CHAPTER 1 INTRODUCTION

The California Department of Water Resources is (DWR) is releasing this Preliminary Design and Cost Estimate Report to present information related to the preliminary designs and cost estimates for the facilities included in the alternative plans developed for North-of-the-Delta Offstream Storage (NODOS) Project. This report is a companion to the NODOS Investigation 2013 Progress Report, by U.S. Bureau of Reclamation (Reclamation) and DWR, as well as the NODOS Preliminary Administrative Draft Environmental Impact Report 2014, by DWR. This information was derived from previous studies and on-going investigation by Reclamation and DWR.

1.1 Chronology of NODOS Engineering Studies

The NODOS concept has been studied by DWR since 1957, and by Reclamation since 1964. Traditionally, reservoirs are created by constructing dams on major streams (on stream storage). An offstream storage reservoir is typically constructed on a small, generally seasonal stream that contributes a minor share of the water supply to the reservoir. Offstream storage involves diverting water from a major stream and transporting the water through a conveyance system to the reservoir.

The earliest published reference to a NODOS Project is found in DWR Bulletin 3, the California Water Plan 1957, which mentions a 48,000 acre-foot (AF) Sites offstream storage reservoir on Stone Corral and Funks Creeks to be supplied by a then-proposed Tehama-Colusa (T-C) Canal.

DWR's Bulletin 109, Colusa Basin Investigation 1964, evaluated potential flood control projects and considered two separate reservoirs of 5,800 and 7,600 AF on Stone Corral and Funks Creeks, respectively. An update of this report in 1990 found these reservoirs economically unjustified for flood control alone.

Consideration of larger projects at the Sites location were first documented in December 1964 in Reclamation's West Sacramento Canal Unit Report, which studied the feasibility of extending the T-C Canal, via a new West Sacramento Valley Canal, into Solano County near Fairfield. To develop additional water supply to support this canal extension plan, a 1.2 million acre-feet (MAF) Sites Reservoir was proposed. This study did not evaluate the potential of Sites as a stand-alone project, but only as part of the extended canal system. Reclamation unsuccessfully attempted to obtain funds for a full feasibility study of Sites Reservoir in 1977 and documented its findings in a report published in 1981.

In March 1990, CH2M HILL prepared a long-range plan for the Glenn-Colusa Irrigation District (GCID) that included an 870,000 AF Sites Reservoir with a normal water surface elevation (WSE) of 460 feet. Based on information contained in Reclamation's 1964 report, GCID determined that an 870,000 AF Sites Reservoir was beyond its financial capability.

In 1993, CH2M HILL published a report, *Meeting California's Water Needs in the 21st Century*, which presented a conceptual Westside Storage and Conveyance

System. The report mentioned a Sites/Colusa Reservoir with a feeder pipeline from Lake Oroville.

A July 1995 draft report by the Colusa Basin Drainage District on its proposed Water Management Program recommended a 62-foot-high dam on Funks Creek that would impound 9,500 AF in Golden Gate Reservoir. The project benefits listed were flood control and modest springtime irrigation yield.

In late 1995, DWR received numerous requests from water interests, including the Northern California Water Association (NCWA), for information regarding the potential of an offstream storage reservoir at the Sites location. In response to this renewed interest, DWR reviewed historic documents on the project to assess its potential to augment local and statewide water supplies during drought periods. DWR conducted a brief investigation of environmental literature, studies, aerial photos, and conducted limited field work in the project area. DWR published its findings in a July 1996 report entitled *Reconnaissance Survey – Sites Offstream Storage Project*.

DWR's 1996 report briefly summarized Sites project planning information and updated earlier cost estimates to 1995 levels. No insurmountable problems were identified that would prevent further evaluation of the project. Rather, DWR found that the project had several unique characteristics that made it an attractive candidate for further feasibility-level investigations. The project has a significantly lower cost per unit of storage than most other storage locations. The area is sparsely populated and contains relatively few environmentally sensitive species. The geography of the potential reservoir location permits a range of storage options for consideration.

In July 2000, a *NODOS Progress Report* was published to summarize the work conducted since 1997. The document provided California Federal Bay-Delta Program (CALFED) agencies and the public with information about projects under evaluation, including Sites, Colusa, Newville, and Red Bank reservoirs. Engineering and geologic investigations conducted at the probable locations of the Golden Gate and Sites Dams indicated they were suitable for construction of dams that could impound a 1.8-MAF Sites Reservoir.

In August 2000, DWR's Division of Engineering (DOE) prepared an *Engineering Progress Report on Feasibility Studies for Sites Reservoir*. The report documented progress on feasibility-level studies for Sites Reservoir facilities. It summarized the conceptual design for Golden Gate and Sites Dams, spillway, inlet/outlet works, and the pumping/generating plant directly serving the Sites Reservoir. The report deemed detailed geologic mapping and investigation of the faults, for further studies, essential, because of potential seismic activity at the dam sites.

In June 2002, DOE released another report, *Materials Investigation, Testing, and Evaluation Program for Sites Reservoir*. The investigation objectives included identification of the types of available on-site construction materials, examination of their potential uses, and performance of limited testing and evaluation to determine their suitability for use in the dams and appurtenant structures.

In October 2002, a *NODOS Scoping Report* was published by DWR, summarizing the public concerns, evaluating the magnitude of concerns, and helping the NODOS Project Team determine the range of alternatives for NODOS.

In April 2003, URS Corporation (URS) and CH2M HILL prepared an *Engineering Feasibility Report on Modifications to GCID Fish Screen and Enlargement of Main Canal* for DWR. The study evaluated facility improvements, operating concepts, capital costs, and overall feasibility of expanding GCID's Main Pump Station and Main Canal in order to convey Sacramento River diversions to the proposed Sites Reservoir project.

In May 2003, URS and CH2M HILL prepared a *Final Engineering Feasibility Report for TC Canal Alternatives* for DWR. The study evaluated alternatives for the T-C Canal intake facilities including enlargement of the canal itself to meet the needs of the proposed Sites Reservoir project.

In May 2003, CH2M HILL prepared, *Stony Creek Alternative for Conveyance to Sites Reservoir NODOS Evaluations* for DWR. The purpose was to conduct feasibility-level evaluations of alternative routes and associated conveyance facilities from the Black Butte Dam Afterbay to the T-C Canal near Orland.

In June 2003, DOE released another report, *Sites Reservoir Engineering Feasibility Study, Pumping Plants, and Appurtenant Facilities*. The purpose of the study was to evaluate the engineering feasibility for the design and construction of a pumping plant, inlet/outlet channel, tunnel, reservoir inlet/outlet structure, emergency release structure, and an ungated spillway. The study found each of these appurtenances to be technically feasible.

In July 2003, DOE released *Geologic Feasibility Report, Sites Reservoir Project*. The report summarized all of the geologic information that had been developed to that time. The report found that the proposed project was geologically feasible and that there were no geological fatal flaws.

In August 2003, DOE released *Conveyance, Colusa Basin Drain, and Funks Reservoir Modification*. The report focused on three tasks for the Sites project: conveyance from the Sacramento River to Funks Reservoir; utilizing the Colusa Basin Drain as a source of supply; and modification of Funks Reservoir to meet the requirements of the Sites Reservoir project.

In September 2005, DOE released a *Feasibility Study for Reverse Flow and Pumping-Generating Plants*. The report considered the feasibility and benefits of a reverse-flow conveyance system from Funks Reservoir to the Sacramento River.

In May 2006, URS prepared a *NODOS Investigation Initial Alternatives Information Report* (IAIR) for Reclamation. The purpose of the investigation was to identify and screen alternatives for NODOS.

In June 2008, CH2M HILL prepared a feasibility study for DWR for the fish screen facility at the proposed diversion location for NODOS.

In July 2008, DOE prepared an addendum amending the August 2003 *Feasibility Study Report*. The addendum updated the costs of the pumping/generating plants for pumping capacities of 1,500 and 2,000 cubic feet per second (cfs), and a complete site plan of the pumping/generating plant, in concert with CH2M HILL's updated *Fish Screen Facility Study*.

In September 2008, URS prepared the *NODOS Plan Formulation Report* (PFR) for Reclamation, describing the formulation, evaluation, and comparison of initial alternatives plans that address NODOS Investigation planning objectives.

1.2 Proposed Alternatives

In early 2011, the Reclamation and DWR Project Team (Team) met to discuss and review 19 storage and conveyance options being evaluated for NODOS. Based upon the meeting, the Team selected three of the options to be the alternatives carried forward for detail evaluation in the NODOS Environmental Impact Report/Environmental Impact Statement. Table 1-1 outlines key aspects of these alternatives.

Table 1-1. Proposed NODOS Project Alternatives

	Alternative		
	A	**B**	**C**
Screening Study Identifier	R12C3	R18C3 (No Pump)	R18C3
Storage Capacity			
Sites Reservoir	1.27 MAF	1.81 MAF	1.81 MAF
Conveyance Capacities To Sites Reservoir			
Tehama-Colusa Canal	2,100 cfs	2,100 cfs	2,100 cfs
Glenn-Colusa Canal	1,800 cfs	1,800 cfs	1,800 cfs
Delevan Pipeline	2,000 cfs	0 cfs	2,000 cfs
Conveyance Capacities from Sites Reservoir			
Delevan Pipeline	1,500 cfs	1,500 cfs	1,500 cfs

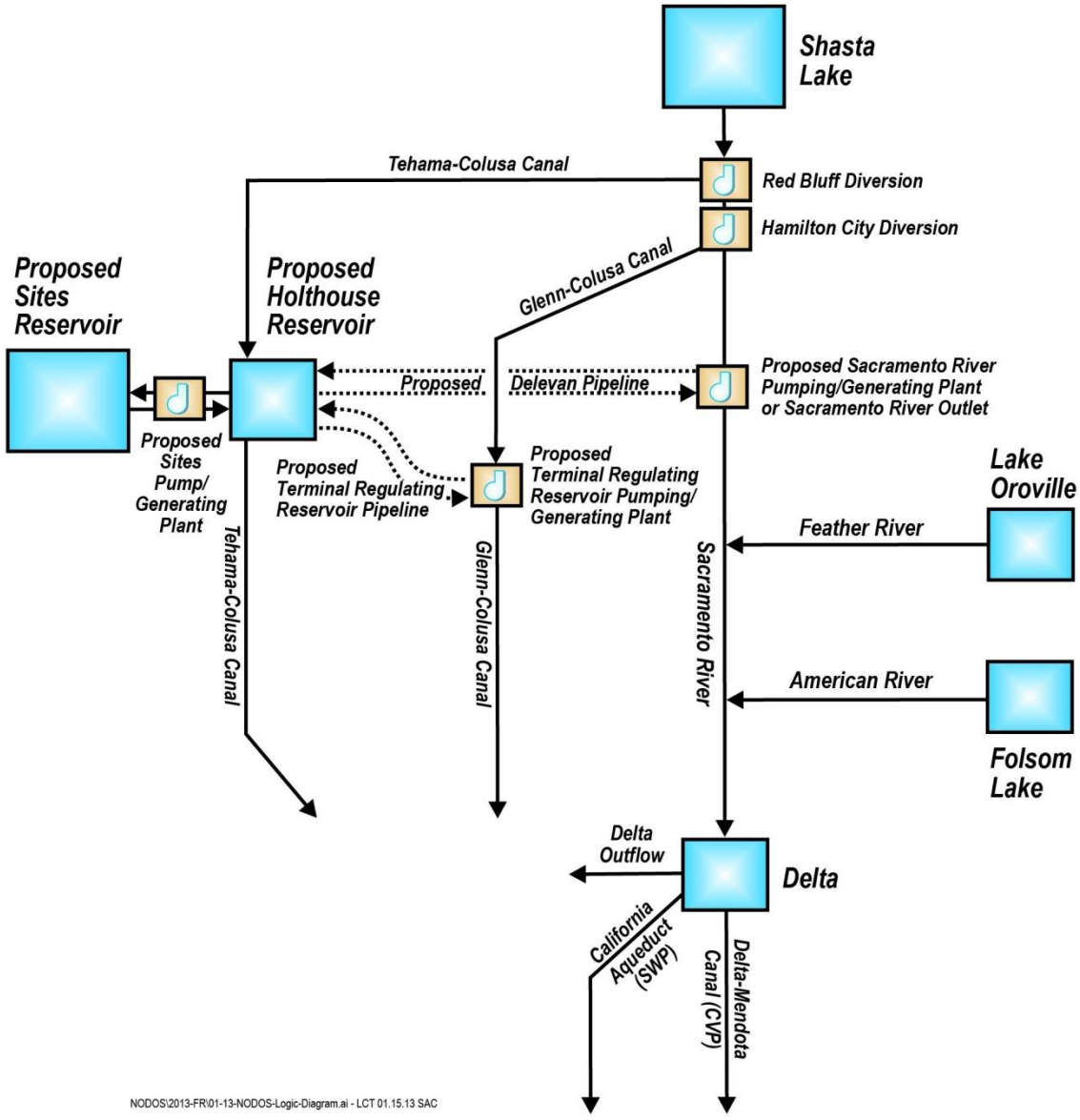
cfs = cubic feet per minute
MAF = million-acre feet

1.3 Project Description

Figure 1-1 is a schematic representation of the principal components of the proposed NODOS Project showing direction of flow, and storage volumes. Most of the facilities shown are common to all three project alternatives currently under consideration. The proposed project would include water conveyance from the Sacramento River through existing, expanded, or new facilities and water storage in the Sites Reservoir. Water would be diverted to Sites Reservoir from the Sacramento River, primarily in winter months. The stored water would be released from Sites Reservoir in summer months to deliver water to local water users through existing facilities such as the GCID and T-C Canal, or to return water to the Sacramento River using a new conveyance system. Water would be provided from Sites Reservoir in exchange for water that otherwise would have been released from Shasta Lake. The

exchanged water would then remain in Shasta Lake for beneficial use later in the summer. Shasta Lake water could help cool the upper river for fishery maintenance purposes, and be used downstream for agricultural, environmental, and urban purposes.

Figure 1-1. NODOS Project – Schematic Layout



Sites Reservoir would be located approximately 10 miles west of Maxwell, California. The reservoir would be formed by constructing Sites Dam approximately 290 feet high on Stone Corral Creek and Golden Gate Dam approximately 310 feet high on Funks Creek. Sites Dam would range in height from 290 feet for the

1.81-MAF reservoir to 250 feet for the 1.27-MAF reservoir. Golden Gate Dam would range in height from 310 feet for the 1.81-MAF reservoir to 270 feet for the 1.27-MAF reservoir. Nine saddle dams ranging up to 130 feet high would also be built along the reservoir's northern boundary for the 1.81-MAF reservoir. Six saddle dams would be required for the 1.27-MAF reservoir.

The proposed Sites Reservoir water control features (appurtenances) include water intake and outlet structures, the Sites Pumping/Generating Plant (SPGP) located downstream of the Golden Gate Dam site on Funks Creek, and an emergency signal spillway located at Saddle Dam 6. Sites Dam and Golden Gate Dam would have low-level outlet works capable of releasing stream maintenance flows into Stone Corral Creek and Funks Creek after construction is completed. These low-level outlet works will be incorporated as permanent facilities in the creek diversion systems installed at both dam sites to pass winter storm runoff through the construction sites.

Presently, the existing 40-foot-high Funks Dam forms a 2,250-AF reservoir 1 mile downstream of the Golden Gate Dam site. This reservoir was constructed by Reclamation and is part of the T-C Canal system. Funks Reservoir serves as a re-regulating reservoir to stabilize flows in the canal below Funks Reservoir as diverters come online and offline. The existing Funks Reservoir will be expanded to form the Holthouse Reservoir by constructing a new dam and reservoir to the east and breaching the existing Funks Dam so that the new and existing reservoirs act as one unit with an enlarged active storage capacity of approximately 6,500 AF. In addition to facilitating water inflow and outflow water management, the additional capacity provided for pump-back storage would enhance project power generation, particularly during daily on-peak periods. Holthouse Reservoir would serve as a forebay/afterbay to the SPGP. Water diverted from the Sacramento River to fill Sites Reservoir would pass through Holthouse Reservoir.

Development of Sites Reservoir with a diversion capability from the Sacramento River would require at least:

- Minimal modification of the T-C Canal and GCID Canal intakes.

- Construction of a terminal regulating reservoir and pumping/generating plant on the GCID Canal.

- Inter-connection from the GCID Canal to the T-C Canal.

- Construction of the proposed Sacramento River Pumping/Generating Plant for Project Alternatives A and C, which would divert up to 2,000 cfs from the Sacramento River, through a new pipeline. Project Alternative B would not include Sacramento River pumping as a project feature, but seasonal releases would still be made back to the Sacramento River through the Delevan Pipeline.

Winter flows diverted into these canals and pipeline would be conveyed into Holthouse Reservoir and then pumped into Sites Reservoir. These modified or new facilities would allow winter diversions of water from the Sacramento River when downstream criteria are met. Total diversion capacity from the Sacramento River for the currently proposed source and conveyance alternatives would not exceed

5,900 cfs for Alternatives A and C, or 3,900 cfs for Alternative B with no Sacramento River pumping.

When water is released from Sites Reservoir, it would be routed through reversible pump-turbine-generators to generate clean hydroelectric power. These releases could help offset energy costs associated with pumping and provide firm power to support wind and solar generation. Holthouse Reservoir is sized to provide approximately 6 hours per day of on demand generation during peak power periods.

As currently envisioned, water would be pumped on a seasonal basis into Sites Reservoir during periods of relatively lower energy cost and released through the hydroelectric generation facilities during times of higher energy value. Volume regulation would occur in Holthouse Reservoir on a daily basis. Pumping and release would each take place approximately five months a year. During the approximately two months per year that water is not stored or released to accomplish major project goals, daily pump-back operations potentially would be performed to enhance the peak power generating capability to help offset the power usage and provide some ancillary power benefits to enhance the reliability of California's electric grid. This would also increase the economic return on the project without losing control of the water impounded by Sites Reservoir.

Table 1-2 summarizes the major features of the NODOS alternatives.

1.4 Organization

Chapter 2 of this report presents the NODOS Project settings, and a summary of the geotechnical investigation conducted for the project. Chapter 3 discusses project design considerations to date. Chapter 4 presents the summary of preliminary cost estimates for the three NODOS Project alternatives. Chapter 5 compares the preliminary annual benefits and costs of the three NODOS Project alternatives.

Table 1-2. Summary of the Major Features of the NODOS Alternatives

Facility	Feature	Alternative A	Alternative B	Alternative C
Sites Reservoir	Gross Storage Capacity Water Surface Elevation Dam Crest Elevation Minimum Operating Pool Inundation Area (approximate) Inlet/Outlet Type	1.27 MAF 480 feet msl 500 feet msl 320 feet msl 12,500 acres Multi-level inlet/outlet tower A low-level inlet/outlet structure	1.8 MAF 520 feet msl 540 feet msl 320 feet msl 14,000 acres Multi-level inlet/outlet tower A low-level inlet/outlet structure	1.8 MAF 520 feet msl 540 feet msl 320 feet msl 14,000 acres Multi-level inlet/outlet tower A low-level inlet/outlet structure
Golden Gate Dam (Sites Reservoir)	Location Type Crest Length Maximum Height Embankment Volume	Funks Creek Earth/Rockfill Embankment 1,450 feet 260 feet 5,987,000 cubic yards	Funks Creek Earth/Rockfill Embankment 2,120 feet 310 feet 10,590,000 cubic yards	Funks Creek Earth/Rockfill Embankment 2,120 feet 310 feet 10,590,000 cubic yards
Sites Dam (Sites Reservoir)	Location Type Crest Length Maximum Height Embankment Volume	Stone Corral Creek Earth/Rockfill Embankment 725 feet 250 feet 2,853,000 cubic yards	Stone Corral Creek Earth/Rockfill Embankment 850 feet 290 feet 3,836,000 cubic yards	Stone Corral Creek Earth/Rockfill Embankment 850 feet 290 feet 3,836,000 cubic yards
Saddle Dams for Sites Reservoir	Location Type Saddle Dam Numbers	North End of reservoir from Funks Creek to Hunters Creek Earth/Rockfill Embankments 1, 6, 8b – <5 feet to 25 feet high 3, 5, 8a -50 feet to 85 feet high	North End of reservoir from Funks Creek to Hunters Creek Earth/Rockfill Embankments 1, 4, 9 -40 to 50 feet high 2, 3, 5, 6, 7, 8 - 70 to 130 feet high	North End of reservoir from Funks Creek to Hunters Creek Earth/Rockfill Embankments 1, 4, 9 -40 to 50 feet high 2, 3, 5, 6, 7, 8 - 70 to 130 feet high
Emergency Spillway (Sites Reservoir)	Location Diameter Inlet Elevation	Saddle Dam 6 7-foot RCP 486.5 feet (top of PMF storage)	Saddle Dam 6 7-foot RCP 525.5 feet (top of PMF storage)	Saddle Dam 6 7-foot RCP 525.5 feet (top of PMF storage)
Sites Reservoir Inlet/Outlet Works	Type Capacity Size	Multi-level Inlet Tower and Low-Level Outlet 23,000 cfs (emergency release) 30-foot-diameter concrete and steel-lined pressure tunnel	Multi-level Inlet Tower and Low-Level Outlet 23,000 cfs (emergency release) 30-foot-diameter concrete and steel-lined pressure tunnel	Multi-level Inlet Tower and Low-Level Outlet 23,000 cfs (emergency release) 30-foot-diameter concrete and steel-lined pressure tunnel
Sites Pumping/Generating Plant	Location Flow Capacity	Downstream from Golden Gate Dam 5,900 cfs pumping 5,100 cfs generating	Downstream from Golden Gate Dam 3,900 cfs pumping 5,100 cfs generating	Downstream from Golden Gate Dam 5,900 cfs pumping 5,100 cfs generating

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	Pumping Head Generating Capacity	295 feet 123 MW at 5,100 cfs	335 feet 123 MW at 5,100 cfs	335 feet 123 MW at 5,100 cfs

Table 1-2. (Continued)

Facility	Feature	Alternative A	Alternative B	Alternative C
Holthouse Reservoir	Maximum Height Max WSE Surface Area Total Capacity Remaining Storage	45 feet 205 feet msl 6,500 AF 6,500 AF	45 feet 205 feet msl 6,500 AF 6,500 AF	45 feet 205 feet msl 6,500 AF 6,500 AF
Delevan Pipeline from Sacramento River to T-C Canal	Flow Capacities Length Size From/To	2,000 cfs pumping 1,500 cfs releasing 13 miles Two 12-foot-diameter RCP Sacramento River to Holthouse Reservoir	No Pumping 1,500 cfs releasing 13 miles Two 12-foot-diameter RCP Sacramento River to Holthouse Reservoir	2,000 cfs pumping 1,500 cfs releasing 13 miles Two 12-foot-diameter RCP Sacramento River to Holthouse Reservoir
Sacramento River Pumping/Generating Plant	Location Flow Capacities Fish Screens Required	West side of Sacramento River, near Highway 45 2,000 cfs pumping 1,500 cfs releasing Yes	West side of Sacramento River, near Highway 45 No Pumping 1,500 cfs releasing No	West side of Sacramento River, near Highway 45 2,000 cfs pumping 1,500 cfs releasing Yes
TRR	Capacity Footprint Depth Maximum Embankment Height	2,000 AF 191 acres 17 feet 21 feet	2,000 AF 191 acres 17 feet 21 feet	2,000 AF 191 acres 17 feet 21 feet
TRR Pumping/Generating Plant	Location Capacity Pumping Head (Net) Generation	TRR Reservoir 1,890 cfs pumping 1,500 cfs generating 98 to 114 feet 9.8 MW	TRR Reservoir 1,890 cfs pumping 1,500 cfs generating 98 to 114 feet 9.8 MW	TRR Reservoir 1,890 cfs pumping 1,500 cfs generating 98 to 114 feet 9.8 MW
TRR Pipeline	Location Flow Capacities Length Size	TRR Reservoir 1,890 cfs pumping 1,500 cfs releasing 5 miles Two 12-foot-diameter RCP	TRR Reservoir 1,890 cfs pumping 1,500 cfs releasing 5 miles Two 12-foot-diameter RCP	TRR Reservoir 1,890 cfs pumping 1,500 cfs releasing 5 miles Two 12-foot-diameter RCP

Table 1-2. (Continued)

Facility	Feature	Alternative A	Alternative B	Alternative C
	From/To	TRR Reservoir to Holthouse Reservoir	TRR Reservoir to Holthouse Reservoir	TRR Reservoir to Holthouse Reservoir

AF = acre- feet
cfs = cubic feet per second
GCID = Glenn-Colusa Irrigation District
MAF = million acre-feet
msl = mean sea level
MW = megawatt
NODOS = North-of-the-Delta Offstream Storage
PFR = Plan Formulation Report
PMF = probable maximum flood
RCP = reinforced concrete pipe
T-C = Tehama-Colusa
TRR = Terminal Regulating Reservoir
WSE = water surface elevation
< = less than