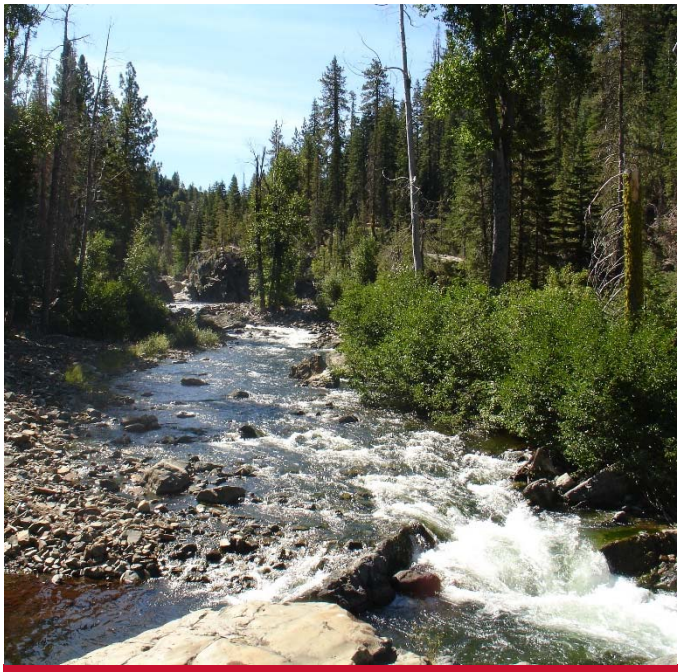


Water Supply Analysis TM

Nevada Irrigation District (NID)

August 26, 2020

NID

NEVADA IRRIGATION DISTRICT

Date: 8/25/2020

Sergio Jimenez, P.E.

HDR Engineering, Inc.

Civil Engineer, C55698

Expiration Date: December 31, 2020

Date: 8/25/2020

Megan Lionberger, P.E.

HDR Engineering, Inc.

Civil Engineer, C74543

Expiration Date: December 31, 2020

Contents

Figures

Tables

Appendices

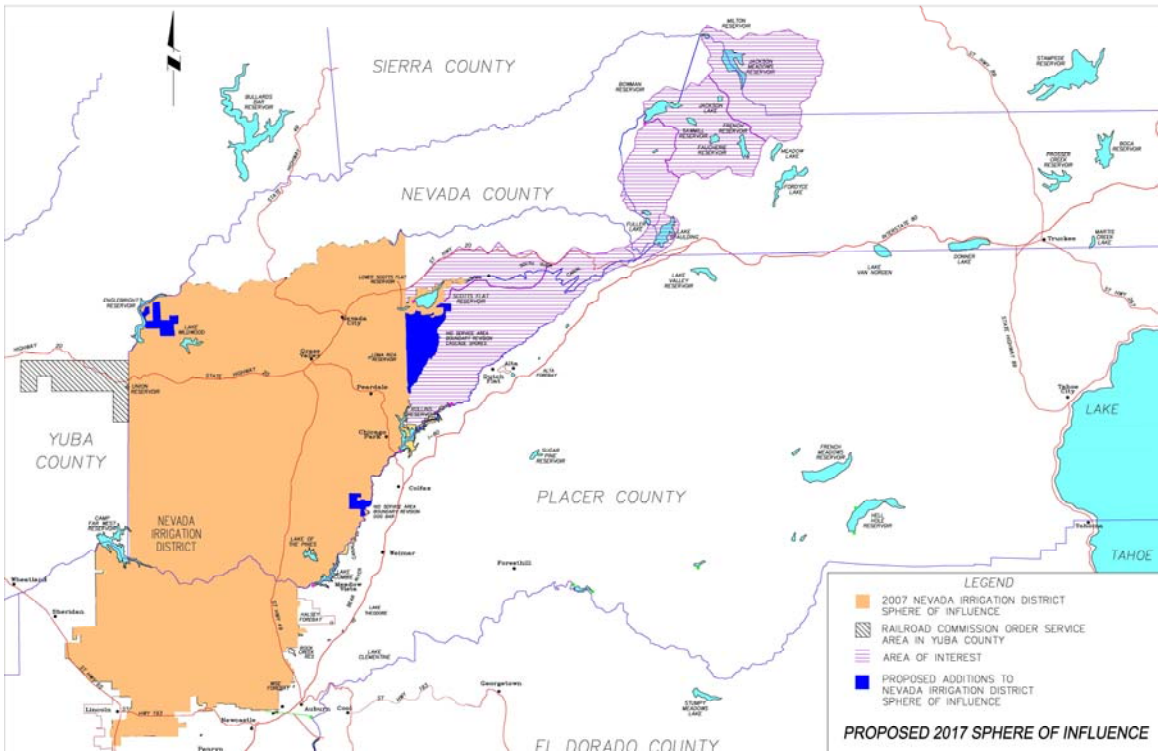
This page intentionally left blank.

1 Introduction

Nevada Irrigation District (NID) is an independent public agency that is governed by a five-member elected Board of Directors and employs approximately 200 full- and part-time employees. The District supplies water to nearly 25,000 homes, farms, and businesses in portions of Nevada, Placer and Yuba counties in the foothills of Northern California's Sierra Nevada. (Figure 1-1) Water is collected from mountain watersheds and stored in a system of reservoirs. As water flows to its customers in the foothills, it is used to generate clean, hydroelectric energy in excess of 354 gigawatt hours per year, to maintain environmental flows, and to provide public recreation opportunities. NID supplies both treated drinking water and raw water for irrigation. Approximately 90 percent of NID's annual demand is made up of raw water/agricultural demand during the irrigation season, April 15 – October 15 annually.

NID's water supply system is primarily a "store and release" system, in that reservoirs store snow melt and seasonal rains for release during the typically dry irrigation seasons. NID also has direct diversion water rights for the irrigation season in a number of tributaries. Based on the timing of seasonal precipitation events, NID's water supply management is dependent on a combination of springtime snowmelt and winter period rains to fill its storage reservoirs. While there is some natural runoff during the summer months, much of this water is required to meet necessary environmental flows in the rivers; therefore, the irrigation season demand is met primarily with withdrawals from storage reservoirs. Careful management and operation of storage reservoirs is essential to capture the maximum amount of runoff, minimize spillage from reservoirs, and ensure there is sufficient volume available in reservoirs to accommodate runoff during the spring snow melt and storm events.

Figure 1-1. Nevada Irrigation District Location Map



1.1 Water Supply Projection Update

NID regularly evaluates and updates its water supply availability projections. In the past, this was completed through the Raw Water Master Plan (RWMP), originally developed in 1985. The primary purpose of the RWMP was to assess the adequacy of the existing water storage and conveyance system to accommodate current and future water demand. Since 1985, the RWMP has been updated in two phases. The phase I update was completed in 2005 (Kleinschmidt et al. 2005), and the phase II update was completed in 2011 (Kleinschmidt Associates 2011).

NID's water supply comes from four main sources: natural runoff (including snowmelt) from the contributing watershed areas, reservoir carryover storage, contract water purchases, and recycled water. Events such as drought and climate change create imminent challenges for NID in maintaining a sustainable water supply system. According to NID's RWMP (Kleinschmidt Associates 2011), the margin between average watershed runoff volume and NID customer demand is diminishing. Increased future demands within NID's service area and increased environmental flows will result in increased demand on water storage and greater drawdown of NID's reservoirs, especially during summer months when there is little natural runoff.

The 2011 RWMP was based on projected 2032 water management practices. The following supply projection updates are needed to reflect current regulatory standards, climate change analyses, and anticipated operations:

- Expand the planning horizon to 50 years, to be consistent with other regional planning studies (Sustainable Groundwater Management Act and the 2018 California Water Plan Update)[1].
- Update customer demand projections to reflect the new planning horizon based on the updated demand model described in the Raw Water Demand Model Update TM.
- Utilize hydrologic impacts from climate change, which is expected to change the volume and timing of watershed runoff relative to existing conditions.
- Include new Federal Energy Regulatory Commission (FERC) license conditions, which will generally increase flow in rivers downstream of NID reservoirs for environmental benefit, resulting in less available water to meet NID customer demand.
- Include new long-term water purchase agreement with Pacific Gas and Electric (PG&E).
- Expand the extreme drought water supply analysis from 3 years to 5 years, per Executive Order SB-37-16(8).

1.2 Goals and Objectives

The goal of this study is to update and present the water supply projections. This study will present projections for future water supply under critical drought scenarios within the service areas for NID. In February 2018, HDR prepared a memorandum (Appendix A) summarizing updated assumptions for water supply projections. The work in this technical memorandum builds upon that analysis, with the work completed in the Hydrologic Analysis TM (HDR, 2020a) and Raw Water Demand Model Update TM (HDR, 2020b).

2 Projected Water Supply

The State of California is developing new guidelines to define a 5-year drought in their 2020 update to the Urban Water Management Plan (UWMP) guidebook. At the time this TM is being written, these guidelines are not yet available to the public. In anticipation of this new requirement, water supply for a 5-year drought has been developed, based on the best available information to NID, which includes climate change projections, This section summarizes the process used to develop the projected 5-year drought water supply for NID in 2070 utilizing the following methodology and assumptions.

[1] There is not a strict rule on planning horizons, although Integrated Regional Water Management Plans and Urban Water Management need “at least” 20 years. The Sustainable Groundwater Management Act (SGMA) stipulates that the planning and implementation horizon is a **50-year time period** over which (groundwater sustainability) plans and measures will be implemented in a basin to ensure that the basin is operated within its sustainable yield. Other related plans have followed suit, such as the 2018 California Water Plan Update. The new 2020 guidelines for UWMPs are expected to be released in the summer of 2020.

2.1 Watershed Runoff

Unimpaired flow is defined as the hydrologic response of watershed basins with no influence (i.e., regulation) of stream flow by man-made structures such as dams or diversions. Quantification of unimpaired flow is important because it is used to estimate watershed runoff. Watershed runoff is the largest contributor to NID's water supply (Kleinschmidt Associates 2011).

HDR prepared historical unimpaired hydrology data and modeling tools developed for the joint FERC relicensing of NID's Yuba-Bear Hydroelectric Project (FERC Project Number 2266) and PG&E's Drum-Spaulding Hydroelectric Project (FERC Project Number 2310). These data and tools were accepted by FERC, other state and federal agencies, and non-governmental organizations to adequately represent historical conditions within the two hydroelectric project areas and were used to evaluate impacts to water resources as a result of potential operations and facilities modifications during the relicensing process.

Following completion of the historical unimpaired hydrology data set developed during the 2008 FERC relicensing, as part of the current supply projection update study, HDR updated these data to transform the historical unimpaired hydrology data set to represent projected conditions in 50 years (2070) as a result of three climate change scenarios. The three climate change scenarios are:

- Median climate change conditions, based on 20 global climate models (GCMs) and representative concentration pathway (RCP) combinations;
- Drier/extreme-warming (DEW) conditions, representing a pessimistic trajectory of greenhouse gas emissions throughout this century; and
- Wetter/moderate-warming (WMW) conditions, representing an optimistic trajectory of greenhouse gas emissions throughout this century.

Hydrologic projections for future conditions representative of year 2070 were developed using simulated historical and projected runoff from the Variable Infiltration Capacity (VIC) model (Liang et al., 1994) to translate historical unimpaired hydrology, developed during the 2008 FERC relicensing, into projected unimpaired hydrology. VIC model runoff predictions for water years 1976 through 2011 were provided by the California Water Commission (CWC, 2016). A full description of the hydrologic data and methods used to develop the 2070 projection of unimpaired hydrology are presented in the Hydrologic Analysis TM (HDR, 2020a).

Current DWR guidelines require urban water suppliers to submit a multiple-dry year drought assessment of three or more years (DWR 2016). Under Executive Order SB-37-16, urban water suppliers will now be required to submit a five-year drought risk assessment[2]. The study region has not experienced a continuous five-year drought during the available 1976 through 2011 period of record; however, there are a number of dry years that can be juxtaposed to simulate a hypothetical five-year drought.

Annual runoff of the projected 2070 unimpaired hydrology was quantified as the watershed runoff in watersheds where NID has water rights (Middle Yuba River, South

[2] Guidelines are not yet available from the State of California to define the annual assessment methodology for a five-year drought.

Yuba River, Bear River, Deer Creek, Wolf Creek, Coon Creek, and Auburn Ravine). Watersheds were generally grouped into two categories:

- Watersheds with storage reservoirs that can capture runoff year-round.
- Watersheds without storage reservoirs that divert runoff during the irrigation season (April 16-October 15).

It was assumed that year-round runoff was able to be stored in watersheds with storage reservoirs within NID's water rights[3] and was quantified in the annual runoff volume as runoff over the entire year. In watersheds without storage reservoirs, only runoff occurring during the irrigation season was quantified in the annual runoff volume calculation. Not all runoff is available for use by NID. Some runoff is used to meet environmental flow requirements below NID facilities, or is lost to spill when NID reservoirs are full. Annual runoff was not adjusted to account for either.

To simulate watershed runoff conditions for a five-year drought the five driest water years were placed back to back and ordered from wettest to driest, based on their annual runoff volume: 1994, 1987, 1988, 1976 and 1977.

2.2 Carryover Storage

Carryover storage is stored water in NID reservoirs held in reserve for droughts or for emergency supply to avoid water shortages, and to meet environmental flow requirements. Reservoir carryover storage is the second largest source of water supply available to NID to meet customer demand (Kleinschmidt Associates 2011). Carryover storage is the water remaining in reservoir storage at the end of the irrigation season, around October 15.

Carryover storage is likely to change relative to historical conditions because of increased environmental flow requirements (Table 2-1) and changes in the timing and magnitude of reservoir inflows resulting from climate change (Dettinger et al., 2018). The HEC-ResSim reservoir operations model, described in the Hydrologic Analysis Technical Memorandum (HDR 2020a), was run to simulate reservoir conditions with 2070 median climate change hydrology (HDR 2020a), anticipated FERC license conditions (minimum flow requirements), and 2060 projections of customer demand (HDR, 2020b). Based on model output, the average annual carryover storage for Water Years 1976 through 2011 was 87,520[4] acre-feet (ac-ft), 30,073 ac-ft less than the historical baseline model scenario.

[3] PG&E has water rights to the first 350 cfs of natural Bear River inflow to Rollins Reservoir.

[4] Carryover does not include 9,218 ac-ft of unusable storage (HDR, 2020a). Unusable storage is the volume within a reservoir that cannot be drained by gravity through a dam's outlet works or a regulatory minimum-pool requirement.

Table 2-1. Non-recoverable environmental flow requirements below NID facilities (FERC, 2014).

Environmental Flow Requirement	Water Year Type	Non-Recoverable Environmental Flow Volume (ac-ft)
Existing	All Years	7,600
Projected	Wet	59,800
	Above Normal	51,800
	Below Normal	42,000
	Dry	27,900
	Critically Dry	22,700
	Extremely Critically Dry	16,400

Assuming an average annual carryover storage (87,520 ac-ft) beginning in year 1, carryover storage can be calculated for sub-sequent years of the theoretical 5-year drought using mass balance as the previous year's available carryover storage[5] plus the previous year's inflows (watershed runoff, PG&E contract purchases, and recycled water) minus outflows (water supplied to customers, and non-recoverable environmental flows). Based on the 2015 NID drought management plan (Appendix B), the drought action stage was determined for each year of the 5-year drought based on the projected supply. Demand reduction targets provided by the drought contingency plan were applied to projected 2060 demands to determine the annual demand after reduction. Environmental flow requirements are firm demands that cannot be reduced. Carryover storage was calculated as the difference between the annual supply, and annual demand with reduction. Results are presented below in Section 3.

2.3 Contract Purchases

Contract purchases between NID and PG&E are dictated by long-term consolidated contracts. For this analysis, contract purchase assumptions are based on the Coordinated Operations Agreement between PG&E and NID (NID 2018). In an average year, contract purchases are projected to be 7,500 ac-ft per year. For the 5-year drought scenario in this analysis, contract purchases were estimated based on Appendix B of the Coordinated Operations Agreement.

2.4 Recycled Water

The most up to date projection of municipal recycled water is available from the 2015 Urban Water Management Plan (UWMP) (NID 2016). Table 5-4 of the UWMP provides projections of recycled water every 5 years from 2015 to 2040. A value of 5,275 ac-ft for 2070 was obtained by extending the UWMP values to 2070.

[5] Carryover does not include 9,218 ac-ft of unusable storage. Unusable storage is the volume within a reservoir that cannot be drained by gravity through a dam's outlet works or a regulatory minimum-pool requirement.

3 Conclusion

The 2070 total water supply during a 5-year drought is shown in Table 3-1. All components of NID's total water supply drop throughout the 5-year drought except the recycled water estimate, which is a small contribution to the total water supply. Carryover storage drops to essentially zero after the first two years, contributing to a greater than 85% overall reduction of supply at the end of the 5-year hypothetical drought.

Table 3-1. Summary of 2070 5-Year Drought Water Supply.

Analysis Variable	Avg. Year	Hypothetical 5-Year Drought				
		1994	1987	1988	1976	1977
Watershed Runoff (ac-ft) [1]	383,500	101,350	97,200	95,250	85,500	38,300
Available Carryover Storage (ac-ft) [2,3]	87,500	87,500	25,126	1,289	0	0
Contract Purchases from PG&E (ac-ft) [4]	7,500	37,300	31,800	30,300	27,500	26,200
Recycled Water (ac-ft) [5]	5,300	5,300	5,300	5,300	5,300	5,300
Total Supply (ac-ft) [6]	***483,800***	***231,450***	***159,426***	***132,139***	***118,300***	***69,800***
Environmental Flow Requirement (ac-ft)	46,200	31,100	24,700	24,000	23,200	16,400
Total Demand Before Reduction (ac-ft)	255,136	240,036	233,636	232,936	232,136	225,336
Drought Action Stage	-	I	IV	IV	IV	IV
Drought Demand Reduction	0%	20%	40%	50%	50%	50%
Total Demand with Reduction (ac-ft)	255,136	206,324	158,137	132,506	127,668	120,868
Shortage With Reductions & Contract Purchases (ac-ft)	0	0	0	-367	-9,368	-51,068

1 Average historical watershed run-off based on results of the Hydrologic Analysis TM under median climate change conditions, per NID water rights.
2 Projected storage is usable storage (carry over storage minus 9,218 ac-ft dead storage) based on FERC FEIS minimum flows, 2060 projected demands from the Raw Water Demand Model Update, and 2070 median climate change hydrology developed in the Hydrologic Analysis TM.
3 Carryover storage represents conditions at beginning water year and is calculated as the previous year's carryover storage plus the previous year's total supply minus the previous year's total demand with reduction.
4 Estimates based on Appendix B of the Coordinated Operations Agreement. Availability is subject to hydrologic conditions.
5 Projected municipal recycled water supply from 2015 UWMP.
6 Total supply is equal to watershed runoff + available carryover storage + contract purchases from PG&E + recycled water.

4 References

California Department of Water Resources (DWR), 2015 Urban Water Management Plans Guidebook for Urban Water Suppliers, Final, March 2016.

California Water Commission (CWC). 2016. Technical Reference, Water Storage Investment Program, November 2016.

Dettinger, Michael, Holly Alpert, John Battles, Jonathan Kusel, Hugh Safford, Dorian Fougeres, Clarke Knight, Lauren Miller, Sarah Sawyer. (United States Geological Survey). 2018. Sierra Nevada Summary Report. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-004.

Federal Energy Regulatory Commission (FERC). 2014. Final Environmental Impact Statement for Hydropower License. Upper Drum-Spaulding Hydroelectric Project, Project No. 2310-193 – California. Lower Drum Hydroelectric Project, Project No.14531-000 – California. Deer Creek Hydroelectric Project, Project No. 14530-000 – California. Yuba-Bear Hydroelectric Project, Project No. 2266-102 – California. FERC/EIS-F-0244. December 2014

HDR. 2020a. Hydrologic Analysis Technical Memorandum. March 2020.

HDR. 2020b. Raw Water Demand Model Update. March 2020.

Kleinschmidt, West Yost & Associates, and Robertson-Bryan, Inc. (NID). 2005. Nevada Irrigation District Raw Water Master Plan Update, Phase 1. September 2005.

Kleinschmidt Associates. 2011. Nevada Irrigation District Raw Water Master Plan Update, Phase 1. December 2011.

Liang, X., D. P. Lettenmaier, E. F. Wood, and S. J. Burges. 1994, A Simple Hydrologically Based Model of Land Surface Water and Energy Fluxes for General Circulation Models, Journal of Geophysical Research, 99, 14,415–14,428, doi:10.1029/94JD00483.

NID. 2016. Urban Water Management Plan. June 2016.

NID. 2018. Coordinated Operations Agreement Between Nevada Irrigation District and Pacific Gas and Electric Company. August 2018.

.

Appendix A. Updated 2032 Projected Water Supply Deficits Under Extreme Hypothetical Drought

Appendix B. NID Drought Management Plan