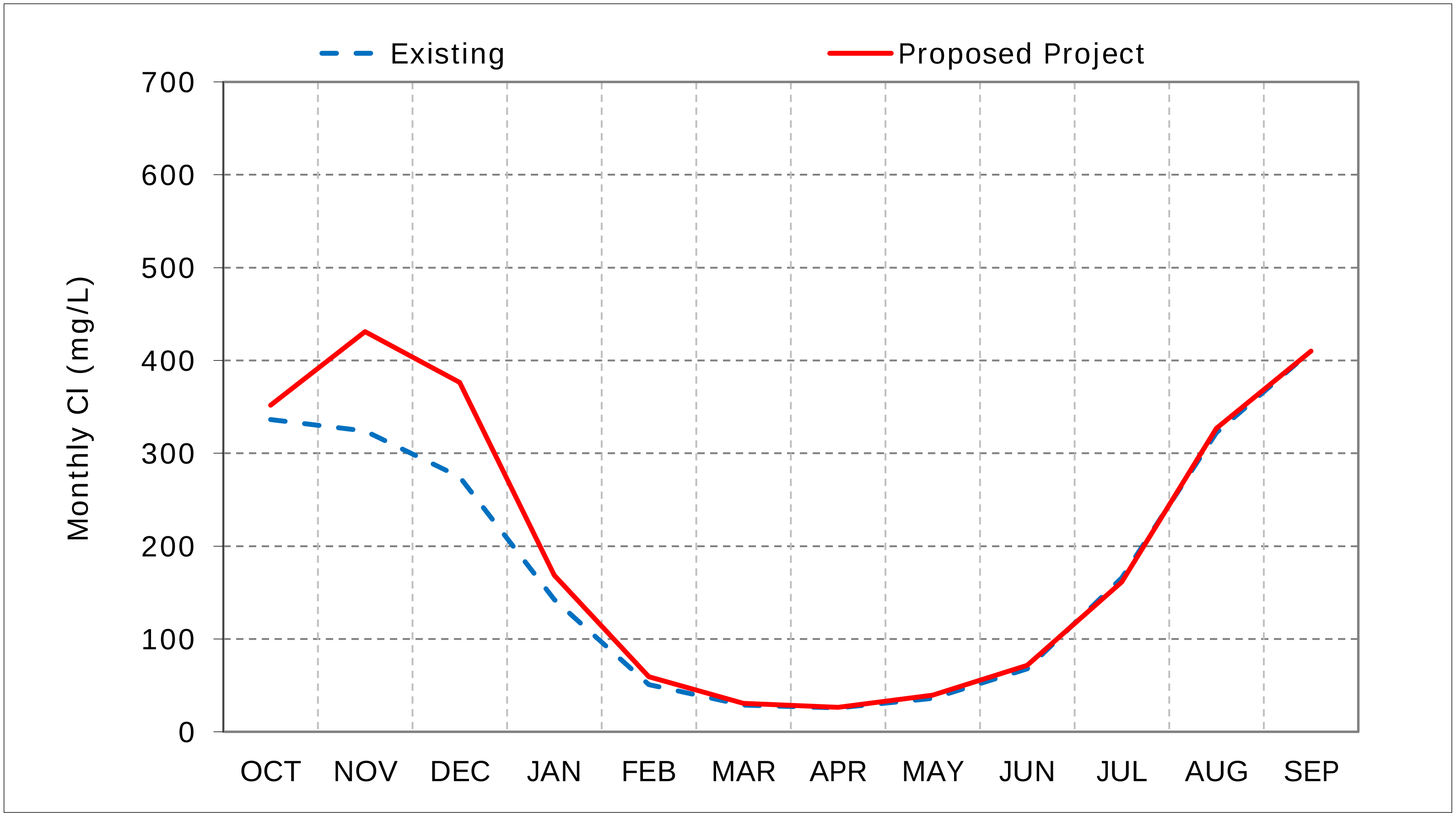
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	639	645	651	414	127	46	43	78	118	364	465	675
20%	595	596	613	317	68	29	25	55	98	240	417	657
30%	573	541	573	254	43	25	22	38	79	184	383	616
40%	526	485	506	201	34	24	21	23	58	165	355	566
50%	456	447	414	103	29	23	20	21	35	109	322	507
60%	127	380	337	59	27	22	20	19	25	83	287	216
70%	110	361	146	28	23	21	19	18	21	70	273	197
80%	89	298	100	24	21	19	19	17	18	47	248	176
90%	67	151	29	22	20	19	18	17	17	25	216	139
Long Term												
Full Simulation Period[a]	352	431	376	169	59	31	26	39	71	161	327	410
Water Year Types[b]												
Wet (32%)	267	340	159	39	24	21	19	18	23	47	220	153
Above Normal (15%)	397	441	420	135	32	22	20	19	29	70	271	197
Below Normal (17%)	374	469	475	187	36	23	22	27	46	147	381	656
Dry (22%)	370	469	465	246	78	30	26	42	88	264	374	600
Critical (15%)	438	517	555	344	162	69	55	116	226	364	481	609

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	-6	8	38	76	15	0	6	16	7	6	18	35
20%	1	4	78	46	5	0	0	18	15	-33	27	45
30%	8	-16	186	51	5	0	-1	10	2	-19	13	26
40%	-12	-3	194	59	1	0	-1	-2	4	-15	13	9
50%	0	131	228	6	0	1	-1	-3	-3	-11	2	12
60%	16	248	175	8	1	1	-1	-4	-1	-7	-8	-26
70%	55	297	51	1	0	0	-2	-4	-1	-6	-4	-29
80%	50	257	62	1	0	0	-1	-4	-1	1	-5	-33
90%	36	123	9	1	0	0	-1	-2	-1	0	-19	-61
Long Term												
Full Simulation Period[a]	16	107	102	26	8	2	1	4	4	-4	5	0
Water Year Types[b]												
Wet (32%)	25	132	67	5	0	0	-2	-2	1	-1	-13	-32
Above Normal (15%)	21	124	152	36	2	1	-2	-4	-4	-3	1	-22
Below Normal (17%)	20	101	116	24	1	0	-1	2	0	-16	31	55
Dry (22%)	13	83	129	49	15	1	1	10	10	-11	3	6
Critical (15%)	-10	78	70	29	31	8	9	14	13	11	19	18

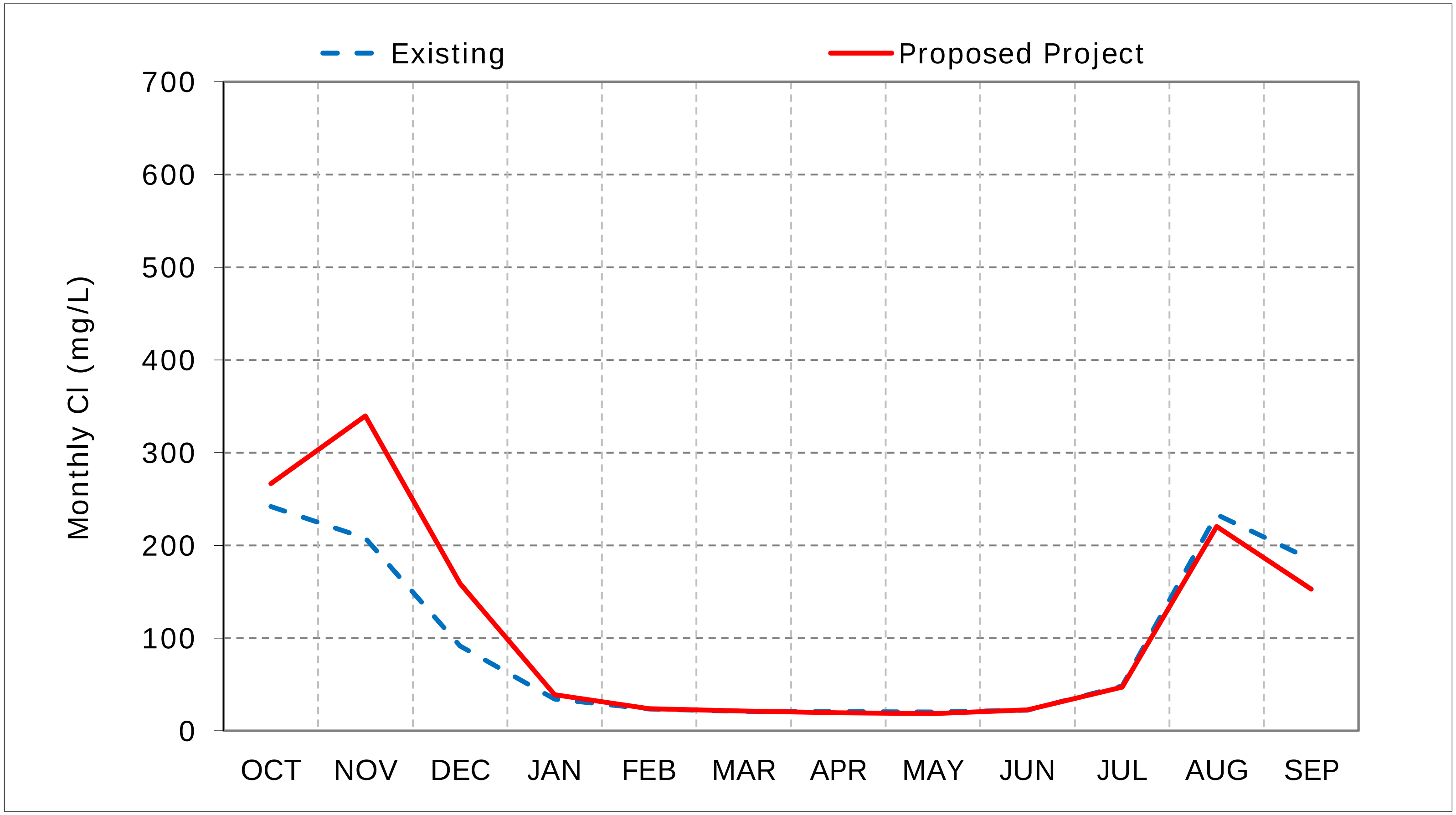
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 4-1. San Joaquin River at Jersey Point Chloride, Long-Term Average Cl



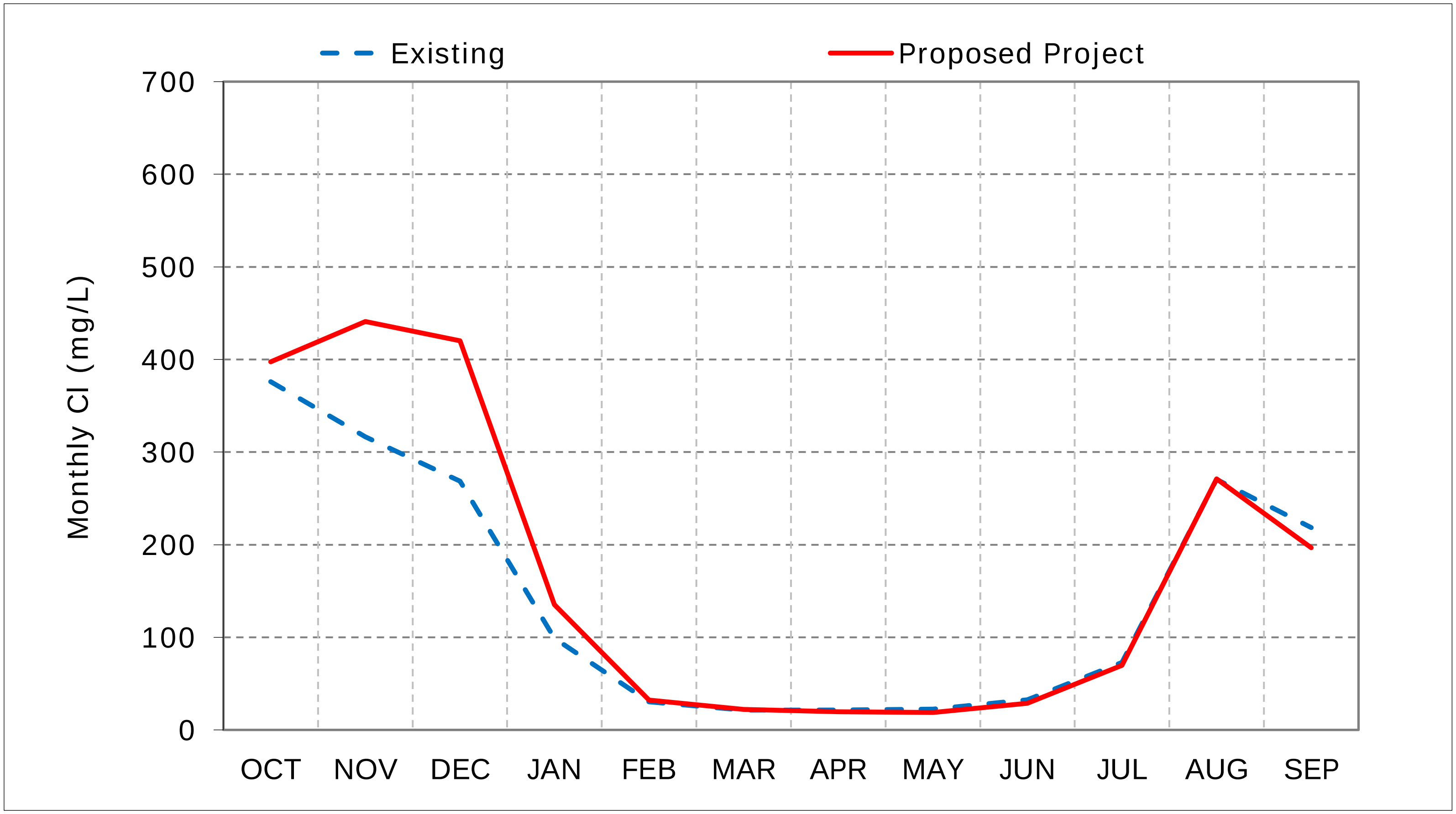
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 4-2. San Joaquin River at Jersey Point Chloride, Wet Year Average Cl



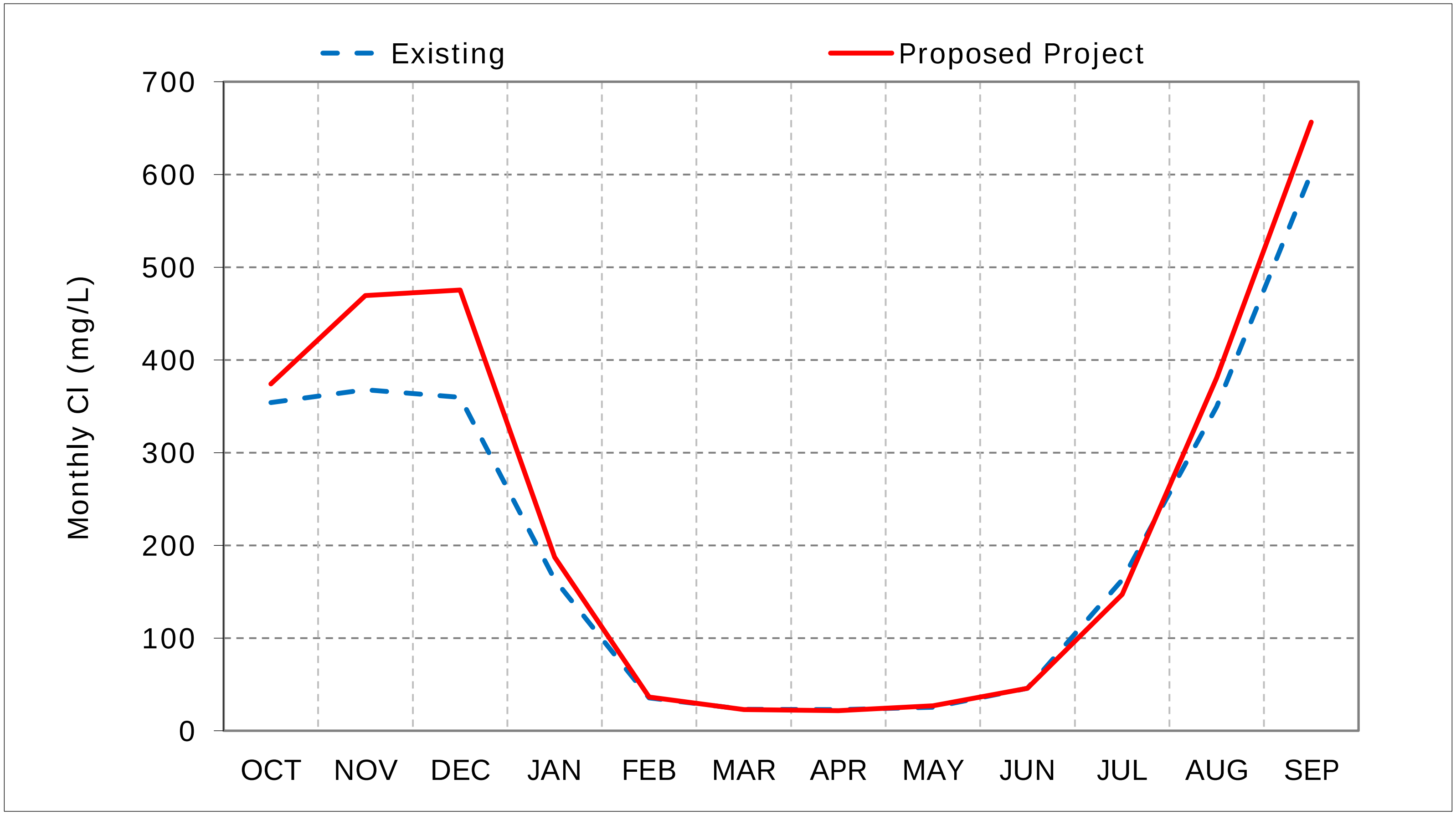
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 4-3. San Joaquin River at Jersey Point Chloride, Above Normal Year Averag



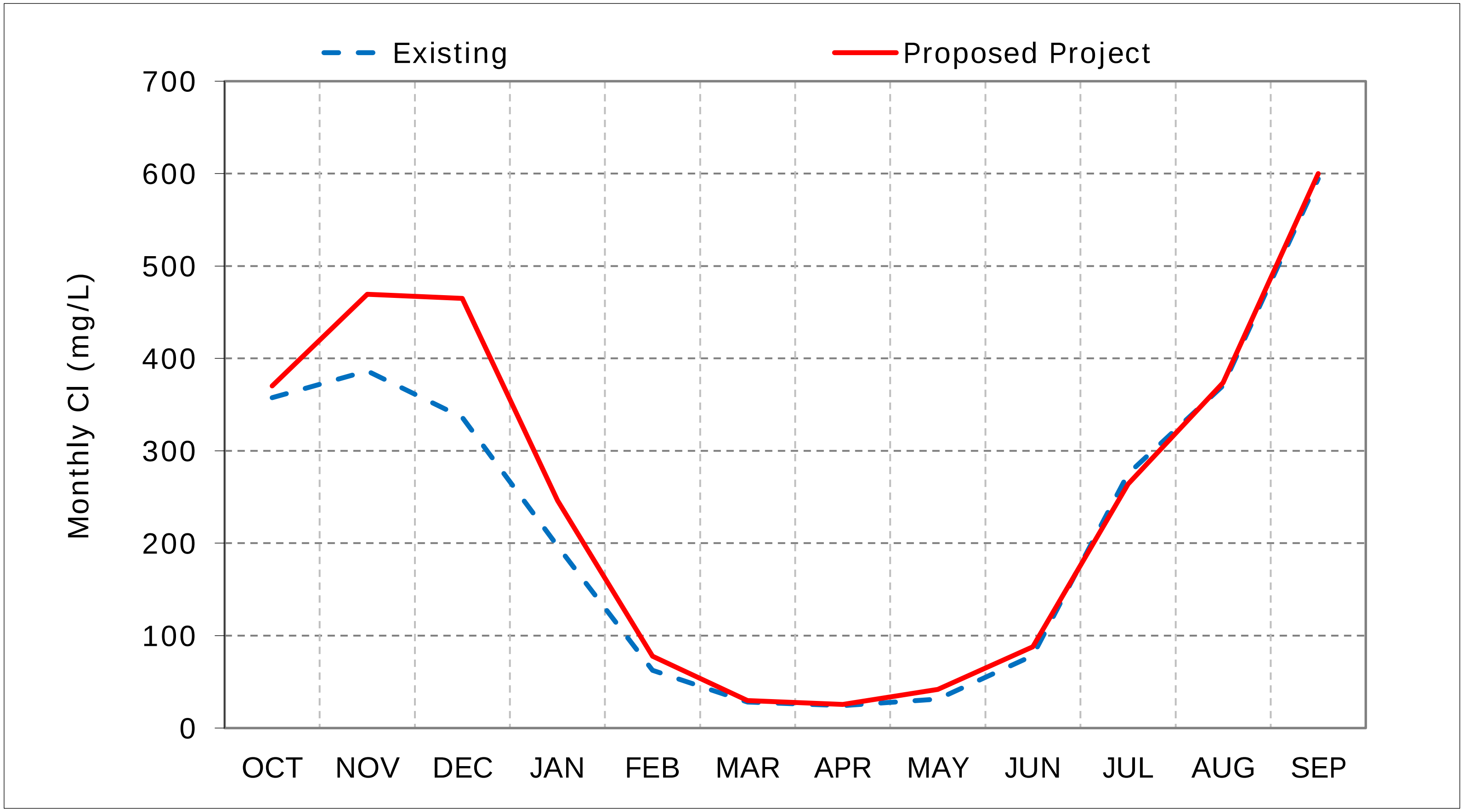
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 4-4. San Joaquin River at Jersey Point Chloride, Below Normal Year Averag



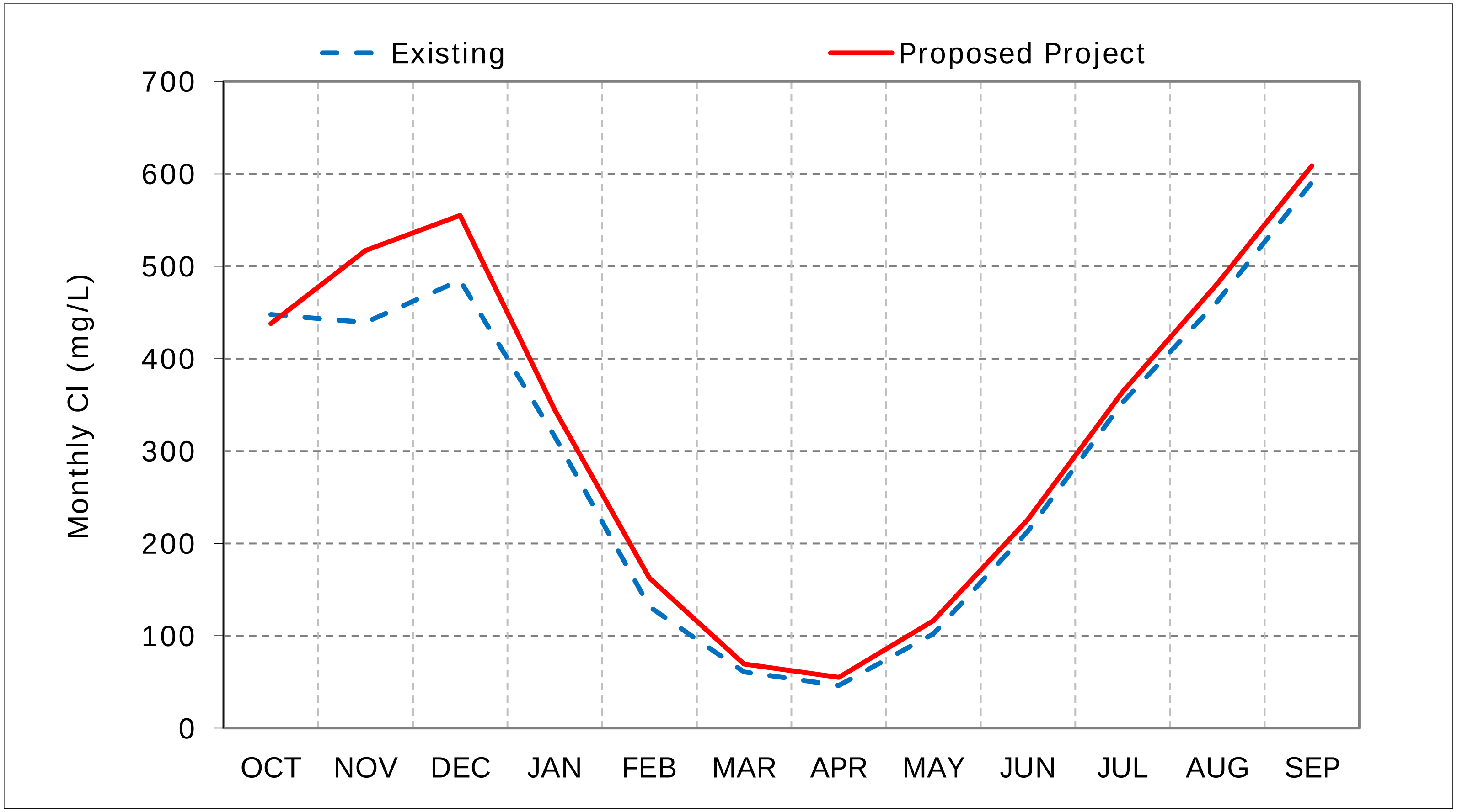
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 4-5. San Joaquin River at Jersey Point Chloride, Dry Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 4-6. San Joaquin River at Jersey Point Chloride, Critical Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 4-7. San Joaquin River at Jersey Point Chloride, January Cl

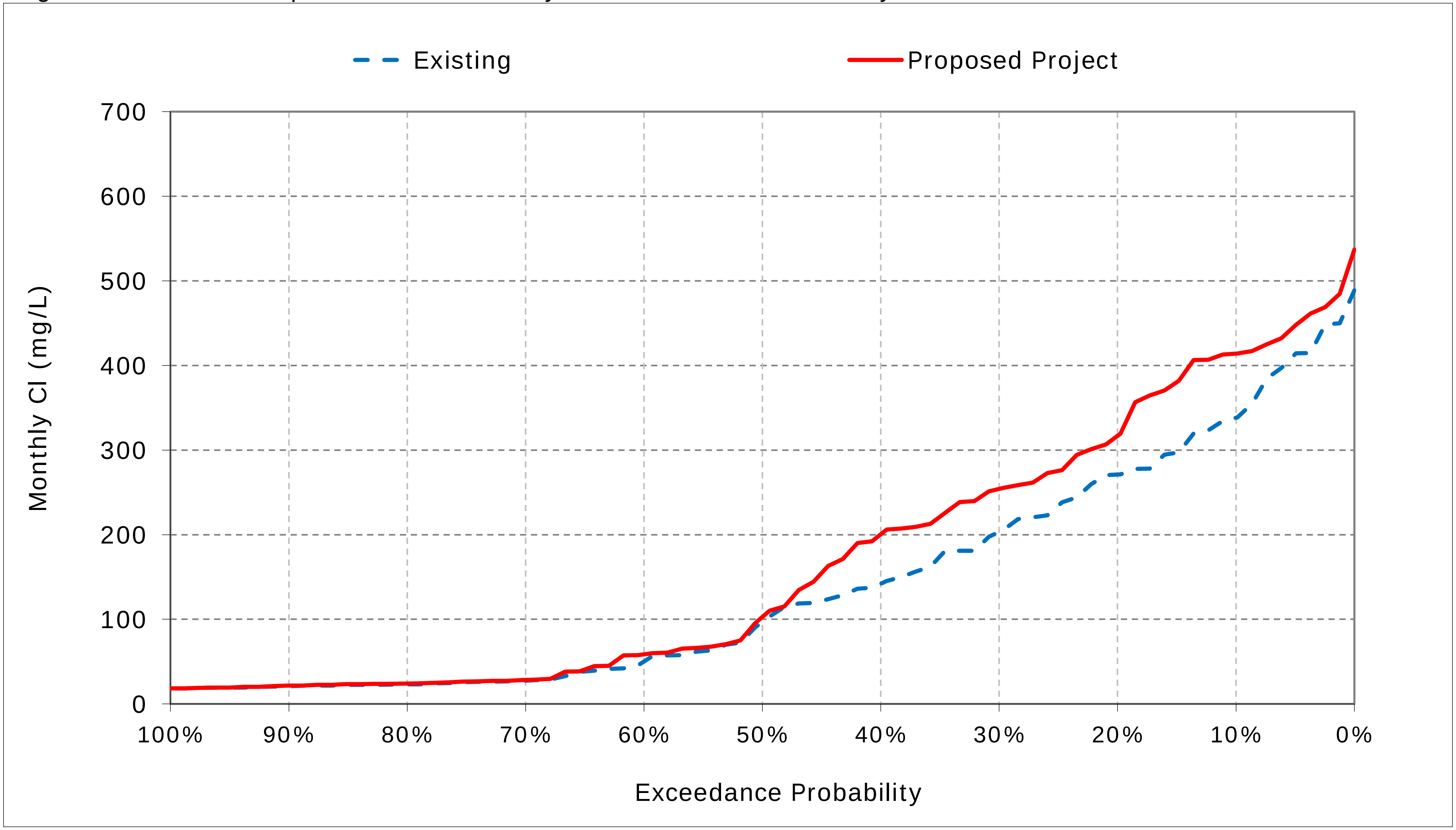


Figure 4-8. San Joaquin River at Jersey Point Chloride, February Cl

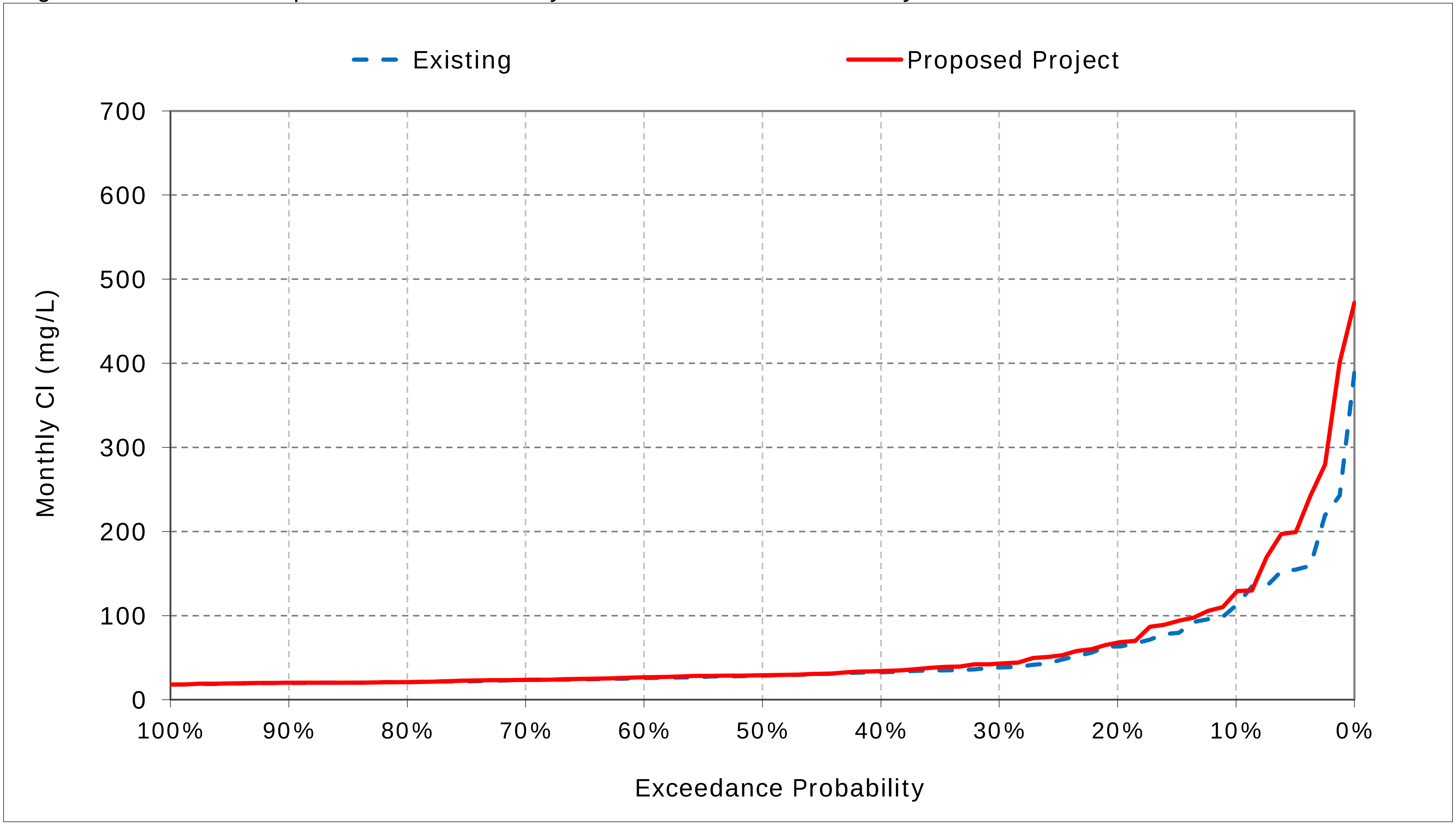


Figure 4-9. San Joaquin River at Jersey Point Chloride, March Cl

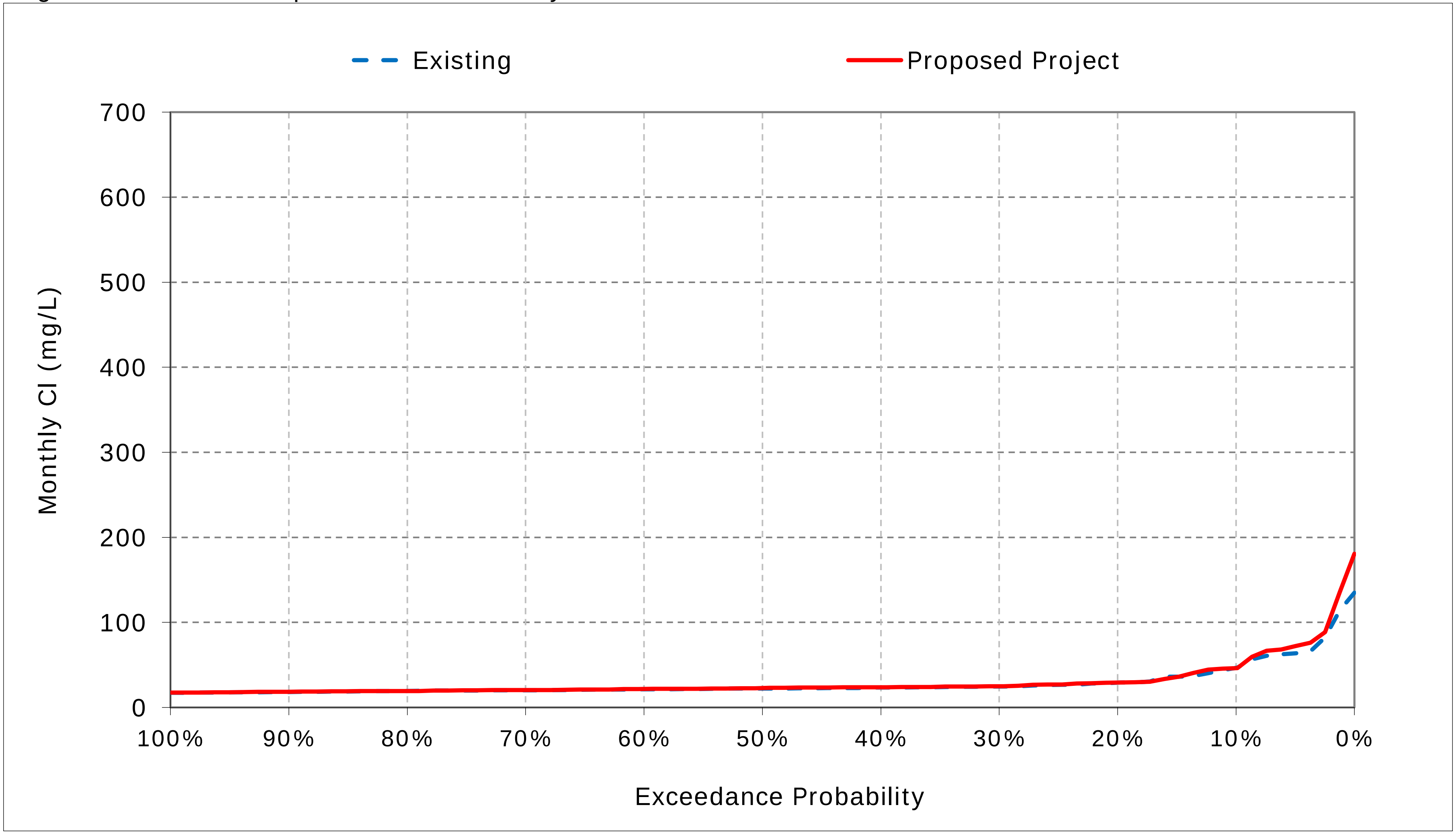


Figure 4-10. San Joaquin River at Jersey Point Chloride, April Cl

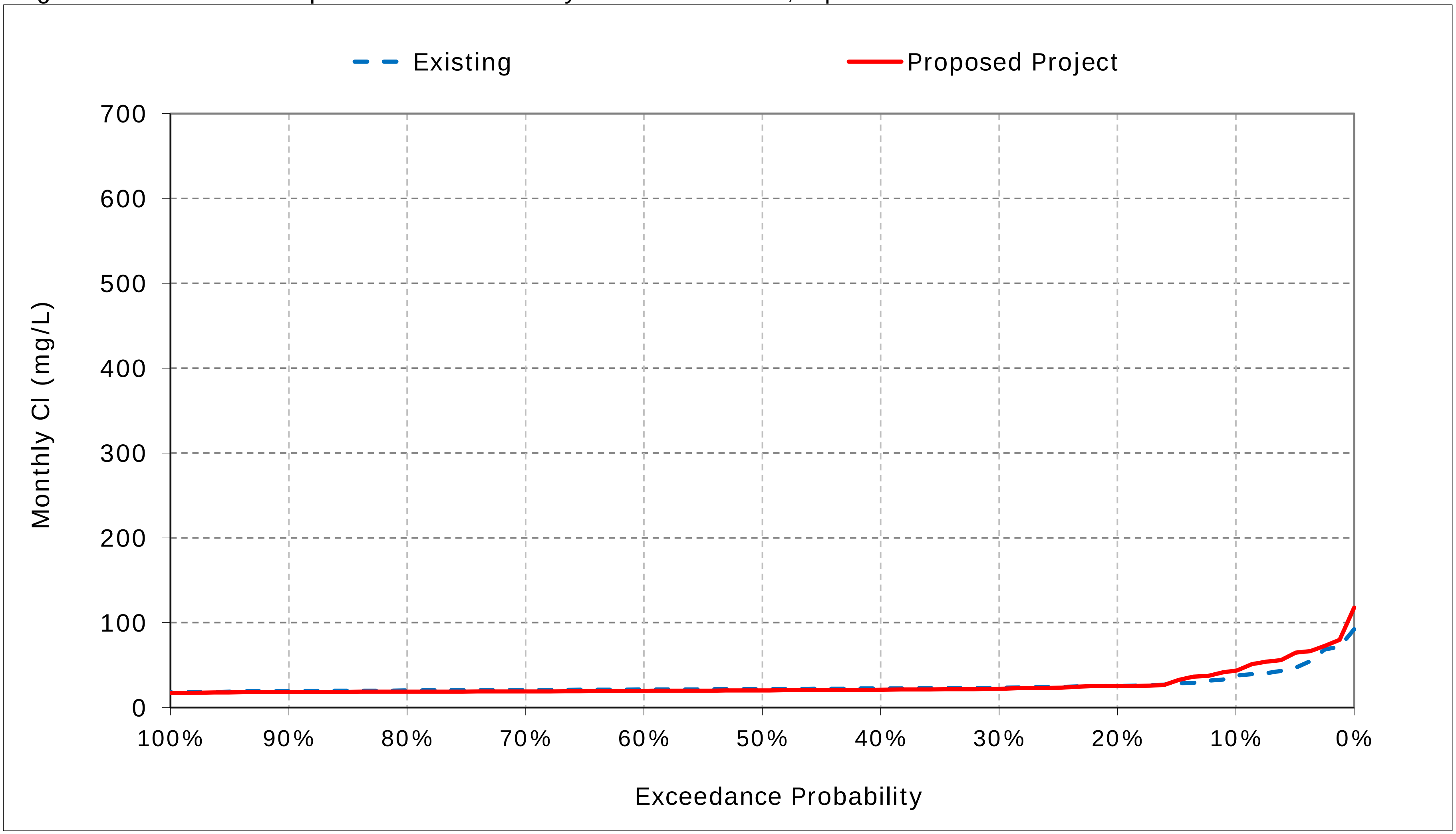


Figure 4-11. San Joaquin River at Jersey Point Chloride, May Cl

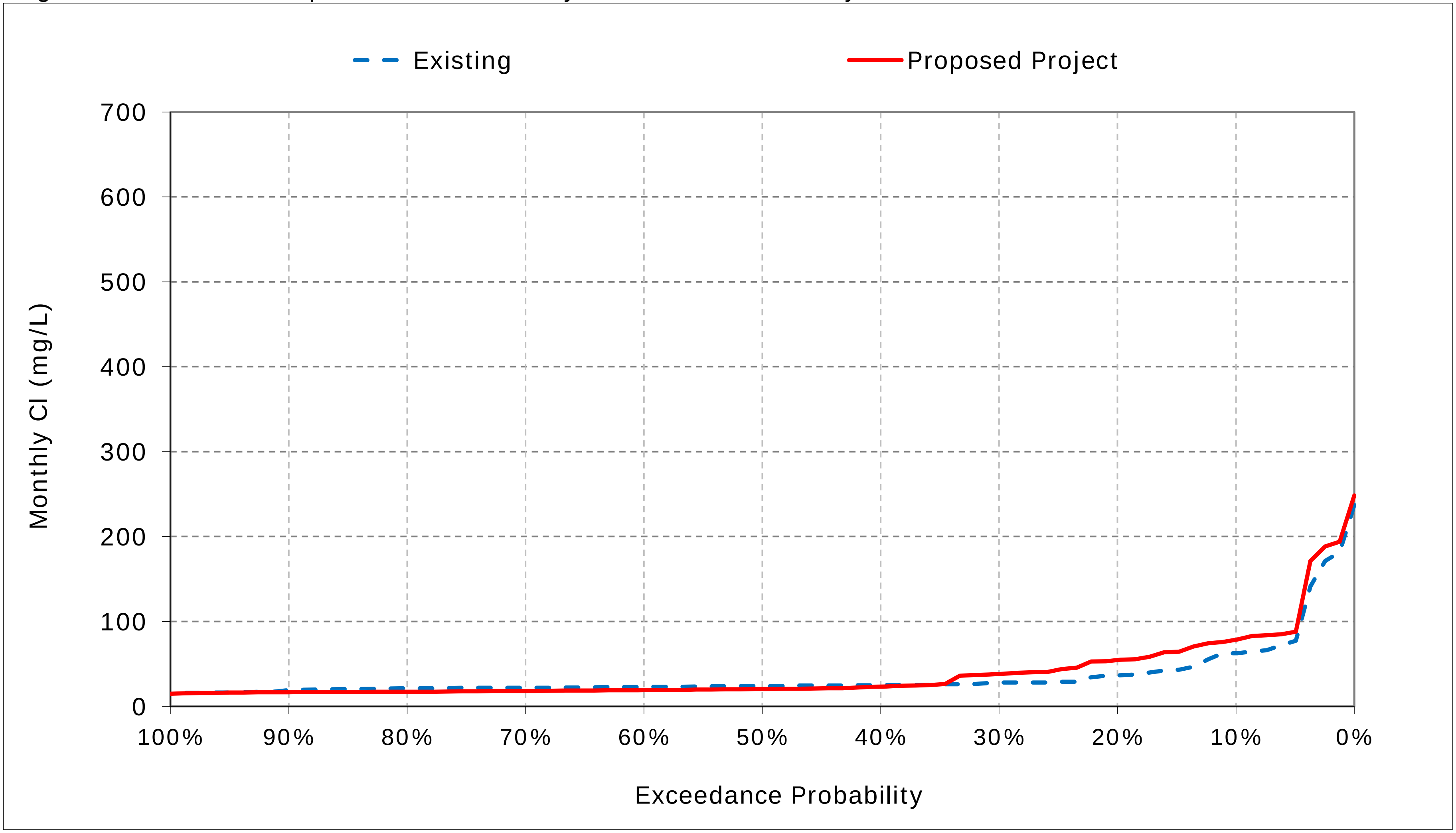


Figure 4-12. San Joaquin River at Jersey Point Chloride, June Cl

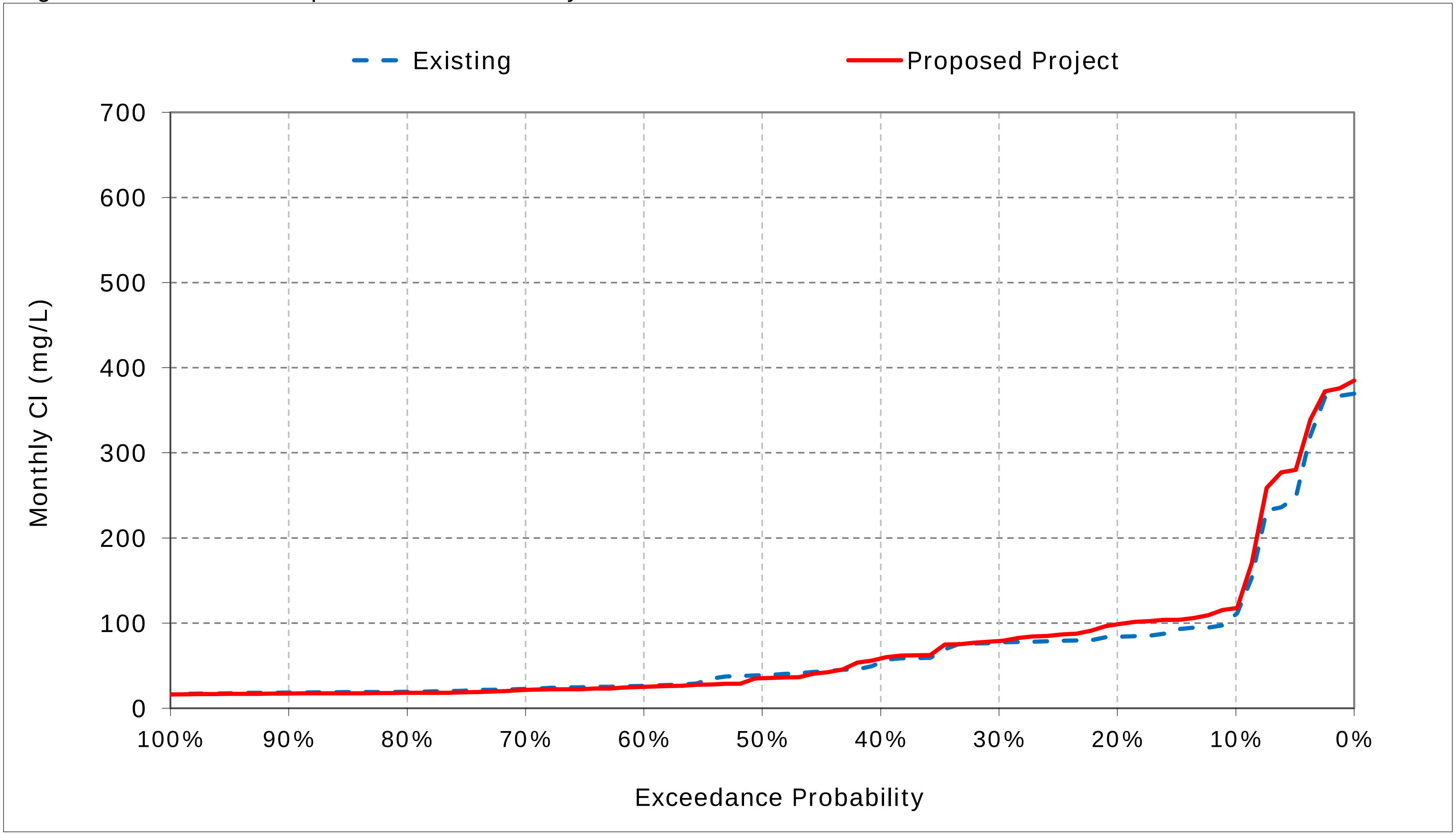


Figure 4-13. San Joaquin River at Jersey Point Chloride, July Cl

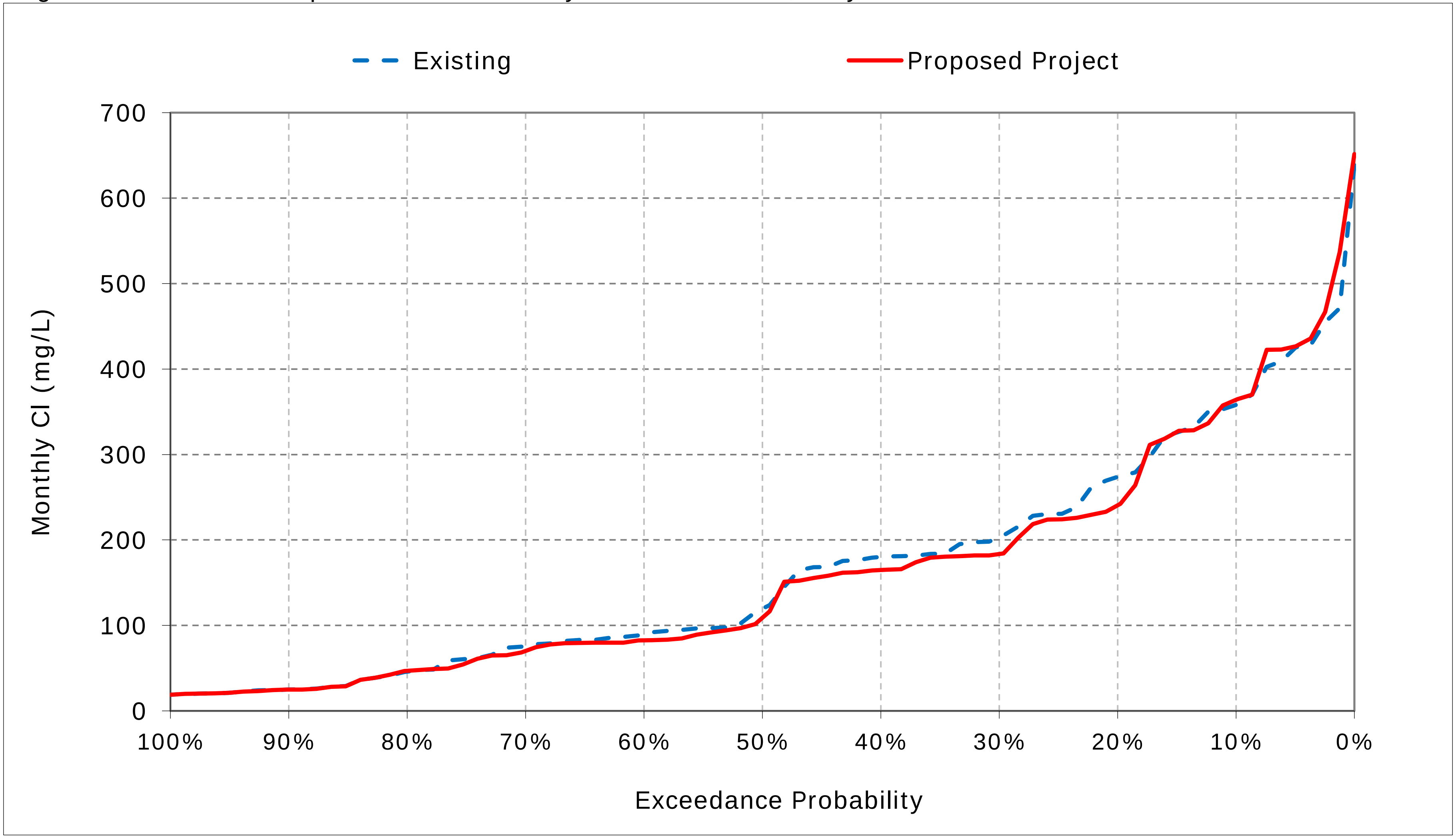


Figure 4-14. San Joaquin River at Jersey Point Chloride, August Cl

Figure 4-15. San Joaquin River at Jersey Point Chloride, September Cl

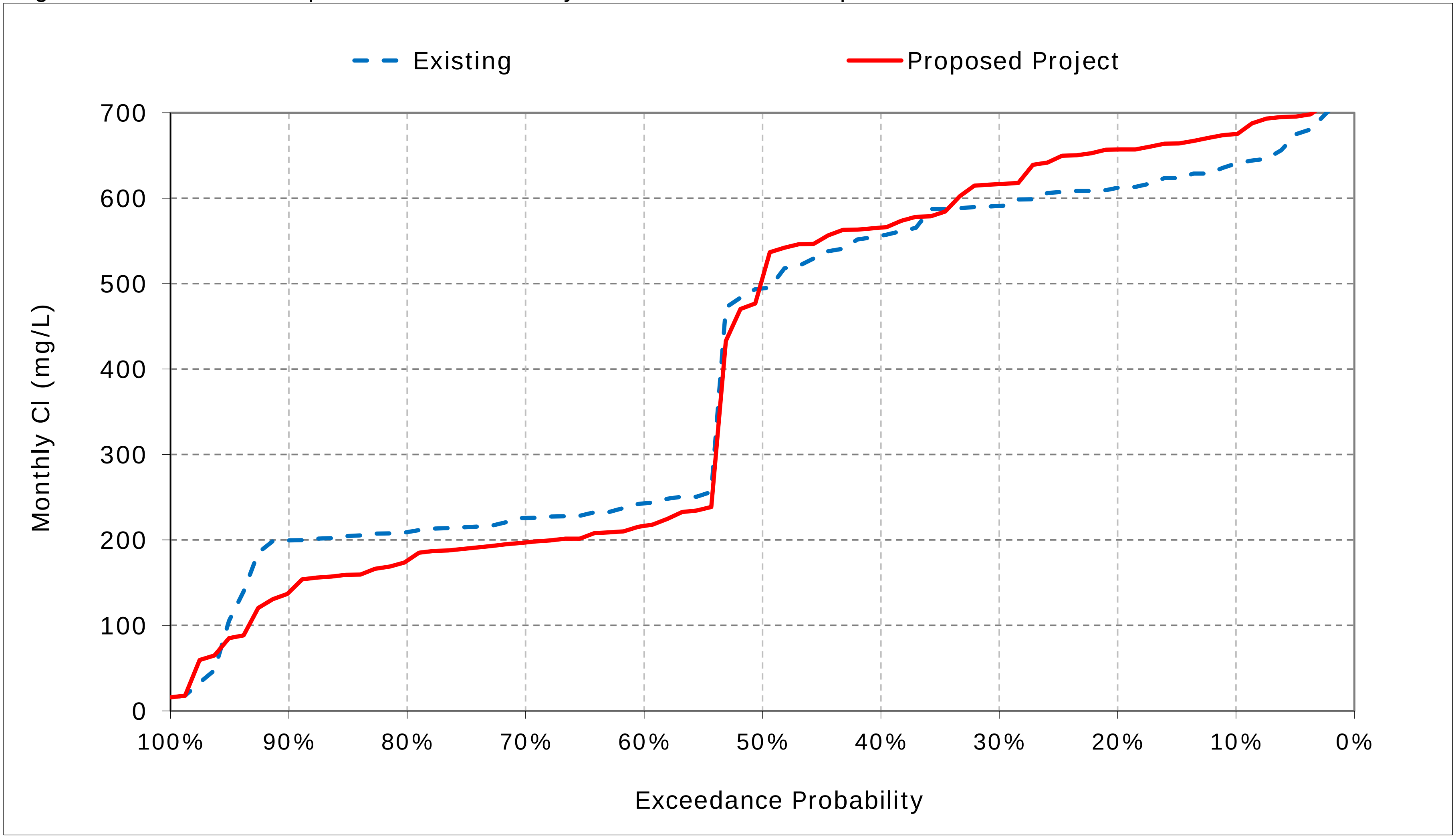


Figure 4-16. San Joaquin River at Jersey Point Chloride, October Cl

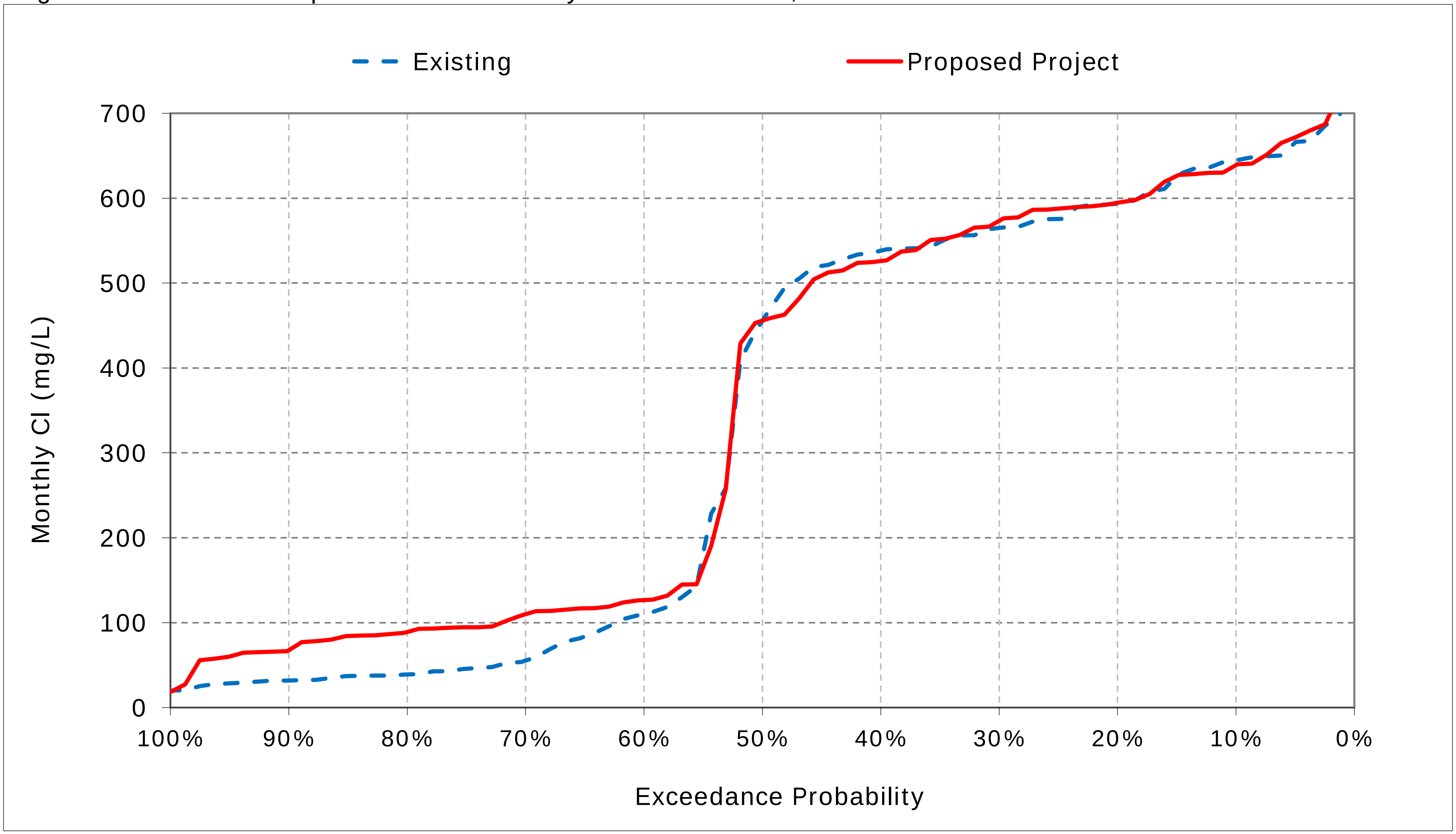


Figure 4-17. San Joaquin River at Jersey Point Chloride, November Cl

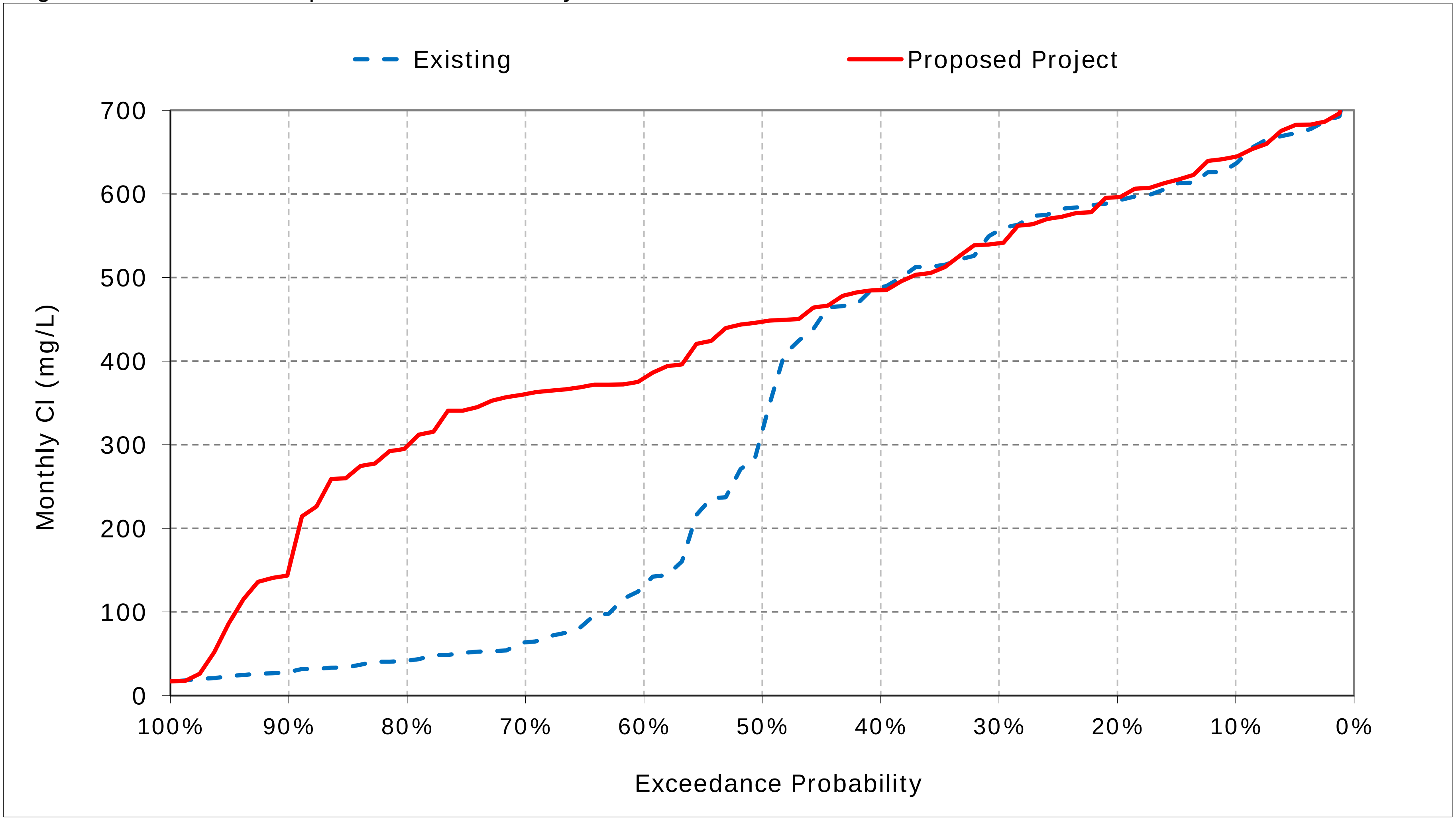


Figure 4-18. San Joaquin River at Jersey Point Chloride, December Cl

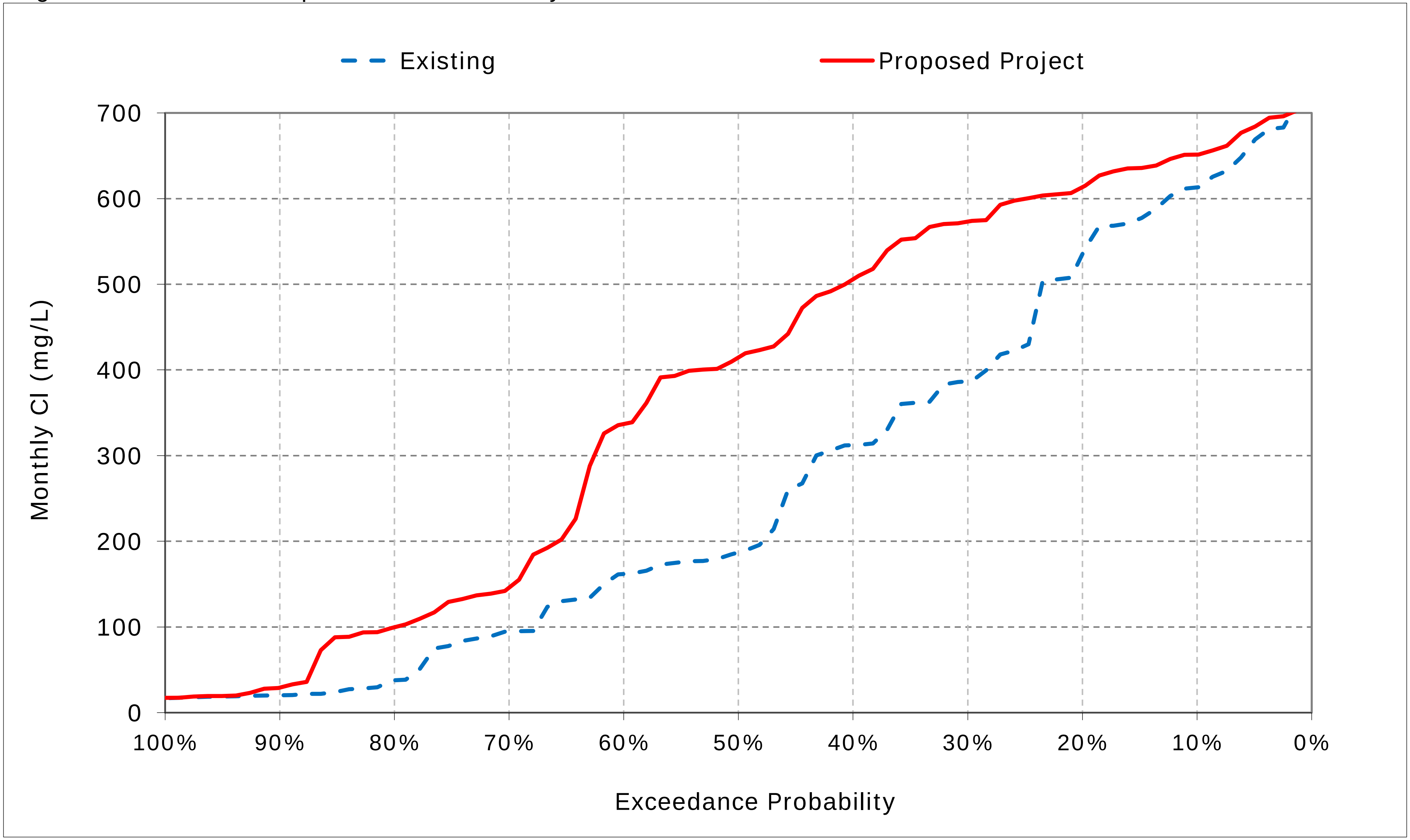


Table 5-1. San Joaquin River at San Andreas Chloride, Monthly Cl

Existing

Statistic	Monthly Cl (mg/L)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	136	132	148	112	41	23	24	25	23	53	84	117
20%	117	117	136	91	29	22	23	24	21	36	71	112
30%	111	110	116	68	25	21	22	24	20	28	61	104
40%	105	99	84	53	23	20	21	23	19	26	52	97
50%	92	70	42	38	22	19	20	22	19	21	47	84
60%	21	27	33	27	21	18	20	21	18	19	42	67
70%	20	20	27	22	19	18	19	20	17	19	33	56
80%	19	19	21	20	18	17	19	19	17	18	31	37
90%	18	18	17	18	17	17	17	16	16	17	29	29
Long Term												
Full Simulation Period[a]	71	71	72	54	26	20	21	22	21	30	51	78
Water Year Types[b]												
Wet (32%)	53	49	33	23	19	18	18	18	17	18	31	52
Above Normal (15%)	81	70	70	41	22	18	20	21	18	19	34	31
Below Normal (17%)	72	76	89	61	23	20	21	22	19	25	51	102
Dry (22%)	75	82	85	68	29	20	22	23	20	38	67	100
Critical (15%)	94	94	119	107	46	26	23	29	39	62	86	124

Proposed Project

Statistic	Monthly Cl (mg/L)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	132	139	166	144	46	23	22	23	24	54	83	127
20%	123	125	152	111	30	22	21	21	21	32	69	117
30%	114	113	148	93	26	21	20	20	20	28	60	111
40%	106	102	132	73	23	20	19	19	19	24	54	99
50%	100	90	123	38	22	19	18	18	17	21	46	86
60%	24	67	105	27	21	19	18	17	17	19	39	31
70%	21	57	46	23	19	18	17	16	16	18	32	28
80%	20	46	31	20	18	17	17	16	16	18	30	27
90%	18	30	19	18	17	17	16	15	16	17	26	25
Long Term												
Full Simulation Period[a]	73	87	103	66	29	21	19	19	21	30	51	73
Water Year Types[b]												
Wet (32%)	55	68	52	25	19	18	17	16	16	18	30	25
Above Normal (15%)	83	93	118	57	23	19	18	17	17	19	34	29
Below Normal (17%)	74	89	121	71	23	20	19	18	18	23	52	113
Dry (22%)	77	94	125	90	33	21	20	20	20	37	66	102
Critical (15%)	96	106	144	118	56	29	23	29	41	64	88	128

Proposed Project minus Existing

Statistic	Monthly Cl (mg/L)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-4	7	18	32	6	0	-3	-2	0	1	-1	10
20%	7	8	17	20	1	0	-2	-3	0	-3	-2	5
30%	3	3	33	25	1	0	-2	-4	0	0	-1	8
40%	1	3	48	20	0	0	-2	-4	-1	-2	2	2
50%	8	20	81	0	0	0	-2	-4	-2	0	-1	2
60%	3	40	73	0	0	0	-2	-4	-1	0	-3	-36
70%	1	37	19	0	0	0	-2	-4	-1	0	-1	-28
80%	0	28	9	0	0	0	-2	-3	-1	0	-1	-10
90%	0	12	2	0	0	0	-1	-1	-1	0	-2	-4
Long Term												
Full Simulation Period[a]	2	16	31	11	3	1	-2	-3	0	0	0	-6
Water Year Types[b]												
Wet (32%)	2	19	19	2	0	0	-1	-2	-1	0	-2	-26
Above Normal (15%)	1	23	49	16	1	0	-2	-4	-1	0	0	-2
Below Normal (17%)	2	13	33	10	0	0	-3	-4	-1	-2	1	11
Dry (22%)	1	12	39	21	4	1	-3	-4	0	-1	-2	2
Critical (15%)	1	12	24	11	10	3	0	0	2	2	2	4

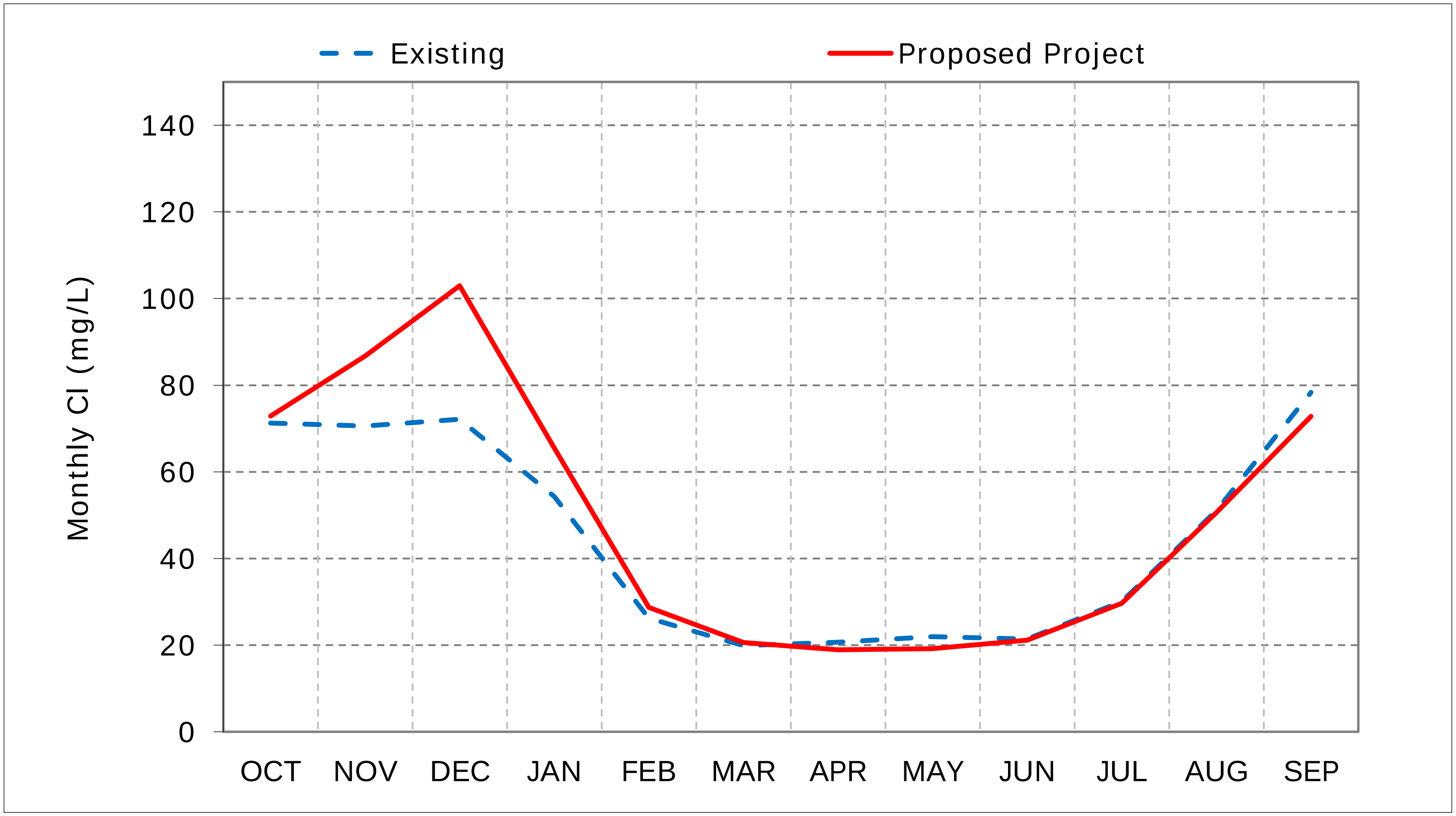
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

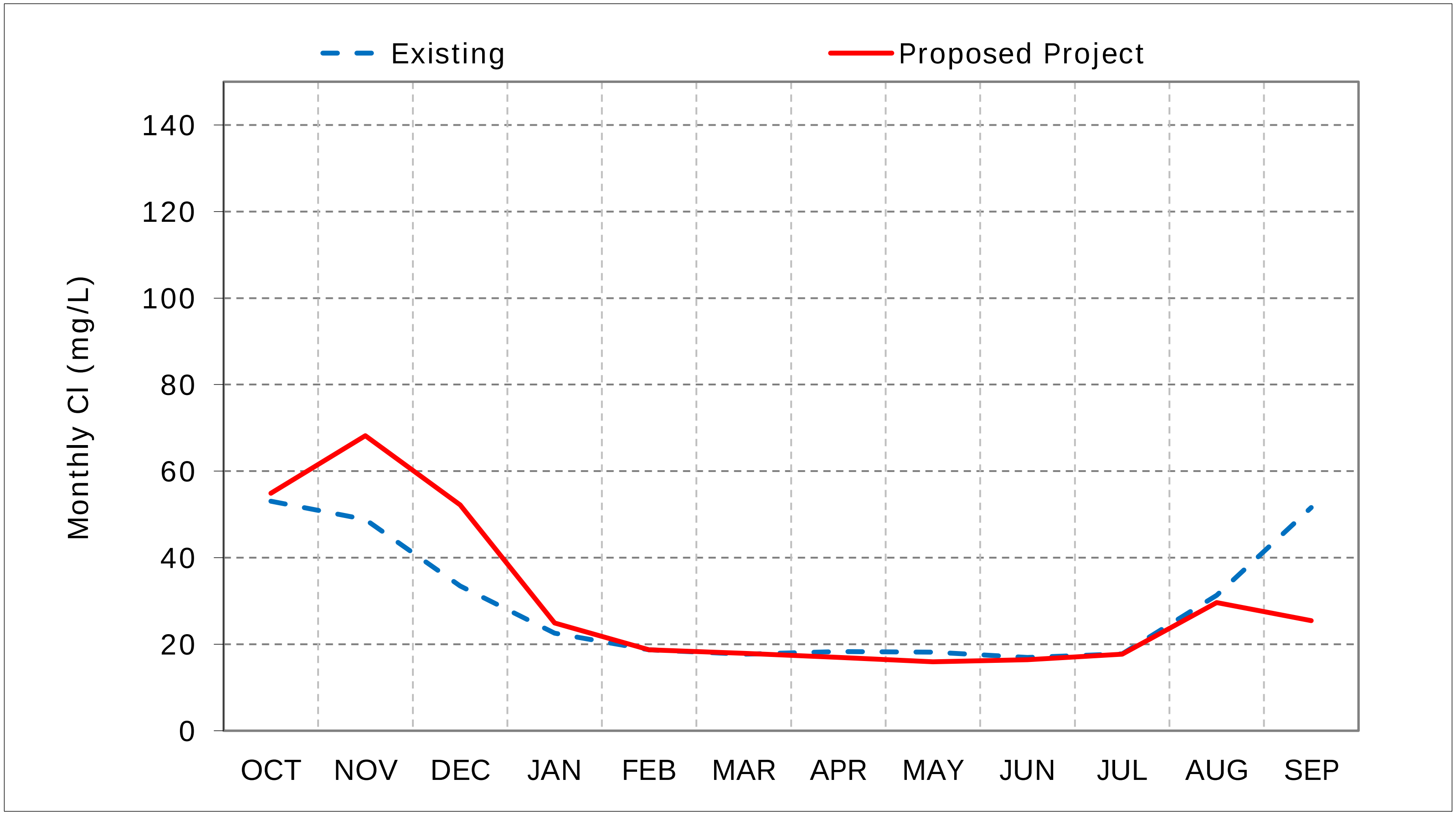
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 5-1. San Joaquin River at San Andreas Chloride, Long-Term Average Cl



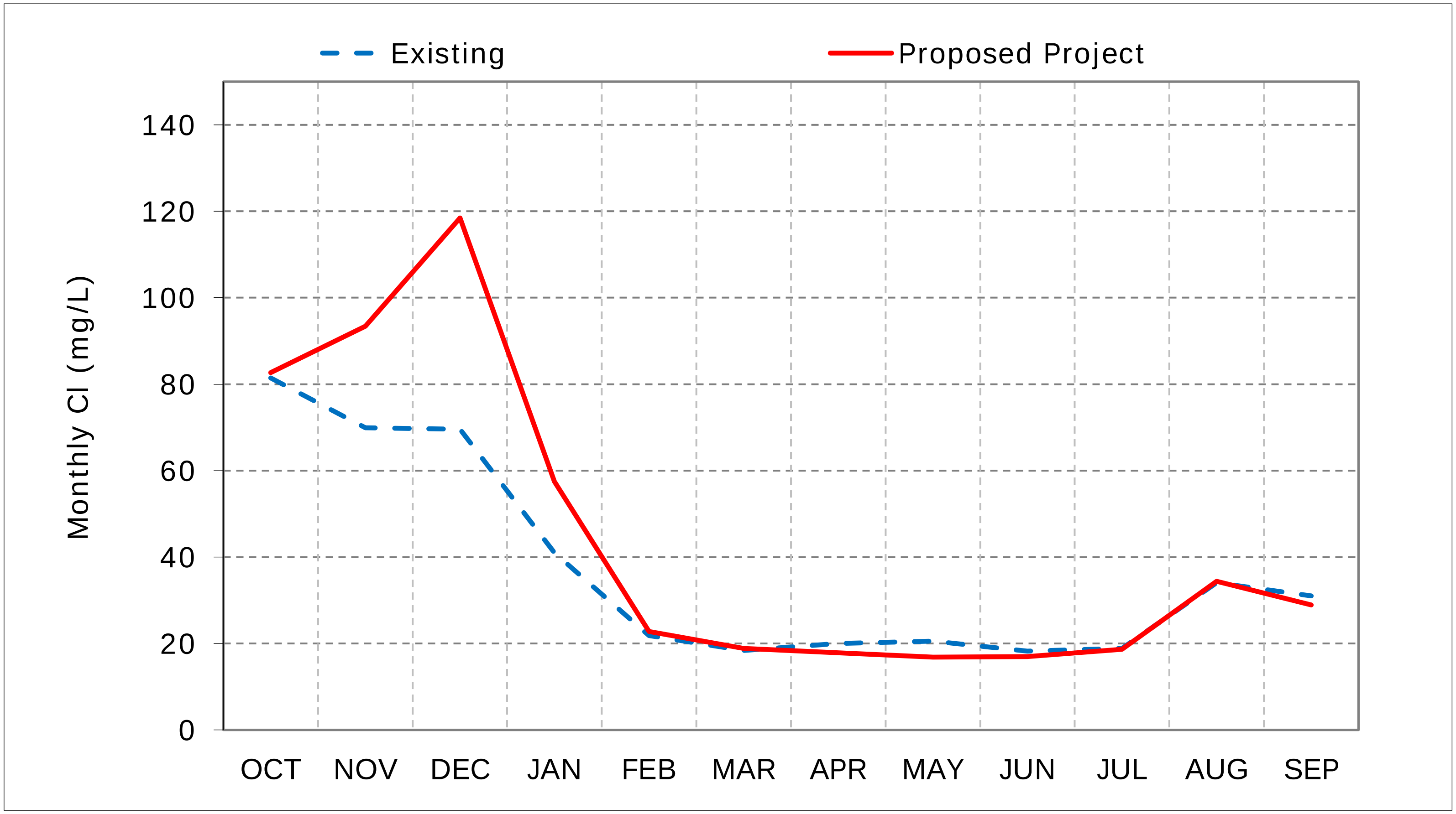
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 5-2. San Joaquin River at San Andreas Chloride, Wet Year Average Cl



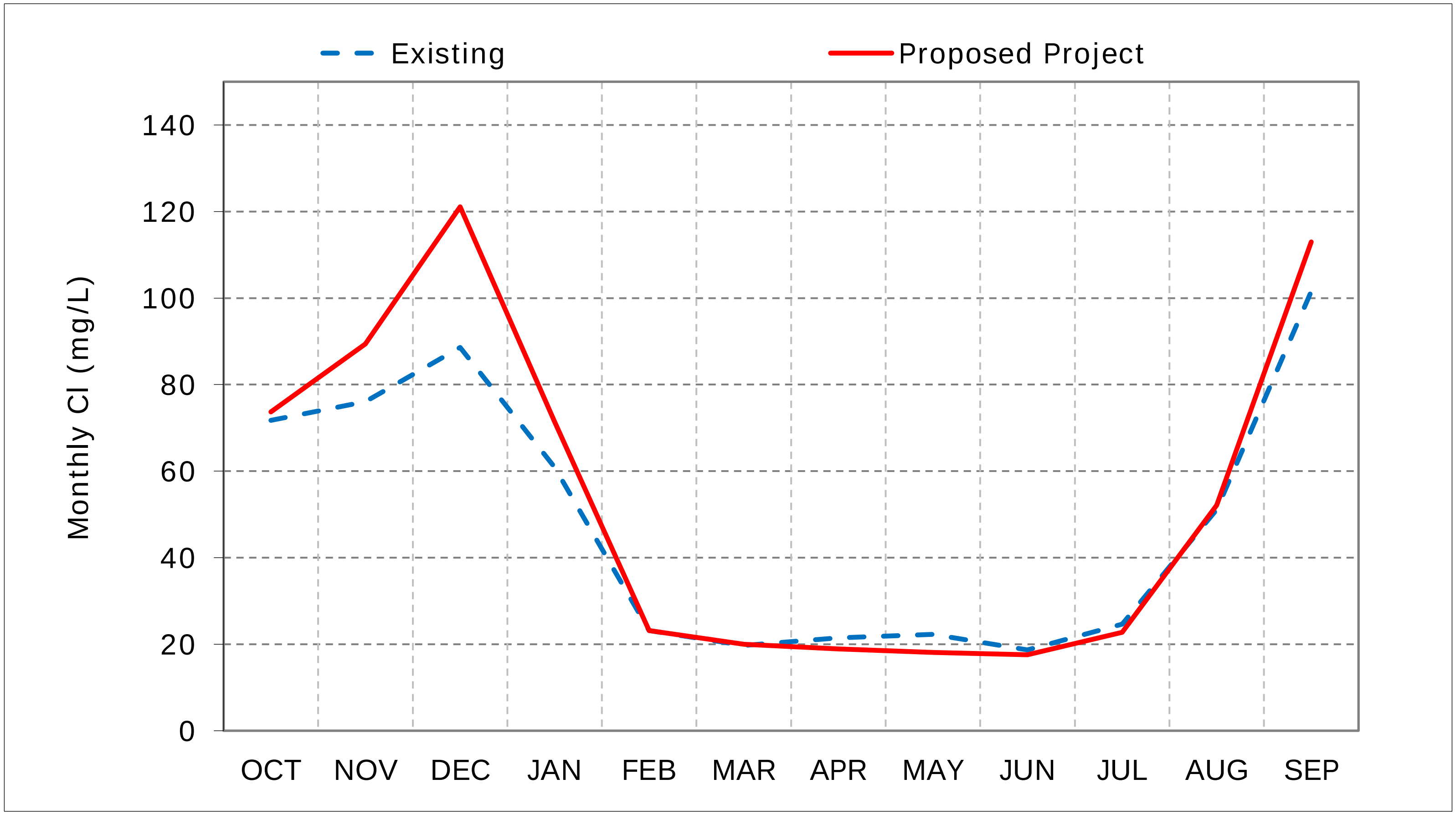
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 5-3. San Joaquin River at San Andreas Chloride, Above Normal Year Averag



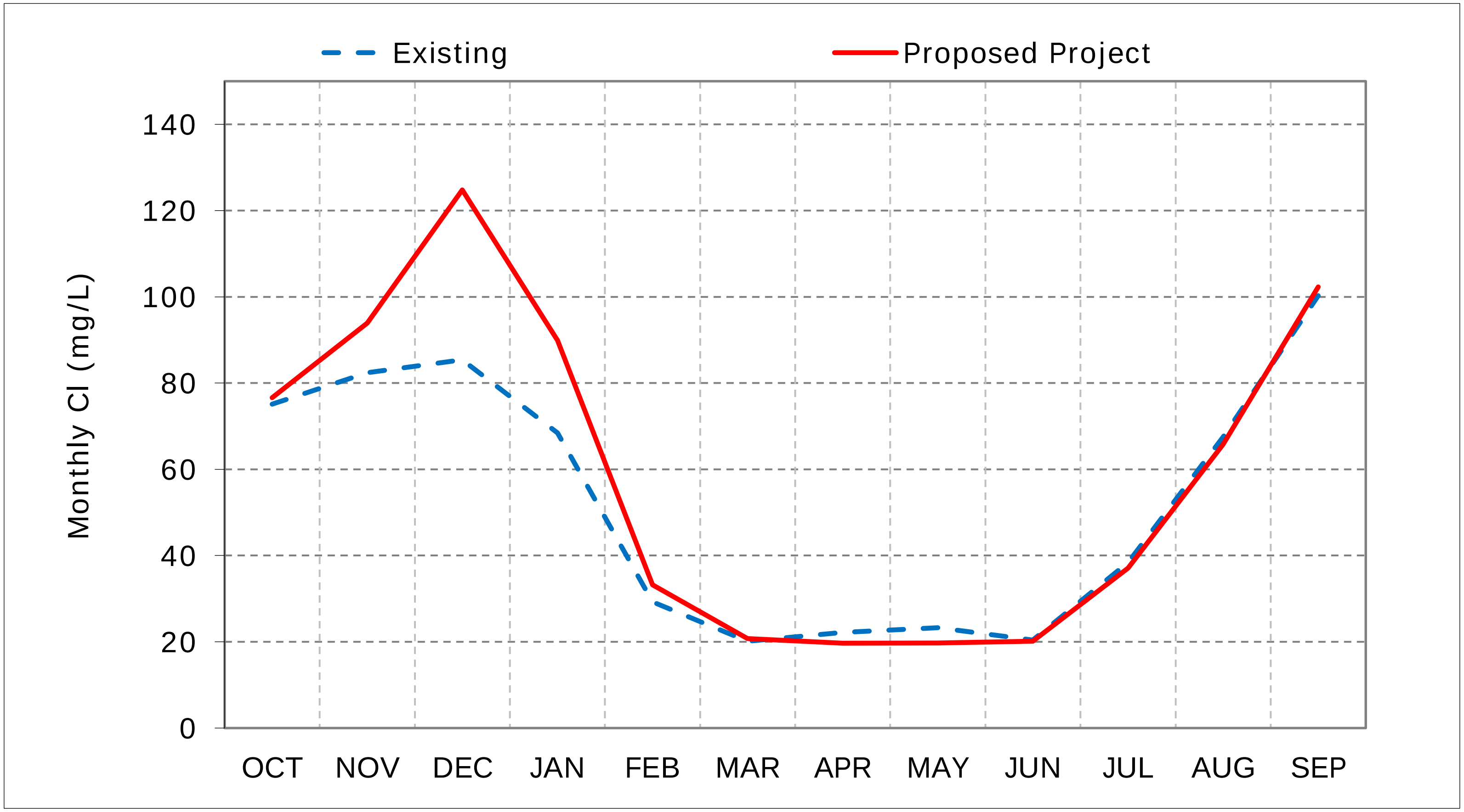
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 5-4. San Joaquin River at San Andreas Chloride, Below Normal Year Averag



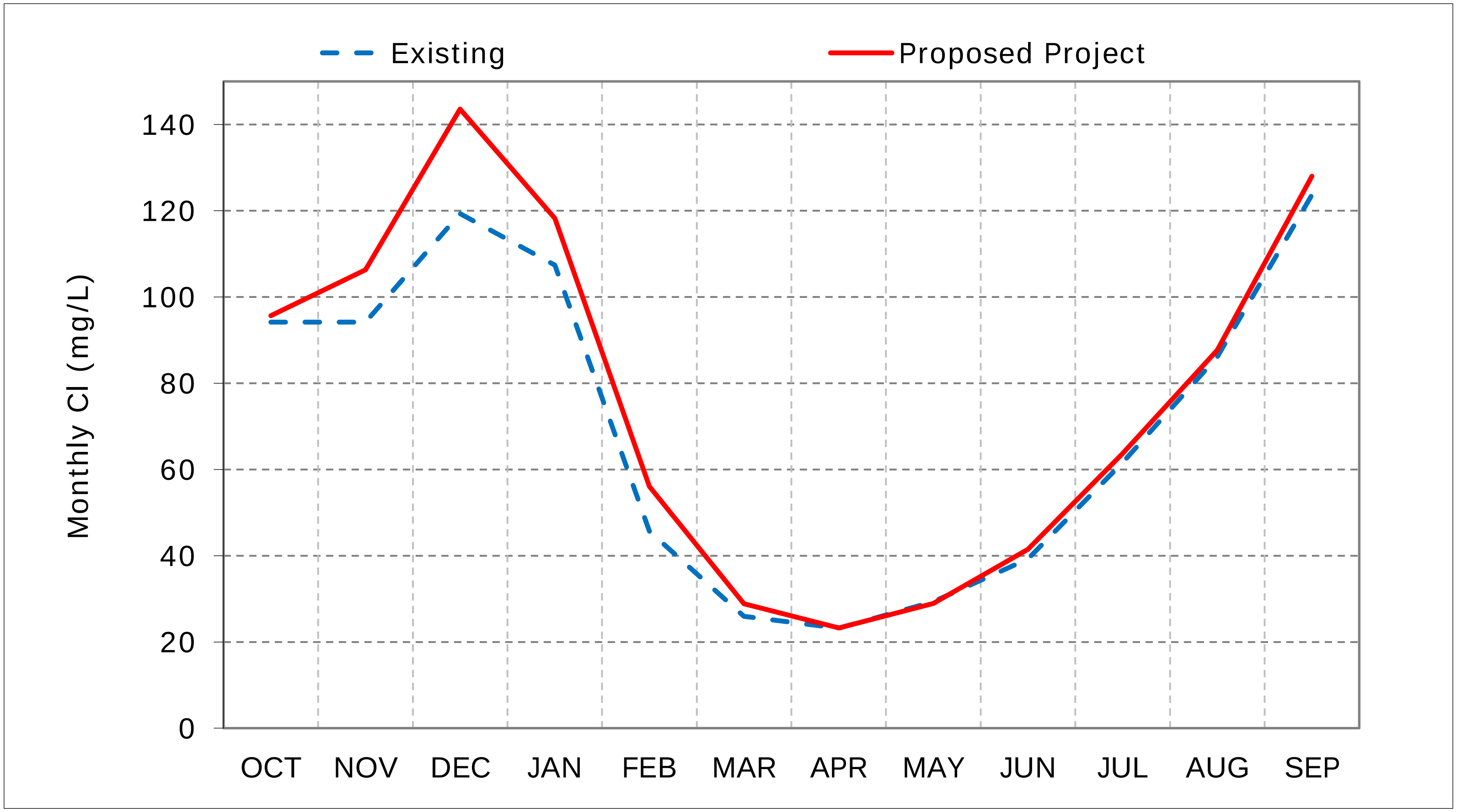
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 5-5. San Joaquin River at San Andreas Chloride, Dry Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 5-6. San Joaquin River at San Andreas Chloride, Critical Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 5-7. San Joaquin River at San Andreas Chloride, January Cl

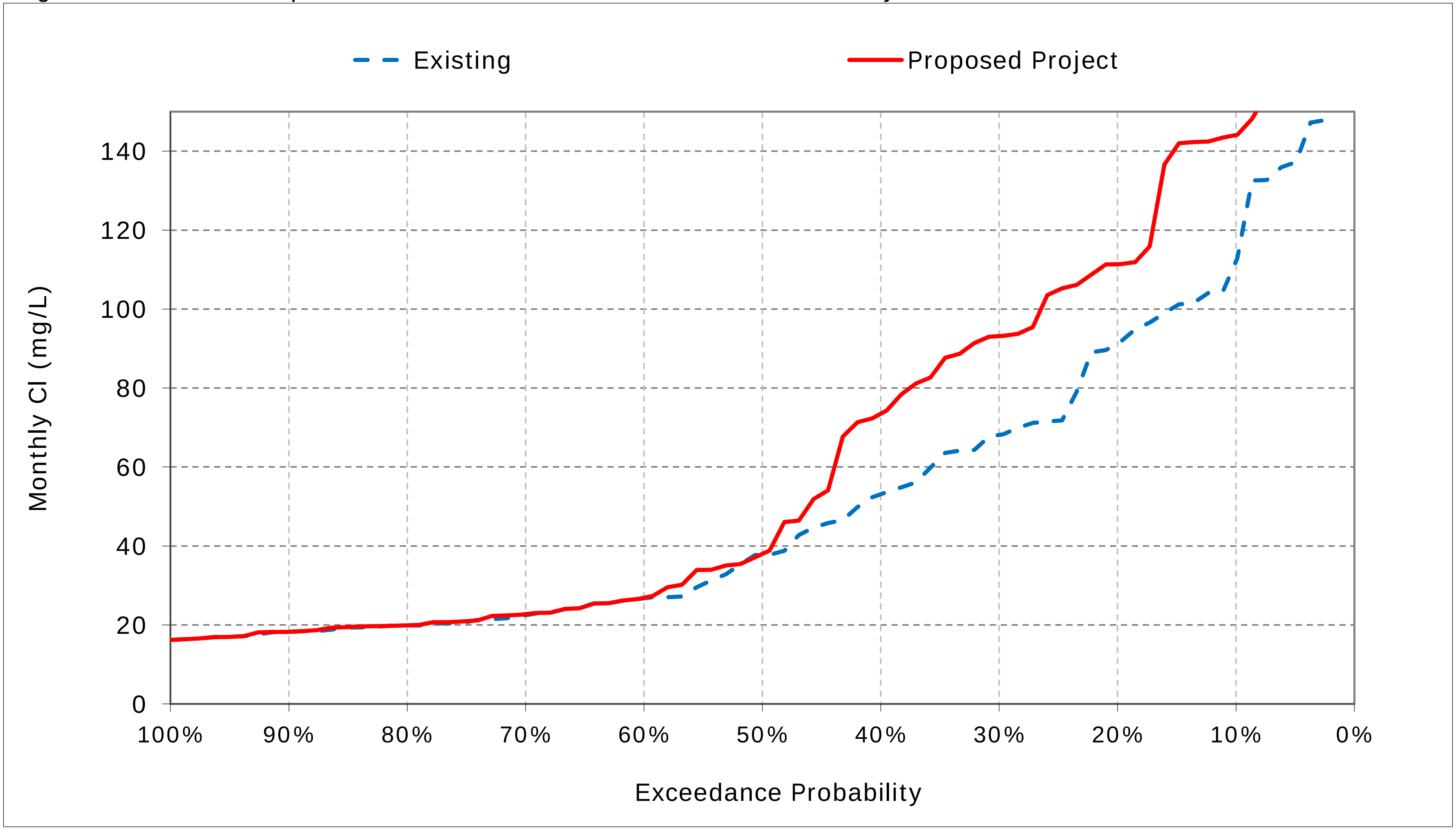


Figure 5-8. San Joaquin River at San Andreas Chloride, February Cl

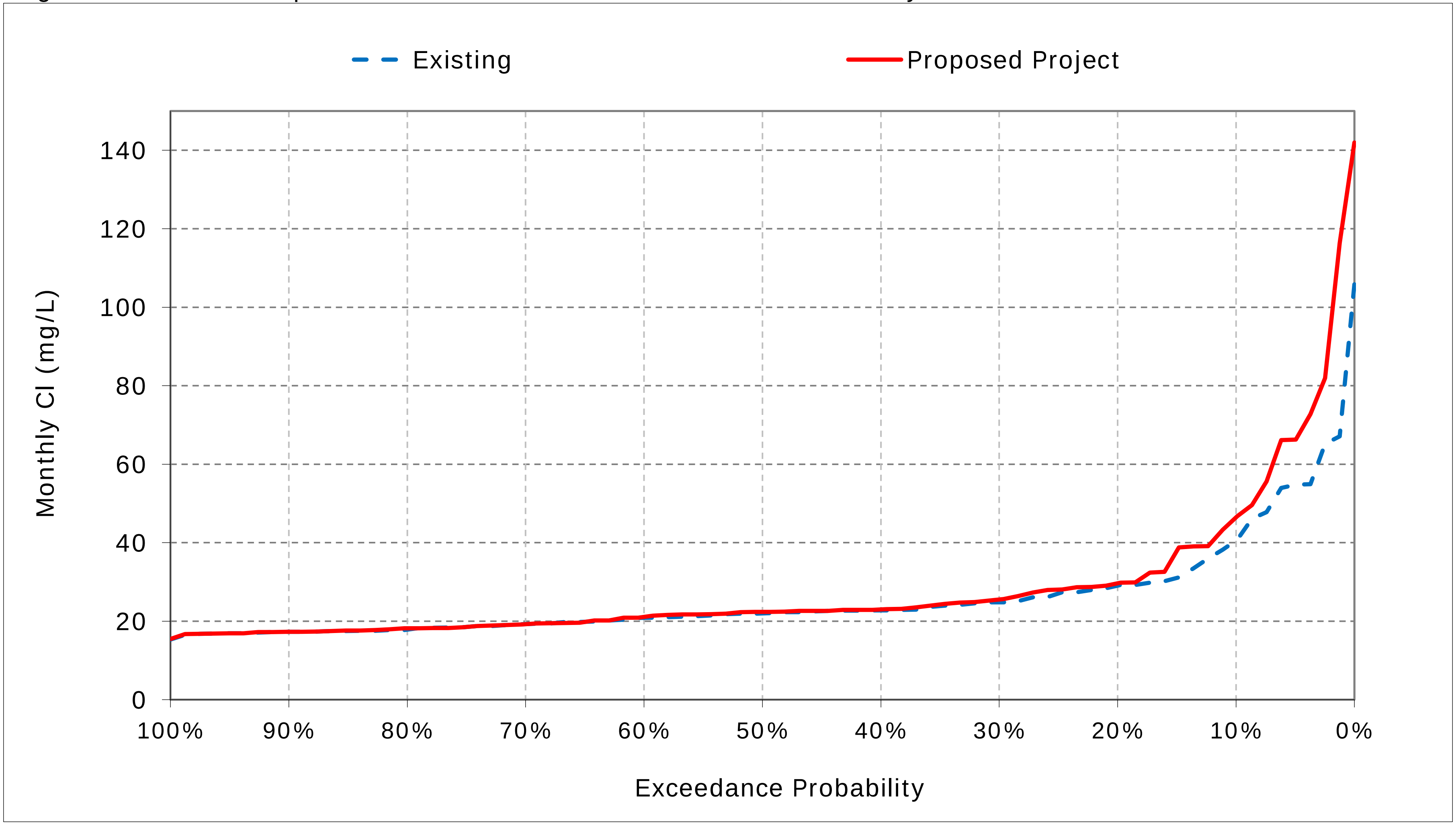


Figure 5-9. San Joaquin River at San Andreas Chloride, March Cl

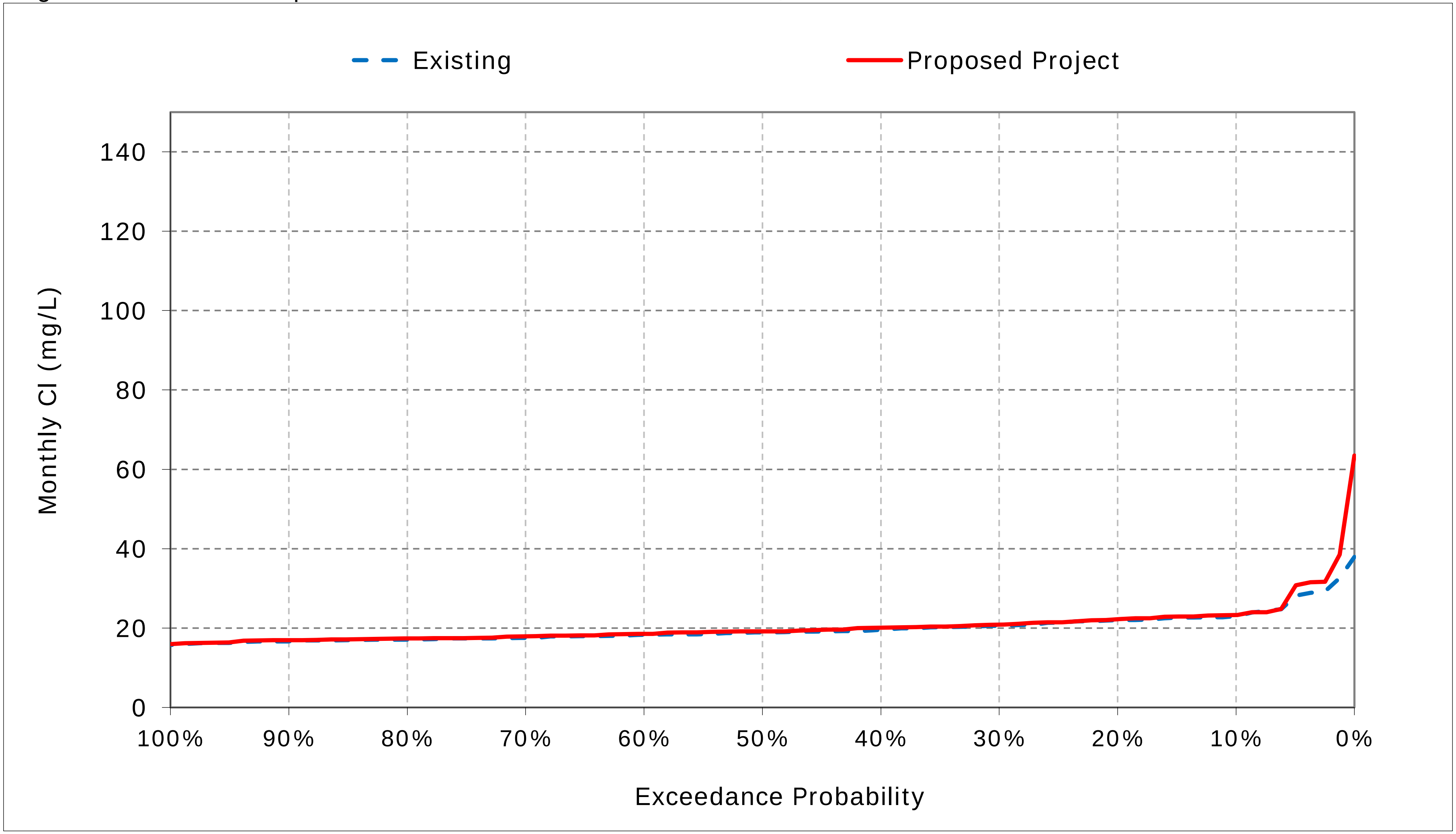


Figure 5-10. San Joaquin River at San Andreas Chloride, April Cl

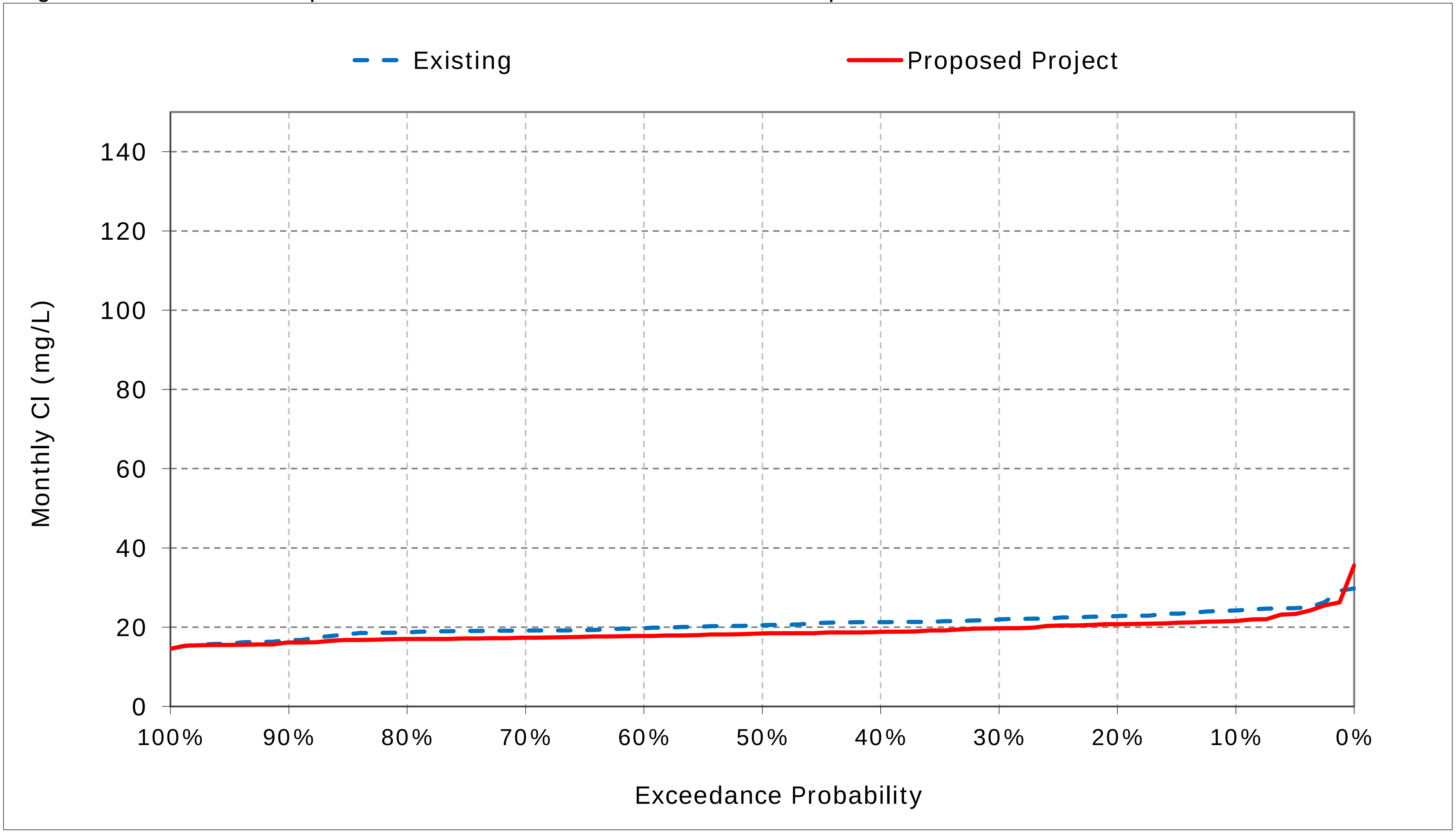


Figure 5-11. San Joaquin River at San Andreas Chloride, May Cl

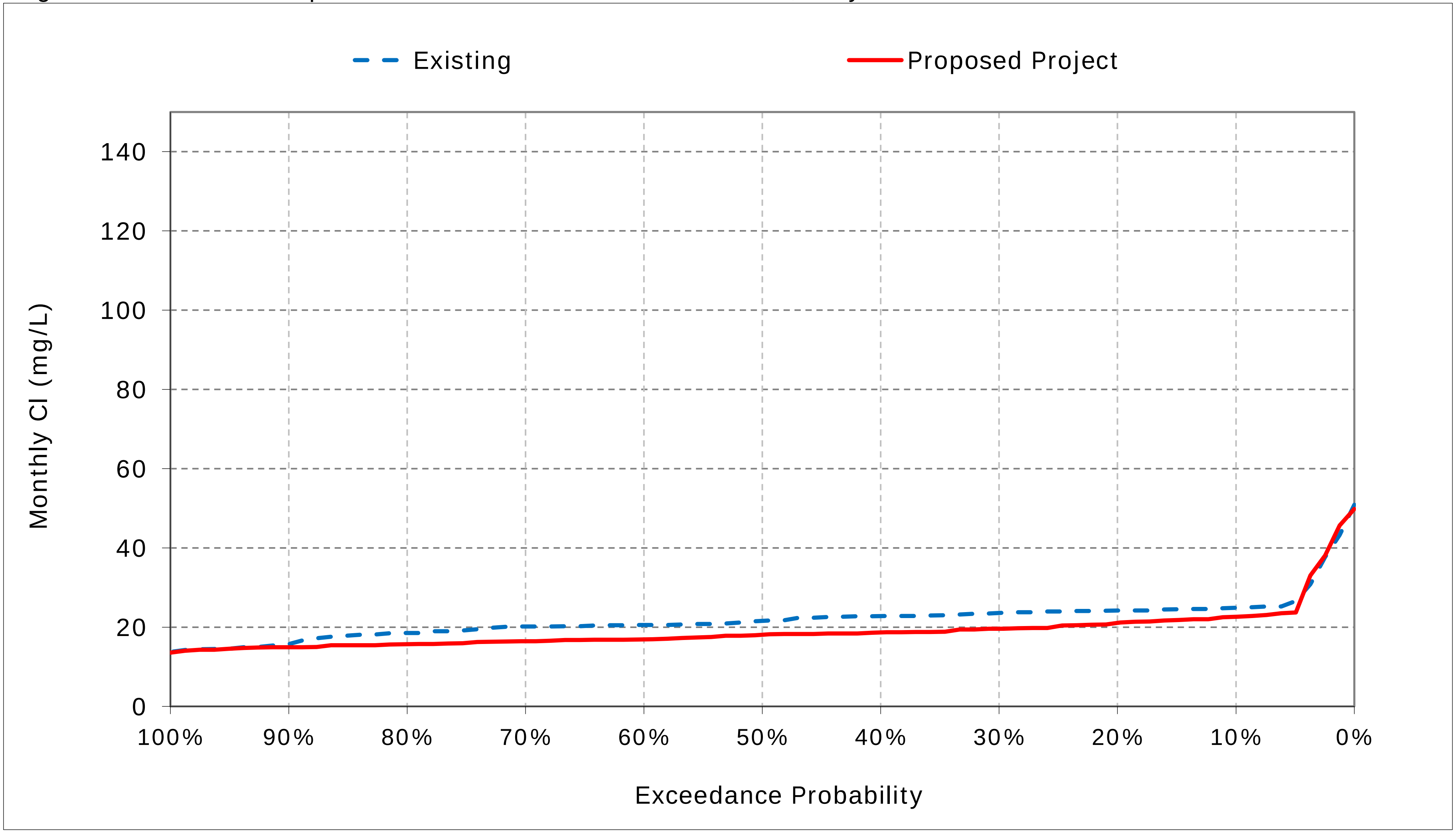


Figure 5-12. San Joaquin River at San Andreas Chloride, June Cl

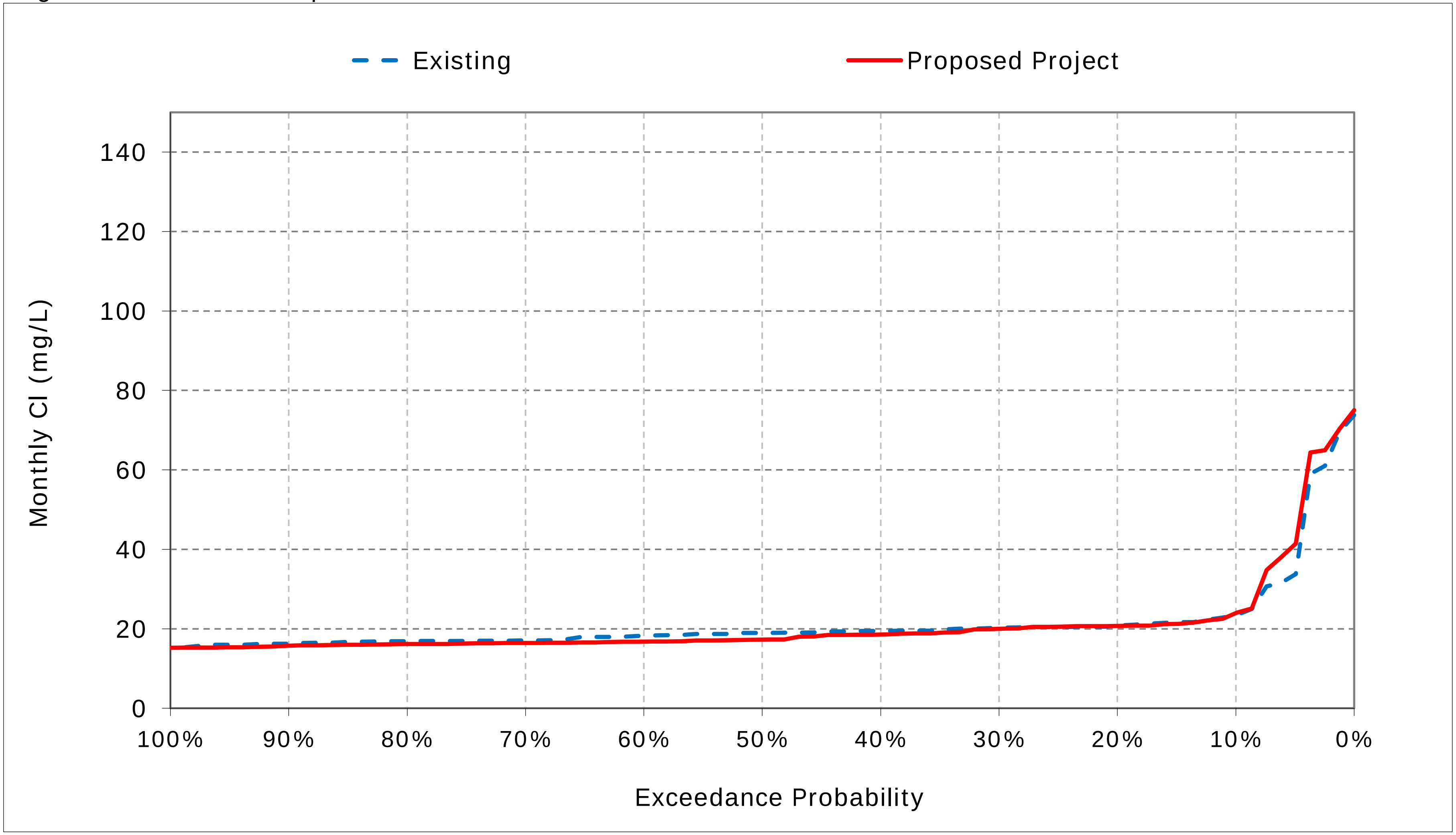


Figure 5-13. San Joaquin River at San Andreas Chloride, July Cl

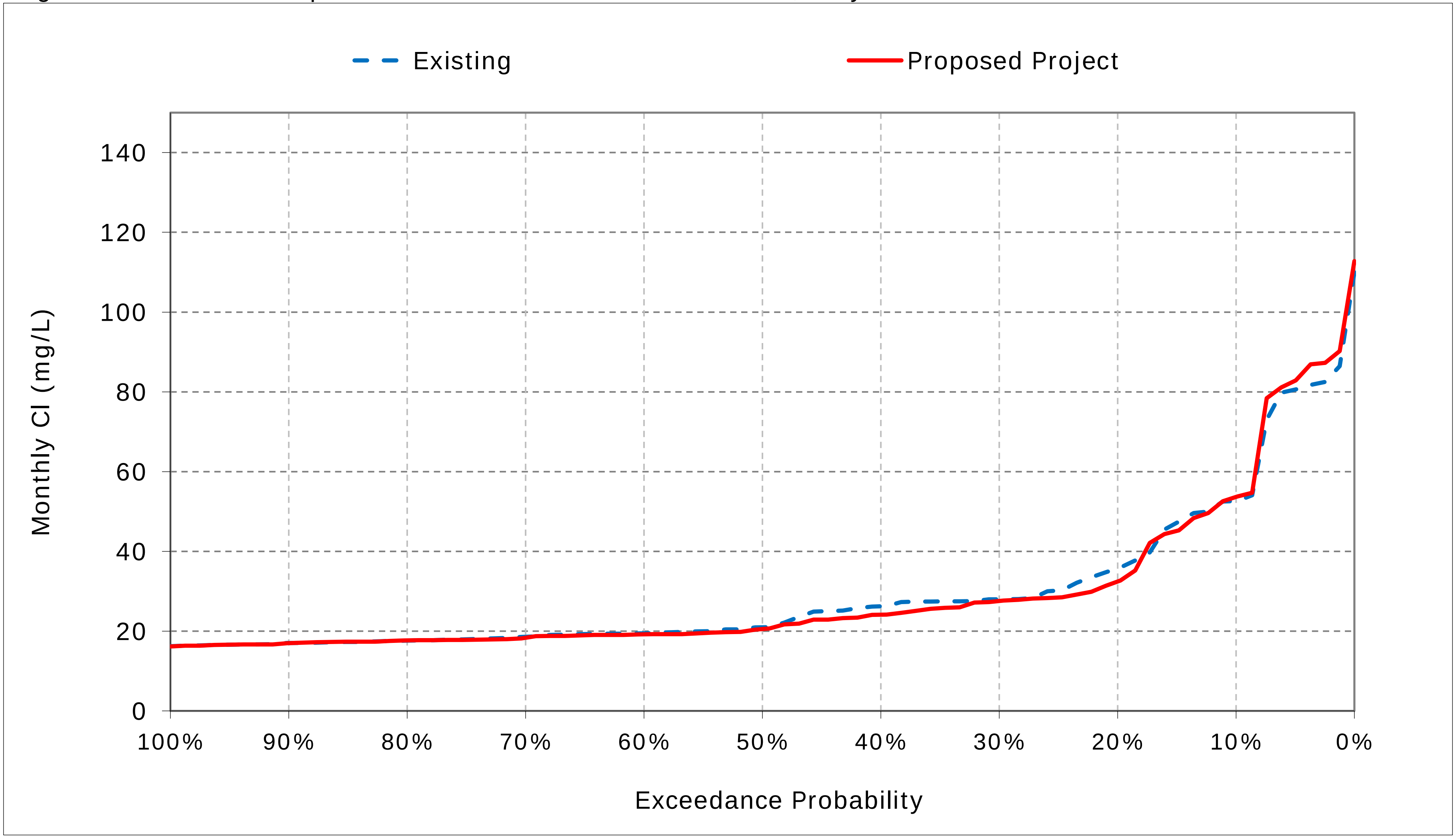


Figure 5-14. San Joaquin River at San Andreas Chloride, August Cl

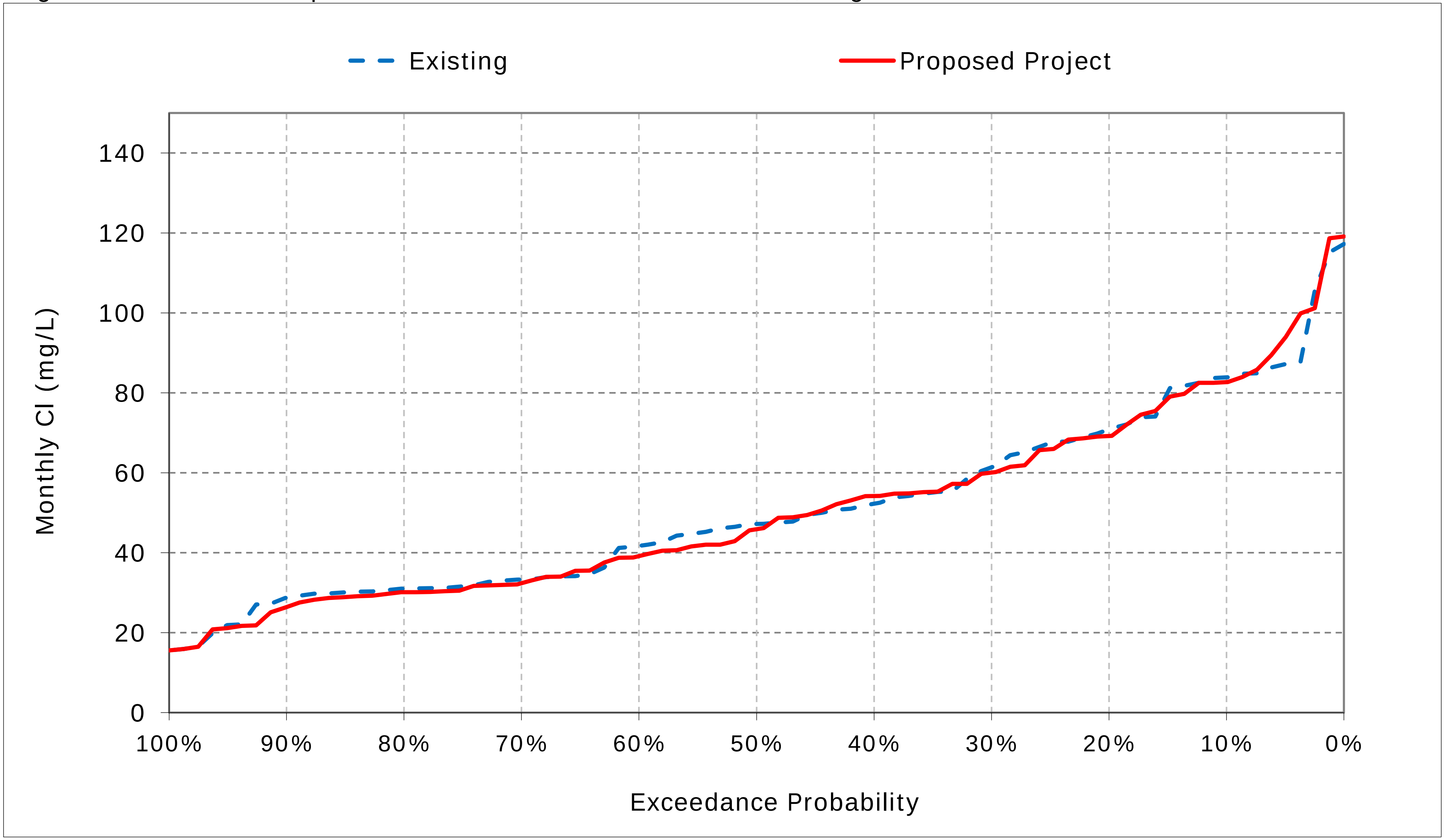


Figure 5-15. San Joaquin River at San Andreas Chloride, September Cl

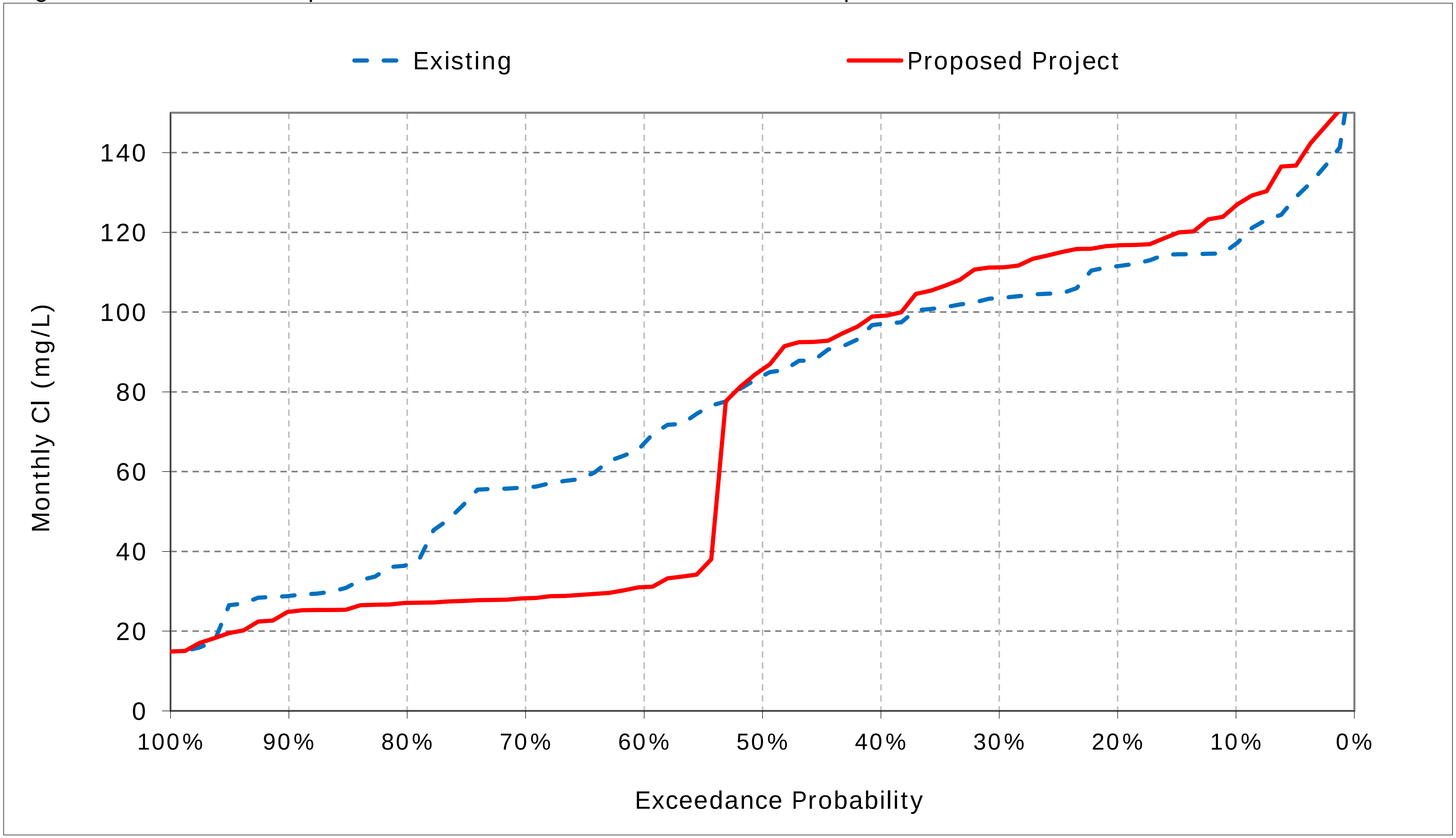


Figure 5-16. San Joaquin River at San Andreas Chloride, October Cl

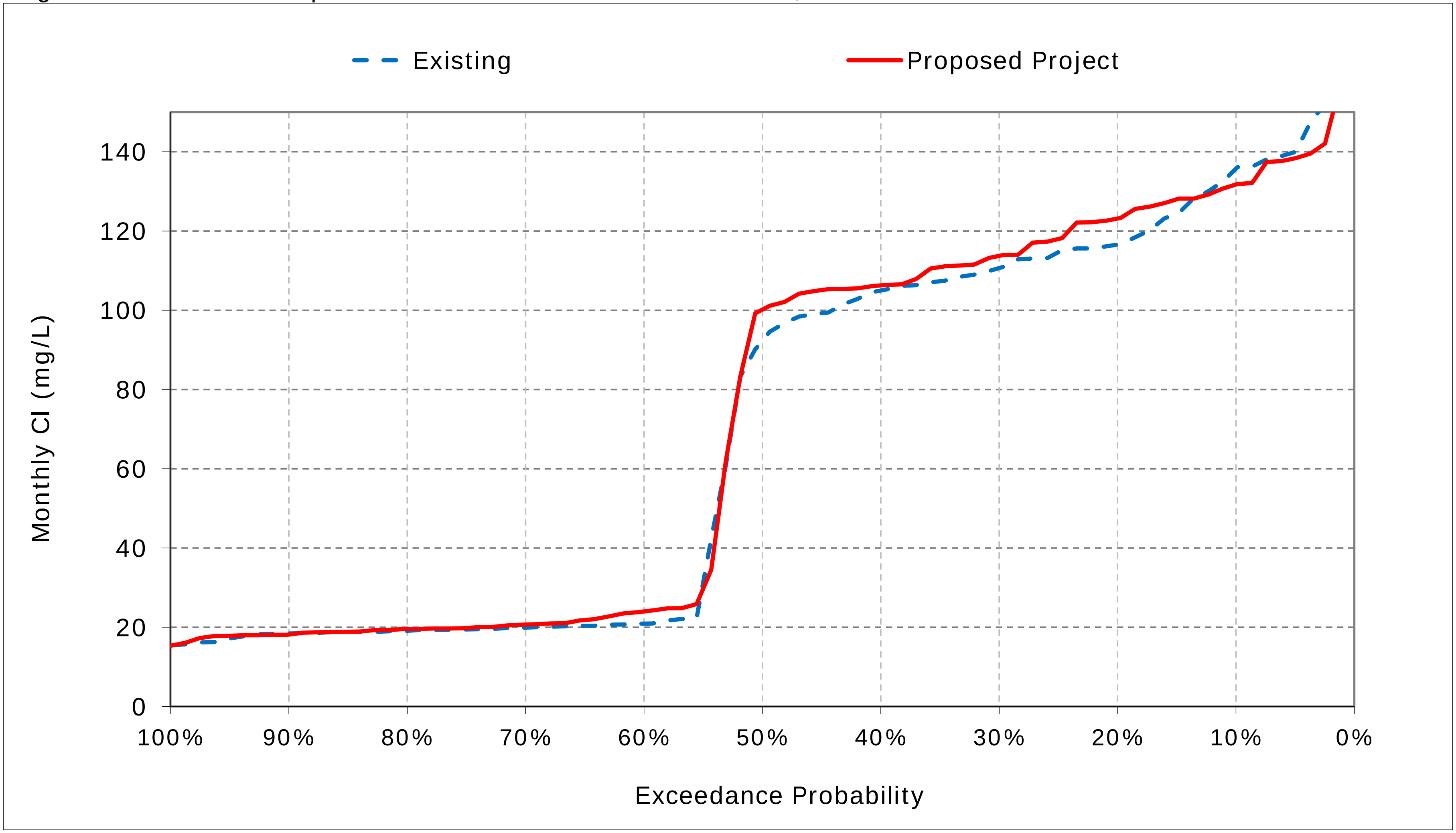


Figure 5-17. San Joaquin River at San Andreas Chloride, November Cl

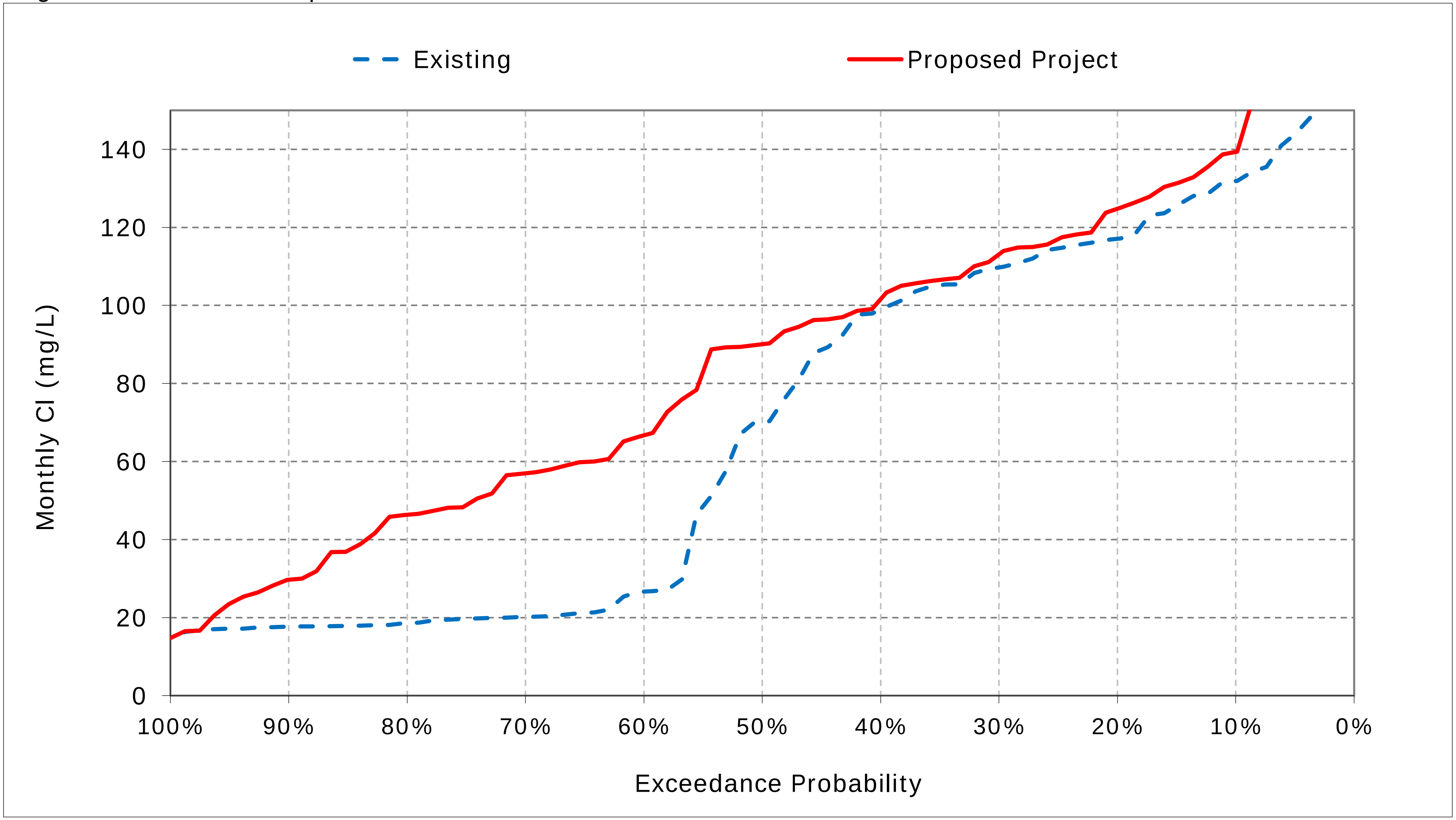


Figure 5-18. San Joaquin River at San Andreas Chloride, December Cl

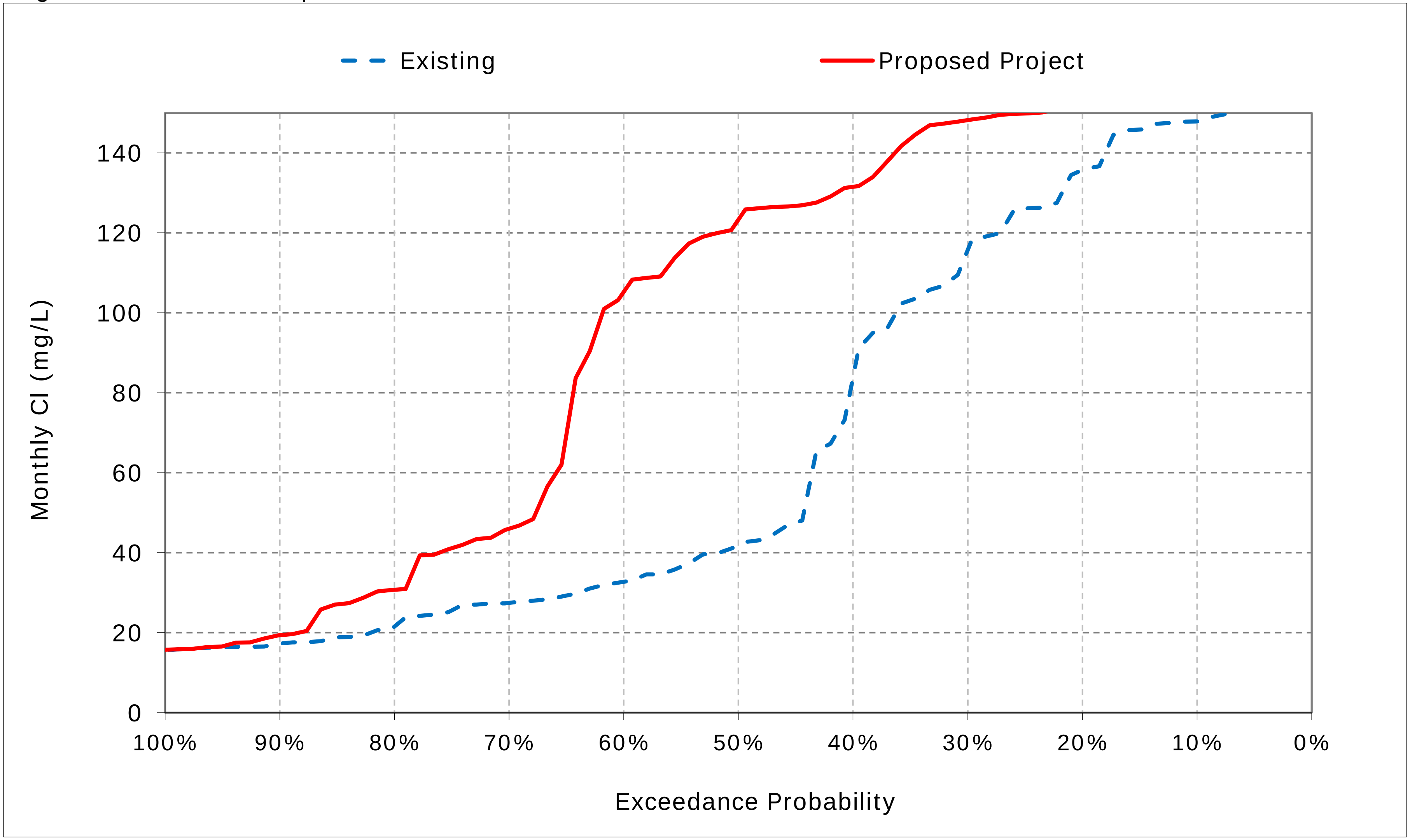


Table 6-1. San Joaquin River at Prisoners Point Chloride, Monthly Cl

Existing

	Monthly Cl (mg/L)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	121	120	146	135	76	47	54	50	33	57	85	112
20%	111	107	135	105	63	42	51	46	29	36	66	107
30%	107	99	118	95	59	38	47	44	28	30	58	98
40%	102	88	94	71	51	35	44	42	26	27	52	91
50%	91	78	57	65	45	31	40	40	25	26	46	82
60%	27	29	38	57	40	29	39	37	24	23	40	74
70%	25	24	31	49	32	28	34	36	24	22	32	67
80%	23	23	26	41	30	26	29	31	23	21	30	52
90%	22	22	24	31	28	24	27	22	22	19	29	42
Long Term												
Full Simulation Period[a]	69	67	76	75	48	34	40	39	28	32	50	80
Water Year Types[b]												
Wet (32%)	55	51	45	46	40	32	31	30	26	22	31	61
Above Normal (15%)	80	69	75	69	52	39	41	38	26	21	33	45
Below Normal (17%)	72	72	91	87	48	35	47	43	24	26	53	106
Dry (22%)	71	74	88	81	46	32	48	45	25	40	66	92
Critical (15%)	86	83	110	121	62	37	41	44	42	59	79	104

Proposed Project

	Monthly Cl (mg/L)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	122	126	163	163	77	51	41	28	32	57	85	125
20%	116	112	151	144	69	46	37	27	28	33	63	114
30%	110	103	143	127	62	40	32	26	26	28	57	106
40%	106	95	135	101	55	36	30	25	23	27	51	90
50%	95	83	128	73	48	33	29	25	22	24	47	74
60%	23	64	114	59	40	31	28	24	21	22	38	47
70%	22	50	73	49	34	29	26	23	21	21	31	41
80%	21	38	61	43	30	27	25	23	20	20	29	38
90%	20	28	34	34	28	24	23	20	19	19	26	32
Long Term												
Full Simulation Period[a]	71	79	110	91	51	37	30	25	25	32	49	74
Water Year Types[b]												
Wet (32%)	56	64	70	51	40	33	27	22	24	22	30	35
Above Normal (15%)	82	89	126	95	54	42	31	24	23	21	34	42
Below Normal (17%)	73	82	124	104	48	37	33	25	20	24	52	117
Dry (22%)	72	82	128	108	52	36	33	25	22	38	64	94
Critical (15%)	88	91	139	133	74	40	30	32	40	62	82	109

Proposed Project minus Existing

	Monthly Cl (mg/L)											
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	1	6	17	28	0	4	-13	-22	-1	0	0	13
20%	6	6	16	39	6	4	-14	-19	-1	-3	-2	7
30%	4	4	25	32	3	2	-15	-17	-2	-2	-1	8
40%	3	7	41	31	4	1	-13	-16	-3	-1	-2	-1
50%	4	4	72	9	3	2	-11	-15	-3	-1	1	-8
60%	-4	35	77	2	0	1	-11	-13	-3	0	-2	-27
70%	-3	26	42	1	2	0	-7	-12	-4	0	0	-26
80%	-3	16	35	2	0	1	-4	-8	-4	0	-1	-14
90%	-2	7	11	3	0	0	-3	-2	-4	0	-2	-10
Long Term												
Full Simulation Period[a]	1	12	34	16	3	2	-10	-13	-3	0	0	-6
Water Year Types[b]												
Wet (32%)	1	14	25	5	0	0	-5	-8	-2	0	-2	-27
Above Normal (15%)	2	20	51	26	2	3	-10	-14	-4	0	0	-3
Below Normal (17%)	1	9	34	17	0	2	-14	-17	-4	-2	0	11
Dry (22%)	1	8	39	27	6	4	-15	-19	-3	-1	-2	2
Critical (15%)	2	8	29	11	11	3	-10	-13	-1	3	4	5

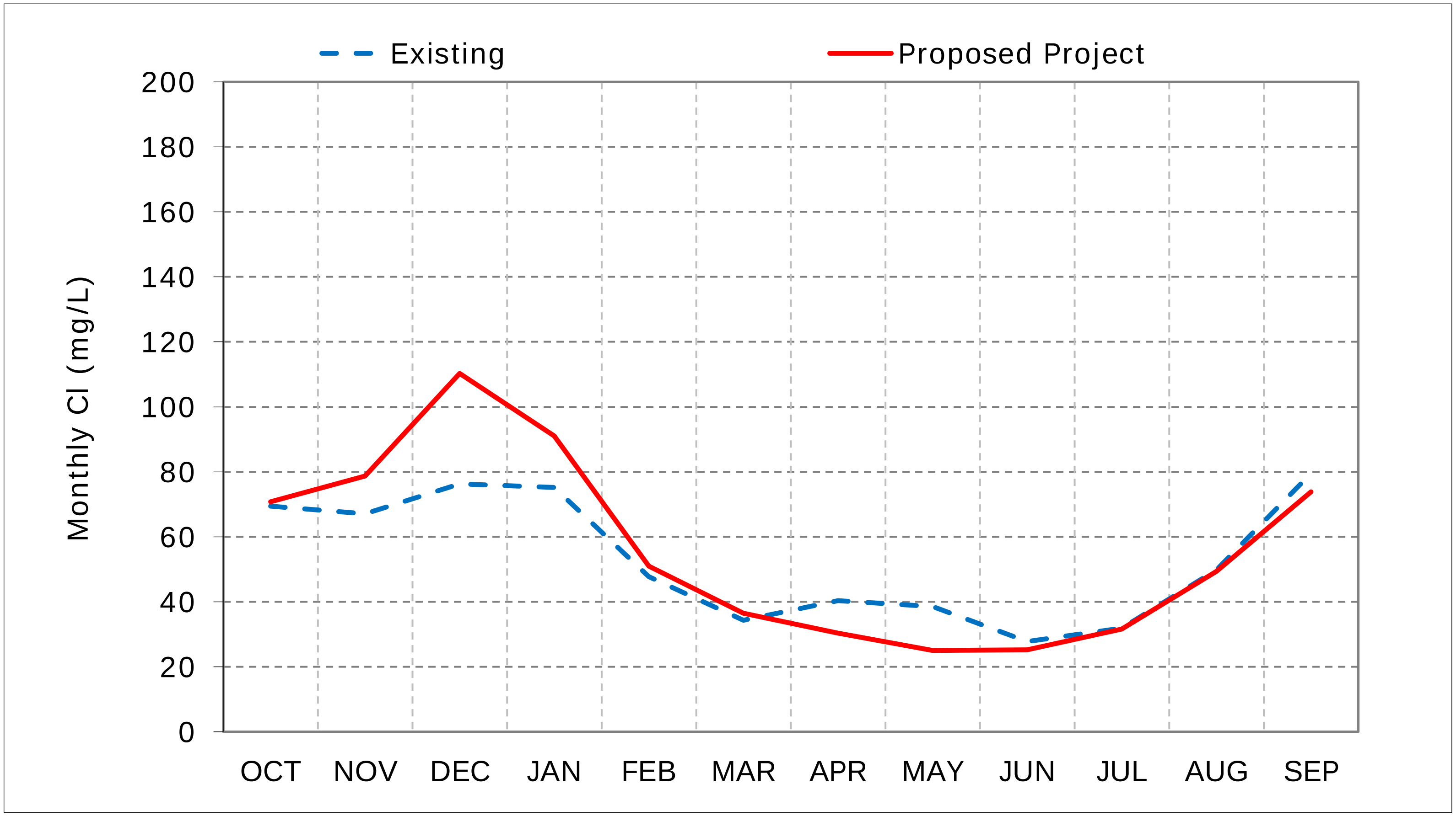
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

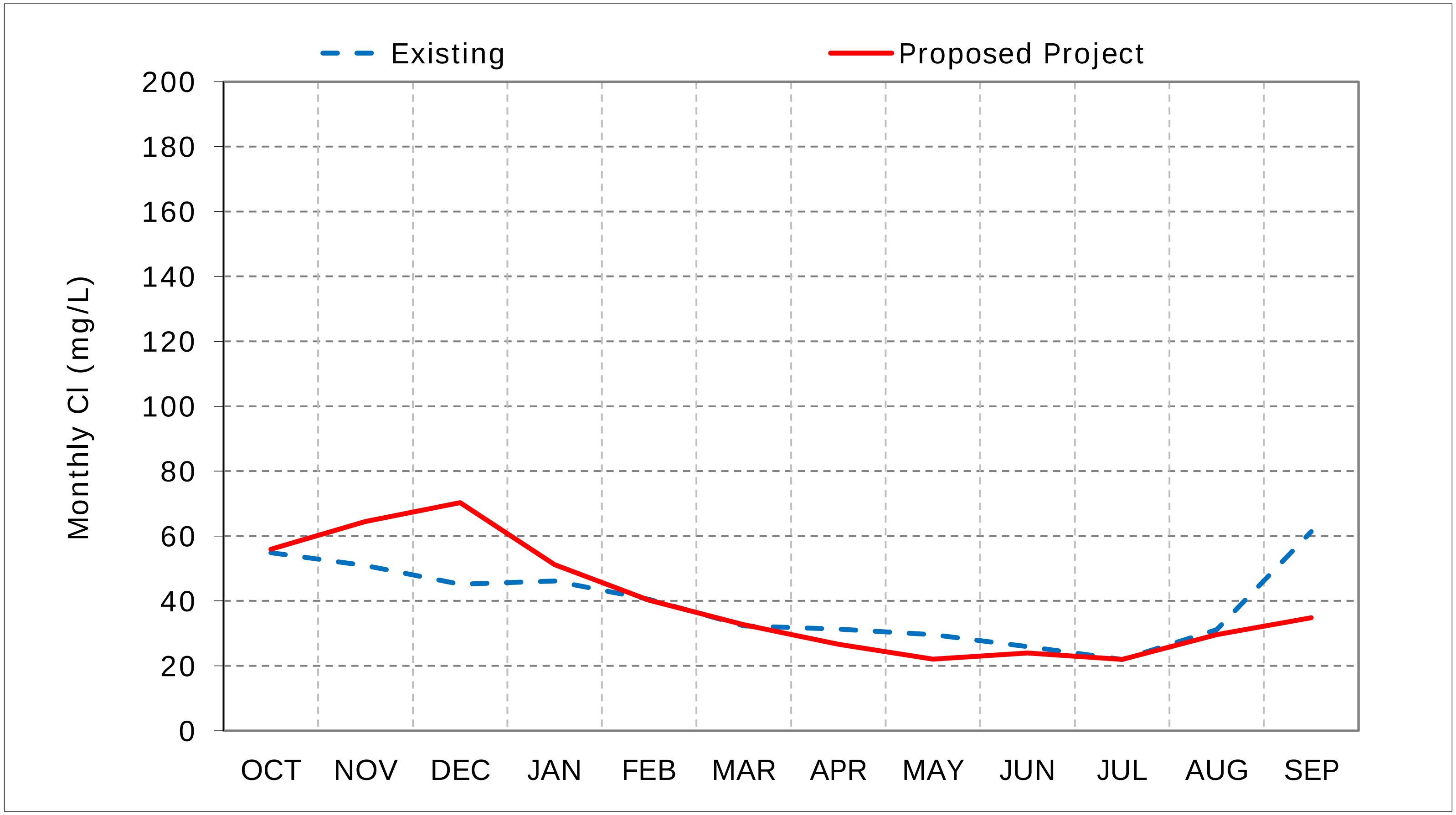
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 6-1. San Joaquin River at Prisoners Point Chloride, Long-Term Average Cl



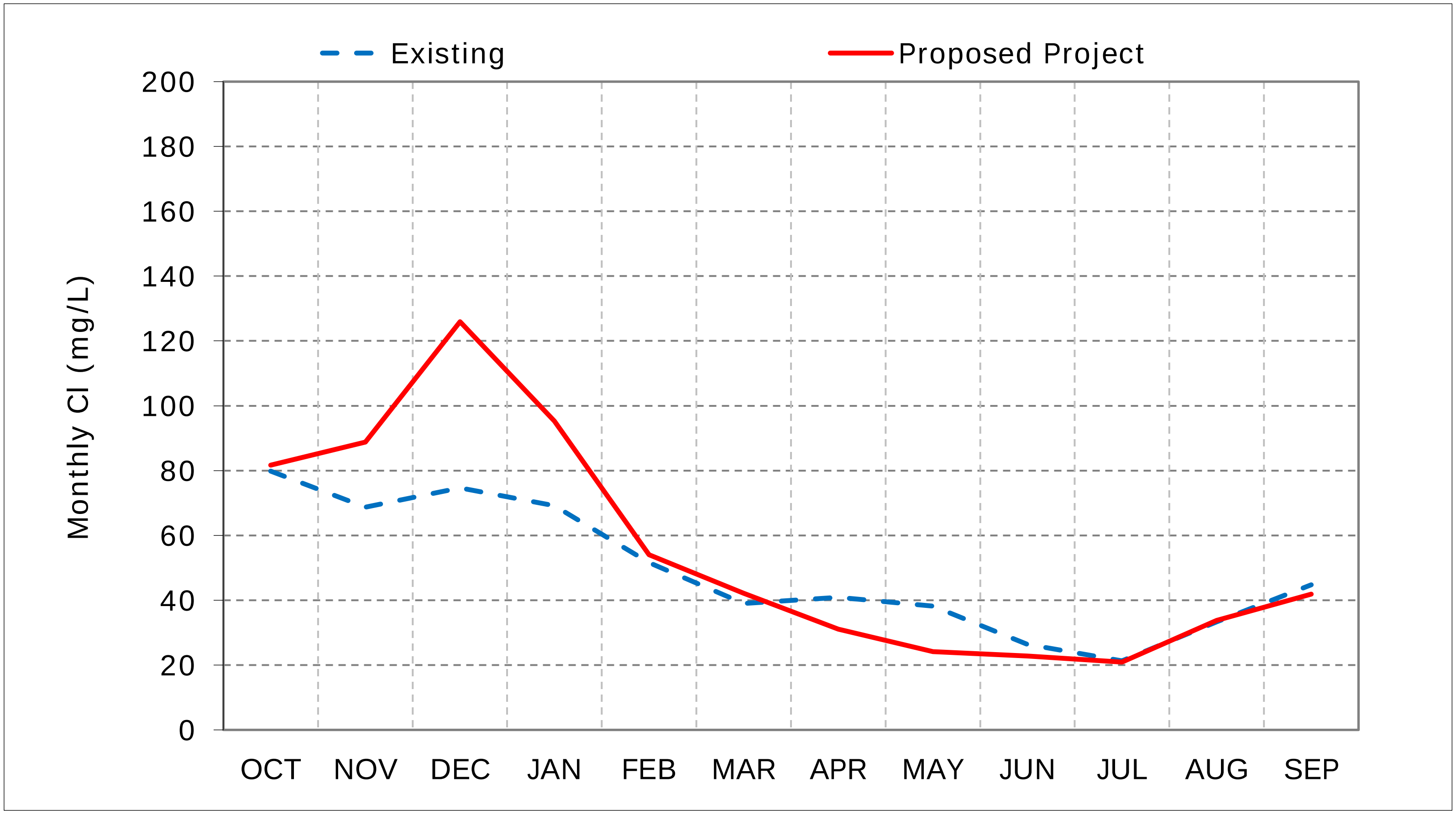
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 6-2. San Joaquin River at Prisoners Point Chloride, Wet Year Average Cl



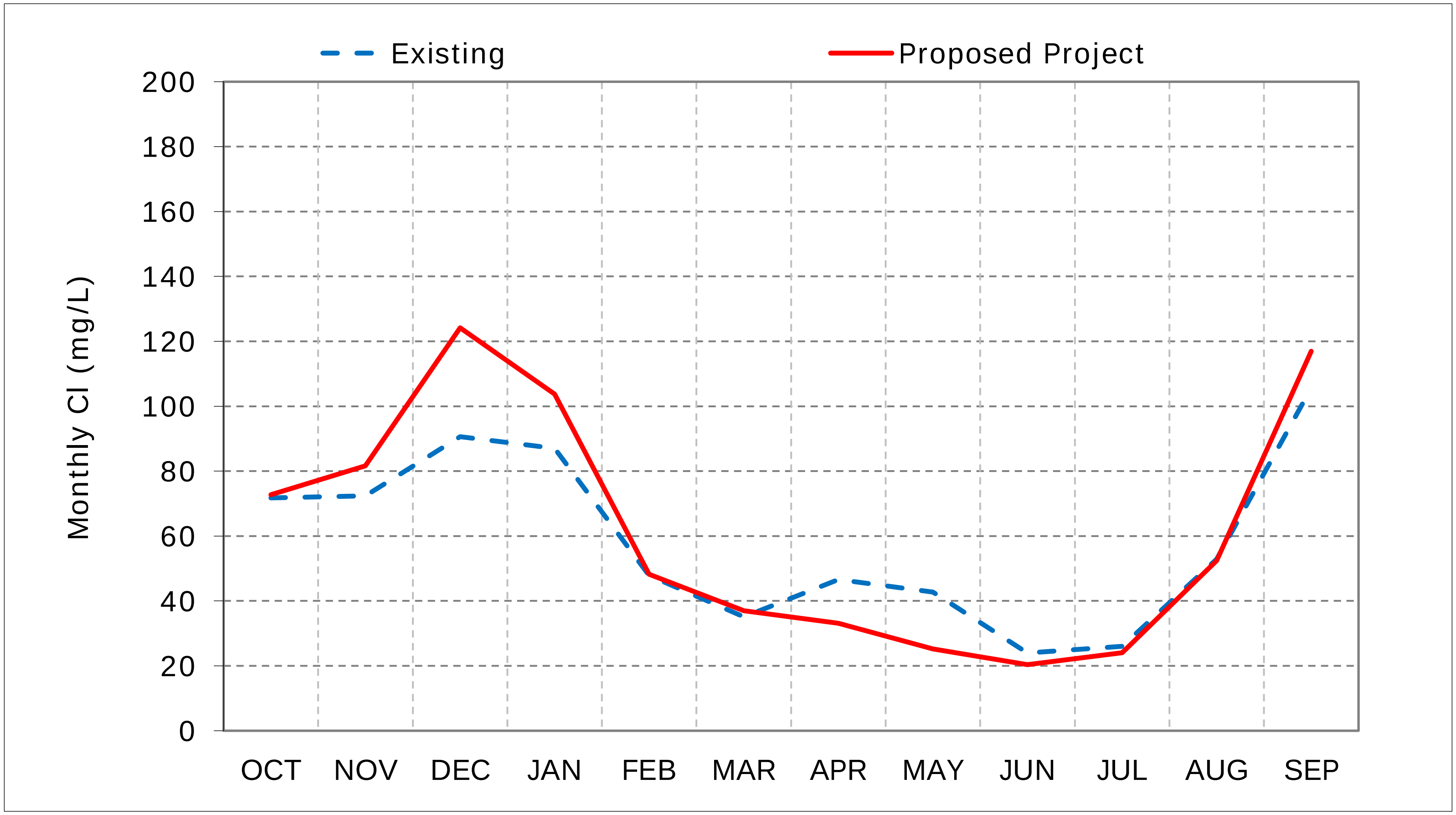
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 6-3. San Joaquin River at Prisoners Point Chloride, Above Normal Year Ave



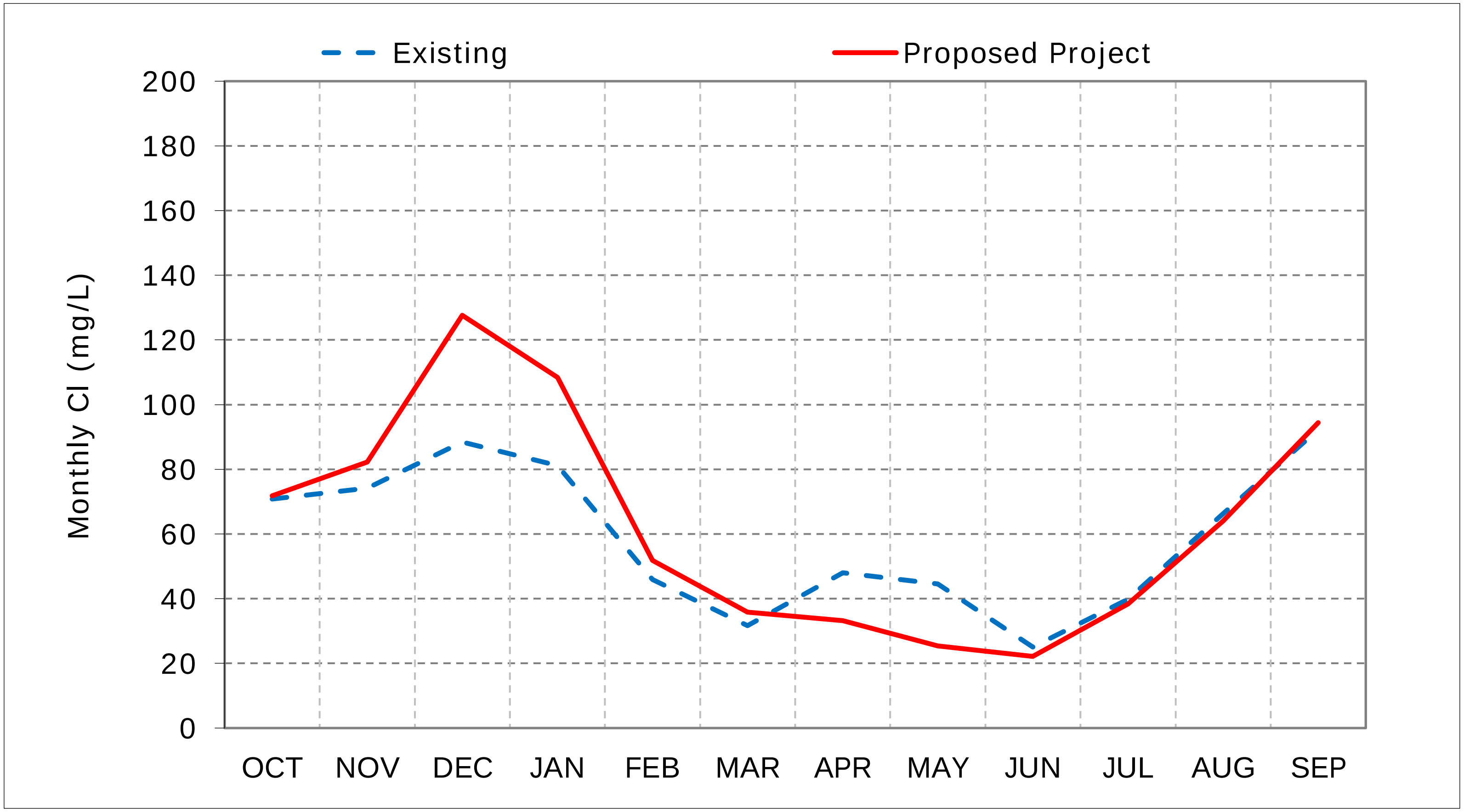
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 6-4. San Joaquin River at Prisoners Point Chloride, Below Normal Year Ave



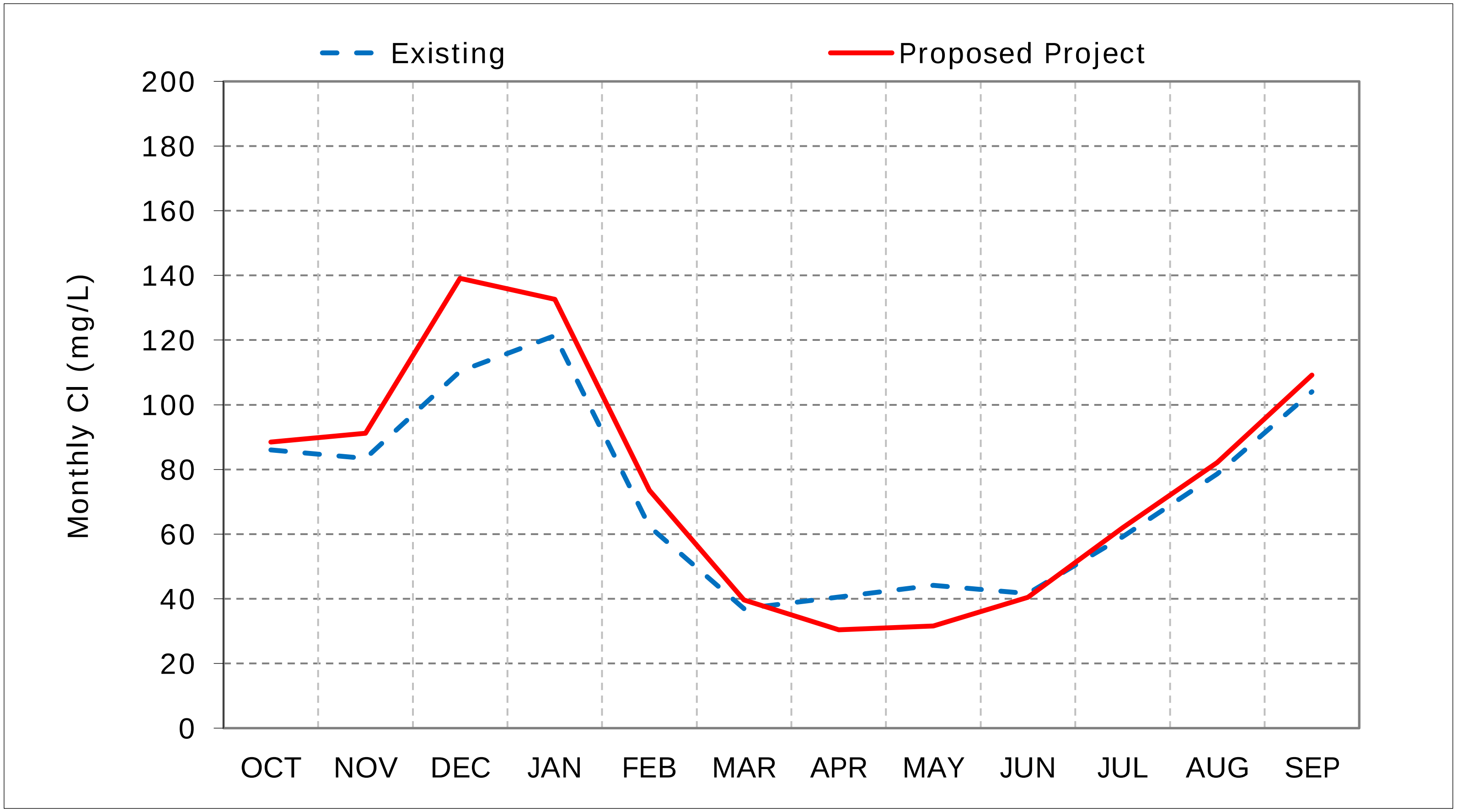
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 6-5. San Joaquin River at Prisoners Point Chloride, Dry Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 6-6. San Joaquin River at Prisoners Point Chloride, Critical Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 6-7. San Joaquin River at Prisoners Point Chloride, January Cl

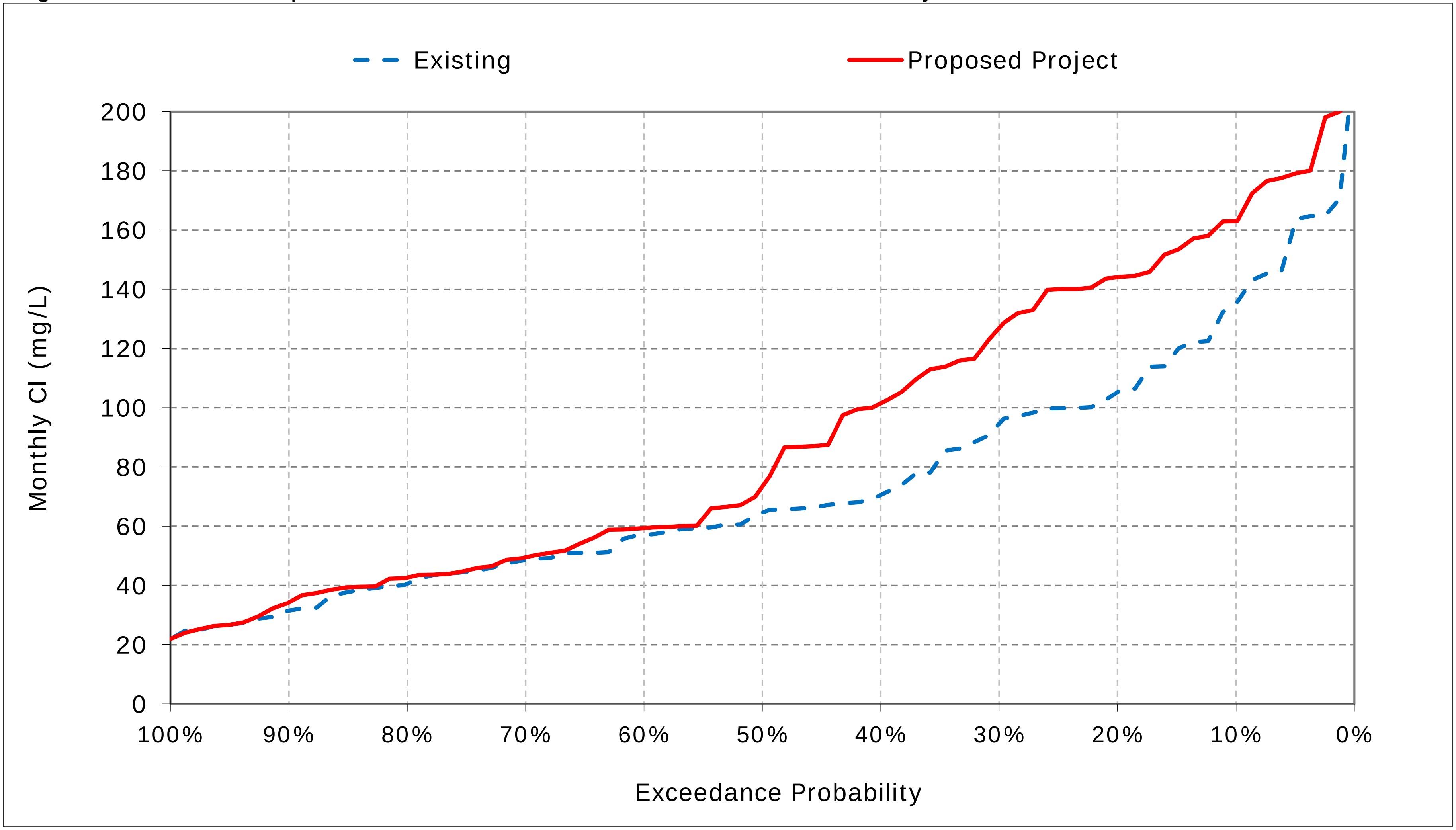


Figure 6-8. San Joaquin River at Prisoners Point Chloride, February Cl

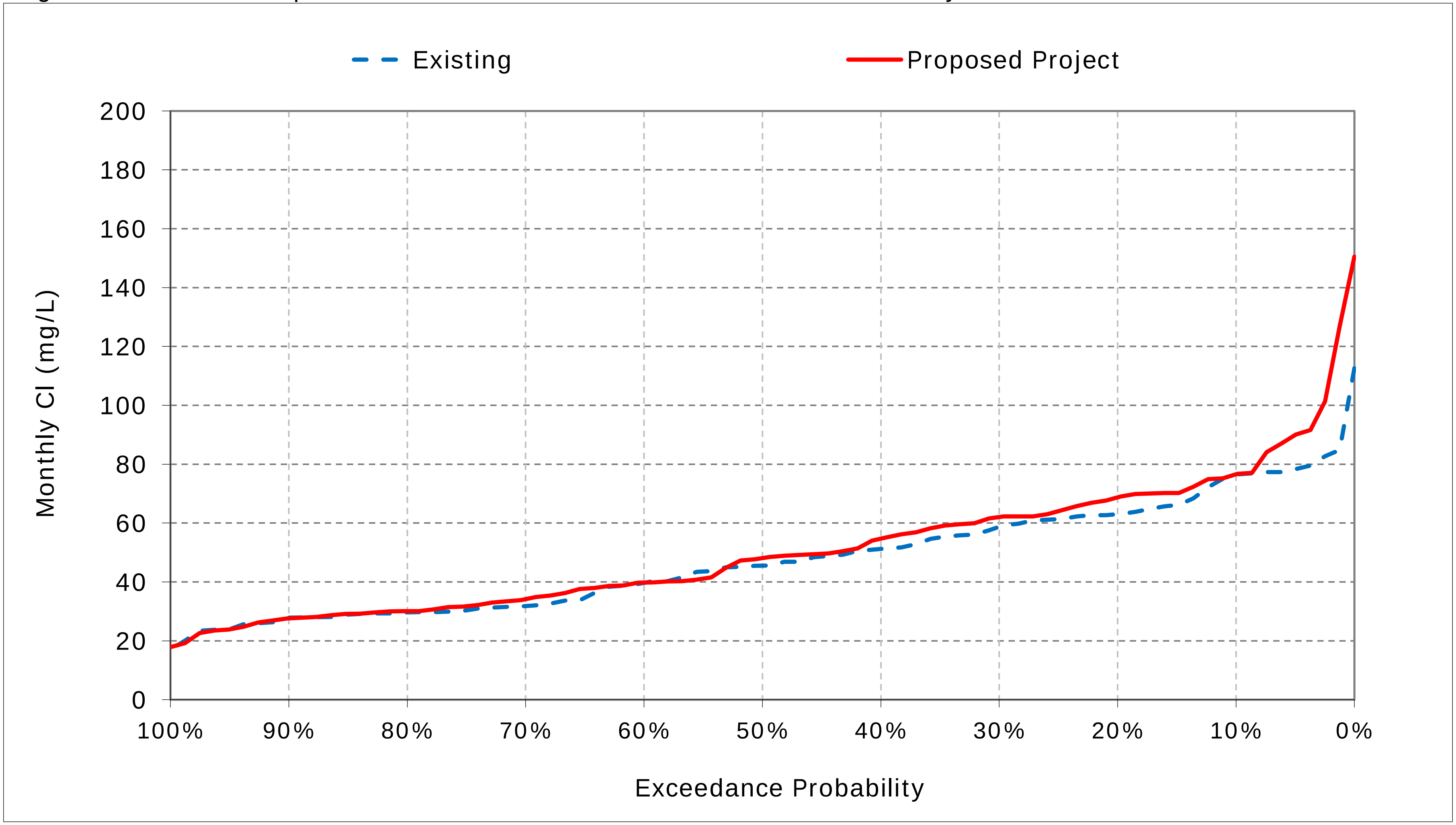


Figure 6-9. San Joaquin River at Prisoners Point Chloride, March Cl

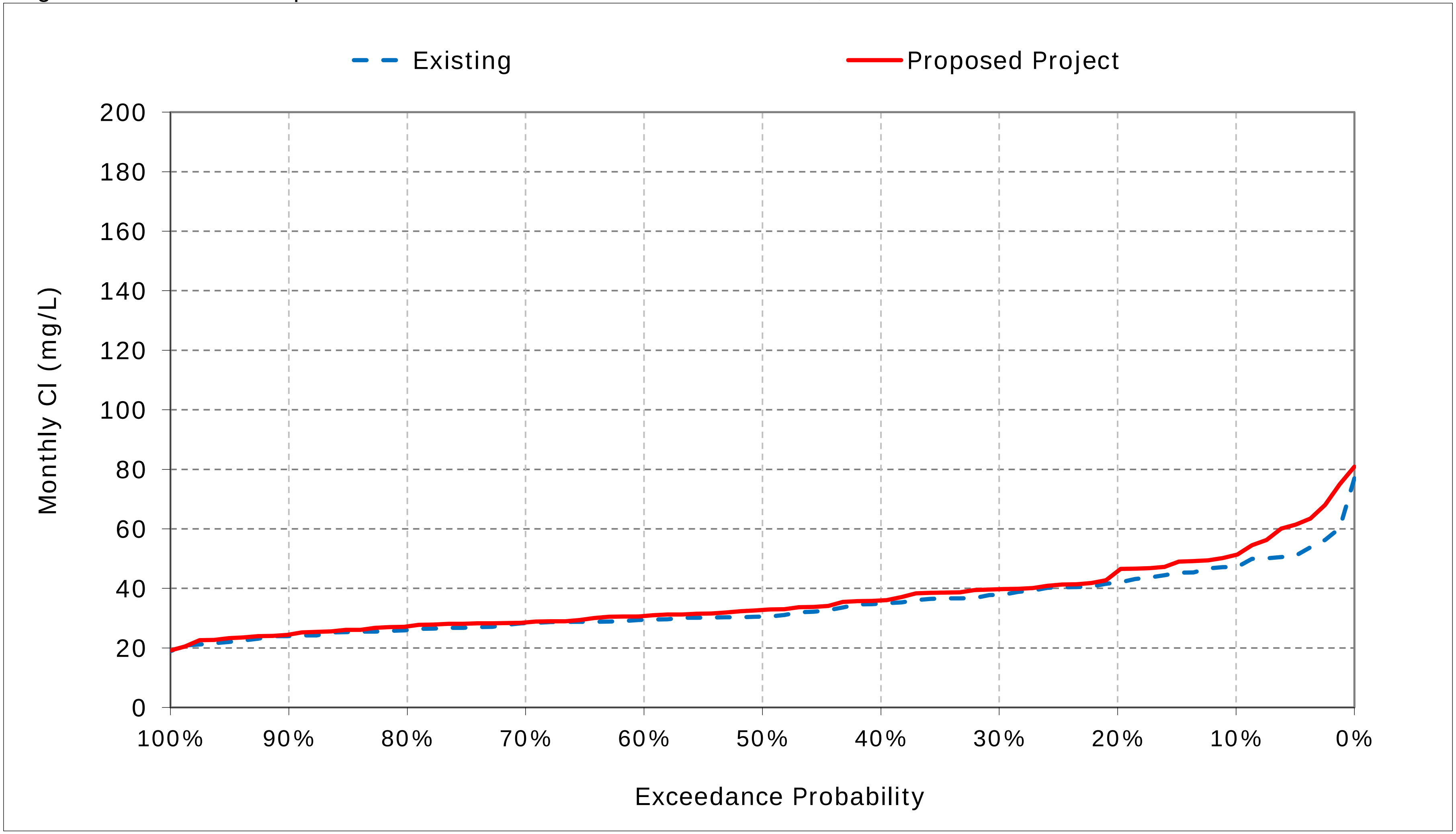


Figure 6-10. San Joaquin River at Prisoners Point Chloride, April Cl

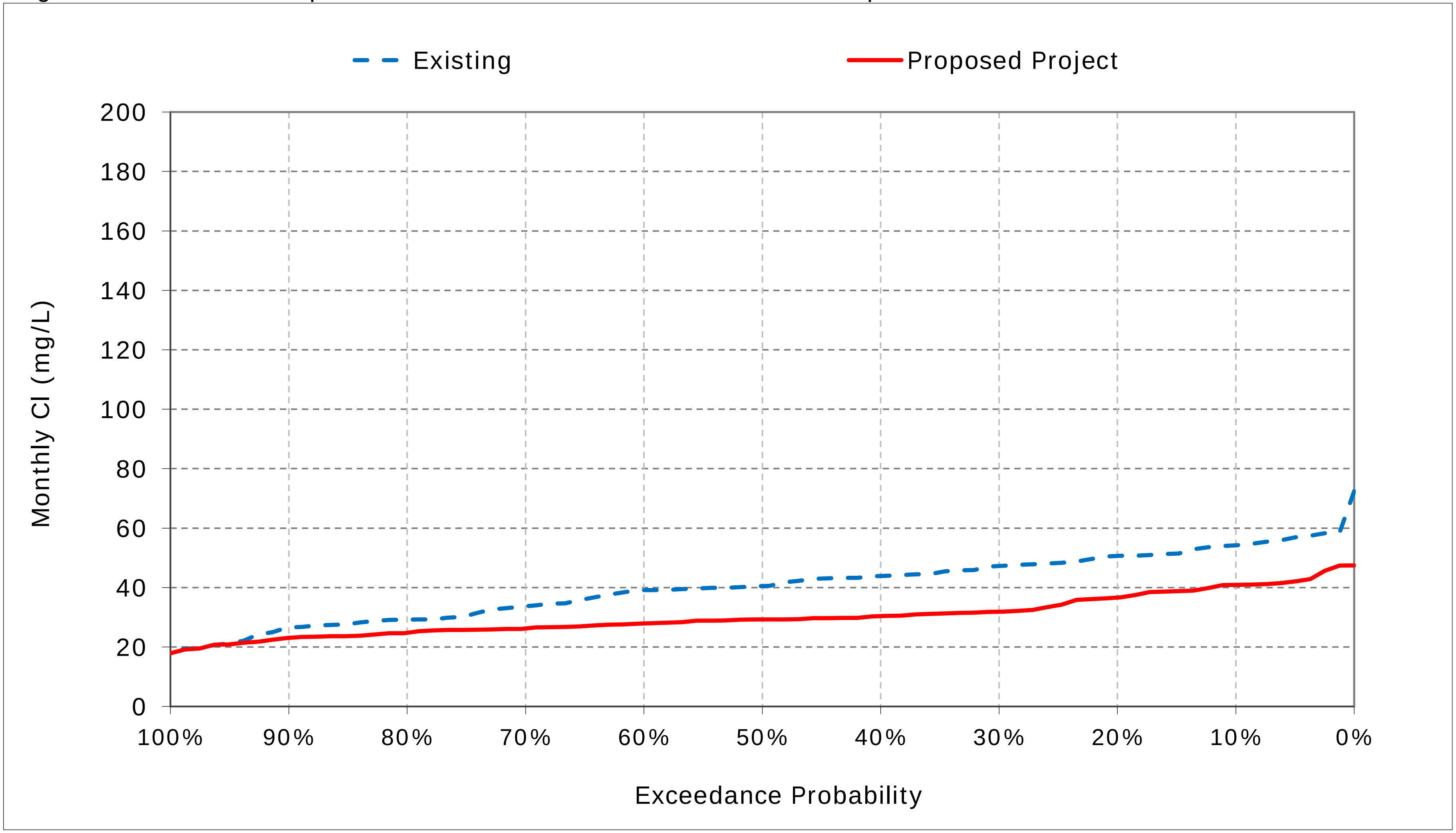


Figure 6-11. San Joaquin River at Prisoners Point Chloride, May Cl

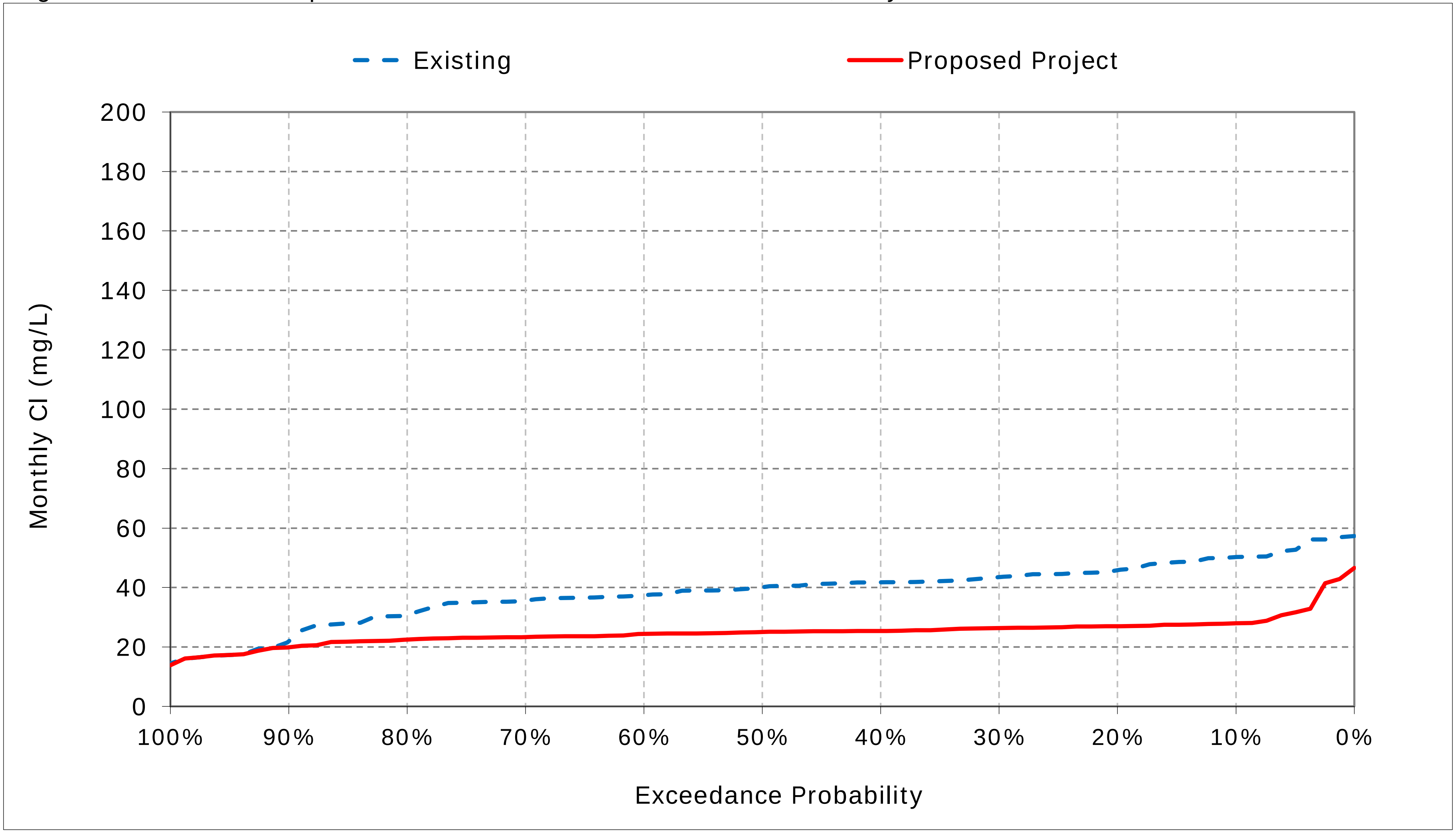


Figure 6-12. San Joaquin River at Prisoners Point Chloride, June Cl

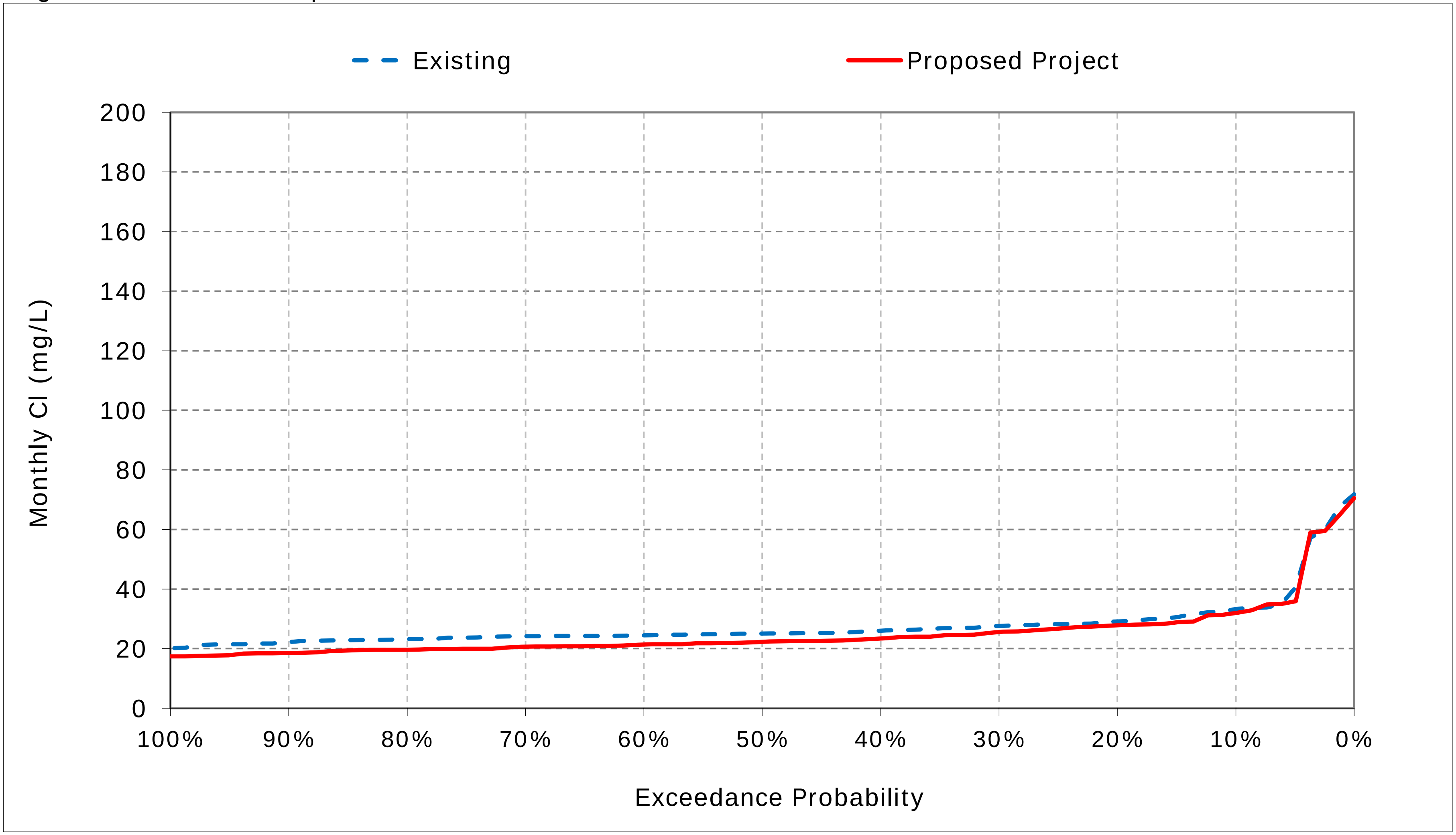


Figure 6-13. San Joaquin River at Prisoners Point Chloride, July Cl

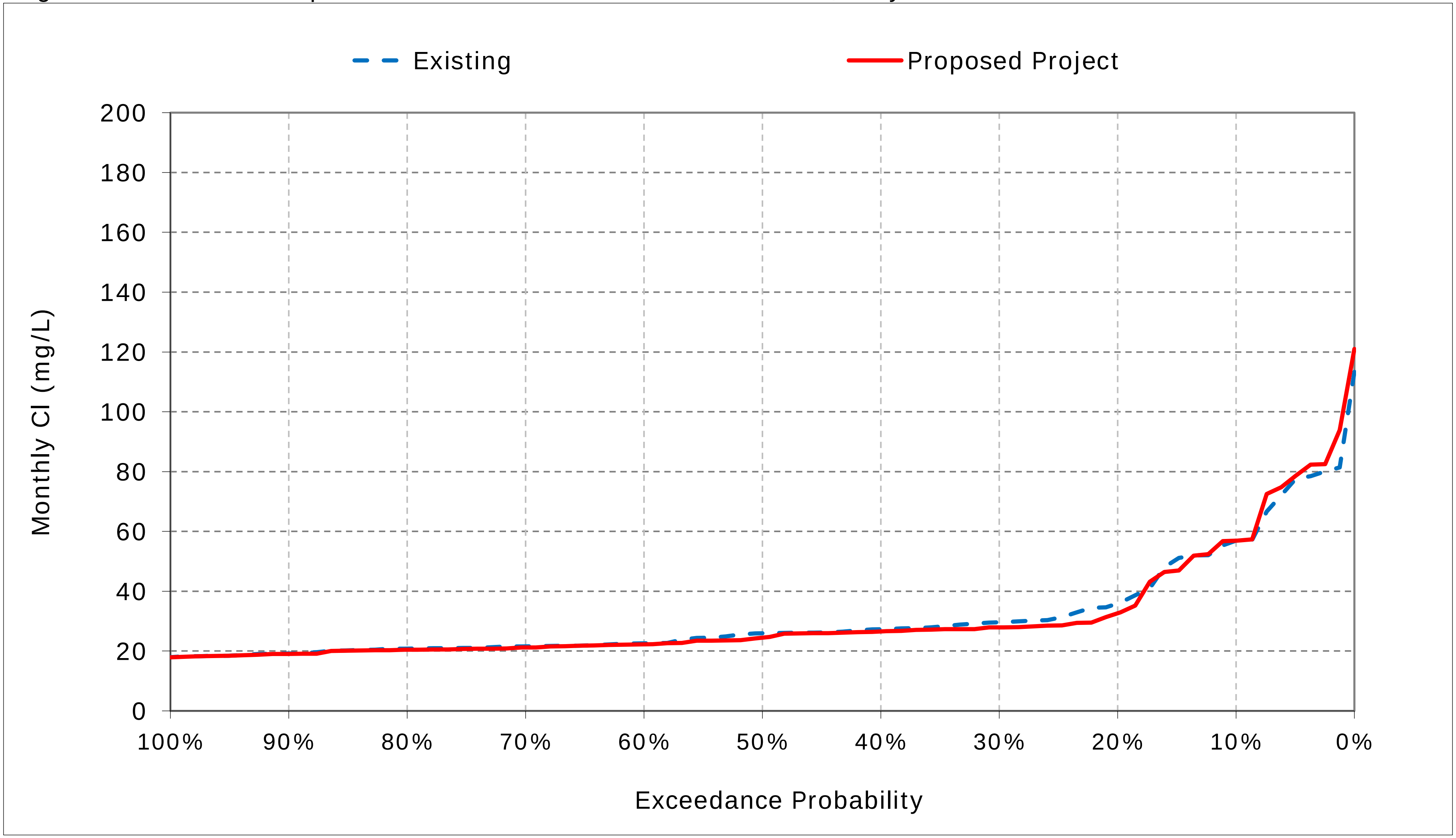


Figure 6-14. San Joaquin River at Prisoners Point Chloride, August Cl

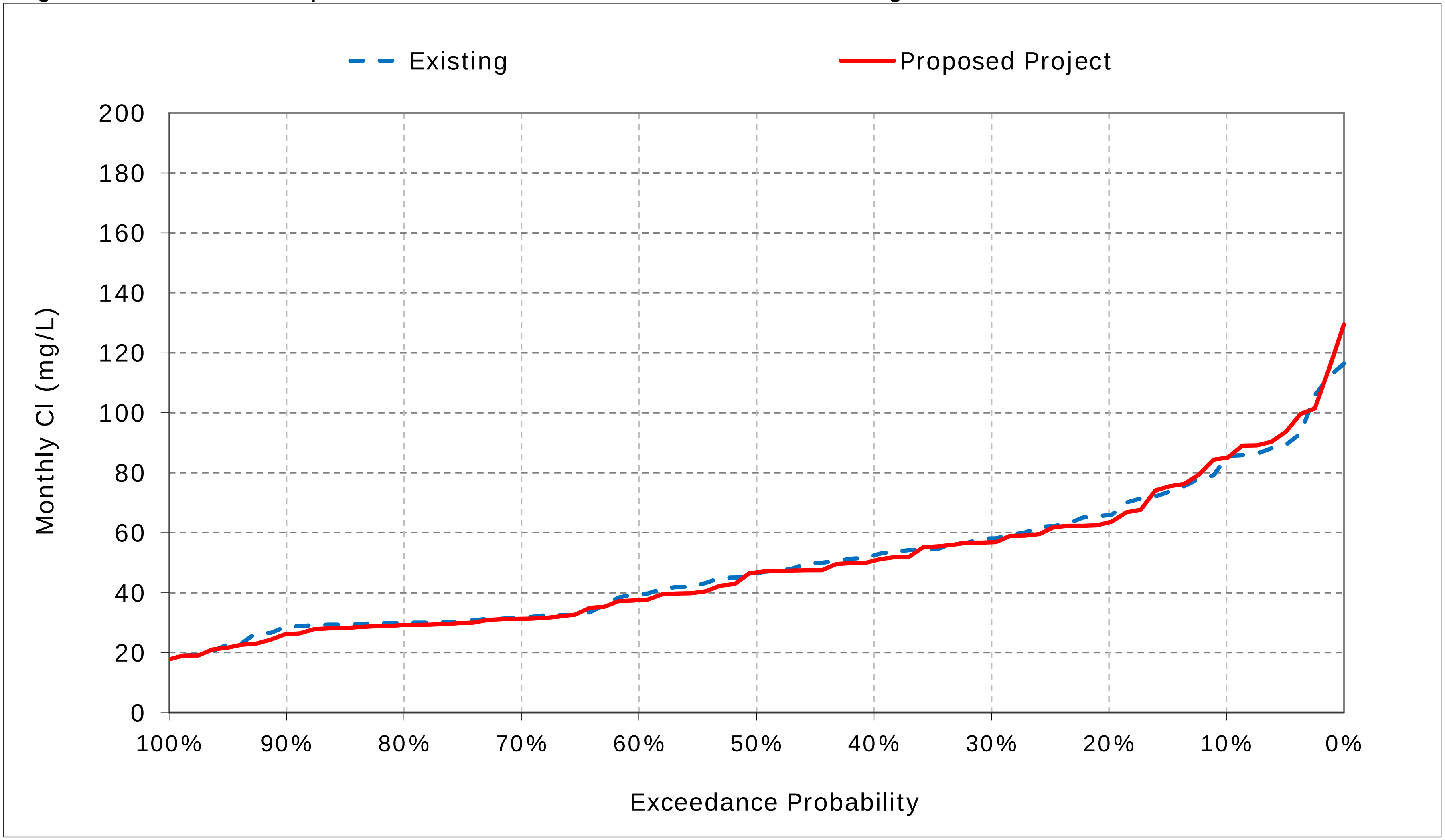


Figure 6-15. San Joaquin River at Prisoners Point Chloride, September Cl

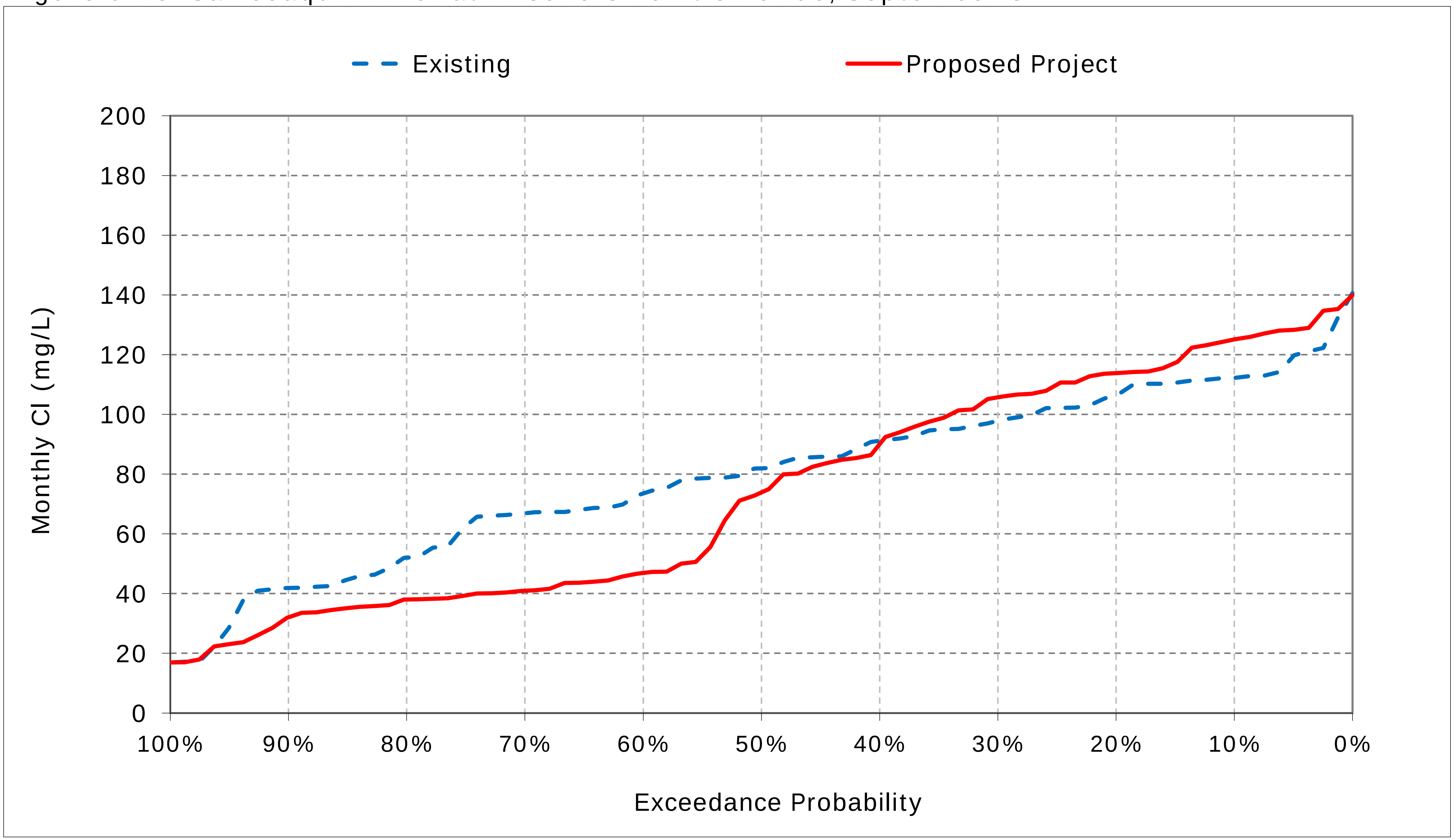


Figure 6-16. San Joaquin River at Prisoners Point Chloride, October Cl

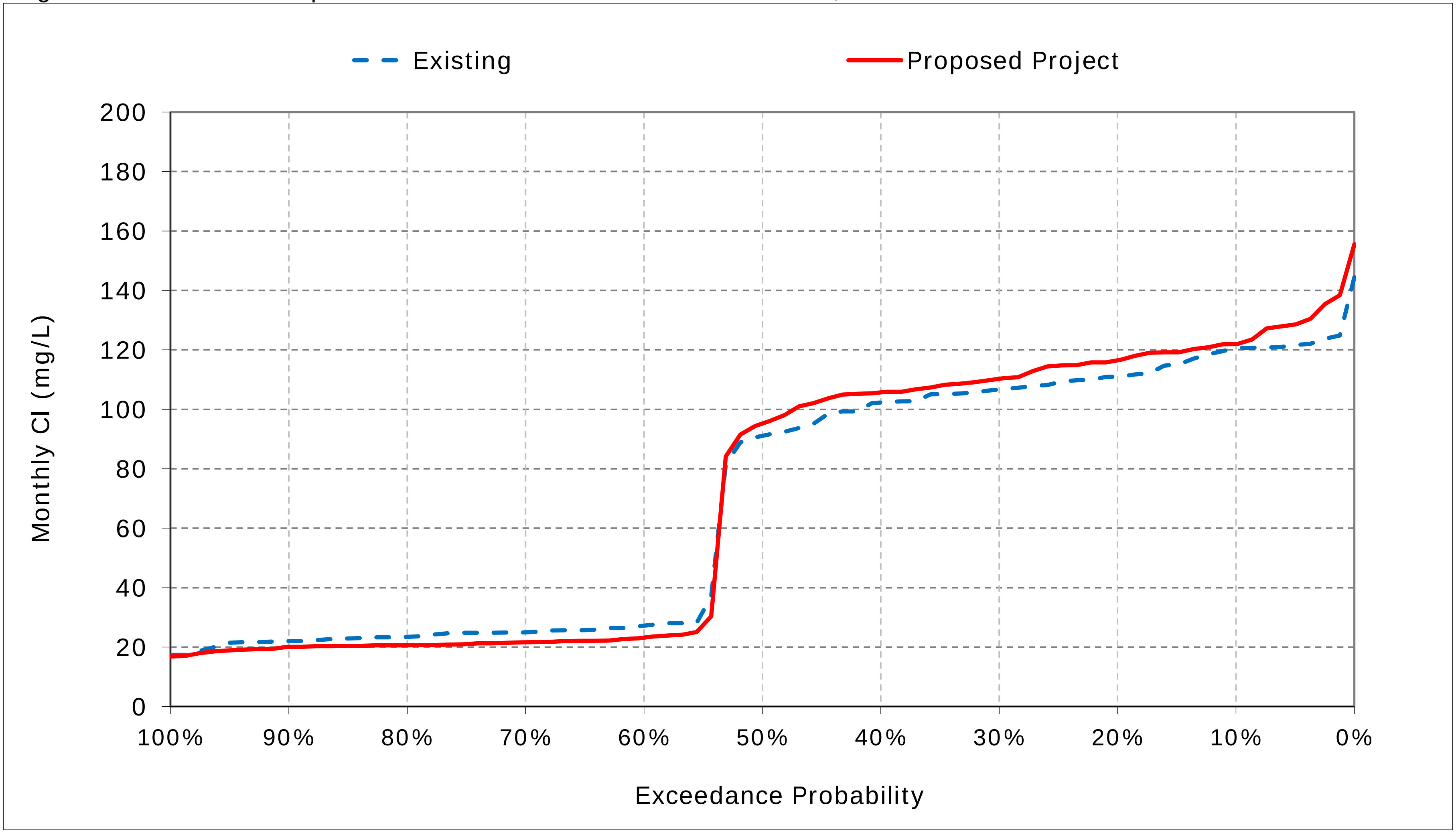


Figure 6-17. San Joaquin River at Prisoners Point Chloride, November Cl

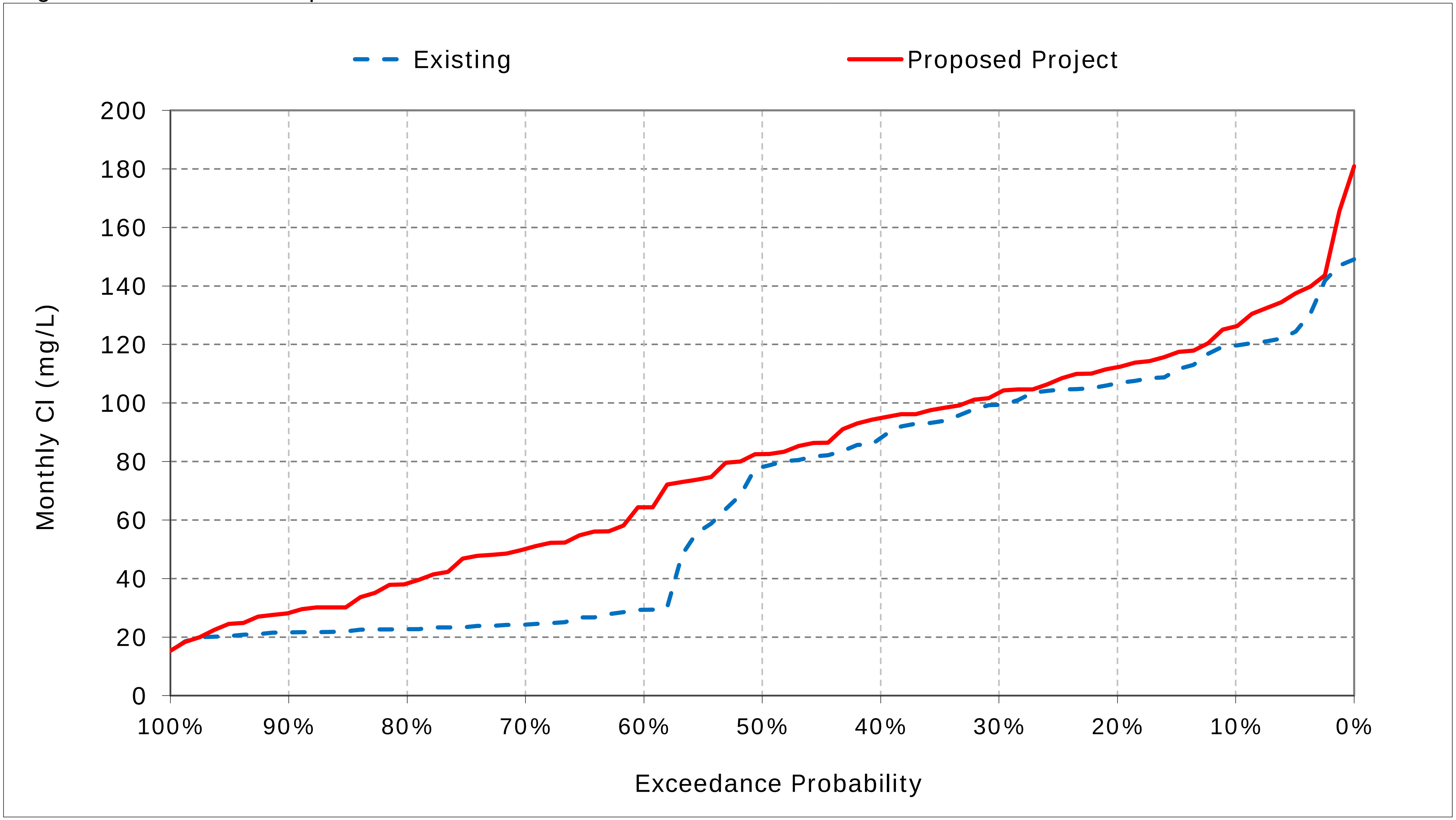


Figure 6-18. San Joaquin River at Prisoners Point Chloride, December Cl

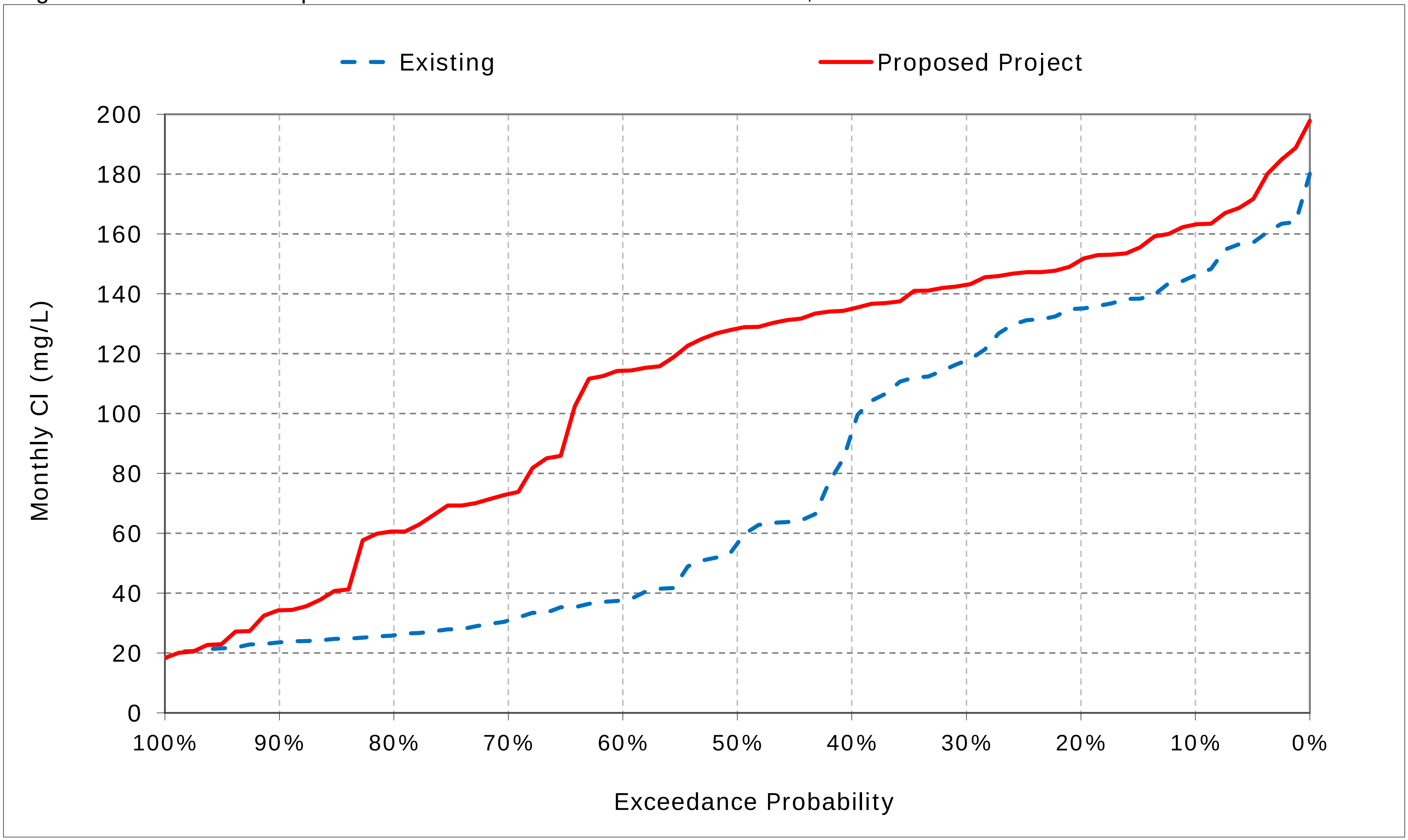


Table 7-1. Old River at Highway 4 Chloride, Monthly Cl

Existing

Statistic	Monthly Cl (mg/L) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	165	161	180	173	109	74	69	69	53	71	112	146
20%	157	143	169	155	96	66	64	65	43	50	87	138
30%	152	135	156	124	89	55	58	61	40	45	76	128
40%	143	127	125	110	81	52	56	60	38	40	71	118
50%	131	115	71	97	70	49	53	58	38	33	60	109
60%	41	42	55	84	60	46	50	55	36	29	54	97
70%	36	31	39	72	54	42	46	51	35	28	44	91
80%	33	29	31	56	49	39	35	44	31	27	41	78
90%	30	28	30	50	43	32	25	21	29	26	38	69
Long Term												
Full Simulation Period[a]	98	91	98	107	74	52	51	53	40	43	67	106
Water Year Types[b]												
Wet (32%)	78	68	63	69	61	45	36	38	32	28	41	83
Above Normal (15%)	111	97	97	104	78	51	50	54	37	28	45	73
Below Normal (17%)	102	96	113	124	70	49	54	58	37	36	70	137
Dry (22%)	98	100	114	115	76	52	61	62	40	53	90	120
Critical (15%)	121	115	135	161	99	69	67	66	66	80	104	133

Proposed Project

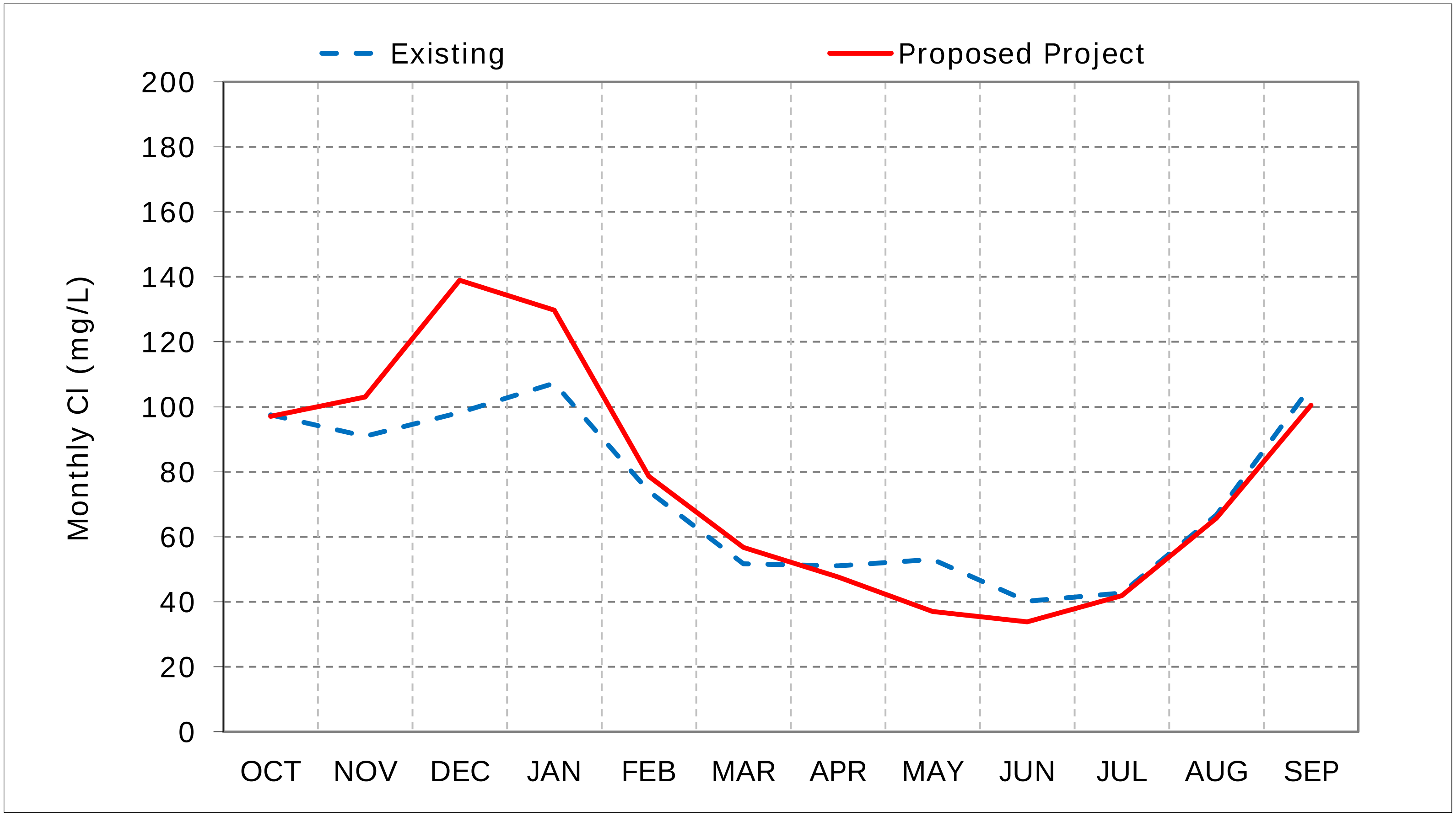
Statistic	Monthly Cl (mg/L) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	171	159	187	222	124	86	66	51	48	73	115	158
20%	163	146	181	199	106	68	59	45	36	47	83	145
30%	154	135	171	171	89	62	55	41	31	42	76	132
40%	144	130	167	151	80	57	49	37	30	37	69	116
50%	134	117	161	116	72	55	46	33	29	30	59	99
60%	31	79	143	95	67	49	44	31	29	29	52	76
70%	28	64	117	78	59	46	41	30	28	27	44	68
80%	27	52	96	65	51	42	37	29	27	27	40	63
90%	27	40	44	52	43	36	30	27	25	26	34	55
Long Term												
Full Simulation Period[a]	97	103	139	130	79	57	48	37	34	42	66	101
Water Year Types[b]												
Wet (32%)	77	84	98	79	61	48	36	28	28	28	39	56
Above Normal (15%)	111	117	155	142	83	58	44	30	28	27	45	70
Below Normal (17%)	101	107	152	149	72	54	51	35	28	32	69	150
Dry (22%)	97	107	157	150	85	59	55	42	32	51	87	121
Critical (15%)	123	120	170	176	112	72	63	58	61	83	108	138

Proposed Project minus Existing

Statistic	Monthly Cl (mg/L) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	6	-3	7	50	15	12	-3	-18	-4	2	2	12
20%	7	3	13	44	10	2	-5	-19	-7	-3	-4	7
30%	2	0	16	46	0	7	-4	-20	-8	-3	0	5
40%	0	3	42	41	0	5	-7	-22	-8	-3	-2	-2
50%	4	2	90	18	2	6	-7	-24	-8	-2	-1	-10
60%	-10	38	88	10	7	3	-6	-24	-8	0	-2	-21
70%	-8	32	78	6	5	4	-5	-21	-7	-1	0	-23
80%	-6	23	64	9	1	3	2	-16	-5	0	-1	-14
90%	-3	12	14	2	0	4	6	6	-4	0	-4	-14
Long Term												
Full Simulation Period[a]	0	12	41	23	5	5	-3	-16	-6	-1	-1	-6
Water Year Types[b]												
Wet (32%)	-1	16	35	9	0	3	0	-10	-4	0	-2	-27
Above Normal (15%)	0	20	58	39	5	7	-6	-23	-8	-1	0	-3
Below Normal (17%)	-1	11	39	24	2	6	-3	-23	-8	-4	-1	13
Dry (22%)	-1	8	43	34	9	7	-6	-20	-8	-2	-3	1
Critical (15%)	2	5	35	15	13	3	-4	-8	-5	3	4	5

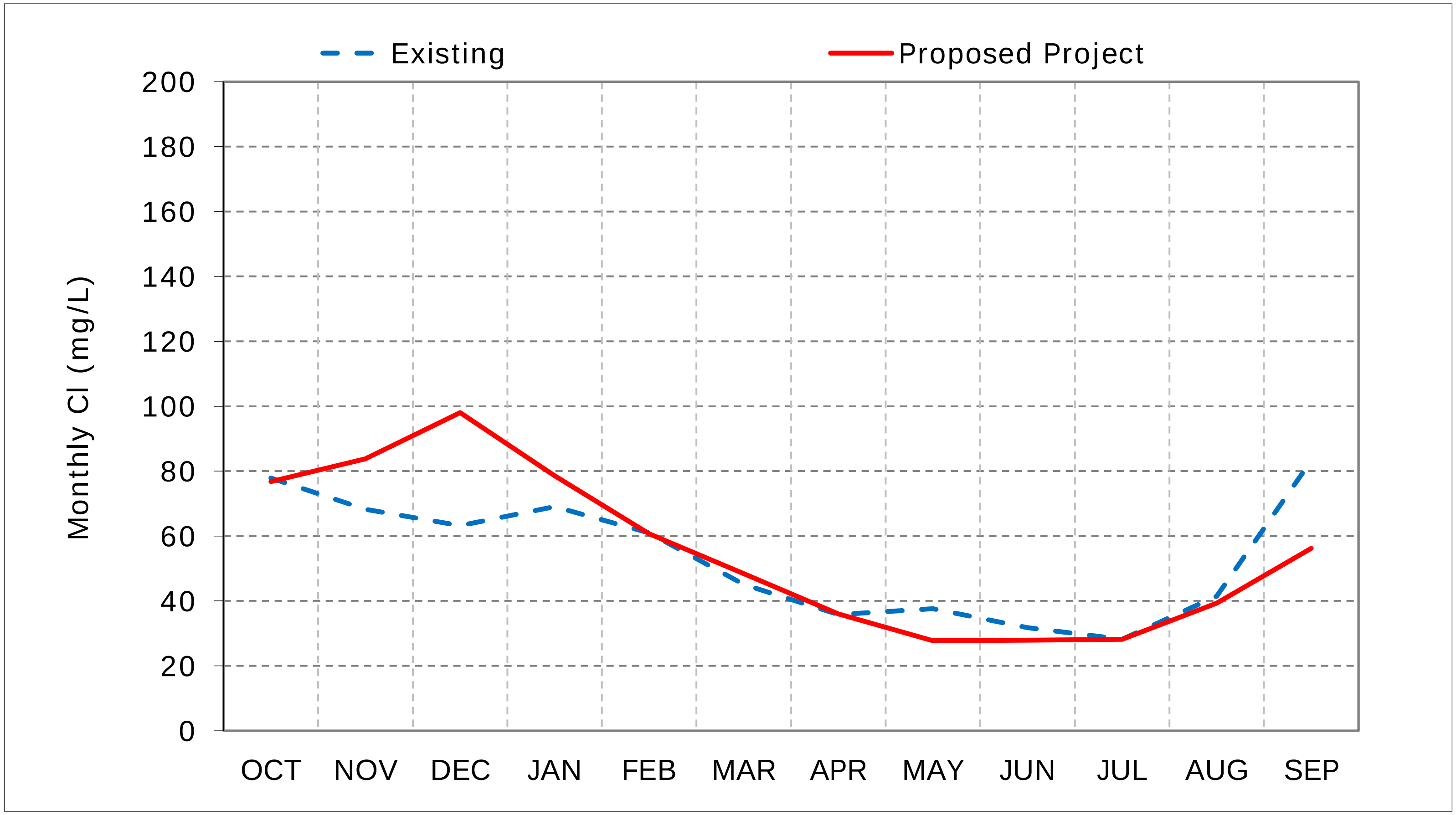
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 7-1. Old River at Highway 4 Chloride, Long-Term Average Cl



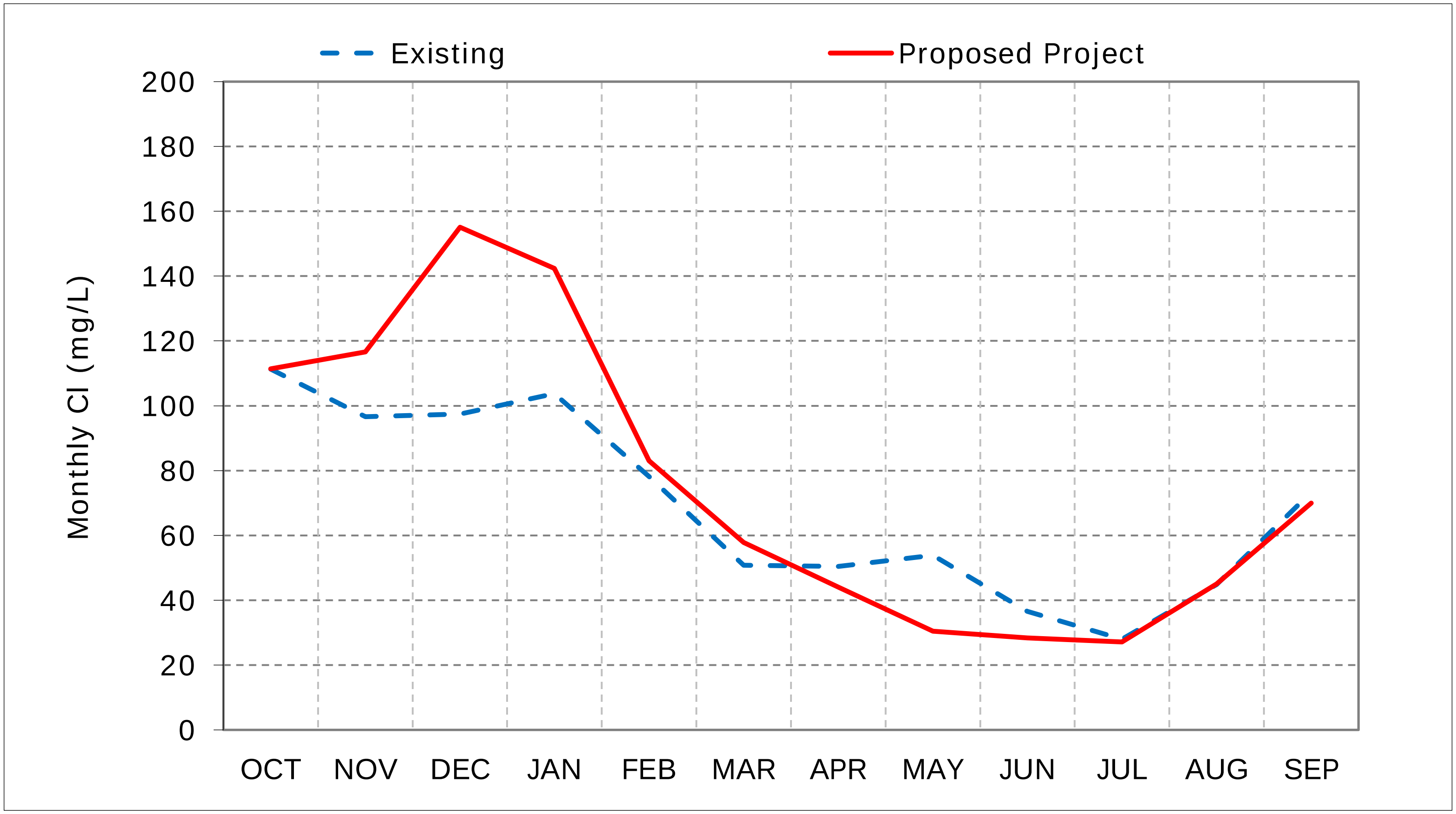
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 7-2. Old River at Highway 4 Chloride, Wet Year Average Cl



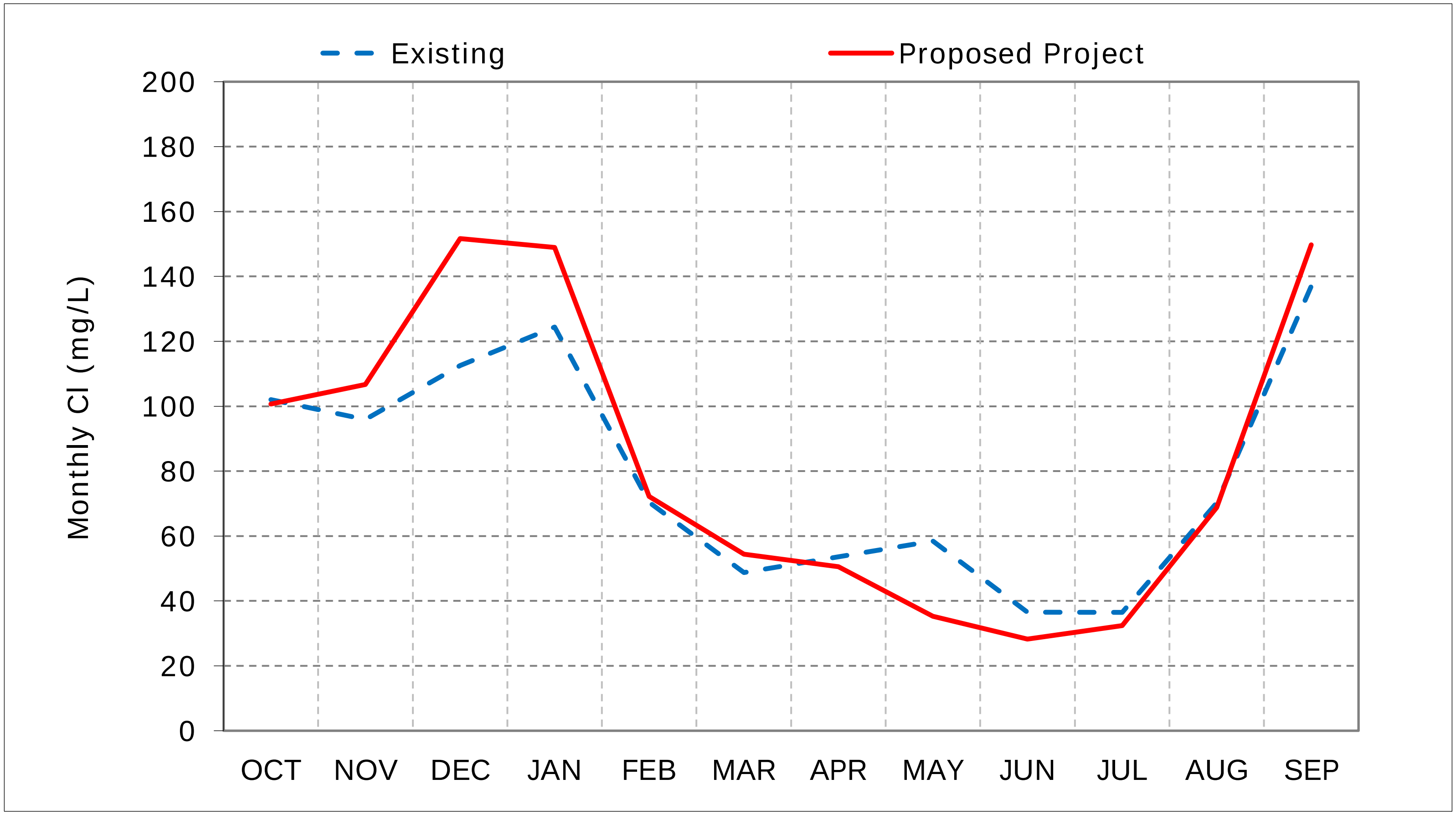
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 7-3. Old River at Highway 4 Chloride, Above Normal Year Average Cl



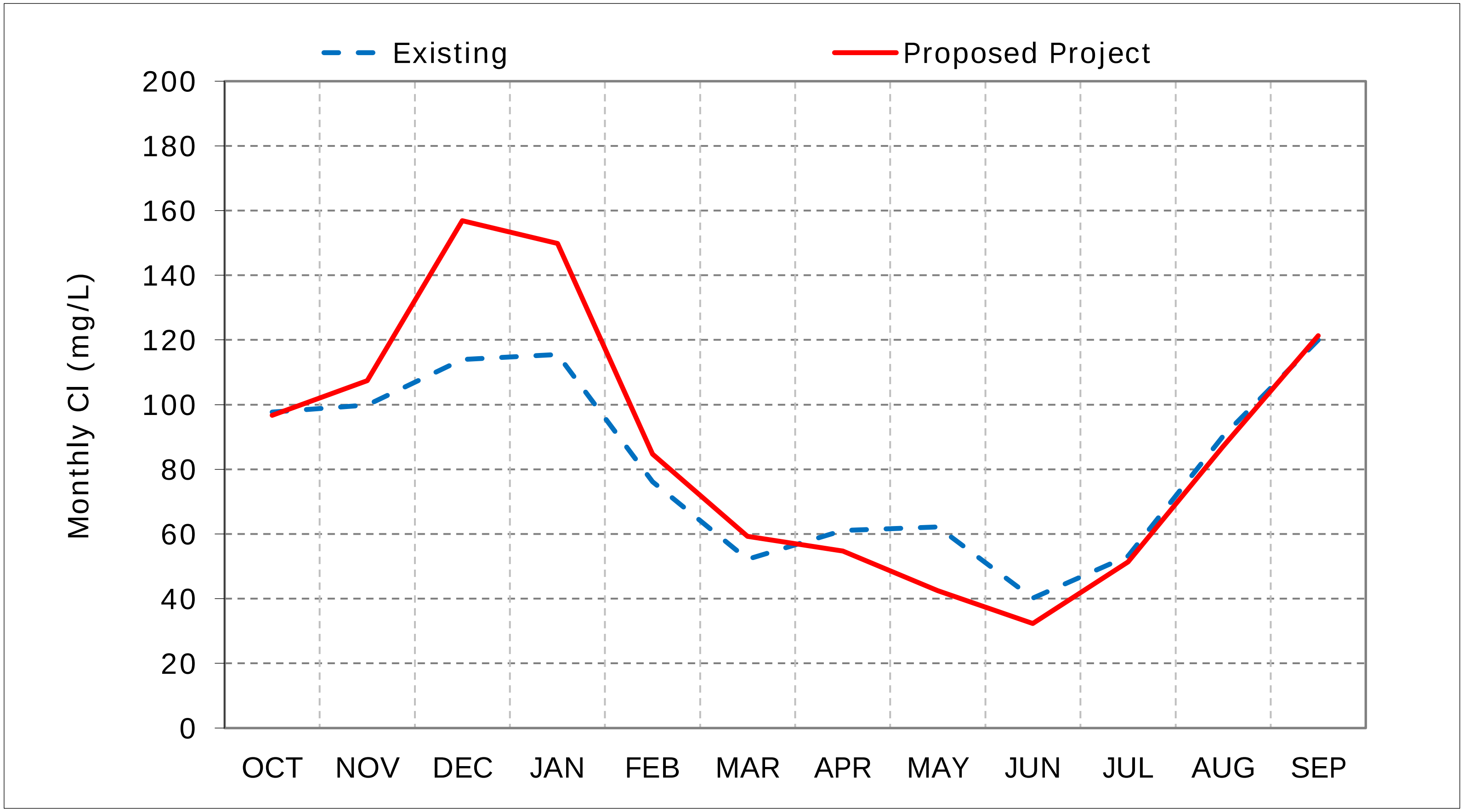
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 7-4. Old River at Highway 4 Chloride, Below Normal Year Average Cl



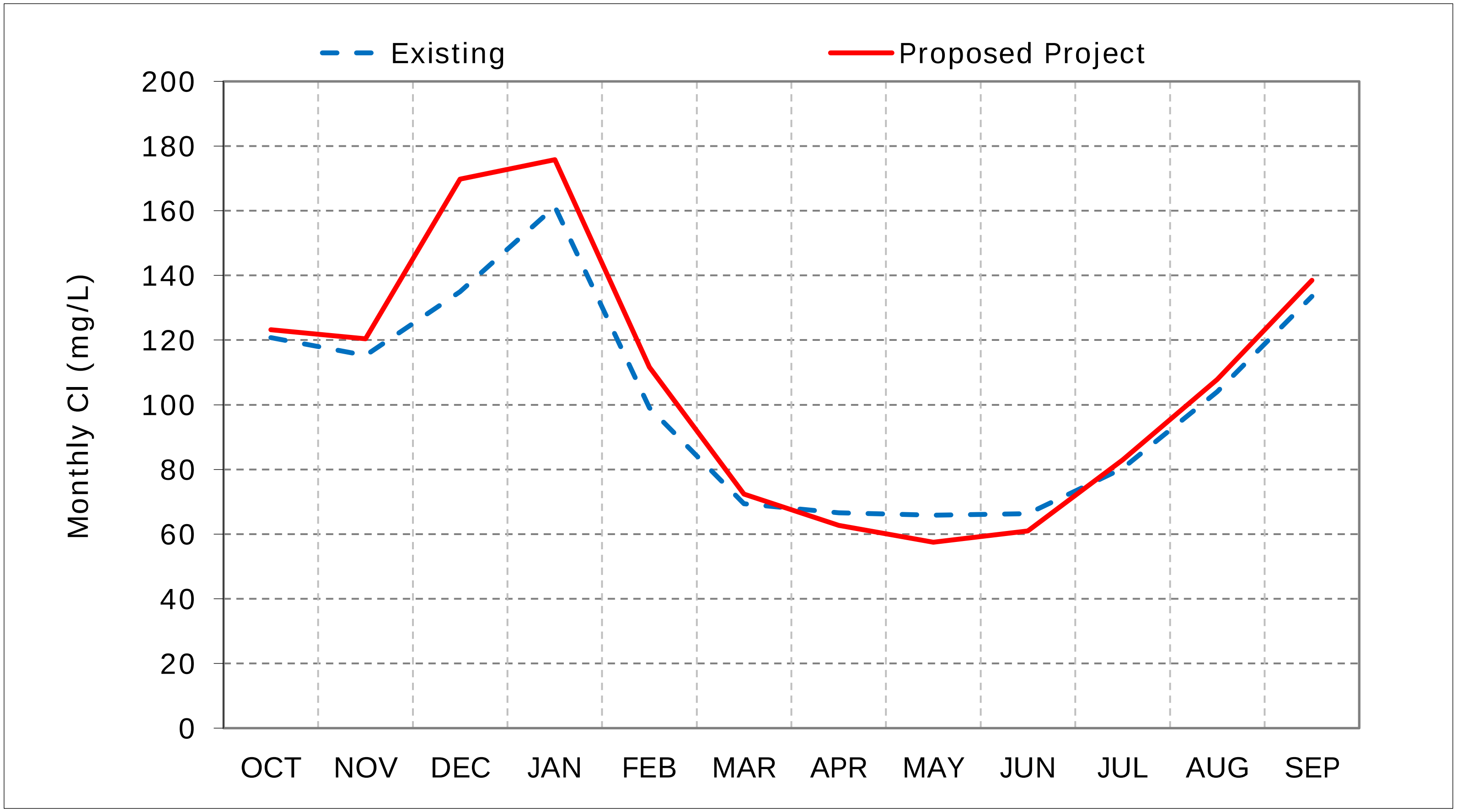
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 7-5. Old River at Highway 4 Chloride, Dry Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 7-6. Old River at Highway 4 Chloride, Critical Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 7-7. Old River at Highway 4 Chloride, January Cl

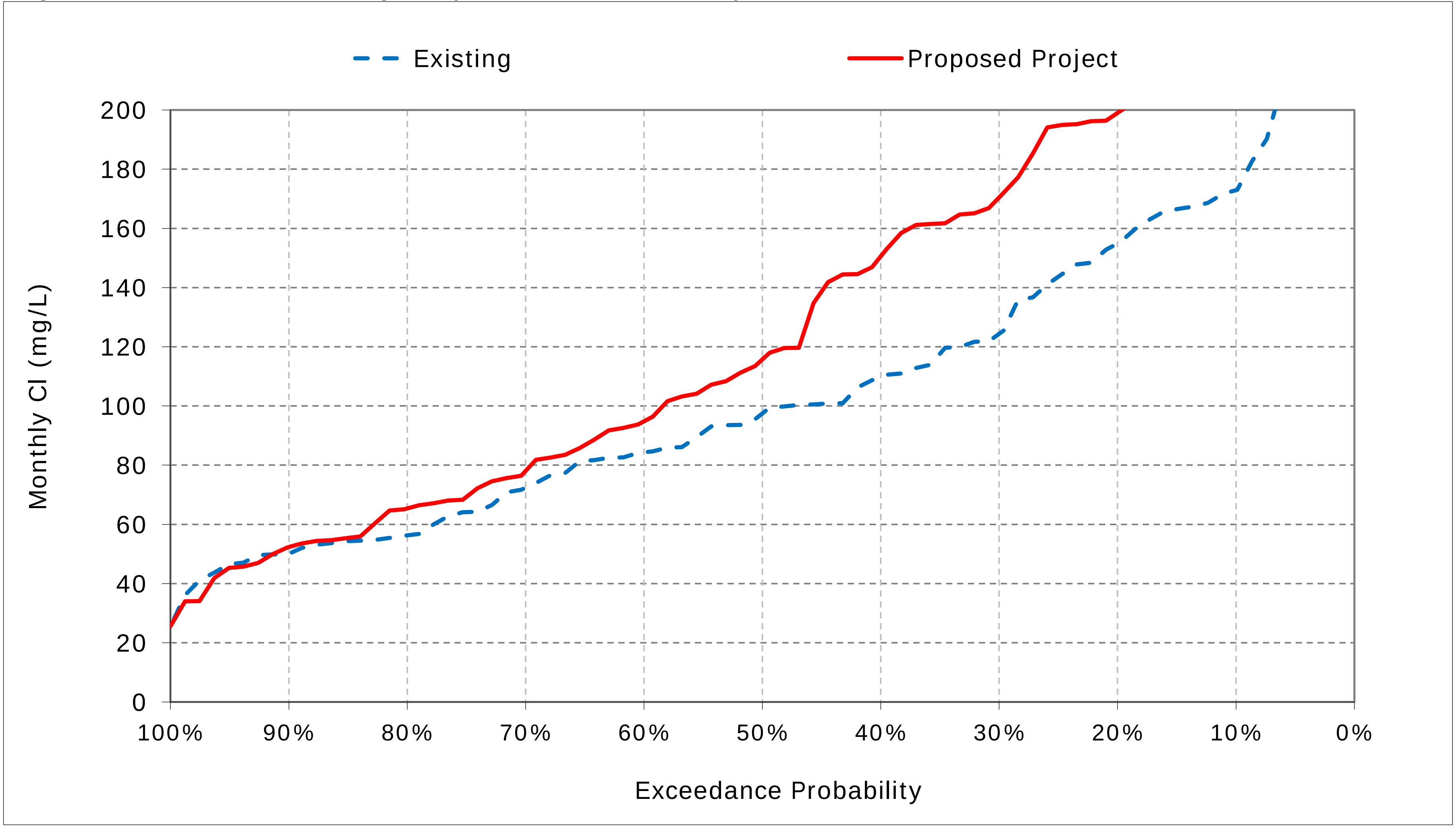


Figure 7-8. Old River at Highway 4 Chloride, February Cl

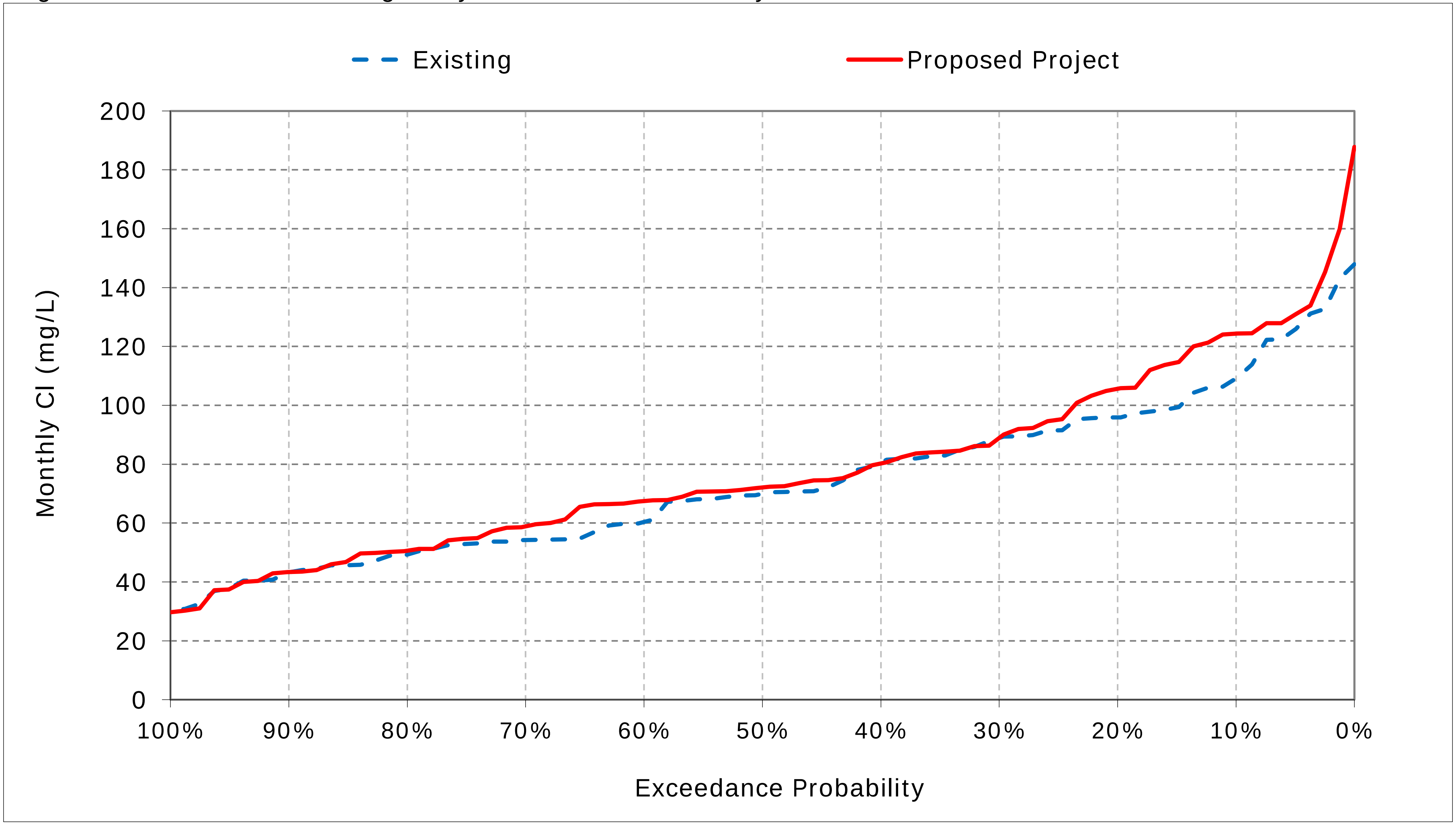


Figure 7-9. Old River at Highway 4 Chloride, March Cl

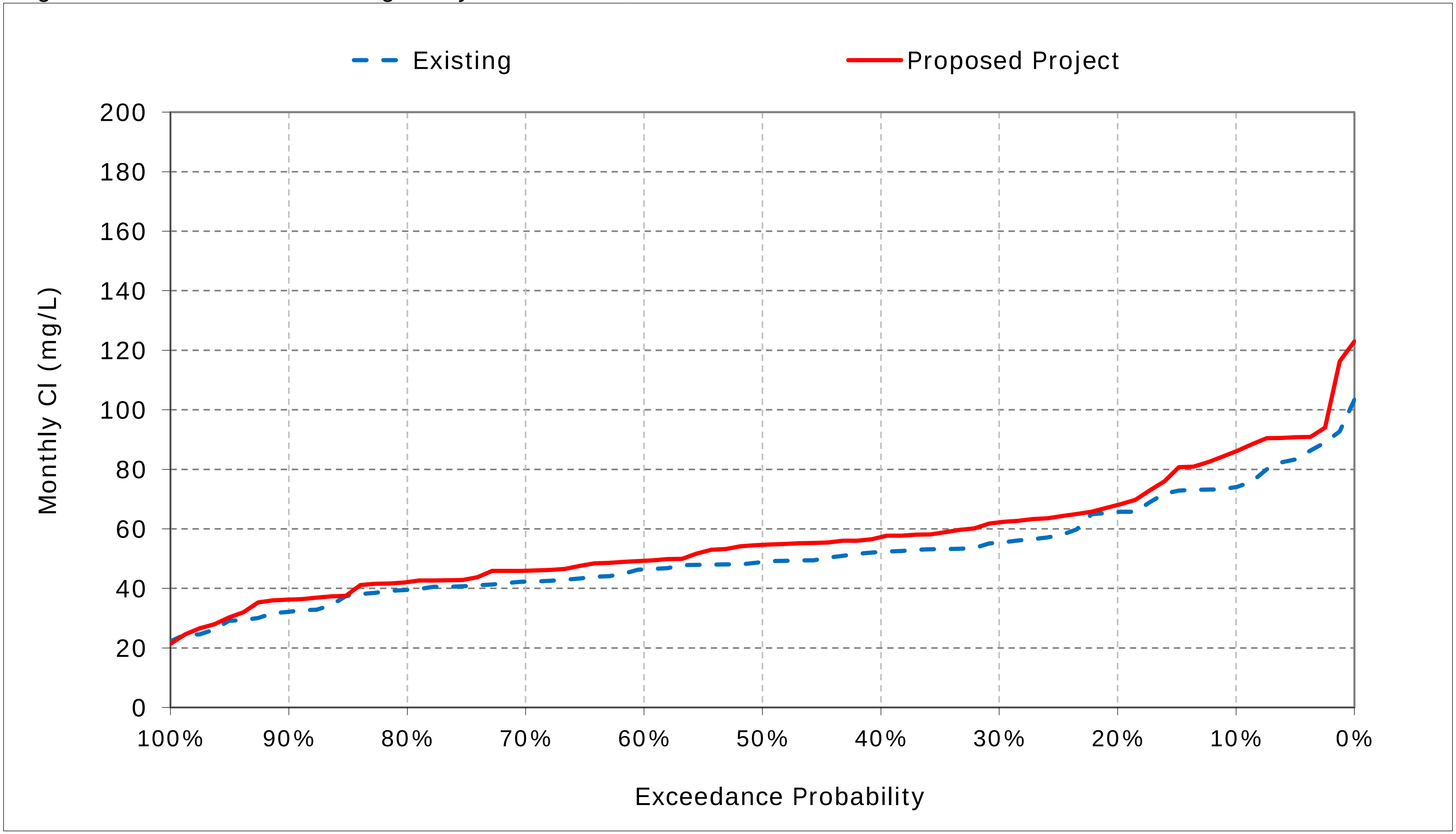


Figure 7-10. Old River at Highway 4 Chloride, April Cl

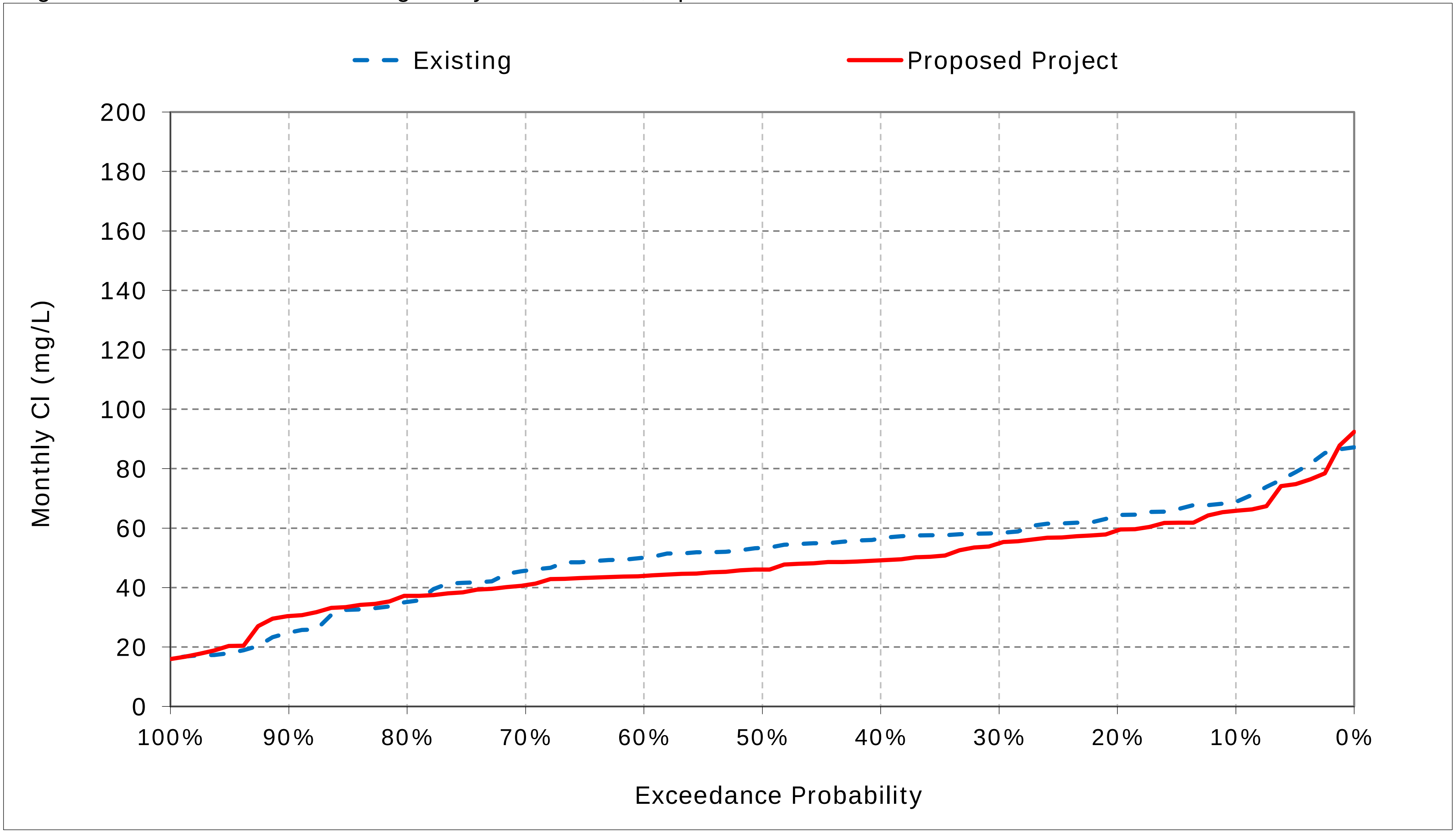


Figure 7-11. Old River at Highway 4 Chloride, May Cl

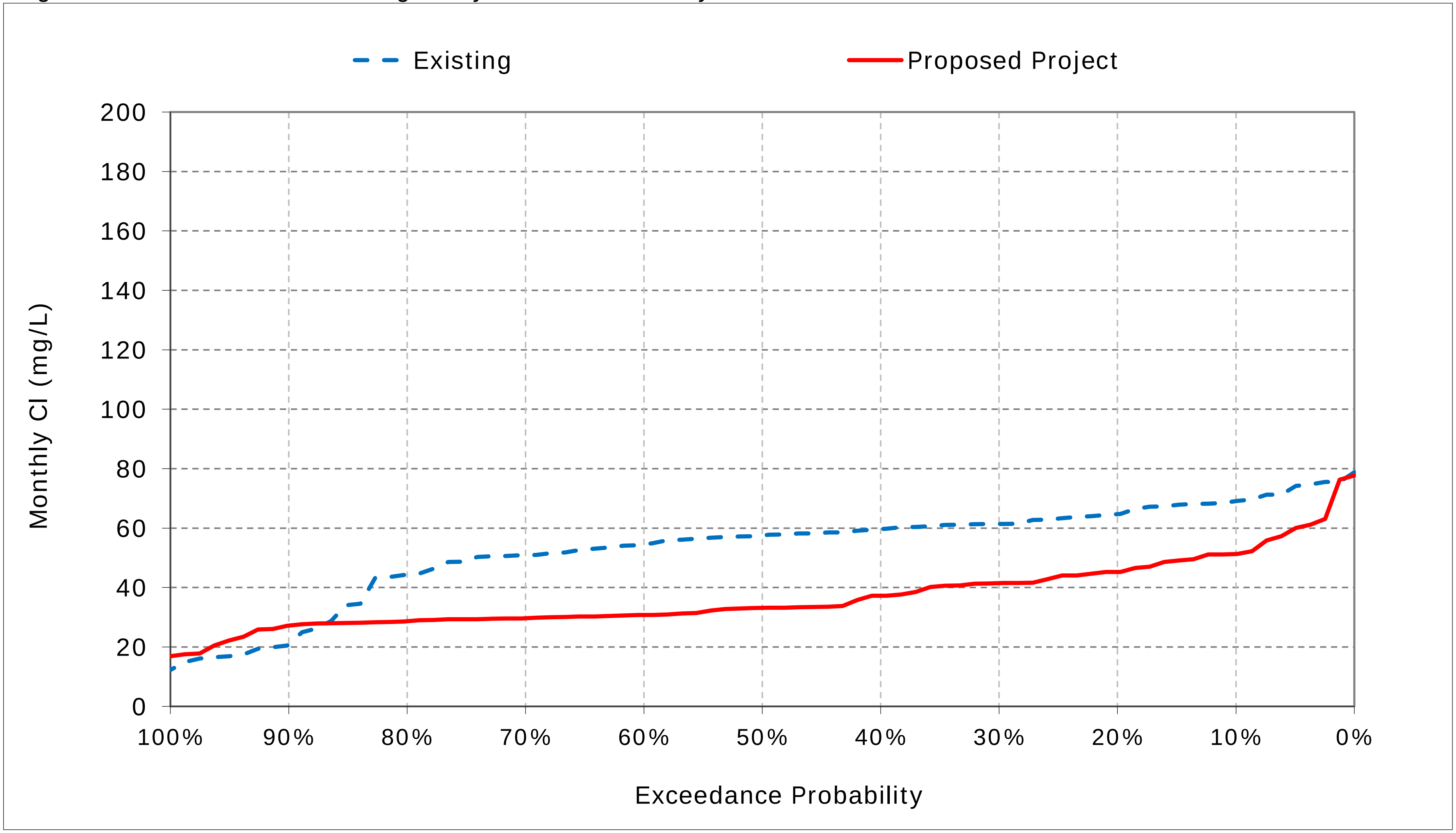


Figure 7-12. Old River at Highway 4 Chloride, June Cl

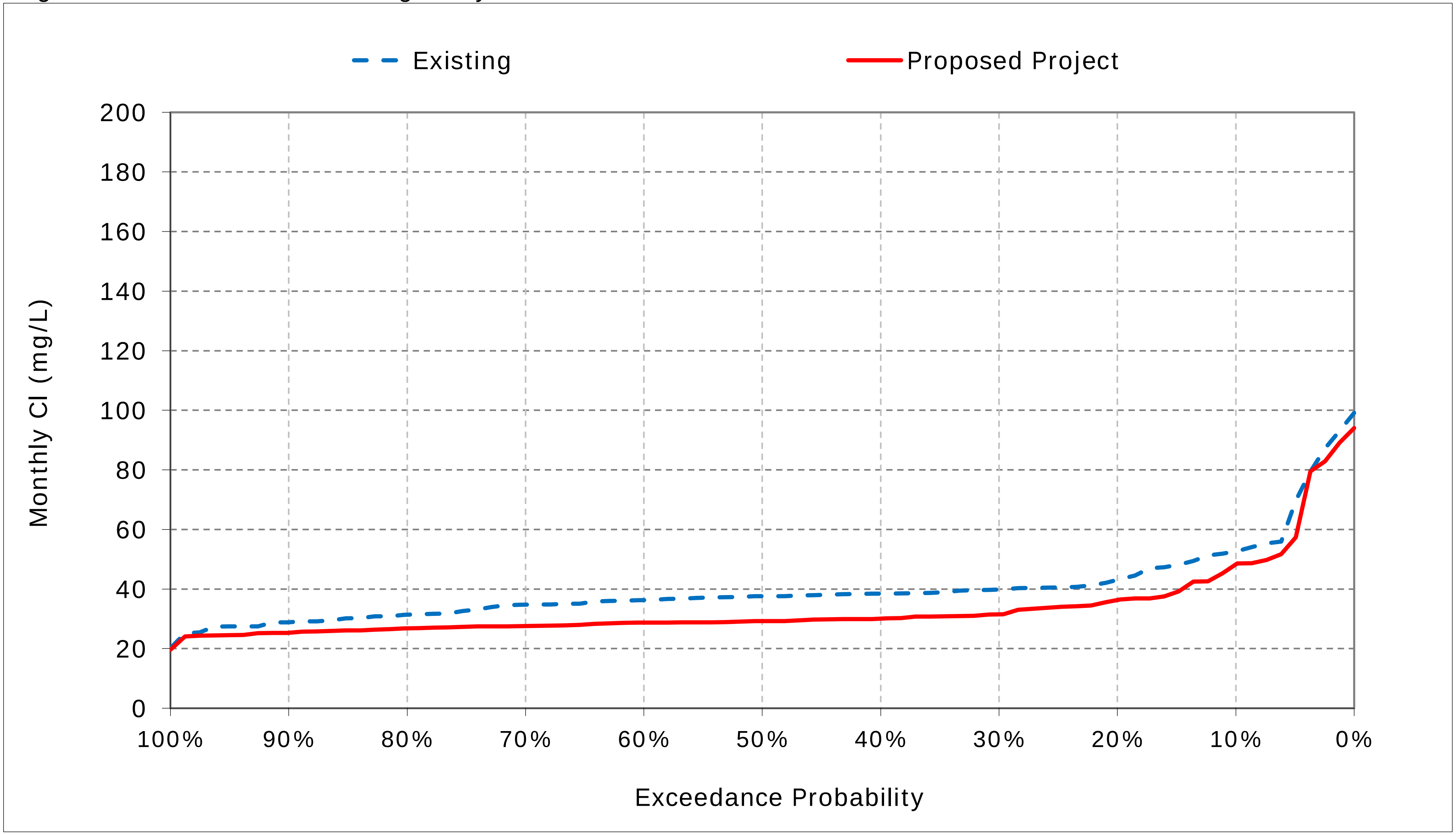


Figure 7-13. Old River at Highway 4 Chloride, July Cl

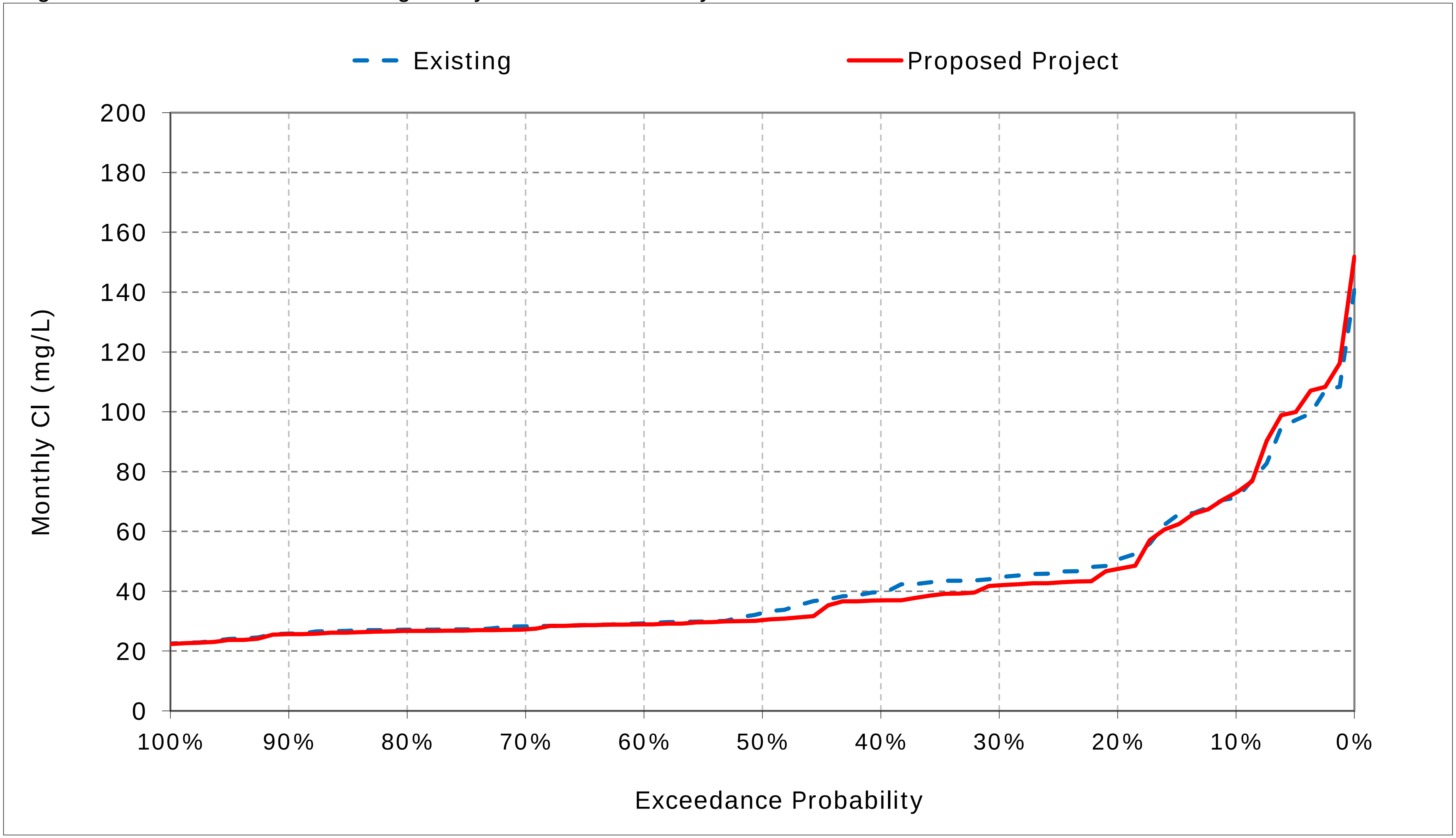


Figure 7-14. Old River at Highway 4 Chloride, August Cl

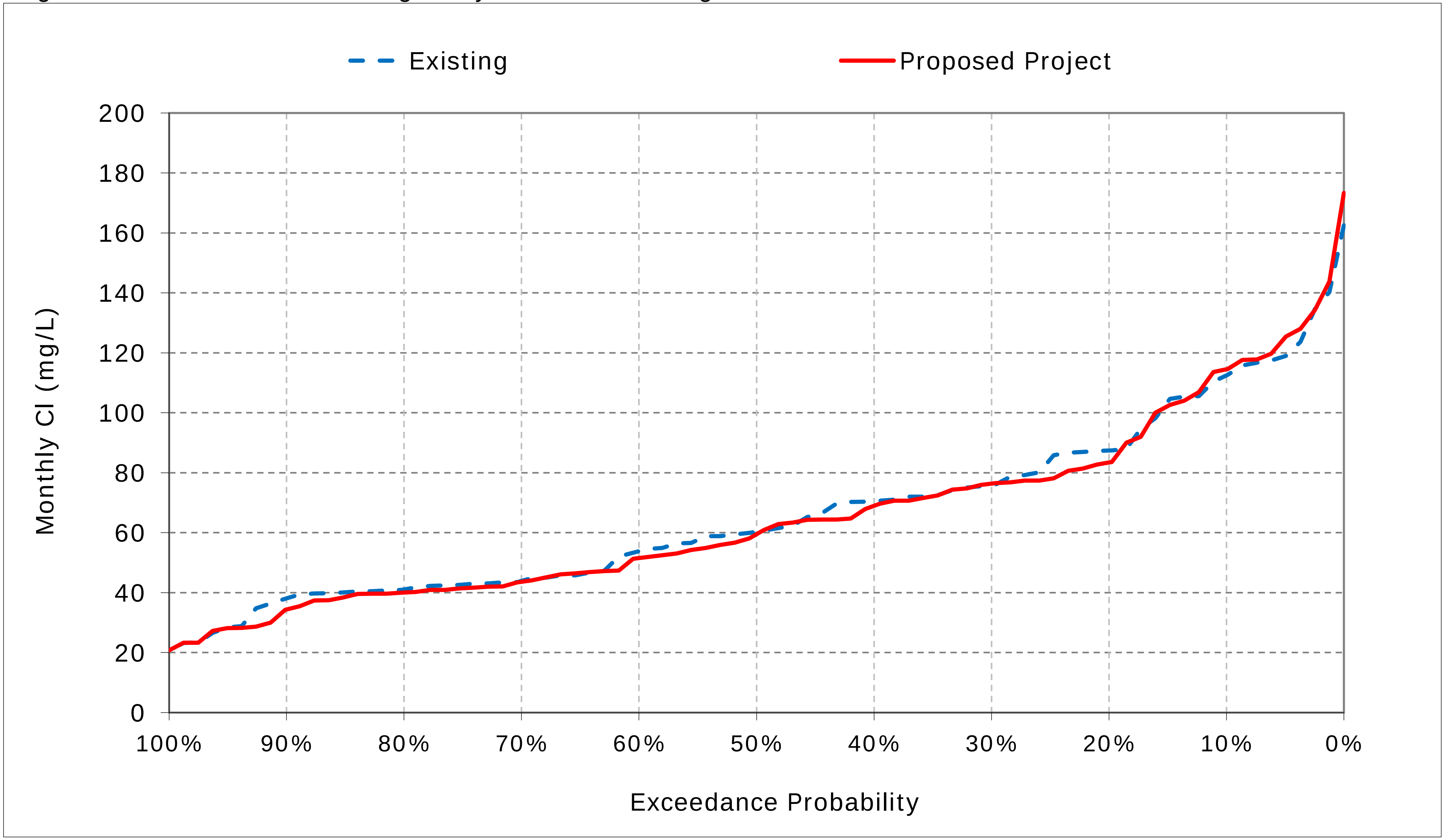


Figure 7-15. Old River at Highway 4 Chloride, September Cl

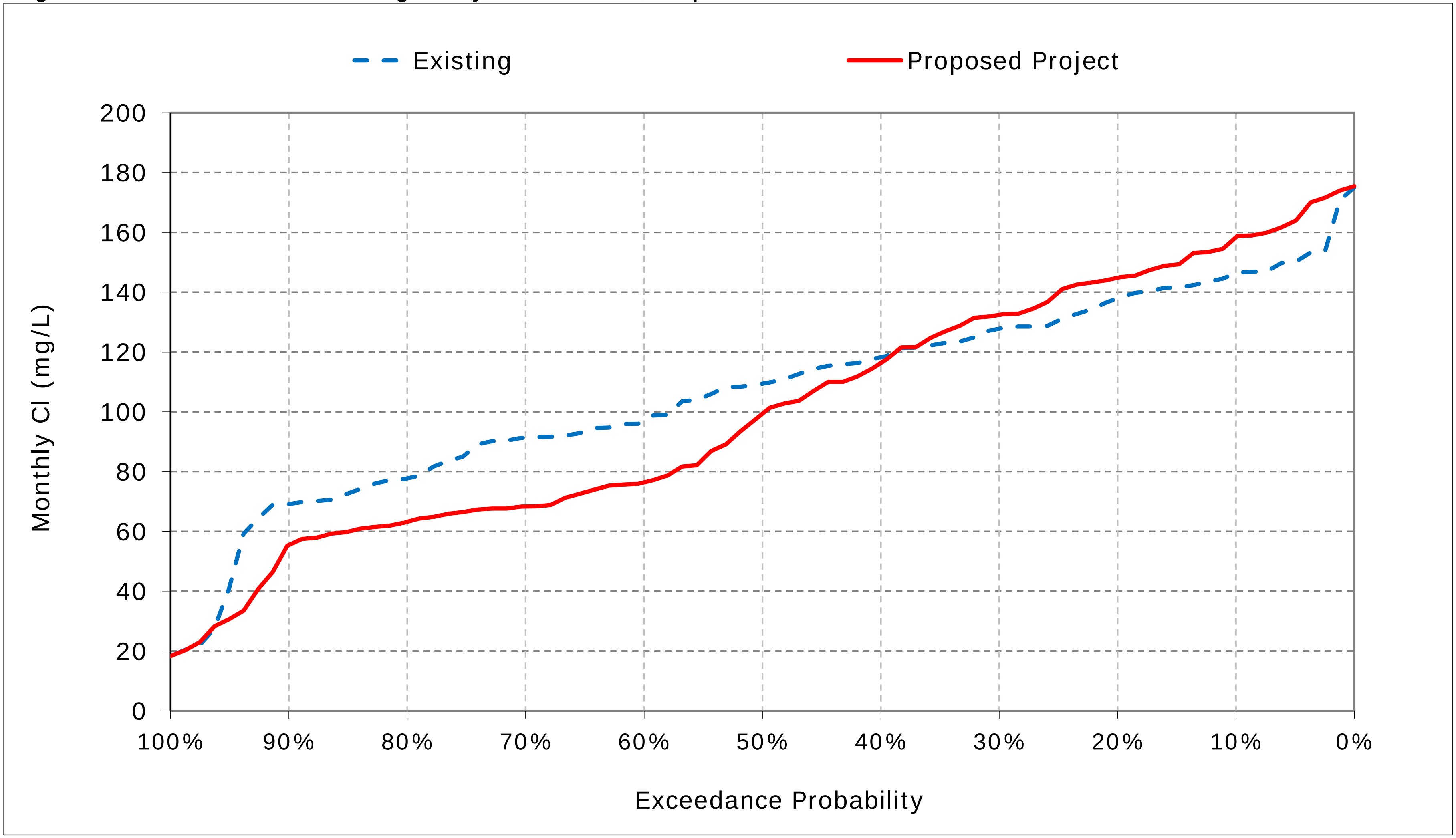


Figure 7-16. Old River at Highway 4 Chloride, October Cl

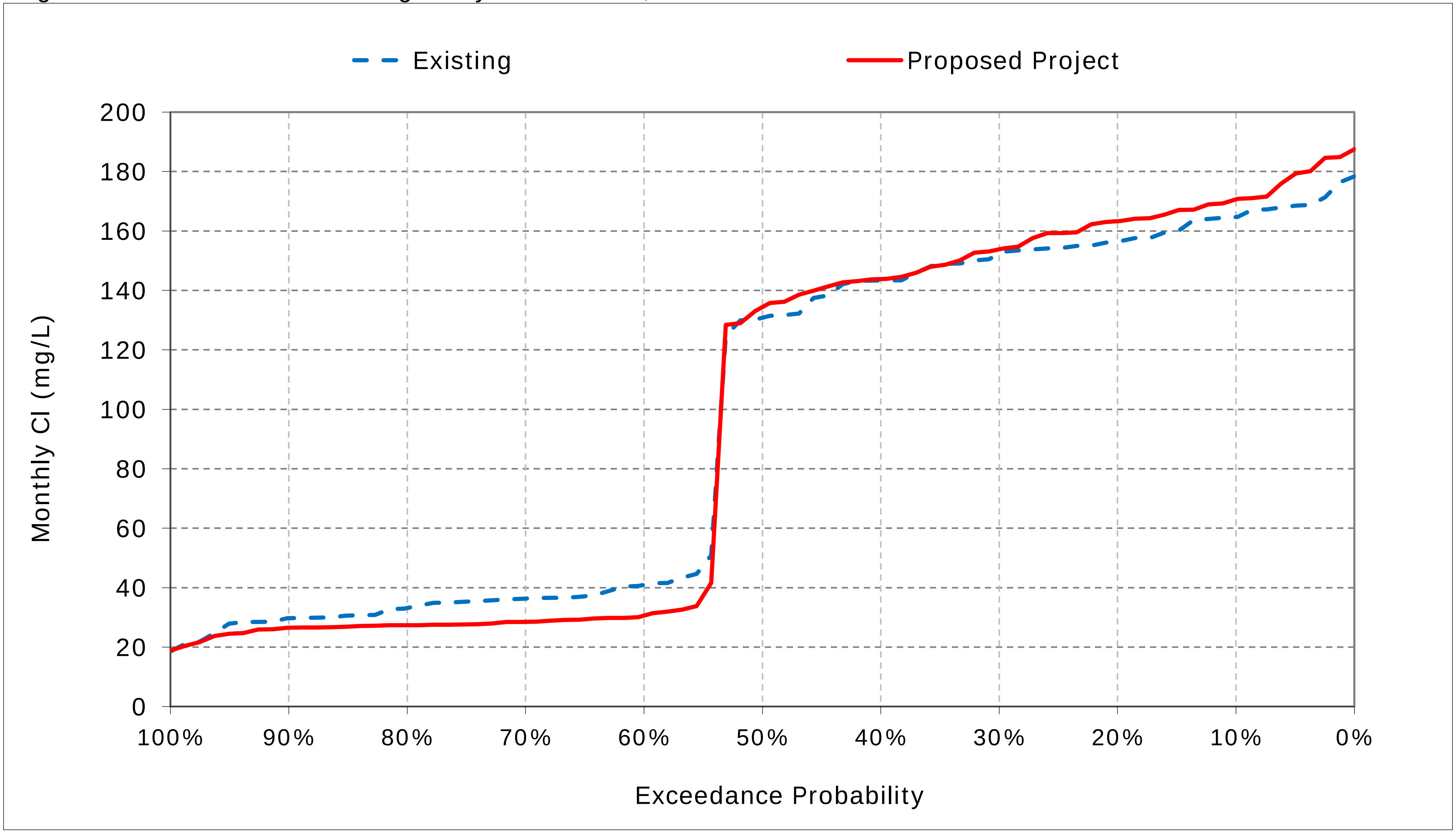


Figure 7-17. Old River at Highway 4 Chloride, November Cl

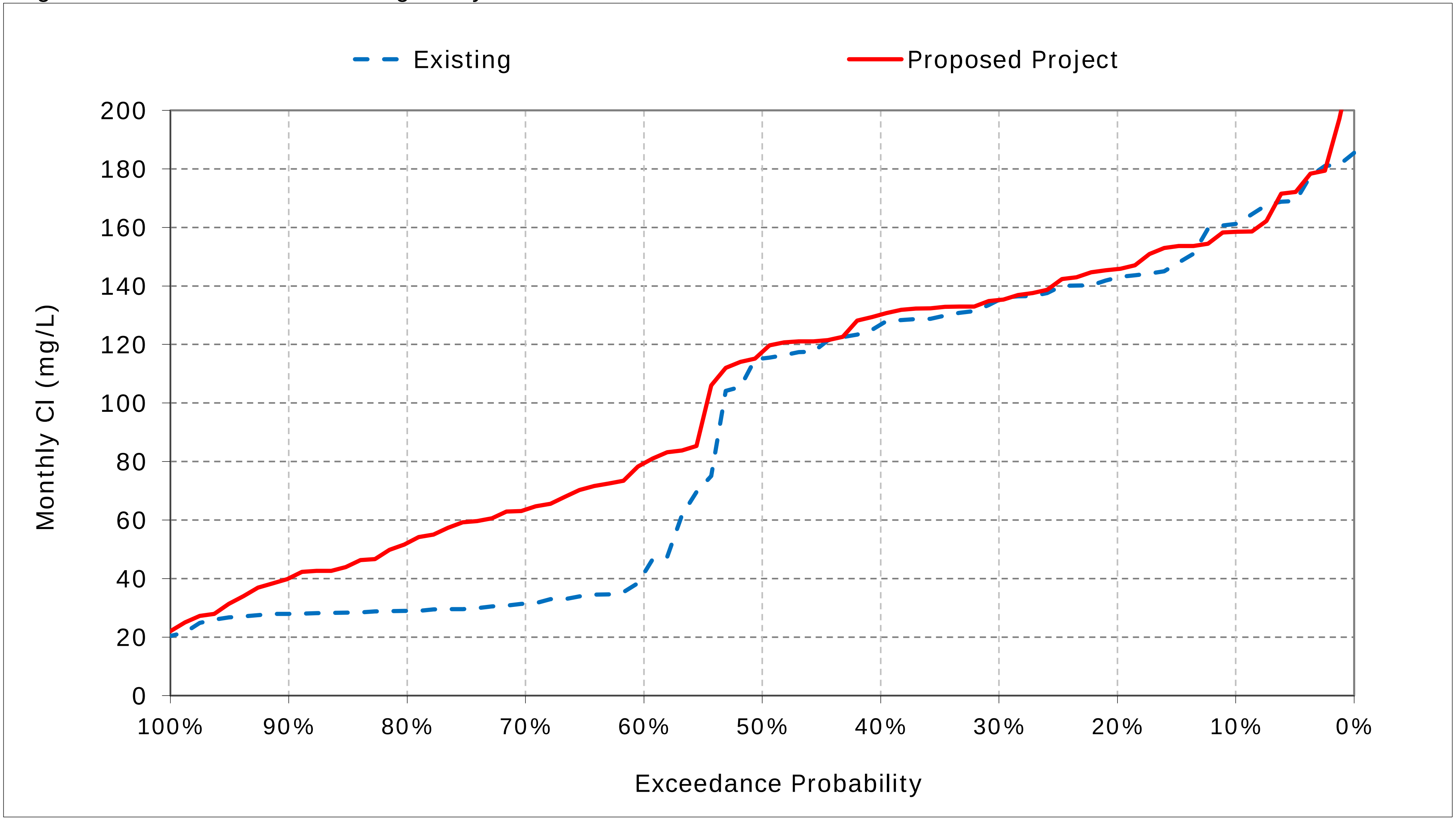


Figure 7-18. Old River at Highway 4 Chloride, December Cl

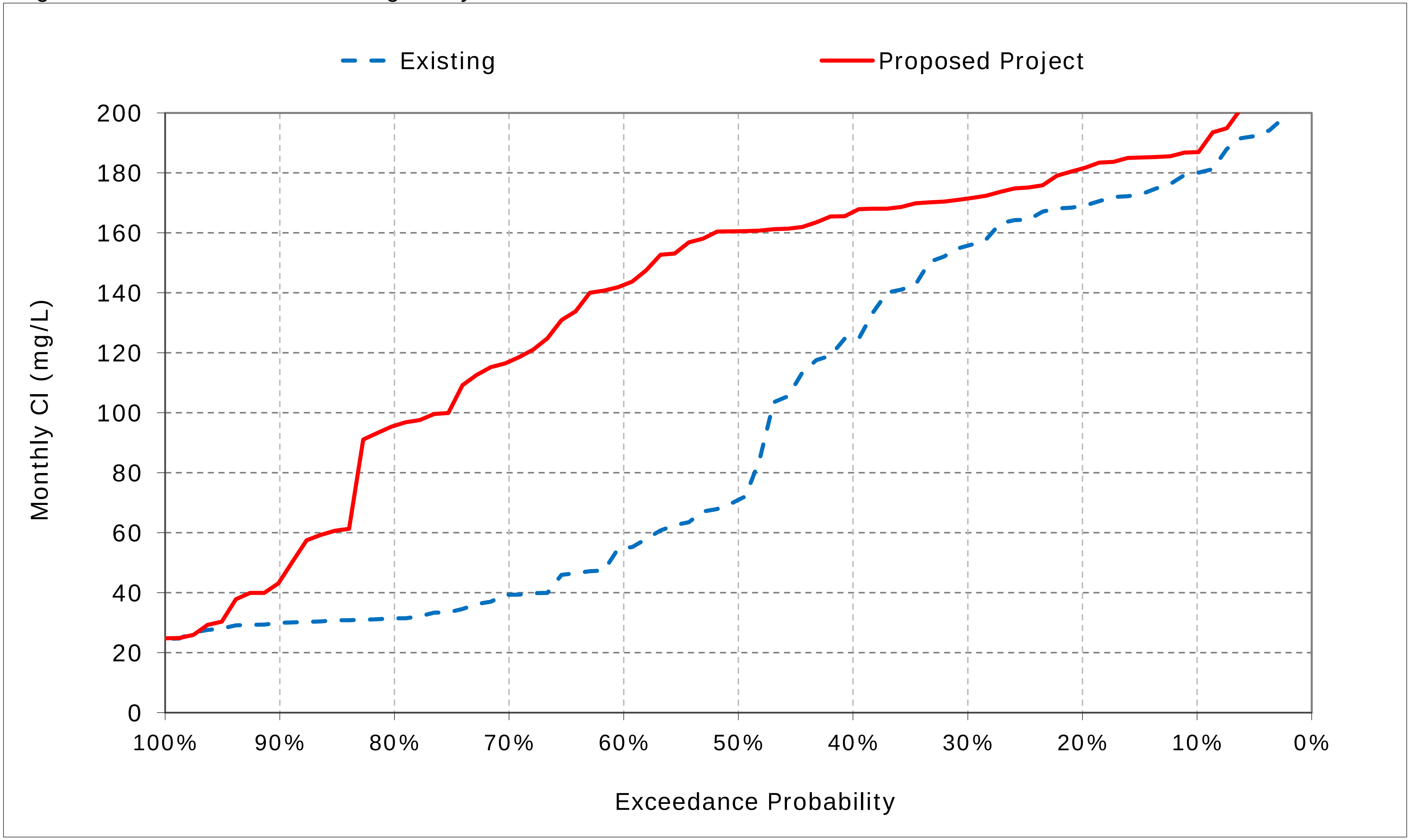


Table 8-1. Victoria Canal Chloride, Monthly Cl

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	96	100	117	141	127	102	91	84	71	55	72	80
20%	90	88	108	134	114	92	84	79	60	51	58	77
30%	86	83	103	116	107	87	78	75	57	43	50	75
40%	83	79	96	108	103	82	72	70	55	38	44	72
50%	77	73	74	100	93	76	67	61	53	35	38	67
60%	55	52	57	93	87	70	55	57	52	32	36	62
70%	51	49	46	87	84	63	45	52	49	30	33	60
80%	45	47	41	78	73	49	36	43	46	29	31	51
90%	41	44	34	72	55	42	25	20	42	27	28	46
Long Term												
Full Simulation Period[a]	69	68	76	104	93	74	61	60	54	39	45	65
Water Year Types[b]												
Wet (32%)	61	58	64	86	72	54	37	38	45	38	32	57
Above Normal (15%)	76	73	75	105	101	72	57	56	53	36	31	48
Below Normal (17%)	70	68	80	113	96	77	65	63	53	31	41	71
Dry (22%)	70	71	82	106	102	89	82	75	57	36	58	69
Critical (15%)	78	82	92	129	112	90	84	83	73	61	68	82

Proposed Project

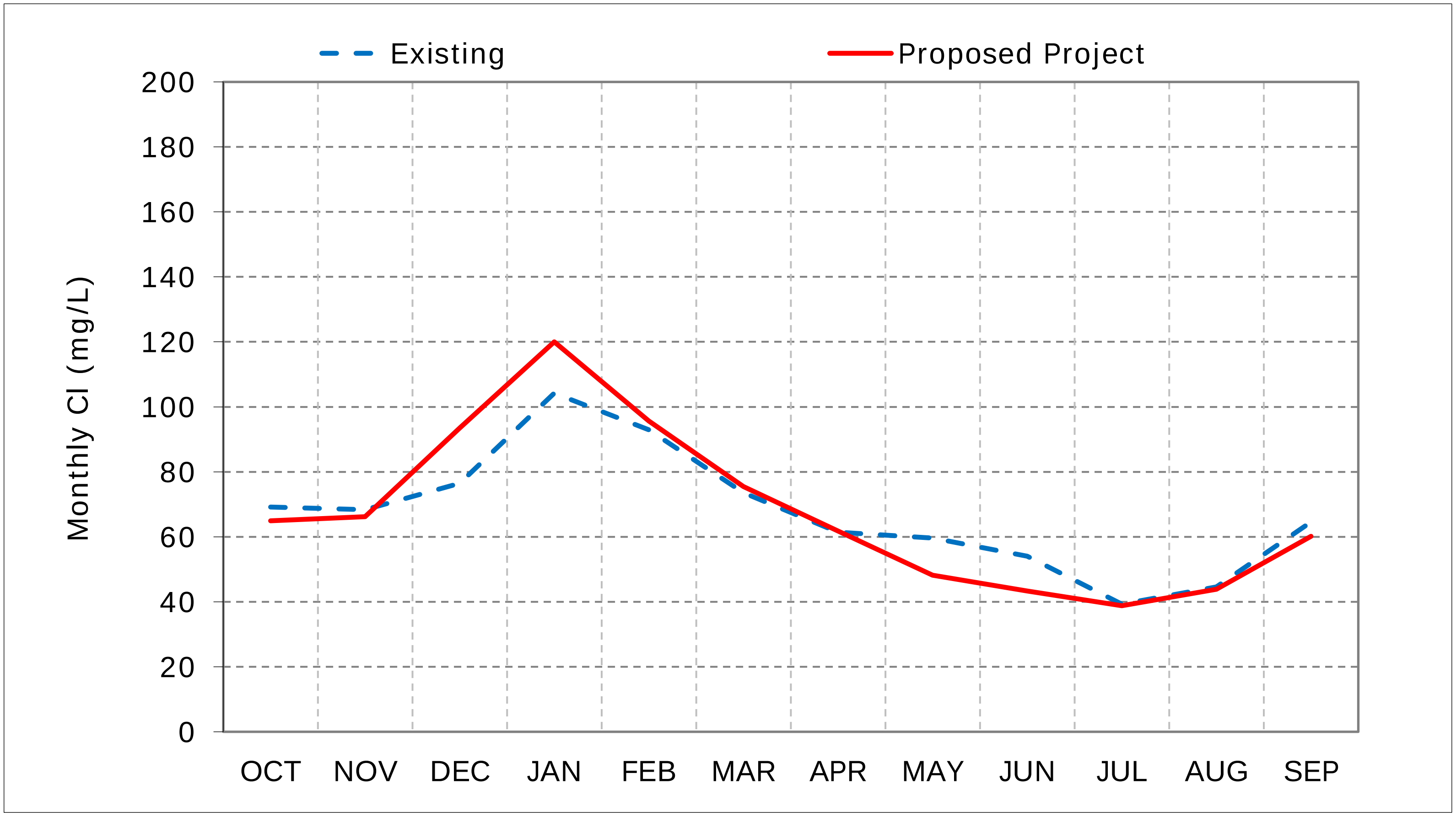
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	100	99	126	170	137	106	88	67	54	56	71	82
20%	92	93	113	155	124	95	82	61	50	51	53	79
30%	88	84	107	142	111	89	76	57	46	43	48	74
40%	84	78	105	134	102	84	71	51	44	38	43	69
50%	80	74	98	116	96	77	66	48	42	34	37	62
60%	38	46	93	108	88	71	58	46	40	31	35	50
70%	36	43	84	97	83	59	49	43	38	29	33	46
80%	34	39	71	87	76	52	41	40	36	27	31	44
90%	32	37	52	74	56	43	32	26	33	26	29	39
Long Term												
Full Simulation Period[a]	65	66	93	120	96	75	62	48	43	39	44	60
Water Year Types[b]												
Wet (32%)	55	56	78	91	72	55	41	34	40	37	31	40
Above Normal (15%)	71	75	103	135	106	74	56	44	42	34	31	47
Below Normal (17%)	65	64	94	130	97	79	69	49	40	30	40	76
Dry (22%)	66	69	99	130	107	93	82	59	42	35	56	69
Critical (15%)	79	78	108	142	118	91	75	67	59	61	69	84

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	5	-2	10	28	10	4	-4	-17	-17	1	0	2
20%	2	5	5	21	10	3	-2	-18	-10	0	-4	2
30%	2	1	4	26	5	2	-2	-18	-11	0	-2	-2
40%	1	-1	8	26	-1	2	-1	-19	-11	-1	-2	-2
50%	3	1	24	16	2	1	-1	-13	-12	-1	-1	-6
60%	-17	-6	35	15	1	1	3	-11	-12	-1	0	-12
70%	-15	-6	38	10	-1	-3	4	-9	-11	-1	-1	-14
80%	-11	-8	31	9	3	3	5	-3	-10	-2	0	-7
90%	-9	-7	18	2	0	1	8	6	-9	-1	0	-7
Long Term												
Full Simulation Period[a]	-4	-2	17	16	3	2	0	-11	-11	0	-1	-4
Water Year Types[b]												
Wet (32%)	-6	-3	14	5	0	1	3	-4	-5	0	-1	-17
Above Normal (15%)	-4	2	27	30	5	2	-1	-12	-11	-1	0	-1
Below Normal (17%)	-5	-4	14	17	0	2	4	-14	-13	-1	-1	5
Dry (22%)	-4	-2	17	24	5	3	0	-16	-15	0	-2	0
Critical (15%)	1	-4	16	13	6	1	-9	-16	-14	0	1	2

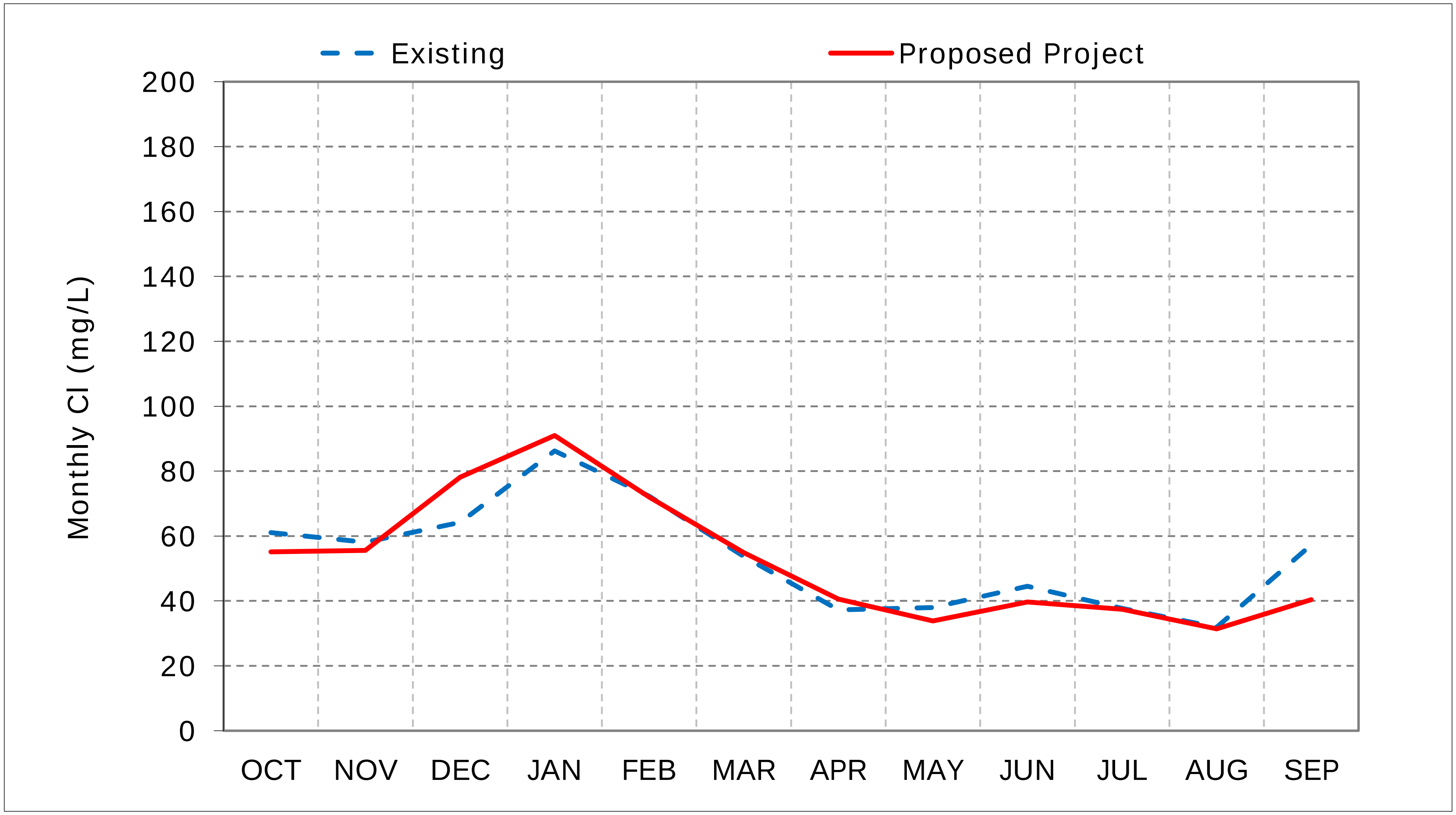
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 8-1. Victoria Canal Chloride, Long-Term Average Cl



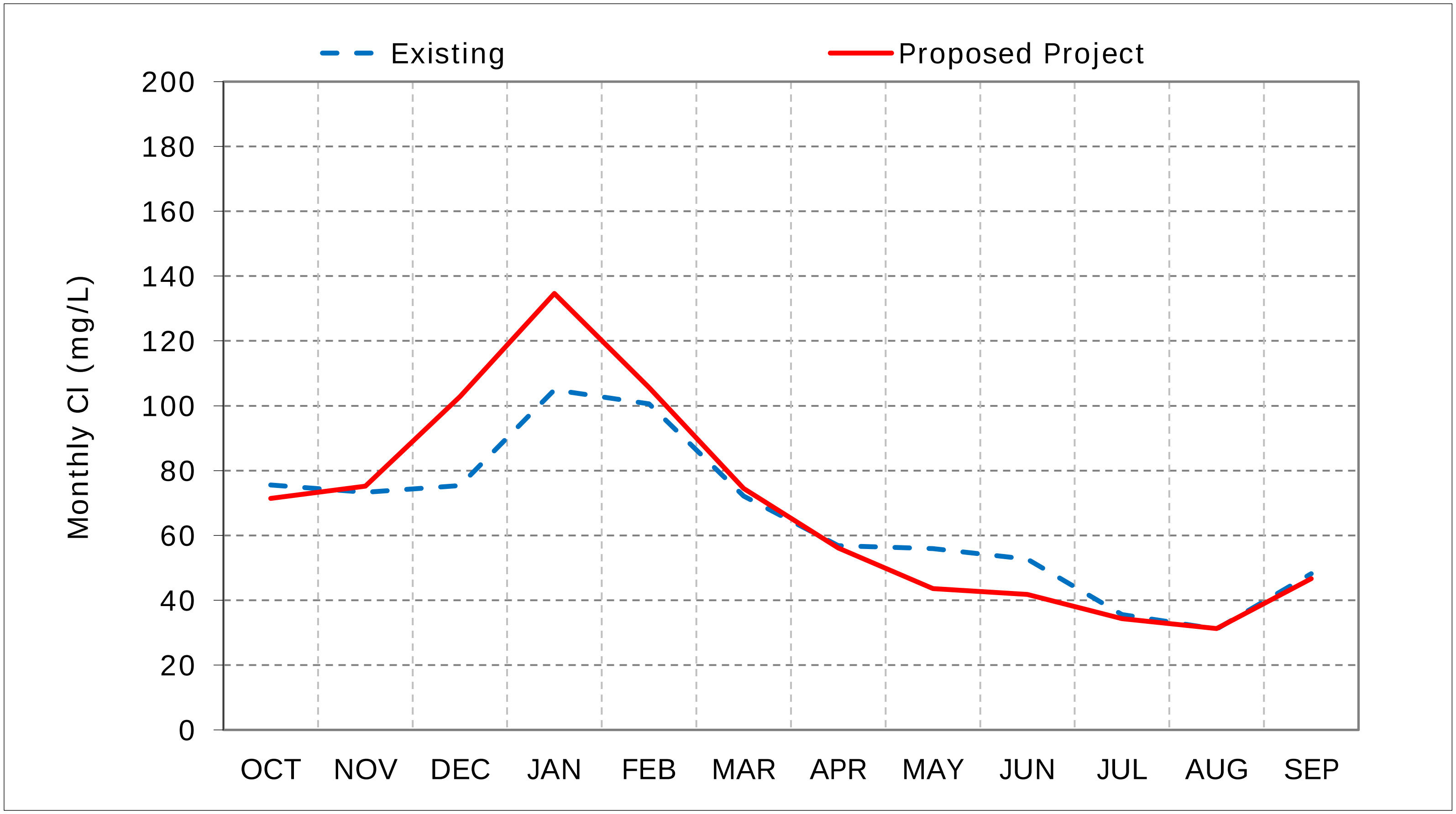
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 8-2. Victoria Canal Chloride, Wet Year Average Cl



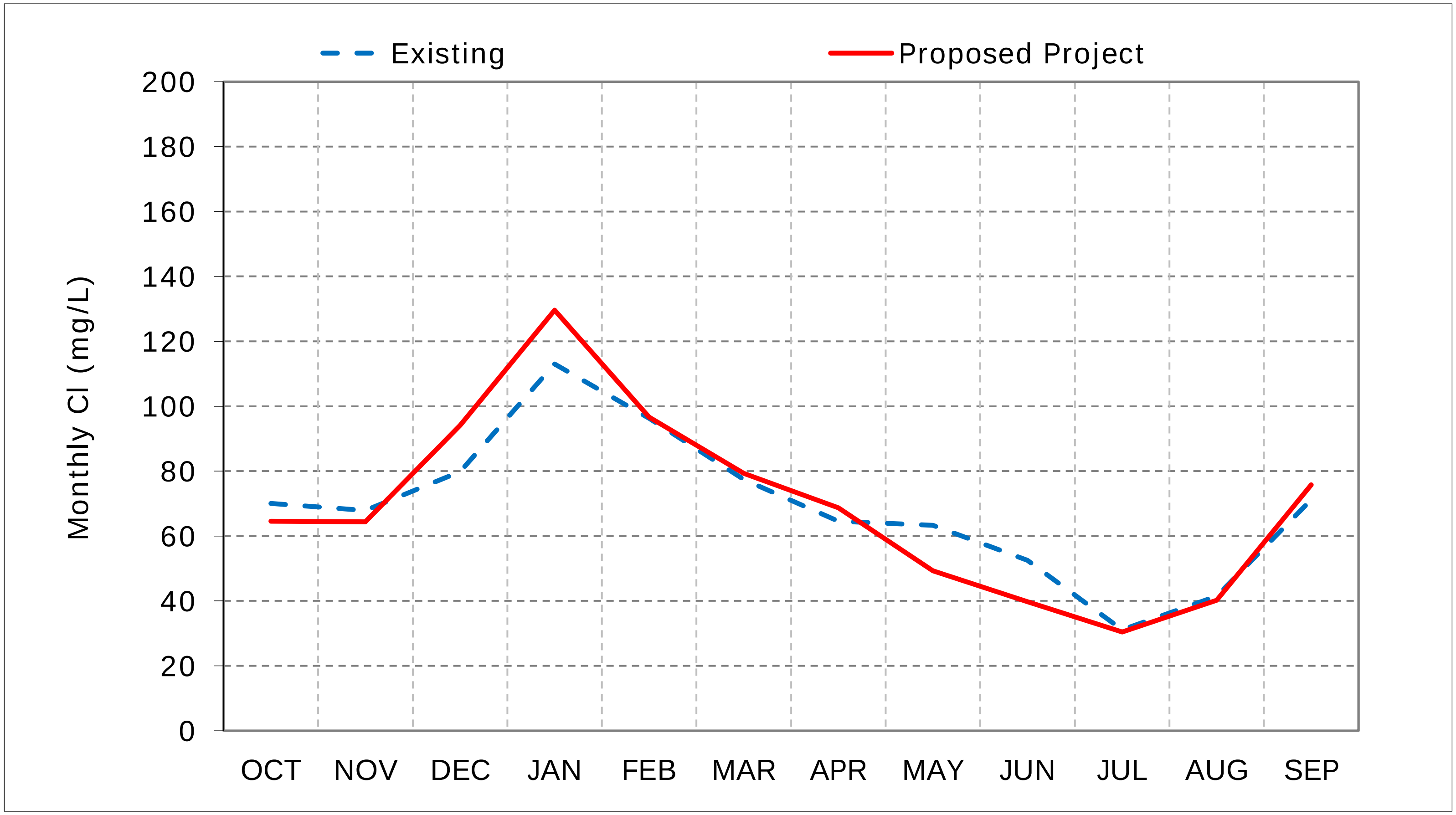
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 8-3. Victoria Canal Chloride, Above Normal Year Average Cl



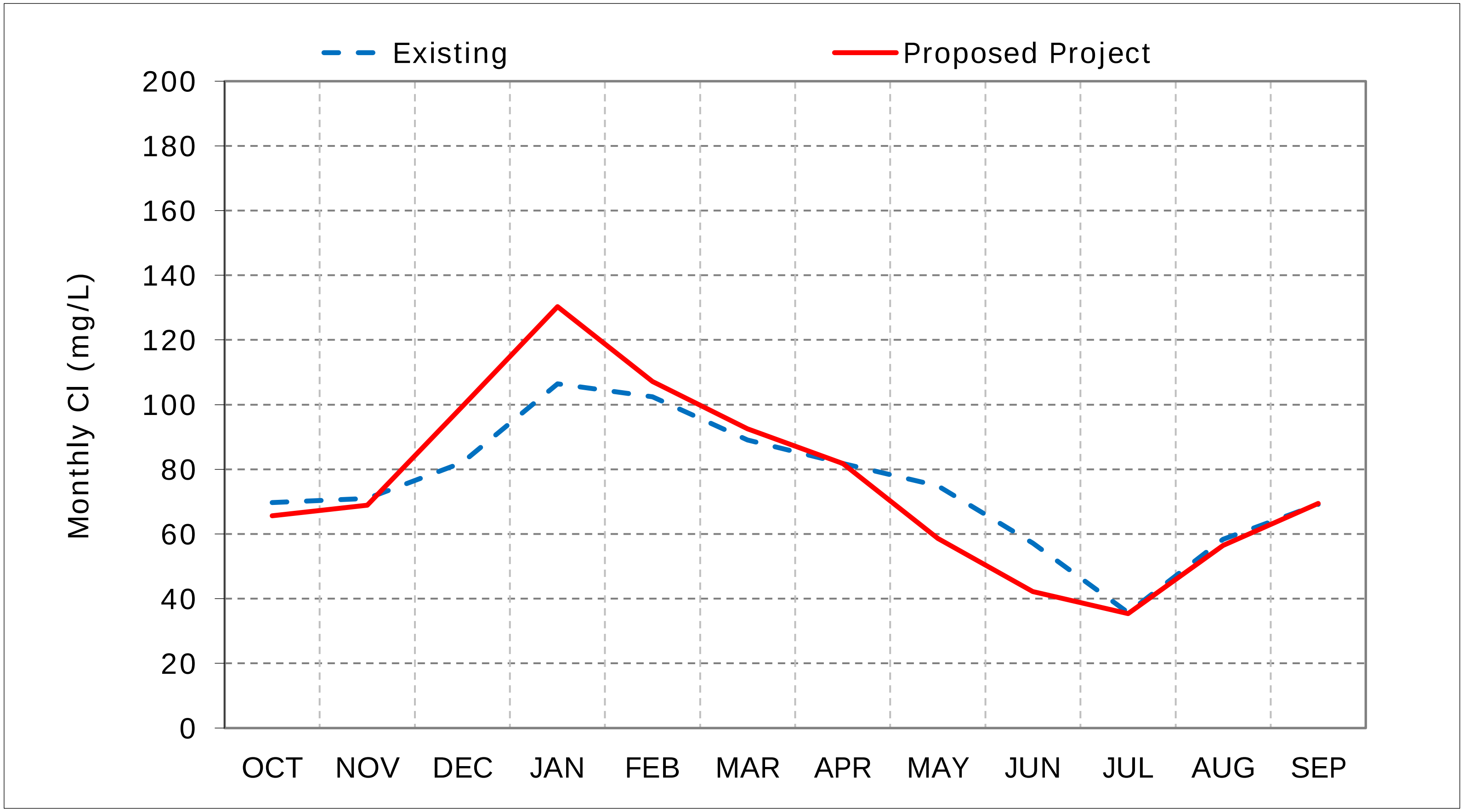
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 8-4. Victoria Canal Chloride, Below Normal Year Average Cl



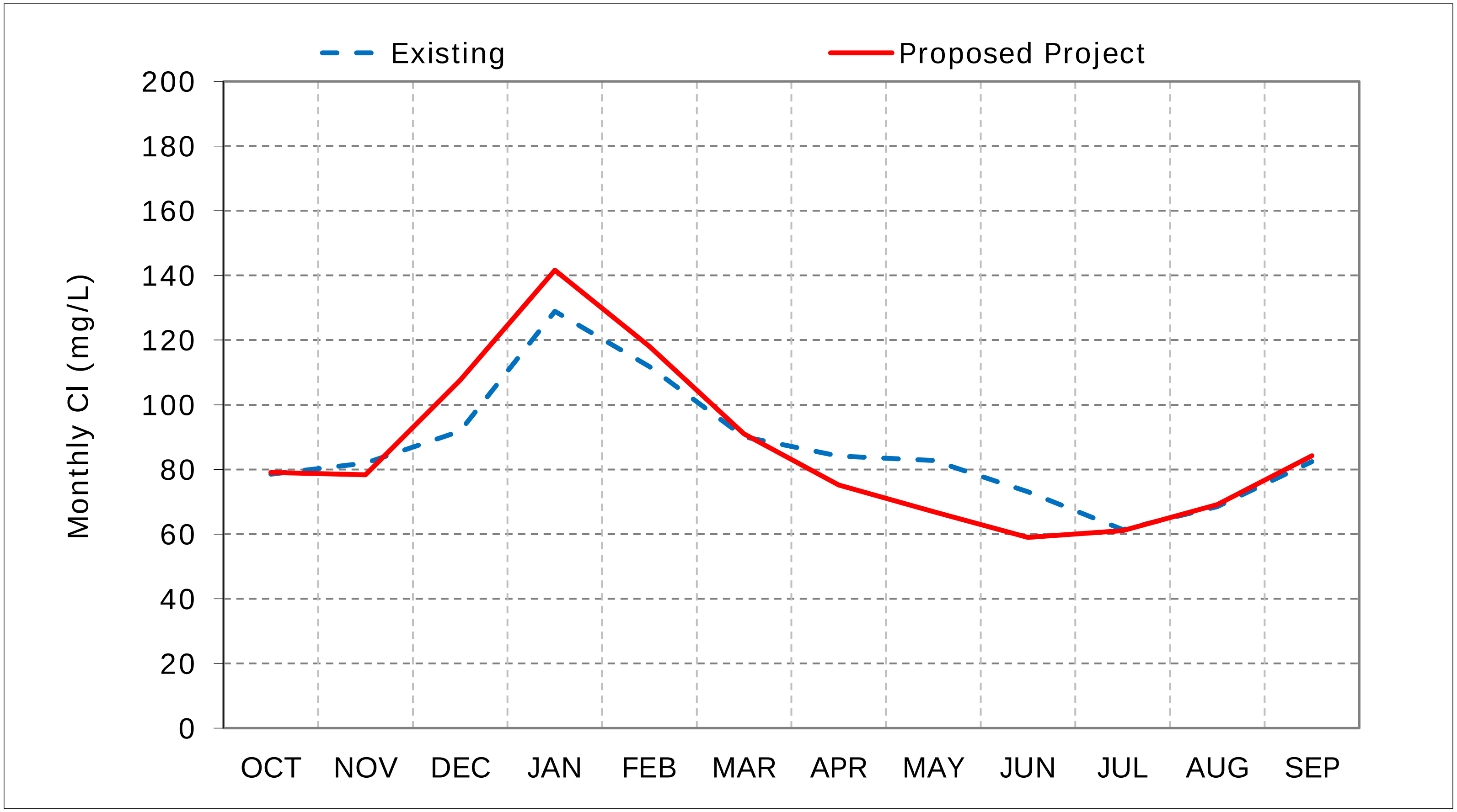
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 8-5. Victoria Canal Chloride, Dry Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 8-6. Victoria Canal Chloride, Critical Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 8-7. Victoria Canal Chloride, January Cl

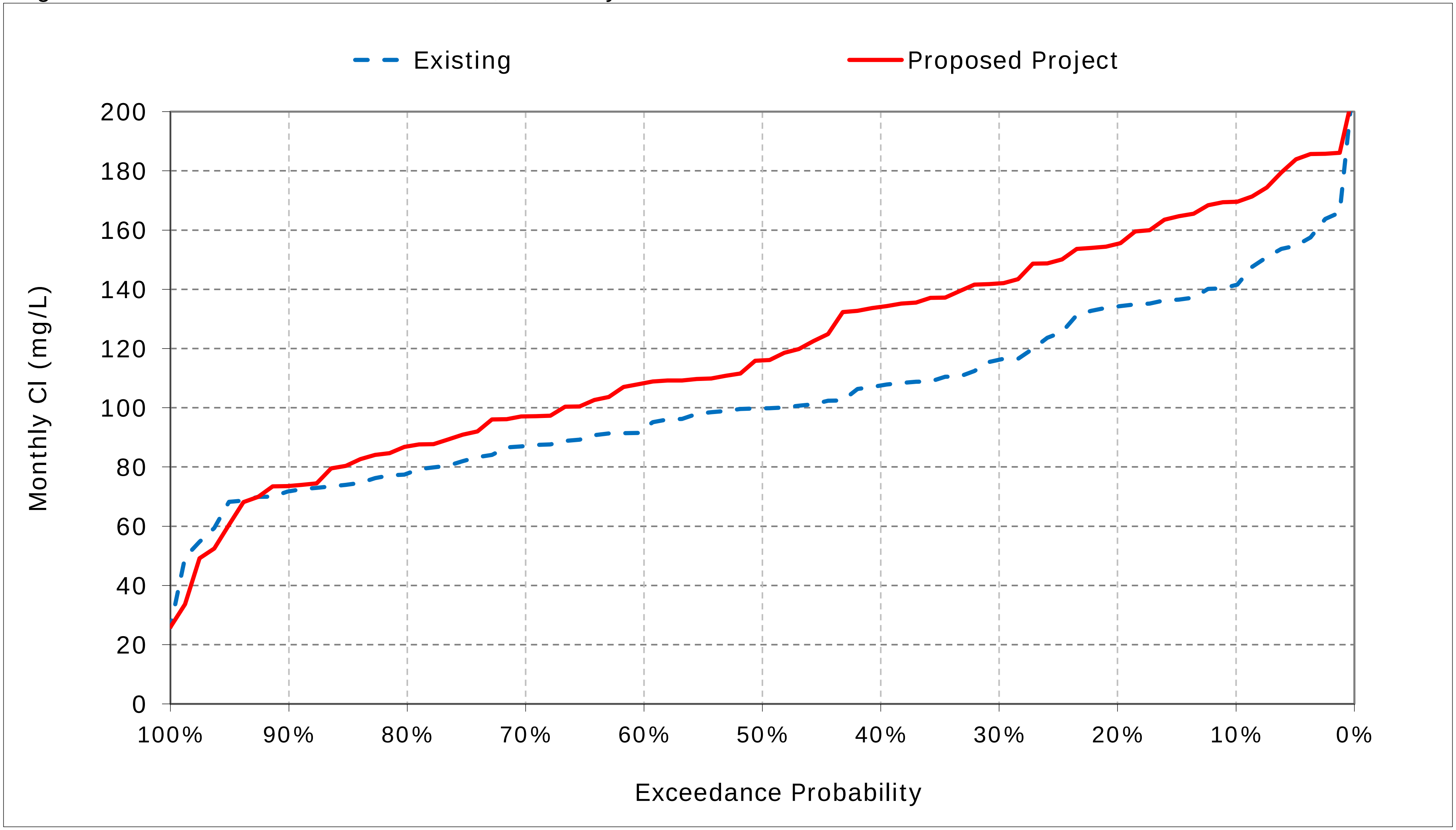


Figure 8-8. Victoria Canal Chloride, February Cl

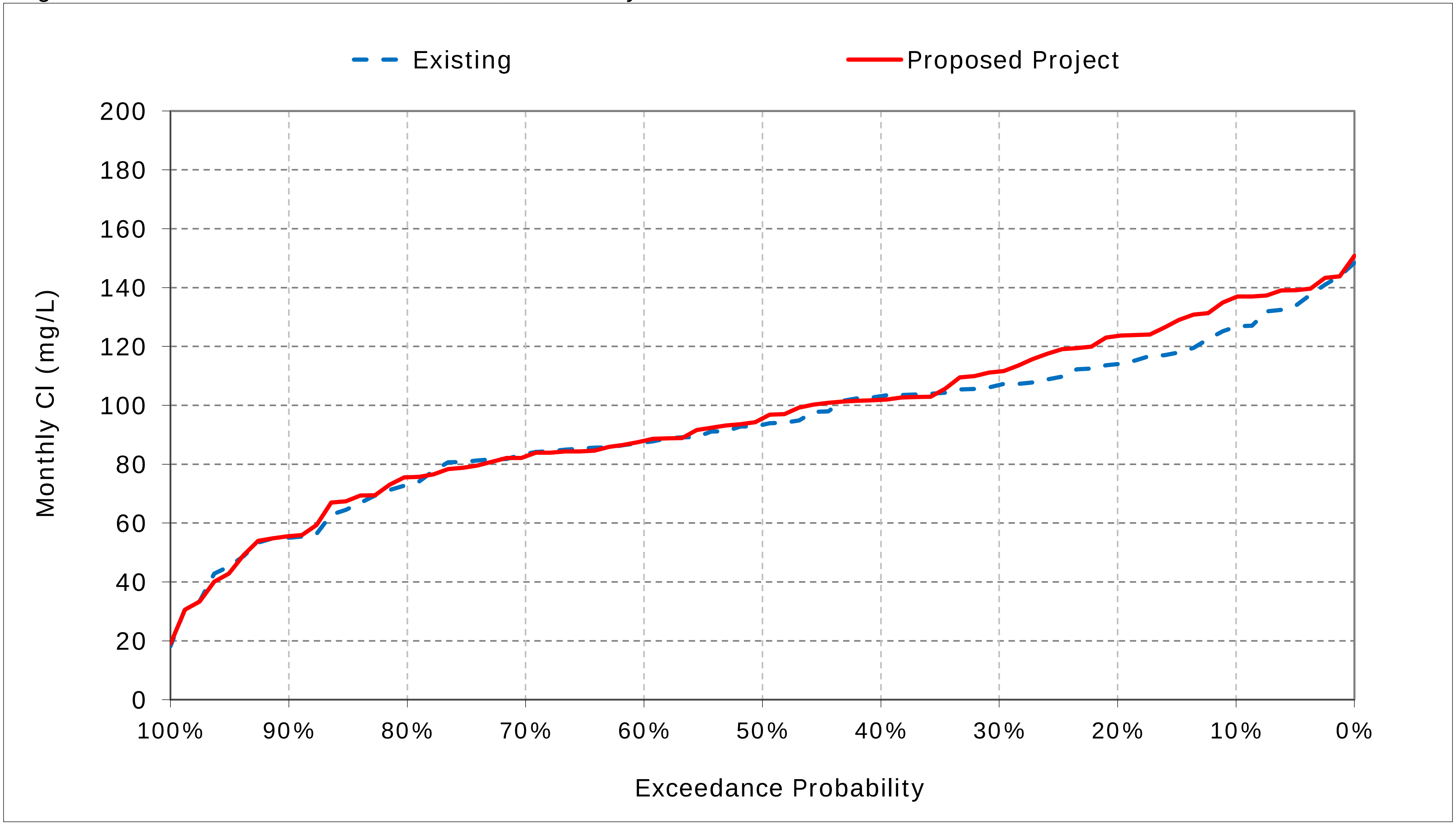


Figure 8-9. Victoria Canal Chloride, March Cl

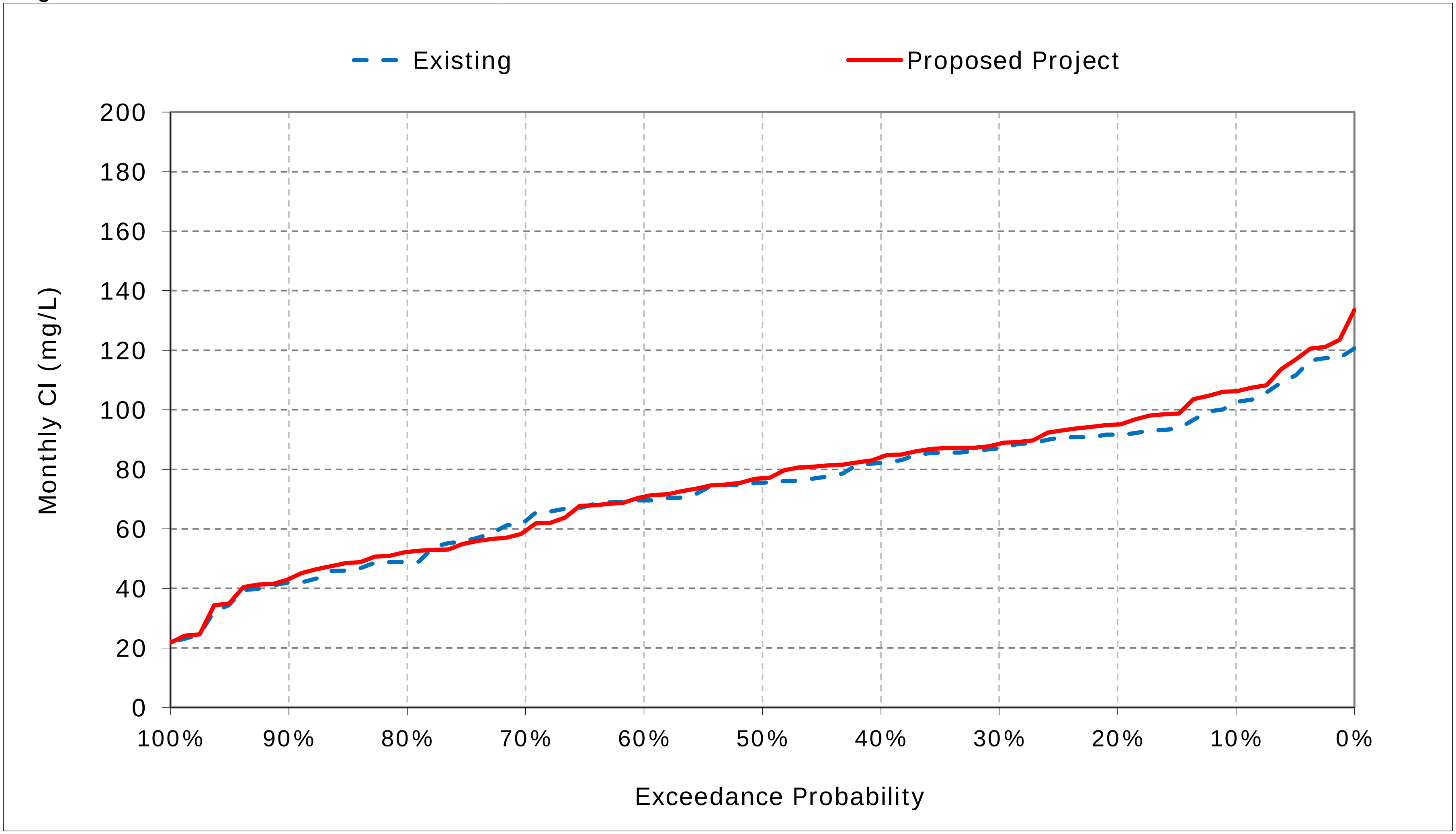


Figure 8-10. Victoria Canal Chloride, April Cl

Figure 8-11. Victoria Canal Chloride, May Cl

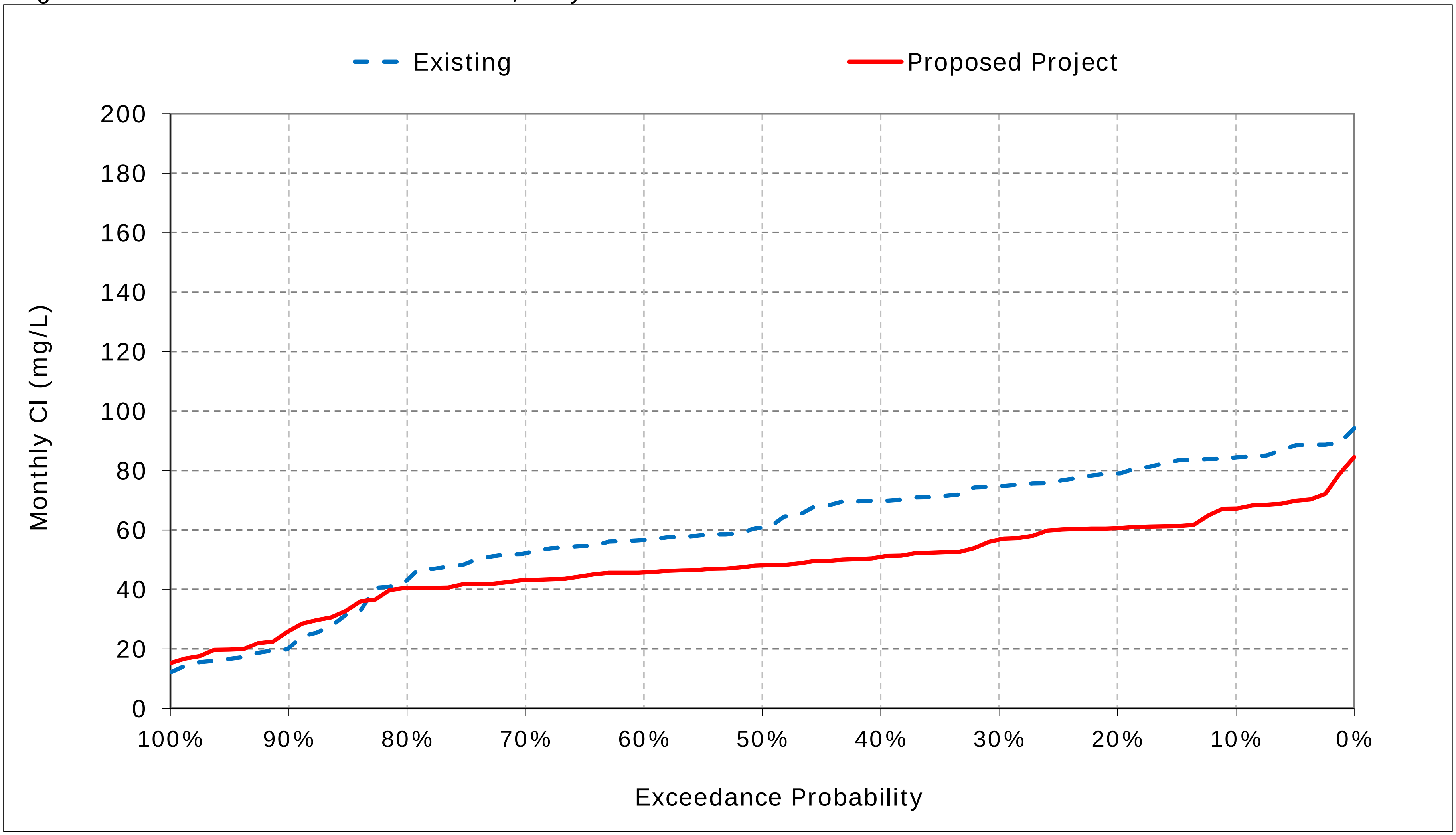


Figure 8-12. Victoria Canal Chloride, June Cl

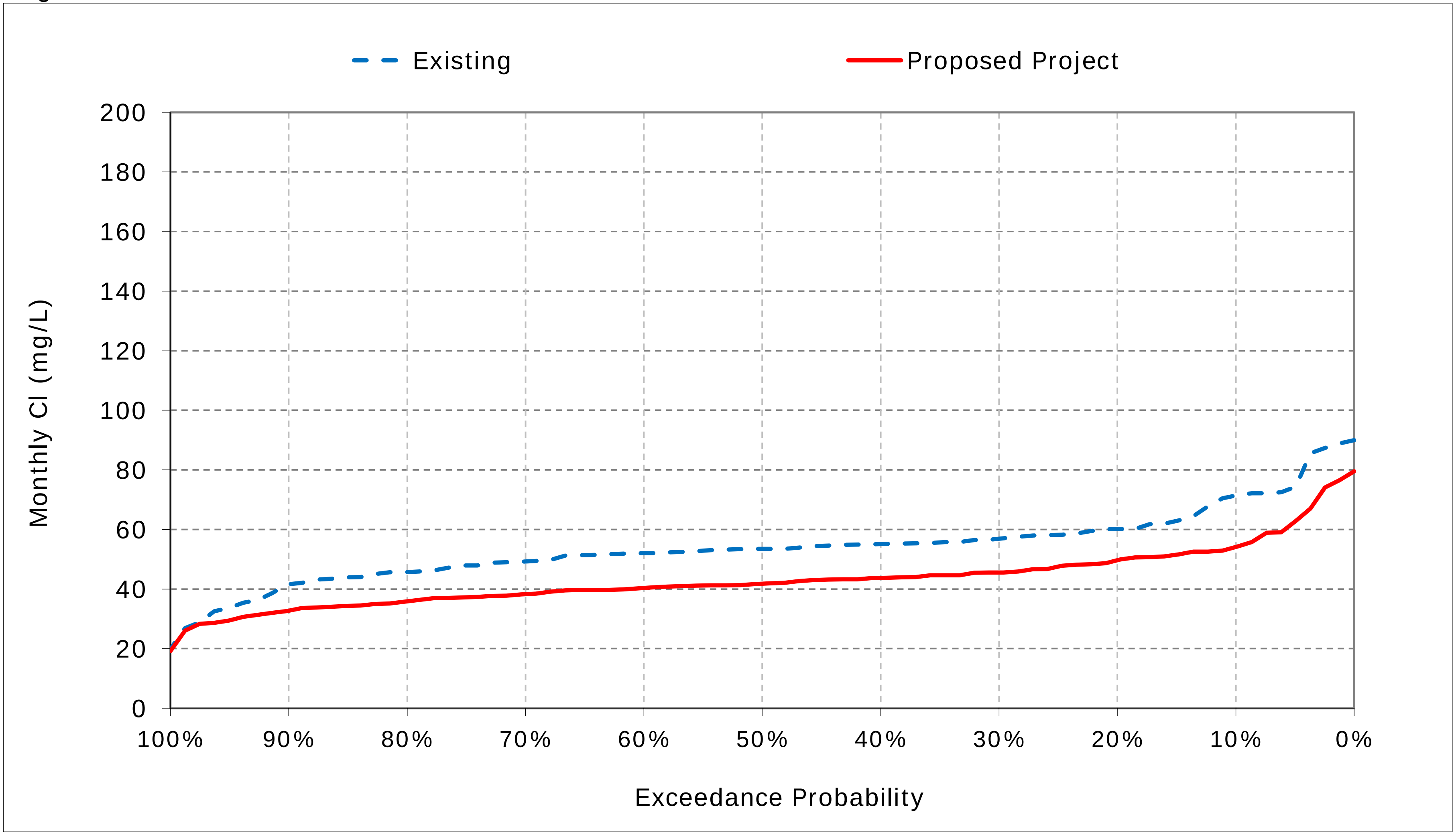


Figure 8-13. Victoria Canal Chloride, July Cl

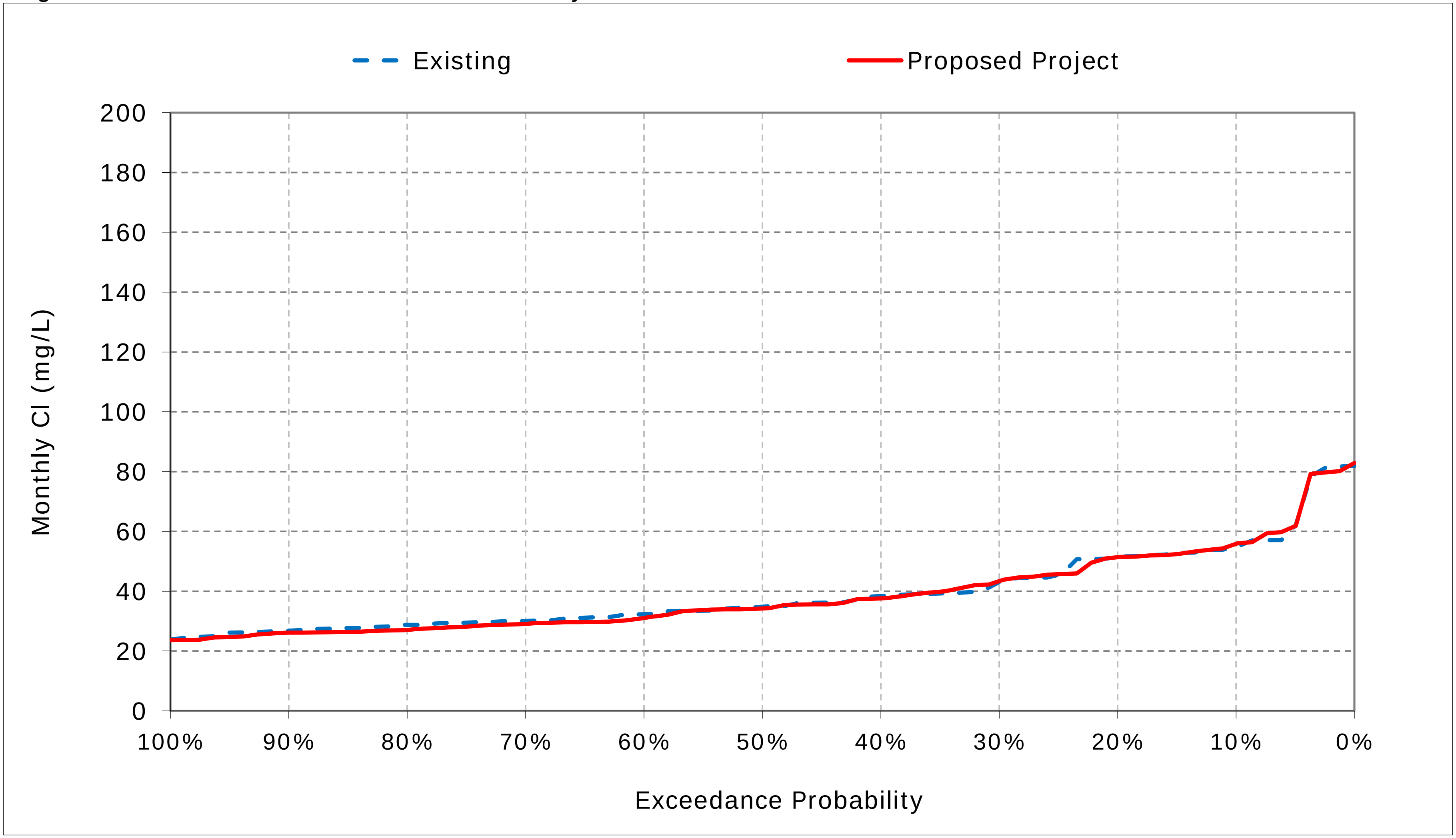


Figure 8-14. Victoria Canal Chloride, August Cl

Figure 8-15. Victoria Canal Chloride, September Cl

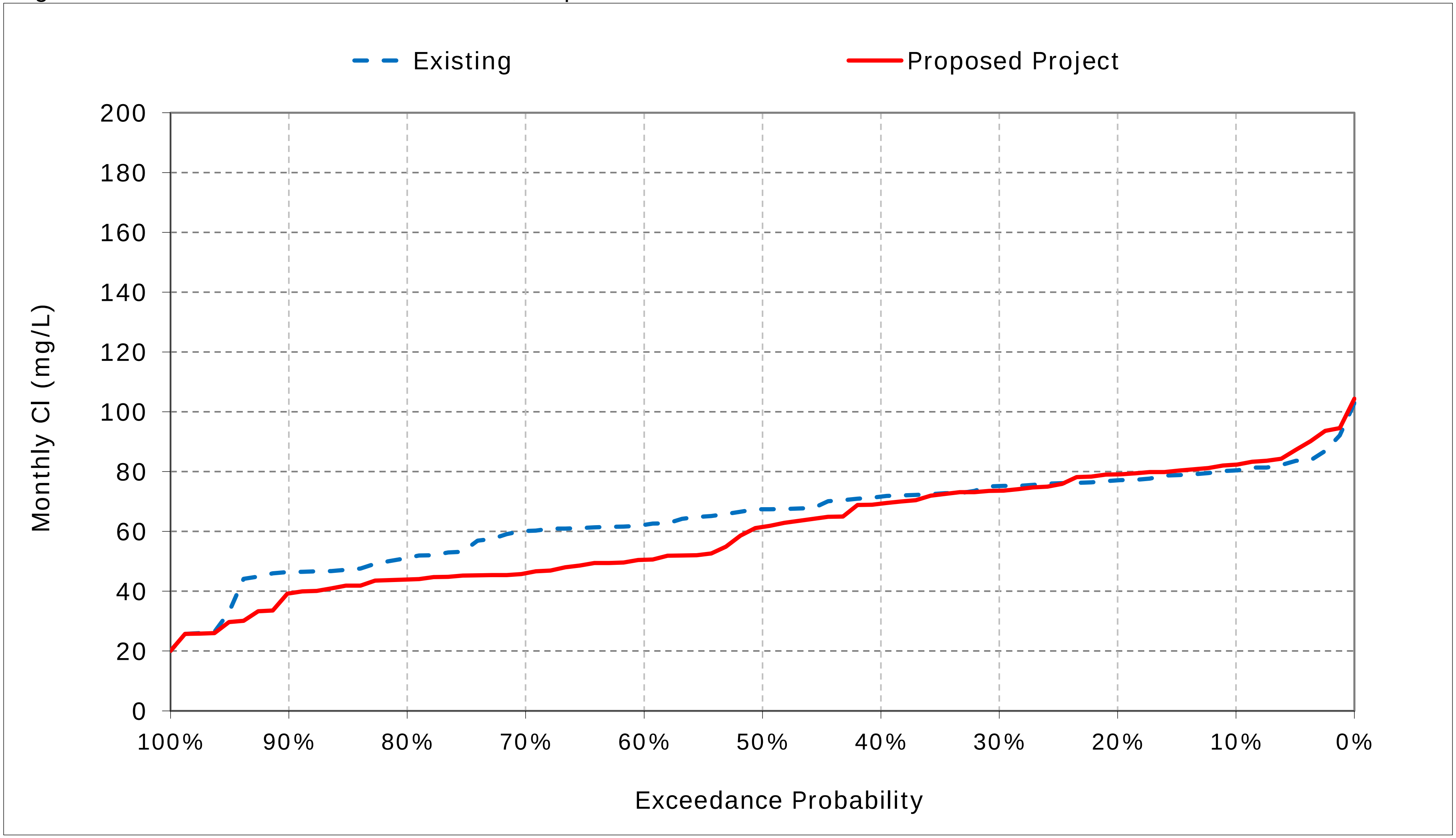


Figure 8-16. Victoria Canal Chloride, October Cl

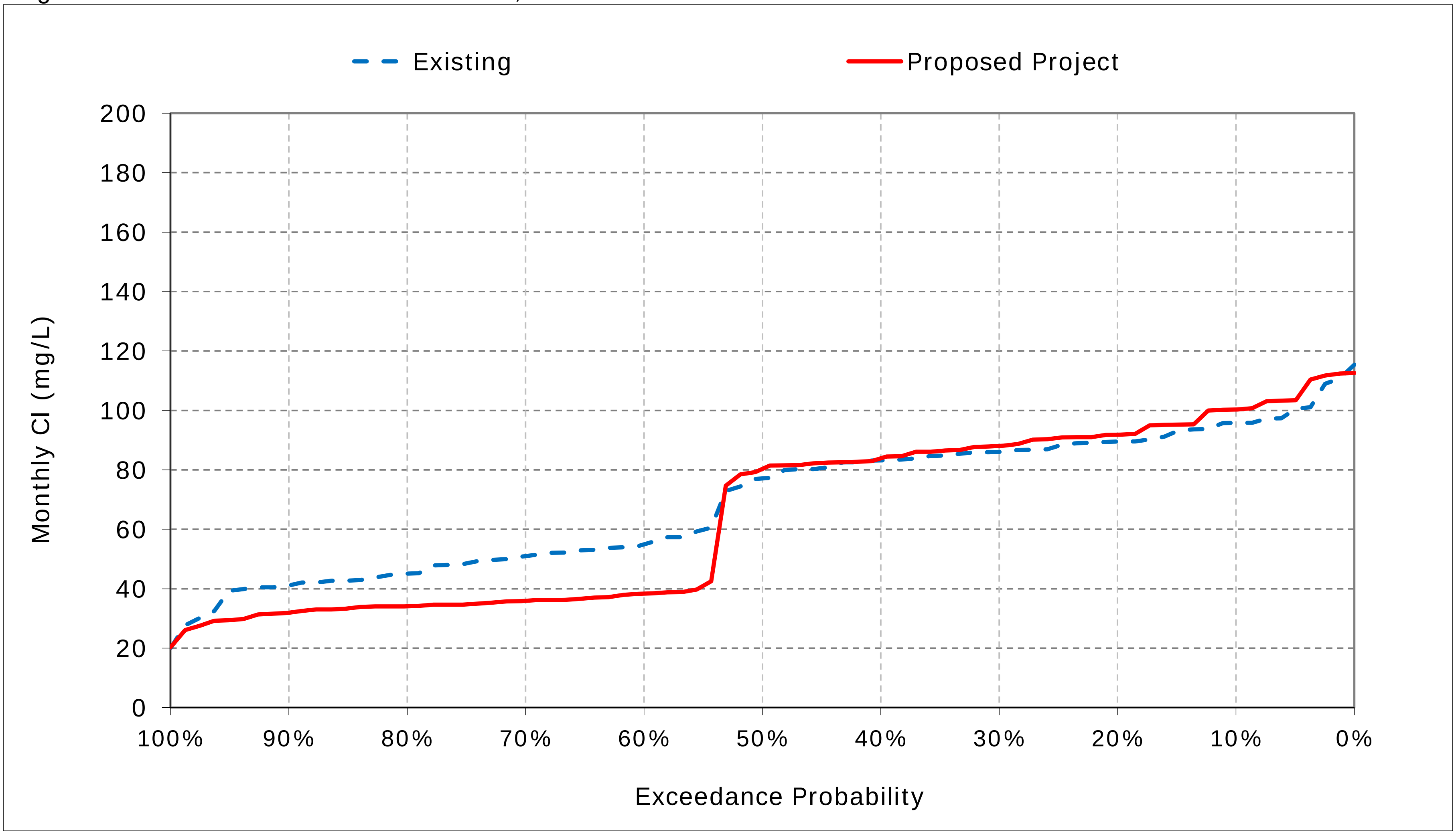


Figure 8-17. Victoria Canal Chloride, November Cl

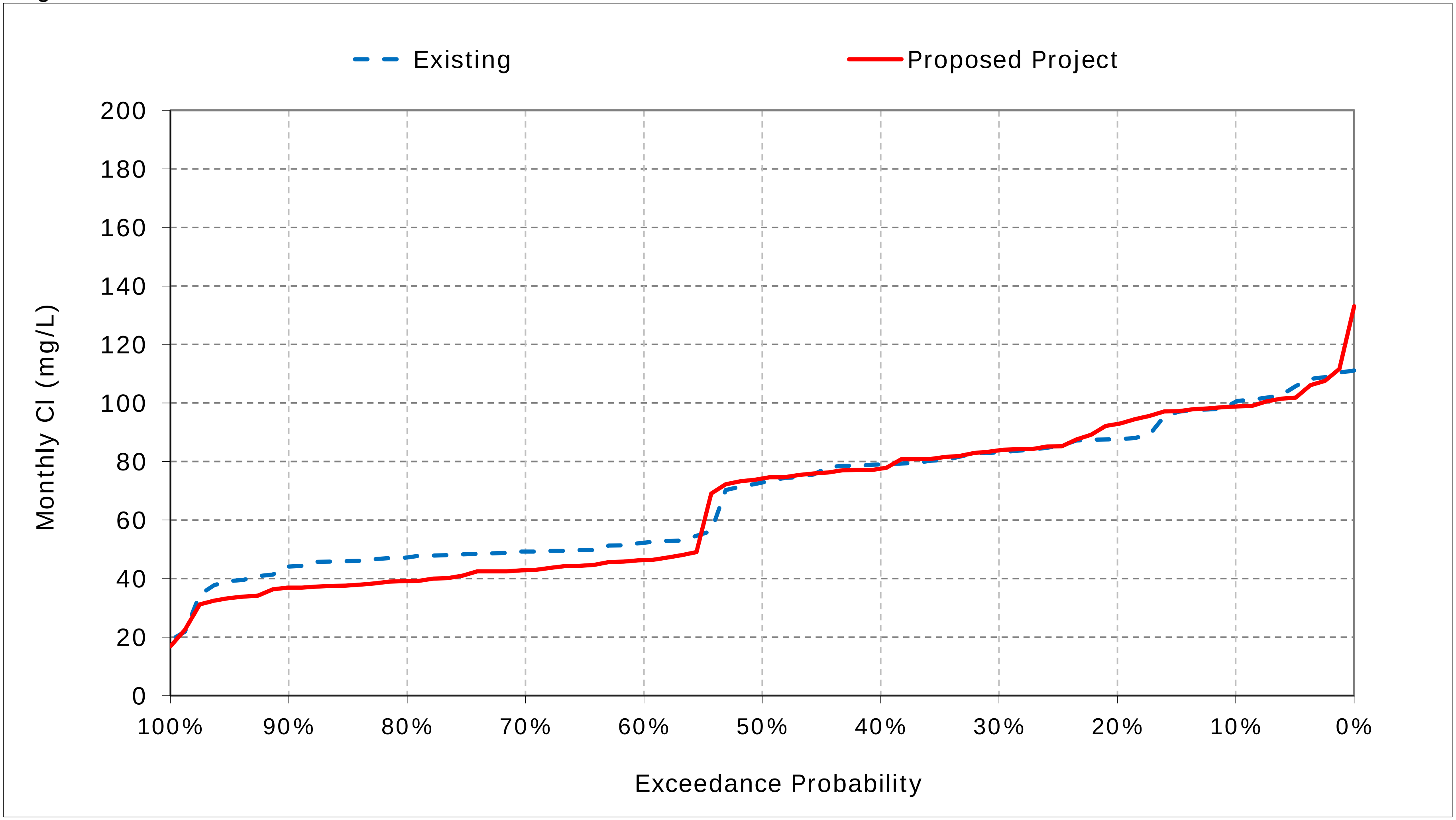


Figure 8-18. Victoria Canal Chloride, December Cl

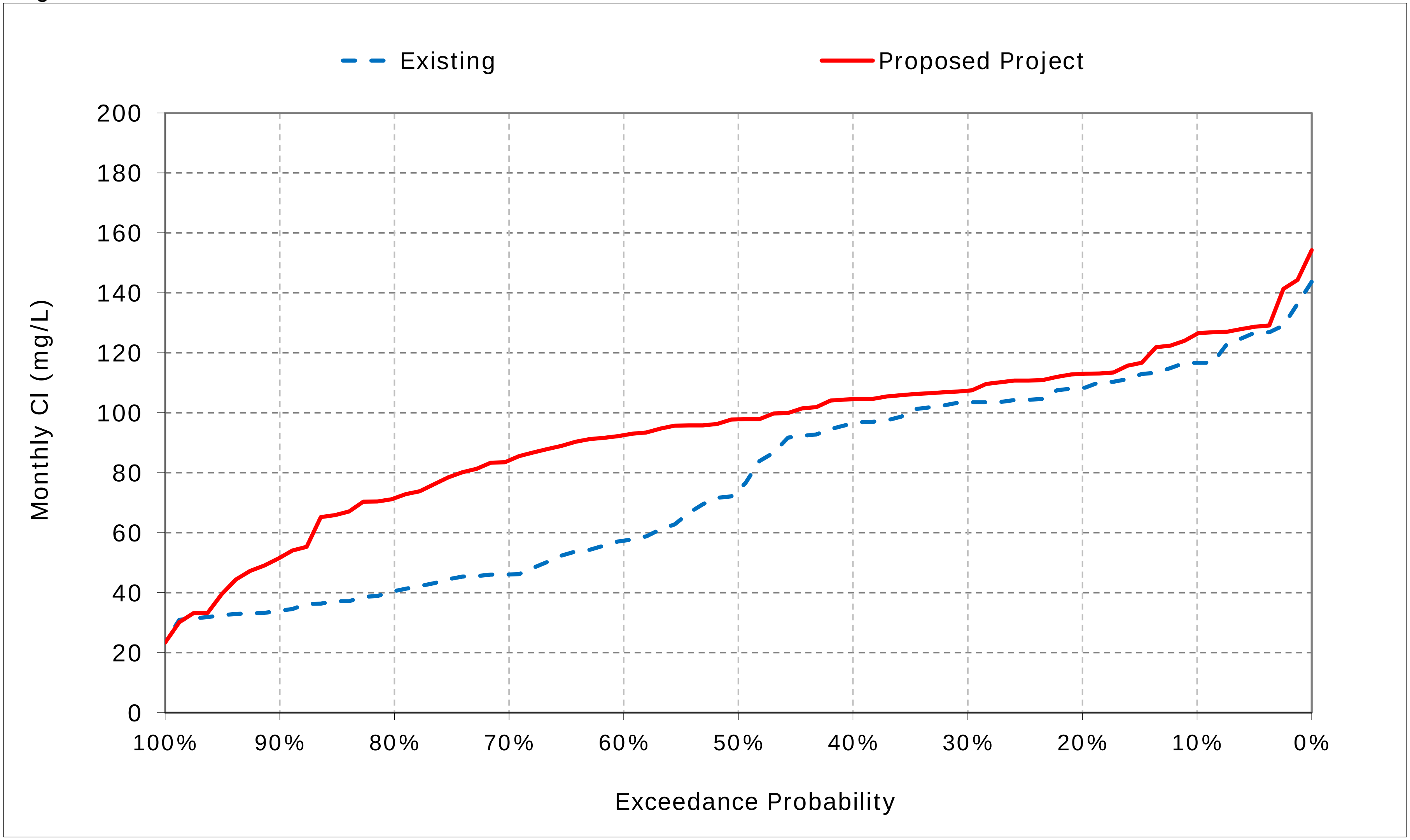


Table 9-1. Contra Costa Pumping Plant #1 Chloride, Monthly Cl

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	198	189	210	187	95	53	52	57	36	88	134	178
20%	187	169	198	149	69	40	47	50	29	56	105	171
30%	180	158	174	124	62	34	42	43	28	46	91	156
40%	171	142	129	99	53	32	38	39	27	36	84	139
50%	153	117	77	81	47	29	36	38	26	29	73	127
60%	29	38	47	70	37	28	32	35	26	26	63	113
70%	27	26	35	47	32	26	31	33	25	25	52	102
80%	27	23	29	39	29	24	28	30	24	23	48	86
90%	25	21	25	29	27	23	25	25	23	21	42	74
Long Term												
Full Simulation Period[a]	110	101	106	98	53	34	37	39	30	44	78	125
Water Year Types[b]												
Wet (32%)	84	72	58	49	45	34	35	33	25	23	47	92
Above Normal (15%)	127	106	104	89	49	33	42	44	26	25	53	79
Below Normal (17%)	115	109	126	118	47	30	40	45	26	38	84	167
Dry (22%)	111	114	126	111	53	29	36	38	28	61	105	146
Critical (15%)	141	131	158	169	81	44	36	40	56	89	125	165

Proposed Project

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	203	190	228	241	101	60	35	30	31	89	134	196
20%	194	177	213	202	89	46	30	27	28	48	100	179
30%	185	158	204	181	66	36	29	26	26	41	92	167
40%	174	150	194	148	58	34	29	24	24	35	82	143
50%	158	129	185	99	50	31	28	24	23	28	73	117
60%	28	101	167	78	41	29	27	23	22	25	61	83
70%	26	77	109	50	36	27	26	22	21	24	50	73
80%	24	62	91	42	31	26	25	22	21	22	46	67
90%	23	42	37	31	28	25	24	21	20	21	35	58
Long Term												
Full Simulation Period[a]	112	121	156	120	59	37	29	25	28	43	77	119
Water Year Types[b]												
Wet (32%)	86	96	99	57	45	36	27	22	22	23	44	59
Above Normal (15%)	130	135	176	126	57	37	29	23	22	24	53	75
Below Normal (17%)	116	127	176	143	49	32	29	24	22	33	83	184
Dry (22%)	112	127	181	148	63	33	28	26	26	59	102	148
Critical (15%)	145	142	200	184	97	49	35	36	57	93	129	172

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	5	1	18	53	7	7	-17	-27	-5	2	0	18
20%	7	8	16	53	20	6	-16	-23	-1	-8	-5	9
30%	5	1	30	57	4	2	-13	-16	-2	-5	1	11
40%	3	9	66	49	5	2	-9	-15	-3	-2	-2	4
50%	5	11	108	18	3	2	-8	-14	-3	0	0	-10
60%	-1	62	120	8	4	1	-5	-12	-3	-1	-2	-29
70%	-2	52	73	2	3	1	-5	-11	-4	-1	-1	-29
80%	-3	39	62	4	1	1	-4	-8	-3	0	-2	-19
90%	-3	20	12	2	0	2	-1	-4	-3	0	-7	-16
Long Term												
Full Simulation Period[a]	2	19	50	23	6	3	-8	-13	-2	-1	-1	-6
Water Year Types[b]												
Wet (32%)	2	24	41	8	0	2	-8	-11	-2	0	-3	-32
Above Normal (15%)	3	29	71	37	7	4	-13	-21	-4	-1	0	-4
Below Normal (17%)	1	18	50	25	2	2	-11	-21	-4	-6	-1	17
Dry (22%)	1	13	55	37	10	3	-7	-13	-2	-3	-4	2
Critical (15%)	4	11	43	15	16	5	-1	-4	1	4	4	7

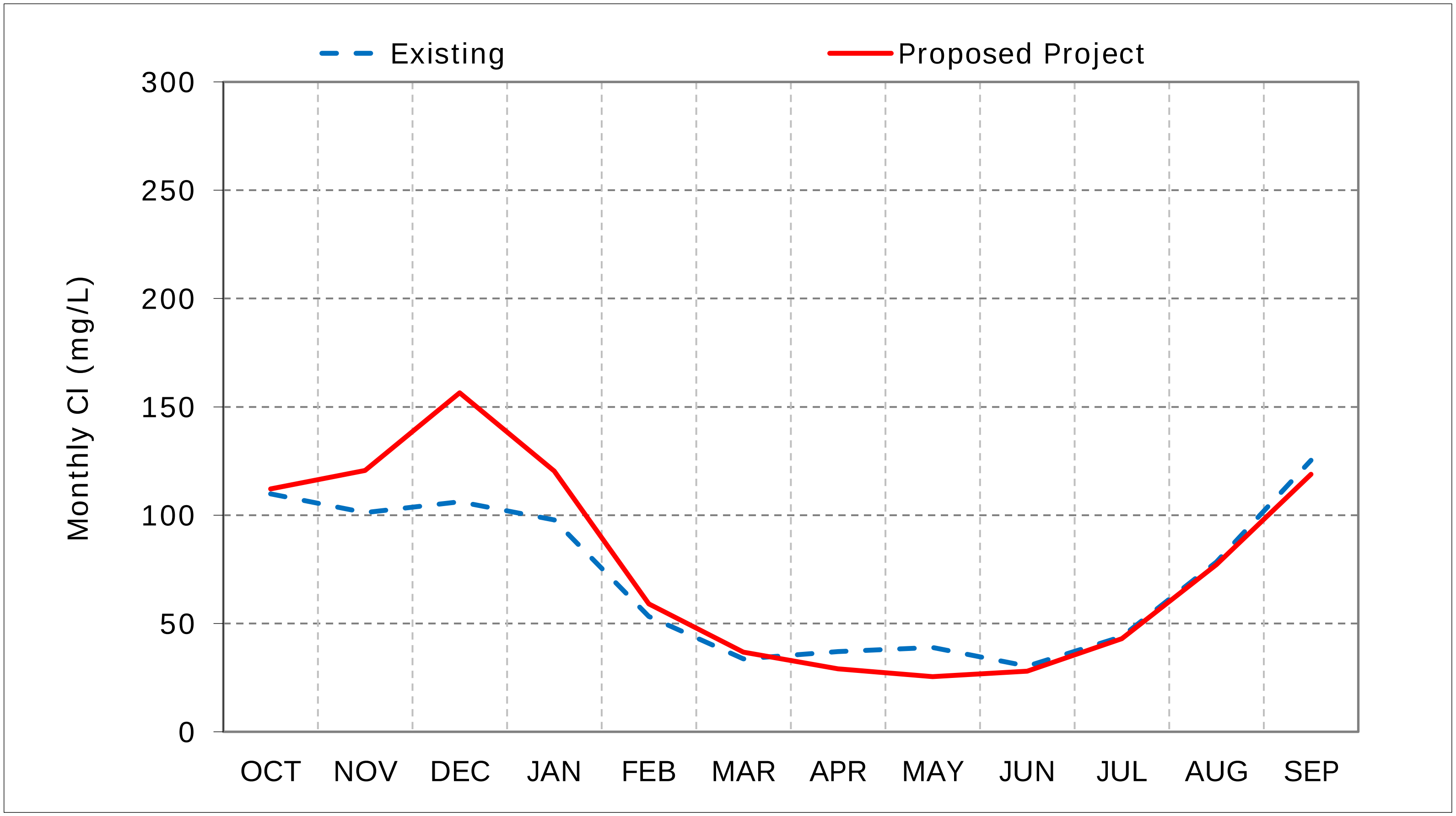
a Based on the 82-year simulation period.

b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

c These results are displayed with water year - year type sorting.

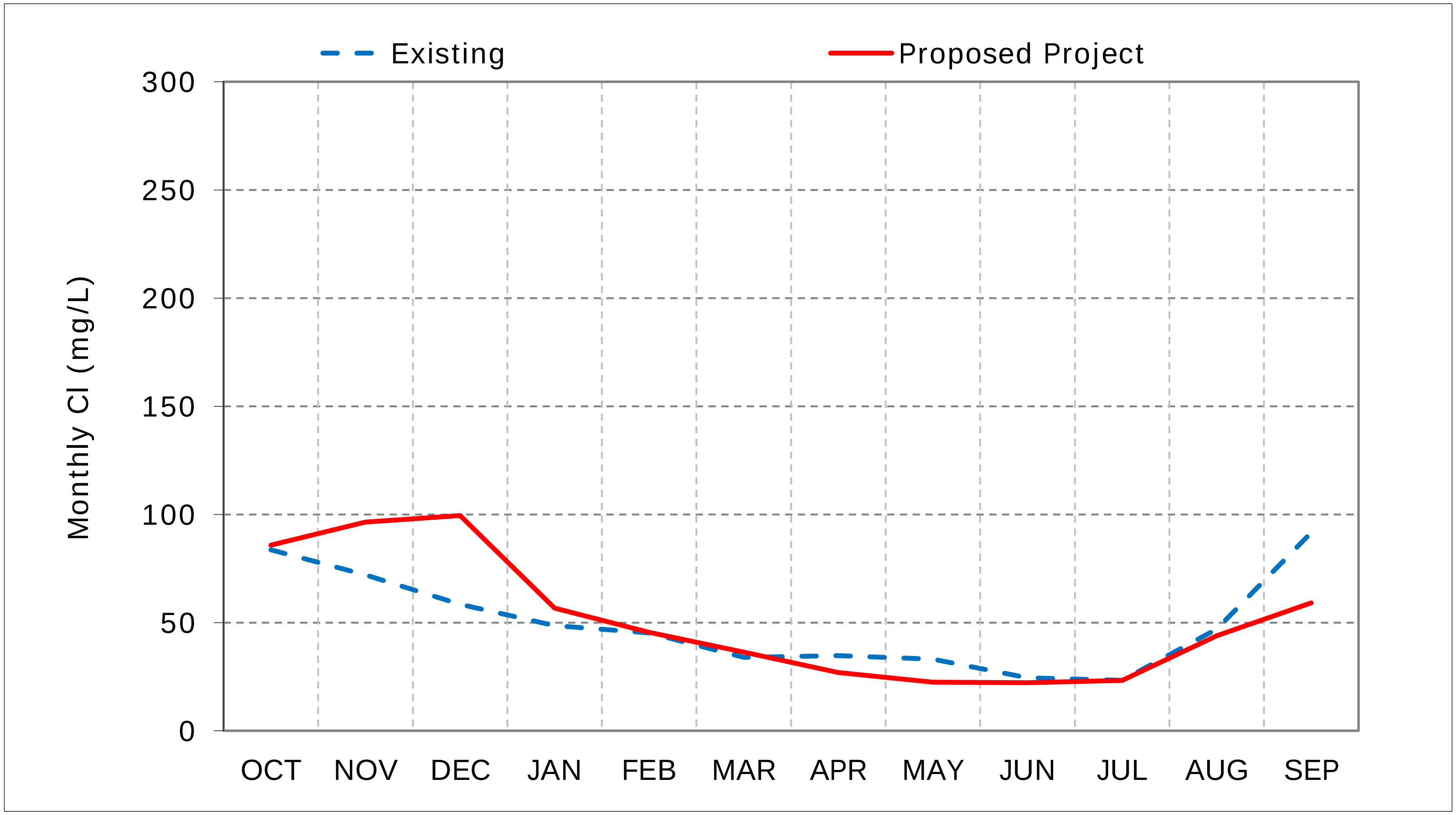
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 9-1. Contra Costa Pumping Plant #1 Chloride, Long-Term Average Cl



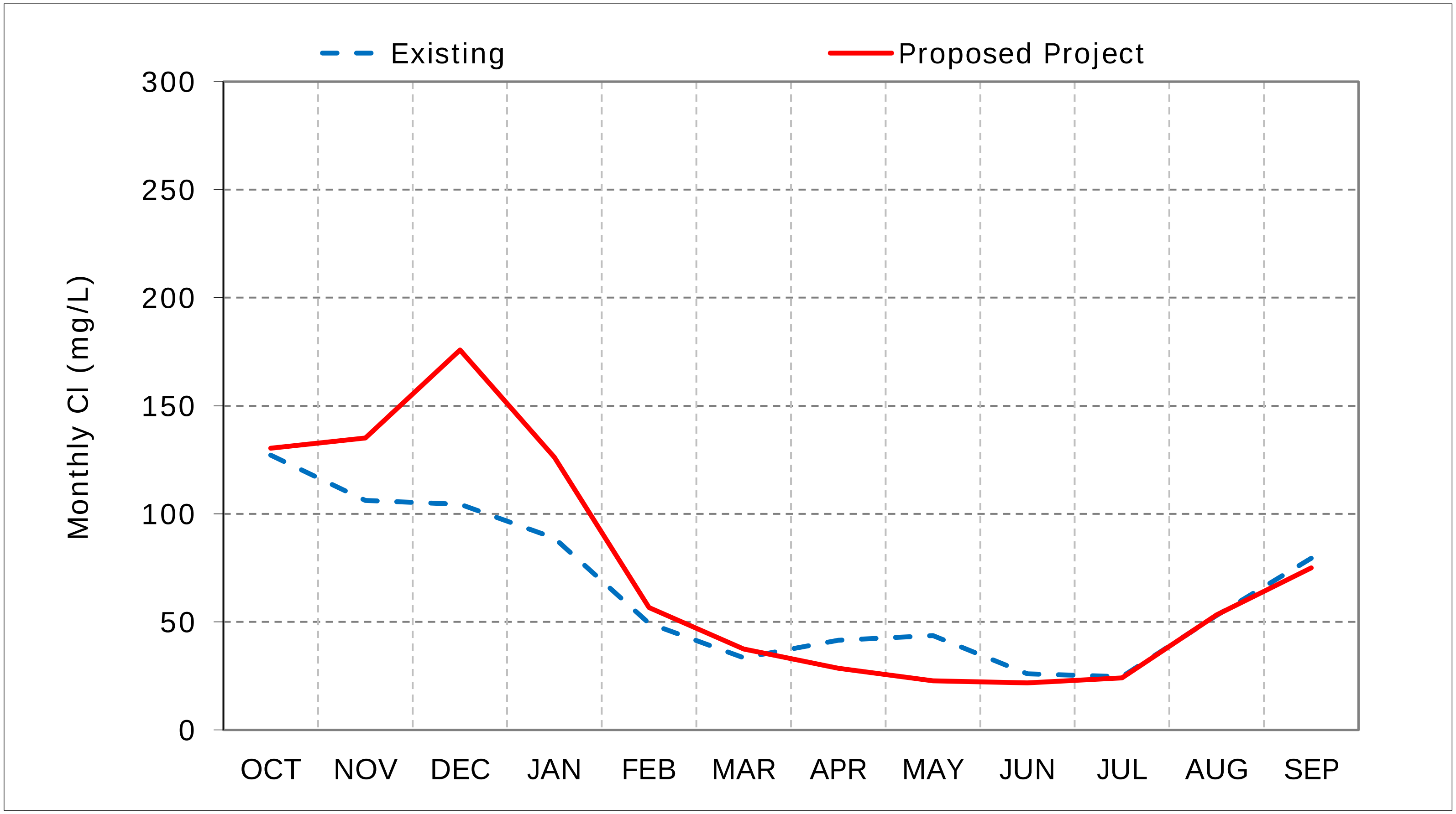
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 9-2. Contra Costa Pumping Plant #1 Chloride, Wet Year Average Cl



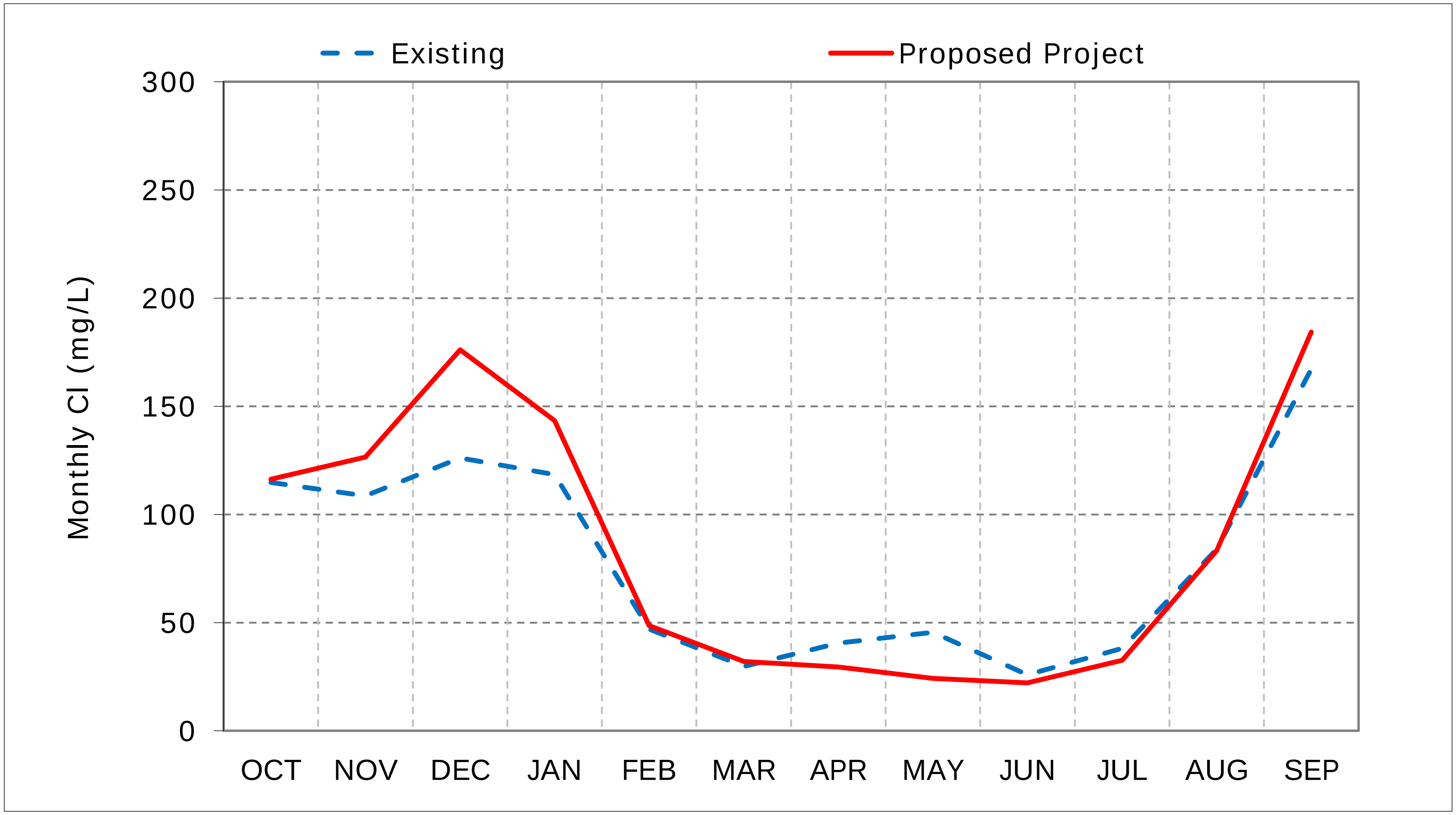
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 9-3. Contra Costa Pumping Plant #1 Chloride, Above Normal Year Average



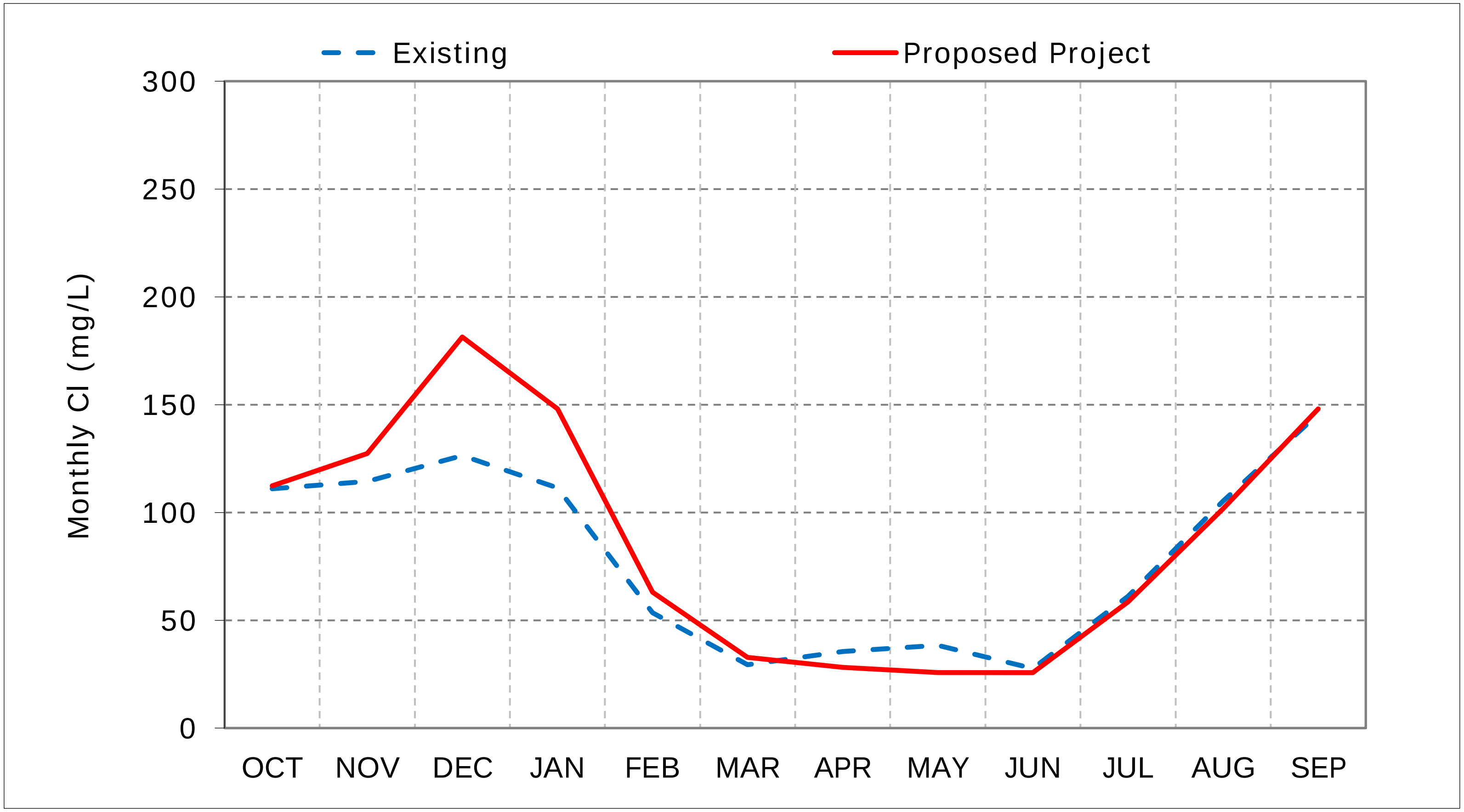
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 9-4. Contra Costa Pumping Plant #1 Chloride, Below Normal Year Average



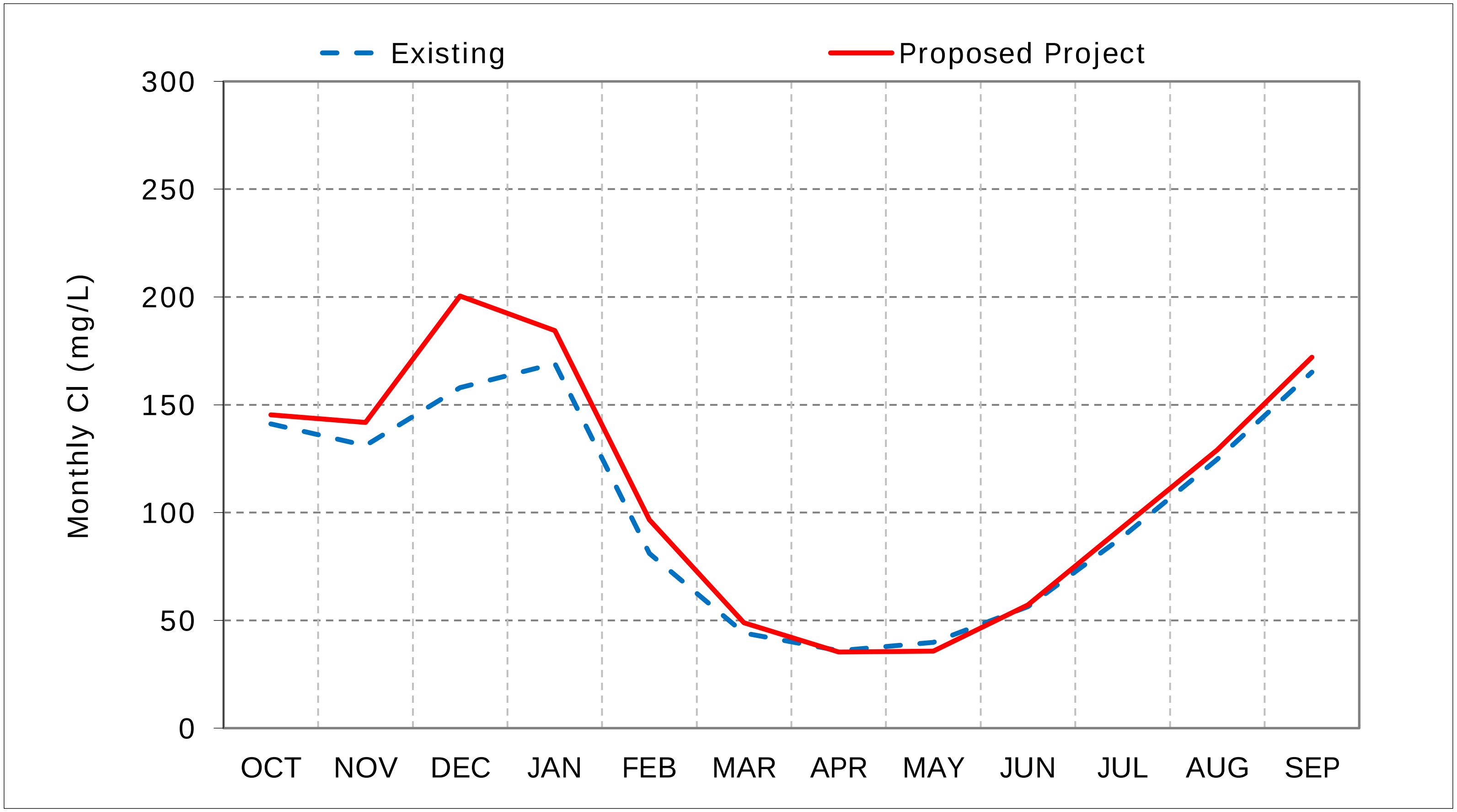
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 9-5. Contra Costa Pumping Plant #1 Chloride, Dry Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 9-6. Contra Costa Pumping Plant #1 Chloride, Critical Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 9-7. Contra Costa Pumping Plant #1 Chloride, January Cl

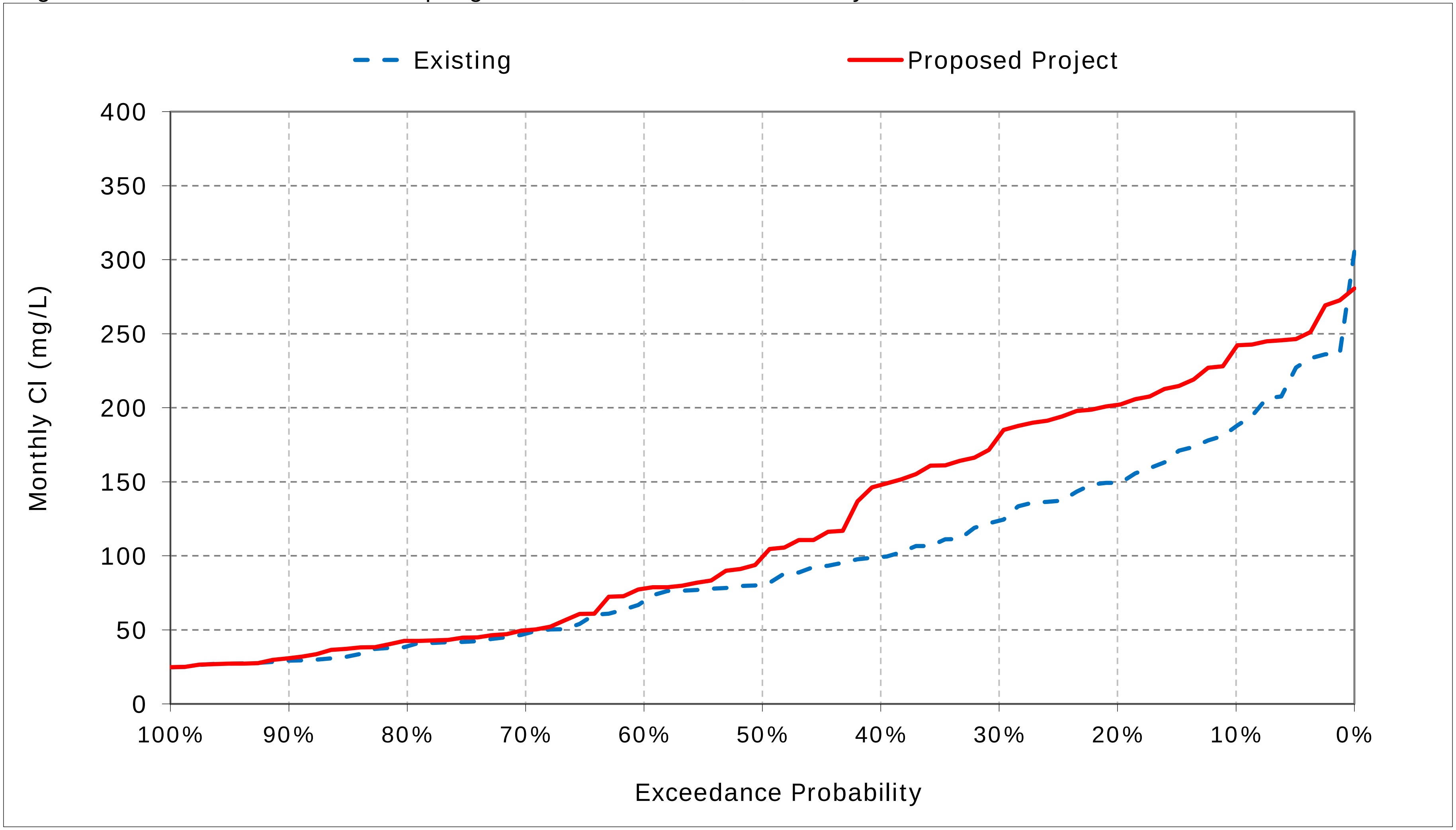


Figure 9-8. Contra Costa Pumping Plant #1 Chloride, February Cl

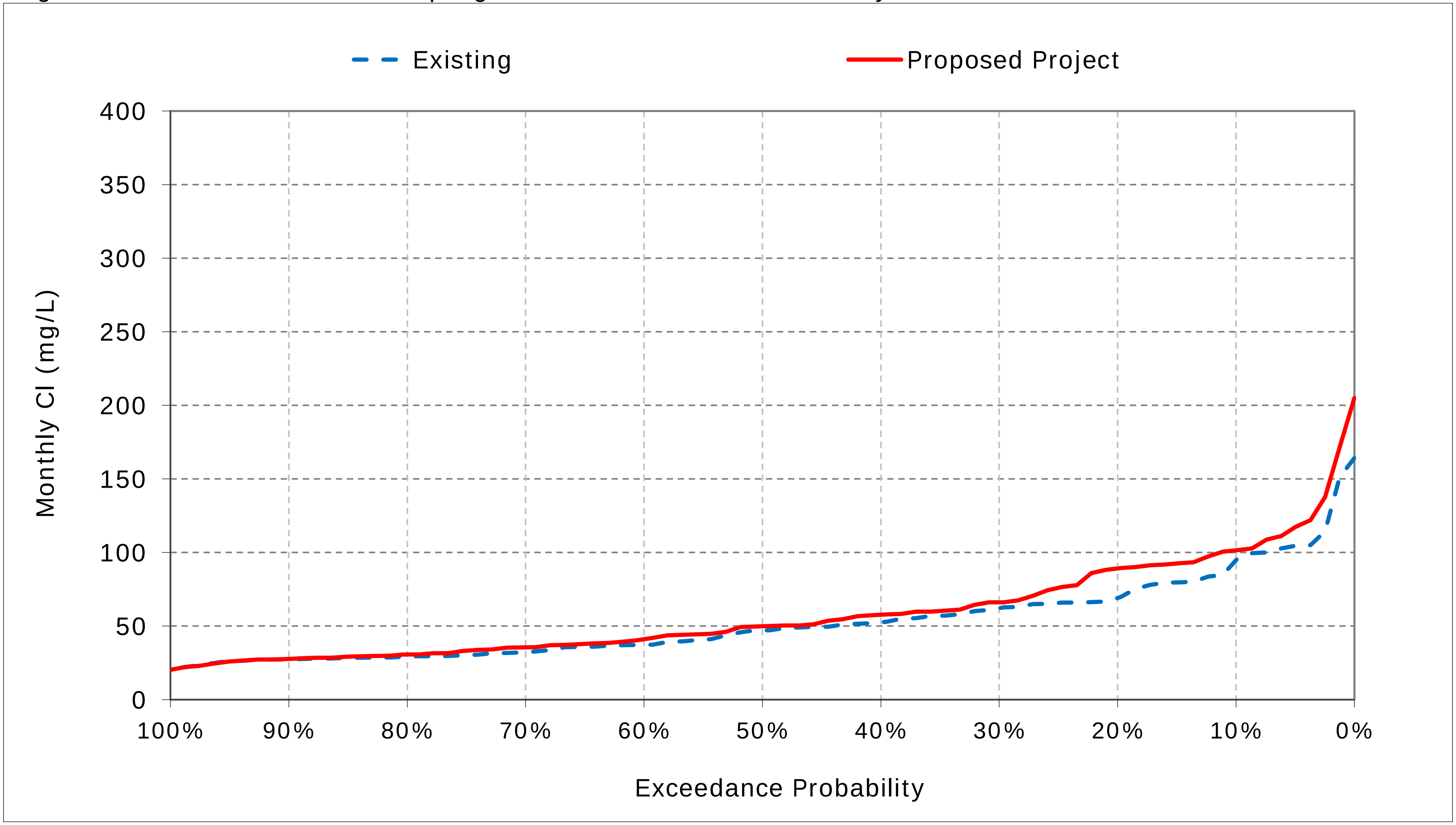


Figure 9-9. Contra Costa Pumping Plant #1 Chloride, March Cl

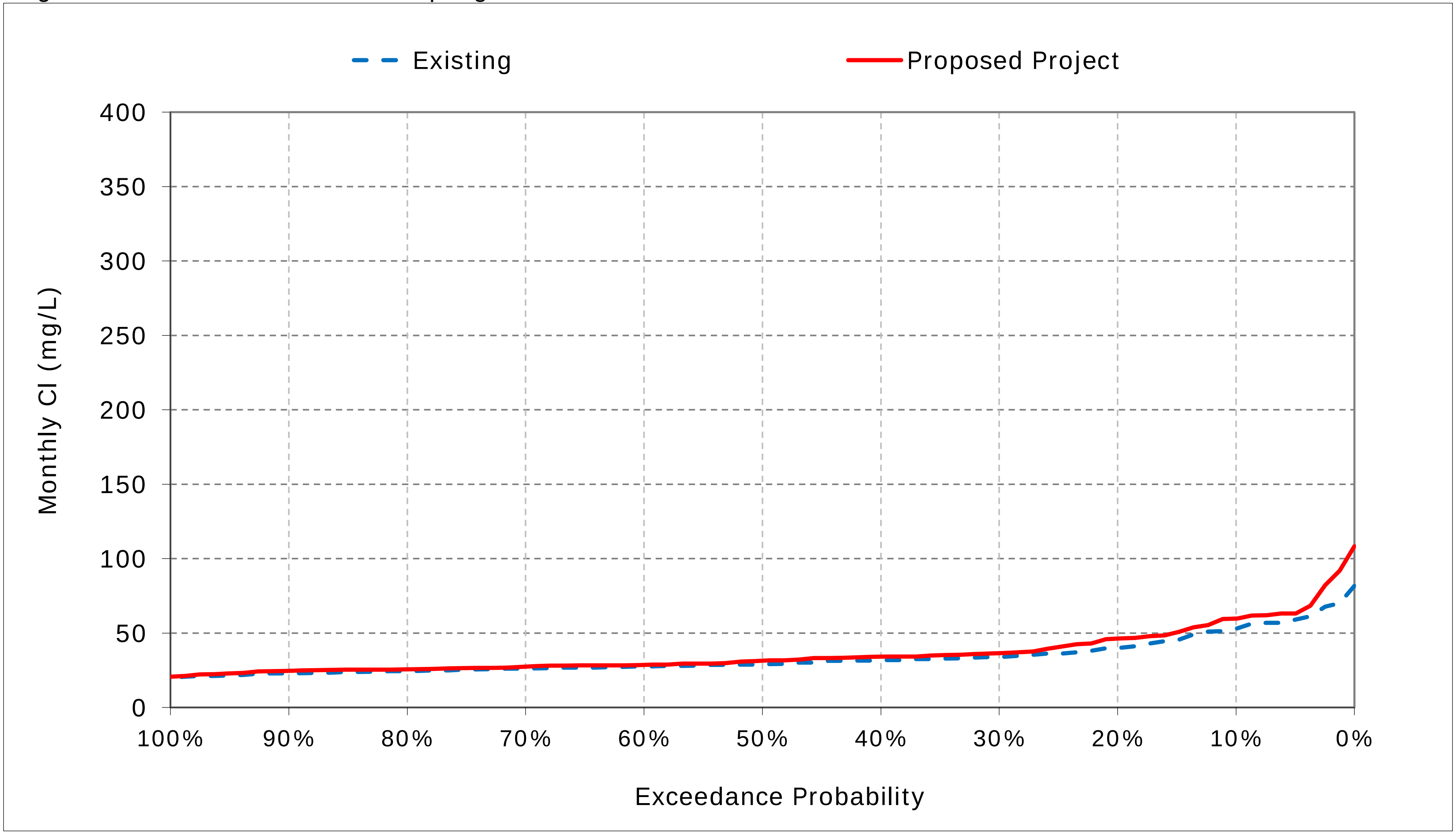


Figure 9-10. Contra Costa Pumping Plant #1 Chloride, April Cl

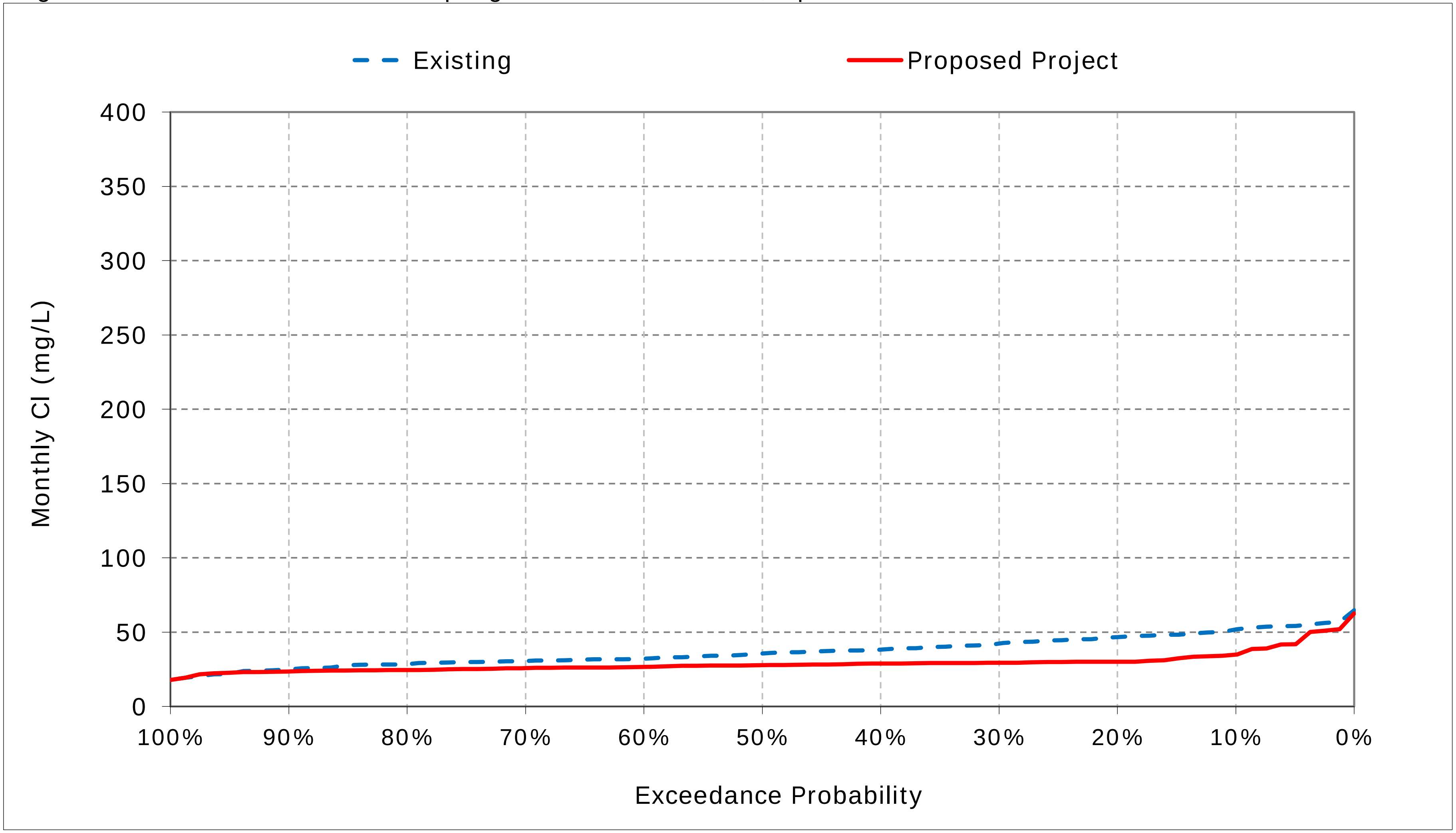


Figure 9-11. Contra Costa Pumping Plant #1 Chloride, May Cl

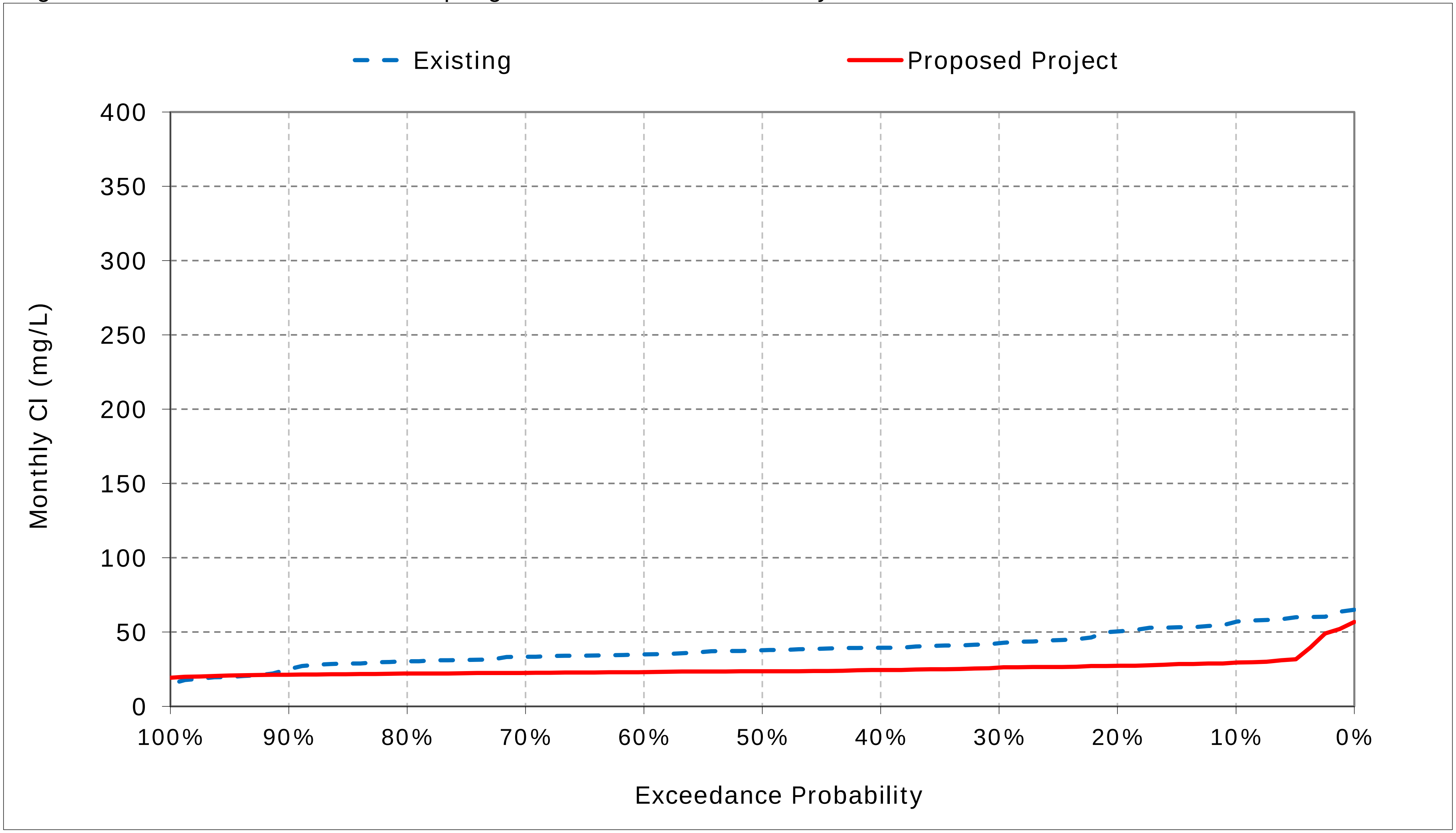


Figure 9-12. Contra Costa Pumping Plant #1 Chloride, June Cl

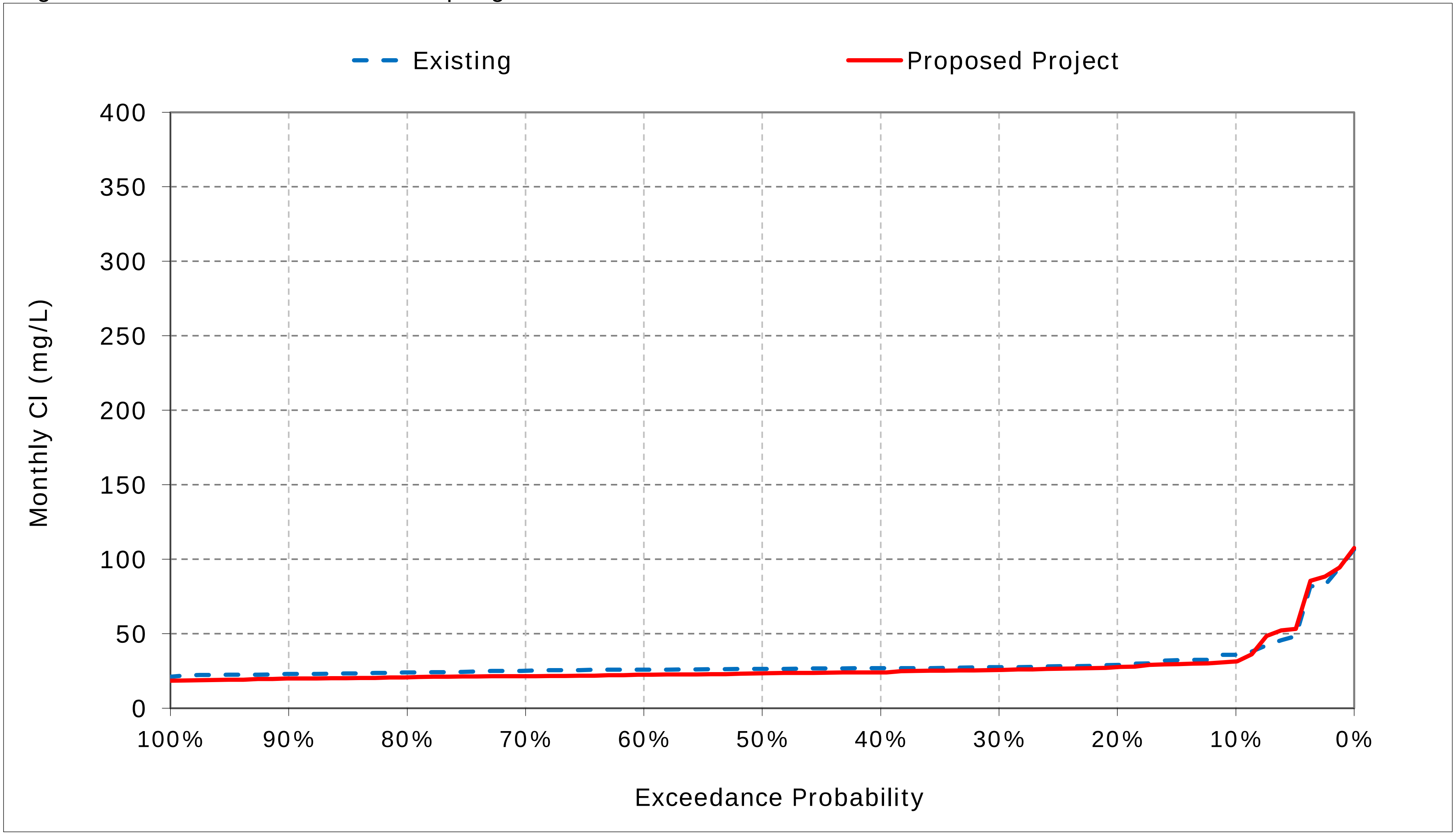


Figure 9-13. Contra Costa Pumping Plant #1 Chloride, July Cl

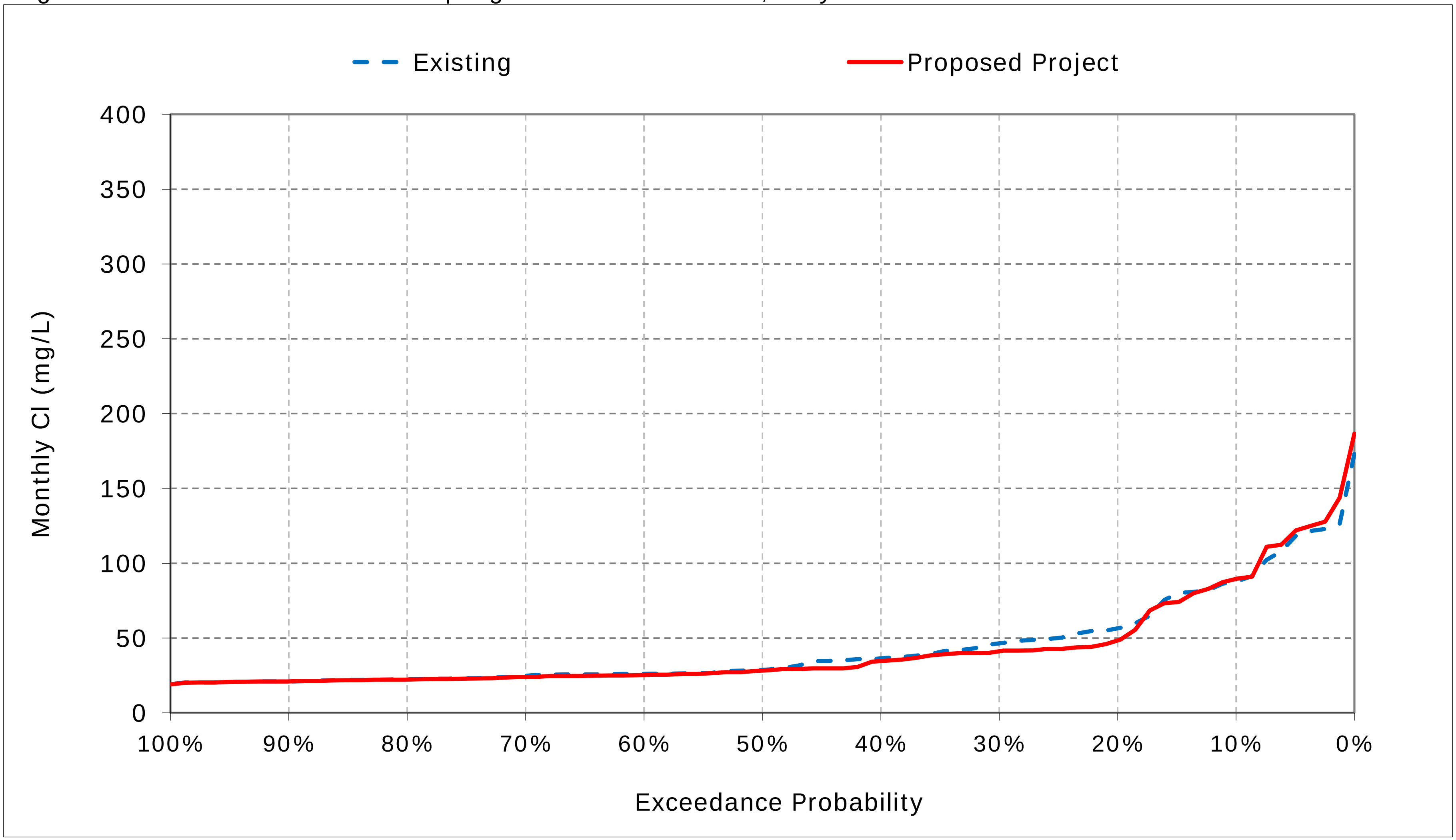


Figure 9-14. Contra Costa Pumping Plant #1 Chloride, August Cl

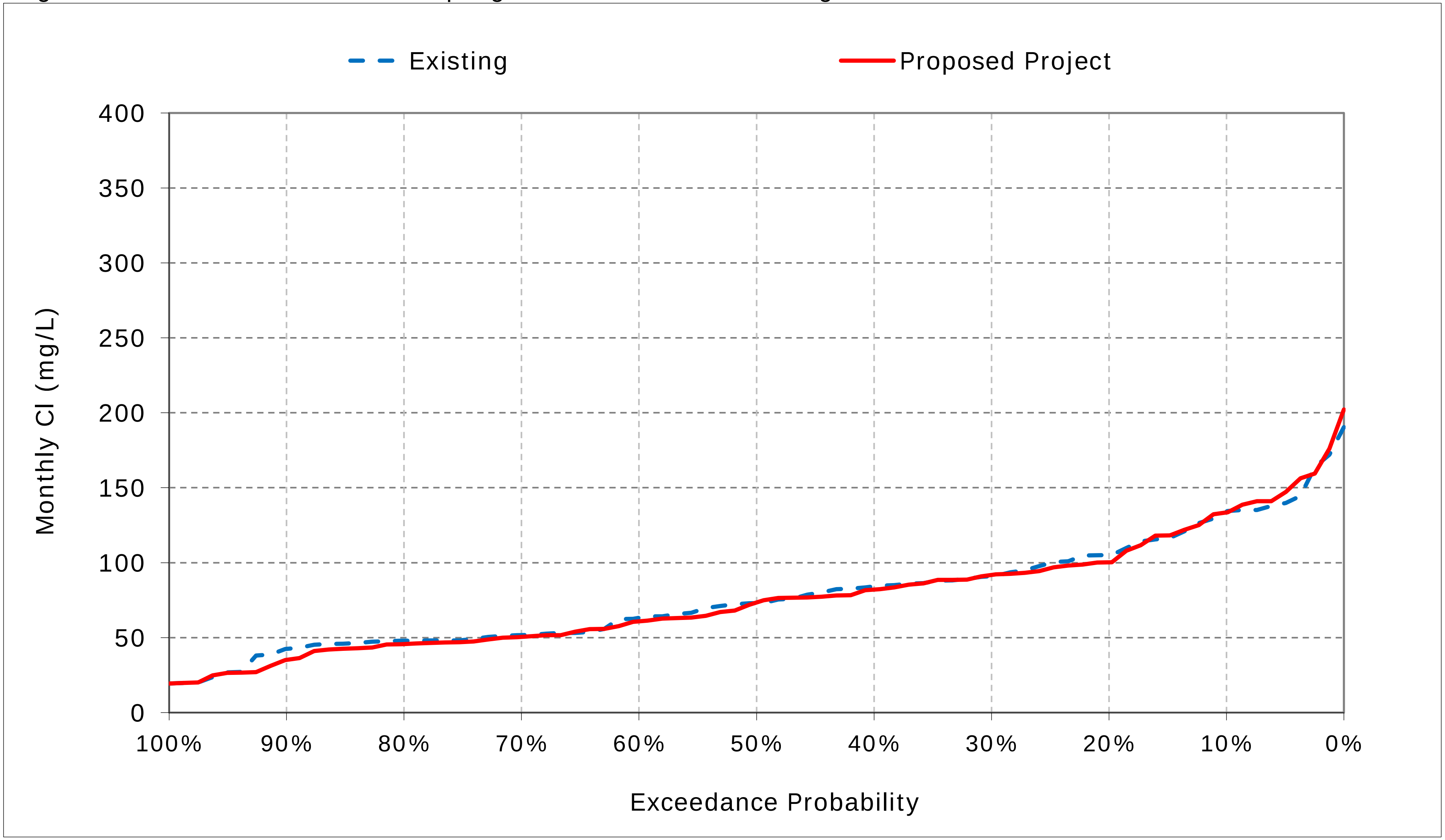


Figure 9-15. Contra Costa Pumping Plant #1 Chloride, September Cl

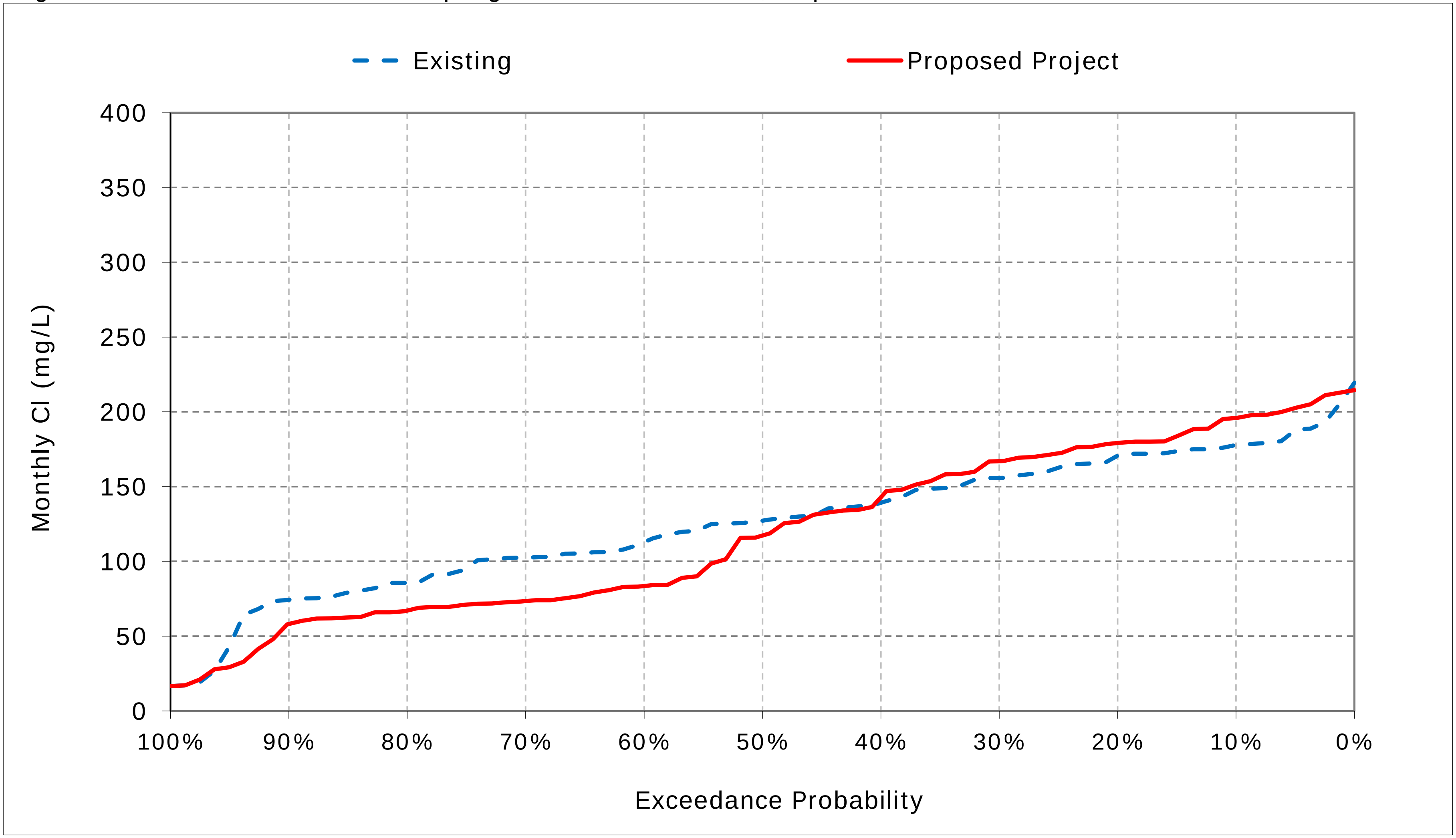


Figure 9-16. Contra Costa Pumping Plant #1 Chloride, October Cl

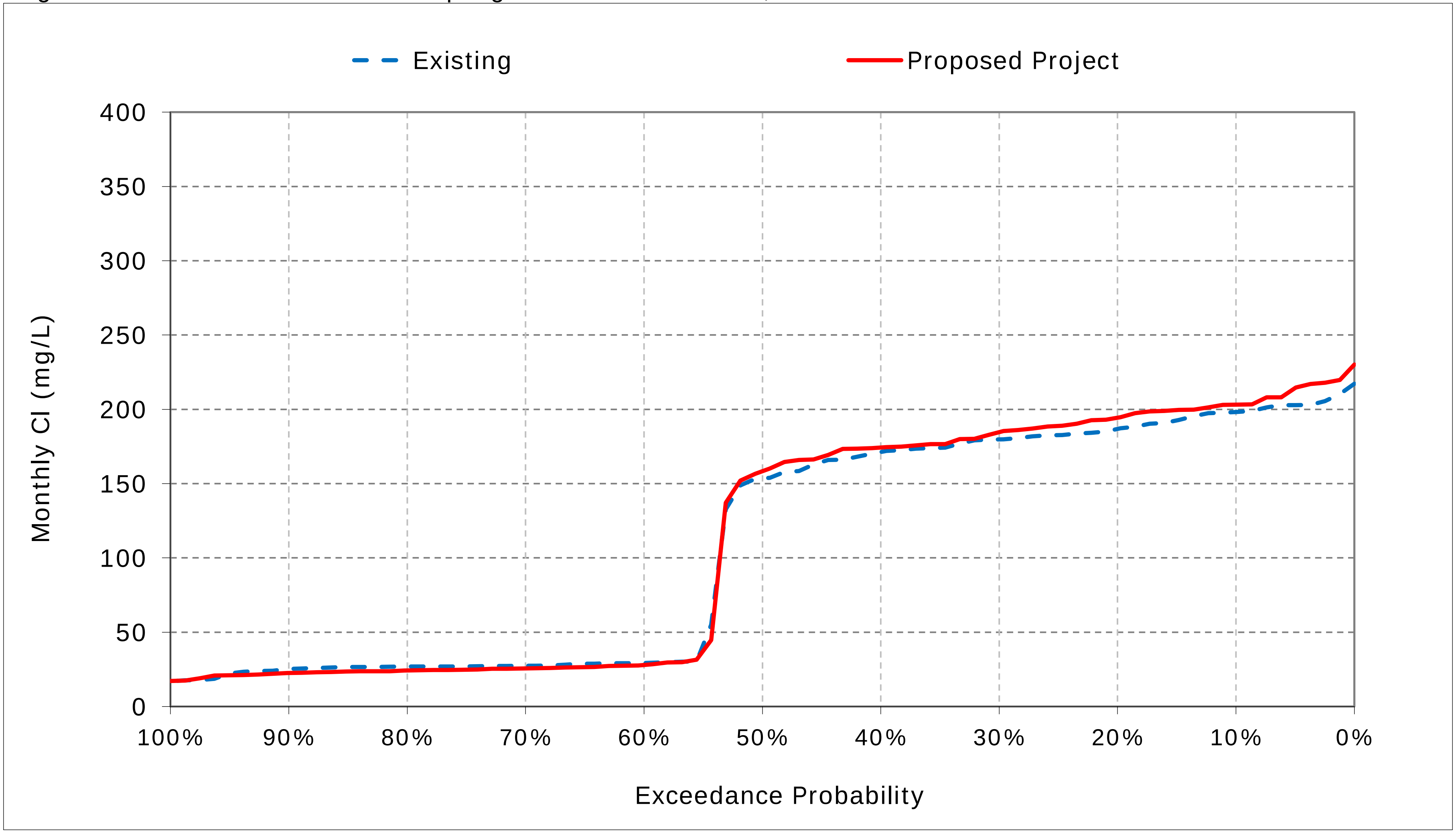


Figure 9-17. Contra Costa Pumping Plant #1 Chloride, November Cl

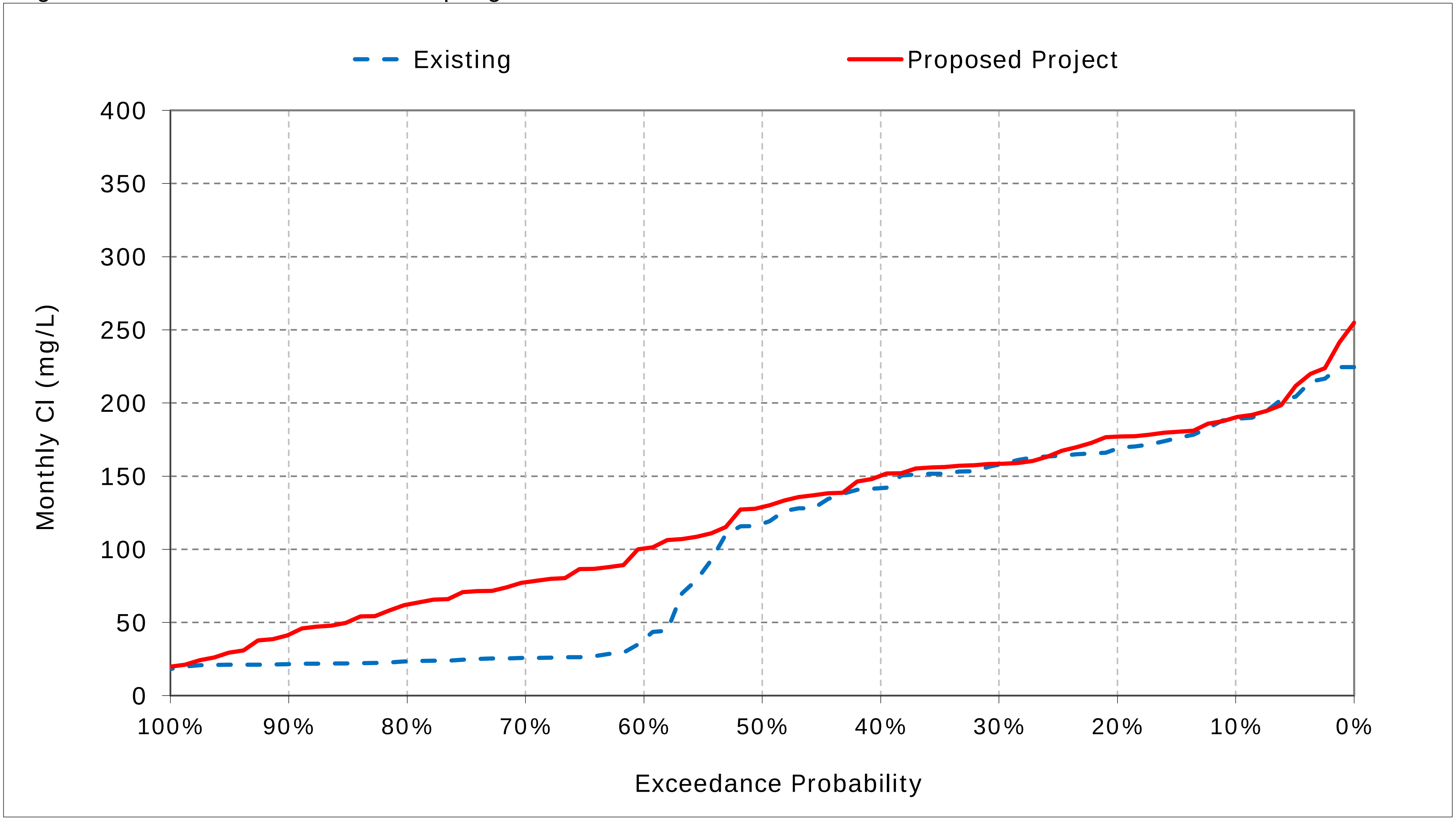


Figure 9-18. Contra Costa Pumping Plant #1 Chloride, December Cl

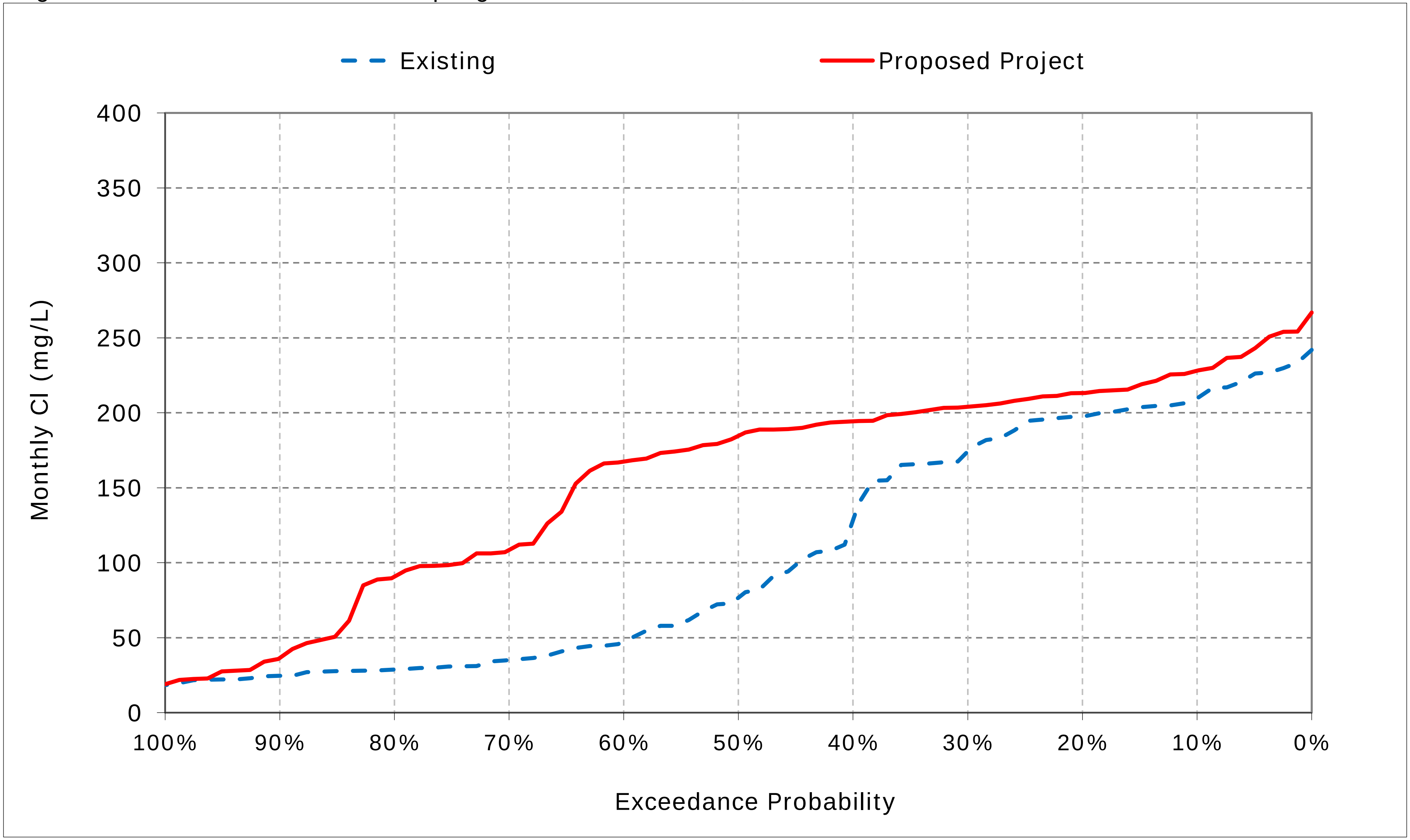


Table 10-1. San Joaquin River at Antioch Chloride, Monthly Cl

Existing

Statistic	Monthly Cl (mg/L)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	2,016	1,853	1,774	907	298	245	224	408	608	1,018	1,523	1,915
20%	1,886	1,807	1,422	756	166	92	94	241	472	851	1,328	1,797
30%	1,857	1,714	898	542	98	34	35	155	437	801	1,240	1,735
40%	1,741	1,651	744	313	55	27	27	70	321	524	1,007	1,603
50%	1,595	652	568	235	31	24	25	33	260	467	892	1,354
60%	534	443	483	90	26	22	22	26	146	301	862	529
70%	271	210	164	27	24	21	21	23	100	278	804	327
80%	221	178	89	23	22	20	20	20	29	222	742	292
90%	191	158	22	21	20	18	19	19	19	138	681	276
Long Term												
Full Simulation Period[a]	1,128	986	722	359	123	71	74	144	319	553	1,004	1,076
Water Year Types[b]												
Wet (32%)	824	571	194	56	25	21	21	26	72	187	682	258
Above Normal (15%)	1,199	987	687	211	45	22	22	27	167	271	762	521
Below Normal (17%)	1,191	1,084	956	389	66	39	37	73	254	487	939	1,471
Dry (22%)	1,210	1,179	886	543	181	84	81	174	430	827	1,280	1,768
Critical (15%)	1,522	1,477	1,382	849	391	246	270	556	913	1,291	1,602	1,906

Proposed Project

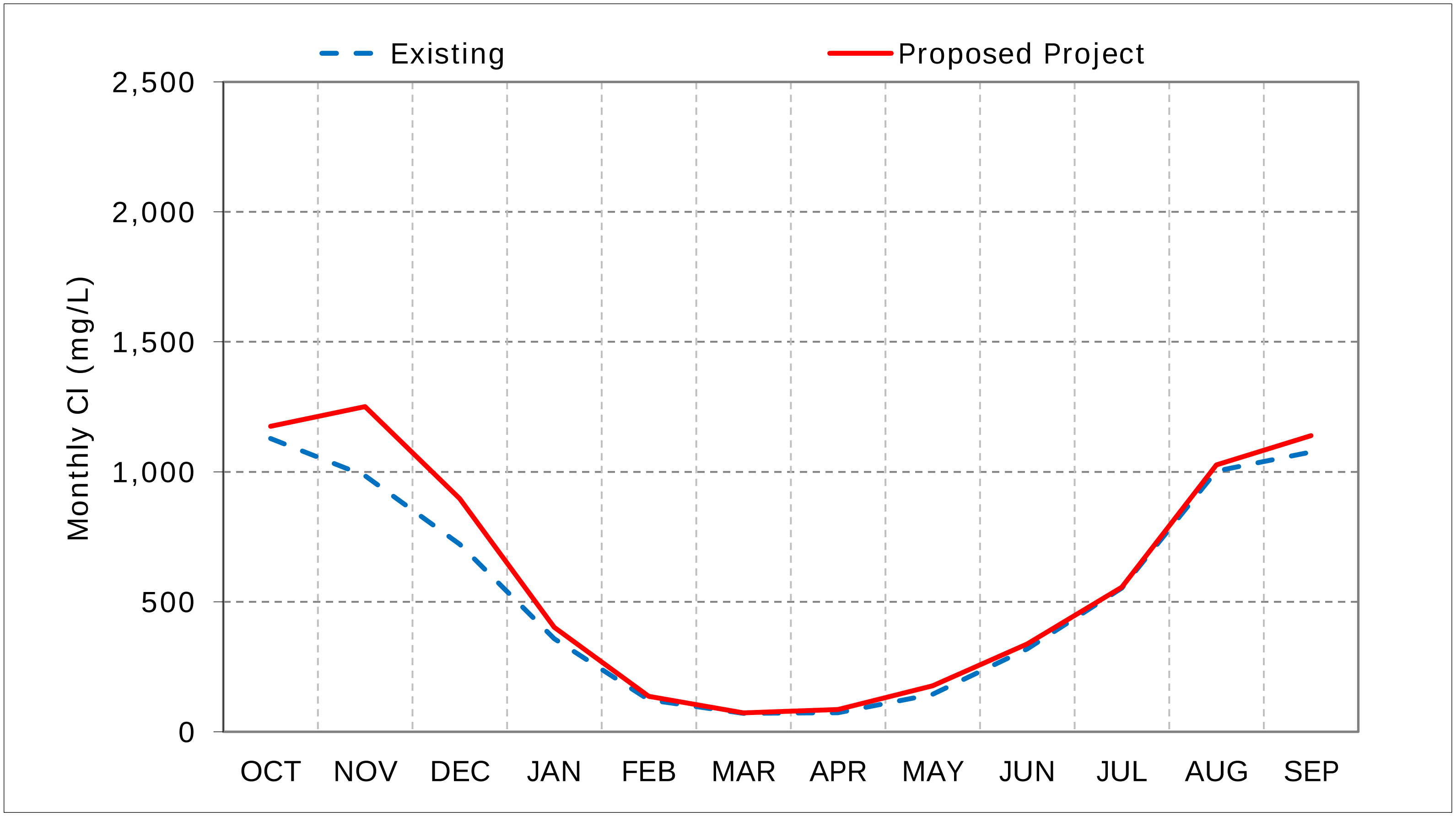
Statistic	Monthly Cl (mg/L)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	1,996	1,844	1,726	1,107	306	248	266	450	625	1,033	1,526	1,937
20%	1,892	1,802	1,439	865	183	93	127	337	518	879	1,331	1,800
30%	1,837	1,699	1,378	587	103	31	57	267	459	799	1,267	1,736
40%	1,741	1,589	1,249	368	57	26	35	108	369	548	1,128	1,663
50%	1,556	1,094	980	242	34	24	25	56	254	463	998	1,417
60%	507	1,036	678	95	27	22	21	37	179	301	850	501
70%	463	1,013	275	29	24	21	20	22	119	270	792	477
80%	450	893	166	24	22	20	19	17	28	226	728	462
90%	412	348	54	21	20	18	18	17	18	138	663	398
Long Term												
Full Simulation Period[a]	1,176	1,251	897	402	137	73	85	177	338	556	1,026	1,139
Water Year Types[b]												
Wet (32%)	899	906	307	59	25	21	22	36	86	187	660	404
Above Normal (15%)	1,247	1,265	941	254	41	22	23	39	169	262	767	473
Below Normal (17%)	1,246	1,335	1,167	416	65	37	49	114	264	505	1,079	1,578
Dry (22%)	1,261	1,417	1,103	631	210	84	104	241	468	831	1,293	1,779
Critical (15%)	1,493	1,635	1,506	930	450	260	298	600	947	1,297	1,616	1,924

Proposed Project minus Existing

Statistic	Monthly Cl (mg/L)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Probability of Exceedance												
10%	-21	-9	-48	199	8	3	42	42	17	14	3	22
20%	6	-6	17	108	17	1	33	96	46	29	3	3
30%	-20	-15	480	44	5	-3	23	112	22	-2	27	1
40%	0	-62	505	55	1	-1	7	38	48	24	121	60
50%	-39	442	412	6	4	0	0	23	-6	-4	106	64
60%	-27	593	194	5	1	0	-1	11	33	0	-12	-28
70%	192	803	111	2	0	0	-1	-1	19	-8	-12	151
80%	228	715	77	1	0	0	-1	-3	0	4	-14	171
90%	221	189	32	0	0	0	-1	-2	-1	0	-18	121
Long Term												
Full Simulation Period[a]	47	265	175	43	14	2	12	33	20	3	23	62
Water Year Types[b]												
Wet (32%)	75	335	113	3	0	0	1	11	14	0	-22	145
Above Normal (15%)	48	279	254	44	-4	0	1	12	2	-9	5	-49
Below Normal (17%)	55	251	210	27	-1	-1	12	41	10	18	141	107
Dry (22%)	52	238	217	88	29	0	23	68	37	4	13	11
Critical (15%)	-29	158	124	80	59	14	28	43	34	6	14	18

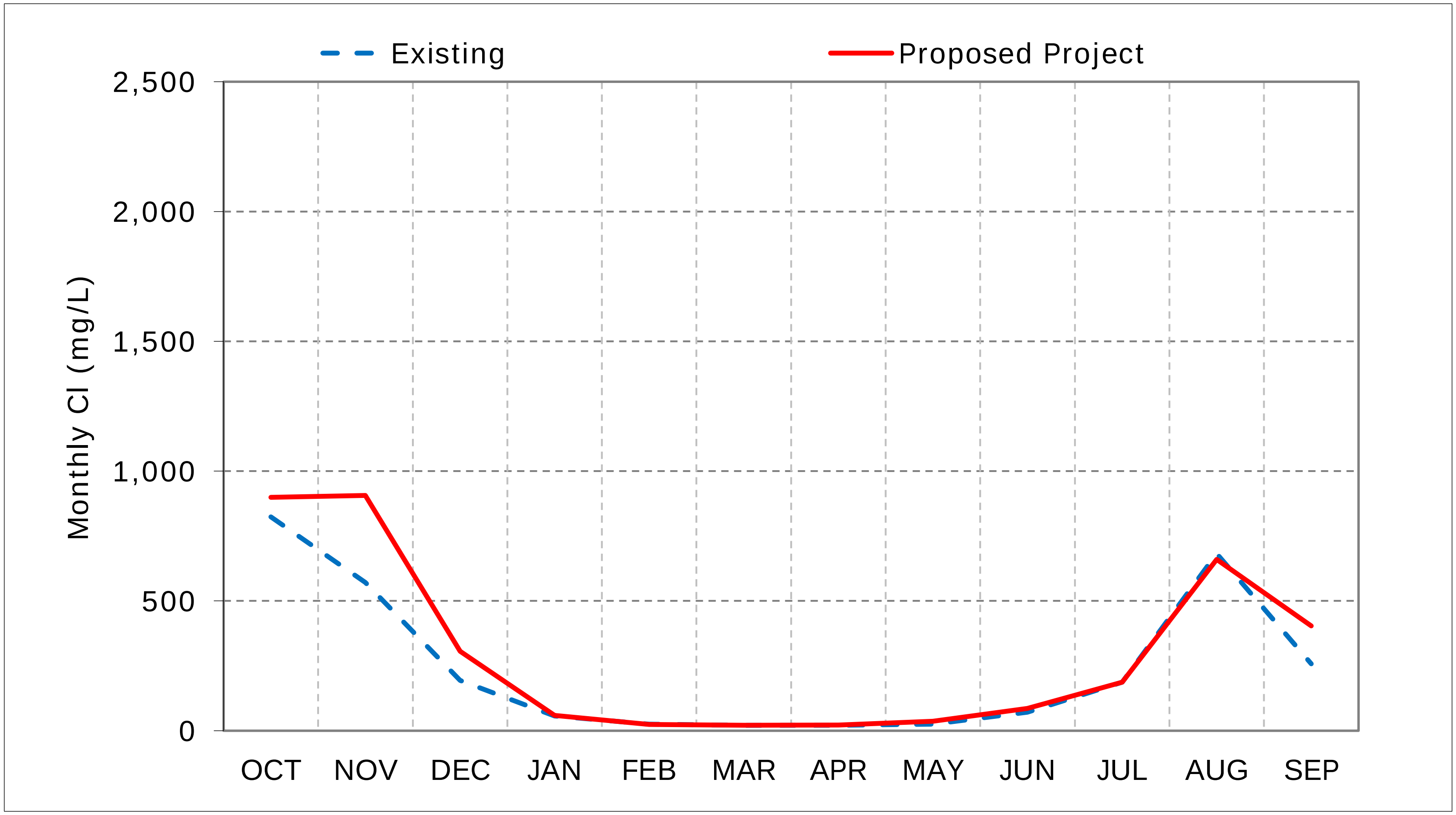
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 10-1. San Joaquin River at Antioch Chloride, Long-Term Average Cl



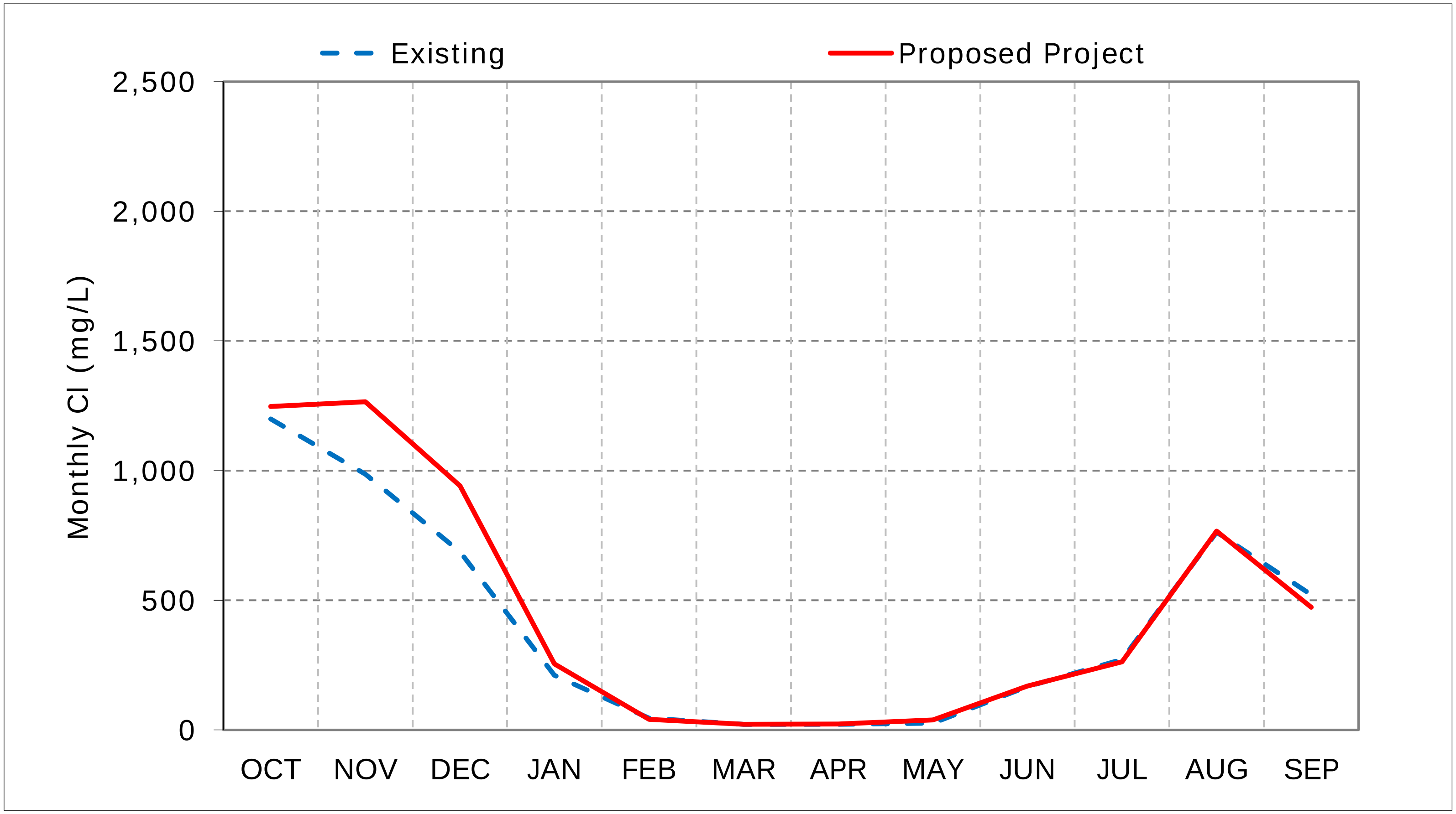
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 10-2. San Joaquin River at Antioch Chloride, Wet Year Average Cl



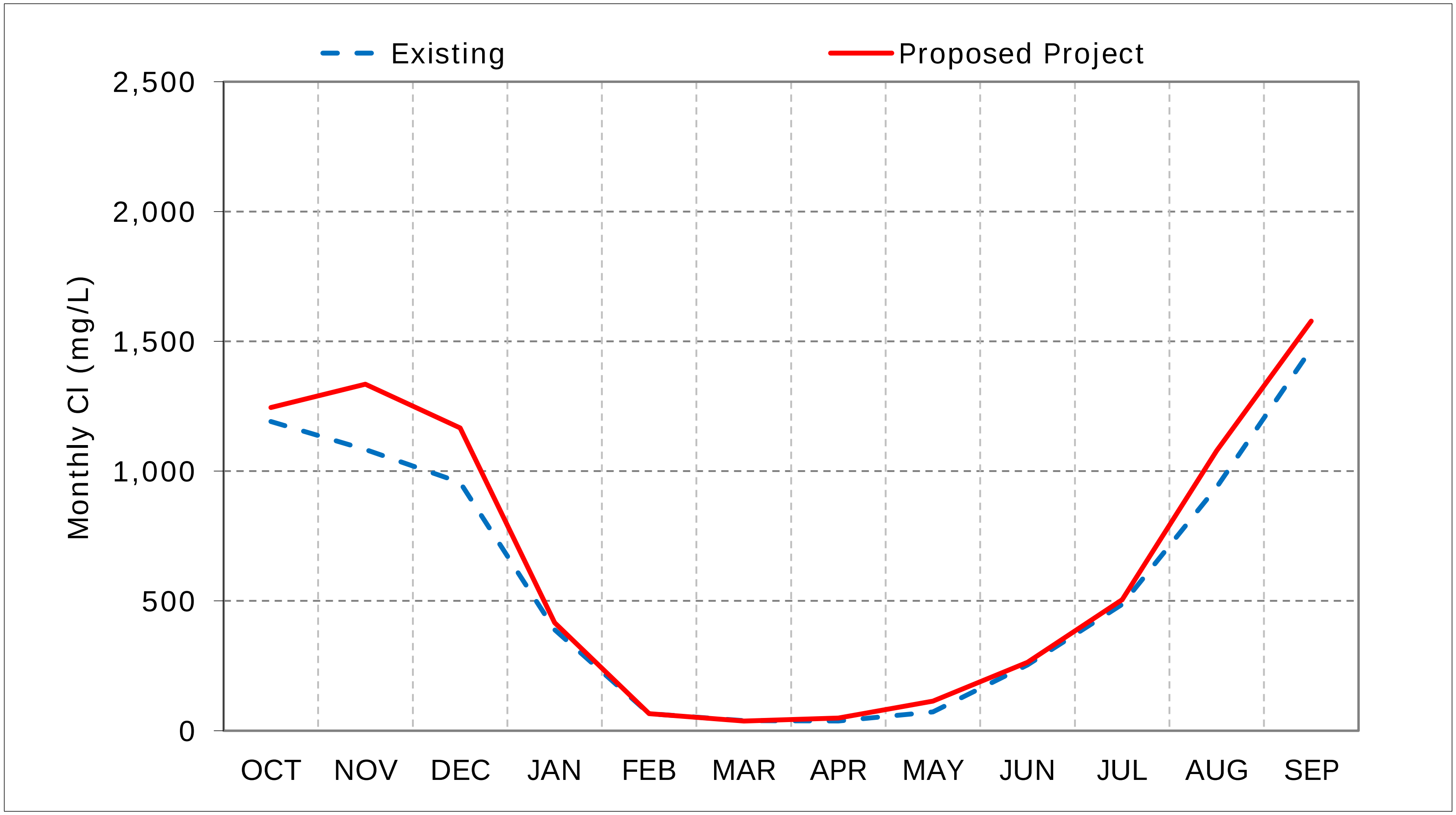
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 10-3. San Joaquin River at Antioch Chloride, Above Normal Year Average C



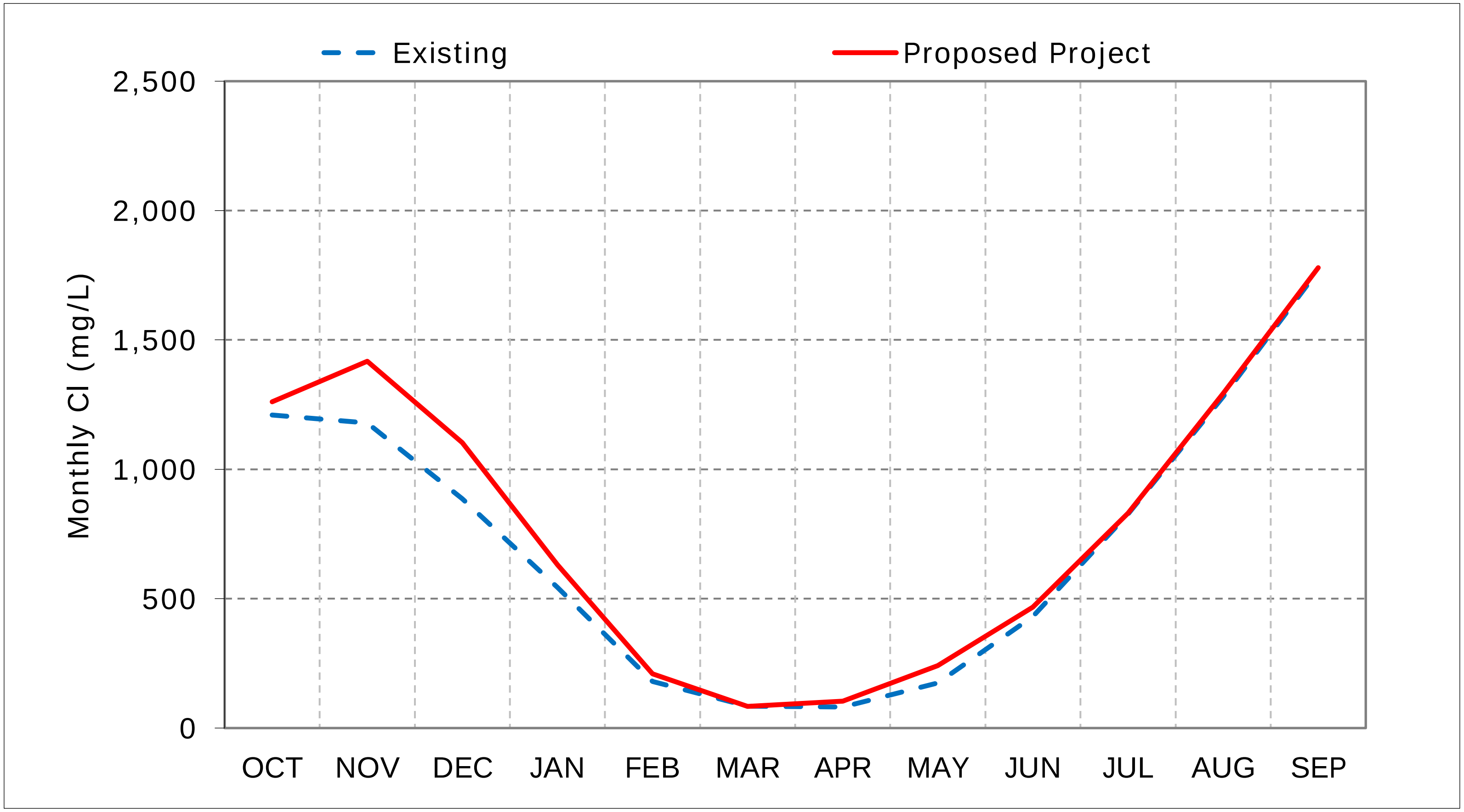
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 10-4. San Joaquin River at Antioch Chloride, Below Normal Year Average C



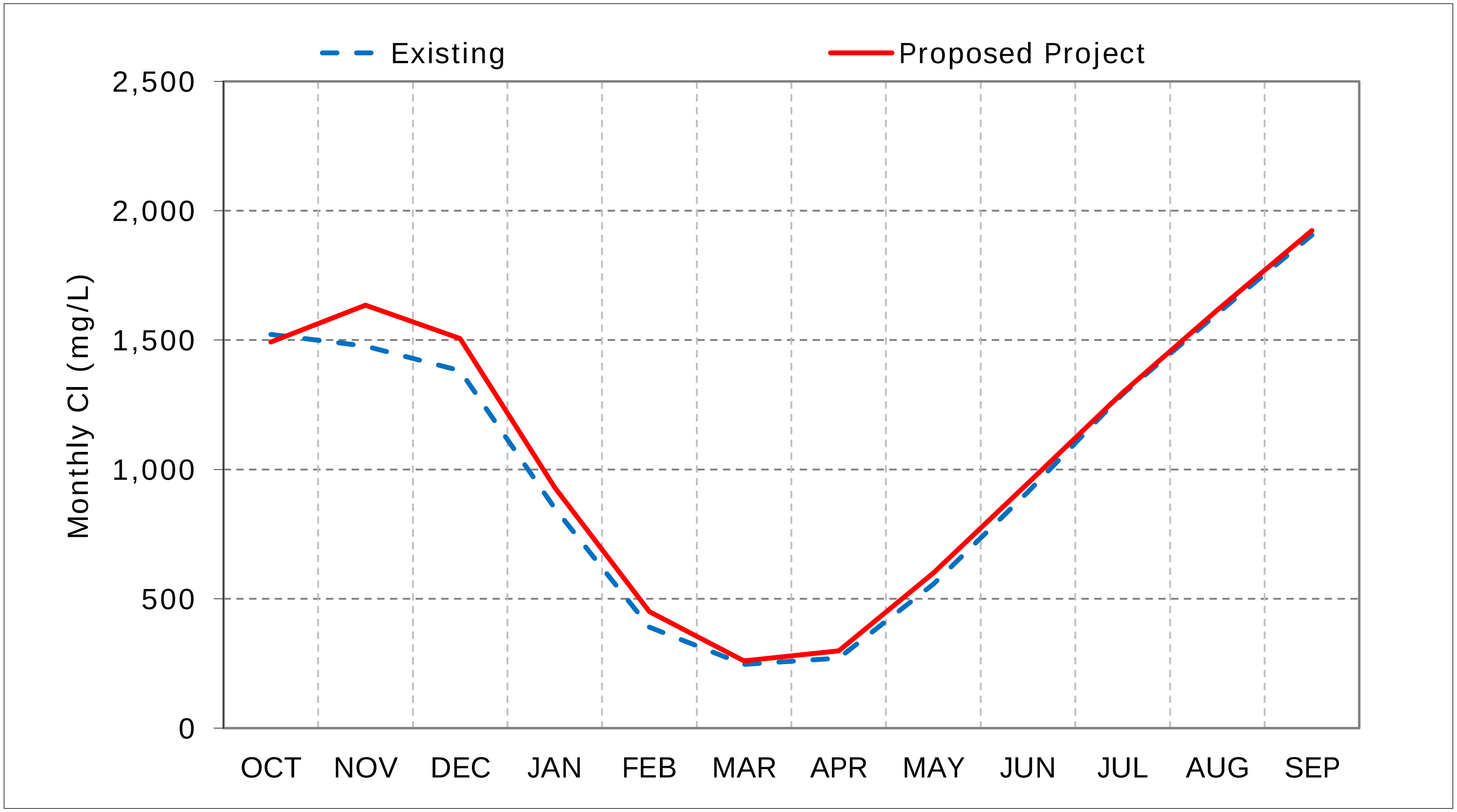
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 10-5. San Joaquin River at Antioch Chloride, Dry Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 10-6. San Joaquin River at Antioch Chloride, Critical Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 10-7. San Joaquin River at Antioch Chloride, January Cl

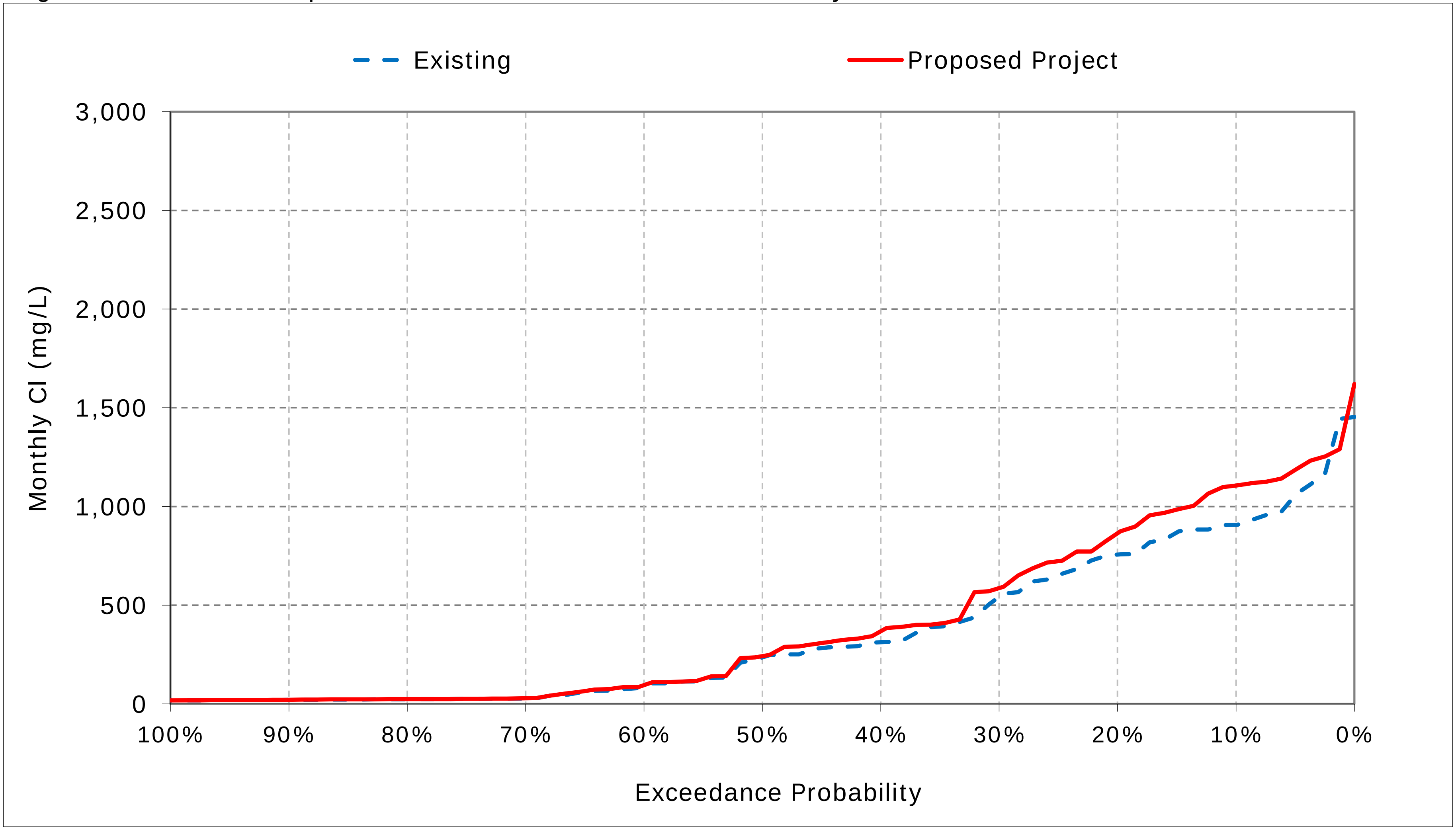


Figure 10-8. San Joaquin River at Antioch Chloride, February Cl

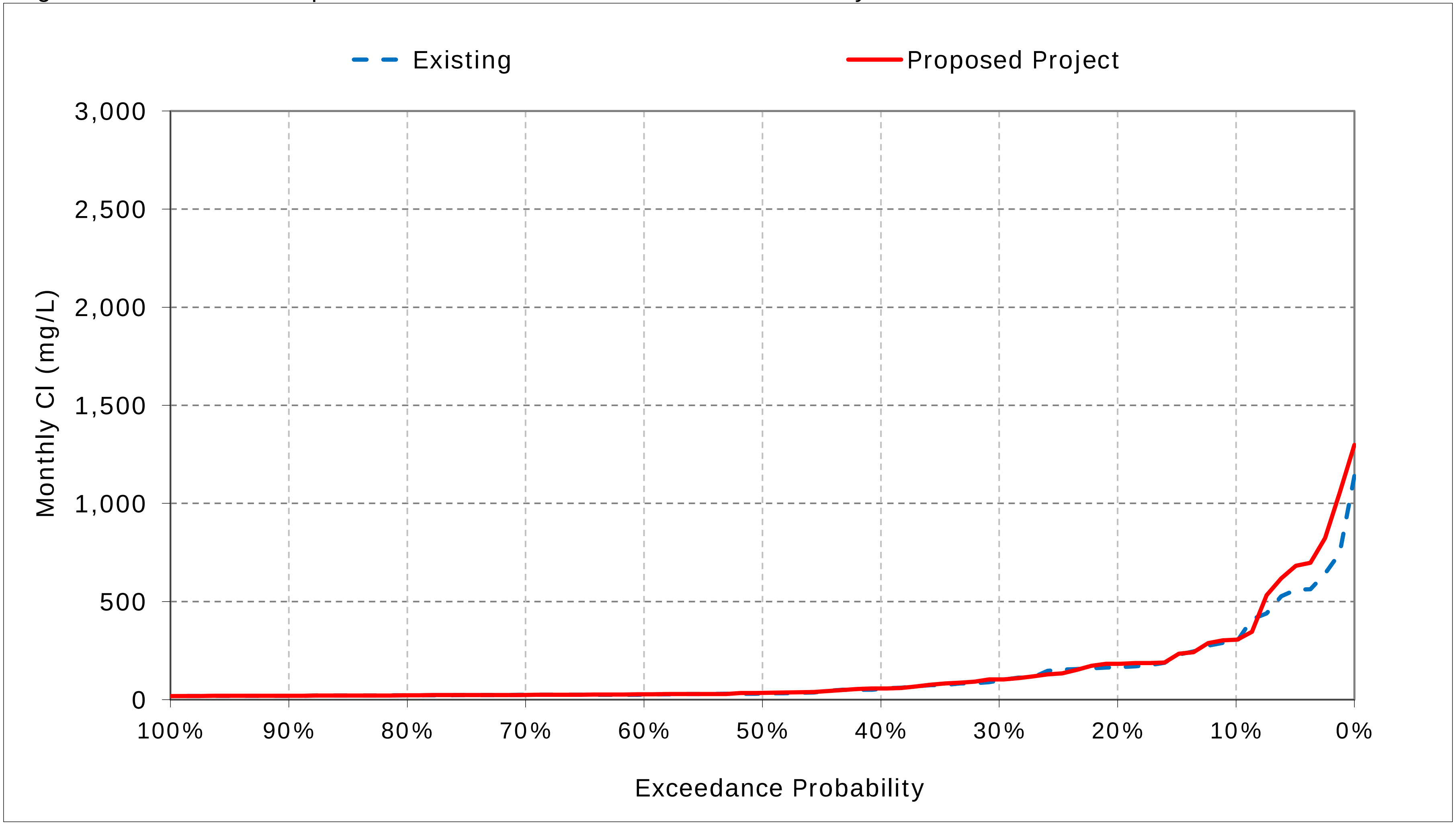


Figure 10-9. San Joaquin River at Antioch Chloride, March Cl

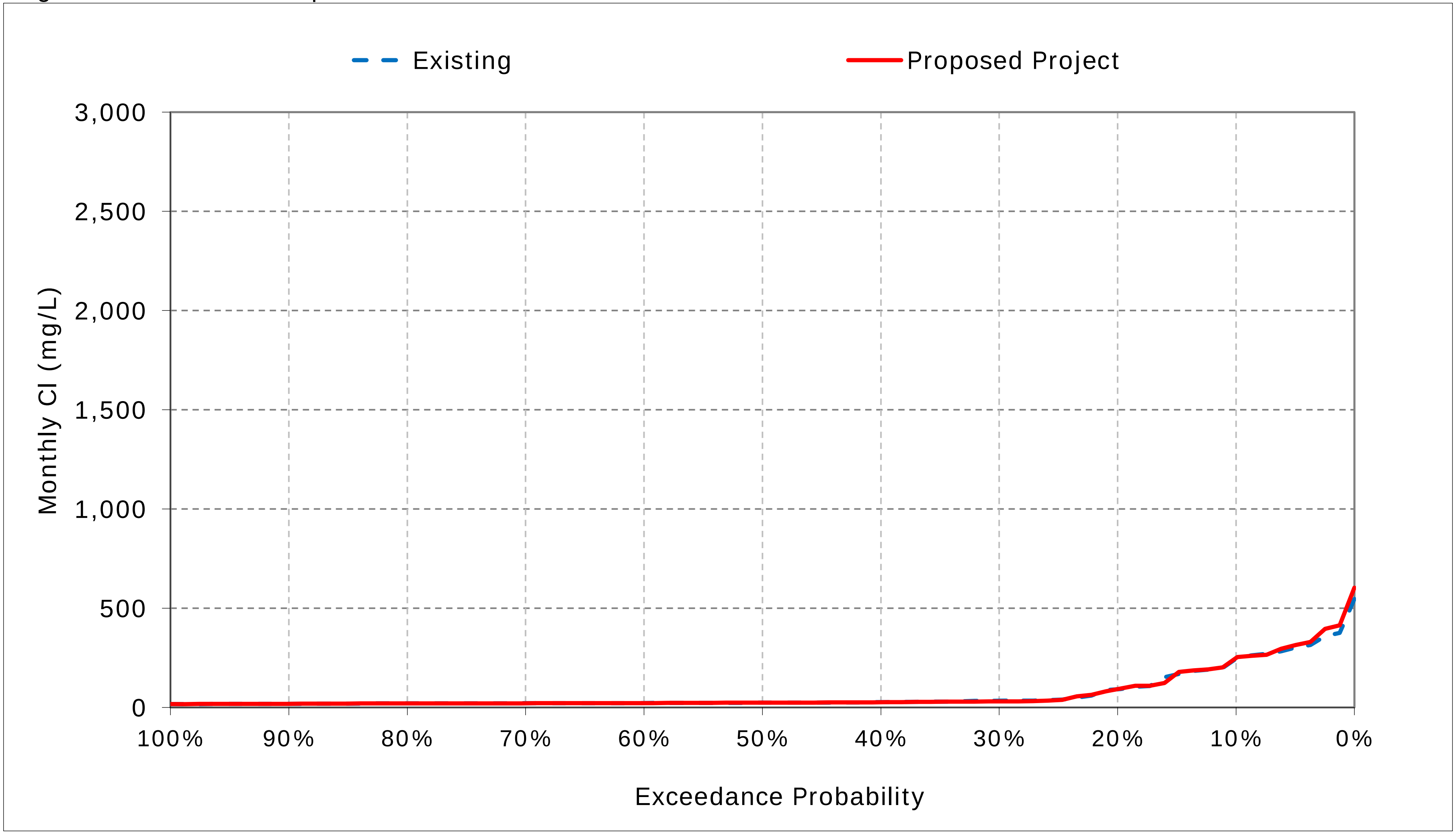


Figure 10-10. San Joaquin River at Antioch Chloride, April Cl

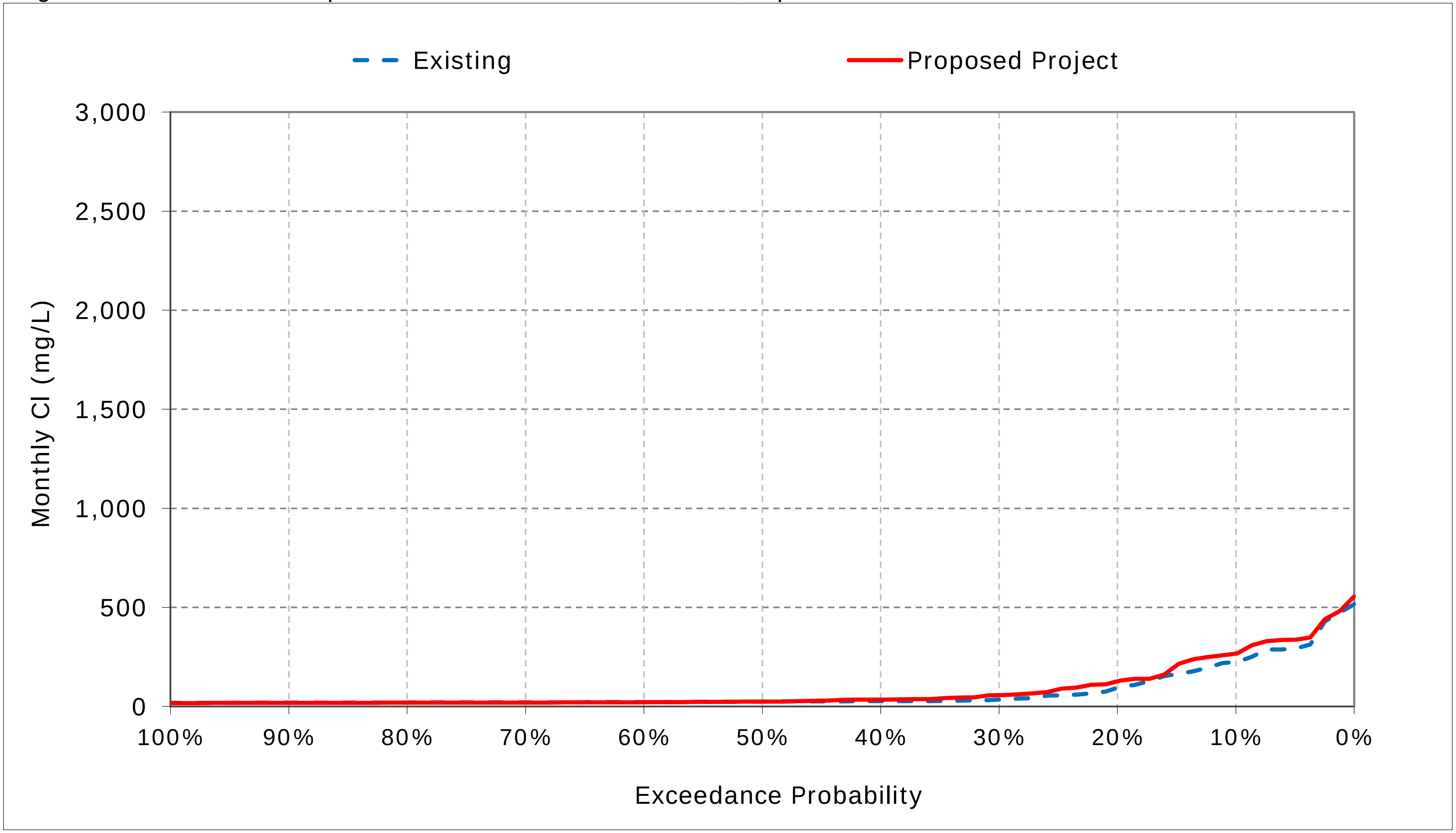


Figure 10-11. San Joaquin River at Antioch Chloride, May Cl

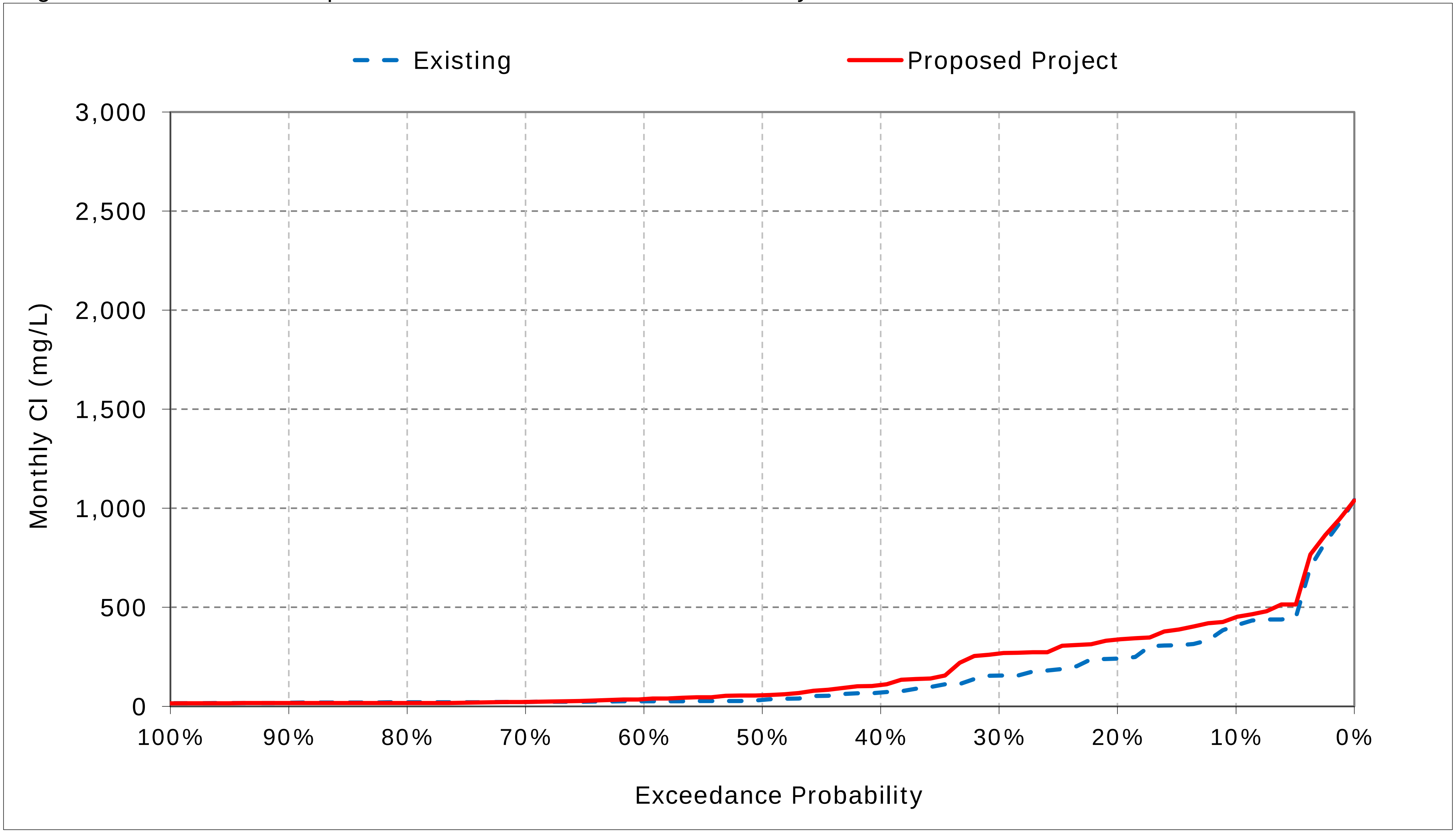


Figure 10-12. San Joaquin River at Antioch Chloride, June Cl

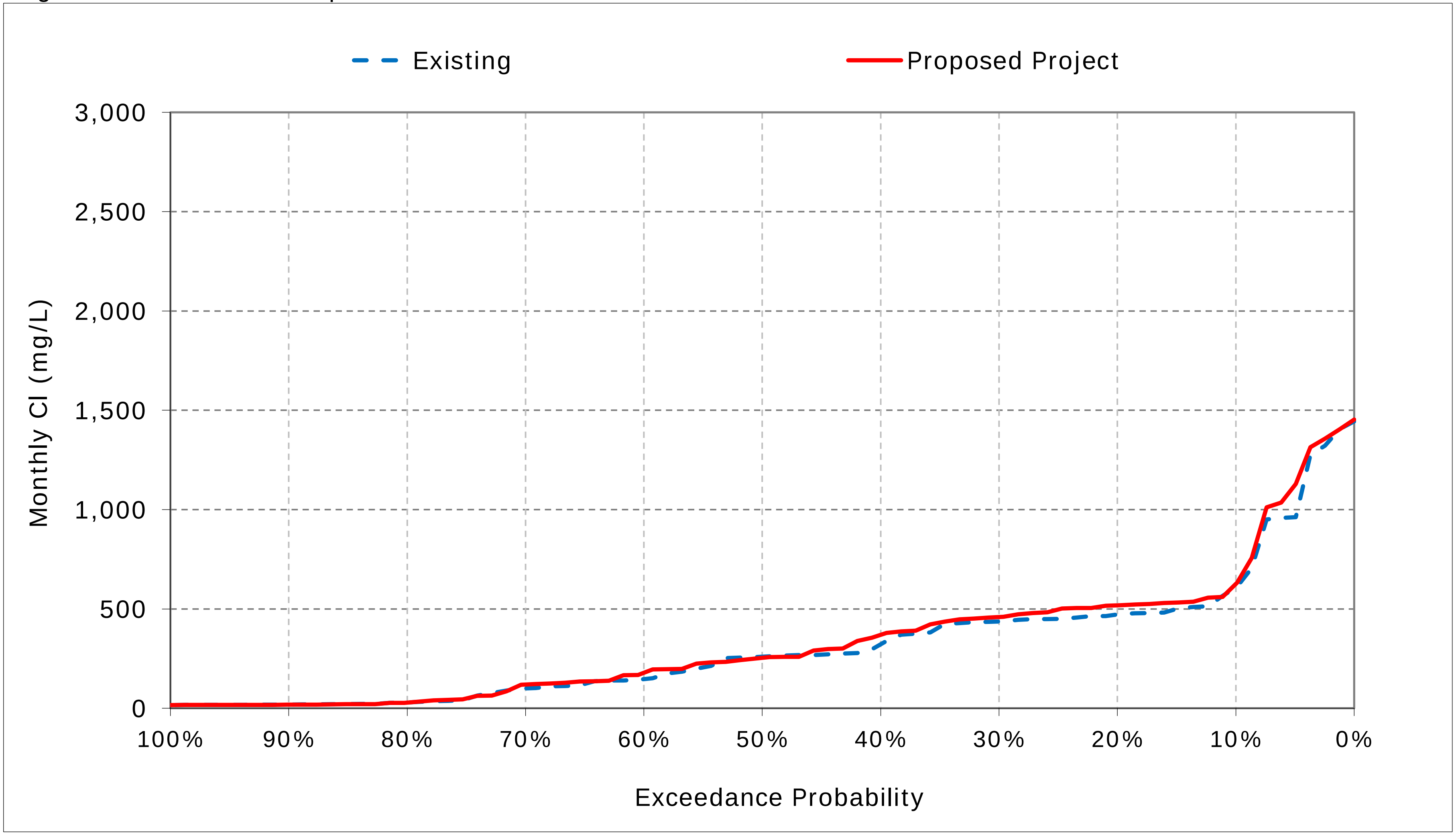


Figure 10-13. San Joaquin River at Antioch Chloride, July Cl

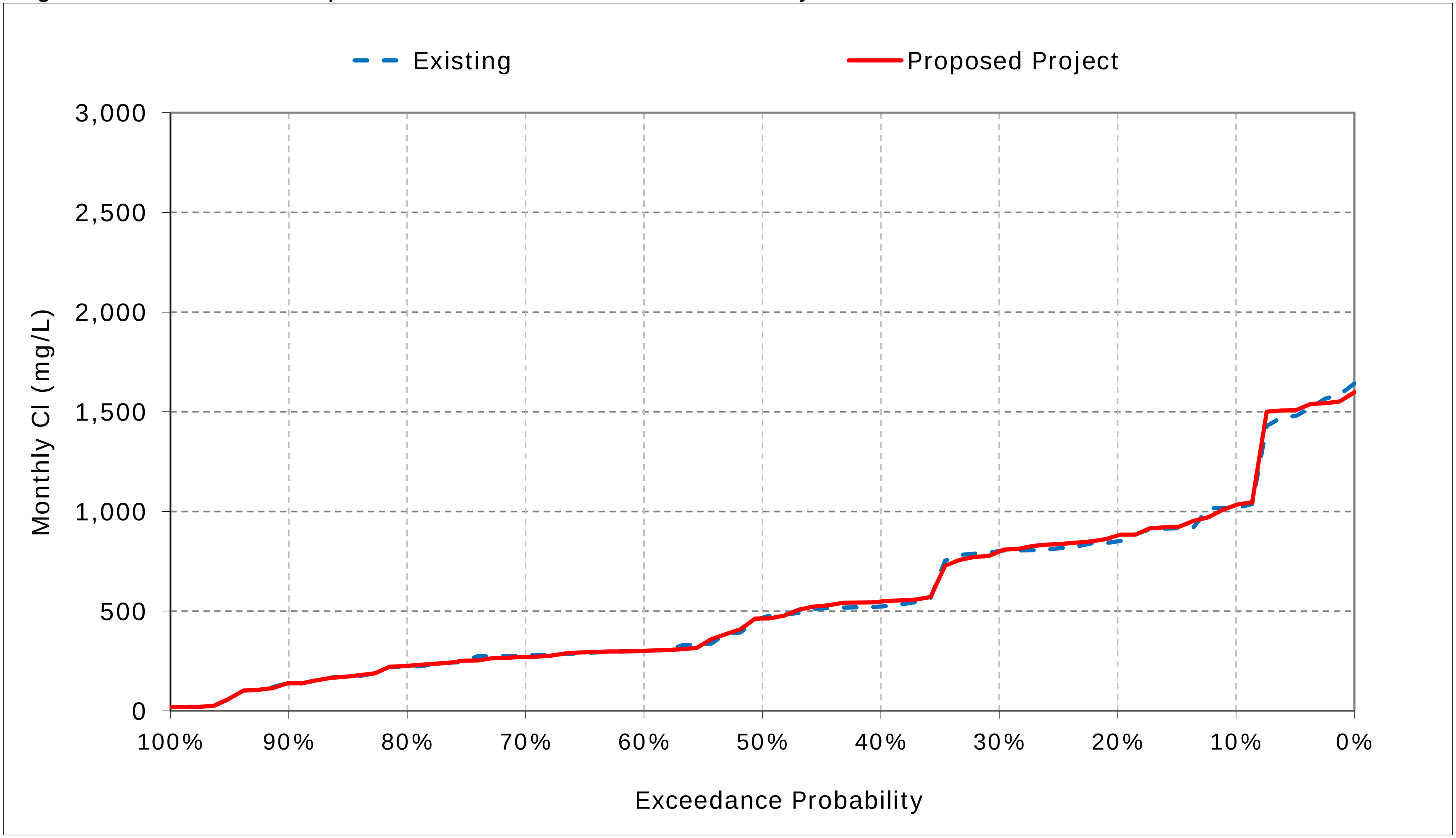


Figure 10-14. San Joaquin River at Antioch Chloride, August Cl

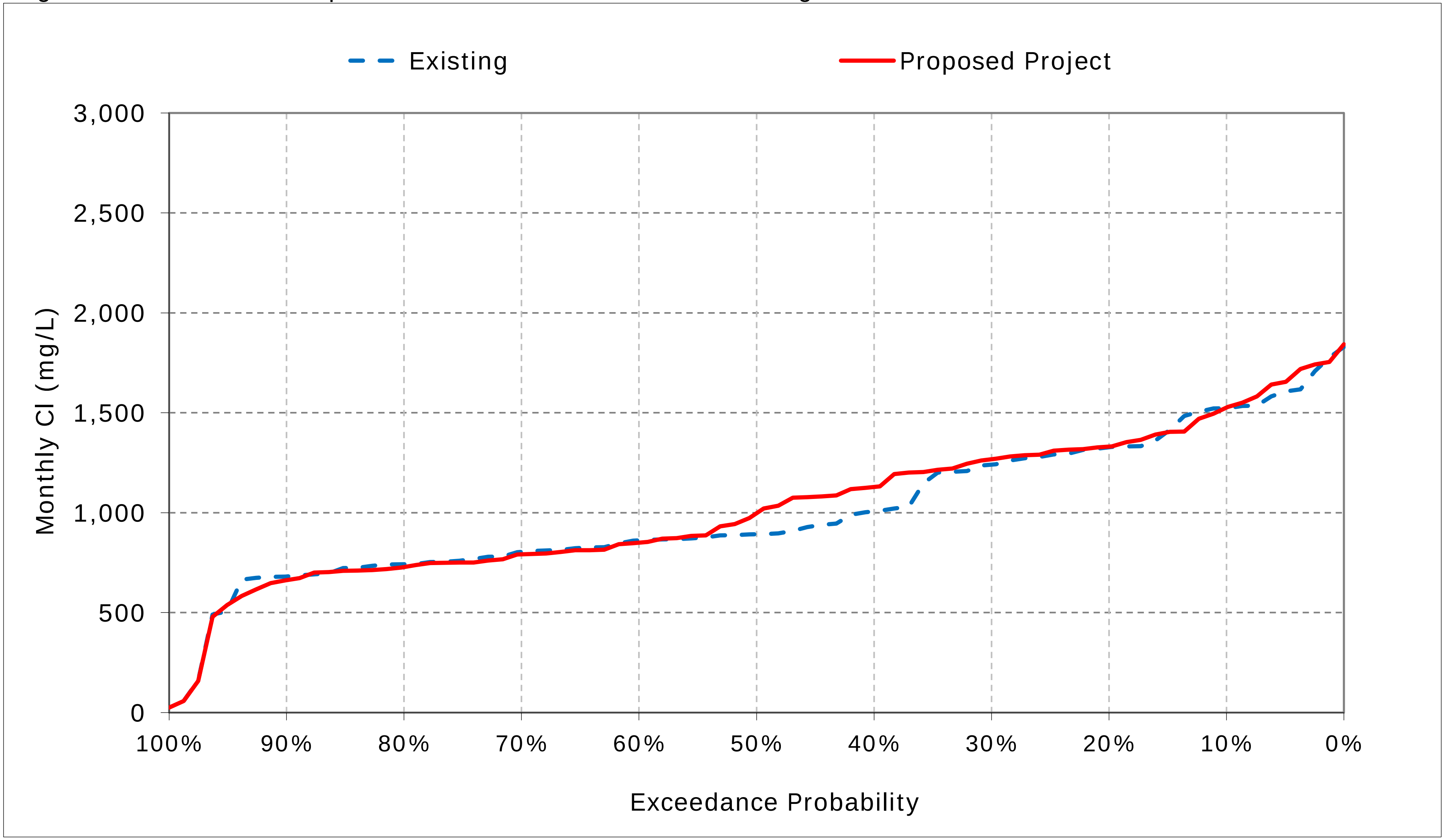


Figure 10-15. San Joaquin River at Antioch Chloride, September Cl

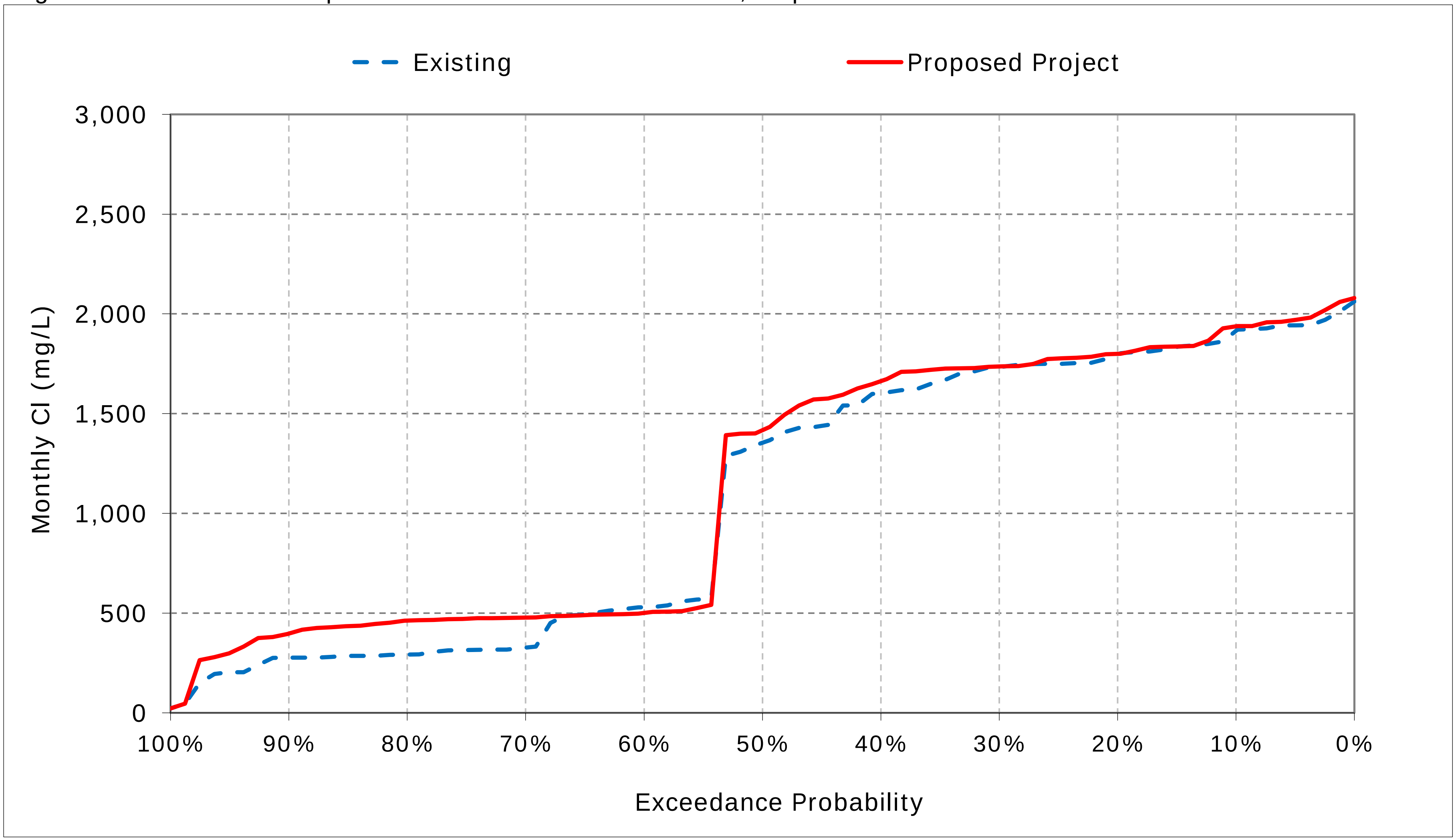


Figure 10-16. San Joaquin River at Antioch Chloride, October Cl

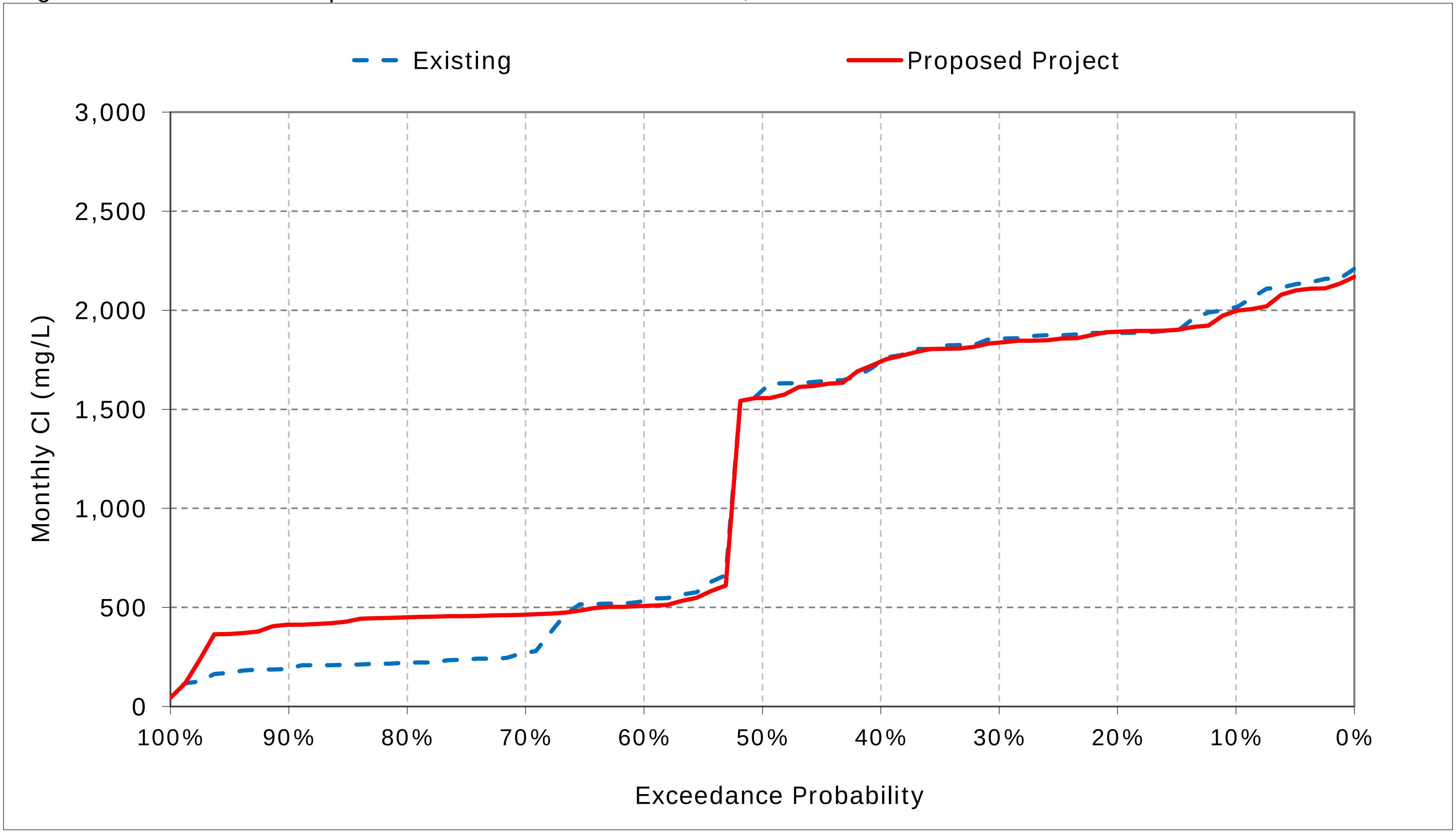


Figure 10-17. San Joaquin River at Antioch Chloride, November Cl

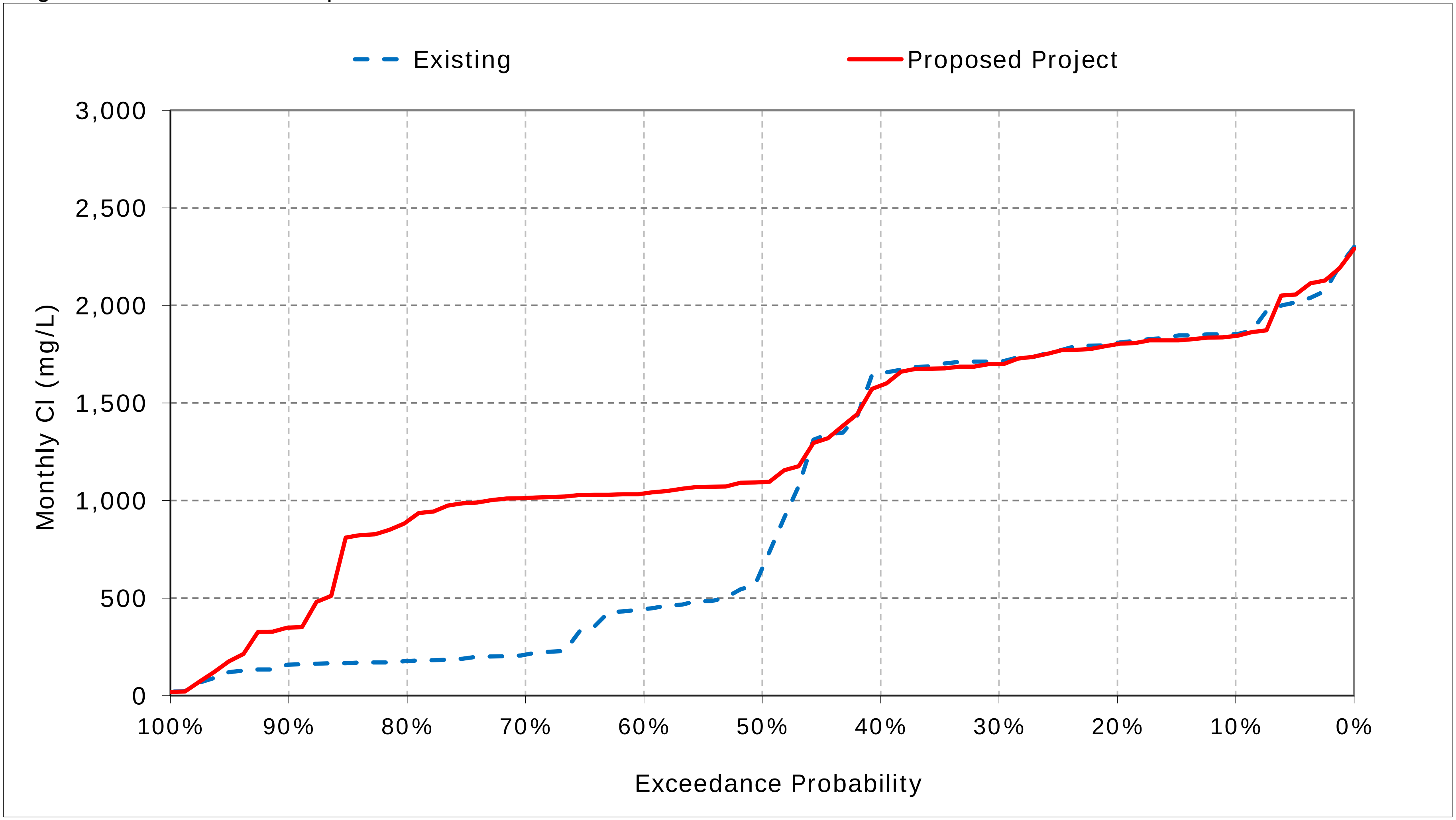


Figure 10-18. San Joaquin River at Antioch Chloride, December Cl

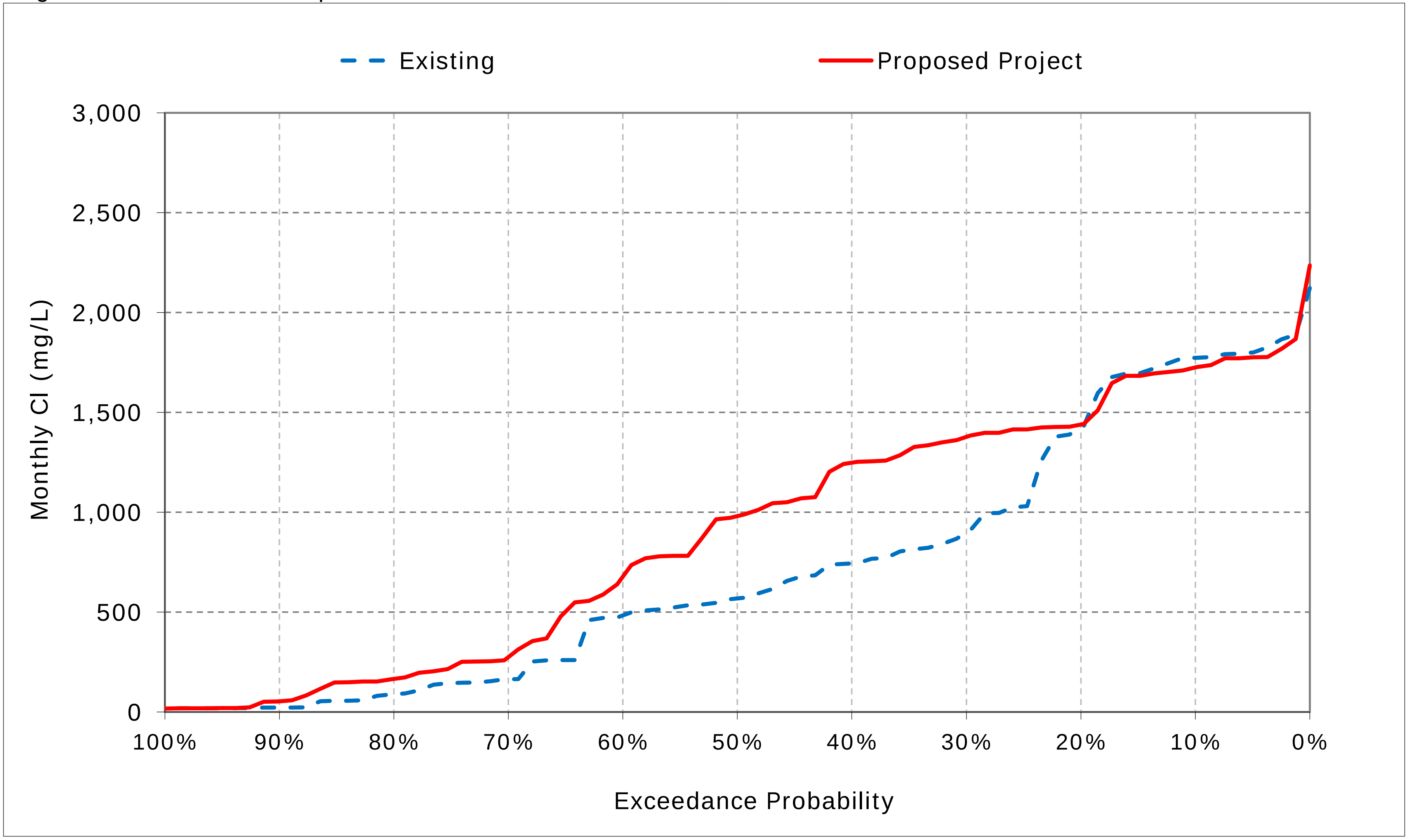


Table 11-1. Banks Pumping Plant South Delta Exports Chloride, Monthly Cl

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	140	141	157	169	127	98	83	84	73	64	102	119
20%	133	122	145	157	112	79	73	76	59	55	74	111
30%	128	119	138	122	98	73	66	72	55	42	62	105
40%	121	113	122	110	93	67	61	68	54	40	58	101
50%	113	107	76	97	81	62	58	63	51	38	50	91
60%	52	46	56	90	76	58	52	60	49	35	43	84
70%	46	39	44	80	69	53	49	53	47	30	39	80
80%	39	36	37	69	64	46	38	45	43	29	37	72
90%	34	34	34	60	49	39	28	23	34	28	34	64
Long Term												
Full Simulation Period[a]	89	84	92	108	86	64	57	60	52	43	57	90
Water Year Types[b]												
Wet (32%)	74	66	67	74	63	47	38	40	40	32	37	75
Above Normal (15%)	101	92	93	108	91	63	53	57	49	32	38	68
Below Normal (17%)	92	86	102	126	88	65	59	64	51	35	59	111
Dry (22%)	88	89	104	116	95	74	70	74	57	47	77	98
Critical (15%)	106	105	118	151	117	89	80	82	77	78	89	108

Proposed Project

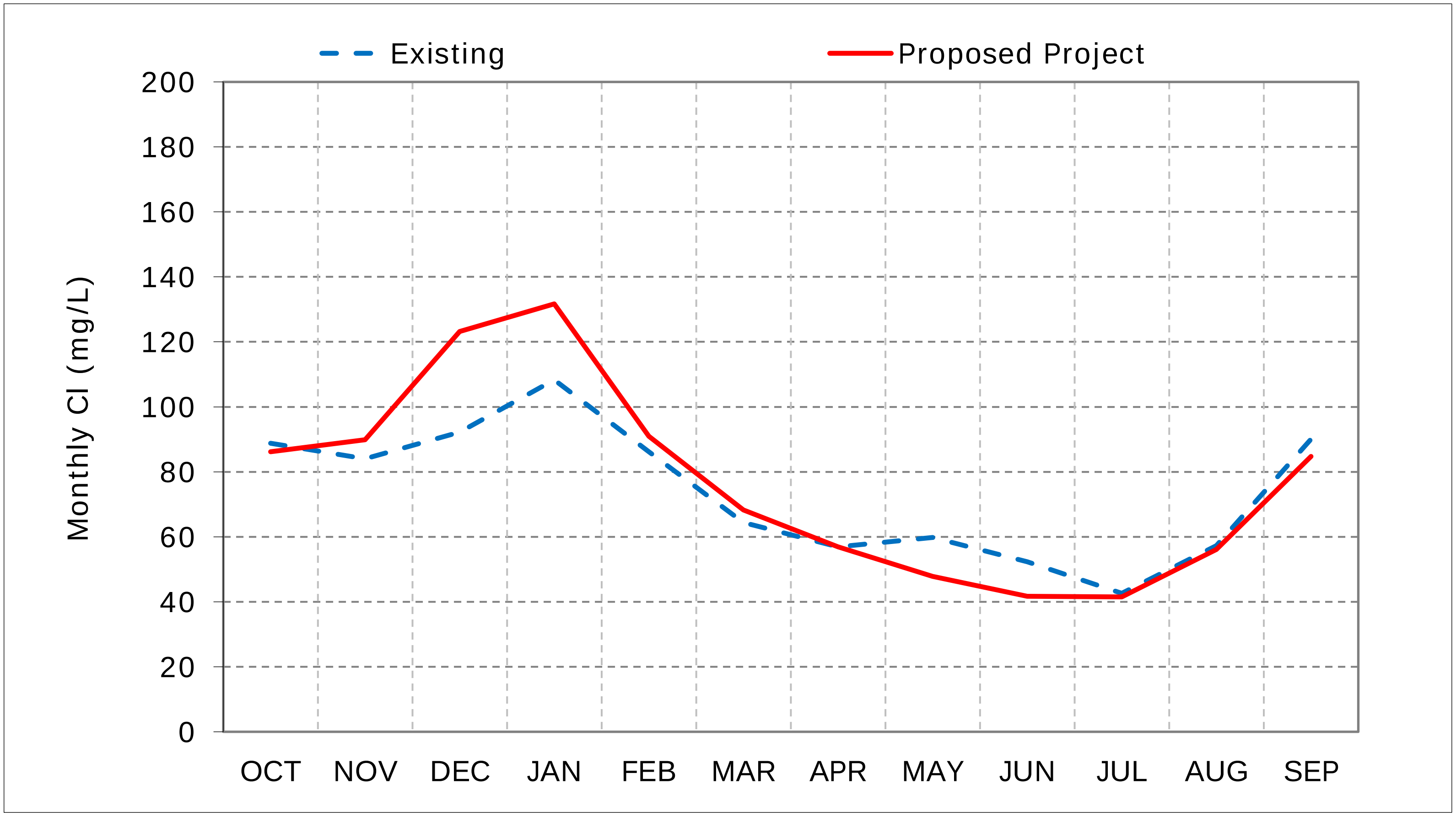
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	149	136	164	210	145	99	79	70	58	64	102	123
20%	138	130	152	192	125	88	74	61	46	52	69	117
30%	131	118	148	168	109	81	67	57	42	41	61	107
40%	120	115	140	156	97	72	63	49	39	39	56	92
50%	118	109	133	121	93	65	59	45	38	36	49	80
60%	34	63	128	101	77	62	50	41	37	34	44	71
70%	32	53	115	91	69	55	45	39	34	30	38	64
80%	30	44	92	73	60	46	39	36	32	28	36	60
90%	29	38	49	64	46	42	31	27	30	27	31	53
Long Term												
Full Simulation Period[a]	86	90	123	132	91	68	57	48	42	42	56	85
Water Year Types[b]												
Wet (32%)	70	73	95	84	62	48	37	31	33	32	36	54
Above Normal (15%)	98	105	137	149	98	69	51	40	36	31	38	65
Below Normal (17%)	88	91	130	151	91	69	59	47	36	33	57	120
Dry (22%)	85	92	135	150	105	80	72	59	43	46	74	98
Critical (15%)	108	106	145	168	126	93	80	76	70	78	91	111

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	9	-4	7	41	18	2	-4	-13	-15	-1	0	4
20%	5	7	6	35	14	9	0	-15	-13	-3	-5	5
30%	3	0	10	46	11	8	1	-15	-13	-1	-1	1
40%	0	3	18	46	4	6	2	-19	-15	-1	-2	-9
50%	4	2	58	24	12	3	2	-18	-13	-2	-1	-11
60%	-18	17	73	11	0	3	-3	-18	-12	-1	0	-14
70%	-14	15	71	11	0	2	-4	-14	-13	0	0	-16
80%	-10	9	55	4	-3	0	0	-9	-11	-1	0	-12
90%	-5	4	15	4	-3	3	3	4	-4	-1	-3	-12
Long Term												
Full Simulation Period[a]	-3	6	31	23	5	4	0	-12	-11	-1	-1	-5
Water Year Types[b]												
Wet (32%)	-4	7	28	10	-1	1	0	-9	-7	0	-1	-22
Above Normal (15%)	-2	12	45	41	7	6	-2	-17	-13	-1	0	-2
Below Normal (17%)	-4	5	28	25	3	3	-1	-17	-15	-3	-2	9
Dry (22%)	-3	3	31	34	9	6	2	-14	-14	-1	-3	0
Critical (15%)	2	1	27	17	10	5	0	-6	-7	-1	2	3

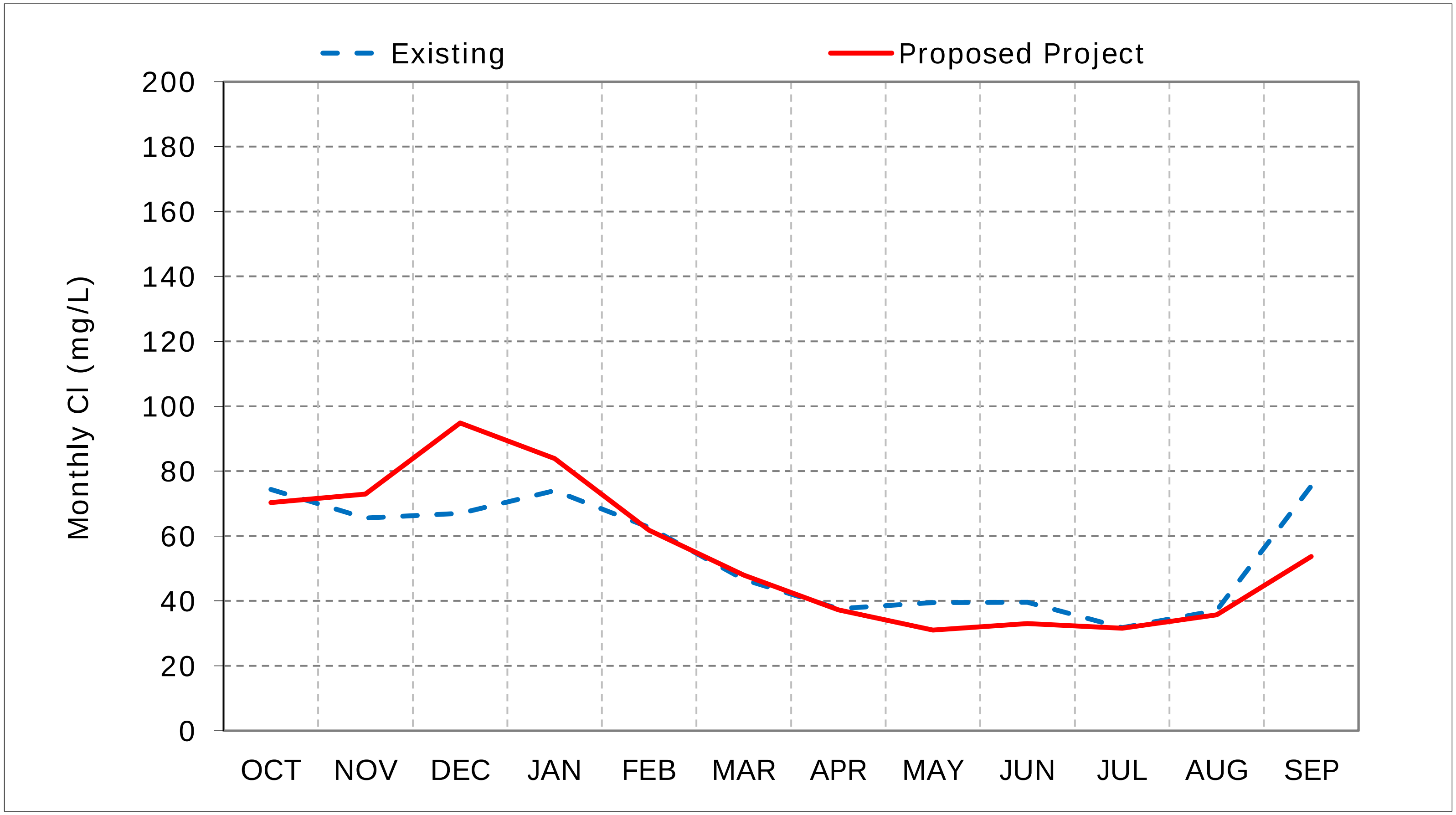
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 11-1. Banks Pumping Plant South Delta Exports Chloride, Long-Term Avera



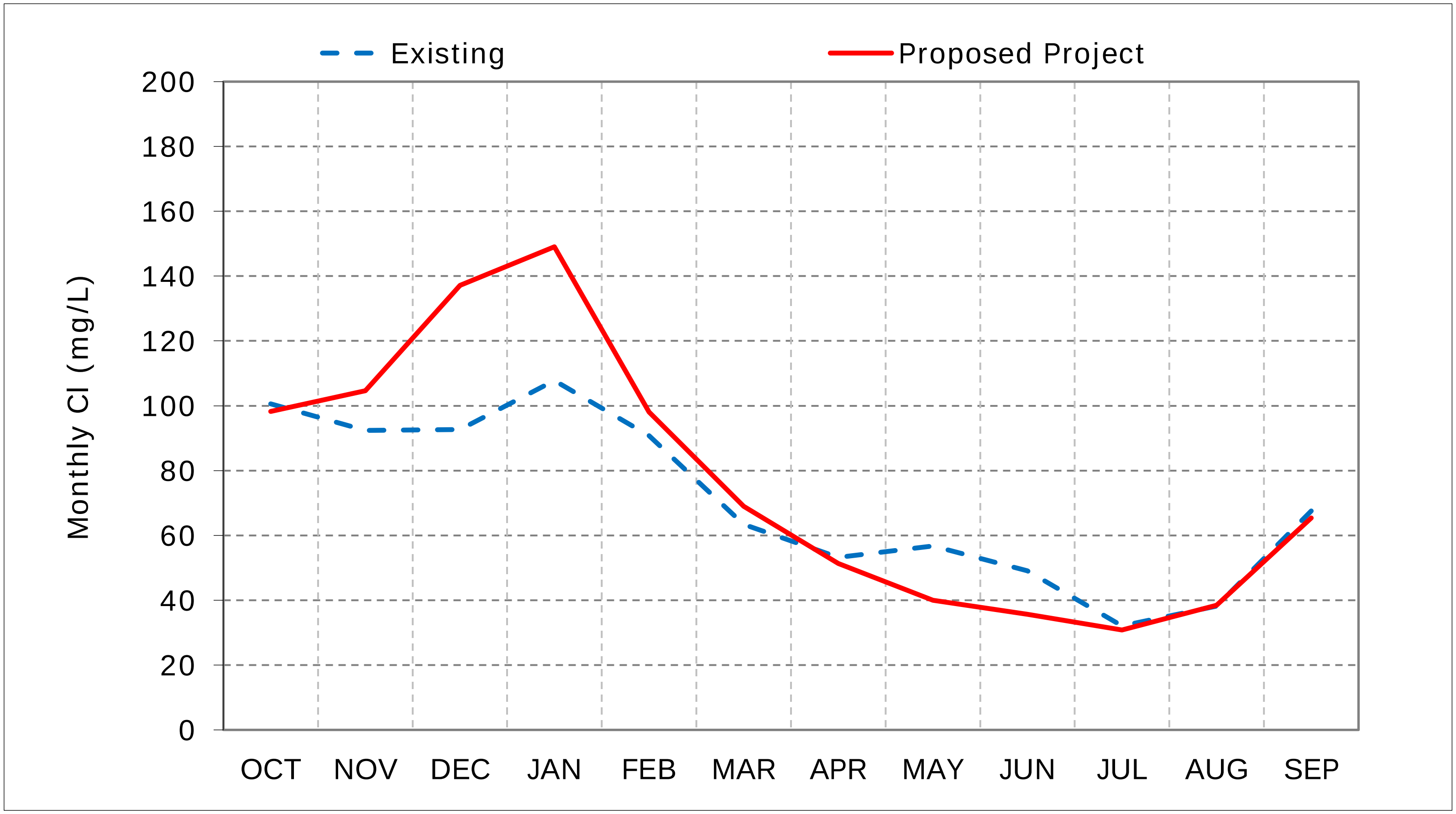
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 11-2. Banks Pumping Plant South Delta Exports Chloride, Wet Year Averag



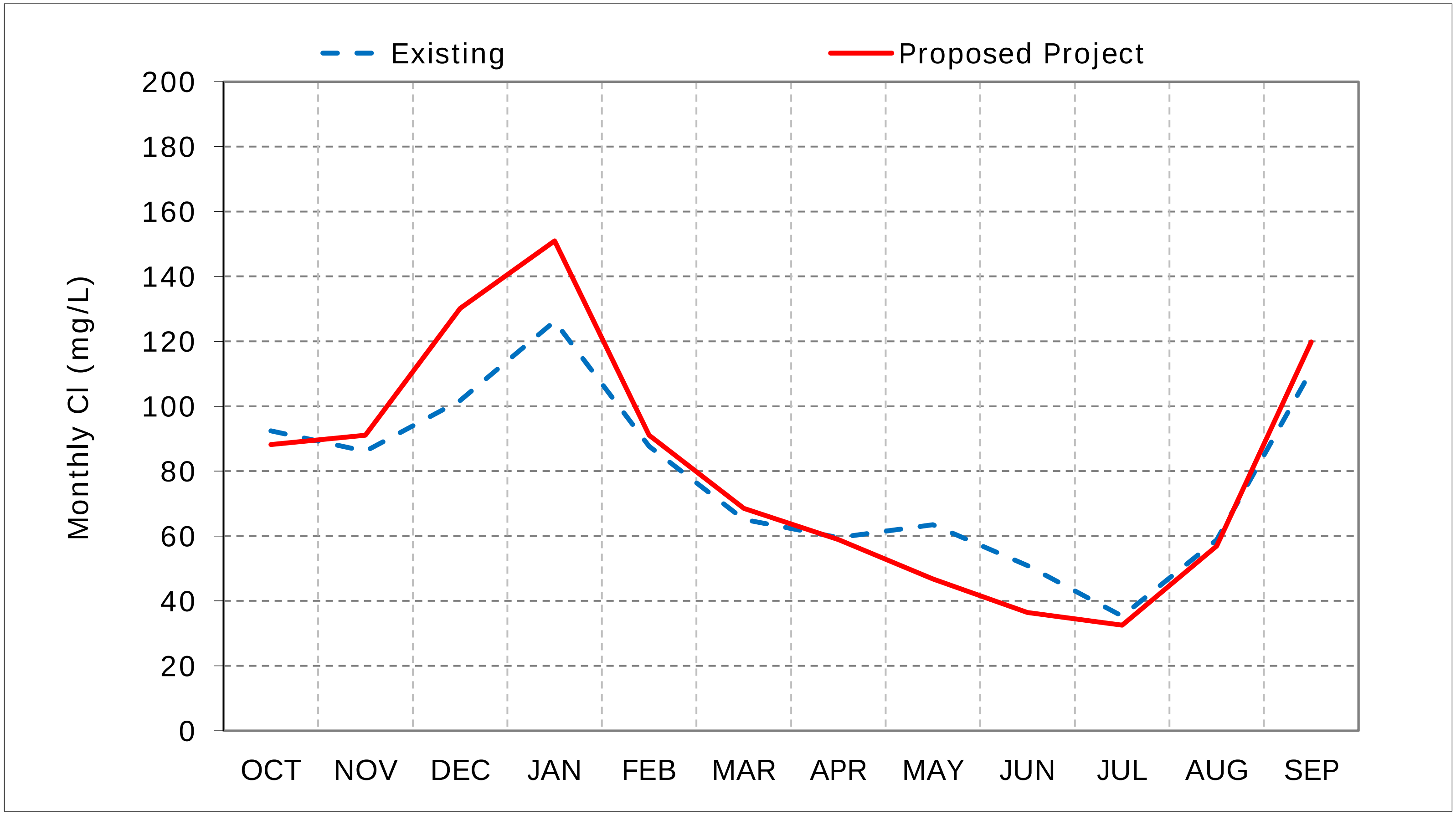
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 11-3. Banks Pumping Plant South Delta Exports Chloride, Above Normal Ye



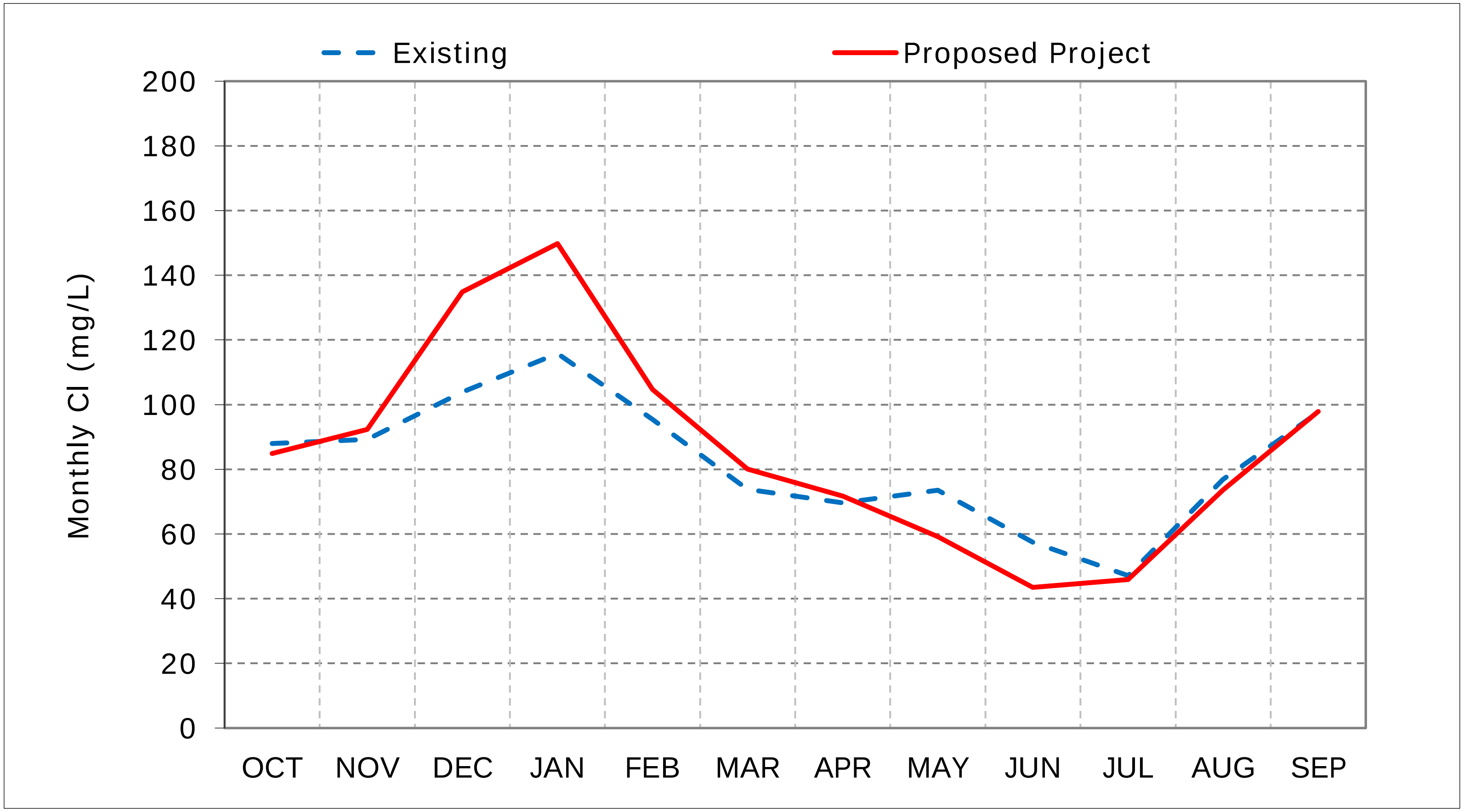
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 11-4. Banks Pumping Plant South Delta Exports Chloride, Below Normal Ye



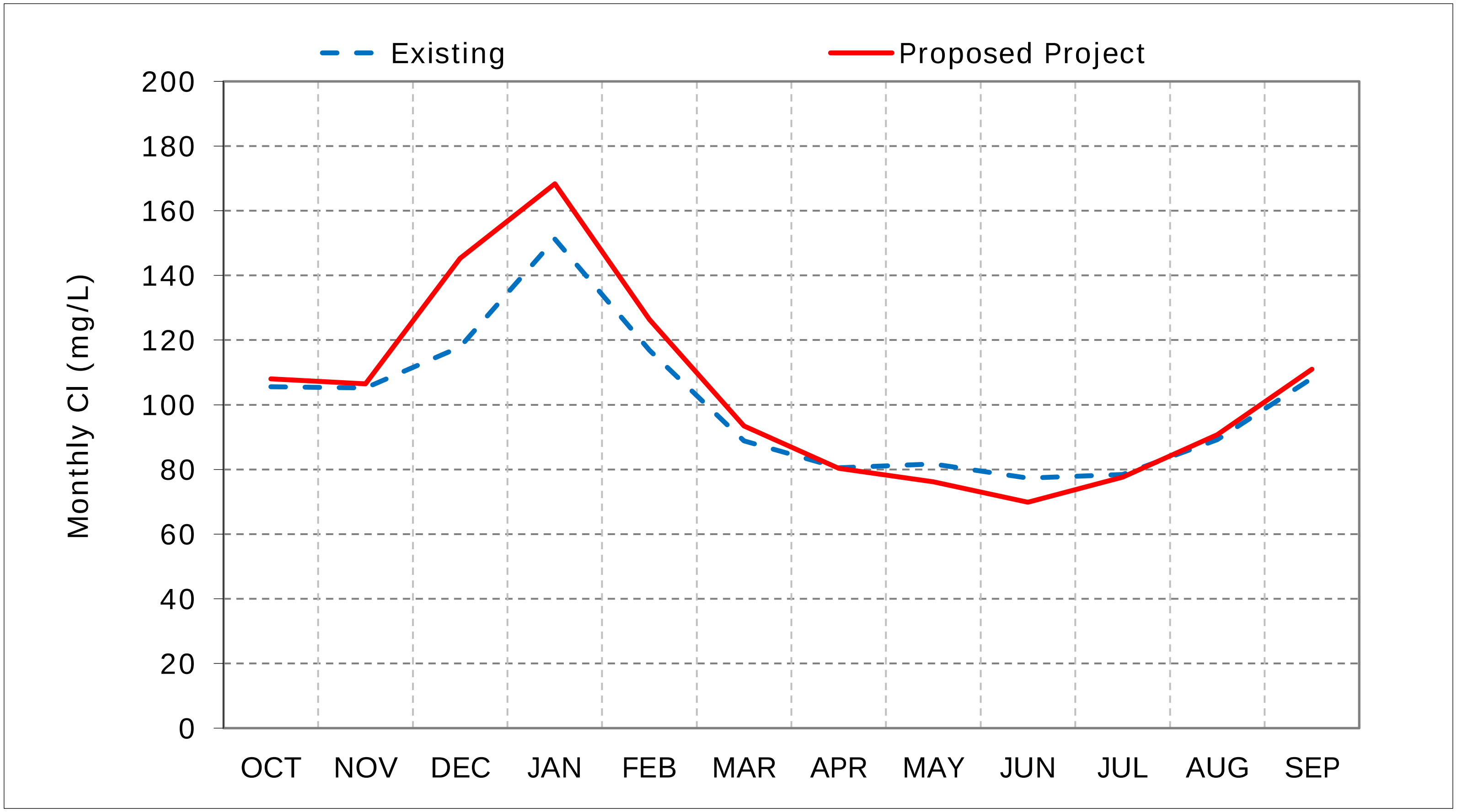
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 11-5. Banks Pumping Plant South Delta Exports Chloride, Dry Year Average



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 11-6. Banks Pumping Plant South Delta Exports Chloride, Critical Year Aver



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 11-7. Banks Pumping Plant South Delta Exports Chloride, January Cl

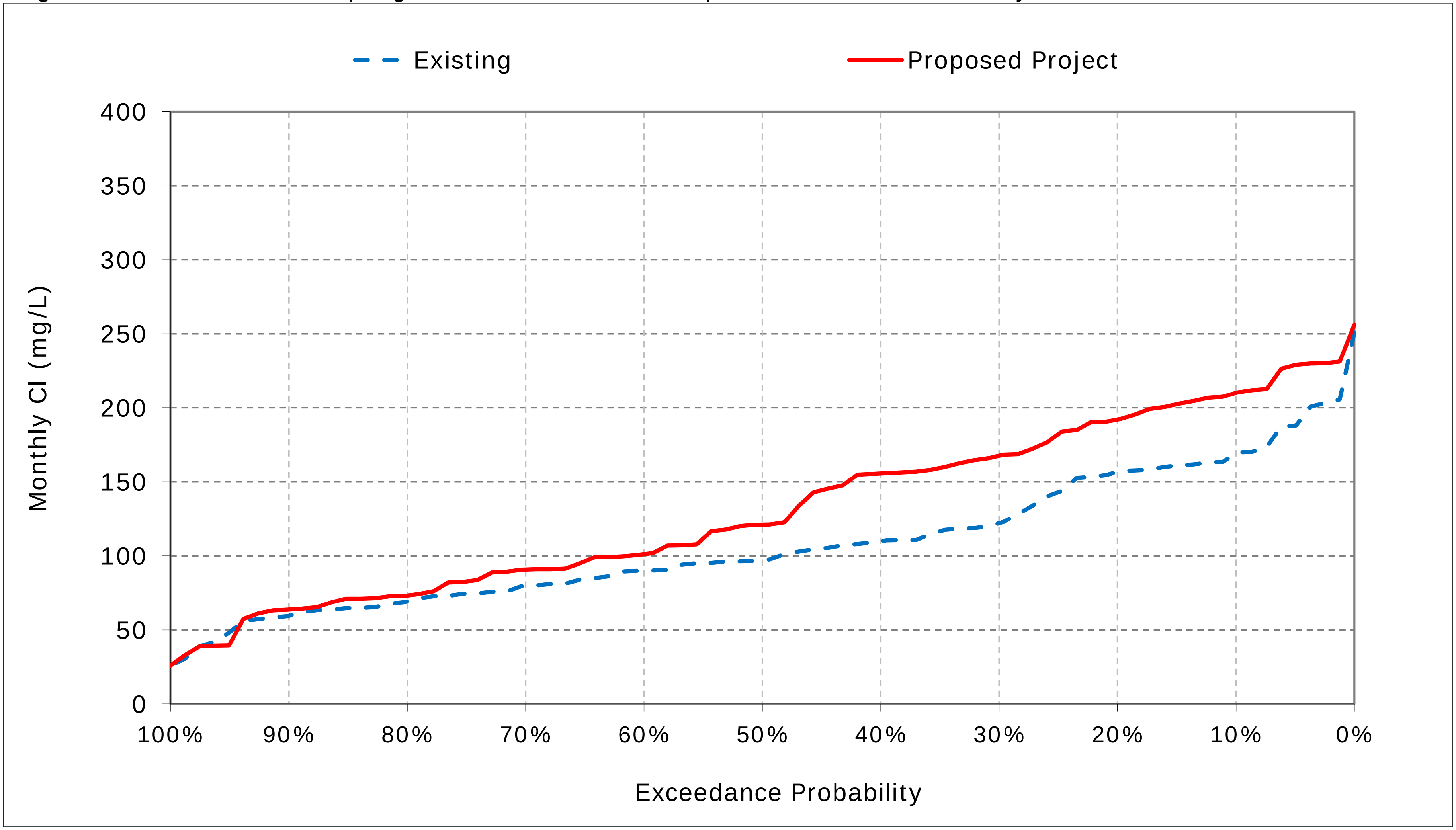


Figure 11-8. Banks Pumping Plant South Delta Exports Chloride, February Cl

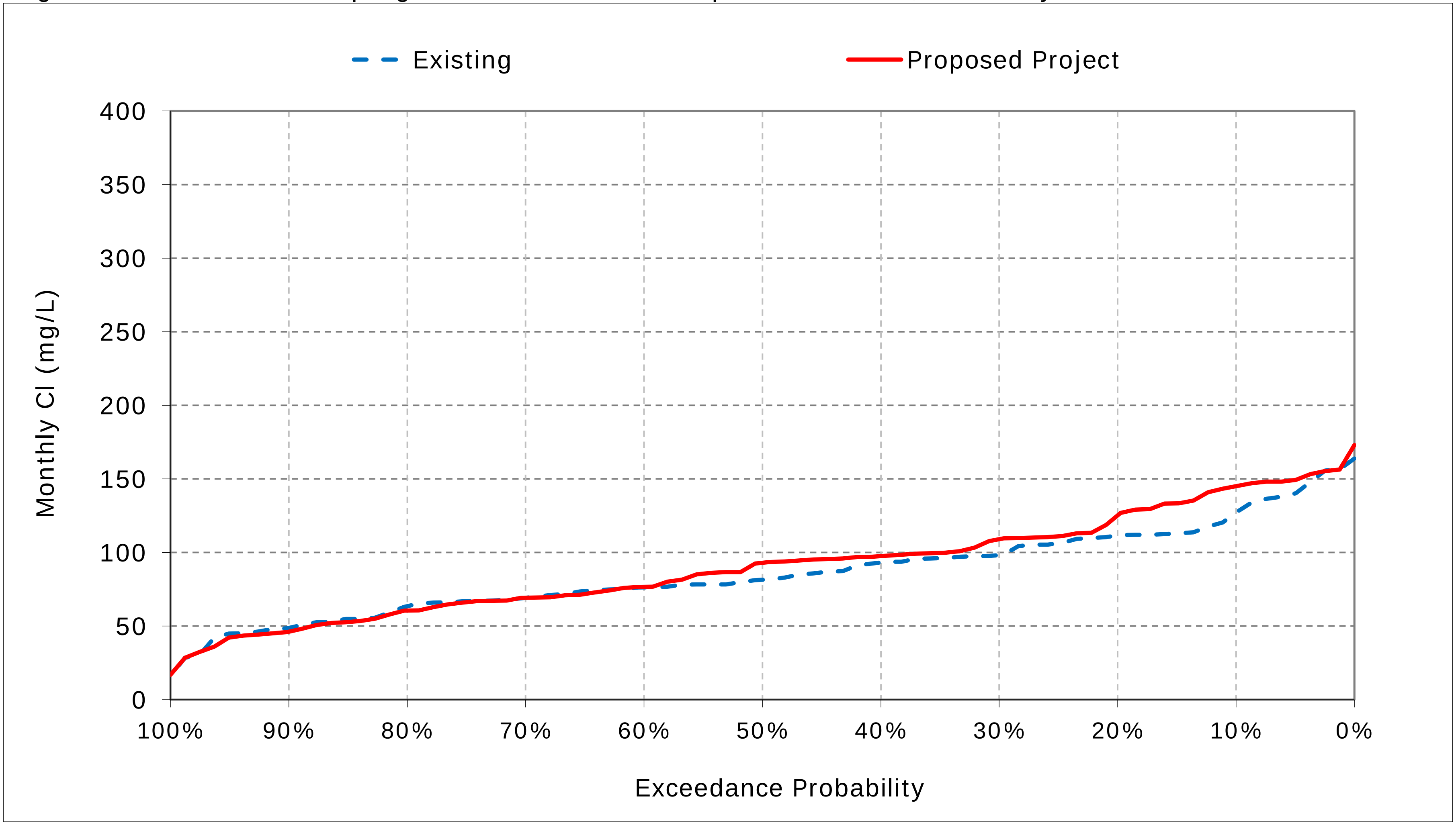


Figure 11-9. Banks Pumping Plant South Delta Exports Chloride, March Cl

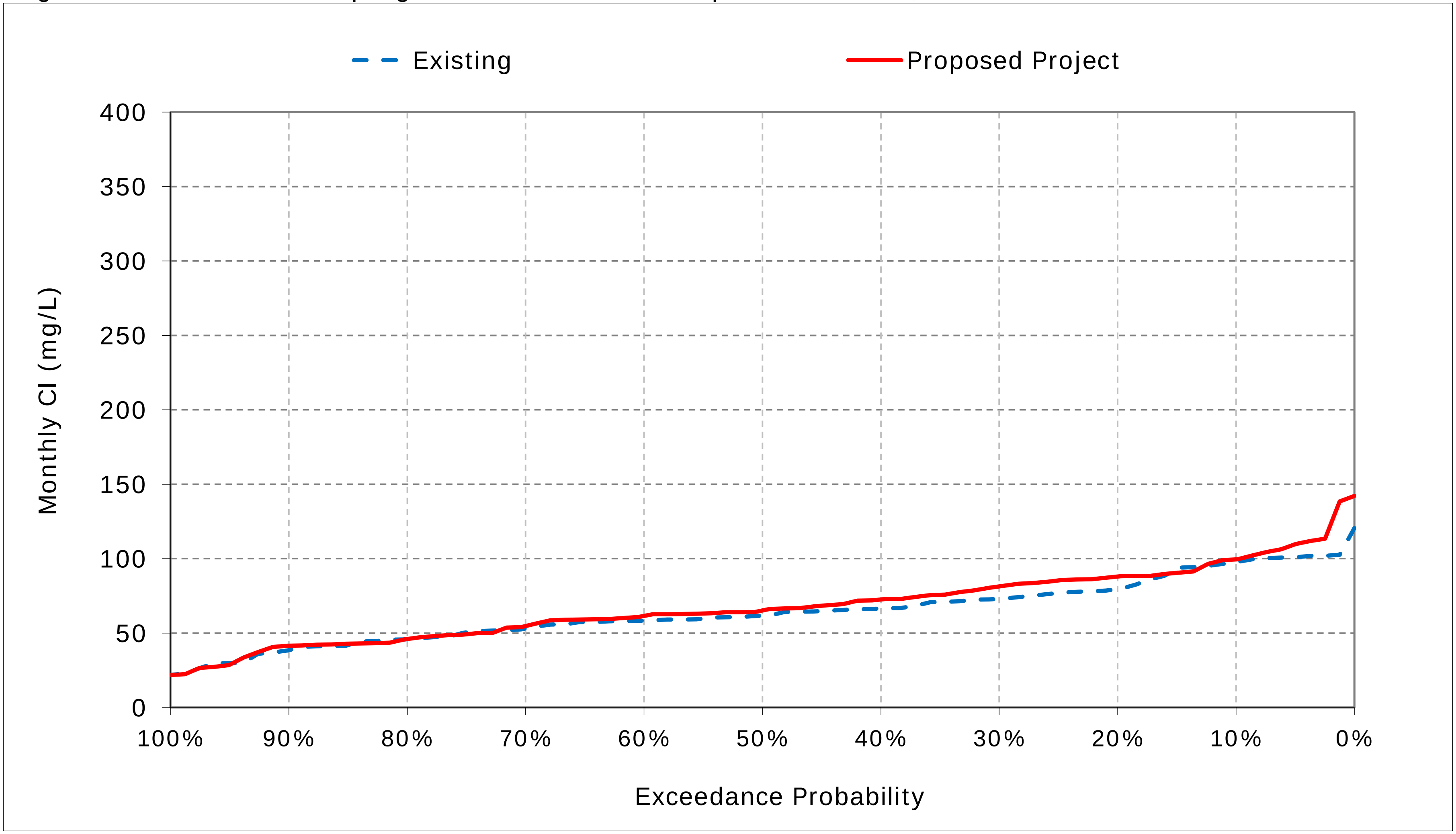


Figure 11-10. Banks Pumping Plant South Delta Exports Chloride, April Cl

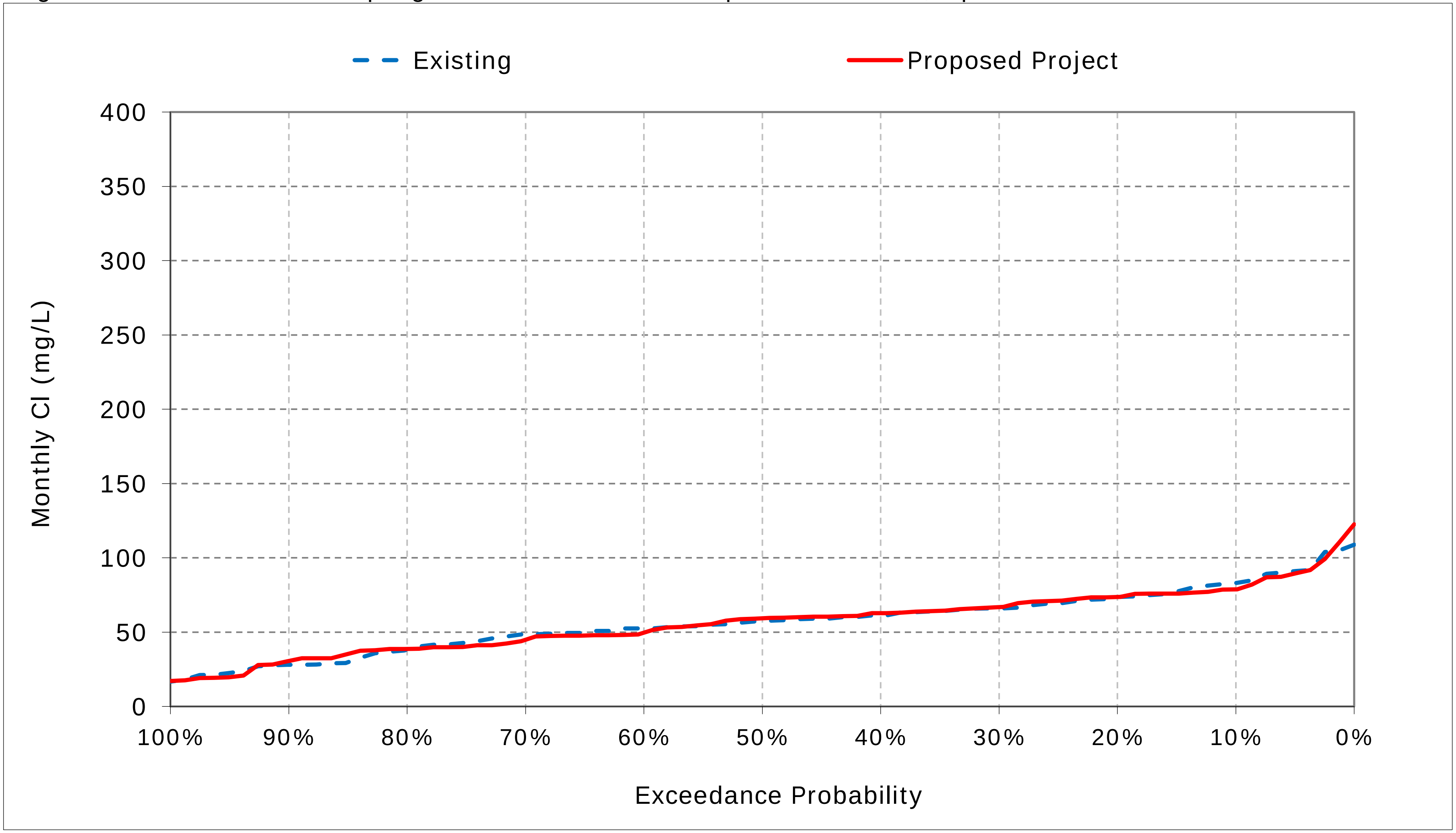


Figure 11-11. Banks Pumping Plant South Delta Exports Chloride, May Cl

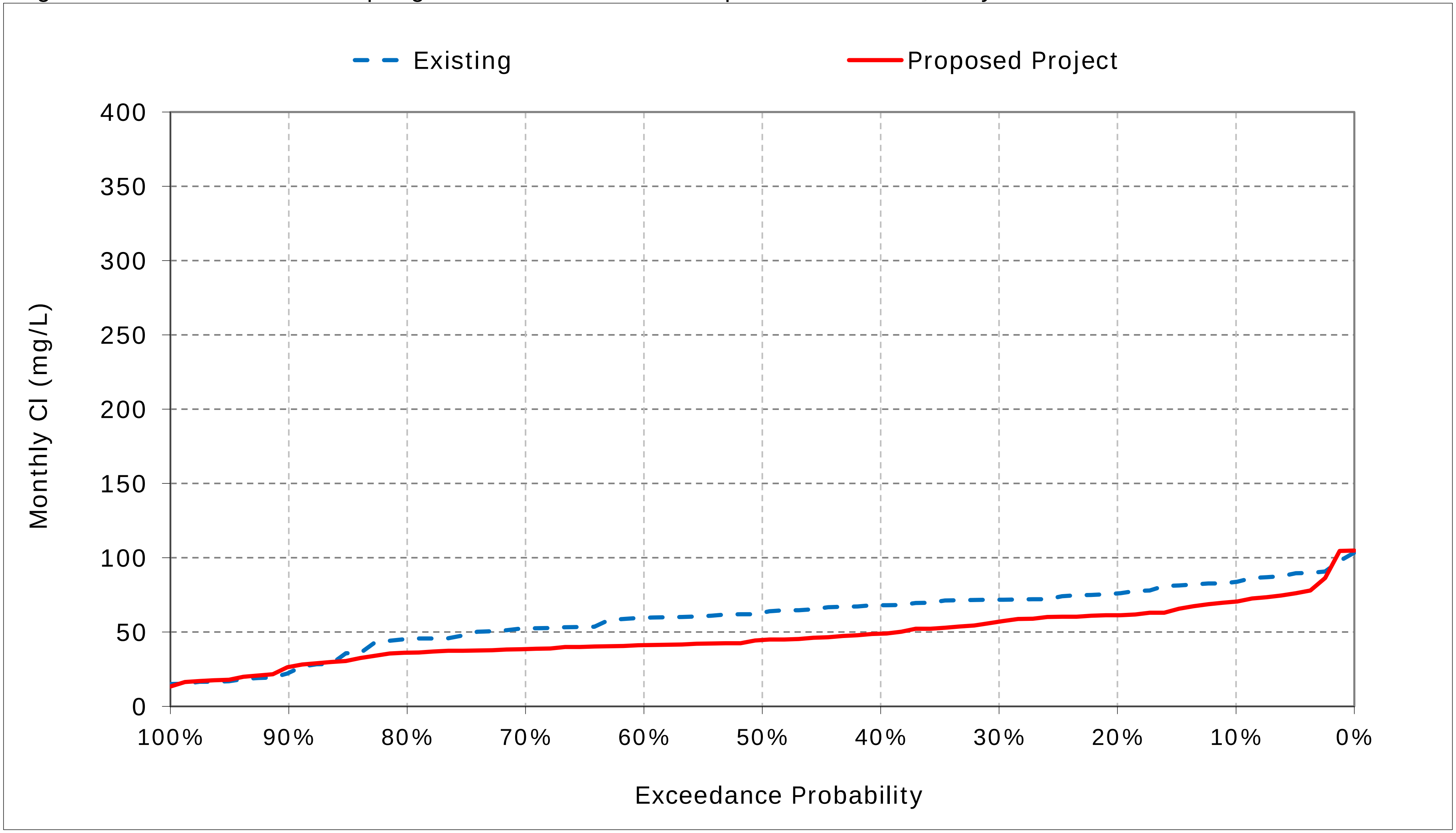


Figure 11-12. Banks Pumping Plant South Delta Exports Chloride, June Cl

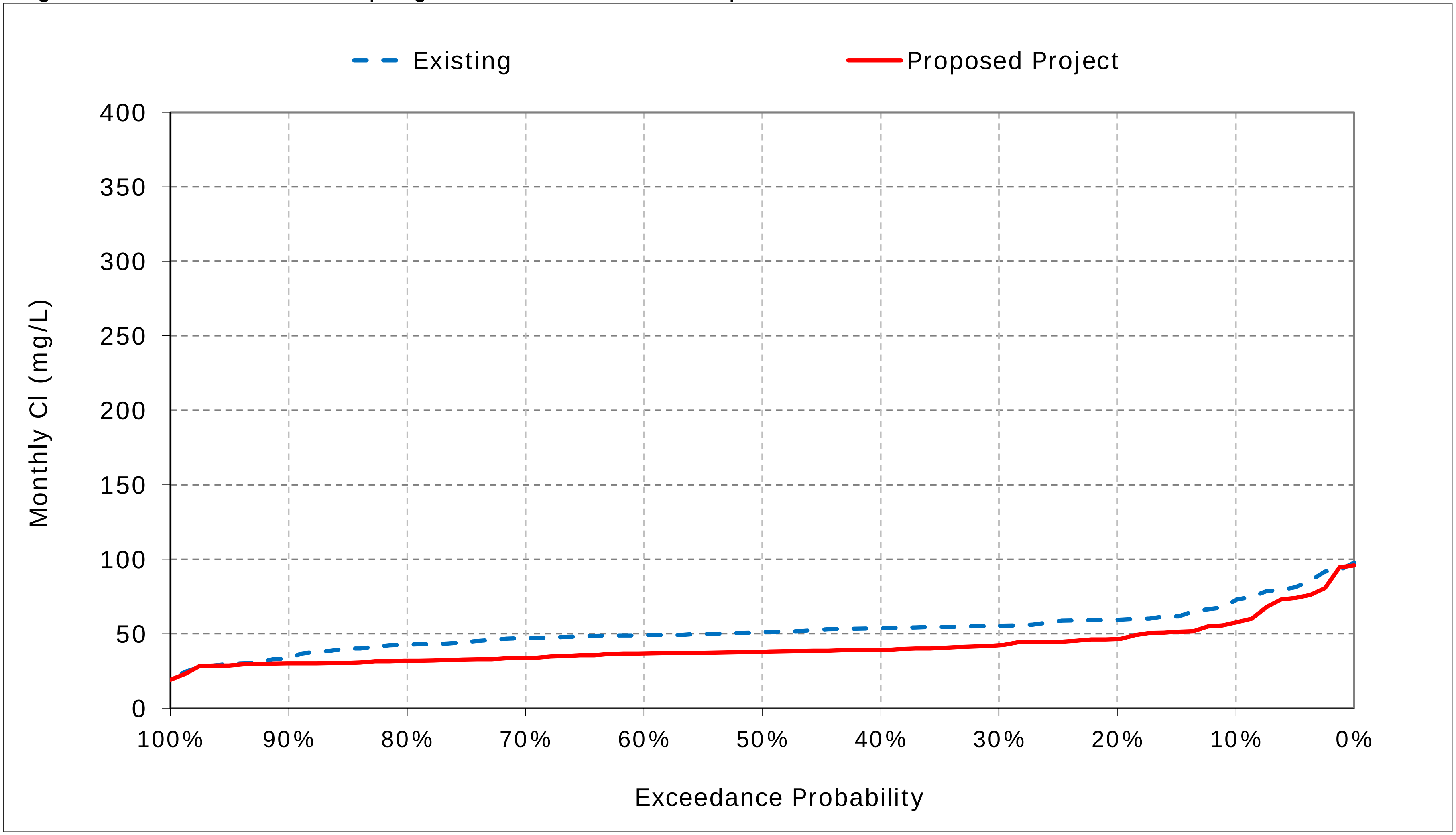


Figure 11-13. Banks Pumping Plant South Delta Exports Chloride, July Cl

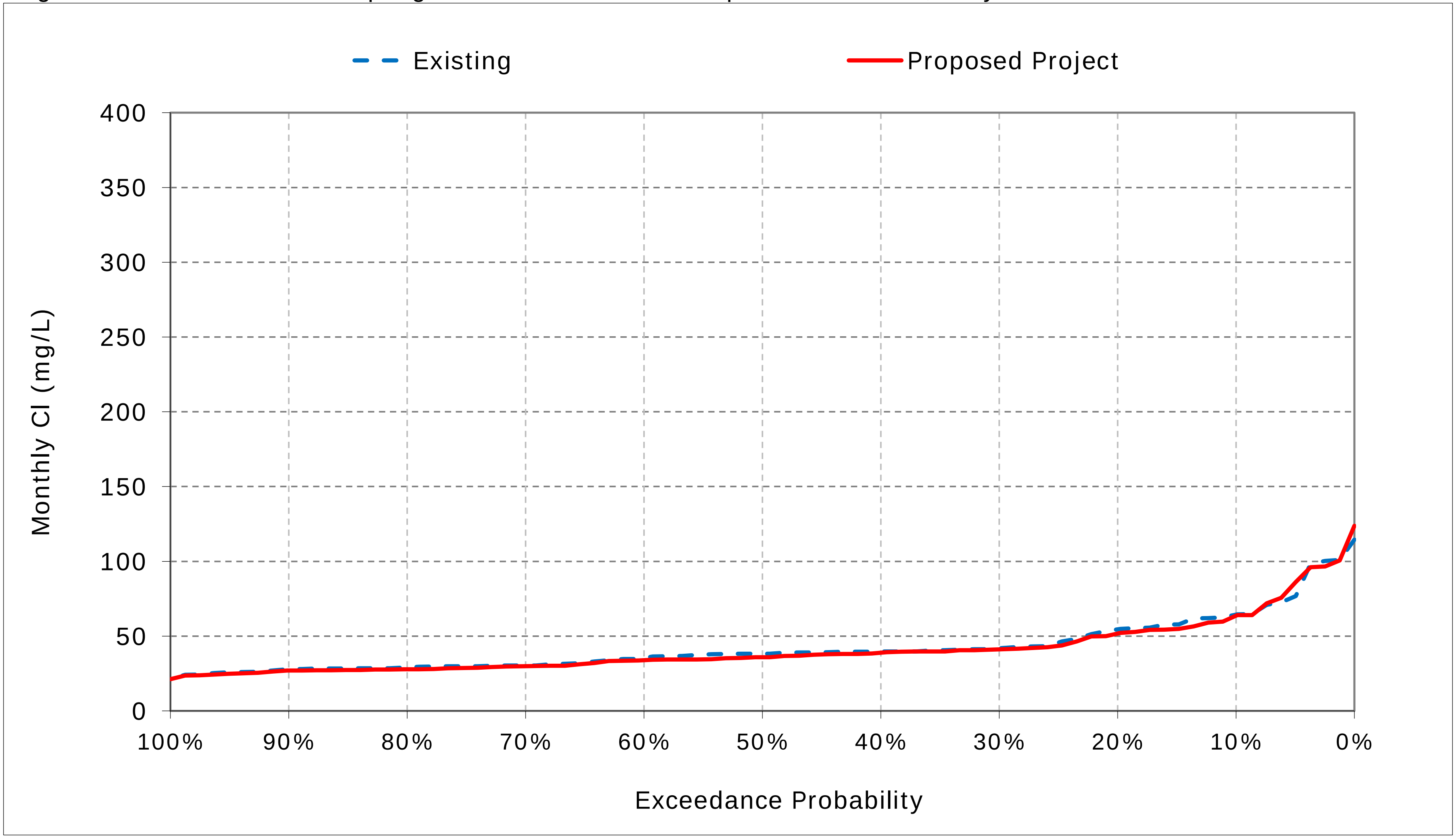


Figure 11-14. Banks Pumping Plant South Delta Exports Chloride, August Cl

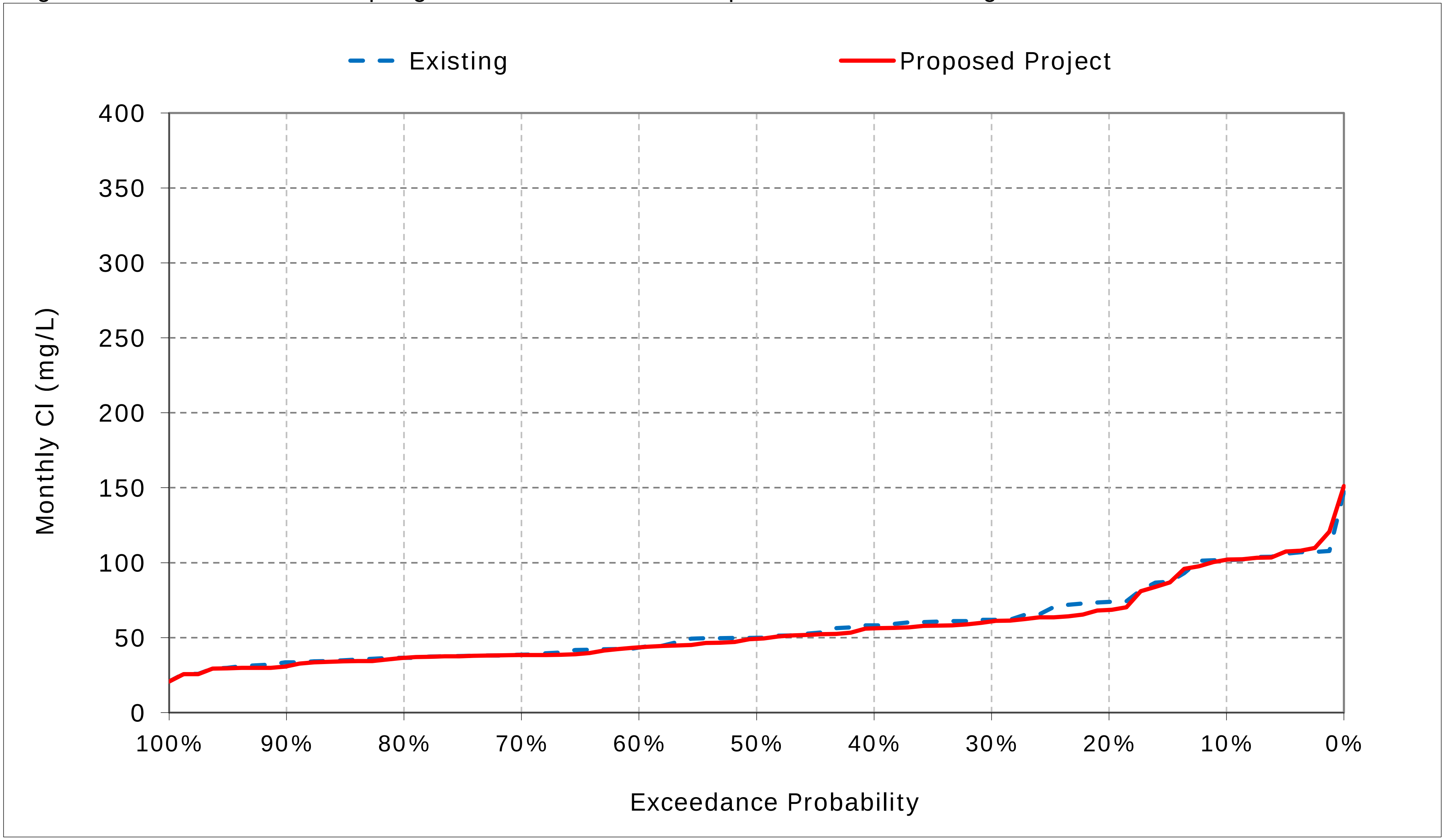


Figure 11-15. Banks Pumping Plant South Delta Exports Chloride, September Cl

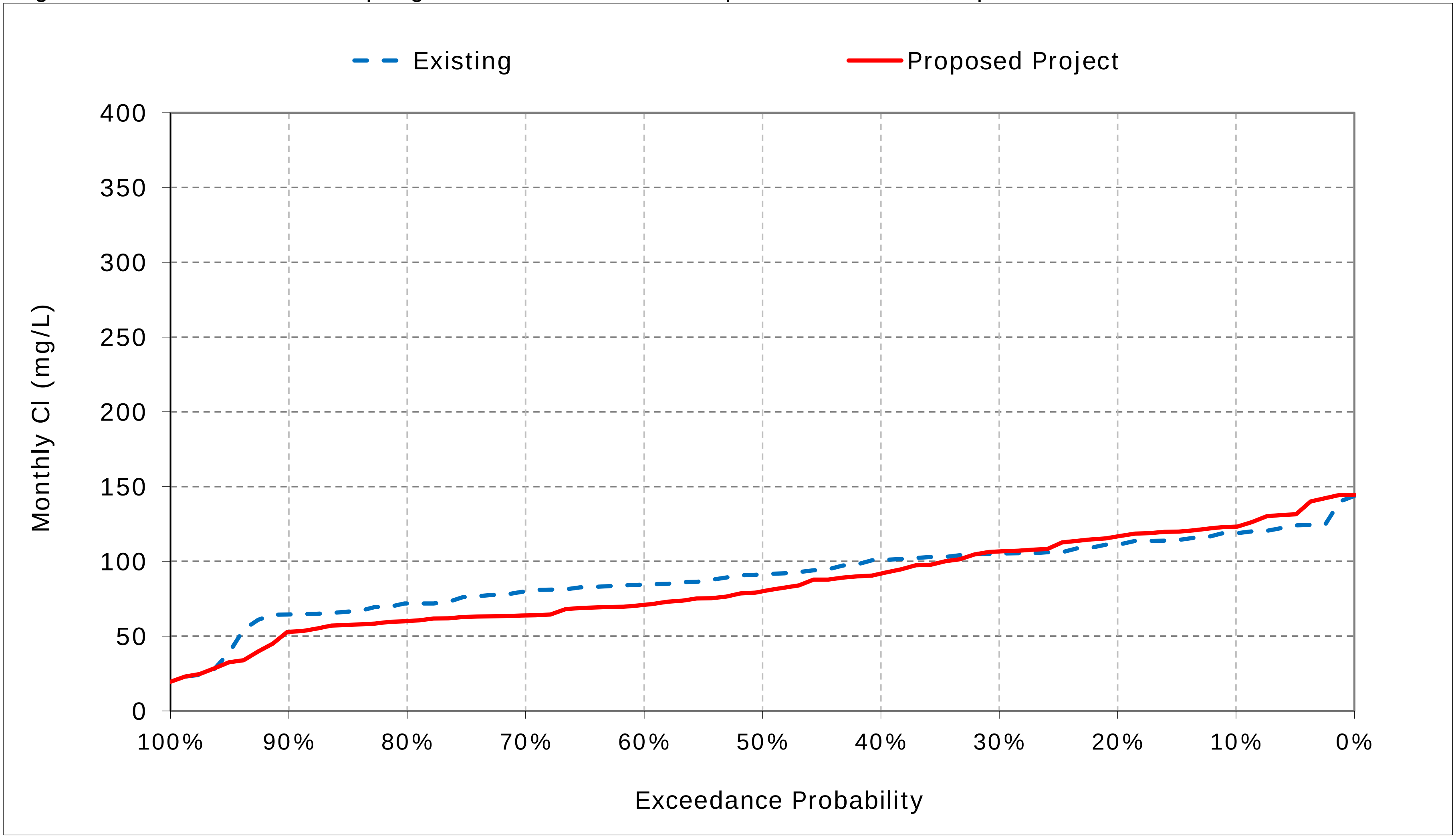


Figure 11-16. Banks Pumping Plant South Delta Exports Chloride, October Cl

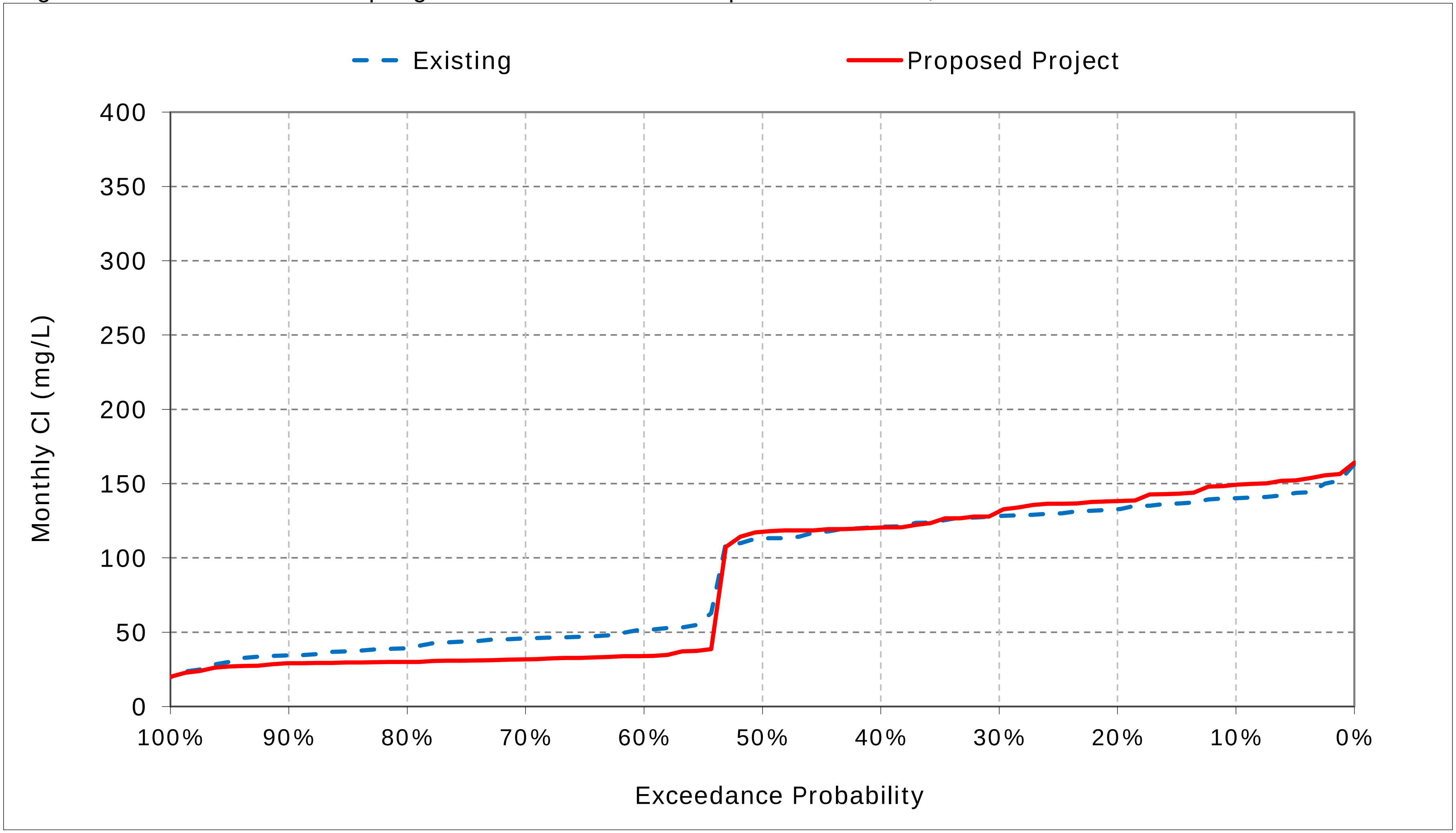


Figure 11-17. Banks Pumping Plant South Delta Exports Chloride, November Cl

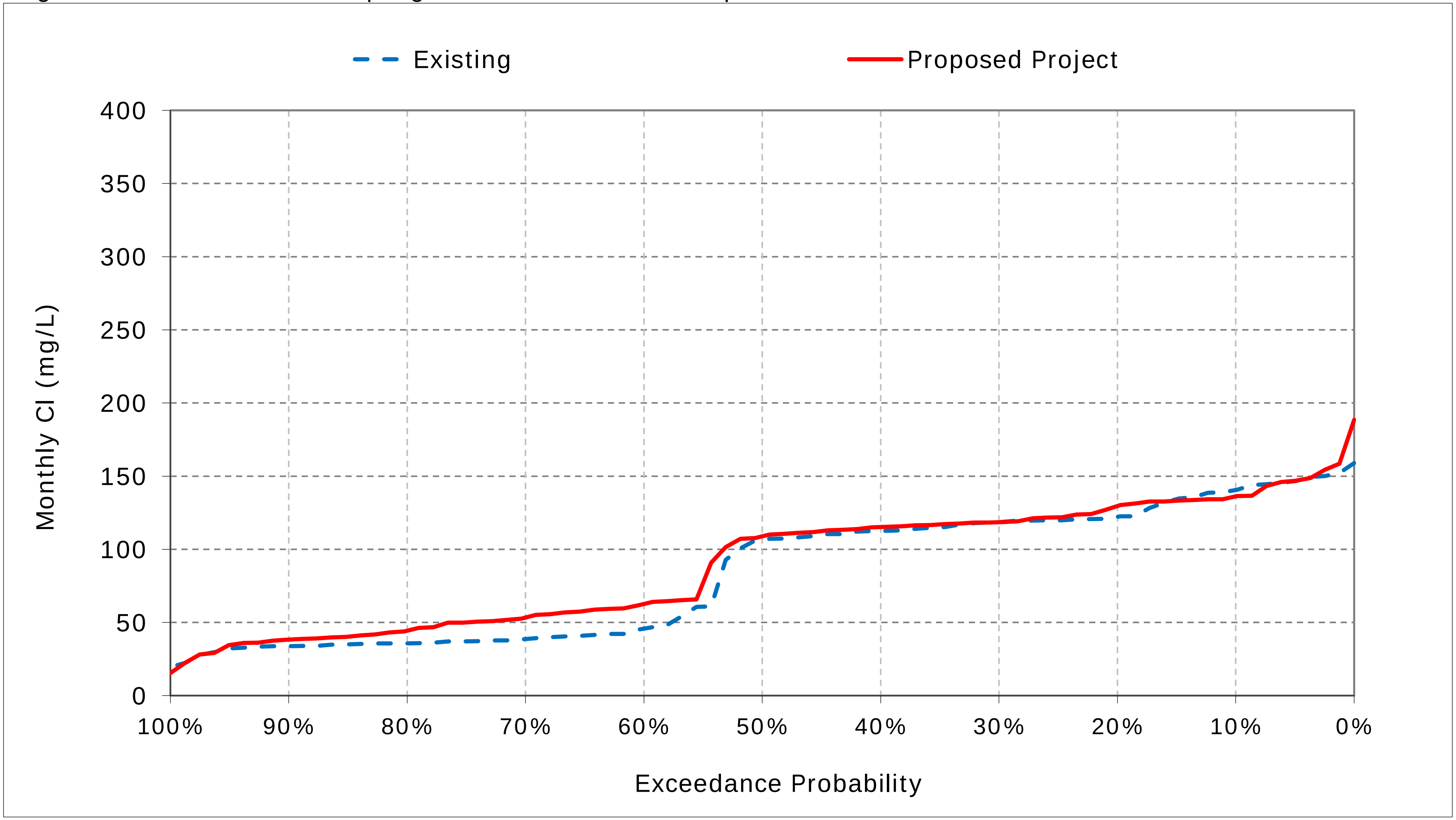


Figure 11-18. Banks Pumping Plant South Delta Exports Chloride, December Cl

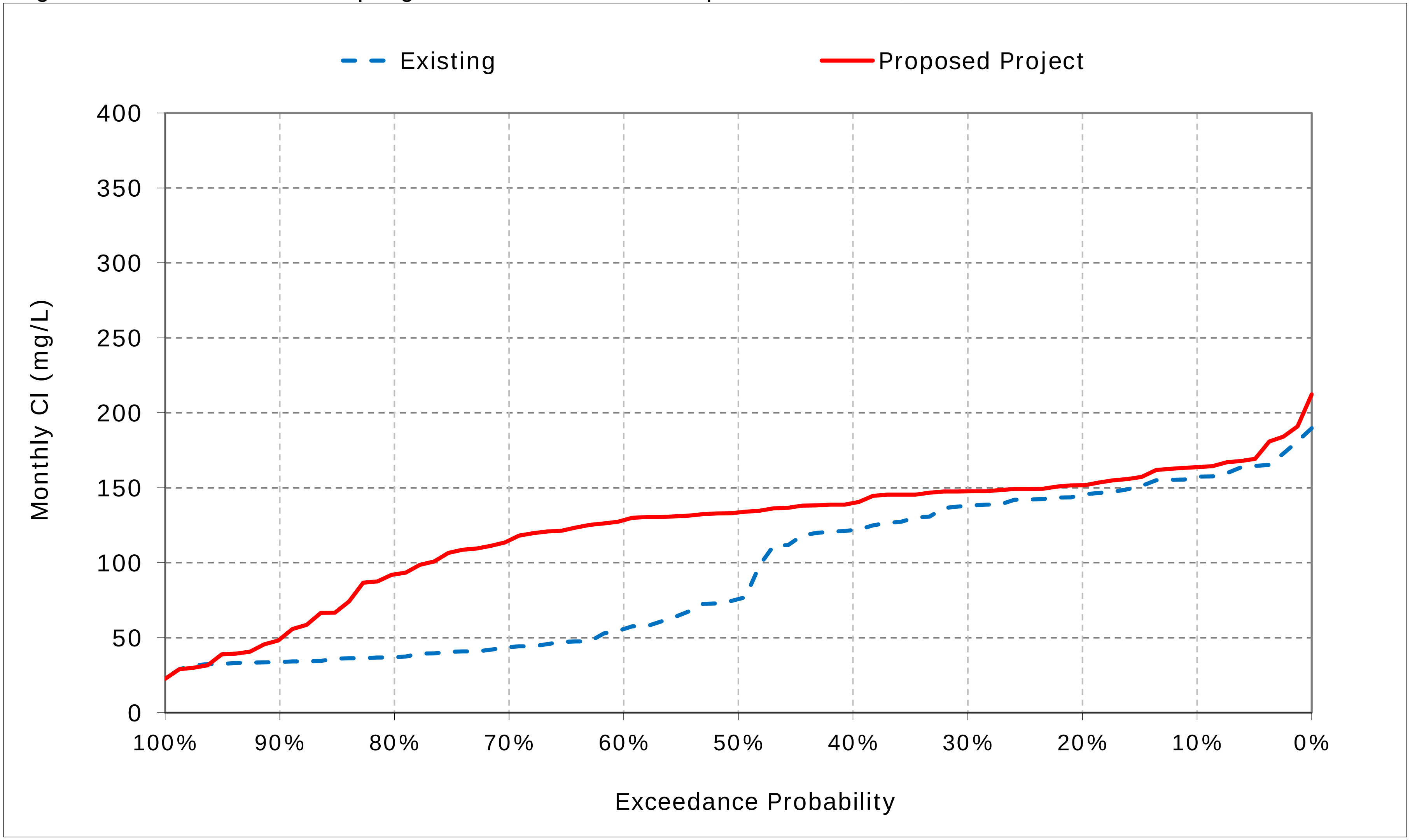


Table 12-1. Jones Pumping Plant South Delta Exports Chloride, Monthly Cl

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	136	138	168	171	144	126	96	82	67	68	103	120
20%	131	122	157	164	138	118	89	77	59	60	82	115
30%	126	119	149	142	126	107	81	73	57	57	71	108
40%	120	113	137	133	119	101	74	70	55	54	68	106
50%	111	106	105	125	112	90	65	62	54	48	62	97
60%	56	65	92	115	99	68	57	57	52	46	55	88
70%	52	52	79	106	84	53	47	53	51	42	49	80
80%	48	47	73	99	64	42	37	45	48	38	46	74
90%	44	44	71	72	44	35	26	22	44	33	44	65
Long Term												
Full Simulation Period[a]	90	90	114	125	103	85	63	60	55	52	65	93
Water Year Types[b]												
Wet (32%)	76	73	93	93	67	48	38	39	48	43	45	75
Above Normal (15%)	101	95	114	125	105	69	57	57	54	44	49	70
Below Normal (17%)	93	93	121	136	99	82	67	64	53	47	69	113
Dry (22%)	91	95	124	136	129	111	81	73	54	55	84	103
Critical (15%)	106	108	139	164	143	144	94	81	73	77	94	117

Proposed Project

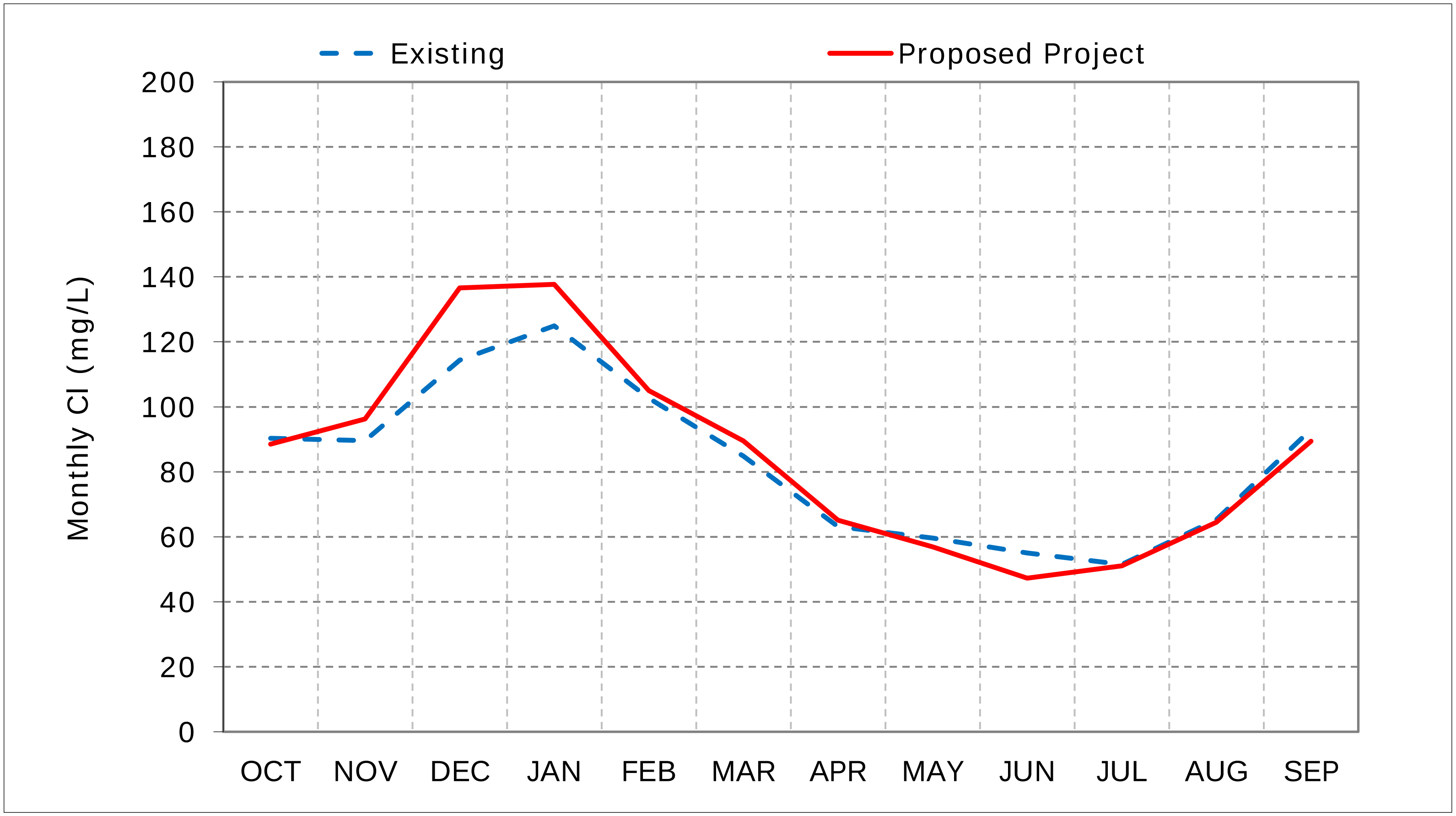
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	139	136	171	193	159	142	113	92	60	68	105	127
20%	129	127	161	184	144	125	97	82	54	62	77	118
30%	124	120	157	169	131	115	84	72	50	58	71	111
40%	118	116	153	159	123	104	68	57	47	52	66	104
50%	112	111	148	139	110	95	58	51	45	46	60	89
60%	51	76	143	124	98	76	50	47	43	43	54	76
70%	47	68	130	108	81	54	45	45	41	40	49	70
80%	45	62	106	99	64	43	37	39	39	37	46	64
90%	43	52	83	72	46	34	25	21	34	32	40	58
Long Term												
Full Simulation Period[a]	88	96	137	138	105	90	65	57	47	51	64	89
Water Year Types[b]												
Wet (32%)	74	82	111	98	66	50	35	34	44	43	43	58
Above Normal (15%)	99	108	148	148	107	69	49	46	45	43	49	71
Below Normal (17%)	89	97	142	150	99	89	62	53	43	46	67	120
Dry (22%)	90	99	147	156	133	121	87	75	44	54	82	104
Critical (15%)	106	110	159	172	153	149	118	95	66	79	96	120

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	3	-2	3	21	16	16	18	10	-7	0	2	6
20%	-2	5	4	20	6	7	8	5	-5	2	-5	3
30%	-2	1	7	26	5	8	3	-1	-7	0	0	3
40%	-2	3	16	26	4	3	-6	-12	-9	-2	-1	-2
50%	0	5	43	15	-2	5	-7	-11	-9	-2	-2	-8
60%	-5	11	51	9	-2	8	-7	-10	-9	-3	-1	-12
70%	-5	16	51	2	-3	1	-3	-8	-10	-2	0	-10
80%	-2	15	33	0	0	1	0	-6	-9	-1	0	-9
90%	-1	9	12	0	1	-1	-1	-1	-9	-1	-4	-7
Long Term												
Full Simulation Period[a]	-2	7	22	13	2	5	2	-3	-8	0	-1	-4
Water Year Types[b]												
Wet (32%)	-2	9	18	4	-1	2	-3	-5	-4	0	-1	-17
Above Normal (15%)	-3	13	34	23	2	1	-8	-11	-10	-2	0	0
Below Normal (17%)	-4	5	21	14	0	7	-5	-10	-10	-1	-1	7
Dry (22%)	-1	4	23	20	4	9	6	1	-10	-1	-2	1
Critical (15%)	0	2	20	9	10	5	24	14	-7	1	3	3

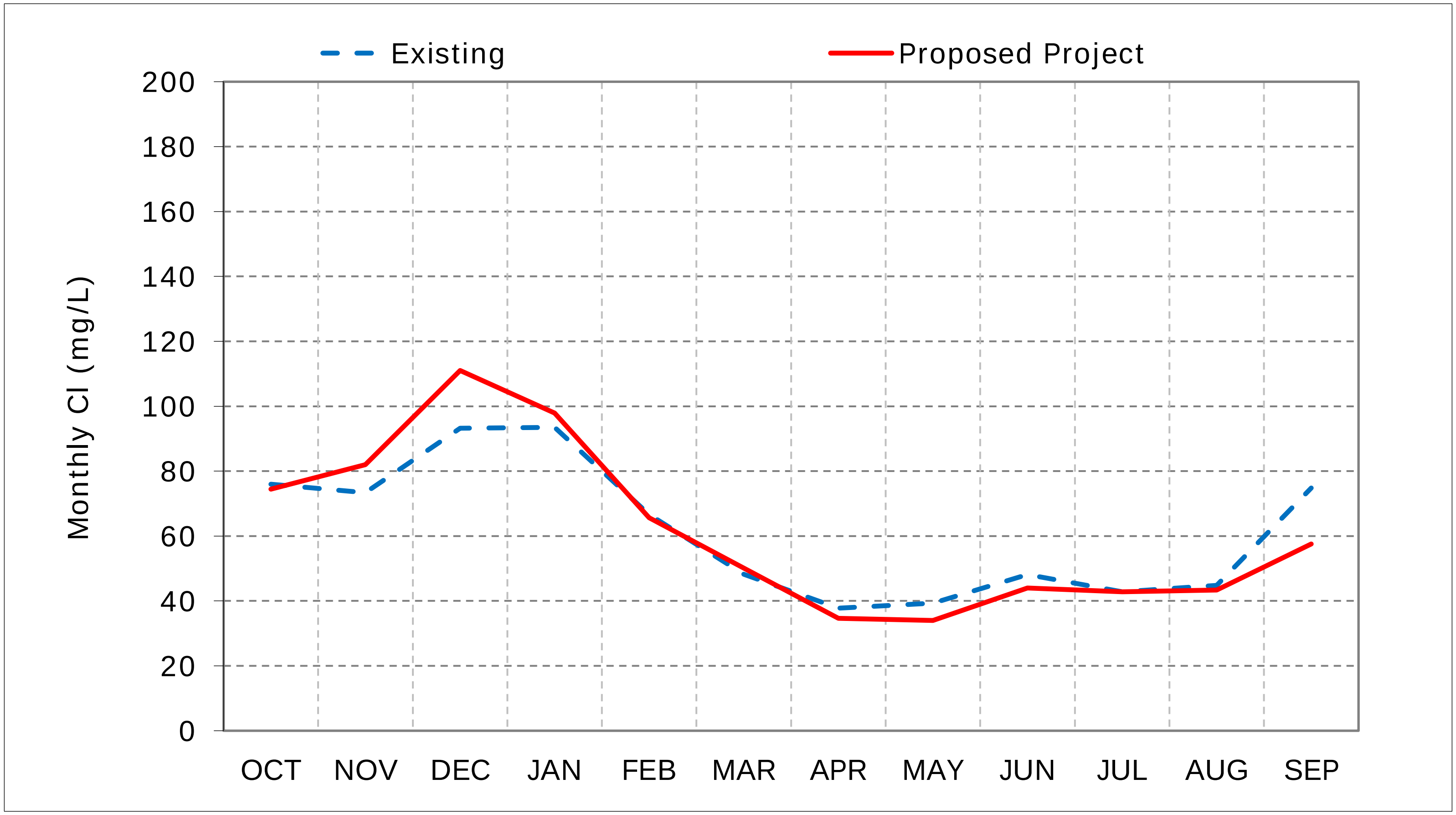
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 12-1. Jones Pumping Plant South Delta Exports Chloride, Long-Term Avera



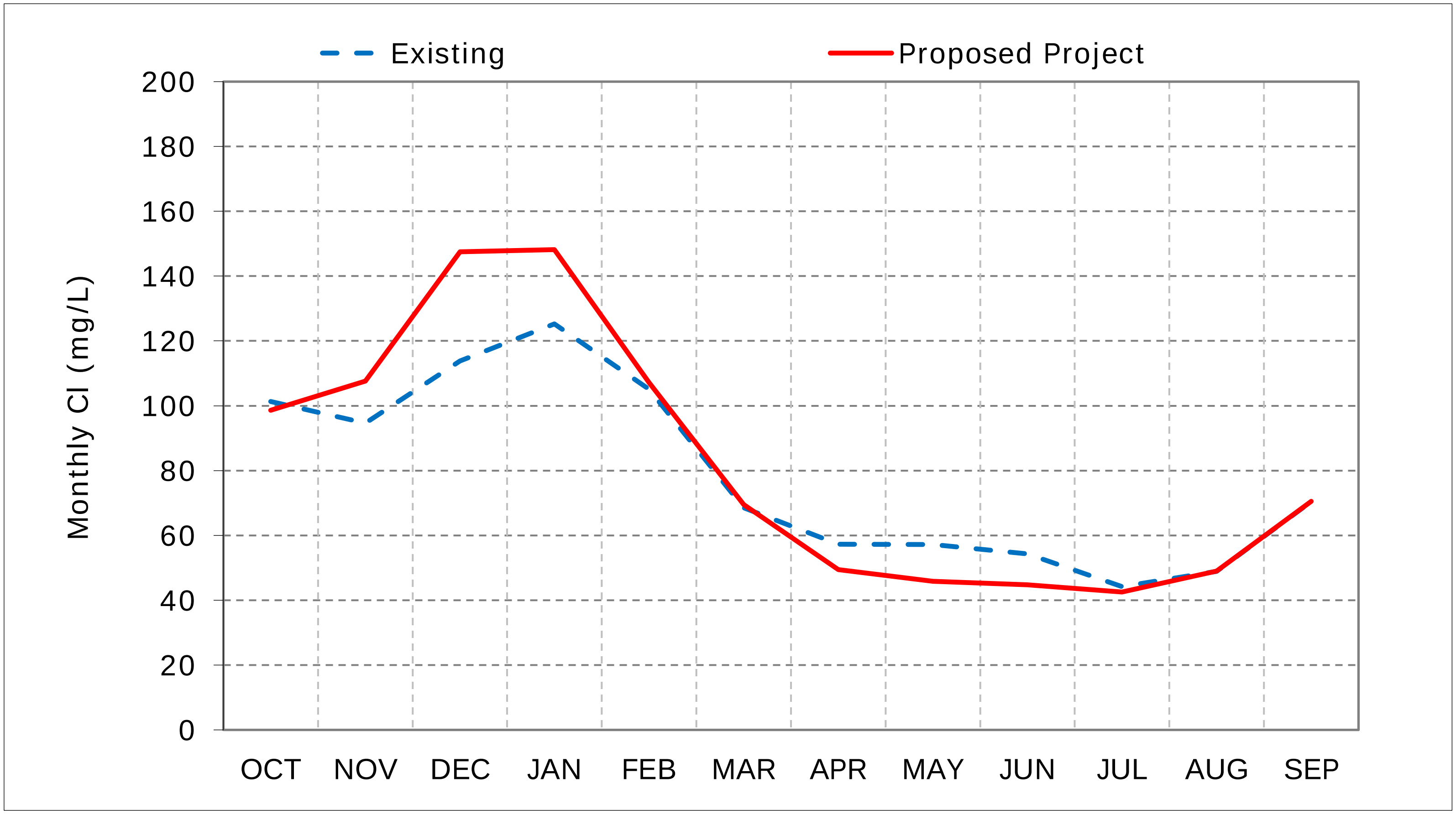
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 12-2. Jones Pumping Plant South Delta Exports Chloride, Wet Year Average



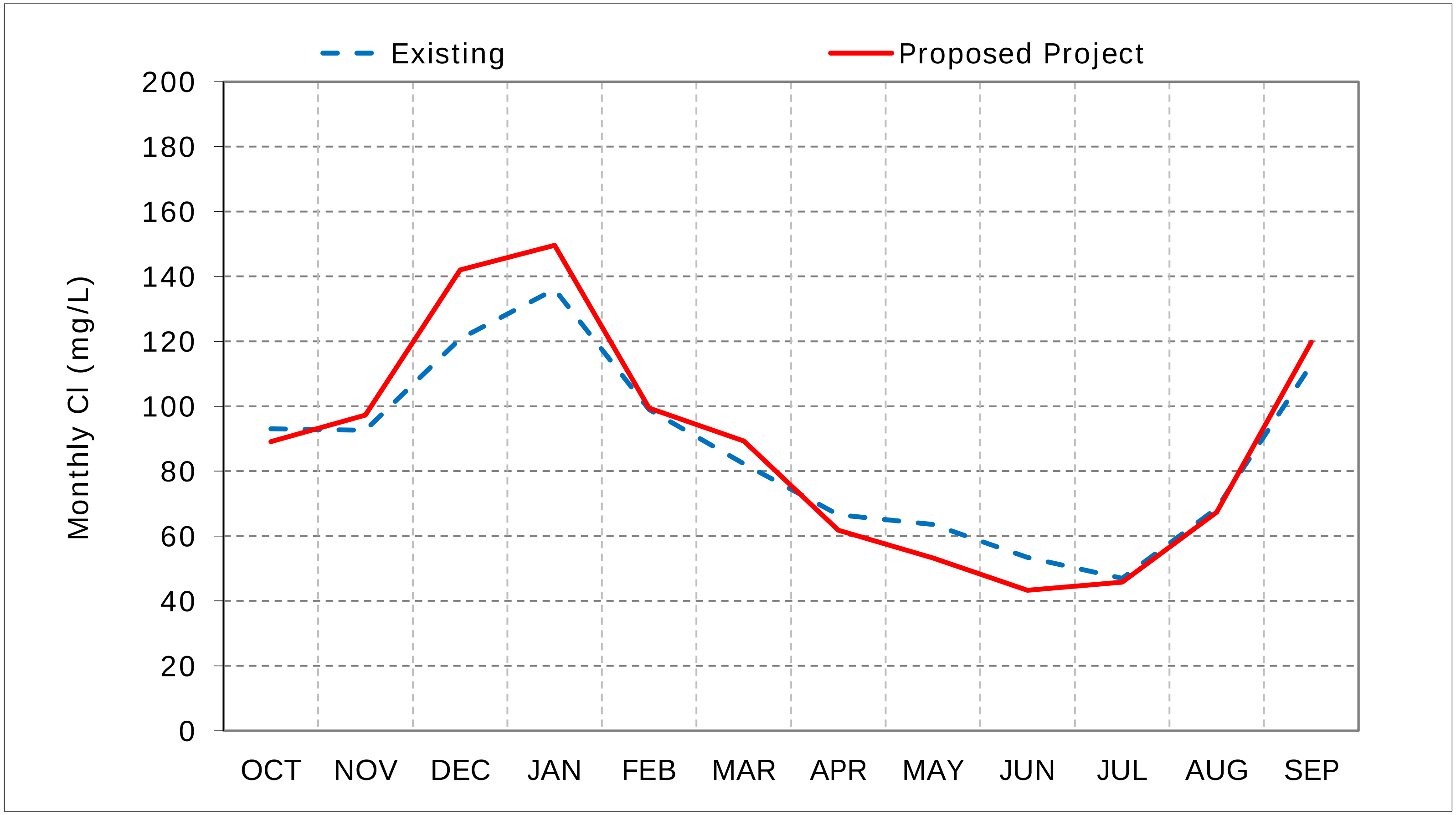
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 12-3. Jones Pumping Plant South Delta Exports Chloride, Above Normal Ye



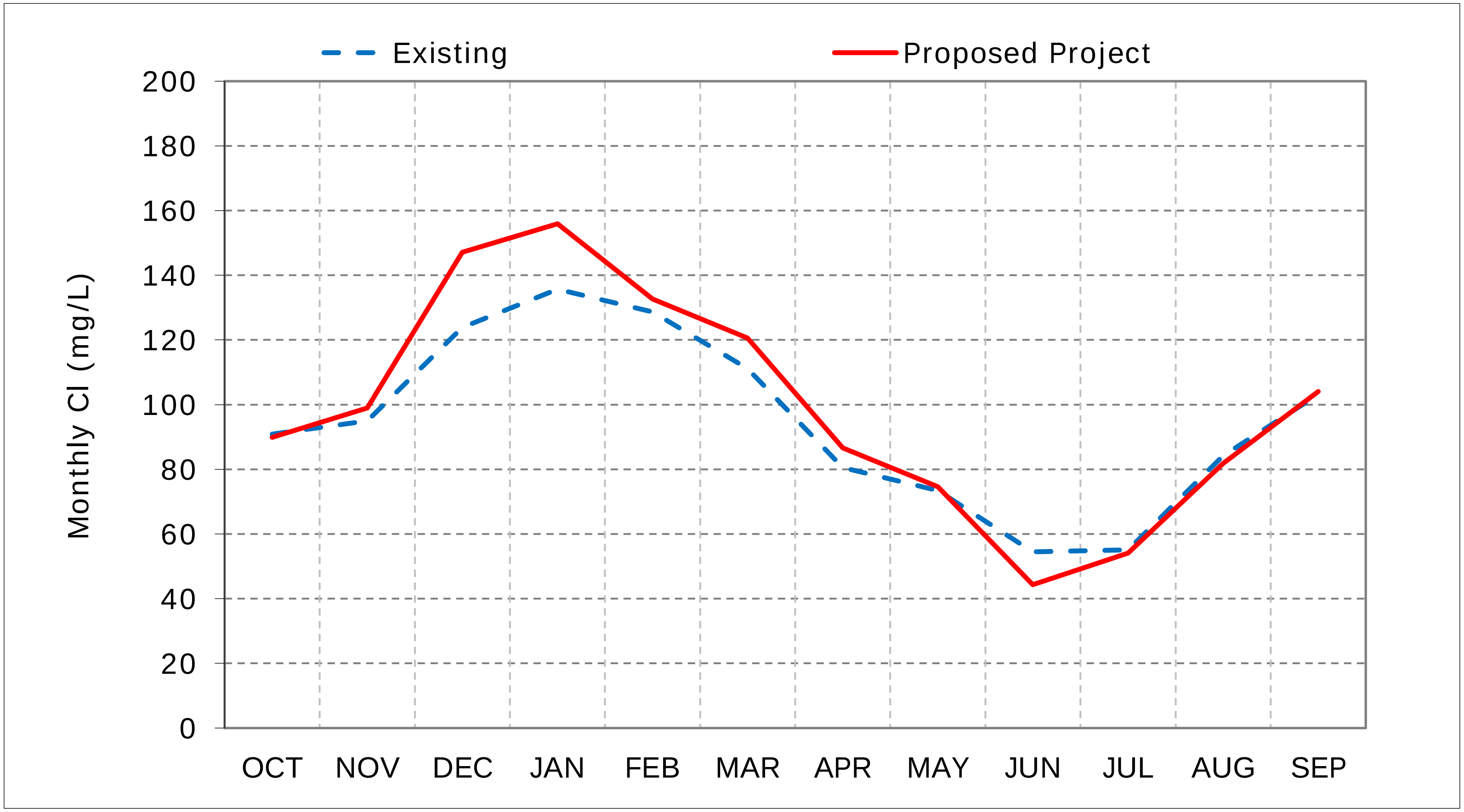
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 12-4. Jones Pumping Plant South Delta Exports Chloride, Below Normal Yea



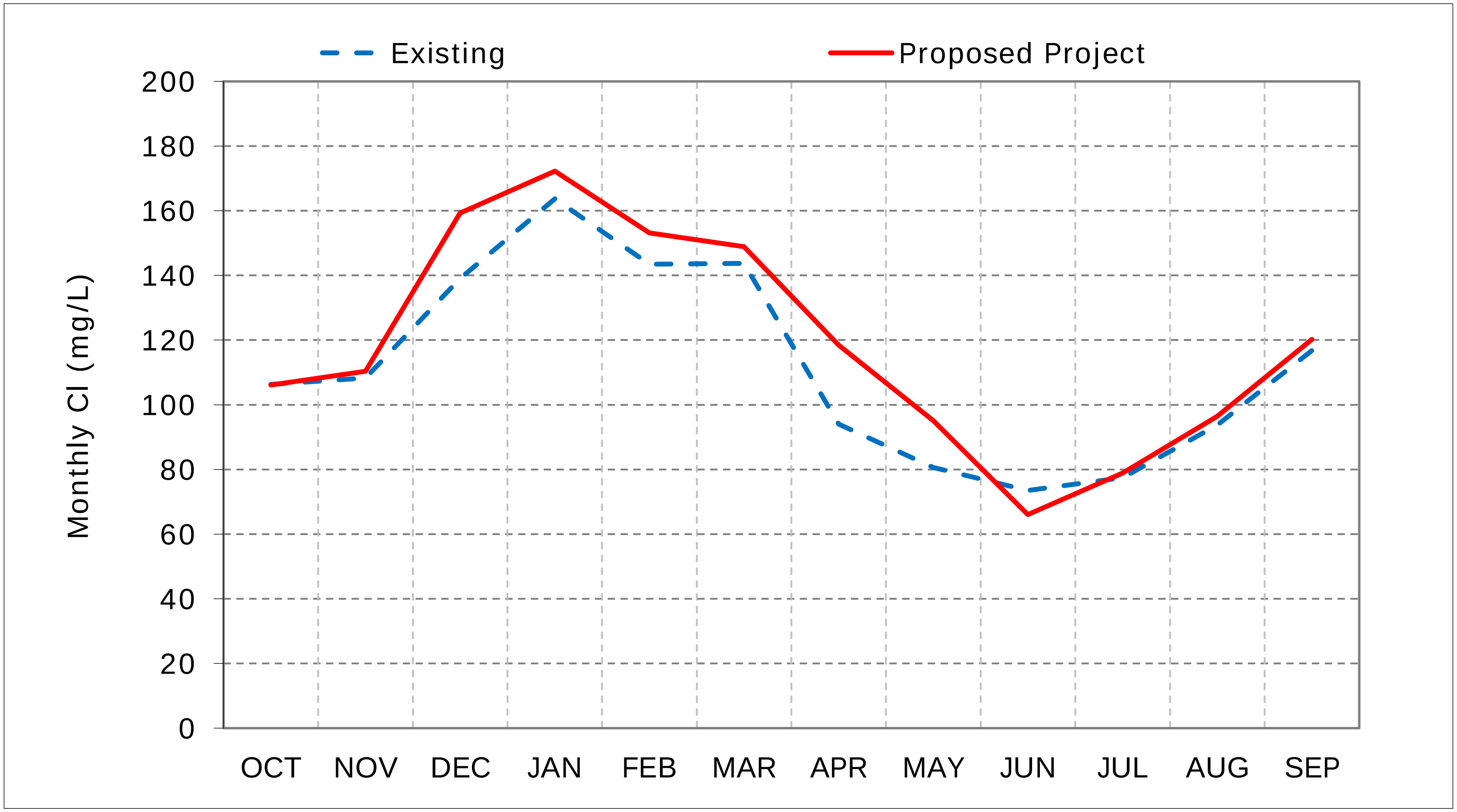
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 12-5. Jones Pumping Plant South Delta Exports Chloride, Dry Year Average



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 12-6. Jones Pumping Plant South Delta Exports Chloride, Critical Year Aver



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 12-7. Jones Pumping Plant South Delta Exports Chloride, January Cl

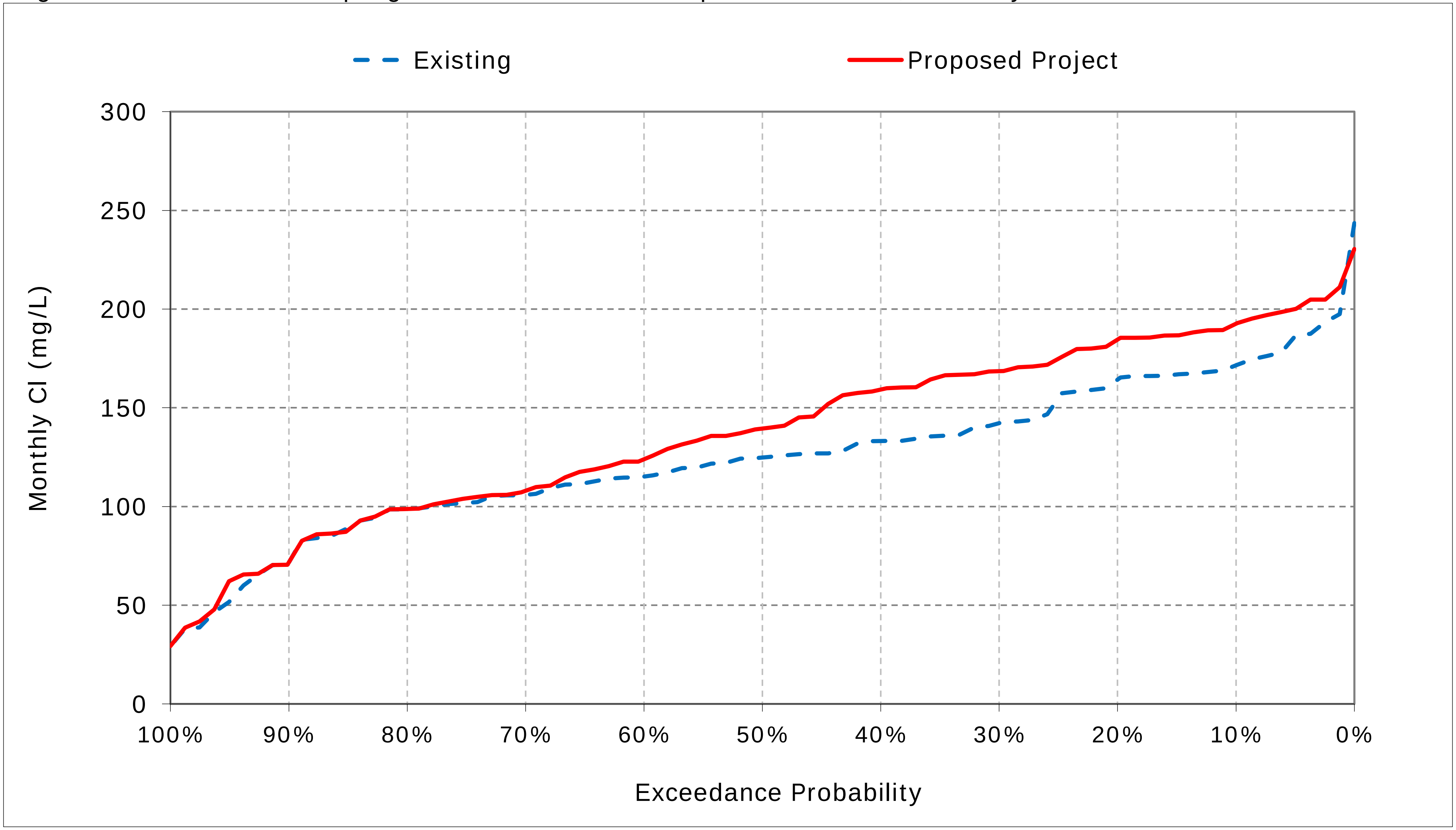


Figure 12-8. Jones Pumping Plant South Delta Exports Chloride, February Cl

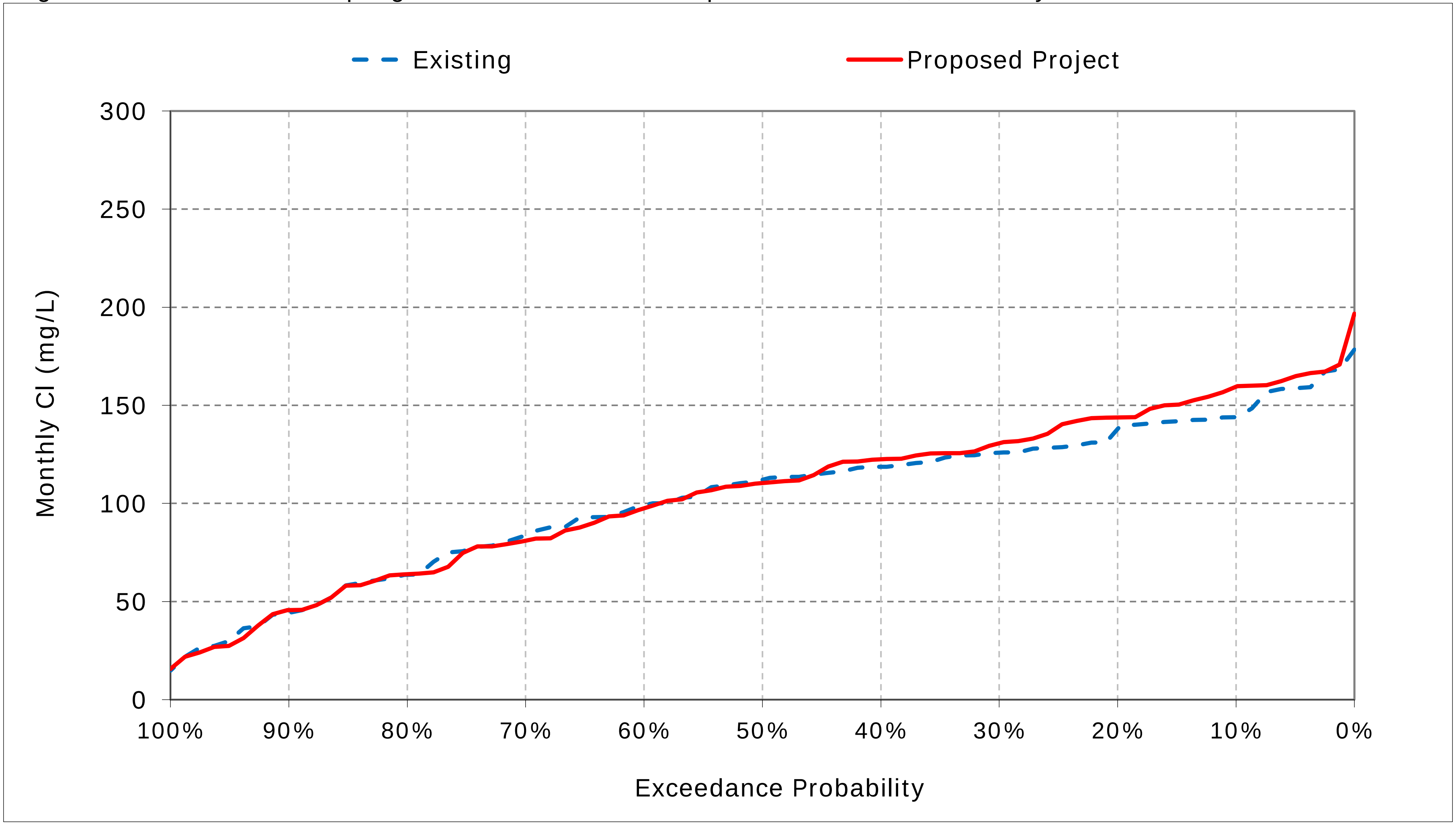


Figure 12-9. Jones Pumping Plant South Delta Exports Chloride, March Cl

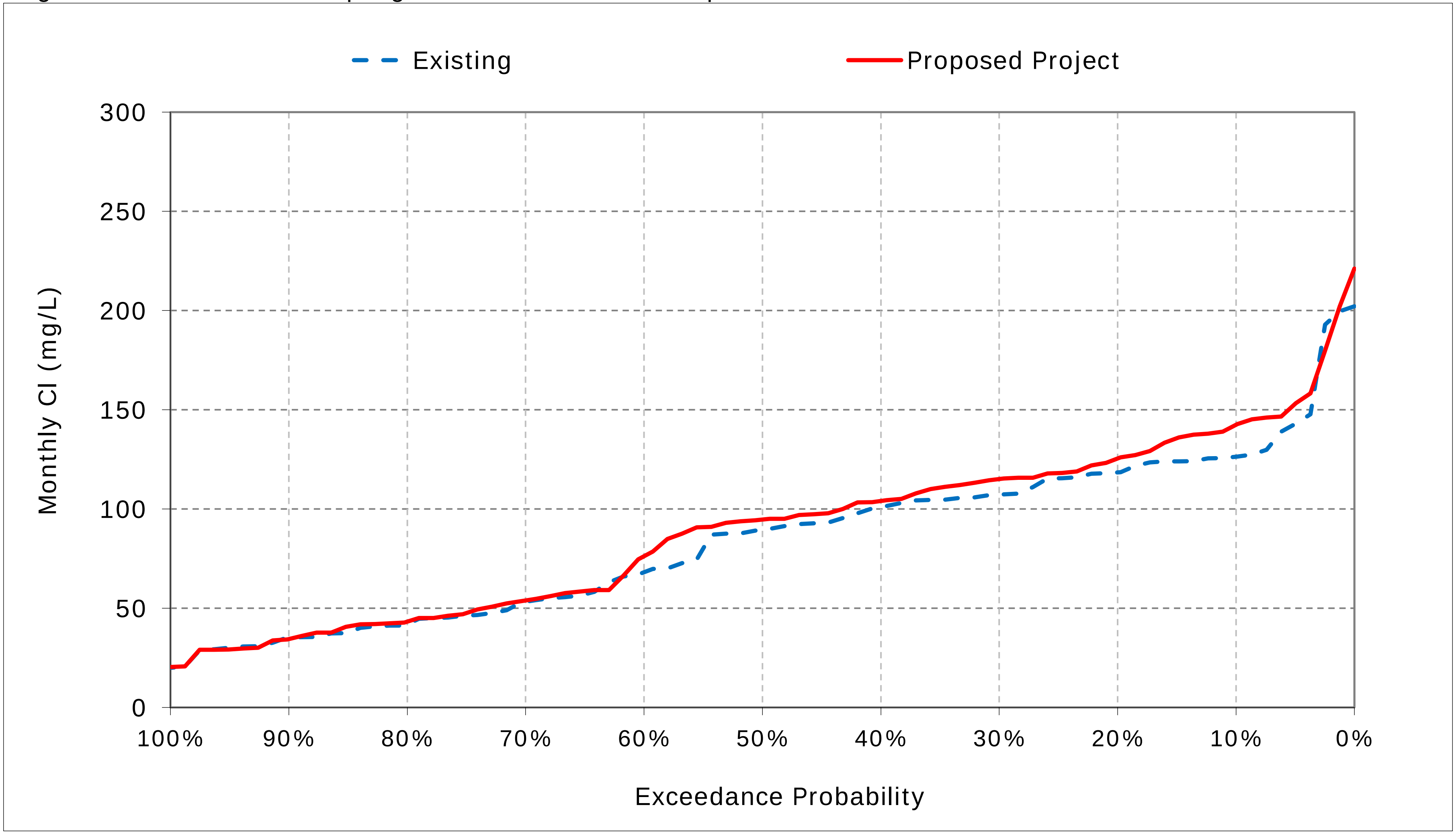


Figure 12-10. Jones Pumping Plant South Delta Exports Chloride, April Cl

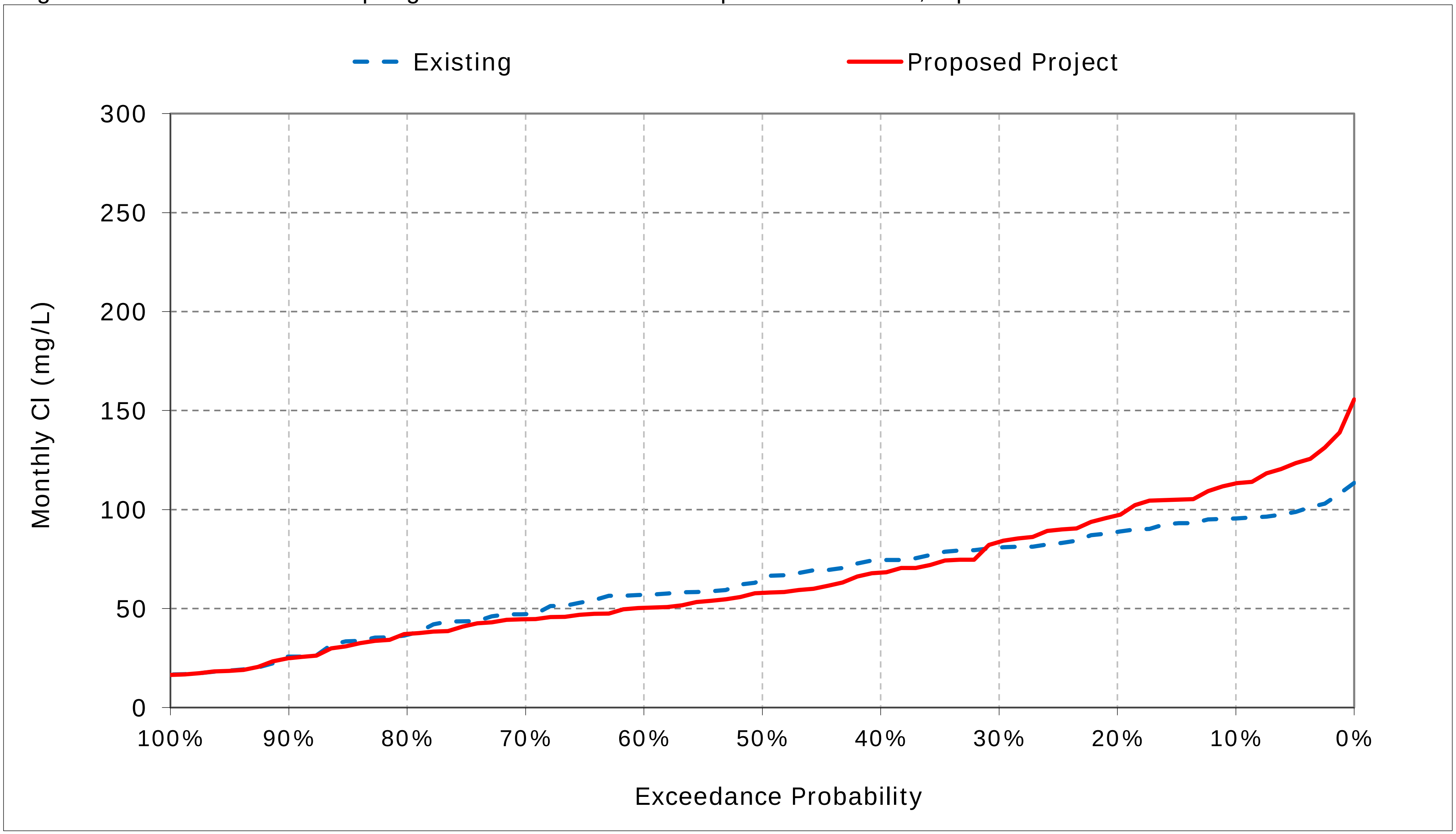


Figure 12-11. Jones Pumping Plant South Delta Exports Chloride, May Cl

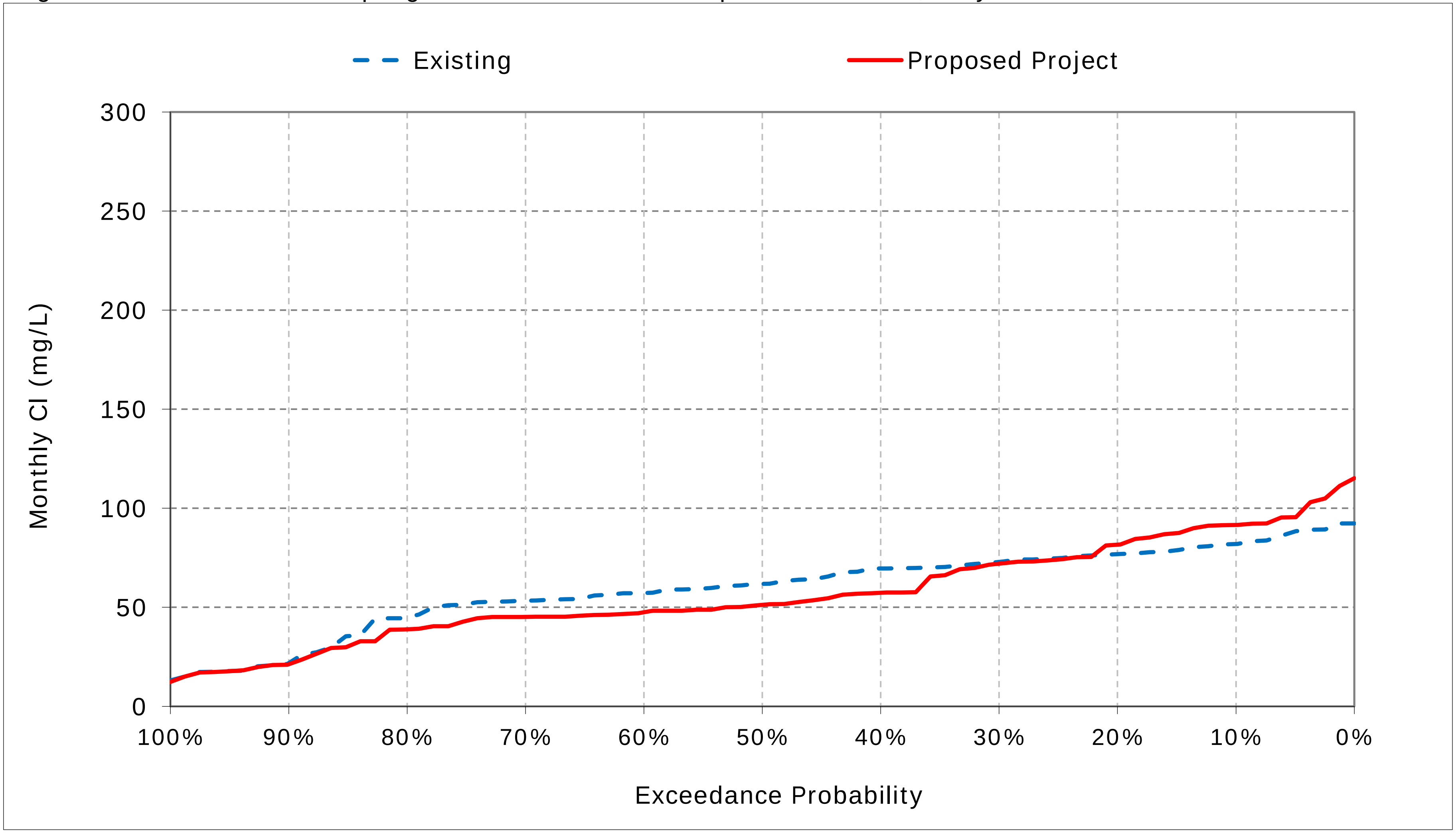


Figure 12-12. Jones Pumping Plant South Delta Exports Chloride, June Cl

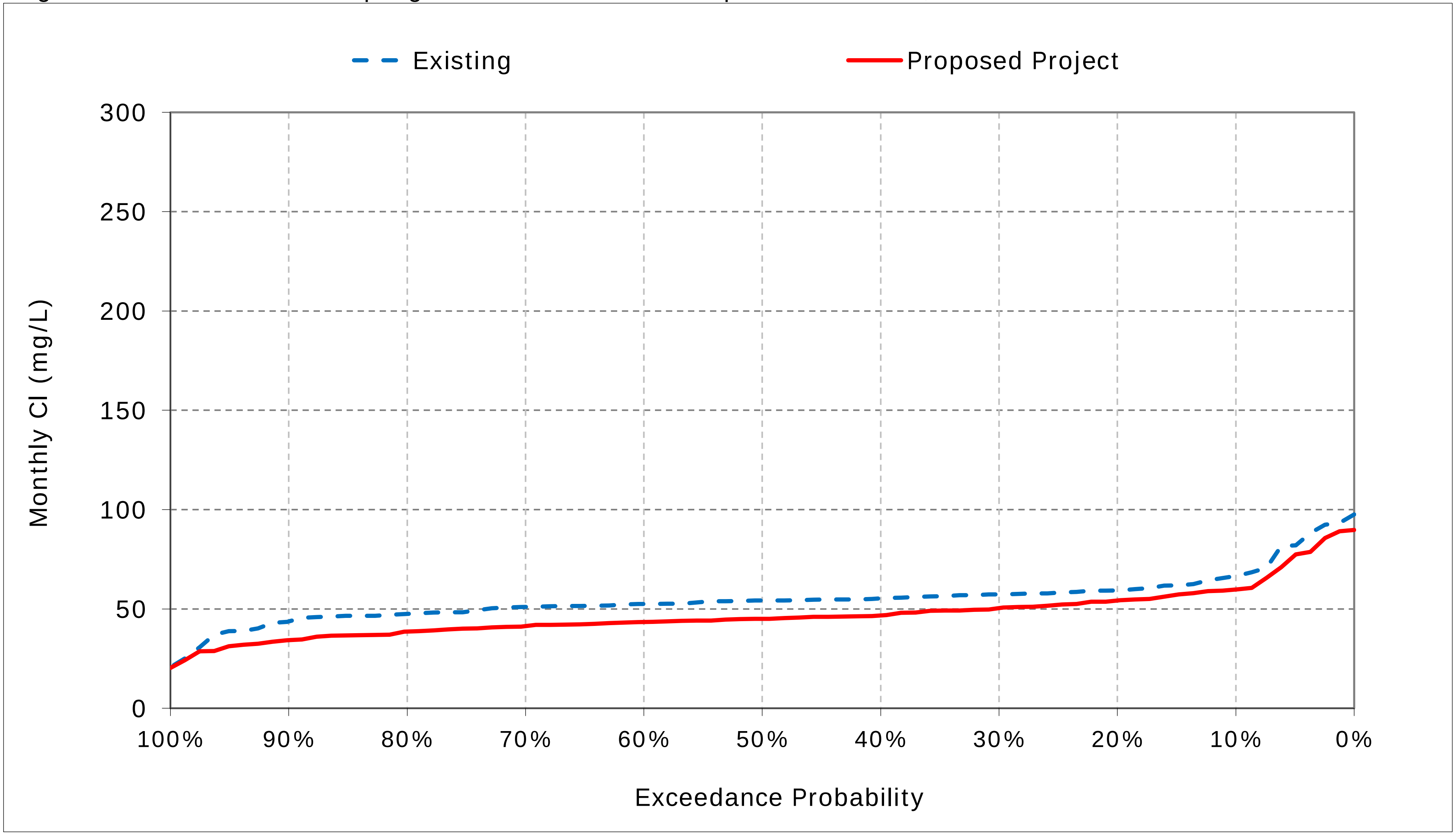


Figure 12-13. Jones Pumping Plant South Delta Exports Chloride, July Cl

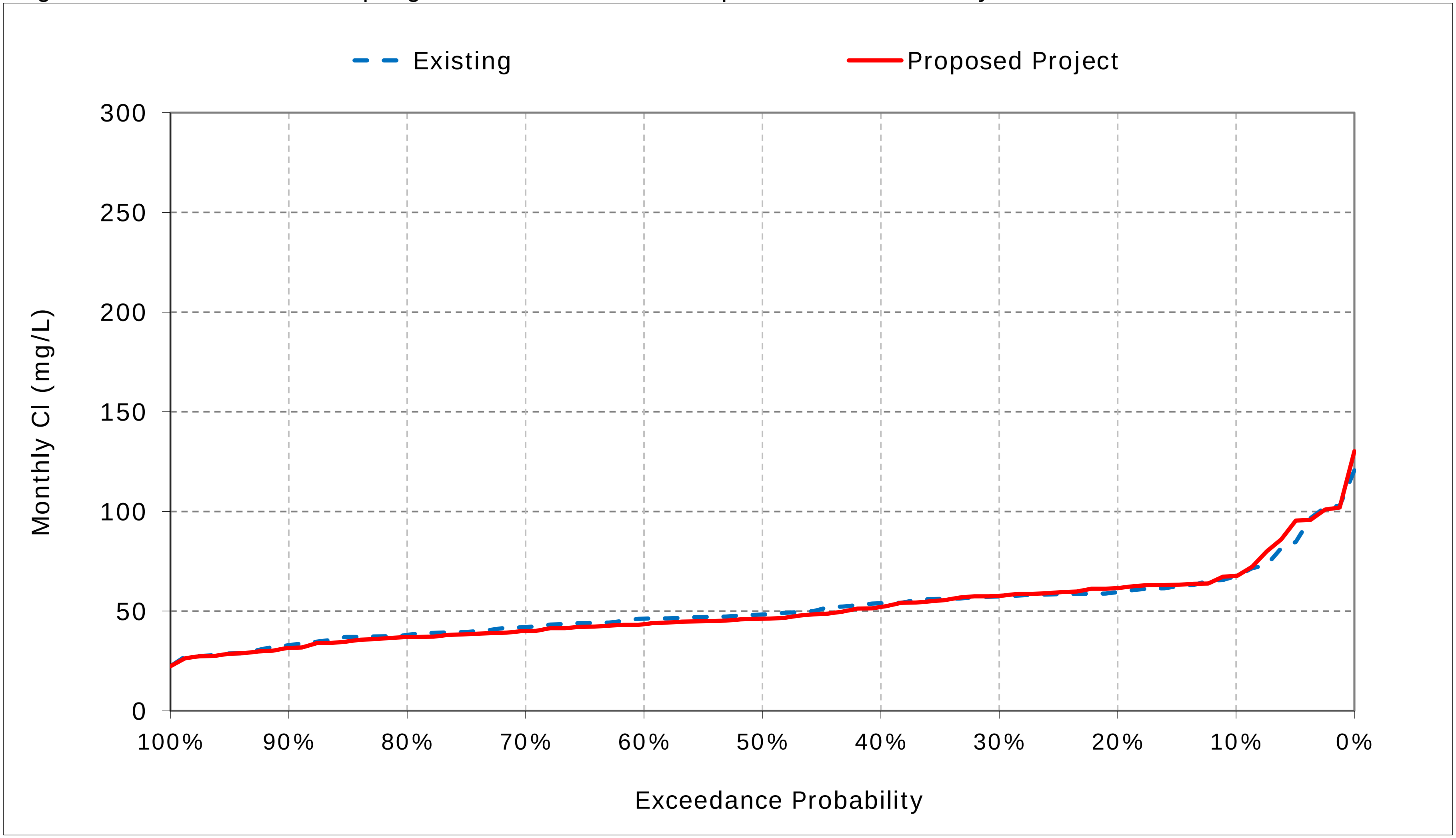


Figure 12-14. Jones Pumping Plant South Delta Exports Chloride, August Cl

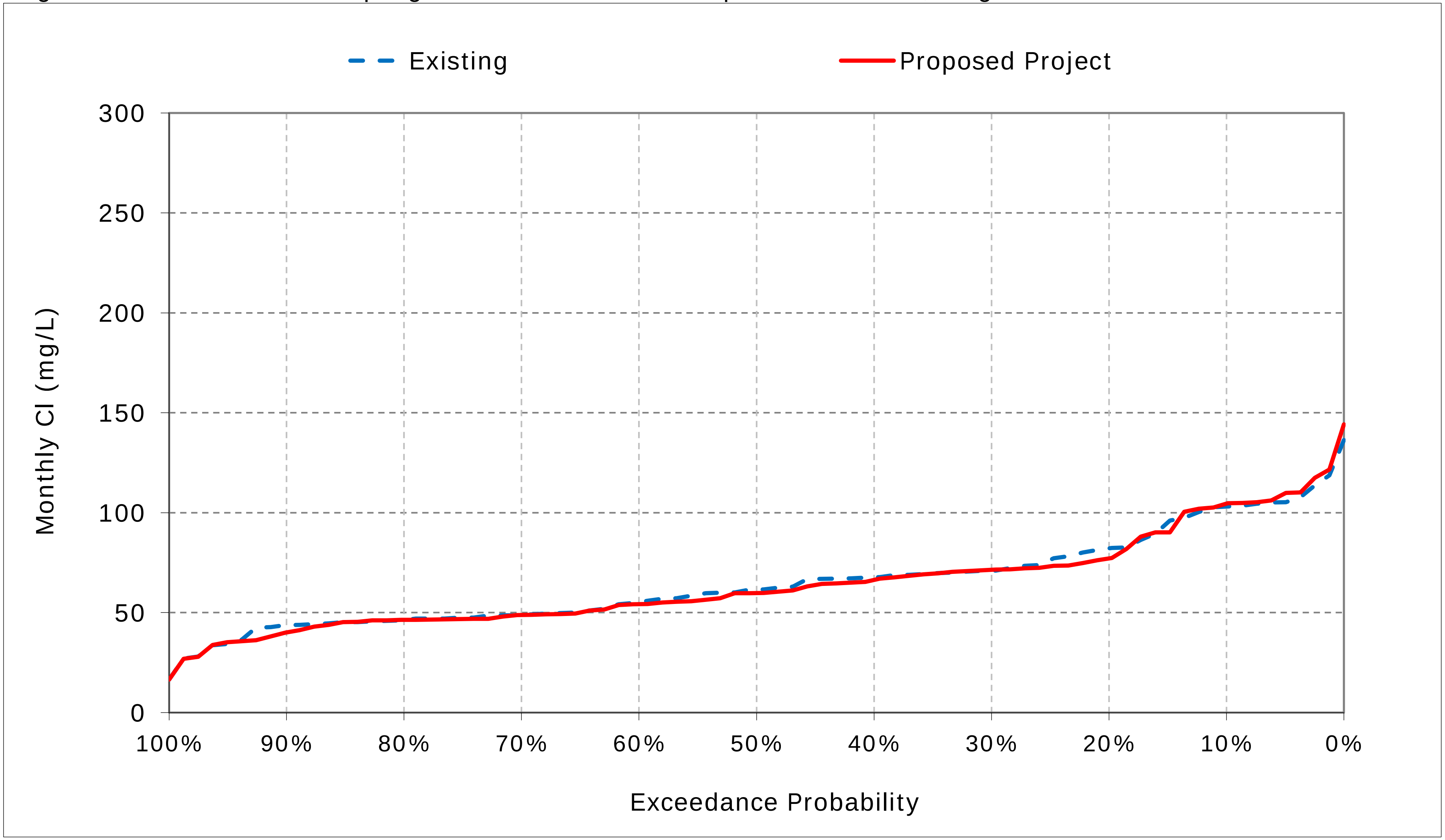


Figure 12-15. Jones Pumping Plant South Delta Exports Chloride, September Cl

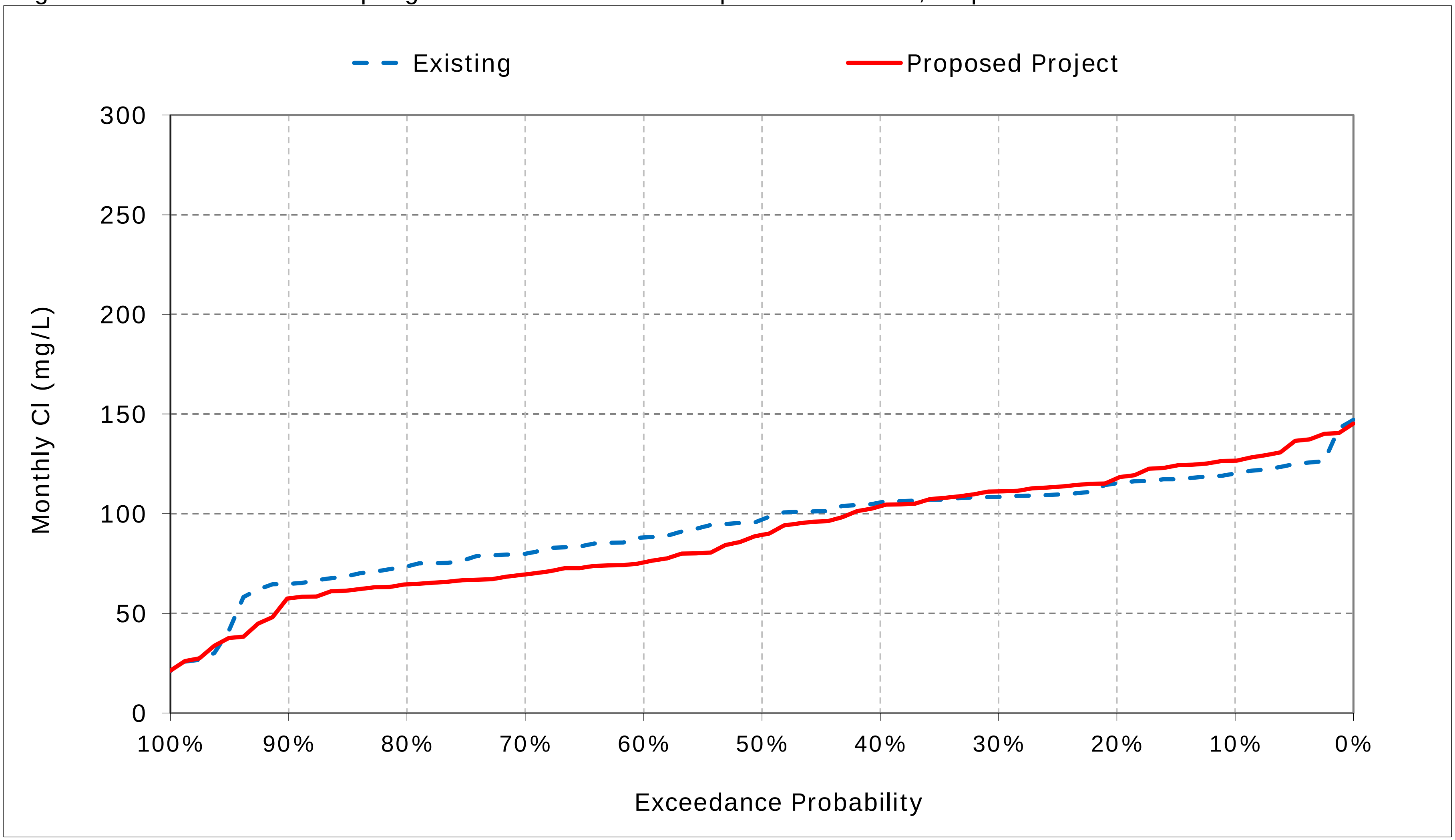


Figure 12-16. Jones Pumping Plant South Delta Exports Chloride, October Cl

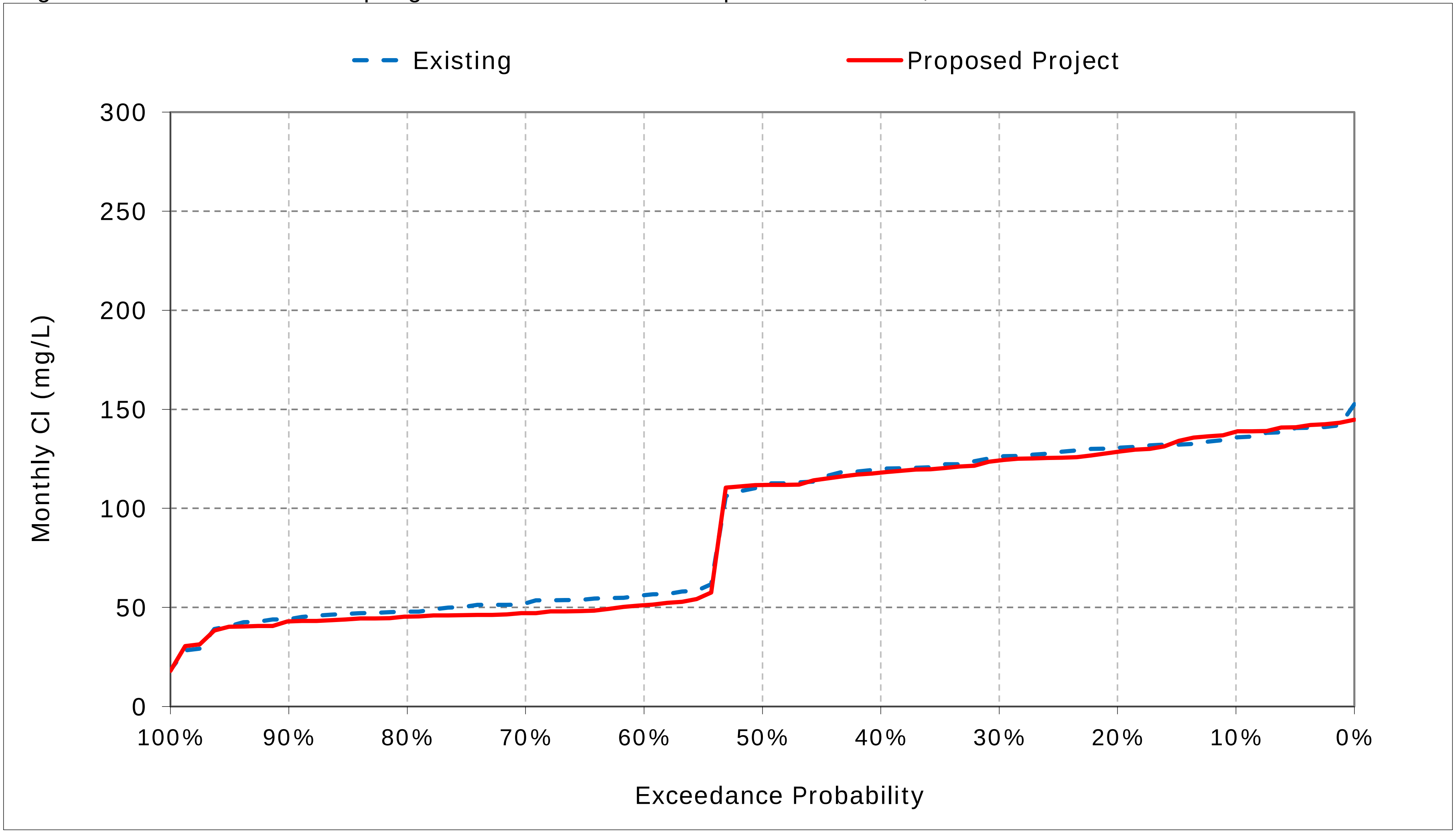


Figure 12-17. Jones Pumping Plant South Delta Exports Chloride, November Cl

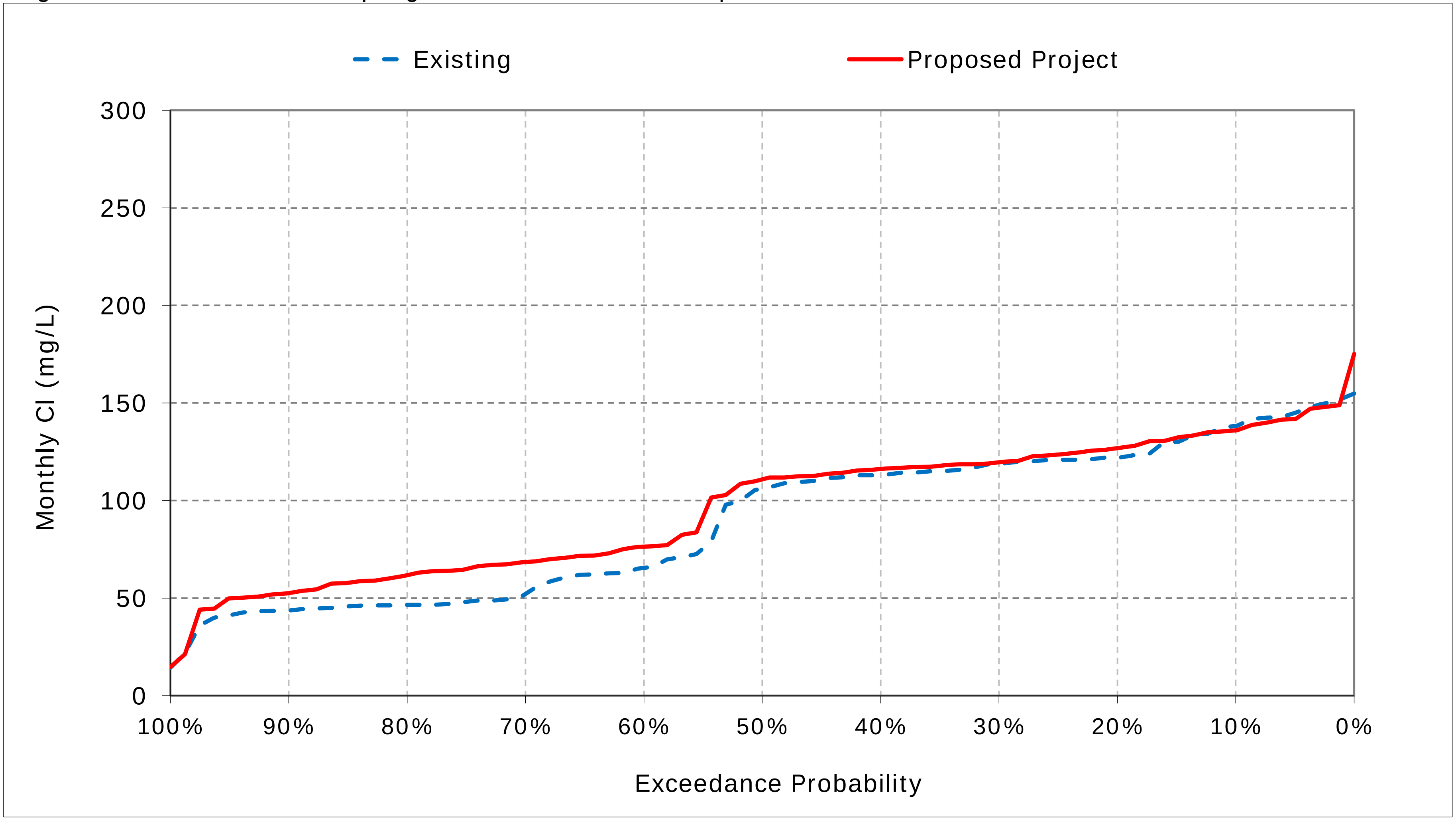


Figure 12-18. Jones Pumping Plant South Delta Exports Chloride, December Cl

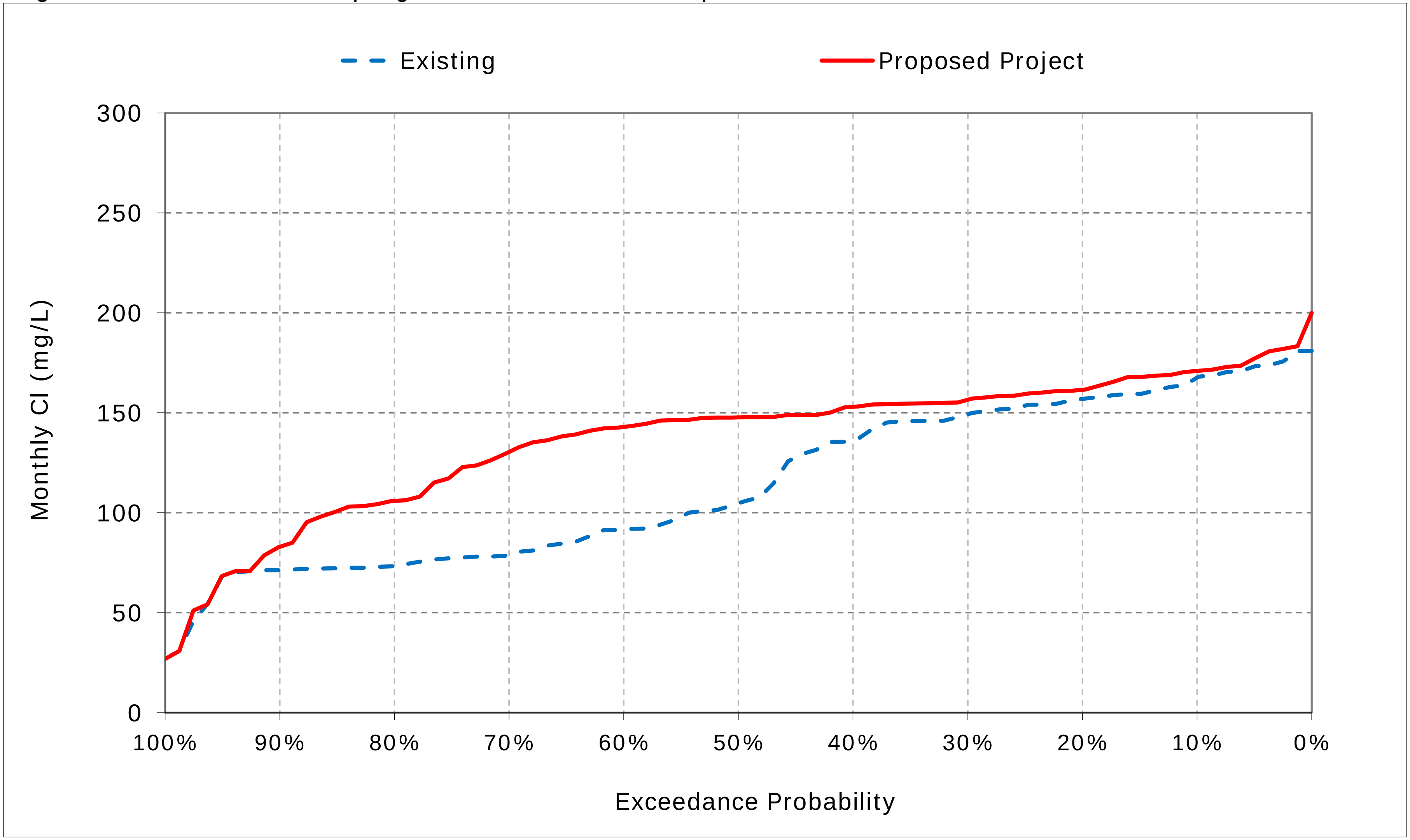


Table 13-1. Barker Slough at NBA Intake Chloride, Monthly Cl

Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	18	18	19	23	25	23	21	19	18	18	18	18
20%	17	18	18	22	24	22	20	18	17	17	17	17
30%	17	17	18	21	23	21	19	18	17	17	16	17
40%	17	17	18	20	22	21	19	18	17	16	16	16
50%	16	17	17	19	21	20	19	17	17	16	16	16
60%	16	17	17	19	20	19	18	17	17	16	16	16
70%	16	16	17	18	20	19	18	17	17	16	16	16
80%	16	16	17	18	19	18	17	17	16	16	16	16
90%	16	16	16	18	19	18	17	16	16	16	16	16
Long Term												
Full Simulation Period[a]	17	17	18	20	22	20	19	18	17	17	16	17
Water Year Types[b]												
Wet (32%)	16	17	18	21	22	20	18	17	16	16	16	16
Above Normal (15%)	17	17	18	21	22	20	18	17	17	16	16	16
Below Normal (17%)	17	17	18	20	22	21	19	17	17	16	16	16
Dry (22%)	17	17	18	20	22	21	20	18	17	17	16	17
Critical (15%)	17	17	17	19	21	21	21	21	20	18	18	18

Proposed Project

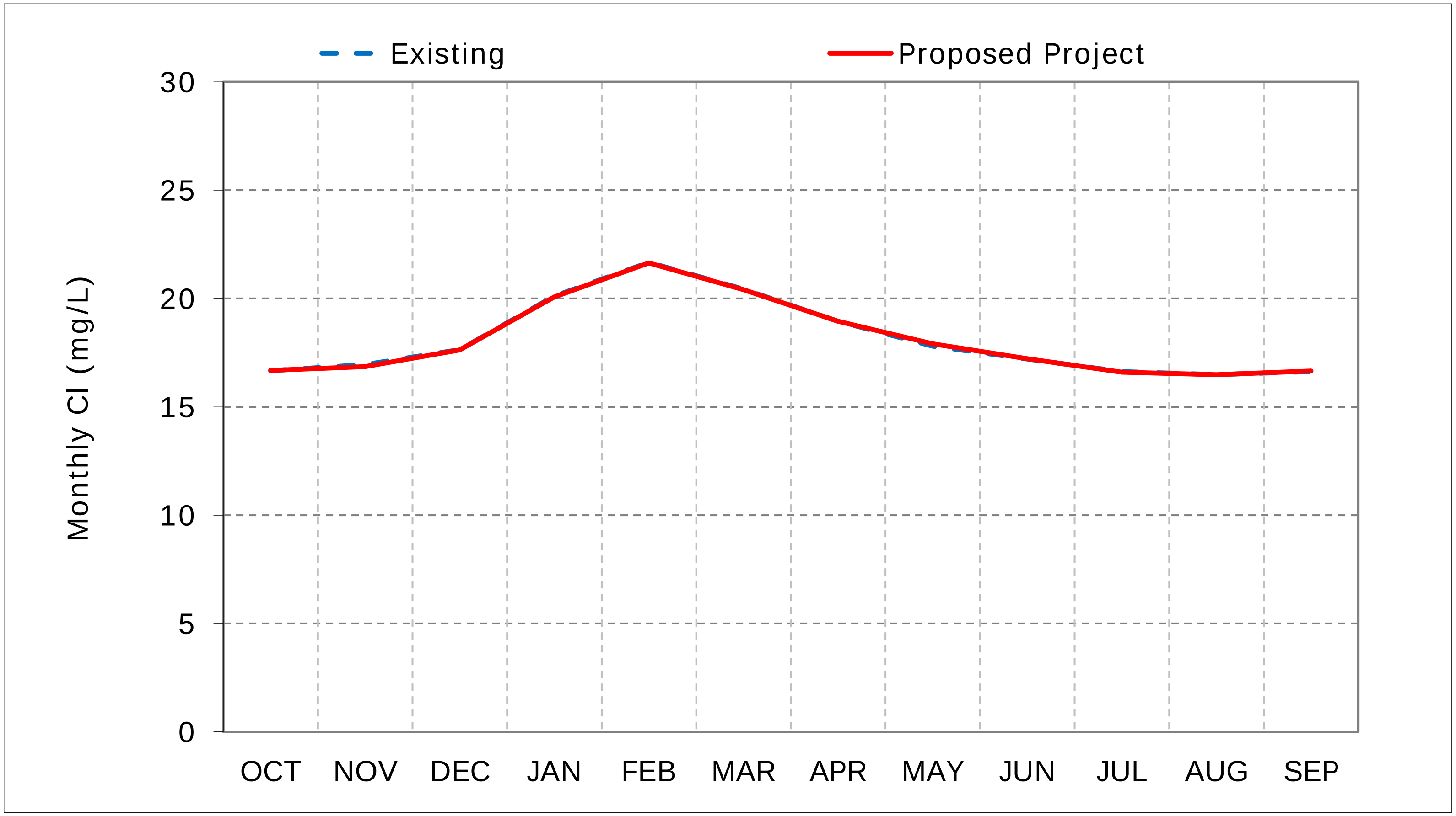
Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	18	18	19	23	25	23	22	20	19	18	18	18
20%	17	18	18	22	24	23	20	19	17	17	17	17
30%	17	17	18	21	23	21	19	18	17	17	16	17
40%	17	17	18	20	22	20	19	17	17	16	16	16
50%	16	17	17	19	21	20	19	17	17	16	16	16
60%	16	16	17	19	20	19	18	17	17	16	16	16
70%	16	16	17	18	20	19	18	17	17	16	16	16
80%	16	16	16	18	19	18	17	17	16	16	16	16
90%	16	16	16	18	19	18	17	16	16	16	16	16
Long Term												
Full Simulation Period[a]	17	17	18	20	22	20	19	18	17	17	16	17
Water Year Types[b]												
Wet (32%)	16	17	18	20	22	20	18	17	16	16	16	16
Above Normal (15%)	16	17	18	21	22	20	18	17	17	16	16	16
Below Normal (17%)	17	17	18	20	22	20	19	17	17	16	16	16
Dry (22%)	17	17	18	20	22	21	20	18	17	17	16	17
Critical (15%)	17	17	17	19	21	21	21	21	20	18	18	18

Proposed Project minus Existing

Statistic	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
	Monthly Cl (mg/L)											
Probability of Exceedance												
10%	0	0	0	0	0	0	0	1	1	0	0	0
20%	0	0	0	0	0	0	0	0	0	0	0	0
30%	0	0	0	0	0	0	0	0	0	0	0	0
40%	0	0	0	0	0	0	0	0	0	0	0	0
50%	0	0	0	0	0	0	0	0	0	0	0	0
60%	0	0	0	0	0	0	0	0	0	0	0	0
70%	0	0	0	0	0	0	0	0	0	0	0	0
80%	0	0	0	0	0	0	0	0	0	0	0	0
90%	0	0	0	0	0	0	0	0	0	0	0	0
Long Term												
Full Simulation Period[a]	0	0	0	0	0	0	0	0	0	0	0	0
Water Year Types[b]												
Wet (32%)	0	0	0	0	0	0	0	0	0	0	0	0
Above Normal (15%)	0	0	0	0	0	0	0	0	0	0	0	0
Below Normal (17%)	0	0	0	0	0	0	0	0	0	0	0	0
Dry (22%)	0	0	0	0	0	0	0	0	0	0	0	0
Critical (15%)	0	0	0	0	0	0	0	1	0	0	0	0

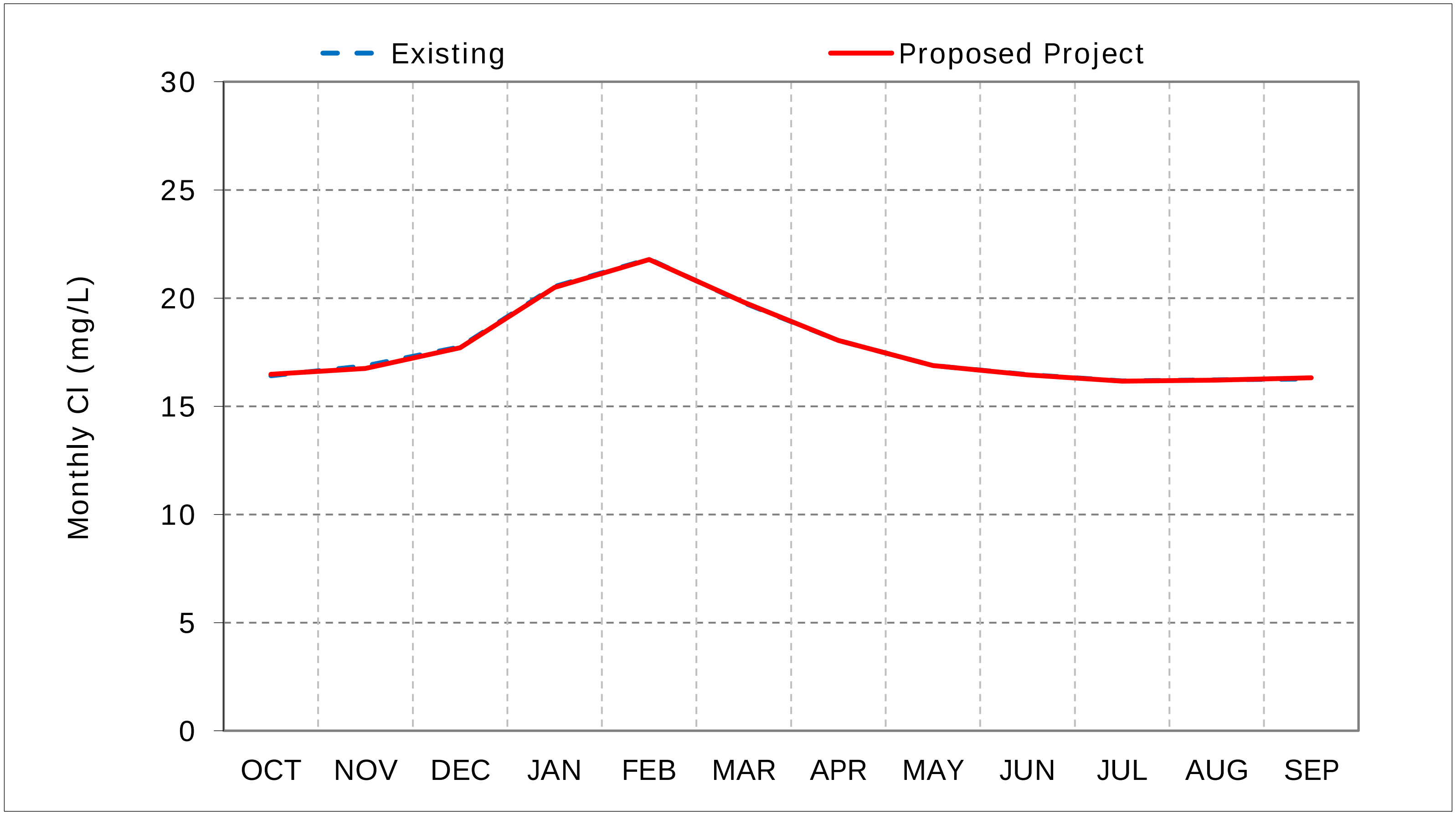
a Based on the 82-year simulation period.
b As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
c These results are displayed with water year - year type sorting.
d Positive differences are highted in red color which indicate increase in Salinity (EC).

Figure 13-1. Barker Slough at NBA Intake Chloride, Long-Term Average Cl



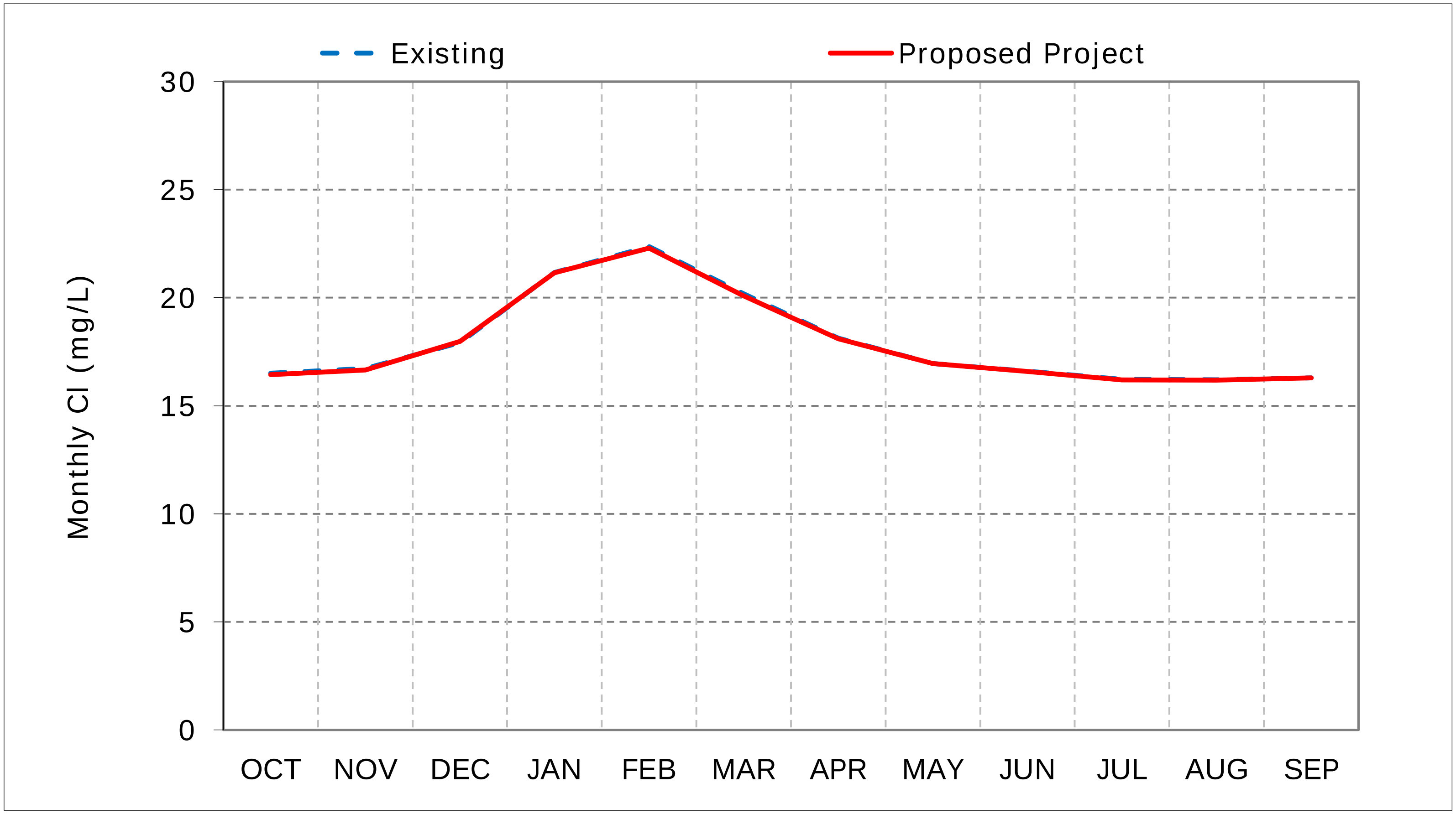
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 13-2. Barker Slough at NBA Intake Chloride, Wet Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

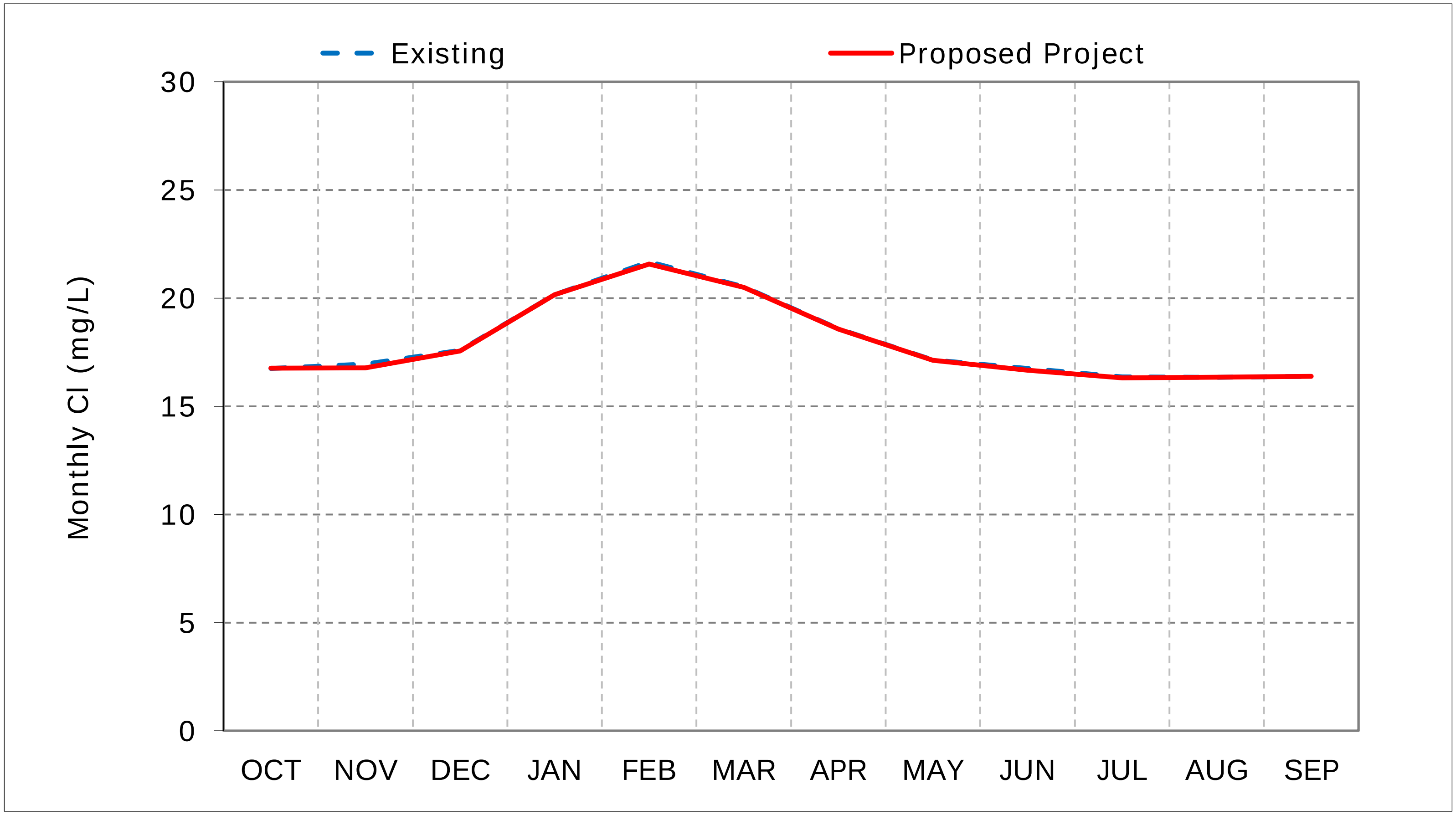
Figure 13-3. Barker Slough at NBA Intake Chloride, Above Normal Year Average C



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).

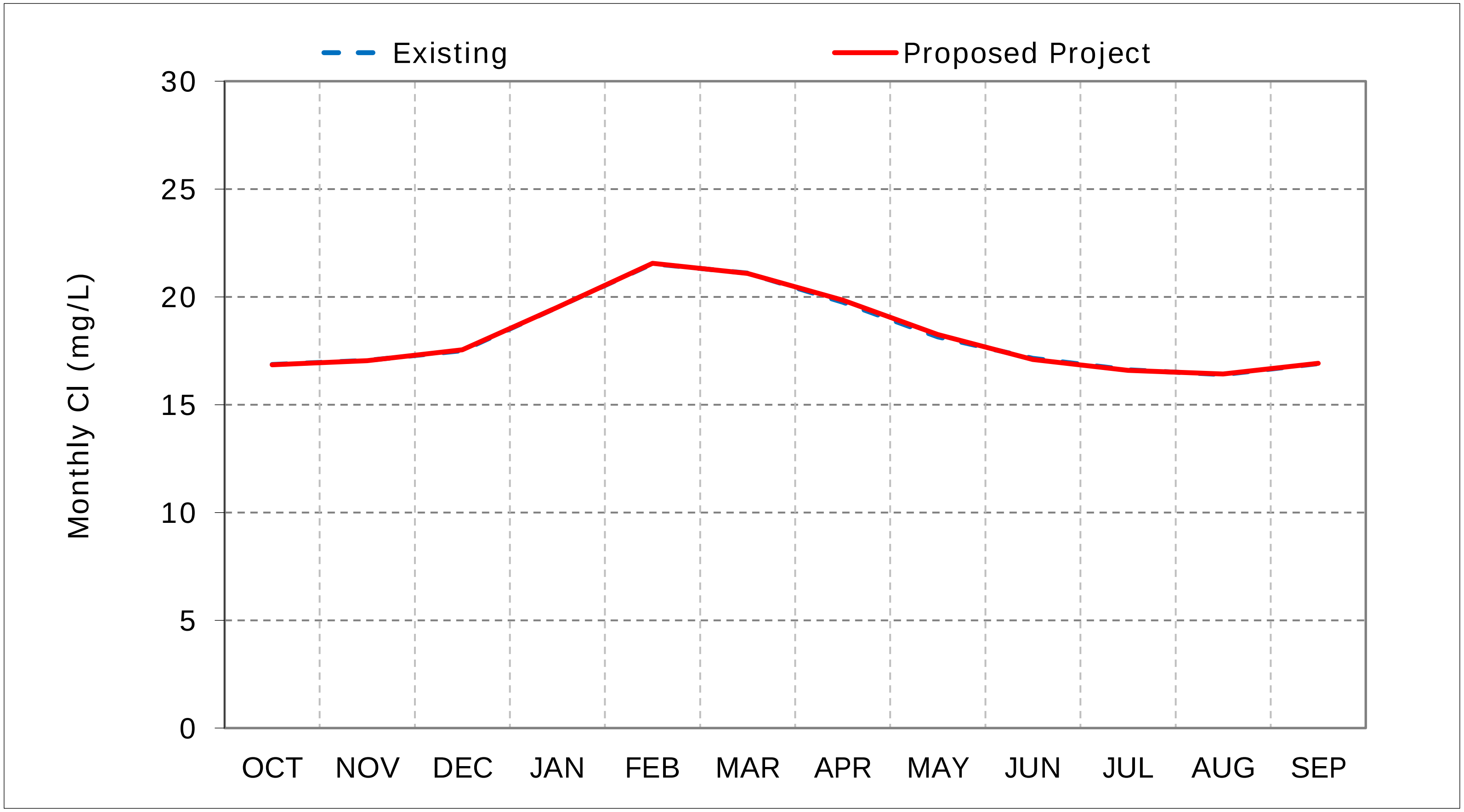
*These results are displayed with water year - year type sorting.

Figure 13-4. Barker Slough at NBA Intake Chloride, Below Normal Year Average C



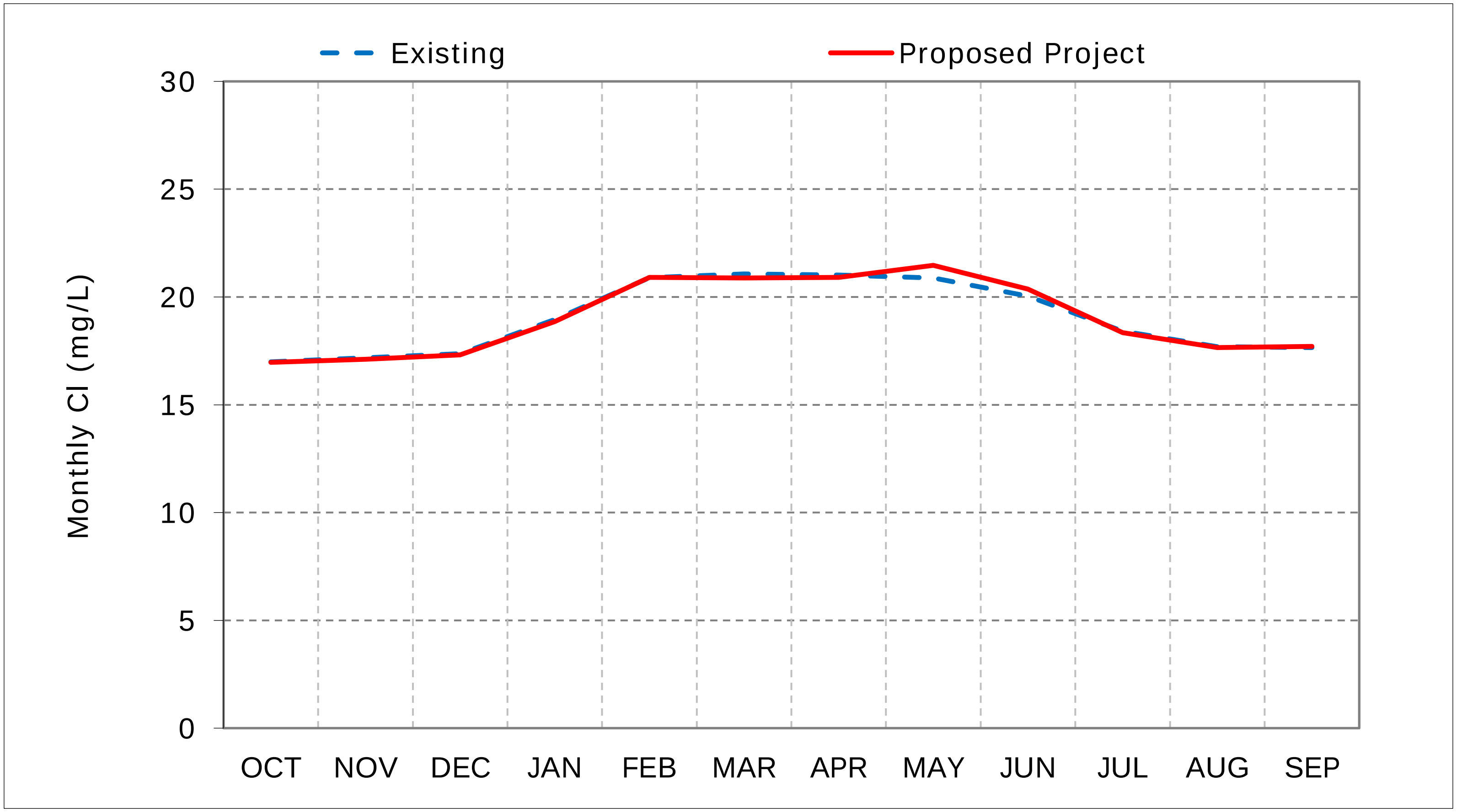
*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 13-5. Barker Slough at NBA Intake Chloride, Dry Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 13-6. Barker Slough at NBA Intake Chloride, Critical Year Average Cl



*As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999).
*These results are displayed with water year - year type sorting.

Figure 13-7. Barker Slough at NBA Intake Chloride, January Cl

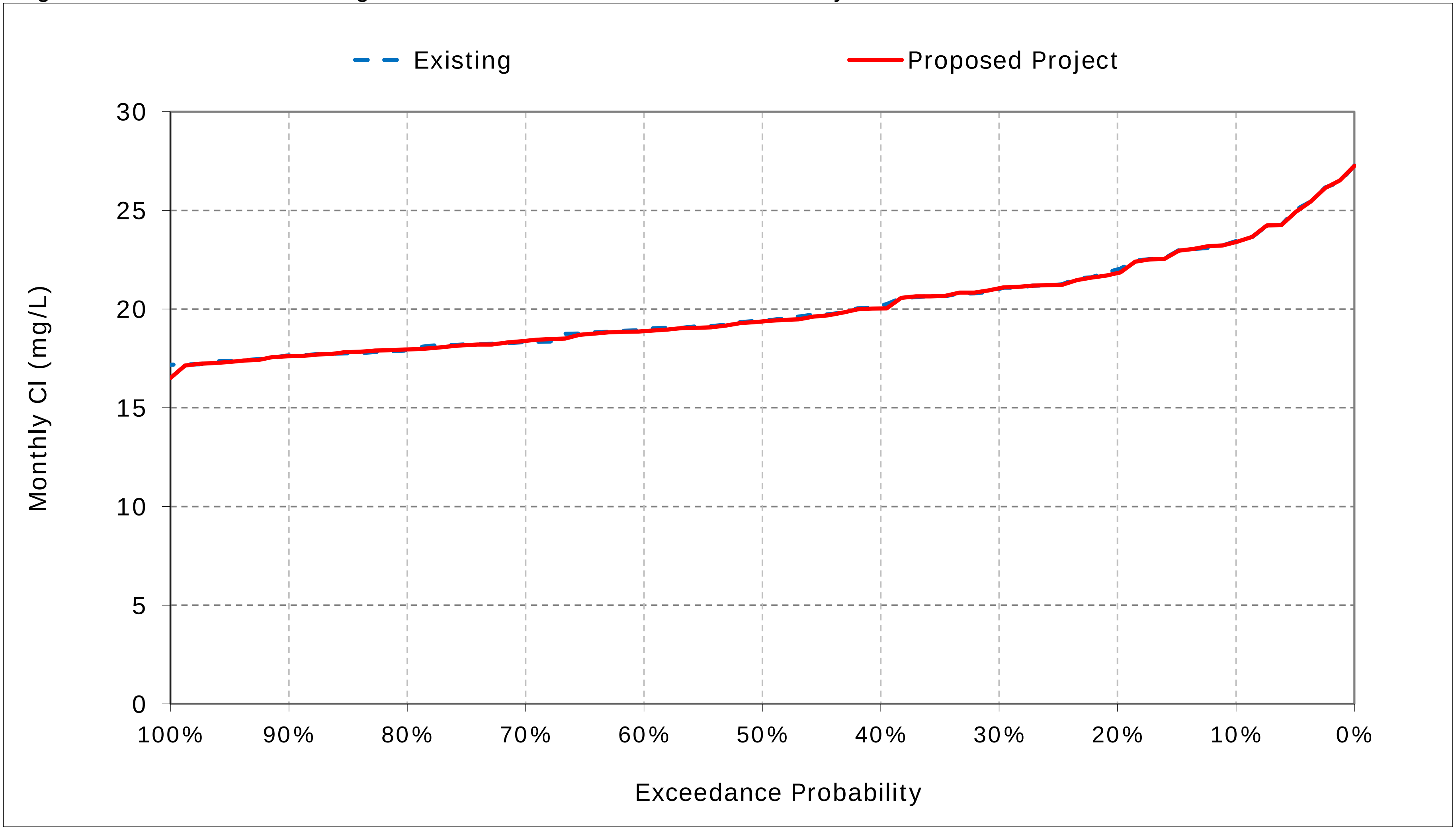


Figure 13-8. Barker Slough at NBA Intake Chloride, February Cl

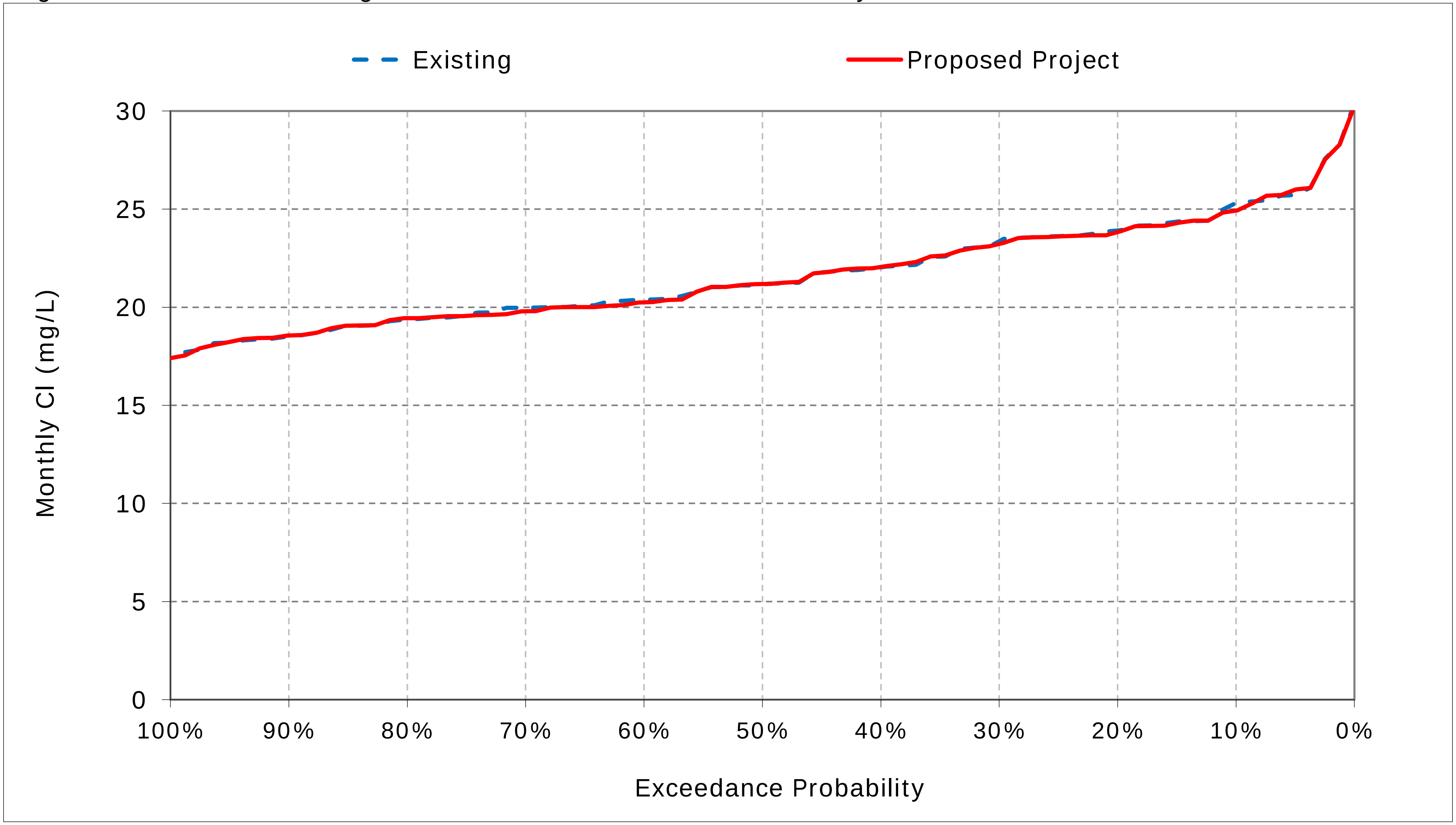


Figure 13-9. Barker Slough at NBA Intake Chloride, March Cl

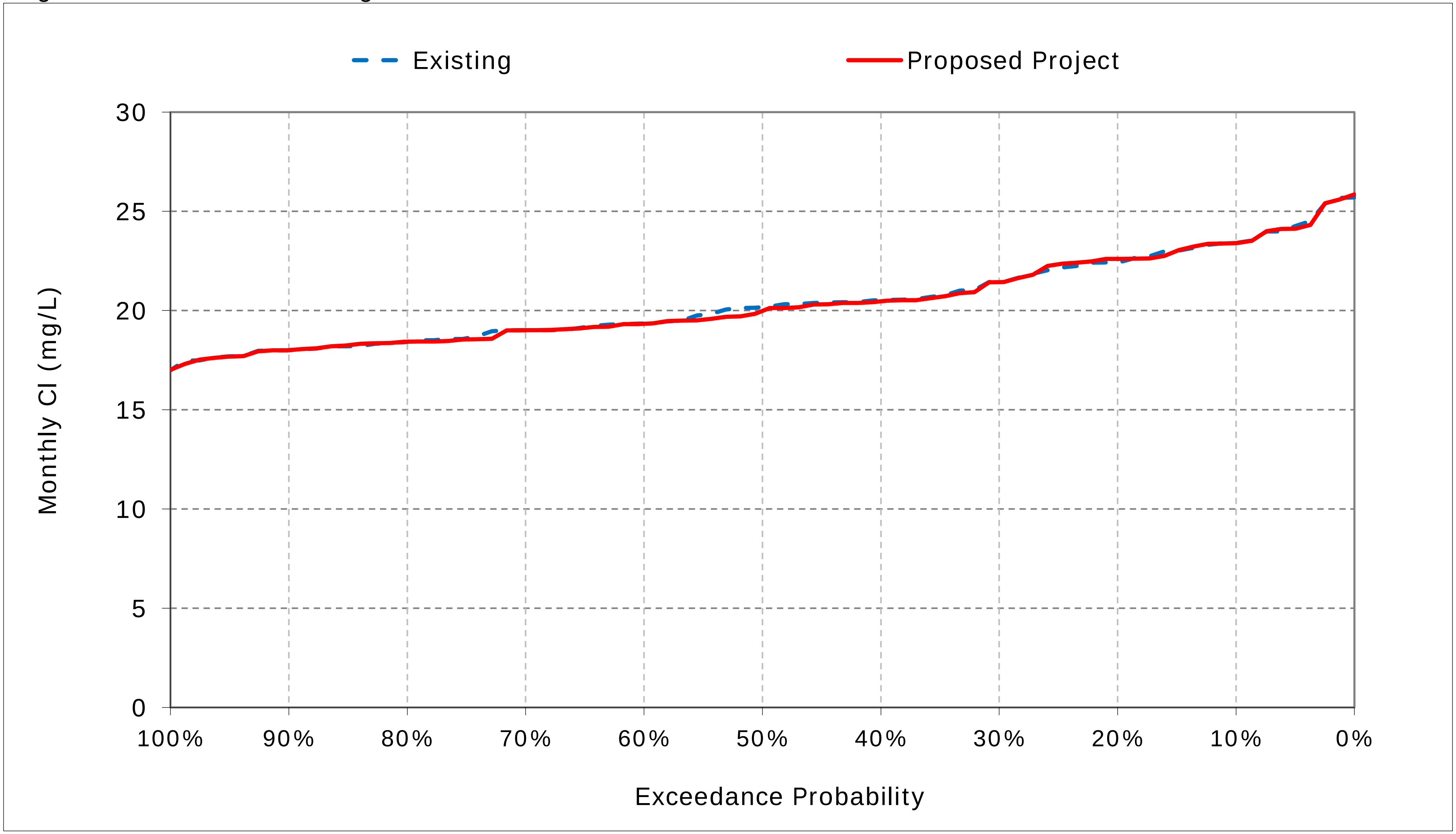


Figure 13-10. Barker Slough at NBA Intake Chloride, April Cl

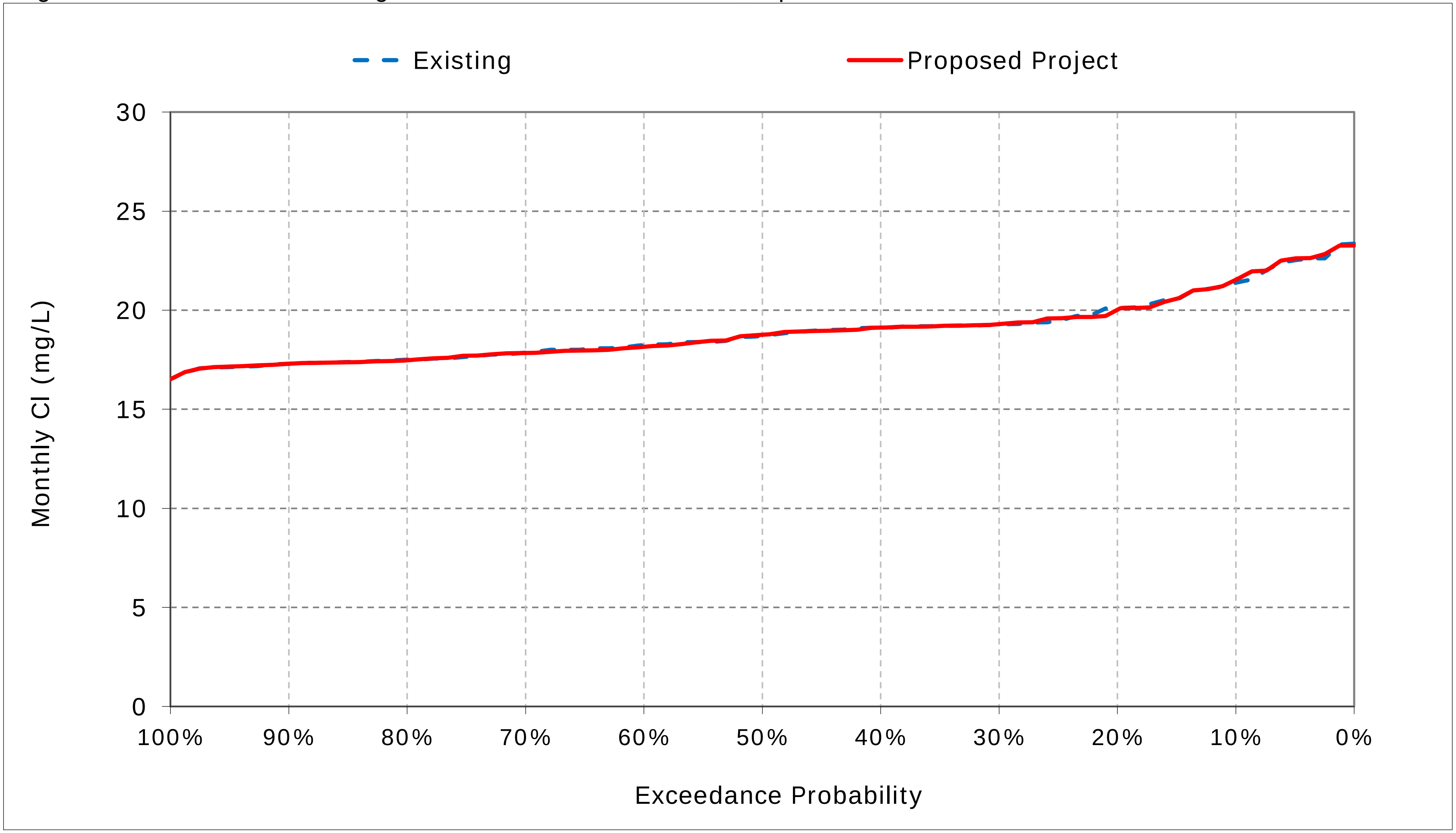


Figure 13-11. Barker Slough at NBA Intake Chloride, May Cl

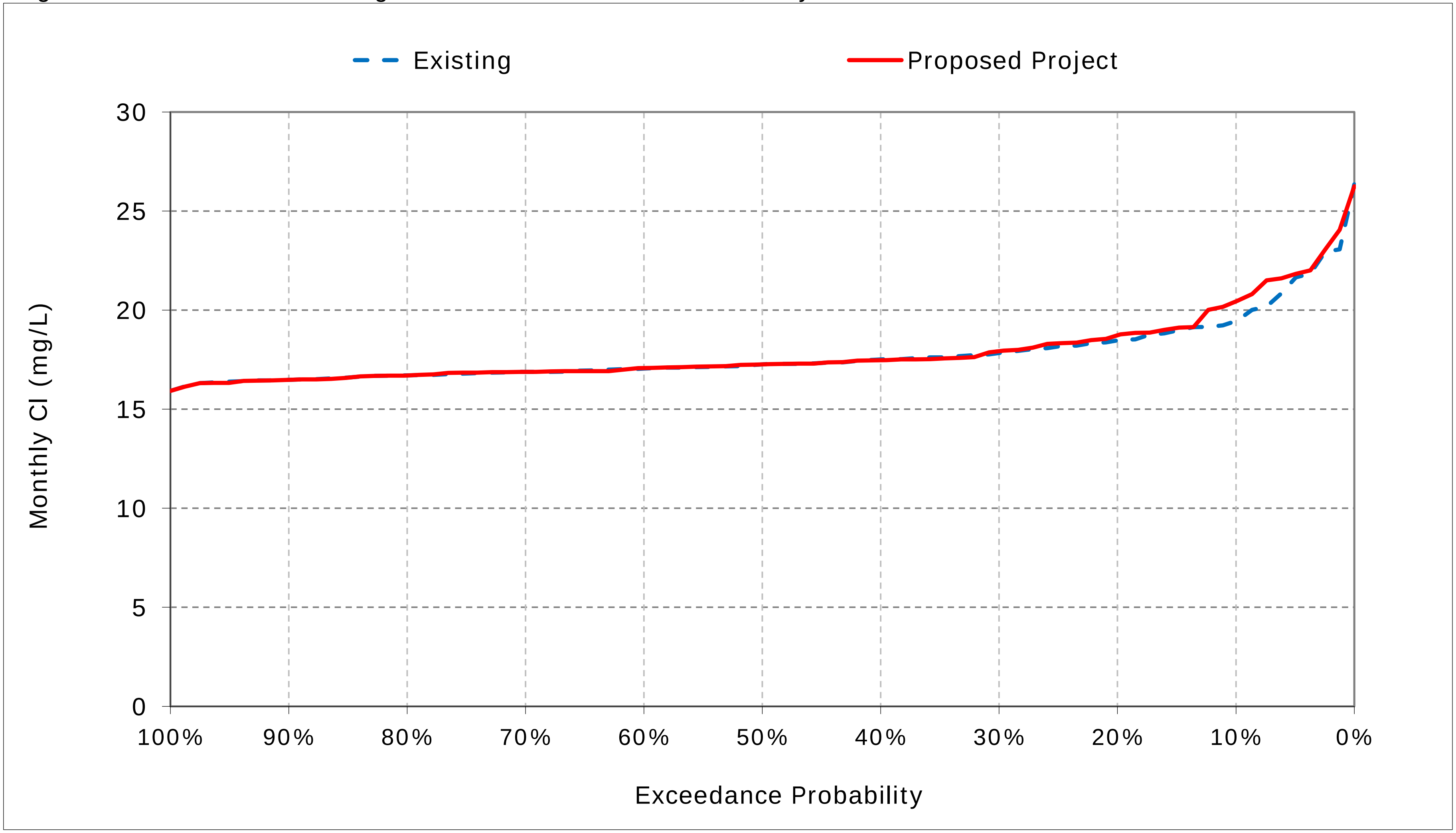


Figure 13-12. Barker Slough at NBA Intake Chloride, June Cl

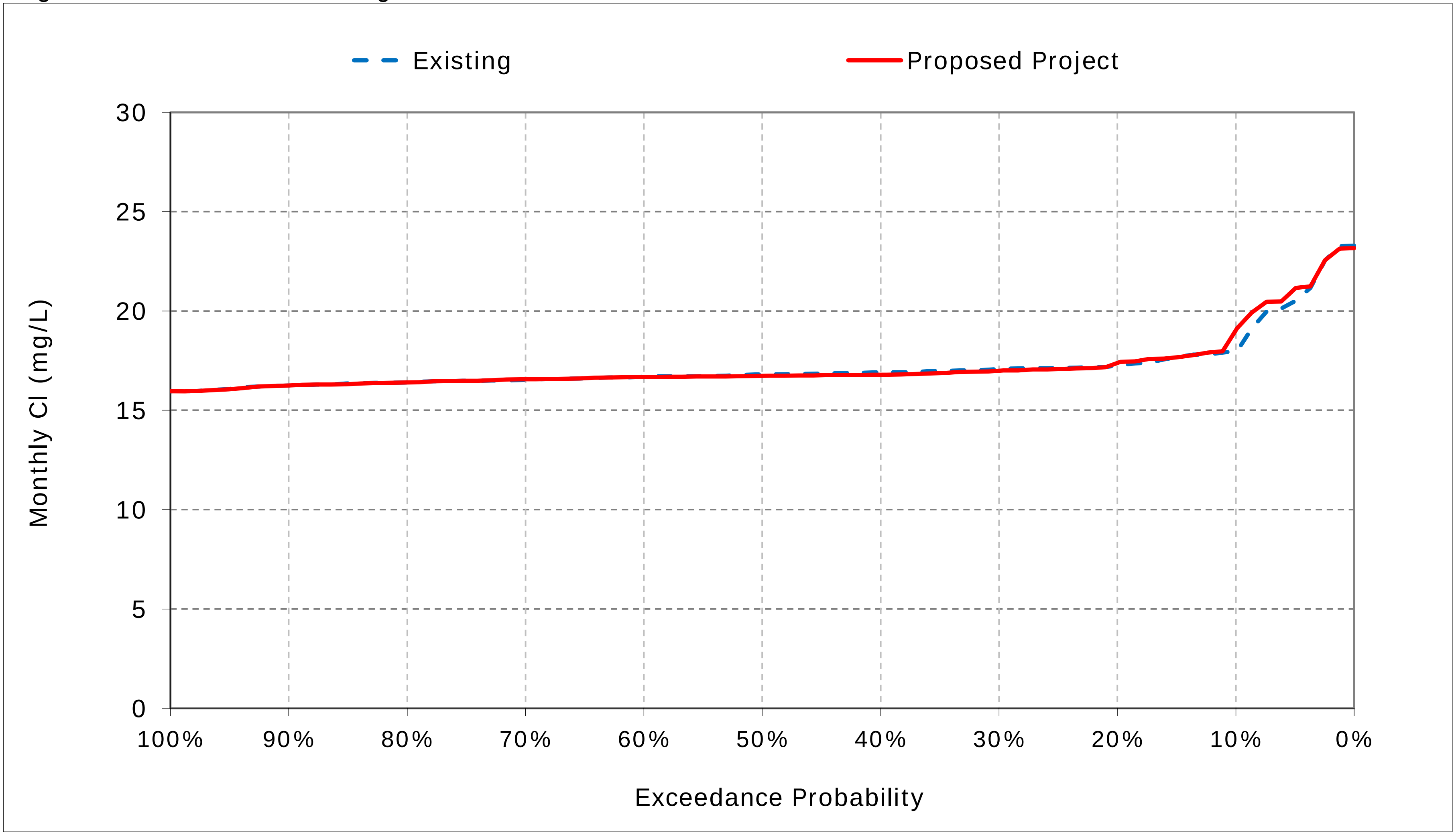


Figure 13-13. Barker Slough at NBA Intake Chloride, July Cl

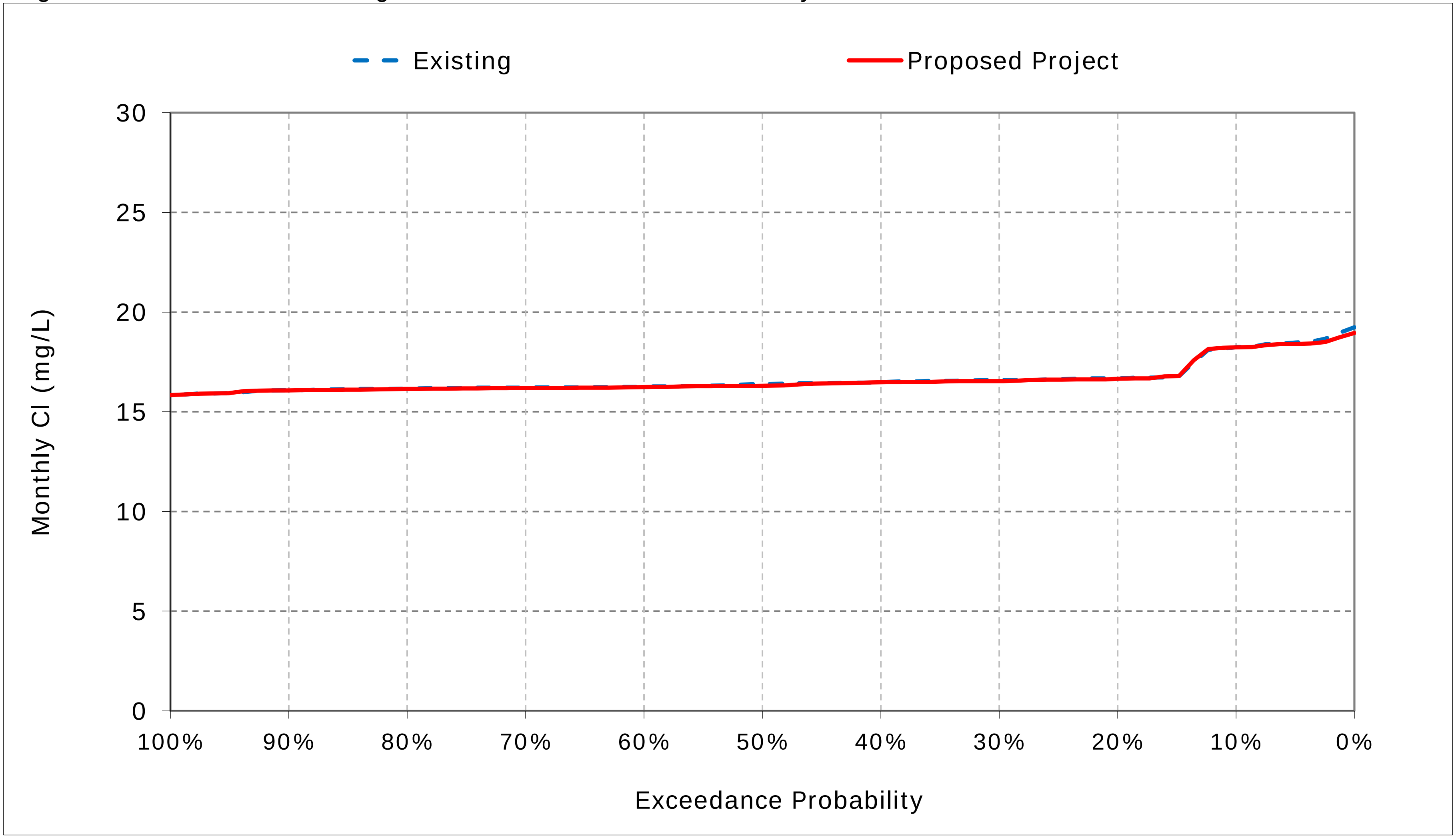


Figure 13-14. Barker Slough at NBA Intake Chloride, August Cl

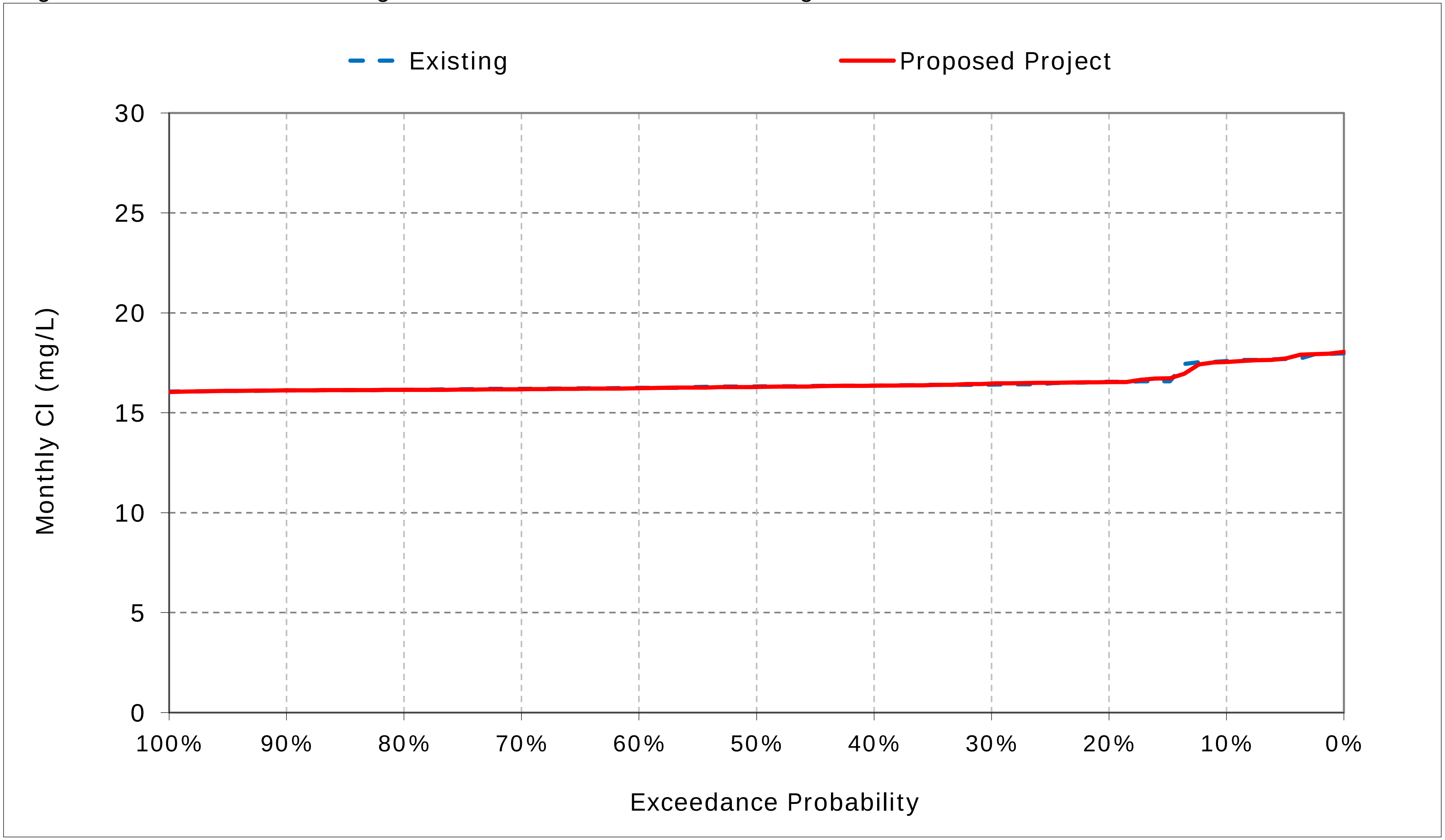


Figure 13-15. Barker Slough at NBA Intake Chloride, September Cl

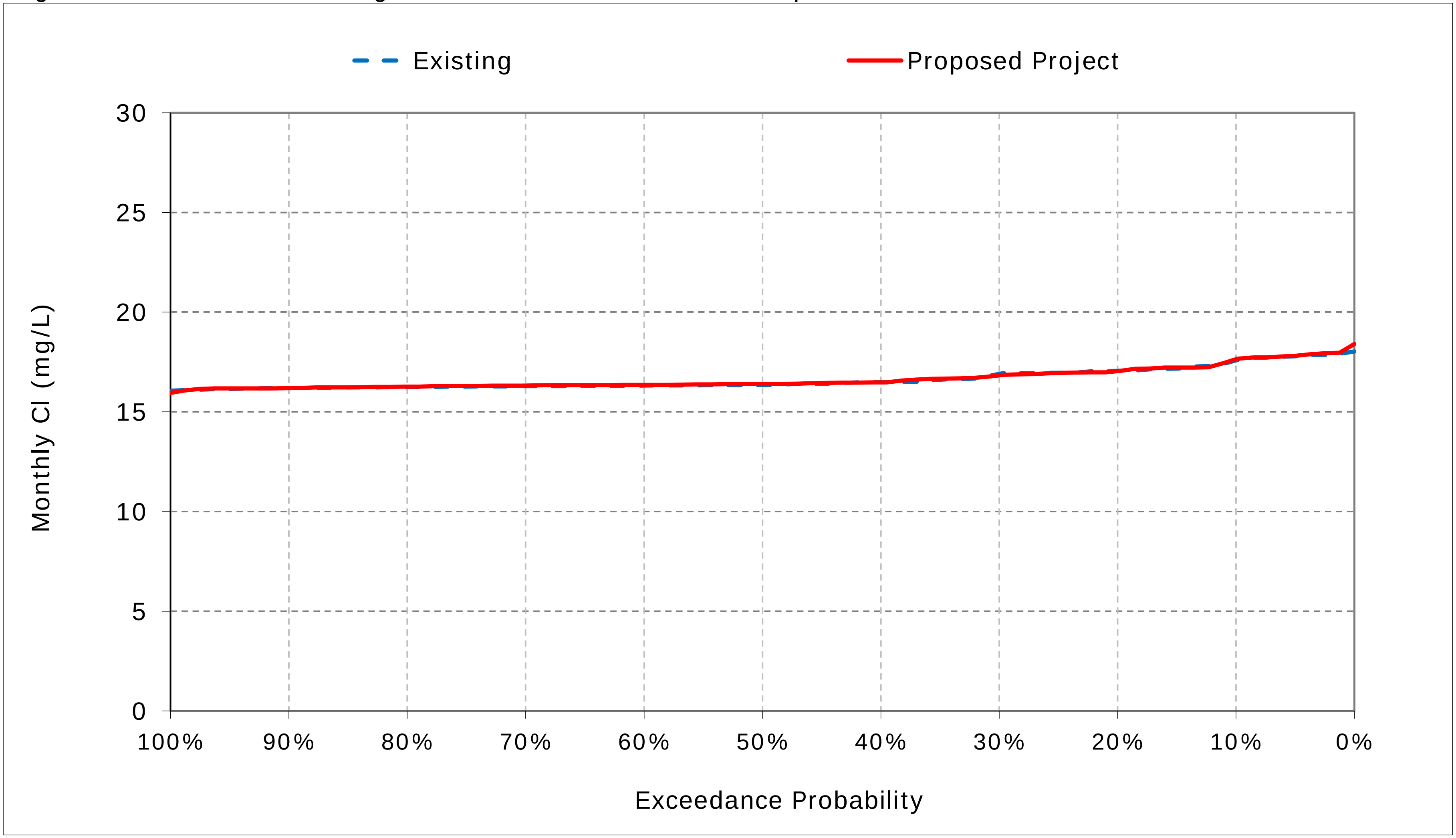


Figure 13-16. Barker Slough at NBA Intake Chloride, October Cl

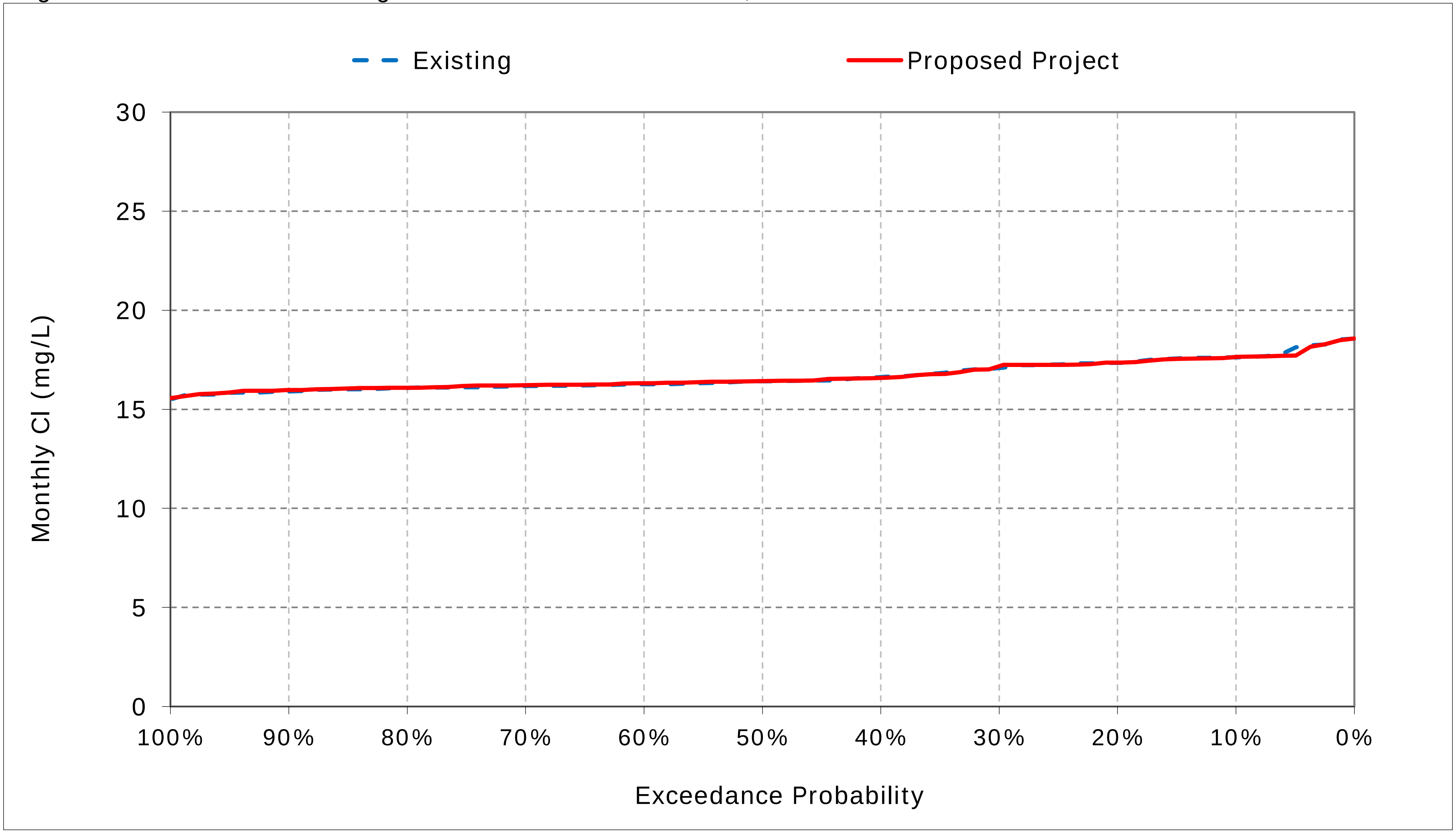


Figure 13-17. Barker Slough at NBA Intake Chloride, November Cl

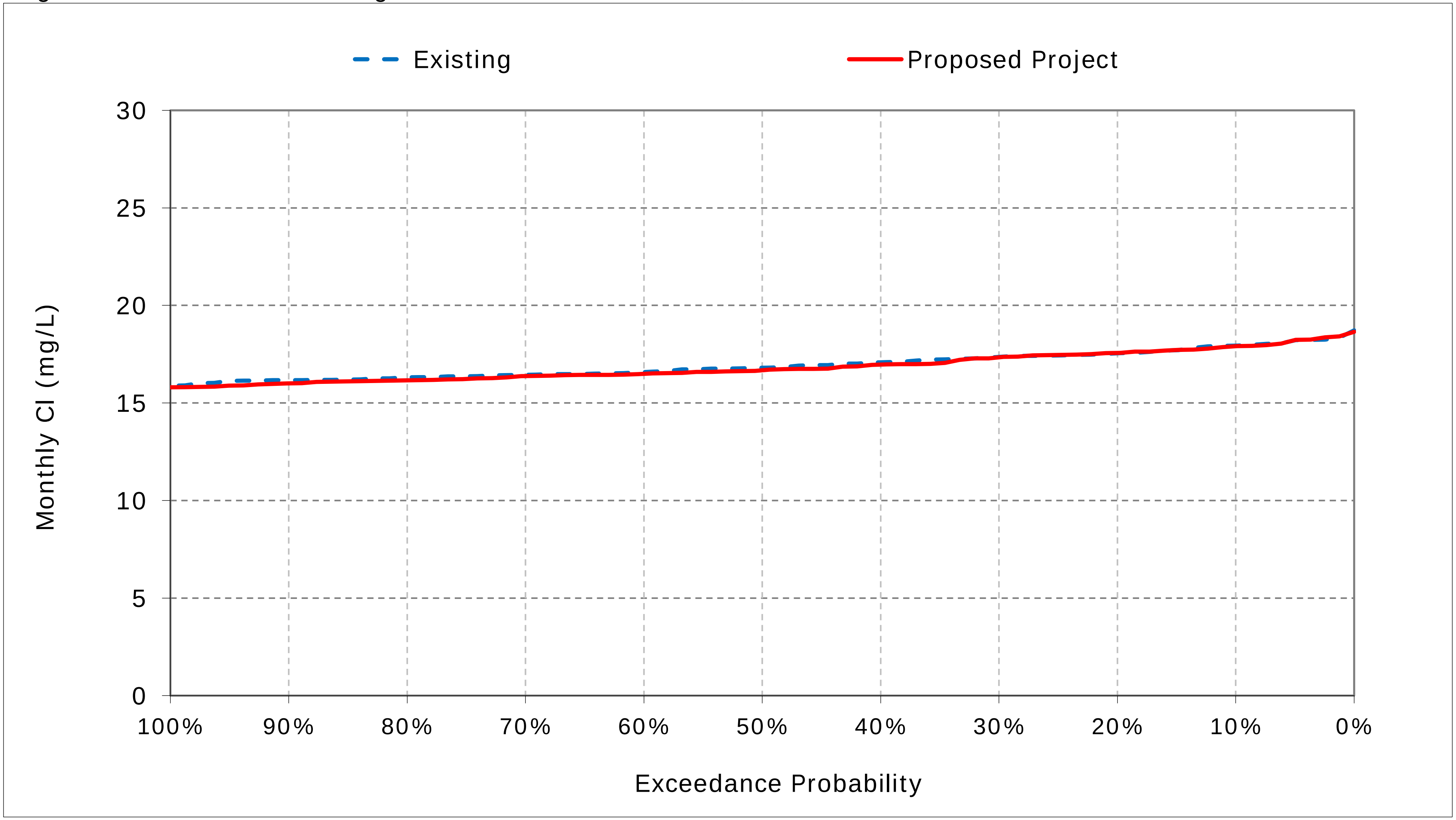
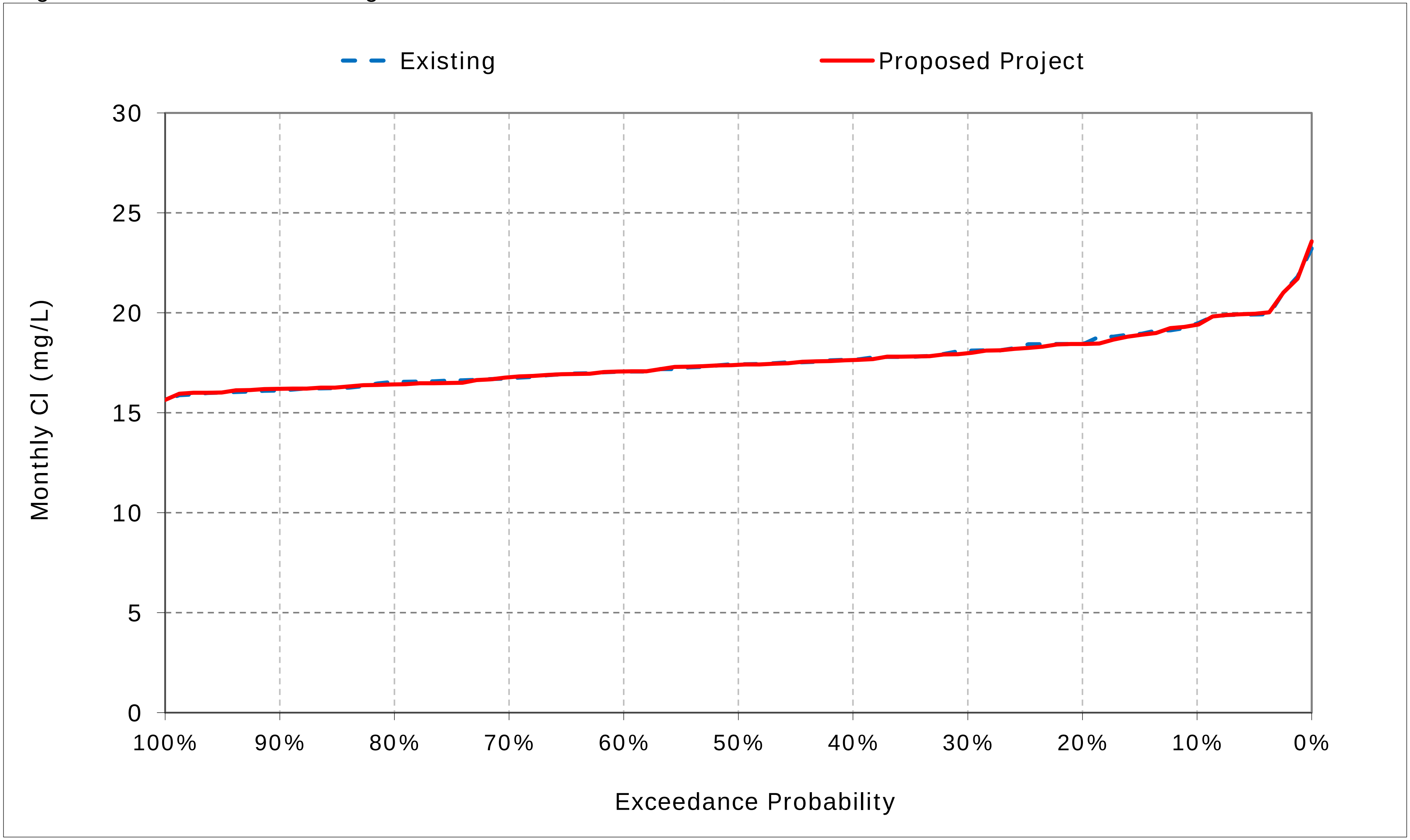


Figure 13-18. Barker Slough at NBA Intake Chloride, December Cl



Appendix C – Modeling

Attachment 2-9 – D1641 Compliance Results (DSM2-QUAL)

The following results of the DSM2-QUAL model are included for Delta compliance conditions for the following alternatives:

- Existing Conditions
- Proposed Project

Table 2-9.1. D1641 Compliance Results (DSM2-QUAL)

Title	Model Parameter	Table Numbers	Figure Numbers
D1641 AG West Canal at mouth of Clifton Court Forebay	CHWST000	NA	1-1
D1641 AG South Fork Mokelumne River at Terminus	RSMKL008	NA	2-1
D1641 AG Sacramento River at Emmaton	RSAC092	NA	3-1
D1641 AG San Joaquin River at Jersey Point	RSAN018	NA	4-1
D1641 AG San Joaquin River at San Andreas Landing	RSAN032	NA	5-1
D1641 AG Delta-Mendota Canal at Tracy Pumping Plant	CHDMC004	NA	6-1
D1641 FWS Chadbourne Slough at Sunrise Duck Club	SLCBN002	NA	7-1
D1641 FWS Montezuma Slough near Beldon Landing	SLMZU011	NA	8-1
D1641 FWS Montezuma Slough at National Steel	SLMZU025	NA	9-1
D1641 FWS Sacramento River at Collinsville	RSAC081	NA	10-1
D1641 FWS San Joaquin River at Jersey Point	RSAN018	NA	11-1
D1641 FWS San Joaquin River at Prisoners Point	RSAN037	NA	12-1
D1641 FWS Suisun Slough 300 ft south of Volanti Slough	SLSUS012	NA	13-1
D1641 MI Cache Slough at City of Vallejo Intake	SLCCH016	NA	14-1
D1641 MI West Canal at mouth of Clifton Court Forebay	CHWST000	NA	15-1
D1641 MI Contra Costa Canal at Pumping Plant #1	ROLD024	NA	16-1

Title	Model Parameter	Table Numbers	Figure Numbers
D1641 MI Delta-Mendota Canal at Tracy Pumping Plant	CHDMC004	NA	17-1
D1641 MI Barker Slough at North Bay Aqueduct Intake	SLBAR002	NA	18-1

Report formats

- Compliance exceedance charts including all scenarios

Figure 1 D1641 AG West Canal at mouth of Clifton Court Forebay Compliance Exceedance Plot

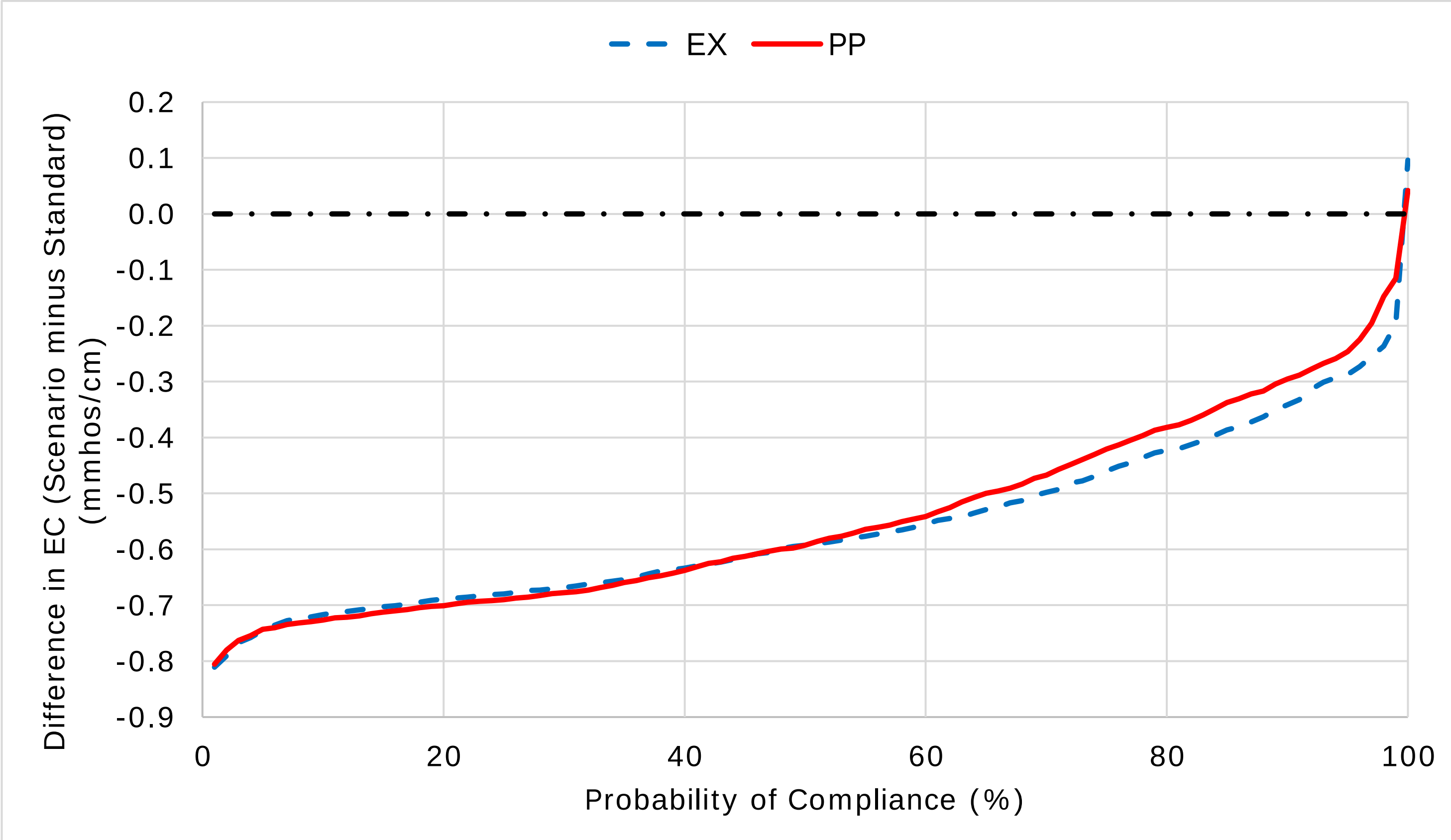


Figure 2 D1641 AG South Fork Mokelumne River at Terminus Compliance Exceedance Plot

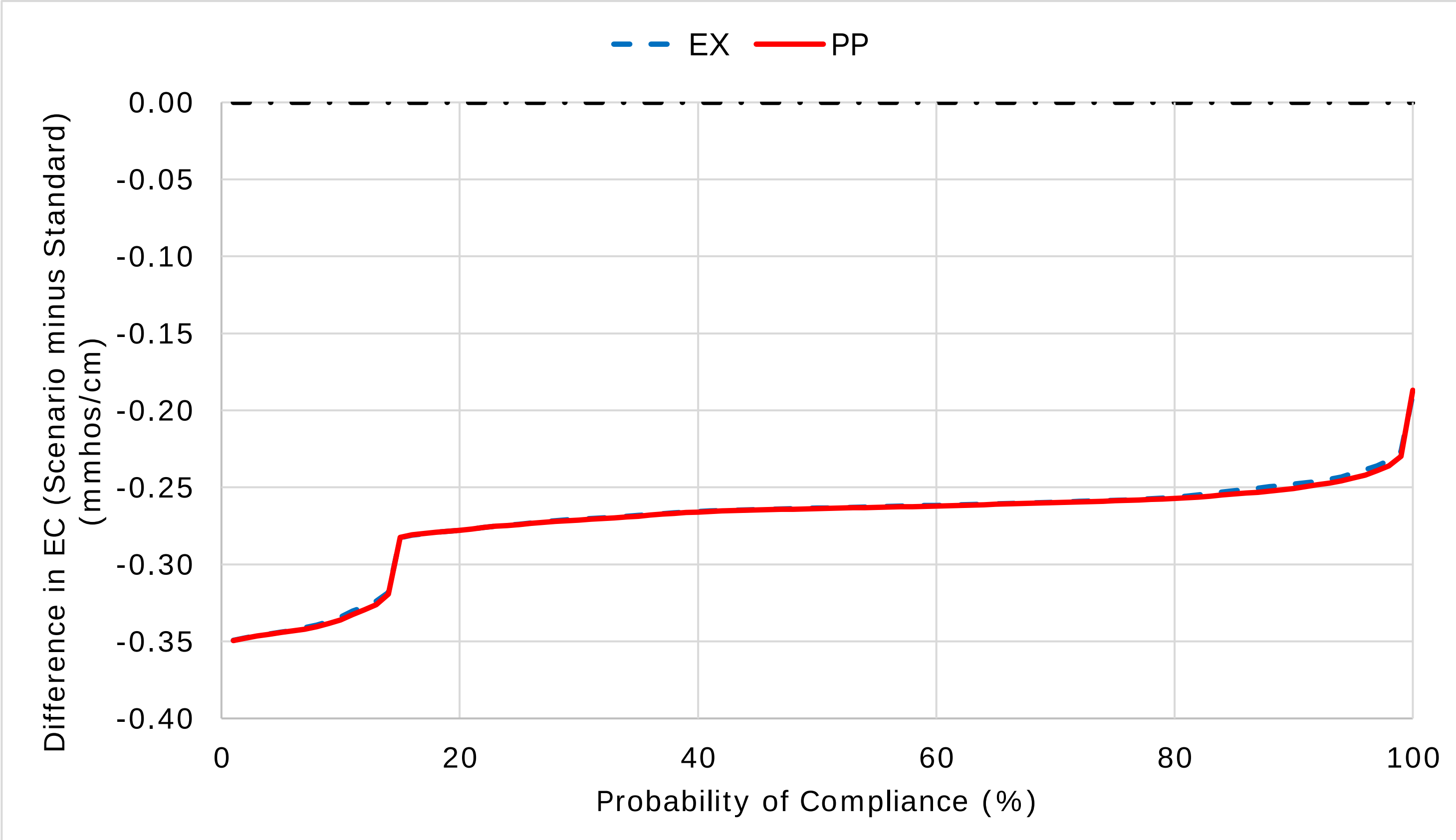


Figure 3 D1641 AG Sacramento River at Emmaton Compliance Exceedance Plot

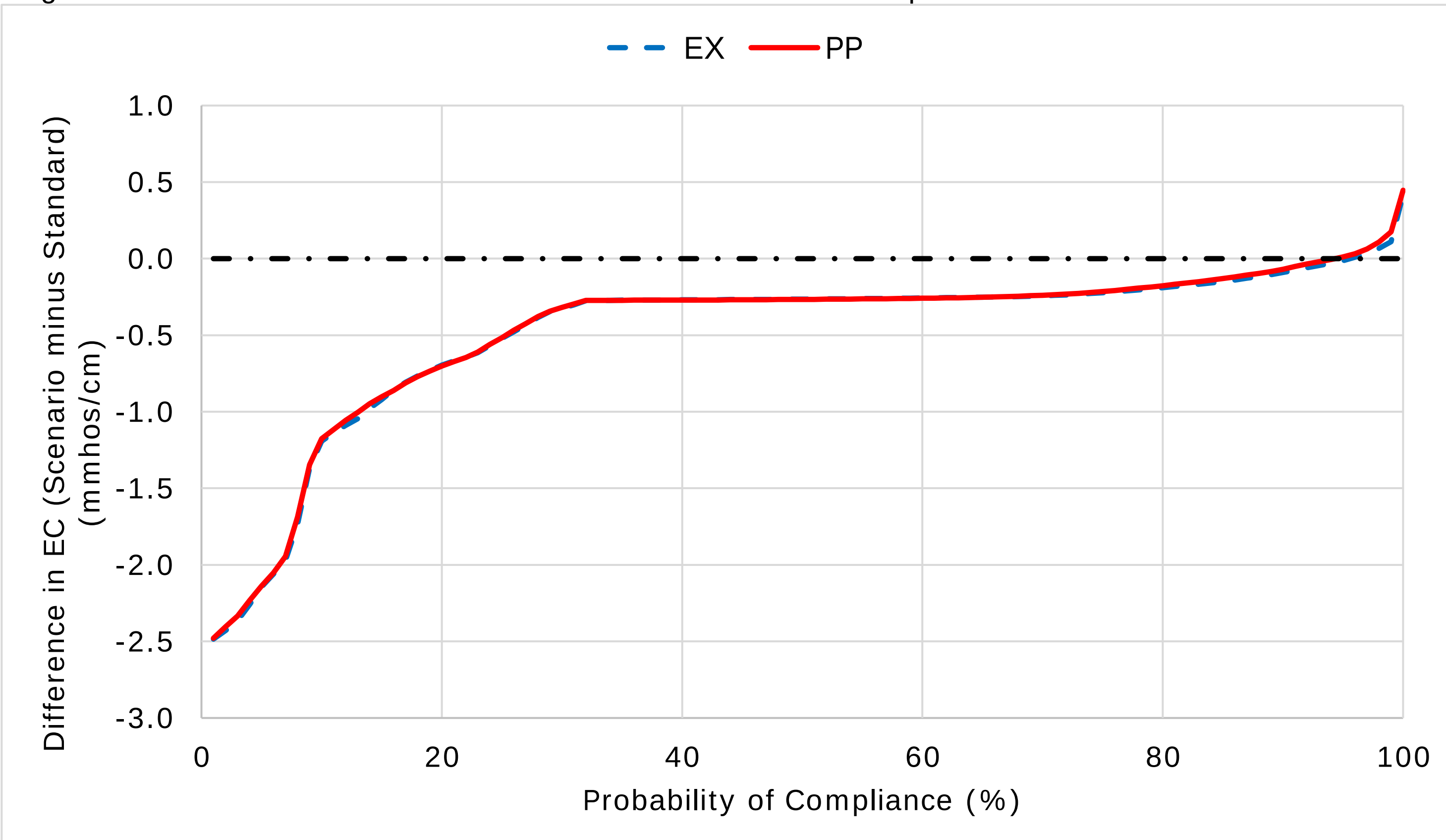


Figure 4 D1641 AG San Joaquin River at Jersey Point Compliance Exceedance Plot

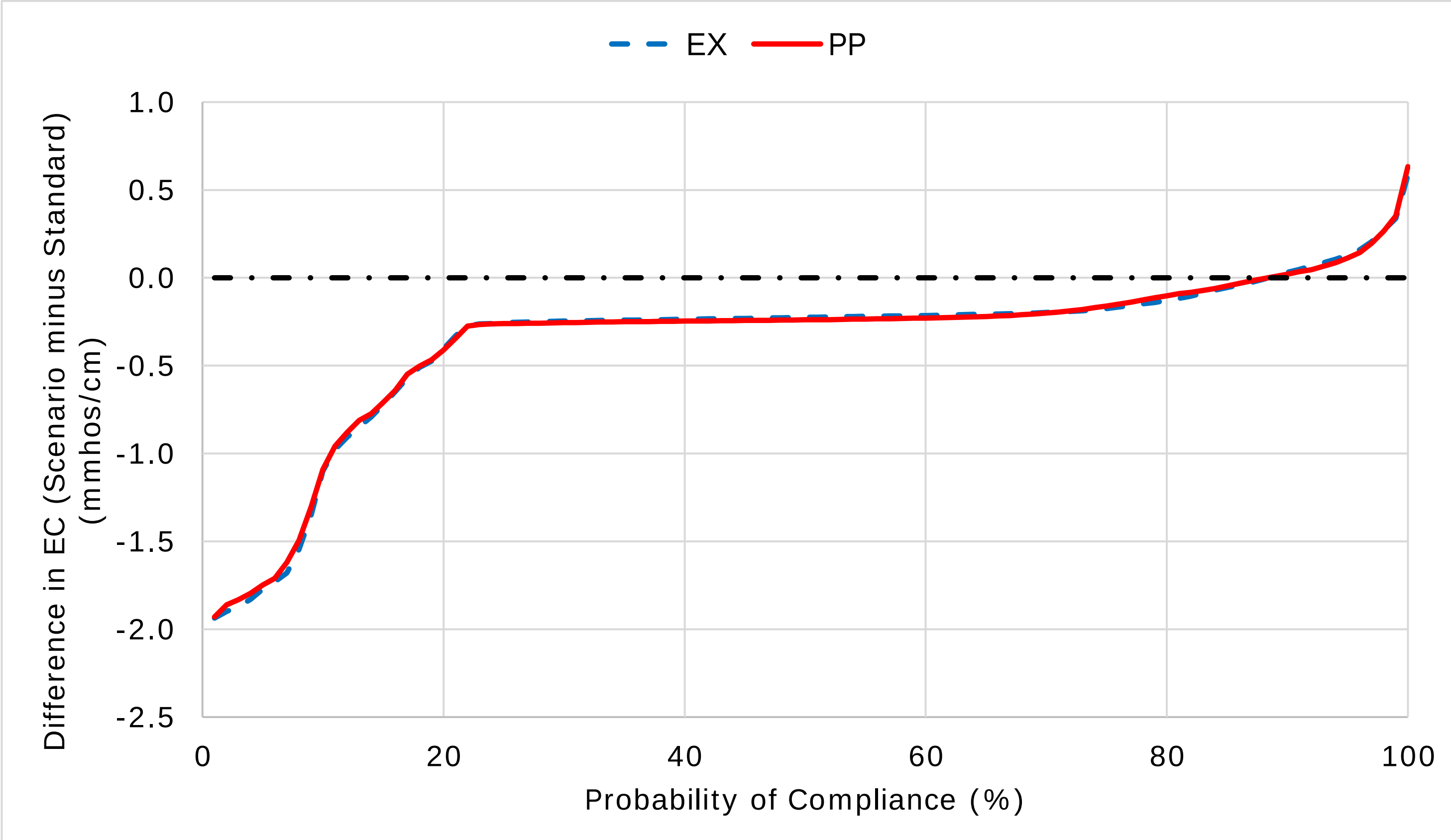


Figure 5 D1641 AG San Joaquin River at San Andreas Landing Compliance Exceedance Plot

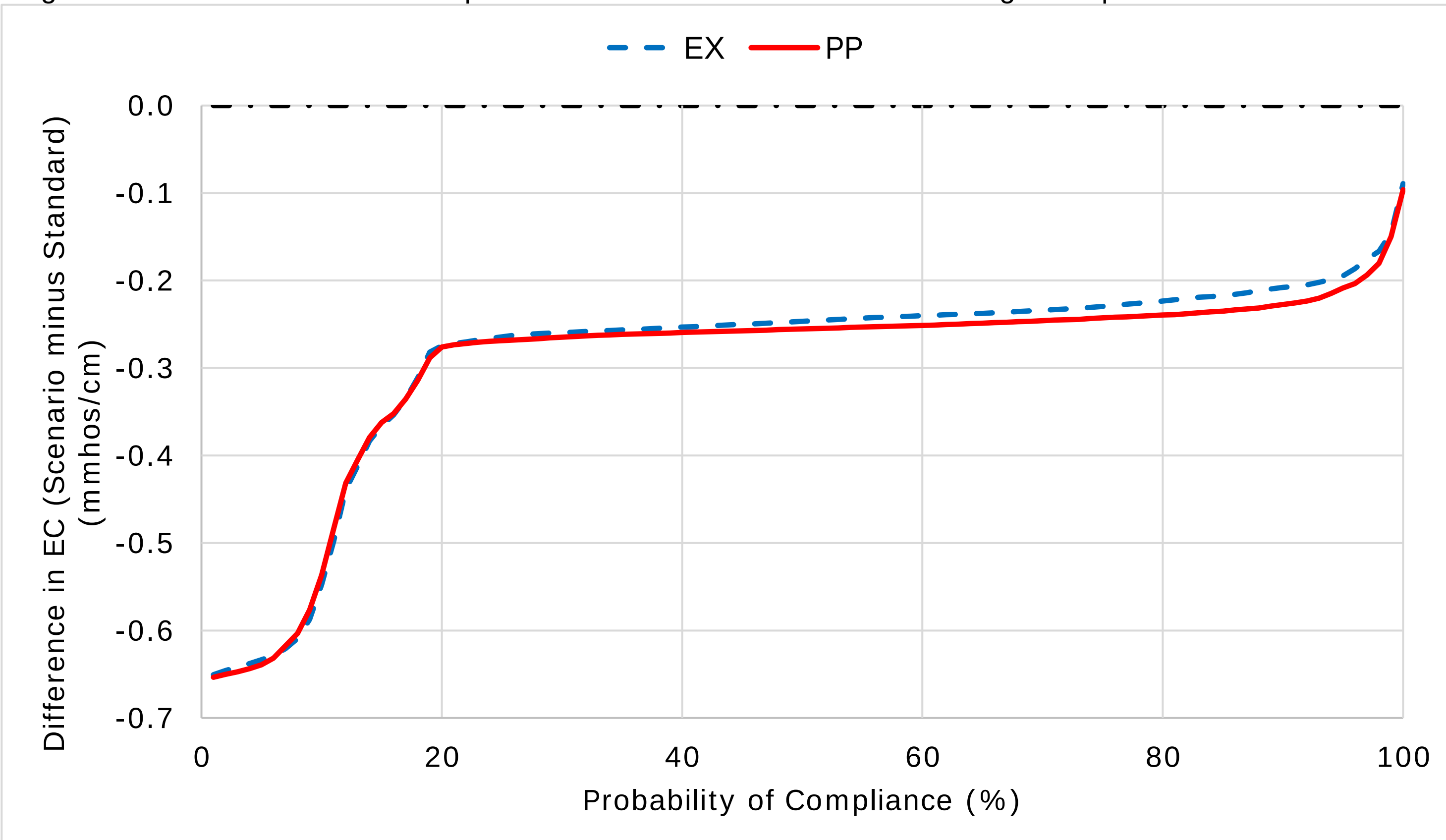


Figure 6 D1641 AG Delta-Mendota Canal at Tracy Pumping Plant Compliance Exceedance Plot

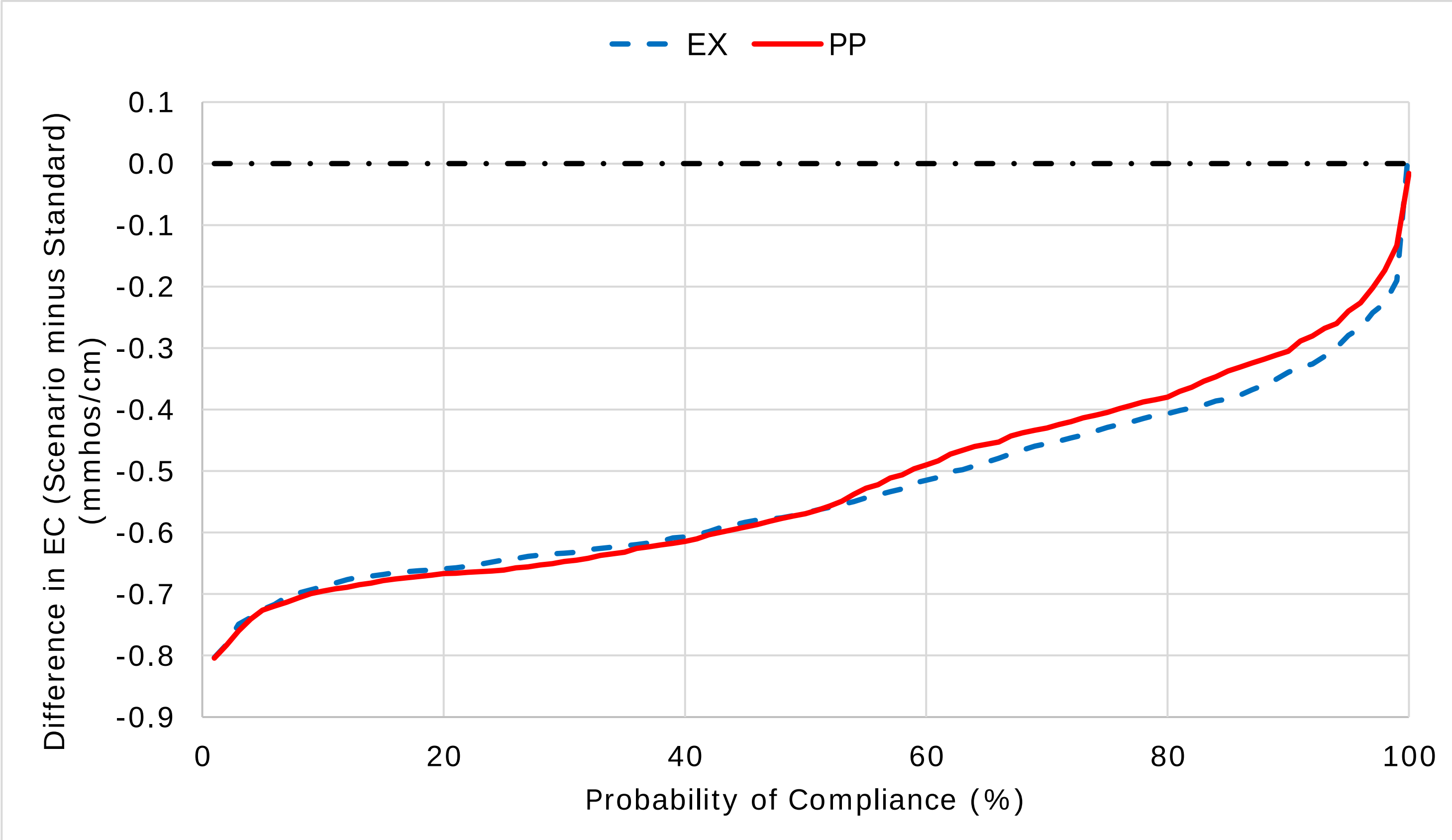


Figure 7 D1641 FWS Chadbourne Slough at Sunrise Duck Club Compliance Exceedance Plot

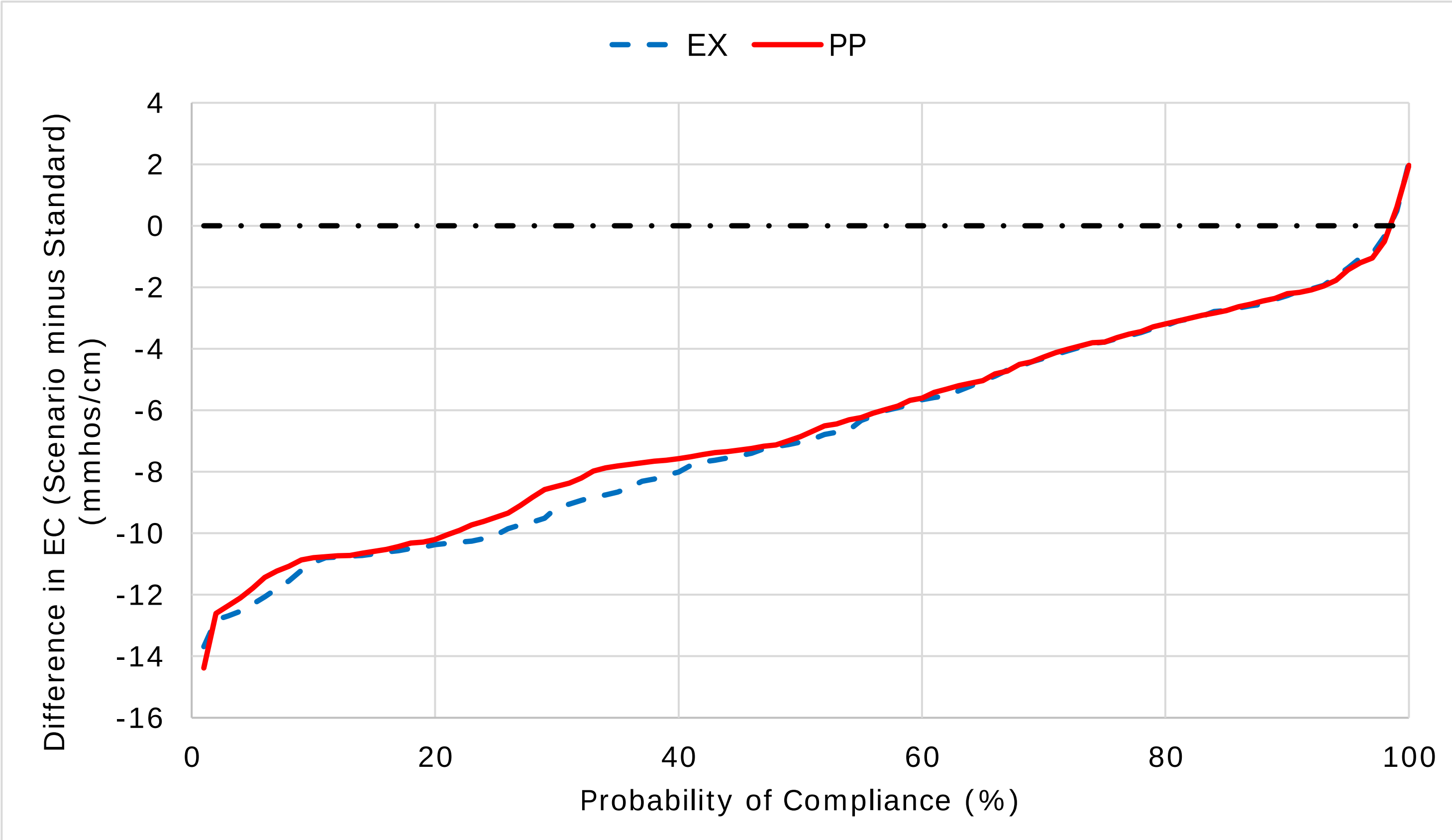


Figure 8 D1641 FWS Montezuma Slough near Beldons Landing Compliance Exceedance Plot

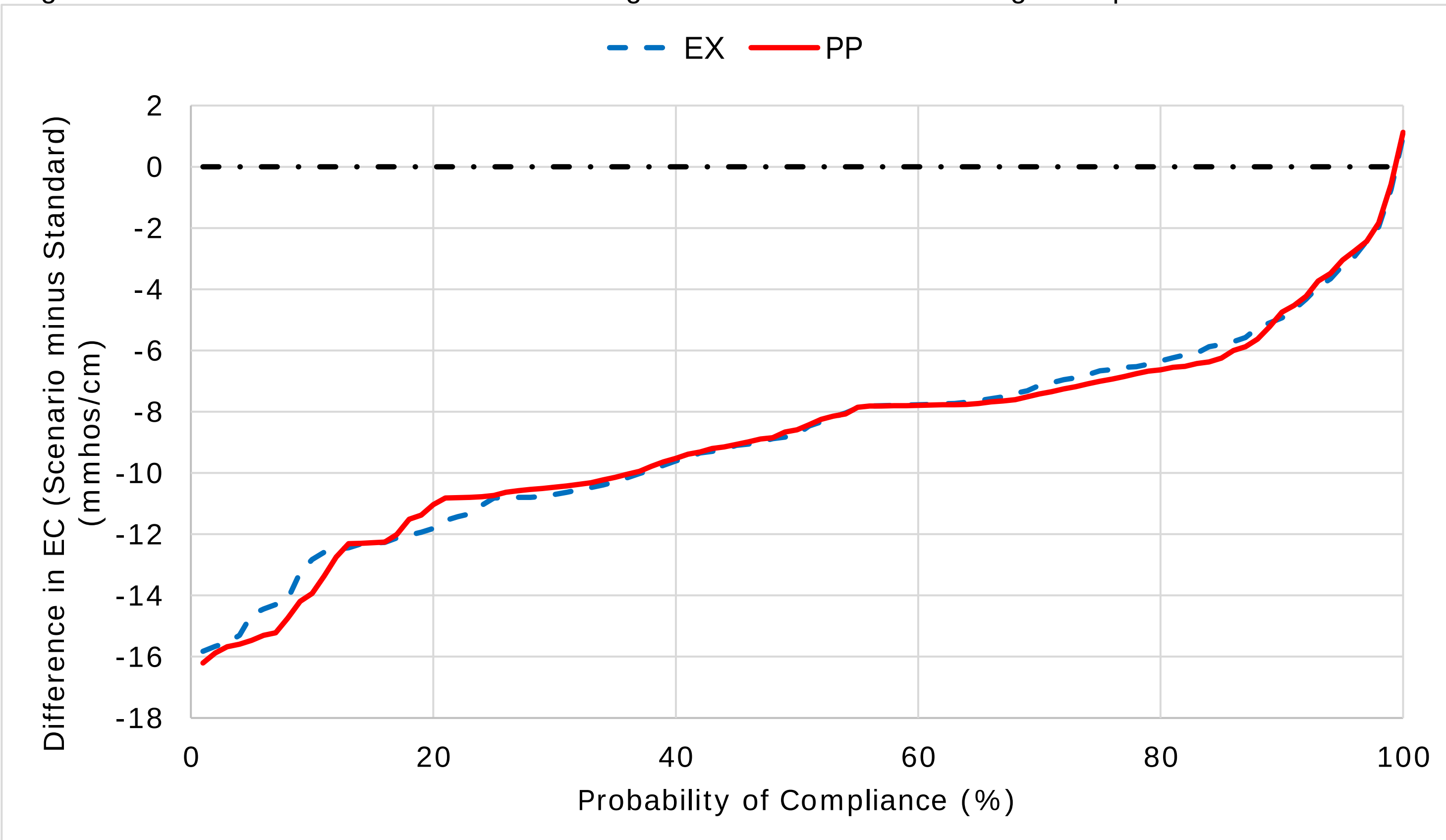


Figure 9 D1641 FWS Montezuma Slough at National Steel Compliance Exceedance Plot

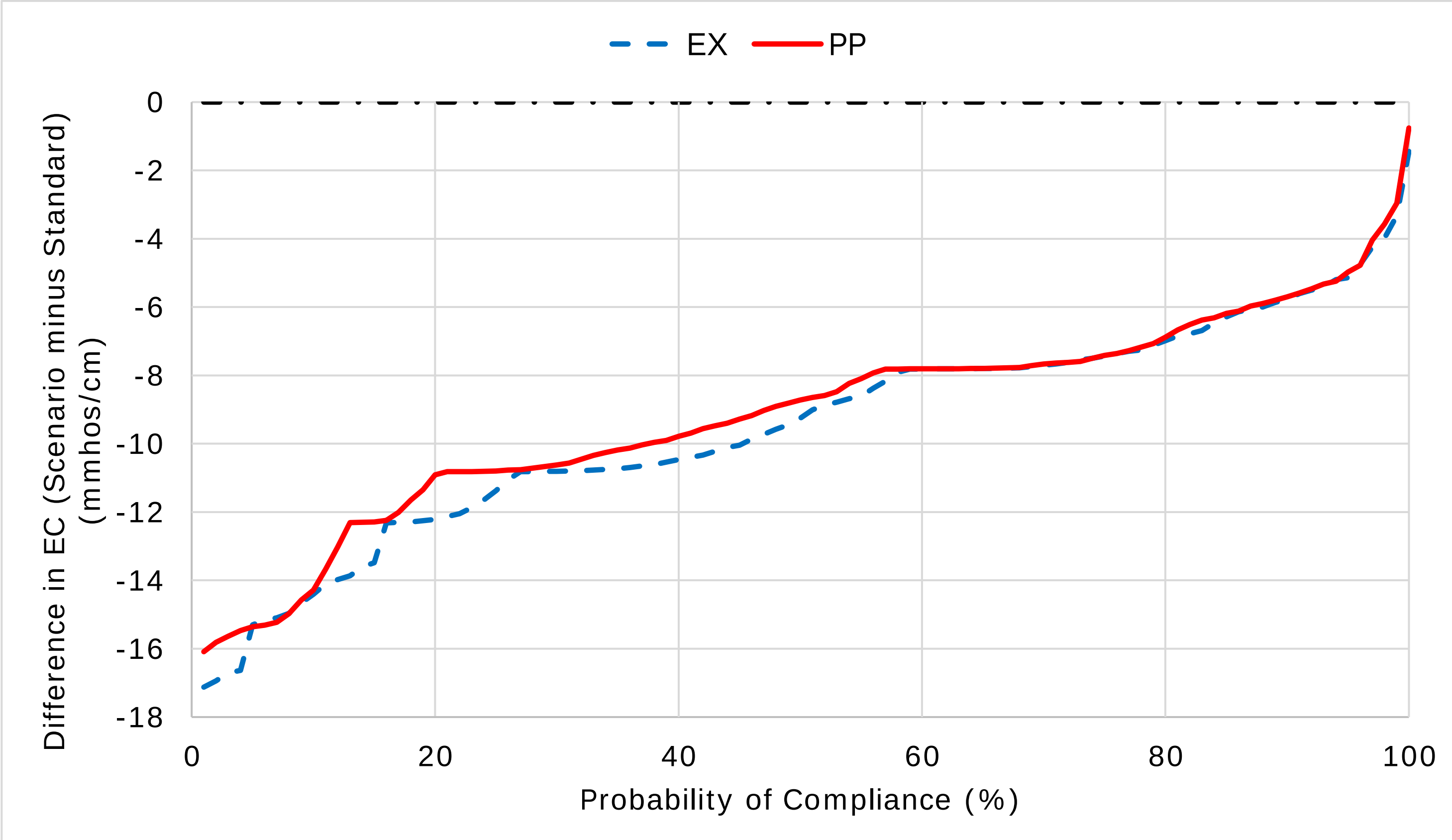


Figure 10 D1641 FWS Sacramento River at Collinsville Compliance Exceedance Plot

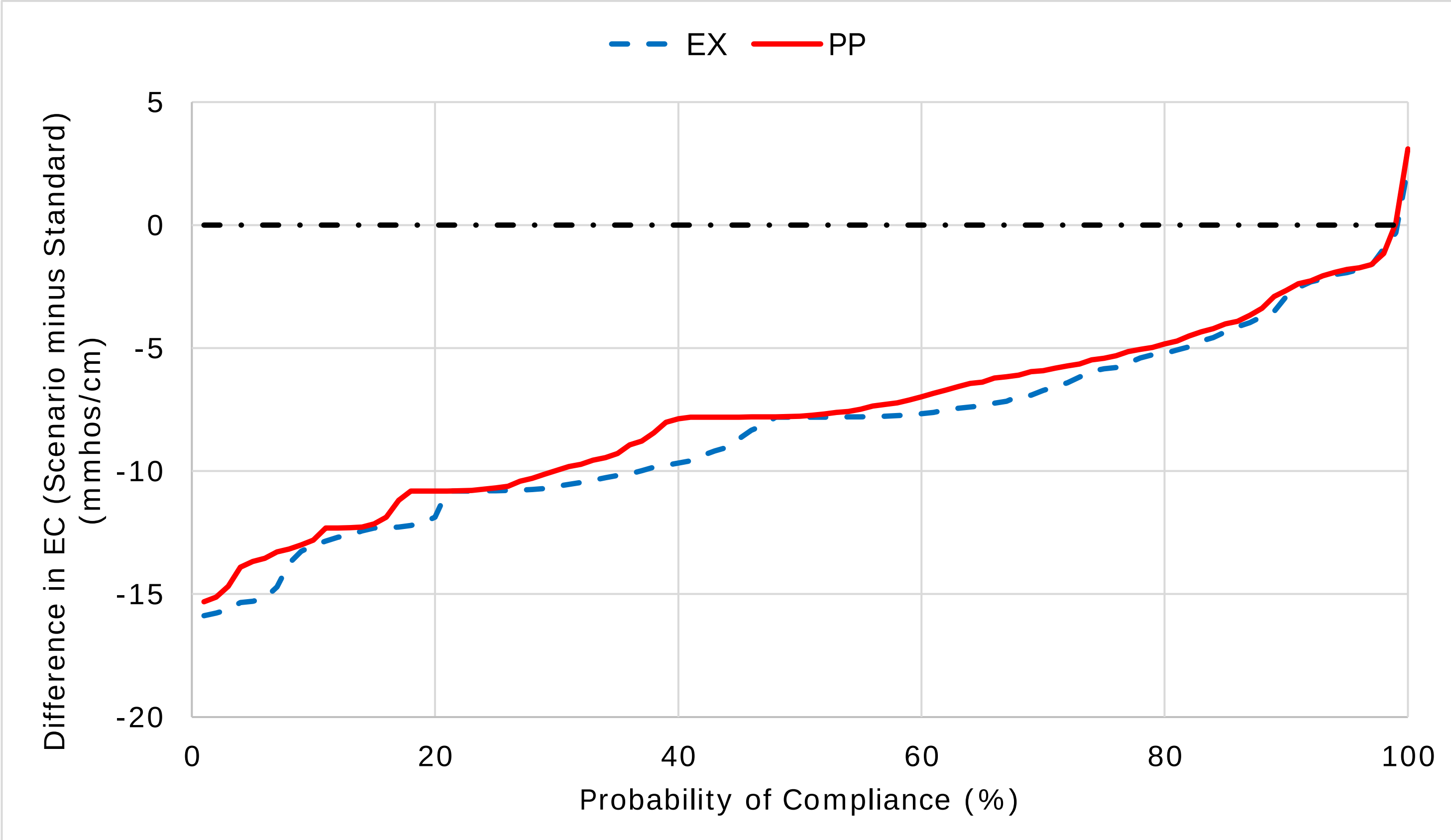


Figure 11 D1641 FWS San Joaquin River at Jersey Point Compliance Exceedance Plot

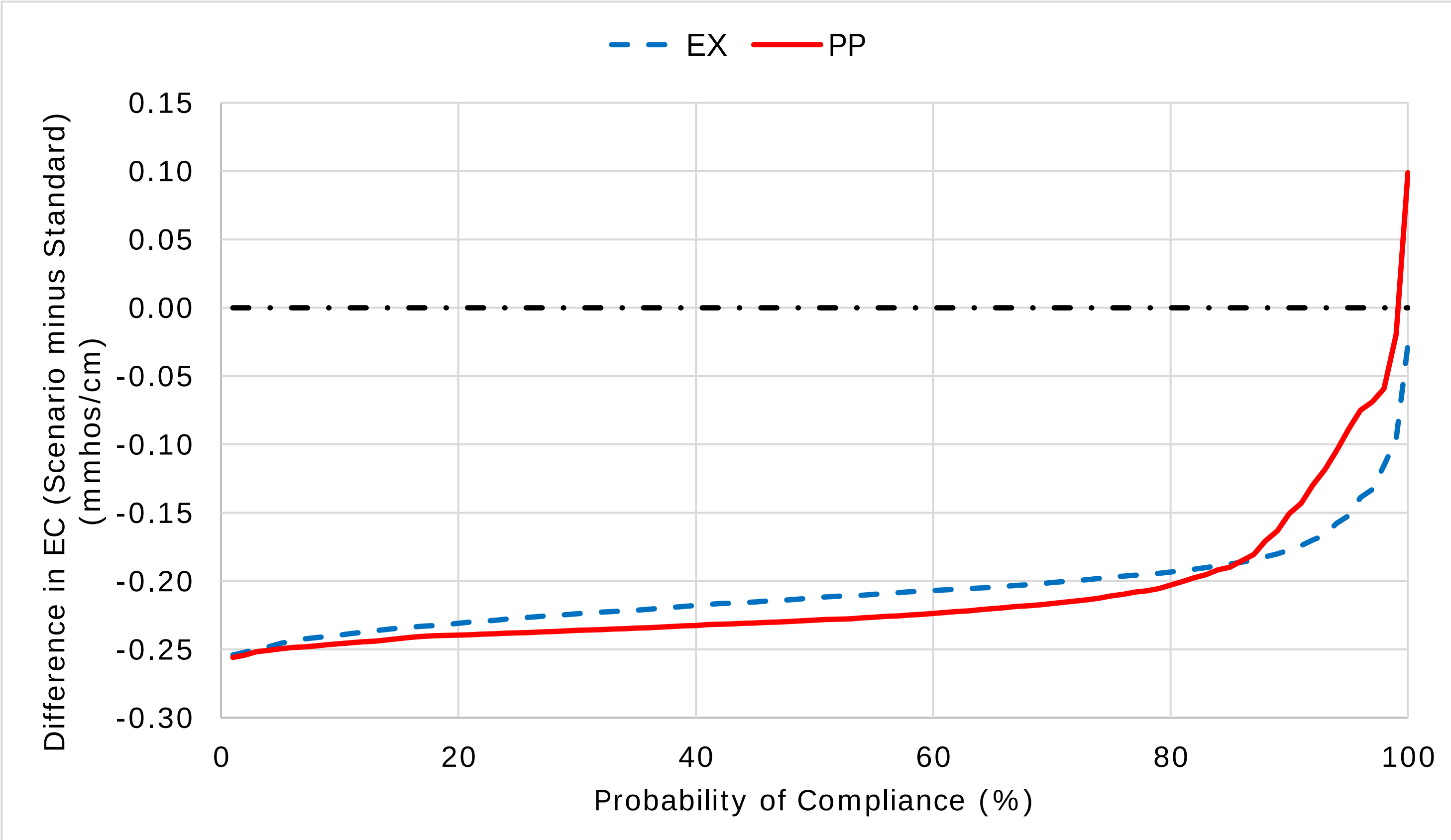


Figure 12 D1641 FWS San Joaquin River at Prisoners Point Compliance Exceedance Plot

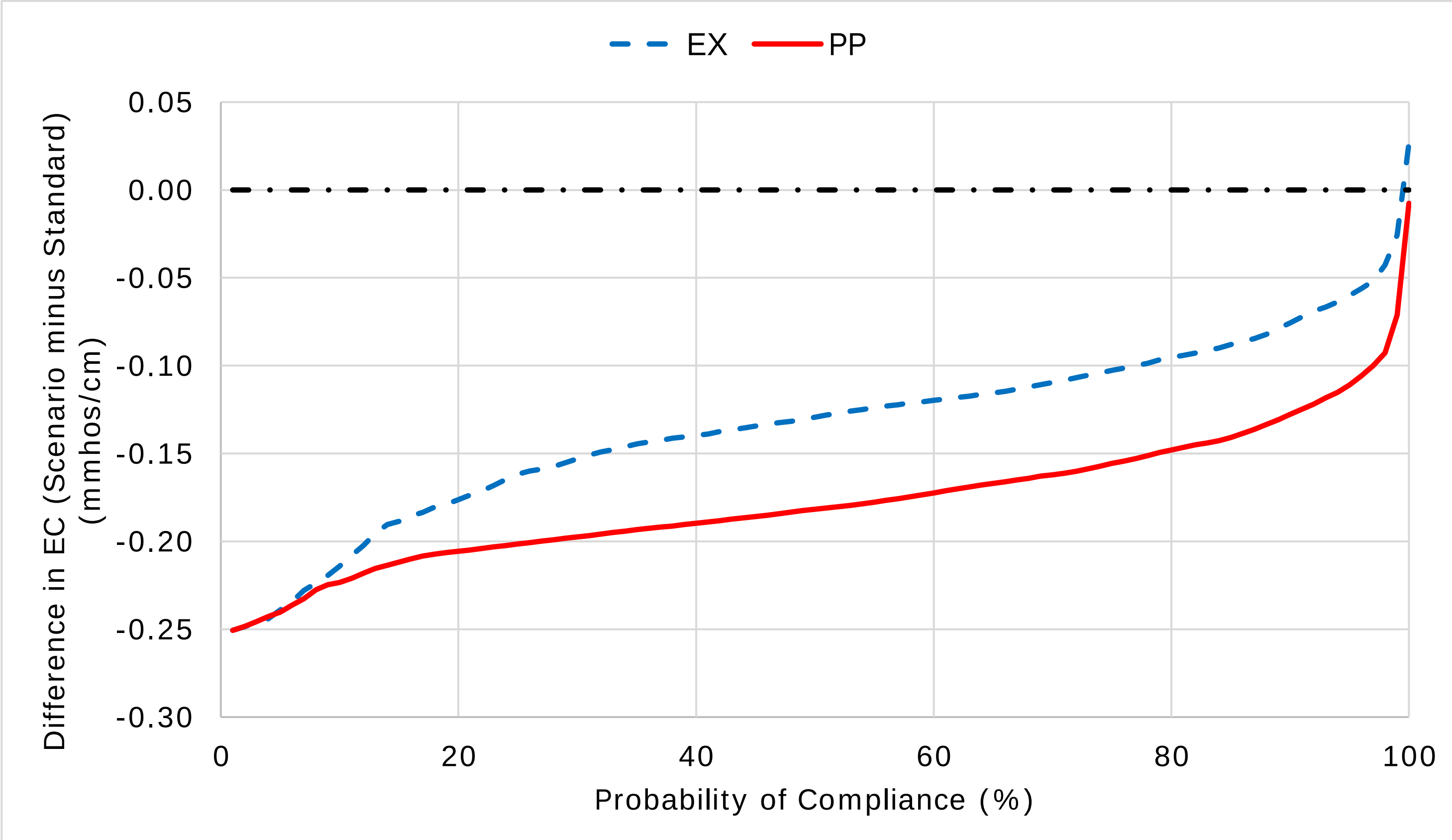


Figure 13 D1641 FWS Suisun Slough 300 ft south of Volanti Slough Compliance Exceedance Plot

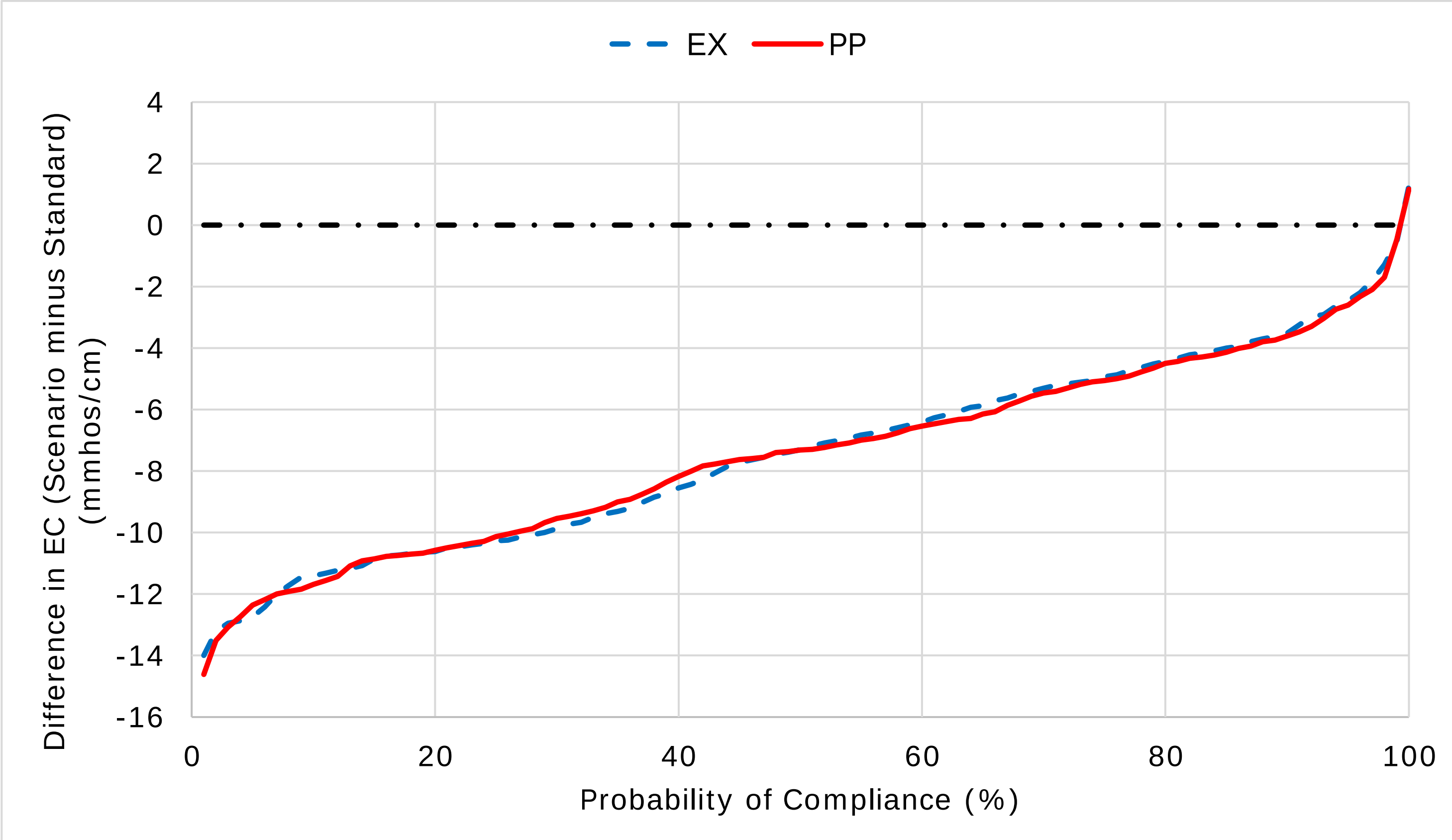


Figure 14 D1641 MI Cache Slough at City of Vallejo Intake Compliance Exceedance Plot

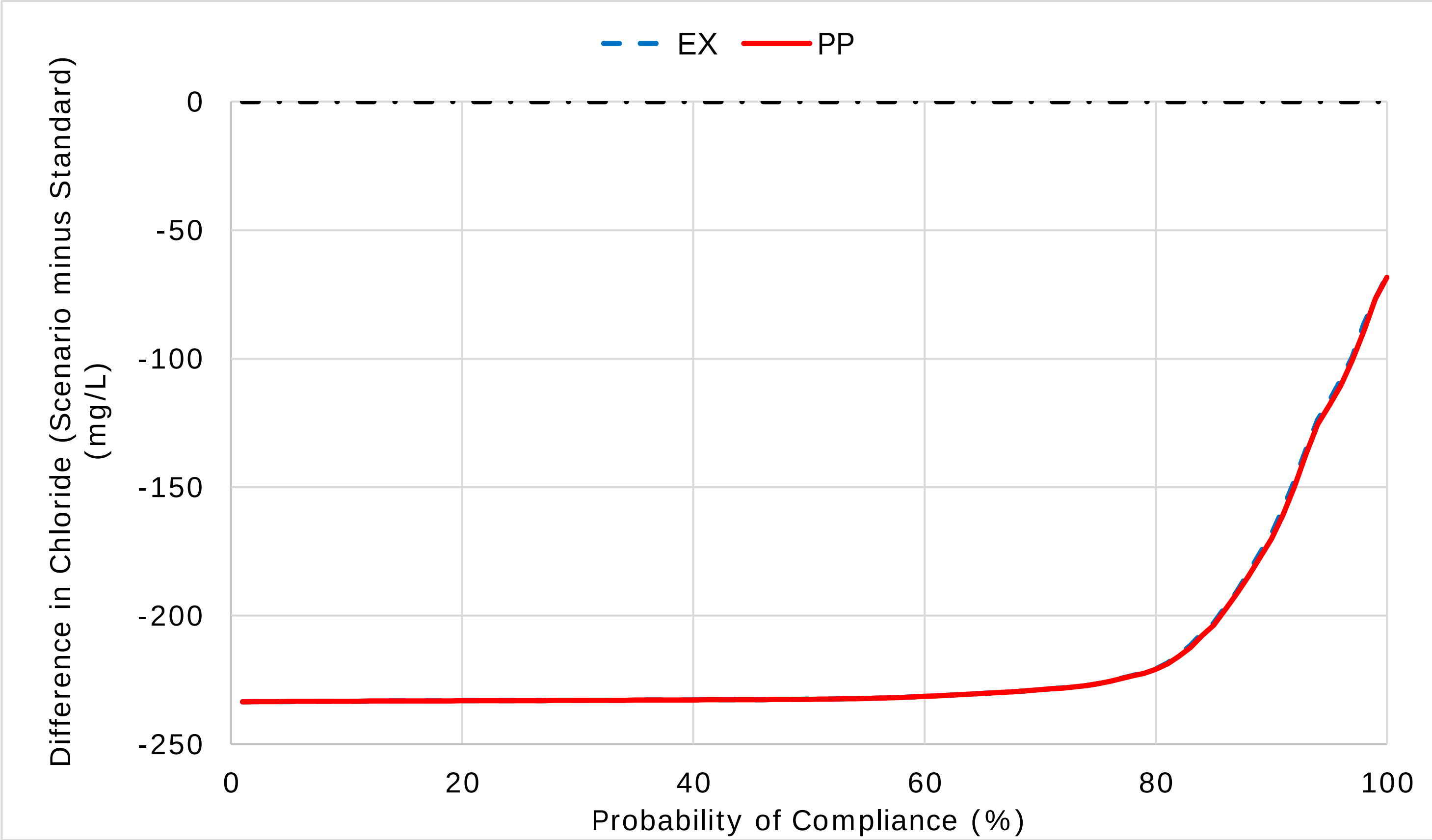


Figure 15 D1641 MI West Canal at mouth of Clifton Court Forebay Compliance Exceedance Plot

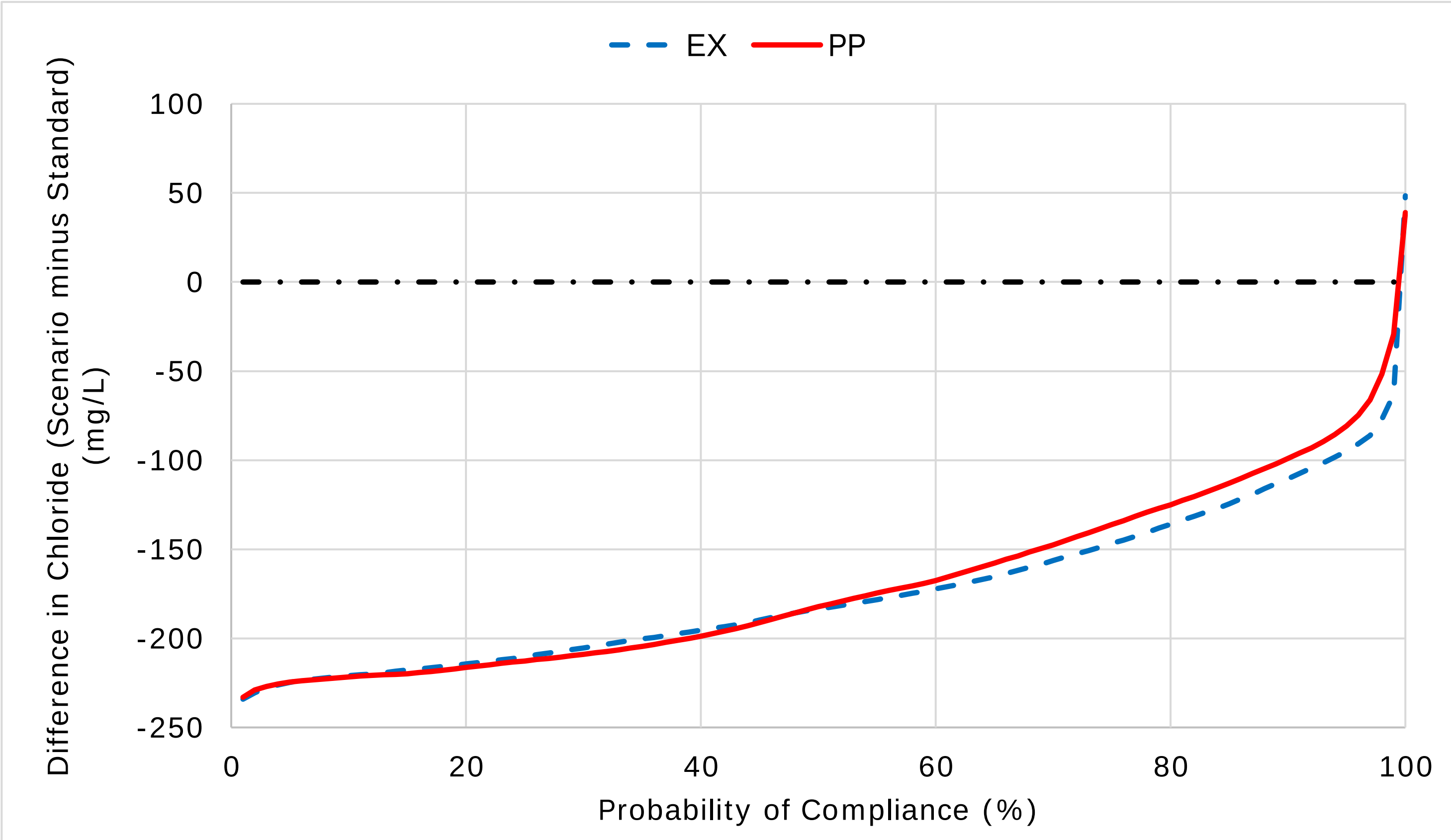


Figure 16 D1641 MI Contra Costa Canal at Pumping Plant #1 Compliance Exceedance Plot

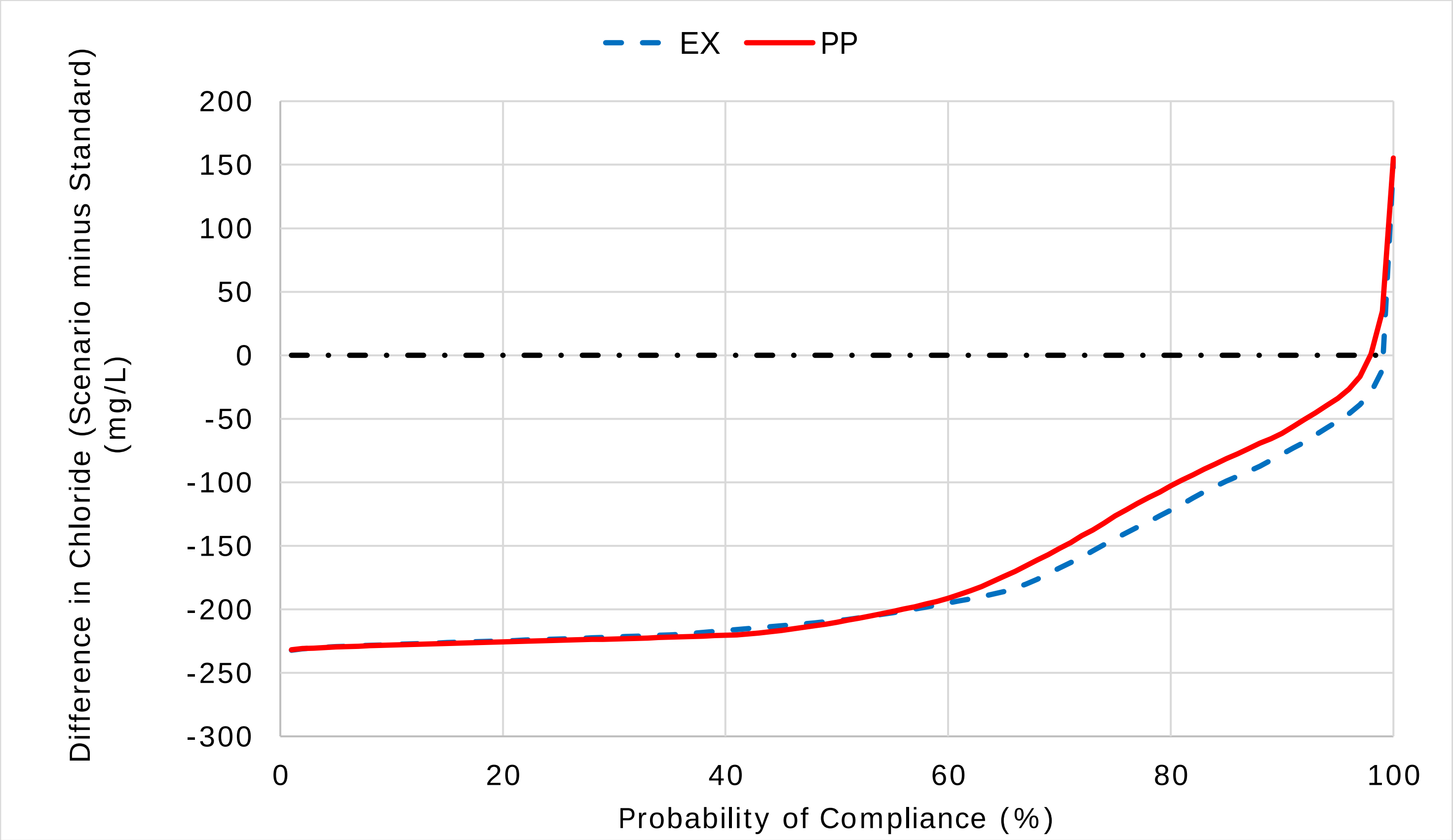


Figure 17 D1641 MI Delta-Mendota Canal at Tracy Pumping Plant Compliance Exceedance Plot

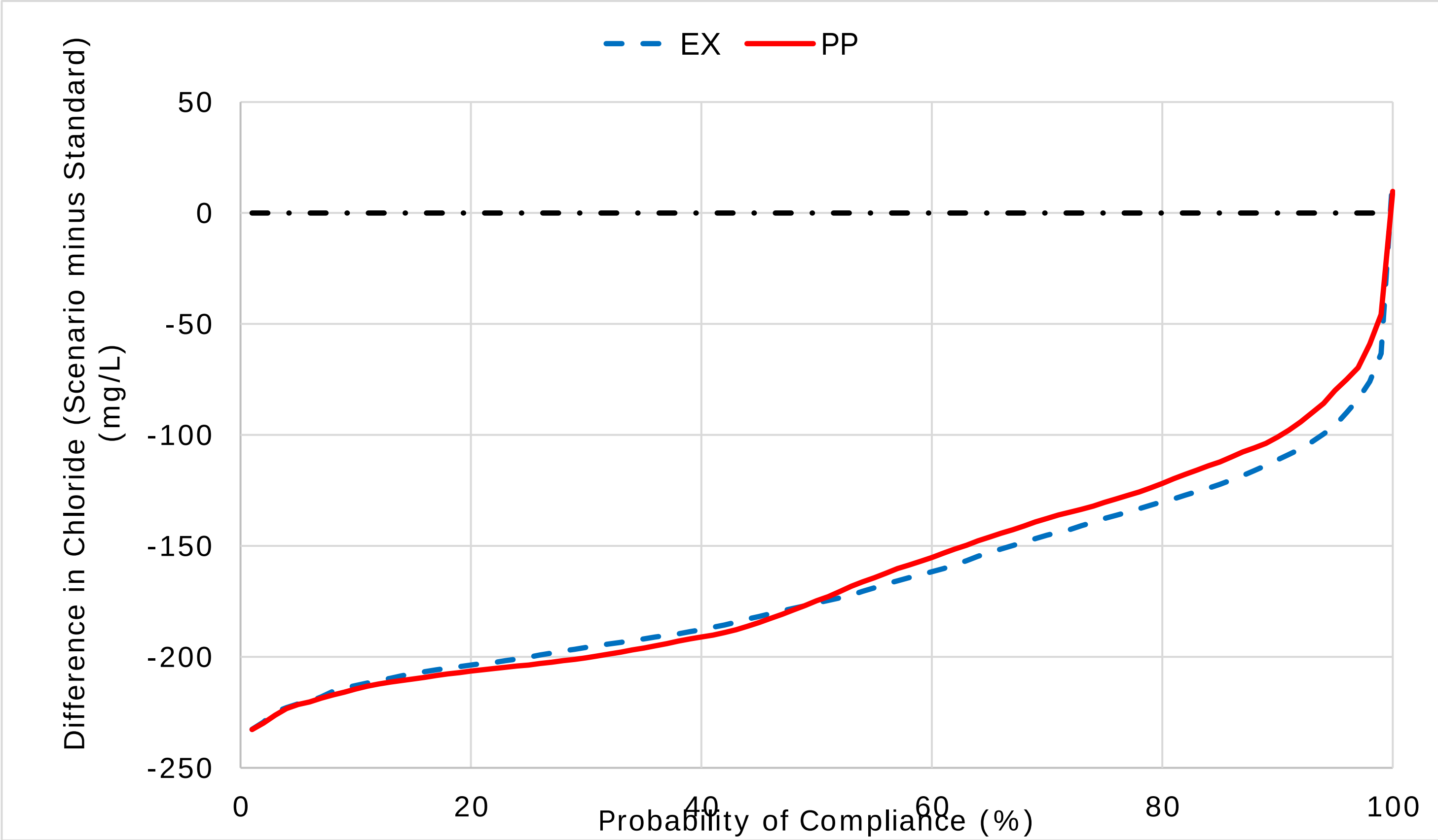
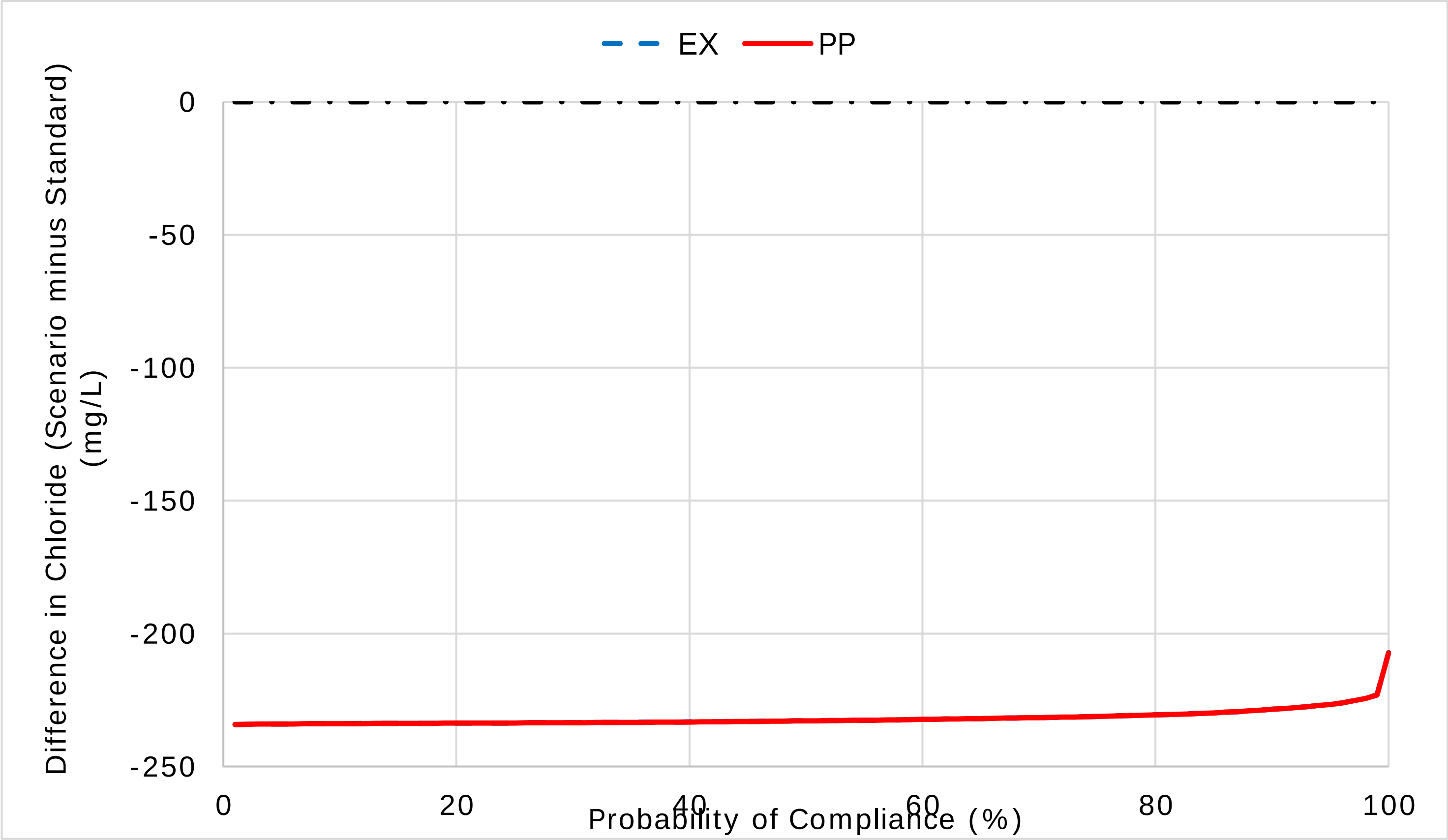


Figure 18 D1641 MI Barker Slough at North Bay Aqueduct Intake Compliance Exceedance Plot



Appendix C – Modeling

Attachment 2-10 – D1641 Compliance Results (CalSim II)

The following results of the CalSim II model are included for Delta compliance conditions for the following alternatives:

- Existing Conditions
- Proposed Project

Table 2-10.1. D1641 Compliance Results (CalSim II)

Title	Model Parameter	Table Numbers	Figure Numbers
D1641 MI Contra Costa Canal at Pumping Plant #1	NA	NA	1
D1641 AG San Joaquin River at Jersey Point	NA	NA	1
D1641 AG Sacramento River at Emmaton	NA	NA	1
D1641 FWS Spring X2	NA	NA	1

Report formats

- Compliance exceedance charts including all scenarios

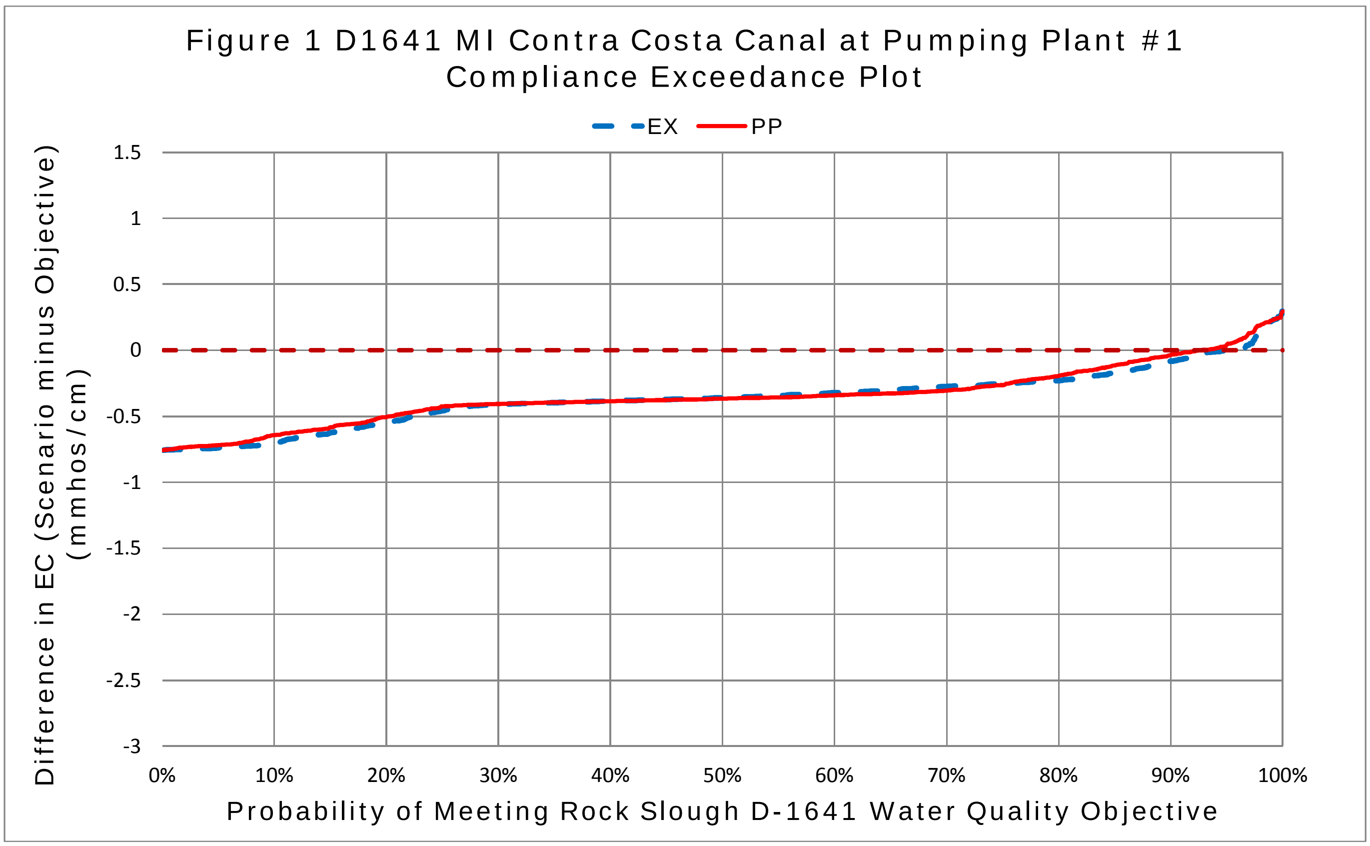


Figure 1 D1641 MI Contra Costa Canal at Pumping Plant #1
Compliance Exceedance Plot
EX
PP
Difference in EC (Scenario minus Objective)
(mmhos/cm)
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Probability of Meeting Rock Slough D-1641 Water Quality Objective

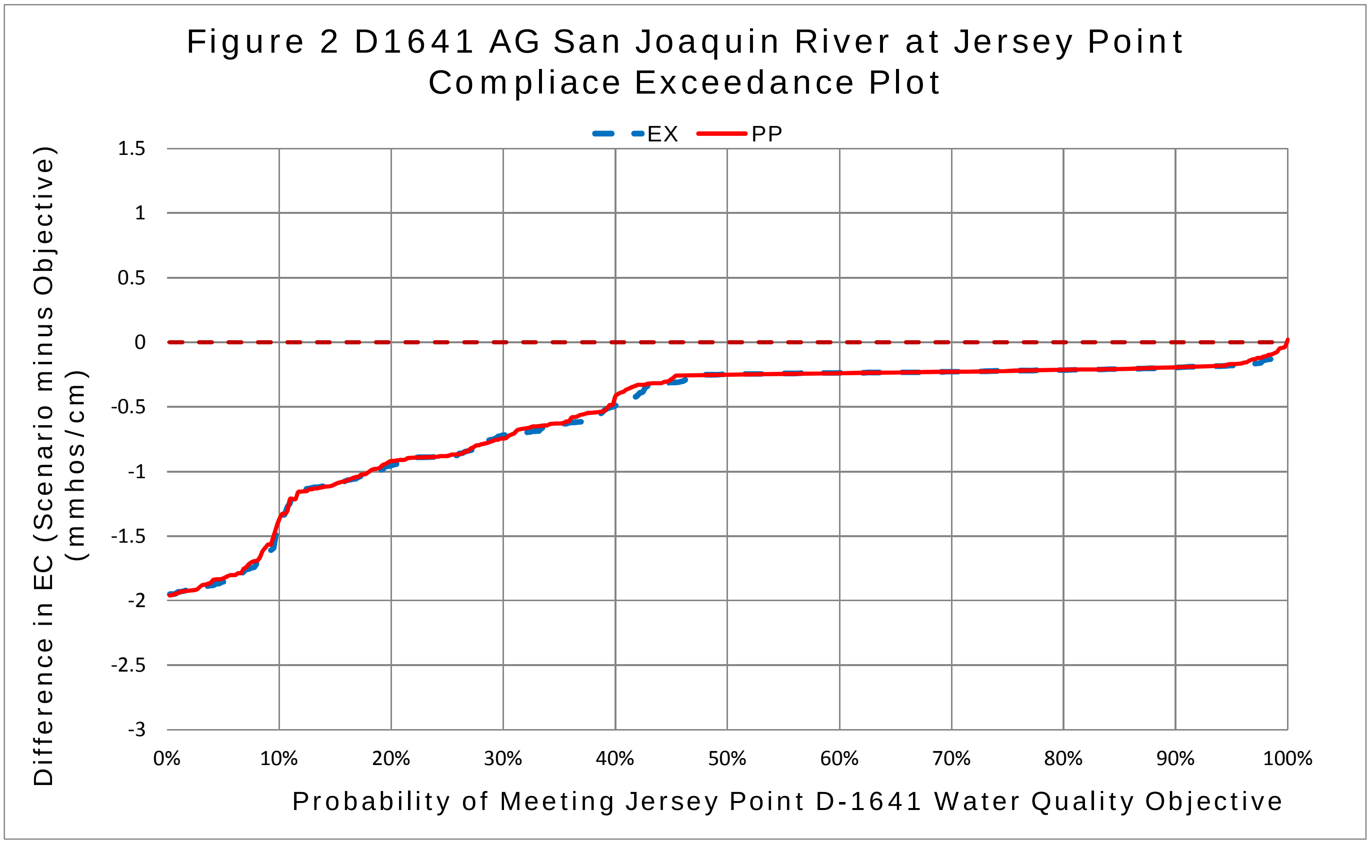


Figure 2 D1641 AG San Joaquin River at Jersey Point
Compliace Exceedance Plot
EX
PP
Difference in EC (Scenario minus Objective) (mmhos/cm)
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Probability of Meeting Jersey Point D-1641 Water Quality Objective

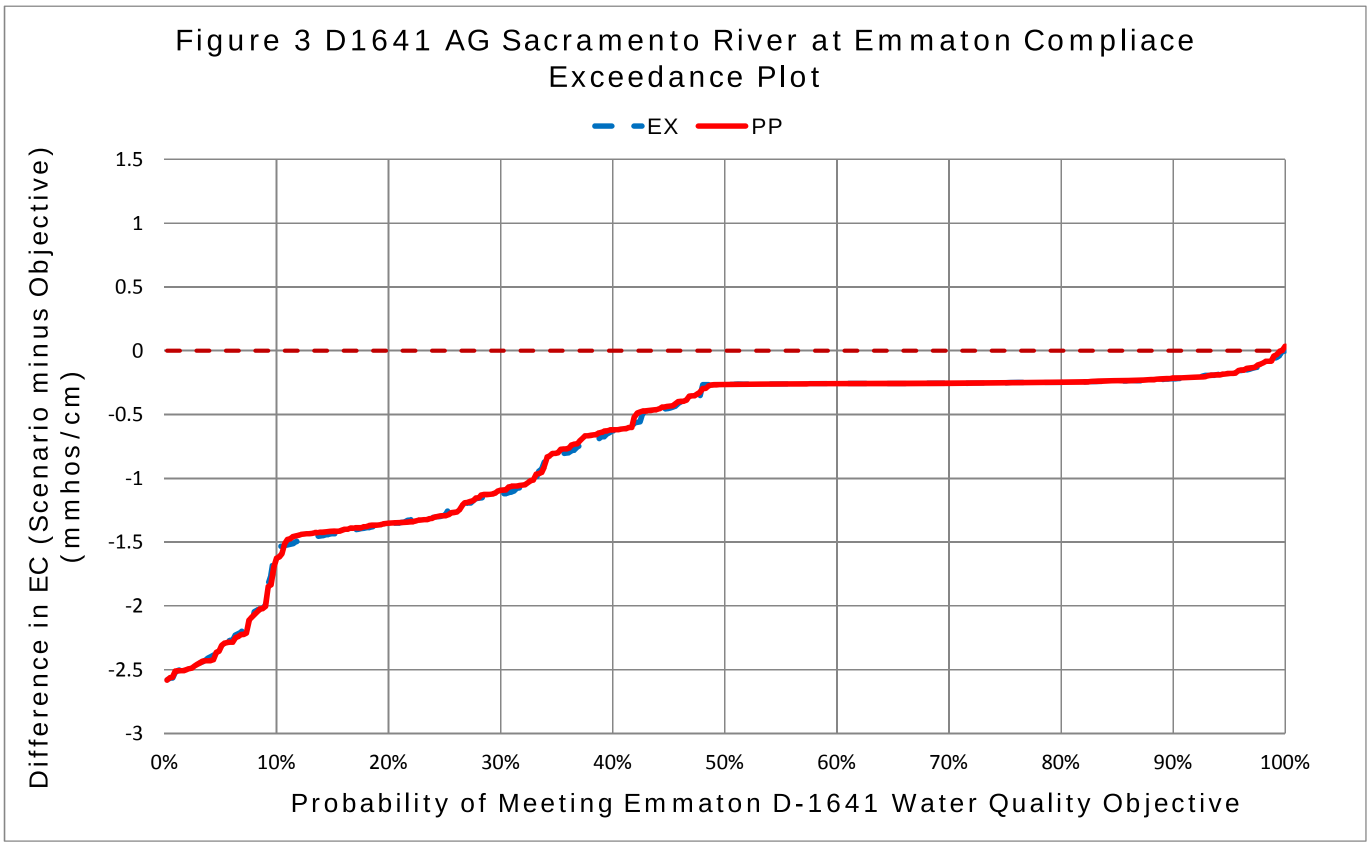


Figure 3 D1641 AG Sacramento River at Emmaton Compliace
Exceedance Plot
EX
PP
Difference in EC (Scenario minus Objective)
(mmhos/cm)
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Probability of Meeting Emmaton D-1641 Water Quality Objective

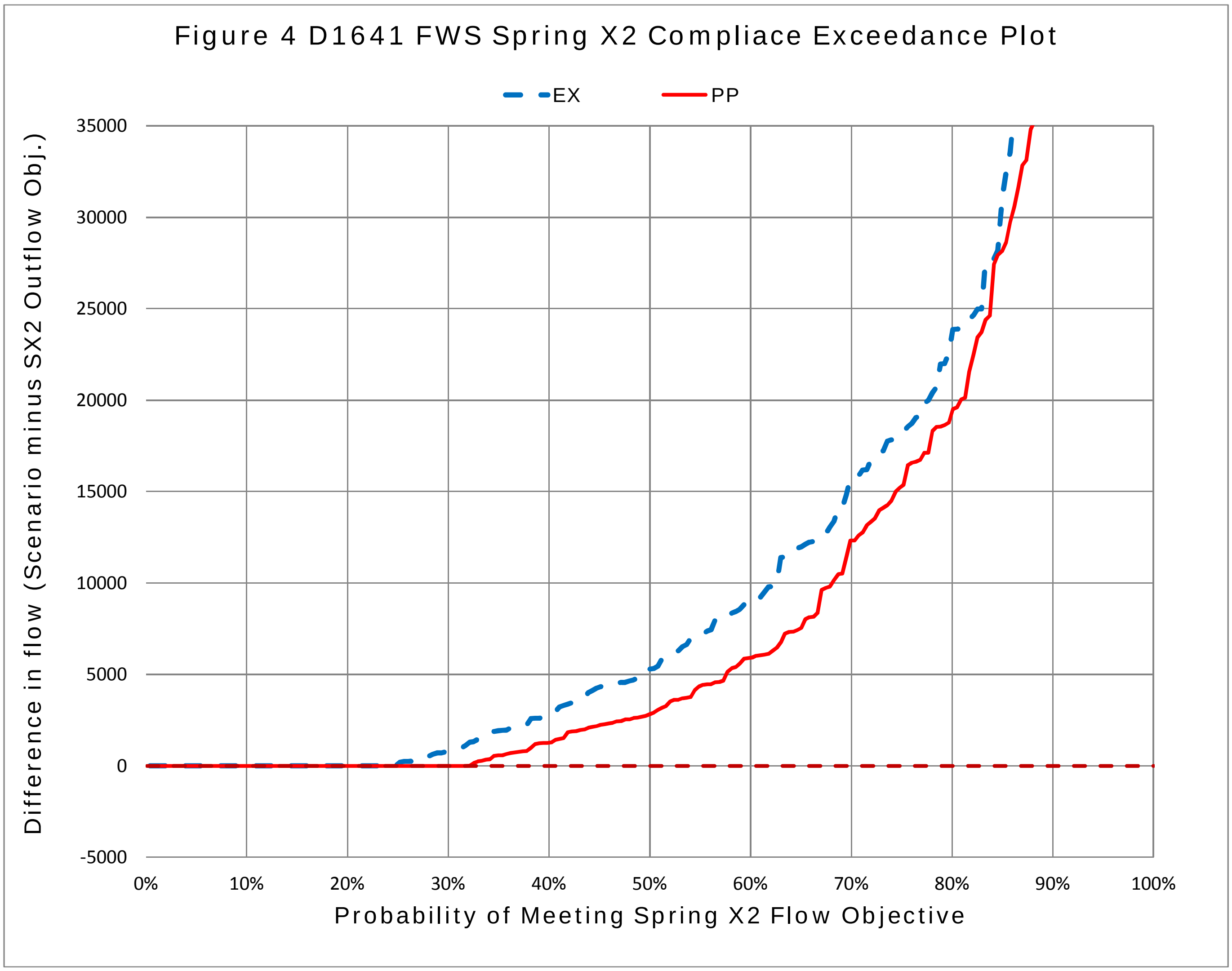


Figure 4 D1641 FWS Spring X2 Compliace Exceedance Plot
EX
PP
Difference in flow (Scenario minus SX2 Outflow Obj.)
35000
30000
25000
20000
15000
10000
5000
0
-5000
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Probability of Meeting Spring X2 Flow Objective

APPENDIX D

Schism Model Results

Table of Contents

Figures

Table

ACRONYMS AND OTHER ABBREVIATIONS

°C	degrees Celsius
CCF	Clifton Court Forebay
CDFW	California Department of Fish and Wildlife
cfs	cubic feet per second
CMOP	Coastal Margin Observation and Prediction
D-1641	State Water Resources Control Board Water Rights Decision 1641
DCC	Delta Cross Channel
DCD	Delta Channel Depletion
DES	Department of Environmental Services
DETAW	Delta Evapotranspiration of Applied Water
DWR	California Department of Water Resources
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
ELCIRC	Eulerian–Lagrangian algorithm
ELM	Eulerian-Lagrangian method
km	kilometer
LSC2	localized sigma coordinates with shaved cells
LSZ	low salinity zone
m	meter
mS/cm	milliSiemens per centimeter
NOAA	National Oceanic and Atmospheric Administration
psu	practical salinity units
SCHISM	Semi-Implicit Cross-scale Hydroscience Integrated System Model
SELFE	semi-implicit Eulerian-Lagrangian finite-element
SMSCG	Suisun Marsh Salinity Control Gate
SMSCG	Suisun Marsh Salinity Control Gate
SWRCB	State Water Resources Control Board
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

SCHISM MODEL RESULTS

INTRODUCTION: STUDY OBJECTIVE

This appendix section summarizes 3-D hydrodynamics modeling and analysis performed by the Bay-Delta Office of the California Department of Water Resources (DWR) to investigate the Suisun Marsh Salinity Control Gate (SMSCG) reoperation and flow augmentation components of the ITP Proposed Project.

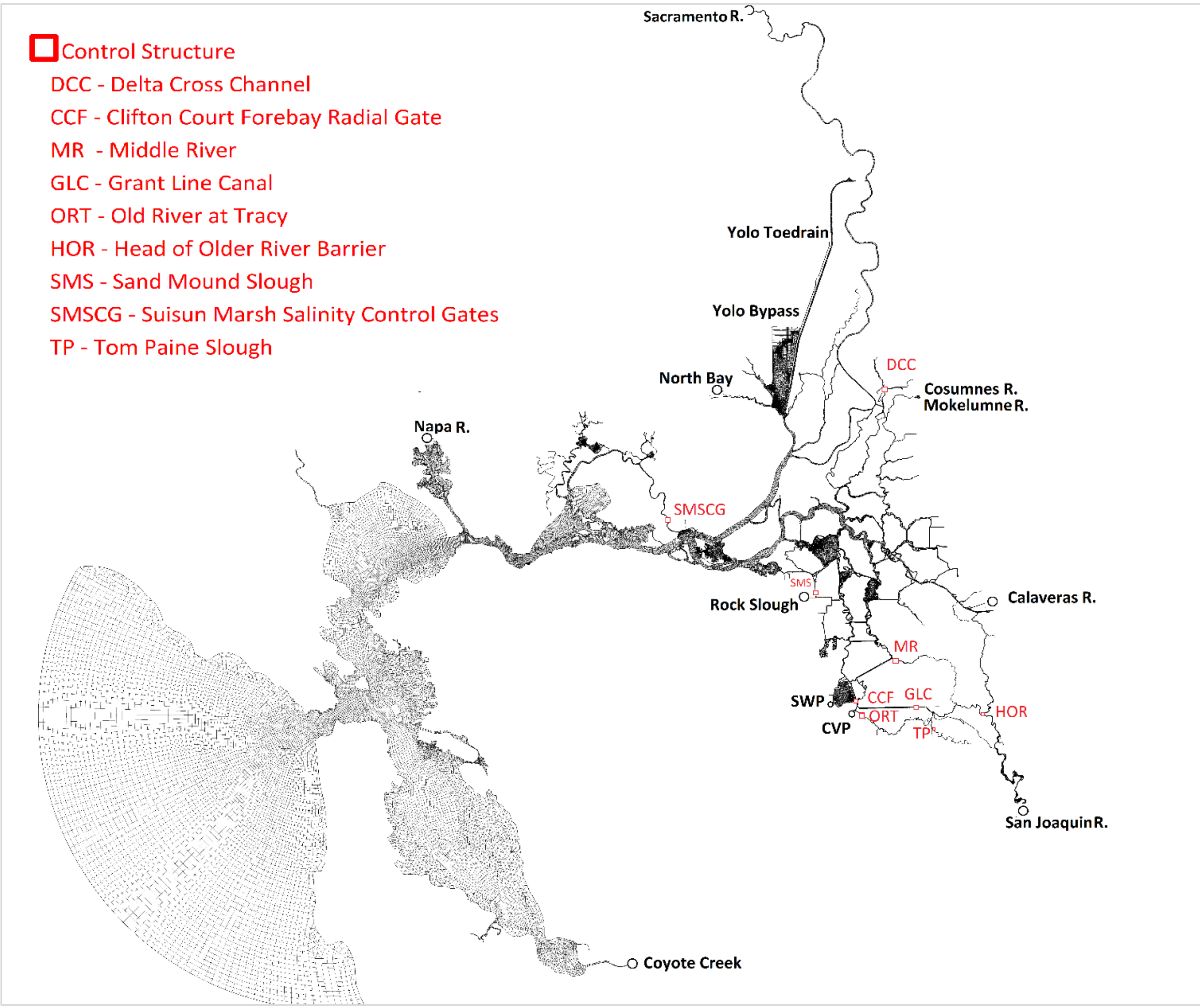
The focus of 3-D circulation modeling incorporated in the Incidental Take Permit (ITP) is to identify the habitat benefits of SMSCG operation and flow augmentation by mapping and computing low salinity zone and smelt habitat indices in various hydrologic and operational scenarios. Long-term water supply impacts of the proposed reoperation are incorporated in the CalSim and DSM2 modeling work described elsewhere.

SCHISM AND BAY-DELTA SCHISM BACKGROUND

The model used in this study is Bay-Delta SCHISM, which is based on the Semi-Implicit Cross-scale Hydroscience Integrated System Model (SCHISM, Zhang et al. 2016), which in turn is derived from the semi-implicit Eulerian-Lagrangian finite-element (SELFE) model (Zhang and Baptista 2008) SCHISM is an open-source community-supported modeling system, whose origins were to serve as a second-generation model (following ELCIRC, a Eulerian–Lagrangian algorithm used to solve shallow water equations) for use in the Columbia River estuary by the Center for Coastal Margin Observation and Prediction (CMOP). The model has subsequently been enhanced by the Virginia Institute of Marine Sciences and used in basins throughout the world in applications as diverse as reservoir temperature, estuarine transport of salinity, morphology, and near-coast tsunami response. The model has participated in numerous regional benchmark projects. A list of peer-review papers is maintained on the model website (http://ccrm.vims.edu/schismweb). The larger SCHISM suite includes modules for sediment transport, ecology/biology, wind-wave interaction, ice, oil spill, and marsh evolution.

The formulation of the core SCHISM hydrodynamic module is based on the 3-D hydrostatic Reynolds-averaged shallow water equations, including mass conservation, horizontal momentum conservation and salinity transport. The SCHISM hydrodynamic algorithm is based on mixed triangular-quadrangular unstructured grids in the horizontal and a flexible coordinate system in the vertical (localized sigma coordinates with shaved cells, or LSC2, Zhang et al. (2015)). The modeling system utilizes a semi-implicit finite-element/finite-volume method together with a Eulerian-Lagrangian method (ELM) for momentum advection to solve the Reynolds-averaged Navier-Stokes and transport equations at ocean to creek scales. It has both a hydrostatic and non-hydrostatic option, but as explained in MacWilliams et al. (2016) non-hydrostatic modeling is not feasible at field scale in the Bay-Delta because of the resolution required.

The DWR application of SCHISM to the Bay-Delta as well as a regional description of performance is described in Ateljevich et al (2014) and Ateljevich et al (2015). The mesh for the present model version 90e is shown in Figure 1 with model boundaries key hydraulic structures. The mesh contains 259,885 elements and 248,056 nodes, with length scales of the elements ranging from 1 kilometer (km) on the coast to 5m inland. The LSC2 vertical grid is terrain-conforming, but tapers in the number of vertical layers from 23 at the Farallon Islands to a single layer (2D horizontal) in the upstream reaches of the Sacramento River, Yolo Bypass and San Joaquin River. Near Suisun Bay and Marsh the mesh has 10-12 vertical layers, resulting in vertical resolution of 1m in the main ship channel and finer than 0.6 meter (m) in Suisun Bay and Montezuma Slough.



In addition, channel depletion sources from the Delta DCD model or similar methods are imposed throughout.

Figure 1: Bay-Delta SCHISM Mesh, Boundary Condition Location and Hydraulic Structure Locations

The Bay-Delta SCHISM model has been applied to study the performance of numerous operational and planning scenarios in the Bay-Delta, including the emergency Drought Barrier (MacWilliams 2016 and DWR efficacy report, in press), restoration of Franks Tract (Ateljevich, 2018), and hydrodynamic transit time through Clifton Court (Shu, 2018). The Franks Tract restoration study includes validation of performance in the western and middle Delta A Bay-only portion of SCHISM extended to Rio Vista is described and validated in Chao et al (2017a) for temperature as well as salinity and used to study a sea surface temperature anomaly in the Bay and near coast in Chao et al (2017b). The work of Cai

(2018) focused on the effects of submerged aquatic vegetation on flow physics and biogeochemistry in the Cache Complex.

Modeling assumptions and boundary conditions for the present study generally conform to the methods described by Ateljevich et al (2014). The mesh has been developed generally as part of the studies cited above and in response to improvements in bathymetry. For the present project, the mesh was modified to incorporate more marsh channels and marsh plains than previous versions of the Bay-Delta SCHISM mesh. Existing Montezuma Slough bathymetry was found to be insufficiently accurate for a focused study of the region and was resurveyed by the Bathymetry and Technical Support group at DWR. This work as well as single beam soundings upstream by UC Davis were incorporated into the latest (v4.1) modeling bathymetry map for modeling produced by DWR's Delta Modeling Section and were used in the current modeling; the production of the elevation model described by Wang (2018) and the elevations are available online in GeoTiff format in the Resources Agency Open Data Portal (DWR 2018).

The standard Bay-Delta SCHISM configuration incorporates approximations of numerous hydraulic structures in the Delta, including the Suisun Marsh Salinity Control Gate (SMSCG), Delta Cross Channel (DCC), and Clifton Court Forebay (CCF). All of which are modeled as radial gates using standard 1D approximations similar to those used in DSM2. No special configuration or recalibration was undertaken for the present work, but new periods of tidal operation were incorporated for SMSCG for some scenarios.

DWR consumptive use models do not account for evaporation and consumptive use in Suisun Marsh (including pond up of Duck Clubs and managed wetlands), and results in Grizzly Bay, the Marsh appear to be sensitive to this assumption. An estimate of evaporation from Suisun Bay and the marsh was included in the model, using a methodology similar to the Delta Evapotranspiration of Applied Water/Delta Channel Depletion (DETAW/DCD) land water balance technique (Liang, 2017) to arrive at an estimated peak total of 1,000-1,500 cubic feet per second (cfs) for July including bay evaporation in Grizzly and Honker Bay and evaporation on the marsh. Managed exports for duck clubs and wetlands were estimated by scaling volumes used by Research Management Associates for the Bay Delta Conservation Program Draft Environmental Impact Report (EIR)/Environmental Impact Statement (EIS) down by 60%, which gives good agreement at the one site in which short term monitoring and gate ratings were available at Roaring River intake. The assumption produces a peak pond-up flow in September that is similar to the peak evapotranspiration in June, consistent with the relatively constant rate of salinity intrusion across this transition.

SCENARIOS

DWR studied the proposed 60 days of additional tidal operation of the Suisun Marsh Salinity Control Gates in 2012 and 2017, two years representing different hydrologic, regulatory and antecedent salinity conditions. The scenarios are summarized in Table 1.

Table 1: Scenario Descriptions for SCHISM Modeling of ITP Proposed Operations for Suisun Marsh Habitat

Scenario Label	Year	SMSCG Gate operation	Flow
2012 Base	2012	Historical	Historical
2012 Gate (Jun)	2012	Historical + Tidal Op Jun 14, 60 days	Historical + Compensating
2012 Gate (Aug)	2012	Historical + Tidal Op Aug 14, 60 days	Historical + Compensating
2017 Base	2017	Historical	Historical
2017 Base No X2	2017	Historical	Base (modified historical)
2017 Gate (Sep)	2017	Historical + Tidal Op Sep 1, 60 days	Base (modified historical) + Compensating
2017 X2 80km	2017	Historical	Meet 80km X2 in Sep-Oct
2017 Gate (Sep) + X2 80km	2017	Historical + Tidal Op Sep 1, 60 days	Meet 80km-X2 in Sep-Oct + Compensating
2017 X2 74km	2017	Historical	Meet 74km X2 in Sep-Oct

Notes: km = kilometer
SMSCG = Suisun Marsh Salinity Control Gate
SCHISM = Semi-Implicit Cross-scale Hydroscience Integrated System Model
X2 = monthly averaged position of the 2.64 mS/cm isocontour of specific conductance at the surface (see caveats).

Two types of flow augmentation appear on this table. The term *X2 74km and X2 80km* refer to flow actions to provide habitat. The term *Compensating Flow* refers to additional flow used to maintain salinity at or below the level of the corresponding base case when the gate is tidally operated. Such compensating flow is required as the diversion of net flow to Montezuma Slough causes salinity on the main stem Sacramento and San Joaquin Rivers to increase. When the main action considered only includes tidal reoperation of the gate, the compensating flow is applied to maintain Jersey Point salinity. When the action includes both the X2 flow augmentation and the gate reoperation, the compensation maintains the X2 position.

Modified historical refers to historical inputs in which exports to achieve Fall X2 objectives have been eliminated. Operational constraints are instead provided by project capacity, State Water Resources Control Board (SWRCB) Water Rights Decision 1641 (D-1641) and upstream considerations such as reservoir drawdown. The reservoir drawdown in September was significant and to a certain extent releases were scheduled around X2, so increasing exports did not significantly change salinity conditions in September. In October, the modified historical scenario is significantly saltier. Finally, for the scenarios described as meeting X2 of 74km or 80km, Sacramento River flow was reduced to make this possible in September, ignoring some upstream constraints.

2012 was a year with Below Normal hydrological classification and is typical of an average operational situation in the Delta, with operations controlled by outflow in summer, D-1641 agricultural EC objectives in late summer through August 15 and informal guidance targets for the protection of mid-Delta water quality after August 15. In 2012, the historical hydrology was used unmodified as the base case.

The SMSCG was tidally operated historically starting October 15, 2012 and this historical operation is incorporated as part of the base case as well as the reoperation case. In the cases listed with additional August tidal gate operations in 2012, those operations begin on August 14, last 60 days, and transition immediately into the historical operation. Earlier gate operations were investigated on a screening basis, however, marsh salinity was not high enough in early-mid summer for tidal gate operations to have a large freshening effect.

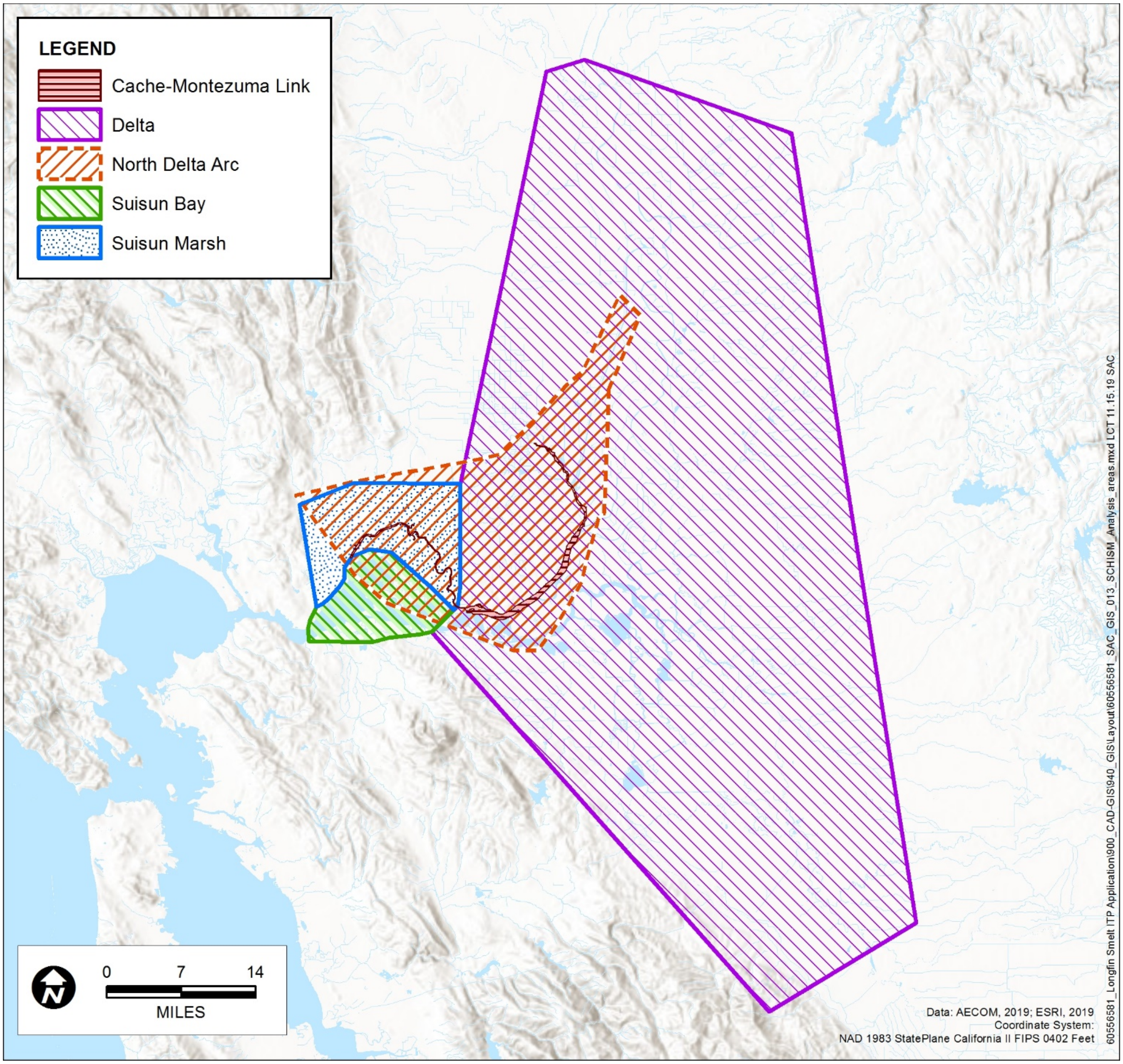
In contrast to 2012, 2017 was classified as a Wet year. Historical operations and water quality in the fall were controlled by a need to draw down upstream reservoirs and by a fall X2 objective that ranged between 74km and 79km based on coordination with U.S. Fish and Wildlife Service (USFWS) and California Department of Fish and Wildlife (CDFW). Water quality in the Suisun Marsh and even in Suisun Bay was fresh historically through most of October. For ease of modeling the proposed project X2 target of 80km, the base case for 2017 was modeled by backing out the component of outflow that was used to achieve fall X2 requirements in 2017. Historical exports and inflows were modified for this scenario. The primary mechanism was increased exports, as close to project capacity as possible. Inflow reduction was also used in September to achieve 80km in cases where this was not possible with export increases alone.

In the cases listed with additional September tidal gate operations in 2017, those operations begin on September 1 and last 60 days, and transition immediately into the historical operation. Earlier gate operations were not considered as the marsh salinity was not high enough in early-mid summer for tidal gate operations to have a large freshening effect. In the 2017 cases listed with X2 flow, the historical exports and inflows were modified to maintain X2 conditions at 80 km in September and October.

Two metrics of habitat were produced in this study. The first identified the spatial area and acreage of habitat that met a low salinity zone (LSZ) threshold of 6psu (practical salinity units or psu, ubiquitous in modeling, are used throughout this text; they are essentially interchangeable with parts per thousand). The second combined this threshold with a target Secchi disk depth of 0.5m or less (higher turbidity) and water temperature of 25C or lower. These were aggregated within the zones shown in Figure 2. Temperature was interpolated from a network of DWR Department of Environmental Services (DES), National Oceanic and Atmospheric Administration (NOAA) and U.S. Geological Survey (USGS) stations. Secchi Depth was interpolated from the entire network of CDFW Summer Townet and Fall Midwater Trawl sites. The latter provided coverage in much of the North Delta Arc, but less so in the upper reaches of the Sacramento and San Joaquin Rivers (often excluded based on water temperatures).

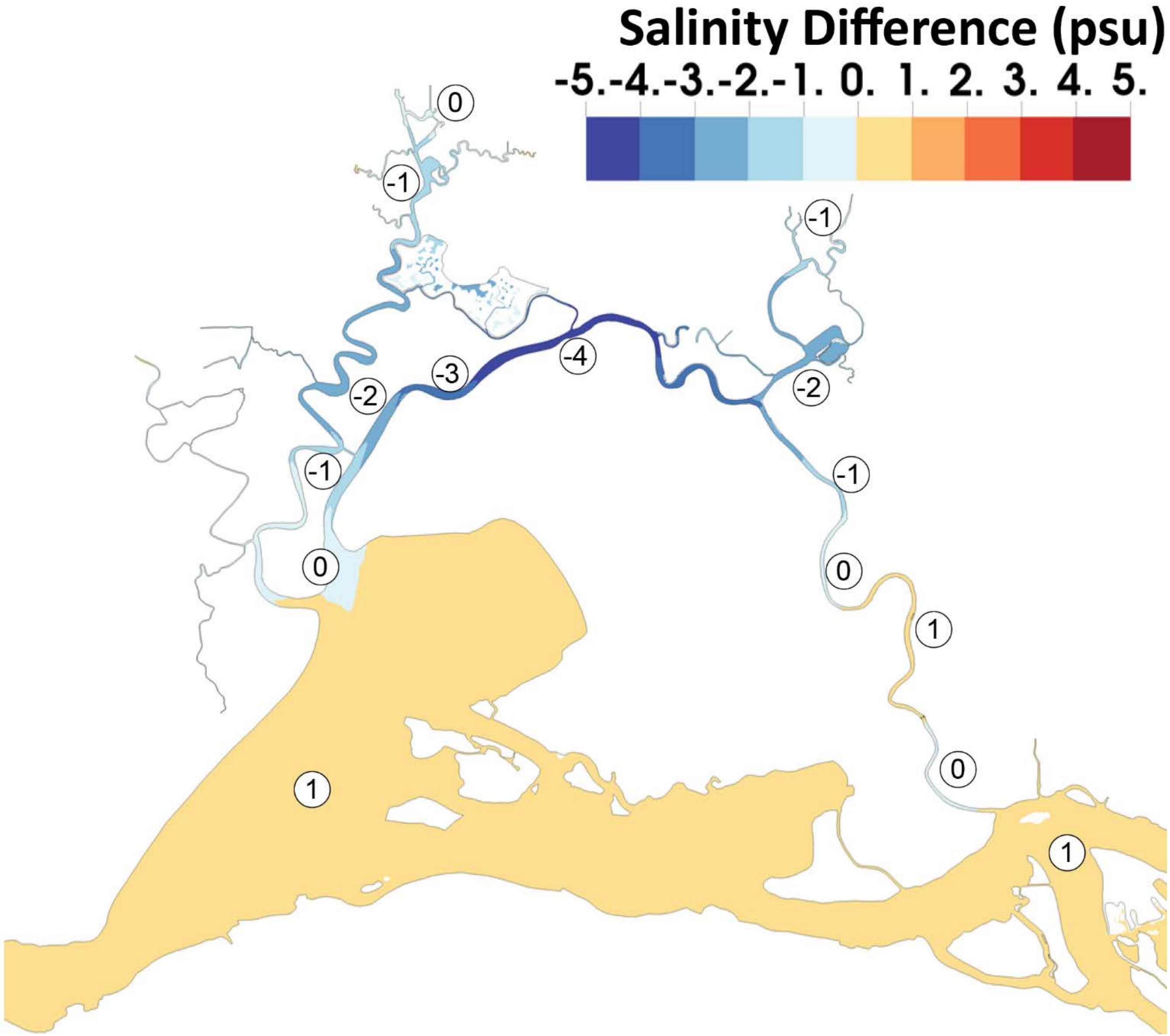
KEY RESULTS

The Suisun Marsh Salinity Control Structure is known to effectively freshen the marsh area. Figure 3 shows the change in salinity averaged over a fortnightly period in 2012 during operations. Tidal operation freshens the marsh with mild increases along the main stem of the estuary. Note that for 2012 approximately 550 cfs compensating flow has been applied (derived from DSM2 water cost studies), so that upstream at Jersey Point the salinity difference is zero – without this flow the increase in salinity on the main stem would be somewhat larger.



The category “All” represents the spatial union of areas in the legal Delta, Suisun Marsh and Suisun Bay.

Figure 2: Regions Used to Aggregate Low Salinity Zone and Habitat Suitability Indexes



The averaging period is August 29 – September 12, 2012.

Figure 3: Change in Fortnightly Salinity (in psu, equivalent to psu) in the Marsh Region Induced by Operating the Gates Tidally Starting August 14, 2012

Figure 6 and Figure 7 show time series of Low Salinity Zone and suitable habitat within zones under the gate actions in 2012. Figure 8 and Figure 9 show the same results for 2017. As demonstrated by these figures, SMSCG freshens the Suisun Marsh and has the potential to improve marsh habitat under some conditions. The potential increase in habitat from gate operations was most pronounced in the late August-September period in 2012 when external considerations such as the D-1641 agricultural standards do not incidentally freshen the marsh. Time continuity of habitat is also achievable for years such as 2012 if the gates are operated in August-September, bridging the period when LSZ habitat is protected by D-1641 objectives outside the marsh, with the period water quality is protected by standard tidal operation of the SMSCG radial gates typically starting mid-October. Such time continuity is evident in the LSZ acreage plot of Suisun Marsh in 2012. A sustained freshet peaking at a Net Delta

Outflow Index of 65,000 cfs coincides with the end of the habitat time series plot so the acreage at that time appears to represent habitat potential as represented by the model domain, slightly over 3,800 acres in the case of Suisun Marsh.

Similarly high flows predominated in 2017. Trivially, operation of the gate is not beneficial in the marsh under conditions that are already fresh, which continue to November. In fact, summer or fall tidal operation of the gate in very wet years such as 2017 improves water quality but does not create habitat as defined by the 6psu LSZ threshold. The tidal gate operation does, however, have a residual freshening effect in November that is visible in Figure 8. Additionally, during this November residual effect there seems to be a synergistic effect in the marsh between the 80km X2 flow augmentation and the tidal operation of the gate.

Fresh antecedent conditions would be expected in all Wet years through the August 15 end of the D-1641 agricultural objective. They would also hold under a Fall X2 requirement of 80km or better, or as a result of aggressive drawdown of reservoirs for flood control reasons that leads to high outflow. Low salinity does not otherwise seem to be a guaranteed consequence of a Wet year classification especially in drier fall months -- in some historical wetter years prior to the 2008/2009 biological opinions (e.g., 2000, which was regulated as Wet based on forecasts), fall salinity rose significantly enough that a gate action by itself might have been beneficial.

According to the modeling presented here, SMSCG tidal operation does not improve water quality over an appreciable acreage in Grizzly Bay during the operation period and in fact can rotate the salinity field in a way that slightly reduces LSZ habitat, as shown in Figure 3. The change is usually small (<1 psu) relative to the 6psu threshold for LSZ – for comparison, Beldons Landing salinity under these circumstances and averaging period decreases by 4.25psu from 7.29 to 3.04 psu.

The lack of LSZ habitat improvement in Grizzly Bay due to the gate action is visually important and represents a difference with prior results by AnchorQEA (2018) suggested freshening of 1-2psu over a substantial acreage in Grizzly Bay during a 2018 operational experiment. Field evidence on this point supports the position presented here, that Grizzly Bay is not freshened by tidal operation. Figure 4 shows the relationship between tidally averaged salinity at Collinsville and Grizzly Bay and, for comparison, at Hunter Cut. Points are colored by the gate operating regime. The colored dots represent 2008–2019 for Hunter Cut and the shorter 2016–2019 period of record for Grizzly Bay. The points have been filtered to eliminate periods of large flow transitions or Delta filling extremes (stage values far from 14-day average). The exception is the black dots, which represent the seven day transition (two before and five after) at the conclusion of the 2018 SMSCG field experiment. If Grizzly Bay were significantly freshened while Collinsville goes up as suggested by the AnchorQEA (2018) result, the scatter between Grizzly Bay and Collinsville when SMSCG is tidally operating, would shift compared to when SMSCG is open. Hunter Cut, which does exhibit this shift, is shown for contrast. Instead, Collinsville and Grizzly Bay seem to have the same relationship or only show minor differences regardless of the operating regime of the gate, suggesting that the SMSCG operation may have minimal effect on Grizzly Bay salinity conditions and that the salinity at Collinsville and Grizzly Bay would likely respond mostly to a common dynamic. In SCHISM results, this change is manifest as a mild increase in salinity at both locations when the SMSCG was tidally operating.

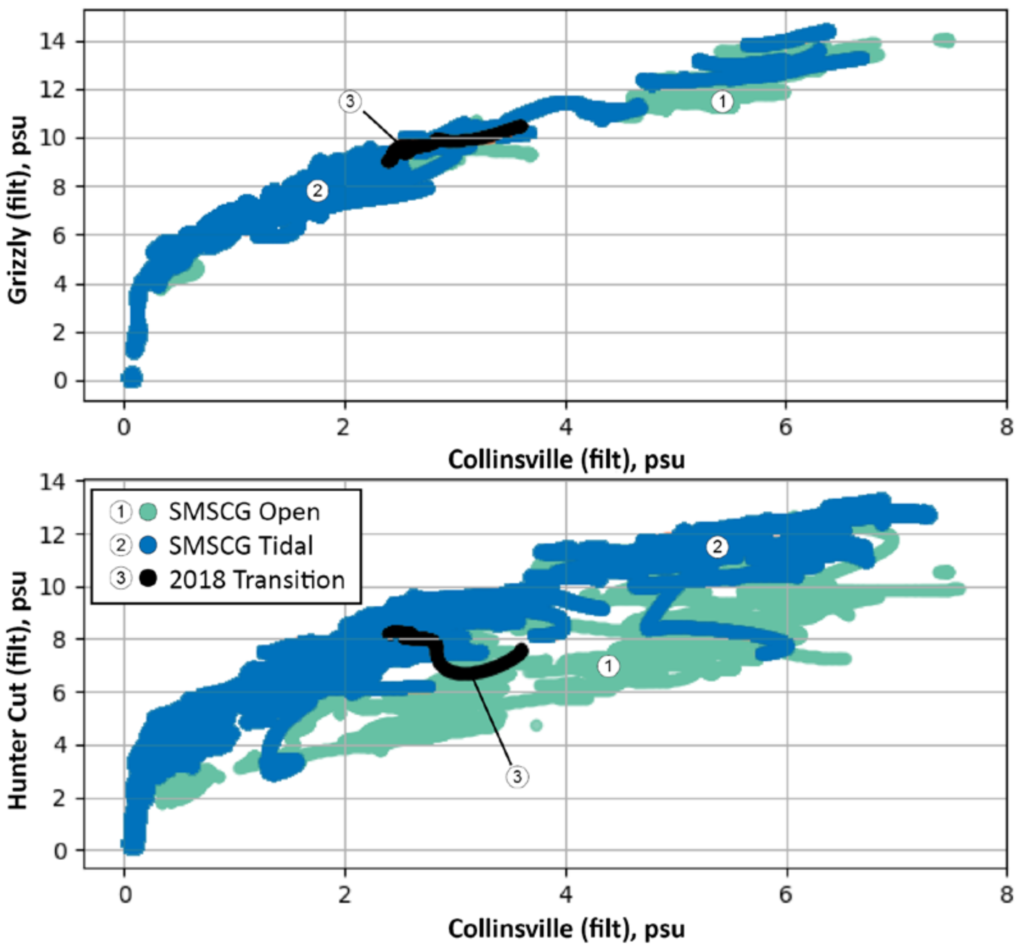
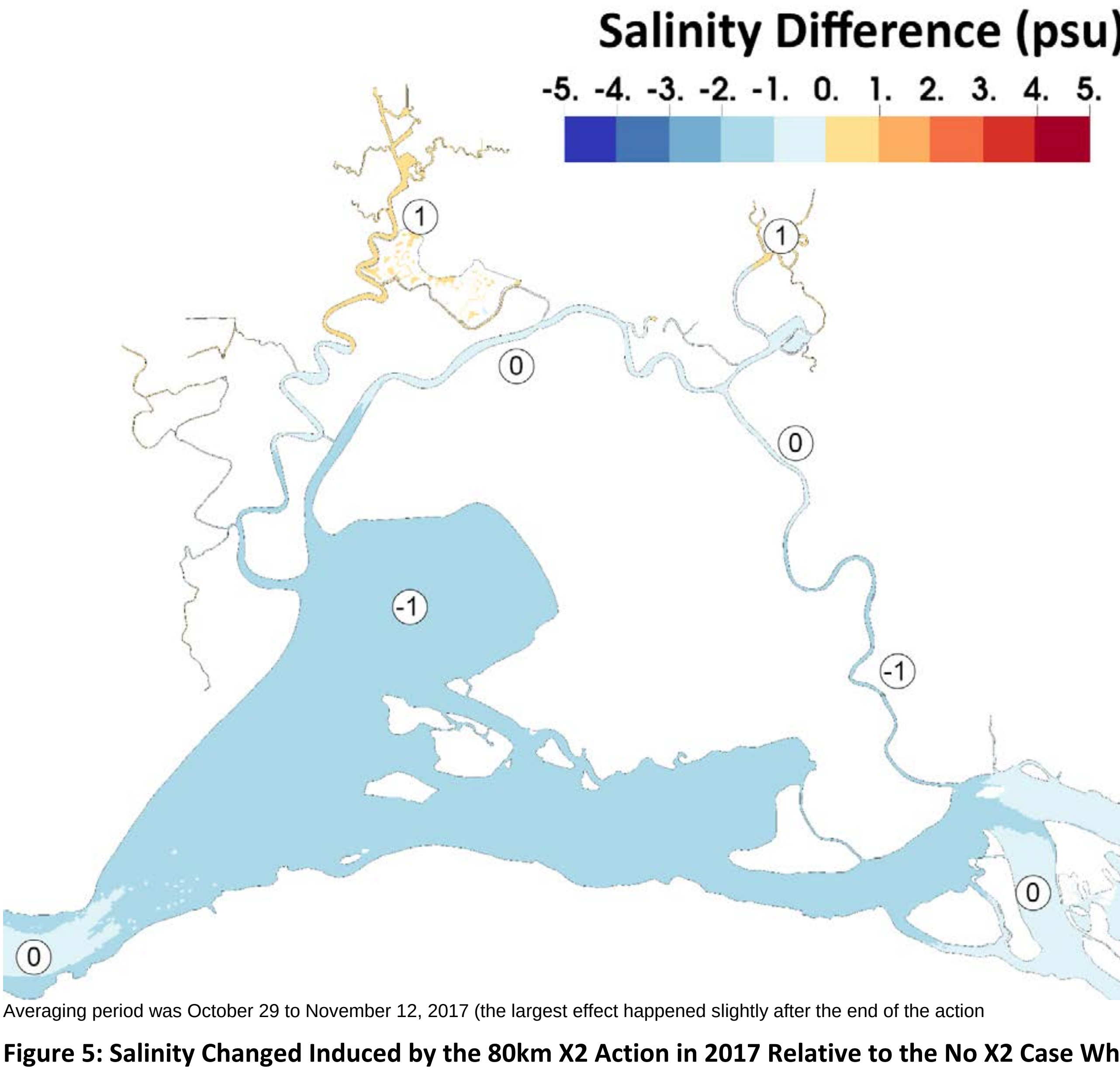


Figure 4: Comparison of Tidally Filtered Salinity at Collinsville (x-axis) Versus Grizzly Bay (CDEC GZB, top) and Hunter Cut (CDEC HUN, bottom)

Flow augmentation in fall 2017 targeting an X2 of 80km has little effect on LSZ of habitat in Grizzly Bay, particularly in October when it is very similar to the base condition. There is a decrease in LSZ habitat in parts of September, but this is because base September values are affected by reservoir drawdown so that X2 is lower in the base than in the action. The salinity change induced by this action relative to the No X2 case for that year is shown in Figure 5. Operating the gate tidally in addition to such a flow augmentation creates persistent habitat in November as noted above. The improved habitat conditions in November may be partly a result of the additional outflow needed to maintain the X2 at 80 km when gate is operating tidally. The gate action requires considerable compensating flow to maintain X2 at 80 km on the main stem, essentially supplementing the full 2,500 cfs net flow that is directed to Montezuma Slough with gate operations.

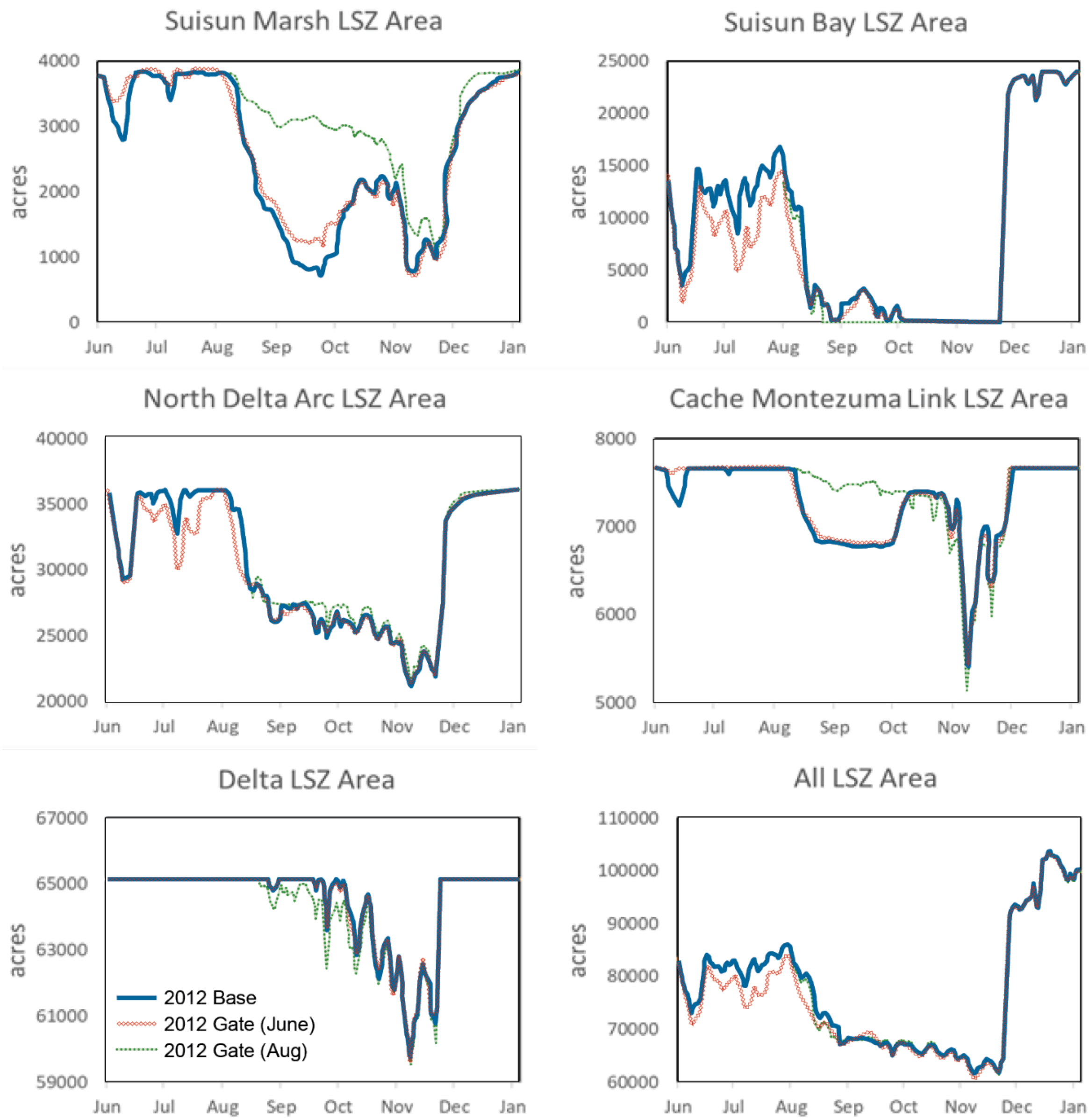
Flow augmentation in fall 2017 targeting a lower X2 value of 74km generates up to 11,000 acres of LSZ of habitat in Suisun Bay relative to the base case, with an improvement of 1000 acres or more persisting from October 9 to December 1.

When temperature (25 degrees Celsius [○C]) and Secchi Depth (0.5m) are considered in the three-variable habitat suitability index. The water clarity considerations (and to a lesser extent temperature) restrict candidate habitat considerably. This is particularly true when aggregated over large areas like the full statutory Delta, since water clarity or high temperatures excludes most of the interior Delta. Much of the remaining eligible habitat was in Suisun Bay and Marsh and the North Delta. However, one striking result in 2017 is that Suisun Bay LSZ habitat is greatly expanded but the three-variable habitat suitability index is not. This condition appears to be driven by water clarity, and a great deal more habitat would be available if the indexes were not binary (i.e., greater than >0.5 m Secchi not suitable versus <0.5 m suitable) and therefore brittle. In the present methodology, 6.1 psu is not habitat and 5.9 psu is.



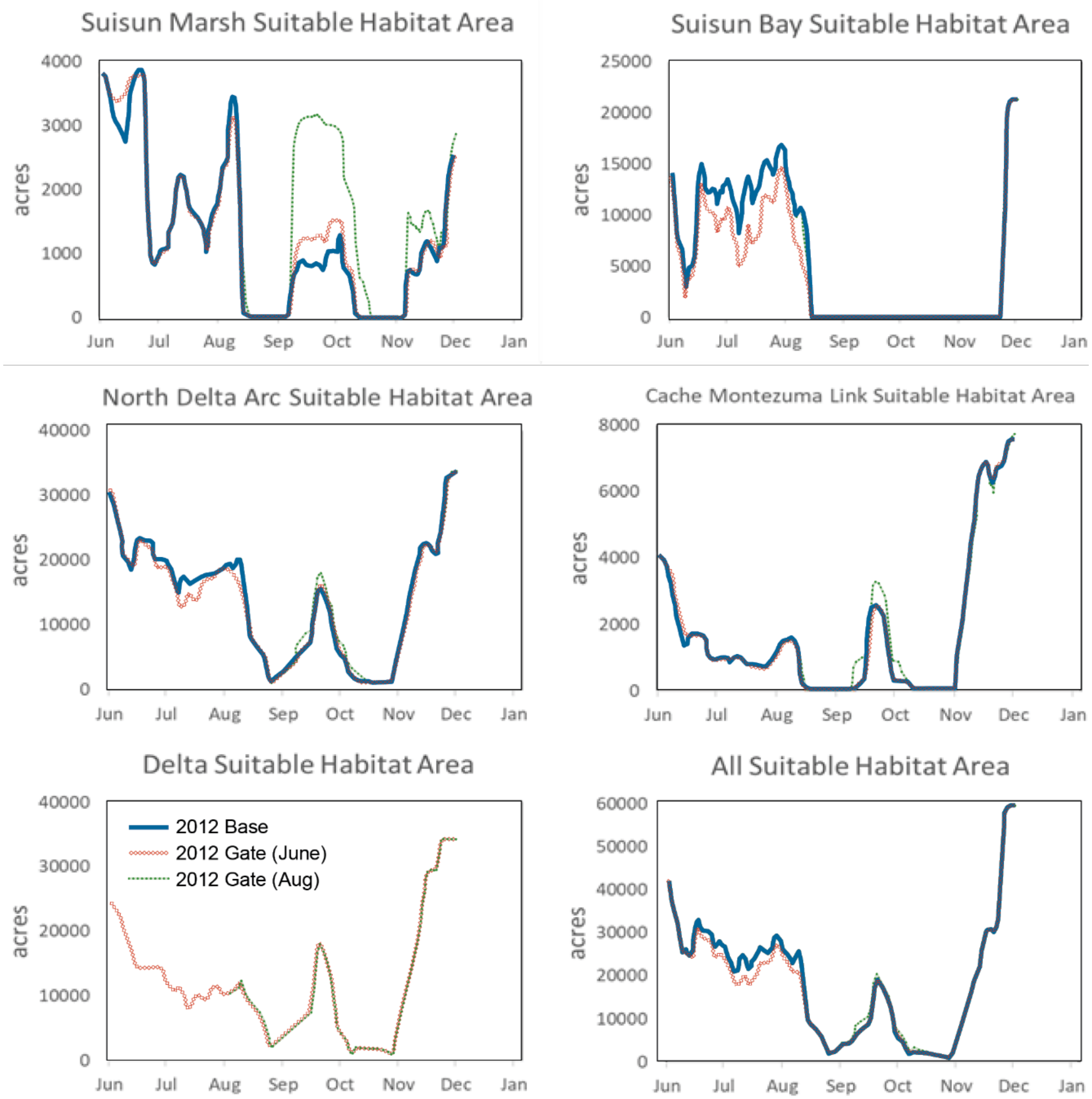
Averaging period was October 29 to November 12, 2017 (the largest effect happened slightly after the end of the action

Figure 5: Salinity Changed Induced by the 80km X2 Action in 2017 Relative to the No X2 Case Where the Historical 2017 fall X2 Action was Rolled Back to Conform to Other Regulatory Objectives and Obligations



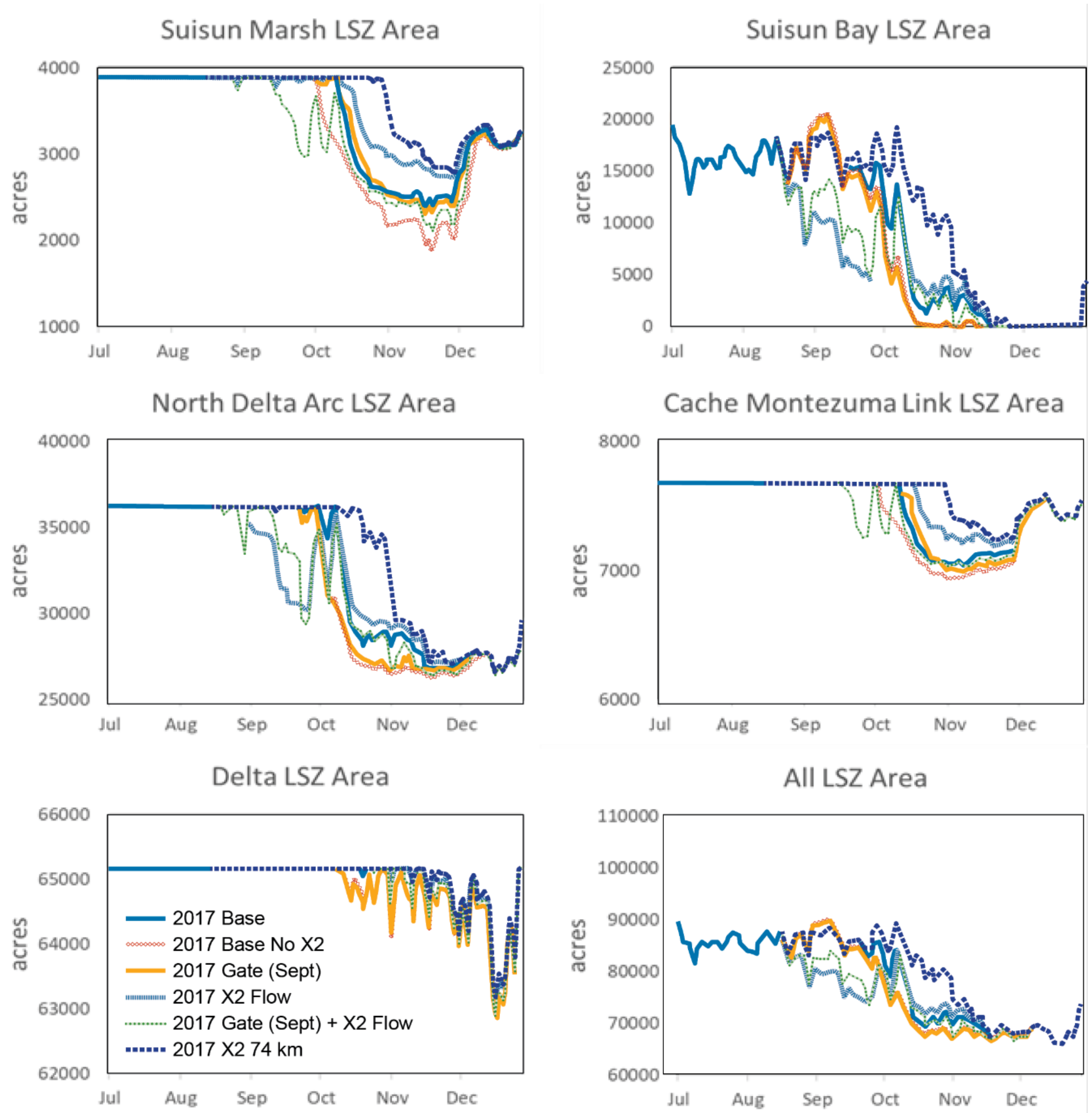
The base and two alternate gate timings are shown.

Figure 6: Low Salinity Zone Acreage in each of the Study Regions, Daily Averaged, for 2012



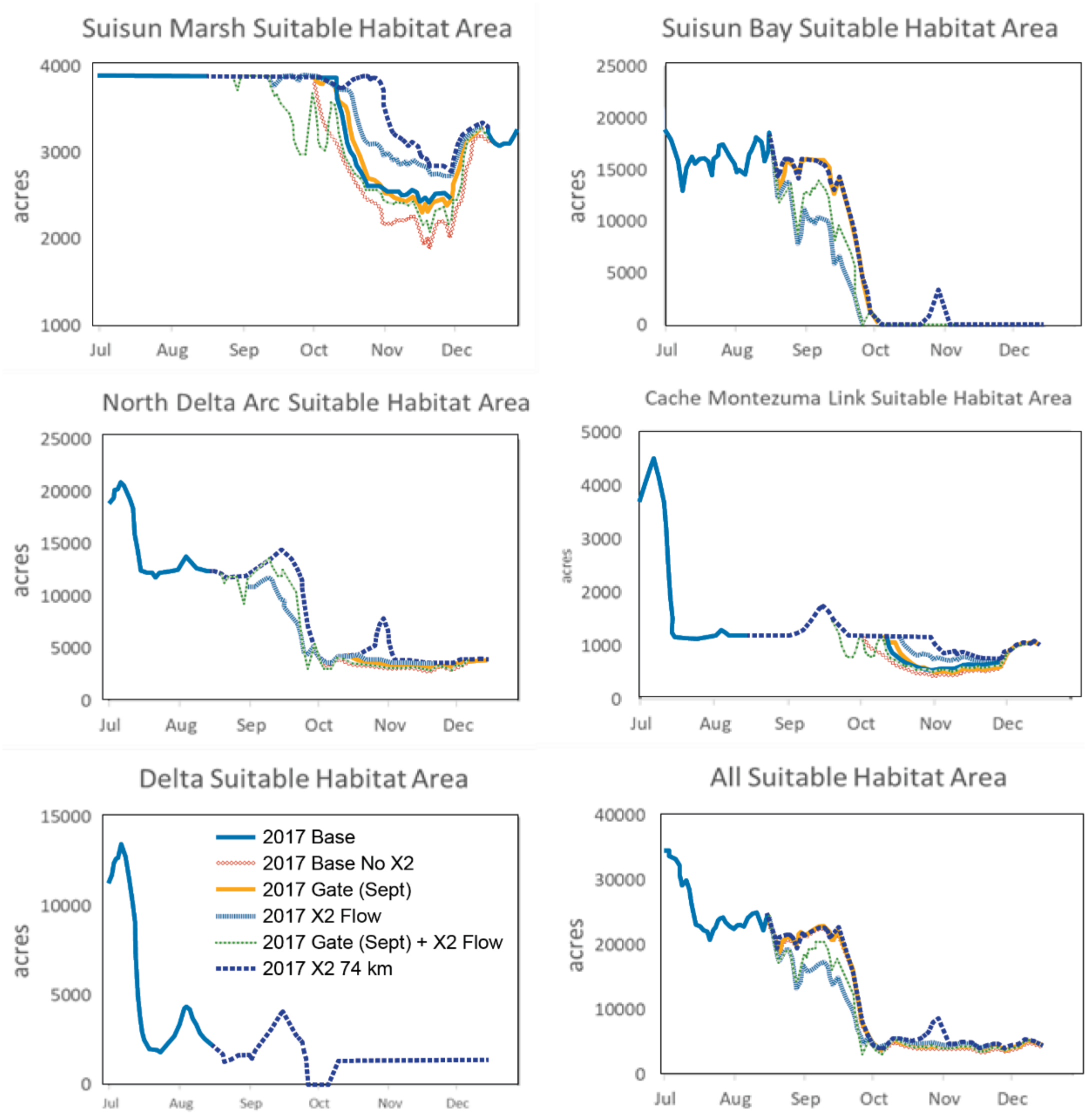
Areas are daily averaged.

Figure 7: Suitable Habitat Acreage within each of the Study Regions in 2012 using the Temperature, Seccchi Depth and Salinity Thresholds Described in the Text



The base, September gate operation, September-October 80 km X2, and both gate and 80 km X2 scenarios are shown.

Figure 8: Low Salinity Zone Acreage in each of the Study Regions, Daily Averaged, for 2017



Areas are daily averaged.

Figure 9: Suitable Habitat Acreage within each of the Study Regions in 2017 using the Temperature, Seccchi Depth and Salinity Thresholds Described in the Text

CONCLUSIONS

SMSCG tidal operation reliably freshens the marsh, but not Suisun Bay. The habitat benefits dependent on water clarity. Over a variety of year types, the most effective period for SMSCG tidal operations is after August 15 when mid-marsh salinity would otherwise rise steadily until any typical October action. When such SMSCG actions are followed by operations in October, considerable time continuity of the habitat can be achieved within the marsh. This seasonality is also largely predictable, which helps avoid thresholds which are hard to design in a way that they do not initiate the action too early.

Flow augmentation that maintains X2 at 80km appears to open up an additional 2,000–8,000 acres of LSZ habitat in Suisun Bay during the period of the action, as well as marsh habitat if the marsh is not so fresh as to render the action redundant. In 2017, this redundancy in the marsh was an issue through October. The flow and gate actions generated up to 500 acres (20%) extra LSZ habitat, but only as a residual improvement in November after the actions had already ended. Unlike the marsh, Suisun Bay LSZ habitat tends to respond to flow and gate interventions during higher flows.

One increment that may be of interest is the habitat difference between 74km and 80km X2. Comparison of the historical base run in 2017 (approximately 74km) and the 2017 X2 Flow run (80km) indicates that the LSZ habitat difference between these cases is approximately 5,000–6,000 acres (peaking at the end of September) in Suisun Bay. There is little change in the marsh because both X2 targets are sufficient to provide LSZ habitat there.

Even though there appears to be significant increase in low salinity habitat for some of the actions, the improvements in three-variable habitat index were muted, mainly due to the definition used for suitable water clarity. Tidal gate operations while holding 80km X2 requires an additional 2,500 cfs of additional flow beyond the 80km X2 action, which means that nearly all the flow diverted along Montezuma Slough must be compensated by releases or export reductions. It is not clear whether it is the flow or the gate operation provides the habitat benefit.

LIMITATIONS AND CAVEATS

Thresholds are sensitive: The threshold-based habitat metrics posed thus far are brittle for Suisun Marsh and Bay. 6psu is a common value for salinity in summer under the regulatory regime for many water types. A 0.1-0.4 psu variation would yield different significant area calculations. The same is true for the Secchi disk threshold of 0.5m, since at least in parts of 2012 and 2017 Suisun Bay hovered near this value. Although the study did not investigate either threshold in detail, it appears that values of 6.5 psu and 0.55m would more distinctly partition common operating regimes.

Turbidity is a sensitive component of habitat metric calculations limiting the habitat area severely in late summer and early fall outside of Suisun Marsh, Suisun Bay and parts of the North Delta. Temperature was less influential, except upstream on the San Joaquin River and in the South Delta where it excluded habitat.

Suisun Marsh Consumptive Use: Uncertainty over Suisun Marsh Consumptive Use was described in the modeling description. Work on marsh consumptive use is relatively recent. Progress has been made in estimating channel depletions and managed flows in the marsh in recent years. In the present study, uncertainty has been addressed with estimates that agree well with seasonality of flow and salinity measurements that are available and with reasonableness bounds imposed by evapotranspiration.

Definition of X2: Components of this study required that X2 be positioned at 80km. For these actions, the regulatory surrogate (2.64 milliSiemens per centimeter [mS/cm] surface EC) was used to position the salinity field, not the conceptual value of 2psu bottom salinity. The regulatory X2 represents the compliance method and has a higher outflow burden on the projects. The X2 surrogate used in compliance and the ecological literature is nearly always lower than conceptual X2 and therefore conservative. Stratification and shoal-channel differences do not completely explain the difference when X2 is near Collinsville. Figure 4 shows that salinity at Collinsville (81km) must be considerably fresher than 2psu for salinity at Grizzly Bay gage to fall below the 6 psu LSZ habitat threshold.

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APPENDIX E

Biological Modeling Methods and Selected Results

TABLE OF CONTENTS

Attachment

Figures

Tables

ACRONYMS AND OTHER ABBREVIATIONS

AIC	Akaike's Information Criterion
AUC	area under the curve
AUCo	area under the curve overlapping portions
AUCt	total area under the curve
Banks pumping plant	Harvey O. Banks Pumping Plant
CAMT	Collaborative Adaptive Management Team
CDFW	California Department of Fish and Wildlife
cfs	cubic feet per second
COS	Continued Operations Scenario
CVP	Central Valley Project
CWT	coded wire tag
DCC	Delta Cross Channel
DFG	California Department of Fish and Game
DLO	driver-linkage-outcome
ESU	Evolutionarily Significant Unit
EXG	existing condition
FL	fork length
FMWT	Fall Mid-water Trawl
HOR	head of Old River
I-E	inflow-export ratio
ITP	Incidental Take Permit
km	kilometers
km/day	kilometers per day
LFS	Longfin Smelt
m^3/sec	cubic meters per second
mm	millimeter
MRV	Middle River
NAA	No Action Alternative
NBA	North Bay Aqueduct
OMR	Old and Middle River flows
ORV	Old River
PA	Proposed Action
PCA	principal components analysis
POD	Pelagic Organism Decline
PP	Proposed Project
PTM	particle tracking model

Skinner fish facility	John E. Skinner Delta Fish Protective Facility
SL	standard length
SLS	Smelt Larva Survey
SST	Salmonid Scoping Team
STARS	Survival, Travel Time, and Routing Analysis
SWP	State Water Project
taf	thousand acre feet
TL	total length
USFWS	U.S. Fish and Wildlife Service
WOA	Without Operations Scenario

BIOLOGICAL MODELING METHODS AND SELECTED RESULTS

E.1 INTRODUCTION

This appendix provides biological modeling methods and selected results for fish species for which quantitative modeling approaches are used. The appendix is divided into Section 2 *Delta Smelt*, Section 3 *Longfin Smelt*, and Section 4 *Salmonids*, and Section 5 *References*.

E.2 DELTA SMELT

E.2.1 PARTICLE TRACKING MODELING (LARVAL ENTRAINMENT)

For the present effects analysis, the most recent version of DSM2 particle tracking model (PTM) was used in the effects analysis to estimate the proportional entrainment of Delta Smelt larvae by various water diversions (i.e., the south Delta export facilities and the North Bay Aqueduct (NBA) Barker Slough Pumping Plant). This approach assumed that the susceptibility of Delta Smelt larvae can be represented by entrainment of passive particles, based on existing literature (Kimmerer 2008, 2011). Results of the PTM simulations do not represent the actual entrainment of larval Delta Smelt that may have occurred in the past or would occur in the future, but rather should be viewed as a comparative indicator of the relative risk of larval entrainment under Existing and Proposed Project (PP) scenarios. For purposes of this effects analysis, those particles that were estimated to have entered the various water diversion locations included in the PTM outputs (e.g., south Delta export facilities and NBA) are characterized as having been entrained. The latest version of DSM2-PTM allows agricultural diversions to be excluded as sources of entrainment (while still being included as water diversion sources): for this effects analysis, these agricultural diversions were excluded, given the relative coarseness of the assumptions related to specific locations of the agricultural diversions, the timing of water withdrawals by individual irrigators, and field observations that the density of young Delta Smelt entrained by these diversions is relatively low (Nobriga et al. 2004, Kimmerer 2008).

Delta smelt starting distributions used in the PTM larval entrainment analysis were based on the California Department of Fish and Wildlife (CDFW) 20 millimeter (mm) larval survey and were developed in association with M. Nobriga (USFWS Bay-Delta Office). This method paired observed Delta Smelt larval distributions from survey data with modeled hydraulic conditions from DSM2 PTM. Each pair was made by matching the observed Delta outflows of the first 20 mm survey that captured larval smelt (16 years of 20 mm surveys, 1995–2011) with the closest modeled mean monthly Delta outflow for the months of March to June in the 82 years of PTM simulations.

The 20 mm survey samples multiple stations throughout the Delta fortnightly. The average length of Delta Smelt caught during each survey was averaged across all stations (8–10 surveys per year) (Table E.2-1). The survey with mean fish length closest to 13 mm was chosen to represent the starting distribution of larval smelt in the Delta for that particular year (Table E.2-1). A length of 13 mm was chosen in order to represent a consistent period each year with respect to size/age of Delta Smelt larvae, while accounting for the mean size by survey across all years and the general pattern of more efficient capture with greater size. Catch efficiency changes rapidly for Delta Smelt larvae as they grow (see Figure 8 of Kimmerer 2008); the choice of 13 mm represents a compromise between larger larvae/early juveniles (e.g., ≥ 20 mm) that are captured more efficiently but which may have moved too far to accurately represent starting distribution and likely would be behaving less like passive particles, and smaller larvae (e.g., < 10 mm) that are not sampled efficiently enough to provide a reliable depiction of starting distribution. During the period included in the analysis (1995–2011), the fourth survey was selected most frequently (range between the first and fifth surveys).

Once a survey date was chosen for a given year, the actual Delta Smelt catch during this survey was examined by station number (Table E.2-2). Stations downstream of the confluence of the Sacramento and San Joaquin River confluence (in Suisun Bay and Suisun Marsh) were eliminated, as particles originating in these areas would not be subject to entrainment in the Delta and the PTM is better suited for the channels of the Delta than for the open-estuary environment of Suisun Bay. Several stations in the Cache Slough area also were not included as they were introduced in 2008 and did not have data for the entire period from which starting distributions are calculated. A list of stations and counts of Delta Smelt are provided in Table E.2-2, along with the fish count not used to calculate the starting distribution, as a percentage of total fish caught during a given survey. Note that the percentage of larvae collected downstream of the Sacramento–San Joaquin confluence varies from zero to almost 100%, depending on water year. For example, in 2002 (survey 4), with relatively low outflow of approximately 13,500 cubic feet per second (cfs), only 2.5% of larvae were downstream of the confluence (Table E.2-2). In contrast, over 70% of larvae were downstream in 1998 (survey 4), with outflow of nearly 70,000 cfs (Figure E.2-1). These percentages were used to adjust the percentage of particles (particles representing larvae) that would be considered susceptible to entrainment.

Delta smelt counts per station were then divided by the contributing area of a given station in acres (Table E.2-3), to remove spatial disparities, and percentages of the total number of Delta Smelt caught were calculated for each of the main areas included in the analysis. The final annual starting distributions then were established by evenly distributing assigned percentages to each DSM2 PTM node (i.e., model particle insertion points) in a given area.

Table E.2-1. Distribution of Larval Delta Smelt (Number of Smelt) in Selected Survey Period (Survey Number) – Table E.2-1 a – E.2-1 h

Table E.2-1 a. Distribution of Larval Delta Smelt (Number of Smelt) in Selected Survey Period (Survey Number) at West Delta/Lower Sacramento River Sampling Stations

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Survey Number	1	3	4	4	2	4	5	4	4	4	4	5	4	4	4	4	4
Average Monthly Outflow (cfs)2	90,837	46,021	12,257	67,612	35,509	22,057	9,612	13,483	41,877	12,354	29,876	82,004	11,235	9,482	11,944	25,102	84,981
Station No. 508	–	51	–	1	3	1	–	–	1	–	2	–	–	–	–	–	–
Station No. 513	–	110	3	–	1	18	1	–	1	7	7	–	–	–	–	2	–
Station No. 520	4	65	26	1	–	9	–	–	1	–	2	–	–	–	–	1	1
Station No. 801	–	41	2	–	8	18	–	–	2	13	1	–	–	1	–	1	–

Table E.2-1 b. Distribution of Larval Delta Smelt (Number of Smelt) in Selected Survey Period (Survey Number) at West Delta/ Sacramento–San Joaquin Confluence Sampling Stations

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Survey Number	1	3	4	4	2	4	5	4	4	4	4	5	4	4	4	4	4
Average Monthly Outflow (cfs)2	90,837	46,021	12,257	67,612	35,509	22,057	9,612	13,483	41,877	12,354	29,876	82,004	11,235	9,482	11,944	25,102	84,981
704	–	11	8	–	4	–	3	–	–	1	–	–	–	1	–	–	–
705	–	4	12	–	–	1	14	5	1	8	–	1	–	–	1	–	–
706	–	4	14	2	–	1	5	1	–	3	1	–	1	–	–	1	–
707	–	–	–	–	–	–	11	–	–	2	–	–	–	–	–	–	–

Table E.2-1 c. Distribution of Larval Delta Smelt (Number of Smelt) in Selected Survey Period (Survey Number) at Cache Slough and North Delta Sampling Stations

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Survey Number	1	3	4	4	2	4	5	4	4	4	4	5	4	4	4	4	4
Average Monthly Outflow (cfs)2	90,837	46,021	12,257	67,612	35,509	22,057	9,612	13,483	41,877	12,354	29,876	82,004	11,235	9,482	11,944	25,102	84,981
711	–	–	7	–	–	1	1	1	–	–	–	1	1	–	–	–	–
716	–	–	6	–	–	3	5	1	2	2	1	3	–	–	1	2	1
719	–	–	–	–	–	–	–	–	–	–	–	–	–	2	12	38	39

Table E.2-1 d. Distribution of Larval Delta Smelt (Number of Smelt) in Selected Survey Period (Survey Number) at West Delta/Lower San Joaquin River Sampling Stations

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Survey Number	1	3	4	4	2	4	5	4	4	4	4	5	4	4	4	4	4
Average Monthly Outflow (cfs)2	90,837	46,021	12,257	67,612	35,509	22,057	9,612	13,483	41,877	12,354	29,876	82,004	11,235	9,482	11,944	25,102	84,981
804	–	8	32	12	15	8	–	4	4	5	–	1	–	1	–	1	–
809	–	20	13	–	–	–	28	1	1	87	–	–	–	–	–	–	–
812	–	8	6	–	–	1	49	3	–	6	–	–	–	1	–	–	–
815	–	3	5	–	18	1	13	5	–	26	1	1	–	2	1	1	–
901	–	5	5	–	7	–	13	2	1	4	–	–	–	–	–	–	–

Table E.2-1 e. Distribution of Larval Delta Smelt (Number of Smelt) in Selected Survey Period (Survey Number) at South Delta Sampling Stations

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Survey Number	1	3	4	4	2	4	5	4	4	4	4	5	4	4	4	4	4
Average Monthly Outflow (cfs)2	90,837	46,021	12,257	67,612	35,509	22,057	9,612	13,483	41,877	12,354	29,876	82,004	11,235	9,482	11,944	25,102	84,981
902–915	–	0	4	–	45	18	11	14	8	3	2	–	–	3	2	1	–
918	–	1	–	–	–	21	1	1	–	2	1	–	–	–	–	–	–

Table E.2-1 f. Distribution of Larval Delta Smelt (Number of Smelt) in Selected Survey Period (Survey Number) at East Delta Sampling Stations

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Survey Number	1	3	4	4	2	4	5	4	4	4	4	5	4	4	4	4	4
Average Monthly Outflow (cfs)2	90,837	46,021	12,257	67,612	35,509	22,057	9,612	13,483	41,877	12,354	29,876	82,004	11,235	9,482	11,944	25,102	84,981
919	–	1	5	–	–	1	10	1	–	–	–	–	–	–	–	–	–

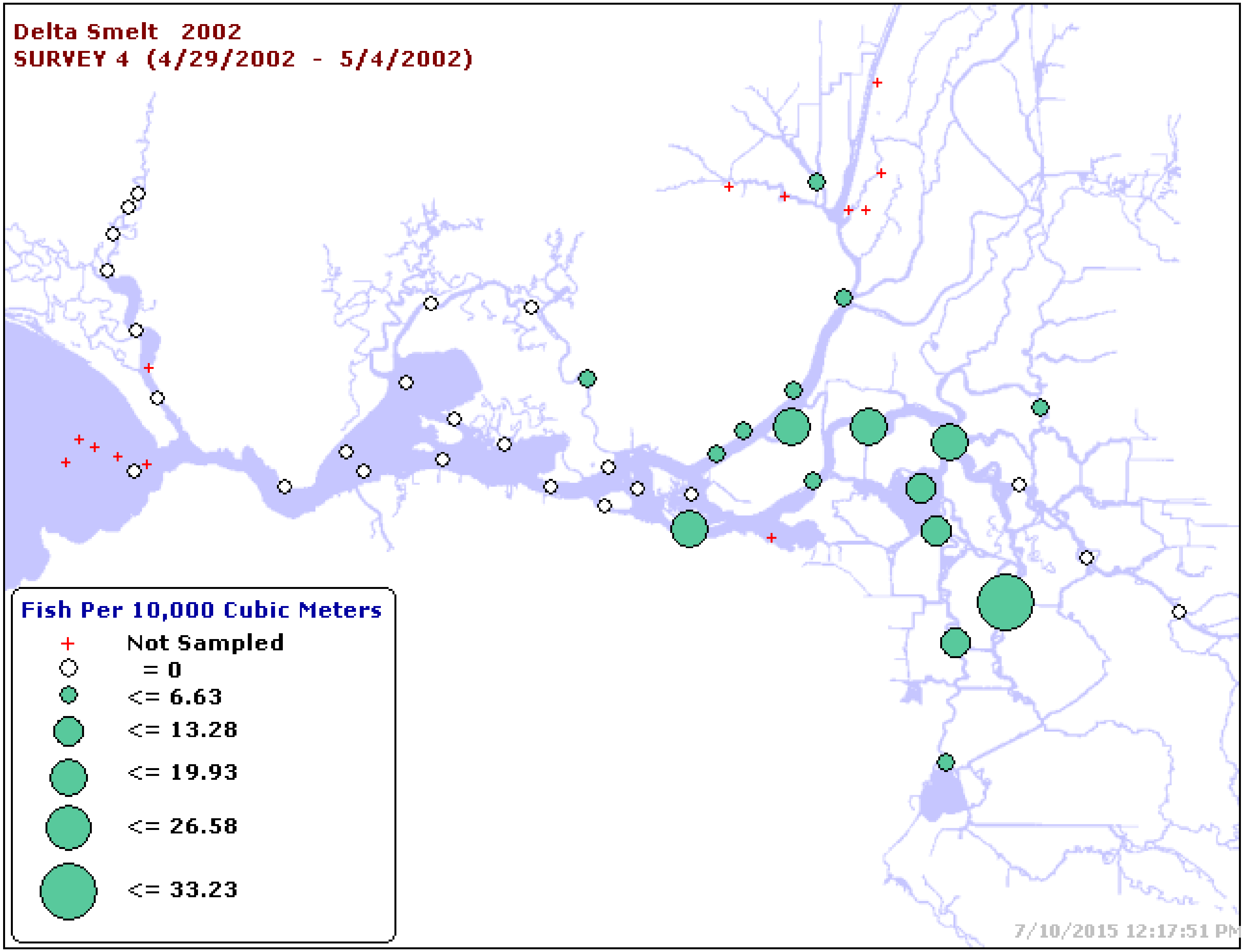
Table E.2-1 g. Distribution of Larval Delta Smelt (Number of Smelt) in Selected Survey Period (Survey Number) at Other Sampling Stations

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Survey Number	1	3	4	4	2	4	5	4	4	4	4	5	4	4	4	4	4
Average Monthly Outflow (cfs)2	90,837	46,021	12,257	67,612	35,509	22,057	9,612	13,483	41,877	12,354	29,876	82,004	11,235	9,482	11,944	25,102	84,981
Cache Slough Stations	0	0	0	0	0	0	0	0	0	0	0	0	0	10	4	16	4
Downstream of Confluence	7	567	66	43	127	46	8	1	7	20	50	242	1	0	1	4	120

Table E.2-1 h. Percentage of Total Larval Delta Smelt Count in Selected Survey Period (Survey Number) Not Considered for Starting Distribution

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Survey Number	1	3	4	4	2	4	5	4	4	4	4	5	4	4	4	4	4
Average Monthly Outflow (cfs)2	90,837	46,021	12,257	67,612	35,509	22,057	9,612	13,483	41,877	12,354	29,876	82,004	11,235	9,482	11,944	25,102	84,981
Cache Slough Stations	0	0	0	0	0	0	0	0	0	0	0	0	0	47.6	18.2	23.5	2.4
Downstream of Confluence	63.6	63.1	30.8	72.9	55.7	31.1	4.6	2.5	24.1	10.6	73.5	97.2	33.3	0	4.5	5.9	72.7

Note:
"–" indicates the cell is blank.



Source: http://www.dfg.ca.gov/delta/data/20mm/CPUE_map.asp. Accessed: July 10, 2015.

Figure E.2-1. Density of Delta Smelt from 20 mm Survey 4, 2002

Table E.2-2. Area of Water Represented by Each 20 mm Survey Station

Station	Area (acres)
508	2,296
513	1,703
520	438
801	2,226
704	605
705	277
706	931
707	1,859
711	1,994
716	3,110*
719	3,110*
804	1,195
809	1,392
812	1,767
815	4,023
901	3,822
902	1,744
906	1,780
910	1,925
912	1,225
914	1,554
915	1,146
918	1,601
919	2,043

Source: Saha 2008.
*Acreage for Station 716 was split between Stations 716 and 719

Each of the 328 months included in the PTM (i.e., March-June in 82 years) was matched to the closest starting distribution based on the average monthly Delta outflow. Average monthly Delta outflow for the months modeled by PTM hydro periods were based on CALSIM (Existing scenario) (Table E.2-2). Average monthly Delta outflow during the selected 20 mm survey period was calculated from DAYFLOW. If the selected survey period spanned two months (usually April–May), the applied outflow was for the month when most of the sampling occurred. The correspondence between the modeled Delta outflow and the applied starting distribution outflow from the 20 mm survey was reasonable: the mean difference was 4% (median = 1%), with a range from -221% (modeled Delta outflow of over 290,000 cfs in March 1983 matched with historical outflow of 90,837 cfs during survey 1 of 1995) to +58% (modeled Delta outflow of 4,000 cfs in several months matched with historical outflow of 9,482 cfs during survey 4 of 2008). Analysis of the PTM outputs was then done by multiplying the percentage of particles entrained from each release location by the applicable starting distribution percentage summarized in Table E.2-3. Results were summarized for 30-day particle tracking periods as the percentage of particles being entrained at the south Delta exports (Clifton Court Forebay, with CVP considered separately for cumulative effects), or NBA. The total number of particles released at each location was 4,000. Note that a 30-day particle tracking period may result in relatively low fate resolution at low flows (Kimmerer and Nobriga 2008), but the relative differences between scenarios would be expected to be consistent, based on previous model comparisons of 30-day and 60-day fates.

Results of the PTM analysis for entrainment into the SWP's Clifton Court Forebay and Barker Slough Pumping Plant are presented in Section 4.4 of the DEIR. Table E.2-4 provides results for the CVP Jones Pumping Plant for consideration of cumulative impacts in the DEIR Section 4.6.

Table E.2-3. Percentage of Particles at PTM Insertion Location Used as Starting Distributions in the Delta Smelt Particle Tracking Analysis - Table E.2-3 a - E.2-3 f

Table E.2-3 a. Percentage of Particles at PTM Insertion Locations in Sacramento–San Joaquin Confluence Area Used as Starting Distributions in the Delta Smelt Particle Tracking Analysis

Average Monthly Outflow in cfs:	9,482	9,612	11,235	11,944	12,257	12,354	13,483	22,057	25,102	29,876	35,509	46,021	67,612	82,004	84,891	90,837
Sacramento River at Sherman Lake	16.52	7.72	1.65	0	8.21	0	0.11	2.65	0	6.55	2.65	19.9	3.65	0	2.92	25.00
Sacramento River at Port Chicago	16.52	7.72	1.65	0	8.21	0	0.11	2.65	0	6.55	2.65	19.9	3.65	0	2.92	25.00
San Joaquin River downstream of Dutch Slough	16.52	7.72	1.65	0	8.21	0	0.11	2.65	0	6.55	2.65	19.9	3.65	0	2.92	25.00
Sacramento River at Pittsburg	16.52	7.72	1.65	0	8.21	0	0.11	2.65	0	6.55	2.65	19.9	3.65	0	2.92	25.00

Table E.2-3 b. Percentage of Particles at PTM Insertion Locations in Lower Sacramento River Area Used as Starting Distributions in the Delta Smelt Particle Tracking Analysis

Average Monthly Outflow in cfs:	9,482	9,612	11,235	11,944	12,257	12,354	13,483	22,057	25,102	29,876	35,509	46,021	67,612	82,004	84,891	90,837
Threemile Slough	1.30	0.67	4.24	8.76	6.96	10.64	9.10	2.35	6.00	4.13	2.35	2.13	2.12	8.76	0	0
Sacramento River at Rio Vista	1.30	0.67	4.24	8.76	6.96	10.64	9.10	2.35	6.00	4.13	2.35	2.13	2.12	8.76	0	0
Sacramento River downstream of Decker Island	1.30	0.67	4.24	8.76	6.96	10.64	9.10	2.35	6.00	4.13	2.35	2.13	2.12	8.76	0	0

Table E.2-3 c. Percentage of Particles at PTM Insertion Locations in Cache Slough and North Delta Area Used as Starting Distributions in the Delta Smelt Particle Tracking Analysis

Average Monthly Outflow in cfs:	9,482	9,612	11,235	11,944	12,257	12,354	13,483	22,057	25,102	29,876	35,509	46,021	67,612	82,004	84,891	90,837
Miner Slough	0.32	0.35	0.06	5.86	1.26	1.05	0.40	0	9.11	0.60	0	0	0	5.86	9.82	0
Sacramento Deep Water Ship Channel	0.32	0.35	0.06	5.86	1.26	1.05	0.40	0	9.11	0.60	0	0	0	5.86	9.82	0
Cache Slough at Shag Slough	0.32	0.35	0.06	5.86	1.26	1.05	0.40	0	9.11	0.60	0	0	0	5.86	9.82	0
Cache Slough at Liberty Island	0.32	0.35	0.06	5.86	1.26	1.05	0.40	0	9.11	0.60	0	0	0	5.86	9.82	0
Lindsey Slough at Barker Slough	0.32	0.35	0.06	5.86	1.26	1.05	0.40	0	9.11	0.60	0	0	0	5.86	9.82	0
Sacramento River at Sacramento	0.32	0.35	0.06	5.86	1.26	1.05	0.40	0	9.11	0.60	0	0	0	5.86	9.82	0
Sacramento River at Sutter Slough	0.32	0.35	0.06	5.86	1.26	1.05	0.40	0	9.11	0.60	0	0	0	5.86	9.82	0
Sacramento River at Ryde	0.32	0.35	0.06	5.86	1.26	1.05	0.40	0	9.11	0.60	0	0	0	5.86	9.82	0
Sacramento River near Cache Slough confluence	0.32	0.35	0.06	5.86	1.26	1.05	0.40	0	9.11	0.60	0	0	0	5.86	9.82	0

Table E.2-3 d. Percentage of Particles at PTM Insertion Locations in West Delta/San Joaquin River Area Used as Starting Distributions in the Delta Smelt Particle Tracking Analysis

Average Monthly Outflow in cfs:	9,482	9,612	11,235	11,944	12,257	12,354	13,483	22,057	25,102	29,876	35,509	46,021	67,612	82,004	84,891	90,837
San Joaquin River at Potato Slough	0.80	2.86	25.12	7.00	10.87	11.13	19.73	17.80	0	13.16	17.80	4.24	26.34	7.00	0	0
San Joaquin River at Twitchell Island	0.80	2.86	25.12	7.00	10.87	11.13	19.73	17.80	0	13.16	17.80	4.24	26.34	7.00	0	0
San Joaquin River near Jersey Point	0.80	2.86	25.12	7.00	10.87	11.13	19.73	17.80	0	13.16	17.80	4.24	26.34	7.00	0	0

Table E.2-3 e. Percentage of Particles at PTM Insertion Locations in Central/South Delta Area Used as Starting Distributions in the Delta Smelt Particle Tracking Analysis

Average Monthly Outflow in cfs:	9,482	9,612	11,235	11,944	12,257	12,354	13,483	22,057	25,102	29,876	35,509	46,021	67,612	82,004	84,891	90,837
San Joaquin River downstream of Rough and Ready Island	2.47	5.50	0.47	0	0.07	2.34	0.50	2.89	0	1.66	2.89	0.10	0	0	0	0
San Joaquin River at Buckley Cove	2.47	5.50	0.47	0	0.07	2.34	0.50	2.89	0	1.66	2.89	0.10	0	0	0	0
San Joaquin River near Medford Island	2.47	5.50	0.47	0	0.07	2.34	0.50	2.89	0	1.66	2.89	0.10	0	0	0	0
Old River near Victoria Canal	2.47	5.50	0.47	0	0.07	2.34	0.50	2.89	0	1.66	2.89	0.10	0	0	0	0
Old River at Railroad Cut	2.47	5.50	0.47	0	0.07	2.34	0.50	2.89	0	1.66	2.89	0.10	0	0	0	0
Old River near Quimby Island	2.47	5.50	0.47	0	0.07	2.34	0.50	2.89	0	1.66	2.89	0.10	0	0	0	0
Middle River at Victoria Canal	2.47	5.50	0.47	0	0.07	2.34	0.50	2.89	0	1.66	2.89	0.10	0	0	0	0
Middle River u/s of Mildred Island	2.47	5.50	0.47	0	0.07	2.34	0.50	2.89	0	1.66	2.89	0.10	0	0	0	0
Grant Line Canal	2.47	5.50	0.47	0	0.07	2.34	0.50	2.89	0	1.66	2.89	0.10	0	0	0	0
Frank's Tract East	2.47	5.50	0.47	0	0.07	2.34	0.50	2.89	0	1.66	2.89	0.10	0	0	0	0

Table E.2-3 f. Percentage of Particles at PTM Insertion Locations in East Delta Area Used as Starting Distributions in the Delta Smelt Particle Tracking Analysis

Average Monthly Outflow in cfs:	9,482	9,612	11,235	11,944	12,257	12,354	13,483	22,057	25,102	29,876	35,509	46,021	67,612	82,004	84,891	90,837
Little Potato Slough	0	0.08	0	0	0.26	0.30	0.74	0.00	0	0	0	0.03	0	0	0	0
Mokelumne River downstream of Cosumnes confluence	0	0.08	0	0	0.26	0.30	0.74	0.00	0	0	0	0.03	0	0	0	0
South Fork Mokelumne	0	0.08	0	0	0.26	0.30	0.74	0.00	0	0	0	0.03	0	0	0	0
Mokelumne River downstream of Georgiana confluence	0	0.08	0	0	0.26	0.30	0.74	0.00	0	0	0	0.03	0	0	0	0
North Fork Mokelumne	0	0.08	0	0	0.26	0.30	0.74	0	0	0	0	0.03	0	0	0	0
Georgiana Slough	0	0.08	0	0	0.26	0.30	0.74	0	0	0	0	0.03	0	0	0	0

Table E.2-4. Percentage of Particles Entrained Over 30 Days into the Central Valley Project Jones Pumping Plant.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
March	Wet	2.20	1.83	-0.37 (-17%)
March	Above Normal	3.57	3.01	-0.55 (-16%)
March	Below Normal	7.56	6.45	-1.11 (-15%)
March	Dry	11.94	10.01	-1.93 (-16%)
March	Critical	9.43	10.54	1.11 (12%)
April	Wet	0.79	1.63	0.84 (107%)
April	Above Normal	1.85	2.87	1.03 (56%)
April	Below Normal	4.21	5.41	1.20 (28%)
April	Dry	5.49	5.23	-0.26 (-5%)
April	Critical	4.84	4.31	-0.53 (-11%)
May	Wet	1.82	3.69	1.87 (103%)
May	Above Normal	3.19	7.96	4.77 (150%)
May	Below Normal	3.15	8.37	5.22 (166%)
May	Dry	5.82	8.30	2.48 (43%)
May	Critical	8.99	7.70	-1.29 (-14%)
June	Wet	9.56	9.67	0.11 (1%)
June	Above Normal	13.20	13.00	-0.20 (-2%)
June	Below Normal	16.01	16.07	0.06 (0%)
June	Dry	17.49	17.15	-0.35 (-2%)
June	Critical	12.12	11.04	-1.07 (-9%)

E.2.2 *EURYTEMORA AFFINIS*-X2 ANALYSIS

This analysis followed Kimmerer's (2002) methods to conduct an analysis of the relationship between *Eurytemora affinis* and spring (March–May) X2 for the period from 1980 to 2017, as described by Greenwood (2018). The main steps in preparing the data for analysis were as follows:

1. Historical zooplankton data were obtained from ftp://ftp.dfg.ca.gov/IEP_Zooplankton/1972-2017CBMatrix.xlsx
    a. Data were subsetted to only include surveys 3, 4, and 5 (March-May).
    b. Specific conductance was converted to salinity by applying Schemel's (2001) method, then only samples within the low salinity zone (salinity = 0.5-6) were selected.
    c. A constant of 10 was added to *E. affinis* adult catch per unit effort (number per cubic meter) in each sample, then the resulting value was $\log_{10}$-transformed.
    d. The $\log_{10}$-transformed values were averaged first by month, and then by year.
2. Historical X2 data were obtained from DAYFLOW (https://www.water.ca.gov/Programs/Environmental-Services/Compliance-Monitoring-And-Assessment/Dayflow-Data)

a. For years prior to water year 1997 (which is the year DAYFLOW X2 values began to be provided), the DAYFLOW daily predictive equation for X2 was used, based on a starting value from Anke Mueller-Solger (see Greenwood 2018 for details).

b. The mean March-May X2 was calculated for each year.

Similar to Kimmerer (2002), a general linear model was used to regress mean annual $\log_{10}$-transformed *E. affinis* catch per unit effort against mean March-May X2, including a step change between 1987 and 1988 to reflect the *Potamocorbula amurensis* clam invasion and a step change between 2002 and 2003 to reflect the onset of the Pelagic Organism Decline (POD; Thomson et al. 2010). The interaction of X2 and the step change was included in a full model, but the interaction was not statistically significant, so the model was re-run with only X2 and the step changes included. These analyses were conducted in SAS 9.4 software. The statistical outputs indicate that there is little difference in the coefficients for the post-*Potamocorbula* and POD step changes, whereas both coefficients were significantly less than the coefficient for the pre-*Potamocorbula* period. Regression coefficients from the model were stored for prediction of *E. affinis* relative abundance for the Existing and PP scenarios.

The stored regression coefficients from the regression of historical *E. affinis* catch per unit effort vs. X2 and step changes were then applied to the Existing and PP X2 inputs using PROC PLM in SAS 9.4 software. The basic regression model being applied was:

$$\log_{10}(\textit{E. affinis}\text{ catch per unit effort}) = 3.9404 - 0.0152\ (\text{mean March-May X2}) - 0.7863$$

where 3.9404 is the intercept and -0.7863 is the coefficient for the POD step change. Predictions were back-transformed to the original measurement scale (catch per unit effort, number per cubic meter) for summary of results.

E.3 LONGFIN SMELT

E.3.1 PARTICLE TRACKING MODELING (LARVAL ENTRAINMENT)

E.3.1.1 DERIVATION OF LARVAL LONGFIN SMELT HATCHING LOCATIONS

The potential effect of the PP on larval Longfin Smelt entrainment in the Delta and Suisun Marsh was evaluated through a PTM of neutrally buoyant particles representing newly hatched larvae inserted at various locations in the Delta. The first step in the analysis involved determining appropriate weights for particle insertion points to reflect the hatching locations of larval Longfin Smelt. Injection points for comparisons of Existing to PP effects were determined through examination of the spatial distributions of larvae observed in the Smelt Larva Survey (SLS) from 2009 to 2014. This methodology is consistent with the approach used by California Department of Fish and Game (DFG) in its effects and Incidental Take Permit (ITP) analysis for State Water Project (SWP) and Central Valley Project (CVP) Data (California Department of Fish and Game 2009a). Data were obtained from the CDFW website (ftp://ftp.delta.dfg.ca.gov/Delta%20Smelt/SLS.mdb). For most of this time period, the SLS generally included 5-6 surveys at 35 stations in the Delta and Suisun Marsh and Bay during January-March; stations 323 to 343 in the Napa River were added in 2014, but are not considered in the present analysis because there is only one year of data. Data were filtered to include Longfin Smelt larvae ≤ 6-mm total length (TL), which represents mostly newly hatched larvae, but includes some larvae up to 8 days old, assuming conservative hatch lengths as low of 4-mm standard length (SL) and growth rate of 0.25 mm d^{-1} (California Department of Fish and Game 2009b). Inspection of size distribution and presence of yolk-sacs of the larval Longfin Smelt catch from the SLS data suggest that most newly hatched larvae are around 6-mm TL (Figure E.3-1), which is consistent with the presumed range of 4- to 8-mm SL (Wang 2007; California Department of Fish and Game 2009b).

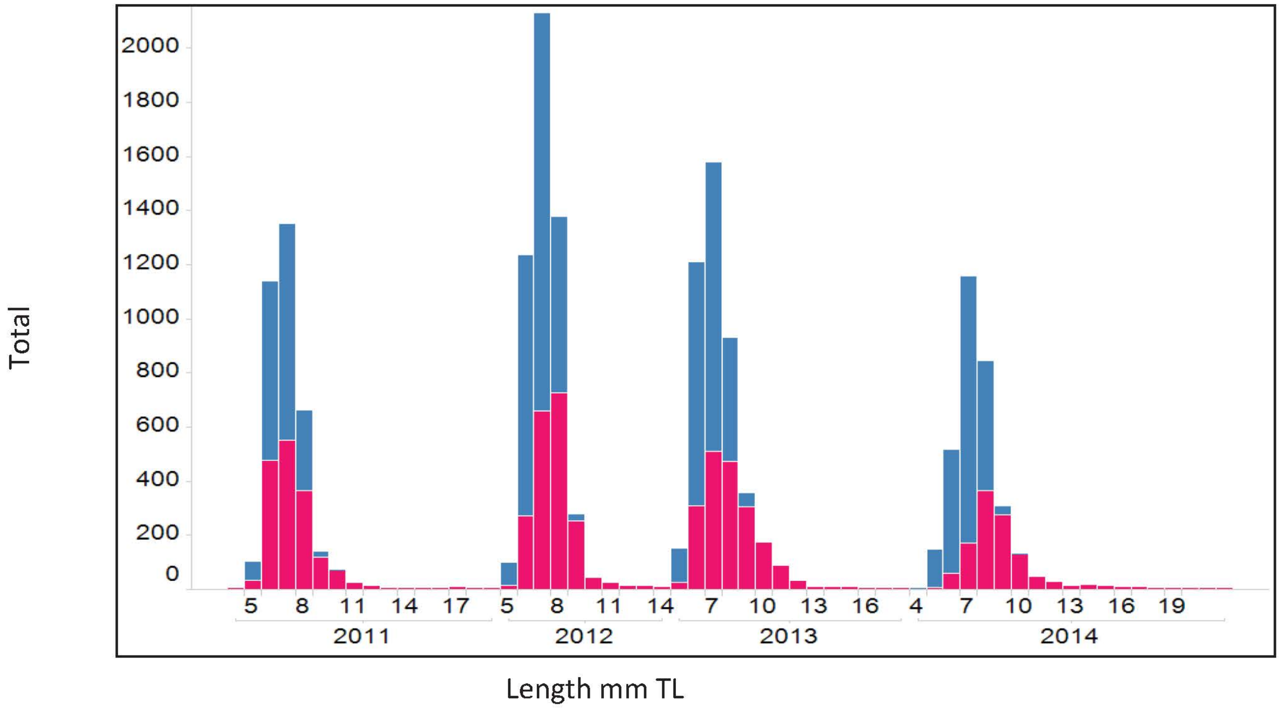


Figure E.3-1. Length-frequency histogram of Longfin Smelt larvae collected in the SLS. Larvae with yolk-sacs are represented by blue bars. DFG did not distinguish yolk sac larvae in 2009 and 2010

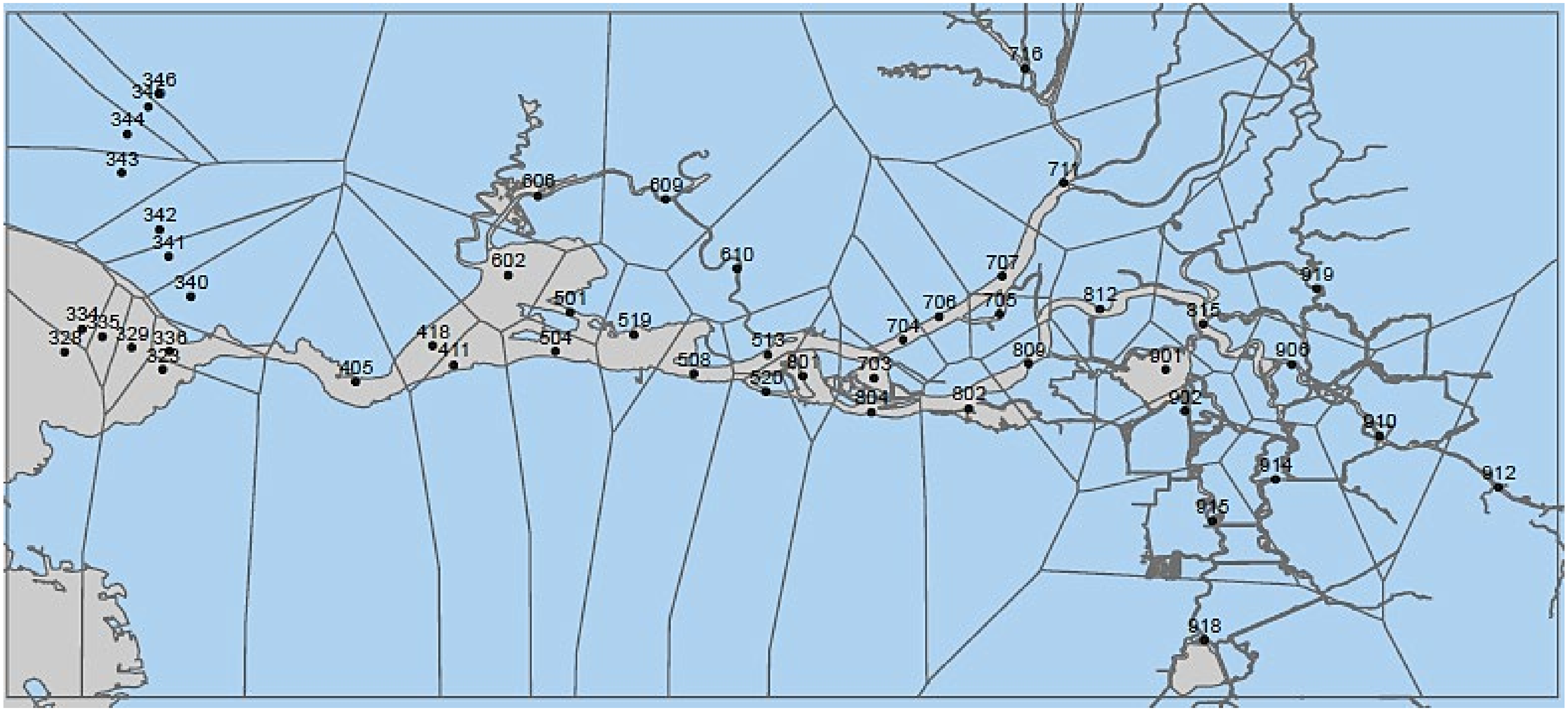
The density of larvae (≤ 6 mm TL) per cubic meter sampled at each station was calculated as:

Density = Number of larvae/(0.37*(26873+99999)*Net meter reading),

where the conversion factor derives from calibration of the net flow meter used during SLS sampling.[1]

The SLS includes a subset of the stations that are used for the March-June 20-mm survey for larval/juvenile delta smelt. Saha (2008) estimated the areas and volumes that each of the 20-mm stations represents within the Delta and Suisun Marsh and Bay using a Voronoi diagram (Figure E.3-2). There is a station (723) that was not part of the 20-mm Survey when Saha (2008) made the area and volume calculations; this station is close to station 716, so the area and volume represented by station 716 were halved for the present analysis, with the other half being considered to be the area and volume represented by station 723 (Table E.3-1).

[1] See Eijkelkamp Agrisearch Equipment (no date) for further details.



Source: Saha (2008).

Figure E.3-2. Division of the Delta and Suisun Marsh and Bay Around 20-mm Survey Stations With a Voronoi Diagram

Table E.3-1. Area and Volume Represented by Smelt Larval Survey Stations

Station	Area (ac)	Volume (ac-ft)	Area (m2)	Volume (m3)
405	3,547	139,804	14,354,198	172,445,718
411	2,119	37,344	8,575,288	46,063,152
418	2,756	63,186	11,153,135	77,938,794
501	3,692	36,856	14,940,992	45,461,213
504	2,403	44,046	9,724,595	54,329,948
508	2,296	53,344	9,291,581	65,798,864
513	1,703	41,921	6,891,796	51,708,799
519	4,101	67,942	16,596,156	83,805,234
520	438	12,130	1,772,523	14,962,137
602	7,361	72,852	29,788,907	89,861,631
606	1,332	17,685	5,390,412	21,814,129
609	727	8,114	2,942,064	10,008,473
610	259	3,156	1,048,136	3,892,869
703	2,091	25,853	8,461,976	31,889,210
704	605	15,952	2,448,348	19,676,505
705	277	3,741	1,120,979	4,614,456
706	931	24,539	3,767,623	30,268,415
707	1,859	37,076	7,523,105	45,732,579
711	1,994	39,391	8,069,431	48,588,089
716*	3,110	51,796	12,583,699	63,889,434
723*	3,110	51,796	12,583,699	63,889,434
801	2,226	45,662	9,008,301	56,323,255
802	3,546	45,094	14,350,151	55,622,637
804	1,195	32,119	4,835,993	39,618,208
809	1,392	33,562	5,633,224	41,398,123
812	1,767	43,810	7,150,795	54,038,846
815	4023	72053	16,280,502	88,876,079
901	3,822	33,855	15,467,084	41,759,533
902	1,744	22,095	7,057,717	27,253,785
906	1,780	32,694	7,203,404	40,327,461
910	1,925	25,760	7,790,198	31,774,496
912	1,225	13,747	4,957,399	16,956,677
914	1,554	23,552	6,288,814	29,050,968
915	1,146	13,302	4,637,697	16,407,778
918	1601	14,685	6,479,016	18,113,683
919	2,043	20,702	8,267,727	25,535,544

Source: Saha (2008)

*See text for discussion of values for stations 716 and 723.

The total number of Longfin Smelt larvae ≤ 6 mm in the volume of water represented by each station (Table E.3-1) was calculated by multiplying the density of larvae by the volume of each station.[2] The proportion of larvae in the volume of water represented by each SLS station was calculated for each survey as the number of larvae per station divided by the total sum of larvae across all stations (Table E.3-2).

There was little evidence that the general distribution of Longfin Smelt larvae from the SLS varied by year in relation to hydrological conditions, at least for the groups of stations examined herein[3] (Table E.3-3). Therefore an overall mean distribution was used to weigh the results of the DSM2-PTM analysis, based on the mean proportion by station from all surveys during 2009–2014.

E.3.1.2 DSM2-PTM Runs

Sixty-day-long DSM2-PTM[4] runs were undertaken for the Existing and PP scenarios at 39 particle injection locations in the Delta and Suisun Marsh and Bay (Table E.3-4) during January, February, and March in 1922–2003. The particle injection locations were chosen to provide a representative variety of locations generally associated with SLS stations, with particular emphasis on the Delta. For each run, 4,000 neutrally buoyant passive particles were injected evenly every hour (i.e., about 160 particles per hour) over a 24.75-hour period at the beginning of the month. The fate of the particles was output at forty-five days, which was assumed to represent the duration that newly hatched larvae could be considered to act as neutrally buoyant particles with relatively poor swimming ability, and would therefore be susceptible to movement by prevailing channel currents, including entrainment. By the time larvae develop air bladders at around 12-mm TL, they are able to manipulate their position in the water column (Bennett et al. 2002), although they are still susceptible to entrainment, which is not represented by the tracking of particles for 45 days in the present analysis. For consistency with the analysis conducted by DFG (2009a), runs were also undertaken with surface (top 10% of water column) orientation of particles.

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[2] For reference, the overall estimated number of larvae across all stations ranged from around 600,000 (survey 6 in 2014) to around 160,000,000 (survey 4 in 2009). Dividing these estimates by fecundity of 7,500 (California Department of Fish and Game 2009b: Figure 3) for a 2-year-old female and multiplying by 2 (under the assumption of a 1:1 sex ratio) gives an estimate of adult Longfin Smelt abundance, assuming 100% survival from eggs to larvae . Applying 10%, 50%, and 90% survival from eggs to larvae gives estimates of adult population size of around 500-2,300 (survey 6 in 2014) to 130,000-650,000 (survey 4 in 2009). These estimates bracket the “tens of thousands” of adults suggested by Newman (pers. comm. to California Department of Fish and Game 2009b), perhaps providing some indication that the numbers are of a reasonable order of magnitude for the purposes of the present analysis. Note, however, that the analysis is not dependent on absolute numbers of larvae to be accurately represented, as gear efficiency for smaller stages would need to be refined.

[3] This does not preclude the possibility of a considerable proportion of the population occurring downstream of the SLS sampling area during wet years, for example.

[4] DSM2 modeling methods and results for the NAA and PP are presented in ICF International (2016: Appendix 5.B *DSM2 Modeling and Results*).

Table E.3-2. Volume-Weighted Proportion of Longfin Smelt Larvae ≤ 6 mm By Station, 2009-2014

Year	Survey	405	411	418	501	504	508	513	519	520	602	606	609	610	703	704	705	706	707	711	716	723	801	804	809	812	815	901	902	906	910	912	914	915	918	919
2009	1	0.0466	0.0000	0.0000	0.0118	0.0000	0.0151	0.2600	0.0217	0.0079	0.0000	0.0164	0.0000	0.0000	0.0164	0.0173	0.0104	0.2071	0.0365	0.0504	0.0161	0.0470	0.1693	0.0089	0.0193	0.0000	0.0000	0.0110	0.0000	0.0106	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2009	2	0.0000	0.0000	0.0000	0.0034	0.0000	0.1338	0.0993	0.0057	0.0227	0.0142	0.0015	0.0014	0.0033	0.0144	0.0771	0.0221	0.0779	0.2020	0.0296	0.0254	0.0045	0.0437	0.0848	0.0651	0.0150	0.0179	0.0324	0.0000	0.0000	0.0000	0.0000	0.0000	0.0027	0.0000	0.0000
2009	3	0.0000	0.0000	0.0000	0.0035	0.0021	0.0479	0.0019	0.0099	0.0099	0.0029	0.0083	0.0037	0.0009	0.0774	0.0369	0.0125	0.1055	0.1392	0.0355	0.1416	0.1250	0.0784	0.0316	0.0437	0.0632	0.0124	0.0056	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006	0.0000	0.0000
2009	4	0.1055	0.0222	0.0320	0.0052	0.0016	0.0773	0.2536	0.0267	0.0164	0.0827	0.0007	0.0013	0.0005	0.0126	0.0231	0.0027	0.0101	0.0309	0.0000	0.0305	0.0302	0.1554	0.0467	0.0209	0.0016	0.0028	0.0050	0.0008	0.0000	0.0000	0.0000	0.0008	0.0005	0.0000	0.0000
2009	5	0.0152	0.0190	0.0447	0.1238	0.0582	0.2174	0.1067	0.0734	0.0199	0.0931	0.0095	0.0012	0.0002	0.0129	0.0052	0.0015	0.0062	0.0139	0.0000	0.0178	0.0185	0.0587	0.0543	0.0047	0.0084	0.0064	0.0090	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2010	1	0.0130	0.0118	0.0218	0.0429	0.0161	0.1210	0.0807	0.0456	0.0451	0.0300	0.0000	0.0014	0.0006	0.0048	0.0105	0.0078	0.0526	0.1396	0.0035	0.0639	0.0745	0.0257	0.0383	0.0734	0.0421	0.0000	0.0272	0.0038	0.0000	0.0000	0.0000	0.0021	0.0000	0.0000	0.0000
2010	4	0.0506	0.0167	0.0480	0.0663	0.1274	0.0574	0.0304	0.0226	0.0283	0.0371	0.0000	0.0019	0.0033	0.0086	0.0753	0.0031	0.0841	0.1396	0.0038	0.0225	0.0094	0.0457	0.0631	0.0208	0.0095	0.0133	0.0097	0.0019	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2010	5	0.0670	0.1457	0.0848	0.1239	0.0744	0.0428	0.0147	0.0515	0.0162	0.0436	0.0000	0.0011	0.0000	0.0280	0.0164	0.0038	0.0361	0.0436	0.0106	0.0197	0.0534	0.0400	0.0274	0.0283	0.0175	0.0000	0.0071	0.0016	0.0000	0.0000	0.0000	0.0000	0.0000	0.0011	0.0000
2010	6	0.0171	0.0000	0.0000	0.0000	0.0106	0.1488	0.3585	0.0163	0.0095	0.0103	0.0095	0.0000	0.0005	0.0143	0.0479	0.0000	0.1063	0.0431	0.0167	0.0220	0.1016	0.0112	0.0161	0.0120	0.0138	0.0000	0.0088	0.0000	0.0000	0.0000	0.0000	0.0000	0.0022	0.0000	0.0029
2011	1	0.0130	0.0110	0.0187	0.0146	0.0212	0.1665	0.0837	0.2172	0.0349	0.0542	0.0204	0.0008	0.0006	0.0159	0.0576	0.0030	0.0682	0.1289	0.0000	0.0096	0.0102	0.0034	0.0278	0.0186	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2011	2	0.0336	0.0024	0.0307	0.0287	0.0181	0.0758	0.0363	0.0819	0.0251	0.0191	0.0053	0.0005	0.0044	0.0029	0.0314	0.0042	0.0487	0.0846	0.0193	0.0785	0.1454	0.0624	0.0531	0.0296	0.0137	0.0134	0.0490	0.0013	0.0000	0.0000	0.0008	0.0000	0.0000	0.0000	0.0000
2011	3	0.0000	0.0079	0.0062	0.0150	0.0301	0.0522	0.0043	0.0143	0.0067	0.0000	0.0000	0.0009	0.0010	0.0725	0.0207	0.0069	0.0611	0.1476	0.0775	0.2083	0.1842	0.0000	0.0228	0.0259	0.0190	0.0075	0.0075	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2011	4	0.0000	0.0038	0.0000	0.0916	0.1170	0.2984	0.0612	0.0802	0.0198	0.0184	0.0000	0.0000	0.0005	0.0113	0.0252	0.0030	0.0097	0.1250	0.0144	0.0057	0.0846	0.0128	0.0044	0.0000	0.0050	0.0000	0.0049	0.0031	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2011	5	0.2285	0.0972	0.0192	0.0641	0.1032	0.0171	0.0000	0.0814	0.0078	0.2402	0.0000	0.0000	0.0009	0.0236	0.0183	0.0012	0.0000	0.0000	0.0124	0.0000	0.0289	0.0000	0.0100	0.0096	0.0259	0.0000	0.0106	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2012	1	0.0000	0.0000	0.0127	0.0206	0.0000	0.1460	0.1212	0.0000	0.0075	0.0282	0.0017	0.0022	0.0000	0.0224	0.0130	0.0028	0.0766	0.1361	0.0000	0.1099	0.1076	0.0275	0.0437	0.0819	0.0196	0.0189	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2012	2	0.2521	0.0066	0.0415	0.0310	0.0193	0.0884	0.0153	0.0077	0.0072	0.0519	0.0029	0.0010	0.0009	0.0301	0.0301	0.0011	0.0460	0.0765	0.0000	0.0543	0.0935	0.0384	0.0047	0.0355	0.0373	0.0000	0.0203	0.0035	0.0019	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012
2012	3	0.0000	0.0000	0.0143	0.0081	0.0000	0.1628	0.0815	0.0082	0.0225	0.0258	0.0000	0.0009	0.0024	0.0026	0.0182	0.0024	0.0551	0.1591	0.0164	0.1159	0.1445	0.0047	0.0522	0.0050	0.0373	0.0508	0.0095	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2012	4	0.0593	0.0053	0.0236	0.0390	0.0248	0.0813	0.0322	0.1418	0.0230	0.0000	0.0000	0.0011	0.0000	0.0099	0.0250	0.0015	0.0829	0.1637	0.0168	0.0388	0.1124	0.0754	0.0192	0.0043	0.0000	0.0000	0.0102	0.0063	0.0000	0.0000	0.0000	0.0000	0.0000	0.0019	0.0000
2012	6	0.0894	0.0469	0.0522	0.0211	0.2308	0.1499	0.0583	0.0204	0.0683	0.1683	0.0000	0.0000	0.0048	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0151	0.0000	0.0392	0.0082	0.0000	0.0274	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2013	1	0.1422	0.0980	0.0000	0.0635	0.1968	0.0000	0.2731	0.0000	0.0000	0.1031	0.0000	0.0000	0.0000	0.0000	0.0078	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0208	0.0000	0.0141	0.0192	0.0000	0.0614	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2013	2	0.0124	0.0147	0.1148	0.0597	0.0858	0.0918	0.0308	0.1344	0.0087	0.1266	0.0000	0.0000	0.0000	0.0330	0.0013	0.0009	0.0704	0.0787	0.0034	0.0423	0.0280	0.0224	0.0202	0.0117	0.0000	0.0000	0.0079	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2013	3	0.0440	0.0000	0.0713	0.0527	0.0554	0.0301	0.0232	0.0568	0.0187	0.0499	0.0000	0.0000	0.0000	0.0514	0.0289	0.0037	0.0223	0.0807	0.0462	0.0927	0.1084	0.0435	0.0099	0.0472	0.0098	0.0164	0.0348	0.0000	0.0018	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2013	4	0.0000	0.0548	0.0103	0.0188	0.0253	0.0369	0.0194	0.0912	0.0116	0.0510	0.0000	0.0000	0.0000	0.0045	0.0296	0.0035	0.0585	0.1107	0.0934	0.1044	0.1985	0.0276	0.0201	0.0110	0.0036	0.0000	0.0134	0.0017	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2013	5	0.0689	0.0000	0.0506	0.0253	0.0280	0.1278	0.0172	0.0957	0.0245	0.0084	0.0000	0.0000	0.0000	0.0083	0.0134	0.0029	0.0422	0.1206	0.0498	0.0531	0.1243	0.0666	0.0384	0.0192	0.0115	0.0000	0.0034	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2013	6	0.0000	0.0680	0.0000	0.0000	0.0000	0.0000	0.1270	0.0000	0.0550	0.0000	0.0000	0.0000	0.0000	0.0411	0.0000	0.0000	0.3130	0.0000	0.0000	0.0000	0.0000	0.0000	0.3286	0.0000	0.0000	0.0000	0.0673	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2014	1	0.0000	0.0000	0.0190	0.0094	0.0000	0.2113	0.2272	0.0000	0.0332	0.0382	0.0053	0.0022	0.0100	0.0320	0.0287	0.0008	0.0131	0.0197	0.0276	0.0126	0.0259	0.0814	0.0425	0.0773	0.0467	0.0175	0.0183	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2014	2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0494	0.0598	0.0291	0.0171	0.0373	0.0020	0.0009	0.0007	0.0137	0.0079	0.0021	0.0095	0.0501	0.0446	0.2024	0.2176	0.0570	0.0096	0.0156	0.1374	0.0143	0.0162	0.0057	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2014	3	0.0000	0.0168	0.0415	0.0223	0.0137	0.0434	0.0381	0.0462	0.0159	0.0413	0.0000	0.0042	0.0000	0.0148	0.0024	0.0046	0.0042	0.0230	0.0367	0.2676	0.1165	0.1119	0.0160	0.0664	0.0324	0.0000	0.0201	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2014	4	0.0000	0.0000	0.0000	0.0000	0.0098	0.0124	0.0606	0.1058	0.0194	0.0000	0.0000	0.0018	0.0014	0.0208	0.0358	0.0000	0.0762	0.1184	0.0000	0.0980	0.2803	0.1038	0.0000	0.0280	0.0207	0.0000	0.0070	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2014	5	0.0000	0.0000	0.2679	0.0000	0.1638	0.0460	0.0423	0.0652	0.0338	0.0000	0.0000	0.0000	0.0105	0.0000	0.0000	0.0000	0.0221	0.0000	0.0000	0.0000	0.0000	0.0900	0.1203	0.0316	0.0391	0.0000	0.0673	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2014	6	0.0000	0.0000	0.0000	0.0000	0.3797	0.0000	0.0000	0.0000	0.1078	0.0000	0.0000	0.0000	0.0338	0.0000	0.0000	0.0000	0.4788	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note: Surveys 2 and 3 in 2010 and 5 in 2012 had missing data and were excluded from the analysis.

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Table E.3-3. Mean Proportion of Longfin Smelt Larvae In Each Group of SLS Stations

Year	Mean Dec.-Mar. Delta Outflow (cfs)	400s	500s	600s	700s	800s	900s
2009	13,808	0.06	0.33	0.05	0.35	0.20	0.02
2010	19,863	0.12	0.39	0.03	0.32	0.12	0.02
2011	55,663	0.09	0.37	0.07	0.37	0.07	0.02
2012	11,946	0.12	0.33	0.06	0.36	0.13	0.01
2013	23,600	0.13	0.31	0.06	0.35	0.13	0.03
2014	8,331	0.06	0.31	0.03	0.38	0.19	0.02
Mean	**–**	**0.09**	**0.34**	**0.05**	**0.36**	**0.14**	**0.02**

Note:
"–" indicates the cell is blank.

Each particle injection location was assigned to one or more SLS stations, and some SLS stations had multiple particle injection locations assigned to them, reflecting the relative distribution of the nearest SLS station to particle injection locations (e.g., station 919 had five injection locations assigned to it, whereas station 901 had one injection location assigned to it; Table E.3-4). The weight assigned to the particles injected at each PTM injection location reflected the mean proportion of larvae captured at the associated SLS station (Table E.3-2) divided by the number of injection locations at a given station. As an example, station 707 was assigned two particle injection locations: Threemile Slough (location no. 15) and Sacramento River at Rio Vista (location no. 31) (Table E.3-4). The overall mean proportion of larval Longfin Smelt at station 707 across all surveys in 2009–2014 was 0.078 (mean of values in the 707 column of Table E.3-2 This 0.078 (i.e., 7.8% of larvae) was then divided equally among the two particle injection locations assigned to SLS station 707, giving a weight of 0.039 (i.e., 3.9% of larvae) for the particles injected at both locations (Table E.3-4). Professional judgement was used to assign representative weights in situations where a broader area needed to be represented by relatively few stations (e.g., Cache Slough Complex stations 22–26 represented by SLS stations 716 and 713).

Table E.3-4. Particle Injection Locations, Associated SLS Stations, and Location Weight for the DSM2-PTM Analysis of Potential Larval Longfin Smelt Entrainment

PTM Injection Location Number	PTM Injection Location Name	SLS Station	Weight
1	San Joaquin River at Vernalis	912	0.000014
2	San Joaquin River at Mossdale	912	0.000014
3	San Joaquin River D/S of Rough and Ready Island	910	0.000000
4	San Joaquin River at Buckley Cove	910	0.000000
5	San Joaquin River near Medford Island	906	0.000463
6	San Joaquin River at Potato Slough	815	0.003088
7	San Joaquin River at Twitchell Island	812	0.021832
8	Old River near Victoria Canal	918	0.000032
9	Old River at Railroad Cut	915	0.000191
10	Old River near Quimby Island	902	0.000957
11	Middle River at Victoria Canal	918	0.000032
12	Middle River u/s of Mildred Island	914	0.000094
13	Grant Line Canal	918	0.000032
14	Frank's Tract East	901	0.017578
15	Threemile Slough	707	0.038899
16	Little Potato Slough	919	0.000026
17	Mokelumne River d/s of Cosumnes confluence	919	0.000026
18	South Fork Mokelumne	919	0.000026
19	Mokelumne River d/s of Georgiana confluence	815	0.003088

PTM Injection Location Number	PTM Injection Location Name	SLS Station	Weight
20	North Fork Mokelumne	919	0.000026
21	Georgiana Slough	919	0.000026
22	Miner Slough	716+723	0.028025
23	Sacramento Deep Water Ship Channel	716+723	0.028025
24	Cache Slough at Shag Slough	716+723	0.028025
25	Cache Slough at Liberty Island	716+723	0.028025
26	Cache Slough near Lindsey Slough	716+723	0.028025
27	Sacramento River at Sacramento	upstream	0.000000
28	Sacramento River at Sutter Slough	upstream	0.000000
29	Sacramento River at Ryde	711	0.009815
30	Sacramento River near Cache Slough confluence	711	0.009815
31	Sacramento River at Rio Vista	707	0.038899
32	Sacramento River d/s of Decker Island	705+706	0.075899
33	Sacramento River at Sherman Lake	704	0.022743
34	Sacramento River at Port Chicago	downstream	0.000000
35	Montezuma Slough near National Steel	downstream	0.000000
36	Montezuma Slough at Suisun Slough	downstream	0.000000
37	San Joaquin River d/s of Dutch Slough	703+804	0.058814
38	Sacramento River at Pittsburg	801	0.048938
39	San Joaquin River near Jersey Point	809	0.026464

SLS stations downstream of the Sacramento-San Joaquin river confluence (i.e., stations numbered 400s to 600s) were considered to be downstream of the influence of the SWP/CVP export facilities, and so were not included in the PTM analysis (but were used in the calculation of proportions; see Table E.3-2). Similarly, PTM injection locations downstream of the confluence were assigned zero weight[5], because these particles would not be susceptible to entrainment at the locations of interest. In addition, particles injected in the Sacramento River at Sacramento and Sutter Slough were assigned zero weight because they are upstream of the range of the SLS (suggesting that this portion of the river is of minor concern for Longfin Smelt management). The summed weight of all the PTM injection locations in the analysis was 0.52, reflecting that 0.48 of the larval population was assumed to be downstream of the confluence and therefore not susceptible to entrainment in the Delta (see sum of the 400s, 500s, and 600s stations in Table E.3-3). As discussed further in Section E.3.1.3 *Note on Proportion of Larval Population Outside the Delta and Suisun Marsh and Bay*, the spatial extent of the SLS data used in the present analysis includes only the Delta and Suisun Marsh and Bay, but the full extent of the distribution of larval Longfin Smelt may be considerably greater.

For each simulated month in the DSM2-PTM analysis, the percentage of particles from each particle injection location was output for several fates: entrainment (the SWP's Clifton Court Forebay, the CVP's Jones Pumping Plant, and the NBA Barker Slough Pumping Plant), and passing Chipps Island. These percentages were multiplied by the weight for each particle injection location (Table E.3-4), and then summed across all injection locations to give a relative comparison of the overall percentage of larvae that would have been entrained or entered the south Delta under the Existing and PP scenarios. Note that these percentages are not intended to represent an absolute estimate of the actual

[5] PTM results for injection locations assigned zero weight are available upon request.

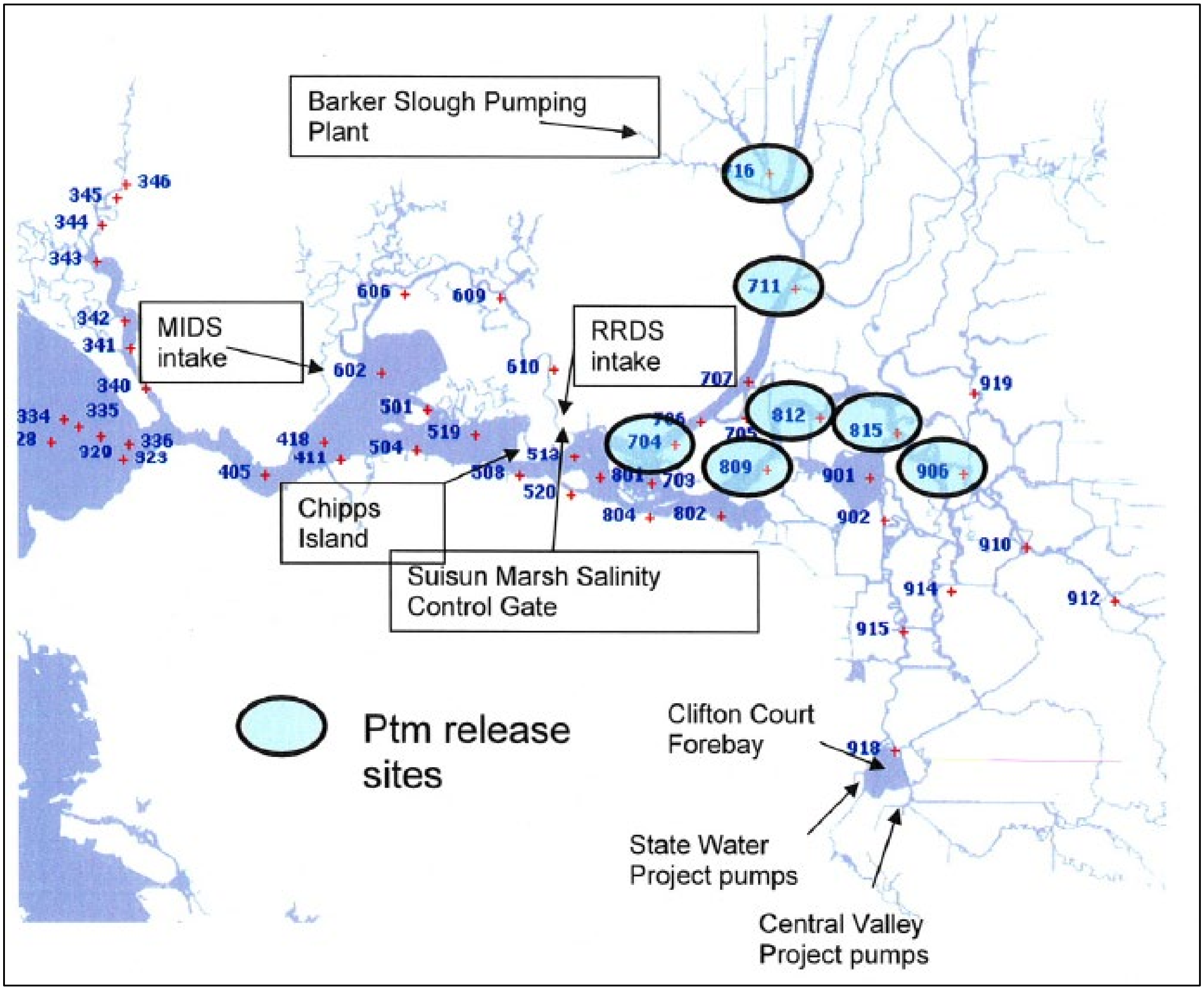
percentage of larvae that would be entrained, and should be interpreted only as a comparison of two operational scenarios (Existing and PP). The latest version of DSM2-PTM allows the user to not allow particles to be entrained into small agricultural diversions; this option was used for the present analysis in order to represent the hypothesis that such losses may not be substantial for Longfin Smelt (based on observations for delta smelt; Nobriga et al. 2004) and because losses at agricultural diversions were not the focus of the present analysis. In addition to reporting of the above fates, the percentage of particles remaining in the DSM2-PTM modeling domain after 45 days (i.e., neither entrained nor having left the domain) was also calculated.

E.3.1.3 Note on Proportion of Larval Population Outside the Delta and Suisun Marsh and Bay

The spatial distribution of newly hatched larvae determined from the SLS is likely much broader than observed, especially during wet years. Grimaldo et al. (2014) recently showed that larval Longfin Smelt are hatching in shallow water and tidal marsh habitats in salinities up to 8 parts per thousand (ppt). Previously thought to concentrate spawning in freshwater (Rosenfield and Baxter 2007; California Department of Fish and Game 2009a,b; Kimmerer et al. 2009), the analysis presented here and work by Grimaldo et al. (2014) shows that Longfin Smelt hatching is broadly distributed throughout Suisun Bay in most years (Table E.3-2). The proportion of newly hatched larvae from Delta stations was consistently lower than densities observed in Suisun Bay. Further, because overall larval Longfin Smelt abundance in the SLS is lowest during wet years, it is likely that spawning and hatching is occurring in San Pablo Bay and adjacent tributaries (e.g., Napa River, Petaluma River) when the area becomes suitable for spawning. Ultimately, this does not affect interpretation of results presented here because relative comparisons of Existing and PP were made using data for observations of larvae. The potential effects of survey bias would be more relevant for real-time operations where interpretation of proportional losses are likely to be affected by the observed versus actual distribution of larvae in the SLS survey.

E.3.1.4 Detailed Results for DFG (2009a) Stations of Interest

To supplement the above analysis and provide some comparability with the DFG (2009a) effects analysis, PTM results were summarized for the seven particle injection stations analyzed by DFG (2009; Figure E.3-3). The results are presented below in Tables E.3-5, E.3-6, E.3-7, E.3-8, E.3-9, E.3-10, E.3-11, E.3-12, E.3-13, E.3-14, E.3-15, E.3-16, E.3-17, and E.3-18. Note that these are 'raw' results, with no weighting as undertaken by DFG (2009a).



Source: DFG (2009a).

Figure E.3-3. Particle Tracking Injection (Release) Locations Used by DFG (2009a)

Table E.3-5. Percentage of Neutrally Buoyant Particles Injected at Station 716 (Cache Slough at Liberty Island) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island - Table E.3-5 a - E.3-5 d

Table E.3-5 b. Percentage of Neutrally Buoyant Particles Injected at Station 716 (Cache Slough at Liberty Island) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.33	0.35	0.02 (6%)
January	Above Normal	0.86	0.85	-0.01 (-2%)
January	Below Normal	1.90	1.84	-0.06 (-3%)
January	Dry	3.01	3.59	0.58 (19%)
January	Critical	3.32	3.55	0.23 (7%)
February	Wet	0.06	0.09	0.02 (36%)
February	Above Normal	0.29	0.24	-0.05 (-18%)
February	Below Normal	0.68	0.69	0.01 (2%)
February	Dry	1.39	1.58	0.19 (14%)
February	Critical	2.21	2.25	0.04 (2%)
March	Wet	0.09	0.06	-0.03 (-31%)
March	Above Normal	0.10	0.08	-0.03 (-26%)
March	Below Normal	0.51	0.38	-0.13 (-25%)
March	Dry	0.72	0.61	-0.11 (-15%)
March	Critical	0.97	1.19	0.23 (23%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-5 b. Percentage of Neutrally Buoyant Particles Injected at Station 716 (Cache Slough at Liberty Island) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.27	0.21	-0.06 (-24%)
January	Above Normal	0.75	0.84	0.09 (12%)
January	Below Normal	1.53	1.56	0.03 (2%)
January	Dry	2.92	3.23	0.31 (10%)
January	Critical	3.56	3.79	0.23 (7%)
February	Wet	0.06	0.05	-0.01 (-16%)
February	Above Normal	0.26	0.22	-0.04 (-15%)
February	Below Normal	0.56	0.57	0.01 (2%)
February	Dry	1.29	1.37	0.08 (6%)
February	Critical	2.38	2.54	0.16 (7%)
March	Wet	0.05	0.04	-0.01 (-25%)
March	Above Normal	0.06	0.06	-0.01 (-10%)
March	Below Normal	0.42	0.27	-0.15 (-36%)
March	Dry	0.75	0.49	-0.26 (-35%)
March	Critical	0.93	1.12	0.19 (20%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-5 c. Percentage of Neutrally Buoyant Particles Injected at Station 716 (Cache Slough at Liberty Island) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	1.54	1.53	-0.01 (-1%)
January	Above Normal	1.61	1.54	-0.07 (-5%)
January	Below Normal	1.91	1.78	-0.13 (-7%)
January	Dry	2.09	2.15	0.07 (3%)
January	Critical	1.74	1.69	-0.05 (-3%)
February	Wet	1.54	1.55	0.01 (1%)
February	Above Normal	1.58	1.50	-0.08 (-5%)
February	Below Normal	1.78	1.67	-0.11 (-6%)
February	Dry	1.44	1.44	0.00 (0%)
February	Critical	1.30	1.33	0.03 (3%)
March	Wet	1.47	1.46	-0.01 (-1%)
March	Above Normal	1.68	1.61	-0.07 (-4%)
March	Below Normal	2.08	2.07	-0.01 (0%)
March	Dry	1.52	1.45	-0.06 (-4%)
March	Critical	0.79	0.84	0.04 (6%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-5 d. Percentage of Neutrally Buoyant Particles Injected at Station 716 (Cache Slough at Liberty Island) That Passed Chipps Island.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	92.34	92.55	0.21 (0%)
January	Above Normal	86.53	87.23	0.70 (1%)
January	Below Normal	80.40	81.17	0.77 (1%)
January	Dry	68.70	66.79	-1.91 (-3%)
January	Critical	62.09	60.02	-2.08 (-3%)
February	Wet	93.90	93.89	-0.01 (0%)
February	Above Normal	91.41	91.86	0.46 (0%)
February	Below Normal	86.16	86.56	0.40 (0%)
February	Dry	79.71	79.43	-0.28 (0%)
February	Critical	67.77	67.99	0.22 (0%)
March	Wet	96.16	96.24	0.08 (0%)
March	Above Normal	95.87	95.88	0.00 (0%)
March	Below Normal	91.56	92.10	0.54 (1%)
March	Dry	86.49	87.15	0.66 (1%)
March	Critical	75.64	73.82	-1.82 (-2%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-6. Percentage of Surface-Oriented Particles Injected at Station 716 (Cache Slough at Liberty Island) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island - Table E.3-6 c - E.3-6 d

Table E.3-6 d. Percentage of Surface-Oriented Particles Injected at Station 716 (Cache Slough at Liberty Island) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	1.02	1.01	-0.01 (-1%)
January	Above Normal	0.98	1.03	0.05 (5%)
January	Below Normal	0.99	1.08	0.08 (8%)
January	Dry	0.37	0.38	0.01 (3%)
January	Critical	0.31	0.35	0.04 (12%)
February	Wet	0.76	0.56	-0.20 (-26%)
February	Above Normal	1.33	1.15	-0.17 (-13%)
February	Below Normal	1.20	1.10	-0.10 (-8%)
February	Dry	0.50	0.40	-0.10 (-20%)
February	Critical	0.24	0.21	-0.03 (-12%)
March	Wet	0.38	0.43	0.05 (12%)
March	Above Normal	0.48	0.48	0.00 (0%)
March	Below Normal	0.22	0.24	0.02 (7%)
March	Dry	0.24	0.23	-0.01 (-5%)
March	Critical	0.09	0.07	-0.01 (-15%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-6 b. Percentage of Surface-Oriented Particles Injected at Station 716 (Cache Slough at Liberty Island) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.87	0.78	-0.09 (-10%)
January	Above Normal	0.90	1.00	0.10 (11%)
January	Below Normal	0.85	1.10	0.24 (28%)
January	Dry	0.49	0.48	-0.01 (-3%)
January	Critical	0.45	0.44	-0.02 (-4%)
February	Wet	0.42	0.39	-0.03 (-7%)
February	Above Normal	1.10	1.15	0.04 (4%)
February	Below Normal	1.16	0.86	-0.30 (-26%)
February	Dry	0.79	0.73	-0.06 (-8%)
February	Critical	0.37	0.36	-0.01 (-4%)
March	Wet	0.21	0.27	0.06 (28%)
March	Above Normal	0.35	0.30	-0.05 (-13%)
March	Below Normal	0.22	0.19	-0.03 (-14%)
March	Dry	0.23	0.20	-0.03 (-12%)
March	Critical	0.09	0.16	0.08 (88%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-6 c. Percentage of Surface-Oriented Particles Injected at Station 716 (Cache Slough at Liberty Island) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	1.96	1.92	-0.04 (-2%)
January	Above Normal	2.77	2.59	-0.18 (-6%)
January	Below Normal	3.54	3.33	-0.21 (-6%)
January	Dry	2.90	2.90	0.00 (0%)
January	Critical	1.72	1.79	0.08 (4%)
February	Wet	1.77	1.72	-0.06 (-3%)
February	Above Normal	2.50	2.51	0.02 (1%)
February	Below Normal	3.01	2.92	-0.10 (-3%)
February	Dry	0.79	0.84	0.05 (6%)
February	Critical	0.35	0.54	0.19 (55%)
March	Wet	2.54	2.41	-0.13 (-5%)
March	Above Normal	3.28	3.08	-0.20 (-6%)
March	Below Normal	4.94	5.00	0.06 (1%)
March	Dry	1.25	1.26	0.01 (1%)
March	Critical	0.28	0.22	-0.06 (-20%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-6 d. Percentage of Surface-Oriented Particles Injected at Station 716 (Cache Slough at Liberty Island) That Passed Chipps Island.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	73.50	74.51	1.02 (1%)
January	Above Normal	49.84	50.25	0.41 (1%)
January	Below Normal	11.72	13.57	1.86 (16%)
January	Dry	5.31	5.36	0.05 (1%)
January	Critical	0.10	0.14	0.04 (40%)
February	Wet	75.05	75.92	0.87 (1%)
February	Above Normal	57.91	59.16	1.25 (2%)
February	Below Normal	25.76	29.46	3.70 (14%)
February	Dry	8.62	8.95	0.33 (4%)
February	Critical	0.94	0.82	-0.11 (-12%)
March	Wet	61.93	62.46	0.53 (1%)
March	Above Normal	45.26	46.46	1.20 (3%)
March	Below Normal	4.23	4.21	-0.02 (-1%)
March	Dry	4.45	5.02	0.57 (13%)
March	Critical	0.80	0.64	-0.17 (-21%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-7. Percentage of Neutrally Buoyant Particles Injected at Station 711 (Sacramento River near Cache Slough confluence) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island - Table E.3-7 e - E.3-7 d

Table E.3-7 f. Percentage of Neutrally Buoyant Particles Injected at Station 711 (Sacramento River near Cache Slough confluence) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.42	0.39	-0.03 (-7%)
January	Above Normal	0.93	1.01	0.08 (8%)
January	Below Normal	2.39	2.46	0.07 (3%)
January	Dry	3.61	4.44	0.83 (23%)
January	Critical	4.02	4.46	0.44 (11%)
February	Wet	0.06	0.06	0.00 (8%)
February	Above Normal	0.35	0.28	-0.07 (-19%)
February	Below Normal	0.90	0.95	0.05 (6%)
February	Dry	1.81	1.94	0.13 (7%)
February	Critical	2.89	2.92	0.03 (1%)
March	Wet	0.10	0.06	-0.04 (-41%)
March	Above Normal	0.12	0.09	-0.03 (-27%)
March	Below Normal	0.67	0.40	-0.27 (-41%)
March	Dry	0.99	0.83	-0.16 (-16%)
March	Critical	1.20	1.78	0.57 (48%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-7 b. Percentage of Neutrally Buoyant Particles Injected at Station 711 (Sacramento River near Cache Slough confluence) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.35	0.27	-0.08 (-23%)
January	Above Normal	0.89	0.93	0.04 (5%)
January	Below Normal	1.97	2.12	0.16 (8%)
January	Dry	3.51	3.71	0.19 (5%)
January	Critical	4.28	4.51	0.23 (5%)
February	Wet	0.06	0.04	-0.02 (-36%)
February	Above Normal	0.28	0.22	-0.06 (-22%)
February	Below Normal	0.81	0.79	-0.01 (-2%)
February	Dry	1.66	1.83	0.17 (10%)
February	Critical	3.16	3.24	0.08 (2%)
March	Wet	0.06	0.04	-0.03 (-43%)
March	Above Normal	0.09	0.06	-0.03 (-34%)
March	Below Normal	0.51	0.27	-0.24 (-47%)
March	Dry	0.96	0.67	-0.29 (-31%)
March	Critical	1.45	1.55	0.10 (7%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-7 c. Percentage of Neutrally Buoyant Particles Injected at Station 711 (Sacramento River near Cache Slough confluence) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.11	0.10	-0.02 (-14%)
January	Above Normal	0.26	0.24	-0.02 (-7%)
January	Below Normal	0.35	0.34	-0.01 (-2%)
January	Dry	0.40	0.45	0.05 (12%)
January	Critical	0.39	0.40	0.01 (2%)
February	Wet	0.05	0.05	0.00 (-2%)
February	Above Normal	0.12	0.12	0.00 (-2%)
February	Below Normal	0.27	0.25	-0.02 (-8%)
February	Dry	0.29	0.29	0.00 (1%)
February	Critical	0.24	0.29	0.05 (23%)
March	Wet	0.08	0.09	0.01 (11%)
March	Above Normal	0.11	0.11	0.00 (-2%)
March	Below Normal	0.36	0.36	0.00 (0%)
March	Dry	0.28	0.28	0.00 (0%)
March	Critical	0.17	0.18	0.02 (10%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-7 d. Percentage of Neutrally Buoyant Particles Injected at Station 711 (Sacramento River near Cache Slough confluence) That Passed Chipps Island.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	93.51	93.83	0.32 (0%)
January	Above Normal	88.03	88.57	0.54 (1%)
January	Below Normal	81.30	81.42	0.11 (0%)
January	Dry	70.49	68.92	-1.56 (-2%)
January	Critical	64.71	62.78	-1.93 (-3%)
February	Wet	95.62	95.68	0.06 (0%)
February	Above Normal	93.12	93.61	0.49 (1%)
February	Below Normal	88.05	88.19	0.14 (0%)
February	Dry	81.42	81.21	-0.21 (0%)
February	Critical	70.65	70.81	0.16 (0%)
March	Wet	98.38	98.39	0.02 (0%)
March	Above Normal	98.14	98.28	0.14 (0%)
March	Below Normal	95.73	96.58	0.85 (1%)
March	Dry	92.33	92.97	0.64 (1%)
March	Critical	84.48	82.83	-1.65 (-2%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-8. Percentage of Surface-Oriented Particles Injected at Station 711 (Sacramento River near Cache Slough confluence) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island – Table E.3-8 a - d

Table E.3-8 g. Percentage of Surface-Oriented Particles Injected at Station 711 (Sacramento River near Cache Slough confluence) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	4.44	4.46	0.02 (0%)
January	Above Normal	9.64	8.96	-0.69 (-7%)
January	Below Normal	14.73	15.18	0.45 (3%)
January	Dry	12.66	12.43	-0.24 (-2%)
January	Critical	10.36	9.99	-0.37 (-4%)
February	Wet	2.88	2.59	-0.29 (-10%)
February	Above Normal	6.62	6.15	-0.47 (-7%)
February	Below Normal	10.29	9.52	-0.77 (-7%)
February	Dry	12.98	12.61	-0.37 (-3%)
February	Critical	11.22	11.64	0.41 (4%)
March	Wet	3.04	3.42	0.38 (13%)
March	Above Normal	3.90	3.84	-0.06 (-2%)
March	Below Normal	9.38	10.26	0.88 (9%)
March	Dry	8.92	9.71	0.80 (9%)
March	Critical	5.55	7.37	1.81 (33%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-8 b. Percentage of Surface-Oriented Particles Injected at Station 711 (Sacramento River near Cache Slough confluence) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	3.76	3.71	-0.05 (-1%)
January	Above Normal	9.21	8.97	-0.24 (-3%)
January	Below Normal	13.56	13.18	-0.38 (-3%)
January	Dry	14.75	14.29	-0.46 (-3%)
January	Critical	14.62	12.24	-2.39 (-16%)
February	Wet	2.09	1.79	-0.30 (-14%)
February	Above Normal	6.14	5.59	-0.54 (-9%)
February	Below Normal	8.65	8.32	-0.33 (-4%)
February	Dry	13.83	13.59	-0.25 (-2%)
February	Critical	14.04	15.00	0.96 (7%)
March	Wet	2.03	2.00	-0.04 (-2%)
March	Above Normal	3.12	2.70	-0.42 (-13%)
March	Below Normal	8.03	6.97	-1.06 (-13%)
March	Dry	10.85	9.40	-1.45 (-13%)
March	Critical	7.06	7.18	0.12 (2%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-8 c. Percentage of Surface-Oriented Particles Injected at Station 711 (Sacramento River near Cache Slough confluence) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.36	0.33	-0.03 (-8%)
January	Above Normal	0.94	0.77	-0.17 (-19%)
January	Below Normal	1.20	0.99	-0.21 (-18%)
January	Dry	1.38	1.40	0.02 (2%)
January	Critical	1.06	1.05	-0.01 (-1%)
February	Wet	0.08	0.09	0.00 (6%)
February	Above Normal	0.35	0.25	-0.10 (-29%)
February	Below Normal	0.72	0.63	-0.10 (-14%)
February	Dry	0.26	0.26	0.00 (1%)
February	Critical	0.12	0.20	0.07 (62%)
March	Wet	0.28	0.24	-0.04 (-15%)
March	Above Normal	0.34	0.38	0.04 (11%)
March	Below Normal	1.58	1.44	-0.14 (-9%)
March	Dry	0.48	0.39	-0.08 (-18%)
March	Critical	0.11	0.09	-0.02 (-16%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-8 d. Percentage of Surface-Oriented Particles Injected at Station 711 (Sacramento River near Cache Slough confluence) That Passed Chipps Island

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	77.16	78.06	0.90 (1%)
January	Above Normal	51.37	52.42	1.05 (2%)
January	Below Normal	17.27	19.44	2.17 (13%)
January	Dry	6.41	6.26	-0.15 (-2%)
January	Critical	0.43	0.60	0.18 (41%)
February	Wet	83.65	84.15	0.51 (1%)
February	Above Normal	64.73	65.66	0.94 (1%)
February	Below Normal	40.83	43.19	2.36 (6%)
February	Dry	14.97	15.18	0.20 (1%)
February	Critical	2.63	2.68	0.05 (2%)
March	Wet	78.34	79.33	1.00 (1%)
March	Above Normal	69.90	72.93	3.03 (4%)
March	Below Normal	23.04	25.63	2.59 (11%)
March	Dry	11.47	12.57	1.10 (10%)
March	Critical	3.72	3.54	-0.18 (-5%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-9. Percentage of Neutrally Buoyant Particles Injected at Station 704 (Sacramento River at Sherman Lake) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island – Table E.3-9 a - E.3-9 d

Table E.3-9 h. Percentage of Neutrally Buoyant Particles Injected at Station 704 (Sacramento River at Sherman Lake) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.01	0.01	0.00 (8%)
January	Above Normal	0.04	0.05	0.01 (41%)
January	Below Normal	0.12	0.15	0.02 (17%)
January	Dry	0.16	0.22	0.06 (38%)
January	Critical	0.21	0.22	0.01 (4%)
February	Wet	0.00	0.00	0.00 (0%)
February	Above Normal	0.00	0.01	0.00 (50%)
February	Below Normal	0.02	0.02	0.00 (-10%)
February	Dry	0.04	0.06	0.02 (43%)
February	Critical	0.10	0.10	0.00 (-4%)
March	Wet	0.00	0.00	0.00 (-100%)
March	Above Normal	0.00	0.00	0.00 (-100%)
March	Below Normal	0.01	0.01	0.00 (-40%)
March	Dry	0.02	0.02	0.00 (-20%)
March	Critical	0.03	0.05	0.02 (63%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-9 b. Percentage of Neutrally Buoyant Particles Injected at Station 704 (Sacramento River at Sherman Lake) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.02	0.01	-0.01 (-35%)
January	Above Normal	0.03	0.05	0.03 (108%)
January	Below Normal	0.10	0.12	0.02 (24%)
January	Dry	0.17	0.24	0.07 (39%)
January	Critical	0.24	0.32	0.08 (32%)
February	Wet	0.00	0.00	0.00 (0%)
February	Above Normal	0.00	0.00	0.00 (0%)
February	Below Normal	0.01	0.02	0.01 (71%)
February	Dry	0.04	0.06	0.02 (56%)
February	Critical	0.15	0.12	-0.03 (-22%)
March	Wet	0.00	0.00	0.00 (0%)
March	Above Normal	0.00	0.00	0.00 (0%)
March	Below Normal	0.01	0.00	-0.01 (-80%)
March	Dry	0.02	0.01	-0.01 (-64%)
March	Critical	0.03	0.04	0.01 (19%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-9 c. Percentage of Neutrally Buoyant Particles Injected at Station 704 (Sacramento River at Sherman Lake) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.00	0.00	0.00 (0%)
anuary	Above Normal	0.00	0.00	0.00 (0%)
January	Below Normal	0.00	0.00	0.00 (0%)
January	Dry	0.00	0.00	0.00 (0%)
January	Critical	0.00	0.00	0.00 (0%)
February	Wet	0.00	0.00	0.00 (0%)
February	Above Normal	0.00	0.00	0.00 (0%)
February	Below Normal	0.00	0.00	0.00 (0%)
February	Dry	0.00	0.00	0.00 (0%)
February	Critical	0.00	0.00	0.00 (0%)
March	Wet	0.00	0.00	0.00 (0%)
March	Above Normal	0.00	0.00	0.00 (0%)
March	Below Normal	0.00	0.00	0.00 (0%)
March	Dry	0.00	0.00	0.00 (0%)
March	Critical	0.00	0.00	0.00 (0%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-9 d. Percentage of Neutrally Buoyant Particles Injected at Station 704 (Sacramento River at Sherman Lake) That Passed Chipps Island.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	94.87	95.04	0.17 (0%)
January	Above Normal	91.45	91.68	0.23 (0%)
January	Below Normal	86.50	86.74	0.24 (0%)
January	Dry	81.15	80.47	-0.68 (-1%)
January	Critical	78.49	76.51	-1.98 (-3%)
February	Wet	96.63	96.65	0.02 (0%)
February	Above Normal	94.68	95.07	0.39 (0%)
February	Below Normal	91.55	91.73	0.18 (0%)
February	Dry	87.77	87.71	-0.06 (0%)
February	Critical	81.69	81.90	0.21 (0%)
March	Wet	98.61	98.61	0.00 (0%)
March	Above Normal	98.65	98.60	-0.04 (0%)
March	Below Normal	99.17	99.17	0.01 (0%)
March	Dry	99.07	98.95	-0.13 (0%)
March	Critical	98.09	97.88	-0.21 (0%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-10. Percentage of Surface-Oriented Particles Injected at Station 704 (Sacramento River at Sherman Lake) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island – Table E.3-10 a - E.3-10 d

Table E.3-10 i. Percentage of Surface-Oriented Particles Injected at Station 704 (Sacramento River at Sherman Lake) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	3.16	2.70	-0.47 (-15%)
January	Above Normal	8.10	7.54	-0.56 (-7%)
January	Below Normal	15.90	16.41	0.51 (3%)
January	Dry	21.30	22.92	1.62 (8%)
January	Critical	21.36	21.80	0.44 (2%)
February	Wet	0.89	0.81	-0.08 (-9%)
February	Above Normal	3.93	3.10	-0.83 (-21%)
February	Below Normal	9.23	7.53	-1.70 (-18%)
February	Dry	14.24	13.41	-0.83 (-6%)
February	Critical	15.00	15.22	0.22 (1%)
March	Wet	0.77	1.20	0.43 (56%)
March	Above Normal	0.80	0.89	0.09 (11%)
March	Below Normal	4.93	7.86	2.92 (59%)
March	Dry	7.64	10.07	2.43 (32%)
March	Critical	9.31	12.14	2.82 (30%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-10 b. Percentage of Surface-Oriented Particles Injected at Station 704 (Sacramento River at Sherman Lake) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	2.55	2.19	-0.37 (-14%)
January	Above Normal	7.48	7.57	0.09 (1%)
January	Below Normal	14.41	14.17	-0.24 (-2%)
January	Dry	24.50	25.08	0.58 (2%)
January	Critical	28.37	27.17	-1.20 (-4%)
February	Wet	0.84	0.54	-0.30 (-35%)
February	Above Normal	3.59	2.84	-0.75 (-21%)
February	Below Normal	6.82	6.60	-0.22 (-3%)
February	Dry	14.80	13.71	-1.09 (-7%)
February	Critical	19.48	20.42	0.94 (5%)
March	Wet	0.66	0.75	0.09 (13%)
March	Above Normal	0.87	0.78	-0.09 (-11%)
March	Below Normal	5.06	4.97	-0.10 (-2%)
March	Dry	10.03	7.95	-2.08 (-21%)
March	Critical	11.88	12.32	0.44 (4%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-10 c. Percentage of Surface-Oriented Particles Injected at Station 704 (Sacramento River at Sherman Lake) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.00	0.00	0.00 (-100%)
January	Above Normal	0.00	0.00	0.00 (0%)
January	Below Normal	0.00	0.00	0.00 (-100%)
January	Dry	0.00	0.01	0.01 (600%)
January	Critical	0.01	0.00	-0.01 (-100%)
February	Wet	0.00	0.00	0.00 (0%)
February	Above Normal	0.00	0.00	0.00 (0%)
February	Below Normal	0.00	0.00	0.00 (0%)
February	Dry	0.00	0.00	0.00 (0%)
February	Critical	0.00	0.00	0.00 (0%)
March	Wet	0.00	0.00	0.00 (0%)
March	Above Normal	0.00	0.00	0.00 (0%)
March	Below Normal	0.01	0.00	0.00 (-67%)
March	Dry	0.00	0.00	0.00 (0%)
March	Critical	0.00	0.00	0.00 (0%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-10 d. Percentage of Surface-Oriented Particles Injected at Station 704 (Sacramento River at Sherman Lake) That Passed Chipps Island.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	82.10	82.92	0.82 (1%)
January	Above Normal	56.95	59.00	2.06 (4%)
January	Below Normal	22.70	24.98	2.29 (10%)
January	Dry	6.46	6.41	-0.05 (-1%)
January	Critical	0.83	1.19	0.35 (43%)
February	Wet	88.98	89.12	0.15 (0%)
February	Above Normal	73.33	74.77	1.45 (2%)
February	Below Normal	49.97	51.99	2.02 (4%)
February	Dry	20.67	20.91	0.23 (1%)
February	Critical	3.80	4.10	0.29 (8%)
March	Wet	86.52	87.19	0.67 (1%)
March	Above Normal	84.57	86.75	2.18 (3%)
March	Below Normal	37.35	41.07	3.72 (10%)
March	Dry	17.83	20.73	2.90 (16%)
March	Critical	6.53	6.36	-0.17 (-3%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-11. Percentage of Neutrally Buoyant Particles Injected at Station 809 (San Joaquin River near Jersey Point) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island - Table E.3-11 j - E.3-11 d

Table E.3-11 k. Percentage of Neutrally Buoyant Particles Injected at Station 809 (San Joaquin River near Jersey Point) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.96	0.89	-0.06 (-7%)
January	Above Normal	1.99	2.15	0.16 (8%)
January	Below Normal	4.35	4.57	0.22 (5%)
January	Dry	6.86	7.98	1.12 (16%)
January	Critical	6.85	7.22	0.37 (5%)
February	Wet	0.22	0.22	0.01 (3%)
February	Above Normal	0.97	0.86	-0.11 (-12%)
February	Below Normal	2.01	2.06	0.06 (3%)
February	Dry	4.00	4.22	0.22 (5%)
February	Critical	5.68	5.84	0.16 (3%)
March	Wet	0.26	0.17	-0.09 (-34%)
March	Above Normal	0.37	0.24	-0.12 (-34%)
March	Below Normal	1.53	1.01	-0.52 (-34%)
March	Dry	2.11	1.61	-0.50 (-24%)
March	Critical	2.43	3.19	0.76 (31%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-11 b. Percentage of Neutrally Buoyant Particles Injected at Station 809 (San Joaquin River near Jersey Point) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.77	0.70	-0.08 (-10%)
January	Above Normal	1.81	2.17	0.35 (20%)
January	Below Normal	3.85	4.08	0.23 (6%)
January	Dry	6.51	6.95	0.44 (7%)
January	Critical	7.34	7.34	0.00 (0%)
February	Wet	0.15	0.14	-0.02 (-11%)
February	Above Normal	0.81	0.78	-0.03 (-4%)
February	Below Normal	1.71	1.87	0.15 (9%)
February	Dry	3.51	3.85	0.34 (10%)
February	Critical	5.87	6.25	0.38 (6%)
March	Wet	0.17	0.10	-0.07 (-39%)
March	Above Normal	0.26	0.13	-0.13 (-50%)
March	Below Normal	1.16	0.72	-0.43 (-37%)
March	Dry	2.04	1.38	-0.67 (-33%)
March	Critical	2.56	2.92	0.36 (14%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-11 c. Percentage of Neutrally Buoyant Particles Injected at Station 809 (San Joaquin River near Jersey Point) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.00	0.00	0.00 (0%)
January	Above Normal	0.00	0.00	0.00 (0%)
January	Below Normal	0.00	0.00	0.00 (0%)
January	Dry	0.00	0.00	0.00 (0%)
January	Critical	0.00	0.00	0.00 (0%)
February	Wet	0.00	0.00	0.00 (0%)
February	Above Normal	0.00	0.00	0.00 (0%)
February	Below Normal	0.00	0.00	0.00 (0%)
February	Dry	0.00	0.00	0.00 (0%)
February	Critical	0.00	0.00	0.00 (0%)
March	Wet	0.00	0.00	0.00 (0%)
March	Above Normal	0.00	0.00	0.00 (0%)
March	Below Normal	0.00	0.00	0.00 (0%)
March	Dry	0.00	0.00	0.00 (0%)
March	Critical	0.00	0.00	0.00 (0%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-11 d. Percentage of Neutrally Buoyant Particles Injected at Station 809 (San Joaquin River near Jersey Point) That Passed Chipps Island.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	93.10	93.42	0.32 (0%)
January	Above Normal	86.18	86.39	0.21 (0%)
January	Below Normal	77.81	78.24	0.43 (1%)
January	Dry	64.65	62.47	-2.18 (-3%)
January	Critical	59.64	57.83	-1.81 (-3%)
February	Wet	95.87	96.01	0.14 (0%)
February	Above Normal	91.84	92.50	0.67 (1%)
February	Below Normal	86.08	86.16	0.08 (0%)
February	Dry	77.42	76.98	-0.44 (-1%)
February	Critical	64.72	64.28	-0.44 (-1%)
March	Wet	98.38	98.58	0.20 (0%)
March	Above Normal	97.95	98.28	0.33 (0%)
March	Below Normal	94.37	95.99	1.62 (2%)
March	Dry	89.18	91.17	1.98 (2%)
March	Critical	81.11	78.27	-2.84 (-4%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-12. Percentage of Surface-Oriented Particles Injected at Station 809 (San Joaquin River near Jersey Point) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island - Table E.3-12 I - E.3-12 h

Table E.3-12 m. Percentage of Surface-Oriented Particles Injected at Station 809 (San Joaquin River near Jersey Point) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	13.49	13.39	-0.10 (-1%)
January	Above Normal	23.36	23.49	0.13 (1%)
January	Below Normal	37.59	38.78	1.18 (3%)
January	Dry	37.53	39.73	2.21 (6%)
January	Critical	34.41	36.73	2.32 (7%)
February	Wet	8.50	7.62	-0.88 (-10%)
February	Above Normal	18.99	17.61	-1.38 (-7%)
February	Below Normal	28.53	26.42	-2.12 (-7%)
February	Dry	34.66	34.40	-0.27 (-1%)
February	Critical	33.24	33.50	0.26 (1%)
March	Wet	9.05	9.78	0.73 (8%)
March	Above Normal	12.68	12.21	-0.47 (-4%)
March	Below Normal	26.79	30.06	3.27 (12%)
March	Dry	29.40	30.84	1.44 (5%)
March	Critical	22.12	26.04	3.92 (18%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-12 b. Percentage of Surface-Oriented Particles Injected at Station 809 (San Joaquin River near Jersey Point) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	11.54	10.74	-0.80 (-7%)
January	Above Normal	23.63	23.60	-0.03 (0%)
January	Below Normal	36.47	35.45	-1.01 (-3%)
January	Dry	43.67	42.91	-0.76 (-2%)
January	Critical	47.84	44.31	-3.53 (-7%)
February	Wet	6.05	5.14	-0.91 (-15%)
February	Above Normal	16.51	15.15	-1.36 (-8%)
February	Below Normal	25.05	23.41	-1.64 (-7%)
February	Dry	38.72	38.03	-0.69 (-2%)
February	Critical	42.67	43.76	1.09 (3%)
March	Wet	5.79	5.75	-0.04 (-1%)
March	Above Normal	10.08	7.82	-2.26 (-22%)
March	Below Normal	22.04	19.37	-2.67 (-12%)
March	Dry	33.57	29.03	-4.54 (-14%)
March	Critical	31.73	32.54	0.81 (3%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-12 c. Percentage of Surface-Oriented Particles Injected at Station 809 (San Joaquin River near Jersey Point) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.00	0.00	0.00 (-100%)
January	Above Normal	0.00	0.00	0.00 (0%)
January	Below Normal	0.00	0.01	0.00 (50%)
January	Dry	0.01	0.01	0.00 (0%)
January	Critical	0.00	0.00	0.00 (-100%)
February	Wet	0.00	0.00	0.00 (0%)
February	Above Normal	0.00	0.00	0.00 (0%)
February	Below Normal	0.00	0.00	0.00 (0%)
February	Dry	0.00	0.00	0.00 (-100%)
February	Critical	0.00	0.00	0.00 (0%)
March	Wet	0.00	0.00	0.00 (0%)
March	Above Normal	0.00	0.00	0.00 (0%)
March	Below Normal	0.01	0.01	-0.01 (-38%)
March	Dry	0.00	0.00	0.00 (50%)
March	Critical	0.00	0.00	0.00 (0%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-12 d. Percentage of Surface-Oriented Particles Injected at Station 809 (San Joaquin River near Jersey Point) That Passed Chipps Island.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	63.60	64.38	0.78 (1%)
January	Above Normal	35.21	35.65	0.44 (1%)
January	Below Normal	5.17	5.42	0.24 (5%)
January	Dry	1.15	1.12	-0.03 (-3%)
January	Critical	0.08	0.10	0.02 (24%)
February	Wet	74.93	76.17	1.23 (2%)
February	Above Normal	46.38	46.88	0.50 (1%)
February	Below Normal	23.16	25.54	2.38 (10%)
February	Dry	4.13	3.57	-0.56 (-13%)
February	Critical	0.44	0.50	0.06 (15%)
March	Wet	64.99	66.54	1.54 (2%)
March	Above Normal	48.39	54.24	5.85 (12%)
March	Below Normal	9.62	11.94	2.32 (24%)
March	Dry	2.08	3.03	0.95 (46%)
March	Critical	0.70	0.59	-0.11 (-16%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-13. Percentage of Neutrally Buoyant Particles Injected at Station 812 (San Joaquin River at Twitchell Island) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island - Table E.3-13 n - E.3-13 d

Table E.3-13 o. Percentage of Neutrally Buoyant Particles Injected at Station 812 (San Joaquin River at Twitchell Island) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	5.86	5.79	-0.07 (-1%)
January	Above Normal	11.13	11.31	0.18 (2%)
January	Below Normal	19.01	19.51	0.50 (3%)
January	Dry	25.27	27.88	2.61 (10%)
January	Critical	24.64	26.25	1.61 (7%)
February	Wet	3.37	3.22	-0.15 (-4%)
February	Above Normal	7.90	7.52	-0.38 (-5%)
February	Below Normal	11.82	11.91	0.09 (1%)
February	Dry	19.67	20.61	0.94 (5%)
February	Critical	22.67	23.41	0.74 (3%)
March	Wet	3.24	2.13	-1.12 (-34%)
March	Above Normal	4.80	2.86	-1.94 (-40%)
March	Below Normal	11.17	7.88	-3.29 (-29%)
March	Dry	14.17	10.61	-3.55 (-25%)
March	Critical	12.30	15.02	2.72 (22%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-13 b. Percentage of Neutrally Buoyant Particles Injected at Station 812 (San Joaquin River at Twitchell Island) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	4.52	4.30	-0.21 (-5%)
January	Above Normal	9.55	9.68	0.12 (1%)
January	Below Normal	15.97	15.99	0.03 (0%)
January	Dry	23.43	24.19	0.76 (3%)
January	Critical	26.37	25.15	-1.22 (-5%)
February	Wet	2.19	1.89	-0.30 (-14%)
February	Above Normal	6.11	5.99	-0.11 (-2%)
February	Below Normal	9.38	9.43	0.05 (1%)
February	Dry	17.16	17.75	0.59 (3%)
February	Critical	23.38	23.66	0.28 (1%)
March	Wet	1.66	1.03	-0.63 (-38%)
March	Above Normal	3.15	1.74	-1.41 (-45%)
March	Below Normal	7.79	4.85	-2.93 (-38%)
March	Dry	12.89	8.82	-4.07 (-32%)
March	Critical	12.85	14.38	1.53 (12%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-13 c. Percentage of Neutrally Buoyant Particles Injected at Station 812 (San Joaquin River at Twitchell Island) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.00	0.00	0.00 (0%)
January	Above Normal	0.00	0.00	0.00 (0%)
January	Below Normal	0.00	0.00	0.00 (0%)
January	Dry	0.00	0.00	0.00 (0%)
January	Critical	0.00	0.00	0.00 (0%)
February	Wet	0.00	0.00	0.00 (0%)
February	Above Normal	0.00	0.00	0.00 (0%)
February	Below Normal	0.00	0.00	0.00 (0%)
February	Dry	0.00	0.00	0.00 (0%)
February	Critical	0.00	0.00	0.00 (0%)
March	Wet	0.00	0.00	0.00 (0%)
March	Above Normal	0.00	0.00	0.00 (0%)
March	Below Normal	0.00	0.00	0.00 (0%)
March	Dry	0.00	0.00	0.00 (0%)
March	Critical	0.00	0.00	0.00 (0%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-13 d. Percentage of Neutrally Buoyant Particles Injected at Station 812 (San Joaquin River at Twitchell Island) That Passed Chipps Island.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	84.70	84.90	0.20 (0%)
January	Above Normal	69.76	69.96	0.20 (0%)
January	Below Normal	51.08	51.50	0.42 (1%)
January	Dry	30.00	27.74	-2.26 (-8%)
January	Critical	22.89	23.22	0.33 (1%)
February	Wet	90.30	90.79	0.49 (1%)
February	Above Normal	79.31	80.01	0.71 (1%)
February	Below Normal	66.57	66.76	0.20 (0%)
February	Dry	44.38	43.28	-1.10 (-2%)
February	Critical	26.43	26.40	-0.02 (0%)
March	Wet	92.89	94.74	1.85 (2%)
March	Above Normal	88.53	92.27	3.74 (4%)
March	Below Normal	68.22	75.35	7.14 (10%)
March	Dry	48.74	56.86	8.13 (17%)
March	Critical	35.72	32.15	-3.56 (-10%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-14. Percentage of Surface-Oriented Particles Injected at Station 812 (San Joaquin River at Twitchell Island) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island - Table E.3-14 p - E.3-14 d

Table E.3-14 q. Percentage of Surface-Oriented Particles Injected at Station 812 (San Joaquin River at Twitchell Island) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	27.52	28.22	0.70 (3%)
January	Above Normal	35.75	35.86	0.11 (0%)
January	Below Normal	44.07	45.30	1.23 (3%)
January	Dry	41.57	43.84	2.27 (5%)
January	Critical	36.92	40.56	3.64 (10%)
February	Wet	24.75	22.78	-1.97 (-8%)
February	Above Normal	35.94	34.19	-1.75 (-5%)
February	Below Normal	41.13	40.69	-0.44 (-1%)
February	Dry	41.31	40.94	-0.37 (-1%)
February	Critical	37.44	37.65	0.21 (1%)
March	Wet	23.36	22.69	-0.67 (-3%)
March	Above Normal	31.33	30.93	-0.40 (-1%)
March	Below Normal	41.44	43.47	2.03 (5%)
March	Dry	37.84	39.04	1.21 (3%)
March	Critical	27.63	30.91	3.28 (12%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-14 b. Percentage of Surface-Oriented Particles Injected at Station 812 (San Joaquin River at Twitchell Island) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	22.36	20.65	-1.71 (-8%)
January	Above Normal	35.83	35.77	-0.06 (0%)
January	Below Normal	43.55	42.99	-0.56 (-1%)
January	Dry	48.32	46.85	-1.47 (-3%)
January	Critical	52.50	48.43	-4.07 (-8%)
February	Wet	14.57	13.31	-1.25 (-9%)
February	Above Normal	27.66	27.39	-0.26 (-1%)
February	Below Normal	33.57	32.28	-1.29 (-4%)
February	Dry	45.95	45.79	-0.16 (0%)
February	Critical	48.36	49.10	0.74 (2%)
March	Wet	11.31	11.33	0.03 (0%)
March	Above Normal	20.77	18.79	-1.98 (-10%)
March	Below Normal	30.30	27.36	-2.94 (-10%)
March	Dry	41.88	38.35	-3.53 (-8%)
March	Critical	39.06	40.33	1.26 (3%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-14 c. Percentage of Surface-Oriented Particles Injected at Station 812 (San Joaquin River at Twitchell Island) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.00	0.00	0.00 (0%)
January	Above Normal	0.00	0.00	0.00 (0%)
January	Below Normal	0.00	0.00	0.00 (0%)
January	Dry	0.00	0.00	0.00 (0%)
January	Critical	0.00	0.00	0.00 (0%)
February	Wet	0.00	0.00	0.00 (0%)
February	Above Normal	0.00	0.00	0.00 (0%)
February	Below Normal	0.00	0.00	0.00 (0%)
February	Dry	0.00	0.00	0.00 (0%)
February	Critical	0.00	0.00	0.00 (0%)
March	Wet	0.00	0.00	0.00 (0%)
March	Above Normal	0.00	0.00	0.00 (0%)
March	Below Normal	0.00	0.00	0.00 (0%)
March	Dry	0.00	0.00	0.00 (0%)
March	Critical	0.00	0.00	0.00 (0%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-14 d. Percentage of Surface-Oriented Particles Injected at Station 812 (San Joaquin River at Twitchell Island) That Passed Chipps Island.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	37.69	38.35	0.66 (2%)
January	Above Normal	14.72	14.45	-0.27 (-2%)
January	Below Normal	0.50	0.60	0.09 (19%)
January	Dry	0.04	0.06	0.02 (67%)
January	Critical	0.00	0.00	0.00 (-100%)
February	Wet	46.73	48.53	1.79 (4%)
February	Above Normal	20.70	21.47	0.76 (4%)
February	Below Normal	8.44	8.88	0.44 (5%)
February	Dry	0.21	0.20	-0.01 (-6%)
February	Critical	0.02	0.02	0.00 (-10%)
March	Wet	45.01	47.48	2.47 (5%)
March	Above Normal	20.38	23.49	3.12 (15%)
March	Below Normal	0.96	1.66	0.70 (72%)
March	Dry	0.15	0.26	0.10 (66%)
March	Critical	0.02	0.01	-0.01 (-50%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-15. Percentage of Neutrally Buoyant Particles Injected at Station 815 (San Joaquin River at Potato Slough) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island - Table E.3-15 r - E.3-15 d

Table E.3-15 s. Percentage of Neutrally Buoyant Particles Injected at Station 815 (San Joaquin River at Potato Slough) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	10.50	10.56	0.07 (1%)
January	Above Normal	16.79	16.76	-0.03 (0%)
January	Below Normal	24.77	25.68	0.91 (4%)
January	Dry	30.69	33.07	2.38 (8%)
January	Critical	29.09	30.61	1.53 (5%)
February	Wet	7.76	7.41	-0.36 (-5%)
February	Above Normal	13.66	13.10	-0.55 (-4%)
February	Below Normal	18.34	18.10	-0.24 (-1%)
February	Dry	25.23	26.77	1.53 (6%)
February	Critical	27.50	28.23	0.73 (3%)
March	Wet	7.57	5.04	-2.53 (-33%)
March	Above Normal	10.56	6.88	-3.68 (-35%)
March	Below Normal	17.83	13.06	-4.77 (-27%)
March	Dry	20.72	16.53	-4.19 (-20%)
March	Critical	15.85	18.83	2.98 (19%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-15 b. Percentage of Neutrally Buoyant Particles Injected at Station 815 (San Joaquin River at Potato Slough) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	7.41	7.19	-0.22 (-3%)
January	Above Normal	13.71	14.29	0.58 (4%)
January	Below Normal	20.96	20.51	-0.45 (-2%)
January	Dry	28.27	28.71	0.43 (2%)
January	Critical	31.27	28.84	-2.42 (-8%)
February	Wet	4.38	4.00	-0.38 (-9%)
February	Above Normal	9.65	9.64	-0.01 (0%)
February	Below Normal	13.26	13.80	0.54 (4%)
February	Dry	22.80	23.26	0.46 (2%)
February	Critical	28.08	28.73	0.65 (2%)
March	Wet	3.46	2.24	-1.22 (-35%)
March	Above Normal	6.16	3.86	-2.30 (-37%)
March	Below Normal	11.99	7.97	-4.02 (-34%)
March	Dry	18.76	13.26	-5.50 (-29%)
March	Critical	16.66	18.57	1.91 (11%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-15 c. Percentage of Neutrally Buoyant Particles Injected at Station 815 (San Joaquin River at Potato Slough) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.00	0.00	0.00 (0%)
January	Above Normal	0.00	0.00	0.00 (0%)
January	Below Normal	0.00	0.00	0.00 (0%)
January	Dry	0.00	0.00	0.00 (0%)
January	Critical	0.00	0.00	0.00 (0%)
February	Wet	0.00	0.00	0.00 (0%)
February	Above Normal	0.00	0.00	0.00 (0%)
February	Below Normal	0.00	0.00	0.00 (0%)
February	Dry	0.00	0.00	0.00 (0%)
February	Critical	0.00	0.00	0.00 (0%)
March	Wet	0.00	0.00	0.00 (0%)
March	Above Normal	0.00	0.00	0.00 (0%)
March	Below Normal	0.00	0.00	0.00 (0%)
March	Dry	0.00	0.00	0.00 (0%)
March	Critical	0.00	0.00	0.00 (0%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-15 d. Percentage of Neutrally Buoyant Particles Injected at Station 815 (San Joaquin River at Potato Slough) That Passed Chipps Island.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	77.07	77.33	0.25 (0%)
January	Above Normal	60.64	60.59	-0.05 (0%)
January	Below Normal	42.34	42.76	0.42 (1%)
January	Dry	24.18	22.41	-1.77 (-7%)
January	Critical	18.78	19.94	1.16 (6%)
February	Wet	83.59	84.36	0.76 (1%)
February	Above Normal	70.48	71.05	0.58 (1%)
February	Below Normal	57.21	57.46	0.26 (0%)
February	Dry	36.41	34.70	-1.72 (-5%)
February	Critical	22.07	21.94	-0.13 (-1%)
March	Wet	86.43	90.30	3.87 (4%)
March	Above Normal	79.51	85.81	6.29 (8%)
March	Below Normal	58.72	67.13	8.41 (14%)
March	Dry	40.96	49.58	8.63 (21%)
March	Critical	33.43	29.57	-3.85 (-12%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-16. Percentage of Surface-Oriented Particles Injected at Station 815 (San Joaquin River at Potato Slough) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island - Table E.3-16 t - E.3-16 d

Table E.3-16 u. Percentage of Surface-Oriented Particles Injected at Station 815 (San Joaquin River at Potato Slough) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	31.93	32.48	0.55 (2%)
January	Above Normal	38.64	39.35	0.70 (2%)
January	Below Normal	44.37	46.03	1.66 (4%)
January	Dry	41.76	44.49	2.73 (7%)
January	Critical	37.28	41.25	3.97 (11%)
February	Wet	30.86	29.30	-1.56 (-5%)
February	Above Normal	39.82	38.15	-1.67 (-4%)
February	Below Normal	44.31	43.77	-0.54 (-1%)
February	Dry	42.03	41.80	-0.23 (-1%)
February	Critical	38.20	38.47	0.27 (1%)
March	Wet	30.29	28.31	-1.98 (-7%)
March	Above Normal	36.59	35.40	-1.19 (-3%)
March	Below Normal	44.56	46.08	1.52 (3%)
March	Dry	39.14	40.51	1.37 (4%)
March	Critical	28.69	31.70	3.01 (10%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-16 b. Percentage of Surface-Oriented Particles Injected at Station 815 (San Joaquin River at Potato Slough) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	24.92	23.34	-1.58 (-6%)
January	Above Normal	37.68	37.45	-0.23 (-1%)
January	Below Normal	44.49	43.48	-1.01 (-2%)
January	Dry	49.38	47.42	-1.95 (-4%)
January	Critical	53.48	48.65	-4.83 (-9%)
February	Wet	17.04	15.39	-1.65 (-10%)
February	Above Normal	29.33	28.77	-0.55 (-2%)
February	Below Normal	34.62	33.71	-0.91 (-3%)
February	Dry	47.01	46.94	-0.07 (0%)
February	Critical	49.47	50.00	0.53 (1%)
March	Wet	12.93	12.67	-0.26 (-2%)
March	Above Normal	22.68	20.64	-2.04 (-9%)
March	Below Normal	31.32	28.40	-2.93 (-9%)
March	Dry	43.37	39.86	-3.51 (-8%)
March	Critical	40.29	41.57	1.27 (3%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-16 c. Percentage of Surface-Oriented Particles Injected at Station 815 (San Joaquin River at Potato Slough) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.00	0.00	0.00 (0%)
January	Above Normal	0.00	0.00	0.00 (0%)
January	Below Normal	0.00	0.00	0.00 (0%)
January	Dry	0.00	0.00	0.00 (0%)
January	Critical	0.00	0.00	0.00 (0%)
February	Wet	0.00	0.00	0.00 (0%)
February	Above Normal	0.00	0.00	0.00 (0%)
February	Below Normal	0.00	0.00	0.00 (0%)
February	Dry	0.00	0.00	0.00 (0%)
February	Critical	0.00	0.00	0.00 (0%)
March	Wet	0.00	0.00	0.00 (0%)
March	Above Normal	0.00	0.00	0.00 (0%)
March	Below Normal	0.00	0.00	0.00 (0%)
March	Dry	0.00	0.00	0.00 (0%)
March	Critical	0.00	0.00	0.00 (0%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-16 d. Percentage of Surface-Oriented Particles Injected at Station 815 (San Joaquin River at Potato Slough) That Passed Chipps Island.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	32.66	33.54	0.88 (3%)
January	Above Normal	12.21	11.88	-0.33 (-3%)
January	Below Normal	0.47	0.48	0.01 (2%)
January	Dry	0.05	0.05	0.00 (-8%)
January	Critical	0.00	0.00	0.00 (0%)
February	Wet	40.61	42.63	2.02 (5%)
February	Above Normal	17.95	19.15	1.19 (7%)
February	Below Normal	7.32	7.79	0.47 (6%)
February	Dry	0.24	0.17	-0.06 (-26%)
February	Critical	0.02	0.01	-0.01 (-64%)
March	Wet	40.15	43.38	3.23 (8%)
March	Above Normal	17.53	20.71	3.18 (18%)
March	Below Normal	1.00	1.86	0.86 (86%)
March	Dry	0.12	0.18	0.06 (48%)
March	Critical	0.02	0.02	0.00 (0%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-17. Percentage of Neutrally Buoyant Particles Injected at Station 906 (San Joaquin River near Medford Island) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island - Table E.3-17 v - E.3-17 d

Table E.3-17 w. Percentage of Neutrally Buoyant Particles Injected at Station 906 (San Joaquin River near Medford Island) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	28.64	28.61	-0.03 (0%)
January	Above Normal	37.74	38.20	0.46 (1%)
January	Below Normal	44.61	45.81	1.20 (3%)
January	Dry	47.66	50.32	2.66 (6%)
January	Critical	42.85	46.20	3.35 (8%)
February	Wet	24.46	23.40	-1.06 (-4%)
February	Above Normal	33.36	33.35	-0.01 (0%)
February	Below Normal	39.56	40.07	0.51 (1%)
February	Dry	46.52	46.70	0.18 (0%)
February	Critical	44.61	45.08	0.47 (1%)
March	Wet	22.38	17.07	-5.31 (-24%)
March	Above Normal	29.93	22.72	-7.21 (-24%)
March	Below Normal	39.47	34.50	-4.97 (-13%)
March	Dry	42.91	39.14	-3.77 (-9%)
March	Critical	31.15	34.07	2.92 (9%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-17 b. Percentage of Neutrally Buoyant Particles Injected at Station 906 (San Joaquin River near Medford Island) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	19.13	18.19	-0.94 (-5%)
January	Above Normal	29.91	30.38	0.48 (2%)
January	Below Normal	36.99	36.63	-0.36 (-1%)
January	Dry	43.60	42.31	-1.29 (-3%)
January	Critical	46.92	42.01	-4.91 (-10%)
February	Wet	12.79	11.81	-0.98 (-8%)
February	Above Normal	22.62	22.59	-0.04 (0%)
February	Below Normal	28.39	27.78	-0.61 (-2%)
February	Dry	41.41	42.35	0.94 (2%)
February	Critical	45.54	45.47	-0.07 (0%)
March	Wet	9.08	7.22	-1.86 (-20%)
March	Above Normal	16.64	12.01	-4.62 (-28%)
March	Below Normal	25.32	19.85	-5.48 (-22%)
March	Dry	37.94	32.21	-5.73 (-15%)
March	Critical	33.77	35.45	1.68 (5%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-17 c. Percentage of Neutrally Buoyant Particles Injected at Station 906 (San Joaquin River near Medford Island) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.00	0.00	0.00 (0%)
January	Above Normal	0.00	0.00	0.00 (0%)
January	Below Normal	0.00	0.00	0.00 (0%)
January	Dry	0.00	0.00	0.00 (0%)
January	Critical	0.00	0.00	0.00 (0%)
February	Wet	0.00	0.00	0.00 (0%)
February	Above Normal	0.00	0.00	0.00 (0%)
February	Below Normal	0.00	0.00	0.00 (0%)
February	Dry	0.00	0.00	0.00 (0%)
February	Critical	0.00	0.00	0.00 (0%)
March	Wet	0.00	0.00	0.00 (0%)
March	Above Normal	0.00	0.00	0.00 (0%)
March	Below Normal	0.00	0.00	0.00 (0%)
March	Dry	0.00	0.00	0.00 (0%)
March	Critical	0.00	0.00	0.00 (0%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-17 d. Percentage of Neutrally Buoyant Particles Injected at Station 906 (San Joaquin River near Medford Island) That Passed Chipps Island.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	47.95	48.93	0.98 (2%)
January	Above Normal	26.91	26.20	-0.71 (-3%)
January	Below Normal	11.24	10.91	-0.33 (-3%)
January	Dry	2.82	2.45	-0.38 (-13%)
January	Critical	1.82	2.98	1.16 (63%)
February	Wet	58.82	60.70	1.87 (3%)
February	Above Normal	39.47	39.53	0.06 (0%)
February	Below Normal	25.86	25.82	-0.04 (0%)
February	Dry	5.65	4.73	-0.92 (-16%)
February	Critical	2.06	2.01	-0.05 (-2%)
March	Wet	64.79	72.08	7.29 (11%)
March	Above Normal	47.99	59.81	11.82 (25%)
March	Below Normal	25.84	33.67	7.83 (30%)
March	Dry	6.47	11.77	5.31 (82%)
March	Critical	7.47	5.49	-1.98 (-27%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-18. Percentage of Surface-Oriented Particles Injected at Station 906 (San Joaquin River near Medford Island) That Were Entrained Over 45 Days into Clifton Court Forebay, Central Valley Project (Jones Pumping Plant), and Barker Slough Pumping Plant; or That Passed Chipps Island - Table E.3-18 x - E.3-18 d

Table E.3-18 y. Percentage of Surface-Oriented Particles Injected at Station 906 (San Joaquin River near Medford Island) That Were Entrained Over 45 Days into Clifton Court Forebay

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	42.84	42.95	0.11 (0%)
January	Above Normal	47.30	47.00	-0.30 (-1%)
January	Below Normal	46.25	47.74	1.49 (3%)
January	Dry	43.19	46.29	3.10 (7%)
January	Critical	37.85	42.56	4.71 (12%)
February	Wet	43.95	42.07	-1.88 (-4%)
February	Above Normal	49.26	48.23	-1.03 (-2%)
February	Below Normal	51.22	51.21	-0.01 (0%)
February	Dry	44.28	44.17	-0.11 (0%)
February	Critical	40.14	40.51	0.37 (1%)
March	Wet	43.50	40.92	-2.58 (-6%)
March	Above Normal	50.03	50.34	0.31 (1%)
March	Below Normal	52.20	53.97	1.77 (3%)
March	Dry	42.98	44.30	1.32 (3%)
March	Critical	32.22	34.48	2.26 (7%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-18 b. Percentage of Surface-Oriented Particles Injected at Station 906 (San Joaquin River near Medford Island) That Were Entrained Over 45 Days into Central Valley Project (Jones Pumping Plant).

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	32.30	30.85	-1.45 (-5%)
January	Above Normal	43.51	43.57	0.06 (0%)
January	Below Normal	46.74	45.69	-1.05 (-2%)
January	Dry	50.53	48.25	-2.28 (-5%)
January	Critical	55.34	49.81	-5.53 (-10%)
February	Wet	23.02	21.17	-1.85 (-8%)
February	Above Normal	35.54	35.53	-0.01 (0%)
February	Below Normal	38.54	38.11	-0.43 (-1%)
February	Dry	49.94	50.08	0.14 (0%)
February	Critical	52.52	53.27	0.75 (1%)
March	Wet	16.71	16.24	-0.47 (-3%)
March	Above Normal	29.72	28.46	-1.26 (-4%)
March	Below Normal	36.15	32.62	-3.53 (-10%)
March	Dry	46.77	44.21	-2.55 (-5%)
March	Critical	44.07	45.98	1.91 (4%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-18 c. Percentage of Surface-Oriented Particles Injected at Station 906 (San Joaquin River near Medford Island) That Were Entrained Over 45 Days into Barker Slough Pumping Plant

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.00	0.00	0.00 (0%)
January	Above Normal	0.00	0.00	0.00 (0%)
January	Below Normal	0.00	0.00	0.00 (0%)
January	Dry	0.00	0.00	0.00 (0%)
January	Critical	0.00	0.00	0.00 (0%)
February	Wet	0.00	0.00	0.00 (0%)
February	Above Normal	0.00	0.00	0.00 (0%)
February	Below Normal	0.00	0.00	0.00 (0%)
February	Dry	0.00	0.00	0.00 (0%)
February	Critical	0.00	0.00	0.00 (0%)
March	Wet	0.00	0.00	0.00 (0%)
March	Above Normal	0.00	0.00	0.00 (0%)
March	Below Normal	0.00	0.00	0.00 (0%)
March	Dry	0.00	0.00	0.00 (0%)
March	Critical	0.00	0.00	0.00 (0%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

Table E.3-18 d. Percentage of Surface-Oriented Particles Injected at Station 906 (San Joaquin River near Medford Island) That Passed Chipps Island.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	18.47	19.63	1.16 (6%)
January	Above Normal	3.87	3.85	-0.02 (-1%)
January	Below Normal	0.00	0.00	0.00 (0%)
January	Dry	0.00	0.00	0.00 (0%)
January	Critical	0.00	0.00	0.00 (0%)
February	Wet	26.10	28.71	2.61 (10%)
February	Above Normal	9.70	11.29	1.59 (16%)
February	Below Normal	3.27	3.54	0.27 (8%)
February	Dry	0.00	0.00	0.00 (0%)
February	Critical	0.00	0.00	0.00 (0%)
March	Wet	29.60	32.61	3.01 (10%)
March	Above Normal	8.65	8.90	0.25 (3%)
March	Below Normal	0.16	1.04	0.88 (536%)
March	Dry	0.00	0.00	0.00 (0%)
March	Critical	0.00	0.00	0.00 (0%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

E.3.1.5 CENTRAL VALLEY PROJECT RESULTS

Results of the PTM analysis for entrainment into the SWP's Clifton Court Forebay and Barker Slough Pumping Plant are presented in Section 4.4 of the DEIR. Tables E.3-19 and E.3-20 provides results for the CVP Jones Pumping Plant for consideration of cumulative impacts in the DEIR Section 4.6.

Table E.3-19. Percentage of Neutrally Buoyant Particles Entrained Over 45 Days into the Central Valley Project Jones Pumping Plant.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	0.54	0.51	-0.04 (-7%)
January	Above Normal	1.01	1.06	0.05 (4%)
January	Below Normal	1.64	1.68	0.04 (2%)
January	Dry	2.47	2.57	0.10 (4%)
January	Critical	2.80	2.76	-0.04 (-2%)
February	Wet	0.29	0.26	-0.03 (-11%)
February	Above Normal	0.64	0.62	-0.02 (-3%)
February	Below Normal	0.94	0.98	0.03 (4%)
February	Dry	1.63	1.70	0.08 (5%)
February	Critical	2.33	2.35	0.02 (1%)
March	Wet	0.23	0.16	-0.06 (-27%)
March	Above Normal	0.41	0.28	-0.13 (-32%)
March	Below Normal	0.77	0.53	-0.24 (-31%)
March	Dry	1.21	0.88	-0.33 (-27%)
March	Critical	1.23	1.37	0.14 (11%)

Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_20191030.dat

Table E.3-20. Percentage of Surface-Oriented Particles Entrained Over 45 Days into the Central Valley Project Jones Pumping Plant.

Month	Water Year Type	Existing	Proposed Project	Proposed Project vs. Existing
January	Wet	3.06	2.84	-0.21 (-7%)
January	Above Normal	6.18	6.08	-0.10 (-2%)
January	Below Normal	9.40	9.15	-0.25 (-3%)
January	Dry	12.40	12.34	-0.06 (0%)
January	Critical	13.84	12.81	-1.03 (-7%)
February	Wet	1.63	1.41	-0.22 (-14%)
February	Above Normal	4.05	3.76	-0.30 (-7%)
February	Below Normal	6.05	5.74	-0.30 (-5%)
February	Dry	9.85	9.55	-0.30 (-3%)
February	Critical	11.53	11.87	0.34 (3%)
March	Wet	1.37	1.37	0.00 (0%)
March	Above Normal	2.35	2.00	-0.35 (-15%)
March	Below Normal	5.08	4.59	-0.50 (-10%)
March	Dry	7.93	6.85	-1.08 (-14%)
March	Critical	8.05	8.35	0.30 (4%)

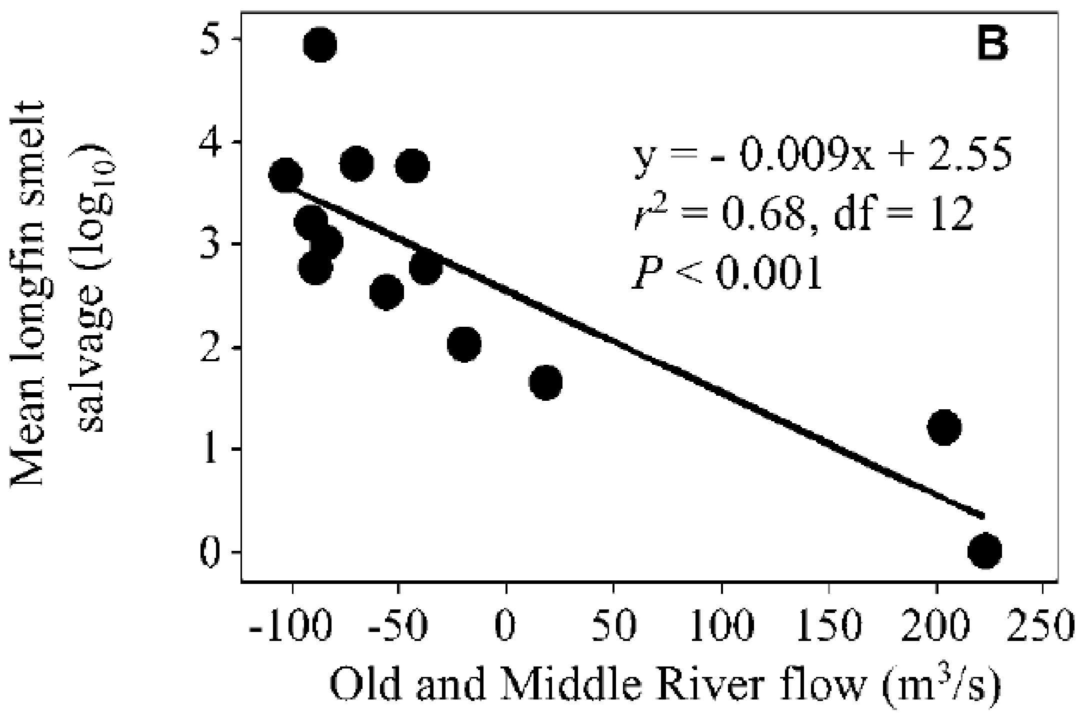
Source: ptm_fate_results_45day_Dec-Mar_qa_ITP_EX_BHV_20191030.dat; ptm_fate_results_45day_Dec-Mar_qa_ITP_PP_BHV_20191030.dat

E.3.2 SALVAGE-OLD AND MIDDLE RIVER FLOW ANALYSIS (BASED ON GRIMALDO ET AL. 2009)

Grimaldo et al. (2009: their Figure 7B) found a significant relationship between juvenile Longfin Smelt salvage in April and May as a function of mean April–May Old and Middle River flows. In order to assess potential differences in salvage between Existing and PP scenarios, the regression of Grimaldo et al. (2009) was recreated in order to be able to fully account for sources of error in the predictions; this allowed calculation of prediction intervals from CalSim-derived estimates of Old and Middle River flows for Existing and PP scenarios, as recommended by Simenstad et al. (2016).

Longfin Smelt salvage data for April and May 1993–2005 were obtained from the DFW salvage monitoring website[6]. Consistent with Grimaldo et al. (2009), a record of 616 Longfin Smelt salvaged on April 7, 1998, was assumed to be in error, and was converted to zero for the analysis. Old and Middle River flow data were provided by Smith (pers. comm.). Following Grimaldo et al. (2009), $\log_{10}$(total salvage) was regressed against mean April–May Old and Middle River flow (converted to cubic meters/second). The resulting regression equation was very similar to that obtained by Grimaldo et al. (2009; Figure E.3-4):

Log_{10}(April–May total Longfin Smelt salvage) = 2.5454 (± 0.2072 SE) – 0.0100 (± 0.0020 SE)*(Mean April–May Old and Middle River flow); $r^2 = 0.70$, 12 degrees of freedom.



Source: Grimaldo et al. (2009)

Figure E.3-4. Regression of April–May Longfin Smelt Salvage as a Function of Old and Middle River Flow

[6] http://www.dfg.ca.gov/delta/apps/salvage/SalvageExportChart.aspx?Species=1&SampleDate=1%2f22%2f2016&Facility=1, accessed January 1, 2016, and August 17, 2016 (salvage for Longfin Smelt at both facilities was selected).

For the comparison of Existing and PP scenarios, CalSim data outputs were used to calculate mean April–May Old and Middle River flows for each year of the 1922–2003 simulation. The salvage-Old and Middle River flow regression calculated as above was used to estimate salvage for the Existing and PP scenarios. The log-transformed salvage estimates were back-transformed to a linear scale for comparison of Existing and PP. In order to illustrate the variability in predictions from the salvage-Old and Middle River flow regression, annual estimates were made for the mean and upper and lower 95% prediction limits of the salvage estimates, as recommended by Simenstad et al. (2016). Means and predictions limits giving negative estimates of salvage were converted to zero before statistical summary. Statistical analyses were conducted with PROC GLM and PROC PLM in SAS/STAT software, Version 9.4 of the SAS System for Windows.[7]

E.3.3 Delta Outflow-Abundance Analysis (Based on Nobriga and Rosenfield 2016)

This analysis used the Nobriga and Rosenfield (2016) Longfin Smelt population dynamics model to assess potential effects of the PP as a function of changes in winter/spring outflow.

E.3.3.1 Reproduction of Nobriga and Rosenfield (2016) Model

This analysis reproduced the methods described in Nobriga and Rosenfield (2016) for calculation of the two-life-stage model referred to as the "2abc" model, which includes the embedded hypotheses that understanding the trend in age-0 LFS relative abundance requires explicit modeling of spawning and recruit relative abundance; that the production of age-0 fish is density dependent; and that juvenile survival from age 0 to age 2 has changed over time. For purposes of this effects analysis, the "2abc" model was selected because its median predictions visually fit recent years of empirical data better than the other model evaluated (Figure E.3-5).

Model input data used to reproduce the "2abc" model were as provided in Table 2 of Nobriga and Rosenfield (2016). The input data are provided in Appendix A of Greenwood and Phillis (2018). The analyses were run in R software (R Core Team 2016).

Graphical comparison of the reproduction of the "2abc" model to the original Nobriga and Rosenfield (2016) "2abc" model (Figure E.3-5) suggests that the reproduced model was a reasonable approximation of the original model (i.e., the reproduction of the method was reasonably successful). It should be noted that the original "2abc" model 95% confidence intervals are wider than the reproduction utilized in this analysis. However, the model coefficients and standard errors are identical between the original and reproduced models. Therefore, the reproduced "2abc" model utilized in this analysis is considered appropriate, and the differences in 95% confidence intervals among the original and reproduced models do not affect the comparison of the scenarios discussed below.

[7] Copyright 2002–2010, SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA

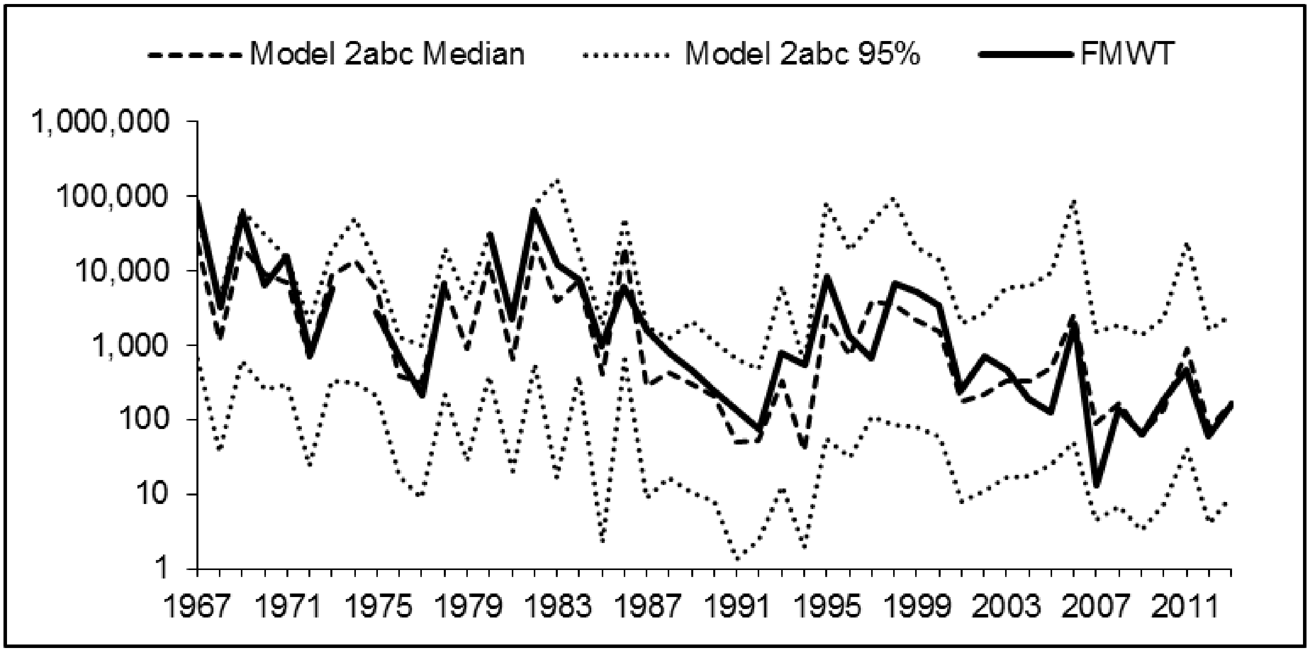


Figure E.3-5 a. Reproduction of Nobriga and Rosenfield (2016) 2abc Model Predictions Compared to Historical Fall Midwater Trawl Survey Longfin Smelt Abundance Index.

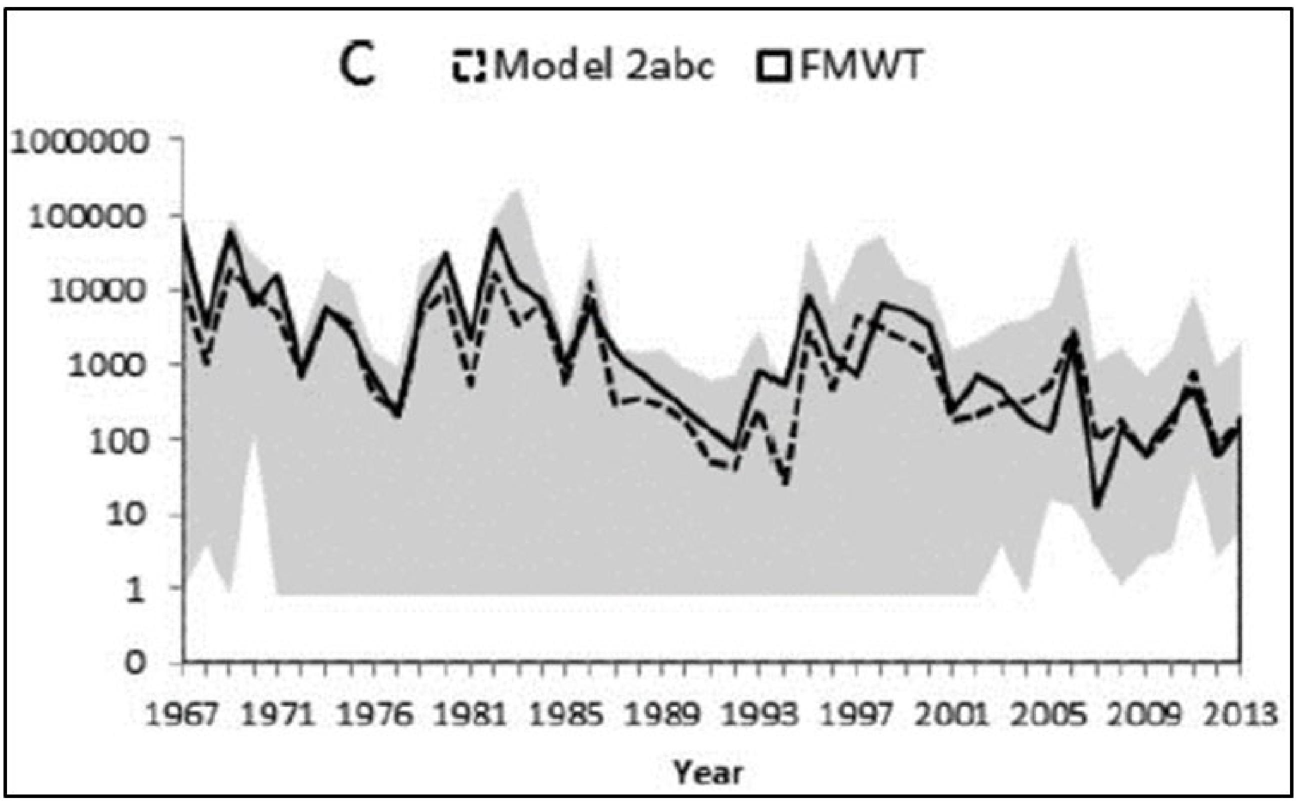


Figure E.3-5 b. Original (Figure 6c of Nobriga and Rosenfield 2016) 2abc Model Predictions Compared to Historical Fall Midwater Trawl Survey Longfin Smelt Abundance Index. Grey shading indicates 95% interval.

E.3.3.2 CALCULATION OF DELTA OUTFLOW MODEL INPUTS FOR SCENARIO COMPARISON

To obtain the required first principal component (PC1) model inputs for comparison of the PP and Existing scenarios, it was first necessary to reproduce the principal components analysis (PCA). Following Nobriga and Rosenfield (2016), historical daily Delta outflow data were acquired from the DAYFLOW database[8]. Flow data were averaged for December to May by month and year and the Principal Component Analysis was conducted using the 'PCA' function in the R package FactoMineR (Le et al. 2008) on water years 1956-2013. The resulting PC1 outputs were very similar to the original values computed by Nobriga and Rosenfield (2016), suggesting that the reported method had been successfully reproduced[9]. The 'predict PCA' function was then used to predict PC1 values for the PP and Existing scenarios for water years 1956-2017 on the same projection as the PCA. The resulting PC1 values were used as the input for the model simulation of the flow scenarios described in the next section.

E.3.3.3 MODEL SIMULATION TO COMPARE SCENARIOS

Model simulation to compare the Existing Conditions, Proposed Project, Alternative 2a, Alternative 2b, and Alternative 3 scenarios used the PC1 flow inputs. To produce a simulation for the 1922-2003 time series, and consistent with Nobriga and Rosenfield (2016), the model was initiated with 2 years (i.e., years 1922 and 1923) of Fall Mid-water Trawl (FMWT) indices equal to 798, which represents the median observed FMWT index from 1967 to 2013. The simulation was conducted for two juvenile survival functions:

- 'good', which used the pre-1991 relatively high survival for simulation over the full 1922-2003 time series;
- 'poor', which used the post-1991 relatively low survival for simulation over the full 1922-2003 simulation time series.

Following Nobriga and Rosenfield (2016), 1,000 stochastic simulations were conducted in which random draws were made based on the mean and standard error of the model parameters. Consistent with Nobriga and Rosenfield (2016), the variability among the estimates was examined using the 95% intervals. Violin plots were used to illustrate the distribution of simulated FMWT indices.

E.4 SALMONIDS

E.4.1 SALVAGE-DENSITY METHOD

The basic procedure used for the salvage-density method was an update of previous methods, such as that used in the California WaterFix ITP Application. The updated method reflected more recently available data and was as follows:

[8] https://www.water.ca.gov/Programs/Environmental-Services/Compliance-Monitoring-And-Assessment/Dayflow-Data

[9] The small differences may have arisen because of varying PCA algorithms in different statistical software packages, for example.

- All data were downloaded from https://apps.wildlife.ca.gov/Salvage[10];
- Water years 1994–2018 were included as these water years were complete and the water year type was known (http://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST);
- Fish with clipped and unclipped adipose fins were included, as together they represent hatchery-origin and wild fish that are all part of the Evolutionary Significant Unit (ESU);
- Daily loss density (fish per thousand acre feet (taf) of water exported) was calculated for the SWP south Delta export facility (Clifton Court Forebay, Skinner fish facility, and Banks pumping plant)[11], month, and water year type;

The daily loss density values for each month, facility, and water year type were multiplied by the CalSim-modeled exports for the Existing and PP scenarios to give estimates of fish loss.

Results of the loss density analysis for entrainment into the SWP's south Delta export facility are presented in Section 4.4 of the DEIR. Tables E.4-1 and E.4-2 provide results for the CVP south Delta export facility for consideration of cumulative impacts in the DEIR Section 4.6.

[10] This website includes salvage density for all species, and loss density for salmonids; the latter was used in this analysis.

[11] Loss density was also calculated for the CVP Jones Pumping Plant in consideration of cumulative effects.

Table E.4-1. Estimates of Winter-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Table E.4-1 a – f

Table E.4-1 a. Estimates of Winter-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Wet.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	232	97	187	31	1	0	0	0	0	0	0	57
Proposed Project	220	88	179	68	2	0	0	0	0	0	0	56

Table E.4-1 b. Estimates of Winter-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Above Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	659	184	212	19	9	2	0	0	0	0	0	137
Proposed Project	663	183	198	55	30	2	0	0	0	0	0	136

Table E.4-1 c. Estimates of Winter-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Below Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	273	255	288	14	0	0	0	0	0	0	0	14
Proposed Project	271	254	238	35	0	0	0	0	0	0	0	14

Table E.4-1 d. Estimates of Winter-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Dry

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	238	331	497	25	0	0	0	0	0	0	0	41
Proposed Project	235	337	416	45	0	0	0	0	0	0	0	40

Table E.4-1 e. Estimates of Winter-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Critical

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	294	529	403	37	0	0	0	0	0	0	0	26
Proposed Project	271	521	411	48	0	0	0	0	0	0	0	26

Table E.4-1 f. Estimates of Winter-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Totals

Totals per Scenario	Wet	Above Normal	Below Normal	Dry	Critical
Existing	604	1,222	845	1,132	1,289
Proposed Project	613	1,266	811	1,073	1,278
Proposed Project vs. Existing	10 (2%)	44 (4%)	-34 (-4%)	-58 (-5%)	-11 (-1%)

Table E.4-2. Estimates of Spring-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Table E.4-2 a – f

Table E.4-2 g. Estimates of Spring-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Wet.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	1	15	2,242	5,412	4,268	803	0	0	0	0	0	1
Proposed Project	1	14	2,147	11,924	9,748	792	0	0	0	0	0	1

Table E.4-2 h. Estimates of Spring-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Above Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	7	19	2,256	3,713	916	17	0	0	0	0	0	0
Proposed Project	7	18	2,108	10,632	3,039	17	0	0	0	0	0	0

Table E.4-2 i. Estimates of Spring-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Below Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	1	5	663	761	379	9	0	0	0	0	0	0
Proposed Project	1	5	548	1,877	1,214	8	0	0	0	0	0	0

Table E.4-2 j. Estimates of Spring-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Dry

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	4	3	418	1,762	234	6	0	0	0	0	0	0
Proposed Project	4	3	350	3,164	510	6	0	0	0	0	0	0

Table E.4-2 k. Estimates of Spring-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Critical

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	0	2	123	770	406	2	0	0	0	0	0	0
Proposed Project	0	2	126	984	490	2	0	0	0	0	0	0

Table E.4-2 l. Estimates of Spring-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Totals

Totals per Scenario	Wet	Above Normal	Below Normal	Dry	Critical
Existing	12,742	6,928	1,818	2,427	1,303
Proposed Project	24,626	15,822	3,654	4,036	1,604
Proposed Project vs. Existing	11,884 (93%)	8,894 (128%)	1,836 (101%)	1,609 (66%)	300 (23%)

Table E.4-3. Estimates of Fall-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Table E.4-3 a – f

Table E.4-3 m. Estimates of Fall-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Wet.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	4,914	8,489	1,030	1,736	7,256	9,000	161	4	2	18	19	82
Proposed Project	4,667	7,713	986	3,824	16,571	8,875	158	4	2	19	20	81

Table E.4-3 n. Estimates of Fall-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Above Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	176	6,119	1,617	1,253	3,273	1,296	14	0	44	28	40	0
Proposed Project	177	6,072	1,511	3,589	10,864	1,266	15	0	43	29	42	0

Table E.4-3 o. Estimates of Fall-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Below Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	9	58	1,515	385	824	201	2	0	0	1	1	0
Proposed Project	9	57	1,252	948	2,639	196	2	0	0	1	2	0

Table E.4-3 p. Estimates of Fall-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Dry

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	31	27	519	2,084	1,149	383	1	2	0	4	1	14
Proposed Project	31	28	435	3,741	2,503	371	1	2	0	4	1	14

Table E.4-3 q. Estimates of Fall-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Critical

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	8	18	12	225	907	56	0	0	0	0	43	42
Proposed Project	7	18	12	287	1,094	52	0	0	0	0	49	43

Table E.4-3 r. Estimates of Fall-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Totals

Totals per Scenario	Wet	Above Normal	Below Normal	Dry	Critical
Existing	32,711	13,862	2,996	4,217	1,311
Proposed Project	42,919	23,609	5,106	7,131	1,563
Proposed Project vs. Existing	10,208 (31%)	9,747 (70%)	2,110 (70%)	2,914 (69%)	252 (19%)

Table E.4-4. Estimates of Late Fall-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Table E.4-4 a – f

Table E.4-4 s. Estimates of Late Fall-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Wet.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	182	2	0	0	0	1	0	0	0	0	6	263
Proposed Project	173	2	0	1	0	1	0	0	0	0	6	260

Table E.4-4 t. Estimates of Late Fall-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Above Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	104	0	0	0	0	16	0	0	0	2	13	116
Proposed Project	104	0	0	0	0	16	0	0	0	2	14	115

Table E.4-4 u. Estimates of Late Fall-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Below Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	96	9	1	0	0	0	0	0	0	0	0	15
Proposed Project	95	9	1	1	0	0	0	0	0	0	0	14

Table E.4-4 v. Estimates of Late Fall-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Dry

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	9	0	0	0	0	0	0	0	0	0	5	65
Proposed Project	9	0	0	0	0	0	0	0	0	0	5	65

Table E.4-4 w. Estimates of Late Fall-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Critical

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	68	9	2	0	0	0	0	0	0	0	1	76
Proposed Project	63	9	2	0	0	0	0	0	0	0	1	78

Table E.4-4 x. Estimates of Late Fall-run Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Totals

Totals per Scenario	Wet	Above Normal	Below Normal	Dry	Critical
Existing	454	251	121	79	157
Proposed Project	443	251	120	78	153
Proposed Project vs. Existing	-12 (-3%)	0 (0%)	-2 (-1%)	-1 (-1%)	-3 (-2%)

Table E.4-5. Estimates of Steelhead Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Table E.4-5 a – f

Table E.4-5 y. Estimates of Steelhead Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Wet.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	129	210	271	76	35	53	4	0	0	0	1	5
Proposed Project	123	191	259	167	80	52	4	0	0	0	1	5

Table E.4-5 z. Estimates of Steelhead Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Above Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	1,109	797	413	63	40	8	2	0	0	0	7	31
Proposed Project	1,117	791	386	181	134	8	2	0	0	0	7	31

Table E.4-5 aa. Estimates of Steelhead Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Below Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	56	960	386	47	29	9	0	0	0	0	0	1
Proposed Project	56	955	319	116	93	9	0	0	0	0	0	1

Table E.4-5 bb. Estimates of Steelhead Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Dry

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	60	571	790	125	21	17	0	0	0	0	1	5
Proposed Project	59	581	662	224	46	16	0	0	0	0	1	5

Table E.4-5 cc. Estimates of Steelhead Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Critical

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	76	396	135	31	8	6	0	0	0	0	0	0
Proposed Project	70	391	138	39	10	5	0	0	0	0	0	0

Table E.4-5 dd. Estimates of Steelhead Chinook Salmon Juvenile Loss (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Condition and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Totals

Totals per Scenario	Wet	Above Normal	Below Normal	Dry	Critical
Existing	785	2,472	1,489	1,590	652
Proposed Project	883	2,658	1,549	1,595	653
Proposed Project vs. Existing	98 (13%)	186 (8%)	61 (4%)	5 (0%)	1 (0%)

E.4.2 Salvage Analysis (Based on Zeug and Cavallo 2014)

An analysis to evaluate differences in entrainment (salvage) at the south Delta export facilities between the existing condition (EXG) and the PP was done following the statistical models of salvage of marked (coded wire tags) hatchery-reared Chinook salmon published by Zeug and Cavallo (2014). This analysis focused on winter-run Chinook salmon; spring-run Chinook salmon were not included because very few marked individuals were salvaged and the statistical models could not be fit successfully (Zeug and Cavallo 2014). Several modifications to the methods of Zeug and Cavallo (2014) were employed to focus on relevant model predictors. First, statistical models of the empirical data were constructed using only releases of winter-run Chinook salmon raised at the Livingston Stone Hatchery. Second, salvage at the SWP south Delta export facilities and SWP-specific exports were modeled in addition to combined values from both the SWP and CVP facilities. This was done to focus on effects of the SWP to the greatest extent possible and provide context with total salvage. Some variables were excluded from the statistical models because they were not significant in the original analysis or they were not relevant in this context. For example, the original analysis used the variable "distance of release from the facilities". However, winter-run Chinook salmon were only released from a single location, making this predictor irrelevant. Finally, to determine which hydrologic variables were the best predictors of salvage, a model selection exercise was performed using the original data from Zeug and Cavallo (2014). The model selection exercise included five potential hydrologic predictor variables including; Old and Middle River flows (OMR), inflow-export ratio (I-E), total south Delta exports, San Joaquin River flow, Sacramento River flow and one biological variable (mean fork length at release). Most of these variables were strongly correlated so models were constructed only with variables that had correlation coefficients $<|0.70|$. One million individuals were used as the total release size (offset variable) for each candidate model with standardized predictors for both the count and zero-inflation portion of the models. To select the best approximating model, Akaike's Information Criterion (AIC) was calculated for each model. The model with the lowest AIC value was identified as the best approximating model. The AIC value of all other models was subtracted from the value of the best approximating model to calculate the ΔAIC. Any model that had a ΔAIC value ≤ 2.0 was considered a competing model with the best approximating model.

A single best model of salvage was selected with no other model having a ΔAIC <2.8. This model had three predictor variables for the count model and zero inflation models including mean fork length of fish at release, Sacramento River flow, and total exports. The final count model indicated that non-zero salvage was greater when fish were released at a larger size, flow in the Sacramento River was higher, and exports were higher. For the zero inflation model, coefficients indicated zero salvage was more likely when fish were released at a smaller size, Sacramento River flow was higher, and exports were lower.

To predict salvage under the existing condition and the Proposed Project scenarios, daily flow and export data from DSM2 output was aggregated into 7-day running means and standardized to the same scale as the empirical data. This was done to mimic the way data were aggregated in the original publication (7-day means) and the winter-run specific models described above. A 7-day mean was used because an acoustic tagging study revealed that was the approximate mean time Chinook salmon smolts spent transiting through the Delta (Zeug and Cavallo 2014). The total number of fish entering the Delta in a season was then multiplied by the daily entry proportion defined by the same distribution used in the Delta Passage Model. The log-transformed product of this calculation was used as the offset on each day. The distribution did not weight the result but simply distributed the fish over time.

The values described above (DSM2 data, offset, fish fork length) are used as inputs in the ZINB model to predict the mean salvage for each day. The size of fish entering the delta was set as the midpoint size on the 15th of each month using the Delta length-at-date model. After January, the midpoint value was higher than the observed sizes at release and the model was set to the maximum observed fork length from February–June (95 mm). However, it should be noted that the statistical model uses size at release in the Sacramento River near Redding, CA, and fish are assumed to grow between release and the salvage facilities. The mean daily salvage values were then summarized by month and reported as the proportion of total annual salvage observed in each month. Additionally, the annual predicted value of salvage in each of the 82 water years was plotted for the Existing and PP scenarios.

Results of the analysis for salvage at the SWP are presented in Section 4.4 of the DEIR. For consideration of cumulative impacts in the DEIR Section 4.6, calculations were also made for combined salvage at the SWP + CVP south Delta facilities. Across the 82-year DSM2 simulation period, salvage of juvenile Winter Run Chinook Salmon was predicted to be less than 0.04% of the total juvenile population for both facilities combined. Predicted salvage at both facilities combined was slightly lower for the PP (0.353%) relative to Existing (0.380%) over the entire modeling period. Despite the trend of lower salvage under the PP across all years, there was variation in which scenario produced lower salvage in individual years (Figure E.4-1).

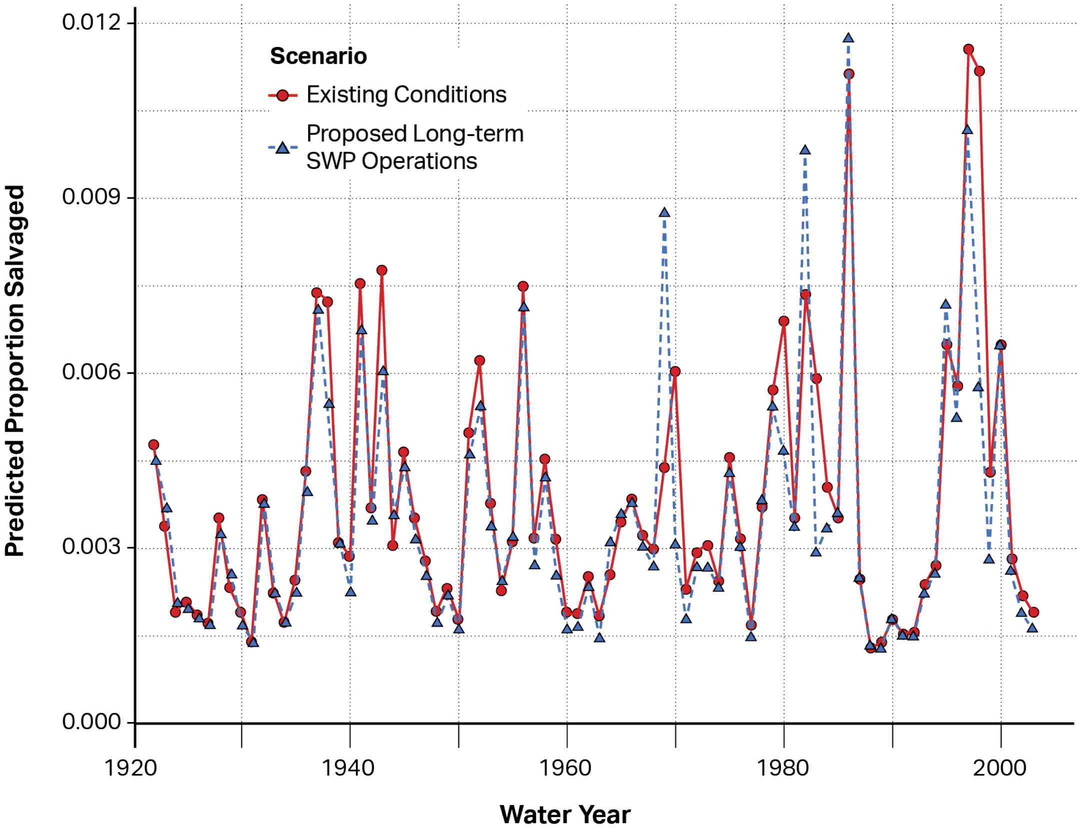
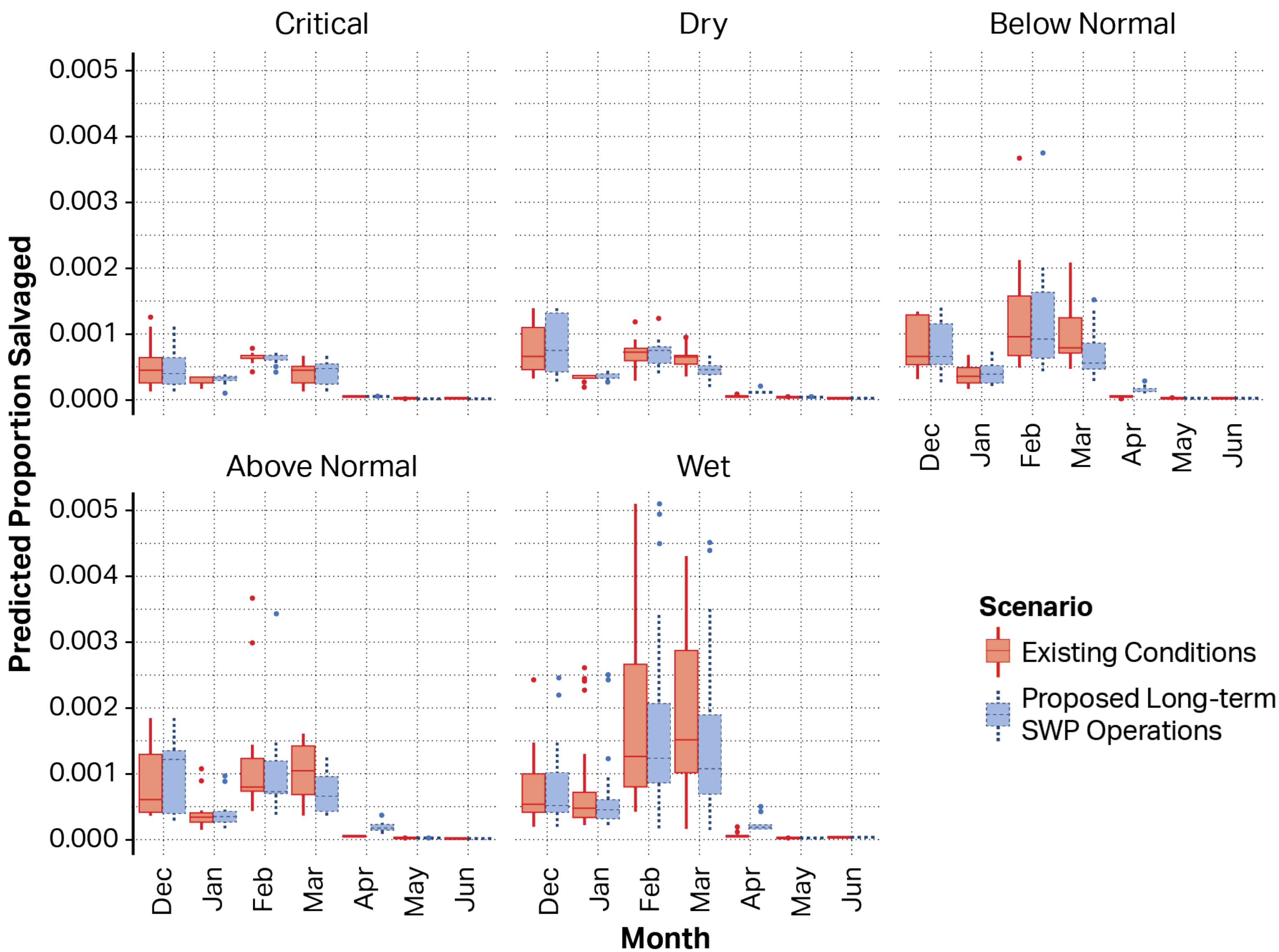


Figure E.4-1. Predicted proportion of Juvenile Winter-Run Chinook Salmon salvage at the Skinner Delta Fish Protective Facility of the State Water Project under the Existing and Proposed Project scenarios across the 82-year DSM2 simulation period.

The highest median salvage for the combined facilities occurred in wet water years; however, salvage did not exceed 0.625% in any month (Figure E.4-2). Within wet water years, the interquartile range of salvage at the combined facilities for both scenarios overlapped considerably in all months except February and March, which were the months with the highest salvage. In February, 75th percentile values of combined salvage were greater under Existing than PP and in March, 25th, median, and 75th percentile values of salvage were greater under Existing (Figure E.4-2). In above normal years salvage at the combined facilities was greatest in December for both scenarios though values were below 0.2% of all juveniles and interquartile ranges were similar between the two scenarios. In March, all interquartile values were greater for the existing condition (Figure E.4-2). The interquartile range of combined salvage was higher for the PP in April but the total value of salvage in this month was low. In below normal years salvage at the combined facilities was similar between scenarios in all months except March when interquartile values for Existing were greater than PP (Figure E.4-2). In dry years salvage was greatest in December and median and 75th percentile values were greater for the PP in that month. In March of dry years, predicted combined salvage was lower under PP than Existing. In all other months of dry years salvage was low and similar between scenarios. The lowest salvage at the combined facilities for both scenarios occurred in critical water years (Figure E.4-2).



Note: The horizontal line is the median value, the box defines the interquartile range and vertical lines define the minimum and maximum values. Single points are outliers.

Figure E.4-2. Box and whisker plots of predicted proportion of juvenile Winter-Run Chinook Salmon salvaged at the Skinner Delta Fish Protective Facility of the State Water Project and the Tracy Fish Facility of the Central Valley Project as a function of SWP exports and Sacramento River flow for Existing and PP scenarios.

E.4.3 Delta Hydrodynamic Assessment and Junction Routing Analysis

E.4.3.1 Velocity Assessment

Hydrodynamic changes associated with river inflows and South Delta exports have been suggested to adversely affect juvenile Chinook Salmon in two distinct ways: 1) “near-field” mortality associated with entrainment to the export facilities, and 2) “far-field” mortality resulting from altered hydrodynamics. Near-field or entrainment effects of proposed seasonal operations can be assessed by examining patterns of proportional population entrainment available from decades of coded wire tag studies (e.g., Zeug and Cavallo 2014). A foundation for assessing far-field effects has been provided by work of the Collaborative Adaptive Management Team’s (CAMT) Salmonid Scoping Team (SST). The SST completed a thorough review of this subject and defined a driver-linkage-outcome (DLO) framework for specifying how water project operations (the “driver”) can influence juvenile salmonid behavior (the “linkage”) and potentially cause changes in survival or routing (the “outcome”). The SST concluded altered “Channel Velocity” and altered “Flow Direction” were the only two hydrodynamic mechanisms by which exports and river inflows could affect juvenile salmonids in the Delta. Figure E.4-3 provides a simplified conceptual model of the DLO defined by the CAMT SST.

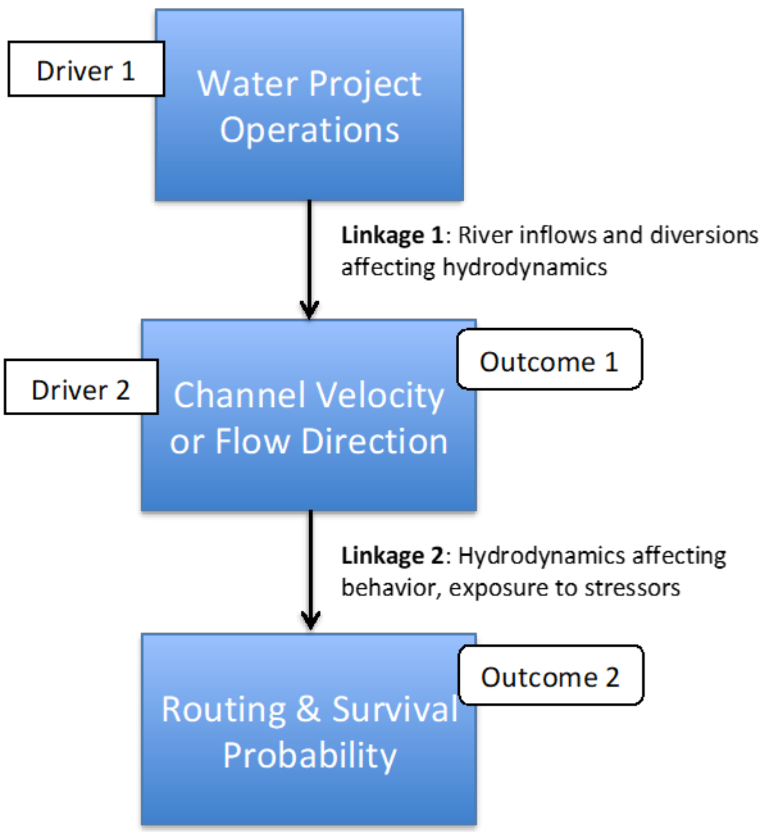


Figure E.4-3. Conceptual Model for Far-field Effects of Water Project Operations on Juvenile Salmonids in the Delta. This CM is a Simplified Version of the Information Provided by the CAMT SST

In order to assess the potential for water project operations to influence survival and routing, Delta hydrodynamic conditions were analyzed by creating maps from DSM2 Hydro modeling. The maps are based on a comparative metric, proportion overlap (more below), to capture channel-level hydrodynamic details as a single number for color-scale mapping of Delta channels.

The objective of the comparative metric is to summarize the water velocity time series for each channel and scenario such the channel-level comparison is captured in a single number. For the proportion overlap metric, kernel density estimates are calculated on each time series. The kernel density estimates represent a non-parametric smoothing of the empirical distribution of time series values. The proportion overlap of two kernel density estimates is calculated with the following steps: 1) calculate the total area under the curve (AUC_t) as the sum of the AUC for each density estimate, 2) calculate the AUC of the overlapping portions (AUC_o) of the two density distributions being compared, and 3) calculate the overlapping proportion of the density distributions as AUC_o/AUC_t. Proportion overlap is naturally bound by zero and one; a value of zero indicates no overlap and a value of one indicates complete overlap. Lower values of proportion overlap identify channels demonstrating larger differences in a scenario comparison.

The proportion overlap metric is best applied over relatively short time periods because seasonal and annual variation in water velocity can overwhelm differences between scenarios. Thus, the proportion overlap for every DSM2 channel for two seasons (December-February, March-May) in each water year (1922-2003) was calculated. DSM2 output was excluded from water year 1921 to allow for an extensive burn-in period. The proportion overlap was calculated based on hourly DSM2 output. Because each season was roughly 90 days, each comparison involved roughly 4,300 DSM2 values (2 scenarios * 24 hours * 90 days) for each channel.

Because the proportion overlap was calculated for each channel in each water year, the proportion overlap values were summarized prior to mapping (i.e., not feasible to map proportion overlap for every comparison in every water year). To summarize, the minimum and median proportion overlap for each channel for each water year type for each comparison was found. The minimum values represent the maximum expected effect. The median values represent the average expected effect. Note that the year with the minimum (or median) proportion overlap for one channel might not be the same year as for another channel.

E.4.3.2 Routing Analysis

Many routes can potentially be used by fish migrating through the Delta and survival through these routes can be significantly different (Newman 2008; Perry et al. 2010). Thus, routing of fish at junctions and how routing could be affected by project operations has the potential to influence through-Delta survival. In general, routes that keep fish in the mainstem Sacramento and San Joaquin Rivers are superior to routes leading into the interior Delta (Hankin et al. 2010; Perry et al. 2010), although some recent findings for the San Joaquin River have not supported this generality (Buchanan et al. 2013). Perry (2010) found that the routing of fish into the interior delta through the combined junction of Georgiana Slough and the Delta Cross Channel was a function of the total flow entering the interior delta through both of those junctions. This is the function represented in Figure 6.7 within Perry (2010). This function indicated that the slope of the relationship was less than 1.

Cavallo et al. (2015) performed a meta-analysis of routing at 6 Delta junctions and found that the proportion of flow entering a junction explained 70% of the variation in routing. Similar to the Perry (2010) study, the slope of this relationship was less than 1 suggesting fish move into junctions at a rate less than the proportion of flow. Both of these studies present strong evidence that routing at junctions is a function of the proportion of flow into that junction.

For the present analysis of the PP, flow routing into junctions was based on the proportion of flow entering a junction away from the main stem, from DSM2-HYDRO outputs. Fifteen-minute data were used to calculate the daily proportion of flow that enters the junction, following the methods of Cavallo et al. (2015). Similar to the analysis of velocity described previously, the daily value calculated from the 15-minute data was used to calculate summary statistics (box plots) for each month (December–June) and water year-type. If the median entrainment values under EXG and PP differed by ≥ 5% for any month, greater detail in the description of results was provided, based on a comparison of minimum values, maximum values, 25th quantile, 75th quantile, and median values.

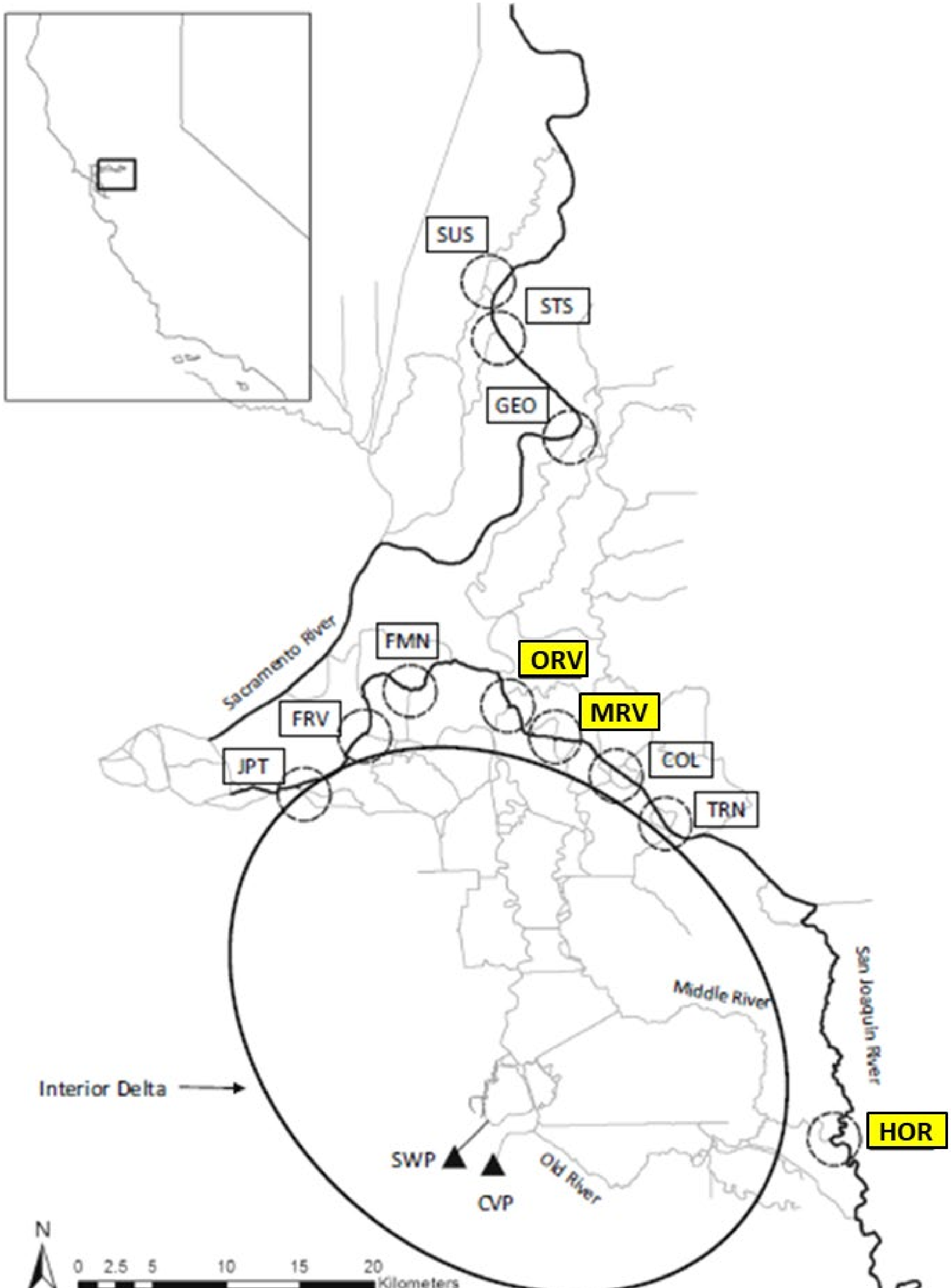
Flow into three junctions of interest with respect to movement towards the south Delta were included in this analysis: the head of Old River (HOR), the mouth of Old River (ORV), and the mouth of Middle River (MRV) (Figure E.4-4).

The combined evidence from the literature strongly indicates routing is a function of flow. Thus, it can be assumed routing of fish toward the interior delta will increase as the proportion of flow entering the junction increases. However, the slope of the relationship will be less than 1.

E.4.4 Delta Passage Model

E.4.4.1 Introduction

The DPM simulates migration of Chinook salmon smolts entering the Delta from the Sacramento River basin and estimates survival to Chipps Island. The DPM uses available time-series data and values taken from empirical studies or other sources to parameterize model relationships and inform uncertainty, thereby using the greatest amount of data available to dynamically simulate responses of smolt survival to changes in water management. Although the DPM is based primarily on studies of winter-run Chinook salmon smolt surrogates (late fall–run Chinook salmon), it is applied here for winter-run, spring-run, fall-run, and late fall–run Chinook salmon by adjusting emigration timing and assuming that all migrating Chinook salmon smolts will respond similarly to Delta conditions. The DPM results presented here reflect the current version of the model, which continues to be reviewed and refined, and for which a sensitivity analysis has been completed to examine various aspects of uncertainty related to the model's inputs and parameters.



Source: Adapted from Cavallo et al. (2015). Note: Only highlighted junctions were examined in this analysis, i.e., ORV (mouth of Old River), MRV (mouth of Middle River), and HOR (head of Old River).

Figure E.4-4. Highlighted Junctions Examined in the Routing Analysis

Although studies have shown considerable variation in emigrant size, with Central Valley Chinook salmon migrating as fry, parr, or smolts (Brandes and McLain 2001; Williams 2001), the DPM relies predominantly on data from acoustic-tagging studies of large (>140 mm) smolts, and therefore should be applied very cautiously to pre-smolt migrants. Salmon juveniles less than 70 mm are more likely to exhibit rearing behavior in the Delta (Moyle 2002) and thus likely will be represented poorly by the DPM. It has been assumed that the downstream emigration of fry, when spawning grounds are well upstream, is probably a dispersal mechanism that helps distribute fry among suitable rearing habitats. However, even when rearing habitat does not appear to be a limiting factor, downstream movement of fry still may be observed, suggesting that fry emigration is a viable alternative life-history strategy (Healy 1980; Healey and Jordan 1982; Miller et al. 2010). Unfortunately, survival data are lacking for small (fry-sized) juvenile emigrants because of the difficulty of tagging such small individuals. Therefore, the DPM should be viewed as a smolt survival model only, with its survival relationships generally having been derived from larger smolts (>140 mm), with the fate of pre-smolt emigrants not incorporated into model results.

The DPM has undergone substantial revisions based on comments received through the Bay Delta Conservation Plan preliminary proposal anadromous team meetings and in particular through feedback received during a workshop held on August 24, 2010, a 2-day workshop held June 23–24, 2011, and since then from various meetings of a workgroup consisting of agency biologists and consultants during preparation of the California WaterFix Biological Assessment. This effects analysis uses the most recent version of the DPM as of September 2015, with updates as noted below. The DPM is viewed as a simulation framework that can be changed as more data or new hypotheses regarding smolt migration and survival become available. The results are based on these revisions.

Survival estimates generated by the DPM are not intended to predict future outcomes. Instead, the DPM provides a simulation tool that compares the effects of different water management options on smolt migration survival, with accompanying estimates of uncertainty. The DPM was used to evaluate overall through-Delta survival for the COS, PA and WOA scenarios. Note that the DPM is a tool to compare different scenarios and is not intended to predict actual through-Delta survival under current or future conditions. In keeping with other methods found in the effects analysis, it is possible that underlying relationships (e.g., flow-survival) that are used to inform the DPM will change in the future; there is an assumption of stationarity of these basic relationships to allow scenarios to be compared for the current analysis, recognizing that it may be necessary to re-examine the relationships as new information becomes available.

E.4.4.2 Model Overview

The DPM is based on a detailed accounting of migratory pathways and reach-specific mortality as Chinook salmon smolts travel through a simplified network of reaches and junctions. The biological functionality of the DPM is based on the foundation provided by Perry et al. (2010) as well as other acoustic tagging–based studies (San Joaquin River Group Authority 2008, 2010; Holbrook et al. 2009) and coded wire tag (CWT)–based studies (Newman and Brandes 2010; Newman 2008). Uncertainty is explicitly modeled in the DPM by incorporating environmental stochasticity and estimation error whenever available.

The major model functions in the DPM are as follows.

1. Delta Entry Timing, which models the temporal distribution of smolts entering the Delta for each race of Chinook salmon.
2. Fish Behavior at Junctions, which models fish movement as they approach river junctions.
3. Migration Speed, which models reach-specific smolt migration speed and travel time.
4. Route-Specific Survival, which models route-specific survival response to non-flow factors.
5. Flow-Dependent Survival, which models reach-specific survival response to flow.
6. Export-Dependent Survival, which models survival response to water export levels in the Interior Delta reach (see Table E.4-6 for reach description).

Functional relationships are described in detail in the Section discussing *Model Functions*.

Model Time Step

The DPM operates on a daily time step using simulated daily average flows and Delta exports as model inputs. The DPM does not attempt to represent sub-daily flows or diel salmon smolt behavior in response to the interaction of tides, flows, and specific channel features. The DPM is intended to represent the net outcome of migration and mortality occurring over days, not three dimensional movements occurring over minutes or hours (e.g., Blake and Horn 2003). It is acknowledged that finer scale modeling with a shorter time step may match the biological processes governing fish movement better than a daily time step (e.g., because of diel activity patterns; Plumb et al. 2015) and that sub-daily differences in flow proportions into junctions make daily estimates somewhat coarse (Cavallo et al. 2015).

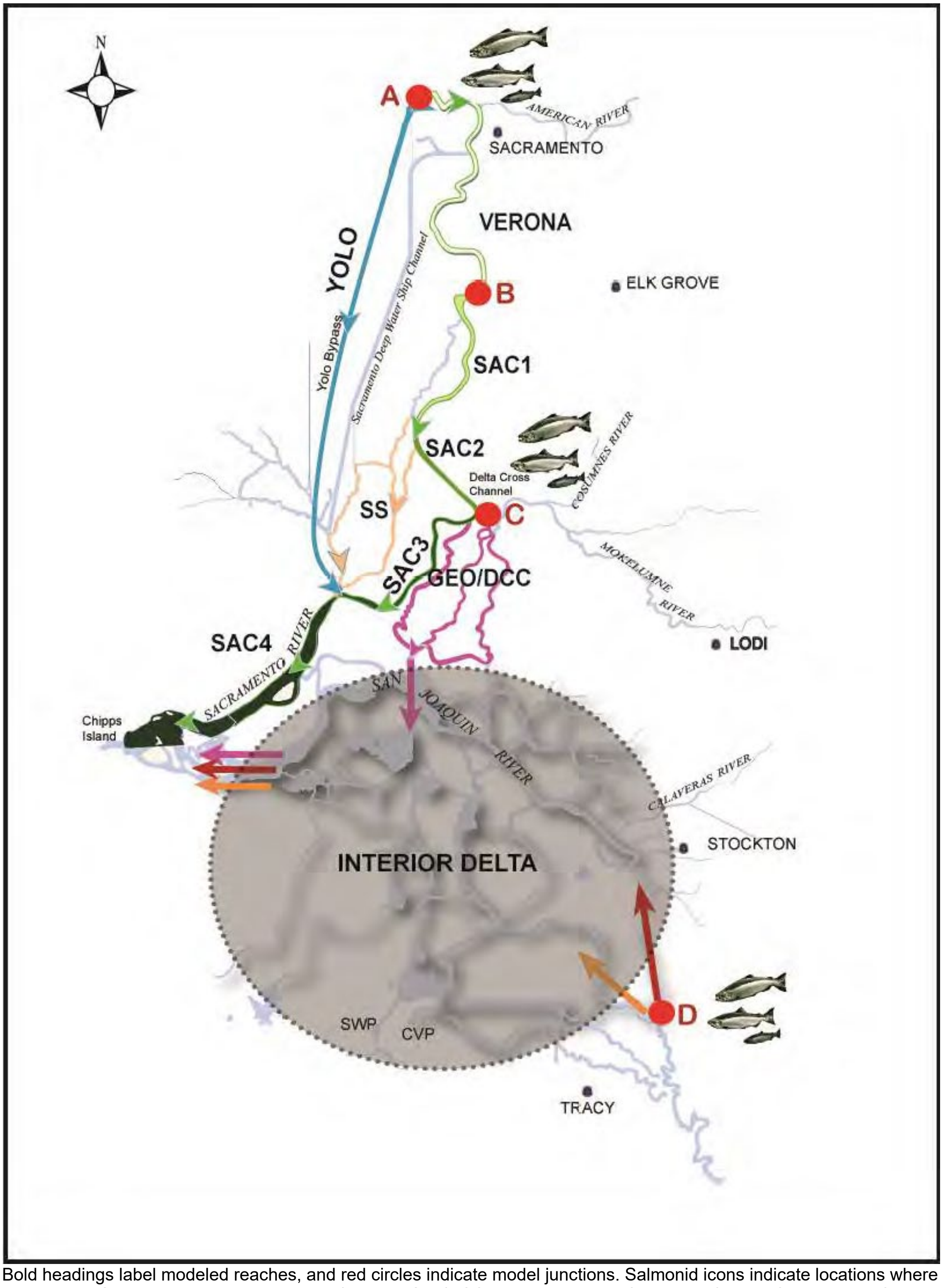
Spatial Framework

The DPM is composed of nine reaches and four junctions (Figure E.4-5; Table E.4-6) selected to represent primary salmonid migration corridors where high-quality data were available for fish and hydrodynamics. For simplification, Sutter Slough and Steamboat Slough are combined as the reach SS; and Georgiana Slough, the Delta Cross Channel (DCC), and the forks of the Mokelumne River to which the DCC leads are combined as Geo/DCC. The Geo/DCC reach can be entered by Sacramento runs through the combined junction of Georgiana Slough and DCC (Junction C). The Interior Delta reach can be entered from Geo/DCC. The entire Interior Delta region is treated as a single model reach3. The four distributary junctions (channel splits) depicted in the DPM are (A) Sacramento River at Fremont Weir (head of Yolo Bypass), (B) Sacramento River at head of Sutter and Steamboat Sloughs, and (C) Sacramento River at the combined junction with Georgiana Slough and DCC (Figure E.4-5, Table E.4-6).

Table E.4-6. Description of Modeled Reaches and Junctions in the Delta Passage Model

Reach/ Junction	Description	Reach Length (km)
Sac1	Sacramento River from Freeport to junction with Sutter/Steamboat Sloughs	19.33
Sac2	Sacramento River from Sutter/Steamboat Sloughs junction to junction with Delta Cross Channel/Georgiana Slough	10.78
Sac3	Sacramento River from Delta Cross Channel junction to Rio Vista, California	22.37
Sac4	Sacramento River from Rio Vista, California to Chipps Island	23.98
Yolo	Yolo Bypass from entrance at Fremont Weir to Rio Vista, California	NA[a]
Verona	Fremont Weir to Freeport	57
SS	Combined reach of Sutter Slough and Steamboat Slough ending at Rio Vista, California	26.72
Geo/DCC	Combined reach of Georgiana Slough, Delta Cross Channel, and South and North Forks of the Mokelumne River ending at confluence with the San Joaquin River in the Interior Delta	25.59
Interior Delta	Begins at end of reach Geo/DCC, San Joaquin River via Junction D, or Old River via Junction D, and ends at Chipps Island	NAb
A	Junction of the Yolo Bypass[c] and the Sacramento River	NA
B	Combined junction of Sutter Slough and Steamboat Slough with the Sacramento River	NA
C	Combined junction of the Delta Cross Channel and Georgiana Slough with the Sacramento River	NA

[a] Reach length for Yolo Bypass is undefined because reach length currently is not used to calculate Yolo Bypass speed and ultimate travel time.
[b] Reach length for the Interior Delta is undefined because salmon can take multiple pathways. Also, timing through the Interior Delta does not affect Delta survival because there are no Delta reaches located downstream of the Interior Delta.
[c] Flow into the Yolo Bypass is primarily via the Fremont Weir but flow via Sacramento Weir is also included.



Bold headings label modeled reaches, and red circles indicate model junctions. Salmonid icons indicate locations where smolts enter the Delta in the DPM. Smolts enter the Interior Delta from the Geo/DCC reach. Because of the lack of data informing specific routes through the Interior Delta, and tributary specific survival, the entire Interior Delta region is treated as a single model reach. Note that junction D is not modeled for fish entering the Delta from the Sacramento River basin, as in this analysis.

Figure E.4-5. Map of the Sacramento–San Joaquin River Delta Showing the Modeled Reaches and Junctions of the Delta Applied in the Delta Passage Model

Flow Input Data

Water movement through the Delta as input to the DPM is derived from daily (tidally averaged) flow output produced by the hydrology module of the Delta Simulation Model II (DSM2- HYDRO; <http://baydeltaoffice.water.ca.gov/modeling/deltamodeling/>) or from CALSIM-II.

The nodes in the DSM2-HYDRO and CALSIM II models that were used to provide flow for specific reaches in the DPM are shown in Table E.4-7.

Table E.4-7. Delta Passage Model Reaches and Associated Output Locations from DSM2-HYDRO and CALSIM II Models

DPM Reach or Model Component	DSM2 Output Locations	CALSIM Node
Sac1	rsac155	--
Sac2	rsac128	--
Sac3	rsac123	--
Sac4	rsac101	--
Yolo	--	d160a+d166aa
Verona	--	C160a
SS	slsbt011	--
Geo/DCC	dcc+georg_sl	--
South Delta Export Flow	Clifton Court Forebay + Delta Mendota Canal	--
Sacramento River flow at Fremont Weir	--	C129a

Note:
"–" indicates the cell is blank.

E.4.4.3 Model Functions

Delta Entry Timing

Recent sampling data on Delta entry timing of emigrating juvenile smolts for six Central Valley Chinook salmon runs were used to inform the daily proportion of juveniles entering the Delta for each run (Table E.4-8). Because the DPM models the survival of smolt-sized juvenile salmon, pre-smolts were removed from catch data before creating entry timing distributions. The lower 95th percentile of the range of salmon fork lengths visually identified as smolts by the USFWS in Sacramento trawls was used to determine the lower length cutoff for smolts. A lower fork length cutoff of 70 mm for smolts was applied, and all catch data of fish smaller than 70 mm were eliminated. To isolate wild production, all fish identified as having an adipose-fin clip (hatchery production) were eliminated, recognizing that most of the fall-run hatchery fish released upstream of Sacramento are not marked. Daily catch data for each brood year were divided by total annual catch to determine the daily proportion of smolts entering the Delta for each brood year. Sampling was not conducted daily at most stations and catch was not expanded for fish caught but not measured. Finally, the daily proportions for all brood years were plotted for each race, and a normal distribution was visually approximated to obtain the daily proportion of smolts entering the DPM for each run (Figure E.4-6). Because a bi-modal distribution appeared evident for winter-run entry timing, a generic probability density function was fit to the winter-run daily proportion data using the package "sm" in R software (R Core Team 2012). The R fitting procedure estimated the best-fit probability distribution of the daily proportion of fish entering the DPM for winter-run. A sensitivity analysis of this assumption was undertaken and showed that patterns in results would be expected to be similar for a range of entry distribution assumptions.

For the current analysis, the most recent data from the Sacramento Trawl survey was added to the previous data to determine if entry distributions had shifted since the original fitting. Only late fall Chinook Salmon exhibited substantial change from the original fit and the entry distribution for that race was updated (Figure E.4-6).

Table E.4-8. Sampling Gear Used to Create Juvenile Delta Entry Timing Distributions for Each Central Valley Run of Chinook Salmon

Chinook Salmon Run	Gear	Agency	Brood Years
Sacramento River Winter Run	Trawls at Sacramento	USFWS	1995–2009
Sacramento River Spring Run	Trawls at Sacramento	USFWS	1995–2005
Sacramento River Fall Run	Trawls at Sacramento	USFWS	1995–2005
Sacramento River Late Fall Run	Trawls at Sacramento	USFWS	1995–2005

Agencies that conducted sampling are listed: USFWS = U.S. Fish and Wildlife Service.

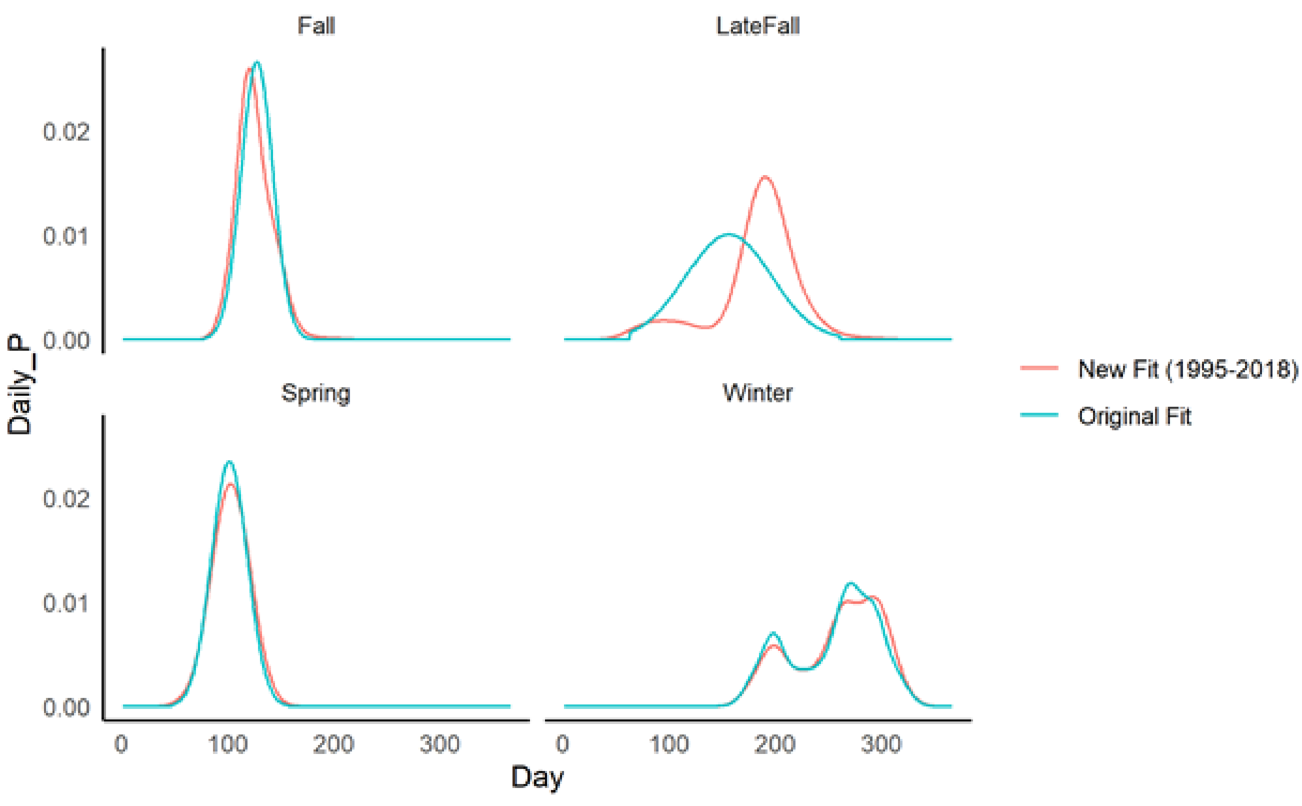


Figure E.4-6. Delta Entry Distributions for Chinook Salmon Smolts Applied in the Delta Passage Model for Sacramento River Winter-Run, Central Valley Spring-Run (from the Sacramento River basin), Central Valley Fall-Run (from the Sacramento River basin), and Central Valley Late Fall–Run

Migration Speed

The DPM assumes a net daily movement of smolts in the downstream direction. The rate of smolt movement in the DPM affects the timing of arrival at Delta junctions and reaches, which can affect route selection and survival as flow conditions or water project operations change.

Smolt movement in all reaches except Yolo Bypass and the Interior Delta is a function of reach-specific length and migration speed as observed from acoustic-tagging results. Reach-specific length (kilometers [km]) (Table E.4-6) is divided by reach migration speed (km/day) the day smolts enter the reach to calculate the number of days smolts will take to travel through the reach.

For north Delta reaches Verona, Sac1, Sac2, SS, and Geo/DCC, mean migration speed through the reach is predicted as a function of flow. Many studies have found a positive relationship between juvenile Chinook salmon migration rate and flow in the Columbia River Basin (Raymond 1968; Berggren and Filardo 1993; Schreck et al. 1994), with Berggren and Filardo (1993) finding a logarithmic relationship for Snake River yearling Chinook salmon. Ordinary least squares regression was used to test for a logarithmic relationship between reach-specific migration speed (km/day) and average daily reach-specific flow (cubic meters per second [m3/sec]) for the first day smolts entered a particular reach for reaches where acoustic-tagging data was available (Sac1, Sac2, Sac3, Sac4, Geo/DCC, and SS):

$$Speed = \beta_0 \ln(flow) + \beta_1$$

Where β_0 is the slope parameter and β_1 is the intercept.

Individual smolt reach-specific travel times were calculated from detection histories of releases of acoustically tagged smolts conducted in December and January for three consecutive winters (2006/2007, 2007/2008, and 2008/2009) (Perry 2010). Reach-specific migration speed (km/day) for each smolt was calculated by dividing reach length by travel days (Table E.4-9). Flow data was queried from the California Department of Water Resources (DWR's) California Data Exchange website (<http://cdec.water.ca.gov/>).

Table E.4-9. Reach-Specific Migration Speed and Sample Size of Acoustically-Tagged Smolts Released during December and January for Three Consecutive Winters (2006/2007, 2007/2008, and 2008/2009)

Reach	Gauging Station ID	Release Dates	Sample Size	Avg Speed (km/day)	Min Speed (km/day)	Max Speed (km/day)	SD Speed (km/day)
Sac1	FPT	12/05/06–12/06/06, 1/17/07–1/18/07, 12/04/07–12/07/07, 1/15/08–1/18/08, 11/30/08–12/06/08, 1/13/09–1/19/09	452	13.32	0.54	41.04	9.29
Sac2	SDC	1/17/07–1/18/07, 1/15/08–1/18/08, 11/30/08–12/06/08, 1/13/09–1/19/09	294	9.29	0.34	10.78	3.09
Sac3	GES	12/05/06–12/06/06, 1/17/07–1/18/07, 12/04/07–12/07/07, 1/15/08–1/18/08, 11/30/08–12/06/08, 1/13/09–1/19/09	102	9.24	0.37	22.37	7.33
Sac4	GES[a]	12/05/06–12/06/06, 1/17/07–1/18/07, 12/04/07–12/07/07, 1/15/08–1/18/08, 11/30/08–12/06/08, 1/13/09–1/19/09	62	8.60	0.36	23.98	6.79
Geo/DCC	GSS	12/05/06–12/06/06, 1/17/07–1/18/07, 12/04/07–12/07/07, 1/15/08–1/18/08, 11/30/08–12/06/08, 1/13/09–1/19/09	86	14.20	0.34	25.59	8.66
SS	FPT-SDC[b]	12/05/06–12/06/06, 12/04/07–12/07/07, 1/15/08–1/18/08, 11/30/08–12/06/08, 1/13/09–1/19/09	30	9.41	0.56	26.72	7.42

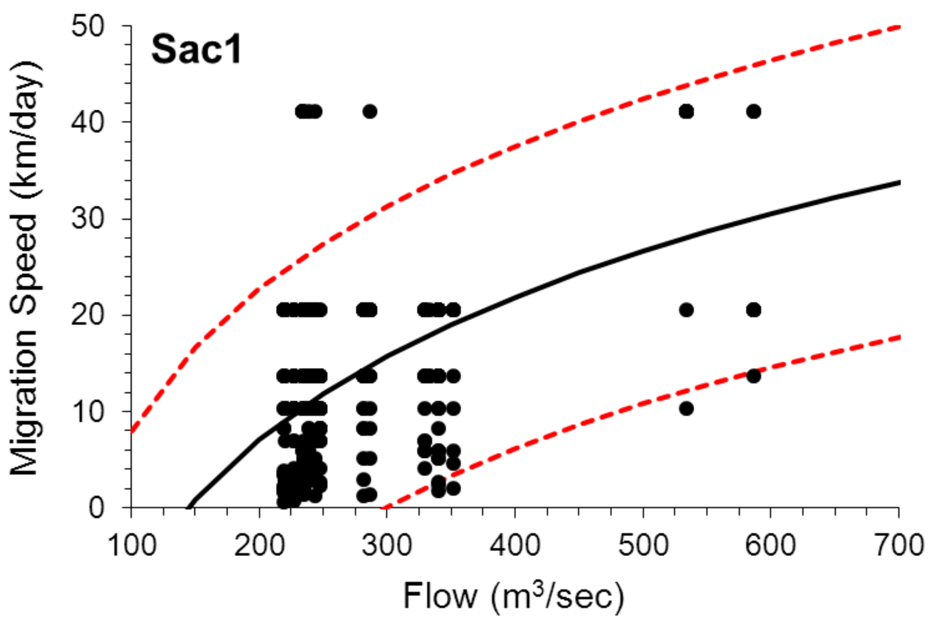
[a] Sac3 flow is used for Sac4 because no flow gauging station is available for Sac4.

[b] SS flow is calculated by subtracting Sac2 flow (SDC) from Sac1 flow (FPT).

Migration speed was significantly related to flow for reaches Sac1 (df = 450, F = 164.36, P < 0.001), Sac2 (df = 292, F = 4.17, P = 0.042), and Geo/DCC (df = 84, F = 13.74, P <0.001). Migration speed increased as flow increased for all three reaches (Table E.4-10, Figure E.4-7). Therefore, for reaches Sac1, Sac2, and Geo/DCC, the regression coefficients shown in Table E.4-10 are used to calculate the expected average migration rate given the input flow for the reach and the associated standard error of the regressions is used to inform a normal probability distribution that is sampled from the day smolts enter the reach to determine their migration speed throughout the reach. The minimum migration speed for each reach is set at the minimum reach-specific migration speed observed from the acoustic-tagging data (Table E.4-4). The flow-migration rate relationship that was used for Sac1 also was applied for the Verona reach.

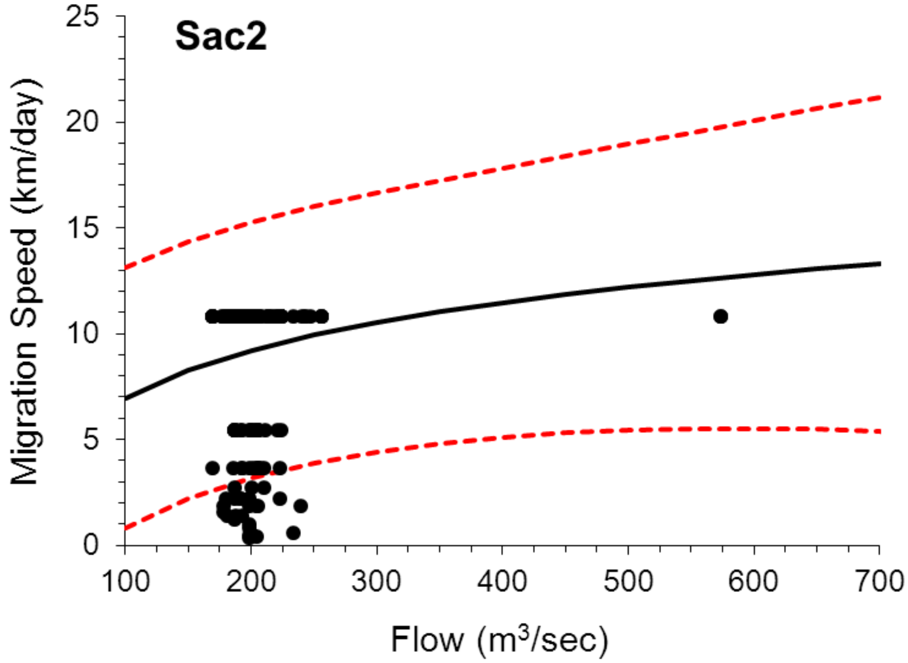
Table E.4-10. Sample Size (N) and Slope (β0) and Intercept (β1) Parameter Estimates with Associated Standard Error (in Parenthesis) for the Relationship between Migration Speed and Flow for Reaches Sac1, Sac2, and Geo/DCC

Reach	Sample Size (N)	Slope [β_0] (with standard error)	Intercept [β_1] (with standard error)
Sac1	452	21.34 (1.66)	-105.98 (9.31)
Sac2	294	3.25 (1.59)	-8.00 (8.46)
Geo/DCC	86	11.08 (2.99)	-33.52 (12.90)



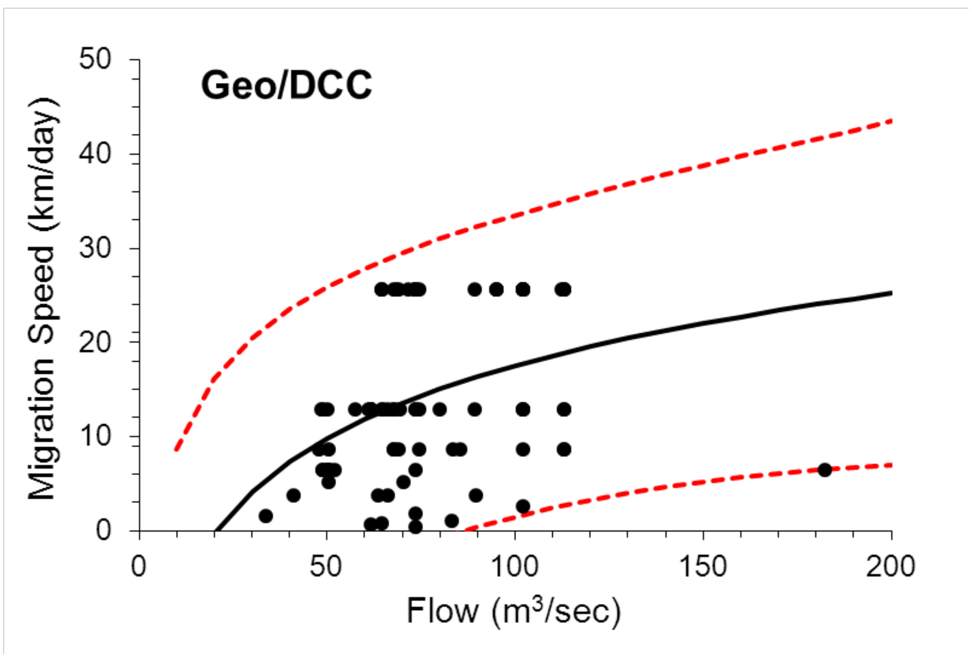
Circles are observed migration speeds of acoustically tagged smolts from acoustic-tagging studies from Perry (2010), solid lines are predicted mean migration speed, and dotted lines are 95% prediction intervals used to inform uncertainty.

Figure E.4-7 a. Reach-Specific Migration Speed (km/day) as a Function of Flow (m^3/sec) Applied in Reach Sac1



Circles are observed migration speeds of acoustically tagged smolts from acoustic-tagging studies from Perry (2010), solid lines are predicted mean reach survival curves, and dotted lines are 95% prediction intervals used to inform uncertainty.

Figure E.4-7 b. Reach-Specific Migration Speed (km/day) as a Function of Flow (m^3/sec) Applied in Reach Sac2



Circles are observed migration speeds of acoustically tagged smolts from acoustic-tagging studies from Perry (2010), solid lines are predicted mean reach survival curves, and dotted lines are 95% prediction intervals used to inform uncertainty.

Figure E.4-7 c. Reach-Specific Migration Speed (km/day) as a Function of Flow (m^3/sec) Applied in Reach Geo/DCC

No significant relationship between migration speed and flow was found for reaches Sac3 (df = 100, F = 1.13, P =0.29), Sac4 (df = 60, F = 0.33, P = 0.57), and SS (df = 28, F = 0.86, P = 0.36). Therefore, for these reaches the observed mean migration speed and associated standard deviation (Table E.4-9) is used to inform a normal probability distribution that is sampled from the day smolts enter the reach to determine their migration speed throughout the reach. As applied for reaches Sac1, Sac2, and Geo/DCC, the minimum migration speed for reaches Sac3, Sac4, and SS is set at the minimum reach-specific migration speed observed from the acoustic-tagging data (Table E.4-9).

Yolo Bypass travel time data from Sommer et al. (2005) for acoustic-tagged, fry-sized (mean size = 57 mm fork length [FL]) Chinook salmon were used to inform travel time through the Yolo Bypass in the DPM. Because the DPM models the migration and survival of smolt-sized juveniles, the range of the shortest travel times observed across all three years (1998–2000) by Sommer et al. (2005) was used to inform the bounds of a uniform distribution of travel times (range = 4–28 days), on the assumption that smolts would spend less time rearing, and would travel faster than fry. On the day smolts enter the Yolo Bypass, their travel time through the reach is calculated by sampling from this uniform distribution of travel times.

The travel time of smolts migrating through the Interior Delta in the DPM is informed by observed mean travel time (7.95 days) and associated standard deviation (6.74) from North Delta acoustic-tagging studies (Perry 2010). However, the timing of smolt passage through the Interior Delta does not affect Delta survival because there are no Delta reaches located downstream of the Interior Delta.

Fish Behavior at Junctions (Channel Splits)

Perry et al. (2010) found that acoustically-tagged smolts arriving at Delta junctions exhibited inconsistent movement patterns in relation to the flow being diverted. For Junction A (entry into the Yolo Bypass at Fremont Weir), the following relationships were used.

- Proportion of smolts entering Yolo Bypass = Fremont Weir spill[12] / (Fremont Weir spill + Sacramento River at Verona flows).

As noted above in *Flow Input Data*, the flow data informing Yolo Bypass entry were obtained by disaggregating CALSIM estimates using historical daily patterns of variability because DSM2 does not provide daily flow data for these locations.

For Junction B (Sacramento River-Sutter/Steamboat Sloughs), Perry et al. (2010) found that smolts consistently entered downstream reaches in proportion to the flow being diverted. Therefore, smolts arriving at Junction B in the model were assumed to move proportionally with flow. Similarly, with data lacking to inform the nature of the relationship, a proportional relationship between flow and fish movement for Junction D (San Joaquin River–Old River) also was applied. Note that the operation of the Head of Old River gate proposed under the PA is accounted for in the DSM2 flow input data (i.e., with a closed gate, relatively more flow [and therefore smolts] remains in the San Joaquin River).

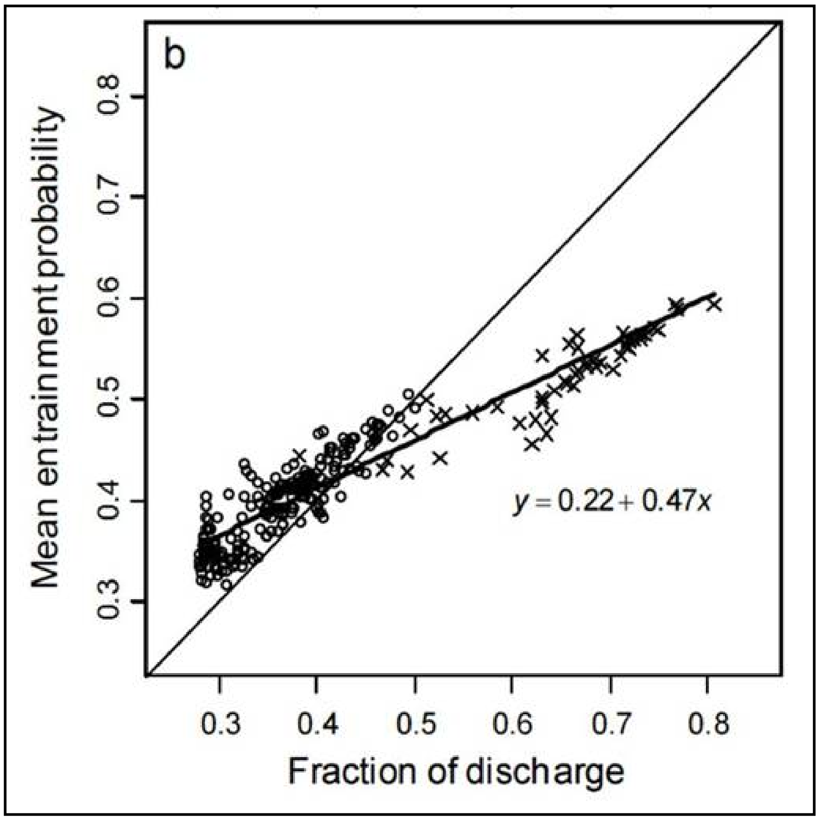
[12] As noted in Table DPM2, Yolo Bypass flow includes spill from both Fremont Weir and Sacramento Weir. The DPM simplifies the occasional entry of fish via Sacramento Weir by adding Sacramento Weir spill to Fremont Weir spill.

For Junction C (Sacramento River–Georgiana Slough/DCC), Perry (2010) found a linear, nonproportional relationship between flow and fish movement. This relationship for Junction C was applied in the DPM:

$$y = 0.22 + 0.47x;$$

where *y* is the proportion of fish diverted into Geo/DCC and *x* is the proportion of flow diverted into Geo/DCC (Figure E.4-8).

In the DPM, this linear function is applied to predict the daily proportion of fish movement into Geo/DCC as a function of the proportion of flow into Geo/DCC.



Note: Circles Depict DCC Gates Closed, Crosses Depict DCC Gates Open.

Figure E.4-8. Figure from Perry (2010) Depicting the Mean Entrainment Probability (Proportion of Fish Being Diverted into Reach Geo/DCC) as a Function of Fraction of Discharge (Proportion of Flow Entering Reach Geo/DCC)

Route-Specific Survival

Survival through a given route (individual reach or several reaches combined) is calculated and applied the first day smolts enter the reach. For reaches where literature showed support for reach-level responses to environmental variables, survival is influenced by flow (Sac1, Sac2, Sac3 and Sac4 combined, SS and Sac 4 combined, Interior Delta via San Joaquin River, and Interior Delta via Old River) or south Delta water exports (Interior Delta via Geo/DCC). For these reaches, daily flow or exports occurring the day of reach entry are used to predict reach survival during the entire migration period through the reach (Table E.4-11). For all other reaches (Geo/DCC and Yolo), reach survival is assumed to be unaffected by Delta conditions and is informed by means and standard deviations of survival from acoustic-tagging studies.

Table E.4-11. Route-Specific Survival and Parameters Defining Functional Relationships or Probability Distributions for Each Chinook Salmon Run and Methods Section Where Relationship is Described

Route	Chinook Salmon Run	Survival[a]	Methods Section Description
Verona	All Sacramento runs	0.931 (0.02)	This section
Sac1	All Sacramento runs	Function of flow	Flow-Dependent Survival
Sac2	All Sacramento runs	Function of flow	Flow-Dependent Survival
Sac3 and Sac4 combined	All Sacramento runs	Function of flow	Flow-Dependent Survival
Yolo	All Sacramento runs	Various	This section
Sac4 via Yolo[b]	All Sacramento runs	0.698 (0.153)	This section
SS and Sac4 combined	All Sacramento runs	Function of flow	Flow-Dependent Survival
Geo/DCC	All Sacramento runs	0.65 (0.126)	This section
Interior Delta	All Sacramento runs	Function of exports	Export-Dependent Survival
Interior Delta	San Joaquin fall-run via Old River	Function of flow	Flow-Dependent Survival
Interior Delta	San Joaquin fall-run via San Joaquin River	Function of flow	Flow-Dependent Survival

[a] For routes where survival is uninfluenced by Delta conditions, mean survival and associated standard deviation (in parentheses) observed during acoustic-tagging studies (Michel 2010; Perry 2010) are used to define a normal probability distribution that is sampled from the day smolts enter a reach to calculate reach survival.

[b] Although flow influences survival of fish migrating through the combined routes of SS–Sac4 and Sac3–Sac4, flow does not influence Sac4 survival for fish arriving from Yolo.

For reaches Geo/DCC, Yolo, and Sac4 via Yolo, no empirical data were available to support a relationship between survival and Delta flow conditions (channel flow, exports). Therefore, for these reaches mean reach survival is used along with reach-specific standard deviation to define a normal probability distribution that is sampled from when smolts enter the reach to determine reach survival (Table E.4-11).

Mean reach survival and associated standard deviation for Geo/DCC are informed by survival data from smolt acoustic-tagging studies from Perry (2010; Table E.4-12). Smolts migrating down the Sacramento River during the acoustic-tagging studies could enter the DCC or Georgiana Slough when the DCC was open (December releases), therefore, group survivals for both routes are used to inform the mean survival and associated standard deviation for the Geo/DCC reach for Sacramento River runs.

Smolt survival data for the Yolo Bypass were obtained from the UC Davis Biotelemetry Laboratory (M. Johnston pers. comm.). These data included survival estimates for five reaches from release near the head of the bypass to the base of the bypass. The means (and standard errors) of these estimates defined normal probability distributions from which daily value for the DPM were drawn, and were as follows: reach 1 (release site): 1.00; reach 2 (release site to I-80): 0.96 (SE = 0.059); reach 3 (I-80 to screw trap): 0.96 (0.064); reach 4 (screw trap to base of Toe Drain): 0.94 (0.107); reach 5 (base of Toe Drain to base of Bypass): 0.88 (0.064). Fish leaving the Yolo reach in the model then entered Sac4 and were subject to survival at the rate shown in Table E.4-11.

Mean survival and associated standard deviation for the Verona reach between Fremont Weir and Yolo Bypass were derived from the 2007–2009 acoustic-tag study reported by Michel (2010), who did not find a flow-survival relationship for that reach.

Table E.4-12. Individual Release-Group Survival Estimates, Release Dates, Data Sources, and Associated Calculations Used to Inform Reach-Specific Mean Survivals and Standard Deviations Used in the Delta Passage Model for Reaches Where Survival Is Uninfluenced by Delta Conditions - Table E.4-12 a - E.4-12 b

Table E.4-12 a. Individual Release-Group Survival Estimates, Release Dates, Data Sources, and Associated Calculations Used to Inform Reach-Specific Mean Survivals and Standard Deviations Used in the Delta Passage Model for Reaches Where Survival Is Uninfluenced by Delta Conditions - Geo/DCC via Sacramento River

Survival	Release Dates	Survival Calculation	Mean	Standard Deviation
0.648	12/05/06	S_{D1}	0.559	0.194
0.600	12/04/07–12/06/07	$S_{D1,SAC}$*S_{D2}	0.559	0.194
0.762	1/15/08–1/17/08	$S_{D1,SAC}$*S_{D2}	0.559	0.194
0.774	11/31/08–12/06/08	$S_{D1,SAC}$*S_{D2}	0.559	0.194
0.467	1/13/08–1/19/09	$S_{D1,SAC}$*S_{D2}	0.559	0.194
0.648	12/05/06	S_{C1}* S_{C2}	0.559	0.194
0.286	12/04/07–12/06/07	S_{C1}	0.559	0.194
0.286	11/31/08–12/06/08	S_{C1}	0.559	0.194

Source: Perry 2010.

Table E.4-12 b. Individual Release-Group Survival Estimates, Release Dates, Data Sources, and Associated Calculations Used to Inform Reach-Specific Mean Survivals and Standard Deviations Used in the Delta Passage Model for Reaches Where Survival Is Uninfluenced by Delta Conditions - Sac4 via Yolo

Survival	Release Dates	Survival Calculation	Mean	Standard Deviation
0.714	12/5/2006	S_{A6}*S_{A7}	0.698	0.153
0.858	1/17/2007	S_{A6}*S_{A7}	0.698	0.153
0.548	12/4/07-12/6/07	S_{A7}*S_{A8}	0.698	0.153
0.488	1/15/08-1/17/08	S_{A7}*S_{A8}	0.698	0.153
0.731	11/31/08-12/06/08	S_{A7}*S_{A8}	0.698	0.153
0.851	1/13/09-1/19/09	S_{A7}*S_{A8}	0.698	0.153

Source: Perry 2010.

Flow-Dependent Survival

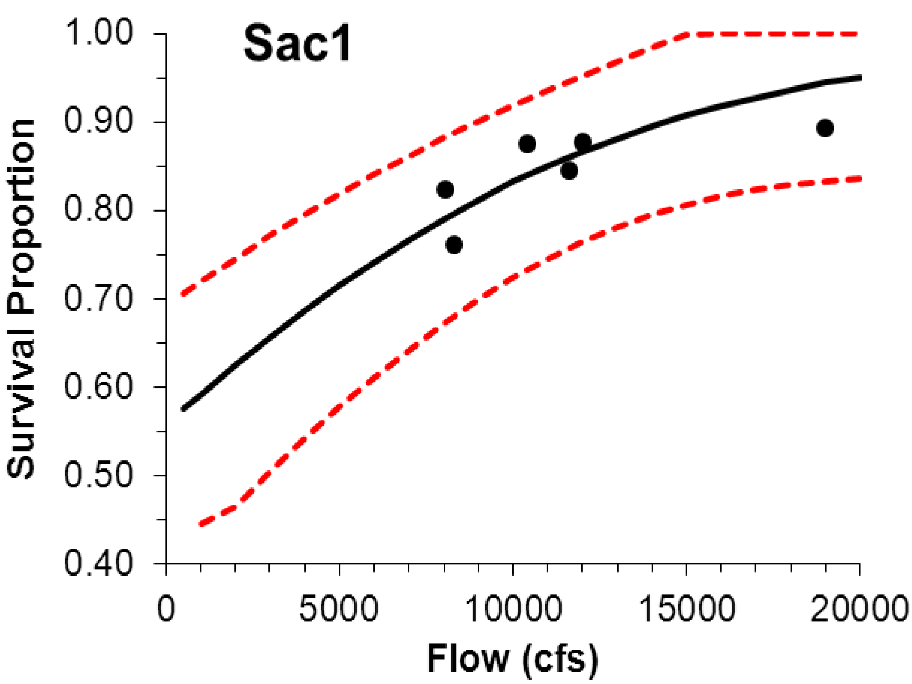
For reaches Sac1, Sac2, Sac3 and Sac4 combined, and SS and Sac4 combined, flow values on the day of route entry are used to predict route survival (Figure E.4-9). Perry (2010) evaluated the relationship between survival among acoustically-tagged Sacramento River smolts and Sacramento River flow measured below Georgiana Slough (DPM reach Sac3) and found a significant relationship between survival and flow during the migration period for smolts that migrated through Sutter and Steamboat Sloughs to Chipps Island (Sutter and Steamboat route; SS and Sac4 combined) and smolts that migrated from the junction with Georgiana Slough to Chipps Island (Sacramento River route; Sac3 and Sac4 combined). Therefore, for route Sac3 and Sac4 combined and route SS and Sac4 combined, the logit survival function from Perry (2010) was used to predict mean reach survival (S) from reach flow (flow):

$$S = \frac{e^{(\beta_0 + \beta_1 flow)}}{1 + e^{(\beta_0 + \beta_1 flow)}}$$

where β_0 (SS and Sac4 = -0.175, Sac3 and Sac4 = -0.121) is the reach coefficient and β_1 (0.26) is the flow coefficient, and *flow* is average Sacramento River flow in reach Sac3 during the experiment standardized to a mean of 0 and standard deviation of 1.

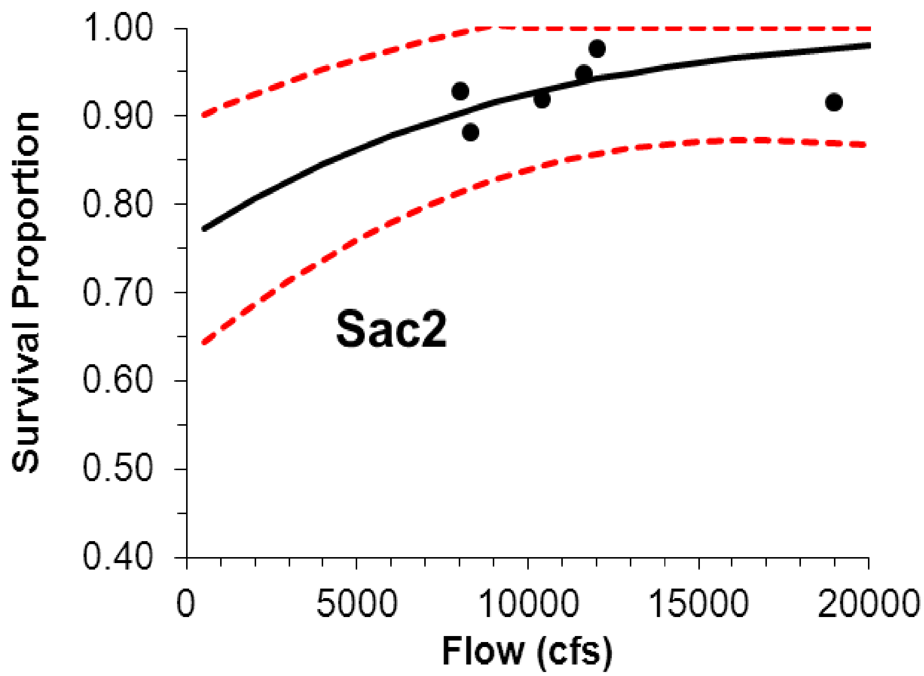
Perry (2010) estimated the global flow coefficient for the Sutter Steamboat route and Sacramento River route as 0.52. For the Sac3 and Sac4 combined route and the SS and Sac4 combined route, mean survival and associated standard error predicted from each flow-survival relationship is used to inform a normal probability distribution that is sampled from the day smolts enter the route to determine their route survival.

With a flow-survival relationship appearing evident for group survival data of acoustically-tagged smolts in reaches Sac1 and Sac2, Perry's (2010) relationship was applied to Sac1 and Sac2 while adjusting for the mean reach-specific survivals for Sac1 and Sac2 observed during the acoustic-tagging studies (Figure E4.-9; Table E.4-13). The flow coefficient was held constant at 0.52 and the residual sum of squares of the logit model was minimized about the observed Sac1 and Sac2 group survivals, respectively, while varying the reach coefficient. The resulting reach coefficients for Sac1 and Sac2 were 1.27 and 2.16, respectively. Mean survival and associated standard error predicted from the flow-survival relationship is used to inform a normal probability distribution that is sampled from the day smolts enter the reach to determining Sac1 and Sac2 reach survival.



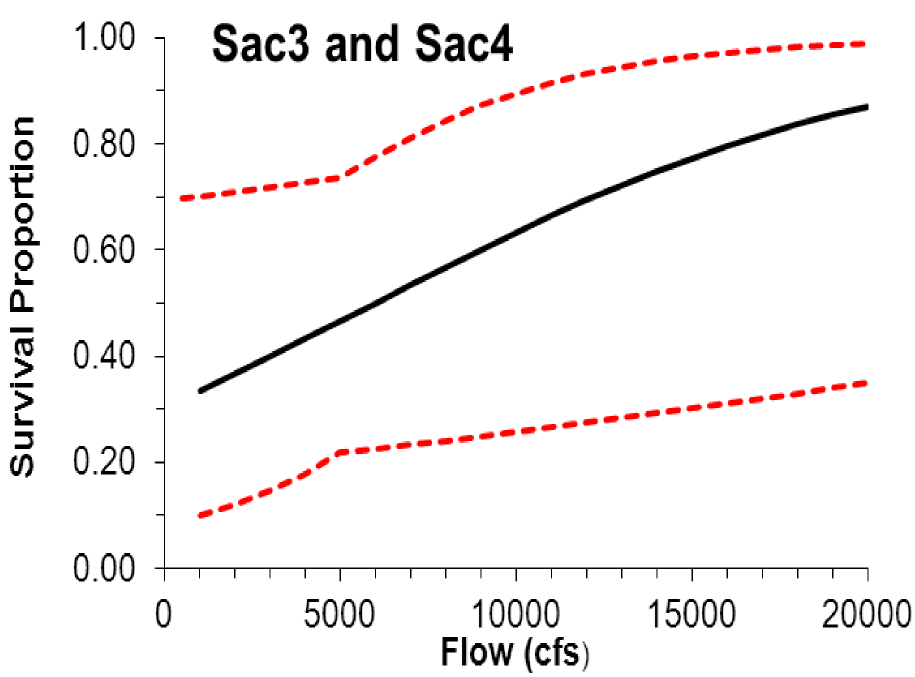
Circles are observed group survivals from acoustic-tagging studies from Perry (2010). Solid lines are predicted mean route survival curves, and dotted lines are 95% confidence bands used to inform uncertainty.

Figure E.4-9 a. Route Survival as a Function of Flow Applied in Sac 1 Reach.



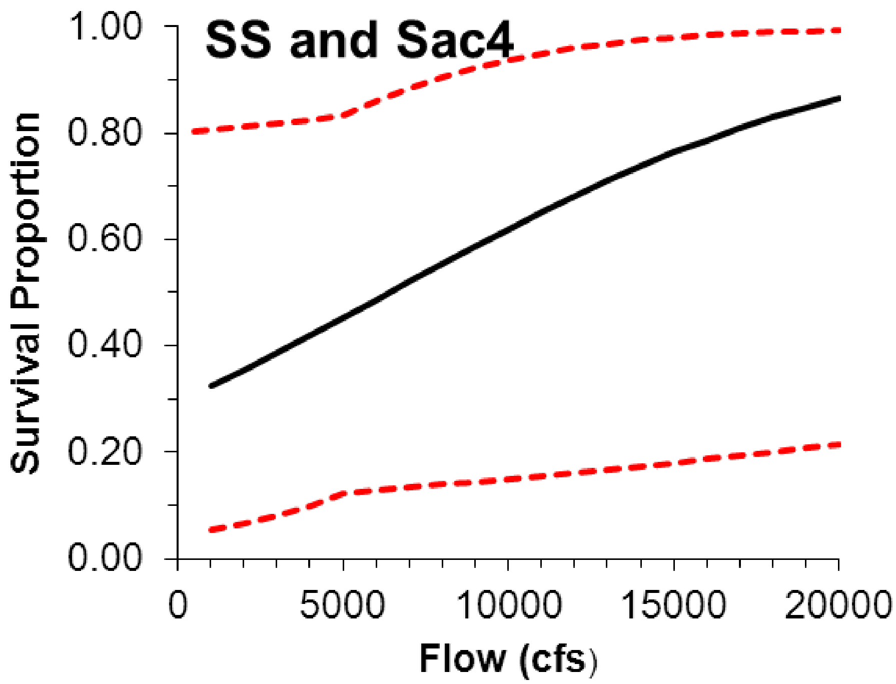
Circles are observed group survivals from acoustic-tagging studies from Perry (2010). Solid lines are predicted mean route survival curves, and dotted lines are 95% confidence bands used to inform uncertainty.

Figure E.4-9 b. Route Survival as a Function of Flow Applied in Sac 2 Reach.



Solid lines are predicted mean route survival curves, and dotted lines are 95% confidence bands used to inform uncertainty.

Figure E.4-9 c. Route Survival as a Function of Flow Applied in combined Sac3 and Sac4 Reach.



Solid lines are predicted mean route survival curves, and dotted lines are 95% confidence bands used to inform uncertainty.

Figure E.4-9 d. Route Survival as a Function of Flow Applied in combined SS and Sac4 reach.

Table E.4-13. Group Survival Estimates of Acoustically-Tagged Chinook Salmon Smolts from Perry (2010) and Associated Calculations Used to Inform Flow-Dependent Survival Relationships for Reaches Sac1 and Sac2

DPM Reach	Survival	Release Dates	Survival Calculation
Sac1	0.844	12/5/06	SA1 *SA2
Sac1	0.876	1/17/07	SA1 *SA2
Sac1	0.874	12/4/07-12/6/07	SA1 *SA2
Sac1	0.892	1/15/08-1/17/08	SA1 *SA2
Sac1	0.822	11/31/08-12/06/08	SA1 *SA2
Sac1	0.760	1/13/09-1/19/09	SA1 *SA2
Sac2	0.947	12/5/06	SA3
Sac2	0.976	1/17/07	SA3
Sac2	0.919	12/4/07-12/6/07	SA3
Sac2	0.915	1/15/08-1/17/08	SA3
Sac2	0.928	11/31/08-12/06/08	SA3
Sac2	0.881	1/13/09-1/19/09	SA3

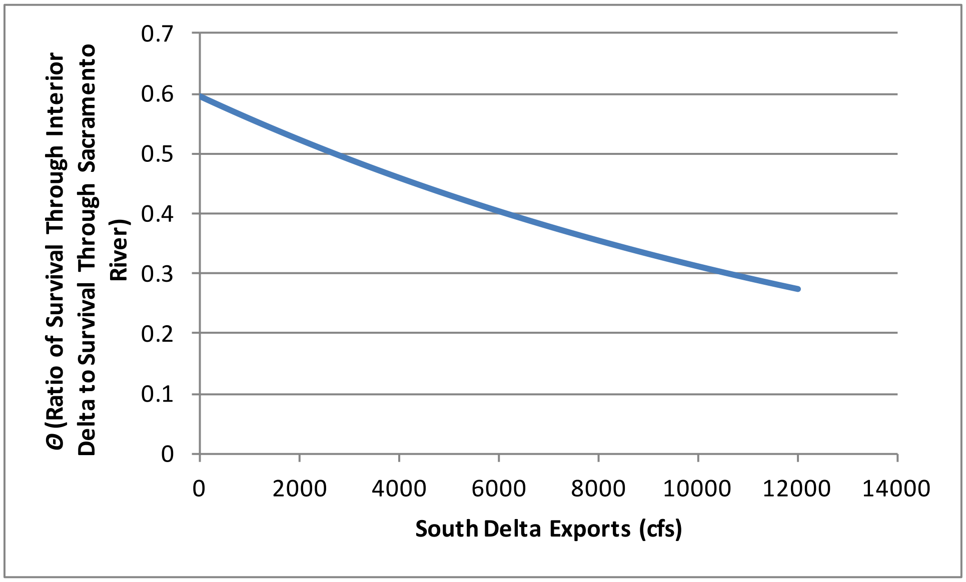
Source: Perry 2010.

Export-Dependent Survival

As migratory juvenile salmon enter the Interior Delta from Geo/DCC for Sacramento River Chinook Salmon, they transition to an area strongly influenced by tides and where south Delta water exports may influence survival. The export–survival relationship described by Newman and Brandes (2010) was applied as follows:

$$\theta = 0.5948 * e^{(-0.000065*Total\_Exports)}$$

where ϑ is the ratio of survival between coded wire tagged smolts released into Georgiana Slough and smolts released into the Sacramento River and Total Exports is the flow of water (cfs) pumped from the Delta from the State and Federal facilities. ϑ is a ratio and ranges from just under 0.6 at zero south Delta exports to ~0.27 at 12,000-cfs south Delta exports (E.4-6).



Source: Newman and Brandes 2010

Figure E.4-10. Relationship between θ (Ratio of Survival through the Interior Delta to Survival through Sacramento River) and South Delta Export Flows

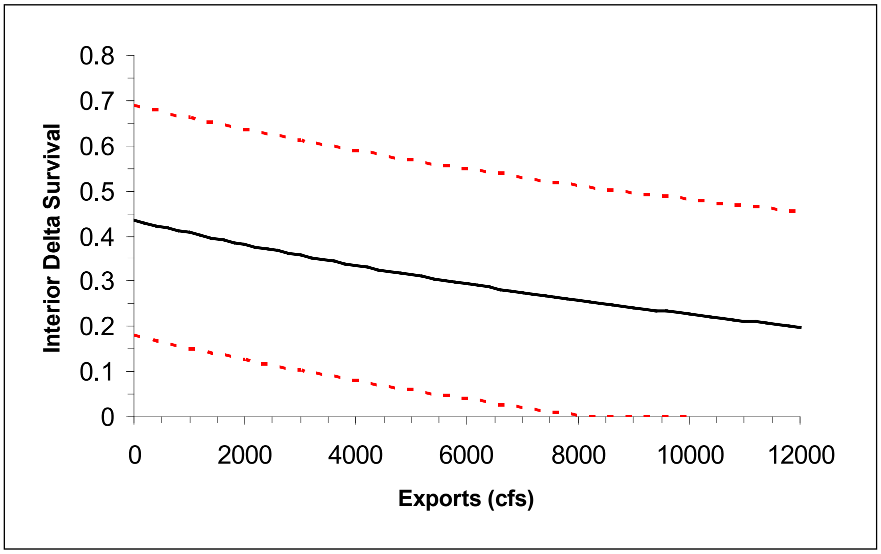
ϑ was converted from a ratio into a value of survival through the Interior Delta using the equation:

$$S_{ID} = \frac{\theta}{S_{Geo/DCC}} * (S_{Sac3} * S_{Sac4})$$

where S_{ID} is survival through the Interior Delta, ϑ is the ratio of survival between Georgiana Slough and Sacramento River smolt releases, $S_{Geo/DCC}$ is the survival of smolts in the Georgiana Slough/Delta Cross Channel reach, S_{Sac3} * S_{Sac4} is the combined survival in reaches Sac 3 and Sac 4 (Figure E.4-10)[13].

Uncertainty is represented in this relationship by using the estimated value of θ and the standard error of the equation to define a normal distribution bounded by the 95% prediction interval of the model that is then re-sampled each day to determine the value of θ.

[13] Although daily survivals in Sac3/Sac4 are used to calculate Sacramento River survival for Sacramento River runs (winter-run, spring-run, Sacramento fall-run, and late fall–run), the combined Sac3/Sac4 survival used to calculate Sacramento River survival would be slightly different than that used to calculate interior Delta survival because of the travel time required for smolts to reach the interior Delta via Geo/DCC.



Survival values in reaches Sac3, Sac4, and Geo/DCC were held at mean values observed during acoustic-tag studies (Perry 2010) to depict export effect on Interior Delta survival in this plot. Dashed lines are 95% prediction bands used to inform uncertainty in the relationship.

Figure E.4-11. Interior Delta Survival as a Function of Delta Exports (Newman and Brandes 2010) as Applied for Sacramento Races of Chinook Salmon Smolts Migrating through the Interior Delta via Reach Geo/DCC

E.4.5 Survival, Travel Time, and Routing Analysis (STARS, Based on Perry et al. 2018)

Detailed methods and results for the STARS model are presented in Attachment 1 *Using the STARS Model to Evaluate the Effects of the Proposed Project on Juvenile Salmon Survival, Travel Time, and Migration Routing for the Long-Term Operation of the State Water Project Incidental Take Permit Application and CEQA Compliance*.

E.4.6 Structured Decision Model (Chinook Salmon Routing Application)

The Delta Structured Decision Model Chinook Salmon Routing Application was developed by the Central Valley Project Improvement Act Science Integration Team to evaluate the effect of different management decisions on the survival and routing of juvenile Fall-Run Chinook Salmon. The model relies on survival-environment relationships and routing-environment relationships from acoustic studies conducted in the Sacramento and San Joaquin Rivers and at the state and federal south Delta export facilities. Here only the results from the San Joaquin River sub model were reported, with separate analyses conducted for Fall-Run and Spring-Run Chinook Salmon. The model and documentation has not been finalized and the code for the most recent model version used here used was accessed at https://github.com/FlowWest/chinookRoutingApp. Total South Delta Survival probability was unmodified from the Routing Application's original "SouFish" equation, which defines survival to Chipps Island for South Delta-routed fish as:

SouFish =

(S_prea * psi_sjr1 * S_a * psi_sjr2 * S_bc) + (S_prea * psi_sjr1 * S_a * psi_TC * S_efc) +

(S_prea * psi_OR * S_d * psi_ORN * S_efc) + (S_prea * psi_OR * S_d * psi_CVP * S_CVP) +

(S_prea * psi_OR * S_d * psi_SWP * S_SWP).

Model functions, parameters, and inputs used for this analysis are described in Table E.4-14. Where inputs were not available, they were assumed to be the mean values for the studies used to establish the model parameters. For implementation of the effects analysis, the model was run using DPM Delta entry weightings for Fall-Run Chinook Salmon from the San Joaquin River basin; Delta entry weightings for Spring-Run Chinook Salmon from the Sacramento River basin were assumed to be representative of daily weightings of Spring-Run Chinook Salmon from the San Joaquin River basin.

Table E.4-14. Functions, Parameter Calculations, and Inputs Used in the Structured Decision Model Chinook Salmon Routing Application San Joaquin Sub Model

Function	Parameters	Inputs
S_prea = survival through the tributaries to the Head of Old River (HOR)	inv.logit(5.77500 + 0.00706 * Q_vern - 0.32810 * Temp_vern + 0.152 *(FL-155.1) / 21.6)	Q_vern (Flow at Vernalis): DSM2 Temp_vern (Temperature at Vernalis): 16.7C FL (Fork length): 120mm
psi_sjr1 = probability of remaining in SJR at HOR	inv.logit(-0.75908 + 1.72020 * hor_barr + 0.00361 * Q_vern + 0.02718 * hor_barr * Q_vern)	hor_barr (Head of Old River barrier): DSM2 (Existing), 0 (Proposed) Q_vern: DSM2
S_a = survival from the HOR to Turner Cut	inv.logit(-2.90330 + 0.01059 * Q_vern + 0.152 * (FL - 155.1) / 21.6)	Q_vern: DSM2 FL: 120mm
psi_sjr2 = the probability of remaining in SJR at Turner Cut	inv.logit(5.83131 - 0.037708993 * Q_stck)	Q_stck (Flow at Stockton): DSM2
S_bc = survival from SJR Turner Cut to Chipps	inv.logit(13.41840 - 0.90070 * Temp_pp + 0.152 * (FL - 155.1) / 21.6)	Temp_pp: 17.8C FL: 120mm
psi_TC = probability of taking Turner Cut	psi_TC <- 1 - psi_sjr2	See psi_sjr2 above
psi_OR = probability of entering Old River	1 - psi_sjr1	See psi_sjr1 above
S_d = Survival down OR to HOR to CVP	inv.logit(2.16030 - 0.20500 * Temp_vern + 0.152 * (FL - 155.1)/21.6)	Temp_vern: 16.7C FL: 120mm
psi_ORN = probability of remaining in Old River North	1 - psi_CVP - psi_SWP	See psi_CVP and psi_SWP, below
S_efc = Survival from Old River North to Chipps Island (San Joaquin River Group Authority)	0.01	0.01
psi_CVP = probability of entrainment at CVP	inv.logit(-3.9435 + 2.9025 * no.pump - 0.3771 * no.pump ^ 2)	no.pump (Number of CVP pumps in operation): DSM2*
psi_SWP = probability of entrainment at SWP	(1 - psi_CVP) * inv.logit(-1.48969 + 0.016459209 * SWP_exp)	SWP_exp (SWP exports): DSM2
S_CVP = survival through CVP (Karp et al. 2017)	inv.logit(-3.0771 + 1.8561 * no.pump - 0.2284 * no.pump ^ 2)	no.pump: DSM2*
S_SWP = survival through SWP (Gingras 1997)	0.1325	0.1325

*The model calculates the number of pumps based on DSM2 export inputs (cfs)

E.5 OTHER SPECIES

Quantitative analyses for other species focused on the salvage-density method, as described above for salmonids. Results of the salvage-density method for the SWP south Delta export facility are presented in Section 4.4 of the DEIR. Results for the CVP south Delta export facility are presented below in consideration of potential cumulative impacts in the DEIR Section 4.6.

Table E.5-1. Estimates of Green Sturgeon Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Table E.5-1 a-f

Table E.5-1 a. Estimates of Green Sturgeon Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Wet

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	0	0	0	1	2	7	14	5	8	5	3	7
Proposed Project	0	0	0	1	4	7	14	5	8	6	3	7

Table E.5-1 b. Estimates of Green Sturgeon Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Above Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	0	0	0	0	0	0	0	0	0	0	0	0
Proposed Project	0	0	0	0	0	0	0	0	0	0	0	0

Table E.5-1 c. Estimates of Green Sturgeon Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Below Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	0	0	0	0	0	0	0	0	0	0	0	0
Proposed Project	0	0	0	0	0	0	0	0	0	0	0	0

Table E.5-1 d. Estimates of Green Sturgeon Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Dry

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	2	0	0	0	0	0	0	0	0	12	14	5
Proposed Project	2	0	0	0	0	0	0	0	0	12	15	5

Table E.5-1 e. Estimates of Green Sturgeon Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Critical

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	1	0	0	0	0	0	0	0	0	0	0	0
Proposed Project	1	0	0	1	0	0	0	0	0	0	0	0

Table E.5-1 f. Estimates of Green Sturgeon Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Totals

Totals per Scenario	Wet	Above Normal	Below Normal	Dry	Critical
Existing	50	0	0	33	2
Proposed Project	53	0	0	34	2
Proposed Project vs. Existing	3 (6%)	0 (0%)	0 (0%)	1 (3%)	0 (3%)

Table E.5-2. Estimates of White Sturgeon Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Table E.5-2 a-f

Table E.5-2 g. Estimates of White Sturgeon Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Wet

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	5	3	8	2	1	13	33	29	34	37	20	8
Proposed Project	5	3	8	4	2	13	32	29	34	39	20	8

Table E.5-2 h. Estimates of White Sturgeon Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Above Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	0	0	0	1	0	3	0	0	0	0	4	0
Proposed Project	0	0	0	4	0	3	0	0	0	0	4	0

Table E.5-2 i. Estimates of White Sturgeon Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Below Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	0	4	0	0	0	0	0	0	0	11	0	2
Proposed Project	0	4	0	0	1	0	0	0	0	12	0	2

Table E.5-2 j. Estimates of White Sturgeon Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Dry

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	0	2	5	2	0	0	4	2	0	0	1	0
Proposed Project	0	2	4	3	0	0	3	2	0	0	1	0

Table E.5-2 k. Estimates of White Sturgeon Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Critical

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	0	0	0	0	0	0	0	0	0	2	0	7
Proposed Project	0	0	0	0	0	0	0	0	0	2	0	8

Table E.5-2 l. Estimates of White Sturgeon Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Totals

Totals per Scenario	Wet	Above Normal	Below Normal	Dry	Critical
Existing	193	9	17	15	10
Proposed Project	197	11	19	15	10
Proposed Project vs. Existing	4 (2%)	2 (28%)	2 (10%)	0 (2%)	0 (1%)

Table E.5-3. Estimates of Lamprey Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Table E.5-3 a-f

Table E.5-3 m. Estimates of Lamprey Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Wet

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	4,449	2,103	140	22	36	75	7	4	2	3	0	308
Proposed Project	4,225	1,911	134	48	81	74	7	4	2	3	0	304

Table E.5-3 n. Estimates of Lamprey Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Above Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	869	1,059	818	14	0	13	25	0	9	16	54	124
Proposed Project	875	1,051	764	41	0	13	25	0	8	17	56	122

Table E.5-3 o. Estimates of Lamprey Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Below Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	1,126	52	204	23	9	0	15	1	0	0	0	0
Proposed Project	1,116	52	169	57	29	0	13	1	0	0	0	0

Table E.5-3 p. Estimates of Lamprey Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Dry

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	297	117	505	22	38	17	2	4	0	0	5	623
Proposed Project	293	119	422	39	83	16	2	4	0	0	5	616

Table E.5-3 q. Estimates of Lamprey Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Critical

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	273	75	33	18	54	9	6	0	2	0	0	4
Proposed Project	252	74	34	23	65	9	6	0	2	0	0	4

Table E.5-3 r. Estimates of Lamprey Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Totals

Totals per Scenario	Wet	Above Normal	Below Normal	Dry	Critical
Existing	7,148	2,999	1,431	1,628	474
Proposed Project	6,793	2,972	1,437	1,600	468
Proposed Project vs. Existing	-355 (-5%)	-28 (-1%)	7 (0%)	-29 (-2%)	-6 (-1%)

Table E.5-4. Estimates of Sacramento Splittail Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Table E.5-4 a-f

Table E.5-4 s. Estimates of Sacramento Splittail Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Wet

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	339	290	647	2,144	1,026,062	1,597,642	183,091	3,072	414	198	56	55
Proposed Project	322	263	620	4,725	2,343,301	1,575,358	179,416	3,072	416	211	58	54

Table E.5-4 t. Estimates of Sacramento Splittail Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Above Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	593	482	496	360	15,330	100,172	5,680	128	33	26	37	23
Proposed Project	597	479	463	1,031	50,877	97,892	5,796	130	32	27	38	23

Table E.5-4 u. Estimates of Sacramento Splittail Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Below Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	123	69	273	22	20,749	9,423	625	15	20	28	6	7
Proposed Project	122	68	226	54	66,483	9,190	548	15	21	31	7	6

Table E.5-4 v. Estimates of Sacramento Splittail Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Dry

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	159	69	221	114	110	1,596	265	14	22	9	6	51
Proposed Project	157	71	185	204	240	1,544	244	14	22	10	6	51

Table E.5-4 w. Estimates of Sacramento Splittail Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Critical

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	94	151	81	9	73	760	59	0	0	0	2	0
Proposed Project	87	149	83	12	88	699	62	0	0	0	2	0

Table E.5-4 x. Estimates of Sacramento Splittail Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Totals

Totals per Scenario	Wet	Above Normal	Below Normal	Dry	Critical
Existing	2,814,011	123,360	31,360	2,638	1,230
Proposed Project	4,107,815	157,386	76,772	2,749	1,182
Proposed Project vs. Existing	1,293,804 (46%)	34,026 (28%)	45,412 (145%)	111 (4%)	-49 (-4%)

Table E.5-5. Estimates of Hardhead Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Table E.5-5 a-f

Table E.5-5 y. Estimates of Hardhead Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Wet

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	0	0	0	0	52	0	2	0	0	0	0	2
Proposed Project	0	0	0	0	120	0	1	0	0	0	0	2

Table E.5-5 z. Estimates of Hardhead Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Above Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	0	0	0	0	0	0	0	0	0	0	0	0
Proposed Project	0	0	0	0	0	0	0	0	0	0	0	0

Table E.5-5 aa. Estimates of Hardhead Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Below Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	0	0	0	0	0	0	0	0	0	0	0	0
Proposed Project	0	0	0	0	0	0	0	0	0	0	0	0

Table E.5-5 bb. Estimates of Hardhead Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Dry

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	0	0	0	0	0	0	0	0	0	0	2	0
Proposed Project	0	0	0	0	0	0	0	0	0	0	2	0

Table E.5-5 cc. Estimates of Hardhead Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Critical

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	0	0	0	0	0	0	0	0	0	0	0	0
Proposed Project	0	0	0	0	0	0	0	0	0	0	0	0

Table E.5-5 dd. Estimates of Hardhead Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Totals

Totals per Scenario	Wet	Above Normal	Below Normal	Dry	Critical
Existing	56	0	0	2	0
Proposed Project	123	0	0	2	0
Proposed Project vs. Existing	67 (121%)	0 (0%)	0 (0%)	0 (6%)	0 (0%)

Table E.5-6. Estimates of Striped Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Table E.5-6 a-f

Table E.5-6 ee. Estimates of Striped Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Wet

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	24,573	8,196	2,995	1,012	6,786	122,629	65,760	22,753	9,581	6,670	5,532	7,769
Proposed Project	23,335	7,447	2,868	2,229	15,497	120,919	64,440	22,753	9,615	7,081	5,690	7,687

Table E.5-6 ff. Estimates of Striped Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Above Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	16,266	14,619	10,428	729	3,807	183,978	52,413	13,561	8,156	3,645	6,443	9,306
Proposed Project	16,380	14,508	9,743	2,089	12,633	179,792	53,478	13,768	7,987	3,854	6,696	9,207

Table E.5-6 gg. Estimates of Striped Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Below Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	7,372	8,990	16,854	684	7,485	97,565	25,430	6,872	2,168	1,518	2,326	2,282
Proposed Project	7,308	8,945	13,928	1,685	23,984	95,158	22,322	6,774	2,216	1,643	2,593	2,173

Table E.5-6 hh. Estimates of Striped Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Dry

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	7,739	10,823	14,078	1,353	47,382	343,380	70,333	4,586	1,870	3,120	10,403	8,435
Proposed Project	7,637	11,028	11,785	2,430	103,169	332,250	64,873	4,558	1,864	3,157	11,068	8,344

Table E.5-6 ii. Estimates of Striped Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Critical

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	9,097	9,320	3,808	656	25,703	437,821	88,970	10,667	2,823	5,023	3,798	4,024
Proposed Project	8,392	9,183	3,889	839	31,025	402,384	92,609	11,346	2,859	4,881	4,348	4,122

Table E.5-6 jj. Estimates of Striped Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Totals

Totals per Scenario	Wet	Above Normal	Below Normal	Dry	Critical
Existing	284,256	323,352	179,545	523,503	601,710
Proposed Project	289,561	330,134	188,729	562,163	575,877
Proposed Project vs. Existing	5,306 (2%)	6,782 (2%)	9,184 (5%)	38,660 (7%)	-25,833 (-4%)

Table E.5-7. Estimates of American Shad Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Table E.5-7 a-f

Table E.5-7 kk. Estimates of American Shad Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Wet

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	26,327	2,298	133	30	77	4,524	90,570	93,052	16,365	89,273	110,438	62,996
Proposed Project	25,001	2,088	127	67	175	4,460	88,753	93,052	16,424	94,774	113,590	62,334

Table E.5-7 ll. Estimates of American Shad Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Above Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	32,461	3,725	289	15	4	5,094	123,350	43,344	19,347	16,992	124,899	60,781
Proposed Project	32,687	3,696	270	42	14	4,978	125,856	44,006	18,946	17,963	129,804	60,135

Table E.5-7 mm. Estimates of American Shad Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Below Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	13,436	5,335	563	87	34	1,604	13,704	10,999	2,279	4,312	44,751	24,258
Proposed Project	13,318	5,308	465	215	109	1,565	12,029	10,842	2,330	4,667	49,884	23,107

Table E.5-7 nn. Estimates of American Shad Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Dry

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	12,944	2,396	379	102	8	700	10,828	7,739	1,381	40,646	57,836	54,623
Proposed Project	12,772	2,441	317	182	17	677	9,987	7,691	1,376	41,136	61,535	54,038

Table E.5-7 oo. Estimates of American Shad Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Critical

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	8,063	1,890	87	21	4	129	14,951	7,102	1,886	2,910	24,166	16,697
Proposed Project	7,438	1,862	89	27	5	119	15,563	7,554	1,910	2,828	27,667	17,106

Table E.5-7 pp. Estimates of American Shad Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Totals

Totals per Scenario	Wet	Above Normal	Below Normal	Dry	Critical
Existing	496,083	430,301	121,363	189,582	77,905
Proposed Project	500,844	438,398	123,840	192,171	82,167
Proposed Project vs. Existing	4,761 (1%)	8,097 (2%)	2,477 (2%)	2,589 (1%)	4,261 (5%)

Table E.5-8. Estimates of Largemouth Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Table E.5-8 a-f

Table E.5-8 qq. Estimates of Largemouth Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Wet

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	682	479	346	163	2,378	24,440	15,273	2,600	1,007	750	739	676
Proposed Project	647	435	332	359	5,432	24,099	14,967	2,600	1,010	797	760	668

Table E.5-8 rr. Estimates of Largemouth Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Above Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	316	578	487	67	746	19,773	4,647	651	422	1,586	2,629	1,162
Proposed Project	318	574	455	192	2,475	19,323	4,742	661	413	1,677	2,733	1,149

Table E.5-8 ss. Estimates of Largemouth Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Below Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	1,497	478	329	69	2,840	41,325	9,484	1,378	448	424	1,934	1,434
Proposed Project	1,484	476	272	171	9,101	40,305	8,325	1,358	458	459	2,156	1,366

Table E.5-8 tt. Estimates of Largemouth Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Dry

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	818	845	465	101	2,680	23,244	8,640	789	238	1,632	965	704
Proposed Project	807	861	389	182	5,835	22,490	7,969	784	237	1,652	1,026	697

Table E.5-8 uu. Estimates of Largemouth Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Critical

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	1,271	1,523	382	117	5,048	13,658	3,711	939	250	599	942	651
Proposed Project	1,173	1,500	390	149	6,093	12,553	3,862	999	253	582	1,078	667

Table E.5-8 vv. Estimates of Largemouth Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Totals

Totals per Scenario	Wet	Above Normal	Below Normal	Dry	Critical
Existing	49,534	33,065	61,639	41,121	29,090
Proposed Project	52,106	34,712	65,929	42,930	29,299
Proposed Project vs. Existing	2,573 (5%)	1,647 (5%)	4,290 (7%)	1,809 (4%)	210 (1%)

Table E.5-9. Estimates of Smallmouth Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Table E.5-9 a-f

Table E.5-9 ww. Estimates of Smallmouth Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Wet

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	5	5	0	0	0	3	2	2	5	9	0	2
Proposed Project	5	5	0	0	0	3	1	2	5	10	0	2

Table E.5-9 xx. Estimates of Smallmouth Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Above Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	0	0	0	0	0	0	7	0	0	0	3	0
Proposed Project	0	0	0	0	0	0	7	0	0	0	4	0

Table E.5-9 yy. Estimates of Smallmouth Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Below Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	1	1	2	0	2	0	0	0	0	0	0	0
Proposed Project	1	1	1	0	6	0	0	0	0	0	0	0

Table E.5-9 zz. Estimates of Smallmouth Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Dry

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	0	0	0	0	0	0	0	0	0	0	0	0
Proposed Project	0	0	0	0	0	0	0	0	0	0	0	0

Table E.5-9 aaa. Estimates of Smallmouth Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Critical

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	0	7	4	0	0	0	4	22	2	0	4	0
Proposed Project	0	7	4	0	0	0	4	24	2	0	5	0

Table E.5-9 bbb. Estimates of Smallmouth Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Totals

Totals per Scenario	Wet	Above Normal	Below Normal	Dry	Critical
Existing	32	10	5	0	43
Proposed Project	32	11	9	0	45
Proposed Project vs. Existing	0 (-1%)	0 (3%)	4 (73%)	0 (0%)	2 (5%)

Table E.5-10. Estimates of Spotted Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Table E.5-10 a-f

Table E.5-10 ccc. Estimates of Spotted Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Wet

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	0	1	0	0	0	0	0	0	0	0	0	0
Proposed Project	0	1	0	0	0	0	0	0	0	0	0	0

Table E.5-10 ddd. Estimates of Spotted Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Above Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	0	0	0	0	0	0	0	0	0	0	44	0
Proposed Project	0	0	0	0	0	0	0	0	0	0	46	0

Table E.5-10 eee. Estimates of Spotted Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Below Normal

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	0	0	2	1	0	0	0	0	0	0	0	2
Proposed Project	0	0	1	2	0	0	0	0	0	0	0	2

Table E.5-10 fff. Estimates of Spotted Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 – Dry

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	0	0	0	0	0	0	0	0	0	0	4	0
Proposed Project	0	0	0	0	0	0	0	0	0	0	4	0

Table E.5-10 ggg. Estimates of Spotted Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Critical

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	0	0	0	0	0	2	1	0	0	0	0	0
Proposed Project	0	0	0	0	0	2	2	0	0	0	0	0

Table E.5-10 hhh. Estimates of Spotted Bass Salvage (Numbers of Fish Per Year) at the Central Valley Project South Delta Export Facility for Existing Conditions and Proposed Project Scenarios, Based on the Salvage-Density Method Applied to Water Years 1922-2003 - Totals

Totals per Scenario	Wet	Above Normal	Below Normal	Dry	Critical
Existing	1	44	5	4	4
Proposed Project	1	46	6	4	4
Proposed Project vs. Existing	0 (-9%)	2 (4%)	1 (16%)	0 (6%)	0 (-3%)

E.6 REFERENCES

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E.6.2 Personal Communications

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ATTACHMENT 1
STARS Model Methodologies and Results

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Copy of attachment is available upon request.

Please contact the Lead Agency at LTO@water.gov.

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APPENDIX F

Climate Change Sensitivity Analysis

OPERATIONS SENSITIVITY TO CLIMATE CHANGE PROJECTIONS

This appendix summarizes key findings from a sensitivity analysis of operational changes to existing conditions and Proposed Project under climate change and sea level rise conditions. The existing conditions and the Proposed Project were simulated using CalSim II under the current climate, Q5 (central tendency) climate centered around year 2030 with 15 cm of sea level rise, and Q5 climate centered around year 2030 with 45 cm of sea level rise. The Q5 climate projections were developed for Bay-Delta Conservation Plan/California WaterFix Analyses (ICF 2016). Differences between CMIP 3 and CMIP 5 model projections of changes to average annual temperature and precipitation are described in Attachment 1.

The selected climate change projection reflects the expected likely duration of the SWP permit. The two sea-level rise scenarios considered reflect the range of projected sea level values identified in the latest Ocean Protection Council Sea-Level Rise Guidance released in 2018. The operations results from these simulations were analyzed to understand the range of uncertainty in the incremental changes between the existing conditions and the Proposed Project. This section summarizes key CalSim II results for the existing conditions and the Proposed Project under the three climate and sea level rise scenarios.

Study Objectives

The CalSim II model was applied to evaluate the sensitivity of the existing conditions and Proposed Project to the future climate and sea level rise conditions listed above. The CalSim II model was used for quantifying the changes in river flows, delta channel flows, exports, and water deliveries. Key output parameters from this analysis are shown in Figures 1 through 9. Effects of climate change and sea level rise are summarized below.

Climate Sensitivity Analyses

The existing conditions and Proposed Project simulations described in the EIR were modeled under current or historic climate and sea level conditions. For this sensitivity analysis, the existing conditions and Proposed Project models were generated using the modified hydrologic inputs based on the projected runoff changes under Q5 climate scenarios at year 2030, and compared to a model run that used the historical hydrologic conditions (Q0). This Q5 scenario represents the ensemble-based change from the 20 to 30 climate projections that most closely reflect the change in annual temperature and precipitation (projections within the 25th to 75th percentile changes). The purpose of conducting these simulations is to help describe the sensitivity in projected CVP/SWP system operations with respect to climate change and sea level rise. The scenario with historical climate (Q0) did not include any sea level rise. The CalSim II simulations in this sensitivity analysis only differ in the hydrology inputs depending on the climate scenario considered and/or sea level rise effect. None of the other system parameters have been changed.

Figures 1 through 9 show the system responses for historical climate or Q0 (black lines), Q5 climate scenario with 15 cm of sea level rise (green lines), and Q5 climate scenario with 45 cm of sea level rise (purple lines). For each climate scenario, each dashed line represents the existing conditions and each solid line represents the Proposed Project. Each plot includes results from the CalSim II simulations for the existing conditions and the Proposed Project under the above climate scenarios. Several key observations can be made based on these simulations:

- Under all climate and sea level rise scenarios, Sacramento River flow at Freeport remains similar. Consistent with the current climate, the Proposed Project flow would be less than existing conditions flow in September and November as a result of changes delta smelt fall habitat outflow.
- Yolo Bypass flows are higher during December through March under the future climate projections considered in this analysis. However, flows under the Proposed Project and existing conditions are nearly identical when comparing to the conditions with the same climate and sea level rise assumptions.
- Incremental changes to flows at Georgiana Slough and Delta Cross Channel (DCC) are similar under all climate and sea level rise conditions. These flows reflect the changes in Sacramento River flow at Freeport due to climate change and sea level rise influence on tidal conditions in the estuary. Georgiana Slough flow under Proposed Project is consistently lower in September and November similar to the Sacramento River flow at Freeport. Whereas, DCC flow under Proposed Project is consistently greater in September and October as a result of reduction in likely closure of DCC gates associated with scour concerns.
- Incremental changes in QWEST flows due to the Proposed Project operations are consistent across all climate change scenarios evaluated. Proposed Project result in lower Qwest flows in April and May, and in fall months, with slightly greater flows in winter and summer months under all climate and sea level rise scenarios.
- Incremental changes in Delta outflow due to the Proposed Project under all climate and sea level scenarios are consistent with current climate and sea level scenario. Under all climate and sea level rise scenarios, Delta outflow is lower in April, May, September and November under the Proposed Project as compared to the existing conditions.
- Old and Middle river flows are reflective of the south Delta export changes. The incremental changes during December – June are consistent across all climate and sea level scenarios.
- Modeled exports are most sensitive to the climate and sea level rise scenarios in the summer and fall reflecting the changes in available water supply for south-of-Delta SWP and CVP deliveries. With increasing warming and sea level rise, exports under existing conditions and Proposed Project decrease. Exports in the months that are significantly constrained (February through June) are not as sensitive to climate change and sea level rise.

Overall the relative changes due to the Proposed Project as compared to the existing conditions under the future climate and sea level rise scenarios are similar to that described under the current climate scenario.

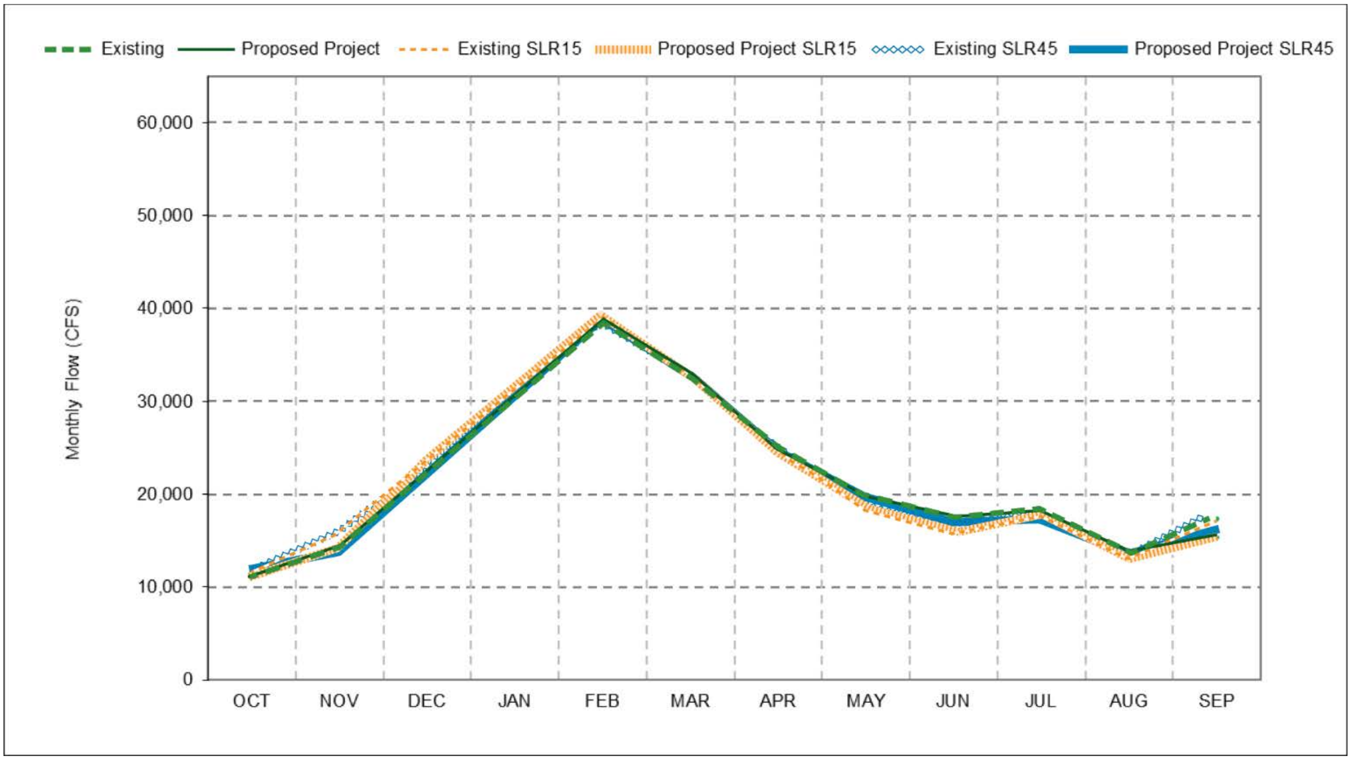

Figure F-1. Sacramento River at Freeport Monthly Flow for the existing conditions and Proposed Project under Q0, Q5 SLR 15 cm, and Q5 SLR 45 cm climate scenarios and sea level rise scenarios at Year 2030

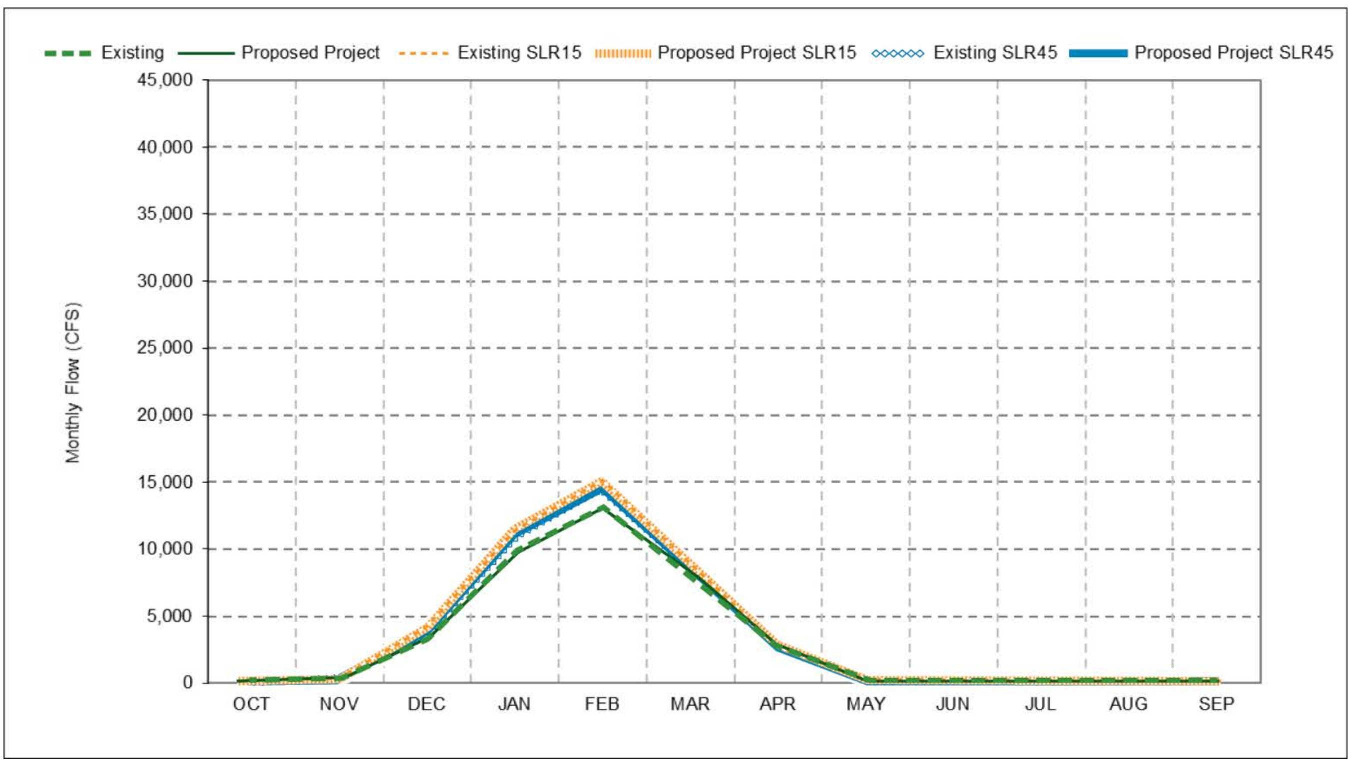

Figure F-2. Monthly Yolo Bypass Flow for the existing conditions and Proposed Project under Q0, Q5 SLR 15 cm, and Q5 SLR 45 cm climate scenarios and sea level rise scenarios at Year 2030

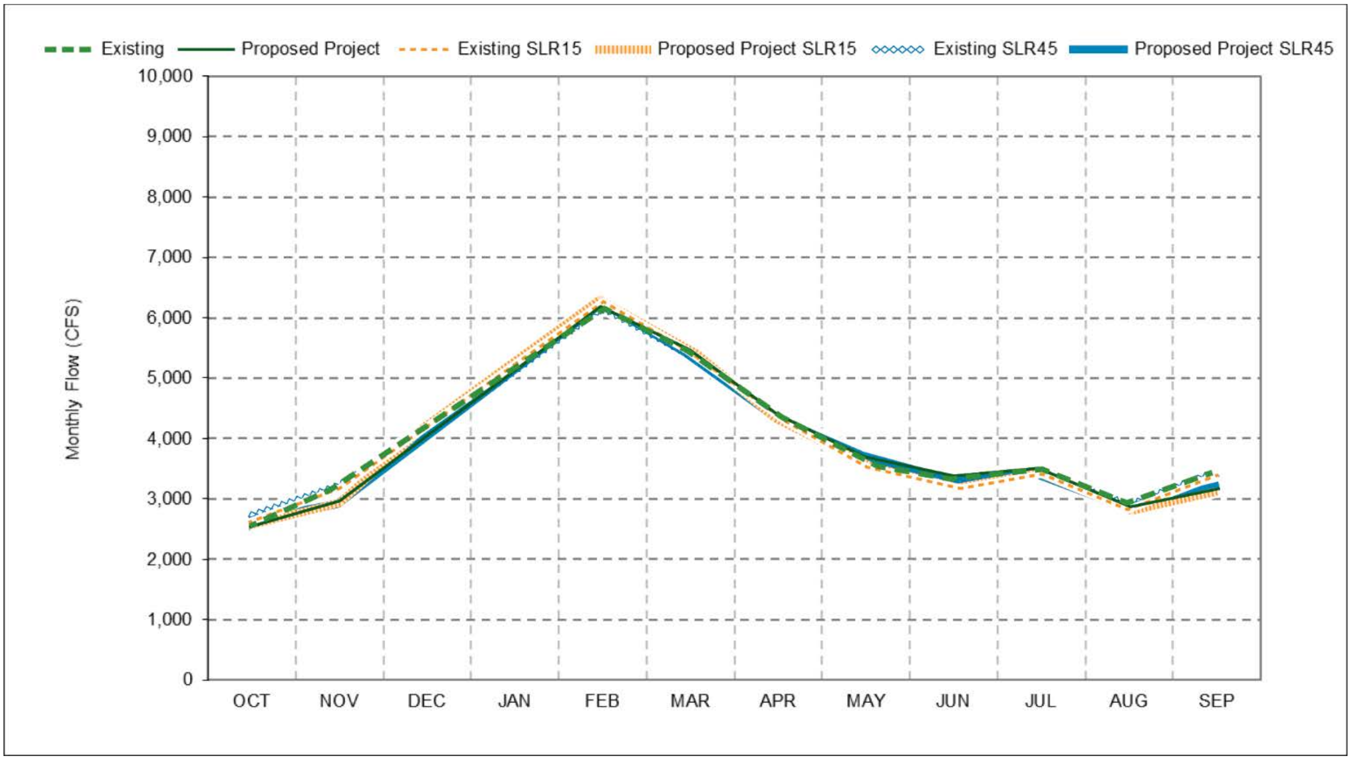

Figure F-3. Monthly Georgiana Slough Flow for the existing conditions and Proposed Project under Q0, Q5 SLR 15 cm, and Q5 SLR 45 cm climate scenarios and sea level rise scenarios at Year 2030

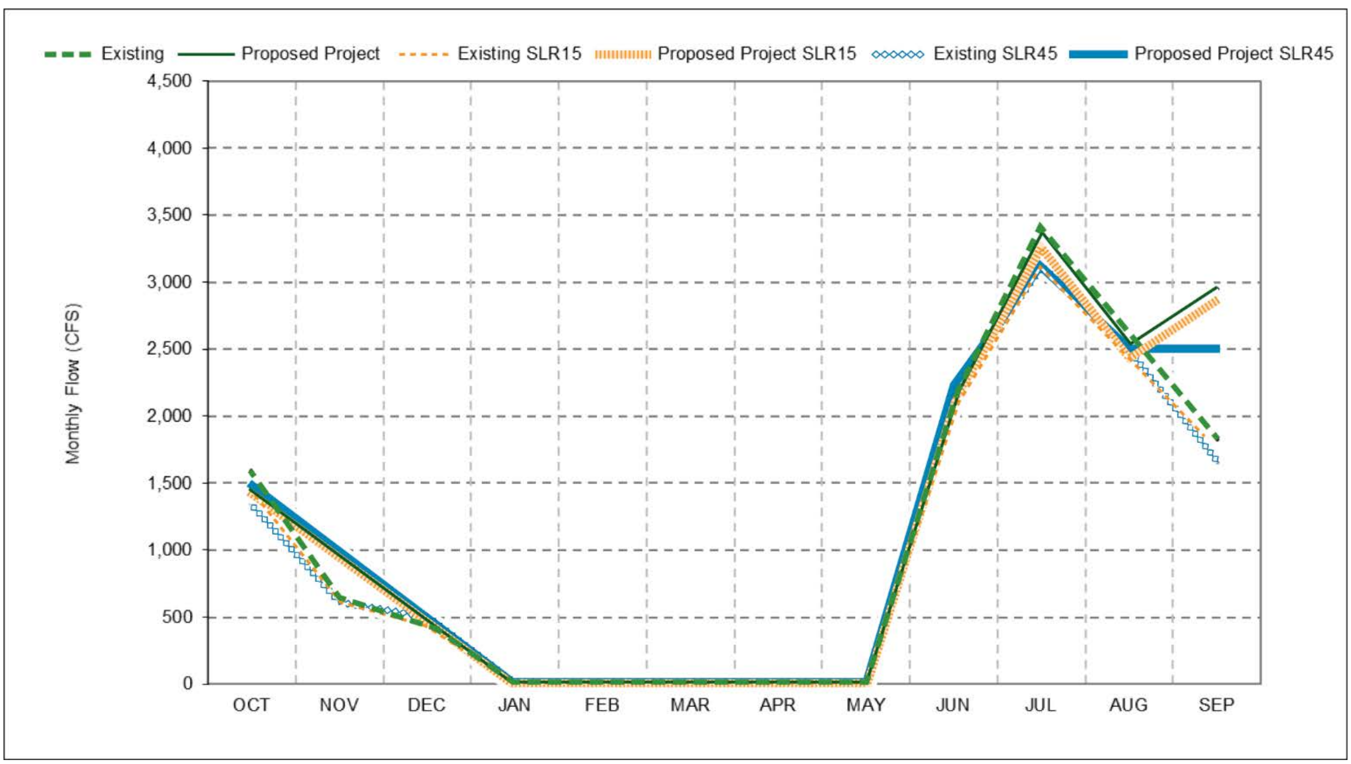

Figure F-4. Monthly DCC Flow for the existing conditions and Proposed Project under Q0, Q5 SLR 15 cm, and Q5 SLR 45 cm climate scenarios and sea level rise scenarios at Year 2030

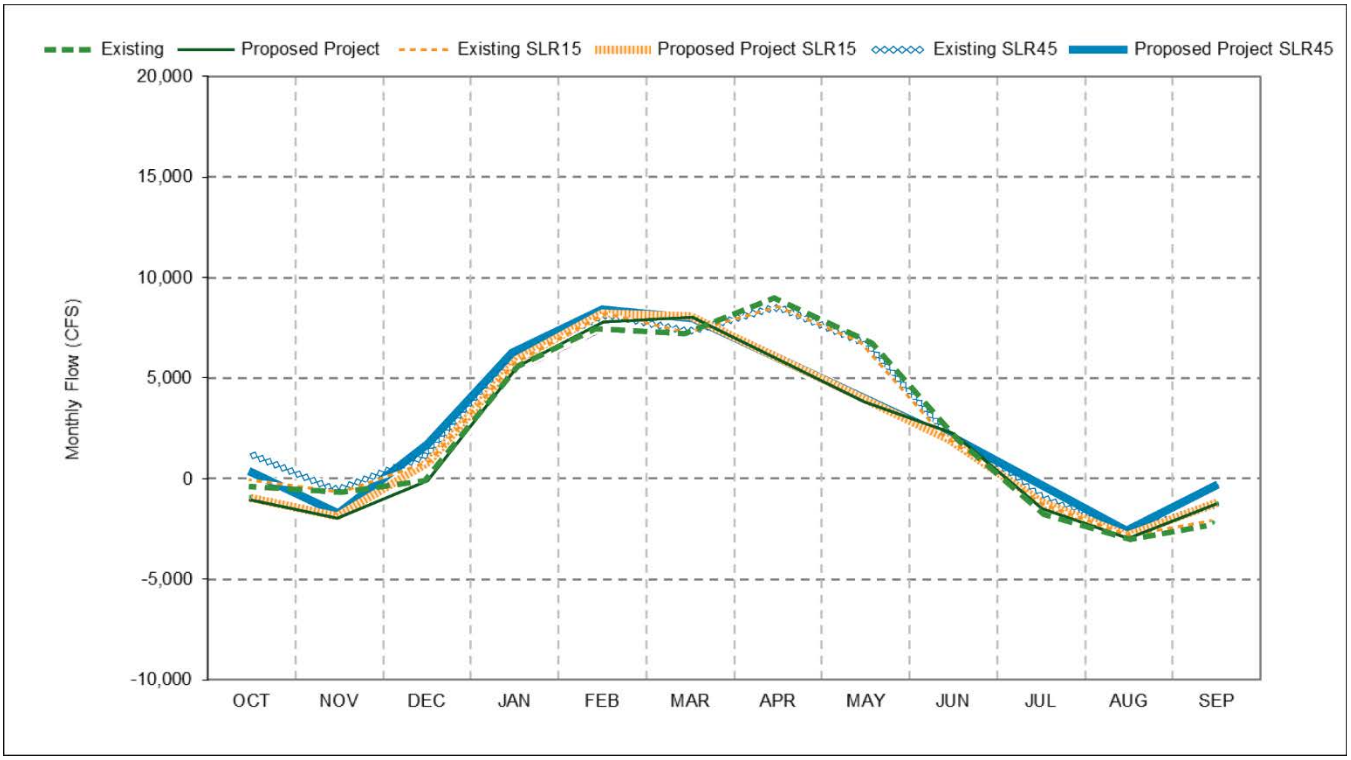

Figure F-5. Monthly Qwest Flow for the existing conditions and Proposed Project under Q0, Q5 SLR 15 cm, and Q5 SLR 45 cm climate scenarios and sea level rise scenarios at Year 2030

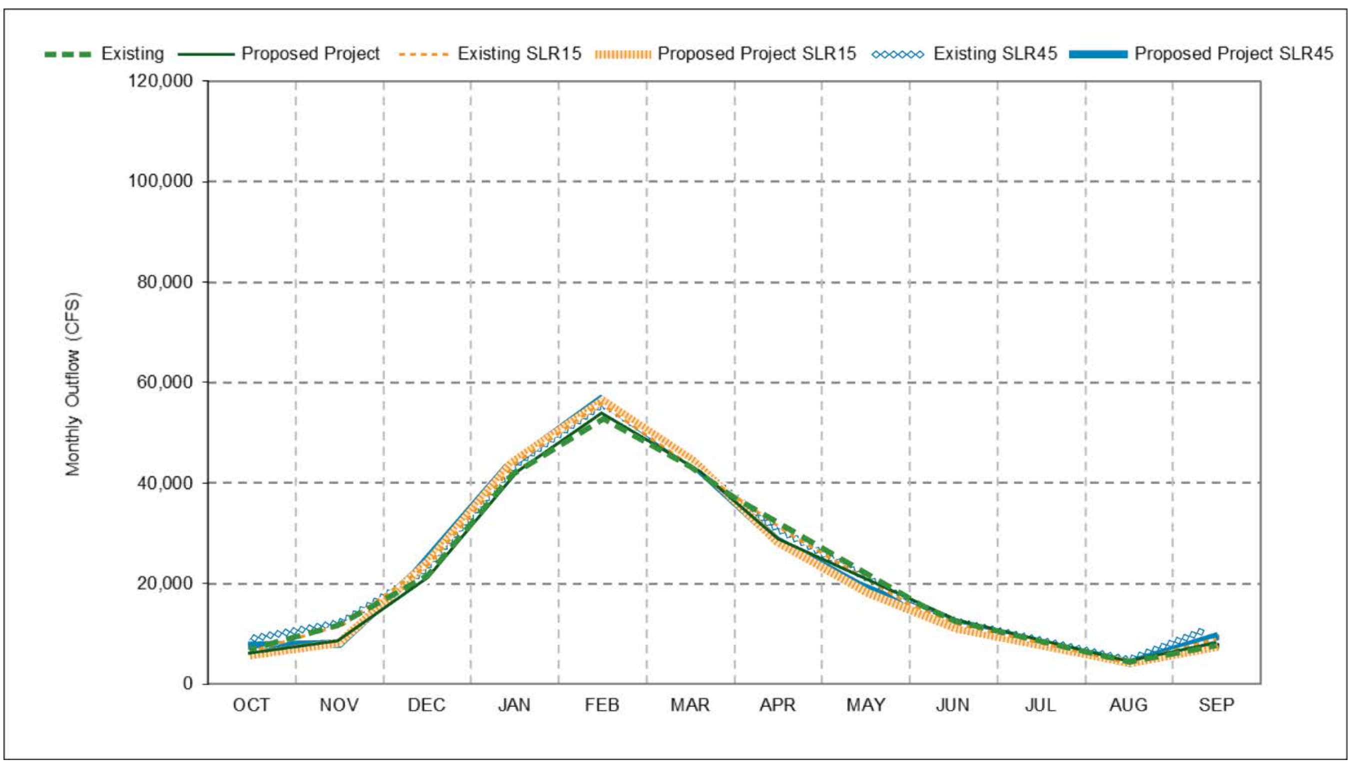

Figure F-6. Monthly Delta Outflow for the existing conditions and Proposed Project under Q0, Q5 SLR 15 cm, and Q5 SLR 45 cm climate scenarios and sea level rise scenarios at Year 2030

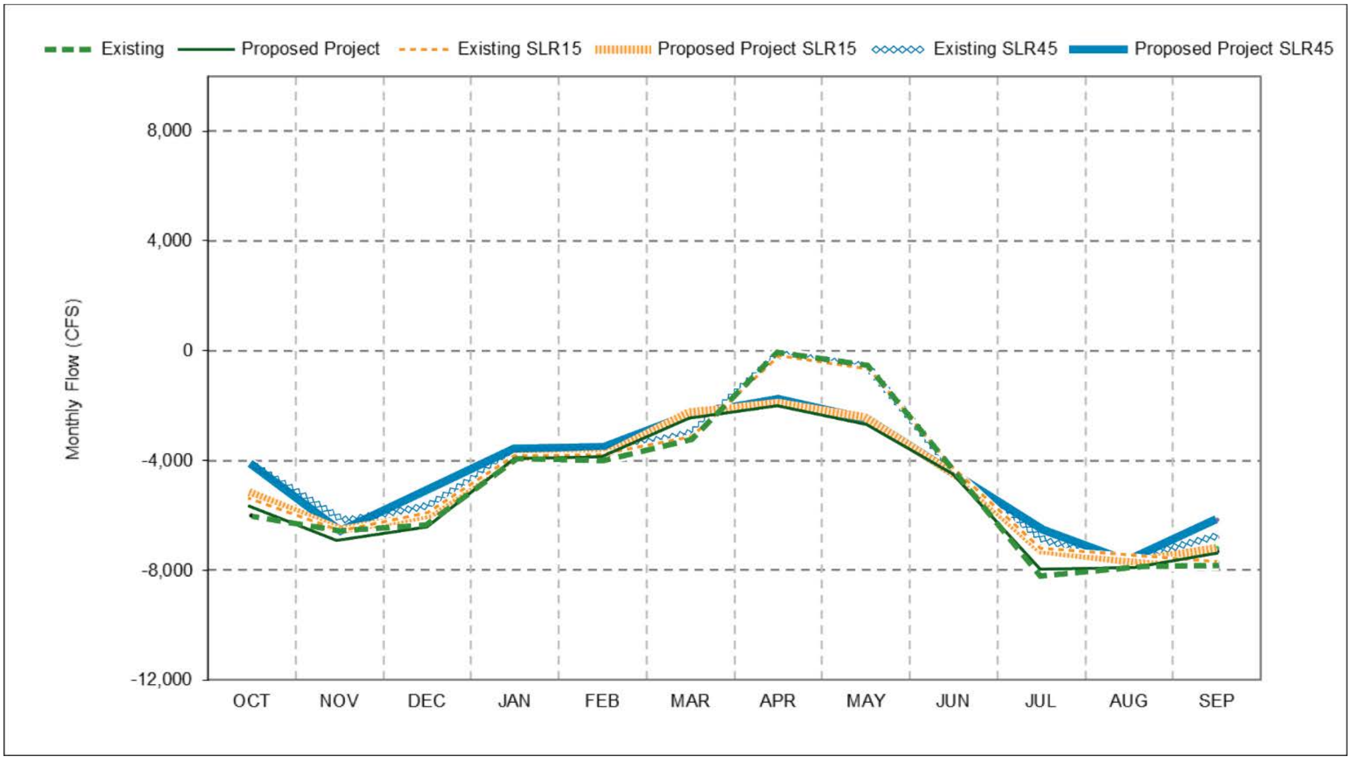

Figure F-7. Combined Old and Middle River Monthly Flow for the existing conditions and Proposed Project under Q0, Q5 SLR 15 cm, and Q5 SLR 45 cm climate scenarios and sea level rise scenarios at Year 2030

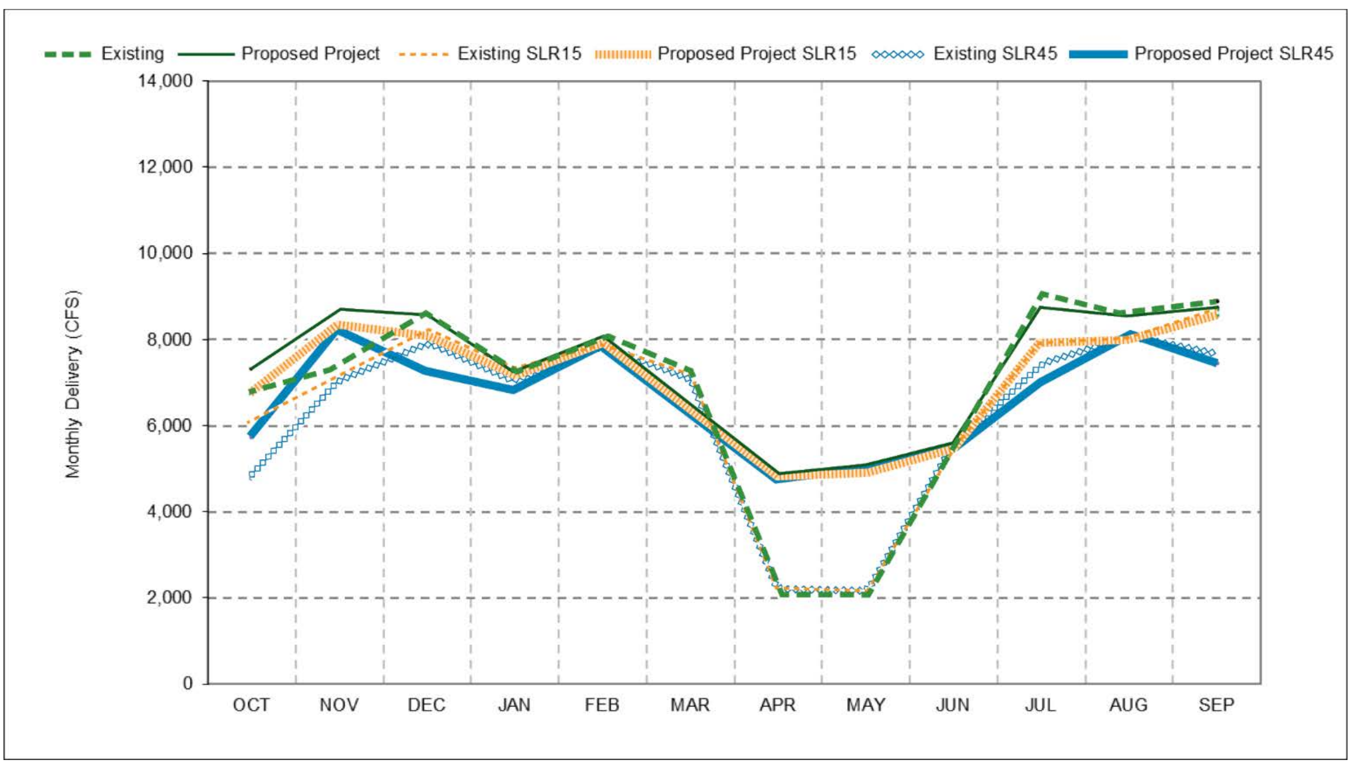

Figure F-8. Monthly Delta Exports for the existing conditions and Proposed Project under Q0, Q5 SLR 15 cm, and Q5 SLR 45 cm climate scenarios and sea level rise scenarios at Year 2030

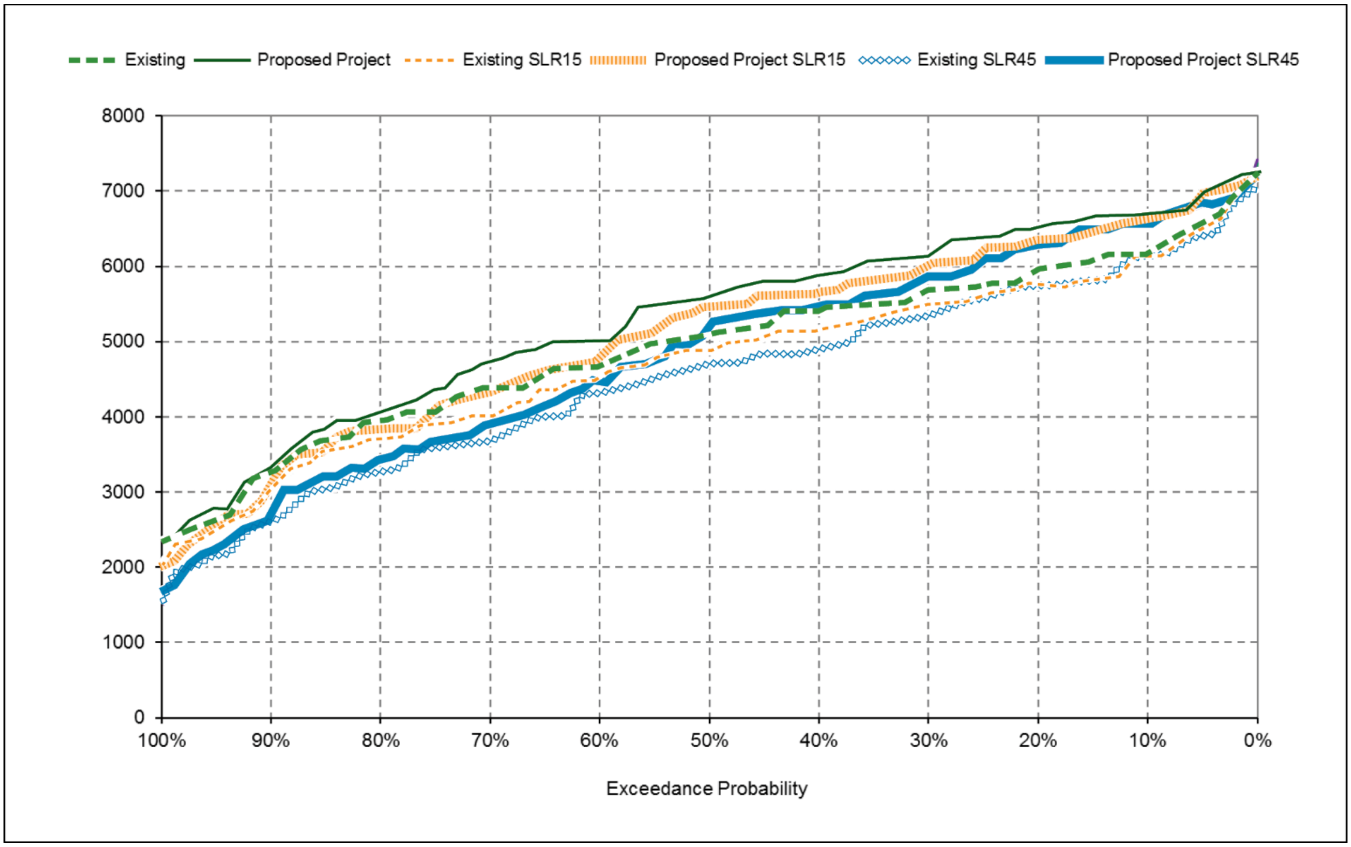

Figure F-9. Annual Delta Exports for the existing conditions and Proposed Project under Q0, Q5 SLR 15 cm, and Q5 SLR 45 cm climate scenarios and sea level rise scenarios at Year 2030

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Attachment 1

Date: Oct 9, 2019

To: Erik Reyes, Supervising Engineer, Central Valley Modeling

From: Romain Maendly, Senior Engineer, Climate Change Program
Wyatt Arnold, Engineer, Climate Change Program

Subject: ***Climate Change Projection Comparison between CMIP 3 and CMIP 5 for the Incidental Take Permit***

Objectives

The purpose of this memorandum is to present a high-level comparison between a subset of climate change projections contained in the Coupled Model Intercomparison Project 3 (CMIP3) and 5 (CMIP3) archives for a thirty-year period centered on 2030 and for the geographic area covering watersheds that drain into the Sacramento-San Joaquin Delta. The comparison will focus on two metrics – average annual temperature and precipitation change – and whether using one archive over the other would have substantial implications for determining social and environmental impacts related to the Incidental Take Permit (ITP) of the State Water Project.

Findings

Due to the short permitting timeline of the ITP (10 years), differences between CMIP3 and CMIP5 model projections of changes in average annual temperature and precipitation are found to be relatively small, suggesting a non-substantial outcome related to the permitting process. Furthermore, in accordance with step 1 screening criteria under DWR Phase II Climate Change Analysis Guidance, this study would not be required to complete climate change analysis due to the ITP short implementation horizon.

Introduction

The ITP for the State Water Project requires the California Department of Water Resources to consider climate change effects relevant over the permit timeframe where climate change refers to any significant change in average climatic conditions (such as mean temperature, precipitation, or wind) or variability (such as seasonality or storm frequency) lasting for an extended period (decades or longer).

In an earlier analysis, climate change was considered in the environmental effects analysis on how it may affect the Project's impacts on resources, i.e., how the resources that are managed are likely to change in response to changing climate conditions and how that modifies or otherwise affects management actions and the impacts of those actions on the resource (California Department of Water Resources 2016). At the time, projections from CMIP3 for temperature and precipitation were used and showed a non-substantial effect of the project under future conditions. However, newer projections generated from CMIP5 are now available. This memorandum explores differences in average annual temperature and precipitation between CMIP3 and CMIP5 projections for a thirty-year period centered on 2030 and determines whether these differences could have a substantial impact on the ITP analysis.

CMIP3

CMIP3 is the model ensemble for the IPCC's Fourth Assessment Report and was released in 2010. CMIP3 is used to generate projections of future climate conditions across the globe. CMIP3 uses four Special Report on Emission Scenarios (SRES) each of which represents a level of greenhouse gas emission trajectories. In total there are 16 general circulation models (GCM) in the CMIP3 archive which use the SRES to represent potential future conditions related to temperature and precipitation changes.

Current climate change analysis used in ITP

The current climate change ITP analysis uses a subset of CMIP3 which includes 16 GCM with three SRES emission scenarios (A2, A1b, and B1) for a total of 112 future climate projections[1] that have been subsequently bias-corrected and statistically downscaled to 1/8th degree (~12km) resolution. The ensemble of 112 projections is broken into quadrants representing (Q1) drier, less warming, (Q2) drier, more warming, (Q3) wetter, more warming, and (Q4) wetter, less warming than the ensemble median. A fifth region (Q5) located in the inner-quartiles (25th to 75th percentile) of the ensemble is used in the ITP analysis for a thirty-year period centered on 2030. The Q5 scenario reflects a composite projection from the individual projections that are closest to the median change, and thus reflect the "consensus" of projections. Figure 1 shows an example of the downscaled ensemble of climate projections and sub-ensembles used for deriving the quadrants. The following steps were applied to incorporate an expended time series which allow the use of long term observed records with the climate change signal from Q5:

1. Extract a 30-year slice of downscaled climate projections based on the ensemble subset for the quadrant of interest and centered on the year of investigation (i.e. 2025 or 2060)
2. For each calendar month (i.e. January) of the future period, determine the statistical properties (cumulative distribution function, CDF) of temperature and precipitation at each grid cell
3. For each calendar month of the historical period (1971-2000 in our case), determine the statistical properties (CDFs) of temperature and precipitation at each grid cell
4. Develop quantile maps between the historic observed CDFs and the future downscaled climate CDFs, such that the entire probability distribution (including means, variance, skew, etc.) at the monthly scale is transformed to reflect the climate scenario
5. Using the quantile maps, redevelop a monthly time series of temperature and precipitation over the observed period (1915 -2003) that incorporates the climate shift of the future period
6. Convert monthly time series to a daily time series by scaling monthly values to daily sequence found in the observed record

The result of the quantile mapping approach is a daily time series of temperature and precipitation that has the range of variability observed in the historical record but also contains the shift in climate

[1] Some GCM are run with multiple initial conditions resulting in multiple projections for the same GCM and SRES scenario.

properties (both mean and expanded variability) found in the downscaled climate projection using CMIP3.

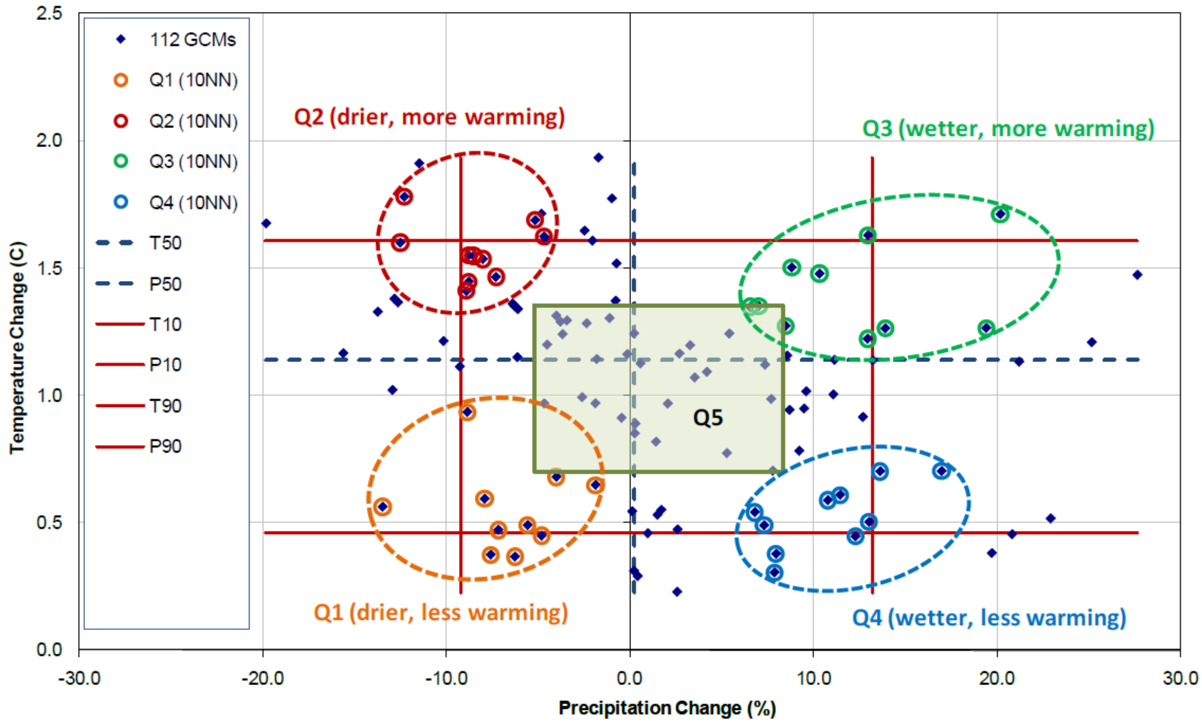

Figure 1. Example downscaled climate projections and sub-ensembles used for deriving climate scenarios (Q1-Q5). The Q5 scenario is bounded by the 25th and 75th percentile joint temperature-precipitation change. Scenarios Q1-Q4 are selected to reflect the results of the 10 projections nearest each of the 10th and 90th joint temperature-precipitation change bounds

CMIP5

CMIP5 is the model ensemble for the IPCC's fifth assessment report and was released in 2013. Similar to CMIP3, CMIP5 is used to generate projections of future climate conditions across the globe. CMIP5 uses four Representative Concentration Pathway (RCP-2.6, -4.5, -6.0 and -8.5) which supersede the SRES and represent greenhouse gas concentration rather than emissions. In overall there are 36 general circulation models (GCM) that are using these scenarios to represent potential future conditions related to temperature and precipitation changes.

Comparison of CMIP5 and CMIP3 Model Projections

Knutti et al. (2012) compared the CMIP3 and CMIP5 model archives and determined that CMIP5 projections are largely consistent with CMIP3. They conclude that differences in global temperature projections are largely attributable to the different greenhouse gas emissions scenarios used in the IPCC AR assessments.

Figures 2 and 3 show the average annual precipitation and annual average temperature anomalies of CMIP5[2] and CMIP3 archives for the region contributing flow to the Sacramento-San Joaquin Delta (see

[2] In this comparison analysis, RCP's 2.6 and 6.0 were not used from the CMIP5 archive. RCP 2.6 scenario is a relatively low greenhouse-gas emission scenario, while RCP 4.5, RCP 6.0, and RCP 8.5 appear as reasonable choices to represent low and high emissions scenarios, given current rates of global fossil fuel consumption and economic development (CCTAG 2015).

Figure 4). The darker lines are mean anomaly across all models in CMIP3 (orange) and CMIP5 (blue) archives. Bars extend to the 95th and 5th percentile model anomalies. Anomaly is calculated using the baseline historical model simulation period 1950-2005.

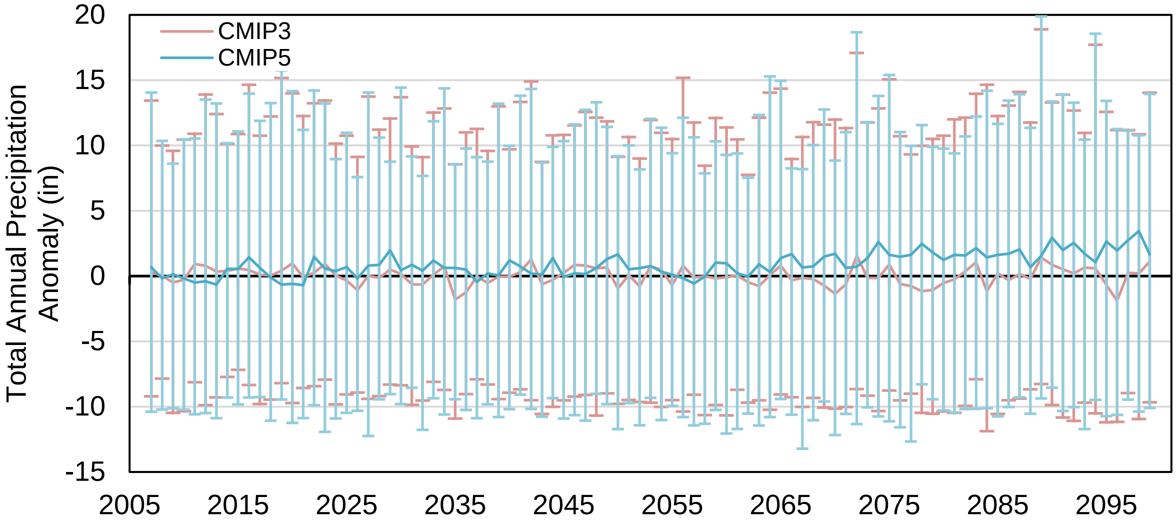

Figure 2. Total Annual Precipitation Anomaly of CMIP5 and CMIP3. Darker lines are mean annual anomaly of the CMIP3 (orange) and CMIP5 (blue) archives. Bars extend to 95th and 5th percentile model anomalies. Anomaly is calculated from baseline1950-2006 historical model simulation period

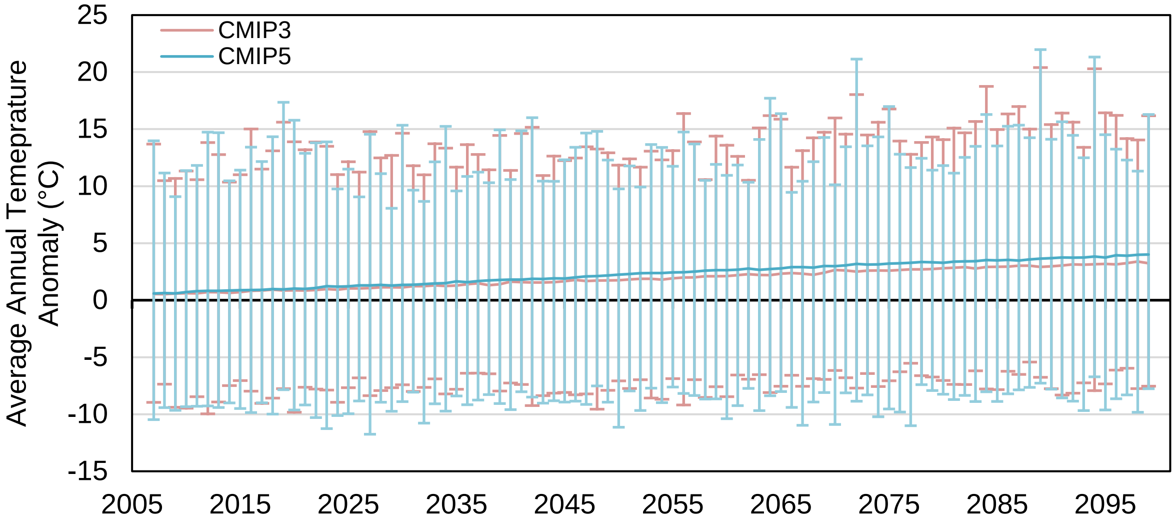

Figure 3. Average Annual Temperature Anomaly of CMIP5 and CMIP3. Darker lines are mean annual anomaly of the CMIP3 (orange) and CMIP5 (blue) archives. Bars extend to 95th and 5th percentile model anomalies. Anomaly is calculated from baseline 1950-2006 historical model simulation period

RCP 6.0 was also not included because there are fewer model run for this specific emission scenarios compared to RCP 4.5 and 8.5.

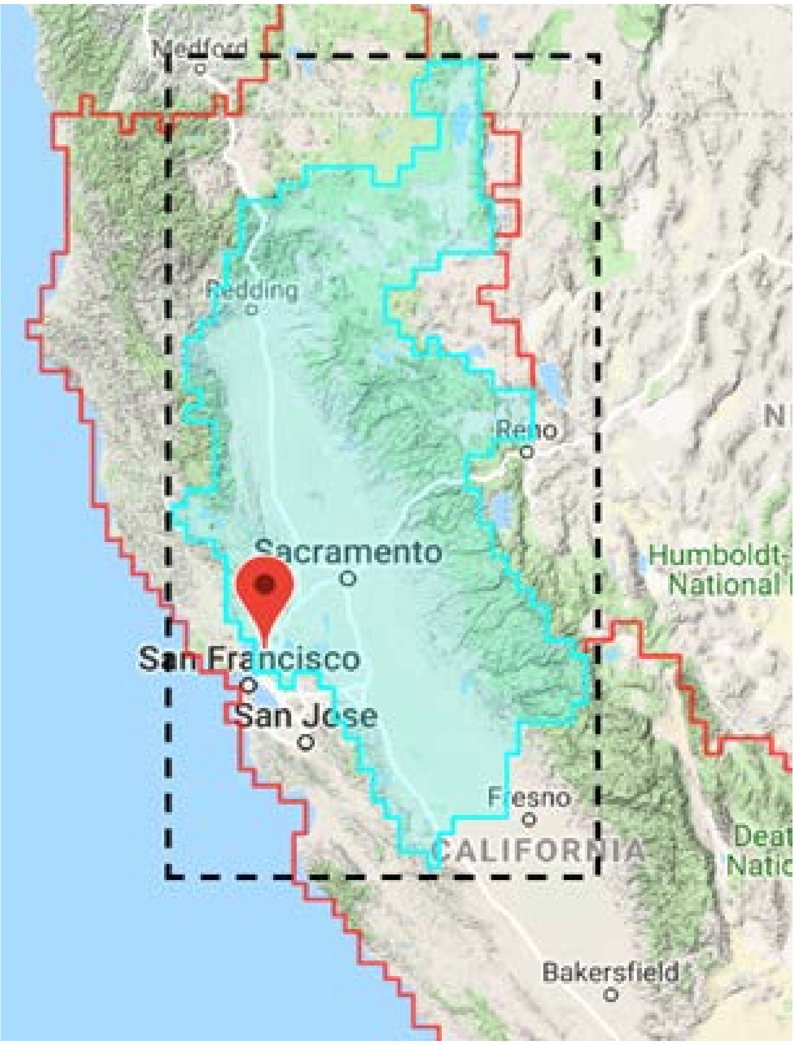

Figure 4: Geographic extent of the region contributing flow to the Sacramento San-Joaquin Delta (polygon highlighted in blue). A bounding box (rectangle is drawn with a dotted line) indicates the area over which GCM grids from the CMIP3 and CMIP5 archives were spatially averaged

An increasing trend in the average CMIP5 archive annual precipitation anomaly is seen in Figure 2. The CMIP3 archive has no such discernible trend. However, the difference in the average precipitation anomaly between CMIP5 and CMIP3 is difficult to distinguish until mid-century. Similar observations can be made for the annual average temperature anomalies. In the long term, the increasing trend in average CMIP5 archive annual average temperature than CMIP3 as shown in Figure 3. However, the difference between CMIP5 and CMIP3 for years up until 2045 is difficult to distinguish.

Tables 1 and 2 show the average annual precipitation and temperature anomaly change for a thirty-year period centered on 2030 from the baseline historical model simulation period 1950-2005. The tables compare the max, min, 25th and 75th percentile, median, and average values under CMIP3 and CMIP5. Table 1 shows that the average annual precipitation change is greater CMIP5 than CMIP3 for the average, median, 25 percentile and 75 percentile values, yet less or equal to 3%.

Table 1. Change in the average annual precipitation anomaly for a thirty-year period centered on 2030 compared to the baseline 1950-2005 historical model period

Annual Precipitation Anomaly Change (%) at Year 2030	Annual Precipitation Anomaly Change (%) at Year 2030 CMIP3	Annual Precipitation Anomaly Change (%) at Year 2030 CMIP5
Average	0%	2%
Median	-2%	1%
25%	-6%	-3%
75%	5%	7%
Min	-14%	-16%
Max	28%	20%

Table 2 shows that the annual average temperature change is greater in CMIP5 than CMIP3 yet that the difference is relatively small (≤0.3°C).

Table 2. Change in the annual average temperature anomaly for a thirty-year period centered on 2030 compared to the baseline 1950-2005 historical model period

Annual Average Temperature Anomaly Change (°C) at Year 2030	Annual Average Temperature Anomaly Change (°C) at Year 2030 CMIP3	Annual Average Temperature Anomaly Change (°C) at Year 2030 CMIPS
Average	1.18	1.39
Median	1.22	1.40
25%	0.83	1.14
75%	1.46	1.67
Min	0.41	0.63
Max	2.02	2.17

Climate Action Plan, Phase II: Climate Change Analysis Guidance

In 2018, DWR published a climate change analysis guidance document to guide DWR in its decision making and assist DWR managers as they incorporate climate change analysis into their planning for DWR activities, such as strategic planning documents, investment decisions, risk assessments, and infrastructure development.

In accordance with step 1 screening criteria under DWR Phase II Climate Change Analysis Guidance, this study would not be required to complete climate change analysis due to the ITP short implementation horizon.

Summary and Conclusion

Based on the differences observed between CMIP3 and CMIP5 average and median anomalies for temperature and precipitation, the use of either archive does not suggest substantial differences in the outcome of the current ITP climate change analysis were a Q5 CMIP5-based ensemble to be used. In general, the slight difference in the CMIP5 precipitation signal would most likely lead to an improvement in the performance objective of the study.

References

California Department of Water Resources. 2016. Bay Delta Conservation Plan. Chapter 29.

California Department of Water Resources. 2018. Climate Action Plan, Phase II: Climate Change Analysis Guidance.

Knutti, Reto, and Jan Sedláček. 2012. Robustness and Uncertainties in the New CMIP5 Climate Model Projections." Nature Climate Change 3 (October:369).

APPENDIX G

Geographic Scope of Project's Influence on Flow

Purpose of this Memorandum

The purpose of this memorandum is to explain how the Department of Water Resources (DWR) identified the geographic scope of flow changes associated with the project described in the Environmental Impact Report (EIR) for the Long-Term Operation of the California State Water Project (Project). In making this determination, DWR considered: (1) the geographic scope of State Water Project (SWP) operations' influence (i.e., the "zone of influence")[1] particularly with respect to the operations described in the Project; and (2) whether, in light of SWP and Central Valley Project (CVP)[2] coordinated operations, the Project would cause a reasonably foreseeable response by United States Bureau of Reclamation (Reclamation) that could result in changes in CVP operations outside the SWP zone of influence.

This memorandum describes the zone of influence affected by the Project as the Sacramento River below the confluence of the Feather River, the legal Delta, and the Suisun Marsh and Bay. This memorandum also explains that DWR cannot reasonably foresee how Reclamation will operate the CVP because, even though DWR and Reclamation coordinate to meet joint regulatory requirements, DWR and Reclamation exercise independent discretion over *how* to operate the SWP and CVP, respectively, to best meet those requirements in concert with other obligations. How Reclamation might respond to the Project, and any potential implications of Reclamation's response, is speculative. Thus, the analysis of flow-related impacts is appropriately focused on the SWP zone of influence and does not include areas that are affected only by CVP actions.

Approach

This memorandum relies on the knowledge and experience of SWP operators to describe both the SWP zone of influence and the independent operational decisions controlling SWP and CVP operations. DWR and Reclamation make operating decisions based on real-time data that constantly change. SWP operators are better able to describe the operational decision-making process than a computer model, such as CalSim, can because a model can only provide a generalized representation of the Projects that simulate operations based on specific rules.[3] Operators, however, understand the complexities of the decision-making process and, therefore, can more accurately and realistically explain how those operational decisions relate to flow changes.

SWP Zone of Influence

The SWP is made up of dams, reservoirs, generation and pumping plants, conveyance, both natural and man-made, and delivery structures, among others. The major components of the SWP that

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[1] For the purpose of this memorandum, the zone of influence means the spatial area or volume of receiving water flow within which some change in flow or water quality is anticipated to occur as a result of a discharge, extraction, or other activity.

[2] The SWP and CVP are jointly referred to a "Projects."

[3] CalSim is developed jointly by DWR and Reclamation to simulate SWP and CVP operations for long-term planning analyses. While the model is not able to capture all complexities of real time operations, it does apply generalized rules that represent SWP and CVP operations. CalSim is currently the best available tool for evaluating the SWP and CVP long-term planning activities.

influence flow in the natural waterways are: 1) the Oroville-Thermalito Hydroelectric Complex (Oroville Complex or Oroville), and 2) SWP Delta facilities, including Clifton Court Forebay, Barker Slough Pumping Plant, and Suisun Marsh Salinity Control Gates.

At Oroville, DWR manages runoff from the Feather River Watershed for flood control, environmental flows, local agricultural use, and water supply for the SWP. Water originating from Oroville only influences waterbodies that are directly downstream and that naturally receive drainage from the Feather River basin. As depicted in the Project Location map in the Draft EIR,[4] the receiving waterbody is the Sacramento River at the confluence with the Feather River. The Sacramento River then drains into the Delta. Operations of the Oroville Complex and resulting flows in the Feather River are not included in the EIR because Oroville operations are governed by separate legal authorizations, including a Federal Energy Regulatory Commission (FERC) license and other associated regulatory reviews and requirements. No changes to operations of the Oroville Complex are proposed as part of this Project.

Within the Delta, SWP export facilities including Clifton Court Forebay and Barker Slough Pumping Plant divert: 1) water that was previously stored in Oroville, and 2) other unstored water that is in excess of all other regulatory requirements. This excess flow may originate from flood control releases or other unstored runoff and is exportable under SWP water rights permits. When the SWP export facilities divert water that was previously stored in Oroville, the Clifton Court Forebay allotment and the Oroville releases are managed together to maintain compliance with the regulatory requirements. These requirements include but are not limited to flow and water quality requirements. The Project's zone of influence during these conditions would extend from the Sacramento River below the confluence with the Feather River to the southern part of the Delta and Suisun Marsh and Bay.

Flows available during excess conditions[5] are independent of export operations at the SWP, where the export operations do not influence the amount of inflow into the Delta but may change the flow paths within the Delta region. The zone of influence during these excess conditions would be limited to the Delta and Suisun Marsh and Bay.

In addition to the changes in releases and diversions at the SWP export facilities, DWR manages the Suisun Marsh Salinity Control Gates (SMSCG) and the south Delta temporary barriers (commonly referred to as the Temporary Barriers Program or TBP). The SMSCG are used to manage the water quality within the Suisun Marsh. The gates are typically operated to tidally pump fresher water into Montezuma Slough. Because the SMSCG effectively pumps fresher water into the Suisun Marsh, a compensating action is typically required to maintain similar salinity conditions within the central Delta. The zone of influence of the SMSCG are the Suisun Marsh and Bay, and the central Delta, however compensating actions could include export or release changes.

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[4] Draft EIR, Figure 1-1. Long-Term SWP Operations Project Area.

[5] The Coordinated Operations Agreement (COA) defines "excess water conditions" as "periods when it is agreed that releases from upstream reservoirs plus unregulated flow exceed Sacramento Valley inbasin uses, plus exports." COA at Article 3(c).

The TBP are temporary rock structures with the primary purpose of maintaining water elevations for the local diverters. These structures influence the water elevations in the south Delta as well as the flow paths. The zone of influence of the TBP is the south Delta starting at the bifurcation of the San Joaquin River into the head of Old River and extending downstream and diminishing before connecting again with the San Joaquin River.

In summary, for the purposes of this EIR, the Project's zone of influence is confined to the Sacramento River below the confluence with the Feather River, the legal Delta, and the Suisun Marsh and Bay.

CVP Independent Operation

When identifying the area of flow changes for the purpose of the EIR, DWR considered whether SWP operations would cause reasonably foreseeable CVP operational responses in areas outside the SWP zone of influence due to coordinated SWP and CVP operations. The SWP and CVP operate together to meet the joint regulatory requirements in the Delta including those defined in the State Water Resources Control Board (SWRCB) Water Quality Control Plan (currently set forth in D-1641). The Coordinated Operations Agreement (COA) is a 1986 agreement, updated in 2018, that governs how the SWP and CVP share water under their water rights and operate to meet these regulatory requirements.[6]

Even though the SWP and CVP coordinate operations, DWR and Reclamation independently decide how to operate the individual projects to best meet applicable requirements. The COA does not define what actions DWR or Reclamation will take in any given set of circumstances. These decisions occur in real-time, allowing operators to account for constantly changing conditions such as tides, accretions and depletions, and hydrology.

Typically, the SWP and CVP either implement storage or export changes to meet many of the regulatory requirements. For example, when making operational decisions, SWP operators essentially have two knobs: 1) releases from Oroville, and 2) SWP exports. When SWP operators manage the Oroville releases and Clifton Court Forebay allotment, they are managing to conditions within the Feather River, like flood and minimum instream flow requirements. They are also managing to conditions in the Delta including outflow, interior flow, and water quality requirements. Although SWP operators discuss their management decisions with CVP operators, SWP operational actions are determined by DWR only.

Similarly, CVP operators select from a set of options to make operational changes to meet regulatory requirements such as Shasta Reservoir, Trinity Reservoir, Folsom Reservoir, the Delta Cross Channel, and CVP exports. Reclamation has manual control over, and has discretion to choose, any potential combination of operational actions to achieve its desired result. It would be speculative for DWR to try to predict how Reclamation will exercise its discretion in real-time.

[6] Agreement Between the United States of American and the State of California for the Coordinate Operation of the Central Valley Project and the State Water Project (Nov. 24, 1986); Addendum to the Agreement Between the United States of America and the Department of Water Resources of the State of California for the Coordinated Operation of the Central Valley Project and the State Water Project (Dec. 12, 2018).

Conclusion

In conclusion, DWR appropriately identified the Project's geographic scope of flow changes as its zone of influence, which includes the Sacramento River below the confluence of the Feather River, the legal Delta, and the Suisun Marsh and Bay. Although DWR and Reclamation jointly operate the SWP and CVP under the COA, the agencies exercise independent discretion regarding how to carry out operations to meet shared legal requirements. It would be speculative for DWR to identify any potential flow changes of the Project outside the zone of influence because DWR cannot reasonably foresee how Reclamation might respond to the Project.

APPENDIX H

CalSim II and DSM2 Model Descriptions and Assumptions

Appendix H

H.1 Introduction

The results of model simulations are provided for informational purposes. Please do not use any information contained in these products for any purpose other than this EIR process. If there are any questions regarding the results of these model simulations, please contact DWR.

Any use of results of model simulations should observe limitations of the models used as well as the limitations to the modeled alternatives. These results should only be used for comparative purposes. More information regarding limitations of the models used as well as the limitations to the modeled alternatives is included Appendix H Attachment 1-7 Model Limitations.

H.2 Modeled Alternatives

The following alternatives were prepared:

- Existing Conditions (EX)
- Proposed Project (PP)

The assumptions used for each alternative and each model listed above are documented in the following attachments:

- Appendix C Attachment 1-1 Model Assumptions
- Appendix C Attachment 1-2 CalSim II Model Assumptions Callouts
- Appendix C Attachment 1-3 DSM2 Model Assumptions Callouts

The following attachments contain documentation of model assumptions and limitations:

- Appendix C Attachment 1-4 Scenario Related Changes to CalSim II and DSM2
- Appendix C Attachment 1-5 SWP Contribution
- Appendix C Attachment 1-6 DSM2-PTM
- Appendix C Attachment 1-7 Model Limitations
- Appendix C Attachment 1-8 CalSim II Assumptions and Real Time Operations

The following is a summary of the alternatives and the models used.

Existing Conditions

The Existing Conditions represents CVP and SWP operations to comply with the “current” regulatory environment as of (April 22, 2019). The Existing Conditions assumptions include existing facilities and ongoing programs that existed as of April 22, 2019- publication date of the Notice of Preparation (NOP).

The Existing Conditions assumptions also include facilities and programs that received approvals and permits by April, 2019 because those programs were consistent with existing management direction as of the NOP.

Proposed Project

The proposed project is the DWR on-going long-term operation of the State Water Project (SWP) consistent with existing regulatory requirements that address water rights, water quality, and the protection and conservation of designated species in compliance with California Endangered Species Act (CESA). The goal of the proposed project is to continue the long-term operation of the SWP for water supply and power generation, consistent with applicable laws, contractual obligations, and agreements, and to increase operational flexibility by focusing on nonoperational measures to avoid significant adverse effects. DWR proposes to store, divert, and convey water in accordance with existing water contracts and agreements up to full contract amounts and other deliveries, consistent with water rights and applicable laws and regulations.

The following model simulations were prepared for each alternative:

- CalSim II
- DSM2

H.3 CalSim II

Reclamation / DWR CalSim II planning model was used to simulate the coordinated operation of the CVP and SWP over a range of hydrologic conditions. CalSim II is a generalized reservoir-river basin simulation model that allows for specification and achievement of user-specified allocation targets, or goals (Draper et al. 2004). CalSim II represents the best available planning model for CVP and SWP system operations and has been used in previous system-wide evaluations of CVP and SWP operations (U.S. Bureau of Reclamation 2015).

Salinity in the Sacramento-San Joaquin Delta is critical to project and ecosystem management. Operation of CVP/SWP facilities and management of Delta flows often depends on salinity standards. An Artificial Neural Network (ANN) was developed (Sandhu et al. 1999) to estimate flow – salinity relationships modeled by DSM2 (described below). The ANN is utilized in CalSim II to ensure upstream reservoir operations and Delta exports meet select D1641 salinity requirements in the Delta. More details regarding the ANN and its implementation in CalSim II can be found in Wilbur and Munévar (2001).

H.4 DSM2

DSM2 is a one-dimensional hydrodynamic and water quality simulation model used to simulate hydrodynamics, water quality, and particle tracking in the Sacramento-San Joaquin Delta (DWR, 2019). DSM2 represents the best available planning model for Delta tidal hydraulic and salinity modeling. It is appropriate for describing the existing conditions in the Delta, as well as performing simulations for the assessment of incremental environmental impacts caused by future facilities and operations (U.S. Bureau of Reclamation 2015).

H.5 References

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Sandhu, N. and D. Wilson, R. Finch, and F. Chung. (1999). "Modeling Flow-Salinity Relationships in the Sacramento-San Joaquin Delta Using Artificial Neural Networks". Technical Information Record OSP-99-1, Sacramento: California Department of Water Resources

U. S. Bureau of Reclamation, 2015. Coordinated Long Term Operation of the CVP and SWP EIS, Appendix 5A CalSim II and DSM2 Modeling.

Wilbur, Ryan & Munevar, Armin. (2001). Chapter 7: Integration of CALSIM and Artificial Neural Networks Models for Sacramento-San Joaquin Delta Flow-Salinity Relationships.

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Attachment 1-1 Model Assumptions

1 Introduction

The following model simulations were prepared to evaluate the impacts of different project:

- Existing Conditions (EX)
- Proposed Project (PP)

Sections 2 and 3 describe the assumptions used for each model simulation. Section 4 lists references cited.

The assumptions for all model simulations are also summarized in table format in the following attachments:

- Appendix H Attachment 1-2 CalSim II Model Assumptions Callouts
- Appendix H Attachment 1-3 DSM2 Model Assumptions Callouts
- Appendix H Attachment 1-4 Scenario Related Changes to CalSim II and DSM2
- Appendix H Attachment 1-5 SWP Contribution
- Appendix H Attachment 1-6 DSM2 – PTM
- Appendix H Attachment 1-7 Model Limitations
- Appendix H Attachment 1-8 CalSim II Assumptions and Real Time Operations

Any use of results of model simulations should observe limitations of the models used as well as the limitations to the modeled alternatives. These results should only be used for comparative purposes. More information regarding limitations of the models used is included Appendix H Attachment 1-7 Model Limitations.

2 Assumptions for the Existing Conditions

This section presents the assumptions used in developing the CalSim II and DSM2, Model simulations of the Existing Conditions considered for the EIR.

The Existing Conditions represents SWP operations to comply with the “current” regulatory environment as of (2019). The Existing Conditions assumptions include existing facilities and ongoing programs that existed as of April 22, 2019- publication date of the Notice of Preparation (NOP).

The Existing Conditions assumptions also include facilities and programs that received approvals and permits by April, 2019 because those programs were consistent with existing management direction as of the NOP.

2.1 CalSim II Assumptions for the Existing Conditions

The following is a description of the assumptions tabulated in Appendix H Attachment 1-2 CalSim II Model Assumptions Callouts.

Hydrology

Inflows/Supplies

The CalSim II model includes the historical hydrology.

Level of Development

CalSim II uses a hydrology which is the result of an analysis of agricultural and urban land use and population estimates. The assumptions used for Sacramento Valley land use result from aggregation of historical survey and projected data developed for the California Water Plan Update (Bulletin 160-98). Generally, land use projections are based on Year 2020 estimates (hydrology serial number 2020D09E), however the San Joaquin Valley hydrology reflects draft 2030 land use assumptions developed by Reclamation. Where appropriate Year 2020 projections of demands associated with water rights and CVP and SWP water service contracts have been included. Specifically, projections of full build out are used to describe the American River region demands for water rights and CVP contract supplies, and California Aqueduct and the Delta Mendota Canal SWP/CVP contractor demands are set to full contract amounts.

CVP Settlement Contractor Consumptive Use of Applied Water (CUAW) Demands are modified to match historical annual volumes and monthly distributions, based on historical data from 2000 – 2016. The monthly distributions of annual contract amounts were also modified to match the distributions of CUAW demand.

Demands, Water Rights, CVP/SWP Contracts

CalSim II demand inputs are preprocessed monthly time series for a specified level of development (e.g. 2020) and according to hydrologic conditions. Demands are classified as CVP project, SWP project, local project or non-project. CVP and SWP demands are separated into different classes based on the contract type. A description of various demands and classifications included in CalSim II is provided in the 2008 OCAP BA Appendix D (USBR, 2008a).

The detailed listing of CVP and SWP contract amounts and other water rights assumptions are included in the delivery specification tables in Appendix H Attachment 1-2 CalSim II Model Assumptions Callouts.

Facilities

All CVP-SWP existing facilities are simulated based on operations criteria under current regulatory environment.

CalSim II includes representation of all the existing CVP and SWP storage and conveyance facilities. Assumptions regarding selected key facilities are included in the callout tables in Appendix H Attachment 1-2 CalSim II Model Assumptions Callouts.

CalSim II also represents the flood control weirs such as the Fremont Weir located along the Sacramento River at the upstream end of the Yolo Bypass (Reclamation, 2017).

The Existing Conditions also includes the Freeport Regional Water Project, located along the Sacramento River near Freeport and the City of Stockton Delta Water Supply Project (30 mgd capacity).

A brief description of the key export facilities that are located in the Delta and included under the Existing Conditions run is provided below.

The Delta serves as a natural system of channels to transport river flows and reservoir storage to the CVP and SWP facilities in the south Delta, which export water to the projects' contractors through two pumping plants: CVP's C.W. Jones Pumping Plant and SWP's Harvey O. Banks Pumping Plant. Jones and Banks Pumping Plants supply water to agricultural and urban users throughout parts of the San Joaquin Valley, South Lahontan, Southern California, Central Coast, and South San Francisco Bay Area regions.

The Contra Costa Canal and the North Bay Aqueduct supply water to users in the northeastern San Francisco Bay and Napa Valley areas.

Fremont Weir

Fremont Weir is a flood control structure located along the Sacramento River at the head of the Yolo Bypass.

CVP C.W. Bill Jones Pumping Plant (Tracy PP) Capacity

The Jones Pumping Plant consists of six pumps including one rated at 800 cfs, two at 850 cfs, and three at 950 cfs. Maximum pumping capacity is assumed to be 4,600 cfs with the 400 cfs Delta Mendota Canal (DMC) –California Aqueduct Intertie that became operational in July 2012.

SWP Banks Pumping Plant Capacity

SWP Banks pumping plant has an installed capacity of about 10,300 cfs. The SWP water rights for diversions specify a maximum of 10,300 cfs, but the U. S. Army Corps' of Engineers (ACOE) permit for SWP Banks Pumping Plant allows a maximum pumping of 6,680 cfs. With additional diversions depending on Vernalis flows the total diversion can go up to 10,300 cfs during December 15 – March 15. Additional capacity of 500 cfs (pumping limit up to 7,180 cfs) is allowed to reduce impact of NMFS BO Action IV.2.1 on the SWP.

CCWD Intakes

The Contra Costa Canal originates at Rock Slough, about four miles southeast of Oakley, and terminates after 47.7 miles at Martinez Reservoir. Historically, diversions at the unscreened Rock Slough facility (Contra Costa Canal Pumping Plant No. 1) have ranged from about 50 to 250 cfs. The canal and associated facilities are part of the CVP; but are operated and maintained by the Contra Costa Water District (CCWD). CCWD also operates a diversion on Old River and the Alternative Intake Project (AIP), the new drinking water intake at Victoria Canal, about 2.5 miles east of Contra Costa Water District's (CCWD) intake on the Old River. CCWD can divert water to the Los Vaqueros Reservoir to store good quality water when available and supply to its customers.

Regulatory Standards

The regulatory standards that govern the operations of the CVP and SWP facilities under the Existing Conditions are briefly described below. Specific assumptions related to key regulatory standards are also outlined below.

D-1641 Operations

The SWRCB Water Quality Control Plan (WQCP) and other applicable water rights decisions, as well as other agreements are important factors in determining the operations of both the Central Valley Project (CVP) and the State Water Project (SWP).

The December 1994 Accord committed the CVP and SWP to a set of Delta habitat protective objectives that were incorporated into the 1995 WQCP and later, were implemented by D-1641. Significant elements in D-1641 include X2 standards, export/inflow (E/I) ratios, Delta water quality standards, real-time Delta Cross Channel operation, and San Joaquin flow standards.

Coordinated Operations Agreement (COA)

The CVP and SWP use a common water supply in the Central Valley of California. Reclamation and DWR have built water conservation and water delivery facilities in the Central Valley in order to deliver water supplies to project contractors. The water rights of the projects are conditioned by the SWRCB to protect the beneficial uses of water within each respective project and jointly for the protection of beneficial uses in the Sacramento Valley and the Sacramento-San Joaquin Delta Estuary. The agencies coordinate and operate the CVP and SWP to meet the joint water right requirements in the Delta.

The Coordinated Operations Agreement (COA), signed in 1986, defines the project facilities and their water supplies, sets forth procedures for coordination of operations, identifies formulas for sharing joint responsibilities for meeting Delta standards as they existed in SWRCB Decision 1485 (D-1485), identifies how unstored flow will be shared, sets up a framework for exchange of water and services between the Projects, and provides for periodic review of the agreement.

DWR and Reclamation re-negotiated COA in 2018. The amendment stipulates a change in responsibility for making storage withdrawals to meet in-basin use (as noted in Table 1) and a change in export capacity when exports are constrained (Table 2).

Table 1. Sharing of Responsibility for Meeting In-basin Use

–	CVP	SWP
W	80%	20%
AN	80%	20%
BN	75%	25%
D	65%	35%
C	60%	40%

Note:

– = This cell is blank

Table 2. Sharing of Applicable Export Capacity When Exports Are Constrained

–	CVP	SWP
Balanced Water Conditions	65%	35%
Excess Water Conditions	60%	40%

Note:

– = This cell is blank

CVPIA (b)(2) Assumptions

The Existing Conditions includes a dynamic representation of the Central Valley Project Improvement Act (CVPIA) 3406(b)(2) water allocation, management and related actions (B2). The selection of discretionary actions for use of B2 water in each year was based on a May 2003 Department of the Interior policy decision. The use of B2 water is assumed to continue in conjunction with the USFWS and NMFS BO RPA actions. CalSim II does not dynamically account for the use of (b)(2) water, but rather assumes pre-determined upstream fish objectives for Clear Creek. Other (b)(2) actions are assumed to be accommodated by USFWS and NMFS BiOp RPA actions.

Continued CALFED Agreements

The Environmental Water Account (EWA) was established in 2000 by the CALFED Record of Decision (ROD). The EWA was initially identified as a 4-year cooperative effort intended to operate from 2001 through 2004 but was extended through 2007 by agreement between the EWA agencies. It is uncertain, however, whether the EWA will be in place in the future and what actions and assets it may include. Because of this uncertainty, the EWA has not been included in the current CalSim II implementation.

One element of the EWA available assets is the Lower Yuba River Accord (LYRA) Component 1 water. In the absence of the EWA and implementation in CalSim II, the LYRA Component 1 water is assumed to be transferred to South of Delta (SOD) State Water Project (SWP) contractors to help mitigate the impact of the NMFS BO and D1641 on SWP exports during April and May. An additional 500 cfs of capacity is permitted at Banks Pumping Plant from July through September to export this transferred water.

USFWS Delta Smelt BO Actions

The USFWS Delta Smelt BO was released on December 15, 2008, in response to Reclamation's request for formal consultation with the USFWS on the coordinated operations of the Central Valley Project (CVP) and State Water Project (SWP) in California. To develop CalSim II modeling assumptions for the RPA documented in this BO, DWR led a series of meetings that involved members of fisheries and project agencies. This group has prepared the assumptions and CalSim II implementations to represent the RPA in the CalSim II model. The following actions of the USFWS BO RPA have been included in the Existing Conditions CalSim II model simulation:

- Action 1: Adult Delta smelt migration and entrainment (RPA Component 1, Action 1 – First Flush)
- Action 2: Adult Delta smelt migration and entrainment (RPA Component 1, Action 2)
- Action 3: Entrainment protection of larval and juvenile Delta smelt (RPA Component 2)
- Action 4: Estuarine habitat during Fall (RPA Component 3)

- Action 5: Temporary spring head of Old River barrier and the Temporary Barrier Project (RPA Component 2)

A detailed description of the assumptions that have been used to model each action is included in the technical memorandum "Representation of U.S. Fish and Wildlife Service Biological Opinion Reasonable and Prudent Alternative Actions for CalSim II Planning Studies", prepared by an interagency working group under the direction of the lead agencies. This technical memorandum is included in the Appendix 5A of the LTO EIS (Reclamation 2015b).

NMFS BO Salmon Actions

The NMFS Salmon BO on long-term operations of the CVP and SWP was released on June 4, 2009. To develop CalSim II modeling assumptions for the RPA's documented in this BO, DWR led a series of meetings that involved members of fisheries and project agencies. This group has prepared the assumptions and CalSim II implementations to represent the RPA in the CalSim II model for future planning studies. The following NMFS BO RPA's have been included in the Existing Conditions CalSim II model simulation:

- Action I.1.1: Clear Creek spring attraction flows
- Action I.4: Wilkins Slough operations
- Action II.1: Lower American River flow management
- Action III.1.3: Stanislaus River flows below Goodwin Dam
- Action IV.1.2: Delta Cross Channel gate operations
- Action IV.2.1: San Joaquin River flow requirements at Vernalis and Delta export restrictions
- Action IV.2.3: Old and Middle River flow management

For Action I.2.1, which calls for a percentage of years that meet certain specified end-of-September and end-of-April storage and temperature criteria resulting from the operation of Lake Shasta, no specific CalSim II modeling code is implemented to simulate the performance measures identified.

A detailed description of the assumptions that have been used to model each action is included in the technical memorandum "Representation of National Marine Fisheries Service Biological Opinion Reasonable and Prudent Alternative Actions for CalSim II Planning Studies", prepared by an interagency working group under the direction of the lead agencies. This technical memorandum is included in the in Appendix 5A of the LTO EIS (Reclamation 2015c) and is incorporated here by reference.

Water Transfers

Lower Yuba River Accord (LYRA)

Acquisitions of Component 1 water under the Lower Yuba River Accord, and use of 500 cfs dedicated capacity at Banks PP during July – September, are assumed to be used to reduce as much of the impact of the Apr – May Delta export actions on SWP contractors as possible.

Phase 8 transfers

Phase 8 transfers are not included in the Existing Conditions simulation.

Short-term or Temporary Water Transfers

Short term or temporary transfers such as Sacramento Valley acquisitions conveyed through Banks PP are not included in the Existing Conditions simulation.

Specific Regulatory Assumptions

Upper Sacramento Flow Management

Model includes SWRCB WR 90-5 and NMFS BO (Jun 2009) Action I.2.2 achieved as possible through other modeled actions.

Lower Feather Flow Management

Model includes 1983 DWR, DFG Agreement (minimum flow 750 – 1,700 cfs, depending on runoff and month).

Lower American Flow Management

The 2006 American River Flow Management Standard (ARFMS) is included in the Existing Conditions.

The flow requirements of ARFMS are further described in Reclamation 2006.

Delta Outflow (Flow and Salinity)

SWRCB D-1641:

All Delta outflow requirements per SWRCB D-1641 are included in the Existing Conditions simulation. Similarly, for the February through June period the X2 standard is included in the Existing Conditions simulation.

USFWS BO (December, 2008) Action 4:

USFWS BO Action 4 requires additional Delta outflow to manage X2 in the fall months following wet and above normal years to maintain an average X2 for September and October no greater (more eastward) than 74 kilometers following wet years and 81 kilometers following above normal years. In November, the inflow to CVP/SWP reservoirs in the Sacramento Basin should be added to reservoir releases to provide an added increment of Delta inflow and to augment Delta outflow up to the fall X2 target. This action is included in the Existing Conditions simulation.

Combined Old and Middle River Flows

USFWS BO restricts south Delta pumping to preserve certain OMR flows in three of its Actions: Action 1 to protect pre-spawning adult Delta smelt from entrainment during the first flush, Action 2 to protect pre-spawning adults from entrainment and from adverse hydrodynamic conditions, and Action 3 to protect larval Delta smelt from entrainment. CalSim II simulates these actions to a limited extent.

Brief description of USFWS BO Actions 1-3 implementations in CalSim is as follows: Action 1 is onset based on a turbidity trigger that takes place during or after December. This action requires limit on exports so that the average daily OMR flow is no more negative than -2,000 cfs for a total duration of 14 days, with a 5-day running average no more negative than -2,500 cfs (within 25 percent of the monthly criteria). Action 1 ends after 14 days of duration or when Action 3 is triggered based on a temperature criterion. Action 2 starts immediately after Action 1 and requires a range of net daily OMR flows to be no more negative than -1,250 to -5,000 cfs (with a 5-day running average within 25 percent of the monthly criteria). The Action continues until Action 3 is triggered. Action 3 also requires net daily OMR flow to be no more negative than -1,250 to -5,000 cfs based on a 14-day running average (with a simultaneous 5-day running average within 25 percent). Although the range is similar to Action 2, the Action implementation is different. Action 3 continues until June 30 or when water temperature reaches a certain threshold. A more detailed description is included in the Appendix 5A of the LTO EIS (Reclamation 2015b).

NMFS BO Action 4.2.3 requires OMR flow management to protect emigrating juvenile winter-run, yearling spring-run, and Central Valley steelhead within the lower Sacramento and San Joaquin rivers from entrainment into south Delta channels and at the export facilities in the south Delta. This action requires reducing exports from January 1 through June 15 to limit negative OMR flows to -2,500 to -5,000 cfs. CalSim II assumes OMR flows required in NMFS BO are covered by OMR flow requirements developed for actions 1 through 3 of the USFWS BO as described in the Appendix 5A of the LTO EIS (Reclamation 2015c).

South Delta Export-San Joaquin River Inflow Ratio

NMFS BO Action 4.2.1 requires exports to be capped at a certain fraction of San Joaquin River flow at Vernalis during April and May while maintaining a health and safety pumping of 1,500 cfs.

Exports at the South Delta Intakes

Exports at Jones and Banks Pumping Plant are restricted to their permitted capacities per SWRCB D-1641 requirements. In addition, the south Delta exports are subjected to Vernalis flow-based export limits during April and May as required by Action 4.2.1. Additional 500 cfs pumping is allowed to reduce impact of NMFS BO Action 4.2.1 and D1641 on SWP during the July through September period.

Under D-1641 the combined export of the CVP Tracy Pumping Plant and SWP Banks Pumping Plant is limited to a percentage of Delta inflow. The percentage ranges from 35 to 45 percent during February depending on the January eight river index and is 35 percent during March through June months. For the rest of the months 65 percent of the Delta inflow is allowed to be exported.

A minimum health and safety pumping of 1,500 cfs is assumed from January through June.

Delta Water Quality

The Existing Conditions simulation includes SWRCB D-1641 salinity requirements. However, not all salinity requirements are included as CalSim II is not capable of predicting salinities in the Delta. Instead, empirically based equations and models are used to relate interior salinity conditions with the flow conditions. DWR's Artificial Neural Network (ANN) trained for salinity is used to predict and interpret salinity conditions at the Emmaton, Jersey Point, and Rock Slough stations. Emmaton and Jersey Point standards are for protecting water quality conditions for agricultural use in the western Delta and they are in effect from April 1 to August 15. The EC requirement at Emmaton varies from 0.45 mmhos/cm to 2.78 mmhos/cm, depending on the water year type. The EC requirement at Jersey Point varies from 0.45 to 2.20 mmhos/cm, depending on the water year type. The Rock Slough standard is for protecting water quality conditions for M&I use for water exported through the Contra Costa Canal. It is a year-round standard that requires a certain number of days in a year with chloride concentration less than 150 mg/L. The number of days requirement is dependent upon the water year type.

San Joaquin River Restoration Program

Friant Dam releases required by the San Joaquin River Restoration Program are included in the Existing Conditions. More detailed description of the San Joaquin River Restoration Program is presented in the Appendix 3A "*No Action Alternative: Central Valley Project and State Water Project Operations*" of the LTO EIS (Reclamation 2015a).

Operations Criteria

Delta Cross Channel Gate Operations

SWRCB D-1641 DCC standards provide for closure of the DCC gates for fisheries protection at certain times of the year. From November through January, the DCC may be closed for up to 45 days. From February 1 through May 20, the gates are closed every day. The gates may also be closed for 14 days during the May 21 through June 15 time period. Reclamation determines the timing and duration of the closures after discussion with USFWS, CDFW, and NMFS.

NMFS BO Action 4.1.2 requires gates to be operated as described in the BO based on the presence of salmonids and water quality from October 1 through December 14; and gates to be closed from December 15 to January 31, except for short-term operations to maintain water quality. CalSim II includes the NMFS BO DCC gate operations in addition to the D-1641 gate operations. When the daily flows in the Sacramento River at Wilkins Slough exceed 7,500 cfs (flow assumed to flush salmon into the Delta), DCC is closed for a certain number of days in a month as described in Appendix 5A of the LTO EIS (Reclamation 2015b). During October 1 – December 14, if the flow trigger condition is such that additional days of DCC gates closure is called for, however water quality conditions are a concern and the DCC gates remain open, then Delta exports are limited to 2,000 cfs for each day in question.

Allocation Decisions

CalSim II includes allocation logic for determining deliveries to north-of-Delta and south-of-Delta CVP and SWP contractors. The delivery logic uses runoff forecast information, which incorporates uncertainty in the hydrology, and standardized rule curves (i.e. Water Supply Index versus Demand Index Curve). The rule curves relate forecasted water supplies to deliverable "demand," and then use deliverable "demand" to assign subsequent delivery levels to estimate the water available for delivery and carryover storage. Updates of delivery levels occur monthly from January 1 through May 1 for the SWP and March 1 through May 1 for the CVP as runoff forecasts become more certain. The south-of-Delta SWP delivery is determined based on water supply parameters and operational constraints. The CVP system wide delivery and south-of-Delta delivery are determined similarly upon water supply parameters and operational constraints with specific consideration for export constraints.

San Luis Operations

CalSim II sets targets for San Luis storage each month that are dependent on the current South-of-Delta allocation and upstream reservoir storage. When upstream reservoir storage is high, allocations and San Luis fill targets are increased. During a prolonged drought when upstream storage is low, allocations and fill targets are correspondingly low. For the Existing Conditions simulation, the San Luis rule curve is managed to minimize situations in which shortages may occur due to lack of storage or exports.

New Melones Operations

In addition to flood control, New Melones is operated for four different purposes: fishery flows, water quality, Bay-Delta flow, and water supply.

Fishery

In the Existing Conditions, fishery flows refer to flow requirements of the 2009 NMFS BO Action III.1.3 (NMFS 2009). These flows are patterned to provide fall attraction flows in October and outmigration pulse flows in spring months (April 15 through May 15 in all years) and total up to 98.9 TAF to 589.5 TAF annually depending on the hydrological conditions based on the New Melones water supply forecast (the end-of-February New Melones Storage, plus the March - September forecast of inflow to the reservoir) (Tables 3 through 5).

Table 3. Annual Fishery Flow Allocation in New Melones

New Melones Water Supply Forecast (TAF)	Fishery Flows (TAF)
0 to 1,399.9	185.3
1,400 to 1,999.9	234.1
2,000 to 2,499.9	346.7
2,500 to 2,999.9	483.7
≥3,000	589.5

Table 4. Monthly "Base" Flows for Fisheries Purposes Based on the Annual Fishery Volume

Annual Fishery Flow Volume (TAF)	Base Flow (CFS) for Oct	Base Flow (CFS) for Nov	Base Flow (CFS) for Dec	Base Flow (CFS) for Jan	Base Flow (CFS) for Feb	Base Flow (CFS) for Mar	Base Flow (CFS) for Apr 1–15	Base Flow (CFS) for May 16–31	Base Flow (CFS) for Jun	Base Flow (CFS) for Jul	Base Flow (CFS) for Aug	Base Flow (CFS) for Sep
98.9	110	200	200	125	125	125	250	250	0	0	0	0
185.3	577.4	200	200	212.9	214.3	200	200	150	150	150	150	150
234.1	635.5	200	200	219.4	221.4	200	500	284.4	200	200	200	200
346.7	774.2	200	200	225.8	228.6	200	1,471.4	1,031.3	363.3	250	250	250
483.7	796.8	200	200	232.3	235.7	1,521	1,614.3	1,200	940	300	300	300
589.5	841.9	300	300	358.1	364.3	1,648.4	2,442.9	1,725	1,100	429	400	400

Table 5. April 15 through May 15 "Pulse" Flows for Fisheries Purposes Based on the Annual Fishery Volume

Annual Fishery Flow Volume (TAF)	Fishery Pulse Flows (CFS) April 15–30	Fishery Pulse Flows (CFS) May 1–15
185.3	687.5	666.7
234.1	1,000.0	1,000.0
346.7	1,625.0	1,466.7
483.7	1,212.5	1,933.3
589.5	925.0	2,206.7

Water Quality

Water quality releases include releases to meet the State Water Resources Control Board (SWRCB) Decision 1641 (D-1641) salinity objectives at Vernalis and the Decision 1422 (D-1422) dissolved oxygen objectives at Ripon. The Vernalis water quality requirement (SWRCB D-1641) is an electrical conductivity (EC) requirement of 700 and 1000 micromhos/cm for the irrigation (Apr-Aug) and non-irrigation (Sep-Mar) seasons, respectively.

Additional releases are made to the Stanislaus River below Goodwin Dam if necessary, to meet the D-1422 dissolved oxygen content objective. Surrogate flows representing releases for DO requirement in CalSim II are presented in Table 6. The surrogate flows are reduced for critical years where New Melones water supply forecast (the end-of-February New Melones Storage, plus the March - September forecast of inflow to the reservoir) is less than 940 TAF. These flows are met through releases from New Melones without any annual volumetric limit.

Table 6. Surrogate flows for D1422 DO requirement at Vernalis (TAF)

	Non-Critical Years	Critical Years
January	0.0	0.0
February	0.0	0.0
March	0.0	0.0
April	0.0	0.0
May	0.0	0.0
June	15.2	11.9
July	16.3	12.3
August	17.4	12.3
September	14.8	11.9
October	0.0	0.0
November	0.0	0.0
December	0.0	0.0

Bay-Delta Flows

Bay-Delta flow requirements are defined by D-1641 flow requirements at Vernalis (not including pulse flows during the April 15 - May 16 period). These flows are met through releases from New Melones without any annual volumetric limit. D-1641 requires the flow at Vernalis to be maintained during the February through June period. The flow requirement is based on the required location of “X2” and the San Joaquin Valley water year hydrologic classification (60-20-20 Index) as summarized in Table 7.

Table 7. Bay-Delta Vernalis Flow Objectives (average monthly cfs)

60-20-20 Index	Flow Required if X2 is West of Chipps Island	Flow required if X2 is East of Chipps Island
Wet	3,420	2,130
Above Normal	3,420	2,130
Below Normal	2,280	1,420
Dry	2,280	1,420
Critical	1,140	710

Water Supply

Water supply refers to deliveries from New Melones to water rights holders (Oakdale Irrigation District and South San Joaquin Irrigation District) and CVP eastside contractors (Stockton East Water District and Central San Joaquin Water Control District). Water is provided to Oakdale ID and South San Joaquin ID in accordance with their 1988 Settlement Agreement with Reclamation (up to 600 TAF based on hydrologic conditions), limited by consumptive use. The conservation account of up to 200 TAF storage capacity defined under this agreement is not modeled in CalSim II.

Water Supply-CVP Eastside Contractors

Annual allocations are determined using New Melones water supply forecast (the end-of- February New Melones Storage, plus the March - September forecast of inflow to the reservoir) for Stockton East WD and Central San Joaquin WCD (Table 8) and are distributed throughout a year using monthly patterns.

Table 8. CVP Contractor Allocations

New Melones Water Supply Forecast (TAF)	CVP Contractor Allocation (TAF)
<1,400	0
1,400 to 1,800	49
>1,800	155

2.2 DSM2 Assumptions for Existing Conditions

The following is a description of the assumptions listed in Appendix H Attachment 1-3 DSM2 Model Assumptions Callouts.

River Flows

For DSM2 simulation, the river flows at the DSM2 boundaries are based on the monthly flow time series from CalSim II.

Tidal Boundary

The tidal boundary condition at Martinez is based on an adjusted astronomical tide normalized for sea level rise (Ateljevich and Yu, 2007).

Water Quality

Martinez EC

The Martinez EC boundary condition in the DSM2 planning simulation is estimated using the G-model based on the net Delta outflow simulated in CalSim II and the pure astronomical tide (Ateljevich, 2001), as modified to account for the salinity changes related to the sea level rise using the correlations derived based on the three-dimensional (UnTRIM) modeling of the Bay-Delta with sea level rise at Year 2030.

Vernalis EC

For the DSM2 simulation, the Vernalis EC boundary condition is based on the monthly San Joaquin EC time series estimated in CalSim II.

Morphological Changes

No additional morphological changes were assumed as part of the Existing Conditions. The DSM2 model and grid developed as part of the 2009 recalibration effort (CH2M HILL, 2009) was used for modeling.

Facilities

Delta Cross Channel

Delta Cross Channel gate operations are modeled in DSM2. The number of days in a month the DCC gates are open is based on the monthly time series from CalSim II.

South Delta Temporary Barriers

South Delta Temporary Barriers are included in the Existing Conditions simulation. The three agricultural temporary barriers located on Old River, Middle River and Grant Line Canal are included in the model. The fish barrier located at the Head of Old River is also included in the model.

Clifton Court Forebay Gates

Clifton Court Forebay gates are operated based on the Priority 3 operation, where the gate operations are synchronized with the incoming tide to minimize the impacts to low water levels in nearby channels. The Priority 3 operation is described in the 2008 OCAP BA Appendix F Section 5.2 (USBR, 2008b).

Operations Criteria

South Delta Temporary Barriers

South Delta Temporary Barriers are operated based on San Joaquin flow conditions. Head of Old River Barrier is assumed to be installed in both the spring and fall months from April 1 to May 31 and September 16 to November 30. The agricultural barriers on Old and Middle Rivers are assumed to be installed starting from May 16 and the one on Grant Line Canal from June 1. All three agricultural barriers are allowed to operate until November 30. The tidal gates on Old and Middle River agricultural barriers are assumed to be tied open from May 16 to May 31.

Suisan Marsh Salinity Control Gate

The radial gates in the Montezuma Slough Salinity Control Gate Structure are assumed to be tidally operating from October through February each year, to minimize propagation of high salinity conditions into the interior Delta.

3 Assumptions for Proposed Project

This section presents the assumptions used in developing the CalSim II, and DSM2 simulations of Proposed Project.

3.1 CalSim II Assumptions for Proposed Project

The following is a description of the assumptions listed in Appendix H Attachment 1-2 CalSim II Model Assumptions Callouts.

Hydrology

Inflows/Supplies

Same as the Existing Conditions.

Level of Development

Same as the Existing Conditions.

Demands, Water Rights, CVP/SWP Contracts

Same as the Existing Conditions.

Facilities

Same as the Existing Conditions.

Fremont Weir

Same as the Existing Conditions.

CVP C.W. Bill Jones Pumping Plant (Tracy PP) Capacity

Same as the Existing Conditions.

SWP Banks Pumping Plant Capacity

Same as the Existing Conditions.

CCWD Intakes

Same as the Existing Conditions.

Regulatory Standards

The regulatory standards that govern the operations of the CVP and SWP facilities are briefly described below. Specific assumptions related to key regulatory standards are also outlined below.

D-1641 Operations

Same as the Existing Conditions.

Coordinated Operations Agreement (COA)

Same as the Existing Conditions.

CVPIA (b)(2) Assumptions

Same as the Existing Conditions.

Clear Creek Flows

Same as the Existing Conditions.

Continued CALFED Agreements

Same as the Existing Conditions.

USFWS Delta Smelt BO Actions

The USFWS Delta Smelt BO RPA actions are replaced with actions developed for Proposed Project as summarized below and described further in this document.

NMFS BO Salmon Actions

The NMFS Salmon BO RPA actions are replaced with actions developed for Proposed Project as summarized below and described further in this document.

Water Transfers

Same as the Existing Conditions.

Specific Regulatory Assumptions

Upper Sacramento Flow Management

Same as the Existing Conditions.

Lower Feather Flow Management

Same as the Existing Conditions.

Lower American Flow Management

Model includes Water Forum's 2017 Lower American Flow Management Standard where the flows range from 500 to 2000 cfs based on time of year and annual hydrology. Planning minimum storage is represented in CalSim with a 275 taf end-of September storage target in Folsom.

Delta Outflow (Flow and Salinity)

SWRCB D-1641:

Same as the Existing Conditions.

Combined Old and Middle River Flows

Reclamation and DWR propose to operate the CVP and SWP in a manner that maximizes exports while minimizing entrainment of fish and protecting critical habitat.

Proposed OMR management is modeled as follows:

Projects operate to an OMR index no more negative than a 14-day moving average of -5,000 cfs between January 1 and June 30 except for the following conditions:

- Integrated Early Winter Pulse Protection: After December 1, and when the 3-day average turbidity is 50 NTU or greater at Sacramento River at Freeport and Sacramento River at Freeport Flow is 25,000 cfs or greater, Reclamation and DWR propose to operate to -2,000 cfs of the 14-day average OMR index for 14 days. The same model index of SAC_RI developed for the USFWS RPA Action I representation is used in the model to determine when the turbidity exceeds 50 NTU.
- Turbidity Bridge Avoidance: For January and February in any water year type, if the Turbidity trigger is reached (SAC_RI greater than or equal to 20,000 cfs), Projects operate to 14-day average OMR Index if -2000 cfs for five days. For March through June of Wet and Above Normal years, it is assumed that there will be one event of turbidity bridge avoidance in each month (-2000 cfs for five days).
- OMR Flexibility: It is assumed that there may be storm-related OMR management flexibility in January and February. In wet years, it is assumed that storm events will coincide with turbidity bridge events and no OMR flexibility is modeled. In Above Normal and Below Normal years, it is assumed that there will be one opportunity in January and one opportunity in February to operate to a more negative OMR index than -6,000 cfs. This is modeled as 14-day OMR index of -6,000 cfs for 7 days in each month. In dry years, it is assumed that one opportunity occurs either in January or February but not both months.
- Species-specific single-year loss threshold: Even though salvage or loss cannot be modeled using CalSim, it is assumed that this threshold would be reached by March and April of wet, above normal, below normal, and dry years and species-specific offramp would be met by June. The OMR restriction for this condition is modeled as a 14-day average OMR index of -3,500 cfs in March and April of all wet, above normal, below normal, and dry year-types.
- Adult Longfin Smelt Entrainment Protection - This action was not modeled in CalSim II due to the lack of data needed to develop a simplifying assumption, however it is conceivable that this action could result in a significant range of required OMR. The tools and processes described in Section 3.3.1 are new and it is uncertain as to what level of OMR restriction would result from those tools and processes.
- Larval and Juvenile Longfin Smelt Criteria – This action was not modeled in CalSim II due to the lack of data needed to develop a simplifying assumption, however it is conceivable that this action could result in a significant range of required OMR. The tools and processes described in Section 3.3.1 are new and it is uncertain as to what level of OMR restriction would result from those tools and processes.
- Delta Smelt Larval – This action was not modeled in CalSim II due to the lack of data needed to develop a simplifying assumption, however it is conceivable that this action could result in a significant range of required OMR. The tools and processes described in Section 3.3.1 are new and it is uncertain as to what level of OMR restriction would result from those tools and processes.

South Delta Export-San Joaquin River Inflow Ratio

NMFS BO Action 4.2.1 would not be implemented under this alternative.

Exports at the South Delta Intakes

Same as the Existing Conditions.

Delta Water Quality

Same as the Existing Conditions.

San Joaquin River Restoration Program

Same as the Existing Conditions.

Operations Criteria

Fremont Weir Operations

Same as the Existing Conditions.

Delta Cross Channel Gate Operations

Same as the Existing Conditions.

Allocation Decisions

Same as the Existing Conditions.

San Luis Operations

Same as the Existing Conditions.

New Melones Operations

In addition to flood control, New Melones is operated for three different purposes: fishery flows, water quality, and water supply.

Fishery

These flows are patterned to provide fall attraction flows in October and outmigration pulse flows in spring months (April 15 through May 15 in all years), and total up to 98.9 TAF to 483.7 TAF annually depending on the hydrological conditions based on the San Joaquin 60-20-20 Index (Tables 9 through 11).

Table 9. Annual Fishery Flow Allocation

60-20-20 Index	Fishery Flows (TAF)
Critical	185.3
Dry	234.1
Below Normal	346.7
Above Normal	346.7
Wet	483.7

Table 10. Monthly "Base" Flows for Fishery Purposes Based on the Annual Fishery Volume

Annual Fishery Flow Volume (TAF)	Base Flow (CFS) for Oct.	Base Flow (CFS) for Nov.	Base Flow (CFS) for Dec.	Base Flow (CFS) for Jan.	Base Flow (CFS) for Feb.	Base Flow (CFS) for Mar.	Base Flow (CFS) for Apr. 1–14	Base Flow (CFS) for May 16–31	Base Flow (CFS) for June	Base Flow (CFS) for July	Base Flow (CFS) for Aug.	Base Flow (CFS) for Sept.
185.3	577.4	200	200	212.9	214.3	200	200	150	150	150	150	150
234.1	635.5	200	200	219.4	221.4	200	500	284.4	200	200	200	200
346.7	774.2	200	200	225.8	228.6	200	1,471.4	1,031.3	363.3	250	250	250
483.7	796.8	200	200	232.3	235.7	1,521	1,614.3	1,200	940	300	300	300

Table 11. April 15 through May 15 "Pulse" Flows for Fishery Purposes Based on the Annual Fishery Volume

Annual Fishery Flow Volume (TAF)	Fishery Pulse Flows (CFS) April 15–30	Fishery Pulse Flows (CFS) May 1–15
185.3	687.5	666.7
234.1	1,000.0	1,000.0
346.7	1,625.0	1,466.7
483.7	1,212.5	1,933.3

Water Quality

Releases are made to the Stanislaus River below Goodwin Dam to meet the D-1422 dissolved oxygen content objective. Surrogate flows representing releases for dissolved oxygen requirement in CalSim II are presented in Table 12. The surrogate flows are reduced for critical years under the San Joaquin 60-20-20 Index. These flows are met through releases from New Melones without any annual volumetric limit.

Table 12. Surrogate flows representing releases for dissolved oxygen requirement in CalSim II

–	Non-Critical Years	Critical Years
January	0.0	0.0
February	0.0	0.0
March	0.0	0.0
April	0.0	0.0
May	15.2	11.9
June	16.3	12.3
July	17.4	12.3
August	14.8	11.9
September	0.0	0.0
October	0.0	0.0
November	0.0	0.0
December	0.0	0.0

Notes:

– = This cell is empty.

Water Supply

Water supply refers to deliveries from New Melones to water rights holders (Oakdale Irrigation District [ID] and South San Joaquin ID) and CVP eastside contractors (Stockton East Water District [WD] and Central San Joaquin Water Control District [WCD]).

Water is provided to Oakdale ID and South San Joaquin ID in accordance with their 1988 Settlement Agreement with Reclamation (up to 600 TAF based on hydrologic conditions), limited by consumptive use. The conservation account of up to 200 TAF storage capacity defined under this agreement is not modeled in CalSim II.

Water Supply-CVP Eastside Contractors

Annual allocations are determined using the San Joaquin 60-20-20 Index for Stockton East WD and Central San Joaquin WCD (Table 13) and are distributed throughout 1 year using monthly patterns.

Table 13. Annual allocations for Stockton East WD and Central San Joaquin WCD

60-20-20 Index	CVP Contractor Allocation (TAF)
Critical	0
Dry	49
Below Normal, Above Normal, and Wet	155

3.2 DSM2 Assumptions for Proposed Project

The following is a description of the assumptions listed in Appendix H Attachment 1-3 DSM2 Model Assumptions Callouts.

River Flows

Same as the Existing Conditions.

Tidal Boundary

Same as the Existing Conditions.

Water Quality

Martinez EC

Same as the Existing Conditions.

Vernalis EC

Same as the Existing Conditions.

Morphological Changes

Same as the Existing Conditions.

Facilities

Delta Cross Channel

Same as the Existing Conditions.

South Delta Temporary Barriers

The three agricultural temporary barriers located on Old River, Middle River and Grant Line Canal are included in the model; however, the fish barrier located at the Head of Old River is not included in the model.

Clifton Court Forebay Gates

Same as the Existing Conditions.

Operations Criteria

South Delta Temporary Barriers

South Delta Temporary Barriers are operated based on San Joaquin flow conditions. The agricultural barriers on Old and Middle Rivers are assumed to be installed starting from May 16 and the one on Grant Line Canal from June 1. All three agricultural barriers are allowed to operate until November 30. The tidal gates on Old and Middle River agricultural barriers are assumed to be tied open from May 16 to May 31. Head of Old River Barrier would not be installed.

Suisan Marsh Salinity Control Gate

The radial gates in the Suisan Marsh Salinity Control Gate Structure are assumed to be tidally operating from October through February each year and from July through August during Below Normal years, to minimize propagation of high salinity conditions into the interior Delta.

Gate operations occur in October through February. Gates open when upstream water level is 0.3 ft above downstream water level. Gates close when current is less than -0.1 fps. Gates are open in March through September.

DWR proposes Suisun Marsh Salinity Control Gates operations in July and August of Below Normal Water year types.

4 References

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Attachment 1-2 CalSim II Model Assumptions Callouts

1 Introduction

The assumptions for all model simulations are summarized in Appendix H Attachment 1-1 Model Assumptions.

2 CalSim II Modeling Assumptions Callouts

The following matrix summarizes the assumptions used for the CalSim II models:

- Existing Condition[1]
- Proposed Project

Table 2-1. Summary of Assumptions used for CalSim II Models - Tables 2-1a through 2-1v

Table 2-1 a. General

–	Existing	Proposed Project
Planning horizon	Year 2030	Same
Period of simulation	82 years (1922-2003)	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 b. Hydrology

–	Existing	Proposed Project
Inflows/Supplies	Inflows based on Historical Hydrology[23, 25]	Same
Level of development	2030 level[2]	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 c. Demands, Water Rights, and CVP/SWP Contracts: Sacramento River Region (excluding American River)

–	Existing	Proposed Project
CVP[3]	Land-use based, full build-out of contract amounts, except for Settlement Contractors represented with historical diversions.	Same
SWP (FRSA)	Land-use based, limited by contract amounts[4,7]	Same
Non-project	Land use based, limited by water rights and SWRCB Decisions for Existing Facilities	Same
Antioch Water Works	Pre-1914 water right	Same
Federal refuges	Firm Level 2 water supply needs[5]	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 d. Demands, Water Rights, and CVP/SWP Contracts: Sacramento River Region - American River

–	Existing	Proposed Project
Water rights	Year 2025, full water rights[6]	Same
CVP	Year 2025, full contracts except for Settlement Contractors at historical diversions, including Freeport Regional Water Project[6]	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 e. Demands, Water Rights, and CVP/SWP Contracts: San Joaquin River Region

–	Existing	Proposed Project
Friant Unit	Limited by contract amounts, based on current allocation policy[26]	Same
Lower Basin	Land-use based, based on district level operations and constraints[24]	Same
Stanislaus River[9, 17]	Land-use based, Revised Operations Plan (2008 model assumptions) and NMFS BO (Jun 2009) Actions III.1.2 and III.1.3	Land-use based, Stepped Release Plan (SRP)

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 f. Demands, Water Rights, and CVP/SWP Contracts: San Francisco Bay, Central Coast, Tulare Lake and South Coast Regions (CVP/SWP project facilities)

–	Existing	Proposed Project
CVP	Demand based on contract amounts[3]	Same
CCWD	195 TAF/yr CVP contract supply and water rights.[10] Modified the hydrology in the Los Vaqueros watershed as well as CCWD's operations to reflect the most recent studies and operational agreements	Same
SWP[4,11]	Demand based on full Table A amounts	Same
Article 56	Based on 2001-08 contractor requests	Same
Article 21	MWD demand up to 200 TAF/month (December to March) subject to conveyance capacity, KCWA demand up to 180 TAF/month and other contractor demands up to 34 TAF/month in all months, subject to conveyance capacity	Same
North Bay Aqueduct (NBA)	77 TAF/yr demand under SWP contracts. Up to 2.635 TAF/mon of excess flow (i.e. when Standard Water Right Term 91 is not in effect, UWFE used as surrogate) under Fairfield, Vacaville and Benecia Settlement Agreement. NOD Allocation Settlement Agreement terms for Napa and Solano[15]	Same
Federal refuges	Firm Level 2 water needs[5]	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 g. Facilities: System-Wide

–	Existing	Proposed Project
Systemwide	Existing facilities	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 h. Facilities: Sacramento River Region

–	Existing	Proposed Project
Shasta Lake	Existing, 4,552 TAF capacity	Same

–	Existing	Proposed Project
Red Bluff Diversion Dam	Diversion dam gates out all year, Pumping Plant operated to deliver CVP water	Same
Fremont Weir	Existing weir	Same
Colusa Basin	Existing conveyance and storage facilities	Same
Lower American River	Hodge criteria for diversion at Fairbairn	Same
Upper American River[6,22]	PCWA American River Pump Station	Same
Lower Sacramento River	Freeport Regional Water Project[12]	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 i. Facilities: San Joaquin River Region

–	Existing	Proposed Project
Millerton Lake (Friant Dam)	Existing, 524 TAF capacity	Same
Lower San Joaquin River	City of Stockton Delta Water Supply Project, 30-mgd capacity	Same
SWP Banks Pumping Plant (South Delta)	Physical capacity is 10,300 cfs but 6,680 cfs permitted capacity in all months. Pumping can be up to 10,300 cfs during Dec 15 – Mar 15 depending on Vernalis flow conditions[18]; additional capacity of 500 cfs (up to 7,180 cfs) allowed Jul – Sep for reducing impact of NMFS BO (Jun 2009) Action IV.2.1 Phase II on SWP[19]	Same
CVP C.W. "Bill" Jones Pumping Plant (formerly Tracy PP)	Permit capacity is 4,600 cfs in all months (allowed for by the Delta-Mendota Canal–California Aqueduct Intertie)	Same
Upper Delta-Mendota Canal Capacity	Existing plus 400 cfs Delta-Mendota Canal–California Aqueduct Intertie	Same
CCWD Intakes	Los Vaqueros existing storage capacity, 160 TAF, existing pump locations, Alternative Intake Project (AIP) included[13]	Same
Head of Old River Barrier (HORB)	Temporary Barrier Project operated based on San Joaquin River flow time series from CalSim II output HORB installed in Fall (Sep 16 – Nov 30) HORB also installed in Spring (April 1 – May 31) when SJR flow is less than 5,000 cfs	Not installed

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 j. Facilities: San Francisco Bay Region

–	Existing	Proposed Project
South Bay Aqueduct (SBA)	SBA rehabilitation, 430 cfs capacity from junction with California Aqueduct to Alameda County FC&WSD Zone 7 diversion point	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 k. Facilities: South Coast Region

–	Existing	Proposed Project
California Aqueduct East Branch	Existing capacity	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 l. Regulatory Standards: North Coast Region

–	Existing	Proposed Project
Trinity River	–	–
Minimum flow below Lewiston Dam	Trinity EIS Preferred Alternative (369-815 TAF/yr)	Same
Trinity River Fall Augmentation Flows	420 cfs August 1 through September 30 in all but very wet years	Same
Trinity Reservoir end-of-September minimum storage	Trinity EIS Preferred Alternative (600 TAF as able)	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 m. Regulatory Standards: Sacramento River Region

–	Existing	Proposed Project
Clear Creek	-	-
Minimum flow below Whiskeytown Dam	Downstream water rights, 1963 Reclamation Proposal to USFWS and NPS, predetermined CVPIA 3406(b)(2) flows[20], and NMFS BO (Jun 2009) Action I.1.1[17]	Same
Upper Sacramento River	-	-
Shasta Lake end-of-September minimum storage	NMFS 2004 Winter-run Biological Opinion, (1900 TAF in non-critically dry years), and NMFS BO (Jun 2009) Action I.2.1[17] (NMFS BiOp storage objectives not explicitly modeled; achieved through project allocation procedures when hydrologically possible)	1900 TAF in non-critically dry years (not explicitly modeled - achieved through project allocation profiles when hydrologically possible)
Minimum flow below Keswick Dam	SWRCB WR 90-5, NMFS BO (Jun 2009) Action I.2.2 achieved as possible through other modeled actions[17]	Same
Feather River	-	-
Minimum flow below Thermalito Diversion Dam	2006 Settlement Agreement (700 / 800 cfs)	Same
Minimum flow below Thermalito Afterbay outlet	1983 DWR, DFG Agreement (750-1,700 cfs)	Same
Yuba River	-	-
Minimum flow below Daguerre Point Dam	D-1644 Operations (Lower Yuba River Accord)[14]	Same
American River	-	-
Minimum flow below Nimbus Dam	American River Flow Management (2006) as required by NMFS BO (Jun 2009) Action II.1[17]	American River Flow Management Standard, per 2017 Water Forum Agreement with a planning minimum end of September storage target of 275 TAF
Minimum Flow at H Street Bridge	SWRCB D-893	Same
Lower Sacramento River	-	-
Minimum flow near Rio Vista	SWRCB D-1641	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 n. Regulatory Standards: San Joaquin River Region

–	Existing	Proposed Project
Mokelumne River	-	-
Minimum flow below Camanche Dam	FERC 2916-029[12], 1996 (Joint Settlement Agreement) (100-325 cfs)	Same
Minimum flow below Woodbridge Diversion Dam	FERC 2916-029[12], 1996 (Joint Settlement Agreement) (25-300 cfs)	Same
Stanislaus River	-	-
Minimum flow below Goodwin Dam	1987 Reclamation, CDFW agreement, and flows required for NMFS BO (Jun 2009) Action III.1.2 and III.1.3[17]	Flows per New Melones SRP
Minimum dissolved oxygen	SWRCB D-1422	Same
Merced River	-	-
Minimum flow below Crocker-Huffman Diversion Dam	Davis-Grunsky (180-220 cfs, Nov-Mar), and Cowell Agreement	Same
Minimum flow at Shaffer Bridge	FERC 2179 (25-100 cfs)	Same
Tuolumne River	-	-
Minimum flow at Lagrange Bridge	FERC 2299-024, 1995 (Settlement Agreement) (94-301 TAF/yr)	Same
San Joaquin River	-	-
San Joaquin River below Friant Dam/ Mendota Pool	San Joaquin River Restoration-full flows not included[26]	Same
Maximum salinity near Vernalis	SWRCB D-1641	Stanislaus contribution per New Melones SRP
Minimum flow near Vernalis	SWRCB D-1641. VAMP is turned off since the San Joaquin River Agreement has expired[16]. NMFS BO (Jun 2009) Action IV.2.1[17] Phase II flows not provided due to lack of agreement for purchasing water.	Stanislaus contribution per New Melones SRP

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 o. Regulatory Standards: Sacramento River/San Joaquin Delta Region

–	Existing	Proposed Project
Delta Outflow Index (flow and salinity)	SWRCB D-1641 and FWS BO (Dec 2008) Action 4[17]	SWRCB D-1641; X2 of 80 km in September and October of wet and above normal years.
Delta Cross Channel gate operation	SRWCB D-1641 with additional days closed from Oct 1 – Jan 31 based on NMFS BO (Jun 2009) Action IV.1.2[17] (closed during flushing flows from Oct 1 – Dec 14 unless adverse water quality conditions)	Same
South Delta export limits (Jones PP and Banks PP)	SWRCB D-1641, Vernalis flow-based export limits Apr 1 – May 31 as required by NMFS BO (Jun, 2009) Action IV.2.1[17] (additional 500 cfs allowed for Jul – Sep for reducing impact on SWP)	SWRCB D-1641 (additional 500 cfs allowed for Jul – Sep for reducing impact on SWP)[19]

–	Existing	Proposed Project
Combined Flow in Old and Middle River (OMR)	Adult Longfin Smelt Entrainment Protection Not explicitly modeled Adult Delta Smelt (First Flush) Trigger: 3 station avg > 12 NTU Period: December 1 to January 31 CalSim assumption: Sacrament River Runoff > 20,000 then OMR = -2,000 cfs for 14 days Adult Delta Smelt (Turbidity Bridge) January to March & Sacramento River Runoff > 20,000 OMR = -2,000 cfs for 5 days Larval and Juvenile Delta & Longfin Smelt Not explicitly modeled Winter Run/Steelhead January 1 to June 30 OMR > -5,000 cfs Salvage Density (based on 2008-2018 historic data) March: OMR = 3 days at -3,500 cfs, 5 days at -2,500 cfs April: OMR – 9 days at -3,500 cfs May: OMR – 5 days at -3,500 cfs OMR Flex (storm flex) No Flex	Adult Longfin Smelt Entrainment Protection Not explicitly modeled Adult Delta Smelt (First Flush) Trigger: Freeport > 50 NTU & Freeport > 25,000 cfs Period: December 1 to January 31 CalSim assumption: Sacrament River Runoff > 20,000 then OMR = -2,000 cfs for 14 days Adult Delta Smelt (Turbidity Bridge) January to March & Sacramento River Runoff > 20,000 OMR = -2,000 cfs for 5 days Larval and Juvenile Delta & Longfin Smelt Not explicitly modeled Winter Run/Steelhead January 1 to June 30 OMR > -5,000 cfs Salvage Threshold (assume triggering 50% single year loss thresholds in Wet, Above Normal, Below Normal, and Dry Years) March: OMR = -3,500 cfs April: OMR = -3,500 cfs OMR Flex (storm flex) If first flush or turbidity bridge are not triggered, then January: OMR = 7 days at OMR -6,000 cfs (AN and BN years) February: OMR = 7 days at OMR -6,000 cfs (AN and BN years) Once in January or February: OMR = 7 days at -6,000 cfs (D)
Water Quality (EC) Standards	SWRCB D-1641	Same
SJR Inflow to Export Ratio	April to May when SJR < 21,750 cfs Wet and Above Normal: SJR IE = 4:1 Below Normal: SJR IE = 3:1 Dry: SJR IE = 2:1 Critical: SJR IE = 1:1	Not implemented

–	Existing	Proposed Project
Summer/Fall Habitat (Fall X2)	September to November Wet years = 74 km Above Normal years = 81 km	September to October Wet and Above Normal years = 80 KM X2 Below Normal = SMSCG operations for 60 days in July and August Salinity requirements adjusted in Below Normal Years to account for the effect of Suisun Marsh Salinity Control Gates (SMSCG) operations for 60 days Emmaton (Jul - Aug, BN only) Jersey Point (Jul - Aug, BN only)

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 p. Operations Criteria: Sacramento River Region

–	Existing	Proposed Project
Upper Sacramento River: Flow objective for navigation (Wilkins Slough)	Revised flow objective for Wilkins Slough. Flow objective for Wilkins Slough based on month, CVP allocation, and Shasta storage condition to reflect CVP operations for local delivery	Same
American River: Folsom Dam flood control	Variable 400/600 flood control diagram (without outlet modifications)	Same
Feather River: Flow at Mouth of Feather River (above Verona)	Maintain the CDFW /DWR flow target of 2,800 cfs for Apr - Sep dependent on Oroville inflow and FRSA allocation	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 q. Operations Criteria: San Joaquin River Region

–	Existing	Proposed Project
Stanislaus River: Flow below Goodwin Dam	1987 USBR, CDFW agreement, and flows required for NMFS BO (Jun 2009) Action III.1.2 and III.1.3[17]	Flows per New Melones SRP
San Joaquin River: Salinity at Vernalis	Grasslands Bypass Project (full implementation)	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 r. Operations Criteria: Systemwide – CVP Water Allocation

–	Existing	Proposed Project
Settlement / Exchange	100% (75% in Shasta critical years)	Same
Refuges	100% (75% in Shasta critical years)	Same
Agriculture Service	100% - 0% based on supply. South-of-Delta allocations are additionally limited due to D-1641, FWS BO (Dec 2008), and NMFS BO (Jun 2009) export restrictions[17]	Same
Municipal & Industrial Service	100% - 50% based on supply. South-of-Delta allocations are additionally limited due to D-1641, FWS BO (Dec 2008), and NMFS BO (Jun 2009) export restrictions[17]	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 s. Operations Criteria: Systemwide – SWP Water Allocation

–	Existing	Proposed Project
North of Delta (FRSA)	Contract-specific NOD Allocation Settlement Agreement terms for Napa and Solano[15]	Same

–	Existing	Proposed Project
South of Delta (including North Bay Aqueduct)	Based on supply; equal prioritization between Ag and M&I based on Monterey Agreement; allocations are limited due to D-1641, FWS BO (Dec 2008), and NMFS BO (Jun 2009) export restrictions[27,17] NOD Allocation Settlement Agreement terms for Napa and Solano[15]	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 t. Operations Criteria: Systemwide – CVP-SWP Coordinated Operations

–	Existing	Proposed Project
Sharing of responsibility for in-basin-use	According to Coordinated Operations Agreement (2018), sharing responsibility for meeting Sacramento Valley In-basin use during balance condition with water year type in percentage for CVP and SWP, respectively are: 80/20 in AN and W 75/25 in BN 65/35 in D 60/40 in C As per NAPA agreement, FRWP and EBMUD 2/3 of the North Bay Aqueduct diversions are considered as Delta export, 1/3 of the North Bay Aqueduct diversion is considered as in-basin use	Same
Sharing of surplus flows	According to Coordinated Operations Agreement (2018), CVP and SWP sharing responsibility during Unstored Water for Export (UWFE) during balanced condition for all year type is 55% and 45%, respectively.	Same
Sharing of restricted export capacity for project- specific priority pumping	The percentage sharing of export capacity under export limits due to (1) SWRCB D-1641 (export/inflow ratio, Vernalis 1:1), (2) 2008 USFWS and 2009 NMFS biological opinions Old and Middle River flow requirements, or (3) 2009 NMFS biological opinion San Joaquin River i:e ratio[27, 17] 60/40 CVP/SWP during excess conditions 65/35 CVP/SWP during balanced conditions No restrictions on Inter-tie use to meet these shares	Same
Water transfers	Acquisitions by SWP contractors are wheeled at priority in Banks Pumping Plant over non-SWP users; LYRA included for SWP contractors[19]	Same
Sharing of export capacity for lesser priority and wheeling-related pumping	Cross Valley Canal wheeling (max of 128 TAF/yr), CALFED ROD defined Joint Point of Diversion (JPOD)	Same
San Luis Reservoir	San Luis Reservoir is allowed to operate to a minimum storage of 100 TAF	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 u. Operations Criteria: Systemwide – CVPIA 3406(b)(2)

–	Existing	Proposed Project
Policy Decision	Per May 2003 Dept. of Interior decision	Same
Allocation	800 TAF, 700 TAF in 40-30-30 dry years, and 600 TAF in 40-30-30 critical years as a function of Ag allocation	Same
Actions	Pre-determined upstream fish flow objectives below Whiskeytown Dams, non-discretionary NMFS BO (Jun 2009) actions for the American and Stanislaus Rivers, and NMFS BO (Jun 2009) and FWS BO (Dec 2008) actions leading to export restrictions[17]	Same
Accounting Adjustments	Releases for non-discretionary FWS BO (Dec 2008) and NMFS BO (Jun 2009)[17] actions may or may not always be deemed (b)(2) actions; in general, it is anticipated, that accounting of these actions using (b)(2) metrics, the sum would exceed the (b)(2) allocation in many years; therefore no additional actions are considered and no accounting logic is included in the model	Same

Notes for Tables 2-1 a through Table 2-1 v are provided following Table 2-1 v.

Table 2-1 v. Operations Criteria: Systemwide – Water Management Actions: Water Transfer Supplies (long term programs)

–	Existing	Proposed Project
Lower Yuba River Accord[19,25]	Yuba River acquisitions for reducing impact of NMFS BO export restrictions[17] on SWP	Same
Phase 8	None	Same

Notes for Table 2-1 (Tables 2-1 a through 2-1 v)
"-" indicates blank cell.

[1] These assumptions have been developed under the direction of the Department of Water Resources team for the Voluntary Settlement Agreement (VA) of the Central Valley Project (CVP) and State Water Project (SWP).

[2] The Sacramento Valley hydrology used in the Future Conditions CALSIM II model reflects 2020 land-use assumptions associated with Bulletin 160-98. The San Joaquin Valley hydrology reflects draft 2030 land-use assumptions developed by Reclamation. Development of Future-level projected land-use are being coordinated with the California Water Plan Update for future models.

[3] CVP contract amounts have been reviewed and updated according to existing and amended contracts, as appropriate. Assumptions regarding CVP agricultural and M&I service contracts and Settlement Contract amounts are listed in table 1, table 2 and table 3 in respect of NOD, American River and SOD accordingly. Summary of CVP contract amounts are tabulated below.

Project Contractor Type	North-of-the-Delta (TAF)	South-of-the-Delta (TAF)
CVP Contractors		
Settlement/Exchanges	2291	840
Water Service Contractor		
Agriculture	358	1937
M&I	360	164
Refuges	191	281

[4] SWP contract amounts have been updated as appropriate based on recent Table A transfers/agreements. The contractors' table A entitlement is obtained from Bulletin 132. Assumptions regarding SWP agricultural and M&I contract amounts are listed in table 4, table 5 and table 6 in respect of NOD, Delta and SOD accordingly. Summary of SWP contract amounts are tabulated below.

Project Contractor Type	North-of-the-Delta (TAF)	South-of-the-Delta (TAF)
SWP Contractors		
Feather River Area + Delta	1087	0
Table A	114	4056
Agriculture	0	1012
M&I	114	3044

[5] Water needs for Federal refuges have been reviewed and updated, as appropriate. Assumptions regarding firm Level 2 refuge water are listed in table 1 and table 3. Refuge Level 4 (and incremental Level 4) water is not included.

[6] Assumptions regarding American River water rights and CVP contracts with the Sacramento River Water Reliability Project are listed in table 2. The Sacramento Area Water Forum agreement, its dry year diversion reductions, Middle Fork Project operations and water is not included.

[7] Demand for rice straw decomposition water from Thermalito Afterbay was added to the model and updated to reflect historical diversion from Thermalito in the October through January period.

[8] The new CalSim-II representation of the San Joaquin River has been included in this model package (CalSim-II San Joaquin River Model, Reclamation, 2005). Updates to the San Joaquin River have been included since the preliminary model release in August 2005. The model reflects the difficulties of on-going groundwater overdraft problems. The 2030 level of development representation of the San Joaquin River Basin does not make any attempt to offer solutions to groundwater overdraft problems. In addition, a dynamic groundwater simulation is not yet developed for the San Joaquin River Valley. Groundwater extraction/ recharge and stream-groundwater interaction are static assumptions and may not accurately reflect a response to simulated actions. These limitations should be considered in the analysis of result

[9] The CALSIM II model representation for the Stanislaus River does not necessarily represent Reclamation's current or future operational policies. A suitable plan for supporting flows has not been developed for NMFS BO (Jun 2009) Action III.1.3.

[10] The actual amount diverted is operated in conjunction with supplies from the Los Vaqueros project. The existing Los Vaqueros storage capacity is 160 TAF. Associated water rights to fill Los Vaqueros with Delta excess flows are included, but CCWD's water right permit and water right license on Mallard Slough are not included.

[11] It is assumed that SWP Contractors can take delivery of all Table A allocations and Article 21 supplies. Article 56 provisions are assumed and allow for SWP Contractors to manage storage and delivery conditions such that full Table A allocations can be delivered. Detailed analysis of the South Coast and Tulare regions support these assumptions. NBA Article 21 deliveries are dependent on excess conditions only, all other Article 21 deliveries also require that San Luis Reservoir be at capacity and that Banks PP and the California Aqueduct has available capacity to divert from the Delta for direct delivery.

[12] Mokelumne River flows are modified to reflect modified operations associated with EBMUD supplies from the Freeport Regional Water Project.

[13] The CCWD Alternate Intake Project, an intake at Victoria Canal, which operates as an alternate Delta diversion for Los Vaqueros Reservoir.

[14] D-1644 and the Lower Yuba River Accord is assumed to be implemented. The Yuba River is not dynamically modeled in CALSIM II. Yuba River hydrology and availability of water acquisitions under the Lower Yuba River Accord are based on modeling performed and the Lower Yuba River Accord EIS/EIR study team.

[15] This includes draft logic for the updated Allocation Settlement Agreement for four NOD contractors: Butte, Yuba, Napa and Solano.

[16] It is assumed that D-1641 requirements will be in place in 2030, and VAMP is turned off.

[17] In cooperation with Reclamation, National Marine Fisheries Service, Fish and Wildlife Service, and CA Department of Fish and Game, the CA Department of Water Resources has developed assumptions for implementation of the FWS BO (Dec 15th 2008) and NMFS BO (June 4th 2009) in CALSIM II. The FWS BO and NMFS BO assumptions are documented in the Appendix 5A of the LTO EIS (Reclamation 2015b).

[18] Current ACOE permit for Banks PP allows for an average diversion rate of 6,680 cfs in all months. Diversion rate can increase up to 1/3 of the rate of San Joaquin River flow at Vernalis during Dec 15th – Mar 15th up to a maximum diversion of 10,300 cfs, if Vernalis flow exceeds 1,000 cfs.

[19] Acquisitions of Component 1 water under the Lower Yuba River Accord and use of 500 cfs dedicated capacity at Banks PP during Jul – Sep, are assumed to be used to reduce as much of the impact of the Apr-May fish related Delta export restrictions on SWP contractors as possible.

[20] Delta actions, under USFWS discretionary use of CVPIA 3406(b)(2) allocations, are no longer dynamically operated and accounted for in the CALSIM II model. The Combined Old and Middle River Flow and Delta Export restrictions under the FWS BO (Dec 15th 2008) and the NMFS BO (June 4th 2009) severely limit any discretion that would have been otherwise assumed in selecting Delta actions under the CVPIA 3406(b)(2) accounting criteria. Therefore, it is anticipated that CVPIA 3406(b)(2) account availability for upstream river flows below Whiskeytown, Keswick and Nimbus Dams would be very limited. It appears the integration of BO RPA actions will likely exceed the 3406(b)(2) allocation in all water year types. For these baseline simulations, upstream flows on the Clear Creek and Sacramento River are pre-determined based on CVPIA 3406(b)(2) based operations from the Aug 2008 BA Study 7.0 and Study 8.0 for Existing and Future No Action baselines respectively. The procedures for dynamic operation and accounting of CVPIA 3406(b)(2) are not included in the CALSIM II model.

[21] Only acquisitions of Lower Yuba River Accord Component 1 water are included.

[22] PCWA American River pumping facility upstream of Folsom Lake is included.

[23] Since the release of DCR 2017, EBMUD has replaced their monthly timestep planning model with a physically based, daily timestep model. To be consistent with EBMUD's planning model, the CalSim II inputs related to the EBMUD operations – Mokelumne River inflow into Delta and allocations from the Freeport Regional Water Project – are updated to match the outputs from Model Run #8079. Key modeling assumptions include: projected 2040 level of development; average demand of 230 MGD; and FWRP operations based on the 2016 Drought Management Program Guidelines.

[24] For consistency, the CalSim II Tuolumne River operations – New Don Pedro storage along with diversions and channel flows downstream of the New Don Pedro dam – are fixed to the Tuolumne operations modeled in the Water Supply Effect (WSE) spreadsheet model of the State Water Resource Control Board (SWRCB). The model inputs to the WSE model were developed from DCR 2017existing conditions CalSim II model run.

[25] Yuba Water Agency (YWA) has recently converted their operations model from a monthly timestep to daily timestep as part of their FERC Relicensing process for a more accurate representation of Yuba River Development Project (YRDP) operations. To be consistent with YWA's planning model, Yuba River Development Project Model (YRDPM), the CalSim II inputs related to the Yuba River operations have been updated, including Yuba River flow above Daguerre Point Dam and Daguerre Point Dam diversion, and the Yuba River transfer operations.

[26] The SJRR flows represented in the CalSim II model so far reflected the long-term flow schedule. A timeseries that reflects the near-term flows is being developed. The near-term SJRR flows can be recaptured using the current facilities before reaching the Delta, which is closer to a CalSim II model run without SJRR flows in terms of the Delta flow and salinity conditions as well as the Delta outflow. As a result, San Joaquin River Restoration flows are turned off.

[27] Fall X2 is considered in-basin-use (IBU) even the Delta outflow requirement under X2 condition is met though export restriction.

3 CalSim II Model Delivery Specifications

This compilation of delivery specifications for the CalSim II model provides additional detail in support of Attachment 1-1.

The delivery specifications for the CalSim II model include Central Valley Project (CVP) and State Water Project (SWP) contract amounts and other water rights assumptions used. These specifications are detailed in the following tables:

- Tables 1a through 1d. CVP North-of-the-Delta – Future Conditions
- Tables 2a and 2b. CVP American River – Future Conditions
- Table 3. CVP Delta – Future Conditions
- Tables 4a through 4e. CVP South-of-the-Delta – Future Conditions
- Table 5. SWP North-of-the-Delta – Future Conditions
- Tables 6a and 6b. SWP South-of-the-Delta – Future Conditions

Table 1a. CVP North-of-the-Delta

CVP Contractor	Geographic Location	CVP Water Service Contracts: AG (TAF/yr)	CVP Water Service Contracts: M&I (TAF/yr)	Settlement / Exchange Contractor (TAF/yr)	Water Rights / Non CVP (TAF/yr)	Level 2 Refugees[1] (TAF/yr)
Anderson Cottonwood ID	Sacramento River Redding Subbasin	-	-	128.0	-	-
Clear Creek CSD	Sacramento River Redding Subbasin	13.8	1.5	-	-	-
Bella Vista WD	Sacramento River Redding Subbasin	22.1	2.4	-	-	-
Shasta CSD	Sacramento River Redding Subbasin	-	1.0	-	-	-
Sac R. Misc. Users	Sacramento River Redding Subbasin	-	-	3.4	-	-
Redding, City of	Sacramento River Redding Subbasin	-	-	21.0	-	-
City of Shasta Lake	Sacramento River Redding Subbasin	2.5	0.3	-	-	-
Mountain Gate CSD	Sacramento River Redding Subbasin	-	0.4	-	-	-
Shasta County Water Agency	Sacramento River Redding Subbasin	0.5	0.5	-	-	-
Redding, City of/Buckeye	Sacramento River Redding Subbasin	-	6.1	-	-	-
Total	**Sacramento River Redding Subbasin**	**38.9**	**12.2**	**152.4**	**-**	**0.0**
Corning WD	Corning Canal	23.0	-	-	-	-
Proberta WD	Corning Canal	3.5	-	-	-	-
Thomes Creek WD	Corning Canal	6.4	-	-	-	-
Total	**Corning Canal**	**32.9**	**0.0**	**0.0**	**-**	**0.0**

Notes:
"-" indicates blank cell
1. Level 4 Refuge water needs are not included.

Table 1b. CVP North-of-the-Delta

CVP Contractor	Geographic Location	CVP Water Service Contracts: AG (TAF/yr)	CVP Water Service Contracts: M&I (TAF/yr)	Settlement / Exchange Contractor (TAF/yr)	Water Rights / Non CVP (TAF/yr)	Level 2 Refugees[1] (TAF/yr)
Kirkwood WD	Tehama-Colusa Canal	2.1	-	-	-	-
Glide WD	Tehama-Colusa Canal	10.5	-	-	-	-
Kanawha WD	Tehama-Colusa Canal	45.0	-	-	-	-
Orland-Artois WD	Tehama-Colusa Canal	53.0	-	-	-	-
Colusa, County of	Tehama-Colusa Canal	20.0	-	-	-	-
Colusa County WD	Tehama-Colusa Canal	62.2	-	-	-	-
Davis WD	Tehama-Colusa Canal	4.0	-	-	-	-
Dunnigan WD	Tehama-Colusa Canal	19.0	-	-	-	-
La Grande WD	Tehama-Colusa Canal	5.0	-	-	-	-
Westside WD	Tehama-Colusa Canal	65.0	-	-	-	-
Total	**Tehama-Colusa Canal**	**285.8**	**0.0**	**0.0**	**-**	**0.0**
Sac. R. Misc. Users[2]	Sacramento River	-	-	1.5	-	-
Glenn Colusa ID	Glenn-Colusa Canal	-	-	441.5	-	-
Glenn Colusa ID	Glenn-Colusa Canal	-	-	383.5	-	-
Sacramento NWR	Glenn-Colusa Canal	-	-	-	-	54.5
Delevan NWR	Glenn-Colusa Canal	-	-	-	-	24.6
Colusa NWR	Glenn-Colusa Canal	-	-	-	-	29.3
Colusa Drain M.W.C.	Colusa Basin Drain	-	-	7.7	-	-
Colusa Drain M.W.C.	Colusa Basin Drain	**-**	**-**	62.3	**-**	**-**
Total	**-**	**0.0**	**0.0**	**895.0**		**108.4**

Notes:
"-" indicates blank cell
1. Level 4 Refuge water needs are not included.

Table 1c. CVP North-of-the-Delta

CVP Contractor	Geographic Location	CVP Water Service Contracts: AG (TAF/yr)	CVP Water Service Contracts: M&I (TAF/yr)	Settlement / Exchange Contractor (TAF/yr)	Water Rights / Non CVP (TAF/yr)	Level 2 Refugees[1] (TAF/yr)
Princeton-Cordova-Glenn ID	Sacramento River	-	-	67.8	-	-
Provident ID	Sacramento River	-	-	54.7	-	-
Maxwell ID	Sacramento River	-	-	1.8	-	-
Maxwell ID	Sacramento River	-	-	16.2	-	-
Sycamore Family Trust	Sacramento River	-	-	31.8	-	-
Roberts Ditch IC	Sacramento River	-	-	4.4	-	-
Sac R. Misc. Users[2]	Sacramento River	-	-	4.9	-	-
Sac R. Misc. Users[2]	Sacramento River	-	-	9.5	-	-
Total	**Sacramento River**	**0.0**	**0.0**	**191.2**	**-**	**0.0**
Reclamation District 108	Sacramento River	-	-	12.9	-	-
Reclamation District 108	Sacramento River	-	-	219.1	-	-
River Garden Farms	Sacramento River	-	-	29.8	-	-
Meridian Farms WC	Sacramento River	-	-	35.0	-	-
Pelger Mutual WC	Sacramento River	-	-	8.9	-	-
Reclamation District 1004	Sacramento River	-	-	71.4	-	-
Carter MWC	Sacramento River	-	-	4.7	-	-
Sutter MWC	Sacramento River	-	-	226.0	-	-
Tisdale Irrigation & Drainage Co.	Sacramento River	-	-	9.9	-	-
Sac R. Misc. Users[2]	Sacramento River	-	-	103.4	-	-
Sac R. Misc. Users[2]	Sacramento River	-	-	0.9	-	-
Feather River WD export	Sacramento River	20.0	-	-	-	-
Total	**Sacramento River**	**20.0**	**0.0**	**722.1**	**-**	**0.0**

Notes:
"-" indicates blank cell
1. Level 4 Refuge water needs are not included.

Table 1d. CVP North-of-the-Delta

CVP Contractor	Geographic Location	CVP Water Service Contracts: AG (TAF/yr)	CVP Water Service Contracts: M&I (TAF/yr)	Settlement / Exchange Contractor (TAF/yr)	Water Rights / Non CVP (TAF/yr)	Level 2 Refugees[1] (TAF/yr)
Sutter NWR	Sutter bypass water for Sutter NWR	-	-	-	-	25.7
Gray Lodge WMA	Feather River	-	-	-	-	41.3
Butte Sink Duck Clubs	Feather River	-	-	-	-	15.6
Total	Feather River	0.0	0.0	0.0	-	82.6
Sac. R. Misc. Users[2]	Sacramento River DSA 65	-	-	56.8	-	-
City of West Sacramento	Sacramento River DSA 65	-	-	23.6	-	-
Davis-Woodland Water Supply Project	Sacramento River DSA 65	-	-	-	-	-
Total	**Sacramento River DSA 65**	**0.0**	**0.0**	**80.4**	**-**	**0.0**
Sac R. Misc. Users	Lower Sacramento River	-	-	4.8	-	-
Natomas Central MWC	Lower Sacramento River	-	-	120.2	-	-
Pleasant Grove-Verona MWC	Lower Sacramento River	-	-	26.3	-	-
City of Sacramento (PCWA)	Lower Sacramento River	-	0.0	-	0.0	-
PCWA (Water Rights)	Lower Sacramento River	-	0.0	-	0.0	-
Total	**Lower Sacramento River**	**0.0**	**0.0**	**151.3**	**0.0**	**-**
Total CVP North-of-Delta	**-**	**377.6**	**12.2**	**2193.8**	**0.0**	**191.0**

Notes:
1. Level 4 Refuge water needs are not included.
"-" indicates blank cell

Table 2a. American River

–	Diversion Location	CVP M&I[1] Contracts (maximum[1])	Water Rights (maximum)	Diversion Limit (maximum capacity)
Placer County Water Agency	Auburn Dam Site	-	65.0	65.0
Total	**Auburn Dam Site**	**0**	**65.0**	**65.0**
Sacramento Suburban Water District[2]	Folsom Reservoir	-	0	0
City of Folsom - includes P.L. 101-514	Folsom Reservoir	7	27	34
Folsom Prison	Folsom Reservoir	-	5	5
San Juan Water District (Placer County)	Folsom Reservoir	-	25	25
San Juan Water District (Sac County) - includes P.L. 101-514	Folsom Reservoir	24.2	33	57.2
El Dorado Irrigation District	Folsom Reservoir	7.55	17	24.55
City of Roseville	Folsom Reservoir	32	30	62.0
Placer County Water Agency	Folsom Reservoir	35	-	35
El Dorado County - P.L.101-514	Folsom Reservoir	15	-	15
Total	**Folsom Reservoir**	**120.75**	**137.0**	**257.75**
So. Cal WC/Arden Cordova WC	Folsom South Canal	-	5	5
California Parks and Recreation	Folsom South Canal	5	-	5
SMUD	Folsom South Canal	30	15	45
Canal Losses	Folsom South Canal	-	1	1
Total	**Folsom South Canal**	**35**	**21**	**56**
City of Sacramento[3]	Lower American River	-	230	230
Carmichael Water District	Lower American River	-	12	12
Total	**Lower American River**	**0**	**242**	**242**
Total American River Diversions	**-**	**155.75**	**465**	**620.75**

Notes for Tables 3-2a and 3-2b are provided after Table 3-2b.
"-" indicates blank cell

Table 2b. American River

–	Diversion Location	CVP M&I[1] Contracts (maximum[1])	Water Rights (maximum)	Diversion Limit (maximum capacity)
City of Sacramento	Lower Sacramento River	-	81.8	81.8
Sacramento County Water Agency	Lower Sacramento River	10	-	10
Sacramento County Water Agency - P.L. 101-514 / FRWP	Lower Sacramento River	35	-	35
Sacramento County Water Agency - water rights and acquisitions	Lower Sacramento River	-	varies[4], average ~32	varies[4], average ~32
East Bay Municipal Utilities District	Lower Sacramento River	133	-	varies[5] , average 14.6
Total Sacramento River Diversions	**-**	**178**	**113.8**	**173.4**
Total	**-**	**333.75**	**578.8**	**794.15**

Notes for Tables 3-2a and 3-2b:
"-" indicates blank cell

1 When the CVP Contract quantity exceeds the quantity of the Diversion Limit minus the Water Right (if any), the diversion modeled is the quantity allocated to the CVP Contract (based on the CVP contract quantity shown times the CVP M&I allocation percentage) plus the Water Right (if any), but with the sum limited to the quantity of the Diversion Limit

2 Diversion is only allowed if and when Mar-Nov Folsom Unimpaired Inflow (FUI) exceeds 1600 TAF

3 When the Hodge single dry year criteria is triggered, Mar-Nov FUI falls below 400 TAF, diversion on the American River is limited to 50 TAF/yr; based on monthly Hodge flow limits assumed for the American, diversion on the Sacramento River may be increased to 223 TAF due to reductions of diversions on American River

4 SCWA targets 68 TAF of surface water supplies annually. The portion unmet by CVP contract water is assumed to come from two sources:
   (1) Delta "excess" water- averages 17.5 TAF annually, but varies according to availability. SCWA is assumed to divert excess flow when it is available, and when there is available pumping capacity.
   (2) "Other" water- derived from transfers and/or other appropriated water, averaging 14.5 TAF annually but varying according remaining unmet demand.

5 EBMUD CVP diversions are governed by the Amendatory Contract, stipulating:
   (1) 133 TAF maximum diversion in any given year
   (2) 165 TAF maximum diversion amount over any 3 year period
   (3) Diversions allowed only when EBMUD total storage drops below 500 TAF
   (4) 155 cfs maximum diversion rate

Table 3. Delta

CVP/ SWP Contractor	Area	Geographic Location	Water Right (TAF/yr)	SWP Table A Amount AG (TAF)	SWP Table A Amount M&I (TAF)	SWP Article 21 Demand (TAF/mon)	CVP Water Service Contracts AG (TAF/yr)	CVP Water Service Contracts M&I (TAF/yr)
City of Vallejo	North Delta	City of Vallejo	-	-	-	-	-	16.0
CCWD[1]	North Delta	Contra Costa County	-	-	-	-	-	195.0
Napa County FC&WCD	North Delta	North Bay Aqueduct	-	-	29.03	1.0	-	-
Solano County WA	North Delta	North Bay Aqueduct	-	-	47.76	1.0	-	-
Fairfield, Vacaville and Benicia Agreement	North Delta	North Bay Aqueduct	31.60	-	-	-	-	-
City of Antioch	North Delta	City of Antioch	18.0	-	-	-	-	-
Total North Delta	**North Delta**	**-**	**49.6**	**0.0**	**76.79**	**2.0**	**0.0**	**211.0**
Delta Water Supply Project	South Delta	City of Stockton	32.4					
Total South Delta	**South Delta**	**-**	**32.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Total	**North and South Delta**	**-**	**82.0**	**0.0**	**76.79**	**2.0**	**0.0**	**211.0**

Notes:
“-“ indicates blank cell
1. The Los Vaqueros module in CalSim II is used to determine the range of demands that are met by CVP contracts or other water rights

Table 4a. CVP South-of-the-Delta

CVP Contractor	Geographic Location	CVP Water Service Contracts AG (TAF/yr)	CVP Water Service Contracts M&I (TAF/yr)	Settlement/ Exchange Contractor (TAF/yr)	Water Rights/ Non-CVP (TAF/yr)	Level 2 Refuges[1] (TAF/yr)	Losses (TAF/yr)
Byron-Bethany ID	Upper DMC	20.6	-	-	-	-	-
Tracy, City of	Upper DMC	-	10.0	-	-	-	-
Tracy, City of	Upper DMC	-	5.0	-	-	-	-
Tracy, City of	Upper DMC	-	5.0	-	-	-	-
Banta Carbona ID	Upper DMC	20.0	-	-	-	-	-
Total	**Upper DMC**	**40.6**	**20.0**	**0.0**	**0.0**	**0.0**	**0.0**
Del Puerto WD	Upper DMC	12.1	-	-	-	-	-
Davis WD	Upper DMC	5.4	-	-	-	-	-
Foothill WD	Upper DMC	10.8	-	-	-	-	-
Hospital WD	Upper DMC	34.1	-	-	-	-	-
Kern Canon WD	Upper DMC	7.7	-	-	-	-	-
Mustang WD	Upper DMC	14.7	-	-	-	-	-
Orestimba WD	Upper DMC	15.9	-	-	-	-	-
Quinto WD	Upper DMC	8.6	-	-	-	-	-
Romero WD	Upper DMC	5.2	-	-	-	-	-
Salado WD	Upper DMC	9.1	-	-	-	-	-
Sunflower WD	Upper DMC	16.6	-	-	-	-	-
West Stanislaus WD	Upper DMC	50.0	-	-	-	-	-
Patterson WD	Upper DMC	16.5	-	-	6.0	-	-
Total	**Upper DMC**	**206.7**	**0.0**	**0.0**	**6.0**	**0.0**	**0.0**

Notes for Tables 3-4a and 3-4e are provided after Table 3-4e.

Table 4b. CVP South-of-the-Delta

CVP Contractor	Geographic Location	CVP Water Service Contracts AG (TAF/yr)	CVP Water Service Contracts M&I (TAF/yr)	Settlement/ Exchange Contractor (TAF/yr)	Water Rights/ Non-CVP (TAF/yr)	Level 2 Refuges[1] (TAF/yr)	Losses (TAF/yr)
Upper DMC Loss	Upper DMC	-	-	-	-	-	18.5
Panoche WD	Lower DMC Volta	6.6	-	-	-	-	-
San Luis WD	Lower DMC Volta	65.0	-	-	-	-	-
Laguna WD	Lower DMC Volta	0.8	-	-	-	-	-
Eagle Field WD	Lower DMC Volta	4.6	-	-	-	-	-
Mercy Springs WD	Lower DMC Volta	2.8	-	-	-	-	-
Oro Loma WD	Lower DMC Volta	4.6	-	-	-	-	-
Total	**Lower DMC Volta**	**84.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Central California ID	Lower DMC Volta	-	-	140.0	-	-	-
Grasslands via CCID	Lower DMC Volta	-	-	-	-	81.8	-
Los Banos WMA	Lower DMC Volta	-	-	-	-	11.2	-
Kesterson NWR	Lower DMC Volta	-	-	-	-	10.5	-
Freitas - SJBAP	Lower DMC Volta	-	-	-	-	6.3	-
Salt Slough - SJBAP	Lower DMC Volta	-	-	-	-	8.6	-
China Island - SJBAP	Lower DMC Volta	-	-	-	-	7.0	-
Volta WMA	Lower DMC Volta	-	-	-	-	13.0	-
Grassland via Volta Wasteway	Lower DMC Volta	-	-	-	-	23.2	-
Total	**Lower DMC Volta**	**0.0**	**0.0**	**140.0**	**0.0**	**161.5**	**0.0**

Notes for Tables 3-4a and 3-4e are provided after Table 3-4e.

Table 4c. CVP South-of-the-Delta

CVP Contractor	Geographic Location	CVP Water Service Contracts AG (TAF/yr)	CVP Water Service Contracts M&I (TAF/yr)	Settlement/ Exchange Contractor (TAF/yr)	Water Rights/ Non-CVP (TAF/yr)	Level 2 Refuges[1] (TAF/yr)	Losses (TAF/yr)
Fresno Slough WD	San Joaquin River at Mendota Pool	4.0	-	-	0.9	-	-
James ID	San Joaquin River at Mendota Pool	35.3	-	-	9.7	-	-
Coelho Family Trust	San Joaquin River at Mendota Pool	2.1	-	-	1.3	-	-
Tranquillity ID	San Joaquin River at Mendota Pool	13.8	-	-	20.2	-	-
Tranquillity PUD	San Joaquin River at Mendota Pool	0.1	-	-	0.1	-	-
Reclamation District 1606	San Joaquin River at Mendota Pool	0.2	-	-	0.3	-	-
Central California ID	San Joaquin River at Mendota Pool	-	-	392.4	-	-	-
Columbia Canal Co.	San Joaquin River at Mendota Pool	-	-	59.0	-	-	-
Firebaugh Canal Co.	San Joaquin River at Mendota Pool	-	-	85.0	-	-	-
San Luis Canal Co.	San Joaquin River at Mendota Pool	-	-	23.6	-	-	-
M.L. Dudley Company	San Joaquin River at Mendota Pool	-	-	-	2.3	-	-
Grasslands WD	San Joaquin River at Mendota Pool	-	-	-	-	29.0	-
Mendota WMA	San Joaquin River at Mendota Pool	-	-	-	-	27.6	-
Losses	San Joaquin River at Mendota Pool	-	-	-	-	-	101.5
Total	**San Joaquin River at Mendota Pool**	**55.5**	**0.0**	**560.0**	**34.8**	**56.6**	**101.5**
San Luis Canal Co.	-	-	-	140.0	-	-	-
Grasslands WD	-	-	-	-	-	2.3	-
Los Banos WMA	-	-	-	-	-	12.4	-
San Luis NWR	-	-	-	-	-	19.5	-
West Bear Creek NWR	-	-	-	-	-	7.5	-
East Bear Creek NWR	-	-	-	-	-	8.9	-
Total	-	**0.0**	**0.0**	**140.0**	**0.0**	**50.6**	**0.0**

Notes for Tables 3-4a and 3-4e are provided after Table 3-4e.

Table 4d. CVP South-of-the-Delta

CVP Contractor	Geographic Location	CVP Water Service Contracts AG (TAF/yr)	CVP Water Service Contracts M&I (TAF/yr)	Settlement/ Exchange Contractor (TAF/yr)	Water Rights/ Non-CVP (TAF/yr)	Level 2 Refuges[1] (TAF/yr)	Losses (TAF/yr)
San Benito County WD (Ag)	San Felipe Aqueduct	35.6	-	-	-	-	-
Santa Clara Valley WD (Ag)	San Felipe Aqueduct	33.1	-	-	-	-	-
Pajaro Valley WD	San Felipe Aqueduct	6.3	-	-	-	-	-
San Benito County WD (M&I)	San Felipe Aqueduct	-	8.3	-	-	-	-
Santa Clara Valley WD (M&I)	San Felipe Aqueduct	-	119.4	-	-	-	-
Total	**San Felipe Aqueduct**	**74.9**	**127.7**	**0.0**	**0.0**	**0.0**	**0.0**
San Luis WD	CA reach 3	60.1	-	-	-	-	-
CA, State Parks and Rec	CA reach 3	2.3	-	-	-	-	-
Affonso/Los Banos Gravel Co.	CA reach 3	0.3	-	-	-	-	-
Total	**CA reach 3**	**62.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Panoche WD	CVP Dos Amigos PP/ CA reach 4	87.4	-	-	-	-	-
Pacheco WD	CVP Dos Amigos PP/ CA reach 4	10.1	-	-	-	-	-
Total	**CVP Dos Amigos PP/ CA reach 4**	**97.5**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Westlands WD (Centinella)	CA reach 4	2.5	-	-	-	-	-
Westlands WD (Broadview WD)	CA reach 4	27.0	-	-	-	-	-
Westlands WD (Mercy Springs WD)	CA reach 4	4.2	-	-	-	-	-
Westlands WD (Widern WD)	CA reach 4	3.0	-	-	-	-	-
Total	**CA reach 4**	**36.7**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Westlands WD: CA Joint Reach 4	CA reach 4	219.0	-	-	-	-	-
Westlands WD: CA Joint Reach 5	CA reach 5	570.0	-	-	-	-	-
Westlands WD: CA Joint Reach 6	CA reach 6	219.0	-	-	-	-	-
Westlands WD: CA Joint Reach 7	CA reach 7	142.0	-	-	-	-	-
Total	**-**	**1150.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Notes for Tables 3-4a and 3-4e are provided after Table 3-4e.

Table 4e. CVP South-of-the-Delta

CVP Contractor	Geographic Location	CVP Water Service Contracts AG (TAF/yr)	CVP Water Service Contracts M&I (TAF/yr)	Settlement/ Exchange Contractor (TAF/yr)	Water Rights/ Non-CVP (TAF/yr)	Level 2 Refuges[1] (TAF/yr)	Losses (TAF/yr)
Avenal, City of	CA reach 7	-	3.5	-	3.5	-	-
Coalinga, City of	CA reach 7	-	10.0	-	-	-	-
Huron, City of	CA reach 7	-	3.0	-	-	-	-
Total	**CA reach 7**	**0.0**	**16.5**	**0.0**	**3.5**	**0.0**	**0.0**
CA Joint Reach 3 - Loss	CVP Dos Amigos PP/CA reach 3	-	-	-	-	-	2.5
CA Joint Reach 4 - Loss	CA reach 4	-	-	-	-	-	10.1
CA Joint Reach 5 - Loss	CA reach 5	-	-	-	-	-	30.1
CA Joint Reach 6 - Loss	CA reach 6	-	-	-	-	-	12.5
CA Joint Reach 7 - Loss	CA reach 7	-	-	-	-	-	8.5
Total	**-**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**63.7**
Cross Valley Canal - CVP	CA reach 14	-	-	-	-	-	-
Fresno, County of	CA reach 14	3.0	-	-	-	-	-
Hills Valley ID-Amendatory	CA reach 14	3.3	-	-	-	-	-
Kern-Tulare WD	CA reach 14	40.0	-	-	-	-	-
Lower Tule River ID	CA reach 14	31.1	-	-	-	-	-
Pixley ID	CA reach 14	31.1	-	-	-	-	-
Rag Gulch WD	CA reach 14	13.3	-	-	-	-	-
Tri-Valley WD	CA reach 14	1.1	-	-	-	-	-
Tulare, County of	CA reach 14	5.3	-	-	-	-	-
Kern NWR	CA reach 14	-	-	-	-	11.0	-
Pixley NWR	CA reach 14	-	-	-	-	1.3	-
Total	**CA reach 14**	**128.3**	**0.0**	**0.0**	**0.0**	**12.3**	**0.0**
Total CVP South-of-Delta	**-**	**1937.1**	**164.2**	**840.0**	**44.3**	**281.0**	**183.7**

Notes for Tables 3-4a and 3-4e:
"-" indicates blank cell
1. Level 4 Refuge water needs are not included.

Table 5. SWP North-of-the-Delta

SWP CONTRACTOR	Geographic Location	FRSA Amount (TAF)	Water Right (TAF/yr)	Table A Amount Ag (TAF)	Table A Amount M&I (TAF)	Article 21 Demand (TAF/mon)	Other (TAF/yr)
Palermo	FRSA	-	17.6	-	-	-	-
County of Butte	Feather River	-	-	-	27.5		
Thermalito	FRSA	-	8.0	-	-	-	-
Western Canal	FRSA	150.0	145.0	-	-	-	-
Joint Board	FRSA	550.0	5.0	-	-	-	-
City of Yuba City	Feather River	-	-	-	9.6	-	-
Feather WD	FRSA	17.0	-	-	-	-	-
Garden, Oswald, Joint Board	FRSA	-	-	-	-	-	-
Garden	FRSA	12.9	5.1	-	-	-	-
Oswald	FRSA	2.9	-	-	-	-	-
Joint Board	FRSA	50.0	-	-	-	-	-
Plumas, Tudor	FRSA	-	-	-	-	-	-
Plumas	FRSA	8.0	6.0	-	-	-	-
Tudor	FRSA	5.1	0.2	-	-	-	-
Total Feather River Area	**-**	**795.8**	**186.9**	**0.0**	**37.1**	-	-
Yuba County Water Agency	Yuba River	-	-	-	-	-	Variable
Yuba County Water Agency	Yuba River	-	-	-	-	-	333.6
Camp Far West ID	Yuba River	-	-	-	-	-	12.6
Bear River Exports	American R/DSA70	-	-	-	-	-	Variable
Bear River Exports	American R/DSA70	-	-	-	-	-	95.2
Feather River Exports to American River (left bank to DSA70)	American R/DSA70	-	11.0	-	-	-	-

Notes:
"-" indicates blank cell

Table 6a. SWP South-of-the-Delta –Future Conditions

SWP Contractor	Geographic Location	Table A Amount Ag (TAF)	Table A Amount M&I (TAF)	Article 21 Demand (TAF/mon)	Losses (TAF/yr)
Alameda Co. FC&WCD, Zone 7	SBA reaches 1-4	-	43.98	1.00	-
Alameda Co. FC&WCD, Zone 7	SBA reaches 5-6	-	36.64	None	-
Alameda Co. FC&WCD, Zone 7	**Total**	-	**80.62**	**1.00**	-
Alameda County WD	SBA reaches 7-8	-	42.00	1.00	-
Santa Clara Valley WD	SBA reach 9	-	100.00	4.00	-
Oak Flat WD	CA reach 2A	5.70	-	None	-
County of Kings	CA reach 8C	9.31	-	None	-
Dudley Ridge WD	CA reach 8D	45.35	-	1.00	-
Empire West Side ID	CA reach 8C	3.00	-	1.00	-
Kern County Water Agency	CA reaches 3, 9-13B	608.86	134.60	None	-
Kern County Water Agency	CA reaches 14A-C	99.20	-	180.00	-
Kern County Water Agency	CA reaches 15A-16A	59.40	-	None	-
Kern County Water Agency	CA reach 31A	80.67	-	None	-
Kern County Water Agency	**Total**	**848.13**	**134.60**	**180.00**	-
Tulare Lake Basin WSD	CA reaches 8C-8D	87.47	-	15.00	-
San Luis Obispo Co. FC&WCD	CA reaches 33A-35	-	25.00	None	-
Santa Barbara Co. FC&WCD	CA reach 35	-	45.49	None	-
Antelope Valley-East Kern WA	CA reaches 19-20B, 22A-B	-	144.84	1.00	-
Castaic Lake WA	CA reach 31A	12.70	-	1.00	-
Castaic Lake WA	CA reach 30	-	82.50	None	-
Castaic Lake WA	**Total**	**12.70**	**82.50**	**1.00**	-
Coachella Valley WD	CA reach 26A	-	138.35	2.00	-
Crestline-Lake Arrowhead WA	CA reach 24	-	5.80	None	-
Desert WA	CA reach 26A	-	55.75	5.00	-
Littlerock Creek ID	CA reach 21	-	2.30	None	-
Mojave WA	CA reaches 19, 22B-23	-	85.80	None	-

SWP Contractor	Geographic Location	Table A Amount Ag (TAF)	Table A Amount M&I (TAF)	Article 21 Demand (TAF/mon)	Losses (TAF/yr)
Metropolitan WDSC	CA reach 26A	-	148.67	90.70	-
Metropolitan WDSC	CA reach 30	-	756.69	74.80	-
Metropolitan WDSC	CA reaches 28G-H	-	102.71	27.60	-
Metropolitan WDSC	CA reach 28J	-	903.43	6.90	-
Metropolitan WDSC	**Total**	-	**1911.50**	**200.00**	-

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Table 6b. SWP South-of-the-Delta

SWP Contractor	Geographic Location	Table A Amount Ag (TAF)	Table A Amount M&I (TAF)	Article 21 Demand (TAF/mon)	Losses (TAF/yr)
Palmdale WD	CA reaches 20A-B	-	21.30	None	-
San Bernardino Valley MWD	CA reach 26A	-	102.60	None	-
San Gabriel Valley MWD	CA reach 26A	-	28.80	None	-
San Gorgonio Pass WA	CA reach 26A	-	17.30	None	-
Ventura County FCD	CA reach 29H	-	3.15	None	-
Ventura County FCD	CA reach 30	-	16.85	None	-
Ventura County FCD	**Total**	**-**	**20.00**	**-**	**-**
SWP Losses	CA reaches 1-2	-	-	-	7.70
SWP Losses	SBA reaches 1-9	-	-	-	0.60
SWP Losses	CA reach 3	-	-	-	10.80
SWP Losses	CA reach 4	-	-	-	2.60
SWP Losses	CA reach 5	-	-	-	3.90
SWP Losses	CA reach 6	-	-	-	1.20
SWP Losses	CA reach 7	-	-	-	1.60
SWP Losses	CA reaches 8C-13B	-	-	-	11.90
SWP Losses	Wheeler Ridge PP and CA reaches 14A-C	-	-	-	3.60
SWP Losses	Chrisman PP and CA reaches 15A-18A	-	-	-	1.80
SWP Losses	Pearblossom PP and CA reaches 17-21	-	-	-	5.10
SWP Losses	Mojave PP and CA reaches 22A-23	-	-	-	4.00
SWP Losses	REC and CA reaches 24-28J	-	-	-	1.40
SWP Losses	CA reaches 29A-29F	-	-	-	1.90
SWP Losses	Castaic PWP and CA reach 29H	-	-	-	3.10
SWP Losses	REC and CA reach 30	-	-	-	2.40
SWP Losses	**Total**	**-**	**-**	**-**	**63.60**
Total	**-**	**1011.66**	**3044.55**	**412.00**	**63.60**

Notes:
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Attachment 1-3 DSM2 Model Assumptions Callouts

1 Introduction

The assumptions for all model simulations in this study are summarized in Appendix H Attachment 1-1 Model Assumptions.

2 DSM2 Modeling Assumptions Callouts

The following matrix summarizes the assumptions used for the DSM2 models:

- Existing Conditions (EX)
- Proposed Project (PP)

Table 1a. Boundary Conditions

–	Existing Conditions (EX)	Proposed Project (PP)
Period of simulation	82 years (1922-2003)[1]	Same as EX
Boundary flows	Monthly timeseries from CalSim II output (at Sacramento River, East Side Streams, San Joaquin River, as well as Delta exports and diversions)[3]	Same as EX
Ag flows (DICU)	2020 Level, DWR Bulletin 160-98[4]	Same as EX
Martinez stage	15-minute adjusted astronomical tide[1]	Same as EX
Vernalis EC	Monthly time series from CalSim II output[5]	Same as EX
Agricultural Return EC	Municipal Water Quality Investigation Program analysis	Same as EX
Martinez EC	Monthly net Delta Outflow from CalSim output & G-model[6]	Same as EX

Notes for Table 1a and 1b are provided after Table 1b.

Table 1b. Facilities

–	Existing Conditions (EX)	Proposed Project (PP)
Period of simulation	82 years (1922-2003)[1]	Same as EX
Freeport Regional Water Project	Monthly output from CalSim II	Same as EX
Delta Cross Channel	Monthly time series of number of days open from CalSim II output[8]	Same as EX
Stockton Delta Water Supply Project	Monthly output from CalSim II	Same as EX
Delta Habitat Improvements	None	Same as EX
Veale Tract Drainage Relocation	The Veale Tract Water Quality Improvement Project, funded by CALFED, relocates the agricultural drainage outlet was relocated from Rock Slough channel to the southern end of Veale Tract, on Indian Slough[7]	Same as EX
Clifton Court Forebay	Priority 3, gate operations synchronized with incoming tide to minimize impacts to low water levels in nearby channels	Same as EX
Contra Costa Water District Delta Intakes	Rock Slough Pumping Plant, Old River at Highway 4 Intake and Alternate Improvement Project Intake on Victoria Canal	Same as EX

–	Existing Conditions (EX)	Proposed Project (PP)
South Delta barriers	Temporary Barriers Project operated based on San Joaquin River flow time series from CalSim II output; HORB installed Apr 1– May 31 and Sep 16 – Nov 30; Agricultural barriers on Old and Middle Rivers are assumed to be installed starting from May 16 and on Grant Line Canal from June 1; All three barriers are allowed to be operated until November 30; May 16 to May 31; the tidal gates are assumed to be tied open for the barriers on Old and Middle Rivers.	Temporary Barriers Project operated based on San Joaquin River flow time series from CalSim II output; HORB is not installed; Agricultural barriers on Old and Middle Rivers are assumed to be installed starting from May 16 and on Grant Line Canal from June 1; All three barriers are allowed to be operated until November 30; May 16 to May 31; the tidal gates are assumed to be tied open for the barriers on Old and Middle Rivers.
Antioch Water Works	Monthly output from CalSim II	Same as EX
Suisun Marsh Salinity Control Gates	Gate operations occur in October through February. Gates open when upstream water level is 0.3 ft above downstream water level. Gates close when current is less than -0.1 fps. Gates are open in March through September.	Gate operations occur in October through February in all years, and July through August during Below Normal water years. Gates open when upstream water level is 0.3 ft above downstream water level. Gates close when current is less than -0.1 fps. In Below Normal years, gates are open in March through June. In all other water years, gates are open in March through September.

Notes for Table 1a and 1b:

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1 Adjusted astronomical tide for use in DSM2 planning studies has been developed by DWR's Bay Delta Office Modeling Support Branch Delta Modeling Section in cooperation with the Common Assumptions workgroup. This tide is based on a more extensive observed dataset and covers the entire 82-year period of record.

2 Footnote not used

3 Although monthly CalSim output was used as the DSM2-HYDRO input, the Sacramento and San Joaquin rivers were interpolated to daily values in order to smooth the transition at the month transitions. DSM2 then uses the daily flow values along with a 15-minute adjusted astronomical tide to simulate effect of the spring and neap tides.

4 The Delta Island Consumptive Use (DICU) model is used to calculate diversions and return flows for all Delta islands based on the level of development assumed. The projected 2020 land-use assumptions are found in Bulletin 160-98.

5 CalSim II calculates monthly EC for the San Joaquin Riverm, which are then represented at a daily interval. Daily EC timeseries data are constant across each month. Fixed concentrations of 150, 175, and 125 μmhos/cm were assumed for the Sacramento River, Yolo Bypass, and eastside streams, respectively.

6 Net Delta outflow based on the CalSim II flows was used with an updated G-model to calculate Martinez EC.

7 Information was obtained based on the information from the draft final “Delta Region Drinking Water Quality Management Plan” dated June 2005 prepared under the CALFED Water Quality Program and a presentation by David Briggs at SWRCB public workshop for periodic review. The presentation “Compliance location at Contra Costa Canal at Pumping Plant #1 – Addressing Local Degradation” notes that the Veale Tract drainage relocation project will be operational in June 2005. The DICU drainage currently simulated at node 204 is moved to node 202 in DSM2.

8 CalSim II calculates number of days DCC gates are open in a given month. For implementation in DSM2, it is assumed the number of days open are the first series of days in that month. For example, if CalSim II output indicates DCC gates are open for 5 days in a given month, DCC gates will be open for the first five days of that month in DSM2.

Attachment 1-4 Scenario Related Changes to CalSim II and DSM2

1 Introduction

This document describes assumptions for scenario related changes to CalSim II and DSM2 utilized in this EIR. Scenario related changes include:

- Application of Summer/Fall Suisun Marsh Salinity Control Gate (SMSCG) Operations
- Old and Middle River flows

2 Application of Summer/Fall SMSCG Operations

The proposed project Summer/Fall Delta Smelt Habitat Action includes a measure to operate SMSCG for up to 60 days in June – October of below normal, above normal years, and, possibly wet years. For more detailed description of the action, see Section 3.3 of the main document. This document describes the changes to CalSim II and DSM2 to model effect of proposed project SMSCG operations.

2.1 Representation in CalSim II

CalSim II uses artificial neural networks (ANNs) to calculate the salinity at select compliance locations in the Delta. However, the CalSim II ANNs do not account for effect SMSCG operations, which increase salinity intrusion in the Sacramento and San Joaquin Rivers. To ensure modeled operations from CalSim II meet D1641 water quality standards, a buffer was applied to the compliance threshold.

Therefore, CalSim II was adjusted to meet water quality standards in the Delta. To model the effect of gate operations, a buffer to D1641 water quality standards at Sacramento River at Emmaton and San Joaquin River at Jersey Point during assumed periods of SMSCG operations. The buffer value represents the increase in Delta Outflow required meet water quality standards when SMSCG are operating. Therefore, operating to a salinity buffer would provide the same operational response as would a simulation that included SMSCG operations explicitly. Methodology for determining CalSim II buffer values is described in Section 2.3.

2.2 Representation in DSM2

DSM2 dynamically models SMSCG operations. Therefore, DSM2 model input were adjusted to match description in proposed project.

2.3 Calculation of CalSim II Buffer

Impact of SMSCG operations on salinity at select compliance locations was studied using the DSM2. DSM2 was run with and without July – August SMSCG operations. Tidally averaged salinity results were then compared at D-1641 regulation stations modeled in CalSim II. Scatter plots, of tidally averaged monthly salinity with and without July – August SMSCG operations are presented in Figure 1. Salinity during the months of January – June and November – December, when modeled SMSCG operations are consistent, are shown in blue. The blue scatter points make a 1:1 line, indicating salinity results during these months are equal. Salinity during the months of July and August are shown in orange. As these points are above the 1:1 line (in blue), monthly average July and August salinity at these locations increases. Salinity results during September and October are represented as grey point. Even though SMSCG are not operating, the salinity impact of July – August operations require about two months to disperse. As changes to salinity follow a linear trend, salinity impacts of SMSCG operations are estimated with a linear regression.

The result of applying linear regressions for the month of July-September at the major regulatory locations (Jersey Point, Emmaton, Contra Costa Canal and Clifton Court) are summarized in Table 1.

Table 1. Regression Coefficients Representing Salinity Effects of SMSCG Operations

–	*Jersey Point*	*Emmaton*	*Old River at Rock Slough*	*Clifton Court Forebay*
Intercept	24.0	32.3	-46.8	-60.6
Slope	1.12	1.09	1.20	1.22

Notes:
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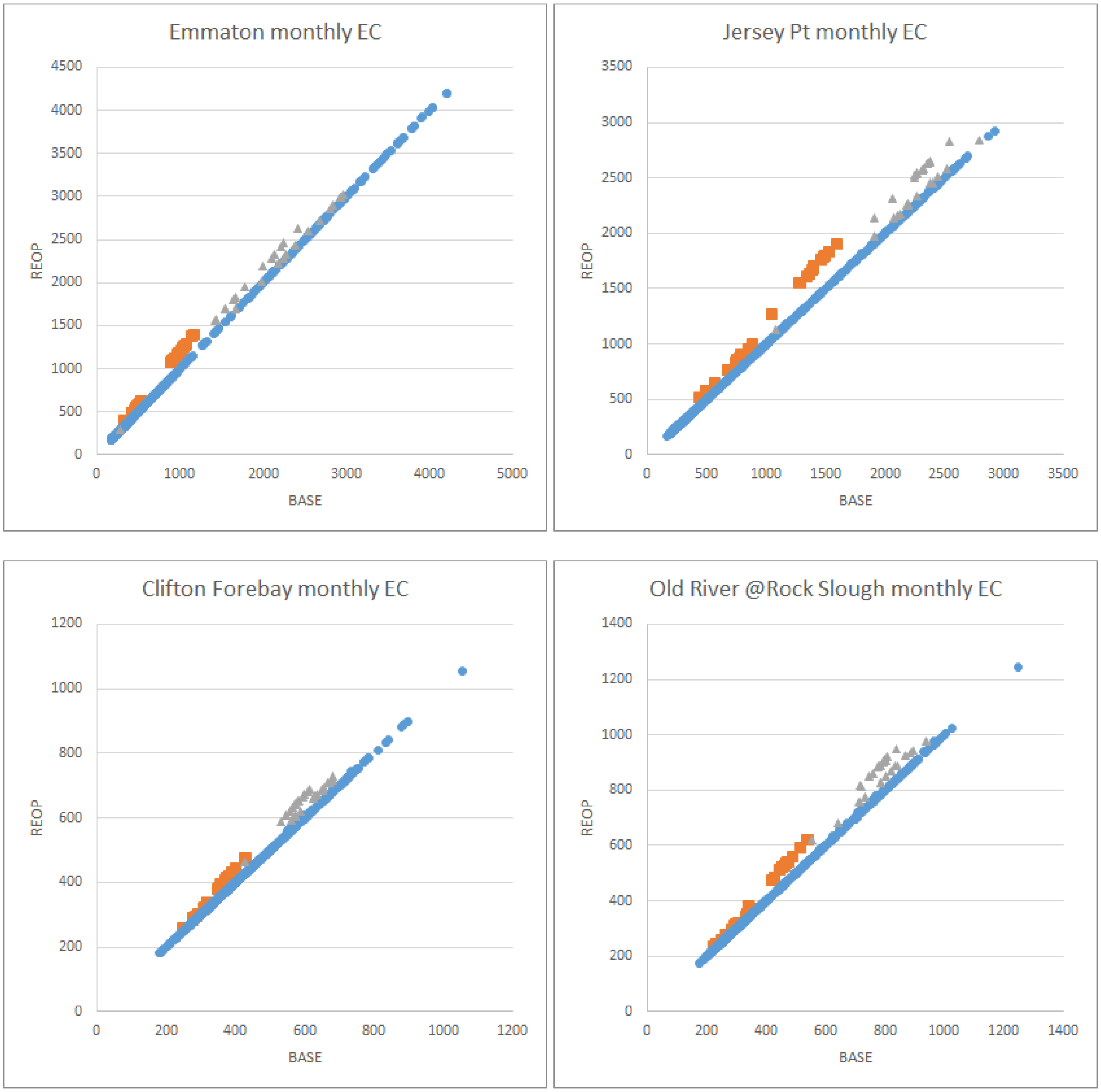

Figure 1. Scatter Plot of With and Without SMSCG Operations, Monthly Averaged EC

- orange square is for Jul-Aug, the SMSCG summer re-operation time
- grey triangle is for Sep-Oct, to show the lingering effect
- blue circles is for all the other months, when both scenarios are almost identical

3 Old and Middle River Flows

3.1 Existing

Calculations of the Net Tidal Flow in Old and Middle River (OMR) have been used in recent years as a surrogate for determining the relative influence of water project export rates on Bay-Delta aquatic species listed for Endangered Species Act protection under both Federal and State law.

The U.S. Fish and Wildlife Service and National Marine Fisheries Service issued Biological Opinions for Delta smelt and Central Valley salmonids in 2008 and 2009 (08/09 BiOps), respectively. The 08/09 BiOps included OMR restrictions to minimize potential loss of sensitive fish species due to the water project exports.

PREVIOUS APPROACH USED FOR CALSIM STUDIES (2009 CalSim II Assumptions)

After the issuance of the 08/09 BiOps, there was a multi-agency effort to develop representations of these new criteria in CalSim II for the purpose of estimating the operations of the SWP and CVP for water supply and CECA/NEPA processes. Many of the assumptions were based on best guesses and limited data at the time. At the time of development, it was expected that the Delta smelt would be the primary driver in the determination of the OMR for the export operations. Salmonids were expected to provide a consistent timing with the explicit onset starting January 1, but otherwise expected to be covered by the Delta smelt criteria.

The methods used in estimating the OMR requirements are detailed in “Representation of U.S. Fish and Wildlife USFWS Biological Opinion Reasonable and Prudent Alternative Actions for CalSim II Planning Studies” and “Representation of National Marine Fisheries Service Biological Opinion Reasonable and Prudent Alternative Actions for CalSim II Planning Studies” included at the end of Appendix H Attachment 1-4 Scenario Related Changes to CalSim II and DSM2.

PROPOSED NEW APPROACH FOR CALSIM STUDIES

As part of the development of the baseline assumptions for the proposed project, previous assumptions that were developed almost 10 years ago prior to the implementation of the 08/09 BiOps, were reevaluated for consistency with current understanding of OMR management. This review is especially necessary considering a known shift in how OMR is determined in real-time for Delta smelt and a recognition that Salmonid protections have been the determining factor on setting OMR more often than originally expected.

Historical OMR determinations, as shown in Figure 2, were used to assess the general representation of the OMR in CalSim II based on assumptions developed roughly 10 years ago. As shown in the figure, there are periods with significant deviations. This comparison demonstrates the need for updated OMR assumptions for appropriate reflection of the existing conditions in the CalSim II model.

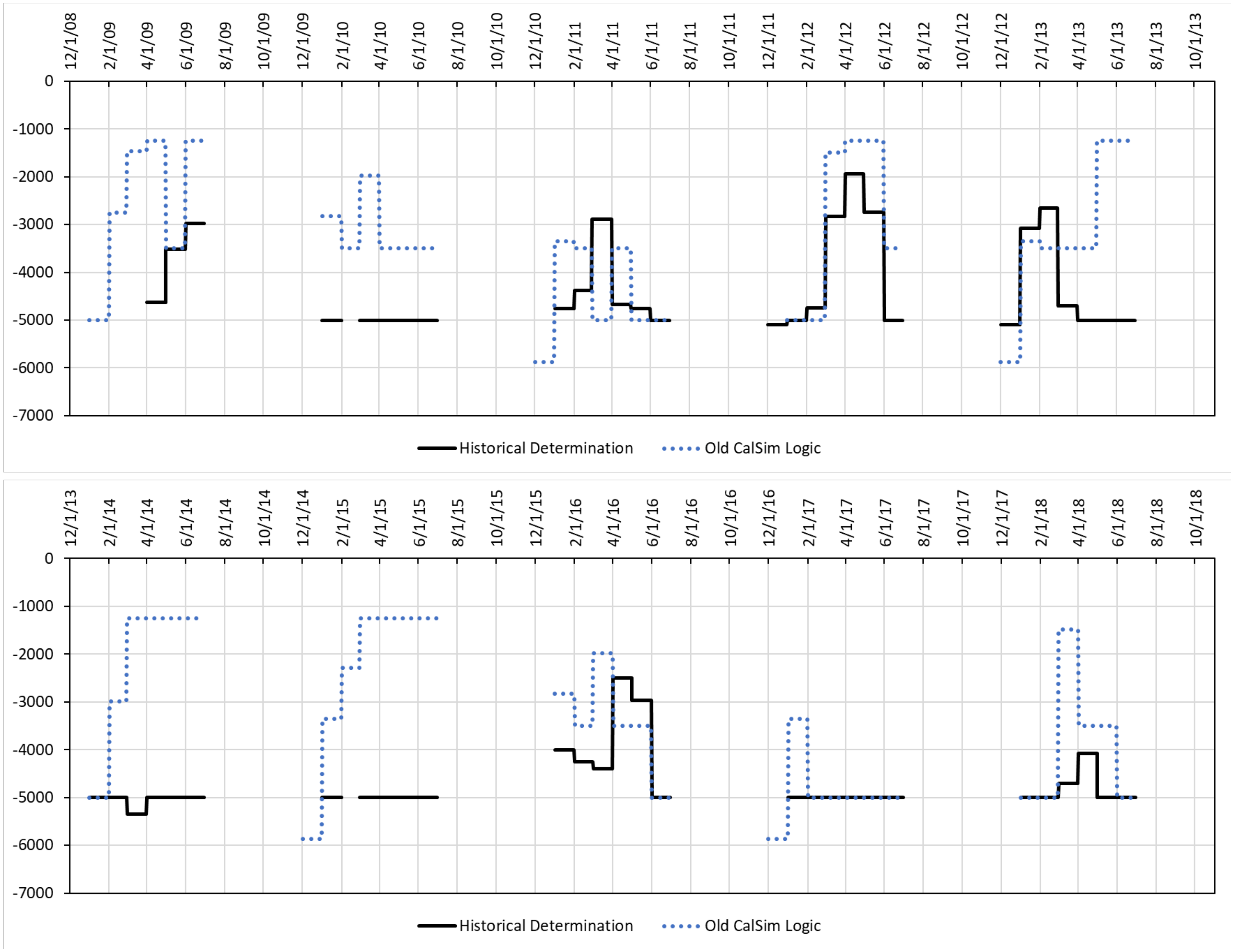

Figure 2: Comparison of the Old CalSim logic to the actual historical OMR determinations.

Method for Estimating the First Flush in CalSim for the Baseline

In modeling the existing condition, 2008 USFWS BiOp Action 1 or "First Flush" was assumed to be implemented under the following conditions:

- December when the unimpaired Sacramento River Runoff (SRR) is greater than 20,000 cfs,
- January if no First Flush occurred in December and when the SRR is greater than 20,000 cfs

This action is consistent with the methodology used in the 2009 CalSim II assumptions, but reduces the timeframe during which this action trigger in the model to December and January. This reduction in timeframe was based on the general understanding that the action would likely not occur after January.

Method for Estimating the Calendar based 2009 NMFS BiOp Action 4.2.3

The implementation of the 2009 NMFS BiOp Action 4.2.3 is a calendar-based OMR that begins on January 1 and ends June 30. An OMR restriction of -5,000 cfs is applied as a background level for this period.

Method for Estimating OMR for Smelt Entrainment Protection in CalSim

The 2008 USFWS BiOp Action 2 CalSim assumptions were updated from using an X2 based measure in the 2009 implementation to a turbidity-based protection measure reflecting the recent OMR determinations. As mentioned above, most recent historical OMR determinations have been based on turbidity-based indicators, rather than strictly fish presence. Instead of an X2 surrogate, this action uses a flow surrogate to indicate central Delta turbidity triggering an Adult Delta smelt entrainment protective OMR action. Old River at Bacon Island (OBI) was chosen to represent the southern part of the central Delta and to trigger an entrainment protection action.

When triggered the modeling assumes a -2000 cfs for 5 days when the following conditions occur:

- Timeframe under which a turbidity avoidance action may occur
    - January to March – if First Flush occurs in December,
    - February to March – if First Flush occurs in January or not at all,
- SRR > 20,000 cfs

Like other turbidity related actions, this one requires the use of a surrogate to determine when an action is triggered. The turbidity station at OBI is in the interior Delta south of the San Joaquin River, which makes it difficult to predict with any great accuracy. However, the SRR is and has been used as a surrogate for other turbidity-based actions in CalSim II. To determine an appropriate flow level, number of days with historical daily average OBI data above 12 NTU, from 2008 to 2019, were summed for each month from January to March. The resulting number of days per month exceeding 12 NTU were compared to the SRR for the same month (Figure 3). The red line indicates the SRR value that captures most instances when daily average OBI turbidity greater than 12 NTU.

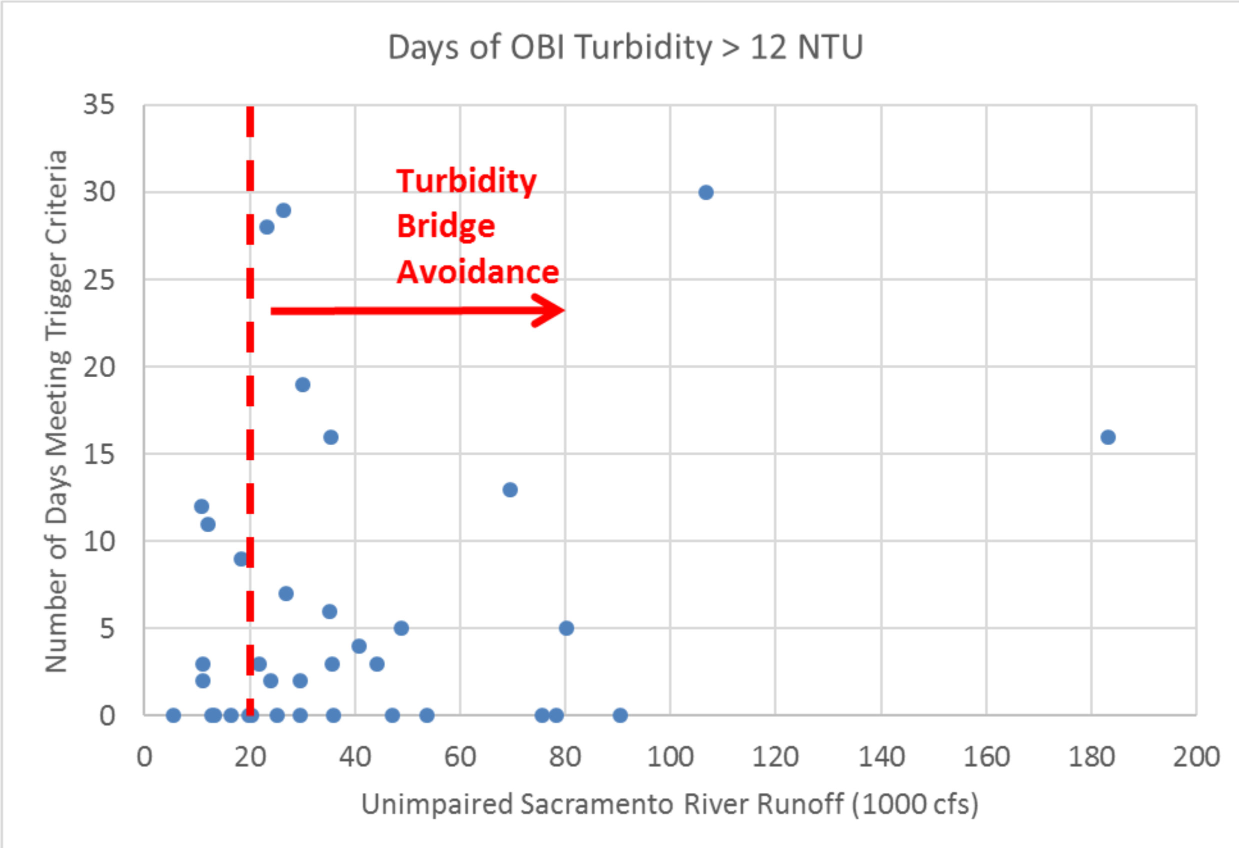

Figure 3: Relationship between Sacramento River Runoff and the number of days of turbidity at Old River at Bacon Island exceeding 12 NTU. Where the red line at a SRR of 20,000 cfs shows the rough transition point of the data.

This relationship could be stronger, but it should be recognized that because of its location, OBI turbidity is subject to many variables, including but not limited to wind driven turbidity and lower turbidity due to proactive Project operations that is embedded in the OBI turbidity data presented here, and may not be representing a true turbidity bridge formation. In general, the historic OBI turbidity data resulted in a 72% frequency of triggering an event. Using an SRR surrogate of 20,000 cfs results in a 61% triggering frequency. Given that in CalSim II the OMR requirements are applied on a monthly timestep, this is a reasonable surrogate for reflecting potential duration of this OMR action in CalSim II.

Representation of OMR due to Salvage Density in CalSim

As described above, the existing conditions modeling was updated to estimate the OMR restrictions based more on the Salmon and Steelhead density triggers rather than the larval and juvenile smelt using the location of X2 consistent with recent historical operations. Based on the historical salvage data a generalized relationship was developed and applied in all year types where:

- March assumed 3 days at Stage 1 (OMR = -3,500 cfs), and 5 days at Stage 2 (OMR = -2,500 cfs)
- April assumed 9 days at Stage 1 (OMR = -3,500 cfs)
- May assumed 5 days at Stage 1 (OMR = -3,500 cfs)

The number of days at each *Stage* were determined using salvage data for winter run, based on length at date, and for steelhead from 2010 to 2019. Daily density was determined for each species by dividing the daily fish loss by the volume of pumping at the SWP and CVP export facilities. Calculated daily densities were then compared to triggers levels, which are determined at the beginning of each year for winter run. Historical winter run trigger levels have ranged 2.5 fish/TAF to 12 fish/TAF for Stage 1 and 5 fish/TAF to 24 fish/TAF for Stage 2. Steelhead triggers were consistently 8 fish/TAF for Stage 1 and 12 fish/TAF for Stage 2.

For each triggering event, a minimum of 5 days of required OMR was assumed, but, if an event continues or another event is triggered immediately, the number of days at a specific OMR level could be greater, or could transition to another *Stage.* Table 2 reports the total number of days determined by the historic data that resulted in Stage 1, and Table 3 reports the total number of days at Stage 2.

Table 2: Number of days of OMR at Stage 1 levels based on historical salvage that exceeded the fish density triggers for Stage 1 for winter run and steelhead.

–	Jan	Feb	Mar	Apr	May	Jun
2010	0	5	0	5	2	0
2011	5	1	3	5	10	10
2012	0	5	5	10	5	0
2013	0	0	12	13	5	0
2014	0	0	0	0	0	0
2015	0	5	0	0	0	0
2016	0	0	0	0	0	0
2017	0	0	0	0	0	0
2018	0	0	5	15	11	0
2019	0	0	0	11	0	0
Average	1	2	3	6	3	1

Note:
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Table 3: Number of days of OMR at Stage 2 levels based on historical salvage that exceeded the fish density triggers for Stage 2 for winter run and steelhead.

–	Jan	Feb	Mar	Apr	May	Jun
2010	0	0	0	0	0	5
2011	0	10	28	2	0	0
2012	0	7	26	6	0	0
2013	0	0	0	12	10	0
2014	0	0	0	0	0	0
2015	0	0	0	0	0	0
2016	0	0	0	0	0	0
2017	0	0	0	0	0	0
2018	0	0	0	5	5	0
2019	0	0	0	0	0	0
Average	0	2	5	3	2	1

Note:
" –" indicates this cell is blank.

For implementation in CalSim, the combined monthly averages for Stage 1 and Stage 2 were used to determine months with an average of 5 more days, which would indicate on average one or more triggering events occurred. Only months with combined averages over 5 were assumed in development of OMR restrictions based on salvage density. Table 4 shows the number of days assumed in the CalSim II logic for Stage 1 and Stage 2 salvage density salmonid protections.

Table 4: Resulting number of days for each trigger stage assumed in the CalSim model under Existing Conditions.

–	Jan	Feb	Mar	Apr	May	Jun
Stage 1 (-3,500 cfs)	0	0	3	9	5	0
Stage 2 (-2,500 cfs)	0	0	5	0	0	0

Note:
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Rollup of OMR Methodology in CalSim

Implementation of the updated assumptions in CalSim, as described above, better represent both the fish species that has been dictating the OMR requirements as well as the restriction level under the recent historic conditions. Figure 4 compares the updated CalSim assumptions to both the historical OMR requirements and the previous (old) CalSim assumptions used in CalSim, where the updated logic appears to better represent the actual historical determinations better.

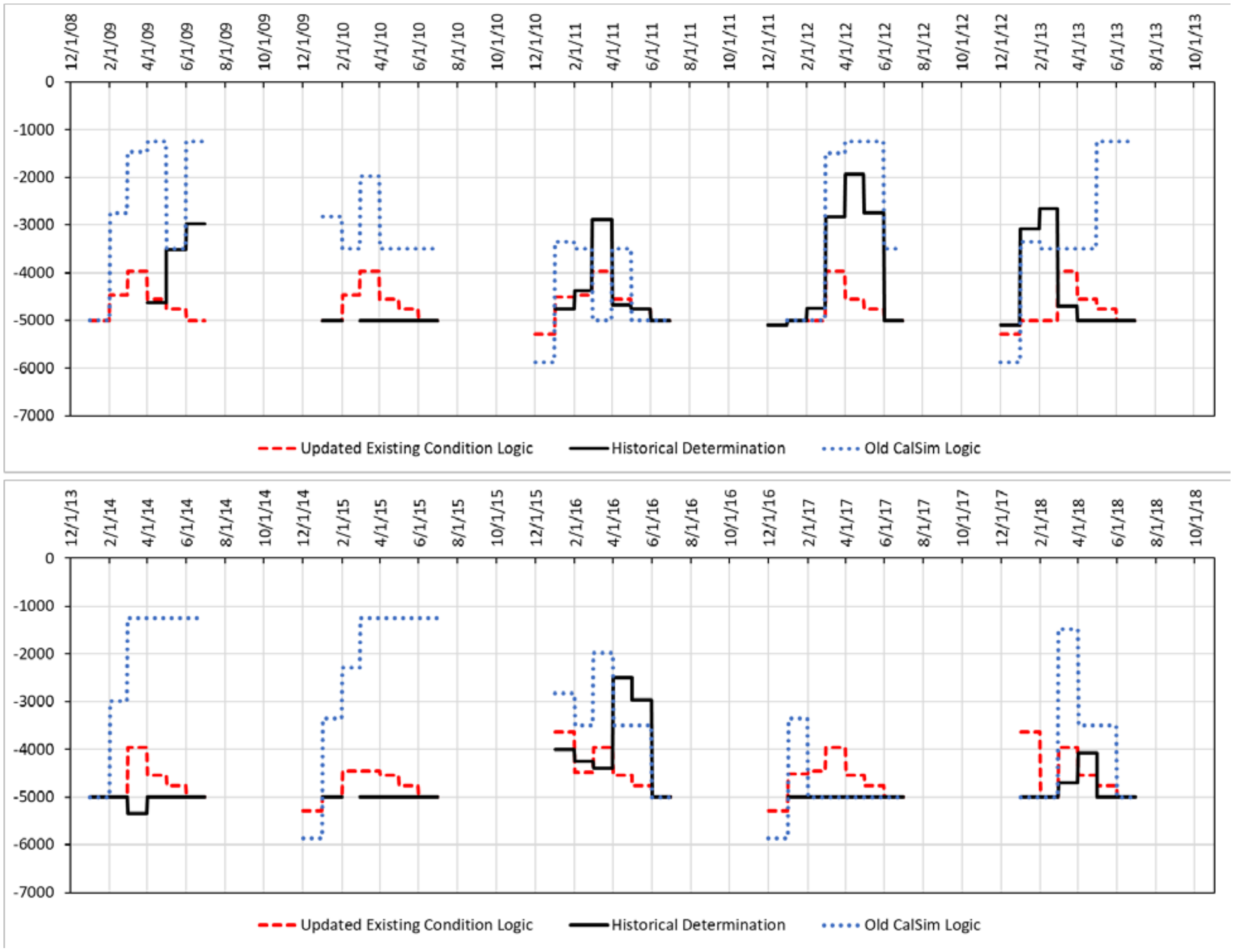

Figure 4: Comparison of the Updated CalSim logic to the actual historical OMR determinations and the Old CalSim logic.

3.2 Proposed Project

The following OMR criteria were implemented in the Proposed Project CalSim II model.

Integrated Early Winter Pulse Protection (First Flush) Trigger and Criteria

In modeling the proposed project, the Integrated Early Winter Pulse Protection or "First Flush" (described in Section 3.3.1 of the main document) was assumed to be implemented under the following conditions:

- December when the unimpaired Sacramento River Runoff (SRR) is greater than 20,000 cfs,
- January if no First Flush occurred in December and when the SRR is greater than 20,000 cfs

The First Flush action is assumed to restrict OMR to -2,000 cfs for 14 days. Since CalSim utilizes a monthly timestep this 14 day action is implemented using a weighted average with a background level. For December the background level is -8,000 cfs and for January the background level is -5,000 cfs.

These assumptions were developed using Sacramento River at Freeport flow and turbidity data from 2008 to 2019. In addition, turbidity data from Sacramento River at Hood was used to fill-in and confirm turbidity data at Freeport. Since the first flush is limited to the December to January period, the data analyzed was also limited to this timeframe. Turbidity is a parameter that is not simulated in CalSim, and so a flow surrogate was used and consistent with past practice. The SRR represents the unimpaired flow from the major tributaries to the Sacramento River. As shown in Figure 5 the approximate transition where Freeport flow and turbidity levels would trigger a first flush is around an SRR of about 20,000 cfs.

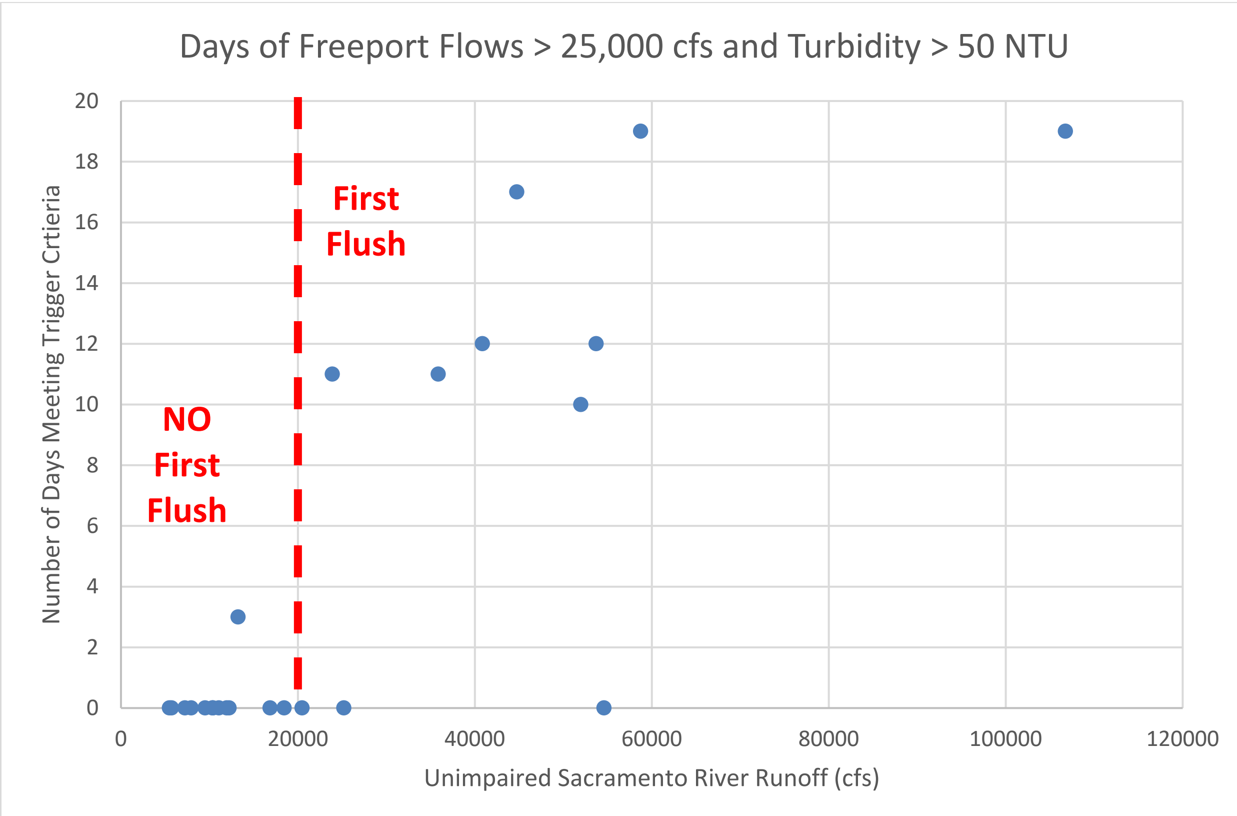

Figure 5: Relationship between Sacramento River Runoff and the flow and turbidity at Freeport exceeding 25,000 cfs and 50 NTU.

Using the SRR is consistent with what was used in the modeling of the Existing Condition which represents a different triggering criterion – Section 3.1 of this attachment describes how the assumptions for the Existing Conditions were developed). As described, the Existing Condition modeling uses an SRR of 20,000 cfs as a surrogate of reaching 12 NTU in the interior Delta. Even though these separate analyses have indicated similar levels of SRR to represent the triggering of the First Flush, the action in the Proposed Project is expected to be triggered more often. Evaluating the historical First Flush actions from the 2008/2009 BiOps (water years 2009 to 2019) has shown that the action was only triggered once, in 2013. However, there was an additional period where the Projects proactively took an action before a trigger could occur, and so in the 11 years of historical operations, the First Flush conditions, as described by the action in the Existing Conditions, occurred twice. Under the newer definition using flow and turbidity at Freeport, this would occur much more frequently. Figure 6 shows that the frequency of the First Flush occurring increases from roughly 20% under Existing Conditions to over 70% with the Proposed Project.

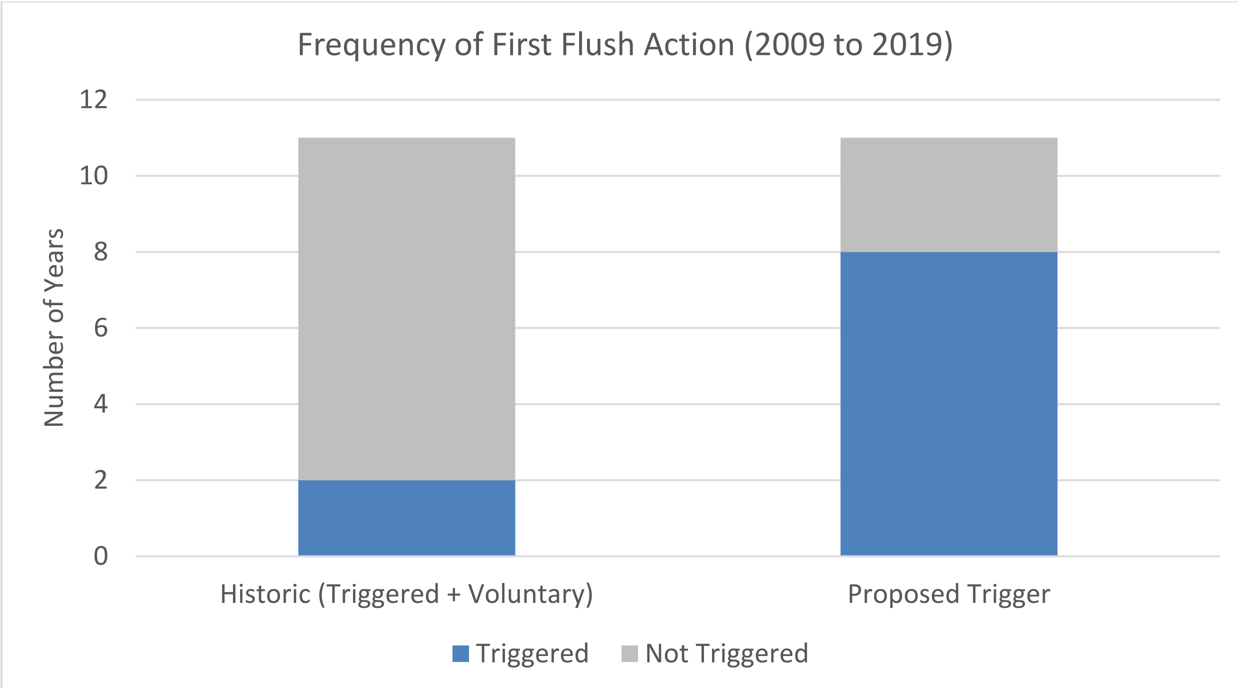

Figure 6: Comparison of the historical triggering of the First Flush action under the 2008/2009 BiOps and the new proposed triggering under the Proposed Project.

It is important to note, that the CalSim assumptions between the Existing Condition and the Proposed Project are the same, however as shown in Figure 6, the frequency of triggering the First Flush action is expected to be higher under the Proposed Project.

Turbidity Bridge Avoidance Trigger and Criteria

In modeling the proposed project, the turbidity bridge avoidance (described in Section 3.3.1 of the main document) was assumed to apply an additional OMR requirement of -2,000 cfs for 5 days when the following conditions occur:

- Timeframe under which a turbidity avoidance action may occur
  - January to March – if First Flush occurs in December,
  - February to March – if First Flush occurs in January or not at all,
- SRR > 20,000 cfs

Like other turbidity related actions, this one requires the use of a surrogate to determine when an action is triggered. The turbidity station at Old River at Bacon Island (OBI) is in the interior Delta south of the San Joaquin River, which makes it difficult to predict with any great accuracy. However, the SRR is and has been used for other turbidity based actions. Using historical OBI data from 2008 to 2019, daily average values above 12 NTU were summed for months January to March. The resulting number of days per month exceeding 12 NTU were compared to the SRR for the same month (Figure 7). The red line indicates the rough transition point using the SRR.

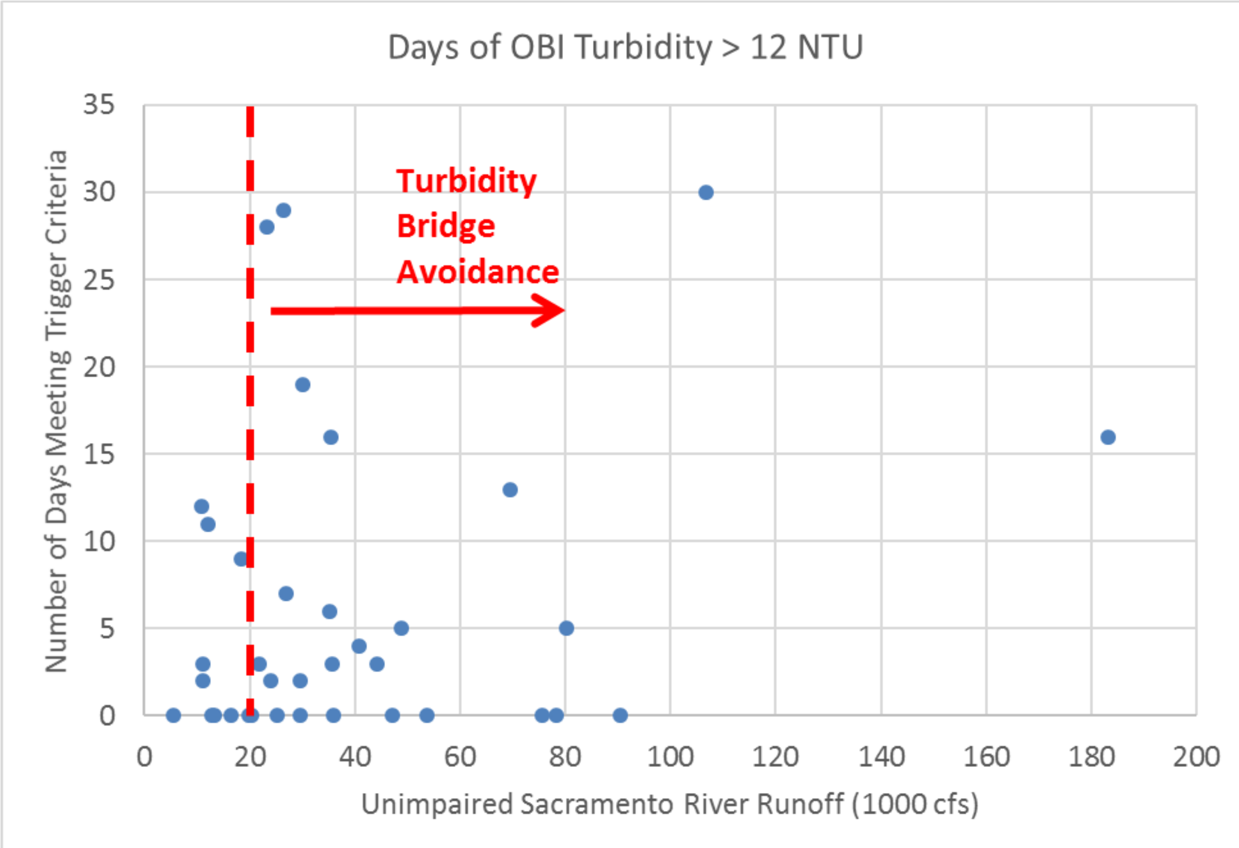

Figure 7: Monthly Comparison of Number of Days in Month Exceeding 12 NTU at OBI and SRR

This relationship could be stronger, but it should be recognized that because of its location, OBI, is subject to many variables, including but not limited to wind driven turbidity and lower turbidity due to proactive Project operations that is embedded in the data. In general, the historic data resulted in a 72% frequency of a triggering event. Using an SRR surrogate of 20,000 cfs results in a 61% triggering frequency.

OMR Flex Trigger and Criteria

In modeling the proposed project, OMR Flex (described in Section 3.3.1 of the main document) was assumed to be implemented under the following conditions:

- Wet water years – no OMR flex was assumed,
- Above normal and below normal water years – 7 days at -6,000 cfs in January and February,
- Dry water years – 7 days at -6,000 cfs in either January or February, and
- Critical water years – no OMR flex was assumed.

These assumptions were developed using historical data from 2009 to 2018 were used to develop a generalized OMR flex implementation in the CalSim model. There are many conditions which need to be met before an OMR flex can occur, however not all conditions are available in the historical data. For estimating the OMR flex in the model the following data and conditions were used:

- Excess condition – Daily historical determinations of excess conditions was used to indicate periods where the first condition under which OMR flex may occur,
- First Flush not occurring – the method for estimating first flush in CalSim (described above) was used to determine periods where a first flush was not occurring,
- Turbidity bridge avoidance not occurring – the method for estimating turbidity avoidance in CalSim (described above was used to determine periods where a turbidity bridge avoidance action was not occurring.
- Salvage threshold not occurring – the method for estimating salvage threshold triggers in CalSim (described above) was used to determine periods when a salvage threshold trigger would not have been active.
- No other risk fishery related concerns – to address the potential for other fishery related concerns, the historical OMR level more negative than -4,000 cfs was assumed, for this purpose, to indicate the low general risk to fish and capture the other conditions described in described in Section 3.3.1 of the main document.

If all conditions above were met, then OMR flex was assumed to be possible. Table 5 reports the number of days that were determined to have potential for OMR flex using the method described.

Table 5: Number of days in each month and water year that had the potential for OMR flex.

Year	Dec	Jan	Feb	Mar	Apr	May	Jun
2009	0	0	7	20	2	0	0
2010	0	1	0	0	0	3	28
2011	17	22	8	0	0	0	23
2012	0	24	0	0	0	14	0
2013	2	3	6	12	0	0	0
2014	0	0	6	13	11	0	0
2015	5	3	15	5	0	0	0
2016	0	9	9	23	0	0	0
2017	8	1	5	0	0	0	23
2018	0	31	11	6	0	0	0

Further aggregating the estimated OMR flex days into a generalized CalSim representation, the water years were consolidated into two groups of 1) wet, above normal, and below normal, and 2) dry and critical. These groups roughly split the available water years into 6 samples and 4 samples respectively. Table 6 shows the results of the water year grouping.

Table 6: Average number of days with potential OMR flex, grouped by critical and dry water years and wet, above normal, and below normal water years. Based on historical analysis of water years 2009 to 2018.

Condition	Dec	Jan	Feb	Mar	Apr	May	Jun
C & D	2	2	9	13	3	0	0
W, AN & BN	4	15	6	5	0	3	12

Table 6 was used to further develop the generalized assumptions for CalSim. The timeframe of OMR flex for modeling purposes was limited to January and February because December in the model would only be activated with a first flush event which would eliminate the ability for OMR flex. Months later in the spring were also not included because of the potential for additional OMR due to larval and juvenile Delta smelt and longfin smelt. In addition, as Table 5 (the annual one) indicates, there is considerable variability in the potential OMR flex days and so for the CalSim implementation only above normal, below normal and dry years were assumed to utilize OMR flex.

Salvage Loss Thresholds Trigger and Criteria

The Proposed Project includes real-time OMR management actions based on percent of Winter-Run Chinook Salmon and Central valley Steelhead salvaged relative to proposed Single Year Loss Thresholds (described in Section 3.3.1 of the main document). The proposed Single Year Loss Thresholds were based on the 90% of the greatest loss observed for each species during water years 2010 through 2018. For Winter-Run loss thresholds were identified for Dec – Mar period. For steelhead, separate loss thresholds were identified for Dec – Mar and Apr – Jun. In modeling the proposed project, the real-time OMR management based on Single Year Loss Thresholds was assumed to be implemented as follows:

- In March and April of wet, above-normal, below-normal and dry years, it is assumed that the 50% of the proposed single year loss thresholds for one or more of the species will be exceeded, which triggers an OMR flow requirement of -3,500 cfs.

Historic salvage data at the fish facilities at Banks and Jones Pumping Plants and fish catch data at Chipps Island trawl during water years 2010 – 2018 were analyzed. Historic salvage data provides the potential timing of triggering the 50% and 75% levels of the proposed single year loss thresholds. The Chipps Island catch data provides the migration timing and estimates for when the 95% of Winter-Run and Steelhead have migrated out of the Delta, which is the proposed offramp for the real-time OMR management for these species.

Figures 8, 9 and 10 show the historical loss of Winter-Run, Steelhead for Dec – Mar and Steelhead for April – Jun, respectively. The historical loss in the figures is expressed as a percent of the proposed single year loss threshold values. Figure 11 and 12 show the migration timing based on the fish catch data at the Chipps Island trawls for Winter-Run and Steelhead. Information from Figures 8 through 12 is summarized below in Table 7, which shows the timing of when 50% and 75% of the proposed loss thresholds are triggered for water years 2010 through 2018, and when 95% of listed salmonid species are estimated to leave the Delta.

The information summarized in Table 7 was used to select the generalized assumptions for implementation of real-time management based on Single Year Loss Thresholds CalSim. It is important to recognize that the historical salvage and fish distribution data are reflective historical hydrologic and environmental conditions and not necessarily reflect of future conditions. However, since the proposed operations are tied to the historical loss at the SWP and CVP pumping facilities, it is appropriate to use historical data to estimate the generalized assumptions for use in CalSim in this case.

Table 7: Historical timing of natural Winter-Run and Steelhead loss at SWP and CVP south Delta pumping facilities. 50% and 75% losses are percentages of “90% of maximum annual loss during 2010-2018 period” – Table 7a – 7b.

Table 7a: Historical timing of natural Winter-Run at SWP and CVP south Delta pumping facilities. 50% and 75% losses are percentages of “90% of maximum annual loss during 2010-2018 period”.

WY	WYT	50% Dec-Mar Loss Timing	75% Dec-Mar Loss Timing	95% past Chipps
2010	BN	--	--	May
2011	W	Feb 16 - 28	Mar 1 - 15	May
2012	BN	Mar 1 - 15	Mar 16 - 31	May
2013	D	--	--	May
2014	C	--	--	May
2015	C	--	--	May
2016	BN	--	--	May
2017	W	--	--	May
2018	BN	--	--	May

Table 7b: Historical timing of natural Steelhead loss at SWP and CVP south Delta pumping facilities. 50% and 75% losses are percentages of “90% of maximum annual loss during 2010-2018 period”.

WY	WYT	50% Dec-Mar Loss Timing	75% Dec-Mar Loss Timing	50% Apr-Jun Loss Timing	75% Apr-Jun Loss Timing	95% past Chipps
2010	BN	Feb	Mar	--	--	May
2011	W	Mar	--	May	Jun	Apr
2012	BN	Mar	--	--	--	Apr
2013	D	Mar	--	May	Jun	Apr
2014	C	--	--	--	--	May
2015	C	--	--	--	--	Apr
2016	BN	--	--	--	--	Mar
2017	W	--	--	--	--	Apr
2018	BN	Mar	Mar	Apr	Apr	May

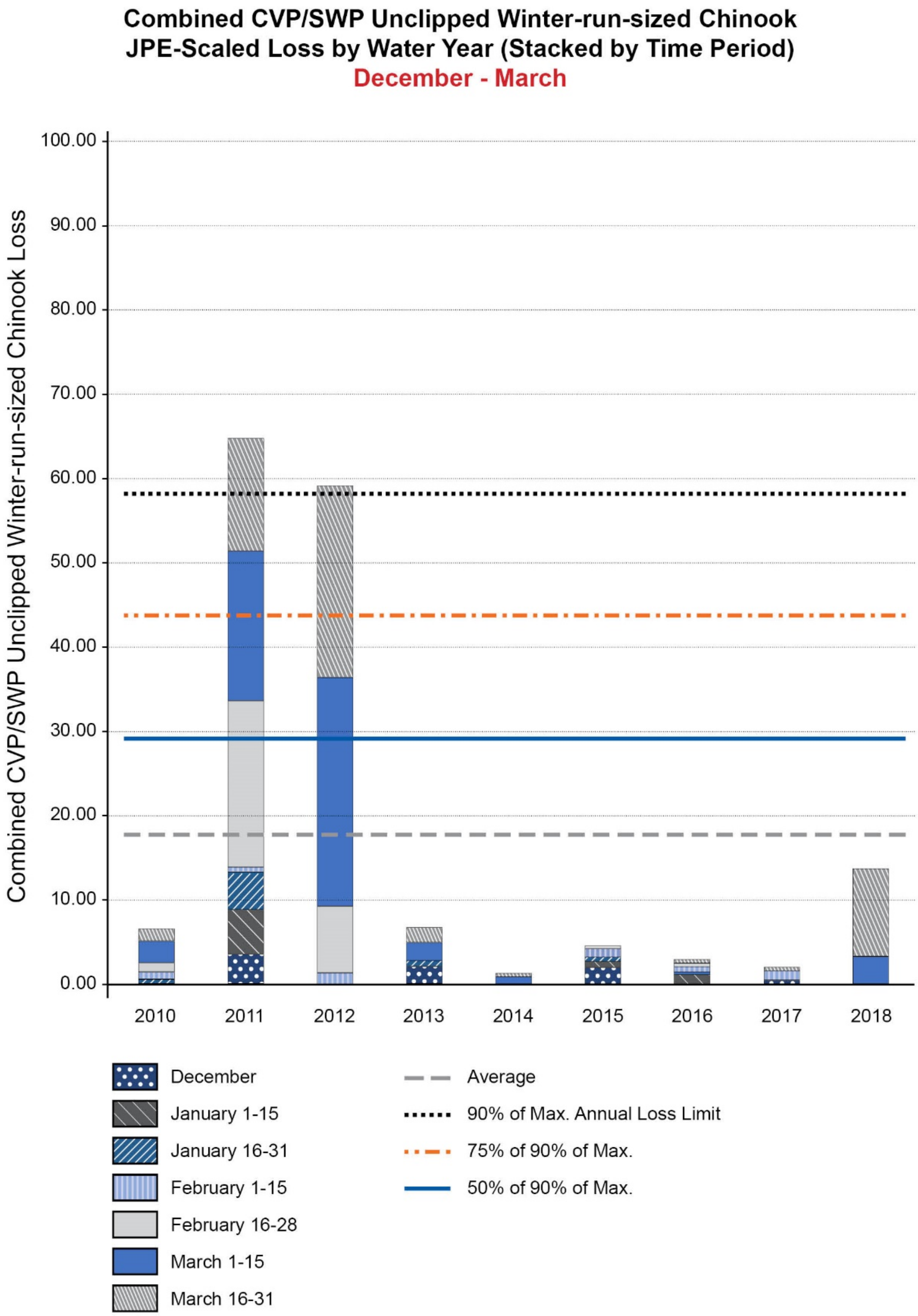

Figure 8: Combined CVP/SWP unclipped winter-run-sized Chinook loss, as a percentage of the winter-run Juvenile Production Estimate (JPE), for WY 2010 through WY 2018. Bars represent cumulative loss from December through March, stacked by month. Horizontal reference lines indicate the loss thresholds relevant for OMR management. (Source: July 2019 ROC Peer Review Draft NMFS Biological Opinion)

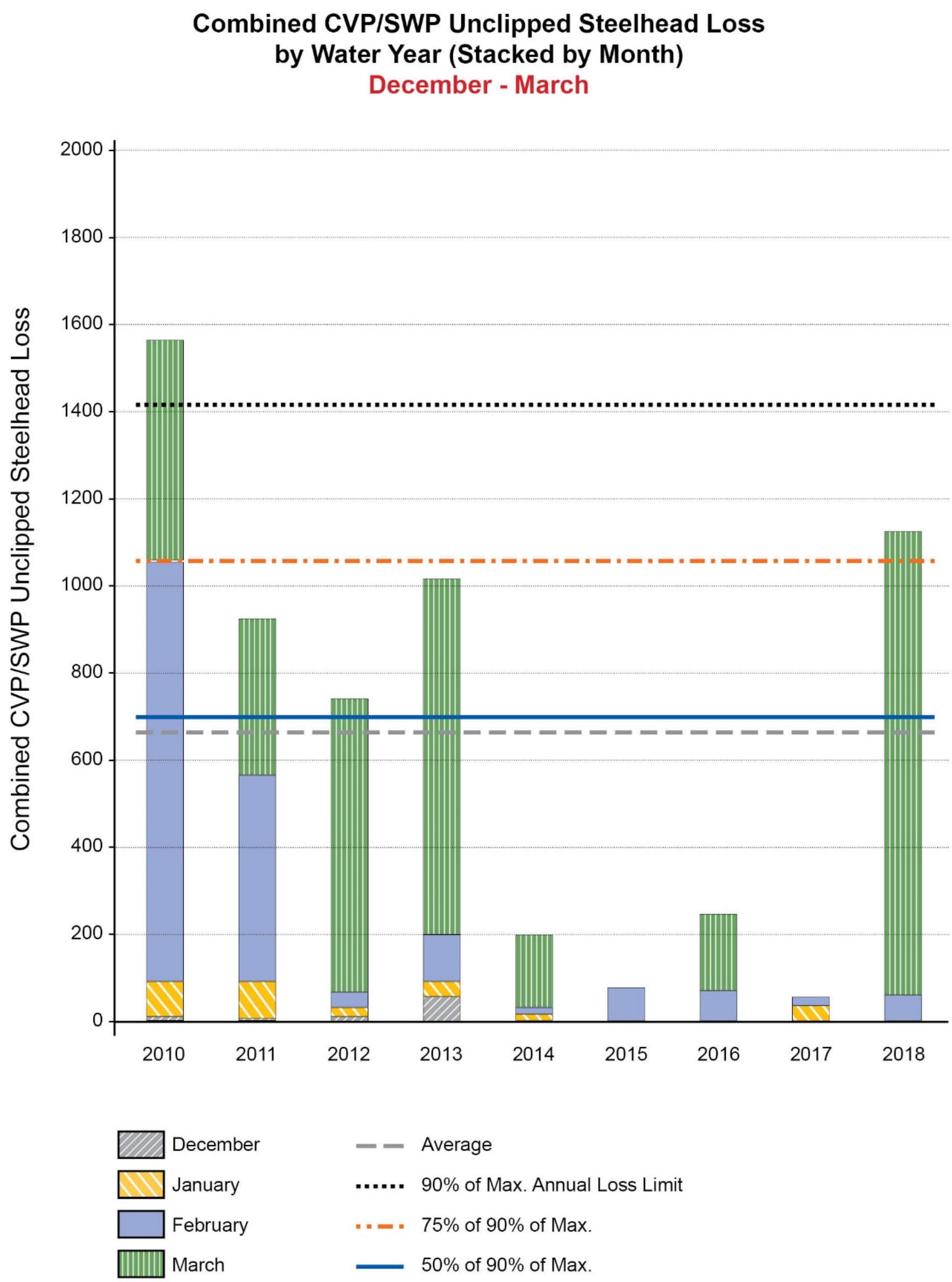

Figure 9: Combined CVP/SWP wild steelhead loss for WY 2010 through WY 2018. Bars represent cumulative loss from December through March, stacked by month. Horizontal reference lines indicate the loss thresholds relevant for OMR management. (Source: July 2019 ROC Peer Review Draft NMFS Biological Opinion)

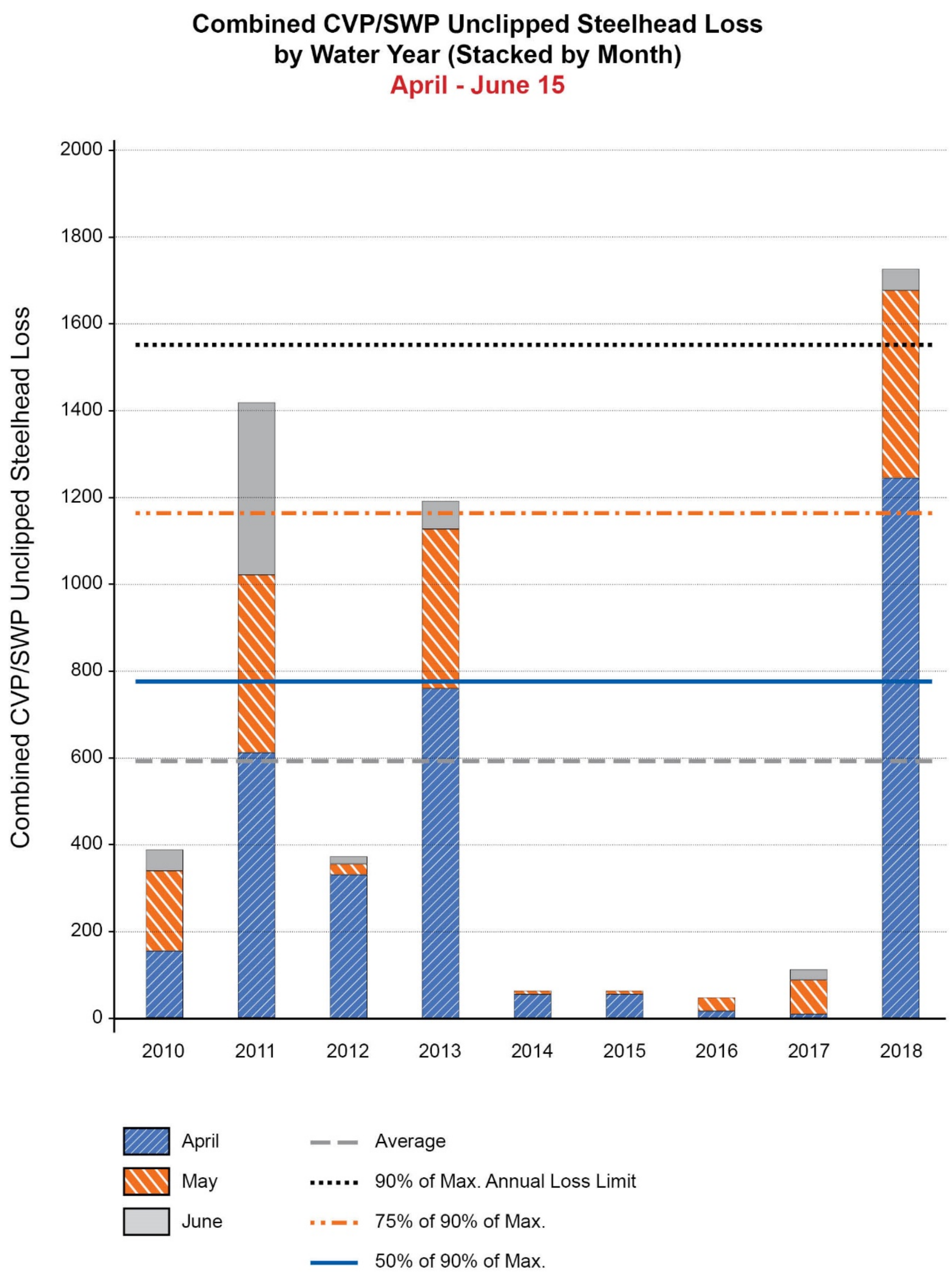

Figure 10: Combined CVP/SWP wild steelhead loss for WY 2010 through WY 2018. Bars represent cumulative loss from April through June 15, stacked by month. Horizontal reference lines indicate the loss thresholds relevant for OMR management. (Source: July 2019 ROC Peer Review Draft NMFS Biological Opinion)

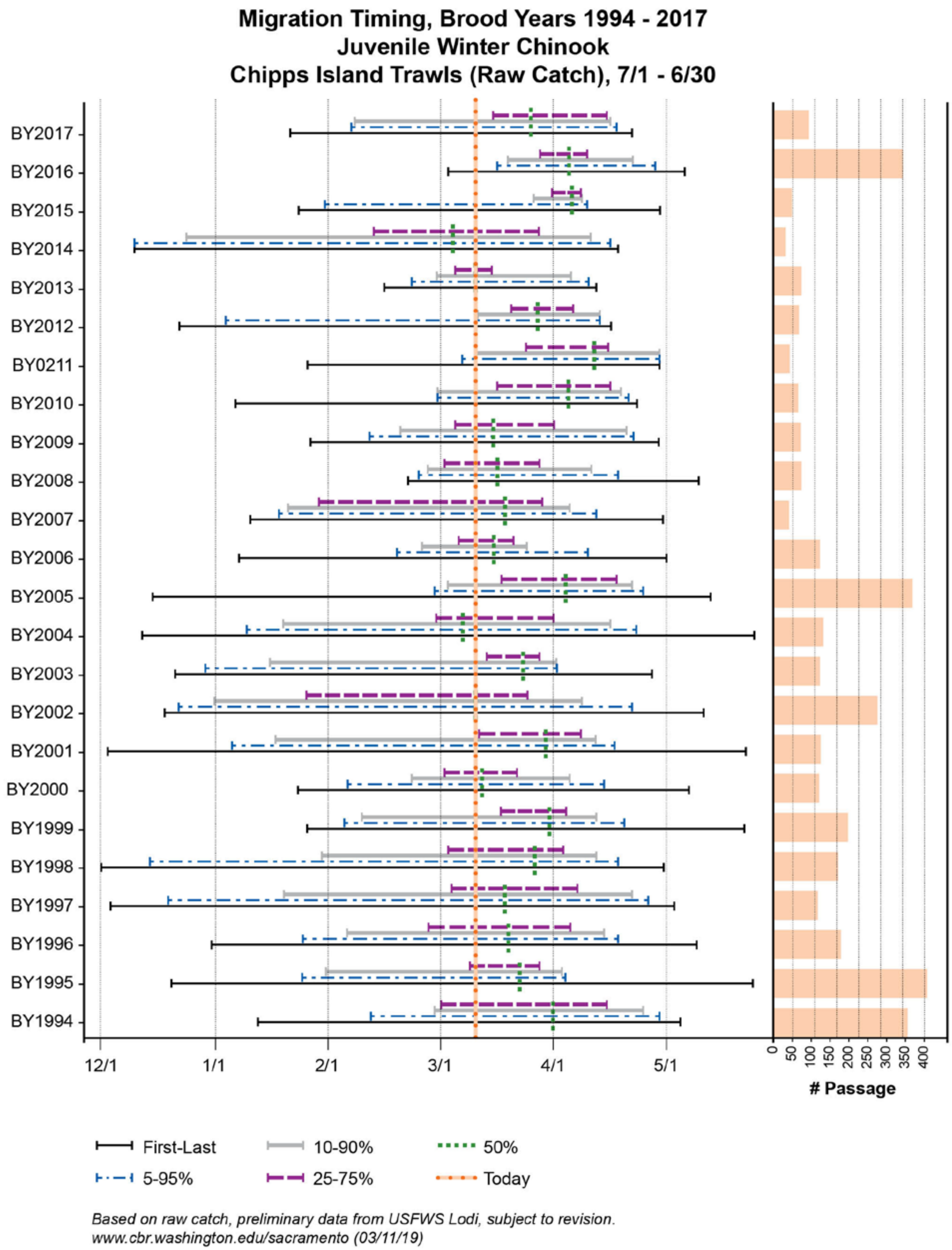

Figure 11: Juvenile winter-run Chinook salmon migration timing past the Chipps Island Trawl location for Brood Years 1994-2017 or Water Years 1995-2018. (Source: January 2019 ROC BA Appendix F)

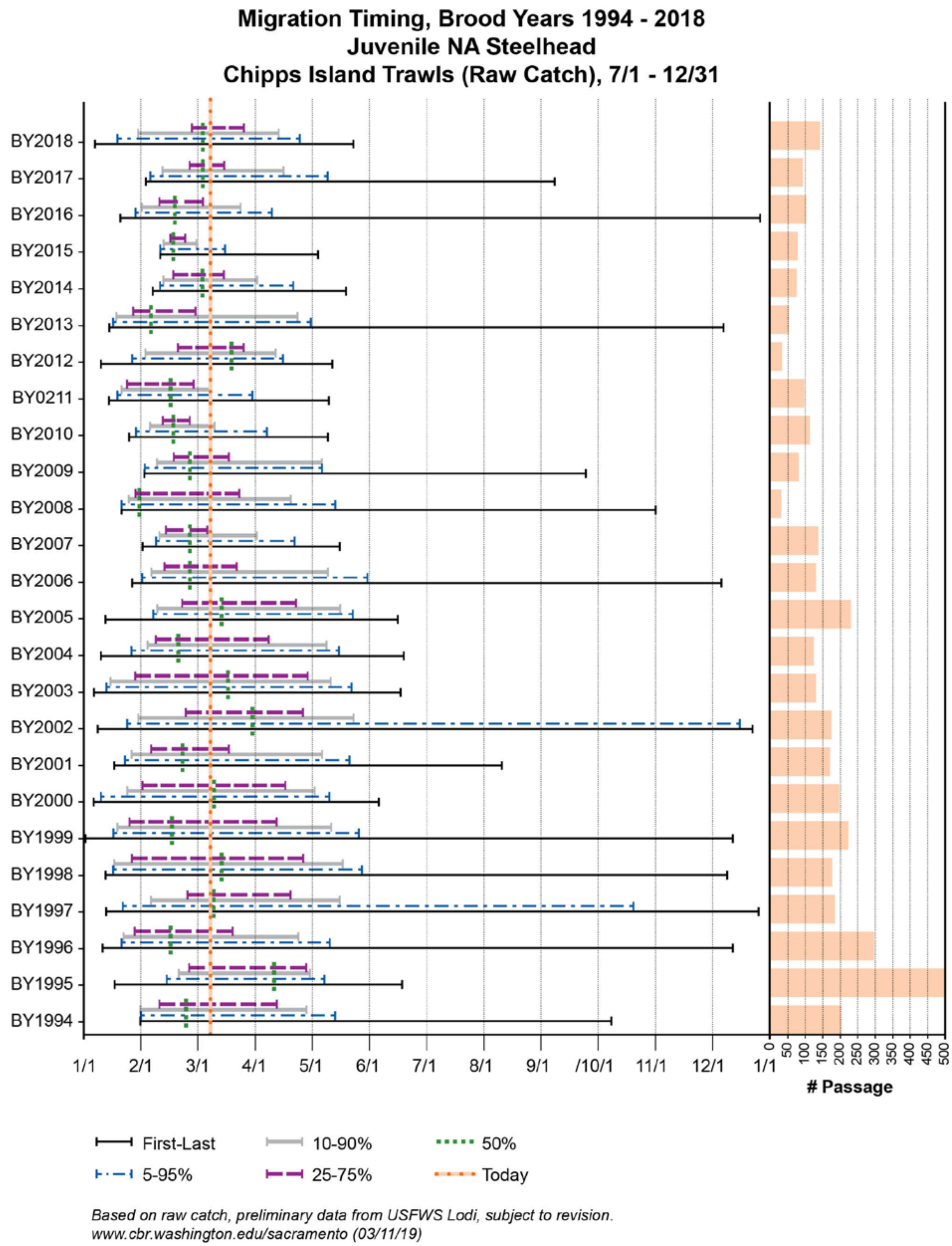

Figure 12: Juvenile unclipped CCV steelhead migration timing past the Chipps Island Trawl location for Brood Years 1994-2017 or Water Years 1995-2018. (Source: January 2019 ROC BA Appendix F)

4 Referenced Material

Representation of U.S. Fish and Wildlife USFWS Biological Opinion Reasonable and Prudent Alternative Actions for CalSim II Planning Studies

The U.S. Fish and Wildlife Services's (USFWS) Delta Smelt Biological Opinion (BiOp) was released on December 15, 2008, in response to the U.S. Bureau of Reclamation's (Reclamation) request for formal consultation with the USFWS on the coordinated operations of the Central Valley Project (CVP) and State Water Project (SWP) in California.

To develop CalSim II modeling assumptions for reasonable and prudent alternative actions (RPA) documented in this BiOp, the California Department of Water Resources (DWR) led a series of meetings that involved members of fisheries and project agencies. The purpose for establishing this group was to prepare the assumptions and CalSim II implementations to represent the RPAs in Existing and Future Condition CalSim II simulations for future planning studies.

This memorandum summarizes the approach that resulted from these meetings and the modeling assumptions that were laid out by the group. The scope of this memorandum is limited to the December 15, 2008 BiOp. Unless otherwise indicated, all descriptive information of the RPAs is taken from Appendix B of the BiOp.

Table 5.A.A.6-1 lists the participants that contributed to the meetings and information summarized in this document.

The RPAs in the USFWS's BiOp are based on physical and biological phenomena that do not lend themselves to simulations using a monthly time step. Much scientific and modeling judgment has been employed to represent the implementation of the RPAs. The group believes the logic put into CalSim II represents the RPAs as best as possible at this time, given the scientific understanding of environmental factors enumerated in the BiOp and the limited historical data for some of these factors.

Table 5.A.A.6-1 Meeting Participants

Aaron Miller/DWR Steve Ford/DWR Randi Field/Reclamation Gene Lee/Reclamation Lenny Grimaldo/Reclamation	Derek Hilts/USFWS Steve Detwiler/USFWS Matt Nobriga/CDFW Jim White/CDFW Craig Anderson/NMFS
Parviz Nader-Tehrani/DWR Erik Reyes/DWR Sean Sou/DWR	Robert Leaf/CH2M HILL Derya Sumer/CH2M HILL

Notes:
CDFW = California Department of Fish and Wildlife
NMFS = National Marine Fisheries USFWS

The simulated Old and Middle River (OMR) flow conditions and CVP/SWP Delta export operations, resulting from these assumptions, are believed to be a reasonable representation of conditions expected to prevail under the RPAs over large spans of years (refer to CalSim II modeling results for more details on simulated operations). Actual OMR flow conditions and Delta export operations will differ from simulated operations for numerous reasons, including having near real-time knowledge and/or estimates of turbidity, temperature, and fish spatial distribution that are unavailable for use in CalSim II over a long period of record. Because these factors and others are believed to be critical for smelt entrainment risk management, the USFWS adopted an adaptive process in defining the RPAs. Given the relatively generalized representation of the RPAs, assumed for CalSim II modeling, much caution is required when interpreting outputs from the model.

Action 1: Adult Delta Smelt Migration and Entrainment (RPA Component 1, Action 1 –First Flush)

Action 1 Summary:

Objective: A fixed duration action to protect pre-spawning adult delta smelt from entrainment during the first flush, and to provide advantageous hydrodynamic conditions early in the migration period.

Action: Limit exports so that the average daily Combined OMR flow is no more negative than -2,000 cubic feet per second (cfs) for a total duration of 14 days, with a 5-day running average no more negative than -2,500 cfs (within 25%).

Timing:

Part A: December 1 to December 20 – Based upon an examination of turbidity data from Prisoner's Point, Holland Cut, and Victoria Canal and salvage data from CVP/SWP (see below), and other parameters important to the protection of delta smelt including, but not limited to, preceding conditions of X2, the Fall Midwater Trawl Survey (FMWT), and river flows; the Smelt Working Group (SWG) may recommend a start date to the USFWS. The USFWS will make the final determination.

Part B: After December 20 – The action will begin if the 3-day average turbidity at Prisoner's Point, Holland Cut, and Victoria Canal exceeds 12 nephelometric turbidity units (NTU). However the SWG can recommend a delayed start or interruption based on other conditions such as Delta inflow that may affect vulnerability to entrainment.

Triggers (Part B):

<u>Turbidity:</u> Three-day average of 12 NTU or greater at all three turbidity stations: Prisoner's Point, Holland Cut, and Victoria Canal.

OR

<u>Salvage:</u> Three days of delta smelt salvage after December 20 at either facility or cumulative daily salvage count that is above a risk threshold based upon the "daily salvage index" approach reflected in a daily salvage index value ≥ 0.5 (daily delta smelt salvage > one-half prior year FMWT index value).

The window for triggering Action 1 concludes when either off-ramp condition described below is met. These off-ramp conditions may occur without Action 1 ever being triggered. If this occurs, then Action 3 is triggered, unless the USFWS concludes on the basis of the totality of available information that Action 2 should be implemented instead.

Off-ramps:

Temperature: Water temperature reaches 12 degrees Celsius (°C) based on a three station daily mean at the temperature stations: Mossdale, Antioch, and Rio Vista

OR

Biological: Onset of spawning (presence of spent females in the Spring Kodiak Trawl Survey [SKT] or at Banks or Jones).

Action 1 Assumptions for CalSim II Modeling Purposes:

An approach was selected based on hydrologic and assumed turbidity conditions. Under this general assumption, Part A of the action was never assumed because, on the basis of historical salvage data, it was considered unlikely or rarely to occur. Part B of the action was assumed to occur if triggered by turbidity conditions. This approach was believed to tend to a more conservative interpretation of the frequency, timing, and extent of this action. The assumptions used for modeling are as follows:

Action: Limit exports so that the average daily OMR flow is no more negative than -2,000 cfs for a total duration of 14 days, with a 5-day running average no more negative than -2,500 cfs (within 25% of the monthly criteria).

Timing: If turbidity-trigger conditions first occur in December, then the action starts on December 21; if turbidity-trigger conditions first occur in January, then the action starts on January 1; if turbidity-trigger conditions first occur in February, then the action starts on February 1; and if turbidity-trigger conditions first occur in March, then the action starts on March 1. It is assumed that once the action is triggered, it continues for 14 days.

Triggers: Only an assumed turbidity trigger that is based on hydrologic outputs was considered. A surrogate salvage trigger or indicator was not included because there was no way to model it.

Turbidity: If the monthly average unimpaired Sacramento River Index (four-river index: sum of Sacramento, Yuba, Feather, and American Rivers) exceeds 20,000 cfs, then it is assumed that an event, in which the 3-day average turbidity at Hood exceeds 12 NTU, has occurred within the month. It is assumed that an event at Sacramento River is a reasonable indicator of this condition occurring, within the month, at all three turbidity stations: Prisoner's Point, Holland Cut, and Victoria Canal.

A chart showing the relationship between turbidity at Hood (number of days with turbidity is greater than 12 NTU) and Sacramento River Index (sum of monthly flow at four stations on the Sacramento, Feather, Yuba and American Rivers, from 2003 to 2006) is shown on Figure 5.A.A.6-1. For months when average Sacramento River Index is between 20,000 cfs and 25,000 cfs a transition is observed in number of days with Hood turbidity greater than 12 NTU. For months when average Sacramento River Index is above 25,000 cfs, Hood turbidity was always greater than 12 NTU for as many as 5 days or more within the month in which the flow occurred. For a conservative approach, 20,000 cfs is used as the threshold value.

Salvage: It is assumed that salvage would occur when first flush occurs.

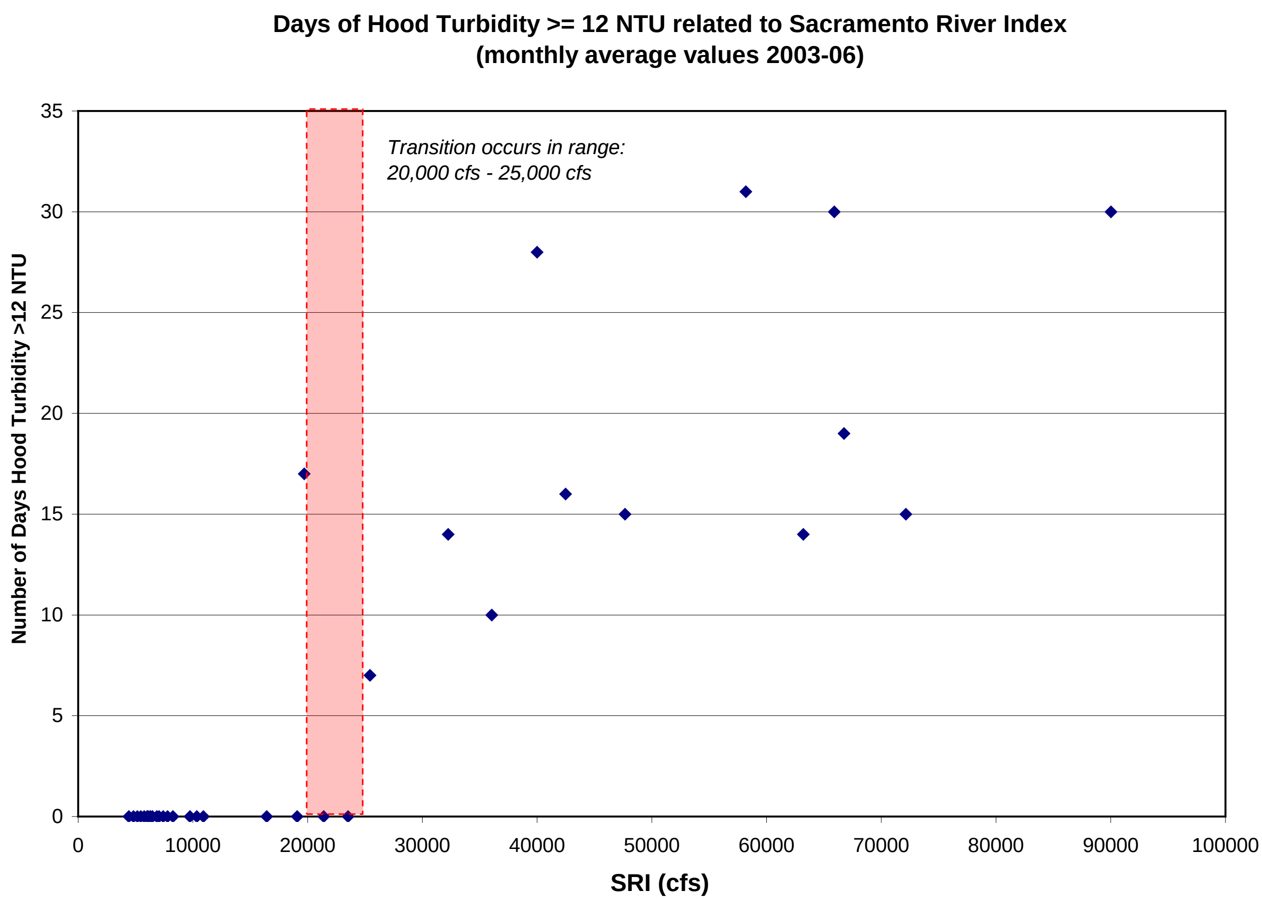

Figure 5.A.A.6-1 Relationship between Turbidity at Hood and Sacramento River Index

Off-ramps: Only temperature-based off-ramping is considered. A surrogate biological off-ramp indicator was not included.

Temperature: Because the water temperature data at the three temperature stations (Antioch, Mossdale, and Rio Vista) are only available for years after 1984, another parameter was sought for use as an alternative indicator. It is observed that monthly average air temperature at Sacramento Executive Airport generally trends with the three-station average water temperature (see Figure 5.A.A.6-2). Using this alternative indicator, monthly average air temperature is assumed to occur in the middle of the month, and values are interpolated on a daily basis to obtain daily average water temperature. Using the correlation between air and water temperature, estimated daily water temperatures are estimated from the 82-year monthly average air temperature. Dates when the three-station average temperature reaches 12°C are recorded and used as input in CalSim. A 1:1 correlation was used for simplicity instead of using the trend line equation illustrated on Figure 5.A.A.6-2.

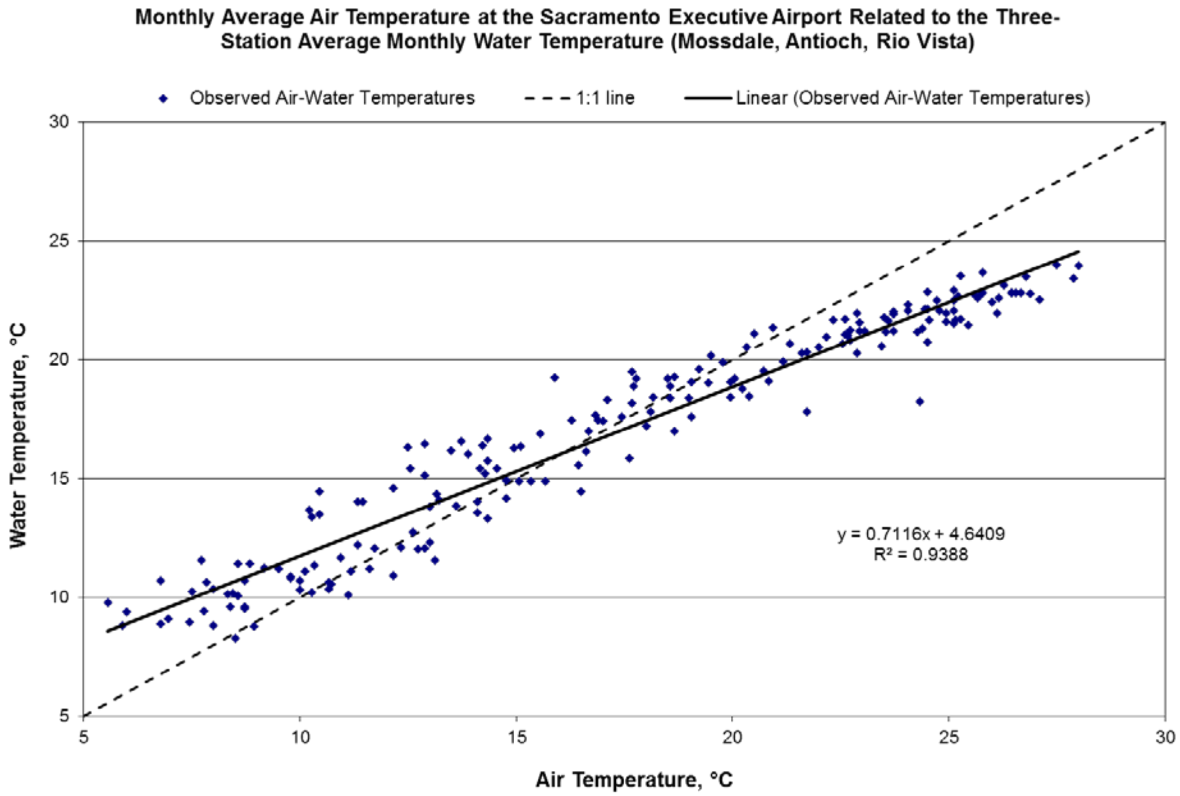

Figure 5.A.A.6-2 Relationship between Monthly Average Air Temperature at the Sacramento Executive Airport and the Three-station Average Monthly Water Temperature

Other Modeling Considerations:

In the month of December in which Action 1 does not begin until December 21, for monthly analysis, a background OMR flow must be assumed for the purpose of calculating a day-weighted average for implementing a partial-month action condition. When necessary, the background OMR flow for December was assumed to be -8,000 cfs.

For the additional condition to meet a 5-day running average no more negative than -2,500 cfs (within 25%), Paul Hutton's equation[1] is used. Hutton concluded that with stringent OMR standards (1,250 to 2,500 cfs), the 5-day average would control more frequently than the 14-day average, but it is less likely to control at higher flows. Therefore, the CalSim II implementation includes both a 14-day (approximately monthly average) and a 5-day average flow criteria based on Hutton's methodology (see Attachment 1).

Rationale: The following is an overall summary of the rationale for the preceding interpretation of RPA Action 1.

[1]Hutton, Paul/Metropolitan Water District of Southern California (MWDSC). Water Supply Impact Analysis of December 2008 Delta Smelt Biological Opinion, Appendix 5. February.

December 1 to December 20 for initiating Action 1 is not considered because seasonal peaks of delta smelt salvage are rare prior to December 20. Adult delta smelt spawning migrations often begin following large precipitation events that happen after mid-December.

Salvage of adult delta smelt often corresponds with increases in turbidity and exports. On the basis of the above discussion and Figure B-2, Sacramento River Index greater than 25,000 cfs is assumed to be an indicator of turbidity trigger being reached at all three turbidity stations: Prisoner's Point, Holland Cut, and Victoria Canal. Most sediment enters the Delta from the Sacramento River during flow pulses; therefore, a flow indicator based on only Sacramento River flow is used.

The 12°C threshold for the off-ramp criterion is a conservative estimate of when delta smelt larvae begin successfully hatching. Once hatched, the larvae move into the water column where they are potentially vulnerable to entrainment.

Results: Using these assumptions, in a typical CalSim II 82-year simulation (1922 through 2003 hydrologic conditions), Action 1 will occur 29 times in the December 21 to January 3 period, 14 times in the January 1 to January 14 period, 13 times in the February 1 to February 14 period, and 17 times in the March 1 to March 14 period. In 3 of these 17 occurrences (1934, 1991, and 2001), Action 3 is triggered before Action 1 and therefore Action 1 is bypassed. Action 1 is not triggered in 9 of the 82 years (1924, 1929, 1931, 1955, 1964, 1976, 1977, 1985, and 1994), typically critically dry years. Refer to CalSim II modeling results for more details on simulated operations of OMR, Delta exports and other parameters of interest.

Action 2: Adult Delta Smelt Migration and Entrainment (RPA Component 1, Action 2)

Action 2 Summary:

Objective: An action implemented using an adaptive process to tailor protection to changing environmental conditions after Action 1. As in Action 1, the intent is to protect pre-spawning adults from entrainment and, to the extent possible, from adverse hydrodynamic conditions.

Action: The range of net daily OMR flows will be no more negative than -1,250 to -5,000 cfs. Depending on extant conditions (and the general guidelines below), specific OMR flows within this range are recommended by the USFWS's Smelt Working Group (SWG) from the onset of Action 2 through its termination (see Adaptive Process description in the BiOp). The SWG would provide weekly recommendations based upon review of the sampling data, from real-time salvage data at the CVP/SWP, and utilizing most up-to-date technological expertise and knowledge relating population status and predicted distribution to monitored physical variables of flow and turbidity. The USFWS will make the final determination.

Timing: Beginning immediately after Action 1. Before this date (in time for operators to implement the flow requirement) the SWG will recommend specific requirement OMR flows based on salvage and on physical and biological data on an ongoing basis. If Action 1 is not implemented, the SWG may recommend a start date for the implementation of Action 2 to protect adult delta smelt.

Suspension of Action:

Flow: OMR flow requirements do not apply whenever a 3-day flow average is greater than or equal to 90,000 cfs in Sacramento River at Rio Vista and 10,000 cfs in San Joaquin River at Vernalis. Once such flows have abated, the OMR flow requirements of the Action are again in place.

Off-ramps:

Temperature: Water temperature reaches 12°C based on a three-station daily average at the temperature stations: Rio Vista, Antioch, and Mossdale.

OR

Biological: Onset of spawning (presence of a spent female in SKT or at either facility).

Action 2 Assumptions for CalSim II Modeling Purposes:

An approach was selected based on the occurrence of Action 1 and X2 salinity conditions. This approach selects from between two OMR flow tiers depending on the previous month's X2 position, and is never more constraining than an OMR criterion of -3,500 cfs. The assumptions used for modeling are as follows:

Action: Limit exports so that the average daily OMR flow is no more negative than -3,500 or -5,000 cfs depending on the previous month's ending X2 location (-3,500 cfs if X2 is east of Roe Island, or -5,000 cfs if X2 is west of Roe Island), with a 5-day running average within 25% of the monthly criteria (no more negative than -4,375 cfs if X2 is east of Roe Island, or -6,250 cfs if X2 is west of Roe Island).

Timing: Begins immediately after Action 1 and continues until initiation of Action 3.

In a typical CalSim II 82-year simulation, Action 1 was not triggered in 9 of the 82 years. In these conditions it is assumed that OMR flow should be maintained no more negative than -5,000 cfs.

Suspension of Action: A flow peaking analysis, developed by Paul Hutton[2], is used to determine the likelihood of a 3-day flow average greater than or equal to 90,000 cfs in Sacramento River at Rio Vista and a 3-day flow average greater than or equal to 10,000 cfs in San Joaquin River at Vernalis occurring within the month. It is assumed that when the likelihood of these conditions occurring exceeds 50%, Action 2 is suspended for the full month, and OMR flow requirements do not apply. The likelihood of these conditions occurring is evaluated each month, and Action 2 is suspended for one month at a time whenever both of these conditions occur.

The equations for likelihood (frequency of occurrence) are as follows:

Frequency of Rio Vista 3-day flow average > 90,000 cfs:

0% when Freeport monthly flow < 50,000 cfs, OR

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[2] Hutton, Paul/MWDSC. 2009. Water Supply Impact Analysis of December 2008 Delta Smelt Biological Opinion, Appendix 4. February.

(0.00289 × Freeport monthly flow – 146)% when 50,000 cfs ≤ Freeport plus Yolo Bypass monthly flow ≤ 85,000 cfs, OR

100% when Freeport monthly flow >85,000 cfs

Frequency of Vernalis 3-day flow average > 10,000 cfs:

0% when Vernalis monthly flow < 6,000 cfs, OR

(0.00901 × Vernalis monthly flow – 49)% when 6,000 cfs ≤ Vernalis monthly flow ≤ 16,000 cfs, OR

100% when Vernalis monthly flow >16,000 cfs

Frequency of Rio Vista 3-day flow average > 90,000 cfs equals 50% when Freeport plus Yolo Bypass monthly flow is 67,820 cfs and the frequency of Vernalis 3-day flow average > 10,000 cfs equals 50% Vernalis monthly flow is 10,988 cfs. Therefore these two flow values are used as thresholds in the model.

Off-ramps: Only temperature-based off-ramping is considered. A surrogate biological off-ramp indicator was not included.

Temperature: Because the water temperature data at the three temperature stations (Antioch, Mossdale, and Rio Vista) are only available for years after 1984, another parameter was sought for use as an alternative indicator. It is observed that monthly average air temperature at Sacramento Executive Airport generally trends with the three-station average water temperature (Figure 5.A.A.6-2). Using this alternative indicator, monthly average air temperature is assumed to occur in the middle of the month, and values are interpolated on a daily basis to obtain daily average water temperature. Using the correlation between air and water temperature, daily water temperatures are estimated from the 82-year monthly average air temperature. Dates when the three-station average temperature reaches 12°C are recorded and used as input in CalSim II. A 1:1 correlation was used for simplicity instead of using the trend line equation illustrated on Figure 5.A.A.6-2.

Rationale: The following is an overall summary of the rationale for the preceding interpretation of RPA Action 2.

Action 2 requirements are based on X2 location that is dependent on the Delta outflow. If outflows are very high, fewer delta smelt will spawn east of Sherman Lake; therefore, the need for OMR restrictions is lessened.

In the case of Action 1 not being triggered, CDFW suggested OMR > -5,000 cfs, following the actual implementation of the BiOp in winter 2009, because some adult delta smelt might move into the Central Delta without a turbidity event.

Action 2 is suspended when the likelihood of a 3-day flow average greater than or equal to 90,000 cfs in Sacramento River at Rio Vista and a 3-day flow average greater than or equal to 10,000 cfs in San Joaquin River at Vernalis occurring concurrently within the month exceeds 50%, because at extreme high flows the majority of adult delta smelt will be distributed downstream of the Delta, and entrainment concerns will be very low.

The 12°C threshold for the off-ramp criterion is a conservative estimate of when delta smelt larvae begin successfully hatching. Once hatched, the larvae move into the water column where they are potentially vulnerable to entrainment.

Results: Using these assumptions, in a typical CalSim II 82-year simulation (1922 through 2003 hydrologic conditions), Action 1, and therefore Action 2, does not occur in 11 of the 82 years (1924, 1929, 1931, 1934, 1955, 1964, 1976, 1977, 1985, 1991, 1994, and 2001), typically critically dry years. The criteria for suspension of OMR minimum flow requirements, described above, results in potential suspension of Action 2 (if Action 2 is active) 6 times in January, 11 times in February, 6 times in March (however Action 2 was not active in 3 of these 6 times), and 2 times in April. The result is that Action 2 is in effect 37 times in January (with OMR at -3,500 cfs 29 times, and at -5,000 cfs 8 times), 43 times in February (with OMR at -3,500 cfs 25 times, and at -5,000 cfs 18 times), 31 times in March (with OMR at -3,500 cfs 14 times, and at -5,000 cfs 17 times), and 80 times in April (with OMR at -3,500 cfs 46 times, and at -5,000 cfs 34 times). The frequency each month is a cumulative result of the action being triggered in the current or prior months. Refer to CalSim II modeling results for more details on simulated operations of OMR, Delta exports and other parameters of interest.

Action 3: Entrainment Protection of Larval and Juvenile Delta Smelt (RPA Component 2)

Action 3 Summary:

Objective: Minimize the number of larval delta smelt entrained at the facilities by managing the hydrodynamics in the Central Delta flow levels pumping rates spanning a time sufficient for protection of larval delta smelt, e.g., by using a VAMP-like action. Because protective OMR flow requirements vary over time (especially between years), the action is adaptive and flexible within appropriate constraints.

Action: Net daily OMR flow will be no more negative than -1,250 to -5,000 cfs based on a 14-day running average with a simultaneous 5-day running average within 25% of the applicable requirement for OMR. Depending on extant conditions (and the general guidelines below), specific OMR flows within this range are recommended by the SWG from the onset of Action 3 through its termination (see Adaptive Process in Introduction). The SWG would provide these recommendations based upon weekly review of sampling data, from real-time salvage data at the CVP/SWP, and expertise and knowledge relating population status and predicted distribution to monitored physical variables of flow and turbidity. The USFWS will make the final determination.

Timing: Initiate the action after reaching the triggers below, which are indicative of spawning activity and the probable presence of larval delta smelt in the South and Central Delta. Based upon daily salvage data, the SWG may recommend an earlier start to Action 3. The USFWS will make the final determination.

Triggers:

Temperature: When temperature reaches 12°C based on a three-station average at the temperature stations: Mossdale, Antioch, and Rio Vista.

OR

Biological: Onset of spawning (presence of spent females in SKT or at either facility).

Off-ramps:

Temporal: June 30;

OR

Temperature: Water temperature reaches a daily average of 25°C for three consecutive days at Clifton Court Forebay.

Action 3 Assumptions for CalSim II Modeling Purposes:

An approach was selected based on assumed temperature and X2 salinity conditions. This approach selects from among three OMR flow tiers depending on the previous month's X2 position and ranges from an OMR criteria of -1,250 to -5,000 cfs. Because of the potential low export conditions that could occur at an OMR criterion of -1,250 cfs, a criterion for minimum exports for health and safety is also assumed. The assumptions used for modeling are as follows:

Action: Limit exports so that the average daily OMR flow is no more negative than -1,250, -3,500, or -5,000 cfs, depending on the previous month's ending X2 location (-1,250 cfs if X2 is east of Chipps Island, -5,000 cfs if X2 is west of Roe Island, or -3,500 cfs if X2 is between Chipps and Roe Island, inclusively), with a 5-day running average within 25% of the monthly criteria (no more negative than -1,562 cfs if X2 is east of Chipps Island, -6,250 cfs if X2 is west of Roe Island, or -4,375 cfs if X2 is between Chipps and Roe Island). The more constraining of this OMR requirement or the VAMP requirement will be selected during the VAMP period (April 15 to May 15). Additionally, in the case of the month of June, the OMR criterion from May is maintained through June (it is assumed that June OMR should not be more constraining than May).

Timing: Begins immediately upon temperature trigger conditions and continues until off-ramp conditions are met.

Triggers: Only temperature trigger conditions are considered. A surrogate biological trigger was included.

Temperature: Because the water temperature data at the three temperature stations (Antioch, Mossdale, and Rio Vista) are only available for years after 1984, another parameter was sought to be used as an alternative indicator. It is observed that monthly average air temperature at Sacramento Executive Airport generally trends with the three-station average water temperature (Figure 5.A.A.6-2). Using this alternative indicator, monthly average air temperature is assumed to occur in the middle of the month, and values are interpolated on a daily basis to obtain daily average water temperature. Using the correlation between air and water temperature, estimated daily water temperatures are estimated from the 82-year monthly average air temperature. Dates when the three-station average temperature reaches 12°C are recorded and used as input in CalSim. A 1:1 correlation was used for simplicity instead of using the trend line equation illustrated on Figure 5.A.A.6-2.

Biological: Onset of spawning is assumed to occur no later than *May* 30.

Clarification Note: This text previously read "Onset of spawning is assumed to occur no later than April 30", where the CalSim II lookup table has May 30 as the date. Based on RPA team discussions in August 2009, it was agreed upon that onset of spawning could not be modeled in CalSim. This trigger was actually coded as a placeholder in case in future this trigger was to be used; and the date was selected *purposefully in a way that it wouldn't affect modeling results. Temperature trigger for Action 3 does occur before end of April. Therefore it does not matter whether the document is corrected to read May 30 or the model lookup table is changed to April 30.*

Off-ramps:

Temporal: It is assumed that the ending date of the action would be no later than June 30.

OR

Temperature: Only 17 years of data are available for Clifton Court water temperature. A similar approach as used in the temperature trigger was considered. However, because 3 consecutive days of water temperature greater than or equal to 25°C is required, a correlation between air temperature and water temperature did not work well for this off-ramp criterion. Out of the 17 recorded years, in one year the criterion was triggered in May (May 31), and in 3 years it was triggered in June (June 3, 21, and 27). In all other years it was observed in July or later. With only four data points before July, it was not possible to generate a rule based on statistics. Therefore, temporal off-ramp criterion (June 30) is used for all years.

Health and Safety: In CalSim II, a minimum monthly Delta export criterion of 300 cfs for SWP and 600 cfs (or 800 cfs depending on Shasta storage) for CVP is assumed. This assumption is suitable for dry-year conditions when allocations are low and storage releases are limited; however, minimum monthly exports need to be made for protection of public health and safety (health and safety deliveries upstream of San Luis Reservoir).

In consideration of the severe export restrictions associated with the OMR criteria established in the RPAs, an additional set of health and safety criterion is assumed. These export restrictions could lead to a situation in which supplies are available and allocated; however, exports are curtailed forcing San Luis to have an accelerated drawdown rate. For dam safety at San Luis Reservoir, 2 feet per day is the maximum acceptable drawdown rate. Drawdown occurs faster in summer months and peaks in June when the agricultural demands increase. To avoid rapid drawdown in San Luis Reservoir, a relaxation of OMR is allowed so that exports can be maintained at 1,500 cfs in all months if needed.

This modeling approach may not fit the real-life circumstances. In summer months, especially in June, the assumed 1,500 cfs for health and safety may not be sufficient to keep San Luis drawdown below a safe 2 ft/day; and under such circumstances the projects would be required to increase pumping in order to maintain dam safety.

Rationale: The following is an overall summary of the rationale for the preceding interpretation of RPA Action 3.

The geographic distribution of larval and juvenile delta smelt is tightly linked to X2 (or Delta outflow). Therefore, the percentage of the population likely to be found east of Sherman Lake is also influenced by the location of X2. The X2-based OMR criteria were intended to model an expected management response to the general increase in delta smelt's risk of entrainment as a function of increasing X2.

The 12°C threshold for the trigger criterion is a conservative estimate of when delta smelt larvae begin successfully hatching. Once hatched, the larvae move into the water column where they are potentially vulnerable to entrainment.

The annual salvage "season" for delta smelt typically ends as South Delta water temperatures warm to lethal levels during summer. This usually occurs in late June or early July. The laboratory-derived upper lethal temperature for delta smelt is 25.4°C.

Results: Action 3 occurs 30 times in February (with OMR at -1,250 cfs 9 times, at -3,500 cfs 11 times, and at -5,000 cfs 10 times), 76 times in March (with OMR at -1,250 cfs 15 times, at -3,500 cfs 27 times, and at -5,000 cfs 34 times), all times (82) in April (with OMR at -1,250 cfs 17 times, at -3,500 cfs 29 times, and at -5,000 cfs 35 times), all times (82) in May (with OMR at -1,250 cfs 19 times, at -3,500 cfs 37 times, and at -5,000 cfs 26 times), and 70 times in June (with OMR at -1,250 cfs 7 times, at -3,500 cfs 37 times, and at -5,000 cfs 26 times). Refer to CalSim II modeling results for more details on simulated operations of OMR, Delta exports and other parameters of interest. (Note: The above information is based on the August 2009 version of the model and documents the development process, more recent versions of the model may have different results.)

Action 4: Estuarine Habitat During Fall (RPA Component 3)

Action 4 Summary:

Objective: Improve fall habitat for delta smelt by managing of X2 through increasing Delta outflow during fall when the preceding water year was wetter than normal. This will help return ecological conditions of the estuary to that which occurred in the late 1990s when smelt populations were much larger. Flows provided by this action are expected to provide direct and indirect benefits to delta smelt. Both the direct and indirect benefits to delta smelt are considered equally important to minimize adverse effects.

Action: Subject to adaptive management as described below, provide sufficient Delta outflow to maintain average X2 for September and October no greater (more eastward) than 74 kilometers in the fall following wet years and 81 kilometers in the fall following above normal years. The monthly average X2 position is to be maintained at or seaward of these location for each individual month and not averaged over the two month period. In November, the inflow to CVP/SWP reservoirs in the Sacramento Basin will be added to reservoir releases to provide an added increment of Delta inflow and to augment Delta outflow up to the fall X2 target. The action will be evaluated and may be modified or terminated as determined by the USFWS.

Timing:

September 1 to November 30.

Triggers:

Wet and above normal water-year type classification from the 1995 Water Quality Control Plan that is used to implement D-1641.

Action 4 Assumptions for CalSim II Modeling Purposes:

Model is modified to increase Delta outflow to meet monthly average X2 requirements for September and October and subsequent November reservoir release actions in Wet and Above Normal years. No off-ramps are considered for reservoir release capacity constraints. Delta exports may or may not be reduced as part of reservoir operations to meet this action. The Action is summarized in Table 5.A.A.6-2.

Table 5.A.A.6-2. Summary of Action 4 implementation in CalSim II

Fall Months following Wet or Above Normal Years	Action Implementation
September	Meet monthly average X2 requirement (74 km in Wet years, 81 km in Above Normal years)
October	Meet monthly average X2 requirement (74 km in Wet years, 81 km in Above Normal years)
November	Add reservoir releases up to natural inflow as needed to continue to meet monthly average X2 requirement (74 km in Wet years, 81 km in Above Normal years)

Rationale: Action 4 requirements are based on determining X2 location. Adjustment and retraining of the ANN was also completed to address numerical sensitivity concerns.

Results: There are 38 September and 37 October months that the Action is triggered over the 82-year simulation period.

Action 5: Temporary Spring Head of Old River Barrier and the Temporary Barrier Project (RPA Component 2)

Action 5 Summary:

Objective: To minimize entrainment of larval and juvenile delta smelt at Banks and Jones or from being transported into the South and Central Delta, where they could later become entrained.

Action: Do not install the Spring Head of Old River Barrier (HORB) if delta smelt entrainment is a concern. If installation of the HORB is not allowed, the agricultural barriers would be installed as described in the Project Description. If installation of the HORB is allowed, the Temporary Barrier Project (TBP) flap gates would be tied in the open position until May 15.

Timing: The timing of the action would vary depending on the conditions. The normal installation of the spring temporary HORB and the TBP is in April.

Triggers: For delta smelt, installation of the HORB will only occur when particle tracking modeling results show that entrainment levels of delta smelt will not increase beyond 1% at Station 815 as a result of installing the HORB.

Off-ramps: If Action 3 ends or May 15, whichever comes first.

Action 5 Assumptions for CalSim II and DSM2 Modeling Purposes:

The South Delta Improvement Program (SDIP) Stage 1 is not included in the Existing and Future Condition assumptions being used for CalSim II and DSM2 baselines. The TBP is assumed instead. The TBP specifies that HORB be installed and operated during April 1 through May 31 and September 16 through November 30. In response to the USFWS BiOp, Action 5, the HORB is assumed to not be installed during April 1 through May 31.

Appendix 4: Approach to Suspend Actions During High Flows

MEMO

Date: December 16, 2008

To: File

From: Paul Hutton

Subject: Modeling Delta Smelt High Flow Action Temporary Suspensions

This memo summarizes an approach that was developed to represent high flow periods when Delta smelt flow actions are temporarily suspended. The actions of interest include the following:

- Wanger Actions – The winter pulse flow action (on or after December 25) is temporarily suspended if the 3-day average flow at Freeport exceeds 80,000 cfs. Similarly, the pre-spawning adult flow action (January and February) is temporarily suspended if the 3-day average flow at Freeport exceeds 80,000 cfs.

- Delta Smelt Biological Opinion Actions – Action 2 is temporarily suspended if the 3-day average flows at Rio Vista and Vernalis exceed 90,000 cfs and 10,000 cfs, respectively.

Methodology

Given that (1) the actions are written in terms of 3-day flow averages and (2) typical water supply impact analyses are conducted assuming monthly average flows, a method is needed to characterize the action in terms of monthly average flows. Historical flows information from DAYFLOW was used to characterize relationships between 3-day flows and monthly flows. The desired product is to determine a frequency of exceeding the 3-day flow target as a function of a monthly flow value. This frequency will be used to proportionally reduce calculated water supply impacts in high flow months.

Results for Wanger Actions

Figure 4-1 plots the frequency that 3-day Freeport flows exceed 80,000 cfs as a function of monthly average Freeport flows (Q_F). The resulting mathematical frequency relationship (in percent units) is as follows:

0% when $Q_F < 50{,}000$ cfs

$0.0126 * \exp(0.000105*Q_F)$ when $50{,}000 \text{ cfs} \leq Q_F \leq 85{,}000$ cfs

100% when $Q_F > 85{,}000$ cfs

Results for BO Actions

Figure 4-2 plots the frequency that 3-day Rio Vista flows exceed 90,000 cfs as a function of monthly average Freeport flows (Q_F). The resulting mathematical frequency relationship (in percent units) is as follows:

0% when $Q_F < 50{,}000$ cfs

$-146 + 0.00289*Q_F$ when $50{,}000 \text{ cfs} \leq Q_F \leq 85{,}000$ cfs

100% when $Q_F > 85{,}000$ cfs

Figure 4-3 plots the frequency that 3-day Vernalis flows exceed 10,000 cfs as a function of monthly average Vernalis flows (Q_V). The resulting mathematical frequency relationship (in percent units) is as follows:

0% when $Q_V < 6{,}000$ cfs

$-49 + 0.00901*Q_V$ when $6{,}000 \text{ cfs} \leq Q_V \leq 16{,}000$ cfs

100% when $Q_V > 16{,}000$ cfs

The BO requires Rio Vista and Vernalis flows to simultaneously exceed the targets to temporarily suspend the flow action. For modeling purposes, it is assumed that these flows are statistically independent. Hence, the suspension frequency is calculated as the product of the individual frequencies. Since Rio Vista and Vernalis flows are modestly correlated, the proposed approach may somewhat understate the true suspension frequency. However, a cursory paired data evaluation suggested that the assumption will provide reasonable results.

Figure 4-1. Frequency of Wanger Freeport Flow Trigger as a Function of Monthly Freeport Flow

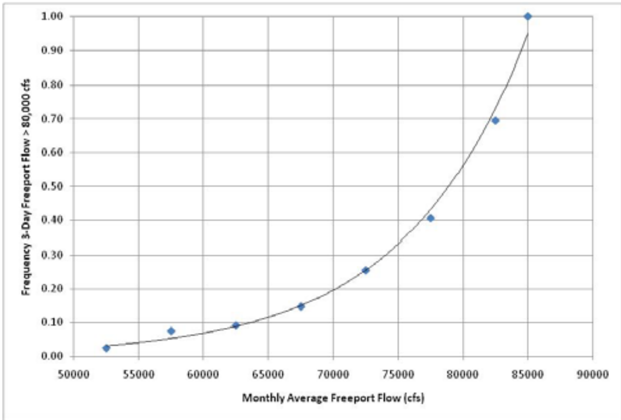


Figure 4-2. Frequency of BO Rio Vista Flow Trigger as a Function of Monthly Freeport Flow

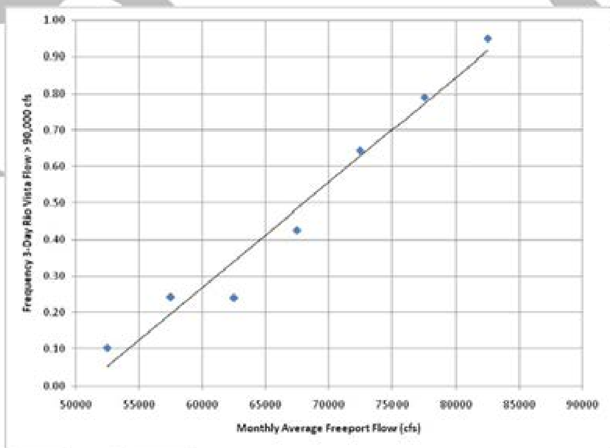
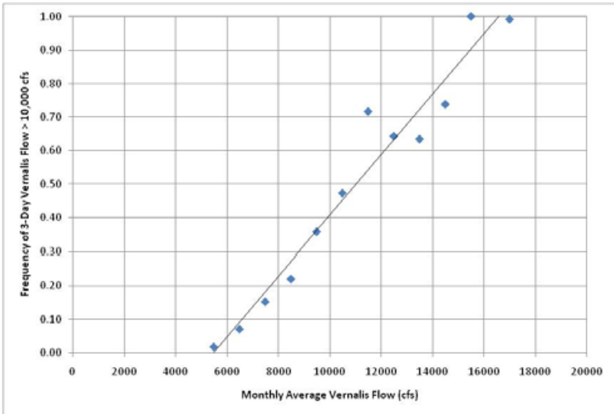


Figure 4-3. Frequency of BO Vernalis Flow Trigger as a Function of Monthly Vernalis Flow



Paul Hutton 2/2/09

Appendix 5: Approach to Relate 5-Day & 14-Day OMR Flows

MEMO

Date:	January 2, 2009
To:	File
From:	Paul Hutton
Subject:	How Frequently Will 5-Day OMR Flows (Rather than 14-Day OMR Flows) Control Project Operations Under New Delta Smelt Biological Opinion?

Background

Several flow actions specified in the December 2008 Delta Smelt biological opinion place limits on reverse flows in Old and Middle Rivers. Limits are given as 14-day averages, but the simultaneous 5-day averages are to be within 25% of the 14-day averages. This memo summarizes an investigation to answer the question "How frequently will 5-day OMR flows, rather than 14-day OMR flows, control project operations under the new Delta smelt biological opinion?"

Water supply impact studies assume the 14-day average flow controls. Such an approach would not be conservative if 5-day flows frequently control project operations. Based upon a recent meeting with SWP and CVP operators, the CVP operators believe that fishery agencies will accept violations of the 5-day flow limit provided that project operators maintain relatively stable pumping operations. Is this belief that 5-day flows will not control operations valid? Will the courts or environmental groups accept such an operation? An investigation into the potential frequency of 5-day flow control seems prudent, given that we don't know the answers to such questions.

Methods

The following methods were employed:

- Review historical Delta flow and operations data for the period between January 1990 and May 2008.
- Identify periods when (1) pumping operations were relatively stable and (2) 5-day OMR flows were more negative than 14-day OMR flows. For periods prior to

5-day OMR flows are more negative than 14-day OMR flows by nearly 1000 cfs (679 cfs + 297 cfs = 976 cfs). At two standard errors, or about 95% confidence, 5-day OMR flows are more negative than 14-day OMR flows by nearly 1300 cfs (679 cfs + 2*297 cfs = 1273 cfs).

By solving the Figure 5-1 regression equation for a condition when the 5-day OMR flow is 25% more negative than the 14-day OMR flow, the following limits are identified when 5-day OMR flows will control:

14-day OMR flow = -2980 cfs at a 50% confidence interval

-4280 cfs at a 67% confidence interval

-5580 cfs at a 95% confidence interval

Conclusions

This memo summarizes an investigation to answer the question "How frequently will 5-day OMR flows, rather than 14-day OMR flows, control project operations under the new Delta smelt biological opinion?" An analysis of historical flow and project operations data suggests that 5-day OMR flows will often control operations when the 14-day flow target is in the most stringent range of -1500 cfs to -2500 cfs. When the projects are operating to less stringent OMR flows in the range of -3000 cfs to -5000 cfs, 5-day OMR flows will occasionally be at least 25% more negative than 14-day OMR flows and might control project operations.

If the projects are required to strictly meet the 5-day OMR flow criteria, (1) the current water supply impact assumption of 14-day OMR flow control is not conservative and (2) it would be prudent to incorporate a factor of safety to address the 5-day flow criteria.

Paul Hutton 2/2/09

Figure 5-1. Average 5d OMR flows as a function of average 14d OMR flows during periods when pumping operations were stable and 5d flows were more negative than 14d flows.

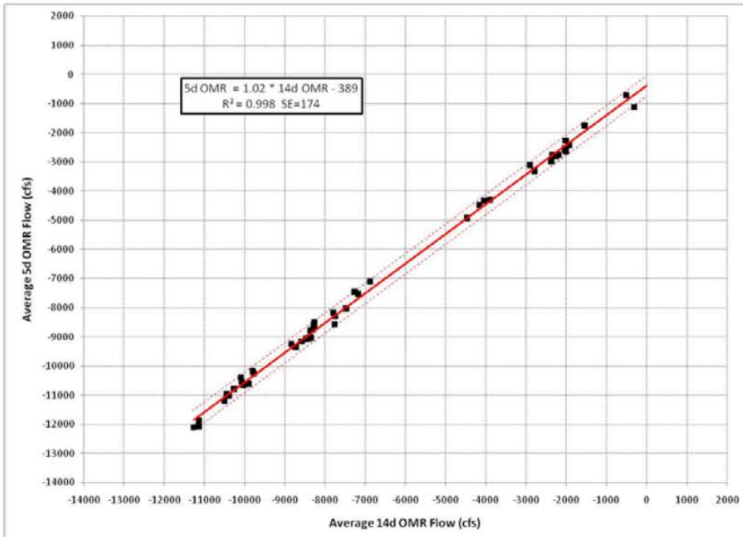
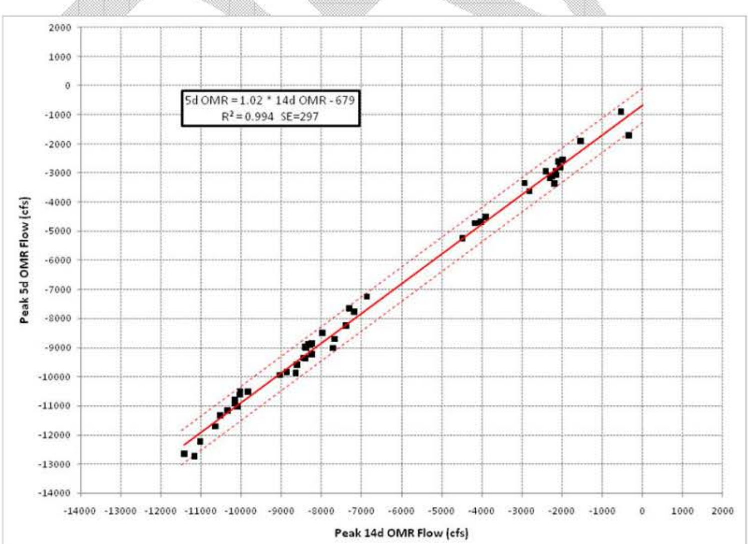


Figure 5-2. Peak 5d OMR flows as a function of peak 14d OMR flows during periods when pumping operations were stable and 5d flows were more negative than 14d flows.



Paul Hutton 2/2/09

Table 5-1. Fifty periods were identified when pumping operations were relatively stable and 5-day OMR flows were more negative than 14-day OMR flows.

Period			Daily Export Range (cfs)			14d Export Range (cfs)			Average OMR Difference (cfs)				Peak OMR Difference (cfs)				
Start Date	End Date	Duration (days)	Min	Max	Range	Min	Max	Range	14d	5d	Diff	%Diff	Date	14d	5d	Diff	%Diff
24-Jan-90	1-Feb-90	9	10000	10700	700	10400	10500	100	-8300	-8760	-460	6%	30-Jan-90	-8390	-9010	-620	7%
9-Feb-90	17-Feb-90	9	9900	10600	700	10400	10400	0	-8270	-8590	-320	4%	12-Feb-90	-8280	-8900	-620	7%
24-Feb-90	3-Mar-90	8	10000	10600	600	10400	10500	100	-8270	-8690	-420	5%	27-Feb-90	-8240	-8870	-630	8%
10-Mar-90	19-Mar-90	10	10000	10800	800	10300	10400	100	-8260	-8510	-250	3%	18-Mar-90	-8340	-8890	-550	7%
24-Mar-90	1-Apr-90	9	10300	10600	300	10300	10500	200	-8830	-9250	-420	5%	31-Mar-90	-9040	-9950	-910	10%
1-Apr-91	8-Apr-91	8	9300	10200	900	10200	10300	100	-7470	-8020	-550	7%	4-Apr-91	-7390	-8260	-870	12%
16-Mar-92	24-Mar-92	9	10000	10700	700	10300	10400	100	-8410	-9060	-650	8%	22-Mar-92	-8640	-9880	-1240	14%
20-Aug-93	27-Aug-93	8	10400	10900	500	10600	10700	100	-8730	-9350	-620	7%	24-Aug-93	-8870	-9850	-980	11%
4-Sep-93	10-Sep-93	7	10900	10900	0	10600	10700	100	-8360	-8790	-430	5%	9-Sep-93	-8420	-8990	-570	7%
18-Sep-93	23-Sep-93	6	10300	10900	600	10800	10900	100	-8370	-9030	-660	8%	20-Sep-93	-8450	-9360	-910	11%
1-Oct-93	9-Oct-93	9	10800	11100	300	10600	10900	300	-8340	-9040	-700	8%	3-Oct-93	-8240	-9240	-1000	12%
17-Oct-93	22-Oct-93	6	10800	10900	100	10900	10900	0	-7790	-8170	-380	5%	18-Oct-93	-7980	-8500	-520	7%
22-Nov-95	30-Nov-95	9	4300	4800	500	4400	4400	0	-2780	-3300	-520	19%	25-Nov-95	-2810	-3640	-830	30%
7-Dec-95	13-Dec-95	7	4200	4400	200	4300	4400	100	-2900	-3100	-200	7%	12-Dec-95	-2930	-3360	-430	15%
22-Dec-95	28-Dec-95	7	4200	4400	200	4200	4300	100	-2370	-2980	-610	26%	26-Dec-95	-2250	-3130	-880	39%
12-Aug-99	22-Aug-99	11	8700	11600	2900	10900	11300	400	-9800	-10180	-380	4%	20-Aug-99	-10040	-10630	-590	6%
28-Aug-99	5-Sep-99	9	10900	11600	700	11100	11400	300	-10260	-10790	-530	5%	1-Sep-99	-10350	-11180	-830	8%
13-Sep-99	19-Sep-99	7	11400	11500	100	11500	11500	0	-10090	-10390	-300	3%	17-Sep-99	-10030	-10530	-500	5%
3-May-00	9-May-00	7	1700	2200	500	2100	2300	200	-1930	-2410	-480	25%	8-May-00	-1980	-2560	-580	29%
5-May-01	13-May-01	9	1500	1700	200	1500	1500	0	-2000	-2630	-630	32%	11-May-01	-2190	-3380	-1190	54%
22-May-01	29-May-01	8	800	1600	800	1500	1500	0	-2020	-2590	-570	28%	27-May-01	-2140	-3080	-940	44%
22-Jul-01	29-Jul-01	8	7900	8800	900	8100	8300	200	-8580	-9160	-580	7%	25-Jul-01	-8610	-9610	-1000	12%
20-Aug-01	26-Aug-01	7	7700	8900	1200	8100	8400	300	-8470	-9080	-610	7%	23-Aug-01	-8410	-9370	-960	11%
6-Sep-01	12-Sep-01	7	7200	8300	1100	7500	7600	100	-7760	-8580	-820	11%	8-Sep-01	-7720	-9030	-1310	17%
19-Sep-01	25-Sep-01	7	7200	8200	1000	7700	7800	100	-7750	-8310	-560	7%	22-Sep-01	-7680	-8720	-1040	14%
27-Apr-02	3-May-02	7	1400	1500	100	1500	2000	500	-2190	-2750	-560	26%	30-Apr-02	-2160	-2960	-800	37%
12-May-02	18-May-02	7	1500	1500	0	1500	1500	0	-2030	-2540	-510	25%	16-May-02	-2040	-2810	-770	38%
26-May-02	31-May-02	6	1600	1600	0	1600	1600	0	-2010	-2260	-250	12%	31-May-02	-2100	-2620	-520	25%
1-May-03	7-May-03	7	1400	1500	100	1500	1500	0	-2340	-2760	-420	18%	3-May-03	-2400	-2950	-550	23%
15-May-03	22-May-03	8	1500	2300	800	1400	1700	300	-2250	-2800	-550	24%	20-May-03	-2300	-3190	-890	39%
15-Aug-03	22-Aug-03	8	11300	11600	300	11200	11400	200	-11260	-12100	-840	7%	20-Aug-03	-11430	-12670	-1240	11%
31-Aug-03	6-Sep-03	7	11200	11500	300	11400	11500	100	-11140	-12070	-930	8%	3-Sep-03	-11170	-12750	-1580	14%
13-Sep-03	21-Sep-03	9	10000	11600	1600	11200	11400	200	-11130	-11880	-750	7%	16-Sep-03	-11030	-12240	-1210	11%
25-Jul-05	31-Jul-05	7	11500	11600	100	11500	11500	0	-10020	-10670	-650	6%	28-Jul-05	-10110	-11040	-930	9%
7-Aug-05	15-Aug-05	9	10900	11700	800	11500	11600	100	-10390	-11020	-630	6%	13-Aug-05	-10530	-11350	-820	8%
22-Aug-05	28-Aug-05	7	11600	11700	100	11500	11600	100	-10500	-11190	-690	7%	25-Aug-05	-10650	-11720	-1070	10%
13-Aug-06	18-Aug-06	6	11500	11600	100	11500	11600	100	-10070	-10560	-490	5%	15-Aug-06	-10170	-10930	-760	7%
26-Aug-06	3-Sep-06	9	11300	11600	300	11500	11500	0	-9760	-10260	-500	5%	1-Sep-06	-9840	-10520	-680	7%
10-Sep-06	16-Sep-06	7	11000	11600	600	11500	11600	100	-9900	-10610	-710	7%	14-Sep-06	-10090	-11040	-950	9%
5-Nov-06	13-Nov-06	9	8600	10000	1400	9200	9400	200	-6880	-7100	-220	3%	7-Nov-06	-6870	-7260	-390	6%
15-Nov-06	23-Nov-06	9	9200	10000	800	9200	9500	300	-7260	-7460	-200	3%	20-Nov-06	-7310	-7660	-350	5%
2-Dec-06	6-Dec-06	5	8400	10200	1800	9600	9800	200	-7170	-7530	-360	5%	4-Dec-06	-7180	-7780	-600	8%
27-Jan-07	1-Feb-07	6	6300	6900	600	6500	6800	300	-3890	-4300	-410	11%	28-Jan-07	-3900	-4530	-630	16%
7-Feb-07	13-Feb-07	7	6400	6900	500	6800	6800	0	-4160	-4490	-330	8%	10-Feb-07	-4170	-4730	-560	13%
22-Feb-07	28-Feb-07	7	6600	6900	300	6800	6900	100	-4030	-4330	-300	7%	25-Feb-07	-4020	-4700	-680	17%
3-Apr-07	9-Apr-07	7	5600	7100	1500	6200	6600	400	-4460	-4920	-460	10%	7-Apr-07	-4480	-5250	-770	17%
15-May-07	20-May-07	6	1200	1500	300	1400	1500	100	-1540	-1750	-210	14%	18-May-07	-1540	-1920	-380	25%
14-Aug-07	24-Aug-07	11	11600	11600	0	11500	11600	100	-10450	-10960	-510	5%	17-Aug-07	-10160	-10810	-650	6%
3-May-08	9-May-08	7	1500	1500	0	1500	1600	100	-310	-1110	-800	258%	6-May-08	-330	-1720	-1390	421%
18-May-08	22-May-08	5	1400	1700	300	1500	1500	0	-500	-710	-210	42%	20-May-08	-530	-900	-370	70%

Paul Hutton 2/2/09

4.1 Representation of National Marine Fisheries Service Biological Opinion Reasonable and Prudent Alternative Actions for CalSim II Planning Studies

The National Marine Fisheries Service's (NMFS) Biological Opinion (BiOp) on the Long-term Operations of the Central Valley Project and State Water Project was released on June 4, 2009.

To develop CalSim II modeling assumptions to represent the operations related reasonable and prudent alternative actions (RPA) required by this BiOp, the California Department of Water Resources (DWR) led a series of meetings that involved members of fisheries and project agencies. The purpose for establishing this group was to prepare the assumptions and CalSim II implementations to represent the RPAs in both Existing- and Future-Condition CalSim II simulations for future planning studies.

This memorandum summarizes the approach that resulted from these meetings and the modeling assumptions that were laid out by the group. The scope of this memorandum is limited to the June 4, 2009 BiOp. All descriptive information of the RPAs is taken from the BiOp.

Table 5.A.A.6-1 lists the participants that contributed to the meetings and information summarized in this document.

The RPAs in NMFS's BiOp are based on physical and biological processes that do not lend themselves to simulations using a monthly time step. Much scientific and modeling judgment has been employed to represent the implementation of the RPAs. The group believes the logic put into CalSim II represents the RPAs as best as possible at this time, given the scientific understanding of environmental factors enumerated in the BiOp and the limited historical data for some of these factors.

Given the relatively generalized representation of the RPAs assumed for CalSim II modeling, much caution is required when interpreting outputs from the model.

Table 5.A.A.7-1 Meeting Participants

Aaron Miller/DWR Randi Field/Reclamation Lenny Grimaldo/Reclamation Henry Wong/Reclamation	Derek Hilts/USFWS Roger Guinee/ USFWS Matt Nobriga/CDFW Bruce Oppenheim/ NMFS
Parviz Nader-Tehrani/ DWR Erik Reyes/ DWR Sean Sou/ DWR Paul A. Marshall/ DWR Ming-Yen Tu/ DWR Xiaochun Wang/ DWR	Robert Leaf/CH2M HILL Derya Sumer/CH2M HILL

Notes:
CDFW = California DWR of Fish and Wildlife
NMFS = National Marine Fisheries Service

USFWS = U.S. Fish and Wildlife Service

4.2 Action Suite 1.1 Clear Creek

Suite Objective: The RPA actions described below were developed based on a careful review of past flow studies, current operations, and future climate change scenarios. These actions are necessary to address adverse project effects on flow and water temperature that reduce the viability of spring-run and CV steelhead in Clear Creek.

Action 1.1.1 Spring Attraction Flows

Objective: Encourage spring-run movement to upstream Clear Creek habitat for spawning.

Action: Reclamation shall annually conduct at least two pulse flows in Clear Creek in May and June of at least 600 cfs for at least three days for each pulse, to attract adult spring-run holding in the Sacramento River main stem.

Action 1.1.1 Assumptions for CalSim II Modeling Purposes

Action: Model is modified to meet 600 cfs for 3 days twice in May. In the CalSim II analysis, Flows sufficient to increase flow up to 600 cfs for a total of 6 days are added to the flows that would have otherwise occurred in Clear Creek.

Rationale: CalSim II is a monthly model. The monthly flow in Clear Creek is an underestimate of the actual flows that would occur subject to daily operational constraints at Whiskeytown Reservoir. The additional flow to meet 600 cfs for a total of 6 days was added to the monthly average flow modeled.

Action 1.1.5. Thermal Stress Reduction

Objective: To reduce thermal stress to over-summering steelhead and spring-run during holding, spawning, and embryo incubation.

Action: Reclamation shall manage Whiskeytown releases to meet a daily water temperature of: (1) 60°F at the Igo gauge from June 1 through September 15; and (2) 56°F at the Igo gauge from September 15 to October 31.

Action 1.1.5 Assumptions for CalSim II Modeling Purposes

Action: It is assumed that temperature operations can perform reasonably well with flows included in model.

Rationale: A temperature model of Whiskeytown Reservoir has been developed by Reclamation. Further analysis using this or other temperature model is required to verify the statement that temperature operations can perform reasonably well with flows included in model.

4.3 Action Suite 1.2 Shasta Operations

Objectives: To address the avoidable and unavoidable adverse effects of Shasta operations on winter-run and spring-run:

- Ensure a sufficient cold water pool to provide suitable temperatures for winter-run spawning between Balls Ferry and Bend Bridge in most years, without sacrificing the potential for cold water management in a subsequent year. Additional actions to those in the 2004 CVP/SWP operations Opinion are needed, due to increased vulnerability of the population to temperature effects attributable to changes in Trinity River ROD operations, projected climate change hydrology, and increased water demands in the Sacramento River system.
- Ensure suitable spring-run temperature regimes, especially in September and October. Suitable spring-run temperatures will also partially minimize temperature effects to naturally-spawning, non-listed Sacramento River fall-run, an important prey base for endangered Southern Residents.
- Establish a second population of winter-run in Battle Creek as soon as possible, to partially compensate for unavoidable project-related effects on the one remaining population.
- Restore passage at Shasta Reservoir with experimental reintroductions of winter-run to the upper Sacramento and/or McCloud rivers, to partially compensate for unavoidable project-related effects on the remaining population.

Action 1.2.1 Performance Measures

Objective: To establish and operate to a set of performance measures for temperature compliance points and End-of-September (EOS) carryover storage, enabling Reclamation and NMFS to assess the effectiveness of this suite of actions over time. Performance measures will help to ensure that the beneficial variability of the system from changes in hydrology will be measured and maintained.

Action: To ensure a sufficient cold water pool to provide suitable temperatures, long-term performance measures for temperature compliance points and EOS carryover storage at Shasta Reservoir shall be attained. Performance measures for EOS carryover storage at Shasta Reservoir are as follows:

- 87% of years: Minimum EOS storage of 2.2 MAF
- 82% of years: Minimum EOS storage of 2.2 MAF and end-of-April storage of 3.8 MAF in following year (to maintain potential to meet Balls Ferry compliance point)
- 40% of years: Minimum EOS storage 3.2 MAF (to maintain potential to meet Jelly’s Ferry compliance point in following year)

Performance measures (measured as a 10-year running average) for temperature compliance points during summer season are:

- Meet Clear Creek Compliance point 95% of time
- Meet Balls Ferry Compliance point 85% of time
- Meet Jelly’s Ferry Compliance point 40% of time
- Meet Bend Bridge Compliance point 15% of time

Action 1.2.1 Assumptions for CalSim II Modeling Purposes

Action: No specific CalSim II modeling code is implemented to simulate the performance measures identified. System performance will be assessed and evaluated through post-processing of various model results.

Rationale: Given that the performance criteria are based on the CalSim II modeling data used in preparation of the Biological Assessment, the system performance after application of the RPAs should be similar as a percentage of years that the end-of-April storage and temperature compliance requirements are met over the simulation period. Post-processing of modeling results will be compared to various new operating scenarios as needed to evaluate performance criteria and appropriateness of the rules developed.

Action 1.2.2 November through February Keswick Release Schedule (Fall Actions)

Objective: Minimize impacts to listed species and naturally spawning non-listed fall-run from high water temperatures by implementing standard procedures for release of cold water from Shasta Reservoir.

Action: Depending on EOS carryover storage and hydrology, Reclamation shall develop and implement a Keswick release schedule, and reduce deliveries and exports as needed to achieve performance measures.

Action 1.2.2 Assumptions for CalSim II Modeling Purposes

Action: No specific CalSim II modeling code is implemented to simulate the Performance measures identified. Keswick flows based on operation of 3406(b)(2) releases in OCAP Study 7.1 (for Existing) and Study 8 (for Future) are used in CalSim II. These flows will be reviewed for appropriateness under this action. A post-process based evaluation similar to what has been explained in Action 1.2.1 will be conducted.

Rationale: Performance measures are set as percentage of years that the end-of-September and temperature compliance requirements are met over the simulation period. Post-processing of modeling results will be compared to various new operating scenarios as needed to evaluate performance criteria and appropriateness of the rules developed.

Action 1.2.3 February Forecast; March – May 14 Keswick Release Schedule (Spring Actions)

Objective: To conserve water in Shasta Reservoir in the spring in order to provide sufficient water to reduce adverse effects of high water temperature in the summer months for winter-run, without sacrificing carryover storage in the fall.

Action:

- Reclamation shall make its February forecast of deliverable water based on an estimate of precipitation and runoff within the Sacramento River basin at least as conservative as the 90% probability of exceedance. Subsequent updates of water delivery commitments must be based on monthly forecasts at least as conservative as the 90% probability of exceedance.
- Reclamation shall make releases to maintain a temperature compliance point not in excess of 56 degrees between Balls Ferry and Bend Bridge from April 15 through May 15.

Action 1.2.3 Assumptions for CalSim II Modeling Purposes

Action: No specific CalSim II modeling code is implemented to simulate the Performance measures identified. It is assumed that temperature operations can perform reasonably well with flows included in model.

Rationale: Temperature models of Shasta Lake and the Sacramento River have been developed by Reclamation. This modeling reflects current facilities for temperature controlled releases. Further analysis using this or another temperature model can further verify that temperature operations can perform reasonably well with flows included in model and temperatures are met reliably at each of the compliance points. In the future, it may be that adjusted flow schedules may need to be developed based on development of temperature model runs in conjunction with CalSim II modeled operations.

Action 1.2.4 May 15 through October Keswick Release Schedule (Summer Action)

Objective: To manage the cold water storage within Shasta Reservoir and make cold water releases from Shasta Reservoir to provide suitable habitat temperatures for winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon in the Sacramento River between Keswick Dam and Bend Bridge, while retaining sufficient carryover storage to manage for next year's cohorts. To the extent feasible, manage for suitable temperatures for naturally spawning fall-run.

Action: Reclamation shall manage operations to achieve daily average water temperatures in the Sacramento River between Keswick Dam and Bend Bridge as follows:

- Not in excess of 56°F at compliance locations between Balls Ferry and Bend Bridge from May 15 through September 30 for protection of winter-run, and not in excess of 56°F at the same compliance locations between Balls Ferry and Bend Bridge from October 1 through October 31 for protection of mainstem spring run, whenever possible.
- Reclamation shall operate to a final Temperature Management Plan starting May 15 and ending October 31.

Action 1.2.4 Assumptions for CalSim II Modeling Purposes

Action: No specific CalSim II modeling code is implemented to simulate the Performance measures identified. It is assumed that temperature operations can perform reasonably well with flows included in model. During the detailed effects analysis, temperature modeling and post-processing will be used to verify temperatures are met at the compliance points. In the long-term approach, for a complete interpretation of the action, development of temperature model runs are needed to develop flow schedules if needed for implementation into CalSim II.

Rationale: Temperature models of Shasta Lake and the Sacramento River have been developed by Reclamation. This modeling reflects current facilities for temperature controlled releases. Further analysis using this or another temperature model is required to verify the statement that temperature operations can perform reasonably well with flows included in model and temperatures are met reliably at each of the compliance points. It may be that alternative flow schedules may need to be developed based on development of temperature model runs in conjunction with CalSim II modeled operations.

4.4 Action Suite 1.3 Red Bluff Diversion Dam (RBDD) Operations

Objectives: Reduce mortality and delay of adult and juvenile migration of winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon caused by the presence of the diversion dam and the configuration of the operable gates. Reduce adverse modification of the passage element of critical habitat for these species. Provide unimpeded upstream and downstream fish passage in the long term by raising the gates year-round, and minimize adverse effects of continuing dam operations, while pumps are constructed replace the loss of the diversion structure.

Action 1.3.1 Operations after May 14, 2012: Operate RBDD with Gates Out

Action: No later than May 15, 2012, Reclamation shall operate RBDD with gates out all year to allow unimpeded passage for listed anadromous fish.

Action 1.3.1 Assumptions for CalSim II Modeling Purposes

Action: Adequate permanent facilities for diversion are assumed; therefore no constraint on diversion schedules is included in the Future condition modeling.

Action 1.3.2 Interim Operations

Action: Until May 14, 2012, Reclamation shall operate RBDD according to the following schedule:

•September 1 - June 14: Gates open. No emergency closures of gates are allowed.

•June 15 - August 31: Gates may be closed at Reclamation's discretion, if necessary to deliver water to TCCA.

Action 1.3.2 Assumptions for CalSim II Modeling Purposes

Action: Adequate interim/temporary facilities for diversion are assumed; therefore no constraint on diversion schedules is included in the No Action Alternative modeling.

4.5 Action 1.4 Wilkins Slough Operations

Objective: Enhance the ability to manage temperatures for anadromous fish below Shasta Dam by operating Wilkins Slough in the manner that best conserves the dam's cold water pool for summer releases.

Action: The Sacramento River Temperature Task Group (SRTTG) shall make recommendations for Wilkins Slough minimum flows for anadromous fish in critically dry years, in lieu of the current 5,000 cfs navigation criterion to NMFS by December 1, 2009. In critically dry years, the SRTTG will make a recommendation.

Action 1.4 Assumptions for CalSim II Modeling Purposes

Action: Current rules for relaxation of NCP in CalSim II (based on BA models) will be used. In CalSim II, NCP flows are relaxed depending on allocations for agricultural contractors. Table 5.A.A.7-2 is used to determine the relaxation.

Table 5.A.A.7-2 NCP Flow Schedule with Relaxation

CVP AG Allocation (%)	NCP Flow (cfs)
<10	3,250
10–25	3,500
25–40	4,000
40–65	4,500
>65	5,000

Rationale: The allocation-flow criteria have been used in the CalSim II model for many years. The low allocation year relaxations were added to improve operations of Shasta Lake subject to 1.9 MAF carryover target storage. These criteria may be reevaluated subject to the requirements of Action 1.2.1

4.6 Action 2.1 Lower American River Flow Management

Objective: To provide minimum flows for all steelhead life stages.

Action: Implement the flow schedule specified in the Water Forum's Flow Management Standard (FMS), which is summarized in Appendix 2-D of the NMFS BiOp.

Action 2.1 Assumptions for CalSim II Modeling Purposes

Action: The AFRMP Minimum Release Requirements (MRR) range from 800 to 2,000 cfs based on a sequence of seasonal indices and adjustments. The minimum Nimbus Dam release requirement is determined by applying the appropriate water availability index (Index Flow). Three water availability indices (i.e., Four Reservoir Index (FRI), Sacramento River Index (SRI), and the Impaired Folsom Inflow Index (IFII)) are applied during different times of the year, which provides adaptive flexibility in response to changing hydrological and operational conditions.

During some months, Prescriptive Adjustments may be applied to the Index Flow, resulting in the MRR. If there is no Prescriptive Adjustment, the MRR is equal to the Index Flow.

Discretionary Adjustments for water conservation or fish protection may be applied during the period extending from June through October. If Discretionary Adjustments are applied, then the resultant flows are referred to as the Adjusted Minimum Release Requirement (Adjusted MRR).

The MRR and Adjusted MRR may be suspended in the event of extremely dry conditions, represented by "conference years" or "off-ramp criteria". Conference years are defined when the projected March through November unimpaired inflow into Folsom Reservoir is less than 400,000 acre-feet. Off-ramp criteria are triggered if forecasted Folsom Reservoir storage at any time during the next twelve months is less than 200,000 acre-feet.

Rationale: Minimum instream flow schedule specified in the Water Forum's Flow Management Standard (FMS) is implemented in the model.

Action 2.2 Lower American River Temperature Management

Objective: Maintain suitable temperatures to support over-summer rearing of juvenile steelhead in the lower American River.

Action: Reclamation shall develop a temperature management plan that contains: (1) forecasts of hydrology and storage; (2) a modeling run or runs, using these forecasts, demonstrating that the temperature compliance point can be attained (see Coldwater Management Pool Model approach in Appendix 2-D); (3) a plan of operation based on this modeling run that demonstrates that all other non-discretionary requirements are met; and (4) allocations for discretionary deliveries that conform to the plan of operation.

Action 2.2 Assumptions for CalSim II Modeling Purposes

Action: The flows in the model reflect the FMS implemented under Action 2.1. It is assumed that temperature operations can perform reasonably well with flows included in model.

Rationale: Temperature models of Folsom Lake and the American River were developed in the 1990's. Model development for long range planning purposes may be required. Further analysis using a verified long range planning level temperature model is required to verify the statement that temperature operations can perform reasonably well with flows included in model and temperatures are met reliably

4.7 Action Suite 3.1 Stanislaus River / Eastside Division Actions

Overall Objectives: (1) Provide sufficient definition of operational criteria for Eastside Division to ensure viability of the steelhead population on the Stanislaus River, including freshwater migration routes to and from the Delta; and (2) halt or reverse adverse modification of steelhead critical habitat.

Action 3.1.2 Provide Cold Water Releases to Maintain Suitable Steelhead Temperatures

Action: Reclamation shall manage the cold water supply within New Melones Reservoir and make cold water releases from New Melones Reservoir to provide suitable temperatures for CV steelhead rearing, spawning, egg incubation smoltification, and adult migration in the Stanislaus River downstream of Goodwin Dam.

Action 3.1.2 Assumptions for CalSim II Modeling Purposes

Action: No specific CalSim II modeling code is implemented to simulate the Performance measures identified. It is assumed that temperature operations can perform reasonably well with flow operations resulting from the minimum flow requirements described in action 3.1.3.

Rationale: Temperature models of New Melones Lake and the Stanislaus River have been developed by Reclamation. Further analysis using this or another temperature model can further verify that temperature operations perform reasonably well with flows included in model and temperatures are met reliably. Development of temperature model runs is needed to refine the flow schedules assumed.

Action 3.1.3 Operate the East Side Division Dams to Meet the Minimum Flows, as Measured at Goodwin Dam

Objective: To maintain minimum base flows to optimize CV steelhead habitat for all life history stages and to incorporate habitat maintaining geomorphic flows in a flow pattern that will provide migratory cues to smolts and facilitate out-migrant smolt movement on declining limb of pulse.

Action: Reclamation shall operate releases from the East Side Division reservoirs to achieve a minimum flow schedule as prescribed in NMFS BiOp Appendix 2-E and generally described in figure 11-1. When operating at higher flows than specified, Reclamation shall implement ramping rates for flow changes that will avoid stranding and other adverse effects on CV steelhead.

Action 3.1.3 Assumptions for CalSim II Modeling Purposes

Action: Minimum flows based on Appendix 2-E flows (presented in Figure 5.A.A.7-1) are assumed consistent to what was modeled by NMFS (5/14/09 and 5/15/09 CalSim II models provided by NMFS; relevant logic merged into baselines models).

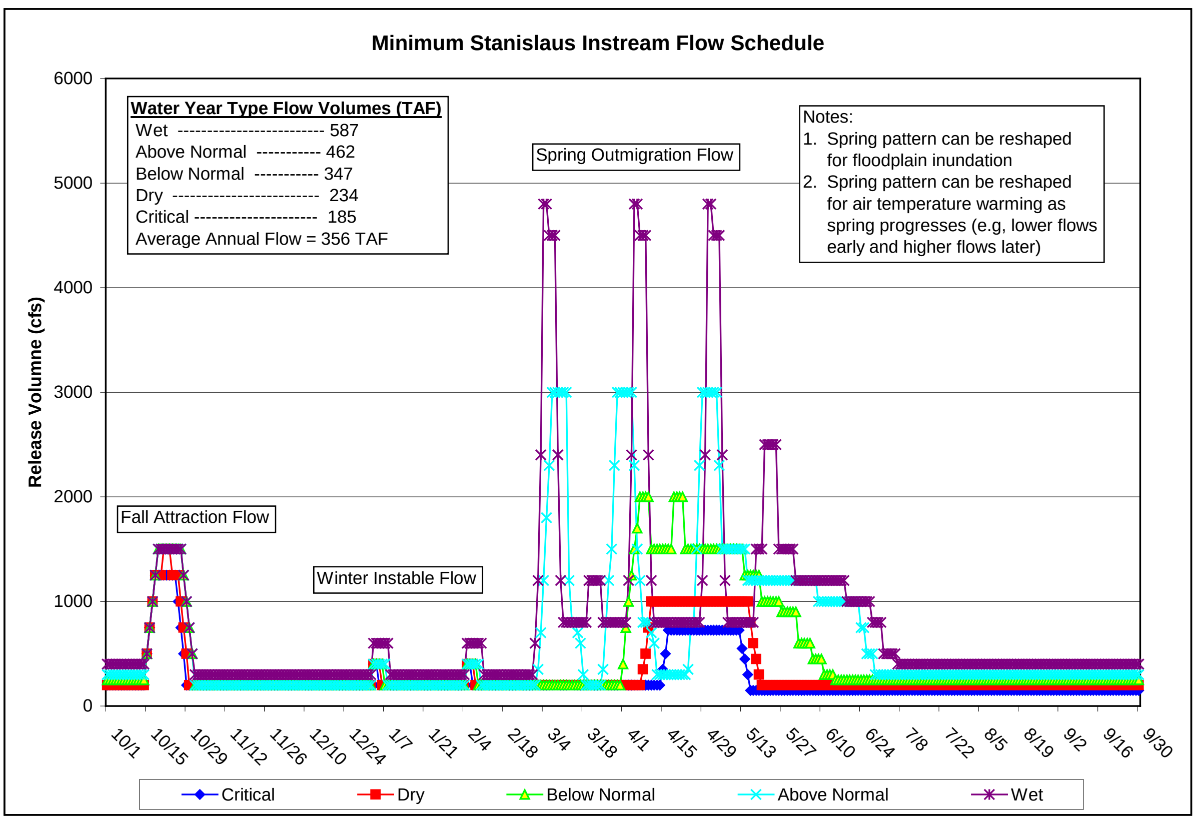


Figure 5.A.A.7-1 Minimum Stanislaus instream flow schedule as prescribed in Appendix 2-E of the NMFS BiOp (06/04/09)

Annual allocation in New Melones is modeled to ensure availability of required instream flows (Table 5.A.A.7-3) based on a water supply forecast that is comprised of end-of-February New Melones storage (in TAF) plus forecasted inflow to New Melones from March 1 to September 30 (in TAF). The "forecasted inflow" is calculated using perfect foresight in the model. Allocated volume of water is released according to water year type following the monthly flow schedule illustrated in Figure 5.A.A.7-1.

Table 5.A.A.7-3 New Melones Allocations to Meet Minimum Instream Flow Requirements

New Melones index (TAF)	Annual Allocation Required for Instream Flows (TAF)
< 1000	0 to 98.9
1,000 to 1,399	98.9
1,400 to 1,724	185.3
1,725 to 2,177	234.1
2,178 to 2,386	346.7
2,387 to 2,761	461.7
2,762 to 6,000	586.9

Rationale: This approach was reviewed by NOAA fisheries and verified that the year typing and New Melones allocation scheme are consistent with the modeling prepared for the BiOp.

4.8 Action Suite 4.1 Delta Cross Channel (DCC) Gate Operation, and Engineering Studies of Methods to Reduce Loss of Salmonids in Georgiana Slough and Interior Delta

Action 4.1.2 DCC Gate Operation

Objective: Modify DCC gate operation to reduce direct and indirect mortality of emigrating juvenile salmonids and green sturgeon in November, December, and January.

Action: During the period between November 1 and June 15, DCC gate operations will be modified from the proposed action to reduce loss of emigrating salmonids and green sturgeon. From December 1 to January 31, the gates will remain closed, except as operations are allowed using the implementation procedures/modified Salmon Decision Tree.

Timing: November 1 through June 15.

Triggers: Action triggers and description of action as defined in NMFS BiOp are presented in Table 5.A.A.7-4.

Table 5.A.A.7-4 NMFS BiOp DCC Gate Operation Triggers and Actions

Date	Action Triggers	Action Responses
October 1 – November 30	Water quality criteria per D-1641 are met and either the Knights Landing Catch Index (KLCI) or the Sacramento Catch Index (SCI) are greater than 3 fish per day but less than or equal to 5 fish per day.	Within 24 hours of trigger, DCC gates are closed. Gates will remain closed for 3 days.
October 1 – November 30	Water quality criteria per D-1641 are met and either the KLCI or SCI is greater than 5 fish per day	Within 24 hours, close the DCC gates and keep closed until the catch index is less than 3 fish per day at both the Knights Landing and Sacramento monitoring sites.
October 1 – November 30	The KLCI or SCI triggers are met but water quality criteria are not met per D-1641 criteria.	DOSS reviews monitoring data and makes recommendation to NMFS and WOMT per procedures in Action IV.5.
December 1 – December 14	Water quality criteria are met per D-1641.	DCC gates are closed. If Chinook salmon migration experiments are conducted during this time period (e.g., Delta Action 8 or similar studies), the DCC gates may be opened according to the experimental design, with NMFS' prior approval of the study.
December 1 – December 14	Water quality criteria are not met but both the KLCI and SCI are less than 3 fish per day.	DCC gates may be opened until the water quality criteria are met. Once water quality criteria are met, the DCC gates will be closed within 24 hours of compliance.
December 1 – December 14	Water quality criteria are not met but either of the KLCI or SCI is greater than 3 fish per day.	DOSS reviews monitoring data and makes recommendation to NMFS and WOMT per procedures in Action IV.5
December 15 – January 31	December 15 – January 31	DCC Gates Closed.
December 15 – January 31	NMFS-approved experiments are being conducted.	Agency sponsoring the experiment may request gate opening for up to 5 days; NMFS will determine whether opening is consistent with ESA obligations.
December 15 – January 31	One-time event between December 15 to January 5, when necessary to maintain Delta water quality in response to the astronomical high tide, coupled with low inflow conditions.	Upon concurrence of NMFS, DCC Gates may be opened one hour after sunrise to one hour before sunset, for up to 3 days, then return to full closure. Reclamation and DWR will also reduce Delta exports down to a health and safety level during the period of this action.
February 1 – May 15	D-1641 mandatory gate closure.	Gates closed, per WQCP criteria
May 16 – June 15	D-1641 gate operations criteria	DCC gates may be closed for up to 14 days during this period, per 2006 WQCP, if NMFS determines it is necessary.

Action 4.1.2 Assumptions for CalSim II Modeling Purposes

Action: The DCC gate operations for October 1 through January 31 were layered on top of the D-1641 gate operations already included in the CalSim II model. The general assumptions regarding the NMFS DCC operations are summarized in Table 5.A.A.7-5.

Timing: October 1 through January 31.

Table 5.A.A.7-5 DCC Gate Operation Triggers and Actions as Modeled in CalSim II

Date	Modeled Action Triggers	Modeled Action Responses
October 1 – December 14	Sacramento River daily flow at Wilkins Slough exceeding 7,500 cfs; flow assumed to flush salmon into the Delta	Each month, the DCC gates are closed for number of days estimated to exceed the threshold value.
October 1 – December 14	Water quality conditions at Rock Slough subject to D-1641 standards	Each month, the DCC gates are not closed if it results in violation of the D-1641 standard for Rock Slough; if DCC gates are not closed due to water quality conditions, exports during the days in question are restricted to 2,000 cfs.
December 15 – January 31	December 15-January 31	DCC Gates Closed.

Flow Trigger: It is assumed that during October 1 – December 14, the DCC will be closed if Sacramento River daily flow at Wilkins Slough exceeds 7,500 cfs. Using historical data (1945 through 2003, USGS gauge 11390500 “Sacramento River below Wilkins Slough near Grimes, CA”), a linear relationship is obtained between average monthly flow at Wilkins Slough and the number of days in month where the flow exceeds 7,500 cfs. This relation is then used to estimate the number of days of DCC closure for the October 1 – December 14 time period (Figure 5.A.A.7-2).

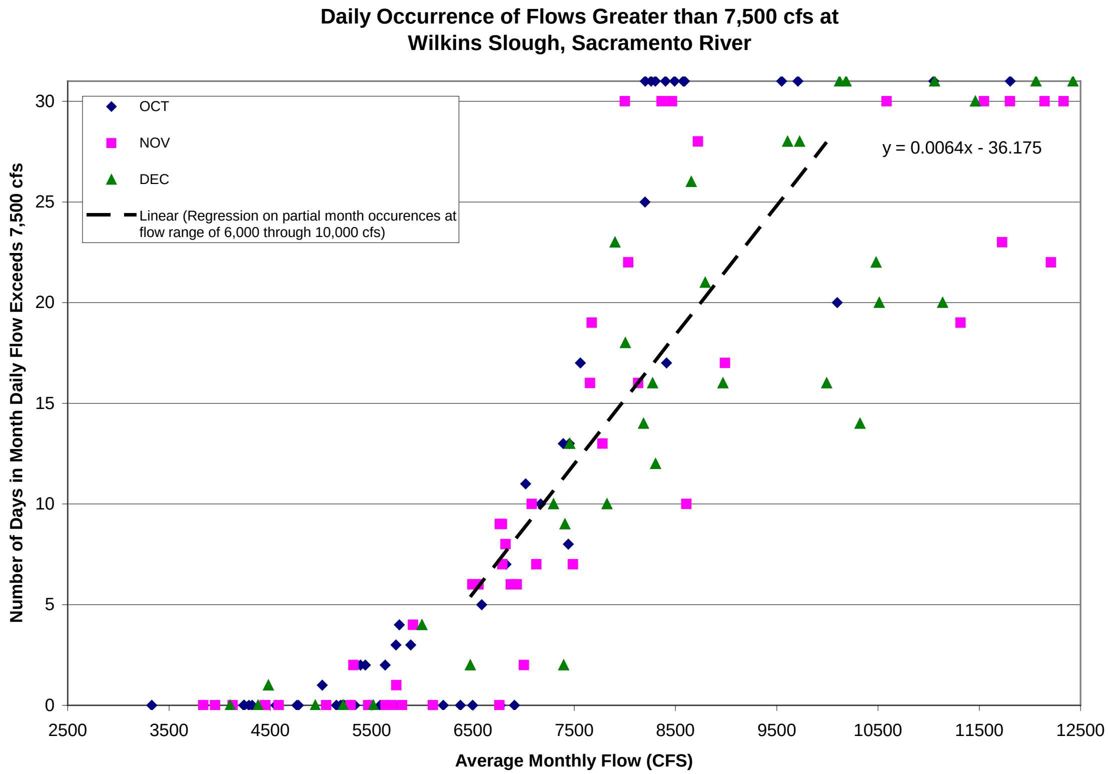


Figure 5.A.A.7-2 Relationship between monthly averages of Sacramento River flows and number of days that daily flow exceeds 7,500 cfs in a month at Wilkins Slough

It is assumed that during December 15 through January 31 that the DCC gates are closed under all flow conditions.

Water Quality: It is assumed that during October 1 – December 14 the DCC gates may remain open if water quality is a concern. Using the CalSim II-ANN flow-salinity model for Rock Slough, current month's chloride level at Rock Slough is estimated assuming DCC closure per NMFS BiOp. The estimated chloride level is compared against the Rock Slough chloride standard (monthly average). If estimated chloride level exceeds the standard, the gate closure is modeled per D1641 schedule (for the entire month).

It is assumed that during December 15 through January 31 that the DCC gates are closed under all water quality conditions.

Export Restriction: During October 1 – December 14 period, if the flow trigger condition is such that additional days of DCC gates closed is called for, however water quality conditions are a concern and the DCC gates remain open, then Delta exports are limited to 2,000 cfs for each day in question. A monthly Delta export restriction is calculated based on the trigger and water quality conditions described above.

Rationale: The proposed representation in CalSim II should adequately represent the limited water quality concerns were Sacramento River flows are low during the extreme high tides of December.

4.9 Action Suite 4.2 Delta Flow Management

Action 4.2.1 San Joaquin River Inflow to Export Ratio

Objectives: To reduce the vulnerability of emigrating CV steelhead within the lower San Joaquin River to entrainment into the channels of the South Delta and at the pumps due to the diversion of water by the export facilities in the South Delta, by increasing the inflow to export ratio. To enhance the likelihood of salmonids successfully exiting the Delta at Chipps Island by creating more suitable hydraulic conditions in the main stem of the San Joaquin River for emigrating fish, including greater net downstream flows.

Action: For CVP and SWP operations under this action, "The Phase II: Operations beginning is 2012" is assumed. From April 1 through May 31, 1) Reclamation shall continue to implement the Goodwin flow schedule for the Stanislaus River prescribed in Action 3.1.3 and Appendix 2-E of the NMFS BiOp); and 2) Combined CVP and SWP exports shall be restricted to the ratio depicted in table B-44 below based on the applicable San Joaquin River Index, but will be no less than 1,500 cfs (consistent with the health and safety provision governing this action.)

Action 4.2.1 Assumptions for CalSim II Modeling Purposes

Action: Flows at Vernalis during April and May will be based on the Stanislaus River flow prescribed in Action 3.1.3 and the flow contributions from the rest of the San Joaquin River basin consistent with the representation of VAMP contained in the BA modeling. In many years this flow may be less than the minimum Vernalis flow identified in the NOAA BiOp.

Exports are restricted as illustrated in Table 5.A.A.7-6.

Table 5.A.A.7-6. Maximum Combined CVP and SWP Export during April and May

San Joaquin River Index	Combined CVP and SWP Export Ratio
Critically dry	1:1
Dry	2:1
Below normal	3:1
Above normal	4:1
Wet	4:1

Rationale: Although the described model representation does not produce the full Vernalis flow objective outlined in the NOAA BiOp, it does include the elements that are within the control of the CVP and SWP, and that are reasonably certain to occur for the purpose of the EIS/EIR modeling.

In the long-term, a future SWRCB flow standard at Vernalis may potentially incorporate the full flow objective identified in the BiOp; and the Merced and Tuolumne flows would be based on the outcome of the current SWRCB and FERC processes that are underway.

Action 4.2.3 Old and Middle River Flow Management

Objective: Reduce the vulnerability of emigrating juvenile winter-run, yearling spring-run, and CV steelhead within the lower Sacramento and San Joaquin rivers to entrainment into the channels of the South Delta and at the pumps due to the diversion of water by the export facilities in the South Delta. Enhance the likelihood of salmonids successfully exiting the Delta at Chipps Island by creating more suitable hydraulic conditions in the mainstem of the San Joaquin River for emigrating fish, including greater net downstream flows.

Action: From January 1 through June 15, reduce exports, as necessary, to limit negative flows to -2,500 to -5,000 cfs in Old and Middle Rivers, depending on the presence of salmonids. The reverse flow will be managed within this range to reduce flows toward the pumps during periods of increased salmonid presence. Refer to NMFS BiOp document for the negative flow objective decision tree.

Action 4.2.3 Assumptions for CalSim II Modeling Purposes

Action: Old and Middle River flows required in this BiOp are assumed to be covered by OMR flow requirements developed for actions 1 through 3 of the FWS BiOp Most Likely scenario (Representation of U.S. Fish and Wildlife Service Biological Opinion Reasonable and Prudent Alternative Actions for CalSim II Planning Studies – DRAFT, 6/10/09).

Rationale: Based on a review of available data, it appears that implementation of actions 1 through 3 of the FWS RPA, and action 4.2.1 of the NOAA RPA will adequately cover this action within the CalSim II simulation. If necessary, additional post-processing of results could be conducted to verify this assumption.

4.10 References

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Attachment 1-5 Estimation of SWP Proportion of Effects

The scope of current project is to secure coverage for the long-term operations of the SWP under CESA. The CalSim modeling performed to analyze the proposed long-term SWP operations simulate the joint SWP and CVP operations. Therefore, following approach was used to isolate potential SWP proportion of any effects that may be a result of joint operation of SWP and CVP.

The approach is based on premise that under excess Delta conditions the joint operations are typically governed by the exports at the SWP and CVP pumping facilities, and under balanced conditions the SWP and CVP responsibility are defined in the Coordinated Operations Agreement (COA). COA identifies two types of balanced conditions: In basin use (IBU) and Unstored water for export (UWFE). In estimating the SWP proportion of effects, following principles were used:

- For months with IBU balanced conditions, the sharing ratio assigned to SWP in the COA is the SWP’s proportion of an effect.
- For months with UWFE balanced conditions and excess conditions, the proportion of exports at Banks Pumping Plant of the total exports at Banks and Jones Pumping Plants is the SWP’s proportion of an effect. All exports including any CVP wheeling and water transfers at the Banks Pumping Plant are used in this estimation.

These principles were applied to each month in the 82-year CalSim simulation period, and the SWP’s proportions were identified for each month. The monthly proportions were averaged by Sacramento 40-30-30 water year types and long-term. Table 1 shows the estimated SWP proportion of an effect that is a result of joint operations of SWP and CVP. The proportions shown in Table 1 are based on the proposed project CalSim modeling performed to support the effects analysis. These proportions are only for use in the effects analysis included in the current project.

Table 1: Estimated SWP proportion of an effect that may be a result of joint operation of SWP and CVP. The proportions presented are averaged by water year type and long-term by month.

Month	Wet	Above-Normal	Below-Normal	Dry	Critical	Long-term Average
OCT	49%	47%	44%	43%	42%	45%
NOV	64%	51%	57%	54%	48%	56%
DEC	50%	56%	56%	54%	49%	53%
JAN	50%	43%	43%	44%	43%	45%
FEB	56%	48%	46%	41%	40%	48%
MAR	57%	46%	49%	41%	39%	48%
APR	49%	47%	51%	45%	47%	48%
MAY	46%	44%	40%	37%	37%	42%
JUN	42%	31%	29%	35%	40%	36%
JUL	39%	20%	25%	35%	40%	33%
AUG	43%	20%	25%	30%	36%	33%
SEP	28%	23%	52%	40%	39%	36%
Annual Average	48%	40%	43%	42%	42%	44%

ATTACHMENT 1-6 DELTA PARTICLE TRACKING MODELING

Particle tracking models (PTM) are excellent tools to visualize and summarize the impacts of modified hydrodynamics in the Delta. These tools can simulate the movement of passive particles or particles with behavior representing either larval or adult fish through the Delta. The PTM tools can provide important information relating hydrodynamic results to the analysis needs of biologists that are essential in assessing the impacts to the habitat in the Delta.

1.1 DSM2 - PTM

DSM2-PTM simulates pseudo 3-D transport of neutrally buoyant particles based on the flow field simulated by HYDRO. The PTM module simulates the transport and fate of individual particles traveling throughout the Delta. The model uses geometry files, velocity, flow, and stage output from the HYDRO module to monitor the location of each individual particle using assumed vertical and lateral velocity profiles and specified random movement to simulate mixing. The location of a particle in a channel is determined as the distance from the downstream end of the channel segment (x), the distance from the centerline of the channel (y), and the distance above the channel bottom (z). PTM has multiple applications ranging from visualization of flow patterns to simulation of discrete organisms such as fish eggs and larvae.

The longitudinal distance traveled by a particle is determined from a combination of the lateral and vertical velocity profiles in each channel. The transverse velocity profile simulates the effects of channel shear that occurs along the sides of a channel. The result is varying velocities across the width of the channel. The average cross-sectional velocity is multiplied by a factor based on the particle’s transverse location in the channel. The model uses a fourth order polynomial to represent the velocity profile. The vertical velocity profile shows that particles located near the bottom of the channel move more slowly than particles located near the surface. The model uses the Von Karman logarithmic profile to create the velocity profile. Particles also move because of random mixing. The mixing rates (i.e., distances) are a function of the water depth and the velocity in the channel. High velocities and deeper water result in greater mixing.

At a junction the path of a particle is determined randomly based on the proportion of flow. The proportion of flow determines the probability of movement into each reach. A random number based on this determined probability then determines where the particle will go. A particle that moves into an open water area, such as a reservoir, no longer retains its position information. A DSM2 open water area is considered a fully mixed reactor. The path out of the open water area is a decision based on the volume in the open water area, the time step, and the flow out of the area. At the beginning of a time step the volume of the open water area the volume of water leaving at each opening of the open water area is determined. From that the probability of the particle leaving the open water area is calculated. Particles entering exports or agricultural diversions are considered "lost" from the system. Their final destination is recorded. Once particles pass the Martinez boundary, they have no opportunity to return to the Delta. (Smith, 1998, Wilbur, 2001, Miller, 2002)

1.2 DSM2 – PTM METRICS

Fate Mapping – an indicator of entrainment. It is the percent of particles that go past various exit points in the system at the end of a given number of days after insertion.

1.3 PTM PERIOD SELECTION

PTM simulation periods for the fate computations were in December through June of the entire 82-year planning simulation period.

1.4 PTM SIMULATIONS

PTM simulations are performed to derive the metrics described above. The particles are inserted at the 39 locations listed in Table 1. The locations were identified based on the 20mm Delta Smelt Survey Stations. 20 mm Deta Smelt Survey Stations and particle insertion locations are display in Figure 1.

A total of 39 PTM simulations are performed in a batch mode for each insertion period. For each insertion period, 4000 particles are inserted at the identified locations over a 24.75-hour period, starting on the 1st of the selected month. The fate of the inserted particles is tracked continuously over a 120-day simulation period. The particle flux is tracked at the key exit locations – exports, Delta agricultural intakes, past Chipps Island, to Suisun Marsh and past Martinez and at several internal tracking locations. Generally, the fate of particles at the end of 30 days, 60 days, 90 days and 120 days after insertion is computed for the fate mapping analysis.

Table 1: List of Particle Insertion Locations for Residence Time and Fate Computations

Location	DSM2 Node
San Joaquin River at Vernalis	1
San Joaquin River at Mossdale	7
San Joaquin River D/S of Rough and Ready Island	21
San Joaquin River at Buckley Cove	25
San Joaquin River near Medford Island	34
San Joaquin River at Potato Slough	39
San Joaquin River at Twitchell Island	41
Old River near Victoria Canal	75
Old River at Railroad Cut	86
Old River near Quimby Island	99
Middle River at Victoria Canal	113
Middle River u/s of Mildred Island	145
Grant Line Canal	174
Frank's Tract East	232
Threemile Slough	240
Little Potato Slough	249
Mokelumne River d/s of Cosumnes confluence	258
South Fork Mokelumne	261

Location	DSM2 Node
Mokelumne River d/s of Georgiana confluence	272
North Fork Mokelumne	281
Georgiana Slough	291
Miner Slough	307
Sacramento Deep Water Ship Channel	314
Cache Slough at Shag Slough	321
Cache Slough at Liberty Island	323
Lindsey slough at Barker Slough	322
Sacramento River at Sacramento	330
Sacramento River at Sutter Slough	339
Sacramento River at Ryde	344
Sacramento River near Cache Slough confluence	350
Sacramento River at Rio Vista	351
Sacramento River d/s of Decker Island	353
Sacramento River at Sherman Lake	354
Sacramento River at Port Chicago	359
Montezuma Slough at Head	418
Montezuma Slough at Suisun Slough	428
San Joaquin River d/s of Dutch Slough	461
Sacramento River at Pittsburg	465
San Joaquin River near Jersey Point	469

1.5 OUTPUT PARAMETERS

The particle tracking models can be used to assist in understanding passive fate and transport, or through consideration of behavior or residence time. In, general the following outputs are generated:

- Fate of particles and cut lines or regions
- Time of travel breakthrough curves
- Residence time

For the purposes of this EIR, only particle fate outputs were assessed.

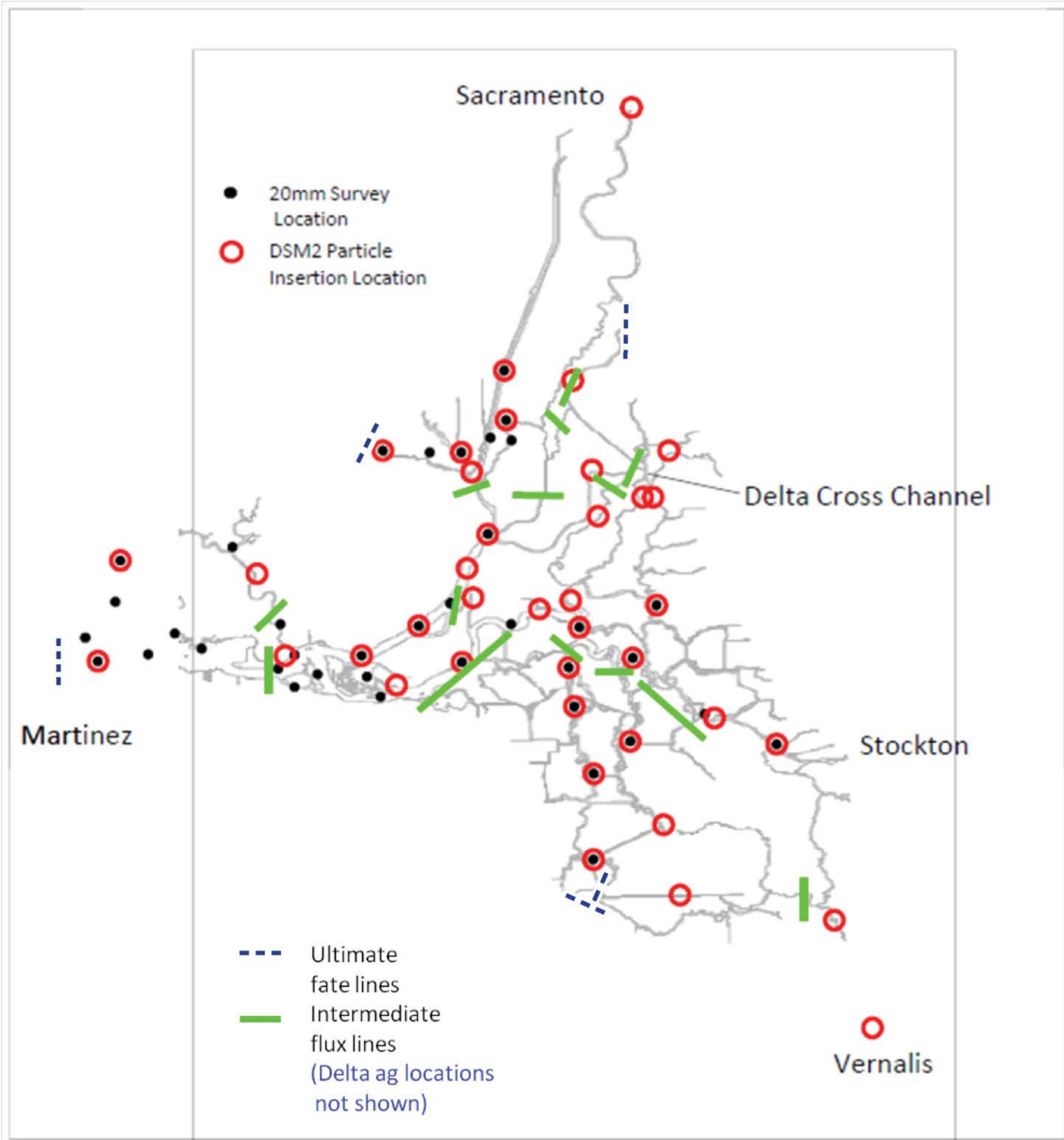

Figure 1. Particle insertion locations for fate computations

Attachment 1-7 Model Limitations

1 Introduction

Models are commonly used to evaluate changes in the management and operations of water resources systems. These models are computer based and use mathematical expressions, methods and input data to represent hydrologic, physical, environmental, operational, and institutional aspects of the water resources systems. As complex as water resources systems are, the representation of the water resources system in input data, calculations and model outputs is understood to be simplified and generalized in comparison to what is observed in the historical records and documents that describe the real-world water resources system. Even so, models are useful tools in assessing historical, current and future projected conditions of the water resources system. These conditions are described by models based on assumptions that are captured in the data and calculations used.

Even though the models used in this document are the best available tools, because the representation of the water resources system in models is understood to be simplified and generalized in comparison to what is observed in the historical records and documents, the use of model results should be subject to a set of agreed upon limitations and subsequent analysis of results is thereby limited. The developers and expert users of the models in question should be consulted in regard to these limitations. The following is a presentation of information that the team of modelers relevant to the limitations of the models. This information should be considered in use of the model results and any subsequent analysis derived from these model results.

2 General Limitations of Models Used

2.1 CalSim II

CalSim II is a monthly model developed for planning level analyses. The model is run for an 82-year historical hydrologic period, at a projected level of hydrology and demands; and under an assumed framework of regulations. Therefore the 82-year simulation does not provide information about historical conditions, but it does provide information about variability of conditions that would occur at the assumed level of hydrology and demand with the assumed operations, under the same historical hydrologic sequence. Because it is not a physically based model, CalSim II is not calibrated and cannot be used in a predictive manner. CalSim II is intended to be used in a comparative manner; which is appropriate for CESA analysis.

In CalSim II, operational decisions are made on a monthly basis, based on a set of pre-defined rules that represent the assumed regulations. Modifications by the model user would be required to allow for variation in these rules based on a sequence of hydrologic events such as a prolonged drought, or statistical performance criteria such as meeting a storage target in an assumed percentage of years.

While there are certain components in the model that are downscaled to a daily time step (simulated or approximated hydrology), such as an air-temperature based trigger for a fisheries action, the results of those daily conditions are always averaged to a monthly time step. For example, a certain number of days with and without the action is calculated and the monthly result is calculated using a day-weighted average based on the total number of days in that month. Operational decisions based on those components are again made on a monthly basis. Any reporting or use of sub-monthly results from CalSim II should include disaggregation methods that are appropriate for the given application, report, or subsequent model.

Appropriate use of model results is important. Despite detailed model inputs and assumptions, the CalSim II results differ from real-time operations under stressed water supply conditions. Such model results occur due to the inability of the model to make unique real-time policy decisions under extreme circumstances, as the actual (human) operators must do. Therefore, results which indicate severely low storage, or inability to meet flow requirements or senior water rights should only be considered an indicator of stressed water supply conditions under that alternative, and should not necessarily be understood to reflect literally what would occur in the future under that alternative. These conditions, in real-time operations, would be avoided by making policy decisions on other requirements in prior months. In actual future operations, as has always been the case in the past, the project operators would work in real time to satisfy legal and contractual obligations given then current conditions and hydrologic constraints.

Reclamation’s 2008 BA on the coordinated long-term operations Appendix W (Reclamation 2008) included a comprehensive sensitivity and uncertainty analysis of CalSim II results relative to the uncertainty in the inputs. This appendix provides a good summary of the key inputs that are critical to the largest changes in several operational outputs. Understanding the findings from this appendix may help in better understanding of the alternatives.

2.2 DSM2

DSM2 is a one-dimensional model with inherent limitations in simulating hydrodynamic and transport processes in a complex estuarine environment such as the Sacramento – San Joaquin Delta. DSM2 assumes that velocity in a channel can be adequately represented by a single average velocity over the channel cross-section, meaning that variations both across the width of the channel and through the water column are negligible. DSM2 does not have the ability to model short-circuiting of flow through a reach, where a majority of the flow in a cross-section is confined to a small portion of the cross-section. DSM2 does not conserve momentum at the channel junctions and does not model the secondary currents in a channel. DSM2 also does not explicitly account for dispersion due to flow accelerating through channel bends. It cannot model the vertical salinity stratification in the channels.

It has inherent limitations in simulating the hydrodynamics related to the open water areas. Since an open water surface area (represented with a reservoir in the model) is constant in DSM2, it impacts the stage in the reservoir and thereby impacts the flow exchange with the adjoining channel. Due to the inability to change the cross-sectional area of the reservoir inlets with changing water surface elevation, the final entrance and exit coefficients were fine tuned to match a median flow range. This causes errors in the flow exchange at breaches (levee openings) during the extreme spring and neap tides. Using an arbitrary bottom elevation value for the reservoirs representing the proposed marsh areas to get around the wetting-drying limitation of DSM2 may increase the dilution of salinity in the reservoirs.

For open water bodies DSM2 assumes uniform and instantaneous mixing over entire open water area. Thus it does not account for the any salinity gradients that may exist within the open water bodies. Significant uncertainty exists in flow and EC input data related to in-Delta agriculture, which leads to uncertainty in the simulated EC values. Caution needs to be exercised when using EC outputs on a sub-monthly scale, and therefore results are only presented at the monthly scale. Water quality results inside the water bodies representing the tidal marsh areas were not validated specifically and because of the bottom elevation assumptions, preferably should not be used for analysis.

3 Appropriate Use of CalSim II and DSM2 Model Results

The modeling conducted to evaluate Existing Conditions and Proposed Project scenarios is a planning analysis. A planning analysis is conducted to understand long-term changes in the Central Valley Project (CVP) and State Water Project (SWP) system due to a proposed change. The models developed and applied in planning analysis are generalized and simplified representations of a complex water resources system. Even so, the models used are informative and helpful in understanding the performance and potential effects (both positive and negative) of the operation of a project and its interaction with the water resources system under consideration. Even though some of the models used in this planning analysis such as DSM2 are calibrated and validated to represent physical processes, given the nature of the boundary conditions used (derived from CalSim II, a generalized system model), DSM2 results would only tend to represent generalized long-term trends. Note that level of confidence, in the results of any well calibrated predictive model is only as good as the level of confidence in the input boundary conditions used. Given the limitations of the planning analysis, a brief description of appropriate use of the model results to compare two scenarios or to compare against threshold values or standards is presented below.

3.1 Absolute Versus Relative Use of the Model Results

The CalSim II and DSM2 results in a planning analysis are appropriately used as “comparative tools” to assess relative changes between Existing Conditions and Proposed Project. In a planning analysis, models used are not predictive models and therefore the results cannot be considered as absolute with a quantifiable confidence interval. The model results are only useful in a comparative analysis and can only serve as an indicator of condition (e.g. compliance with a standard) and of trend or tendency (e.g. generalized impacts). Because CalSim II relies on generalized rules, a coarse representation of project operations, adjusted hydrologic conditions to reflect future demands and land use, and no specific operations in response to extreme events, results should not be expected to reflect what operators might do in real time operations on a specific day, month or year within the simulation period. In reality, the operators would be informed by numerous real-time considerations such as salinity monitoring.

3.2 Appropriate Reporting Time-Step

Due to the assumptions involved in the input data sets and model logic, care must be taken to select the most appropriate time-step for the reporting of model results. Sub-monthly (e.g. weekly or daily) reporting of model results are generally inappropriate for both models and the results should be presented on a monthly basis. There may be exceptions to this, and selected model results can be reported on a sub-monthly basis with adequate caution. An understanding of validity of the underlying operational conditions is critical in interpreting a sub-monthly result.

3.3 Appropriate Reporting Locations

Due to the assumptions involved in the input data sets and model logic, care must be taken to select the most appropriate reference locations (and/or boundaries) for the reporting of model results. Each model assumes a simplified spatial representation of the water resource system and sub-systems. Reporting of model results inconsistent with the spatial representation of the model is inappropriate. Care must be taken in selecting the locations desired for reporting model results and whether or not the models are adequate for that purpose.

3.4 Statistical Comparisons are Preferred

Absolute differences computed at a point in time between model results from an alternative and a baseline to evaluate impacts is an inappropriate use of model results (e.g. computing differences between the results from a baseline and an alternative for a particular day or month and year within the period of record of simulation). Likewise, computing absolute differences between an alternative (or a baseline) and a specific threshold value or standard is an inappropriate use of model results. Statistics based on the absolute differences at a point in time (e.g. maximum of monthly differences) are an inappropriate use of model results. By computing the absolute differences in this way, an analysis disregards the changes in antecedent conditions between individual scenarios and distorts the evaluation of impacts of a specific action (e.g. project).

Reporting seasonal patterns from long-term averages and water year type averages is appropriate. Statistics based on long-term and water year type averages are an appropriate use of model results. Computing differences between long-term or water year type averages of model results from two scenarios is appropriate. Care should be taken to use the appropriate water year type for presenting water year type average statistics of model results (e.g. D1641 Sacramento River 40-30-30 or San Joaquin River 60-20-20, and with or without climate modified conditions).

The most appropriate presentation of monthly and annual model results is in the form of probability distributions and comparisons of probability distributions (e.g. cumulative probabilities). If necessary, comparisons of model results against threshold or standard values should be limited to comparisons based on cumulative probability distributions. Information specific to a model calibration (should be considered in using these types of comparisons.

3.5 Suggested Formats for Presentation of Model Results

The most appropriate format to present model results is:

- Long term average summary and year type based summary tables and graphics showing monthly and/or annual statistics derived from the model results
- Cumulative exceedance probability monthly and/or annual model results shown only by rank/order or only by probability statistic

Comparative statistics based on these two types of presentations are generally acceptable.

4 Model Specific Considerations

As stated earlier, the models developed and applied in planning analysis are generalized and simplified representations of a complex water resources system, which means they are limited in some way. The following is a description of considerations specific to each model.

4.1 CalSim II

CalSim II is a monthly time-step model. It represents projected conditions under current or future regulatory and operational regimes. The operational decisions in CalSim II (e.g. determining the flow needed to meet a salinity standard in the Delta) are on a monthly time-step which does not consider operational responses to changes that are on a sub-monthly timescale. Results for an individual parameter are either a monthly average or an end-of-month condition.

A few specific concerns regarding CalSim II model results include the following:

- Storage results from CalSim II reflect end-of-month conditions and not monthly-average conditions. Therefore, any attributes derived from storage results such as littoral area or water surface elevation in the reservoir reflect end-of-month values.

- CalSim II operates to a monthly approximation of compliance to selected Delta standards. CalSim II monthly average salinity and X2 location outputs are ANN-based. (note that ANN outputs are lagged by one month). Following are some more details on CalSim II D1641 compliance limitations:

    - Even though additional standards are identified in SWRCB D-1641, CalSim II only recognizes five stations for compliance with a salinity standard:

        - Sacramento River at Emmaton

        - San Joaquin River at Jersey Point

        - Old River at Rock Slough

        - Sacramento River at Collinsville

        - Sacramento River at Chipps Island

    - Some standards in SWRCB D-1641 require compliance for a specified number of days in a year (e.g. CCWD 150mg/L Chloride Standard). In such cases, CalSim II does not have any discretion on which days the standards are met, but rather depends on a predetermined schedule, which cannot be altered dynamically.

    - Some of the standards modeled in CalSim II may not match exactly with the values specified in the SWRCB D-1641. Modeled standards may be more constrained ("ramped") to make operations more responsive to comply with a standard over the season.

    - Under extreme operational conditions, CalSim II may fail to comply with D1641 and other standards. This situation occurs rarely and is needed to maintain feasibility of the model solution.

- San Luis Storage operations in CalSim II are simplified compared to real time operations. The results are uncertain and prone to reflect how CalSim II represents CVP and SWP operations. This is due to the relatively coarse SWP/CVP allocation decisions (e.g. no updates after May) used in the model and uncertainty in the model's capability to forecast export capabilities.

4.2 DSM2

In a planning analysis, the flow boundary conditions that drive DSM2 are obtained from the monthly CalSim II model. The agricultural diversions, return flows and associated salinities used in DSM2 are on a monthly time step. The implementation of Delta Cross Channel gate operations in DSM2 assumes that the gates are open from the beginning of a given month, irrespective of the water quality needs in the South Delta.

A few specific concerns regarding DSM2 model results include the following:

- Even though CalSim II releases sufficient flow to meet the standards on a monthly average basis, the resulting EC from DSM2 may exceed the standard for part of a month while complying with the standard for the remainder of the month, depending on the spring/neap tide and other factors (e.g. simplification of operations). It is appropriate to present the results on a monthly basis. Frequency of compliance with a criterion should be computed based on monthly average results. Averaging on a sub-monthly (14-day or more) scale may be appropriate as long as the limitations with respect to the compliance of the baseline model are described in detail and the alternative results are presented as an incremental change from the baseline model.

- In general, it is appropriate to present DSM2 QUAL results including EC, DOC, volumetric fingerprinting and constituent fingerprinting on a monthly time step. When comparing results from two scenarios, computing differences based on these mean monthly statistics would be appropriate.

5 Extreme Operational Conditions under Regulatory Uncertainty

Continuing uncertainty in the regulatory environment makes the long-term planning of CVP and SWP operations challenging. The Existing Conditions CalSim II model used to establish the modeling of the Proposed Project scenario assumes the full implementation of the operational actions of the 2008 USFWS and 2009 NMFS BiOp. However, under full implementation of the BiOps, not all conditions of the BiOps may be met in a given month due to competing hydrologic, operational, and regulatory requirements. As a result the simulation provides what is referred to as “extreme operational conditions”. Frequency of such conditions can increase in the future with climate change, if the hydrology is drier or occurrence of sea level rise, without changes in the existing obligations of CVP-SWP.

Extreme operational conditions are defined as simulated occurrences of storage conditions at CVP and SWP reservoirs in which storage is at “dead pool” levels. Reservoir storage at or below the elevation of the lowest outlet is considered to be at dead pool level.

Under extreme operational conditions, CalSim II will utilize a series of rules within the specified priority to reach a numerically feasible solution to allow for the continuation of the simulation. The outcome of these types of solutions in CalSim II may vary greatly depending upon the antecedent conditions from the previous time-step result. The model may reach a numerical solution, but the results of the simulation may not reflect a reasonably expected outcome (i.e. an outcome which would require negotiation). In such cases, flows may fall short of minimum flow criteria, salinities may exceed standards, diversions may fall short of allocated volumes and operating agreements may not be met, indicating a stressed water supply condition.

6 Limitations of the Delta Salinity Modeling Approach

Delta salinity changes were analyzed based on the modeling results from CalSim II and DSM2 simulations of the Existing Conditions and Proposed Project scenarios. DSM2 salinity results indicated exceedances of a few salinity requirements. This section provides background on the models and examines three types of modeling limitations that could have resulted in exceedances.

CalSim II is a water operations model that simulates Delta flows for regulatory and operational criteria assumed under the scenarios on a monthly time step. The model simulates compliance with salinity standards in the Delta. CalSim II relies on an Artificial Neural Network (ANN) for monthly averaged flow verses salinity relationships in the Delta. ANN emulates flow-salinity relationships derived from DSM2 for a given Delta channel configuration and sea level rise condition.

DSM2 application for analyzing Existing Conditions and Proposed Project scenarios uses the monthly CalSim II Delta inflows and diversions/exports results, and simulates Delta hydrodynamics and salinity from the water year 1922 to water year 2003, on a 15-minute time step. Flow inputs assumed in DSM2 modeling are based on monthly CalSim II outputs. The DSM2 inflows do not represent any sub-monthly operational adjustments that could occur to address any potential issues with salinity control in the Delta.

Monthly CalSim II salinity outputs and daily averaged salinity outputs from DSM2 simulations were used to evaluate compliance with D-1641 salinity requirements. DSM2 salinity results indicated exceedances of a few salinity requirements. The modeling limitations that could have resulted in exceedances are listed below:

a. CalSim II is a monthly model – some salinity standards are partial month
b. CalSim II flow-salinity ANN

6.1 CalSim II is a Monthly Model – Some Salinity Standards Are Partial Month

Since CalSim II is a model with a monthly time-step and a number of daily D-1641 salinity standards are active during only portions of a month (ex: April 1 – June 20 and June 20 to August 15), D-1641 standards are calculated as a monthly weighted average in the model. The model attempts to meet these objectives on a monthly average basis, even though the objectives themselves are often transitioning within a month from one value to the other, and may start or end in the middle of a month. When the monthly weighted average standards calculated for CalSim II are less stringent than the daily D-1641 EC standards, CalSim II adjusts SWP and CVP operations to release less flow to meet monthly weighted average EC standards instead of the flow needed to meet higher daily D-1641 EC standards. Figure 1 “Sacramento River at Emmaton” below shows the difference between daily D-1641 EC standards and the monthly weighted average EC standards modeled in CalSim II, for reference. Therefore, within the months where the salinity standard is transitioning, there may be days where DSM2 inflows are less than the required flow to comply with the salinity standard, and more flow on other days. This results in a few days within such months where the modeled salinity exceeds the compliance standard. Importantly, however, in reality the CVP and SWP operations will be adjusted on day-to-day basis to meet the Delta standards.

6.2 CalSim II Flow-Salinity ANN

In CalSim II, the reservoirs and facilities of the SWP and CVP are operated to assure the flow and water quality requirements for these systems are met. Meeting regulatory requirements, including Delta water quality objectives, is the highest operational priority in CalSim II. CalSim II uses the ANN to configure system operations to meet salinity objectives. Because meeting the objectives is the highest priority in CalSim II, the model attempts to meet the applicable water quality objectives on a monthly average basis according to the ANN, unless there is no feasible way to meet the objective (i.e., upstream reservoirs at dead pool conditions). In some cases, even though the ANN predicts that the objective would be met on a monthly average basis, it can be an imperfect predictor of compliance on the time-step appropriate for a given standard (e.g daily standard) and averaging basis (e.g. 14-day running average) that these objectives need to be met. Thus when using the CalSim II results in such cases, the DSM2 results may indicate an exceedance of a salinity standard, when CalSim II does not.

6.3 Stressed CVP-SWP System Under Extreme Operational Conditions

Existing obligations on the CVP-SWP system (hydrology, water demands, biological opinions and other regulatory requirements) may result in extreme operational conditions. Under such extreme operational conditions, flows may fall short of minimum flow criteria, salinities may exceed standards, diversions may fall short of allocated volumes and operating agreements may not be met in CalSim II simulations. In some months, unavailability of the flow to meet the salinity standards in the Delta when upstream storage is at dead pool conditions can be a factor for the modeled exceedances of the standards. In such cases any salinity standard exceedances are reflections of the system operations in the CalSim II model which does not always recognize the operational flexibility, and adhere to the rigid criteria set forth in the model.

6.4 Modeling Exceedances

CalSim II and DSM2 modeling presented in this document may indicate a few modeled exceedances of the D1641 salinity standards. As noted above the exceedances are mostly a result of limitations in the modeling process. In reality, DWR and Reclamation staff constantly monitor Delta water quality conditions and adjust operations of the SWP and CVP in real time as necessary to meet water quality objectives. These decisions take into account real-time conditions and are able to account for many factors that the best available models cannot simulate. At times, under extreme conditions, negotiations with the State Water Resources Control Board occur in order to effectively maximize and balance protection of beneficial uses and water rights, which cannot be modeled.

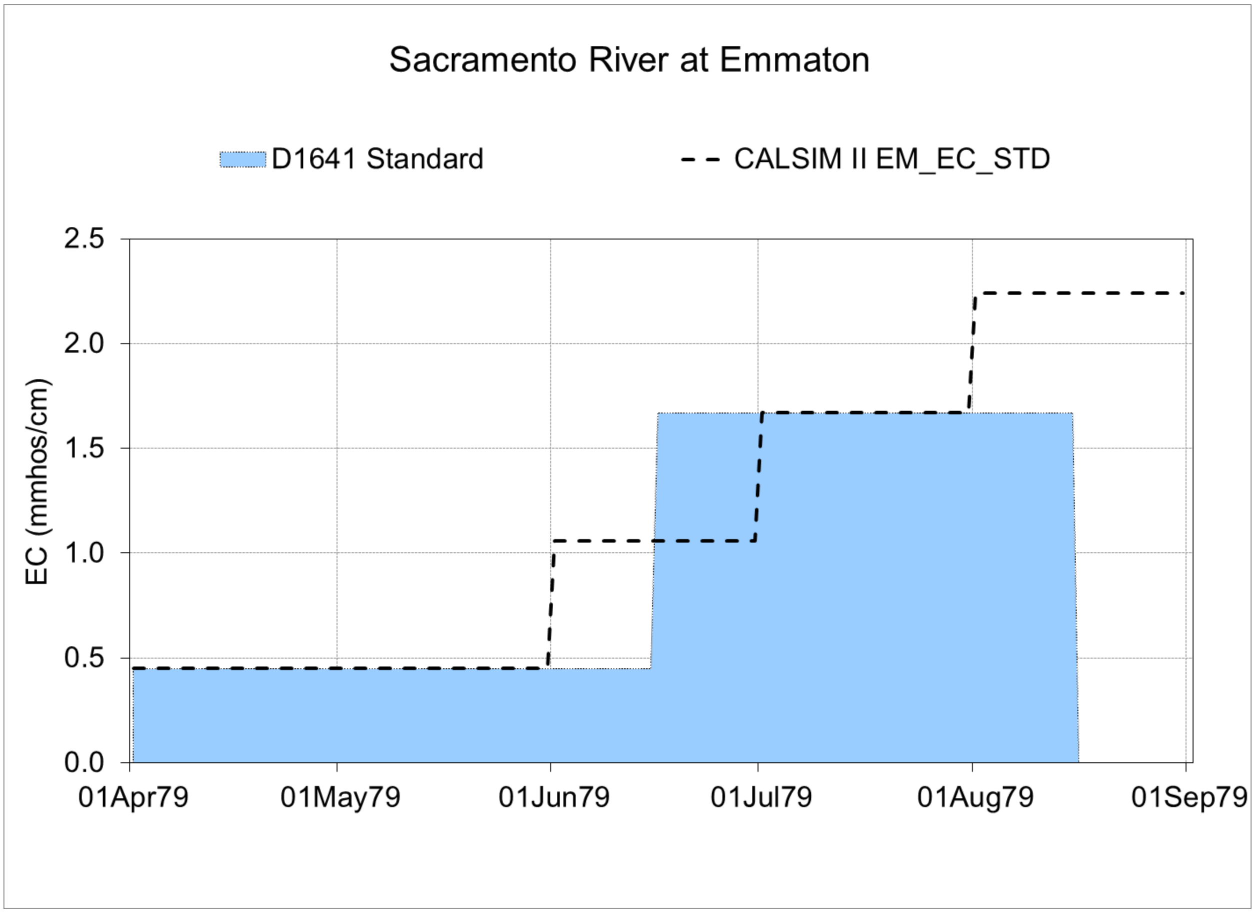

Figure 1. D-1641 Salinity Control Requirement at Emmaton as Simulated in CalSim II

7 References

U. S. Bureau of Reclamation, 2008. Biological Assessment on the Continued Long-term Operations of the Central Valley Project and State Water Project, Appendix W Sensitivity and Uncertainty Analysis, August 2008.

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Attachment 1-8 CalSim II Assumptions and Real-Time Operations

1 Introduction

The purpose of this attachment is to describe some of the limits of the CalSim II model as it relates to simulating real-time project operations, that is, the daily management of the SWP to a variety of conditions. In addition to the uncertainty inherent in attempting to mimic real-time operations with a model, this section explains that future actual operations of the SWP and CVP, themselves, in the Delta cannot be described with certainty because multiple regulatory conditions govern the operations, calling for potentially different protective actions in any given set of circumstances.

2 Modeling Assumptions

The CalSim II model was used to evaluate the Long Term Operations (LTO) of the SWP. CalSim II simulates the operations of the SWP and CVP over 82 years of hydrology. The model simulates water volumes, flows, and water quality, and does not have the capability to simulate fish or turbidity. However, fish presence and turbidity are the primary factors in determining the OMR (permissible Old and Middle River flow direction and magnitude) which at times (January through mid-June) acts as a constraint on export levels in real-time operations. To represent operations governed by fish presence or other real-time variable, simplifying assumptions are made. As described in Appendix H Attachment 1-4 Scenario Related Changes to CalSim II and DSM2, assumptions were developed using historical data and generalized for application in the model. Generalizing historical data for use in models is a common practice especially with representing fishery-based actions. Some of the assumptions and potential uncertainty in the CalSim II implementation of the fishery protection actions are:

- **Adult LFS entrainment protection** – This action was not modeled in CalSim II due to the lack of data needed to develop a simplifying assumption. However, in reality adult LFS entrainment has the potential to trigger an OMR requirement of ‘no more negative than -5,000 cfs’ as early as December 1.
- **Larval and Juvenile LFS entrainment protection** – This action was not modeled in CalSim II due to the lack of data needed to develop a simplifying assumption. However, it is conceivable that this action could result in a significant range of required OMR. The tools and processes described in Section 3.3.1.2 are new and it is uncertain as to what level of OMR restriction would result from those tools and processes.
- **Onset of OMR** – As described in Appendix H Attachment 1-4 Scenario Related Changes to CalSim II and DSM2, this is modeled as starting as early as December 17 or as late as January 1 depending on triggering the “First Flush” action. However, past historical data indicates a triggering event would have occurred as early as December 3rd in 2013. It is conceivable that under actual real time operations this action could start as early as December 1 and as late as January 31 as described in Section 3.3.1.1.

- **Turbidity Bridge Avoidance (DS)** – As described in Appendix H Attachment 1-4 Scenario Related Changes to CalSim II and DSM2, this action is modeled as a variable action based a flow surrogate which triggers the turbidity bridge avoidance action. The modeling assumed that when triggered, the action would apply an additional OMR requirement for 5 days at -2,000 cfs. However, historical data indicates that turbidity levels could persist and with protective risk assessments for Delta smelt, could extend additional OMR action well beyond the 5-day period assumed. Turbidity data in some years can persist for multiple months.
- **Larval and Juvenile DS entrainment protection** – This action was not modeled in CalSim II due to the lack of data needed to develop a simplifying assumption, however it is conceivable that this action could result in a significant range of required OMR. The tools and processes described in Section 3.3.1.1 are new and it is uncertain as to what level of OMR restriction would result from those tools and processes.
- **Salmon and Steelhead Salvage Thresholds** – As described in Appendix H Attachment 1-4 Scenario Related Changes to CalSim II and DSM2, this action is modeled as reaching the 50% salvage threshold in March of wet, above normal, below normal, and dry years and extending through April with 95% of salmonids exiting the Delta. The resulting additional OMR requirement for that period is -3,500 cfs. The assumption was developed using a generalization of the historical salvage. In actual real time operations, the salvage can vary. The historical data indicates that this action could occur as early as February, extend through May, and be as low as -2,500 cfs. In addition, if population levels were to increase, it could result in this action triggering more often with the potential for greater OMR restriction.

3 Potential Differences Between SWP LTO and CVP LTO Criteria

The modeling completed for this CEQA/CESA process assumes that the SWP and CVP operate to consistent regulatory criteria, i.e., the resulting OMR would be the same requirement for the SWP as for the CVP. The modeling assumes the Projects jointly operate to consistent criteria and split responsibilities for Delta inflows and opportunities for Delta export based on the provisions in the COA. As described below, however, there is the potential for the SWP to have more restrictive criteria than the CVP, where the OMR requirement could potentially vary by 3,000 cfs, with the SWP subject to -2,000 cfs and CVP subject to -5,000 cfs OMR flows. If the SWP were required to meet a different regulatory requirement than the CVP, as a result of additional DFW oversight for CESA purposes, the SWP will meet its proportion of the OMR requirement.

As described in Project Description, there are differences in the federal LTO and state LTO processes that could result in different operating criteria between the SWP and CVP. There are several areas within the Federal LTO and State LTO where criteria could deviate, making the SWP be required to operate to a different criterion than the CVP. Different operating criteria could occur under at least two situations: 1) Longfin Smelt action, and 2) risk assessments for off-ramping additional OMR criteria.

3.1 Longfin Smelt Actions

Longfin Smelt (LFS) are a state listed species and are protected by state law, however they are not federally listed and therefore not covered by the federal endangered species act. The State LTO includes specific actions for the protection of longfin that can begin as early as December 1 and includes entrainment protections for Adult LFS, and Larval and Juvenile LFS. These actions could potentially require SWP to operate to criteria that are in addition to the requirements incumbent on the CVP. Specifically, LFS actions that could require OMR requirements different from the CVP requirements include:

- **Adult LFS entrainment protection** – This can begin as early as December 1 based on salvage of longfin at SWP and CVP export facilities. There is a potential for this action to occur before the Delta smelt "First Flush" action. If triggered before the "First Flush", the Adult LFS protection would require an OMR less negative than -5,000 cfs for the SWP. At the same time, the CVP would be operating without any OMR requirement.
- **Larval and Juvenile LFS protection** – This can begin as early as January and would likely coincide with an OMR requirement for other species through the federal LTO with a standard OMR requirement of -5,000 cfs. However, there is a potential for significant differences in the required OMR. An appropriate action is dependent on real-time monitoring, simulation models, and coordination and concurrence with CDFW. A final OMR determination from a real-time assessment could easily be close to -2,000 cfs (i.e. considerably more restrictive for SWP). If situationally the CVP concluded that storm flexibility were available, the SWP could be required to operate to an OMR that is even more than 3,000 cfs more positive (effectively more restrictive to exports) than the CVP requirement.

3.2 Potential for different Risk Assessments and determination of species protection

After the onset of OMR management, there are several prescriptive actions that can trigger additional OMR restrictions based on real-time data. These additional restrictions can require the SWP and CVP to manage to OMR no more negative than -2,000 cfs. However, if DWR and Reclamation determine that the additional actions are no longer warranted for species protection, through an assessment of conditions and risk to species, then the additional restrictions may be lifted. However, CDFW may object to DWR's assessment and planned operations, in which case SWP may be required to operate to a more restrictive OMR than the CVP, and as described above, SWP will meet its proportional share. It is reasonable to assume that there will be situations where the federal and state assessments differ, but too speculative for modeling purposes.

The following species protections allow the projects to evaluate risk to species and potentially offramp from a specific measure if the risk is low enough. If CDFW disagrees with DWR's assessment, CDFW can ultimately require SWP to manage to a different criterion than the CVP.

- **Turbidity Bridge Avoidance** – Requires the Projects to manage to an OMR of -2,000 cfs when the turbidity at CDEC station OBI becomes greater than 12 NTU. However, there are conditions (e.g. bad data, localized event, or inability to control bridge formation) where the Projects could identify a "false" turbidity bridge avoidance event or determine a more appropriate OMR level that would continue to be protective and based on real-time data. The offramp could result in an OMR requirement no more negative than -5,000 cfs. CDFW can object to the Projects conclusions and require DWR to operate to as restrictive as -2,000 cfs OMR. Therefore, the difference between the CVP and SWP criteria could be up to 3,000 cfs, where SWP could be required to meet -2,000 cfs OMR with the CVP allowed to meet -5,000 cfs OMR. Under this condition SWP would meet its proportional share.

- **Larval and Juvenile Delta Smelt Protection** – Requires the Projects to determine a protective OMR for the protection of larval and juvenile Delta smelt. An entrainment assessment for Delta Smelt will occur on or after March 15 when Q-west is negative and larval and juveniles Delta smelt are detected in the OMR corridor. A protective OMR is to be determined by the Projects using the best available models and science. This protective action is open to many possible ways to determine a what an appropriate OMR level should be and therefore has the potential to result in different criteria. However, determining a reasonable range would be too speculative.
- **Cumulative Loss Thresholds** – Designed to meter the long-term salvage by applying a total salvage limit on the next 4 and 10 years of operations. If salvage levels reach those thresholds, then the Projects will coordinate on future actions to limit take. Though this should be a cooperative process, there is some potential for differences in strategy that may result in different criteria. However, determining a reasonable range would be too speculative.
- **Single-Year Loss Thresholds** – A prescriptive OMR requirement based on the salvage of listed species. Additional OMR criteria is imposed when the SWP and CVP reach 50% and 75% of the loss threshold. These thresholds represent an additional OMR requirement of -3,500 cfs and -2,500 cfs respectively. Once a threshold is reached, that OMR restriction would remain in effect until the end of the season. The Projects can, through a risk assessment, determine an OMR restriction that is still protective to the species. CDFW has the ability to object to DWR's risk assessment and require SWP to continue with an additional OMR requirement defined by the salvage loss threshold. At most, this could require SWP to operate to an OMR requirement of -2,500 cfs, with the CVP operating to -5,000 cfs. This is a potential difference that could have SWP operating to a 2,500 cfs more restrictive OMR requirement.
- **OMR Flexibility During Excess Flow Conditions** – Allow for the Projects to operate to more negative OMR when risk to listed species is low. There are many conditions that have to be met before the projects can flex the OMR to something more negative than -5,000 cfs including insuring that no other OMR action has been triggered, as well as evaluating if OMR flexing would exacerbate the need for additional OMR requirements in the near future. In this aspect there is again the potential for the CVP and SWP to each be left operating to a different standard, the potential range of which is speculative.

As explained above, the CalSim II model does not—and cannot--represent real-time operations perfectly. CalSim II incorporates assumptions to provide for general operating conditions, but actual operations can vary and the general operating conditions do not represent extreme possibilities associated with fishery-based regulatory criteria.

Additionally, several conditions could require the CVP and the SWP to operate to different regulatory requirements associated with additional CDFW authority over SWP operations. However, it is too speculative to assume such conditions in the modeling analysis.

Despite CalSim II's limitations, CalSim II offers the best tool available to simulate SWP and CVP potential operational alternatives over a range of hydrologic conditions. Comparison of analysis of different operational regimes (including regulatory conditions) allows reasonable inference of how differently the projects might perform under the differing conditions.

APPENDIX I

California Department of Fish and Wildlife

Proposal for Project Alternative 4

ALTERNATIVE 4 – ALTERNATIVE SUMMER-FALL ACTION

This alternative decribes operations for Delta smelt habitat during the summer and fall that would replace the summer-fall action described in Section 3.3.3 of the Proposed Project. The objective of this alternative is to provide continuous habitat availability in areas of Suisun Bay and Suisun Marsh where complex habitat features and cooler waters can be readily accessed and utilized by Delta smelt.

The IEP-MAST (2015) conceptual model describes the transition probability between life stages of Delta smelt. The transition probability of juveniles to subadults is hypothesized to be driven by specific habitat attributes including water temperature, predation risk, toxicity from harmful algal blooms, and food availability and quality. These same habitat attributes are hypothesized to drive the transition probability from subadults to adults in the fall period, in addition to toxicity related to contaminants and the size and location of the low salinity zone. As the low salinity zone moves westward, stress associated with these habitat attributes during the summer and fall generally decreases.

As referenced in the IEP-MAST (2015), water temperature is known to affect the survival of juvenile and sub adult Delta smelt through the summer and fall periods. Komoroske, Connon et al. (2014) found that juveniles exhibit lower warming tolerance compared to other life stages. During the summer months juveniles are exposed to water temperatures closer to their Critical Thermal Maximum (CTM) and Maximum Chronic Lethal Temperature (CLT) and can be exposed to temperatures above their CTM in the wild. Komoroske, Connon et al. (2014) also found that proportional survival of adults in the laboratory begins to rapidly decline as water temperatures exceed 25°C, with lethal temperatures occurring at approximately 28^{o}C. These results indicate that small differences in temperature (± 1^{o}C) under warmer conditions can have substantial impacts on survival.

In addition, recent findings demonstrate that Delta smelt may be experience sub-lethal impacts when exposed to temperatures lower than 25-28^{o}C. In laboratory conditions Delta smelt exhibited potentially deleterious behavioral responses when exposed to persistent elevated temperatures greater than or equal to 21°C (Davis, Hansen et al. 2019), indicating that sublethal effects can begin to occur before water temperatures reach 25^{o}C. Findings from a retrospective analysis of historic temperature data (1975-2012) show that the coolest average and maximum temperatures occurred in Suisun Bay and San Pablo Bay during the July to August period (average 19-21^{o}C, maximum 24^{o}C) while the western Delta was slightly warmer (average 21-23 °C, maximum 25 °C) (IEP-MAST 2015). These data indicate that the western portions of Suisun will generally provide the coolest water temperatures relative to other upstream regions.

Turbidity is also an important Delta smelt habitat attribute during the summer and fall. Increased turbidity has been hypothesized to increase survival and reduce Delta smelt predation risk. Turbidity is generally hypothesized to be higher in Suisun relative to upstream regions where dynamic variables, such as wind (Rhul and Schoellhamer 2004), interact with high levels of baythmetric complexity and increased erodible sediment supply (Brown, Baxter et al. (2014).

Salinity is also an important Delta smelt habitat attribute. Komoroske, Connon et al. (2014) found that Delta smelt mortality in the laboratory was greatest at high salinities (34 ppt) with little difference between 2 ppt and 18 ppt treatments. However, Baskerville-Bridges, Linderberg et al. (2004) found that Delta smelt experienced increased osmoregulatory stress in the laboratory at salinities greater than 12 ppt, and optimal performance occurred at low salinities (0-6 ppt) and low turbidity (<120 NTU). In the wild, low salinity zone habitat for Delta smelt is defined as areas with salinities ≥ 0.5 PSU but ≤ 6 PSU. Although a subset of the population occupies fresh water regions of the Sacramento Deep Water Ship Channel, recent otolith analyses indicate that the majority of the Delta smelt population typically occupies habitats with salinities > 0.5 PSU during the summer-fall period of most years (Bush 2017). Therefore, managing the location of low salinity habitat during the summer and fall period is important for survival of the population, as it creates access to cooler waters with higher turbidities that are within a salinity range that aligns with optimal conditions for Delta smelt.

Alternative 4 is based on the conceptual model of Delta smelt life history described in the IEP MAST (2015) report and attempts to align low salinity habitat with downstream areas that maintain better conditions for Delta smelt, such as cooler water temperatures. This conceptual model is similar to that described in Brown, Baxter et al. (2014) where a mixture of stationary and dynamic habitat attributes interact to produce conditions which are preferable to Delta smelt during the fall. Alternative 4 also considers recent findings from the 2017 water year, where summer water temperatures became a limiting factor prior to implementation of the fall flow action. This alternative provides suitable habitat conditions for Delta smelt during summer months of most years when survival can be substantially influenced by relatively small changes in abiotic conditions, such as water temperature (Komoroske, Connon et al. 2014).

Table 5-ALT4 summarizes the environmental and operational requirements of Alternative 4 during different water year types.

Table 5-ALT4. Summary of Summer-Fall Actions Proposed for Alternative 4

Season Actions	Month	Critically Dry Water Year	Dry Water Year	Below Normal Water Year	Above Normal Water Year	Wet Water Year
Summer Actions	June	N/A	Up to 60 days of SMSCG operation	X2 < 80, monthly average and Up to 60 days of SMSCG operation	X2 < 80, 14-day average	X2 < 80, 14-day average
Summer Actions	July	N/A	Up to 60 days of SMSCG operation	X2 < 80, monthly average and Up to 60 days of SMSCG operation	X2 < 80 14-day average	X2 < 80, 14-day average
Summer Actions	August	N/A	Up to 60 days of SMSCG operation	X2 < 80, monthly average and Up to 60 days of SMSCG operation	X2 < 80 14-day average	X2 < 80, 14-day average
Fall Actions	September	N/A	N/A1	N/A1	X2 < 80, monthly average	X2 < preceding August, monthly average
Fall Actions	October	N/A	N/A1	N/A1	X2 <, monthly average	X2 < preceding August, monthly average

Notes: 1. SMSCG operation could be extended into September if within the 60 day of operations. October operations of the SMSCG would be as described in Section 3.1.2.5.

Expanded descriptions of the operational and environmental criteria included in Alternative 4 and the rationale for the proposed criteria are provided below by water year type.

Wet years

- **Summer Months:** X2 ≤ 80 km on a 14-day running average for the months of June, July, and August. The 14-day average begins to run on June 1.
- **Rationale**: An analysis of the last 10 years shows that summer flows are achieving these conditions for June-August. This criterion is intended to safeguard beneficial low salinity habitat from compensatory water management strategies related to implementing outflow measures in September and October.
- **Fall Months:** Average monthly X2 ≤ to what occurred in preceding August for the months of September and October.

Above Normal Years

- **Summer Months:** X2 ≤ 80 km on a 14-day running average for the months of June, July, and August. The 14-day average begins to run on June 1.
- **Rationale**: Similar to the rationale for wet years, existing flows during these months will generally meet this objective. This criterion is intended to safeguard beneficial low salinity habitat from compensatory water management strategies related to implementing outflow measures in September and October.
- **Fall Months:** Average monthly X2 ≤ 80 km for the months of September and October.

Below Normal Years

- **Summer and Fall Months:** Based on advice from a real-time working group, and as approved by CDFW, average monthly X2 ≤ 80 km for the months of June, July, and August or up to 60 days of operation of the SMSCG, or a combination of both. Action can be extended into the Fall if within the 60-days of SMSCG operations.
- **Rationale**: An analysis of the last 10 years shows that summer flows in Below Normal years are sometimes naturally achieving an X2 more downstream of 80 km during June, July and August. Therefore, a real-time working group would be established during Below Normal years and meet regularly to determine whether an X2 objective or operation of the SMSCG is appropriate for June, July and August.
- **Objective**: The objective of this criteria is to maintain contiguous habitat through the North Delta Arch, by maintaining salinity ≤ to 4ppt on a daily average in June, July, and August at Beldon's Landing during gate operations and meeting D-1641 outflow requirement.

Dry Years

- **Summer and Fall Months:** Operation of the SMSCG for a period at least 60 days for the months of June, July, and August. A real-time working group will form in Dry years and meet regularly to determine when operation of the SMSCG is appropriate. Action can be extended into September if within the 60-days of SMSCG operations.

- **Objective**: The objective of this criteria is to maintain contiguous habitat through the North Delta Arch, by maintaining salinity $\leq$ to 4ppt on a daily average in June, July, and August at Beldon's Landing during gate operations and meeting D-1641 outflow requirement.

Aquatic Resources

- Algal blooms – not likely to be different from proposed project.
- Predation
- Habitat extent/location

Other Resources

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