Russian River Hydrologic Modeling for the Fish Habitat Flows and Water Rights Project

August 2016

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Suggested Reference

Sonoma County Water Agency. 2016. Russian River Hydrologic Modeling for the Fish Habitat Flows and Water Rights Project. August 2016.

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Attachment 3: Proposed Project Scenario
Attachment 4: Model Results, Cumulative 1 Scenario
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Attachment 6: Model Results, Cumulative 3 Scenario
Attachment 7: Model Results, Cumulative 4 Scenario

1 Introduction

1.1 Purpose and Scope

This report describes the numerical modeling completed to support the environmental impact analysis of the *Fish Habitat Flows and Water Rights Project* (Fish Flow Project) *Draft Environmental Impact Report* (EIR) (SCWA, August 2016). To complete this analysis, a system of numerical models was developed that simulates hydrologic and water quality conditions in the Russian River and Dry Creek from the Potter Valley Project (PVP) to the United States Geologic Survey (USGS) streamflow gaging station 11467000, Russian River near Guerneville (Hacienda Gage), located at the Hacienda Bridge.

1.2 Model Overview

A system of numerical models was used to support the environmental impact analysis of the Fish Flow Project EIR. These models include:

- Russian River ResSim (RR ResSim) a reservoir operations model developed with the Hydrologic Engineering Center (HEC) ResSim software;
- Eel River 2.5 (ER2.5) a system operations model of the Potter Valley Project on the Eel River, which was originally developed by Natural Resources Consulting Engineers (Oakland, CA) and refined by the Water Agency in 2015; and
- Russian River HEC-5Q (RR HEC5Q), a water quality model develop using the Resource Management Associates (RMA) HWMS software.

This system of models was developed to simulate the water supply operations of Lake Mendocino and Lake Sonoma and flow and water quality conditions at multiple locations (model junctions) along the Russian River and Dry Creek on a daily time step. System conditions were analyzed for historical hydrology from 1910 to 2013. System water gains incorporated into the model include diversions from the Eel River through Pacific Gas and Electric's (PG&E) PVP, and unimpaired flows[1] from rainfall runoff and groundwater discharges. System water losses incorporated into the model include (1) lake evaporation, (2) surface-water diversions, (3) losses due to riparian vegetation and (4) losses resulting from surface water/groundwater interactions. Twenty-eight minimum instream flow alternatives were evaluated using this system of models. These alternatives are discussed in further detail in the Fish Flow Project EIR (SCWA, August 2016).

[1] Unimpaired flows are the "natural" flows, unaffected by man-made influences, like water diversions, and reservoir operations.

2 Background

2.1 Russian River System

There are two major reservoirs that affect flows in the Russian River Watershed, Lake Mendocino and Lake Sonoma. The Water Agency makes releases from Lake Mendocino, located in the upper watershed near Ukiah, into the Russian River to meet minimum instream flow requirements and downstream water demands for the Upper Russian River, a 63-mile stretch of the Russian River to the confluence of Dry Creek. The Water Agency makes releases from Lake Sonoma, located in the lower watershed, into Dry Creek to meet minimum instream flow requirements and downstream demands for a 14-mile stretch of Dry Creek to the confluence of the Russian River, as well for the 31-mile stretch of the Russian River from the confluence of Dry Creek to the Pacific Ocean near Jenner. The Water Agency diverts water from the Russian River at its Wohler and Mirabel diversion facilities located near the town of Forestville. The Russian River also receives trans-basin imports from the Eel River through the PVP, a hydroelectric facility owned and operated by PG&E. Imports from the PVP are released into the upper reach of the East Fork Russian River approximately 12 miles upstream of Lake Mendocino.

2.1.1 System Reaches

The Russian River System is divided into three primary reaches:

1. The Upper Russian River is approximately 63 miles long and extends from Coyote Valley Dam to the confluence of Dry Creek;
2. The Lower Russian River is approximately 31 miles long and extends from the confluence of Dry Creek to the confluence with the Pacific Ocean near Jenner; and
3. Dry Creek is approximately 14 miles long and extends from Warm Springs Dam to the confluence of the Russian River.

Figure 2-1 provides a schematic of the Russian River System with the reach extents indicated.

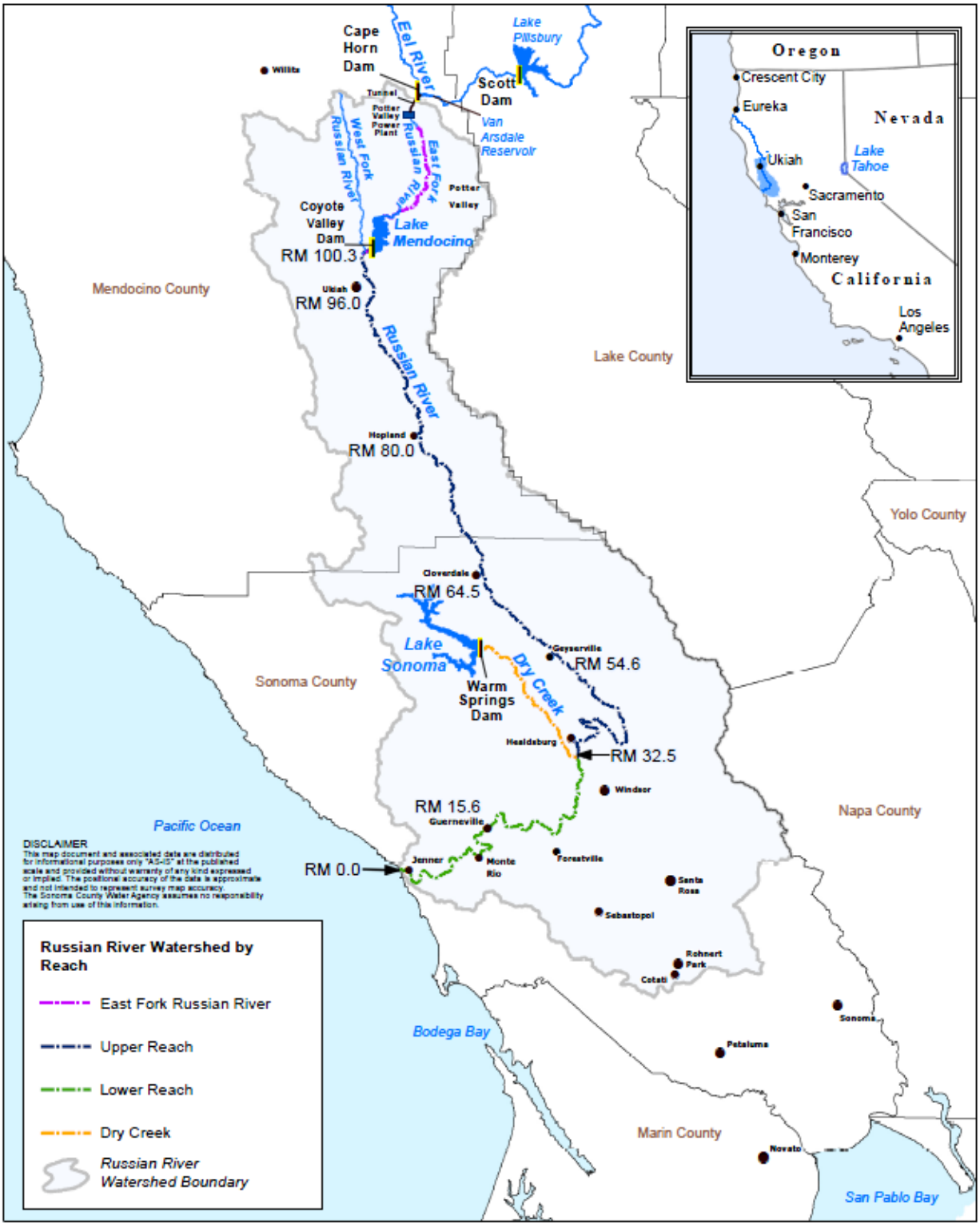

Figure 2-1. Map of the Russian River watershed including the Potter Valley Project.

2.1.2 Climate

The Russian River drains a watershed of approximately 1,485 square miles in the Coast Ranges north of San Francisco. Climate in the Russian River watershed is influenced by the watershed's proximity to the Pacific Ocean. As with much of the California coastal area, the year is divided into wet and dry seasons. Approximately 93 percent of the annual precipitation normally falls during the wet season, October to May, with a large percentage of the rainfall typically occurring during three or four major winter storms. These major storms often come in the form of an Atmospheric River, which is the horizontal transport of large amounts of water vapor through the atmosphere along a narrow corridor. Although brief, Atmospheric Rivers can produce 30-50% of the regions, annual precipitation during a few days (http://www.esrl.noaa.gov/psd/atmrivers/). Winters are cool, and below-freezing temperatures seldom occur, and summers are warm and dry. A significant part of the region is subject to marine influence and fog intrusion. Prevailing winds are from the west and southwest.

Climatic conditions vary across different portions of the watershed. As shown in Figure 2-2, average annual precipitation is as high as 80 inches in the mountainous coastal region of the watershed, and 20 to 30 inches in the valleys where the majority of the water users are located. Precipitation can also vary significantly from season to season, which can result in a large amount of variability in flows in the Russian River. Based on historical estimates of unimpaired flow developed by the USGS (Section 3.1.1), the estimated annual unimpaired flow at the Hacienda Gage has ranged from a low of approximately 66,000 acre-feet in 1977 to a high of 3,884,000 acre-feet in 1983, with an average of 1,479,000 acre-feet per year (AFY) and a standard deviation of 861,000 AFY (USGS, 2016).

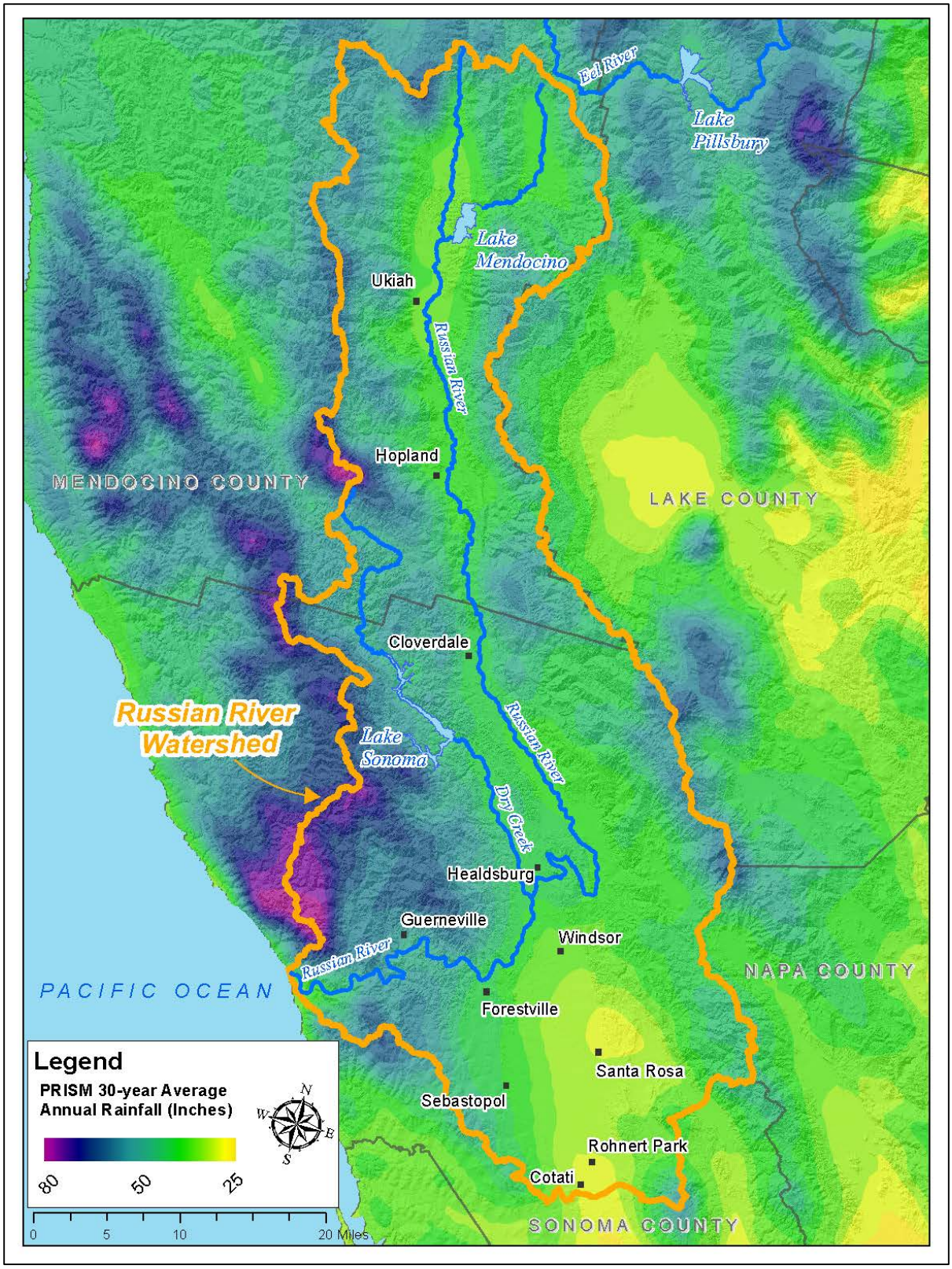

Figure 2-2. 30-year average annual rainfall for the Russian River watershed.

2.1.2.1 Flow Monitoring

The USGS monitors flow along the mainstem of the Russian River and Dry Creek. The USACE monitors flow just downstream of the controlled release outlet structures of Coyote Valley Dam and Warm Springs Dam. Real time data collected from these gages are used extensively by dam operators to inform both flood and water supply operations. Analysis of these data, especially for the long standing gages prior to 2000, were used to support the development of the models described in this report and the environmental impact analysis of the Fish Flow Project EIR. A list of USGS and USACE gages along the mainstem of the Russian River and Dry Creek is provided in Table 2-1 which includes the abbreviated names used to refer to some of these gages throughout this report.

Table 2-1 USGS and USACE streamflow gages along the Upper and Lower Russian River and Dry Creek reaches with abbreviations used in text and owner ID numbers.

Gage ID	Gage Name	Gage Abbreviation	Owner	Reach
COY	Coyote Valley Dam Gage	-	USACE	Upper River
11461000	RR near Ukiah	West Fork Gage	USGS	Upper River
11461500	RR near Calpella	Calpella Gage	USGS	Upper River
11462080	RR near Talmage	-	USGS	Upper River
11462500	RR near Hopland	Hopland Gage	USGS	Upper River
11463000	RR near Cloverdale	Cloverdale Gage	USGS	Upper River
11463500	RR at Geyserville	-	USGS	Upper River
11463682	RR at Jimtown	-	USGS	Upper River
11463980	RR at Digger Bend near Healdsburg		USGS	Upper River
11464000	RR near Healdsburg	Healdsburg Gage	USGS	Upper River
WRS	Warm Springs Dam Gage	-	USACE	Dry Creek
11465200	Dry Creek near Geyserville	Dry Creek Geyserville Gage	USGS	Dry Creek
11465240	Dry Creek below Lambert Bridge	-	USGS	Dry Creek
11465350	Dry Creek near Mouth near Healdsburg	Dry Creek Mouth Gage	USGS	Dry Creek
11465390	RR near Windsor	-	USGS	Lower River
11467000	RR near Guerneville	Hacienda Gage	USGS	Lower River

2.1.3 Potter Valley Project

In 1908, the W. W. Van Arsdale and the Eel River Power & Irrigation Company (later the Snow Mountain Power Company) completed construction of Cape Horn Dam and Van Arsdale Reservoir on the Eel River in Mendocino County, along with a diversion tunnel (Tunnel) that leads from the Eel River, through the mountains, to the East Fork Russian River. Since then, the 450-foot drop in elevation between the Eel River and the East Fork Russian River has been used to generate electrical energy at the Potter Valley Powerhouse, which is located approximately 25 miles northeast of the City of Ukiah. The powerhouse has a capacity of 9.4 megawatts.

In 1921, Scott Dam was constructed on the Eel River approximately 10 miles upstream of Cape Horn Dam, forming Lake Pillsbury. Scott Dam is a concrete gravity dam that captures runoff from a drainage area of 298 square miles. Lake Pillsbury has a gross storage capacity of 74,993 acre-feet, and a surface area of 2,280 acres at the maximum pool elevation. Bathymetric surveys of Lake Pillsbury were completed in 1959, 1984, 2006 and 2015 to estimate reservoir

capacity. A sedimentation rate of approximately 253 AFY has been estimated from the survey information.

Scott Dam has two primary methods for releasing water downstream: 1) by spilling water over a concrete weir at the top of the dam, and 2) through a controlled outlet through the base of the dam called the Needle Valve. Storage capacity of the reservoir to the crest of the weir is approximately 54,000 acre-feet. The dam also has steel radial gates that are lowered in the spring, which increases the maximum storage capacity to 74,993 acre-feet. The date on which the radial gates are lowered each year is contingent on the results of an annual snow survey conducted in the spring, and therefore varies from year to year. When water is not spilling over the concrete weir, reservoir releases are controlled through the Needle Valve. A portion of the water released from Lake Pillsbury to the Eel River is re-diverted downstream at Cape Horn Dam to the Potter Valley Powerhouse through a diversion tunnel and penstocks.

Scott Dam, Lake Pillsbury, Cape Horn Dam, the diversion Tunnel, and the Potter Valley Powerhouse are the primary facilities of the PVP. A map of these facilities is provided in Figure 2-3. The PVP was purchased by PG&E in 1929 and PG&E operates the facility today under a license issued by the Federal Energy Regulatory Commission (FERC). PG&E operates the PVP according to the requirements of the 2004 amended FERC license (FERC, 2004), which is detailed in Appendix A of the FERC license, the NOAA Fisheries' Reasonable and Prudent Alternative (NMFS RPA). The "Flow Regulation and Verification Plan" developed by PG&E in 2006 provides additional details on operational measures for compliance with and verification of flow requirements of the NMFS RPA. The operation of the PVP by PG&E under its FERC license is independent of the Water Agency's operations of Coyote Valley Dam (CVD). PG&E schedules releases from Lake Pillsbury to meet minimum instream flow requirements in the Eel River and to provide water for diversions through the Tunnel to the Potter Valley Powerhouse. Eel River flows diverted through the Potter Valley Powerhouse and not diverted by the Potter Valley Irrigation District (PVID) are released into the East Fork Russian River.

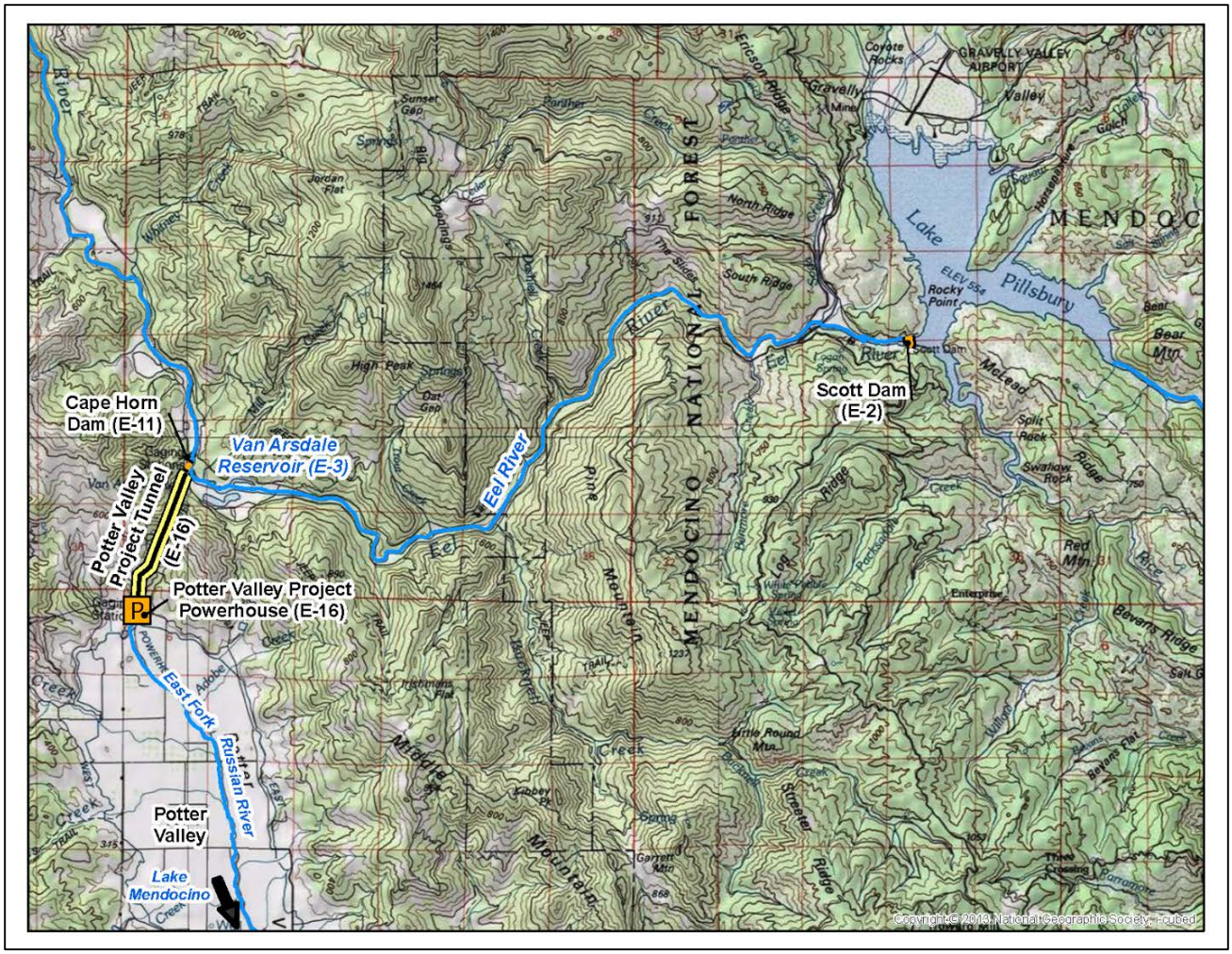

Figure 2-3. Map of the Potter Valley Project

A portion of the annual water year storage in Lake Pillsbury is reserved to benefit downstream fisheries needs. Section D.1 of the NMFS RPA reserves 2,500 acre-feet of storage (Blockwater) to be released at the discretion of resource agencies, which include the NMFS and the California Department of Fish and Wildlife (CDFW). The water is typically released in the later winter/ early spring period to aid compliance with Section B.3 of the NMFS RPA, which requires PG&E to cooperate in the release of warm water from the spillway to promote the timely downstream migration of juvenile Chinook salmon from the Eel River between Scott and Cape Horn Dams.

Water is released from the PVP Tunnel to maintain minimum instream flow requirements in the East Fork Russian River below the tailrace and for a contractual water supply agreement between PG&E and PVID. The minimum instream flow requirements and the contracted volume supplied to PVID vary based on the water supply condition and the time of year. Additional water above the minimum release requirements may be diverted through the Tunnel for additional power production when Lake Pillsbury storage exceeds the Target Storage Curve (TSC) as defined in section E.5 of the NMFS RPA. Section E.6 defines three TSC's (A, B and C). Based on the water year classification as of May 15, the appropriate TSC is used for the

following 12 months beginning on August 1 of that year. A chart of the 3 TSC's is provided as Figure 2-4. Water that is not diverted by PVID or other appropriative water rights users on the East Fork Russian River flows into Lake Mendocino.

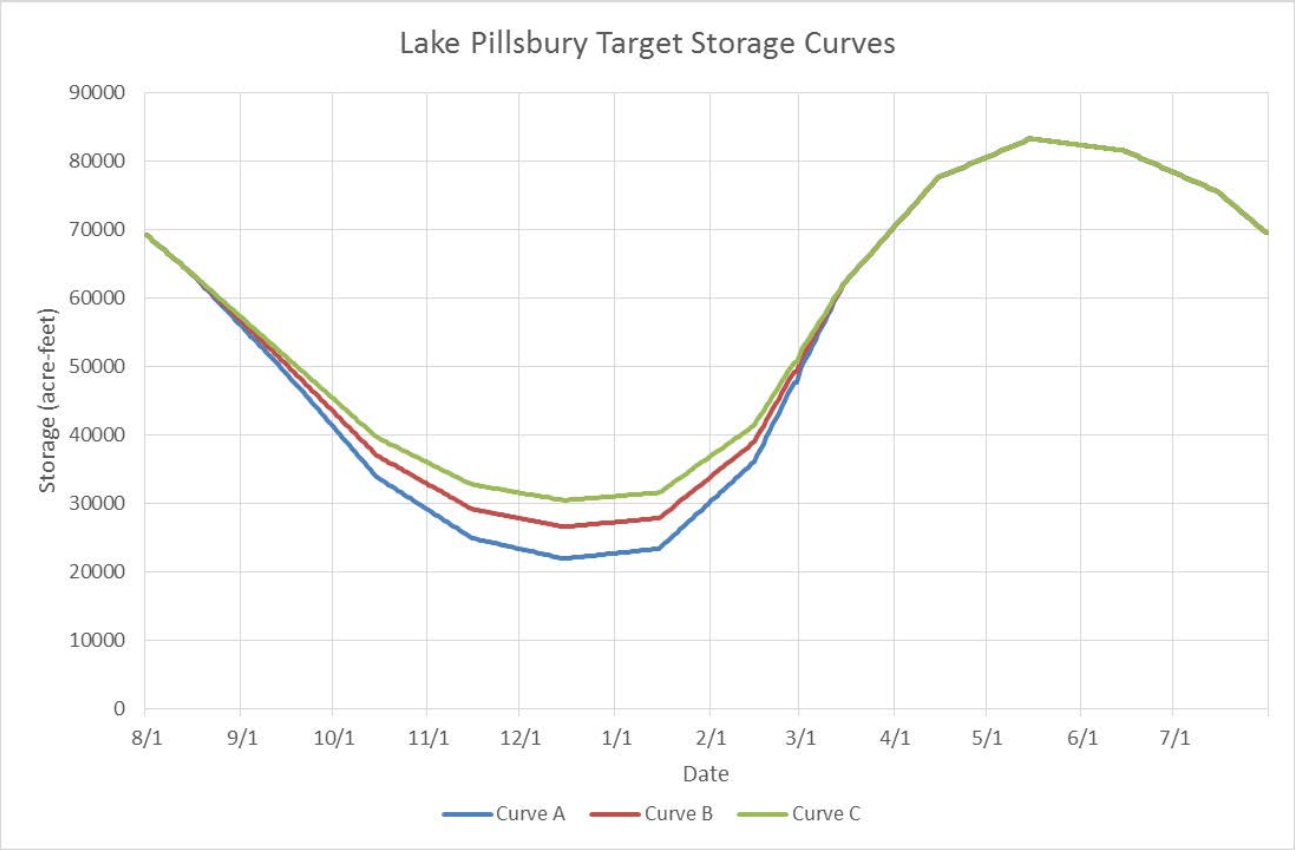

Figure 2-4. Lake Pillsbury Target Storage Curves in acre-feet.

In 2002, NMFS issued a Biological Opinion under the federal Endangered Species Act for the proposed FERC license amendment. FERC amended PG&E's license in 2004 to require implementation of the NMFS RPA proposed in the Biological Opinion to avoid jeopardizing the continued existence of listed salmon species in the Eel River watershed. PG&E began operation of the PVP in accordance with its amended FERC license in 2006, which reduced PVP imports compared to historic levels. Annual PVP diversions now average 67,000 acre-feet as compared to the 151,000 acre-feet per year average annual diversion rate from 1959 to 2006, before implementation of the amended license. The reductions have resulted in reduced inflows into Lake Mendocino from the East Fork Russian River. These reductions are illustrated in Figure 2-5, which shows historic average water year inflow into Lake Mendocino and PVP imports shown in blue for two periods: 1) Operations since the construction of CVD and prior to the implementation of the amended FERC license, 1959-2006, and 2) Operations after the implementation of the amended FERC license, 2007-2015. Figure 2-5 shows that Lake Mendocino inflows for the period 2007 to 2015 have declined from historic inflows, which is largely the result of reduced PVP imports. Seasonal timing of PVP imports have also affected Lake Mendocino water storage reliability. Reduced inflows in the spring have contributed to declining reliability of Lake Mendocino through the summer months, resulting in several

Temporary Urgency Change Petitions (TUCP) being filed by the Water Agency with the SWRCB to preserve water supply storage in Lake Mendocino for subsequent beneficial uses downstream.

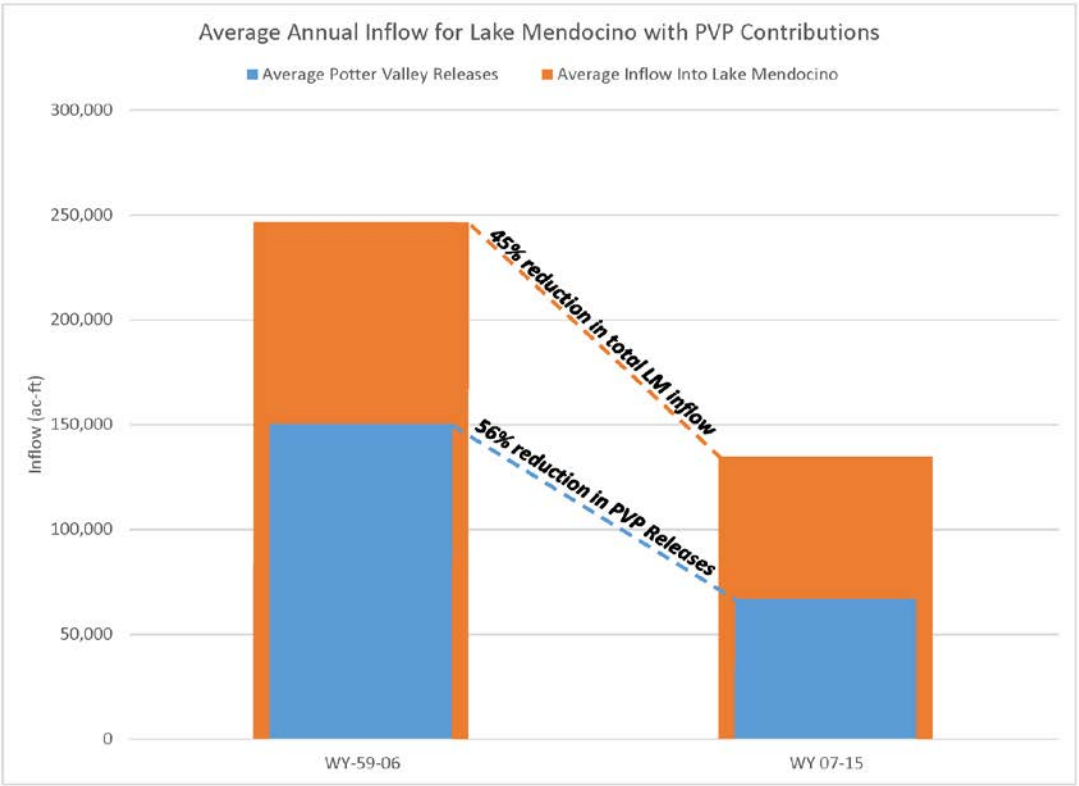

Figure 2-5. Lake Mendocino Average annual inflow in acre-feet per year for periods both prior to the implementation of the PVP FERC license amendment in the fall of 2006.

2.1.4 Lake Mendocino

Lake Mendocino is located on the East Fork Russian River, about 4 miles northeast of the City of Ukiah in Mendocino County, California (Figure 2-1). Lake Mendocino was created by the construction of the Coyote Valley Dam (CVD) Project, which was authorized by the Flood Control Act of 1944 for the purposes of flood control, water supply, recreation and stream flow regulation. Construction was completed by the United States Army Corps of Engineers (USACE) in January 1959, with the Water Agency participating as the non-federal sponsor. CVD is an earth embankment dam approximately 160 feet high with a crest length of 3,500 feet.

Lake Mendocino has a total current storage capacity of 116,500 acre-feet, which includes a water supply pool of between 68,400 acre-feet and 111,000 acre-feet, depending on the time of

year. Based on reservoir bathymetric surveys (original in 1952 and most recent in 2001) the average sedimentation rate in the reservoir is approximately 143 AFY. The invert of the controlled outlet is at an elevation of 637 feet above mean sea level (msl) (USACE 1986). This level in the reservoir establishes the top of the inactive pool, which, according to the 1986 Water Control Manual, was estimated to have a capacity of 135 acre-feet. Based on the historic rate of sedimentation, it is expected that the inactive pool has reached its capacity to accumulate sediment.

The watershed of the reservoir has an area of approximately 105 square miles, which is approximately 7 percent of the total watershed area of the Russian River Basin. Average annual inflow into the reservoir since it was completed is approximately 230,000 AFY, with a peak annual inflow of 443,000 acre-feet in 1983 and a minimum annual inflow of 60,000 acre-feet in 1977. Inflow into the reservoir consists of unimpaired flows from the contributing watershed area and a portion of the water diverted though the PVP from the Eel River.

2.1.4.1 Lake Mendocino Flood Pool Operations

The USACE determines the schedule and amounts of releases of water from Lake Mendocino during flood control operations. Regulation for flood control and water supply operations are described in the Water Control Manual (WCM), Appendix I to the CVD Master Water Control Manual published by the Corps originally in April 1959 and most recently revised in August 1986 (USACE, 1986). Revisions to the CVD Water Control Diagram were made by the USACE in 2004 (USACE, 2004, January).

Storage in the reservoir is controlled by the reservoir guide curve defined in the CVD Water Control Diagram (USACE, 2004, January). This guide curve sets the maximum threshold for storage of conservation water[2] in the reservoir, which varies seasonally. A diagram of the reservoir pools of Lake Mendocino is provided in Figure 2-6. The volume of the water supply pool (also frequently called the conservation pool) decreases during the rainy season to maximize flood space capacity and increases in the dry season to maximize conservation storage for water supply purposes. The flood control pool is defined by the storage capacity levels above the Guide Curve and below the emergency pool. Under typical flood operations, water is temporarily detained in the flood control pool until the threat of flooding downstream has diminished. After the threat of downstream flooding is reduced, water is released from the reservoir to bring storage levels back down to the top of the conservation pool. Operations during flood management are guided by three release schedules defined in the WCM that are determined by storage level in the reservoir flood pool.

[2] Conservation water is water stored in the conservation pool of the reservoir. The conservation pool lies above the dead pool and below flood pool. When a reservoir's conservation pool is full, the reservoir is considered full.

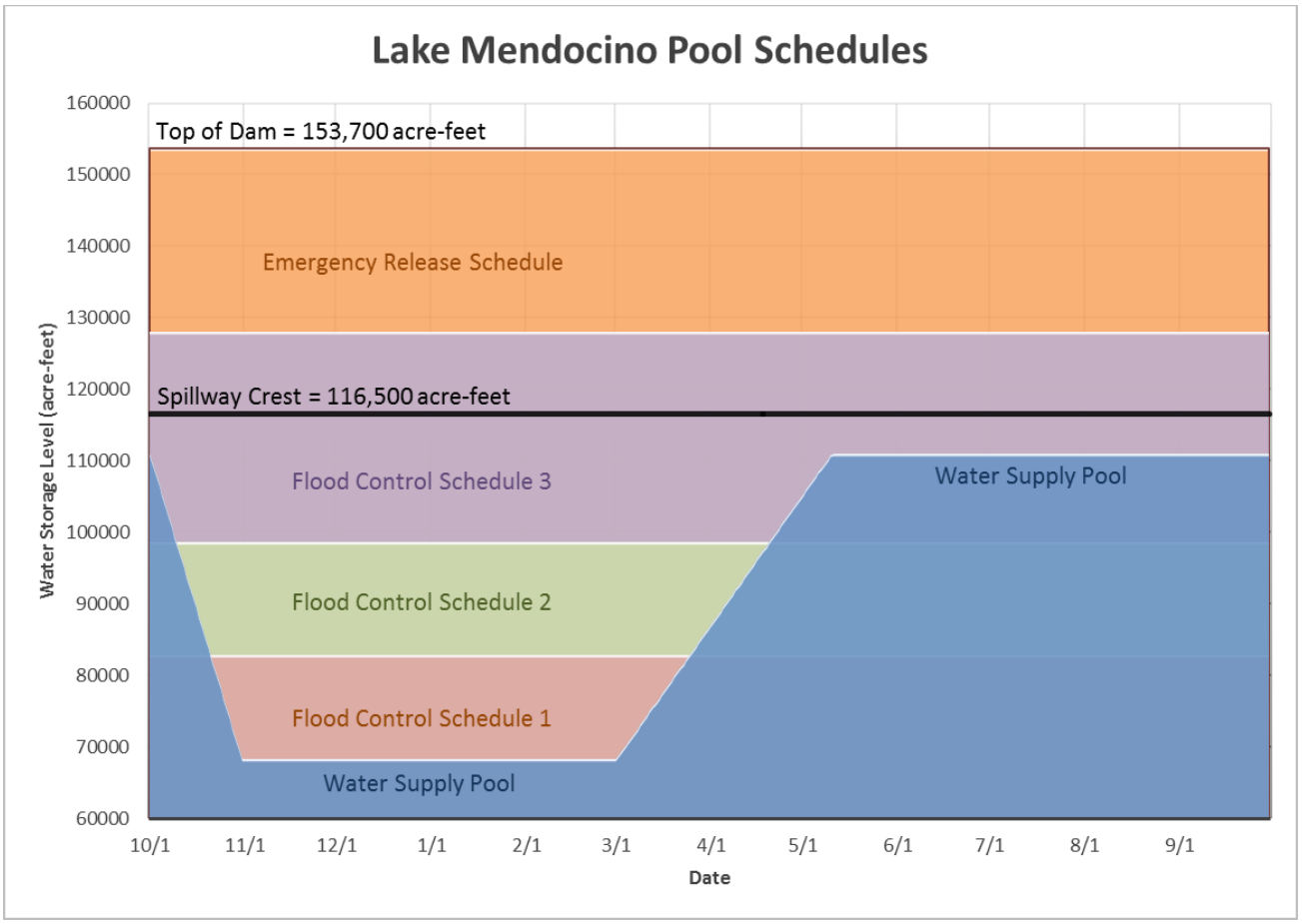

Figure 2-6. Lake Mendocino Pool Schedules in acre-feet defined in the 2004 Water Control Diagram.

Flood releases from Lake Mendocino are further guided by downstream maximum flow criteria defined in the WCM and the 2004 Water Control Diagram. When flow at the USGS Russian River near Ukiah gage (West Fork gage) exceeds 2,500 cfs and is rising, Russian River flows at the USGS Russian River near Hopland gage (Hopland gage) are monitored hourly to assess for any needed release reductions. The WCM further requires that controlled flood releases cannot contribute to flows greater than 8,000 cfs at Hopland gage. When flows at the Hopland gage exceed 8,000 cfs due to unimpaired flows downstream of CVD, reservoir releases cannot exceed the minimum release requirement of 25 cfs (USACE, 2004, January).

Lake Mendocino also has an emergency release schedule that provides guidance for releases made through the emergency gates of CVD when reservoir water levels are within the emergency pool (128,090 to 153,700 acre-feet storage level) (USACE, 2004, January). Since construction of the CVD was completed in 1959 an emergency release has never been made.

2.1.4.2 Lake Mendocino Water Supply Pool Operations

The Water Agency is the local, non-federal sponsor for Lake Mendocino and has an agreement with the USACE dating back to 1959 to store and release water from Lake Mendocino to maintain minimum instream flows downstream of CVD and divert water from the Russian River for reasonable and beneficial uses and purposes. This contract will continue in full force and

effect for the life of the project. As the local sponsor, the Water Agency makes water supply releases as necessary to comply with its water rights permits and diversions made by downstream users when Lake Mendocino storage levels are within the water supply pool as shown in Figure 2-6. These permits implement the provisions of the State Water Resources Control Board's (SWRCB) Decision 1610, which is discussed in further detail in Section 2.1.6.

In addition to the Water Agency's water rights to water stored in Lake Mendocino, the Mendocino County Russian River Flood Control and Water Conservation Improvement District (Mendocino District) and Russian River mainstem post-1949 water right holders in Sonoma County also have water rights that authorize the re-diversion and use of water released from Lake Mendocino storage. The Mendocino District holds water-right Permit 12947B, which authorizes re-diversions and use of up to 8,000 acre-feet per year of water released from Lake Mendocino. The Mendocino RRFC manages this water-right permit through water supply contracts with farmers and public water purveyors in the Hopland, Ukiah, and Redwood valleys. Under a 10,000-AFY reservation established and administered by the SWRCB in Order WR 74-30 water is available to qualifying appropriative water rights in Sonoma County. Redwood Valley County Water District (RVCWD)'s water-right Permit 17593 does not authorize the re-diversion of water stored in Lake Mendocino, it does authorize RVCWD to divert water from Lake Mendocino during times when the reservoir is in its flood control pool.

2.1.4.3 Coyote Valley Dam Egg Collection Facility

At the base of CVD, the California Department of Fish and Wildlife, under a contract with the USACE, operates a fish hatchery facility called the Coyote Valley Dam Egg Collection Facility, which is managed in conjunction with the Don Clausen Fish Hatchery at Warm Springs Dam on Dry Creek, to support a steelhead population. This facility collects eggs from returning steelhead, but does not hatch them on site. Fertilized eggs are transported to the Don Clausen Fish Hatchery to hatch and be raised for a year. After a year, the juvenile fish are brought back to the Coyote Valley Dam facility to be released into the Russian River. The fish hatchery uses water released from Lake Mendocino to support operations. The hatchery requires a minimum flow of 25 cfs to support operations. This flow is diverted from the controlled outlet at CVD and then released back into the river. The hatchery also requests additional water releases from CVD in the winter to help promote released juvenile fish to migrate downstream. This additional release is coordinated with either the Water Agency or USACE, depending on which agency is managing releases at the time, and typically consists of an increase in CVD releases for 1 week in February and 1 week in March.

2.1.4.4 Hydroelectric Power

The City of Ukiah operates a hydroelectric facility at the CVD utilizing incidental releases. This facility was constructed in 1985 and most recently renovated in 2008. The City of Ukiah has a 1986 agreement with the USACE for the operation and maintenance of the facility. The power plant has two turbine/generator units, with capacities of 2.5 and 1 megawatts (MW). According to the CVD WCM the power plant has a minimum flowrate of 22 cfs and maximum flowrate of 398 cfs, with a maximum flow rate of 116 cfs through the 1 MW unit and 282 cfs through the 2.5 MW unit (USACE, 1986). The power plant can generate power for a maximum release of 1,500 cfs from CVD. The City of Ukiah is required to maintain a minimum dissolved oxygen level of 7

milligrams per liter for water released from the power plant. All water diverted by the power plant is returned to the river immediately downstream of the power plant.

2.1.5 Lake Sonoma

Lake Sonoma is located on Dry Creek, a tributary to the Russian River, approximately 10 miles northwest of the City of Healdsburg in Sonoma County, California (Figure 2-1). Lake Sonoma was created by the construction of the Warm Springs Dam (WSD) Project, which was authorized by the Flood Control Act of 1962 for the purposes of flood control, water supply, environmental stewardship and recreation. Construction was completed by the USACE in January 1983, with the Water Agency acting as the local, non-federal sponsor. WSD is an earth embankment dam approximately 319 feet high with a crest length of 3,000 feet.

Lake Sonoma has a total storage capacity of 381,000 acre-feet, which is comprised of a water supply pool of 225,000 acre-feet, a flood control pool of 136,000 acre-feet, and an inactive pool of 20,000 acre-feet. The reservoir has four intakes at different elevations, allowing management of releases to achieve the desired water temperature. A diagram of the Lake Sonoma pool storage schedules is provided in Figure 2-7.

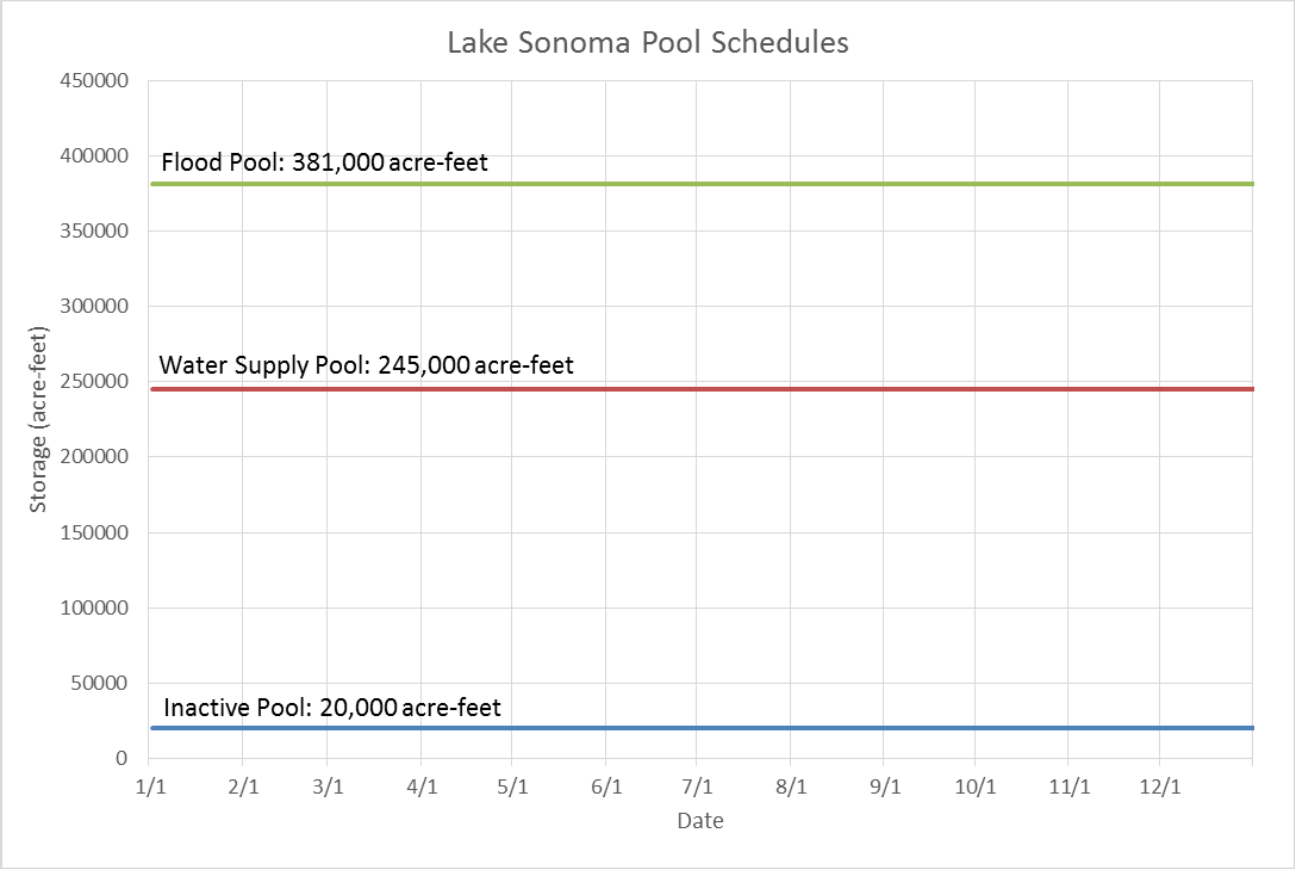

Figure 2-7. Lake Sonoma Pool Schedules in acre-feet defined in the 1984 Water Control Manual

The watershed of the reservoir is approximately 130 square miles, which is approximately 9 percent of the total watershed area of the Russian River Basin. Inflow into the reservoir consists of natural flows from the contributing watershed area. Average annual inflow into the reservoir,

since it was completed, has been approximately 170,000 AFY, with a maximum annual inflow of 392,000 acre-feet in 1995 and a minimum annual inflow of 41,000 acre-feet in 2014.

The USACE has not conducted a bathymetric survey of Lake Sonoma since the construction of the reservoir was completed. The Water Agency has estimated sedimentation rates for Lake Sonoma based on observed bedload measurements collected in Dry Creek near the Geyserville USGS gaging station. For the 15-year period from 1965 to 1979, an average suspended sediment yield of 3,640 tons per square mile was measured (USACE 1984). From this yield, an annual sedimentation rate of approximately 299 acre-feet was estimated. Based on this rate the current storage capacity of the reservoir is estimated to be approximately 370,700 acre-feet and it is estimated that the reservoir has lost approximately 2.6% of its total capacity since construction.

The USACE has allocated 26,000 acre-feet of the total storage capacity (381,000 acre-feet) for silt and sediment accumulation, thereby leaving 355,000 acre-feet for total usable water storage space. Based on the annual sedimentation rate of 299 AFY, as determined above, Lake Sonoma will reach its design sediment accumulation level in approximately 87 years by 2070. The USACE has further allocated sediment accumulation pools of 7,000 acre-feet, 13,000 acre-feet and 6,000 acre-feet (totaling 26,000 acre-feet) for the Minimum Pool, Water Supply Pool and Flood Control Pool respectively. Reservoir pool allocations are then defined by subtracting the respective sediment pools from the total storage capacity for each pool as illustrated in Figure 2-8. The resulting usable water storage space is 13,000 acre-feet, 212,000 acre-feet and 130,000 acre-feet for the Inactive Pool, Water Supply Pool and Flood Control Pool respectively.

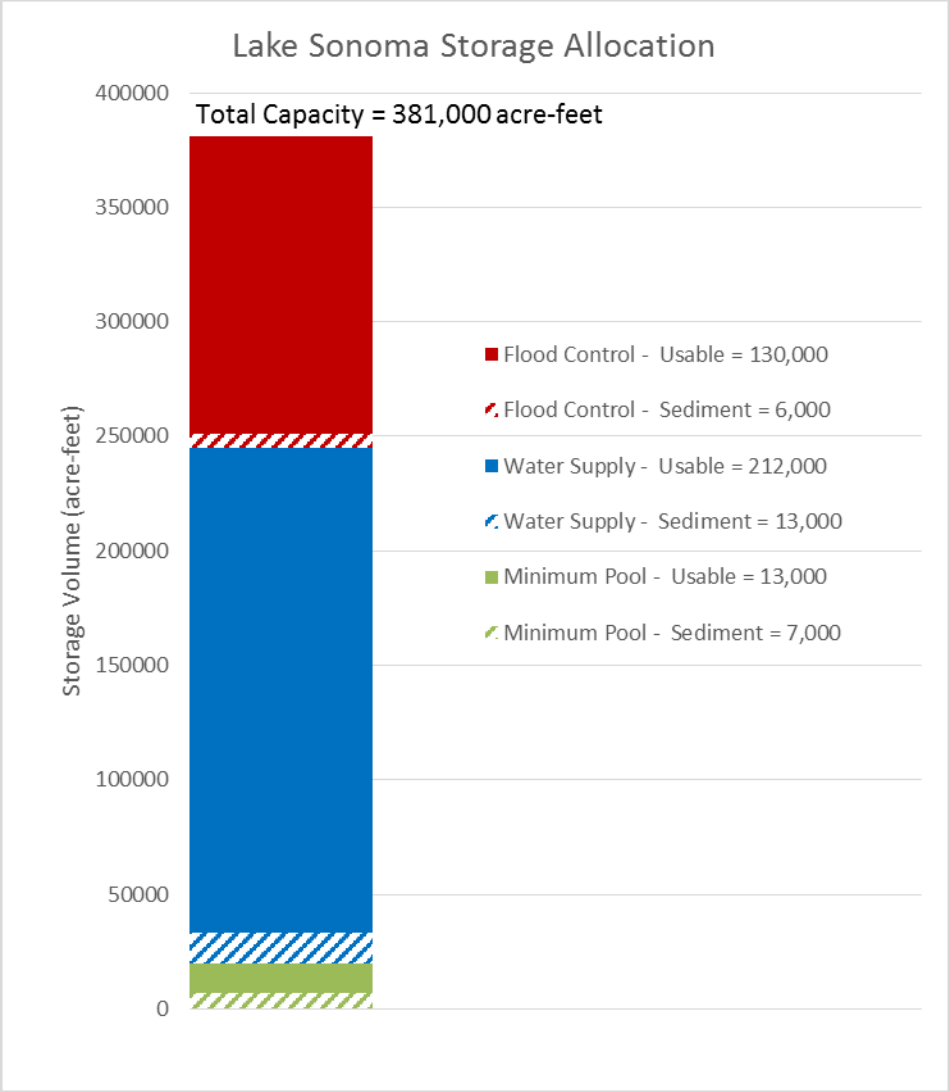

Figure 2-8. Lake Sonoma usable and sediment storage allocation in acre-feet.

2.1.5.1 Flood Management Operations

The Corps determines releases of water from Lake Sonoma during flood control operations. The regulation of flood control and water supply operations is described in the Water Control Manual (WCM), Appendix II to the WSD Master Water Control Manual published by the Corps in September 1984 (USACE, 1984).

Storage in the reservoir is controlled by the reservoir Guide Curve defined in the WCM (Figure 2-8). The top of the water supply pool sets the maximum authorized storage of conservation water in the reservoir. The flood control pool is defined by the storage capacity levels above the water supply pool and below the top of the flood pool. Under flood operations, water is temporarily detained in the flood control pool until the threat of flooding downstream has diminished. After the threat of downstream flooding is reduced, water is released from the reservoir to bring storage levels back down to the top of the water supply pool. Flood control

releases are initiated in accordance with the requirements established in the Water Control Manual.

Under the WSD WCM, the reservoir is allowed to fill to the top of the water supply pool. After the reservoir reaches this level, flood releases are made to a maximum of 6,000 cfs for normal operating procedures. For emergency operations, a maximum release of 8,100 cfs can be made. When inflow into the reservoir reaches 5,000 cfs, releases are reduced to the minimum amount necessary to support downstream fisheries needs. Flood releases are not resumed until inflow falls below 5,000 cfs and the flow at the Russian River near Guerneville has receded to less than 35,000 cfs.

2.1.5.2 Water Supply Operations

The Water Agency is the local, non-federal sponsor for Lake Sonoma and has a 1984 contract with the USACE to store water, in and to divert and release water from, the lake when water-surface elevations are between 292 and 451 feet msl. This contract will continue in full force and effect for the life of the project. As the local sponsor, the Water Agency makes water supply releases from Lake Sonoma as necessary to comply with its water rights permits. These permits implement the provisions of the SWRCB's Decision 1610, which is discussed in further detail in Section 2.1.6. When storage levels in Lake Sonoma are within the water supply pool shown in Figure 2-7, the Water Agency makes release decisions to meet minimum instream flow requirements and satisfy downstream water supply needs.

2.1.5.3 Warm Springs Dam (Don Clausen) Fish Hatchery

The Don Clausen Fish Hatchery (DCFH), located at the base of WSD, is owned by the USACE. Construction of this hatchery was authorized by the Flood Control Act of 1962. This facility went into service in 1992 and the CDFW operates this facility in conjunction with the Lake Mendocino Fish Hatchery at CVD to support steelhead and Coho salmon populations. The DCFH diverts flow from the controlled outlet of Warm Springs Dam to support hatchery operations. Diverted water used by the hatchery is returned back to Dry Creek downstream of the hatchery. When the Water Agency is managing releases from Lake Sonoma, releases are coordinated with the fish hatchery staff to ensure that releases meet operational needs of the hatchery. These minimum releases typically range between 55 and 70 cfs.

2.1.5.4 Hydroelectric Power

After the construction of WSD, the Water Agency worked with the USACE to install a hydroelectric turbine in 1989. The Water Agency operates a hydroelectric facility at WSD under a license from FERC. The powerhouse has a 2.6 MW turbine/generator unit with a maximum discharge capacity of 190 cfs.

2.1.6 Russian River System Water Supply Operations

The Water Agency makes water supply releases from Lake Mendocino and Lake Sonoma as necessary to comply with its water rights permits, which implement the provisions of the SWRCB's Decision 1610. The Water Agency's permits authorize diversions to storage in Lake Mendocino and Lake Sonoma, re-diversions of water released from storage and direct diversions at points downstream. Collection of water into Lake Mendocino's water supply pool is

authorized by the Water Agency's water right Permit 12947A and collection of water into Lake Sonoma's water supply pool is authorized by the water right Permit 16596. Additionally, under these permits and with Permits 12949 and 12950, the Water Agency and its customers may directly divert water from the Russian River with total direct diversions and re-diversions not exceeding 75,000 AFY.

2.1.6.1 Russian River System Minimum Instream Flow Requirements

The Water Agency's water rights permits specify minimum instream flow requirements that must be met when the Water Agency is controlling releases from Lake Sonoma or Lake Mendocino. A summary of these requirements is provided in Figure 2-9. The Water Agency's water right permits define different schedules of minimum instream flows for each of the three reaches of the Russian River System. The Water Agency's water right permits also define a hydrologic index based on cumulative inflow into Lake Pillsbury beginning on October 1st (beginning of the water year). Thresholds of cumulative Lake Pillsbury inflow are defined for the first of the month from January 1 to June 1 to determine the water supply condition. The Water Agency's water right permits have three water supply conditions: *Normal*, *Dry*, and *Critical*. Each of these conditions is used to determine a schedule of flows for each reach of the Russian River System.

Decision 1610 requires a minimum flow of 25 cubic feet per second (cfs) in the East Fork of the Russian River from Coyote Valley Dam to the confluence with the West Fork of the Russian River under all water supply conditions. From this point to Dry Creek, the Decision 1610 required minimum Russian River flows are 185 cfs from April through August and 150 cfs from September through March during *Normal* water supply conditions, 75 cfs during *Dry* conditions and 25 cfs during *Critical* conditions. Decision 1610 further specifies two variations of the *Normal* water supply condition, commonly known as *Normal Dry Spring 1* and *Normal Dry Spring 2*. These conditions provide for lower required minimum flows in the Upper Russian River during times when the combined storage in Lake Pillsbury (owned and operated by the Pacific Gas and Electric Company) and Lake Mendocino on May 31 is unusually low. *Normal Dry Spring 1* conditions exist if the combined storage in Lake Pillsbury and Lake Mendocino is less than 150,000 acre-feet on May 31. Under *Normal Dry Spring 1* conditions, the required minimum flow in the Upper Russian River between the confluence of the East Fork and West Fork and Healdsburg is 150 cfs from June through March, with a reduction to 75 cfs during October through December if Lake Mendocino storage is less than 30,000 acre-feet during those months. *Normal Dry Spring 2* conditions exist if the combined storage in Lake Pillsbury and Lake Mendocino is less than 130,000 acre-feet on May 31. Under *Normal Dry Spring 2* conditions, the required minimum flows in the Upper Russian River are 75 cfs from June through December and 150 cfs from January through March.

The required minimum flows in the Lower Russian River are 125 cfs during *Normal* water supply conditions, 85 cfs during *Dry* conditions and 35 cfs during *Critical* conditions. In Dry Creek below Warm Springs Dam, the required minimum flows are 75 cfs from January through April, 80 cfs from May through October and 105 cfs in November and December during *Normal* water supply conditions. During *Dry* and *Critical* conditions, these required minimum flows are 25 cfs from April through October and 75 cfs from November through March.

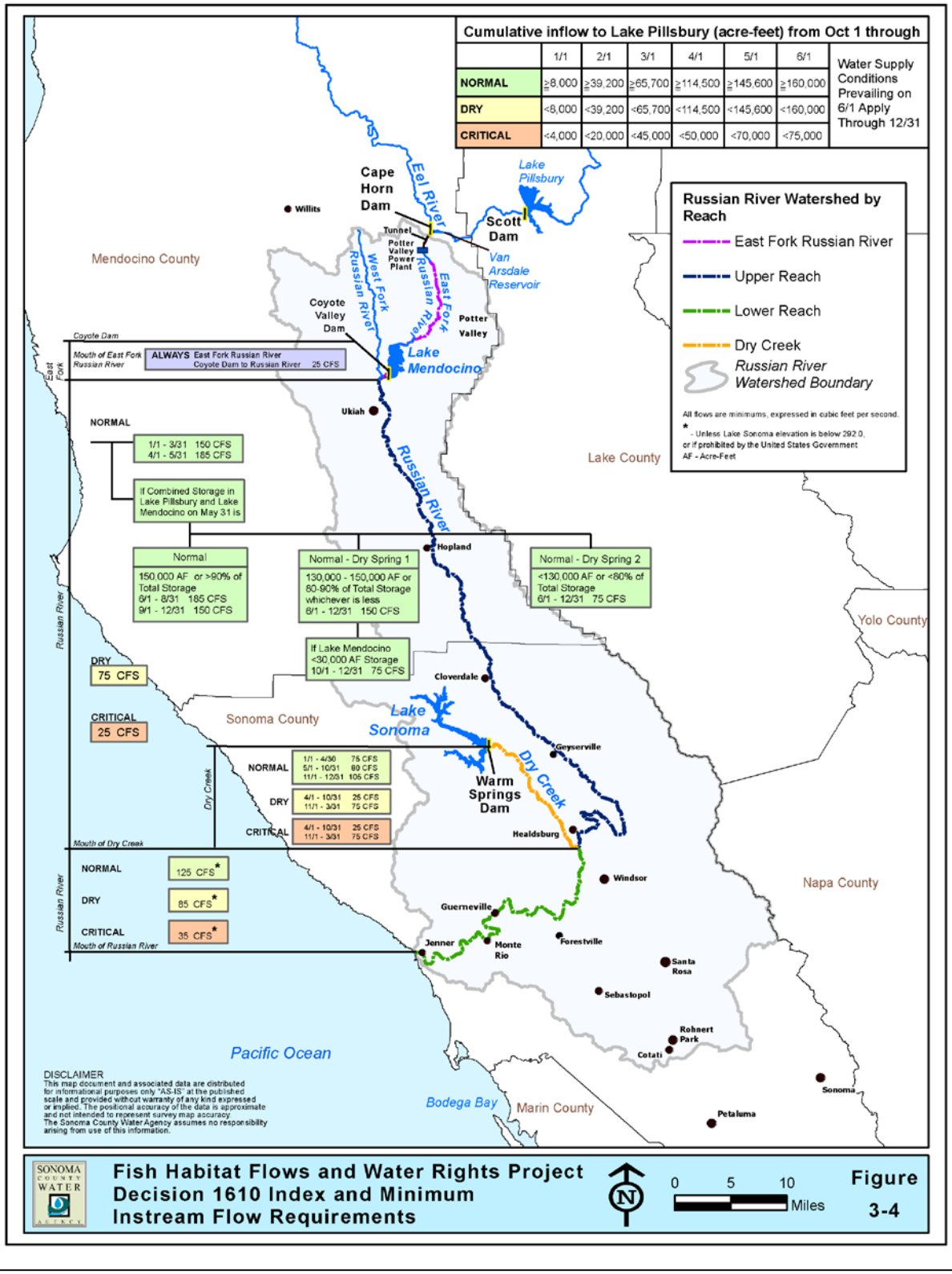

Figure 2-9. Russian River System Hydrologic Index and minimum instream flow requirements defined in the Water Agency's water rights permits.

Adherence to the minimum instream flow requirements is determined from observed flows at the USGS gaging stations that provide real-time information for several locations along the Russian River and Dry Creek. These gaging stations are further discussed in Section 2.1.2.1.

The Water Agency makes releases from Lake Mendocino and Lake Sonoma: (1) to meet the downstream water demands of the hundreds of agricultural, commercial and residential water users, the Water Agency, and several public water systems along the Russian River and Dry Creek; and (2) to maintain minimum in-stream flow requirements in the Russian River and Dry Creek. During water supply operations, the regulation of Lake Mendocino and Lake Sonoma can be considered to be operated in series. Typically, releases from Lake Mendocino are made to meet downstream demands and minimum instream flow requirements for the Upper Russian River. Due to the long travel time (5-7 days during dry season flows) and smaller size of the reservoir, releases from Lake Mendocino are rarely made to help meet demands on or minimum instream flow requirements of the Lower Russian River. Releases from Lake Mendocino made to satisfy the minimum instream flow requirements in the Upper Russian River continue past the lowest instream flow control point on the Upper Russian River at the USGS Russian River at Healdsburg gage (Healdsburg gage) and contribute to the total flow in the Lower Russian River. This Upper Russian River flow contribution can sometimes be a significant portion of the total flow in the Lower Russian River reaches. Water supply releases from Lake Sonoma are made to meet the minimum instream flow requirements and water demands in Dry Creek and the Lower Russian River, which includes the Water Agency's diversions at the Wohler and Mirabel facilities.

Water Agency operational decisions for Lake Mendocino and Lake Sonoma are based on preserving water in the reservoir's water supply pool to the extent possible while complying with the applicable minimum instream flow requirements and downstream demands. During times of sufficient rainfall and natural flows to meet minimum instream flow requirements at downstream gages (compliance points), the Water Agency limits releases from the water supply pool to the amounts needed to meet minimum release requirements. For Lake Mendocino there is a 25 cfs release requirement for minimum flows in the East Fork Russian River immediately downstream of the dam. For Lake Sonoma, the minimum releases are usually determined by fish hatchery needs.

During periods of insufficient unimpaired flow, the Water Agency must make higher releases to ensure that the required minimum instream flows are maintained at compliance points all along the Russian River and Dry Creek. In the spring and early summer when there is typically contributing tributary flow, the Water Agency makes reservoir releases to meet minimum instream flow requirements at the closest compliance point downstream of each reservoir. For CVD, the closest downstream compliance point is the confluence of the East Fork and the West Fork of the Russian River (the Forks), and for WSD this point is the USGS Dry Creek near Geyserville gage (Dry Creek Geyserville gage). As natural flows recede during the dry season, the minimum instream flow compliance point transitions from upstream flow gages to gages further downstream. For Lake Mendocino the farthest downstream compliance point is the Healdsburg gage, and, for Lake Sonoma, the farthest downstream compliance point is the USGS Russian River at Guerneville gage (Hacienda gage).

The Water Agency receives little information from other entities like other public water systems or agricultural diverters to help determine the amounts of releases from Lake Mendocino and Sonoma. Instead, the Water Agency normally sets releases through frequent observation of data from USGS gaging stations on the Russian River and Dry Creek, as well as an understanding of how reach losses change both with forecasted weather conditions and seasonally.

2.1.6.2 Water Agency Facilities

The Water Agency is the largest water diverter in the watershed and diverts surface water from the Russian River and delivers it to the Water Agency's customers through a transmission system. The Water Agency's facilities (at Wohler and Mirabel near the town of Forestville) divert Russian River water as underflow, which is reported under the Water Agency's surface water right permits.

2.1.6.3 Water Agency Customers

In addition to the Water Agency diversions from the Russian River, the Water Agency also has agreements with other entities known as the Russian River customers that authorize them to divert water also from the Russian River under the Water Agency's water rights using their own facilities. These customers are the City of Healdsburg, the Town of Windsor, Camp Meeker Recreation and Parks District and the Occidental Community Services District.

2.1.6.4 Diversion Curtailment Requirements

The Water Agency's water right Permit 16596 has a term that requires the Water Agency to impose a 30 percent deficiency in deliveries from the Russian River to its service area when Lake Sonoma storage levels drop below 100,000 acre-feet before July 15 of any year. This deficiency then must remain in effect until "(1) storage in Lake Sonoma rises to greater than 70,000 acre-feet subsequent to December 31 after having fallen below that level, or (2) permittee has projected, to the satisfaction of the Chief, Division of Water Rights, that storage at Lake Sonoma will not fall below 70,000 acre-feet, or (3) hydrologic conditions result in sufficient flow to satisfy permittee's demands at Wohler and Mirabel Park and minimum flow requirements in the Russian River at Guerneville."

2.1.6.5 Other Municipal Diverters

Besides the Water Agency and the Russian River Customers discussed in Section 2.1.6.3, 24 other public municipalities divert water from the Russian River. A list of these municipalities and the reach of the Russian River System from which each diverts is provided in Table 2-2.

Table 2-2. Public Water Municipalities along the Upper and Lower reaches of the Russian River.

Public Water Systems	Reach on Russian River
Alexander Valley Acres Water Company	Upper
Bucher Water Company	Upper
Calpella County Water District	Upper
City of Cloverdale	Upper
City of Ukiah	Upper
Geyserville Water Works (PUC)	Upper
Gill Creek Mutual Water Company	Upper
Hopland Public Utility District	Upper
Millview County Water District	Upper
Palomino Lakes Mutual Water Co.	Upper
Rains Creek Water District	Lower
Redwood Valley County Water District	Upper
Rio Lindo Adventist Academy	Upper
River Estates Mutual Water Company	Upper
Rogina Water Company Inc.	Upper
Russian River County Water District	Lower
Russian river Flood Control	Upper
Russian River MWC	Upper
Six Acres Water Company	Upper
Sonoma County CSA-41 Fitch Mountain	Upper
South Cloverdale Water Company	Upper
Sweetwater Springs CWD	Lower
West Water Company (PUC)	Upper
Willow County Water District	Upper

2.1.6.5.1 City of Ukiah Water Rights

In 2013, the City of Ukiah filed a Petition of Extension to amend their water rights Permit 12952 (Application 15704) requesting a 80-year extension to allow them additional time to fully utilize the maximum rate of diversion of 20.0 cfs authorized in their permit. The City also filed a Petition for Change in Point of Diversion and a Petition for Change in Place of Use. In support of these petitions, the City prepared a Draft EIR in March 2013 to address the potential impacts of the City's request for a Water Right Permit amendment. The Draft EIR projects a future water demand for the City of 11,527 acre-feet by the year 2080, an increase of 8,442 acre-feet per year relative to the City average demand from 2009 to 2013. The proposed amendment and increased demand identified in the Draft EIR would substantially increase Upper Russian River surface water demands and lead to additional pressures on limited water resources resulting from decreased supplies from the PVP since 2006, impacting storage levels in Lake Mendocino and in-stream flows.

2.1.6.6 Agricultural Diversions for Irrigation

The Russian River Valley is a well-known wine-growing region and has 122,000 acres of agricultural lands, the majority of which is vineyards. Water supplies from both direct diversions

of surface water and off-stream wells, are made for purposes of irrigation, frost protection and heat suppression throughout the Russian River System. Limited agricultural diversion data on daily and monthly time steps are available for the Russian River System.

The Water Agency collaborated with Davids Engineering (Davids, 2013) to estimate amounts of surface-water diversions and well pumping using an agricultural irrigation demand and soil moisture accounting model. Estimates of daily applied water and riparian vegetation water losses were developed by estimating total daily crop evapotranspiration (ET). Daily total crop ET was calculated for different crop types using unique crop coefficients derived from a 2008 analysis of actual ET (ETa), based on the Surface Energy Balance Algorithm for Land (SEBAL®) model, coupled with quality-controlled reference ET (ETo) data from the California Irrigation Management Information System (CIMIS).

The Soil-Water-Atmosphere-Plant (SWAP) model was used to calculate a daily root zone water balance and estimate applied water volumes from 2002 to 2008 for agricultural fields and within the Applied Water Analysis Zone (AWAZ). The AWAZ represents the area within which diversion or consumption of water is either known or presumed to have immediate effects on Russian River flows. Monthly AWAZ applied water volumes were estimated for wet and dry year types as discussed in further detail in Section 3.2.3.

2.1.6.7 Agricultural Diversions for Frost Protection

Another agricultural use of water in the Russian River is the application of water to budding grape vines during frost events to protect the buds from frost damage. During the budding stage of growth, the buds are very sensitive to freezing temperatures. The typical season for this is from March 15 to May 15 each year. Grape growers apply water before and during frost events to help mitigate the potential impacts to the sensitive buds. During periods of low flow this water use practice has been observed to have a noticeable impact on surface water flows. If the Water Agency is under management of reservoir releases, releases may be increased in advance of a forecasted frost event in the spring to prevent flows from dropping below the minimum instream flow requirements.

2.1.6.8 Other System Losses

Other sources of surface water loss in the system include lake evaporation, evapotranspiration from riparian vegetation adjacent to the river and loss to the adjacent aquifer through surface-groundwater interactions. A reach depletion study completed by Stephen Grinnell, P.E. (Grinnell 2016) found that metered direct diversions and estimated agricultural diversion by Davids Engineering could not account for observed reach depletions when examining observed streamflows. These additional losses are likely from natural processes or the cumulative impact of water being pumped from groundwater wells or diverted from tributaries at varying distances from the Russian River or Dry Creek. Grinnell estimated these additional losses using observed streamflow and modeled data from 2002 to 2013.

2.1.6.9 Minimum Instream Flow Compliance Buffer

Minimum instream flow compliance buffers are additional water that is released from a reservoir to account for the dynamic nature of flows in the system and help ensure that flows do not dip below the downstream minimum instream flow requirements. The variability of downstream

flows can be attributed to a number of factors including surface water losses due to consumptive use and natural causes as well as potential error in discharge measurements made at flow gaging stations. Flow travel times during the dry season can be multiple days to some compliance points downstream of Lake Mendocino and Lake Sonoma and predicting the variability in flows can be challenging for operators. Therefore in the operations of Lake Mendocino and Lake Sonoma, extra releases are typically made as buffers above minimum flows to ensure compliance with the instream flow requirements.

Compliance to minimum instream flows under Decision 1610 and the Water Agency's Water Right Permits is evaluated against instantaneous flow data collected at the USGS flow gaging stations on an hourly bases. Beginning in 2010 as part of the Water Agency's petition to the State Water Board to decrease the minimum instream flows consistent with the requirements of the Biological Opinion, the Water Agency requested 5-day moving average compliance to minimum instream flows with an instantaneous flow compliance floor. The State Water Board approved this request and has continued to approve 5-day moving average flow compliance requested in petitions in subsequent years. The 5-day moving average compliance to minimum instream flows provides flexibility to reservoir operators because using the 5-day moving average as a compliance target helps to reduce some of the dynamic variability of the instantaneous flow measurements and allows operators to reduce buffer releases to ensure minimum instream flow compliance. Additionally using the 5-day moving average provides flexibility in the timing of reservoir release changes considering the travel time to some compliance points can be as long as 5-days.

2.2 Fish Habitat Flows EIR

2.2.1 Russian River Biological Opinion

Three species of salmon in the Russian River are listed as threatened or endangered under the Endangered Species Act of 1973, as amended (ESA): Central California Coast (CCC) coho salmon, CCC steelhead, and California Coastal (CC) Chinook salmon. In 1997 the U.S. Army Corps of Engineers (USACE), the National Marine Fisheries Service (NMFS), and the Water Agency entered into a Memorandum of Understanding (MOU) that establishes the framework for a Russian River Section 7 Consultation required by the ESA with respect to the activities of the USACE and the Water Agency and certain activities of the Mendocino RRFC. NMFS issued its *Biological Opinion for Water Supply, Flood Control Operations, and Channel Maintenance conducted by the USACE, the Water Agency, and the Mendocino RRFC* on September 24, 2008. NMFS found that the continued operations of Warm Springs and Coyote Valley dams, together with proposed Dry Creek channel maintenance activities, and estuary management are likely to jeopardize the continued existence of threatened CCC steelhead and endangered CCC coho salmon and adversely modify their critical habitats (NMFS, 2008).

Since 2010 the Water Agency has been required, as part Reasonable and Prudent Alternative of the Biological Opinion, to file a petition with the SWRCB amending the Water Agency's water right permits to change summertime minimum instream flow requirements. From May 1 through October 15, the Biological Opinion's recommended minimum instream flow on the Upper Russian River for *Normal* water supply conditions is 125 cubic feet per second (cfs). On the

Lower Russian River, from the confluence of Dry Creek to the Pacific Ocean, the recommended minimum instream flow for *Normal* and Dry water supply conditions is 70 cfs. In addition to these requirements, the Biological Opinion required that the Water Agency initiate a SWRCB process for permanent changes to the minimum instream flows required by Decisions 1610 to improve rearing habitat conditions in the Upper Russian River mainstem, Lower Russian River in the vicinity of the estuary, and Dry Creek for steelhead, and in Dry Creek for steelhead and coho salmon, which are listed species under the federal and state Endangered Species Acts (NMFS, 2008). These changes were based on the NMFS findings that water supply operations resulted in flow rates that were higher than historic summer conditions and too high for optimal rearing habitat for young salmonids. The potential impact of permanent changes to the Water Agency's water right permits minimum instream flow requirements to improve habitat conditions for listed salmonids are to be analyzed in the Fish Flow Project EIR. The Fish Flow Project EIR will document and analyze the potential environmental impacts of changes in minimum instream flow requirements.

The Biological Opinion includes a Reasonable and Prudent Alternative (RPA) to the operations evaluated in the Biological Opinion that, when implemented, would avoid the likelihood of jeopardizing steelhead and coho salmon populations and adversely modifying critical habitat. Implementation of the RPA allows NMFS to provide incidental take coverage to the USACE and the Water Agency for the operations described in the Biological Opinion for a period of 15 years. The RPA requires the Water Agency to petition the State Water Resources Control Board to modify the Water Agency's water right permits to reduce minimum instream flow requirements in order to restore functional salmonid rearing habitat (NMFS, 2008).

2.2.2 Minimum Instream Flow Alternatives

In addition to the Russian River Biological Opinion recommended minimum instream flows, the Water Agency evaluated 28 alternatives in the Fish Flow Project EIR in an attempt to provide improved summer rearing habitat for juvenile Steelhead. Flow alternatives were also evaluated for other Salmonid life stages such as passage and habitat of spawning and out-migrating steelhead, and Chinook and coho Salmon.

The baseline conditions model scenario (Baseline Conditions) of the Fish Flow Project EIR assumed system losses consistent with existing conditions and minimum instream flow requirements consistent with the current Water Agency's Water Rights Permits which includes instantaneous compliance to minimum instream flows. All alternatives analyzed for the Fish Flow Project EIR assume for the Water Agency and its customers diversion rates of 75,000 acre-feet per year as allowed under the Water Agency's Water Right Permits. The Fish Flow Project EIR analysis included 2 no project scenarios. The first no project (No Project 1) alternative is consistent with the Baseline Conditions scenario in all respects, but evaluates for the Water Agency and its customers a diversion rate of 75,000 acre-feet per year. The second no project alternative (No Project 2) assumes minimum instream flow requirements consistent with the interim flows required in the Biological Opinion. The Fish Flow Project EIR also includes a proposed project alternative (Proposed Project) which incorporates 5-schedules of minimum instream flows. Aside from the No Project 1 alternative all the minimum instream flow alternatives evaluated in the Fish Flow Project EIR assume a 5-day moving average minimum

instream flow compliance for *Normal* and *Dry* condition schedules for the 3-schedule alternatives. A 5-day moving average compliance was also assumed for *Schedules* 1 to 4 for the 5-schedule alternatives. All alternatives assumed instantaneous minimum instream flow compliance for *Critical* and *Schedule 5* flows.

2.2.3 Hydrologic Index

In addition to reducing the minimum instream flow requirements as required in the Biological Opinion, the Water Agency is also pursuing changes to the hydrologic index defined in the Water Agency's water right permits. The hydrologic index is a metric that is intended to represent hydrologic conditions in the watershed for a given period and is used to set the minimum instream flow schedule for the Russian River system. The index should be representative of the system's operational ability to meet all demands for water. As discussed in Section 2.1.6.1, the existing hydrologic index is a 3-schedule index with conditions designated as *Normal*, *Dry* and *Critical*. The index is calculated from cumulative flow into Lake Pillsbury[3] beginning on October 1 and hydrologic conditions are evaluated on the first of the month from January 1 to June 1. The thresholds of the hydrologic index defined in the Water Agency's water right permits are provided in Figure 2-9.

The Water Agency will also be filing petitions with the SWRCB to change the existing hydrologic index defined in its water right permits. To aid in the development of a new hydrologic index the Water Agency assembled a technical advisory group with members from the USGS, NOAA, USACE, California Department of Water Resources, and University of California Berkeley. The USACE Hydrologic Engineering Center (HEC) acted as the technical lead in this process to oversee the development and analysis of a range of possible hydrologic index alternatives. A report summarizing their analysis was prepared by HEC titled "*Determination of a Hydrologic Index of the Russian River Watershed using HEC-ResSim*" in 2012 (HEC, 2012). The Water Agency built off of the efforts of HEC and the technical advisory group to develop the preferred hydrologic index alternative, the Russian River Hydrologic Index, which is described in further detail in the Water Agency report, "*Development of the Russian River Hydrologic Index for the Fish Habitat Flows and Water Rights Project"* (SCWA, 2016).

In summary, the Russian River Hydrologic Index is a five-schedule index (5 schedules of minimum instream flow requirements as opposed to the existing 3 schedule hydrologic index). The minimum instream flow schedules (Flow Schedules) are defined as *Schedule 1*, *Schedule 2*, *Schedule 3*, *Schedule 4*, and *Schedule 5* with *Schedule 1* being the wettest Flow Schedule and *Schedule 5* being the driest. Under the proposed index, Flow Schedules for the Lower Russian River and Dry Creek will be determined by cumulative inflow into Lake Mendocino (Inflow Condition) beginning on October 1of the previous year and evaluated on the first of the month from January 1 to October 1 against a series of cumulative inflow thresholds. The Flow Schedule set by the October 1 evaluation will remain in effect for the remainder of the calendar year. Flow Schedules for the Upper Russian River will be determined by Inflow Condition from January 1 to May 31 and beginning on June 1 to December 31, the proposed index will evaluate

[3] Cumulative inflow into Lake Pillsbury is running accumulated volume of flow into the lake starting with the beginning of the water year (October 1) and ending on May 31.

Lake Mendocino storage levels (Storage Condition) against a series of storage thresholds. On the first day of the month from June 1 to December 1 the combination of Storage Condition and Inflow Condition will be used to determine Flow Schedules for the Upper Russian River. For the evaluation dates from June 1 to September 1, if the Storage Condition exceeds the Inflow Condition then the Flow Schedule is increased to a maximum of one schedule greater than the Inflow Condition. For the evaluation dates from October 1 to December 1 if the Storage Condition exceeds the Inflow Condition by greater than one schedule then the Upper Russian River Flow Schedule may be greater than Inflow Condition but can only change at a rate of one schedule per month.

3 Russian River ResSim

RR ResSim is an operations modeling system for the Russian River developed using the USACE HEC ResSim software package. The model is used as a planning tool to simulate the effects of various climatic and hydrologic conditions, levels of system loss, and operational criteria on the water supply available for use by the Water Agency and others and to simulate resulting streamflows from these processes. RR ResSim simulates storage levels in and releases from Lake Mendocino and Lake Sonoma, and flows at 14 locations (junctions) along the Russian River, taking into account USACE flood control operations criteria and Water Agency Operations to meet minimum instream flow requirements and downstream water demands. Additionally the model was used to simulate conditions for 28 alternatives evaluated in the Fish Flow Project EIR. These alternatives incorporated different combinations of minimum instream flow schedules and hydrologic index alternatives.

Model junctions correspond with existing USGS discharge gaging stations or the confluence of major water bodies. Reach gains from unimpaired flows and losses due to human water use or natural processes are defined at each model junction. Model reaches referenced in this report are defined by their downstream junction. For instance, the Cloverdale reach extends from the Hopland model junction to the Cloverdale model junction. A schematic of the RR ResSim model is provided as Figure 3-1, with red triangular points indicating the locations of model reservoir junctions and blue circular points indicating the locations of model flow junctions. The figure also indicates the locations at which system water gains are defined by green solid arrows and system losses are defined by red hollow arrows. Figure 3-1 provides a list of model junctions ordered from upstream to downstream, indicating the junction type and the corresponding USGS discharge station where appropriate.

The following sub-sections provide descriptions of the difference components of the RR ResSim model as well as the methods employed to develop the datasets to simulate existing conditions and future project conditions. Existing conditions (Existing Conditions) datasets were developed to approximate how the system is currently operated and simulate hydrologic responses consistent existing operations. Projected conditions datasets were developed to support the Cumulative Impact Analysis of the Fish Flow Project EIR (SCWA, August 2016).

Table 3-1. Russian River ResSim Model junctions.

#	RR ResSim Model Junction Name	Junction Type	Gage Owner	Gage Name	Gage ID
1	Potter Valley Project	Flow	USGS	East Fork of the Russian River and Potter Valley PH	11461501
2	Calpella	Flow	USGS	East Fork of the Russian River Near Calpella	11461500
3	Lake Mendocino	Reservoir	USACE	Coyote Valley Dam Release	COY
4	East - West Jct	Flow		-	-
5	Hopland	Flow	USGS	Russian River Near Hopland	11462500
6	Cloverdale	Flow	USGS	Russian River Near Cloverdale	11463000
7	Healdsburg	Flow	USGS	Russian River Near Healdsburg	11464000
8	Lake Sonoma	Reservoir	USACE	Warm Springs Dam Release	WRS
9	Dry Creek Geyserville	Flow	USGS	Dry Creek Near Geyserville	11465200
10	Dry Creek Mouth	Flow	USGS	Dry Creek Mouth Near Healdsburg	11465350
11	Dry Creek - Russian River Jct	Flow		-	-
12	SCWA Diversion	Flow		-	-
13	Mark West Creek Jct	Flow		-	-
14	Hacienda	Flow	USGS	Russian River Near Guerneville	11467000

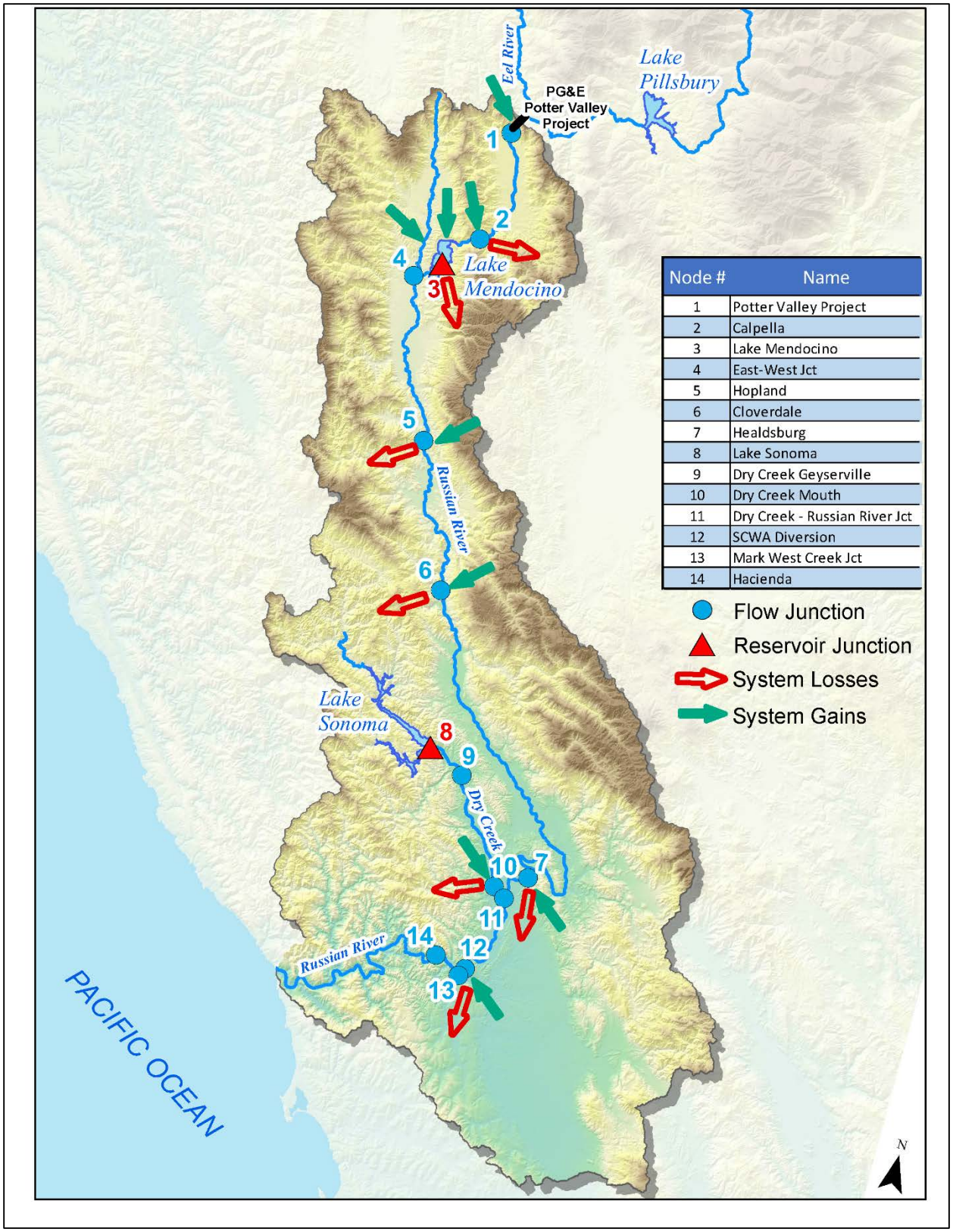

Figure 3-1. Schematic of Russian River ResSim with model junction locations and the locations of defined system gain and loss boundary conditions.

3.1 System Gains

System gains include all water that is added to the system, and are from both natural and man-made sources. The gains accounted for in the model include unimpaired flows (often called "natural" flows) from precipitation runoff or groundwater and diversions from the Eel River through the PVP. Model system gain locations are shown as green solid arrows in Figure 3-1.

3.1.1 USGS Unimpaired Flows

Unimpaired flows are the "natural flows," unaffected by man-made influences such as water demands or reservoir operations. The model accounts for system gains from unimpaired flows at eight geographic points in the Russian River System. Unimpaired flow datasets were developed by the USGS (USGS, 2015) for historical climate from 1910 to 2013. The USGS used the Basin Characterization Model for California (CA-BCM) to integrate high-resolution data of historical and projected climate data to predict watershed-specific hydrologic responses.

3.1.1.1 Review of USGS Unimpaired Flows

The Water Agency conducted a review of the historical unimpaired flow datasets prepared by the USGS in an effort to ensure that these flows accurately represent the hydrology of the Russian River System. To complete this review, modeled unimpaired flows were compared to observed flow gains between model junctions. This analysis was only conducted for the period December to April, because of the relatively low volume of consumptive use during this period. Consequently, the accuracy of the unimpaired flows developed by the USGS can be compared to the observed flow gains for the same period. The total period of this analysis varies for each model junction due to the period of record available of observed flows. The results of this analysis is summarized below for each model reach.

3.1.1.1.1 Lake Mendocino Unimpaired Inflows

Observed daily local flows into Lake Mendocino were estimated by summing daily observed flow gains for the Calpella reach with observed flow gains for the CVD reach for the years 1959 to 2013. Calpella reach gains were estimated by subtracting observed PVP powerhouse releases from observed flows at the USGS East Fork Russian River near Calpella gage (Calpella gage). Similarly CVD reach gains were estimated by subtracting observed Calpella Gage flows from Lake Mendocino inflows calculated by the USACE. Total flow volumes for the period December to April were estimated for both the observed local flows and the estimated unimpaired flows developed by the USGS. A scatter plot of the USGS unimpaired flows and observed local flows for Lake Mendocino is provided in Figure 3-2. These results show that the USGS unimpaired flows compare very well with the observed local flows with a least-squares linear regression fit of approximately 1.02 to 1 correlation and a coefficient of determination (R^2) squared of 0.96. A percent exceedance plot of December to April flow volumes for the USGS unimpaired flows and the observed local flows is provided in Figure 3-3. These results show that the distribution of the modeled unimpaired flow volumes matches very closely with the observed local flow volumes.

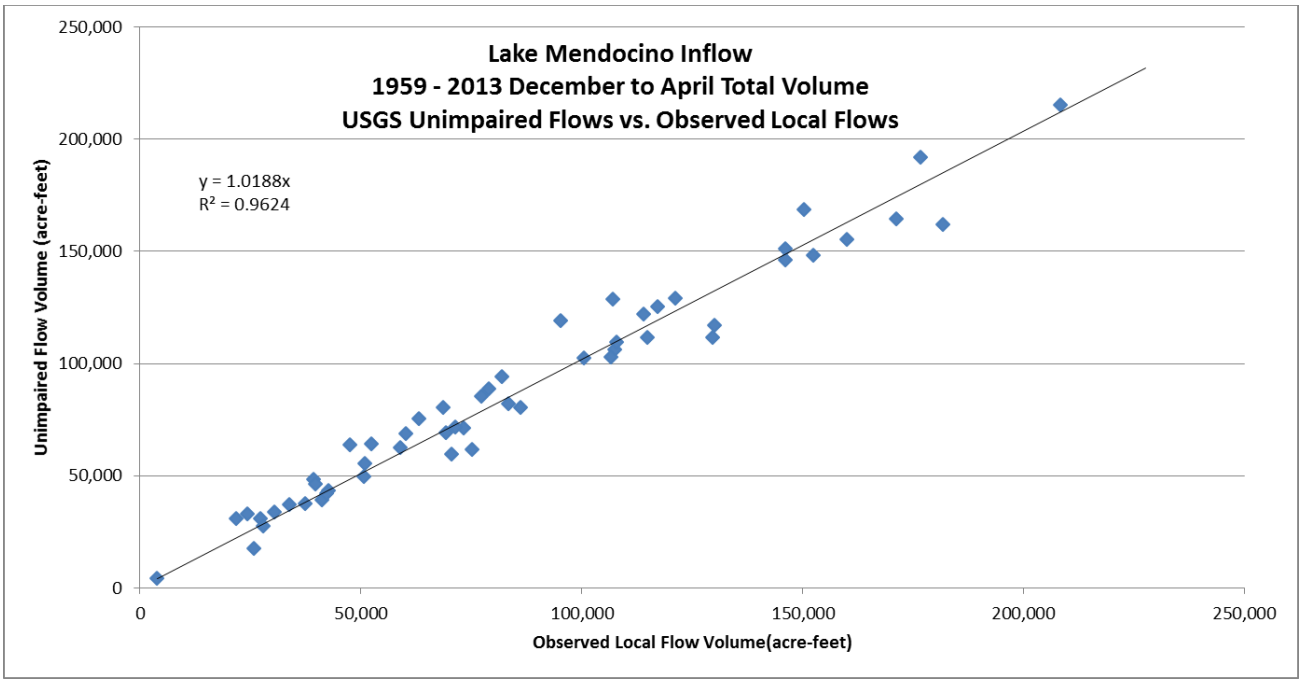

Figure 3-2. Scatter plot of 1959 to 2013 December to April Lake Mendocino unimpaired inflow volumes simulated by the USGS versus observed Lake Mendocino inflow volumes.

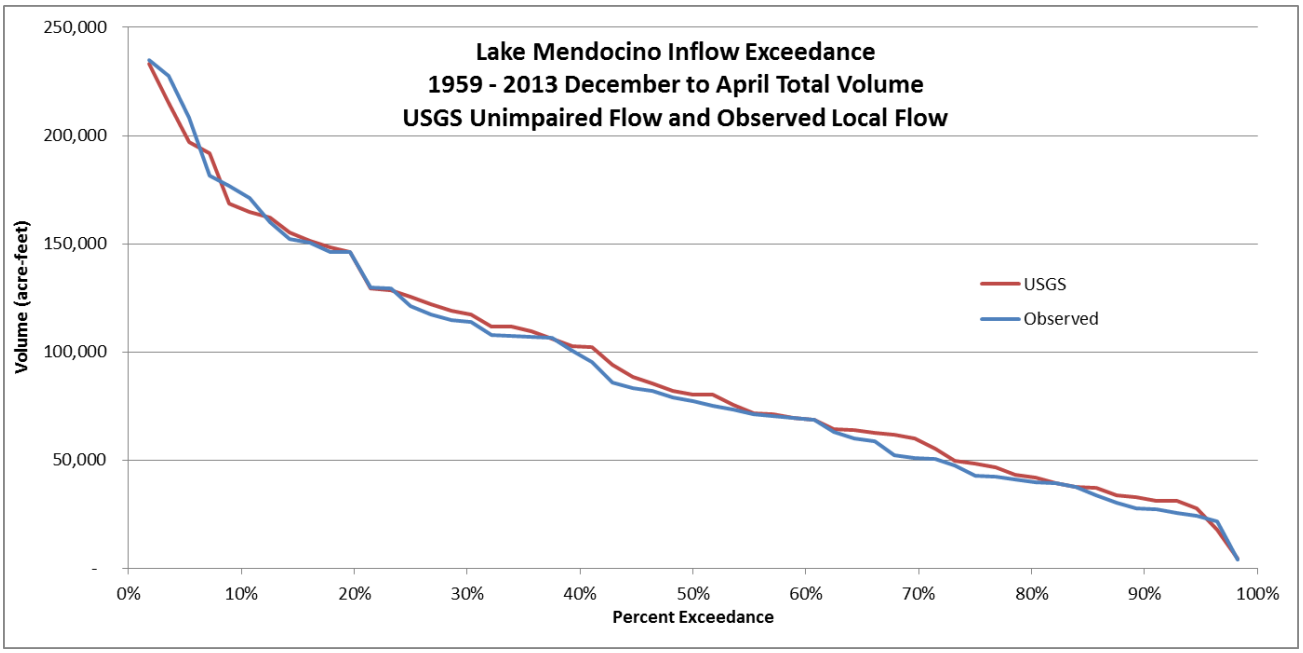

Figure 3-3. Percent exceedance of 1959 to 2013 December to April Lake Mendocino unimpaired inflow volumes simulated by the USGS and observed local flows.

3.1.1.1.2 Upper Russian River Flows

Observed daily local flows for the Upper Russian River reach (CVD to the confluence of Dry Creek) were estimated by summing daily observed flow gains for the Forks, Hopland, Cloverdale, and Healdsburg flow gages for the years 1959 to 2013. With the exception of the

Forks flows, observed daily local flows were calculated for each model junction by subtracting upstream observed flows from downstream observed flows. For the Forks, it was assumed that the observed local flows are equal to the observed flows from the West Fork Gage which is just a short distance from the Forks. Flow travel times, as discussed in Section 0, were taken into consideration in the calculation of the observed local flows. Total observed flow volumes were calculated for the period December to April of each year from the Forks to the Healdsburg flow gages. Similarly total flow volumes of the USGS estimated unimpaired flows were calculated for the December through April period of each year for the Forks to Healdsburg model junctions. A scatter plot of the USGS unimpaired flows and observed local flows for the Upper Russian River is provided in Figure 3-4. These results show that the USGS unimpaired flows compare very well with the observed local flows with a least-squares linear regression fit of approximately 0.99 to 1 correlation and a R^2 of 0.99. A percent exceedance plot of December to April flow volumes for the USGS unimpaired flows and the observed local flows is provided in Figure 3-5. These results show that the distribution of the modeled unimpaired flow volumes matches very closely with the observed local flow volumes.

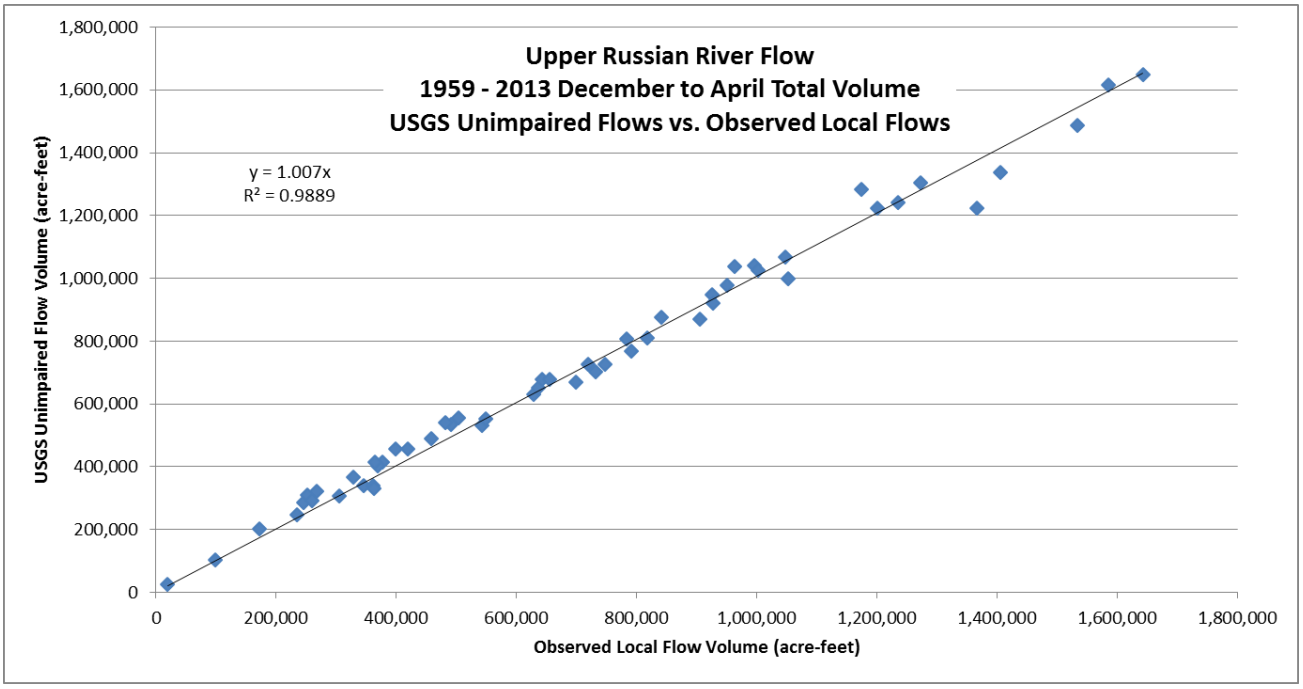

Figure 3-4. Scatter plot of 1959 to 2013 December to April Upper Russian River unimpaired inflow volumes simulated by the USGA versus observed Upper Russian River inflow volumes.

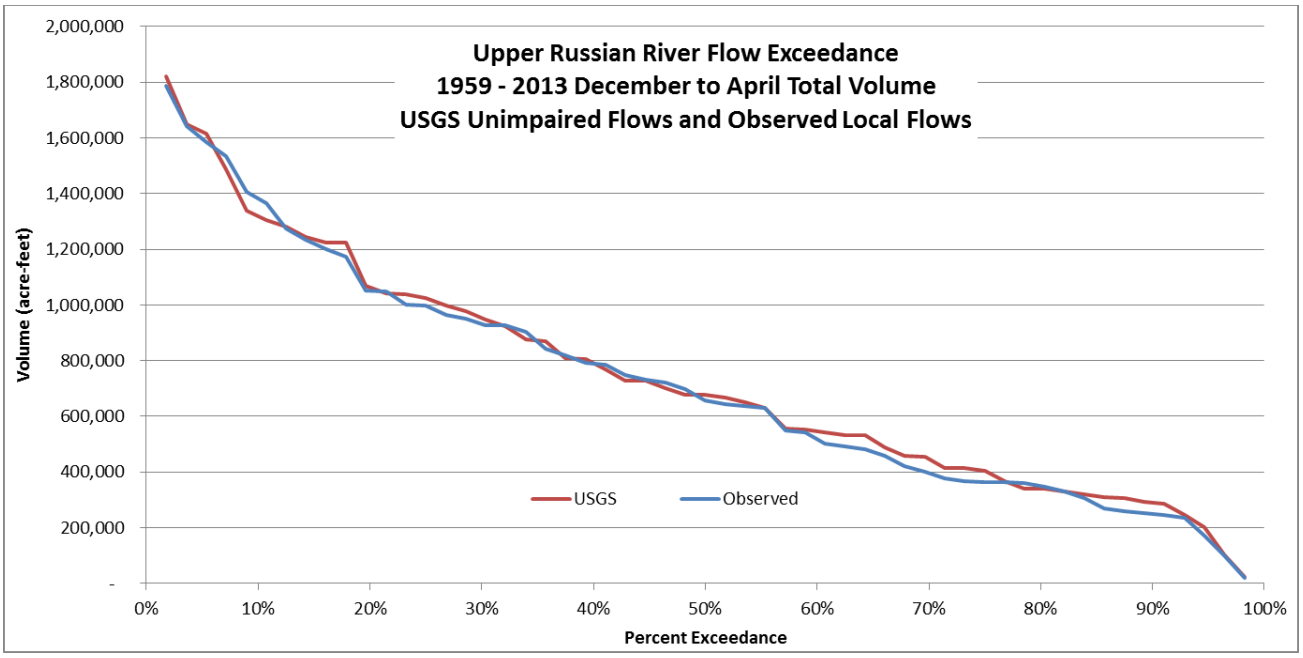

Figure 3-5. Percent exceedance of 1959 to 2013 December to April Upper Russian River unimpaired inflow volumes simulated by the USGS and observed local inflow volumes.

3.1.1.1.3 Lake Sonoma

Total flow volumes for the period December to April were estimated from the Lake Sonoma inflows calculated by the USACE and the estimated unimpaired flows developed by the USGS for the years 1989 to 2013. A scatter plot of the USGS unimpaired inflows versus observed inflows for Lake Sonoma is provided in Figure 3-6. These results show that the USGS unimpaired flows compare very well with the observed local flows with a least-squares linear regression fit of approximately 1 to 1 correlation and a R^2 of 0.97. A percent exceedance chart of December to April inflow volumes for the USGS unimpaired inflows and the observed inflows is provided in Figure 3-7. These results show that the distribution of the modeled unimpaired flow volumes matches very closely with the observed local flow volumes.

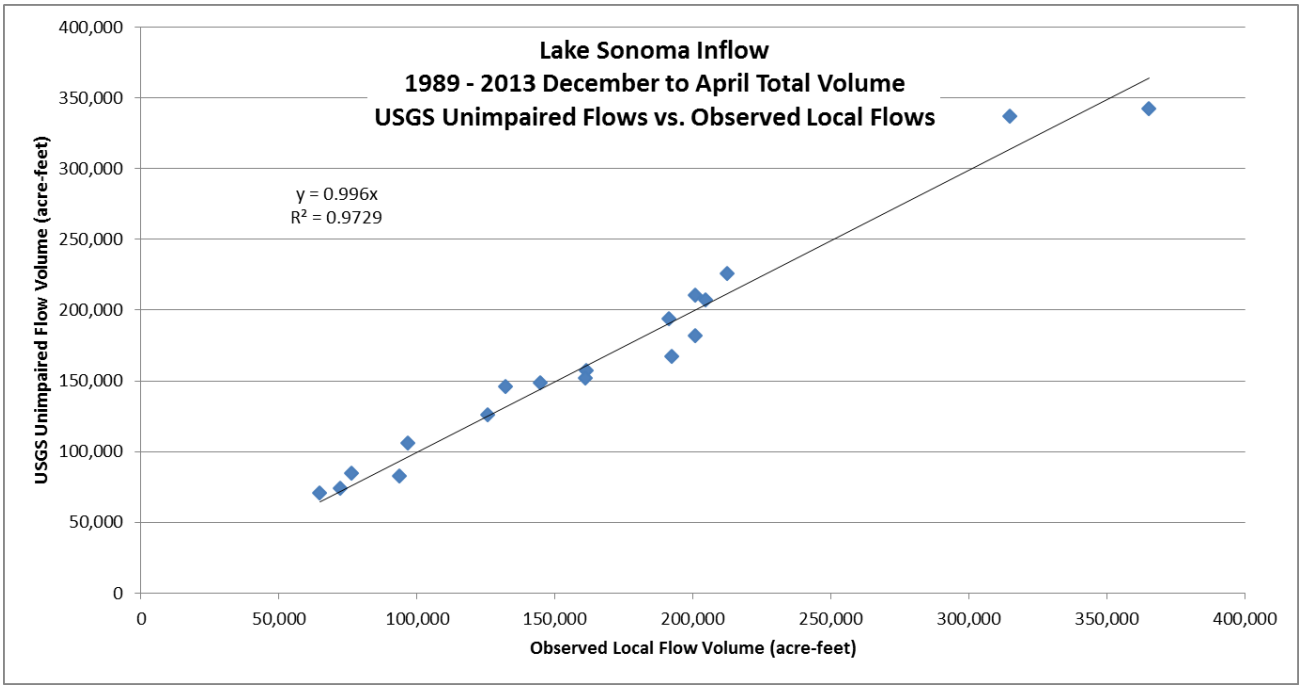

Figure 3-6. Scatter plot of 1989 to 2013, December to April Lake Sonoma unimpaired inflow volumes simulated by the USGS versus observed local Lake Sonoma inflow volumes.

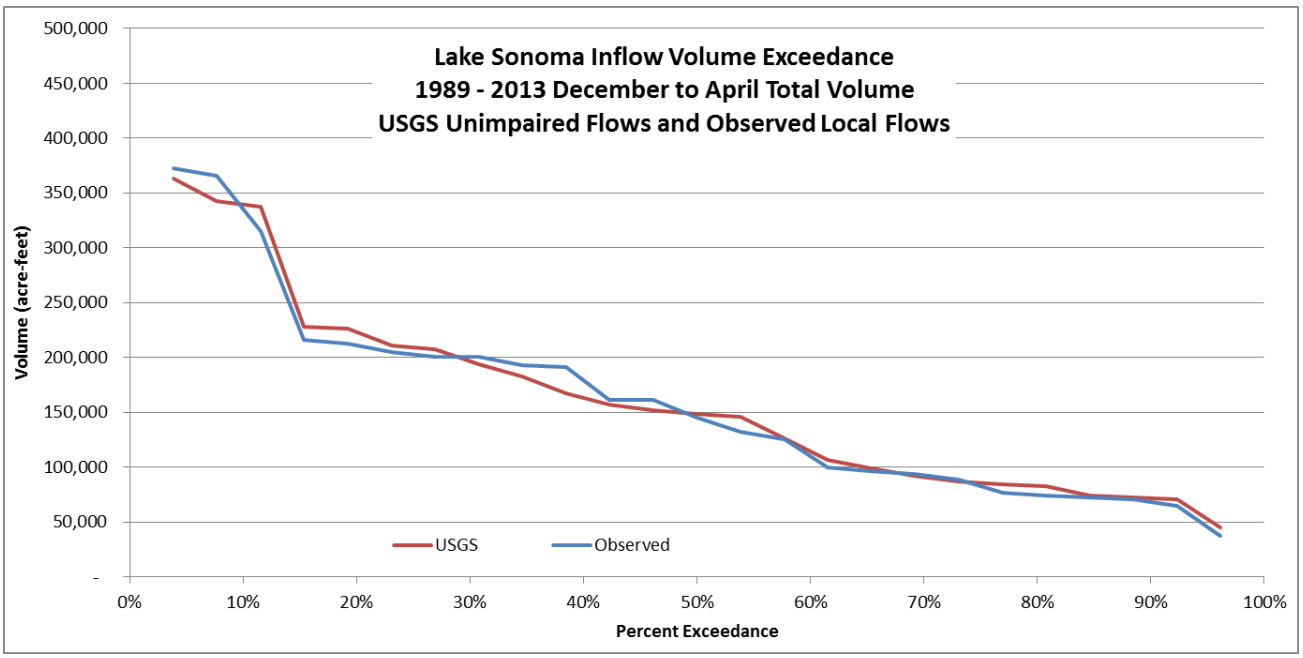

Figure 3-7. Percent exceedance of 1989 to 2013 December to April Lake Sonoma unimpaired inflow volumes simulated by the USGS and observed local inflow volumes.

3.1.1.1.4 Dry Creek

Observed daily local flows for the Dry Creek reach (WSD to the Dry Creek Mouth near Healdsburg gage) were estimated by subtracting observed daily releases from WSD recorded by the USACE from observed flows from the Dry Creek Mouth near Healdsburg gage (Dry Creek Mouth gage) for the years 1982 to 2013. For the period of this analysis, the Dry Creek

Mouth gage was only rated for flows below 200 cfs, and above this amount flows were not estimated. For this analysis, flows above 200 cfs at the Dry Creek Mouth gage were synthetically derived in order to create a continuous time series. Observed flows at the Dry Creek near Geyserville gage were scaled by the ratio of the subwatershed areas of the Dry Creek Mouth gage to the Dry Creek Geyserville gage (a scaling factor of 1.34). Any data gaps in the Dry Creek Mouth gage were filled with the scaled flows. A flow travel time of 1 day, as discussed in Section 0, was taken into consideration in the calculation of the observed local flows. Total observed flow volumes were calculated for the period December to April of each year for the Dry Creek gage. Total flow volumes were also calculated for the USGS unimpaired flows for the Dry Creek Mouth model junction for December to April of each year. A scatter plot of the USGS unimpaired flows and observed local flows for the Dry Creek gage is provided in Figure 3-8. These results show that the USGS unimpaired flows compare very well with the observed local flows with a least-squares linear regression fit of approximately 0.96 to 1 correlation and a R^2 squared of 0.95. A percent exceedance chart of December to April flow volumes for the USGS unimpaired flows and the observed local flows is provided in Figure 3-9. These results show that the distribution of the modeled unimpaired flow volumes matches very closely with the observed local flow volumes.

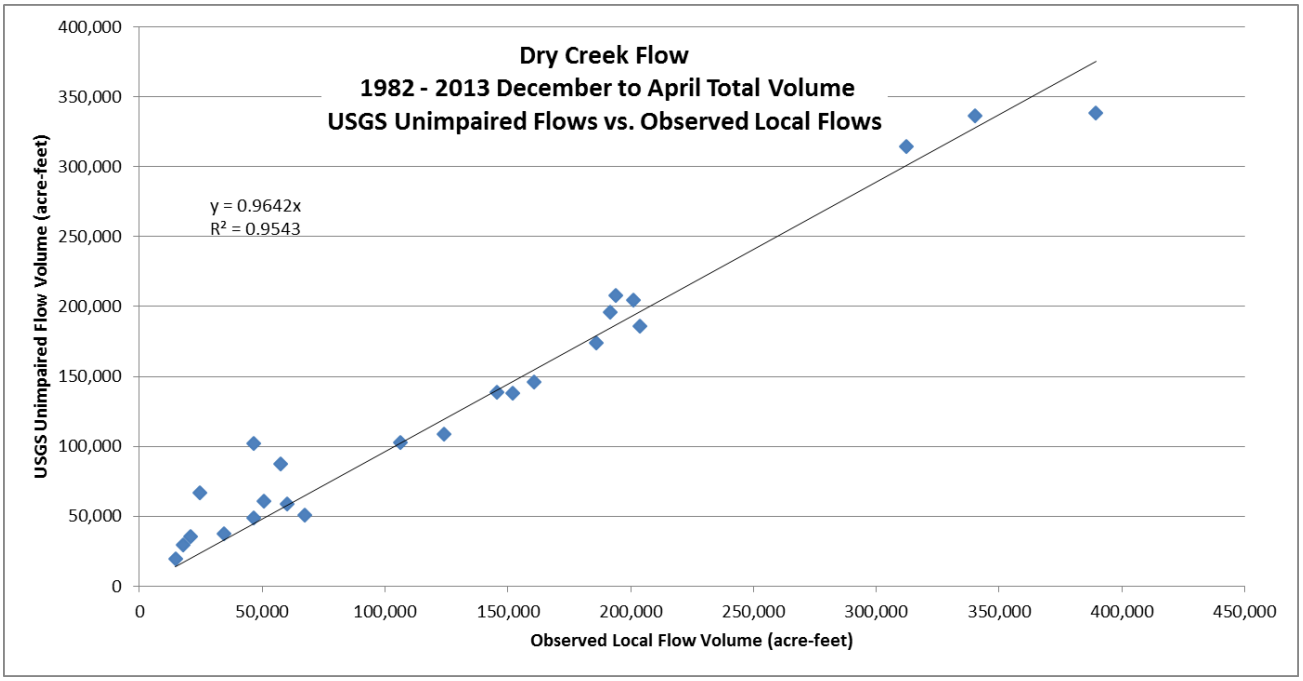

Figure 3-8. Scatter plot of 1982 to 2013 December to April Dry Creek unimpaired inflow volumes simulated by the USGS versus observed local Dry Creek inflow volumes.

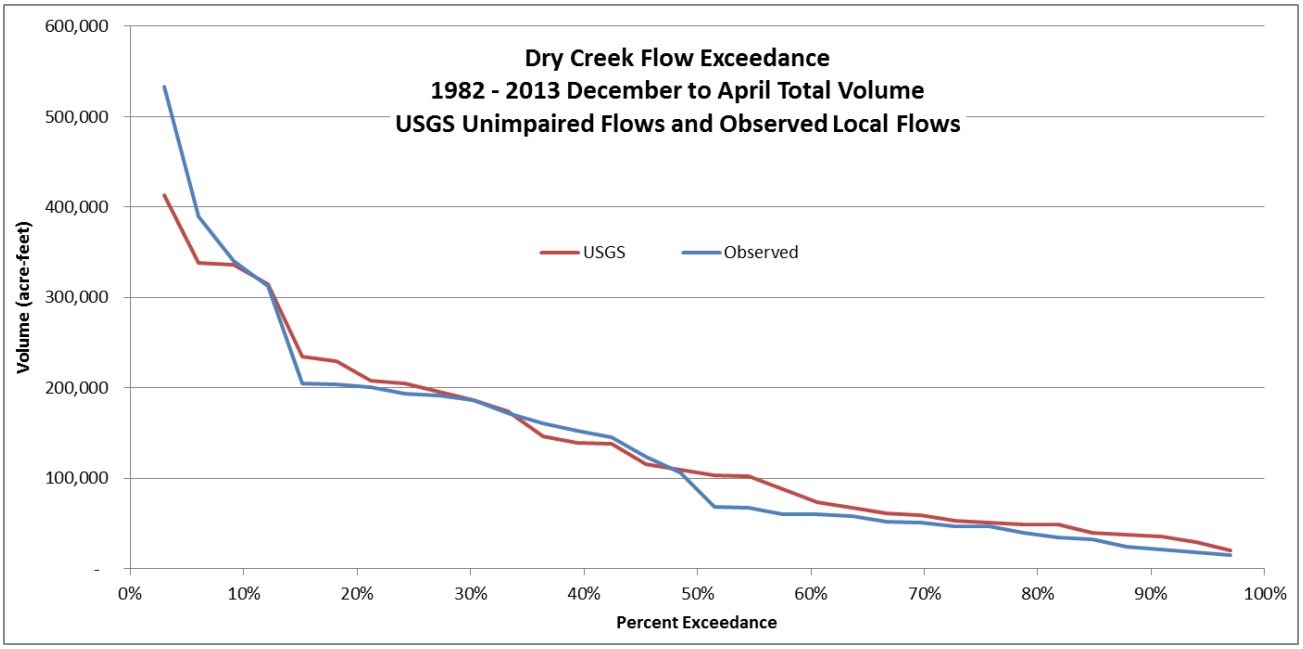

Figure 3-9. Percent exceedance of 1982 to 2013 December to April Dry Creek unimpaired inflow volume simulated by the USGS and observed local inflow volumes.

3.1.1.1.5 Lower Russian River

Observed daily local flows for the Lower Russian River reach (confluence of Dry Creek to Hacienda Bridge) were estimated for the years 1982 to 2013. These local flows were estimated by a water balance analysis of the observed flows from the Dry Creek Mouth gage, the Healdsburg Gage, the Hacienda Gage and metered diversions made by the Water Agency at the Wohler and Mirabel facilities. Flow travel times, as discussed in Section 0, were taken into consideration in the calculation of the observed local flows. Total flow volumes were calculated for the period December to April of each year for the Lower Russian River for both the observed local flows and the estimated unimpaired flows developed by the USGS. A scatter plot of the USGS unimpaired flows and observed local flows for Lower Russian River is provided in Figure 3-10. These results show that the USGS unimpaired flows compare well with the observed local flows with a least-squares linear regression fit of approximately 0.85 to 1 correlation and a R^2 of 0.80. A percent exceedance chart of December to April flow volumes for the USGS unimpaired flows and the observed local flows is provided in Figure 3-11. These results show that the distribution of the modeled unimpaired flow volumes matches very closely with the observed local flow volumes for 45% to 100% exceedance range, which is the drier, lower flow conditions. The USGS unimpaired flows are biased lower than the observed local flows from the 0% to 45% exceedance range, which is the range of for wetter conditions and high stream flows. High winter unimpaired flows were challenging for the USGS to calibrate due to lack of observed flow data for this section of the river and also likely due to the very complex flow dynamics that occur between the Lower Russian River and the Mark West Creek tributary.

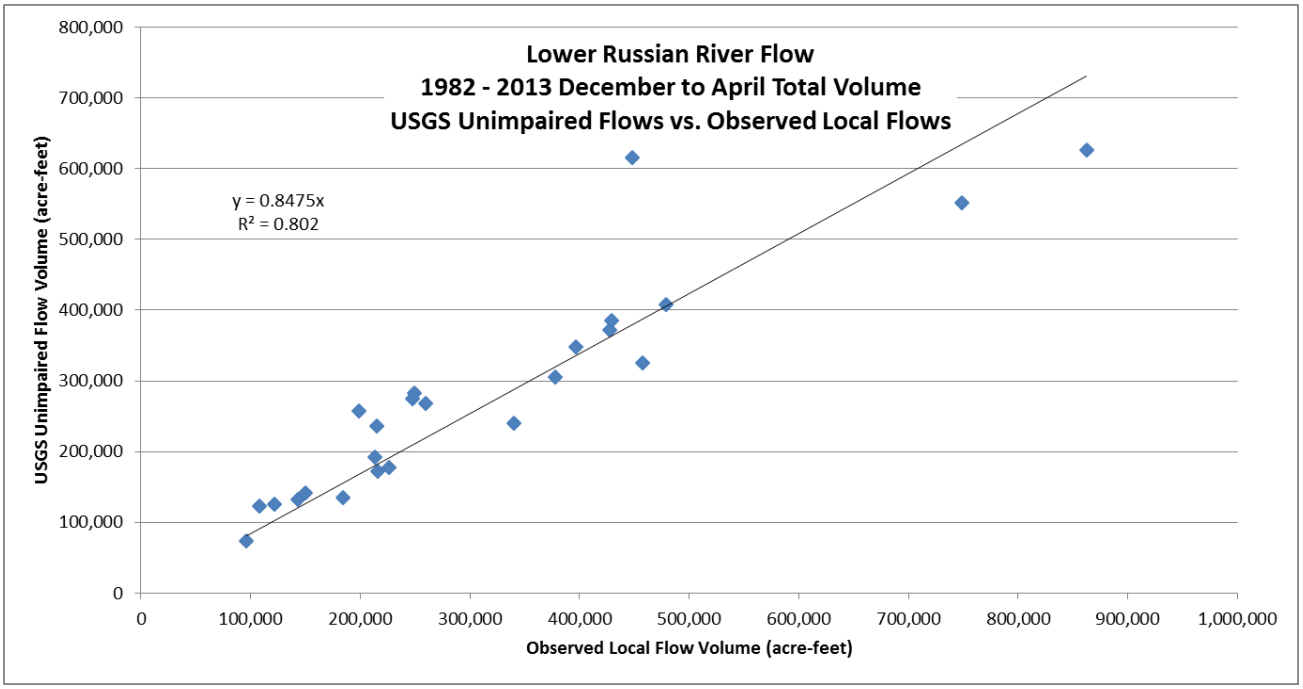

Figure 3-10. Scatter plot of 1982 to 2013 December to April Lower Russian River unimpaired inflow to volumes simulated by the USGS versus observed Lower Russian River inflow volumes.

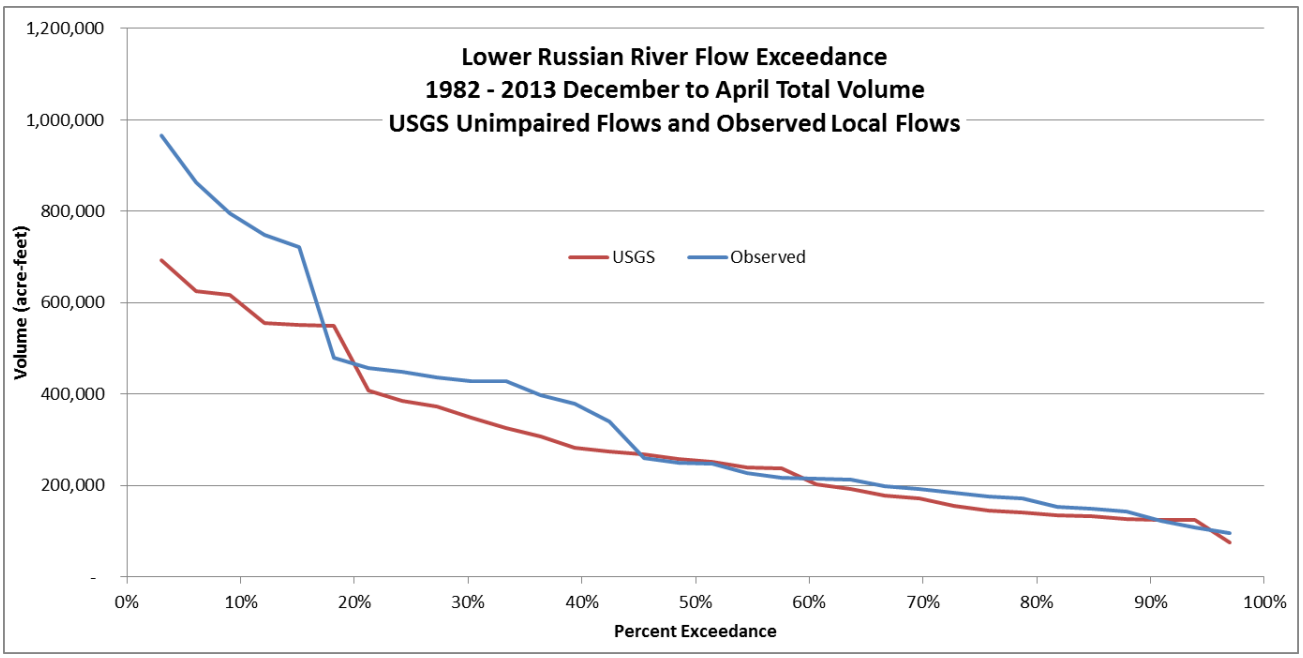

Figure 3-11. Percent exceedance of 1982 to 2013 December to April Lower Russian River unimpaired inflow volumes simulated by the USGS and observed local inflow volumes.

3.1.2 Potter Valley Project Diversions

Trans-basin water imports from the Eel River into the Russian River through the PVP were estimated using the Eel River Model version 2.5. Due to the substantial changes in operations

of the PVP during the historical period simulated by the model, observed historical diversions were not used. As discussed in Section 2.1.3, in the fall of 2006 operations of the PVP changed significantly as a result of a 2004 FERC license amendment for the PVP. Consequently, historical diversions would not be representative of existing operations of the PVP. Modeled PVP diversions were developed to approximate current, post-fall 2006 operational constraints and practices (Existing Conditions). The estimated PVP diversions from the Eel River Model are provided as input into the RR ResSim at model junction 1 as shown in Figure 3-1.

The Eel River Model version 2.3, developed by Natural Resources Consulting Engineers (Oakland, CA), was used for the alternatives analysis that resulted in the 2004 FERC license amendment. In 2007, version 2.4 was developed by the Water Agency and the model was modified to better account for the E5 Condition of the license amendment. The Water Agency further modified the model and developed the Eel River Model version 2.5 (ER2.5). Version 2.5 was developed through further refinements to the model code and input datasets to better simulate existing operations of the PVP under: (a) the 2004 FERC license amendment (FERC 2004) operational requirements as detailed in the "NOAA Fisheries' Reasonable and Prudent Alternative"; and (b) the "Flow Regulation and Verification Plan" (FRVP; PG&E, 2006). ER2.5 was used to estimate PVP Tunnel diversions and Lake Pillsbury storage levels under existing management practices of the PVP for historical hydrology for water years 1910 to 2006. Because PVP operations during water years 2007 to 2013 are consistent with existing management practices, actual diversions were used for those years. Modifications made to the model for the development of ER2.5 are summarized in the following sections.

3.1.2.1 E5 Condition

The E5 condition of the 2004 RPA provides that diversions through the PVP Tunnel in excess of the minimum flow in the East Branch Russian River (E16) and the release to the PVID may only be made when Lake Pillsbury storage is above the Target Storage Curve (TSC). The model code was modified to conform to this condition with an additional minimum release buffer of 5 cfs as required in the FRVP (PG&E, 2006). The previous version (ER2.4) of the code would allow diversions in excess of the minimum flow requirements of E16 if Lake Pillsbury storage was below the TSC and Scott Dam was in a spill condition. The previous version also did not include the minimum release buffer.

3.1.2.2 E6 Condition

Model input datasets were modified to use the TSCs finalized in Condition E6 of the 2004 RPA, which includes three curve types (A, B and C). Different TSCs are used depending on the water year classification of the PVP, which is based on the water year cumulative Lake Pillsbury inflow as of May 15. Based on the water year classification as of May 15, the appropriate TSC is used for the following 12 months beginning on August 1 of that year. Model version ER2.4 only incorporated 2 TSCs, a wet and a dry curve, with different thresholds than those finalized in the 2004 RPA.

3.1.2.3 Maximum Diversions through the PVP Tunnel

The Eel River model defines a maximum diversion parameter to set Tunnel releases during any time when storage in Lake Pillsbury exceeds the TSC. Previous versions of the model assumed

this value to be the physical capacity of the Tunnel, approximately 305 cfs. An analysis of historical PVP operations from water year 2007 to 2014 shows that when storage is above the TSC, operators of the PVP rarely divert this maximum flow rate through the Tunnel and on average divert only approximately 150 cfs. The hydrograph included as Figure 3-12 shows historical Lake Pillsbury storage and diversions through the PVP Tunnel with power production diversion highlighted in red. Figure 3-12 shows that power production diversions only occur when Lake Pillsbury storage is above the TSC and that historical power production diversions were quite variable. The amount diverted for power production diversions is likely a function of several factors including energy demand, energy market prices and current operational constraints due to project maintenance and repair.

Model version ER2.4 set the maximum diversion parameter to 305 cfs, which, when compared to historical operations, overestimates annual diversions. Therefore, in effort to develop a model that best approximates Existing Conditions, post 2007 operations of the PVP, the maximum diversion parameter in ER2.5 was constrained to 150 cfs, the average power production diversion post implementation of the 2004 license amendment.

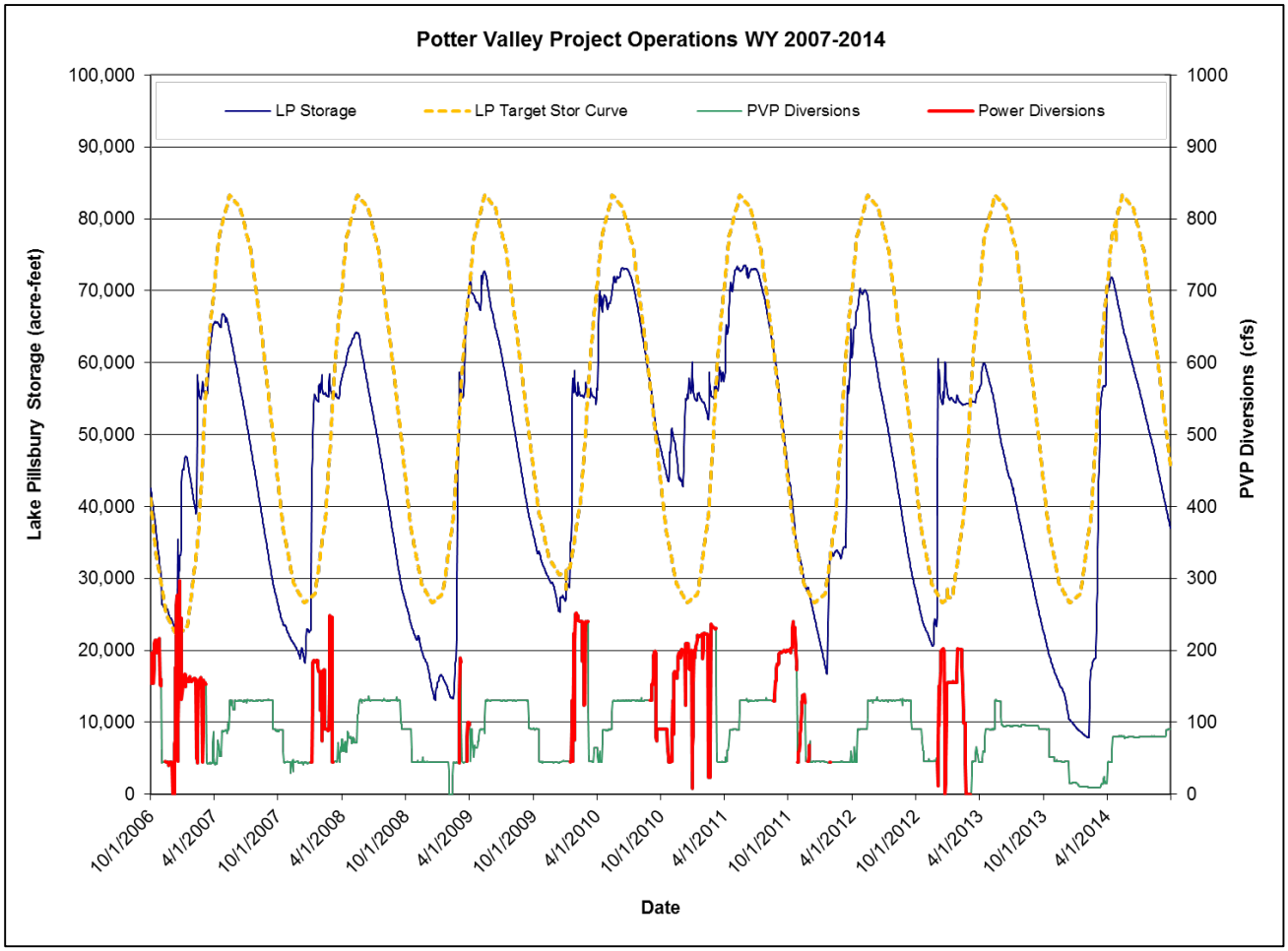

Figure 3-12. Hydrograph of observed Lake Pillsbury storage, Lake Pillsbury target storage curve, and diversions through the Potter Valley Project Tunnel with diversions where Lake Pillsbury storage is above the target storage curve highlighted in red.

3.1.2.4 Minimum Instream Flows at E11

Based on analysis of historical operations from water year 2007 to 2014, when Scott Dam is not in a spill condition and all releases are being made through the needle valve, releases from Scott Dam are made according to the current minimum instream flow requirements below Cape Horn Dam (E11), including a minimum flow buffer and releases through the PVP Tunnel. Accretion flows[4] between Scott Dam and Cape Horn Dam are not taken into consideration when determining Scott Dam releases. Model version ER2.4 included accretion flows in the water balance calculation to set Scott Dam releases when managing for minimum flows at E11. Therefore, the ER2.5 code was modified to better reflect actual operations by not including these accretion flows to help meet minimum flows at E11 and Tunnel releases. By not incorporating these accretion flows to set modeled releases from Scott Dam, ER2.5 more closely matches observed releases from Scott Dam than previous versions of the model.

The FRVP requires a release buffer of approximately 15 cfs from Cape Horn Dam when the minimum flows at E11 exceed 115 cfs. Review of historical operations from water year 2007 to 2014 show that a buffer of approximately 15 cfs is released from Cape Horn Dam at all minimum flows at E11. The ER2.5 model was modified to add a 15 cfs buffer to all minimum flows at E11 consistent with observed operations. The previous version of the model does not include any buffer to minimum flows at E11.

3.1.2.5 No Potter Valley Project Diversions

A scenario was developed for which no diversions from the Eel River to the East Branch of Russian River would be made through the PVP Tunnel. For this scenario, the code for ER2.5 was modified to not allow any diversions through the Tunnel while still making releases from Scott Dam to meet the minimum instream flow requirements below Cape Horn Dam at E11.

3.1.2.6 Projected Lake Pillsbury Storage Capacity

Ongoing sedimentation of Lake Pillsbury will result in a gradual reduction in the storage capacity resulting in reductions in diversions through the PVP Tunnel due to a reduced capacity to reach the thresholds set by the Lake Pillsbury TSC, and therefore reduced opportunities to make Tunnel diversions above the minimum Tunnel release requirements. For the Cumulative Impact Analysis of the Fish Flow Project EIR a model scenario was developed to simulate Tunnel diversions with projected 2040 Lake Pillsbury storage capacity conditions. To account for reduced storage capacity, projections of lake storage, lake surface area, and flow capacity of the needle valve were made using the observed sedimentation rates from the 1959 to 1984 bathymetric surveys.

3.1.2.7 Blockwater

The model allows for the simulation of Blockwater releases according to the requirements of Section D.1 of the NMFS RPA. The model code was modified to account for Blockwater releases consistent with operations under Existing Conditions. ER2.5 assumes that Blockwater is released every year between April and June to achieve a downstream target flow of 800 cfs at E11, downstream of Cape Horn Dam. This downstream flow rate is targeted until the entire Blockwater reserve of 2,500 acre-feet is used or until the Blockwater period (April to June) is

[4] Accretion flows are the gains in flows between Scott Dam and Cape Horn Dam.

over. This assumption is consistent with operations under Existing Conditions where Blockwater is typically reserved to release warmer water from the spillway of Scott Dam in the late winter to promote downstream migration of juvenile Chinook salmon. The model does not account for actual fisheries needs to schedule Blockwater releases, as is done in actual reservoir operations. The primary purpose for accounting for Blockwater releases in the model is to simulate how this operational practice affects Lake Pillsbury storage levels. Model version ER2.4 assumed that all Blockwater would be released between December and March with a downstream flow target at E11 of 100 cfs.

3.1.2.8 Model Scenarios

The ER2.5 model was used to simulate operations of the PVP and Tunnel diversions for 3 different scenarios:

1. Existing Conditions: simulates operations of the PVP consistent with post FERC License amendment operations;
2. Projected 2040 PVP Operations: simulates operations of the PVP consistent with post FERC License amendment operations but assumes Lake Pillsbury storage capacity projected to the year 2040; and
3. No PVP Tunnel Diversions: assumes no diversions of flow from the Eel River into the East Branch of the Russian River through the PVP Tunnel.

3.1.2.9 Eel River Model Results

Results of the updated ER2.5 were compared to observed PVP diversions from water year 2007 to 2013. A scatter plot of modeled monthly diversions versus observed monthly diversions is provided as Figure 3-13. Model results show very good agreement with observed diversions. As provided in Figure 3-13, a least-squares linear regression fit shows a coefficient of determination (R-squared) of 0.71 and also approximately 1 to 1 correlation. Model results correlate best for values below 8,000 acre-feet per month, which captures the range of operations for compliance (non-power production) diversions. Actual power production diversions are a function of numerous factors not accounted for in the model, such as operational constraints due to facility maintenance, energy demand, and energy market prices. Therefore, the increase in scatter for diversions above 8,000 acre-feet per month is expected. Percent occurrence of monthly PVP diversions is provided in Figure 3-14, which shows that the distribution of the simulated monthly diversions matches well with observed diversions, although for flows above 90%, observed diversions exceed simulated diversions. When comparing water year cumulative diversions as provided in Figure 3-15, model results compare very well with observed diversions. It should be noted that while modeled diversions for water years 2007 to 2013 were compared here to actual diversions to assess model performance, modeled diversions for these years were not actually used in the in the RR ResSim model. Instead actual observed diversions were used for water years 2007 to 2013 to provide the most accurate information for those years.

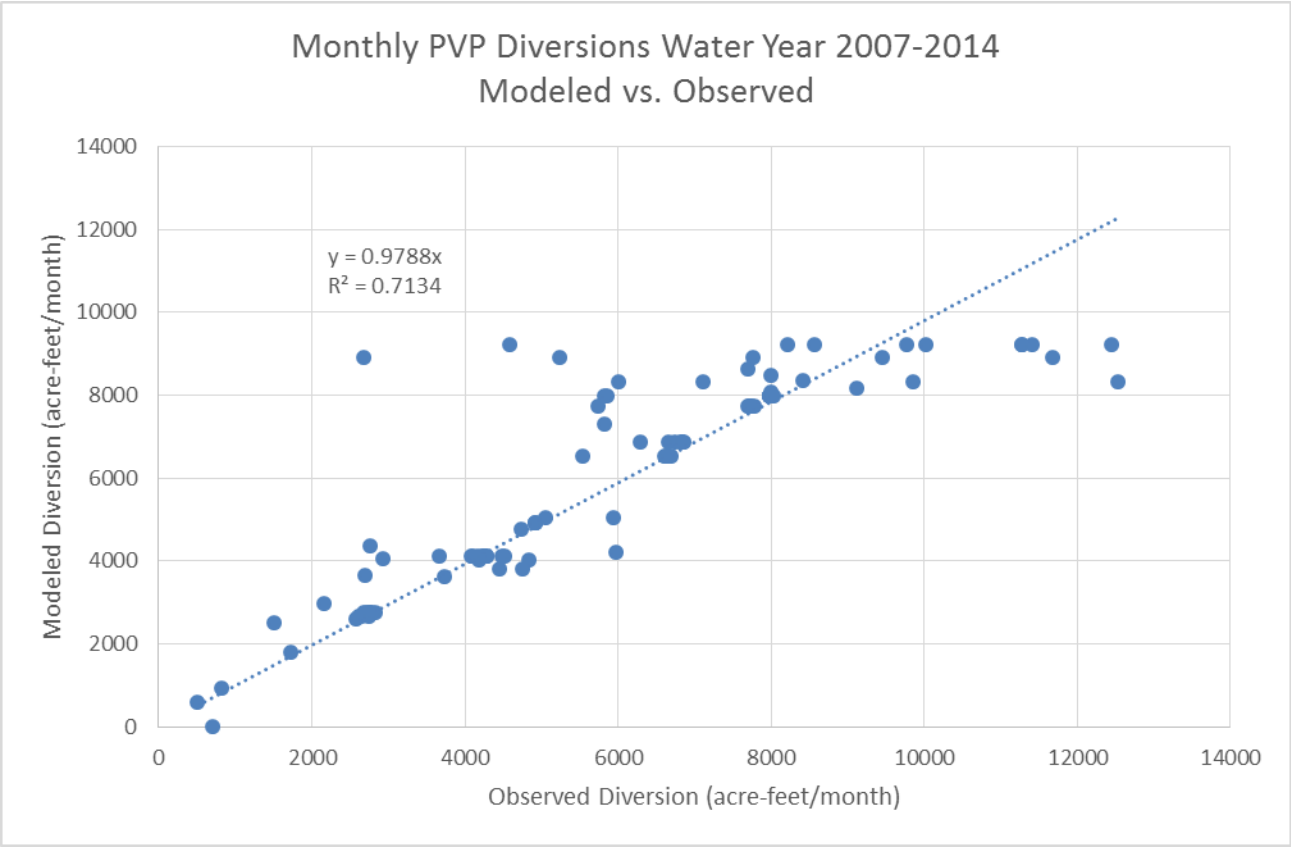

Figure 3-13. Scatter plot of monthly Potter Valley Project Tunnel diversions modeled with ER2.5 versus observed in acre-feet/month.

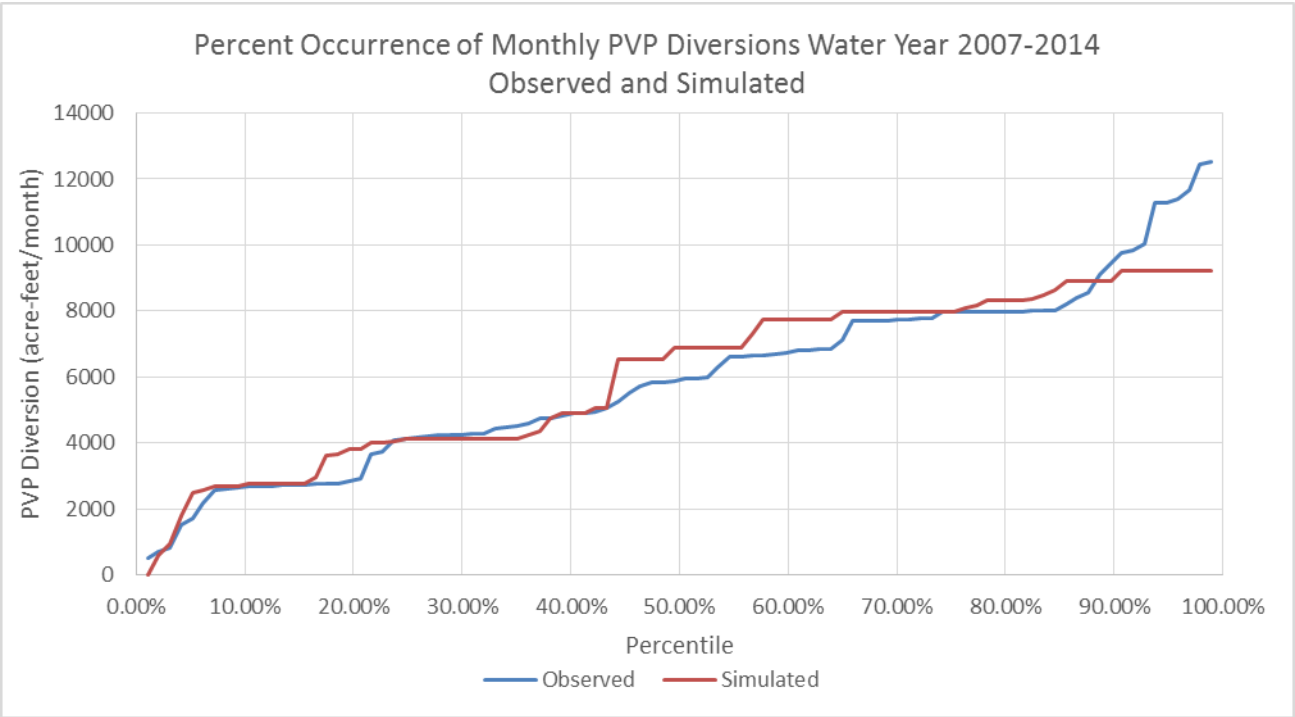

Figure 3-14. Percent occurrence of monthly Potter Valley Project Tunnel diversions modeled with ER2.5 and observed in acre-feet/month.

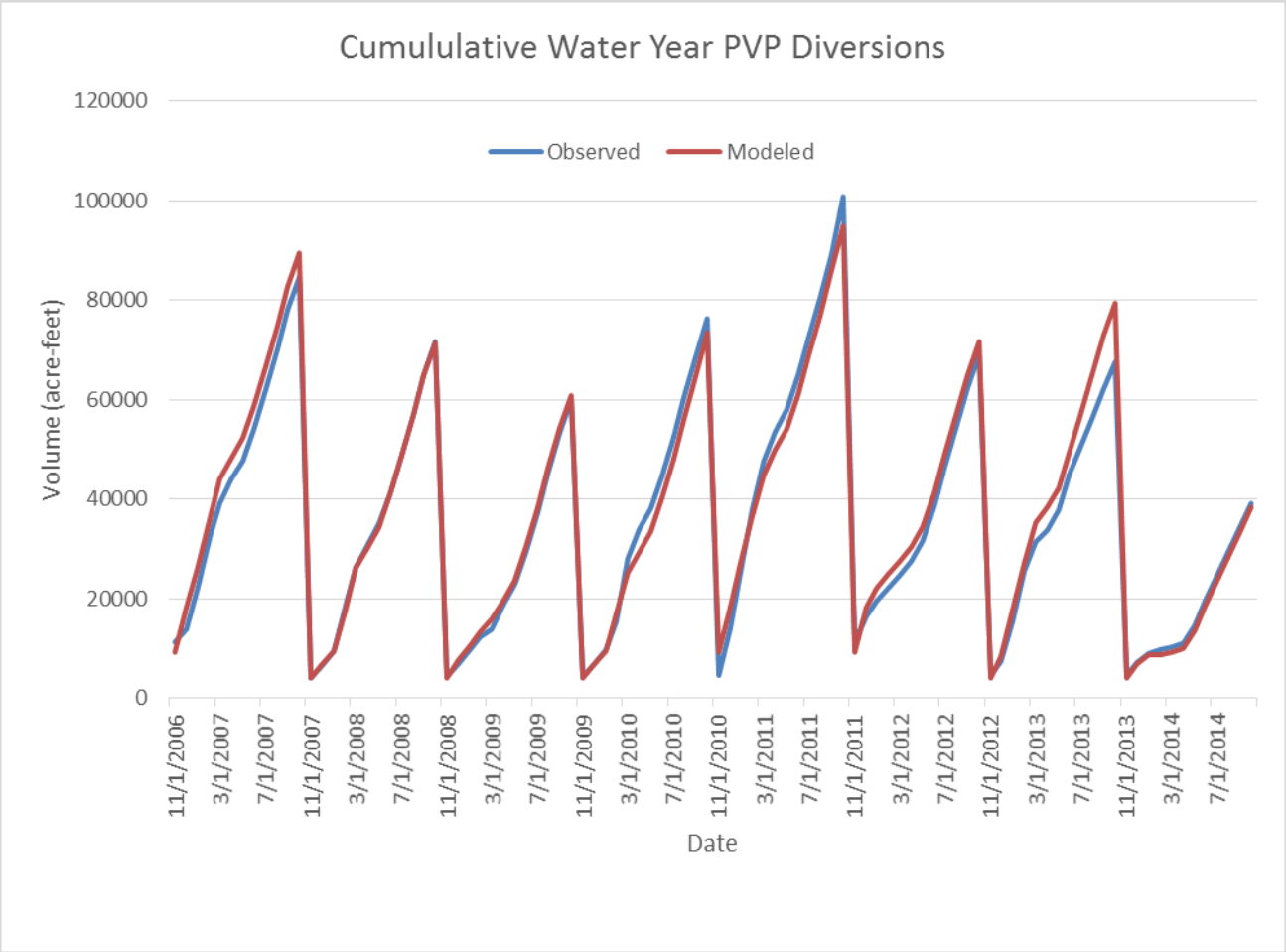

Figure 3-15. Hydrograph of water year cumulative (beginning October 1 and ending September 30) Potter Valley Project Tunnel Diversions modeled with ER2.5 and observed.

3.2 System Losses

The model accounts for system losses at seven geographic points on the Russian River and Dry Creek. System loss locations in the model are shown as hollow red arrows provided in Figure 3-1. System losses accounted for in the model include municipal diversions, agricultural diversions, reservoir surface evaporation, and water balance losses. Losses due to evapotranspiration from riparian vegetation and surface water/groundwater interactions are accounted through the analysis of water balance losses which is further discussed in Section 3.2.3.

3.2.1 Municipal Water Demands

3.2.1.1 Sonoma County Water Agency Demands

Water Agency demands were estimated for Baseline Conditions and the Water Agency's maximum annual diversion limit of 75,000 acre-feet[5]. Average daily baseline demands were estimated by Grinnell (Grinnell, 2016) through an analysis of observed diversions from 2009 through 2014. From this analysis, Grinnell estimated a Baseline Conditions demand of approximately 55,200 AFY. This includes Water Agency diversions from the Wohler and Mirabel production facilities, as well as diversions made by the Russian River customers under the Water Agency's water rights, which include diversions by the Town of Windsor, the City of Healdsburg, the Occidental Community Services District and the Camp Meeker Recreation and Park District. The Water Agency's full water right demands were estimated by multiplying the Baseline Conditions demands developed by Grinnell by a scaling factor to simulate total annual demand of 75,000 acre-feet.

As discussed in Section 2.1.6, under Term 8 of Decision 1610, diversions made by the Water Agency and the Russian River customers are subject to 30% curtailment requirements when storage levels in Lake Sonoma fall below 100,000 acre-feet prior to July 15 of each year. This provision is accounted for as a rule in RR ResSim, although the model assumes delivery deficiencies remain in effect at least until storage has recovered in Lake Sonoma to greater than 70,000 ac-feet after December 31. The model does not allow for earlier termination of curtailments based on other hydrologic conditions as is allowed in Term 8.

Cumulative 1 model scenario developed for the Cumulative Analysis of the Fish Flow Project EIR analyzes the projected demands of the Water Agency and the Russian River customers to the year 2040. These demands were developed in the 2015 Urban Water Management (UWMP) Plan prepared by the Water Agency. Development of the projected demand datasets is described further in the 2015 UWMP (SCWA, 2016). Total annual projected 2040 demand for the Water Agency and the Russian River customers is 75,800 acre-feet.

3.2.1.2 Other Public Water Systems

Water demands for municipal and industrial water use were estimated for 15 of the public water systems in the Russian River basin for which metered pumping data was available. These public water systems are included in Table 3-2. For these water systems, their water supplies are primarily composed of surface water and groundwater wells diverting underflow along the mainstem corridor of the Russian River or Dry Creek. Existing water demands for these water service providers were established using recent metered water production records provided by these public agencies. Demands to approximate Existing Conditions were estimated by Grinnell through an analysis of production records from the five-year period from 2009 to 2013. Over this period, the Russian River System experienced dry, normal, and wet years. Public water systems not accounted for in this analysis were indirectly accounted for in the estimation of water balance losses discussed in Section 3.2.3.

[5] The combined amount of direct diversion and re-diversion authorized by the Water Agency's SWRCB Permits 16596, 12947A, 12949 and 12950 is 75,000 acre-feet per year.

Table 3-2. Public water systems in the Russian River watershed that metered diversions were used for the estimation of model junction losses.

Public Water Systems	Reach
Calpella County Water District	Upper Russian River
Redwood Valley County Water District	Upper Russian River
Millview County Water District	Upper Russian River
River Estates Mutual Water Company	Upper Russian River
Rogina Water Company Inc.	Upper Russian River
City of Ukiah	Upper Russian River
Hopland Public Utility District	Upper Russian River
City of Cloverdale	Upper Russian River
Clear Creek Water Company	Upper Russian River
Geyserville Water Works (PUC)	Upper Russian River
Gill Creek Mutual Water Company	Upper Russian River
Sweetwater Springs CWD	Lower Russian River
Russian River County Water District	Lower Russian River
Occidental Community Services District	Lower Russian River
Camp Meeker Parks & Recreation District	Lower Russian River

A scenario of the Cumulative Impact Analysis of the Fish Flow Project EIR analyzed the projected demands of the City of Ukiah described in Section 2.1.6.5.1. The City of Ukiah prepared a Draft EIR in 2013 which projects an annual demand of 11,527 acre-feet by the year 2085. This is an increase of 8,442 acre-feet per year over the 2009 to 2013 average demand used to quantify Existing Conditions. To simulate the effects of this increased demand, model datasets were developed which increase the demand by 8,442 per year acre-feet for the Hopland model junction.

3.2.2 Agricultural Demands

As discussed in Section 2.1.6.6, Davids Engineering estimated agricultural diversions of surface water and Russian River underflow using land use data and applied water estimates by crop type from 2002 to 2008 (Davids, 2013). These demand estimates were confined to a region defined as the Applied Water Analysis Zone (AWAZ), within which diversions or consumption of water is either known or presumed to have immediate effects on surface water flows. Agricultural diversions not accounted for in this analysis were indirectly accounted for in the estimation of water balance losses discussed in Section 3.2.3

3.2.3 Water Balance Losses

The water balance loss is the additional observed loss that cannot be accounted for from reported municipal diversions as discussed in Section 3.2.1.2 and agricultural diversions within the AWAZ estimated by Davids Engineering as discussed in Section 3.2.2. Water balance losses were quantified as part of an analysis completed by Grinnell, which incorporated multiple datasets including observed Russian River and Dry Creek flows, observed releases from Lake

Mendocino and Lake Sonoma, estimated reach gains as quantified by the unimpaired flows developed by the USGS (USGS, 2015), known metered municipal diversions as discussed in Section 3.2.1.2, and estimated diversions from agriculture as estimated by Davids Engineering as discussed in Section 3.2.2. Water balance losses was estimated for the years 1970 to 2013. This analysis showed that water balance loss trends have changed over time with increasing losses through the 1980's and 1990's and then a reduction in losses, likely due to conservation efforts for the more recent period since 2000. To estimate Existing Conditions water balance losses this analysis was completed for the years 2002 to 2013 as this period is considered to be representative of current watershed conditions. Although water balance losses cannot be directly accounted for by metered diversions or estimated agricultural diversions from the Russian River and Dry Creek, it is assumed that this water balance loss is the result of the cumulative impacts of water losses not directly quantified through other means. These losses include water consumed by riparian vegetation, additional direct diversions not accounted for by other methods, water being pumped from groundwater wells and diverted from tributaries. Monthly water balance loss patterns were estimated for each model reach for wet and dry year types. Development of the loss year types is discussed in further detail in Section 3.2.5.

3.2.4 Water Losses Due to Frost Protection

Flow losses due to diversions made by agricultural producers for the protection of crops from frost damage were estimated for model reaches in which impacts to flows from frost protection have been observed. Diversion datasets for frost protection were estimated through an analysis of observed flow depletions at USGS discharge gages during the periods March 15 to May 15 (the typical frost protection season) for the years 2004, 2007, and 2008. These years were selected because these years had several frost events within the frost season, and due to low unimpaired flows for these years the impacts to surface water flows could be observed and quantified. Several frost events were analyzed using 15-minute interval flow data from the following gaging stations: Calpella gage, Hopland gage, USGS Russian River near Cloverdale (Cloverdale gage), Healdsburg gage, and the Dry Creek Mouth gage. Each event was analyzed independently from the beginning of the event where no flow depletions were observed in the hydrograph, through the period of observed drawdown in the flow hydrograph, and ending at a point where flows were observed to recover to the approximate flow rate at the beginning of the event. The events analyzed typically occurred over a 12- to 16-hour period. For each frost event, flows were estimated if no diversions were made by linearly interpolating from the beginning of the event to the end of the event. The volume of water lost due to frost protection diversions was calculated by taking the difference between the estimated no diversion flows and the observed flows. An example of the loss estimates for a March 2008 frost is event is provided in Figure 3-16. Using this methodology loss volumes were calculated for a number of events at each discharge gage to estimate an average event for each gage or corresponding model junction. Table 3-3 provides the frost events analyzed for each gage with the resultant volumes of water lost from surface flows for each event. The estimated average frost loss is provided at the bottom of the table.

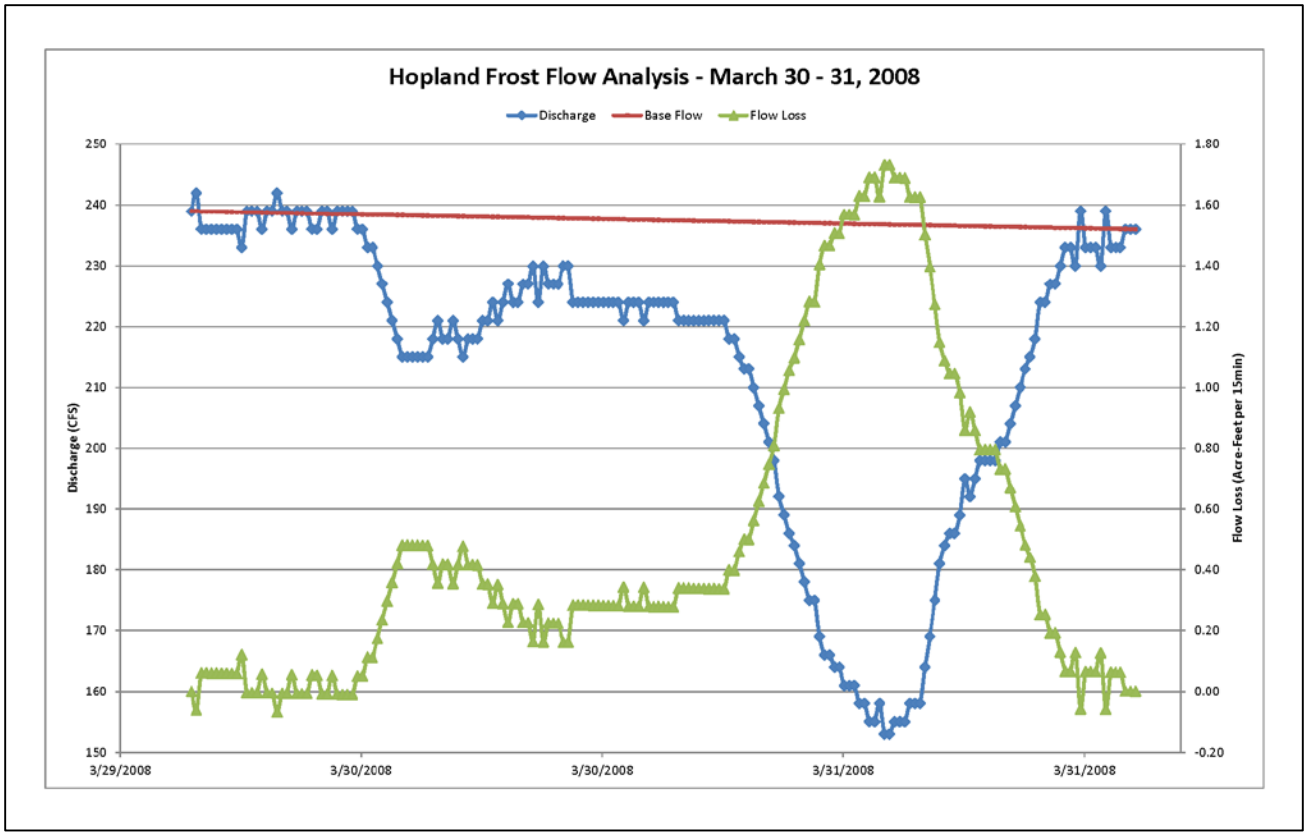

Figure 3-16. Hydrograph of observed Hopland flow for a 2008 frost event from March 30-31, estimated flow with no loss due to diversions for frost protection (red line), and estimated loss due to diversion of water for frost protection (green line).

Table 3-3. Estimated Water loss due to the diversion of water for frost protection and average frost protection loss for the Hopland, Cloverdale, Healdsburg and Dry Creek gages.

Frost Event	Streamflow Gage/Model Junction Frost Event Losses to Surface Water (acre-feet)				
Date	Calpella	Hopland	Cloverdale	Healdsburg	Dry Creek Mouth
4/1/2004	30.0	7.3	2.7	23.3	-
4/2/2004	14.0	-	0.3		
4/16/2004	12.9	17.2	18.4	1.7	8.8
3/28/2007	38.7	22.0	42.2	69.0	1.0
3/29/2007	42.7	17.0	36.6		
3/16/2008	3.4	15.1	57.6	6.8	-
3/20/2008	10.7	18.4	18.6	8.7	-
3/21/2008	-	27.8	48.3	12.6	-
3/26/2008	17.5	18.2	26.3	-	2.9
3/27/2008	44.5	36.4	48.5	6.3	4.7
3/28/2008	21.9	32.7	18.0	70.5	3.4
3/30/2008	29.1	93.4	2.0		
3/31/2008	52.4		80.1	64.2	4.2
4/1/2008	36.1	-	-		
4/2/2008	32.9	25.5	41.9		
4/7/2008	26.6	43.9	29.3	18.1	1.4
4/9/2008	28.1	39.3	70.0	34.9	4.5
4/20/2008	37.7	44.5	69.0	69.0	9.3
4/21/2008	-	69.3	81.3	81.3	9.3
4/22/2008	-	45.0	56.3	56.3	3.8
4/24/2008	60.0	48.8	82.3	82.3	2.1
Average	**29.9**	**34.5**	**41.5**	**40.3**	**4.6**

To create a historical time series of loss due to frost protection practices, an analysis of daily minimum temperatures was completed for the historical simulation period from 1910 to 2013. Minimum daily temperature data was analyzed from the Ukiah, Ukiah Airport, Cloverdale, Healdsburg, and the Santa Rosa Airport National Weather Service weather stations. Collectively, these stations provide a continuous record of minimum daily temperature for the entire historical simulation period (1910-2013) for the study area, although, there are data gaps at each station due to equipment failure, station maintenance, and lapses in funding. For each model reach, minimum daily temperature data was sampled from the closest station where it was available for each daily time step.

Observed minimum daily temperatures were analyzed during the frost season from March 15 to May 15 for each year for the years 1910 to 2013 to identify days where minimum temperatures fell below 34° Fahrenheit (F), the assumed temperature threshold at which diversions would be made from the river for frost protection. Figure 3-17 shows historical minimum daily temperatures for the Hopland reach with days falling below the 34° F threshold within the frost protection season highlighted. For each frost protection event triggered by the criteria discussed above, the average estimated frost protection flow loss (described above) by reach was applied. An example of the daily frost protection loss for the Hopland for the simulation year

2008 is provided as Figure 3-18, showing the average frost loss applied each day temperatures fell below 34° F within the frost protection season. This analysis was completed to develop frost protection water loss datasets for every model junction where frost protection diversions are known to impact surface water flows. These model reaches include Calpella, Hopland, Cloverdale, Healdsburg and Dry Creek.

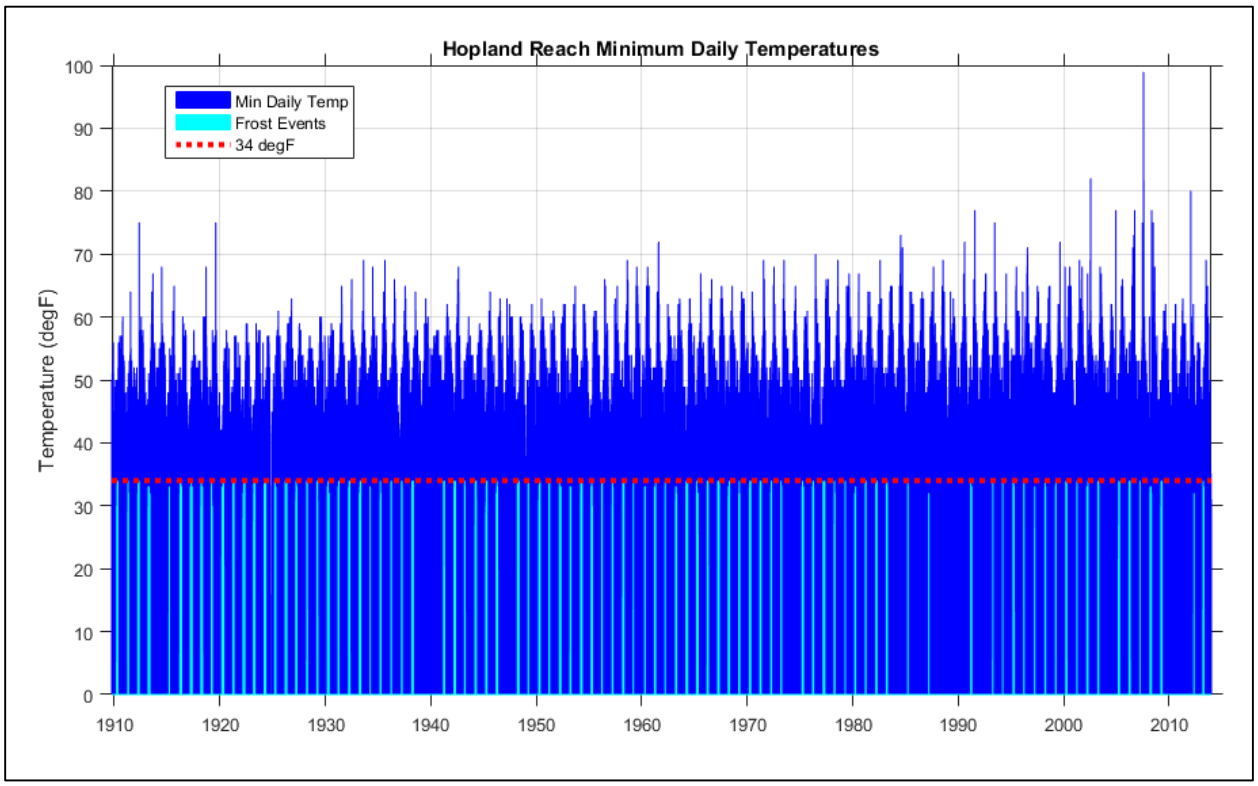

Figure 3-17. Minimum daily temperatures in degrees Fahrenheit (deg F) for the Hopland gage with frost protection events below 34 deg F highlighted in cyan.

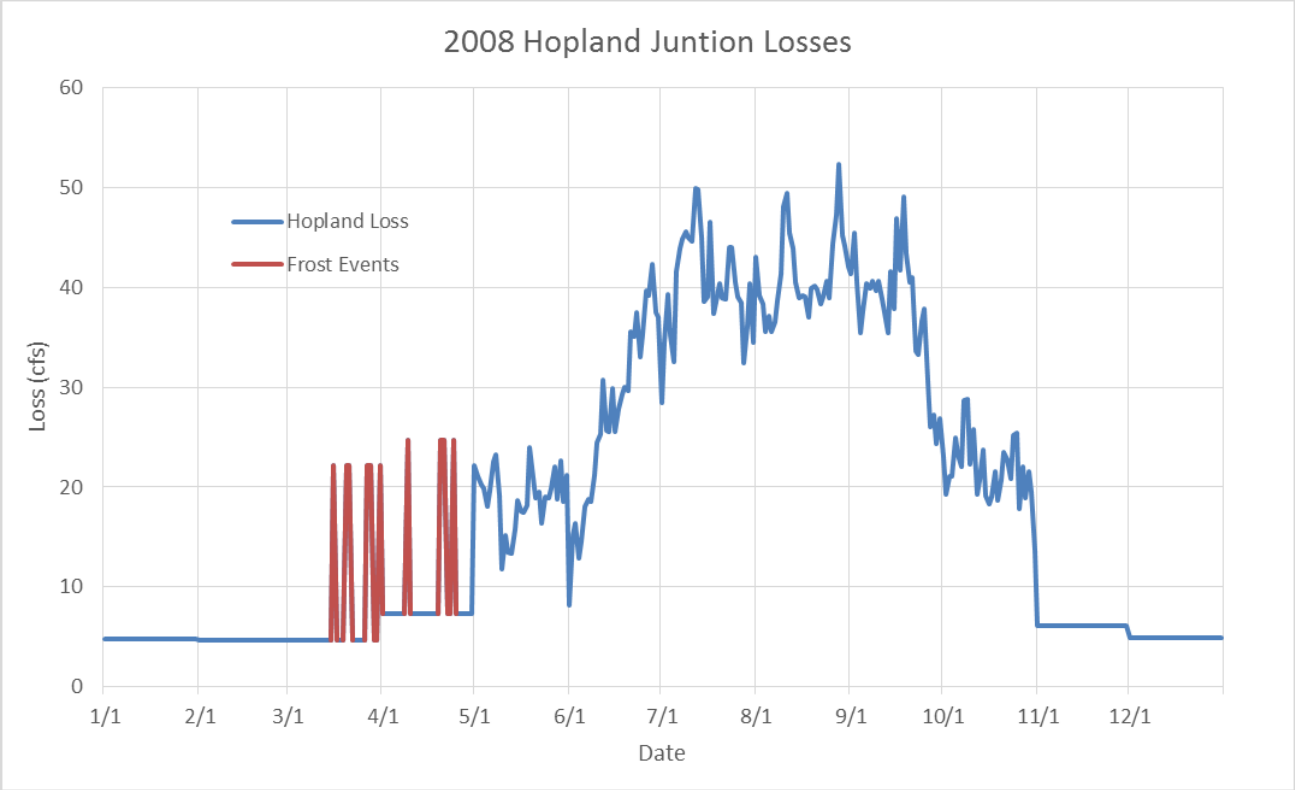

Figure 3-18. Hydrograph of Hopland reach losses for 2008 with days that frost protection losses have been added highlighted in red.

3.2.5 Water Loss Year Types

A historical analysis of observed system loss versus precipitation was completed by Grinnell (Grinnell 2016). Results of this analysis indicate that springtime precipitation (April to June) for the Upper Russian River is an indicator of total basin dry season loss (June to October), where dry season losses decrease with increasing springtime precipitation and conversely dry season losses tended to increase with lower total springtime precipitation . A threshold approach was used to identify years that would likely have higher stream flow loss. The objective of using a threshold precipitation value to determine years with higher stream flow losses was to ensure that the loss time series used in the model properly accounted for the higher losses that occurred in the drier years, which are the years where water supplies are stressed. Grinnell estimated a threshold springtime precipitation of 9 inches for determining the loss year type. Building off the results of this analysis, wet and dry year types were determined from historical precipitation from 1910 to 2013 resulting in 69 dry and 35 wet years. Results of this analysis are shown in Figure 3-19 indicating the wet and dry loss years.

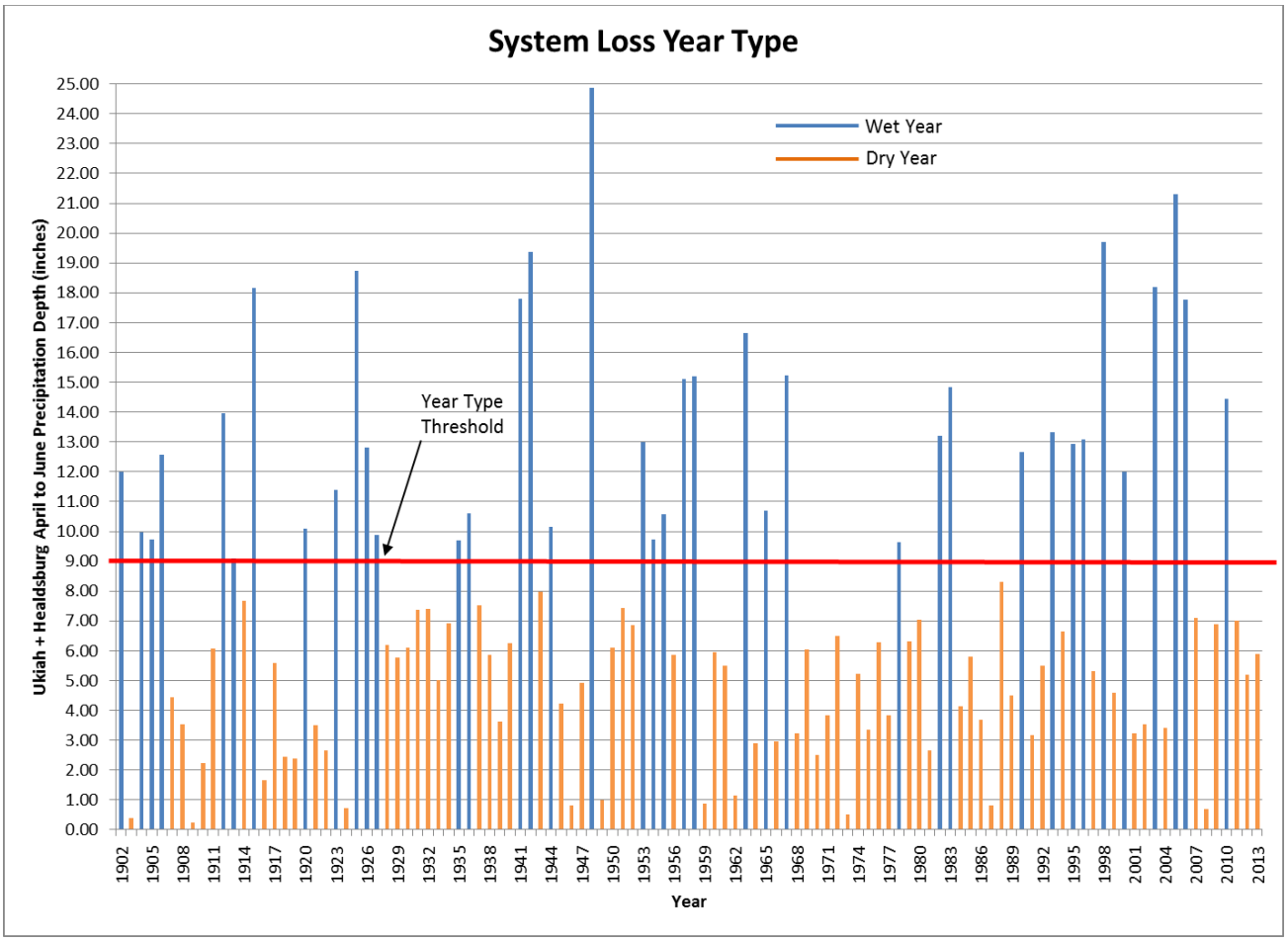

Figure 3-19. April to June precipitation for the Ukiah Airport plus the Healdsburg weather station 1902 to 2013 with years above 9 inches in blue and blow 9 inches in orange.

Grinnell developed wet and dry year annual loss hydrographs for non-municipal system demands for each reach. These losses include estimated applied water from the Davids Engineering study (discussed in Section 2.1.6.6) and water balance losses quantified by Grinnell (discussed in Section 3.2.1.2). The wet and dry loss patterns are applied in the model from 1910 to 2013 based on the loss year type.

3.2.6 Reservoir Surface Evaporation

Losses due to evaporation from Lake Mendocino and Lake Sonoma were accounted for in the model using an annually repeating pattern of monthly evaporation rates. The evaporation rates were calculated based on monthly mean pan evaporation estimates and the monthly evaporation coefficients provided in the WCM for each reservoir. Monthly evaporation rates used in RR ResSim are provide in Figure 3-20.

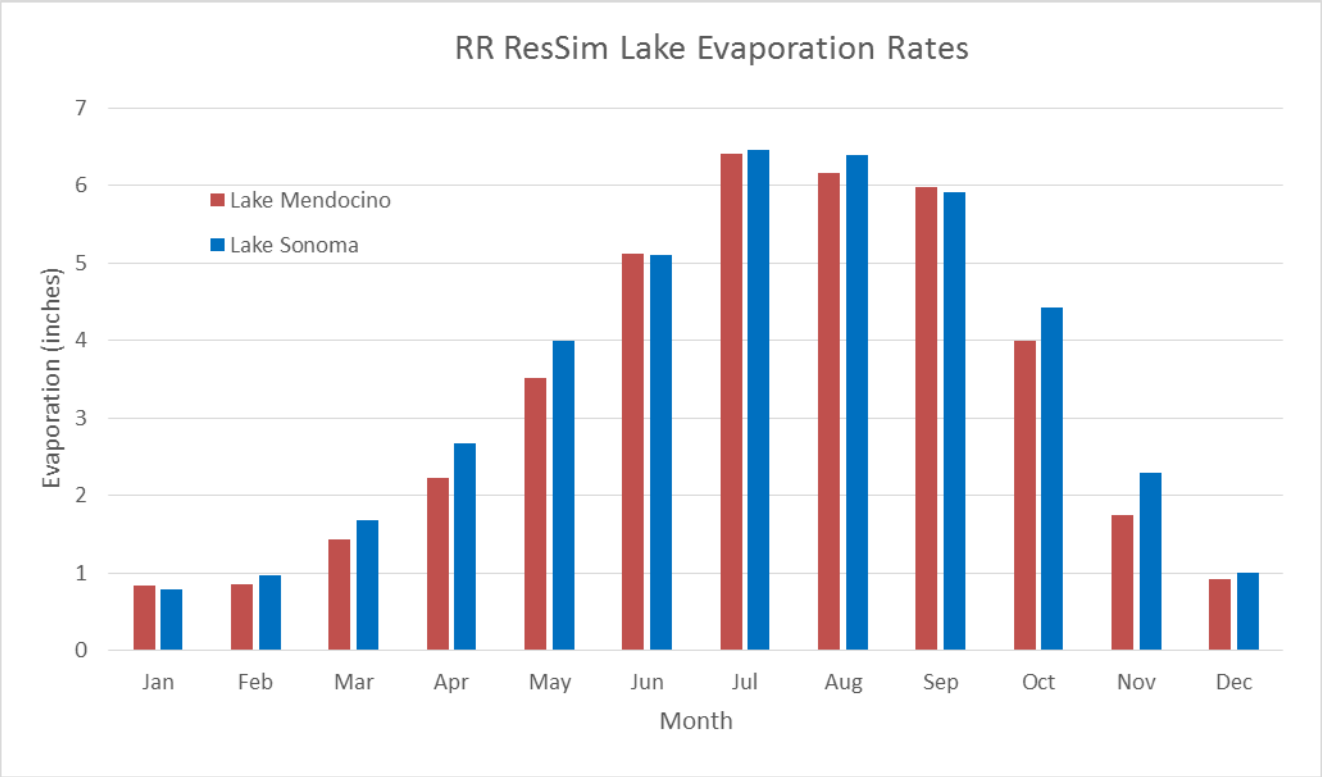

Figure 3-20. Lake Mendocino and Lake Sonoma monthly evaporation rates.

3.3 Flow Routing

RR ResSim uses a constant lag routing method to account for travel times of flows in the system. Using this methodology flow travel times are assumed to be constant and rounded to the nearest day for all flow rates. Flow travel times were derived based on Water Agency operators' historical operational experience of the system. Travel times used in the model are provided in Table 3-4. Travel time in days between model junctions.. Adding the travel times for the reaches below each reservoir results in a travel time of 3 days to the farthest control point at the Healdsburg gage for Lake Mendocino releases and a travel time of 2 days to the farthest control point at the Hacienda gage for Lake Sonoma releases.

Table 3-4. Travel time in days between model junctions.

Model Junctions		Travel Time (Days)
From	**To**	
Potter Valley Project	Calpella	0
Calpella	Lake Mendocino	0
Lake Mendocino	East-West Jct	0
East-West Jct	Hopland	0
Hopland	Cloverdale	1
Cloverdale	Healdsburg	2
Healdsburg	Hacienda	2
Lake Sonoma	Dry Creek	1
Dry Creek	Dry Creek - Russian River Jct	0
Dry Creek - Russian River Jct	SCWA Diversion	1
SCWA Diversion	Mark West Creek Jct	0
Mark West Creek Jct	Hacienda	1

3.4 Reservoir Storage Capacity

The estimated reservoir capacities for Lake Mendocino and Lake Sonoma used in RR ResSim for Existing Conditions are based on the most recent bathymetries of both reservoirs. Current storage capacity for Lake Mendocino and Lake Sonoma were used as boundary conditions to simulate Existing Conditions for the Baseline Conditions scenario and the project alternative scenarios evaluated in the Fish Flow Project EIR.

3.4.1 Lake Mendocino

The Lake Mendocino hypsometry used in RR ResSim was developed by the USACE from a 2001 bathymetric survey. This hypsometry was also used to develop the January 2004 revisions to the Water Control Diagram (USACE, 2004, January) and is currently used by the USACE and the Water Agency to inform flood control and water supply operations. Storage-Elevation plots for Existing Conditions are provided in Figure 3-21.

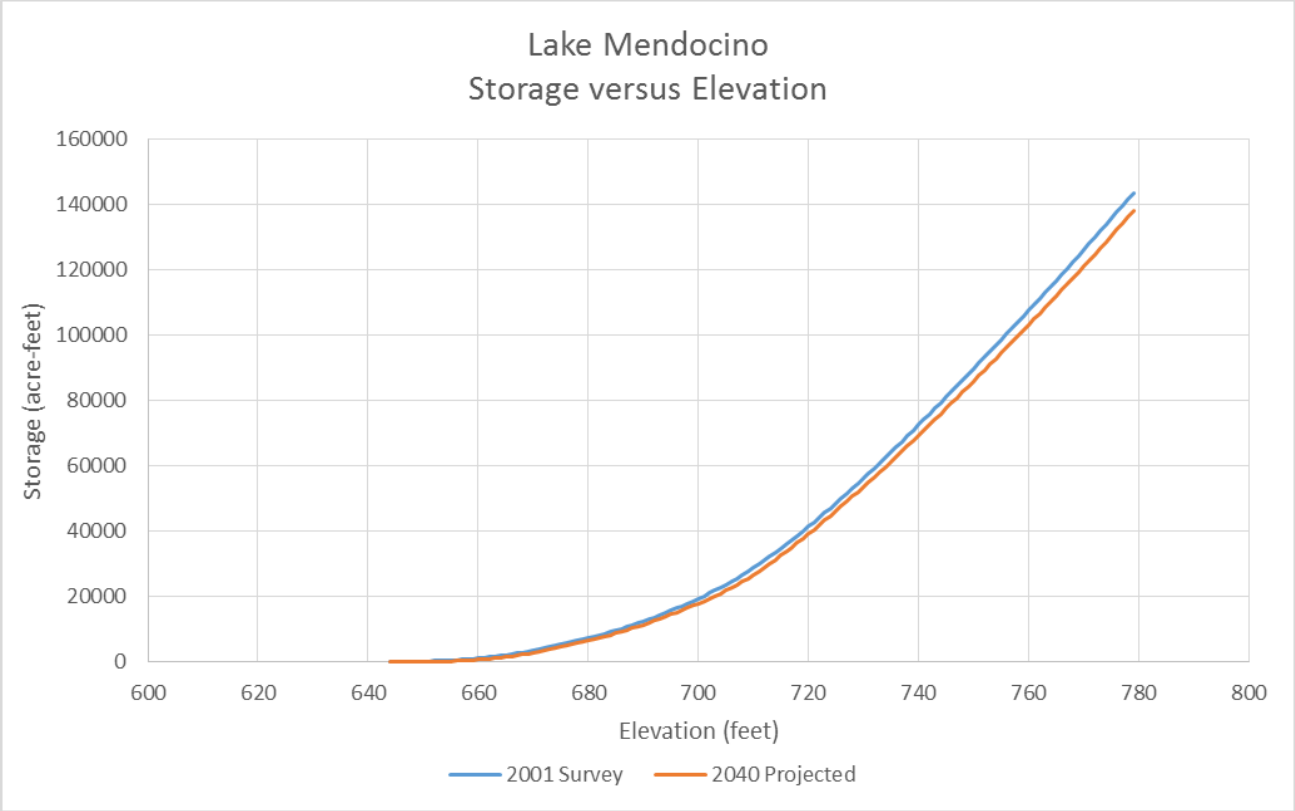

Figure 3-21. Lake Mendocino storage versus elevation for 2001 survey (blue) and 2040 projected estimates (red).

3.4.2 Lake Sonoma

As discussed in Section 2.1.5, the USACE has not conducted a bathymetric survey at Lake Sonoma since the construction of the reservoir was completed in 1983. The hypsometry developed from the original survey (completed in 1982) is currently used by reservoir operators to inform water supply and flood control operations. RR ResSim uses the 1982 hypsometry to define Existing Conditions. A storage-elevation plot based on the 1982 survey is provided in Figure 3-21.

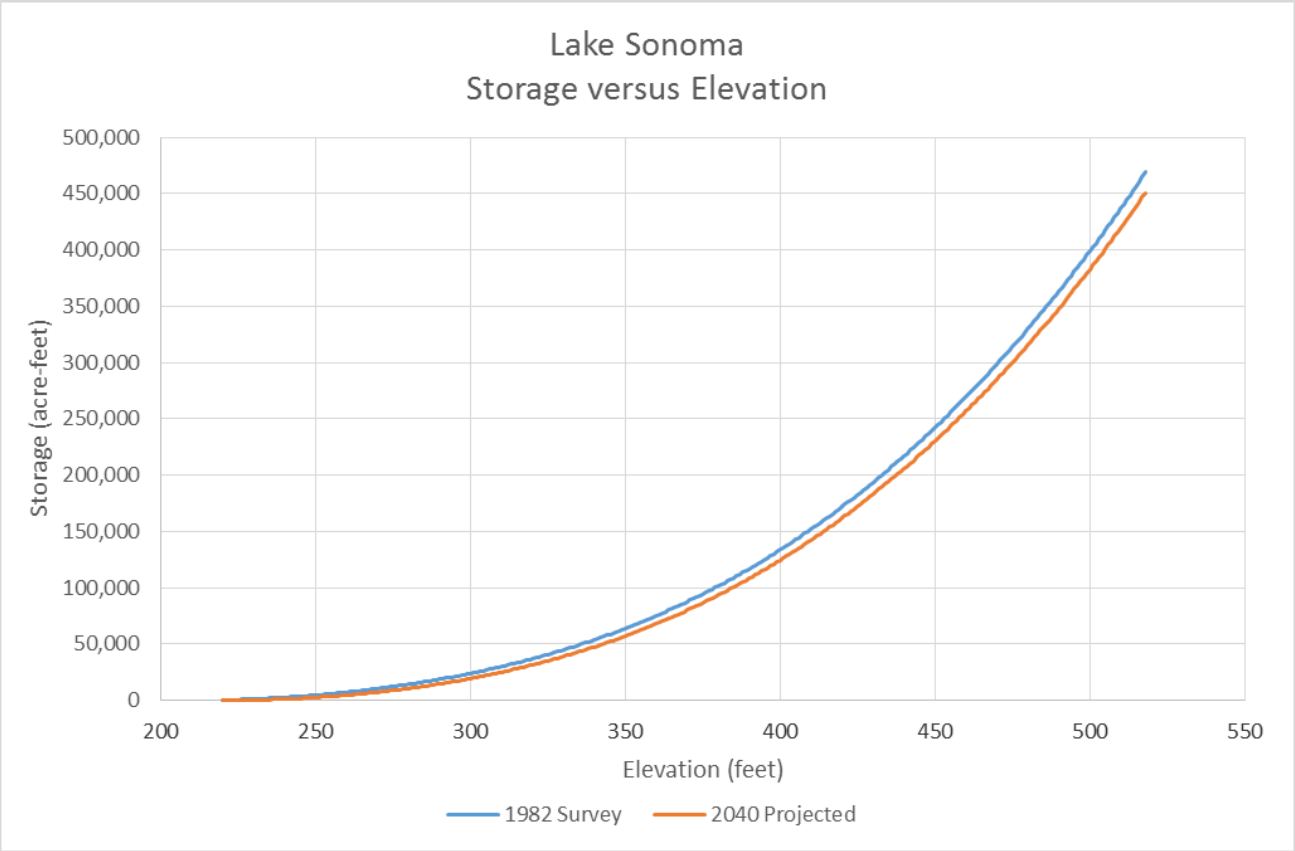

Figure 3-22. Lake Sonoma storage versus elevation for original 1983 survey (blue) and 2040 projected estimates (red).

3.4.3 Reservoir Storage Projections

For the Cumulative Impact Analysis of the Fish Flow Project EIR model scenarios were developed to analyze future watershed conditions projected to the year 2040. Ongoing sedimentation of Lake Pillsbury, Lake Mendocino, and Lake Sonoma will result in a gradual small reduction in the water supply available to the Agency's water transmission system. To account for changes in reservoir storage capacity due to sediment inflow over time the reservoir hypsometry was projected to the year 2040. Storage projections for Lake Pillsbury are discussed in Section 2.1.3.

Lake Mendocino hypsometry was projected to the year 2040 using sedimentation rates derived from the historical 1952 and 2001 surveys. Projected 2040 Storage-Elevation curve for Lake Mendocino is provided in Figure 3-20.

No bathymetric surveys have been conducted since construction of the Lake Sonoma was completed in 1983. Therefore projected 2040 Lake Sonoma hypsometry was developed from the sediment accumulation rate from the original reservoir design of 26,000 acre-feet by the year 2070 (approximately 299 acre-feet per year). Projected 2040 Storage-Elevation curve for Lake Sonoma is provided in Figure 3-21.

3.5 System Operations

3.5.1 Flood Control Operations

3.5.1.1 Lake Mendocino

Flood operations of Lake Mendocino are simulated through a set of rules consistent with the requirements of the CVD WCM (USACE, 1986). The Flood Control Pool is defined as the zone of the reservoir pool which extends from the top of the water supply pool to an elevation of 771 feet msl or 128,100 acre-feet storage. The top of the water supply pool (provided in Figure 2-6) is seasonally varying with a wet season storage threshold of 68,400 acre-feet (737.5 feet msl) from November 1 to March 1 and a dry season storage threshold of 111,000 acre-feet (761.8 feet msl) from May 10 to September 30. When storage is within the Flood Control Pool the model estimates releases from storage until levels are returned back to the top of the water supply pool. Modeled flood control releases are constrained to meet downstream maximum flow requirements and maximum release requirements. Lake Mendocino has 3 flood control release schedules that guide maximum flood control releases based on reservoir storage level. These maximum release schedules are summarized in Table 3-5.

Table 3-5. Lake Mendocino maximum flood release schedule.

Flood Release	**Elevation**	**Storage**	**Max Release**
Schedule	**(feet)**	**(acre-feet)**	**(cfs)**
Schedule 1	737.5 to 746	68,400 to 82,900	2,000
Schedule 2	746 to 755	82,900 to 98,700	4,000
Schedule 3	755 to 771	98700 to 128,100	6,400

The CVD WCM also defines downstream flows constraints that limit the maximum release to 25 cfs when flows at the West Fork gage exceed 2,500 cfs or flows at the Hopland gage exceed 8,000 cfs. The model will backfill releases in order to meet the 8,000 cfs maximum Hopland flow constraint when possible. To explain further, if the proposed releases cause simulated flows to exceed 8,000 cfs the model will calculate the necessary release to exactly meet the maximum flow constraint until unimpaired flow gains prevent the model from reducing releases below the 25 cfs minimum release requirement.

3.5.1.2 Lake Sonoma

Flood operations of Lake Sonoma are simulated through a set of rules consistent with the requirements of the WSD WCM (USACE, 1984). The Flood Control Pool is defined as the zone of the reservoir pool which extends from the top of the water supply pool (451.1 feet msl or 245,000 acre-feet storage) to the top of the flood pool (502 feet msl or 406,190 acre-feet storage).

The WSD WCM defines downstream flows constraints that limit the maximum release to 70 cfs (the minimum release requirement for fish hatchery operations) when flows at the USGS Dry Creek near Geyserville Gage (Dry Creek Geyserville gage) exceed 7,000 cfs or flows at the

Hacienda gage exceed 35,000 cfs. The model will backfill releases in order to meet these downstream maximum flow constraints, when possible. To explain further, if the proposed releases cause simulated flows to exceed the maximum flows the model will calculate the necessary release to exactly meet the maximum flow constraint until unimpaired flow gains prevent the model from reducing release below the 70 cfs minimum release requirement.

3.5.2 Reservoir Emergency Operations

When simulated reservoir storage levels are within the emergency pool, reservoir emergency operations are simulated consistent with the requirements of the water control manuals as discussed in Sections 2.1.4.1 and 0

3.5.2.1 Lake Mendocino

The Lake Mendocino Emergency Pool is defined as the zone of the reservoir pool, which extends from the top of the Flood Control Pool (771 feet msl or 128,100 acre-feet storage) to the top of Coyote Valley Dam (784 feet above msl). The different zones of the Lake Mendocino pool are provided in Figure 2-6. When reservoir storage is within the Emergency Pool the model sets releases according to the schedule requirements of the 2004 Water Control Diagram (USACE, 2004) which is provided in Table 3-6.

Table 3-6. Lake Mendocino Emergency release schedule.

Elevation (feet)	Release (cfs)
764.8	0
771	800
771.3	1,700
771.5	2,500
771.8	3,300
772	4,200
772.3	5000
772.5	5,800
772.8	6,600
773	7,500

3.5.2.2 Lake Sonoma

The Lake Sonoma Emergency Pool is defined as the zone of the reservoir pool, which extends from the top of the Flood Control Pool (502 feet msl or 406,190 acre-feet storage) to the top of Warm Springs Dam (784 feet above msl or 468,830 acre-feet storage). The different zones of the Lake Sonoma Pool are provided in Figure 2-8. When reservoir storage is within the Emergency Pool the model sets releases according to the schedule requirements defined in the Water Control Manual (USACE, 1984) and provided in Table 3-7.

Table 3-7. Lake Sonoma emergency release schedule.

Elevation (feet)	Release (cfs)
502	800
502.3	1,600
502.6	2,400
502.9	3,100
503.2	3,800
503.6	4,600
503.9	5,300
504.3	6,000
504.7	7,000
505	7,900

3.5.3 Water Supply Operations

When model simulated storage is within the water supply pool at Lake Mendocino or Lake Sonoma the RR ResSim simulates releases according to the constraints defined for water supply operations. For this study the Water Agency analyzed numerous water supply operations alternatives, which are discussed in further detail below.

3.5.3.1 Hydrologic Index

The hydrologic index is a metric that sets the water supply condition and the corresponding minimum instream flow schedule for the Russian River system. For this study the model was used to evaluate several hydrologic index methodologies. Existing Conditions were simulated using the hydrologic index defined in Decision 1610 and discussed in Section 2.2.3. RR ResSim was also used to aid in the development and analysis of possible alternatives to the Decision 1610 Hydrologic Index. The development and analysis of the preferred hydrologic index alternative is provided in 2016 Water Agency report *"Development of the Russian River Hydrologic Index for the Fish Habitat Flows and Water Rights Project*" (SCWA, 2016).

For Existing Conditions hydrologic index in RR ResSim, historical water supply conditions were estimated using observed Lake Pillsbury inflow from 1910 to 2013. Lake Pillsbury inflow was used to calculate water year cumulative inflow and evaluated against the water supply condition thresholds defined in Decision 1610. The Decision 1610 historical water supply condition dataset is provided as input into RR ResSim.

A similar process was used to estimate the Inflow Condition for the proposed Russian River Hydrologic Index. Inflow Condition from 1910 to 2013 were determined using estimated inflow into Lake Mendocino (simulated PVP diversions plus simulated unimpaired flows into Lake Mendocino). Inflow Condition was estimated for 3 different scenarios of PVP operations simulated with ER2.5: 1) Existing PVP Operations, 2) Projected 2040 PVP Operations and 3) No PVP Tunnel Diversions. Development of these scenarios is discussed further in Section 3.1.2.8. Inflow Condition levels for the Russian River Hydrologic Index are also provided as

input to RR ResSim for the simulation of the Proposed Project for existing conditions and cumulative impact analysis scenarios.

3.5.3.2 Minimum Instream Flow Requirements

As discussed in Section 2.1.6.1, the minimum instream flow requirements set the floor for flows in the different reaches of the Russian River System. RR ResSim was used to analyze 28 different minimum instream flow alternatives for the Fish Flow Project EIR. This consisted of 21 3-schedule minimum instream flow alternatives evaluated with the current Decision 1610 hydrologic index, and 7 5-schedule minimum instream flow alternatives using the proposed Russian River hydrologic index. Table 3-8 through Table 3-19 provide a summary of the 3-schedule minimum instream flow alternatives that were modeled using the Decision 1610 hydrologic index. These tables are separated by Russian River System reach and by water supply conditions (*Normal, Normal Dry Spring 1, Normal Dry Spring 2, Dry and Critical*). Table 3-20 through Table 3-22 provide a summary of the 5-schedule minimum instream flow alternatives separated by reach that were modeled using the proposed Russian River hydrologic index.

The No Project 1 model scenario as well as the Baseline Conditions model scenarios assume minimum instream flow requirements consistent with the requirements of Decision 1610 and the Water Agency's water rights permits, which also assumes that compliance to minimum instream flow requirements will be evaluated against instantaneous measurements collected at flow gages along the Russian River and Dry Creek. All other 3-Schedule minimum flow alternatives evaluated for the Fish Flow Project EIR assume that compliance to minimum flows will be evaluated against the 5-day moving average measurements of flows for *Normal, Normal Dry Spring 1, Normal Dry Spring 2,* and *Dry* Water Supply Conditions. Similarly the 5-Schedule minimum flow alternatives also assumed 5-day moving average compliance for *Schedules 1* to *4* minimum instream flows. All alternatives assume instantaneous compliance to *Critical* or *Schedule 5* minimum instream flows. The compliance type is included in Table 3-8 to Table 3-22.

Table 3-8. Upper Russian River *Normal* Water Supply Condition 3-Schedule minimum instream flow alternatives (cfs).

Flow Alternative	Compliance Type	Month												
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct 1-15	Oct 16-31	Nov	Dec
No Project 1	Instantaneous	150	150	150	185	185	185	185	185	150	150	150	150	150
No Project 2	5-Day Ave	150	150	150	185	125	125	125	125	125	125	150	150	150
BO	5-Day Ave	150	150	150	185	185	125	125	125	125	125	125	150	150
Flow 1	5-Day Ave	150	150	150	185	185	110	110	110	110	110	110	150	150
Flow 2	5-Day Ave	125	125	125	125	125	125	125	125	125	125	125	125	125
Flow 3	5-Day Ave	150	150	150	150	150	150	150	150	150	150	150	150	150
Flow 4	5-Day Ave	125	125	125	125	125	110	110	110	110	110	110	125	125
Flow 5	5-Day Ave	150	150	150	150	150	110	110	110	110	110	110	150	150
Flow 6-7	5-Day Ave	150	150	150	185	185	125	125	125	125	125	125	150	150
Flow 8-9	5-Day Ave	125	125	125	125	125	110	110	110	110	110	110	125	125
Flow 10-12	5-Day Ave	125	125	125	125	125	125	125	125	125	125	125	125	125
Fflow 13-14	5-Day Ave	125	125	125	90	90	90	90	90	90	90	125	125	125
Flow 15	5-Day Ave	150	150	150	150	105	105	105	105	105	105	150	150	150
Flow 16	5-Day Ave	150	150	150	150	90	90	90	90	90	90	150	150	150
Flow 17	5-Day Ave	150	150	150	150	100	100	100	100	100	100	150	150	150
Flow 18	5-Day Ave	105	105	105	105	105	105	105	105	105	105	105	105	105

Table 3-9. Upper Russian River *Normal Dry Spring 1* Water Supply Condition 3-Schedule minimum instream flow alternatives (cfs).

Flow Alternative	Compliance Type	Month							
		Jun	Jul	Aug	Sep	Oct 1-15	Oct 16-31	Nov	Dec
No Project 1	Instantaneous	150	150	150	150	150	150	150	150
No Project 2	5-Day Ave	125	125	125	125	125	150	150	150
BO	5-Day Ave	125	125	125	125	125	125	150	150
Flow 1	5-Day Ave	110	110	110	110	110	110	125	125
Flow 2	5-Day Ave	125	125	125	125	125	125	125	125
Flow 3	5-Day Ave	150	150	150	150	150	150	150	150
Flow 4	5-Day Ave	110	110	110	110	110	110	125	125
Flow 5	5-Day Ave	110	110	110	110	110	110	150	150
Flow 6-7	5-Day Ave	125	125	125	125	125	125	150	150
Flow 8-9	5-Day Ave	110	110	110	110	110	110	125	125
Flow 10-12	5-Day Ave	125	125	125	125	125	125	125	125
Fflow 13-14	5-Day Ave	90	90	90	90	90	125	125	125
Flow 15	5-Day Ave	105	105	105	105	105	150	150	150
Flow 16	5-Day Ave	90	90	90	90	90	150	150	150
Flow 17	5-Day Ave	100	100	100	100	100	150	150	150
Flow 18	5-Day Ave	105	105	105	105	105	105	105	105

Table 3-10. Upper River *Normal Dry Spring 1* Water Supply Condition if Lake Mendocino storage is less than 30,000 acre-feet from December 3 to December 31 (cfs).

Flow Alternative	Compliance Type	Month			
		Oct 1-15	Oct 16-31	Nov	Dec
No Project 1	Instantaneous	75	75	75	75
No Project 2	5-Day Ave	75	75	75	75
BO	5-Day Ave	75	75	75	75
Flow 1-14	5-Day Ave	75	75	75	75
Flow 15	5-Day Ave	105	125	125	125
Flow 16	5-Day Ave	90	100	100	100
Flow 17-18	5-Day Ave	100	100	100	100

Table 3-11. Upper River *Normal Dry Spring 2* Water Supply Condition 3-Schedule minimum instream flow alternatives (cfs).

Flow Alternative	Compliance Type	Month							
		Jun	Jul	Aug	Sep	Oct 1-15	Oct 16-31	Nov	Dec
No Project 1	Instantaneous	75	75	75	75	75	75	75	75
No Project 2	5-Day Ave	75	75	75	75	75	75	75	75
BO	5-Day Ave	75	75	75	75	75	75	75	75
Flow 1-14	5-Day Ave	75	75	75	75	75	75	75	75
Flow 15	5-Day Ave	75	75	75	75	75	125	125	125
Flow 16	5-Day Ave	70	70	70	70	70	100	100	100
Flow 17	5-Day Ave	80	80	80	80	80	100	100	100
Flow 18	5-Day Ave	65	65	65	65	65	100	100	100

Table 3-12. Upper River *Dry* Water Supply Condition 3-Schdule minimum instream flow alternatives (cfs).

Flow Alternative	Compliance Type	Month												
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct 1-15	Oct 16-31	Nov	Dec
No Project 1	Instantaneous	75	75	75	75	75	75	75	75	75	75	75	75	75
No Project 2	5-Day Ave	75	75	75	75	75	75	75	75	75	75	75	75	75
BO	5-Day Ave	75	75	75	75	75	75	75	75	75	75	75	75	75
Flow 1-14	5-Day Ave	75	75	75	75	75	75	75	75	75	75	75	75	75
Flow 15	5-Day Ave	125	125	125	75	75	75	75	75	75	75	125	125	125
Flow 16	5-Day Ave	100	100	100	100	70	70	70	70	70	70	100	100	100
Flow 17	5-Day Ave	100	100	100	100	80	80	80	80	80	80	100	100	100
Flow 18	5-Day Ave	100	100	100	100	65	65	65	65	65	65	100	100	100

Table 3-13. Upper River *Critical* Water Supply Condition 3-Schedule minimum instream flow alternatives (cfs).

Flow Alternative	Compliance Type	Month												
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct 1-15	Oct 16-31	Nov	Dec
No Project 1	Instantaneous	25	25	25	25	25	25	25	25	25	25	25	25	25
No Project 2	Instantaneous	25	25	25	25	25	25	25	25	25	25	25	25	25
BO	Instantaneous	25	25	25	25	25	25	25	25	25	25	25	25	25
Flow 1-14	Instantaneous	25	25	25	25	25	25	25	25	25	25	25	25	25
Flow 15	Instantaneous	40	40	40	40	40	40	40	40	40	40	40	40	40
Flow 16-17	Instantaneous	30	30	30	30	30	30	30	30	30	30	30	30	30
Flow 18	Instantaneous	25	25	25	25	25	25	25	25	25	25	25	25	25

Table 3-14. Lower River *Normal* Water Supply Condition 3 Schedule minimum instream flow alternatives (cfs).

Flow Alternative	Compliance Type	Month												
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct 1-15	Oct 16-31	Nov	Dec
No Project 1	Instantaneous	125	125	125	125	125	125	125	125	125	125	125	125	125
No Project 2	5-Day Ave	125	125	125	125	70	70	70	70	70	70	125	125	125
BO	5-Day Ave	70	70	70	70	70	70	70	70	70	70	70	70	70
Flow 1-5	5-Day Ave	70	70	70	70	70	70	70	70	70	70	70	70	70
Flow 6	5-Day Ave	85	85	85	85	85	85	85	85	85	85	85	85	85
Flow 7	5-Day Ave	100	100	100	100	100	100	100	100	100	100	100	100	100
Flow 8	5-Day Ave	85	85	85	85	85	85	85	85	85	85	85	85	85
Flow 9	5-Day Ave	100	100	100	100	100	100	100	100	100	100	100	100	100
Flow 10	5-Day Ave	85	85	85	85	85	85	85	85	85	85	85	85	85
Flow 11	5-Day Ave	70	70	70	70	70	70	70	70	70	70	70	70	70
Flow 12	5-Day Ave	85	85	85	85	85	85	85	85	85	85	85	85	85
Flow 13-14	5-Day Ave	70	70	70	70	70	70	70	70	70	70	70	70	70
Flow 15	5-Day Ave	125	125	125	125	85	85	85	85	85	85	125	125	125
Flow 16	5-Day Ave	150	150	150	150	85	85	85	85	85	85	150	150	150
Flow 17	5-Day Ave	150	150	150	150	100	100	100	100	100	100	150	150	150
Flow 18	5-Day Ave	135	135	135	70	70	70	70	70	70	70	135	135	135

Table 3-15. Lower River *Dry* Water Supply Condition 3 Schedule minimum instream flow requirement alternatives (cfs).

Flow	Compliance	Month												
Alternative	Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct 1-15	Oct 16-31	Nov	Dec
No Project 1	Instantaneous	85	85	85	85	85	85	85	85	85	85	85	85	85
No Project 2	5-Day Ave	85	85	85	85	70	70	70	70	70	70	85	85	85
BO	5-Day Ave	70	70	70	70	70	70	70	70	70	70	70	70	70
Flow 1-14	5-Day Ave	70	70	70	70	70	70	70	70	70	70	70	70	70
Flow 15	5-Day Ave	125	125	125	125	85	85	85	85	85	85	125	125	125
Flow 16-17	5-Day Ave	150	150	150	150	85	85	85	85	85	85	150	150	150
Flow 18	5-Day Ave	135	135	135	70	70	70	70	70	70	70	135	135	135

Table 3-16. Lower River *Critical* Water Supply Condition 3-Schedule minimum instream flow requirement alternatives (cfs).

Flow	Compliance	Month												
Alternative	Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct 1-15	Oct 16-31	Nov	Dec
No Project 1	Instantaneous	35	35	35	35	35	35	35	35	35	35	35	35	35
No Project 2	Instantaneous	35	35	35	35	35	35	35	35	35	35	35	35	35
BO	Instantaneous	35	35	35	35	35	35	35	35	35	35	35	35	35
Flow 1-14	Instantaneous	35	35	35	35	35	35	35	35	35	35	35	35	35
Flow 15	Instantaneous	50	50	50	50	50	50	50	50	50	50	50	50	50
Flow 16-18	Instantaneous	35	35	35	35	35	35	35	35	35	35	35	35	35

Table 3-17. Dry Creek *Normal* Water Supply Condition 3-Schedule minimum instream flow requirement alternatives (cfs).

Flow	Compliance	Month												
Alternative	Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct 1-15	Oct 16-31	Nov	Dec
No Project 1	Instantaneous	75	75	75	75	80	80	80	80	80	80	80	105	105
No Project 2	5-Day Ave	75	75	75	75	80	80	80	80	80	80	80	105	105
BO	5-Day Ave	75	75	75	75	40	40	40	40	40	40	40	105	105
Flow 1-10	5-Day Ave	75	75	75	75	40	40	40	40	40	40	40	105	105
Flow 11-12	5-Day Ave	75	75	75	75	50	50	50	50	50	50	105	105	105
Flow 13	5-Day Ave	75	75	75	75	40	40	40	40	40	40	40	105	105
Flow 14-18	5-Day Ave	75	75	75	75	50	50	50	50	50	50	105	105	105

Table 3-18. Dry Creek *Dry* Water Supply Conditions 3-Schedule minimum instream flow requirement alternatives (cfs).

Flow	Compliance	Month												
Alternative	Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct 1-15	Oct 16-31	Nov	Dec
No Project 1	Instantaneous	75	75	75	25	25	25	25	25	25	25	25	75	75
No Project 2	5-Day Ave	75	75	75	25	25	25	25	25	25	25	25	75	75
BO	5-Day Ave	75	75	75	25	25	25	25	25	25	25	25	75	75
Flow 1-10	5-Day Ave	75	75	75	25	25	25	25	25	25	25	25	75	75
Flow 11-12	5-Day Ave	75	75	75	75	50	50	50	50	50	50	75	75	75
Flow `3	5-Day Ave	75	75	75	25	25	25	25	25	25	25	25	75	75
Flow 14-18	5-Day Ave	75	75	75	75	50	50	50	50	50	50	75	75	75

Table 3-19. Dry Creek *Critical* Water Supply Condition 3 Schedule minimum instream flow requirement alternatives (cfs).

Flow	Compliance	Month												
Alternative	Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct 1-15	Oct 16-31	Nov	Dec
No Project 1	Instantaneous	75	75	75	25	25	25	25	25	25	25	25	75	75
No Project 2	Instantaneous	75	75	75	25	25	25	25	25	25	25	25	75	75
BO	Instantaneous	75	75	75	25	25	25	25	25	25	25	25	75	75
Flow 1-10	Instantaneous	75	75	75	25	25	25	25	25	25	25	25	75	75
Flow 11-12	Instantaneous	75	75	75	75	50	50	50	50	50	50	75	75	75
Flow 13	Instantaneous	75	75	75	25	25	25	25	25	25	25	25	75	75
Flow 14-18	Instantaneous	75	75	75	75	50	50	50	50	50	50	75	75	75

Table 3-20. 5-Schedule Upper Russian River minimum instream flow requirement alternatives.

Water Supply Schedule	Flow Alternative	Compliance Type	Month												
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct 1-15	Oct 16-31	Nov	Dec
1	BO	5-Day Ave	150	150	150	185	185	125	125	125	125	125	125	150	150
	No Project 1	5-Day Ave	150	150	150	185	185	185	185	185	150	150	150	150	150
	No Project 2	5-Day Ave	150	150	150	185	125	125	125	125	125	125	150	150	150
	Flow 3	5-Day Ave	150	150	150	150	150	150	150	150	150	150	150	150	150
	Flow 11	5-Day Ave	125	125	125	125	125	125	125	125	125	125	125	125	125
	Flow 15	5-Day Ave	150	150	150	150	105	105	105	105	105	105	150	150	150
	Flow 18	5-Day Ave	105	105	105	105	105	105	105	105	105	105	105	105	105
2	BO	5-Day Ave	115	115	115	130	130	100	100	100	100	100	100	115	115
	No Project 1	5-Day Ave	115	115	115	130	130	130	130	130	115	115	115	115	115
	No Project 2	5-Day Ave	115	115	115	130	100	100	100	100	100	100	115	115	115
	Flow 3	5-Day Ave	115	115	115	115	115	115	115	115	115	115	115	115	115
	Flow 11	5-Day Ave	100	100	100	100	100	100	100	100	100	100	100	100	100
	Flow 15	5-Day Ave	135	135	135	135	85	85	85	85	85	85	135	135	135
	Flow 18	5-Day Ave	105	105	105	105	85	85	85	85	85	85	105	105	105
3	BO	5-Day Ave	75	75	75	75	75	75	75	75	75	75	75	75	75
	No Project 1	5-Day Ave	75	75	75	75	75	75	75	75	75	75	75	75	75
	No Project 2	5-Day Ave	75	75	75	75	75	75	75	75	75	75	75	75	75
	Flow 3	5-Day Ave	75	75	75	75	75	75	75	75	75	75	75	75	75
	Flow 11	5-Day Ave	75	75	75	75	75	75	75	75	75	75	75	75	75
	Flow 15	5-Day Ave	125	125	125	125	75	75	75	75	75	75	125	125	125
	Flow 18	5-Day Ave	100	100	100	100	65	65	65	65	65	65	100	100	100
4	BO	5-Day Ave	50	50	50	50	50	50	50	50	50	50	50	50	50
	No Project 1	5-Day Ave	50	50	50	50	50	50	50	50	50	50	50	50	50
	No Project 2	5-Day Ave	50	50	50	50	50	50	50	50	50	50	50	50	50
	Flow 3	5-Day Ave	50	50	50	50	50	50	50	50	50	50	50	50	50
	Flow 11	5-Day Ave	50	50	50	50	50	50	50	50	50	50	50	50	50
	Flow 15	5-Day Ave	75	75	75	75	50	50	50	50	50	50	75	75	75
	Flow 18	5-Day Ave	70	70	70	70	45	45	45	45	45	45	45	70	70
5	BO	Instantaneous	25	25	25	25	25	25	25	25	25	25	25	25	25
	No Project 1	Instantaneous	25	25	25	25	25	25	25	25	25	25	25	25	25
	No Project 2	Instantaneous	25	25	25	25	25	25	25	25	25	25	25	25	25
	Flow 3	Instantaneous	25	25	25	25	25	25	25	25	25	25	25	25	25
	Flow 11	Instantaneous	25	25	25	25	25	25	25	25	25	25	25	25	25
	Flow 15	Instantaneous	25	25	25	25	25	25	25	25	25	25	25	25	25
	Flow 18	Instantaneous	25	25	25	25	25	25	25	25	25	25	25	25	25

Table 3-21. 5-Schedule Lower River minimum instream flow requirement alternatives.

Water Supply Schedule	Flow Alternative	Compliance Type	Month												
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct 1-15	Oct 16-31	Nov	Dec
1	BO	5-Day Ave	70	70	70	70	70	70	70	70	70	70	70	70	70
	No Project 1	5-Day Ave	125	125	125	125	125	125	125	125	125	125	125	125	125
	No Project 2	5-Day Ave	125	125	125	125	70	70	70	70	70	70	125	125	125
	Flow 3	5-Day Ave	70	70	70	70	70	70	70	70	70	70	70	70	70
	Flow 11	5-Day Ave	70	70	70	70	70	70	70	70	70	70	70	70	70
	Flow 15	5-Day Ave	125	125	125	125	85	85	85	85	85	85	125	125	125
	Flow 18	5-Day Ave	135	135	135	135	70	70	70	70	70	70	135	135	135
2	BO	5-Day Ave	70	70	70	70	70	70	70	70	70	70	70	70	70
	No Project 1	5-Day Ave	105	105	105	105	105	105	105	105	105	105	105	105	105
	No Project 2	5-Day Ave	105	105	105	105	70	70	70	70	70	70	105	105	105
	Flow 3	5-Day Ave	70	70	70	70	70	70	70	70	70	70	70	70	70
	Flow 11	5-Day Ave	70	70	70	70	70	70	70	70	70	70	70	70	70
	Flow 15	5-Day Ave	125	125	125	125	85	85	85	85	85	85	125	125	125
	Flow 18	5-Day Ave	135	135	135	135	70	70	70	70	70	70	135	135	135
3	BO	5-Day Ave	70	70	70	70	70	70	70	70	70	70	70	70	70
	No Project 1	5-Day Ave	85	85	85	85	85	85	85	85	85	85	85	85	85
	No Project 2	5-Day Ave	85	85	85	85	70	70	70	70	70	70	85	85	85
	Flow 3	5-Day Ave	70	70	70	70	70	70	70	70	70	70	70	70	70
	Flow 11	5-Day Ave	70	70	70	70	70	70	70	70	70	70	70	70	70
	Flow 15	5-Day Ave	125	125	125	125	85	85	85	85	85	85	125	125	125
	Flow 18	5-Day Ave	135	135	135	135	70	70	70	70	70	70	135	135	135
4	BO	5-Day Ave	50	50	50	50	50	50	50	50	50	50	50	50	50
	No Project 1	5-Day Ave	60	60	60	60	60	60	60	60	60	60	60	60	60
	No Project 2	5-Day Ave	60	60	60	60	60	60	60	60	60	60	60	60	60
	Flow 3	5-Day Ave	50	50	50	50	50	50	50	50	50	50	50	50	50
	Flow 11	5-Day Ave	50	50	50	50	50	50	50	50	50	50	50	50	50
	Flow 15	5-Day Ave	85	85	85	85	65	65	65	65	65	65	85	85	85
	Flow 18	5-Day Ave	85	85	85	85	50	50	50	50	50	50	85	85	85
5	BO	Instantaneous	35	35	35	35	35	35	35	35	35	35	35	35	35
	No Project 1	Instantaneous	35	35	35	35	35	35	35	35	35	35	35	35	35
	No Project 2	Instantaneous	35	35	35	35	35	35	35	35	35	35	35	35	35
	Flow 3	Instantaneous	35	35	35	35	35	35	35	35	35	35	35	35	35
	Flow 11	Instantaneous	35	35	35	35	35	35	35	35	35	35	35	35	35
	Flow 15	Instantaneous	50	50	50	50	50	50	50	50	50	50	50	50	50
	Flow 18	Instantaneous	35	35	35	35	35	35	35	35	35	35	35	35	35

Table 3-22. 5-Schedule Dry Creek *Critical* Water Supply minimum instream flow requirement alternatives.

Water Supply Schedule	Flow Alternative	Compliance Type	Month												
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct 1-15	Oct 16-31	Nov	Dec
1	BO	5-Day Ave	75	75	75	75	40	40	40	40	40	40	40	105	105
	No Project 1	5-Day Ave	75	75	75	75	80	80	80	80	80	80	80	105	105
	No Project 2	5-Day Ave	75	75	75	75	80	80	80	80	80	80	80	105	105
	Flow 3	5-Day Ave	75	75	75	75	40	40	40	40	40	40	40	105	105
	Flow 11	5-Day Ave	75	75	75	75	50	50	50	50	50	50	105	105	105
	Flow 15	5-Day Ave	75	75	75	75	50	50	50	50	50	50	105	105	105
	Flow 18	5-Day Ave	75	75	75	75	50	50	50	50	50	50	105	105	105
2	BO	5-Day Ave	75	75	75	75	40	40	40	40	40	40	40	105	105
	No Project 1	5-Day Ave	75	75	75	50	50	50	50	50	50	50	50	90	90
	No Project 2	5-Day Ave	75	75	75	50	50	50	50	50	50	50	50	90	90
	Flow 3	5-Day Ave	75	75	75	75	40	40	40	40	40	40	40	105	105
	Flow 11	5-Day Ave	75	75	75	75	50	50	50	50	50	50	105	105	105
	Flow 15	5-Day Ave	75	75	75	75	50	50	50	50	50	50	105	105	105
	Flow 18	5-Day Ave	75	75	75	75	50	50	50	50	50	50	105	105	105
3	BO	5-Day Ave	75	75	75	75	25	25	25	25	25	25	25	75	75
	No Project 1	5-Day Ave	75	75	75	25	25	25	25	25	25	25	25	75	75
	No Project 2	5-Day Ave	75	75	75	25	25	25	25	25	25	25	25	75	75
	Flow 3	5-Day Ave	75	75	75	75	25	25	25	25	25	25	25	75	75
	Flow 11	5-Day Ave	75	75	75	50	50	50	50	50	50	50	75	75	75
	Flow 15	5-Day Ave	75	75	75	50	50	50	50	50	50	50	75	75	75
	Flow 18	5-Day Ave	75	75	75	50	50	50	50	50	50	50	75	75	75
4	BO	5-Day Ave	75	75	75	75	25	25	25	25	25	25	25	75	75
	No Project 1	5-Day Ave	75	75	75	75	25	25	25	25	25	25	25	75	75
	No Project 2	5-Day Ave	75	75	75	75	25	25	25	25	25	25	25	75	75
	Flow 3	5-Day Ave	75	75	75	75	25	25	25	25	25	25	25	75	75
	Flow 11	5-Day Ave	75	75	75	50	50	50	50	50	50	50	75	75	75
	Flow 15	5-Day Ave	75	75	75	50	50	50	50	50	50	50	75	75	75
	Flow 18	5-Day Ave	75	75	75	50	50	50	50	50	50	50	75	75	75
5	BO	Instantaneous	75	75	75	75	25	25	25	25	25	25	25	75	75
	No Project 1	Instantaneous	75	75	75	25	25	25	25	25	25	25	25	75	75
	No Project 2	Instantaneous	75	75	75	25	25	25	25	25	25	25	25	75	75
	Flow 3	Instantaneous	75	75	75	75	25	25	25	25	25	25	25	75	75
	Flow 11	Instantaneous	75	75	75	50	50	50	50	50	50	50	75	75	75
	Flow 15	Instantaneous	75	75	75	50	50	50	50	50	50	50	75	75	75
	Flow 18	Instantaneous	75	75	75	50	50	50	50	50	50	50	75	75	75

3.5.3.3 Minimum Instream Flow Compliance Buffer

The model simulates the operational practice of meeting minimum instream flow requirements by setting the required reservoir releases to exactly meet the minimum flows. Operationally this is not feasible because unlike the model, reservoir operators do not have perfect knowledge of the unimpaired flows and downstream reach losses. As an example, operators make release decisions on Monday for water that will arrive at Healdsburg on Thursday and a portion of that released water will be diverted along the way resulting in streamflow losses that occur during the three day travel time to the Healdsburg gage. These losses are constantly changing and occurring at times after the release decision must be made. In the operations of Lake Mendocino and Lake Sonoma, extra releases are typically made as buffers above minimum flows to ensure compliance with the instream flow requirements. Operationally this buffer release is made to account for the dynamic variability of flows downstream of the reservoir and to help prevent flows from dropping below the minimum instream flow requirements. The dynamic nature of flows within the system is typically caused by direct diversions from the river, diversions of underflow made by wells in close proximity to the river, use of water by riparian vegetation, and potential error in discharge measurements.

To estimate minimum flow compliance buffers to be used in the RR ResSim model which approximate how this operational practice impacts reservoir releases, an analysis of observed flow variability was completed for all model junctions which serve as compliance points for minimum instream flows using observed flow and reservoir release data from 2000 to 2012. To analyze the impact of downstream flow variability on reservoir releases, day to day increases in net reach loss were analyzed for the period each year that a particular discharge gage was a

compliance point for maintaining minimum instream flows. Additionally, to analyze the model flow buffers for 5-day moving average minimum flow compliance the analysis also looked at daily increases in 5-day moving average net reach loss.

For compliance points on the Upper Russian River, net reach loss was estimated by calculating the difference between observed flows at the Forks (by calculating the sum of observed flows from the West Fork gage and observed releases from Lake Mendocino) and each downstream flow gage for the period that each gage served as the minimum instream flow compliance point for setting releases. The downstream gages analyzed for the Upper Russian River include Hopland gage, Cloverdale gage, and the Healdsburg gage. The calculation of the daily differences also considered estimated flow travel times for the different downstream reaches, which were discussed in Section 0. Five-day moving average net loss was also calculated to support analysis of 5-day moving average compliance flow buffers. The analysis focused on daily increases in net reach loss for both daily flows and 5-day moving average flows, because operationally the variability of daily increases is why buffer releases are made – to prevent flows from dropping below the minimum instream flow requirement. The required buffer for instantaneous minimum flow compliance was then estimated as the 1% exceedance of daily increase in net loss, and similarly the 5-day moving average flow compliance buffer was estimated as the 1% exceedance of daily increase in the 5-day moving average net loss. The 1% exceedance was used in place of the maximum because the maximum is likely an outlier in the analysis due to flow gaging inaccuracies. From this analysis an instantaneous compliance buffer of 20 cfs and a 5-day moving average compliance buffer of 9 cfs was estimated for all Upper Russian River minimum flow compliance model junctions. An exceedance plot of daily increase in net loss in river flows during minimum flow compliance operations for the model junctions in the Upper Russian River from 2000 to 2012 is provided as Figure 3-23.

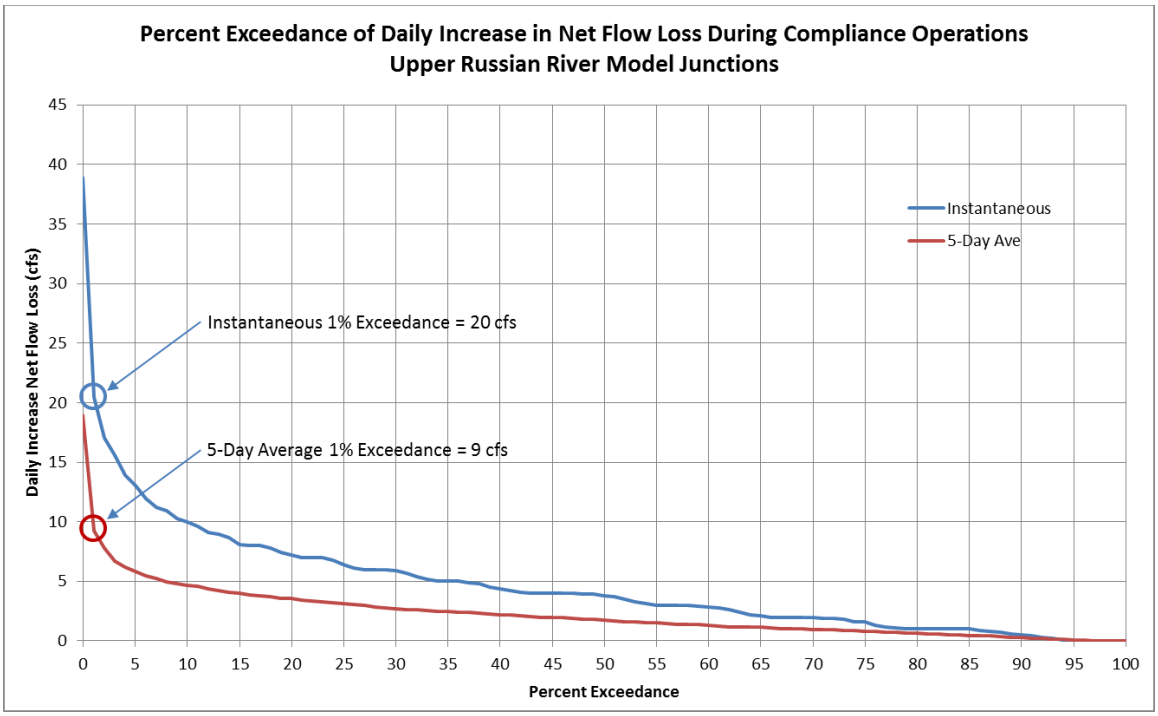

Figure 3-23. Percent exceedance of daily increase in net flow loss during minimum instream flow compliance operations of Coyote Valley Dam for the Upper Russian River.

For compliance points on the Lower Russian River, a similar methodology was used. For the Dry Creek model junction daily increases in net reach loss for daily average and 5-day moving average flows were estimated using observed releases from Lake Sonoma and flows at the Dry Creek Mouth gage. For the Hacienda Bridge compliance point daily increases in net reach loss were estimated using observed releases from Lake Sonoma, observed flows from the Russian River near Healdsburg gage and observed flows from the Hacienda gage. Observed reach losses at the Dry Creek and Hacienda model junctions were analyzed for the period that each gage served as the minimum instream flow compliance point for setting releases from Lake Sonoma. As with the Upper Russian River compliance points discussed above, the required buffer for instantaneous minimum and 5-day moving average flow compliance was estimated as the 1% exceedance of daily increase in net loss. From this analysis an instantaneous compliance buffer of 13 cfs and a 5-day moving average compliance buffer of 7 cfs was estimated for the Dry Creek model junction. For the Hacienda model junction an instantaneous compliance buffer of 34 cfs and a 5-day moving average compliance buffer of 14 cfs was estimated. Exceedance plots of daily increase in net loss in river flows during minimum flow compliance operations for the Hacienda and Dry Creek model junctions is provided in Figure 3-24 and Figure 3-25, respectively.

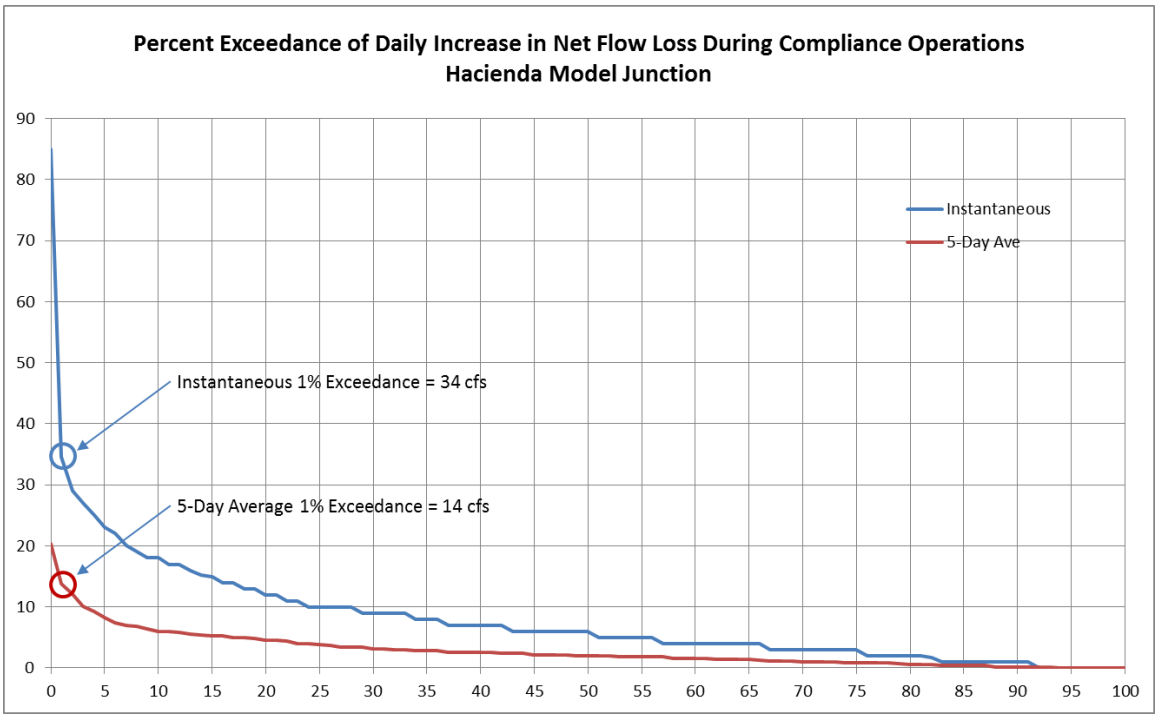

Figure 3-24. Percent exceedance of daily net flow loss between Warm Springs Dam and the Hacienda gage during minimum instream flow compliance operations.

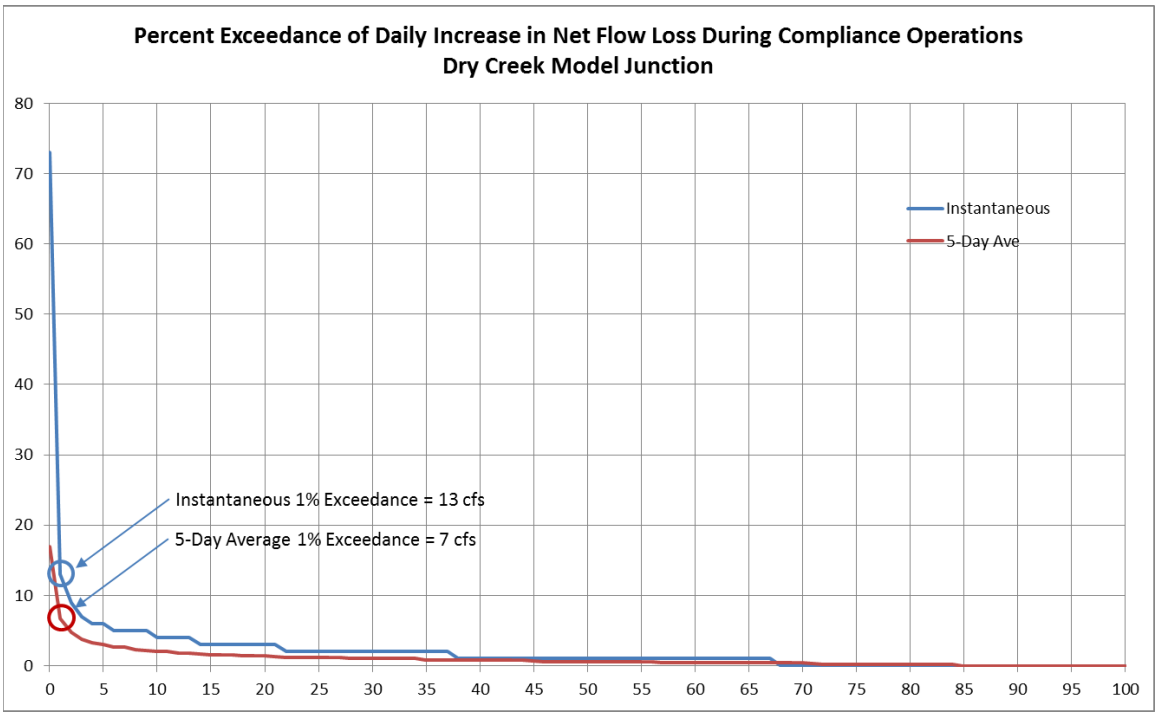

Figure 3-25. Percent exceedance of daily net flow loss between Warm Springs Dam and the Dry Creek gage during minimum instream flow compliance operations.

3.5.4 Fish Hatchery Operations

The Water Agency coordinated with CDFW and the USACE in effort to determine the appropriate flow needs of the fish hatcheries at CVD and WSD to be incorporated into the modeling for the Fish Flow Project EIR environmental impact analysis. On November 5, 2013, a meeting was held at the Water Agency offices with representatives of USACE and CDFW to discuss the appropriate model assumptions for fish hatchery requirements. After the meeting, the Water Agency sent a letter to CDFW staff to confirm mutual agreement of the decisions made at this meeting (SCWA, 2014). Based on the decisions made at this meeting, the modeling assumptions for fish hatchery needs are described below.

3.5.4.1 Lake Mendocino

The releases from CVD to meet the minimum flow requirement of 25 cfs for the East Branch Russian River between CVD and the confluence with the West Fork of the Russian River is adequate to sustain operations of Coyote Valley Dam Egg Collection Facility for most of the year, although a release increase for one week in February and one week in March is preferred to facilitate downstream migration of juvenile hatchery fish. The amount of this release increase would vary based on the water supply condition of the Russian River system. For a *Normal* water supply condition the release increase would be 150 cfs, 100 cfs for a *Dry* water supply condition and for a *Critical* condition no release increase would be made. Under actual operations the dates of the reservoir release increases would be coordinated with the reservoir operators based on conditions at the time, but for the purposes of the hydrologic modeling for this study, it was be assumed that these pulse releases occur from February 12 to 18 and from March 13 to 19 each year.

3.5.4.2 Lake Sonoma

A continuous sustained release is needed to sustain operations at the Don Clausen Fish Hatchery. The amount of this release can vary based on needs at any given time, but for the purposes of the hydrologic modeling a year-round minimum release of 70 cfs was used. It was agreed with CDFW and USACE that this release would be adequate to sustain current and future operations of the hatchery (SCWA, September, 2014).

3.5.5 Hydroelectric Power Generation

Models were developed to simulate power generation for CVD and WSD. Daily power generation in Megawatts-hours per day (MW-hr/day) was simulated using estimates of generator power production capacity and turbine efficiency curves. The models also incorporated known or estimated power plant constraints such maximum and minimum power generation flows, penstock tailwater elevations and turbine headloss coefficients. These models are described further in Sections 3.5.5.1 and 3.5.5.2 below.

3.5.5.1 Lake Mendocino

Hydroelectric power generation for the CVD power plant was estimated using a model that incorporates simulated storage and reservoir releases from the RR ResSim model. The model assumes that no flow can be bypassed to the power plant when: 1) CVD releases are 22 cfs or less (USACE, 1986), 2) CVD releases are greater than 1,500 cfs (Bond, June 10, 2016), or 3) reservoir water surface elevation (WSE) is greater than 755 feet (USACE, 1986). Minimum and

maximum releases through each turbine/generator unit varies with elevation and is provided in Table 3-23 (USACE, 1986).

Table 3-23. Turbine/generator maximum flow constraints.

Reservoir WSE (feet)	Unit Flow Constraints (cfs)	
	1 MW Unit	2.5 MW Unit
<= 746	110	272
> 746	116	282

Power production in megawatt hours per day (MW-h/day) is simulated for each turbine/ generator unit (a 1 MW unit and a 2.5 MW unit) using the following equation:

$$Power = P_g \times C_p \times 24/1{,}000$$

Where:

P_g = generator power capacity
C_p = turbine efficiency

Generator capacity is estimated through the interpolation of power curves that have been estimated for each generator unit, which are rated for multiple levels of flow and net head as provided in Tables Table 3-24 and Table 3-25 (Grandi, Mel pers. comm. June 28, 2016).

Table 3-24. 1-MW generator power capacity (kW-h) for different flow rates and net head.

CVD Power (kW) for 1 MW Unit															
	Net Head (feet)														
Flow (cfs)	80	85	90	95	100	105	110	115	120	125	130	135	140	145	150
25	50	100	150	200	200	225	230	240	260	260	260	260	260	260	260
40	100	150	200	250	250	275	280	290	310	310	310	310	310	310	310
50	150	200	250	300	325	350	375	390	410	430	440	450	460	490	500
60	240	290	340	390	410	430	460	490	510	530	550	570	590	610	630
70	320	370	420	470	500	520	550	590	610	640	660	690	710	730	750
80	400	450	500	550	580	610	640	690	710	745	770	800	830	860	880
90	470	520	570	620	650	700	740	780	810	850	880	910	950	980	1010
100	530	580	630	680	725	775	820	860	905	950	980	1020	1050	1100	1130
110	550	600	650	700	770	830	880	940	970	1020	1060	1110	1150	1205	1240
120	600	650	700	750	800	870	930	1000	1040	1090	1140	1190	1240	1280	1330
130	520	570	620	670	720	790	850	920	960	1010	1060	1110	1160	1350	1420

Table 3-25. 2.5-MW generator power capacity (kW-h) for different flow rates and net head.

CVD Power (kW) for 2.5 MW Unit													
	Net Head (feet)												
Flow (cfs)	80	85	90	95	100	105	110	115	120	125	130	135	140
100	570	610	650	680	740	800	860	910	960	1000	1040	1090	1090
120	650	690	730	760	820	880	940	990	1040	1080	1120	1170	1170
140	810	850	890	920	990	1030	1090	1140	1190	1230	1270	1320	1320
160	960	1000	1040	1070	1140	1200	1260	1320	1390	1450	1500	1550	1550
180	1120	1160	1200	1230	1300	1370	1450	1520	1590	1670	1710	1790	1790
200	1290	1330	1370	1400	1470	1550	1640	1710	1800	1880	1960	2010	2010
220	1450	1490	1530	1560	1650	1730	1830	1900	2000	2090	2180	2250	2250
240	1610	1650	1690	1720	1840	1910	2020	2110	2210	2300	2400	2500	2500
260	1710	1750	1790	1820	1950	2060	2180	2270	2390	2495	2595	2680	2680
280	1840	1880	1920	1950	2070	2190	2310	2440	2520	2700	2760	2860	2860
300	1910	1950	1990	2020	2180	2300	2420	2550	2680	2800	2900	3000	3000

Turbine efficiency is estimated through the interpolation of turbine efficiency curves for each turbine as provided in Table 3-26 (Mead and Hunt, June 2005).

Table 3-26. Turbine efficiency (%) of 1-MW and 2.5-MW turbine/generator units.

	Efficiency (%)	
Net Head (feet)*	1 MW Unit	2.5 MW Unit
146	82	84
140	83	85
130	84	86
125	84	86
120	84	86
110	84	86
100	83	86
90	82	85
80	80	80
70	75	75
63	67	70

Net head is calculated from the following equation:

Net Head = Reservoir WSE – Penstock Tailwater Elevation – Turbine Head Loss

Elevation for the 1 MW penstock was assumed to be 620.5 feet and 622.5 for the 2.5 MW (USACE, 2004, January). The head loss from the turbine is estimated with the following equation:

$h_L = K \times q^2$

Where:

h_L = head loss
K = head loss coefficient
q = turbine flow (cfs)

The head loss coefficient for the 1 MW unit was assumed to be 3×10^{-4} and for the 2.5 MW unit was assumed to be 9×10^{-7}.

3.5.5.2 Lake Sonoma

Hydroelectric power generation for WSD was estimated with a model using methods developed by the Water Agency in 1996 (SCWA, 1996) that incorporates simulated storage and reservoir release results from RR ResSim. The maximum turbine flow was assumed to be 140 cfs. The model uses to following function to estimate power generation:

$Power = (N_t \times N_g \times q \times h/11.8) \times 24/1000$

Where:

Power is in kilowatt hours per day
N_t = turbine efficiency
N_g = generator efficiency
h = static head – head loss (feet)
q = turbine flow (cfs)

Headloss was calculated using the following equation:

$h_L = K \times q^2$

Where:

h_L = head loss
K = head loss coefficient
q = turbine flow (cfs)

Head loss coefficients were estimated using data which was collected during the testing of inlet works to the turbine after the turbine was installed. Head loss coefficients used in the model are summarized in Table 3-27.

Table 3-27. Turbine/generator head loss coefficient.

Water Surface Elevation (feet)	Head Loss Coefficient (x10^-4)
< 395	2.06
>= 395 & < 435	2.61
>= 435	2.18

Net head was calculated by subtracting the elevation of the penstock tailwater (221.5 feet) and the estimated head loss from the lake water surface elevation. Lake water surface elevation interpolated from reservoir hypsometry.

Turbine efficiency is a function of turbine flow and net head. Turbine efficiencies were interpolated using the values from Table 3-28 which were taken from the manufacturer's performance curves.

Table 3-28. Turbine efficiency (%) for different flow rates and net head.

Turbine Flow	Net head (feet)						
(cfs)	140	160	180	200	220	240	260
60	66.6%	69.5%	72.0%	72.0%	72.4%	72.0%	71.0%
70	75.8%	78.0%	78.4%	77.8%	76.6%	76.2%	75.7%
80	78.8%	81.8%	82.2%	81.6%	80.8%	79.6%	79.0%
90	80.7%	88.4%	84.5%	83.8%	83.0%	82.2%	81.5%
100	82.6%	84.9%	86.0%	85.7%	84.8%	84.0%	83.1%
110	84.4%	86.4%	86.6%	87.6%	86.6%	85.6%	84.7%
120	86.0%	88.2%	89.0%	89.3%	88.3%	87.0%	86.0%
130	87.5%	89.8%	90.5%	90.8%	90.1%	88.6%	87.5%
140	88.5%	91.4%	91.9%	92.2%	91.7%	90.2%	88.9%
150	88.8%	92.0%	92.8%	93.0%	92.7%	91.5%	90.0%
160	87.0%	91.4%	93.0%	93.4%	93.0%	92.4%	90.8%
170	0.0%	87.0%	91.7%	92.6%	92.8%	92.5%	91.0%
180	0.0%	0.0%	89.6%	91.2%	91.9%	91.8%	91.0%
190	0.0%	0.0%	0.0%	89.5%	90.4%	90.8%	90.6%

3.6 River Stage

River stage was estimated for the Hopland, Cloverdale, Healdsburg, Hacienda and the Dry Creek Geyserville model junctions. River stage was interpolated from simulated daily average flows from the RR ResSim model using rating curves obtained from the USGS. The rating curves were collected from the USGS website in June, 2016 (USGS, 2016). The rating curves (stage versus storage) used to estimate stage are provided in Figure 3-26.

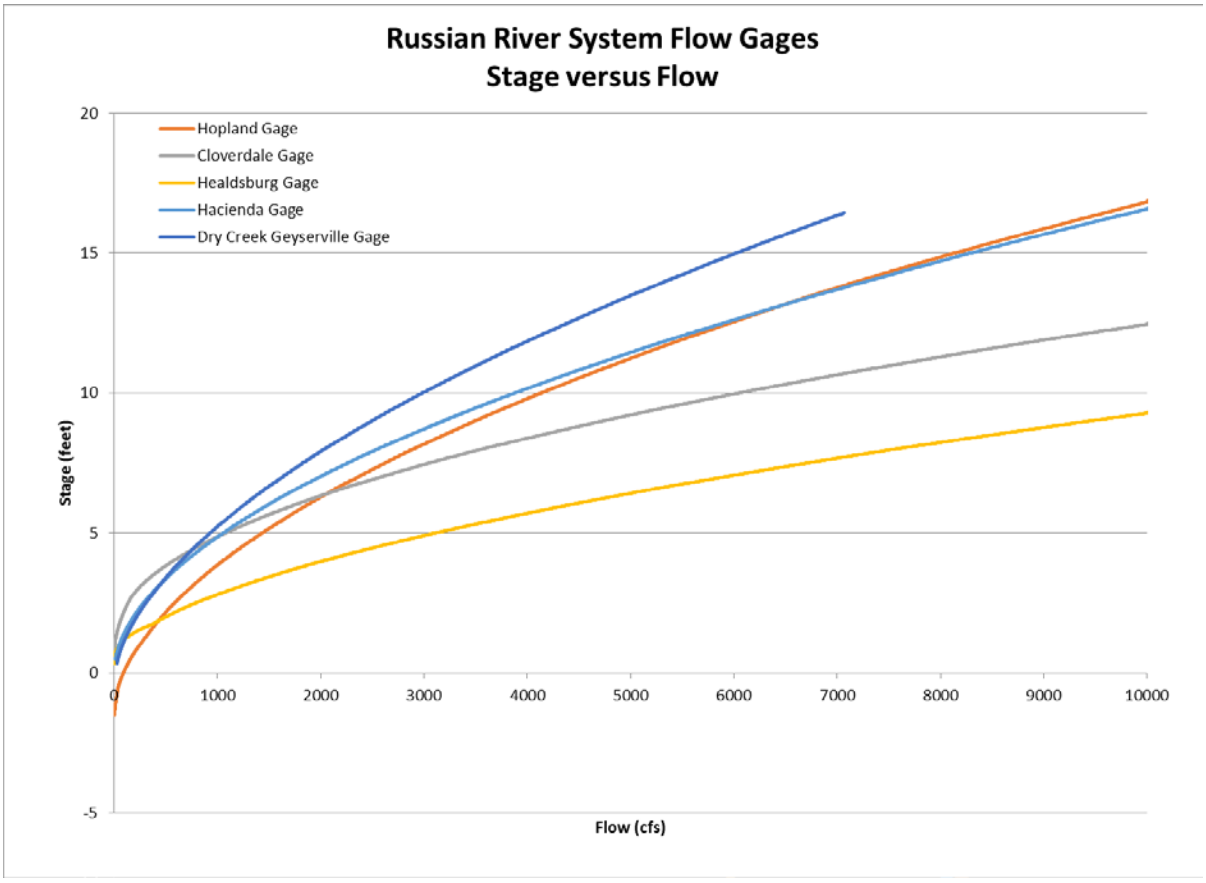

Figure 3-26. Stage versus flow rating curves for stream flow gages on the Russian River and Dry Creek.

3.7 RR ResSim Model Verification

To assess model accuracy, a historical verification model scenario was developed. The period of analysis for the historical simulation is from 2000 to 2013. The primary purpose of this historical simulation is to demonstrate that the primary model assumptions, such as the unimpaired flows and the estimated reach losses, accurately simulate observed conditions in the Russian River System during water supply operations of the reservoirs. Development of the datasets for the historical simulation scenario are described below.

3.7.1 Verification Simulation Setup

3.7.1.1 PVP Operations

The modeled PVP diversions described above in Section 3.1.2 are designed to simulate Existing Conditions, post-2007 operations of the PVP. This dataset was not used for the verification simulation, because it would not accurately simulate 2000 to 2006 operations. For this reason, observed PVP imports were used for the 2000 to 2013 simulation period.

3.7.1.2 Unimpaired Flows

The unimpaired flow dataset developed by the USGS was used for verification simulation. This dataset is discussed in Section 3.1.1.

3.7.1.3 System Losses

With the exception of Water Agency diversions, the system reach losses used for the verification simulation were the Existing Conditions losses discussed in Section 3.2. Wet and dry year patterns were applied based on the results of the loss year type analysis discussed in Section 3.2.5. Observed metered diversions from 2000 to 2013 were used for Water Agency diversions.

3.7.1.4 Lake Mendocino Guide Curve

In spring of 2007, at the request of the Water Agency, the USACE began operating to an alternative Guide Curve schedule. This alternative schedule is the Guide Curve currently used for reservoir operations and is further discussed in Section 3-30. Prior to 2008, the maximum conservation storage was 86,400 acre-feet by March 30. To account for this change, the verification simulation uses the pre-2007 guide curve for the simulation period from 2000 to 2006 and the currently used guide curve from 2007 to 2013.

Review of historical storage of Lake Mendocino for the verification scenario simulation period shows that periodically the USACE allowed for water to be stored in the lake above the guide curve to improve water supply capture. RR ResSim does not allow for encroachment of storage beyond the top of the water supply pool except for short periods during simulated flood operations. To account for this observed historical practice where the USACE has allowed for water to be stored beyond the top of the water supply pool, for the verification model simulation, the model guide curve was modified to allow for conservation storage above the top of the water supply pool to match observed historical operations.

3.7.1.5 Minimum Instream Flow Requirements

Historical water supply operations of the Russian River System from 2000 to 2013 have varied due to changes in regulatory compliance such as temporary emergency actions taken for conservation of water supply and/or changes in minimum flows to comply with the Biological Opinion. The Biological Opinion was issued in 2008 and before this the Water Agency operated Lake Mendocino consistent with the requirements of the Water Agency's water right permits. Additionally, for a number of years within the verification simulation period Temporary Urgency Change Orders were issued by the State Water Resources Control Board to reduce minimum instream flows to conserve storage in Lake Mendocino in response to drought conditions. For

these reasons, actual historical minimum instream flow requirements were used for the verification simulation in place of the baseline conditions in the Fish Flow Project EIR.

The model alternatives for the Fish Flow Project EIR assume a constant minimum instream flow compliance buffer for each reach of the river, as discussed in Section 3.5.3.3. This assumption is consistent with present day water supply operations where operators frequently make changes to releases from Lake Mendocino in an effort to minimize the buffer. Review of historical operations shows that the compliance buffer has varied considerably, especially prior to water year 2007, before full implementation of the 2004 PVP license amendment. In certain years, such as 2004, flows were managed at rates well above the minimum instream flow requirements likely due to sufficient storage levels in the Lake Mendocino and Lake Sonoma and high levels of imports from the PVP. To account for this variability in historic water supply operations, minimum instream flow buffers were adjusted to better approximate observed historic buffers for the verification simulation.

3.7.2 Verification Simulation Results

Results of the verification simulation were compared to observed conditions for reservoir storage levels and flow conditions at select model junctions downstream of the reservoirs for the years 2000 to 2013. Modeled flows were compared to observed flows for the period of June through September of each year. This period was selected because it was identified as the rearing season for steelhead in the Russian River Biological Opinion. Results of the verification simulation are provided in the sections below.

3.7.2.1 Lake Mendocino

Results of simulated Lake Mendocino storage from the verification simulation were compared to observed storage from 2000 to 2013, as shown in Figure 3-27. Simulated storage levels correlate very well with observed storage levels, however, water years 2009 and 2012 showed higher peak modeled storage than observed storage. The higher storage in these years result from an overestimation of modeled unimpaired flows into Lake Mendocino. The unimpaired flows developed by the USGS were calibrated to observed USGS gage data, which may be inaccurate for high flows for those years. This can potentially lead to less accurate unimpaired flows and result in minor differences between modeled and observed storage. In order to assess accuracy of the model for simulating storage during water supply operations both the modeled and the observed storage levels were filtered to reduce the dataset for periods when storage falls below the top of the water supply pool. A scatter plot of the filtered modeled storage versus filtered observed storage is provided in Figure 3-28. These results show a least-squares linear regression fit of approximately 1.00 to 1 correlation and a R^2 of 0.97.

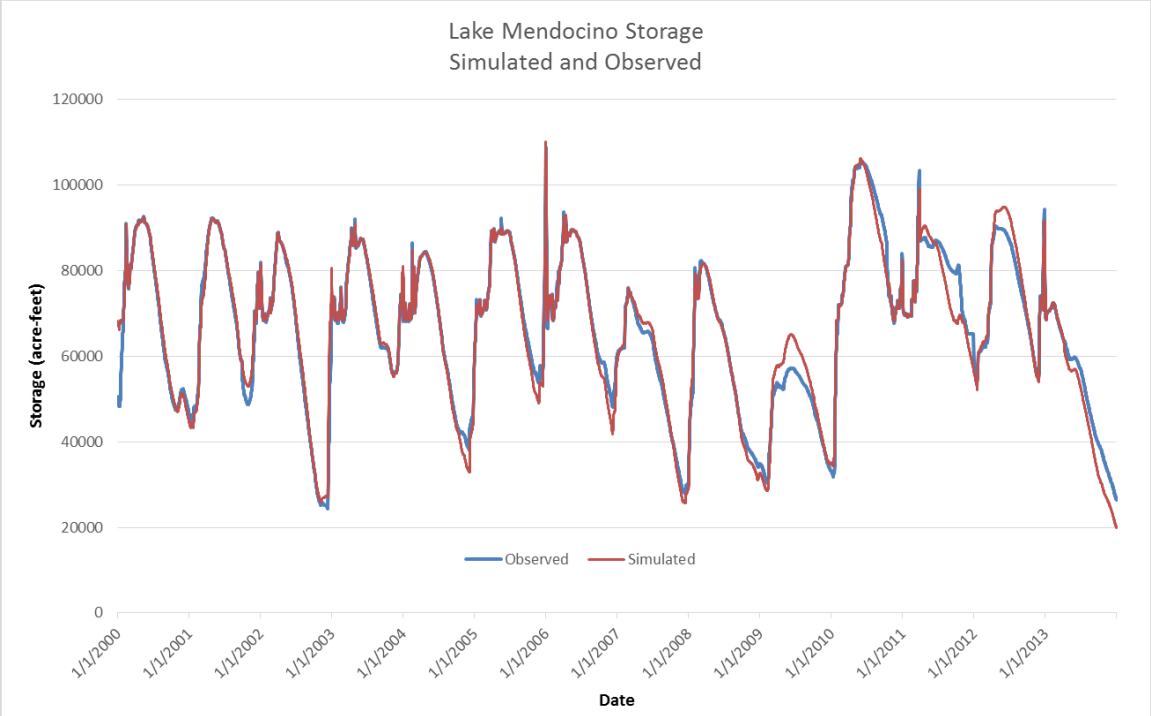

Figure 3-27. Hydrograph of Lake Mendocino storage 2000 to 2013 for observed conditions and simulated scenario results.

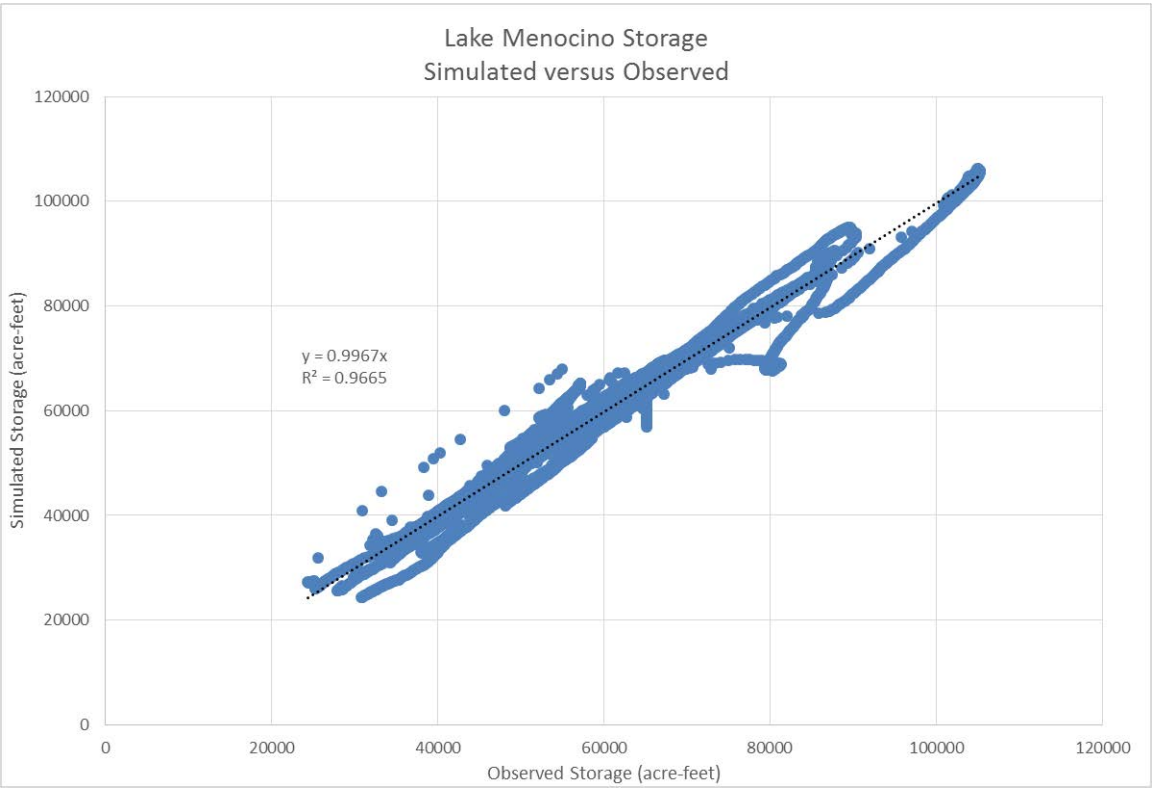

Figure 3-28. Scatter plot of Lake Mendocino storage 2000 to 2013 for verification scenario results versus observed conditions.

3.7.2.2 Lake Sonoma

Results of simulated Lake Sonoma storage from the verification simulation were compared to observed storage from 2000 to 2013, as shown in Figure 3-29. Hydrograph of Lake Sonoma storage 2000-2013 for observed conditions and simulated scenario results.. Simulated storage levels correlate very well with observed storage levels, however, water year 2009 shows a higher peak modeled storage than observed storage. The higher storage 2009 result from an overestimation of modeled unimpaired flows into Lake Sonoma. The unimpaired flows developed by the USGS were calibrated to observed USGS gage data, which may be inaccurate for high flow periods. This can potentially lead to less accurate unimpaired flows and result in minor differences between modeled and observed storage. In order to assess accuracy of the model for simulating storage during water supply operations both the modeled and the observed storage levels were filtered to reduce the dataset for periods when storage falls below the top of the water supply pool. A scatter plot of the filtered modeled storage versus filtered observed storage is provided in Figure 3-30. Scatter plot of Lake Sonoma storage 2000 to 2013 for verification scenario results versus observed conditions. These results show a least-squares linear regression fit of approximately 1.02 to 1 correlation and a R^2 of 0.93.

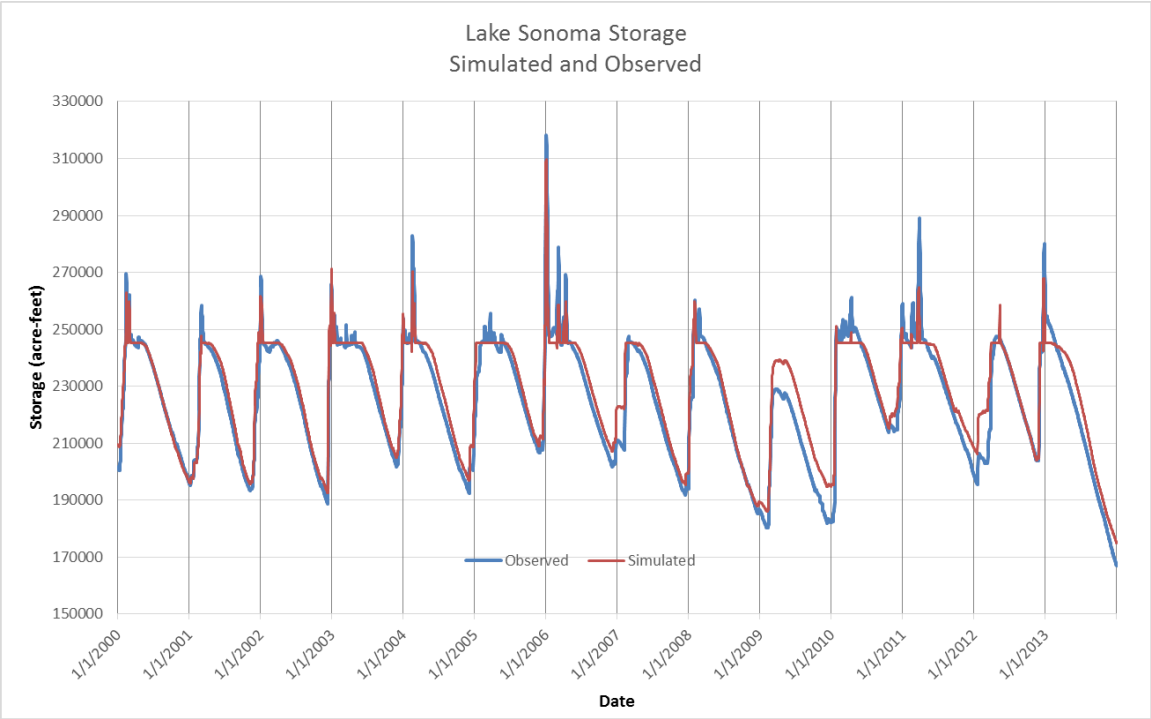

Figure 3-29. Hydrograph of Lake Sonoma storage 2000-2013 for observed conditions and simulated scenario results.

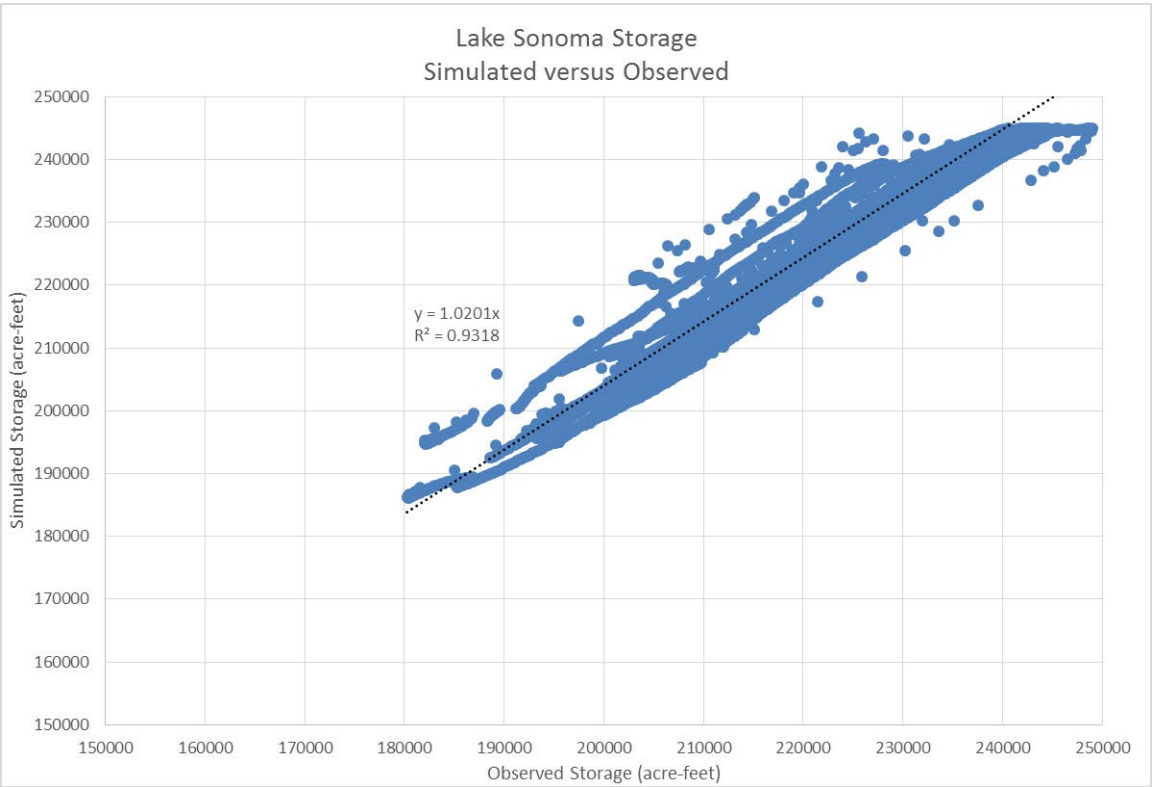

Figure 3-30. Scatter plot of Lake Sonoma storage 2000 to 2013 for verification scenario results versus observed conditions.

3.7.2.3 Hopland Junction

Results of the simulated flows at the Hopland model junction from the verification simulation were compared to observed flows at the Hopland gage for the period June to September each year from 2000 to 2013. A scatter plot of simulated flows versus observed flows is provided in Figure 3-31. These results show a least-squares linear regression fit of approximately 1.03 to 1 correlation and a R^2 of 0.85. A percentile plot of June to September simulated and observed flows is provided in Figure 3-32. These results show that the distribution of the simulated flows matches closely with the observed flows with the simulated flows slightly biased above the observed flows from 0 to 80 percentile range.

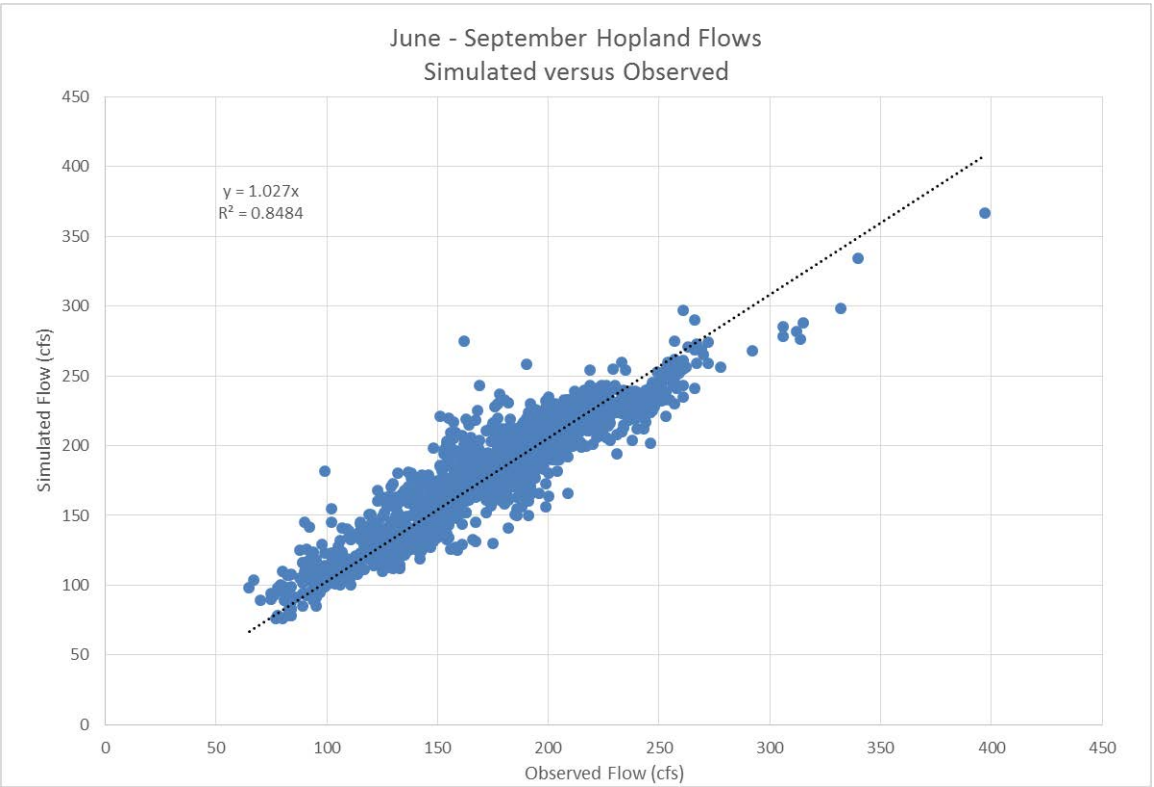

Figure 3-31. Scatter plot of Hopland gage flow 2000 to 2013 for verification scenario results versus observed conditions.

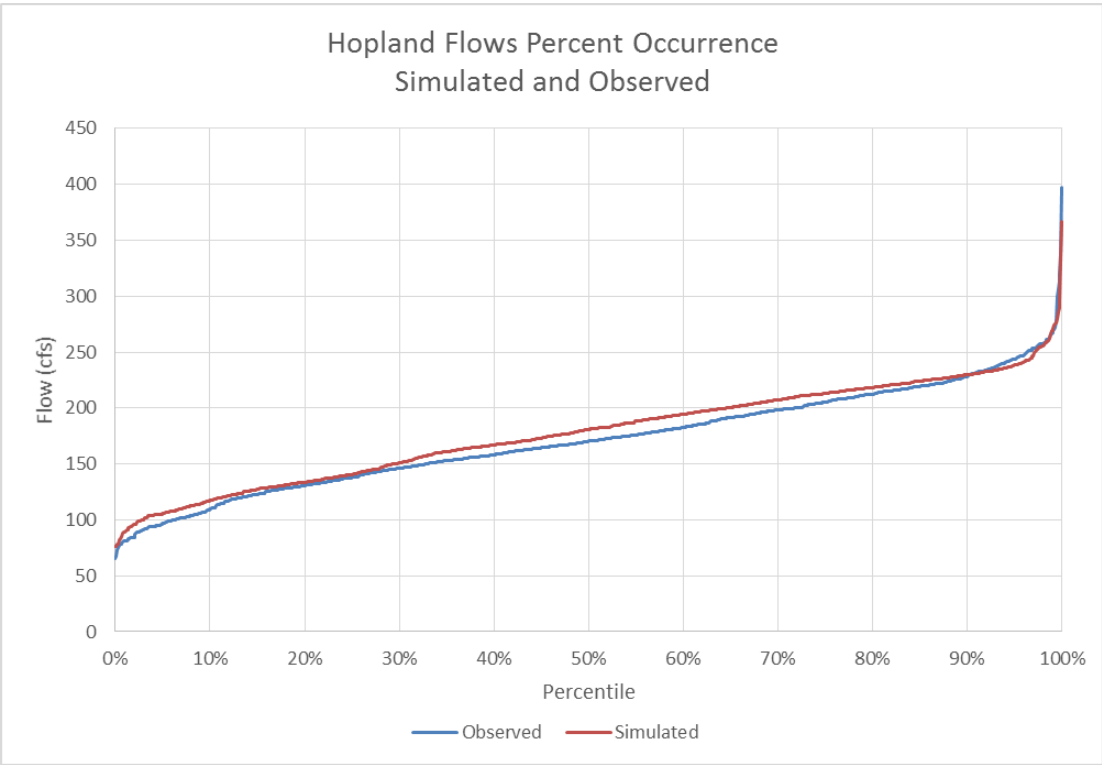

Figure 3-32. Percent exceedance of Hopland gage flow 2000 to 2013 for verification scenario results and observed conditions.

3.7.2.4 Cloverdale Junction

Results of the simulated flows at the Cloverdale model junction were compared to observed flows at the Cloverdale gage for the period June to September each year from 2000 to 2013. A scatter plot of simulated flows versus observed flows is provided in Figure 3-33. These results show a least-squares linear regression fit of approximately 1.01 to 1 correlation and a R^2 of 0.89. A percentile exceedance plot of June to September simulated flows and observed flows is provided in Figure 3-34. These results show that the distribution of the simulated flows matches very closely with the observed flows.

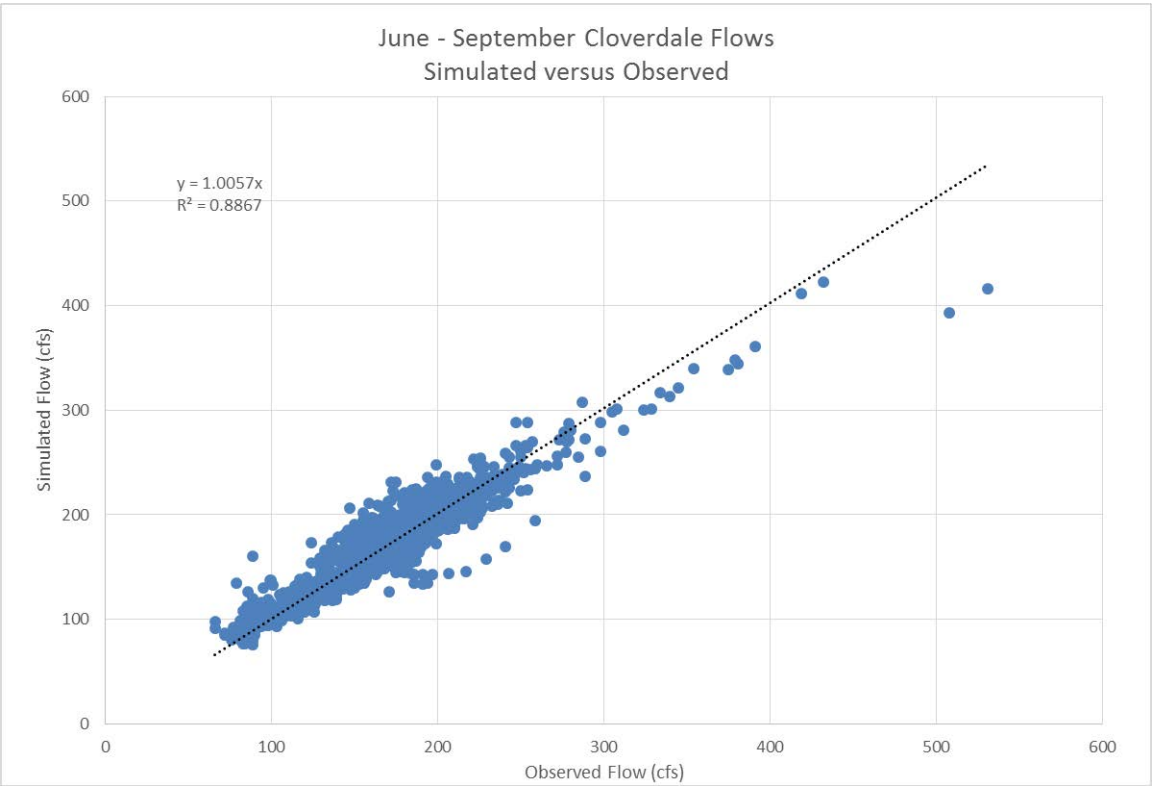

Figure 3-33. Scatter plot of Cloverdale gage flow 2000 to 2013 for verification scenario results versus observed conditions.

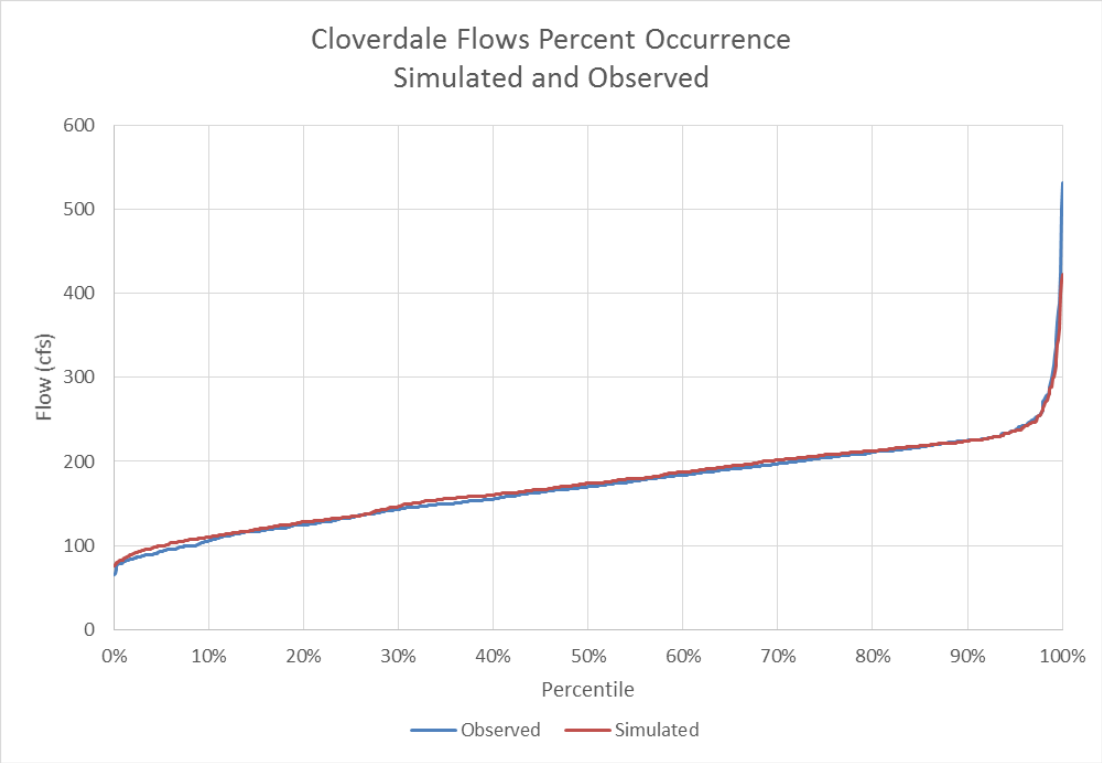

Figure 3-34. Percent exceedance of Cloverdale gage flow 2000 to 2013 for verification scenario results and observed conditions.

3.7.2.5 Healdsburg Junction

Results of the simulated flows at the Healdsburg model junction were compared to observed flows at the Healdsburg gage for the period June to September each year from 2000 to 2013. A scatter plot of simulated flows versus observed flows is provided in Figure 3-35. These results show a least-squares linear regression fit of approximately 0.95 to 1 correlation and a R^2 of 0.76. A percentile plot of June to September simulated flows and observed flows is provided in Figure 3-36. These results show that the distribution of the simulated flows matches closely with the observed flows.

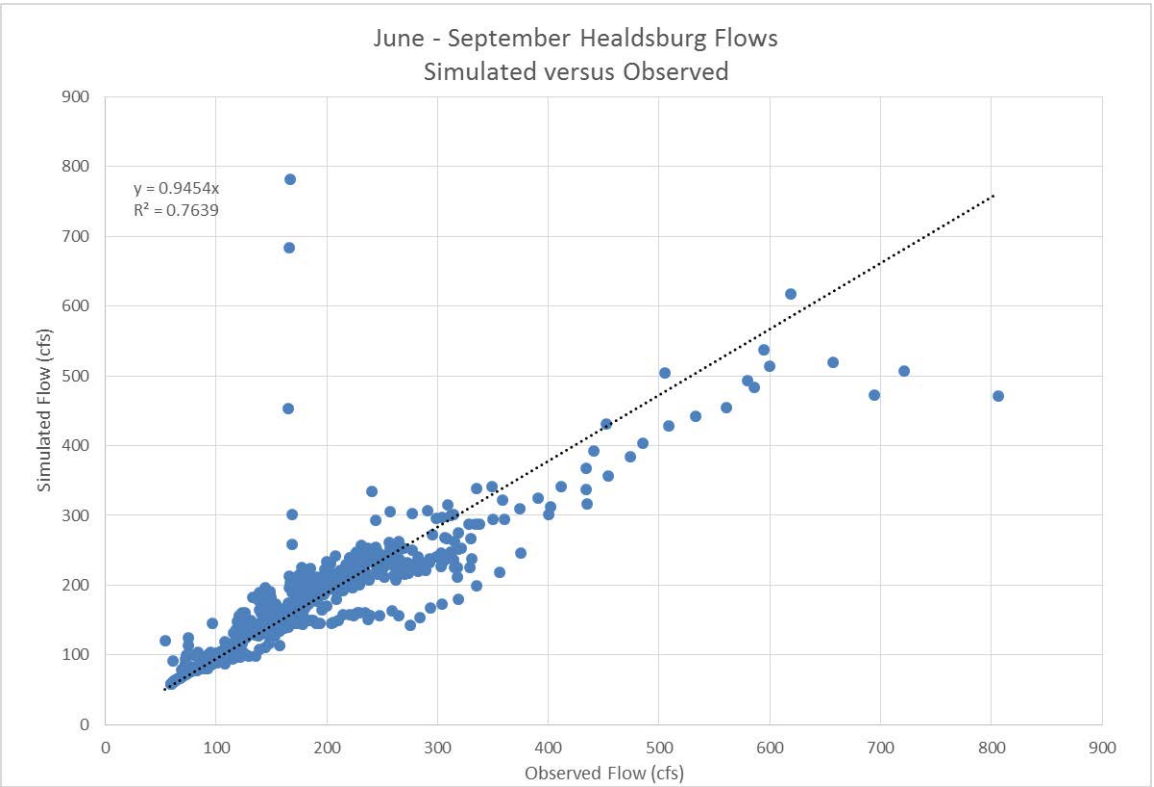

Figure 3-35. Scatter plot of Healdsburg gage flow 2000 to 2013 for verification scenario results and observed conditions.

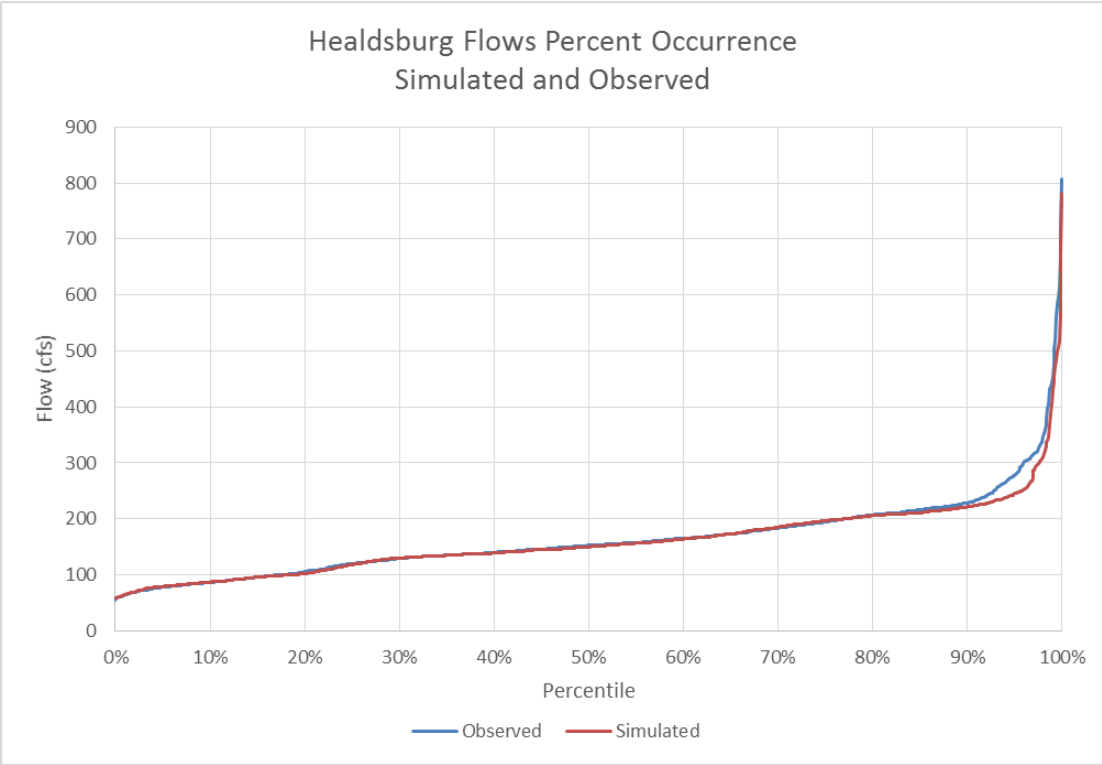

Figure 3-36. Percent exceedance of Healdsburg gage flow 2000 to 2013 for verification scenario results and observed conditions.

3.7.2.6 Dry Creek Junction

Results of the simulated flows at the Dry Creek model junction were compared to observed flows at the Dry Creek Mouth gage for the period June to September each year from 2000 to 2013. A scatter plot of simulated flows versus observed flows is provided in Figure 3-37. These results show a least-squares linear regression fit of approximately 1.01 to 1 correlation and a R^2 of 0.21. These results indicate that there is not a good agreement of the simulated flows to the daily observed flows. Minimum flow compliance for the Hacienda Gage is met through releases from Lake Sonoma, and for the period of comparison (June through September) the compliance point for minimum instream flows is usually at the Hacienda Gage. Therefore, much of the flow variability at the Dry Creek Mouth gage is driven by losses in the Dry Creek reach and the Lower Russian River. Because the model incorporates simplified patterns of loss the simulated flows at the Dry Creek junction are mostly a function of these modeled loss patterns as opposed to the actual observed losses for the period analyzed.

A percentile plot of June to September simulated flows and observed flows is provided in Figure 3-38. These results show that the distribution of the simulated flows matches very closely with the observed flows. So while, as shown above, the daily simulated flows do not well match with observed flows for this model junction due to simplification of system losses, the distribution of flows matches very closely to observed flows, and is therefore a good representation of flows at this model junction.

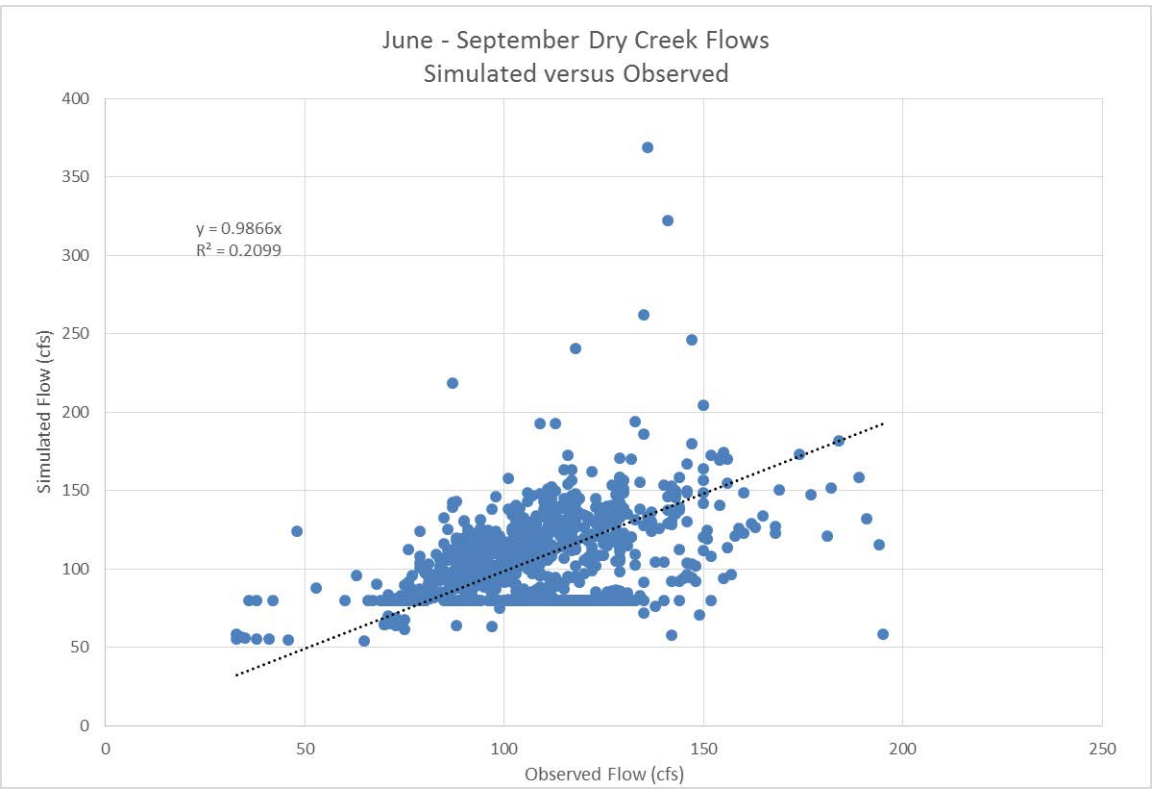

Figure 3-37. Scatter plot of Dry Creek gage flow 2000 to 2013 for verification scenario results and observed conditions.

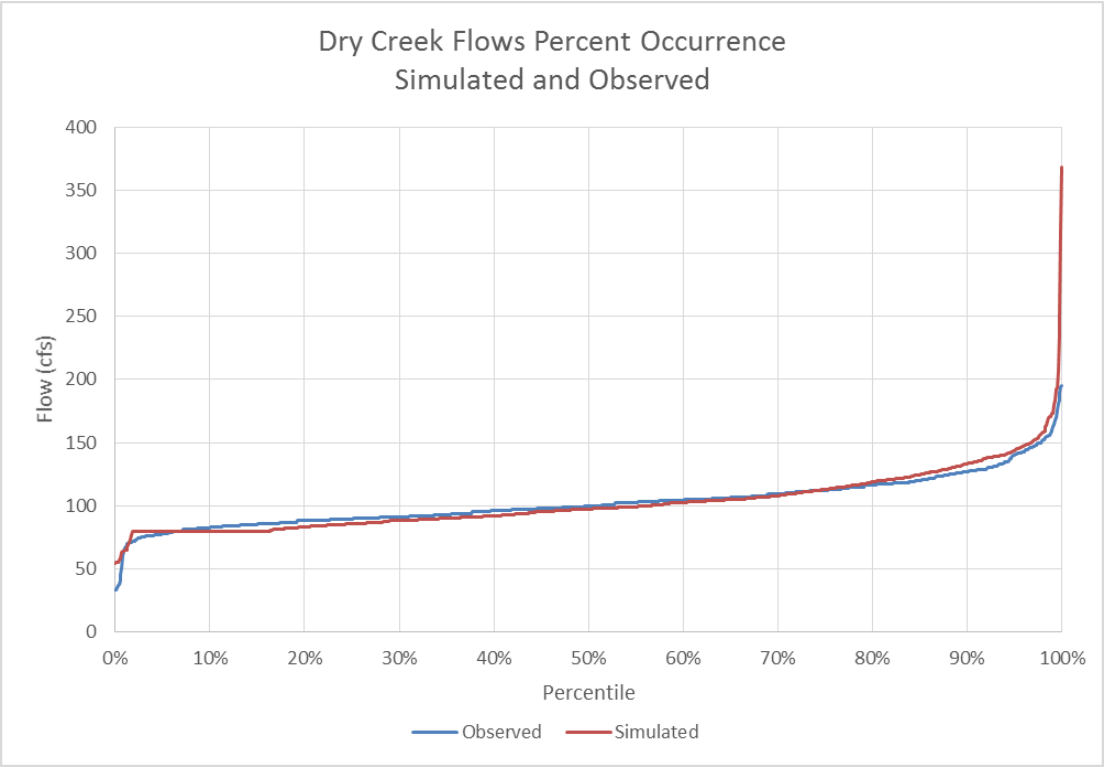

Figure 3-38. Percent exceedance of Dry Creek gage flow 2000 to 2013 for verification scenario results and observed conditions.

3.7.2.7 Hacienda Junction

Results of the simulated flows at the Hacienda model junction were compared to observed flows at the Hacienda Gage for the period June to September each year from 2000 to 2013. A scatter plot of simulated flows versus observed flows is provided in Figure 3-39. These results show a least-squares linear regression fit of approximately 0.85 to 1 correlation and a R^2 of 0.66. A percentile plot of June to September simulated flows and observed flows is provided in Figure 3-40. These results show that the distribution of the simulated flows matches closely with the observed flows.

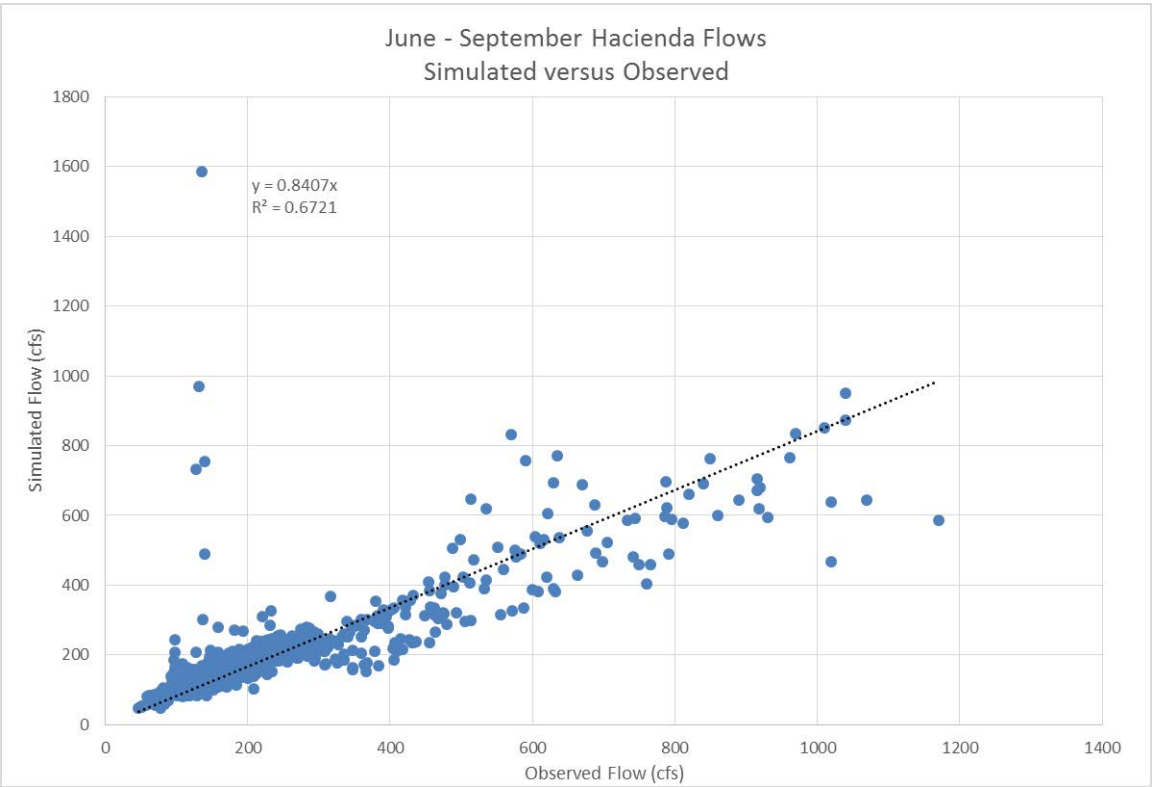

Figure 3-39. Scatter plot of Hacienda gage flow 2000 to 2013 for verification scenario results and observed conditions.

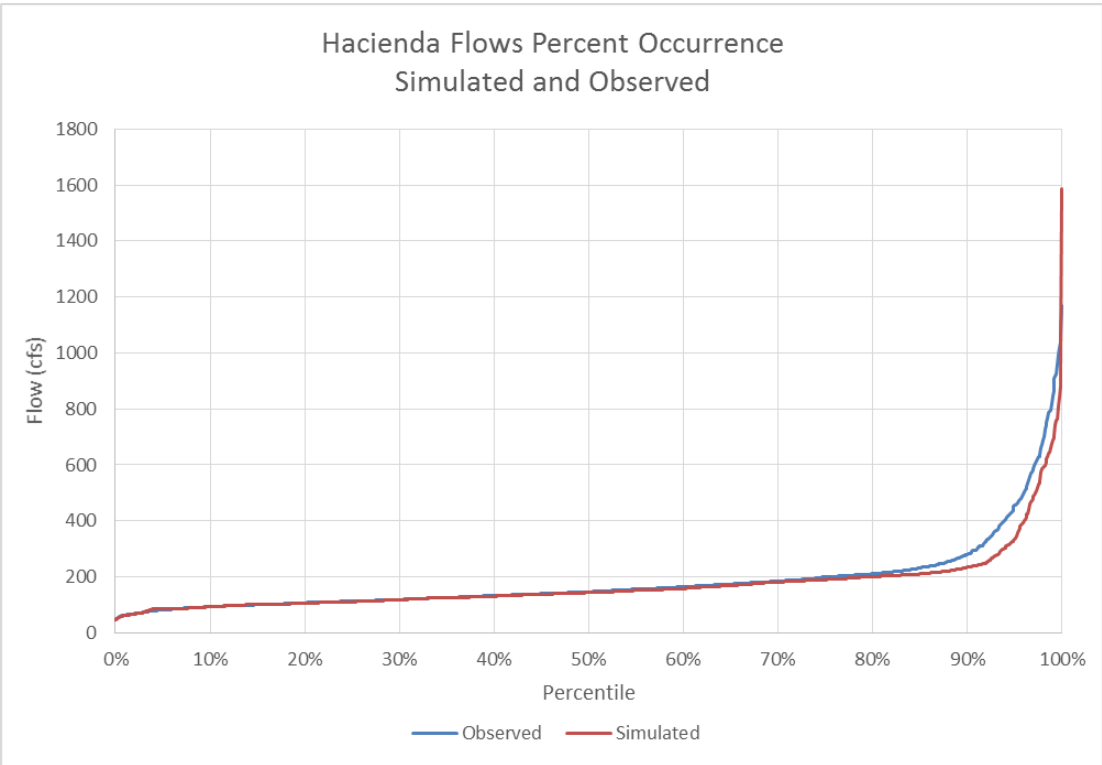

Figure 3-40. Percent exceedance of Hacienda gage flow 2000 to 2013 for verification scenario results and observed conditions.

4 Russian River Water Quality Model

Water Quality conditions of the Russian River System are simulated with the Russian River HEC5Q (RR HEC5Q) model. RR HEC5Q uses the USACE HEC-5Q model to simulate water quality conditions. This model was originally developed by RMA in 2001, and RMA has completed updates and improvements to the model over time to support Water Agency needs. Documentation on the development of this model is provided in the 2016 RMA report, *"HEC-5Q Russian River Basin Model Demonstration*" (RMA, 2016).

RR HEC5Q model was used to simulate of water temperature in degrees Fahrenheit (deg F) and dissolved oxygen in milligrams per liter (mg/L). These results were used to support the environmental impact analysis of the Fish Flow Project EIR to evaluate potential changes in habitat as a result of changes in system management.

5 Model Results

Results have been prepared for 8 model scenarios evaluated in the Fish Flow EIR. Four of these model scenarios include different combinations of minimum instream flows and/or Water Agency demand and are evaluated in the environmental impact analysis included in the EIR. These scenarios include:

1. The Baseline Conditions model scenario incorporates the minimum instream flow requirements defined in the Water Agency's water right permits and Baseline Condition Water Agency demand of 55,200 acre-feet per year as discussed in Section 3.2.1.1;
2. The No Project 1 Alternative model scenario incorporates the minimum instream flow requirements defined in the Water Agency's water right permits and full Water Agency water right demand of 75,000 acre-feet per year as discussed in Section 3.2.1.1;
3. The No Project 2 Alternative model scenario incorporates the temporary changes to minimum instream flows recommended in the Russian River Biological Opinion as discussed in Section 2.2.2 and full Water Agency water right demand of 75,000 acre-feet per year as discussed in Section 3.2.1.1; and
4. The Proposed Project model scenario incorporates the proposed hydrologic index, Russian River Hydrologic Index, as discussed in Section 2.2.3 and Section 3.5.3.1, the preferred minimum instream flows of the Fish Flow Project EIR and full Water Agency water right demand of 75,000 acre-feet per year as discussed in Section 3.2.1.1.

These scenarios are further discussed in the Fish Flow Project EIR. Model results of these scenarios have been prepared in 3 reports which are included as Attachments 1-3. Each report provides numerous plots at multiple model junctions along the Russian River and Dry Creek. Each report shows results of a Fish Flow Project EIR alternative as well as results of the Baseline Condition for direct comparison.

Additional scenarios were developed to support the Cumulative Impact Analysis of the Fish Flow Project EIR. The Cumulative Impact Analysis is intended to evaluate the cumulative impact of the change in the environment which results from the incremental impact of the Proposed Project when added to other closely related past, present, and reasonably foreseeable probable future projects. Four cumulative scenarios were modeled and analyzed which include:

1. The Cumulative 1 model scenario incorporates a modified condition where no diversions are made through the PVP; all other assumptions are consistent with the Proposed Project scenario;
2. The Cumulative 2 model scenario incorporates an increased demand for the City of Ukiah in the Hopland model reach as discussed in Section 3.2.1.2 and projected 2040 storage capacity for Lake Pillsbury, Lake Mendocino and Lake Sonoma as discussed in Sections 3.1.2.6 and 1.1.1; all other assumptions are consistent with the Proposed Project scenario;

3. The Cumulative 3 model scenario incorporates an increased Water Agency demand projected for the year 2040 as analyzed in the 2015 UWMP as discussed in Section 3.2.1.1 and projected 2040 storage capacity for Lake Pillsbury, Lake Mendocino and Lake Sonoma as discussed in Sections 3.1.2.6 and 1.1.1; all other assumptions are consistent with the Proposed Project scenario; and
4. The Cumulative 4 model scenario incorporates all of the changed conditions of Cumulative 1 to 3 into a single scenario.

Table 5-1 provides a summary of the model scenarios evaluated for the Fish Flow Project EIR. Table 5-1 includes fields summarizing model assumptions which were modified to generate the scenarios. Table cells also include Section references of this report for further information regarding the development of the model assumptions.

Table 5-1. Summary of model scenario assumptions including report Section references for further discussion of model assumptions.

Model Scenario	PVP Diversions	Water Agency Annual Demand	Other System Losses	Hydrologic Index	Minimum Flows	Reservoir Storage Capacity
Baseline Conditions	Existing Conditions Section 3.1.2	55,200 acre-feet/year Section 3.2.1.1	Existing Conditions Sections 3.2.1 - 3.2.6	Decision 1610 Section 2.2.3 & 3.5.3.1	Decision 1610 Section 3.4.4.2	Existing Conditions Section 3.4
No Project 1	Existing Conditions Section 3.1.2	75,000 acre-feet/year Section 3.2.1.1	Existing Conditions Sections 3.2.1 - 3.2.6	Decision 1610 Section 2.2.3 & 3.5.3.1	Decision 1610 Section 3.4.4.2	Existing Conditions Section 3.4
No Project 2	Existing Conditions Section 3.1.2	75,000 acre-feet/year Section 3.2.1.1	Existing Conditions Sections 3.2.1 - 3.2.6	Decision 1610 Section 2.2.3 & 3.5.3.1	Biological Opinion Sections 2.2.2 & 3.4.4.2	Existing Conditions Section 3.4
Proposed Project	Existing Conditions Section 3.1.2	75,000 acre-feet/year Section 3.2.1.1	Existing Conditions Sections 3.2.1 - 3.2.6	Russian River Hydrologic Index Section 2.2.3 & 3.5.3.1	Proposed Flows Section 3.4.4.2	Existing Conditions Section 3.4
Cumulative 1	No Tunnel Diversions Section 3.1.2.5	75,000 acre-feet/year Section 3.2.1.1	Existing Conditions Sections 3.2.1 - 3.2.6	Russian River Hydrologic Index Section 2.2.3 & 3.5.3.1	Proposed Flows Section 3.4.4.2	Existing Conditions Section 3.4
Cumulative 2	Projected 2040 Operations Section 3.1.2.8	75,000 acre-feet/year Section 3.2.1.1	2013 City of Ukiah EIR Sections 3.2.1 - 3.2.6	Russian River Hydrologic Index Section 2.2.3 & 3.5.3.1	Proposed Flows Section 3.4.4.2	Projected 2040 Section 3.4.3
Cumulative 3	Projected 2040 Operations Section 3.1.2.8	75,800 acre-feet/year Section 3.2.1.1	Existing Conditions Sections 3.2.1 - 3.2.6	Russian River Hydrologic Index Section 2.2.3 & 3.5.3.1	Proposed Flows Section 3.4.4.2	Projected 2040 Section 3.4.3
Cumulative 4	No Tunnel Diversions Section 3.1.2.5	75,800 acre-feet/year Section 3.2.1.1	2013 City of Ukiah EIR Section 3.2.1.2	Russian River Hydrologic Index Section 2.2.3 & 3.5.3.1	Proposed Flows Section 3.4.4.2	Projected 2040 Section 3.4.3

The Cumulative Impact Analysis scenarios are discussed further in Chapter 5 of the Fish Flow Project EIR. Model results for each of the 4 Cumulative Impact Analysis scenarios have been prepared in 4 reports included as Attachments 4-7. Each report also includes model results of the Proposed Project to allow comparison of potential for cumulatively considerable impacts.

The reports in Attachments 1-7 present results for 16 points along the Russian River and Dry Creek. These points are listed in Table 5-2 including Russian River ResSim model junction names for the report points and the parameters presented for each point.

Table 5-2. Modeling report points of analysis.

Modeling Report Location Name	RR ResSim Junction	Storage (acre-feet)	Flow (cfs)	Stage (feet)	Power (kW-h/day)	Temperature (deg F)	Dissolved Oxygen (mg/L)
Lake Mendocino	Lake Mendocino	X				X	X
Coyote Valley Dam Outlet	Lake Mendocino Outlet		X		X	X	X
Forks	East - West Jct		X			X	X
2 Miles Downstream of Forks						X	X
4 Miles Downstream of Forks						X	X
Hopland Gage	Hopland		X	X		X	X
Cloverdale Gage	Cloverdale		X	X		X	X
Geyserville Gage						X	X
Healdsburg Gage	Healdsburg		X	X		X	X
Russian River at Dry Creek	Dry Creek - Russian River Jct		X			X	X
Hacienda Gage	Hacienda		X	X		X	X
Lake Sonoma	Lake Sonoma	X				X	X
Warm Springs Dam Outlet	Lake Sonoma Outlet		X		X	X	X
Dry Creek at Geyserville Gage	Dry Creek Geyserville		X	X		X	X
Dry Creek at Lambert Bridge Gage						X	X
Dry Creek Mouth Gage	Dry Creek Mouth		X			X	X

6 References

Bond, M. (June 10, 2016). pers. comm.

Davids. (2013). *Russian River Applied Water Estimates.* Davids Engineering.

FERC. (2004). *Order Amending License (106 FERC 61,065).* U.S. Federal Regulatory Commission.

Grandi, Mel pers. comm. June 28, 2016. (n.d.). City of Ukiah.

Grinnell, S. (2016). *Sonoma County Water Agency Operations Model: Streamflow Depletions Time Series Development.* Stephen Grinnell.

HEC. (2012). *Determination of a Hydrologic Index for the Russian River Watershed using HEC-ResSim.* Davis, California: U.S. Army Corps of Engineers Hydrologic Engineering Center.

NMFS. (2008). *Biological Opinion for Water Supply, Flood Control Operations, and Channel Maintenance conducted by the USACE, the SCWA, and the MCRRFCWCID in the Russian River Watershed.* Santa Rosa, California: National Marine Fisheries Service.

PG&E. (2006). *Flow Regulation and Verification Plan, Addressing License Article 52 (A) as they relate to RPA Measurs 3 and 5, Potter Valley Hydroelectric Project, FERC Project No. 77.* Pacific Gas and Electric Company.

RMA. (2016). *HEC-5Q Russian River Basin Model Demonstration.* Resource Management Associates, Inc.

SCWA. (1996). *Russian River System Model, A Water Balance Computer Model of the Russian River System.* Santa Rosa, California: Sonoma County Water Agency.

SCWA. (2016). *2015 Urban Water Management Plan.* Santa Rosa, California: Sonoma County Water Agency.

SCWA. (2016). *Development of the Russian River Hydrologic Index for the Fish Habitat Flows and Water Rights Project.* Santa Rosa, California: Sonoma County Water Agency.

SCWA. (August 2016). *Fish Habitat Flows and Water Rights Project Draft Environmental Impact Report.* Santa Rosa, California: Sonoma County Water Agency.

SCWA. (September, 2014). *Letter to California Department of Fish and Wildlife, Coyote Valley Dam Hatchery and Warm Springs Dam Hatchery Flow Requirements.* Santa Rosa, California: Sonoma County Water Agency.

USACE. (1984). *Warm Springs Dam and Lake Sonoma, Dry Creek, California, Water Control Manual.* U.S. Army Corps of Engineers, Sacramento District.

USACE. (1986). *Coyote Valley Dam and Lake Mendocino Russian River, Californina, Water Control Manual.* U.S. Army Corps of Engineers, Sacramento District.

USACE. (2004, January). *Coyote Valley Dam and Lake Mendocino, Russian River, California, Water Control Diagram. Appendix I to the Master Water Control Manual.* Sacramento District: United States Army Corps of Engineers, revised 2004.

USGS. (2015). *Provisional Simulated Unimpaired Mean Daily Streamflow in the Russian River and Upper Eel River Basins, California, under Historical (1910-2013) and Projected Future (2001-2099) Climates.* U.S. Geologic Survey.

USGS. (2016, June 8). *Streamflow Measurements for California*. Retrieved from National Water Information System: Web Interface: http://waterdata.usgs.gov/ca/nwis/measurements/

Attachment 1: Model Results, No Project 1 Scenario

FISH FLOWS EIR
RR ResSim Modeling Results
Summary Report

Baseline and No Project 1 Minimum Flows
Max Water Right Demand: 75K AF

PLOT LEGEND	**Baseline**	**NoProject1**
Alt Name	225516Bs60	227516Bs60
Sim Begin Date	2/1/1910	2/1/1910
Sim End Date	12/31/2013	12/31/2013
ResSim Network	Base v2.2	Base v2.2
LM Storage Curve	2001	2001
LS Storage Curve	1984	1984
WSD Hatchery Flow (cfs)	70	70
Local Flow	USGS6.0	USGS6.0
Distributed Loss	RR System Losses POR 10011909 to 12312013 v06302015.dss	RR System Losses POR 10011909 to 12312013 v06302015.dss
RRC Demand	RR System Losses POR 10011909 to 12312013 v06302015.dss	RR System Losses POR 10011909 to 12312013 v06302015.dss, SCWA Windsor 75K POR 10011909 to 12312013 v06302015.dss
RRC Vol (Ac-ft/yr)	3,623	5,639
Demand Year	2015	2035
Demand Desc	Baseline, Average 2009-2014, Steve Grinnell	Max Water Right Demand
SCWA Demand	RR System Losses POR 10011909 to 12312013 v06302015.dss	SCWA Windsor 75K POR 10011909 to 12312013 v06302015.dss
SCWA Vol (Ac-ft/yr)	51,588	69,361
Demand Year	2015	2035
Demand Desc	Baseline, Average 2009-2014, Steve Grinnell	Max Water Right Demand
PVP Simulation	150217_V25_E5_Sed2006_RPA-TS_150max	150217_V25_E5_Sed2006_RPA-TS_150max
LP Storage Curve	2006	2006
PVP Max Diversion	150	150
PVP Simulation Desc	Average operating conditions 10/1/2006 to 12/31/2014; Incorporated observed diversions and LP storage post 10/1/2006	Average operating conditions 10/1/2006 to 12/31/2014; Incorporated observed diversions and LP storage post 10/1/2006
Hydrologic Index	D1610	D1610
Index Desc	Cum Lake Pillsbury Inflow	Cum Lake Pillsbury Inflow
Min Flows UR	D1610	D1610
Min Flow Desc	Decision 1610	Decision 1610
Min Flows LR	D1610	D1610
Min Flow Desc	Decision 1610	Decision 1610

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Coyote Valley Dam Outlet

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Monthly Temperature Exceedance Frequency… 106

Monthly D.O. Exceedance Frequency… 164

Forks

Monthly Flow Exceedance Frequency… 33

Monthly Temperature Exceedance Frequency… 110

Monthly D.O. Exceedance Frequency… 168

2 Miles Downstream of Forks

Monthly Temperature Exceedance Frequency… 115

Monthly D.O. Exceedance Frequency… 173

4 Miles Downstream of Forks

Monthly Temperature Exceedance Frequency… 117

Monthly D.O. Exceedance Frequency… 175

Hopland

Monthly Flow Exceedance Frequency… 38

Monthly Stage Exceedance Frequency… 74

Monthly Temperature Exceedance Frequency… 119

Monthly D.O. Exceedance Frequency… 177

Cloverdale

Monthly Flow Exceedance Frequency… 42

Monthly Stage Exceedance Frequency… 78

Monthly Temperature Exceedance Frequency… 123

Monthly D.O. Exceedance Frequency… 181

Geyserville

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Monthly D.O. Exceedance Frequency… 195

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Monthly Stage Exceedance Frequency… 87

Monthly Temperature Exceedance Frequency… 141

Monthly D.O. Exceedance Frequency… 199

Warm Springs Dam Outlet

Monthly Flow Exceedance Frequency… 60

Monthly Temperature Exceedance Frequency… 146

Monthly D.O. Exceedance Frequency… 204

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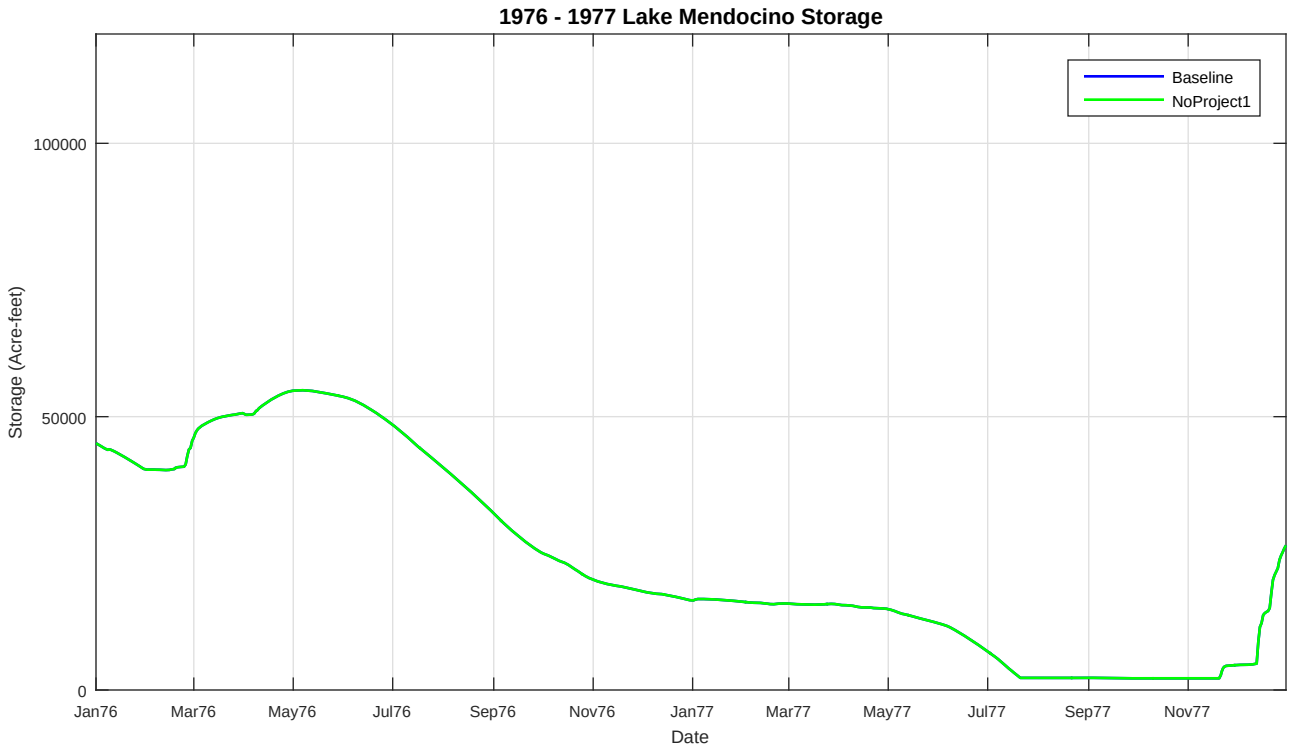
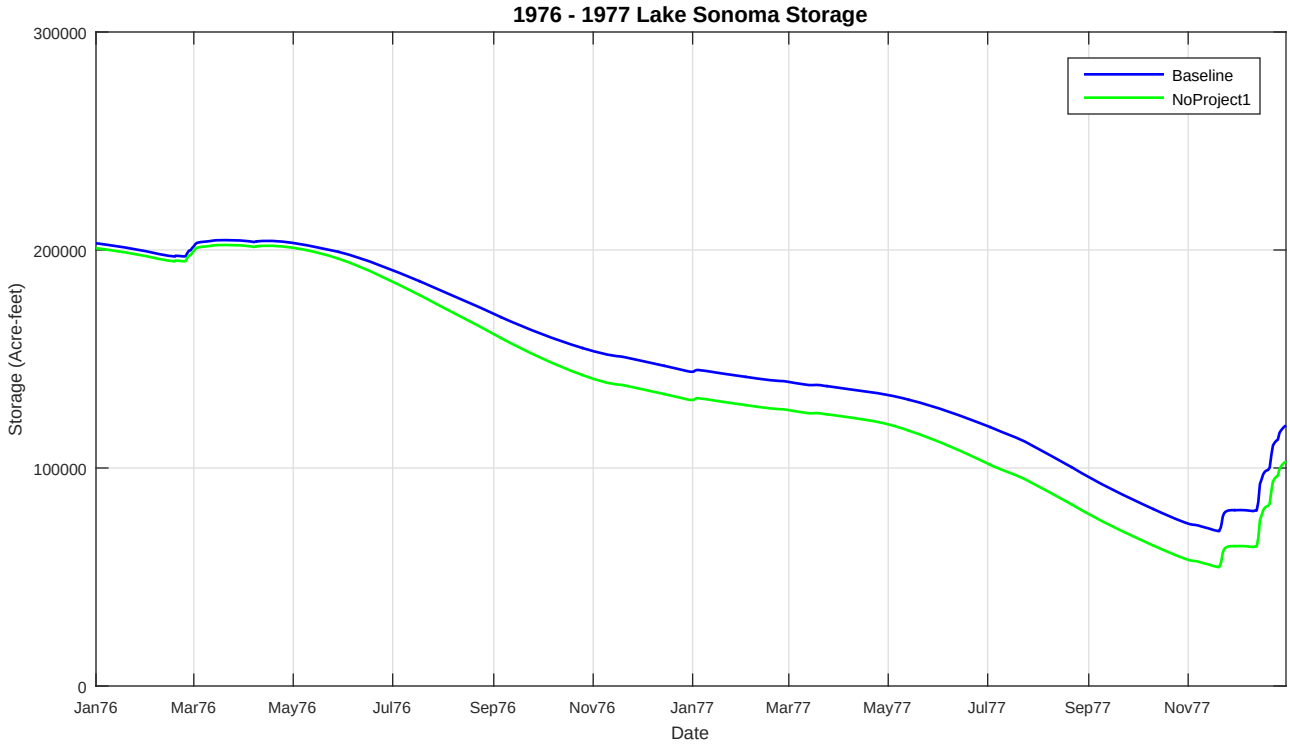
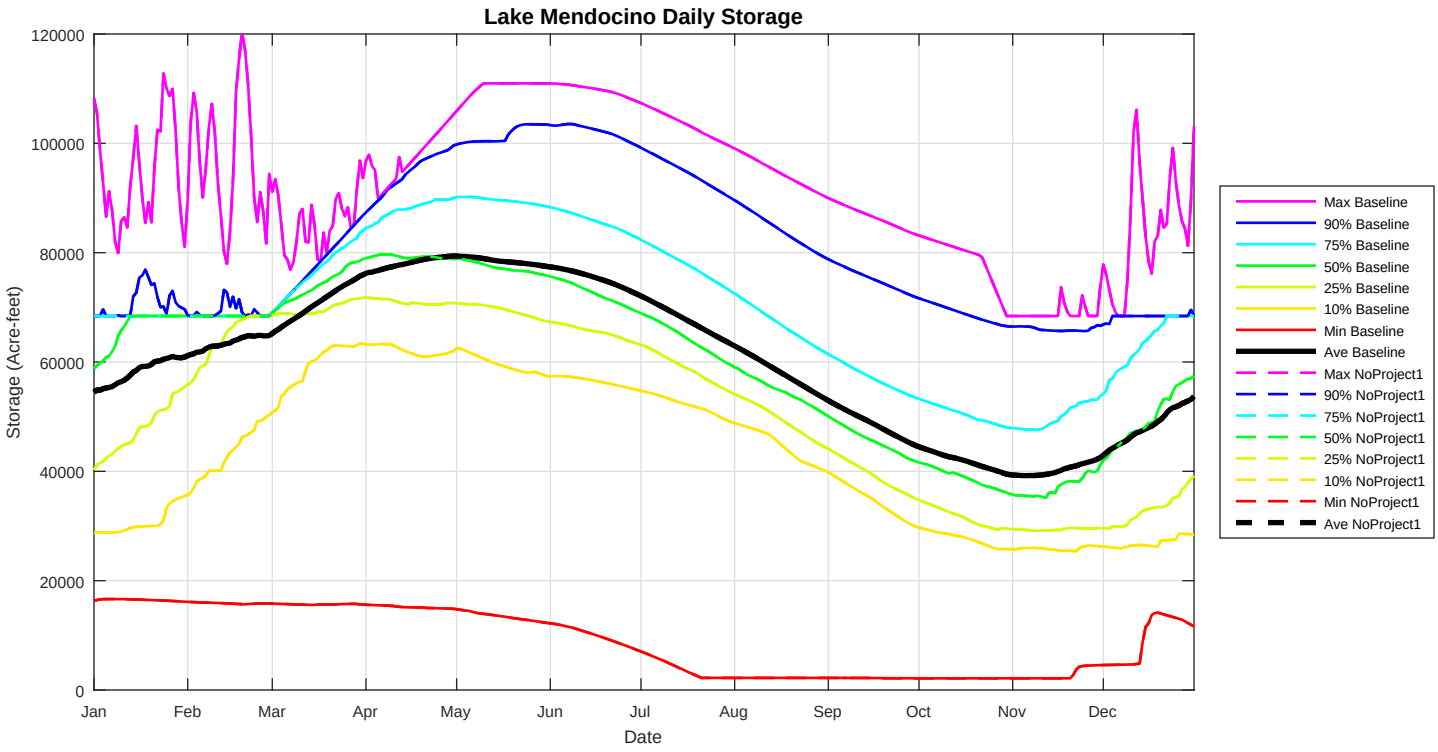
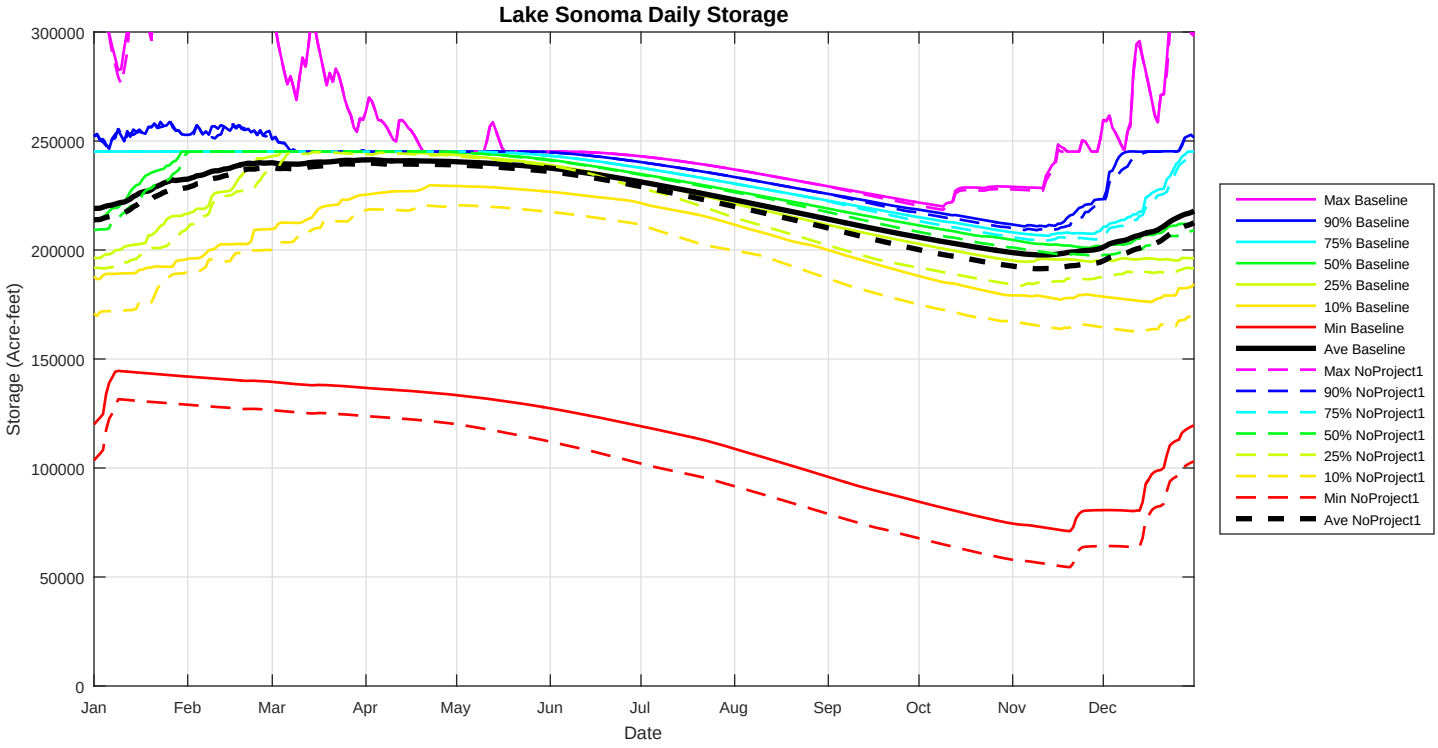
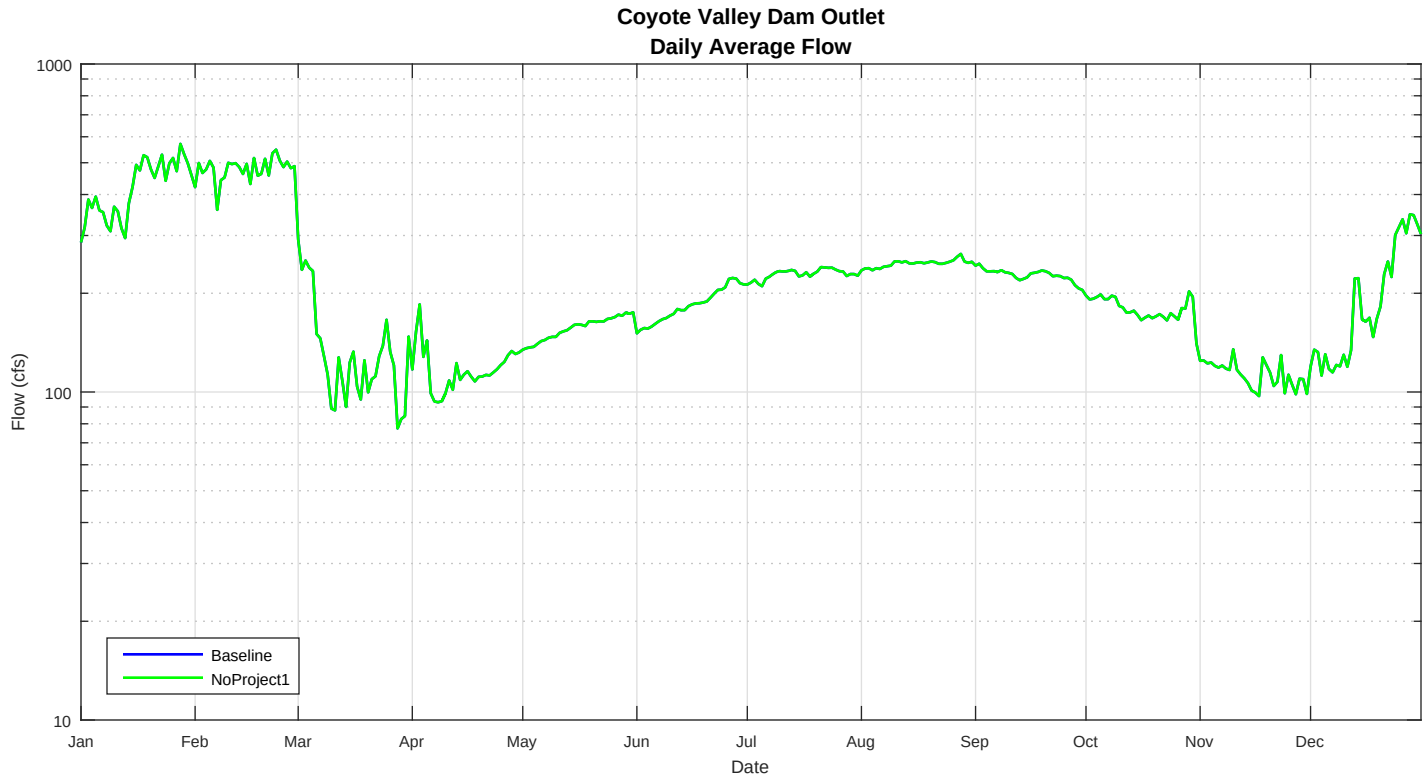
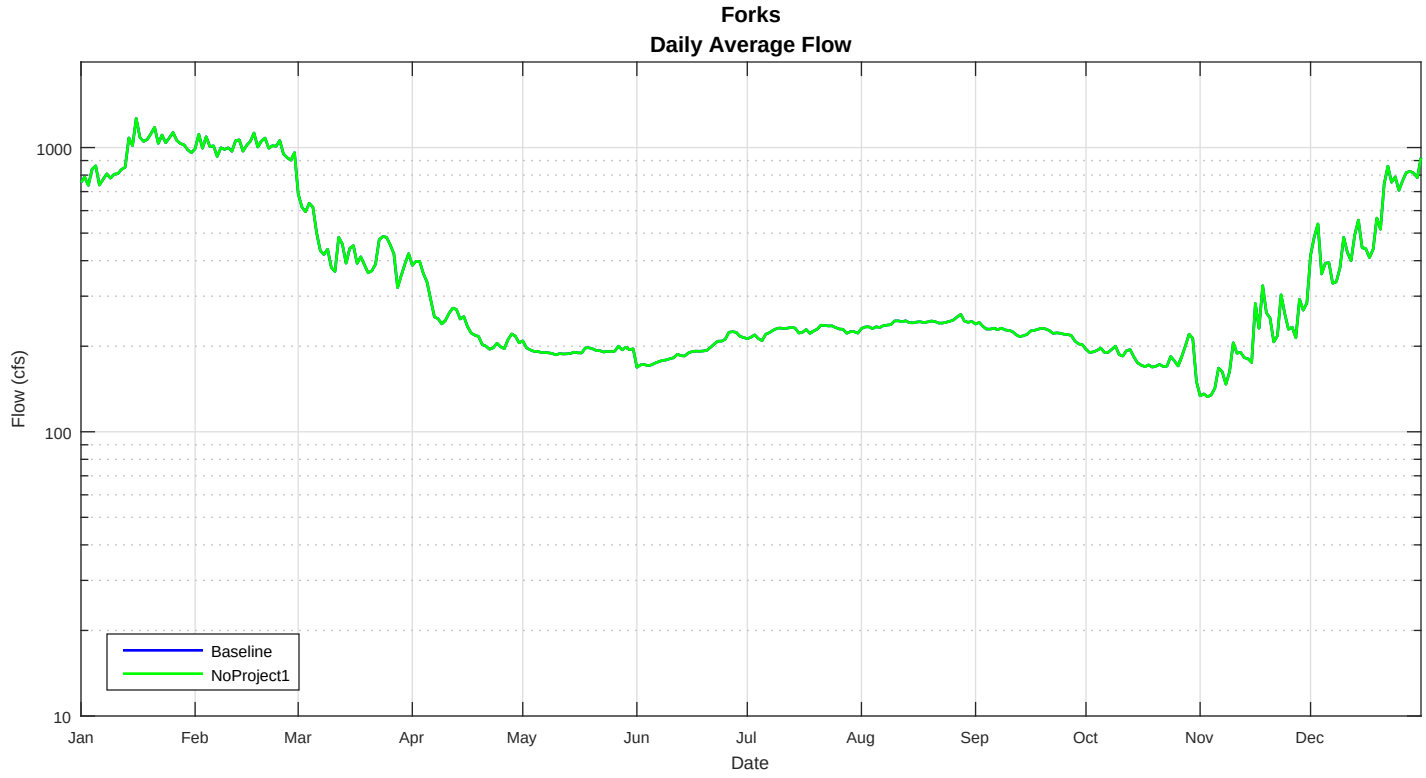

1976 - 1977 Lake Mendocino Storage
Baseline
NoProject1
Storage (Acre-feet)
100000
50000
0
Jan76
Mar76
May76
Jul76
Sep76
Nov76
Jan77
Mar77
May77
Jul77
Sep77
Nov77
Date

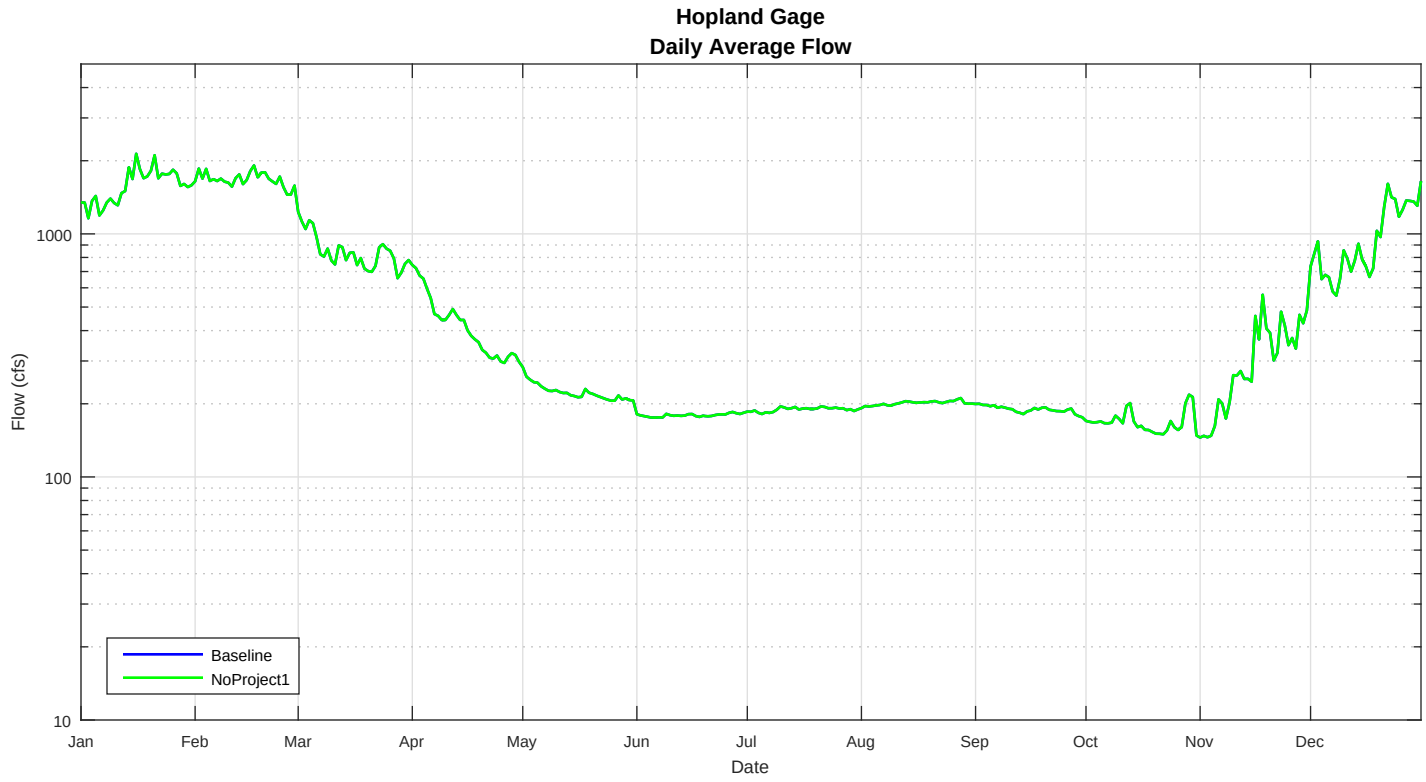

1976 - 1977 Lake Sonoma Storage
Baseline
NoProject1
Storage (Acre-feet)
300000
200000
100000
0
Jan76
Mar76
May76
Jul76
Sep76
Nov76
Jan77
Mar77
May77
Jul77
Sep77
Nov77
Date

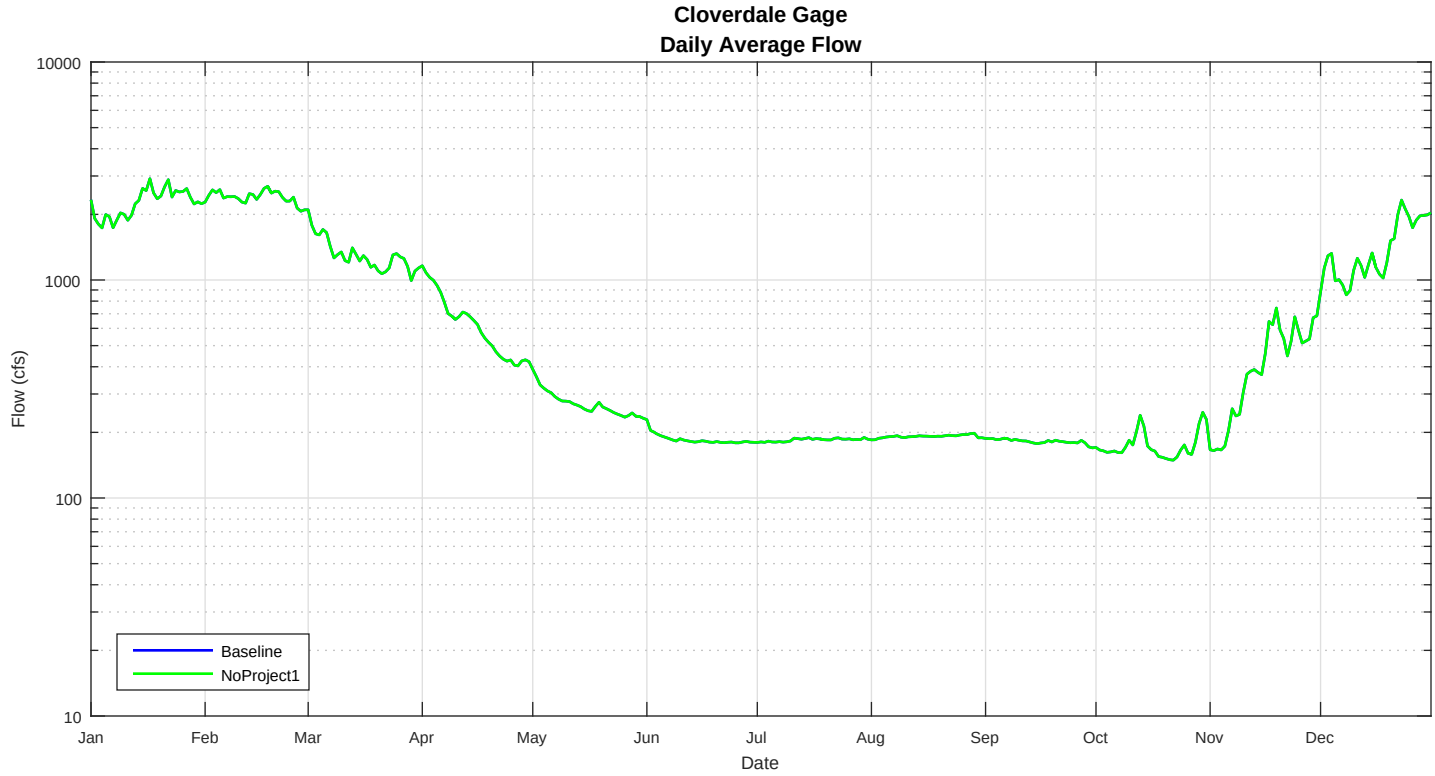

Lake Mendocino Daily Storage
Storage (Acre-feet)
120000
100000
80000
60000
40000
20000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Max Baseline
90% Baseline
75% Baseline
50% Baseline
25% Baseline
10% Baseline
Min Baseline
Ave Baseline
Max NoProject1
90% NoProject1
75% NoProject1
50% NoProject1
25% NoProject1
10% NoProject1
Min NoProject1
Ave NoProject1

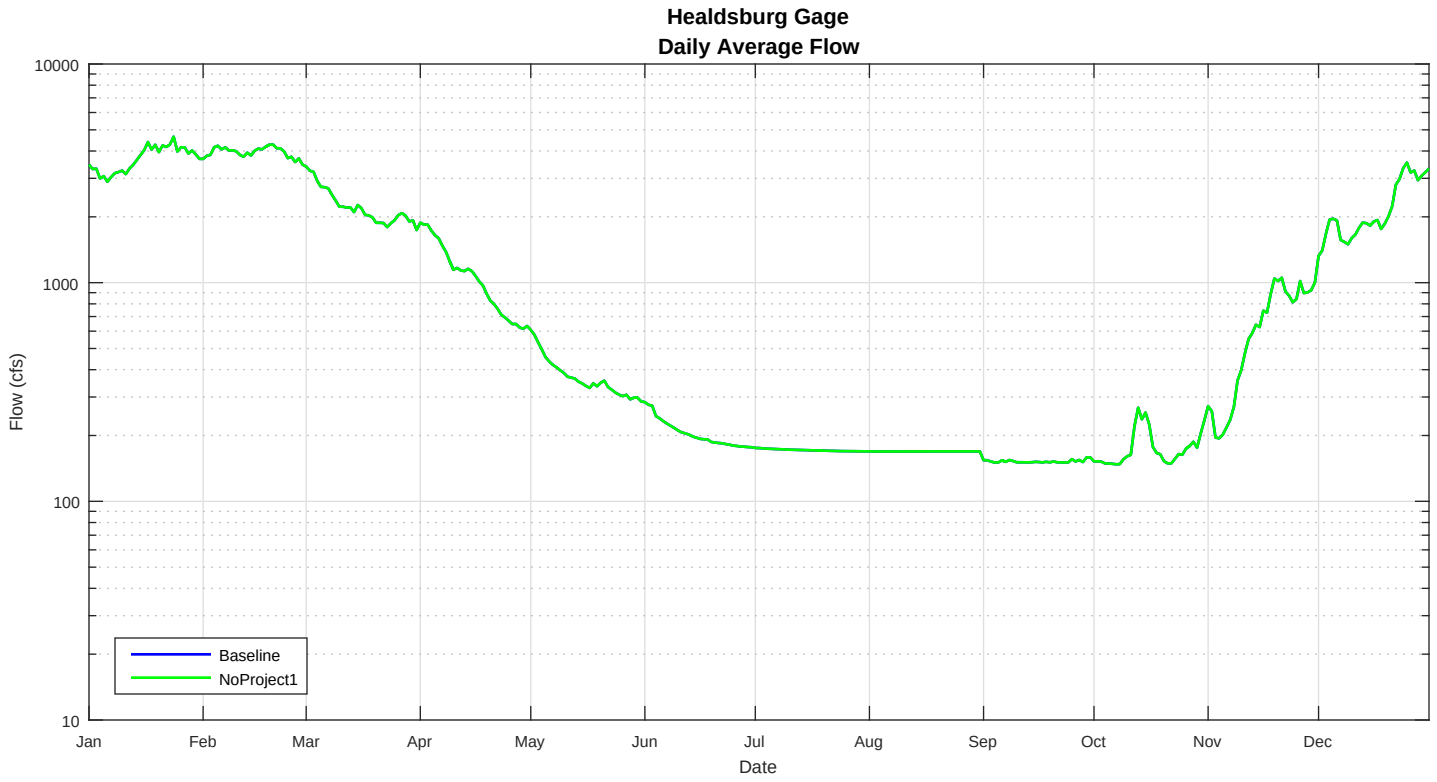

Lake Sonoma Daily Storage
Storage (Acre-feet)
300000
250000
200000
150000
100000
50000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Max Baseline
90% Baseline
75% Baseline
50% Baseline
25% Baseline
10% Baseline
Min Baseline
Ave Baseline
Max NoProject1
90% NoProject1
75% NoProject1
50% NoProject1
25% NoProject1
10% NoProject1
Min NoProject1
Ave NoProject1

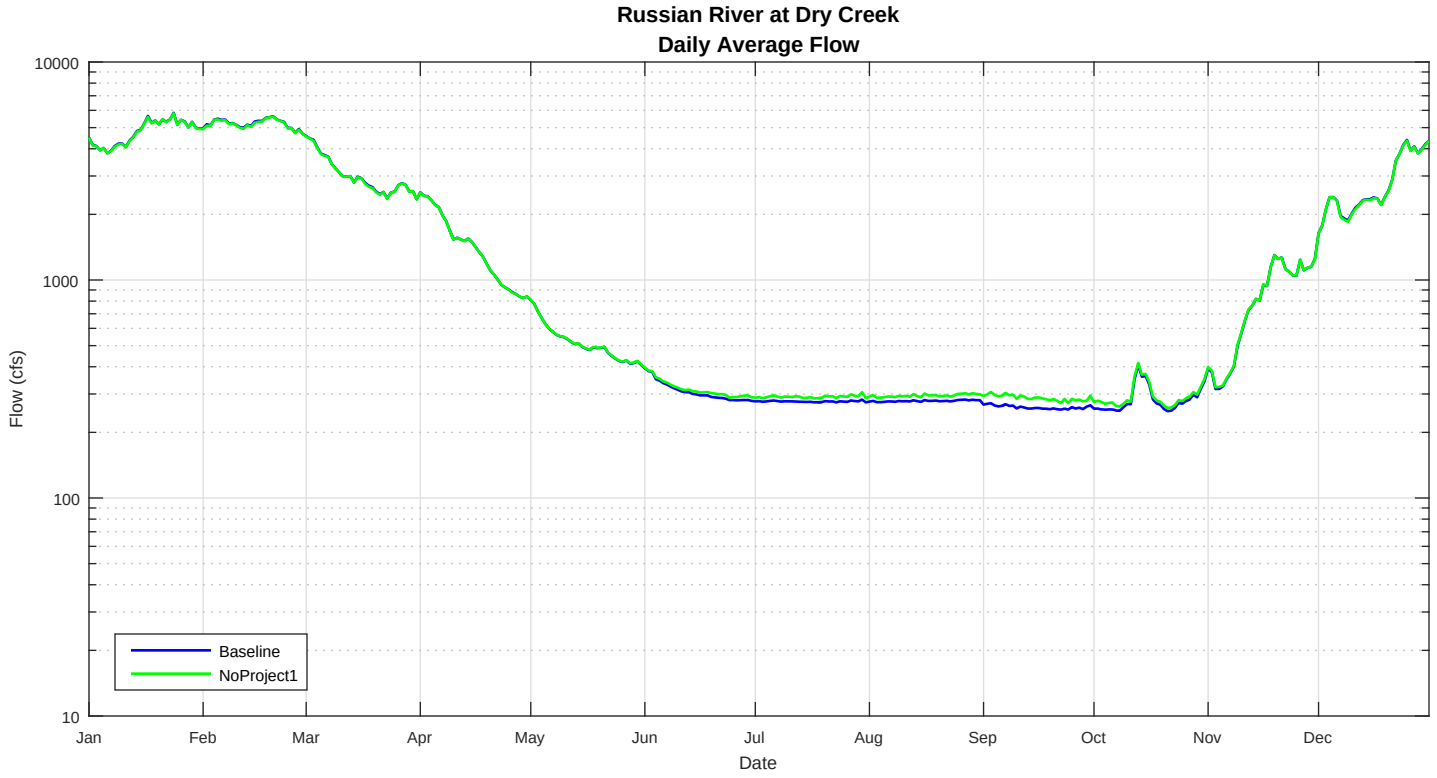

Coyote Valley Dam Outlet
Daily Average Flow
1000
100
10
Flow (cfs)
Baseline
NoProject1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

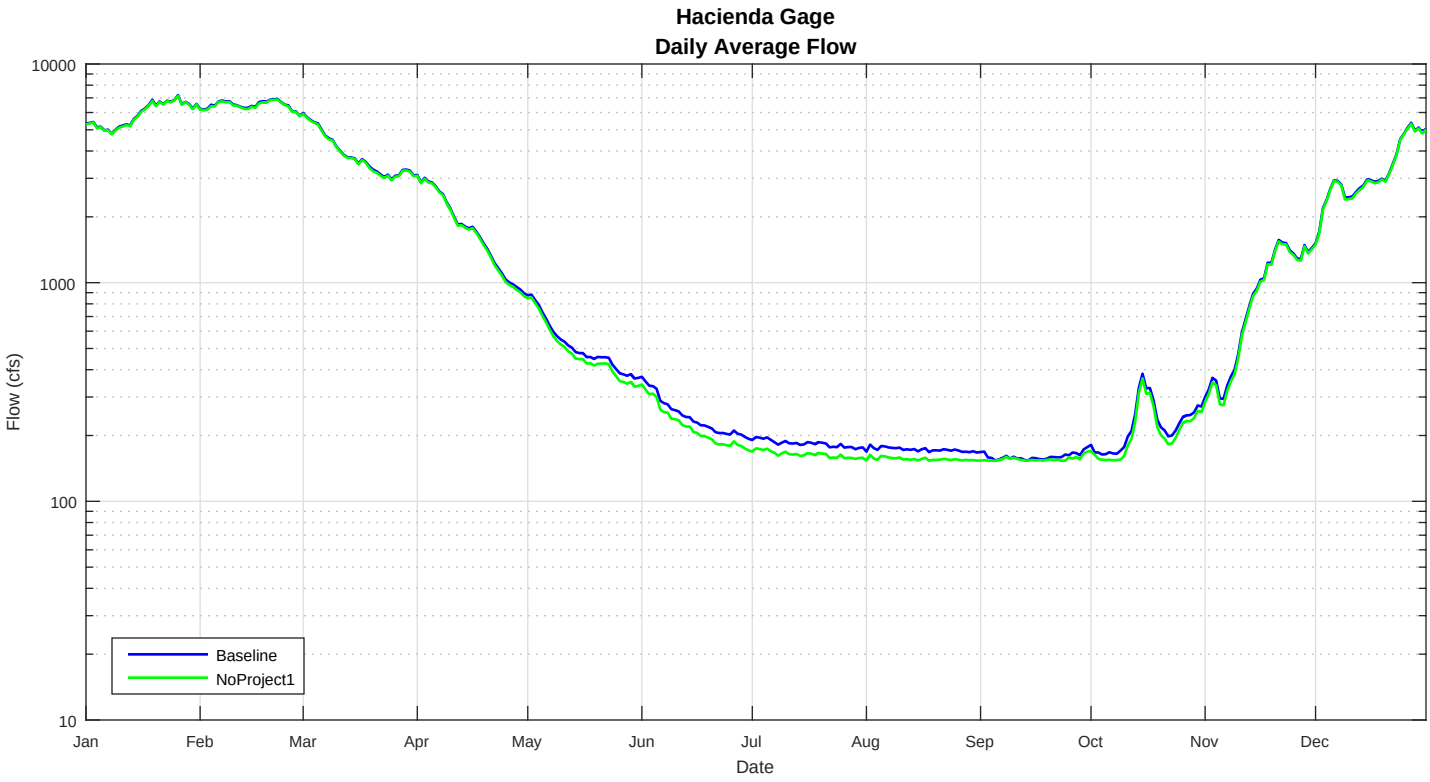

Forks
Daily Average Flow
1000
100
10
Flow (cfs)
Baseline
NoProject1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

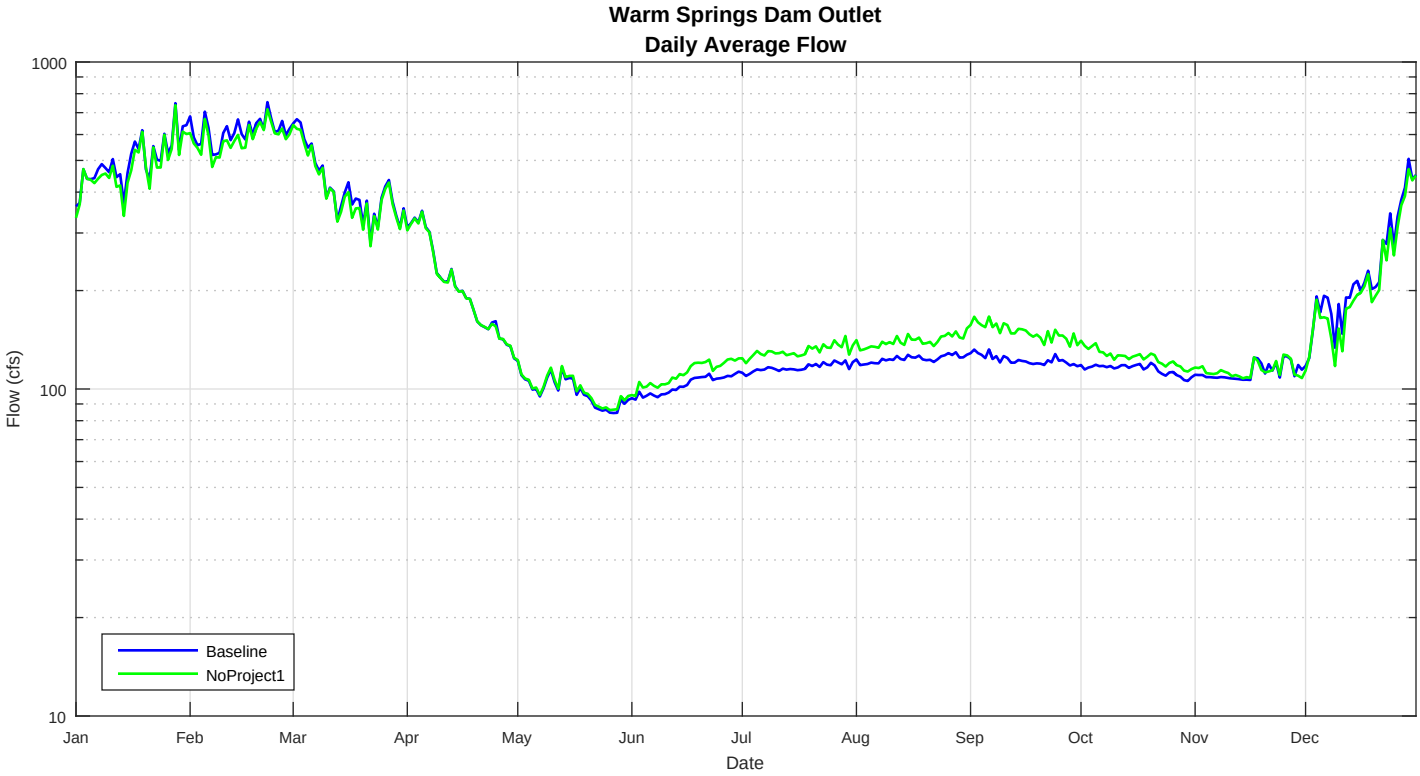

Hopland Gage
Daily Average Flow
Flow (cfs)
1000
100
10
Baseline
NoProject1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

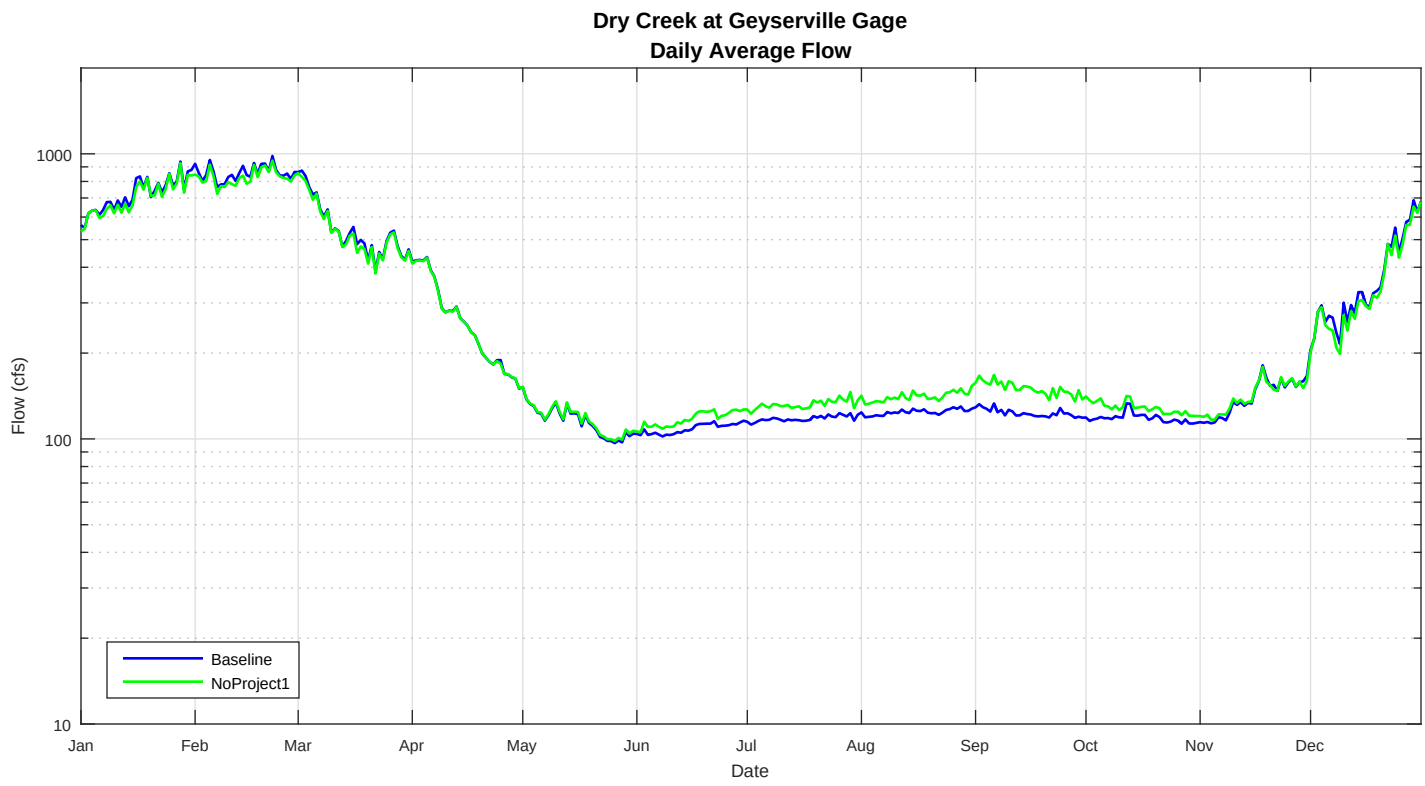

Cloverdale Gage
Daily Average Flow
Flow (cfs)
10000
1000
100
10
Baseline
NoProject1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

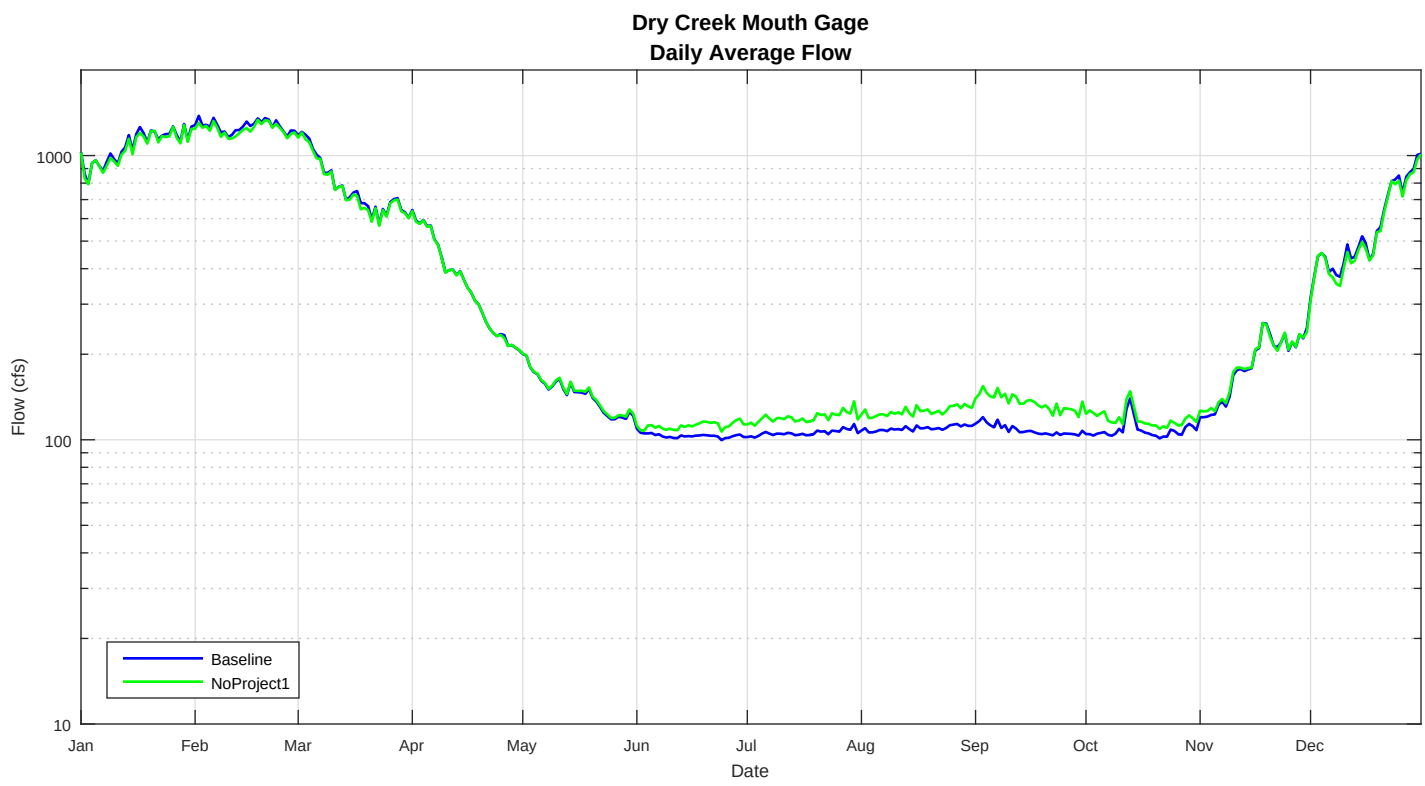

Healdsburg Gage
Daily Average Flow
10000
1000
100
10
Flow (cfs)
Baseline
NoProject1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

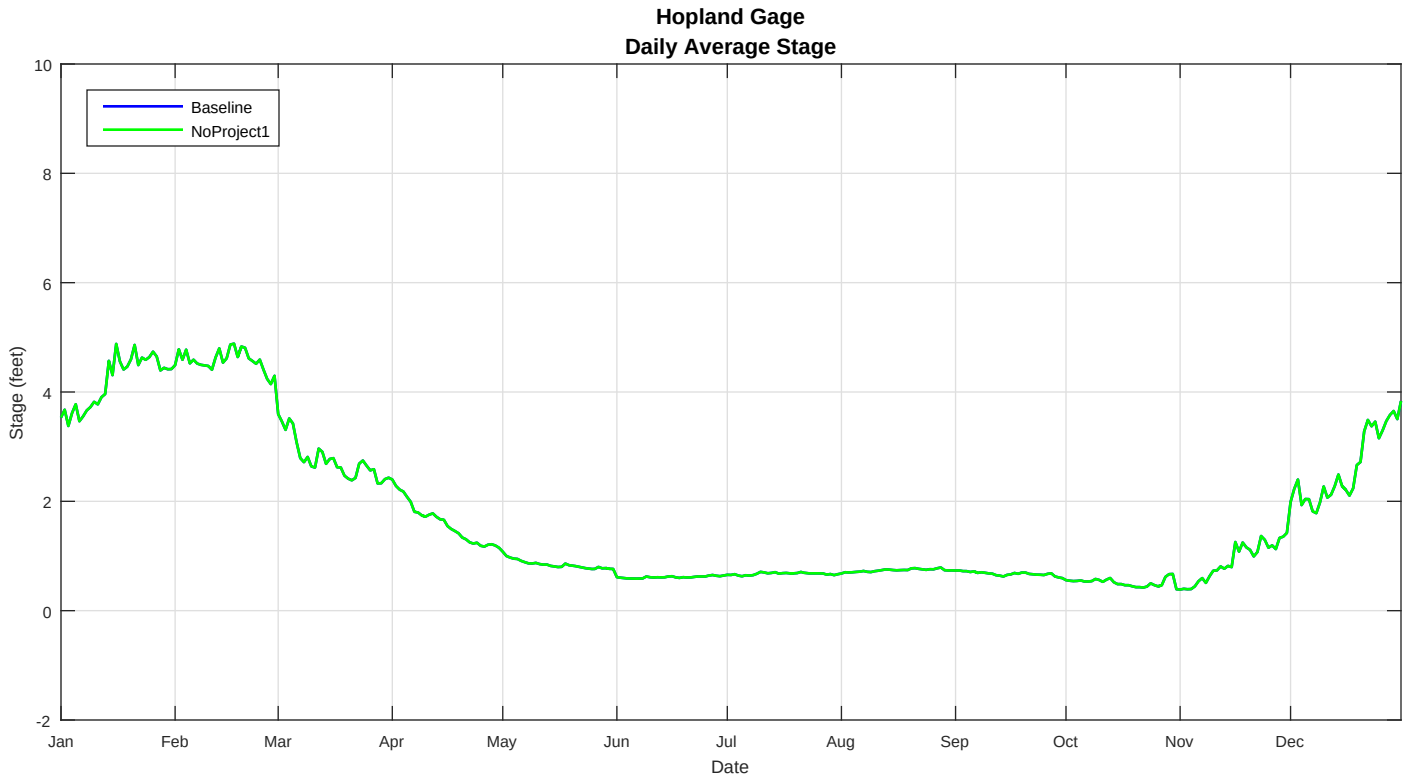

Russian River at Dry Creek
Daily Average Flow
10000
1000
100
10
Flow (cfs)
Baseline
NoProject1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

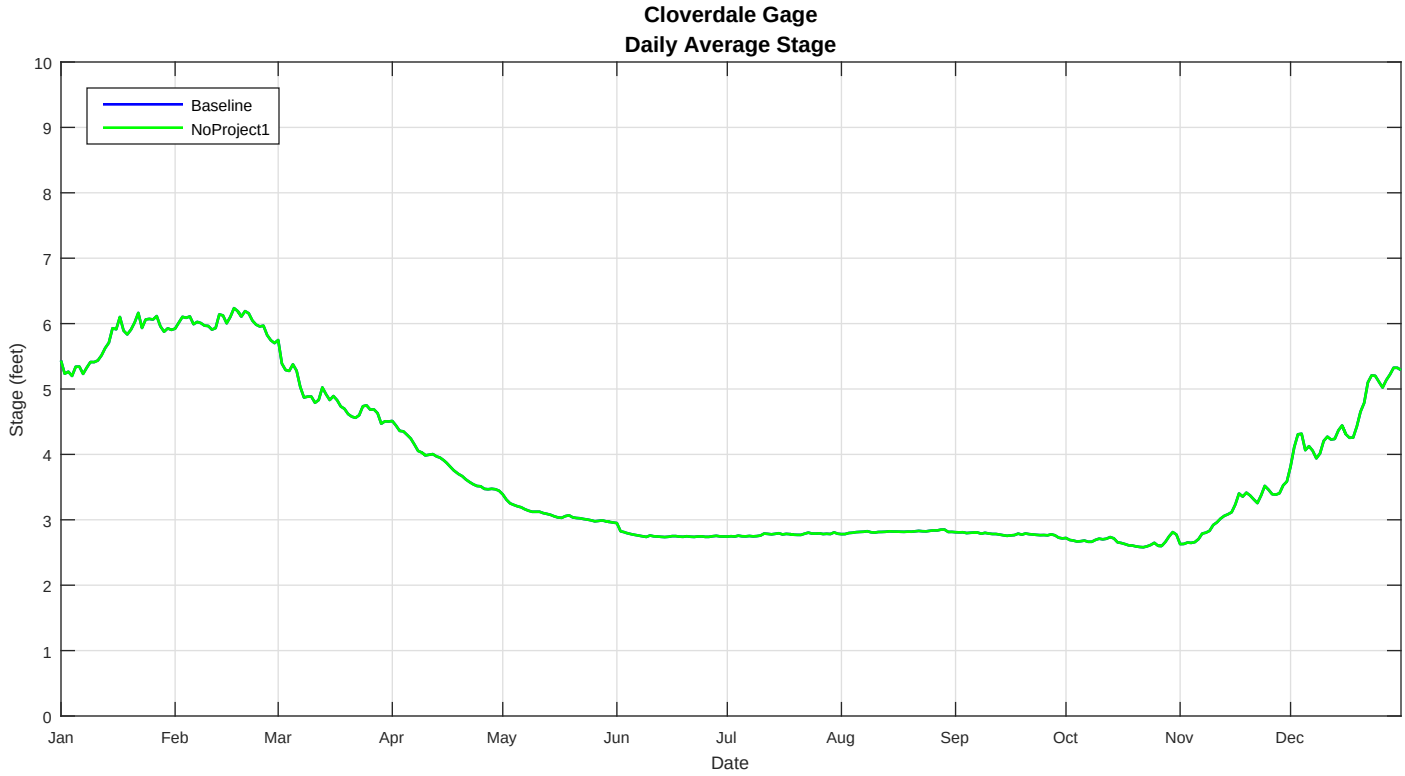

Hacienda Gage
Daily Average Flow
10000
1000
100
10
Flow (cfs)
Baseline
NoProject1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

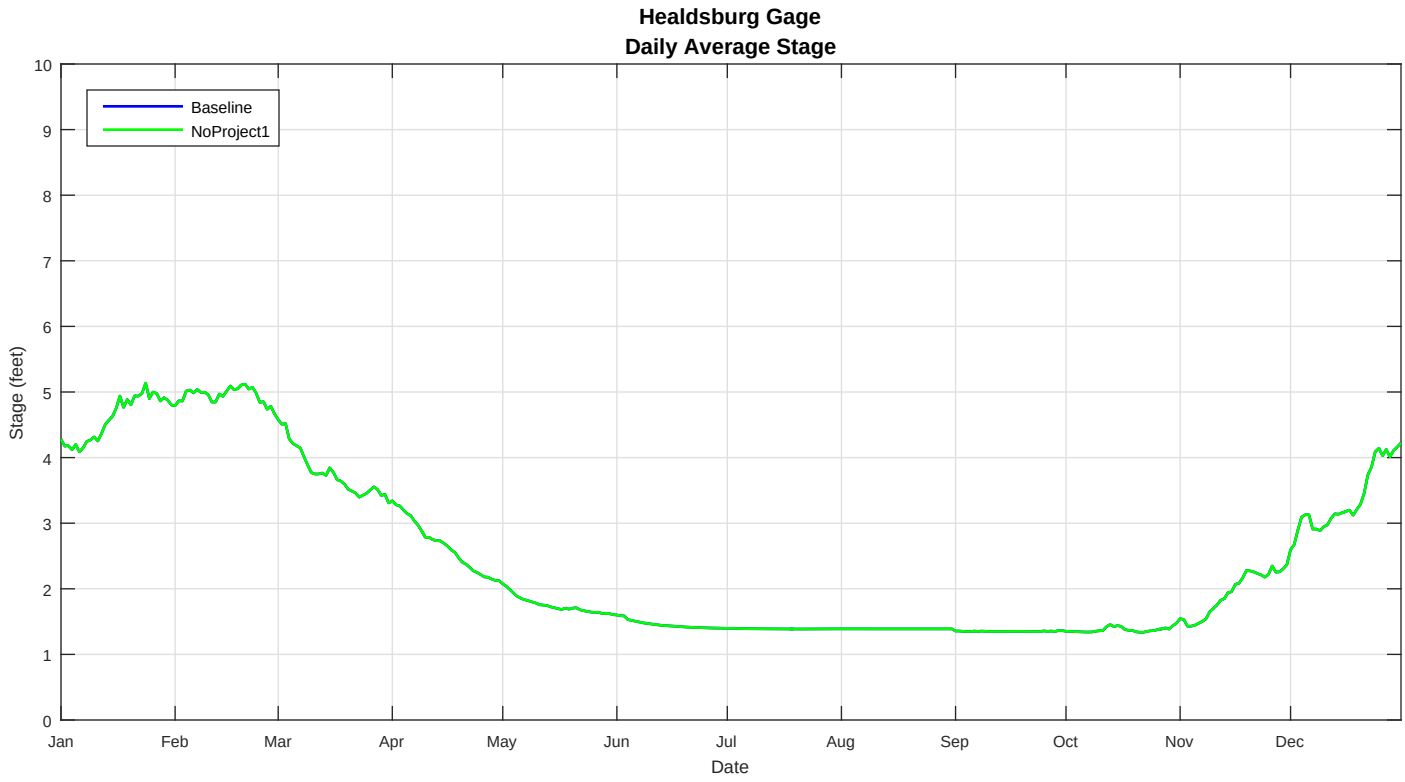

Warm Springs Dam Outlet
Daily Average Flow
1000
100
10
Flow (cfs)
Baseline
NoProject1
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

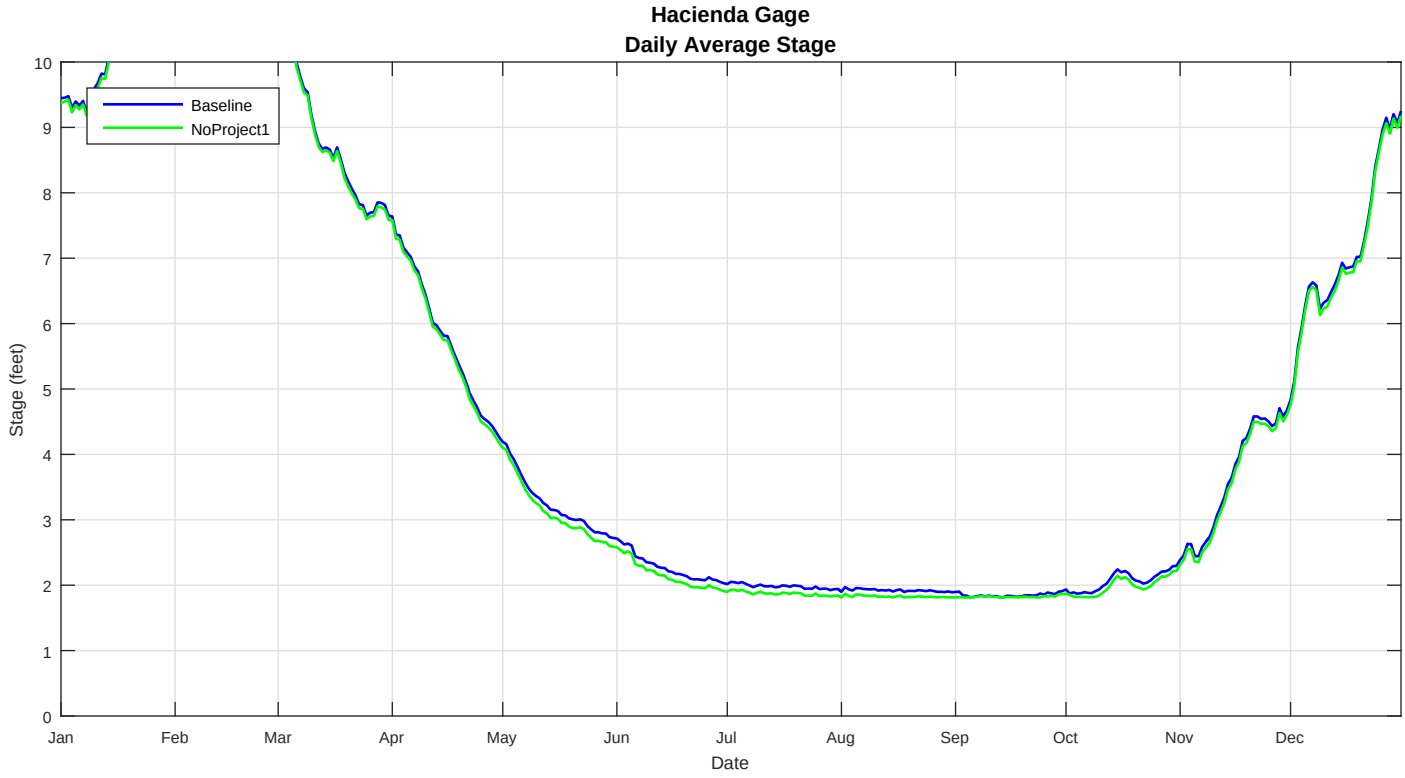

Dry Creek at Geyserville Gage
Daily Average Flow
Flow (cfs)
1000
100
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Baseline
NoProject1

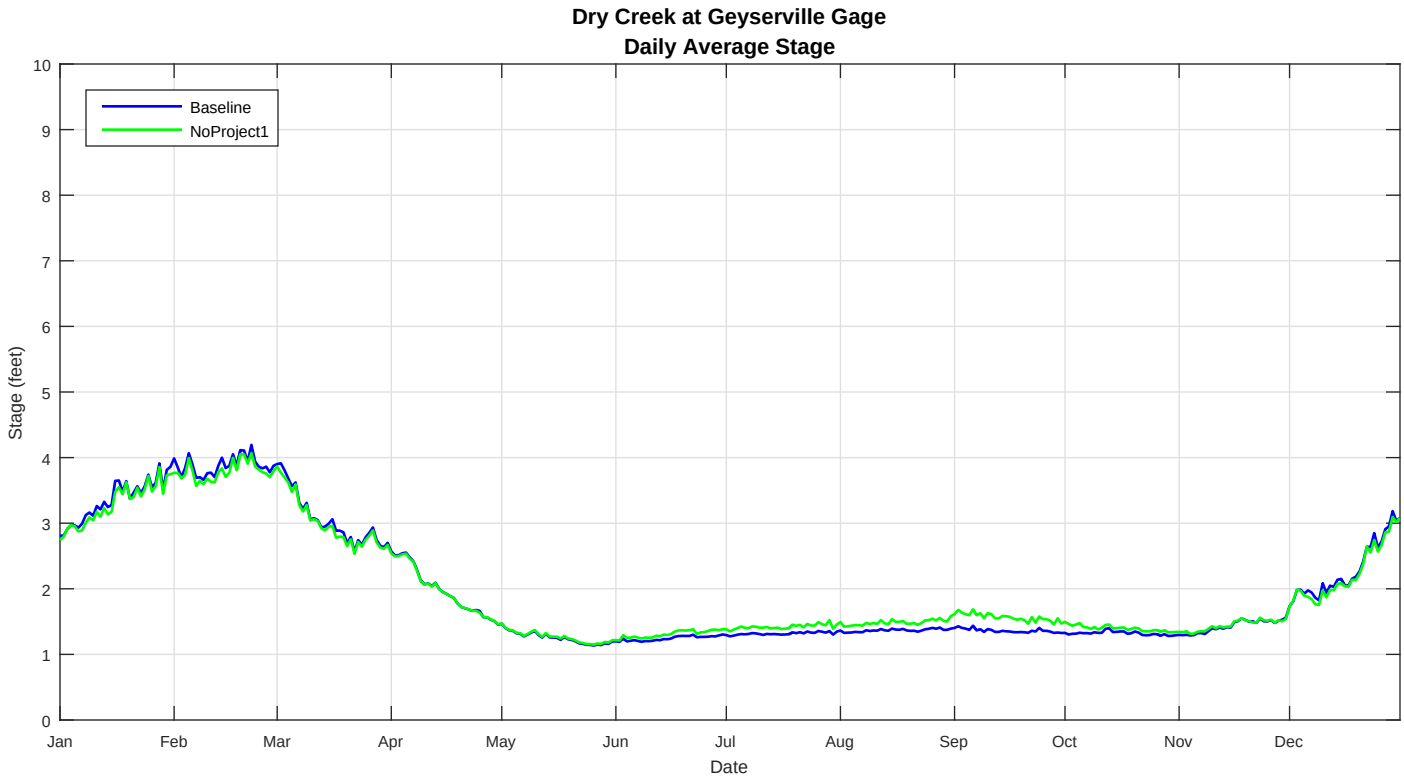

Dry Creek Mouth Gage
Daily Average Flow
Flow (cfs)
1000
100
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Baseline
NoProject1

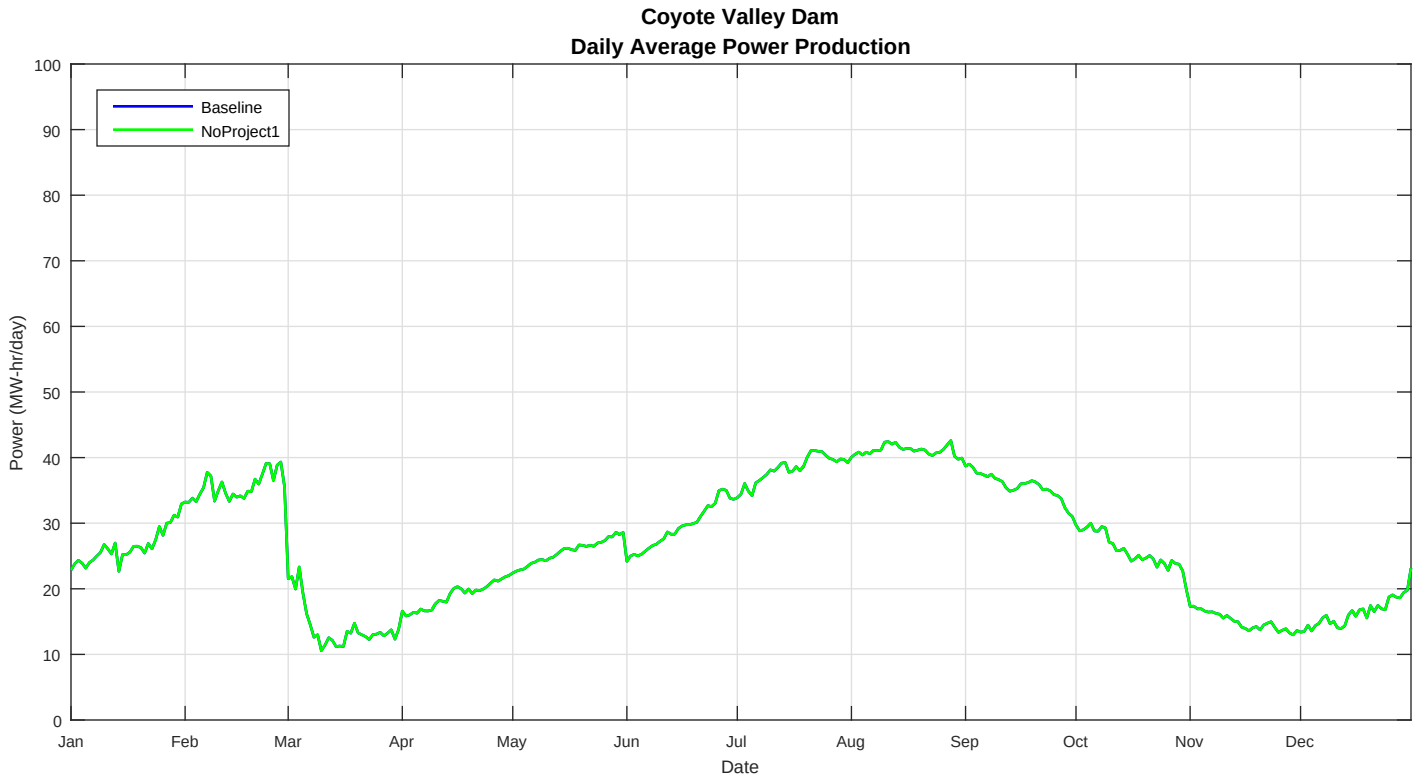

Hopland Gage
Daily Average Stage
Baseline
NoProject1
Stage (feet)
10
8
6
4
2
0
-2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

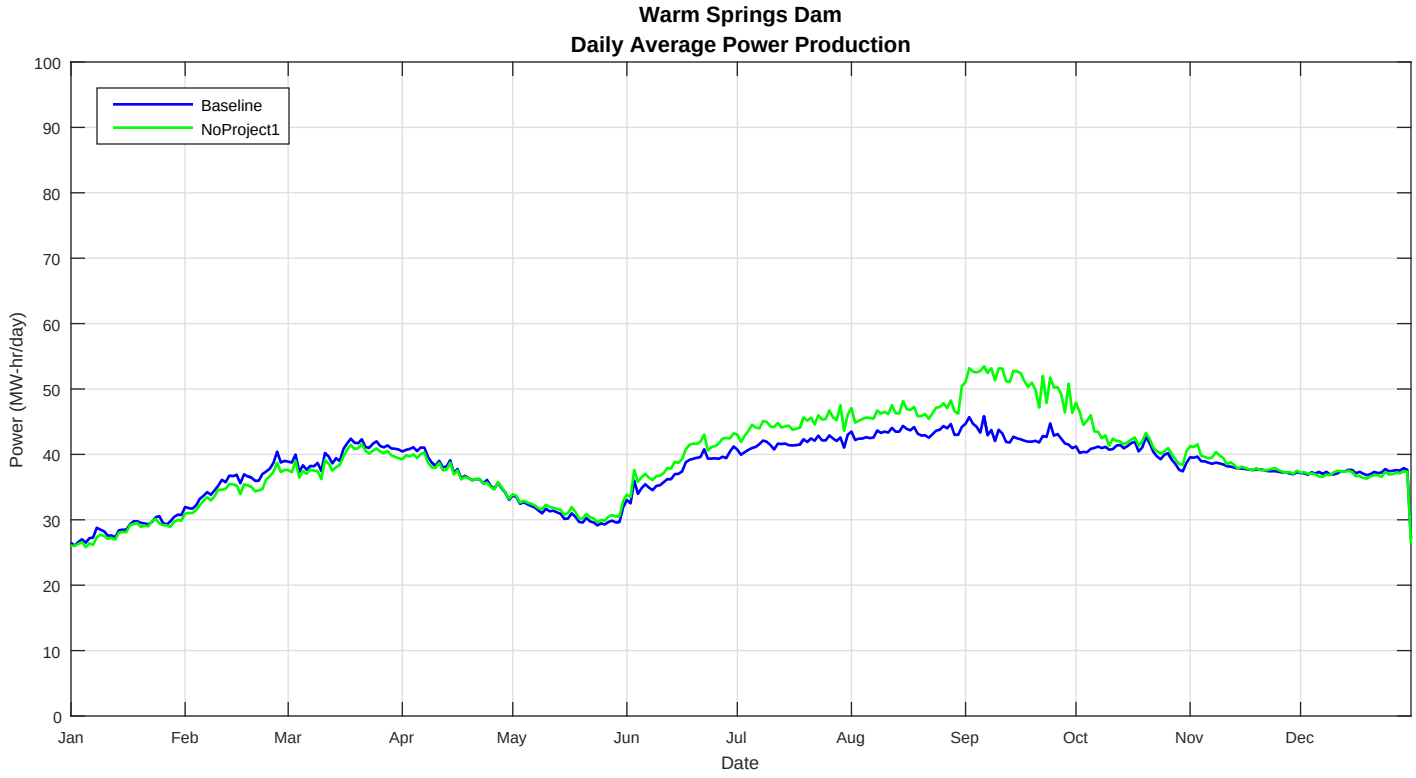

Cloverdale Gage
Daily Average Stage
Baseline
NoProject1
Stage (feet)
10
9
8
7
6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

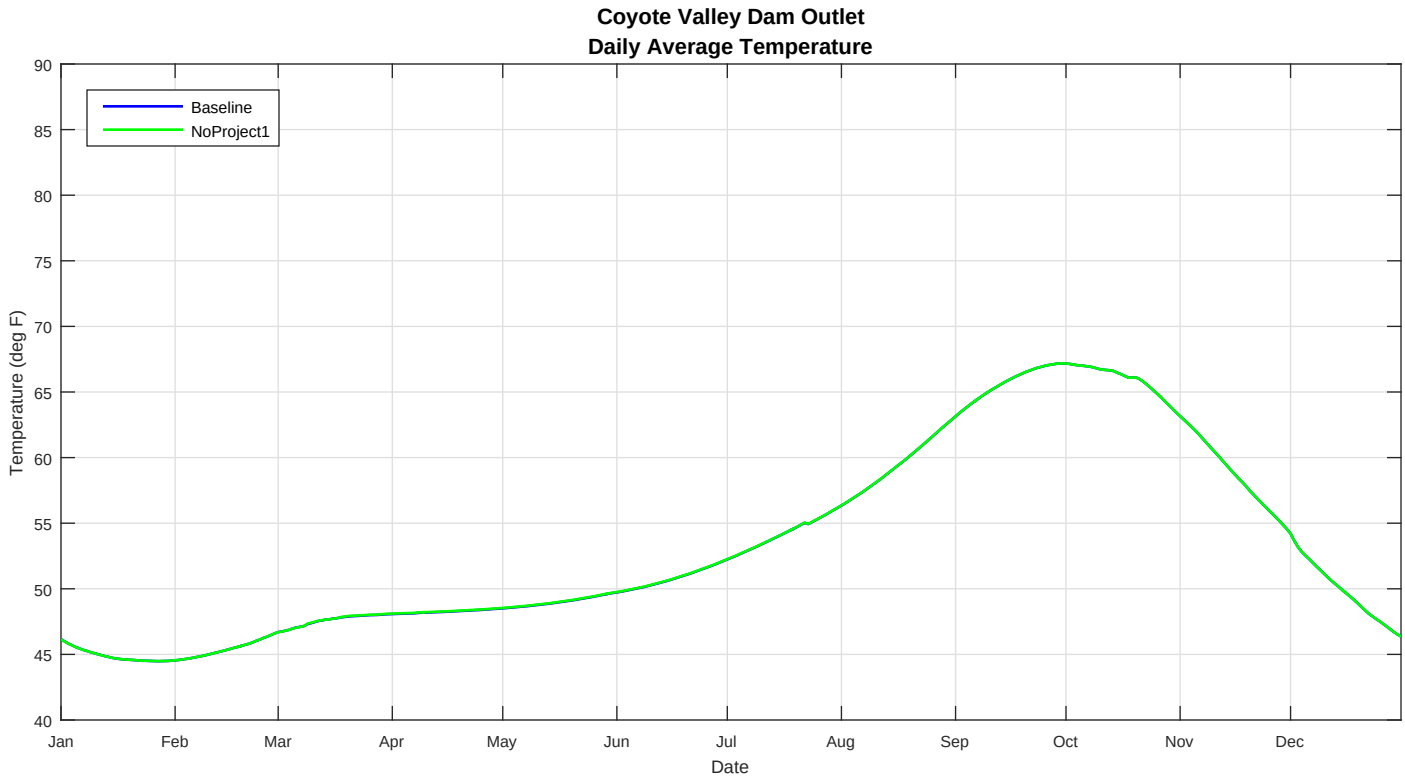

Healdsburg Gage
Daily Average Stage
Baseline
NoProject1
Stage (feet)
0
1
2
3
4
5
6
7
8
9
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

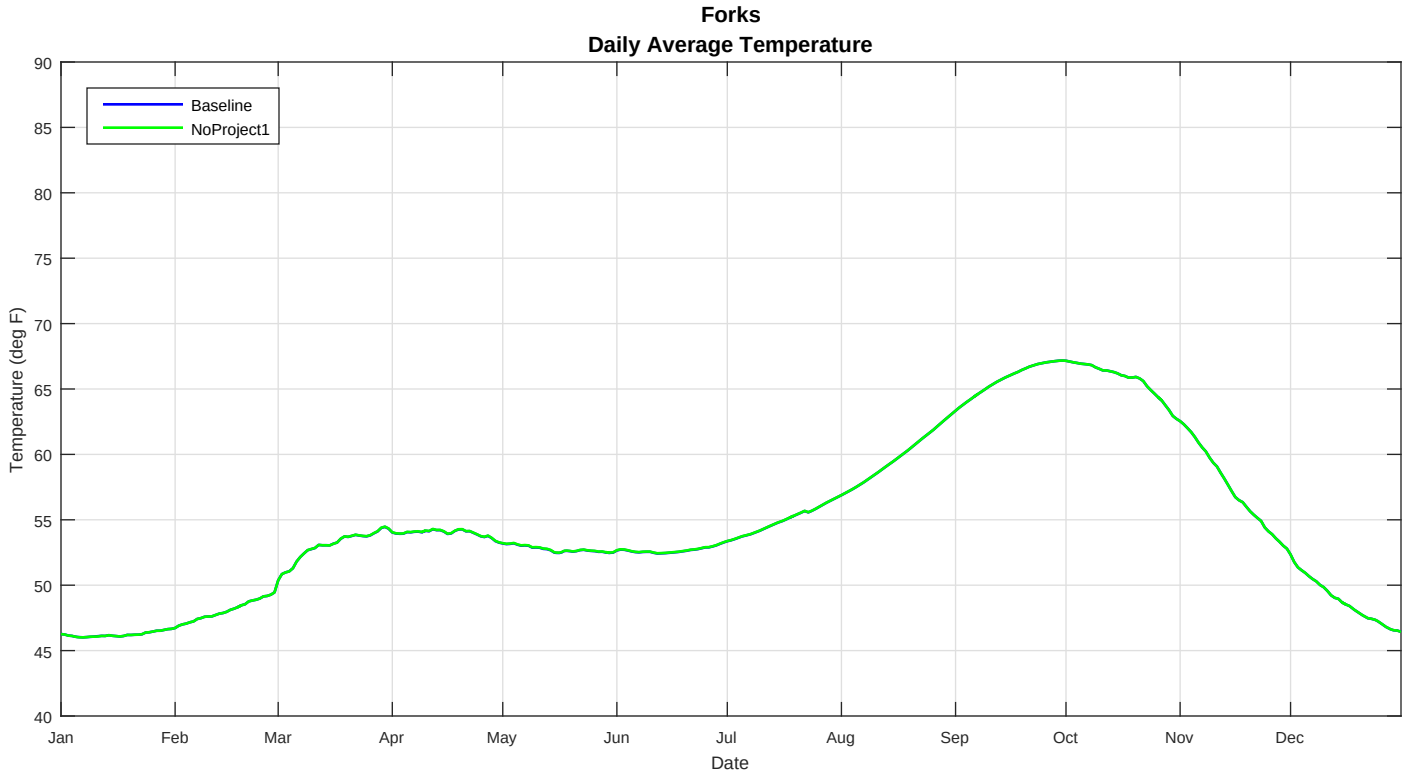

Hacienda Gage
Daily Average Stage
Baseline
NoProject1
Stage (feet)
0
1
2
3
4
5
6
7
8
9
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

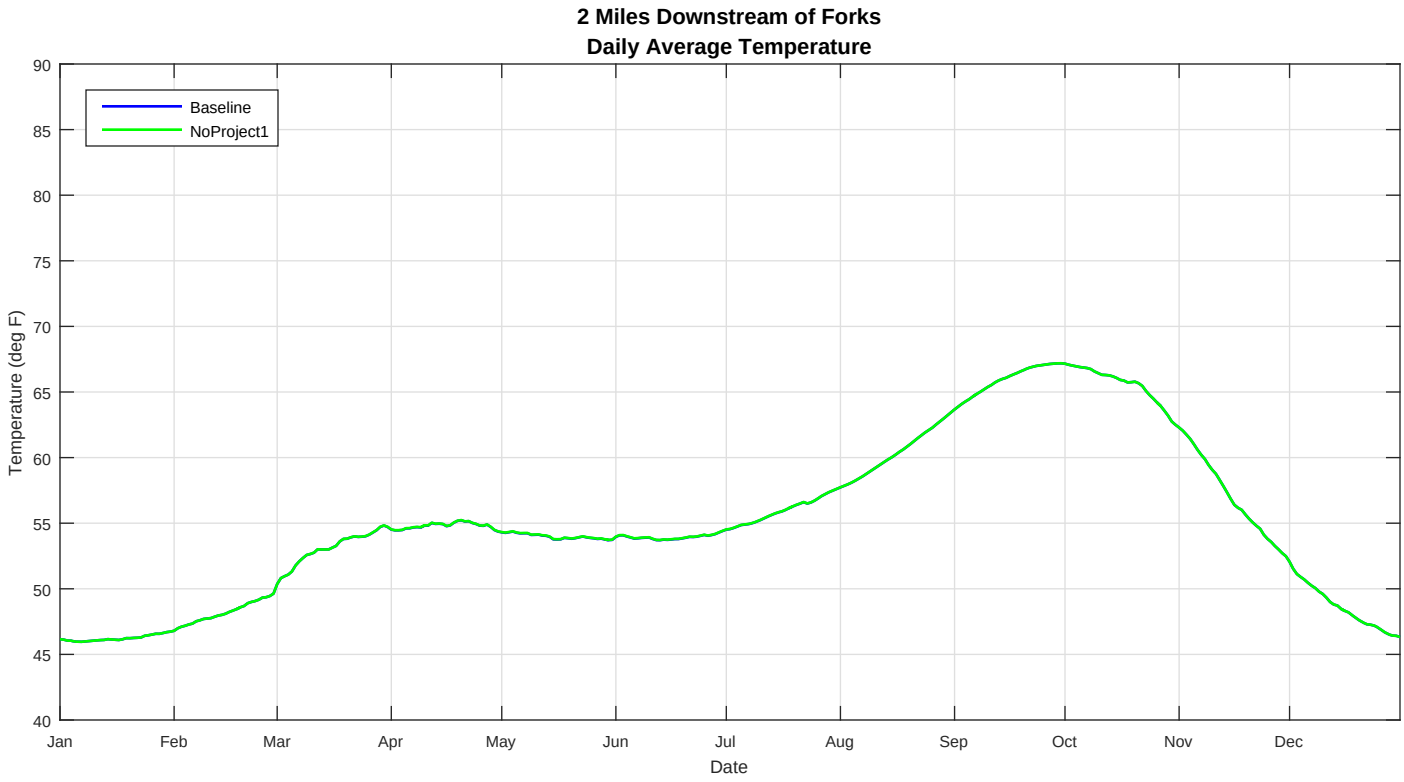

Dry Creek at Geyserville Gage
Daily Average Stage
Baseline
NoProject1
Stage (feet)
0
1
2
3
4
5
6
7
8
9
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

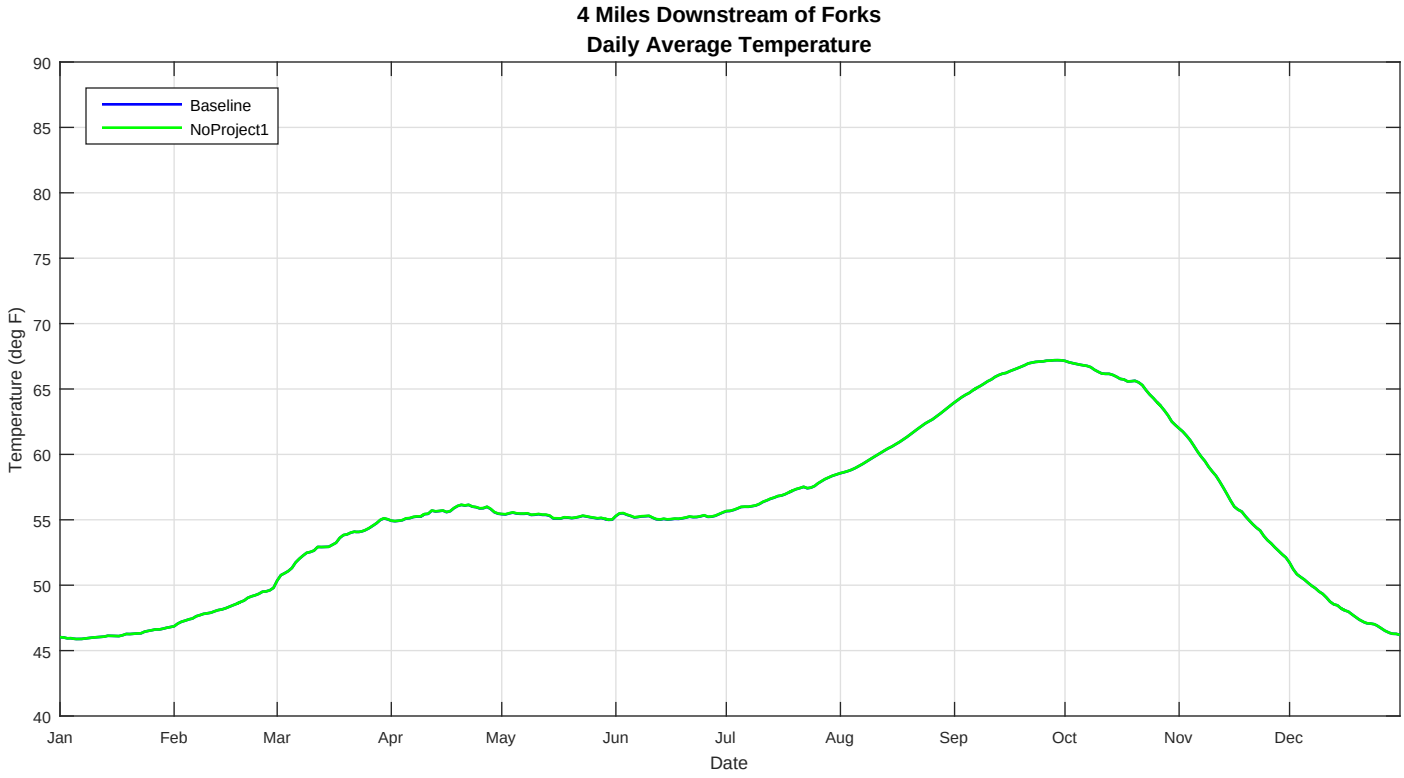

Coyote Valley Dam
Daily Average Power Production
Baseline
NoProject1
Power (MW-hr/day)
0
10
20
30
40
50
60
70
80
90
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

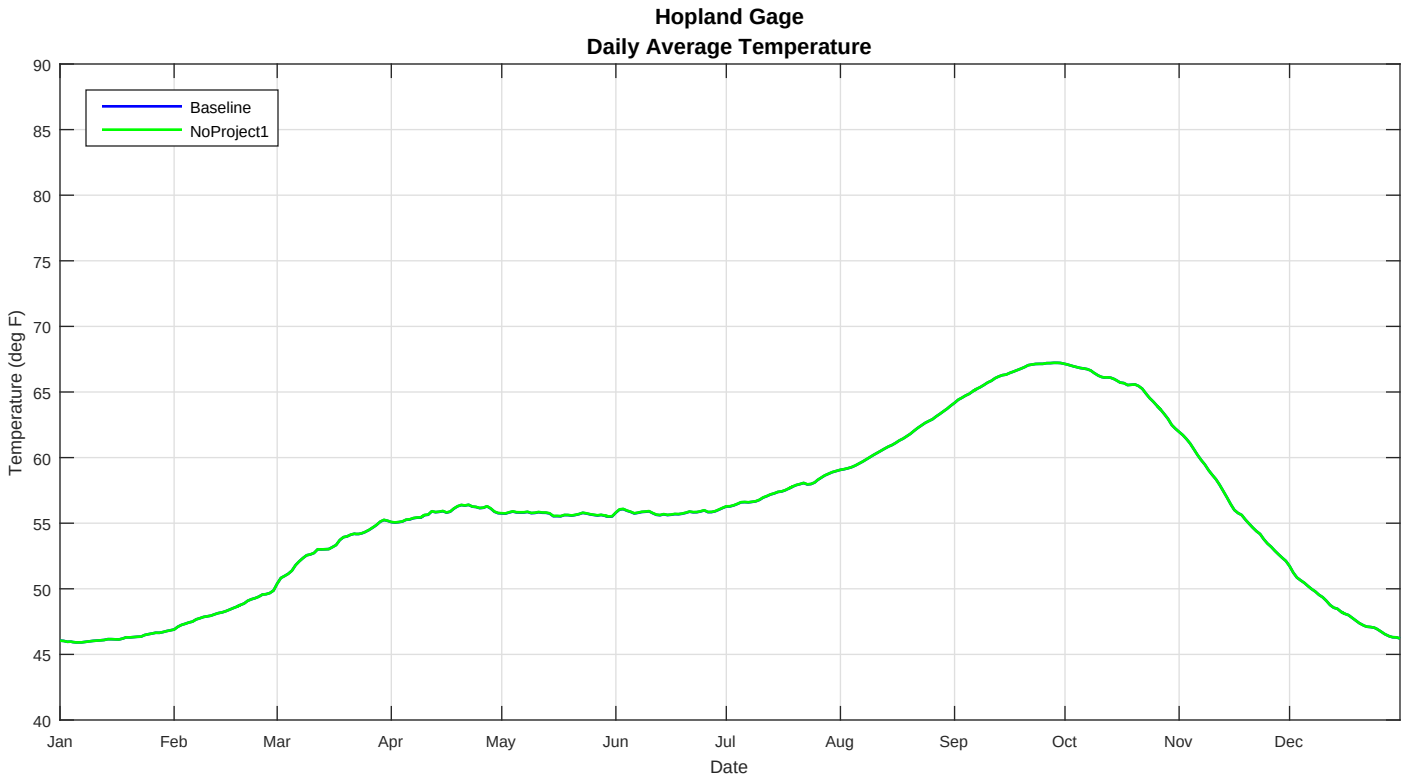

Warm Springs Dam
Daily Average Power Production
Baseline
NoProject1
Power (MW-hr/day)
0
10
20
30
40
50
60
70
80
90
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

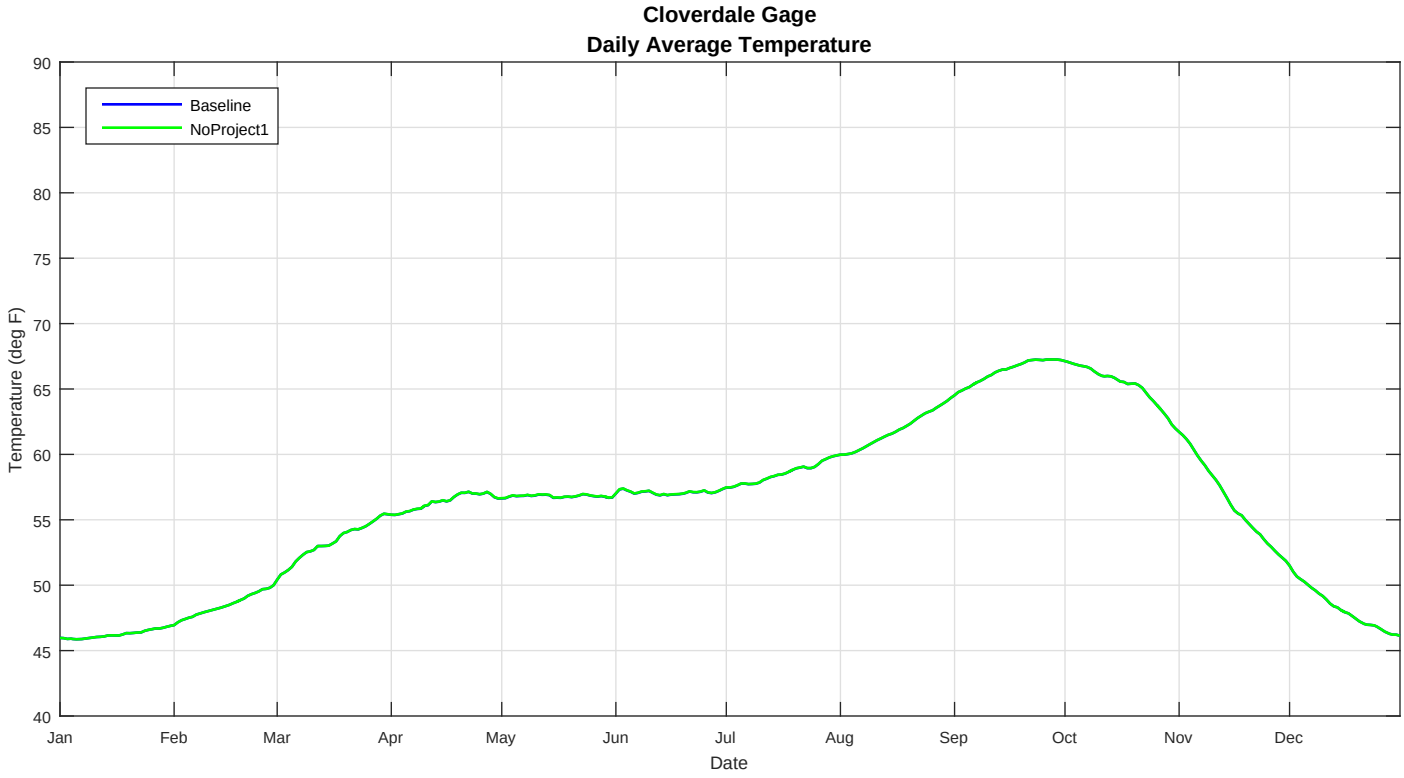

Coyote Valley Dam Outlet
Daily Average Temperature
Baseline
NoProject1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

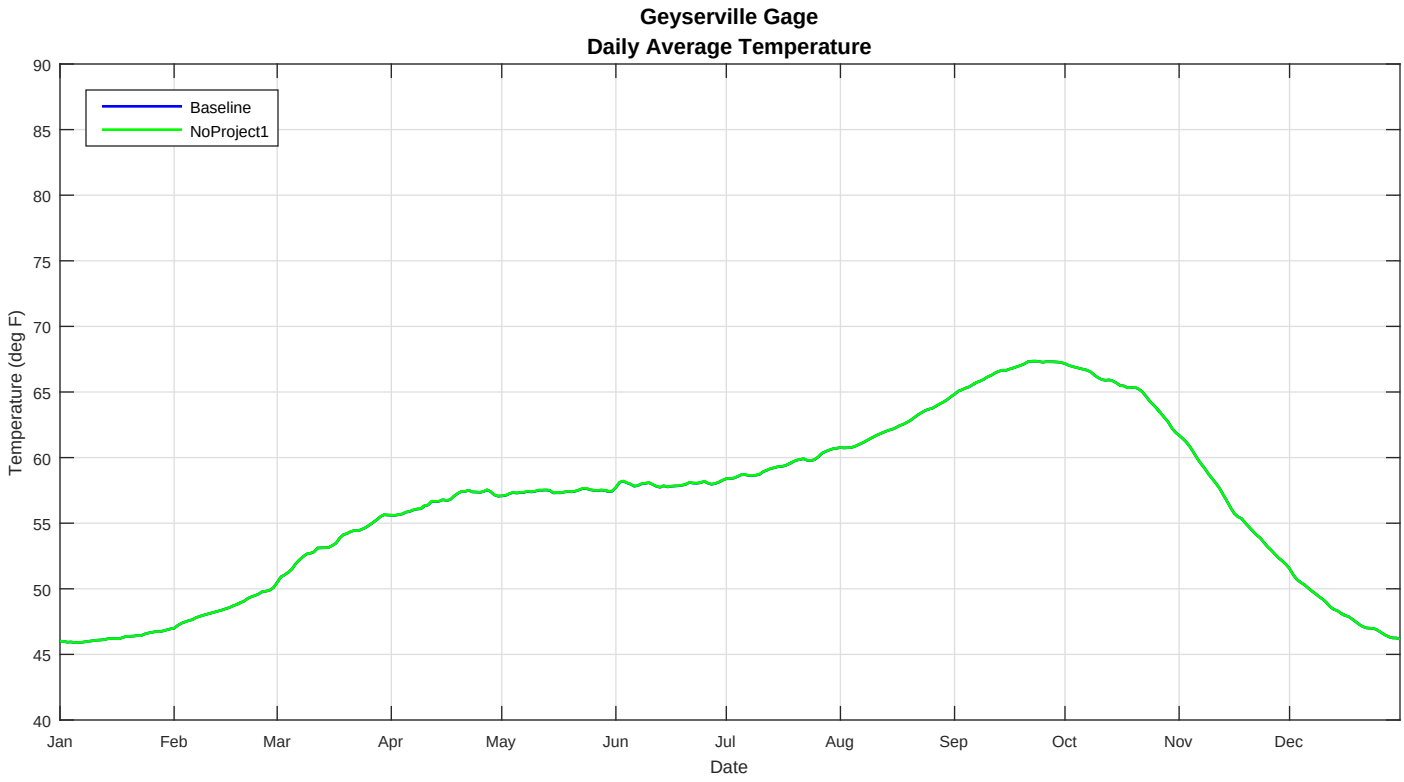

Forks
Daily Average Temperature
Baseline
NoProject1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

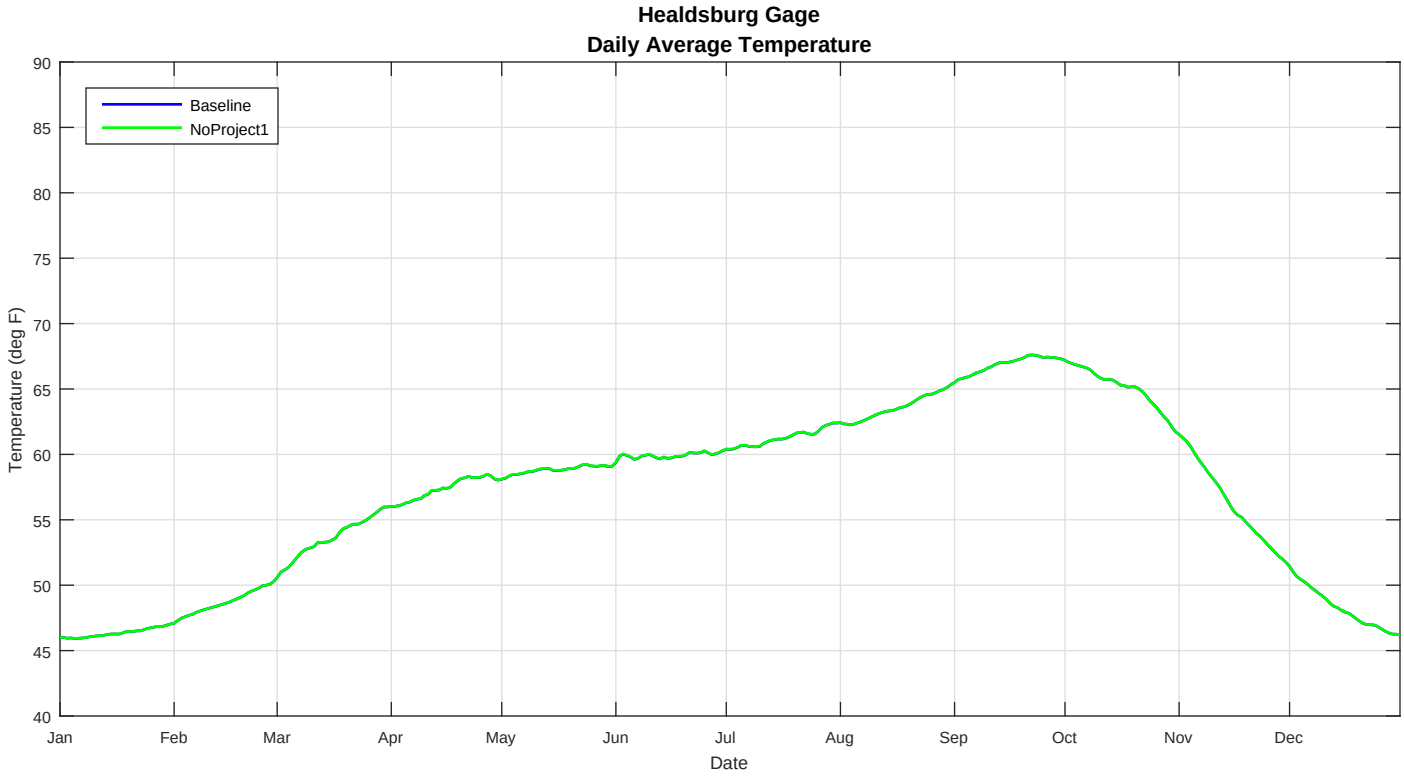

2 Miles Downstream of Forks
Daily Average Temperature
Baseline
NoProject1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

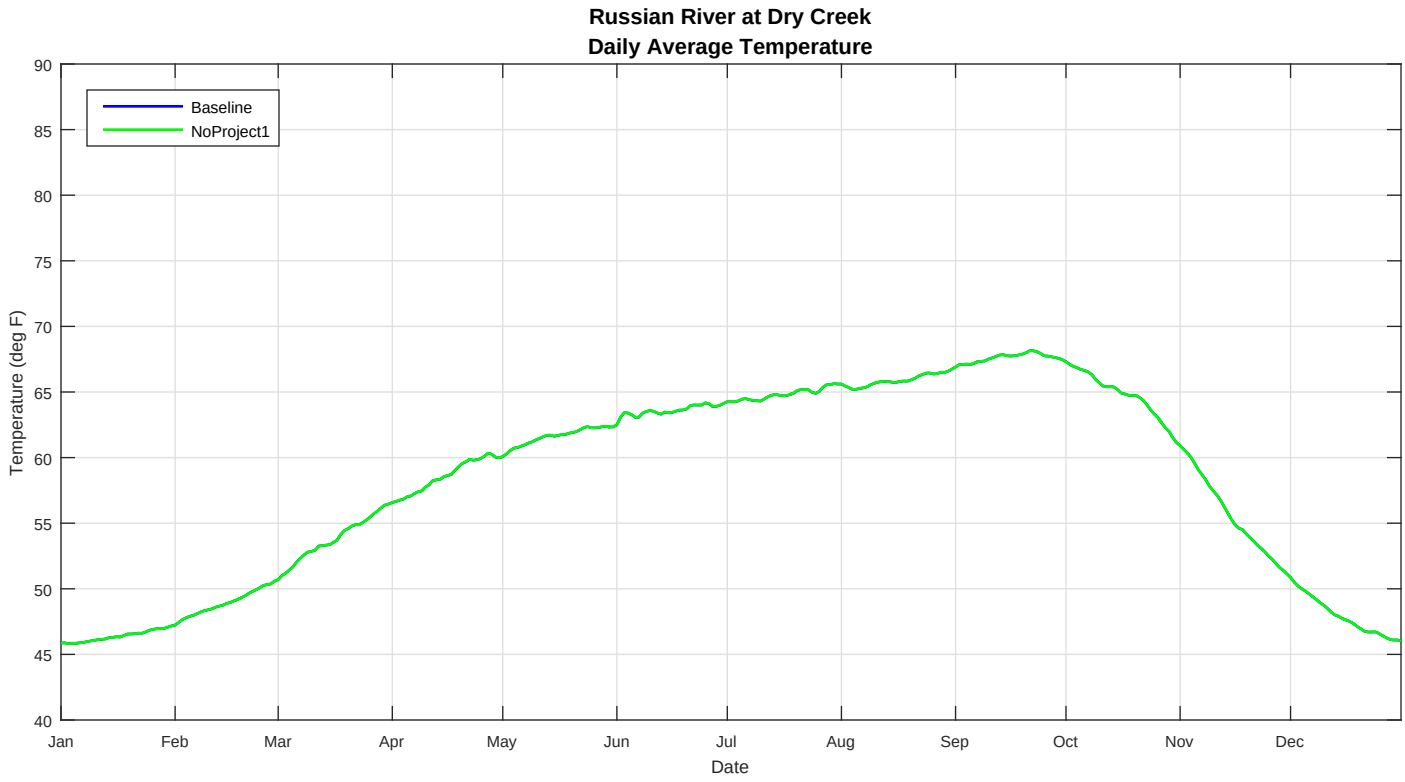

4 Miles Downstream of Forks
Daily Average Temperature
Baseline
NoProject1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

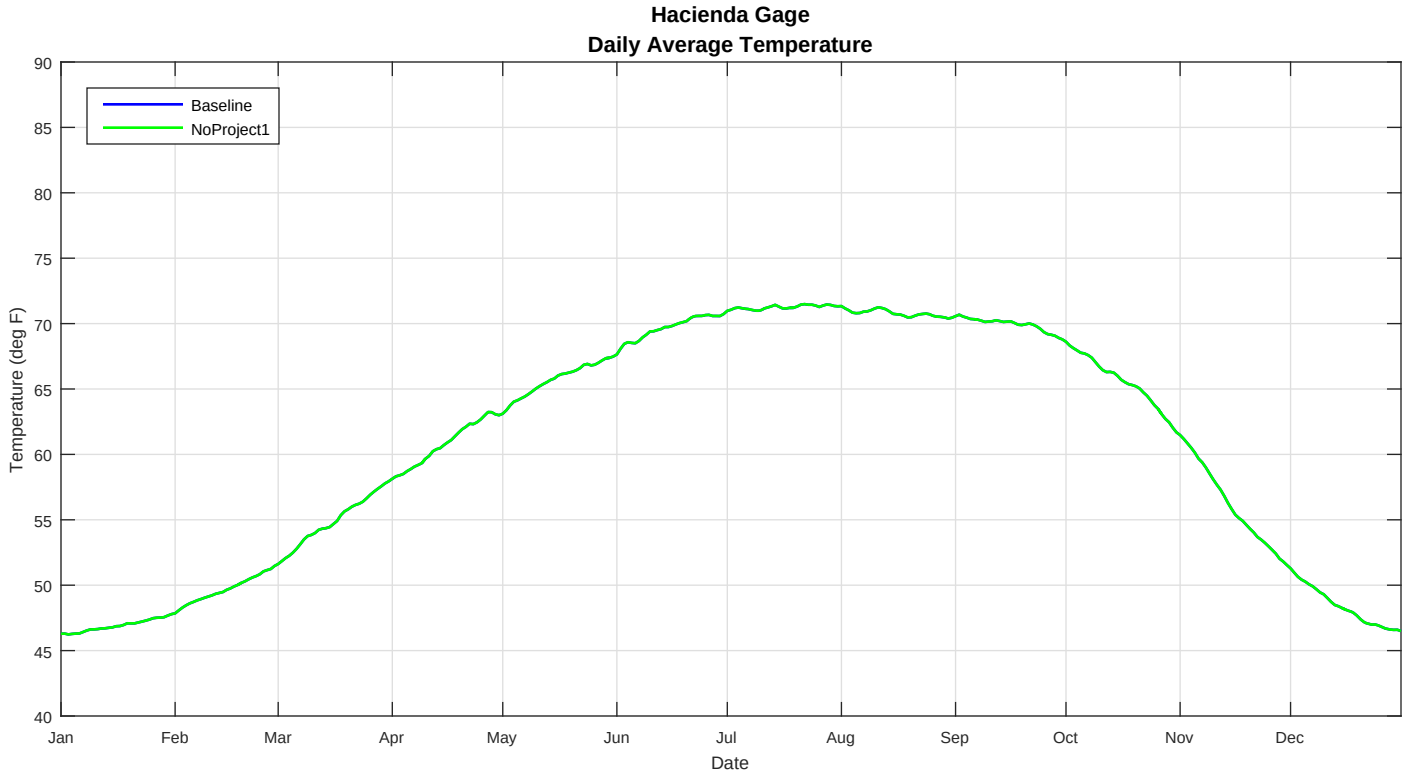

Hopland Gage
Daily Average Temperature
Baseline
NoProject1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

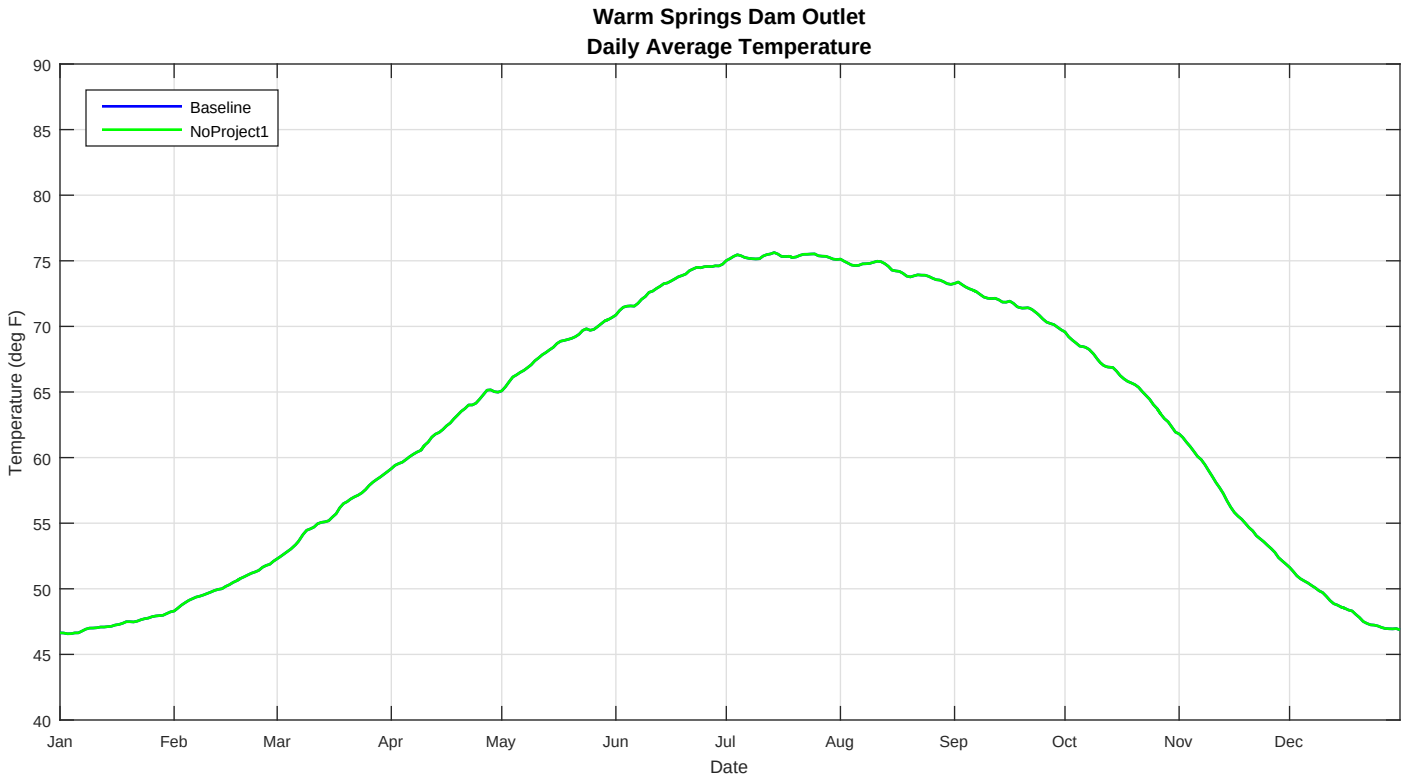

Cloverdale Gage
Daily Average Temperature
Baseline
NoProject1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

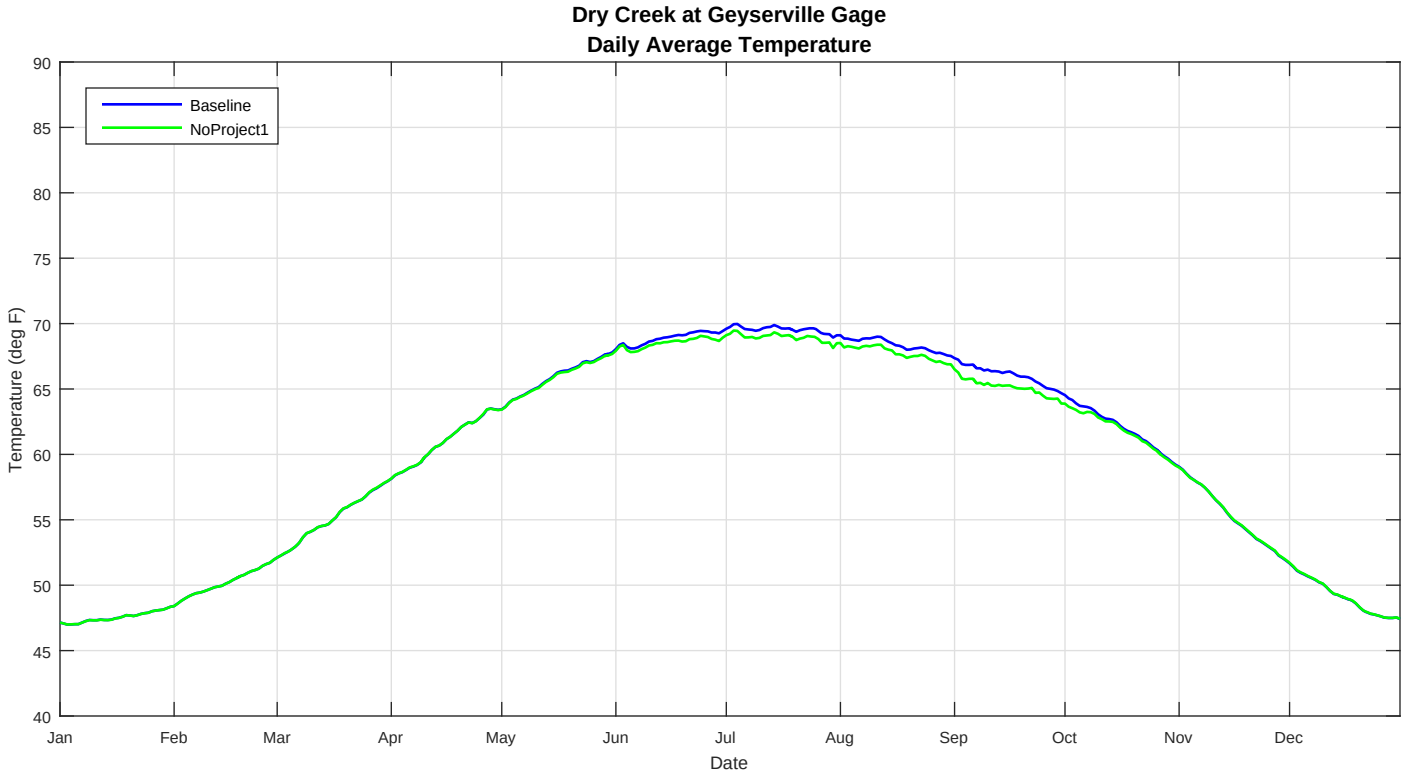

Geyserville Gage
Daily Average Temperature
Baseline
NoProject1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

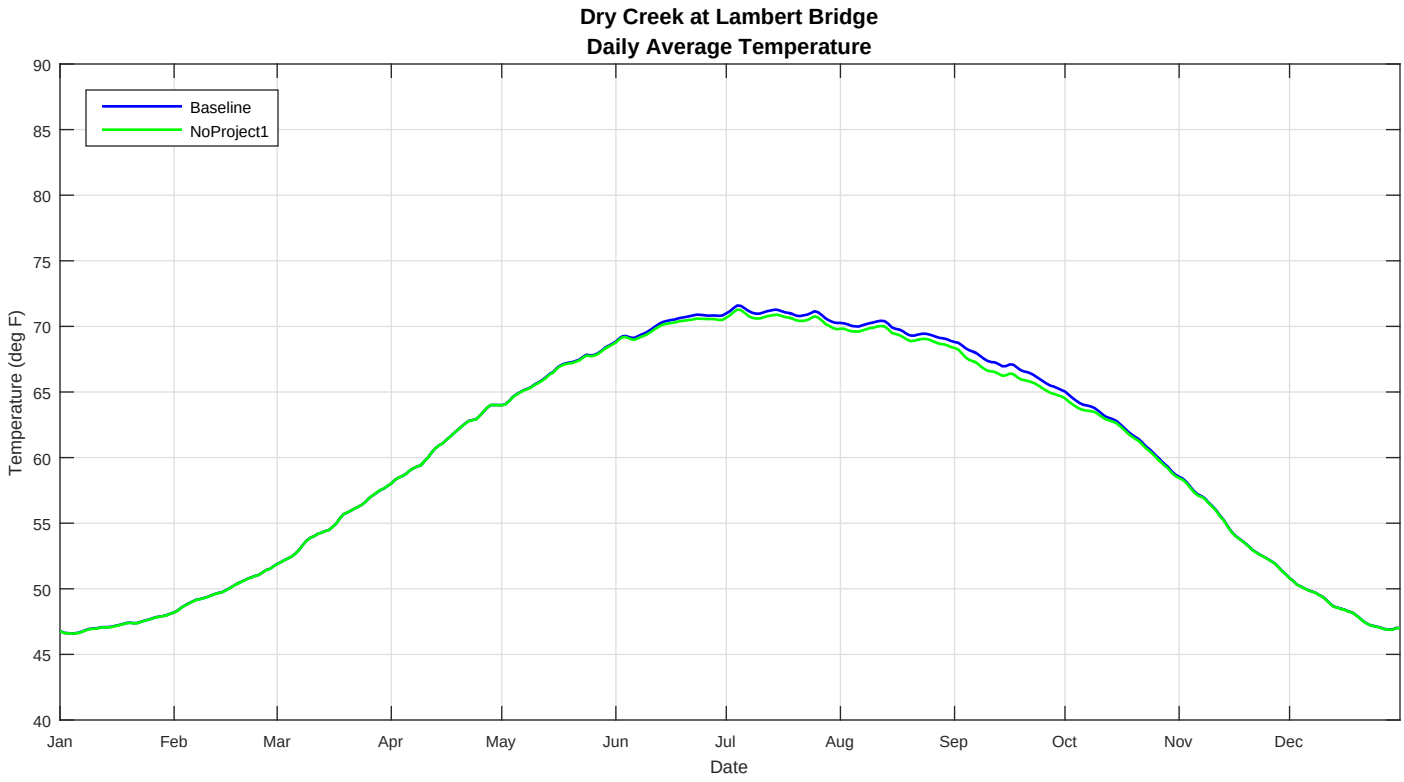

Healdsburg Gage
Daily Average Temperature
Baseline
NoProject1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

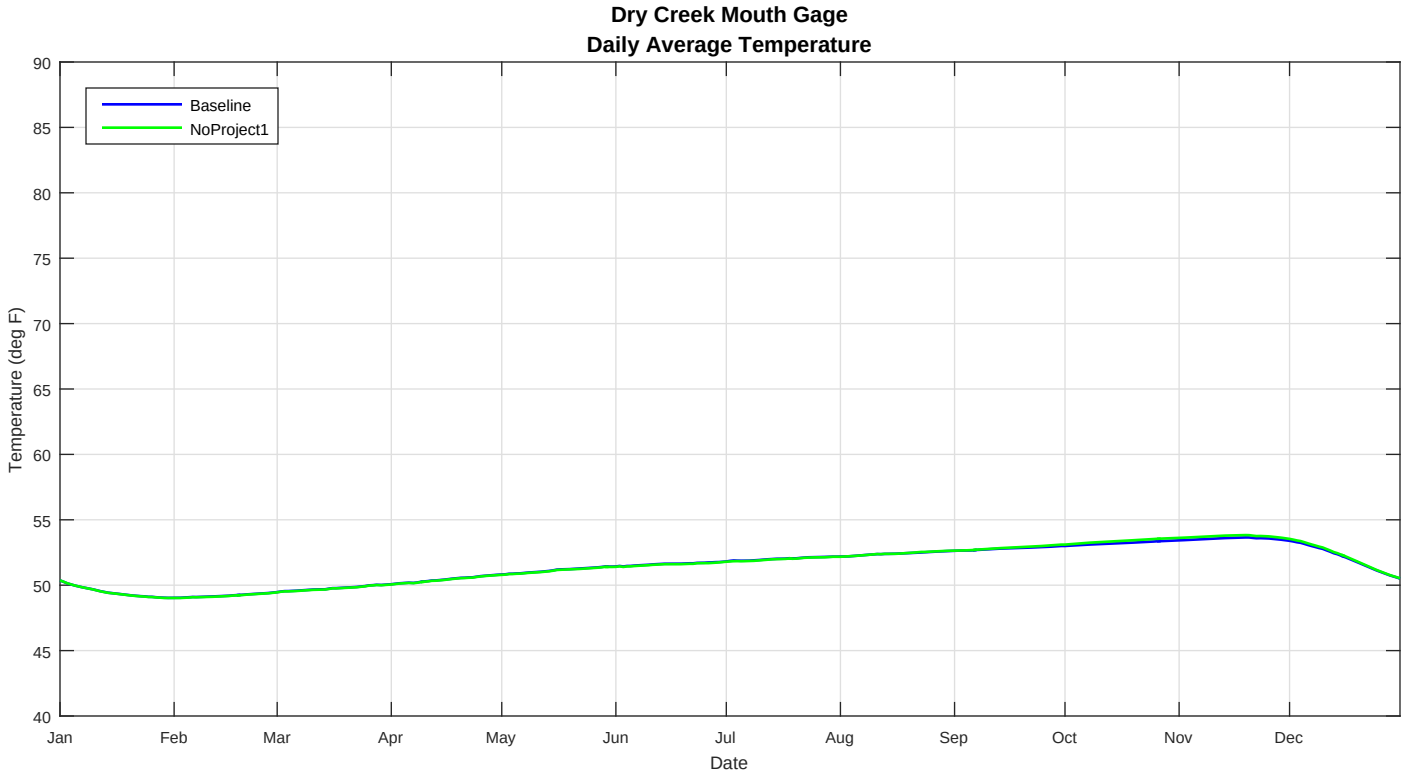

Russian River at Dry Creek
Daily Average Temperature
Baseline
NoProject1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

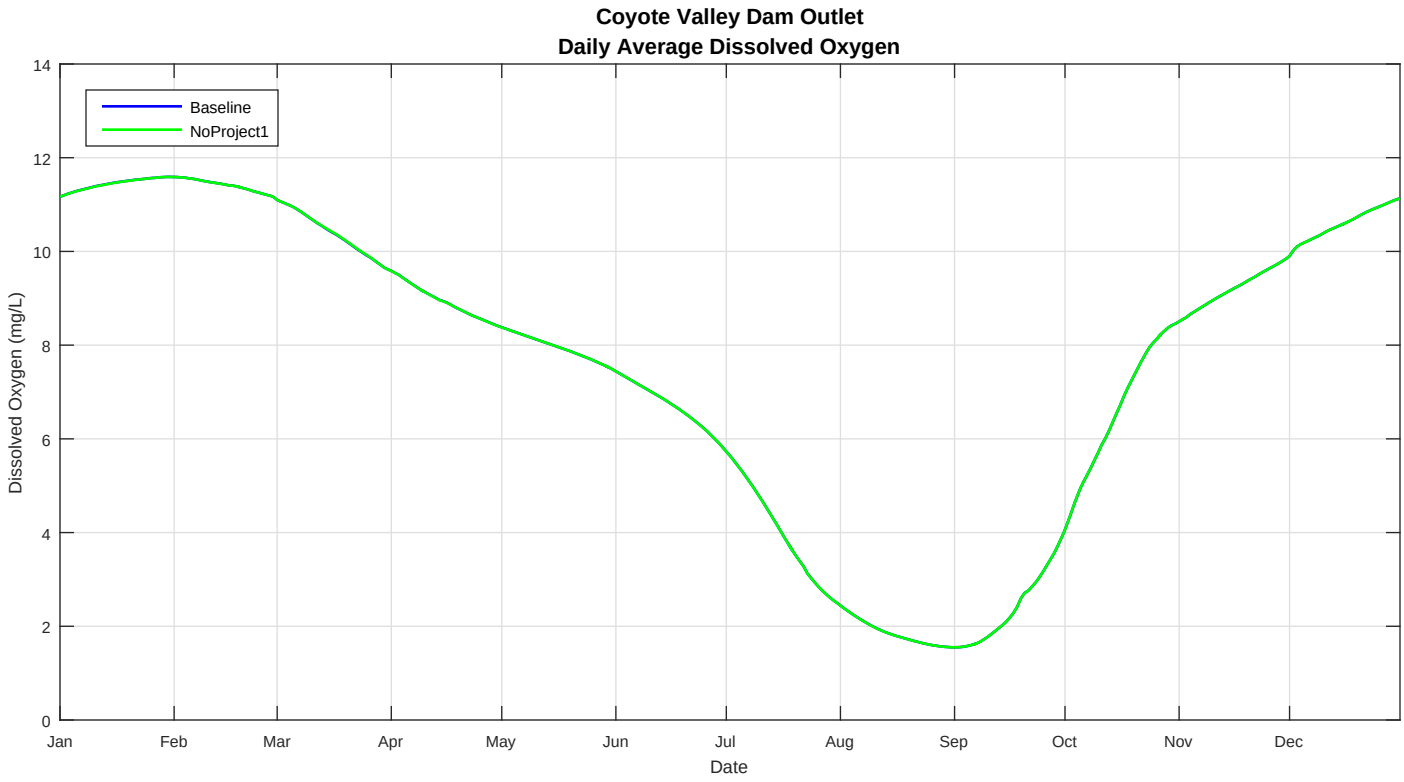

Hacienda Gage
Daily Average Temperature
Baseline
NoProject1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

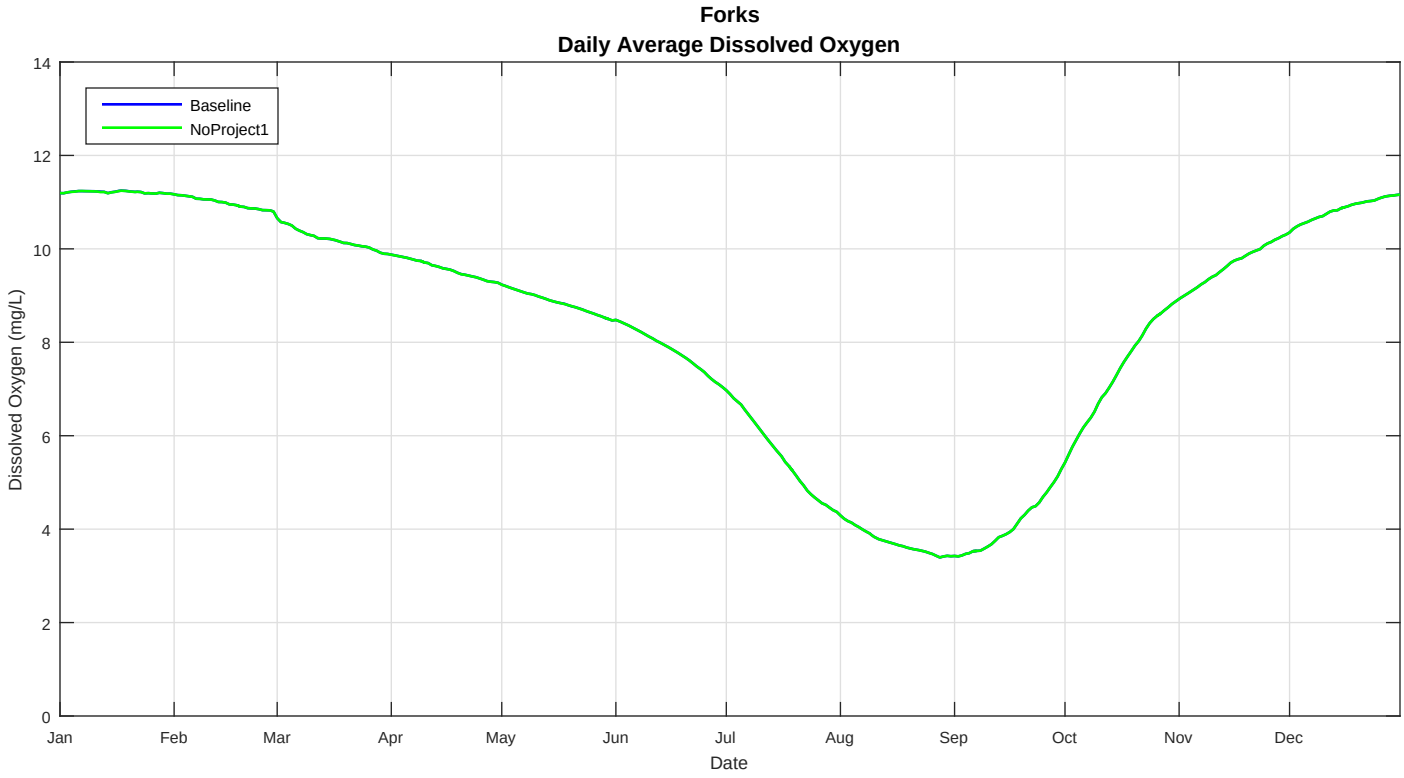

Warm Springs Dam Outlet
Daily Average Temperature
Baseline
NoProject1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

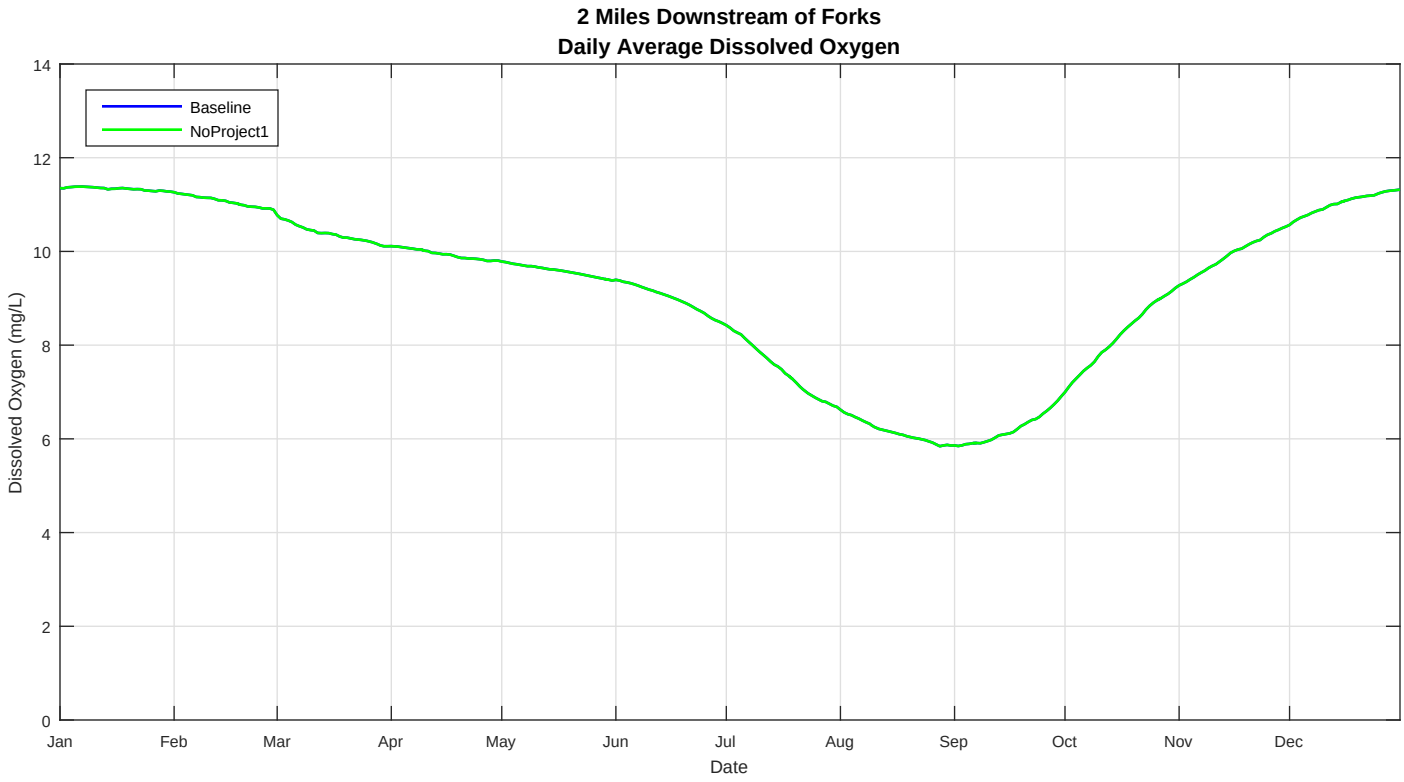

Dry Creek at Geyserville Gage
Daily Average Temperature
Baseline
NoProject1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

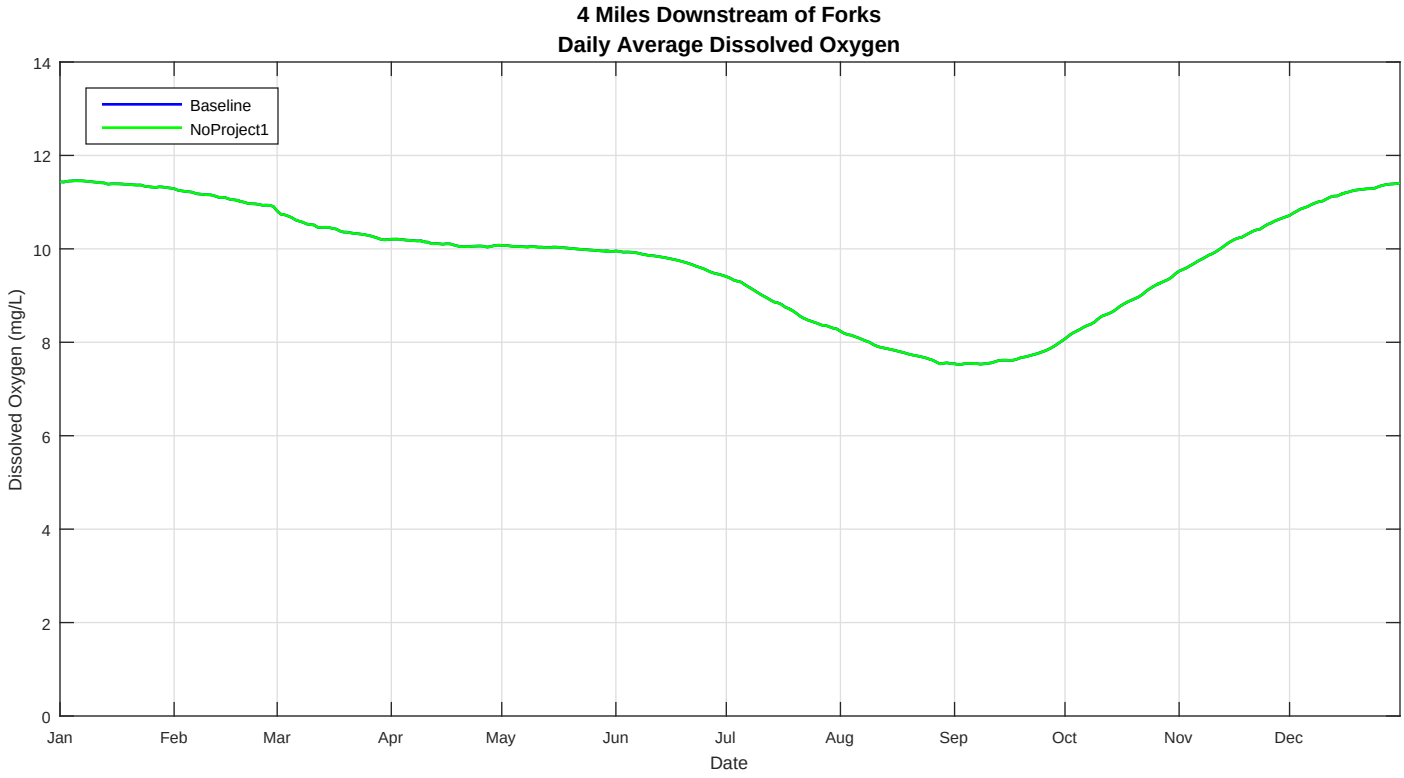

Dry Creek at Lambert Bridge
Daily Average Temperature
Baseline
NoProject1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

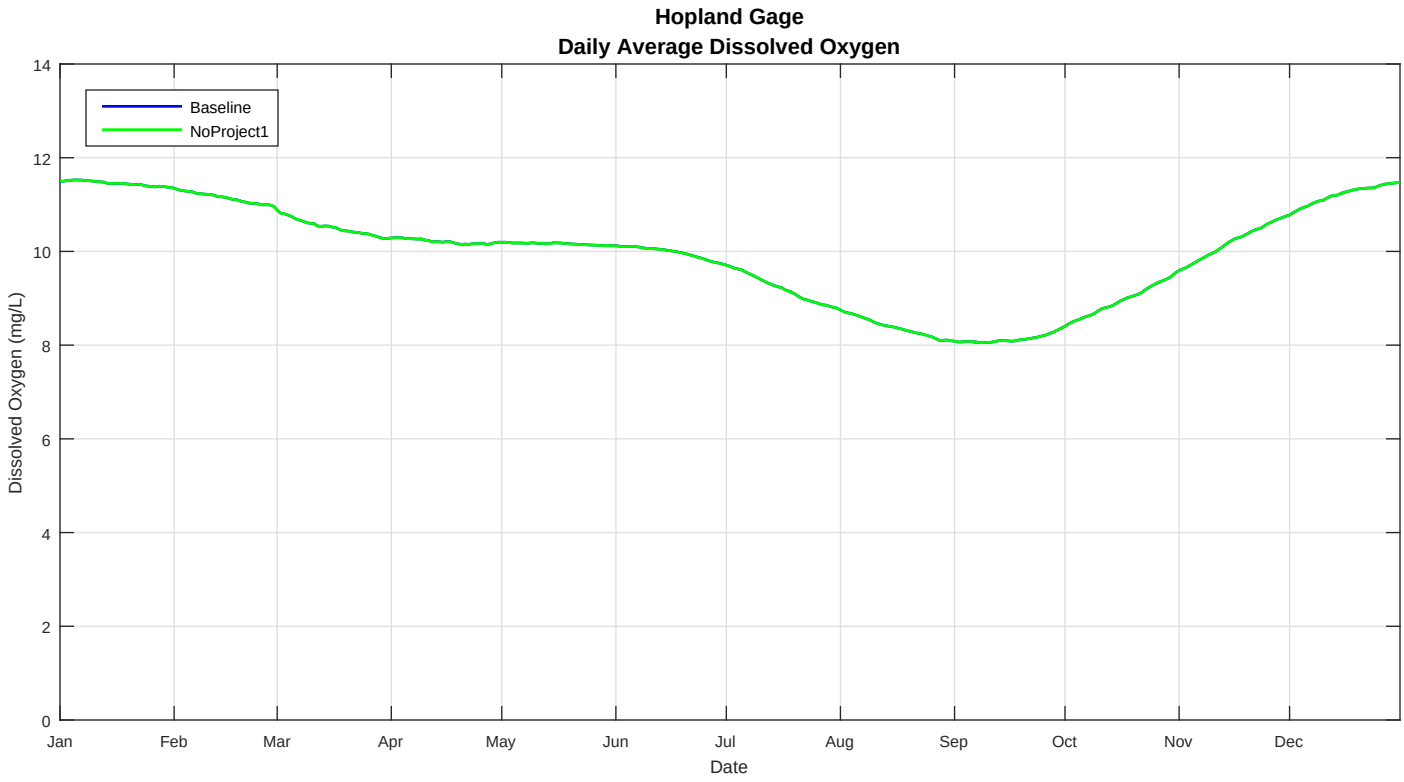

Dry Creek Mouth Gage
Daily Average Temperature
Baseline
NoProject1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

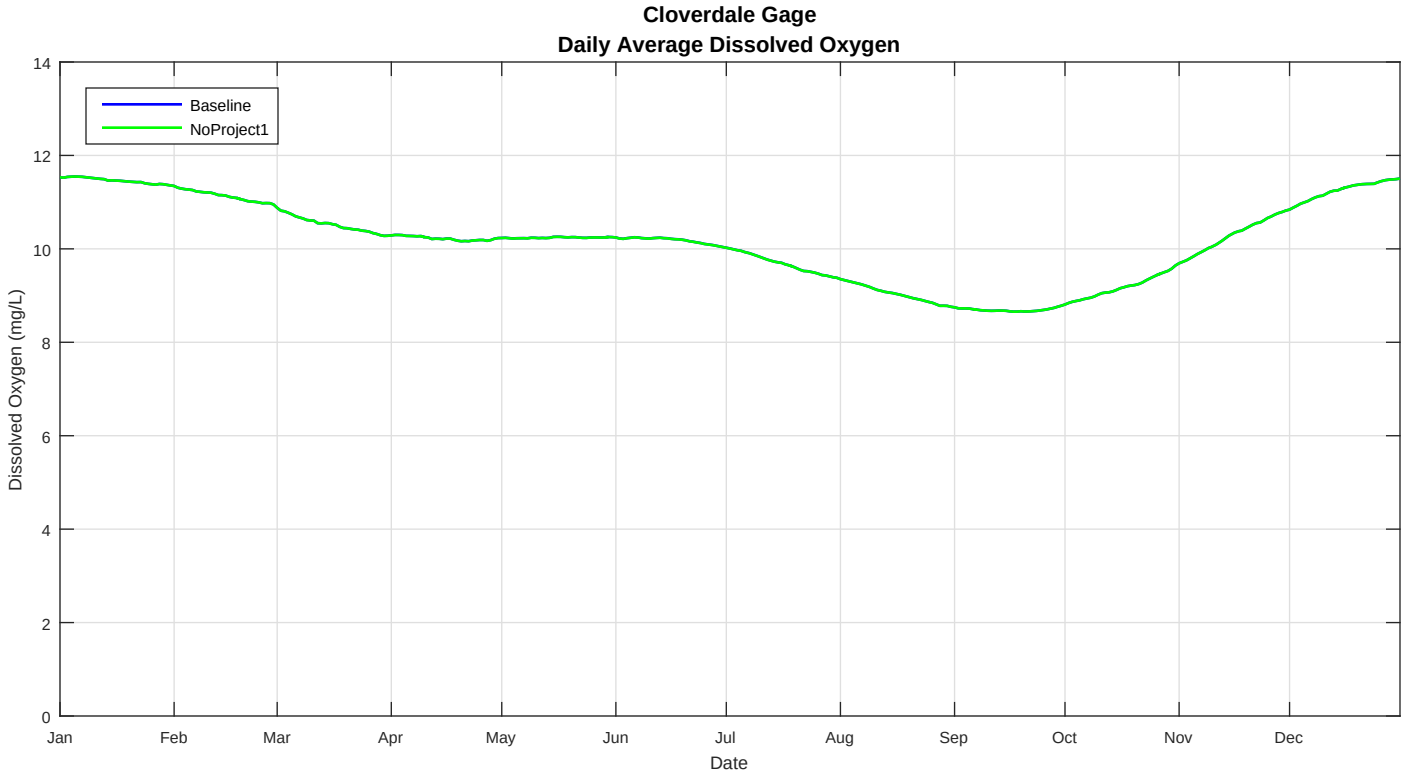

Coyote Valley Dam Outlet
Daily Average Dissolved Oxygen
Baseline
NoProject1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

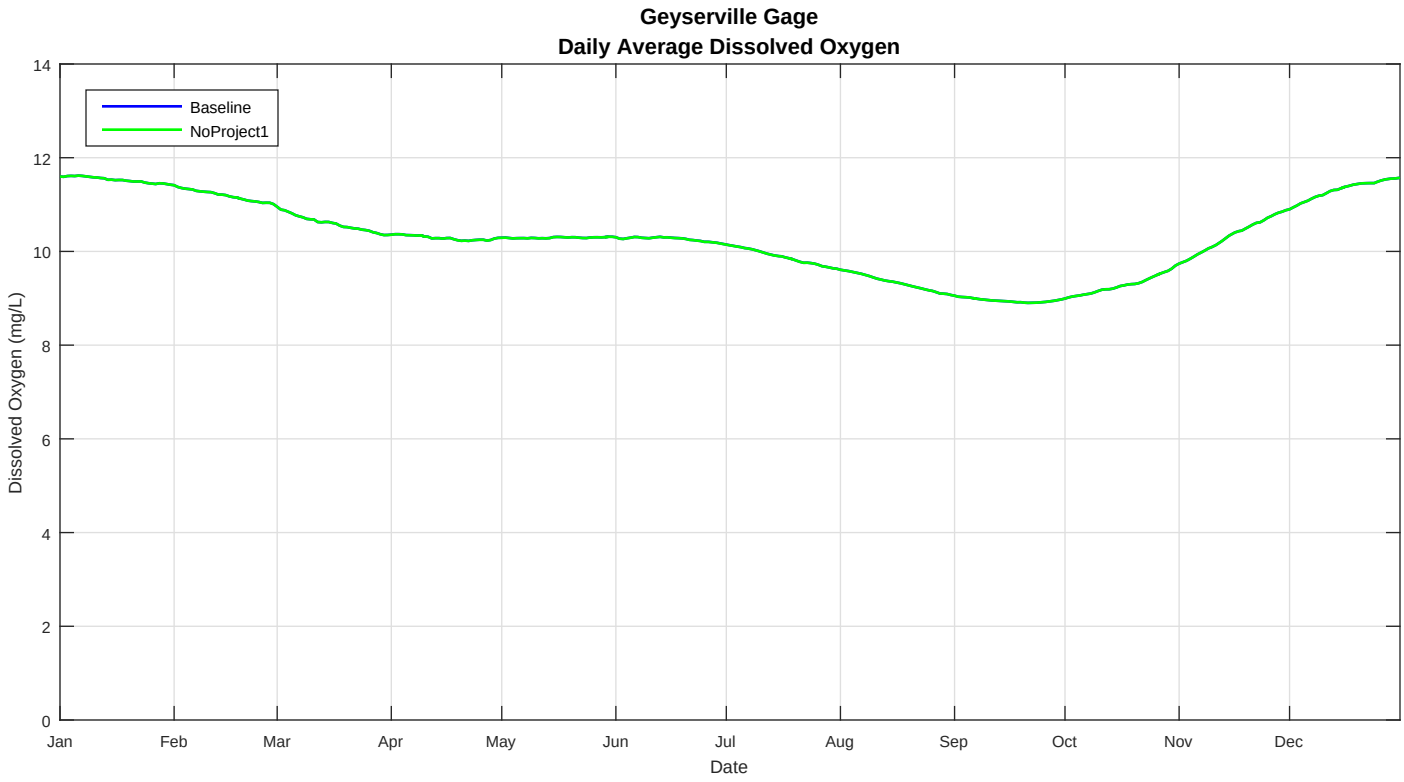

Forks
Daily Average Dissolved Oxygen
Baseline
NoProject1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

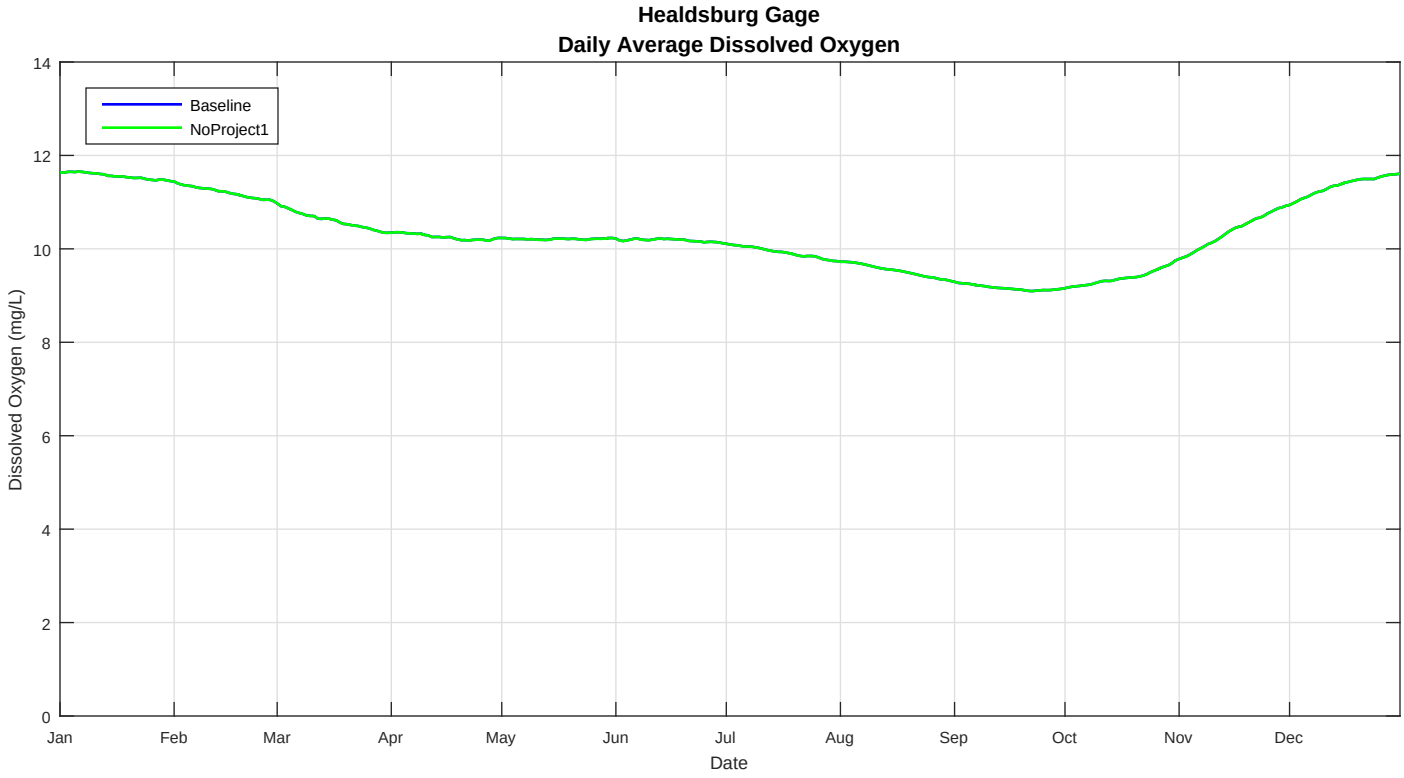

2 Miles Downstream of Forks
Daily Average Dissolved Oxygen
Baseline
NoProject1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

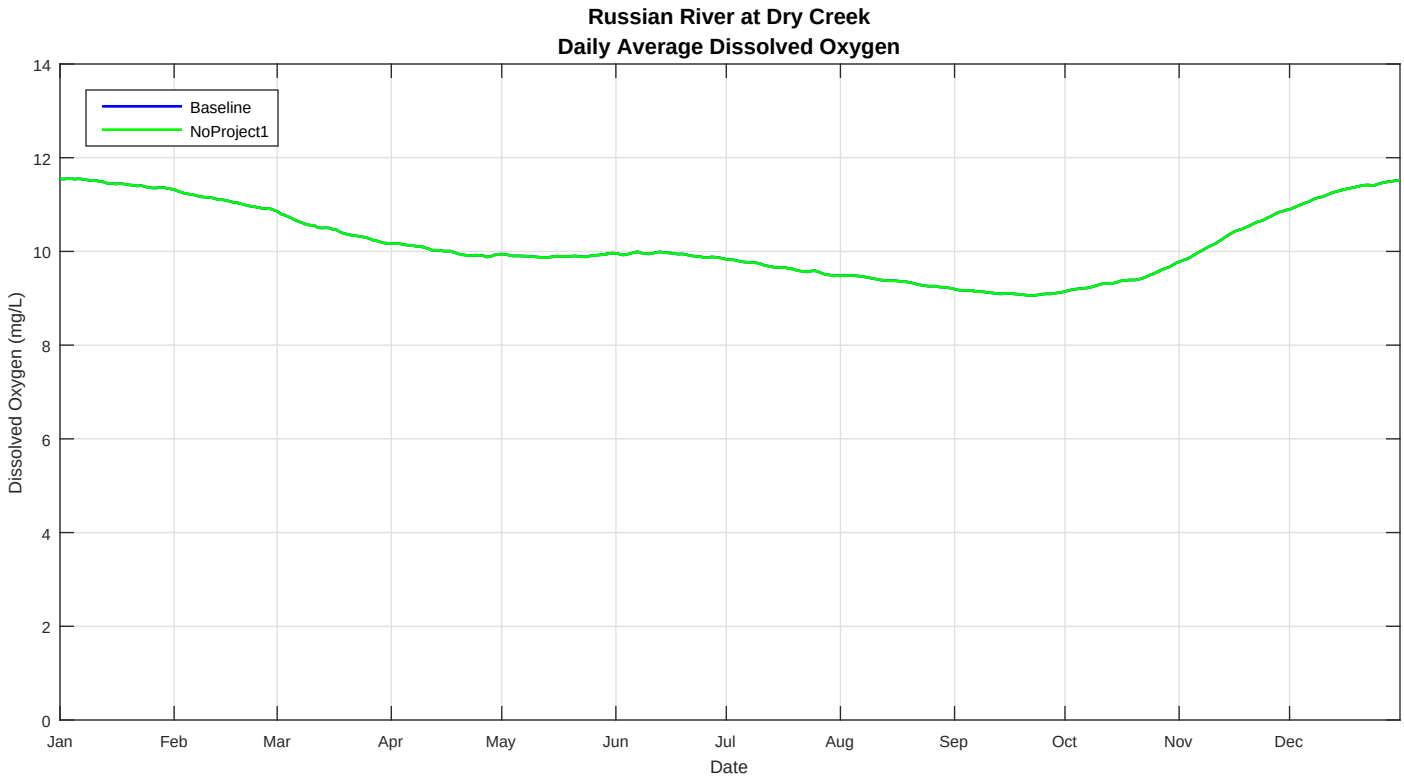

4 Miles Downstream of Forks
Daily Average Dissolved Oxygen
Baseline
NoProject1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

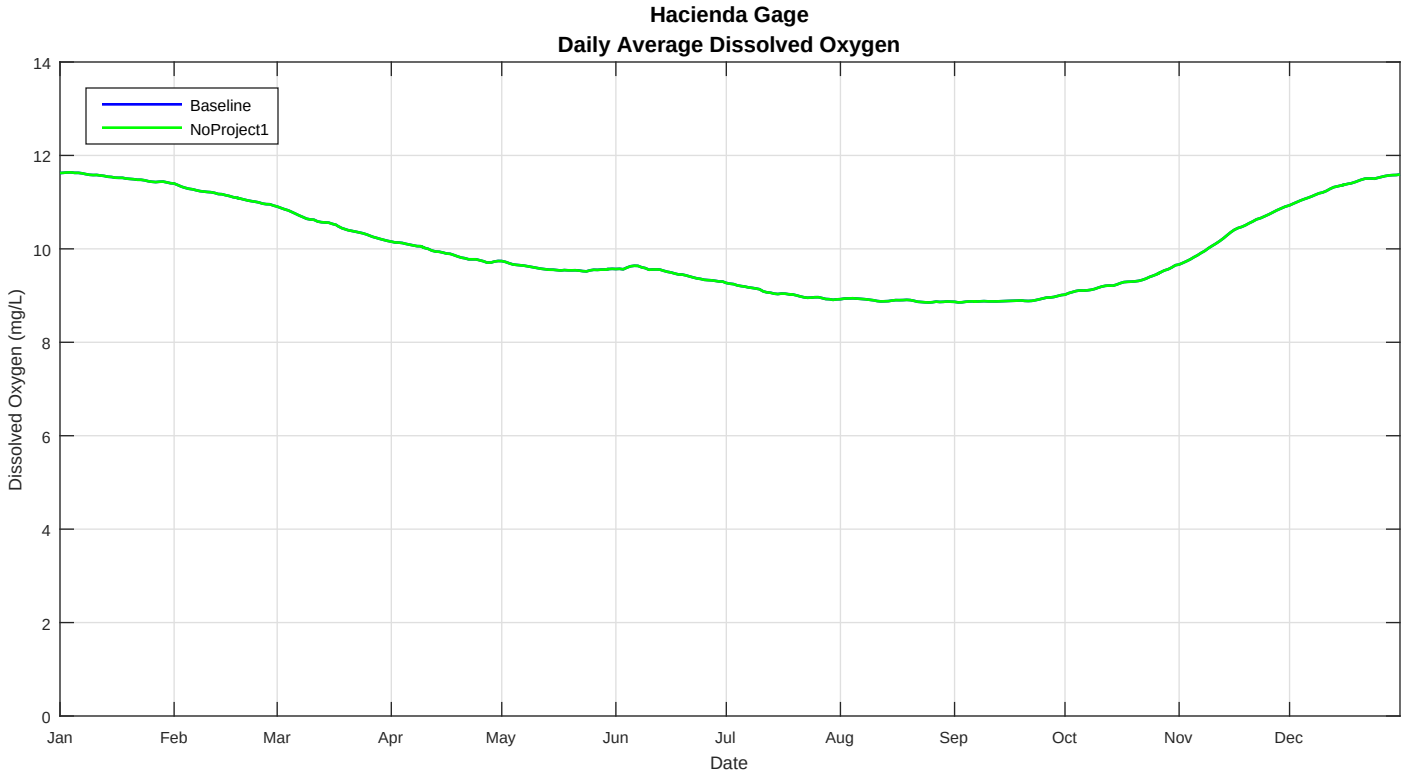

Hopland Gage
Daily Average Dissolved Oxygen
Baseline
NoProject1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

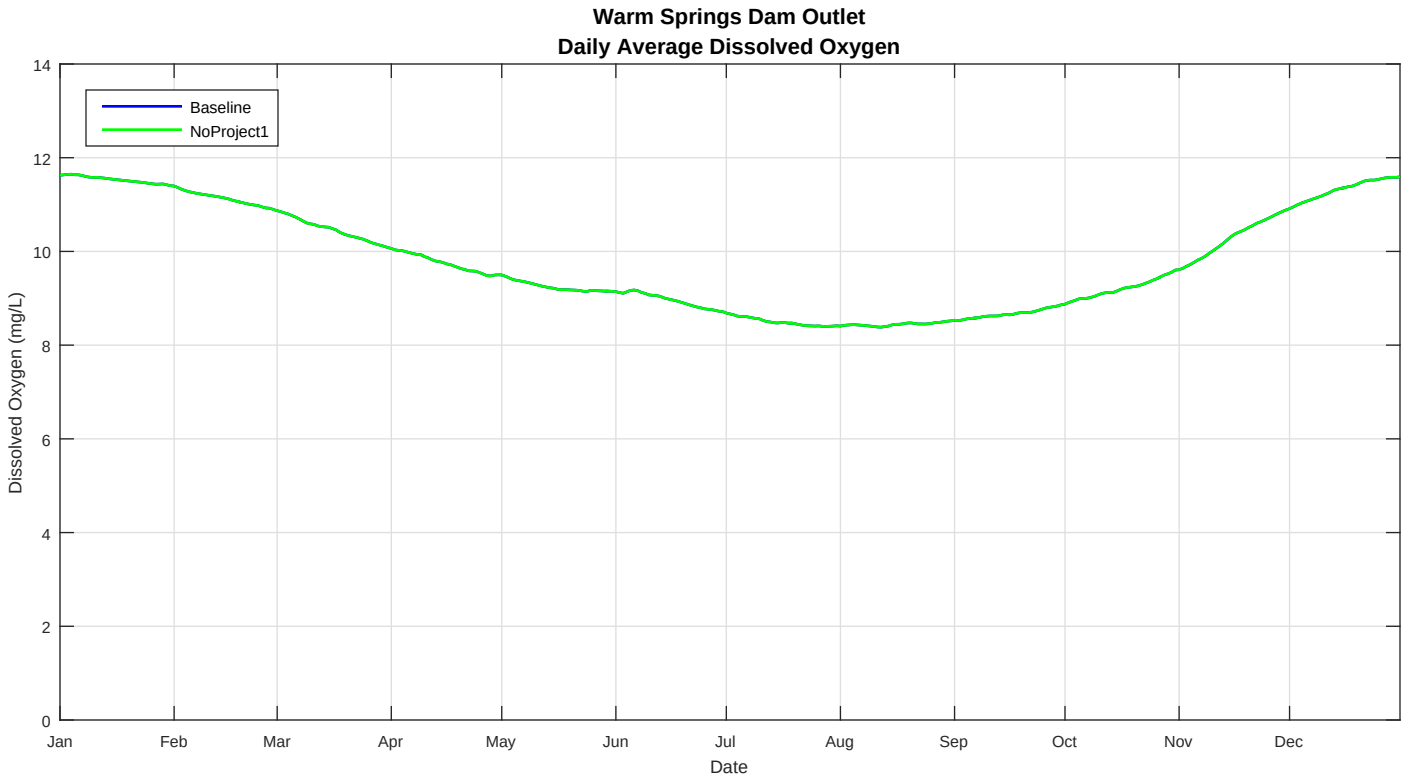

Cloverdale Gage
Daily Average Dissolved Oxygen
Baseline
NoProject1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

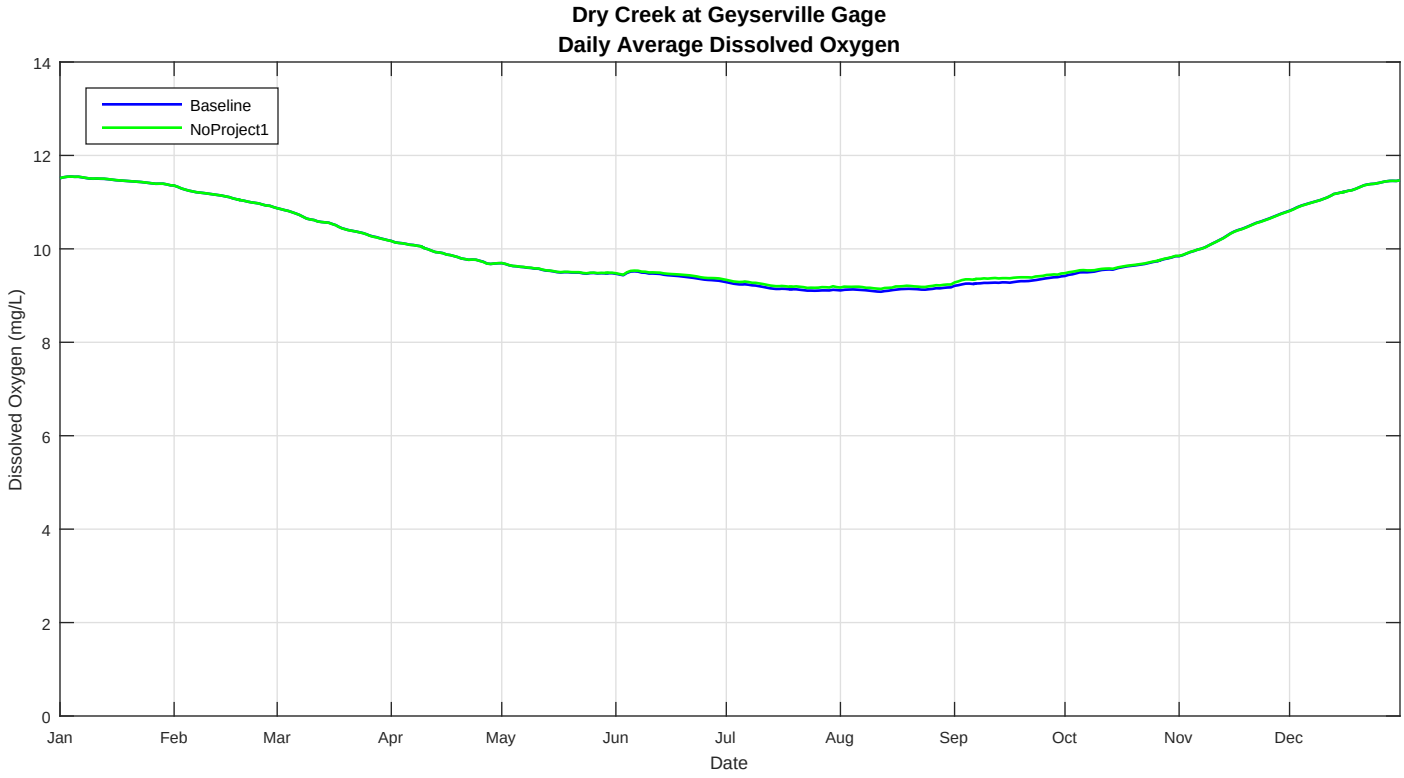

Geyserville Gage
Daily Average Dissolved Oxygen
Baseline
NoProject1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

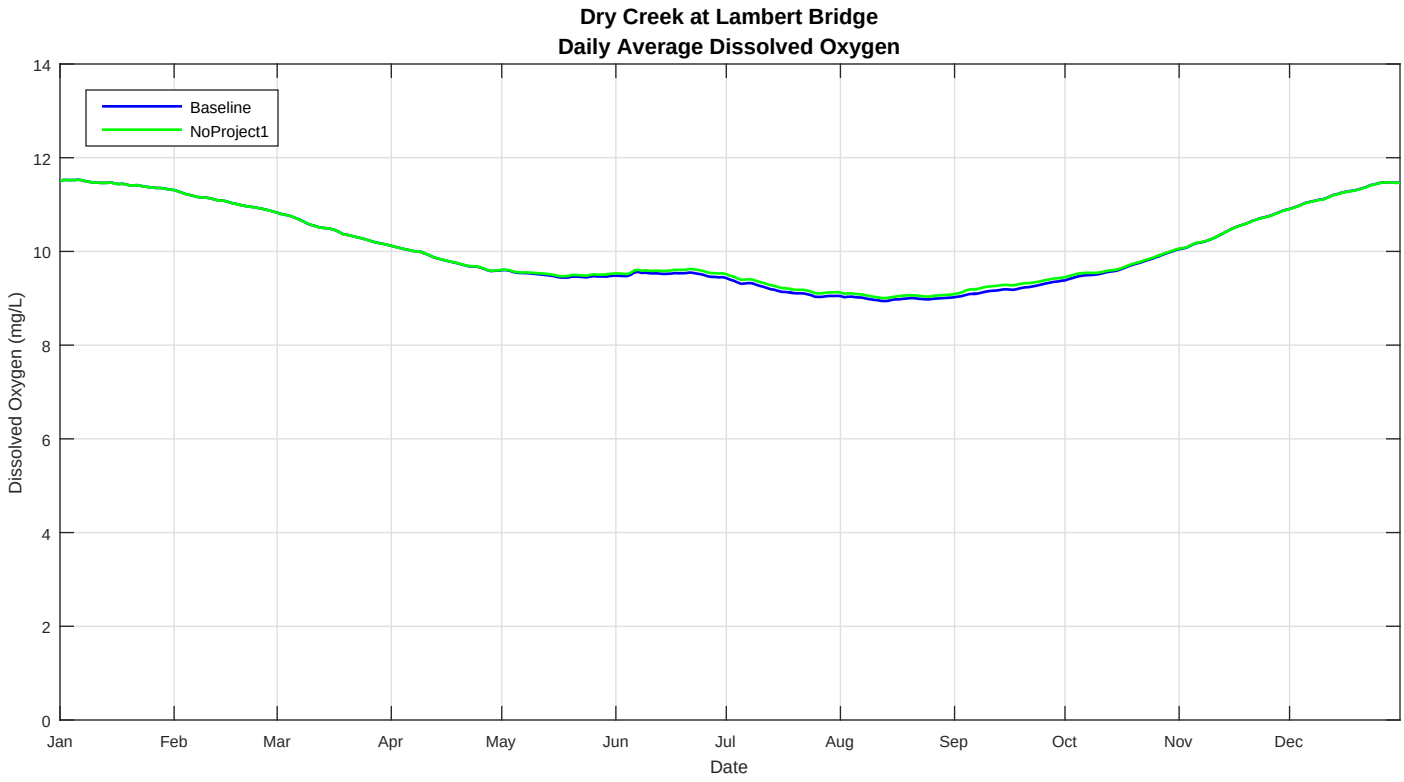

Healdsburg Gage
Daily Average Dissolved Oxygen
Baseline
NoProject1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

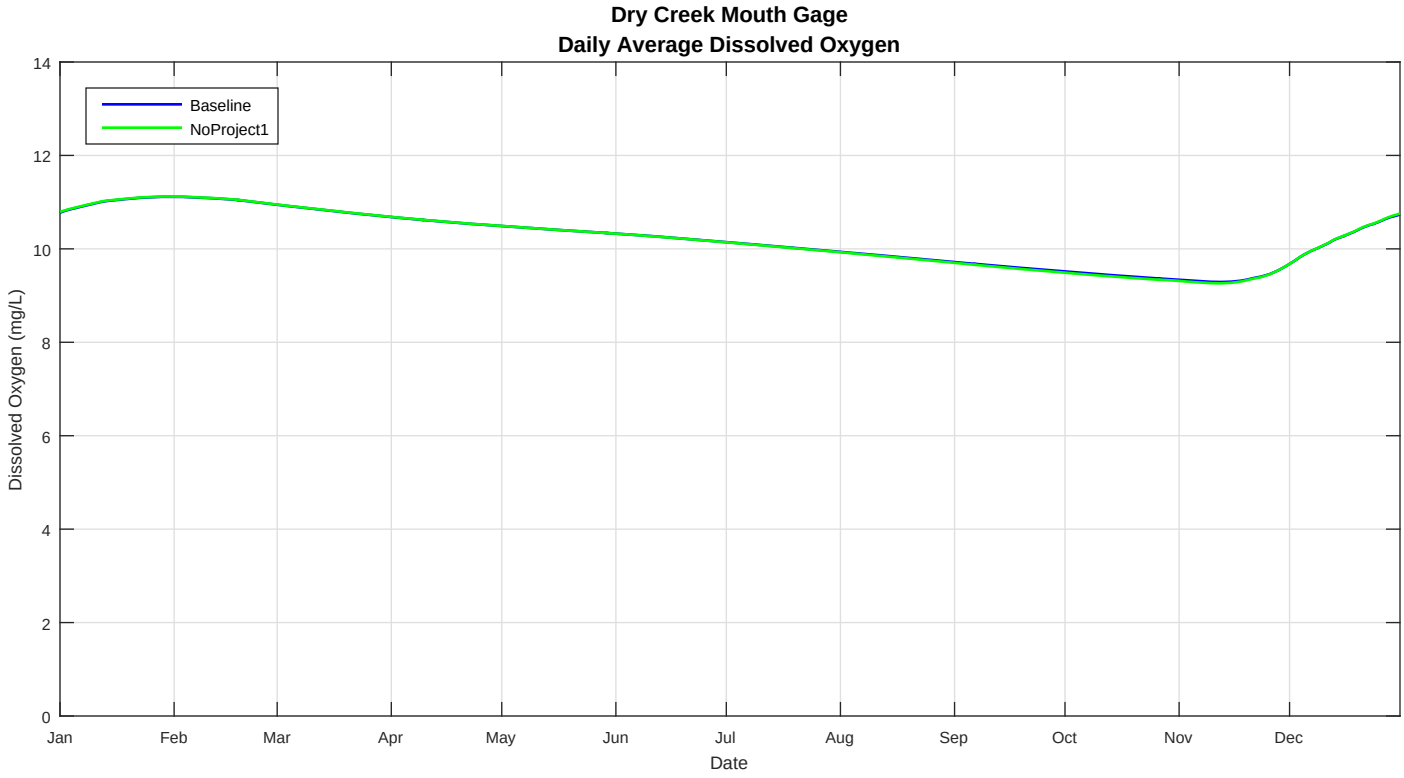

Russian River at Dry Creek
Daily Average Dissolved Oxygen
Baseline
NoProject1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

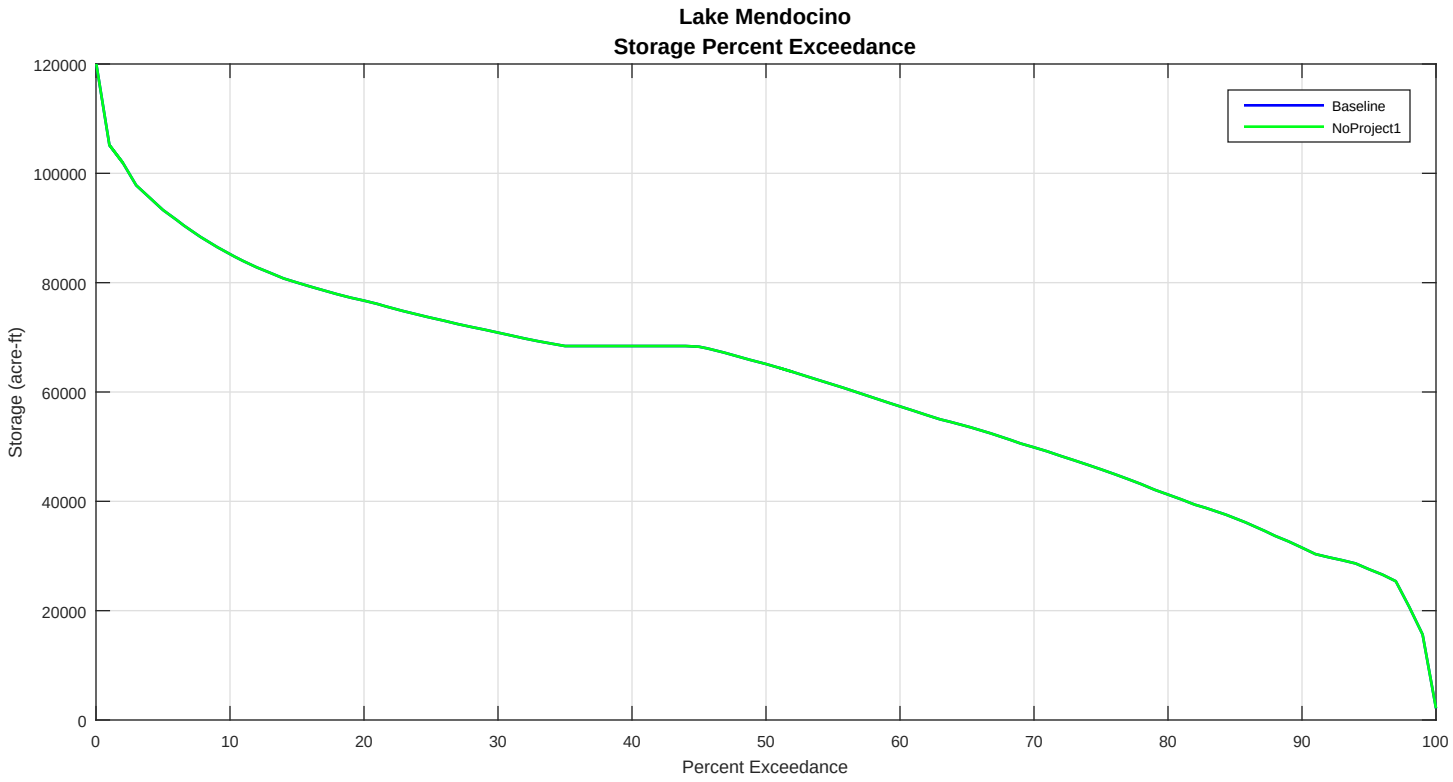

Hacienda Gage
Daily Average Dissolved Oxygen
Baseline
NoProject1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

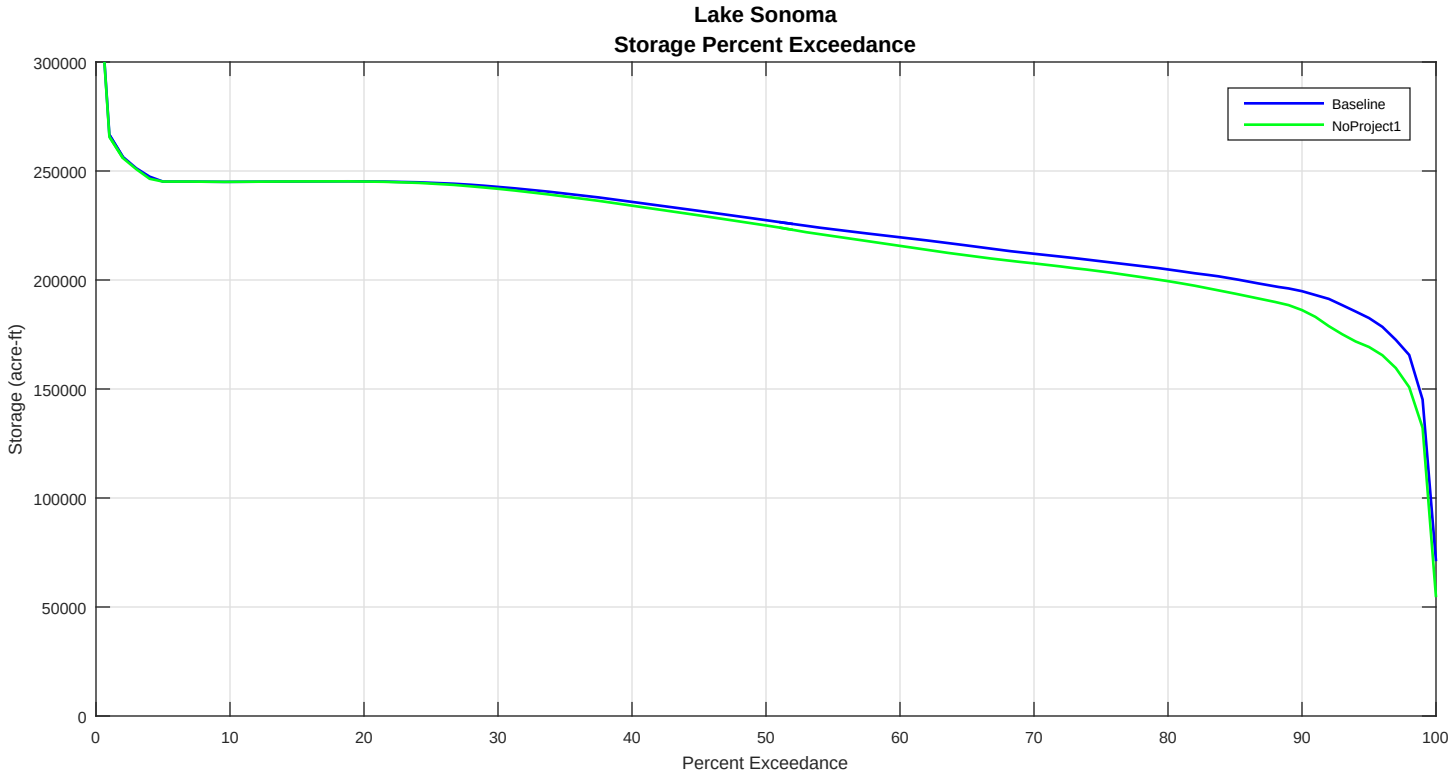

Warm Springs Dam Outlet
Daily Average Dissolved Oxygen
Baseline
NoProject1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

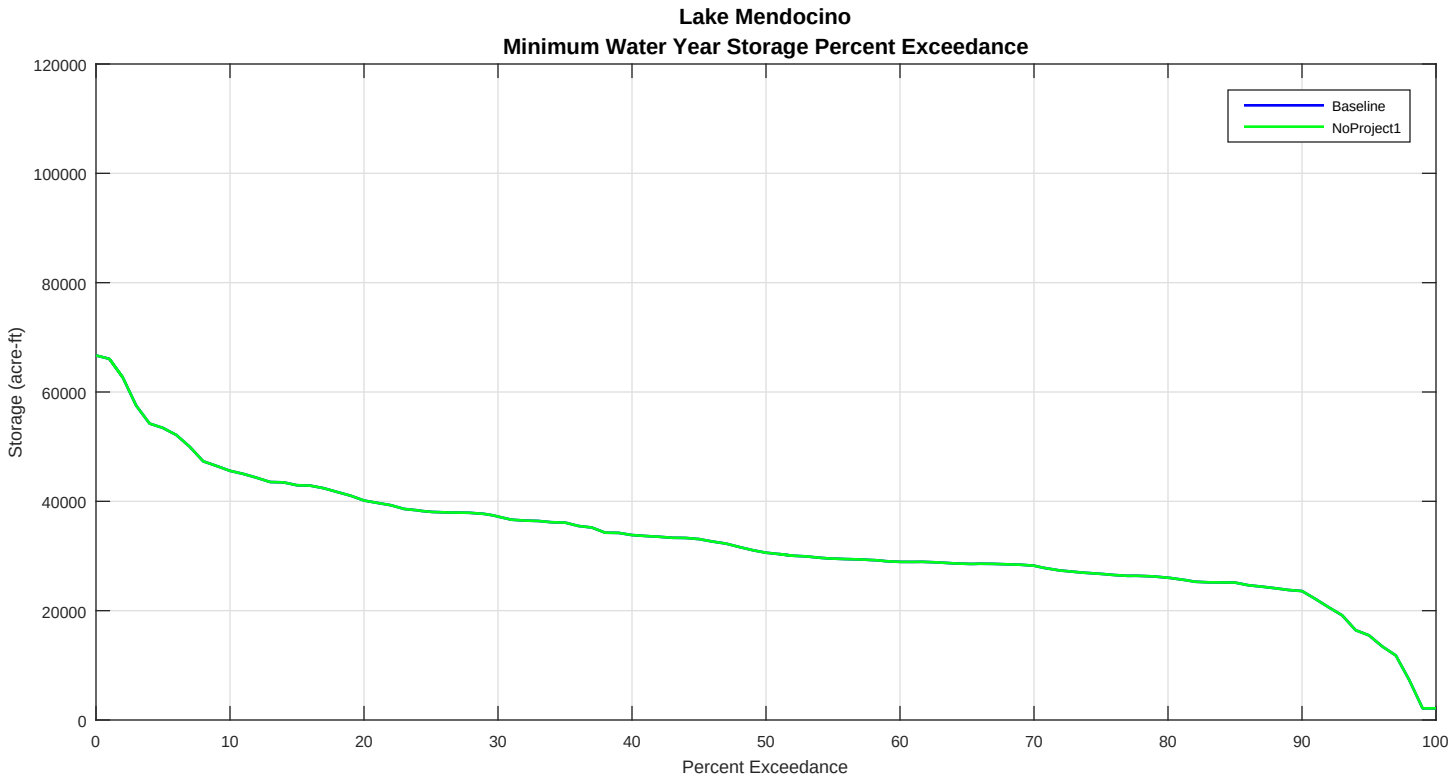

Dry Creek at Geyserville Gage
Daily Average Dissolved Oxygen
Baseline
NoProject1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

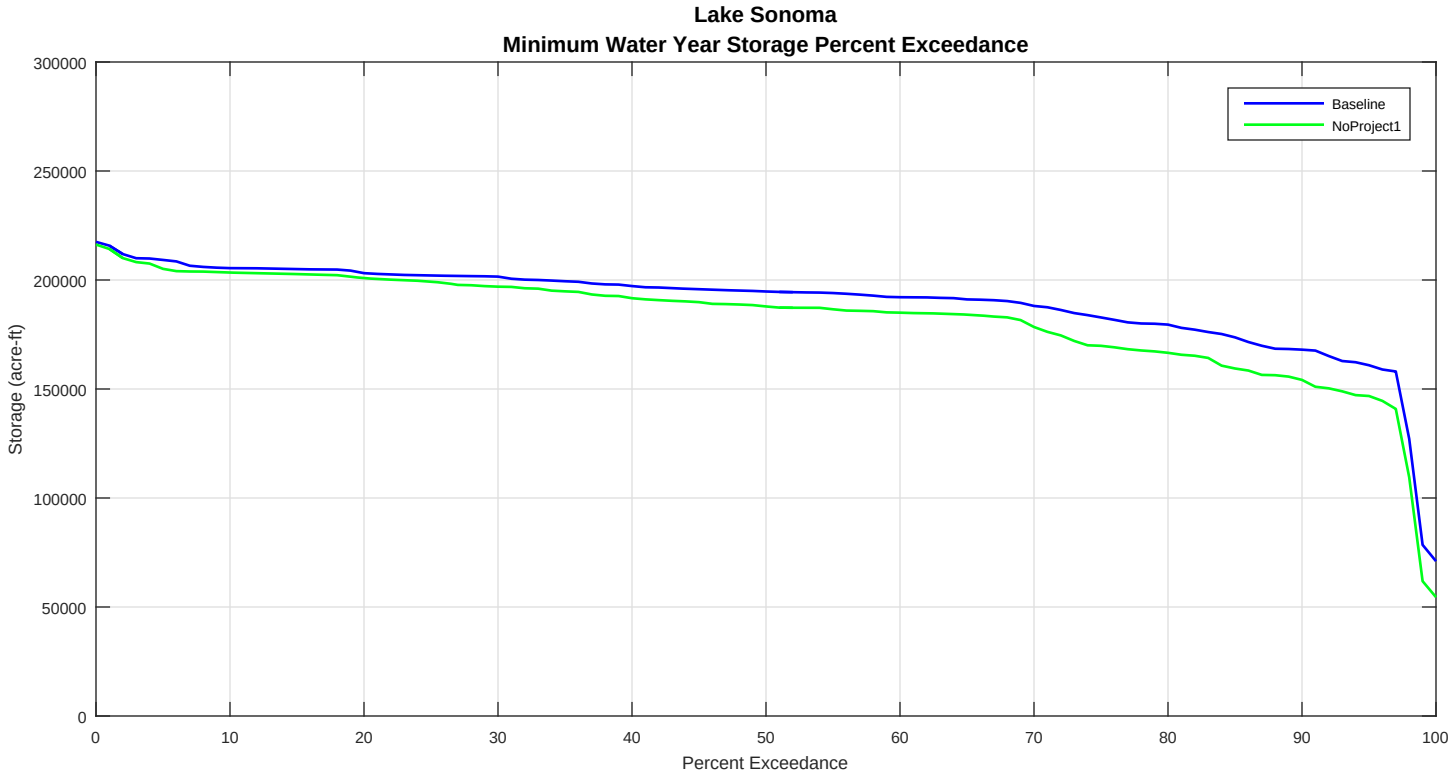

Dry Creek at Lambert Bridge
Daily Average Dissolved Oxygen
Baseline
NoProject1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

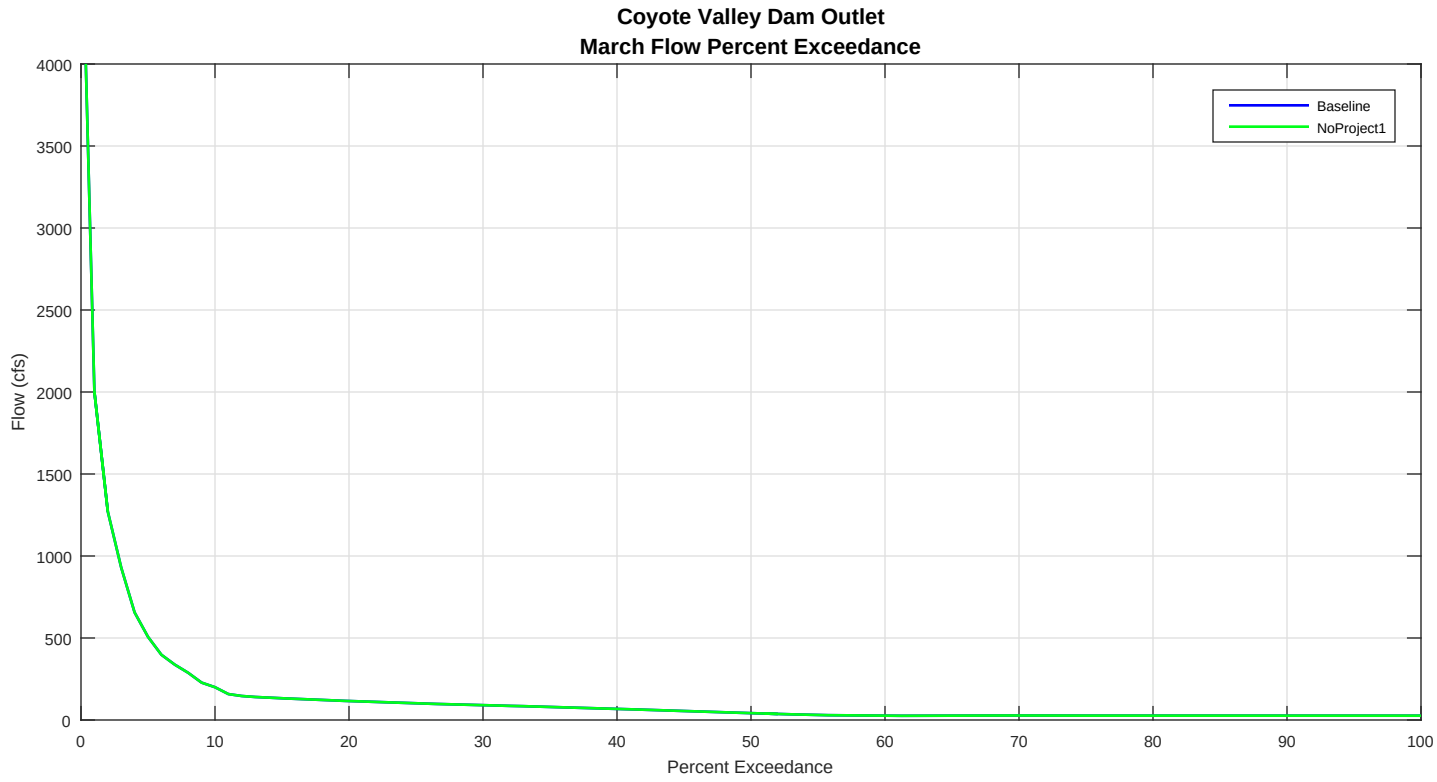

Dry Creek Mouth Gage
Daily Average Dissolved Oxygen
Baseline
NoProject1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

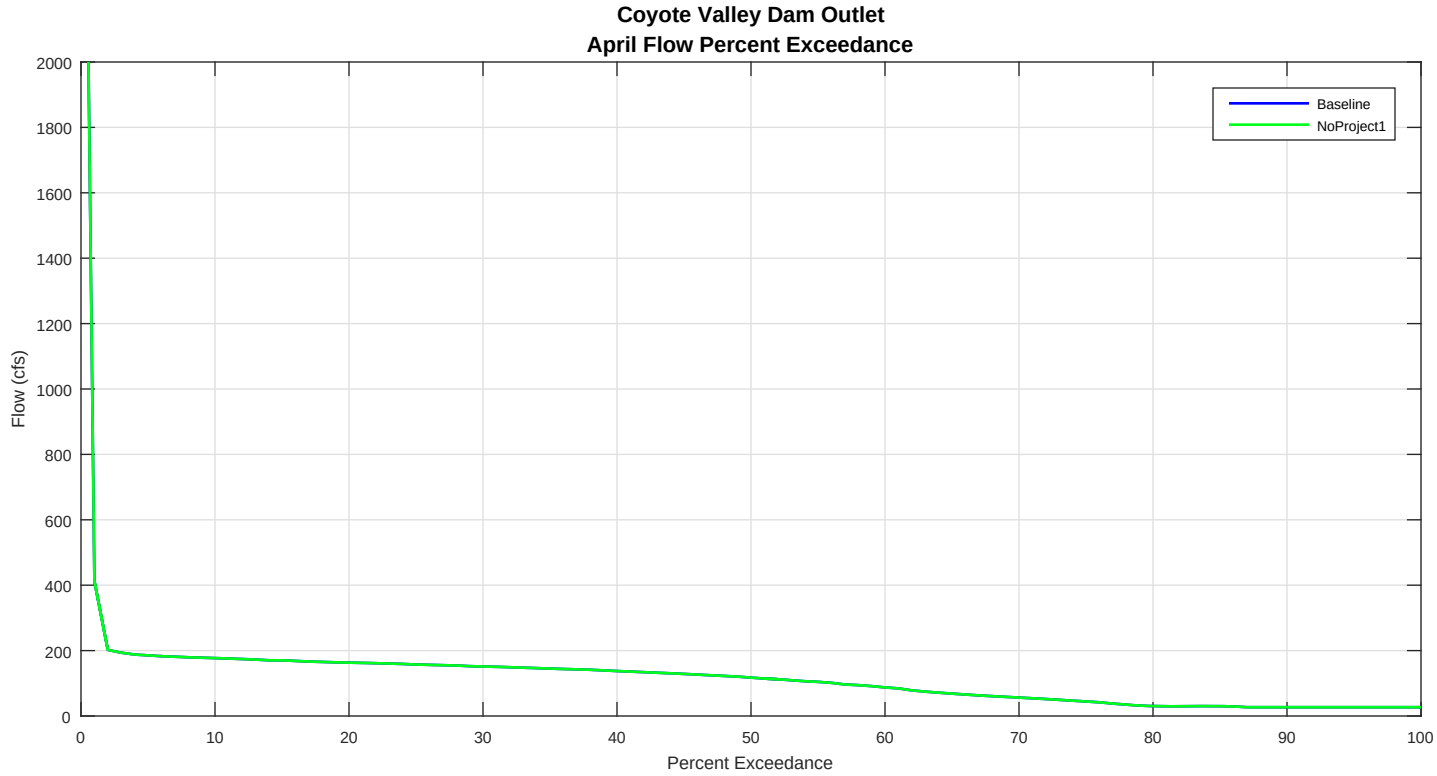

Lake Mendocino
Storage Percent Exceedance
Baseline
NoProject1
Storage (acre-ft)
Percent Exceedance
0
20000
40000
60000
80000
100000
120000
0
10
20
30
40
50
60
70
80
90
100

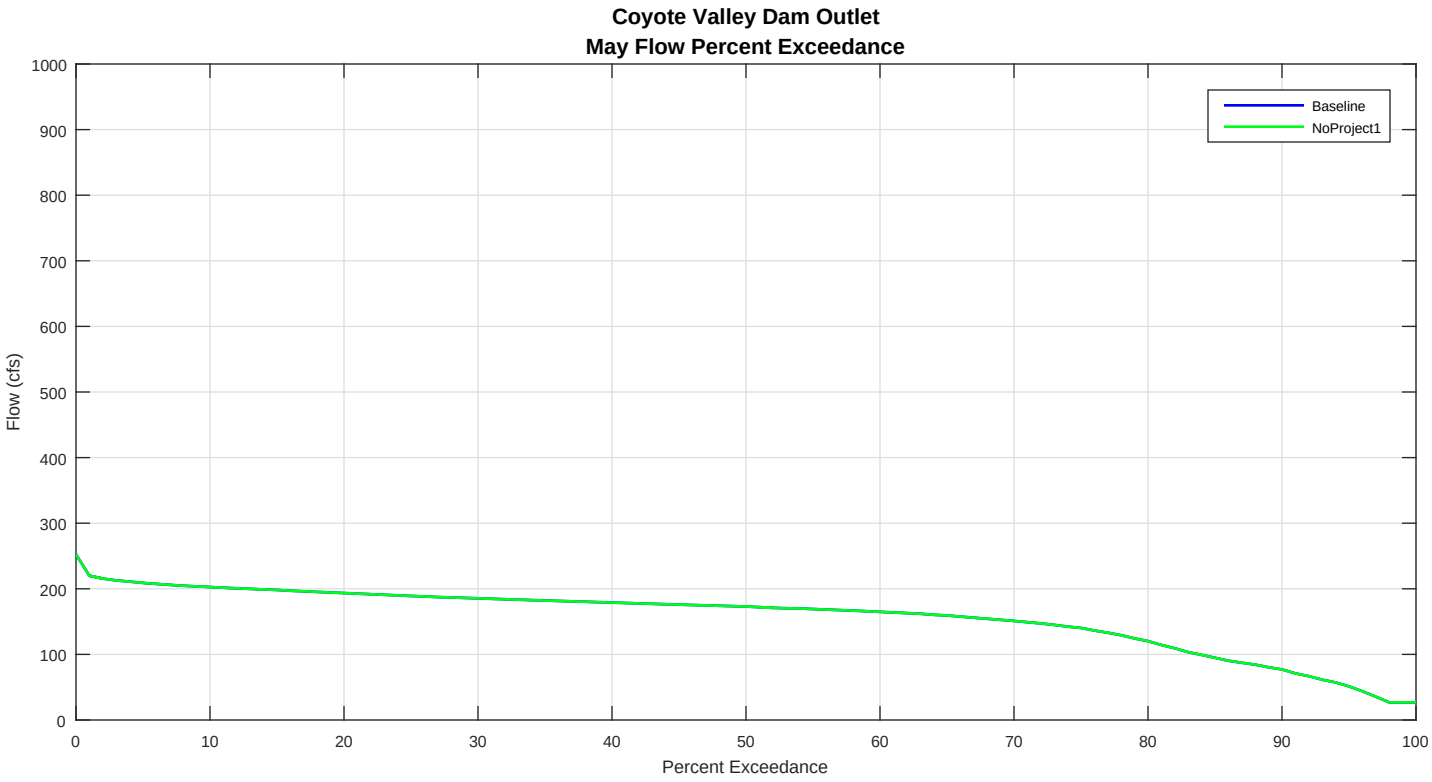

Lake Sonoma
Storage Percent Exceedance
Baseline
NoProject1
Storage (acre-ft)
Percent Exceedance
0
50000
100000
150000
200000
250000
300000
0
10
20
30
40
50
60
70
80
90
100

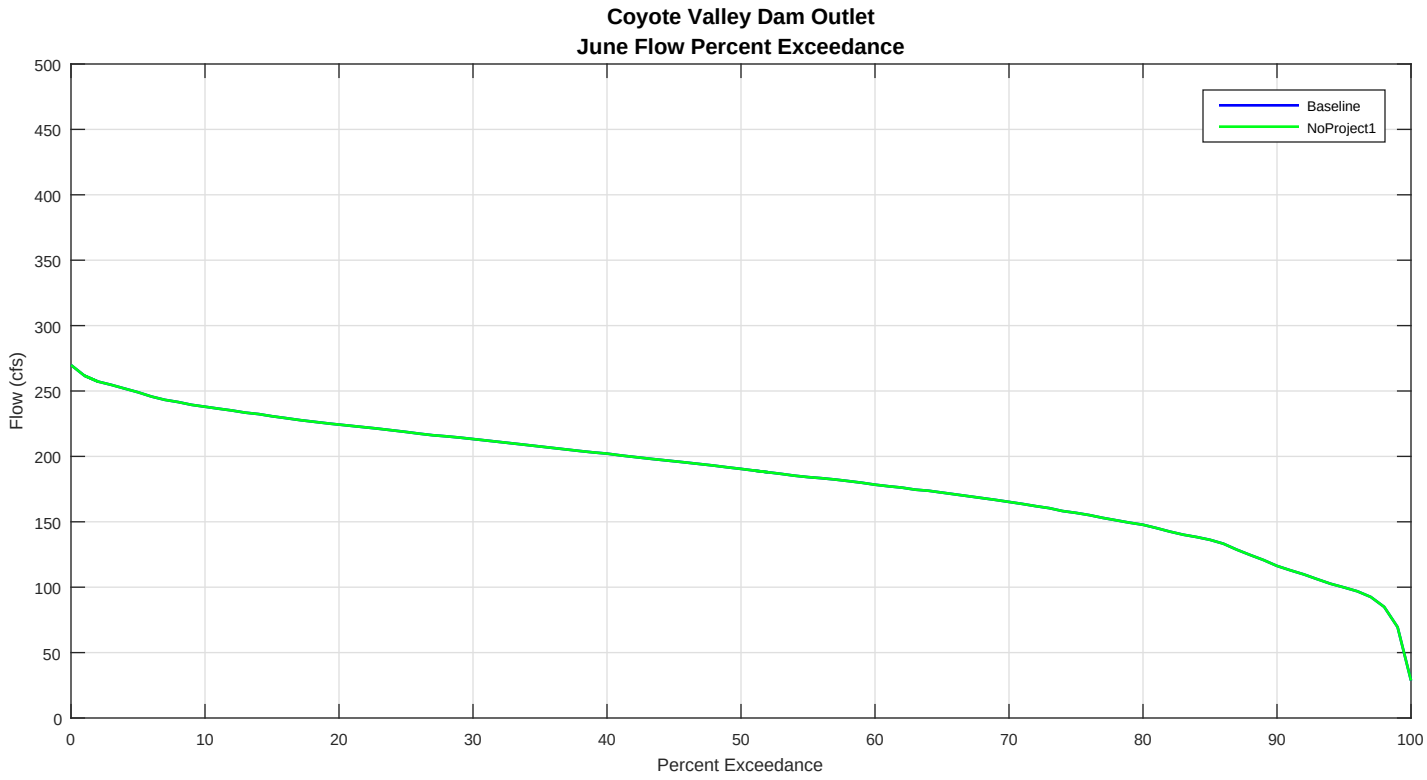

Lake Mendocino
Minimum Water Year Storage Percent Exceedance
Storage (acre-ft)
Percent Exceedance
Baseline
NoProject1
0
20000
40000
60000
80000
100000
120000
0
10
20
30
40
50
60
70
80
90
100

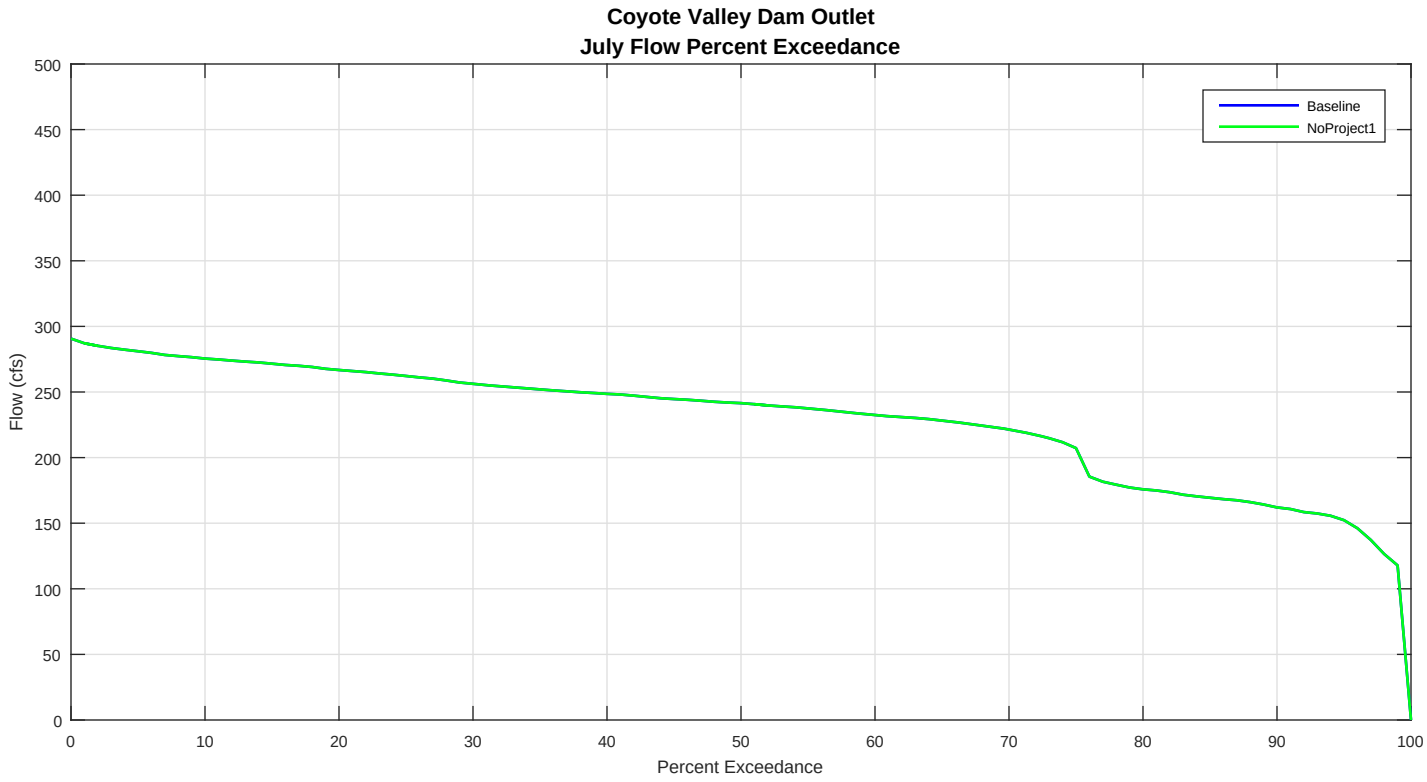

Lake Sonoma
Minimum Water Year Storage Percent Exceedance
Storage (acre-ft)
Percent Exceedance
Baseline
NoProject1
0
50000
100000
150000
200000
250000
300000
0
10
20
30
40
50
60
70
80
90
100

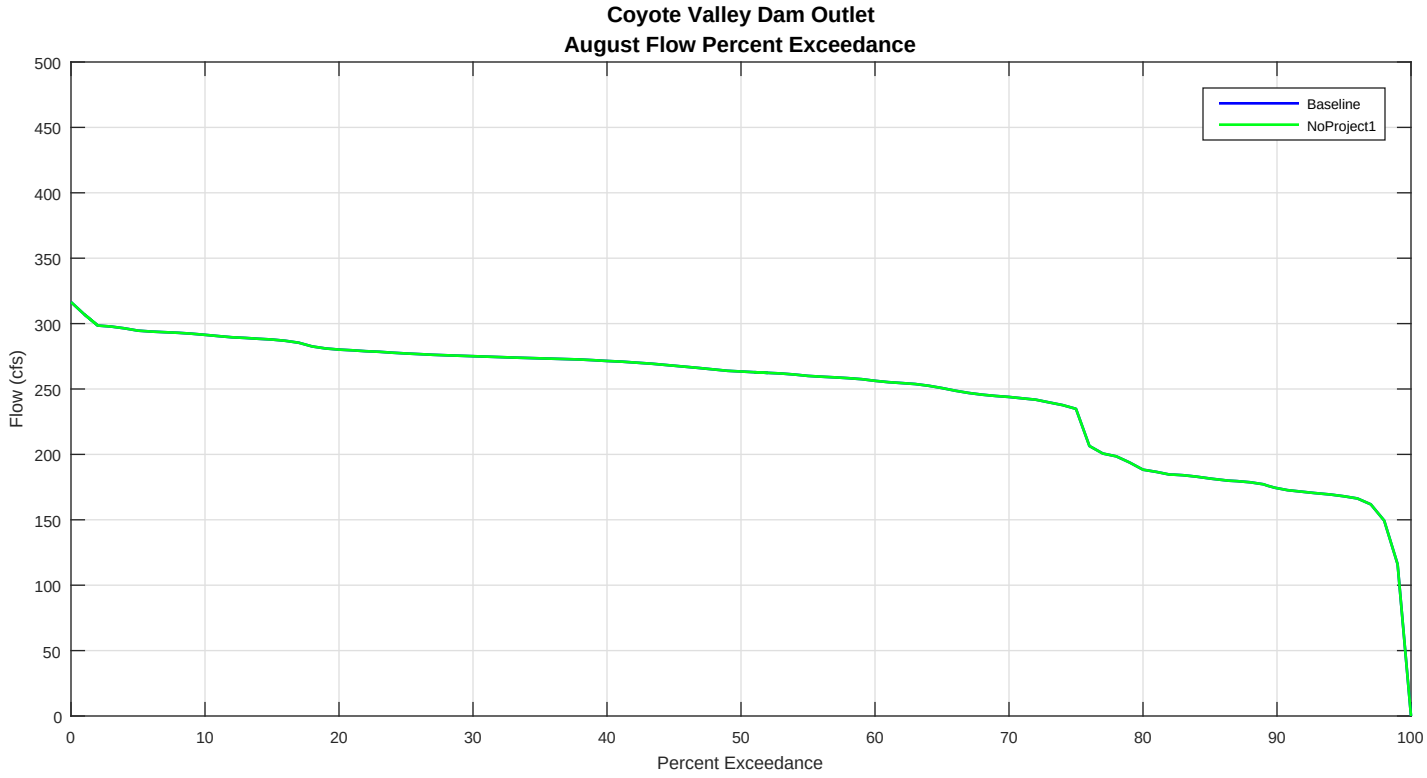

Coyote Valley Dam Outlet
March Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
500
1000
1500
2000
2500
3000
3500
4000
0
10
20
30
40
50
60
70
80
90
100

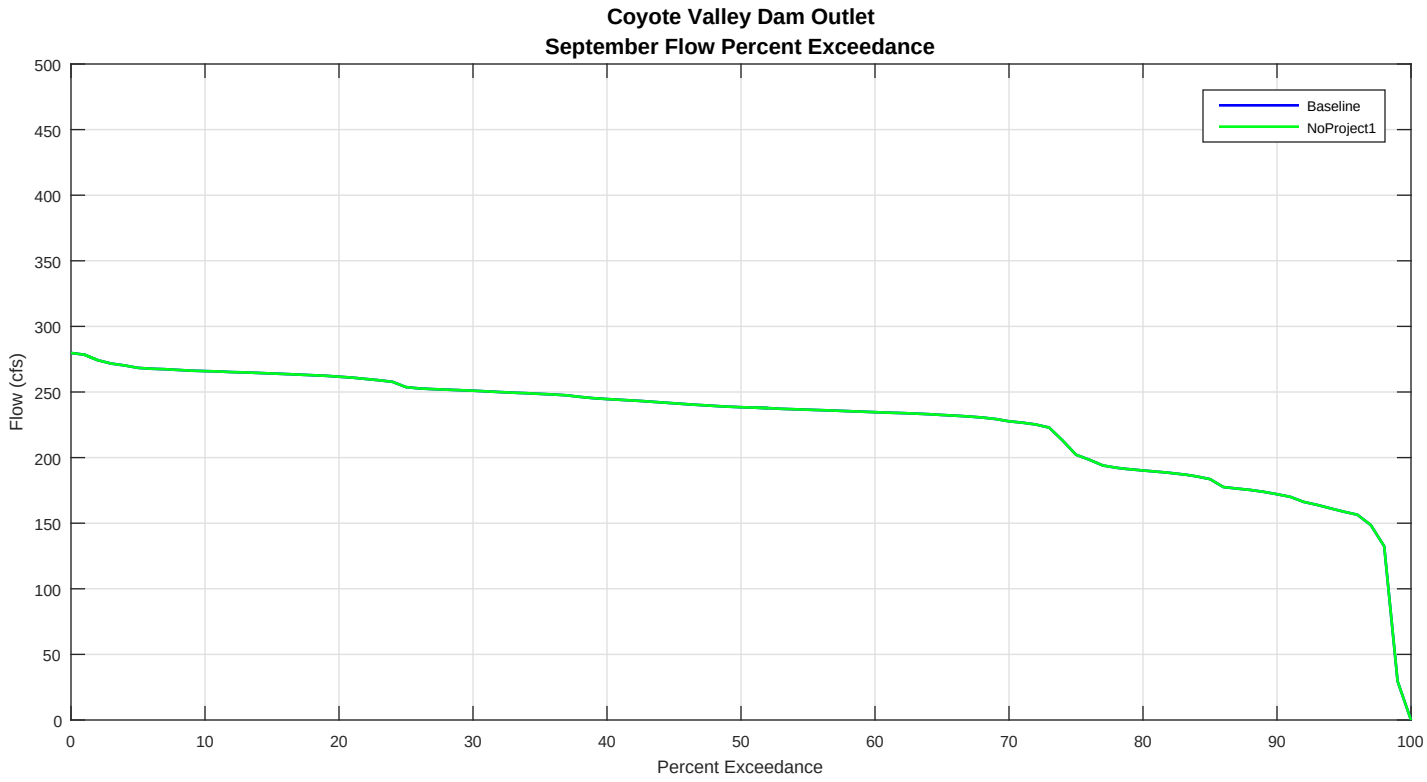

Coyote Valley Dam Outlet
April Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100

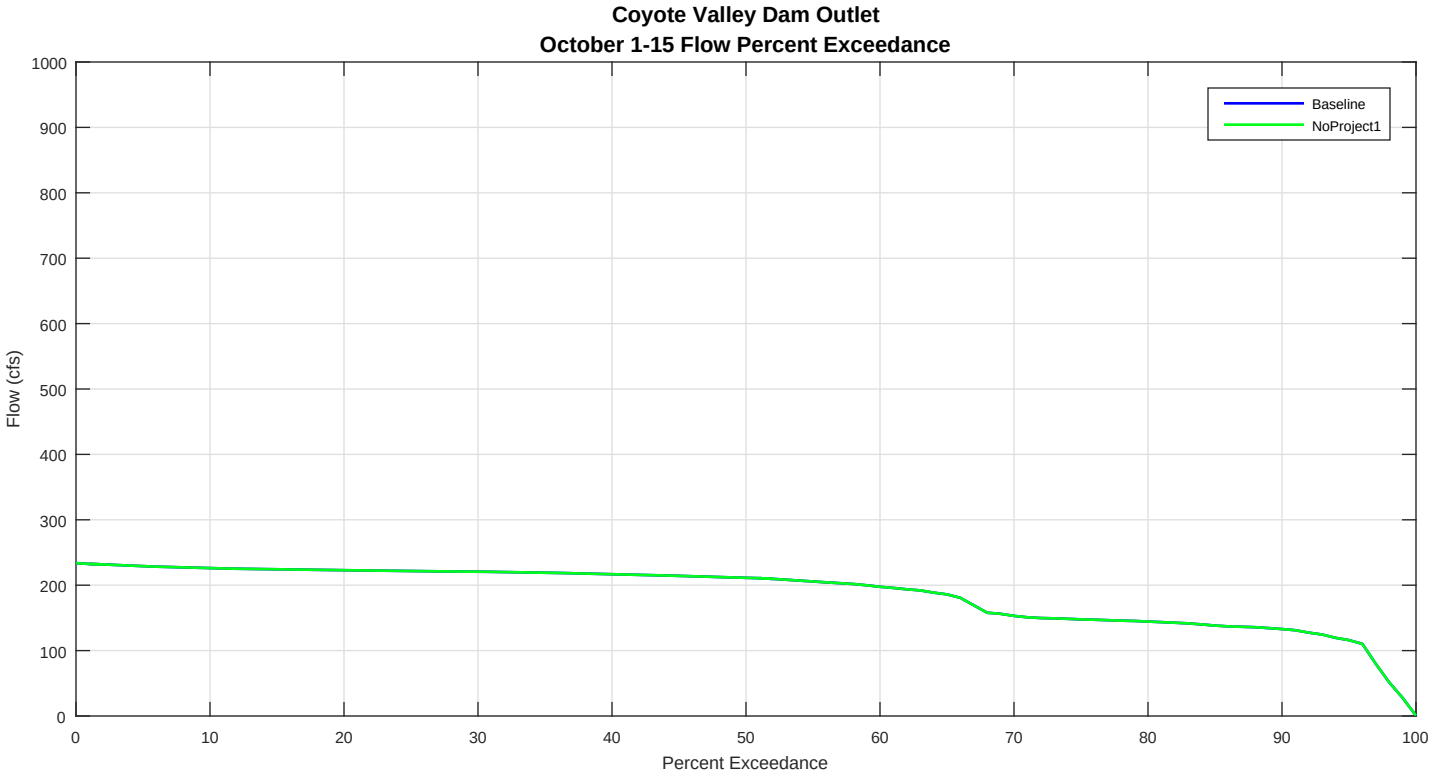

Coyote Valley Dam Outlet
May Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100

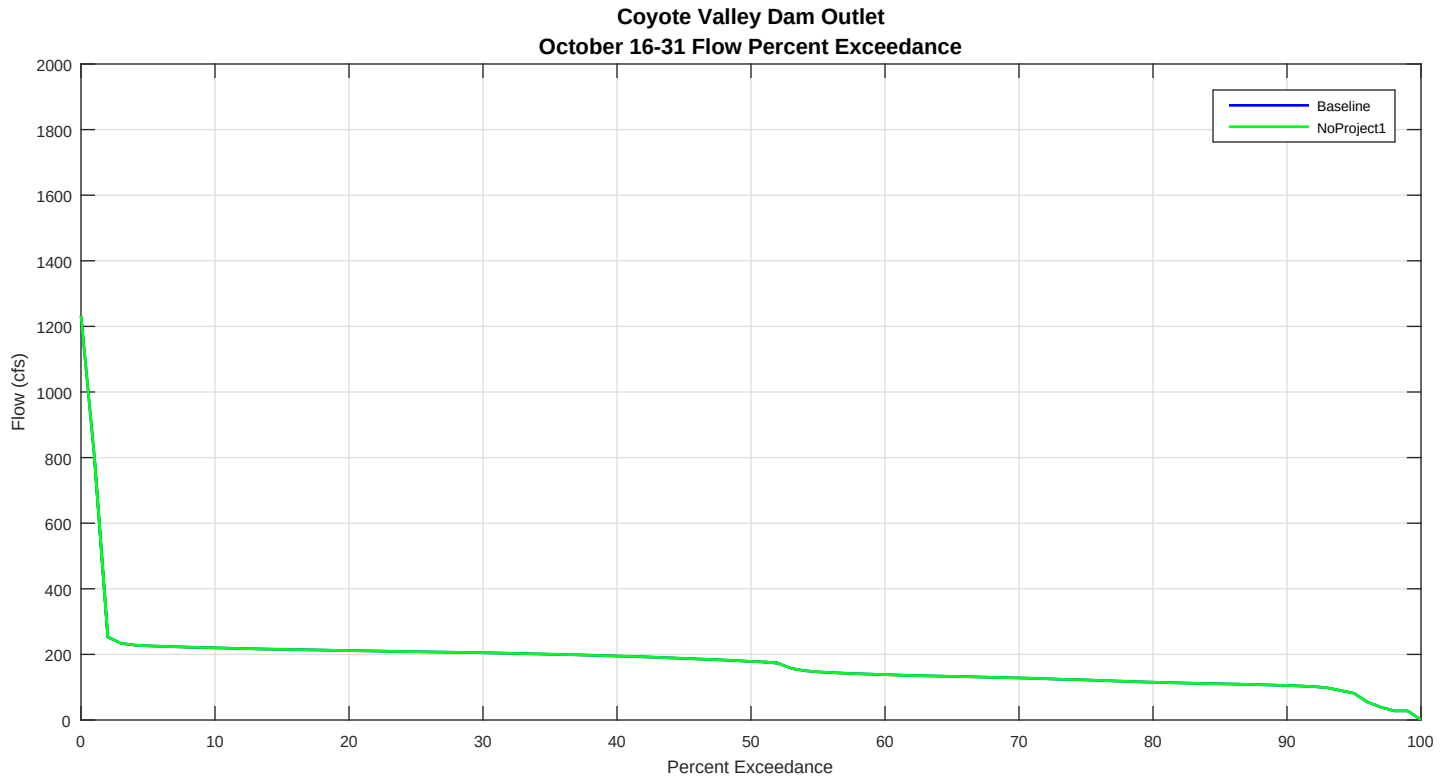

Coyote Valley Dam Outlet
June Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

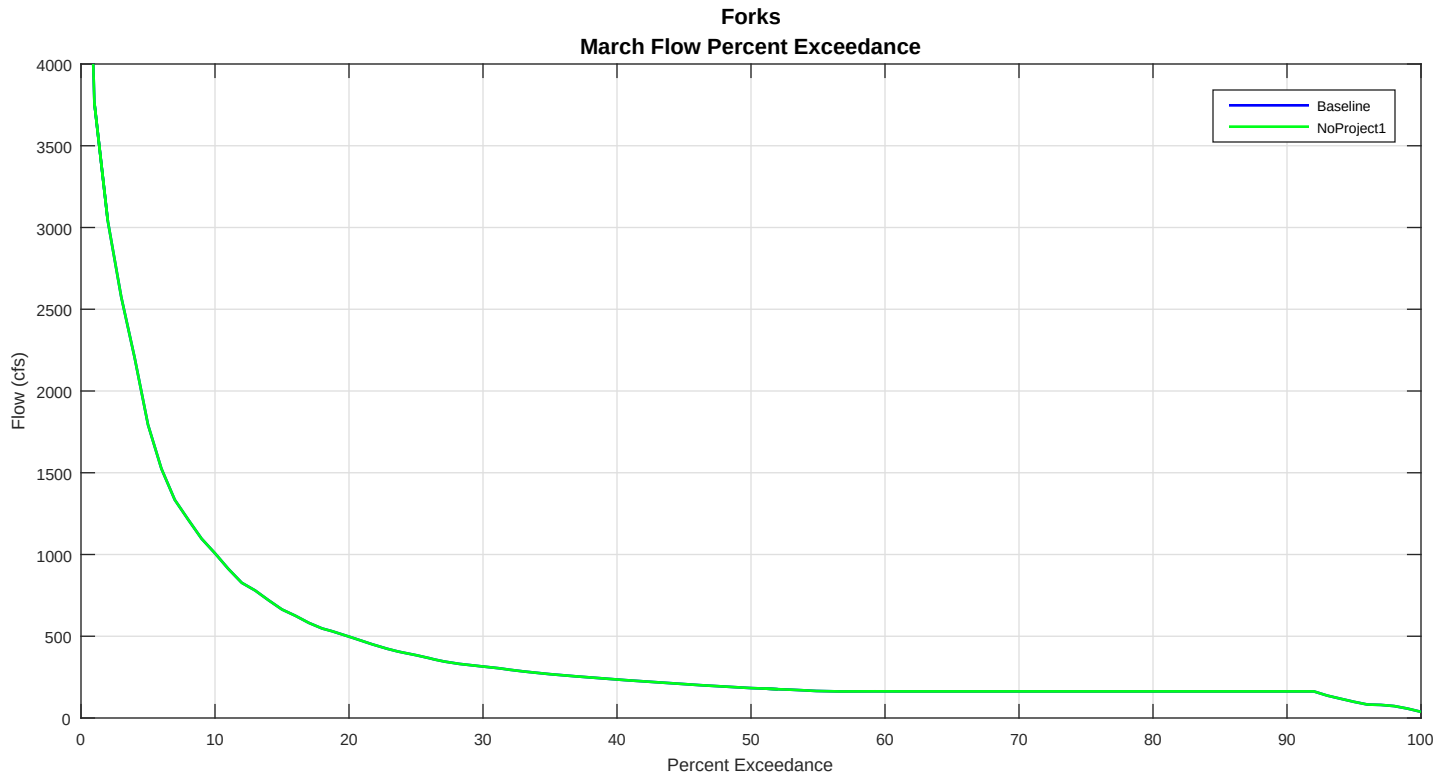

Coyote Valley Dam Outlet
July Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

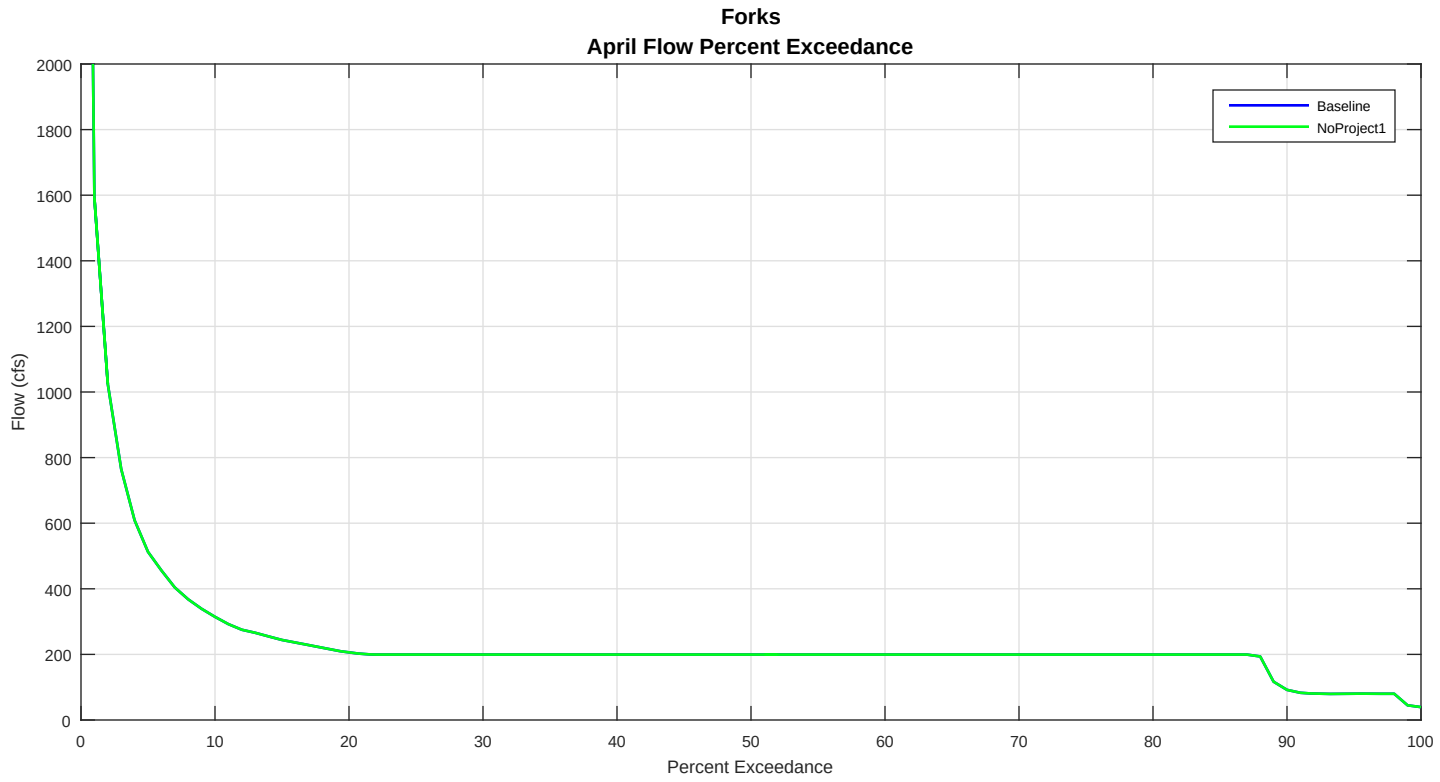

Coyote Valley Dam Outlet
August Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

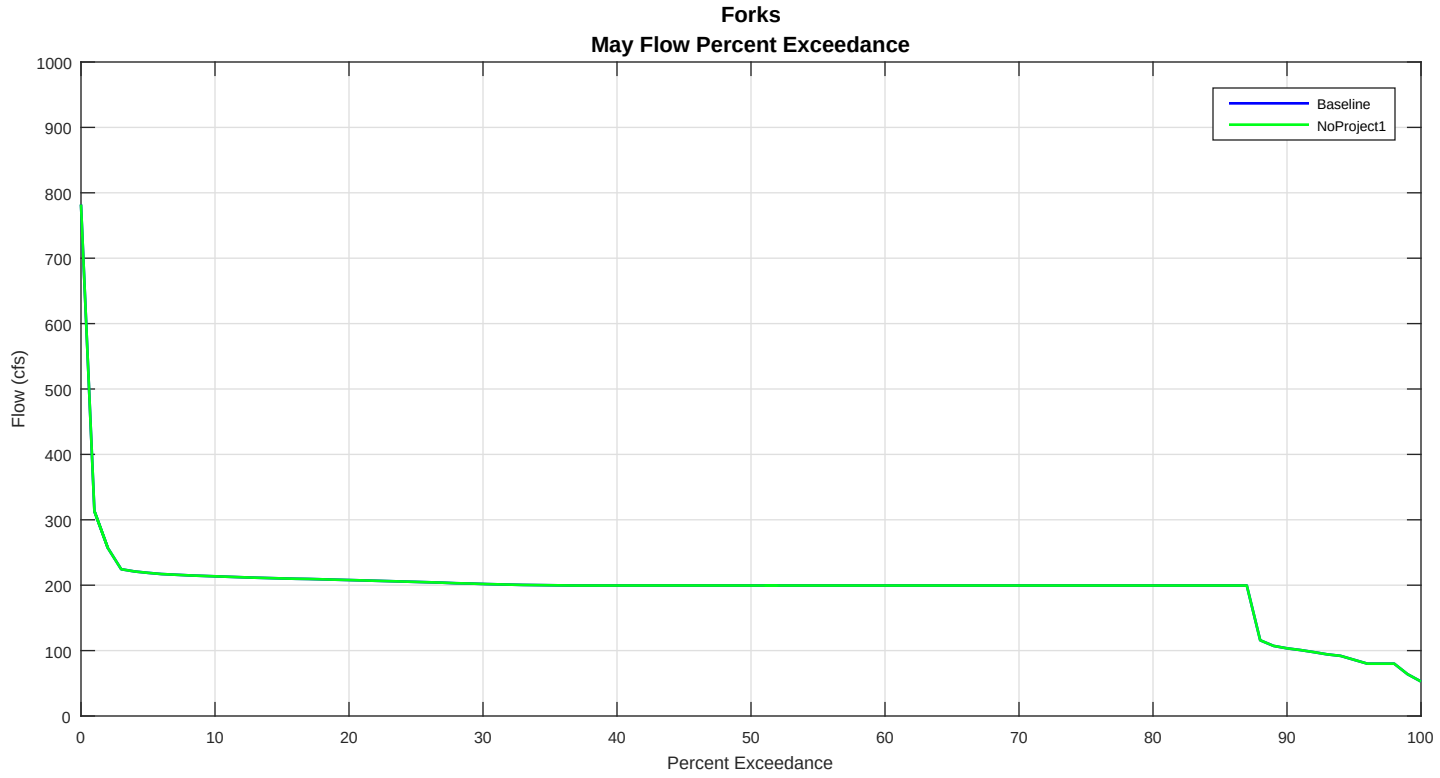

Coyote Valley Dam Outlet
September Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

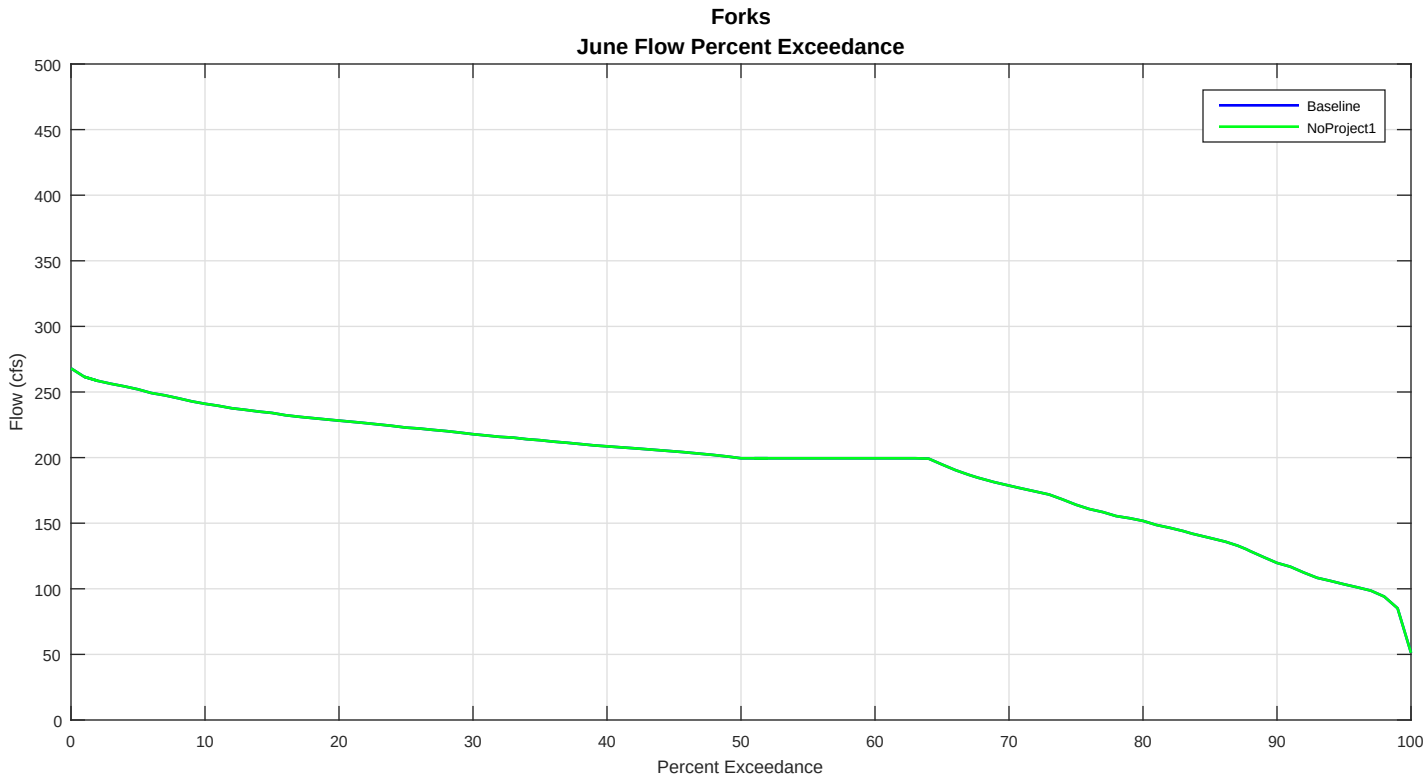

Coyote Valley Dam Outlet
October 1-15 Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100

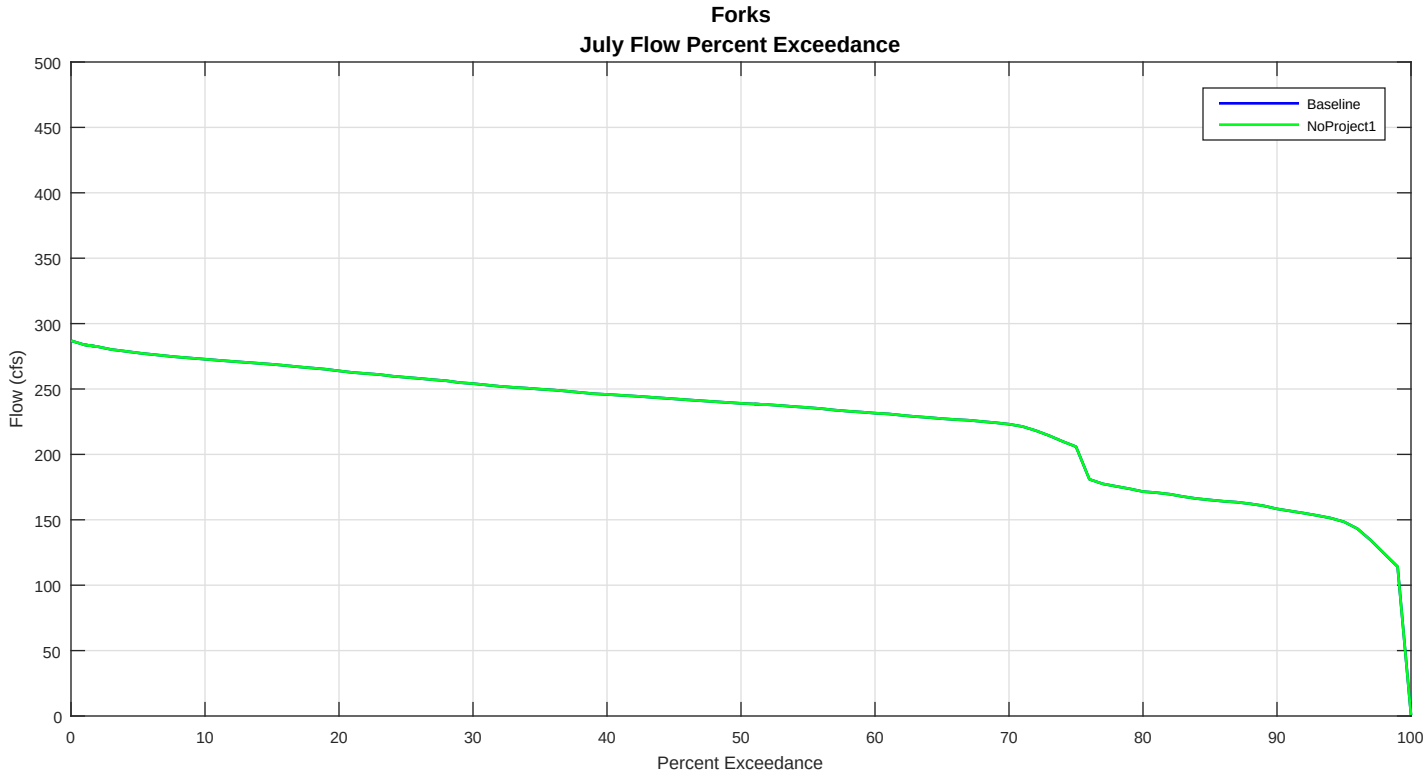

Coyote Valley Dam Outlet
October 16-31 Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100

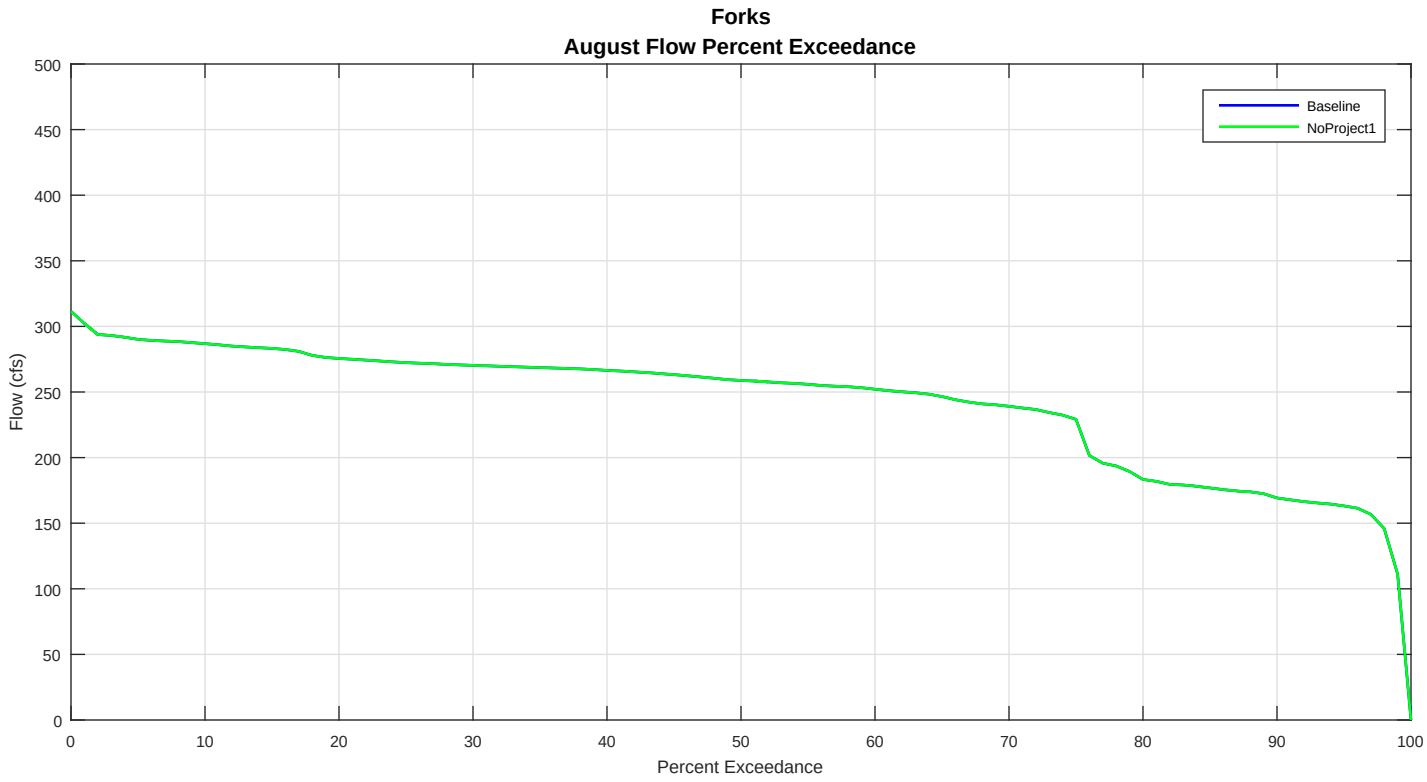

Forks
March Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
500
1000
1500
2000
2500
3000
3500
4000
0
10
20
30
40
50
60
70
80
90
100

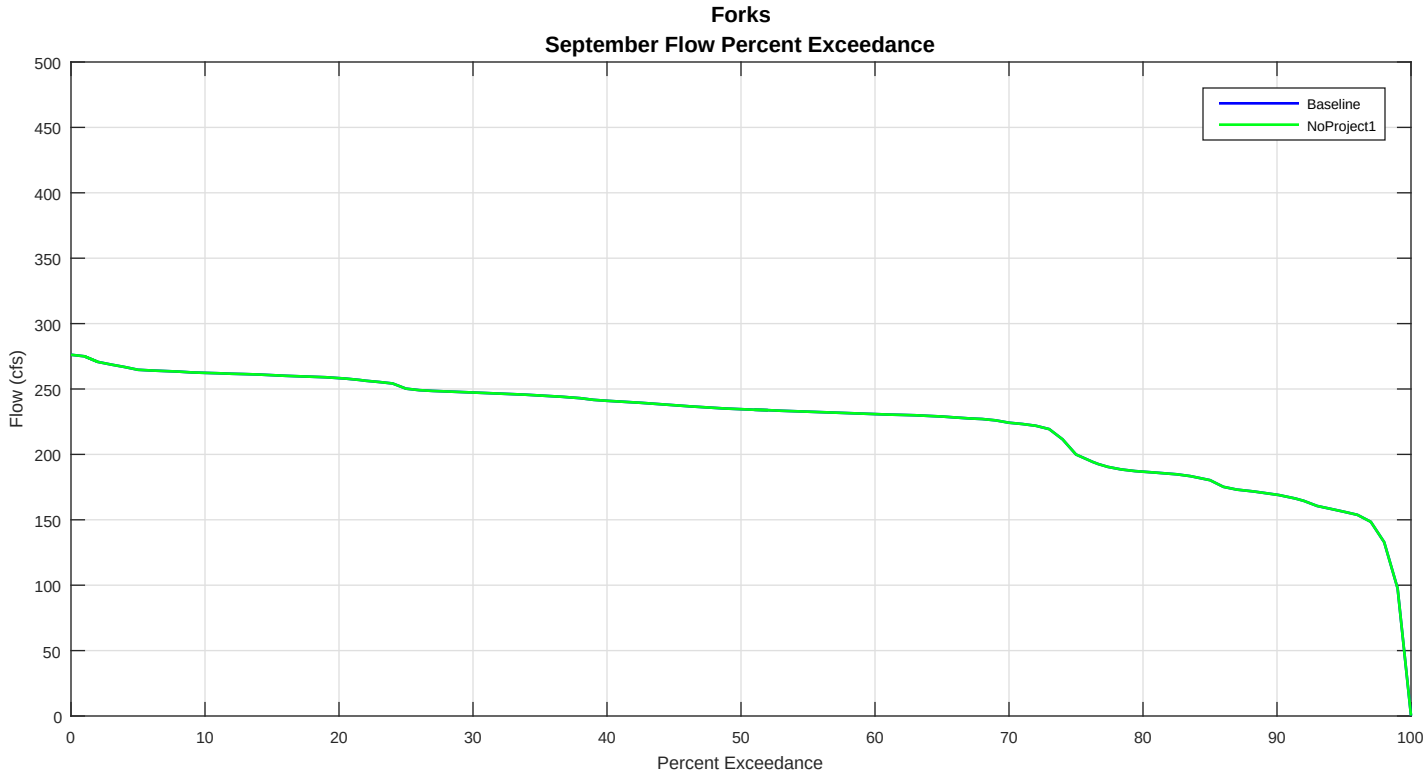

Forks
April Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100

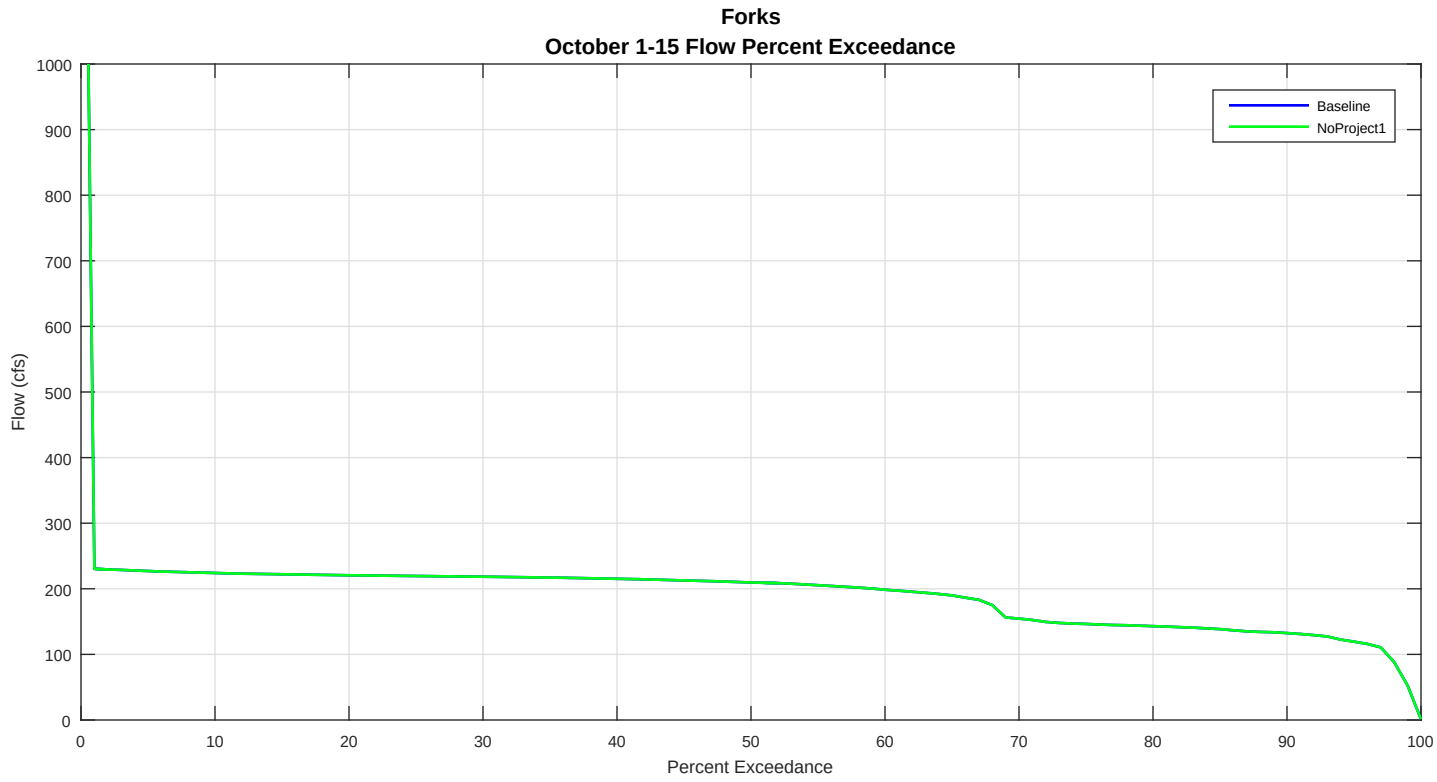

Forks
May Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100

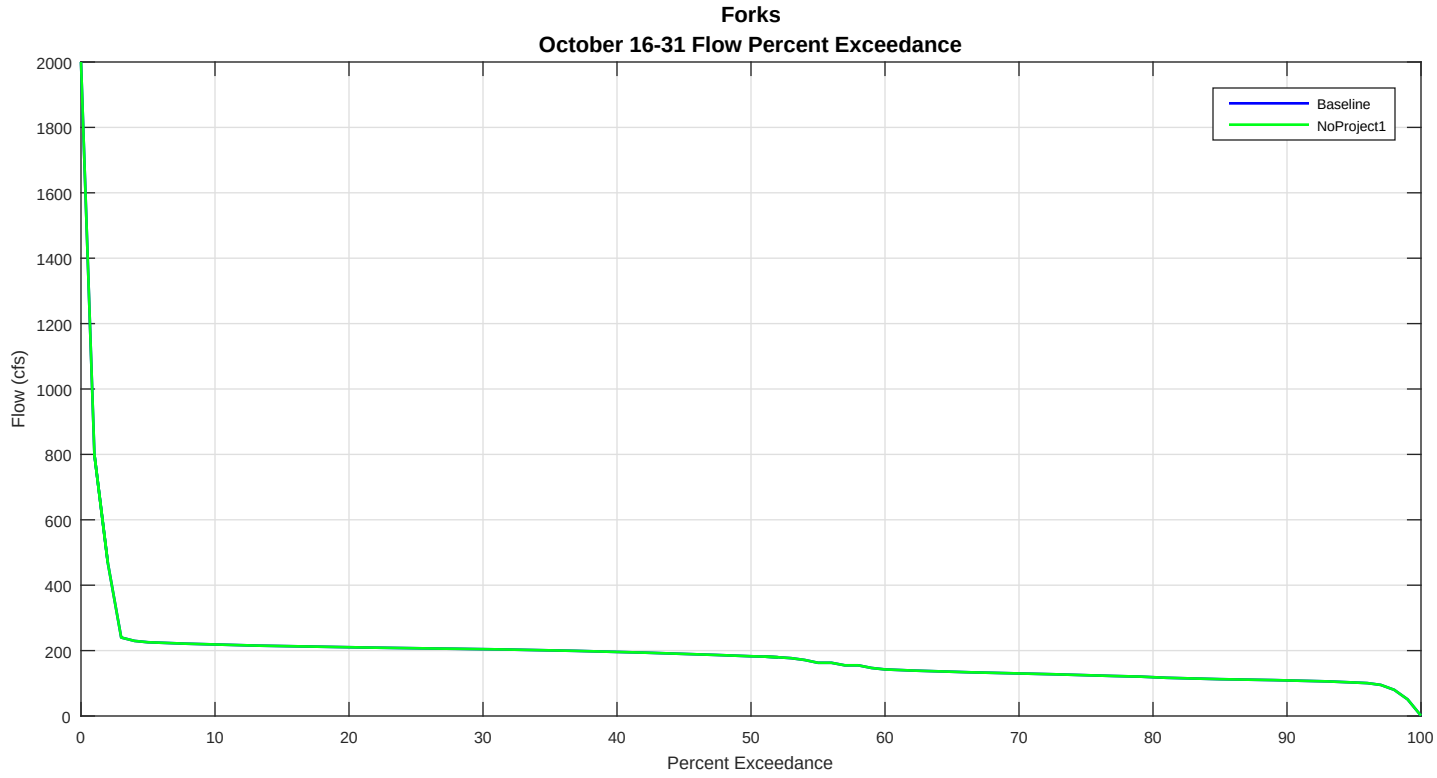

Forks
June Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

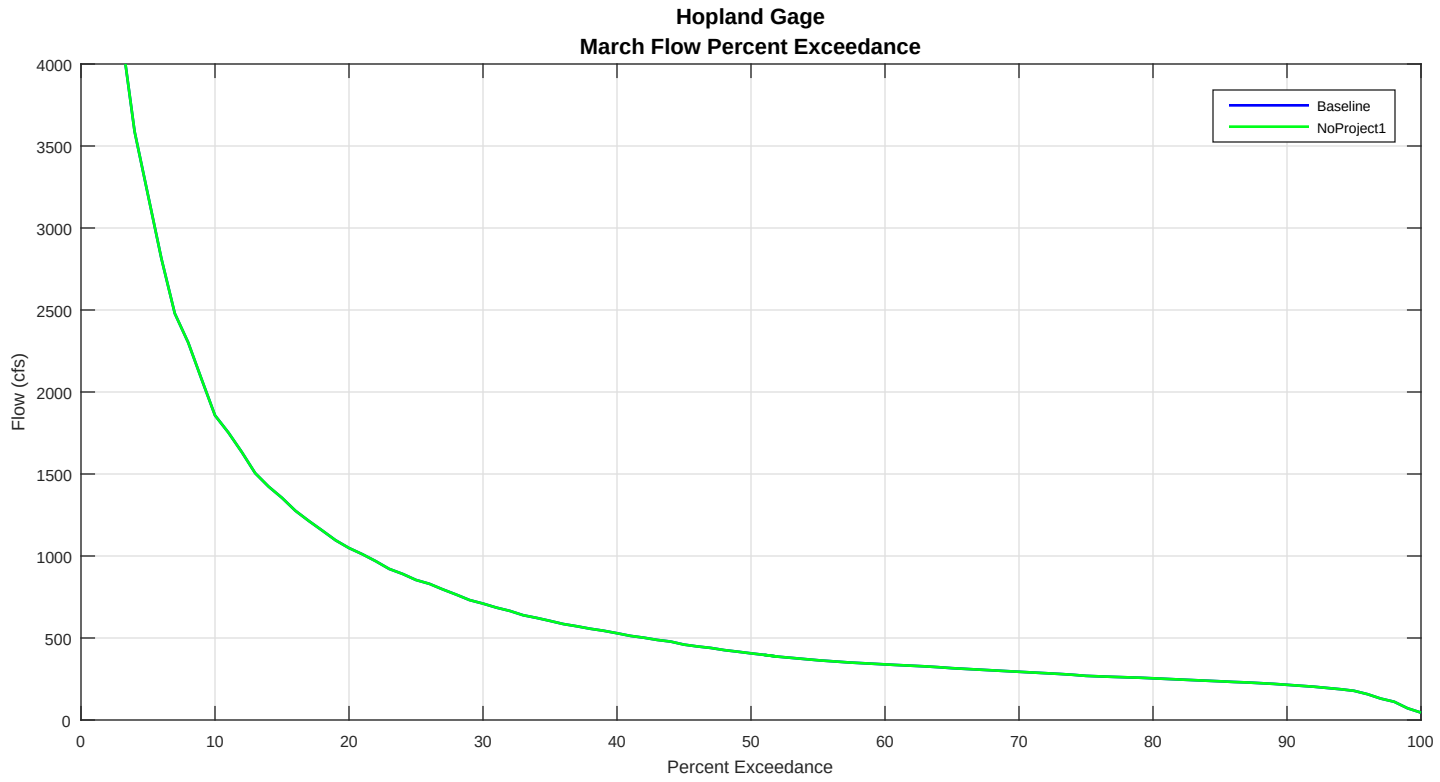

Forks
July Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

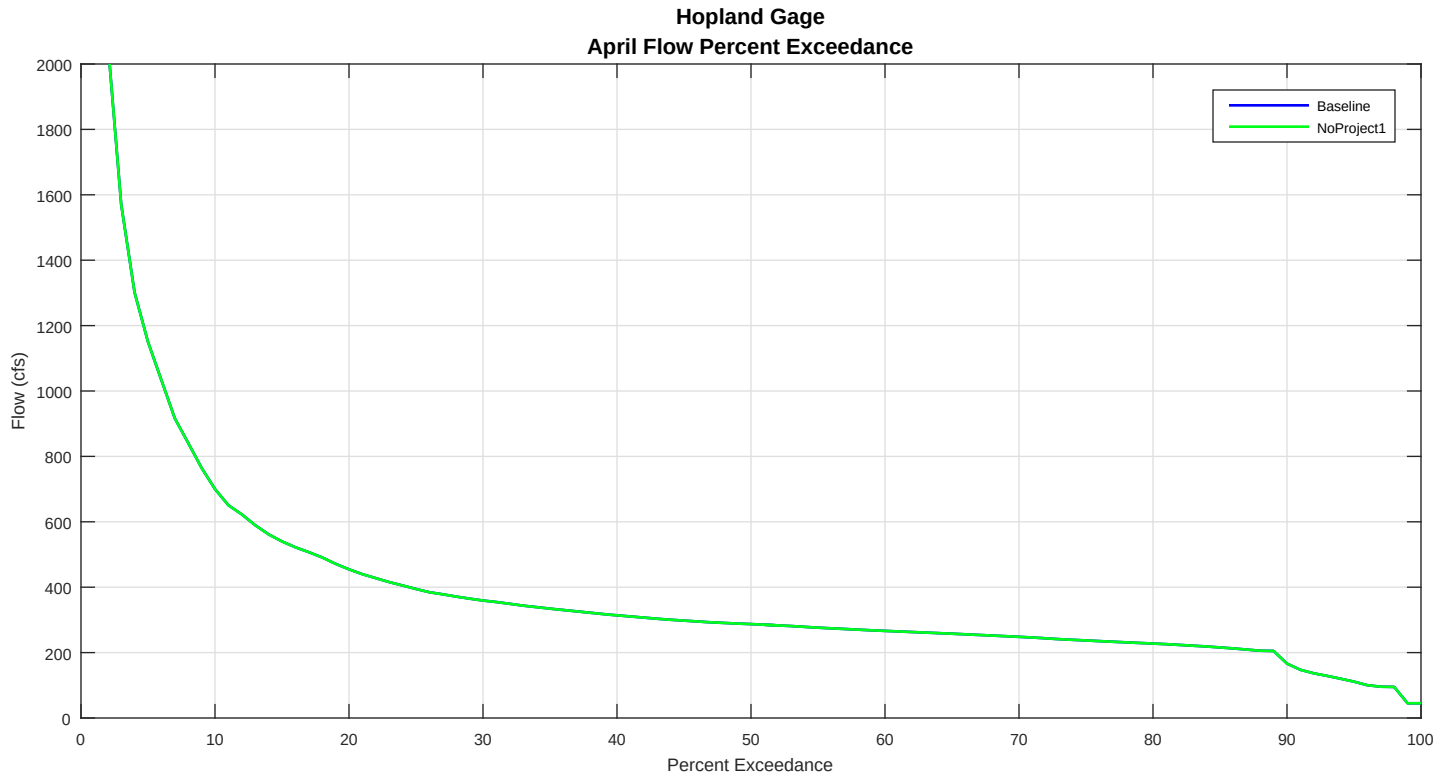

Forks
August Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

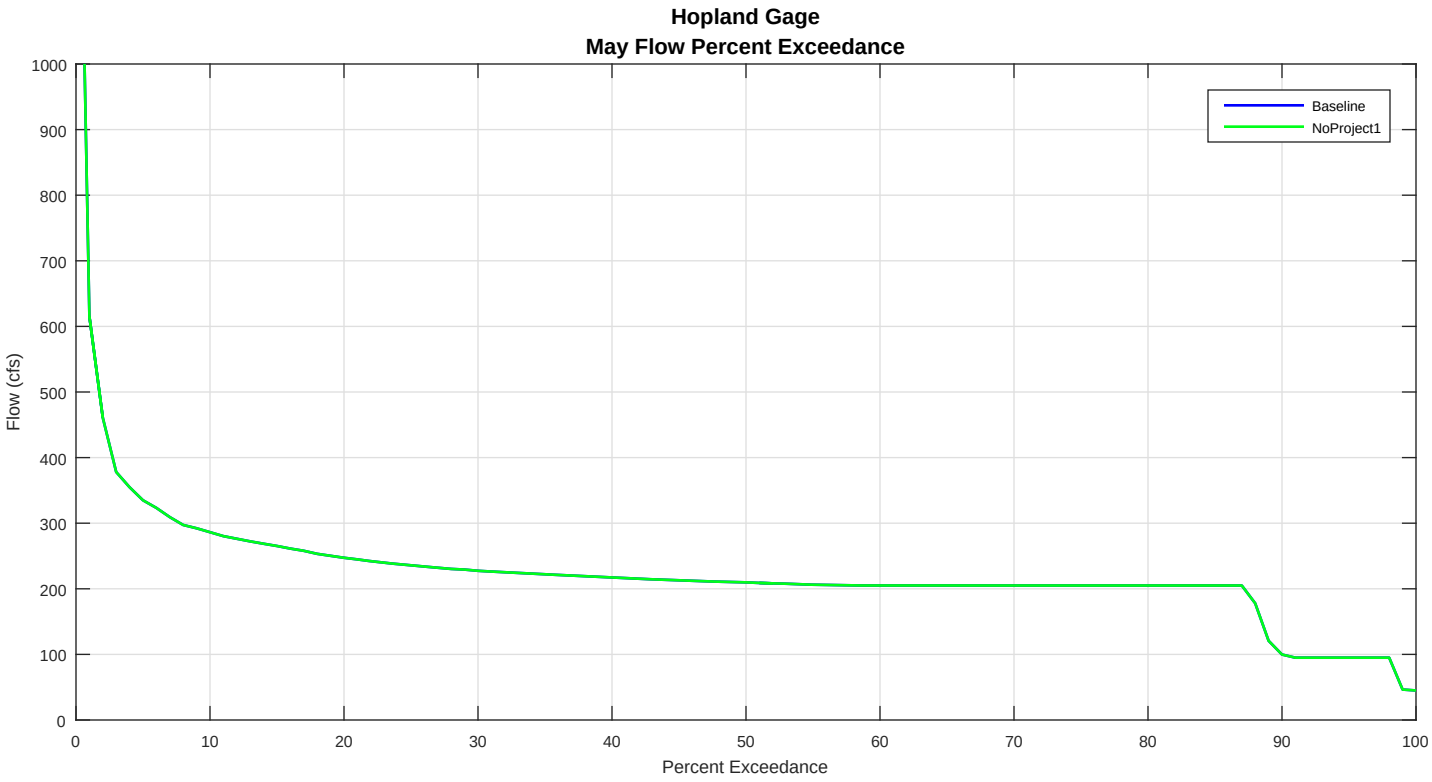

Forks
September Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100


Forks
October 1-15 Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100


Forks
October 16-31 Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100


Hopland Gage
March Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
500
1000
1500
2000
2500
3000
3500
4000
0
10
20
30
40
50
60
70
80
90
100


Hopland Gage
April Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100


Hopland Gage
May Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
100
200
300
400
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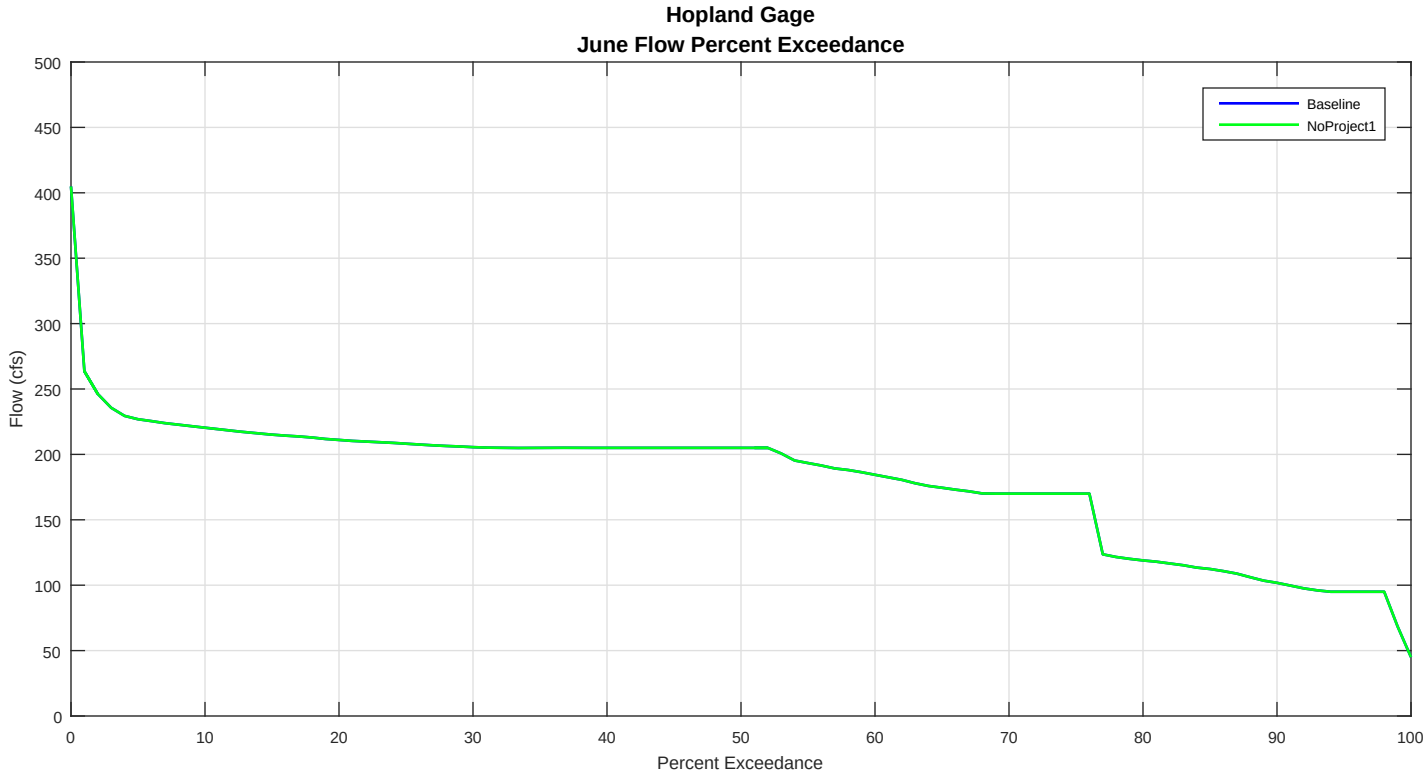
Hopland Gage
June Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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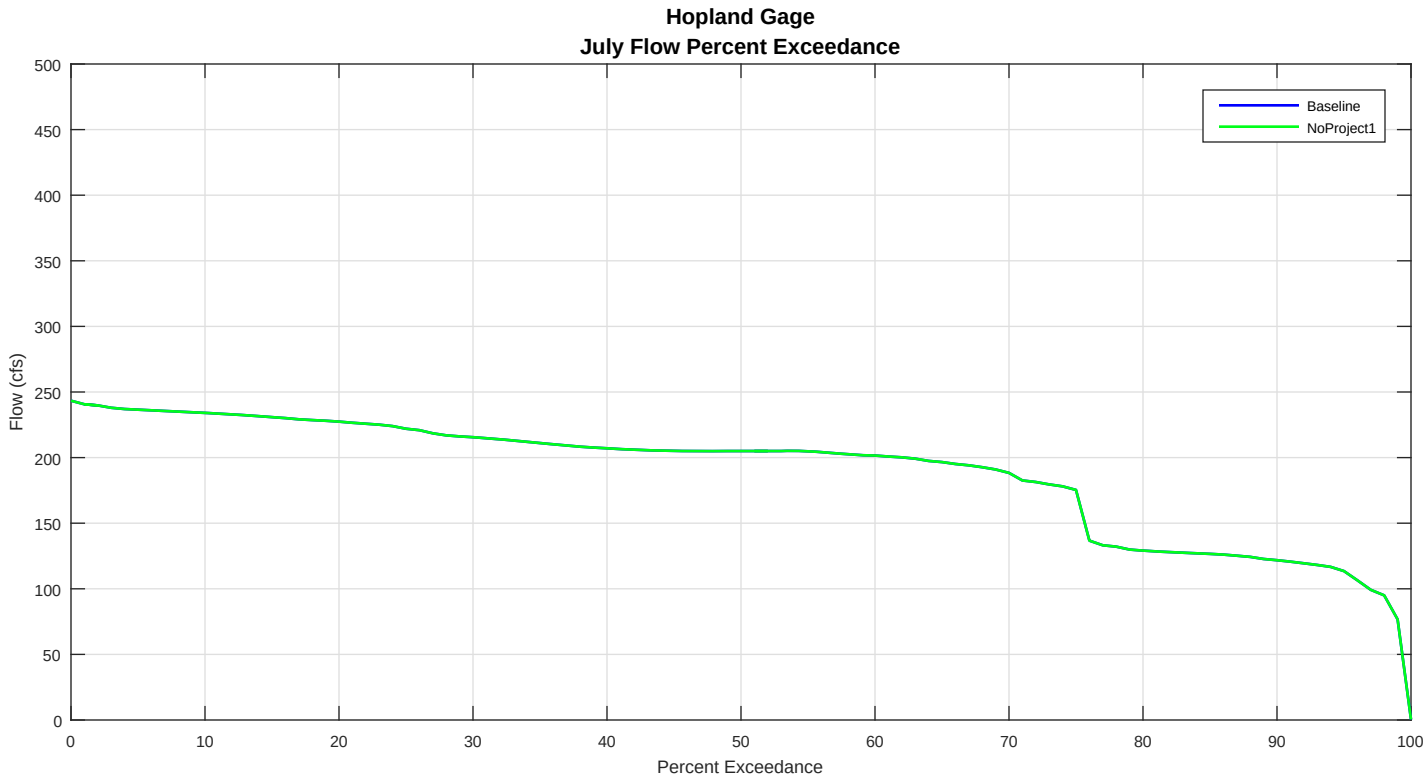
Hopland Gage
July Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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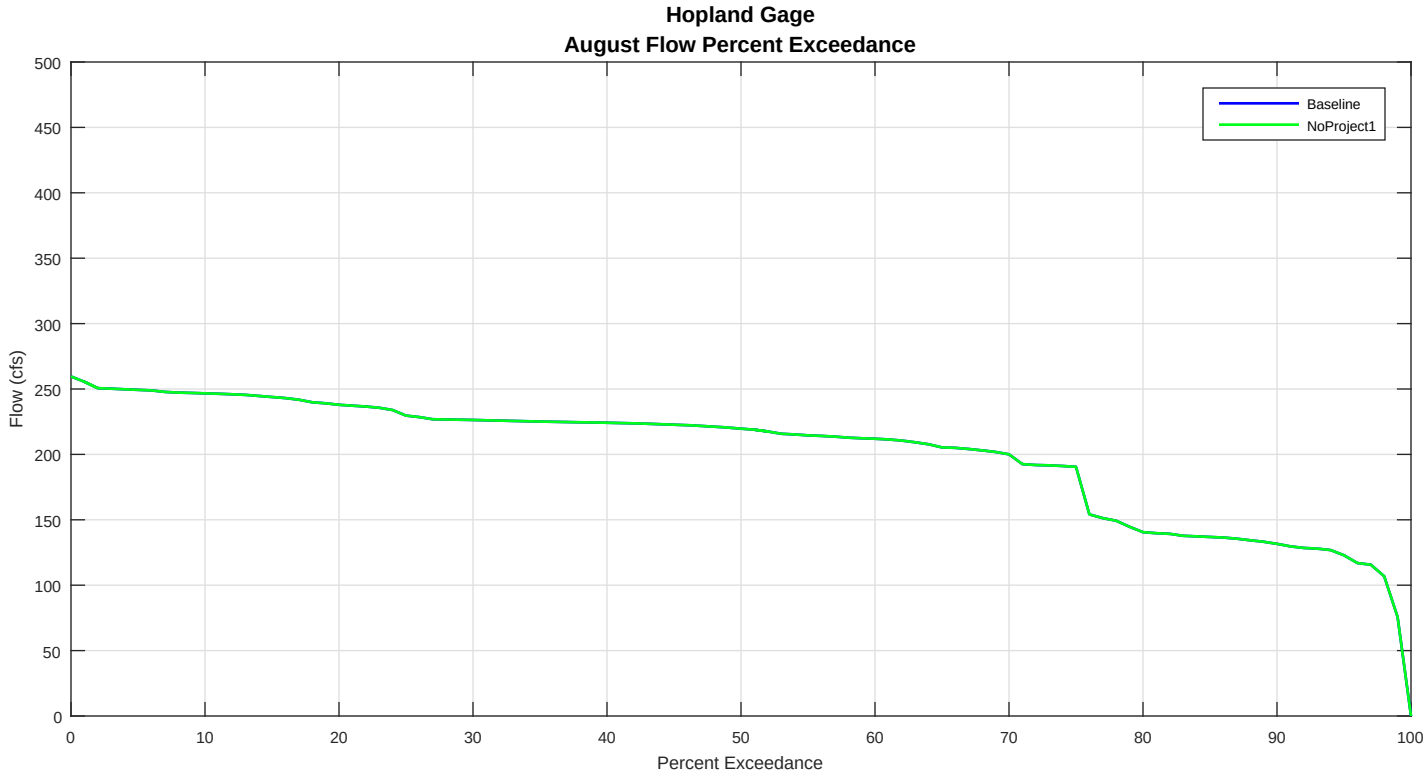
Hopland Gage
August Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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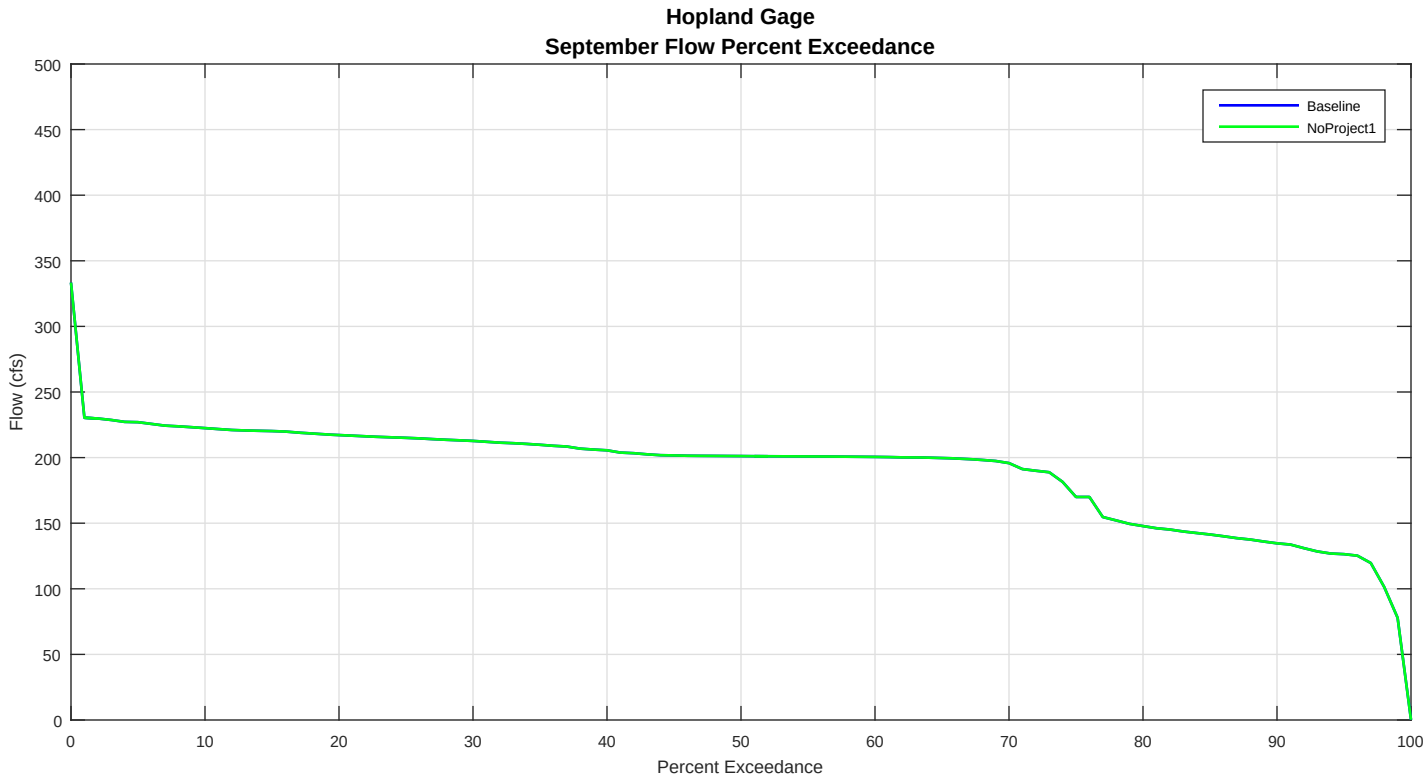
Hopland Gage
September Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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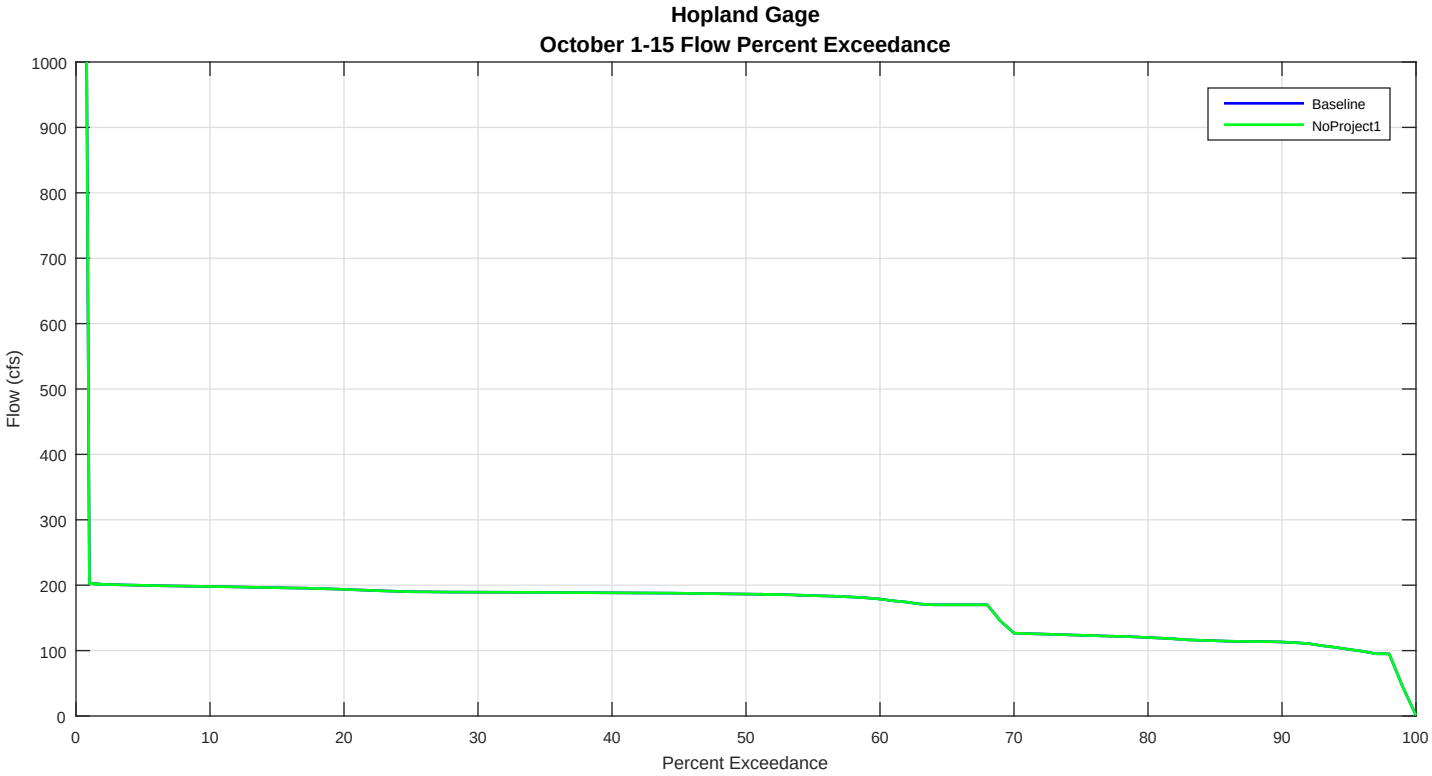
Hopland Gage
October 1-15 Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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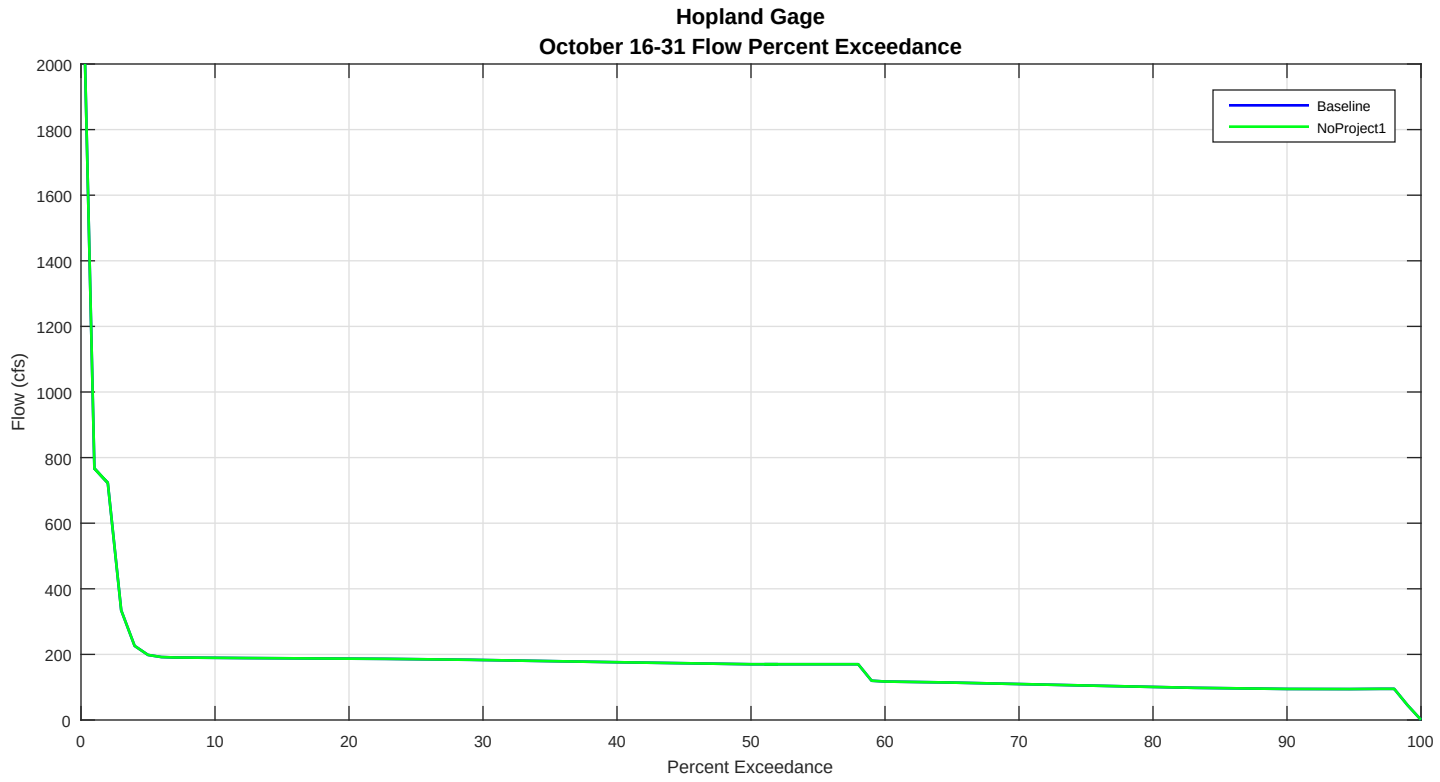
Hopland Gage
October 16-31 Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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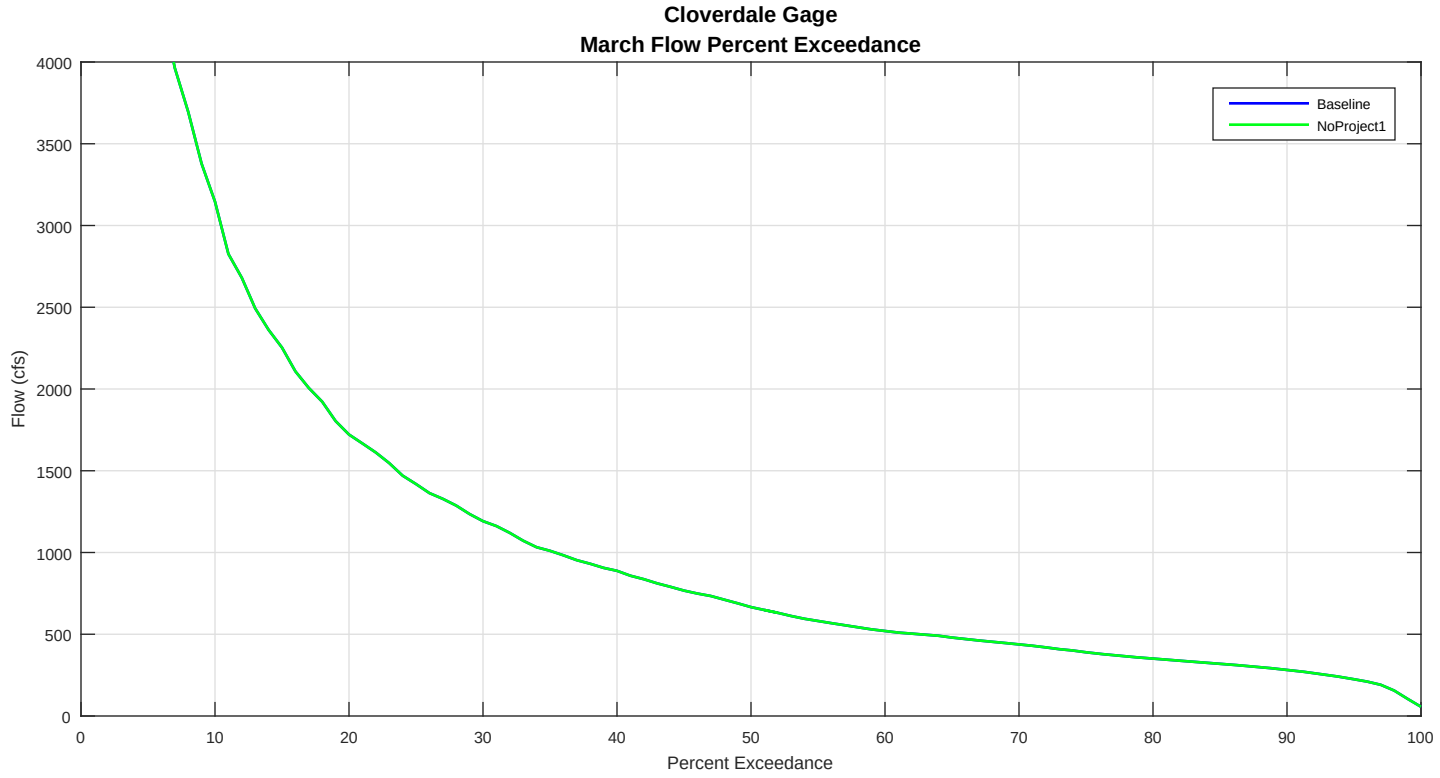
Cloverdale Gage
March Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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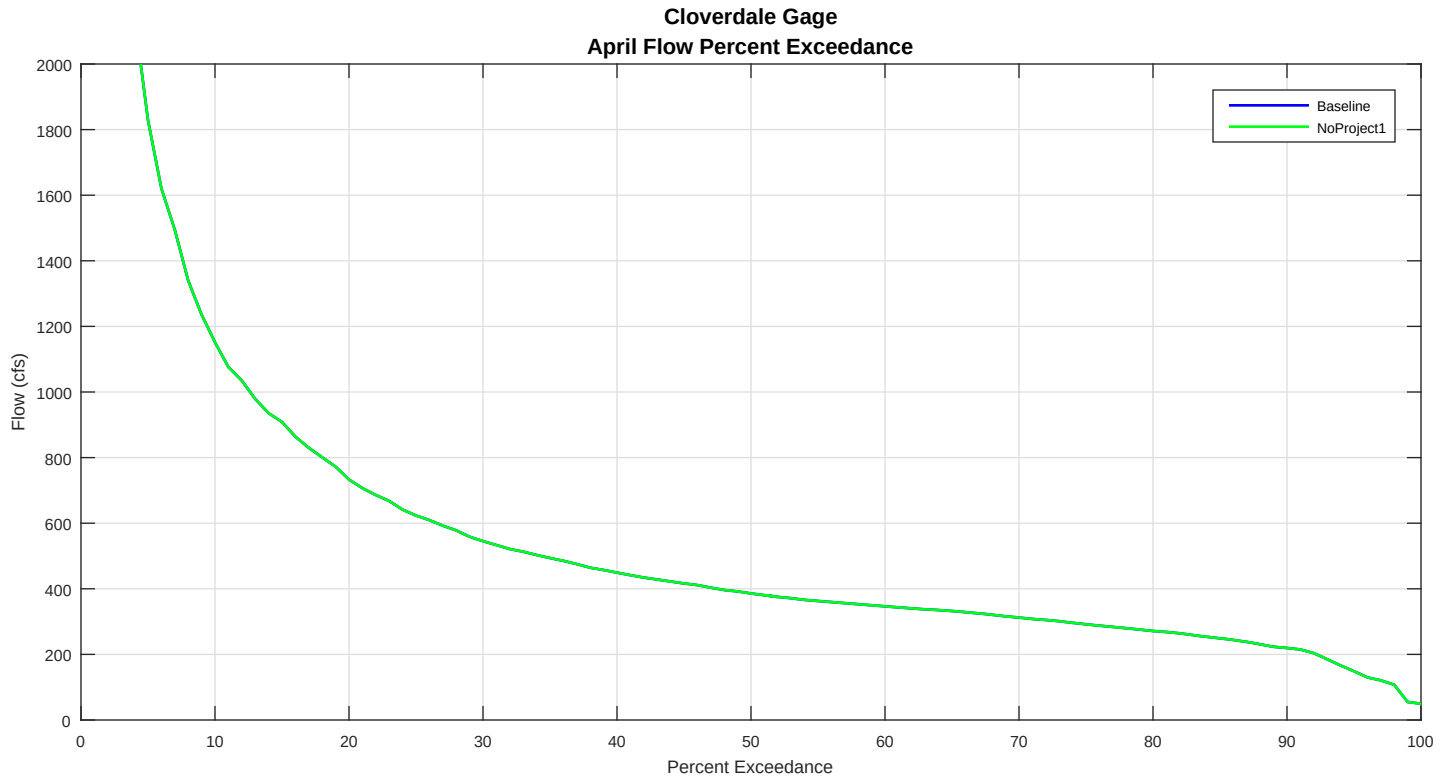
Cloverdale Gage
April Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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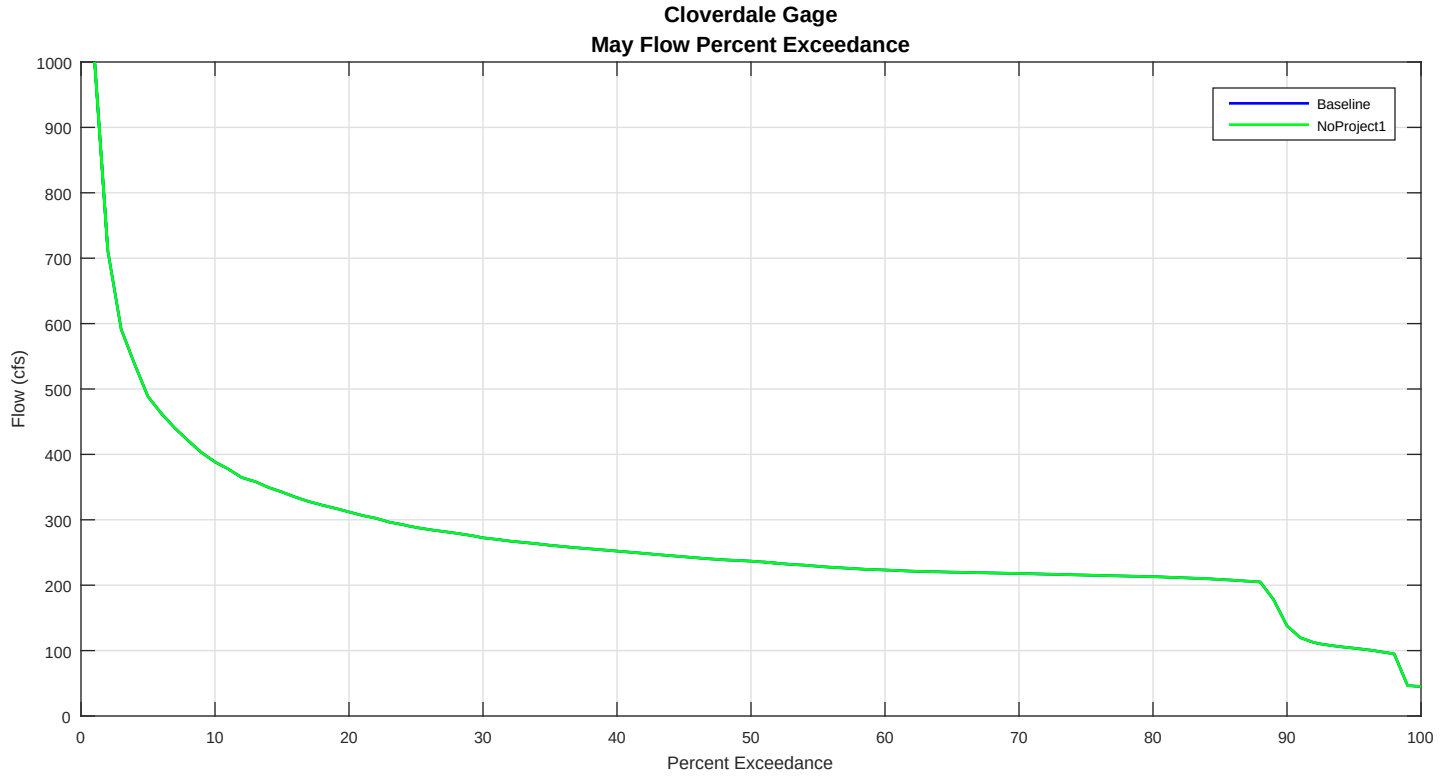
Cloverdale Gage
May Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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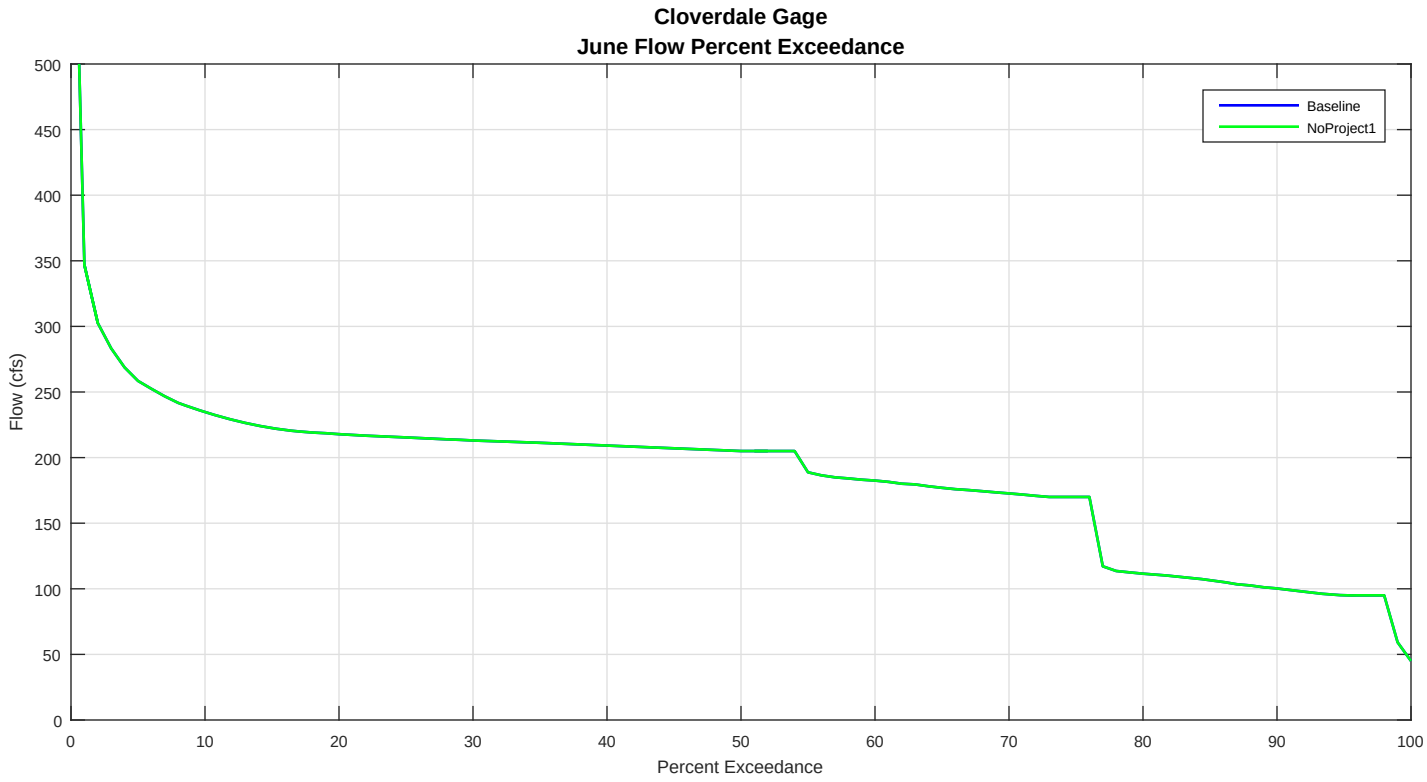
Cloverdale Gage
June Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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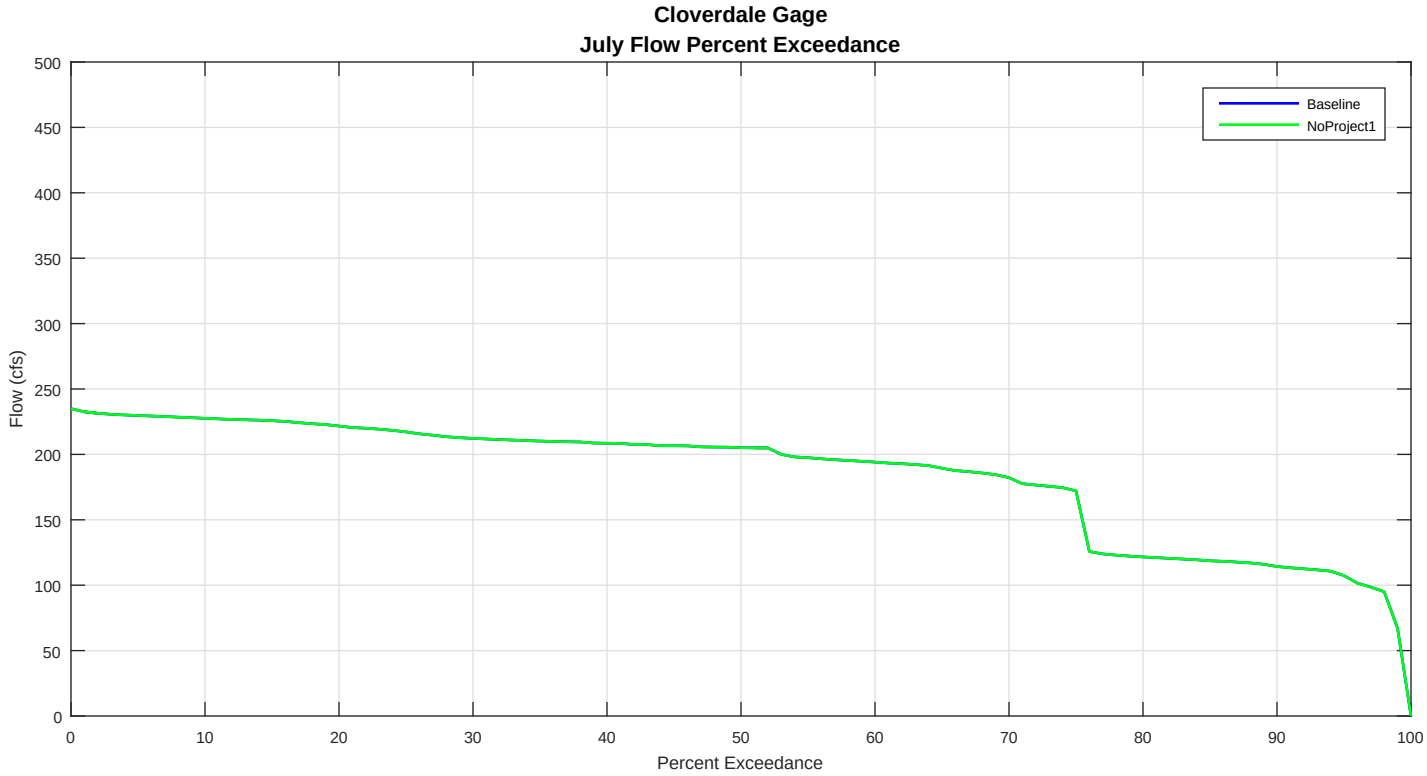
Cloverdale Gage
July Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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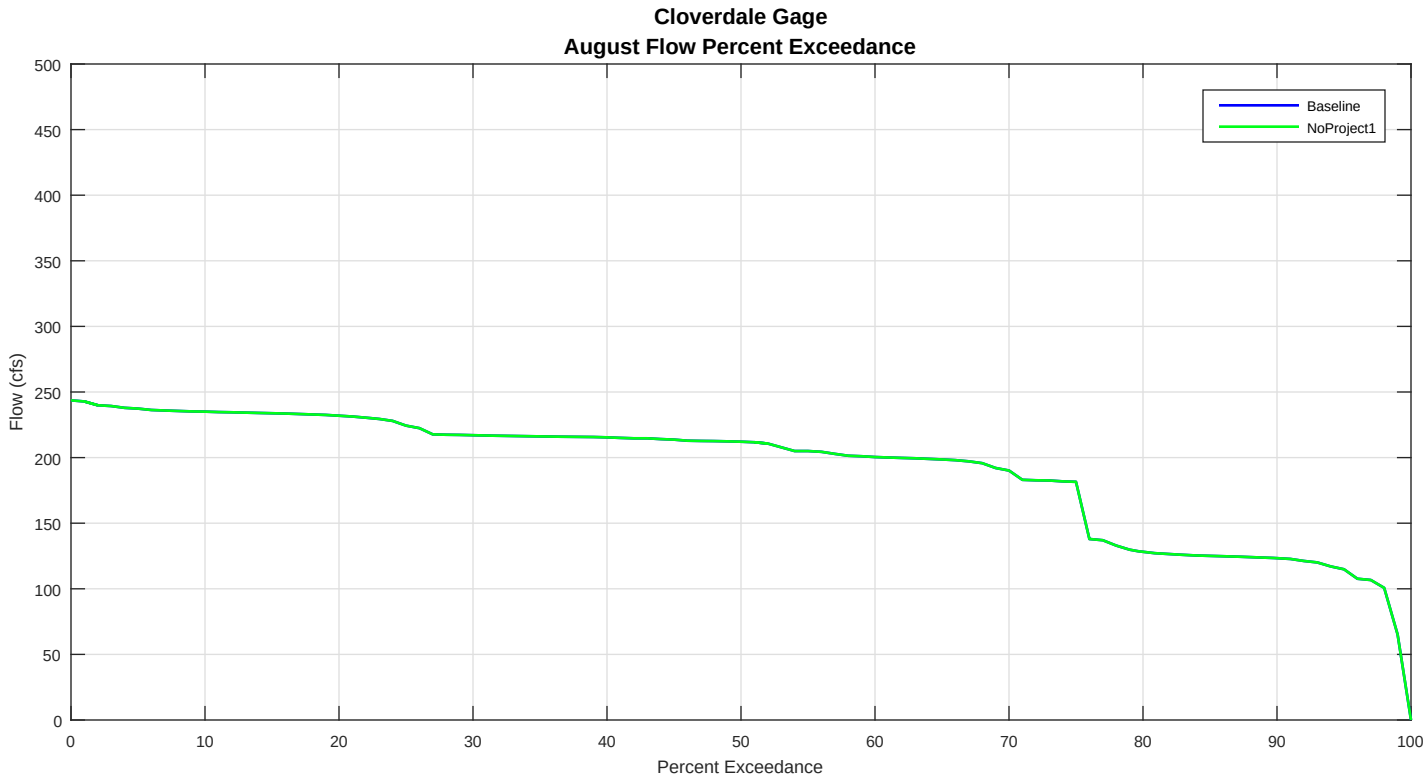
Cloverdale Gage
August Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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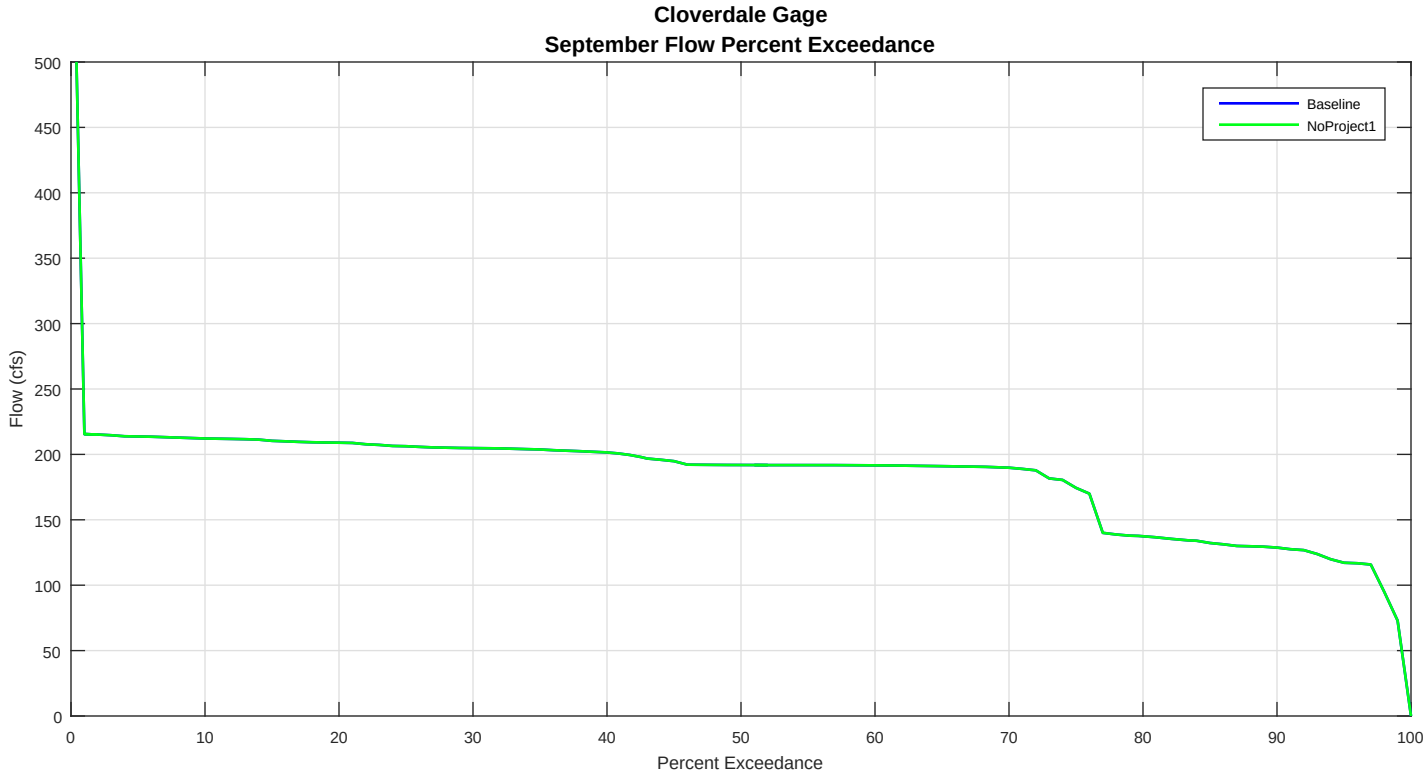
Cloverdale Gage
September Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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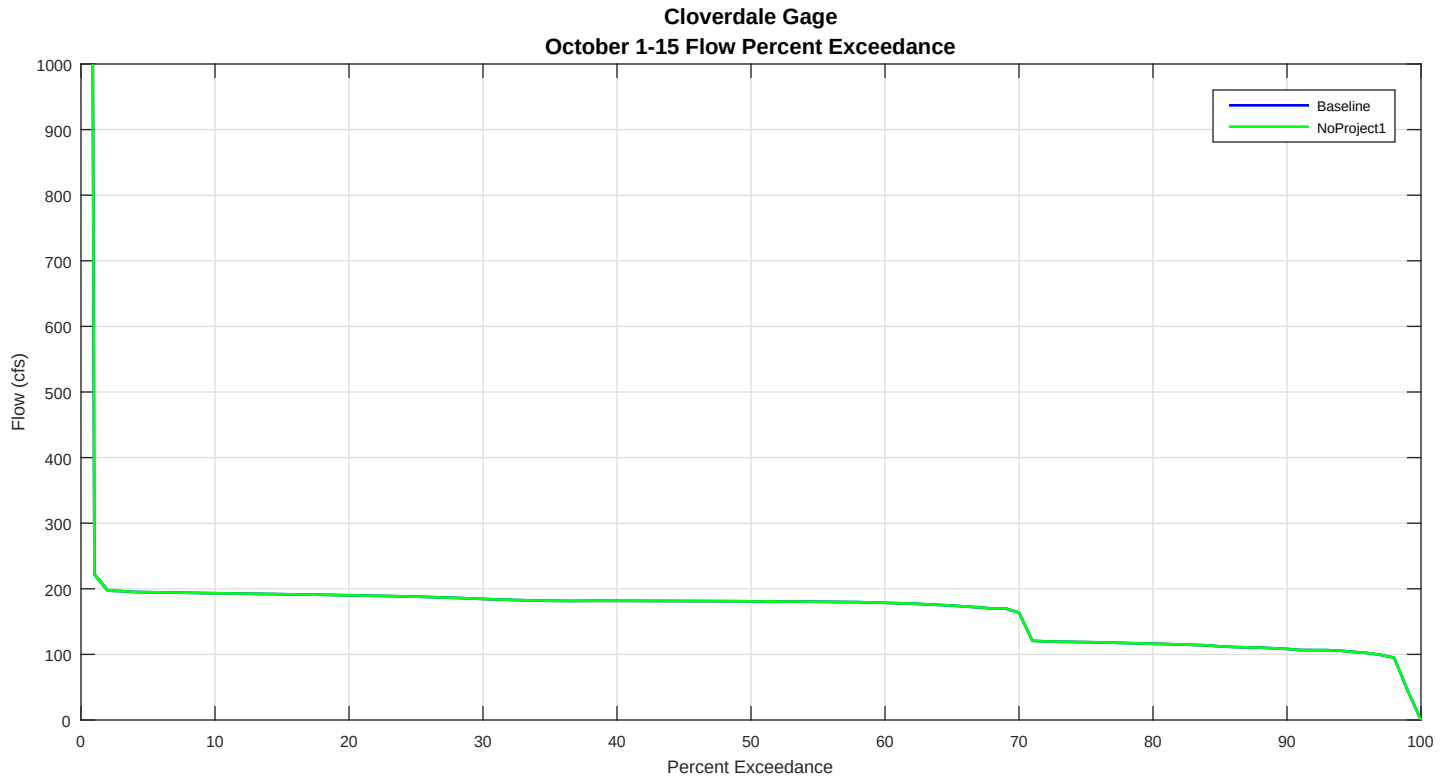
Cloverdale Gage
October 1-15 Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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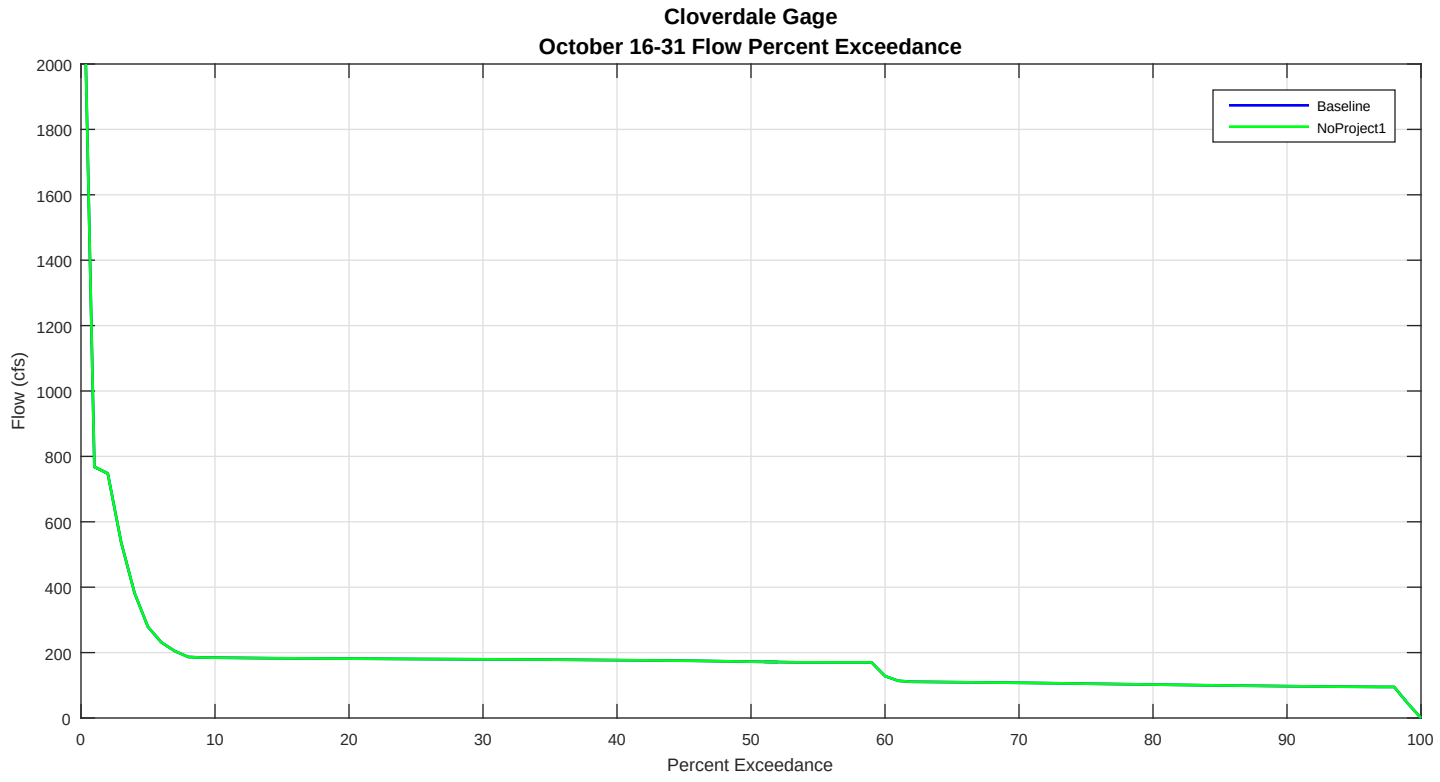
Cloverdale Gage
October 16-31 Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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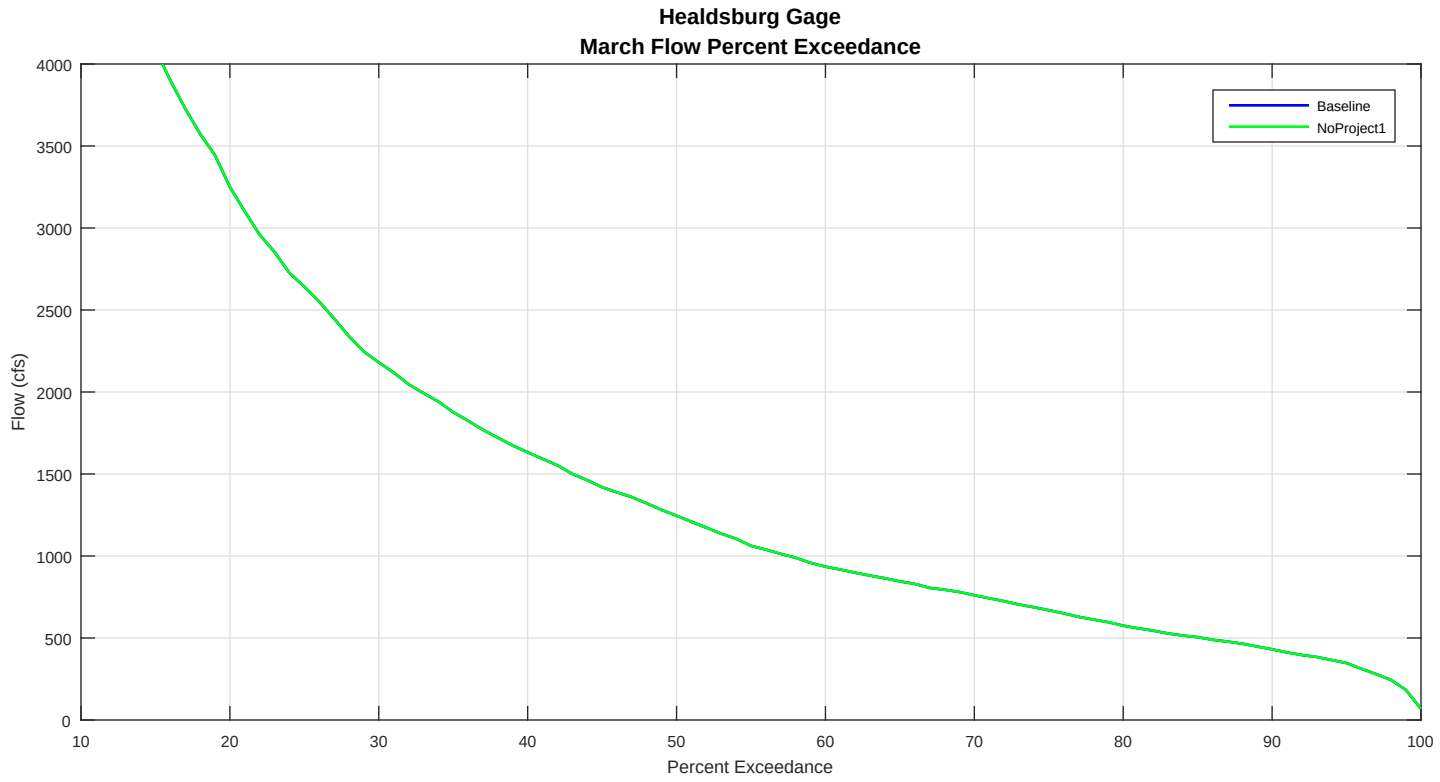
Healdsburg Gage
March Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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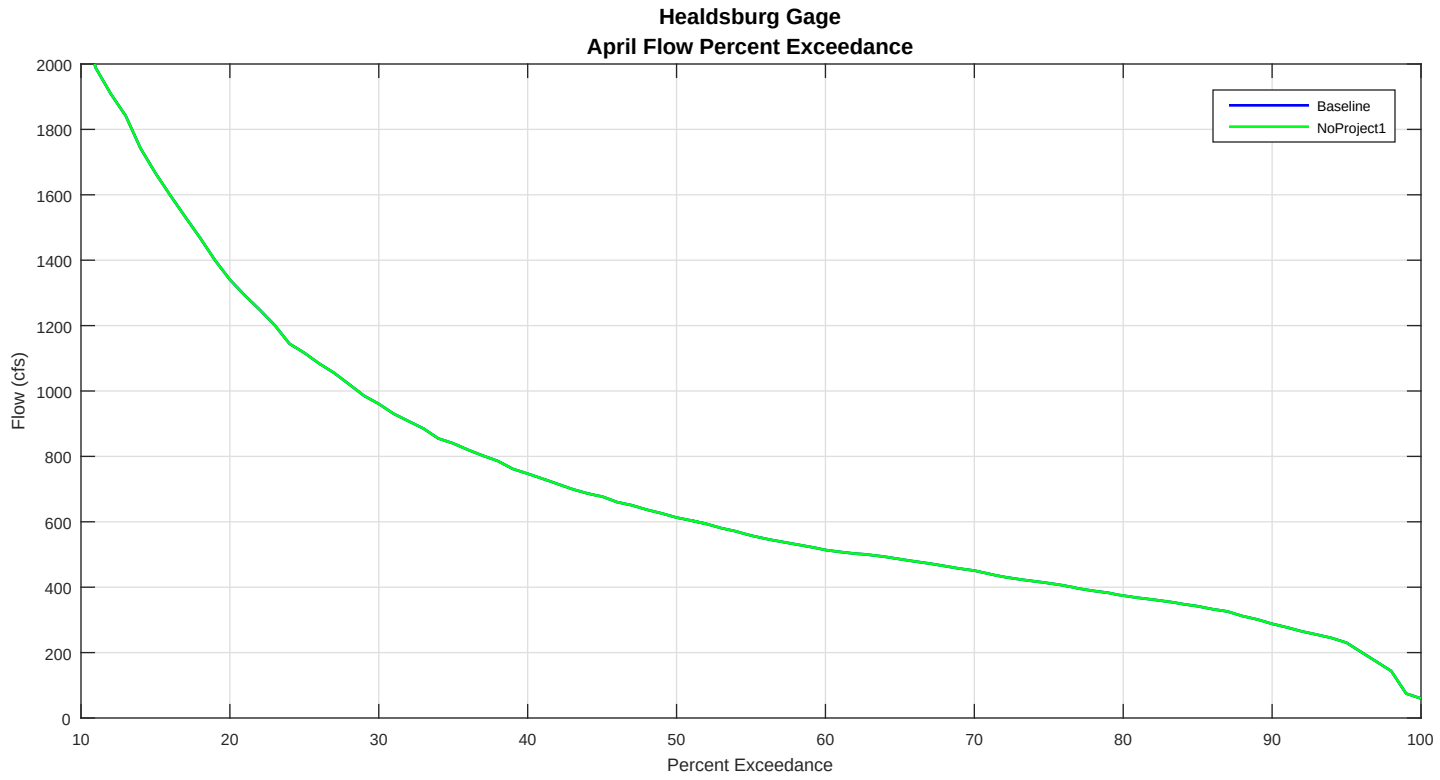
Healdsburg Gage
April Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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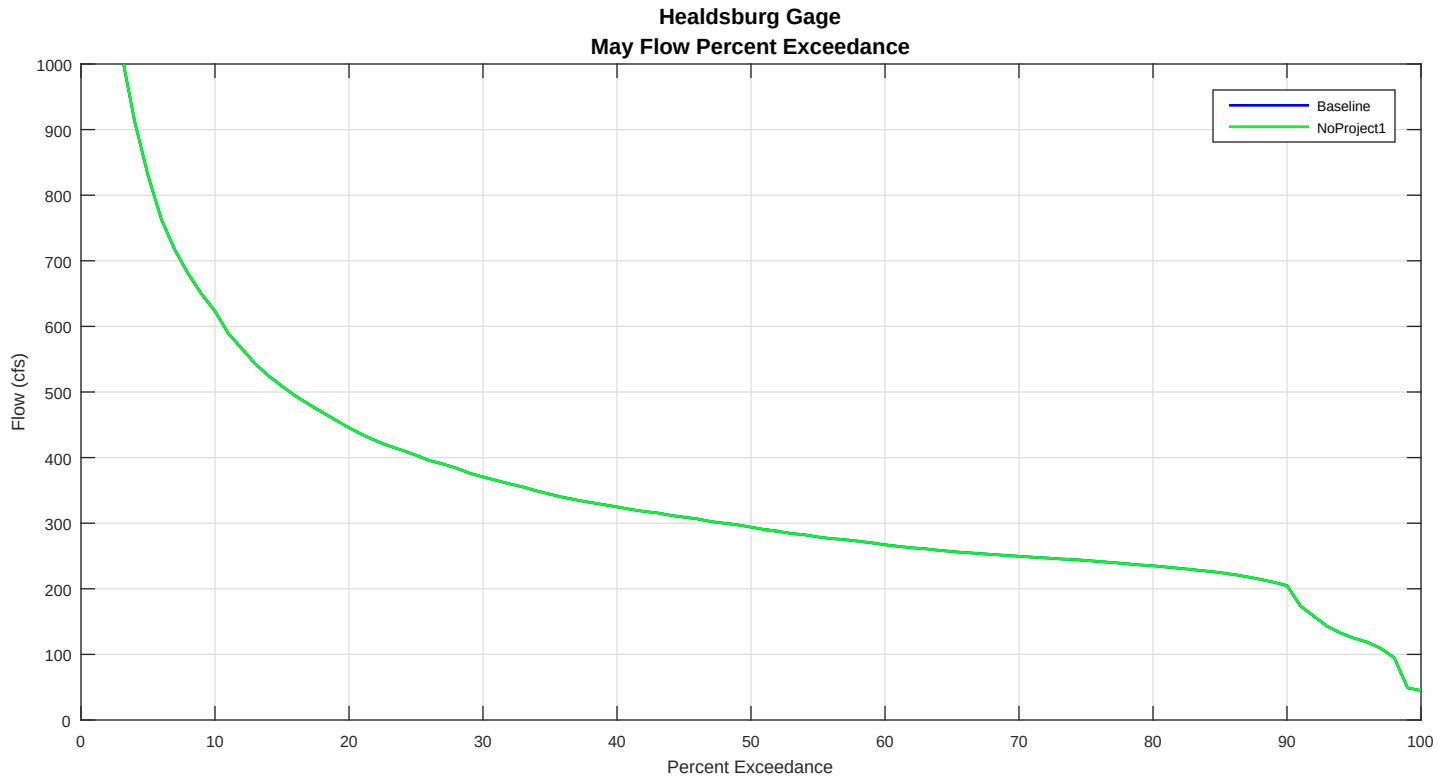
Healdsburg Gage
May Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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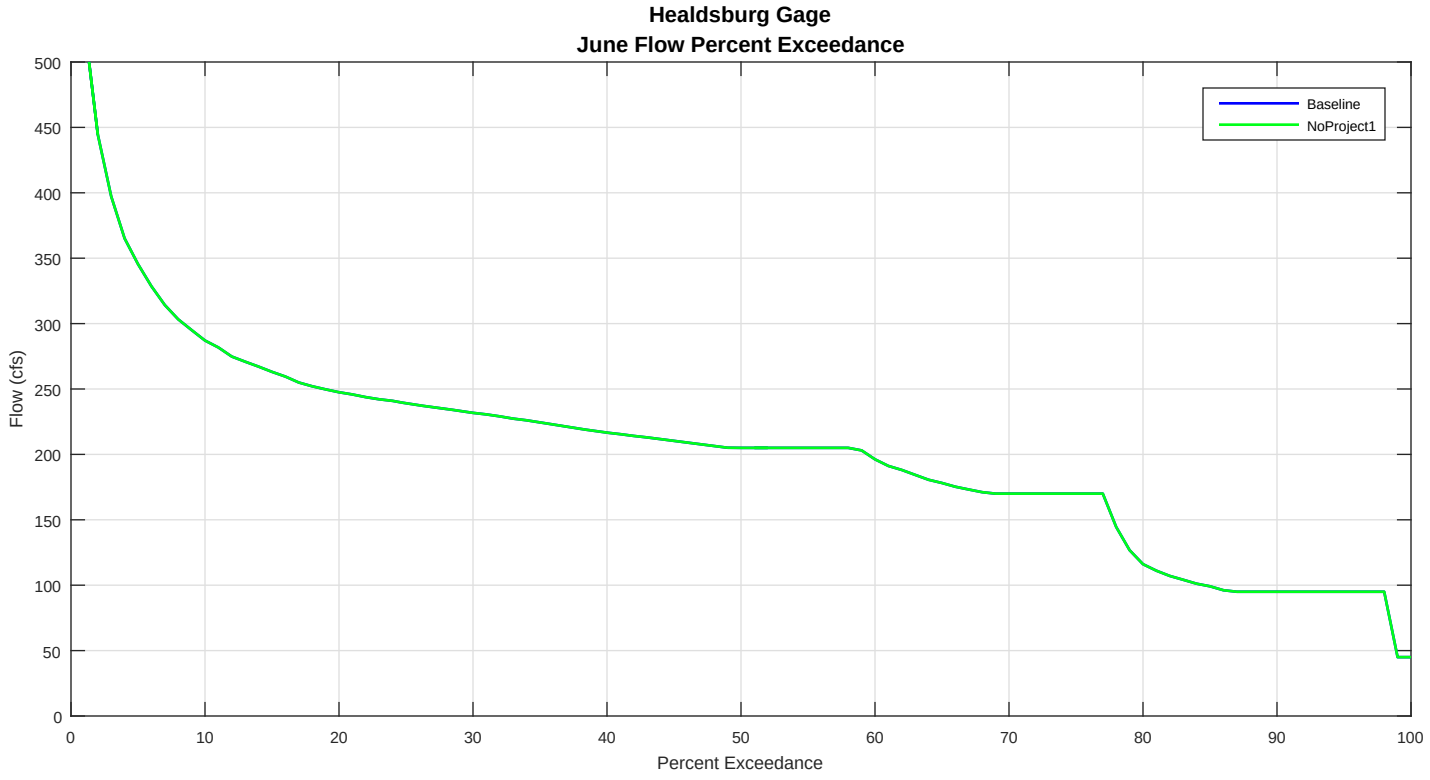
Healdsburg Gage
June Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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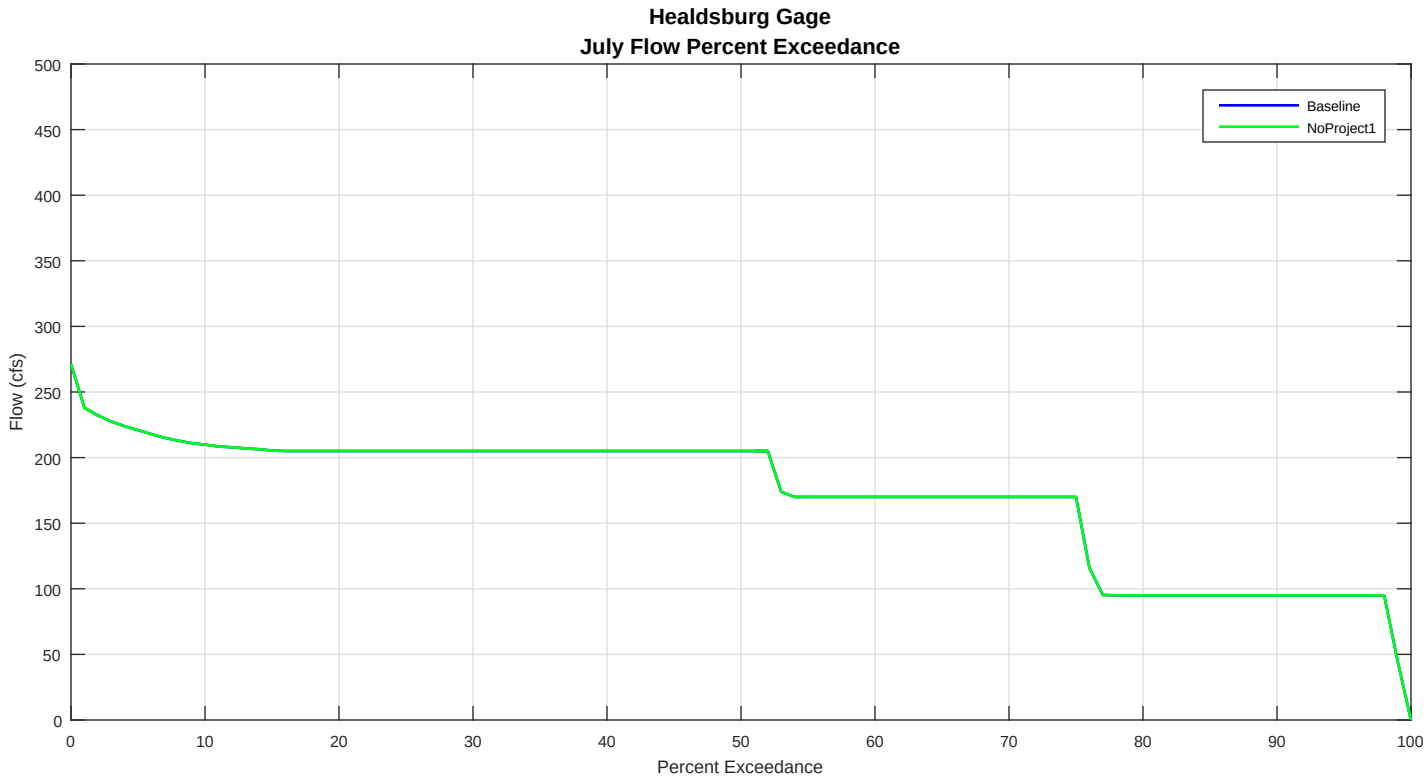
Healdsburg Gage
July Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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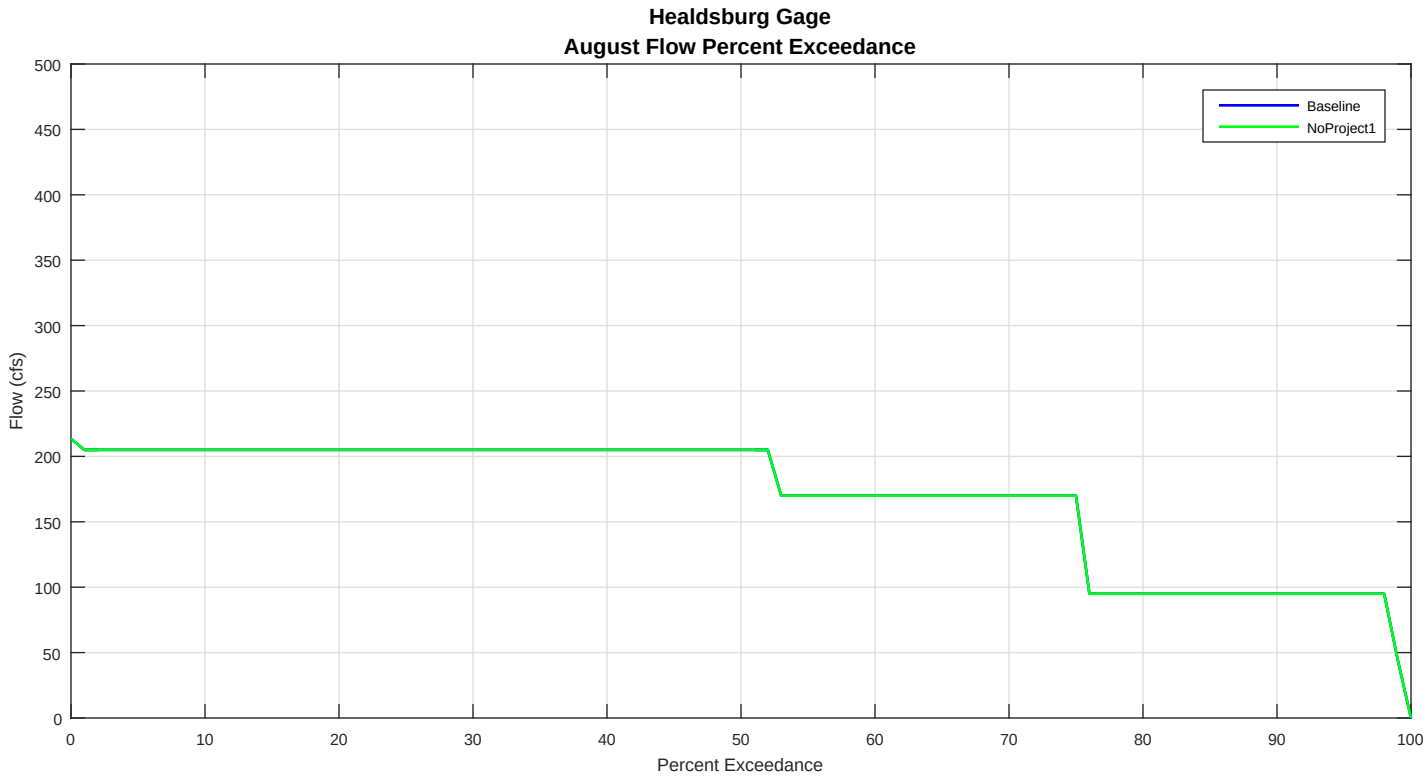
Healdsburg Gage
August Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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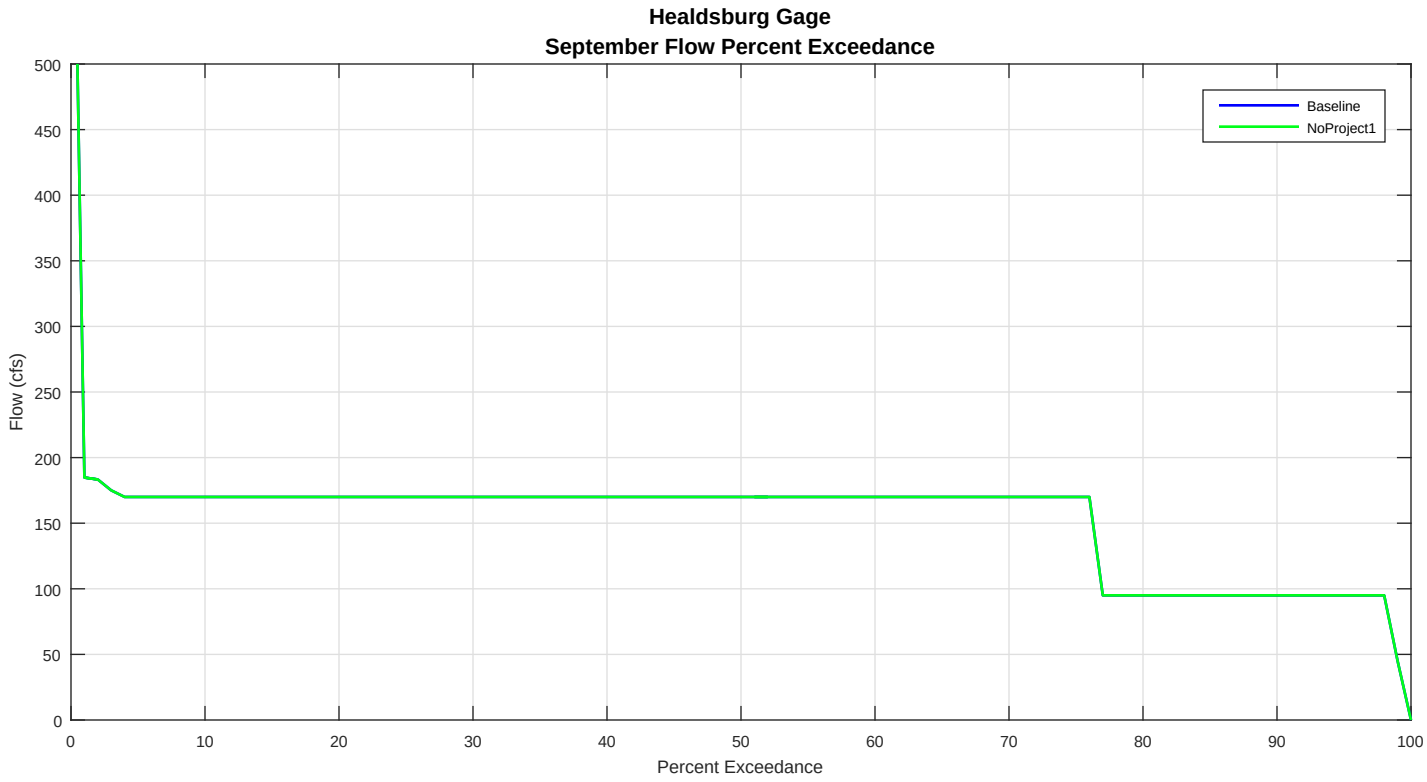
Healdsburg Gage
September Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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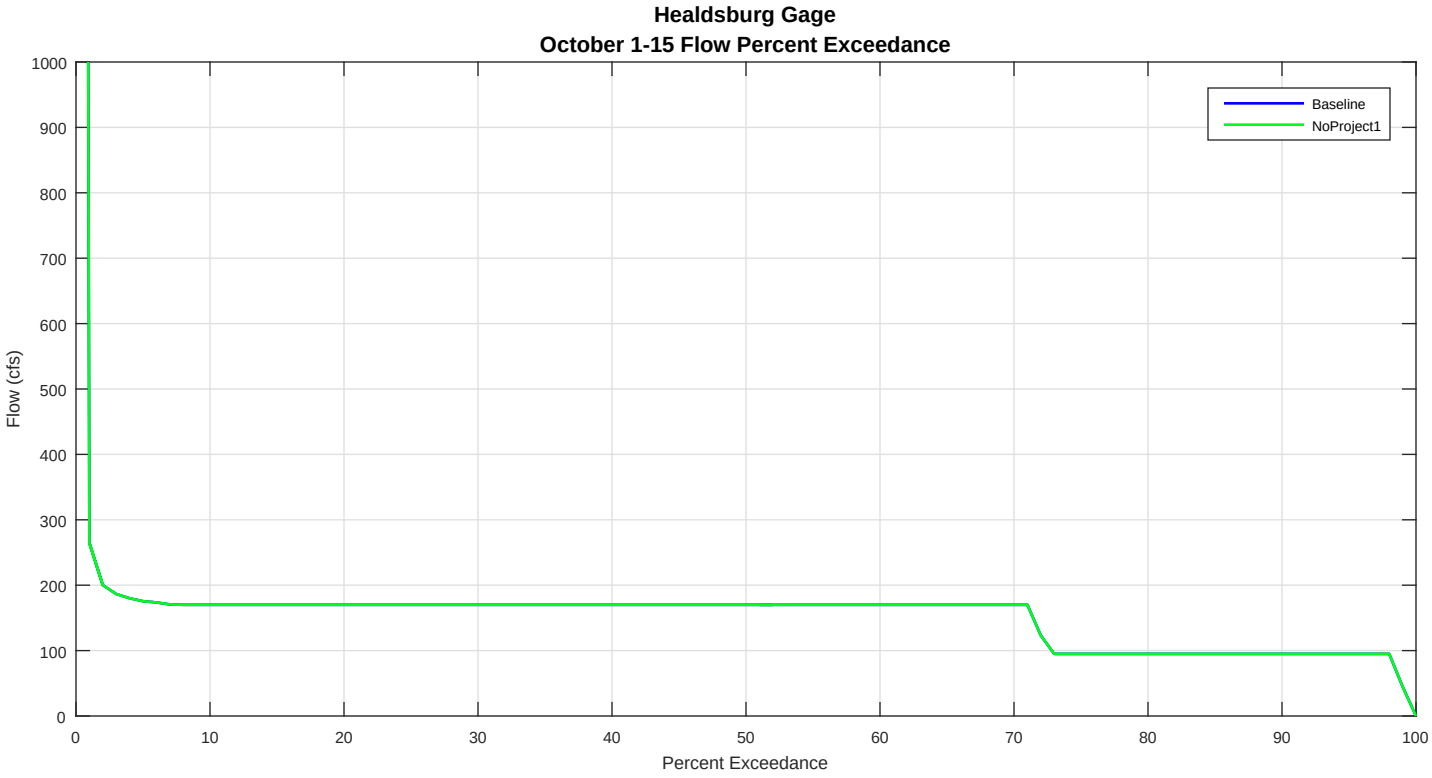
Healdsburg Gage
October 1-15 Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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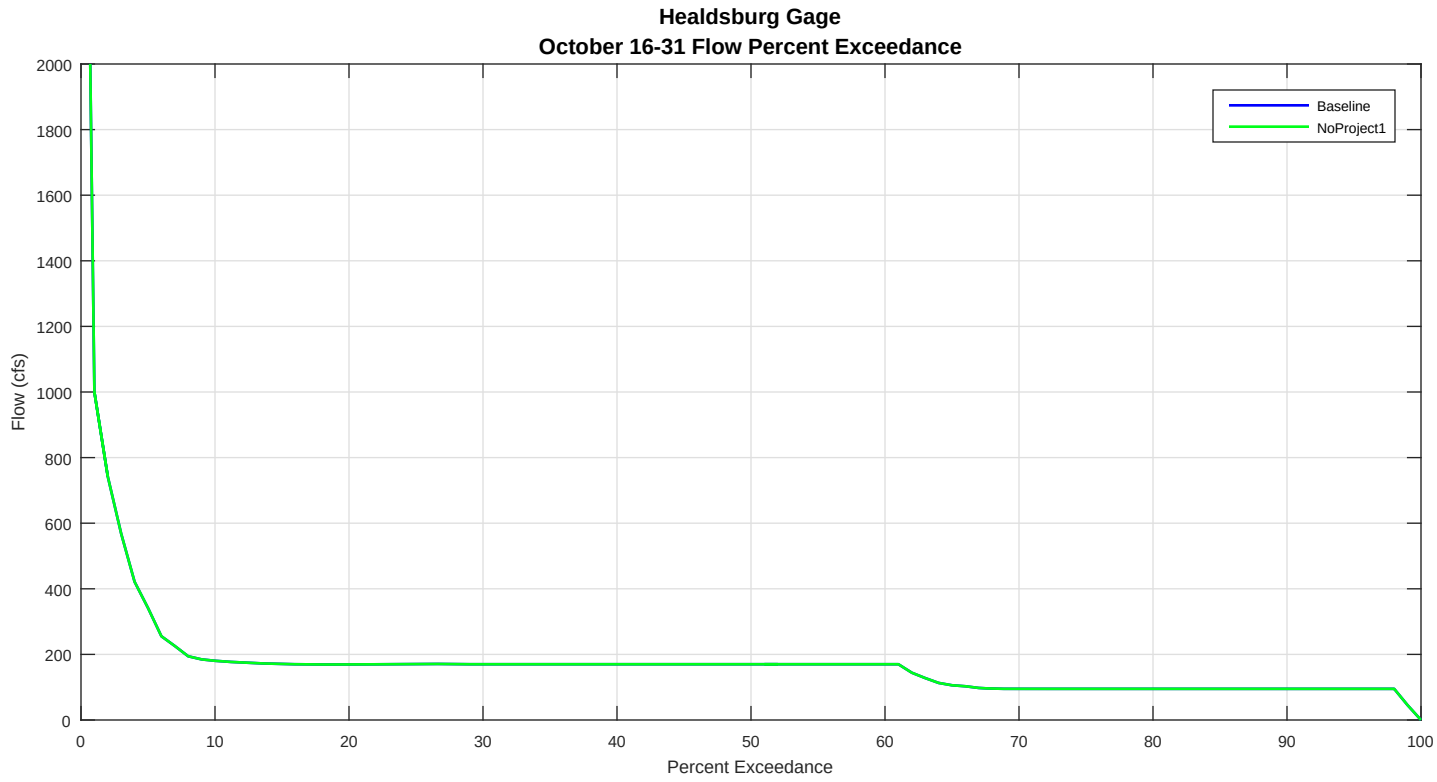
Healdsburg Gage
October 16-31 Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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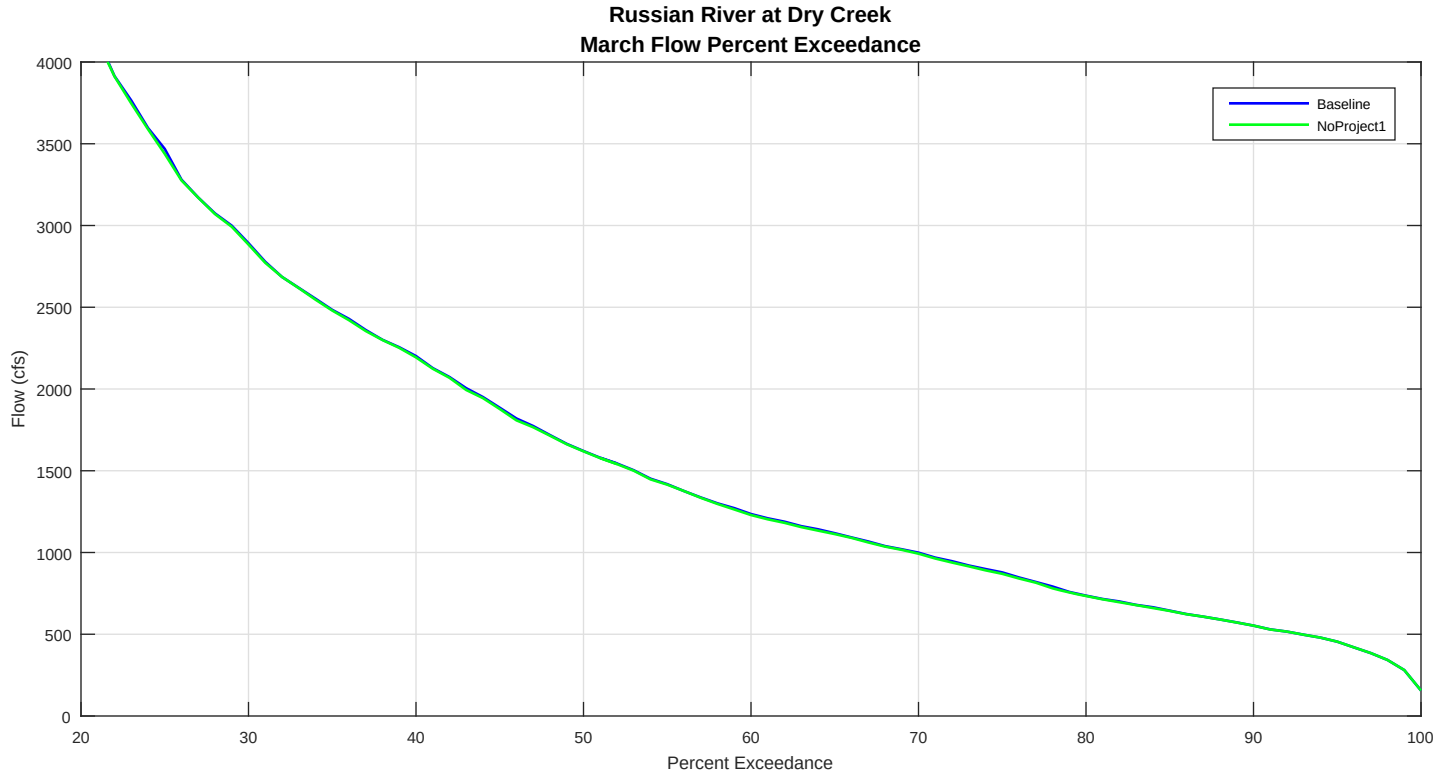
Russian River at Dry Creek
March Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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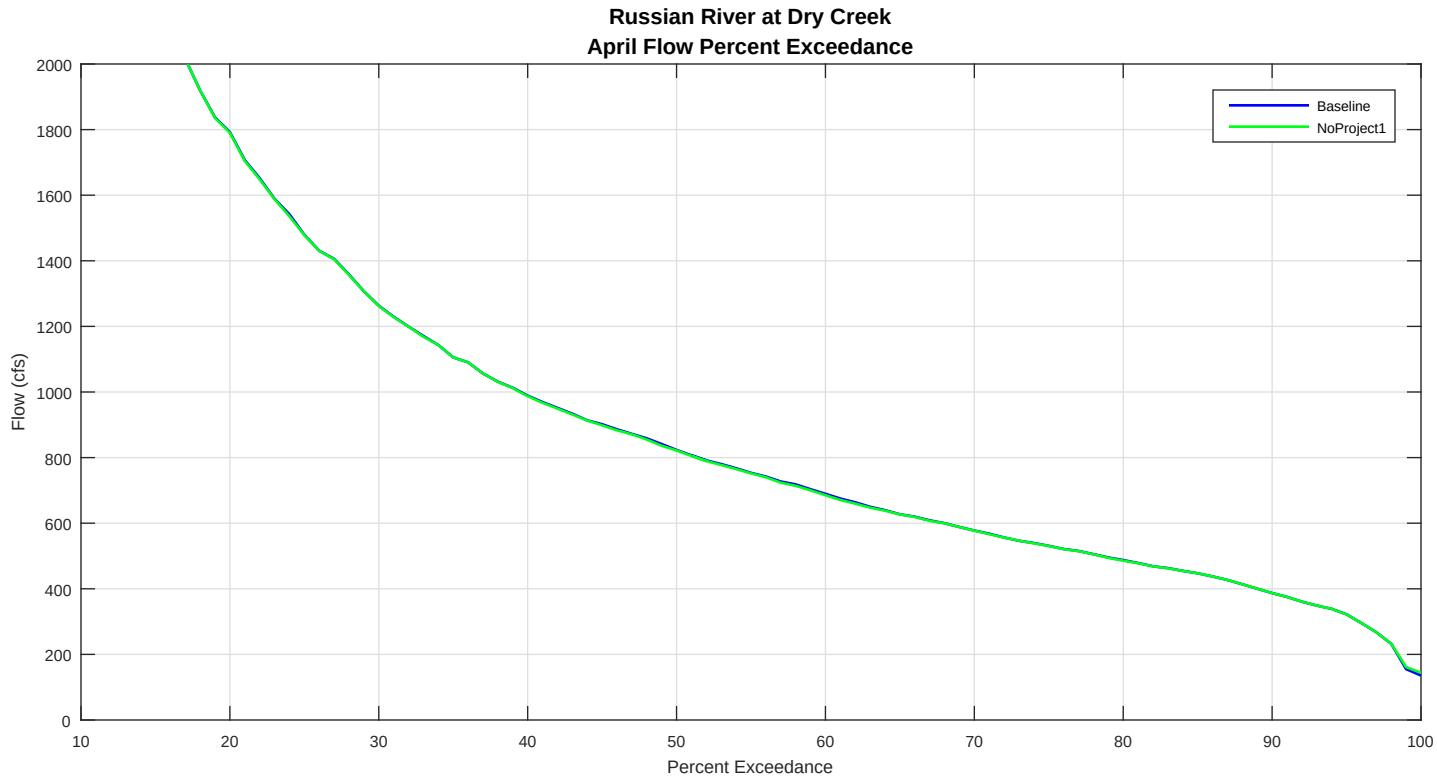
Russian River at Dry Creek
April Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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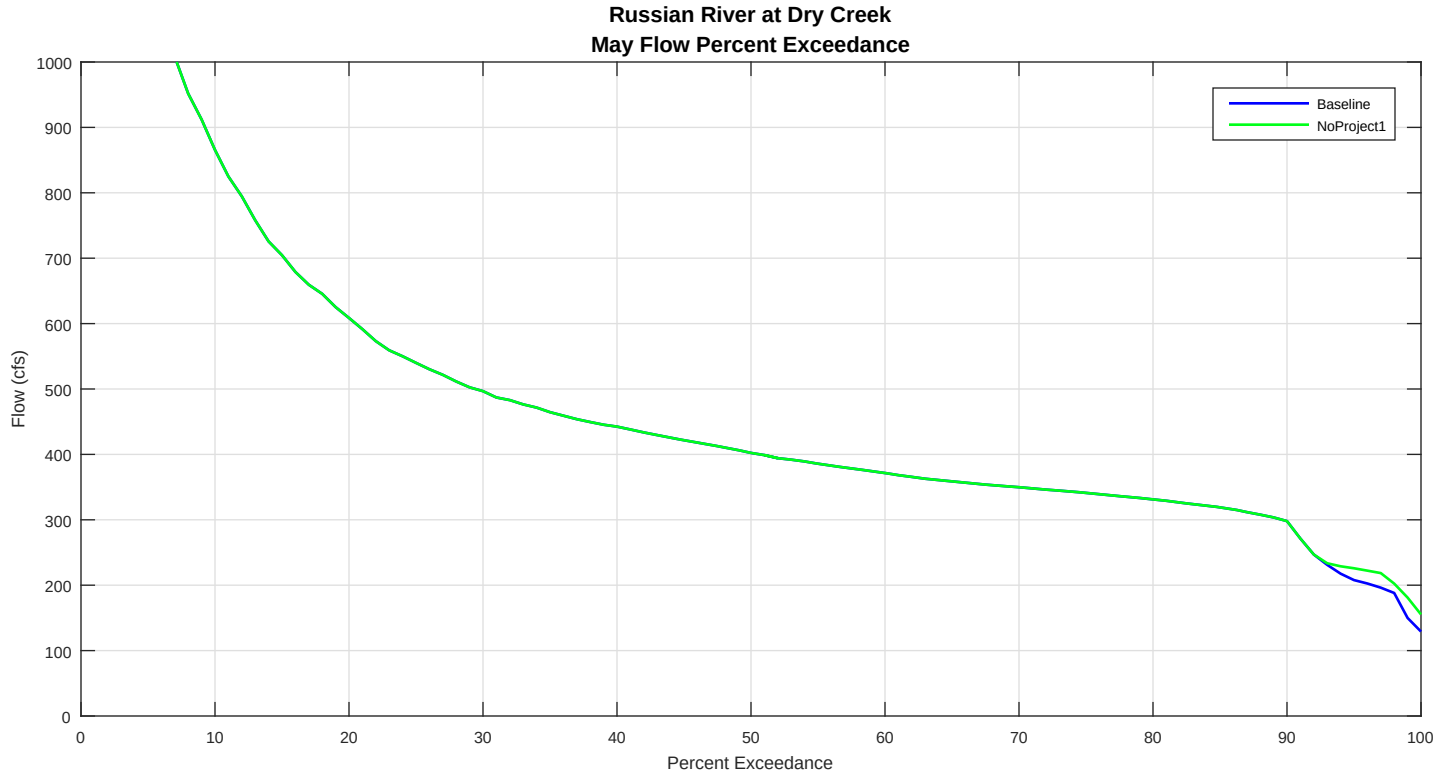
Russian River at Dry Creek
May Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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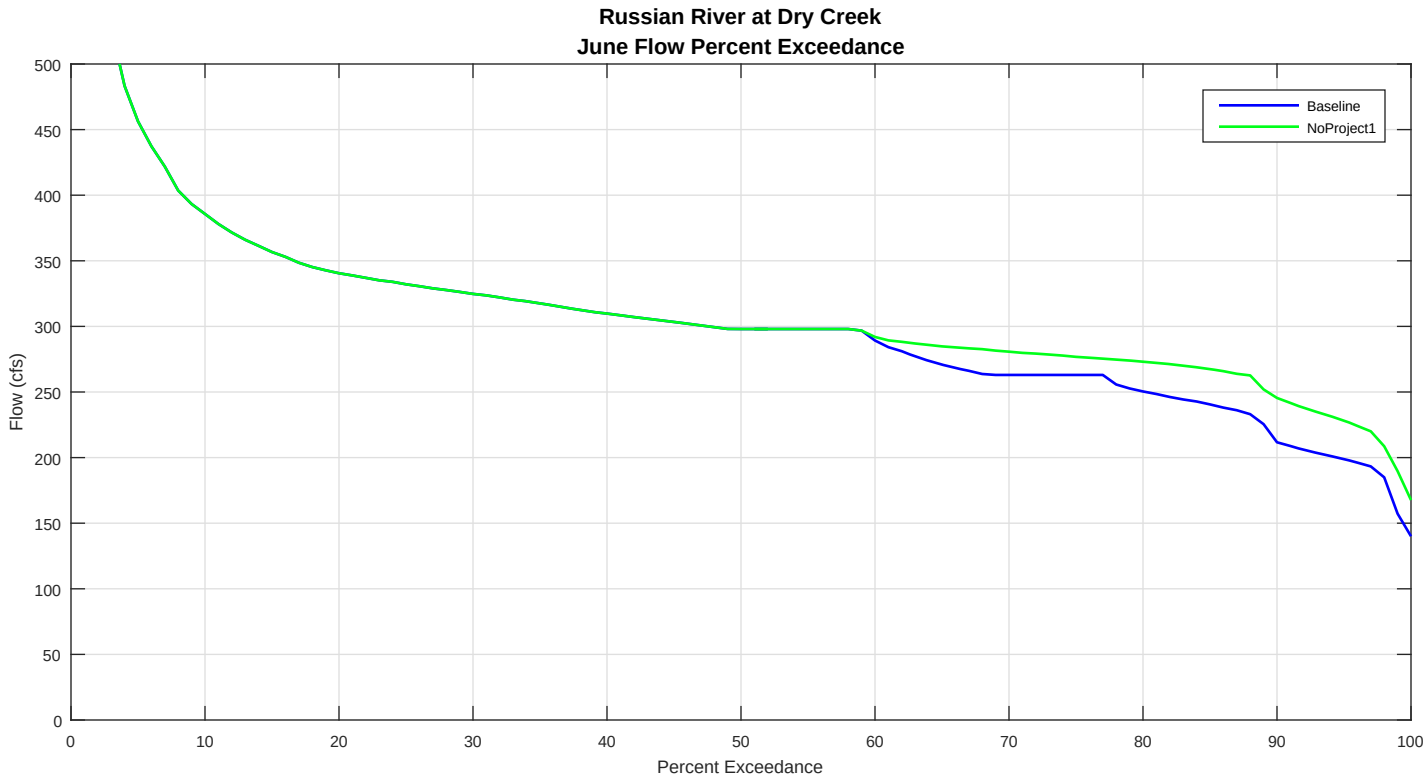
Russian River at Dry Creek
June Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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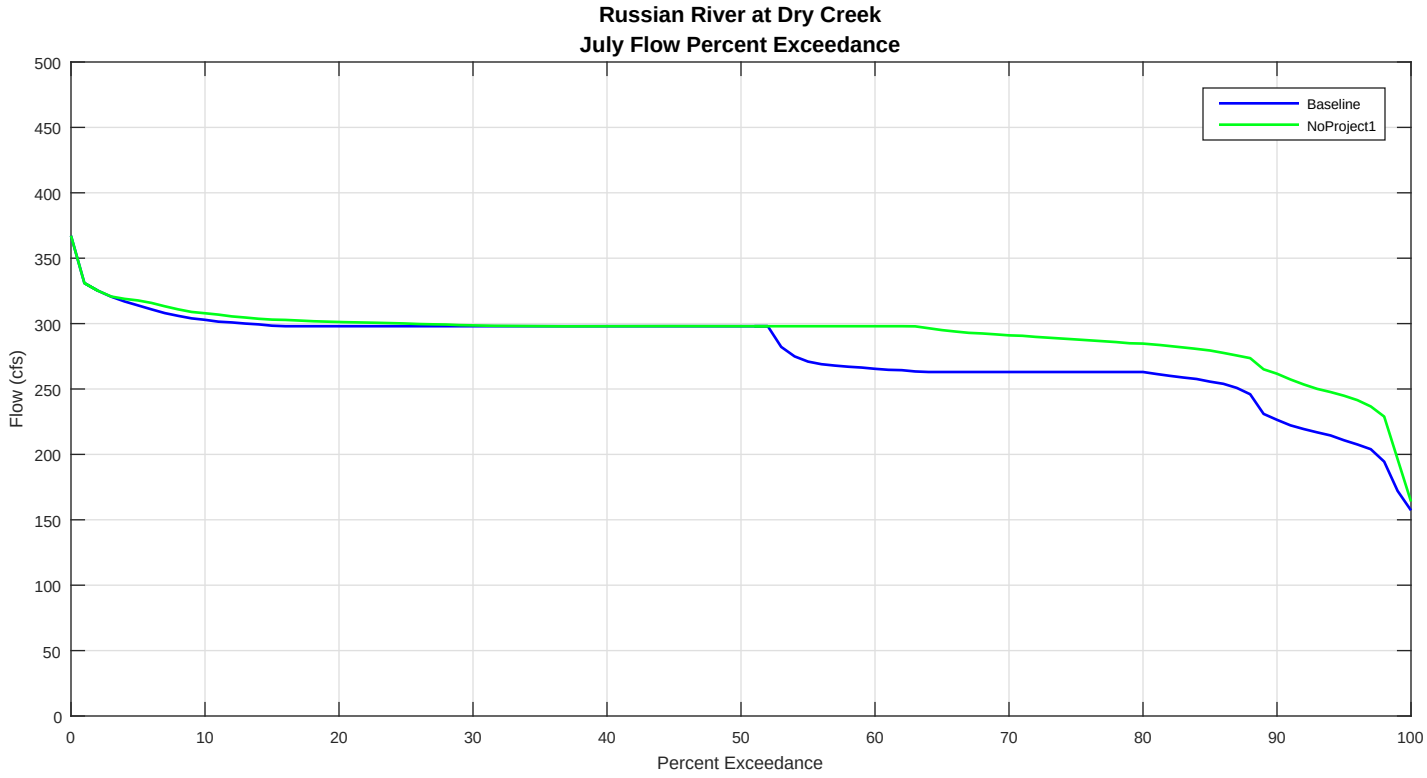
Russian River at Dry Creek
July Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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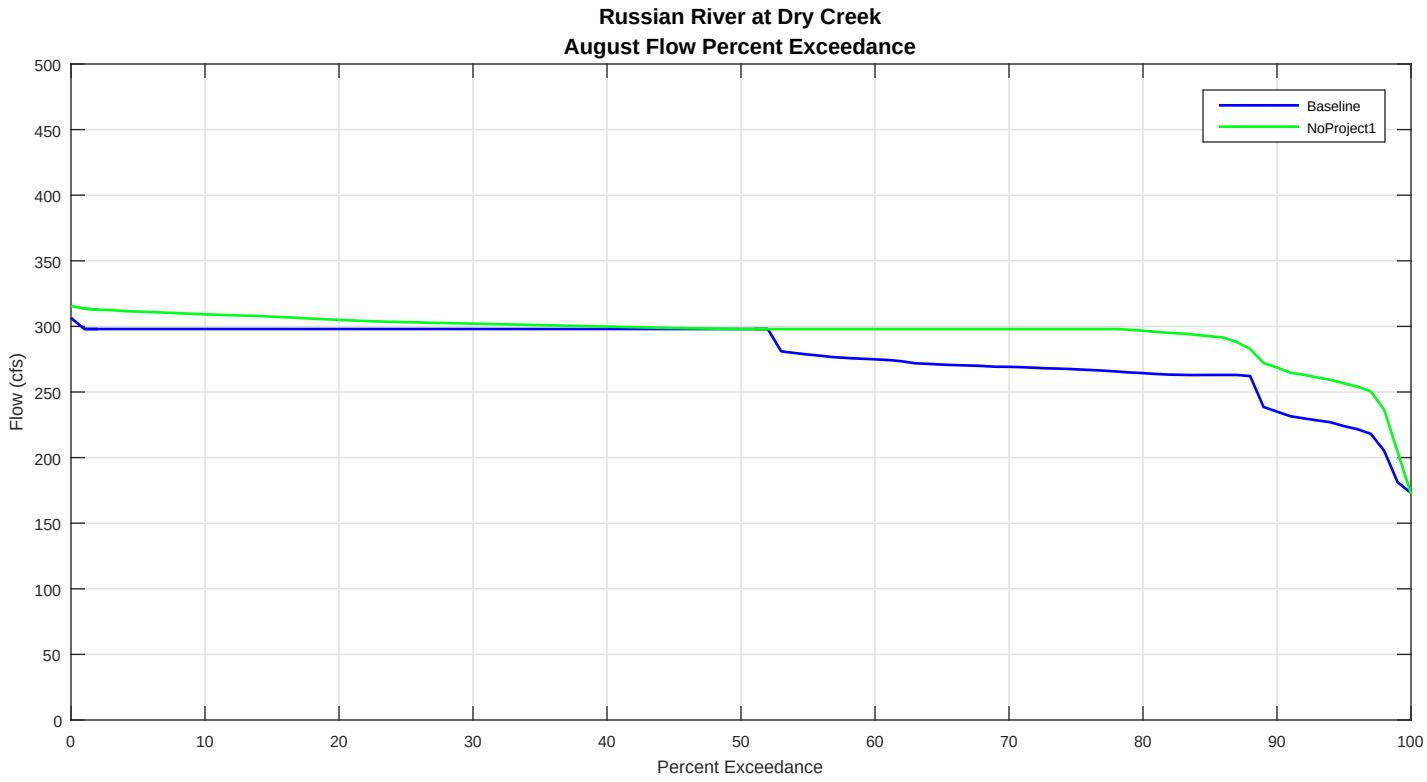
Russian River at Dry Creek
August Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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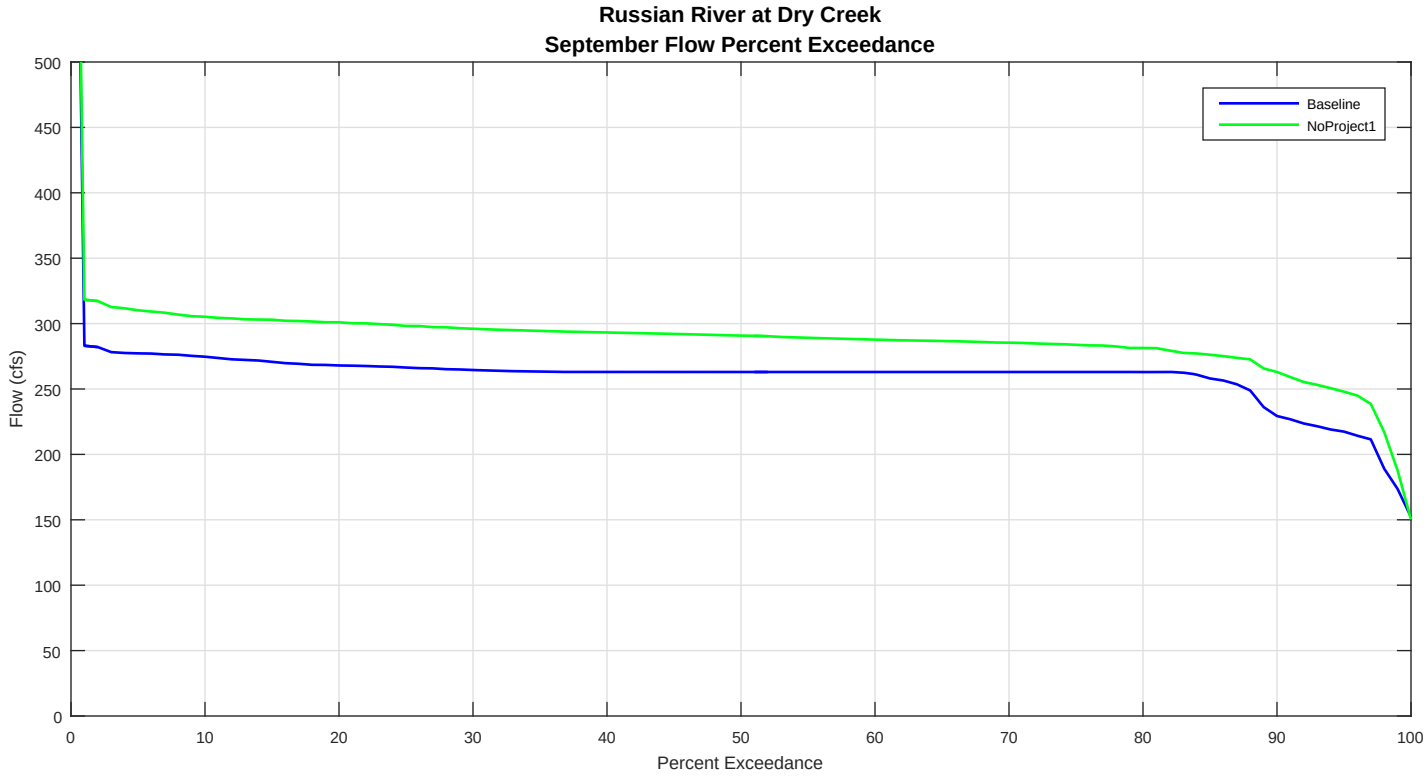
Russian River at Dry Creek
September Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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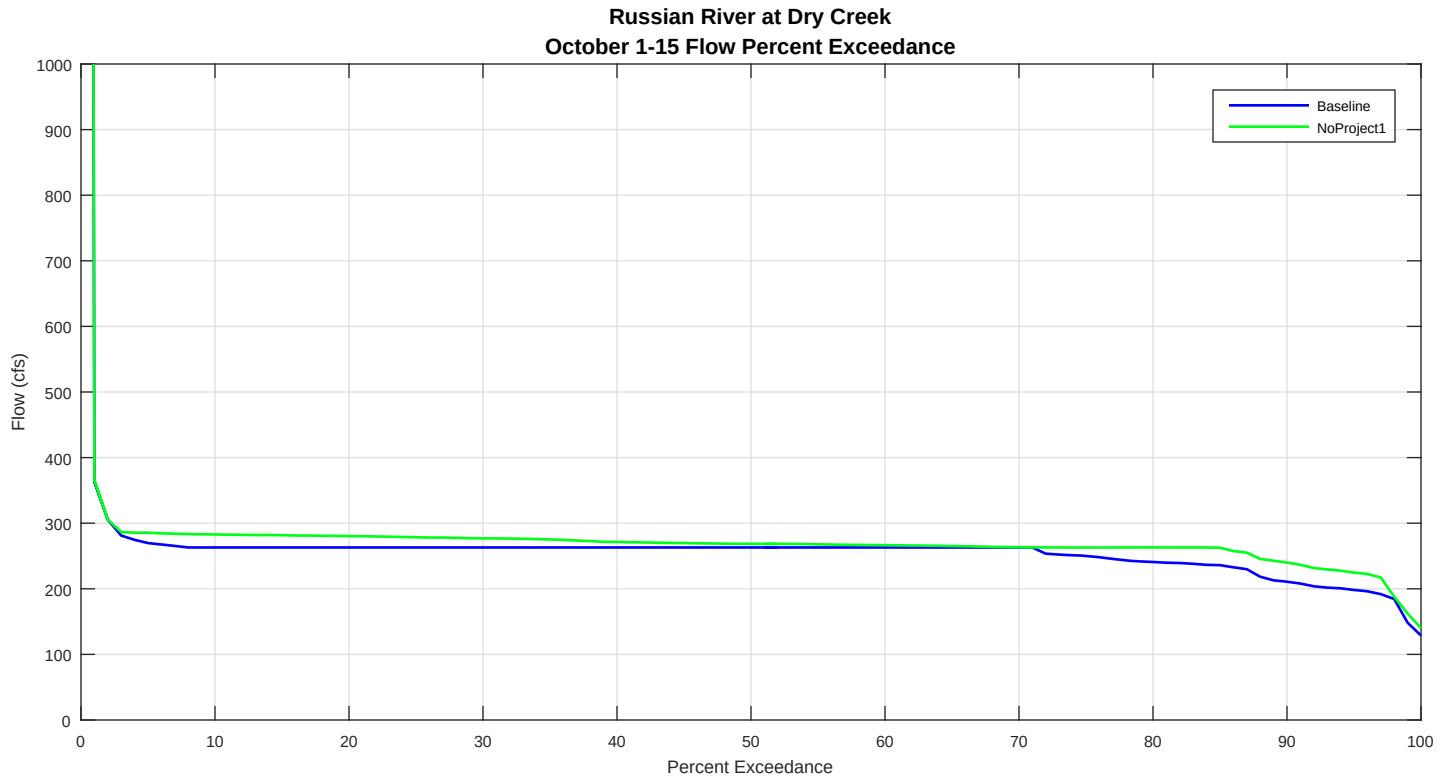
Russian River at Dry Creek
October 1-15 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
Baseline
NoProject1
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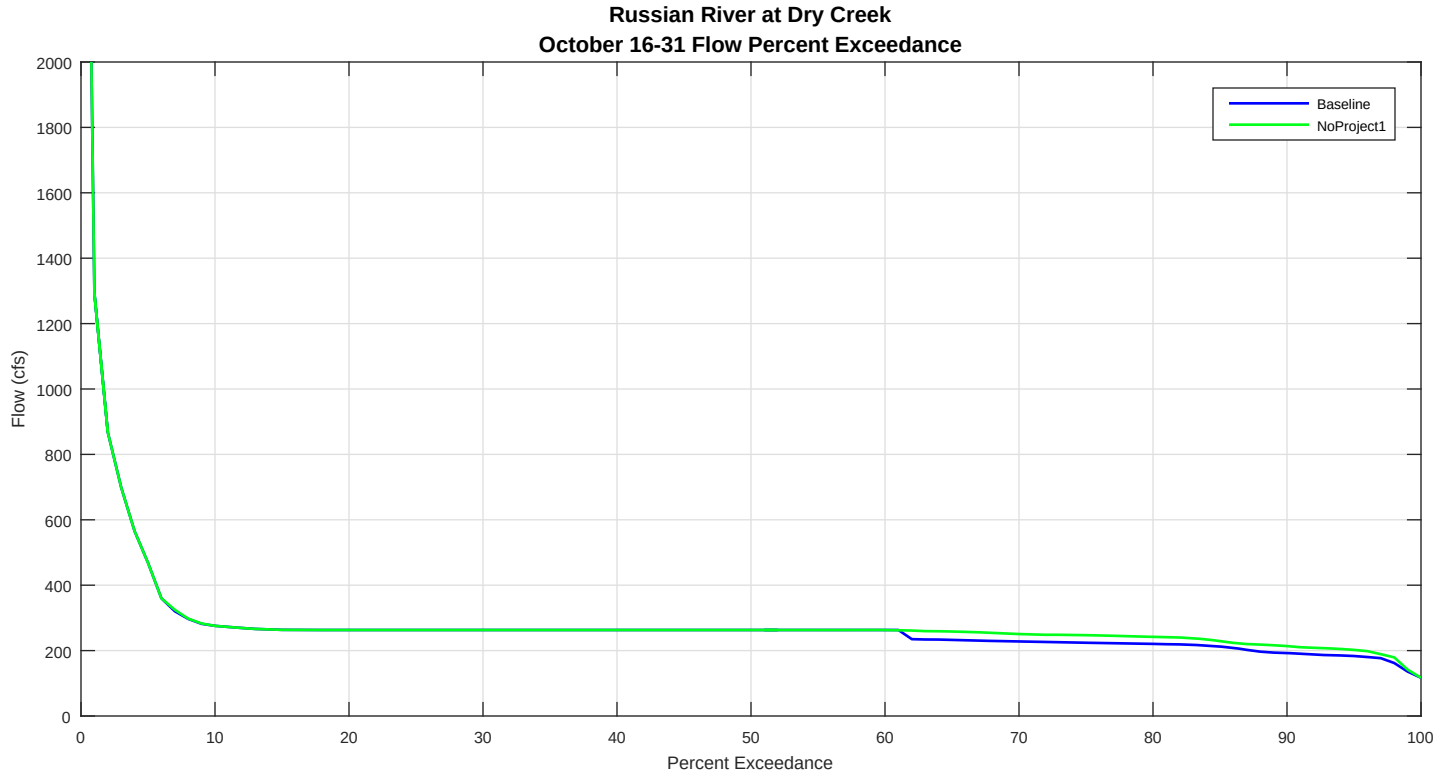
Russian River at Dry Creek
October 16-31 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
Baseline
NoProject1
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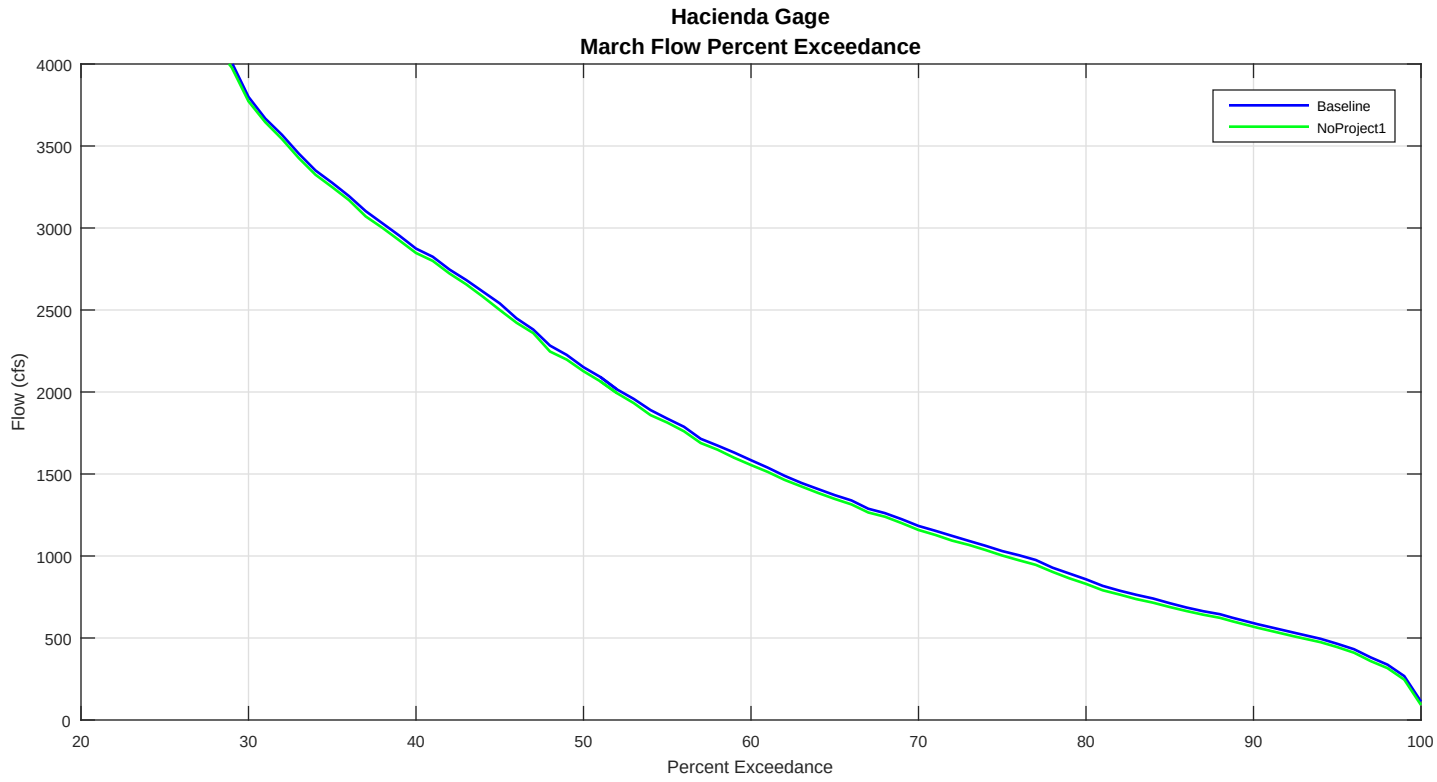
Hacienda Gage
March Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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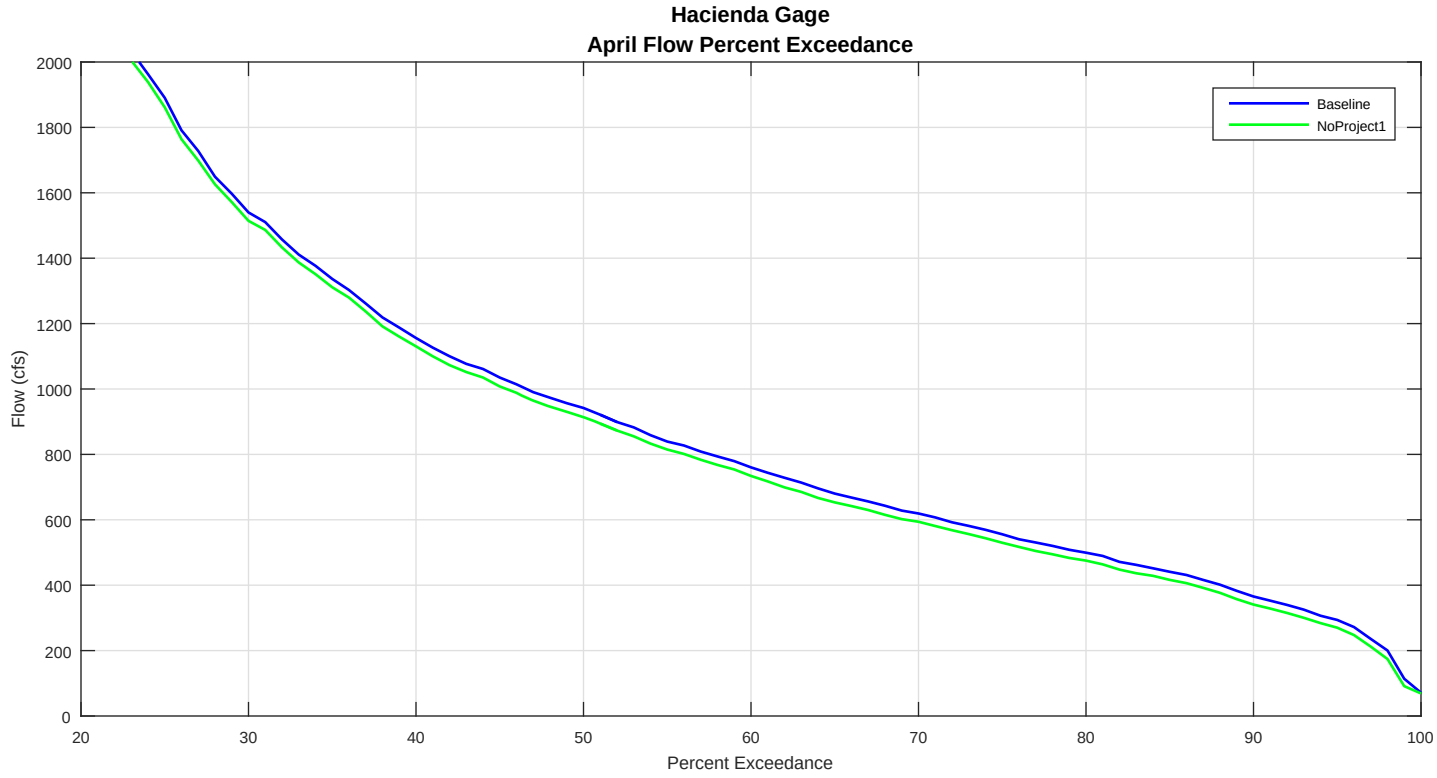
Hacienda Gage
April Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
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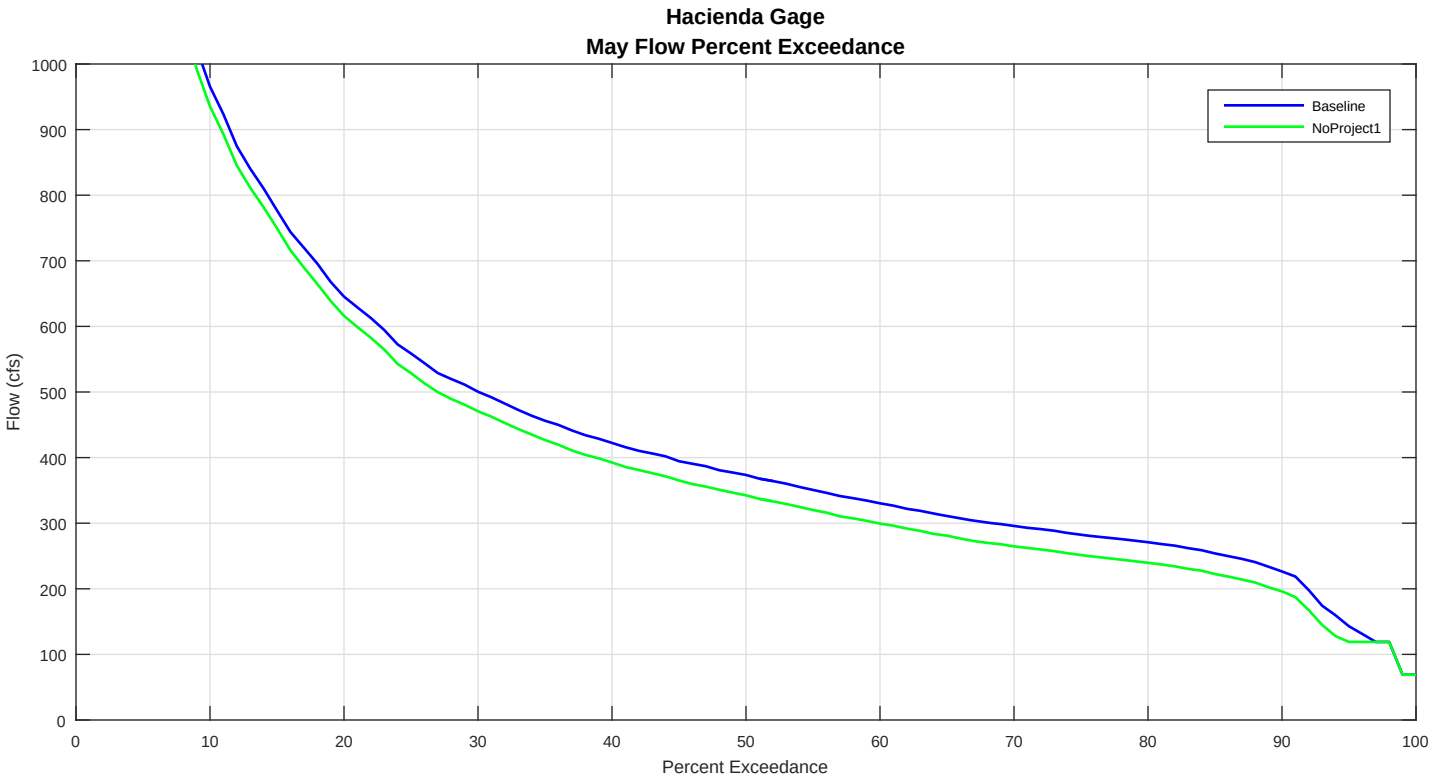
Hacienda Gage
May Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
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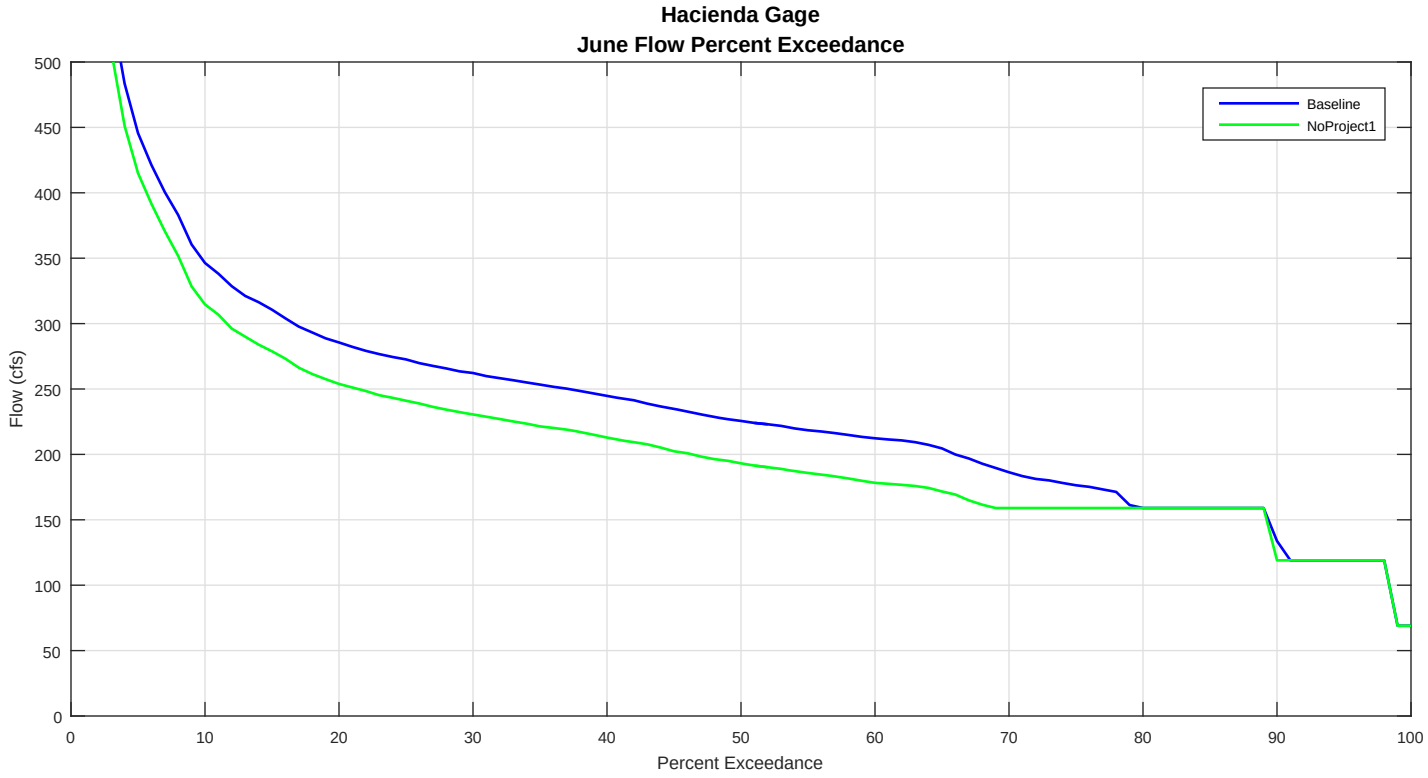
Hacienda Gage
June Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
50
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150
200
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300
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500
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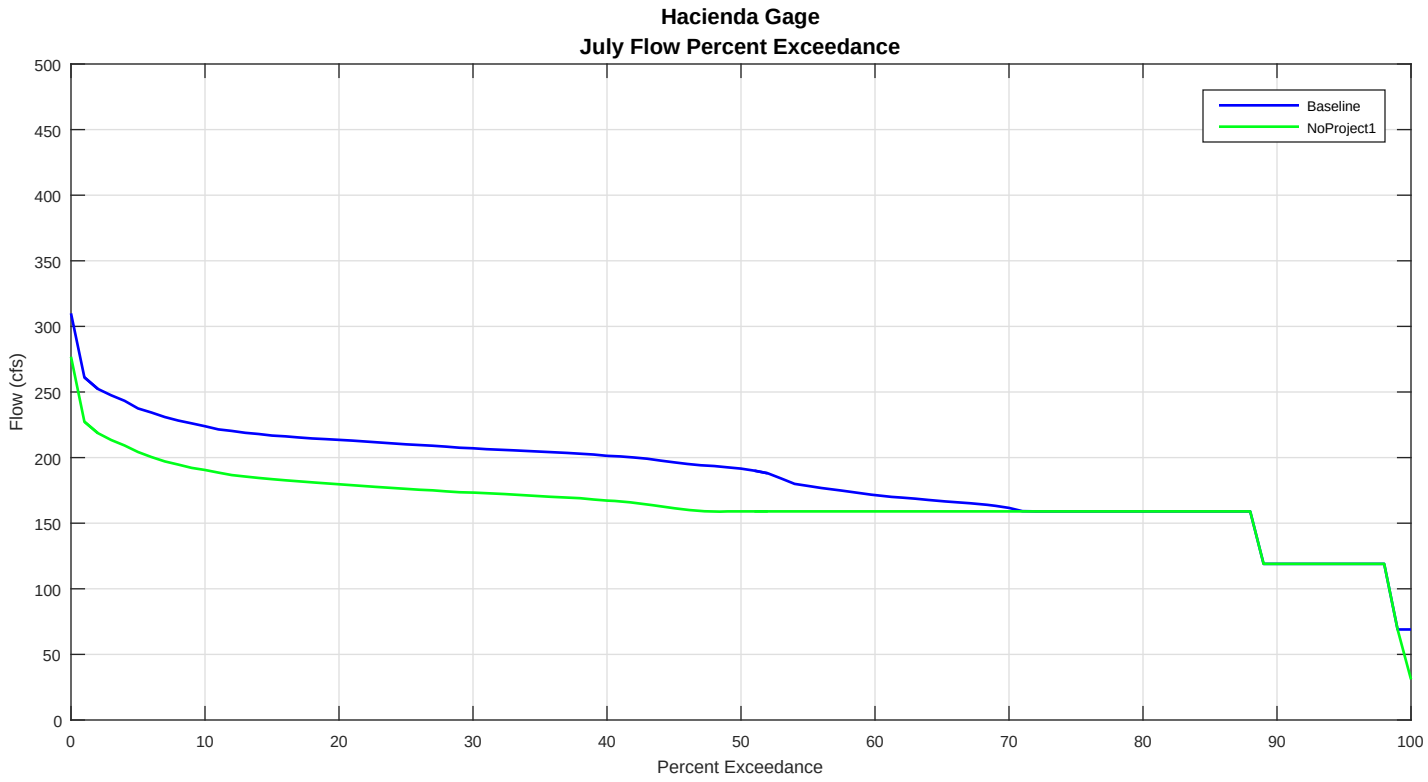
Hacienda Gage
July Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
50
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150
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300
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500
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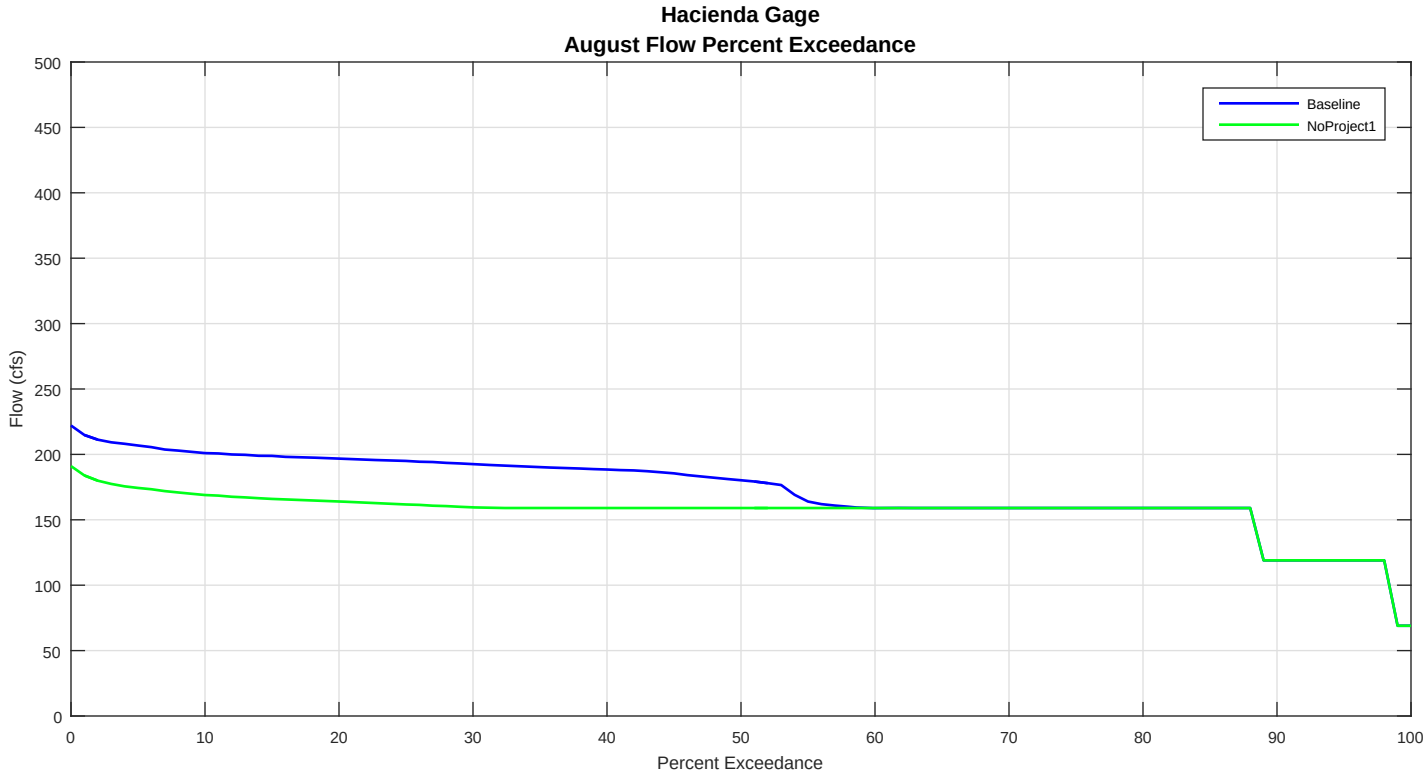
Hacienda Gage
August Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
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350
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450
500
0
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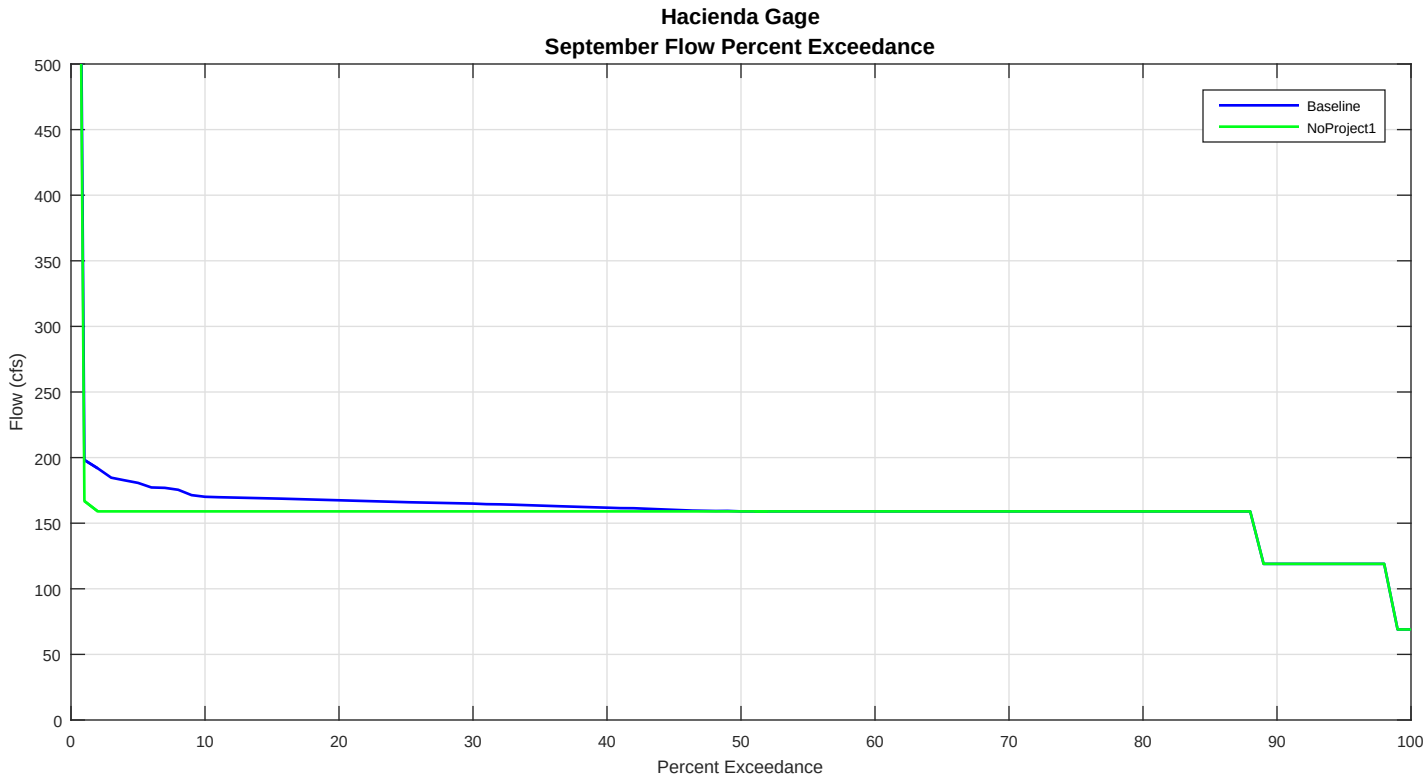
Hacienda Gage
September Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
50
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150
200
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450
500
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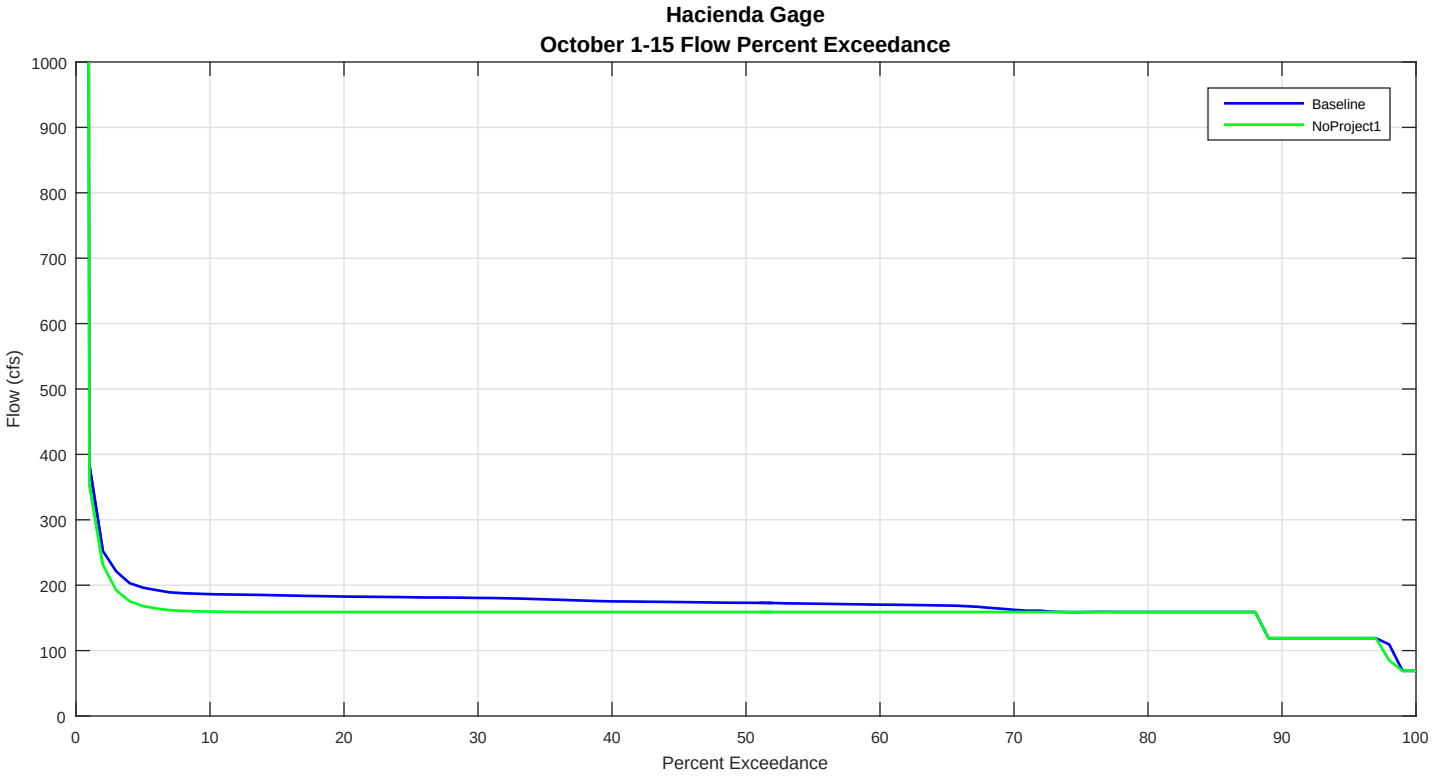
Hacienda Gage
October 1-15 Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
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900
1000
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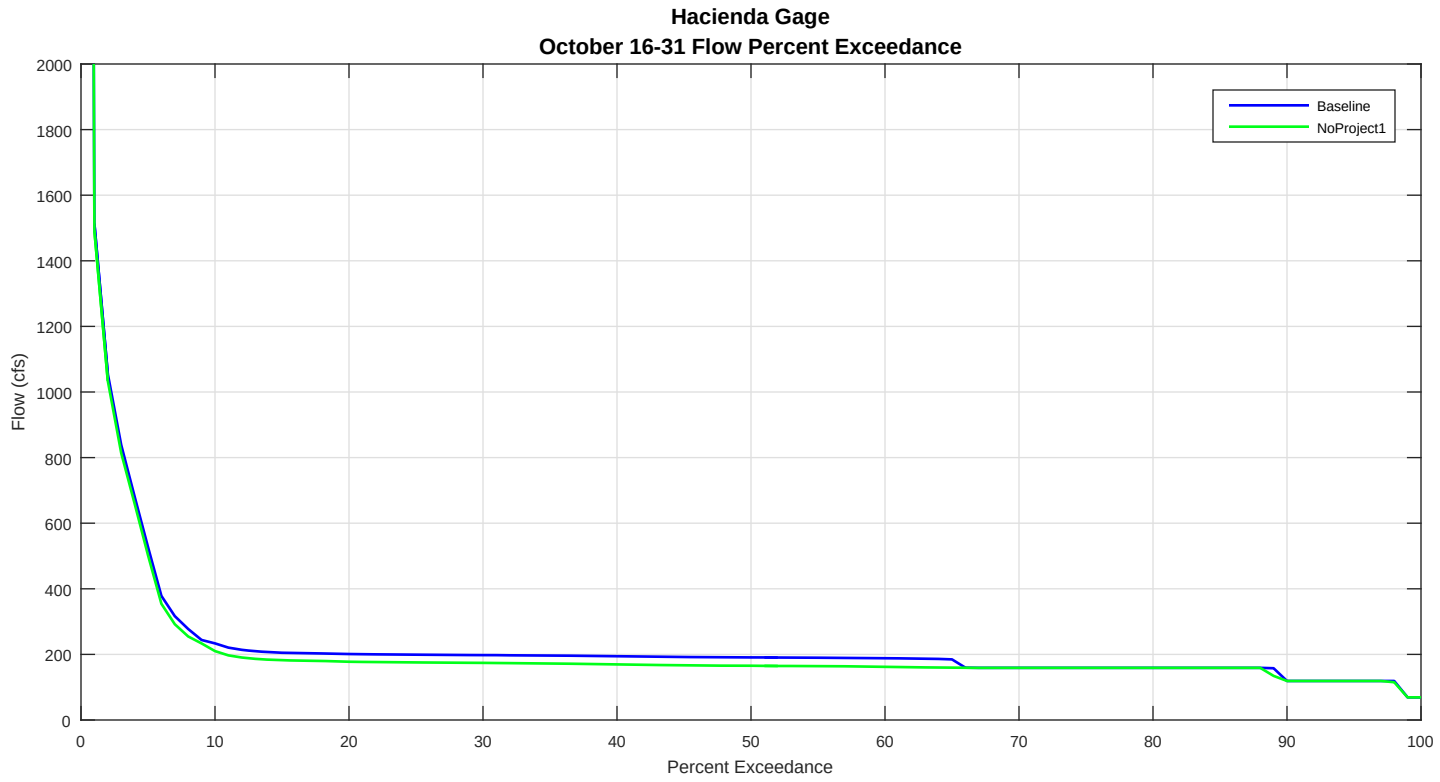
Hacienda Gage
October 16-31 Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
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1800
2000
0
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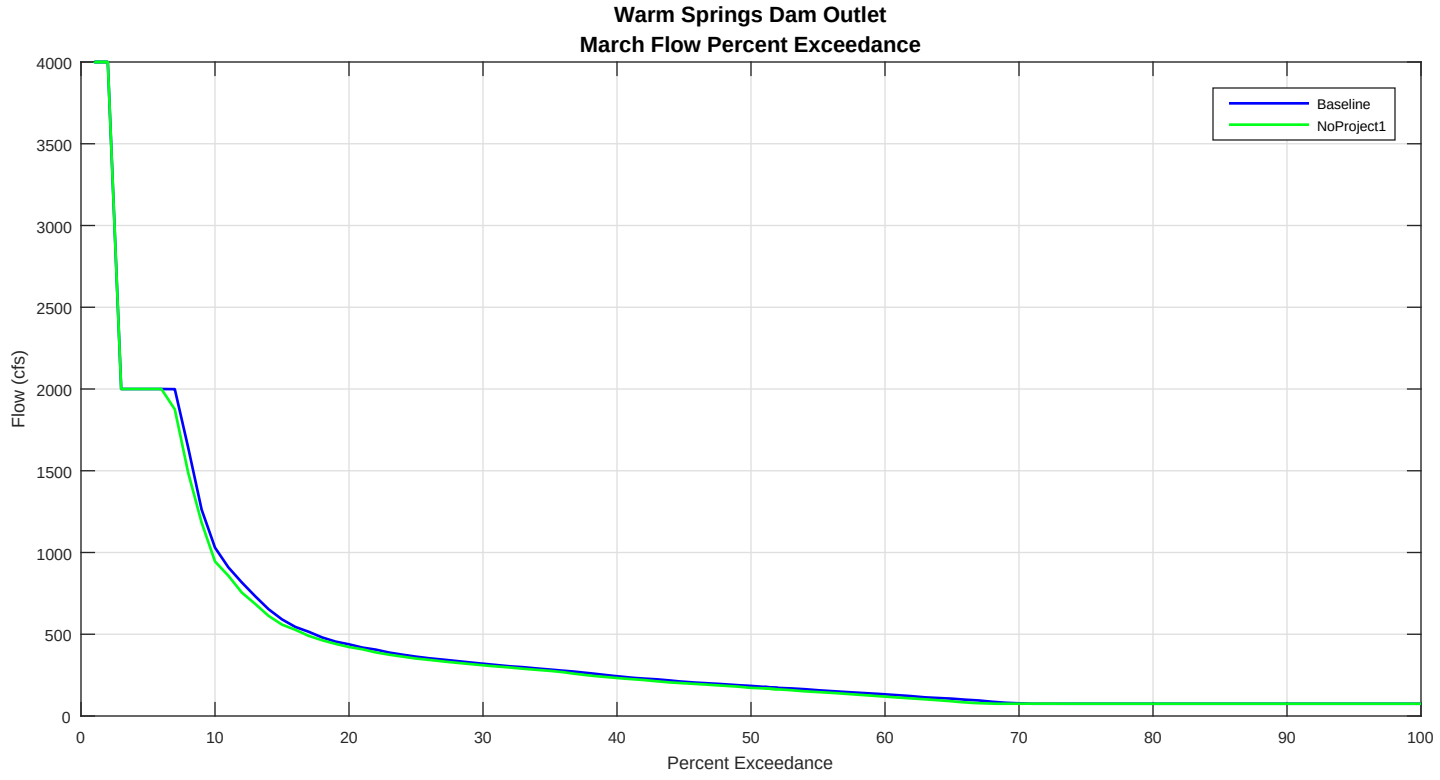
Warm Springs Dam Outlet
March Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
500
1000
1500
2000
2500
3000
3500
4000
0
10
20
30
40
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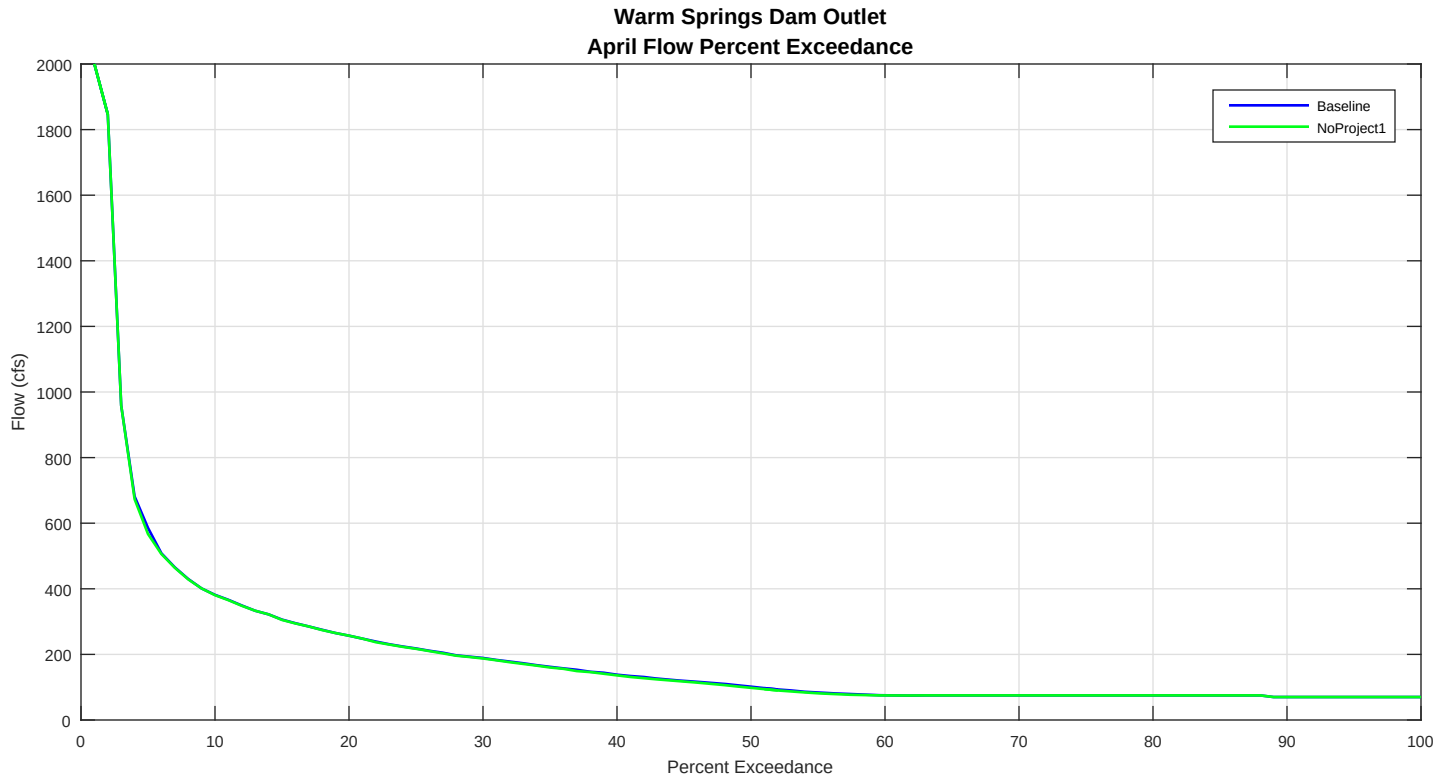
Warm Springs Dam Outlet
April Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
200
400
600
800
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1200
1400
1600
1800
2000
0
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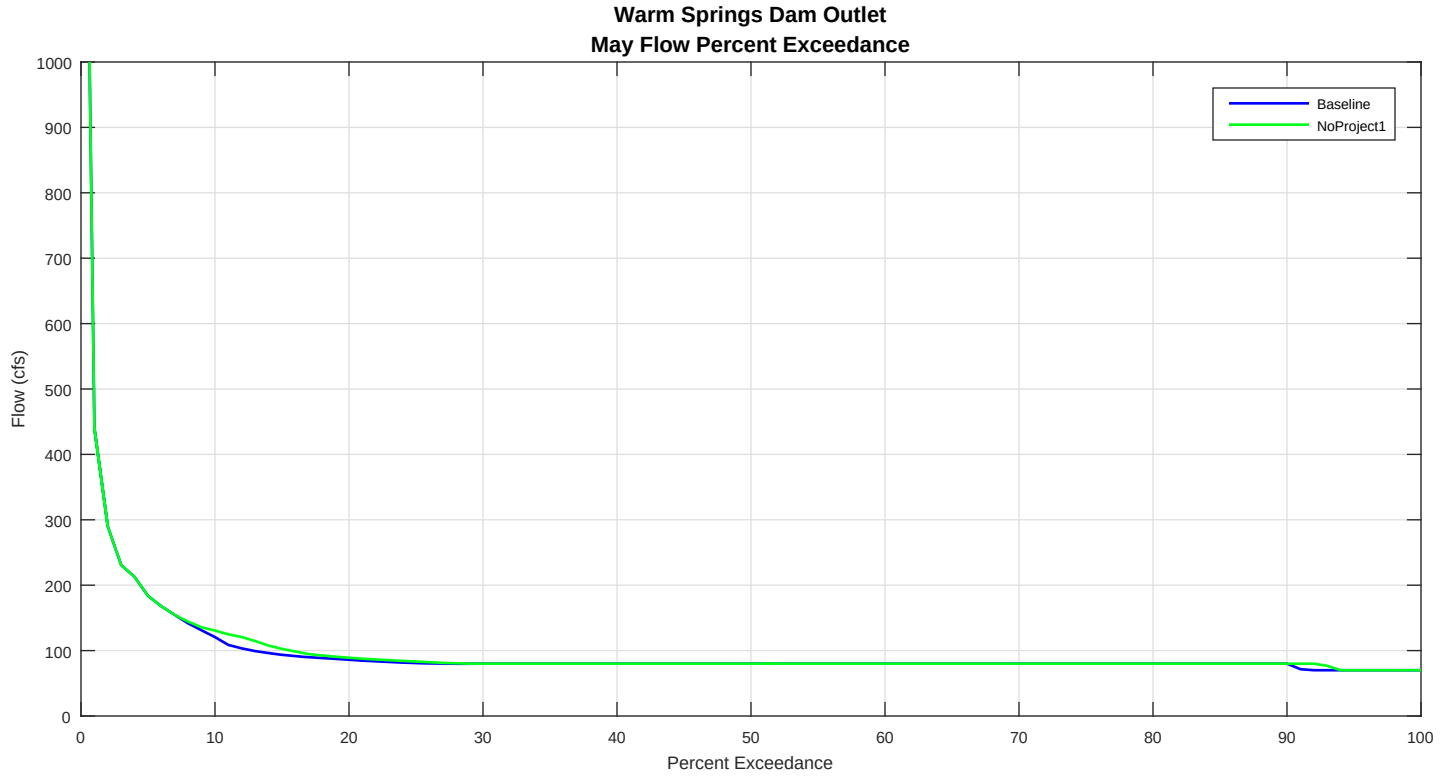
Warm Springs Dam Outlet
May Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
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1000
0
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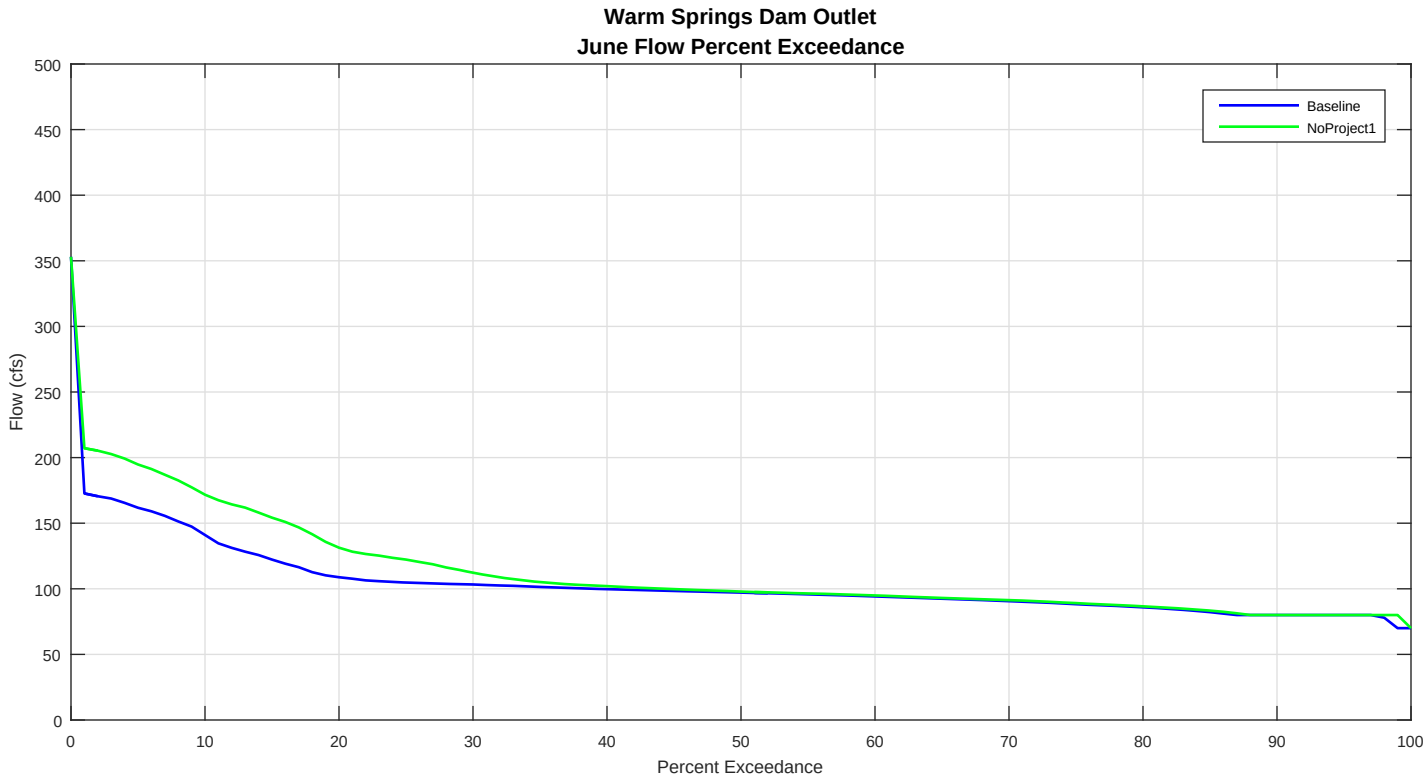
Warm Springs Dam Outlet
June Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
50
100
150
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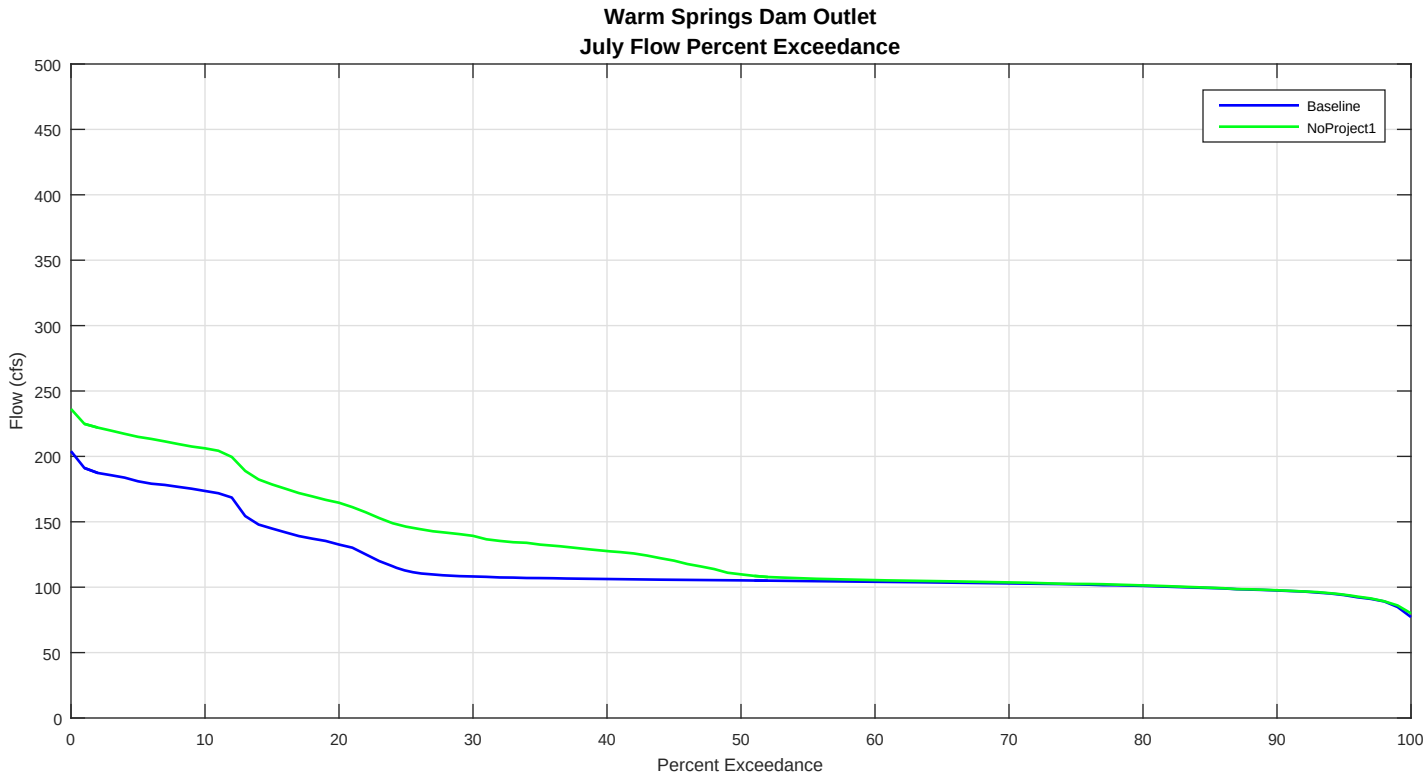
Warm Springs Dam Outlet
July Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
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500
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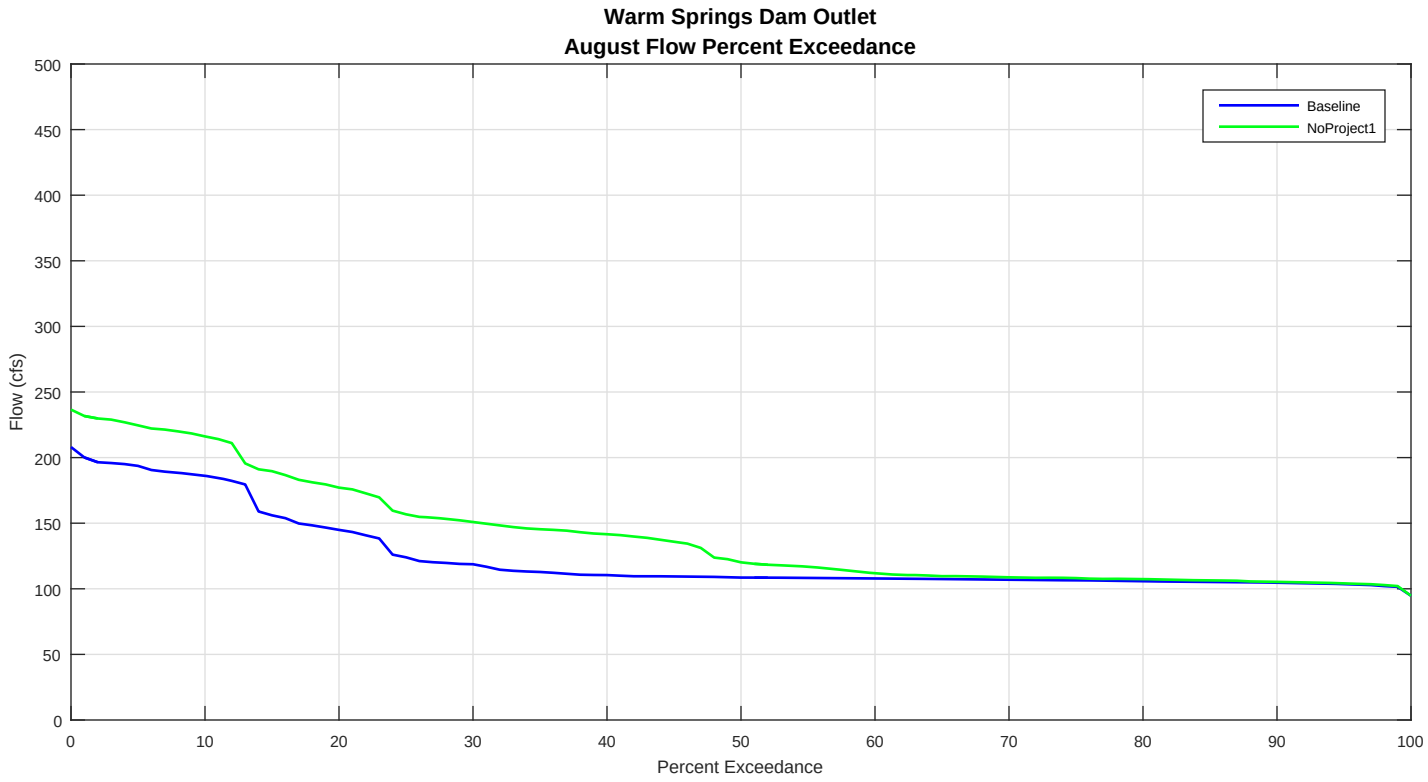
Warm Springs Dam Outlet
August Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
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500
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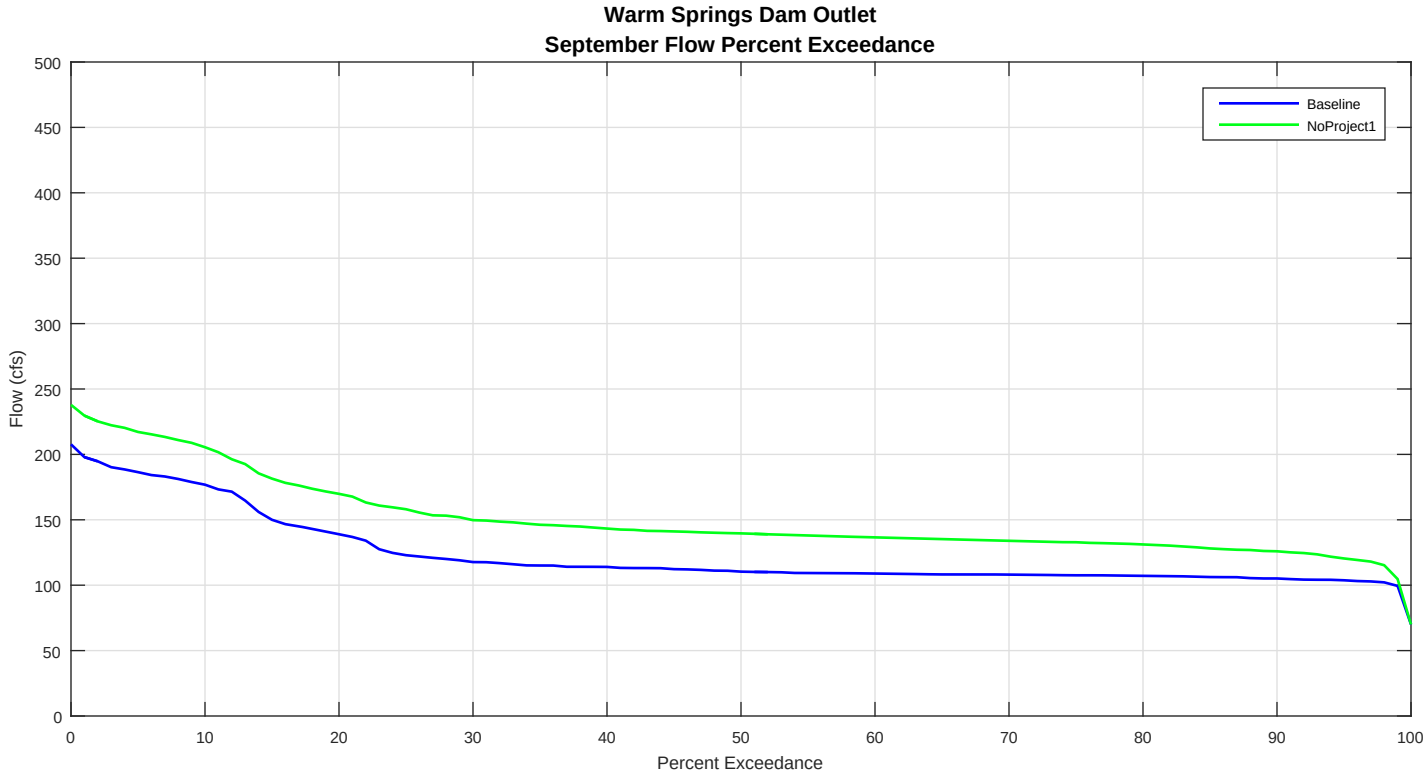
Warm Springs Dam Outlet
September Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
50
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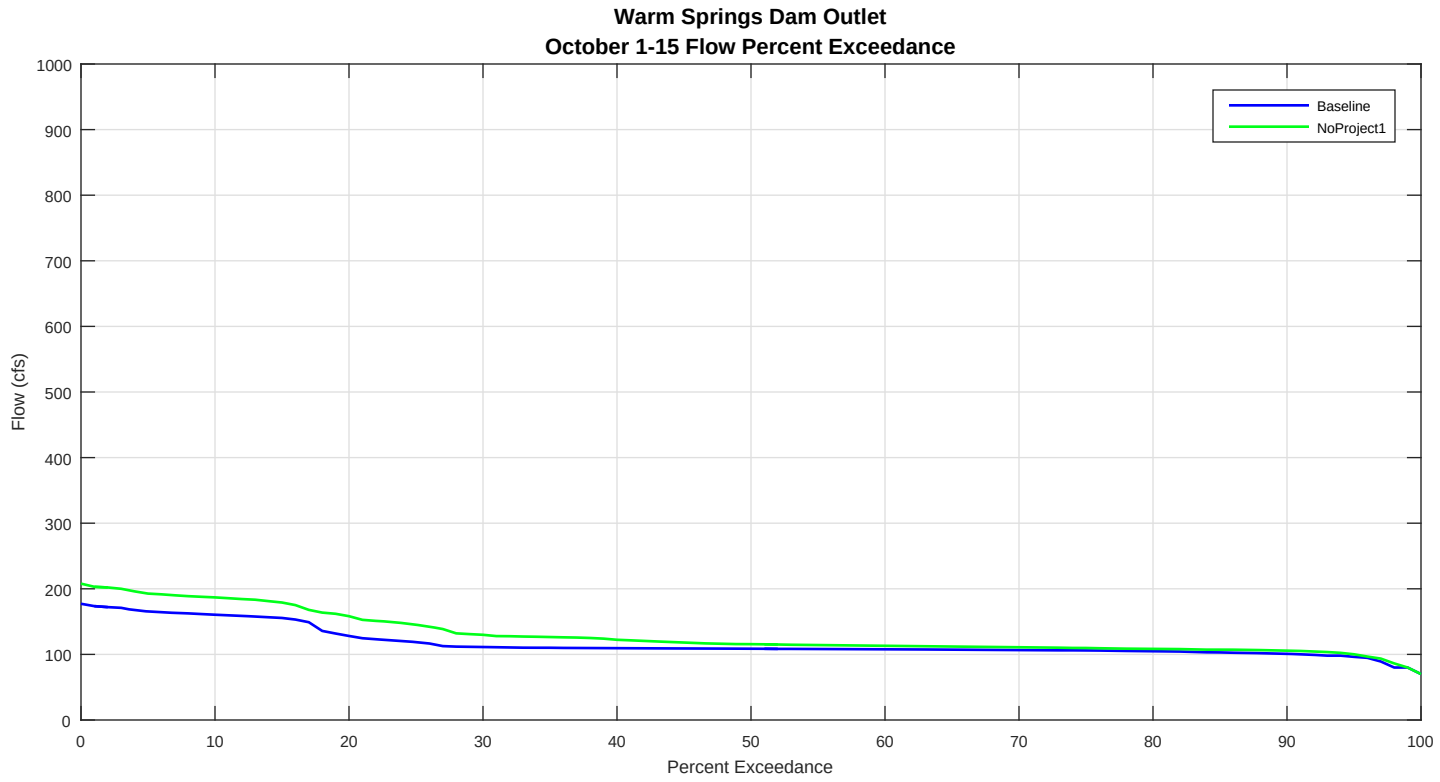
Warm Springs Dam Outlet
October 1-15 Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
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900
1000
0
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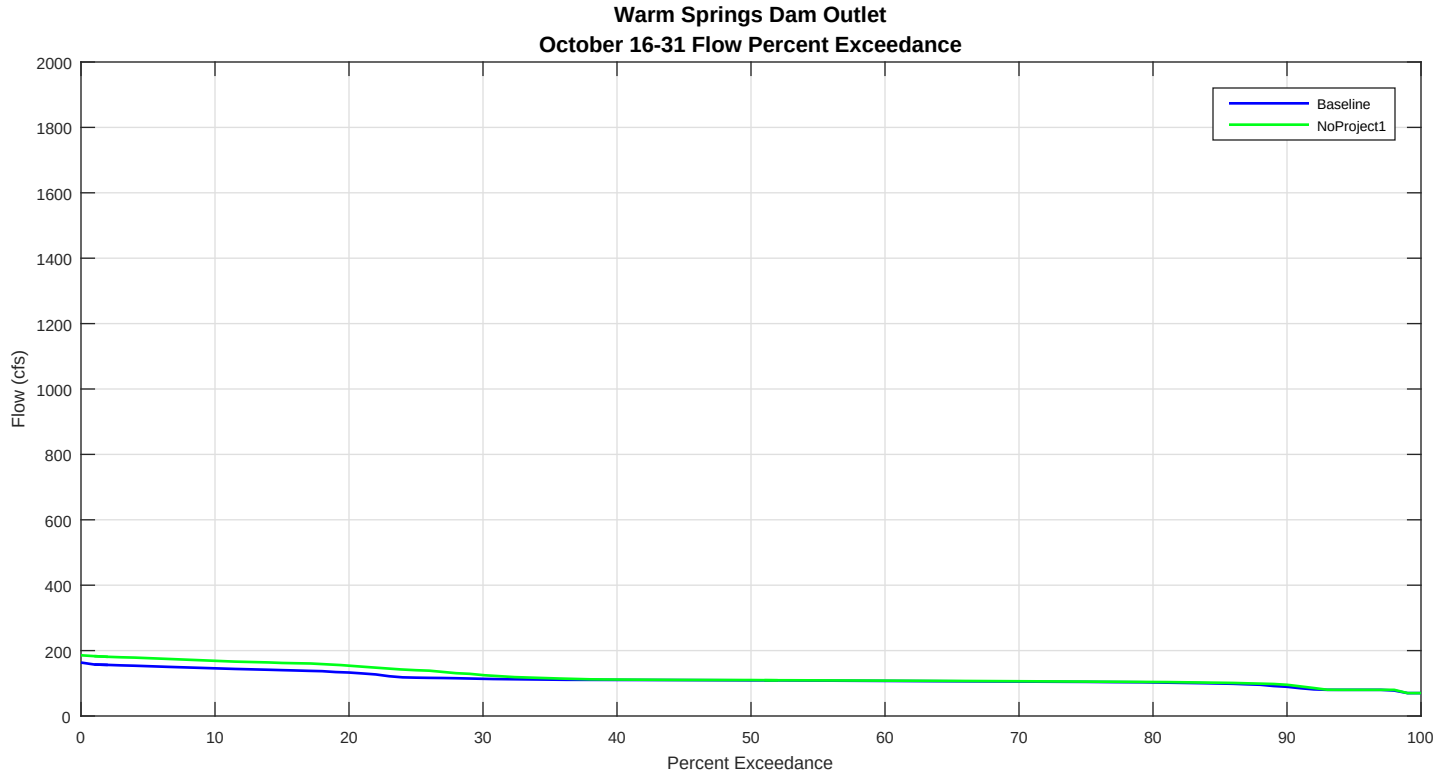
Warm Springs Dam Outlet
October 16-31 Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
200
400
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800
1000
1200
1400
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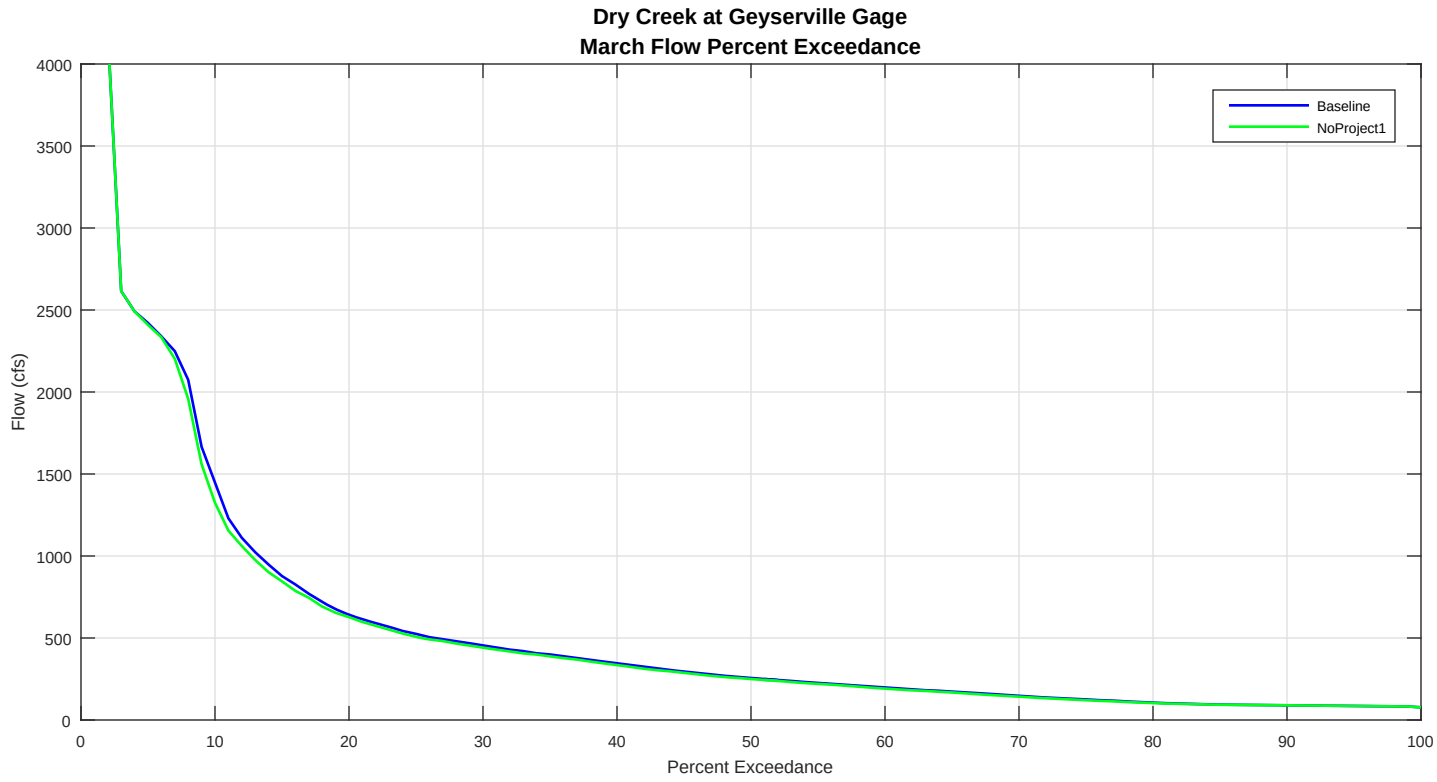
Dry Creek at Geyserville Gage
March Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
500
1000
1500
2000
2500
3000
3500
4000
0
10
20
30
40
50
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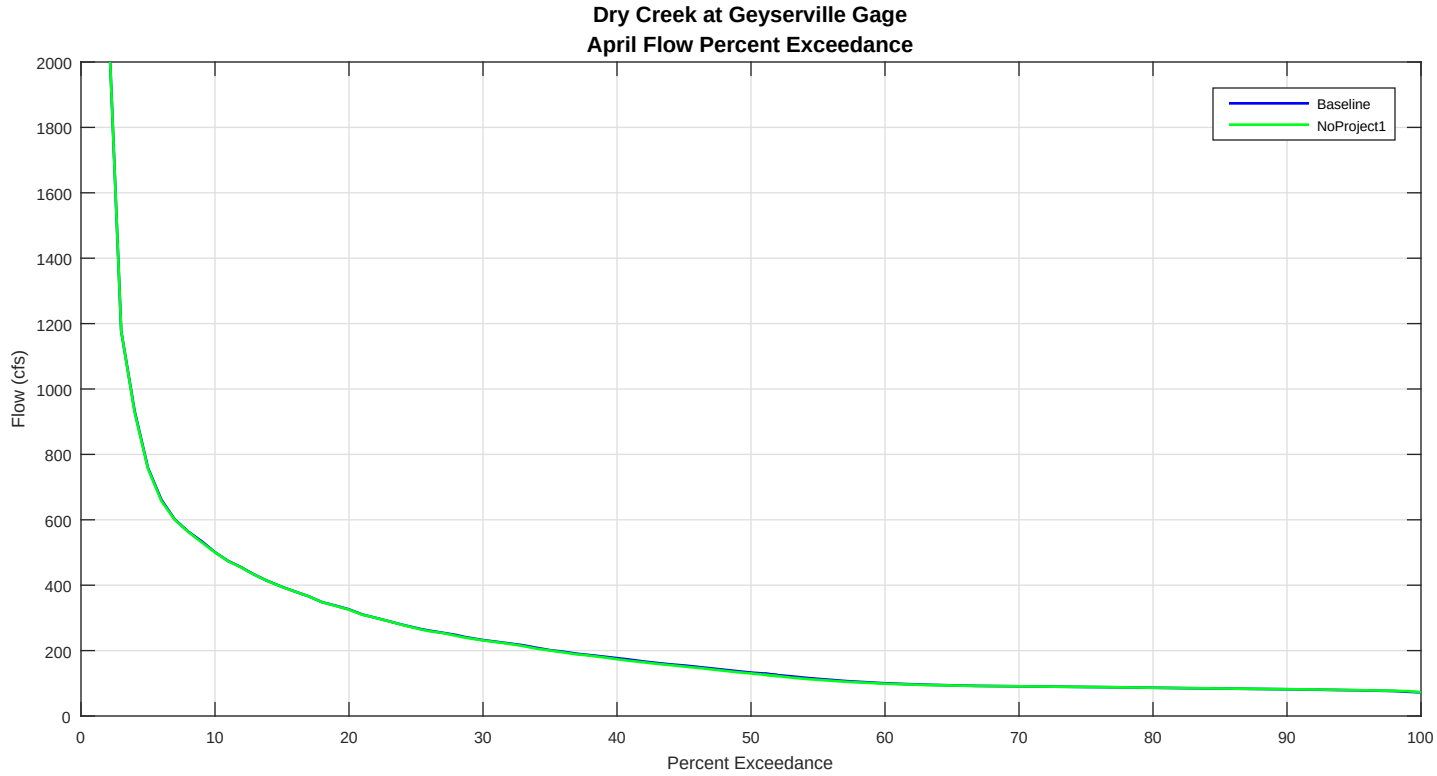
70
80
90
100


Dry Creek at Geyserville Gage
April Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
200
400
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800
1000
1200
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1600
1800
2000
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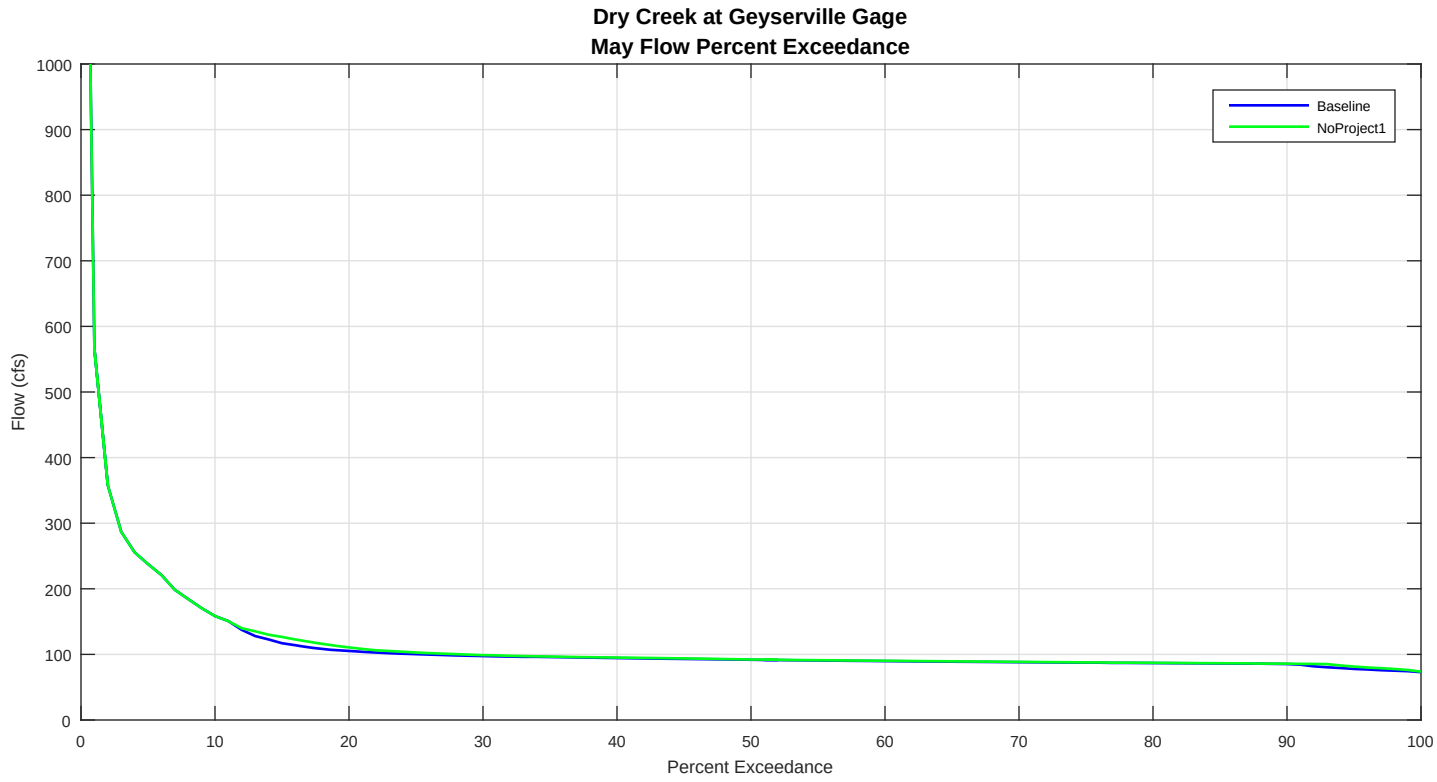
Dry Creek at Geyserville Gage
May Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
100
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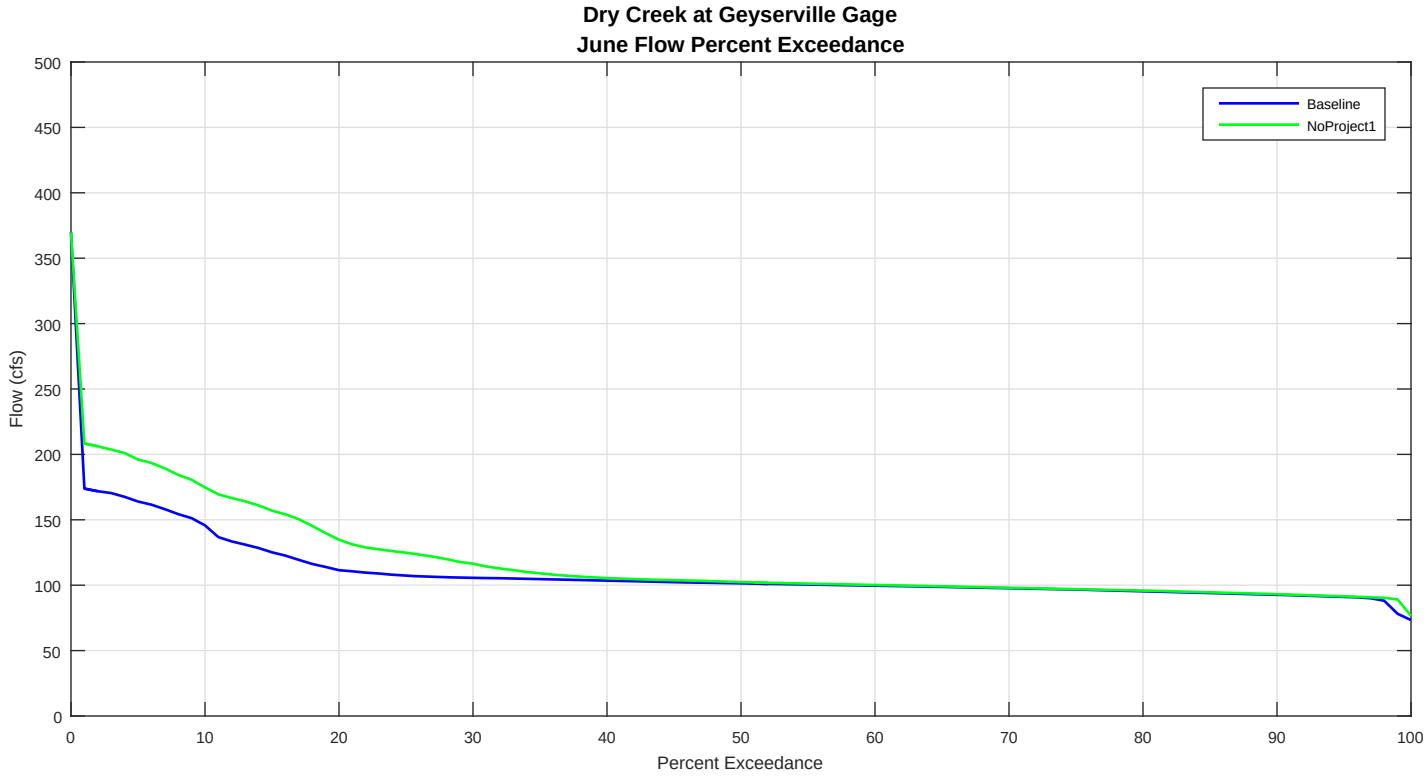
Dry Creek at Geyserville Gage
June Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
50
100
150
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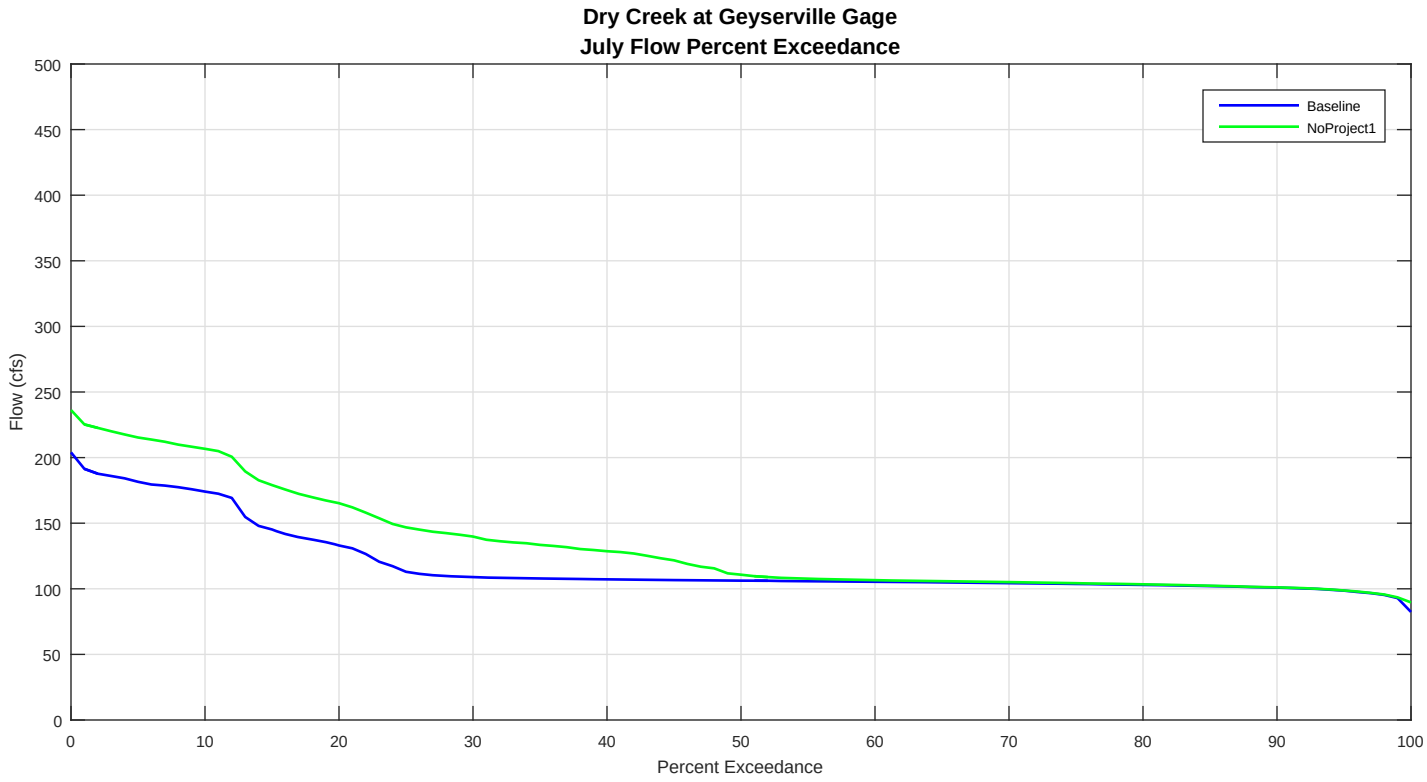
Dry Creek at Geyserville Gage
July Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
50
100
150
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450
500
0
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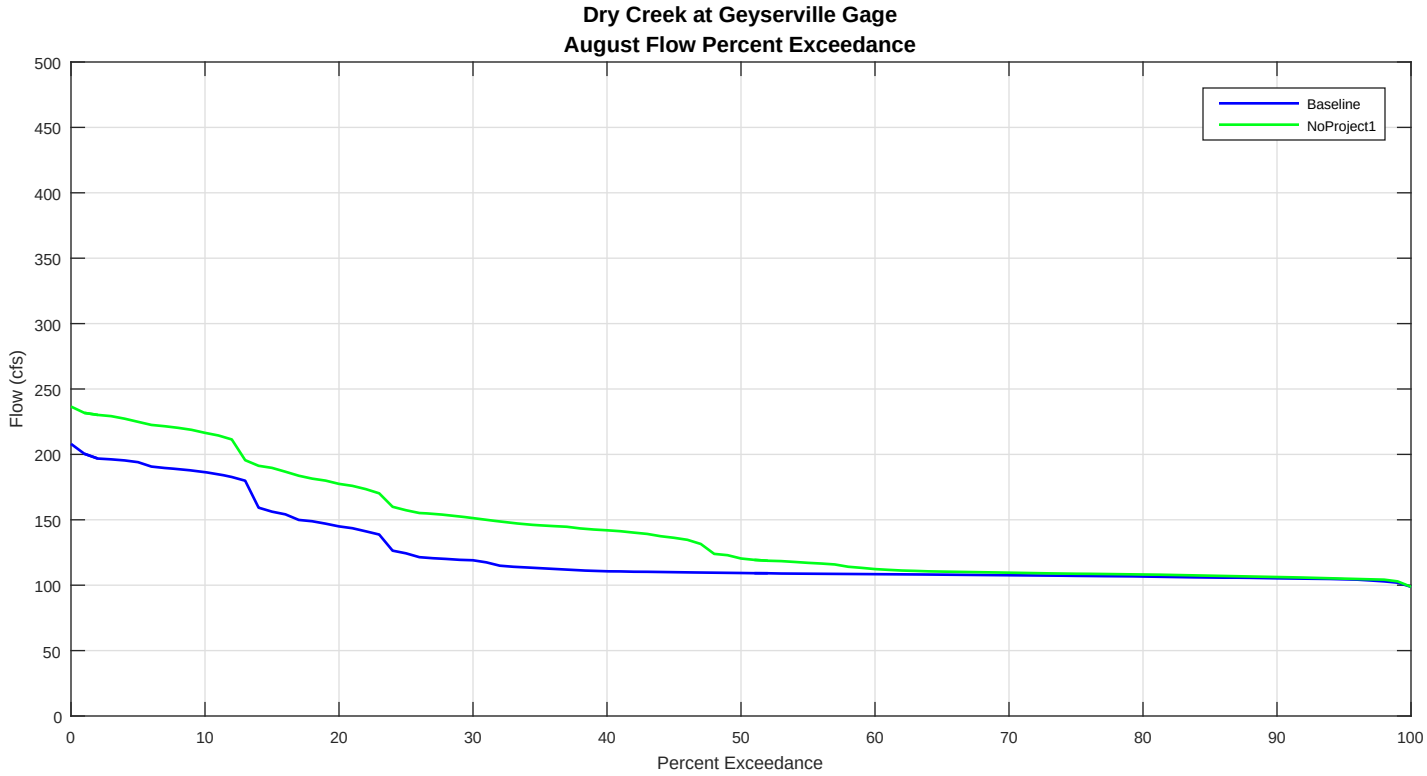
Dry Creek at Geyserville Gage
August Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
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500
0
10
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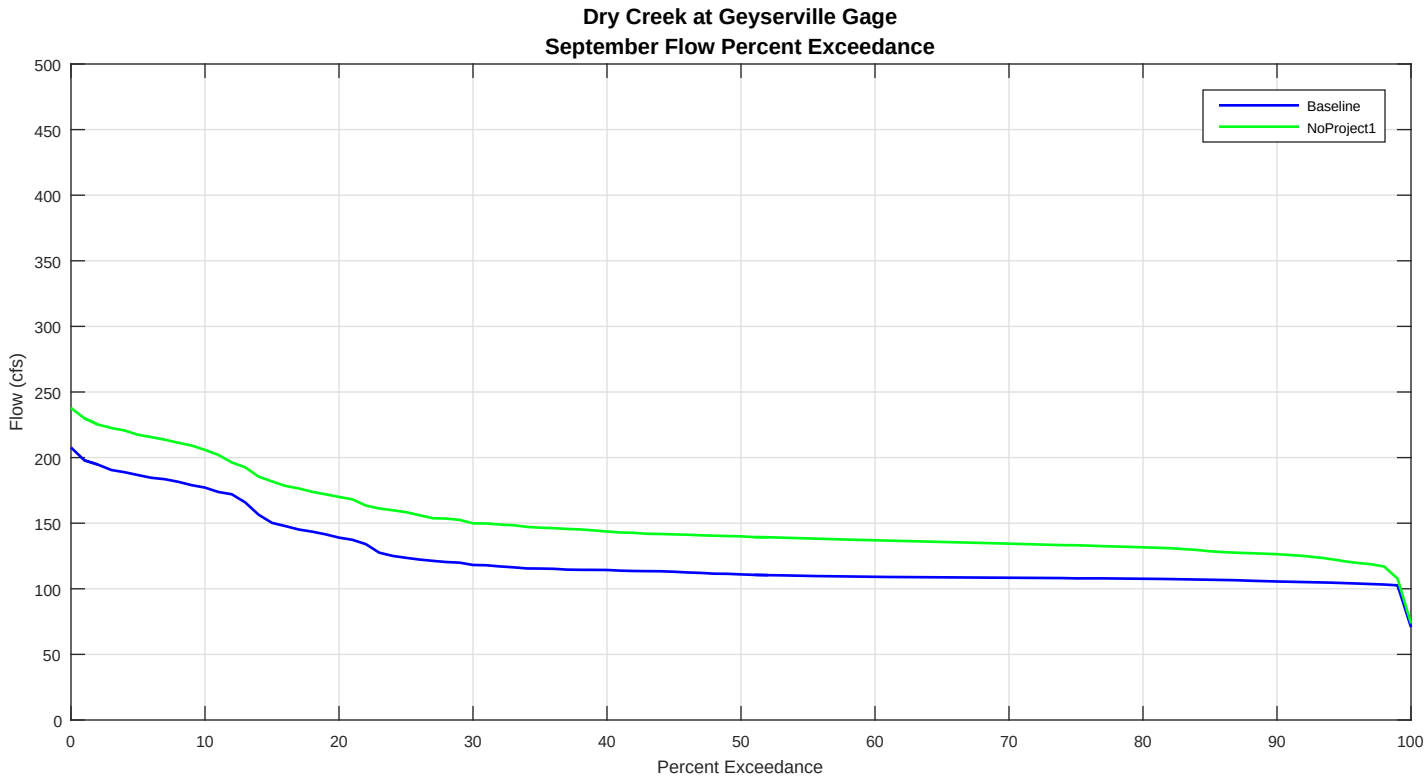
Dry Creek at Geyserville Gage
September Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
50
100
150
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500
0
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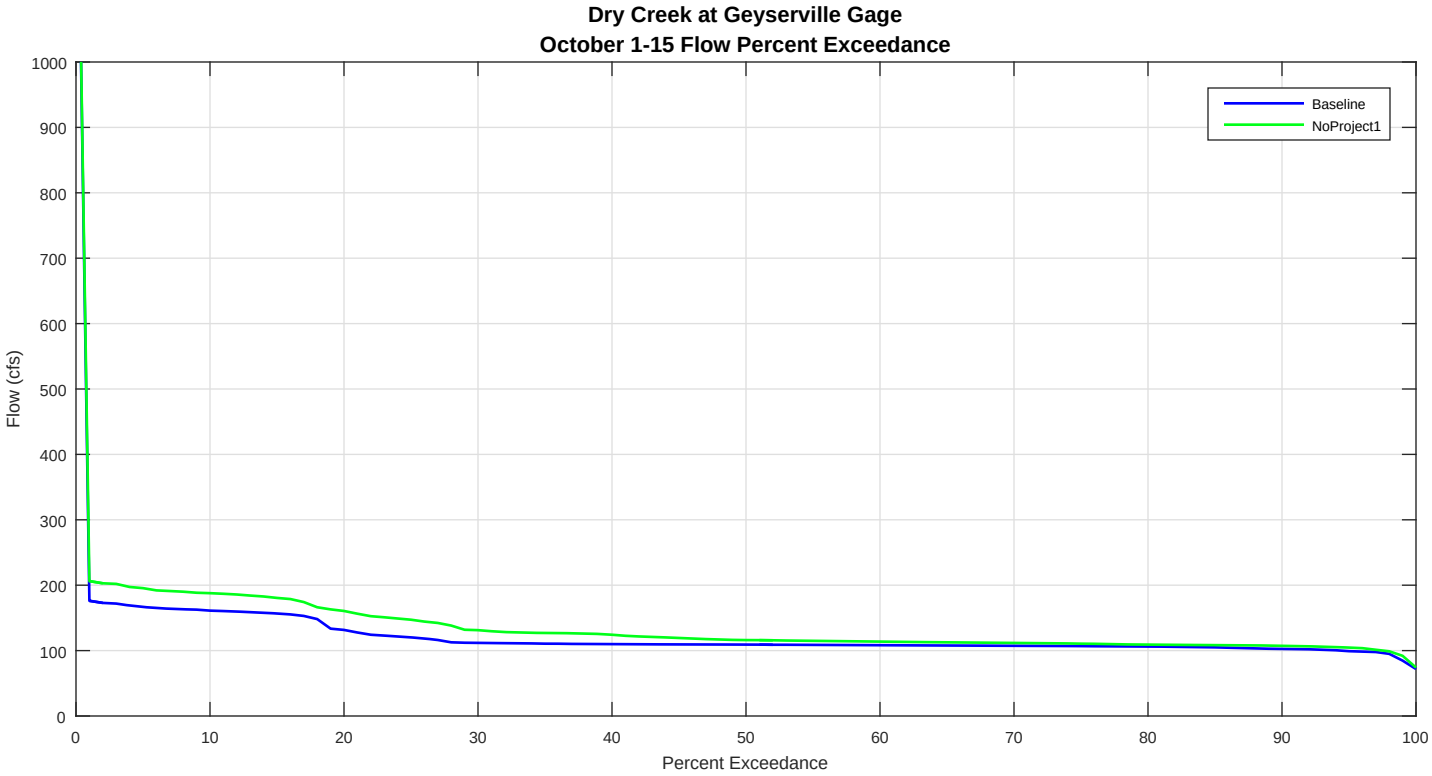
Dry Creek at Geyserville Gage
October 1-15 Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
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70
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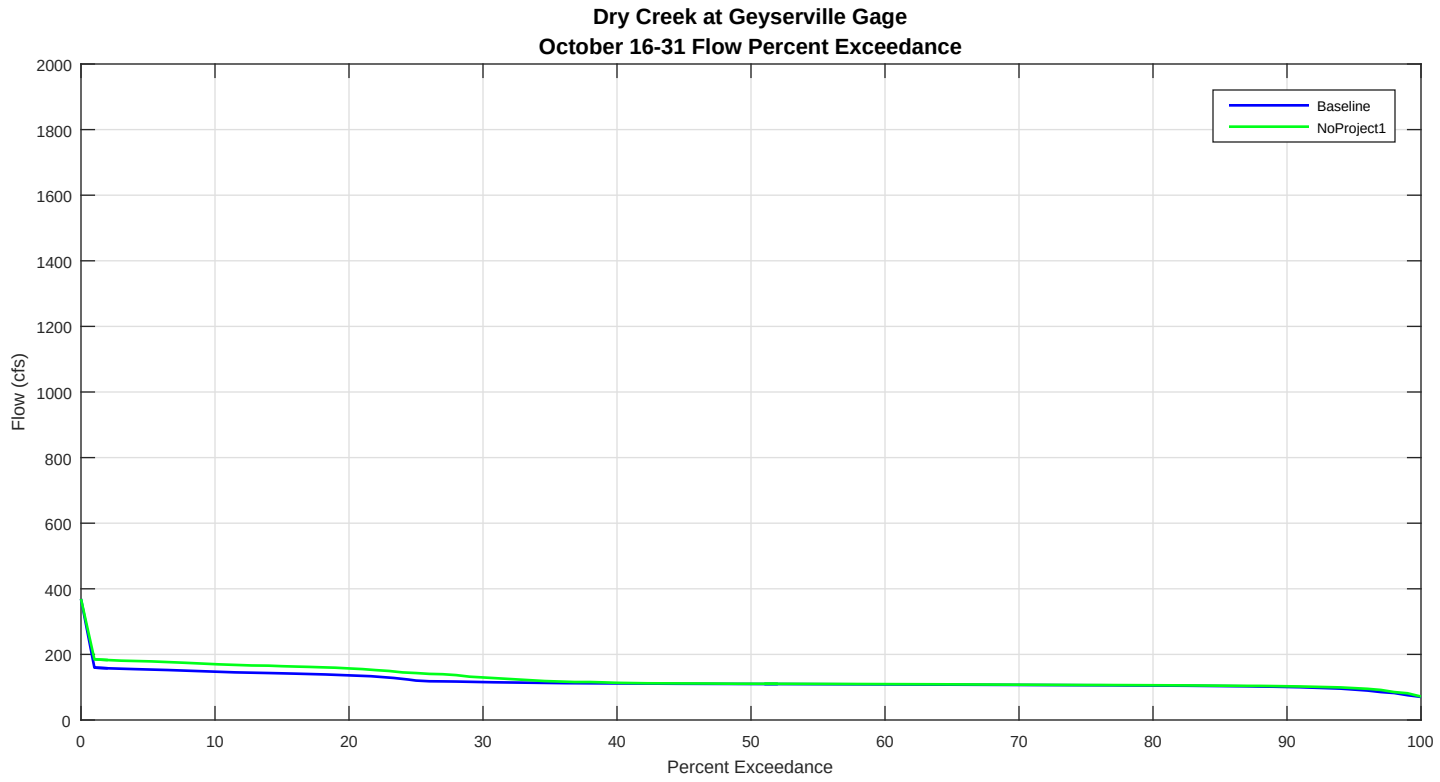
90
100


Dry Creek at Geyserville Gage
October 16-31 Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
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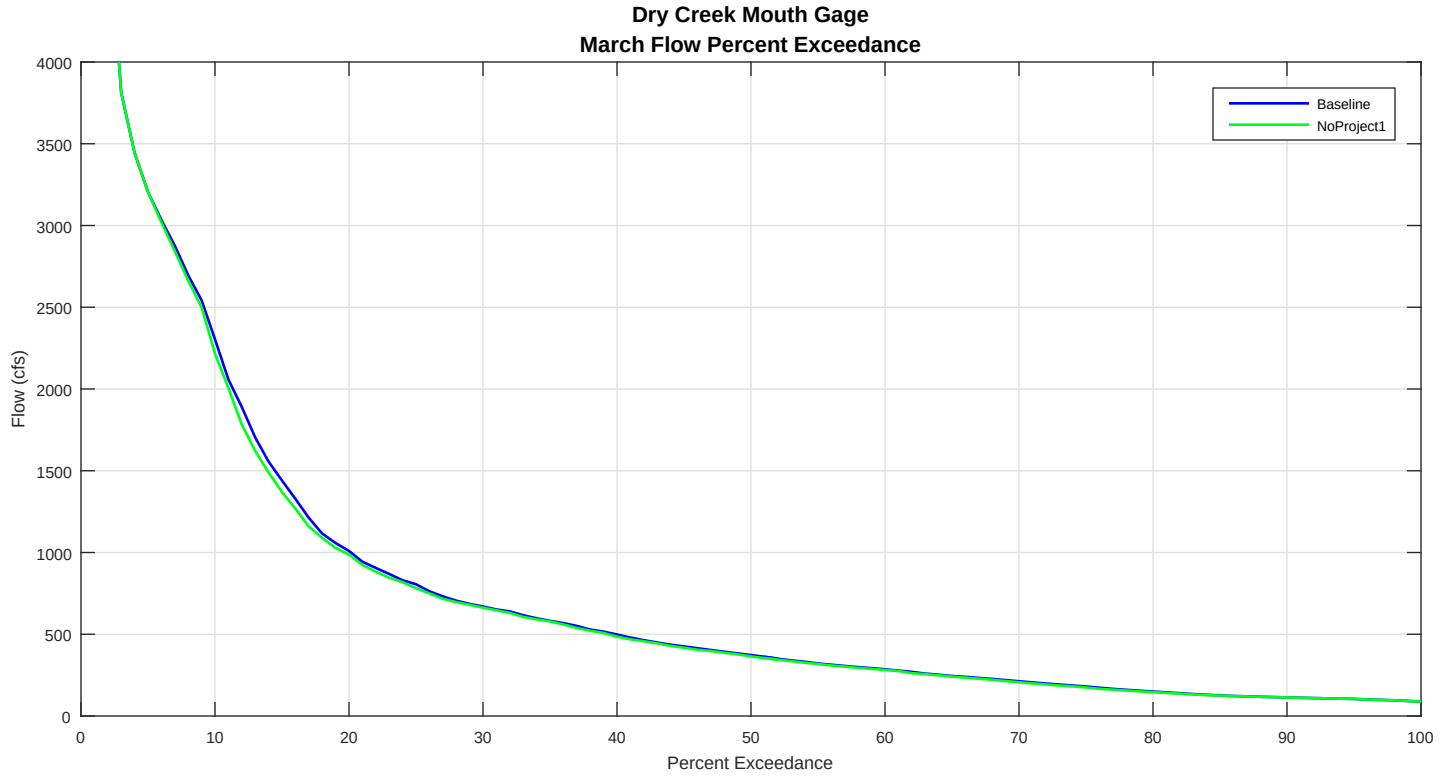
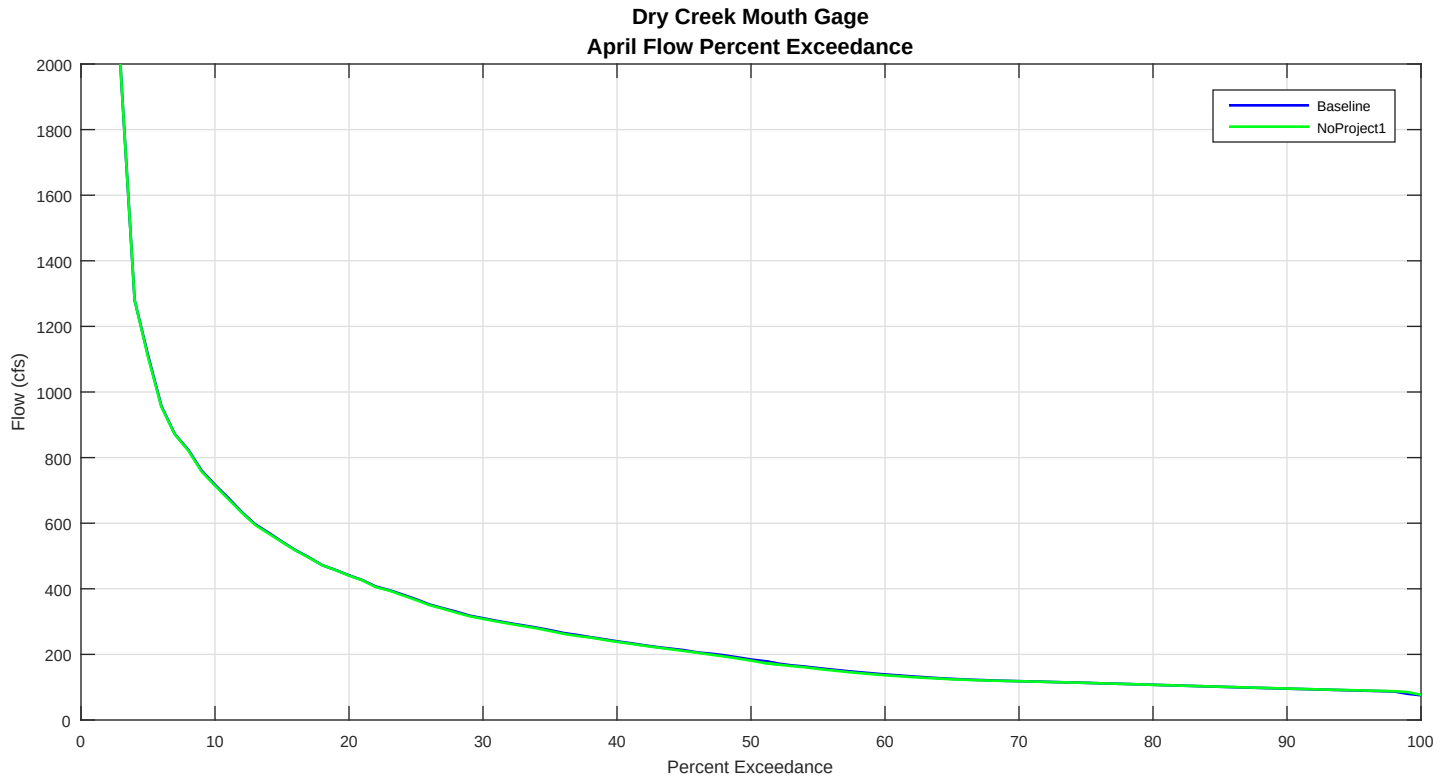

Dry Creek Mouth Gage
March Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
500
1000
1500
2000
2500
3000
3500
4000
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
April Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
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30
40
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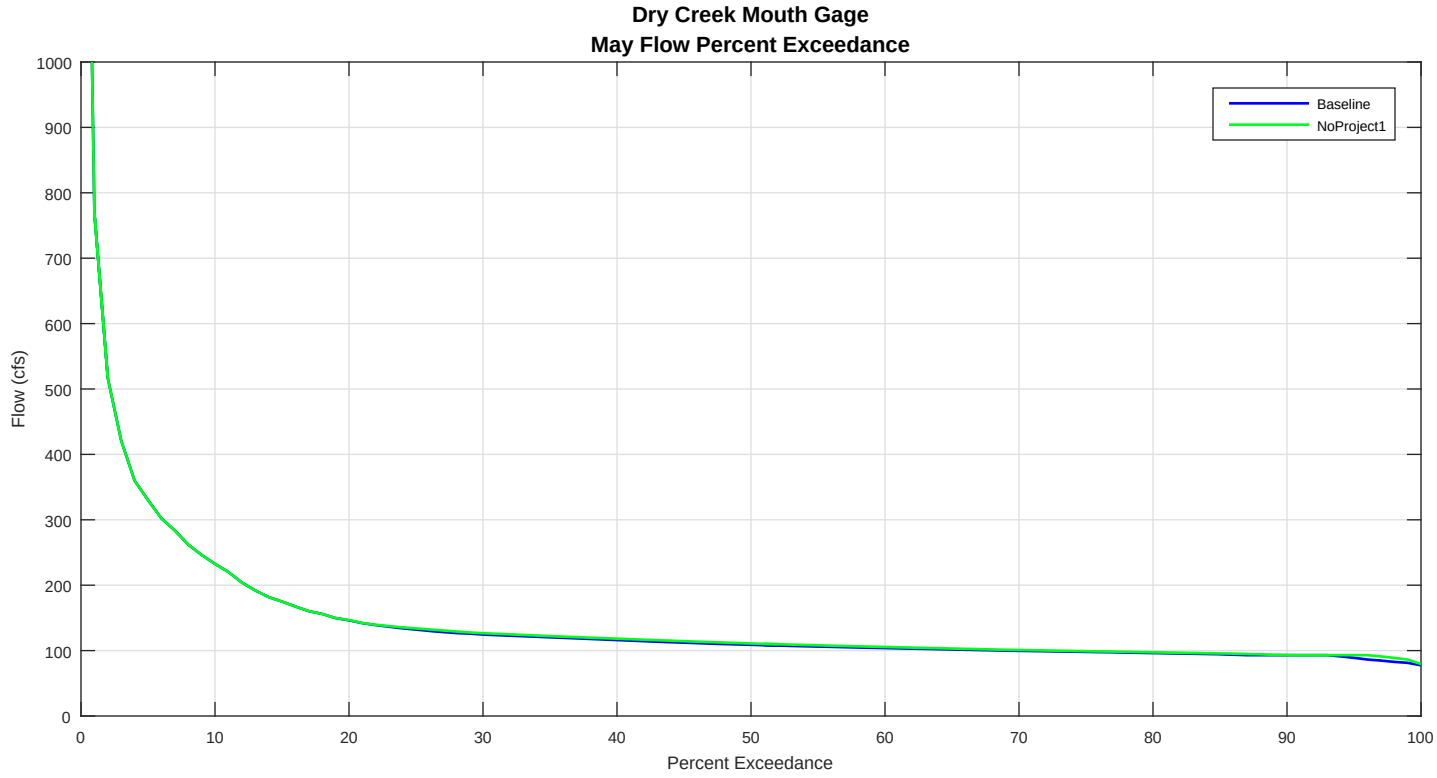
Dry Creek Mouth Gage
May Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
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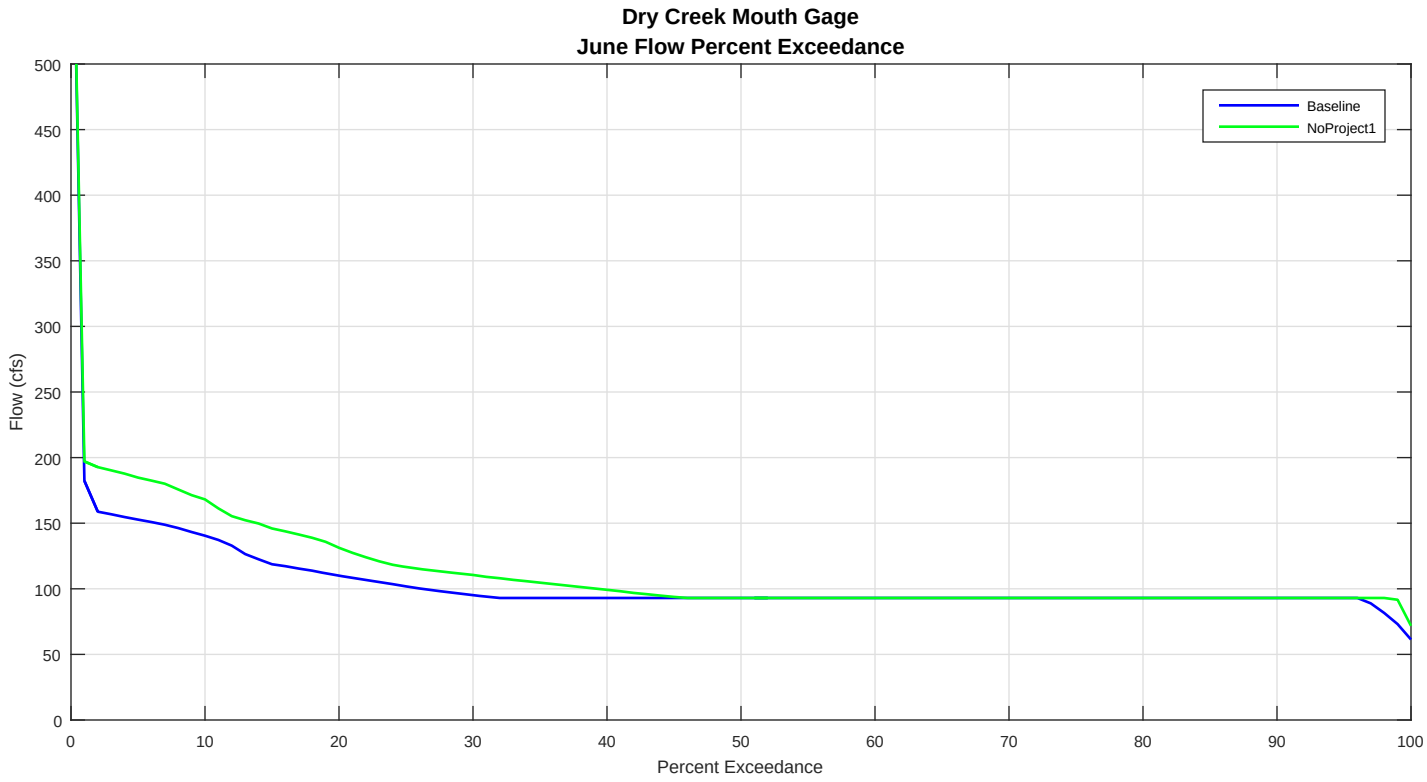
Dry Creek Mouth Gage
June Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
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20
30
40
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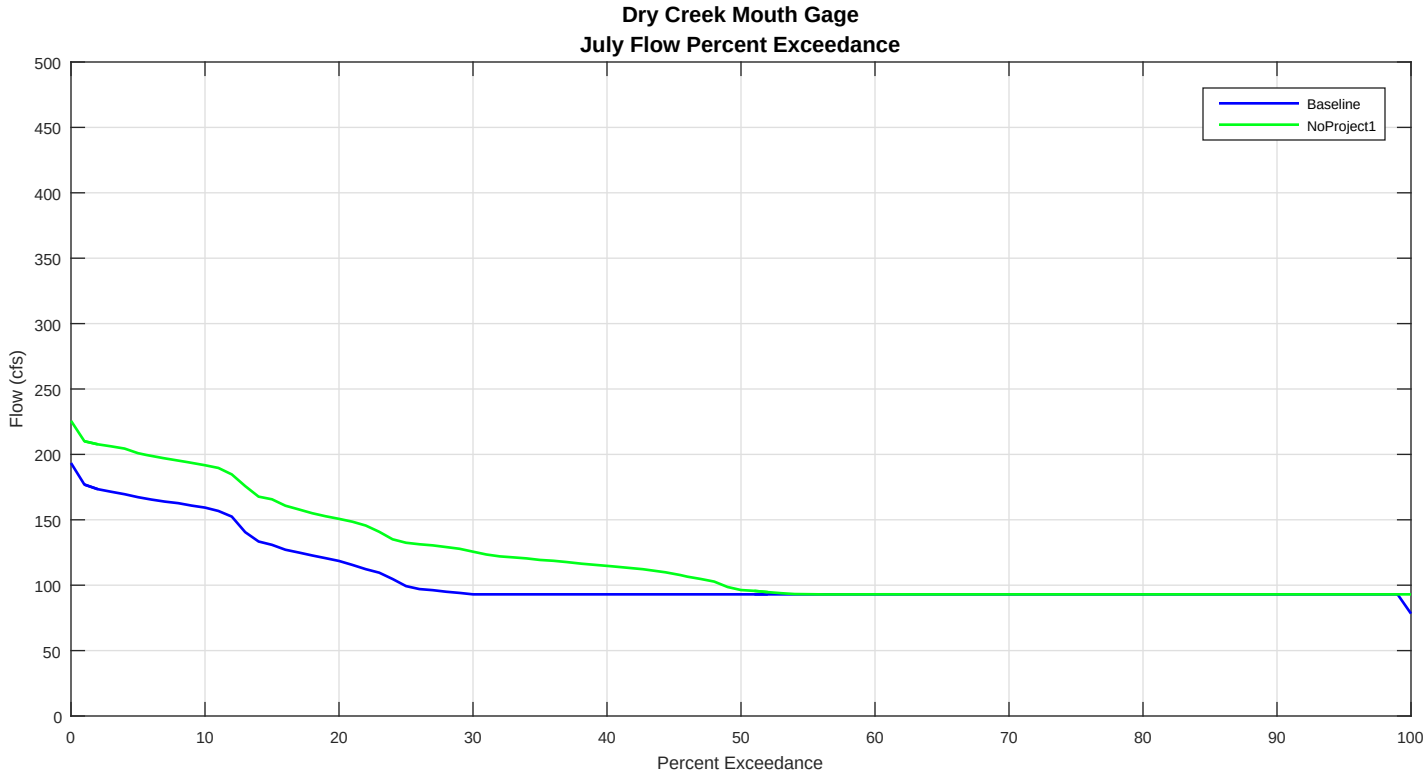
Dry Creek Mouth Gage
July Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
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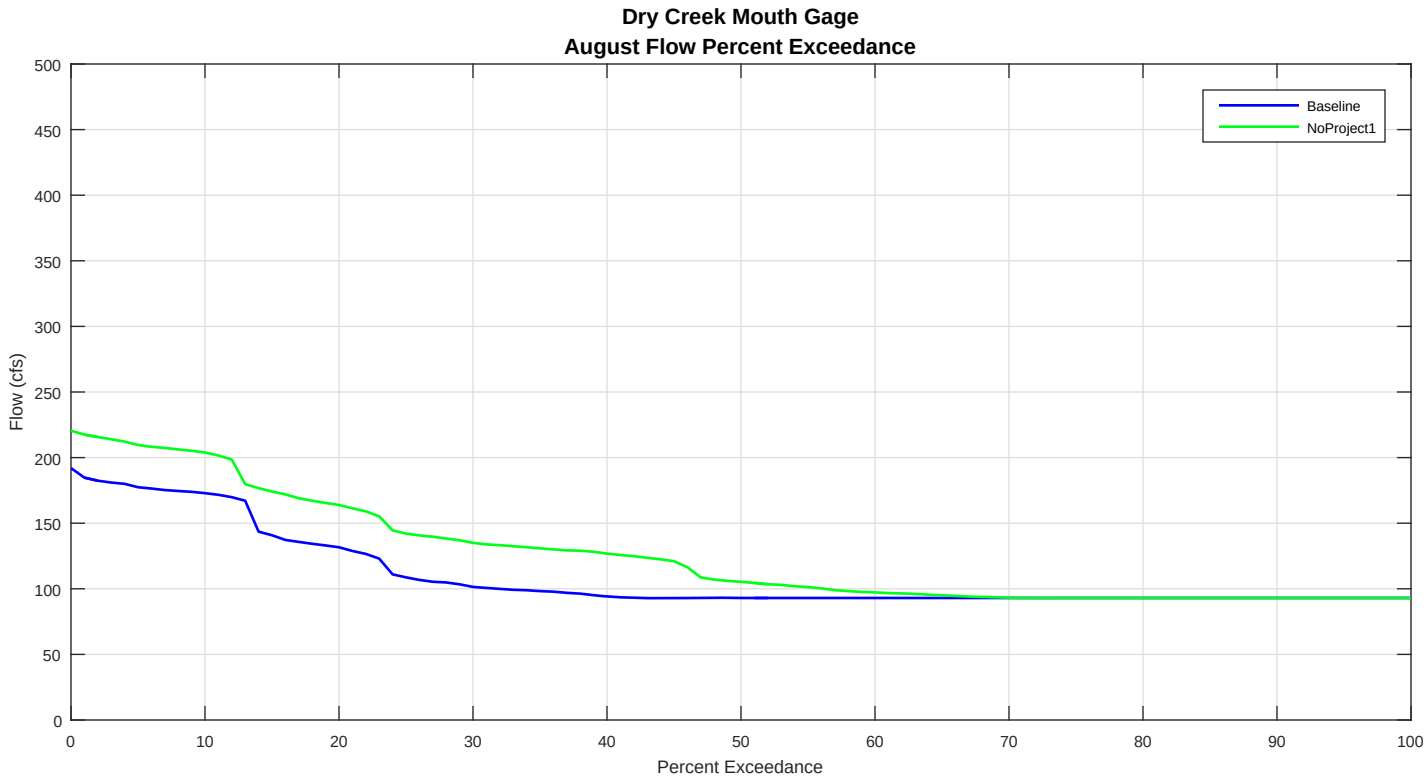
Dry Creek Mouth Gage
August Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
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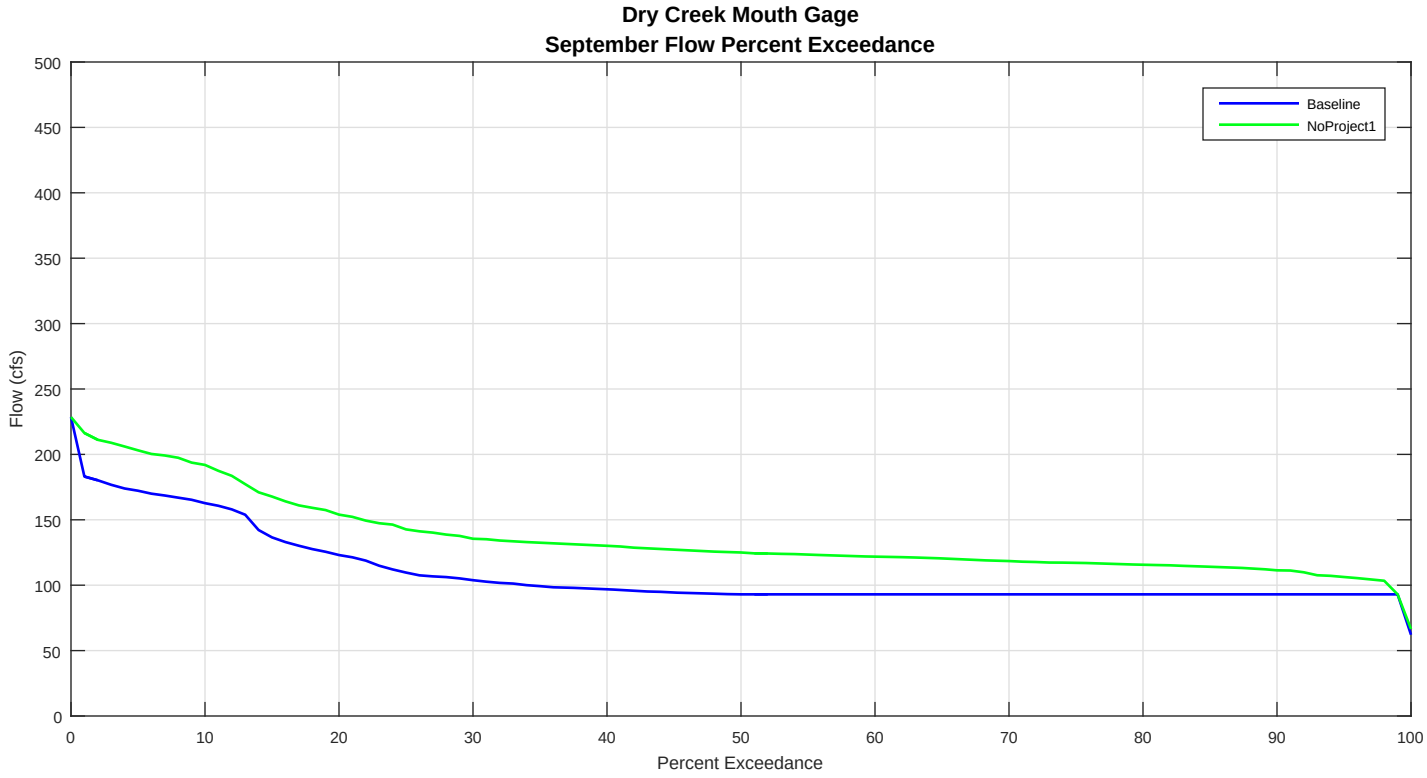
70
80
90
100


Dry Creek Mouth Gage
September Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
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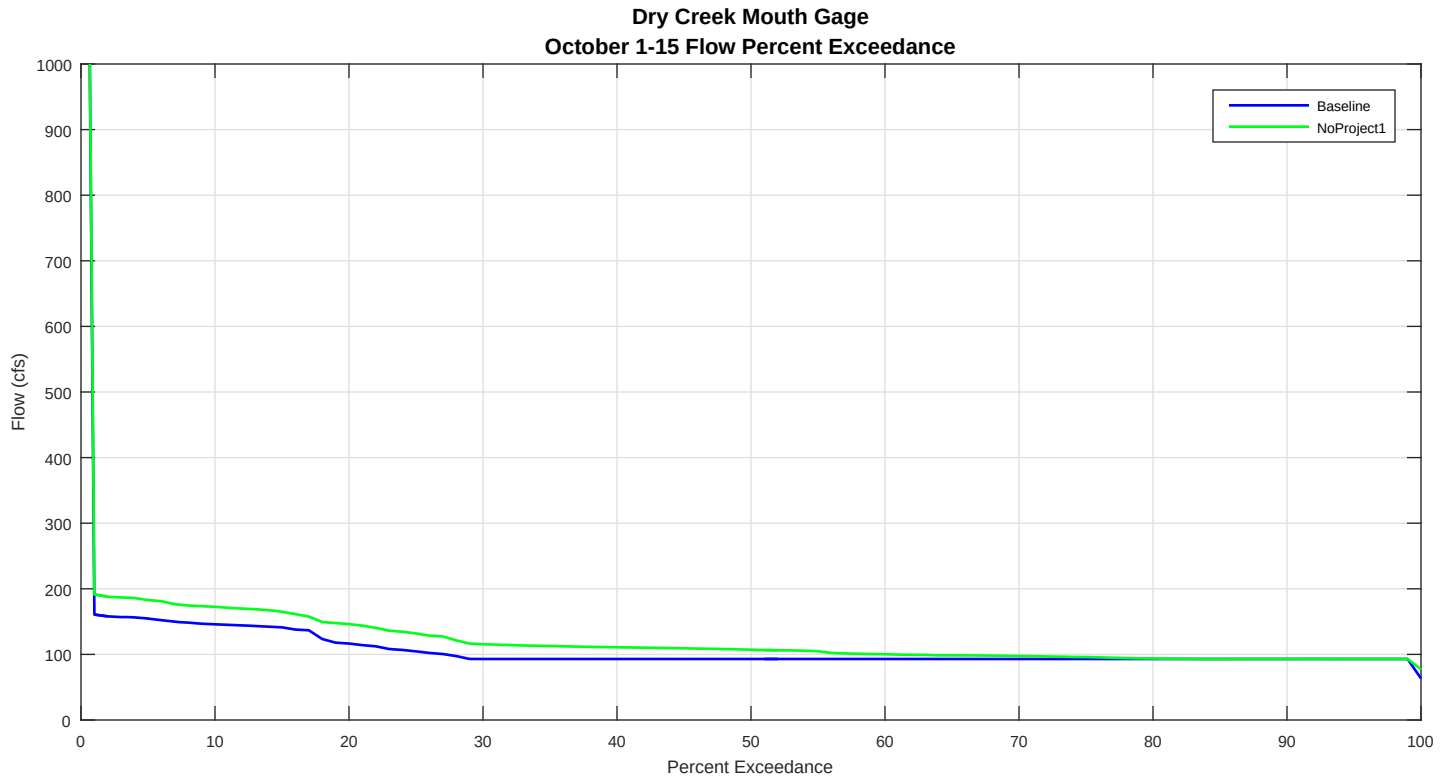
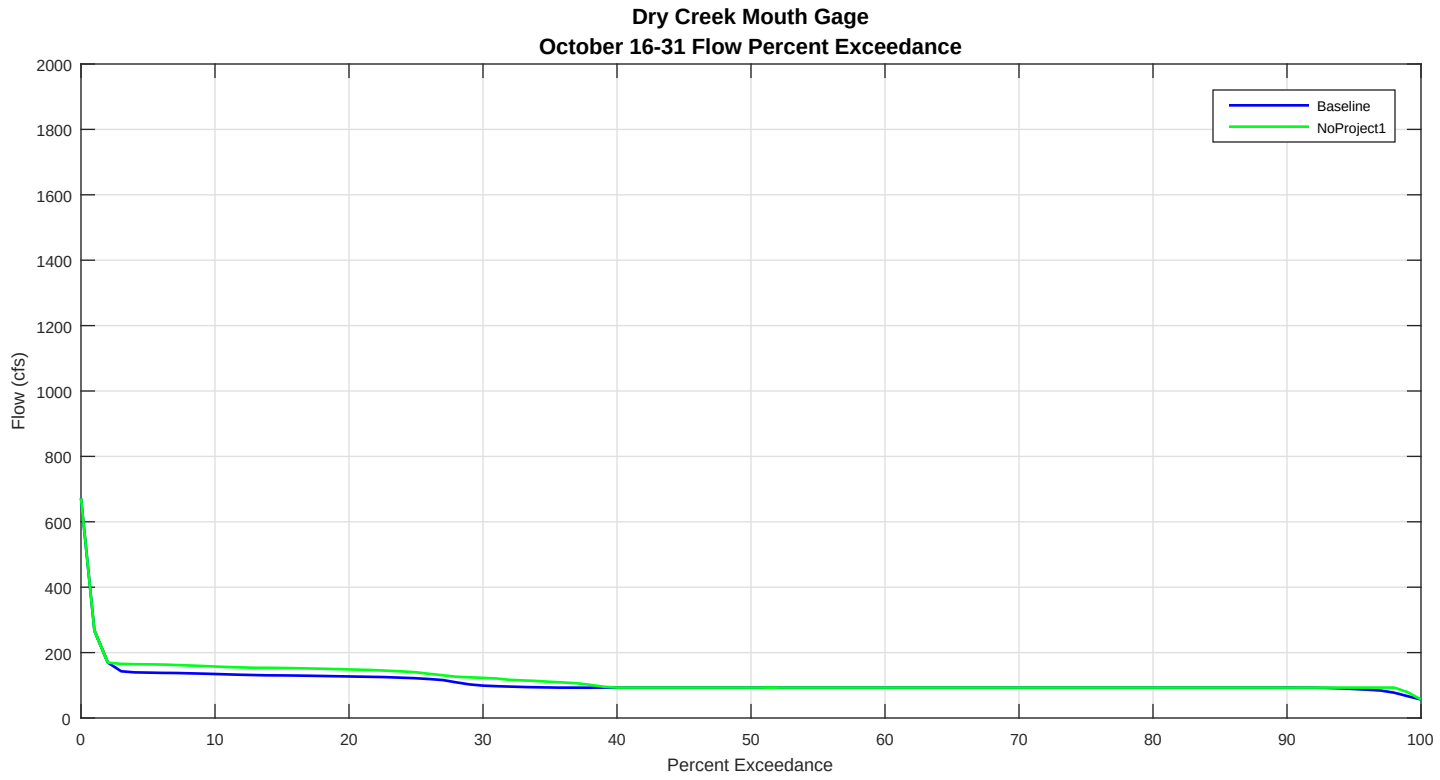
70
80
90
100


Dry Creek Mouth Gage
October 1-15 Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
October 16-31 Flow Percent Exceedance
Baseline
NoProject1
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
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20
30
40
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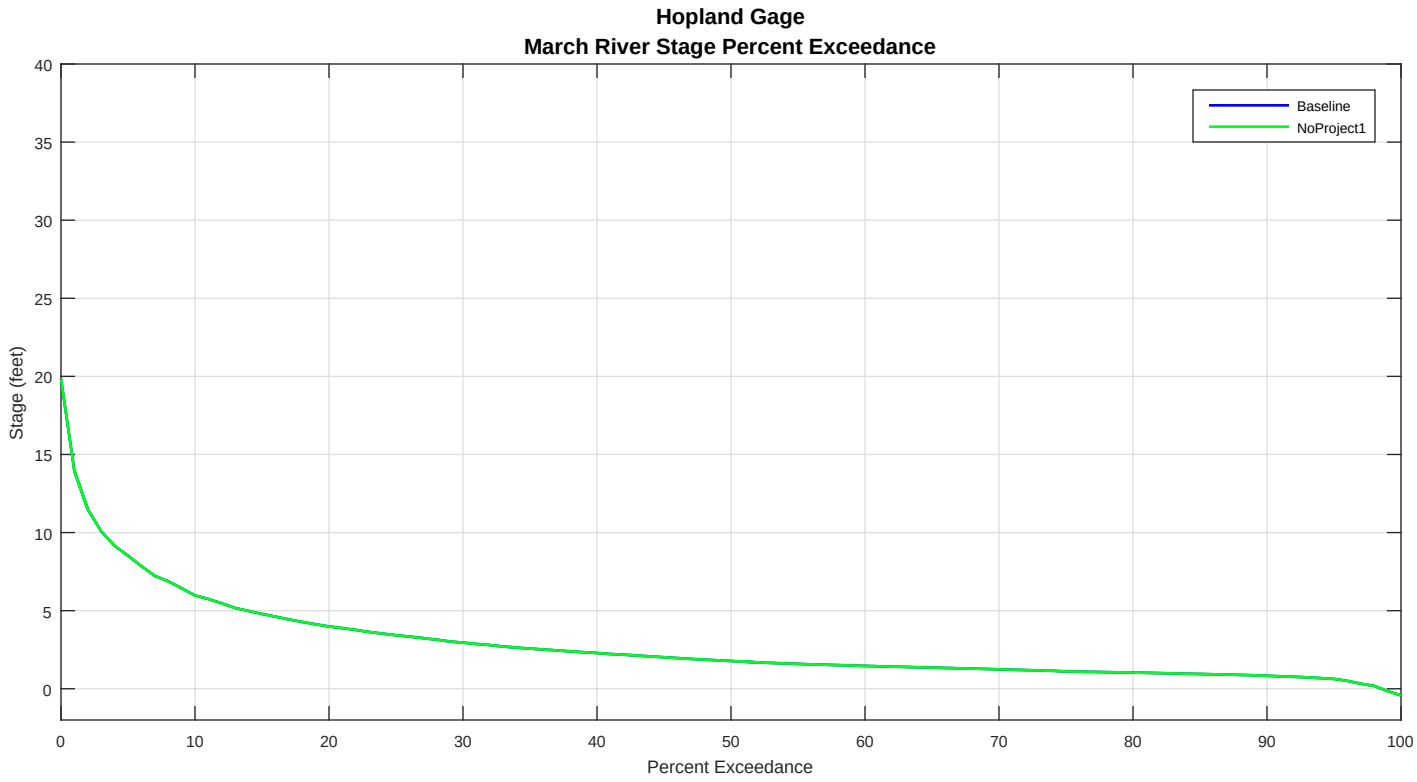
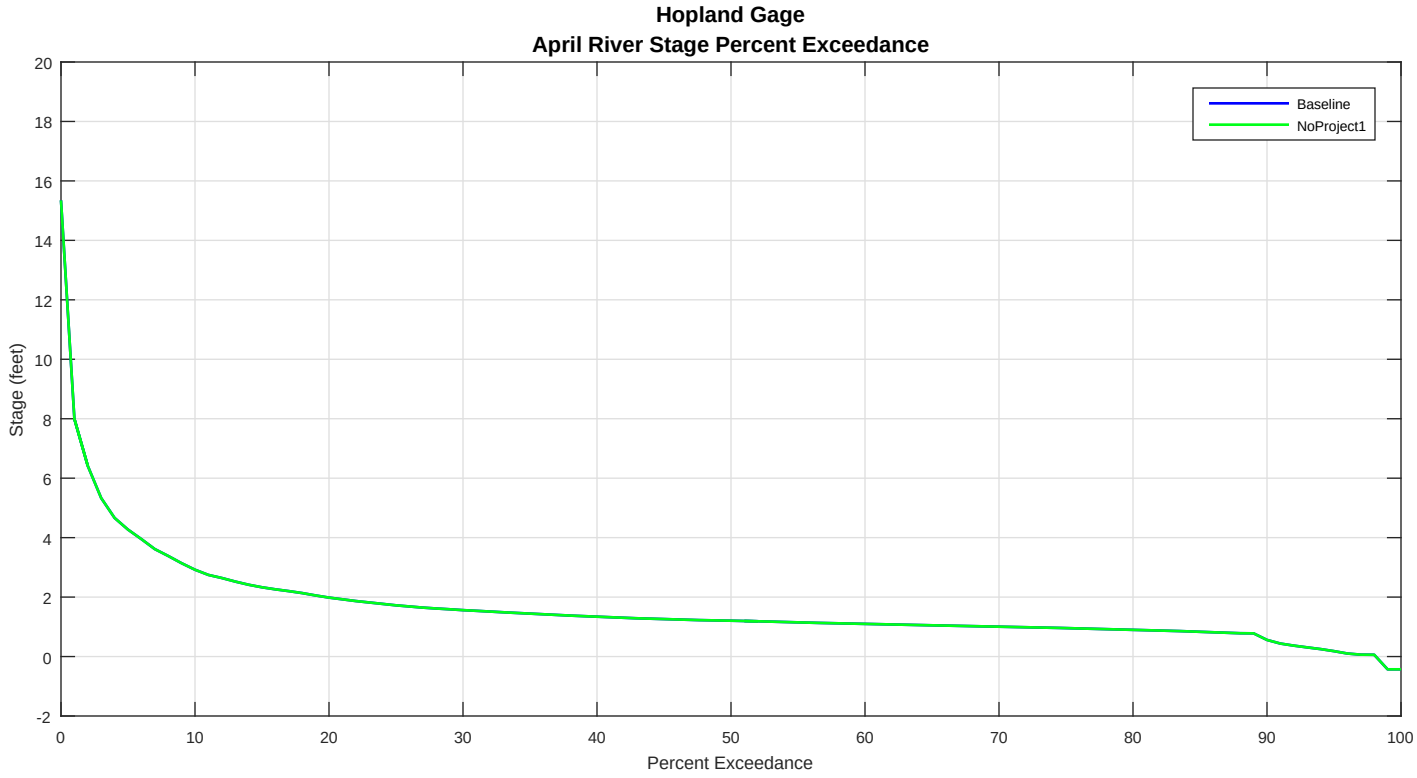
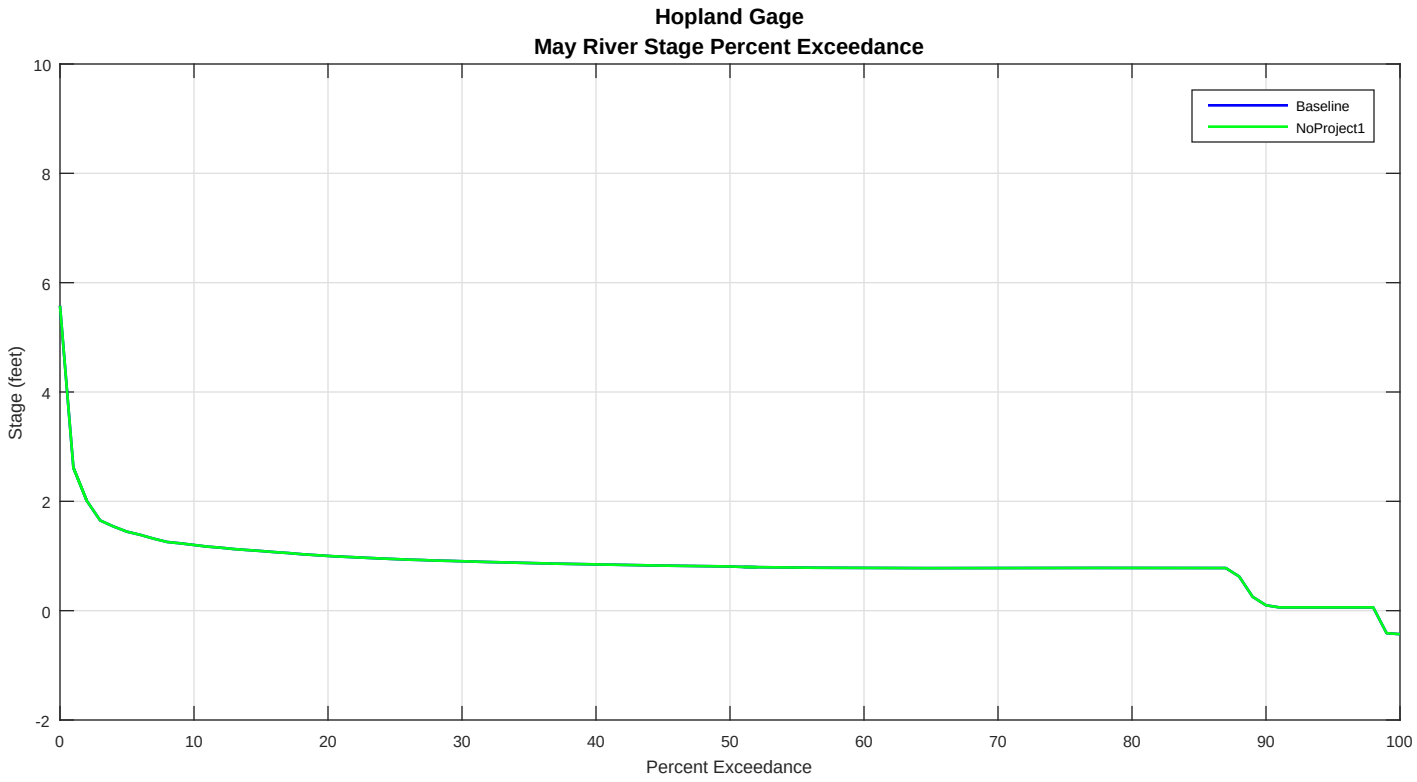
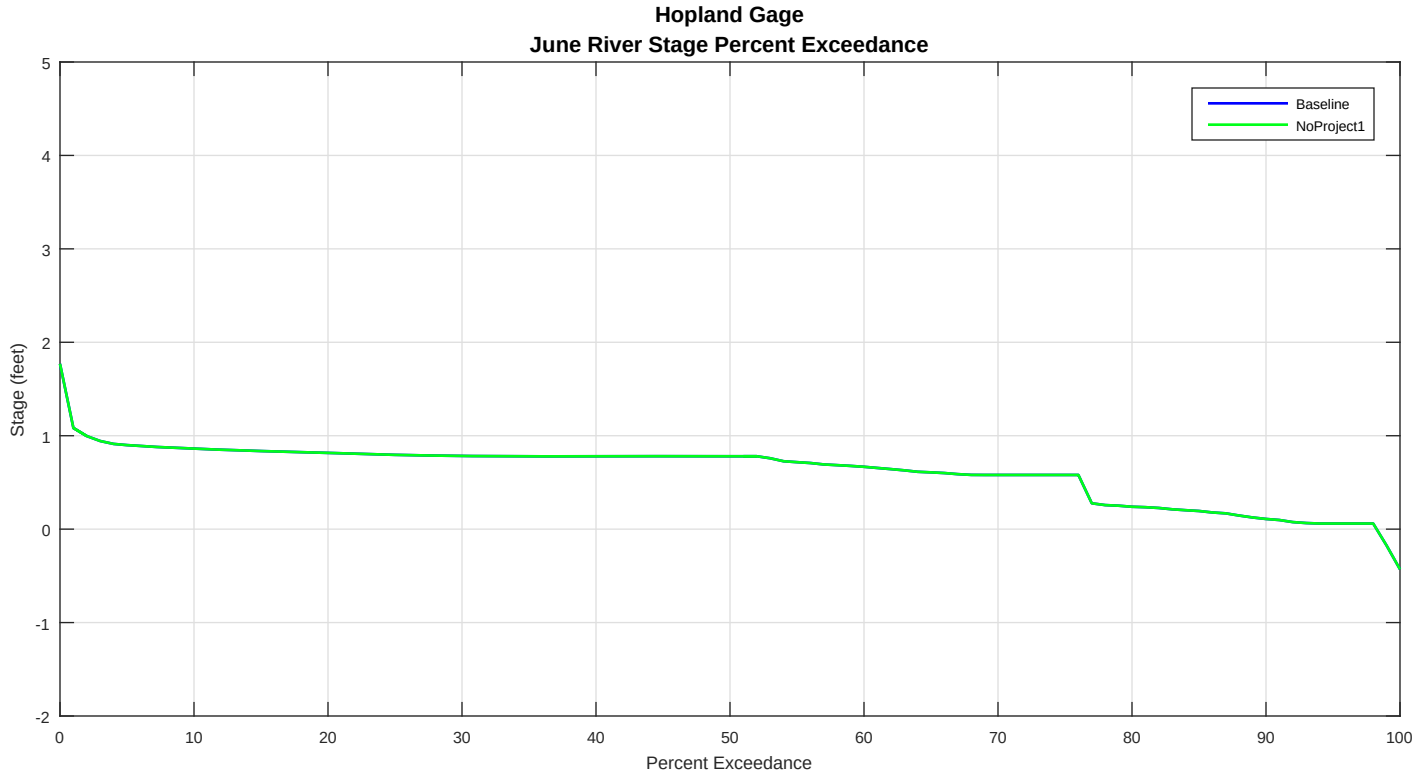
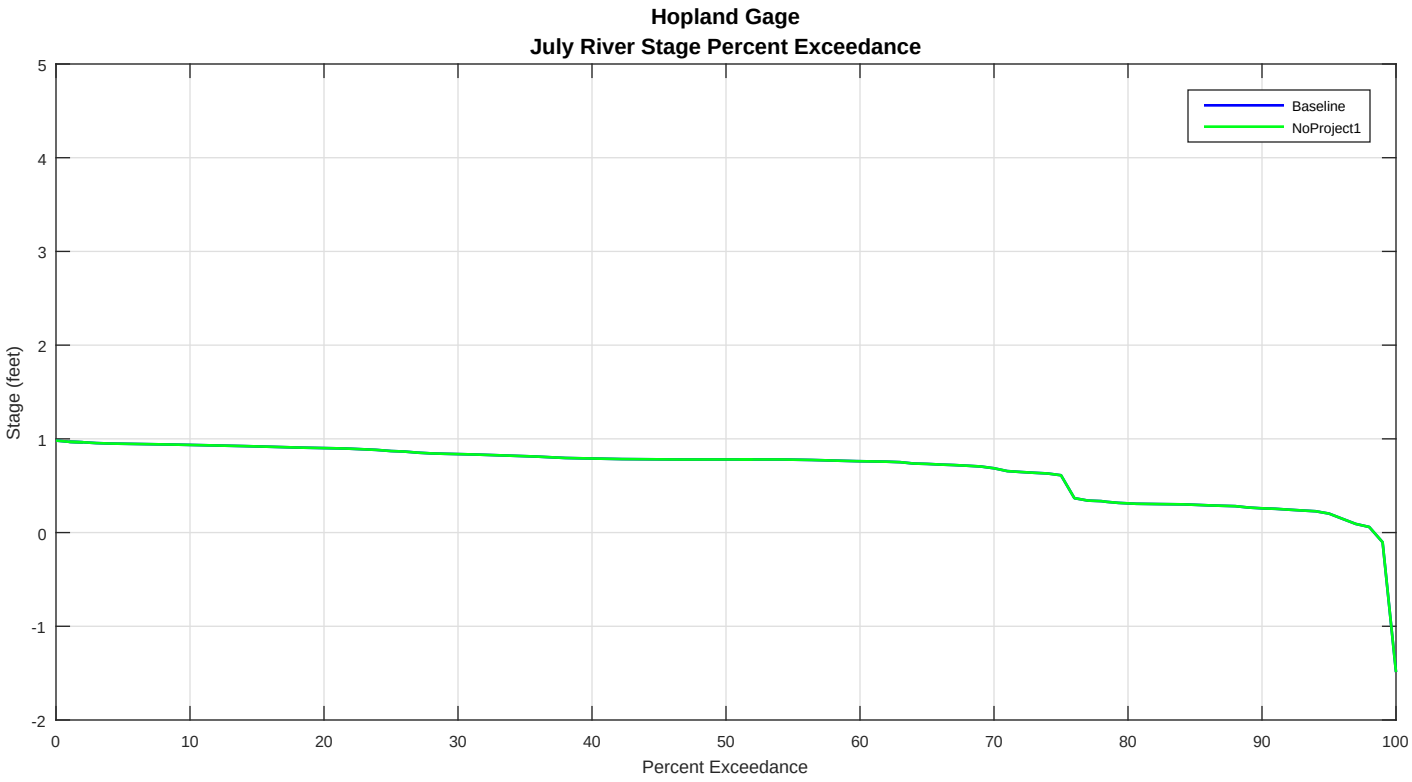
60
70
80
90
100

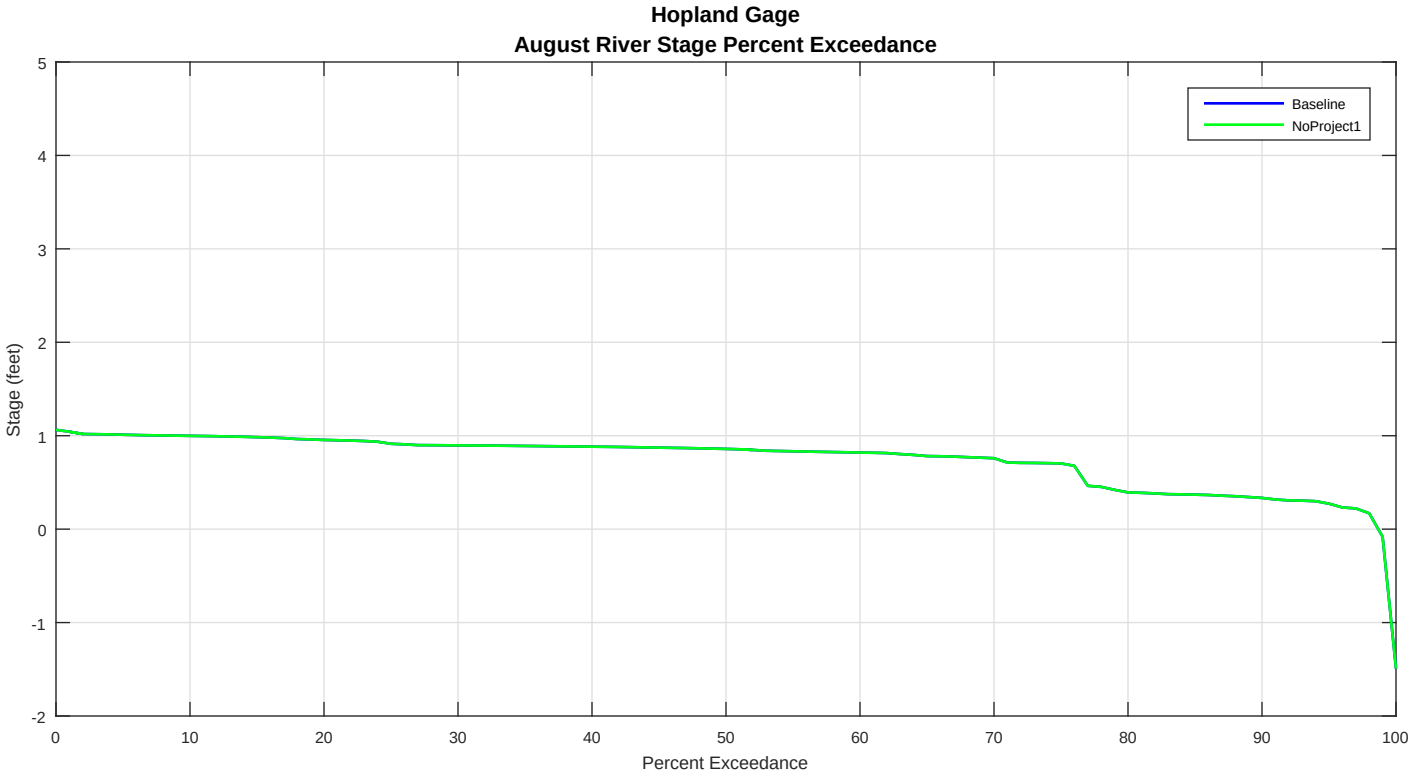

Hopland Gage
March River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100

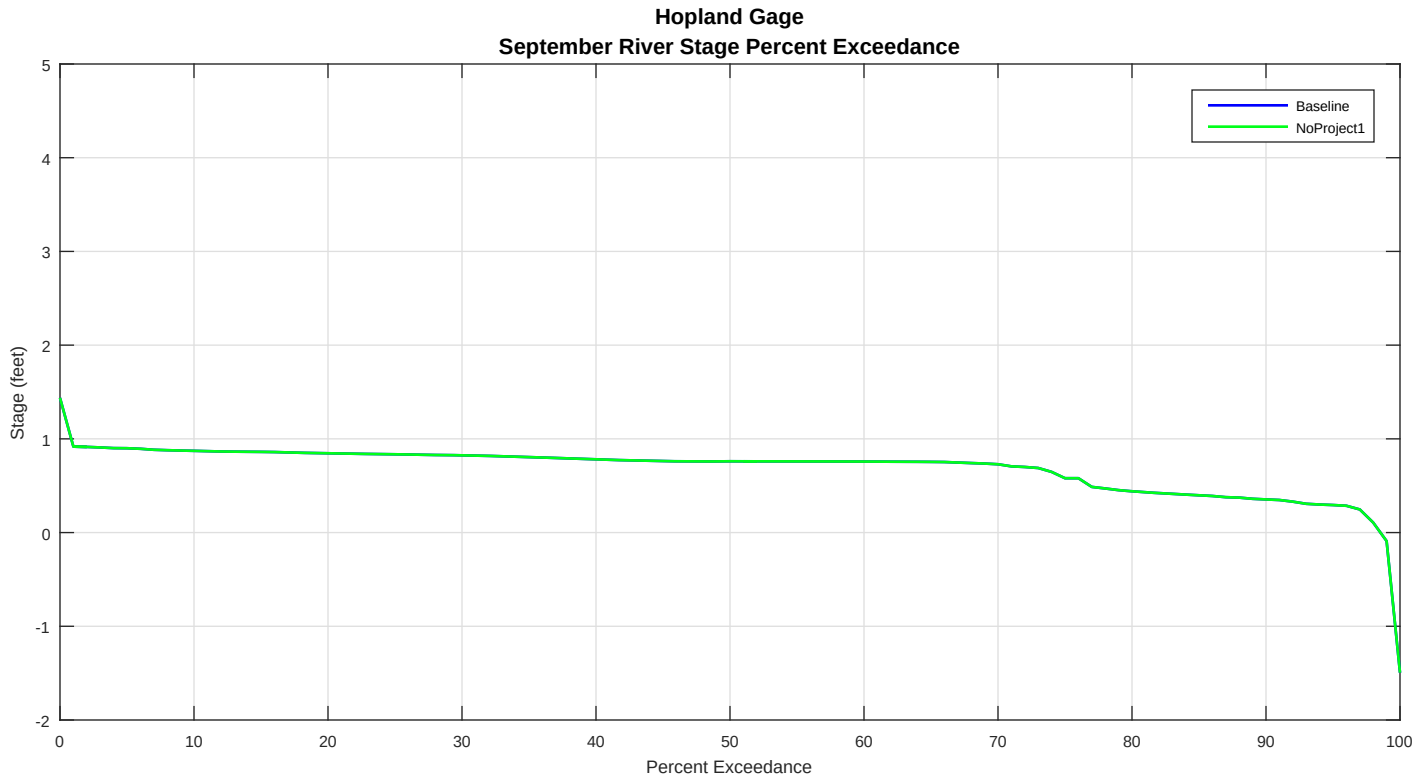

Hopland Gage
April River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
20
18
16
14
12
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

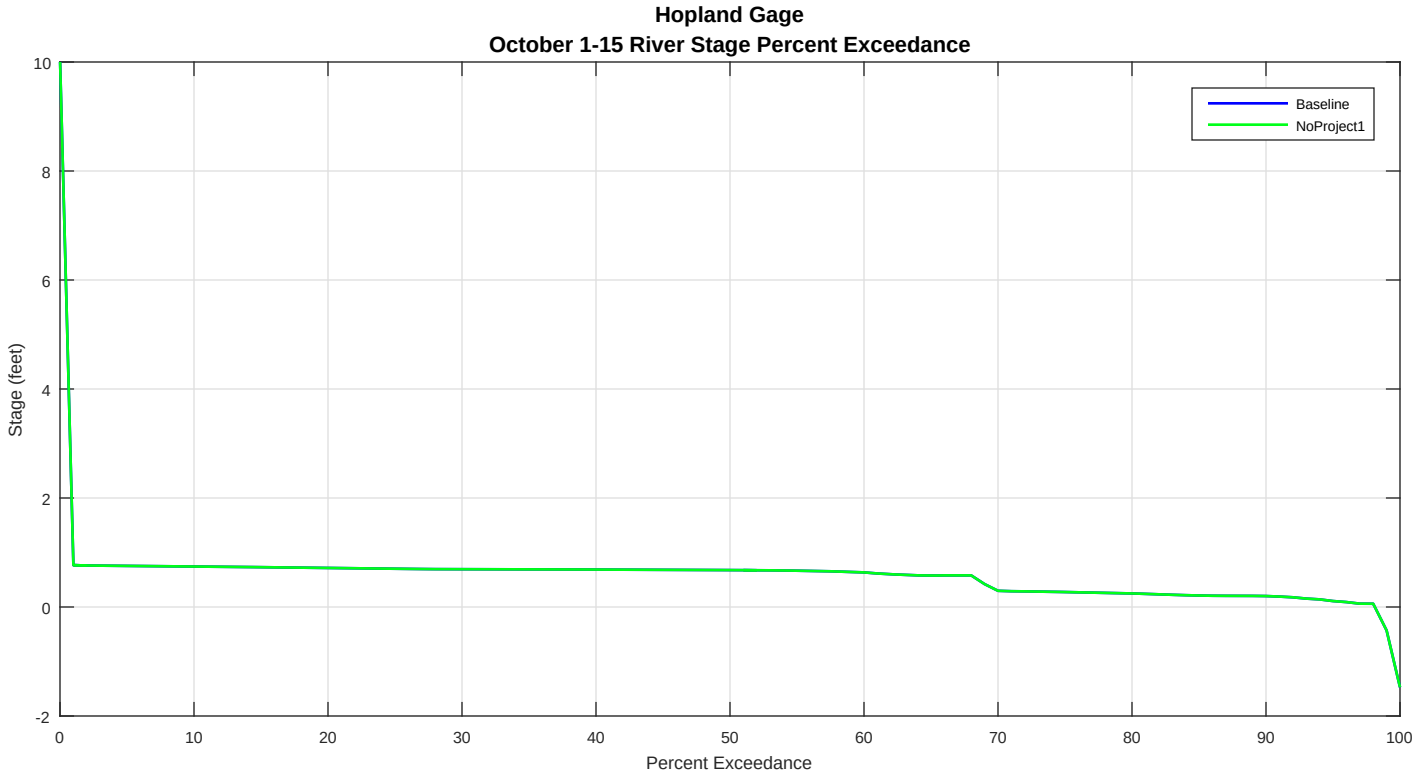

Hopland Gage
May River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

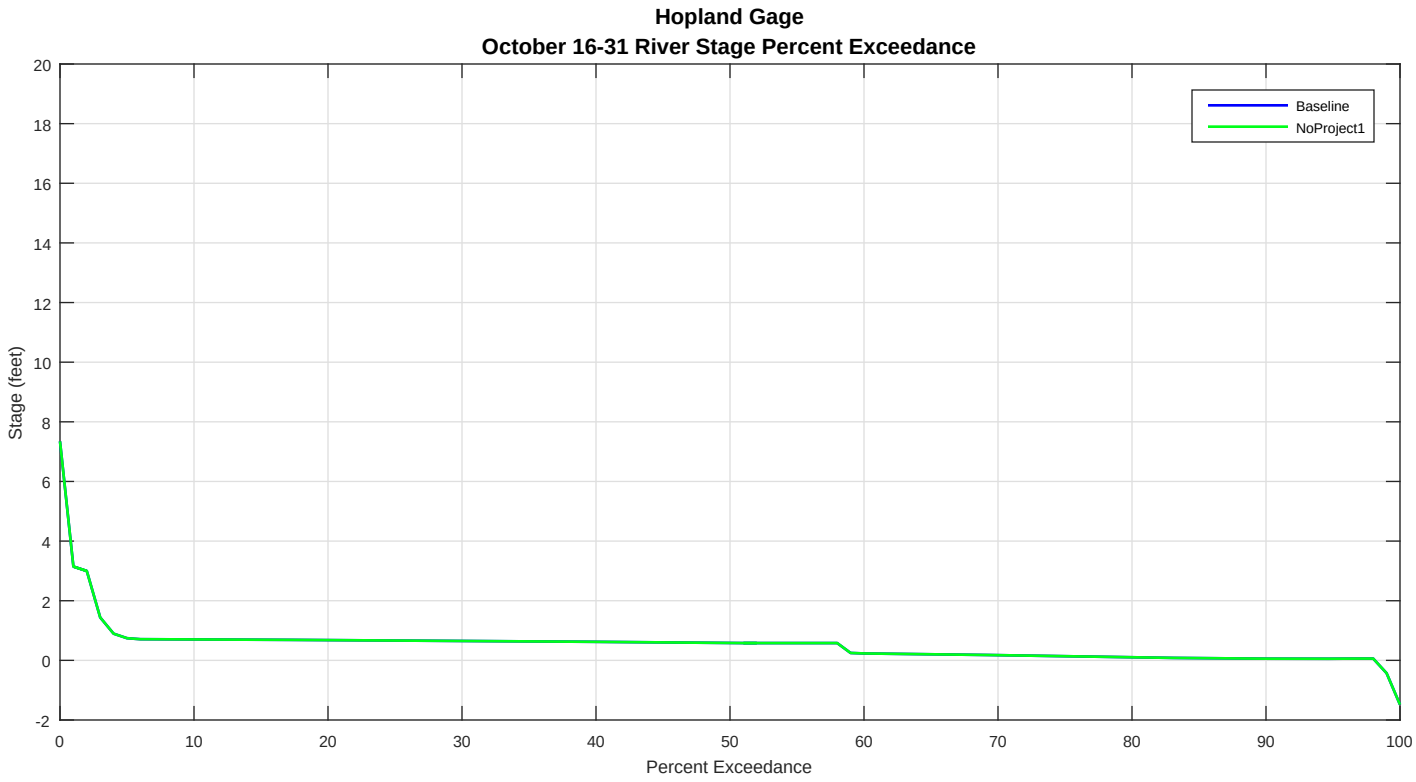

Hopland Gage
June River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

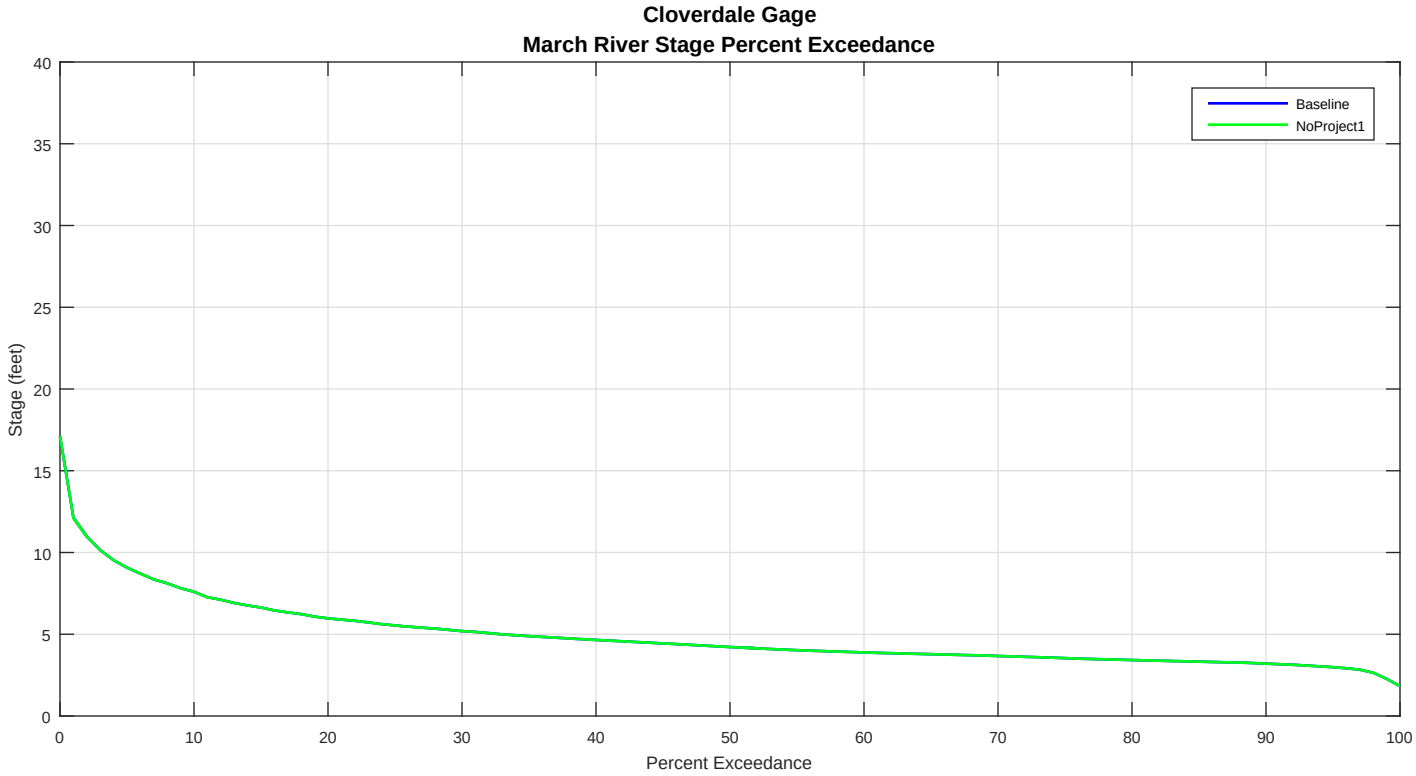

Hopland Gage
July River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

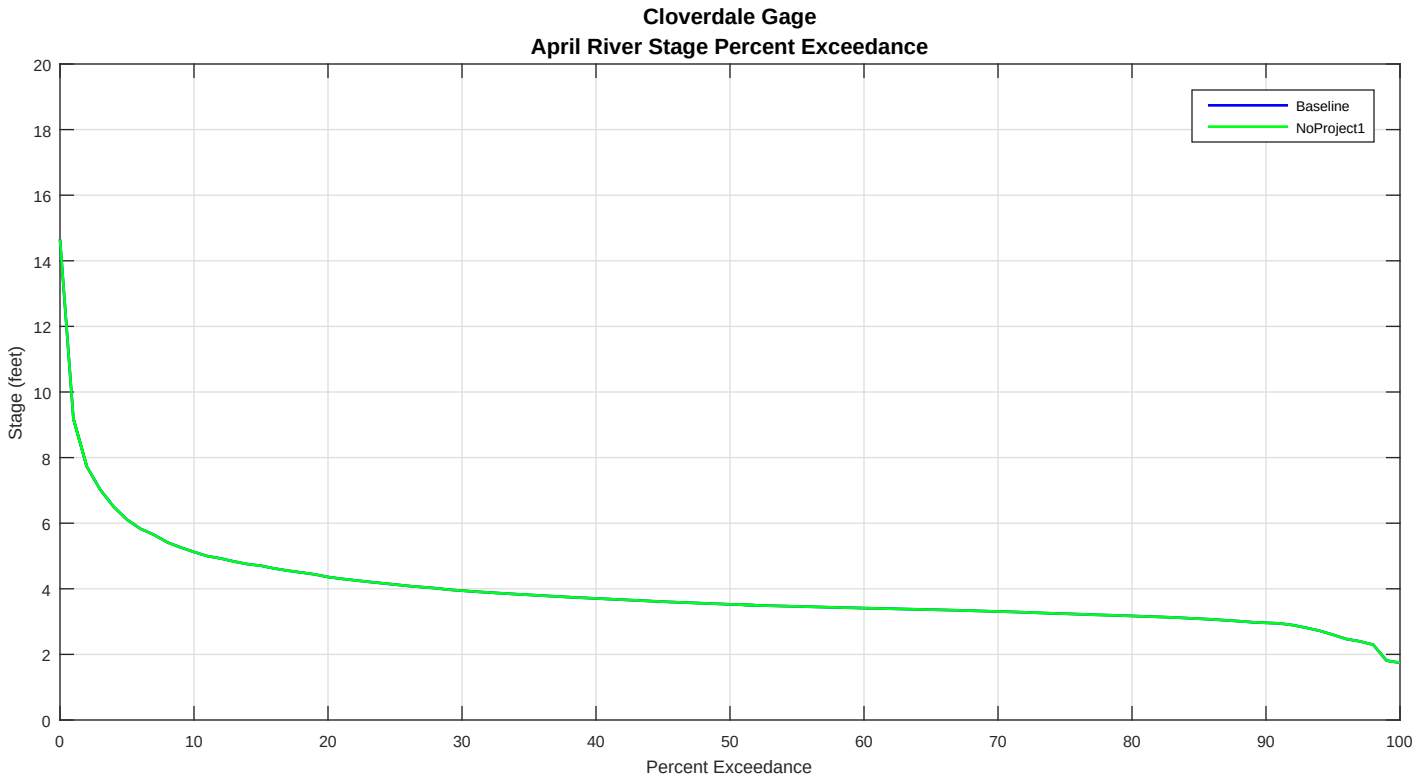

Hopland Gage
August River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

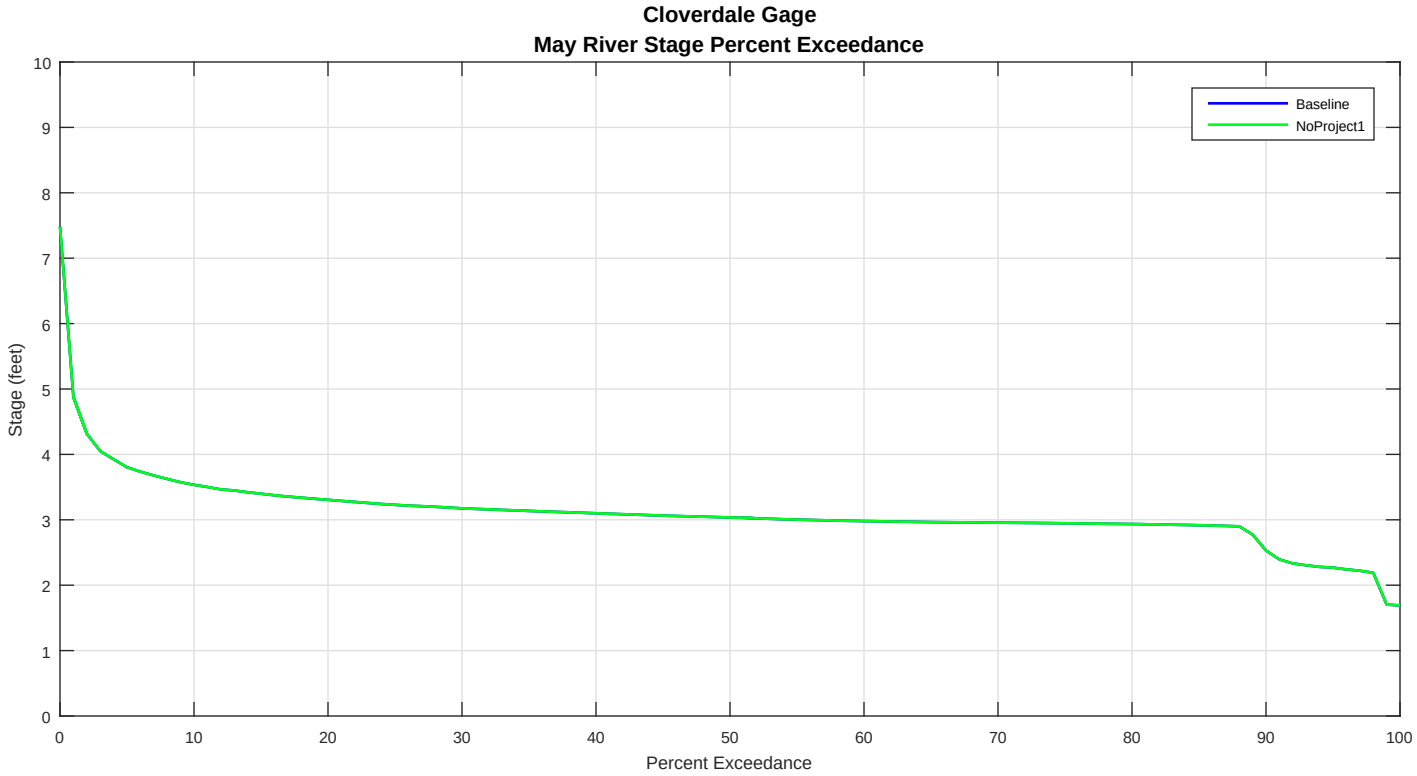

Hopland Gage
September River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

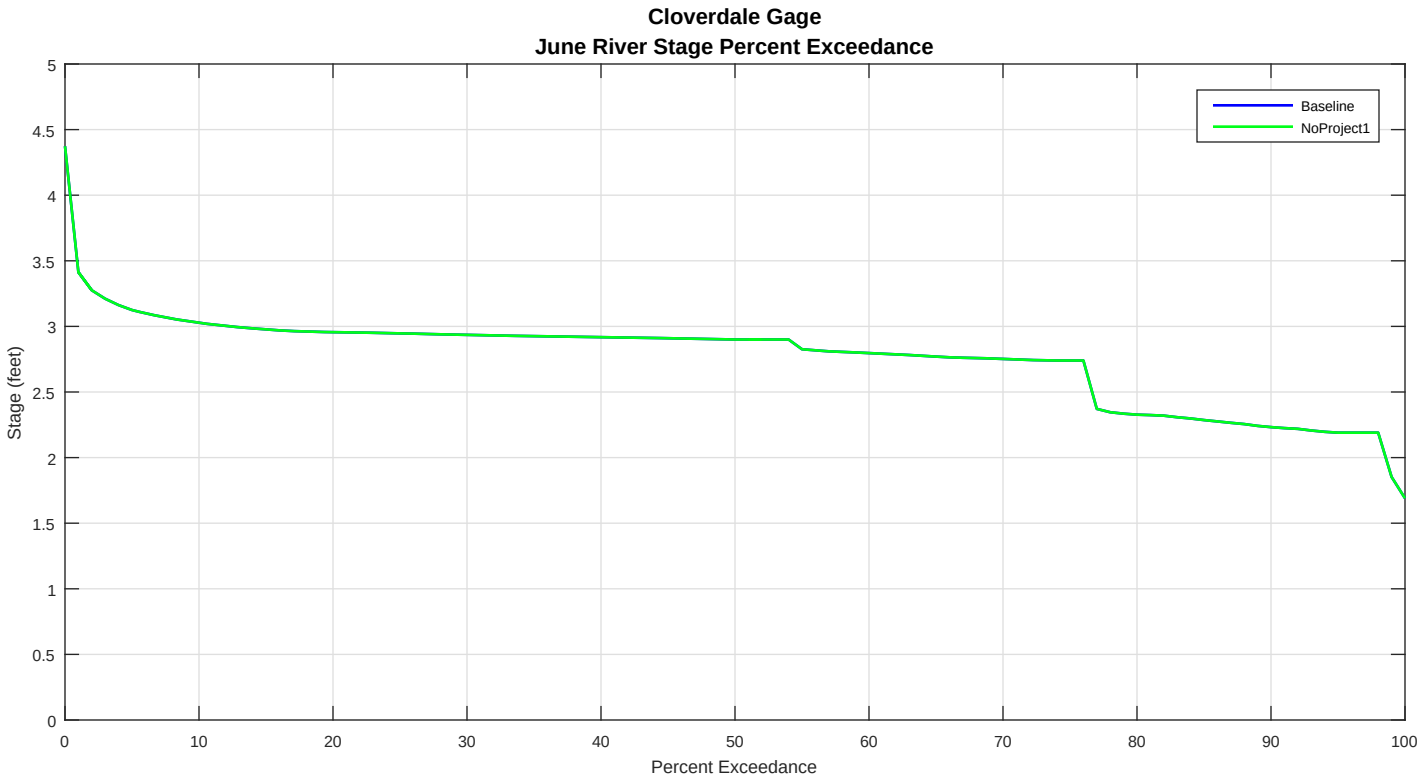

Hopland Gage
October 1-15 River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

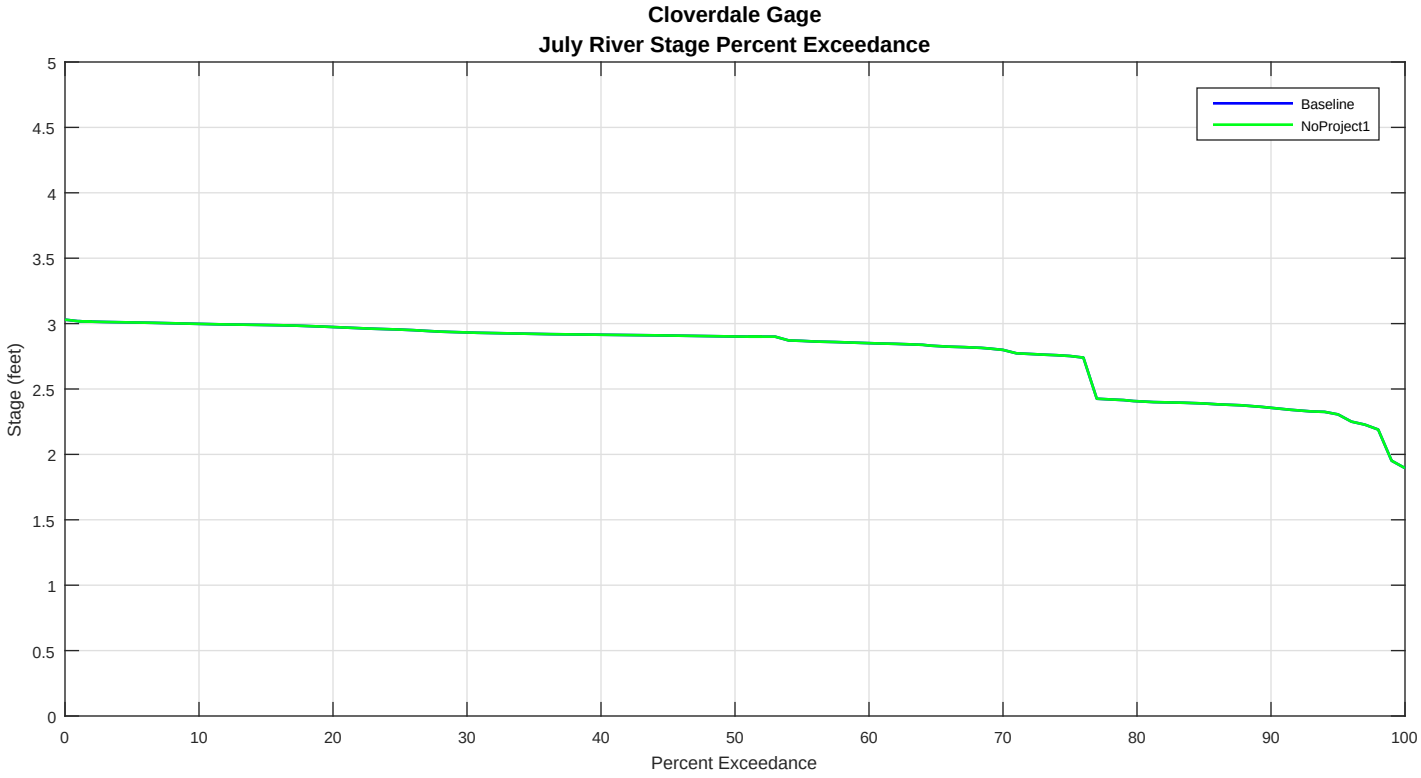

Hopland Gage
October 16-31 River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
20
18
16
14
12
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

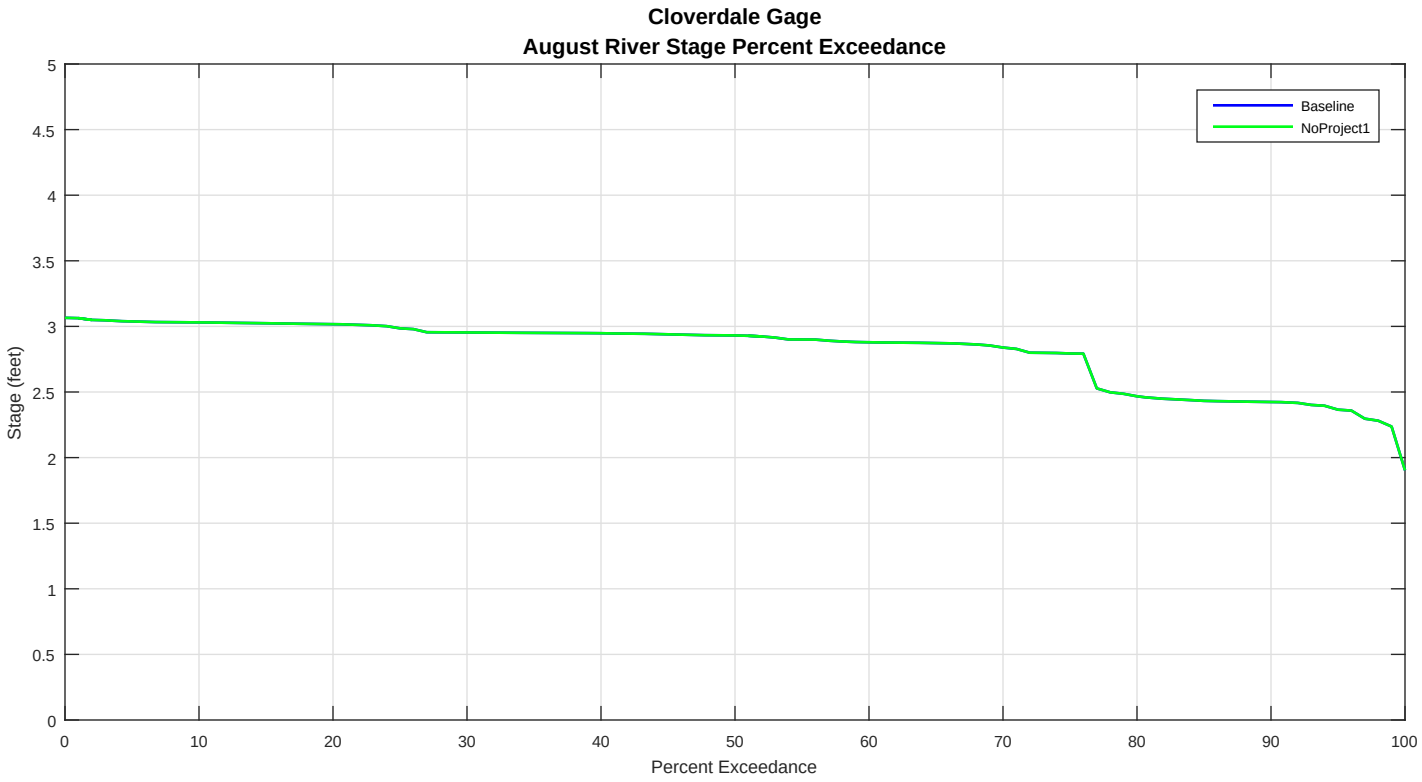

Cloverdale Gage
March River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100

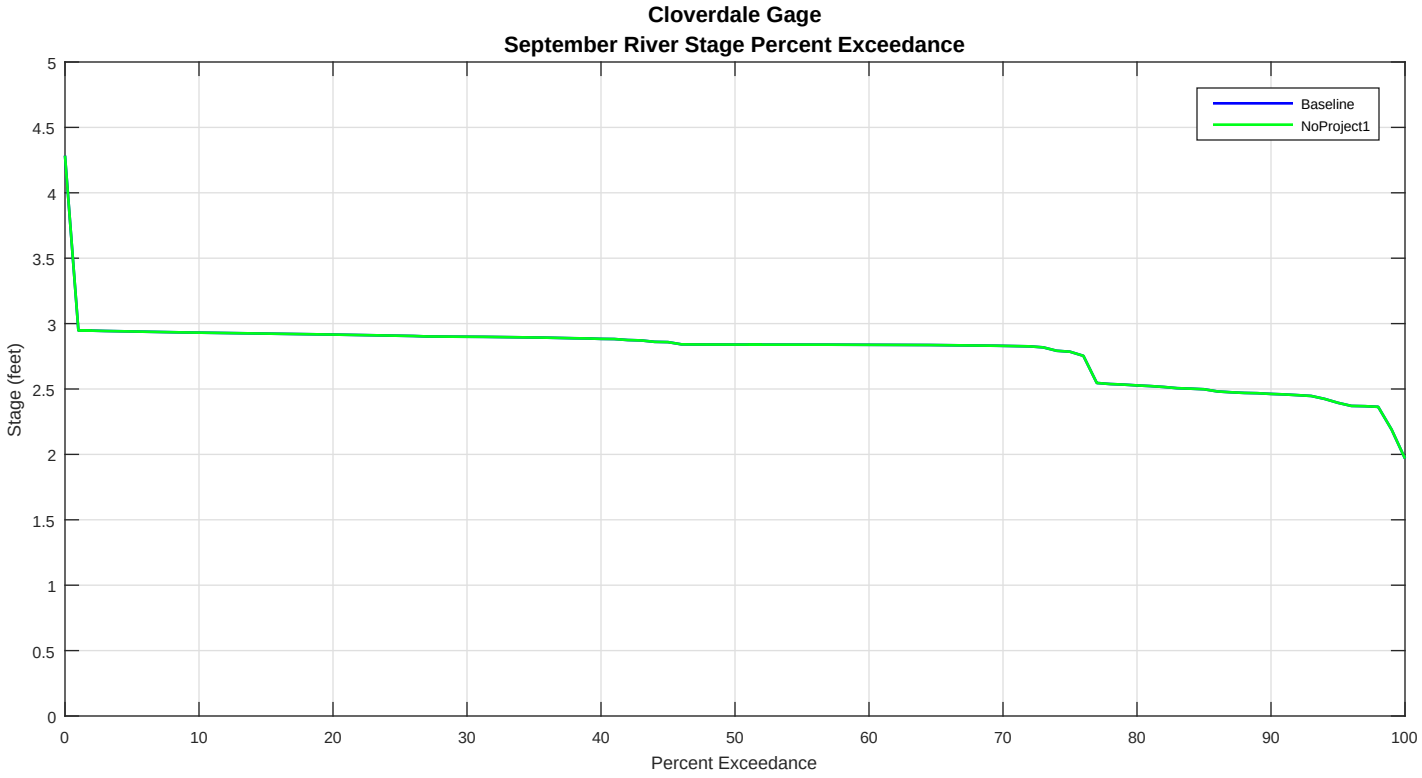

Cloverdale Gage
April River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

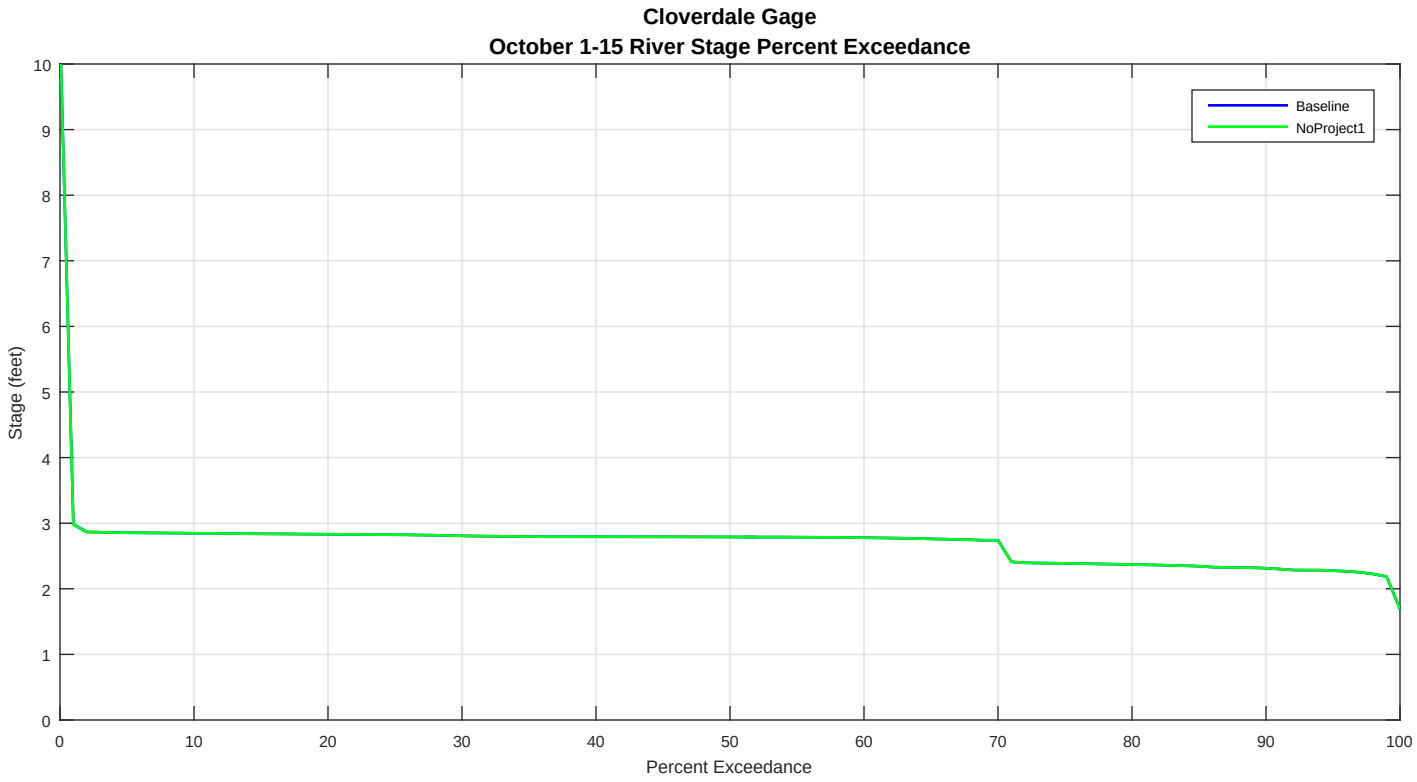

Cloverdale Gage
May River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

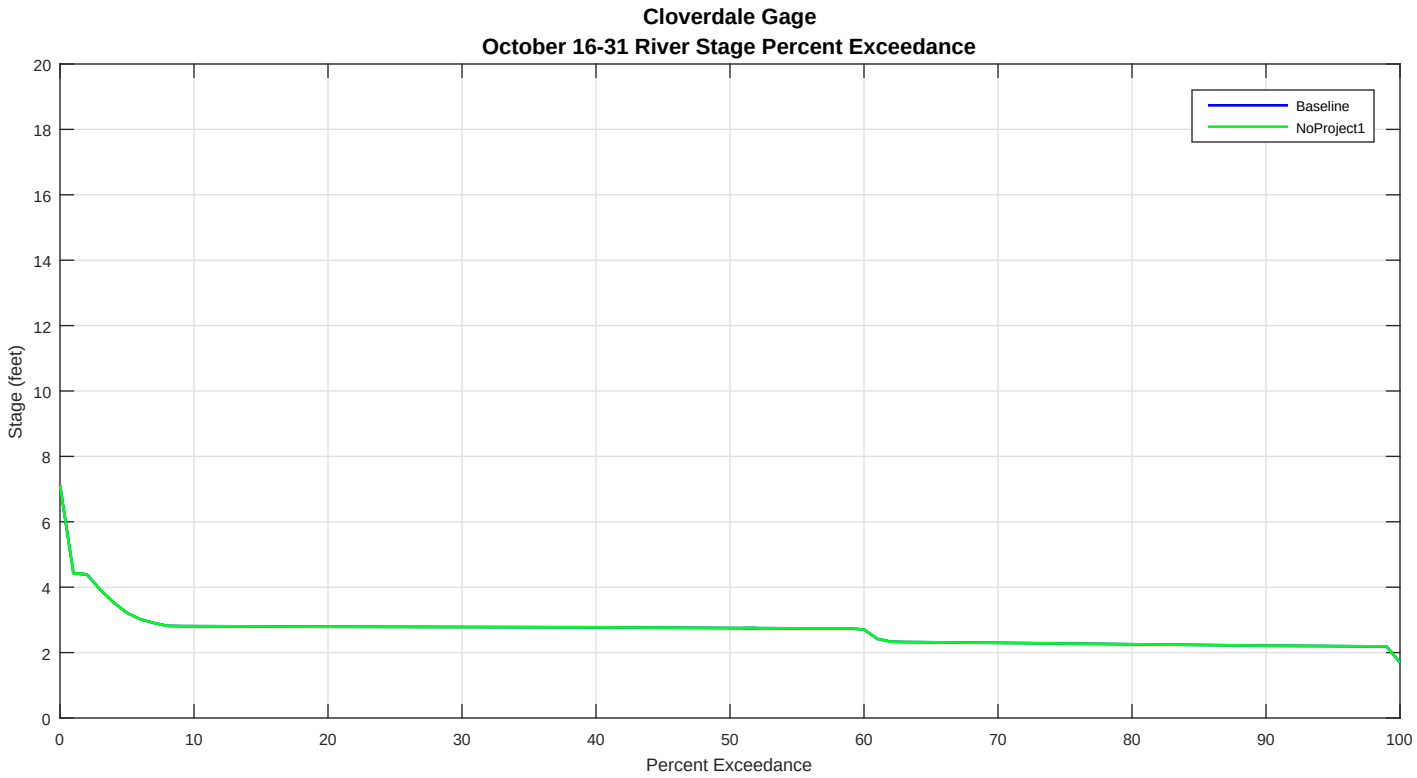

Cloverdale Gage
June River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

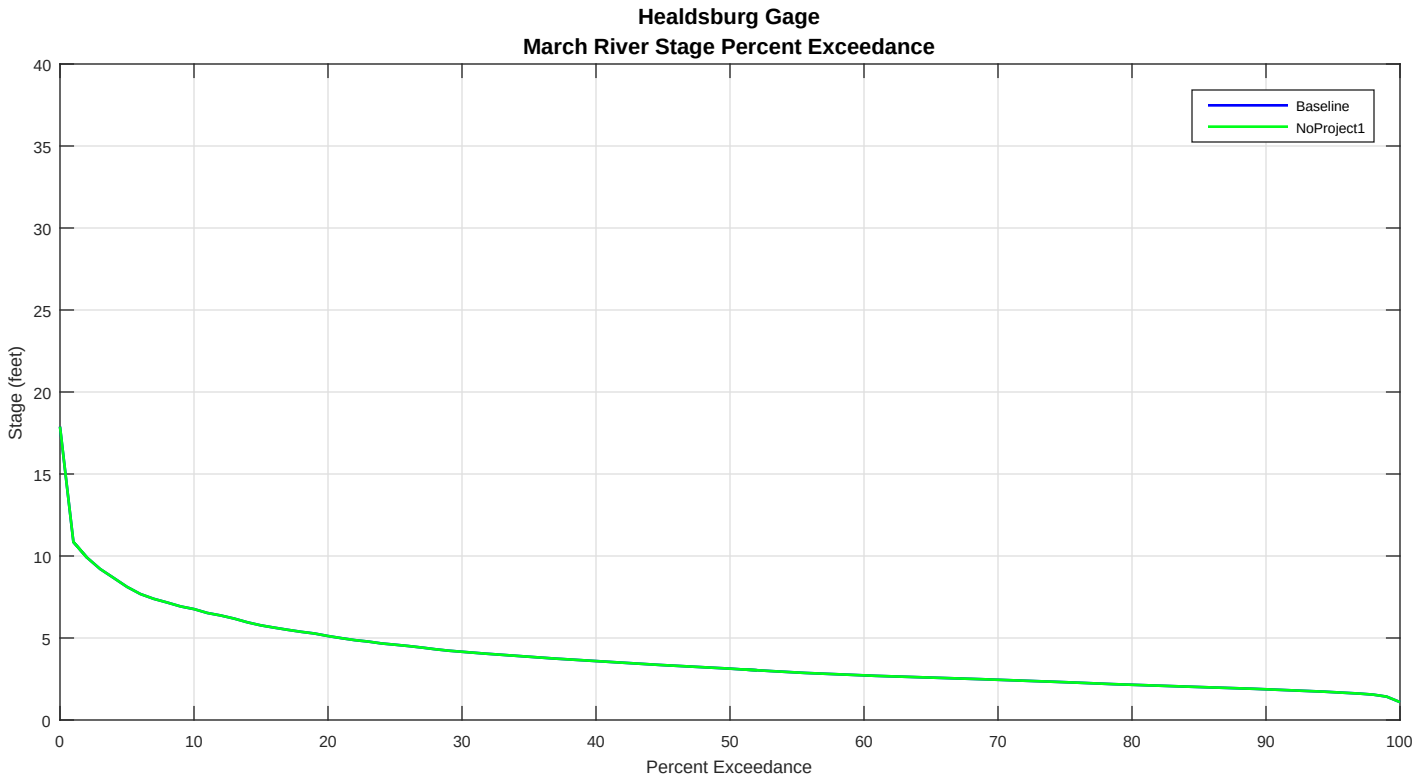

Cloverdale Gage
July River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

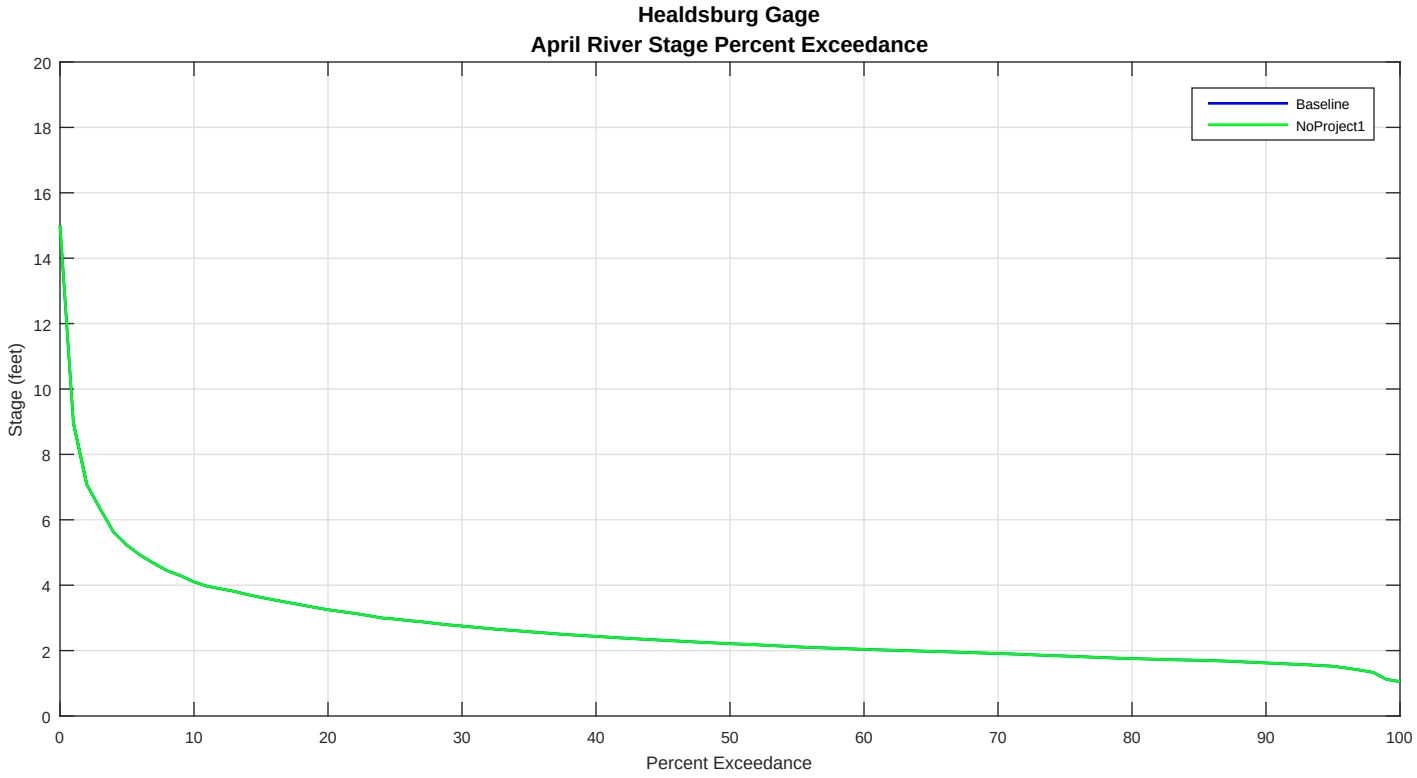

Cloverdale Gage
August River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

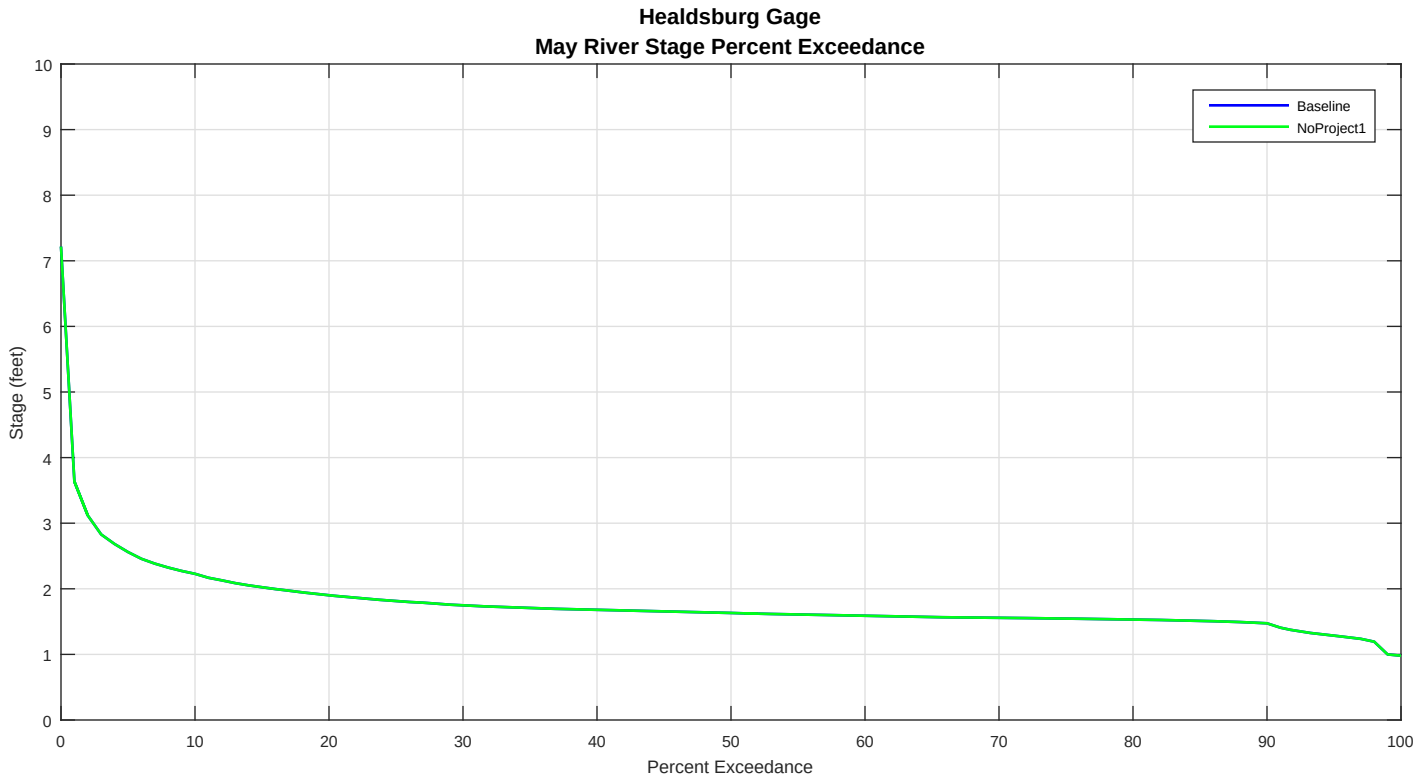

Cloverdale Gage
September River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

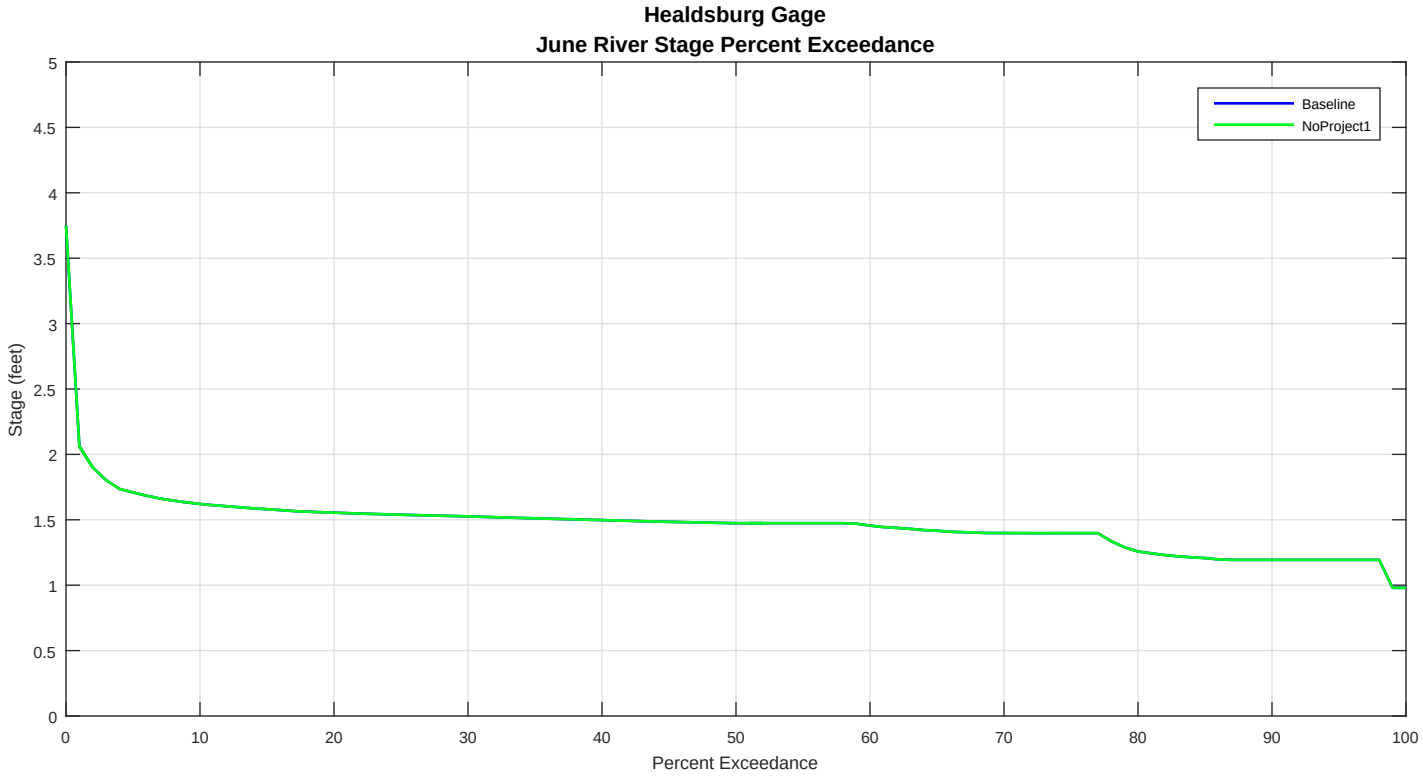

Cloverdale Gage
October 1-15 River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

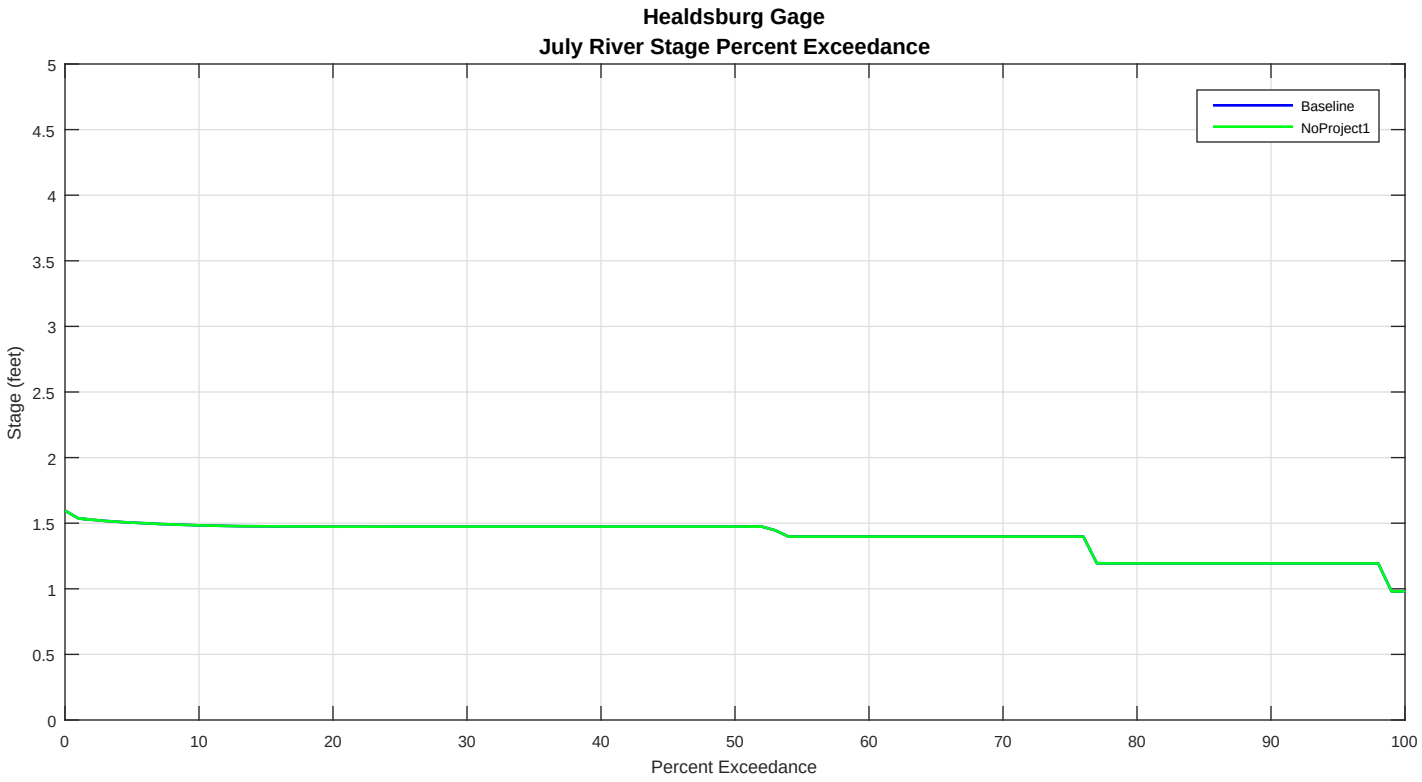

Cloverdale Gage
October 16-31 River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

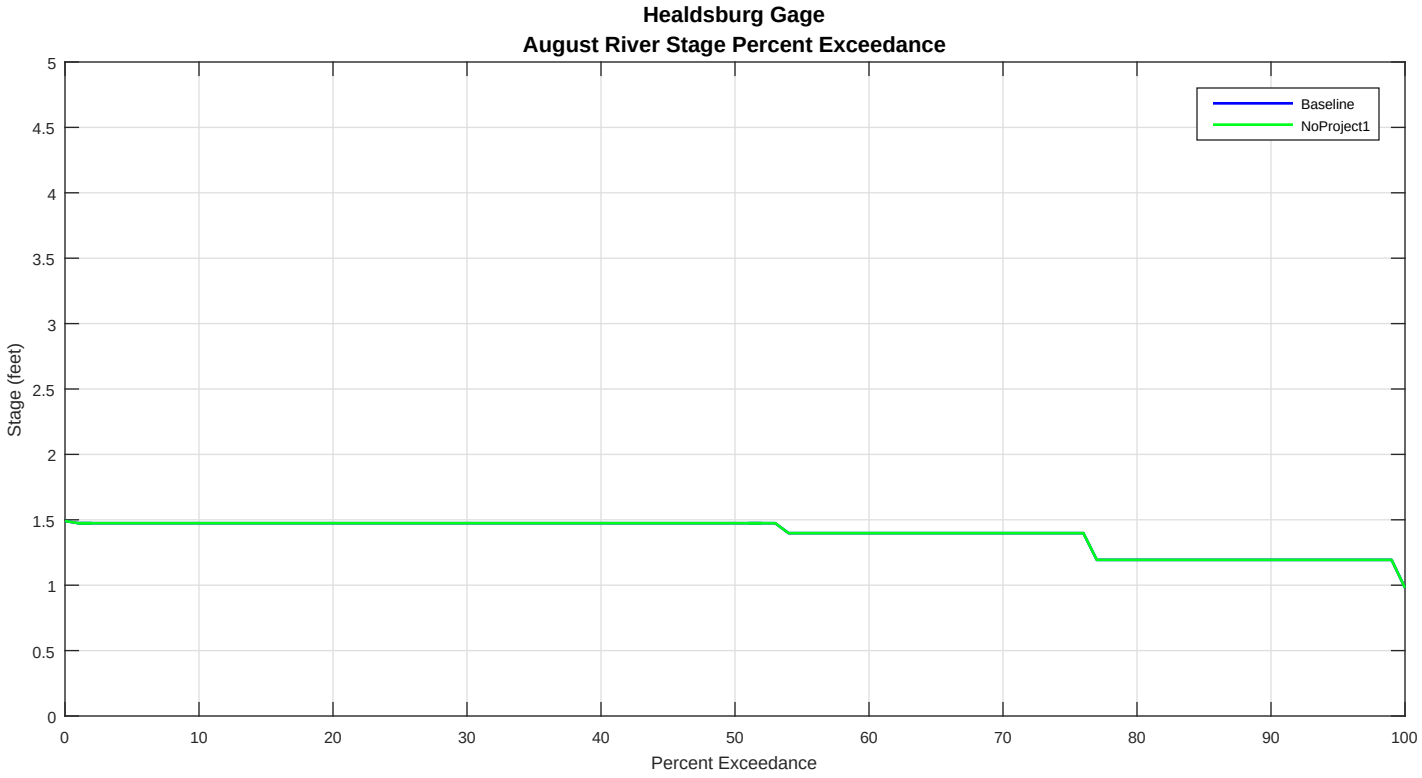

Healdsburg Gage
March River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80
90
100

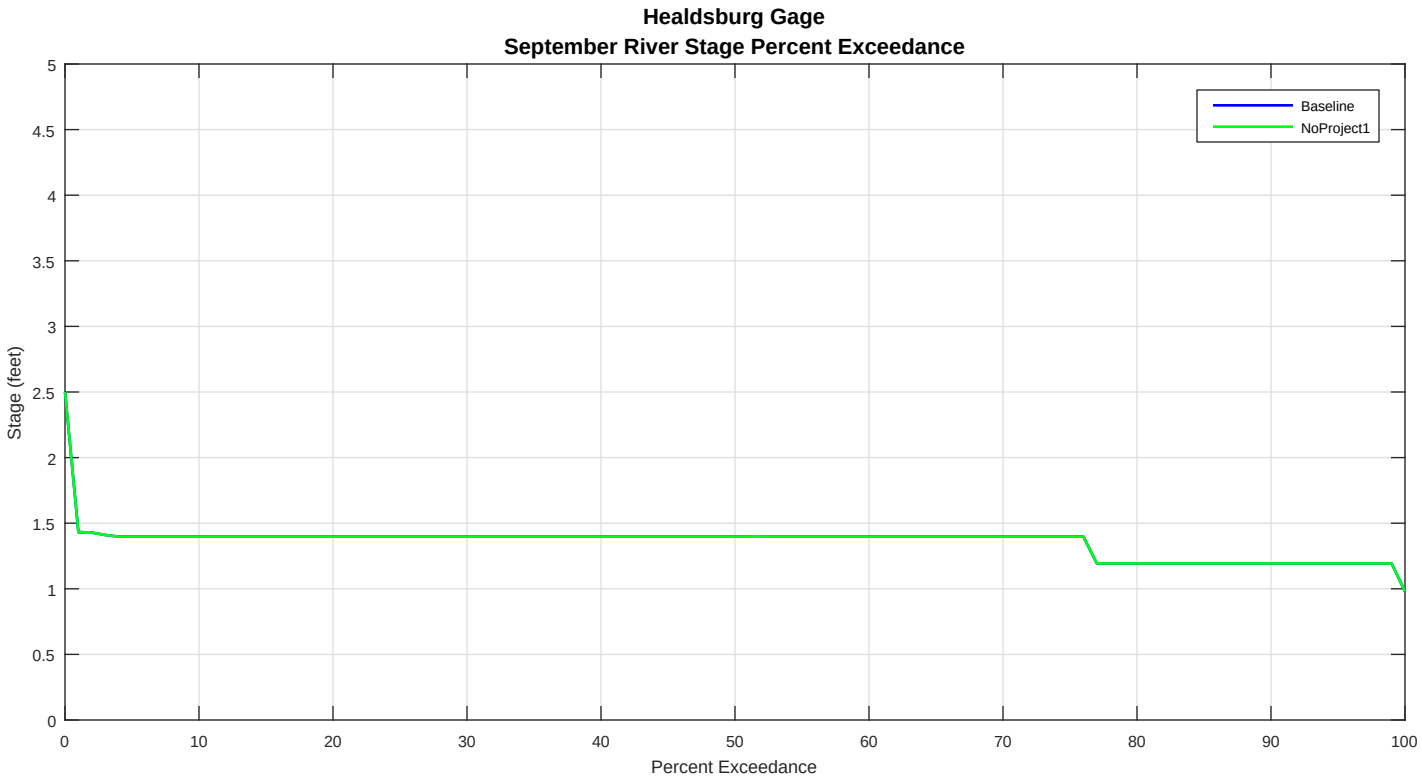

Healdsburg Gage
April River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

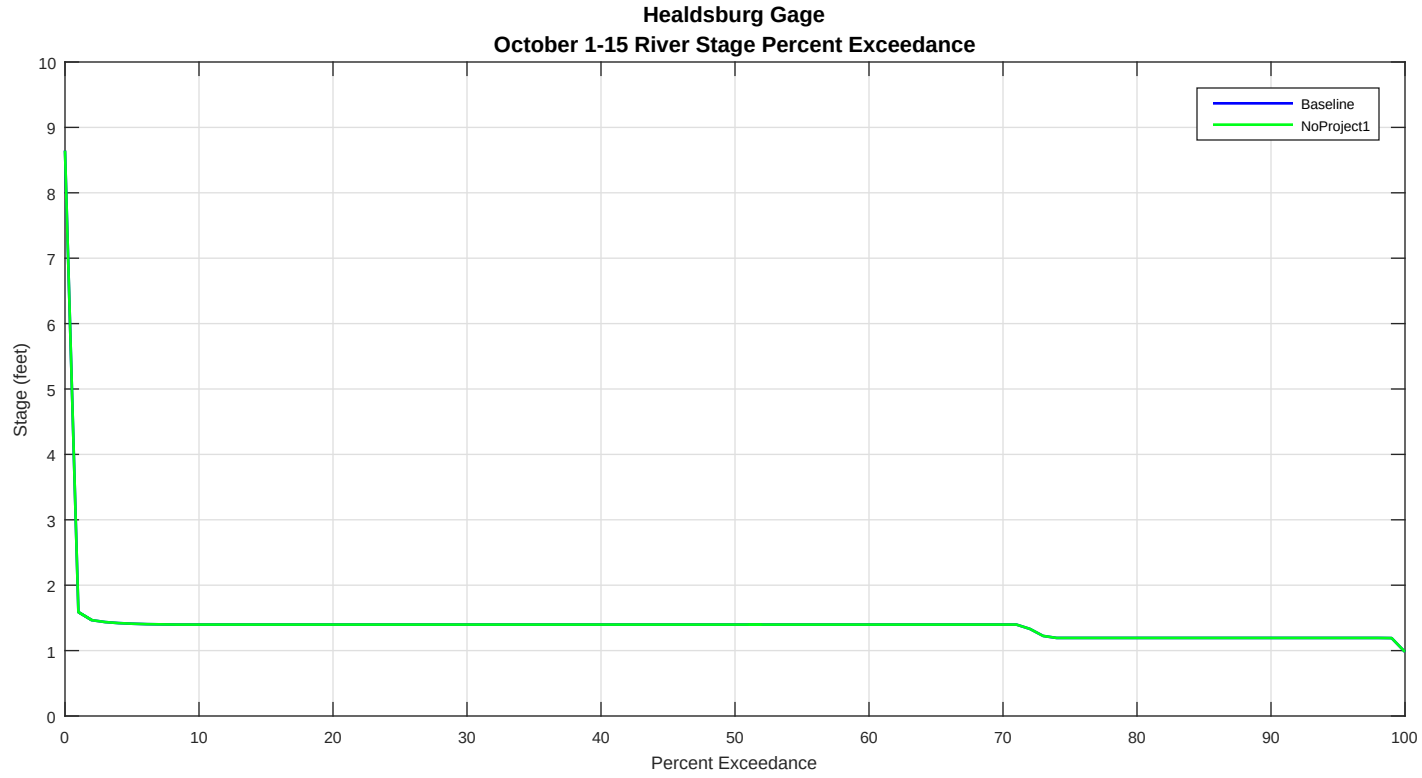

Healdsburg Gage
May River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

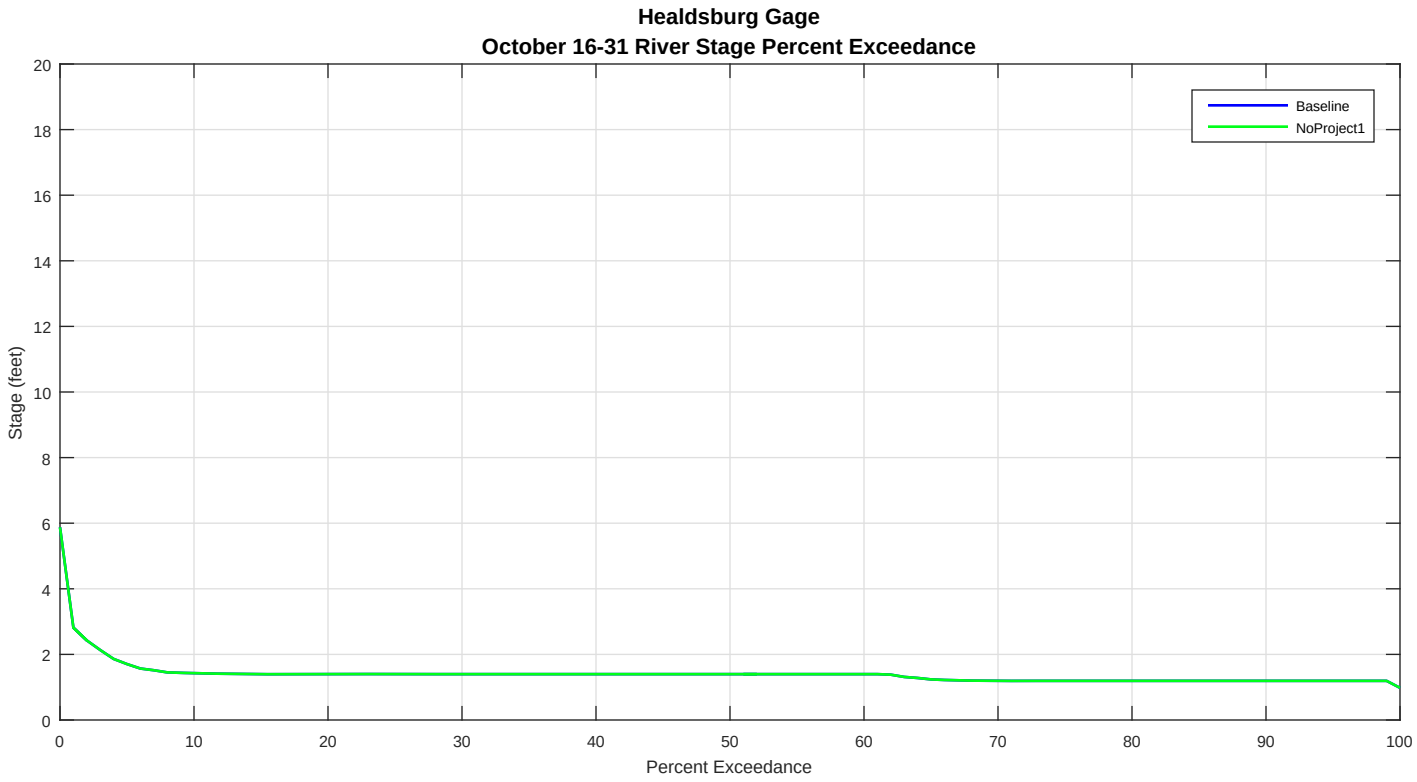

Healdsburg Gage
June River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

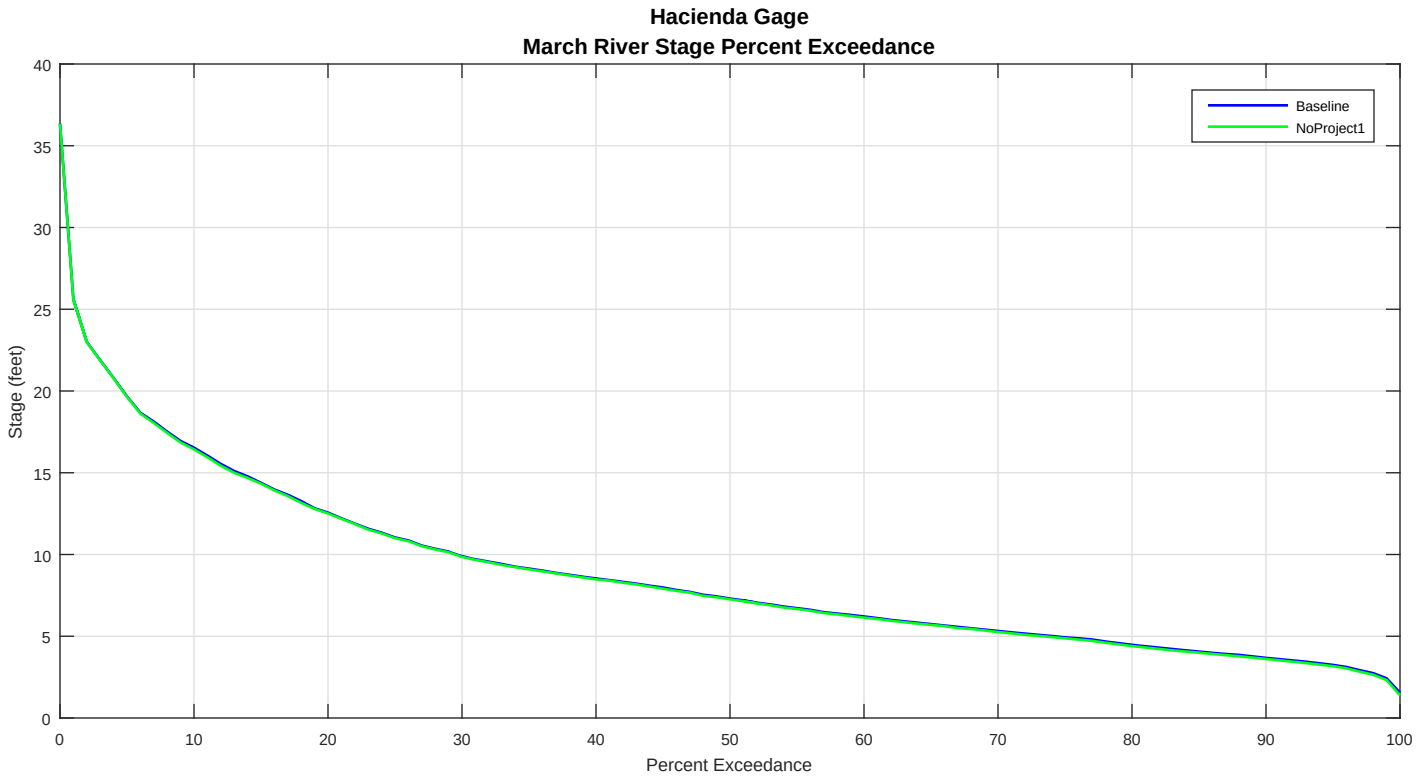

Healdsburg Gage
July River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

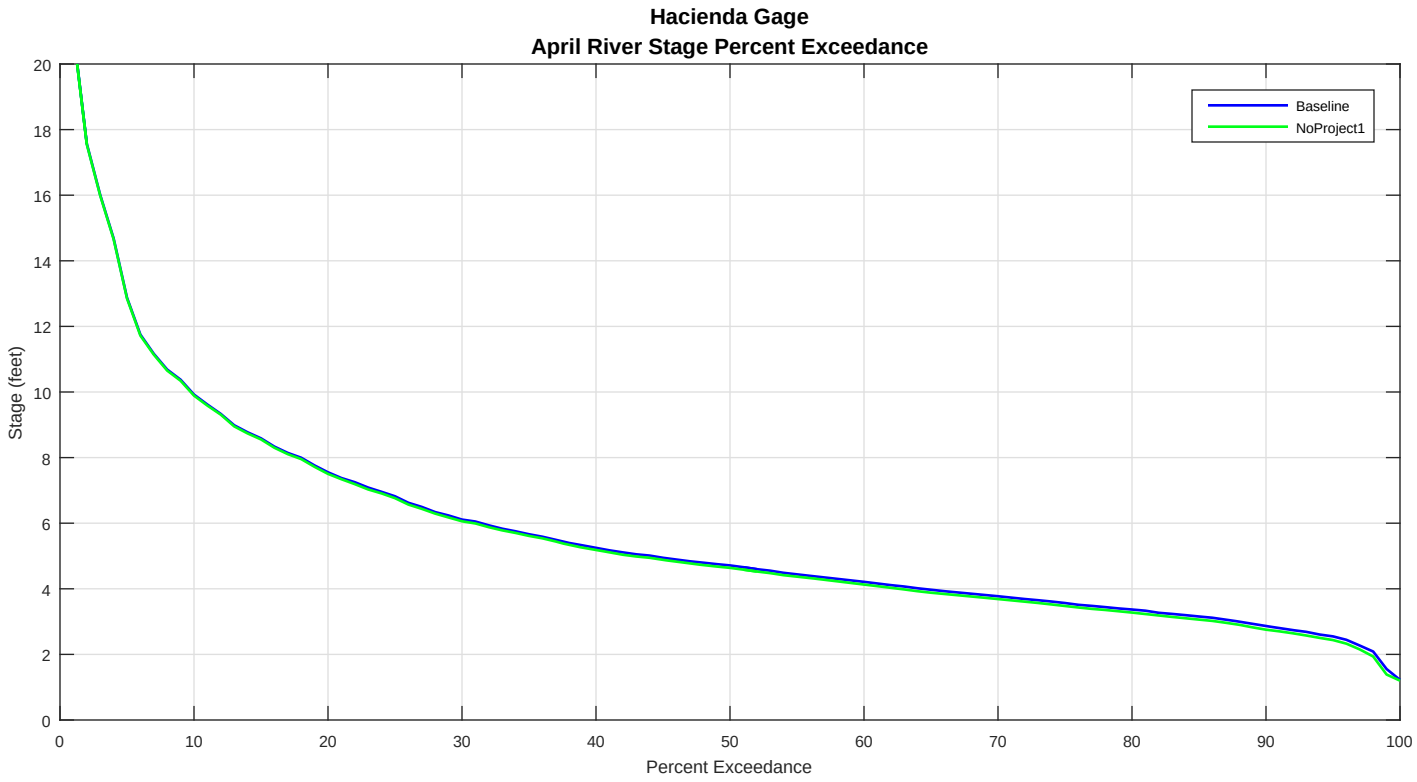

Healdsburg Gage
August River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

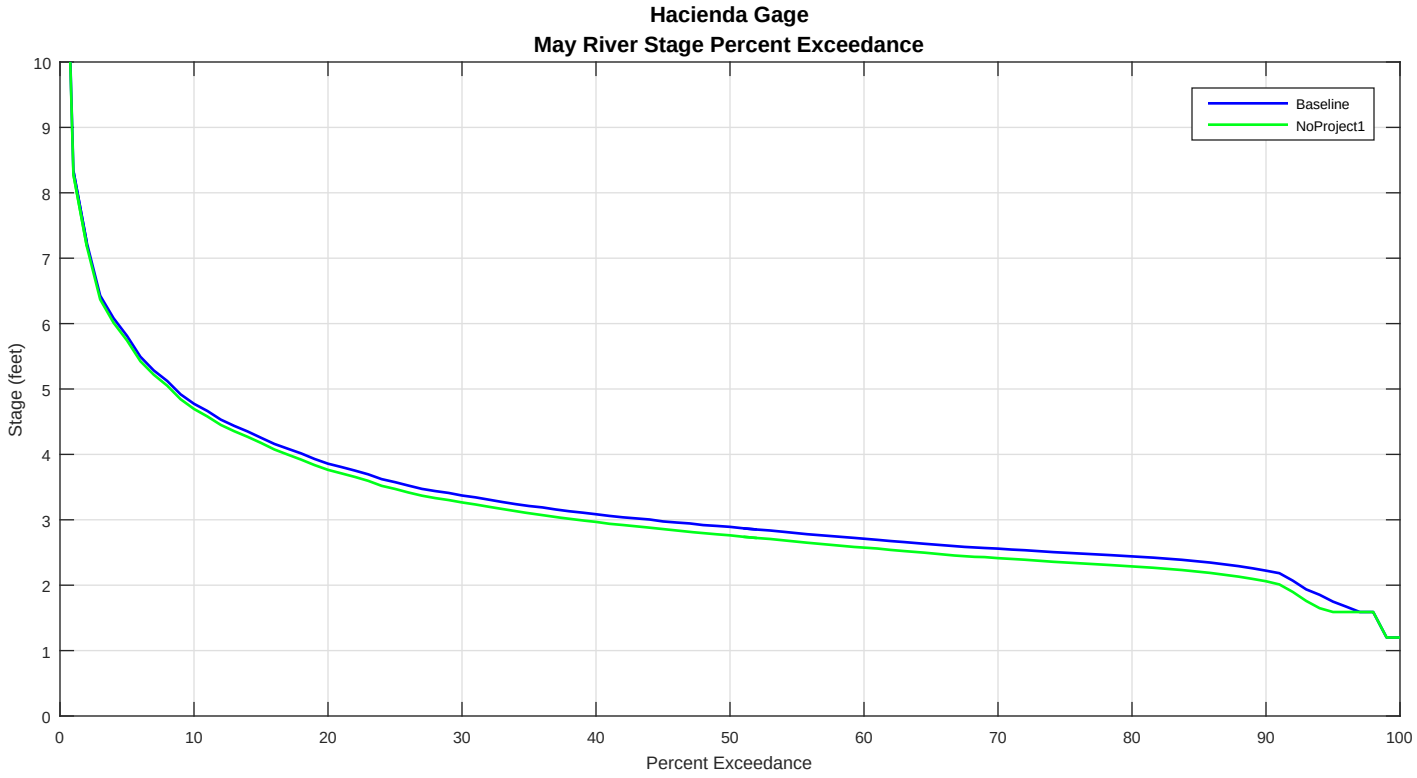

Healdsburg Gage
September River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

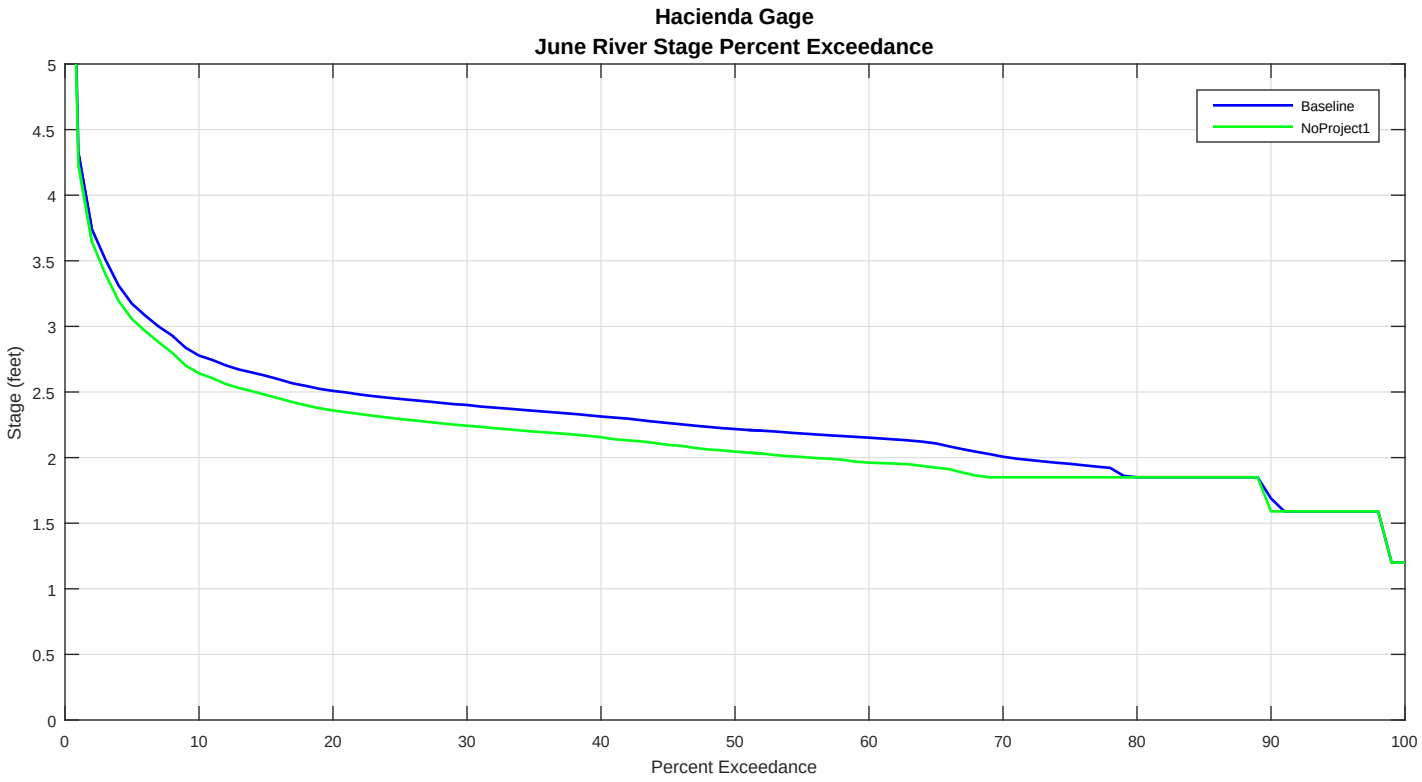

Healdsburg Gage
October 1-15 River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

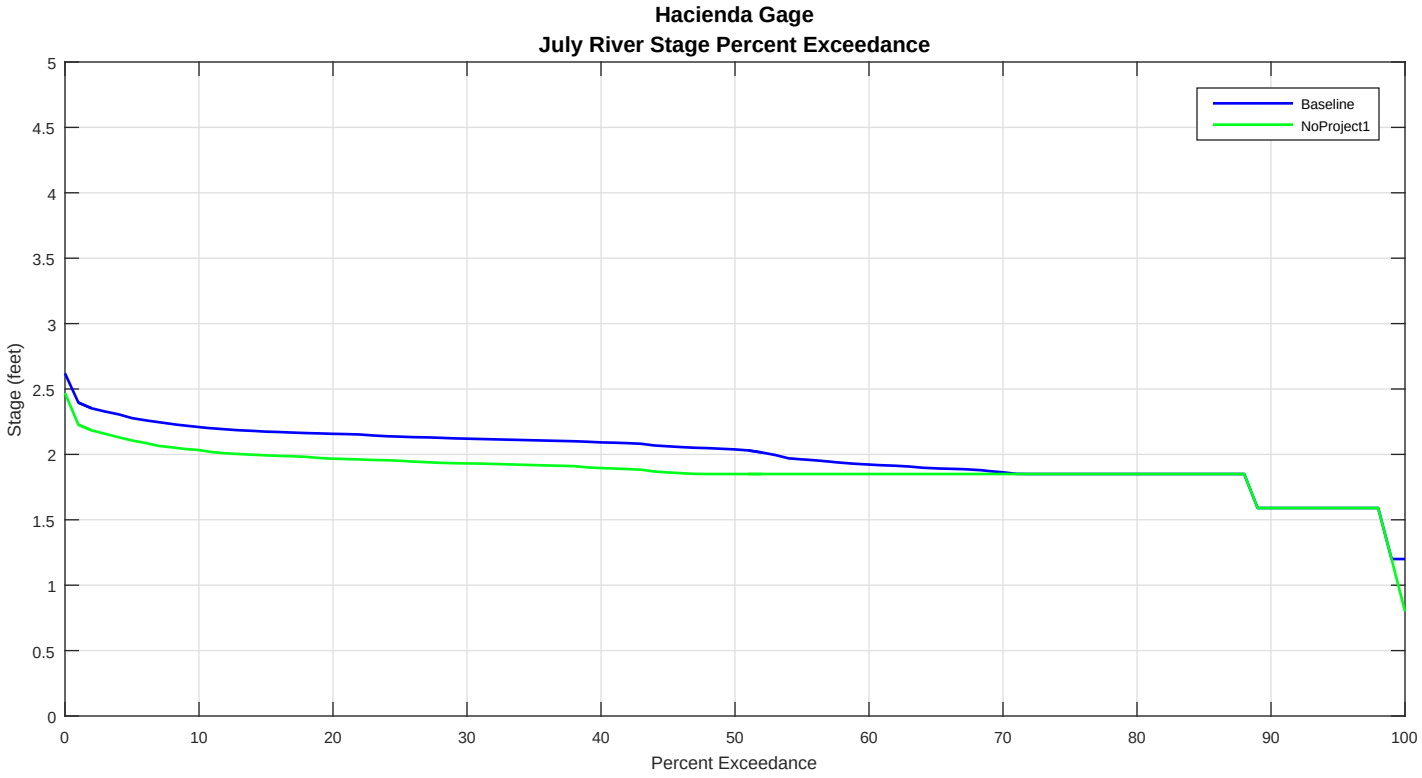

Healdsburg Gage
October 16-31 River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

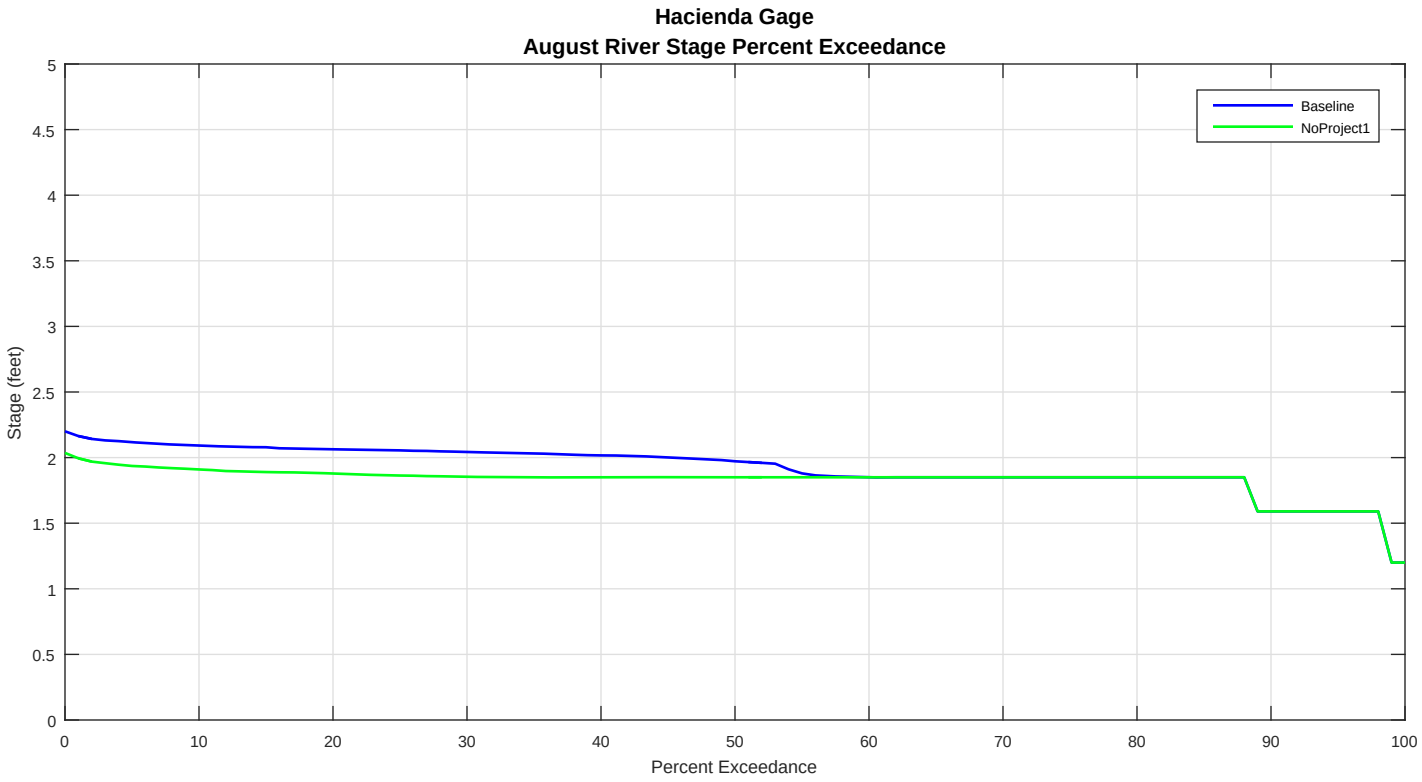

Hacienda Gage
March River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80
90
100

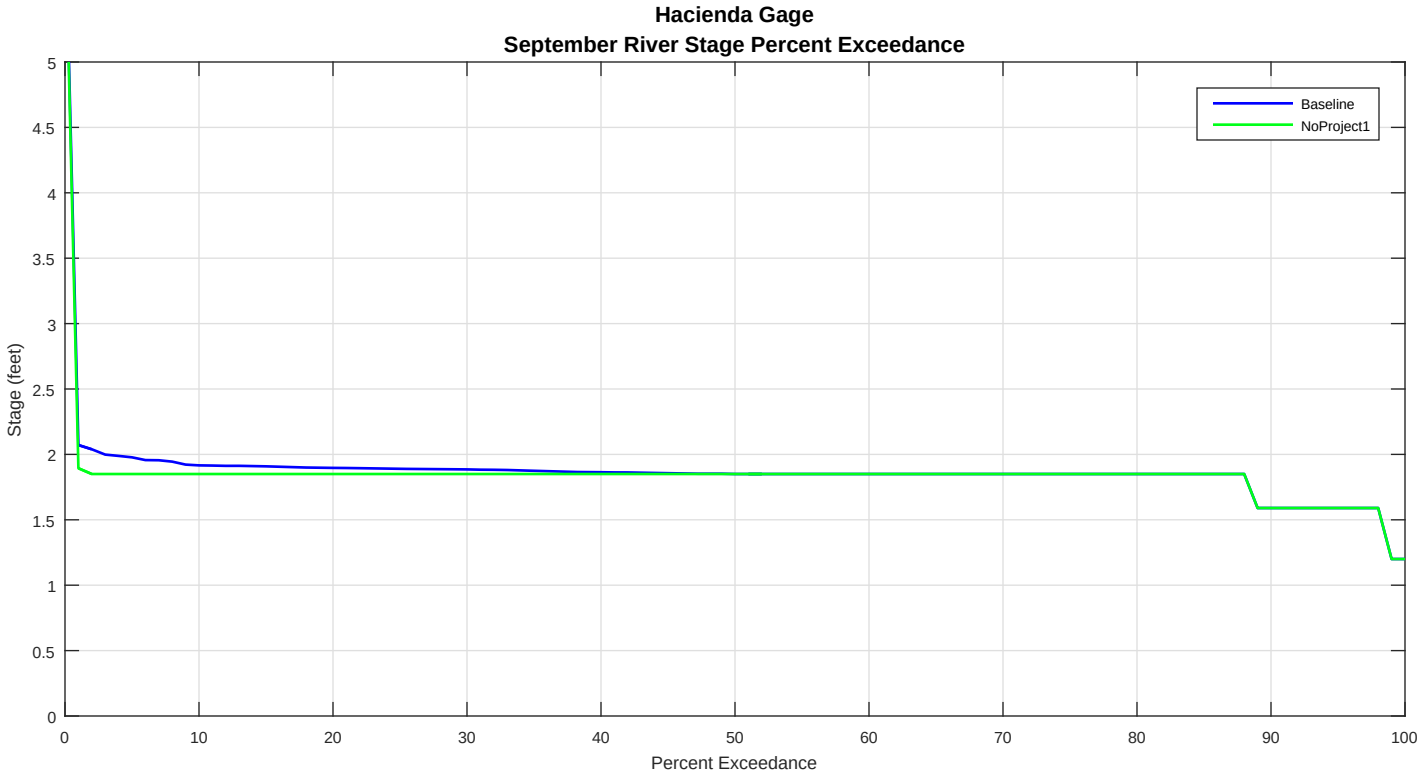

Hacienda Gage
April River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

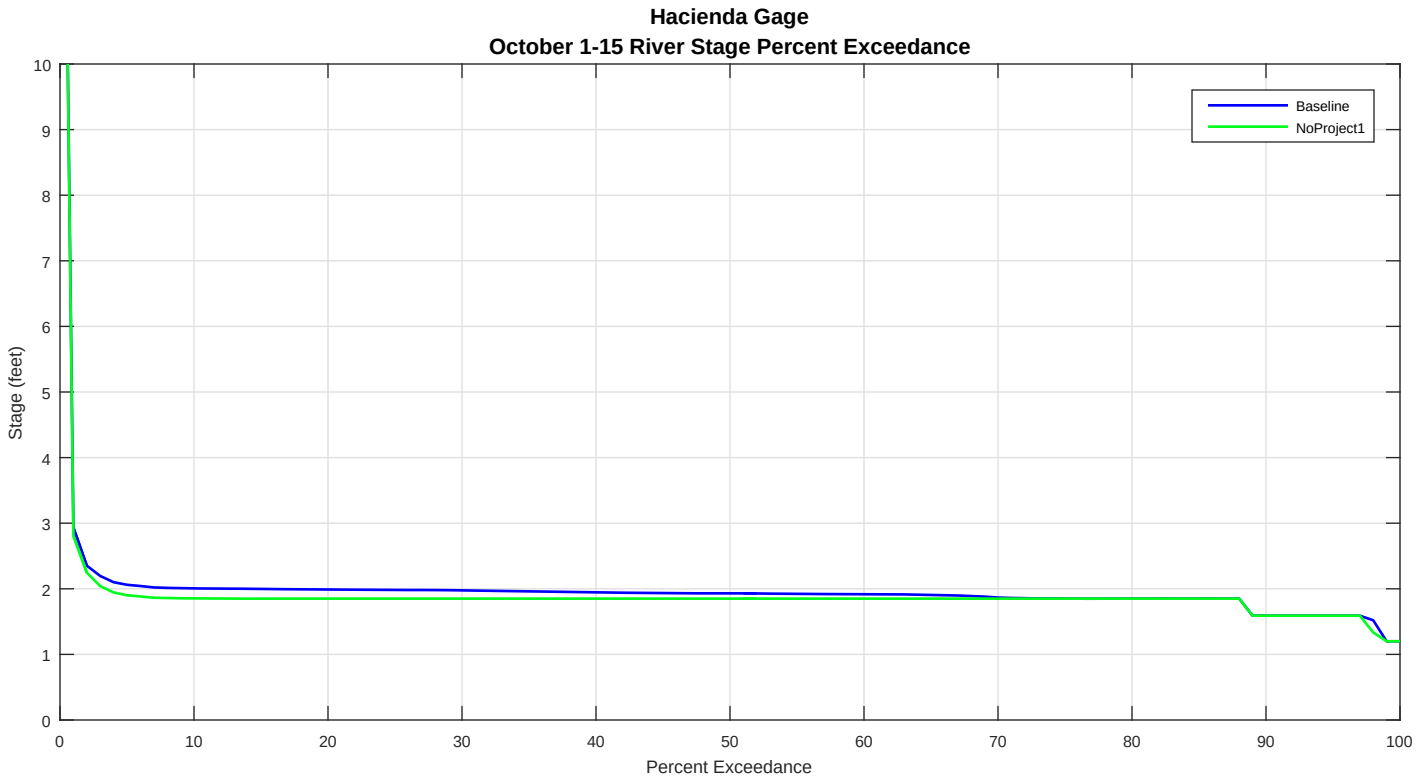

Hacienda Gage
May River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

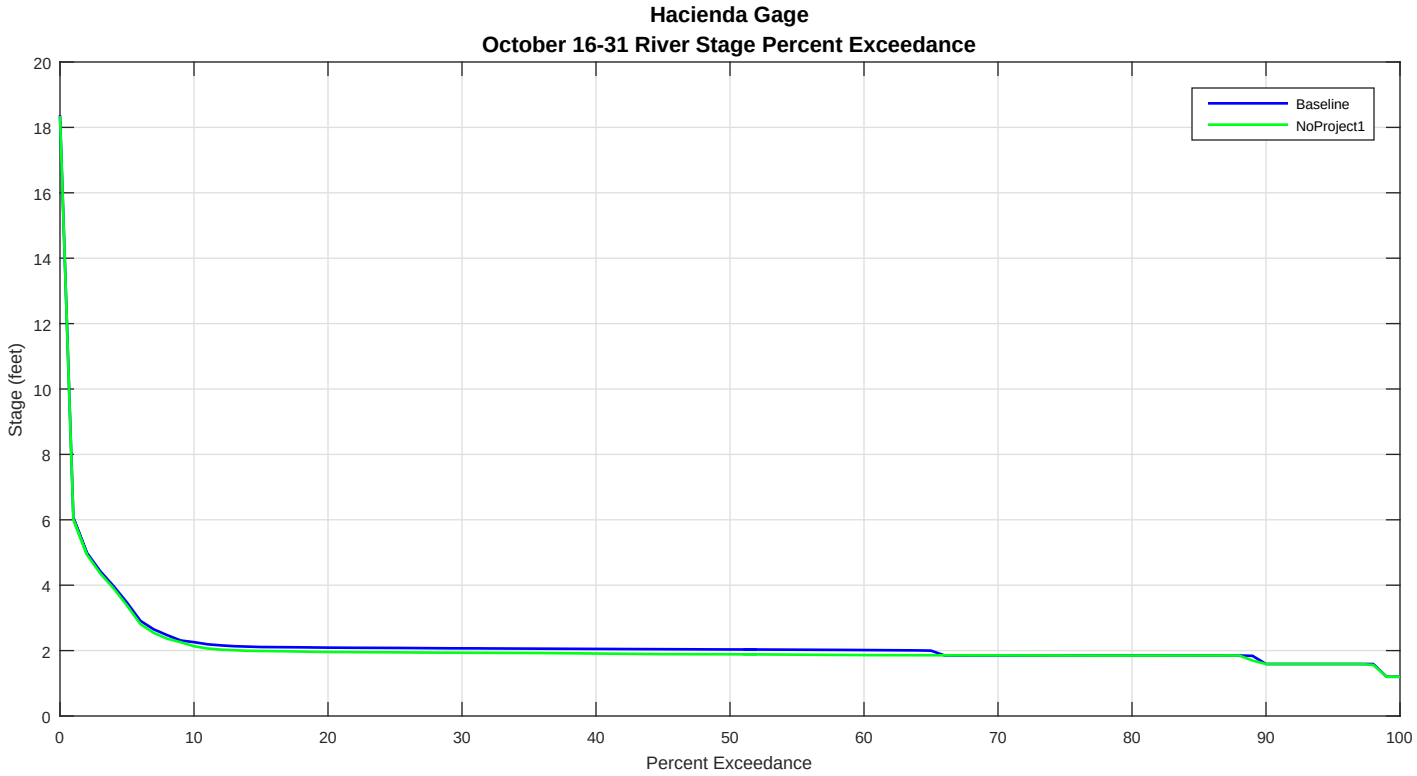

Hacienda Gage
June River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

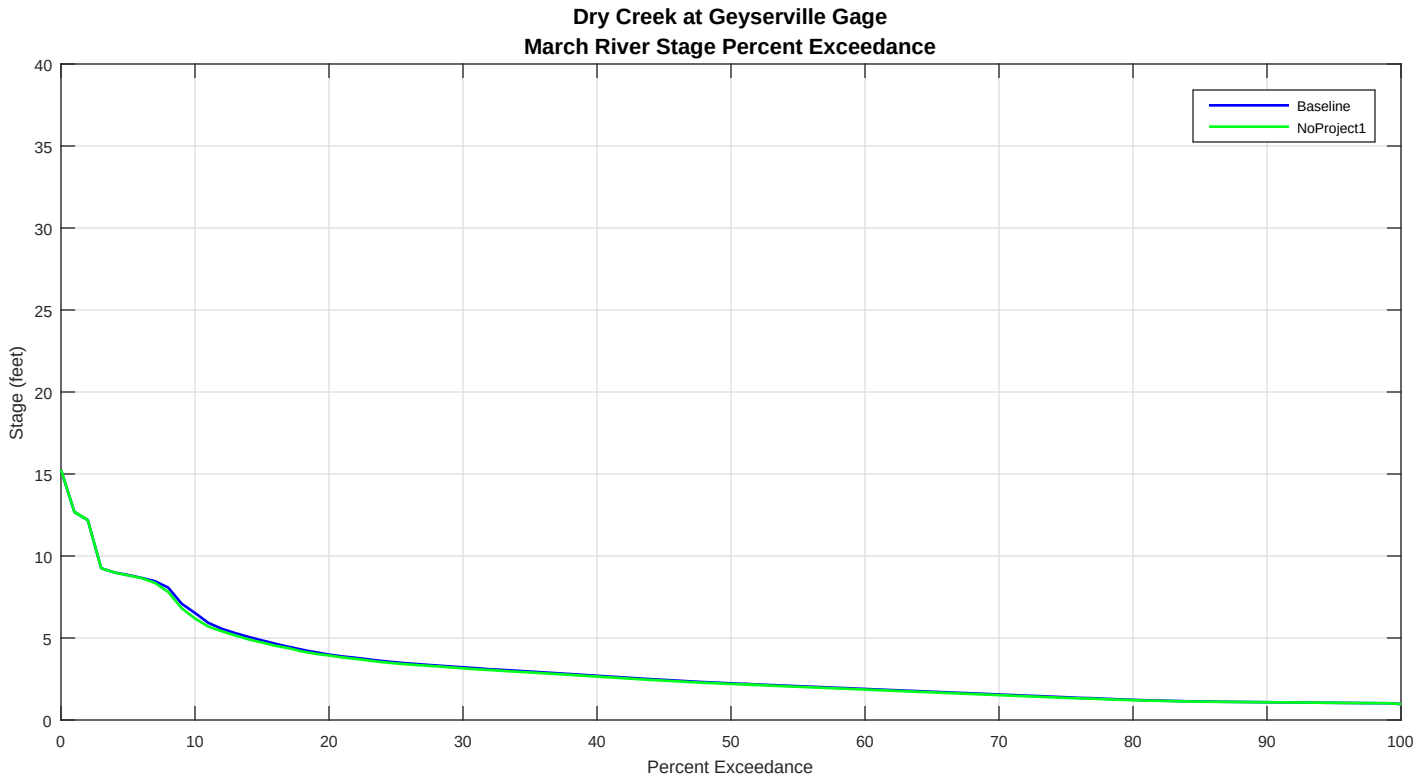

Hacienda Gage
July River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

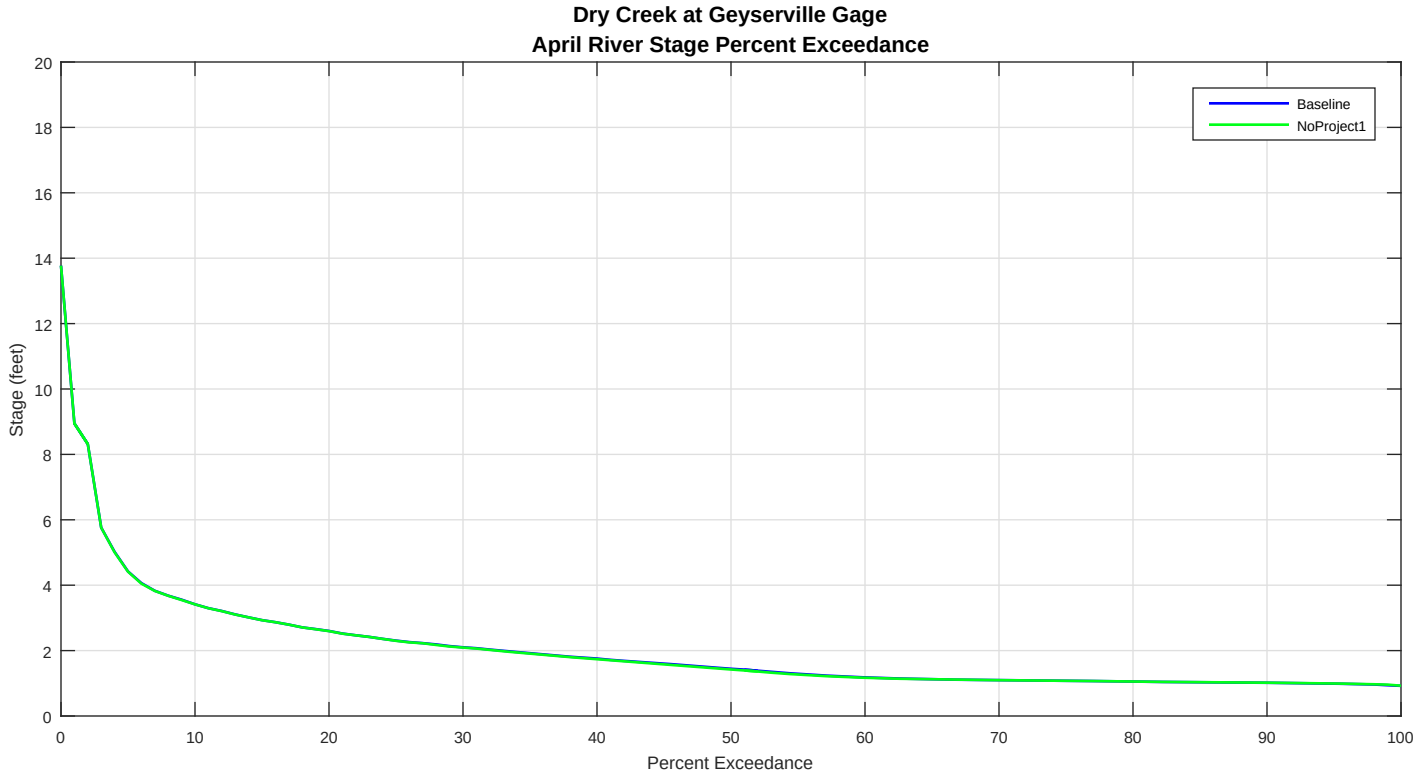

Hacienda Gage
August River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

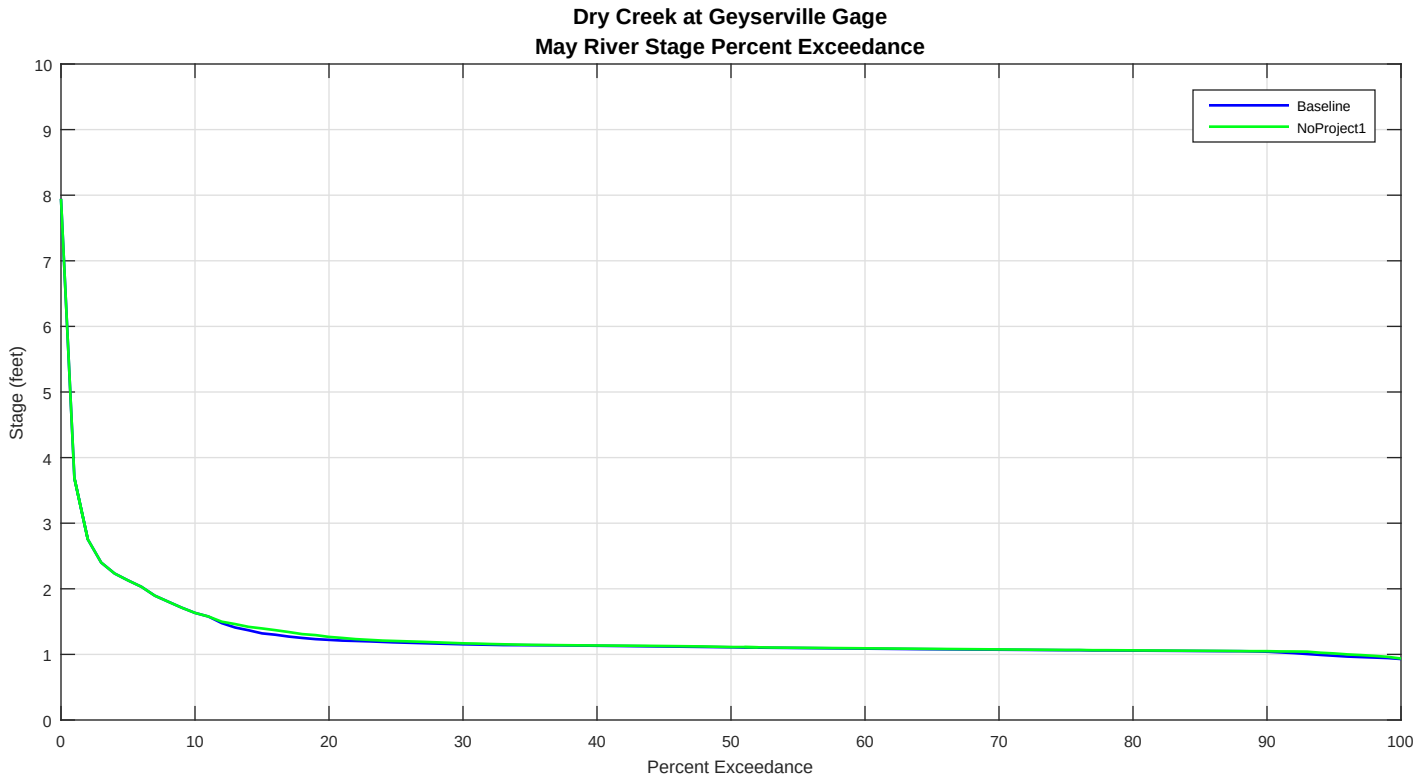

Hacienda Gage
September River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

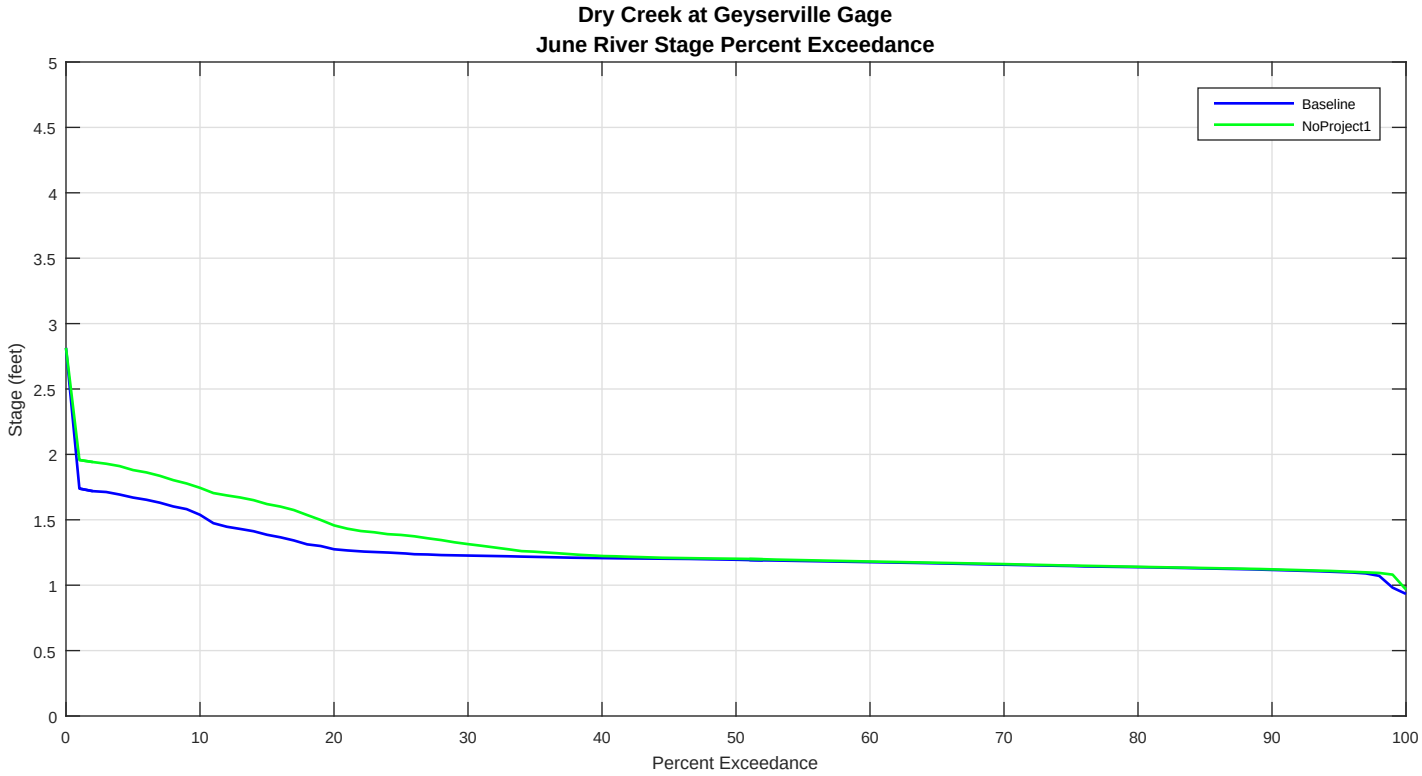

Hacienda Gage
October 1-15 River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

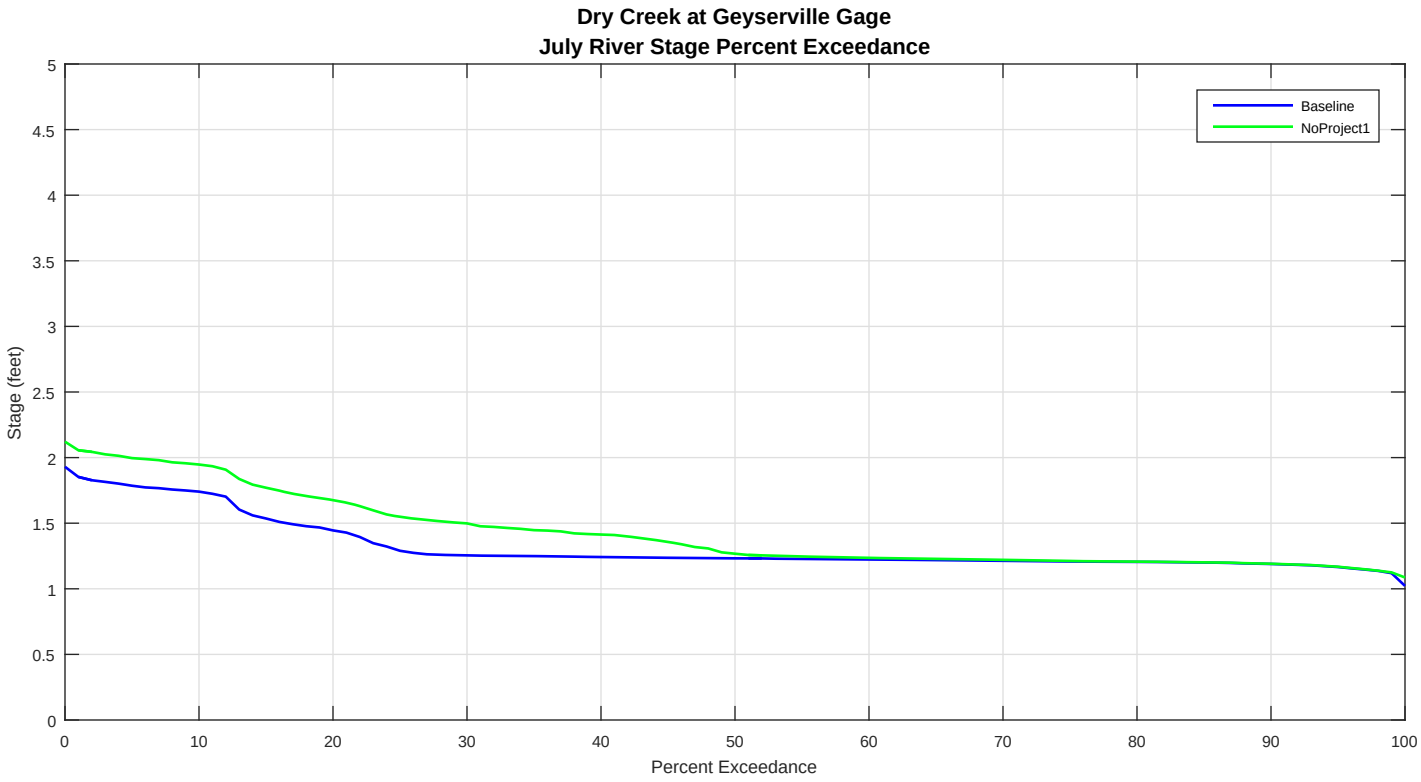

Hacienda Gage
October 16-31 River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

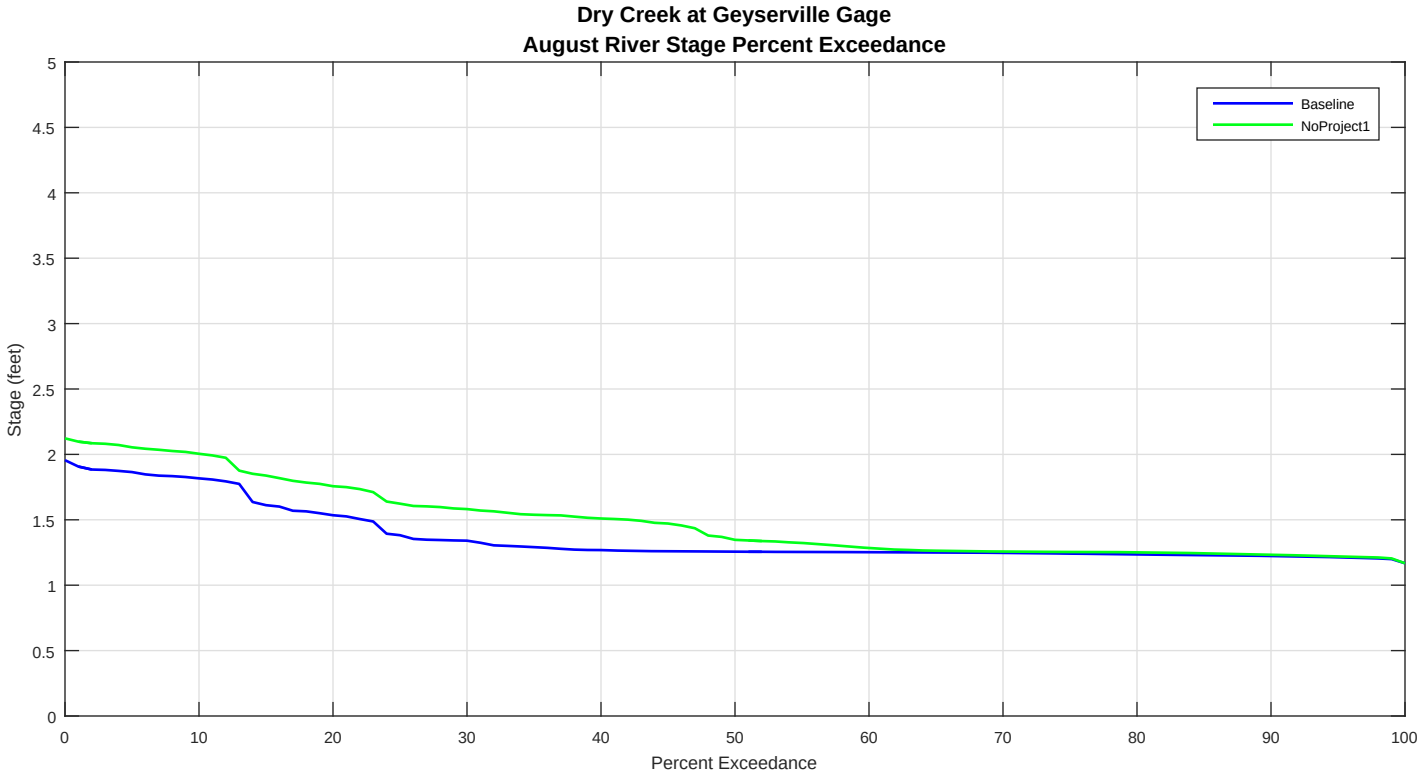

Dry Creek at Geyserville Gage
March River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80
90
100

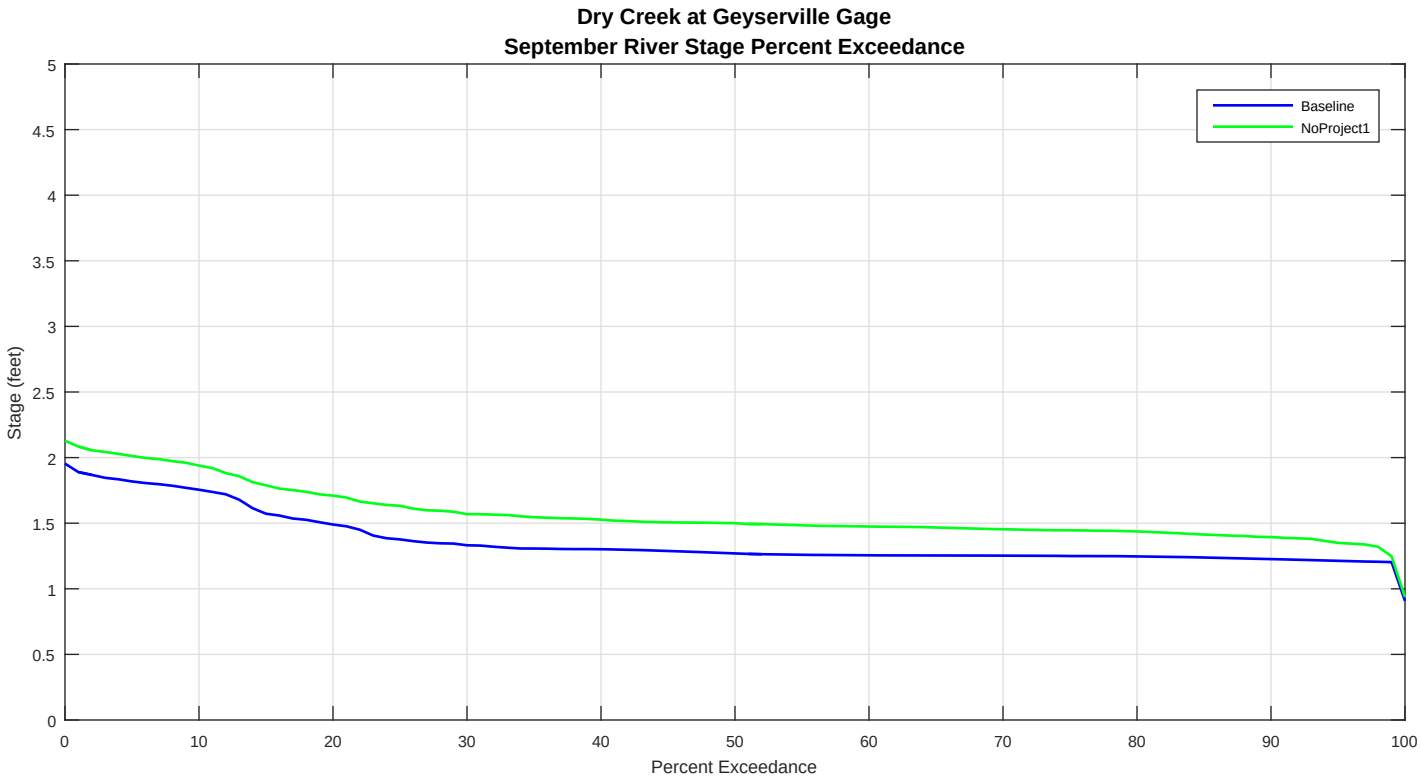

Dry Creek at Geyserville Gage
April River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

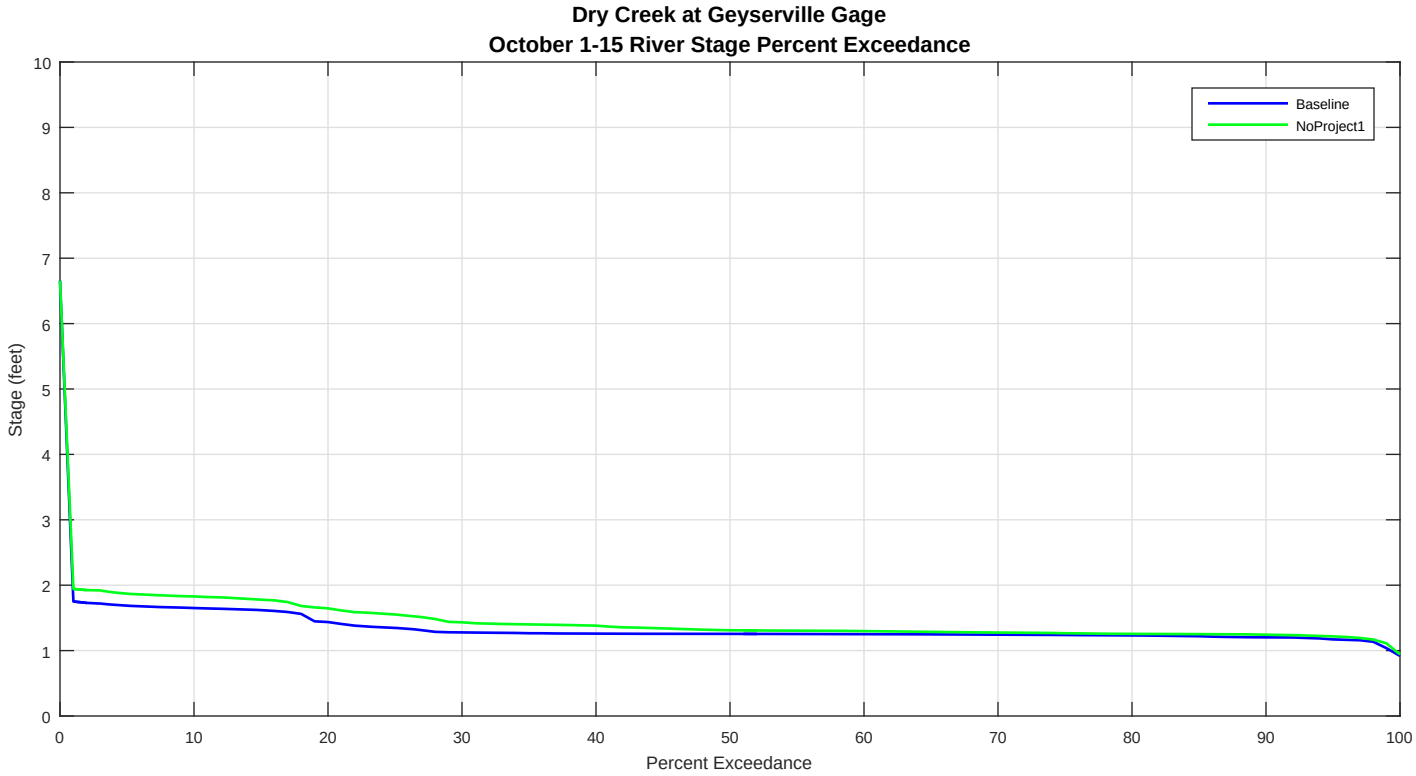

Dry Creek at Geyserville Gage
May River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

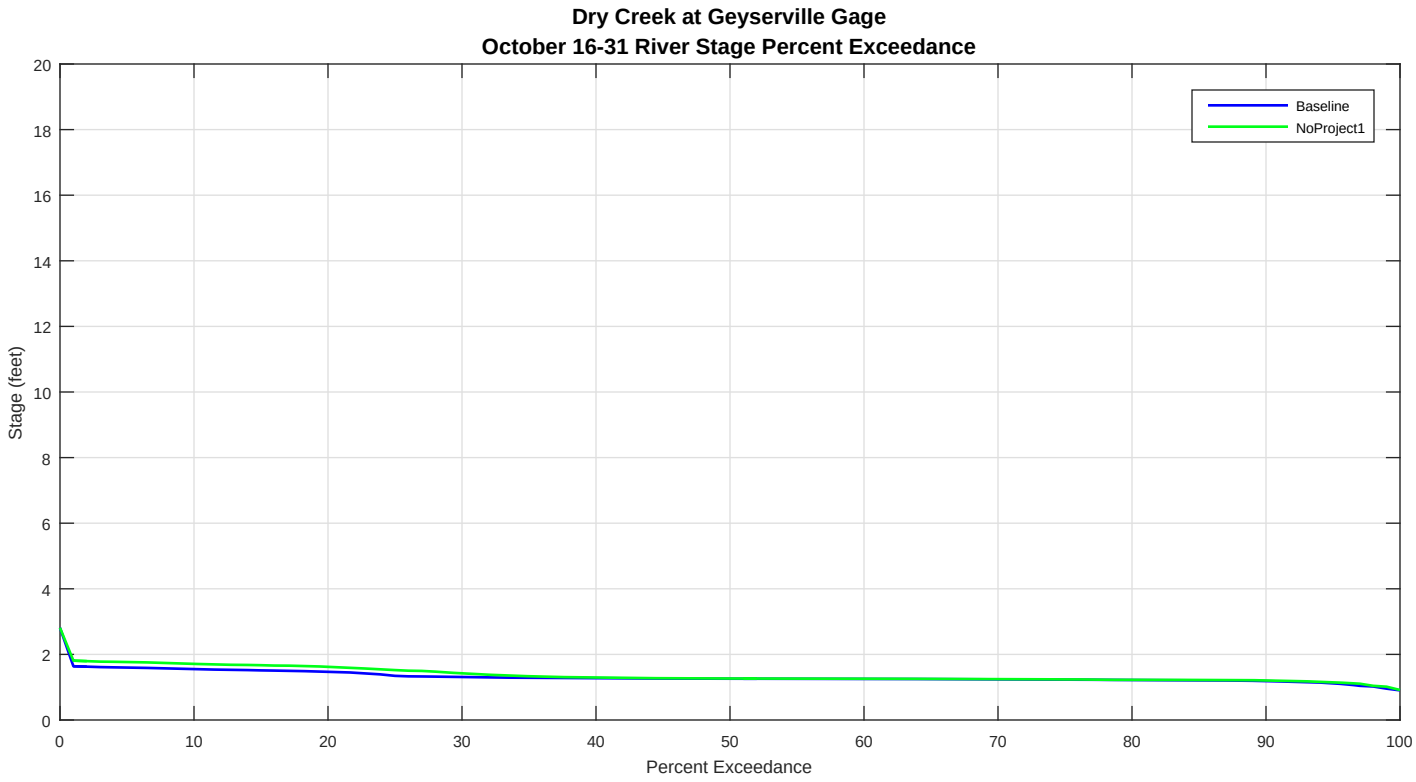

Dry Creek at Geyserville Gage
June River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

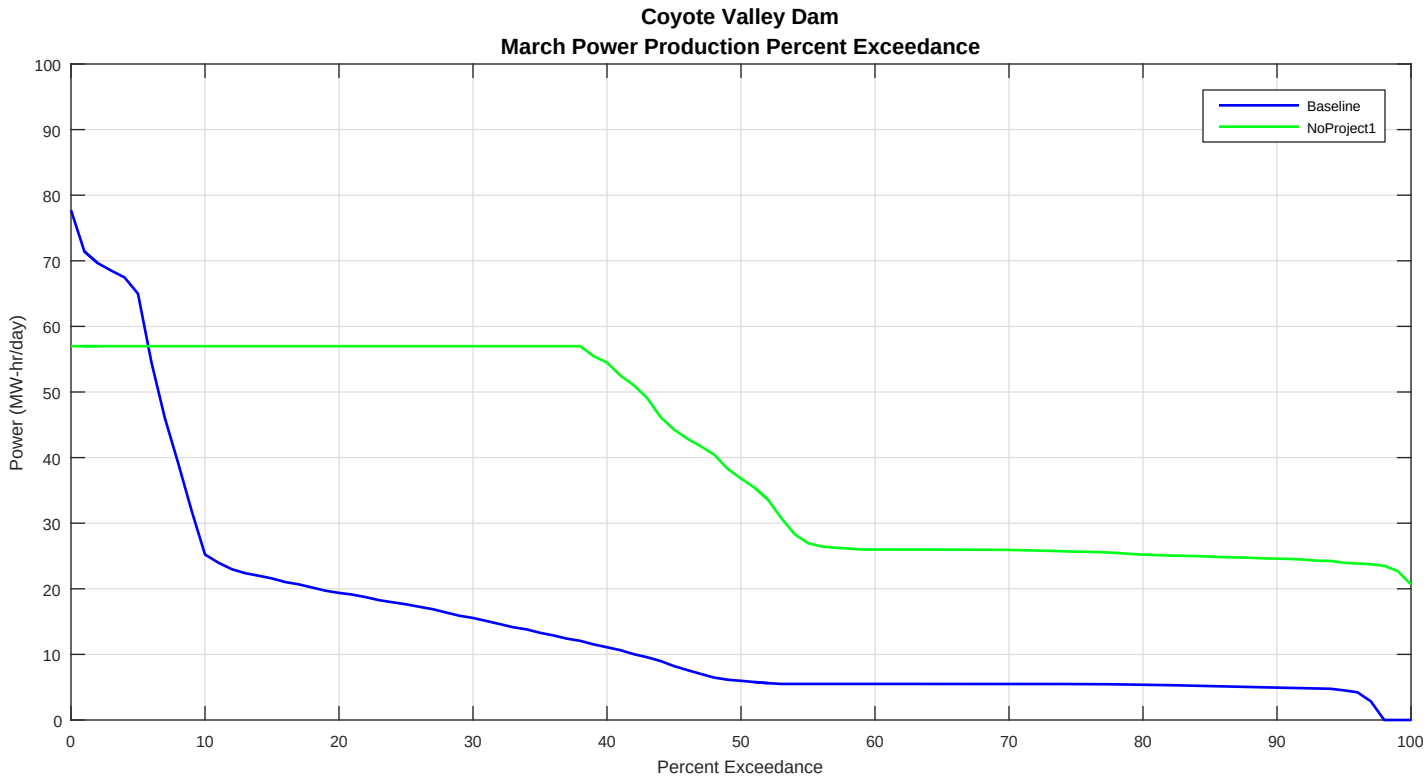

Dry Creek at Geyserville Gage
July River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

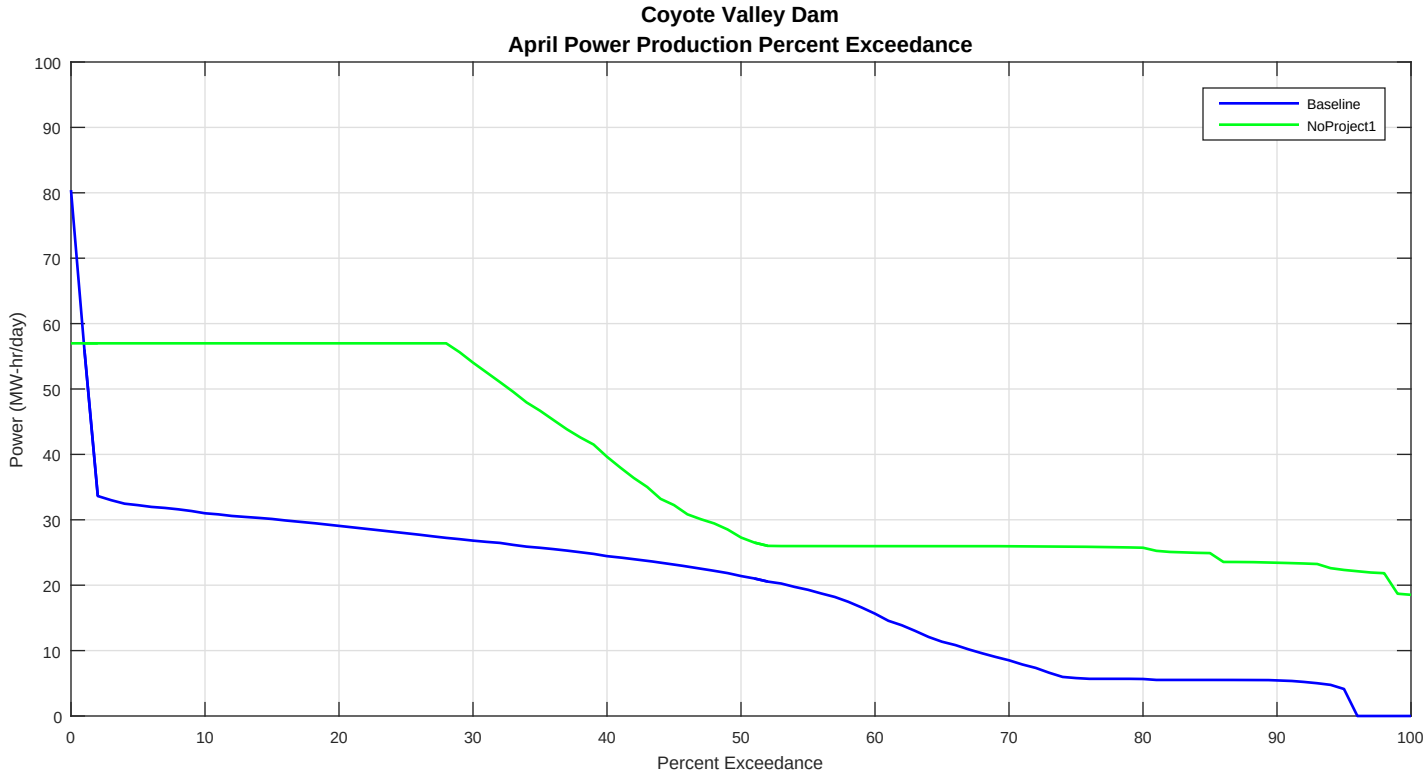

Dry Creek at Geyserville Gage
August River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

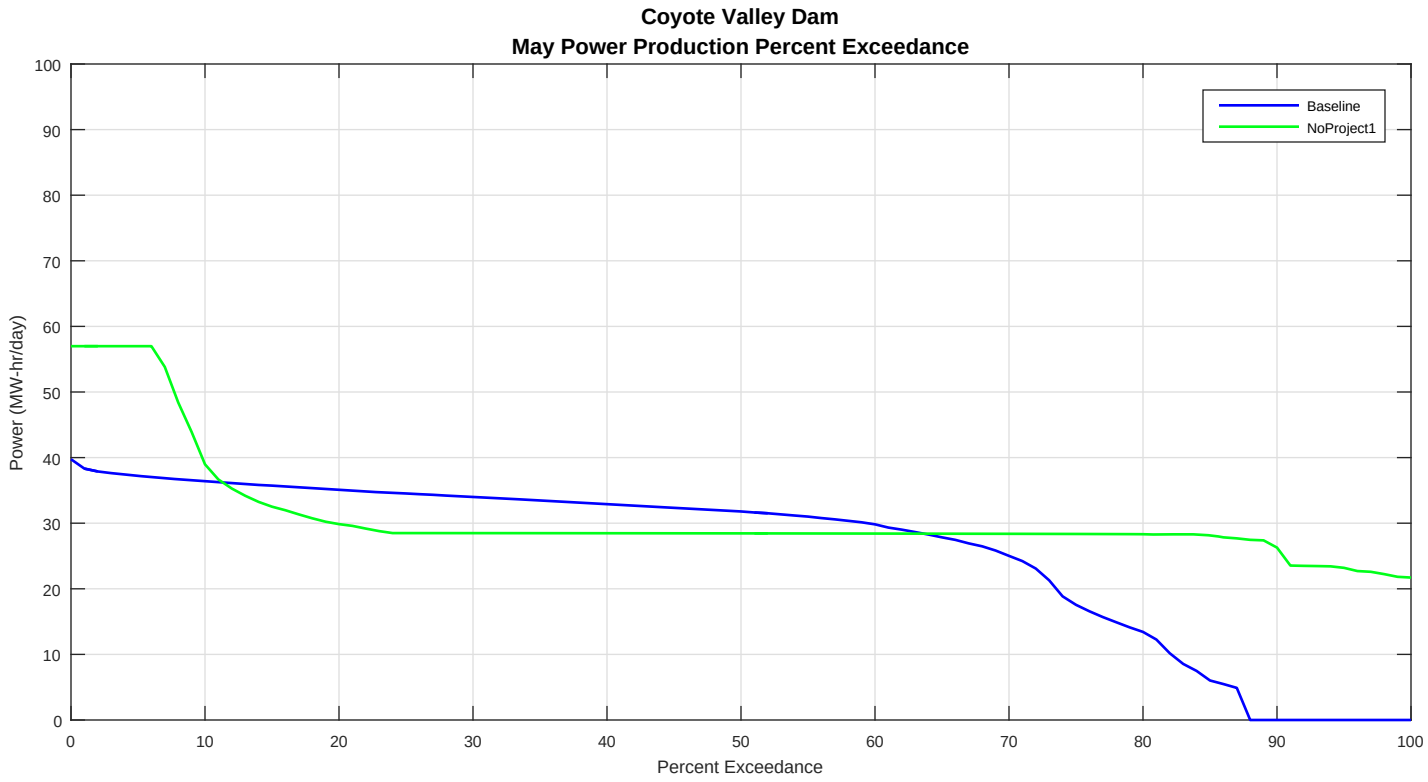

Dry Creek at Geyserville Gage
September River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

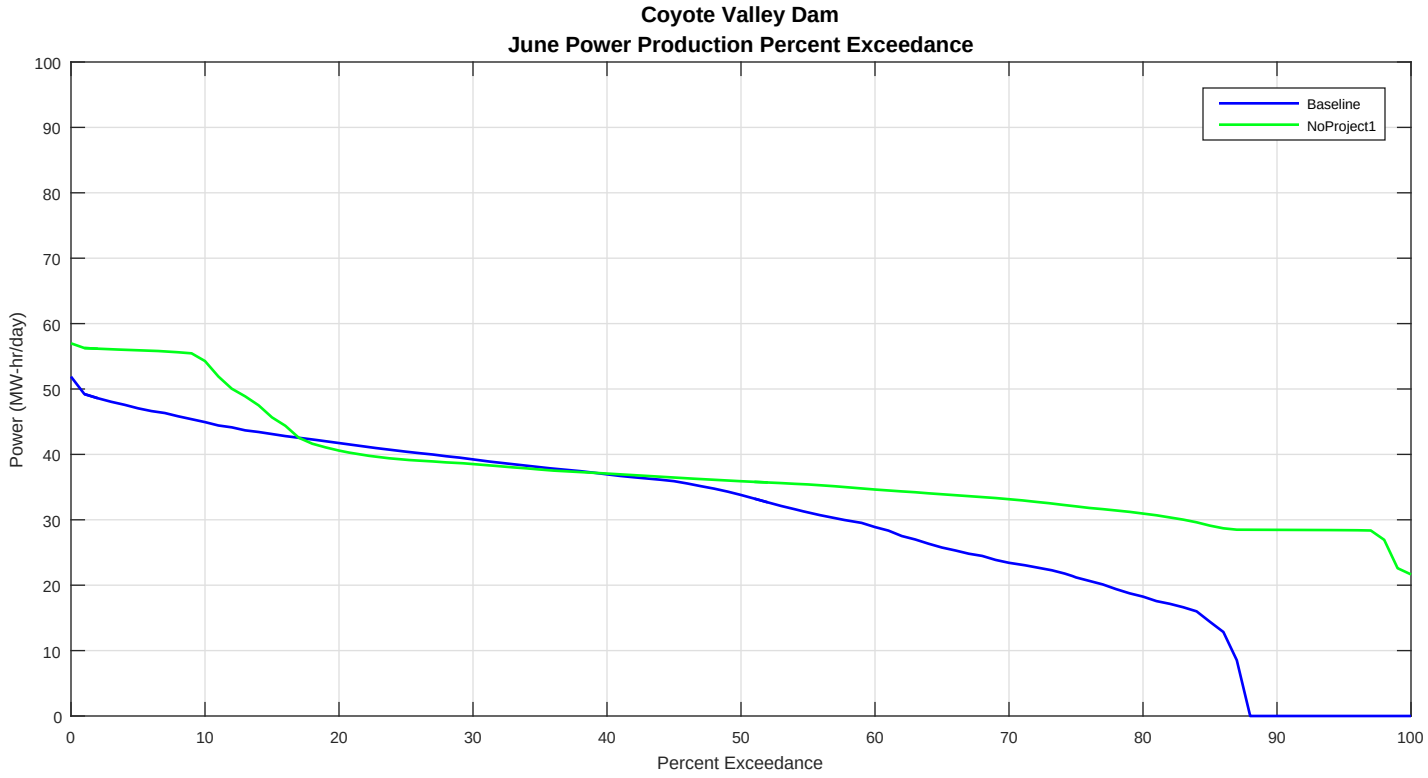

Dry Creek at Geyserville Gage
October 1-15 River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

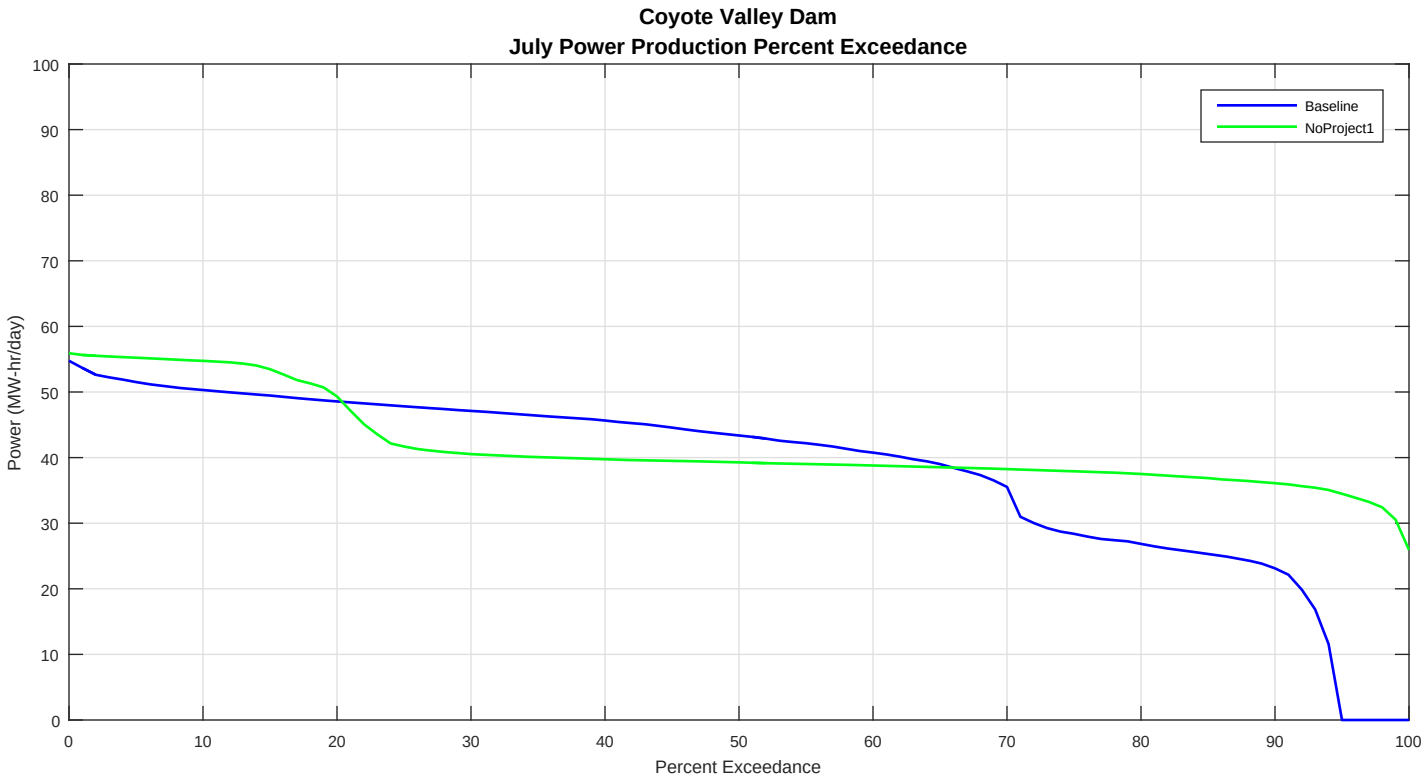

Dry Creek at Geyserville Gage
October 16-31 River Stage Percent Exceedance
Baseline
NoProject1
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

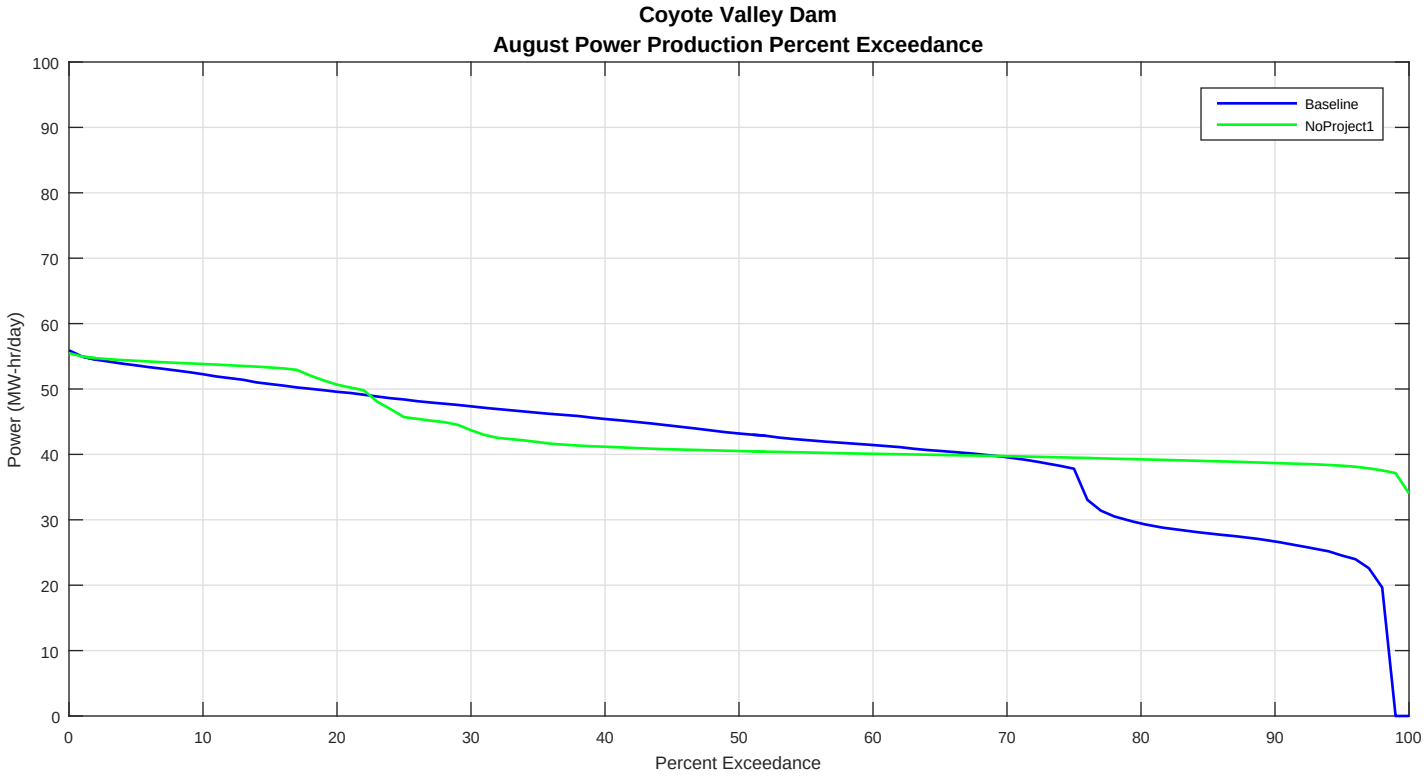

Coyote Valley Dam
March Power Production Percent Exceedance
Baseline
NoProject1
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

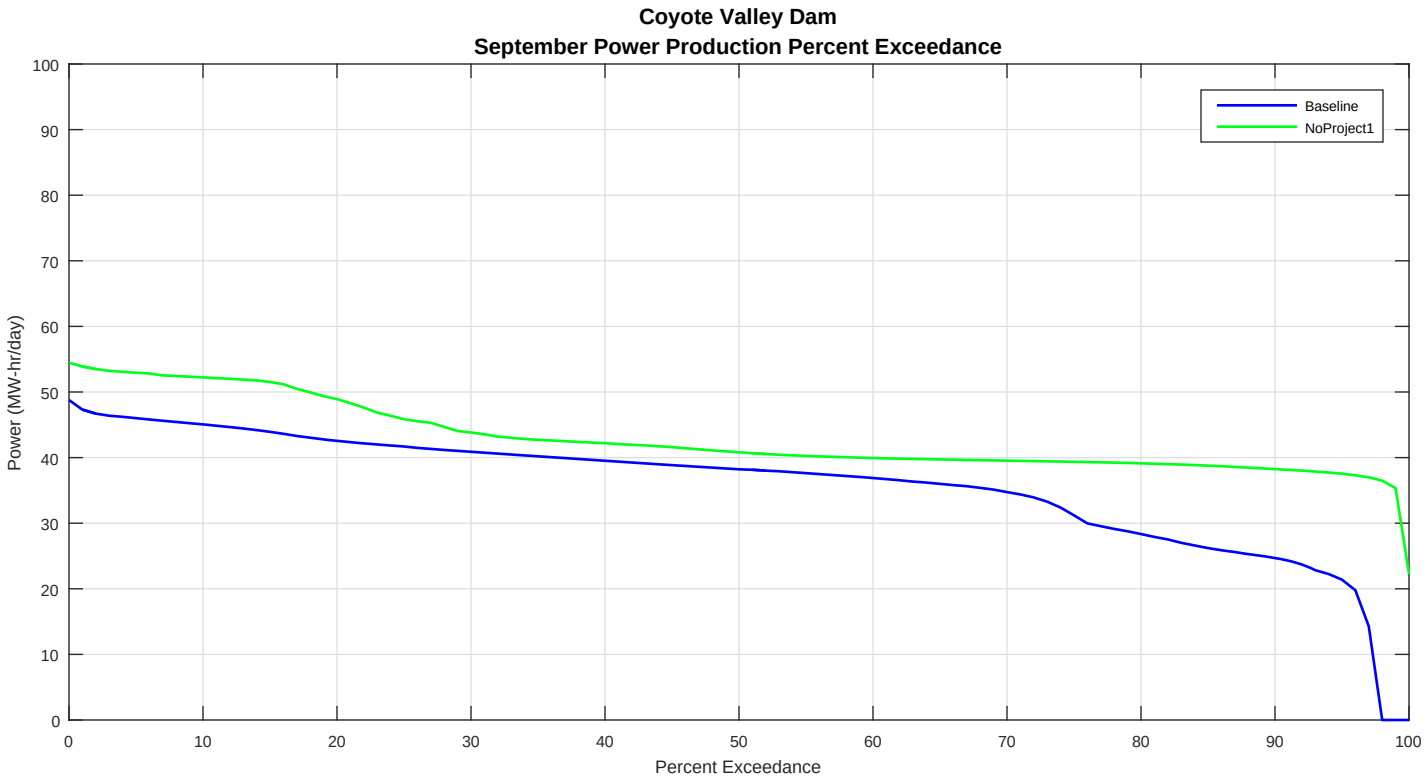

Coyote Valley Dam
April Power Production Percent Exceedance
Baseline
NoProject1
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

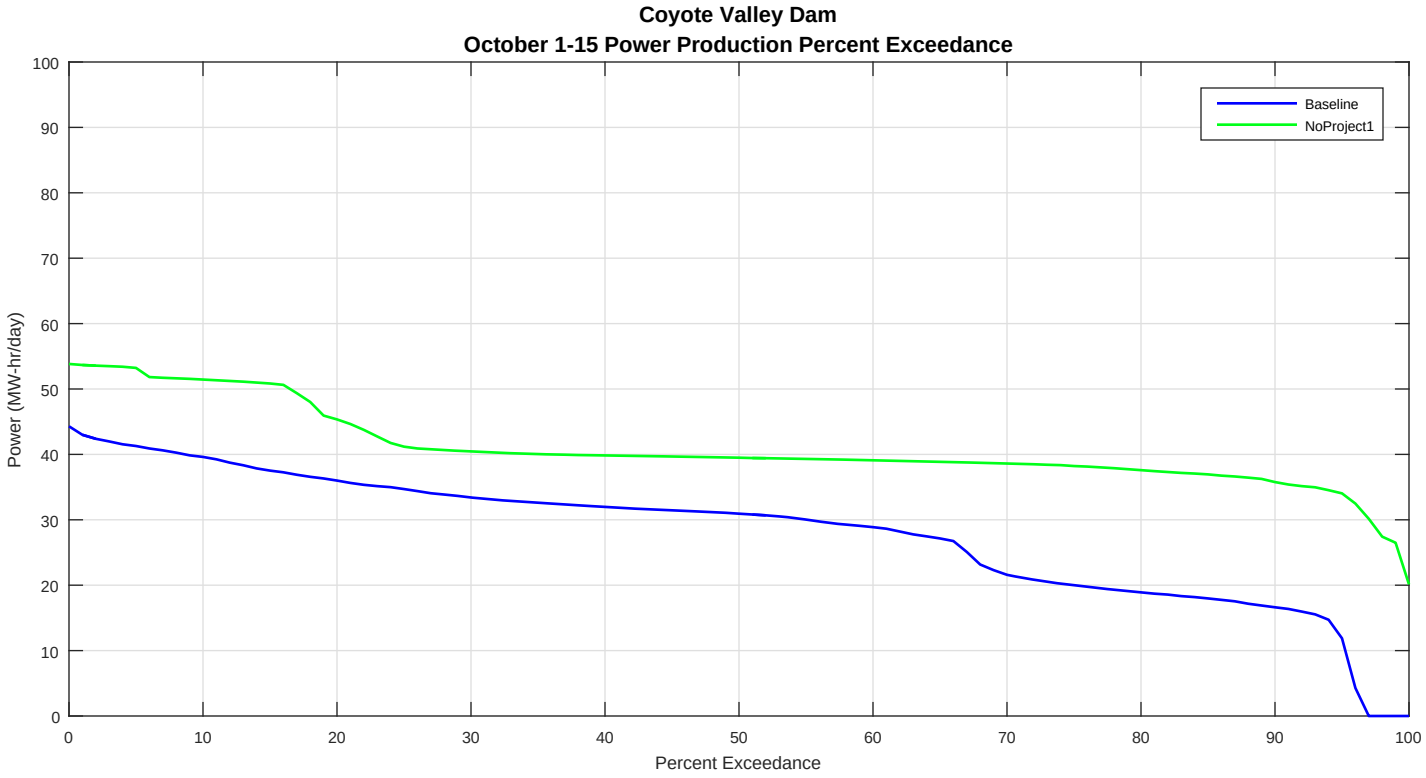

Coyote Valley Dam
May Power Production Percent Exceedance
Baseline
NoProject1
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

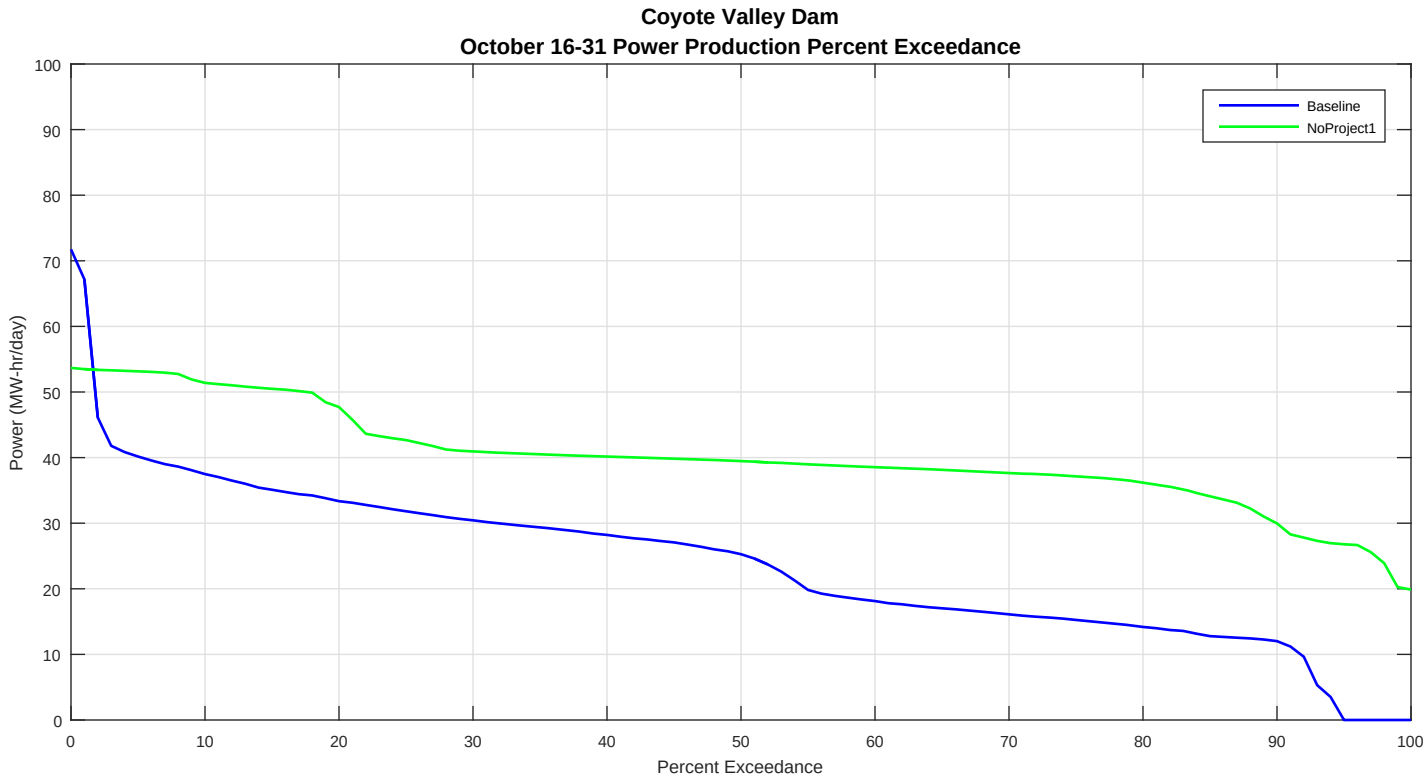

Coyote Valley Dam
June Power Production Percent Exceedance
Baseline
NoProject1
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

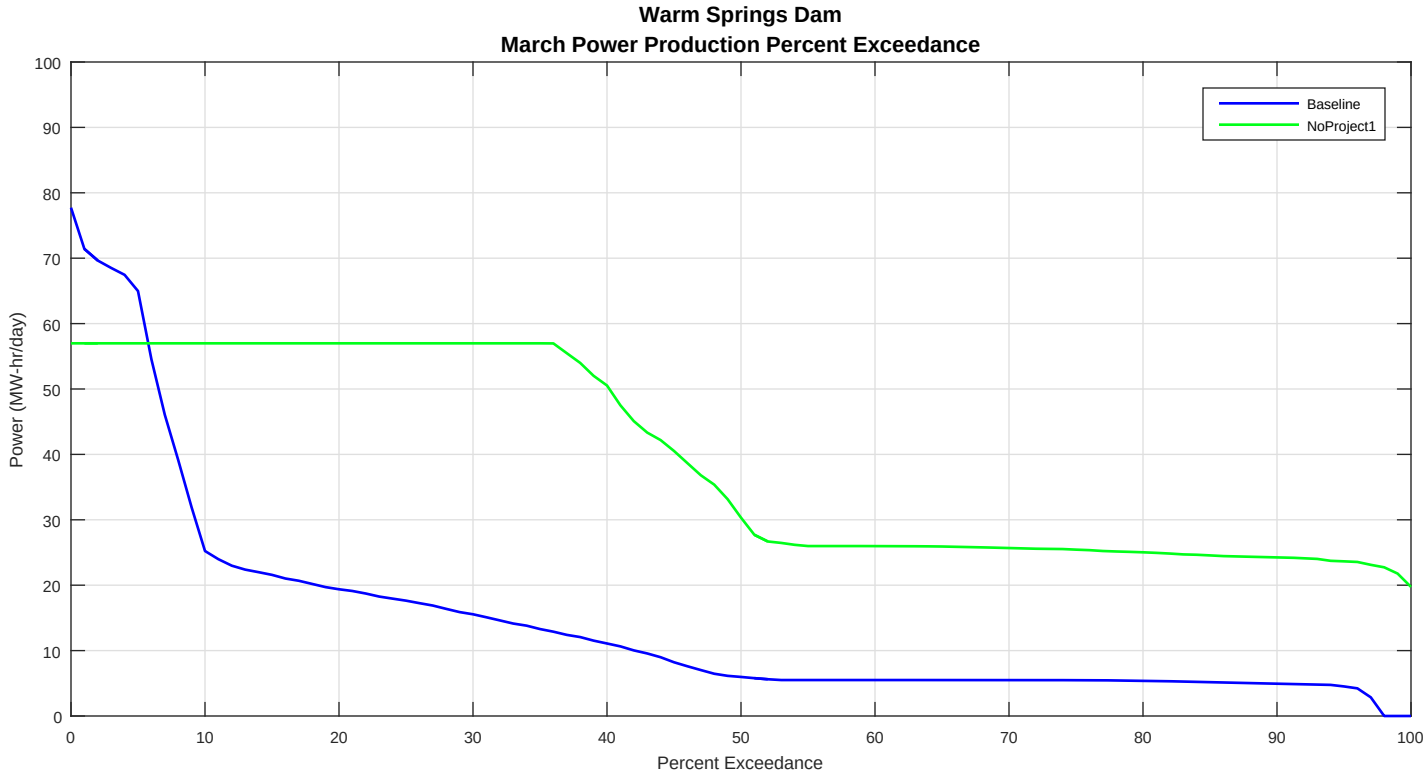

Coyote Valley Dam
July Power Production Percent Exceedance
Baseline
NoProject1
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

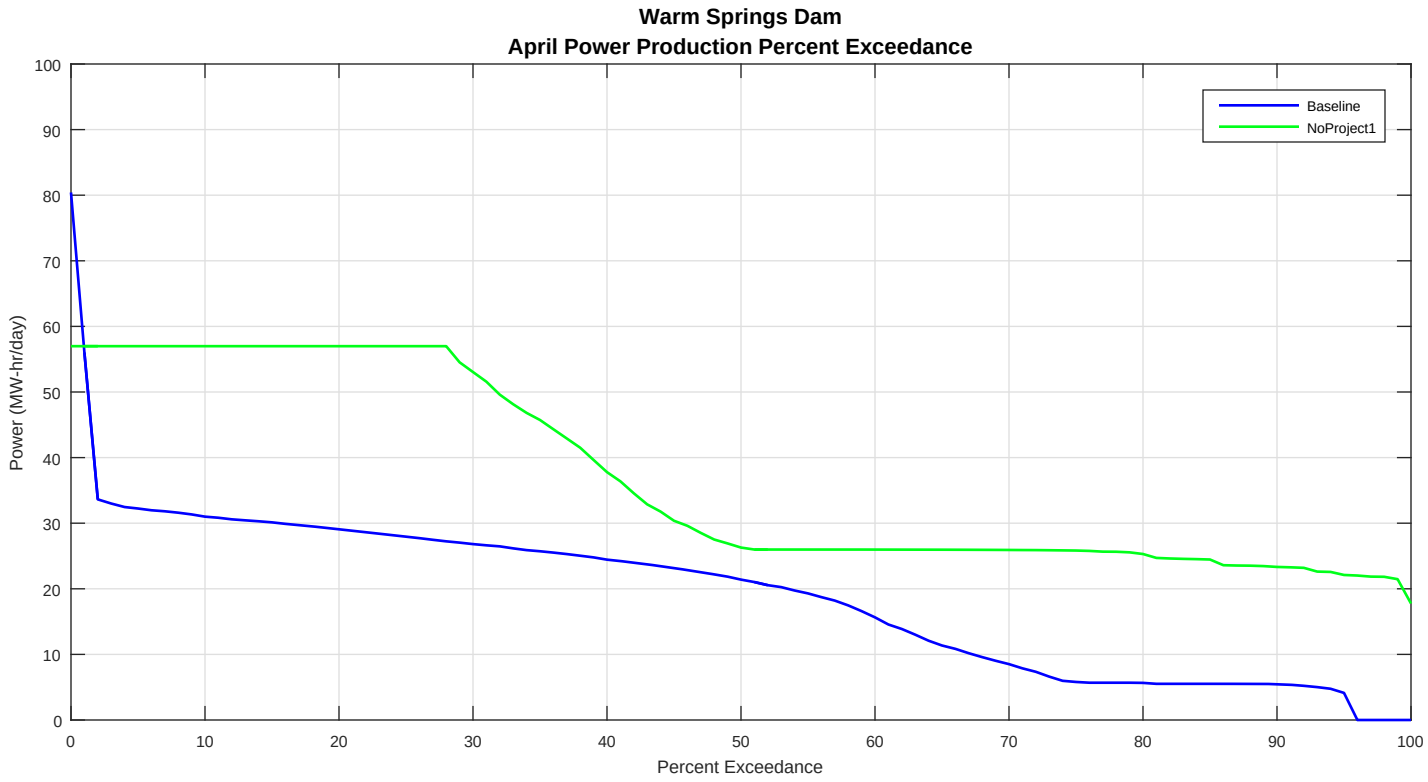

Coyote Valley Dam
August Power Production Percent Exceedance
Baseline
NoProject1
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

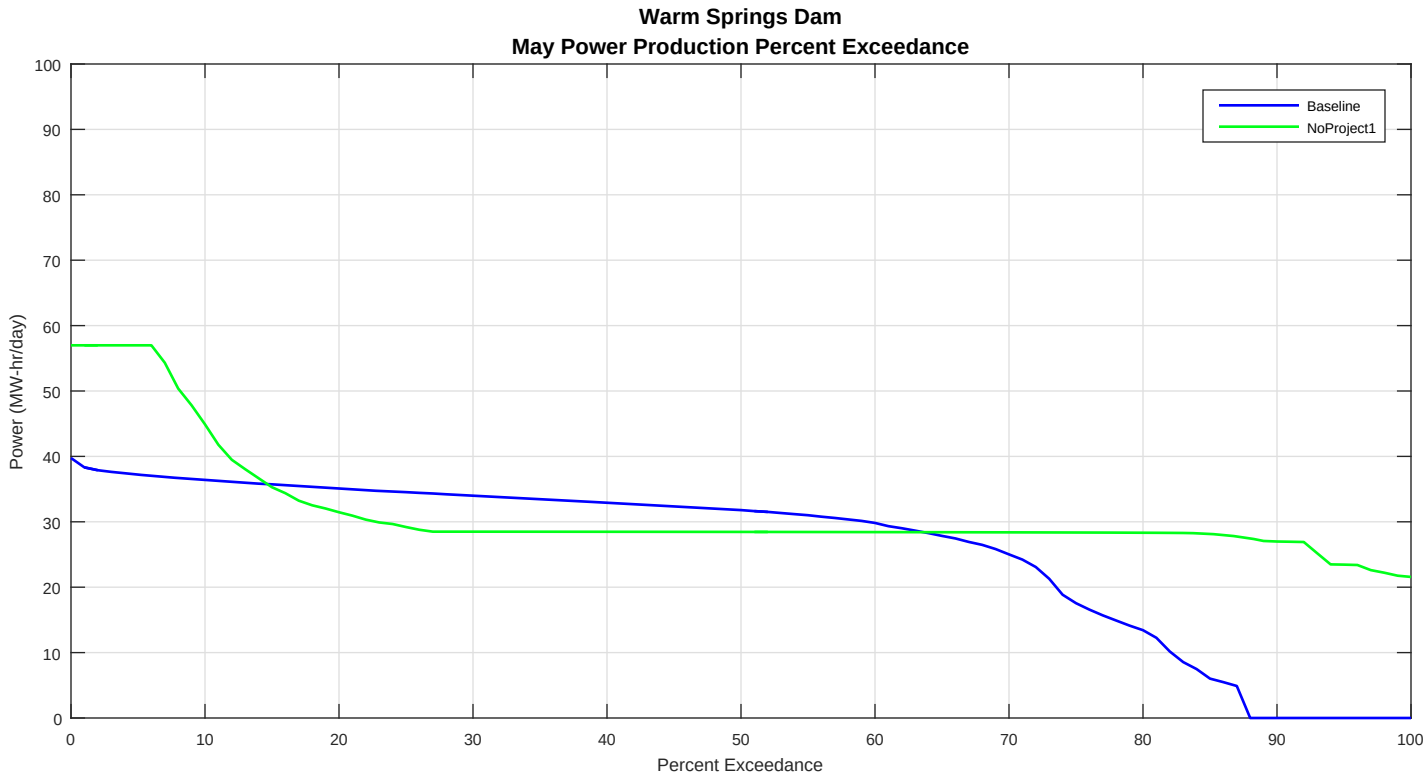

Coyote Valley Dam
September Power Production Percent Exceedance
Baseline
NoProject1
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

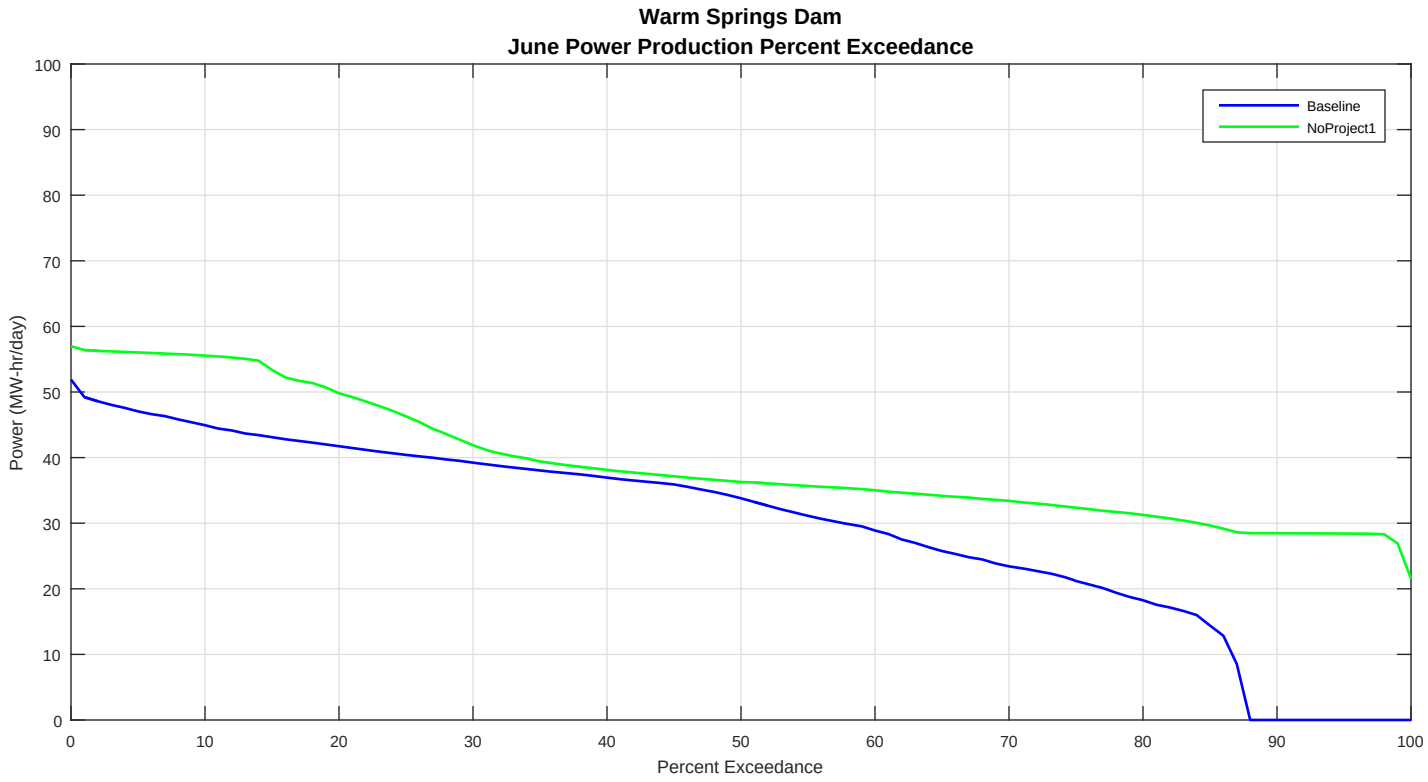

Coyote Valley Dam
October 1-15 Power Production Percent Exceedance
Baseline
NoProject1
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

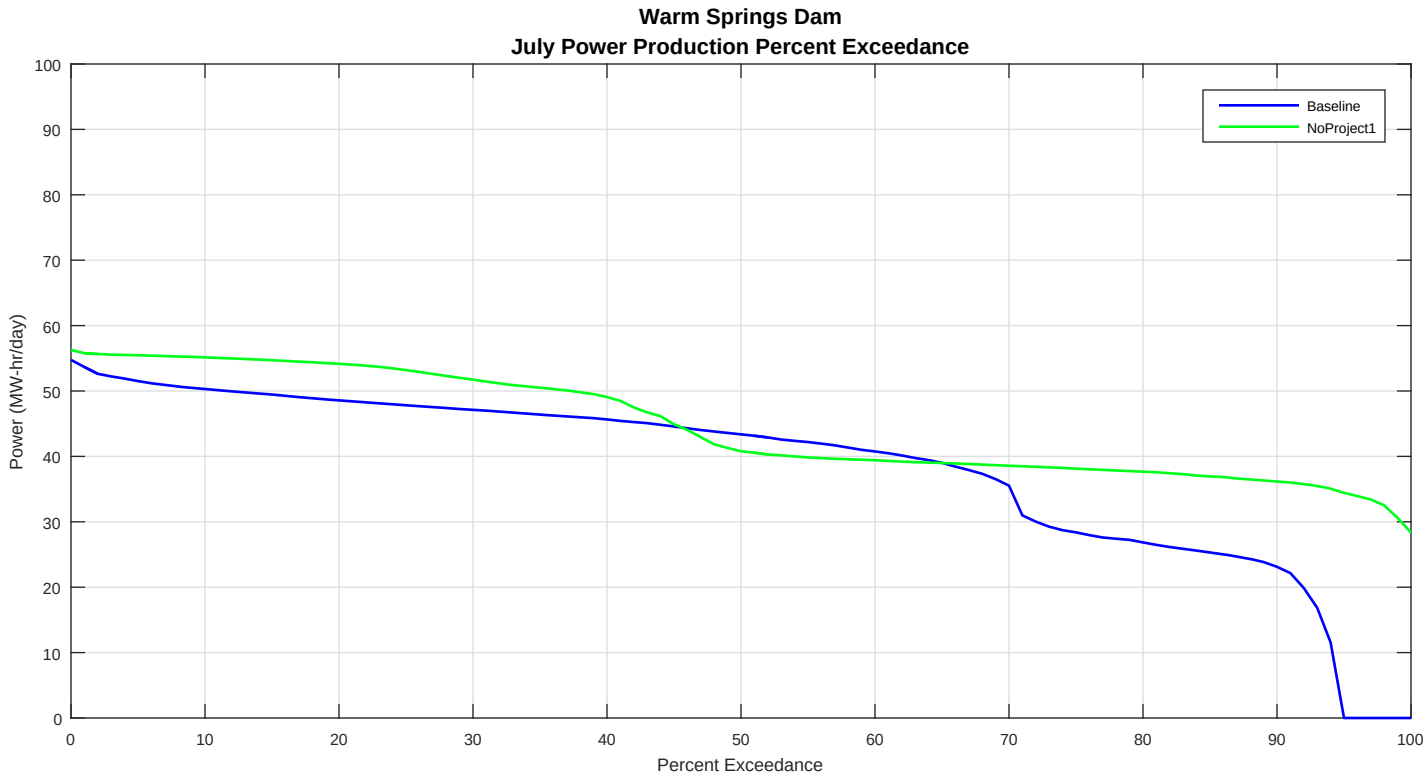

Coyote Valley Dam
October 16-31 Power Production Percent Exceedance
Baseline
NoProject1
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

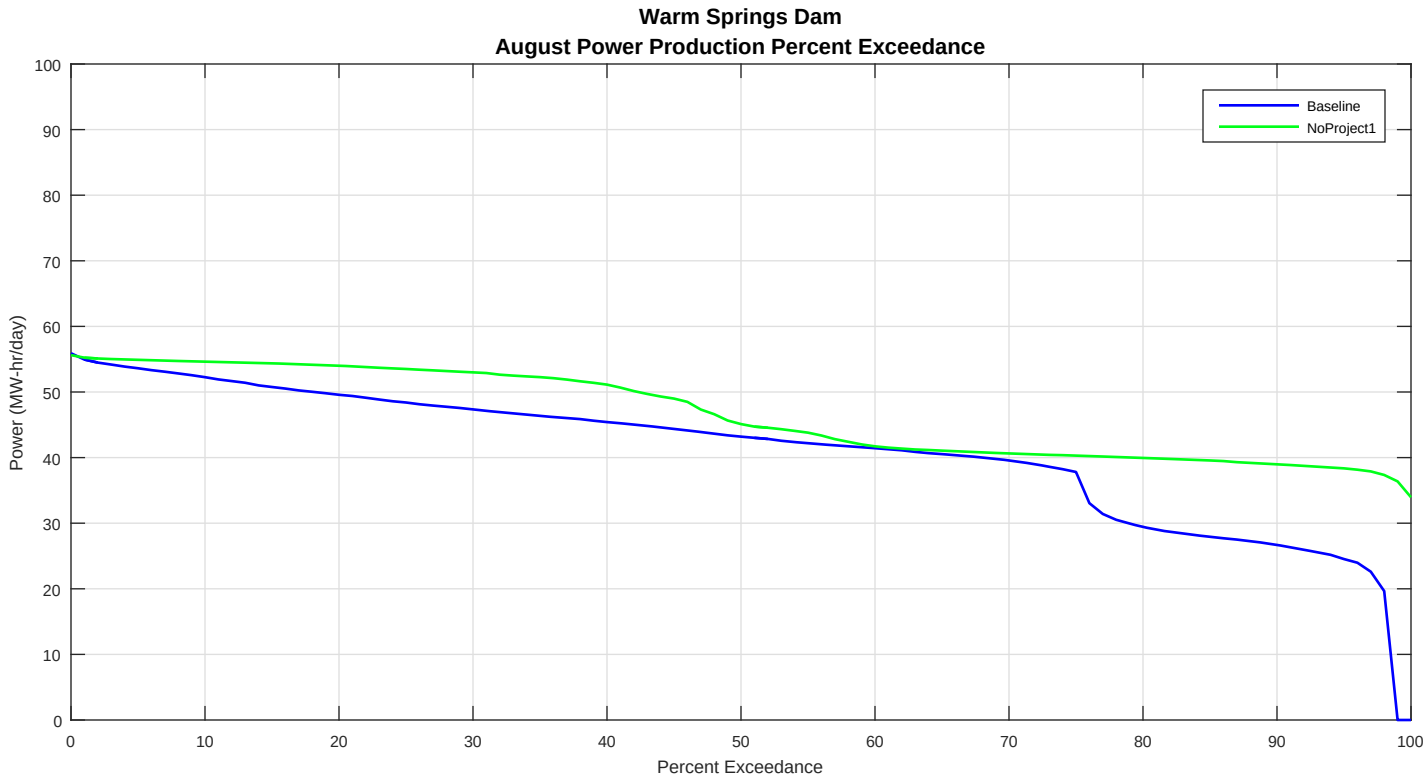

Warm Springs Dam
March Power Production Percent Exceedance
Baseline
NoProject1
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

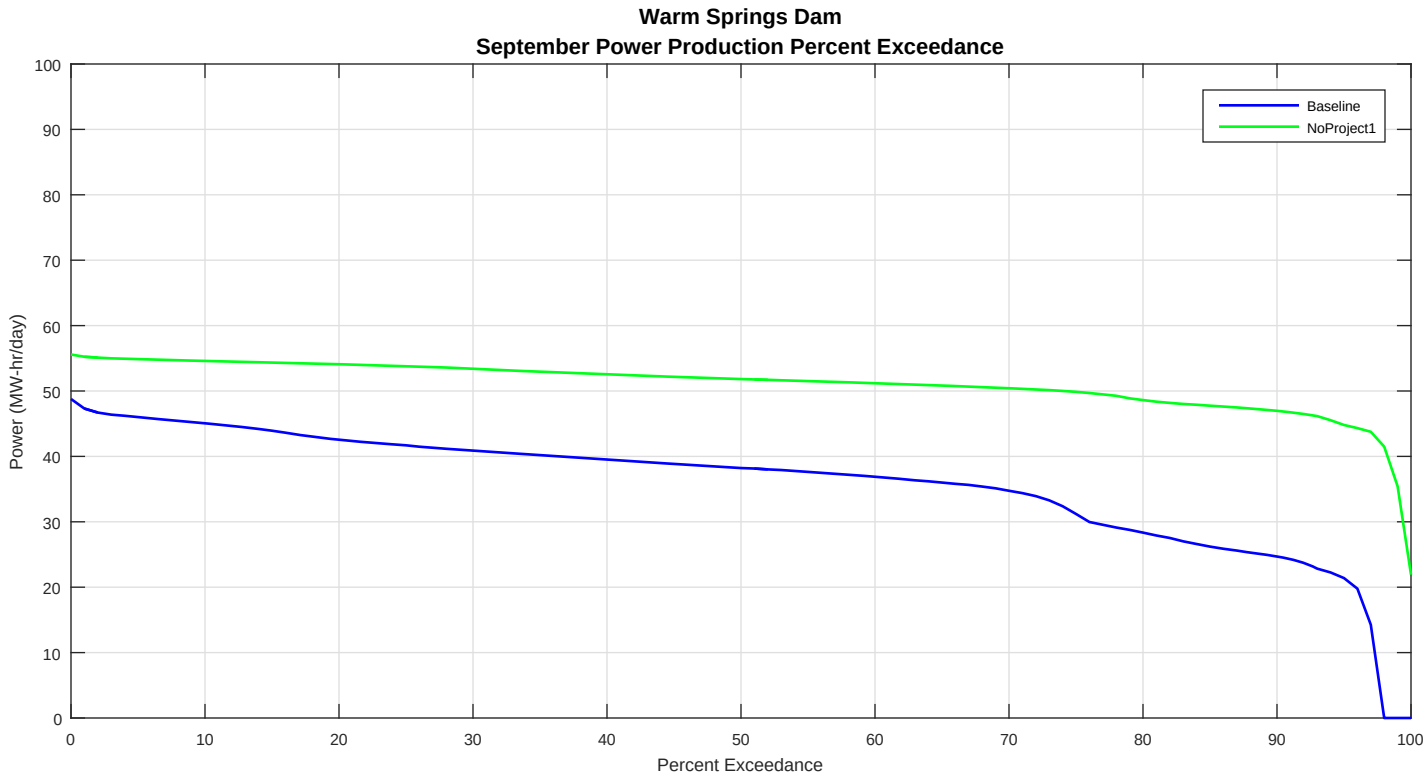

Warm Springs Dam
April Power Production Percent Exceedance
Baseline
NoProject1
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

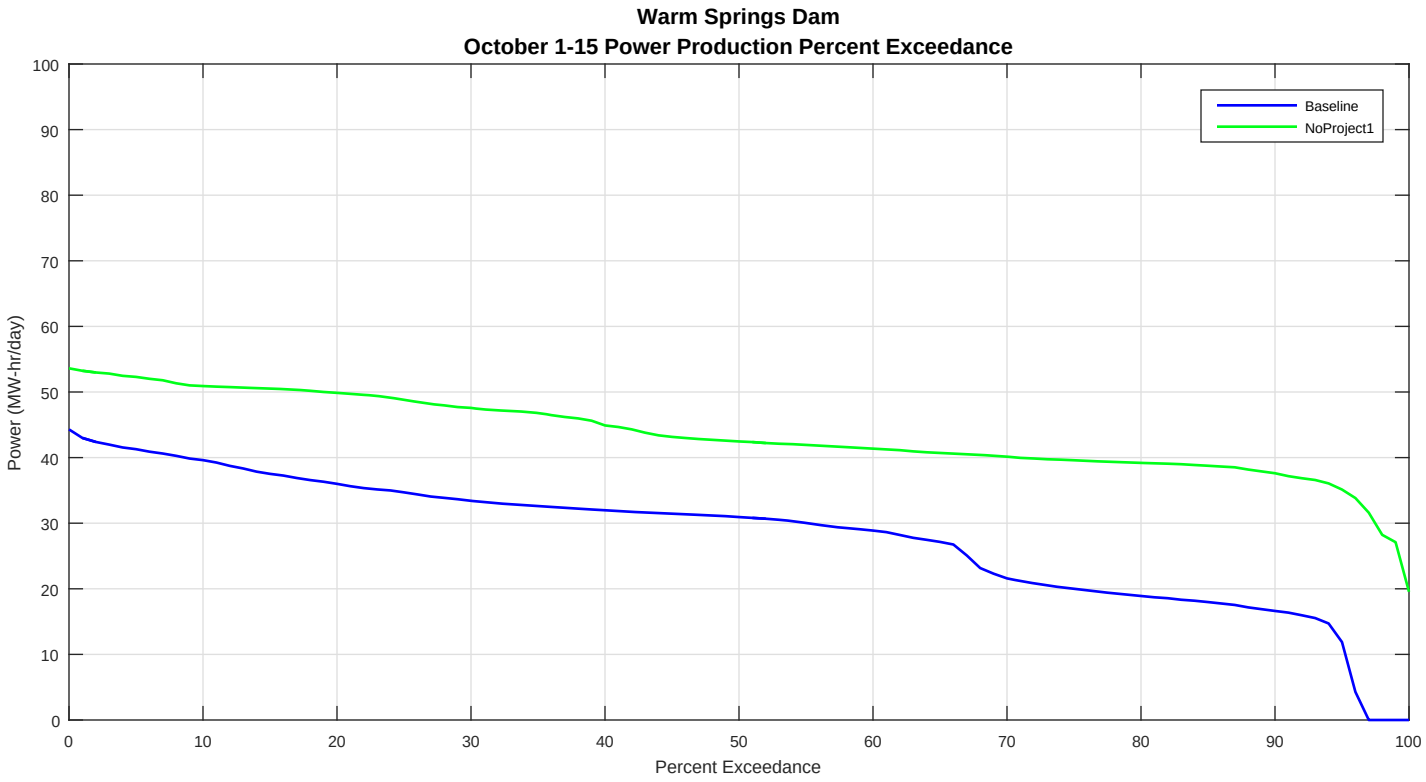

Warm Springs Dam
May Power Production Percent Exceedance
Baseline
NoProject1
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

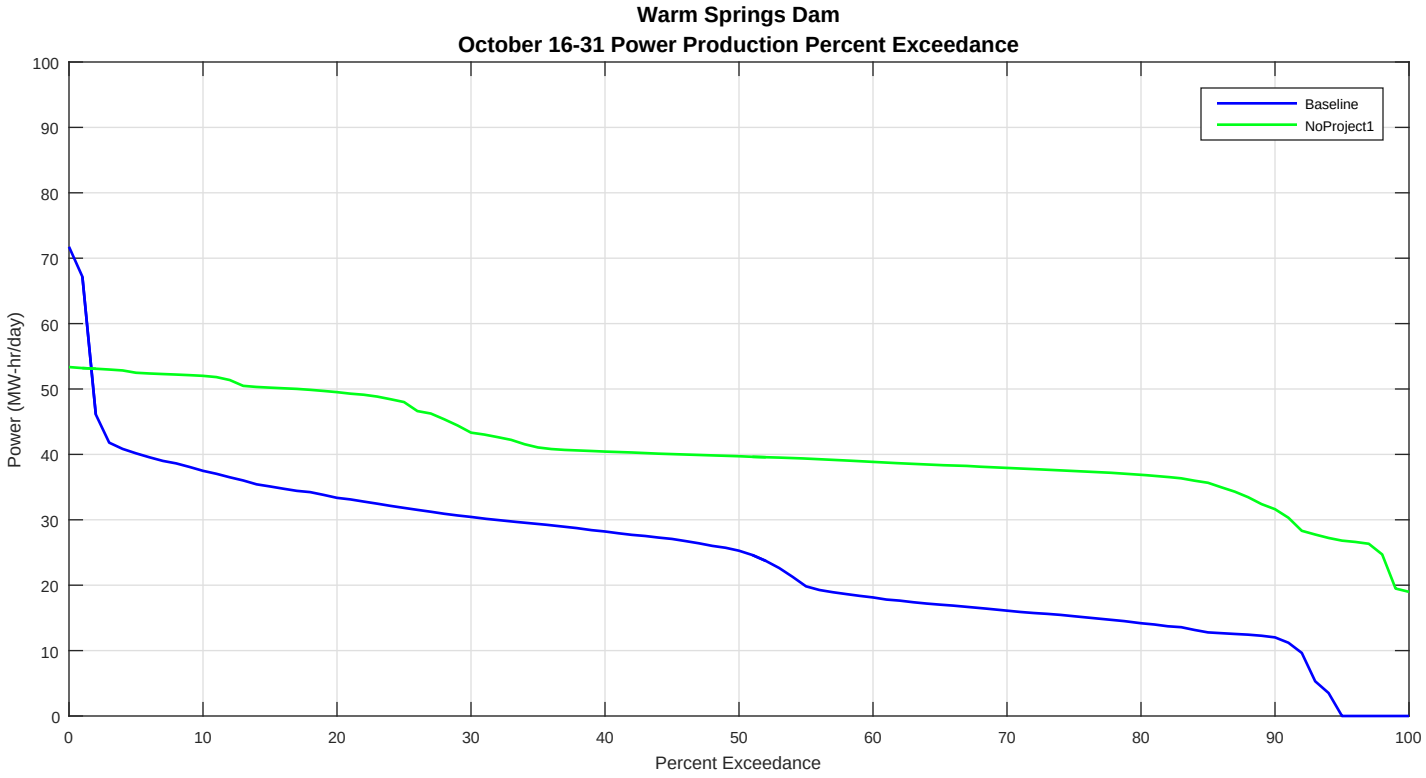

Warm Springs Dam
June Power Production Percent Exceedance
Baseline
NoProject1
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

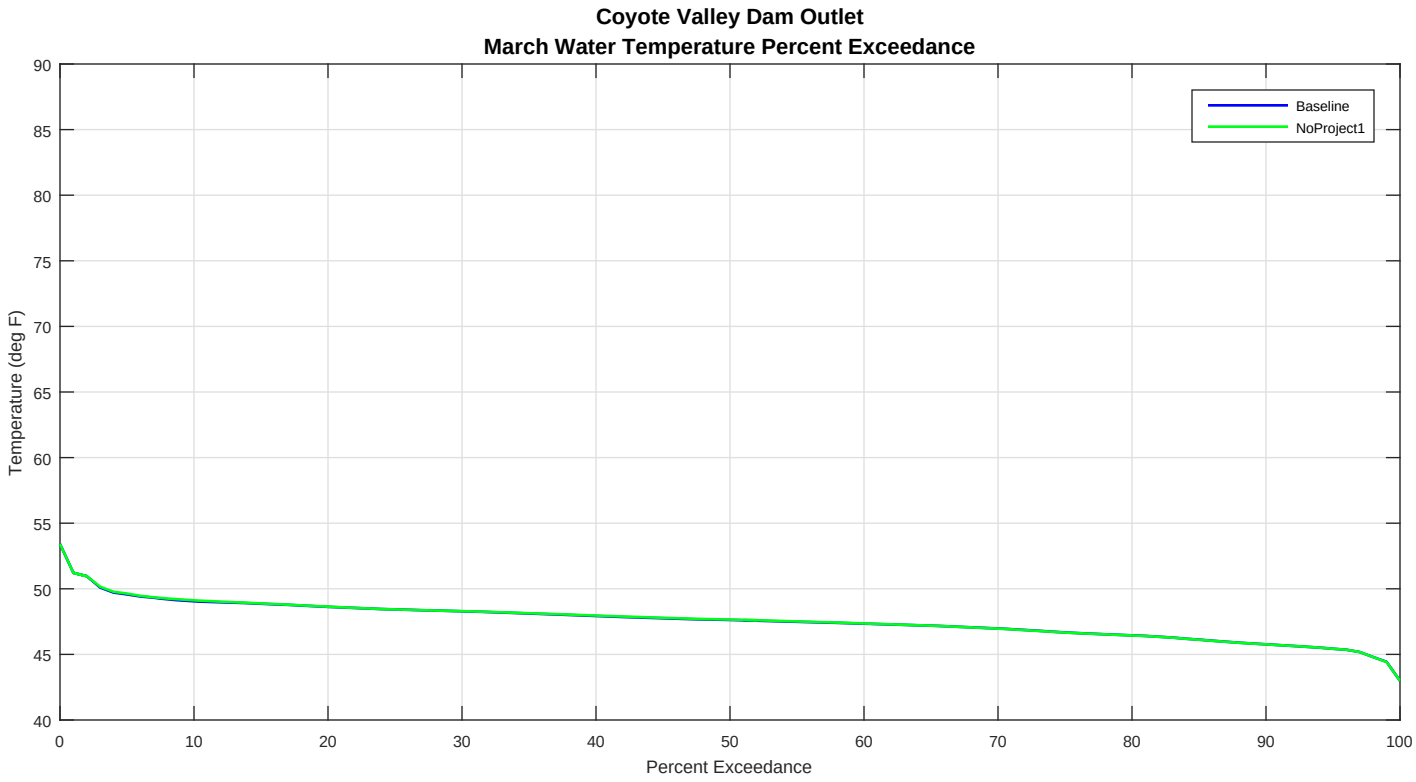

Warm Springs Dam
July Power Production Percent Exceedance
Baseline
NoProject1
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

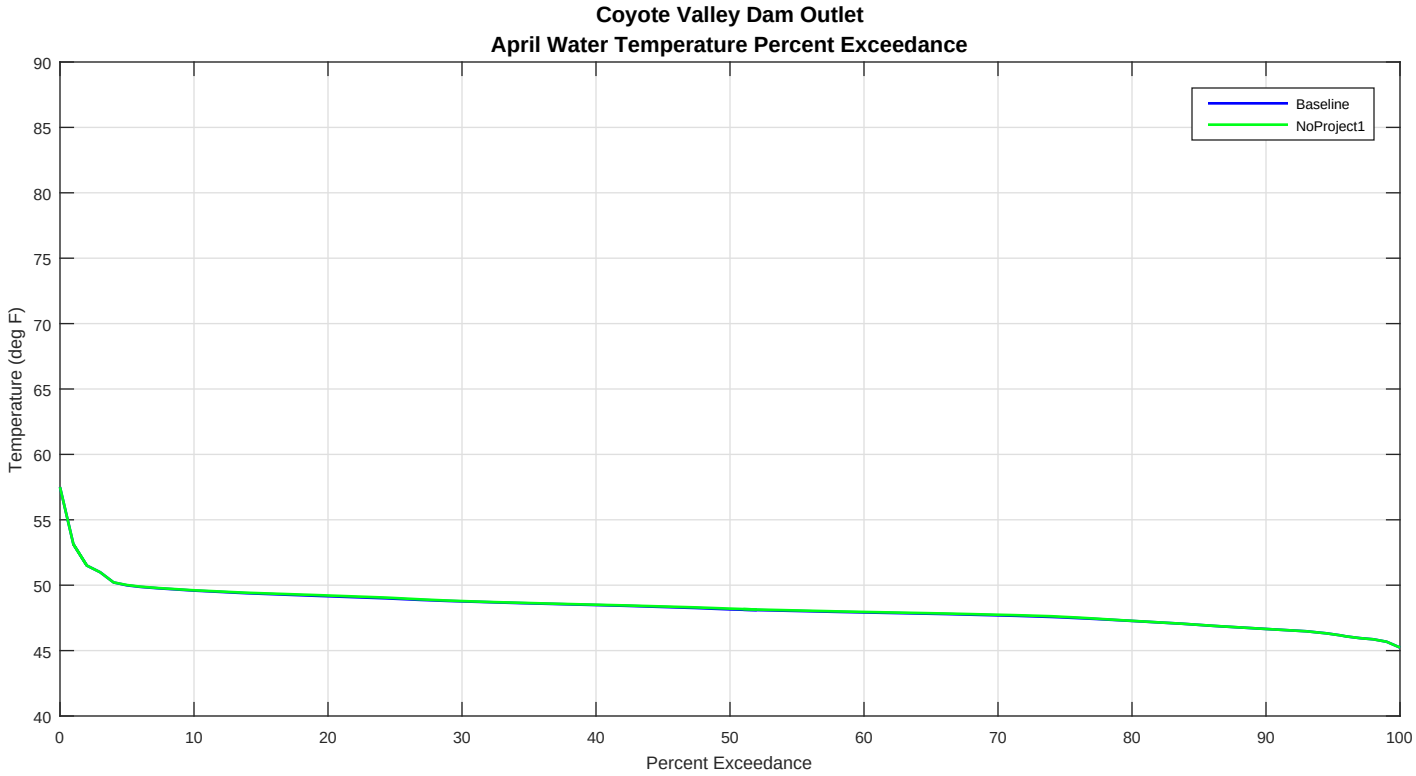

Warm Springs Dam
August Power Production Percent Exceedance
Baseline
NoProject1
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

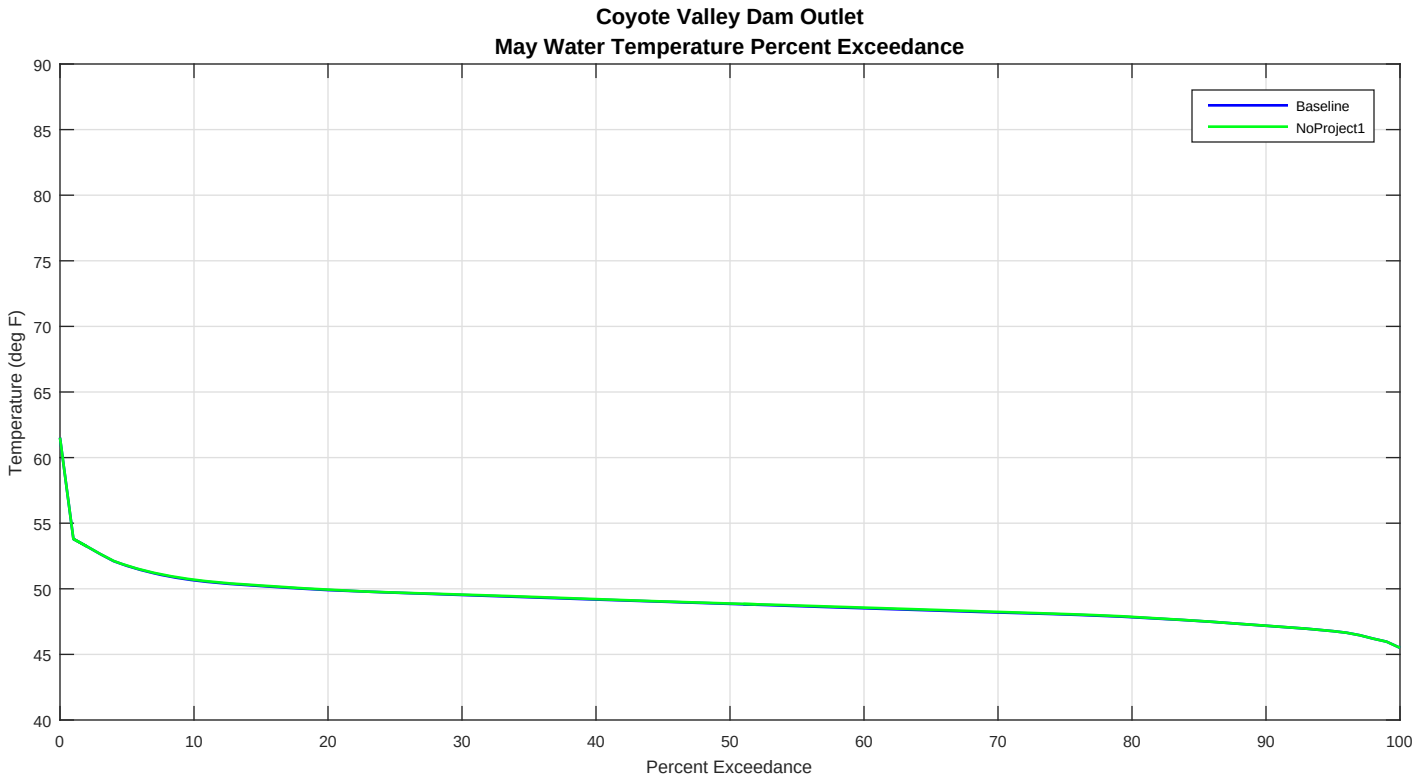

Warm Springs Dam
September Power Production Percent Exceedance
Baseline
NoProject1
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

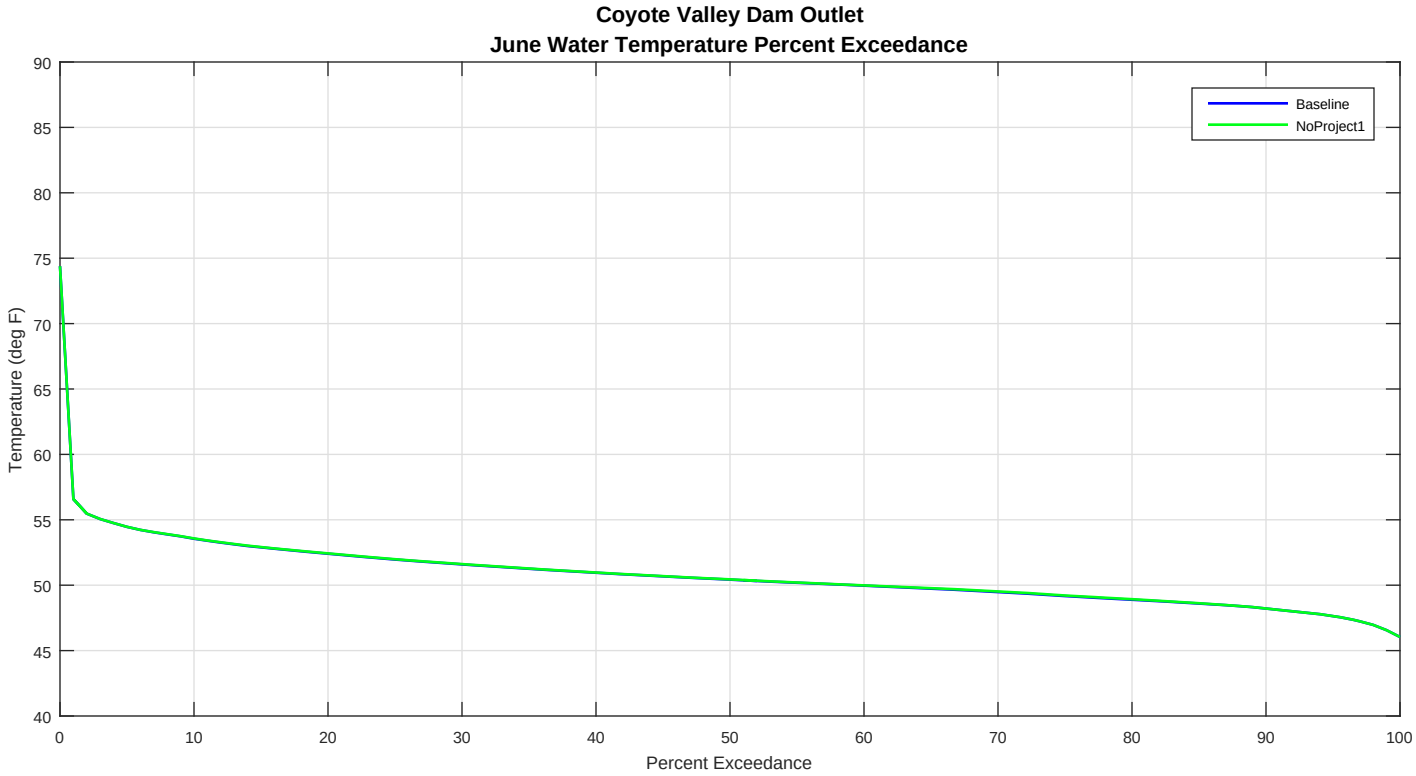

Warm Springs Dam
October 1-15 Power Production Percent Exceedance
Baseline
NoProject1
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

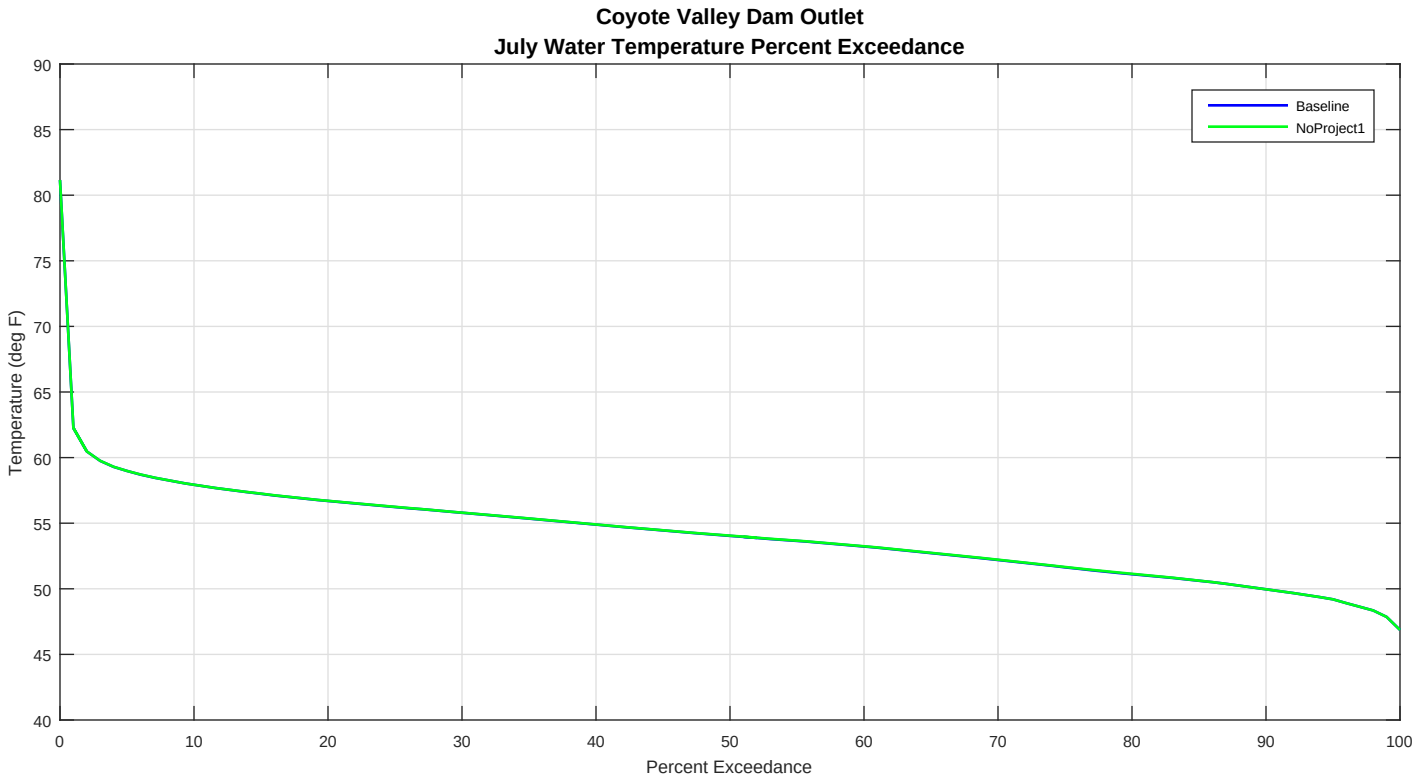

Warm Springs Dam
October 16-31 Power Production Percent Exceedance
Baseline
NoProject1
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

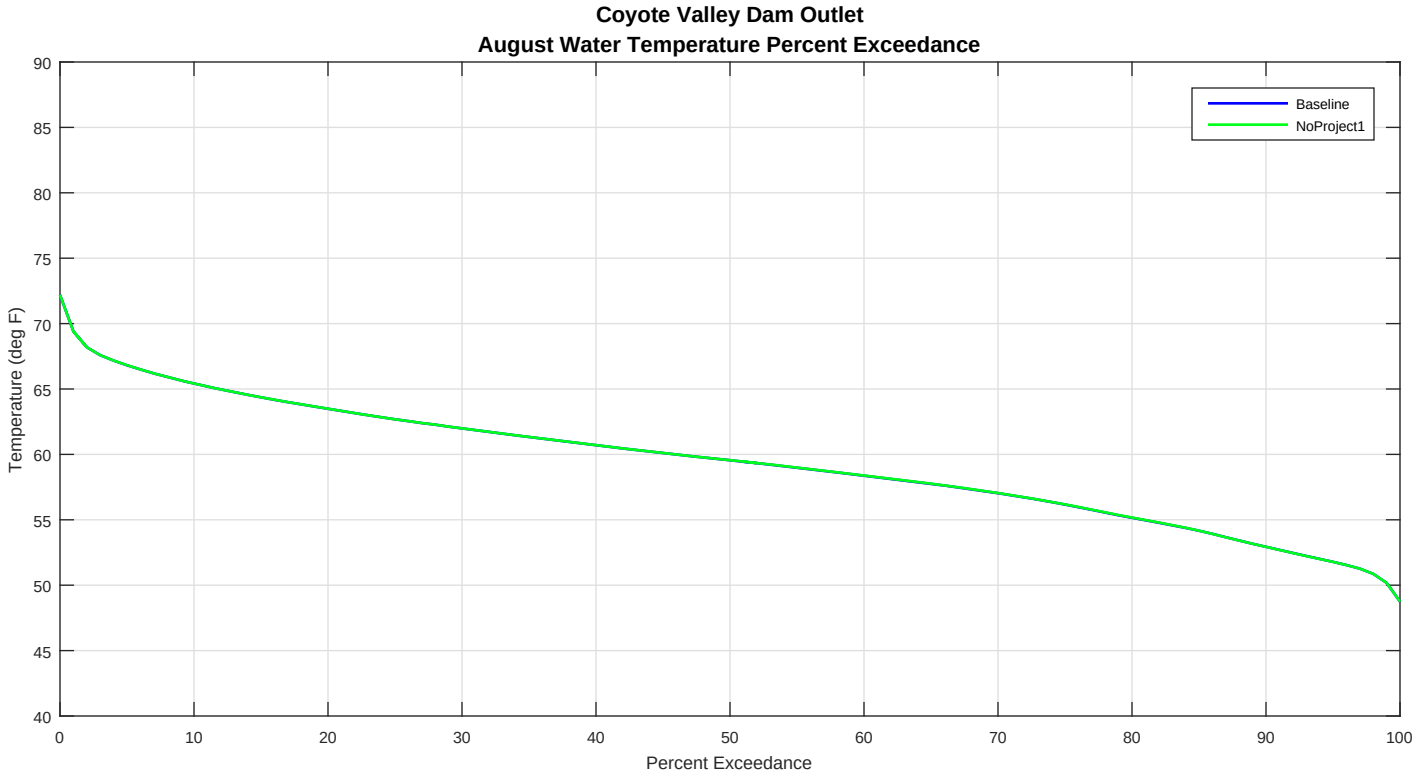

Coyote Valley Dam Outlet
March Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
10
20
30
40
50
60
70
80
90
100

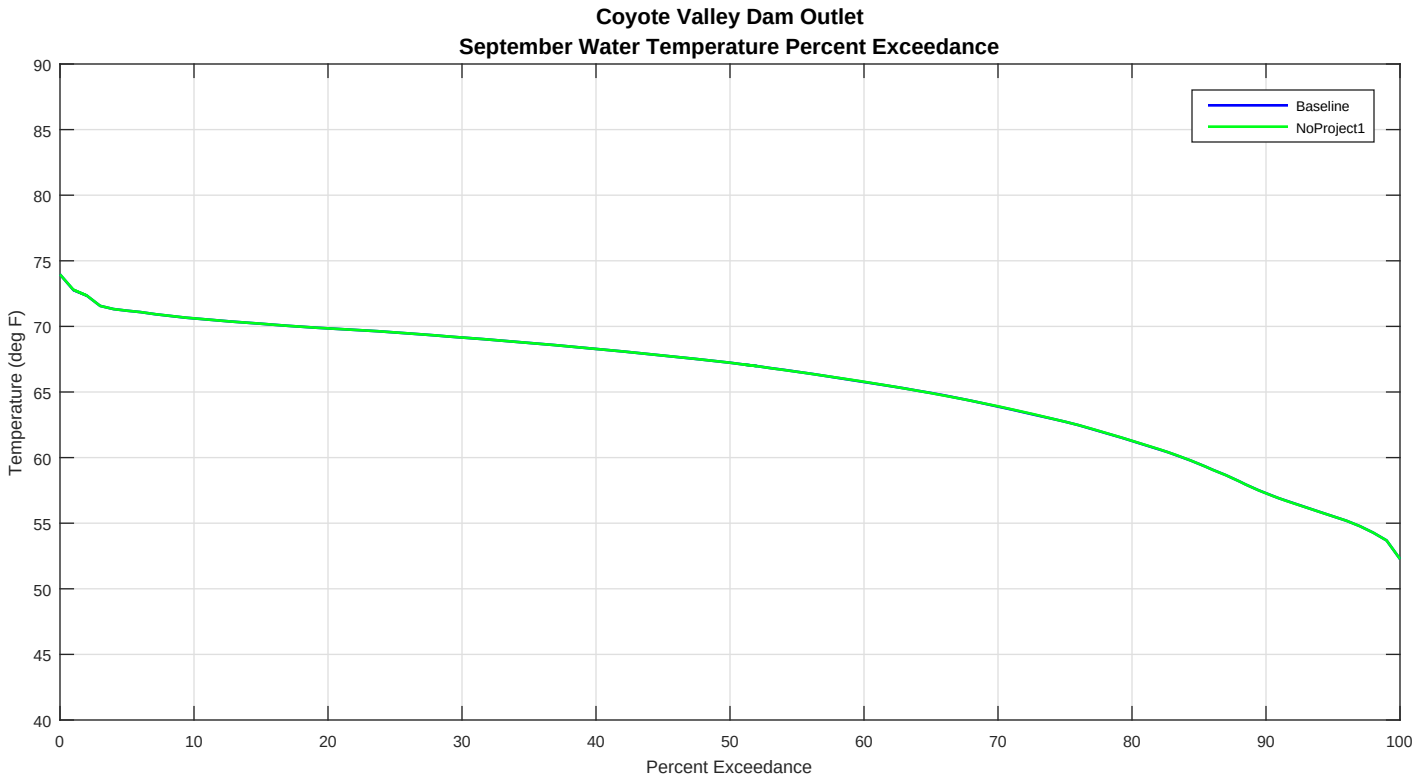

Coyote Valley Dam Outlet
April Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
10
20
30
40
50
60
70
80
90
100

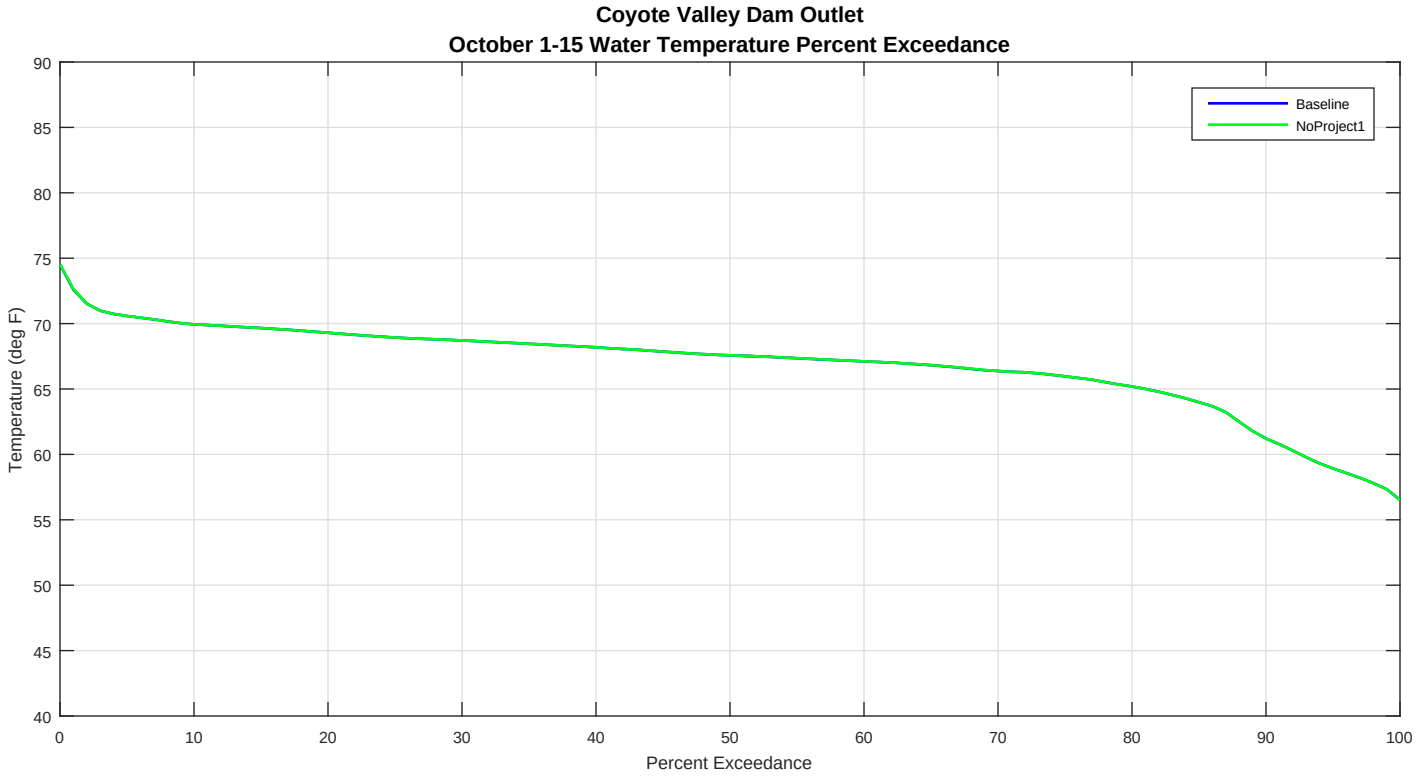

Coyote Valley Dam Outlet
May Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
10
20
30
40
50
60
70
80
90
100

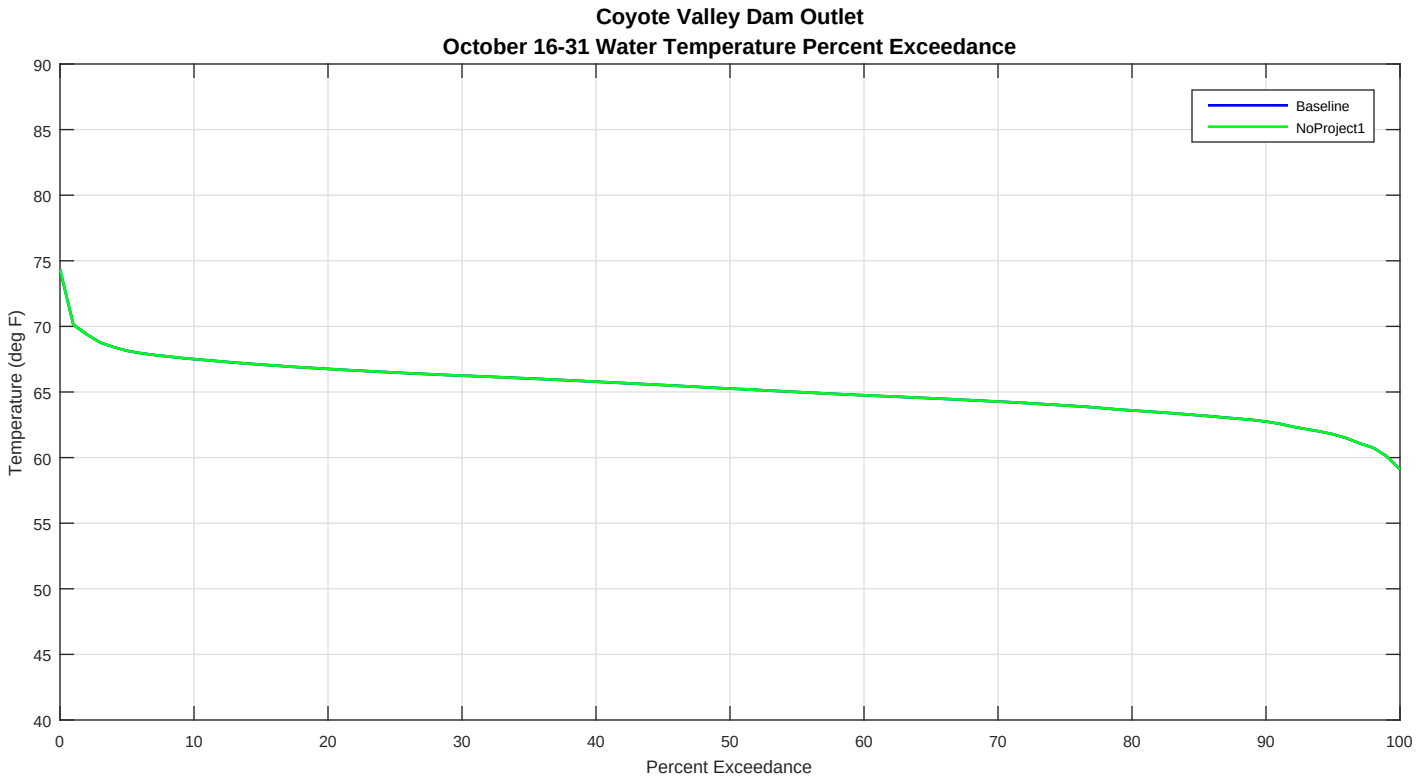

Coyote Valley Dam Outlet
June Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
10
20
30
40
50
60
70
80
90
100

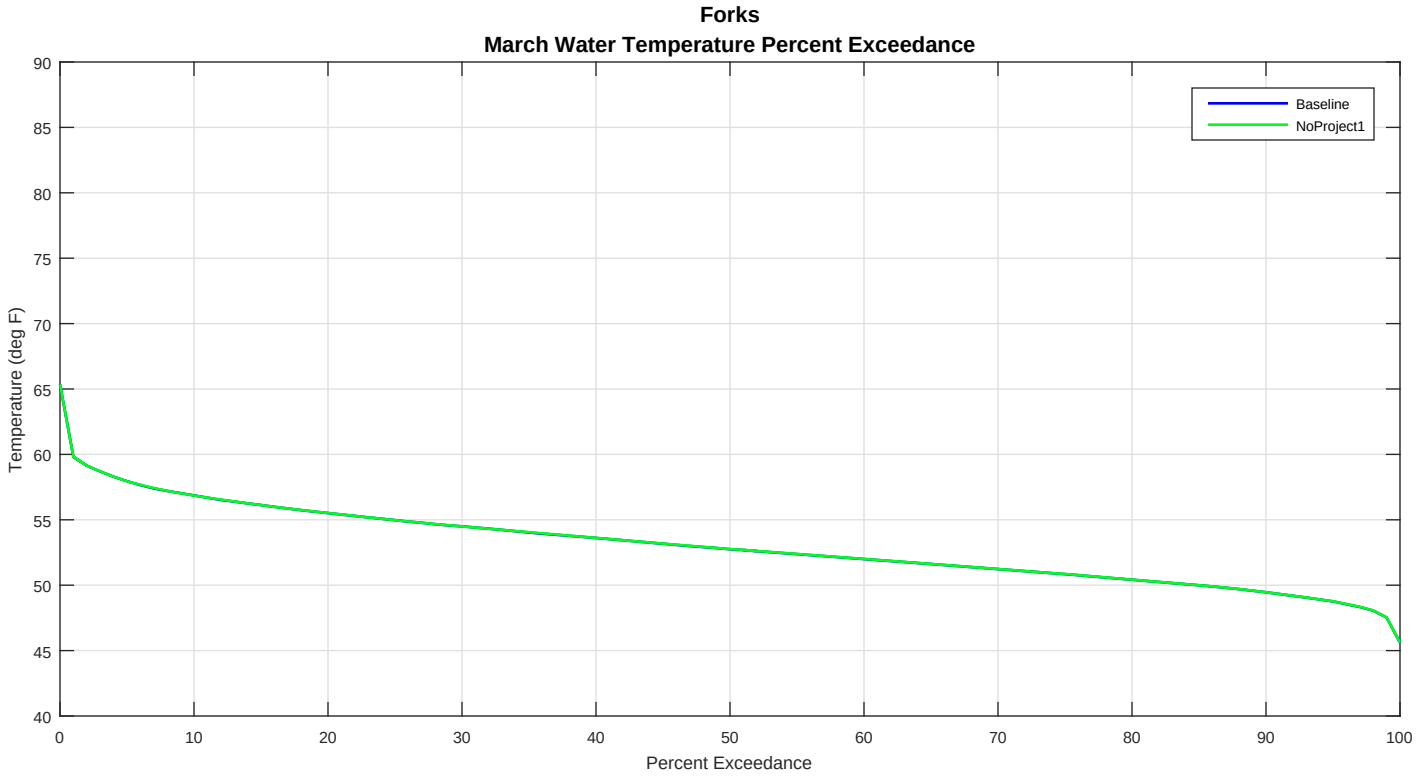

Coyote Valley Dam Outlet
July Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
10
20
30
40
50
60
70
80
90
100

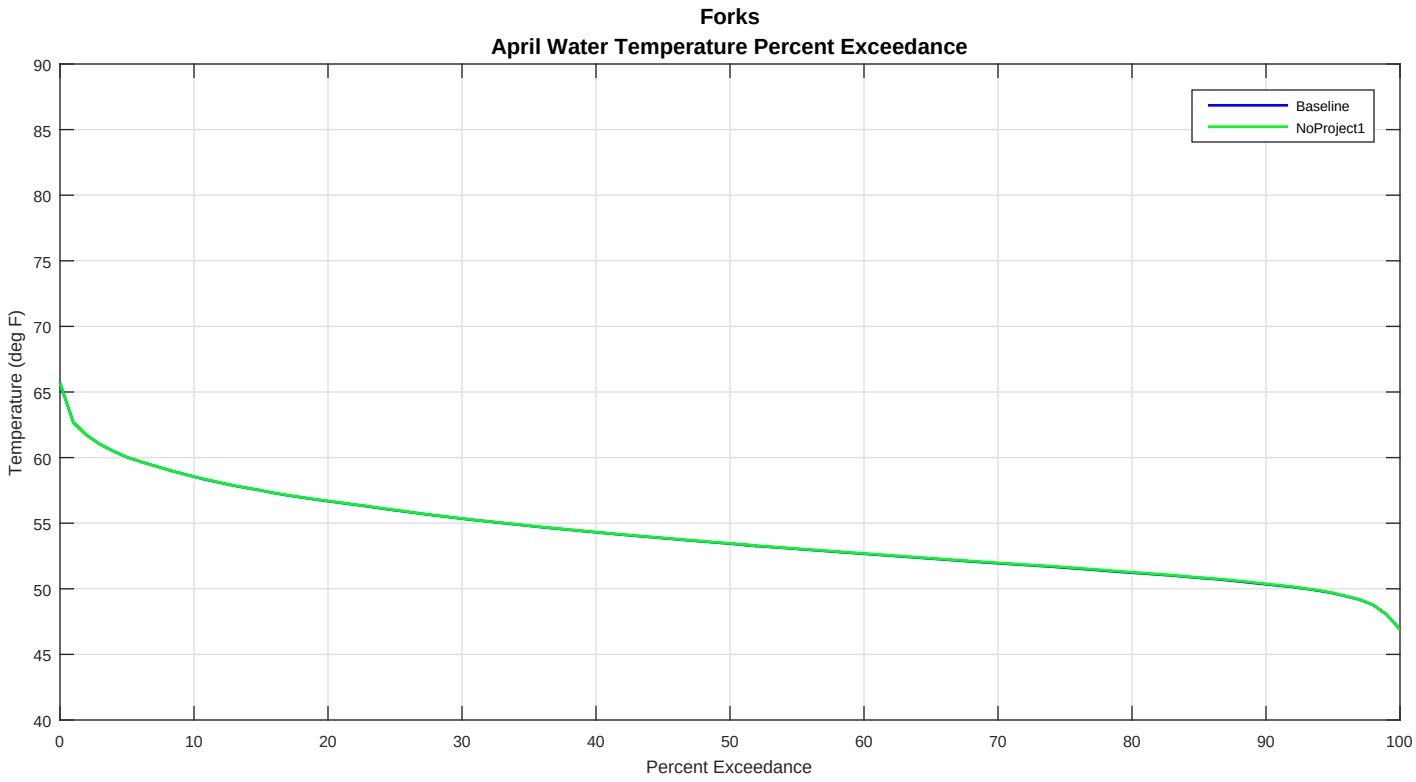

Coyote Valley Dam Outlet
August Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
September Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
October 1-15 Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
October 16-31 Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
10
20
30
40
50
60
70
80
90
100


Forks
March Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
10
20
30
40
50
60
70
80
90
100


Forks
April Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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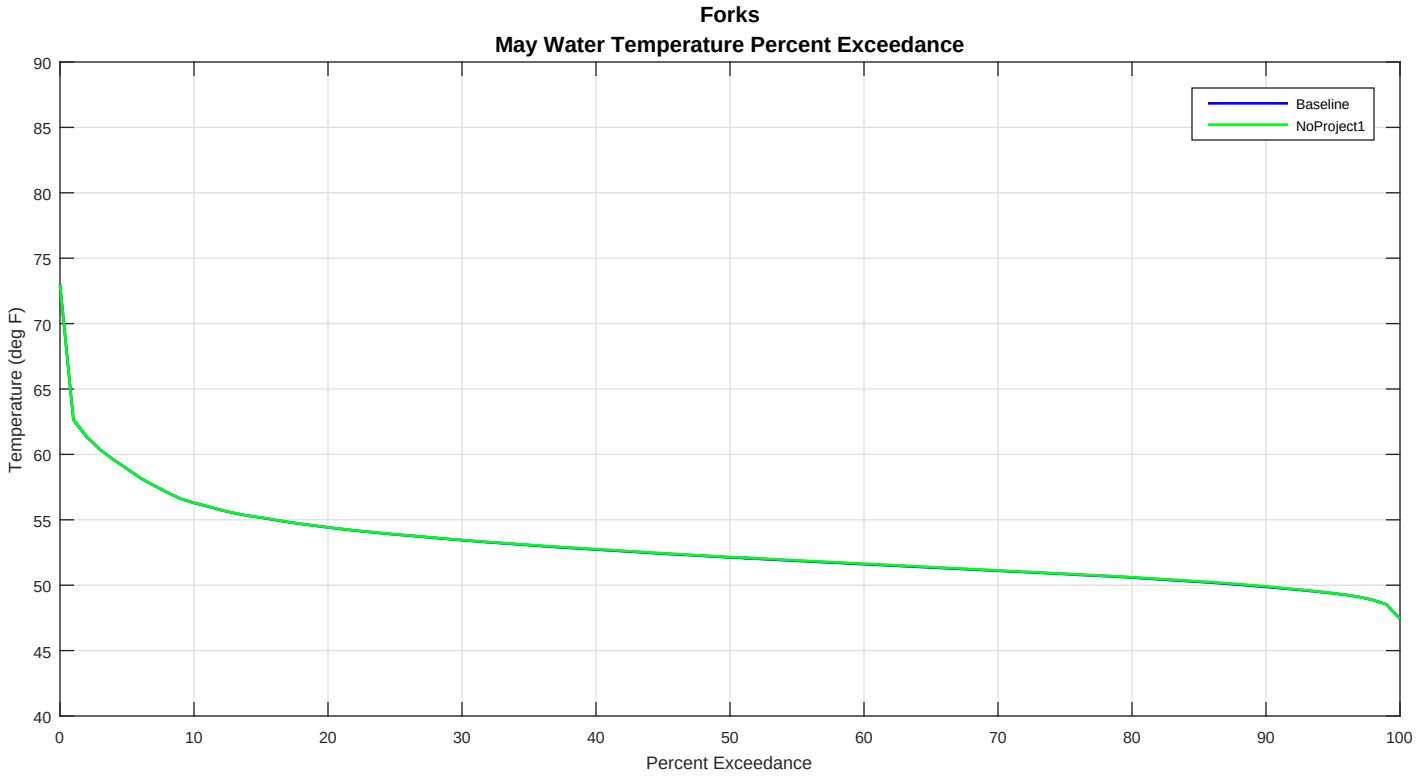
Forks
May Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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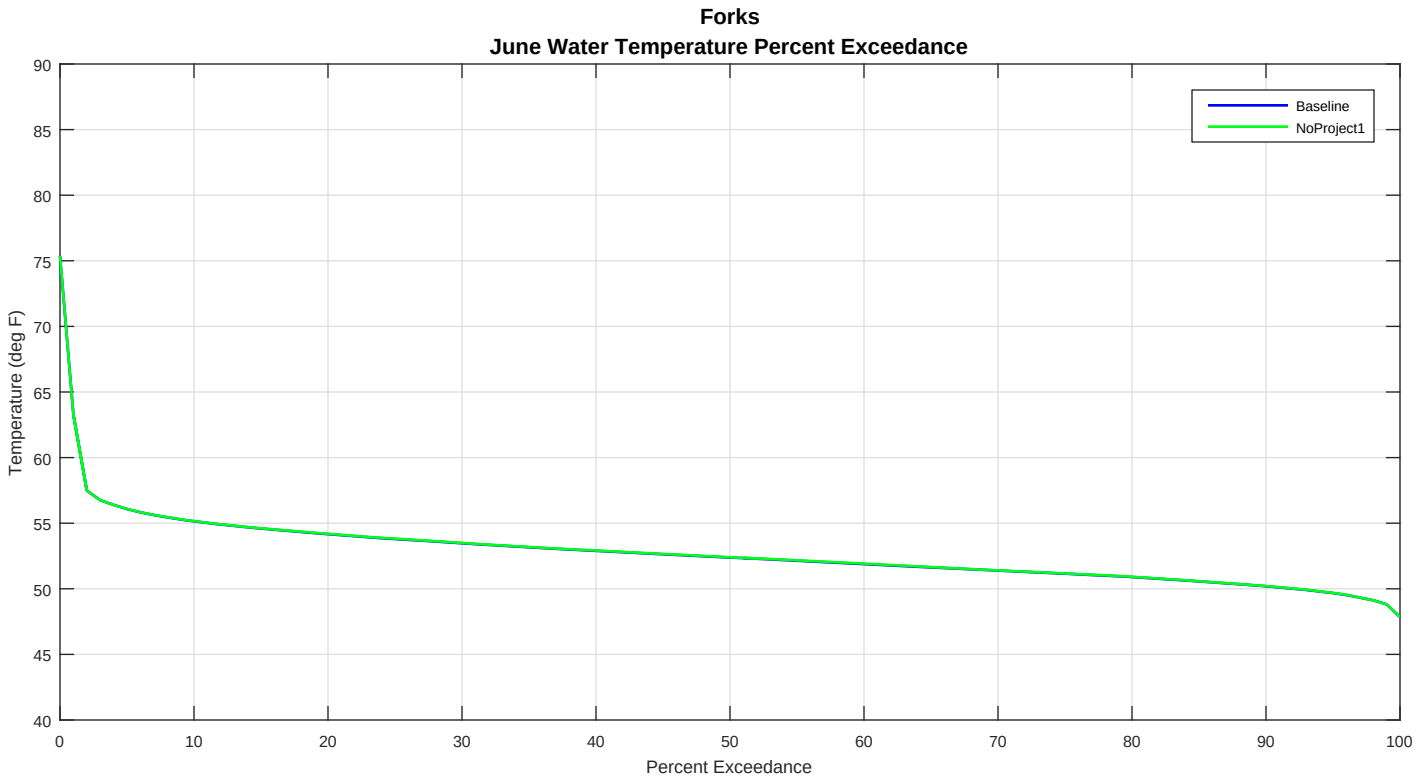
Forks
June Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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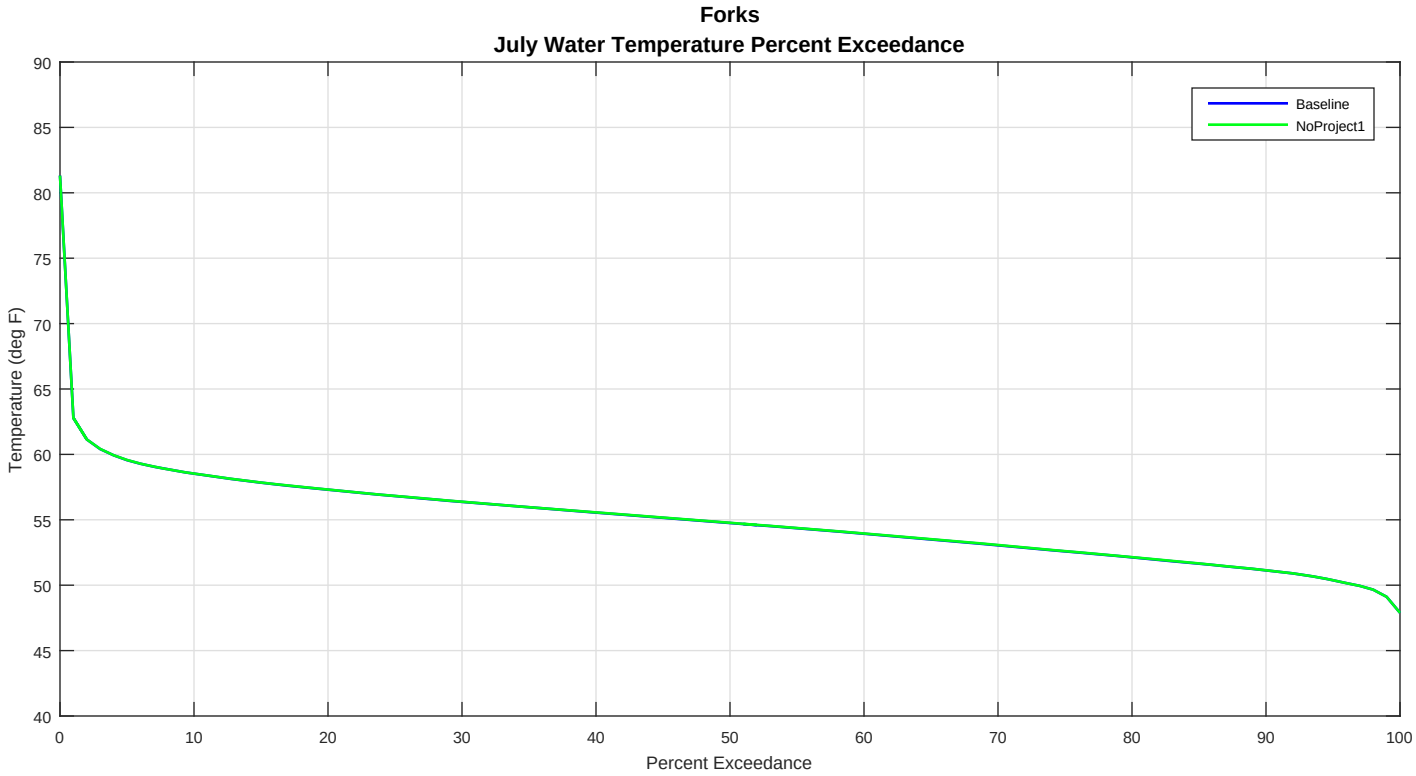
Forks
July Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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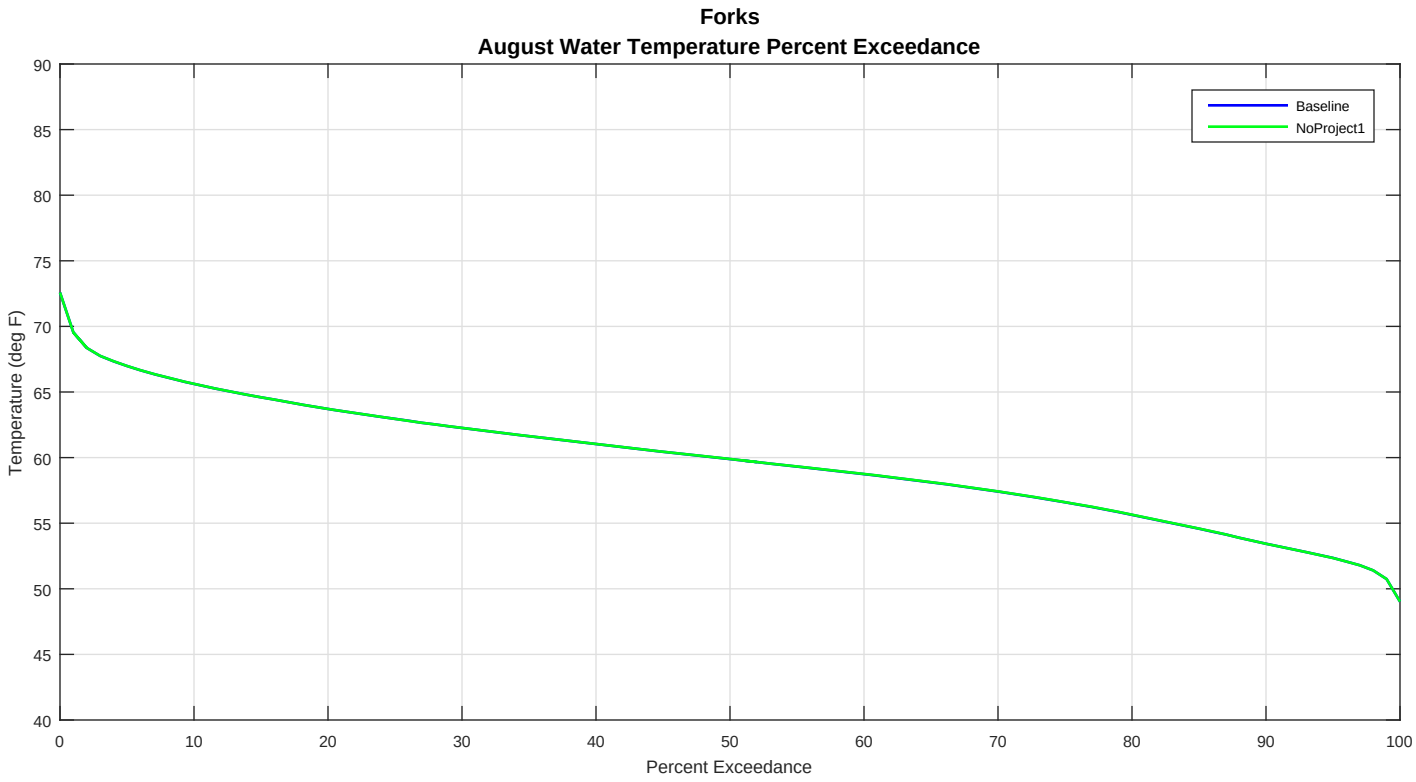
Forks
August Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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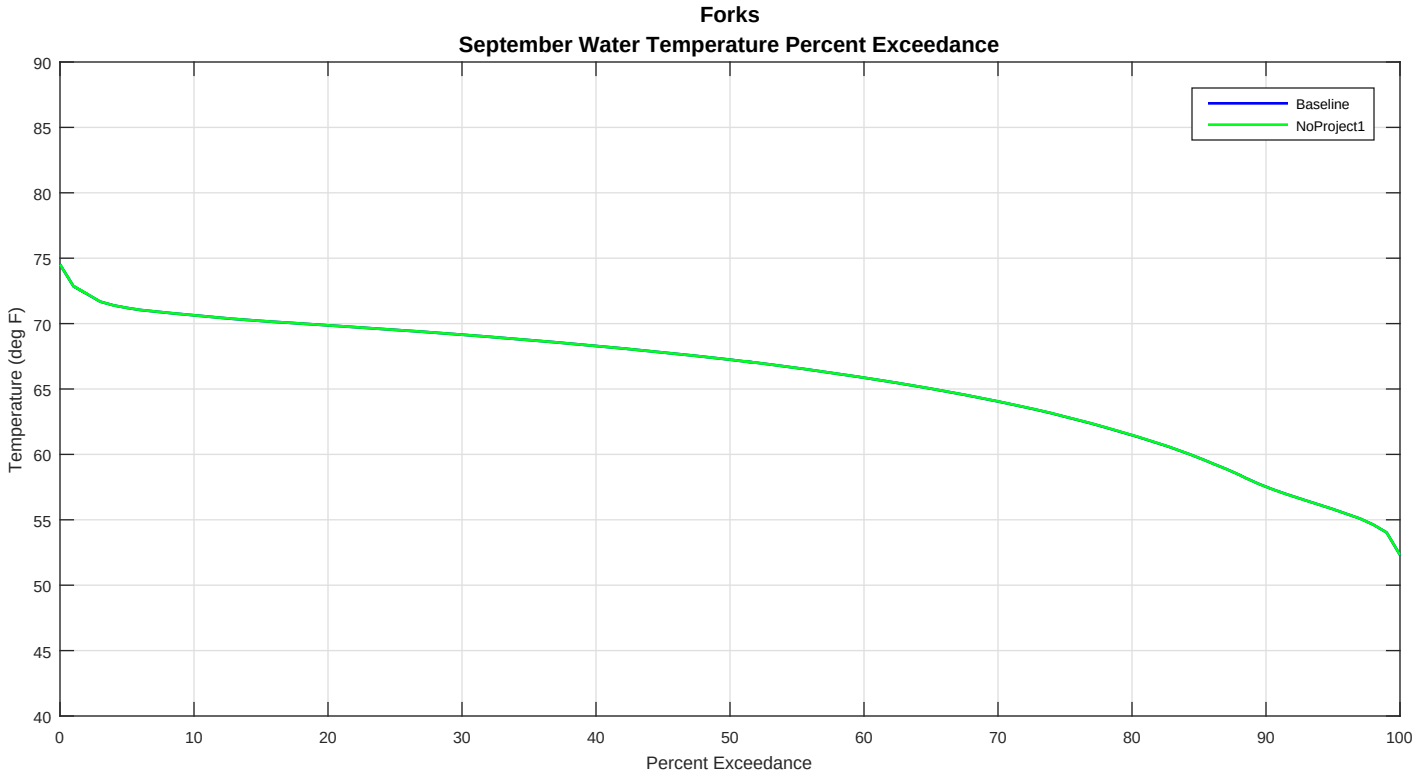
Forks
September Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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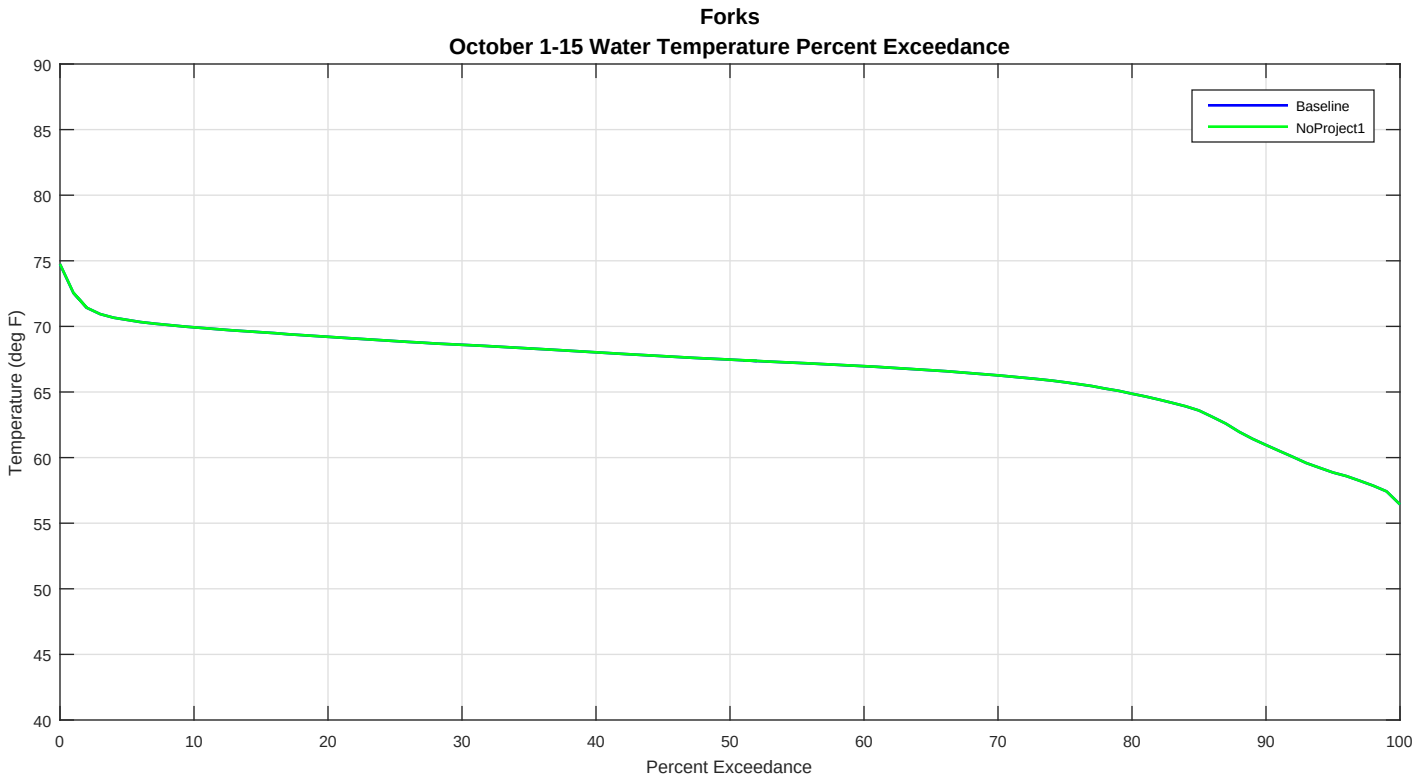
Forks
October 1-15 Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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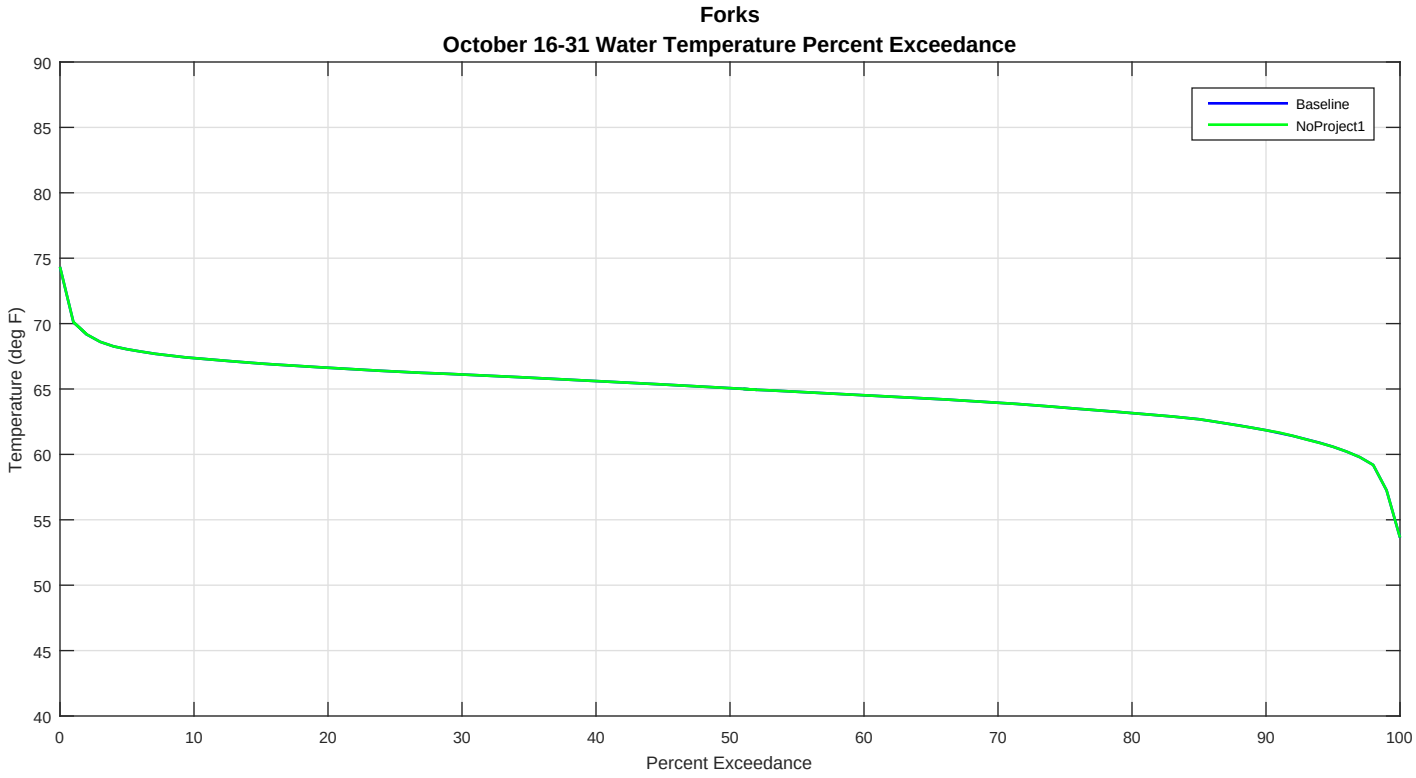
Forks
October 16-31 Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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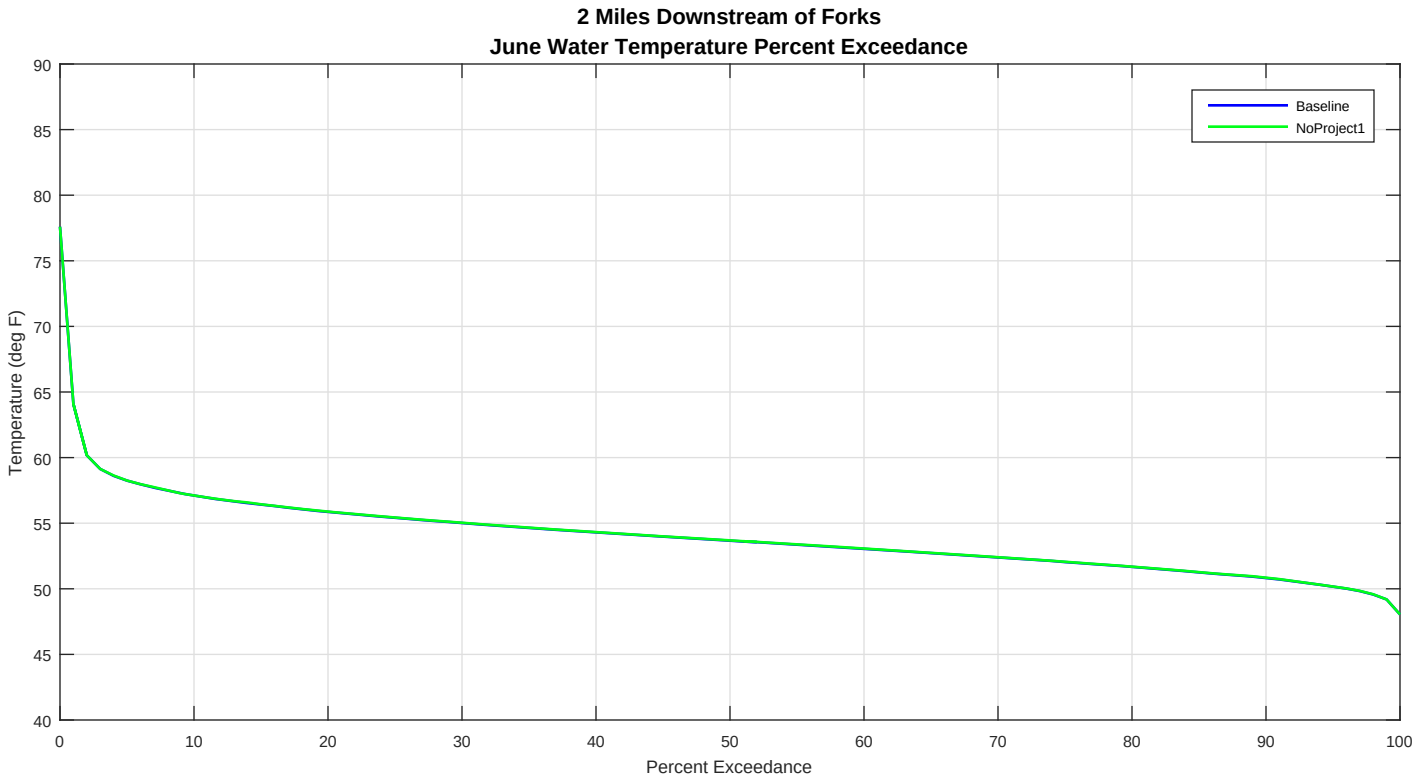
2 Miles Downstream of Forks
June Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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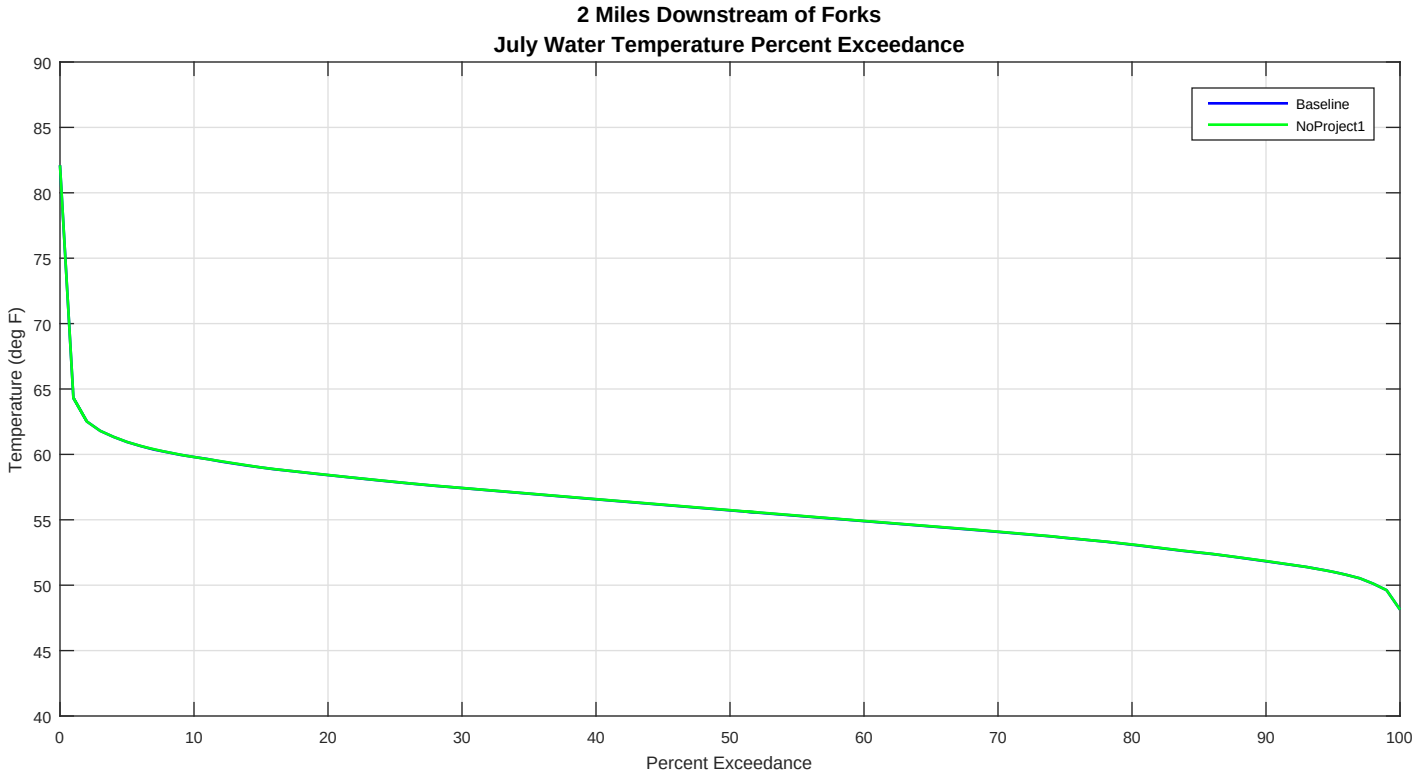
2 Miles Downstream of Forks
July Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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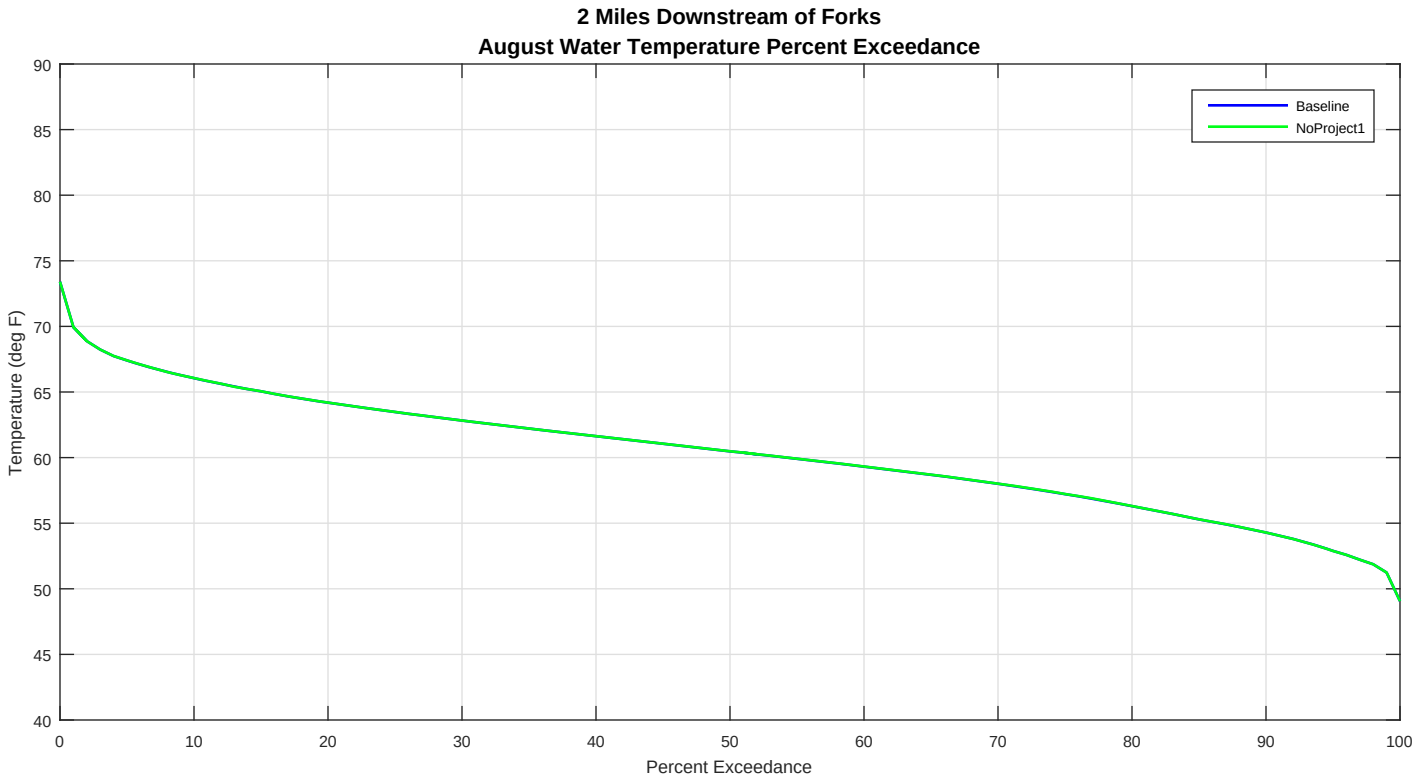
2 Miles Downstream of Forks
August Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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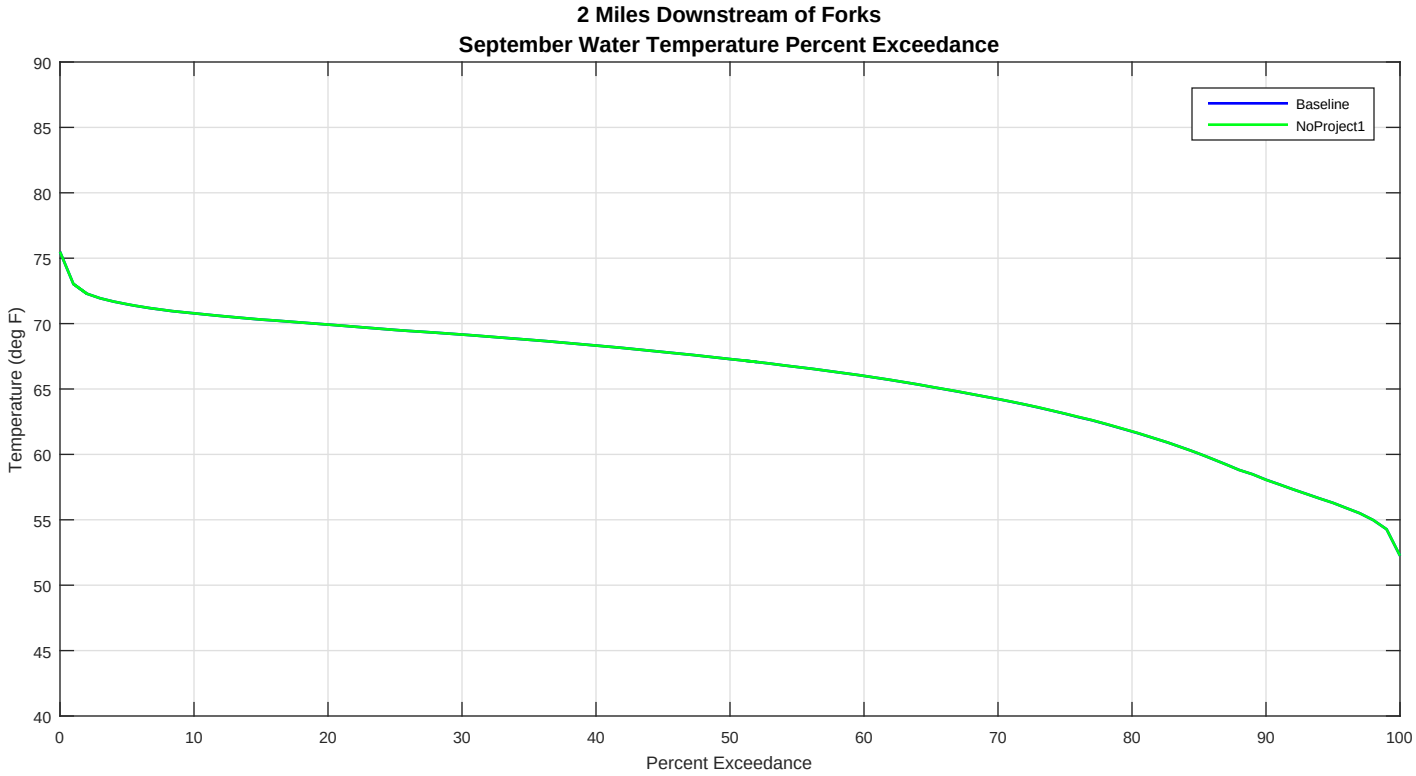
2 Miles Downstream of Forks
September Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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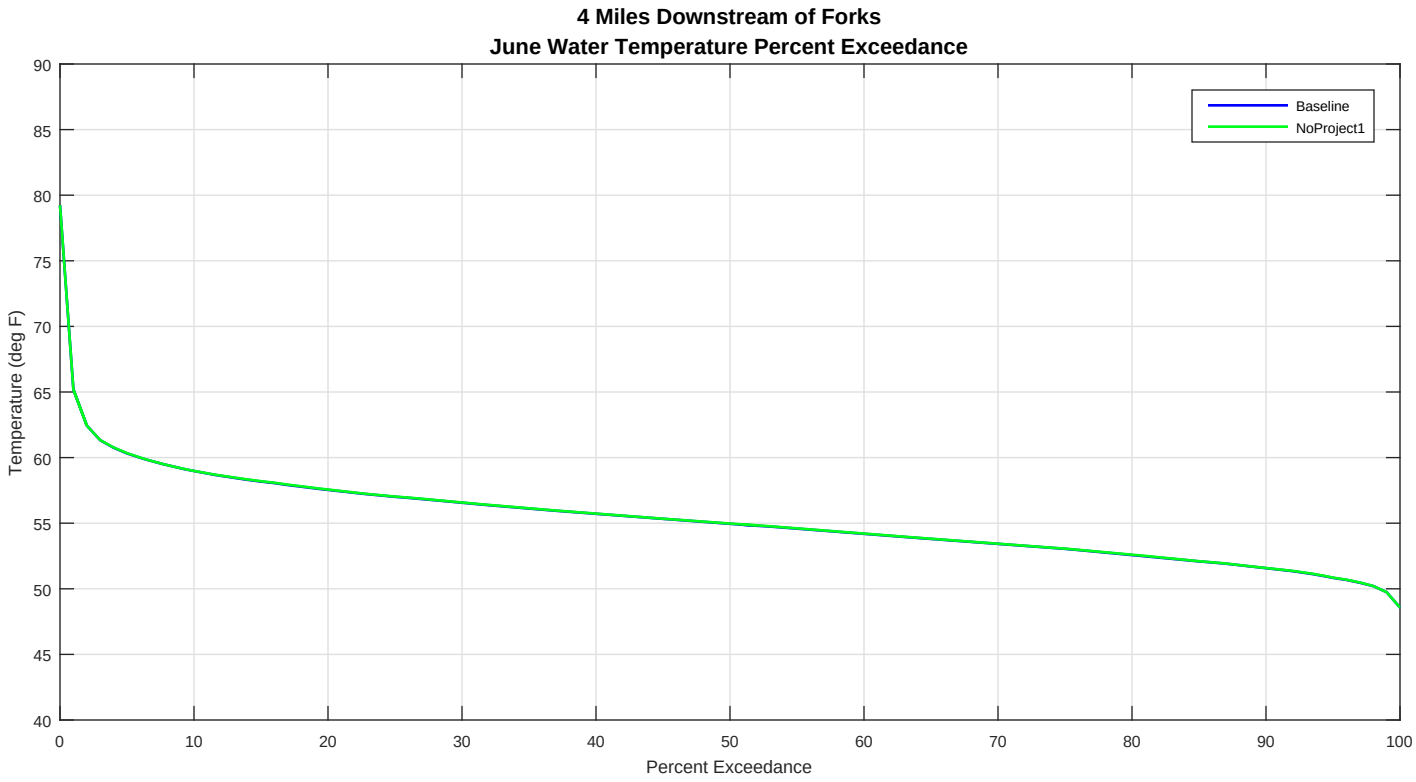
4 Miles Downstream of Forks
June Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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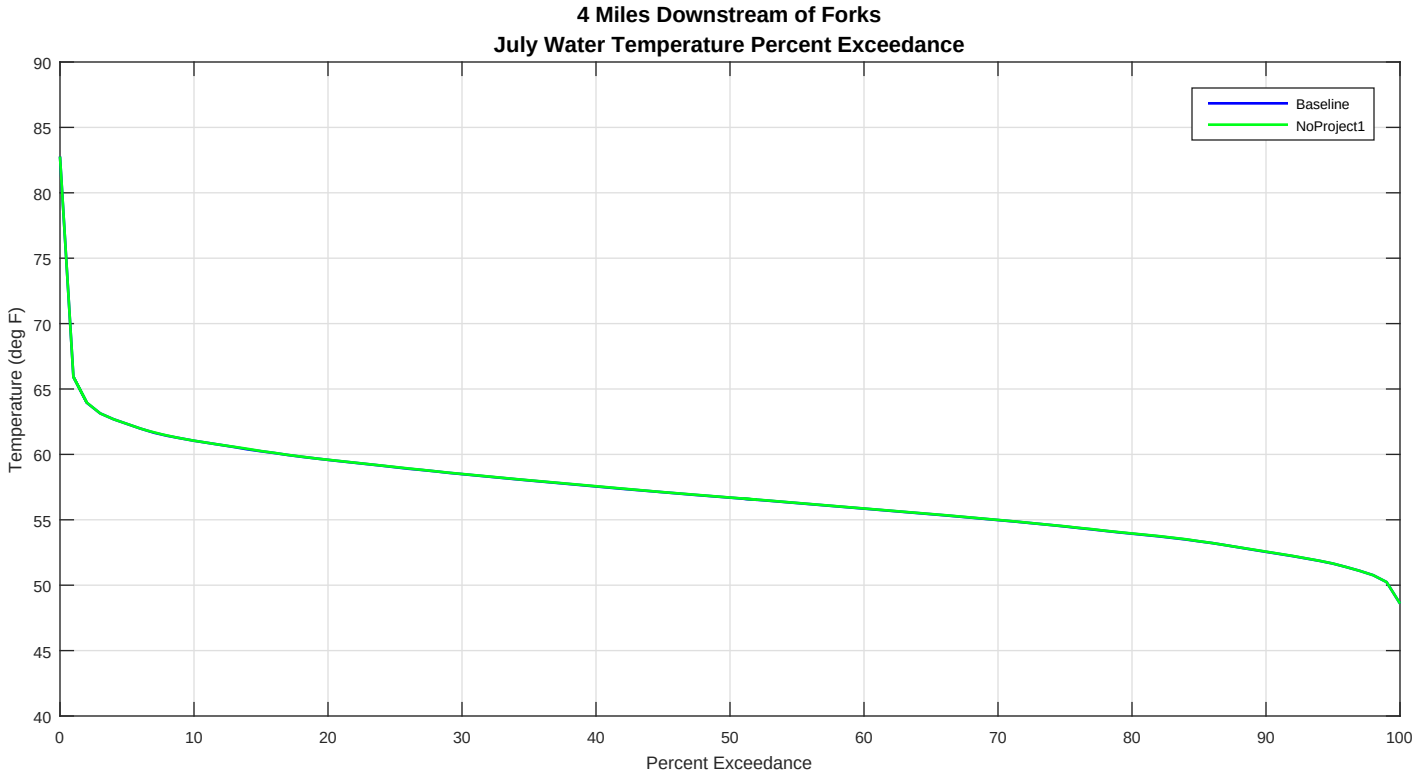
4 Miles Downstream of Forks
July Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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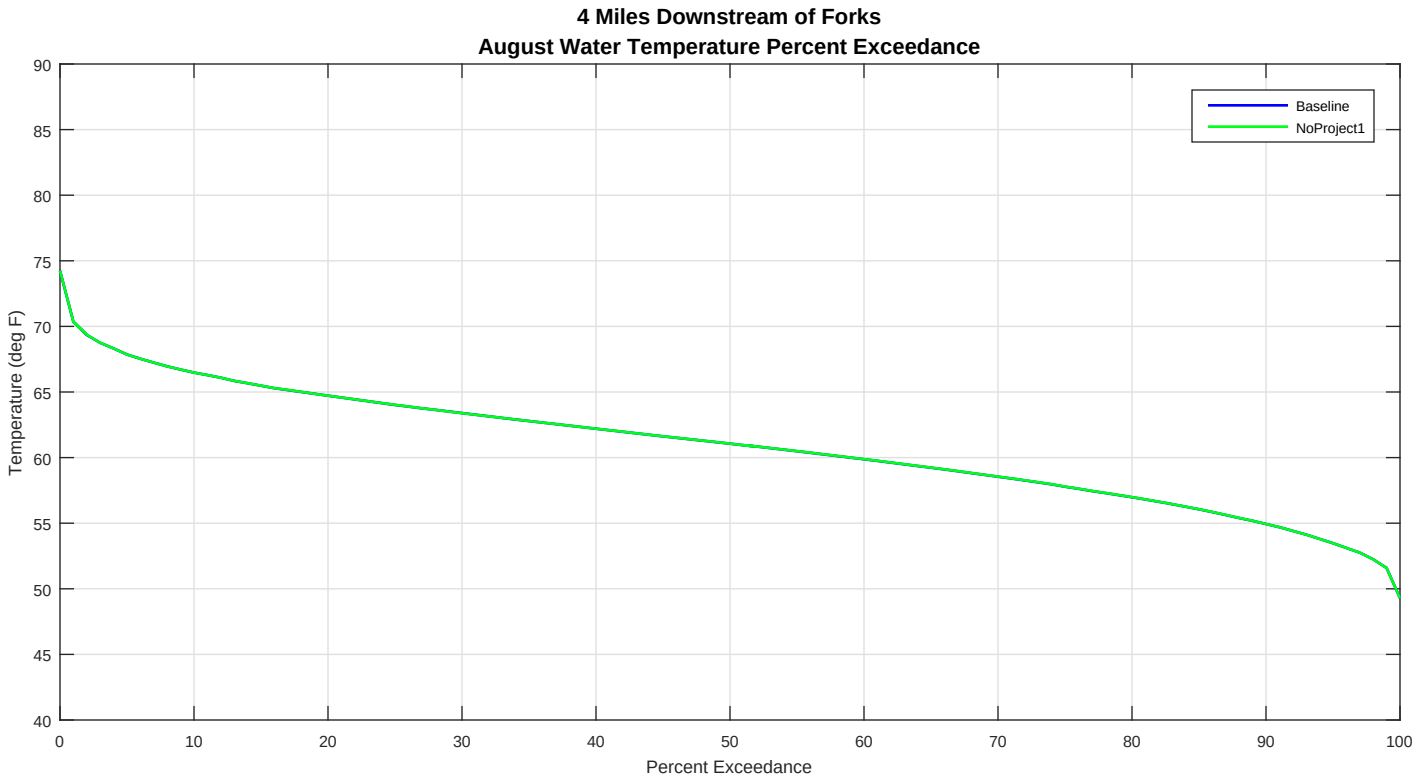
4 Miles Downstream of Forks
August Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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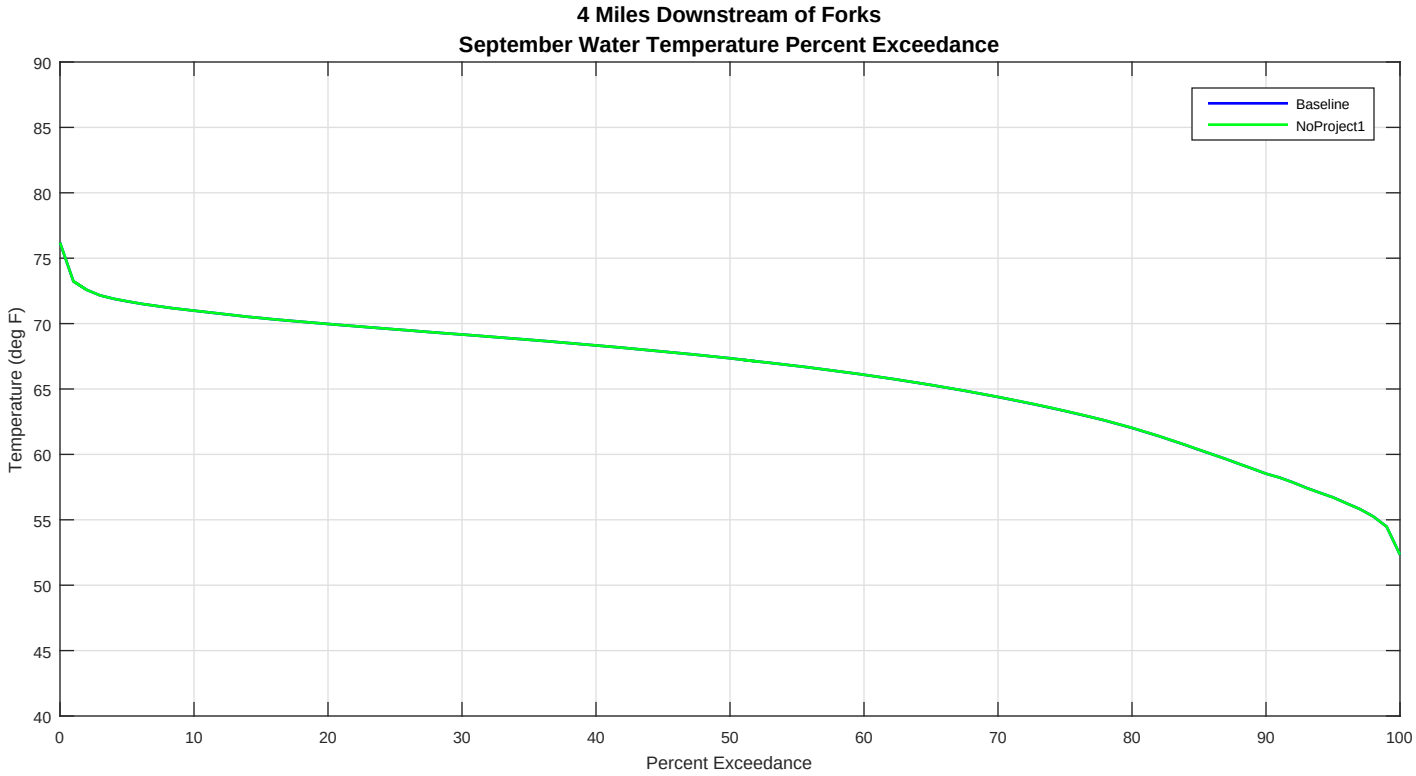
4 Miles Downstream of Forks
September Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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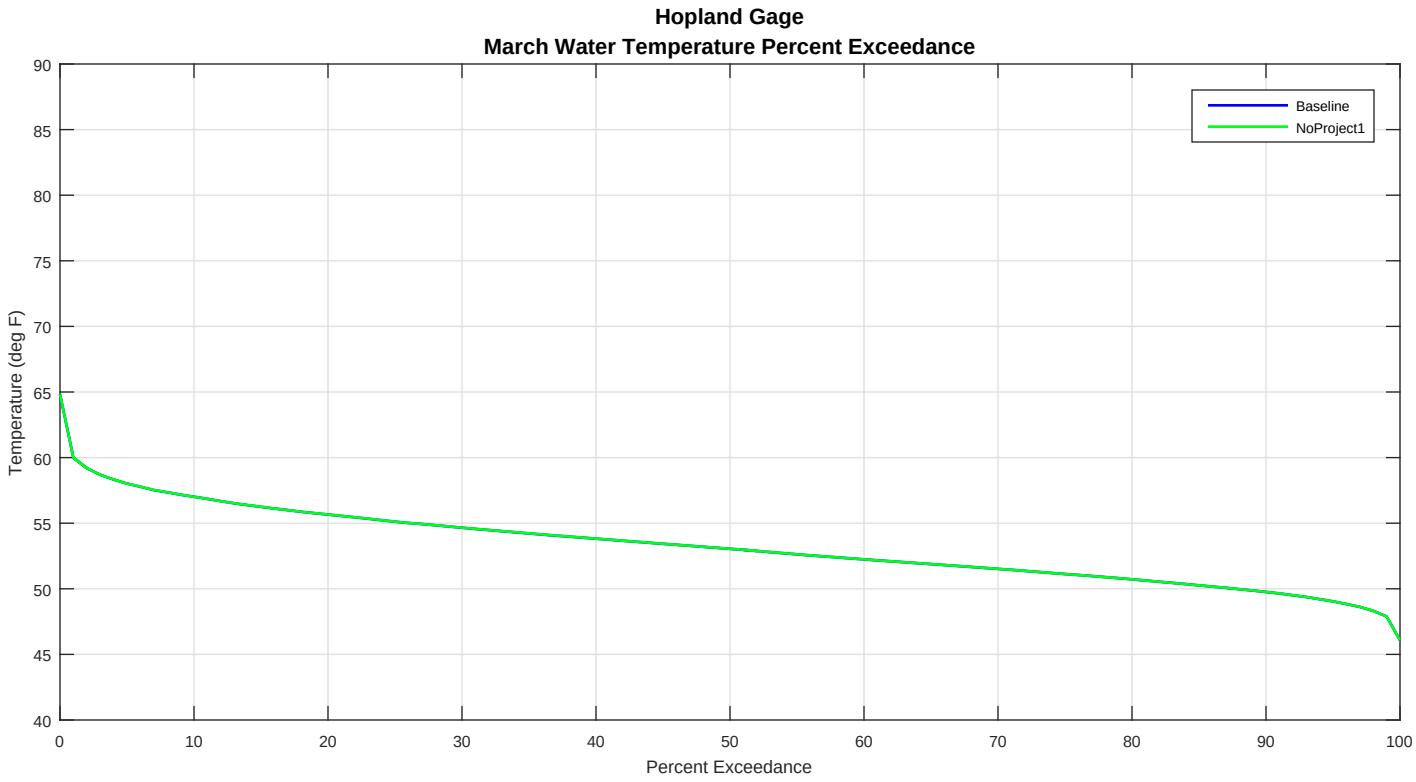
Hopland Gage
March Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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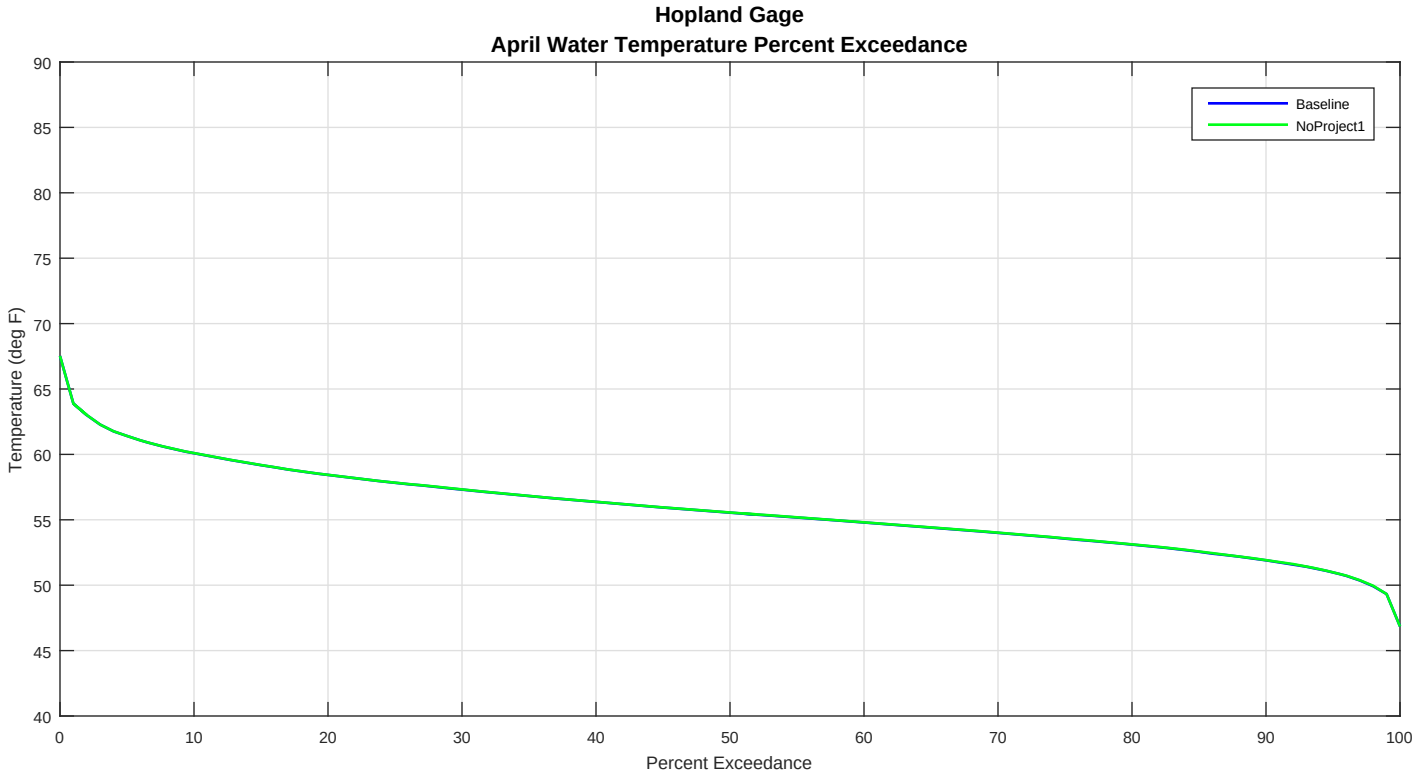
Hopland Gage
April Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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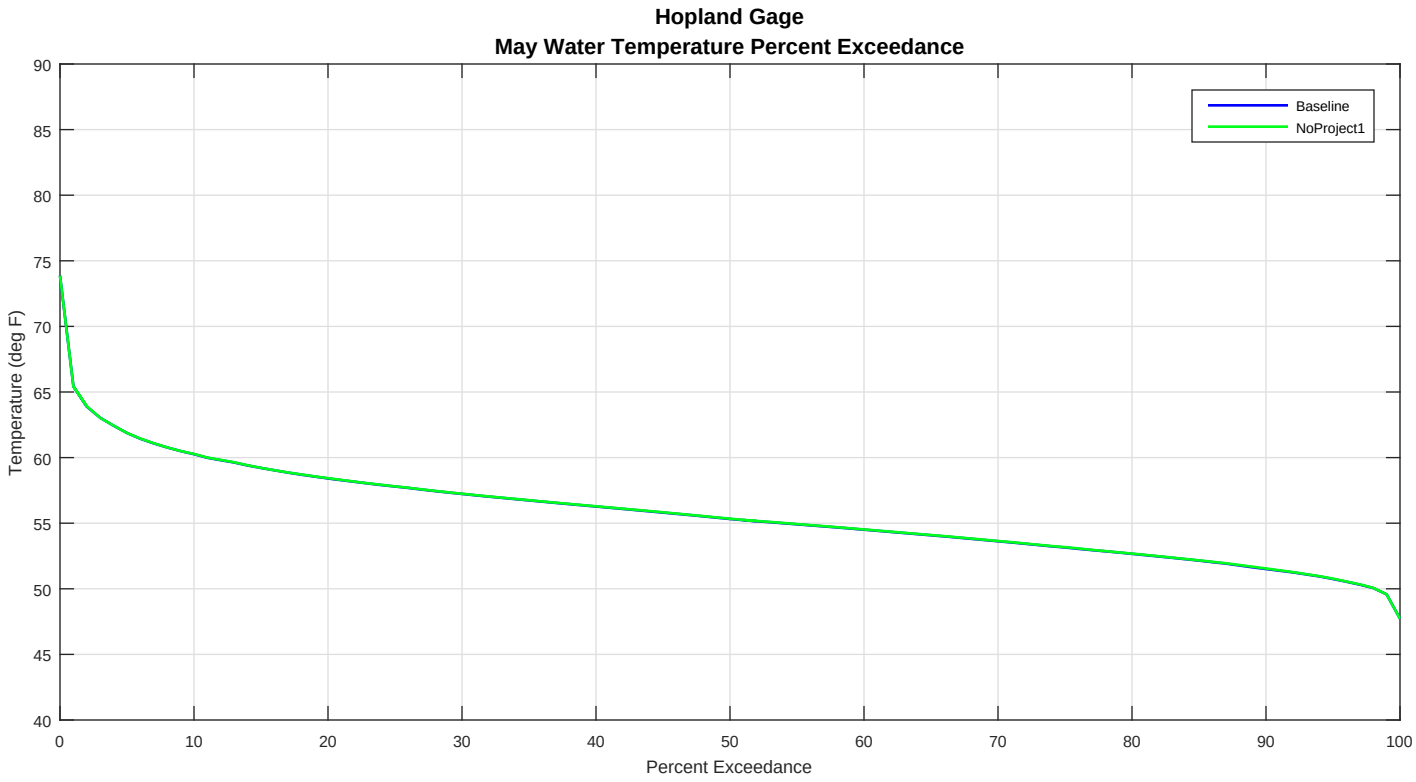
Hopland Gage
May Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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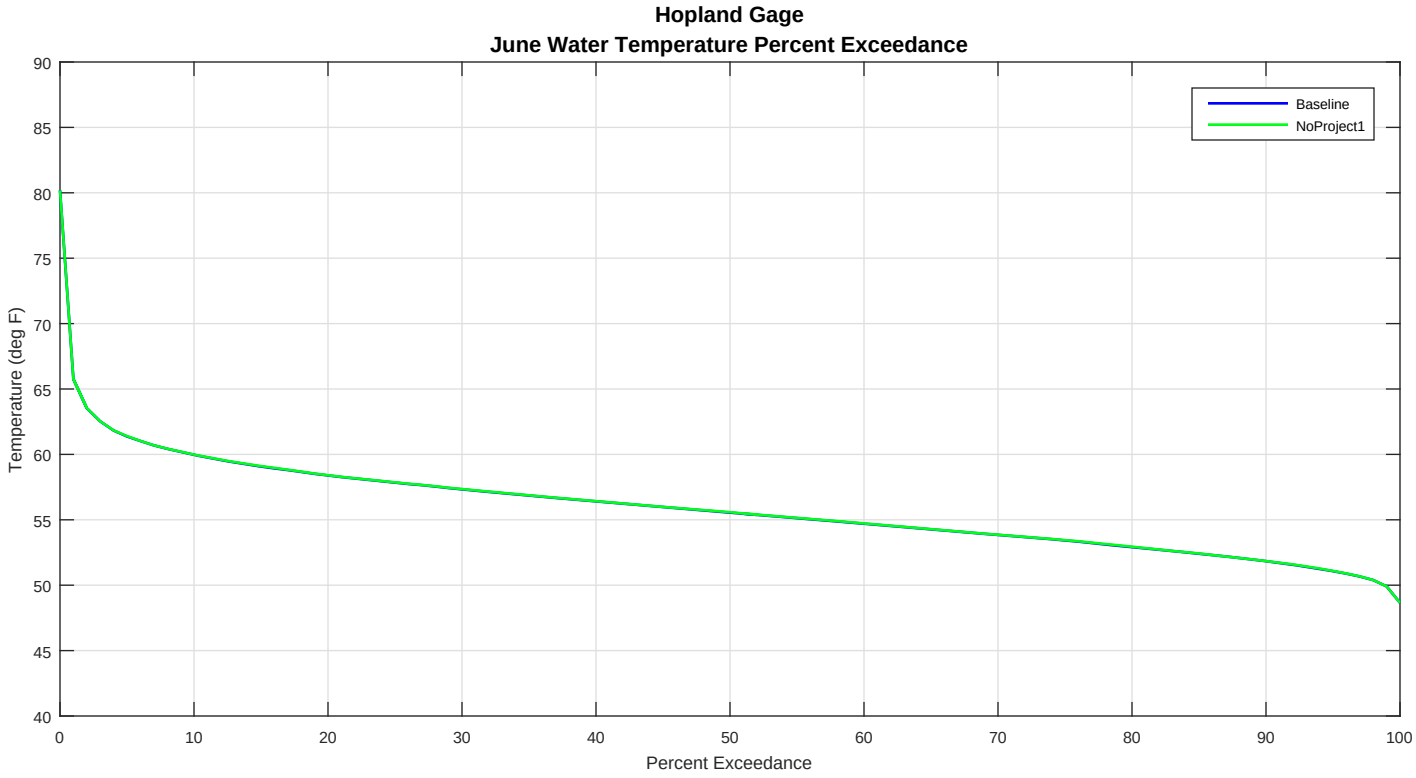
Hopland Gage
June Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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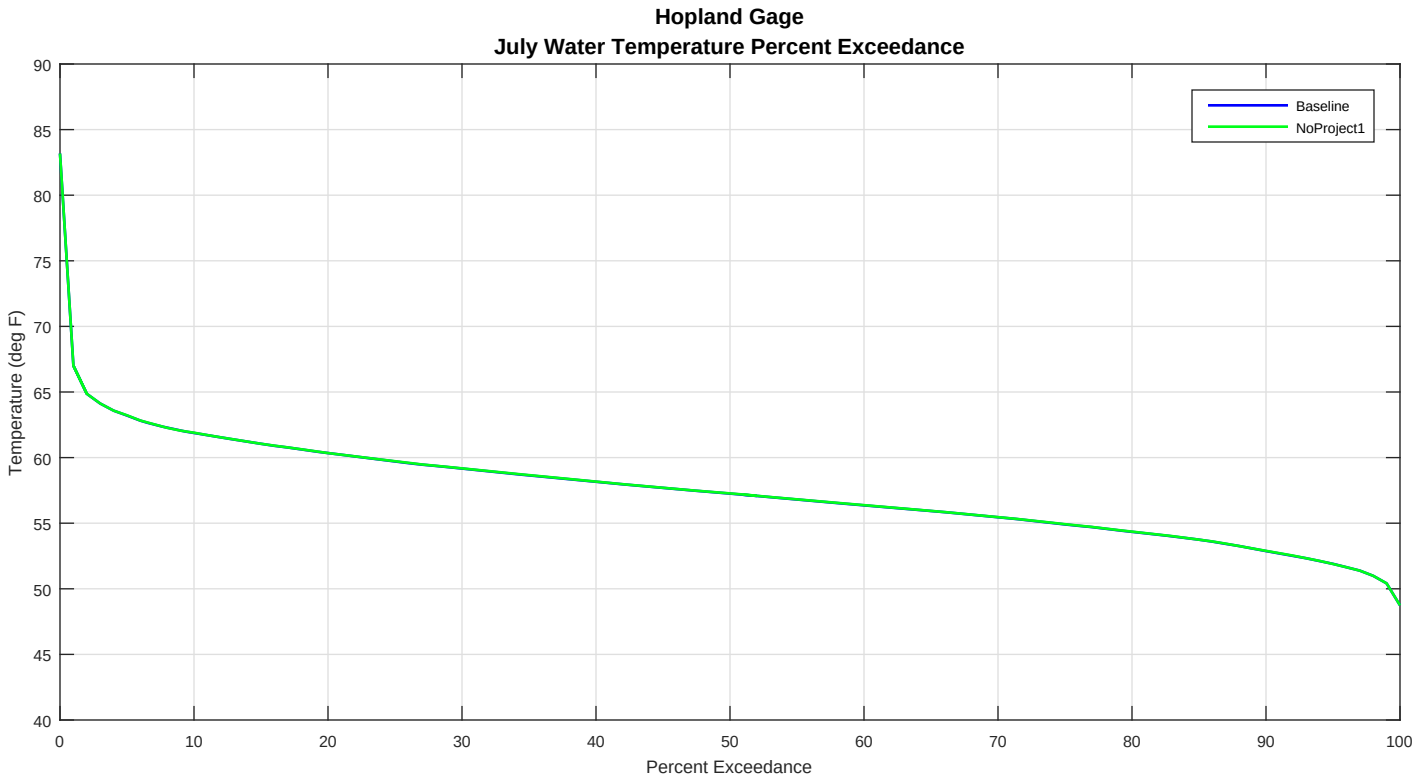
Hopland Gage
July Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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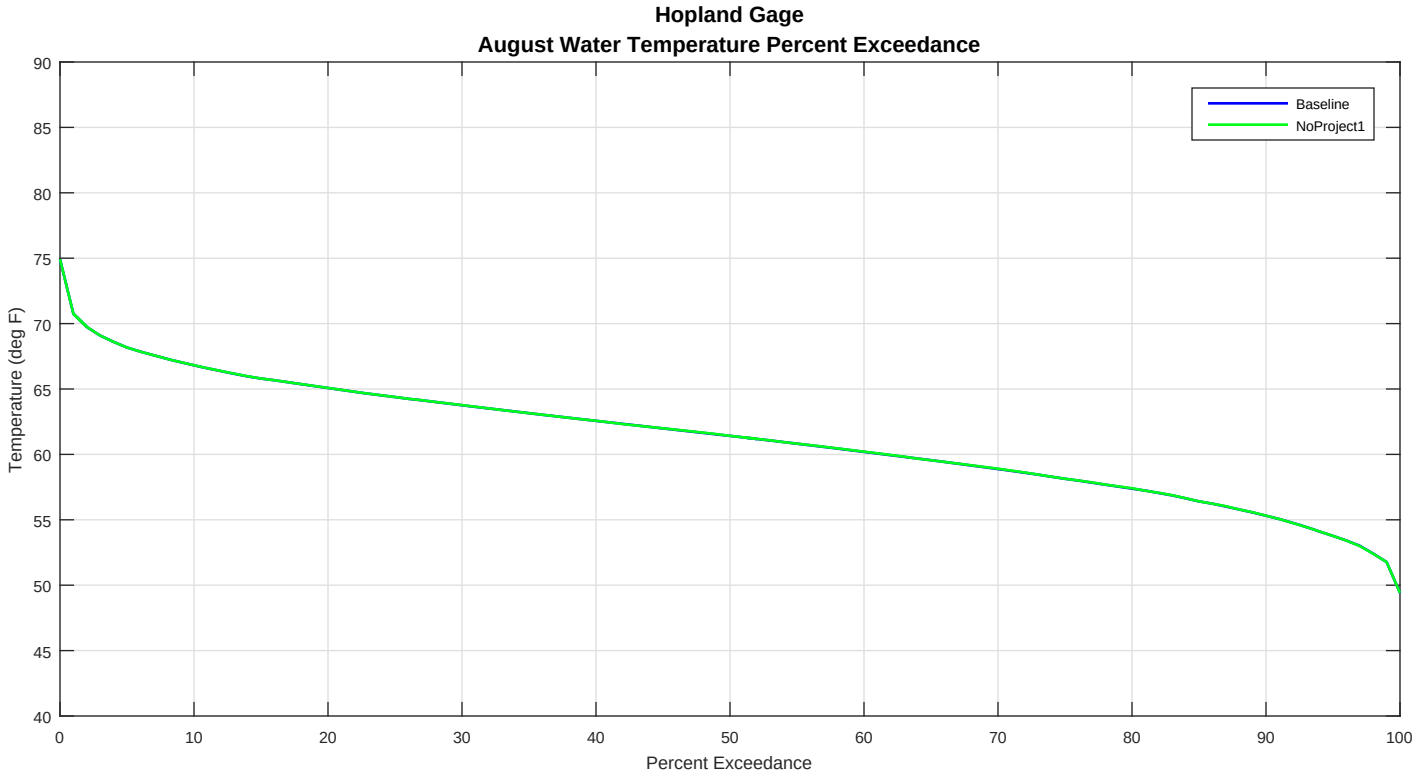
Hopland Gage
August Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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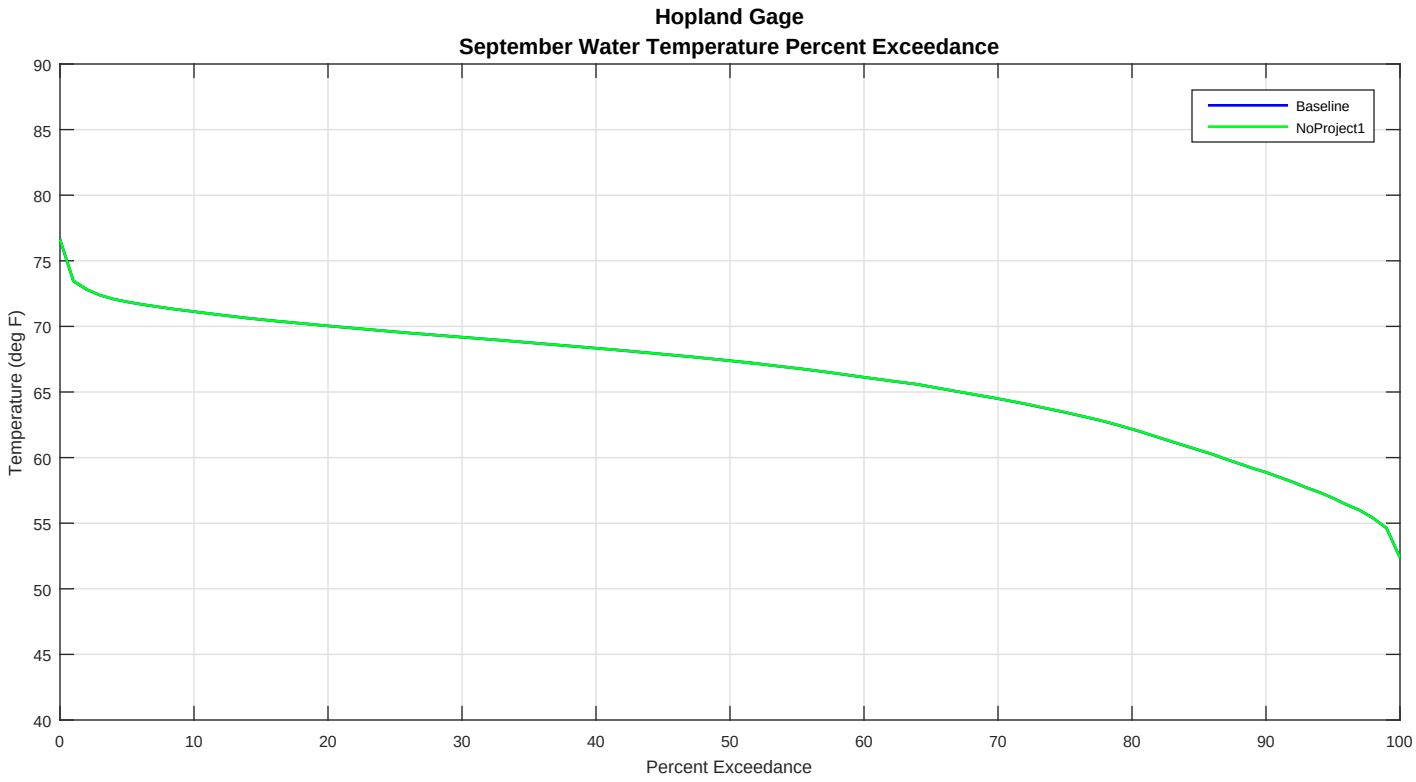
Hopland Gage
September Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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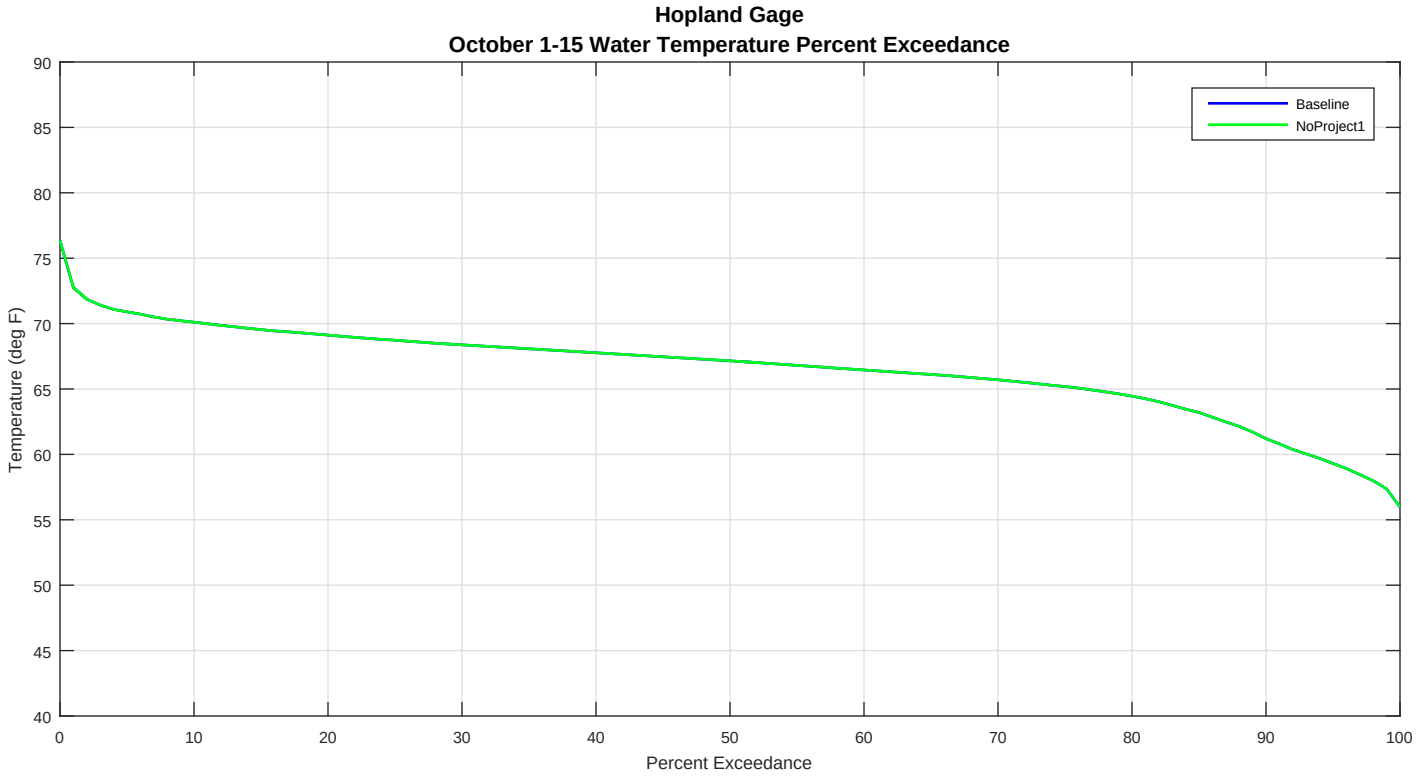
Hopland Gage
October 1-15 Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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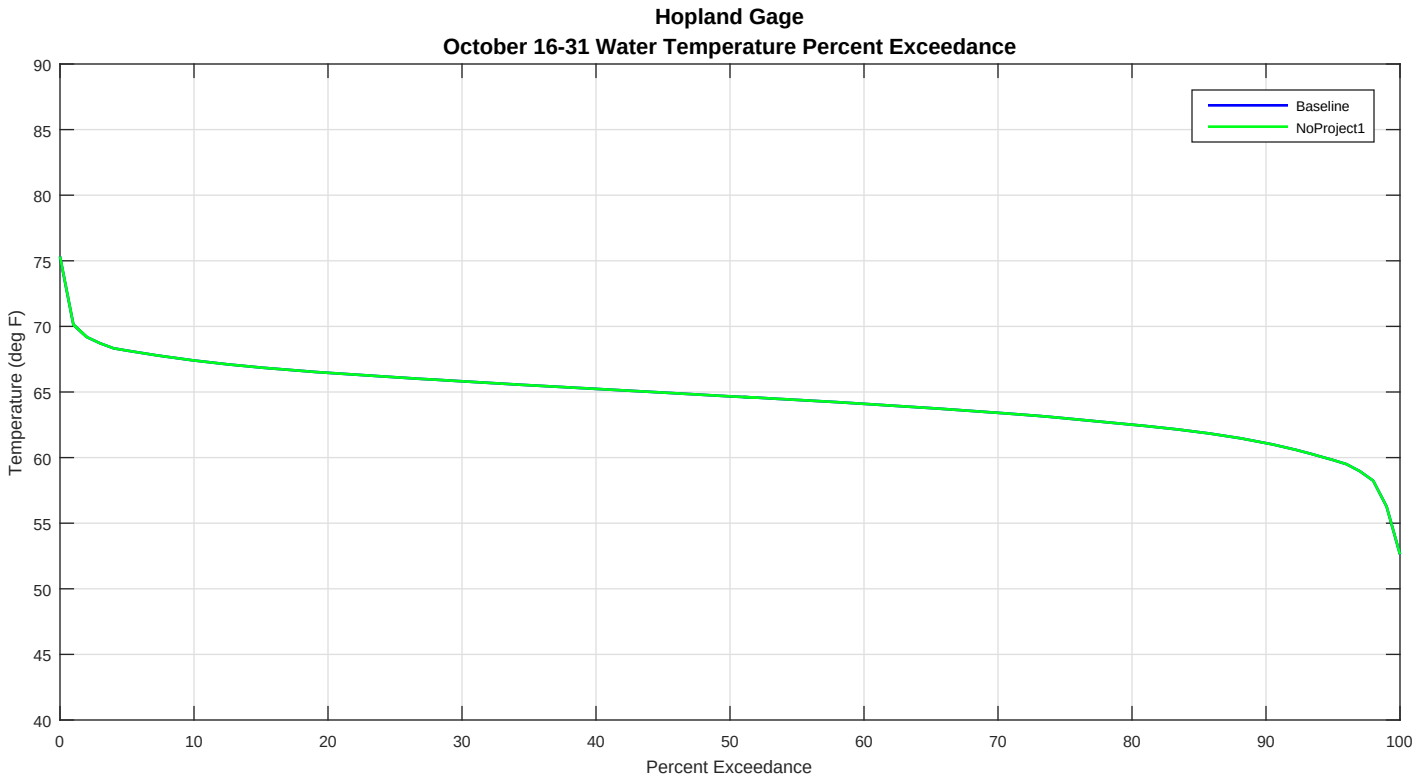
Hopland Gage
October 16-31 Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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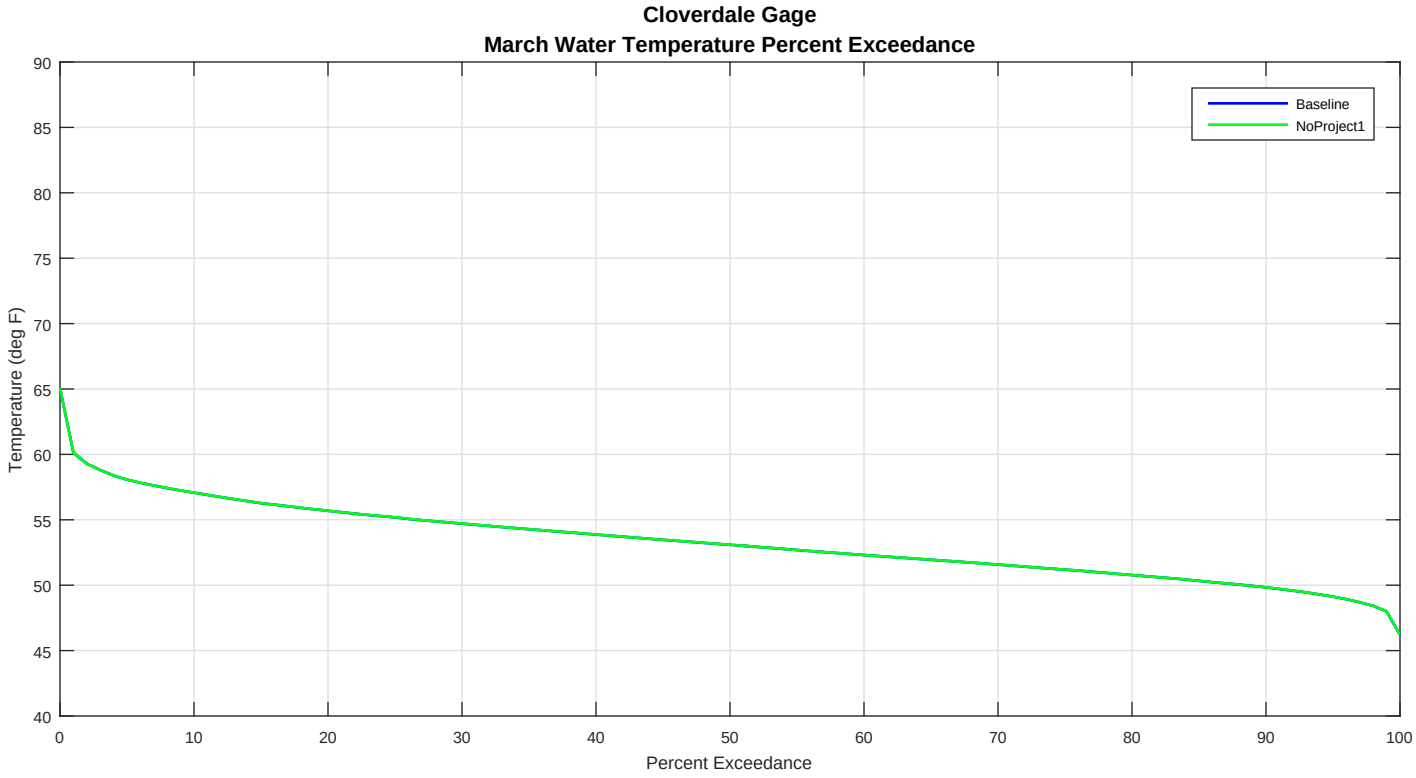
Cloverdale Gage
March Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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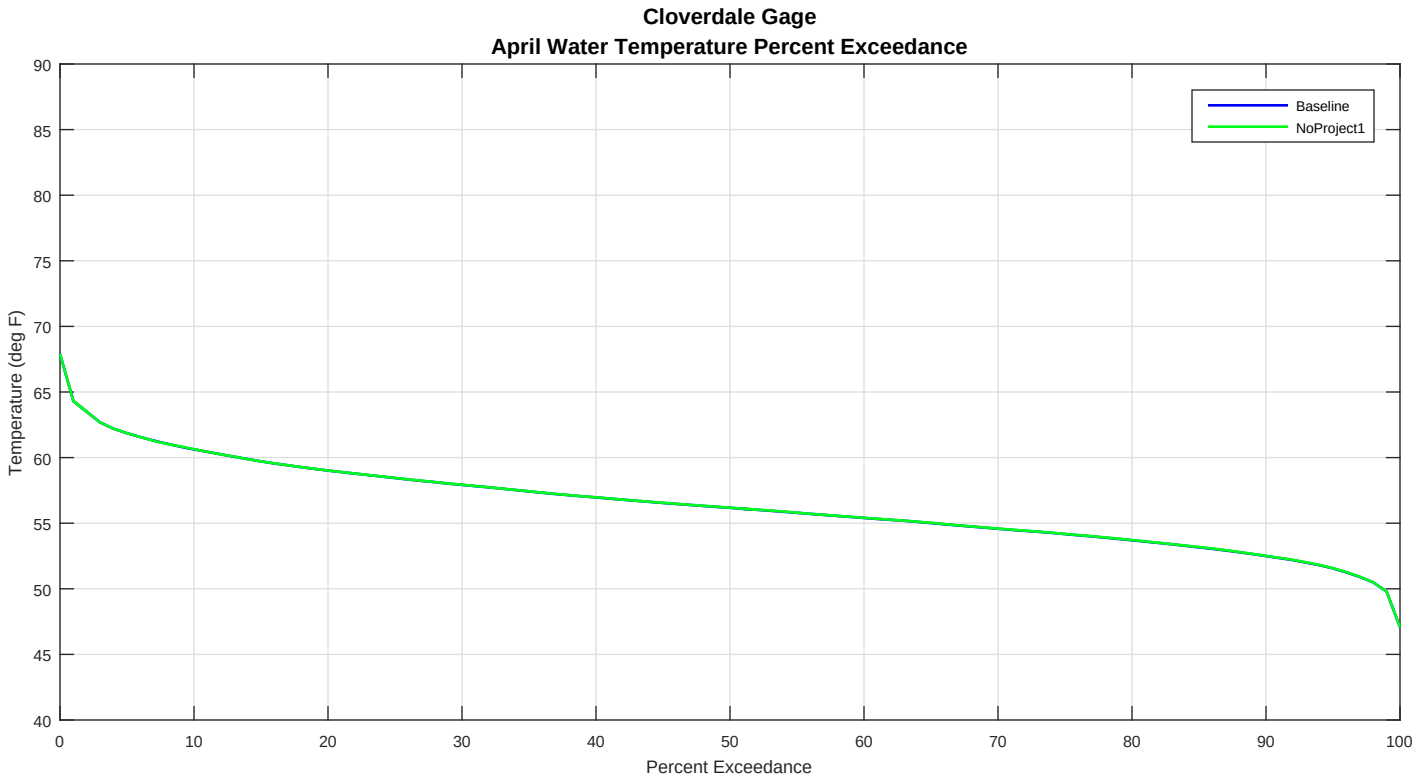
Cloverdale Gage
April Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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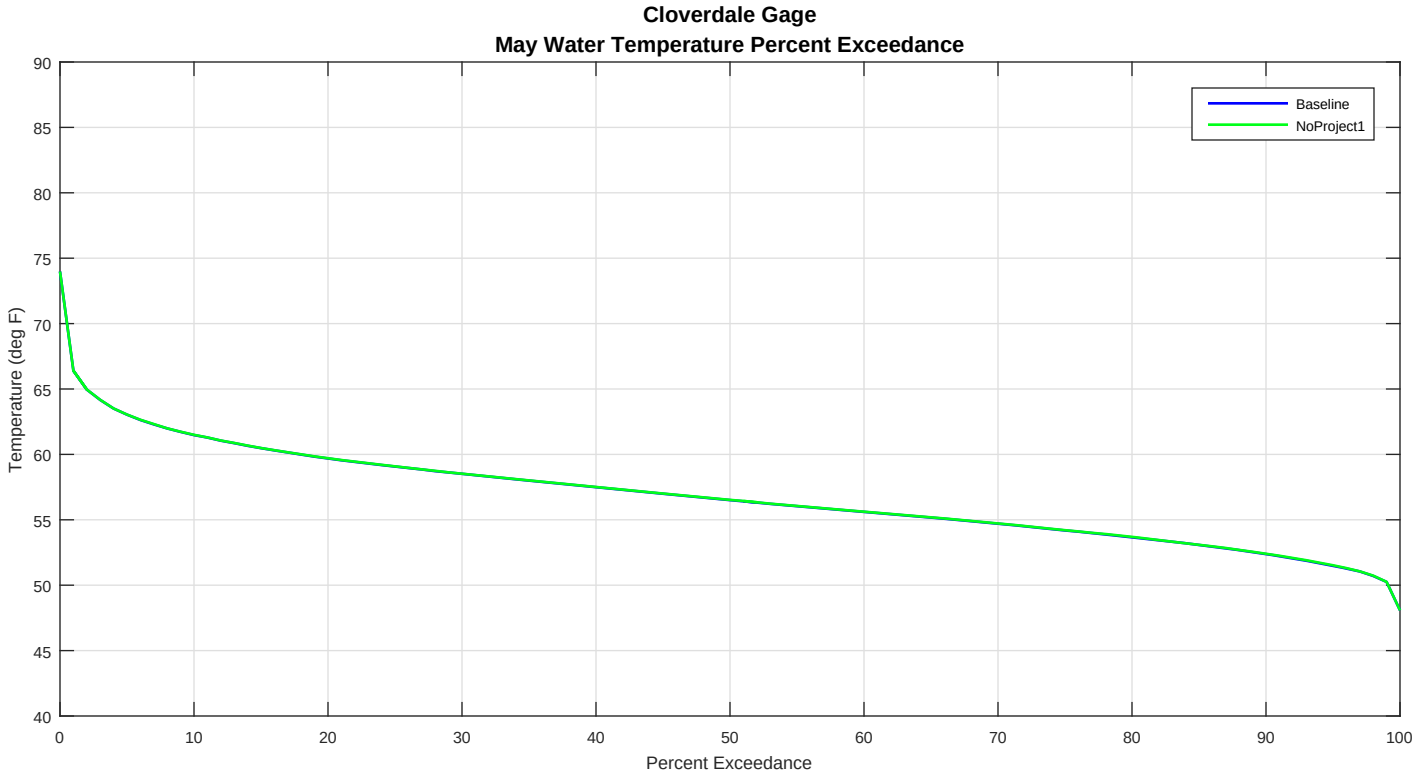
Cloverdale Gage
May Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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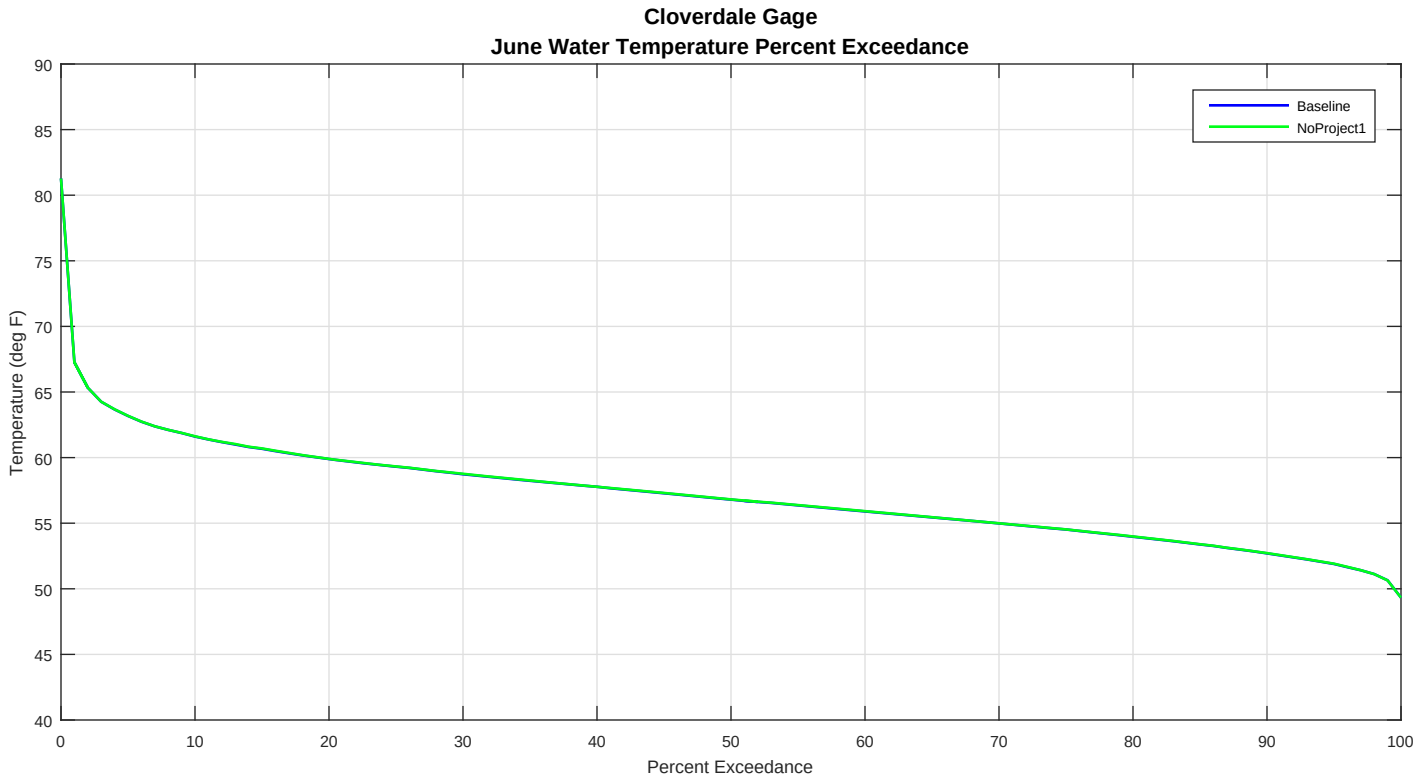
Cloverdale Gage
June Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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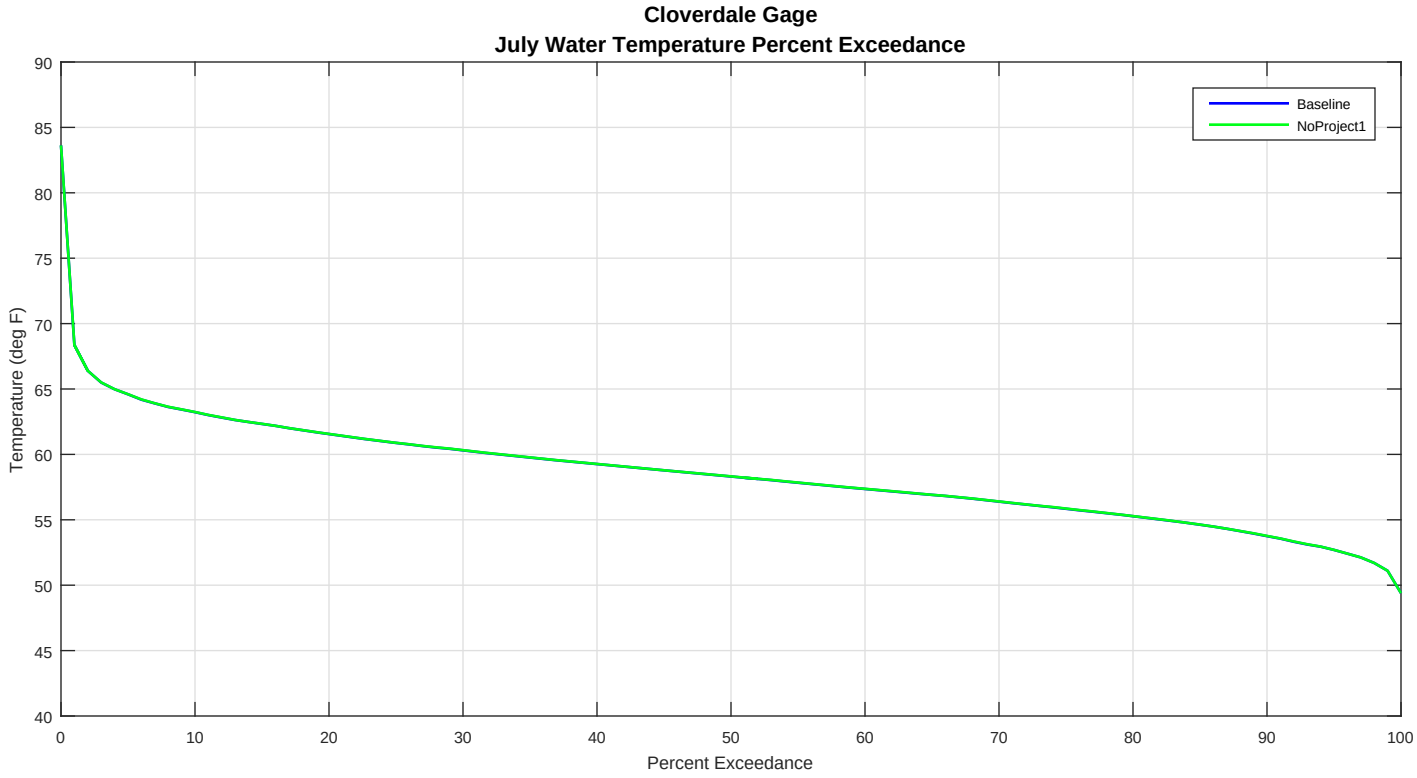
Cloverdale Gage
July Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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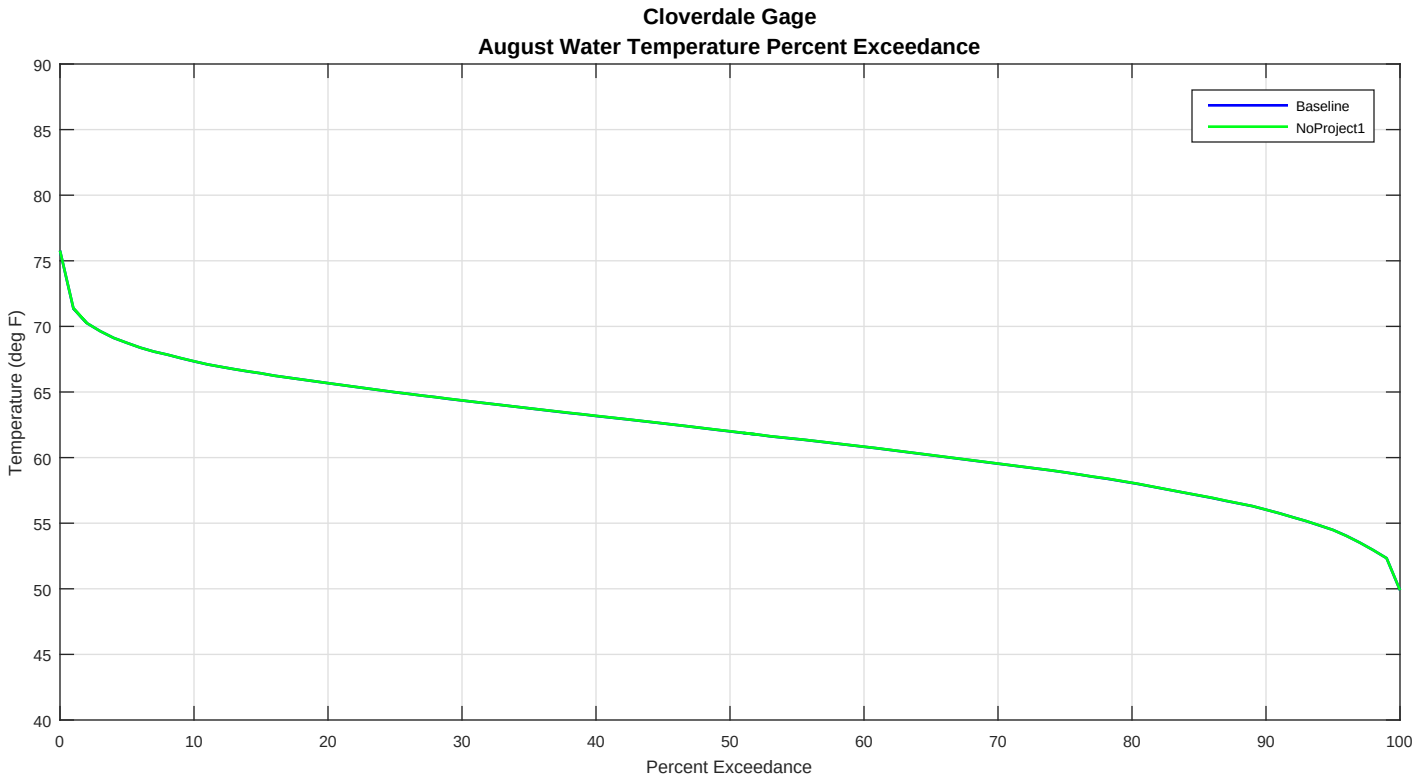
Cloverdale Gage
August Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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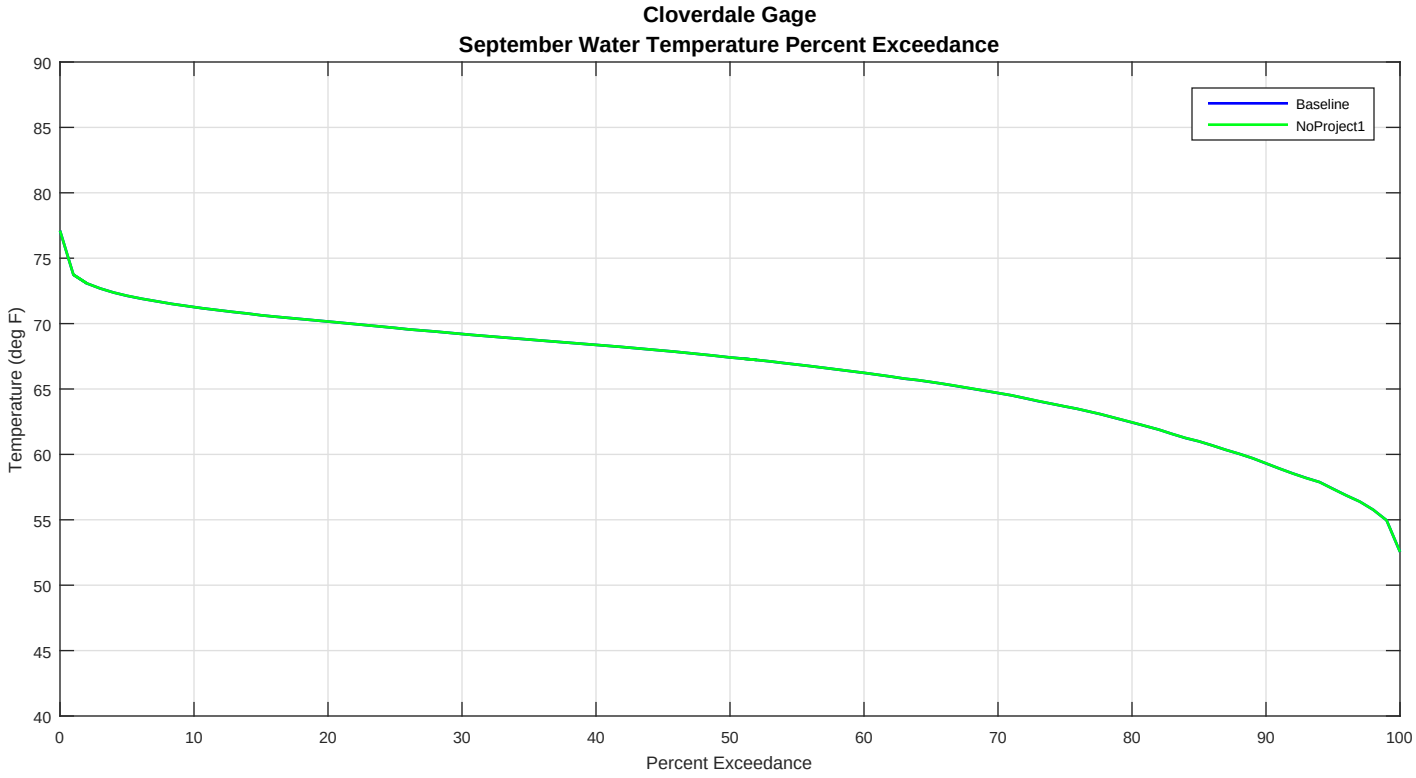
Cloverdale Gage
September Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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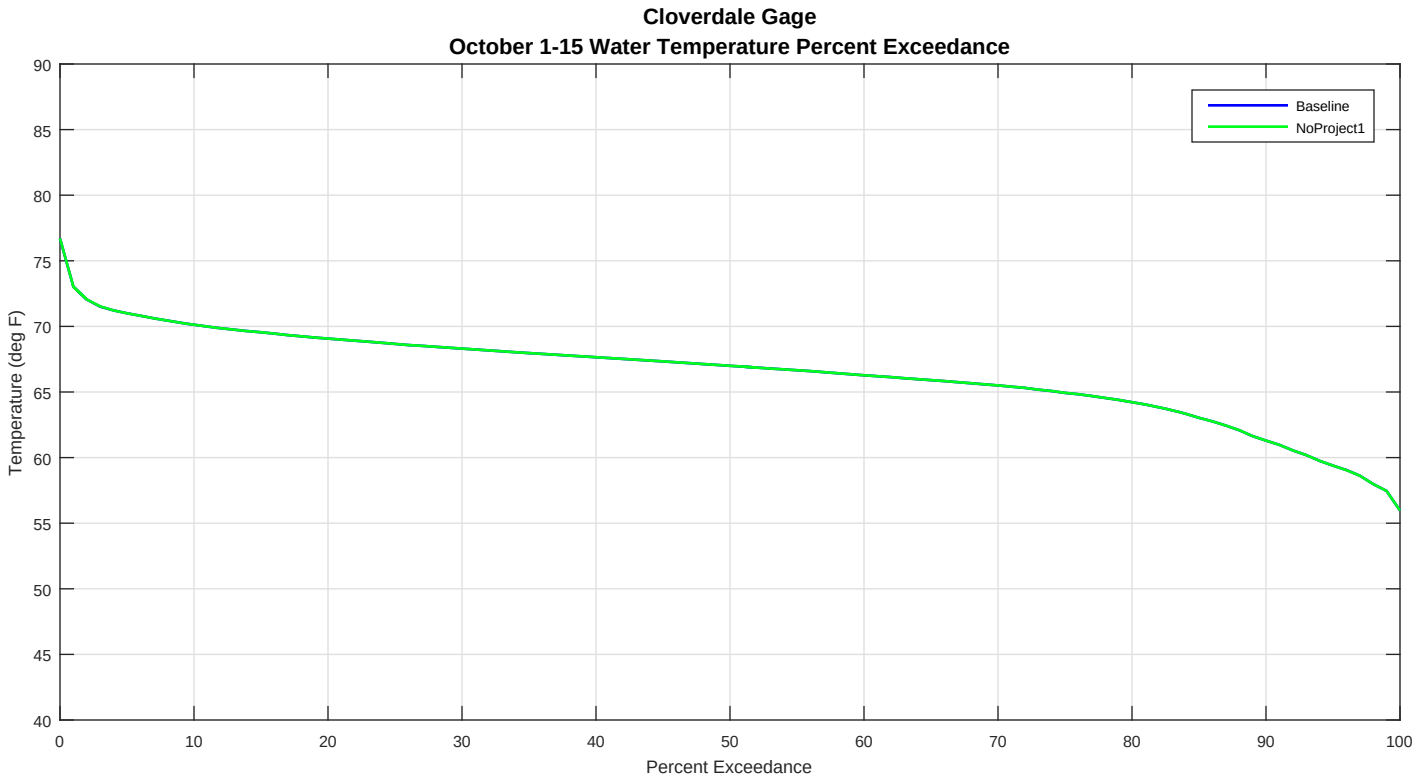
Cloverdale Gage
October 1-15 Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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Cloverdale Gage
October 16-31 Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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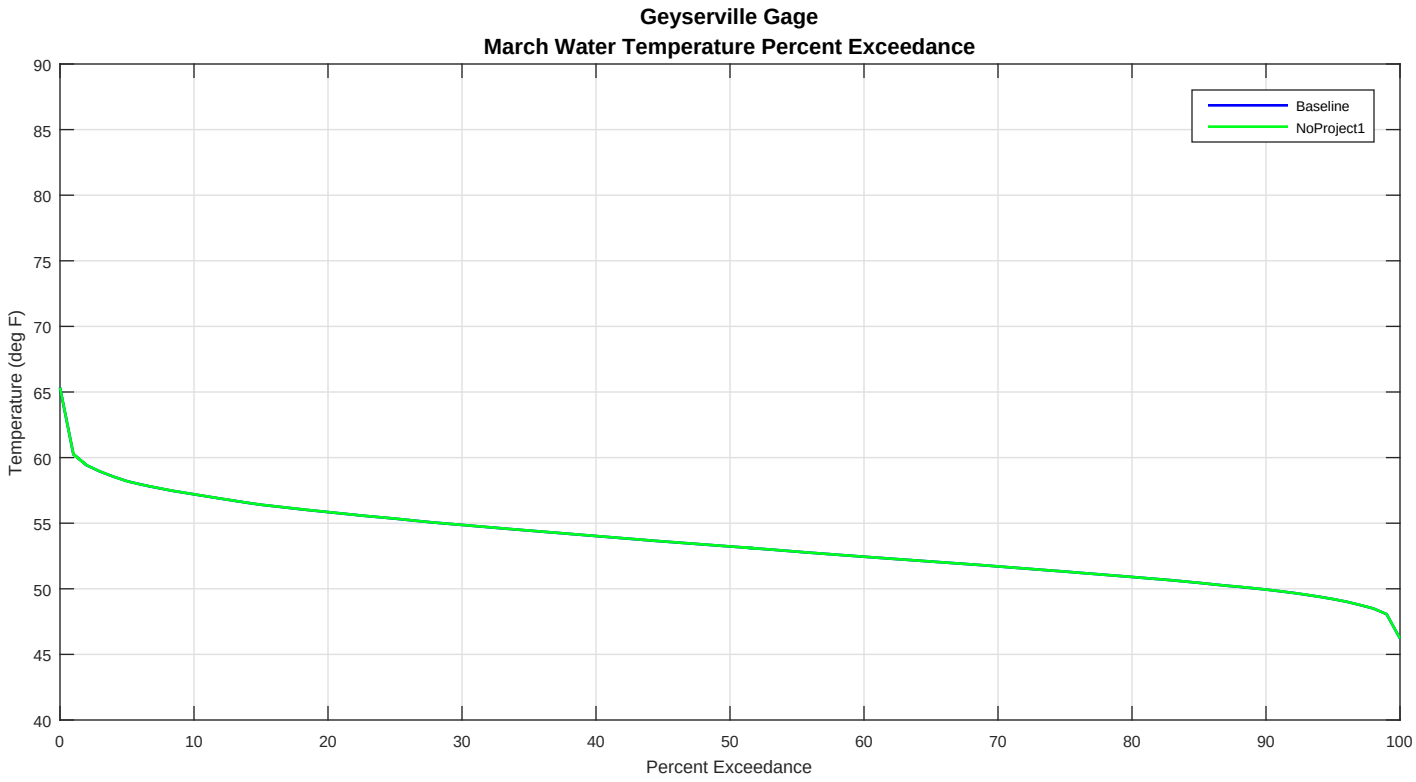
Geyserville Gage
March Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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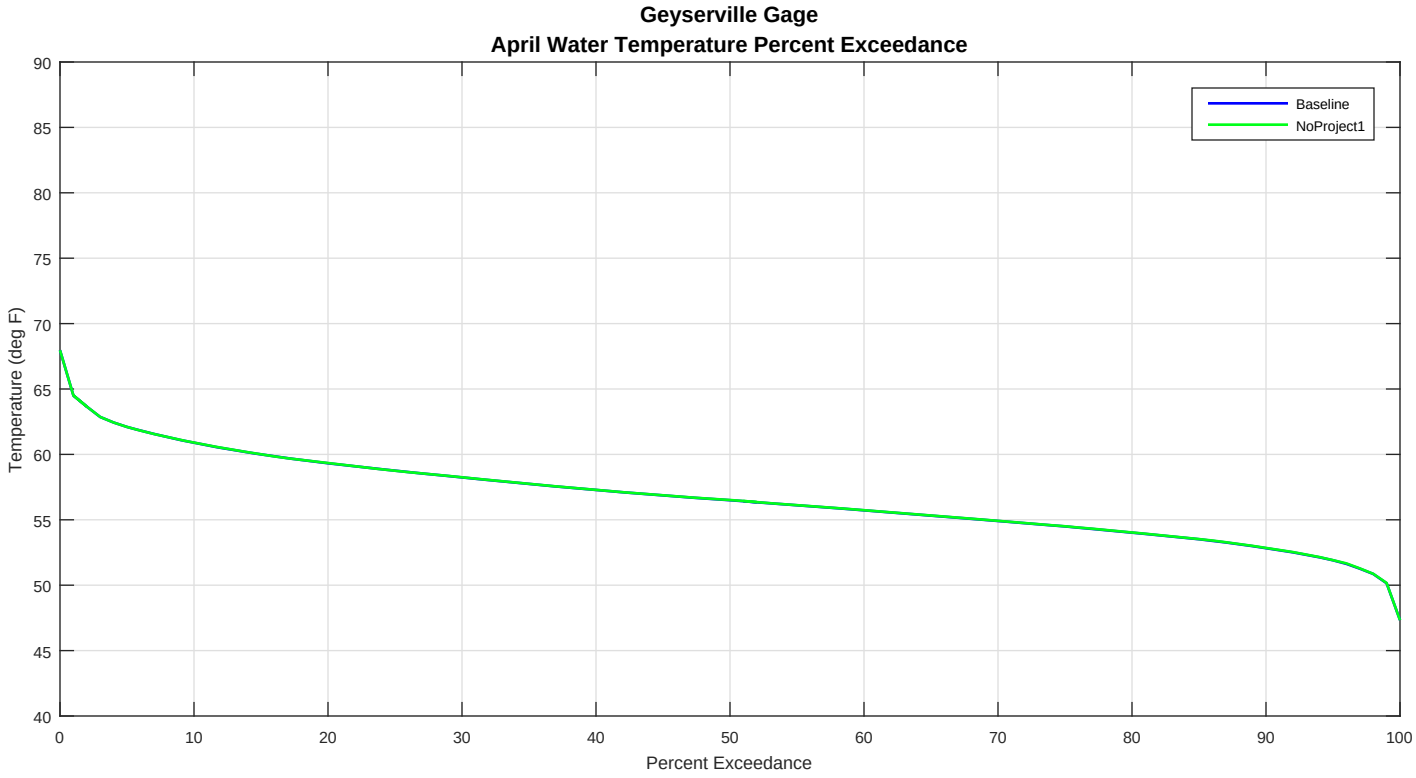
Geyserville Gage
April Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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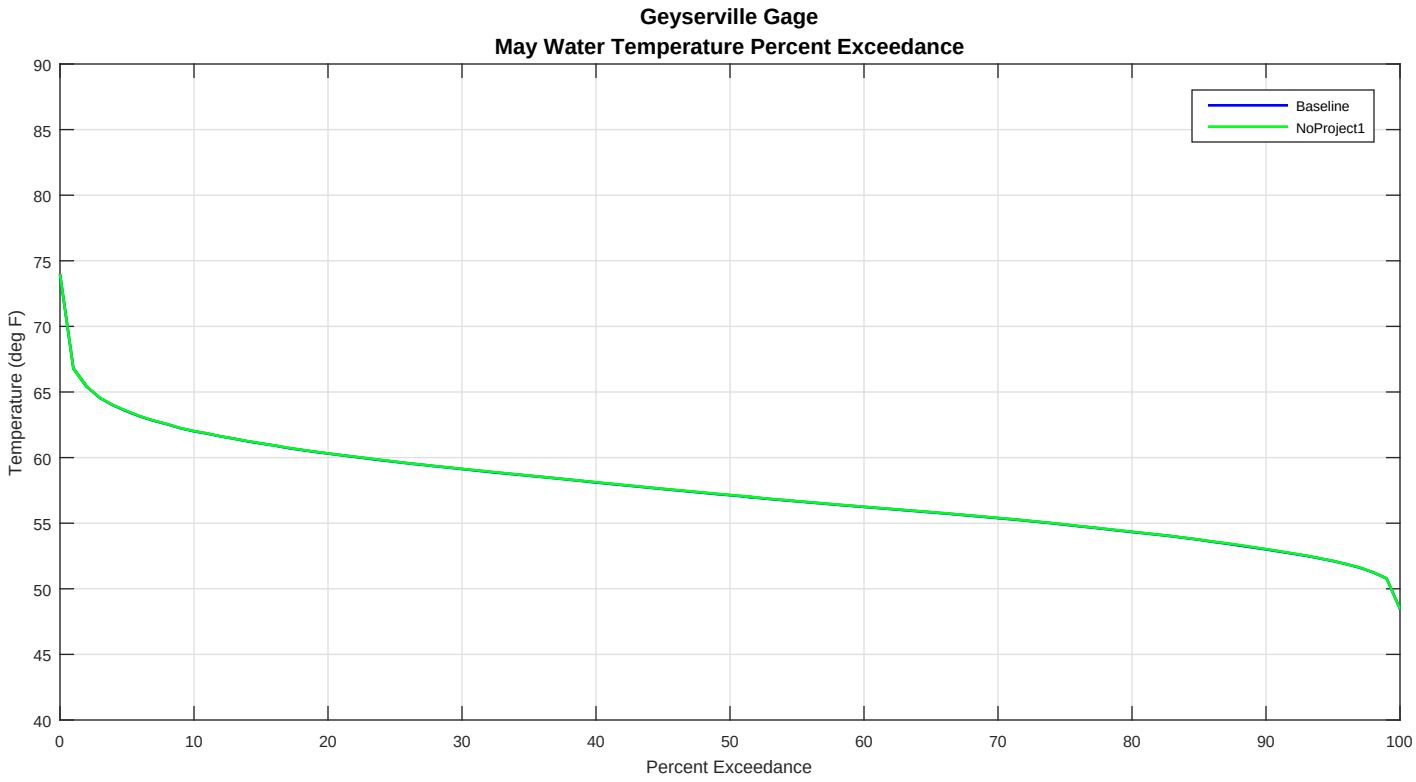
Geyserville Gage
May Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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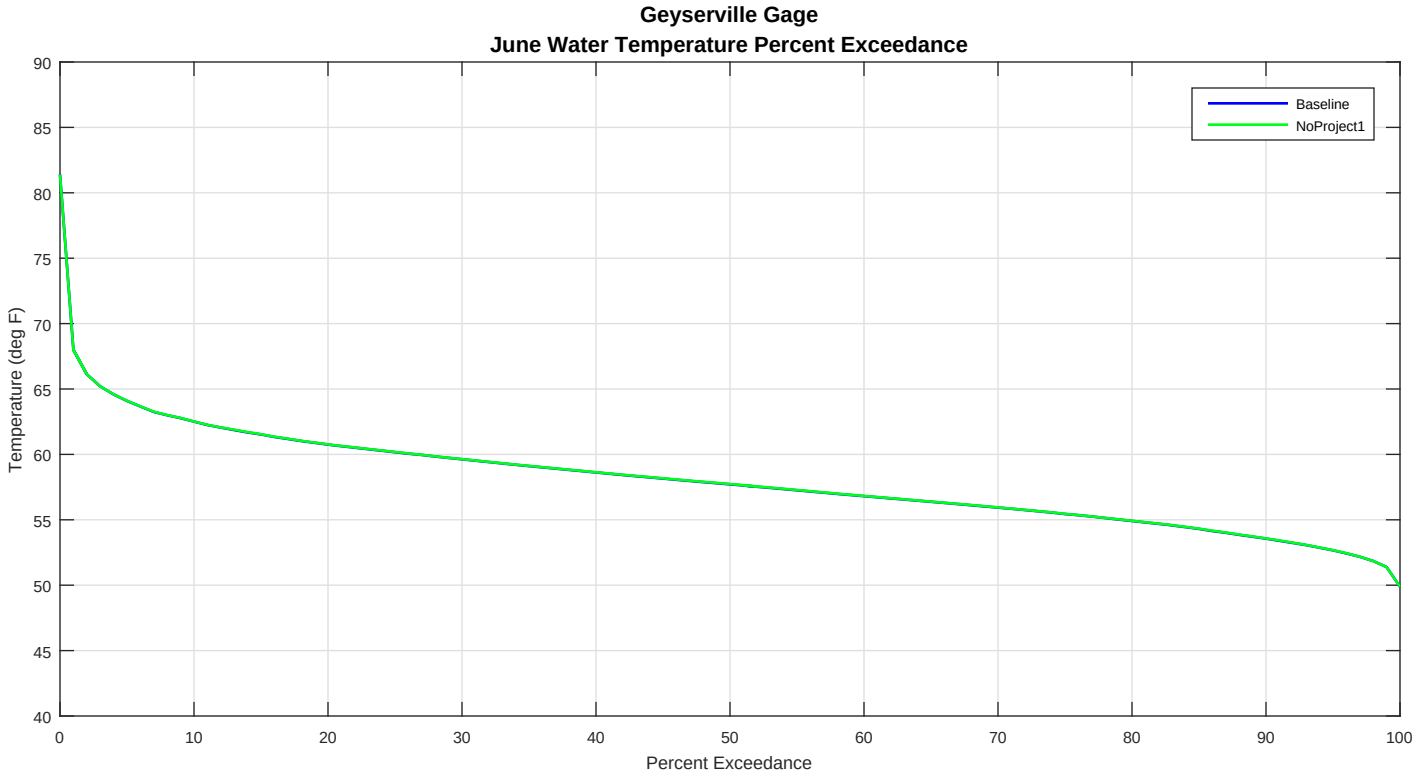
Geyserville Gage
June Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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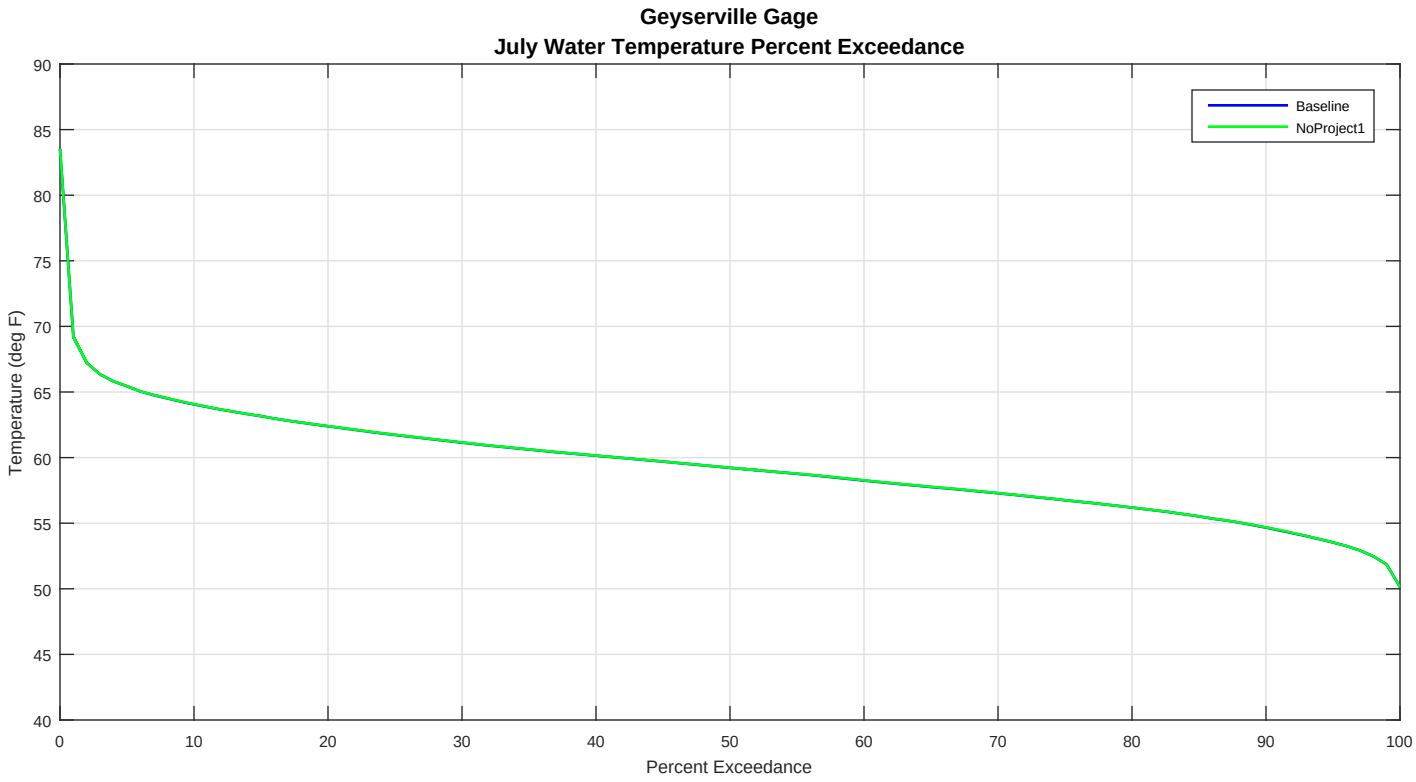
Geyserville Gage
July Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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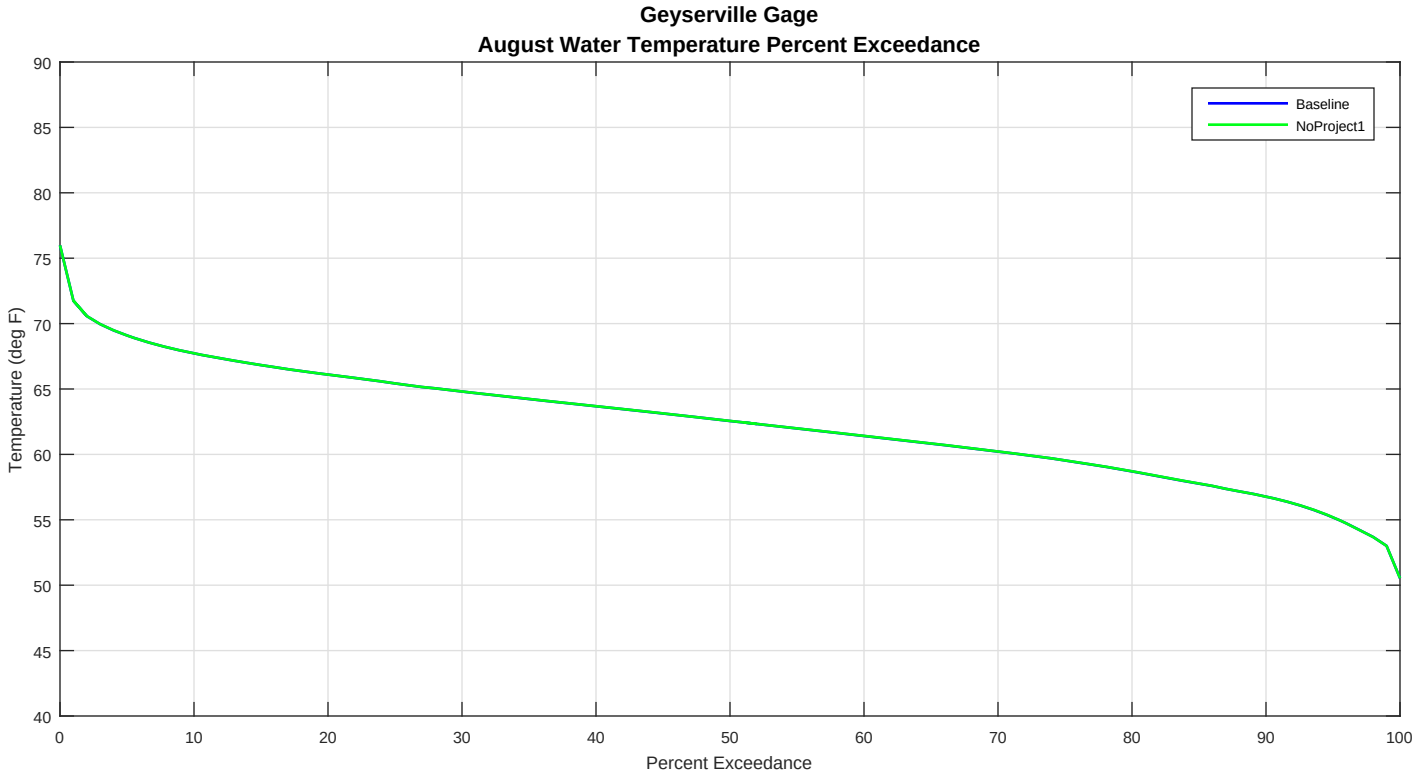
Geyserville Gage
August Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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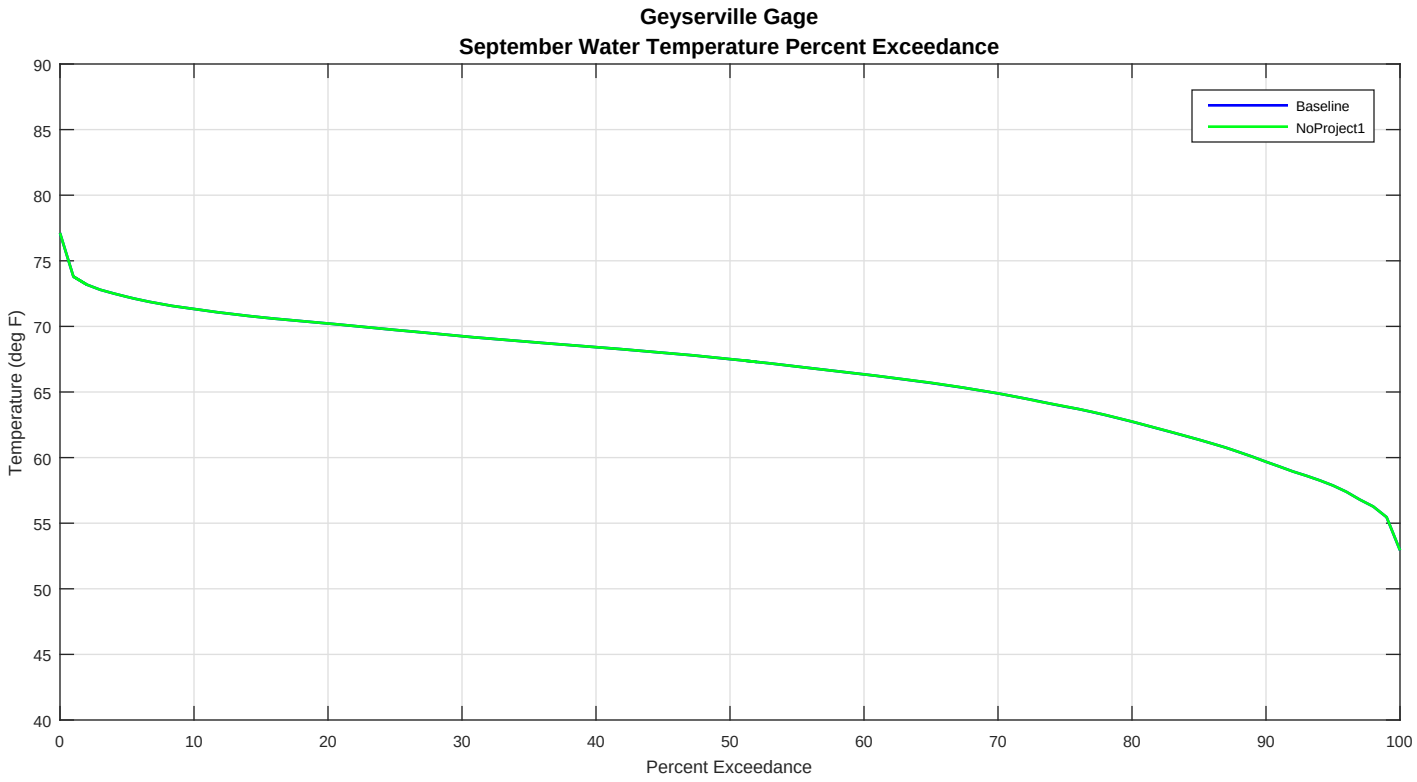
Geyserville Gage
September Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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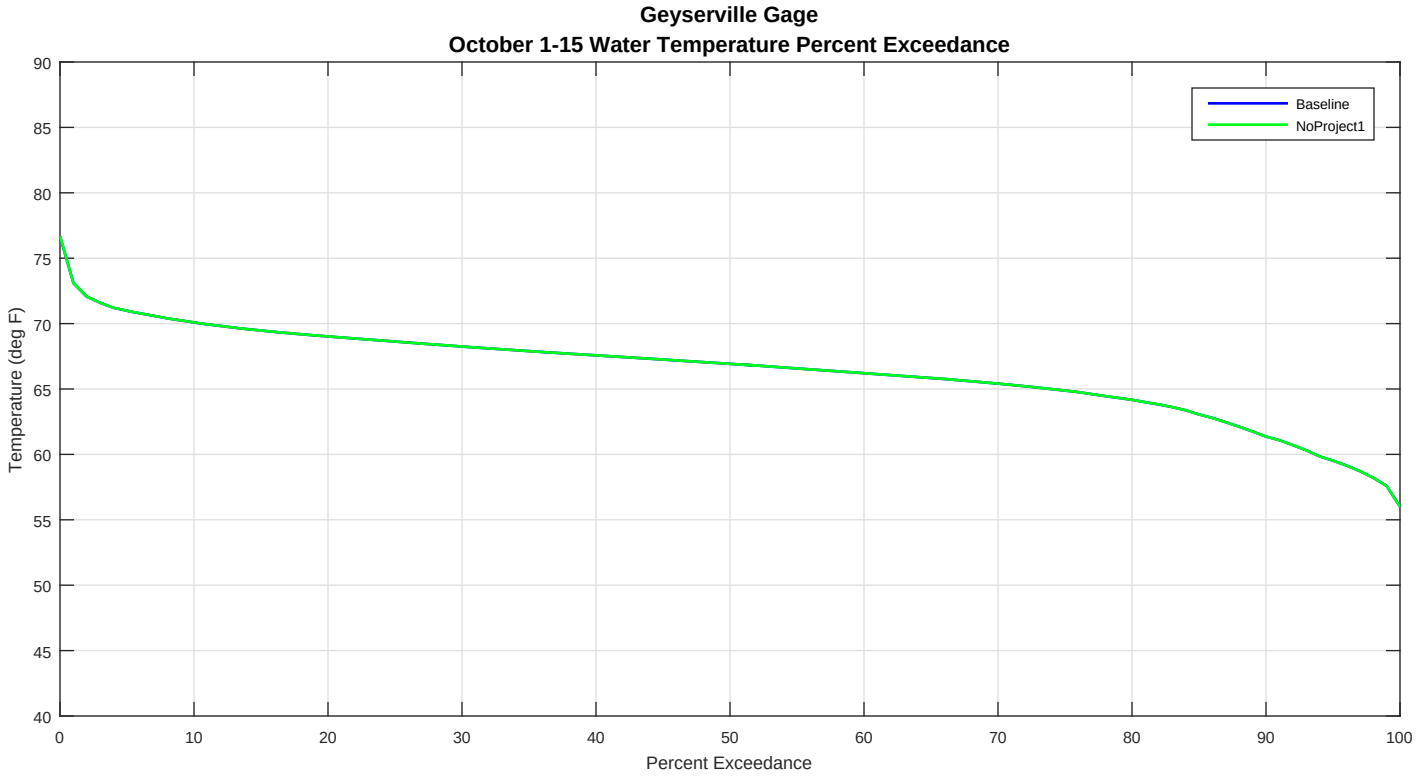
Geyserville Gage
October 1-15 Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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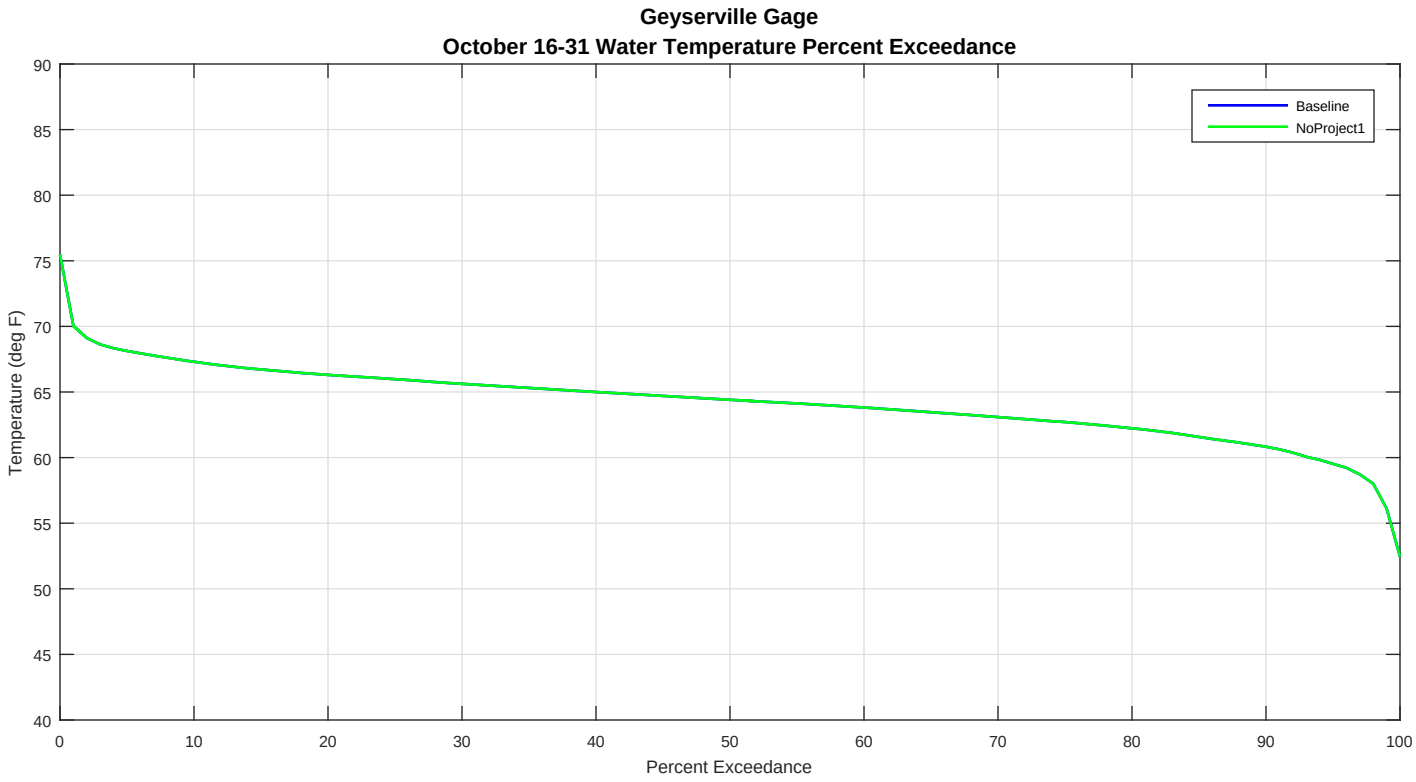
Geyserville Gage
October 16-31 Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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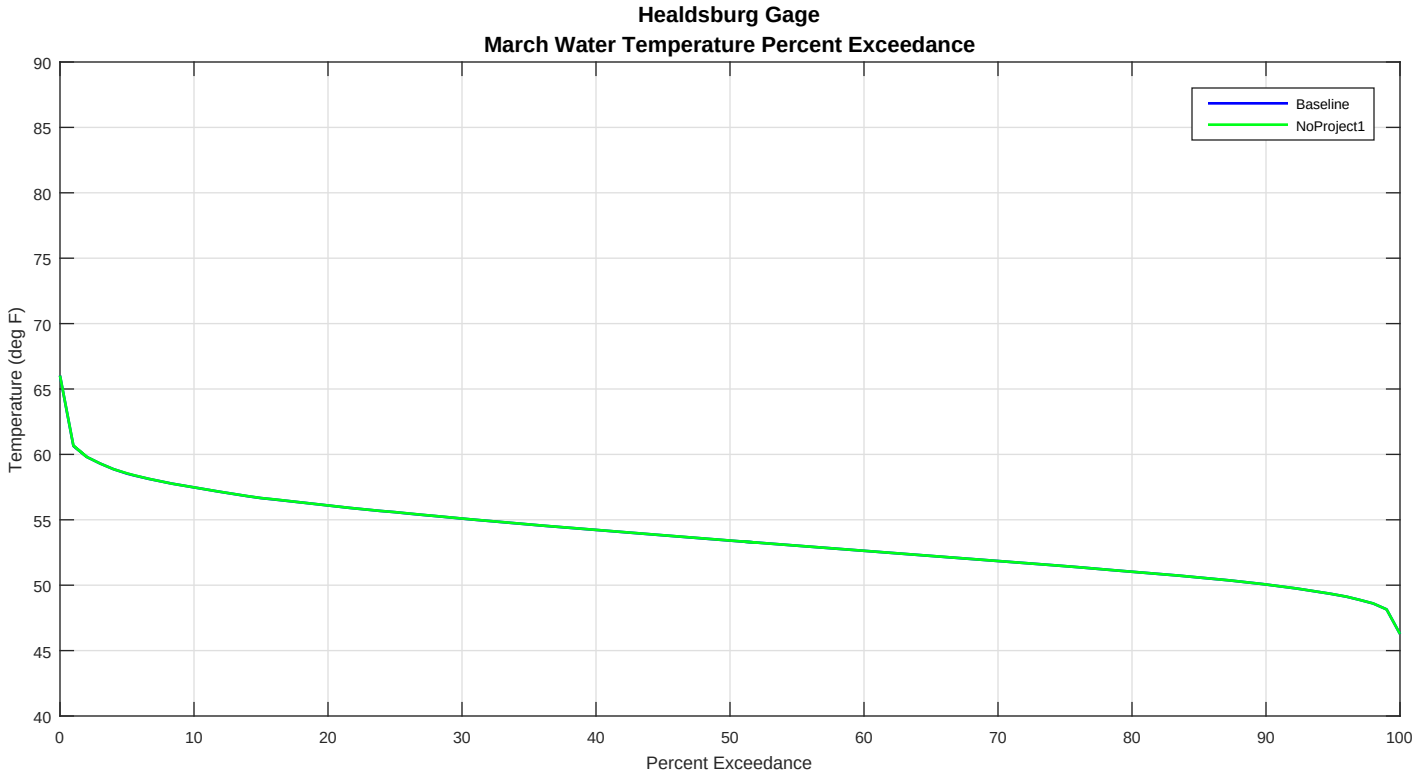
Healdsburg Gage
March Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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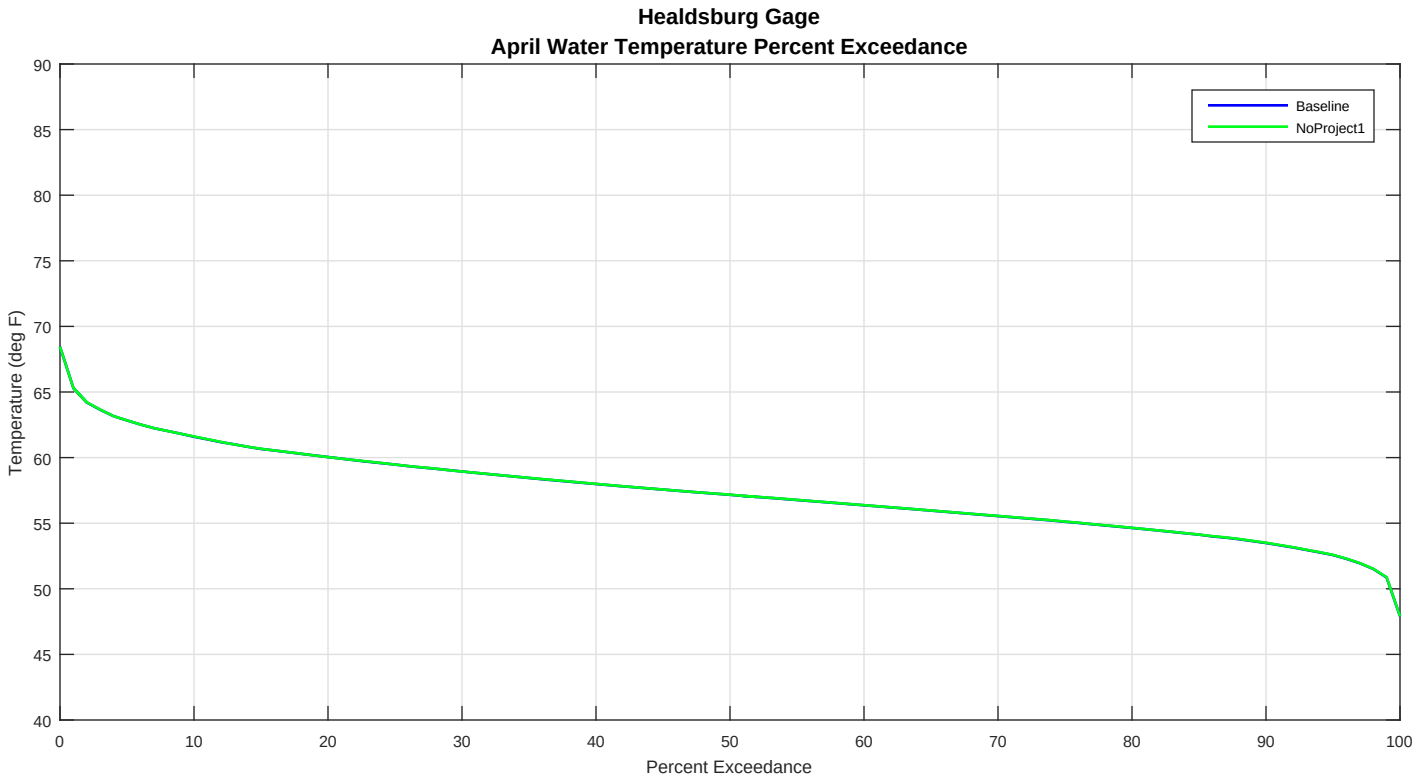
Healdsburg Gage
April Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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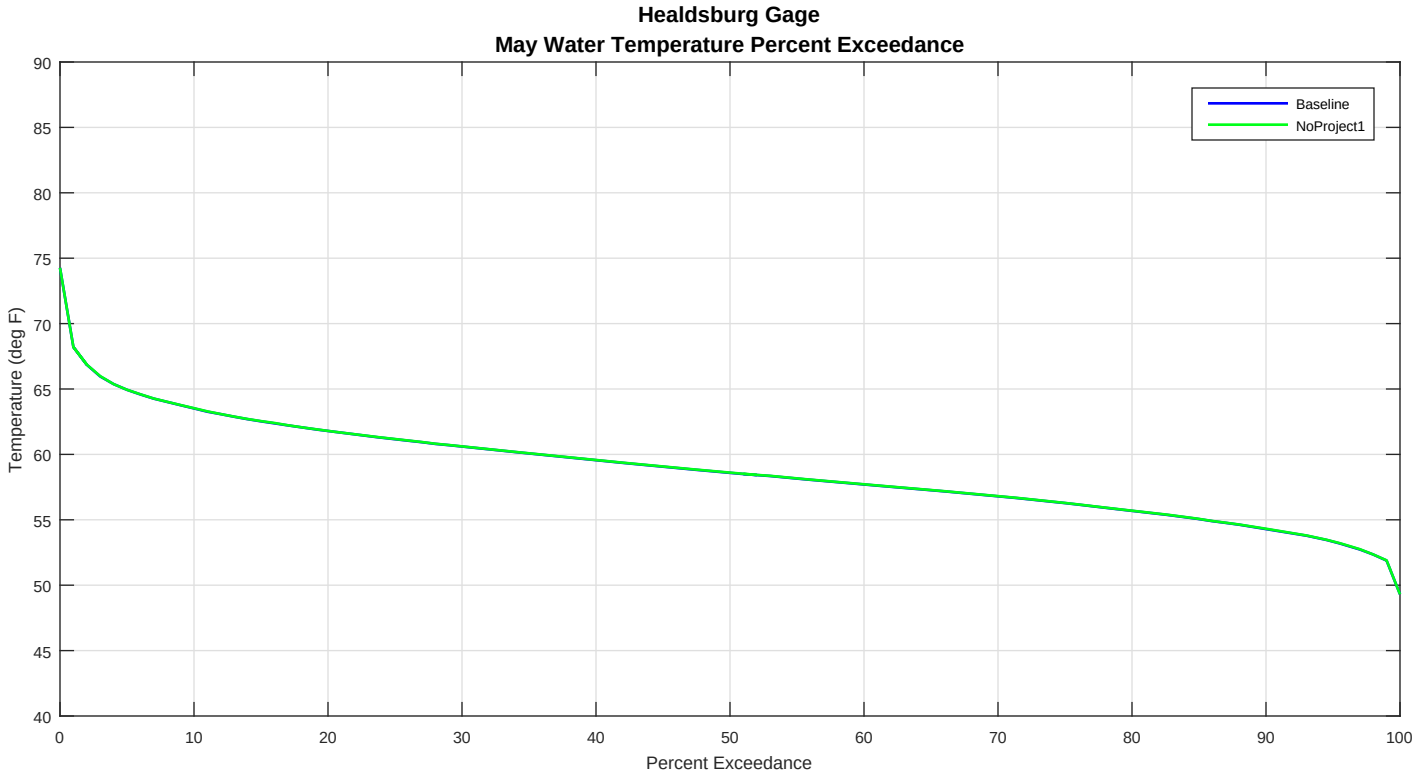
Healdsburg Gage
May Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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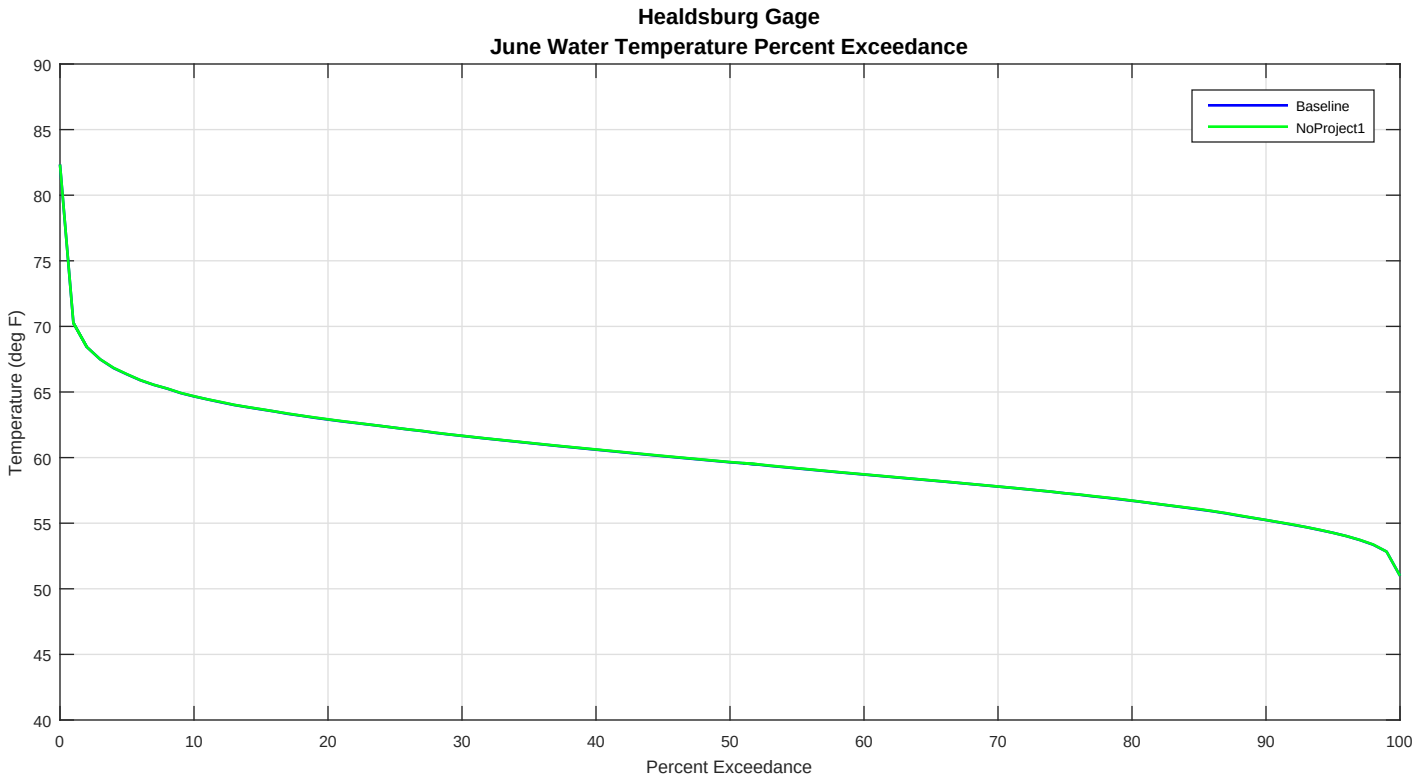
Healdsburg Gage
June Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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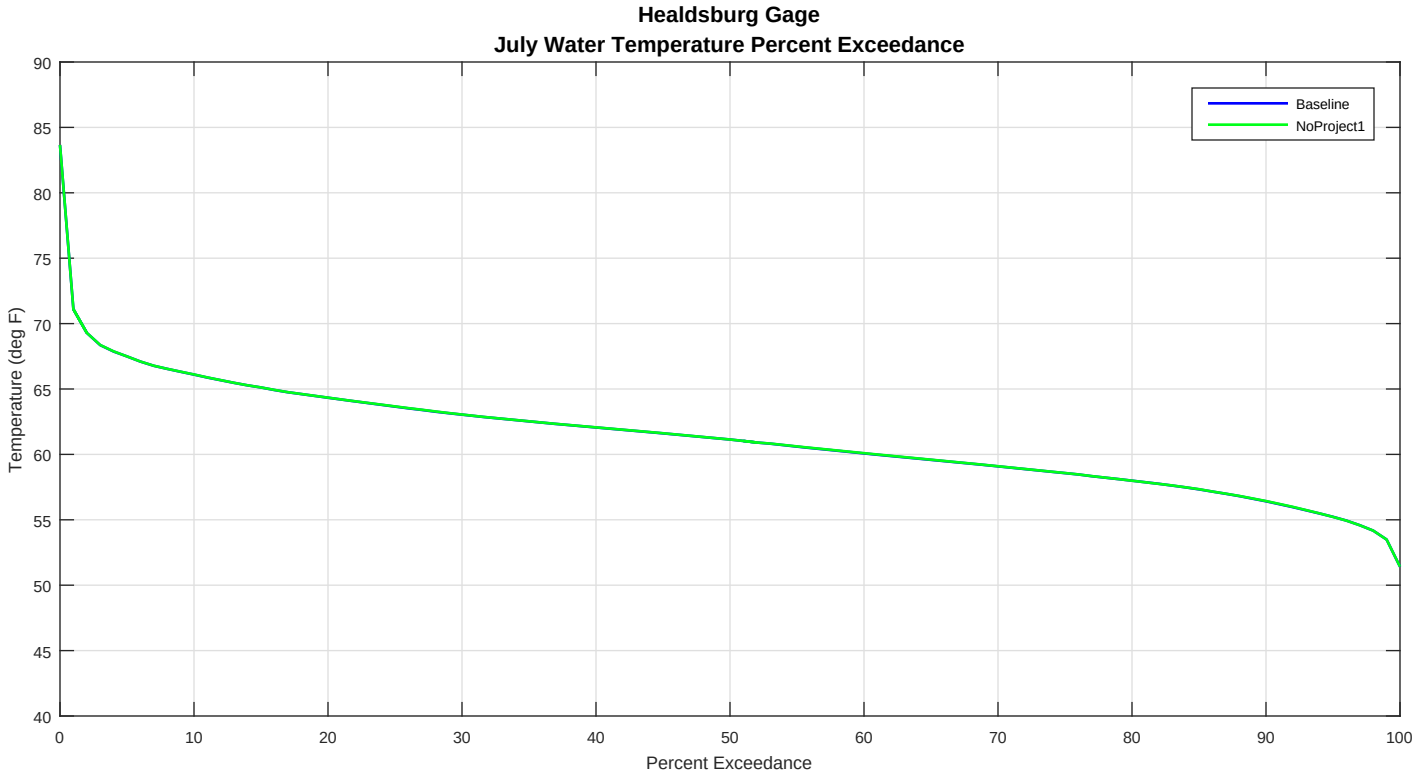
Healdsburg Gage
July Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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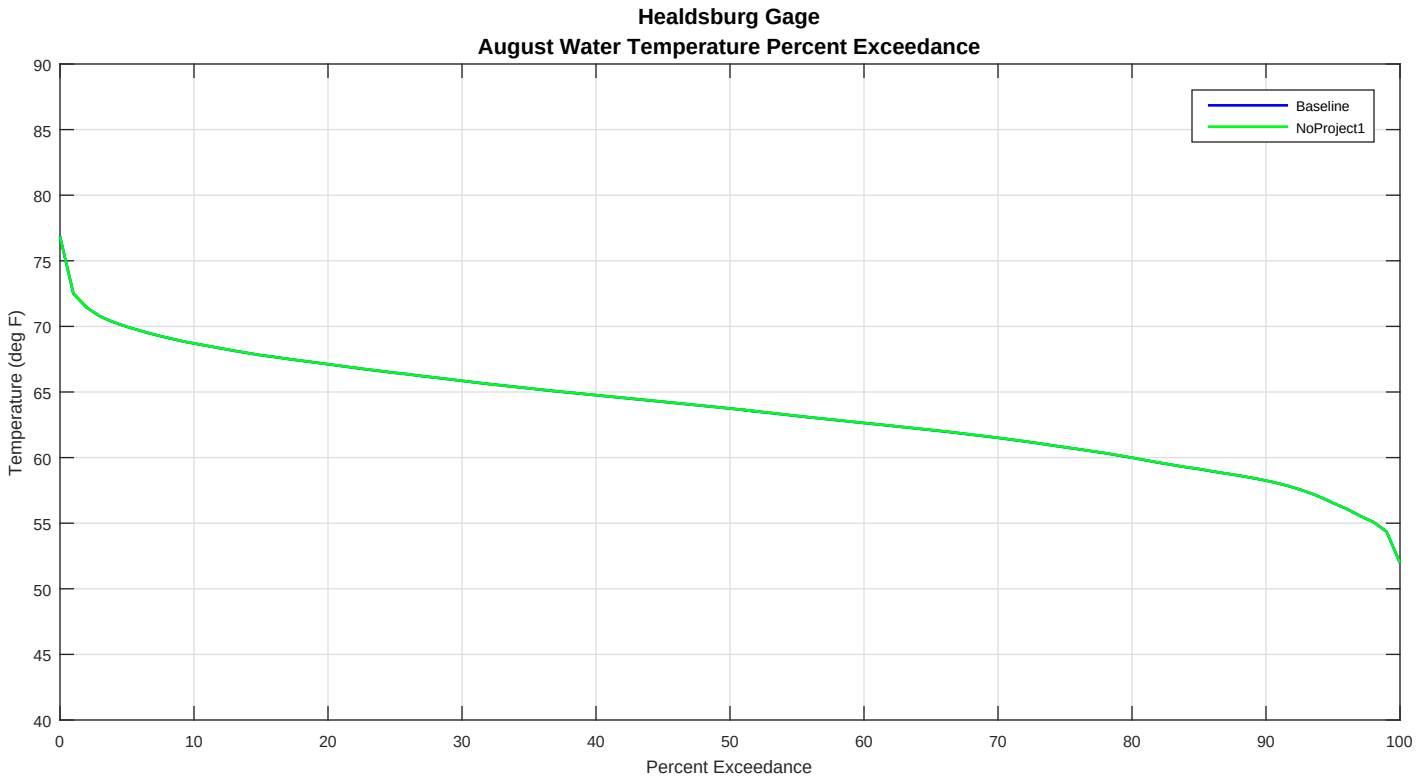
Healdsburg Gage
August Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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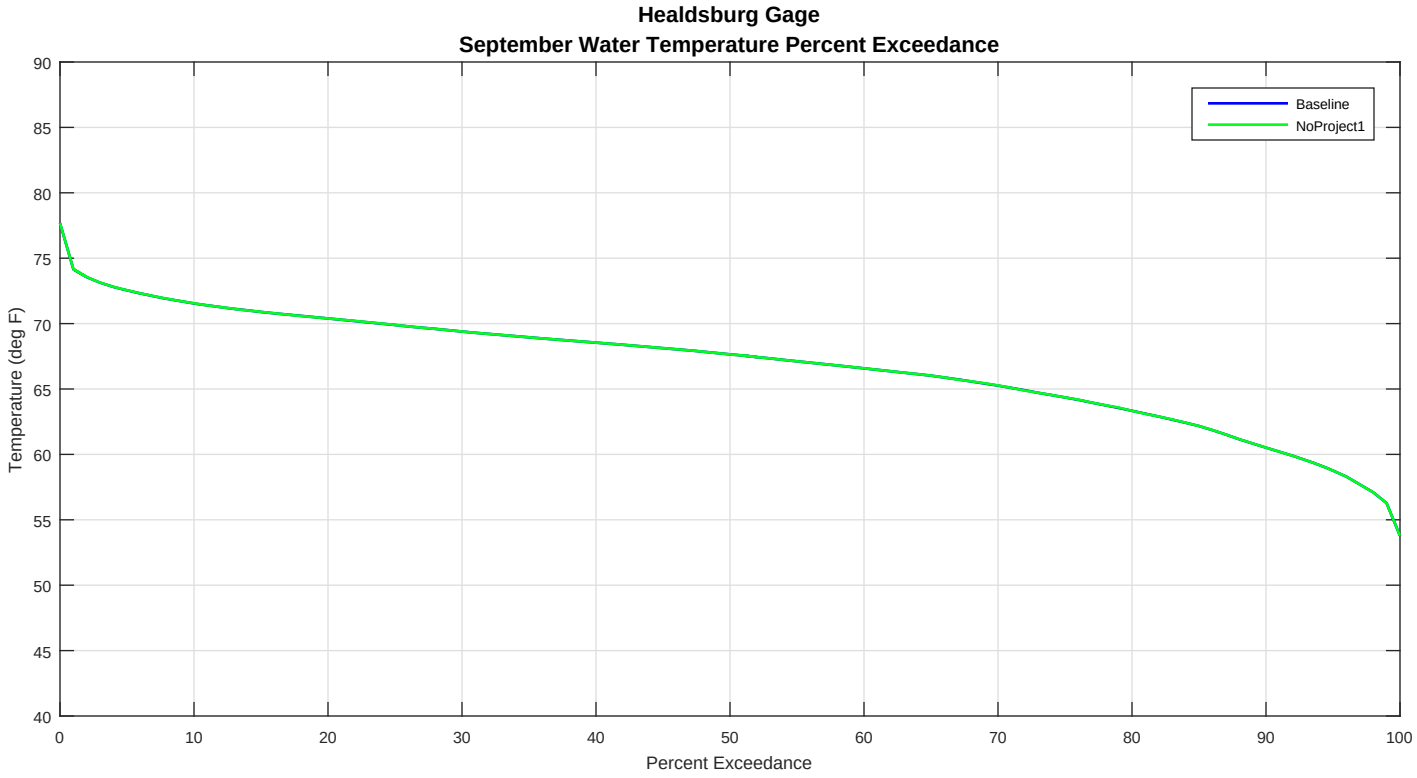
Healdsburg Gage
September Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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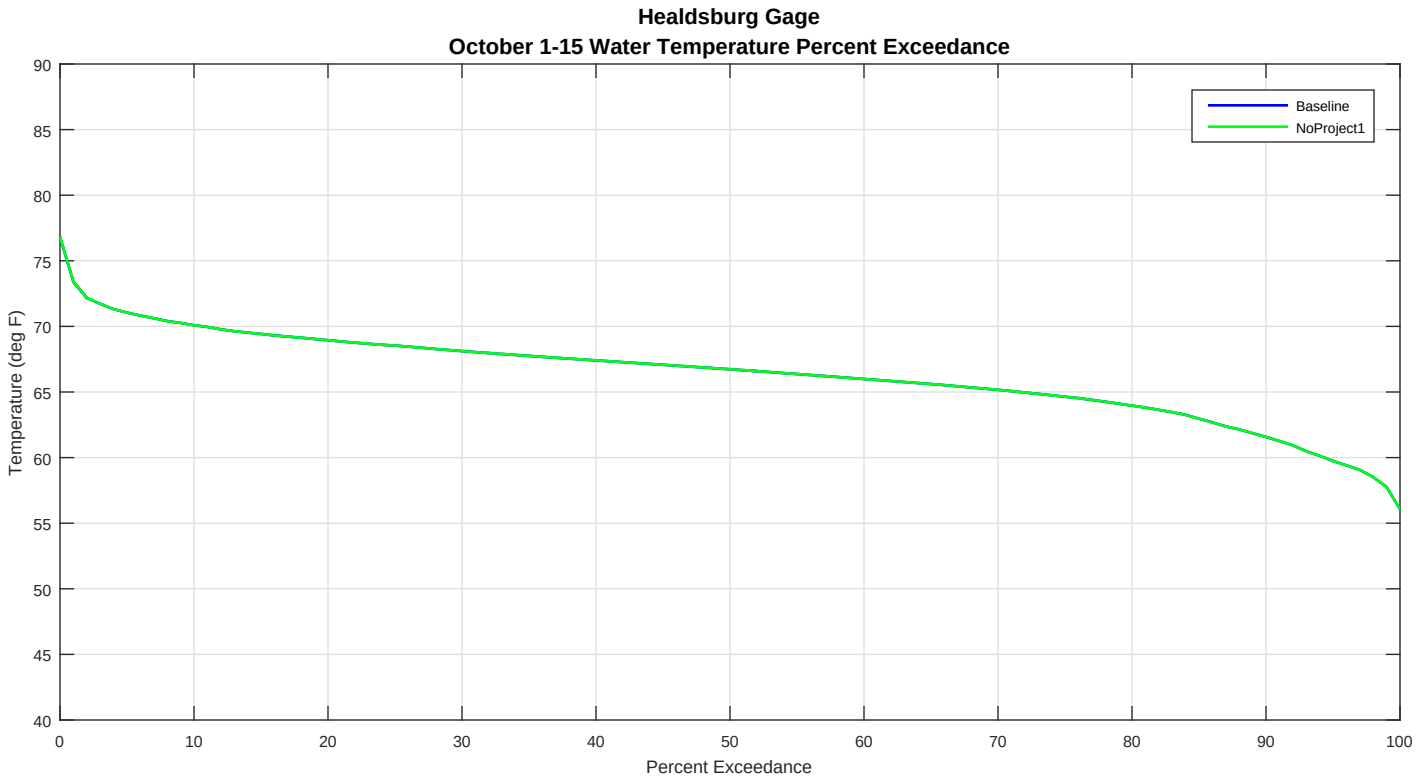
Healdsburg Gage
October 1-15 Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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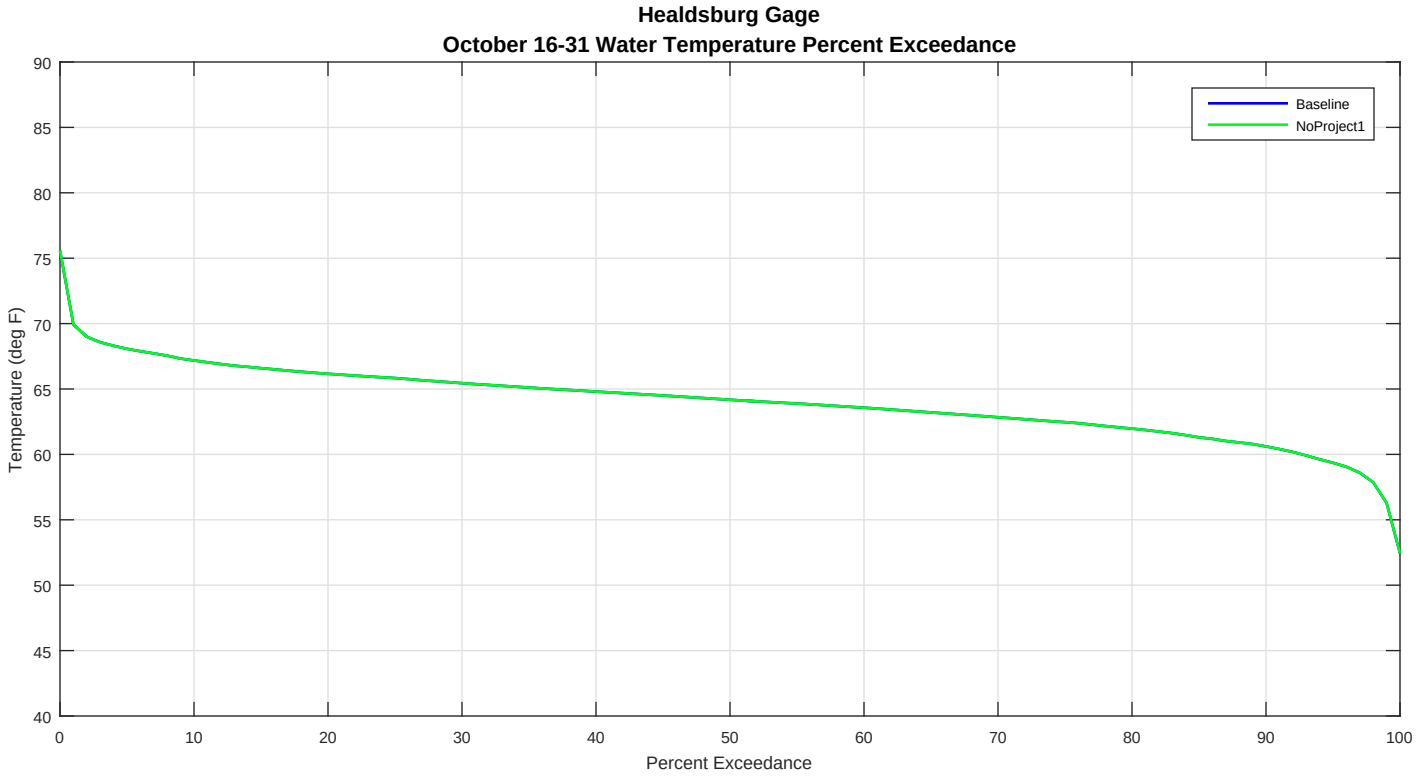
Healdsburg Gage
October 16-31 Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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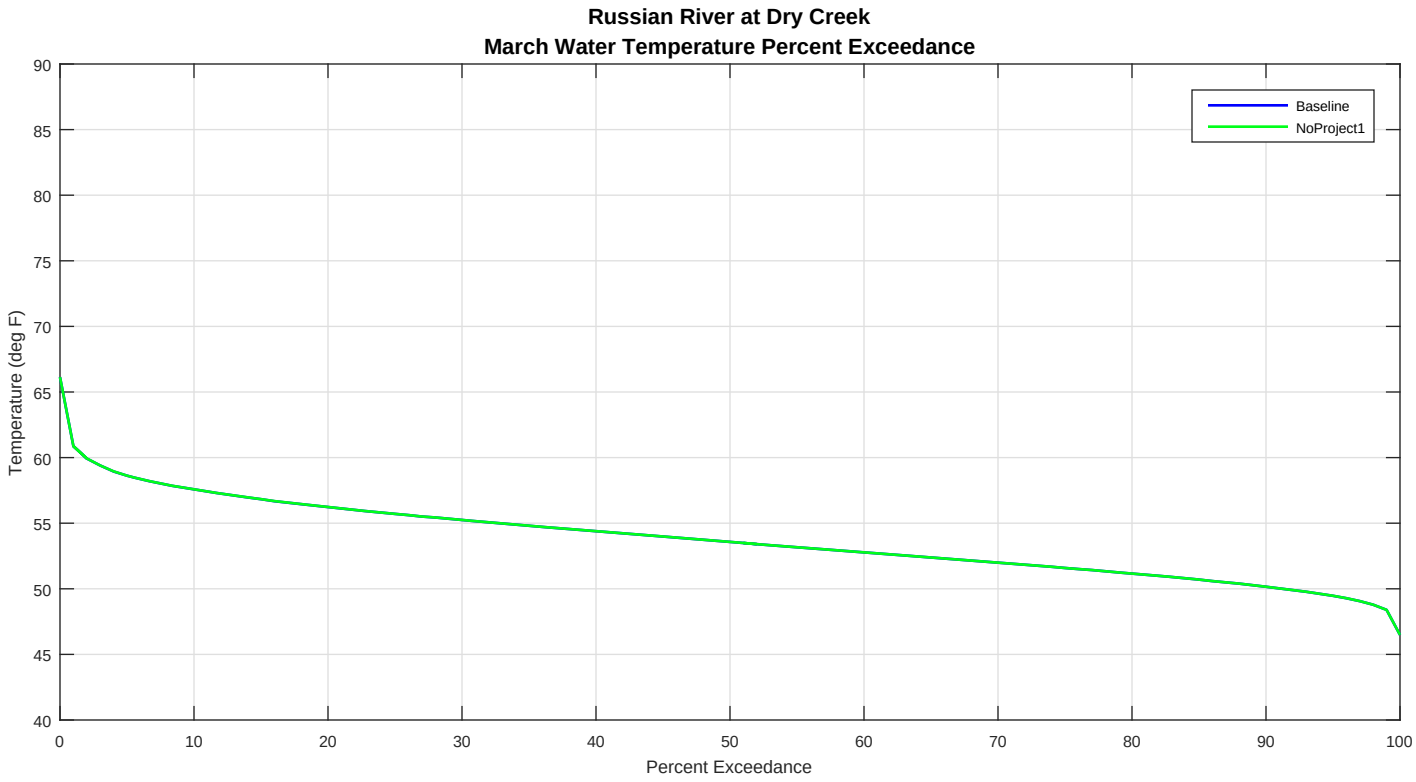
Russian River at Dry Creek
March Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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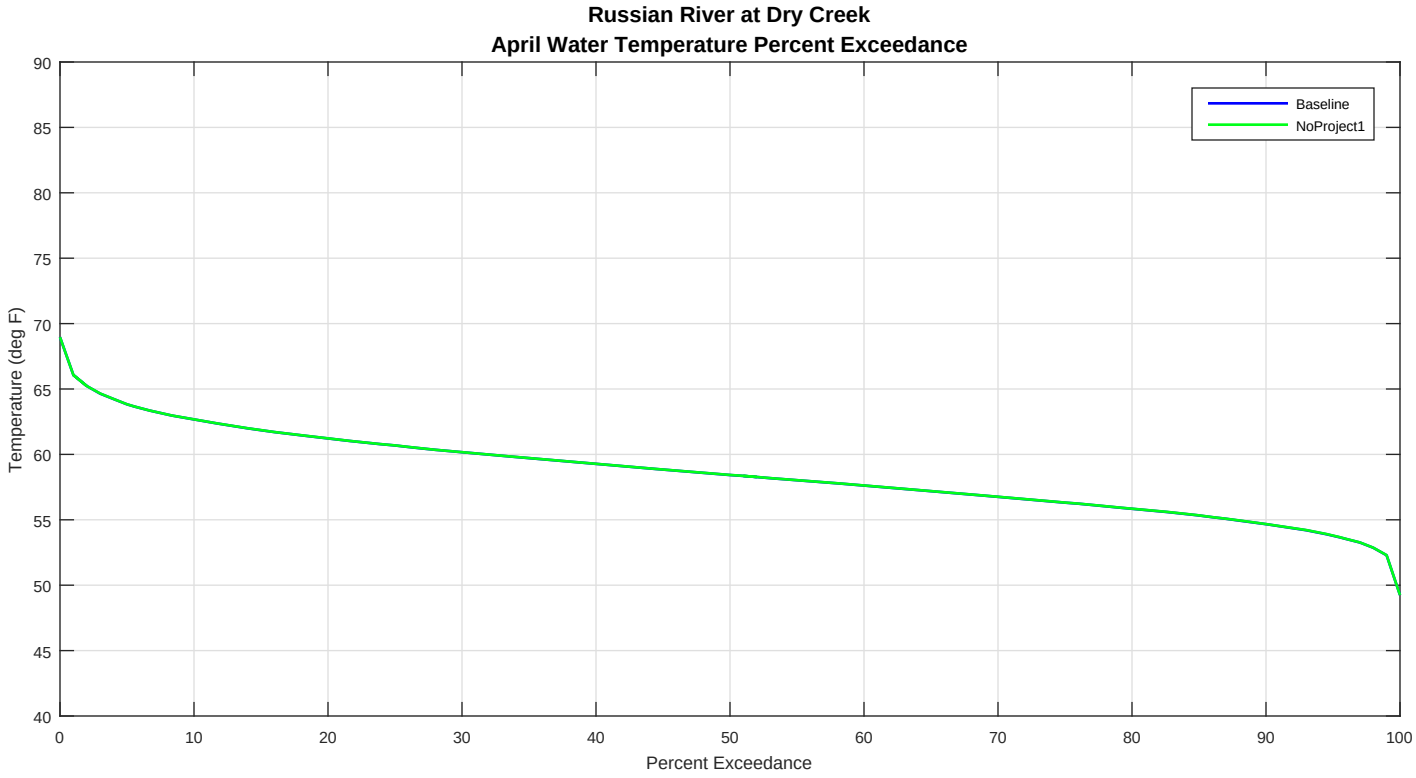
Russian River at Dry Creek
April Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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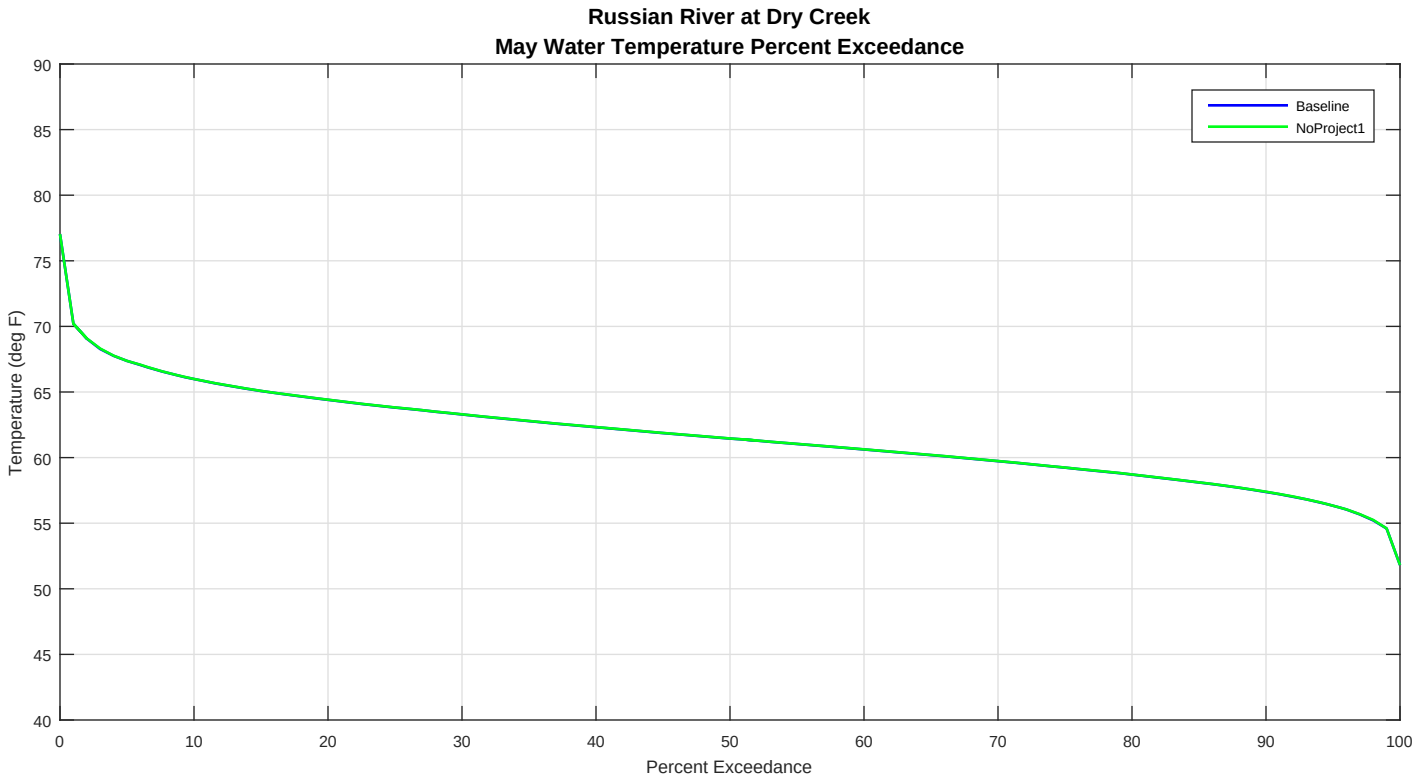
Russian River at Dry Creek
May Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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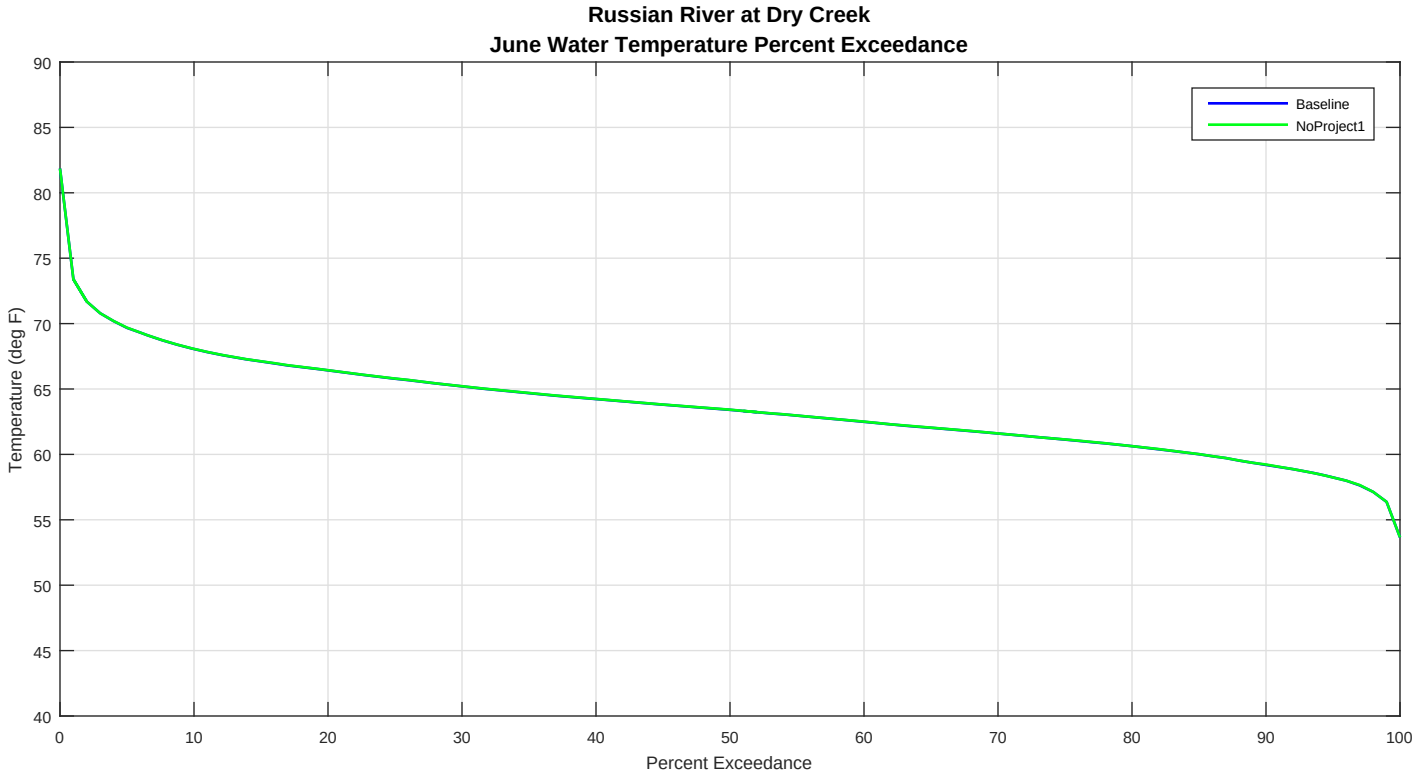
Russian River at Dry Creek
June Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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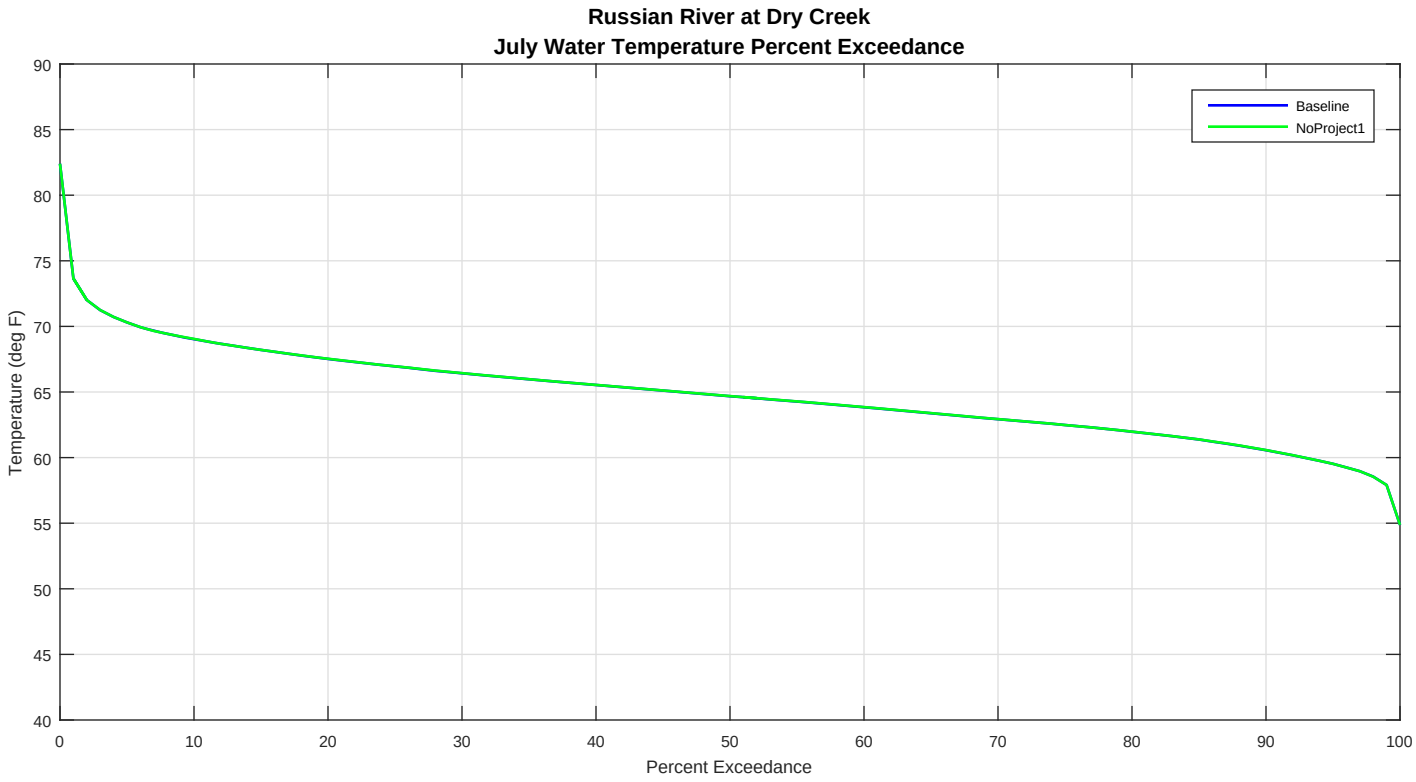
Russian River at Dry Creek
July Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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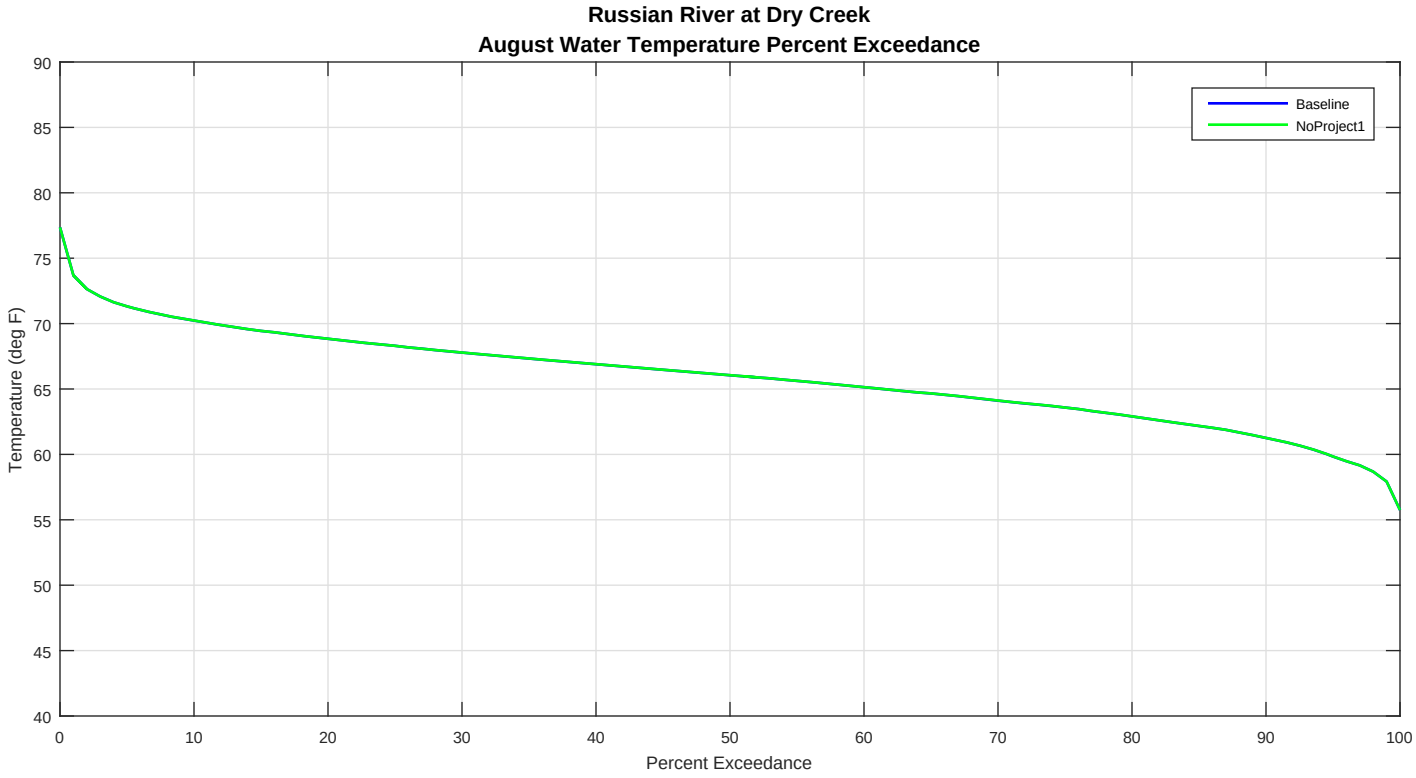
Russian River at Dry Creek
August Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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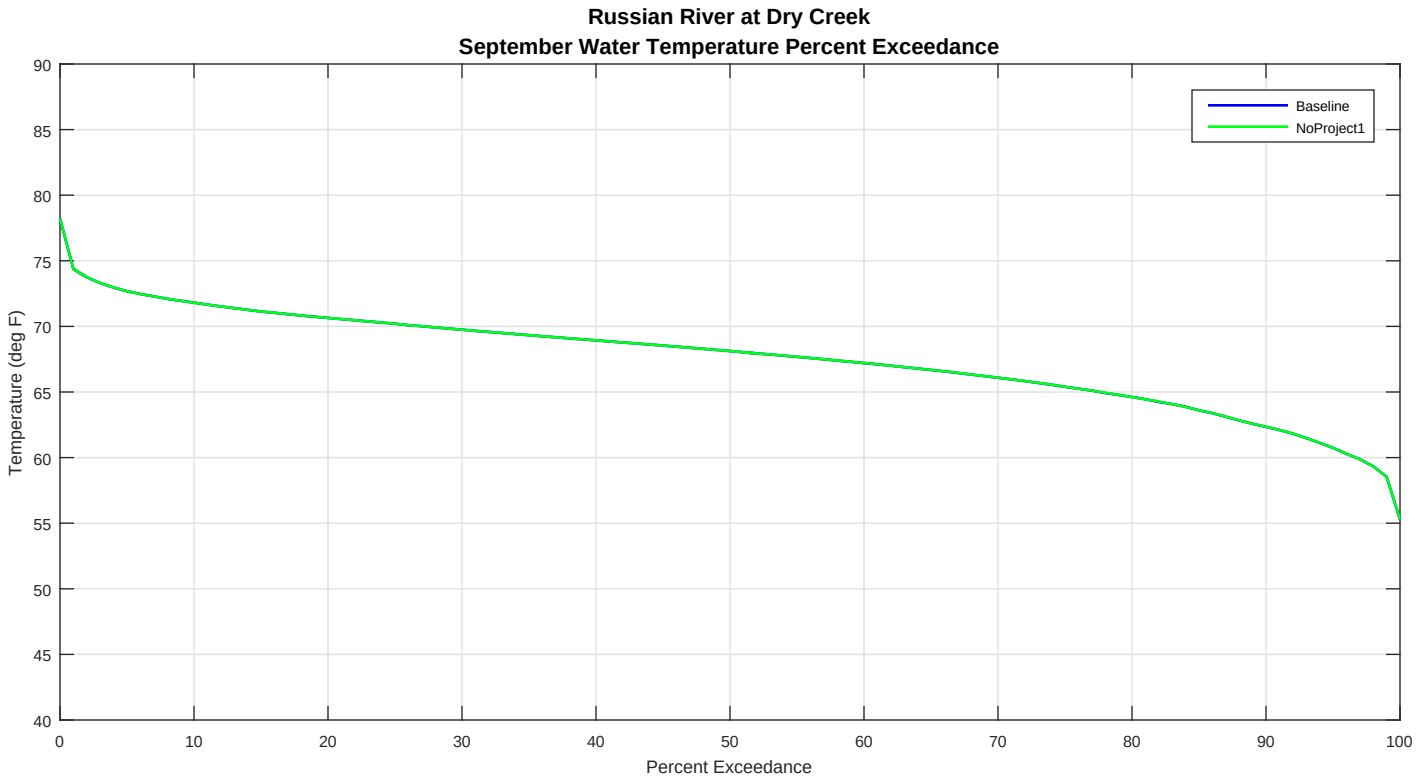
Russian River at Dry Creek
September Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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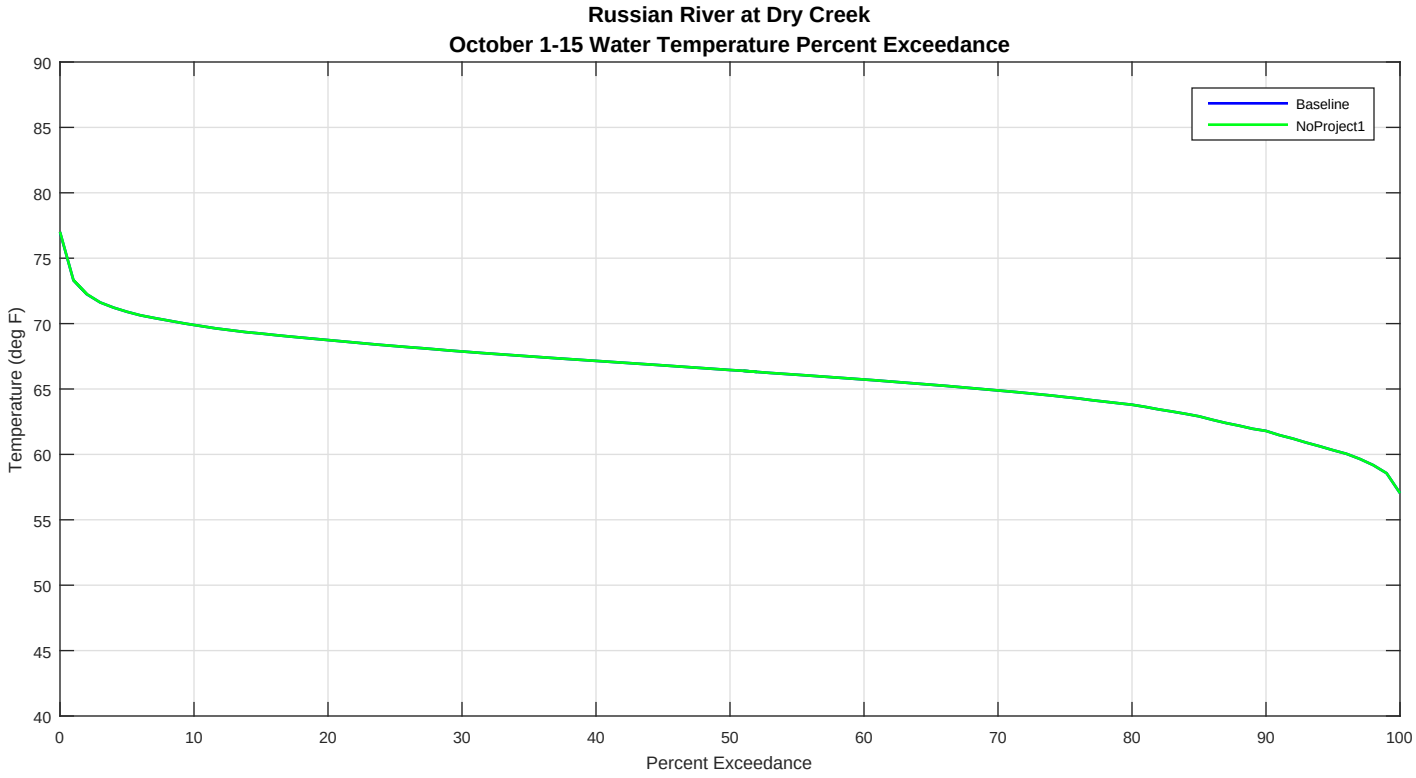
Russian River at Dry Creek
October 1-15 Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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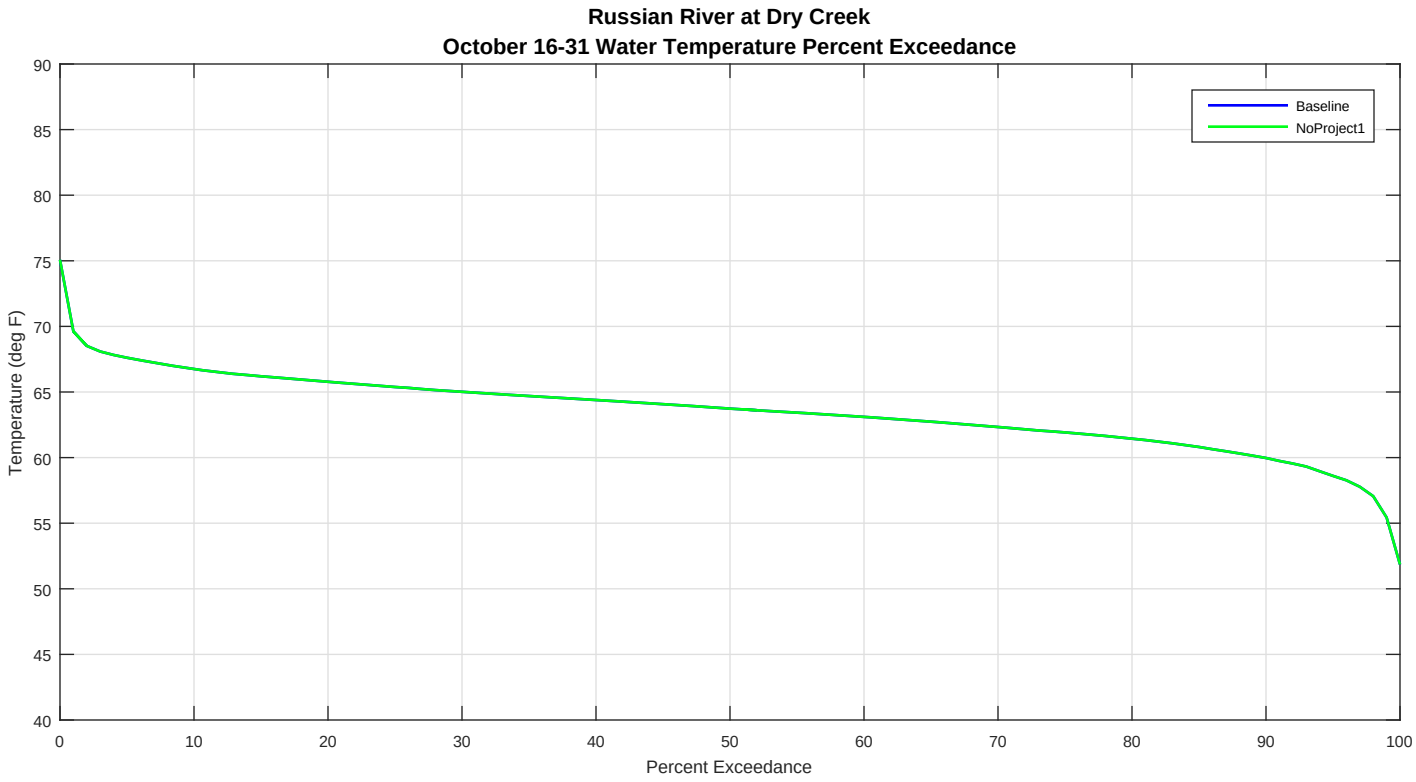
Russian River at Dry Creek
October 16-31 Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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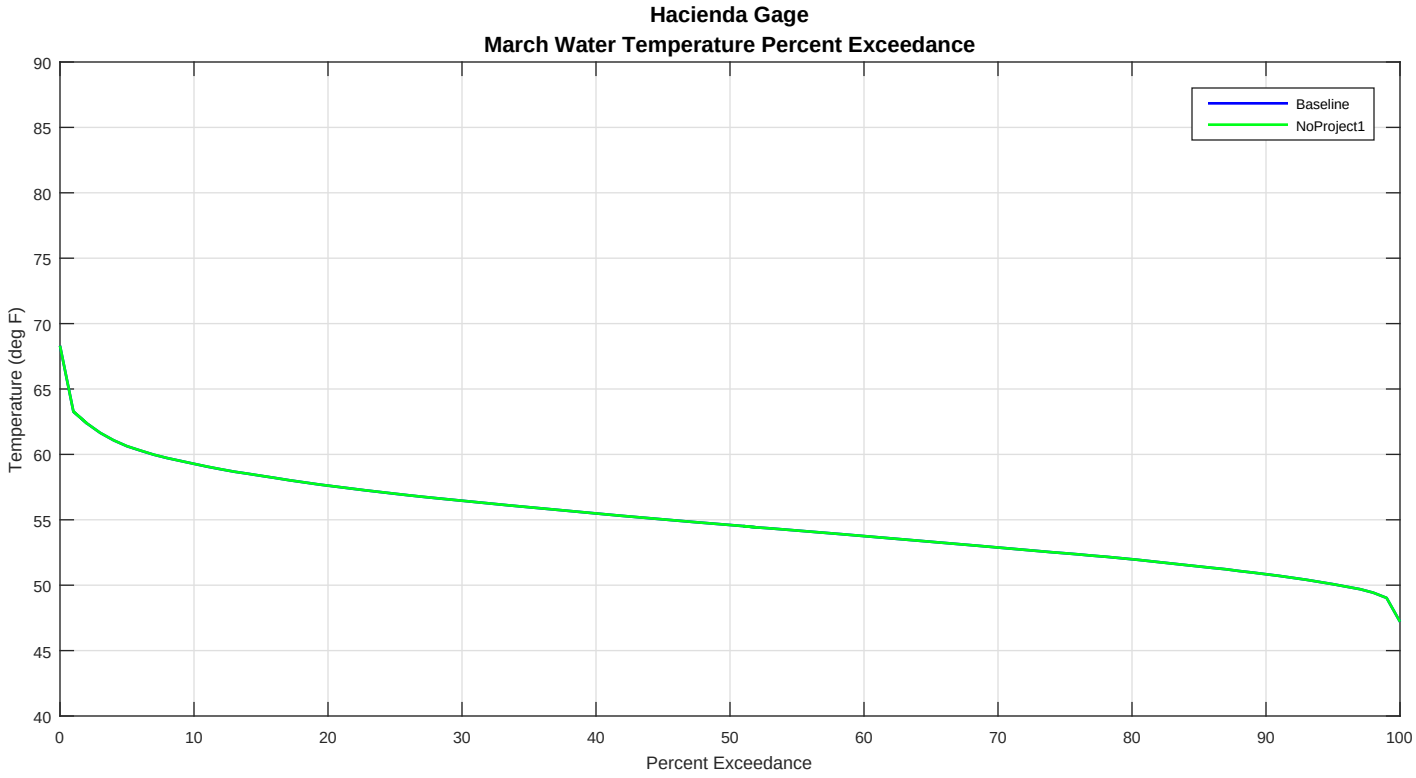
Hacienda Gage
March Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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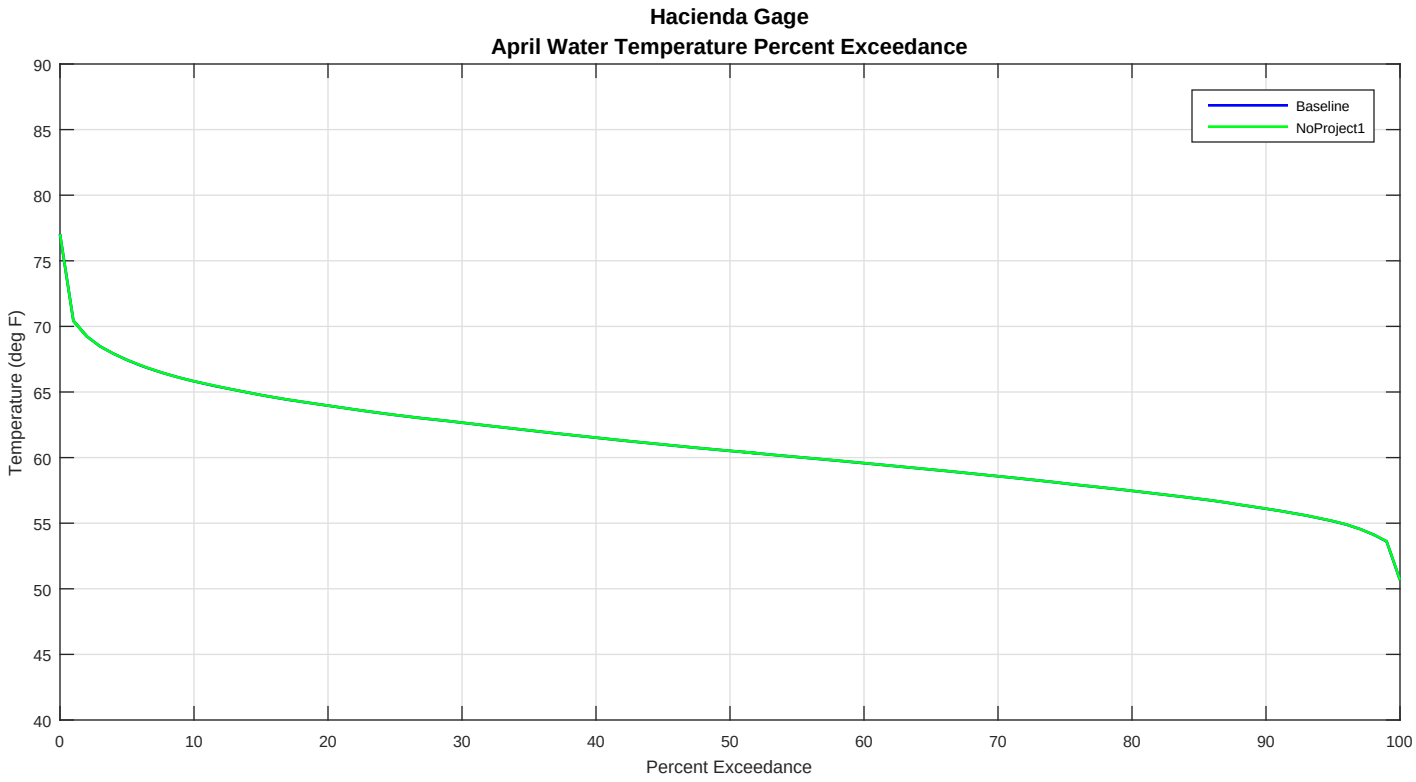
Hacienda Gage
April Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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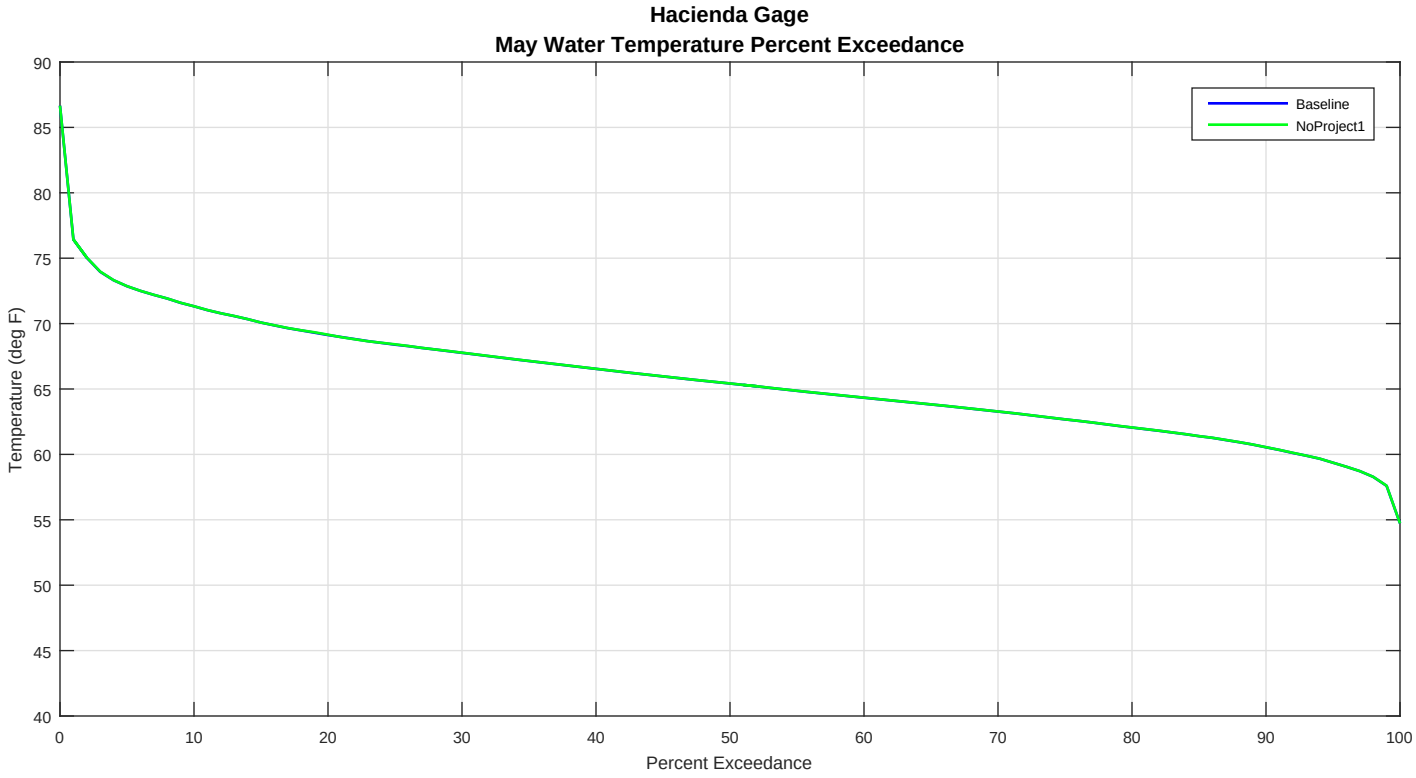
Hacienda Gage
May Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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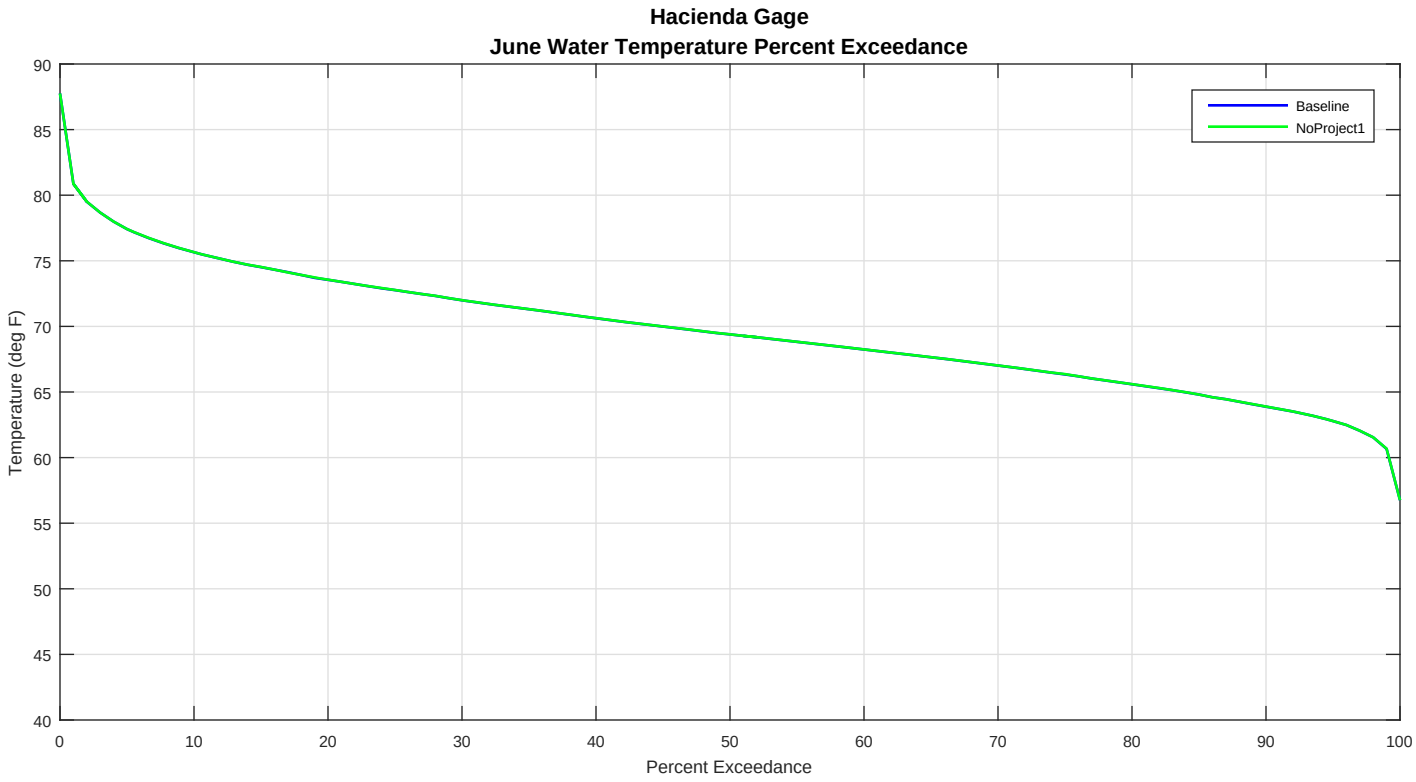
Hacienda Gage
June Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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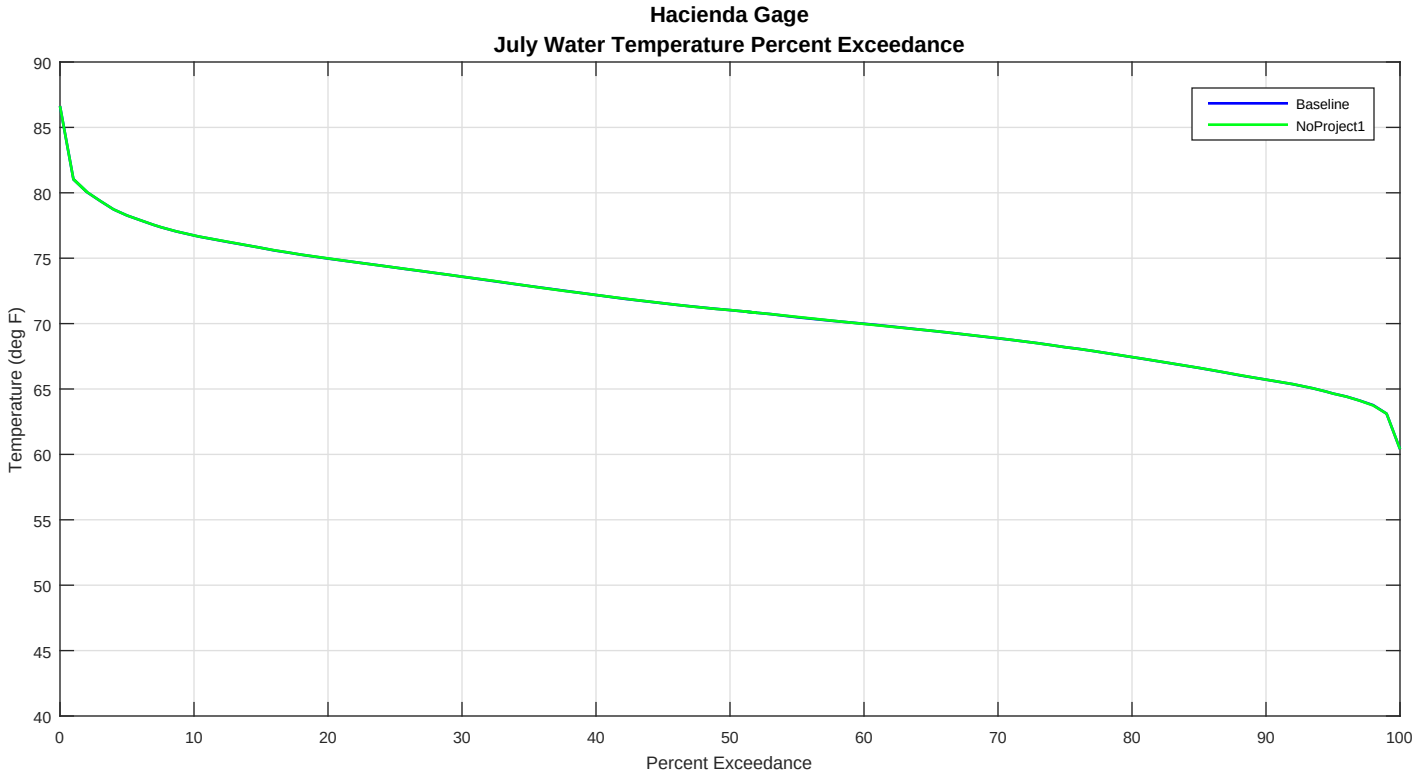
Hacienda Gage
July Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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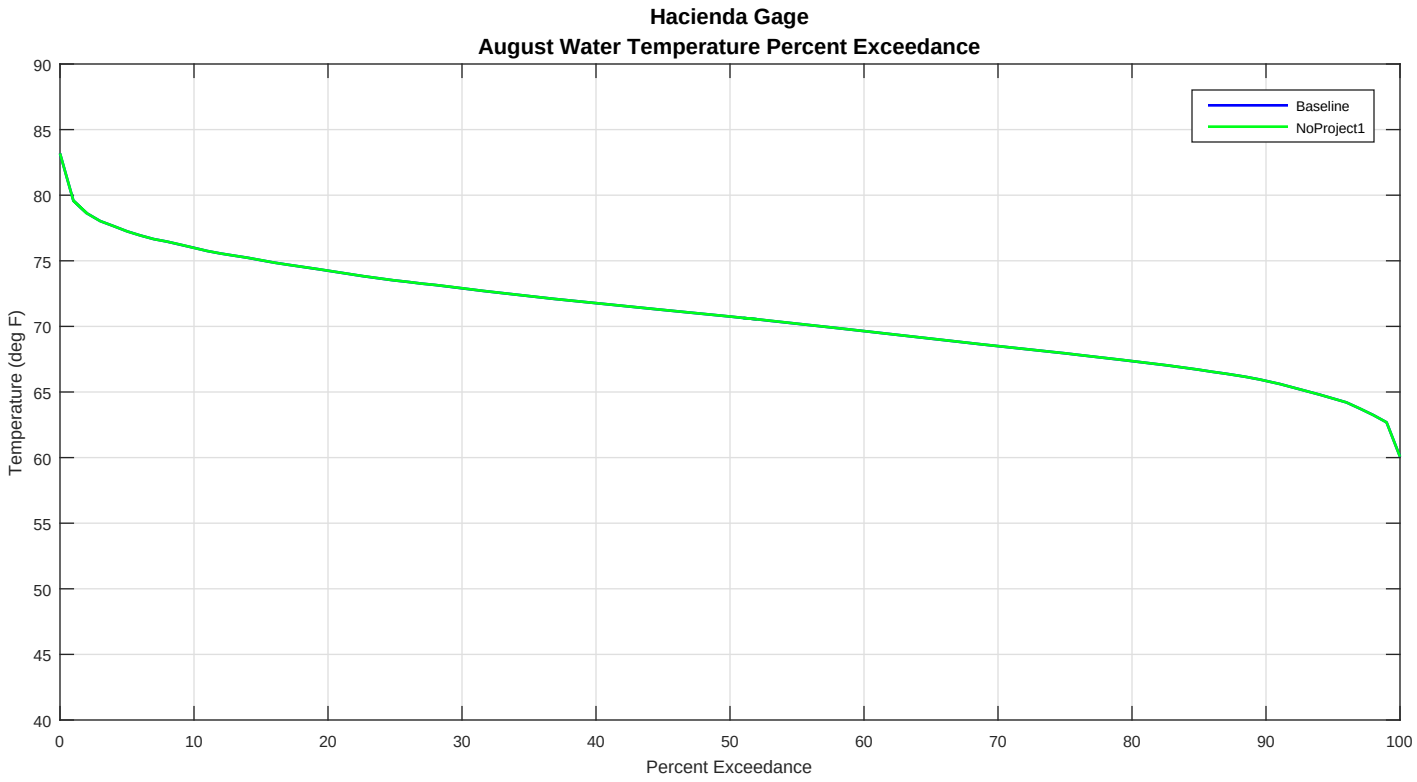
Hacienda Gage
August Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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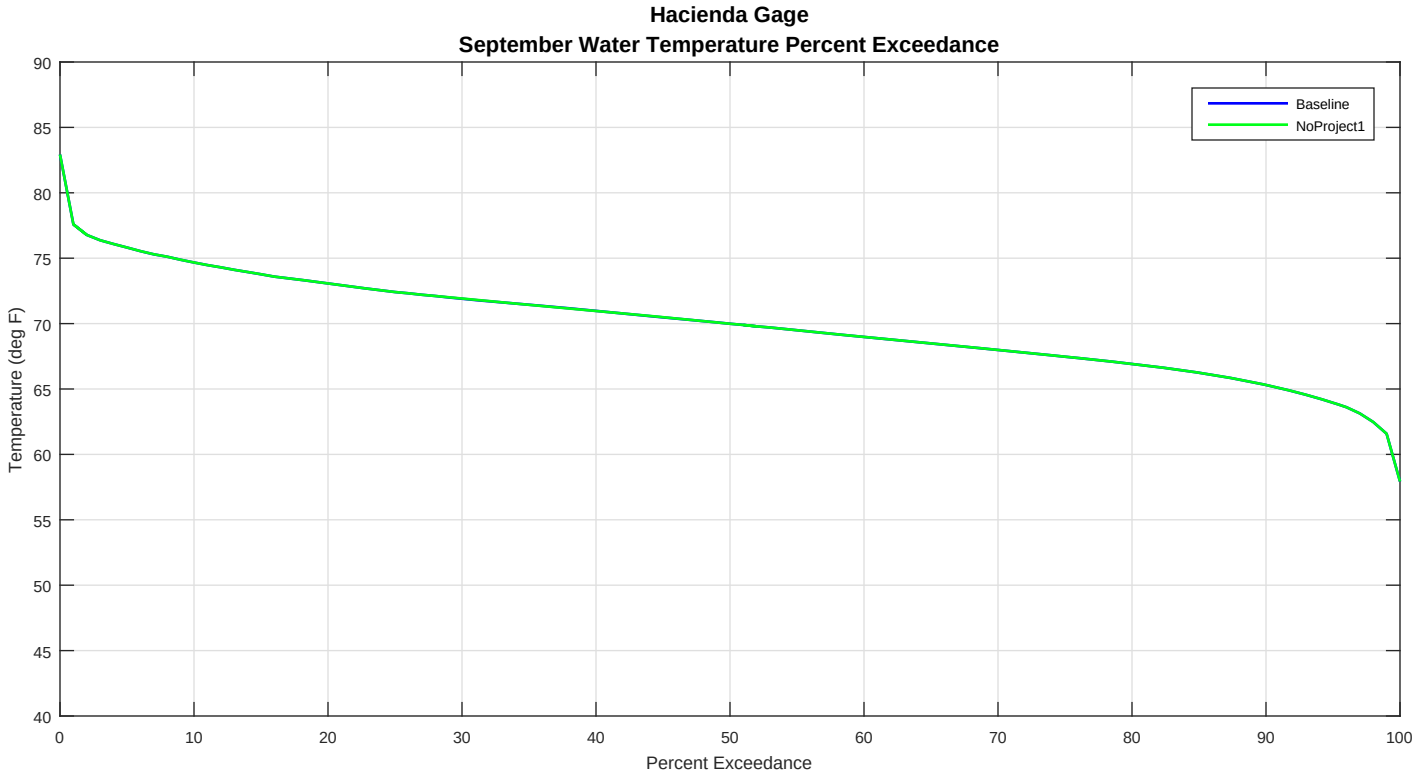
Hacienda Gage
September Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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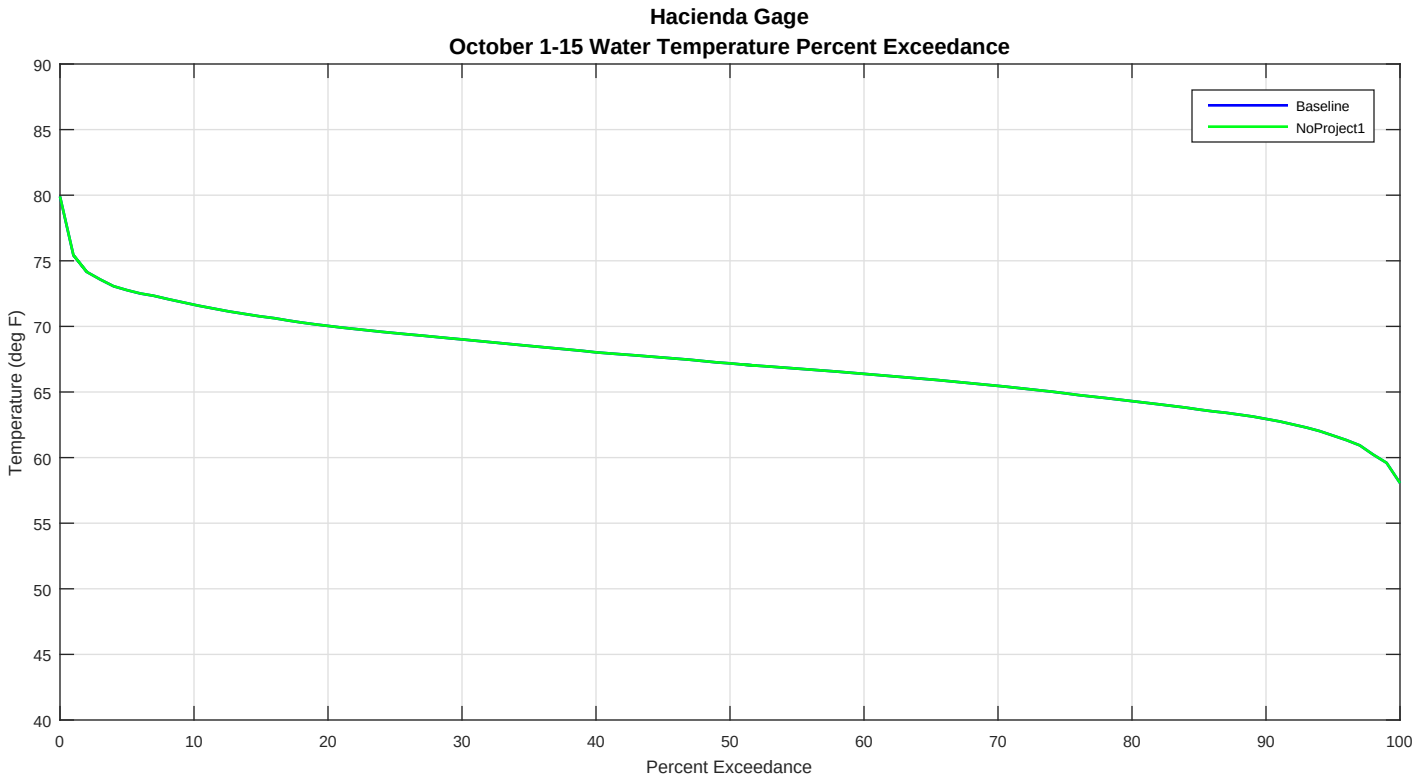
Hacienda Gage
October 1-15 Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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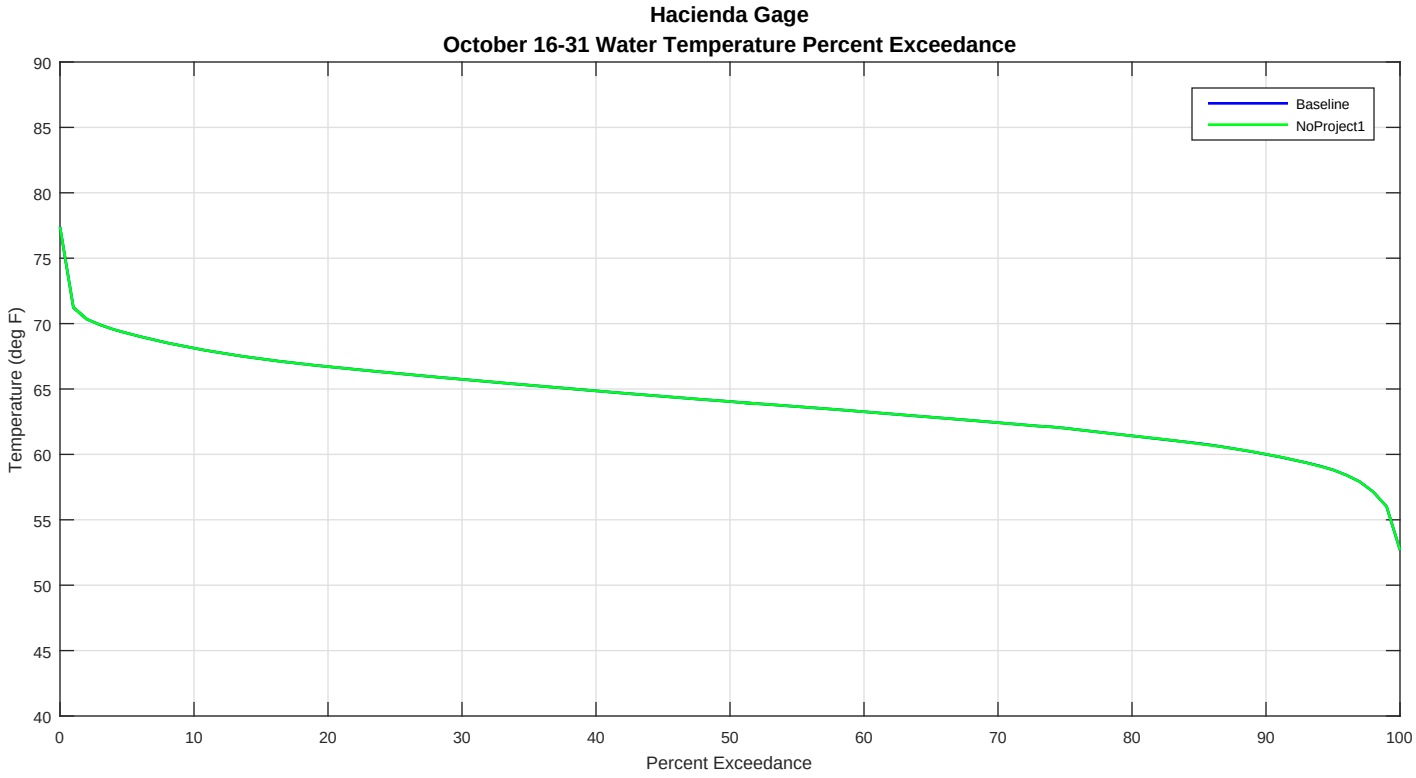
Hacienda Gage
October 16-31 Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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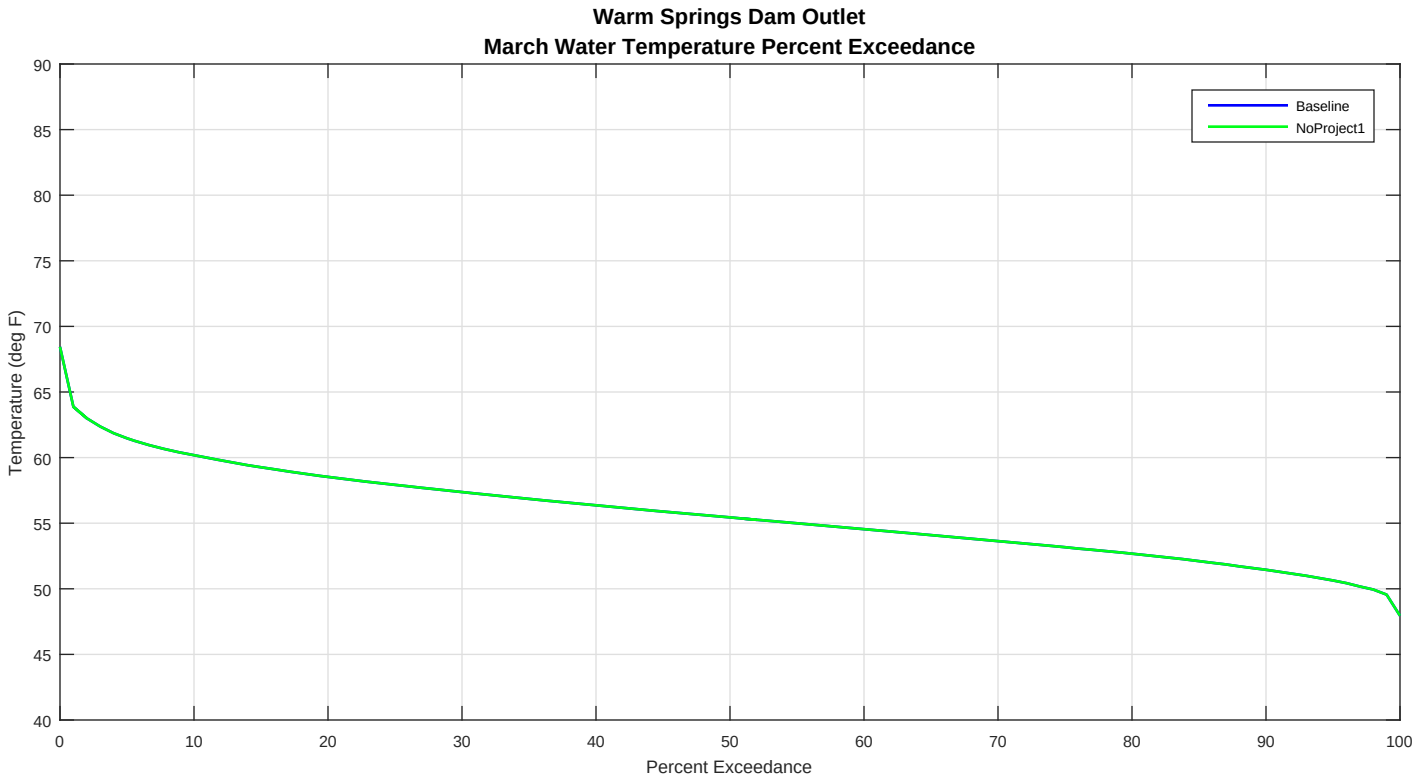
Warm Springs Dam Outlet
March Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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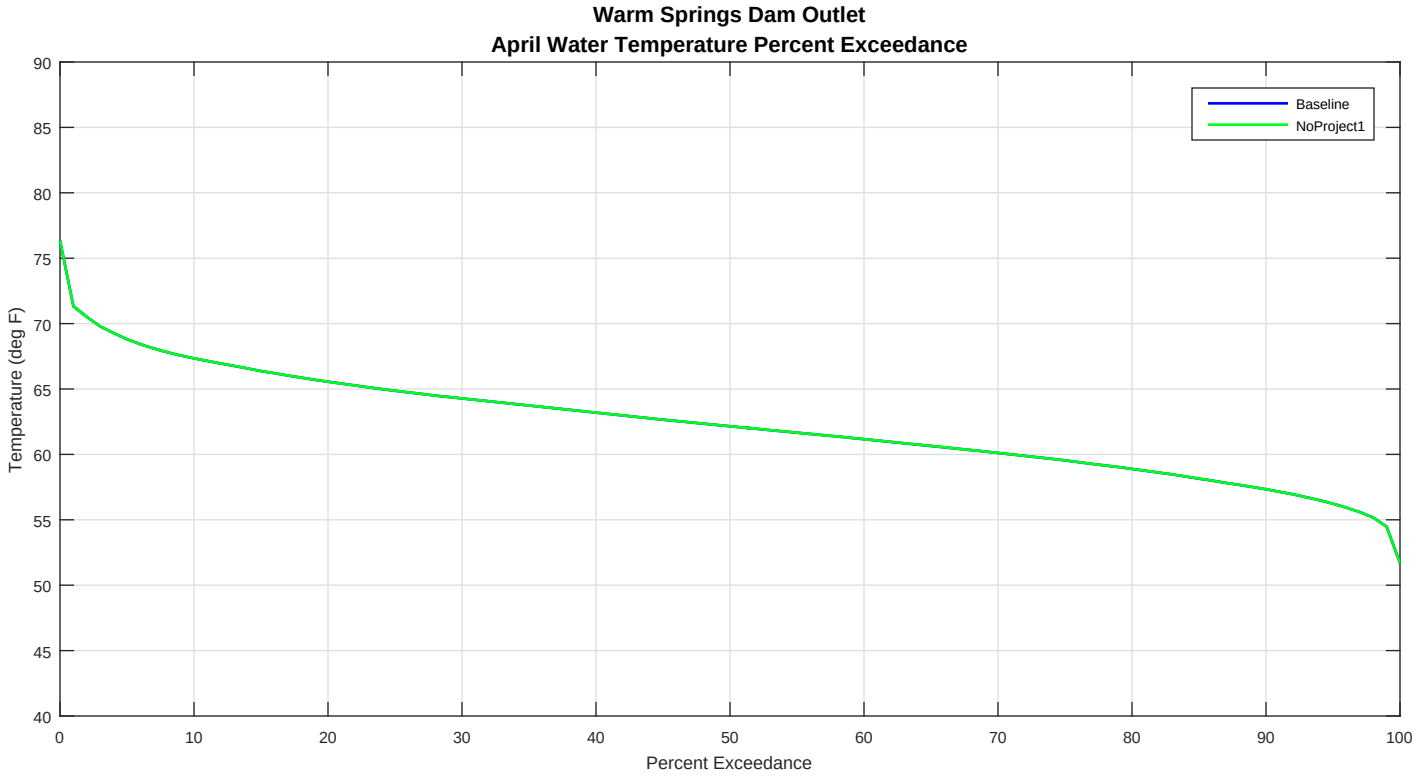
Warm Springs Dam Outlet
April Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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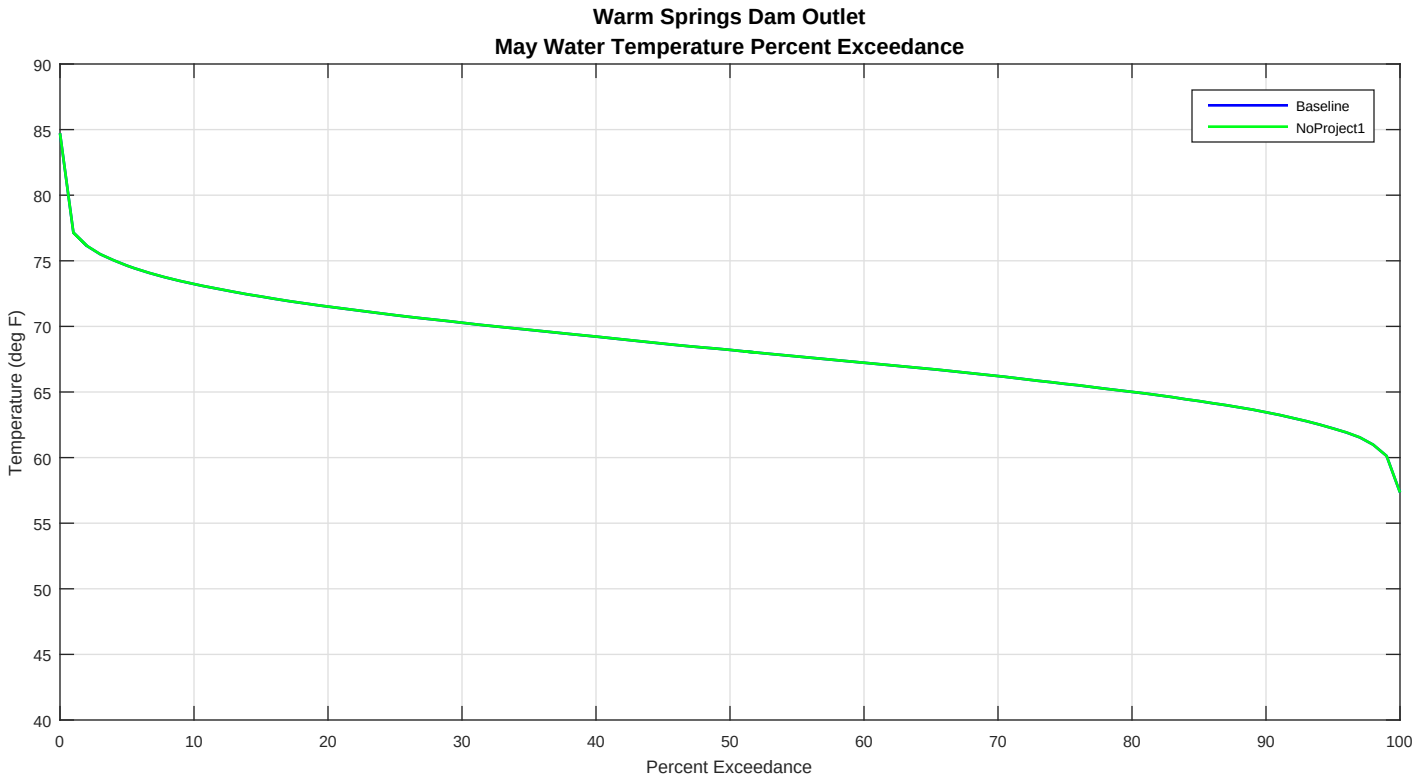
Warm Springs Dam Outlet
May Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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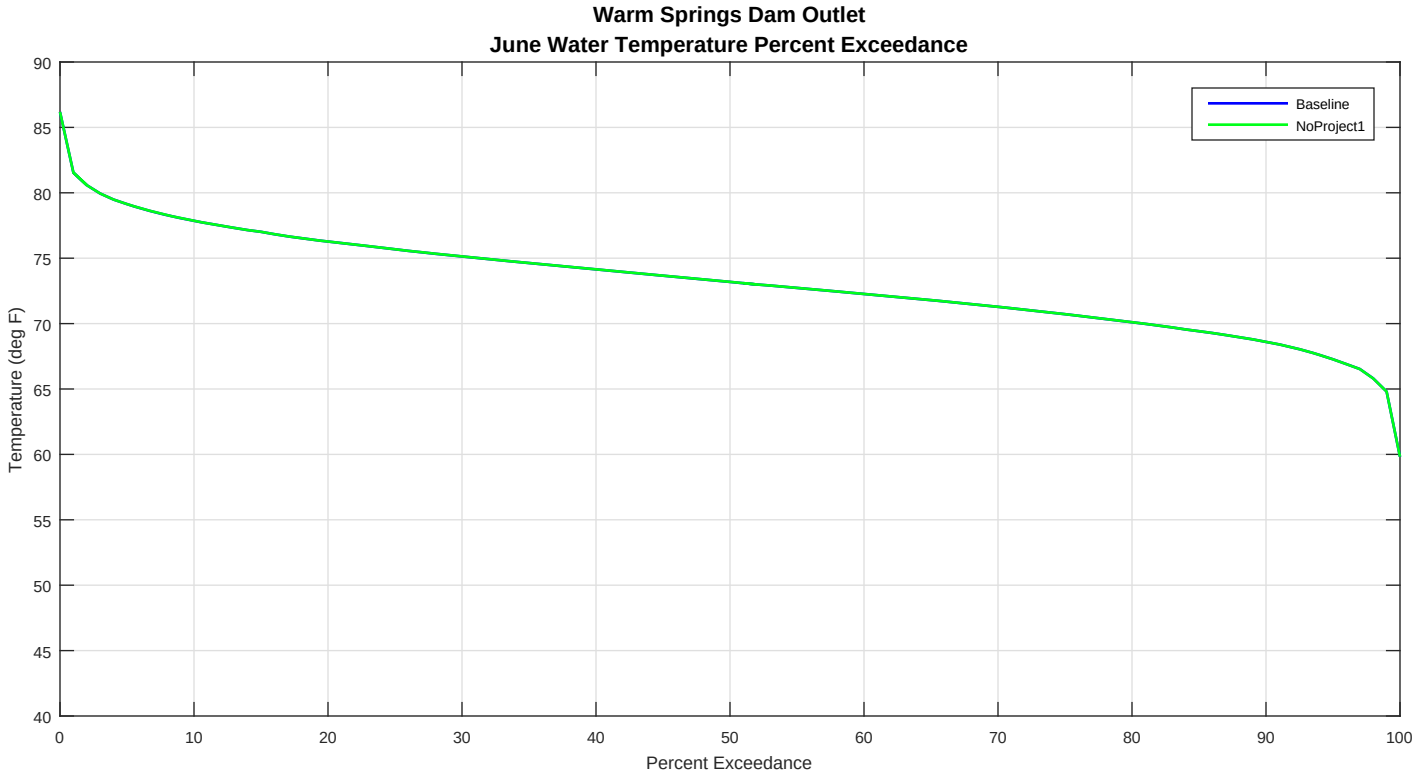
Warm Springs Dam Outlet
June Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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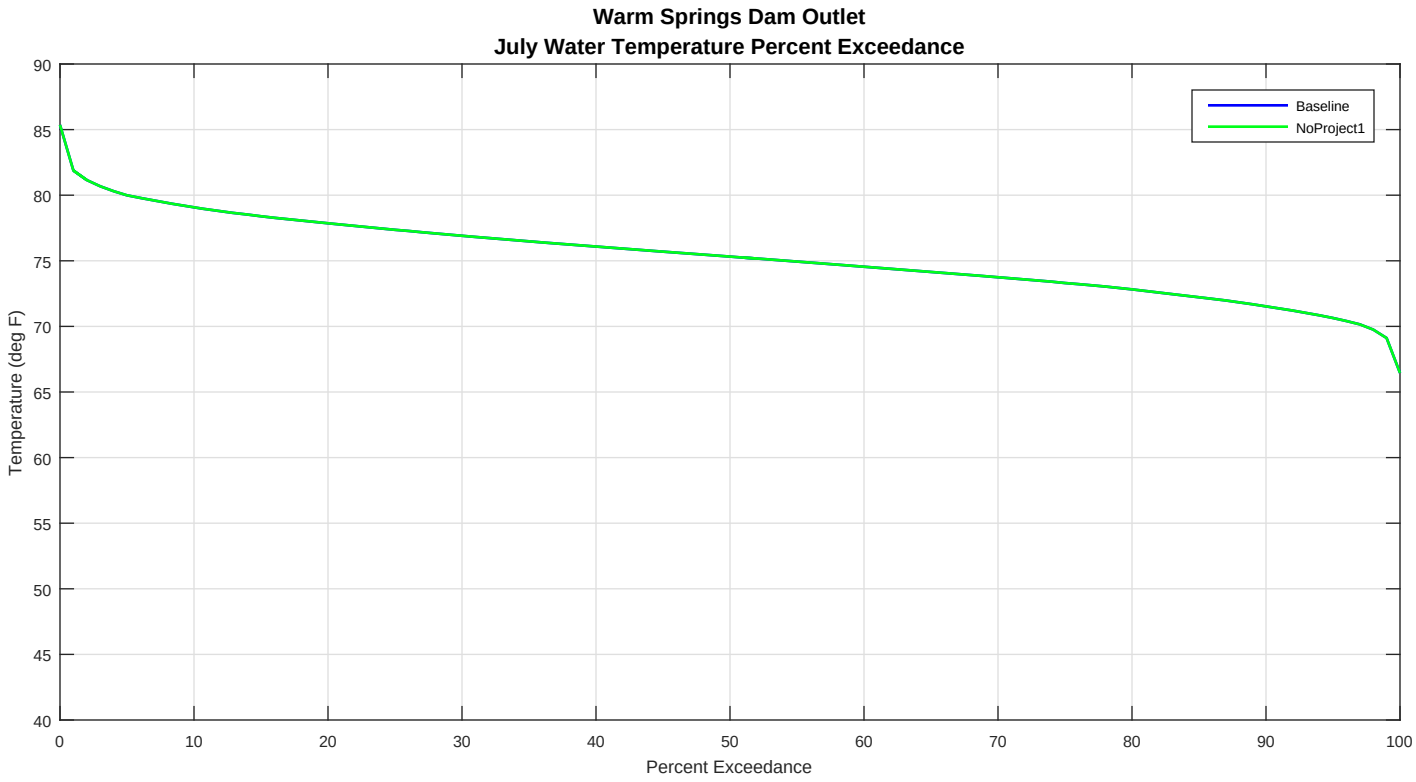
Warm Springs Dam Outlet
July Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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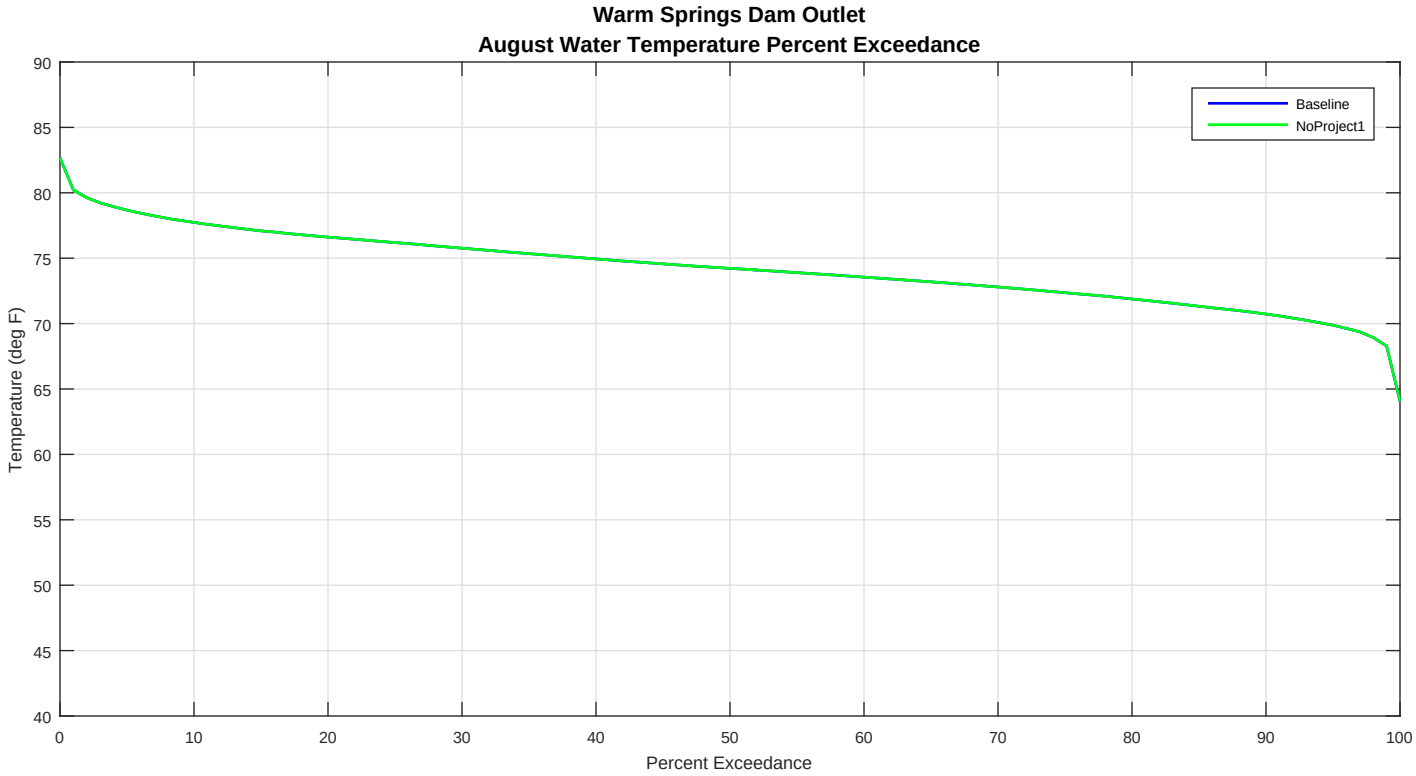
Warm Springs Dam Outlet
August Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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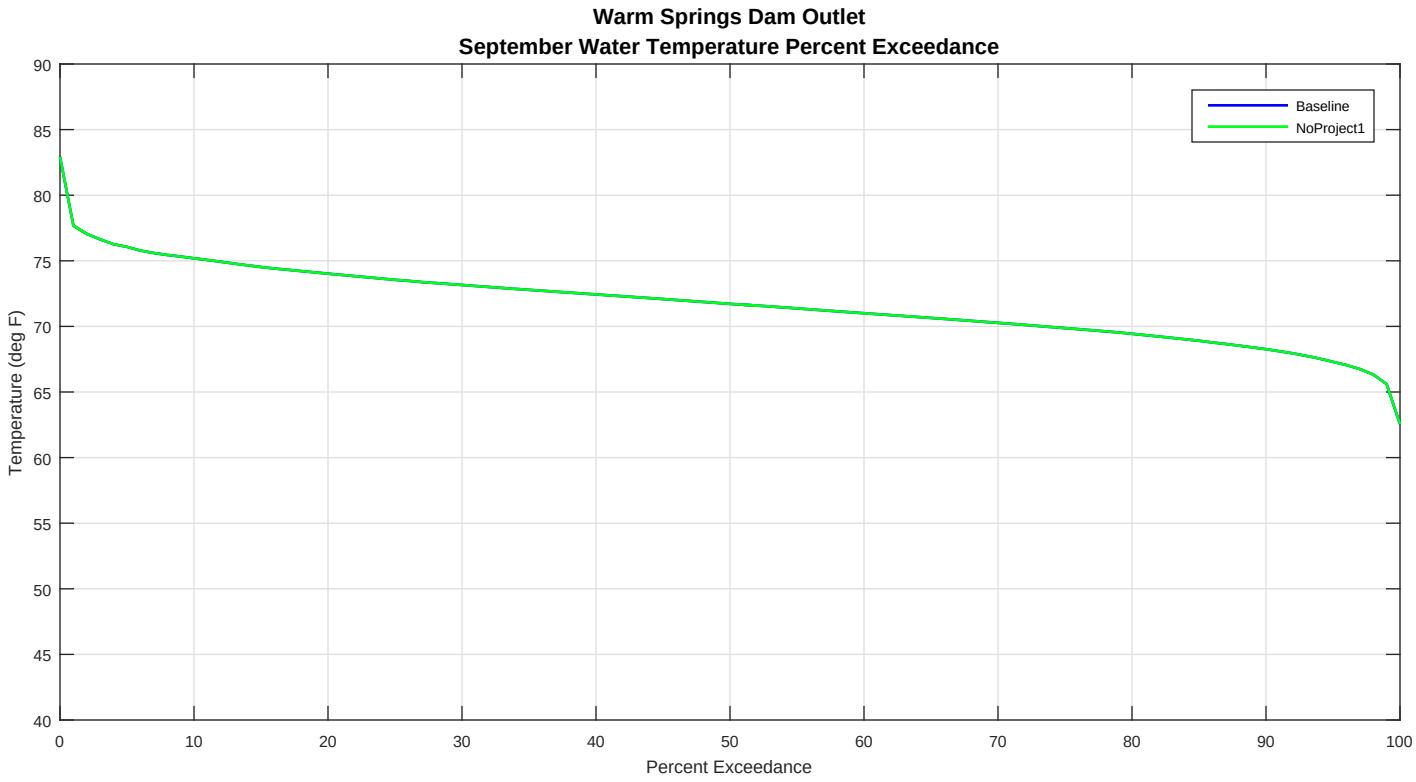
Warm Springs Dam Outlet
September Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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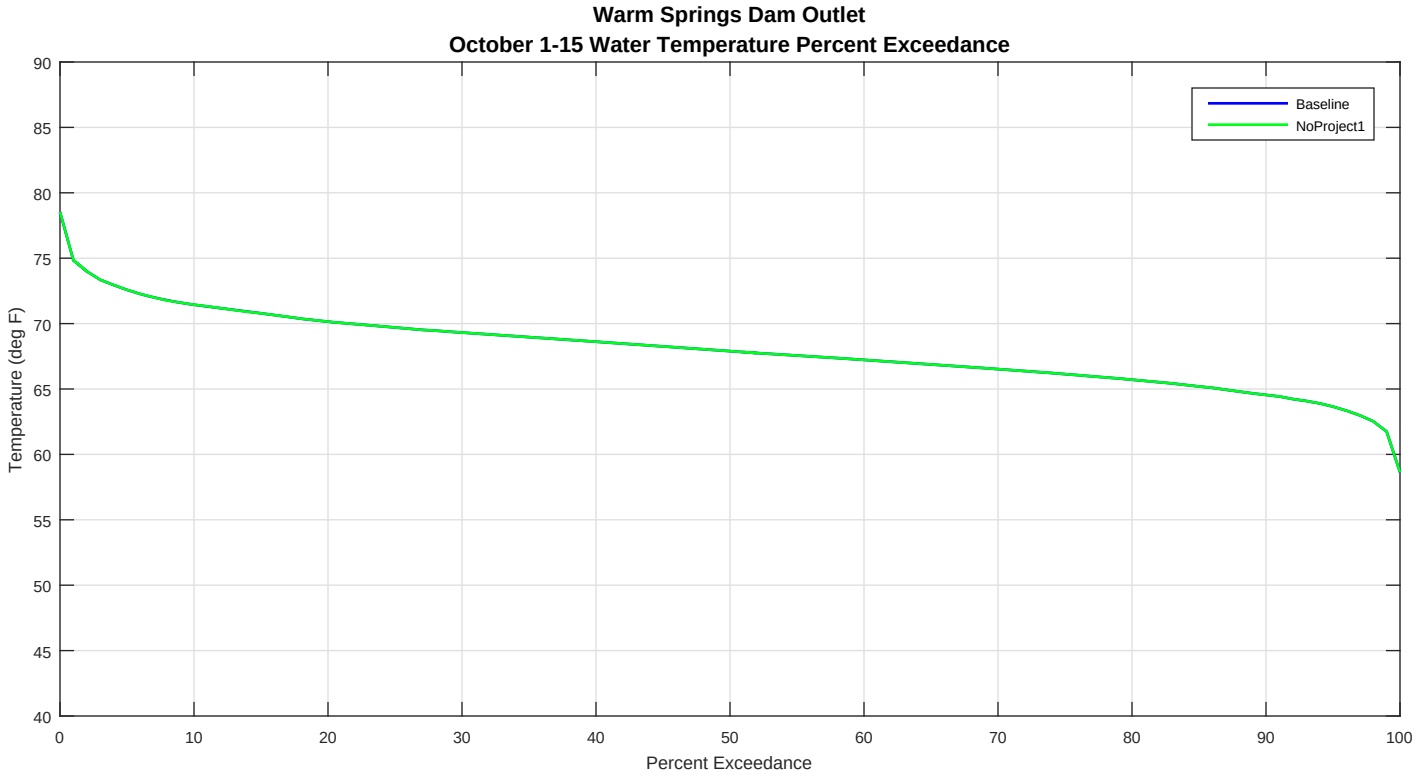
Warm Springs Dam Outlet
October 1-15 Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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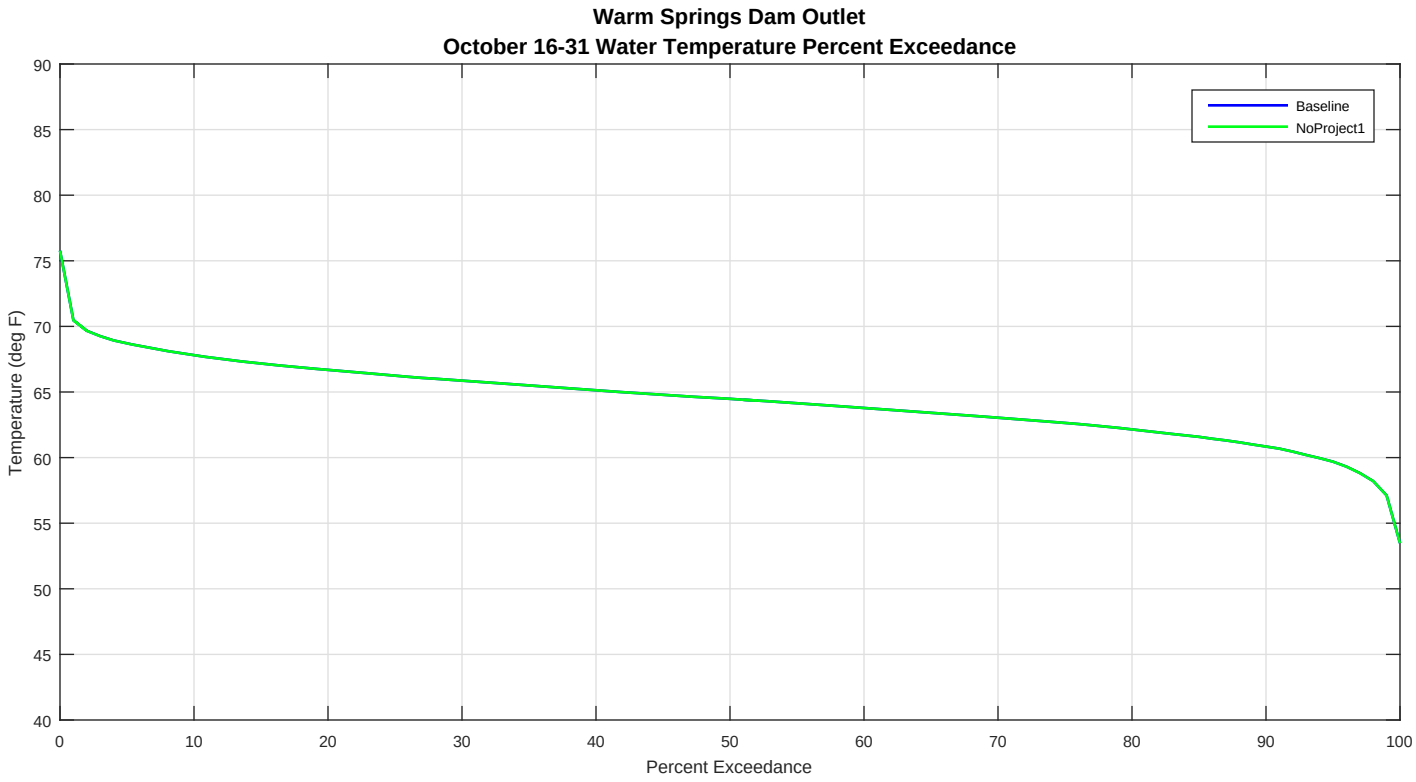
Warm Springs Dam Outlet
October 16-31 Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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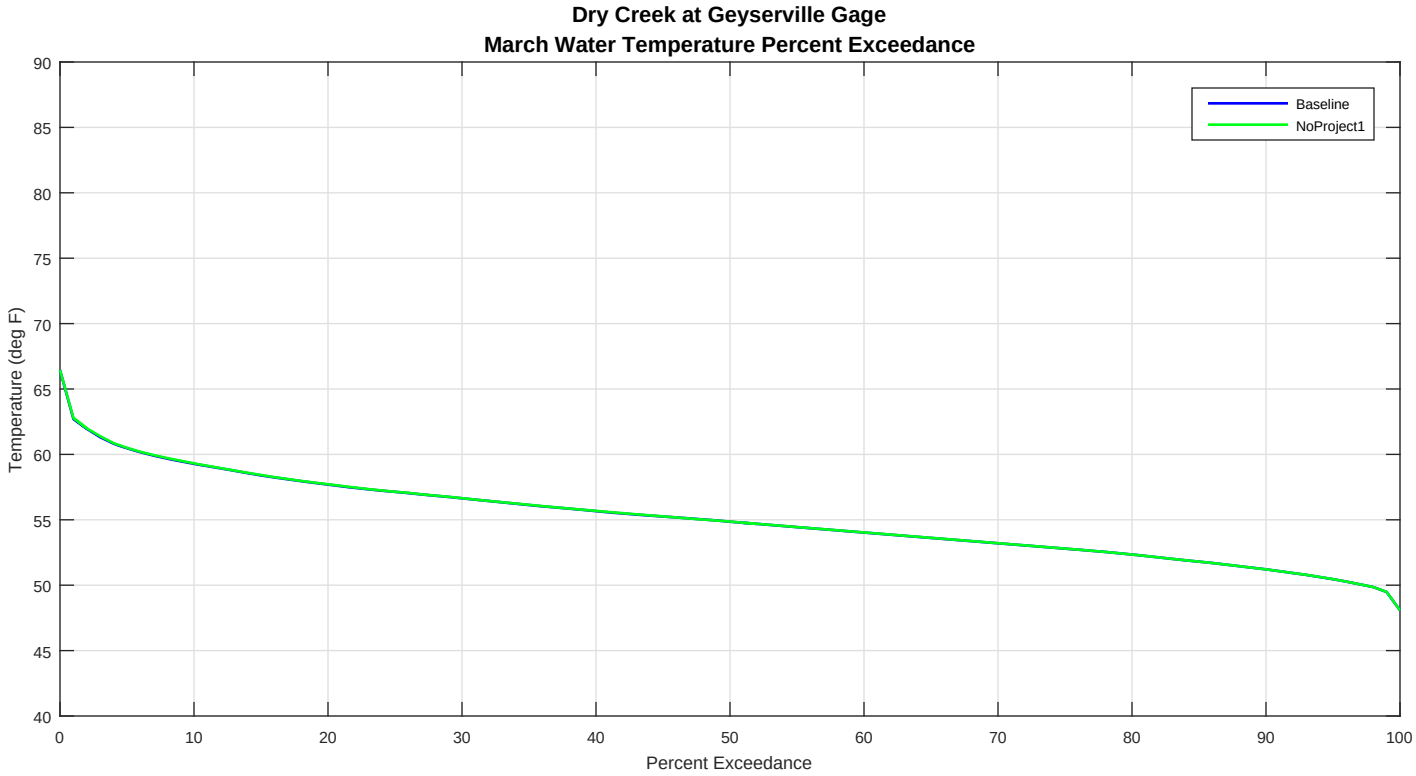
Dry Creek at Geyserville Gage
March Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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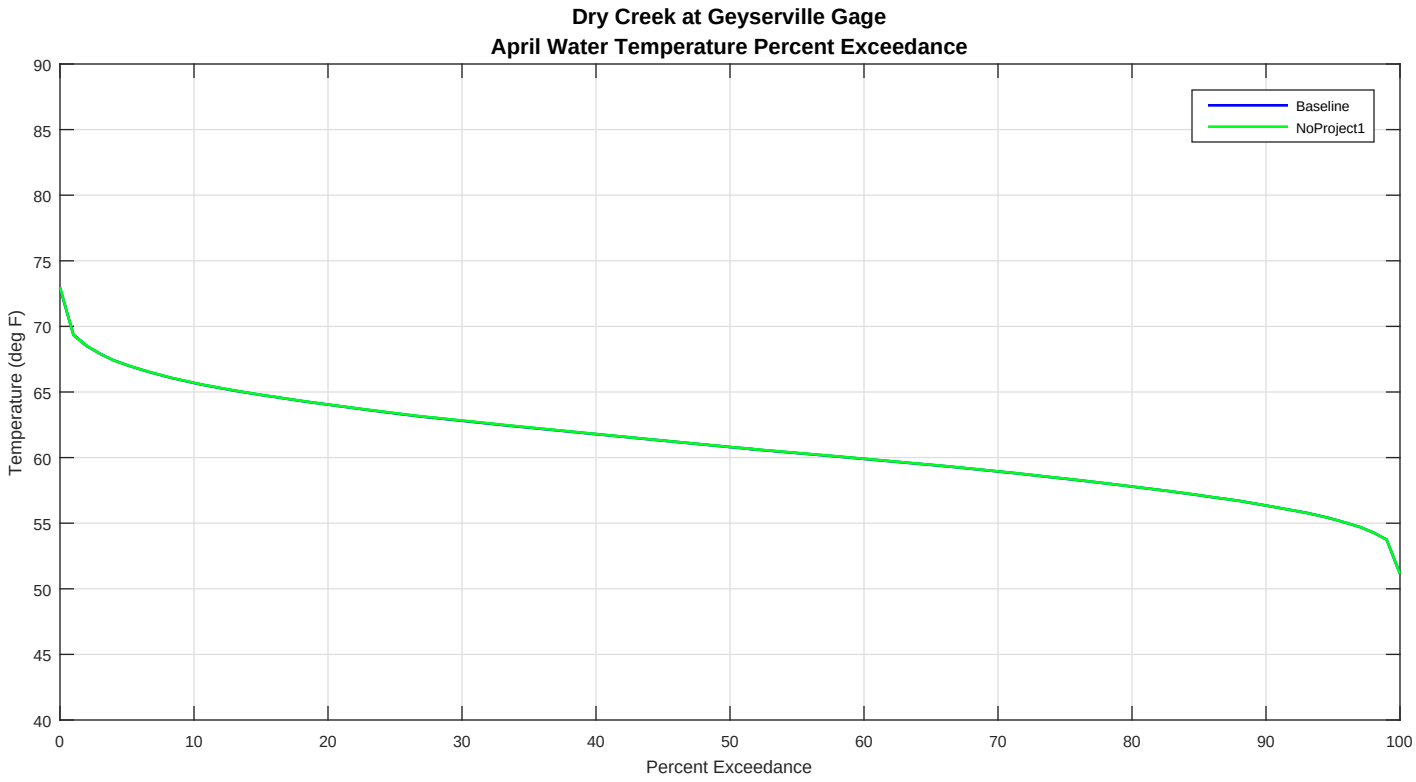
Dry Creek at Geyserville Gage
April Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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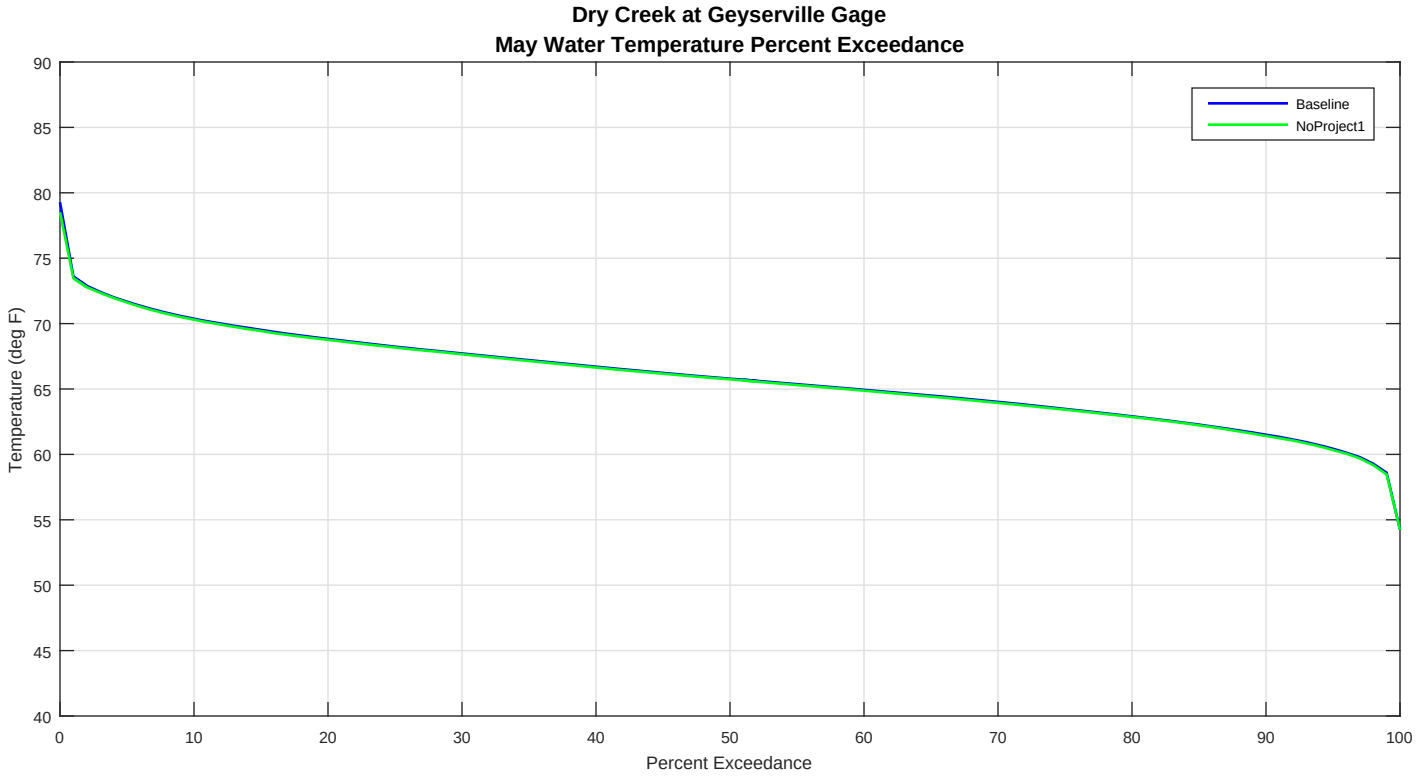
Dry Creek at Geyserville Gage
May Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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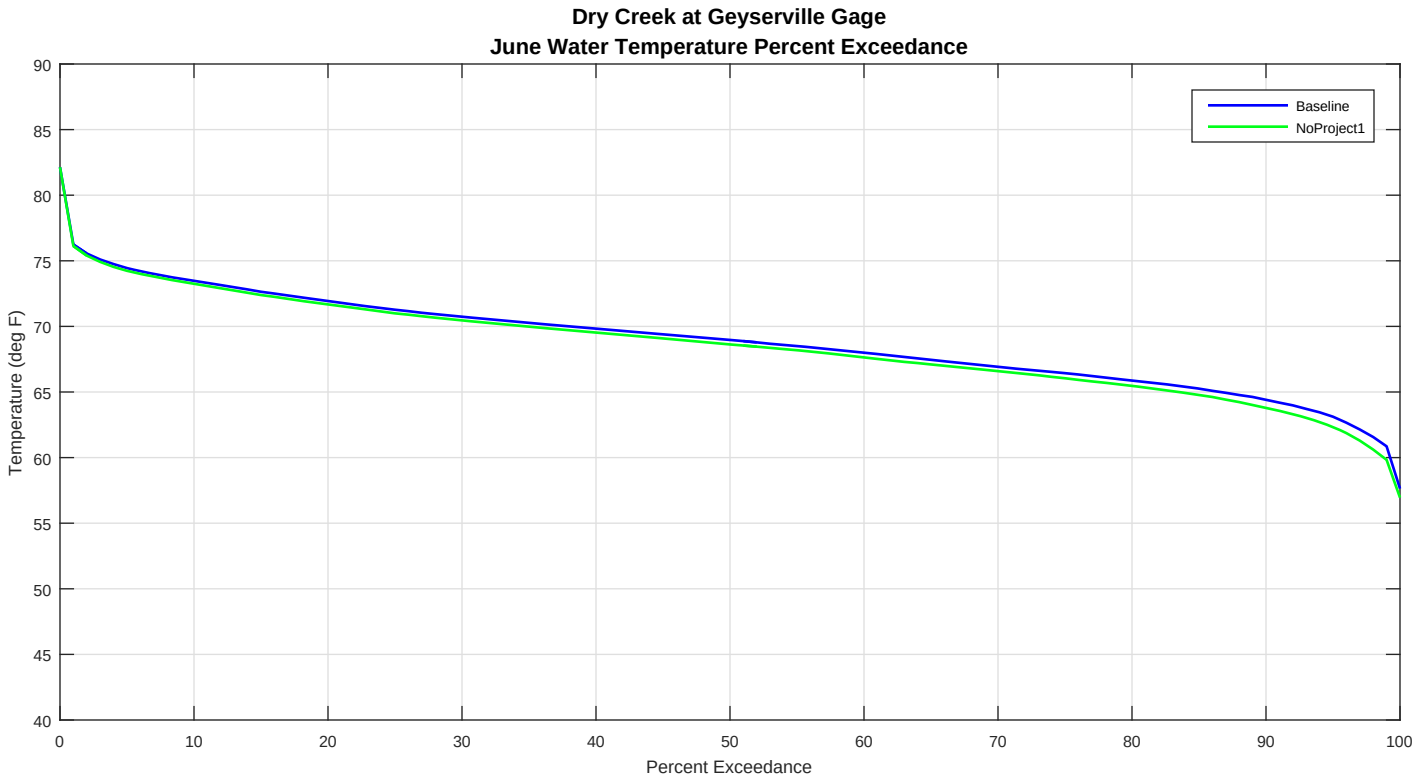
Dry Creek at Geyserville Gage
June Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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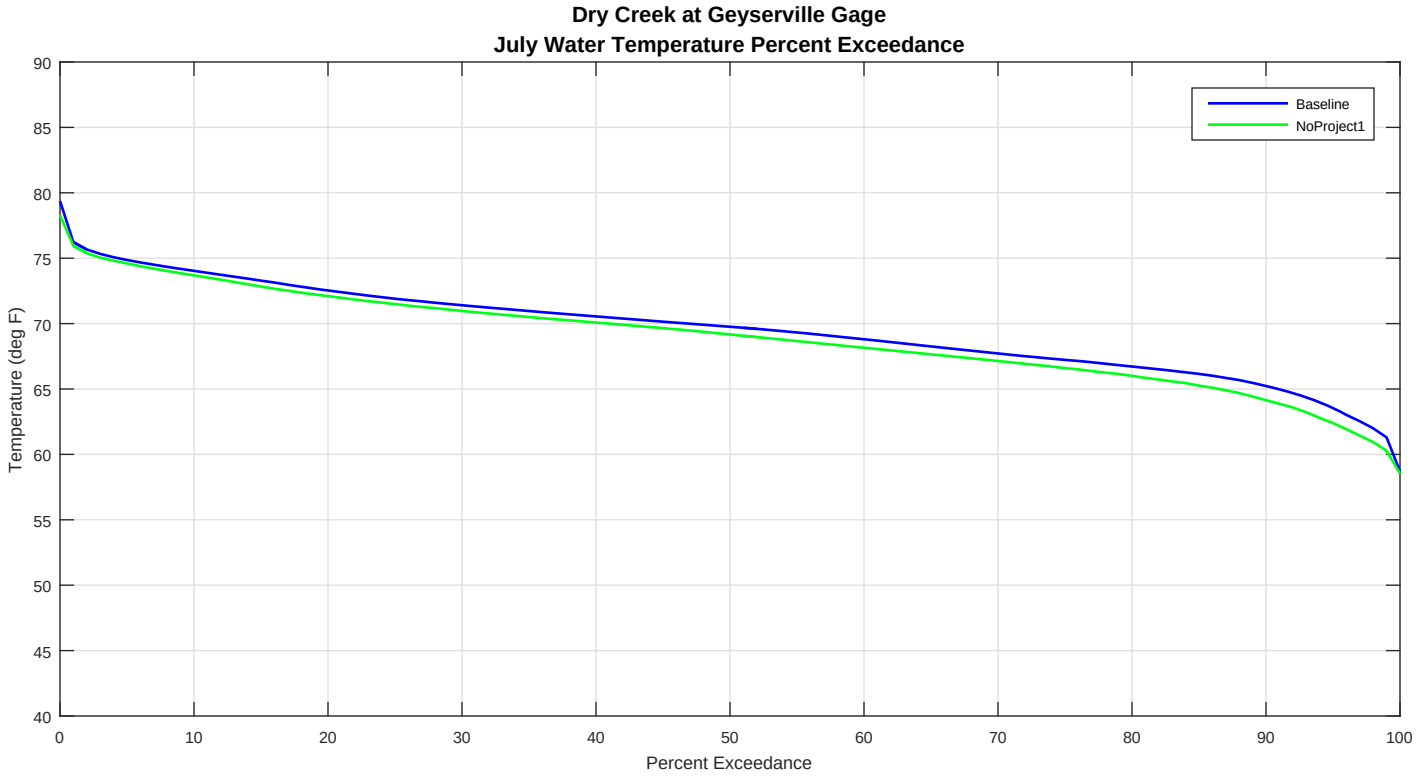
Dry Creek at Geyserville Gage
July Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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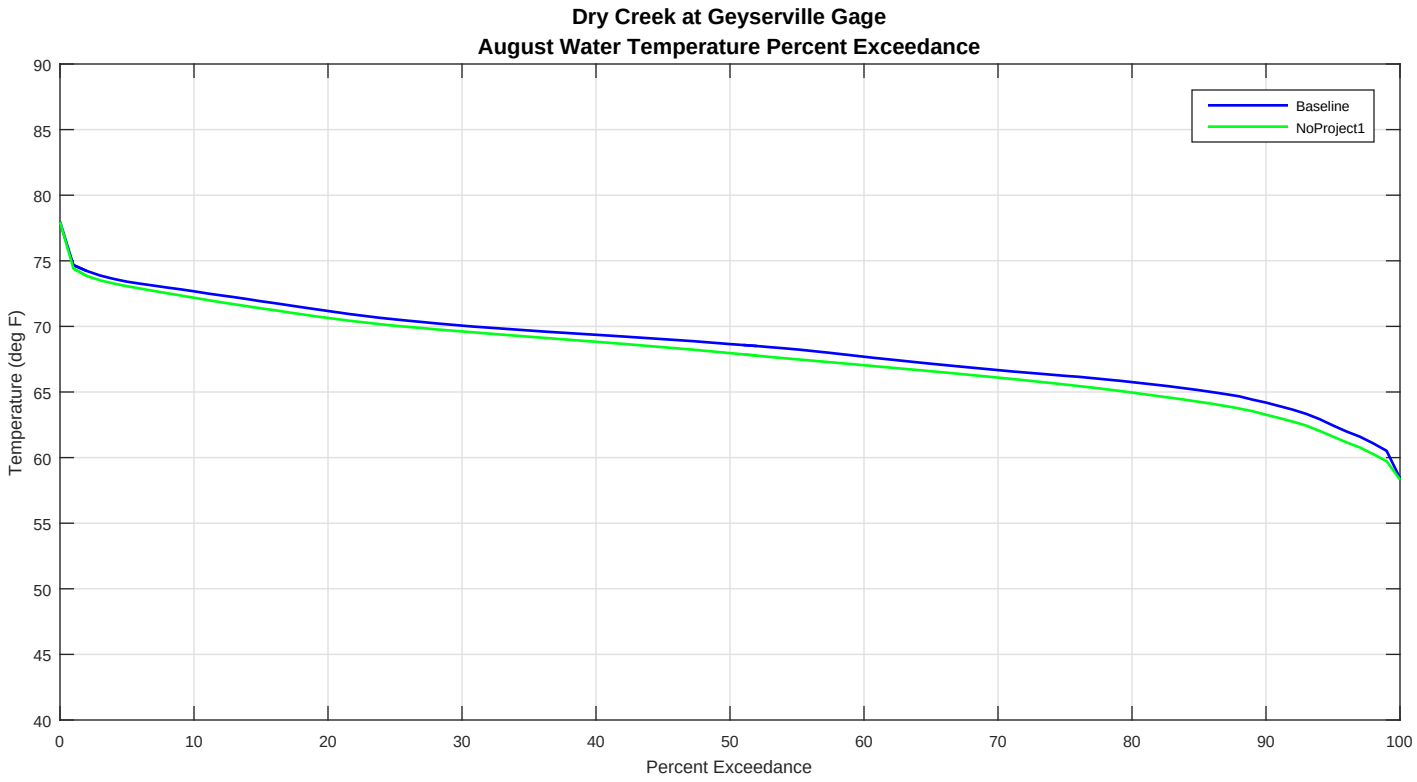
Dry Creek at Geyserville Gage
August Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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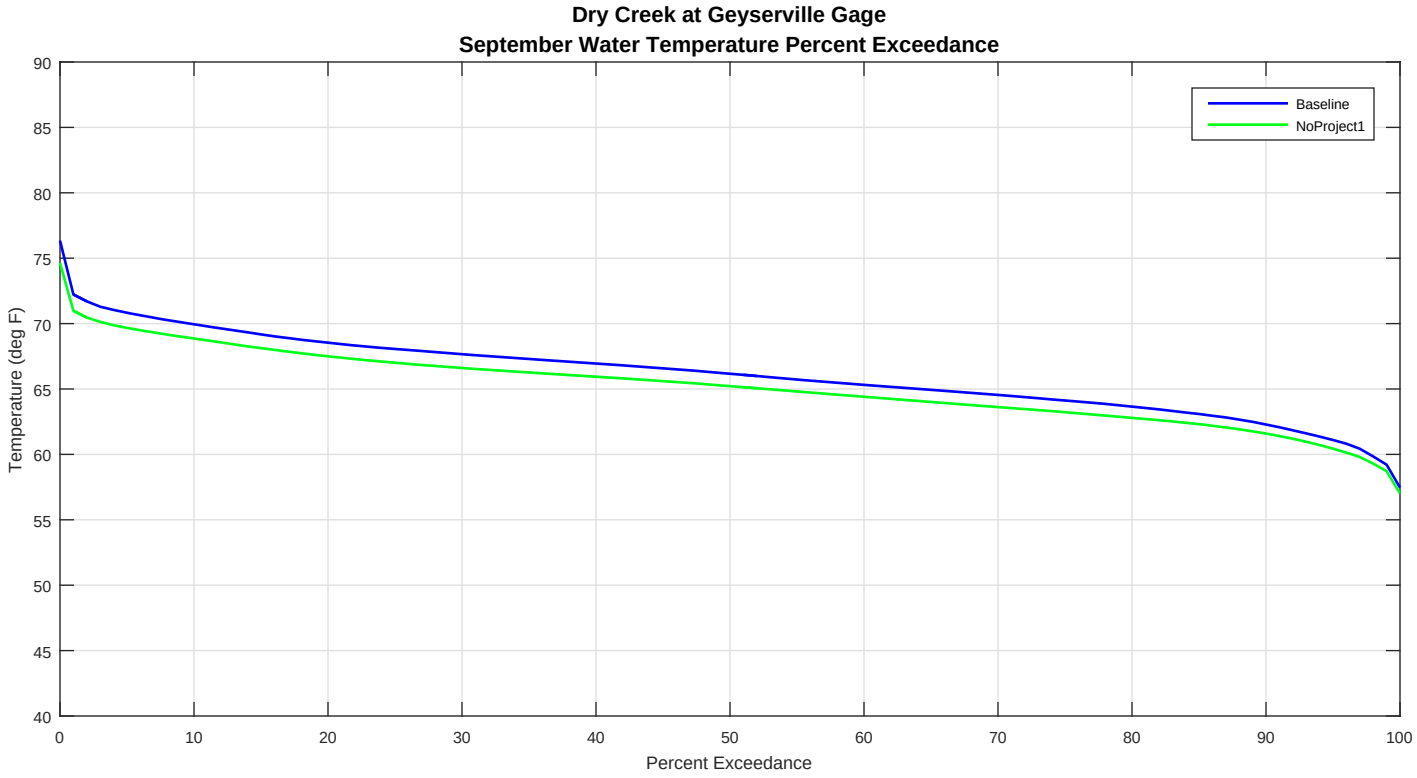
Dry Creek at Geyserville Gage
September Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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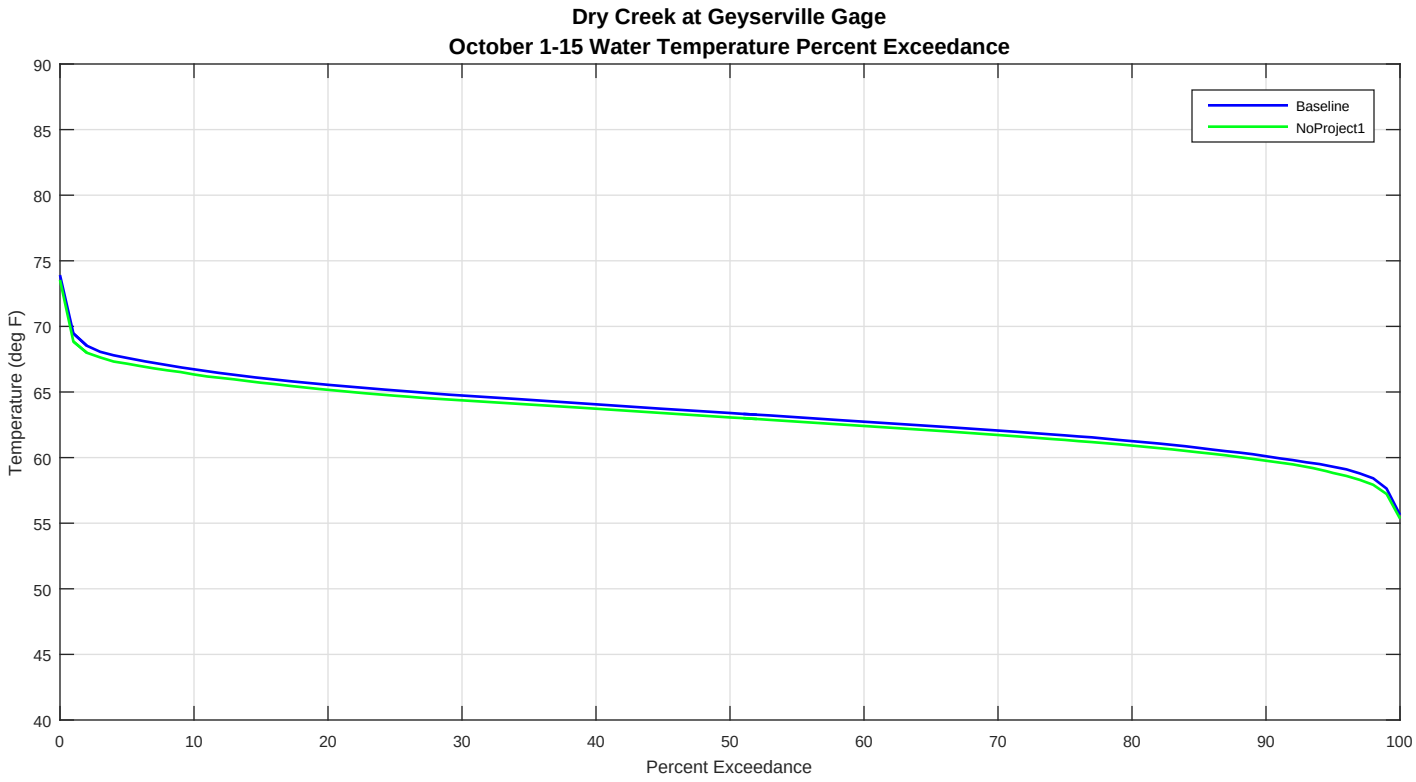
Dry Creek at Geyserville Gage
October 1-15 Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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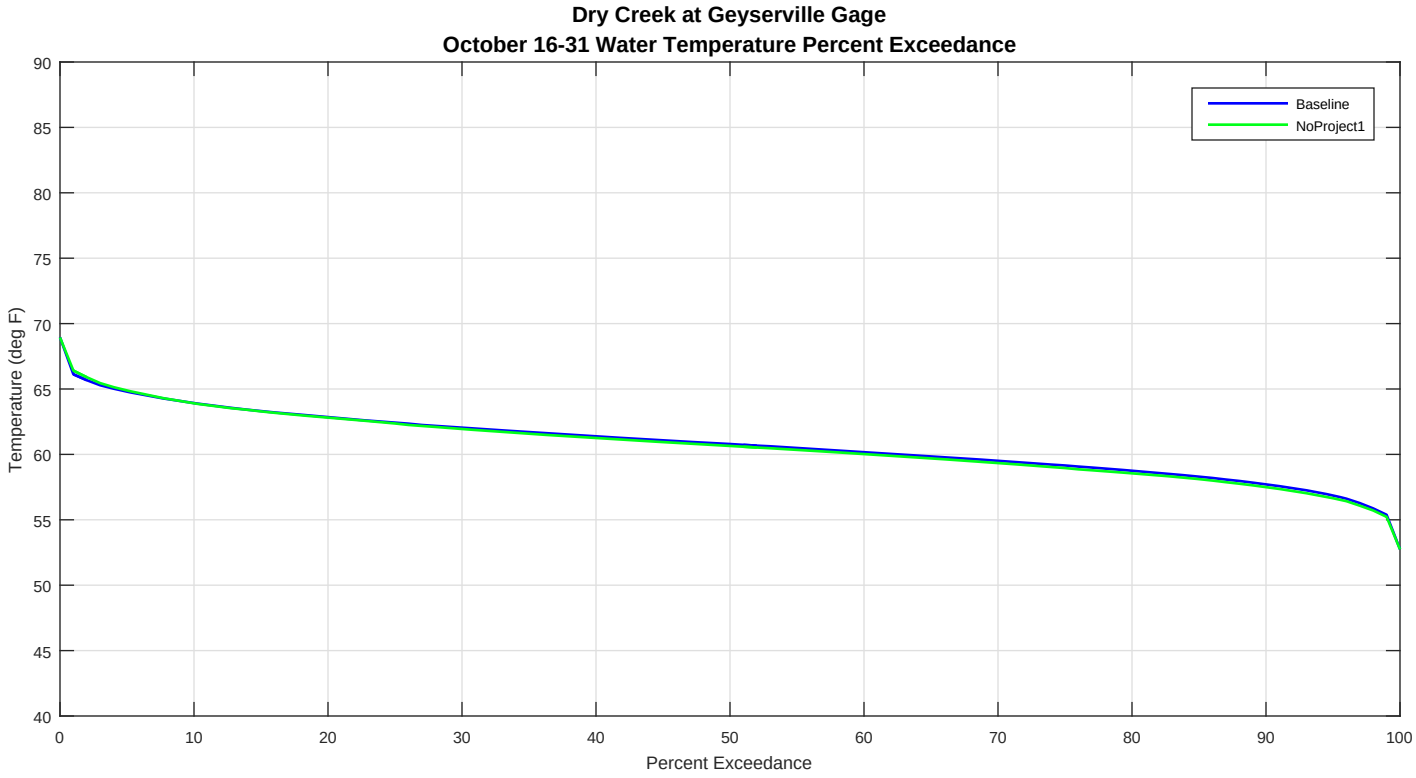
Dry Creek at Geyserville Gage
October 16-31 Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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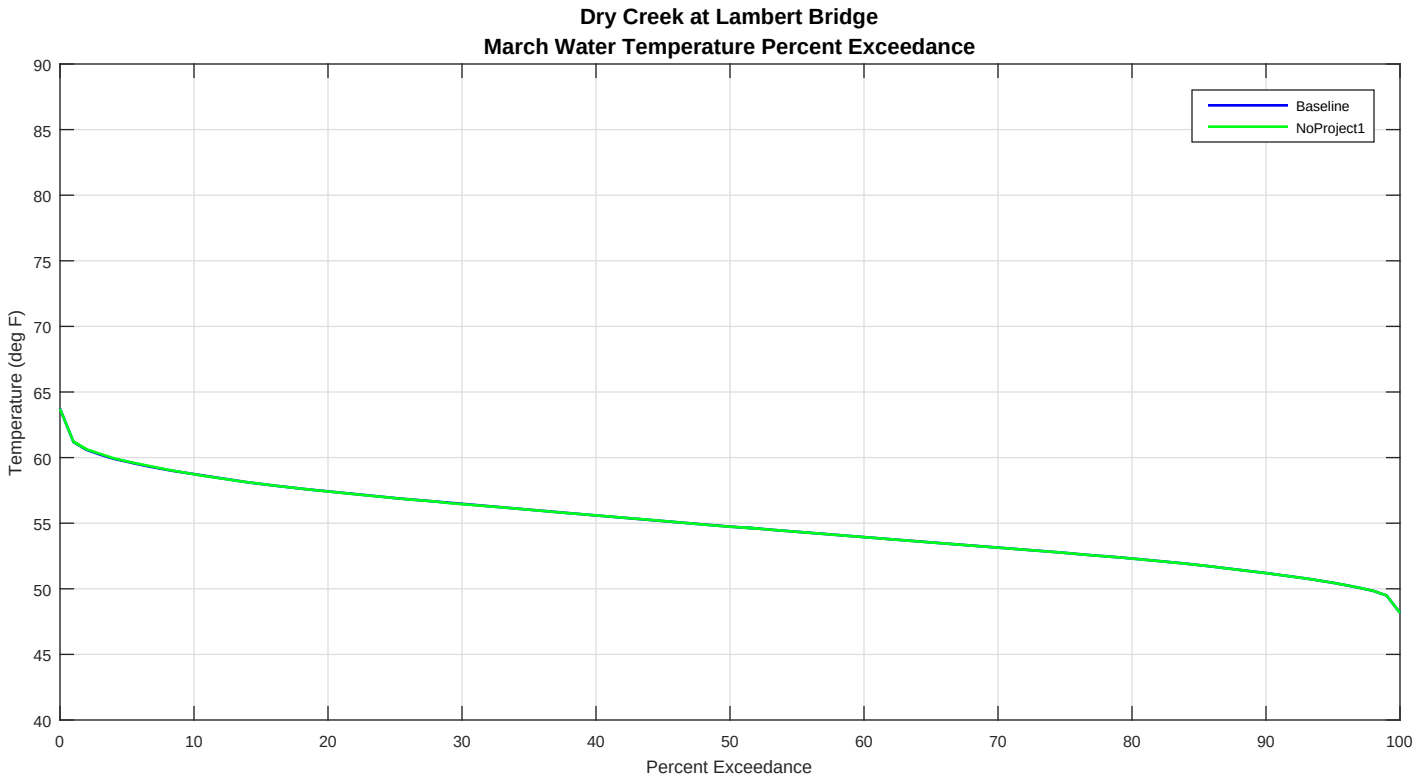
Dry Creek at Lambert Bridge
March Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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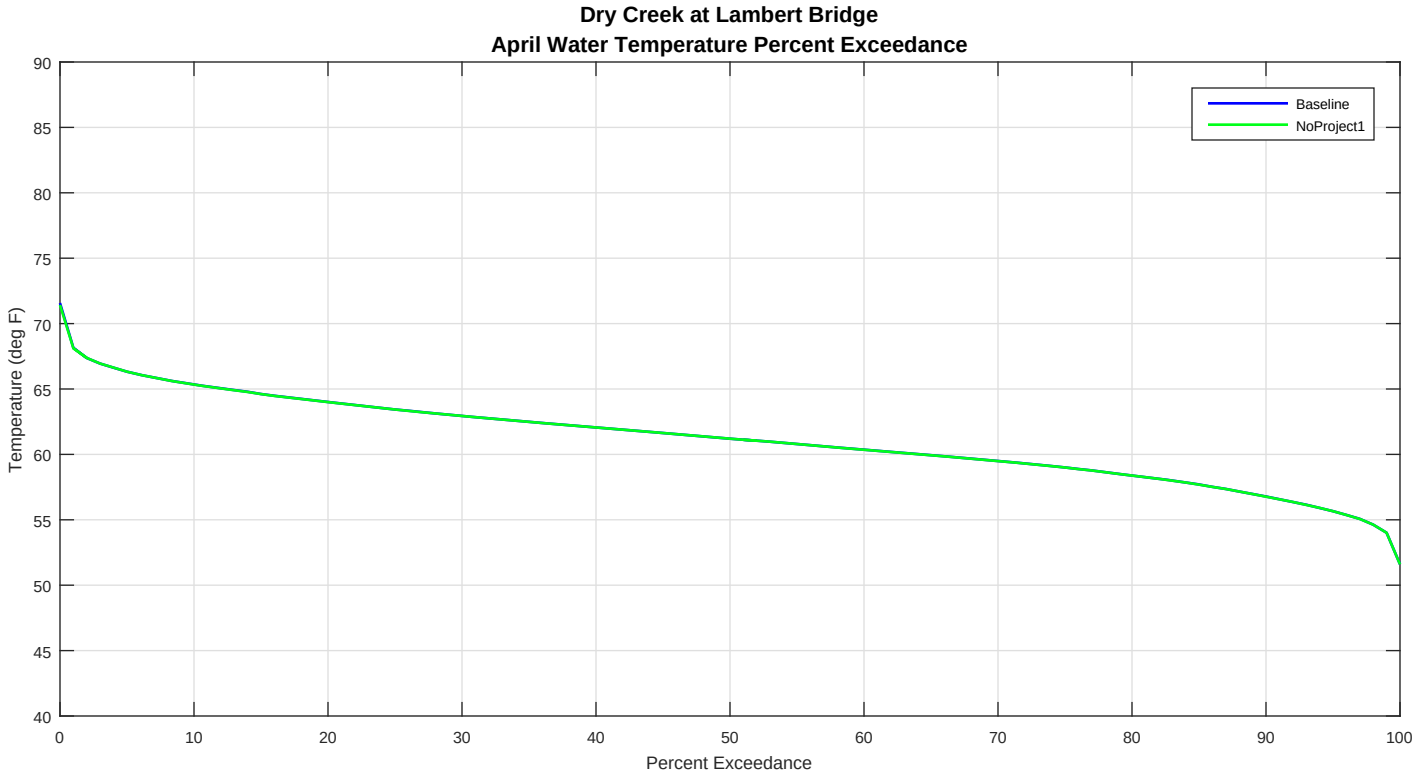
Dry Creek at Lambert Bridge
April Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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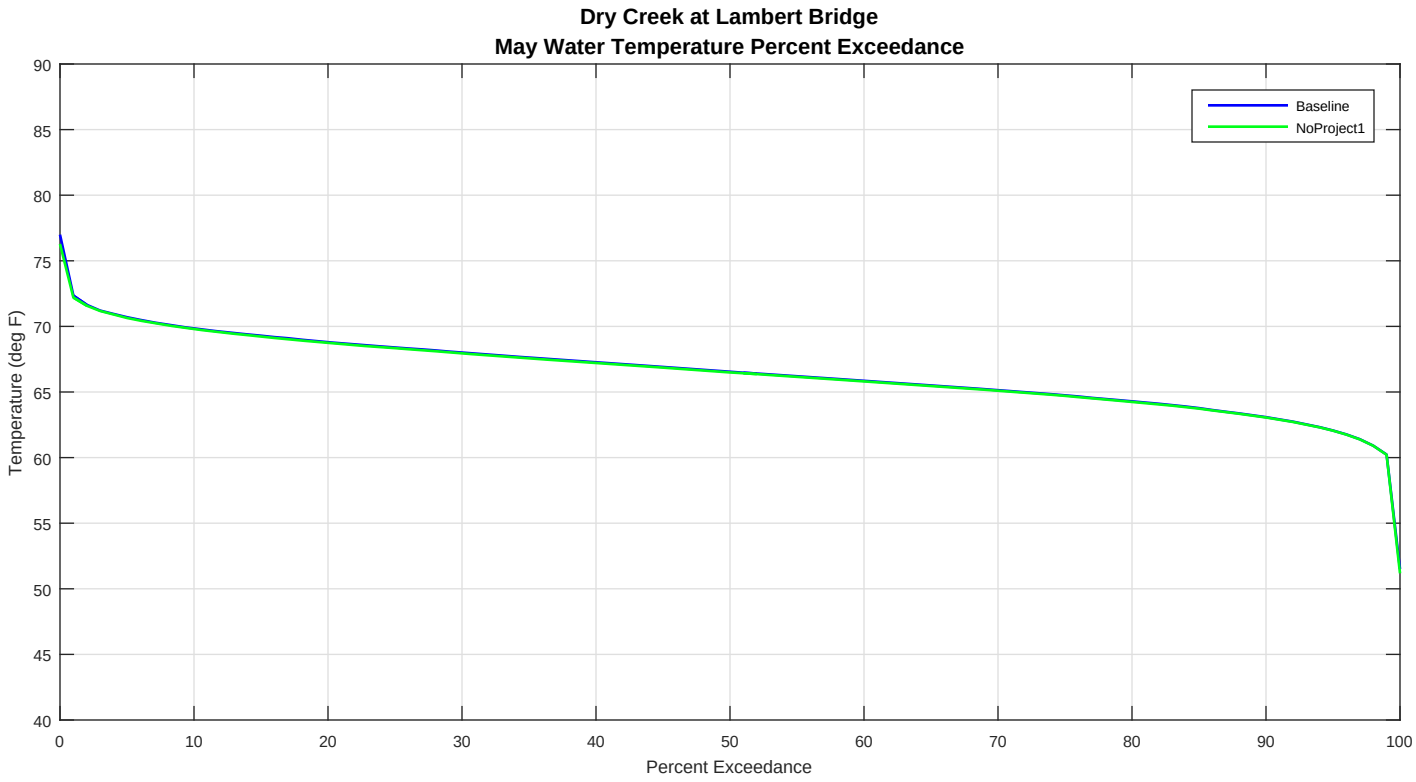
Dry Creek at Lambert Bridge
May Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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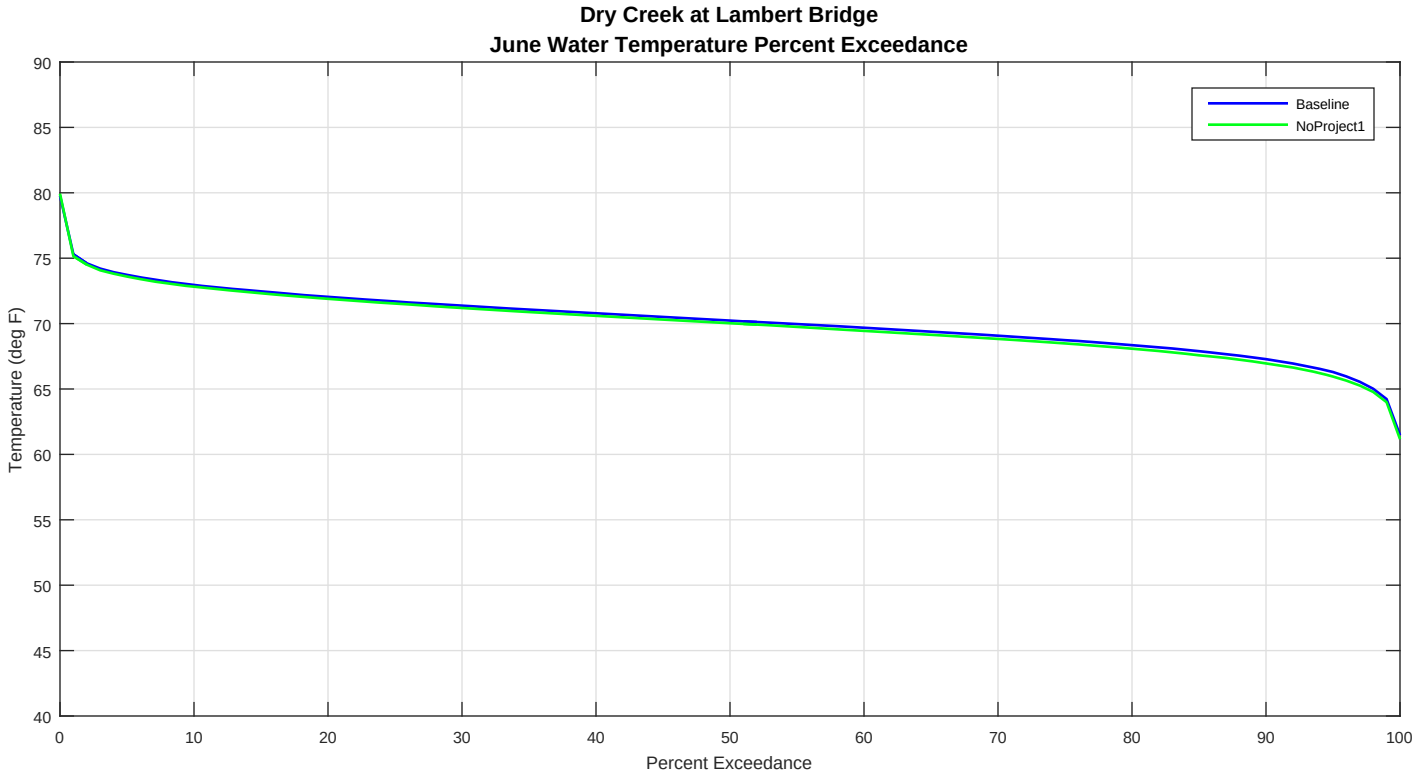
Dry Creek at Lambert Bridge
June Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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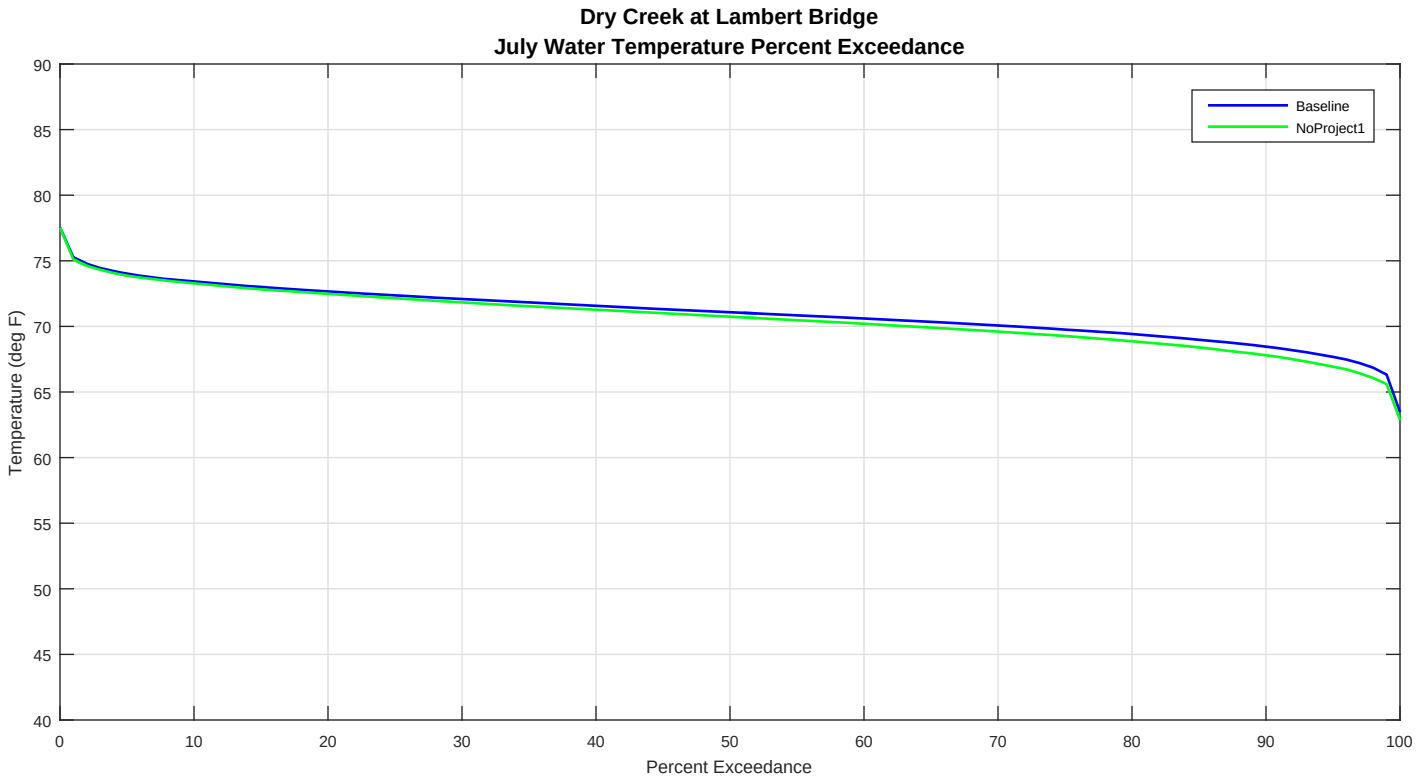
Dry Creek at Lambert Bridge
July Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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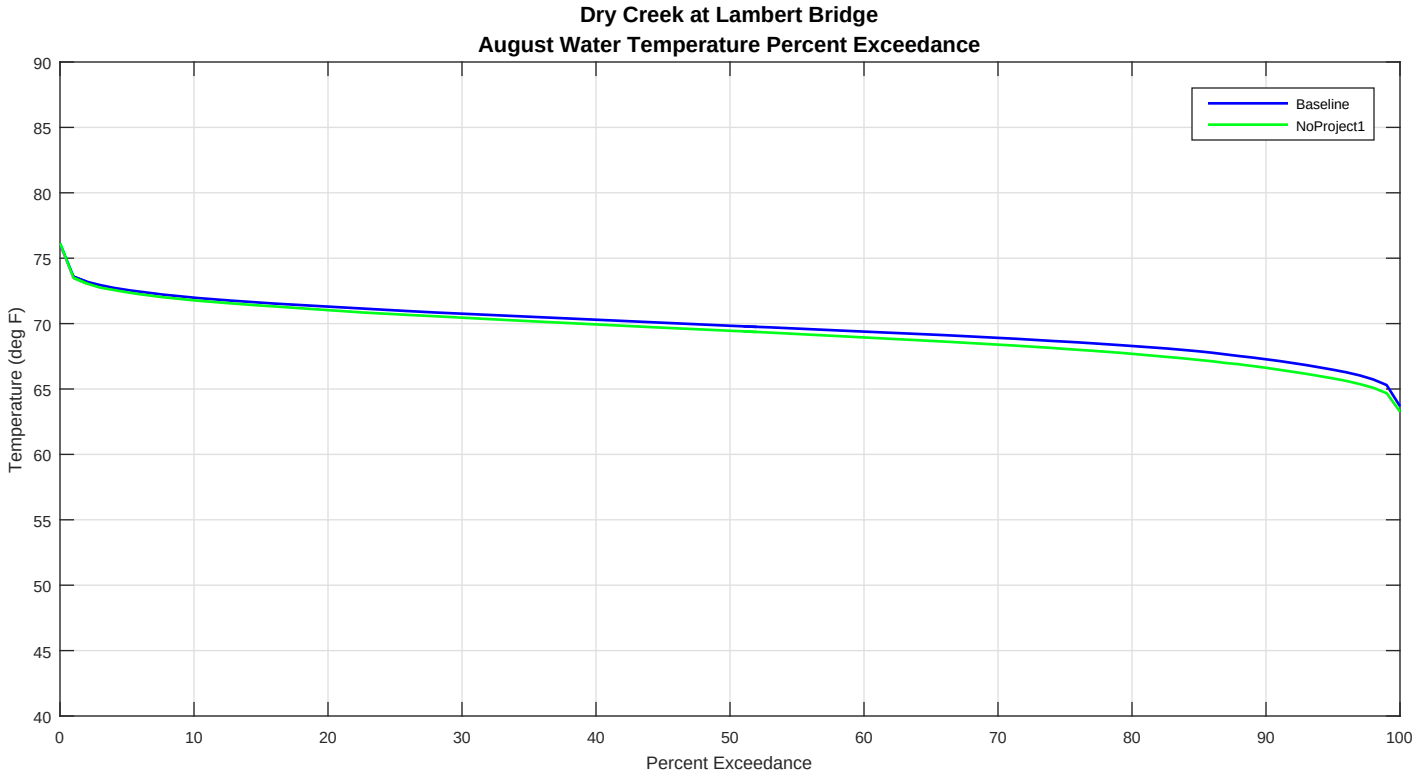
Dry Creek at Lambert Bridge
August Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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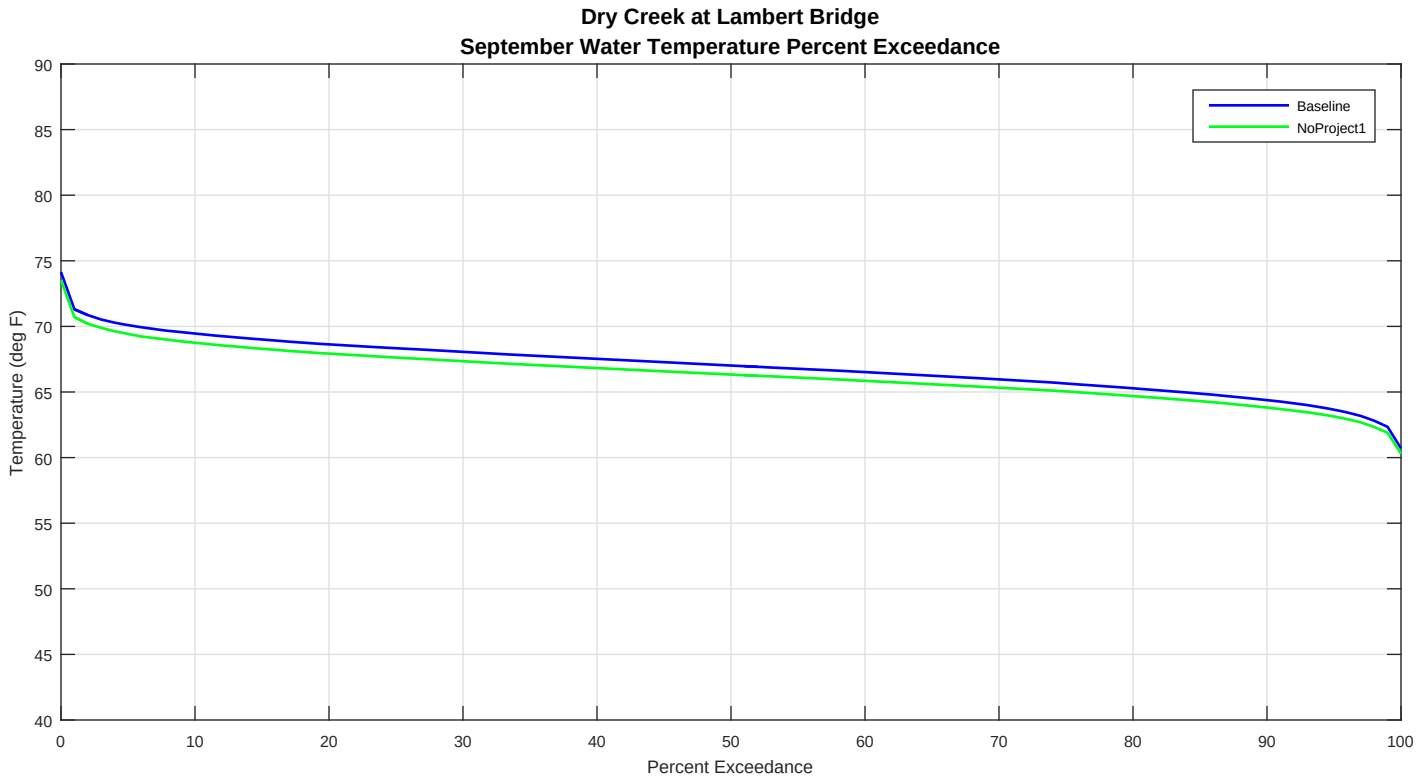
Dry Creek at Lambert Bridge
September Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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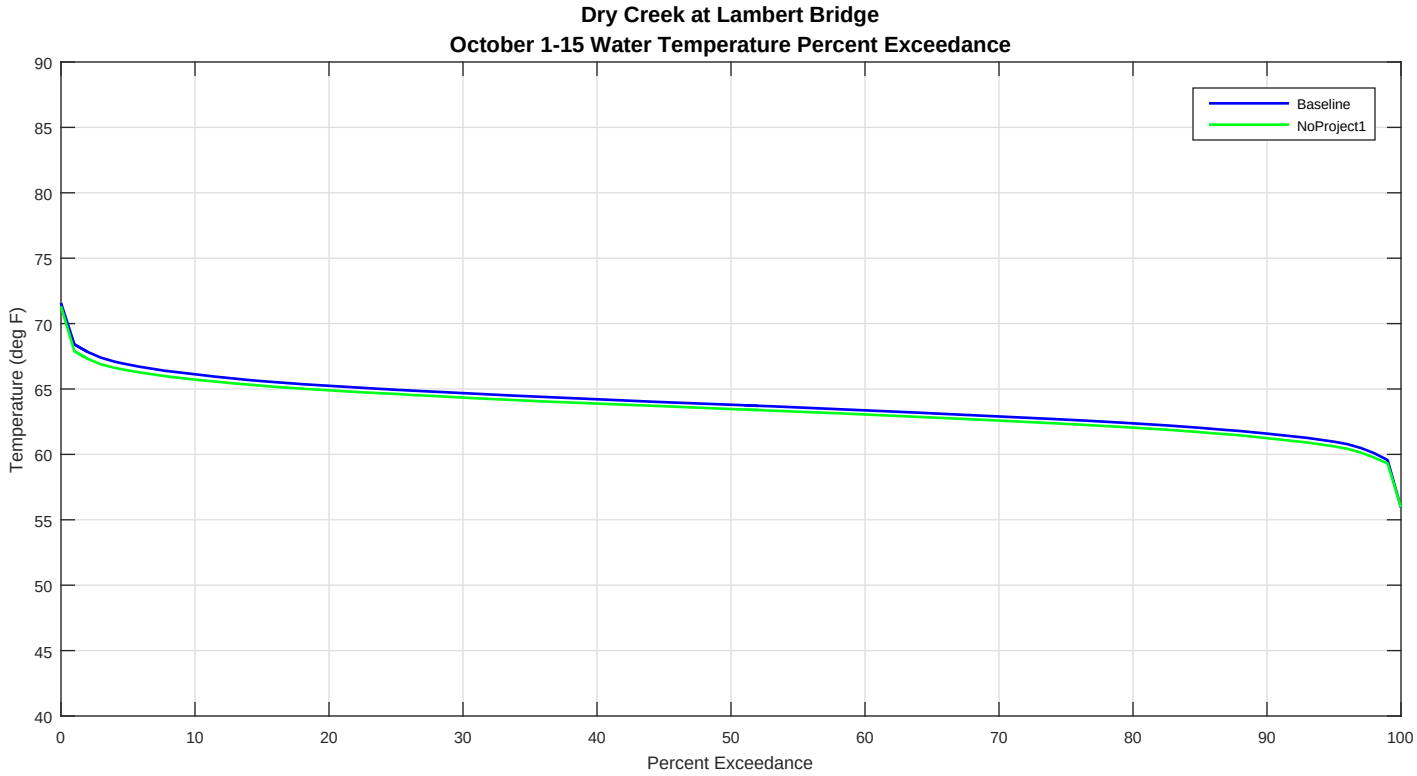
Dry Creek at Lambert Bridge
October 1-15 Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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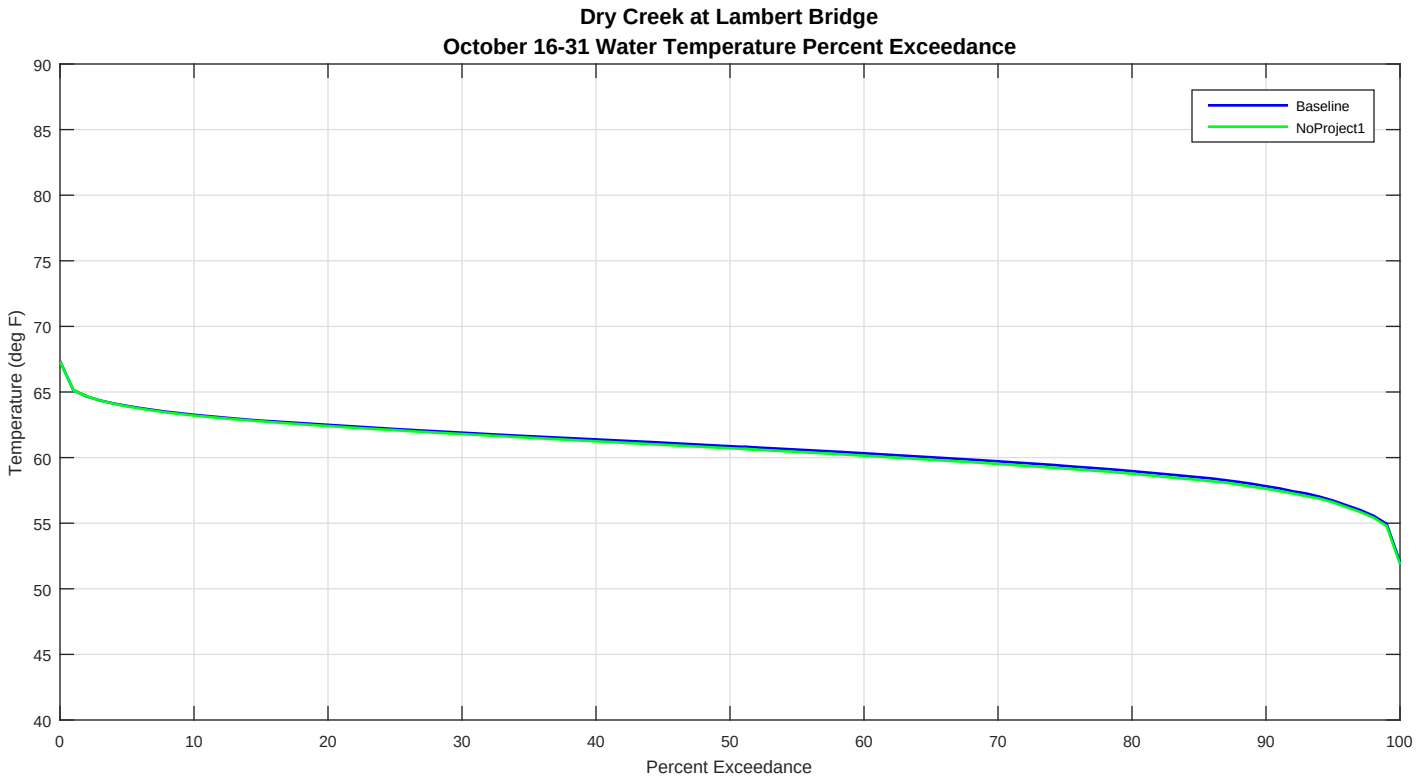
Dry Creek at Lambert Bridge
October 16-31 Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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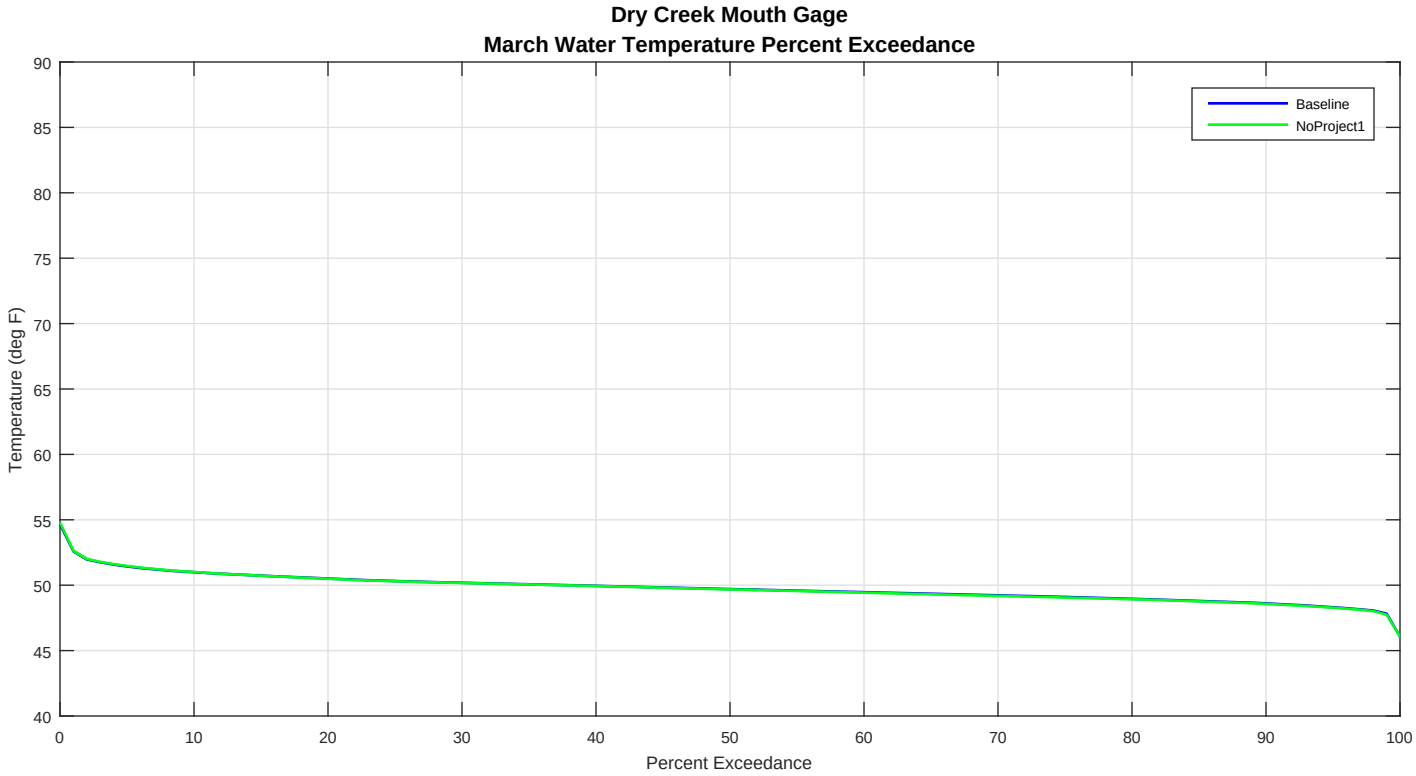
Dry Creek Mouth Gage
March Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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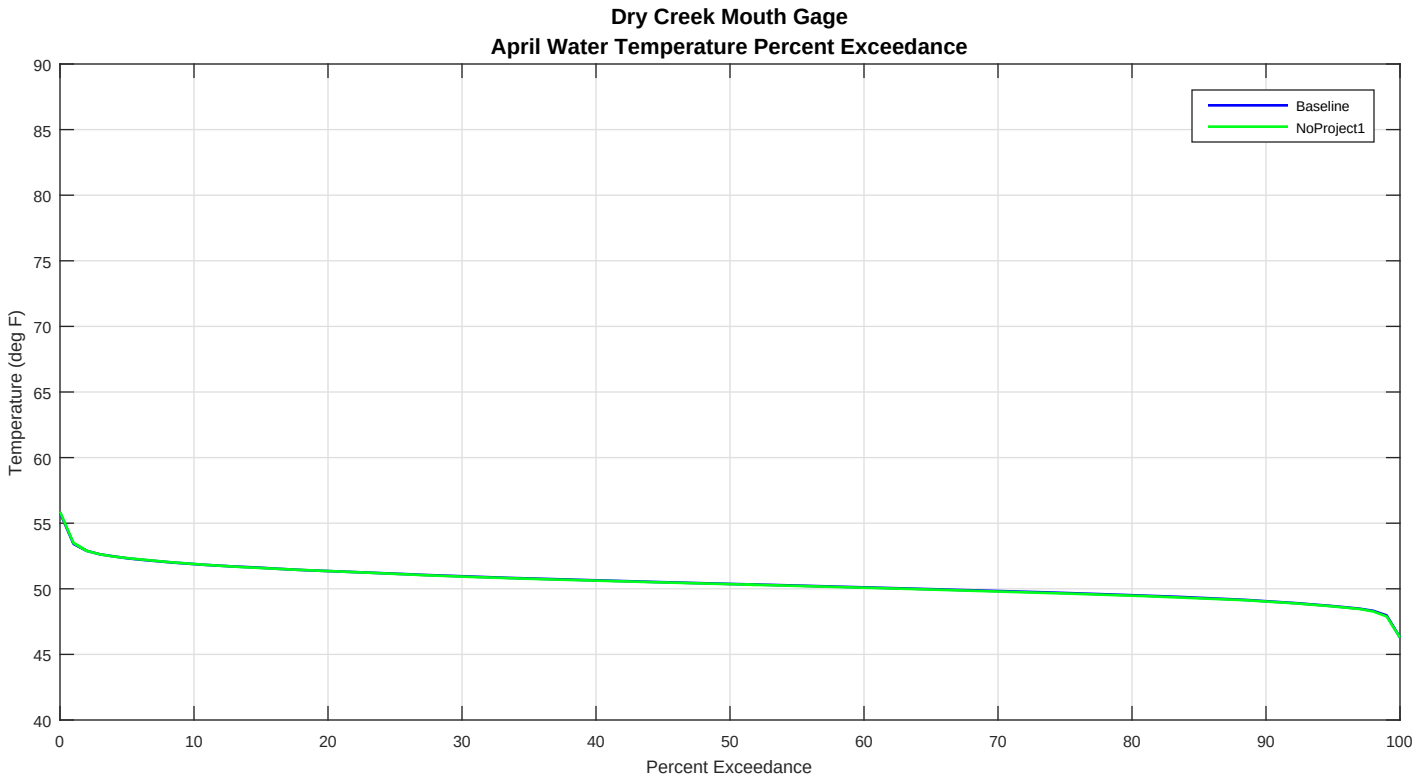
Dry Creek Mouth Gage
April Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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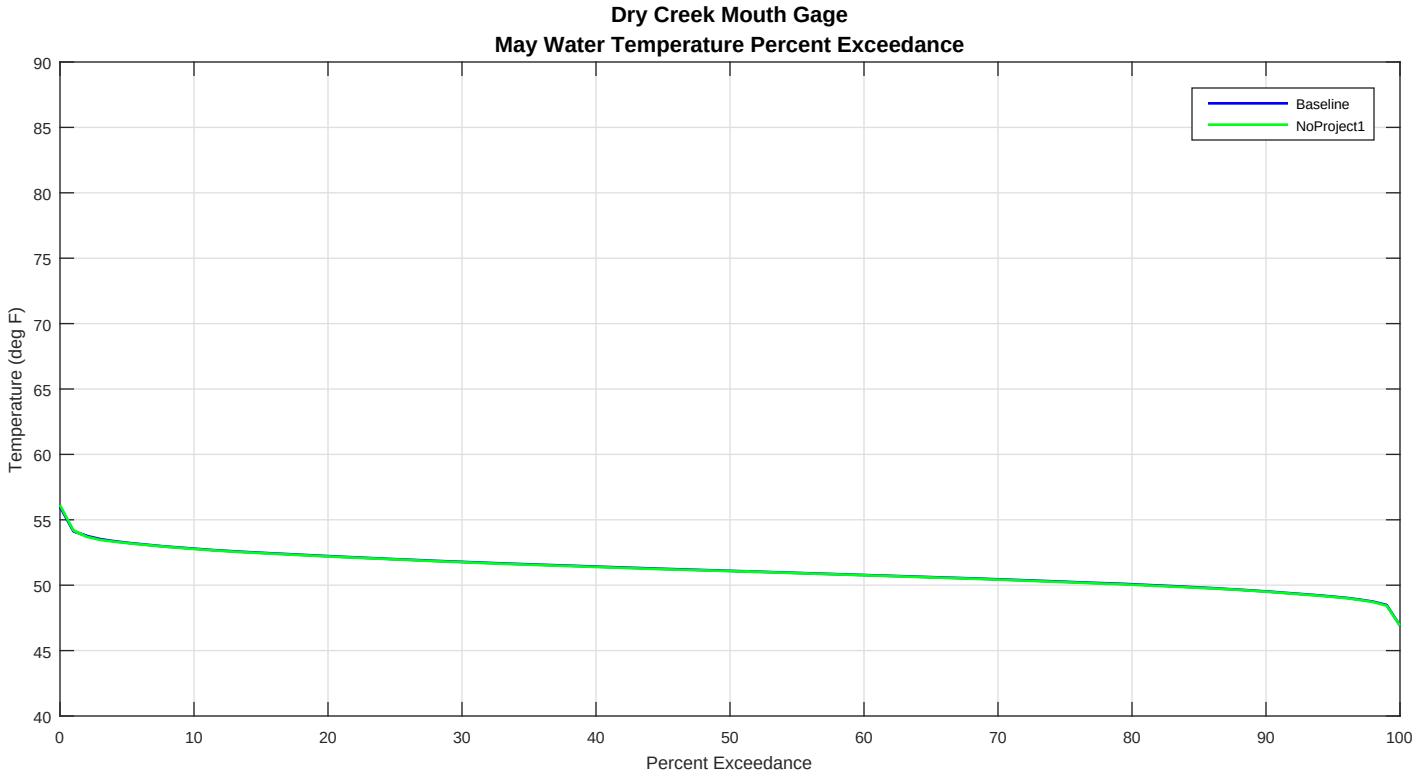
Dry Creek Mouth Gage
May Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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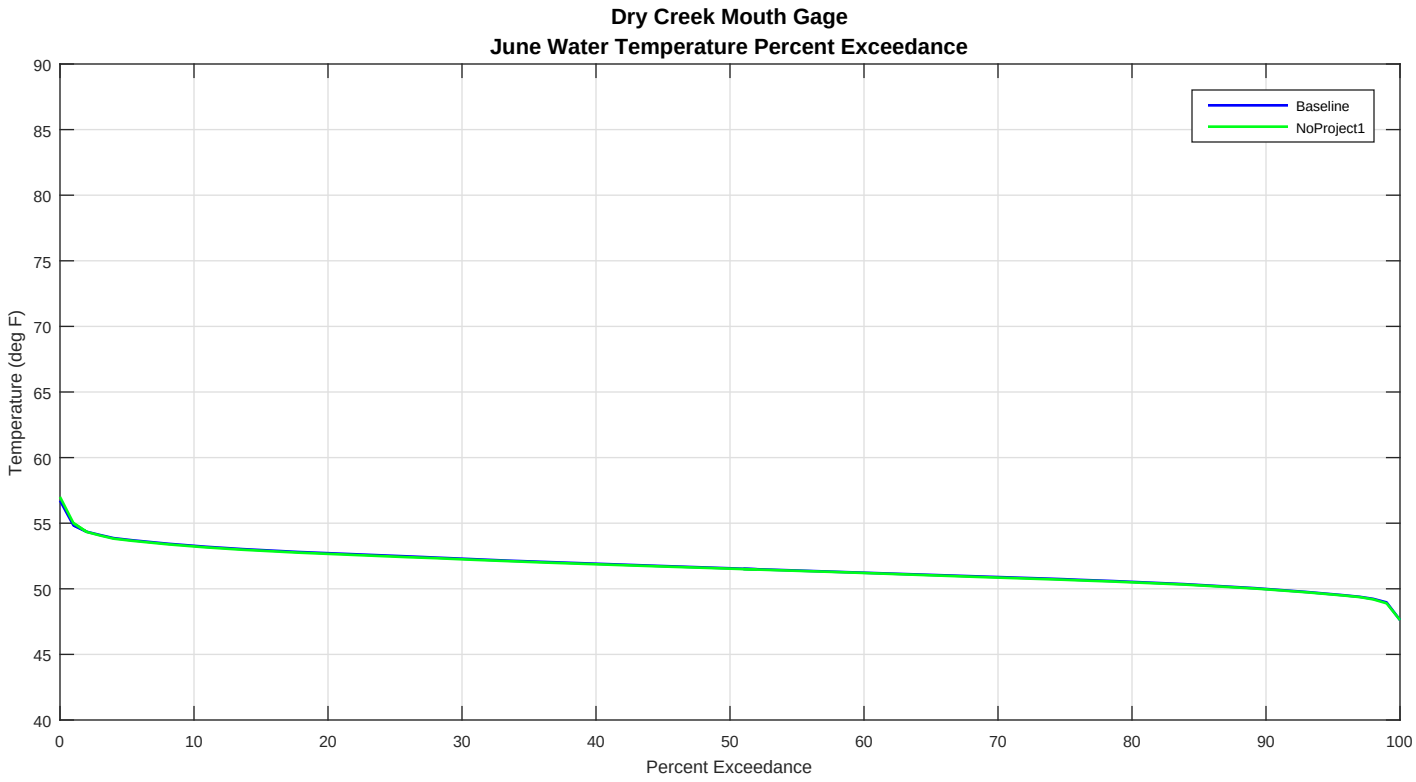
Dry Creek Mouth Gage
June Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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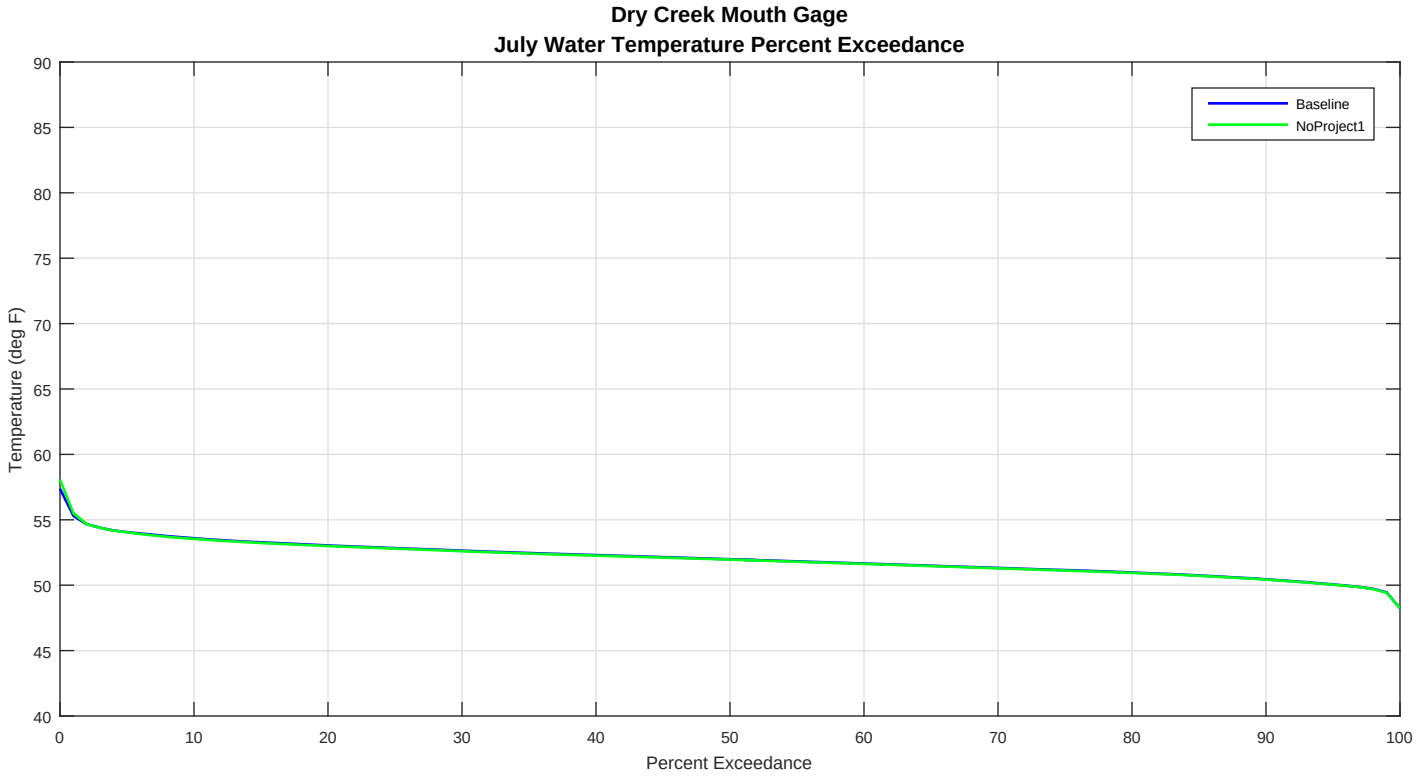
Dry Creek Mouth Gage
July Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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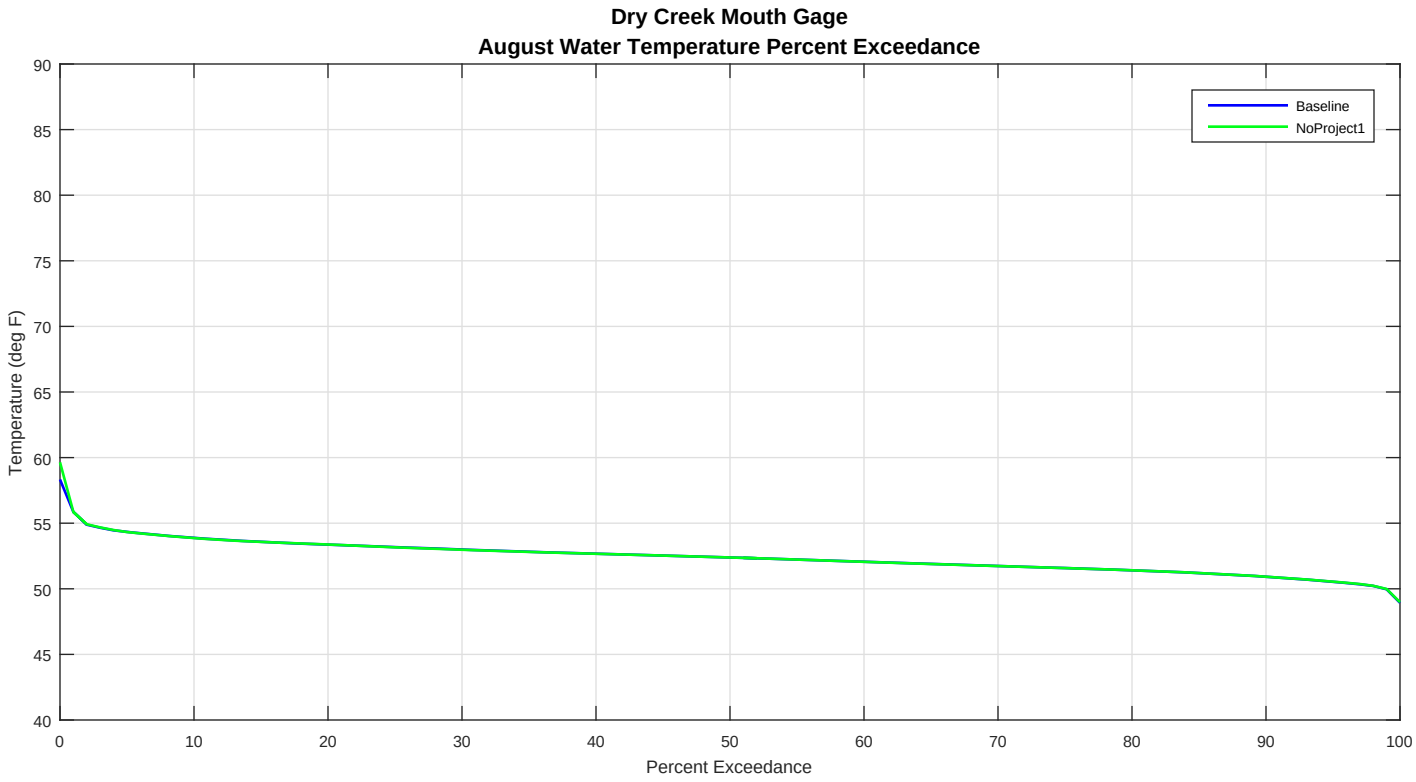
Dry Creek Mouth Gage
August Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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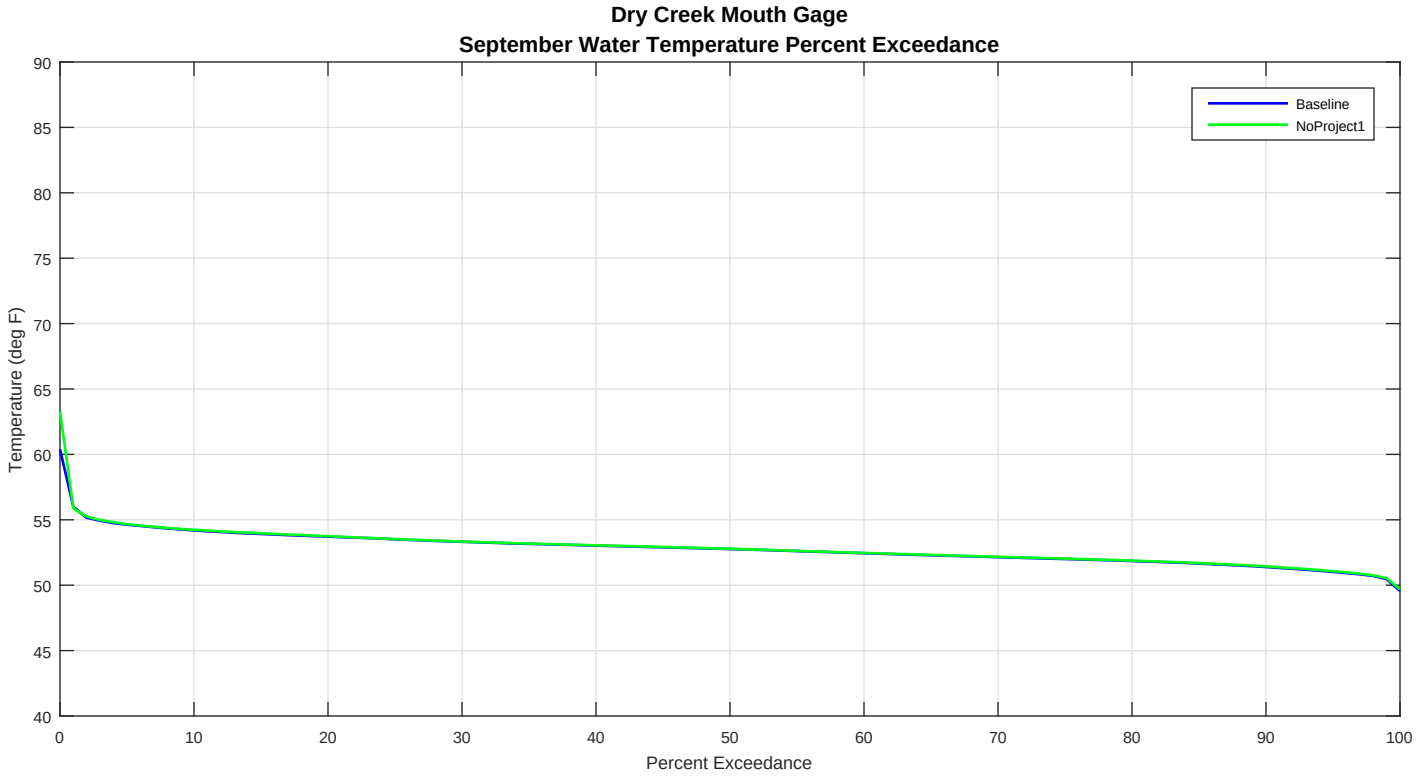
Dry Creek Mouth Gage
September Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
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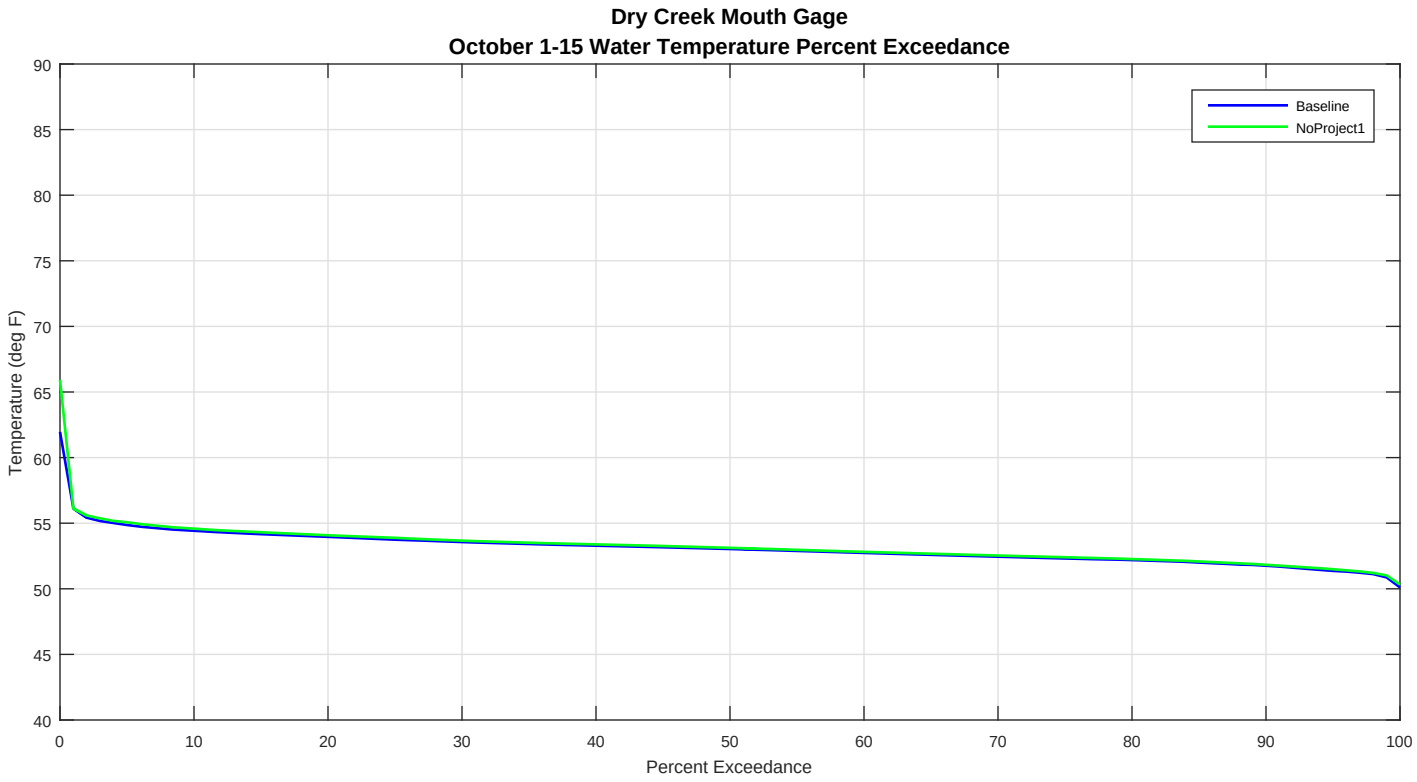
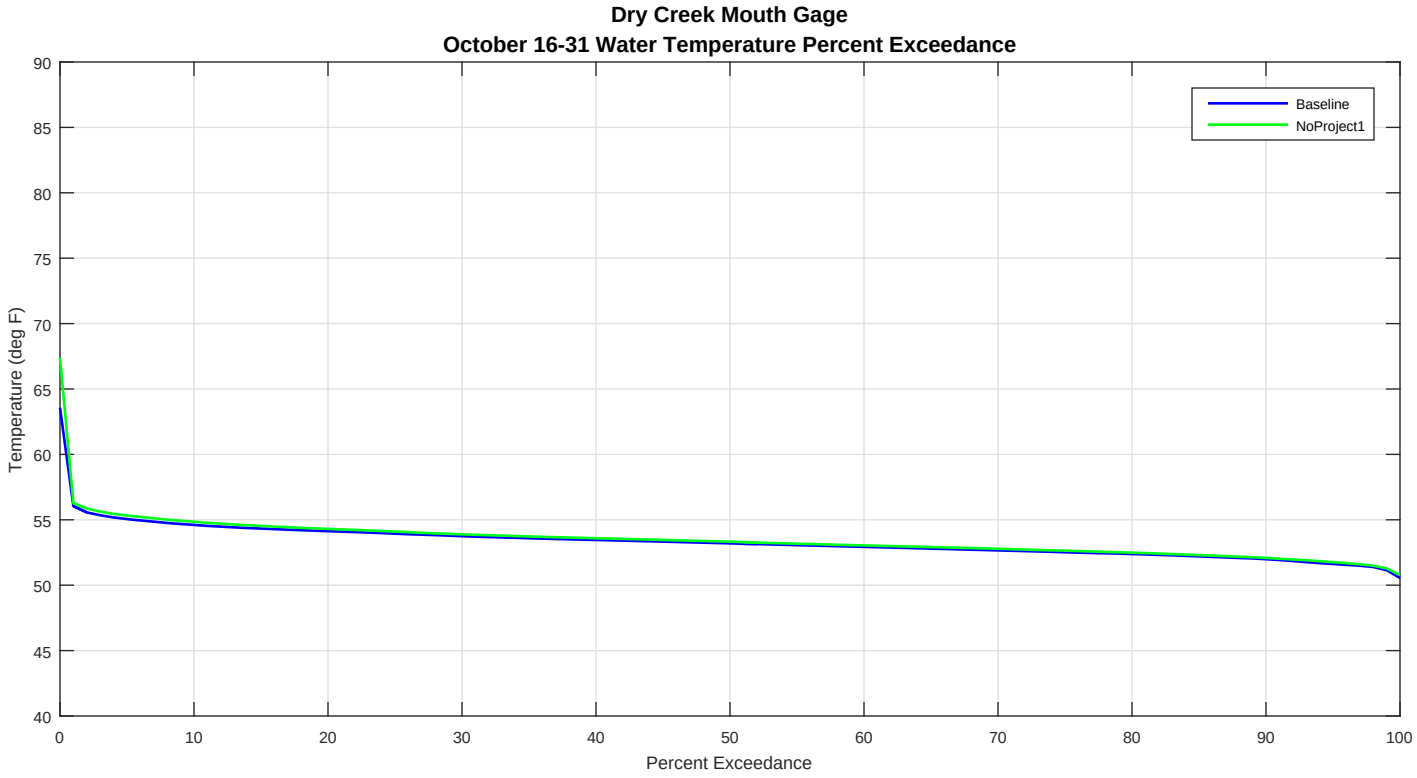
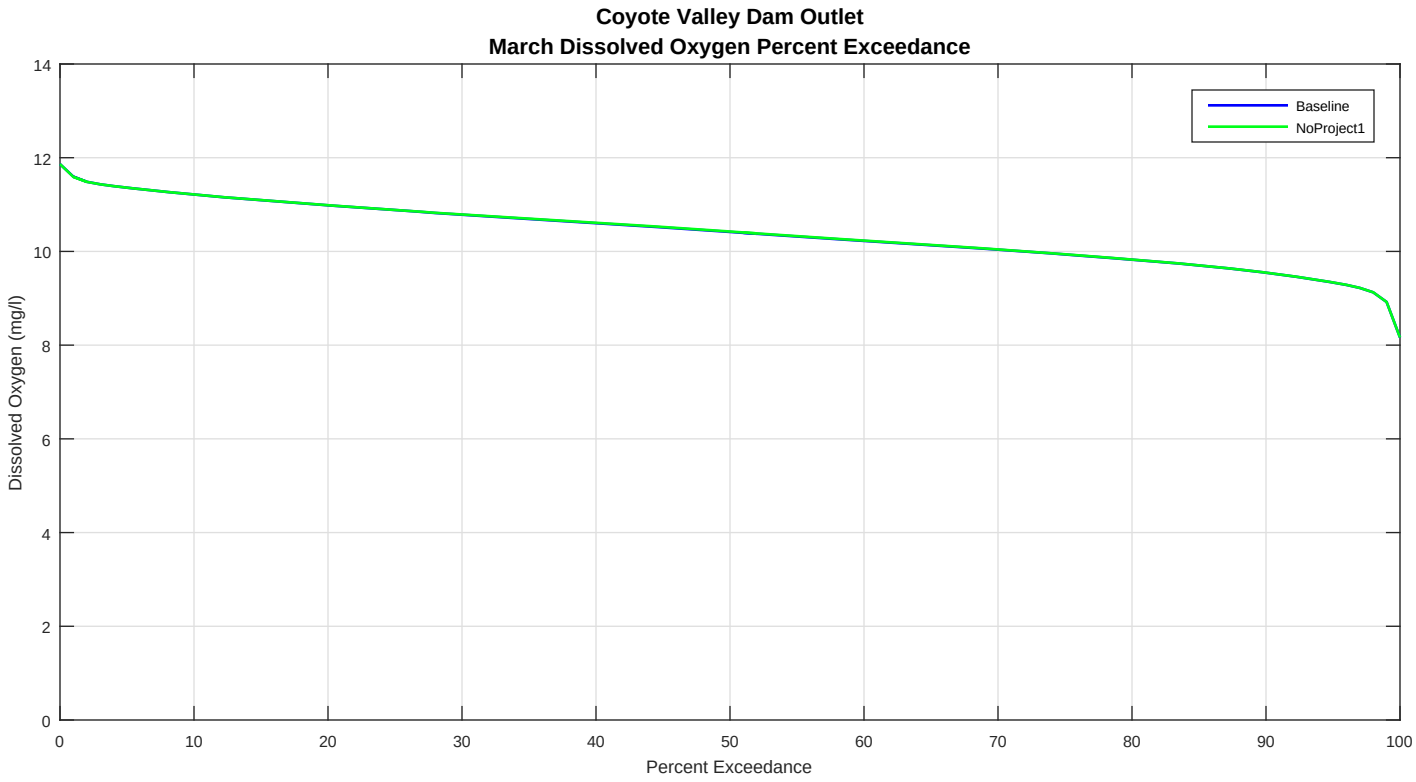
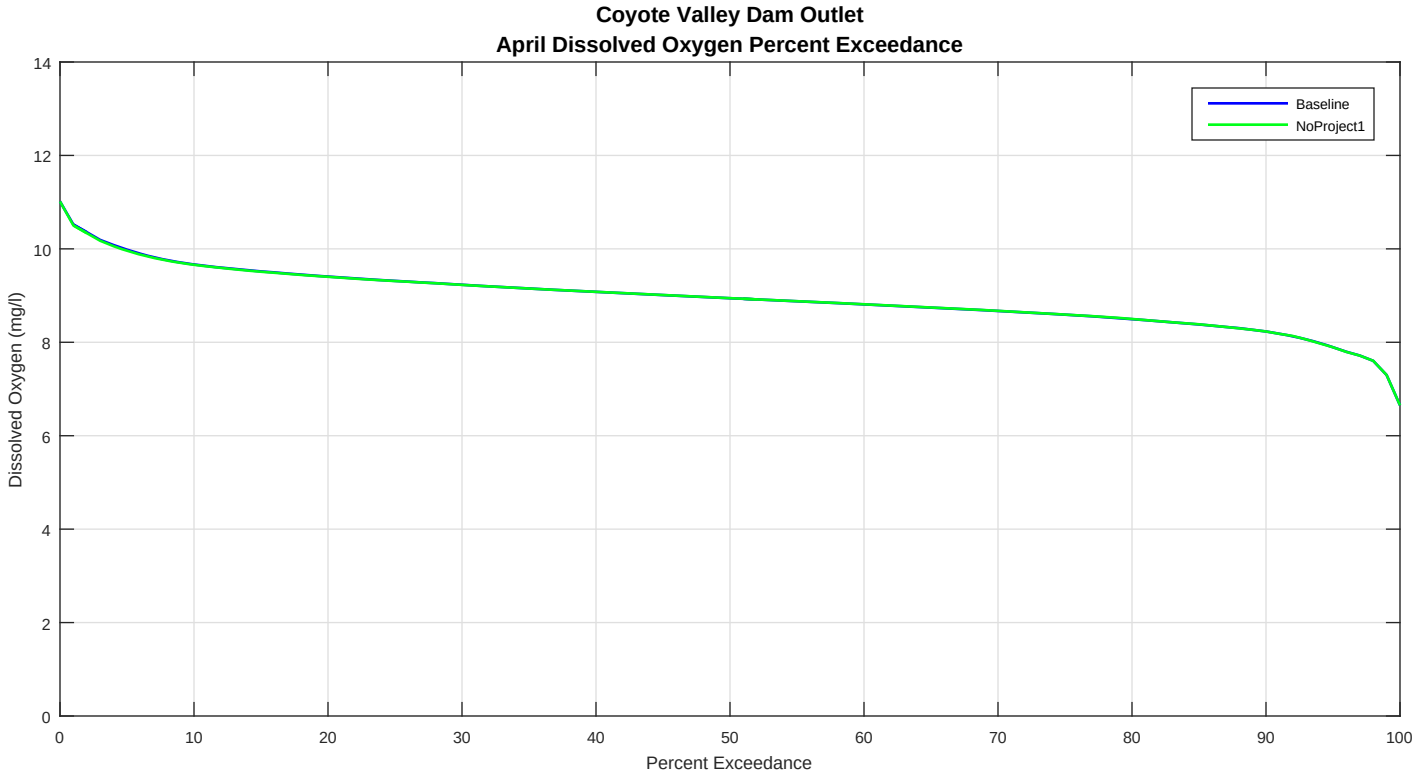
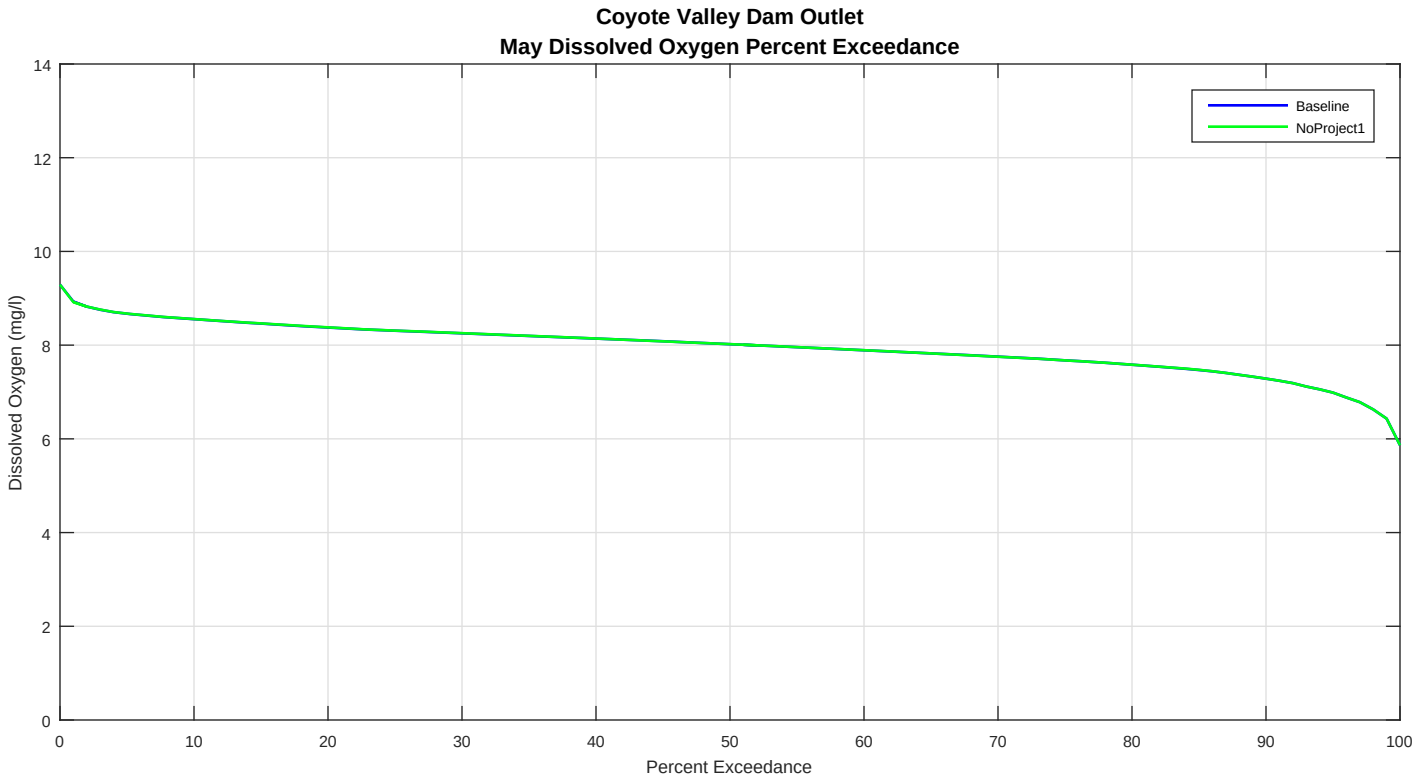
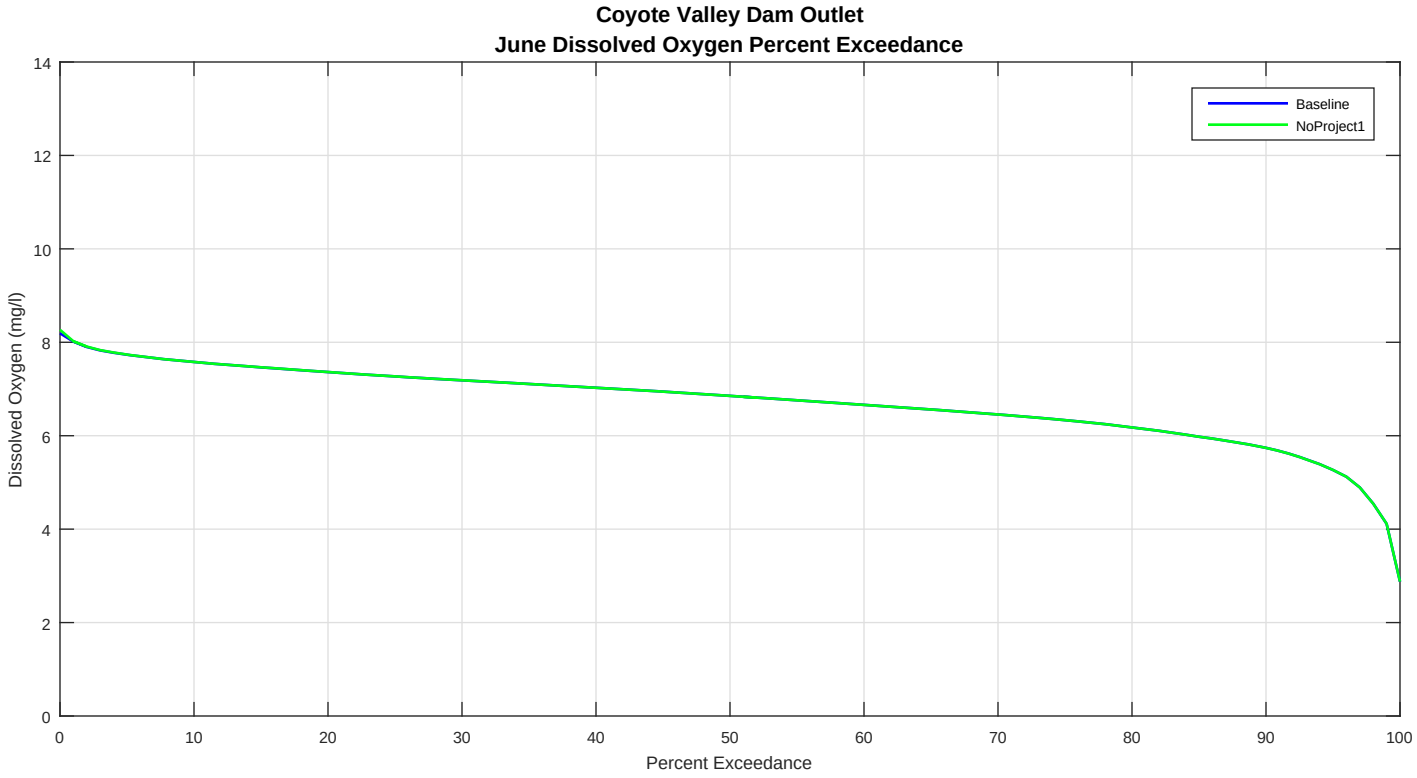

Dry Creek Mouth Gage
October 1-15 Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
10
20
30
40
50
60
70
80
90
100

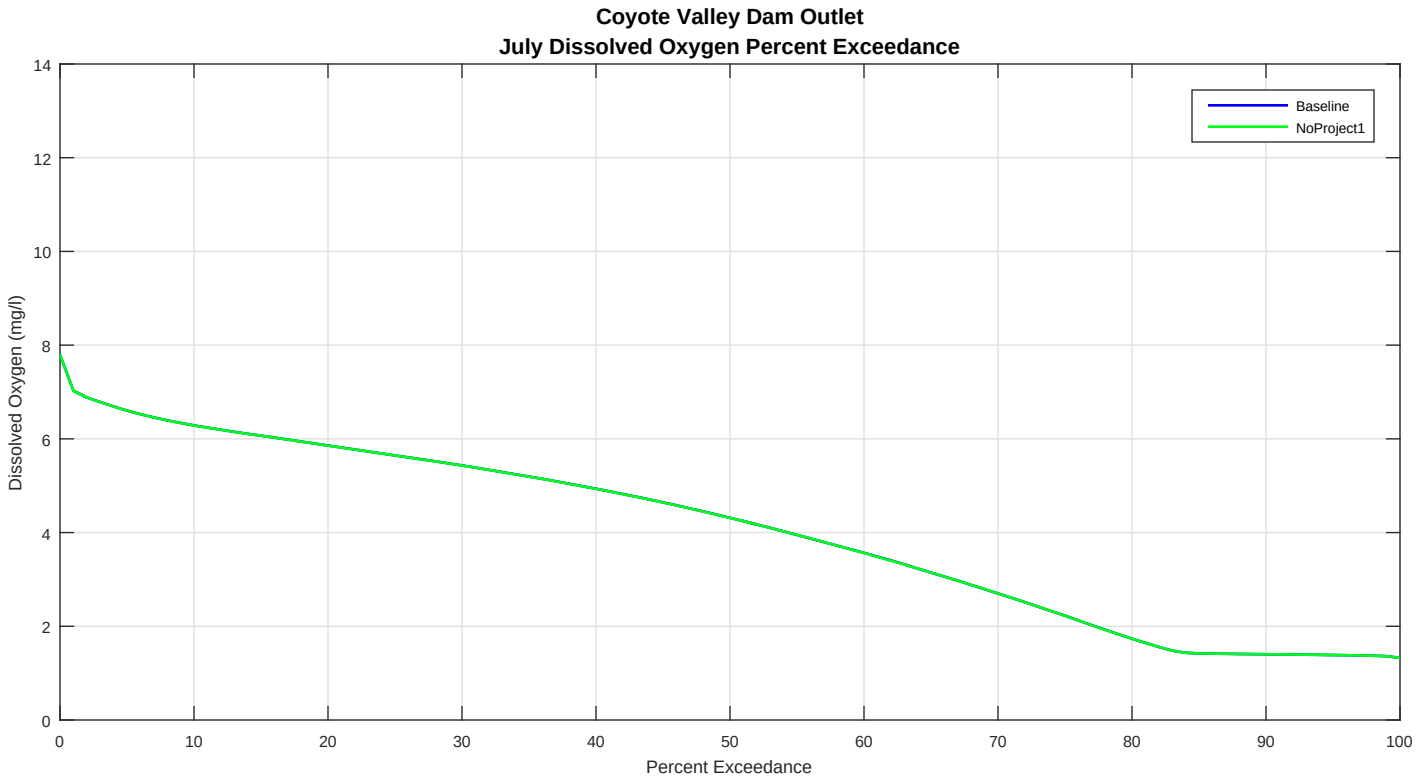

Dry Creek Mouth Gage
October 16-31 Water Temperature Percent Exceedance
Baseline
NoProject1
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
10
20
30
40
50
60
70
80
90
100

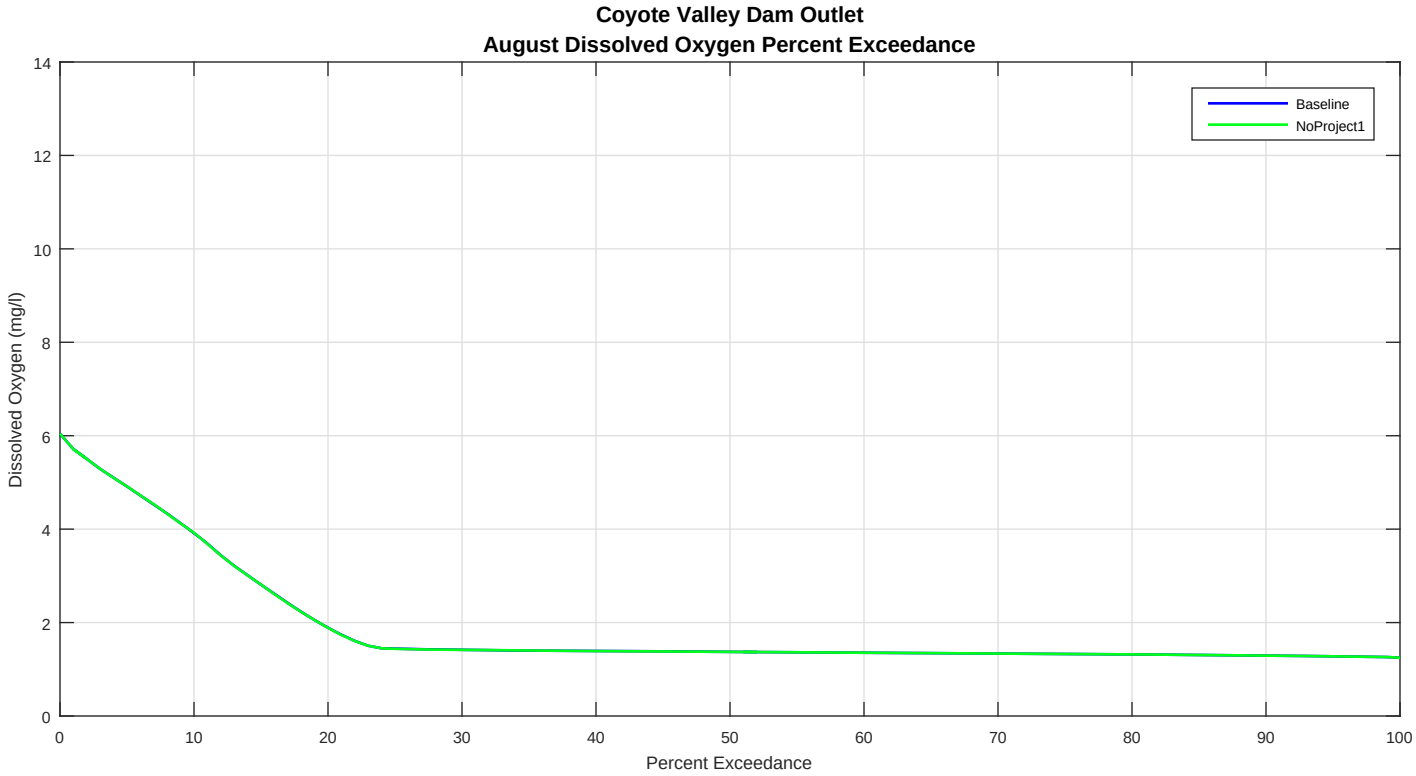

Coyote Valley Dam Outlet
March Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

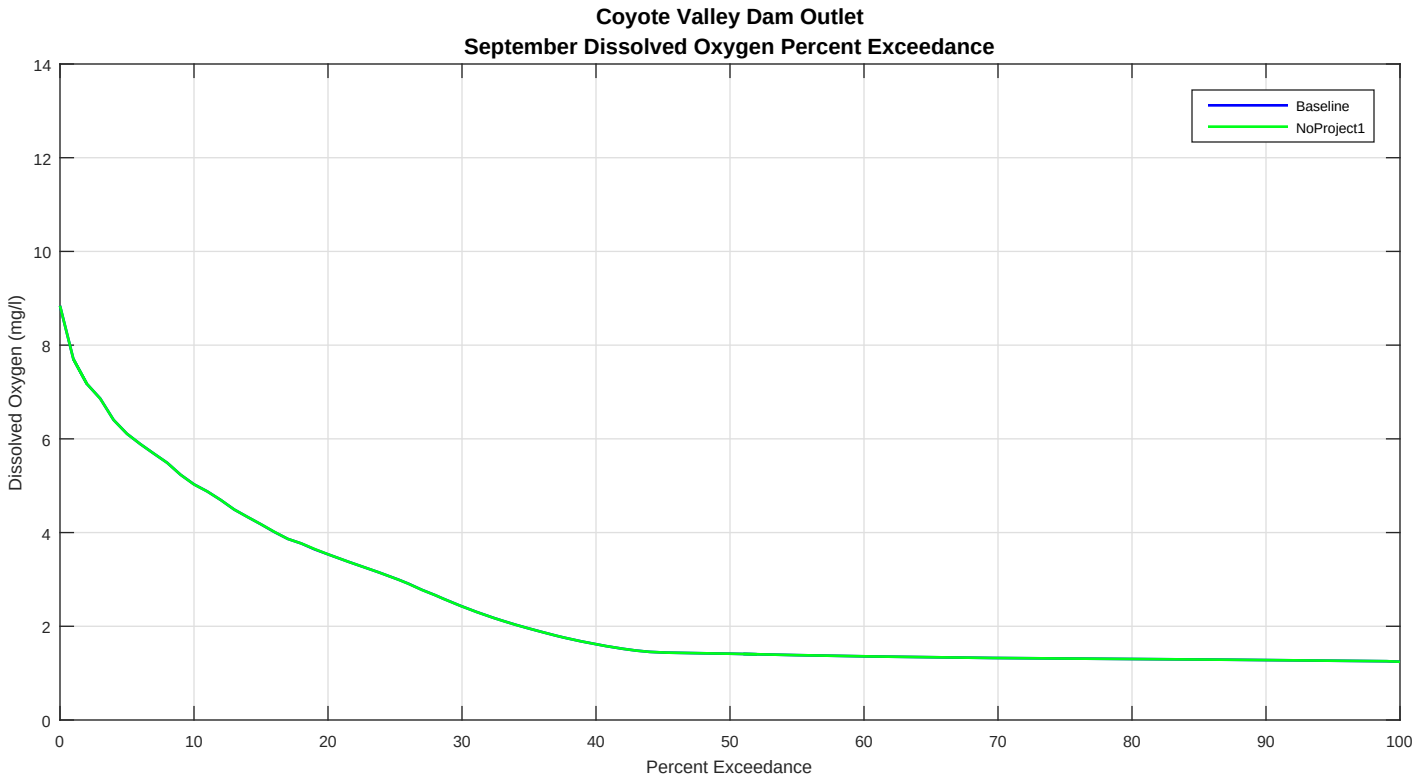

Coyote Valley Dam Outlet
April Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

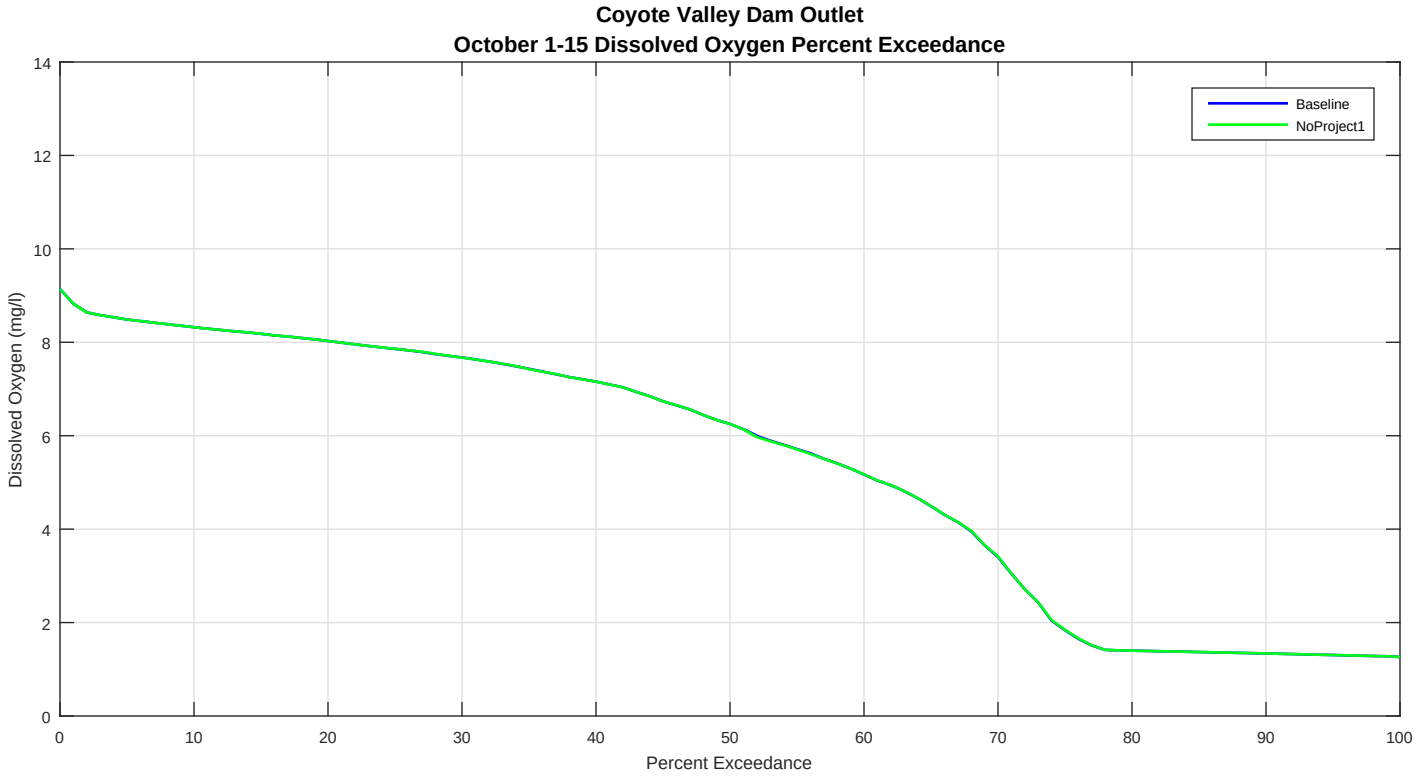

Coyote Valley Dam Outlet
May Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

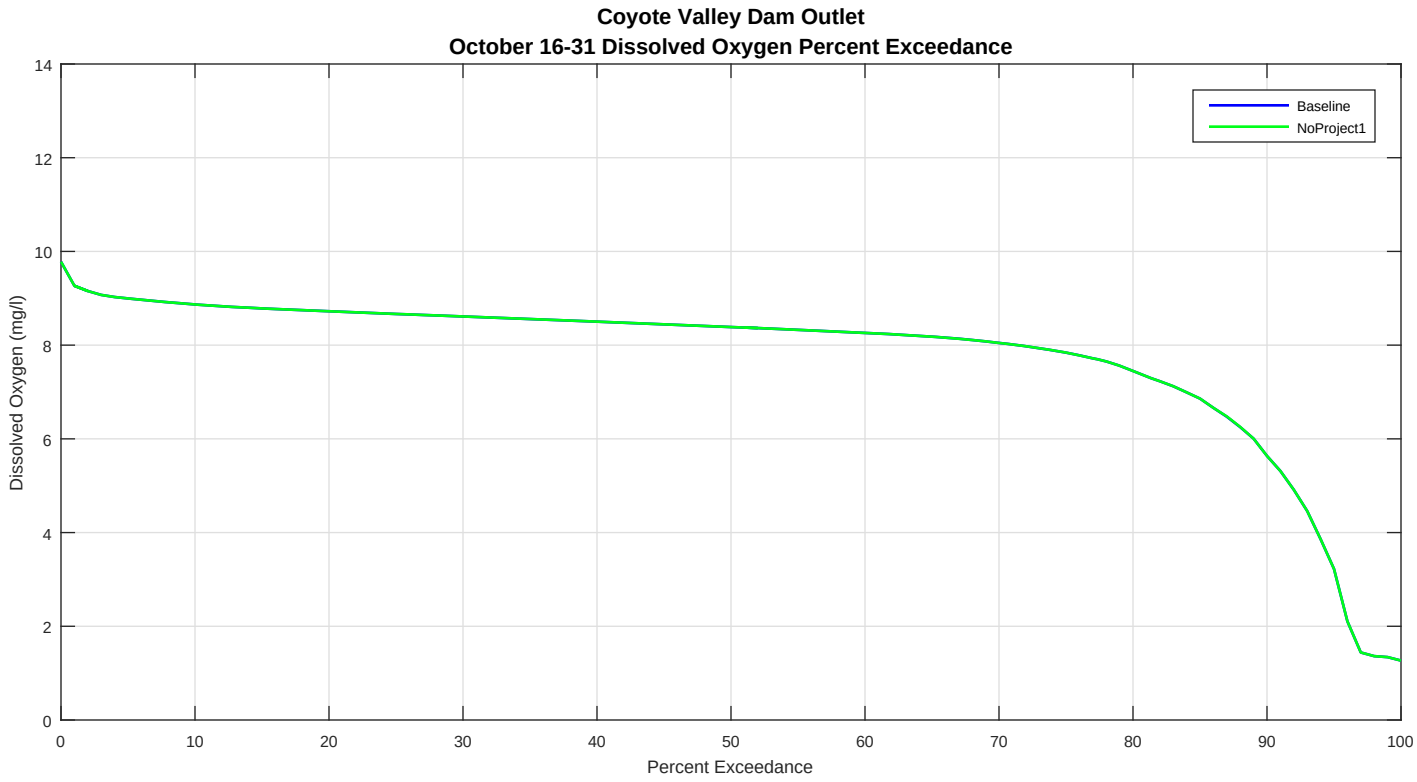

Coyote Valley Dam Outlet
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

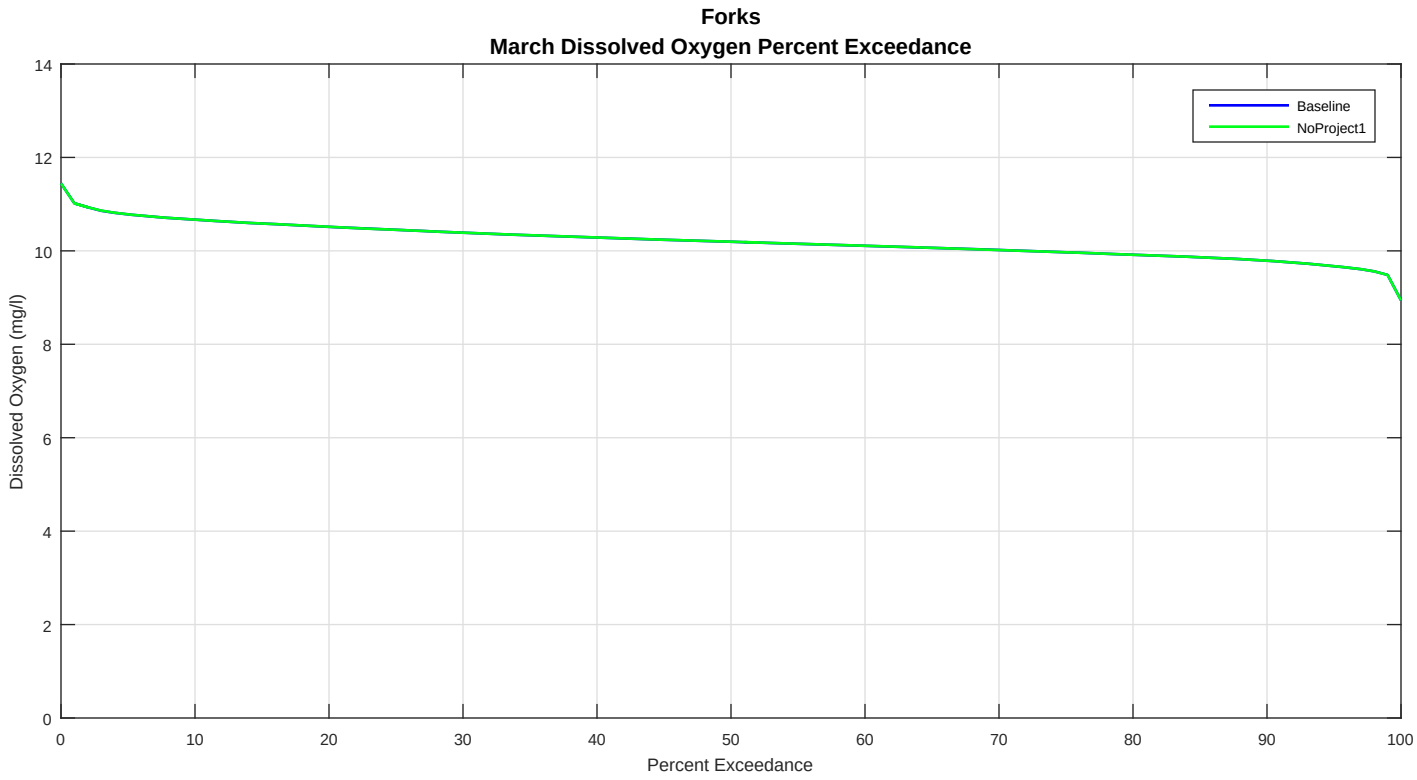

Coyote Valley Dam Outlet
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

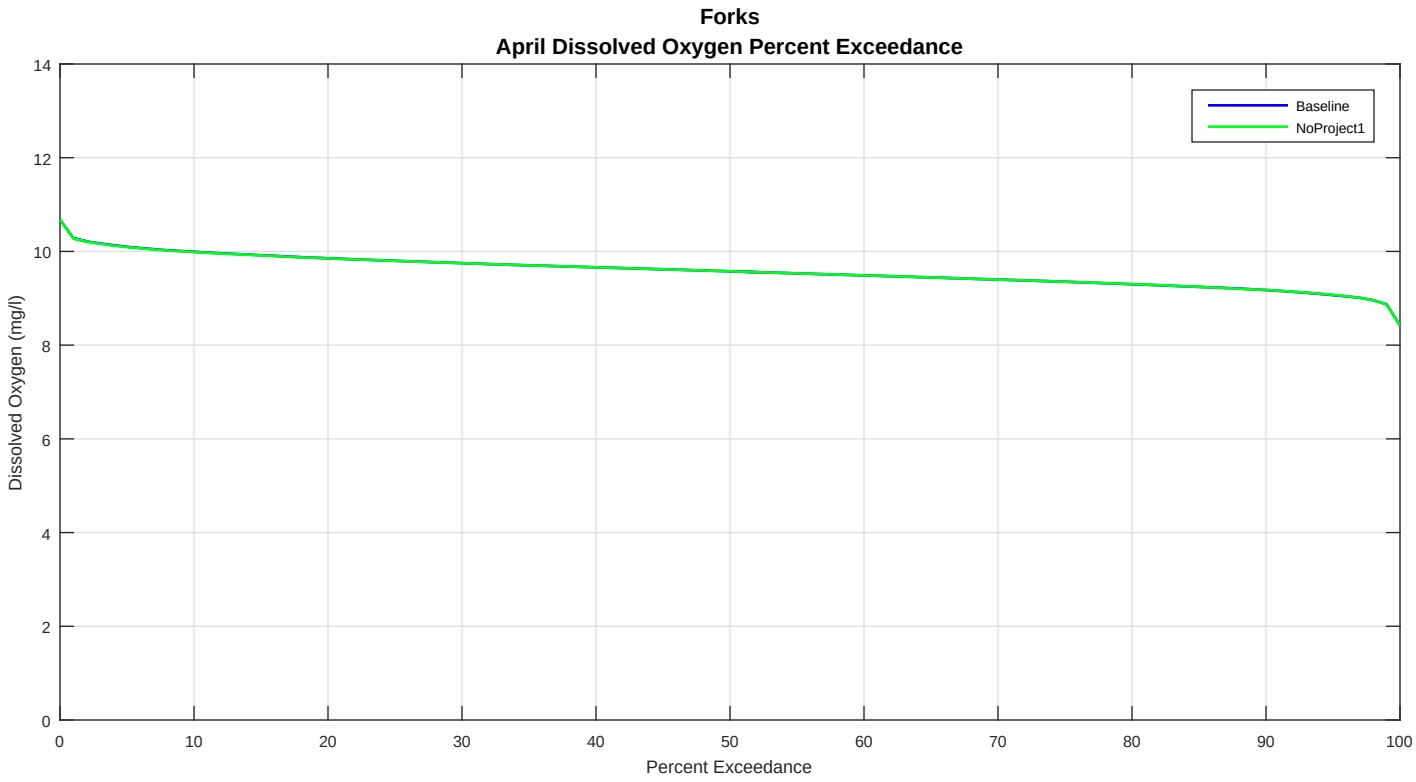

Coyote Valley Dam Outlet
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

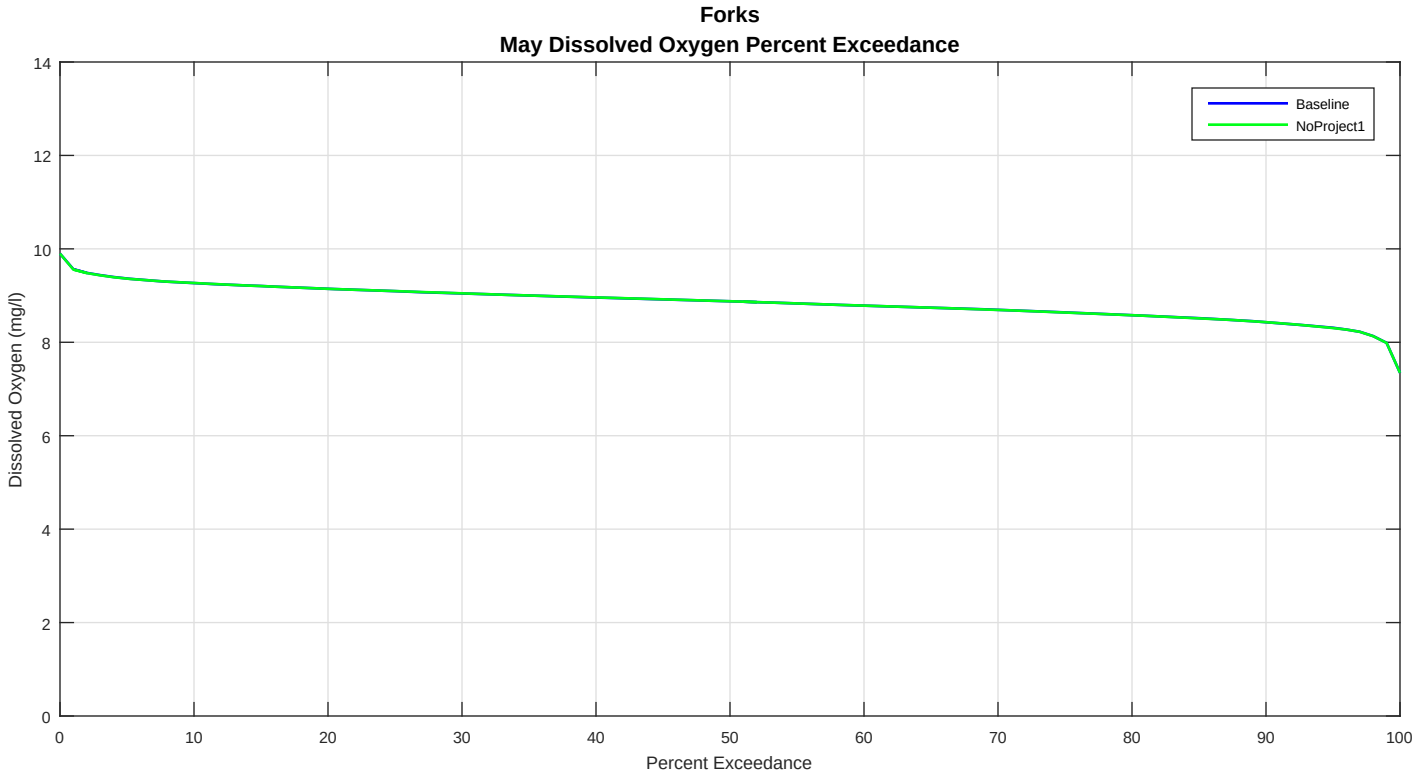

Coyote Valley Dam Outlet
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

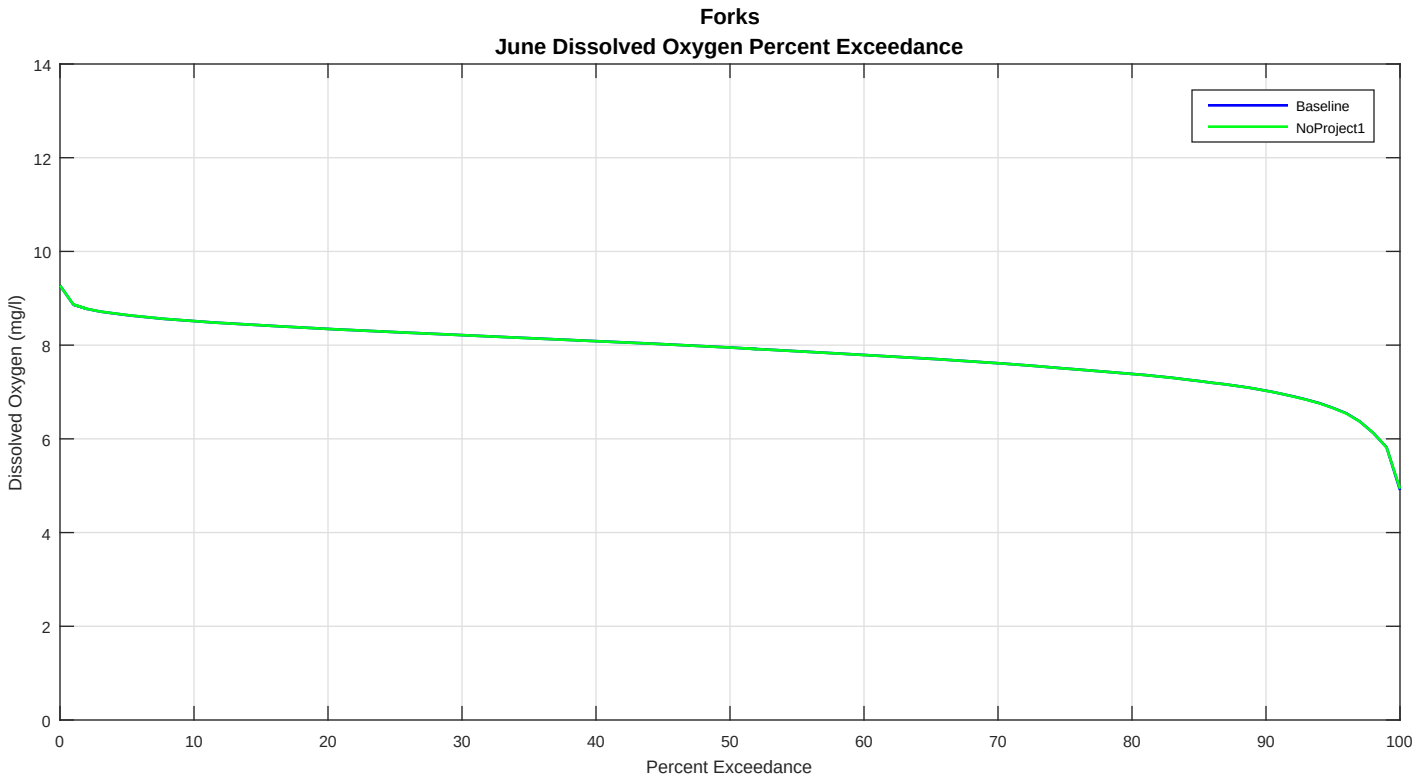

Coyote Valley Dam Outlet
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

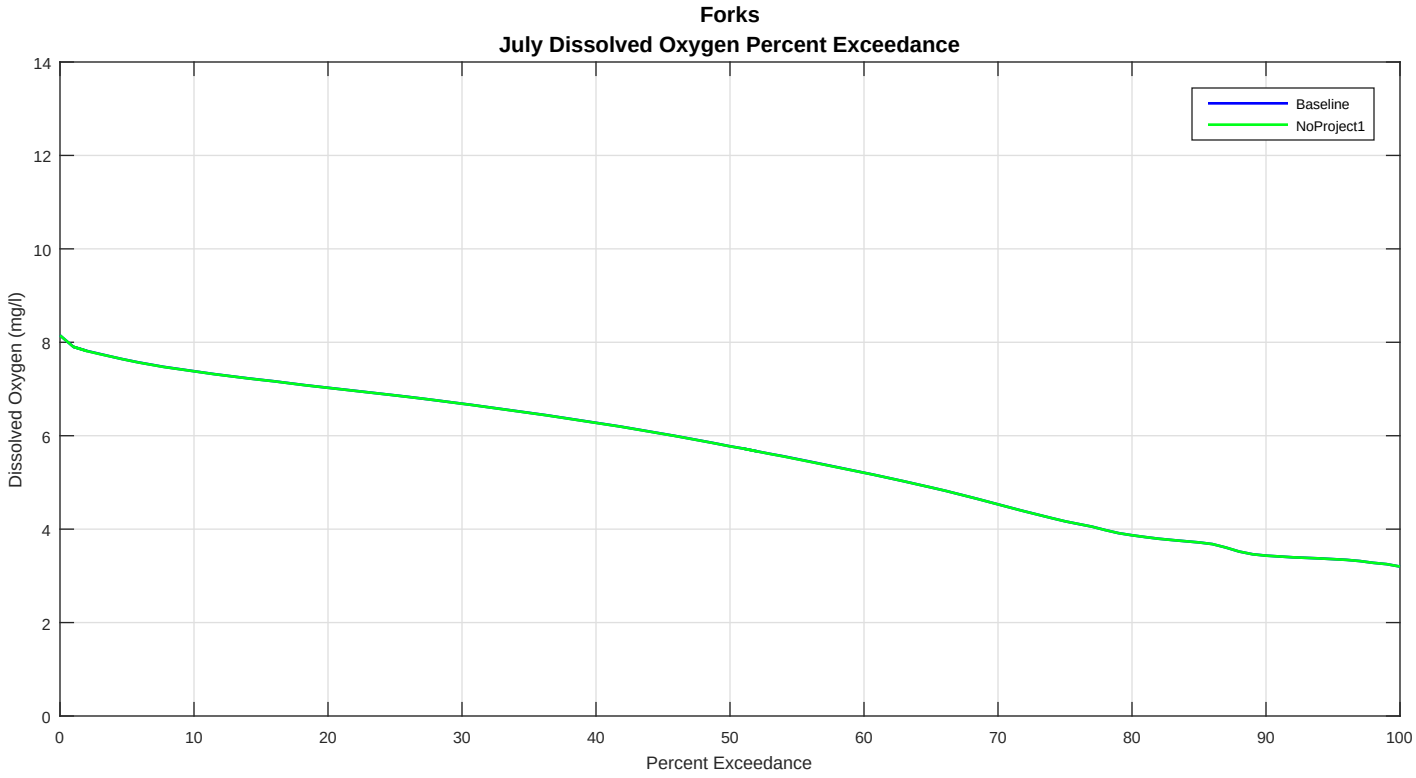

Coyote Valley Dam Outlet
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

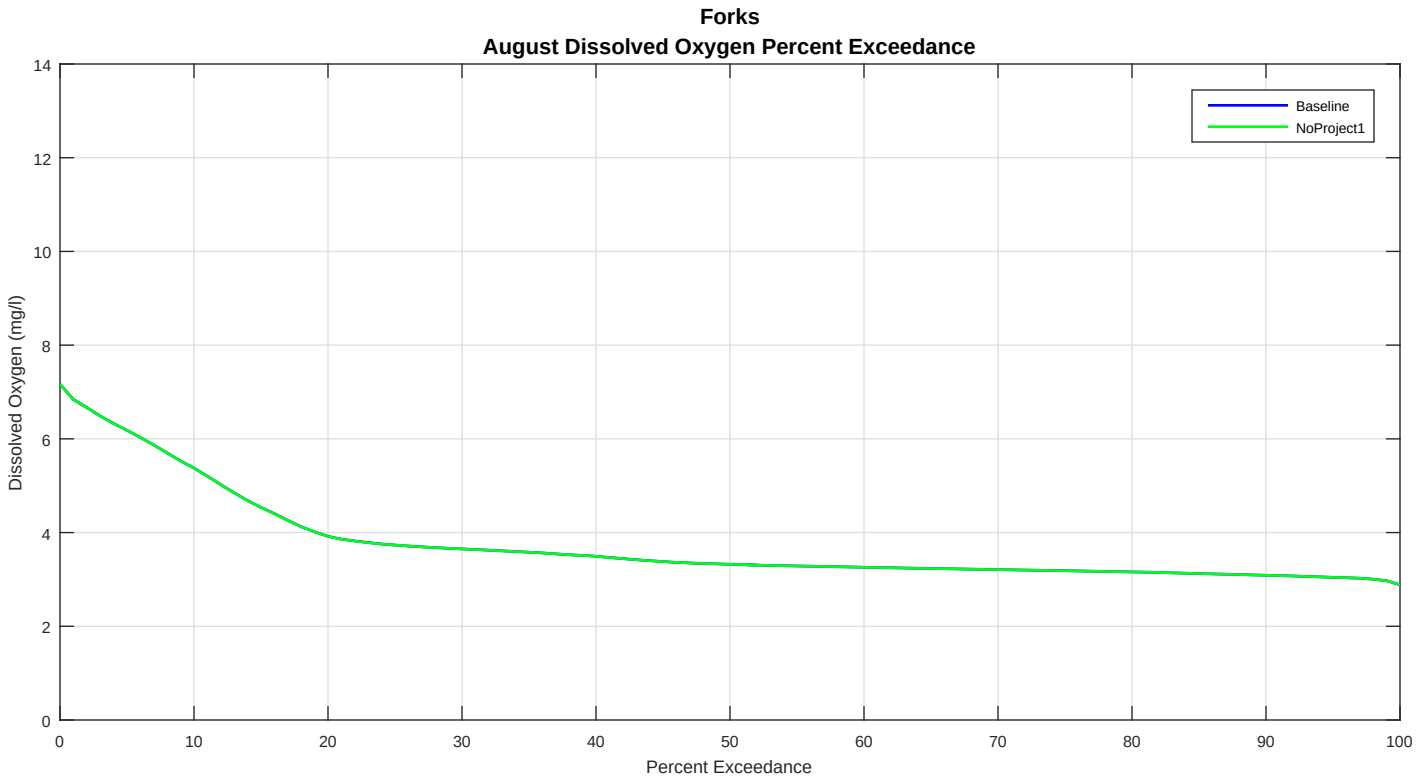

Forks
March Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

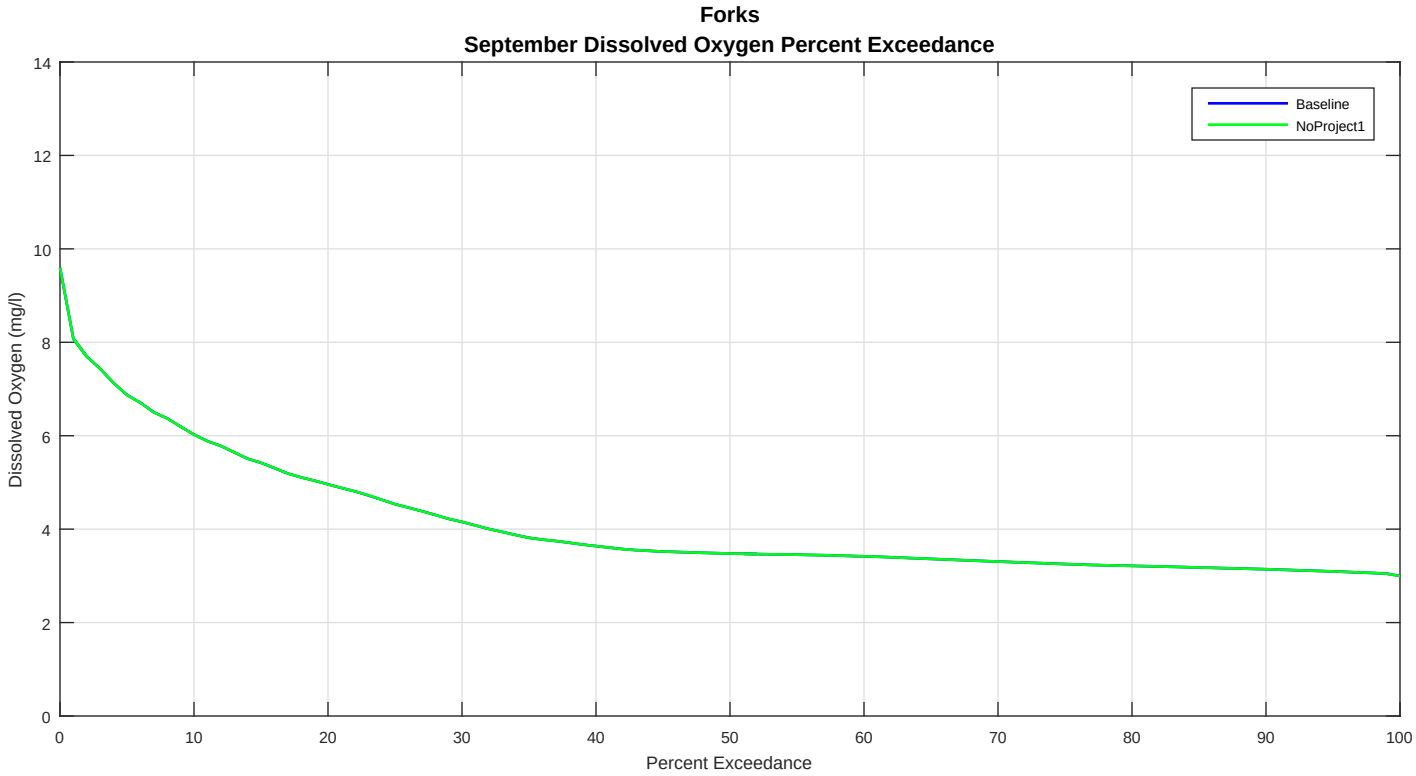

Forks
April Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

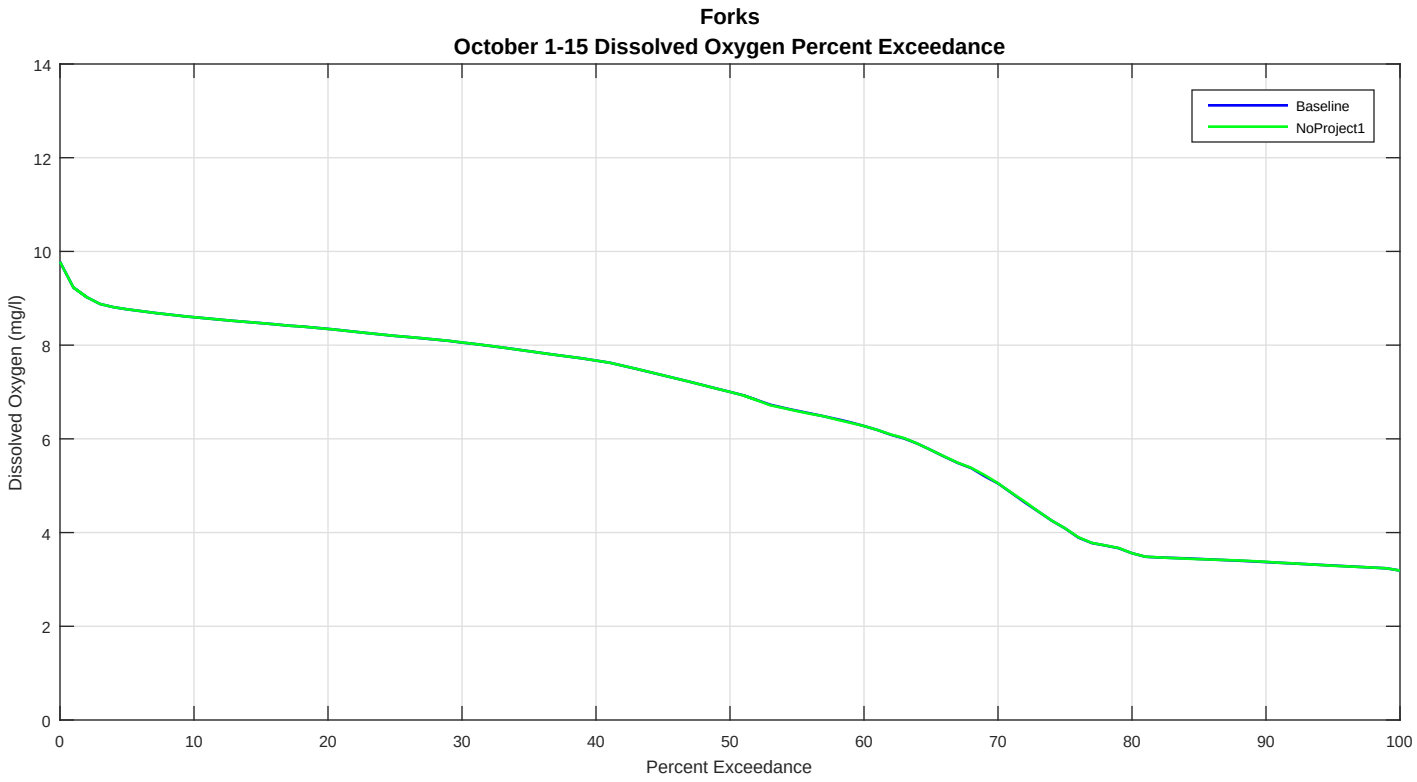

Forks
May Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

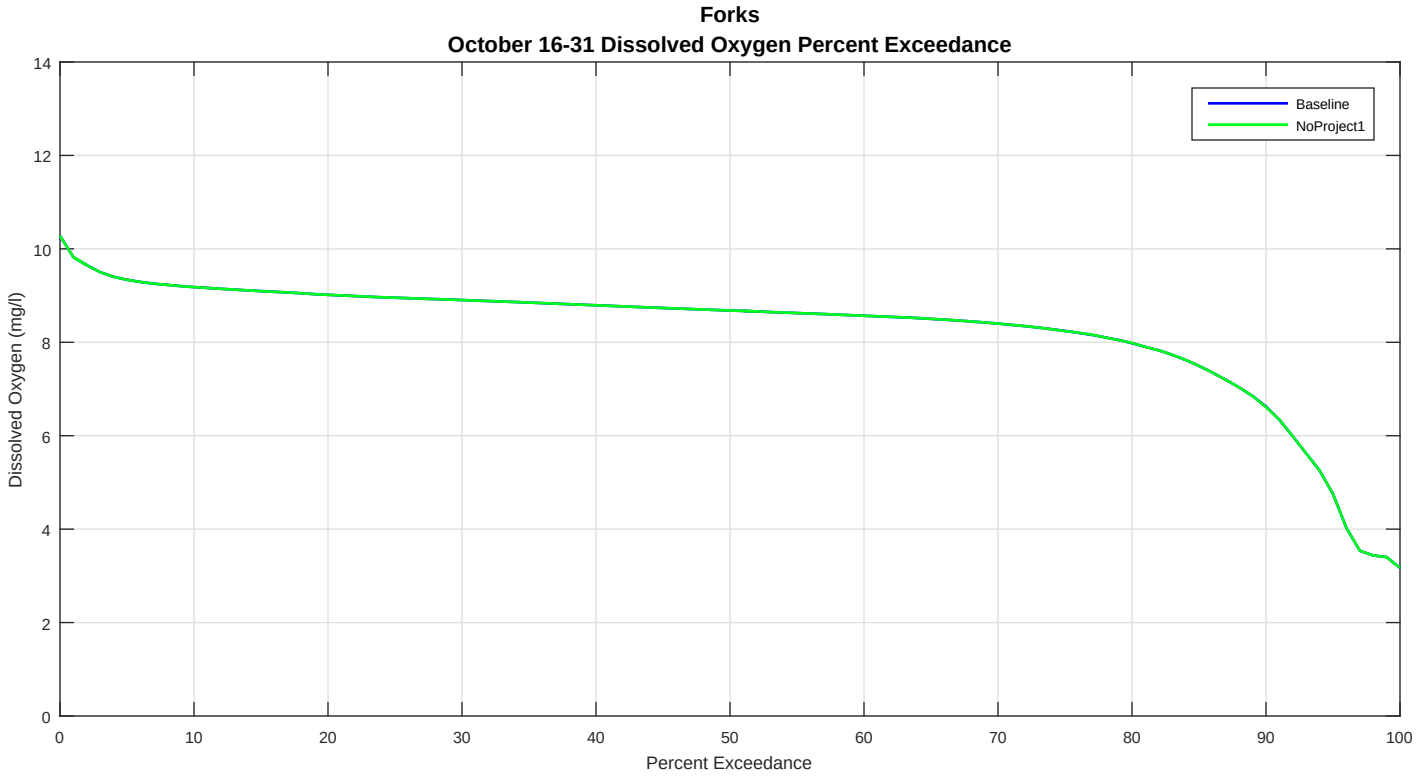

Forks
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

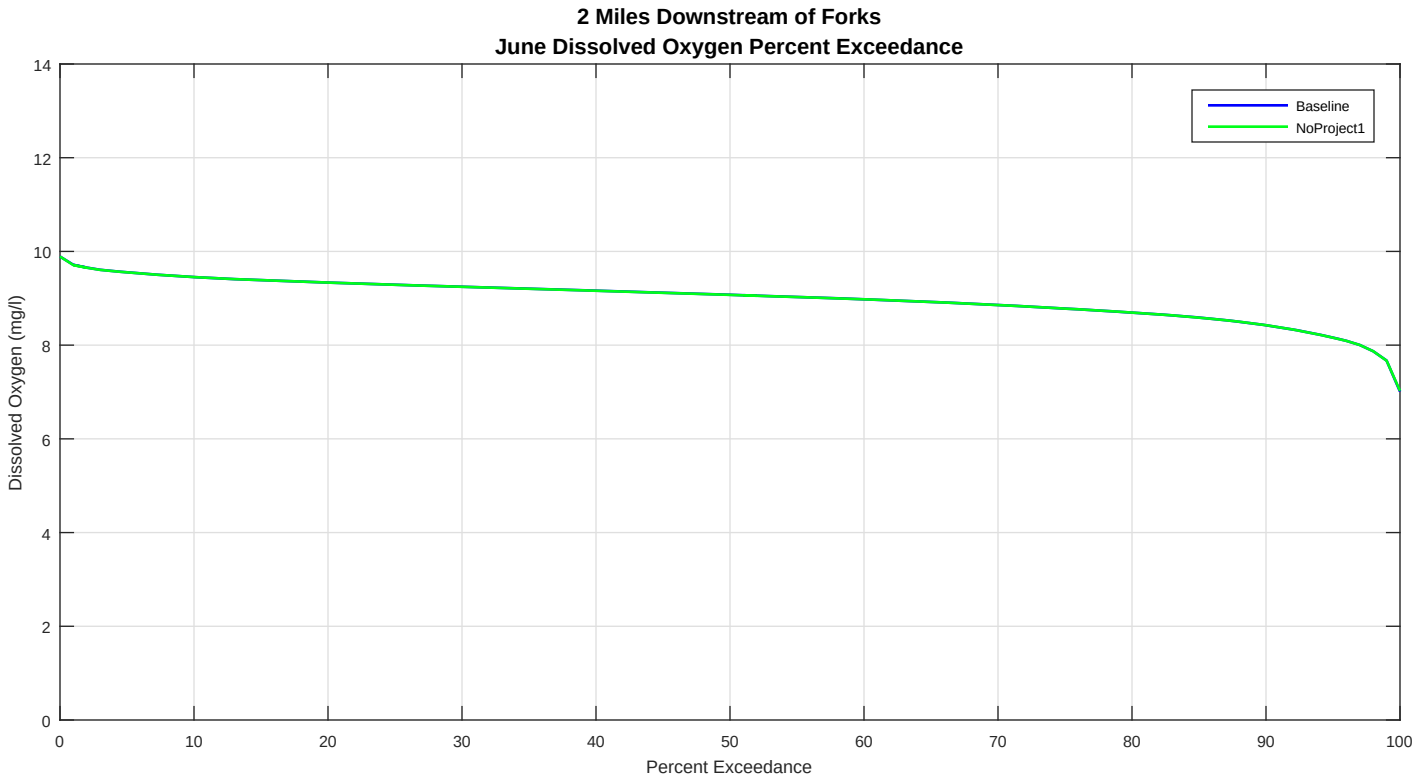

Forks
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

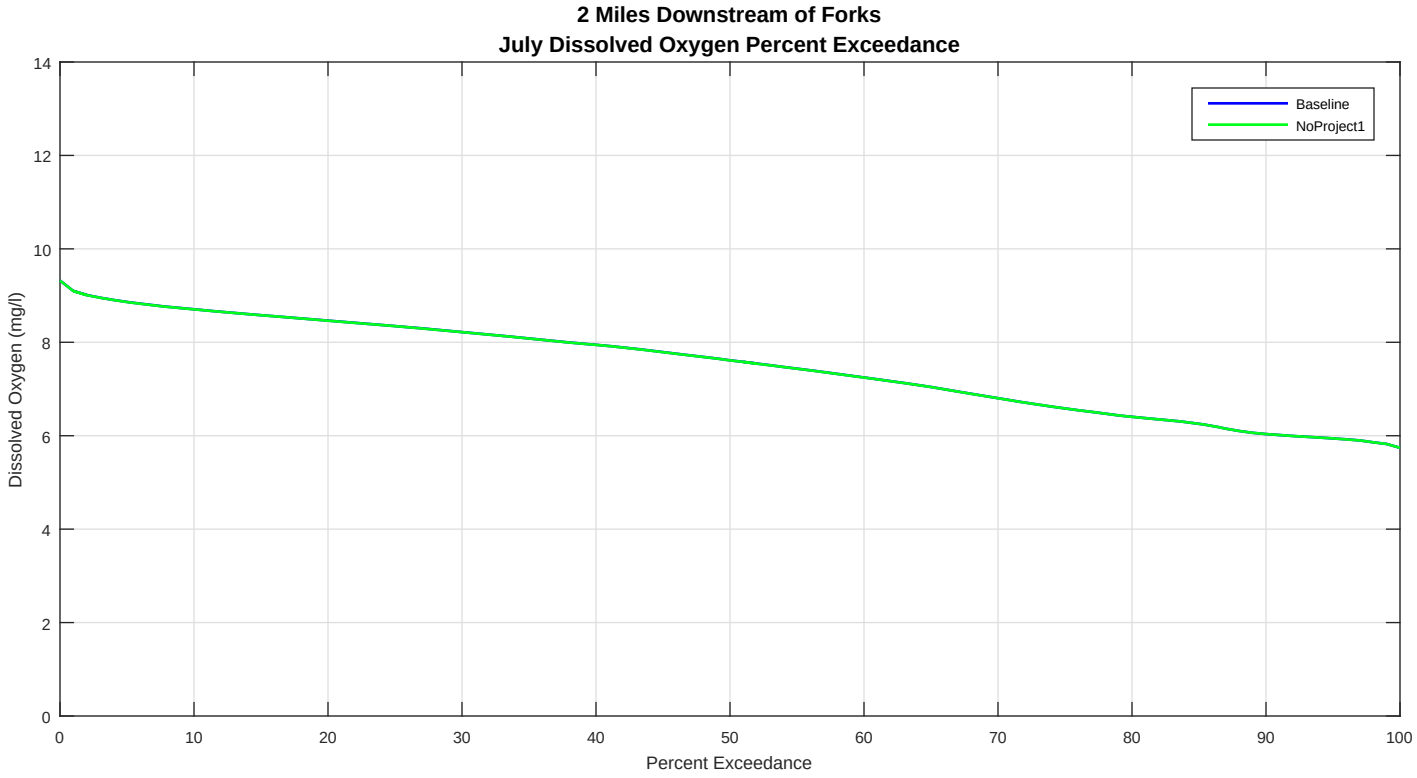

Forks
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

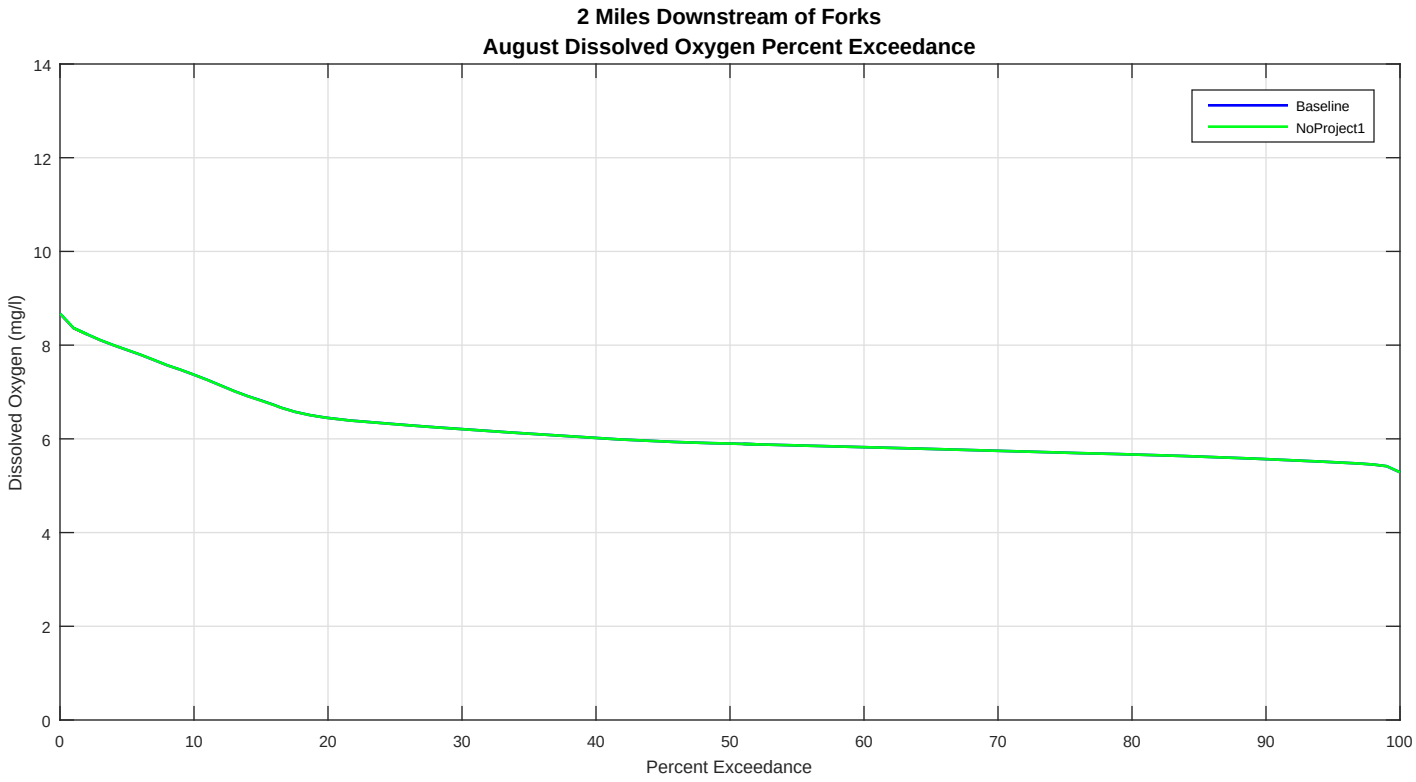

Forks
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

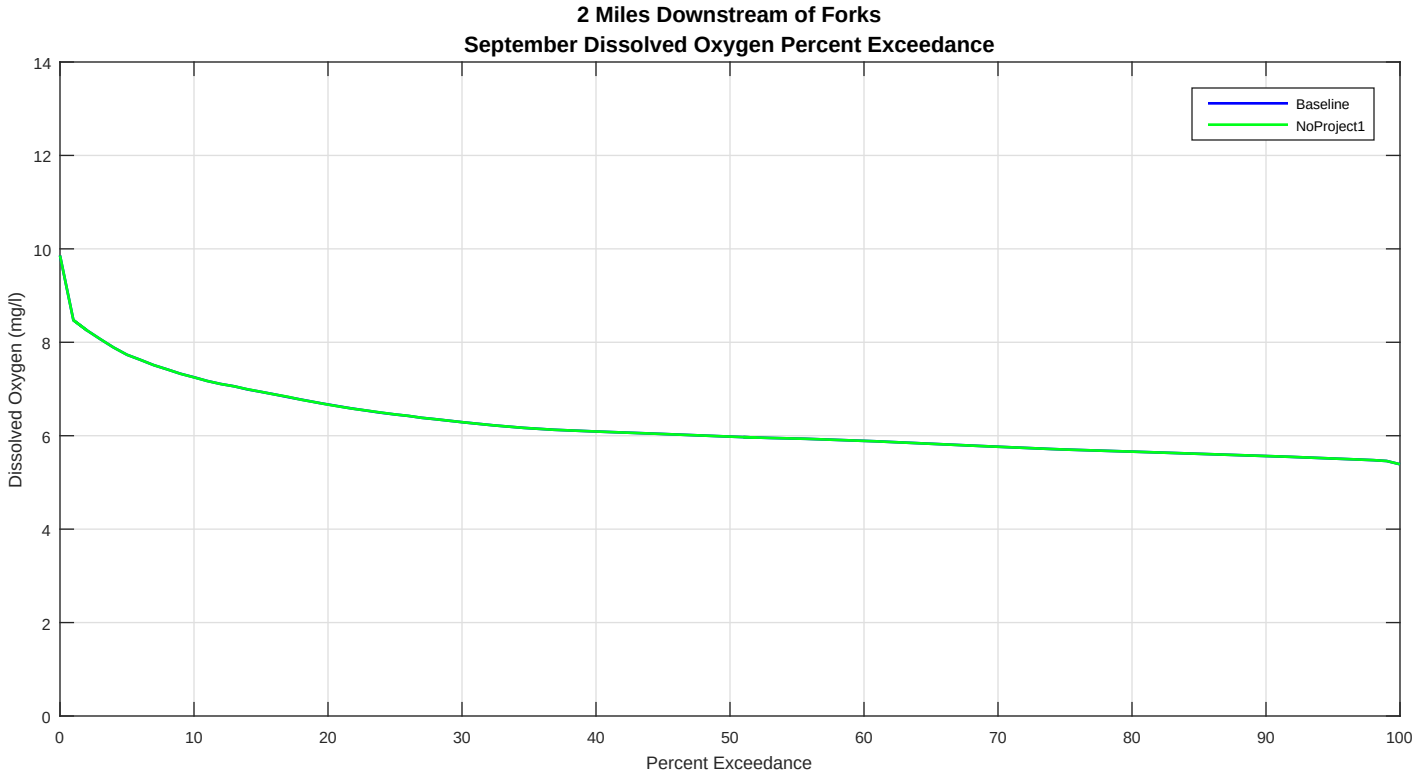

Forks
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

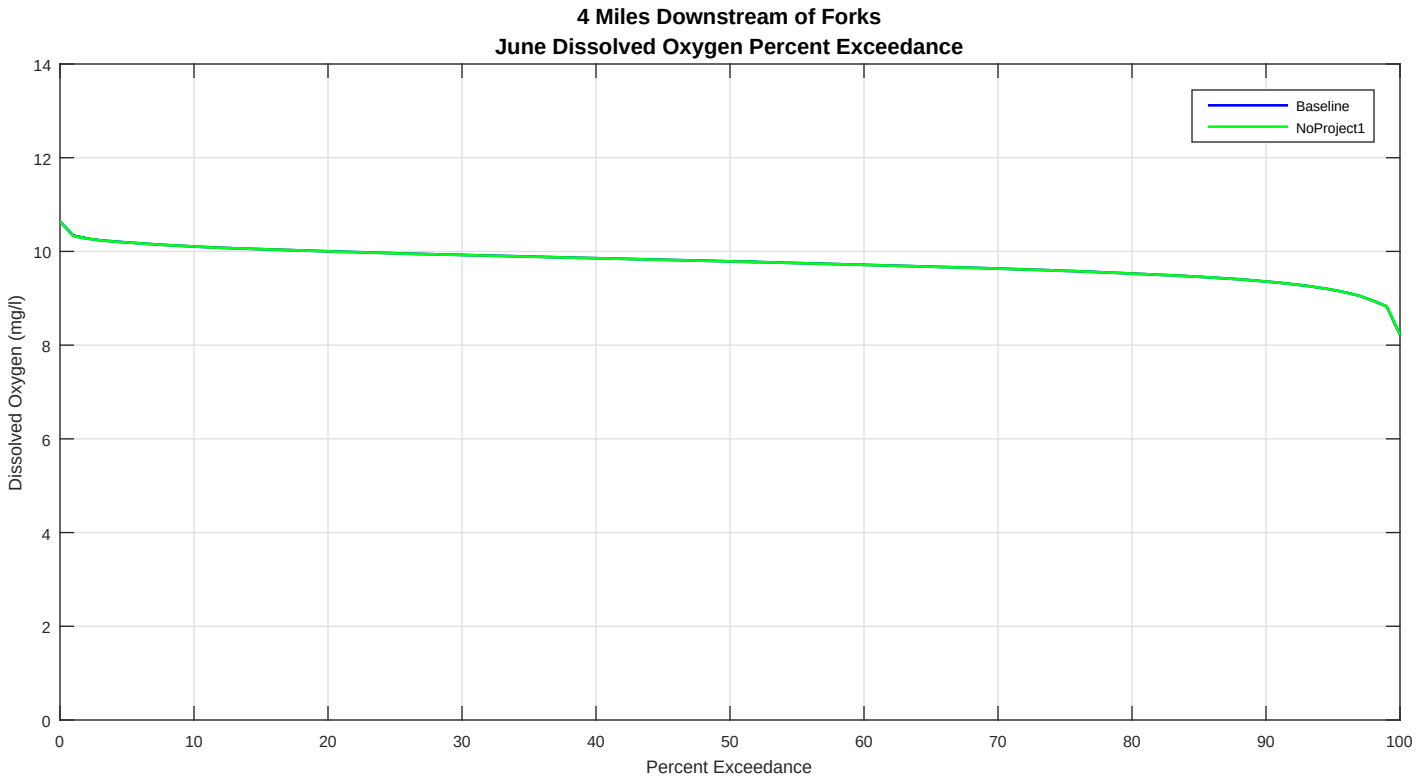

Forks
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

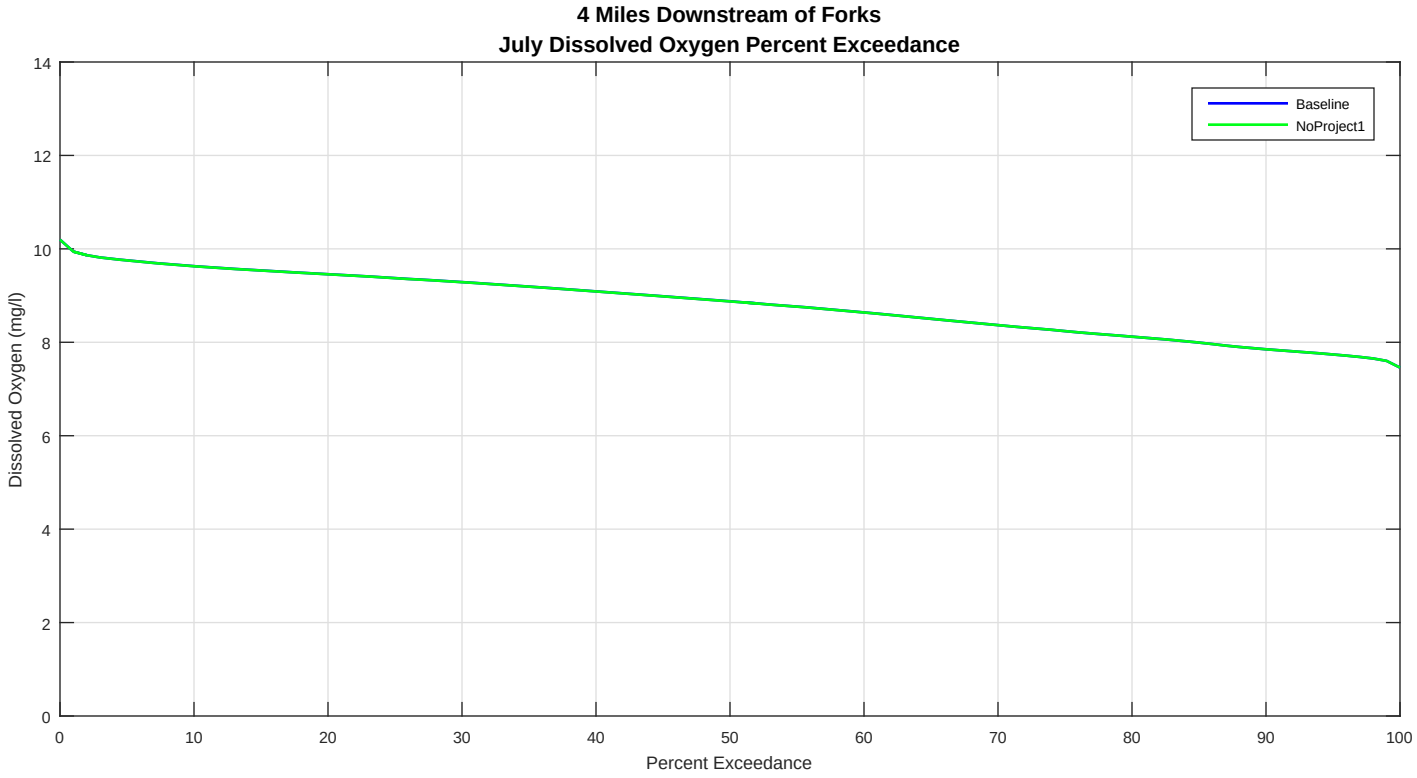

2 Miles Downstream of Forks
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

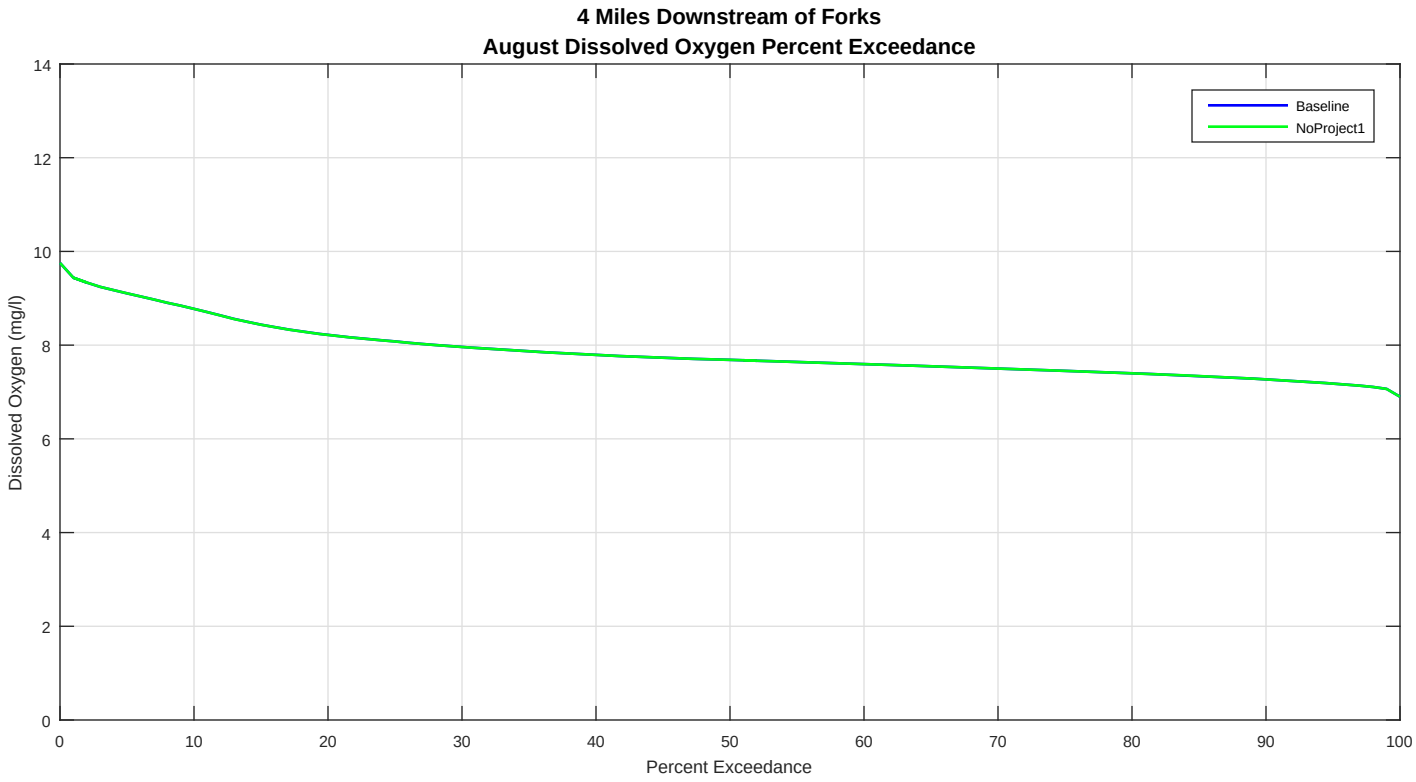

2 Miles Downstream of Forks
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

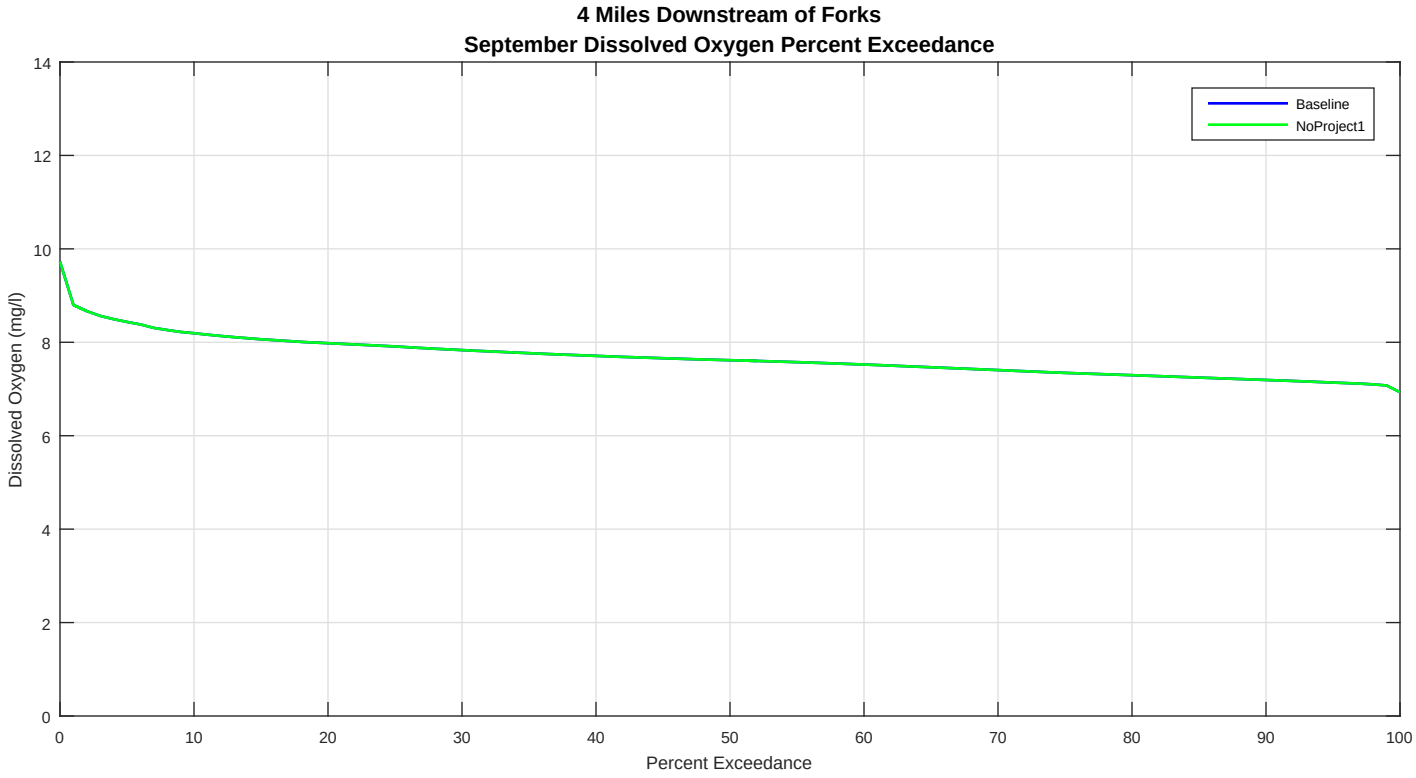

2 Miles Downstream of Forks
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

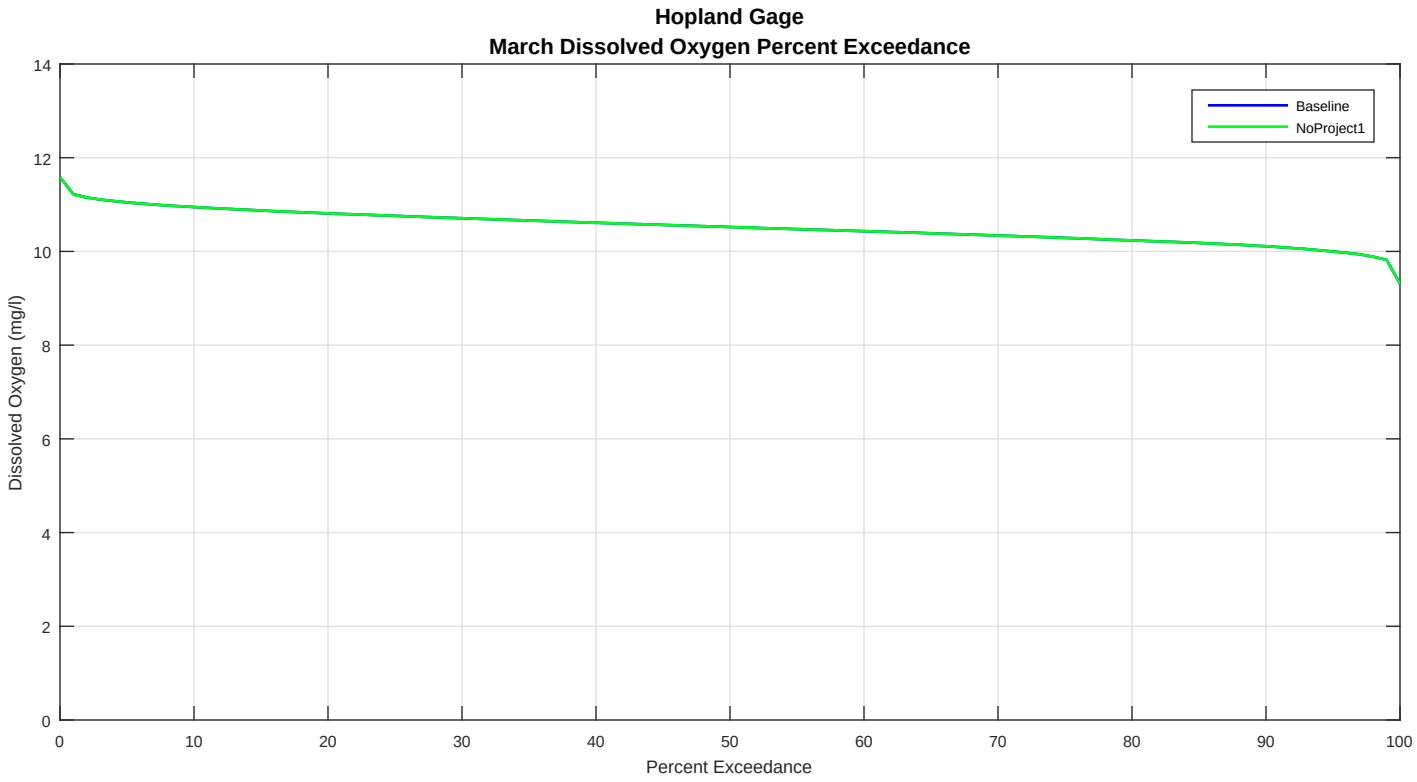

2 Miles Downstream of Forks
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

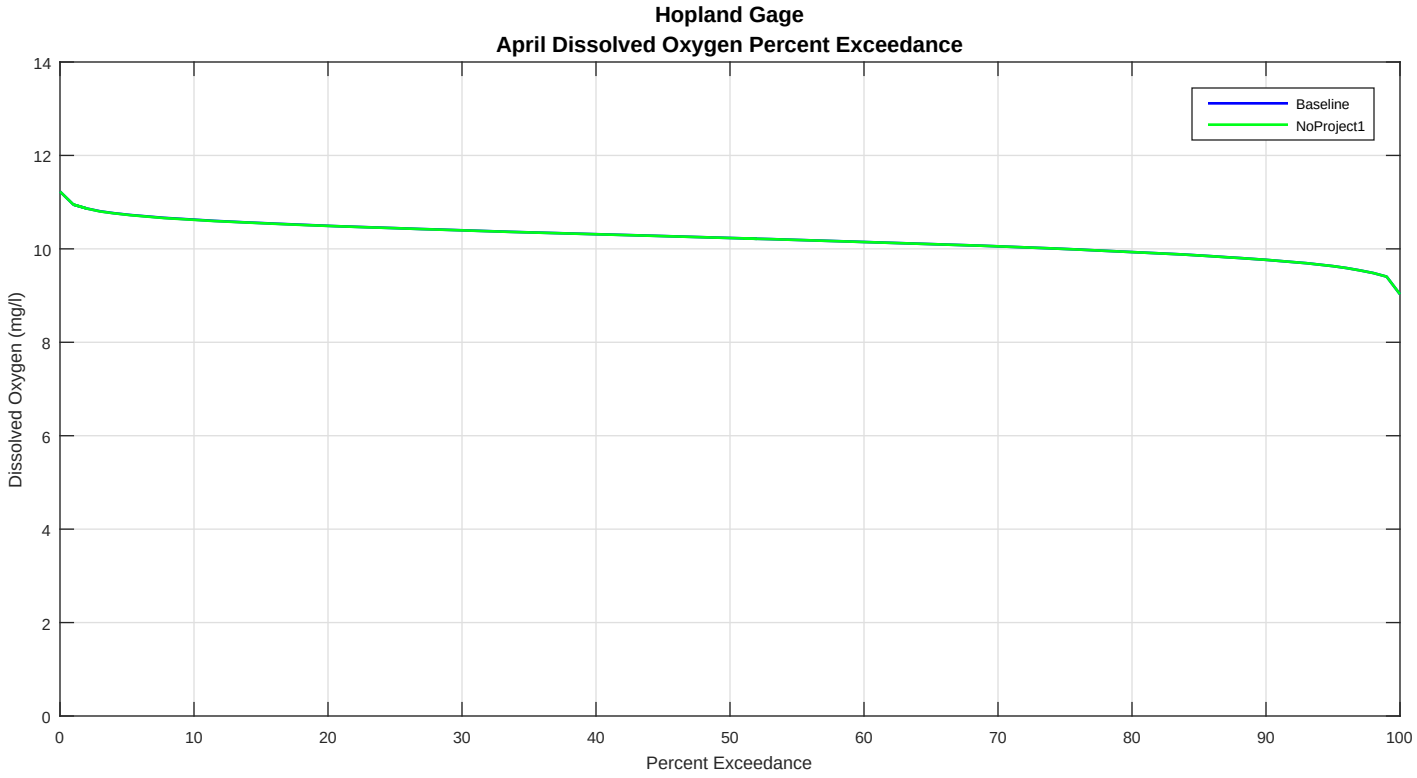

4 Miles Downstream of Forks
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

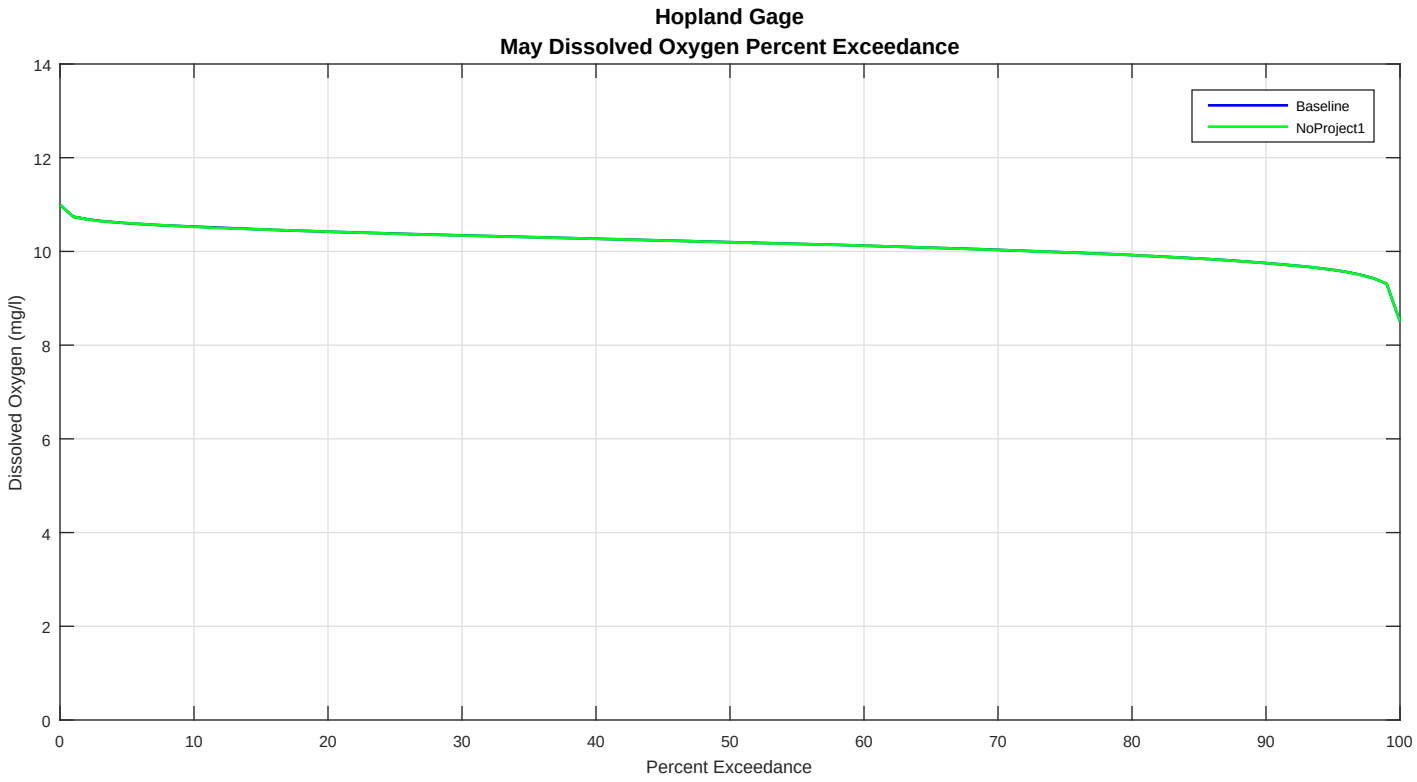

4 Miles Downstream of Forks
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

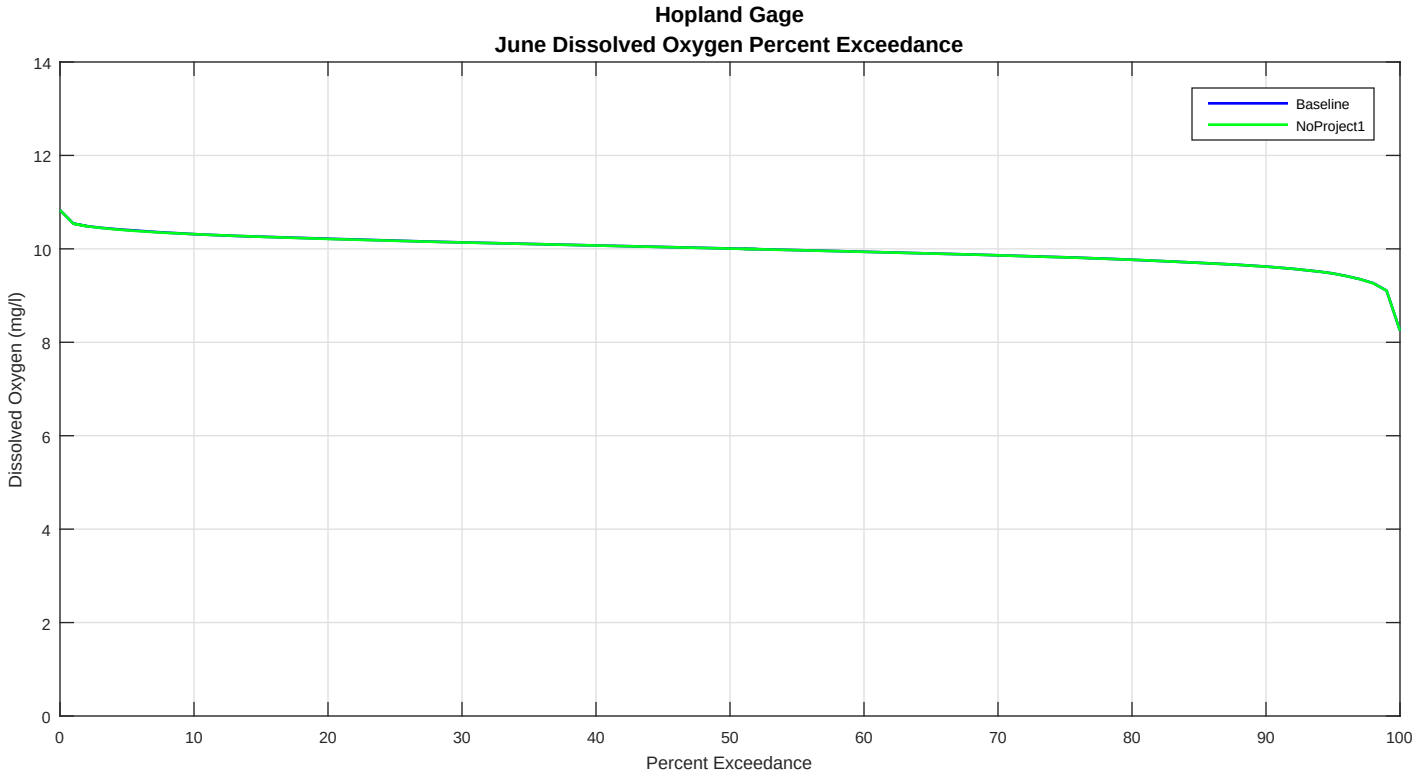

4 Miles Downstream of Forks
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

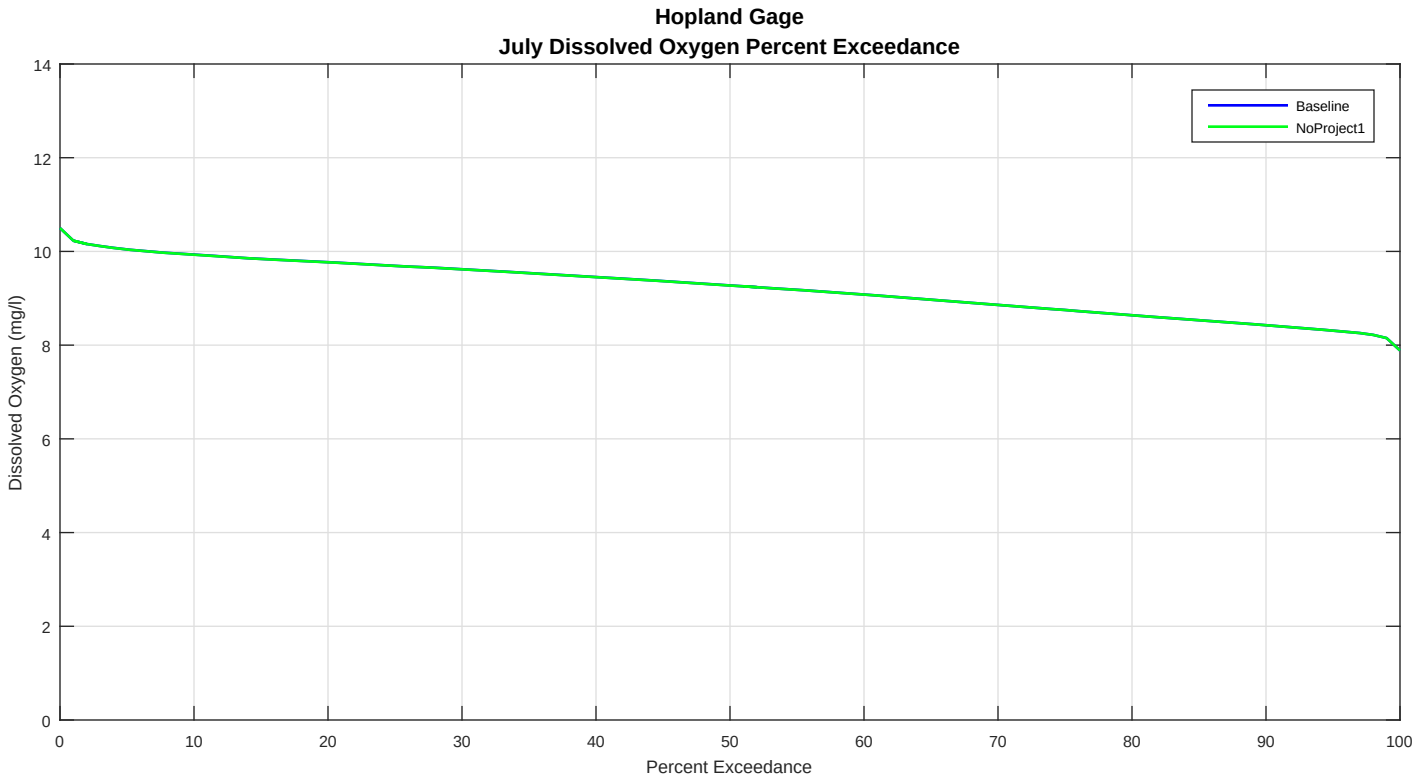

4 Miles Downstream of Forks
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

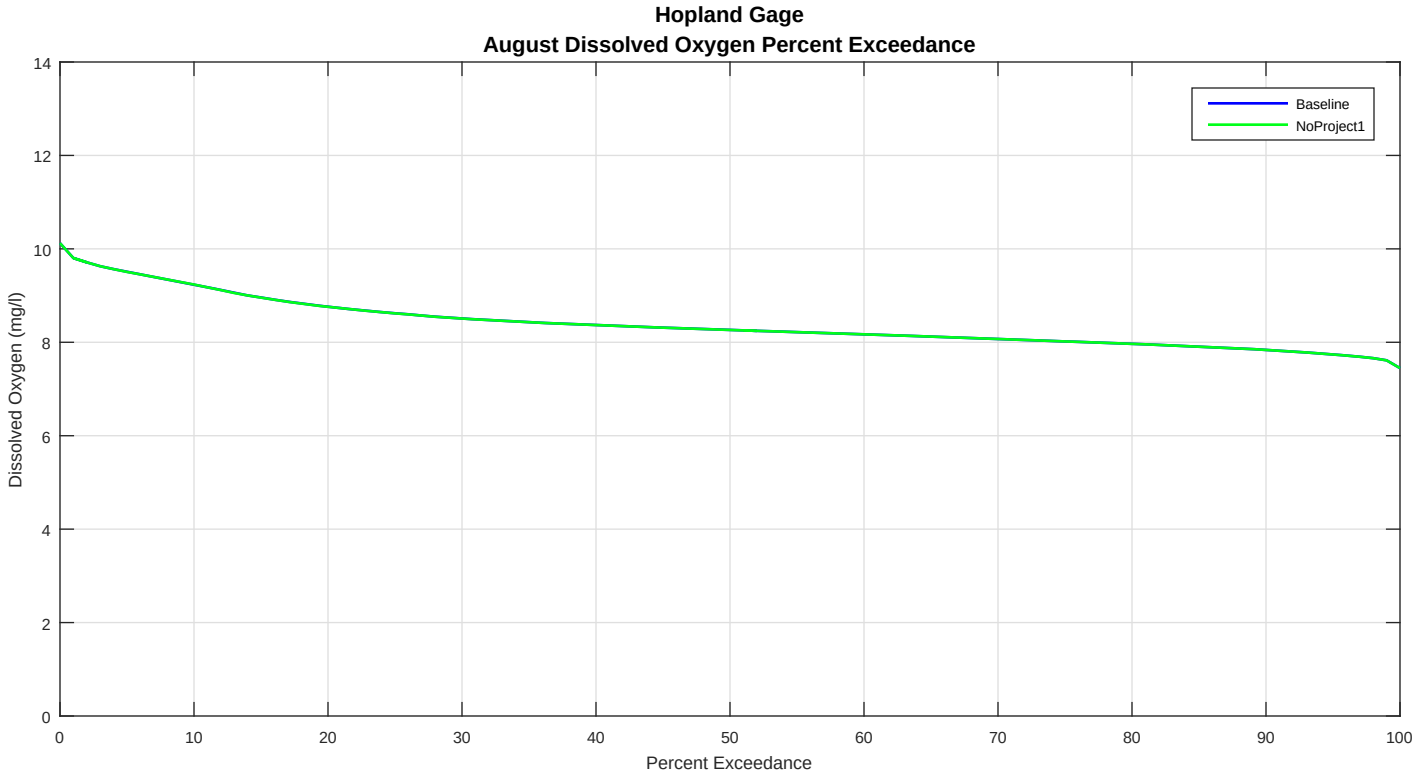

Hopland Gage
March Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

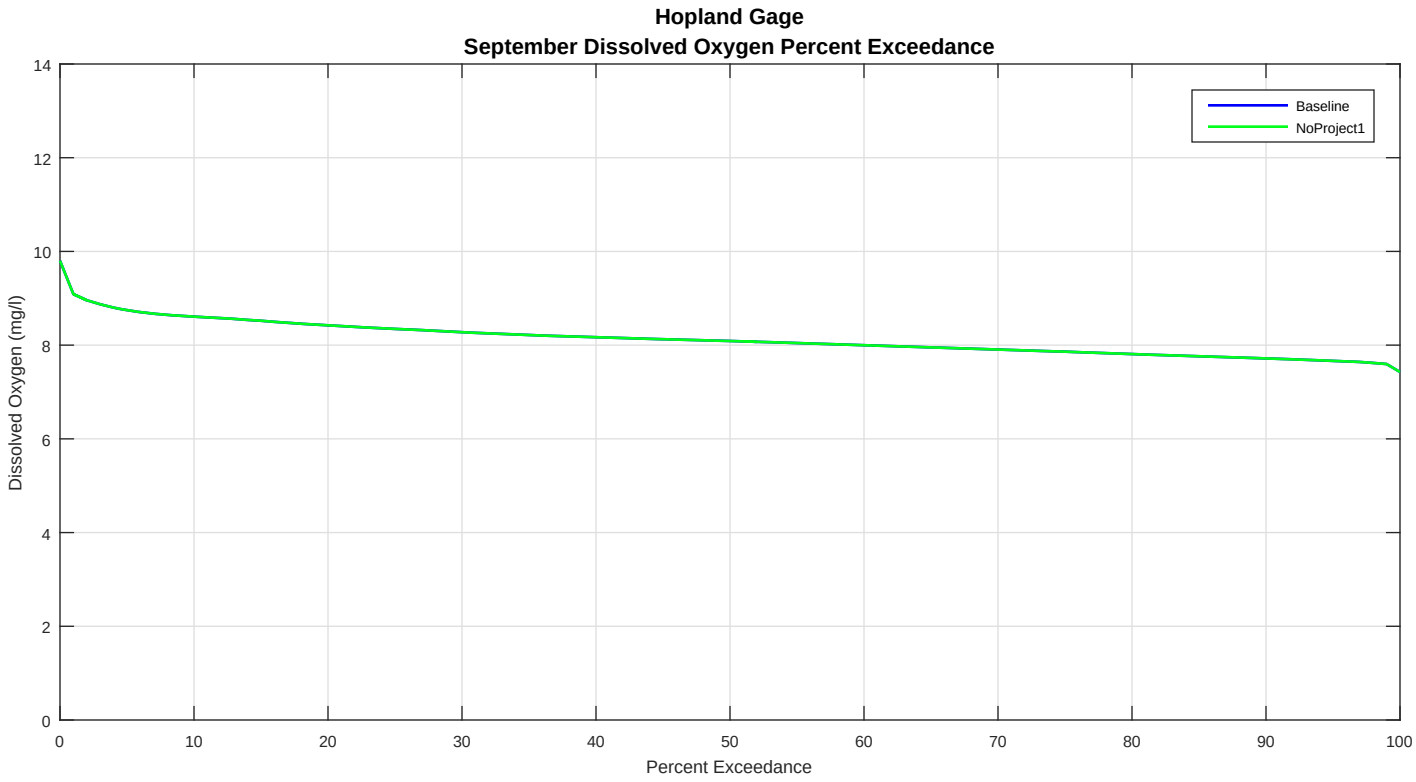

Hopland Gage
April Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

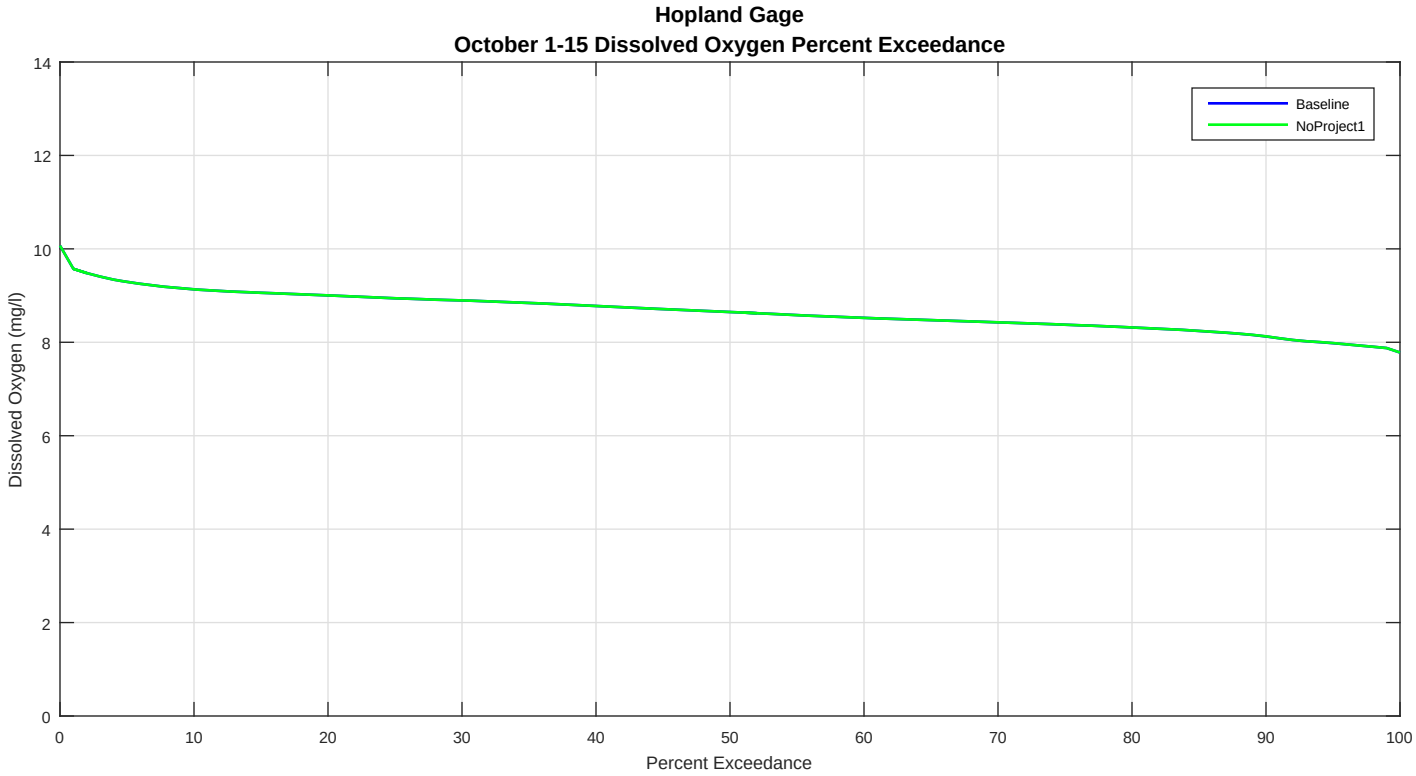

Hopland Gage
May Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

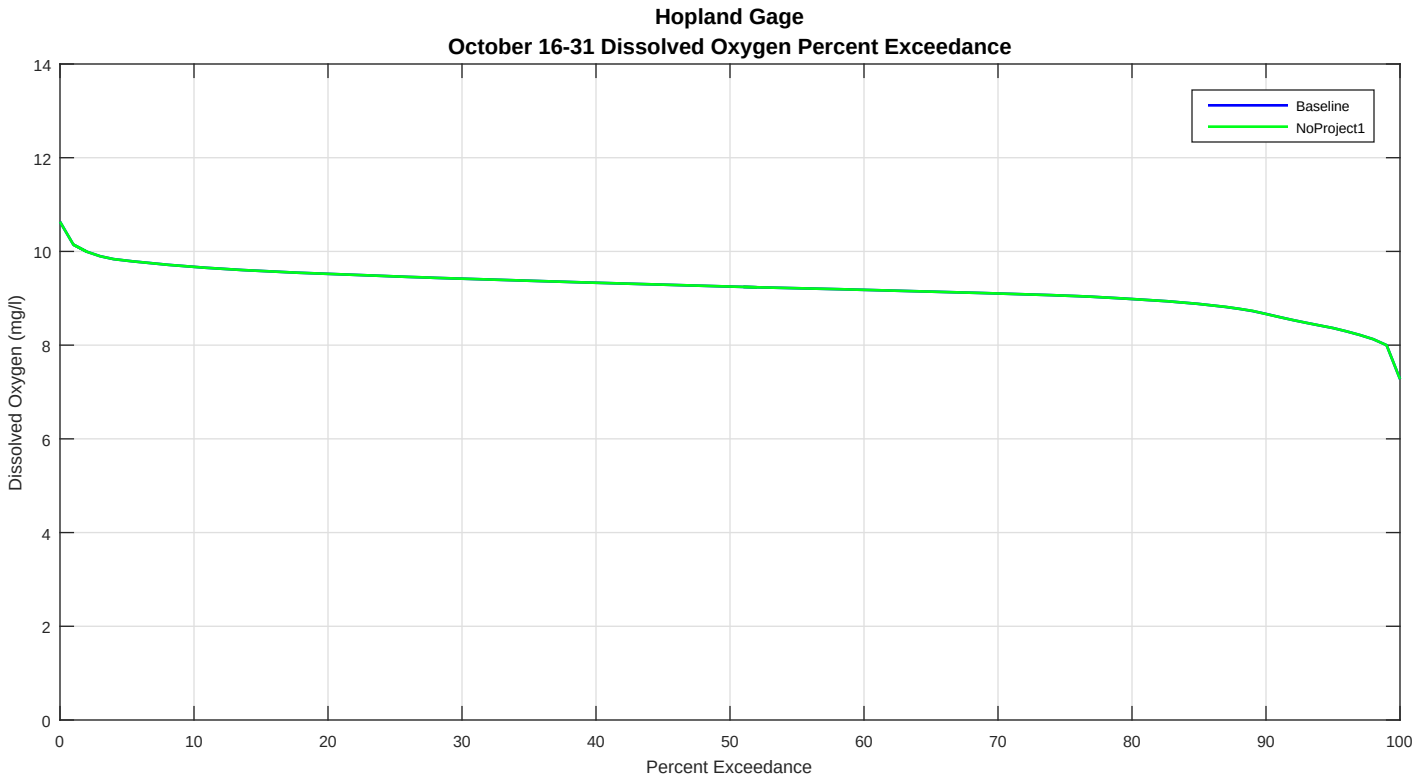

Hopland Gage
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Hopland Gage
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Hopland Gage
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Hopland Gage
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Hopland Gage
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Hopland Gage
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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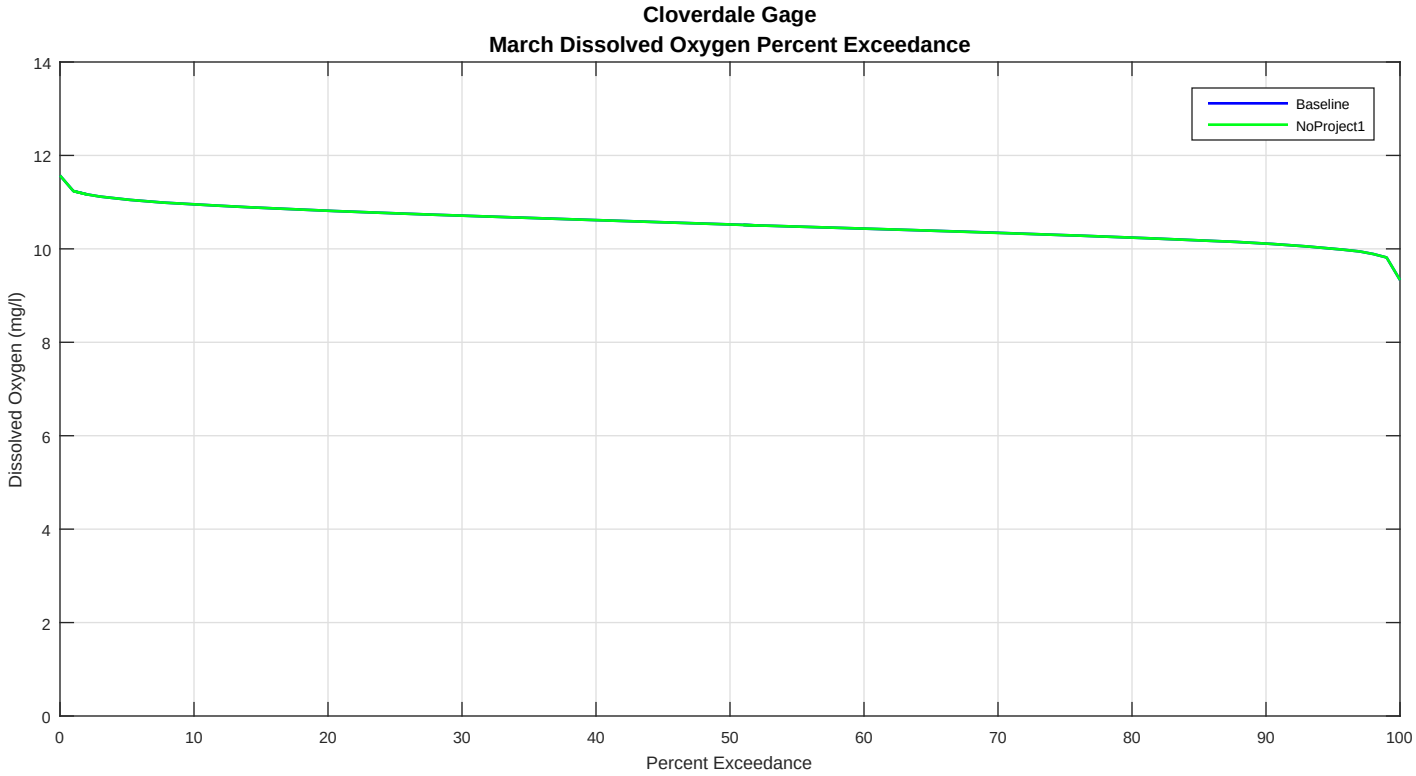
Cloverdale Gage
March Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
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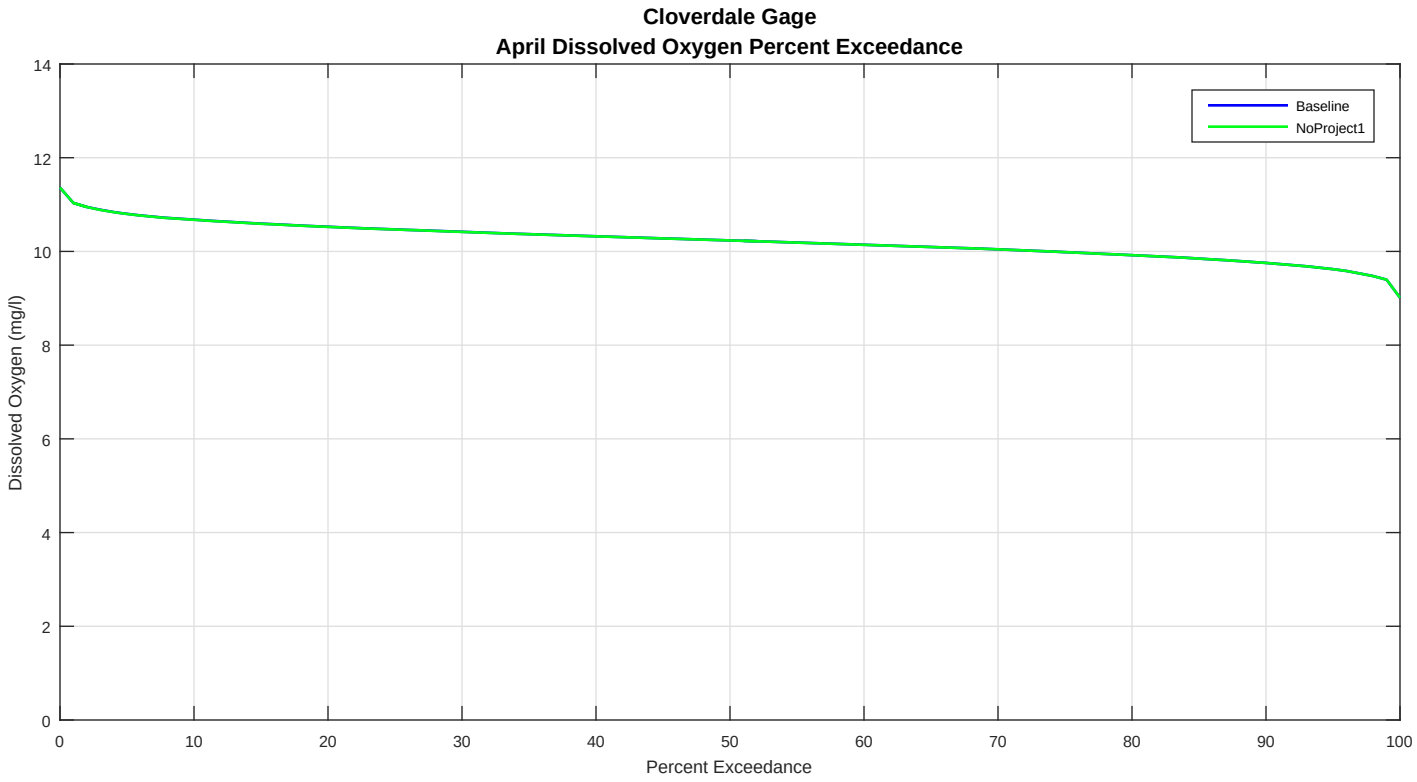
Cloverdale Gage
April Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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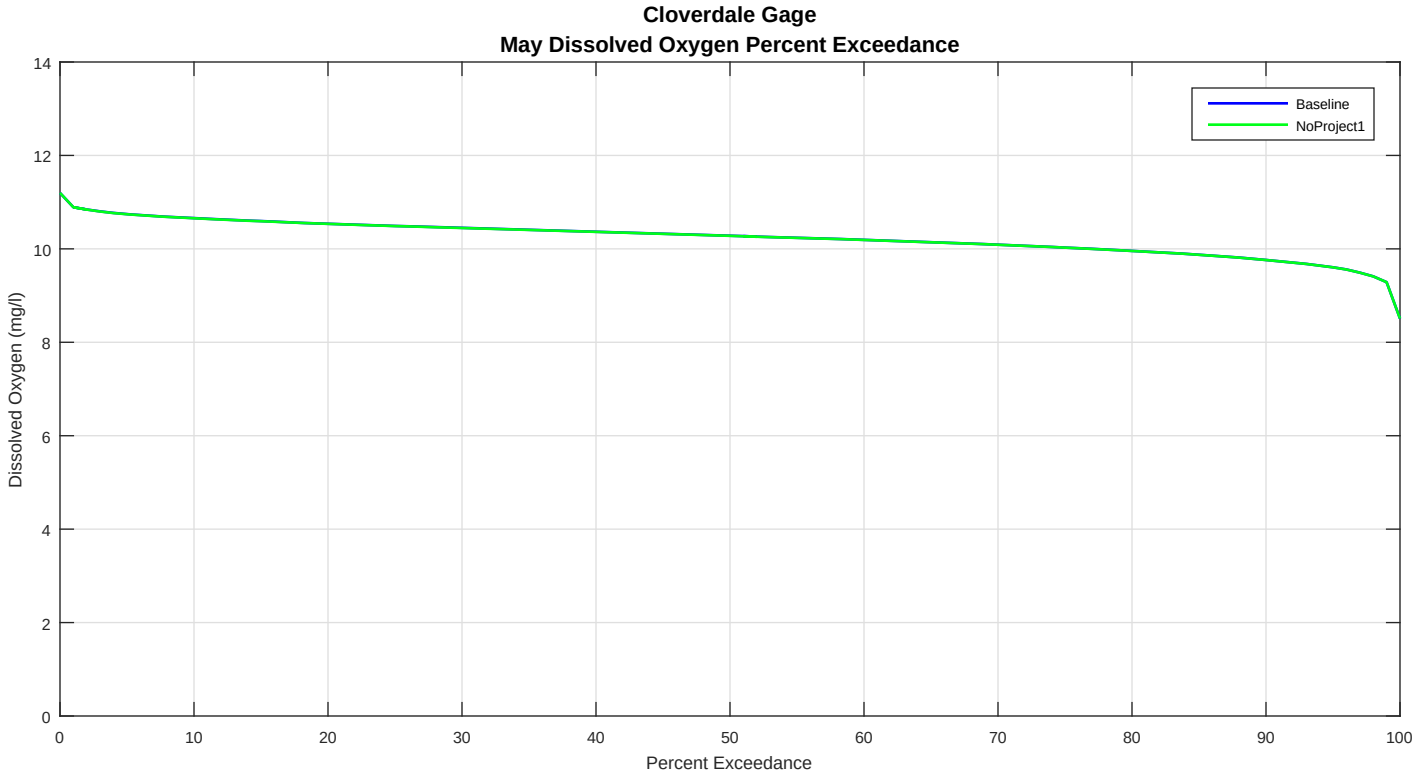
Cloverdale Gage
May Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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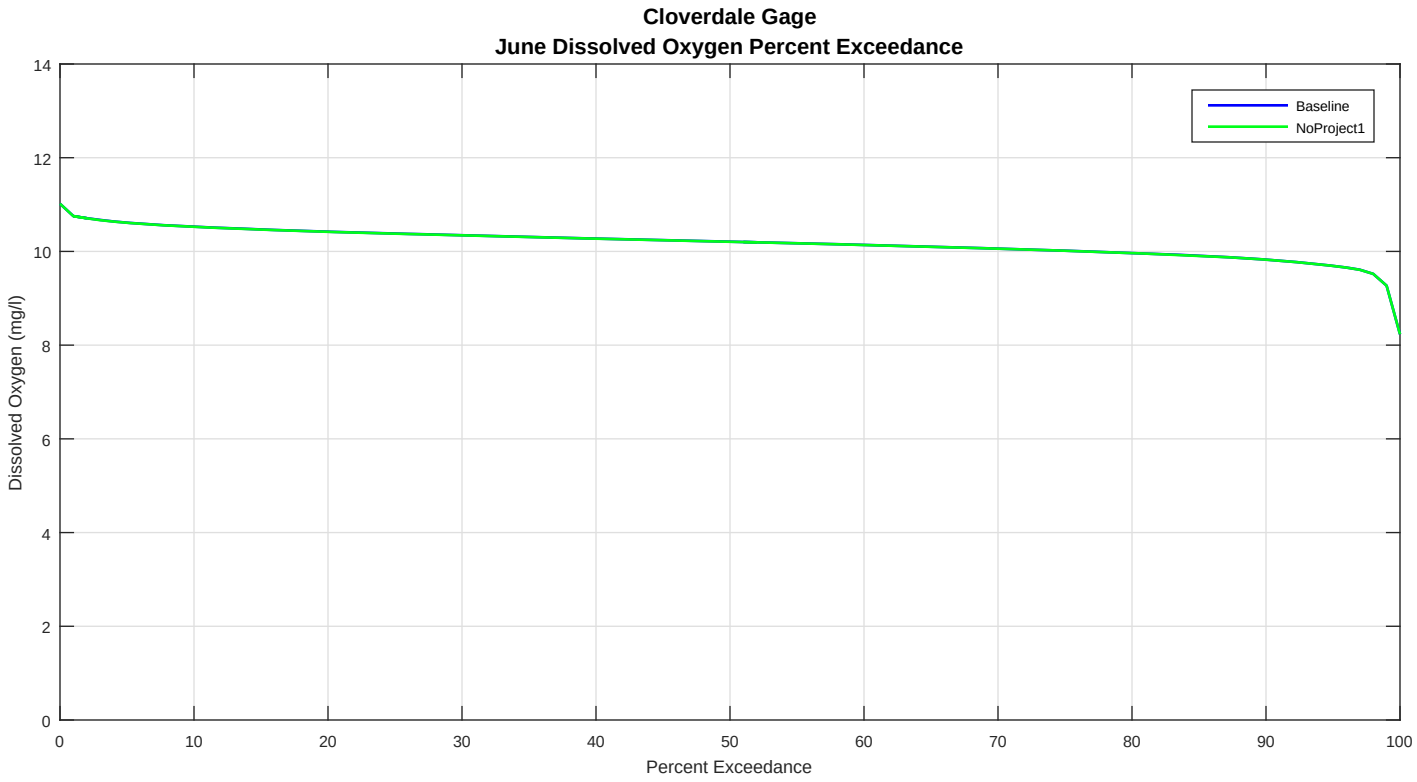
Cloverdale Gage
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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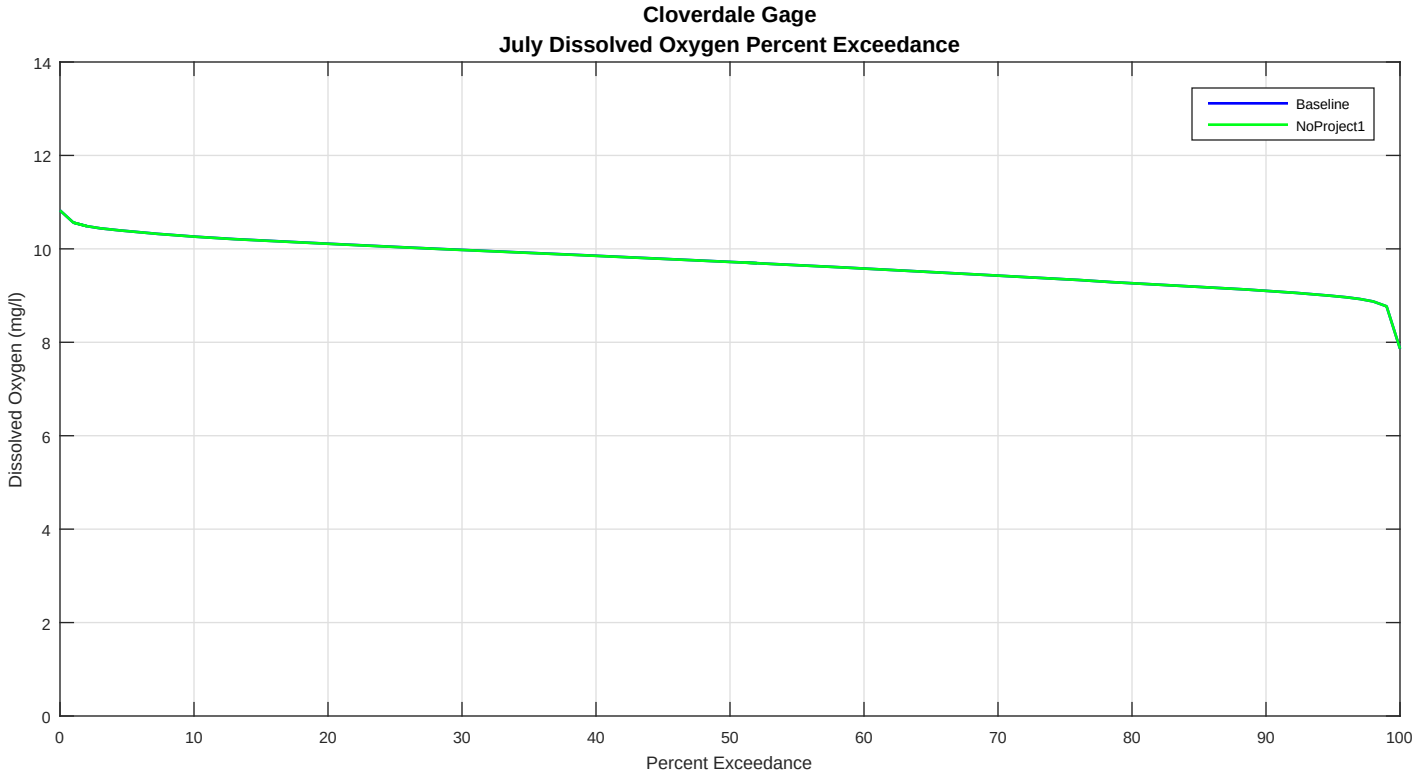
Cloverdale Gage
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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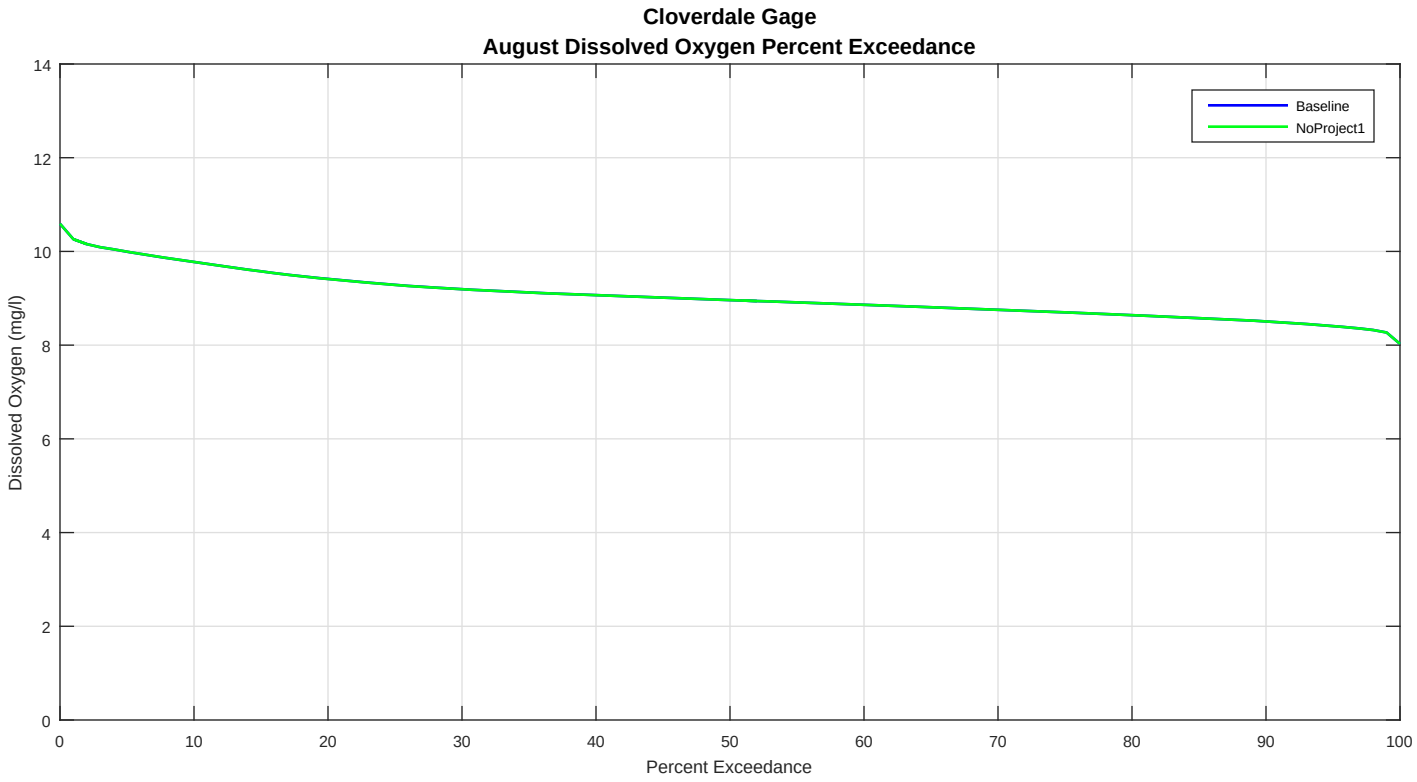
Cloverdale Gage
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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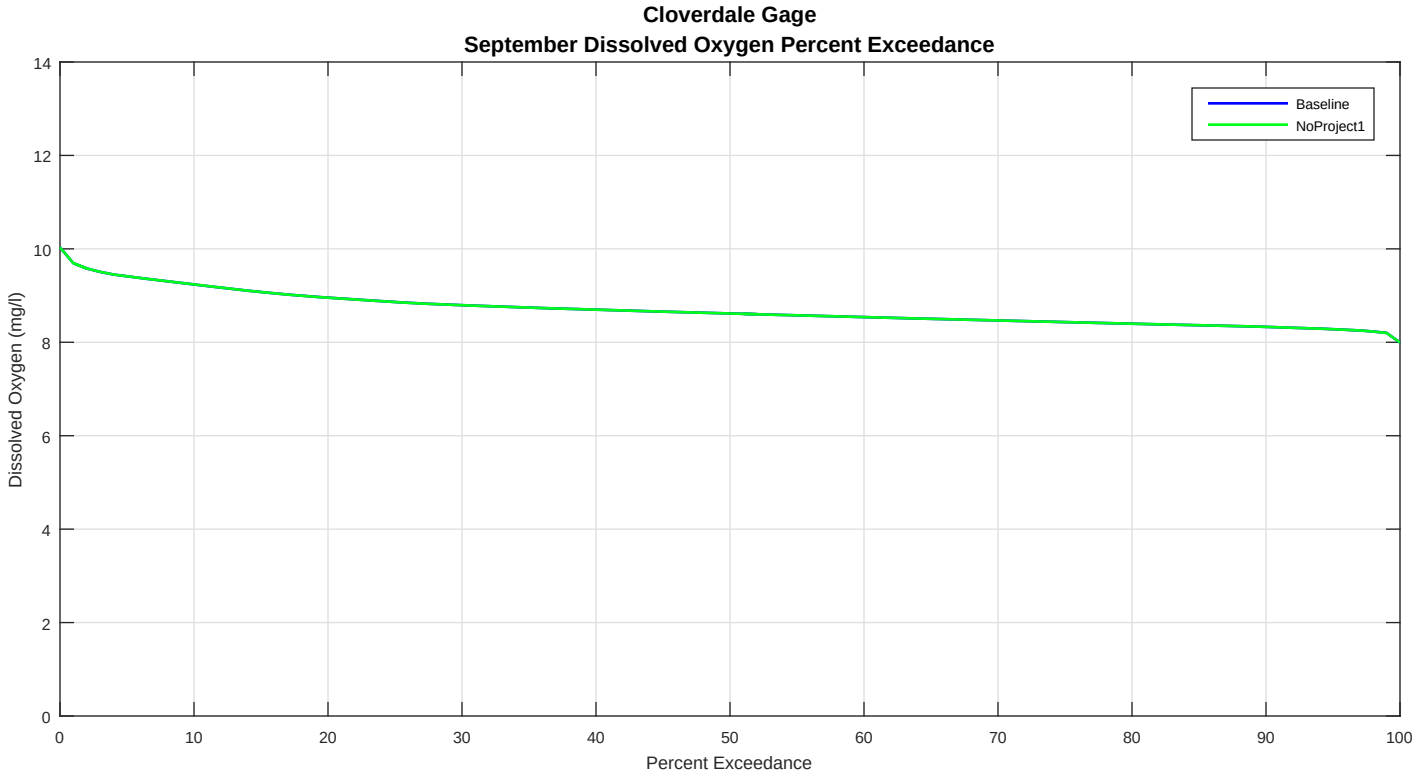
Cloverdale Gage
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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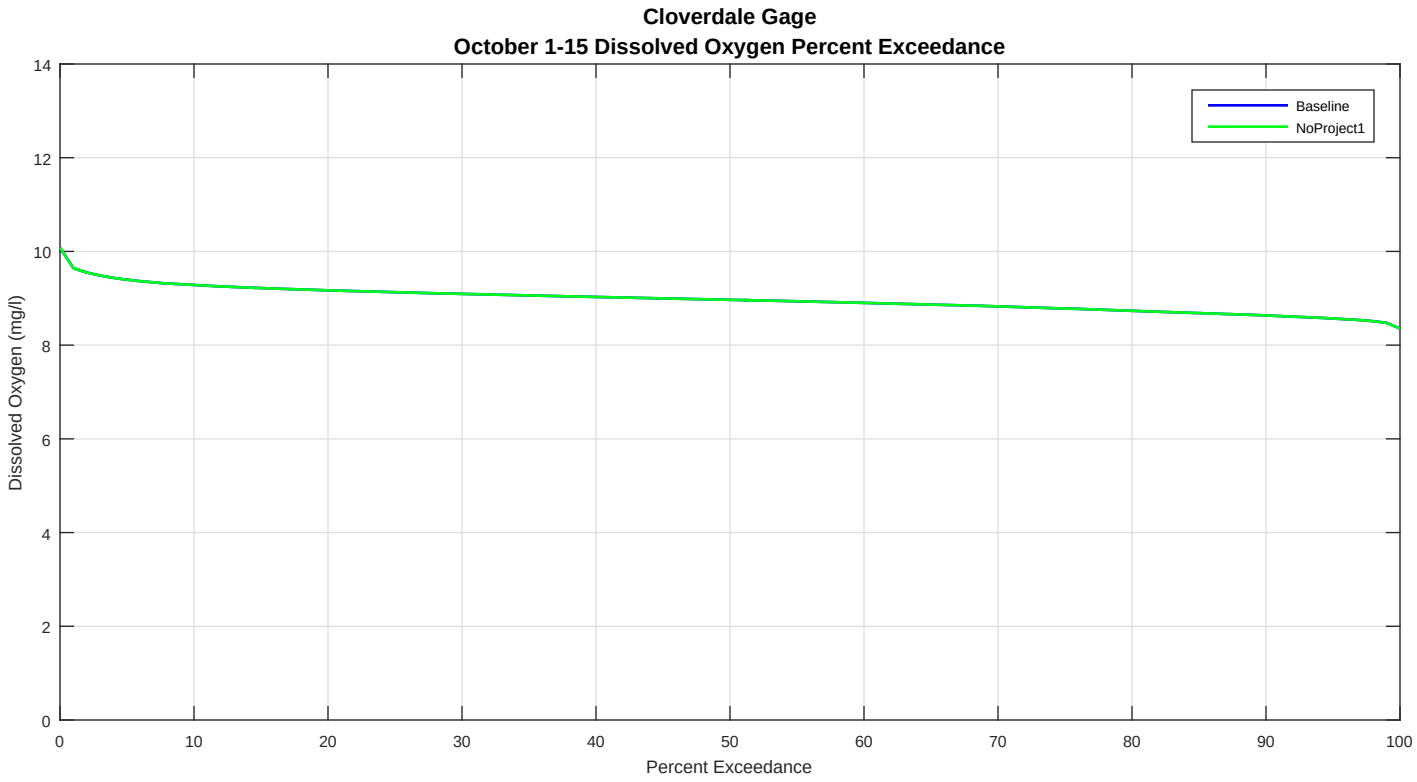
Cloverdale Gage
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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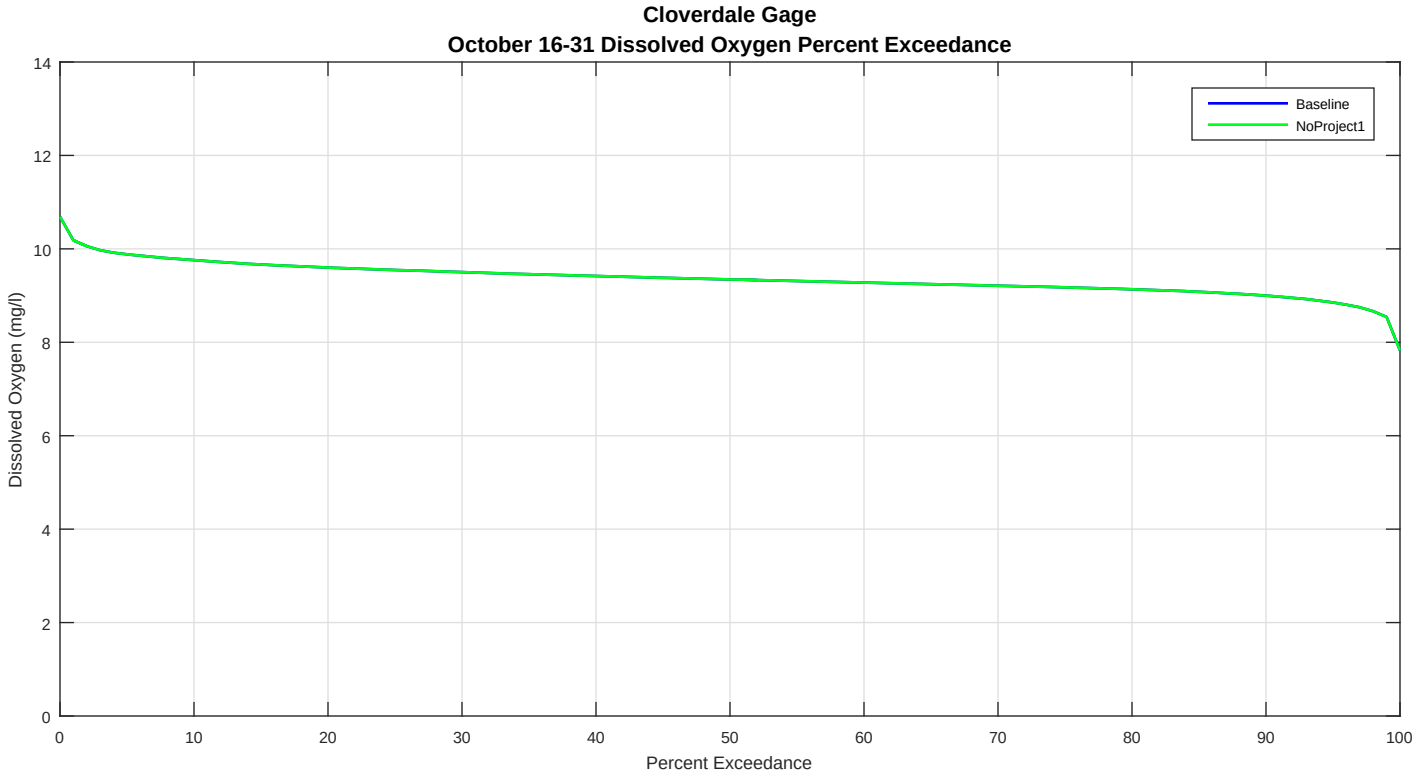
Cloverdale Gage
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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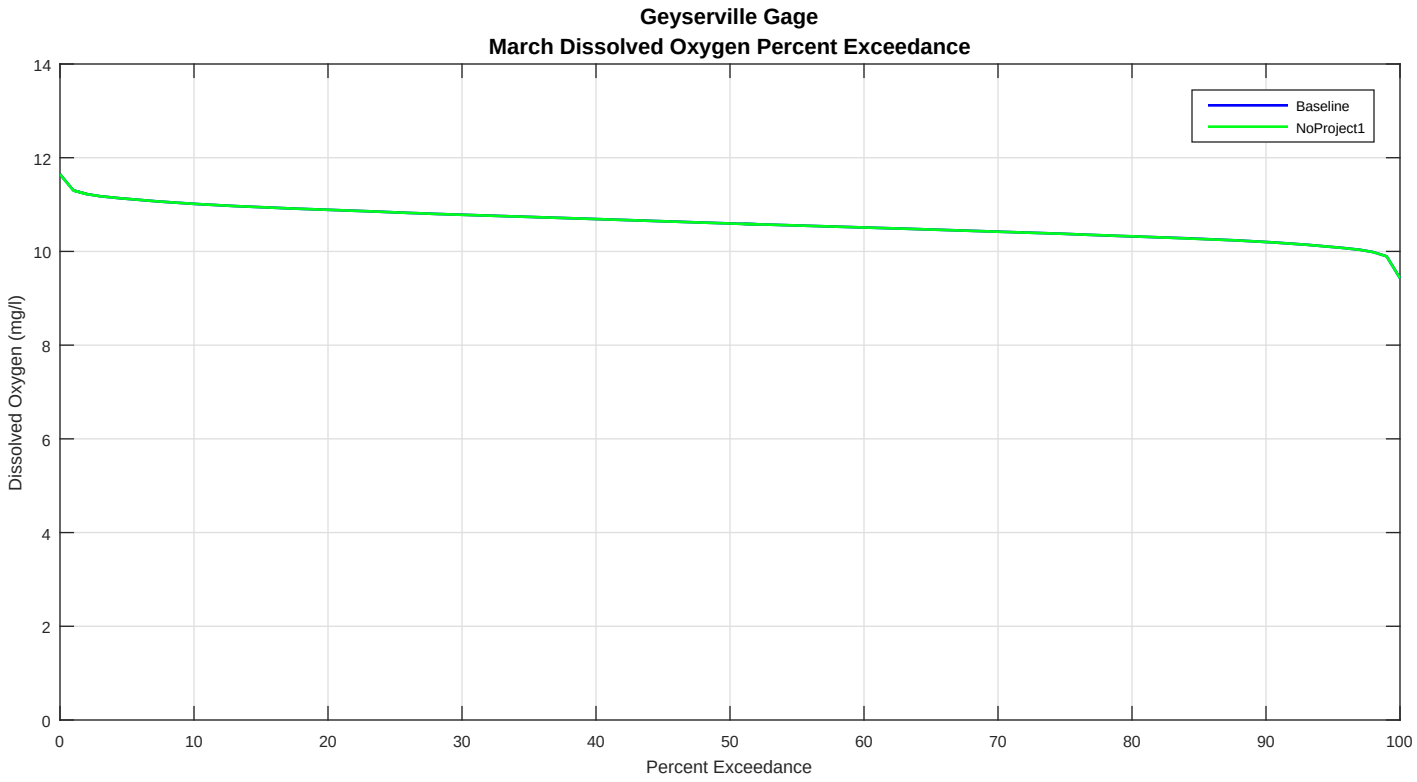
Geyserville Gage
March Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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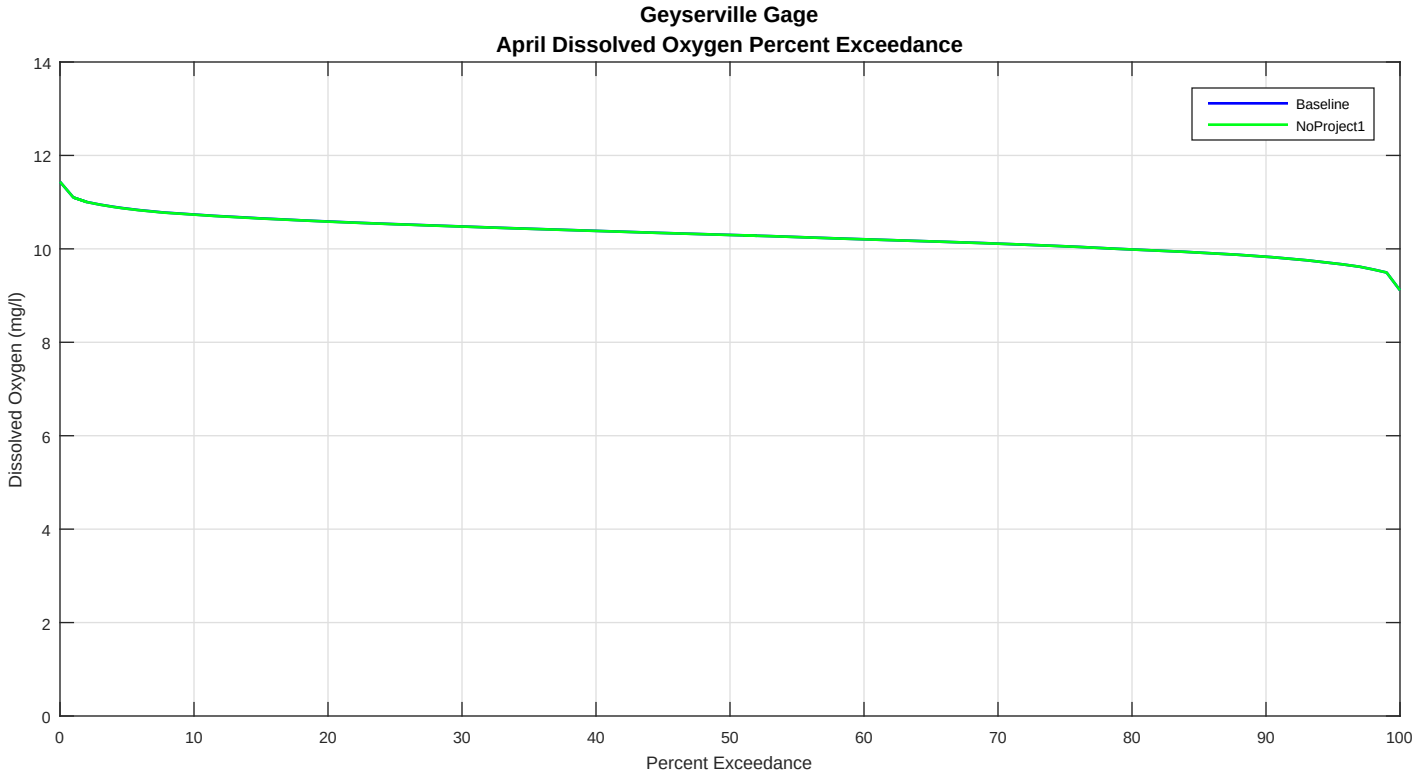
Geyserville Gage
April Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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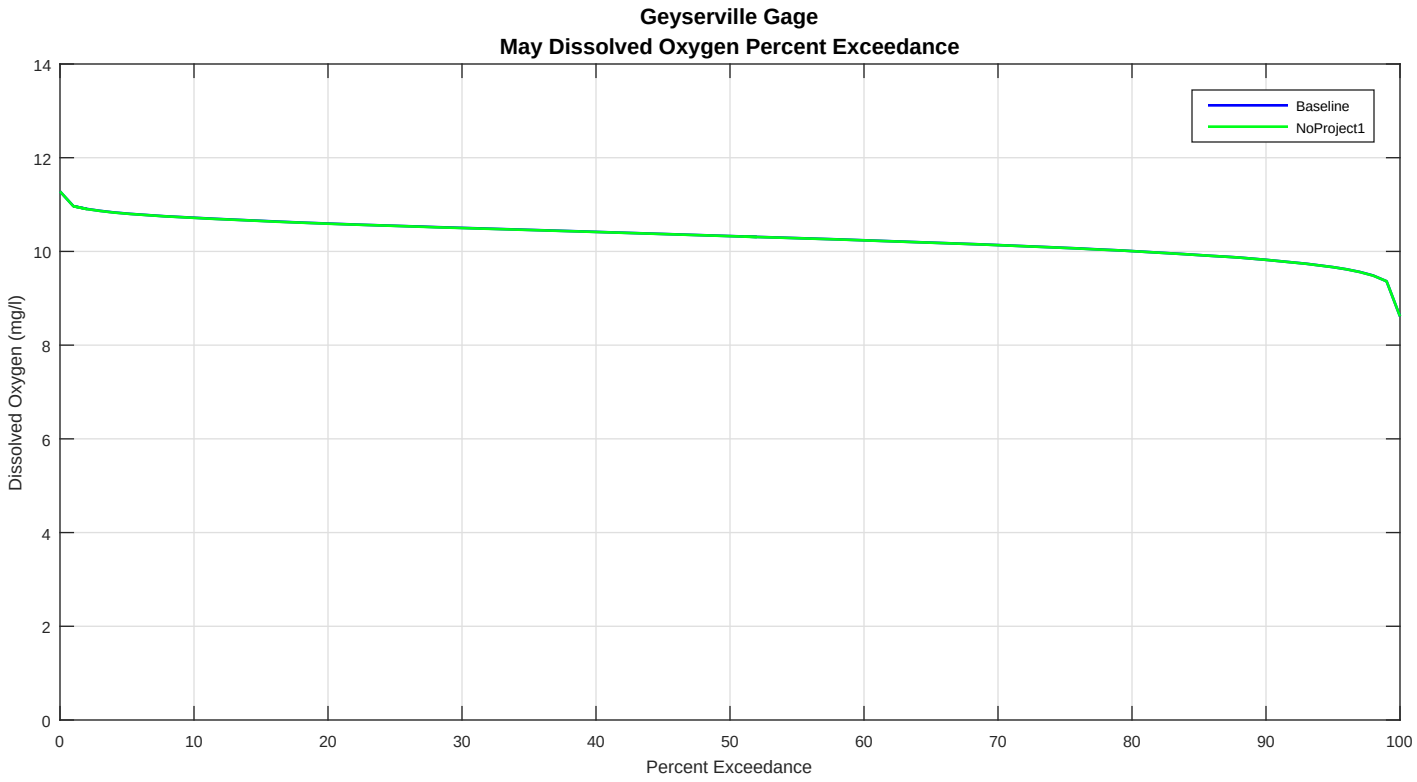
Geyserville Gage
May Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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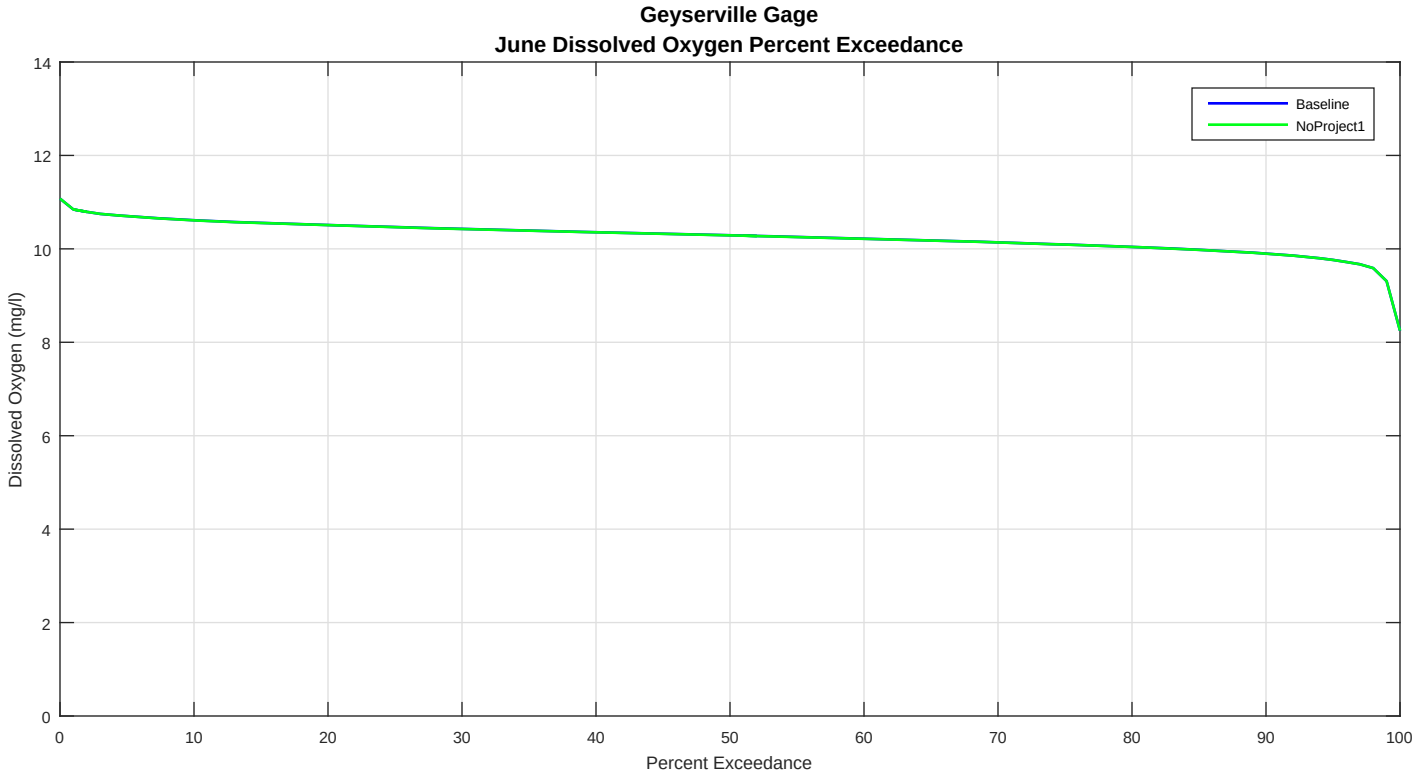
Geyserville Gage
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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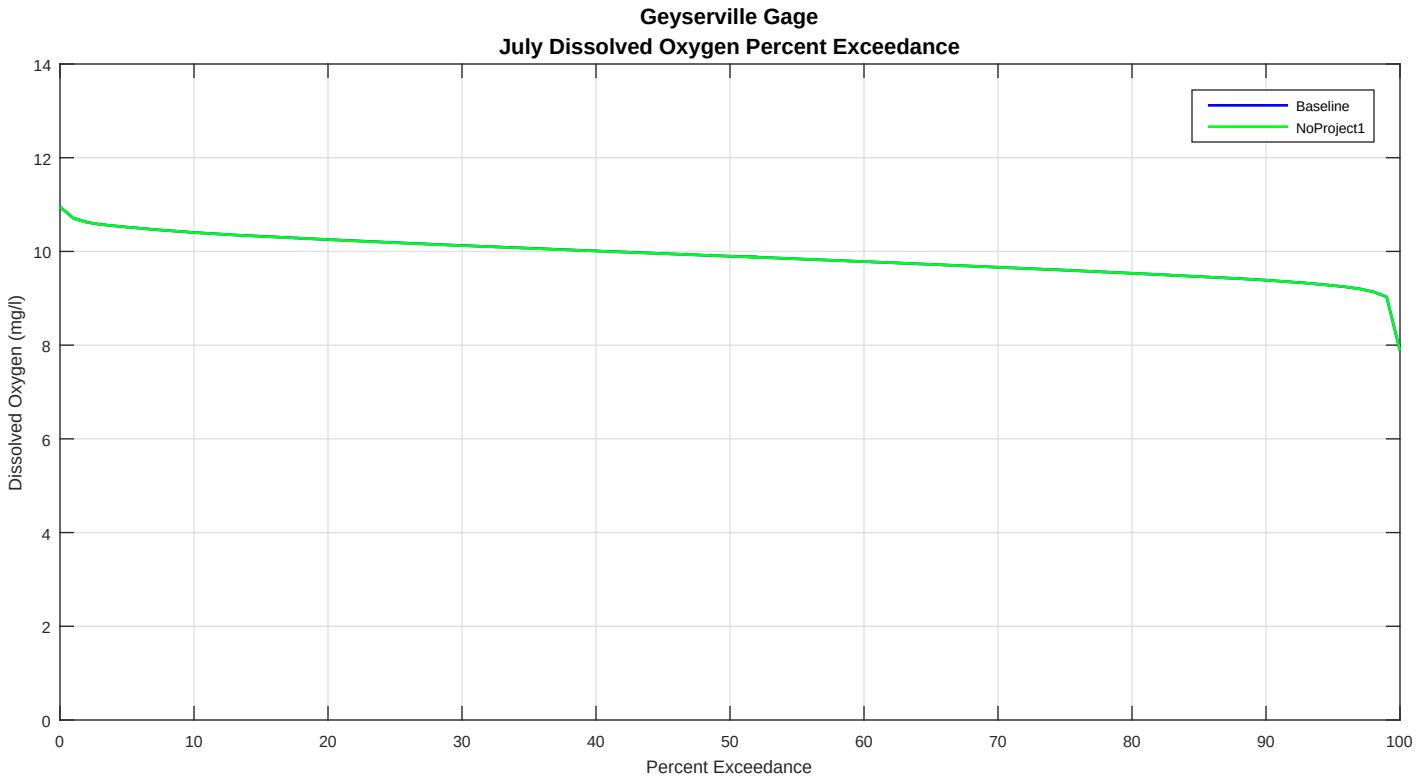
Geyserville Gage
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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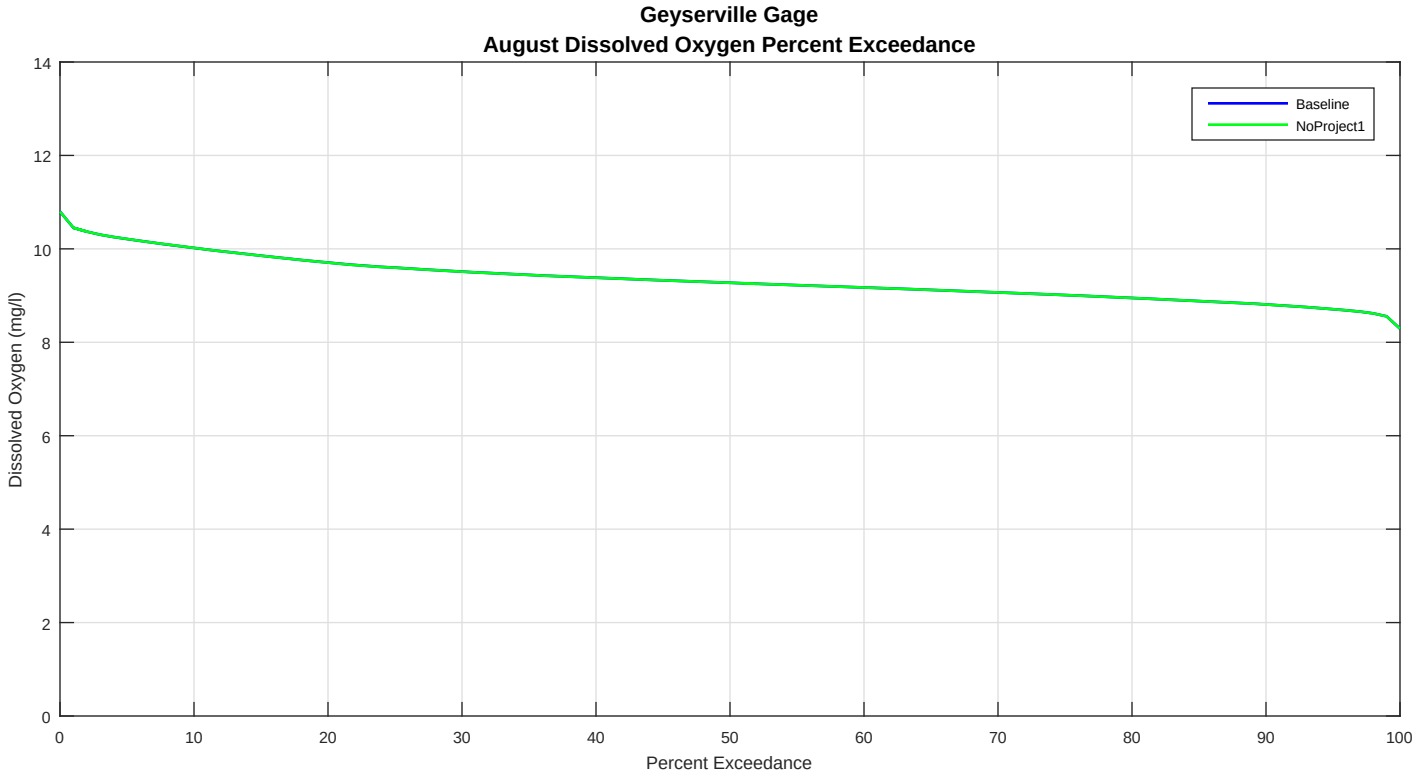
Geyserville Gage
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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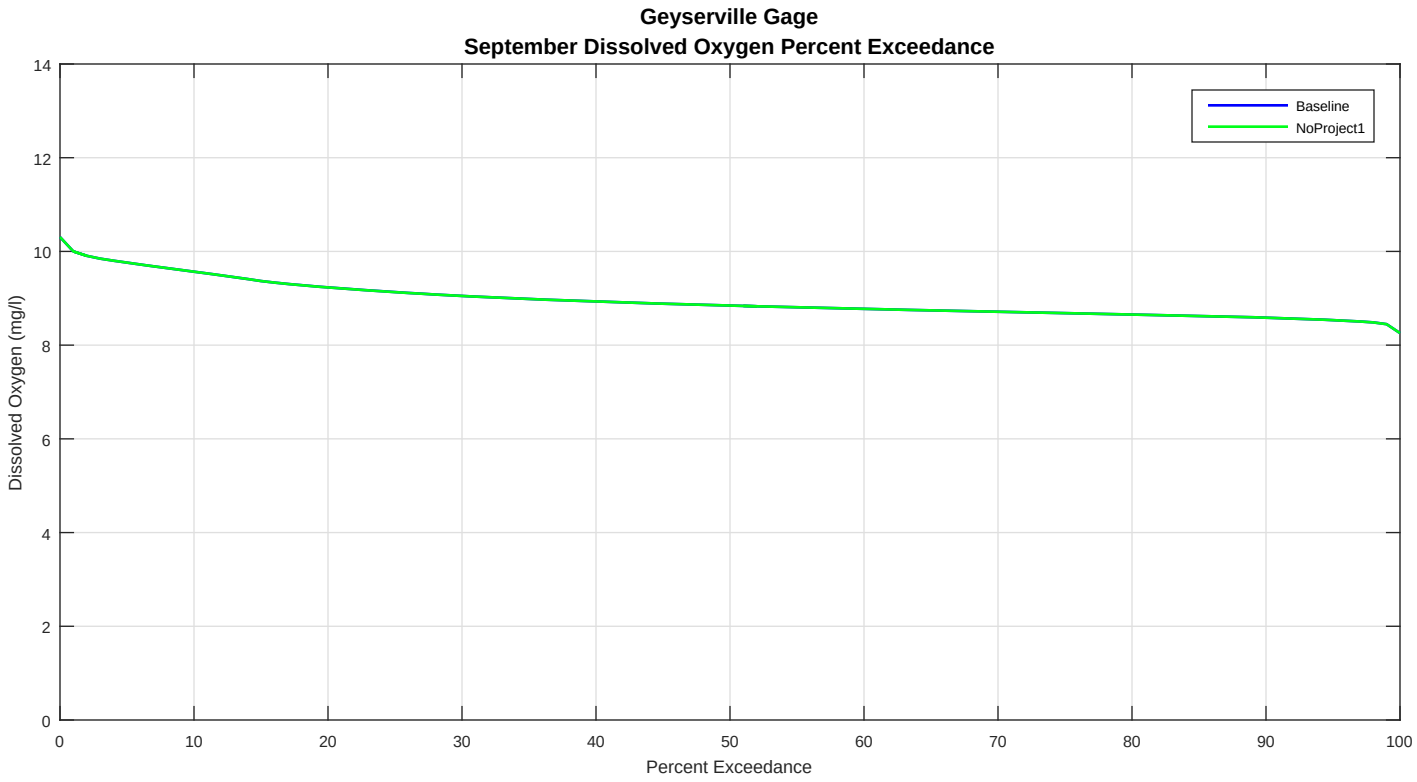
Geyserville Gage
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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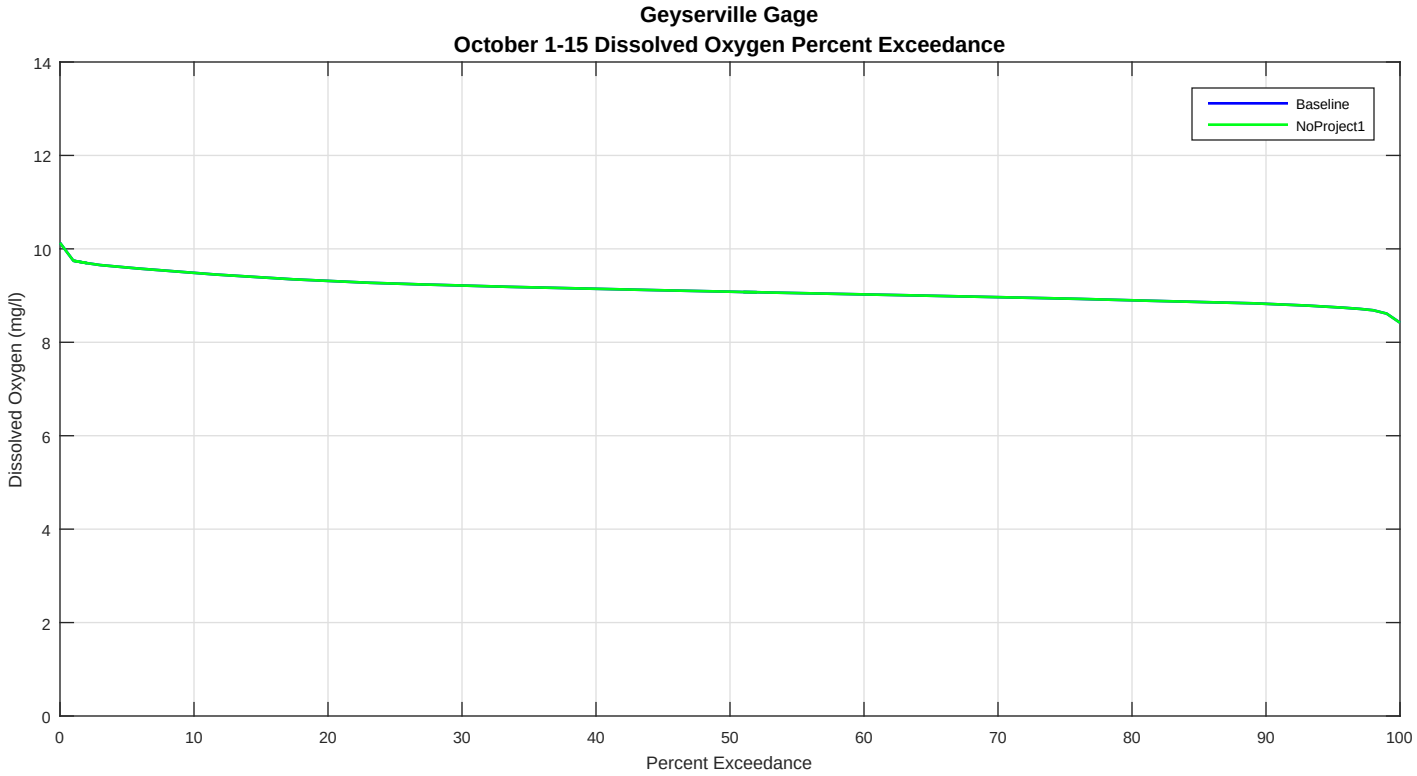
Geyserville Gage
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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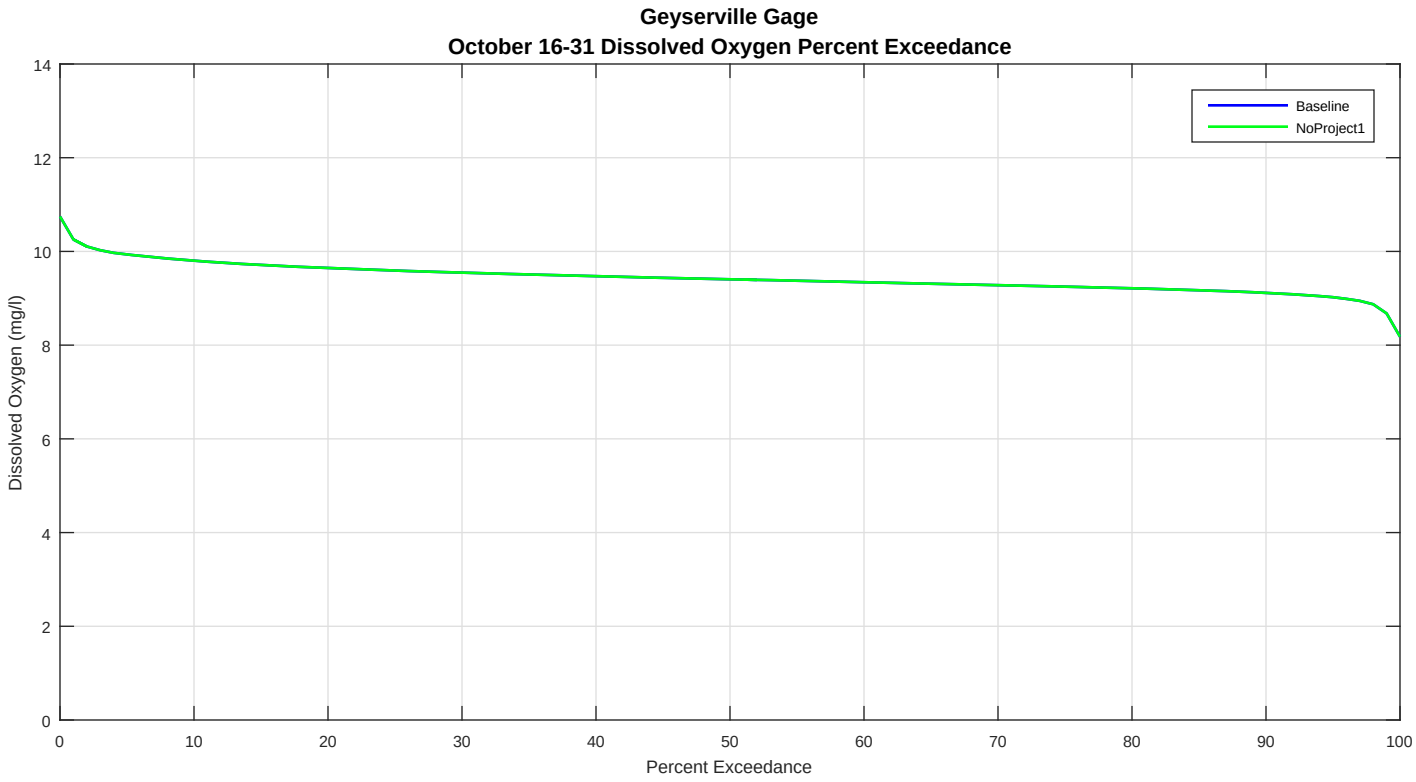
Geyserville Gage
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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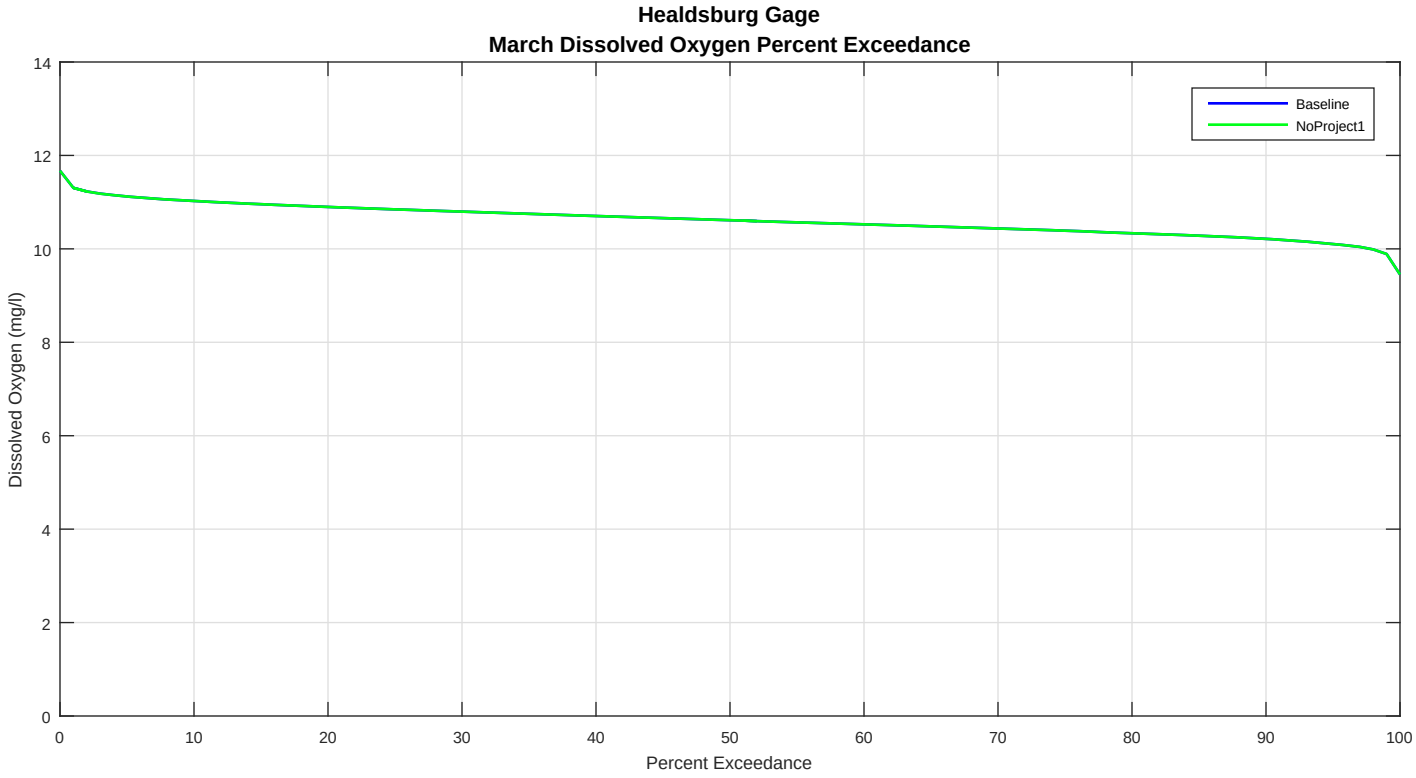
Healdsburg Gage
March Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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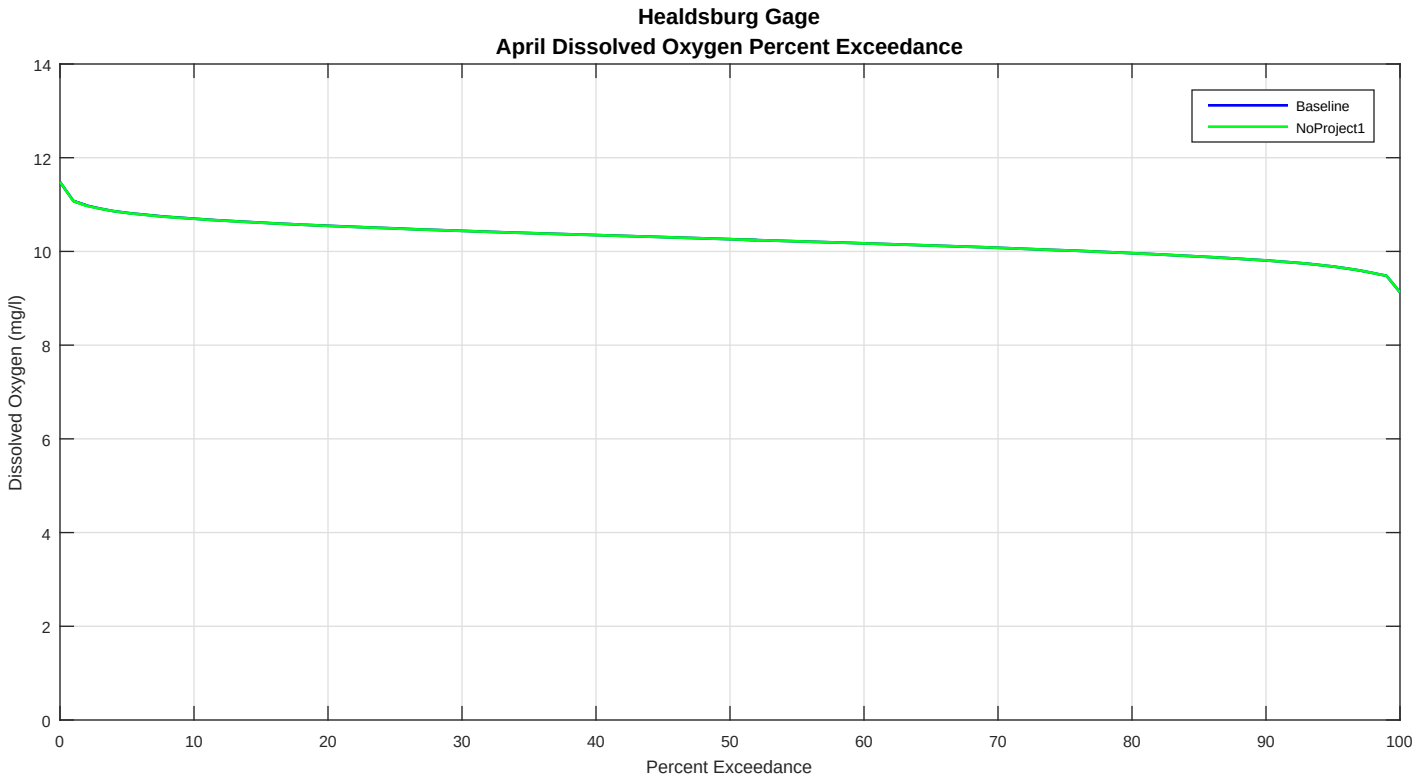
Healdsburg Gage
April Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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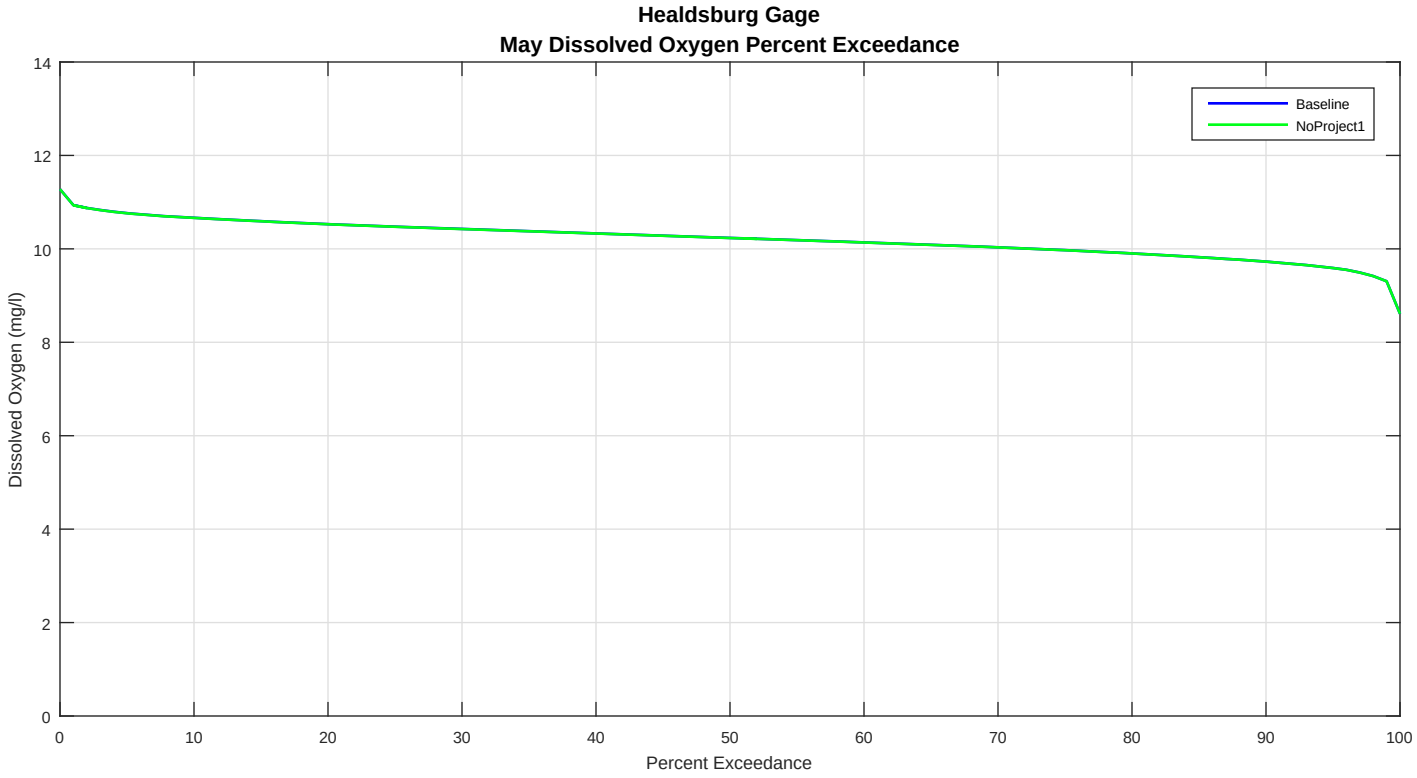
Healdsburg Gage
May Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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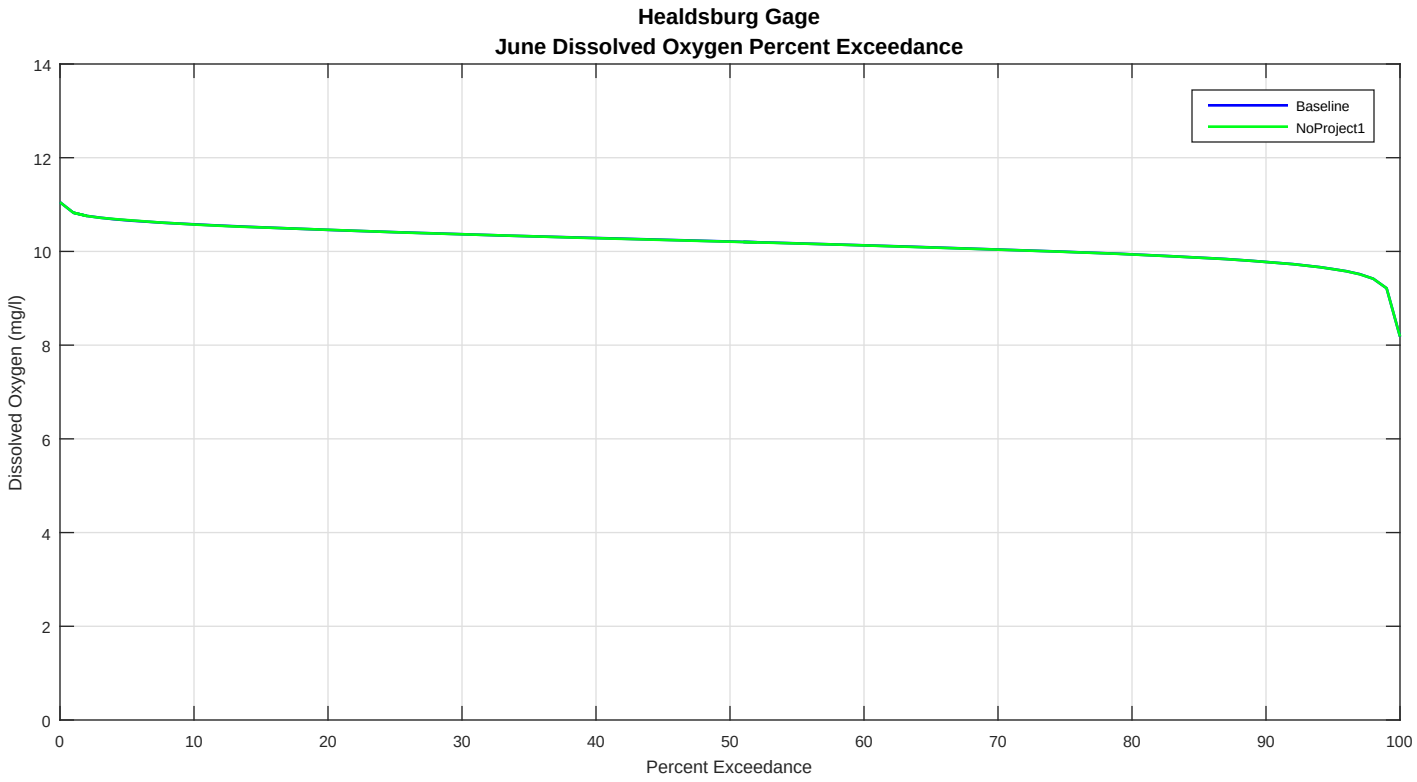
Healdsburg Gage
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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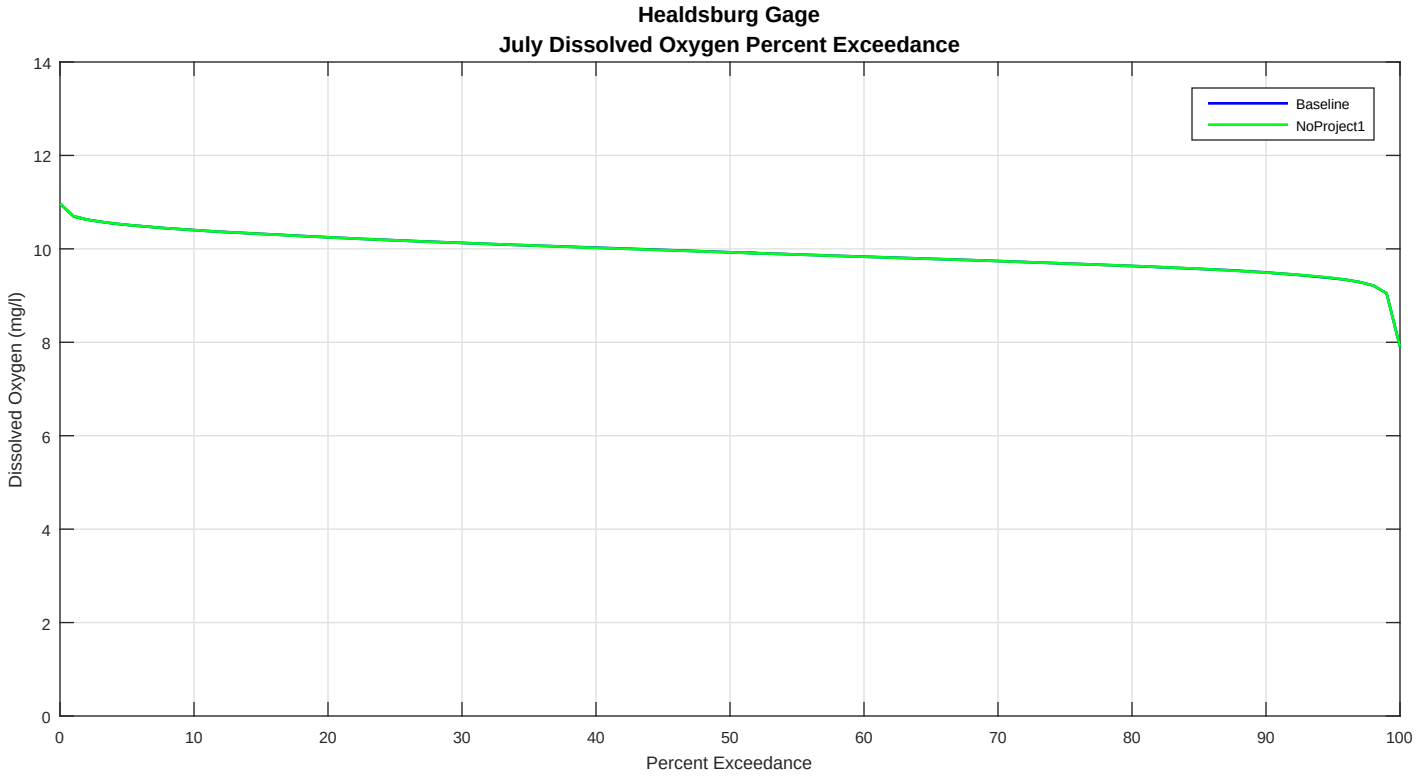
Healdsburg Gage
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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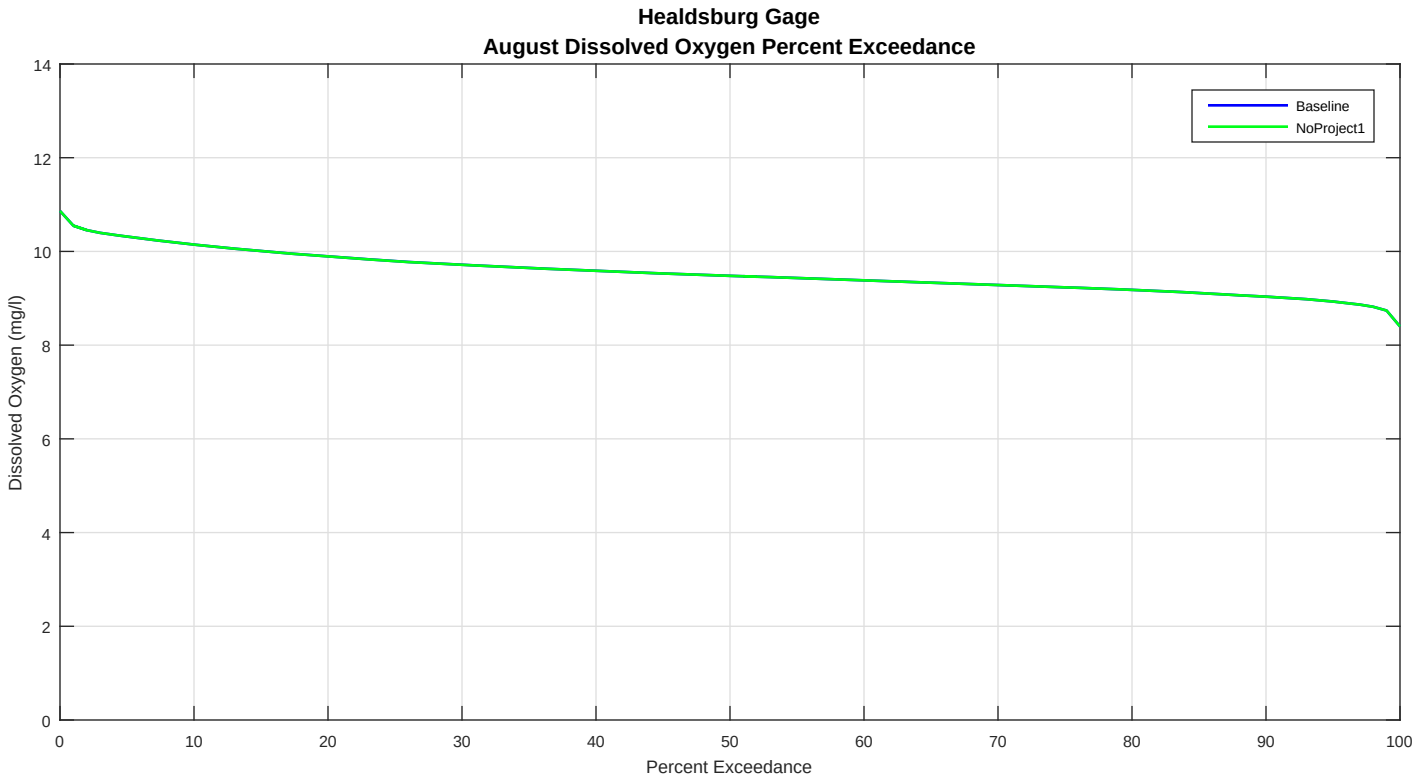
Healdsburg Gage
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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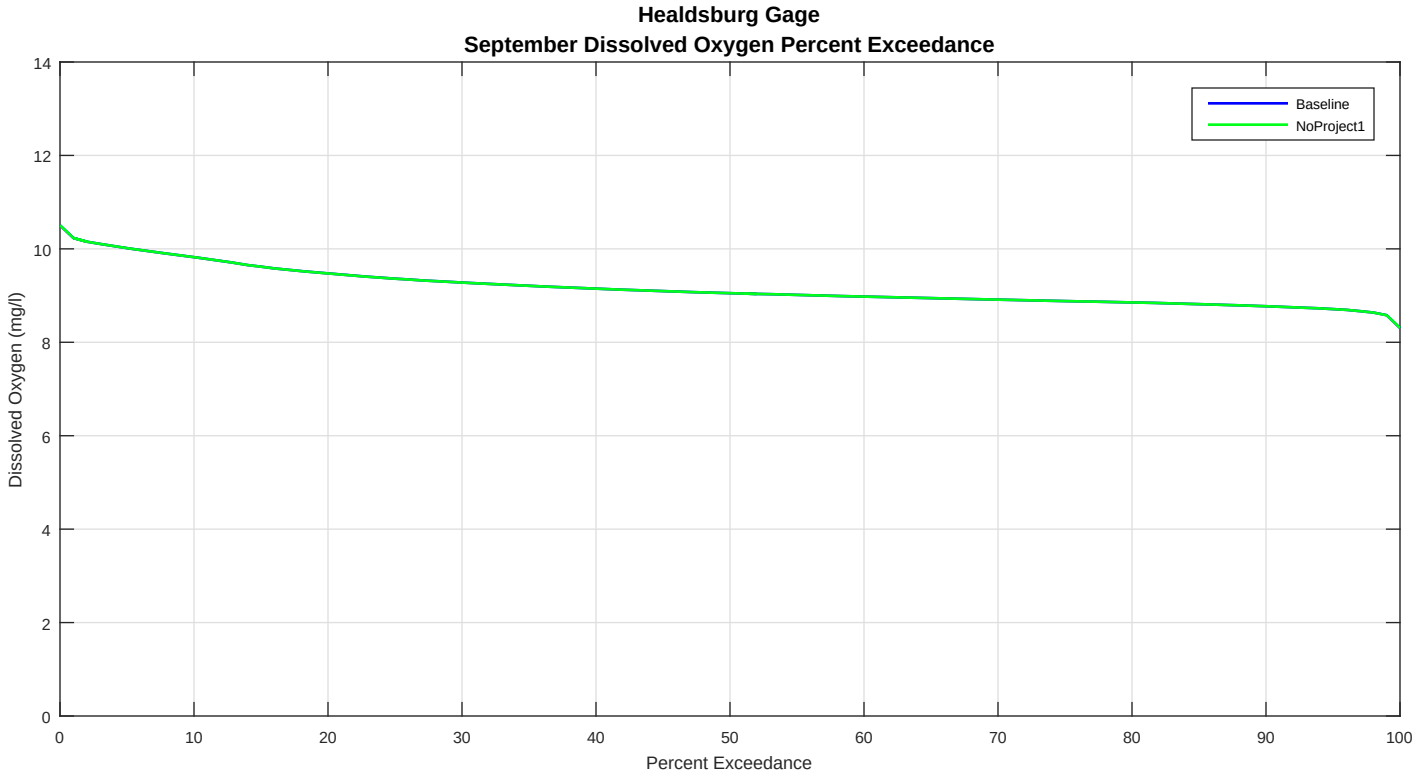
Healdsburg Gage
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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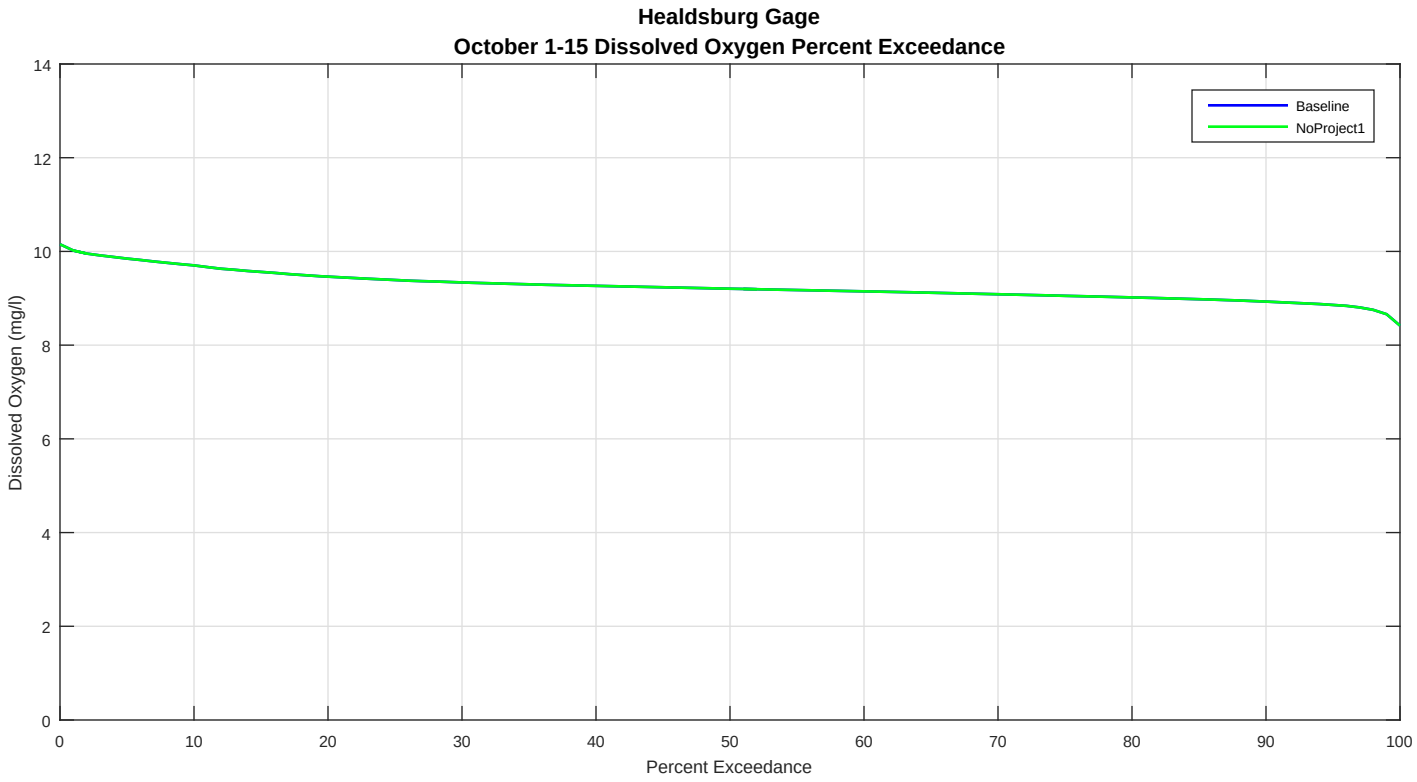
Healdsburg Gage
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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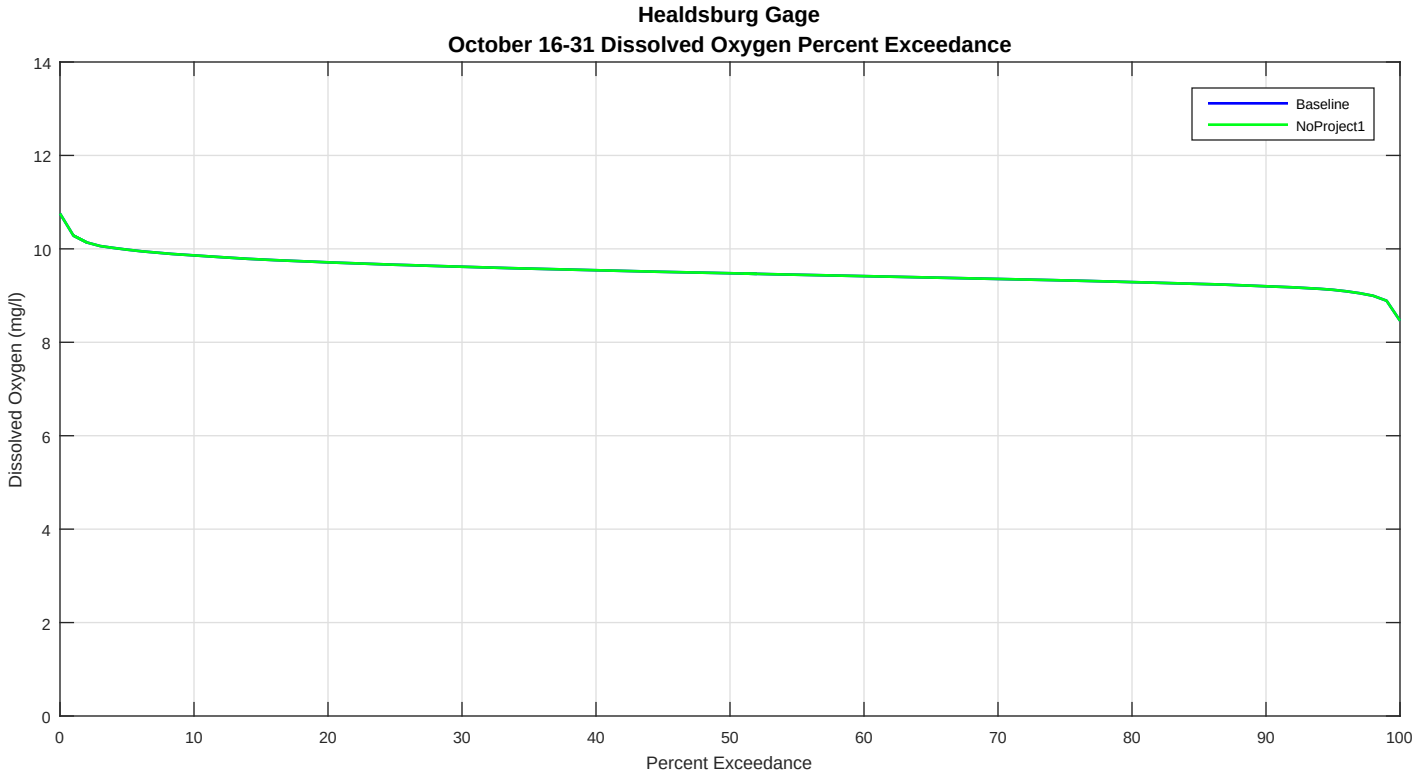
Healdsburg Gage
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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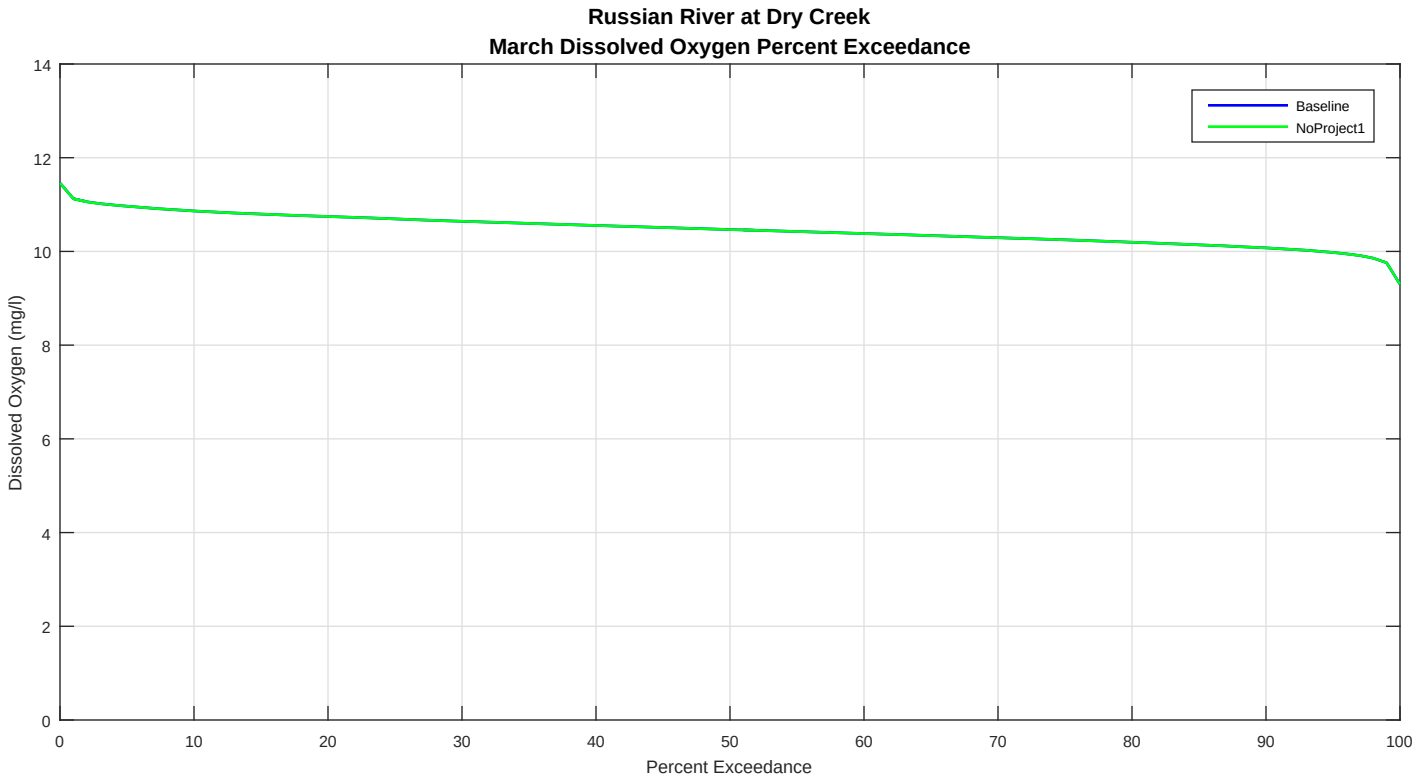
Russian River at Dry Creek
March Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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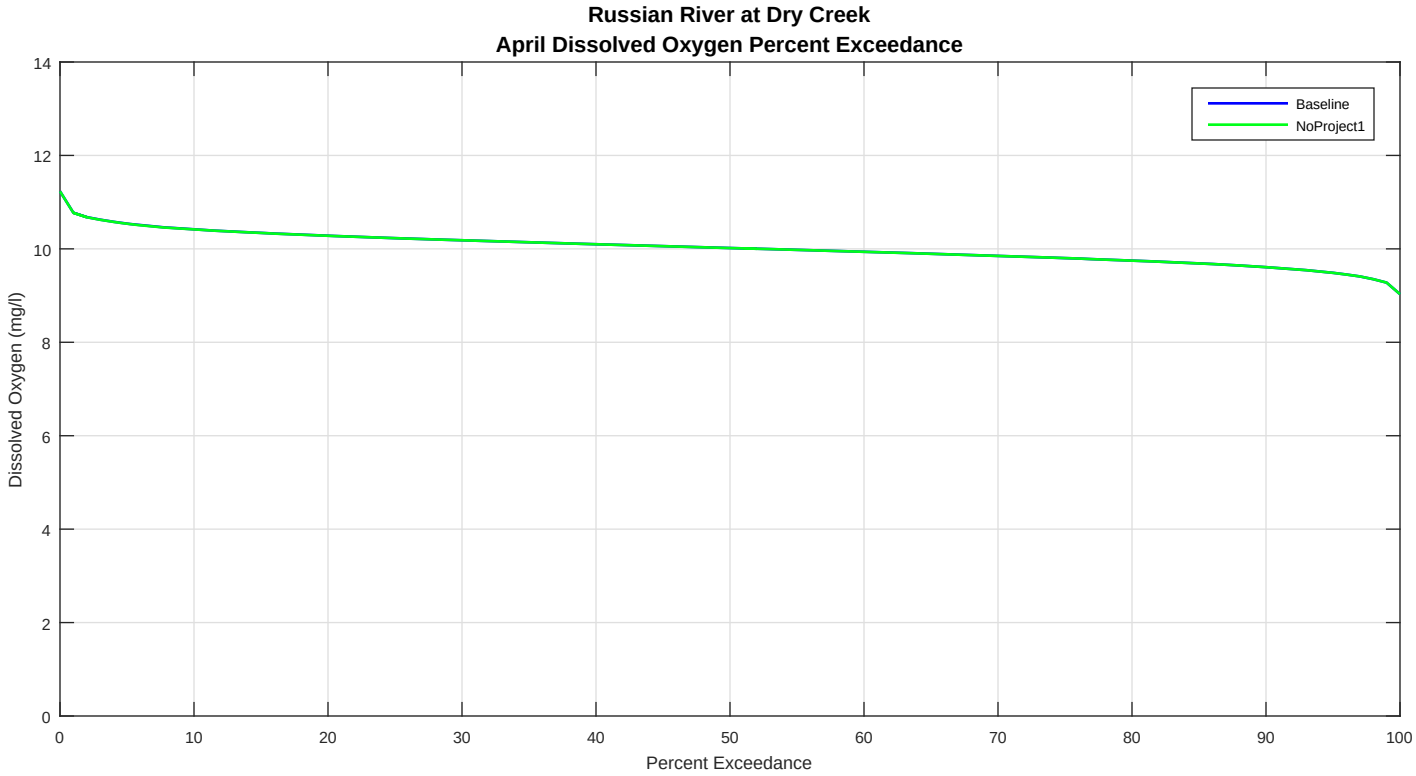
Russian River at Dry Creek
April Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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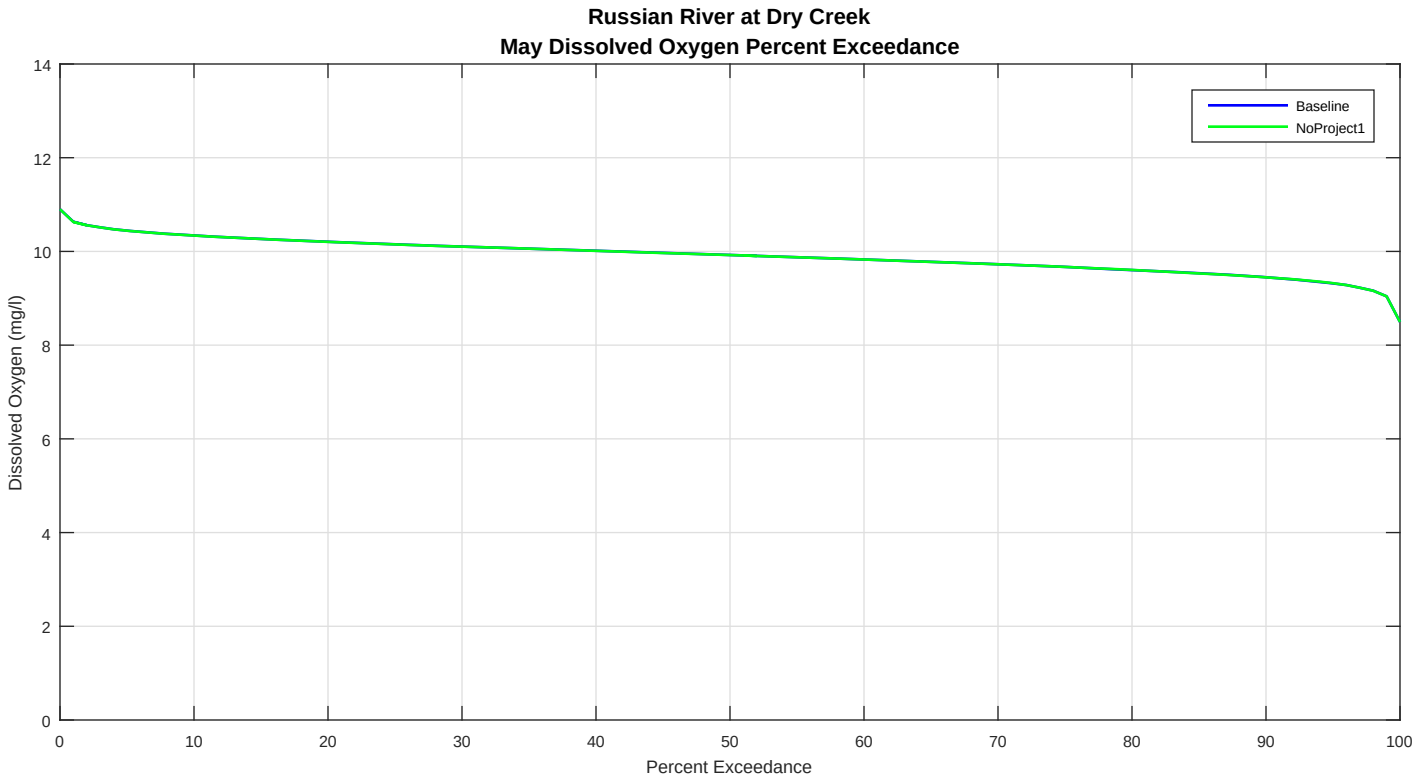
Russian River at Dry Creek
May Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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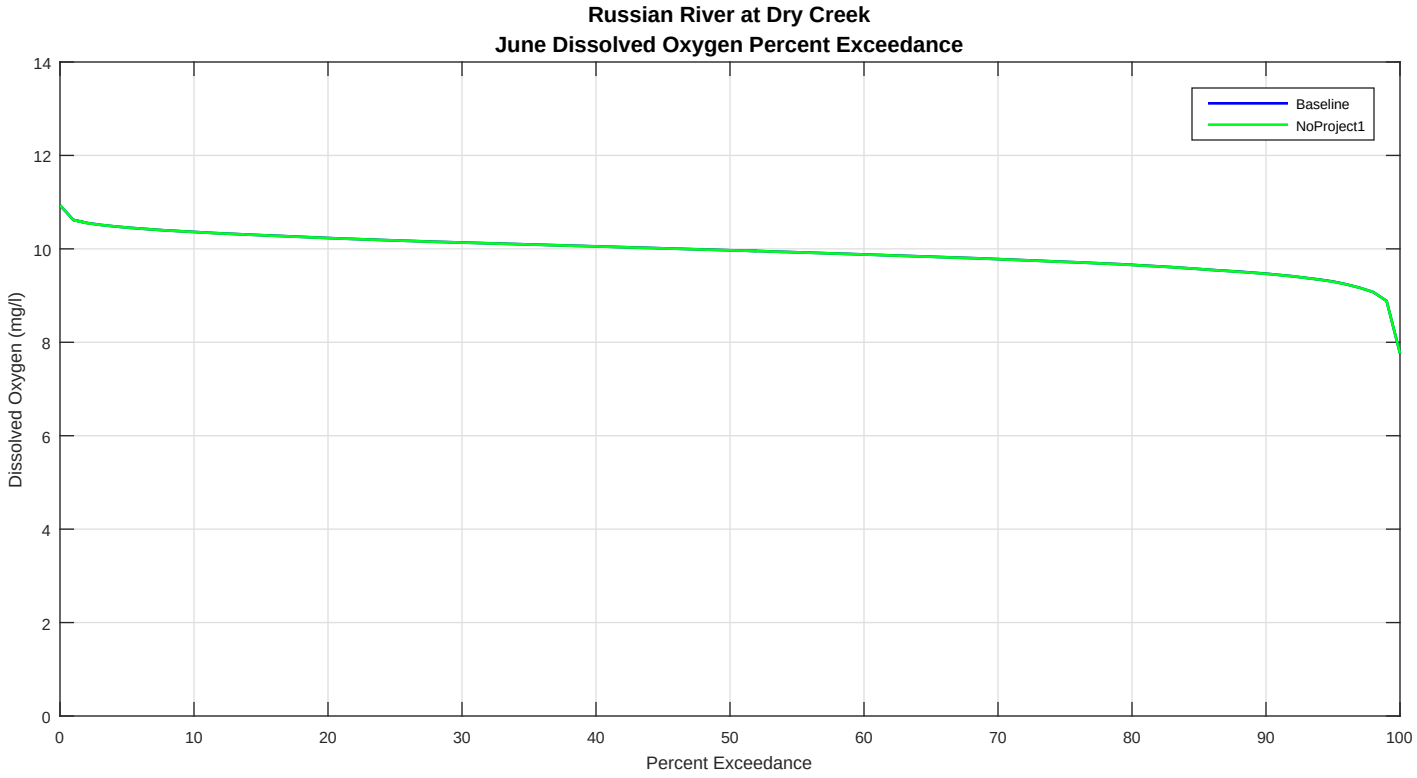
Russian River at Dry Creek
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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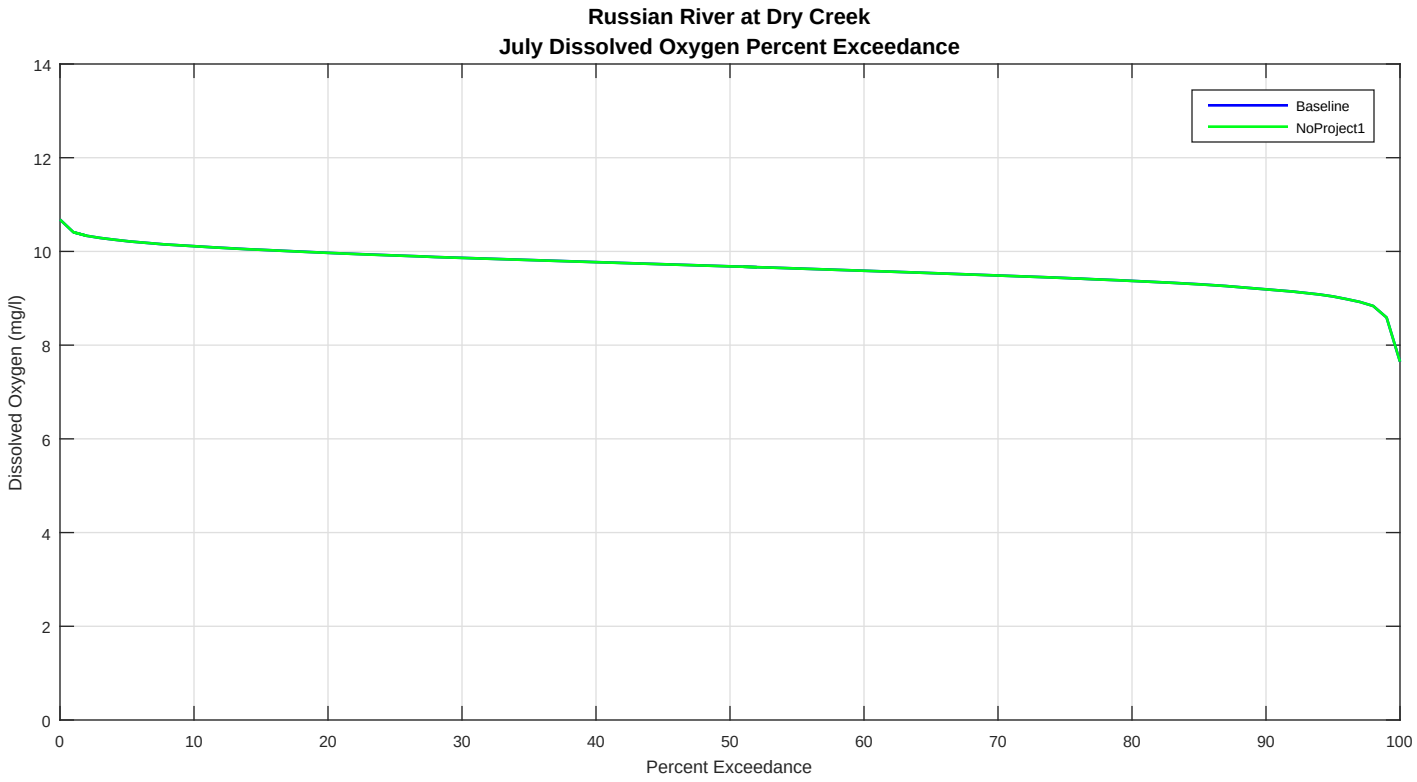
Russian River at Dry Creek
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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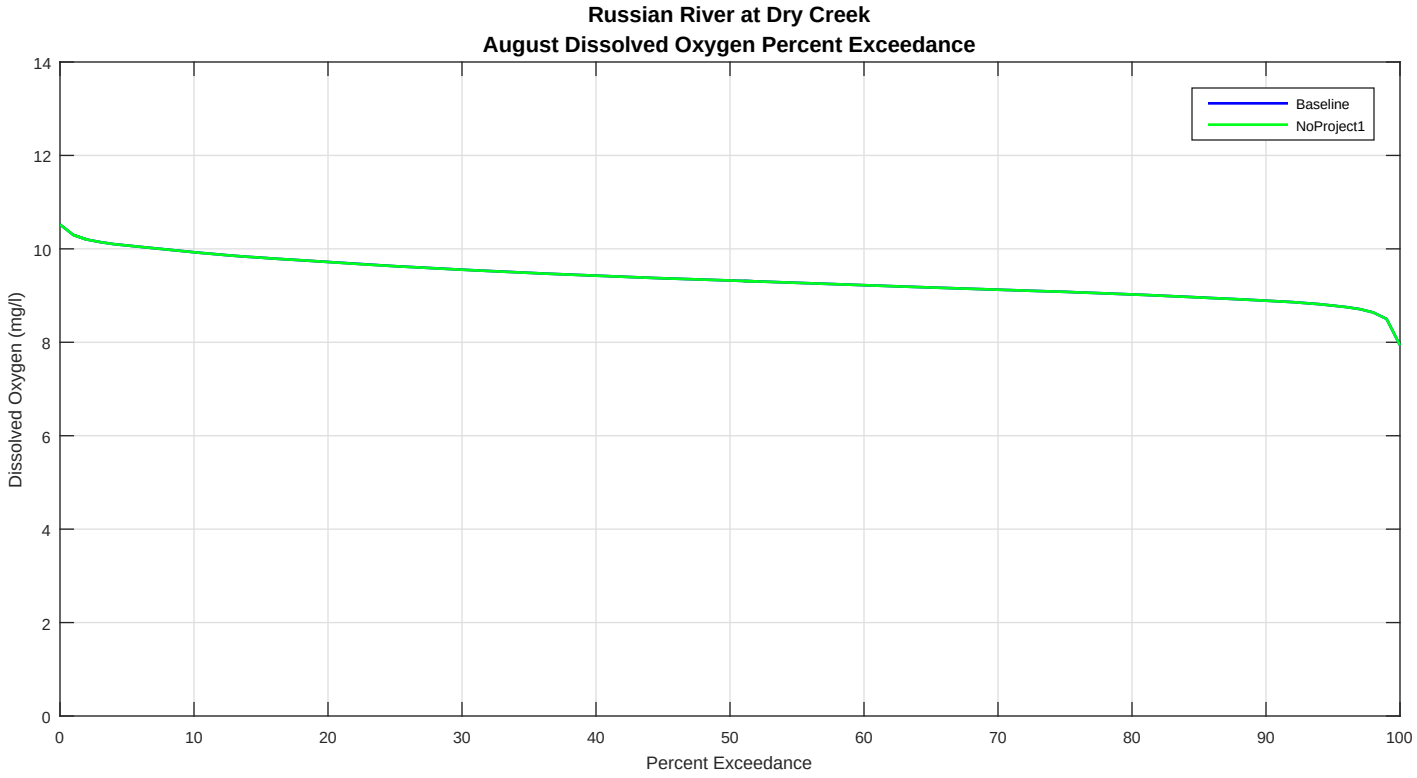
Russian River at Dry Creek
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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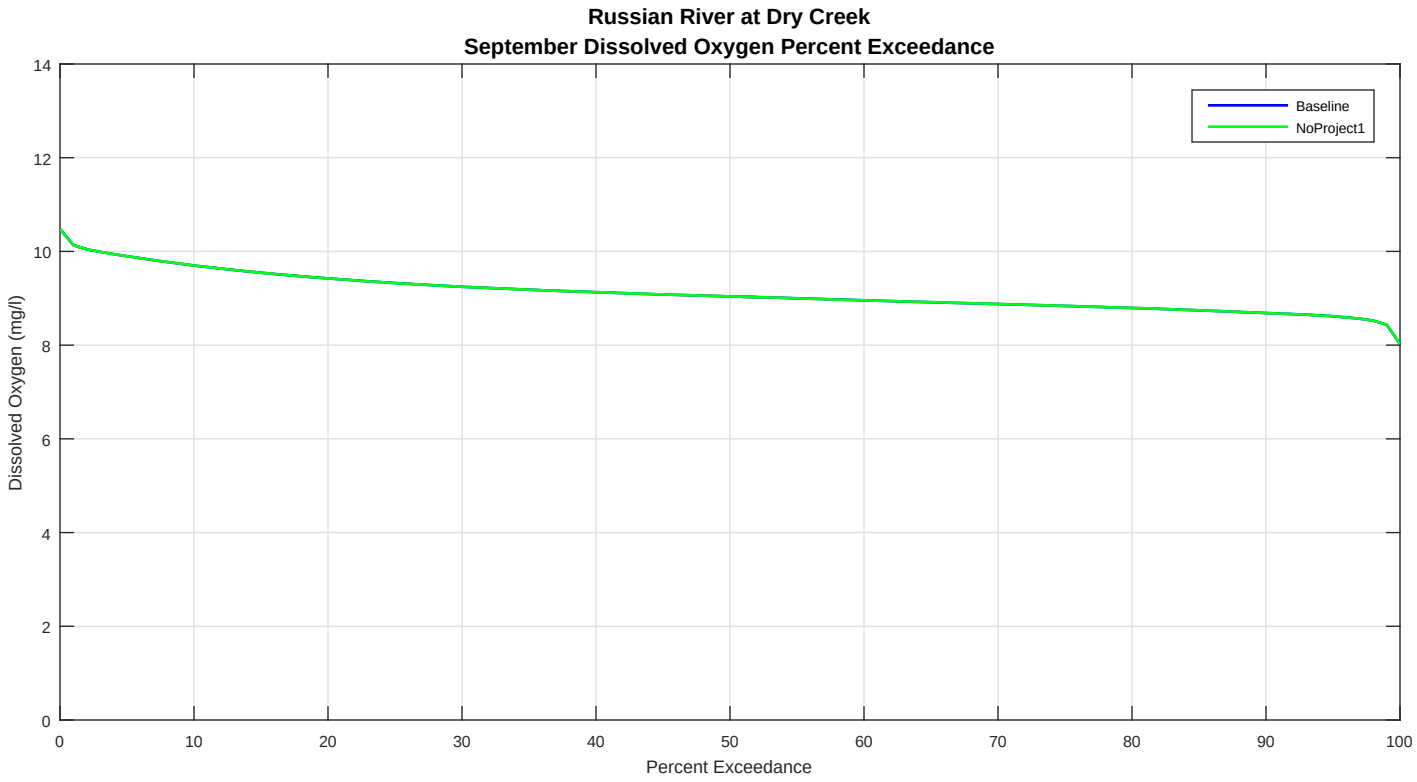
Russian River at Dry Creek
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
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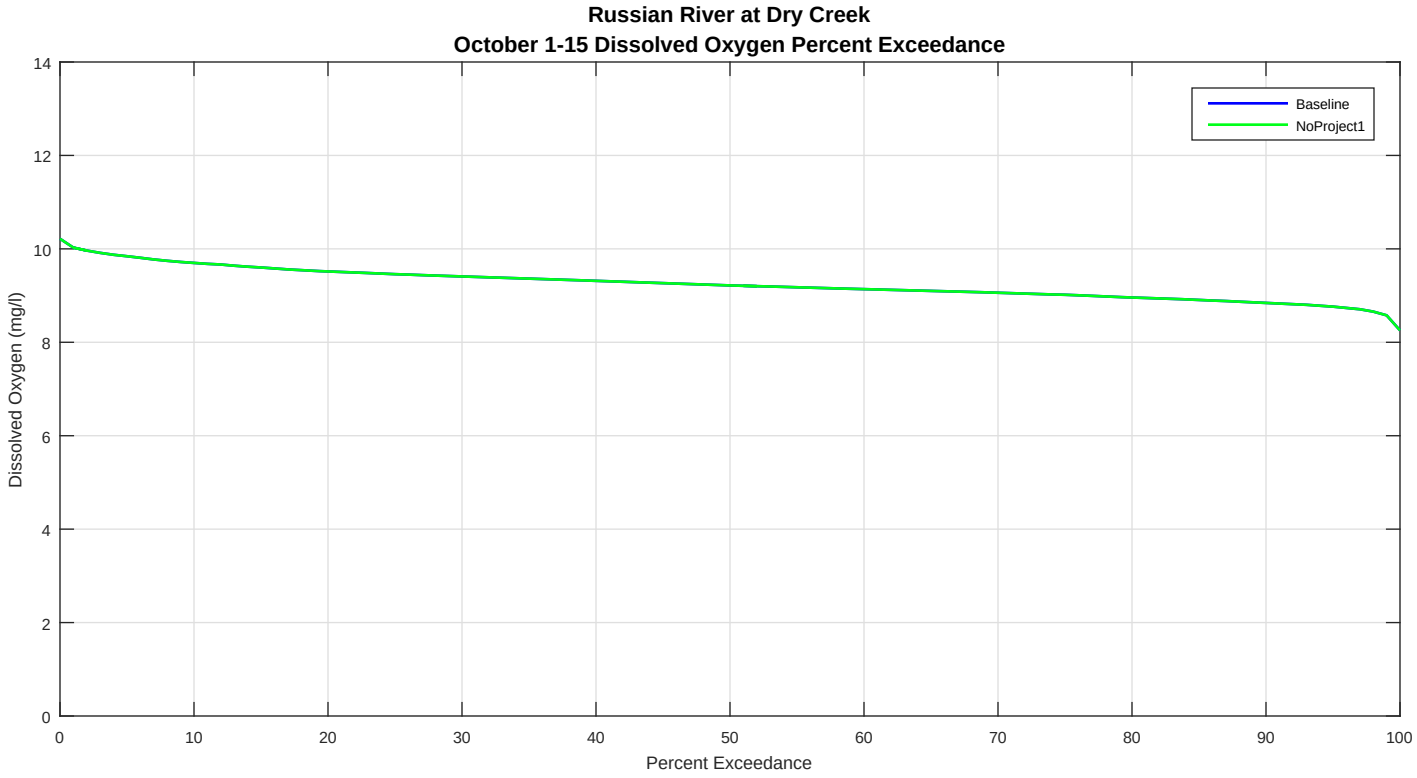
Russian River at Dry Creek
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
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12
14
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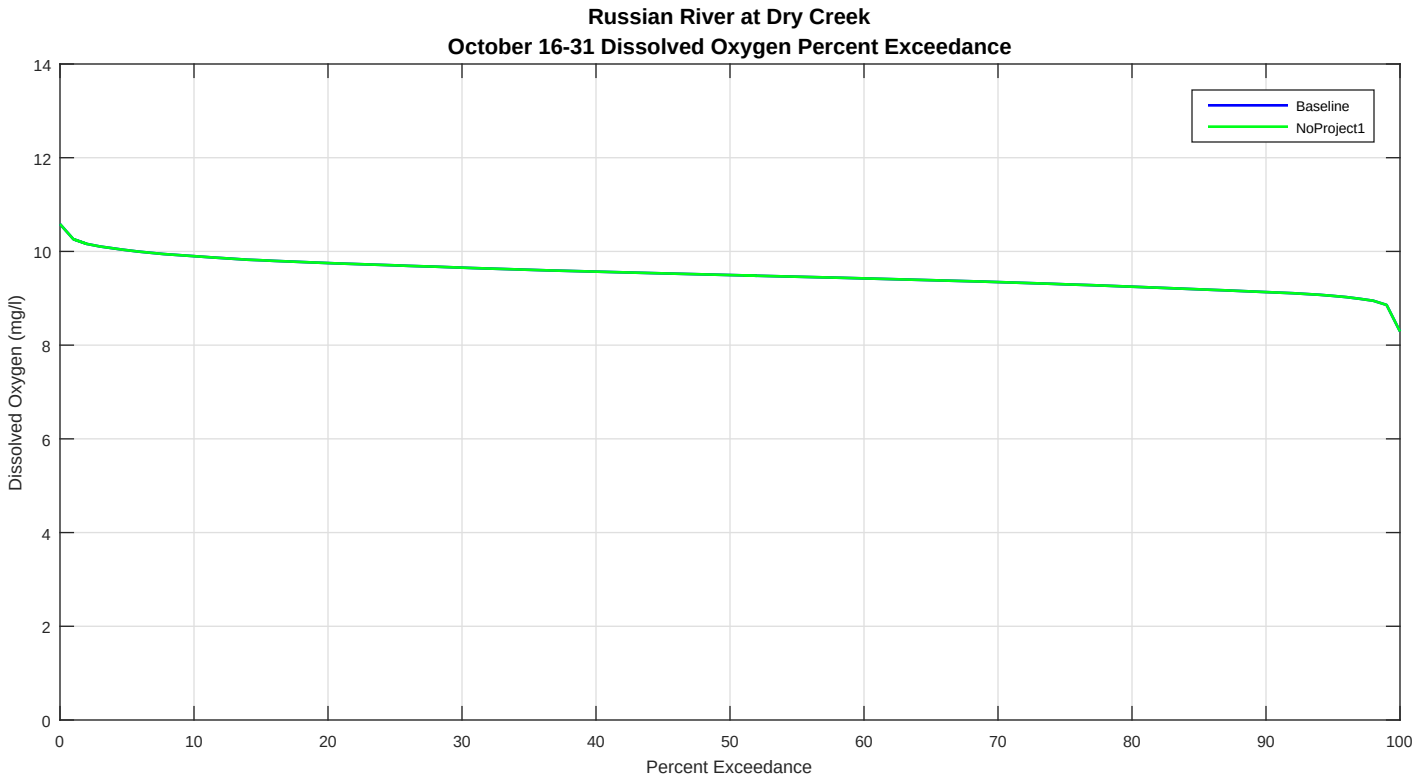
Russian River at Dry Creek
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
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14
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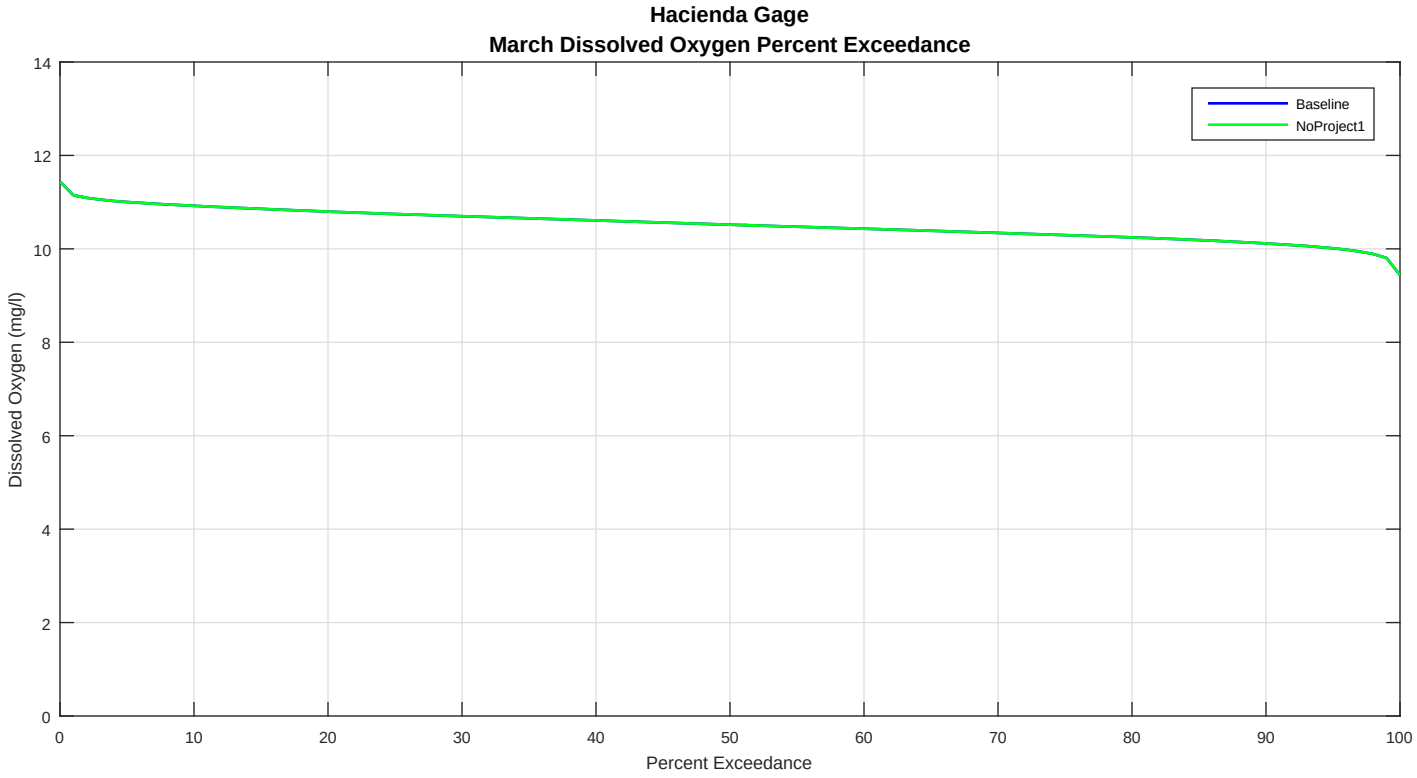
Hacienda Gage
March Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
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8
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12
14
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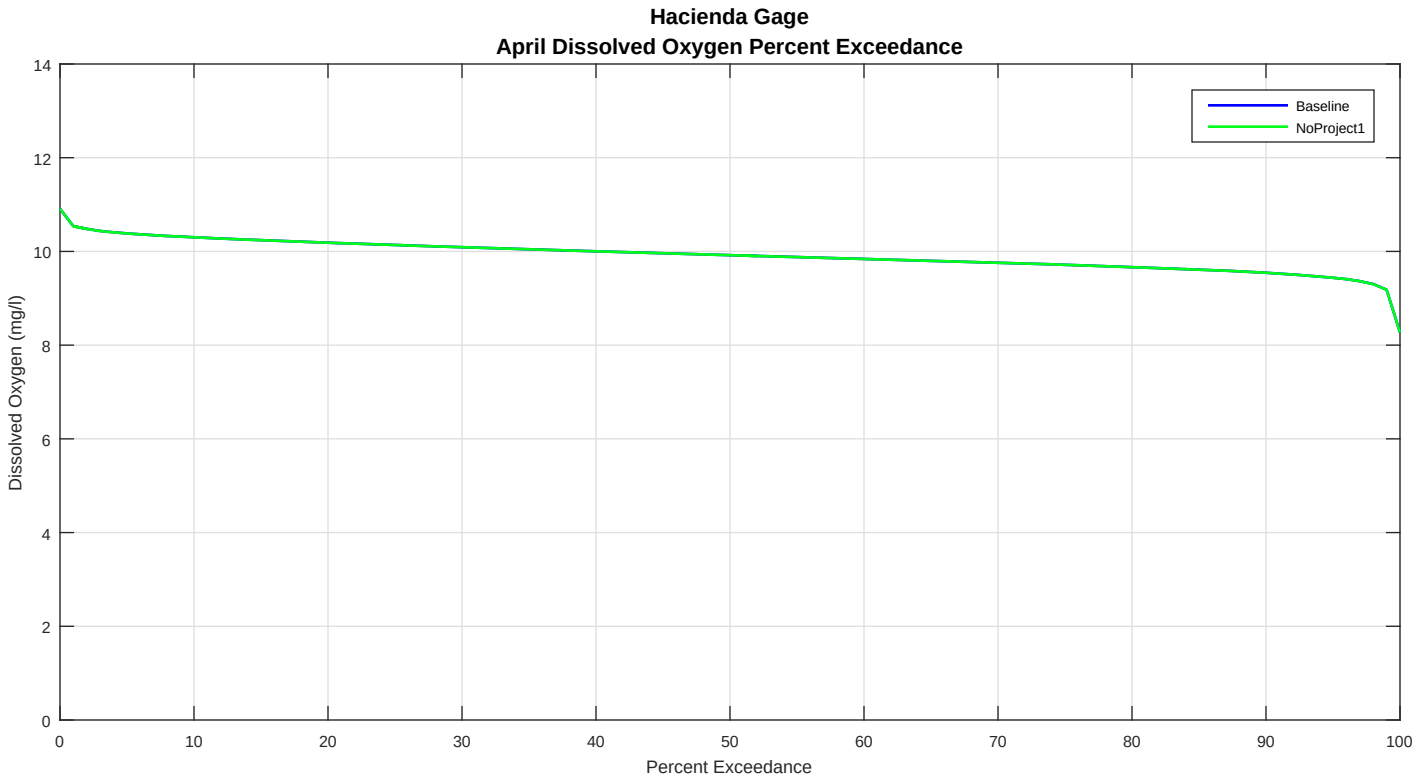
Hacienda Gage
April Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
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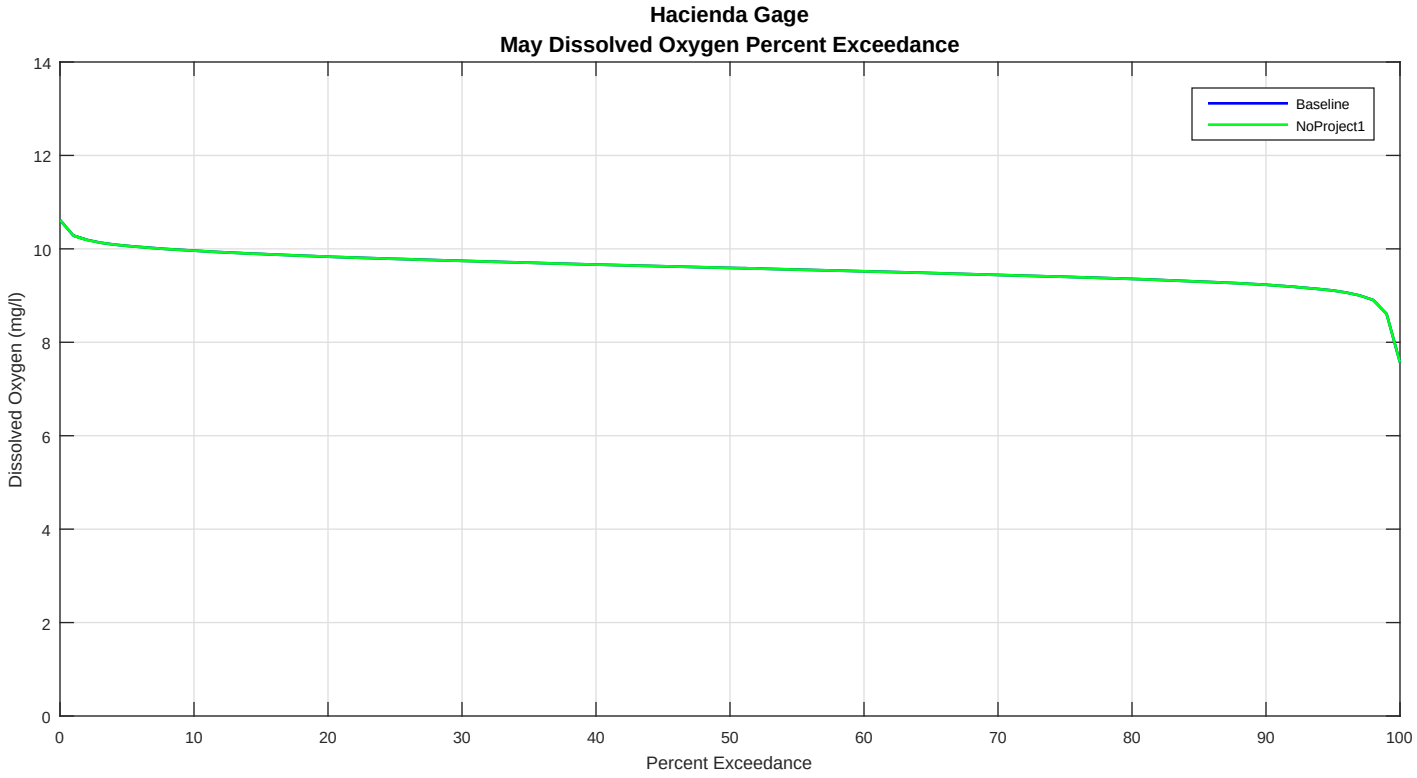
Hacienda Gage
May Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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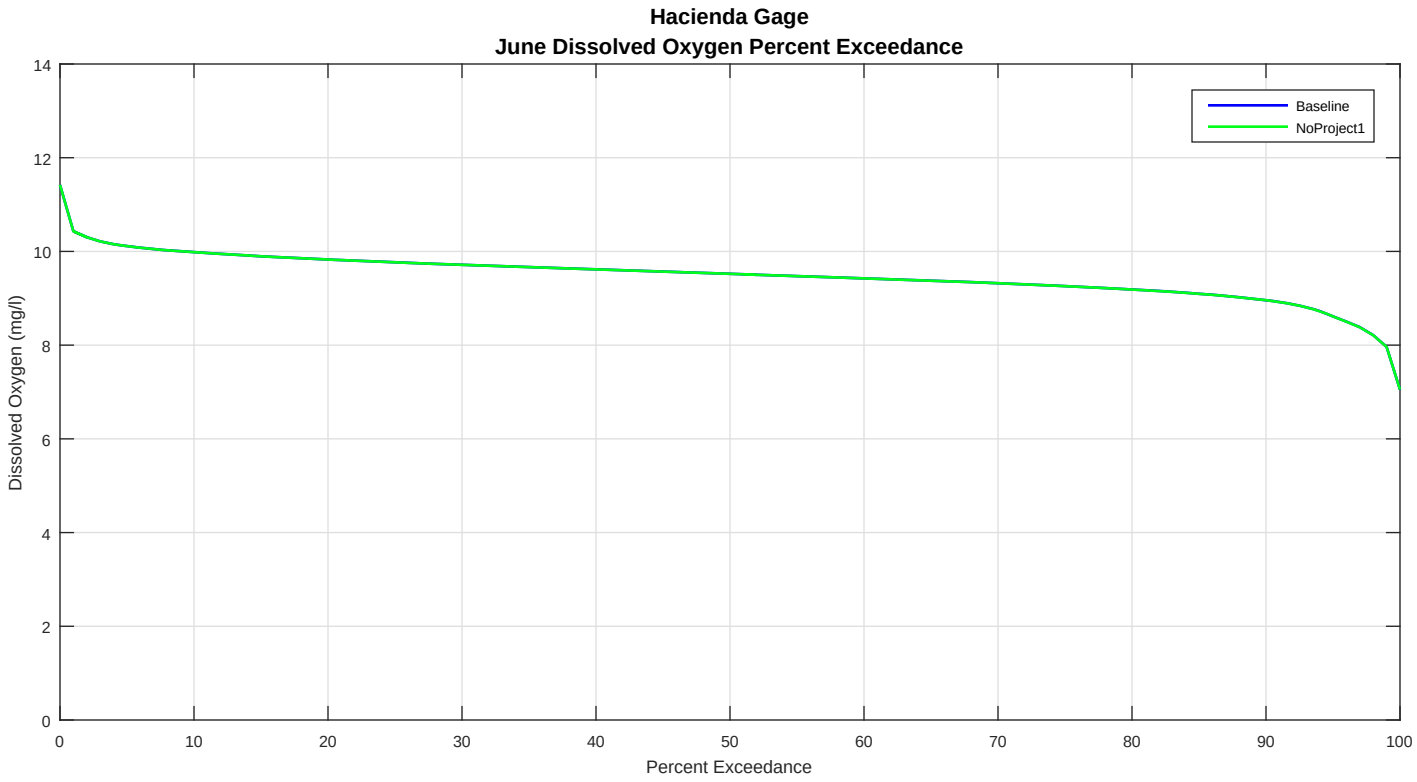
Hacienda Gage
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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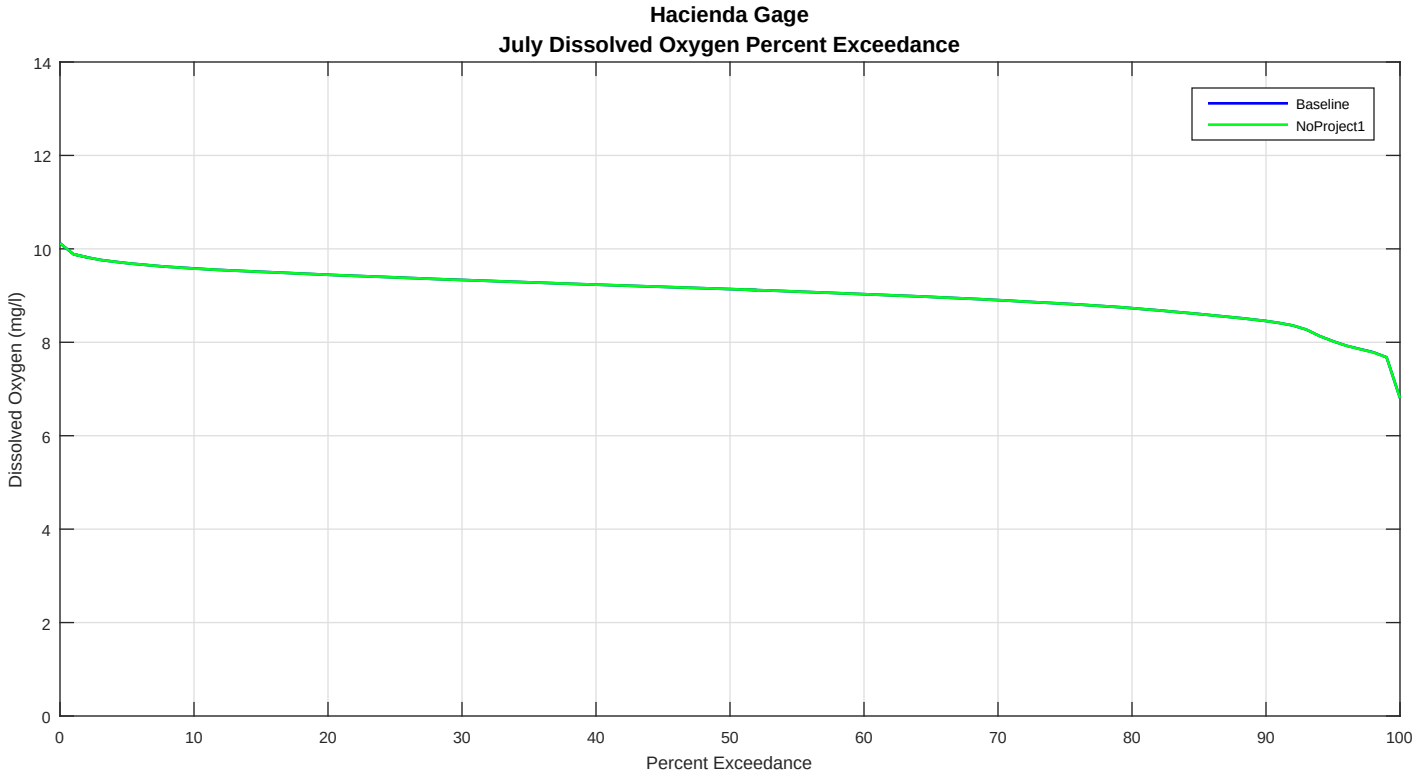
Hacienda Gage
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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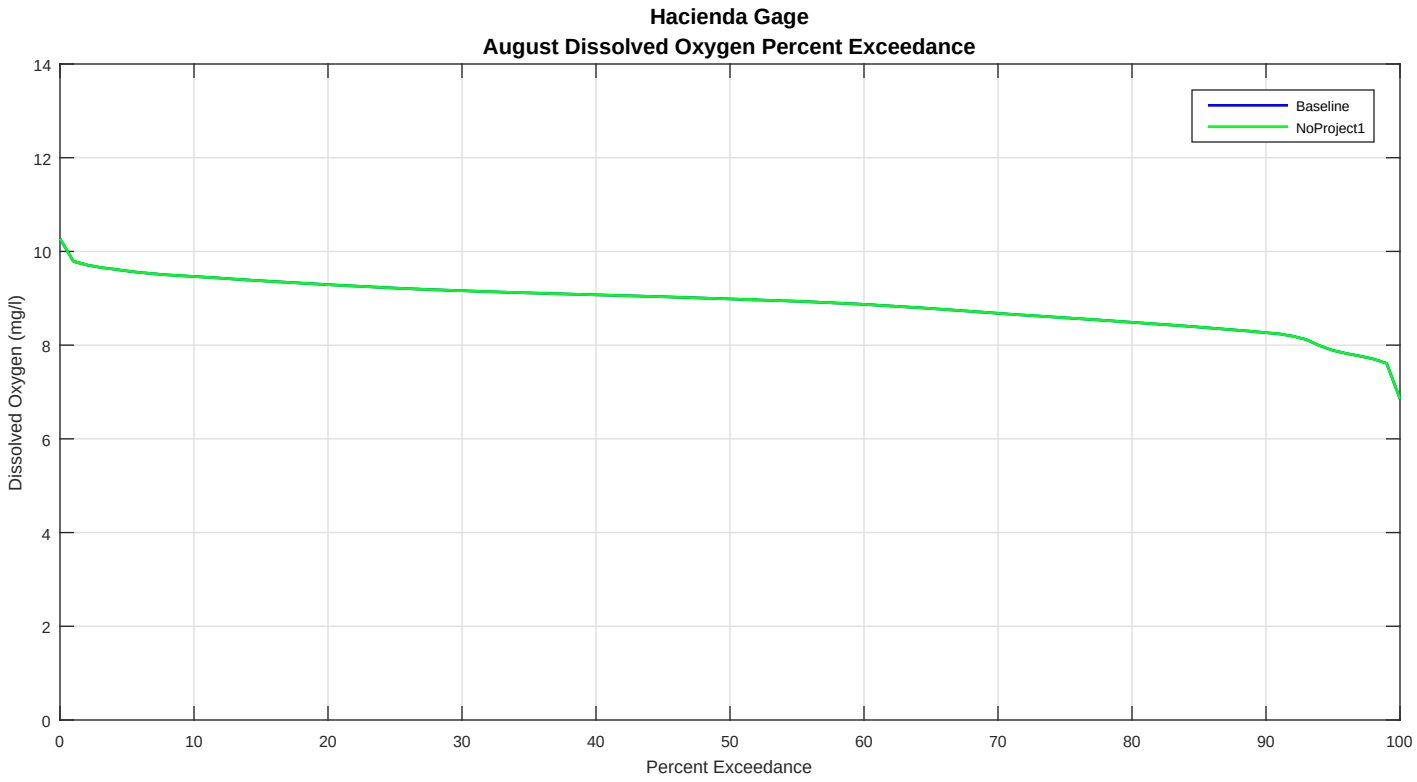
Hacienda Gage
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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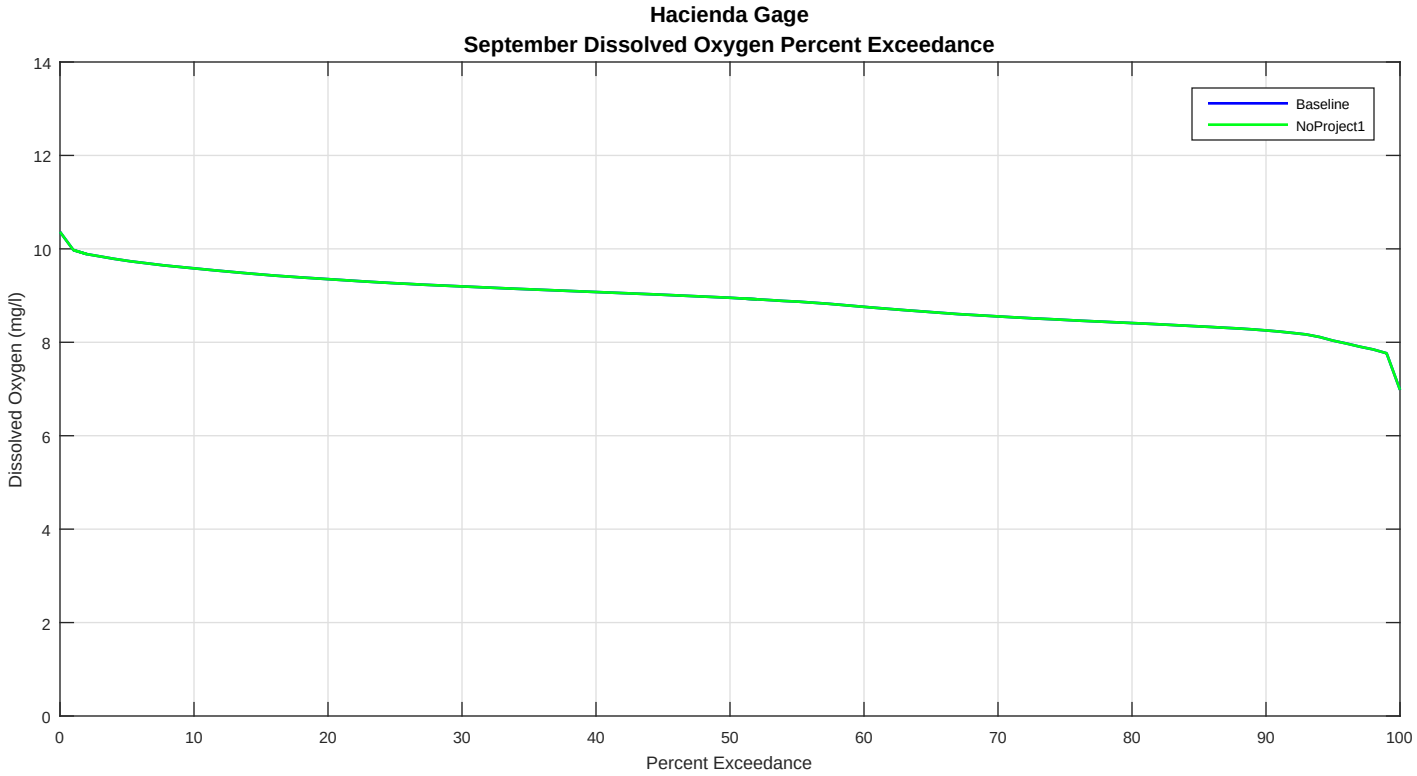
Hacienda Gage
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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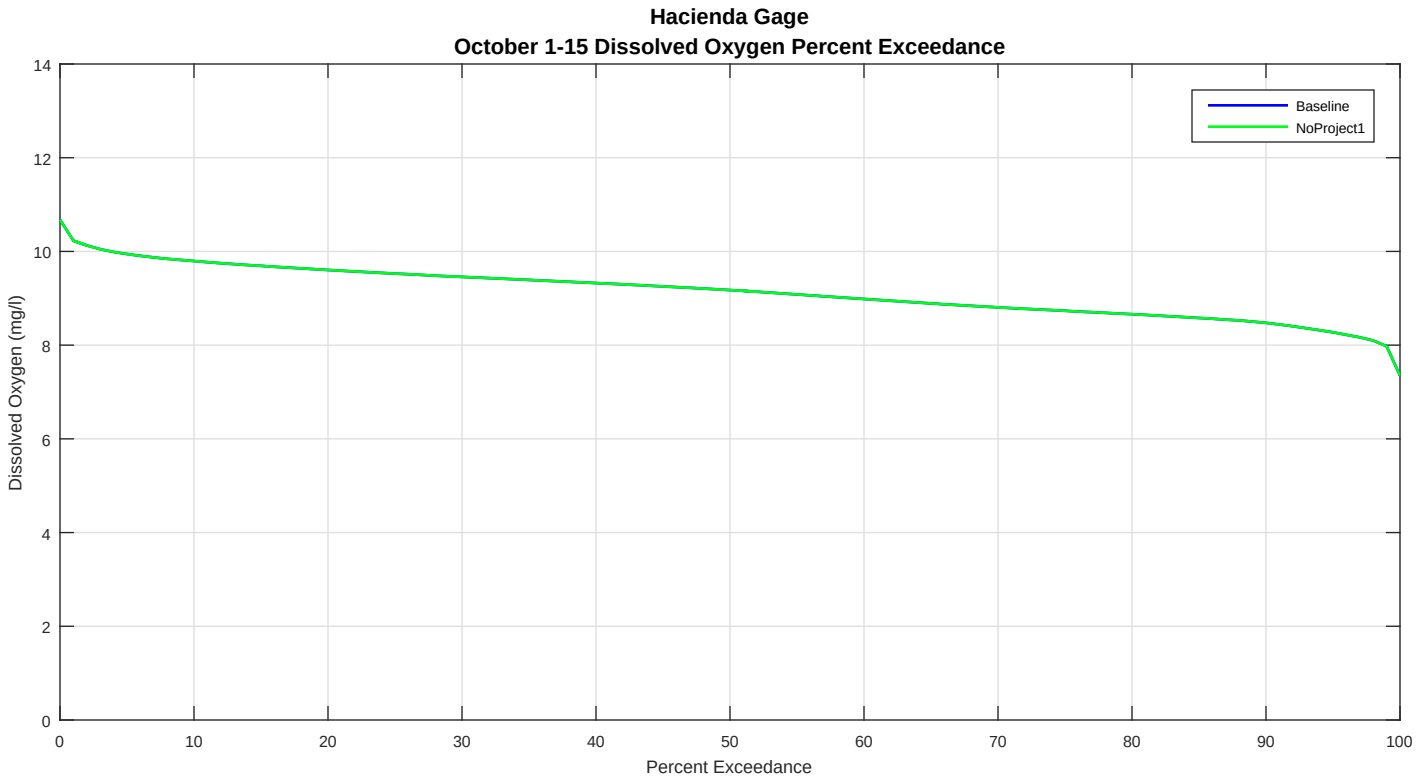
Hacienda Gage
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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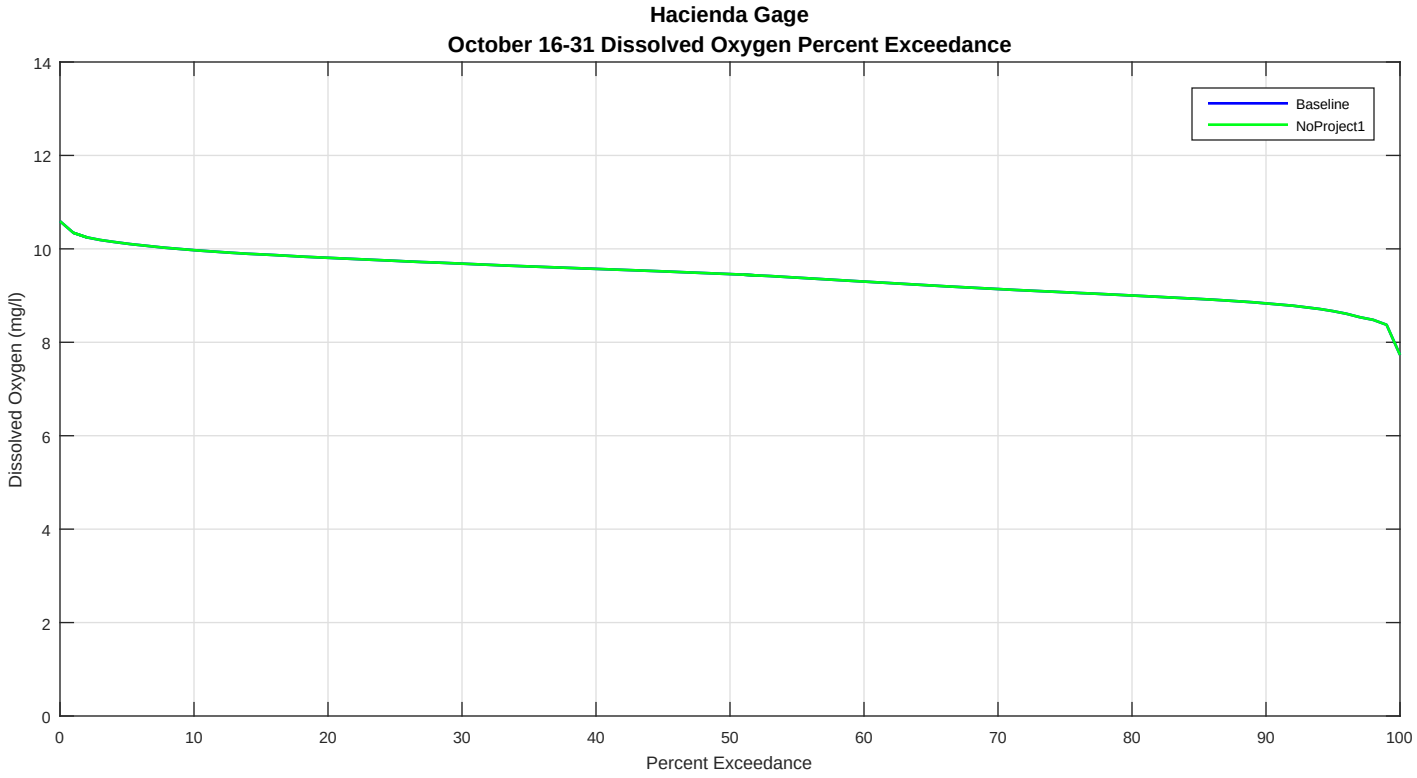
Hacienda Gage
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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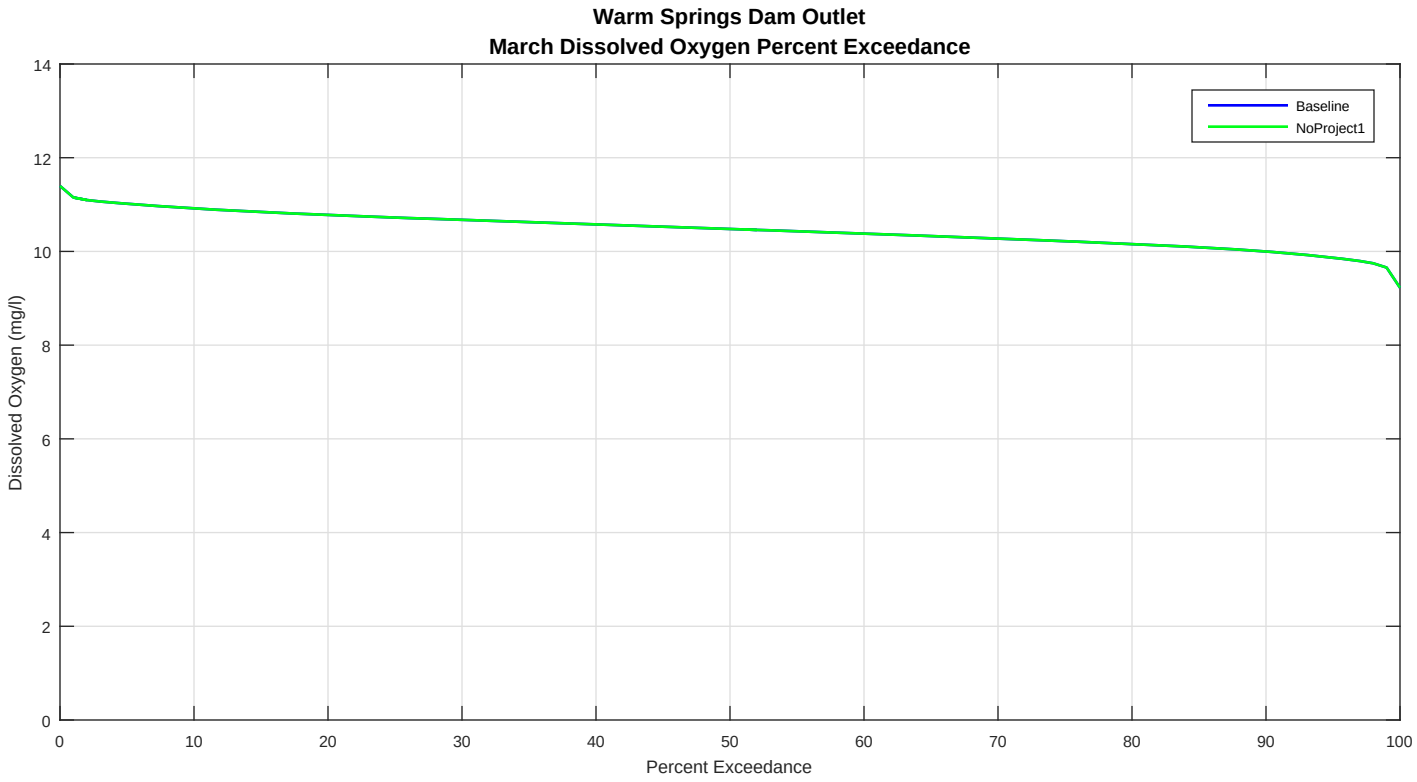
Warm Springs Dam Outlet
March Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
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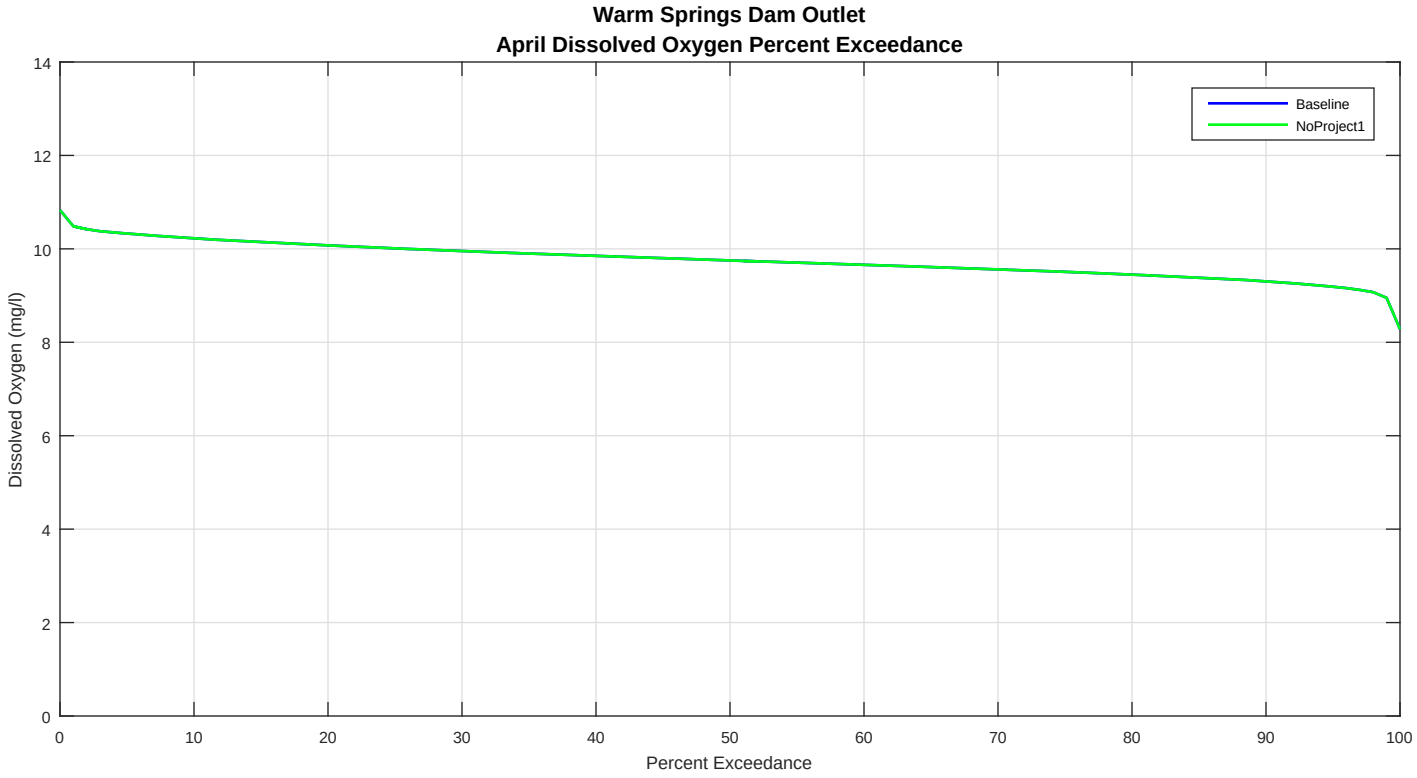
Warm Springs Dam Outlet
April Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
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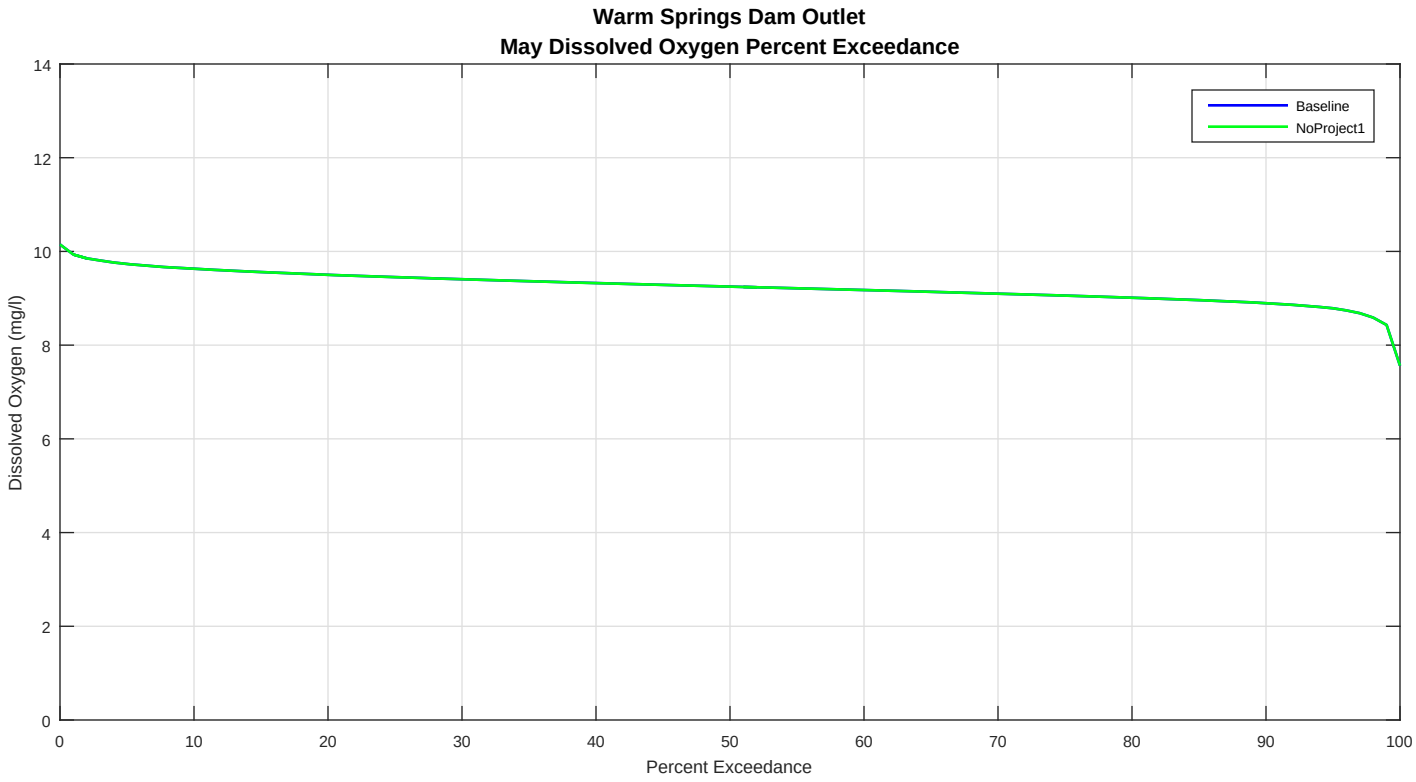
Warm Springs Dam Outlet
May Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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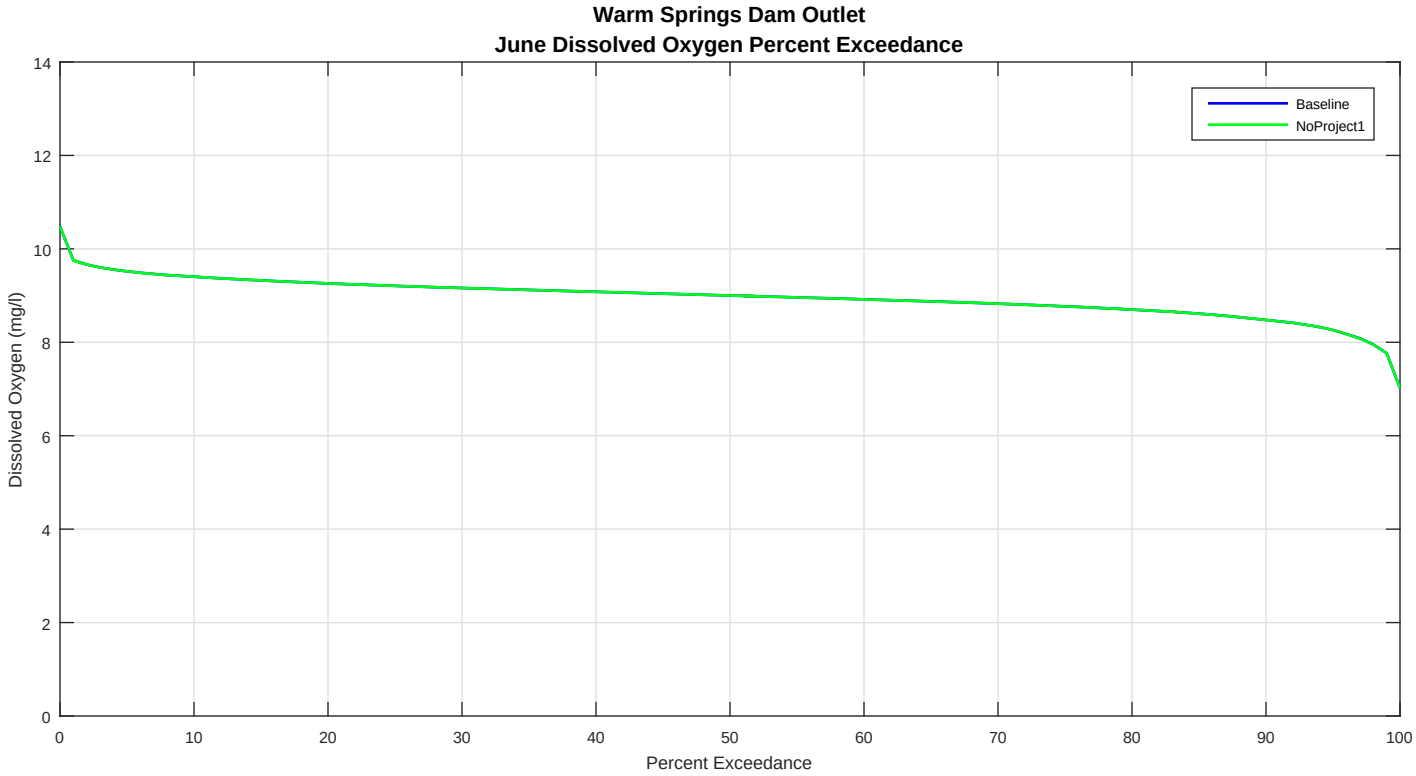
Warm Springs Dam Outlet
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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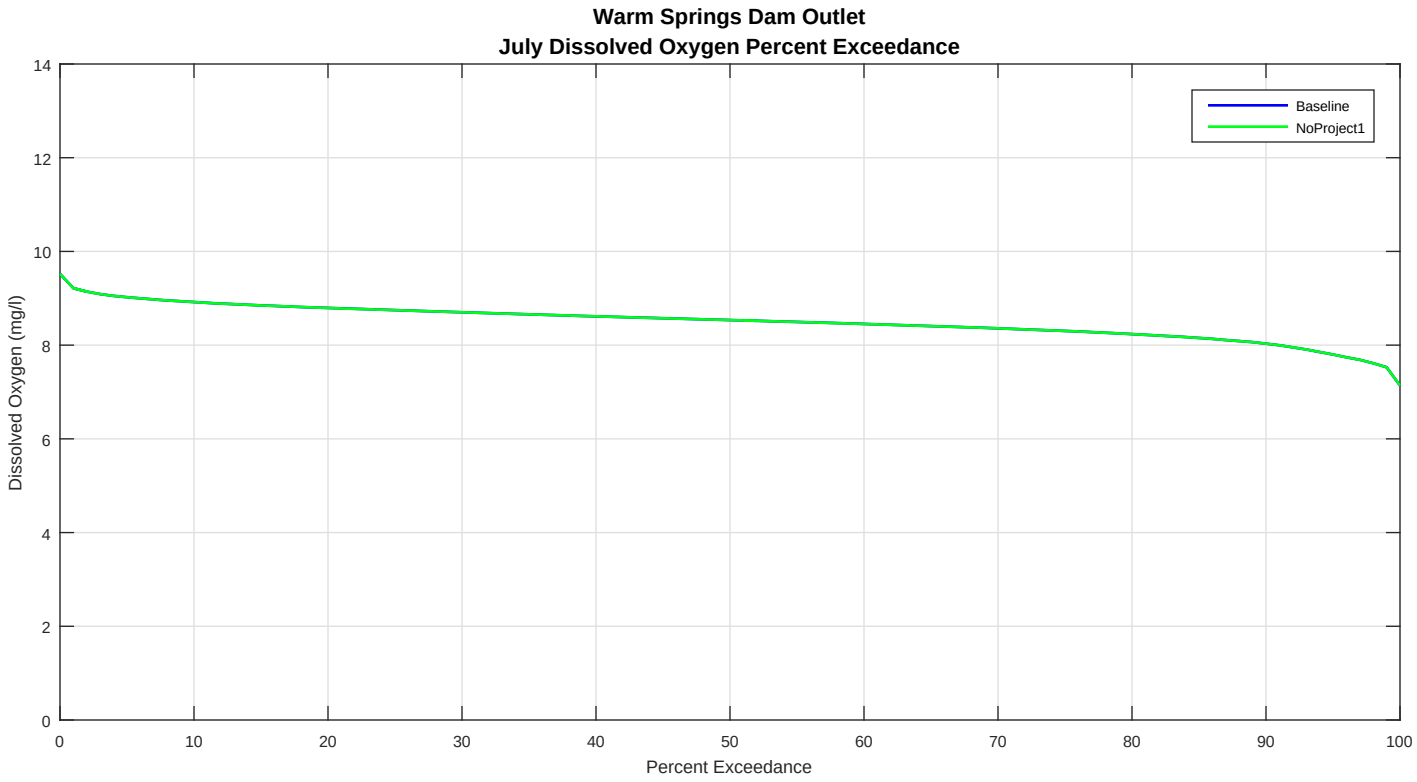
Warm Springs Dam Outlet
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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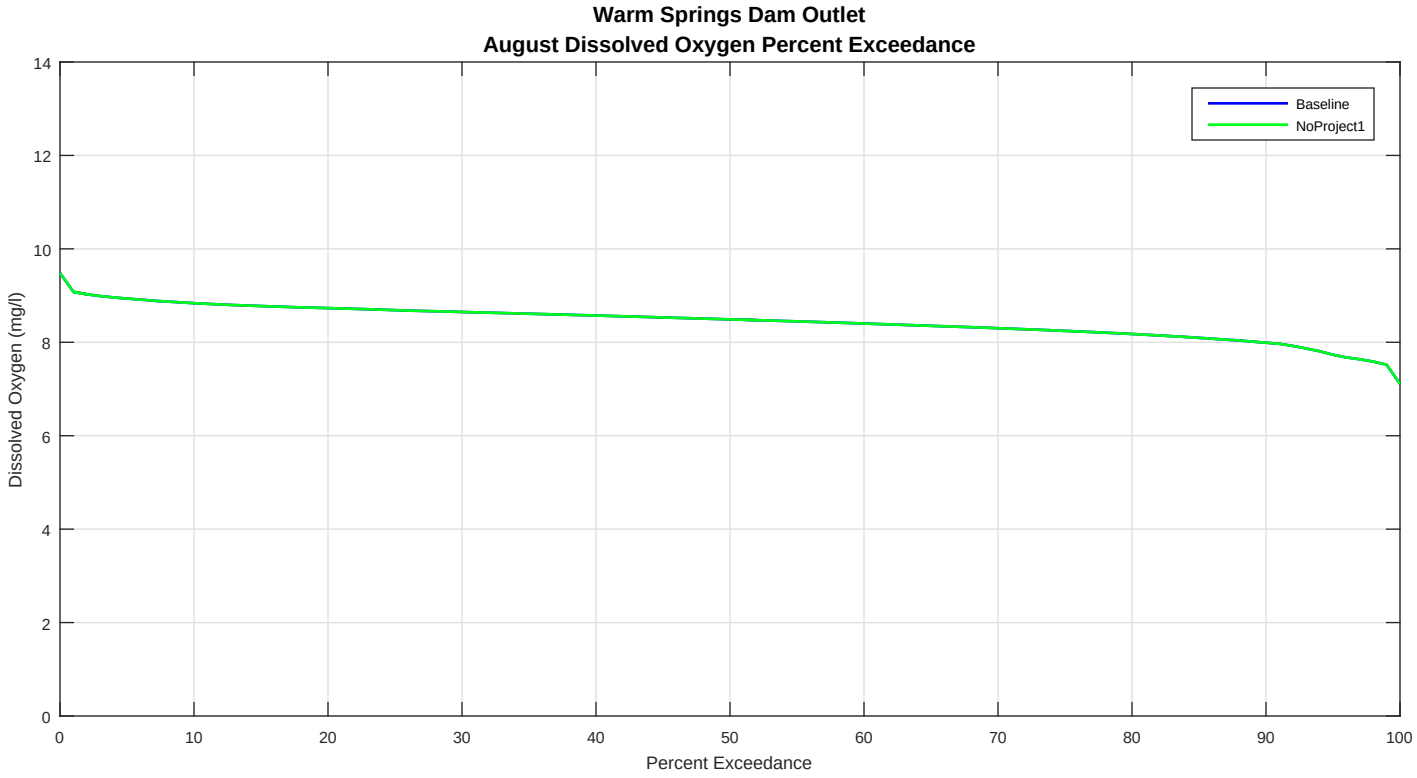
Warm Springs Dam Outlet
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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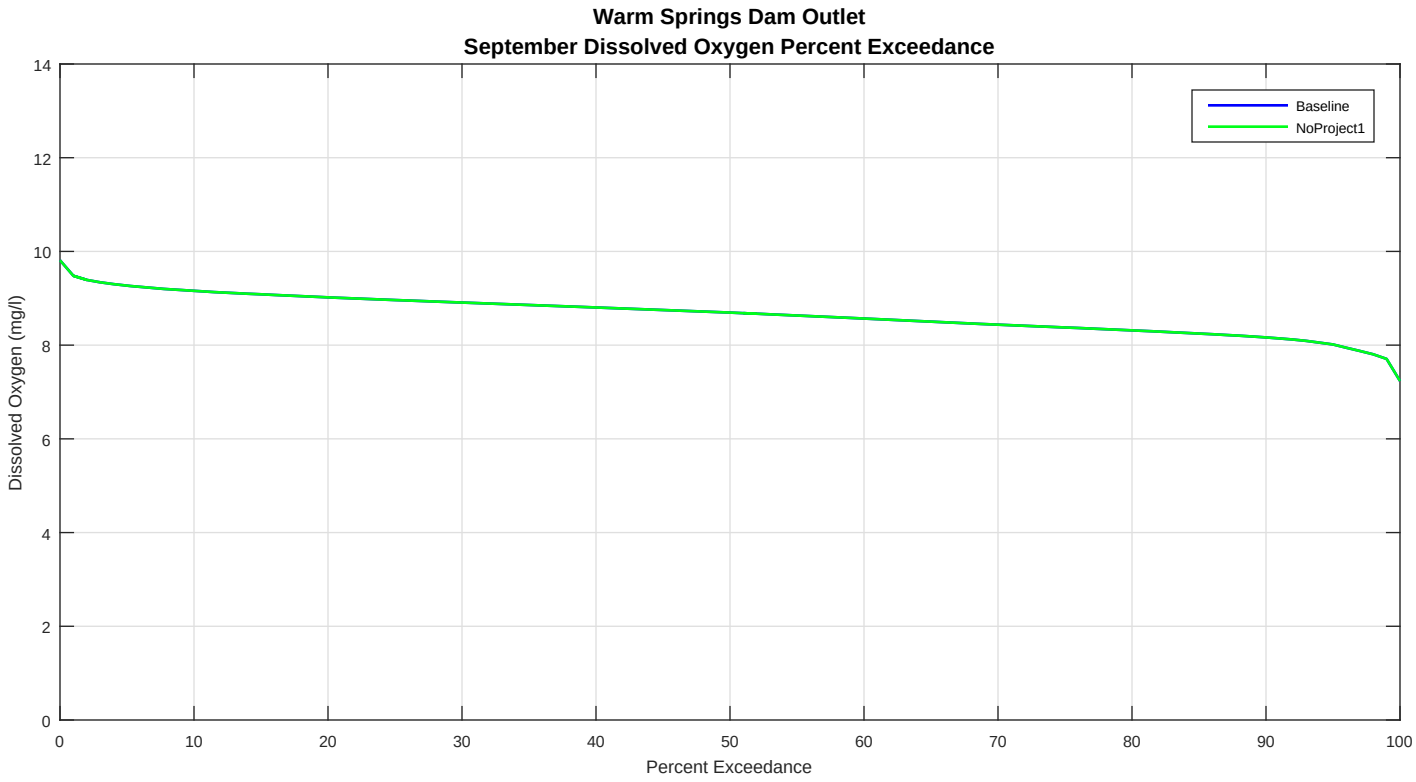
Warm Springs Dam Outlet
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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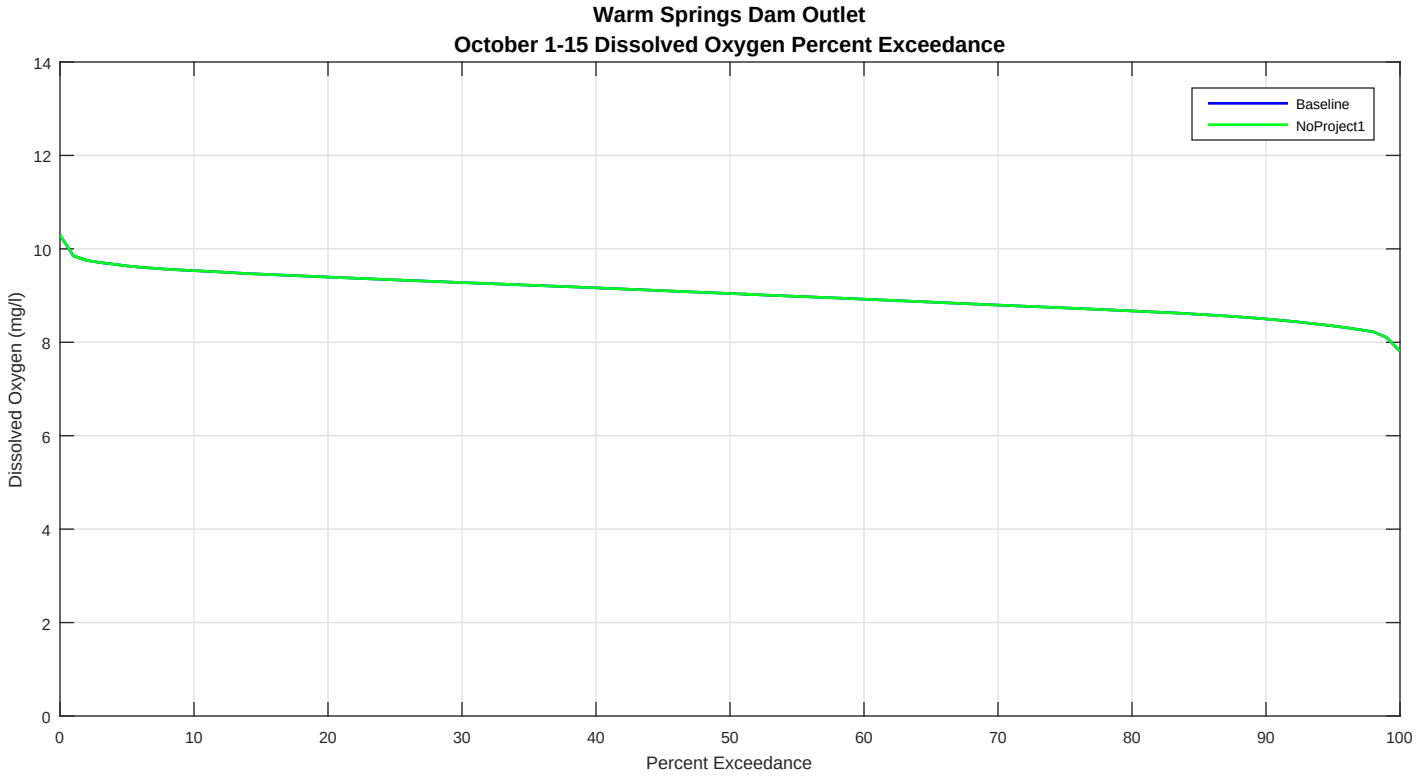
Warm Springs Dam Outlet
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
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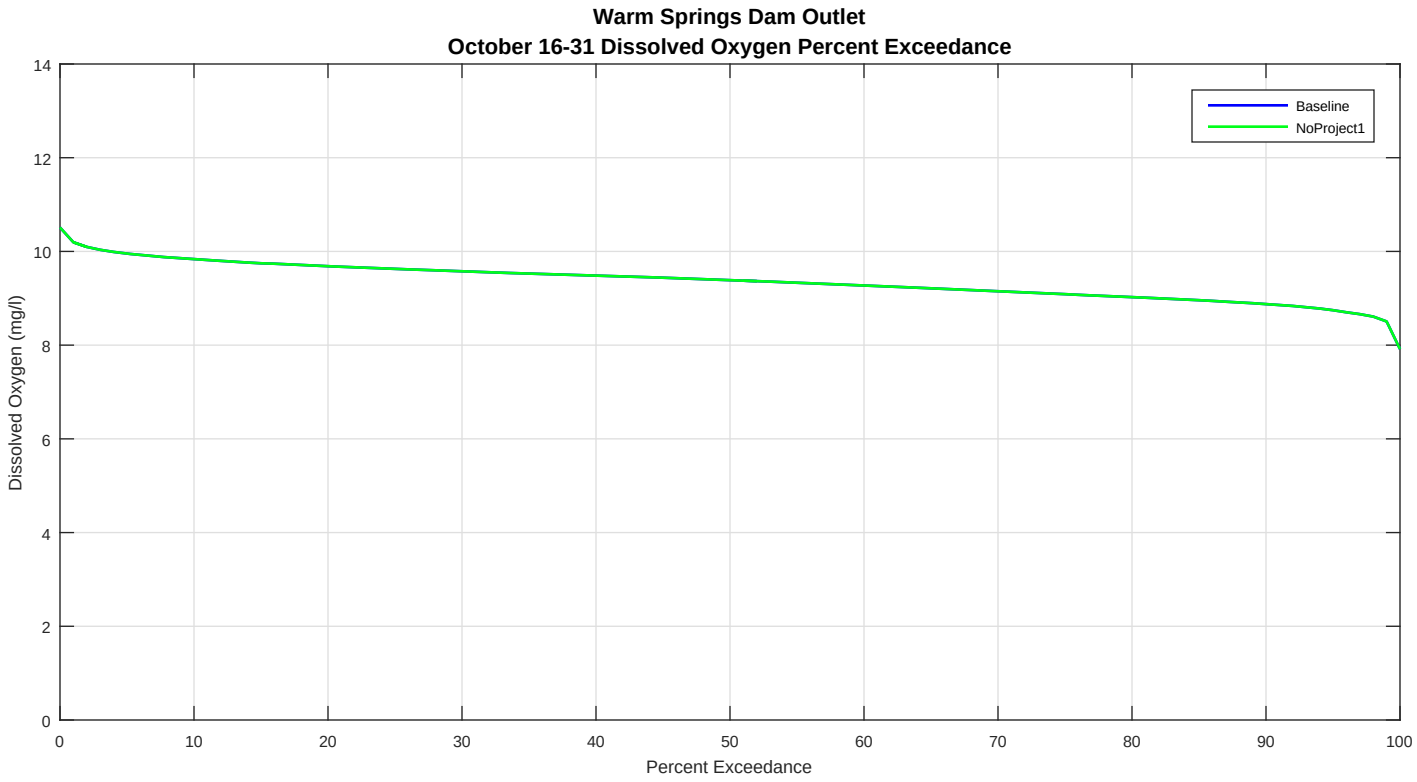
Warm Springs Dam Outlet
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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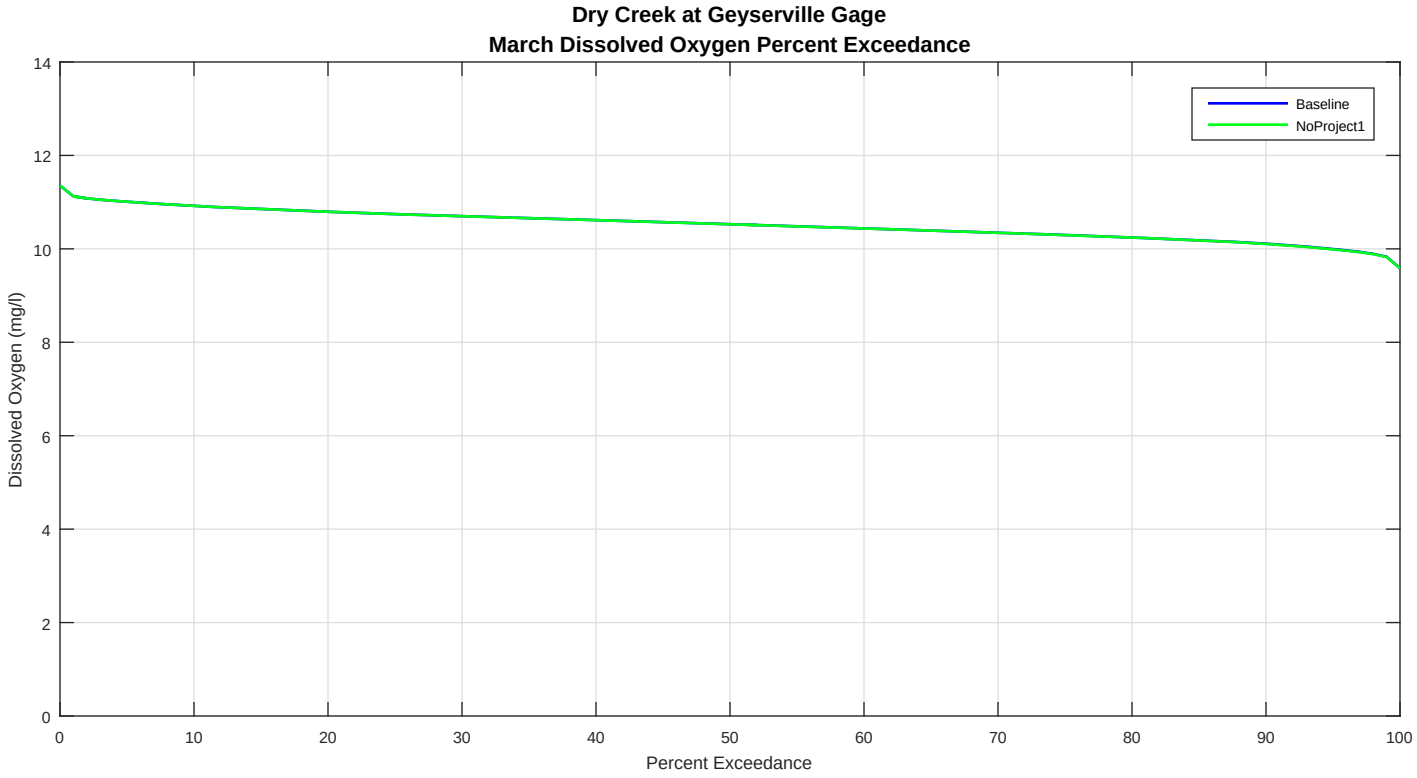
Dry Creek at Geyserville Gage
March Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
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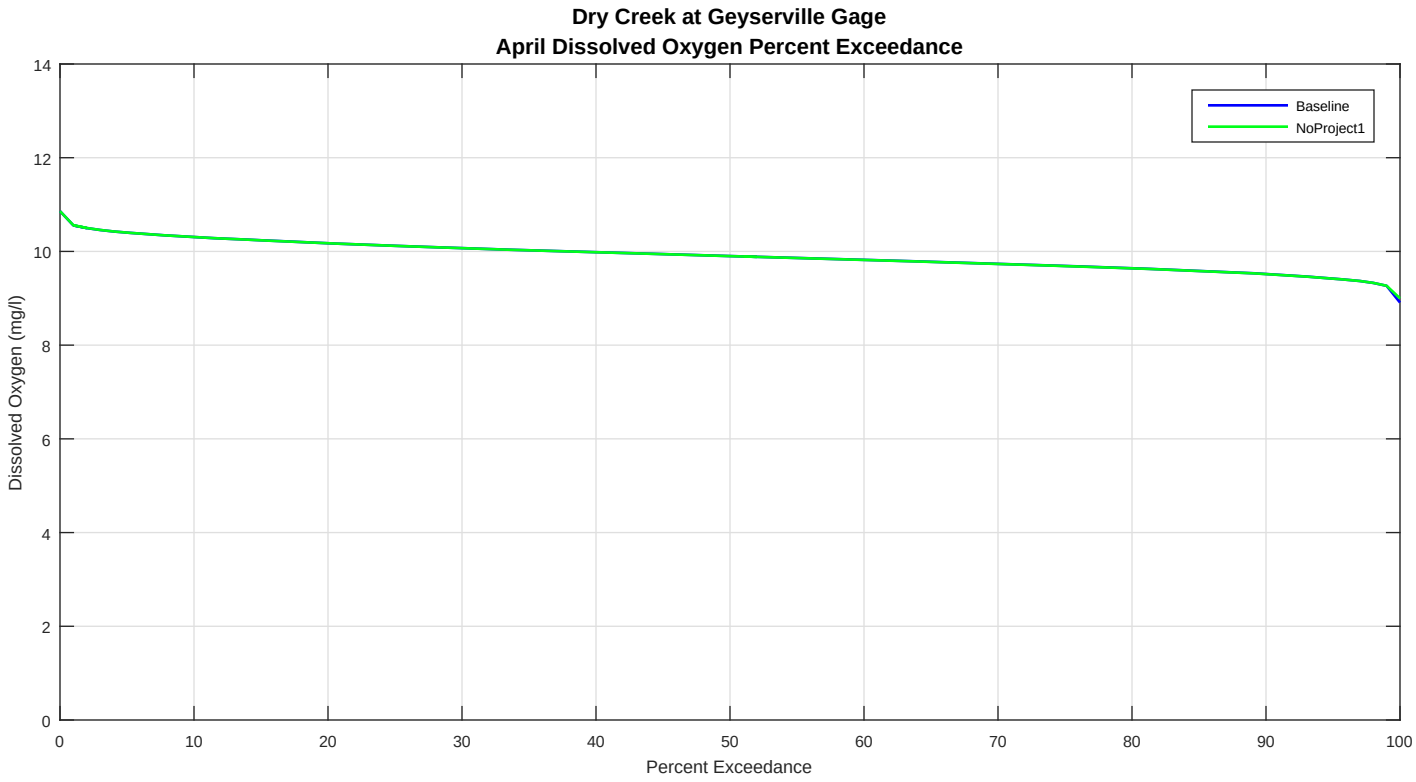
Dry Creek at Geyserville Gage
April Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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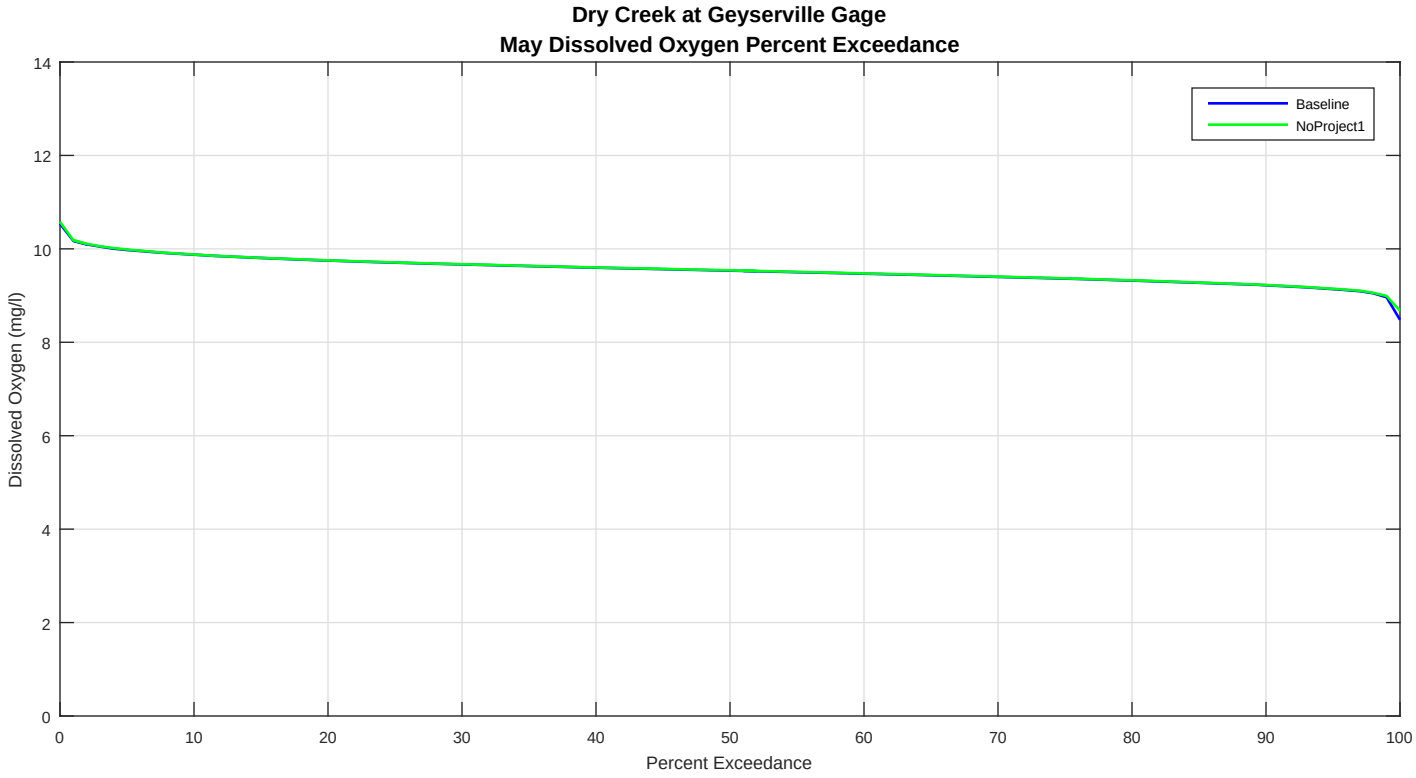
Dry Creek at Geyserville Gage
May Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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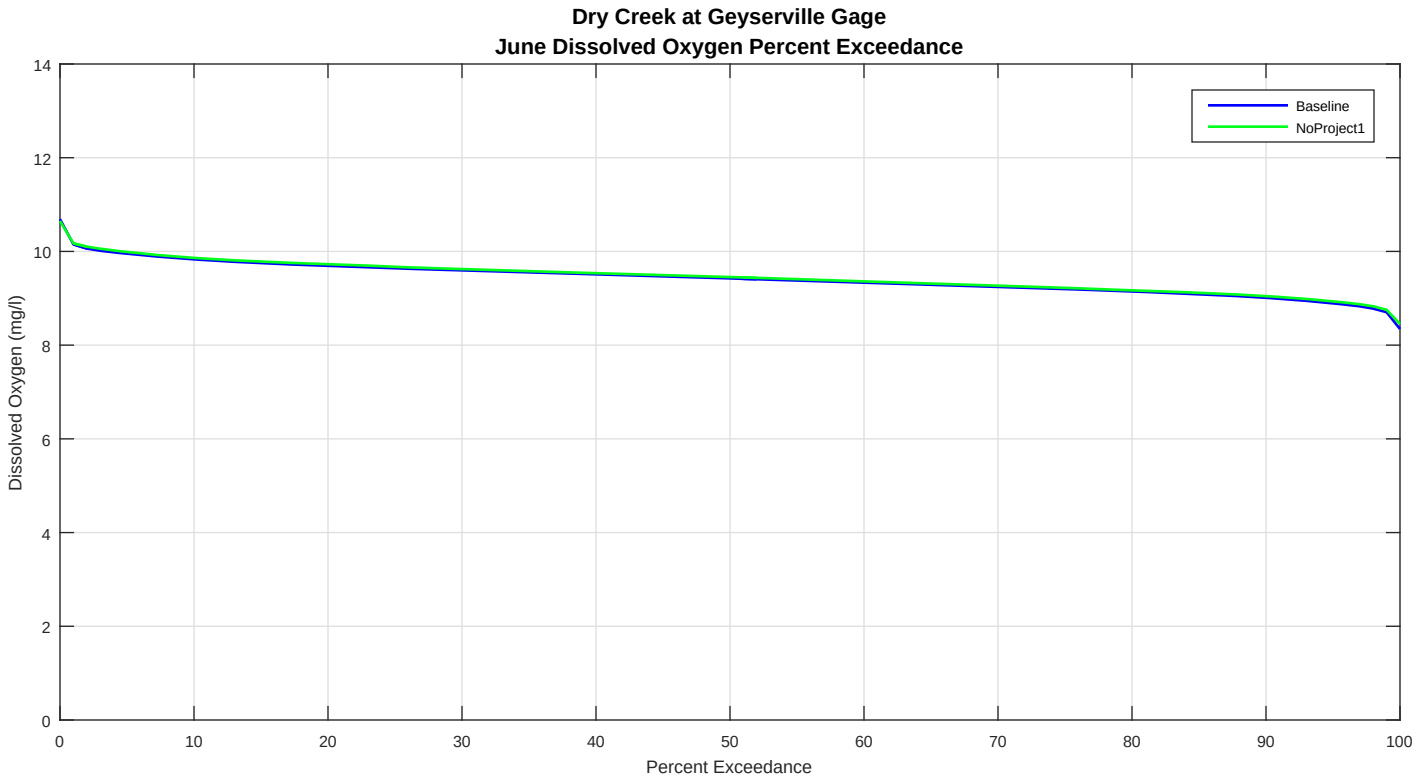
Dry Creek at Geyserville Gage
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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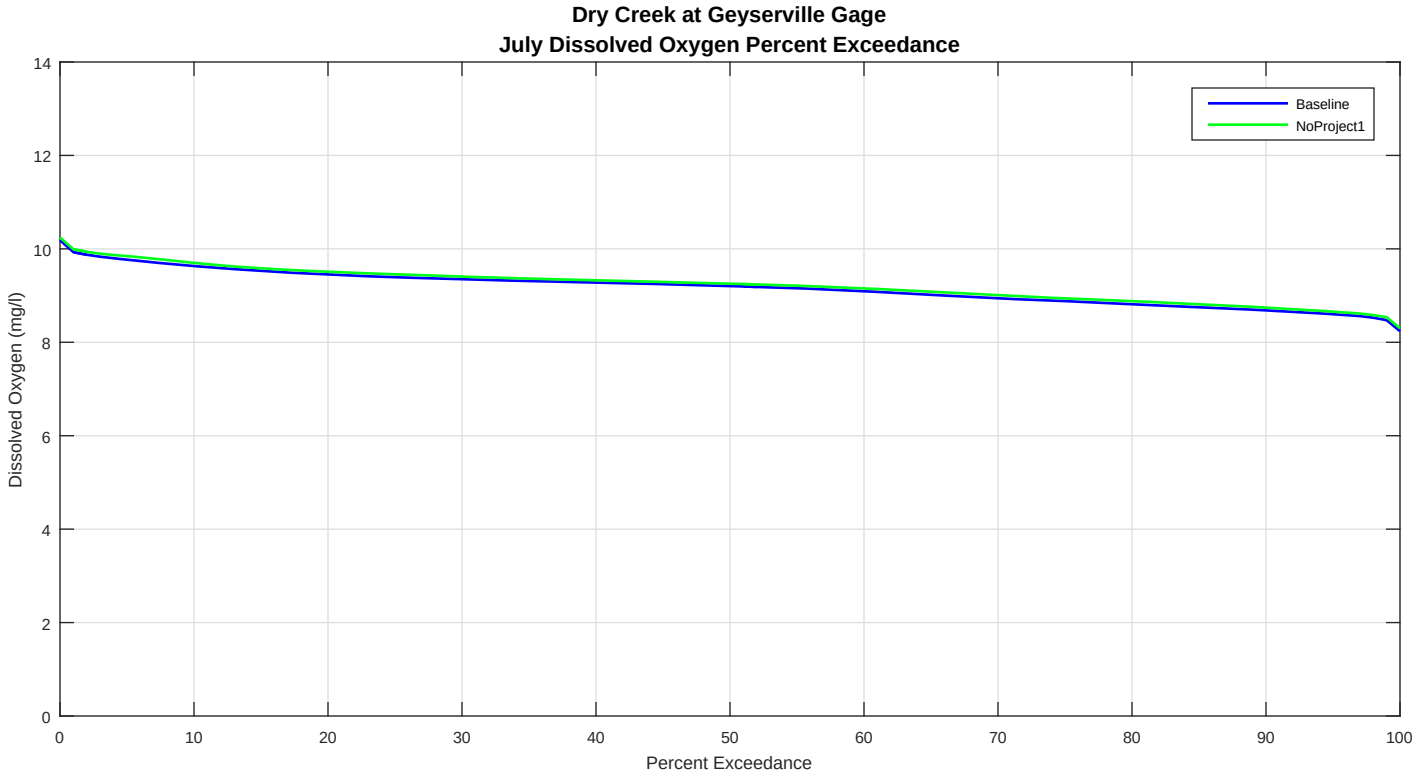
Dry Creek at Geyserville Gage
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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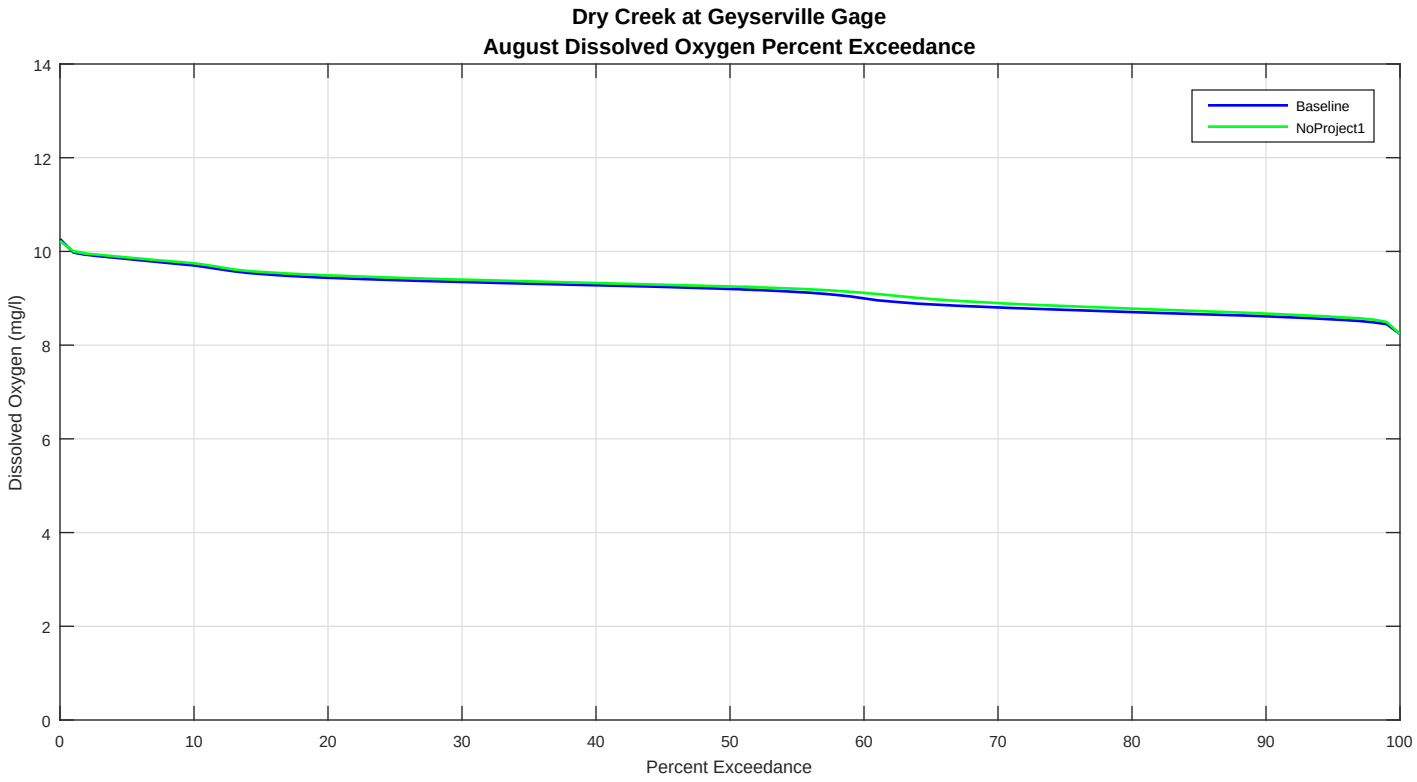
Dry Creek at Geyserville Gage
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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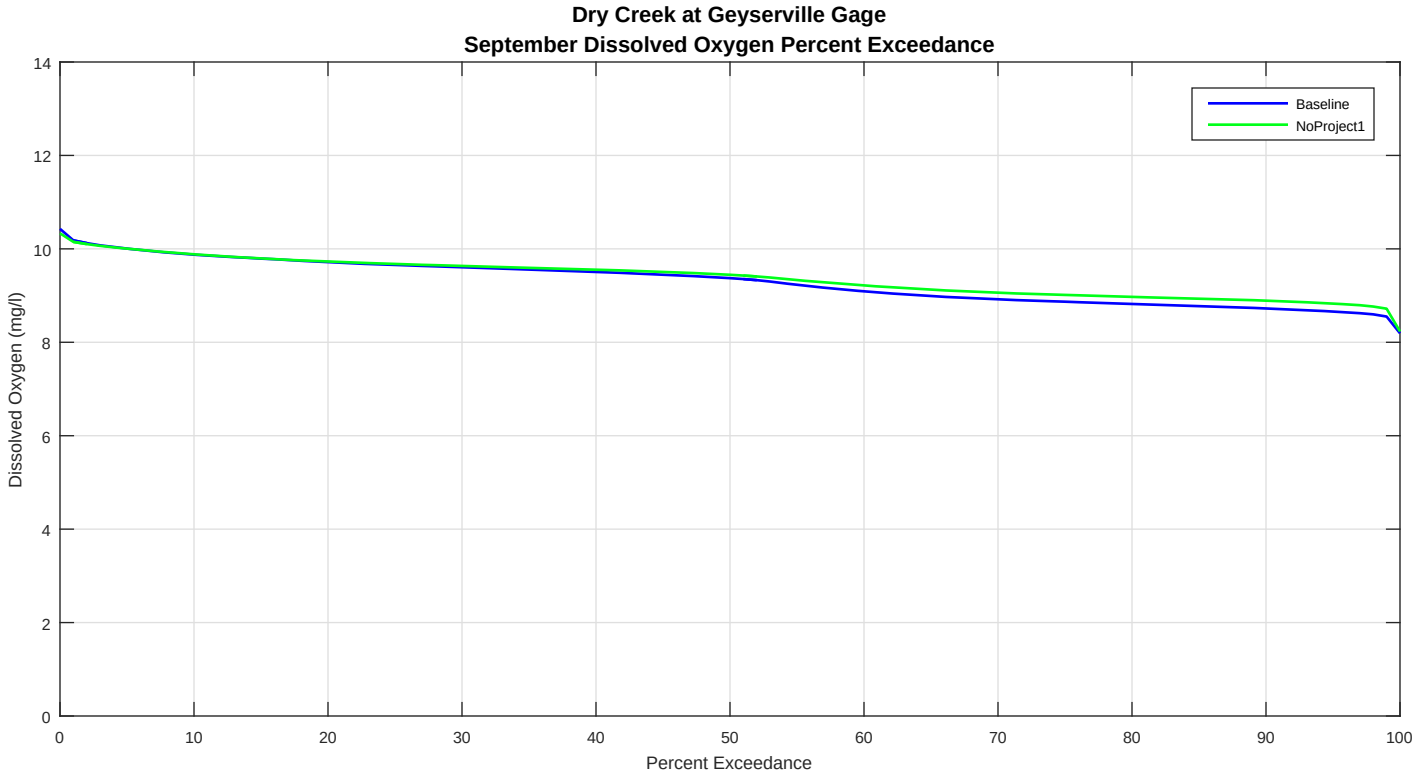
Dry Creek at Geyserville Gage
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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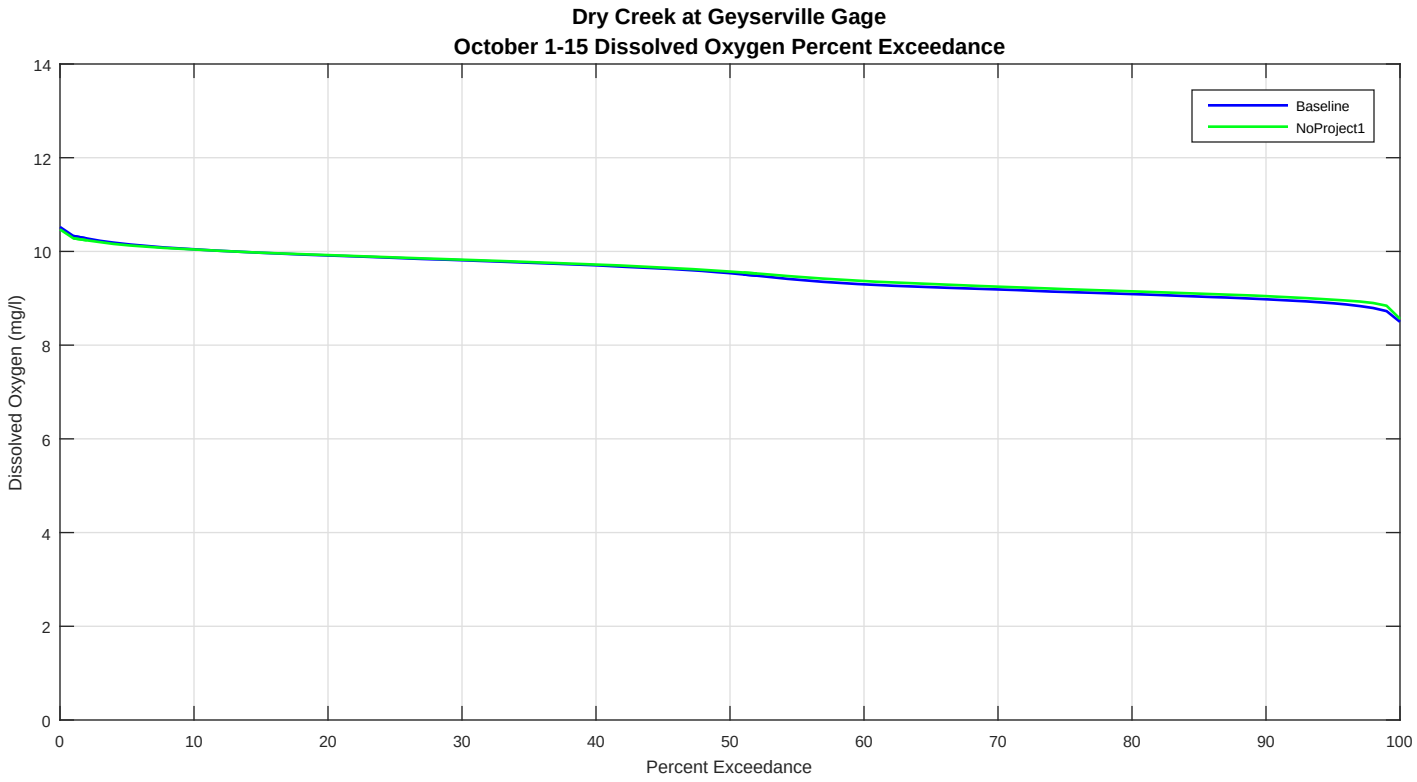
Dry Creek at Geyserville Gage
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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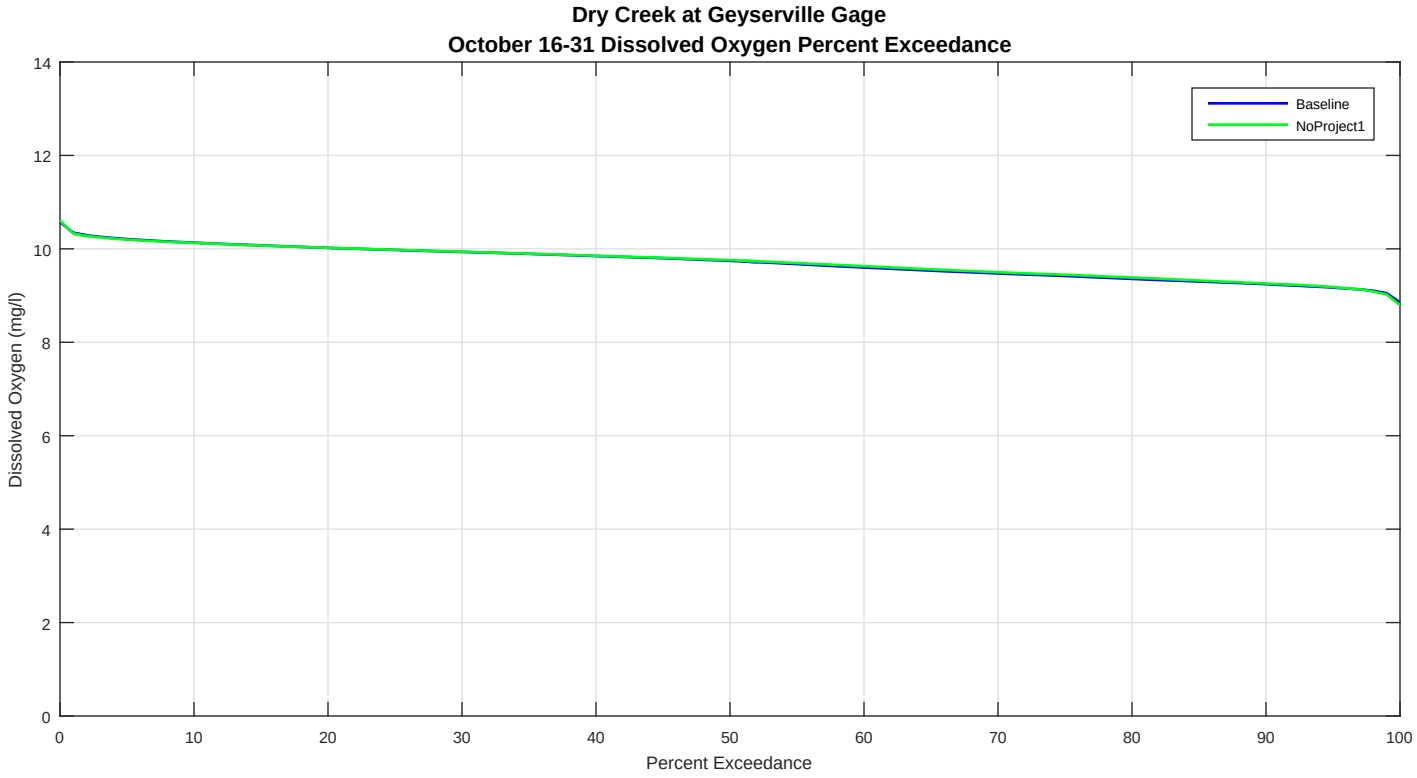
Dry Creek at Geyserville Gage
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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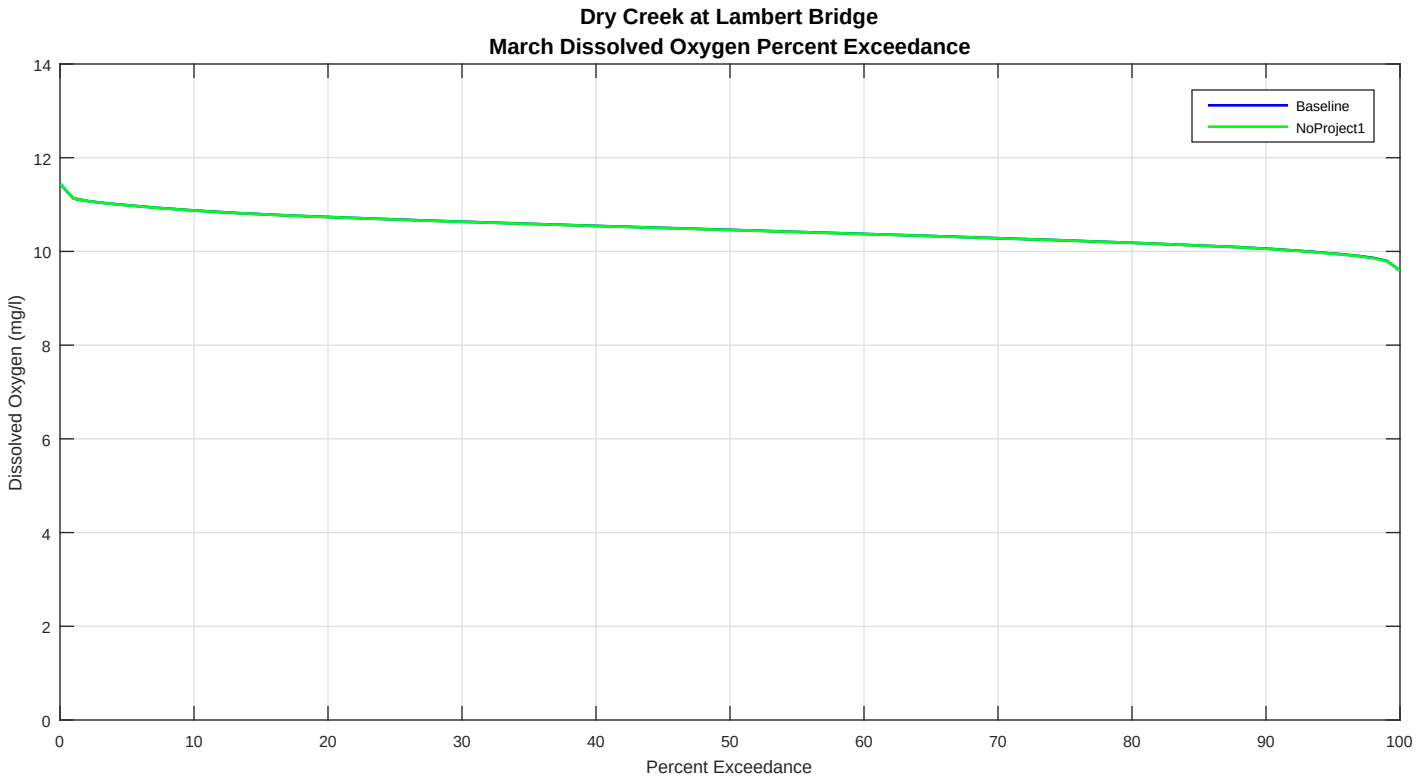
Dry Creek at Lambert Bridge
March Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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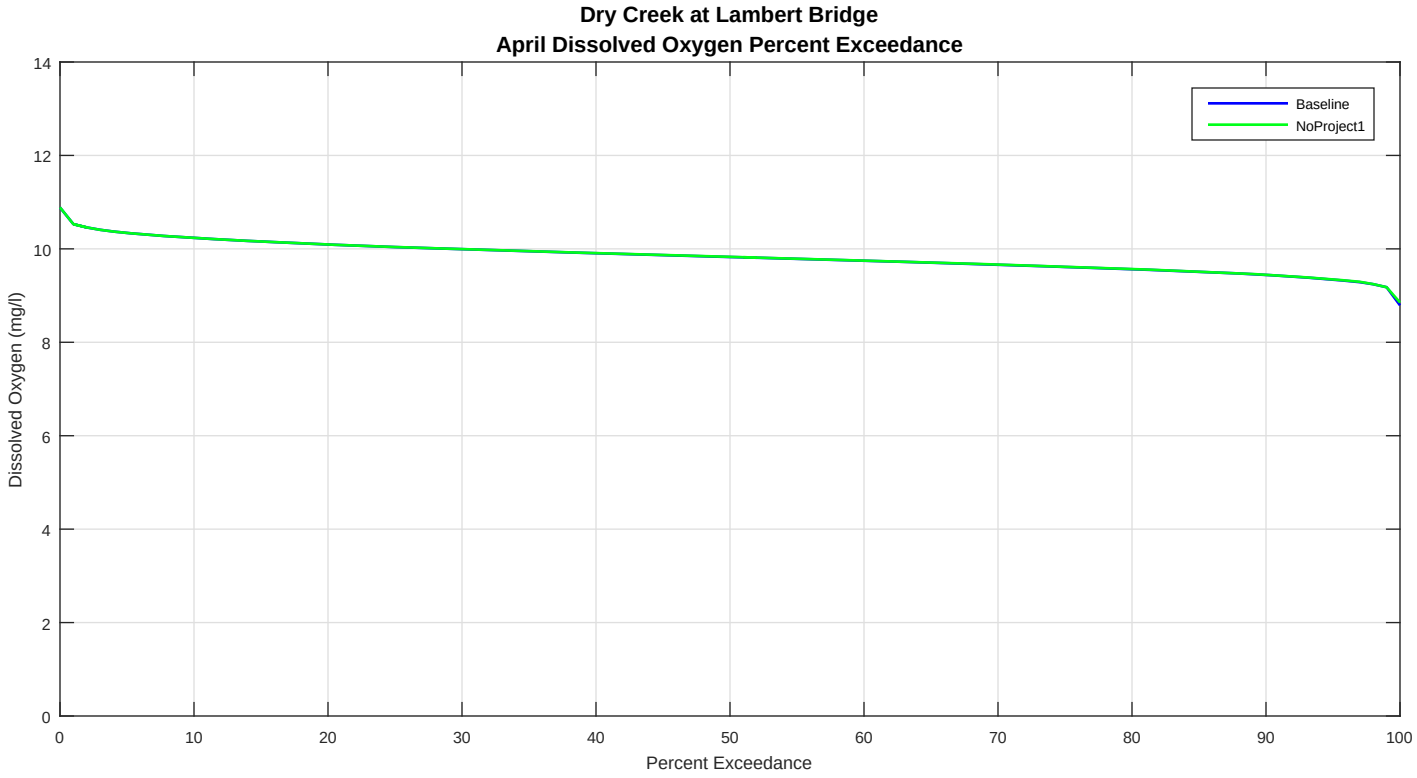
Dry Creek at Lambert Bridge
April Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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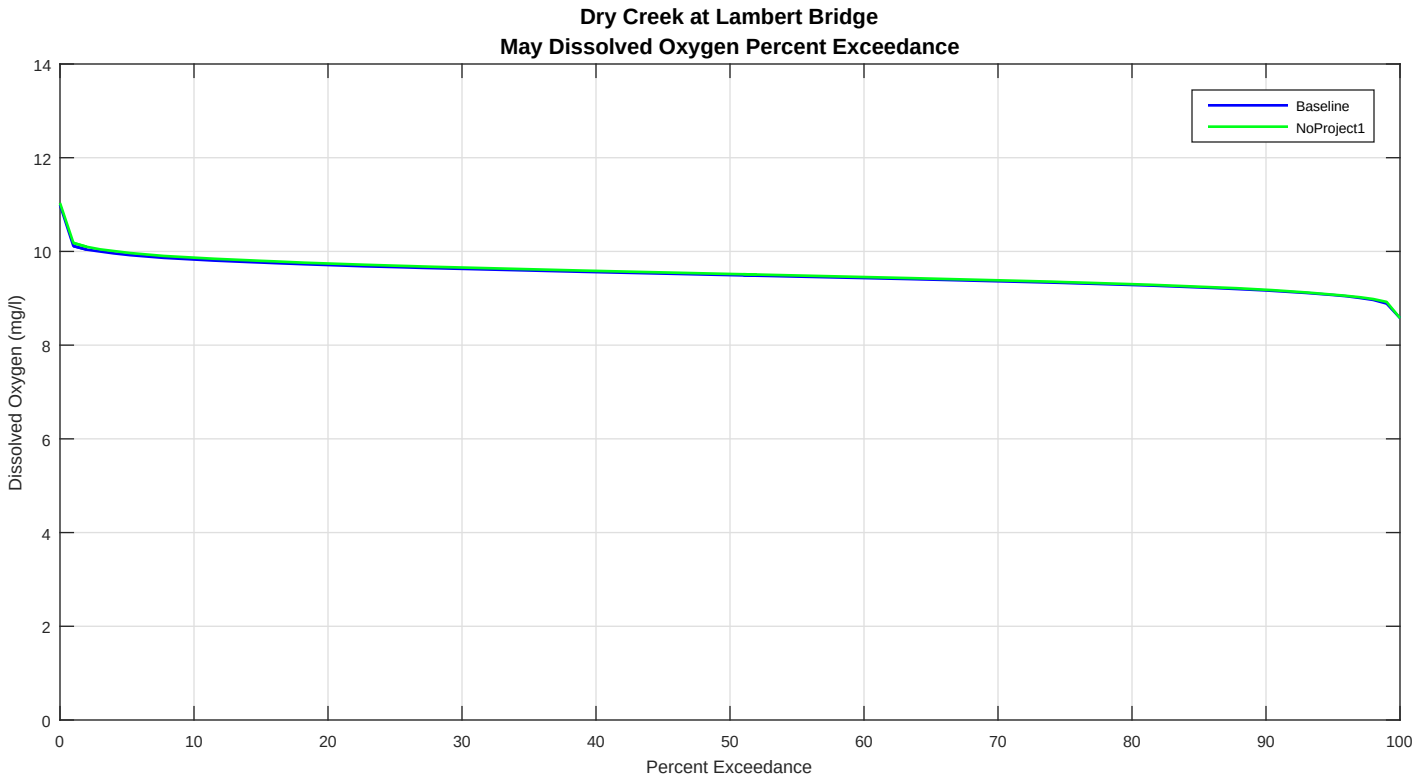
Dry Creek at Lambert Bridge
May Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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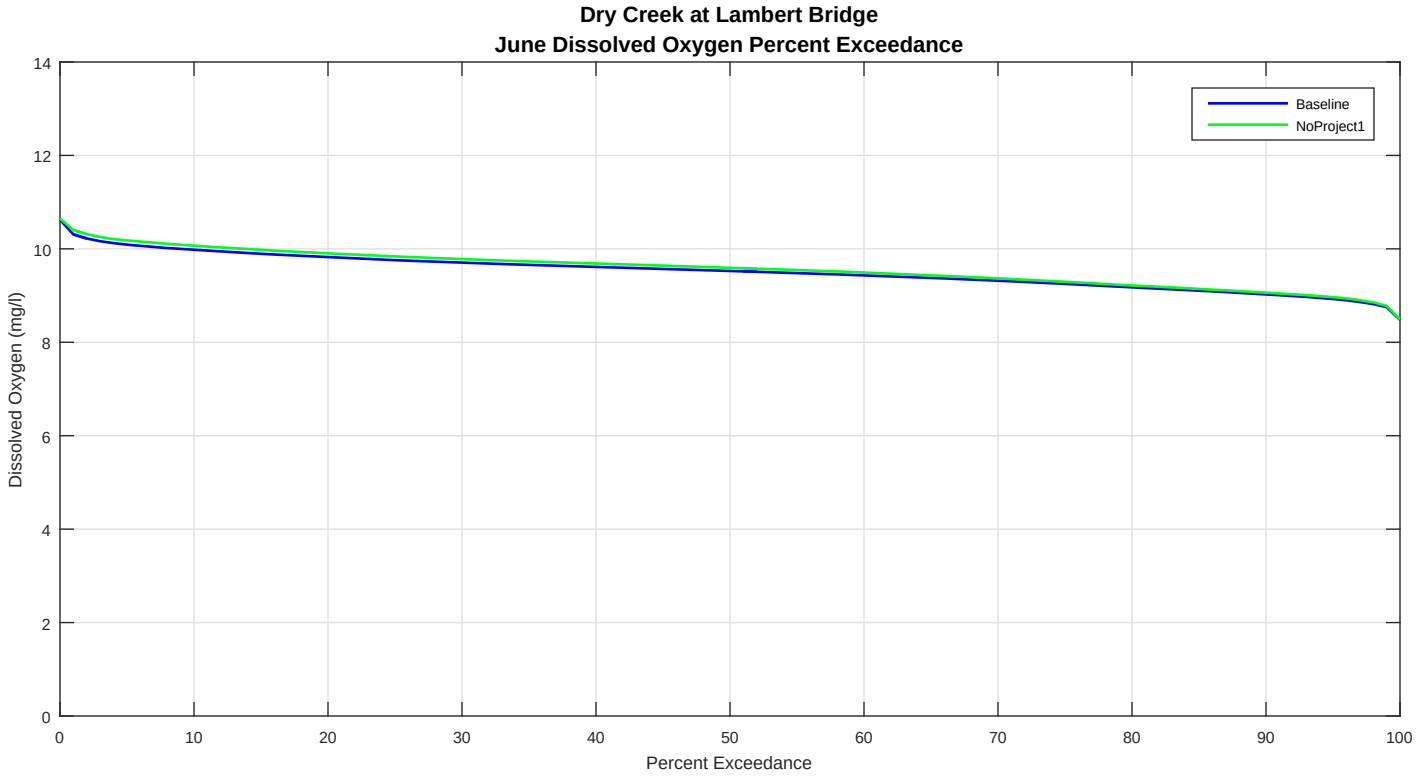
Dry Creek at Lambert Bridge
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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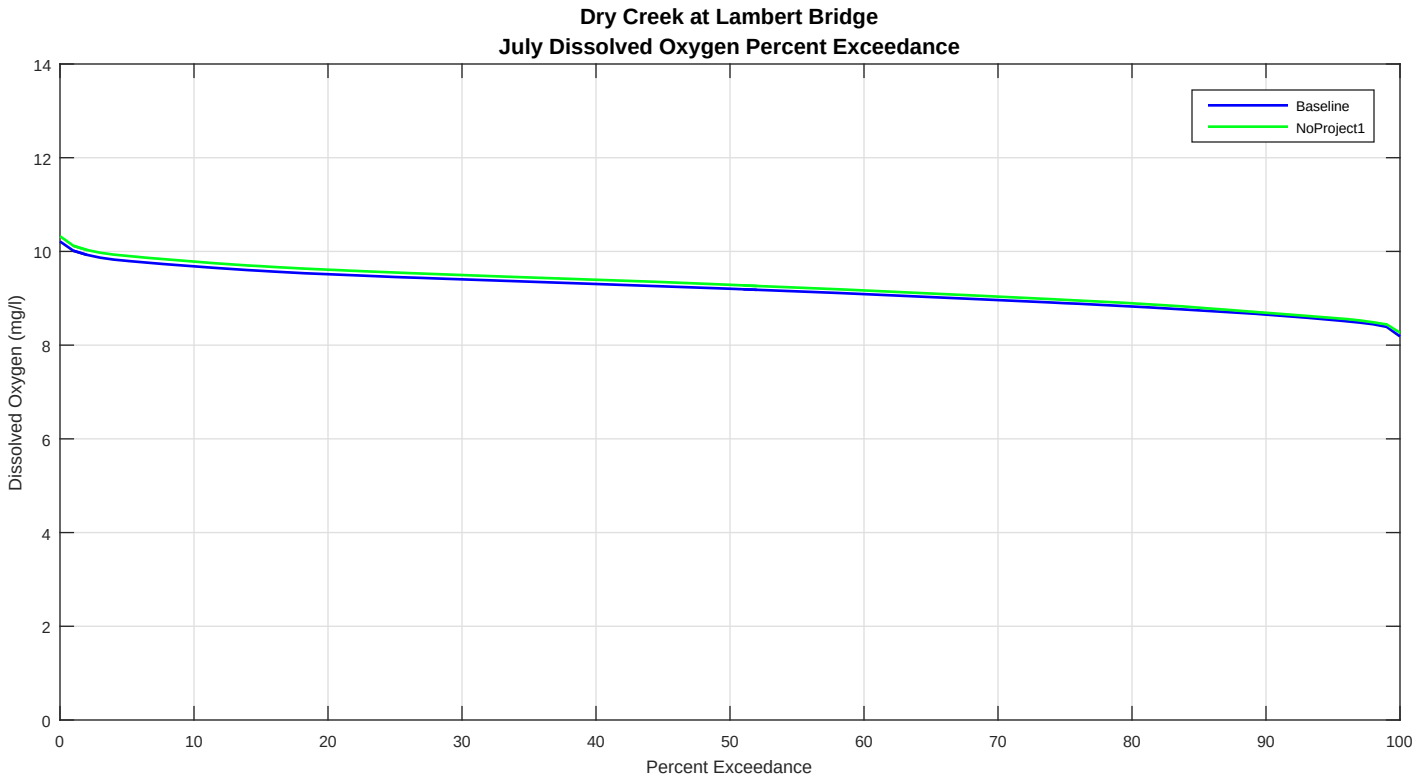
Dry Creek at Lambert Bridge
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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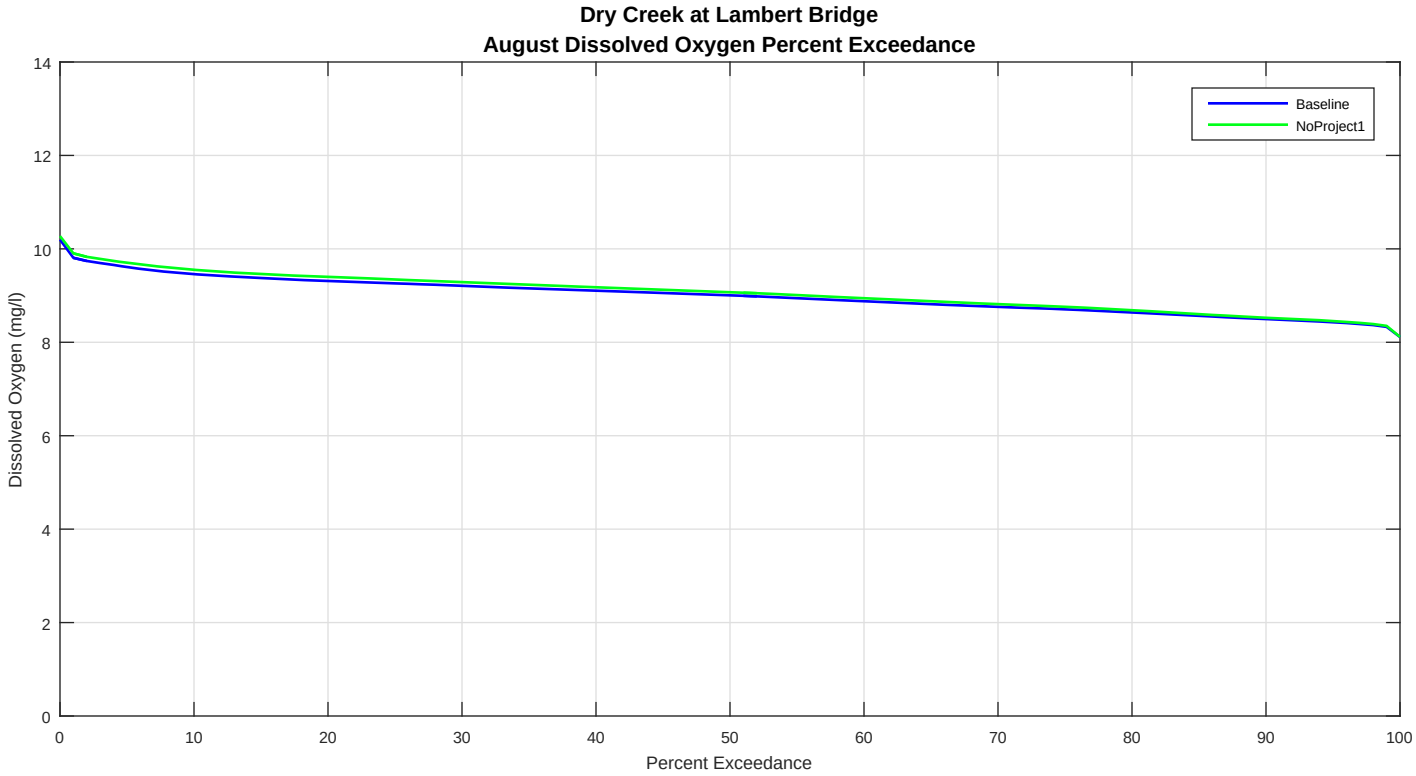
Dry Creek at Lambert Bridge
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
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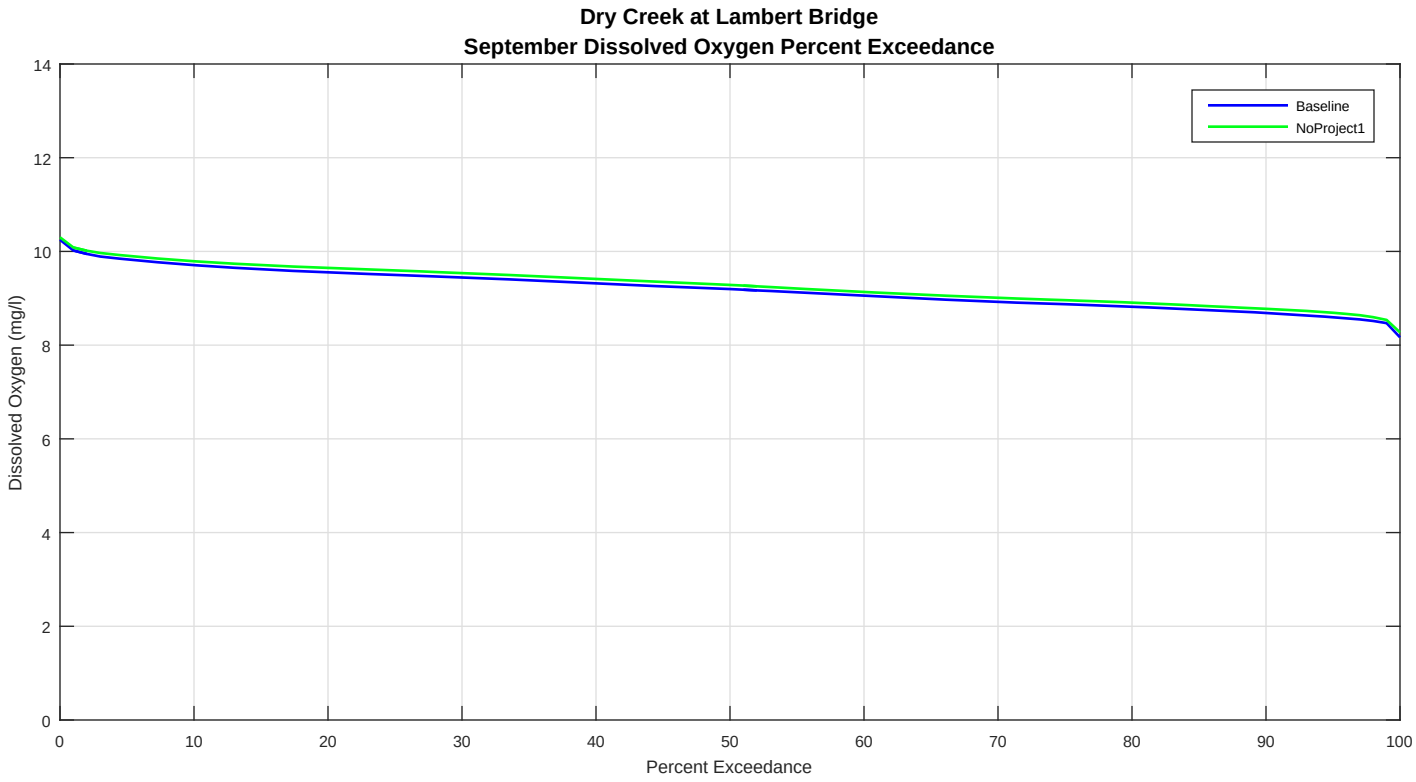
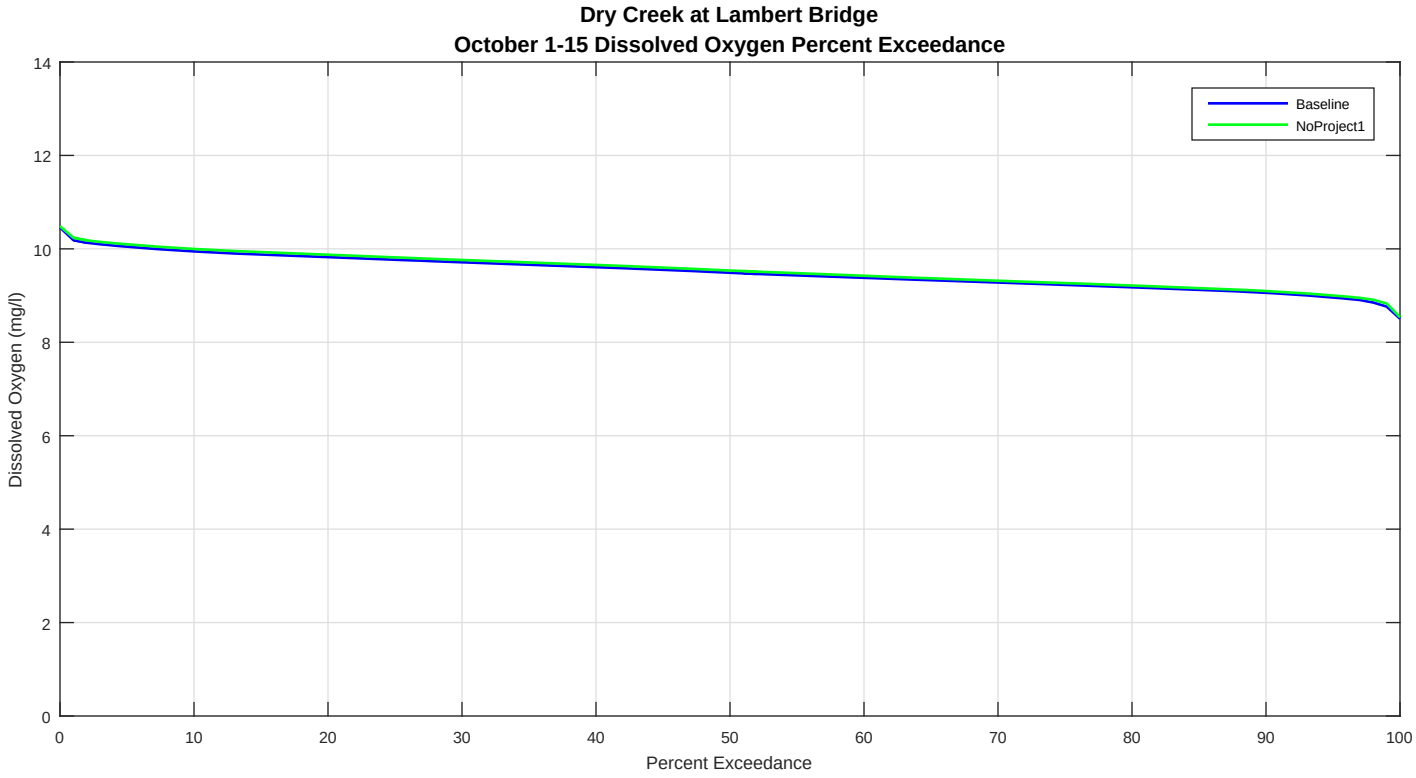
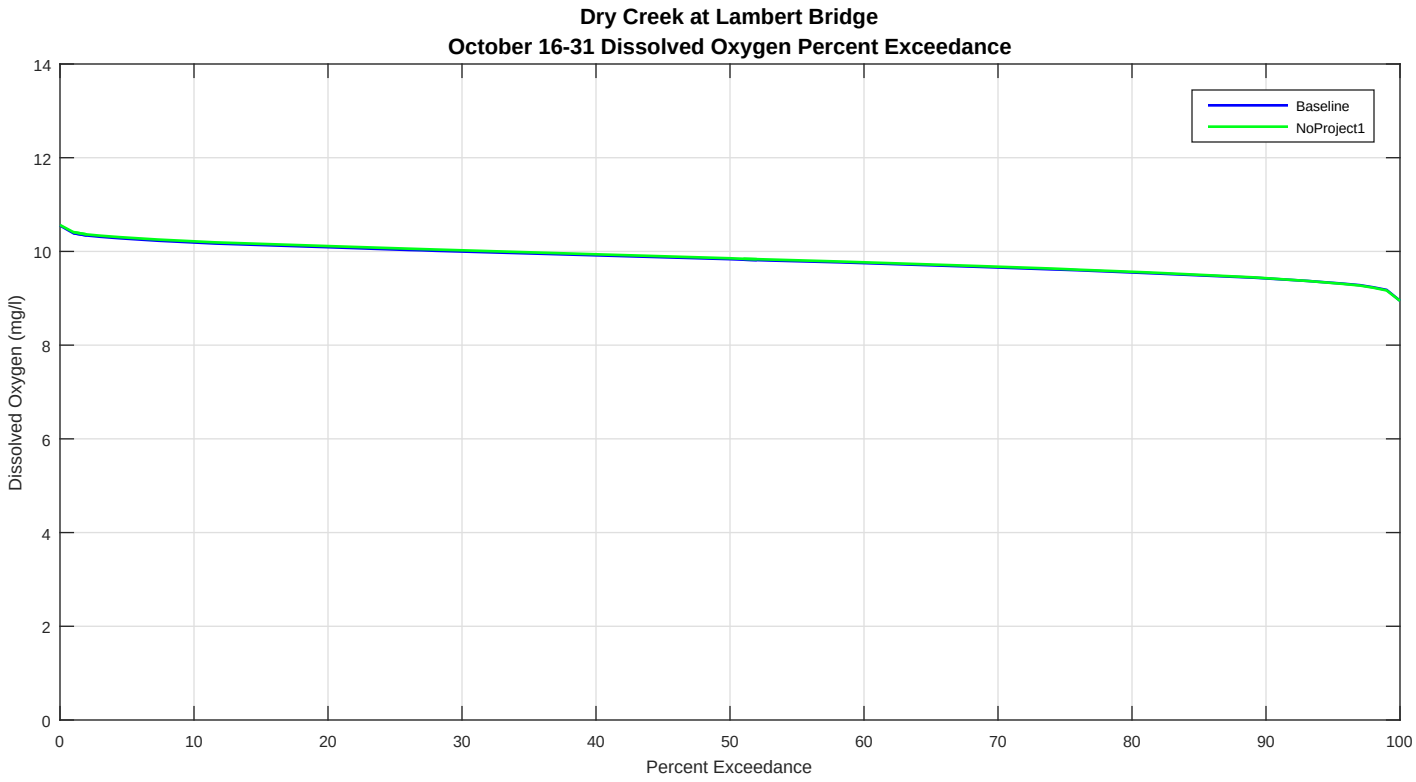
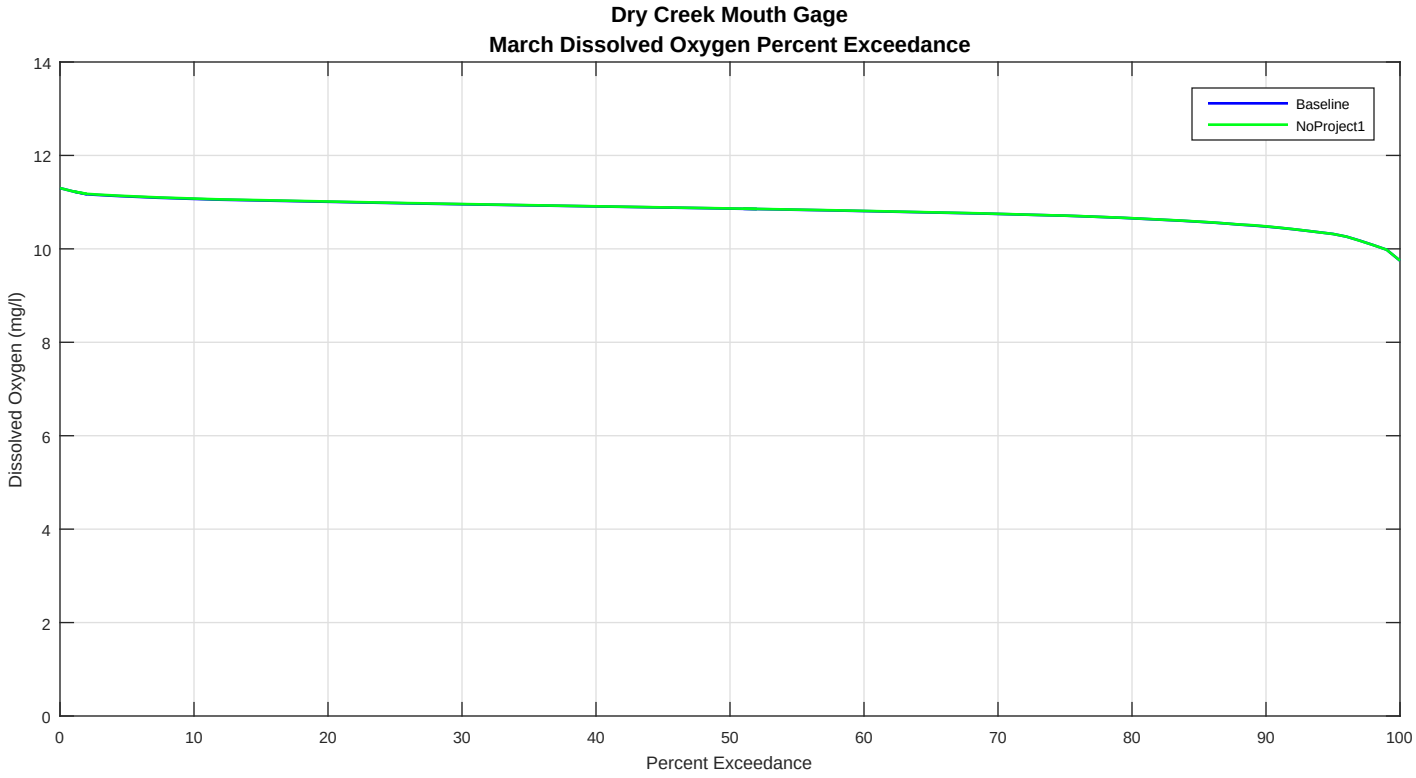
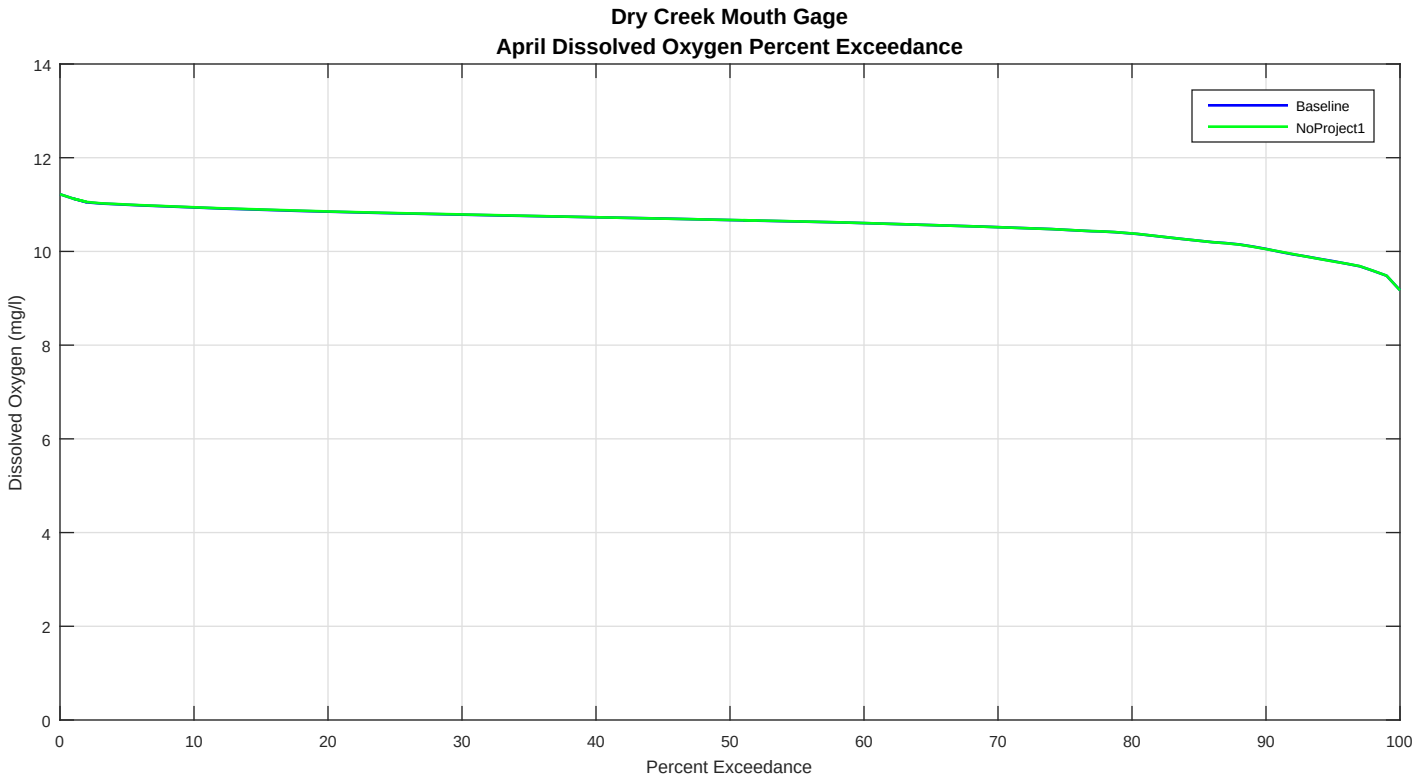
90
100

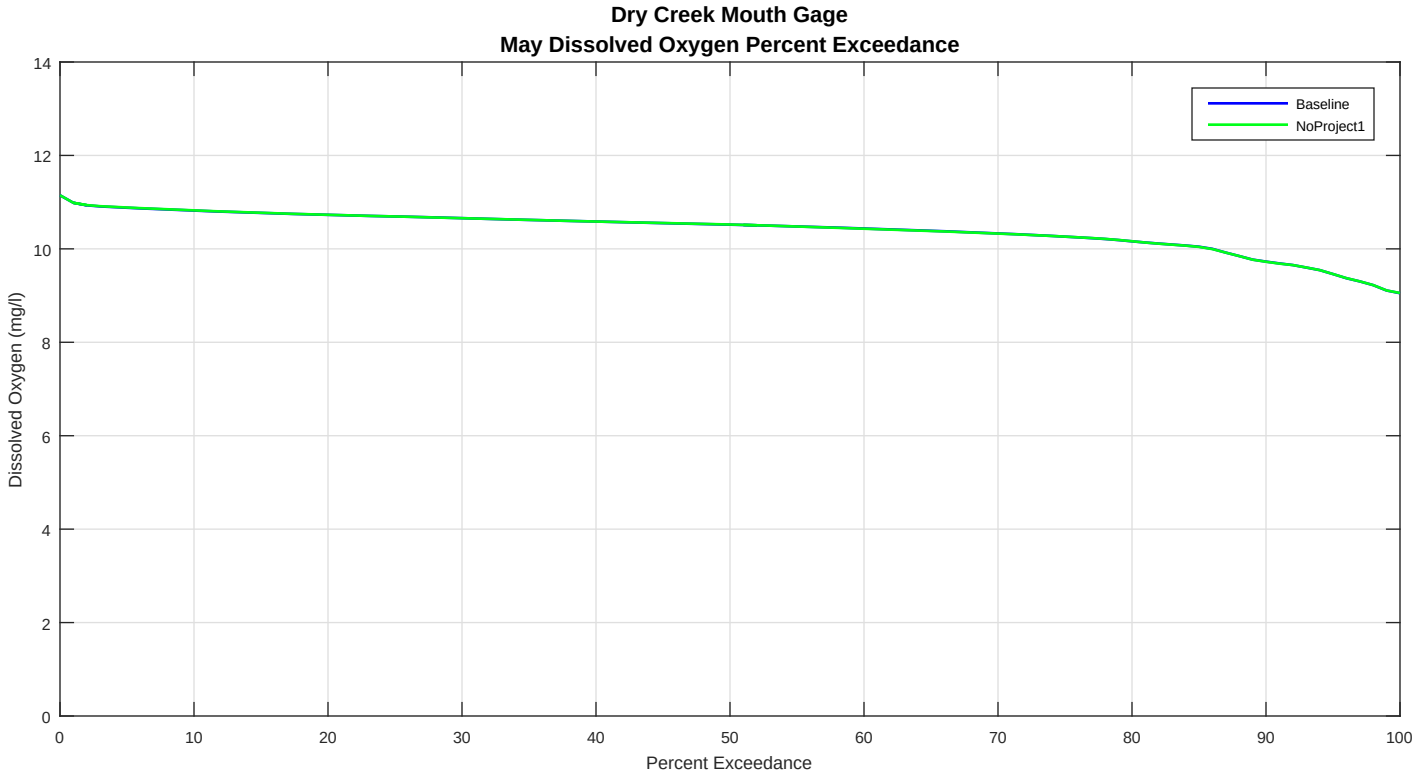

Dry Creek at Lambert Bridge
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

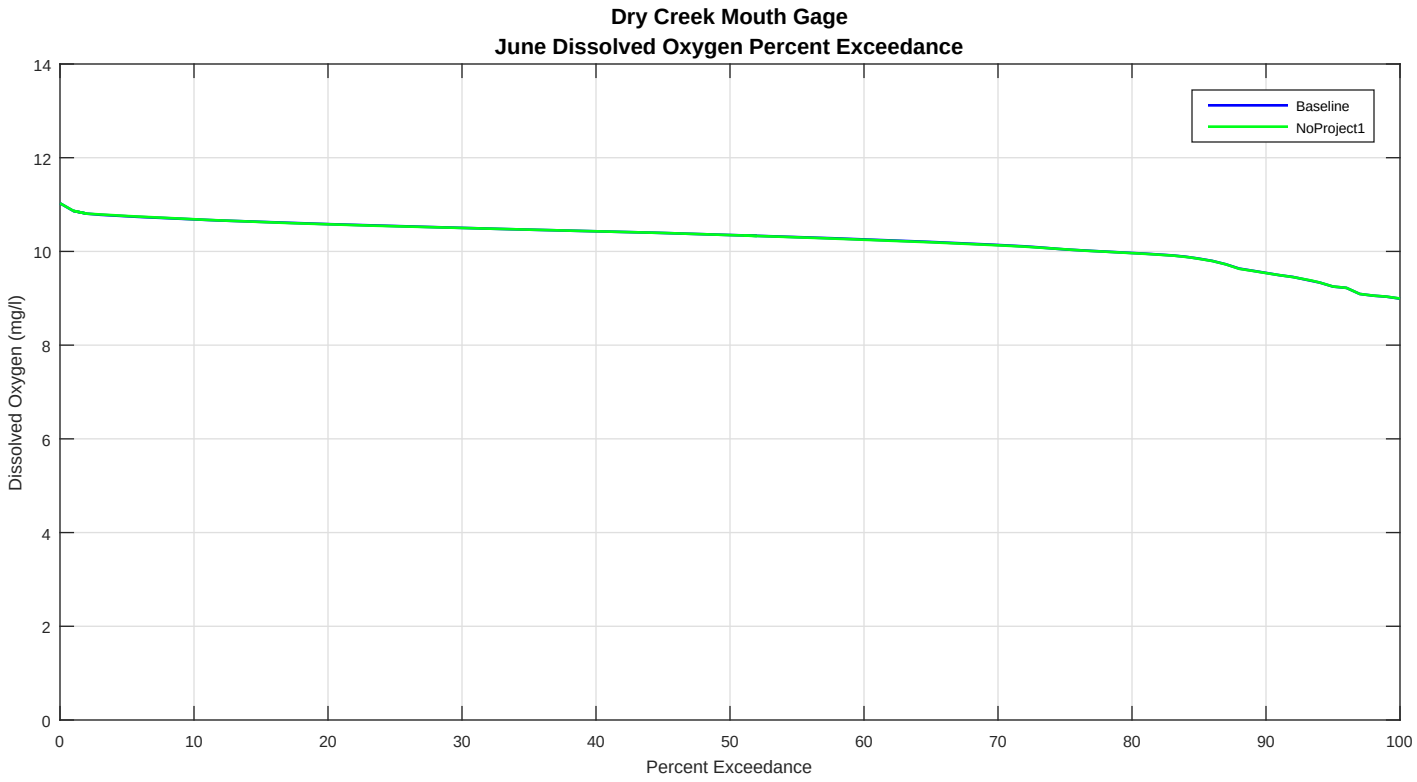

Dry Creek at Lambert Bridge
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

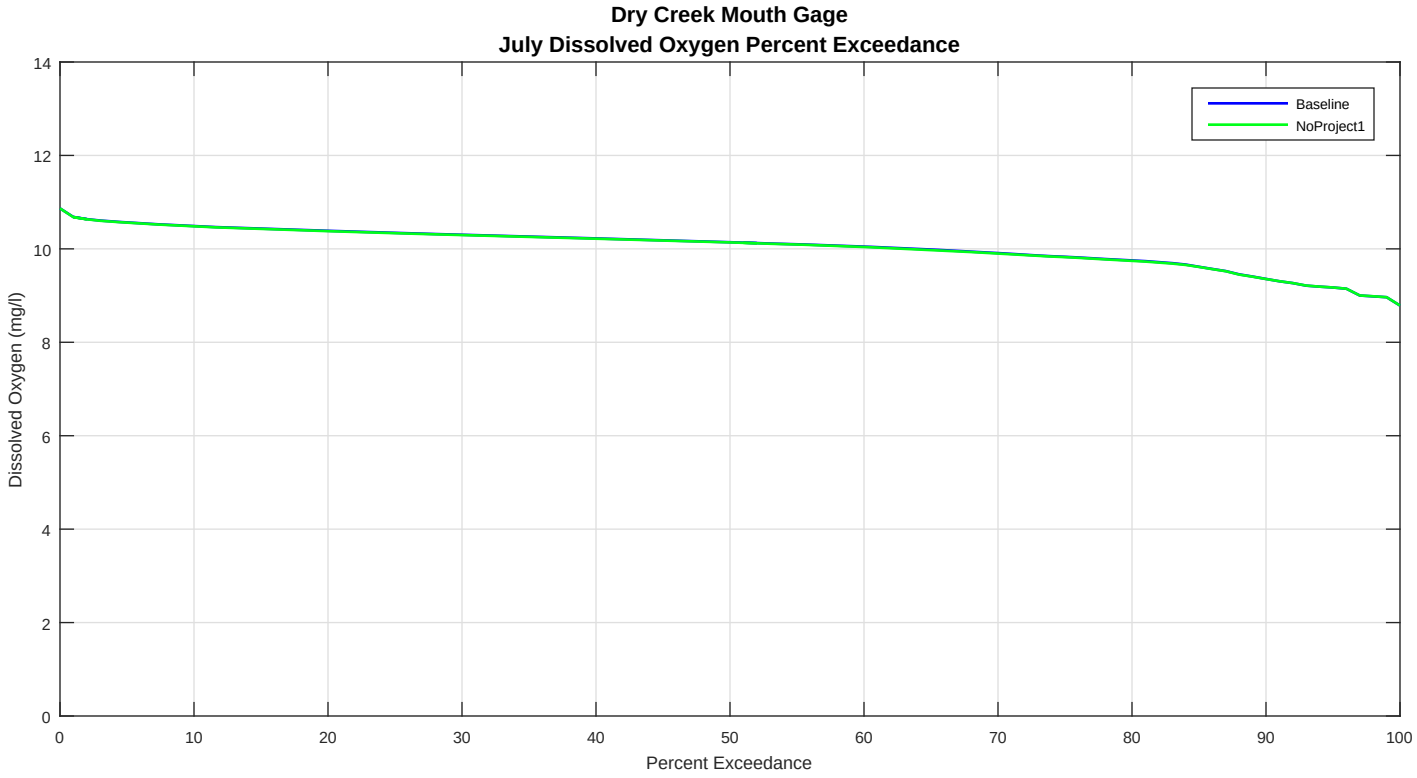

Dry Creek at Lambert Bridge
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

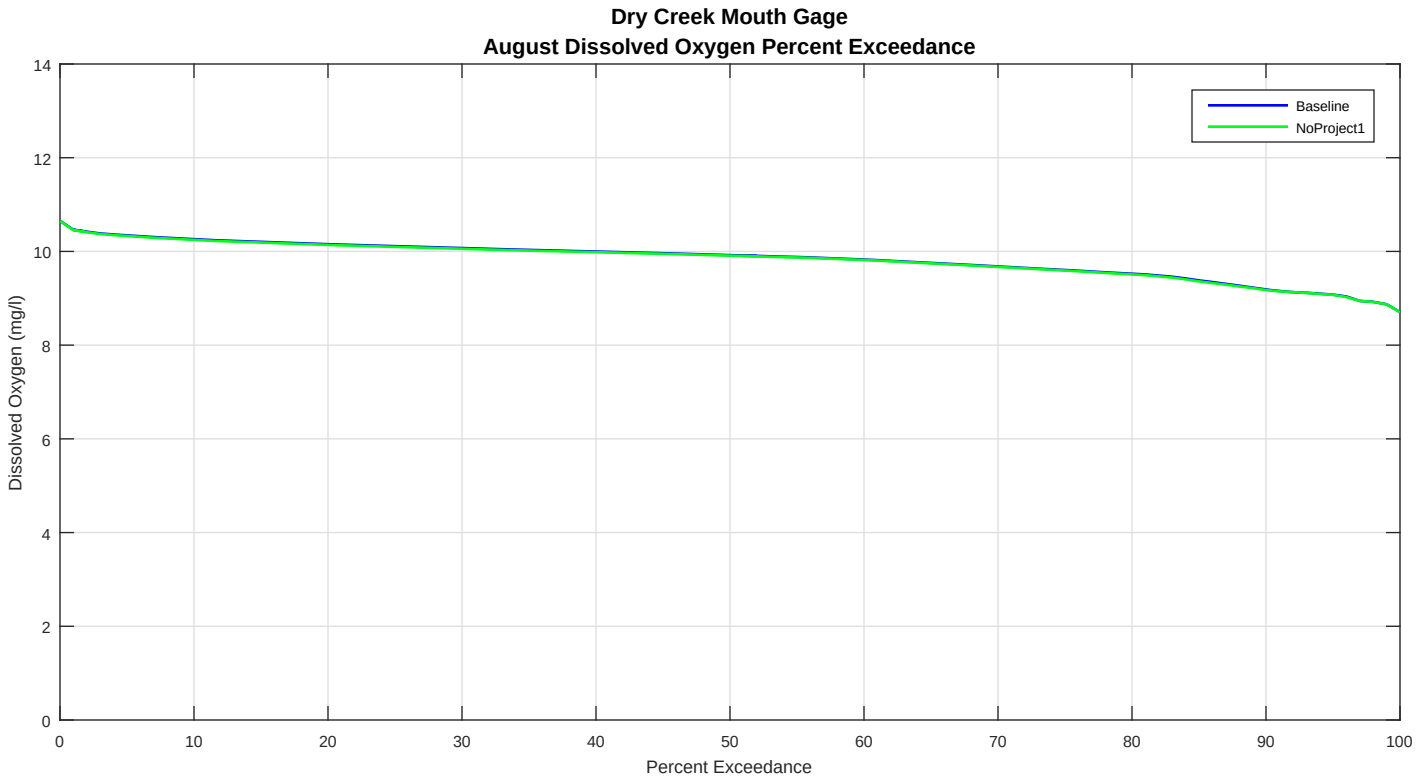

Dry Creek Mouth Gage
March Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

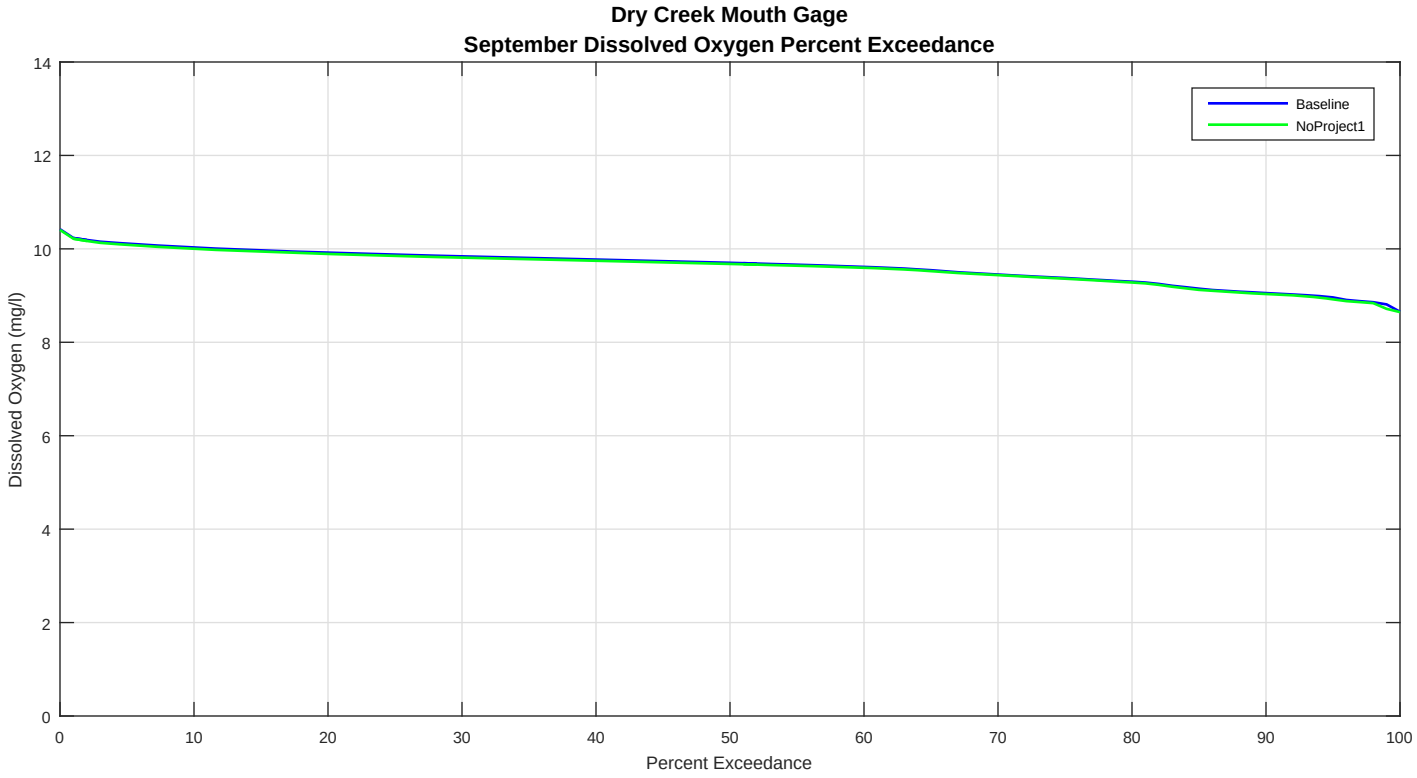

Dry Creek Mouth Gage
April Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

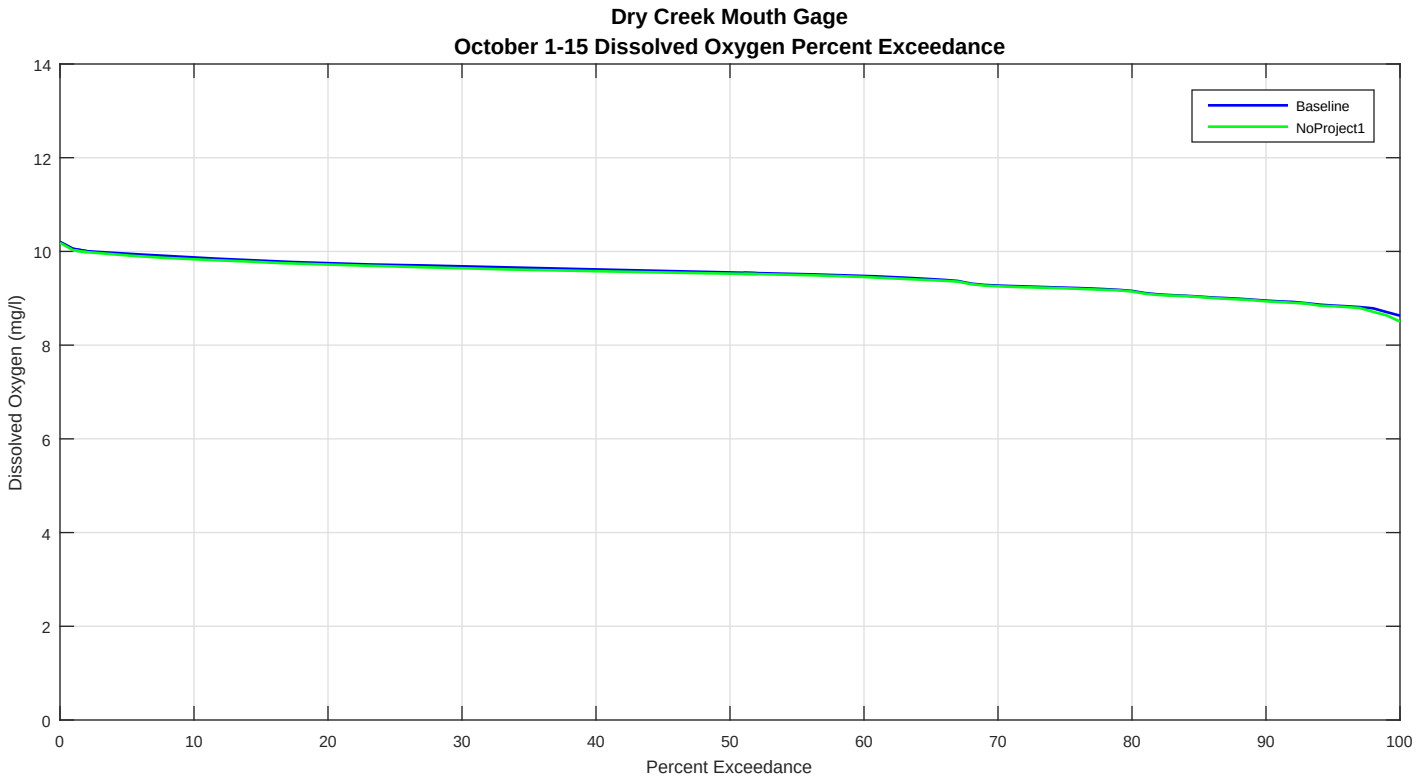

Dry Creek Mouth Gage
May Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

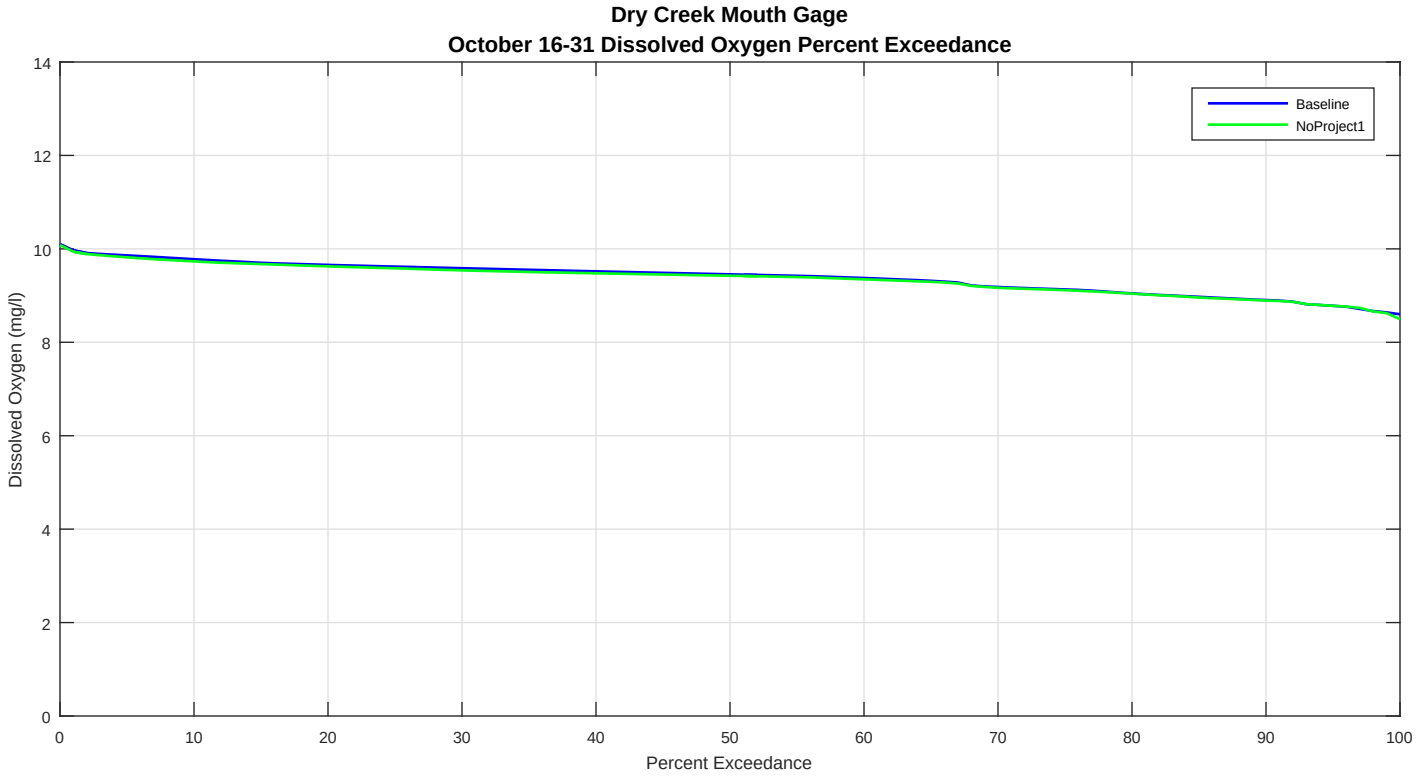

Dry Creek Mouth Gage
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
NoProject1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

Attachment 2: Model Results, No Project 2 Scenario

FISH FLOWS EIR
RR ResSim Modeling Results Summary Report

Baseline and No Project 2 Min Flows
Max Water Right Demand: 75K AF

PLOT LEGEND	Baseline	NoProject2
Alt Name	225516Bs60	227516TU60
Sim Begin Date	2/1/1910	2/1/1910
Sim End Date	12/31/2013	12/31/2013
ResSim Network	Base v2.2	Base v2.2
LM Storage Curve	2001	2001
LS Storage Curve	1984	1984
WSD Hatchery Flow (cfs)	70	70
Local Flow	USGS6.0	USGS6.0
Distributed Loss	RR System Losses POR 10011909 to 12312013 v06302015.dss	RR System Losses POR 10011909 to 12312013 v06302015.dss
RRC Demand	RR System Losses POR 10011909 to 12312013 v06302015.dss	RR System Losses POR 10011909 to 12312013 v06302015.dss, SCWA Windsor 75K POR 10011909 to 12312013 v06302015.dss
RRC Vol (Ac-ft/yr)	3,623	5,639
Demand Year	2015	2035
Demand Desc	Baseline, Average 2009-2014, Steve Grinnell	Max Water Right Demand
SCWA Demand	RR System Losses POR 10011909 to 12312013 v06302015.dss	SCWA Windsor 75K POR 10011909 to 12312013 v06302015.dss
SCWA Vol (Ac-ft/yr)	51,588	69,361
Demand Year	2015	2035
Demand Desc	Baseline, Average 2009-2014, Steve Grinnell	Max Water Right Demand
PVP Simulation	150217_V25_E5_Sed2006_RPA-TS_150max	150217_V25_E5_Sed2006_RPA-TS_150max
LP Storage Curve	2006	2006
PVP Max Diversion	150	150
PVP Simulation Desc	Average operating conditions 10/1/2006 to 12/31/2014; Incorporated observed diversions and LP storage post 10/1/2006	Average operating conditions 10/1/2006 to 12/31/2014; Incorporated observed diversions and LP storage post 10/1/2006
Hydrologic Index	D1610	D1610
Index Desc	Cum Lake Pillsbury Inflow	Cum Lake Pillsbury Inflow
Min Flows UR	D1610	TUCP
Min Flow Desc	Decision 1610	BO Interim Flow Changes
Min Flows LR	D1610	TUCP
Min Flow Desc	Decision 1610	BO Interim Flow Change

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Coyote Valley Dam Outlet

Monthly Flow Exceedance Frequency… 29

Monthly Temperature Exceedance Frequency… 106

Monthly D.O. Exceedance Frequency… 164

Forks

Monthly Flow Exceedance Frequency… 33

Monthly Temperature Exceedance Frequency… 110

Monthly D.O. Exceedance Frequency… 168

2 Miles Downstream of Forks

Monthly Temperature Exceedance Frequency… 115

Monthly D.O. Exceedance Frequency… 173

4 Miles Downstream of Forks

Monthly Temperature Exceedance Frequency… 117

Monthly D.O. Exceedance Frequency… 175

Hopland

Monthly Flow Exceedance Frequency… 38

Monthly Stage Exceedance Frequency… 74

Monthly Temperature Exceedance Frequency… 119

Monthly D.O. Exceedance Frequency… 177

Cloverdale

Monthly Flow Exceedance Frequency… 42

Monthly Stage Exceedance Frequency… 78

Monthly Temperature Exceedance Frequency… 123

Monthly D.O. Exceedance Frequency… 181

Geyserville

Monthly Temperature Exceedance Frequency… 128

Monthly D.O. Exceedance Frequency… 186

Healdsburg

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Monthly Temperature Exceedance Frequency… 132

Monthly D.O. Exceedance Frequency… 190

Russian River at Dry Creek

Monthly Flow Exceedance Frequency… 51

Monthly Temperature Exceedance Frequency… 137

Monthly D.O. Exceedance Frequency… 195

Hacienda

Monthly Flow Exceedance Frequency… 56

Monthly Stage Exceedance Frequency… 87

Monthly Temperature Exceedance Frequency… 141

Monthly D.O. Exceedance Frequency… 199

Warm Springs Dam Outlet

Monthly Flow Exceedance Frequency… 60

Monthly Temperature Exceedance Frequency… 146

Monthly D.O. Exceedance Frequency… 204

Dry Creek at Geyserville Gage

Monthly Flow Exceedance Frequency… 65

Monthly Stage Exceedance Frequency… 92

Monthly Temperature Exceedance Frequency… 150

Monthly D.O. Exceedance Frequency… 208

Dry Creek at Lambert Bridge

Monthly Temperature Exceedance Frequency… 155

Monthly D.O. Exceedance Frequency… 213

Dry Creek Mouth

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Monthly Power Production Exceedance Frequencies

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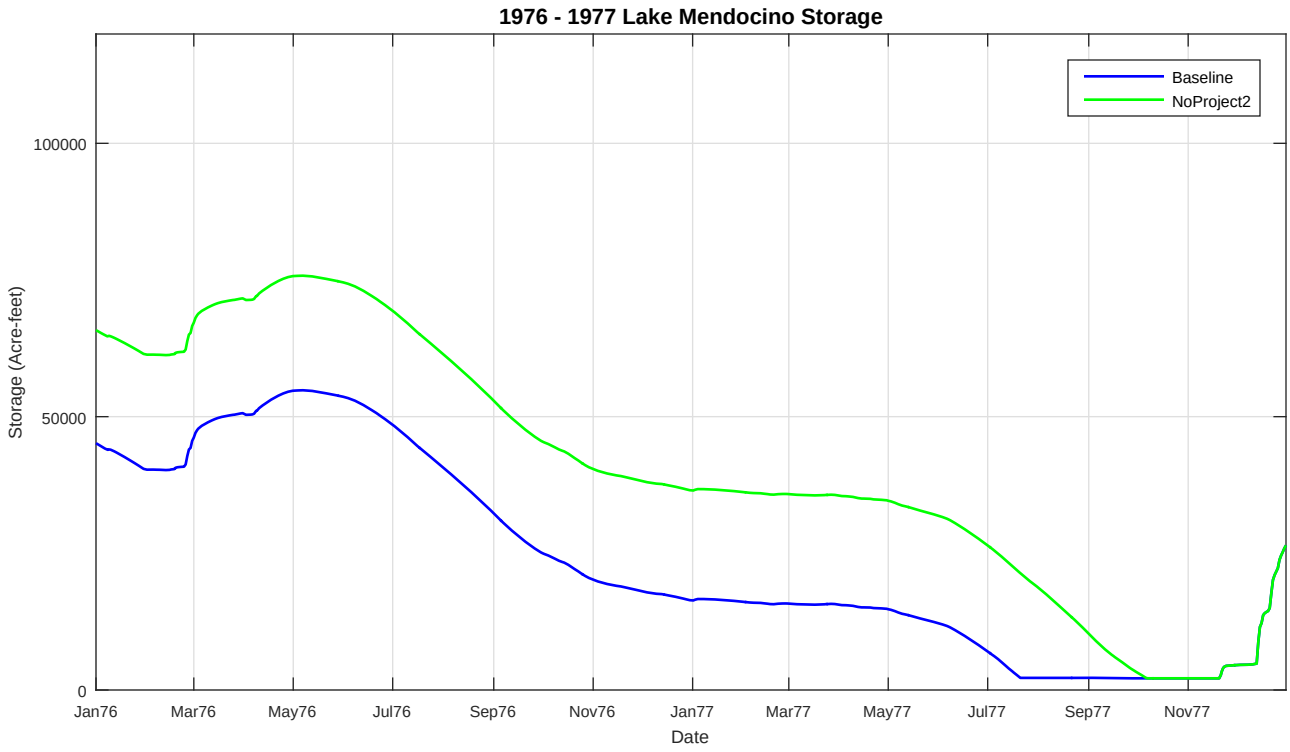
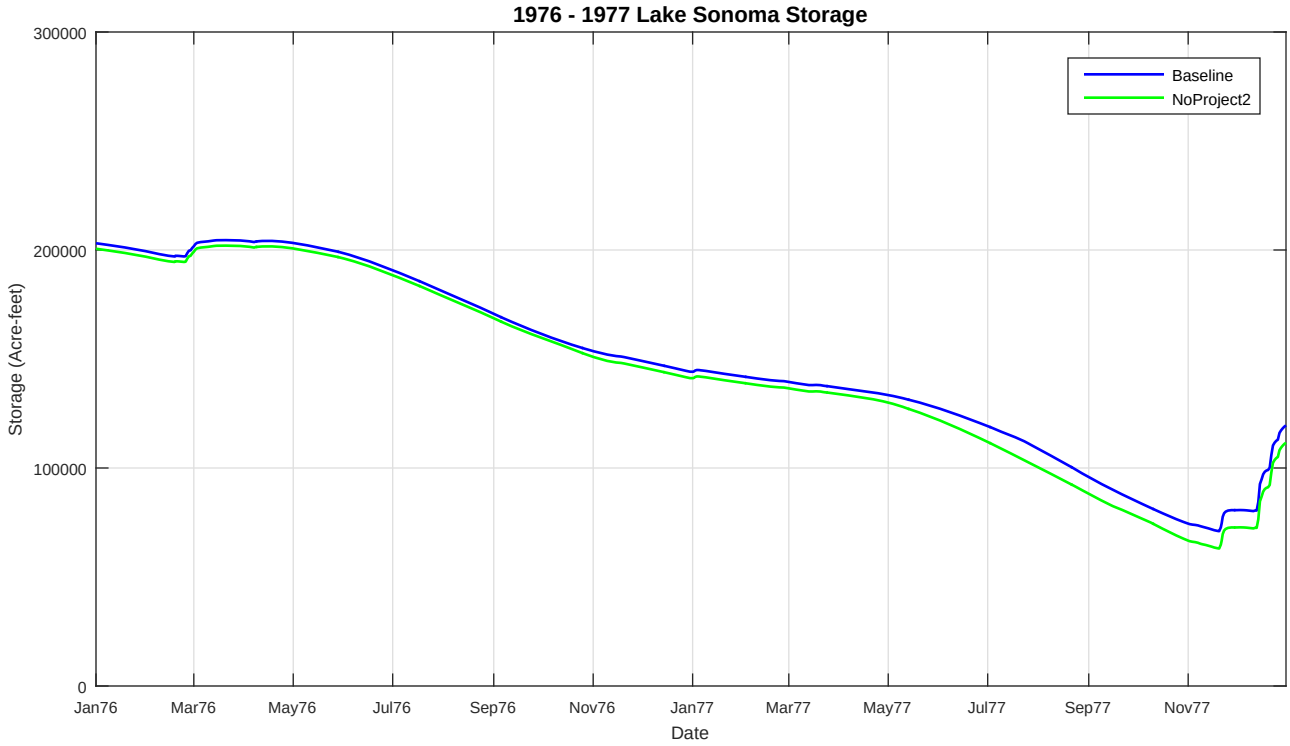
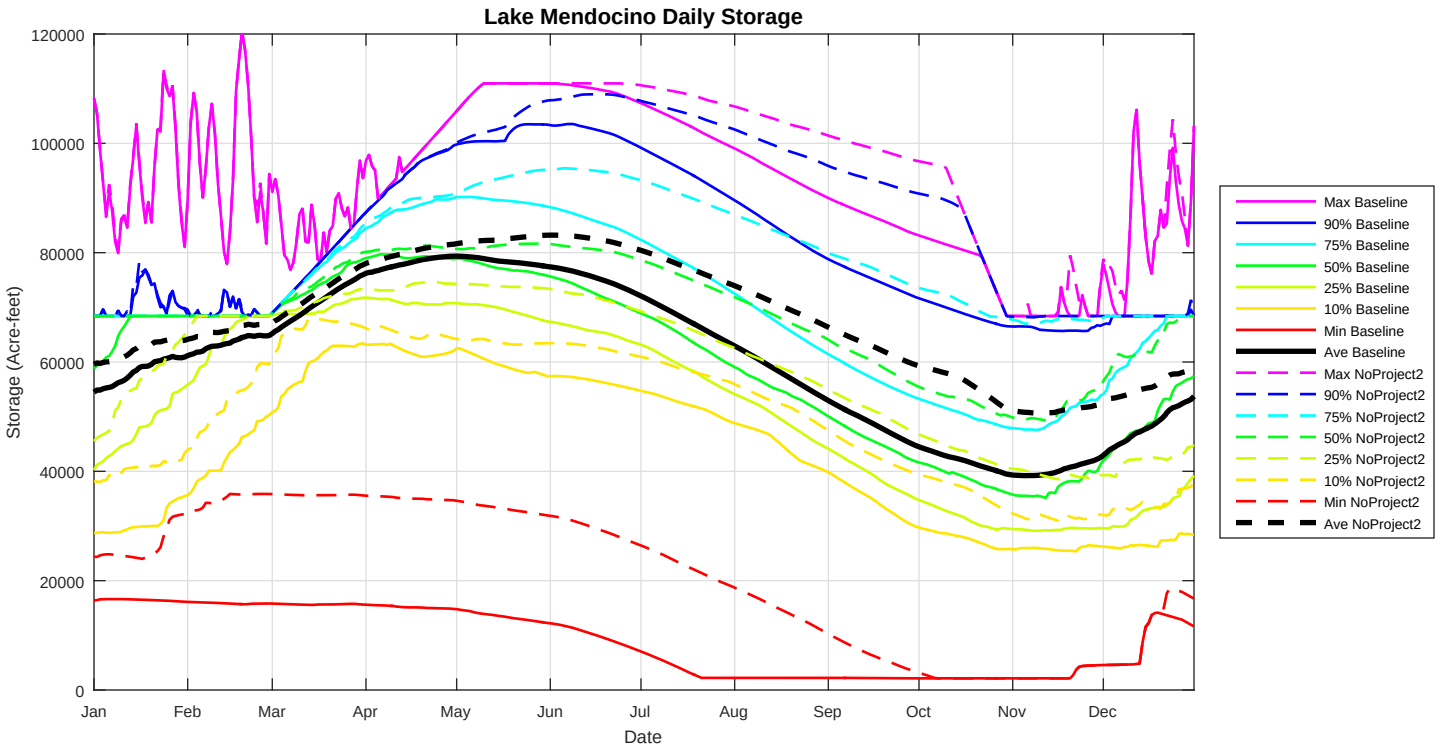
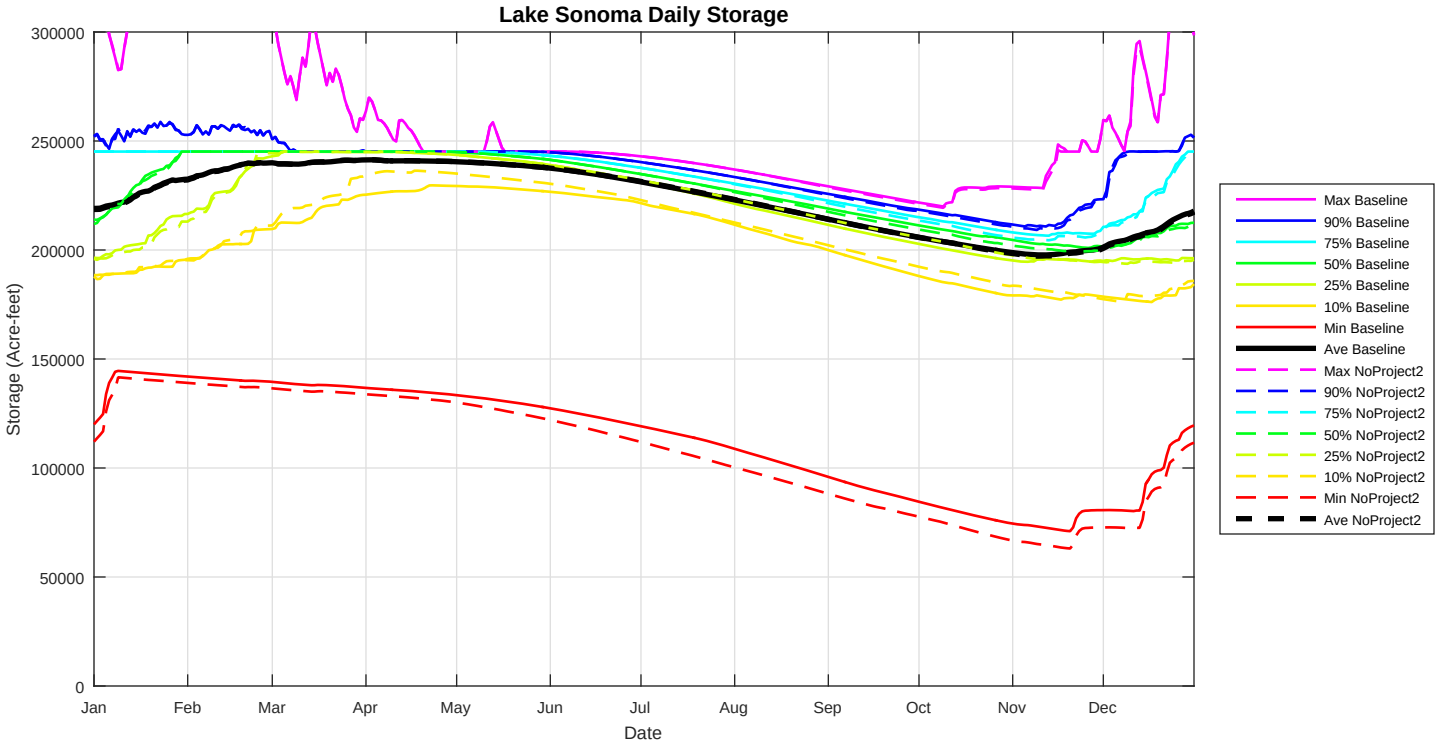
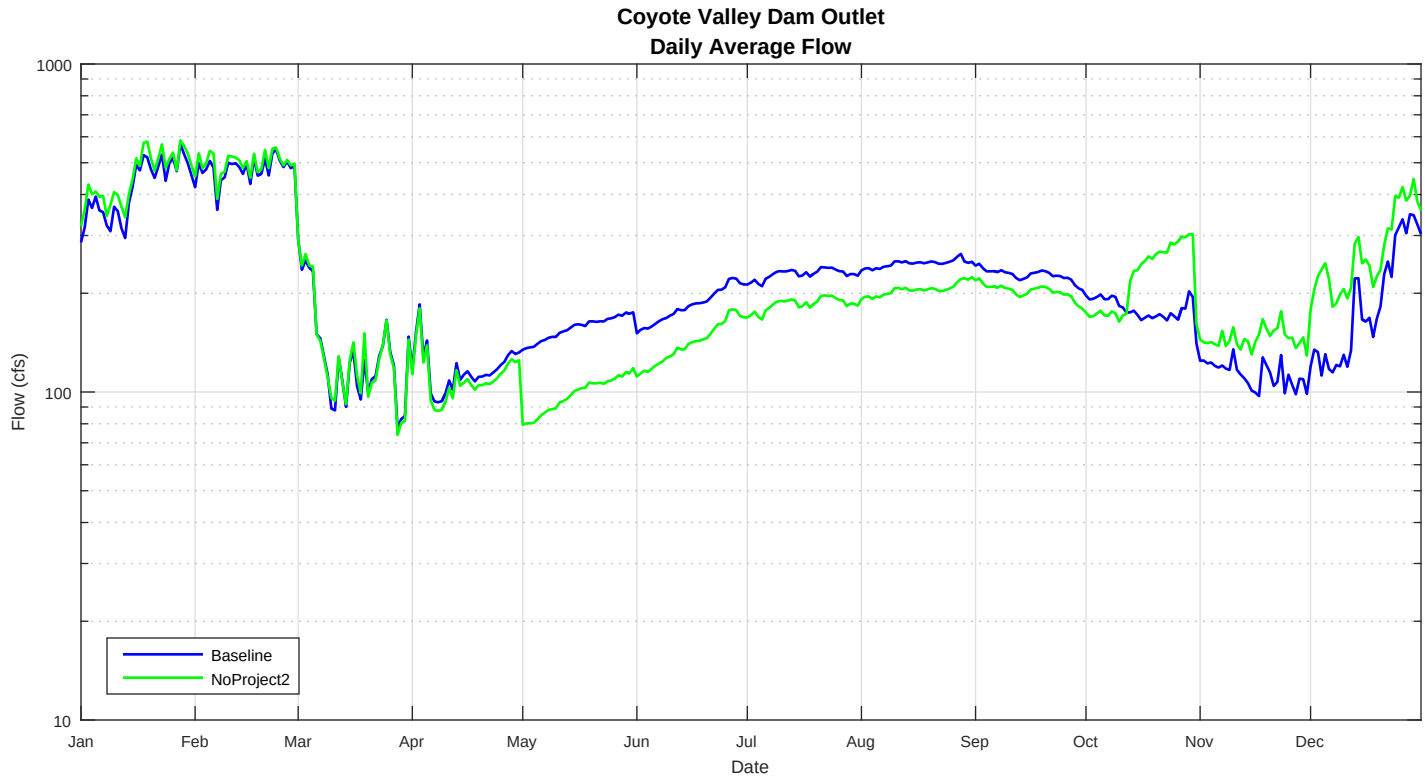
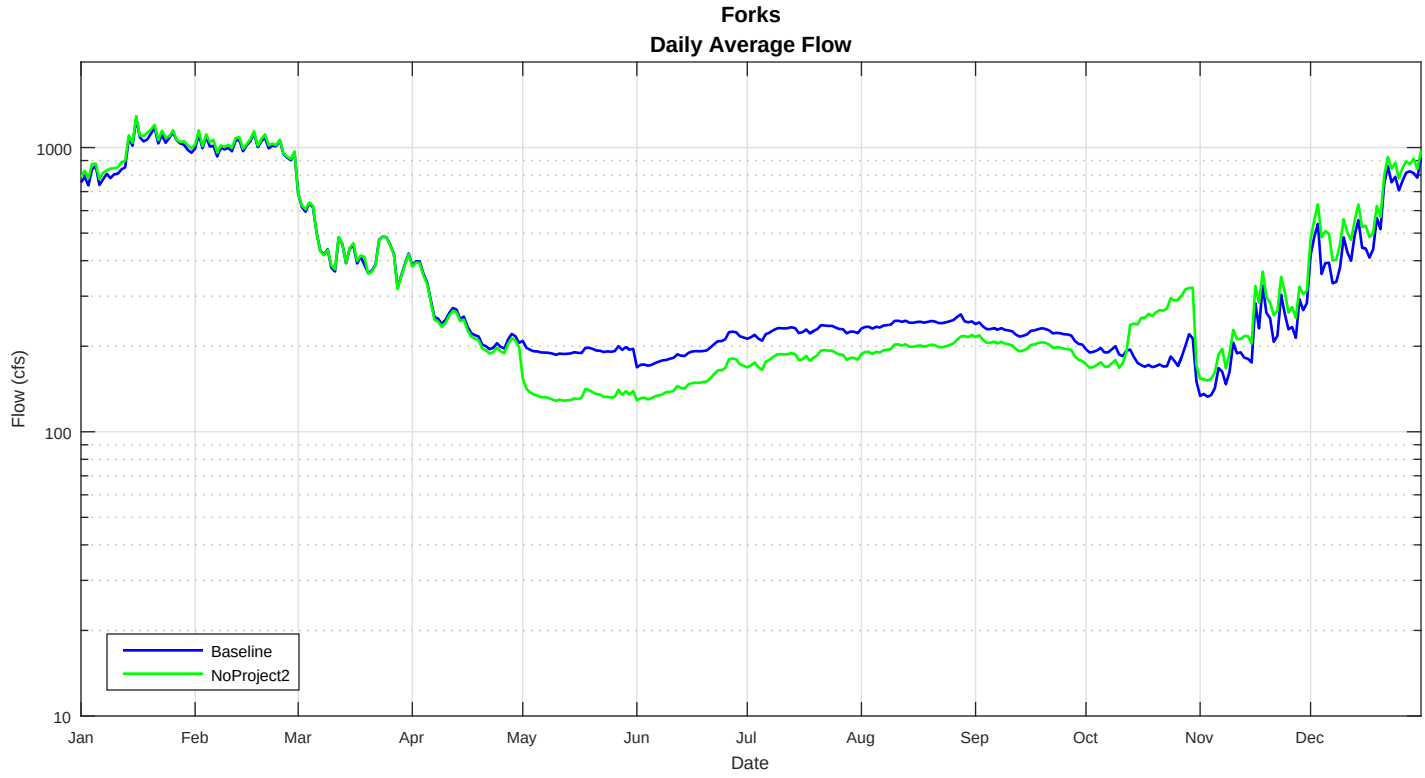

1976 - 1977 Lake Mendocino Storage
Baseline
NoProject2
Storage (Acre-feet)
100000
50000
0
Jan76
Mar76
May76
Jul76
Sep76
Nov76
Jan77
Mar77
May77
Jul77
Sep77
Nov77
Date

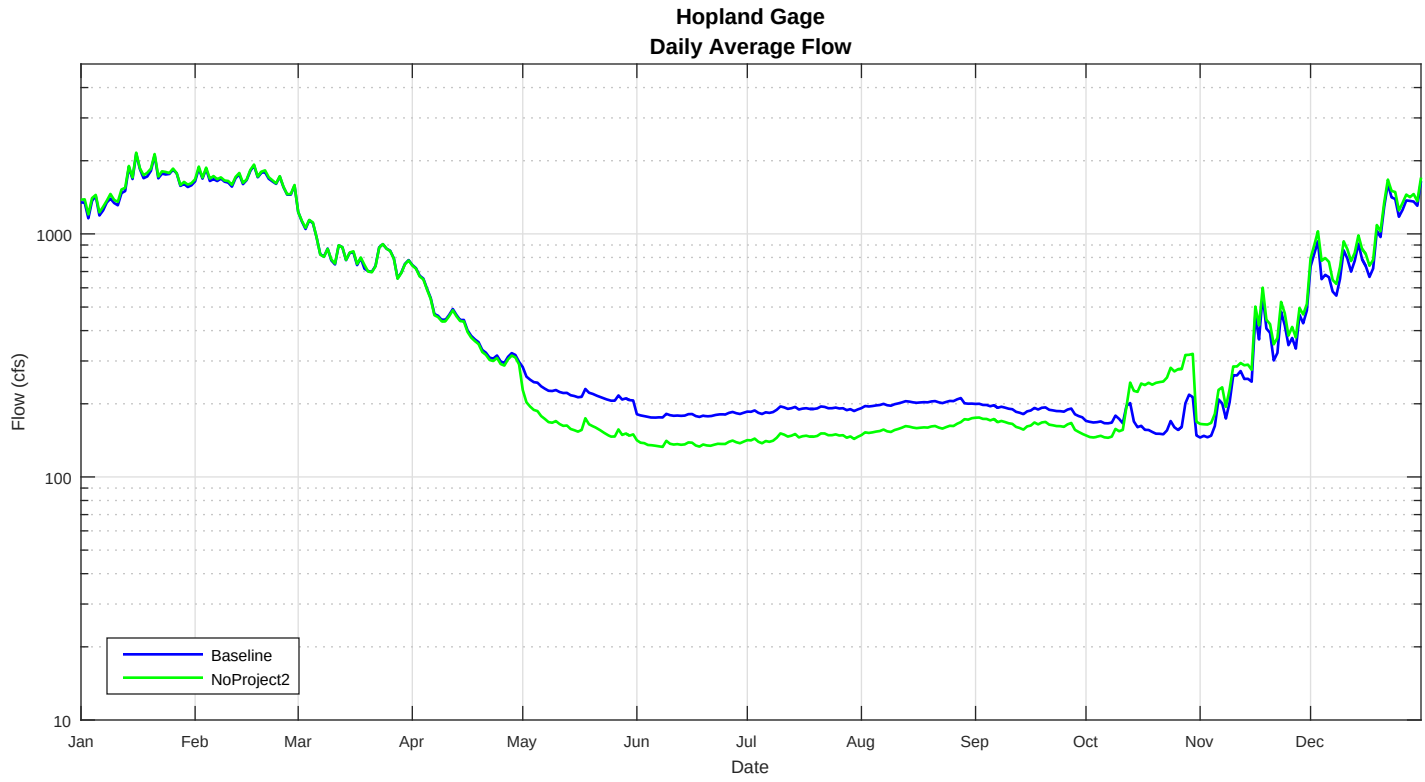

1976 - 1977 Lake Sonoma Storage
Baseline
NoProject2
Storage (Acre-feet)
300000
200000
100000
0
Jan76
Mar76
May76
Jul76
Sep76
Nov76
Jan77
Mar77
May77
Jul77
Sep77
Nov77
Date

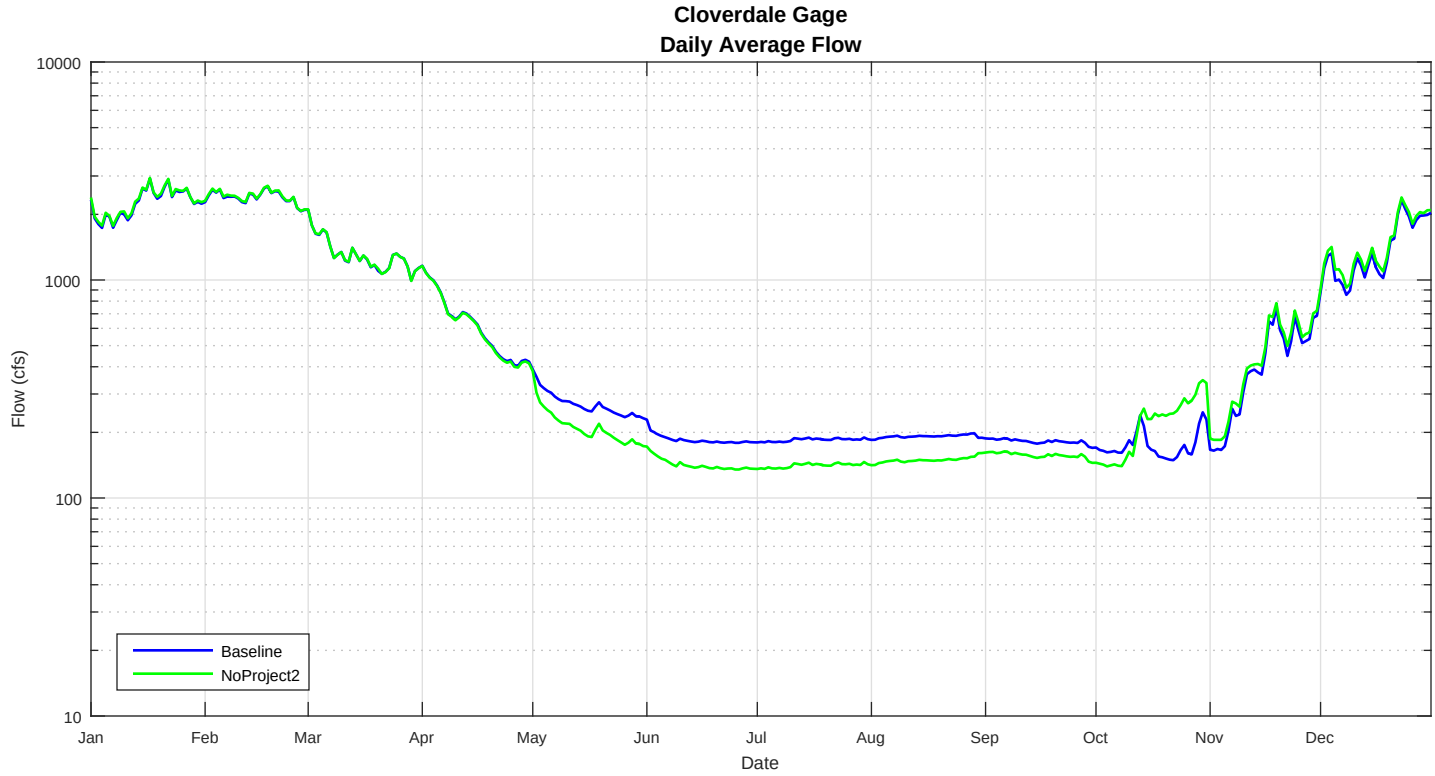

Lake Mendocino Daily Storage
Storage (Acre-feet)
120000
100000
80000
60000
40000
20000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Max Baseline
90% Baseline
75% Baseline
50% Baseline
25% Baseline
10% Baseline
Min Baseline
Ave Baseline
Max NoProject2
90% NoProject2
75% NoProject2
50% NoProject2
25% NoProject2
10% NoProject2
Min NoProject2
Ave NoProject2

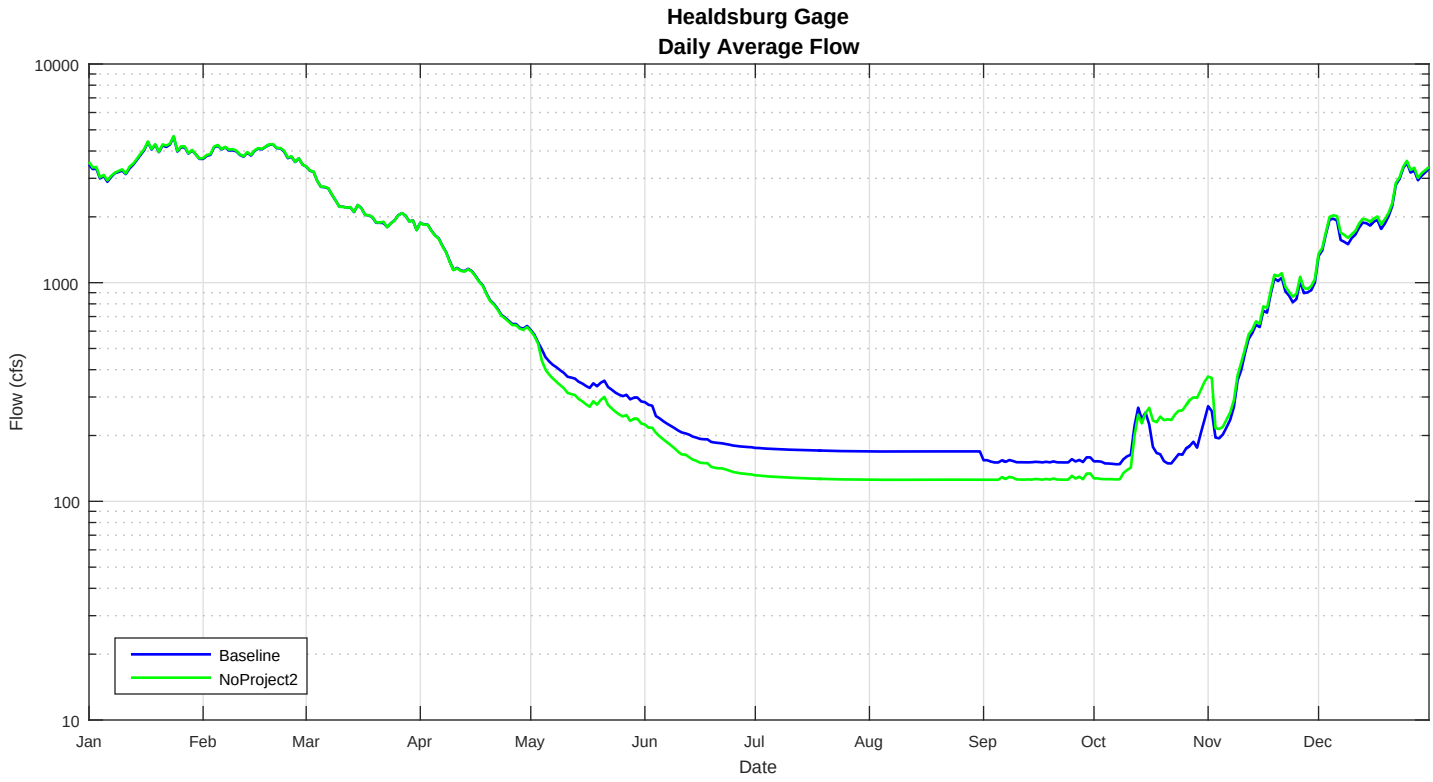

Lake Sonoma Daily Storage
Storage (Acre-feet)
300000
250000
200000
150000
100000
50000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Max Baseline
90% Baseline
75% Baseline
50% Baseline
25% Baseline
10% Baseline
Min Baseline
Ave Baseline
Max NoProject2
90% NoProject2
75% NoProject2
50% NoProject2
25% NoProject2
10% NoProject2
Min NoProject2
Ave NoProject2

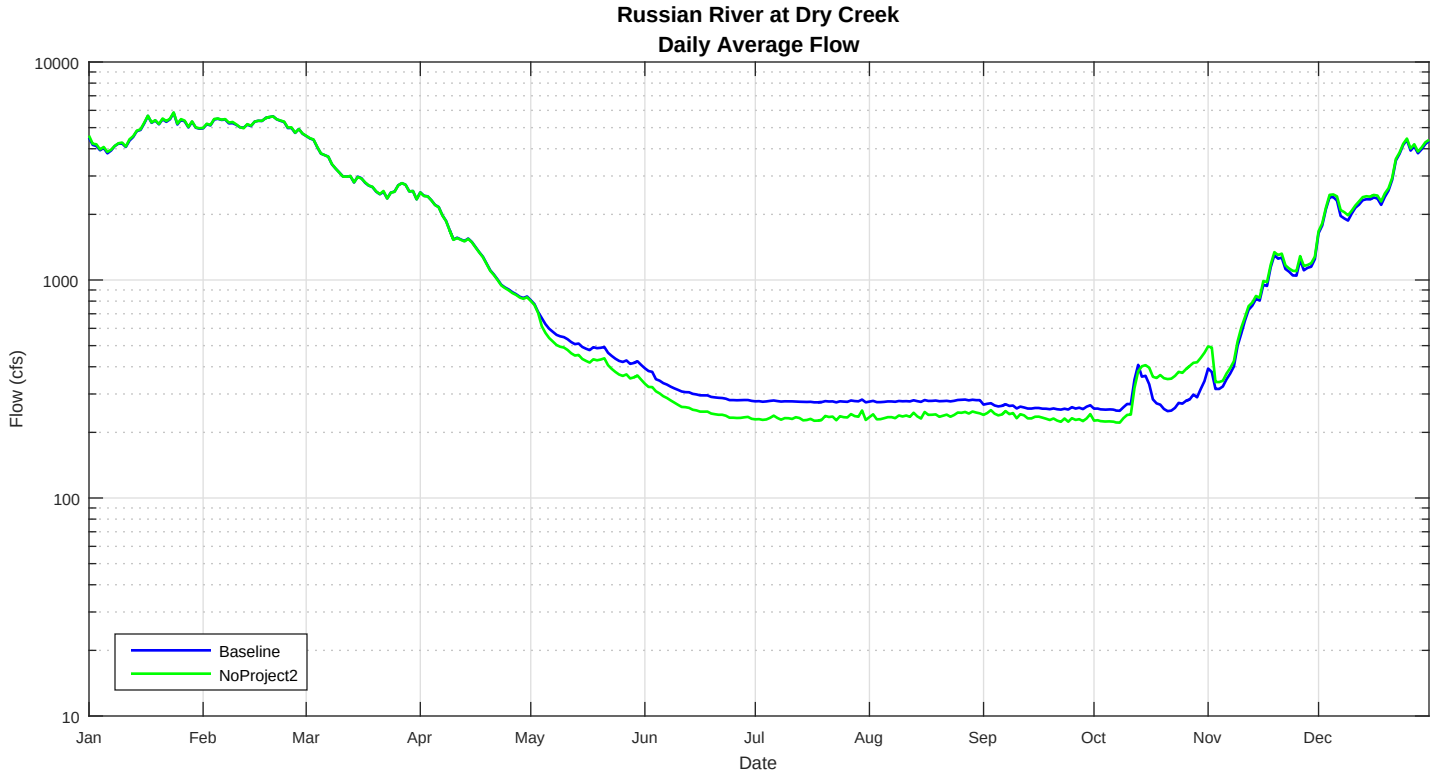

Coyote Valley Dam Outlet
Daily Average Flow
1000
100
10
Flow (cfs)
Baseline
NoProject2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

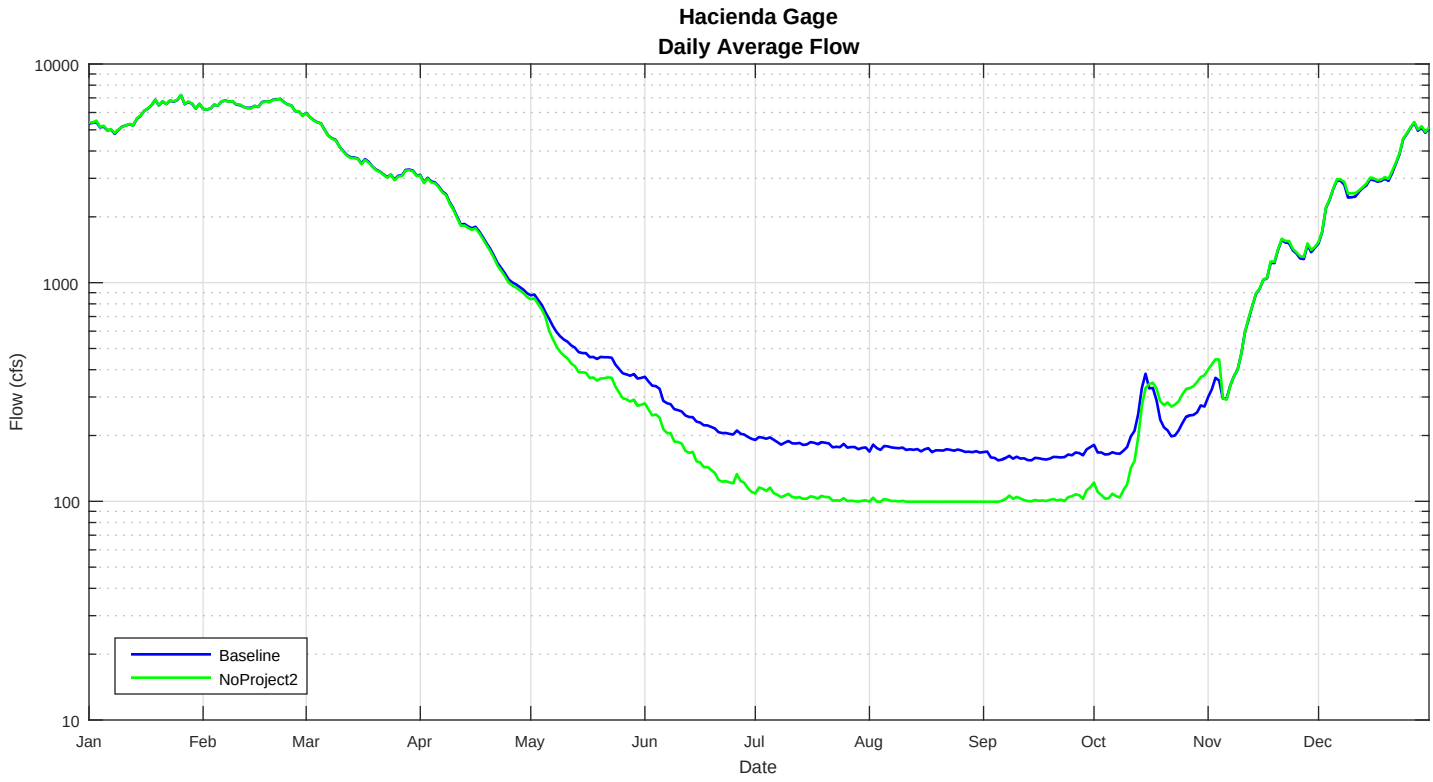

Forks
Daily Average Flow
1000
100
10
Flow (cfs)
Baseline
NoProject2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

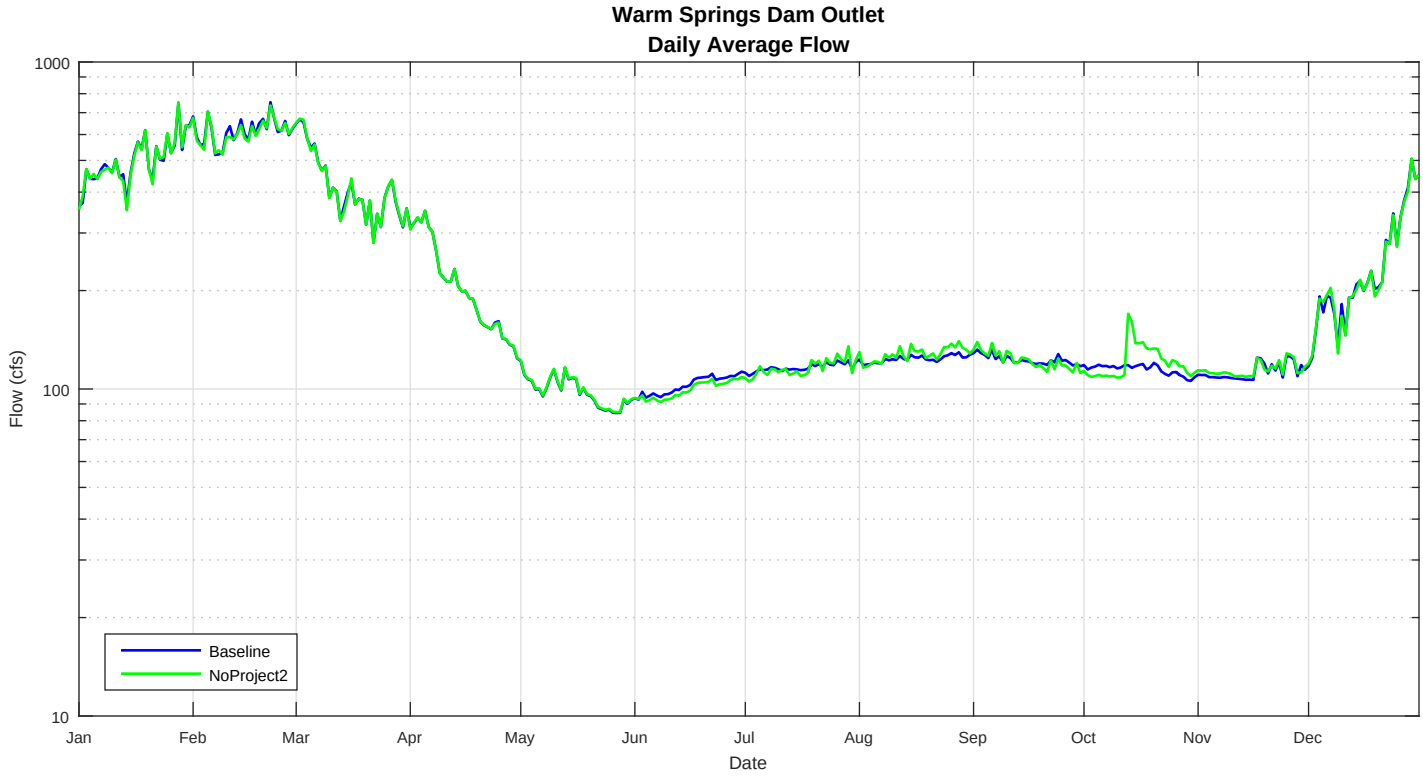

Hopland Gage
Daily Average Flow
Flow (cfs)
1000
100
10
Baseline
NoProject2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

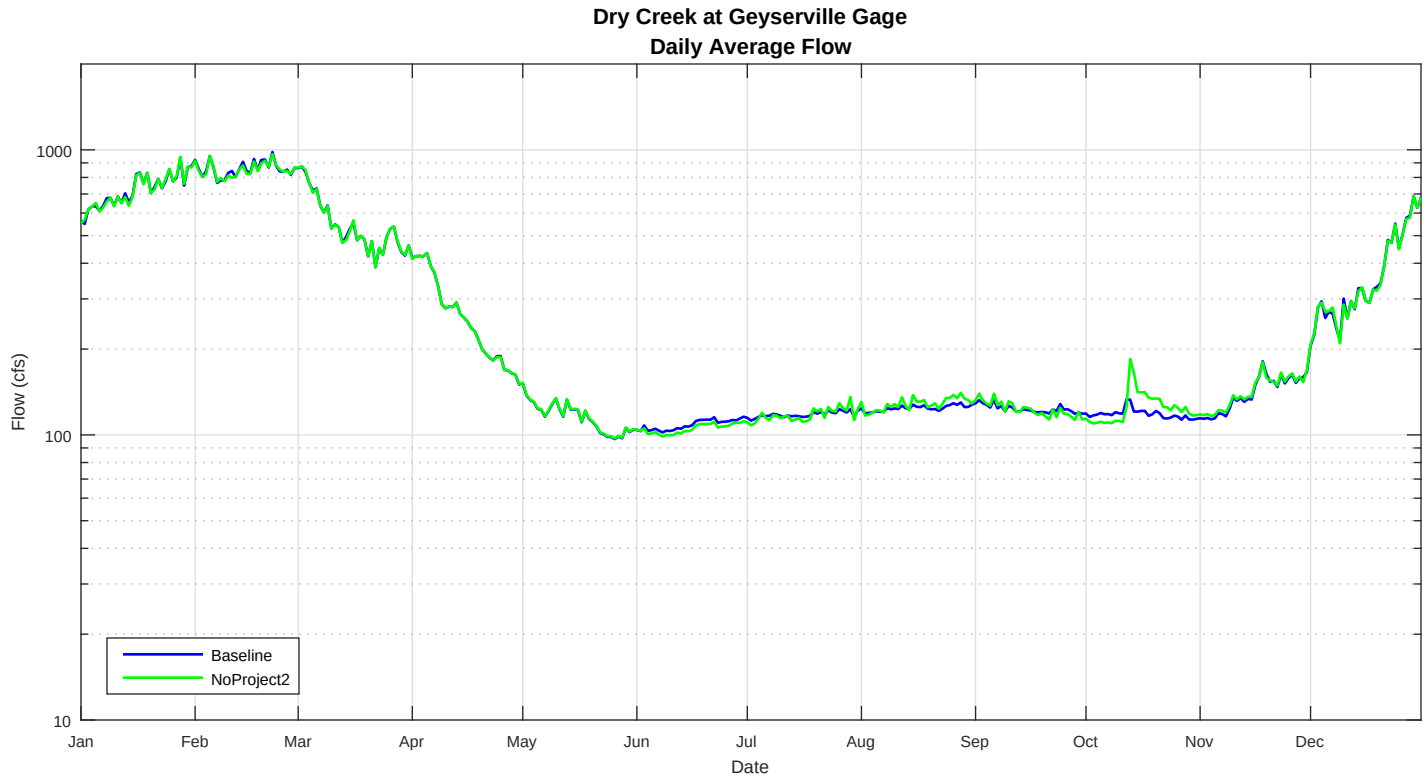

Cloverdale Gage
Daily Average Flow
Flow (cfs)
10000
1000
100
10
Baseline
NoProject2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

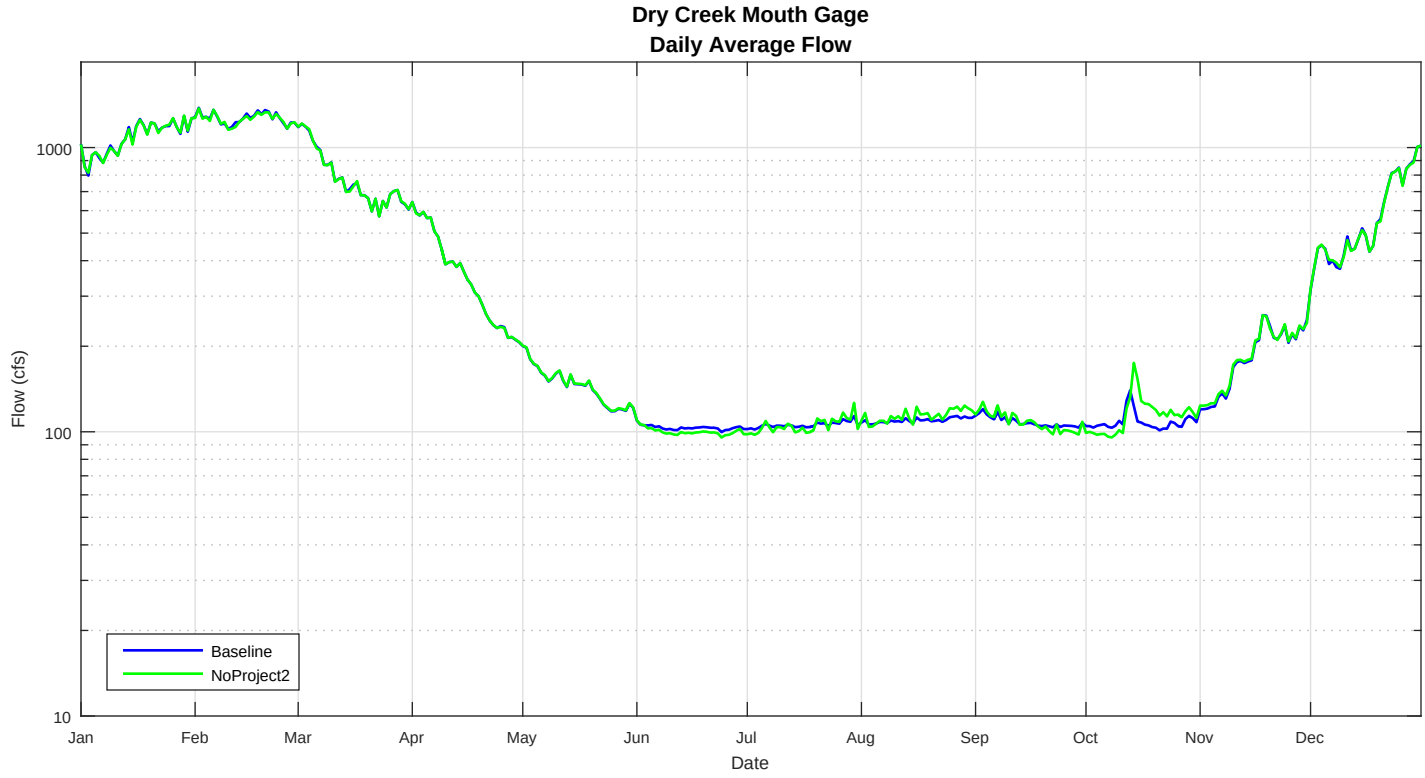

Healdsburg Gage
Daily Average Flow
10000
1000
100
10
Flow (cfs)
Baseline
NoProject2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

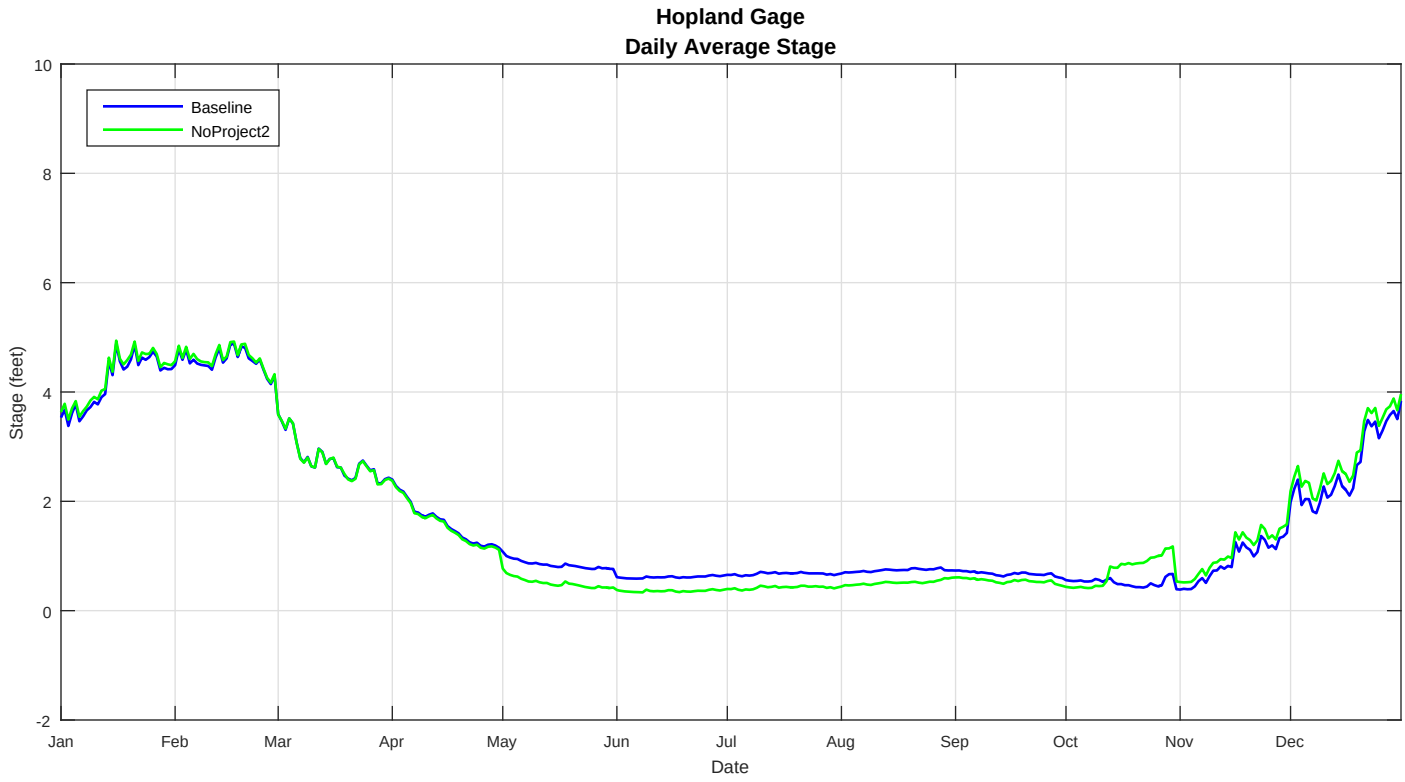

Russian River at Dry Creek
Daily Average Flow
10000
1000
100
10
Flow (cfs)
Baseline
NoProject2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

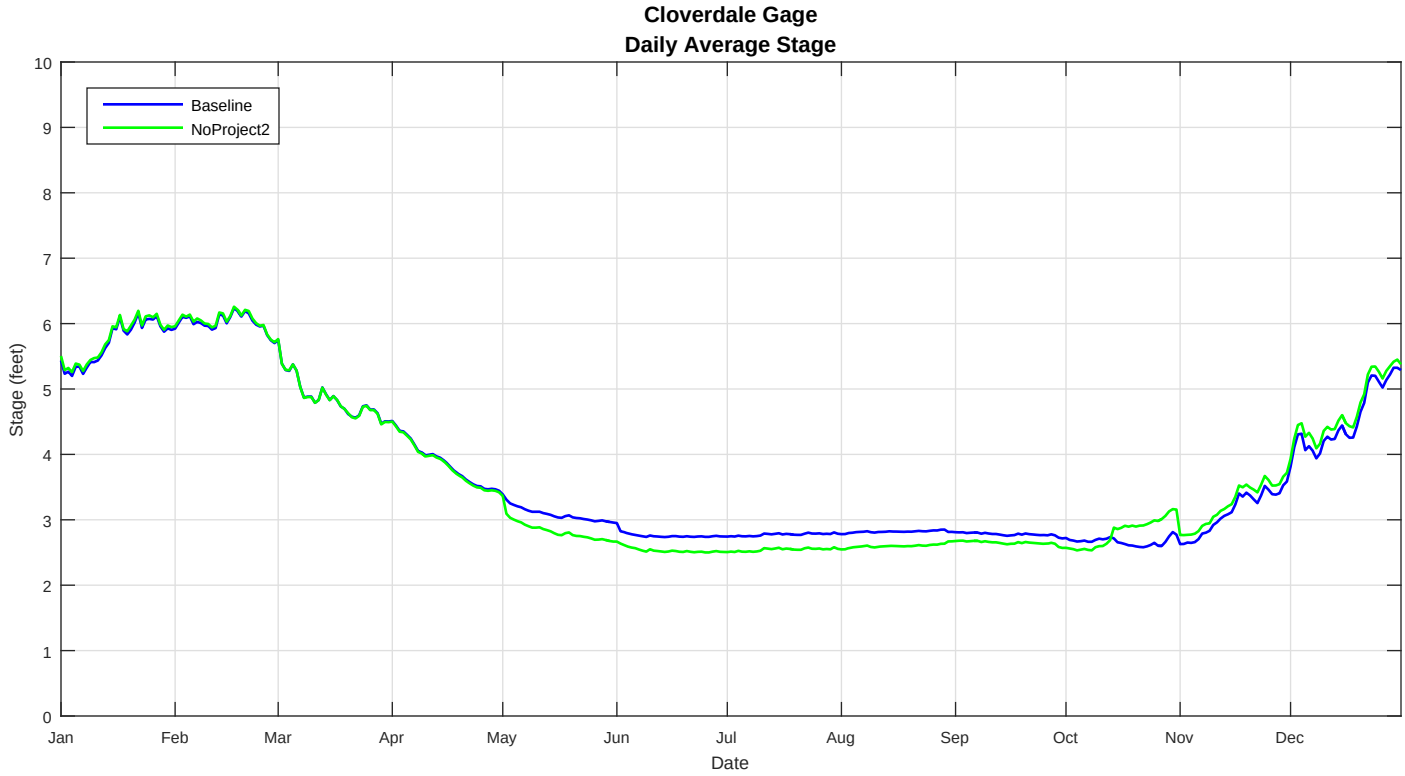

Hacienda Gage
Daily Average Flow
10000
1000
100
10
Flow (cfs)
Baseline
NoProject2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

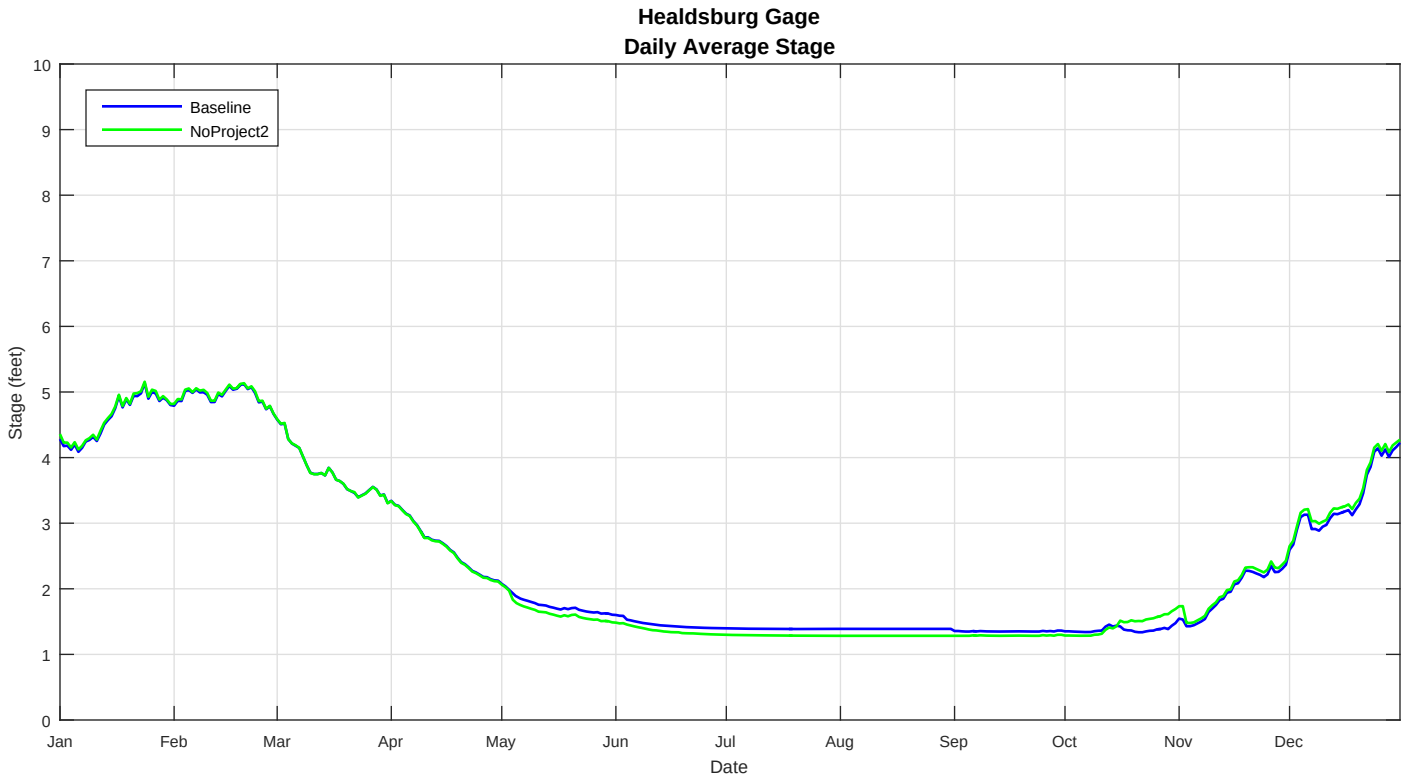

Warm Springs Dam Outlet
Daily Average Flow
1000
100
10
Flow (cfs)
Baseline
NoProject2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

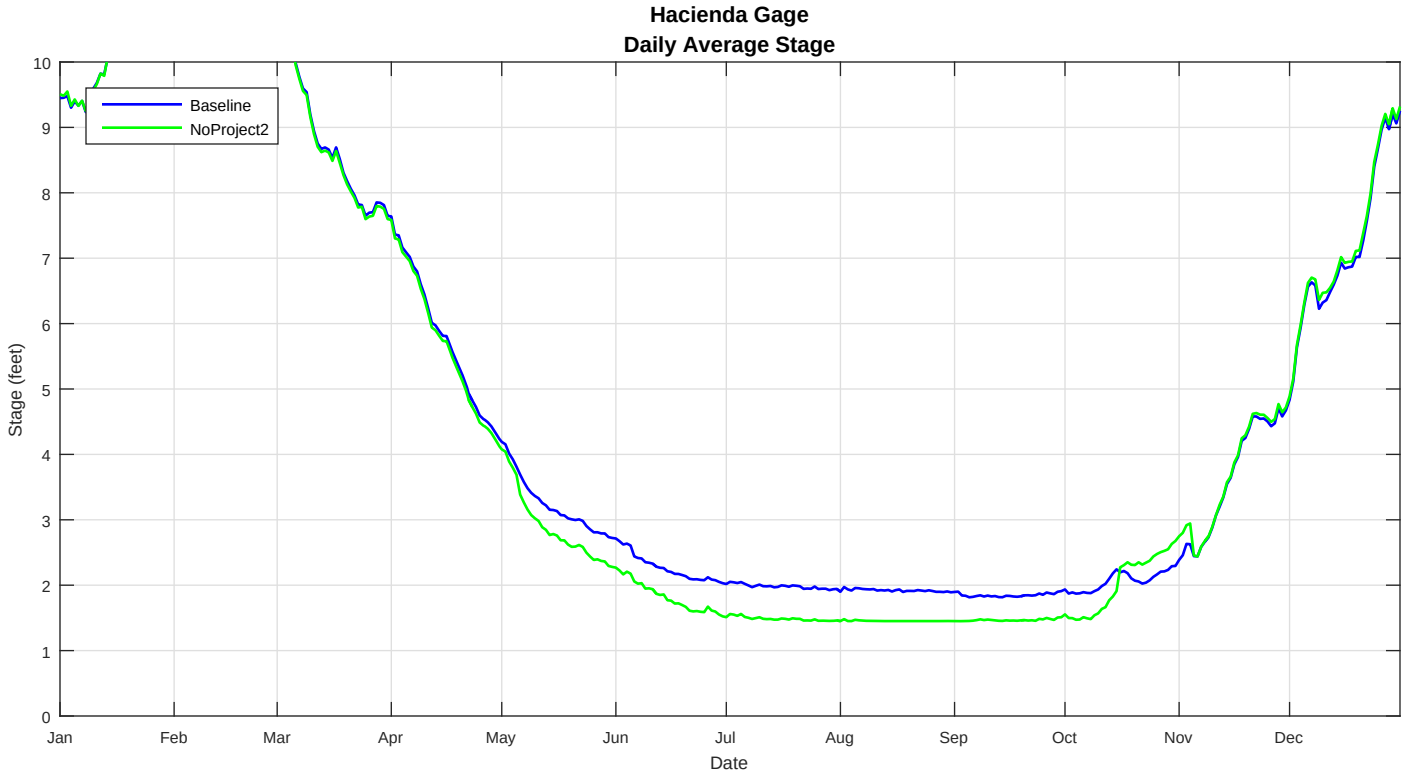

Dry Creek at Geyserville Gage
Daily Average Flow
Flow (cfs)
1000
100
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Baseline
NoProject2

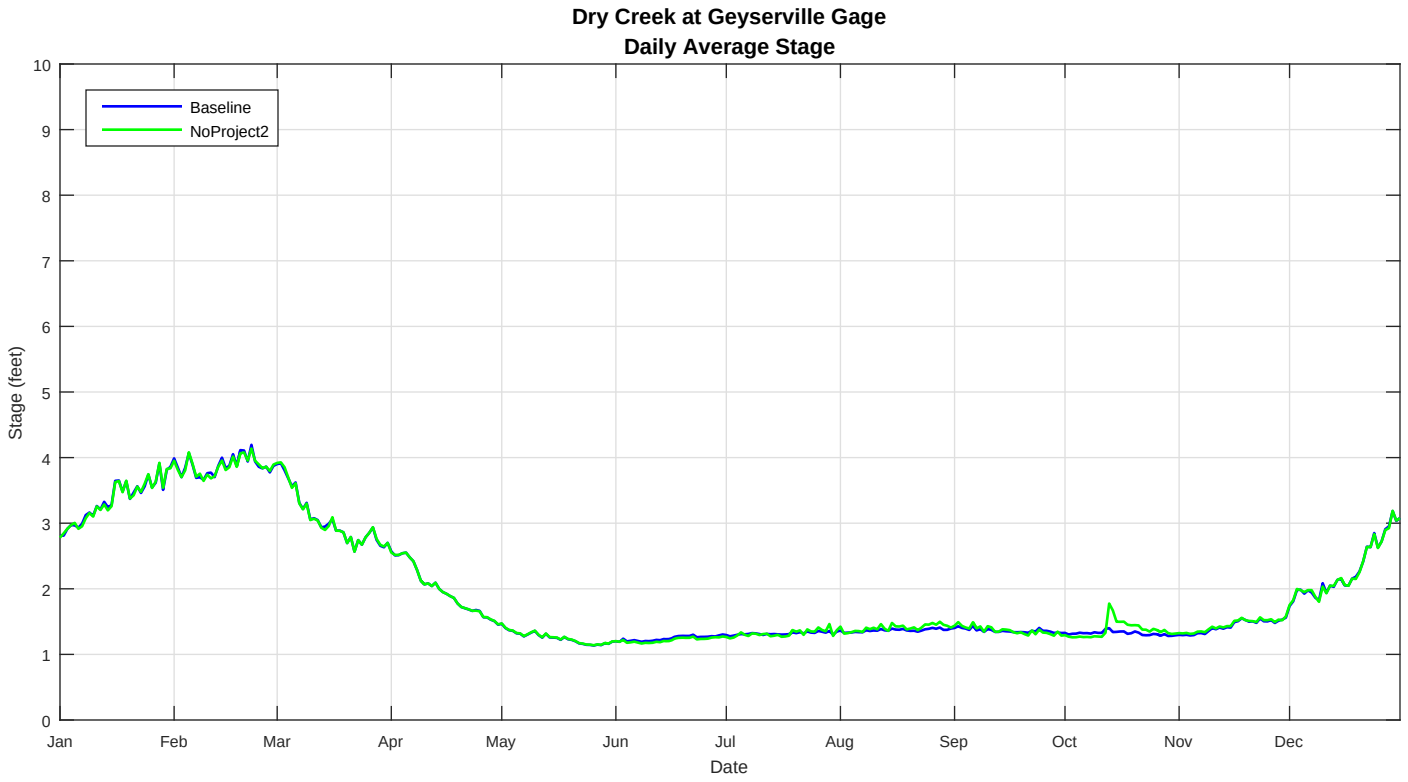

Dry Creek Mouth Gage
Daily Average Flow
Flow (cfs)
1000
100
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Baseline
NoProject2

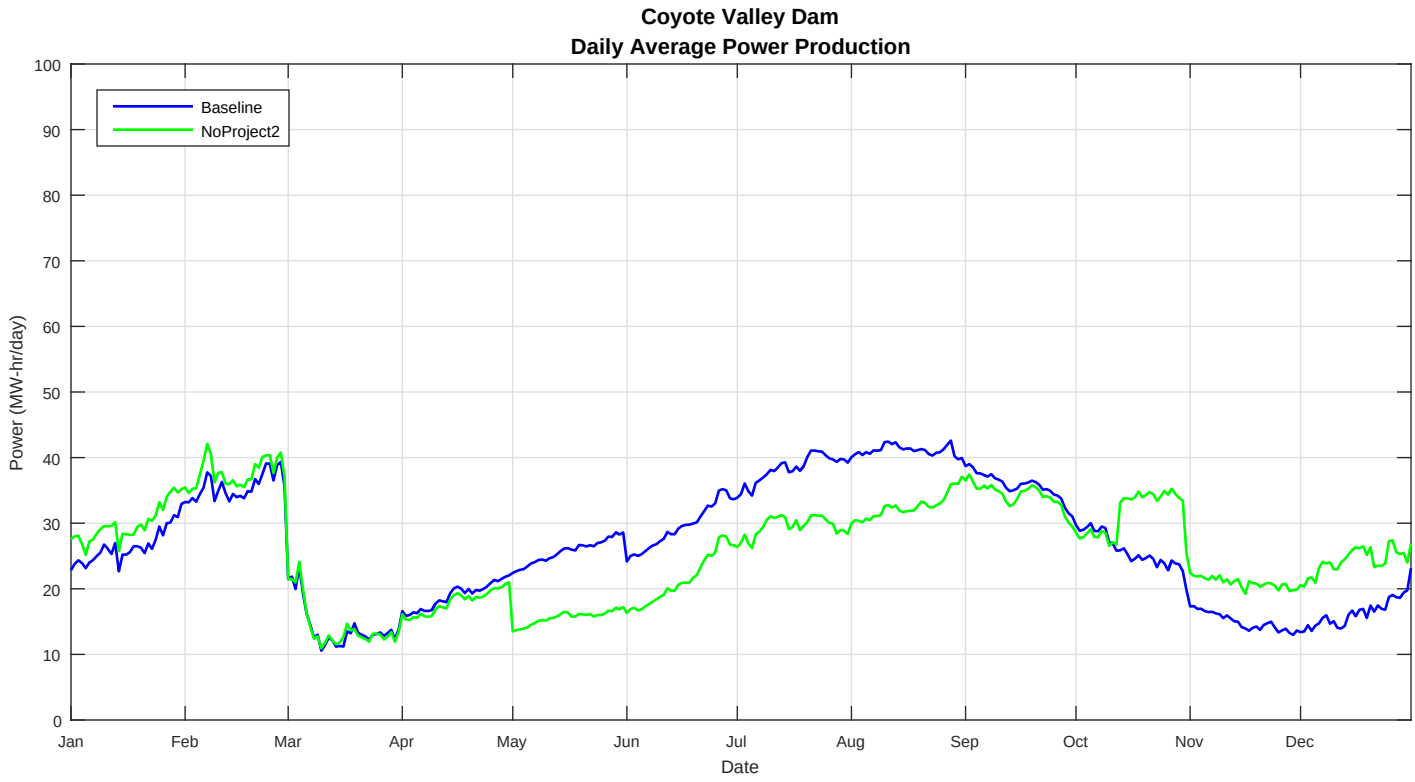

Hopland Gage
Daily Average Stage
Baseline
NoProject2
Stage (feet)
10
8
6
4
2
0
-2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

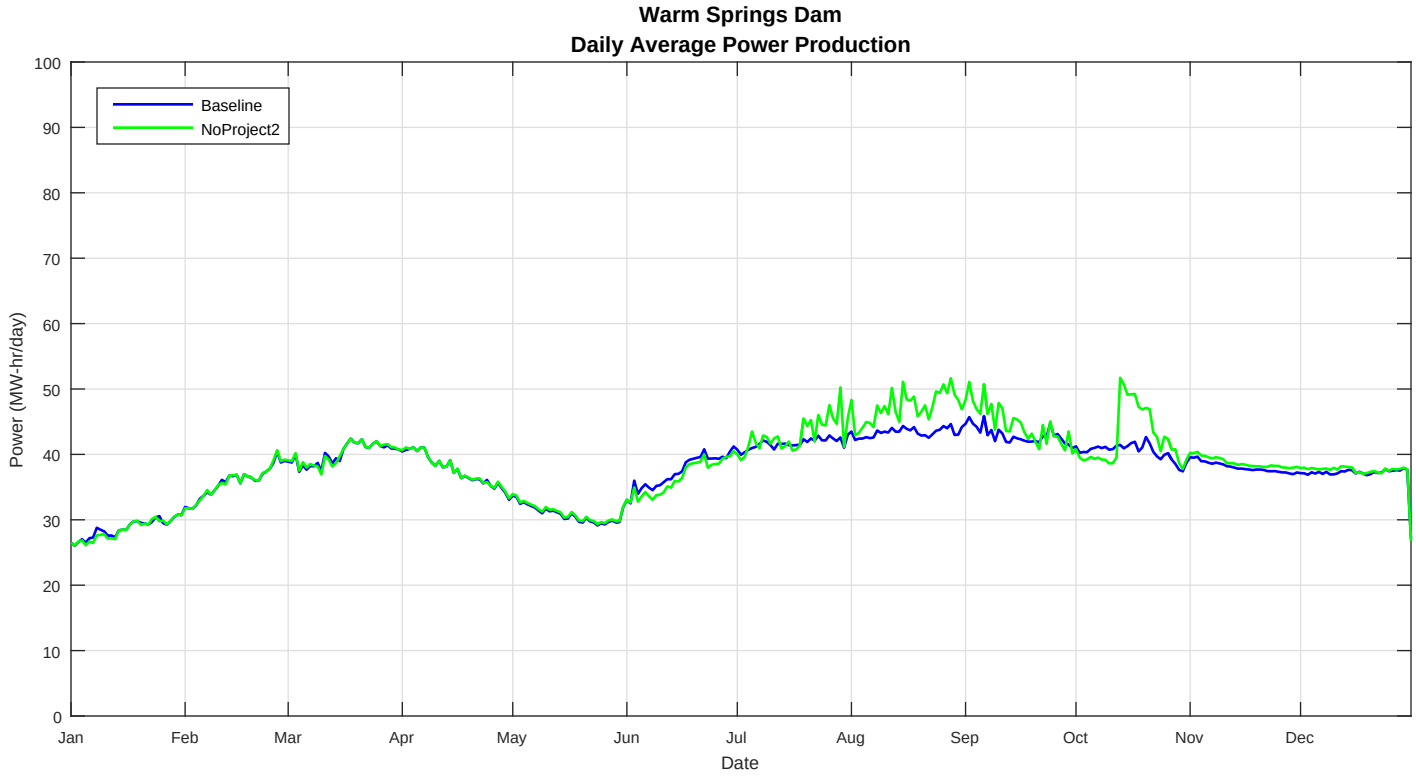

Cloverdale Gage
Daily Average Stage
Baseline
NoProject2
Stage (feet)
10
9
8
7
6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

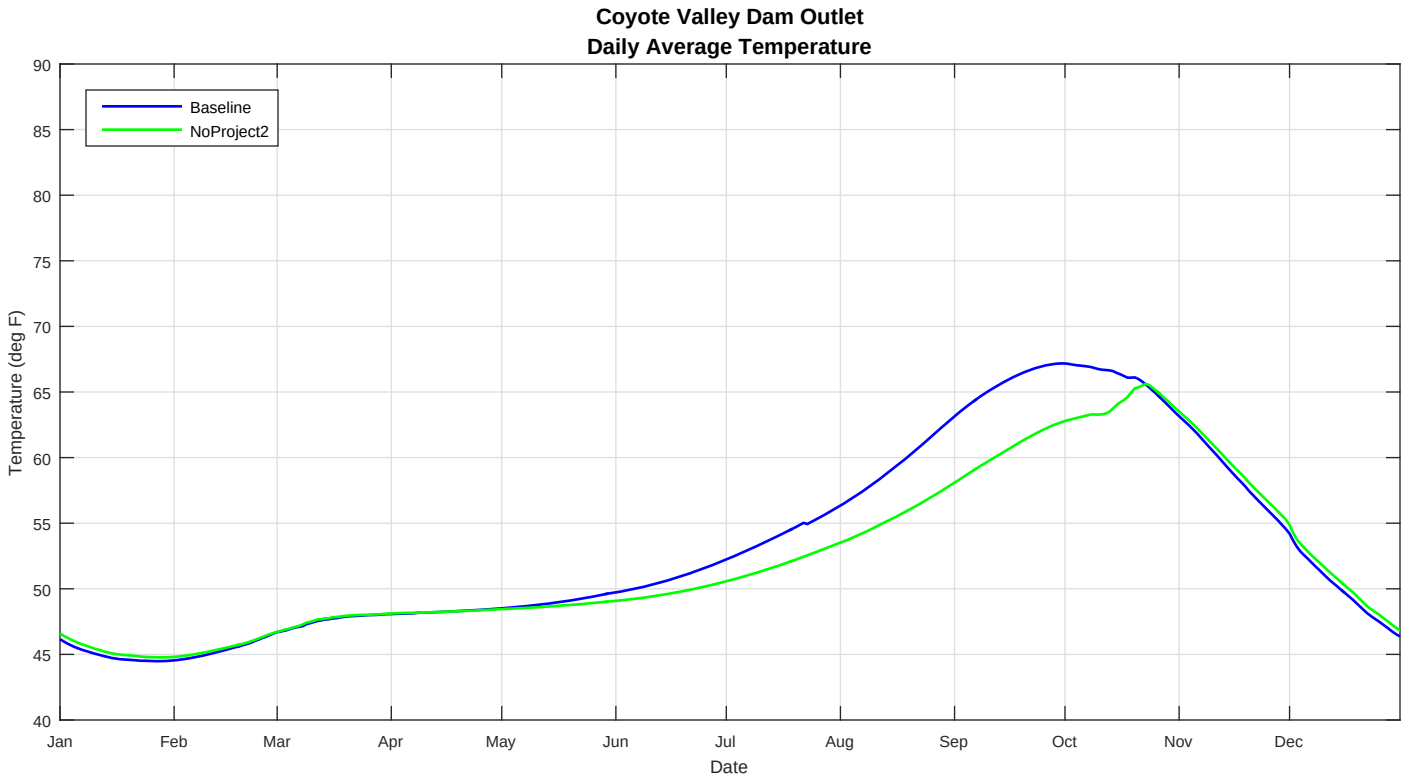

Healdsburg Gage
Daily Average Stage
Baseline
NoProject2
Stage (feet)
0
1
2
3
4
5
6
7
8
9
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

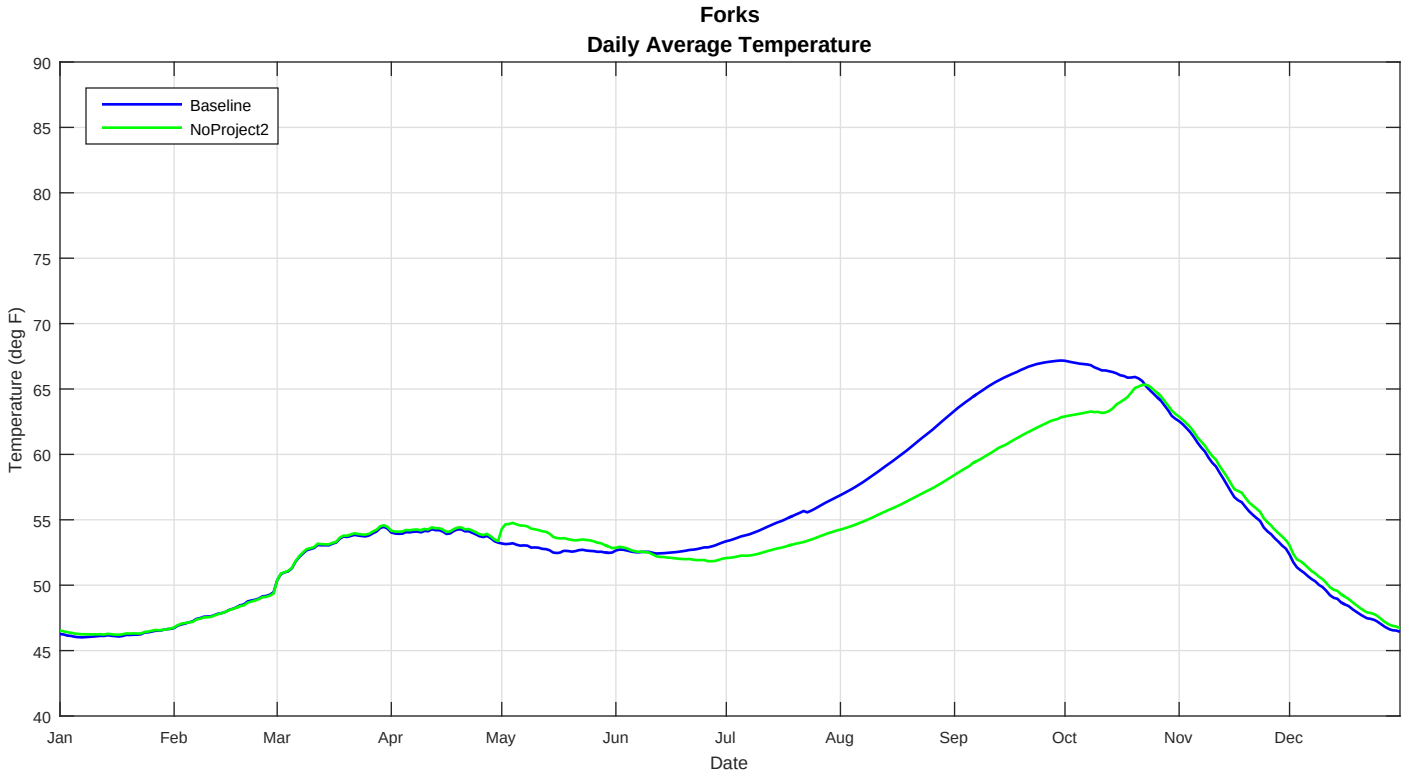

Hacienda Gage
Daily Average Stage
Baseline
NoProject2
Stage (feet)
0
1
2
3
4
5
6
7
8
9
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

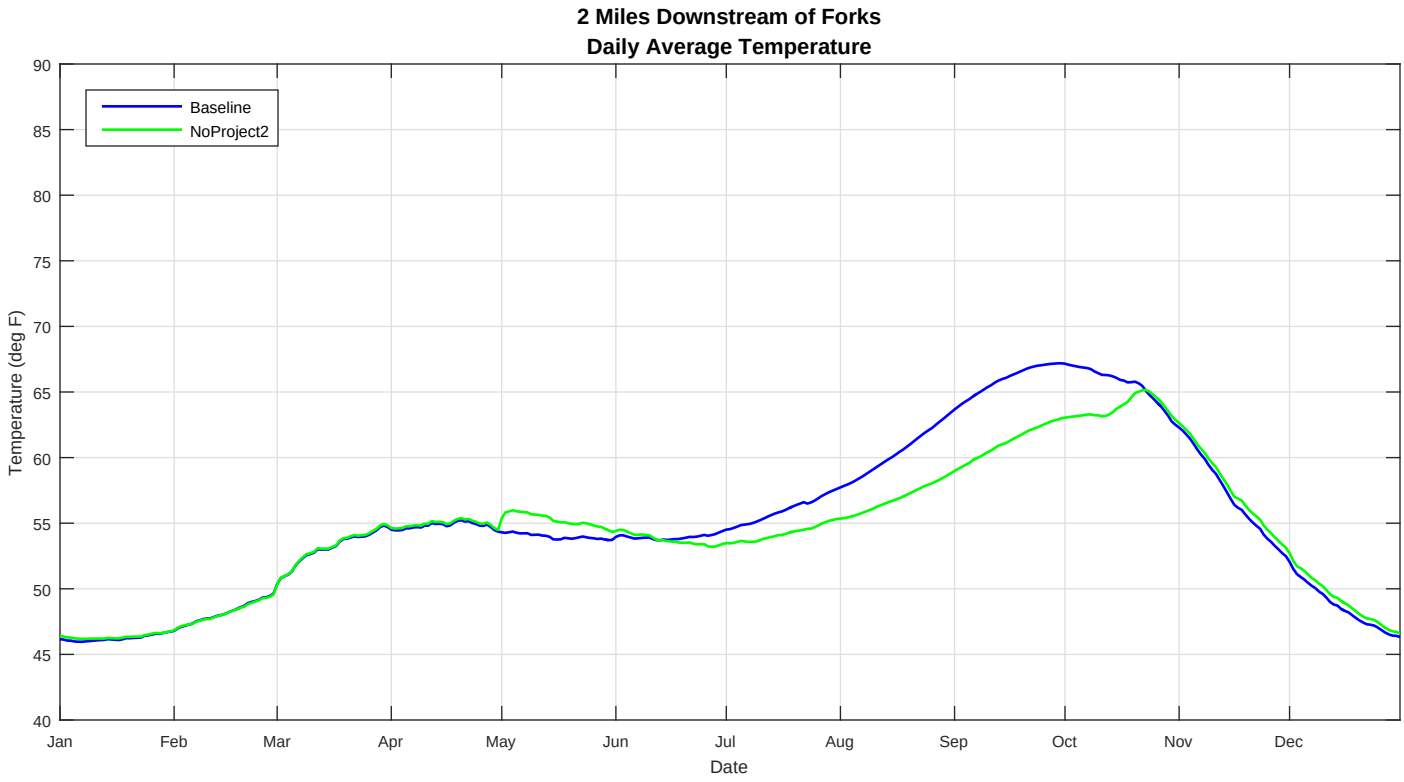

Dry Creek at Geyserville Gage
Daily Average Stage
Baseline
NoProject2
Stage (feet)
0
1
2
3
4
5
6
7
8
9
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

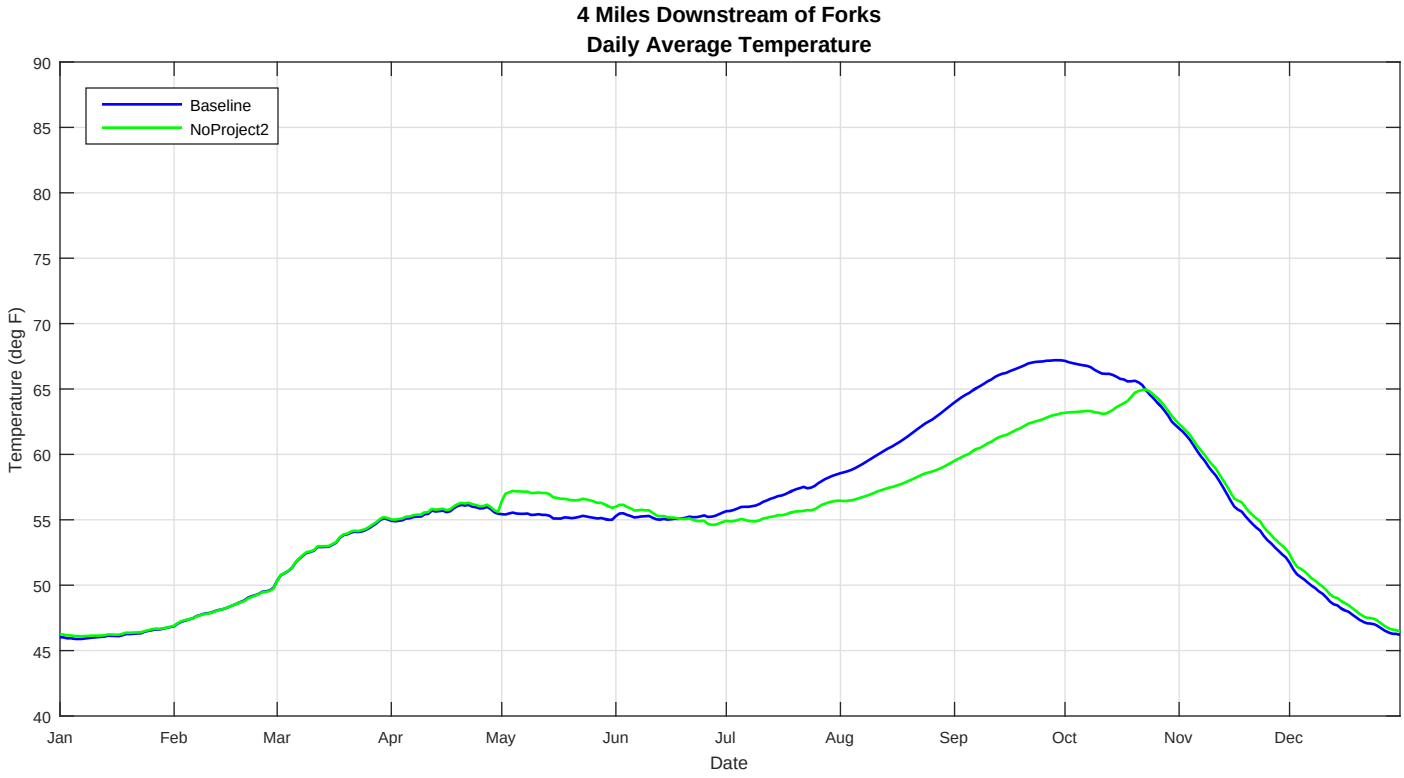

Coyote Valley Dam
Daily Average Power Production
Baseline
NoProject2
Power (MW-hr/day)
0
10
20
30
40
50
60
70
80
90
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

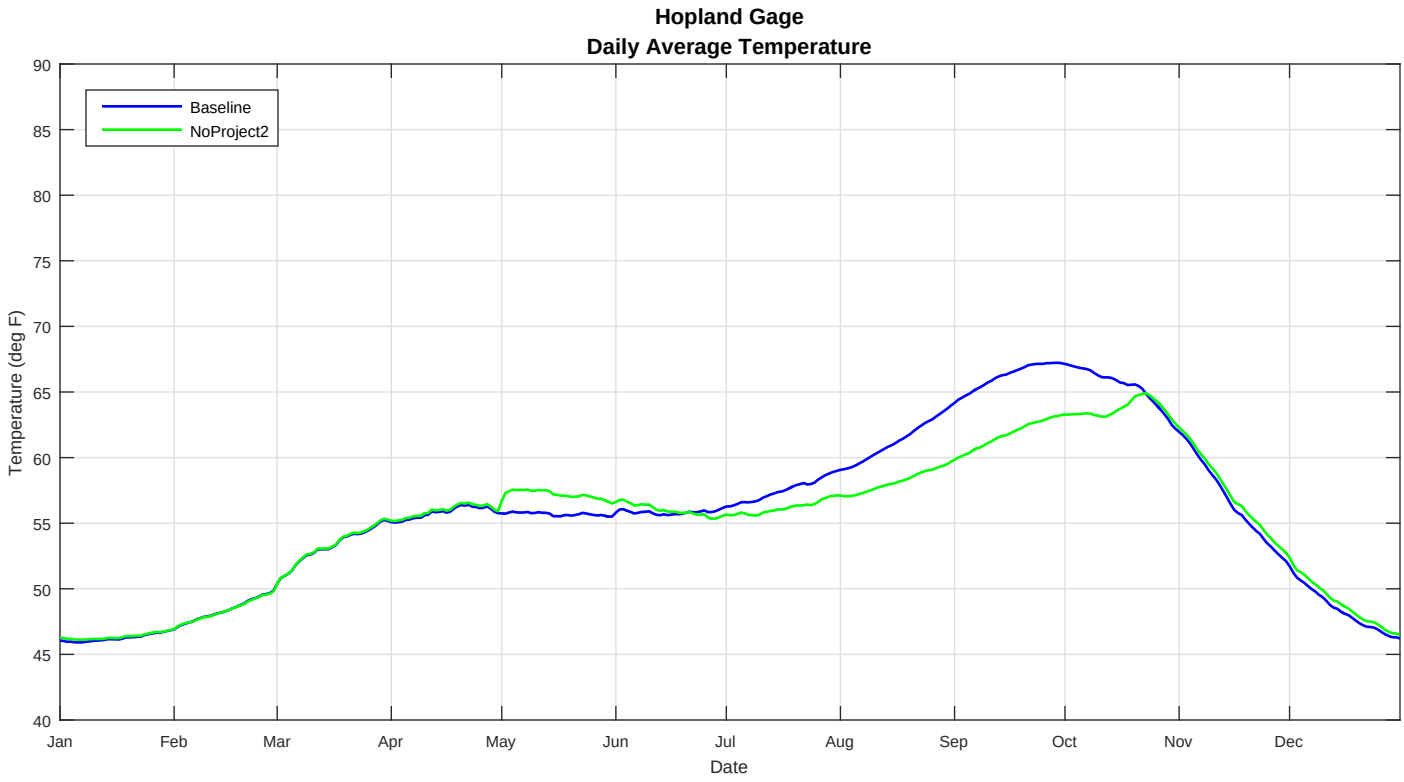

Warm Springs Dam
Daily Average Power Production
Baseline
NoProject2
Power (MW-hr/day)
0
10
20
30
40
50
60
70
80
90
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

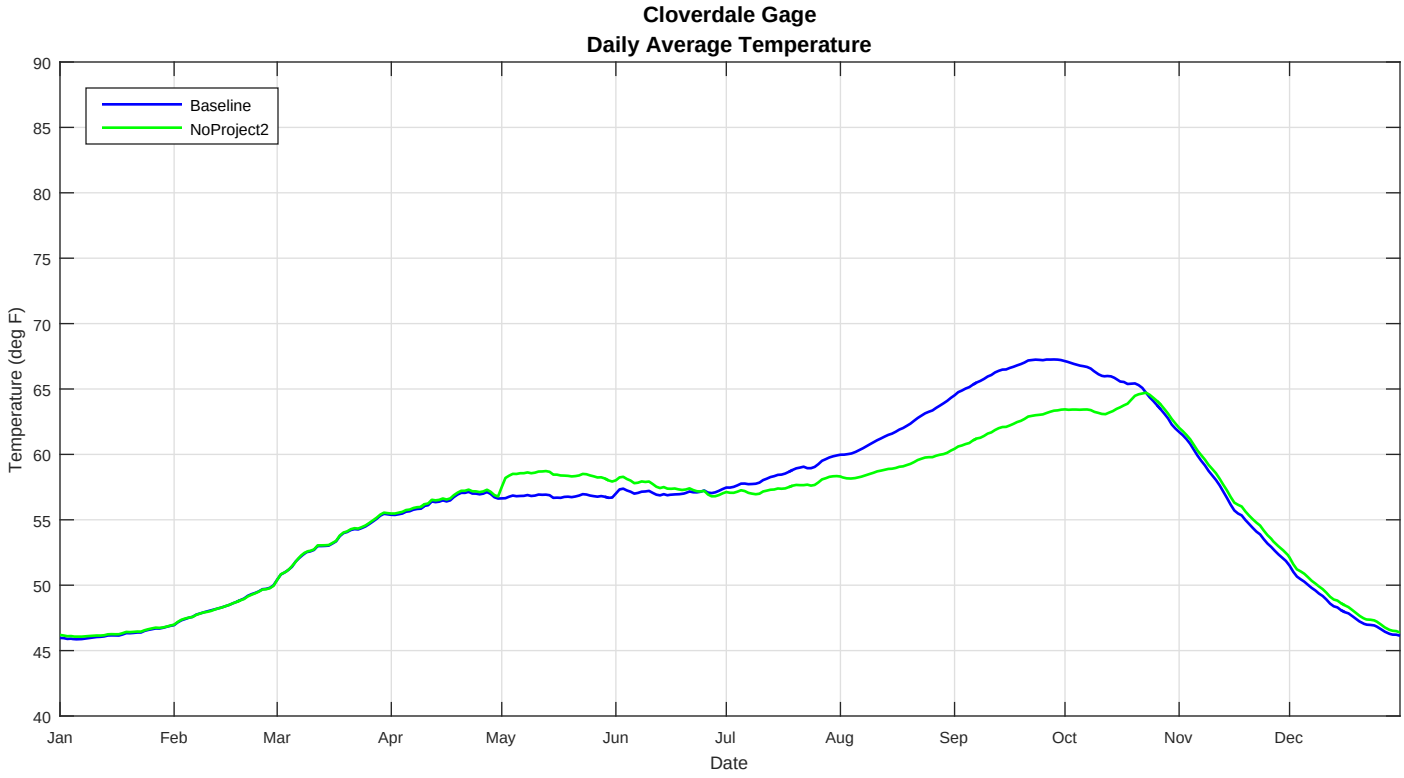

Coyote Valley Dam Outlet
Daily Average Temperature
Baseline
NoProject2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

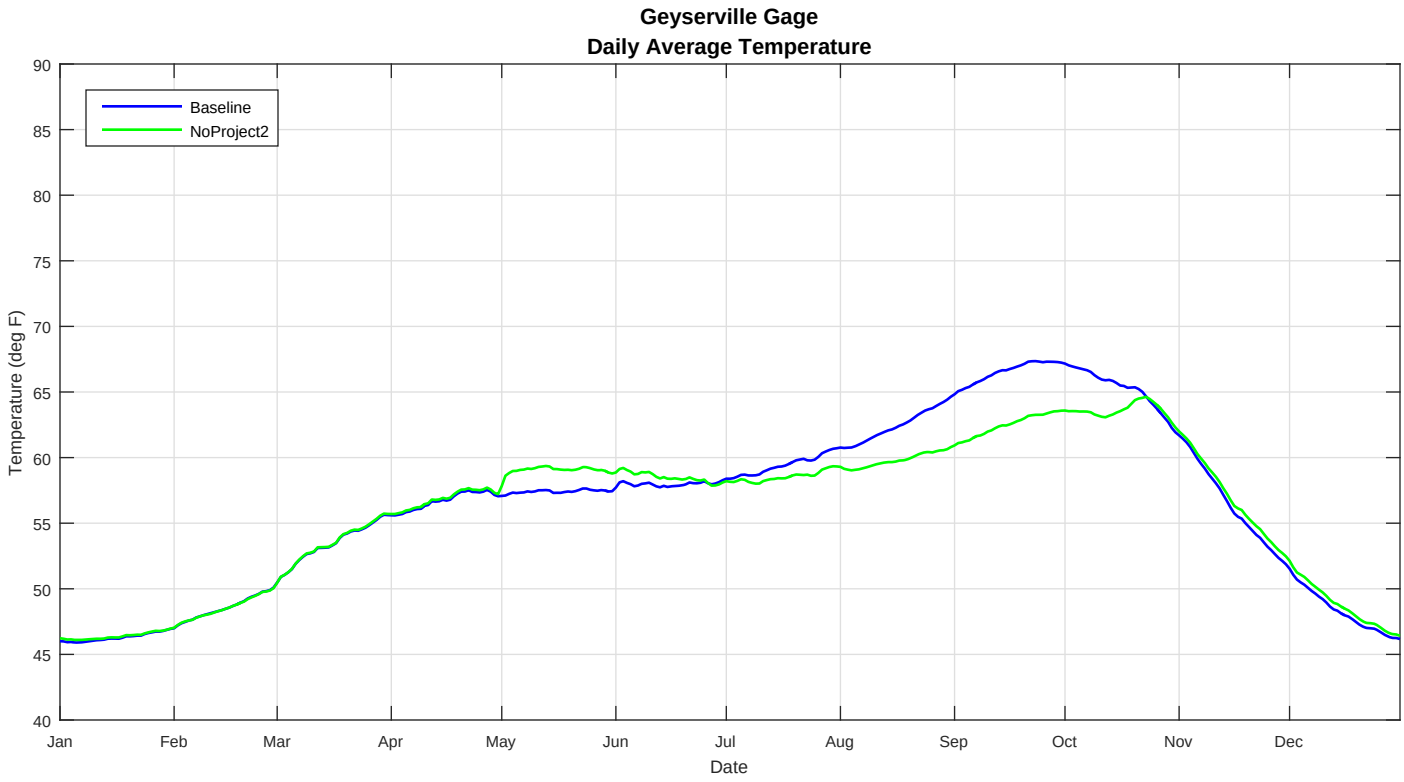

Forks
Daily Average Temperature
Baseline
NoProject2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

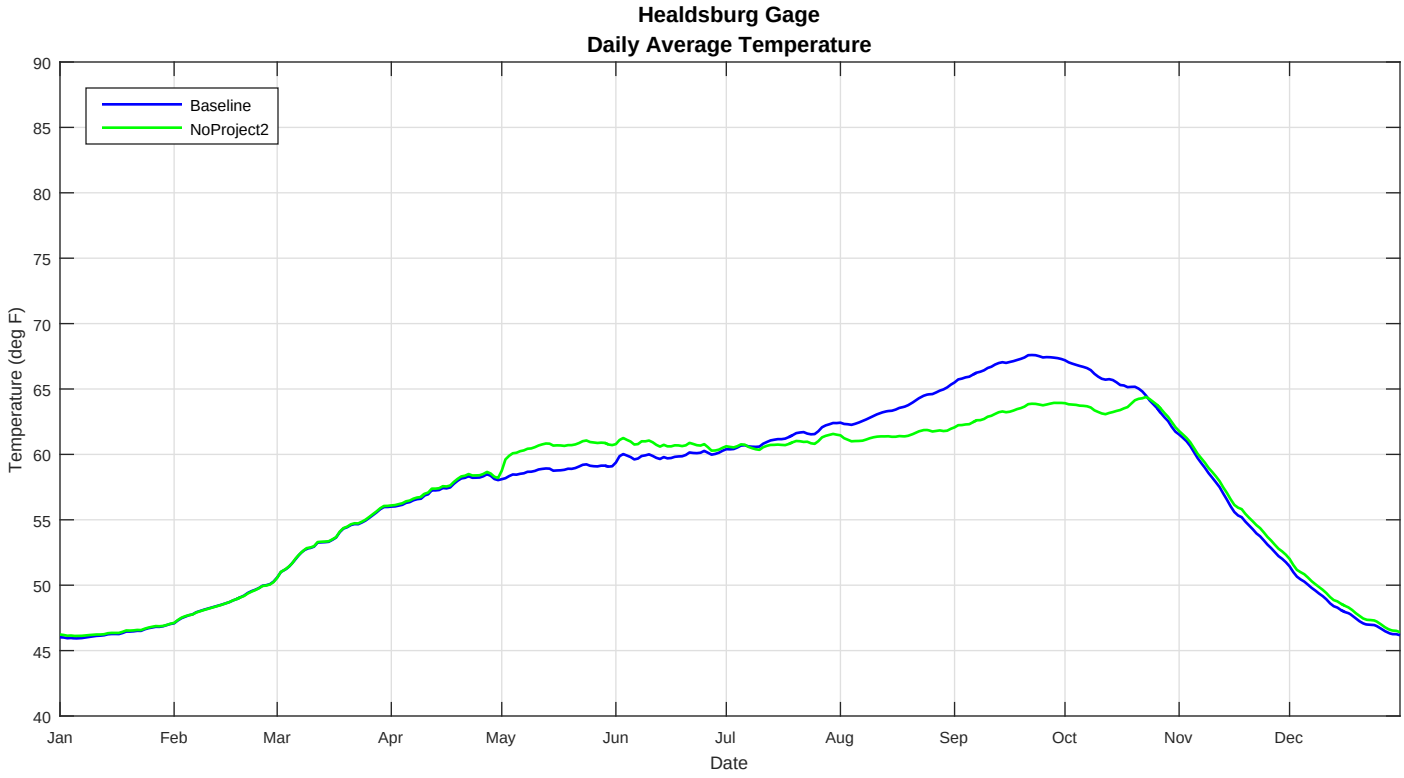

2 Miles Downstream of Forks
Daily Average Temperature
Baseline
NoProject2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

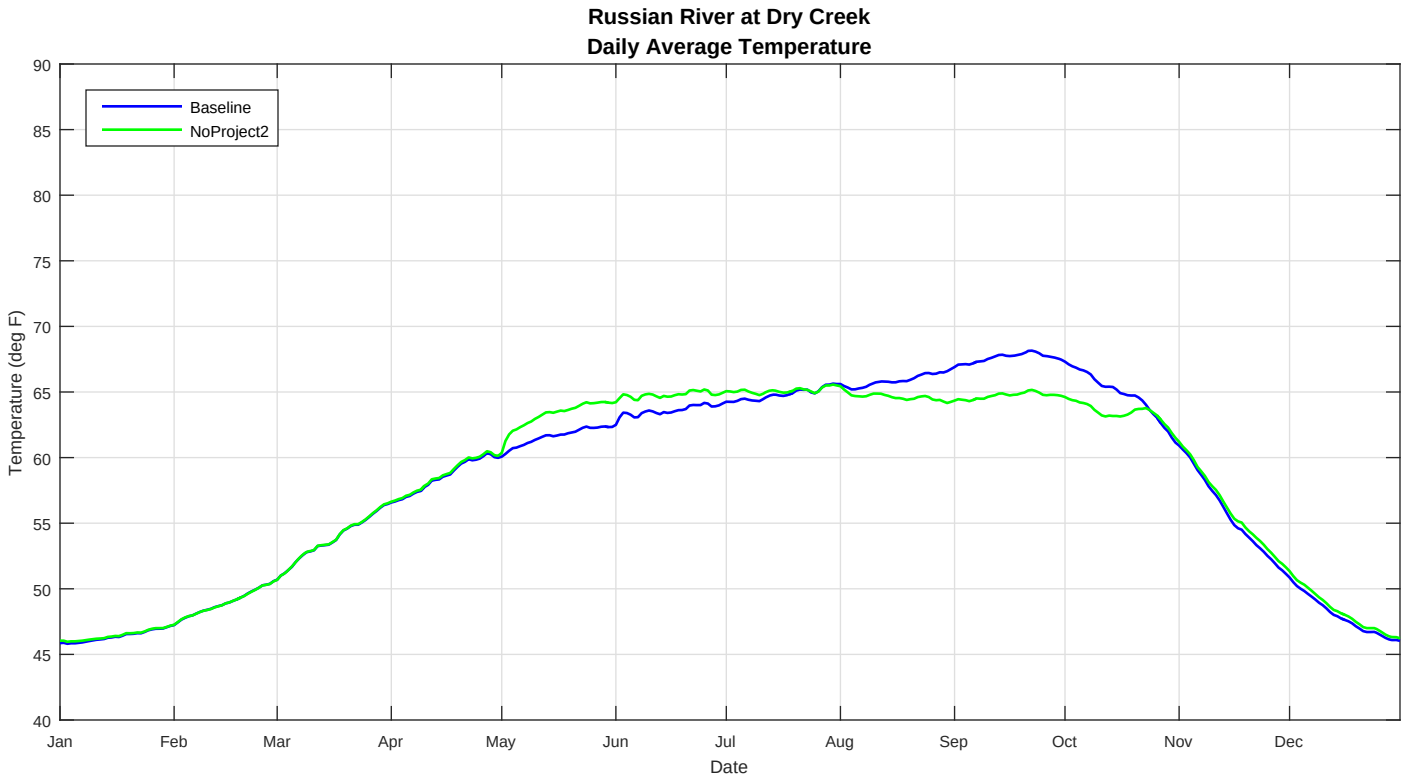

4 Miles Downstream of Forks
Daily Average Temperature
Baseline
NoProject2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

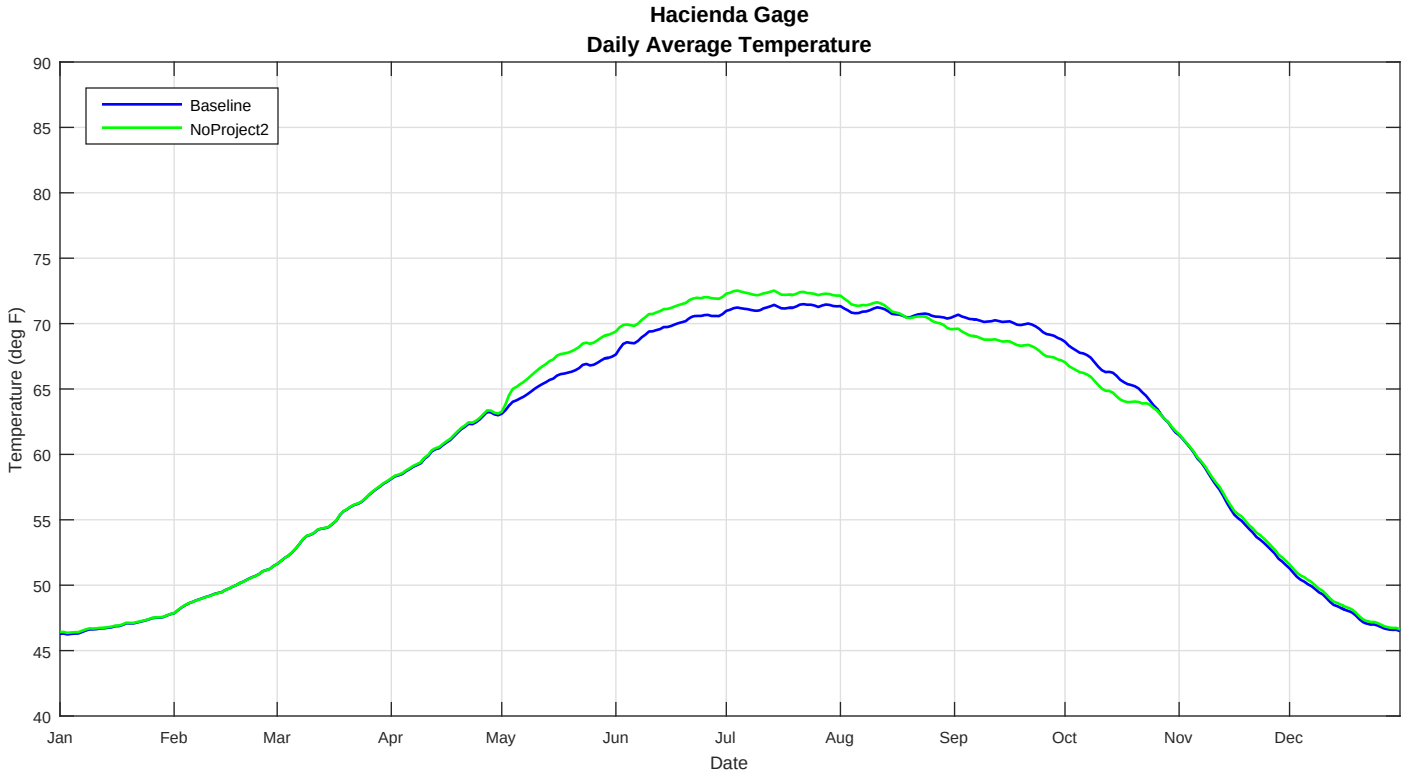

Hopland Gage
Daily Average Temperature
Baseline
NoProject2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

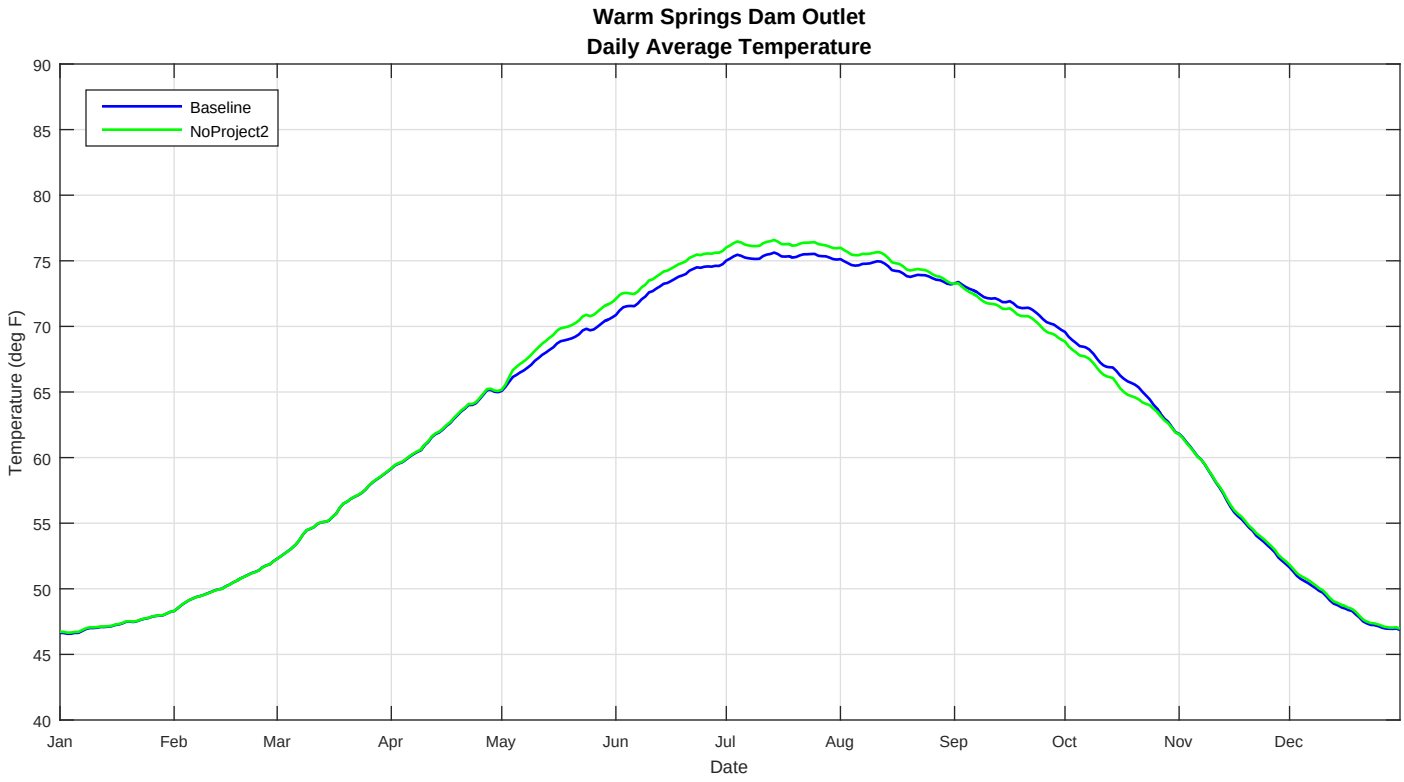

Cloverdale Gage
Daily Average Temperature
Baseline
NoProject2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

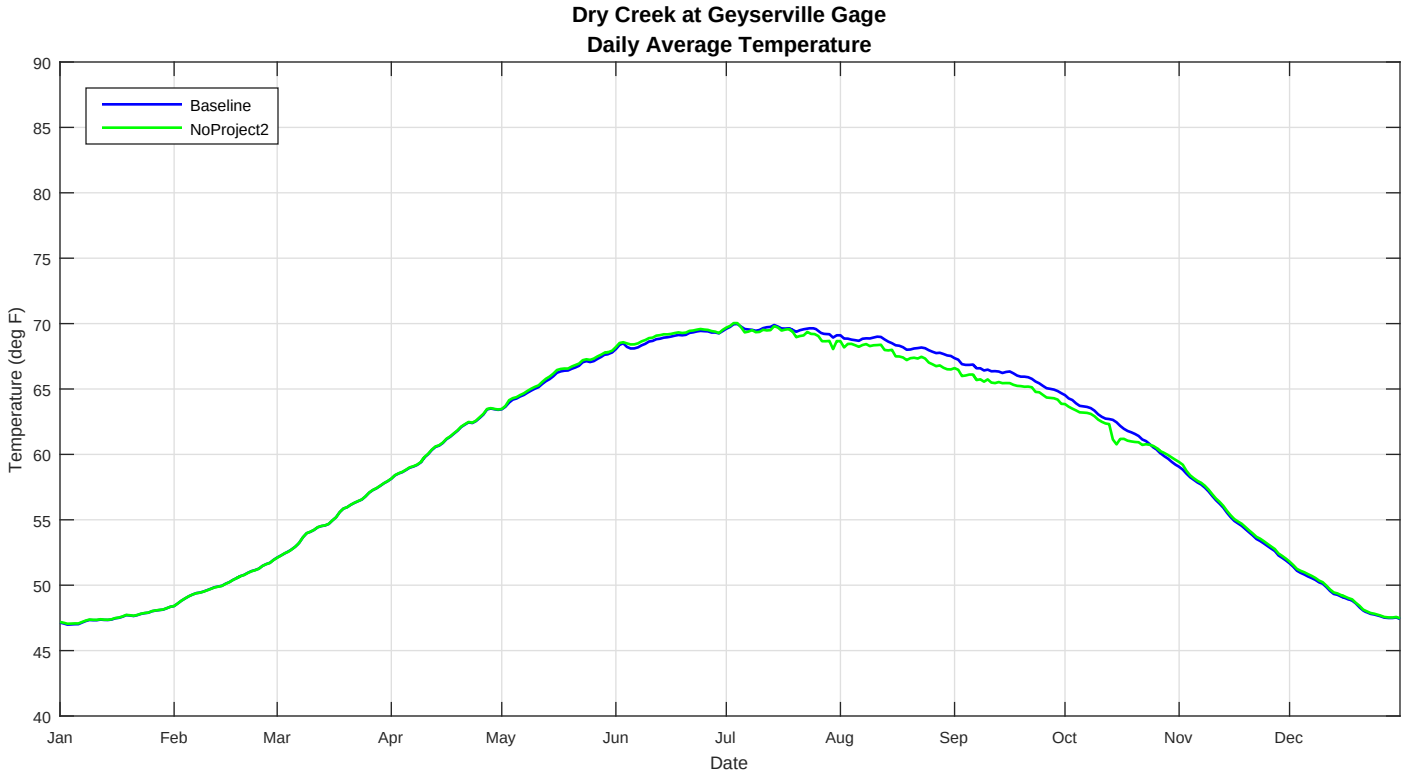

Geyserville Gage
Daily Average Temperature
Baseline
NoProject2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

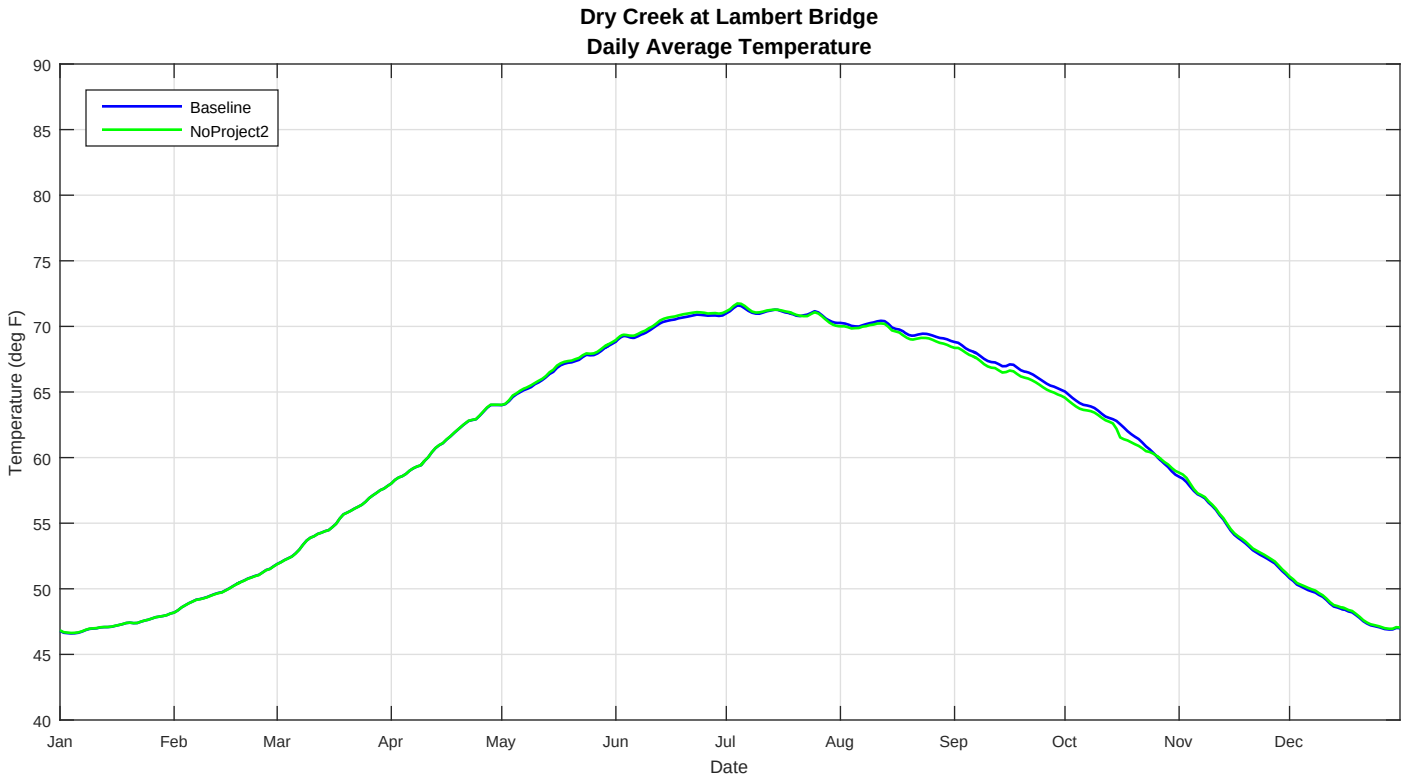

Healdsburg Gage
Daily Average Temperature
Baseline
NoProject2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

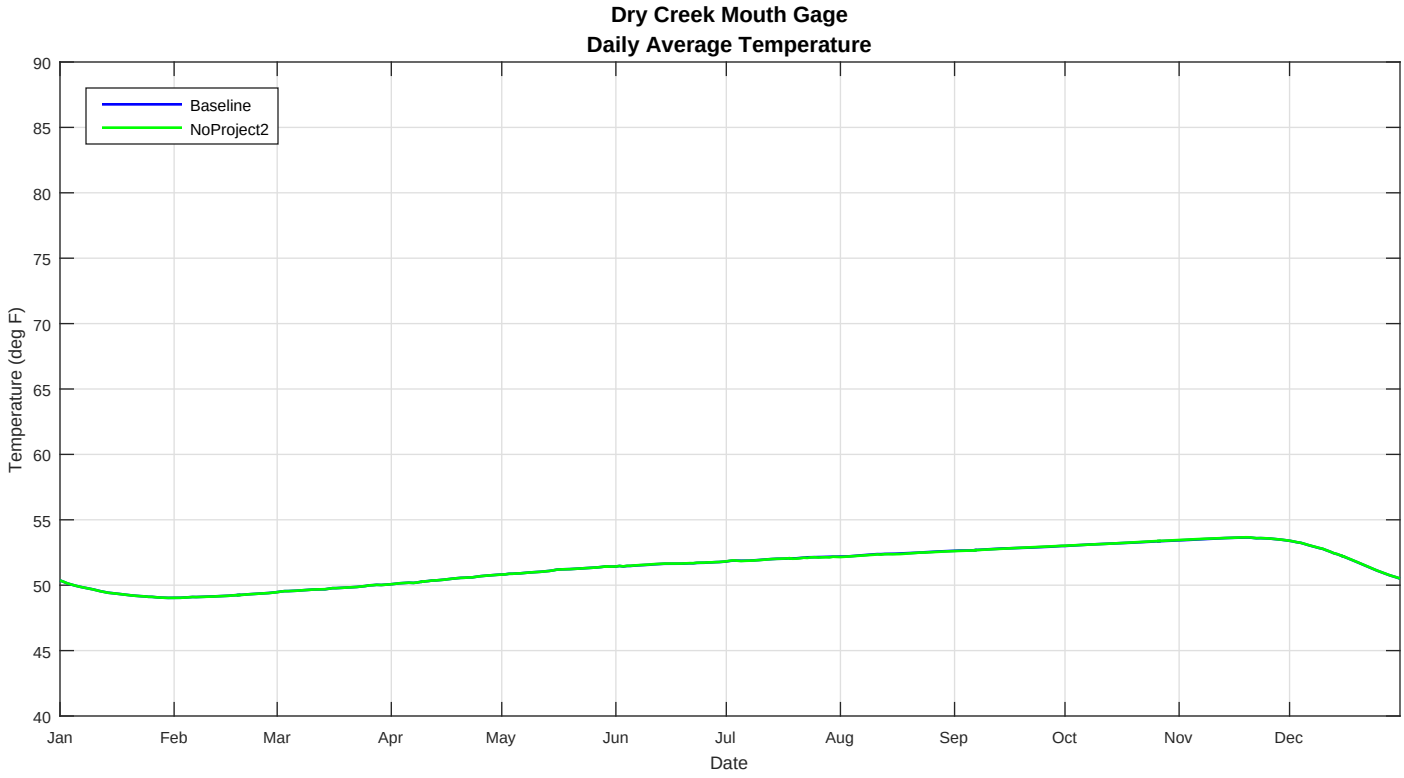

Russian River at Dry Creek
Daily Average Temperature
Baseline
NoProject2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

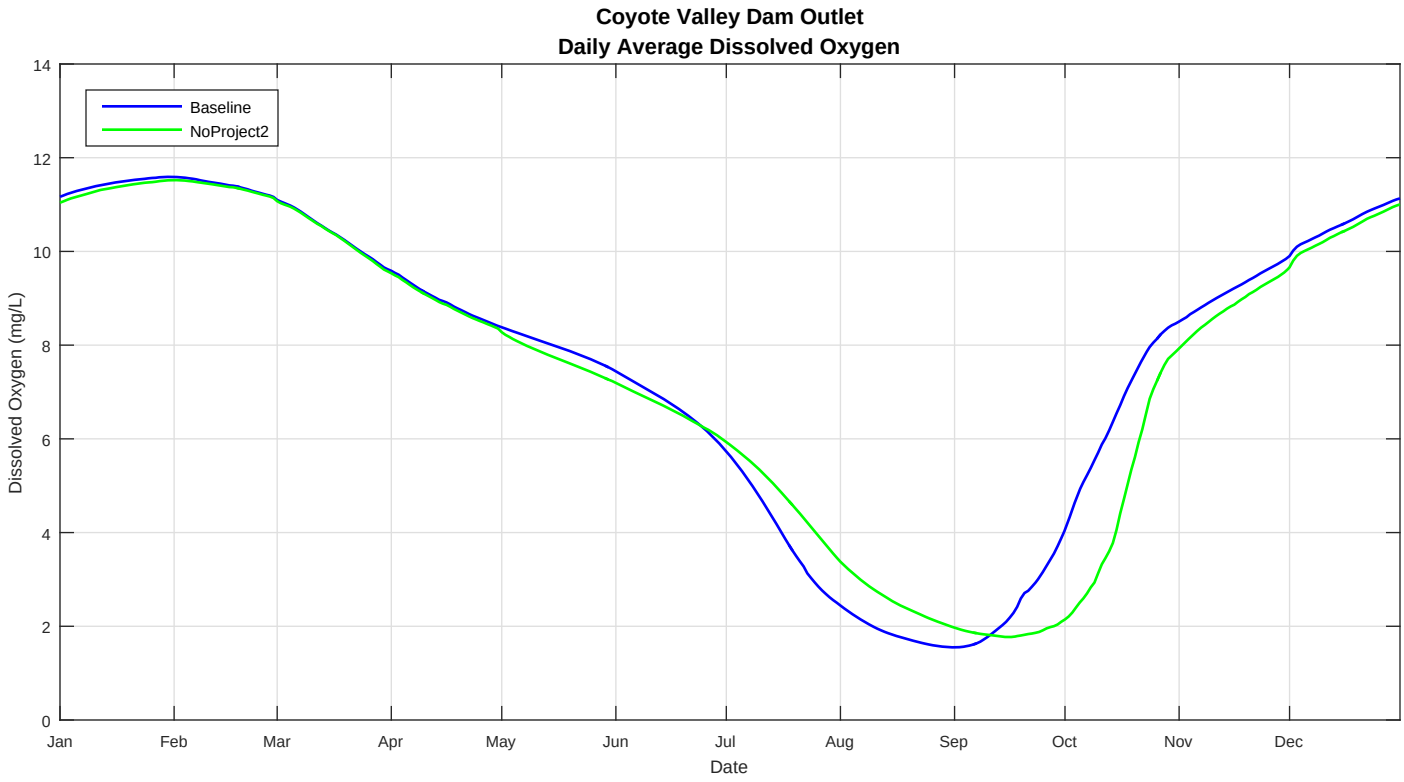

Hacienda Gage
Daily Average Temperature
Baseline
NoProject2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

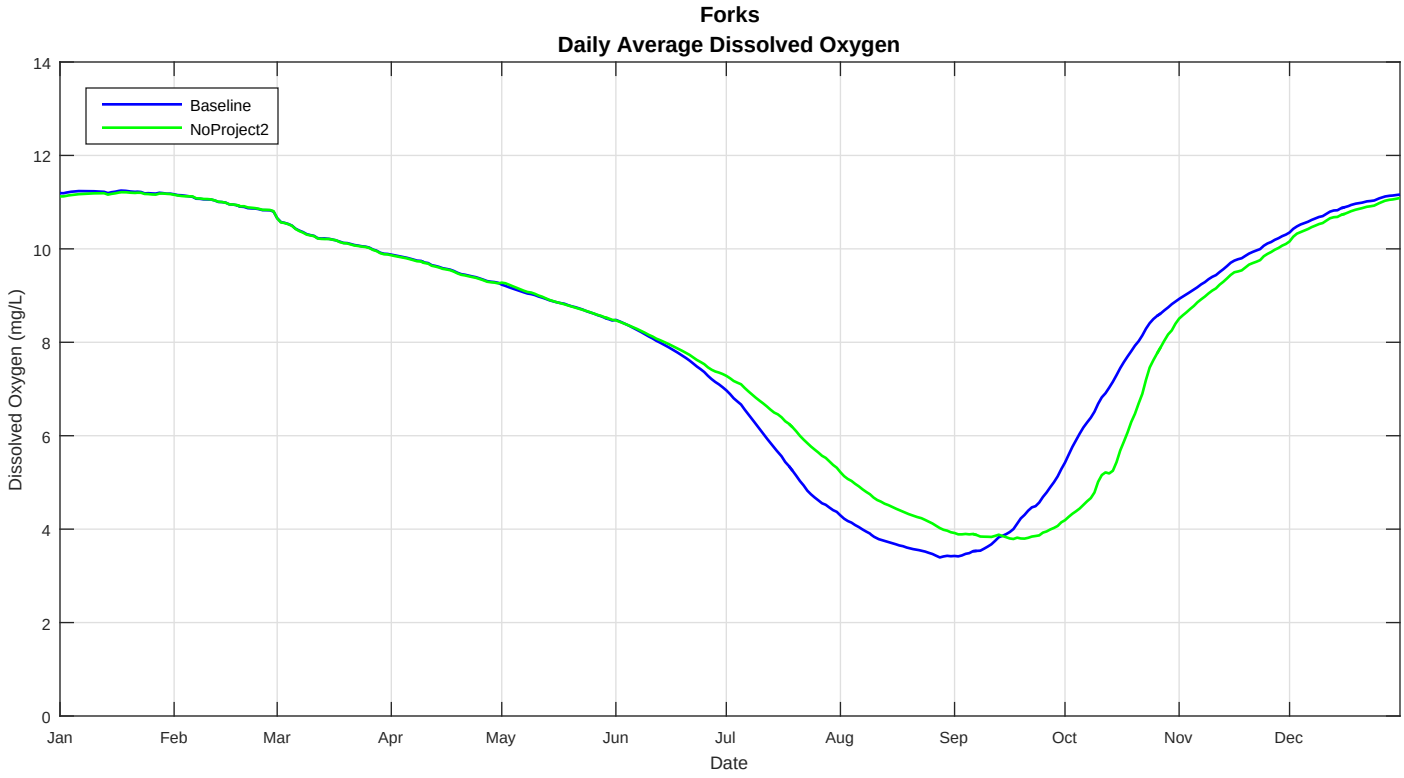

Warm Springs Dam Outlet
Daily Average Temperature
Baseline
NoProject2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

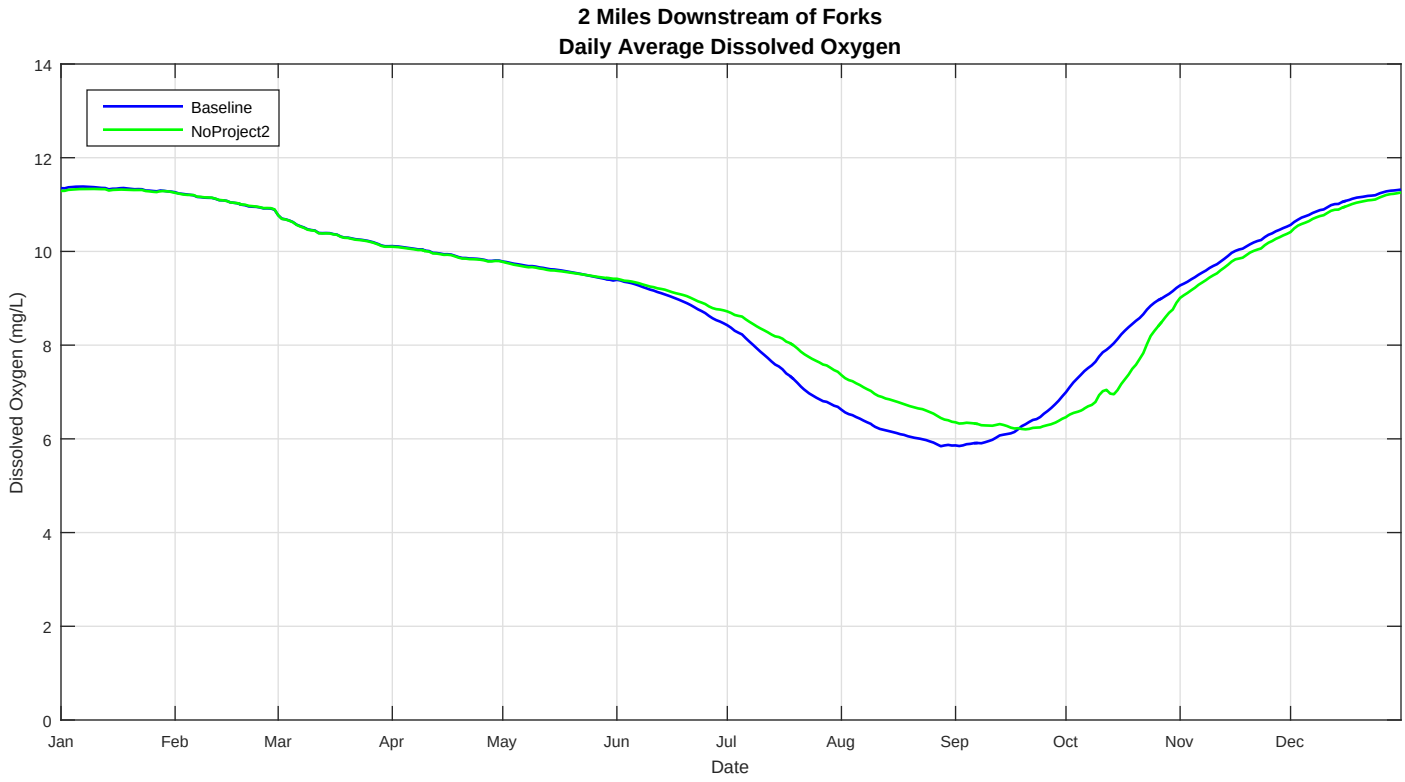

Dry Creek at Geyserville Gage
Daily Average Temperature
Baseline
NoProject2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

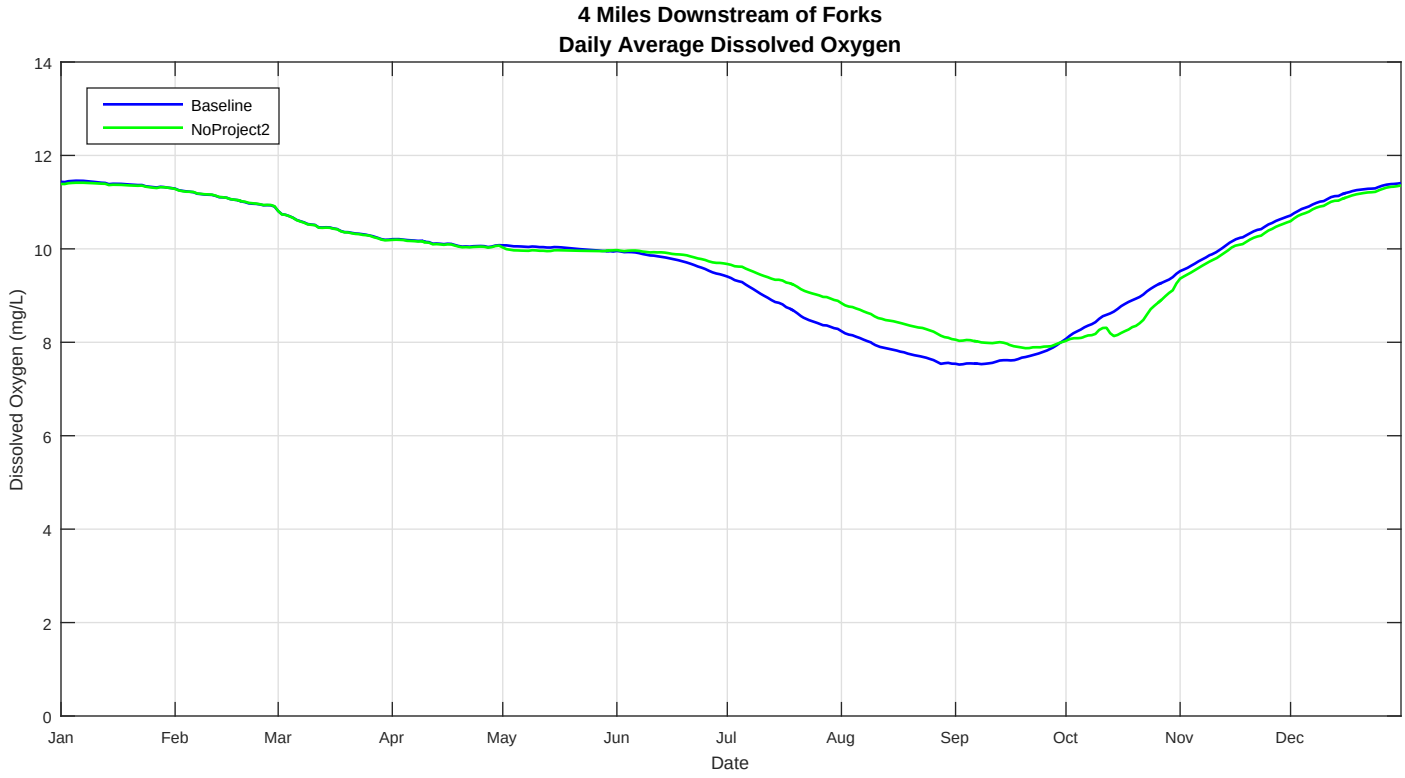

Dry Creek at Lambert Bridge
Daily Average Temperature
Baseline
NoProject2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

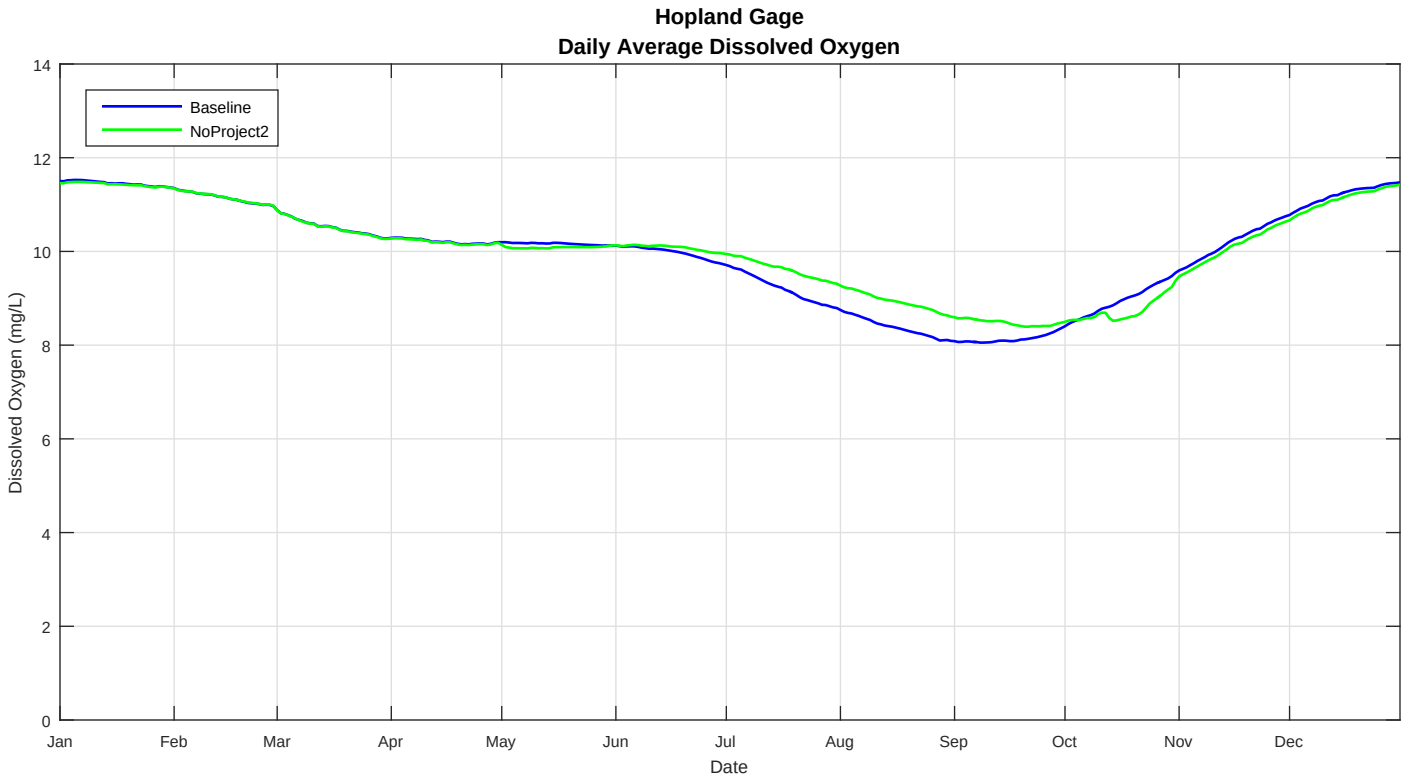

Dry Creek Mouth Gage
Daily Average Temperature
Baseline
NoProject2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

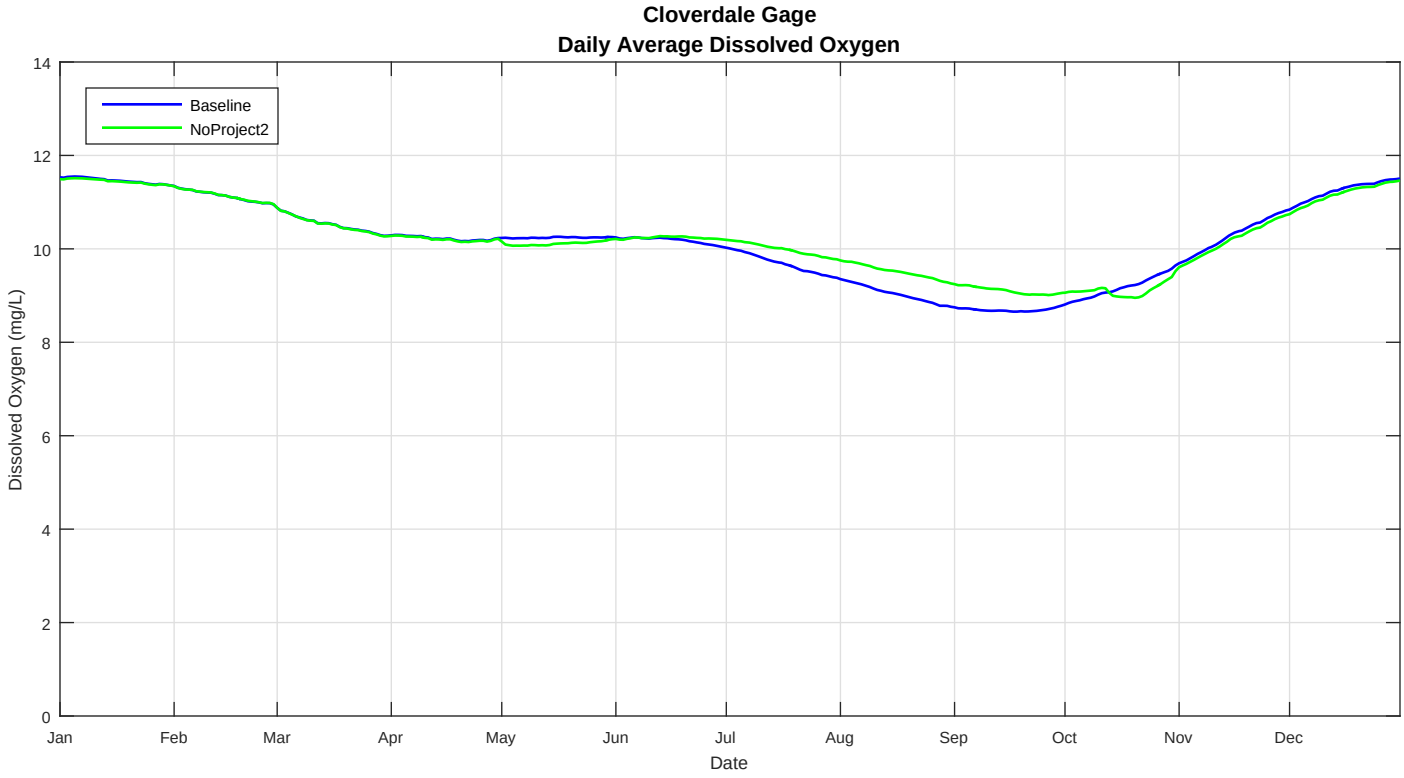

Coyote Valley Dam Outlet
Daily Average Dissolved Oxygen
Baseline
NoProject2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

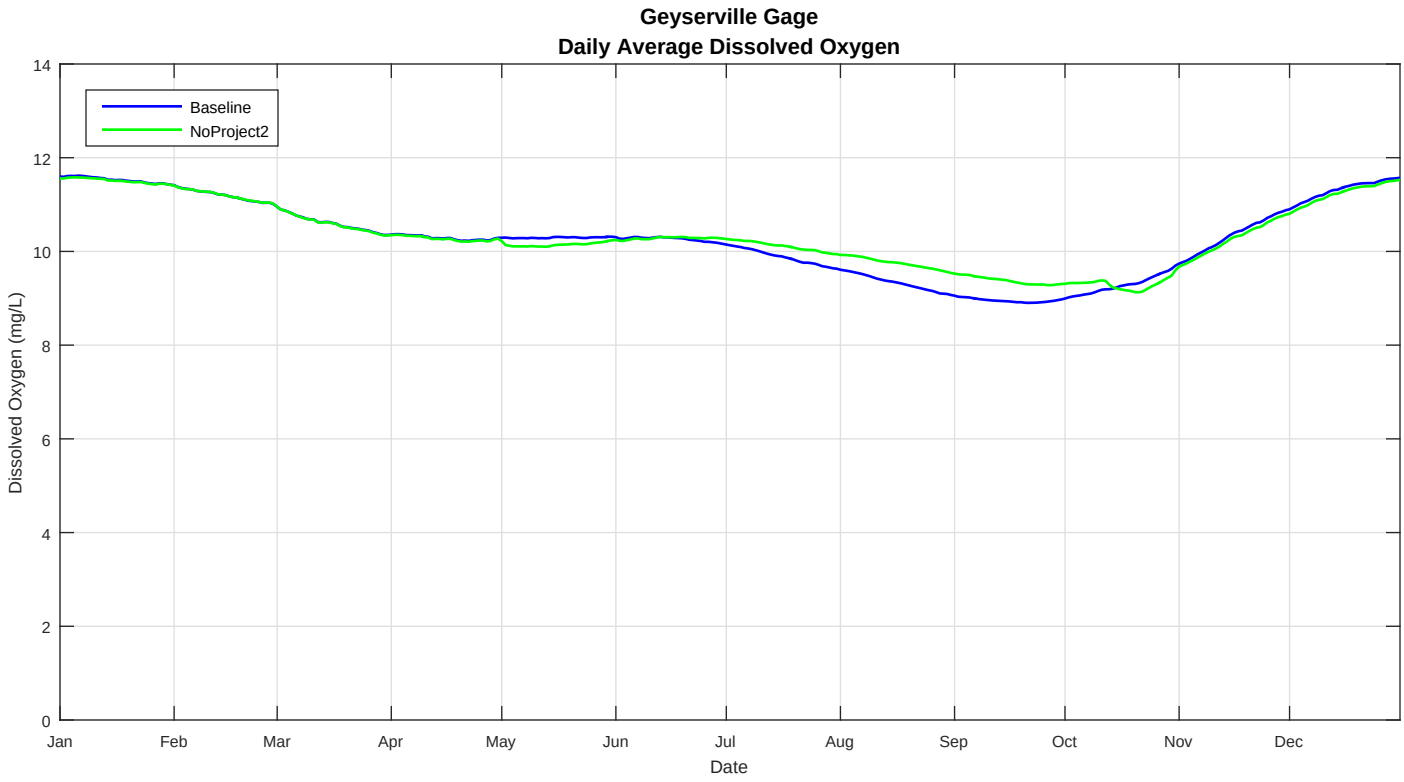

Forks
Daily Average Dissolved Oxygen
Baseline
NoProject2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

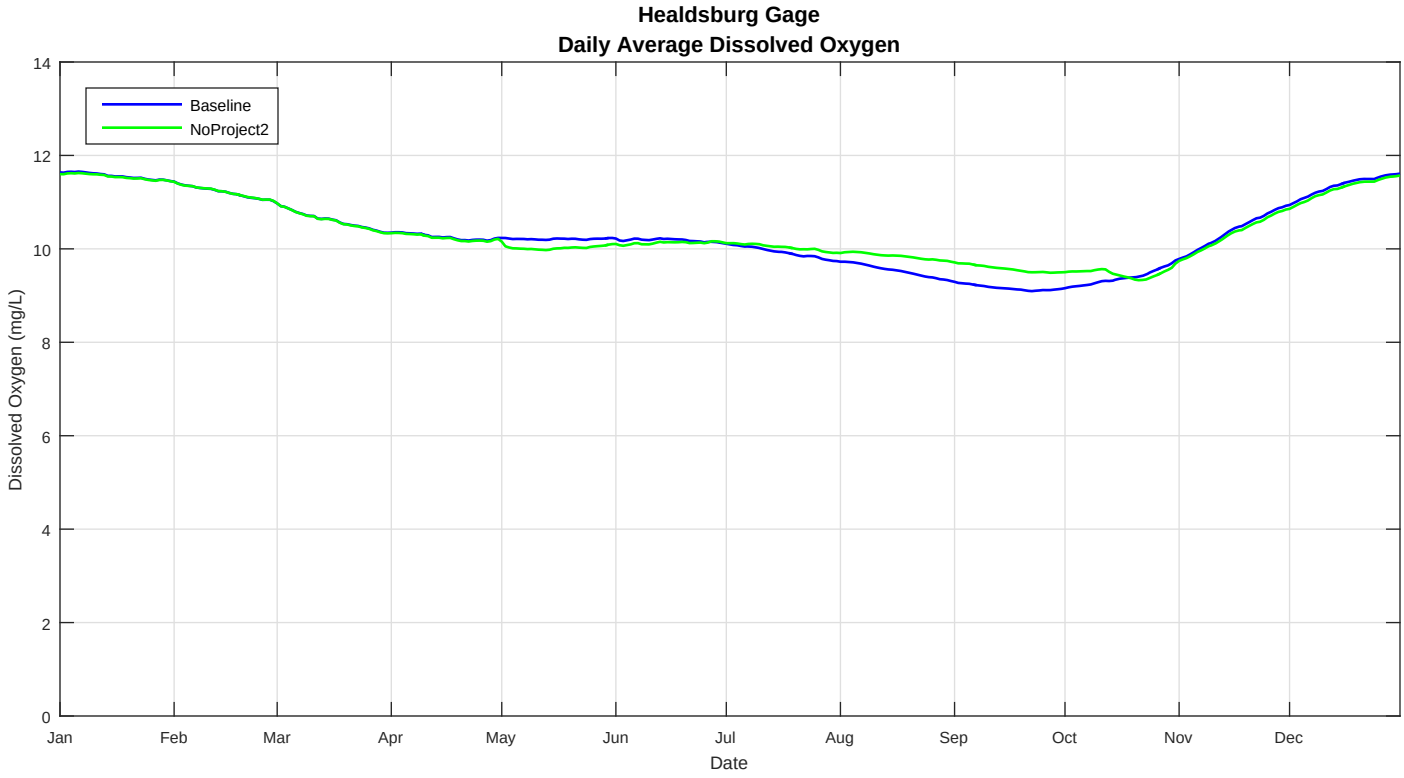

2 Miles Downstream of Forks
Daily Average Dissolved Oxygen
Baseline
NoProject2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

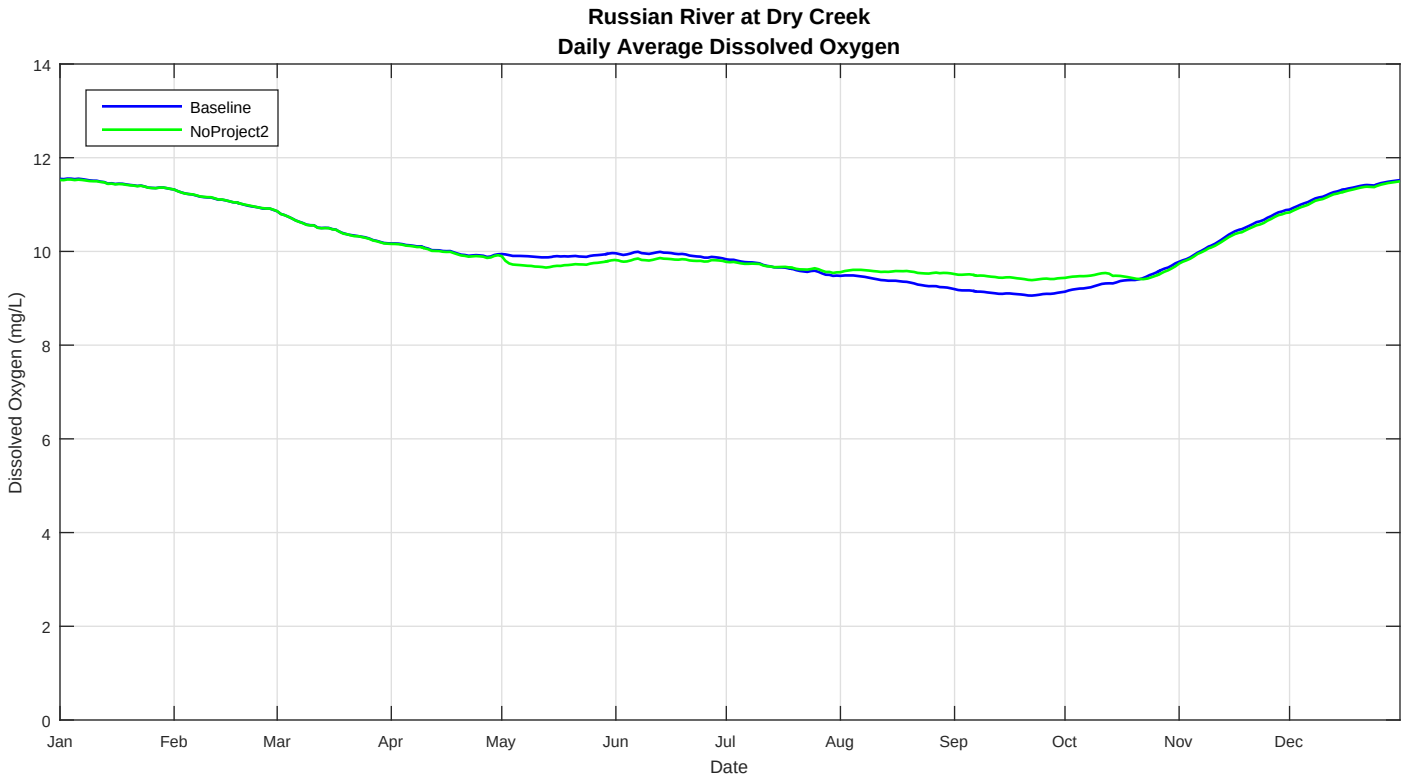

4 Miles Downstream of Forks
Daily Average Dissolved Oxygen
Baseline
NoProject2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

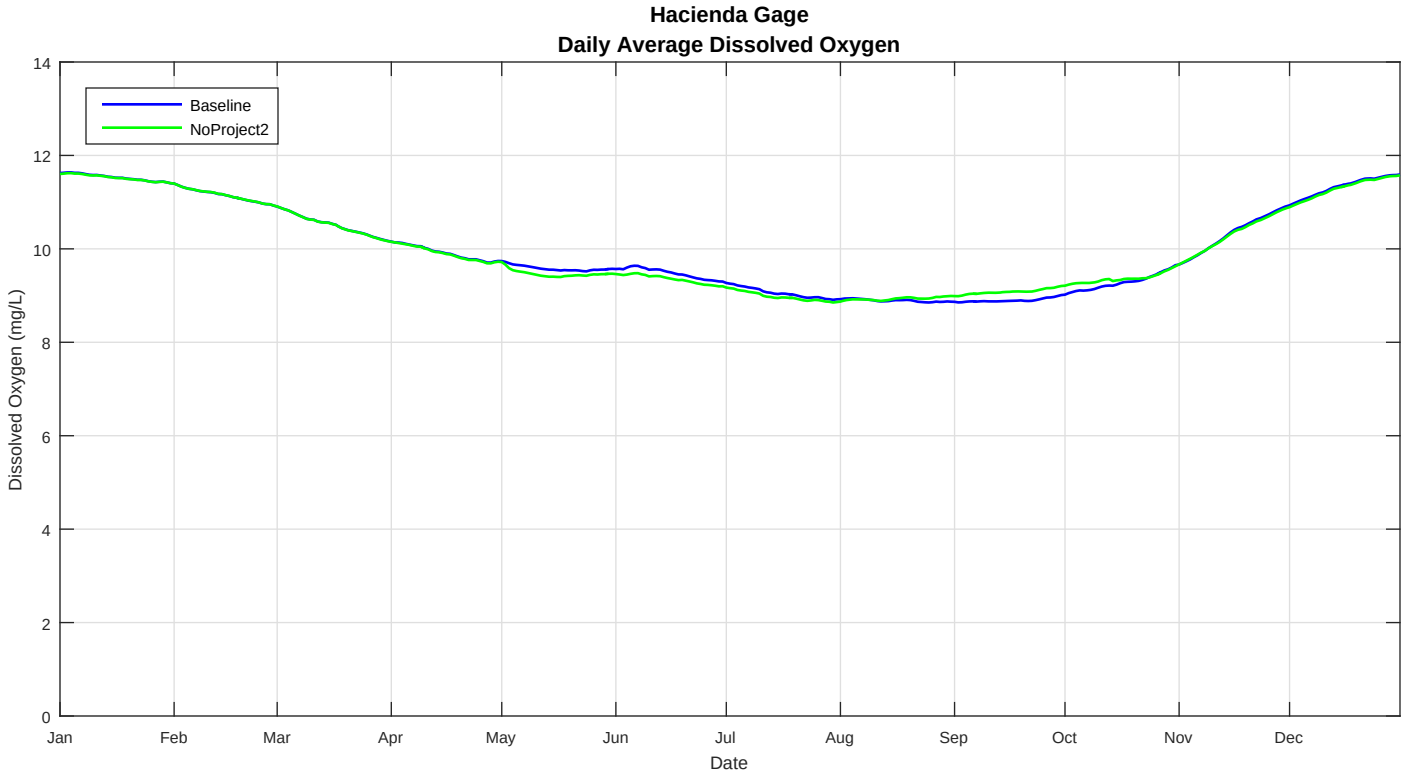

Hopland Gage
Daily Average Dissolved Oxygen
Baseline
NoProject2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

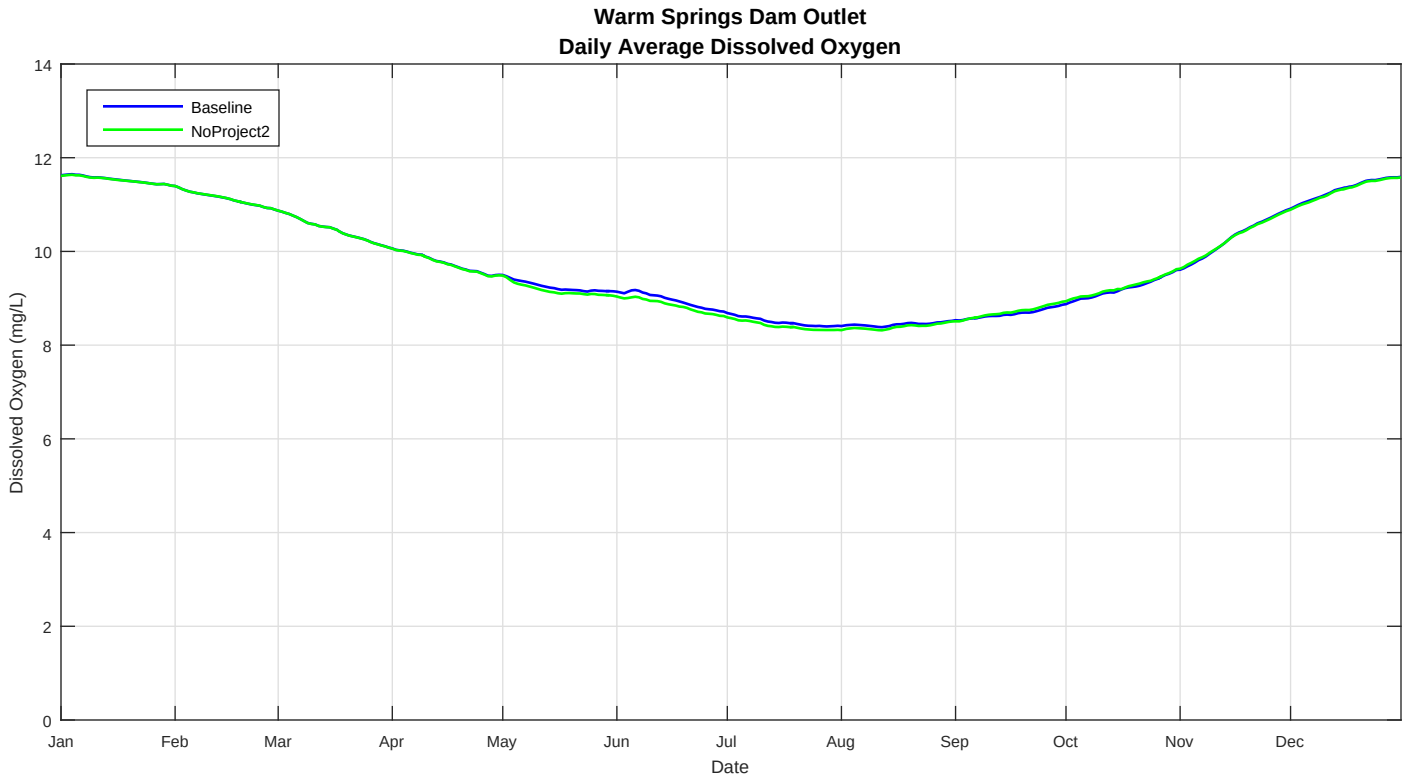

Cloverdale Gage
Daily Average Dissolved Oxygen
Baseline
NoProject2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

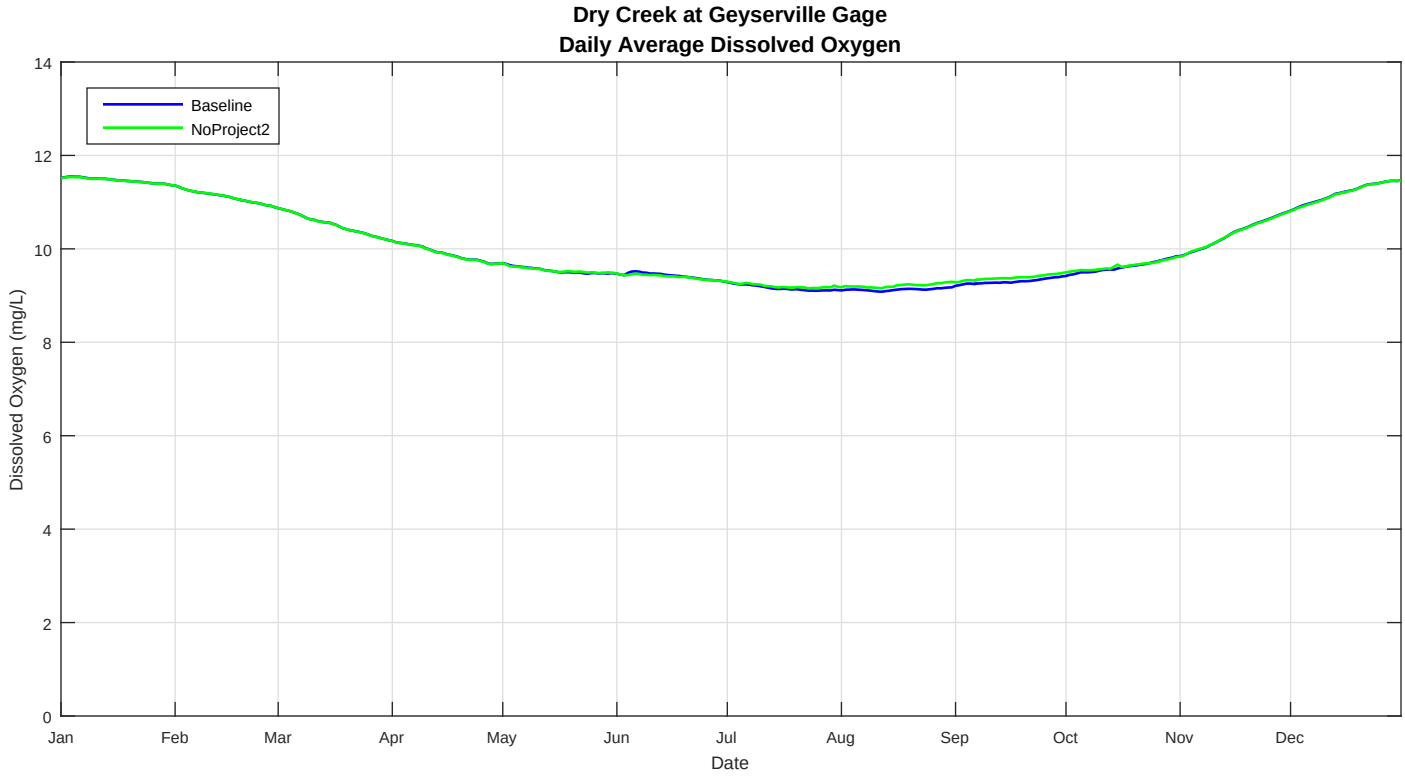

Geyserville Gage
Daily Average Dissolved Oxygen
Baseline
NoProject2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

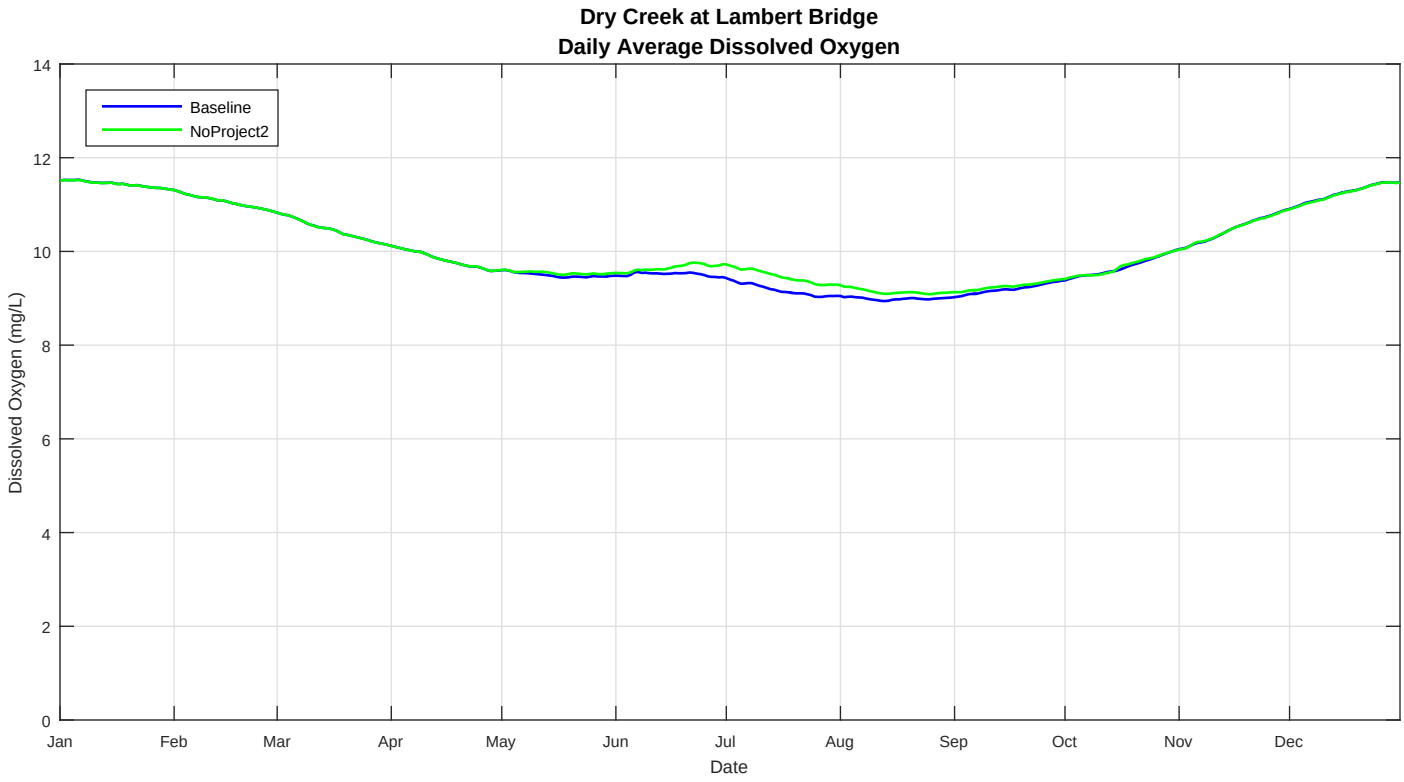

Healdsburg Gage
Daily Average Dissolved Oxygen
Baseline
NoProject2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

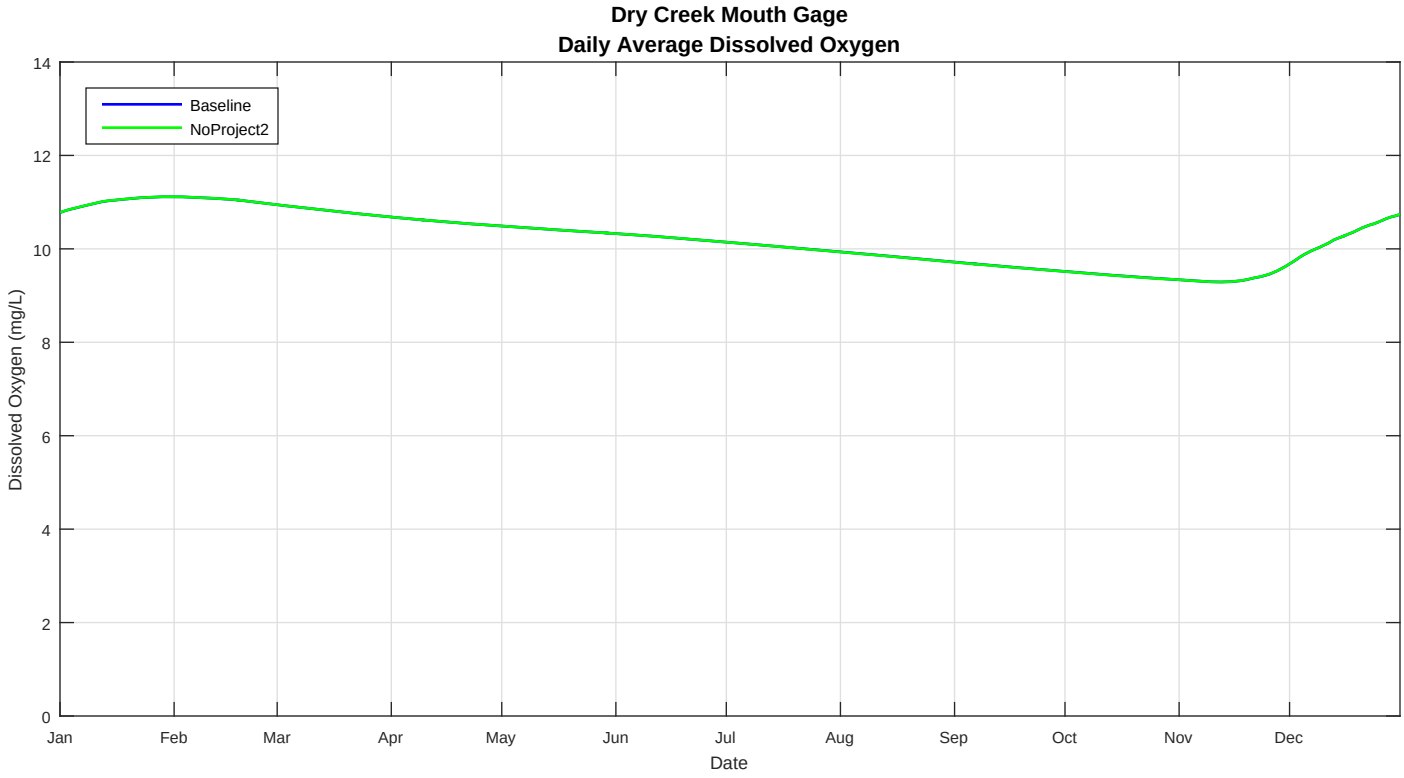

Russian River at Dry Creek
Daily Average Dissolved Oxygen
Baseline
NoProject2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

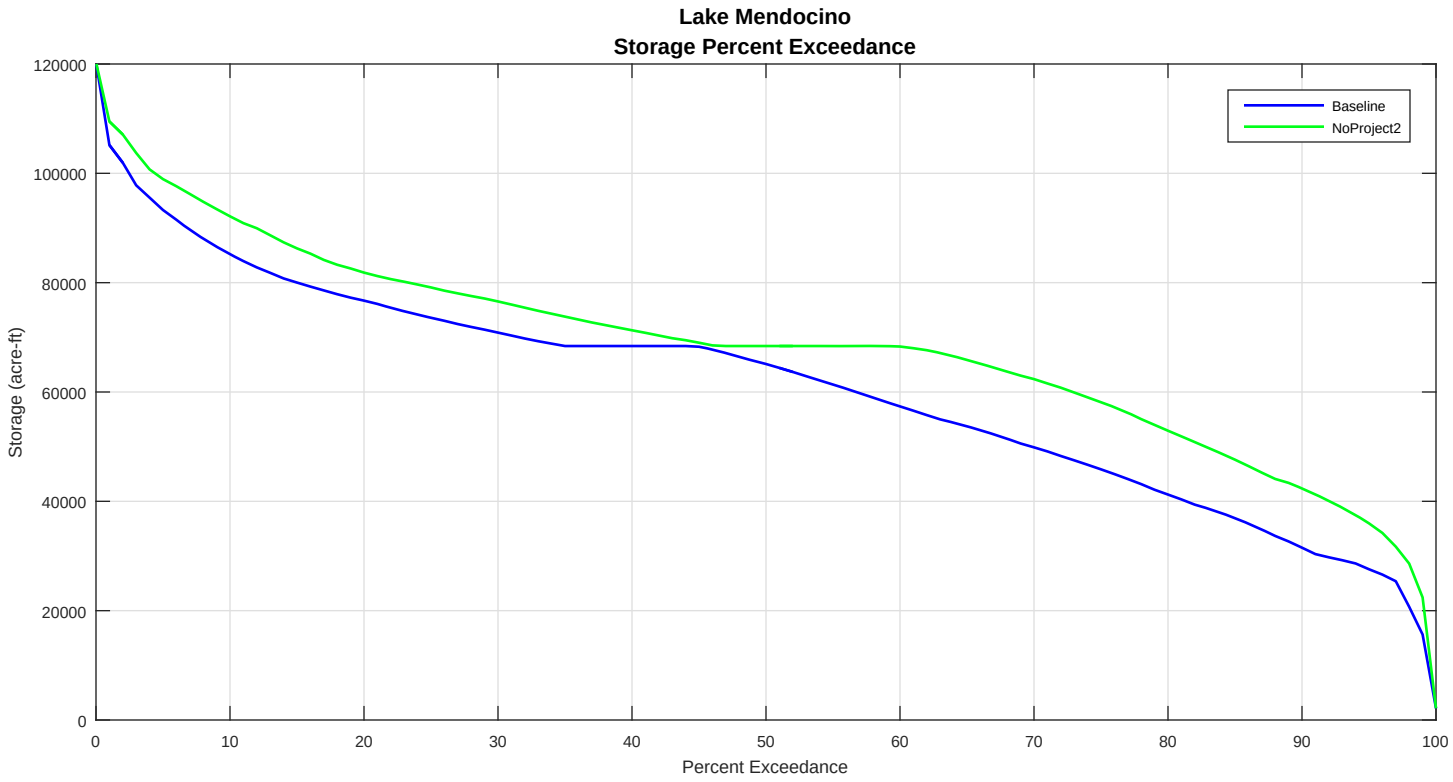

Hacienda Gage
Daily Average Dissolved Oxygen
Baseline
NoProject2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

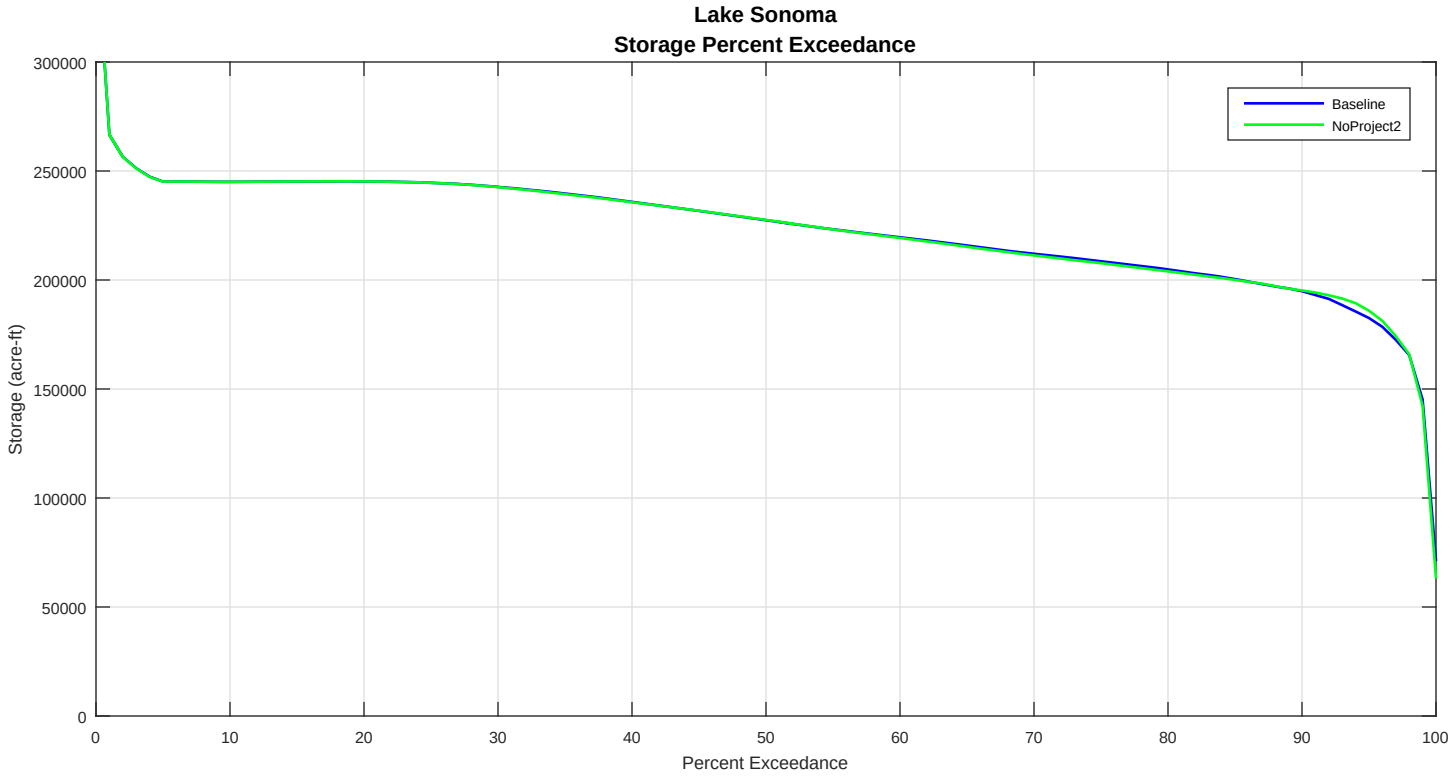

Warm Springs Dam Outlet
Daily Average Dissolved Oxygen
Baseline
NoProject2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

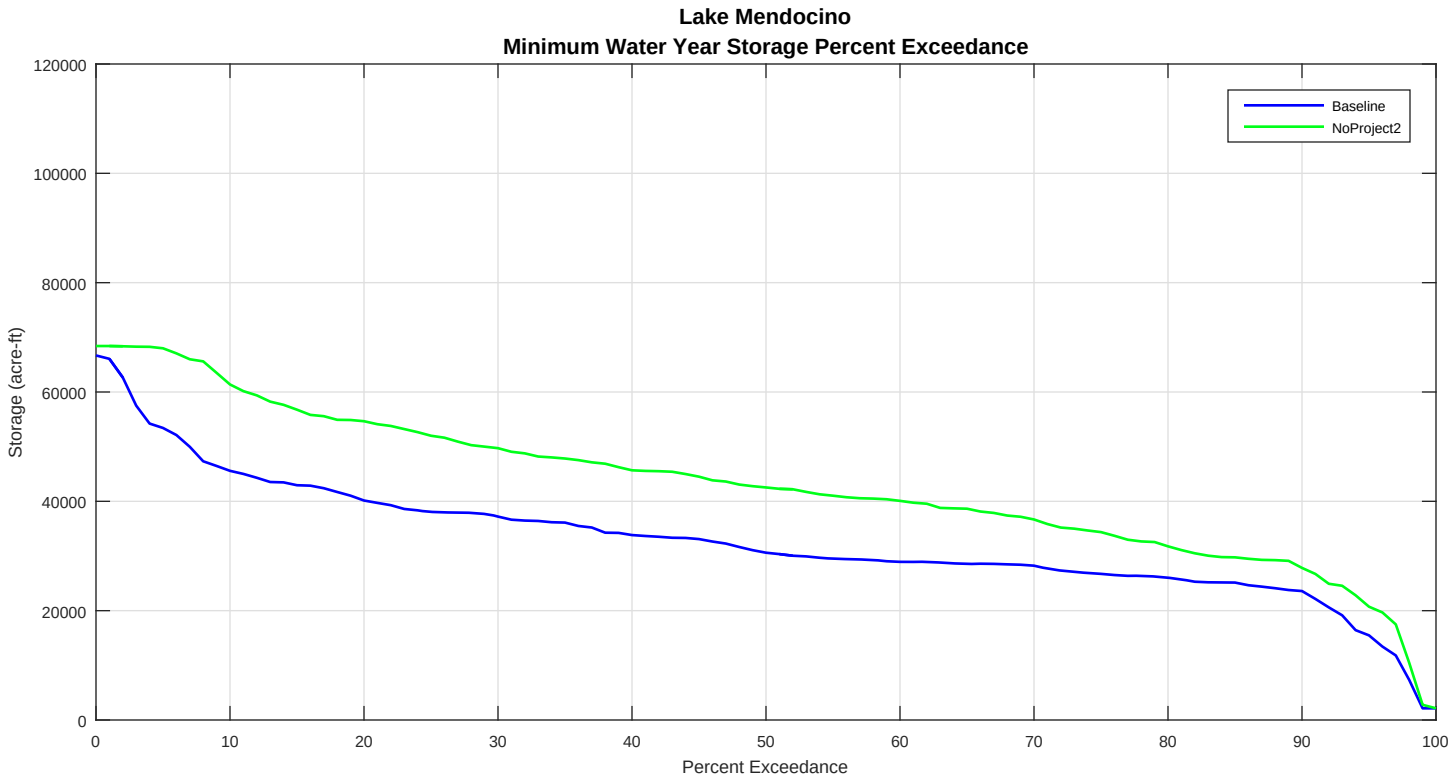

Dry Creek at Geyserville Gage
Daily Average Dissolved Oxygen
Baseline
NoProject2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

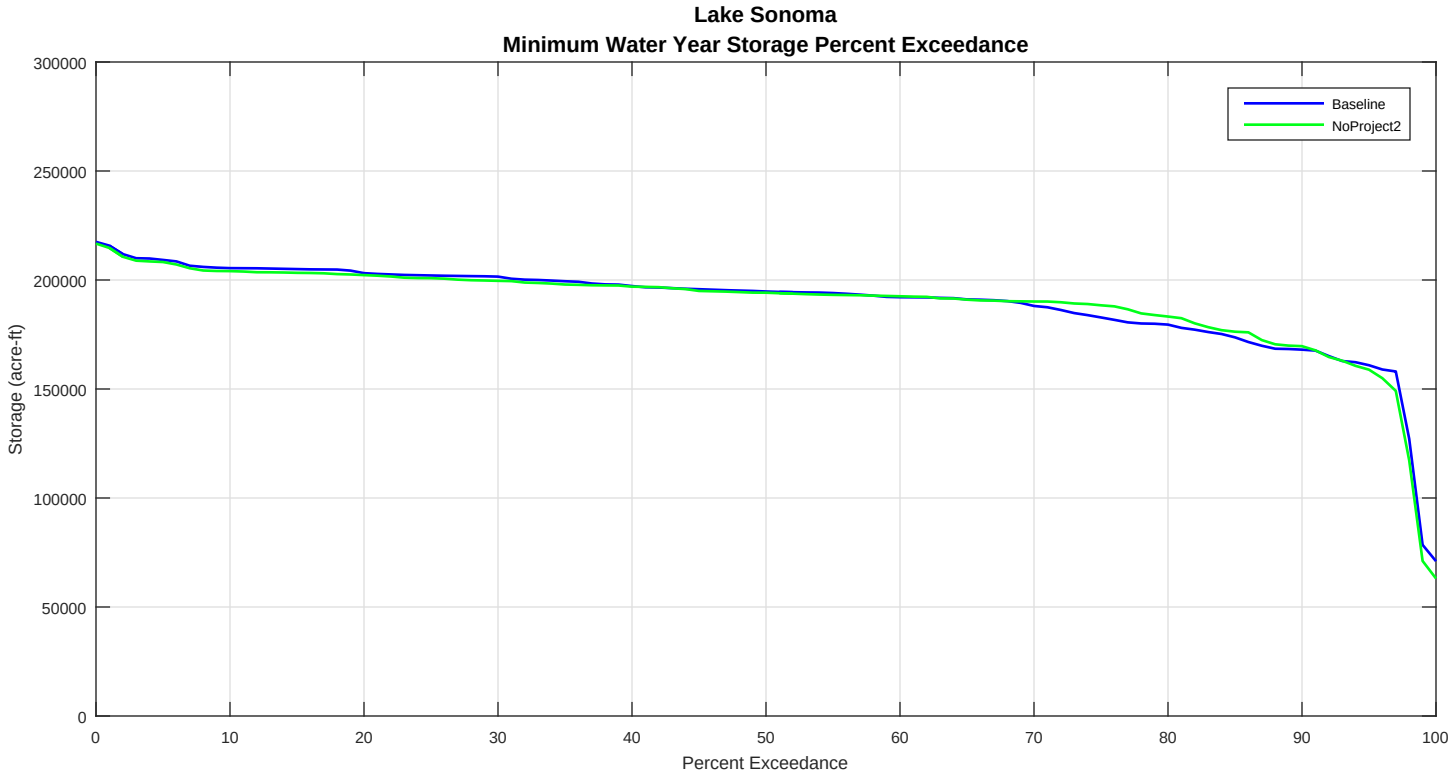

Dry Creek at Lambert Bridge
Daily Average Dissolved Oxygen
Baseline
NoProject2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

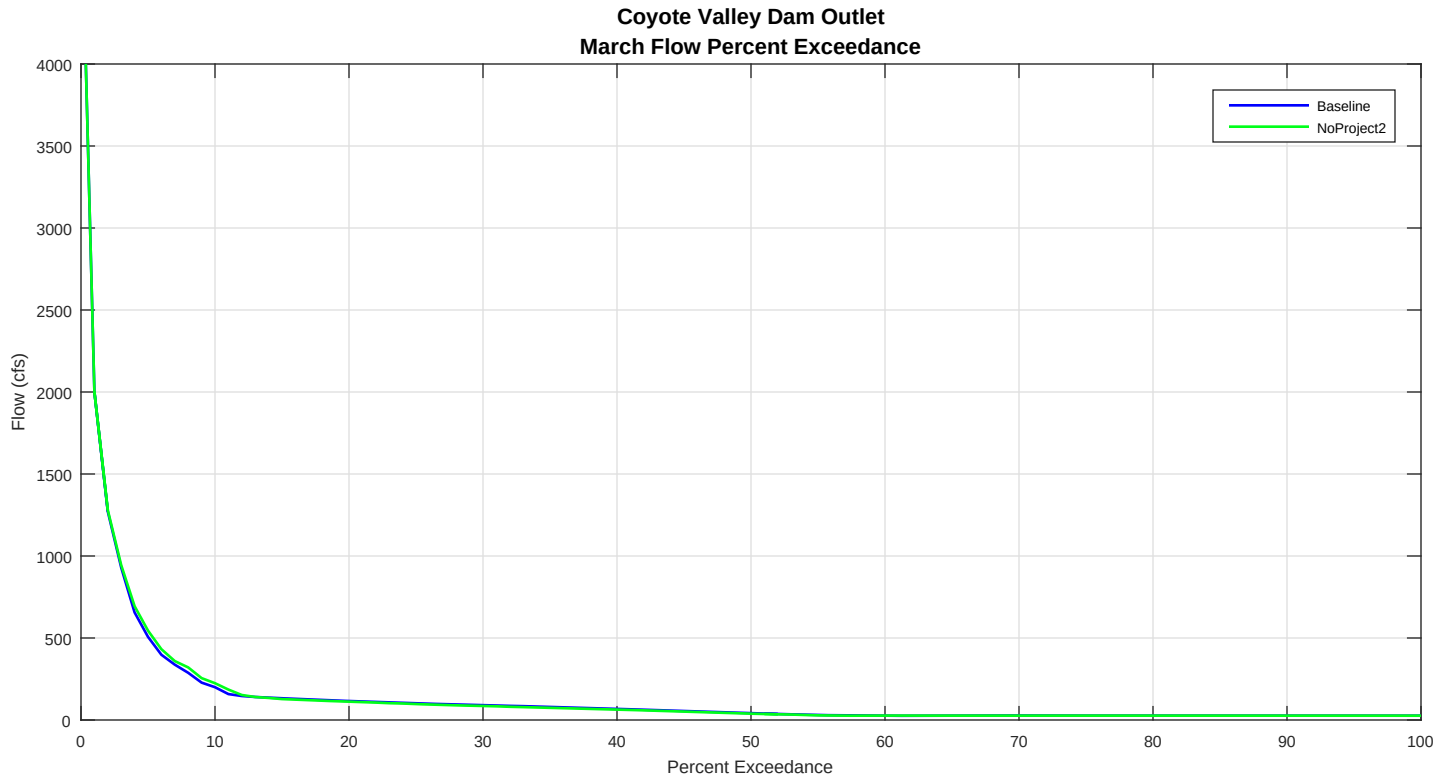

Dry Creek Mouth Gage
Daily Average Dissolved Oxygen
Baseline
NoProject2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date


Lake Mendocino
Storage Percent Exceedance
Storage (acre-ft)
Percent Exceedance
Baseline
NoProject2
0
20000
40000
60000
80000
100000
120000
0
10
20
30
40
50
60
70
80
90
100


Lake Sonoma
Storage Percent Exceedance
Storage (acre-ft)
Percent Exceedance
Baseline
NoProject2
0
50000
100000
150000
200000
250000
300000
0
10
20
30
40
50
60
70
80
90
100


Lake Mendocino
Minimum Water Year Storage Percent Exceedance
Baseline
NoProject2
Storage (acre-ft)
Percent Exceedance
0
20000
40000
60000
80000
100000
120000
0
10
20
30
40
50
60
70
80
90
100


Lake Sonoma
Minimum Water Year Storage Percent Exceedance
Baseline
NoProject2
Storage (acre-ft)
Percent Exceedance
0
50000
100000
150000
200000
250000
300000
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
March Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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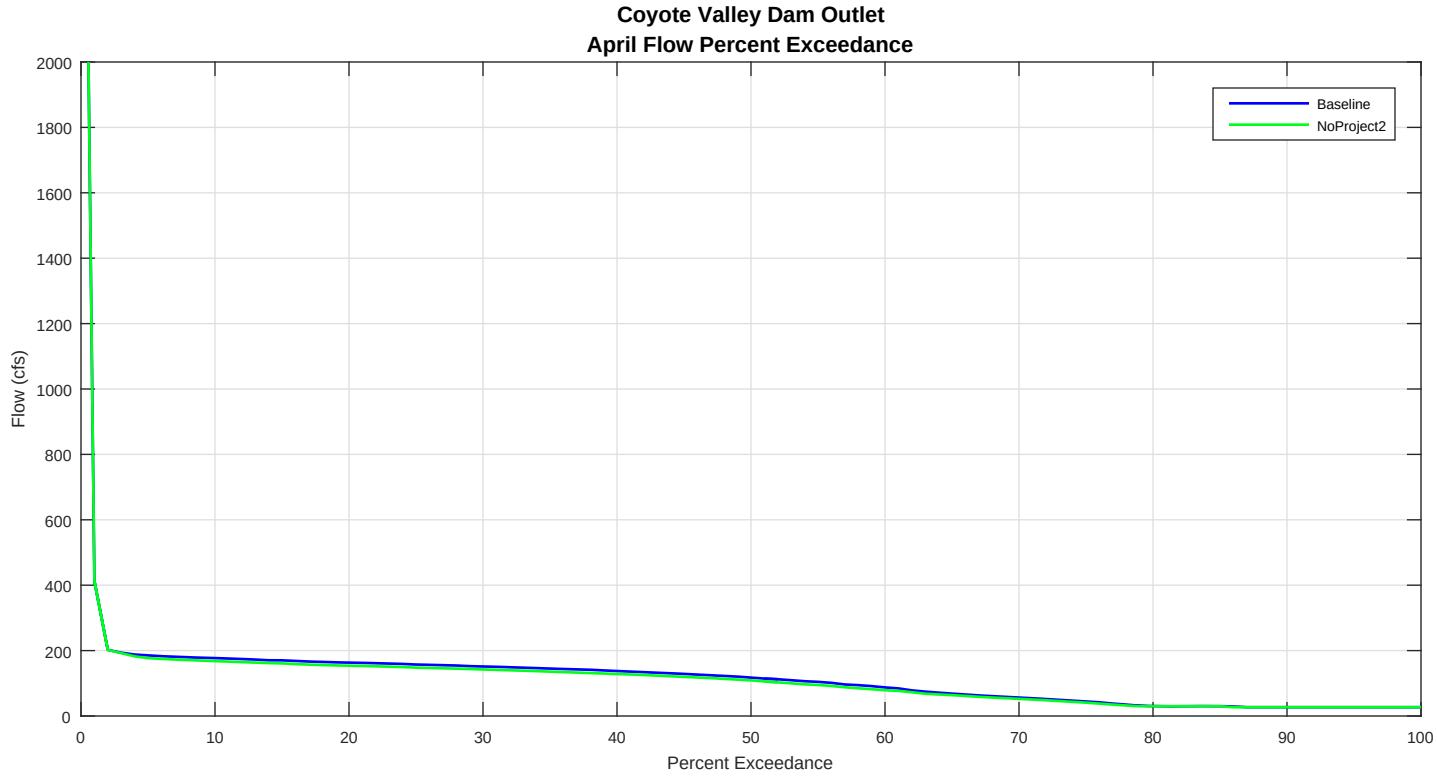
Coyote Valley Dam Outlet
April Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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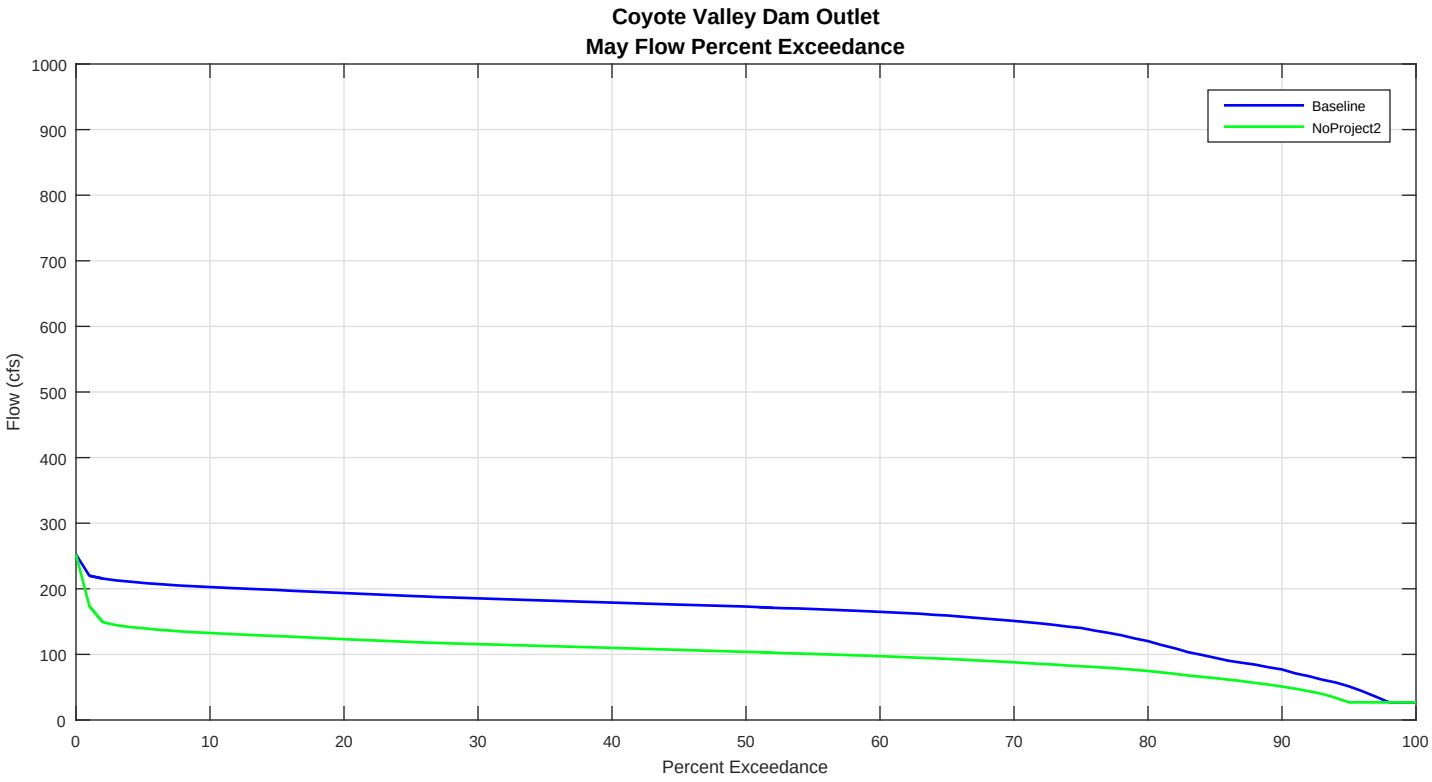
Coyote Valley Dam Outlet
May Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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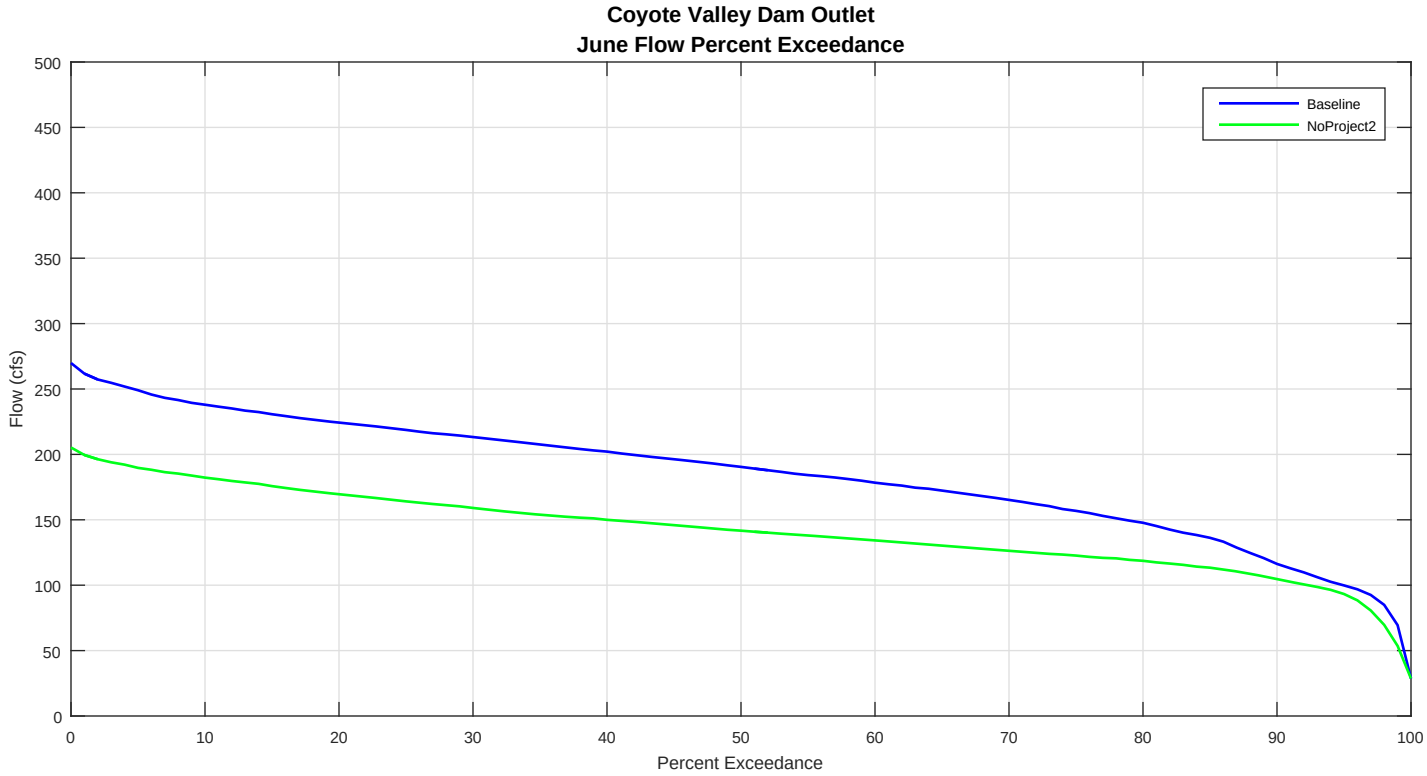
Coyote Valley Dam Outlet
June Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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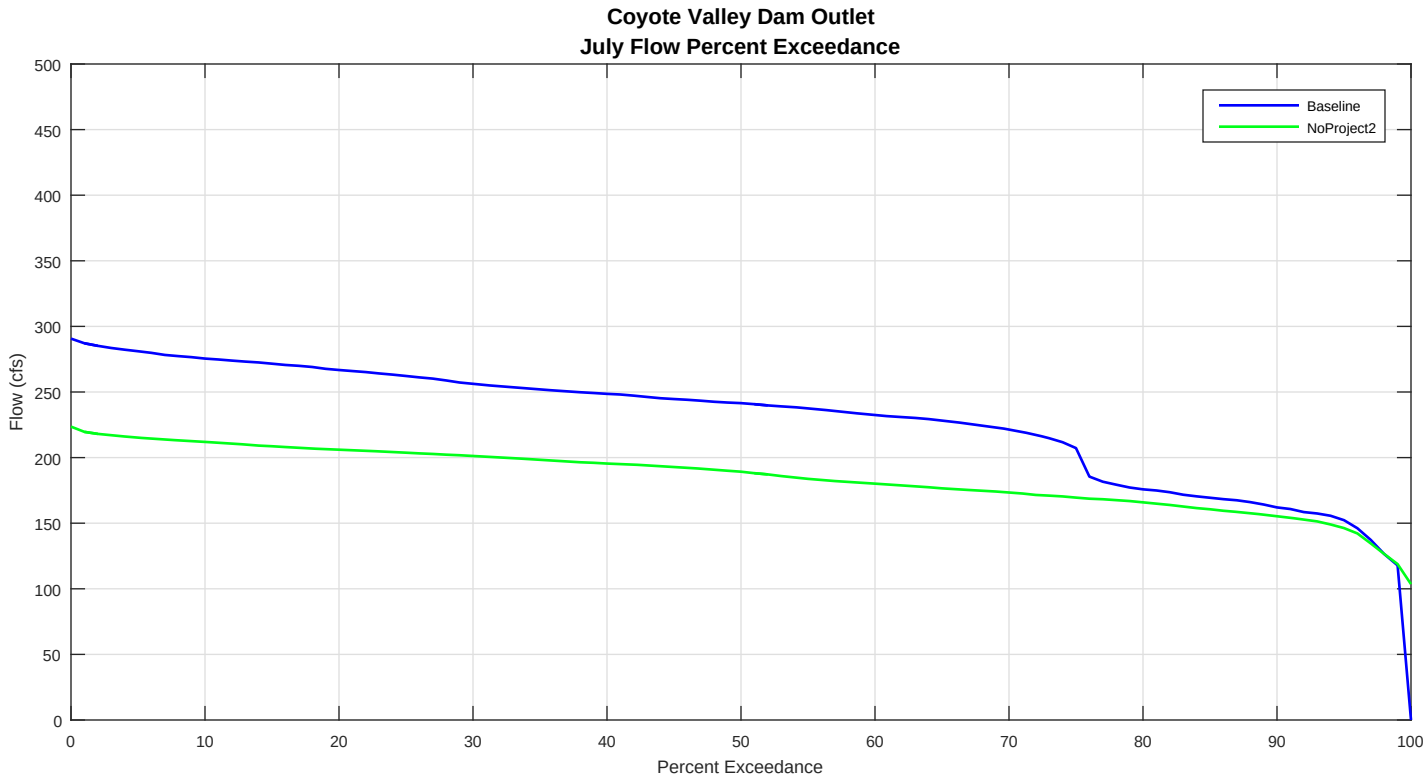
Coyote Valley Dam Outlet
July Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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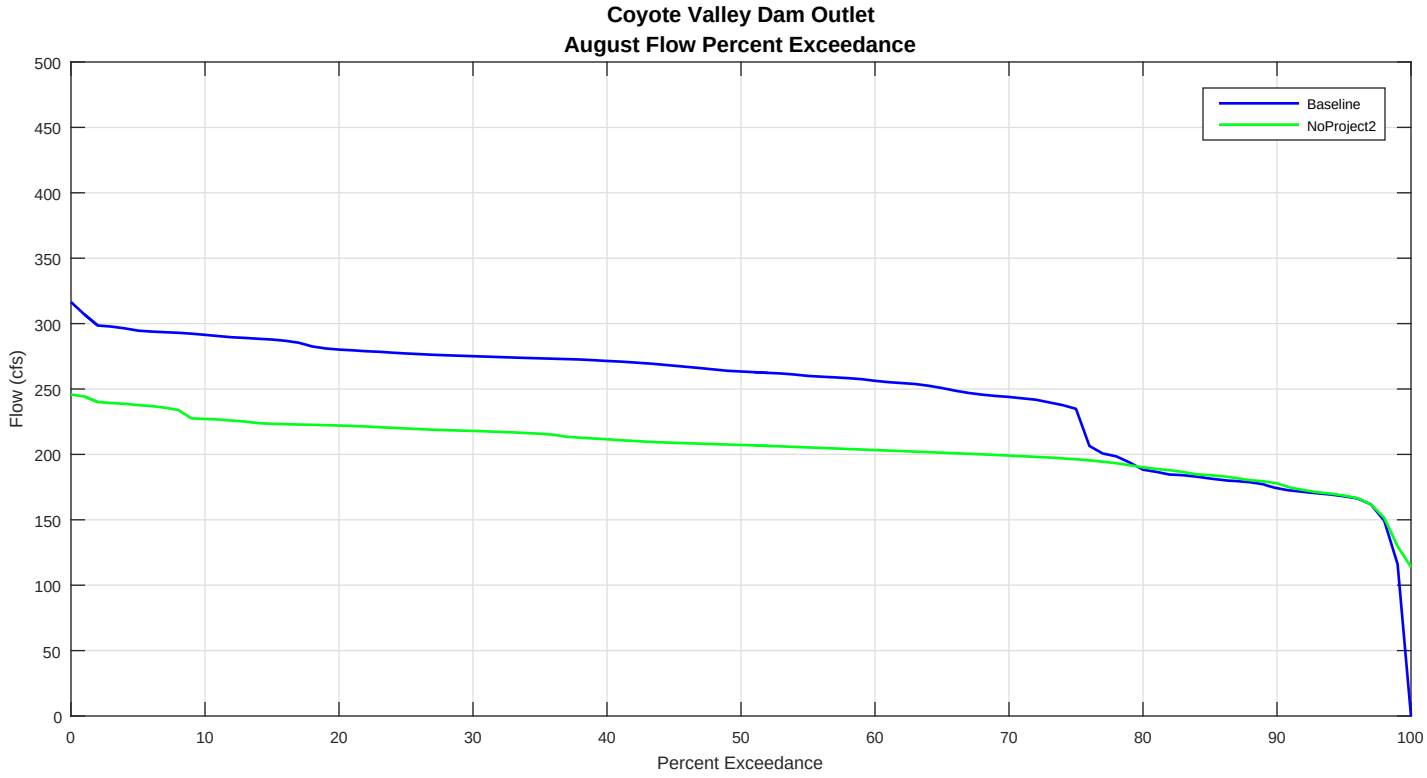
Coyote Valley Dam Outlet
August Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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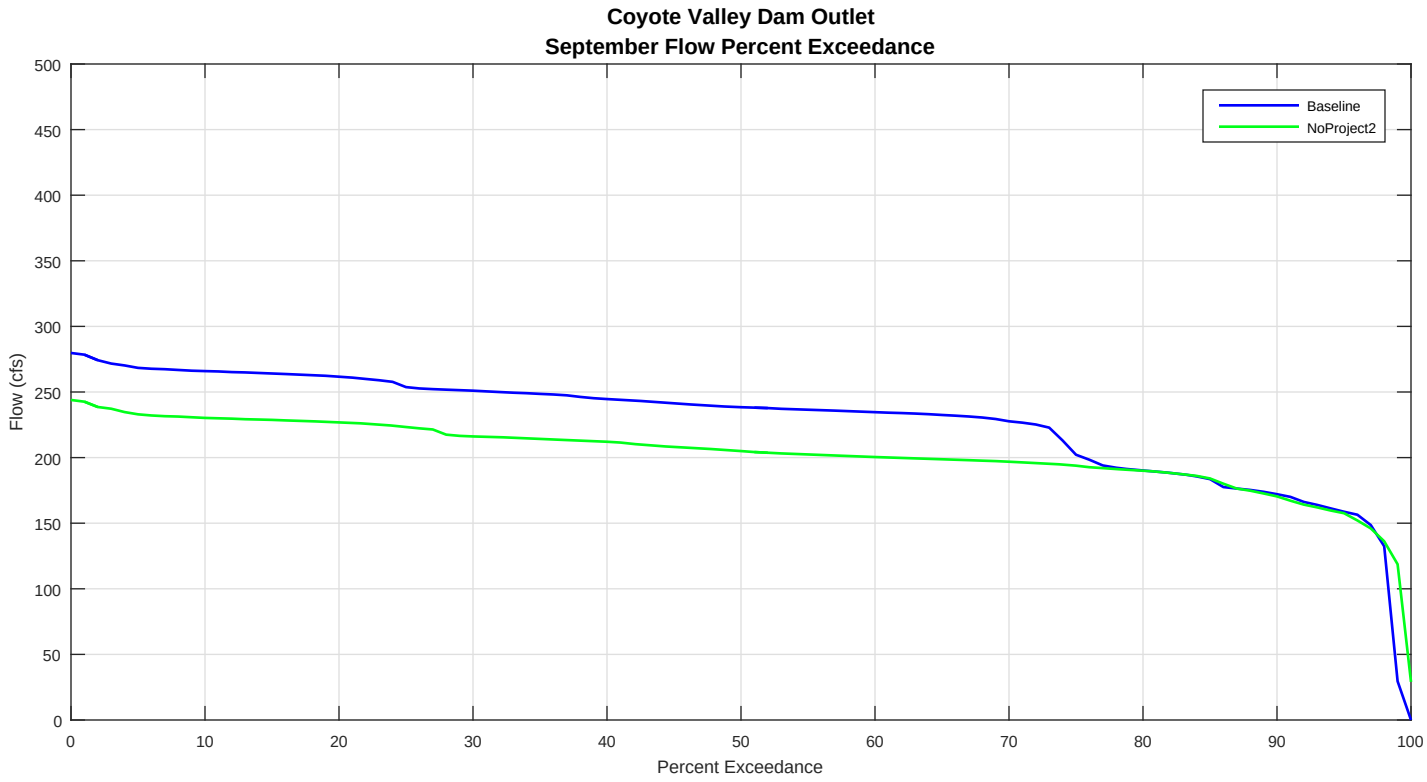
Coyote Valley Dam Outlet
September Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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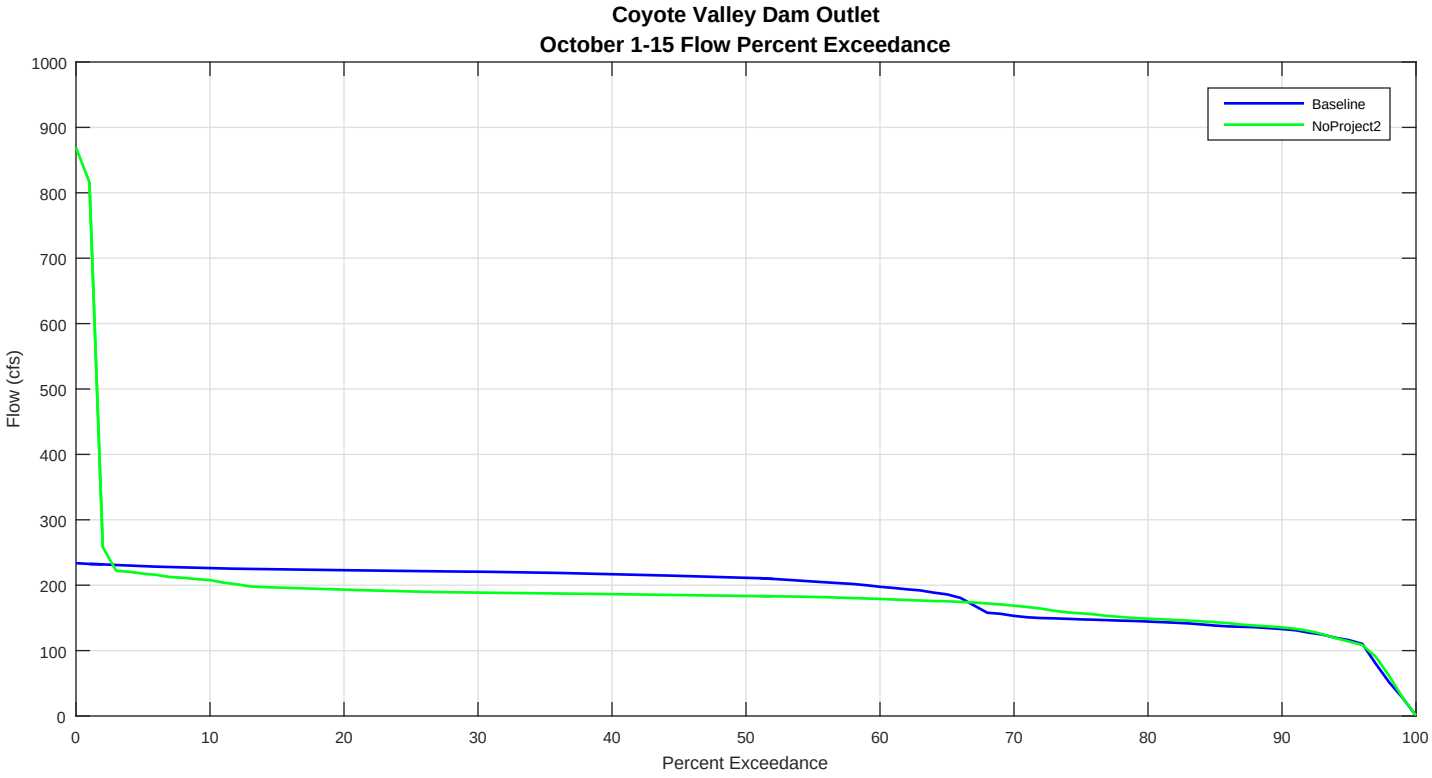
Coyote Valley Dam Outlet
October 1-15 Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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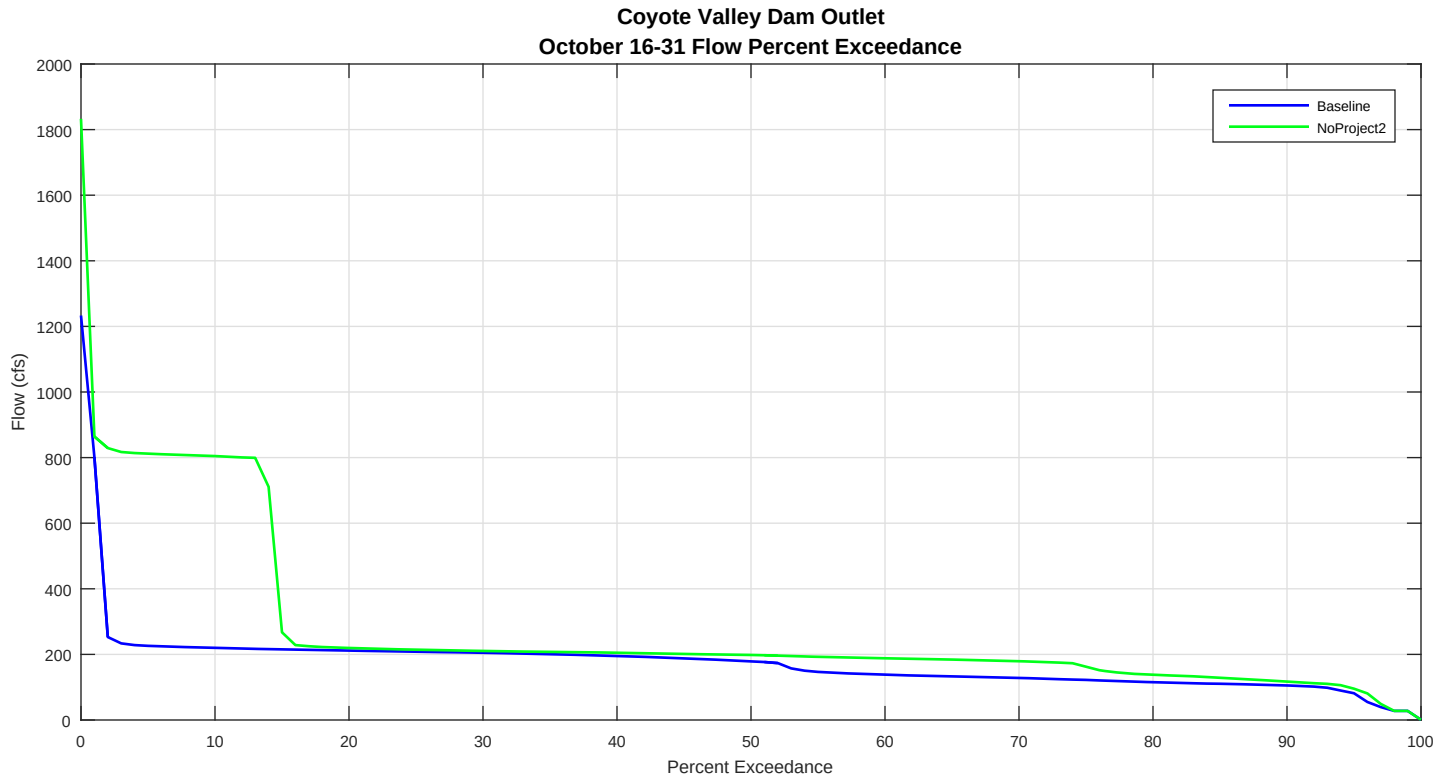
Coyote Valley Dam Outlet
October 16-31 Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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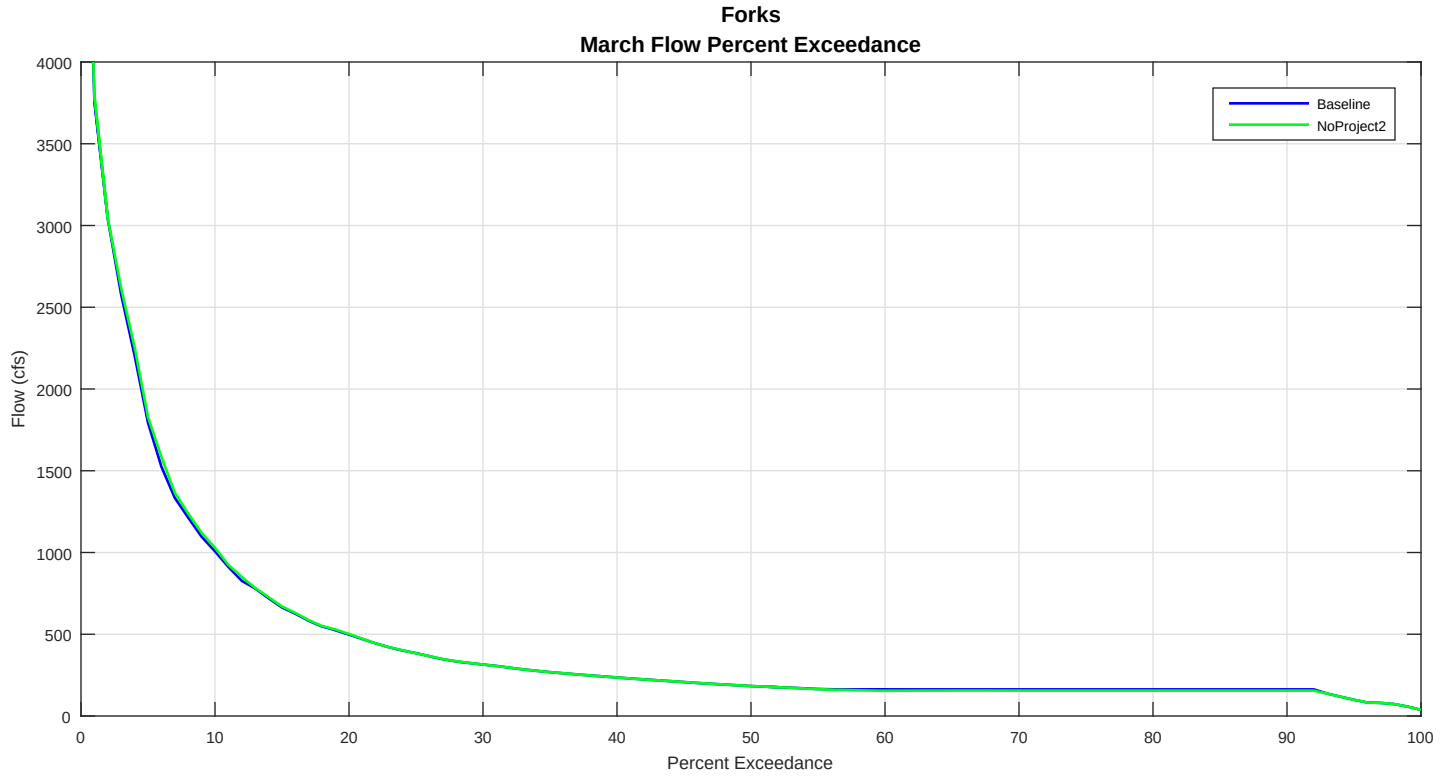
Forks
March Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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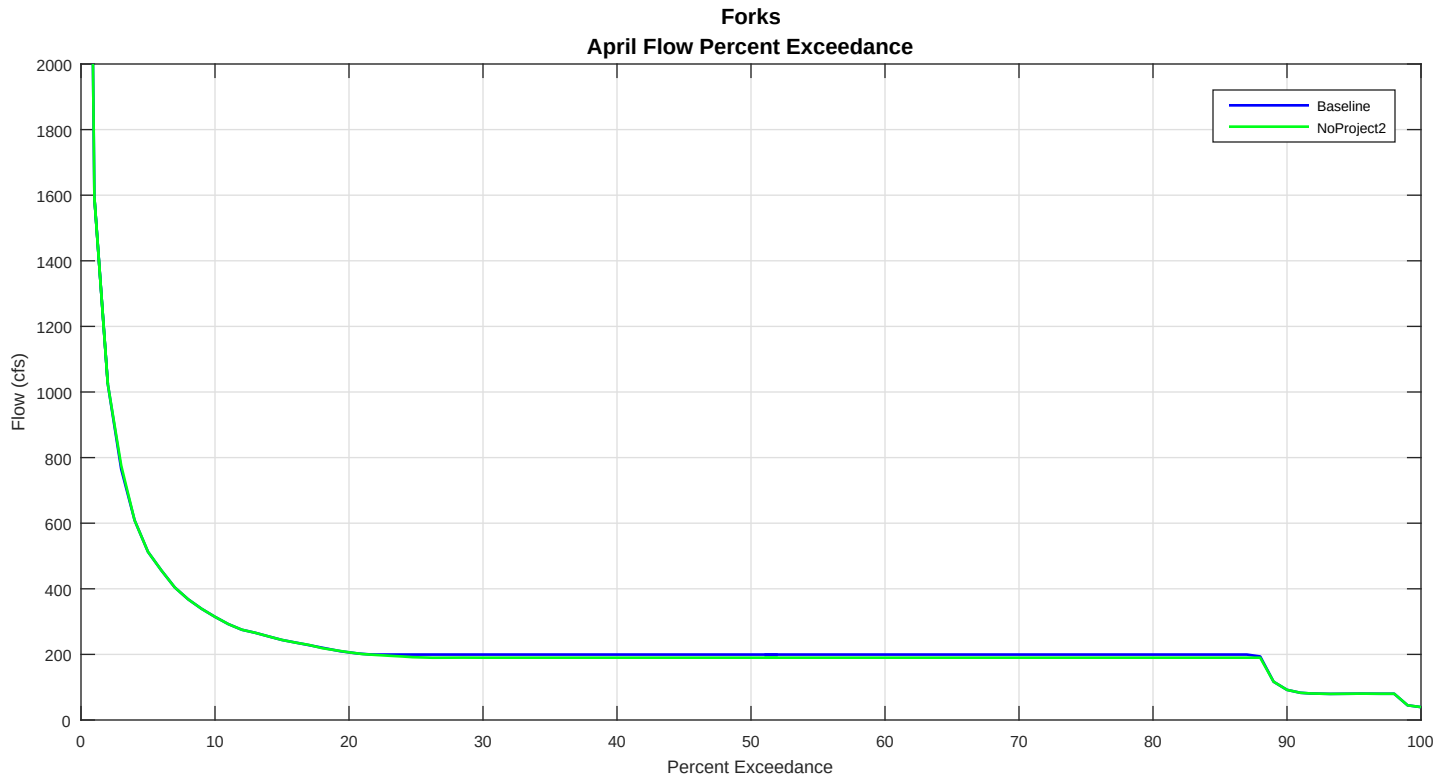
Forks
April Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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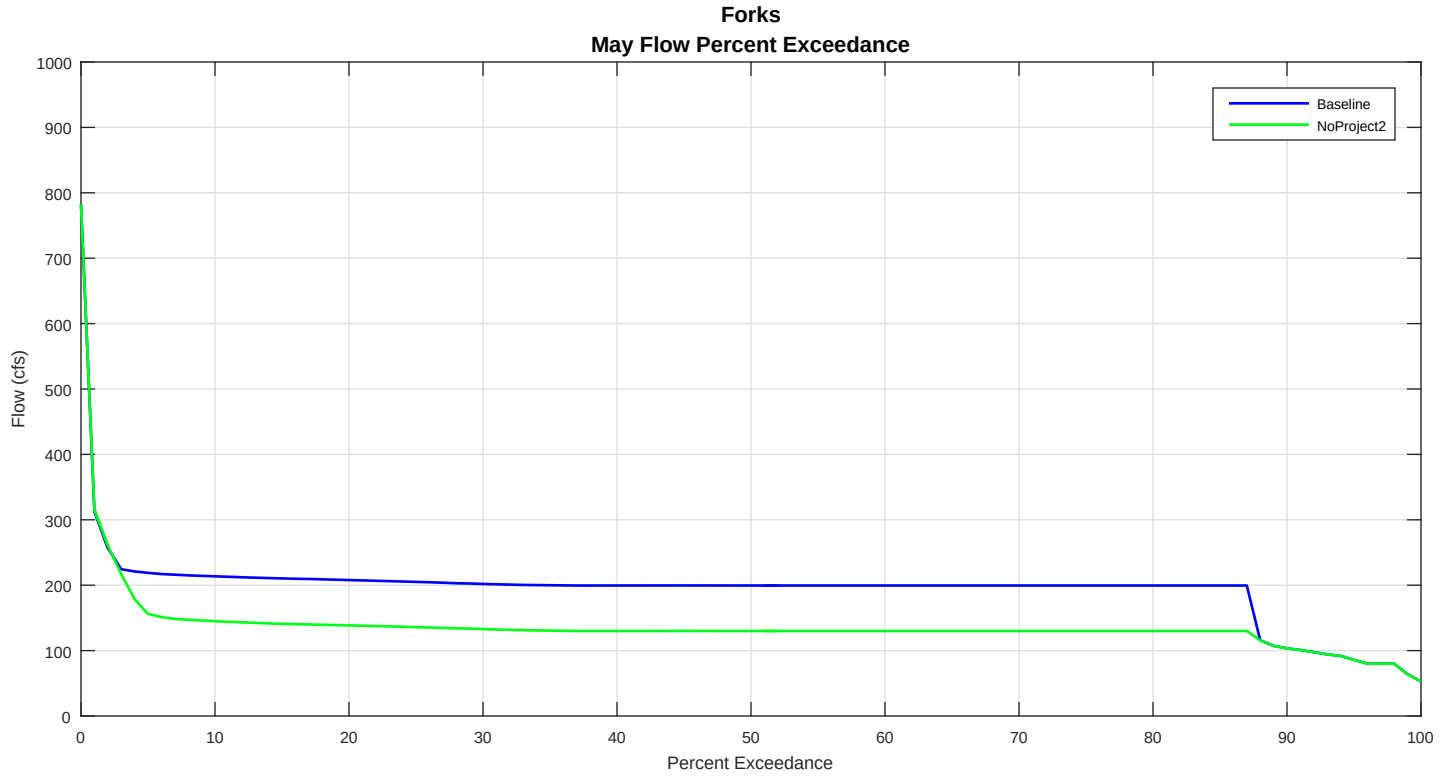
Forks
May Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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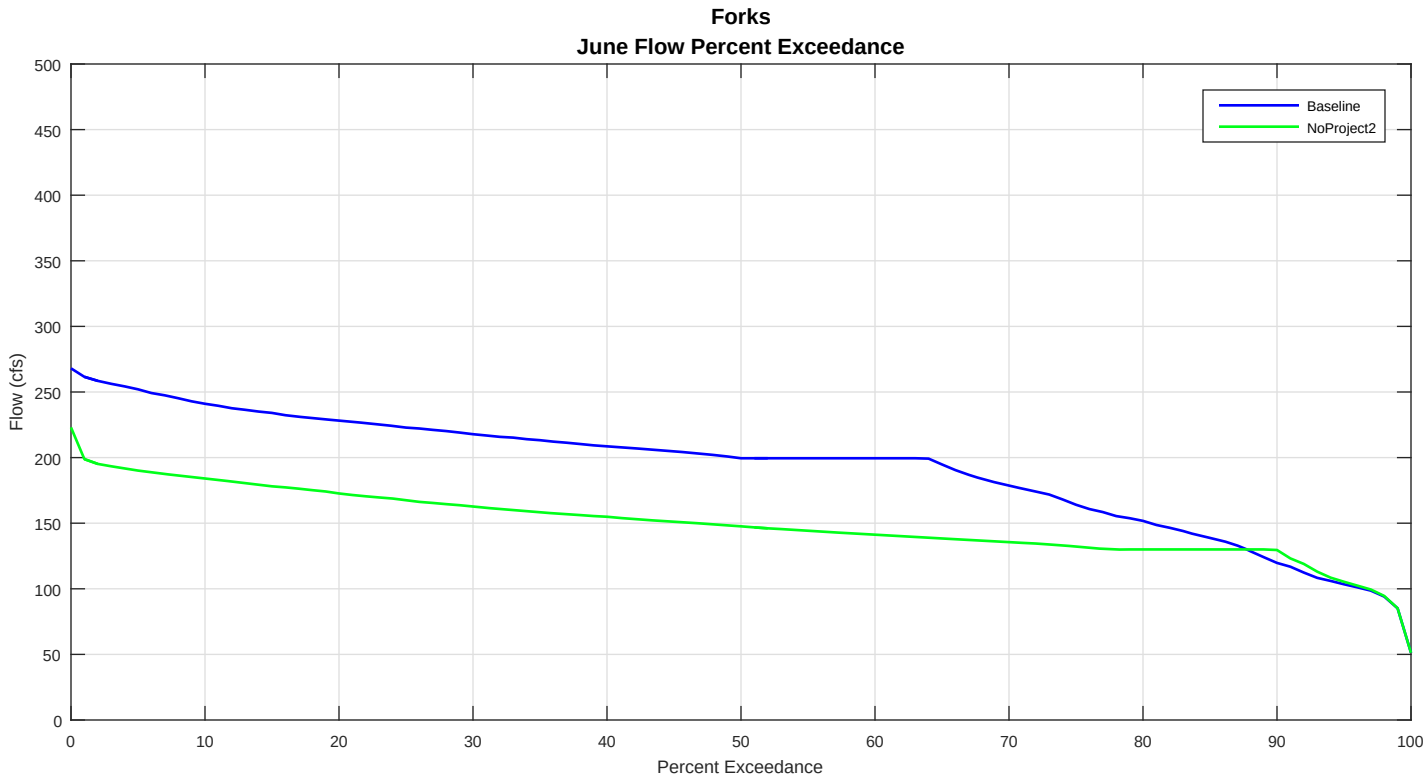
Forks
June Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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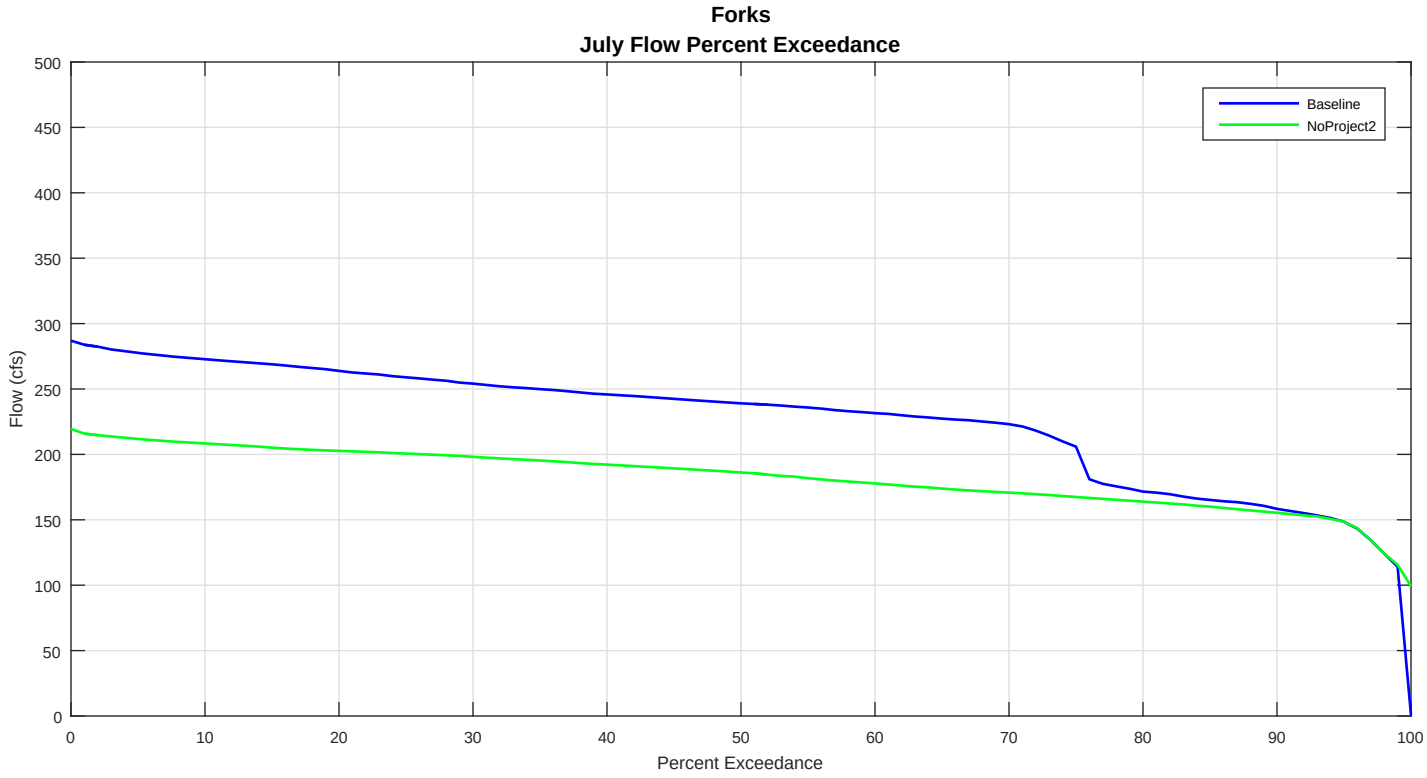
Forks
July Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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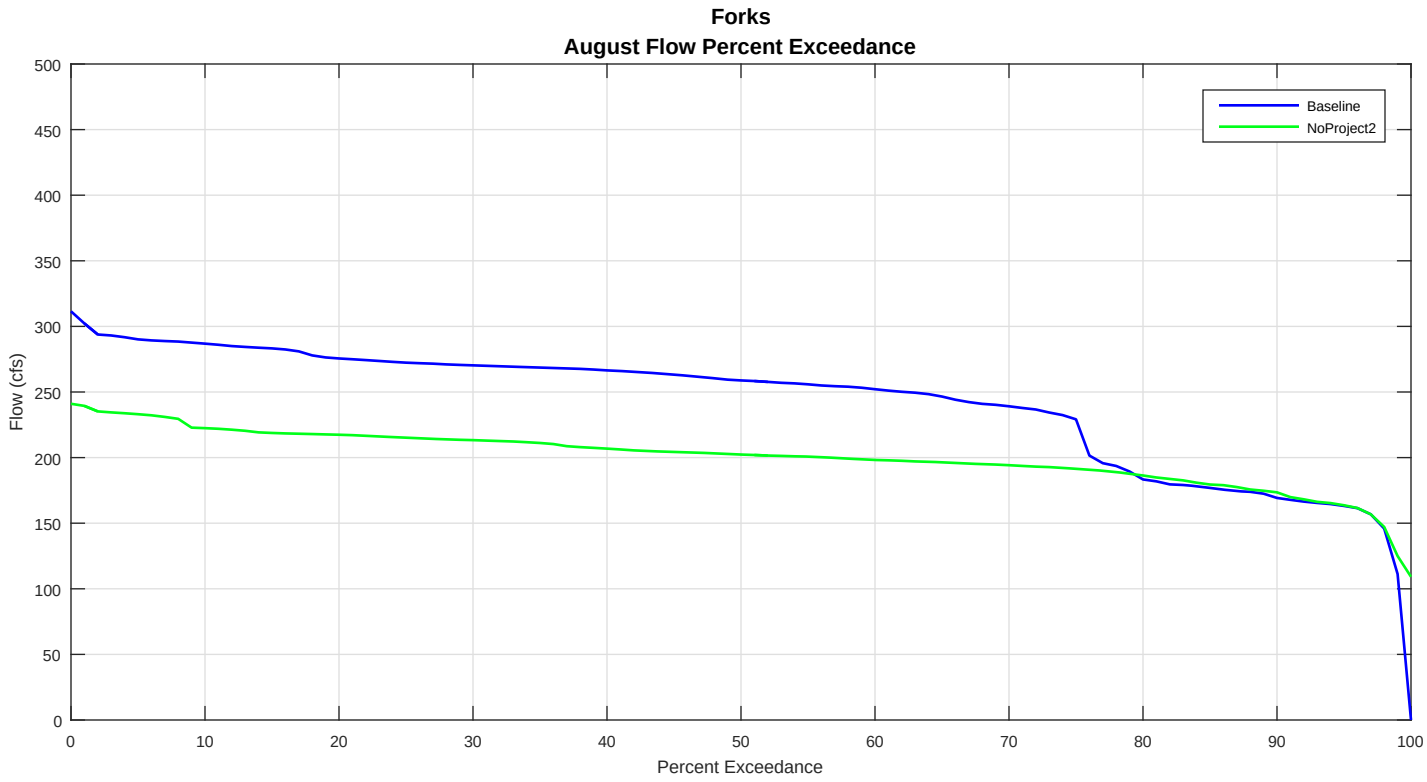
Forks
August Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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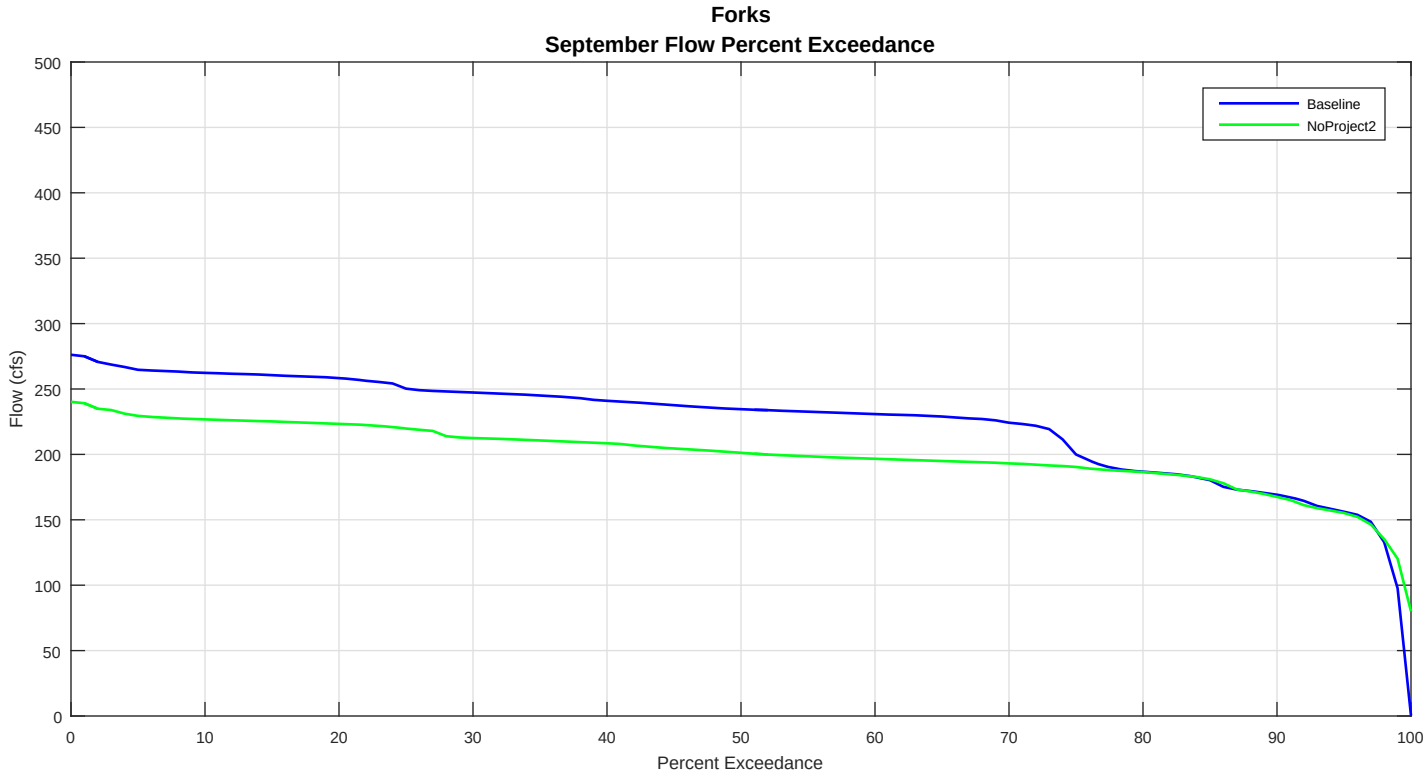
Forks
September Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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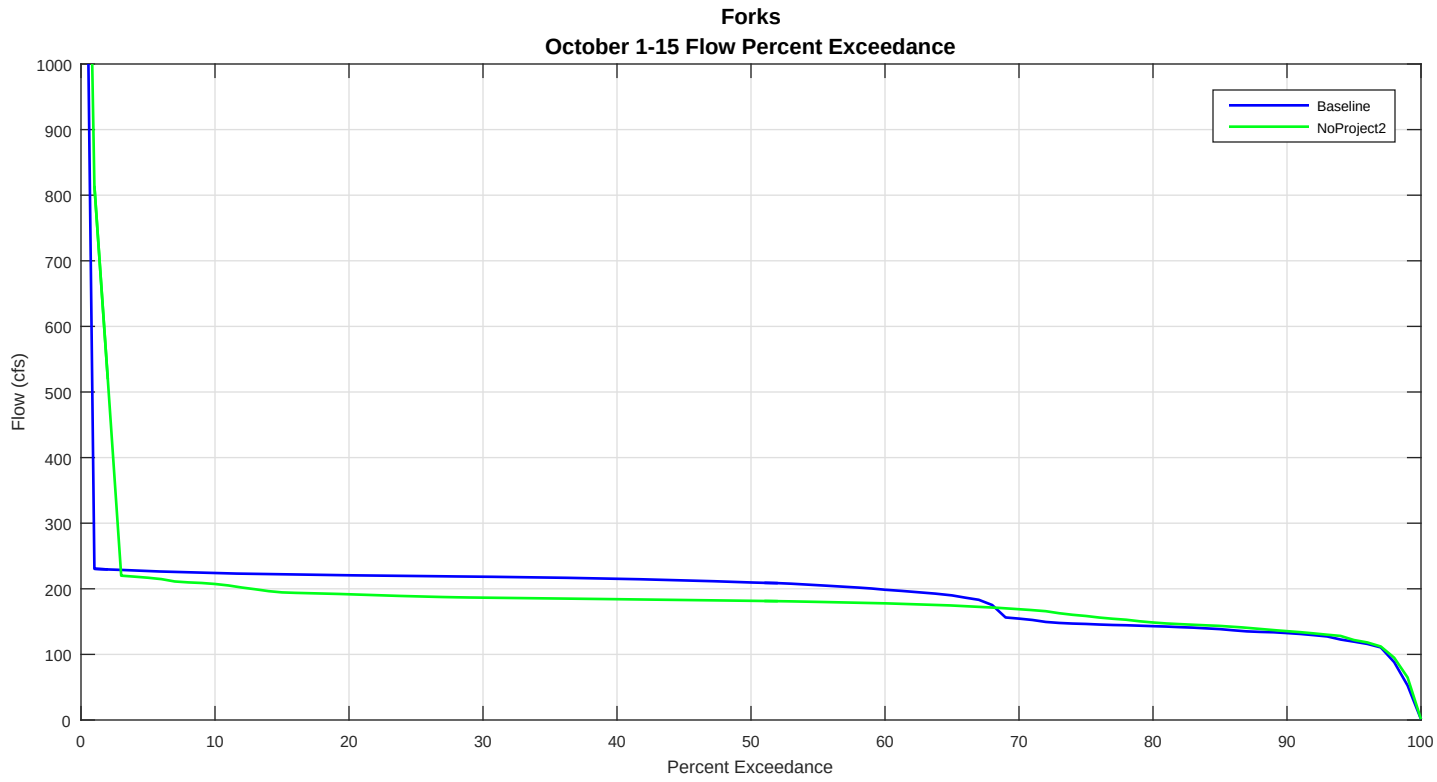
Forks
October 1-15 Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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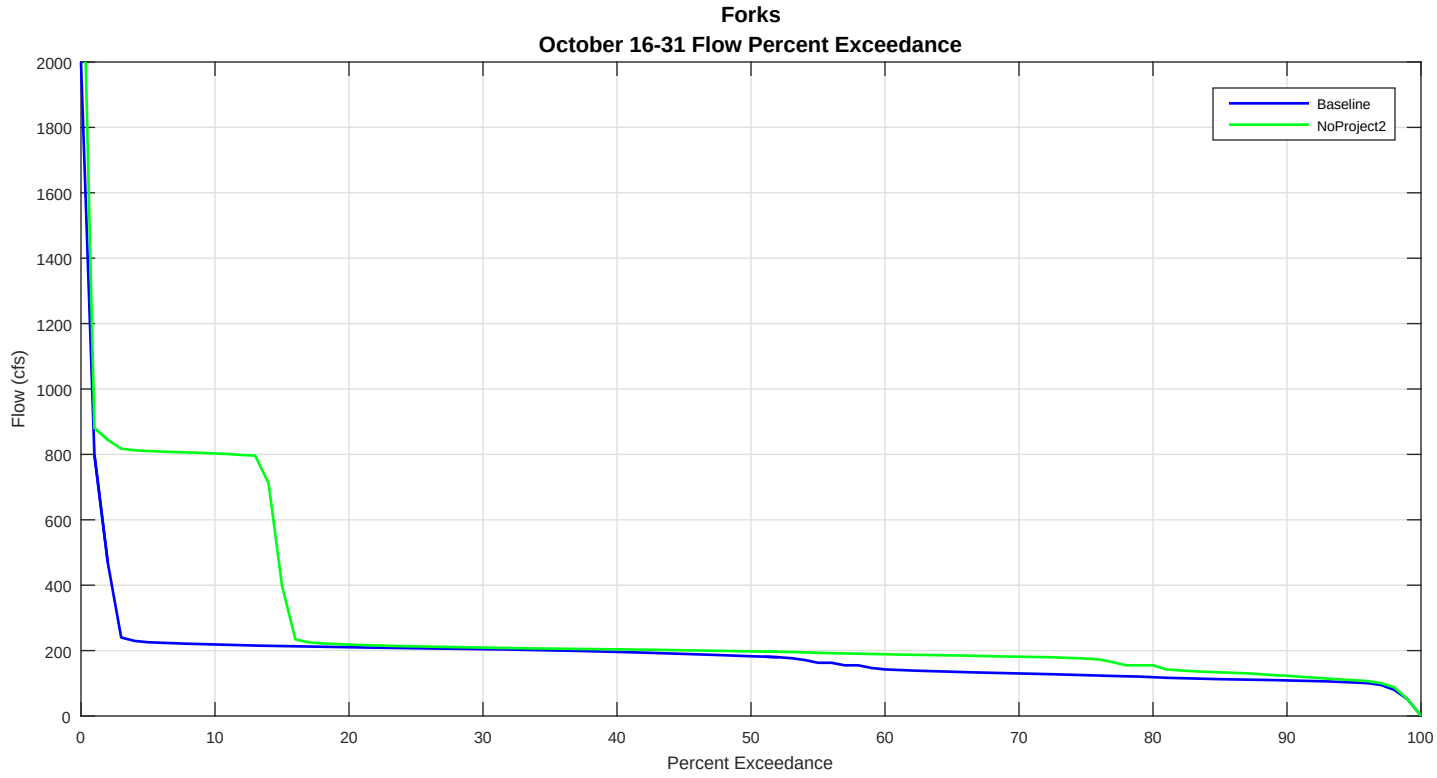
Forks
October 16-31 Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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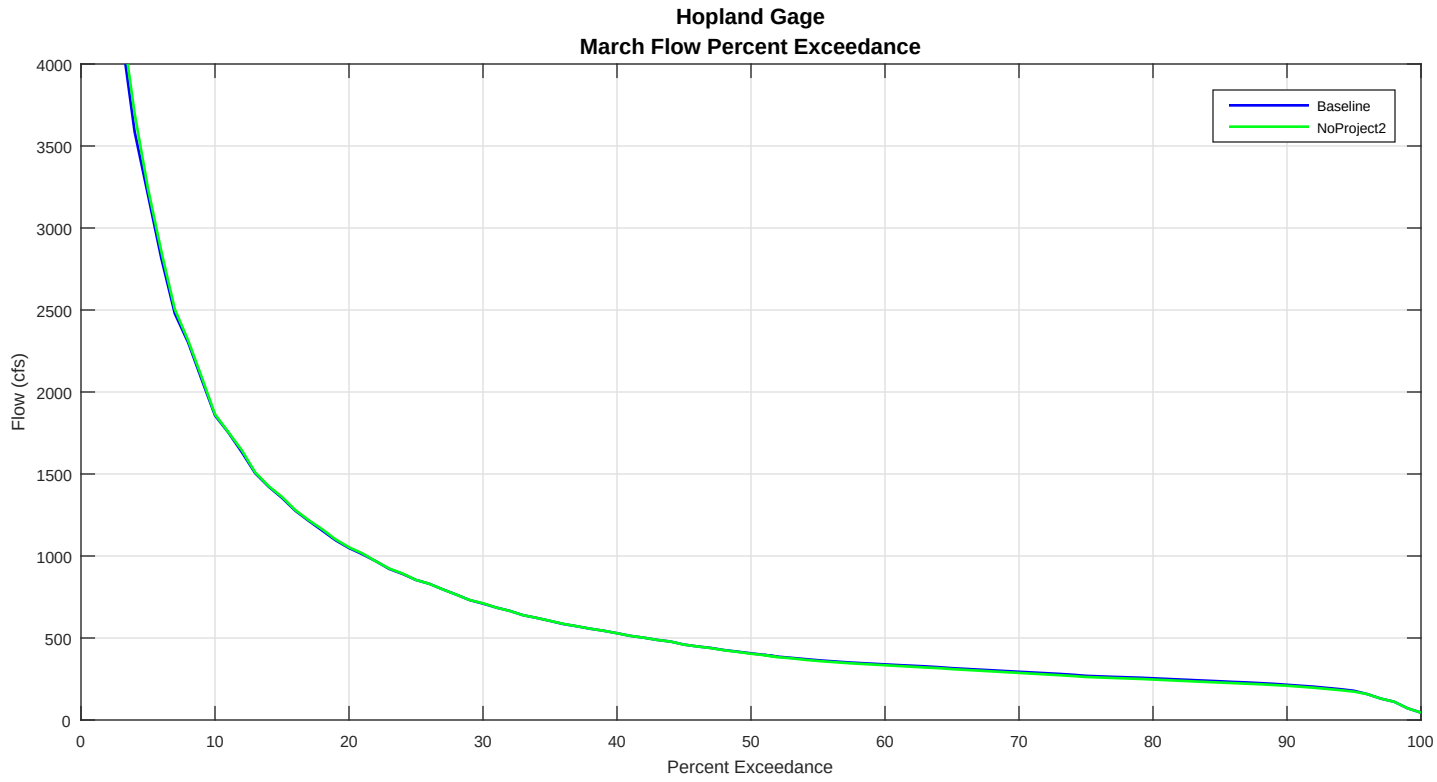
Hopland Gage
March Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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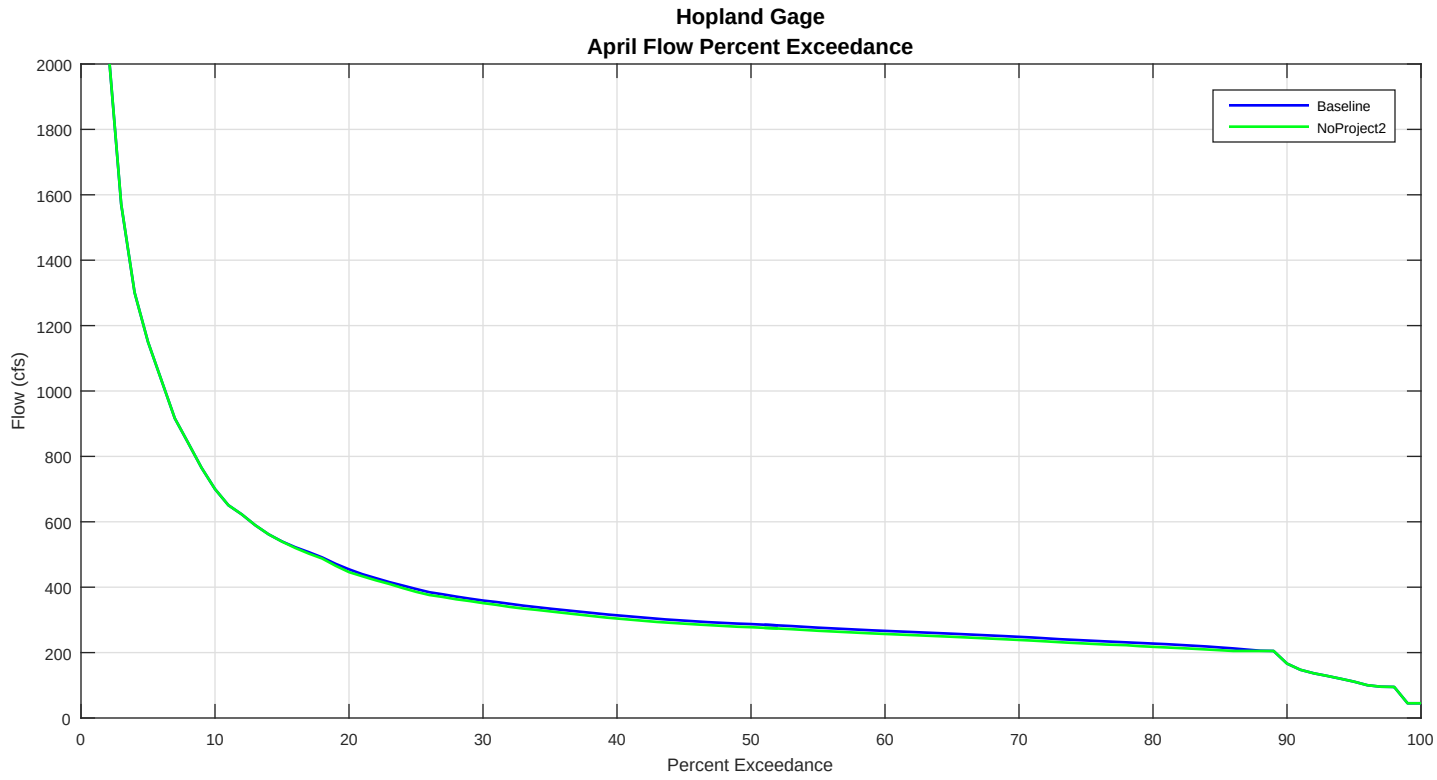
Hopland Gage
April Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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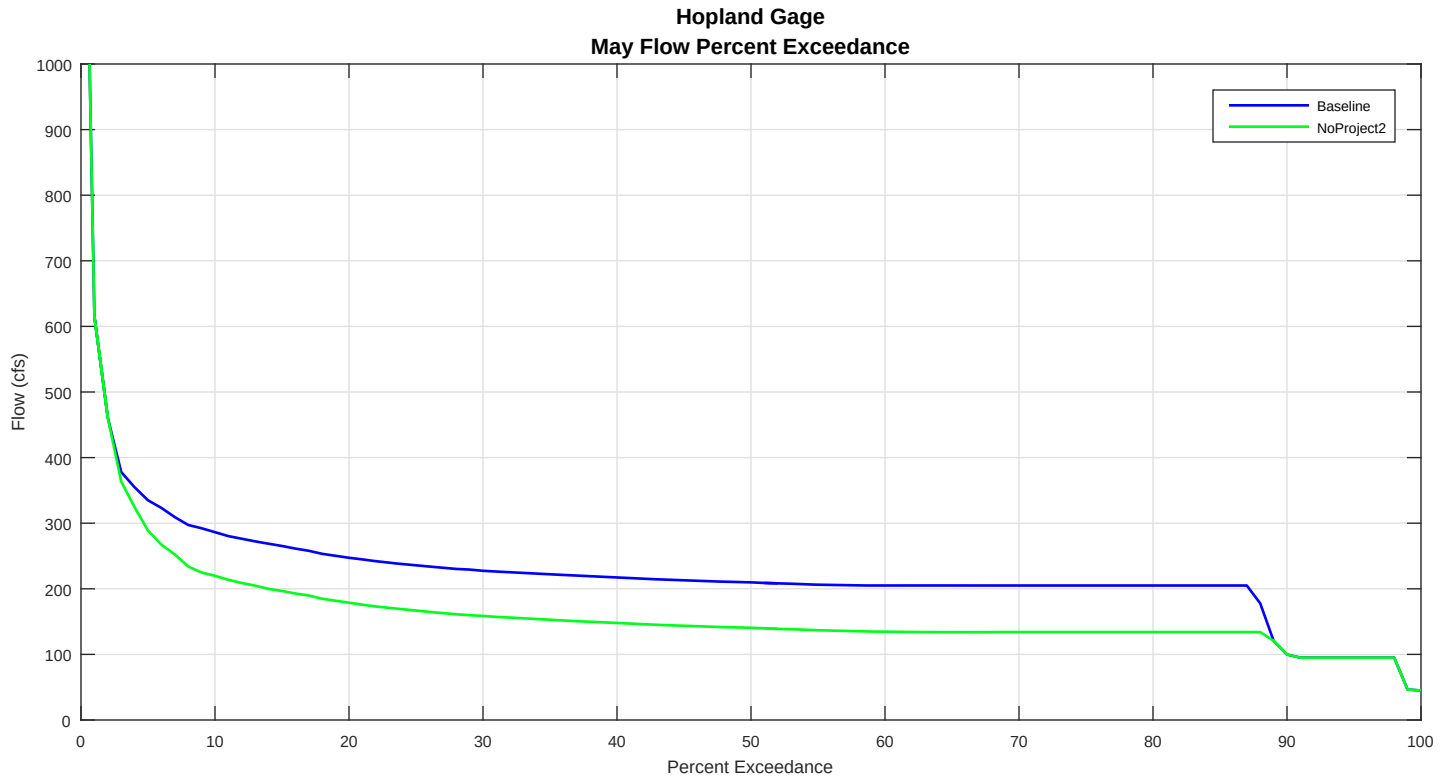
Hopland Gage
May Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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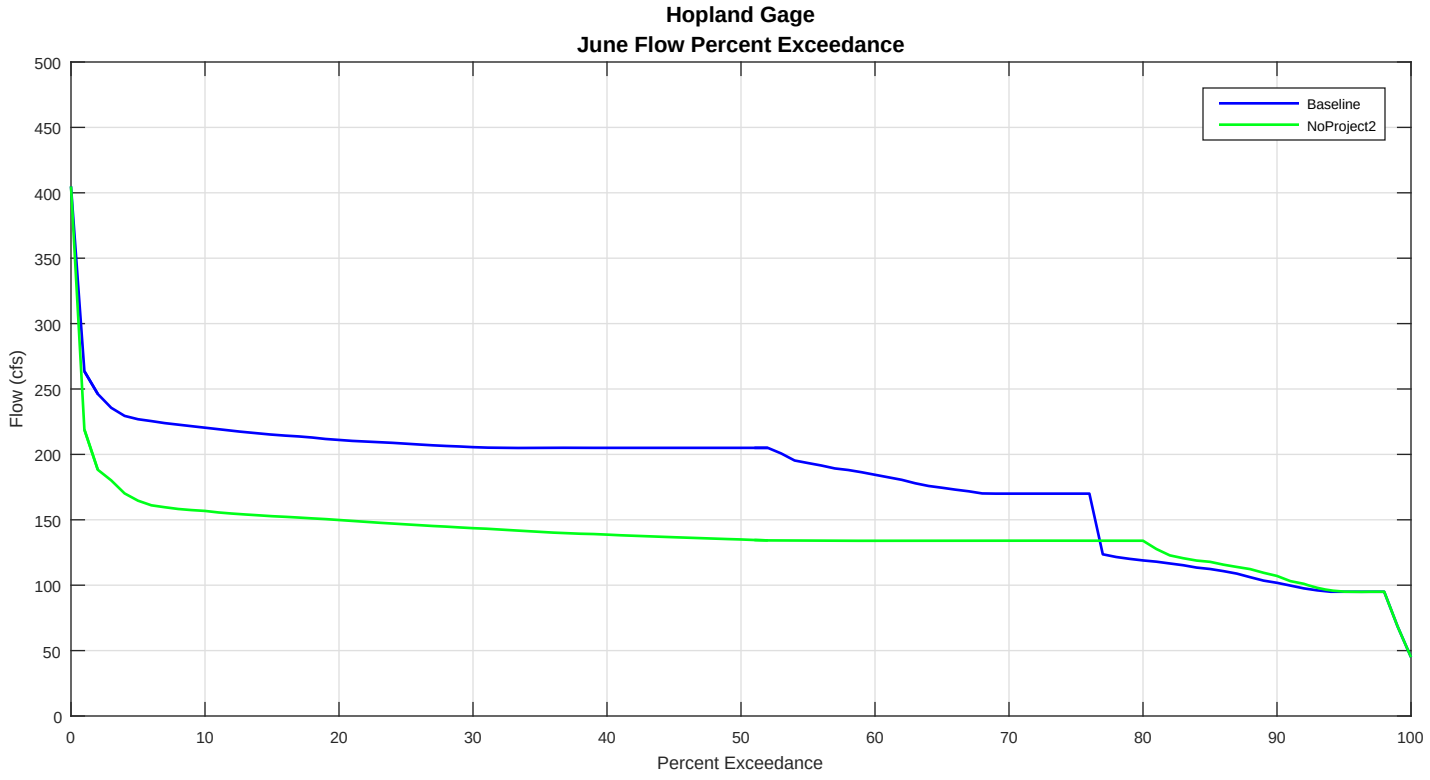
Hopland Gage
June Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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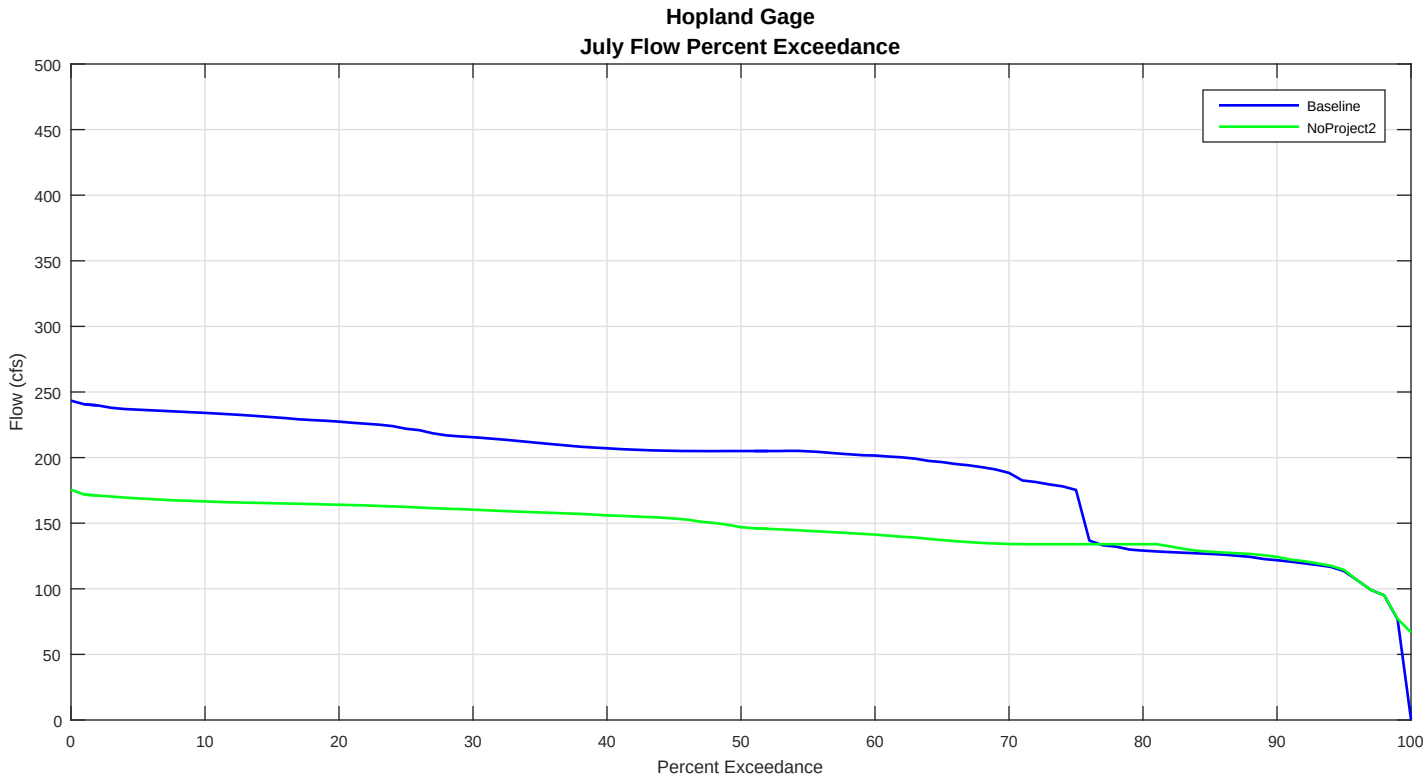
Hopland Gage
July Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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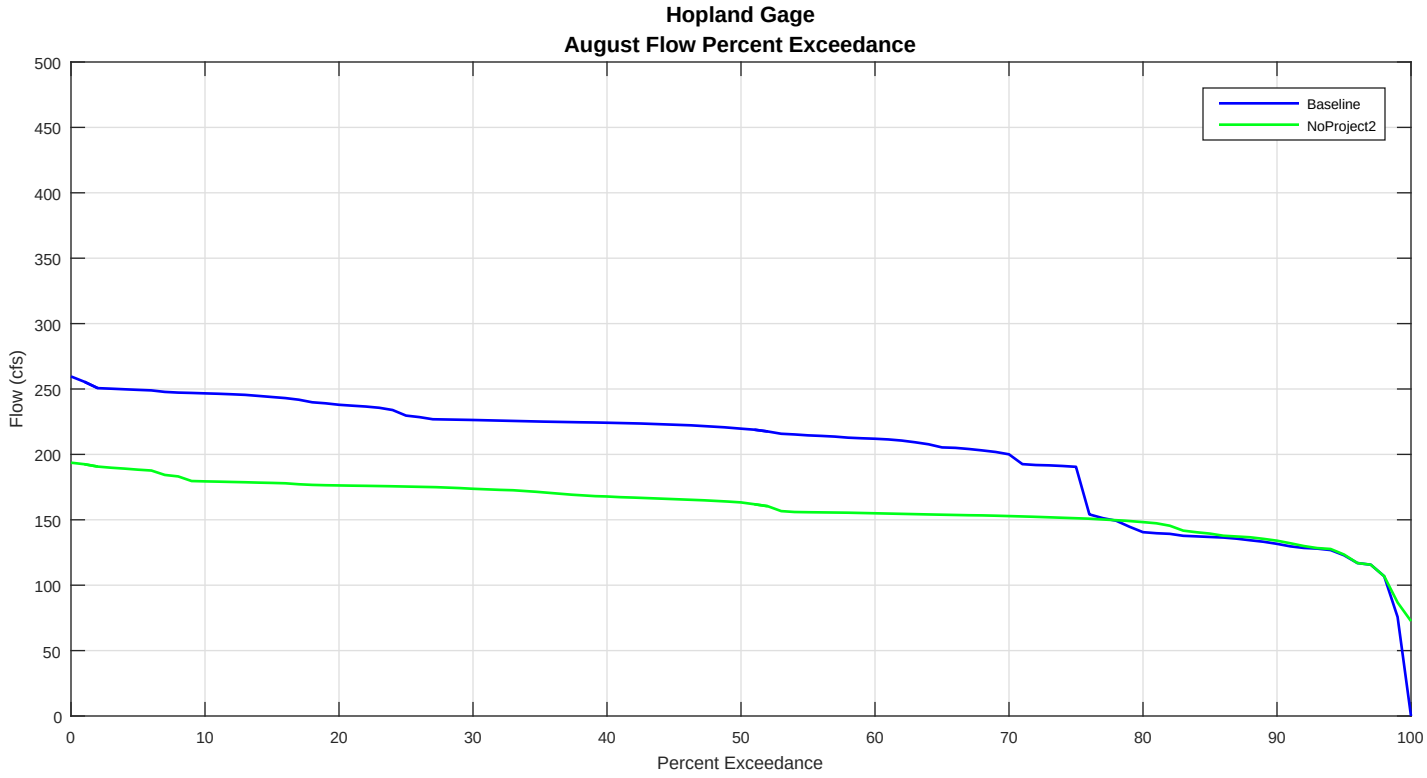
Hopland Gage
August Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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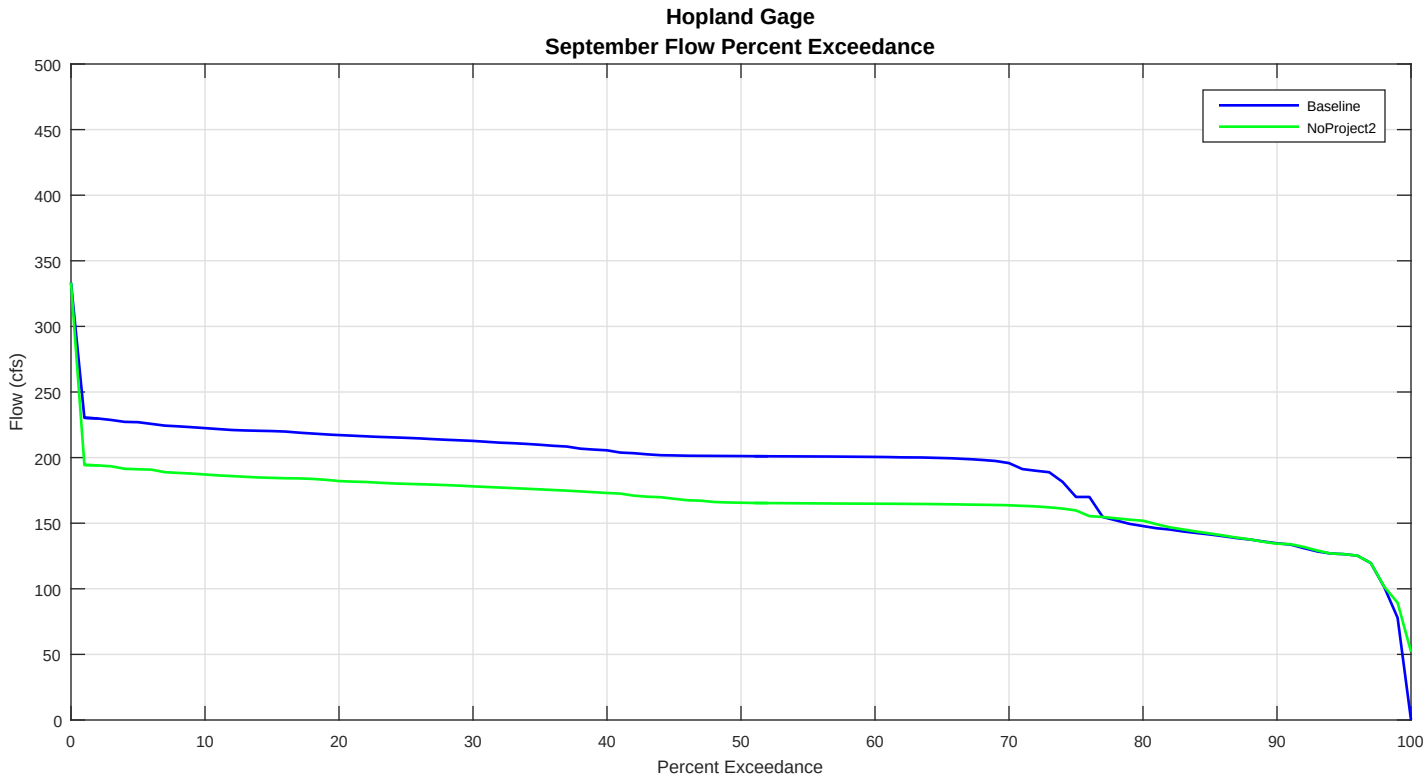
Hopland Gage
September Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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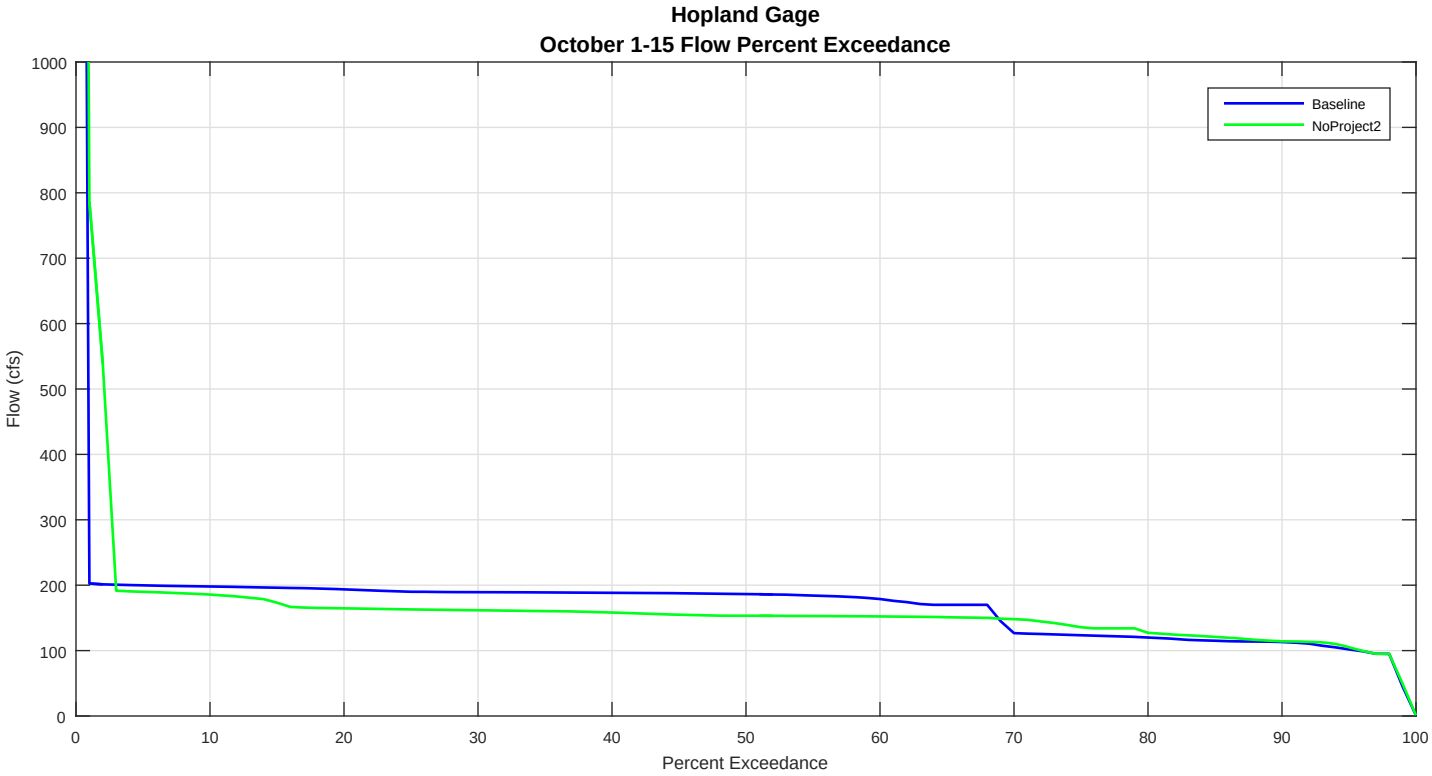
Hopland Gage
October 1-15 Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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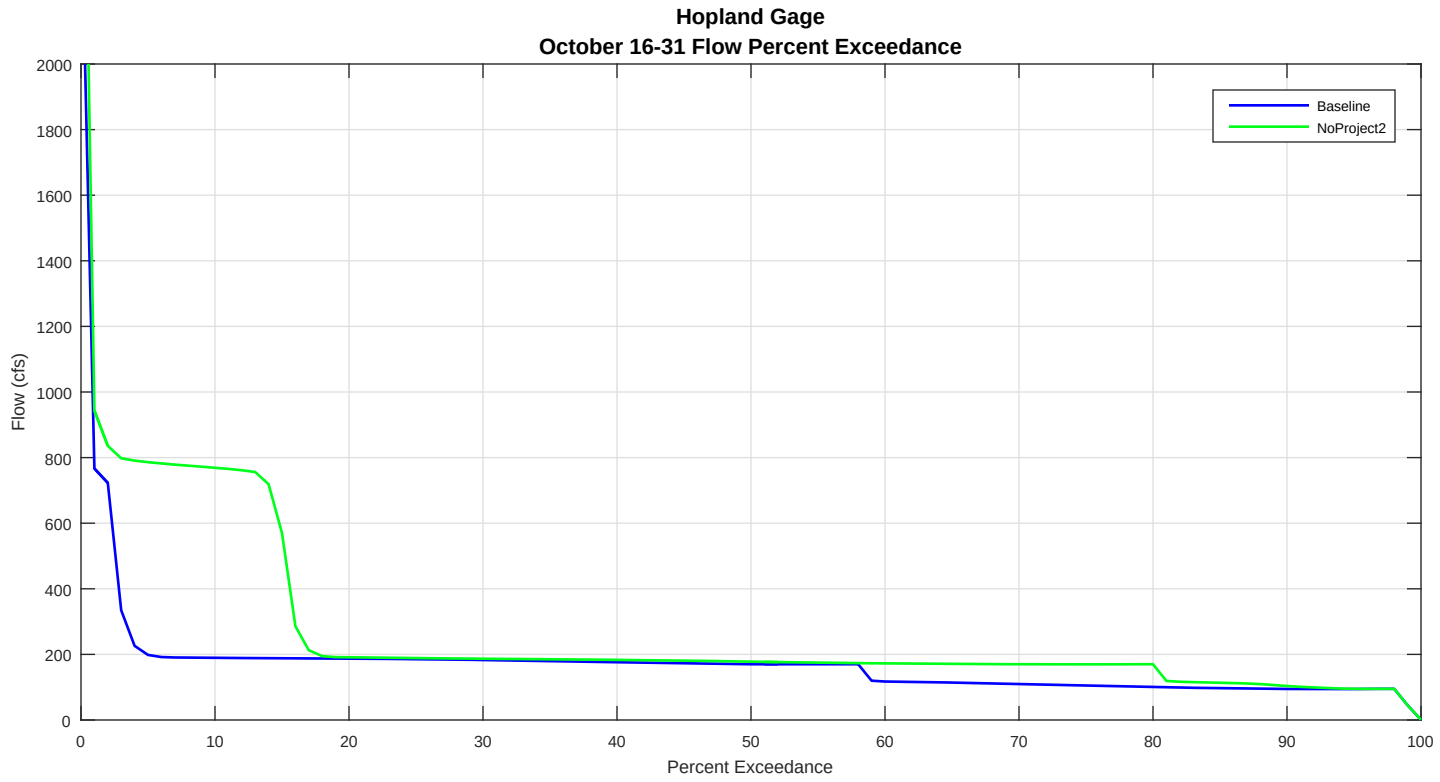
Hopland Gage
October 16-31 Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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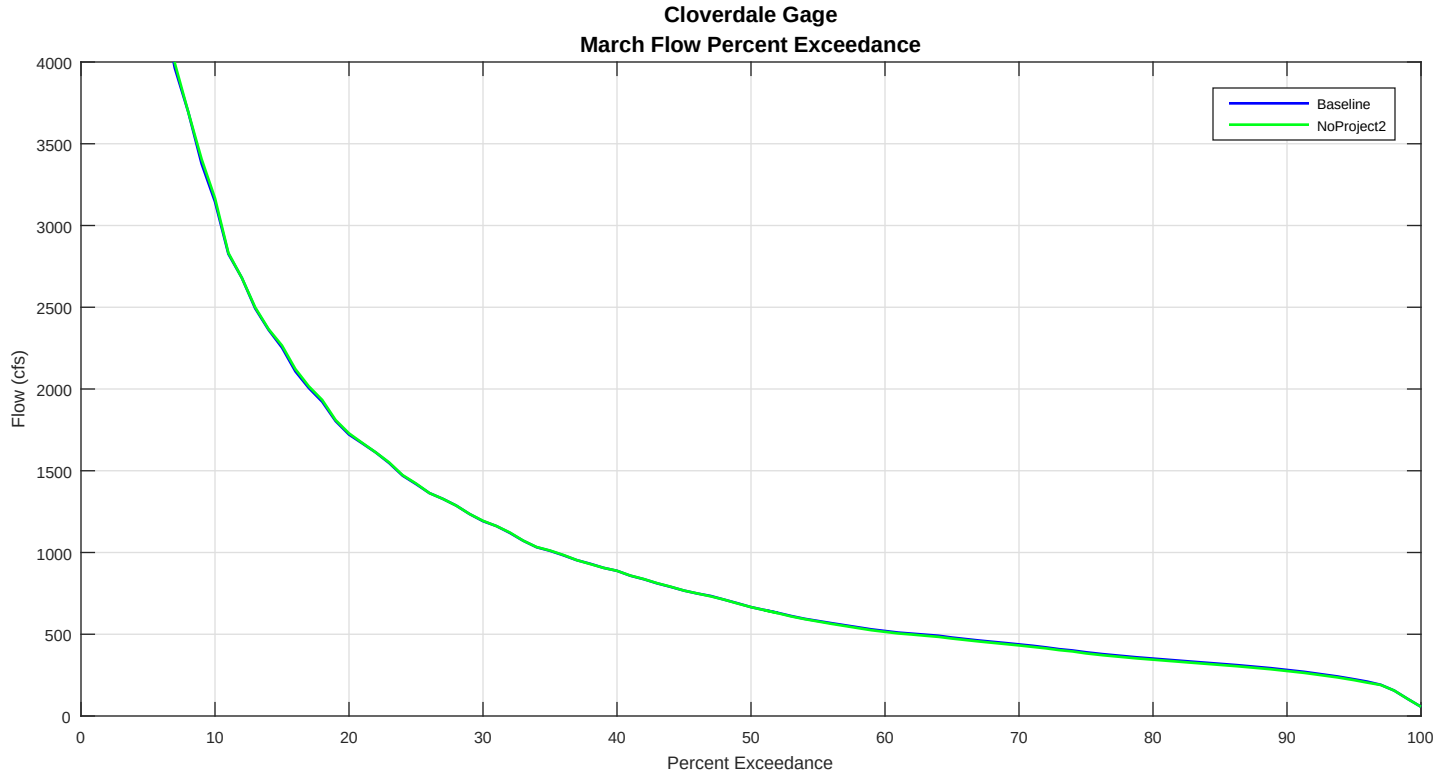
Cloverdale Gage
March Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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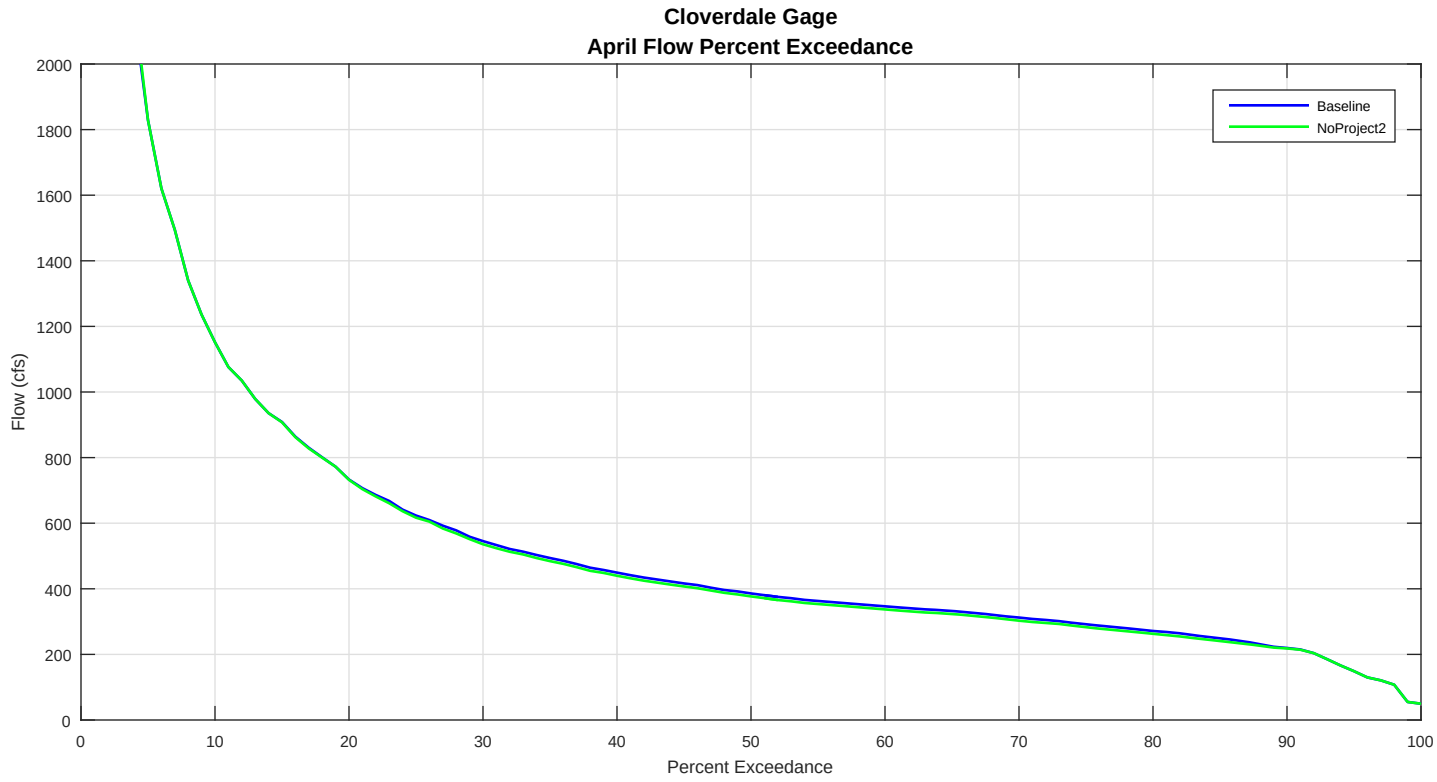
Cloverdale Gage
April Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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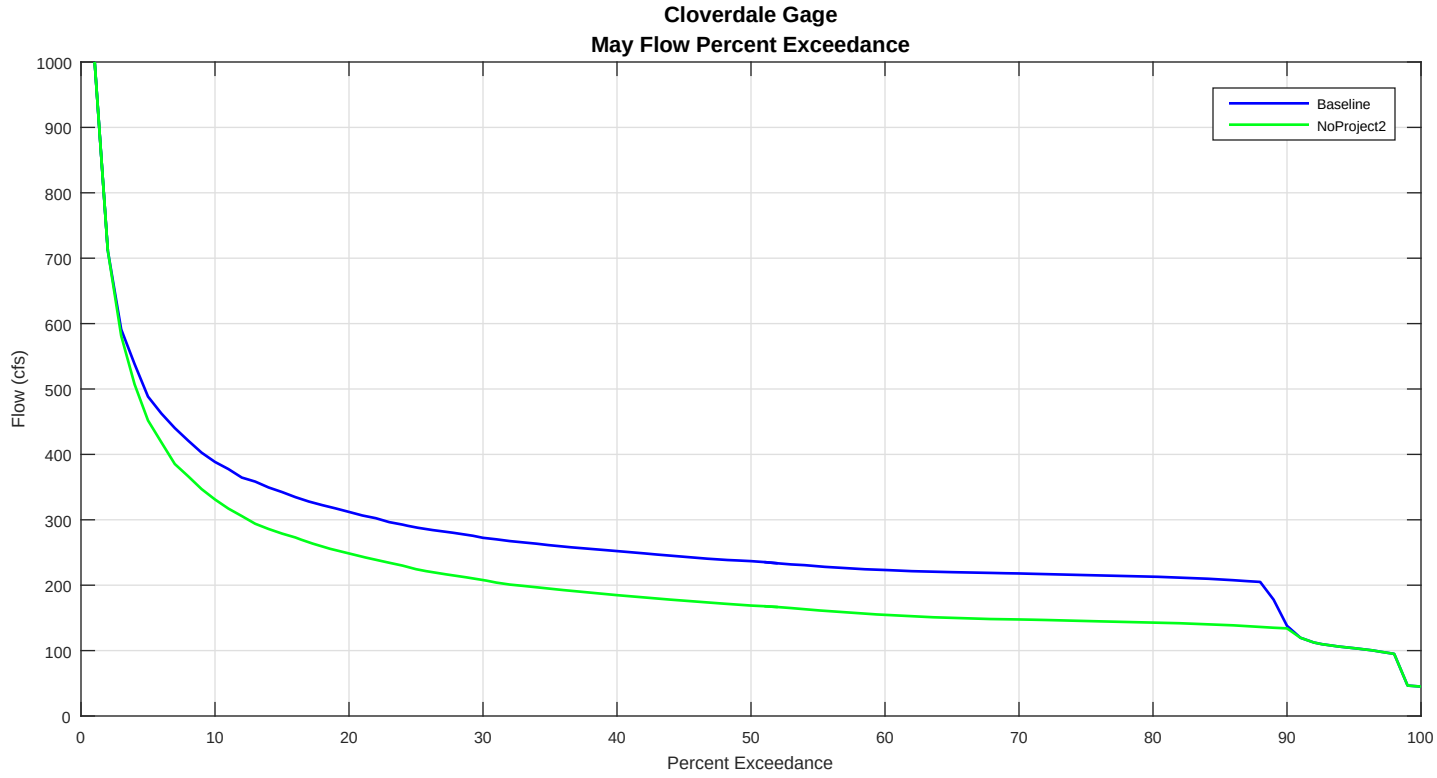
Cloverdale Gage
May Flow Percent Exceedance
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NoProject2
Flow (cfs)
Percent Exceedance
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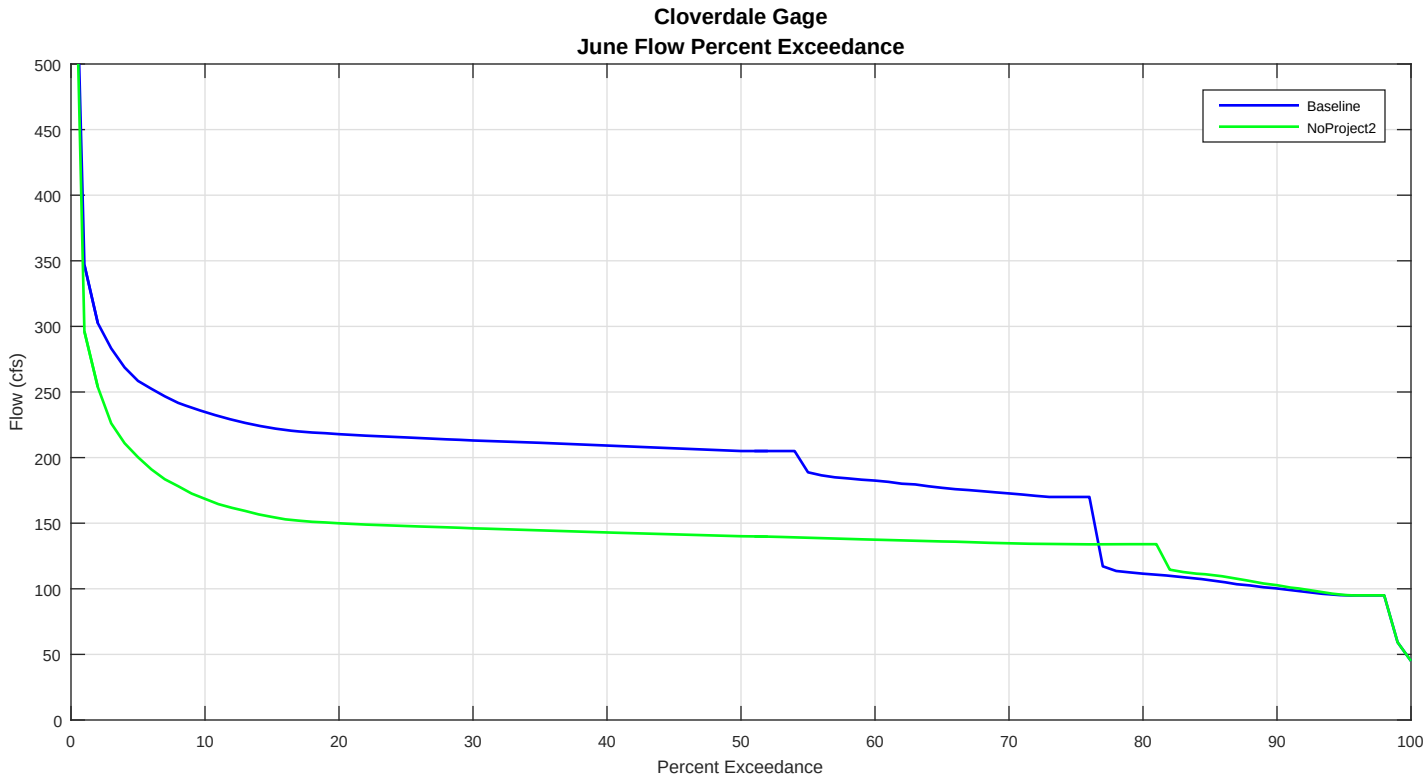
Cloverdale Gage
June Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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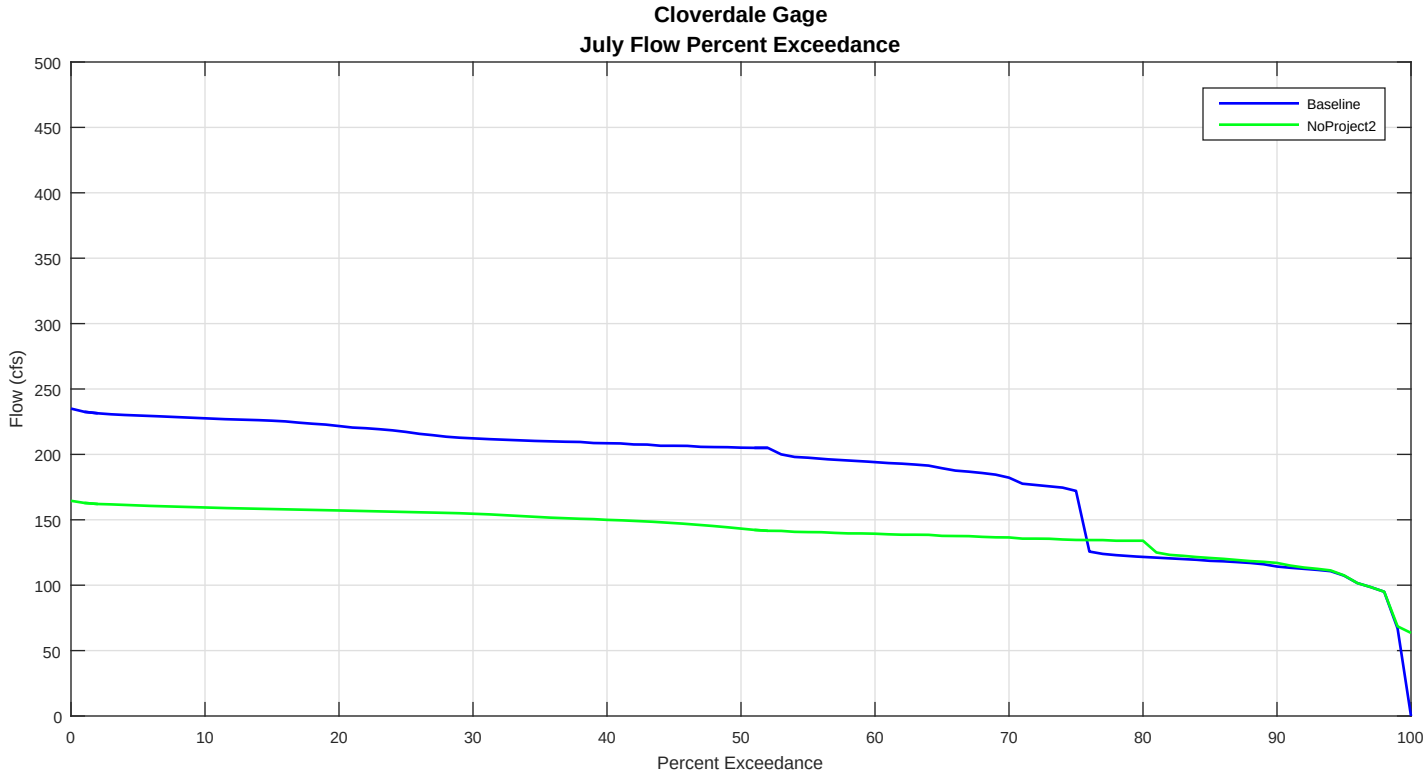
Cloverdale Gage
July Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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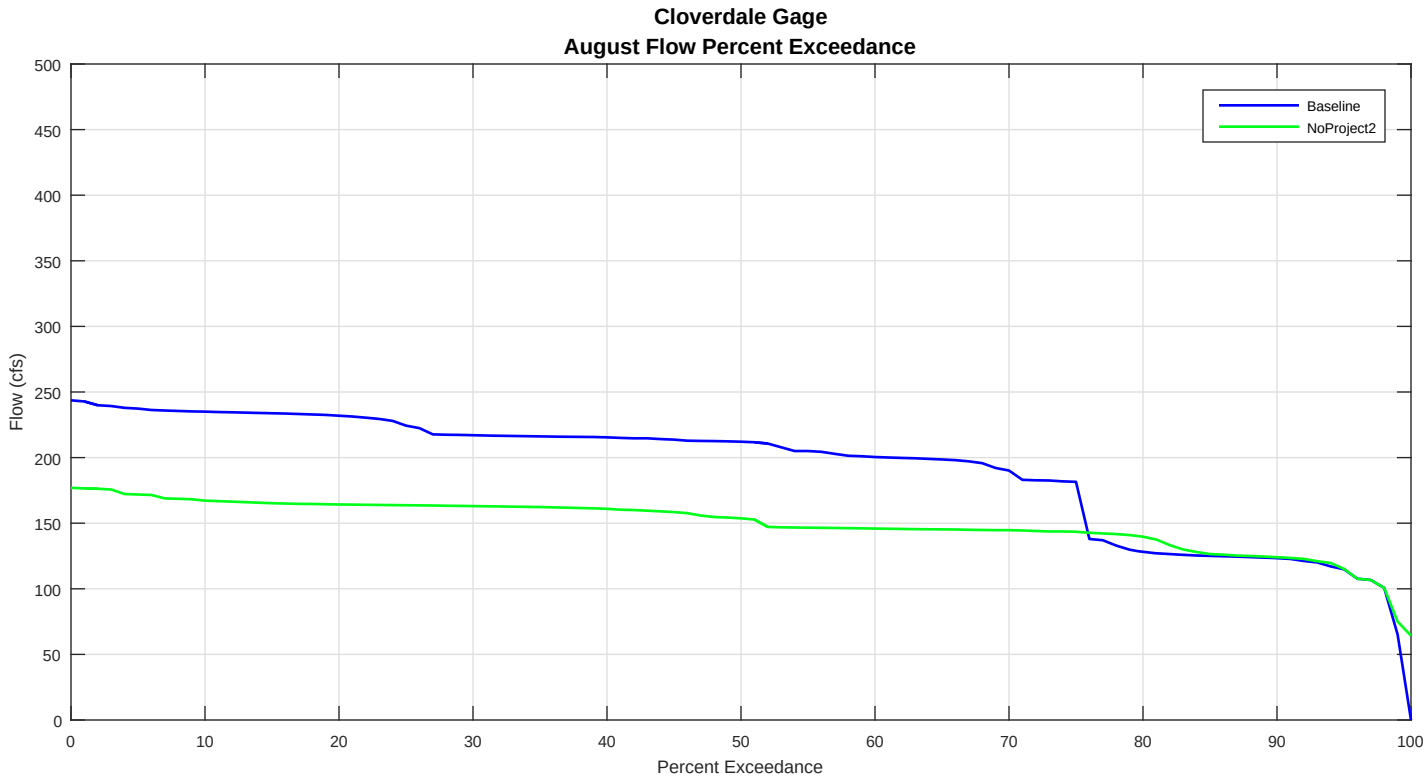
Cloverdale Gage
August Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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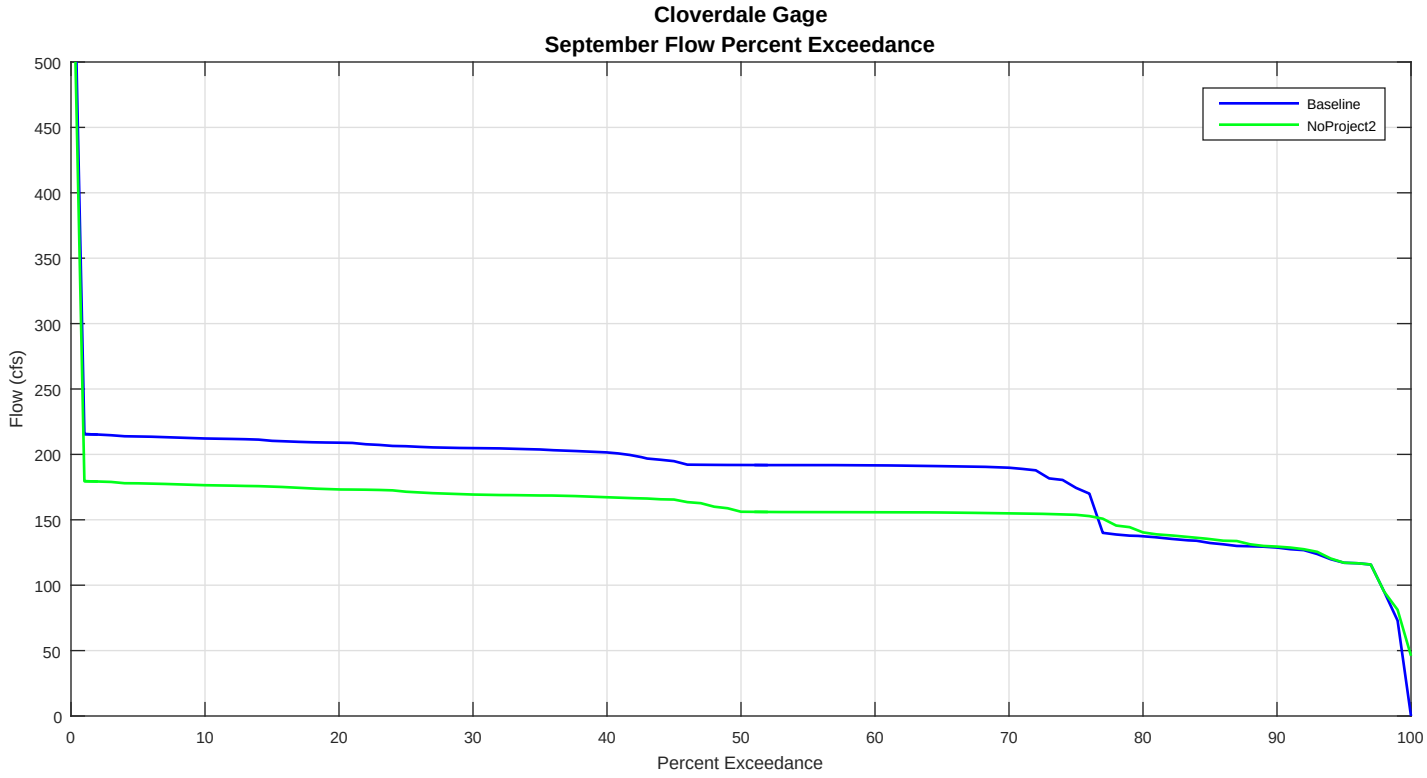
Cloverdale Gage
September Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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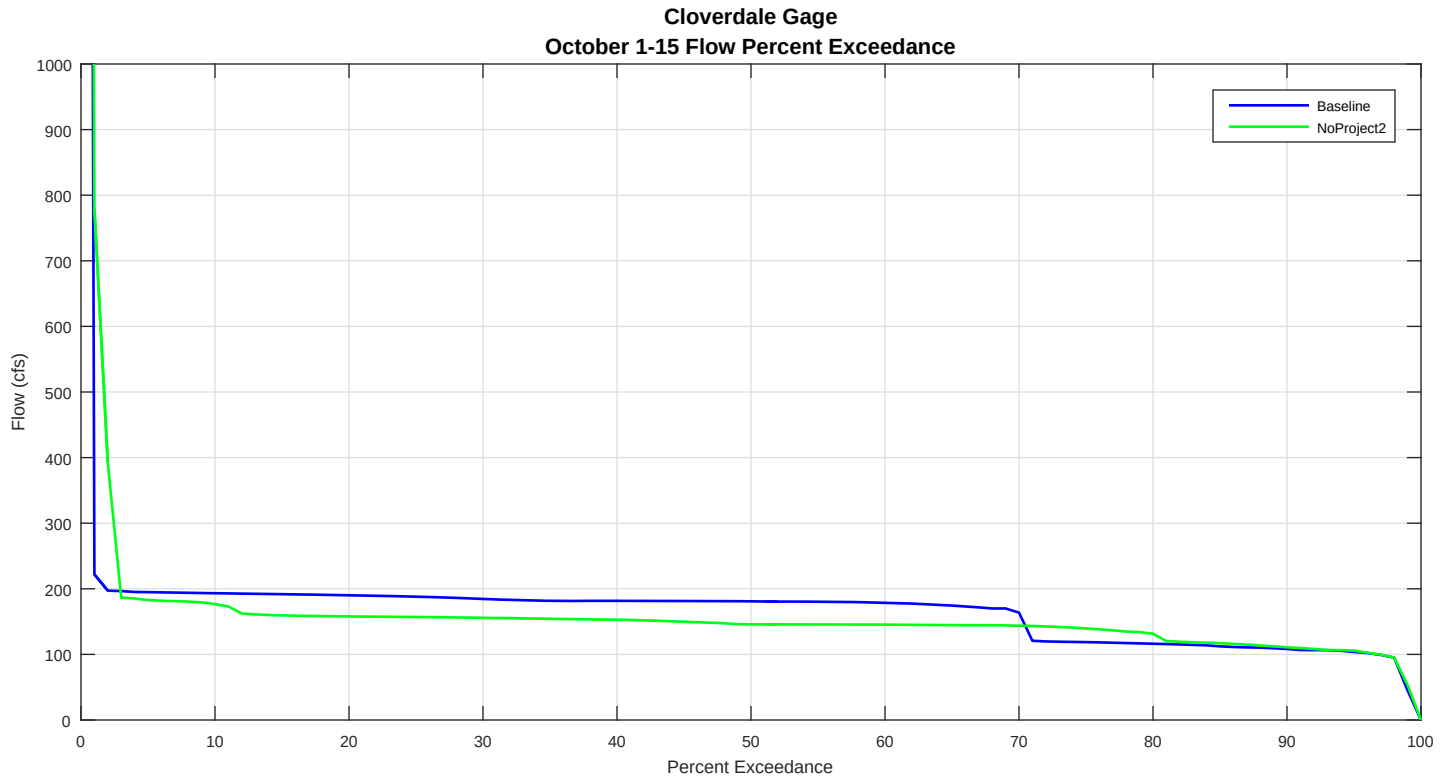
Cloverdale Gage
October 1-15 Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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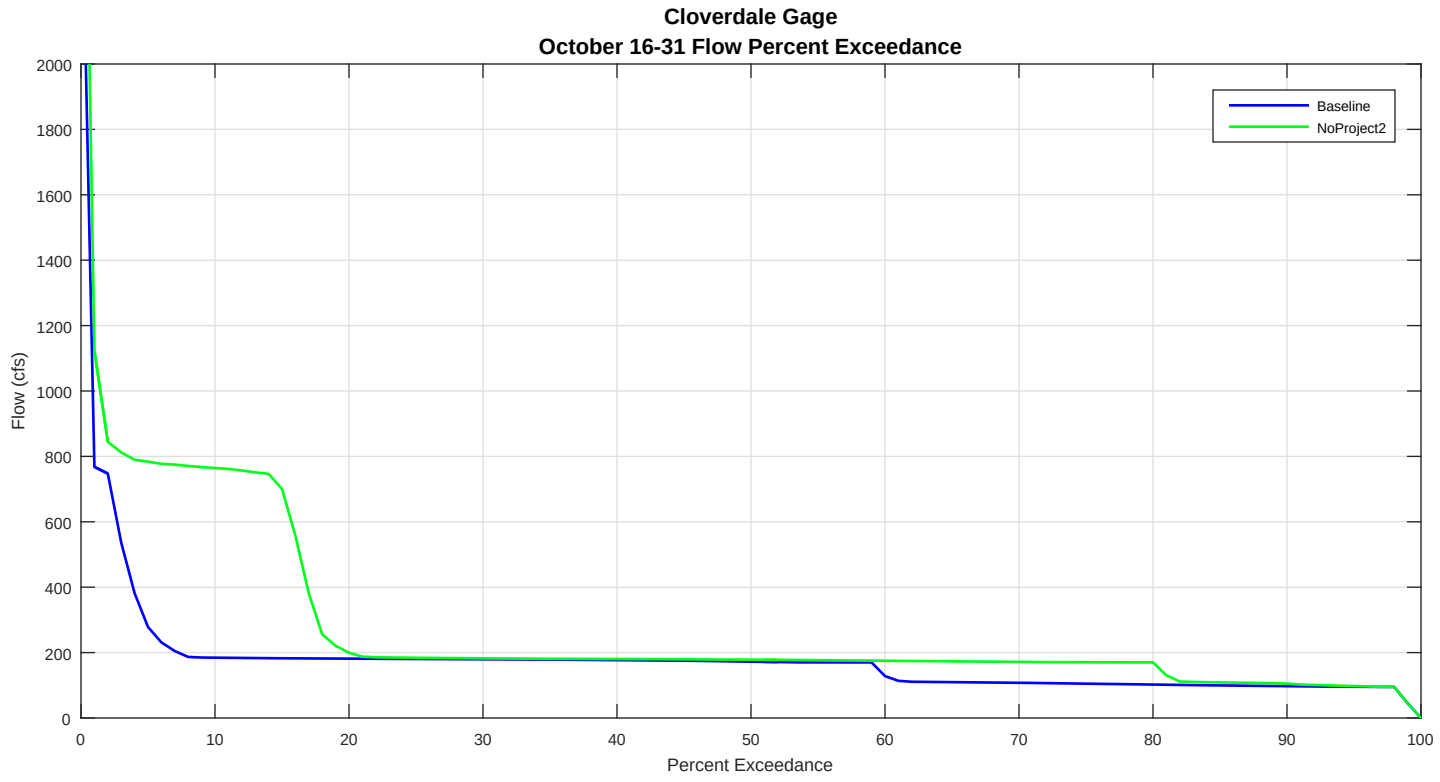
Cloverdale Gage
October 16-31 Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
0
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400
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1200
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2000
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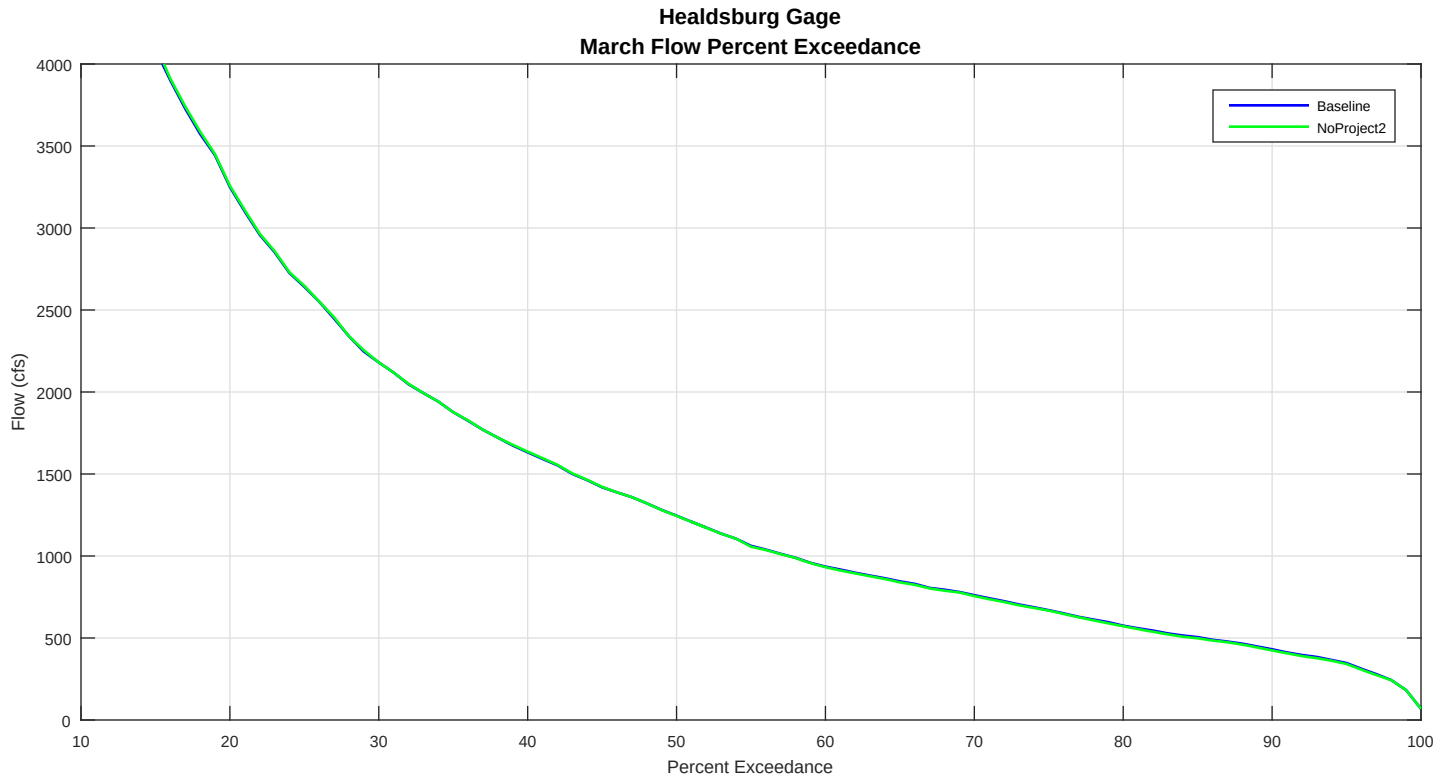
Healdsburg Gage
March Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
0
500
1000
1500
2000
2500
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3500
4000
10
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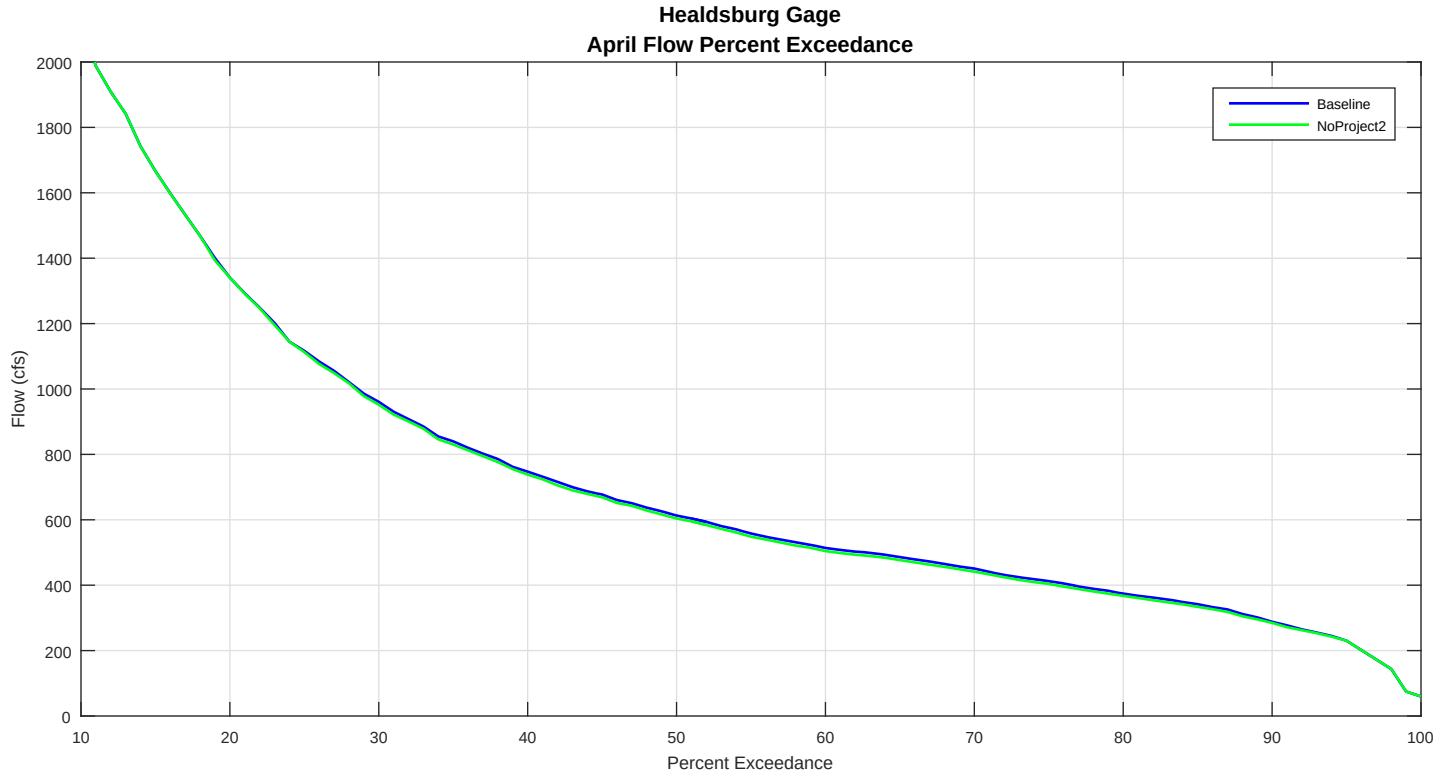
Healdsburg Gage
April Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
0
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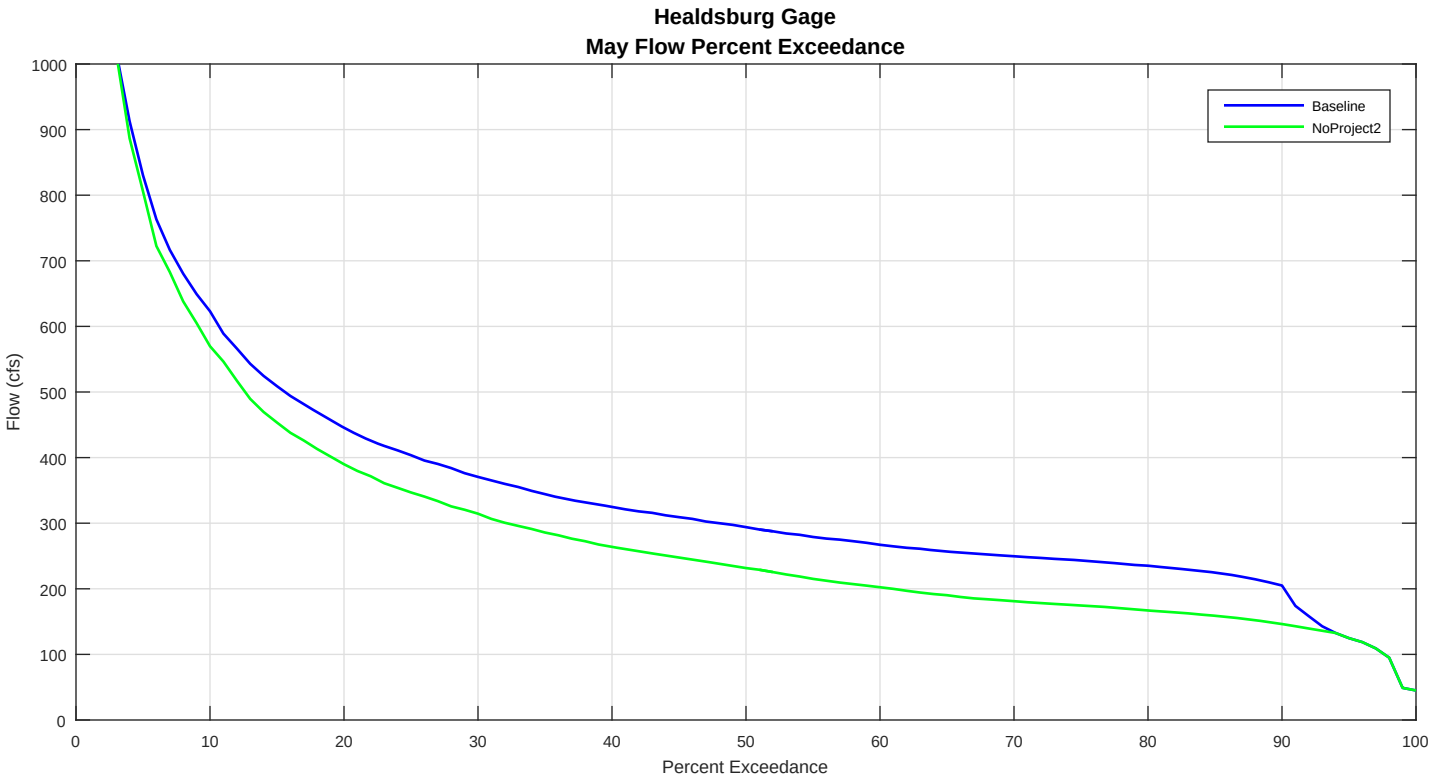
Healdsburg Gage
May Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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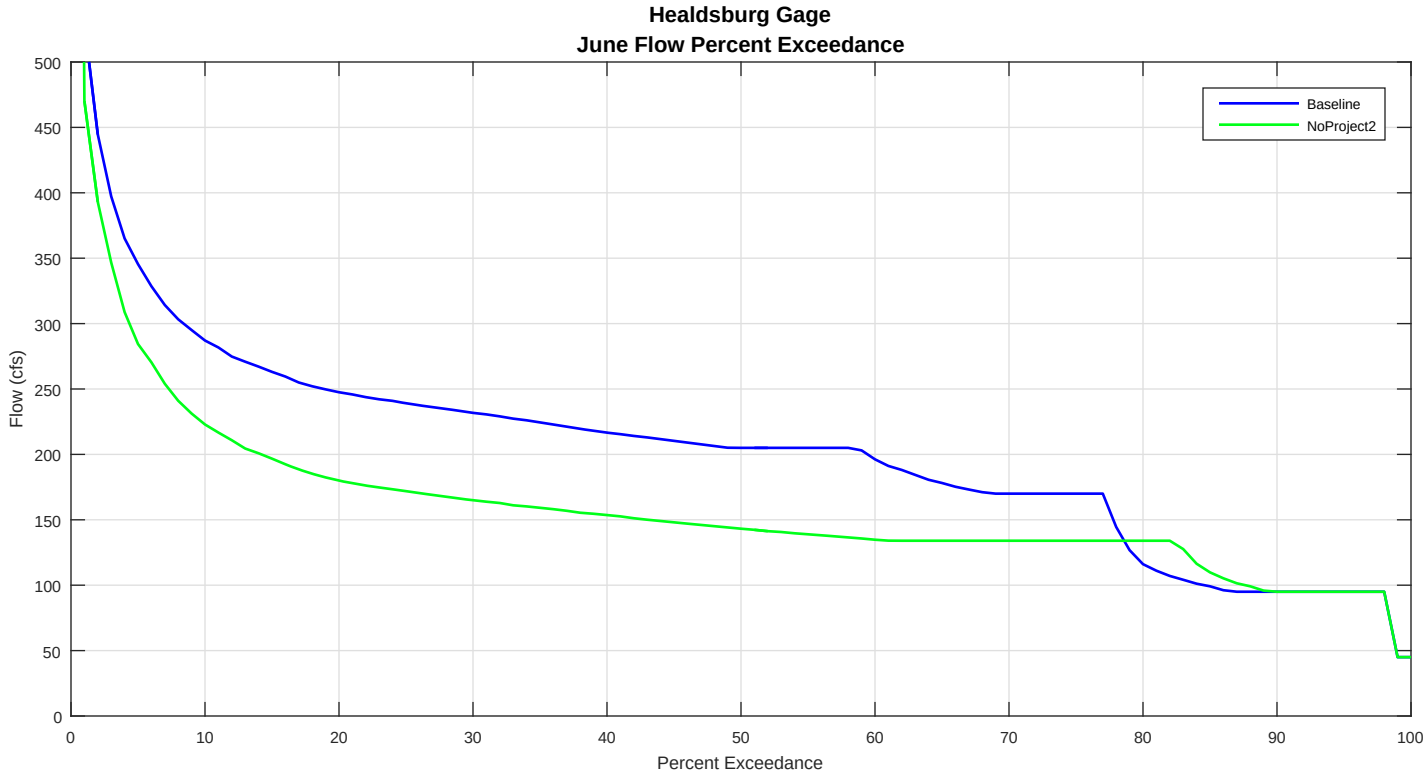
Healdsburg Gage
June Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
0
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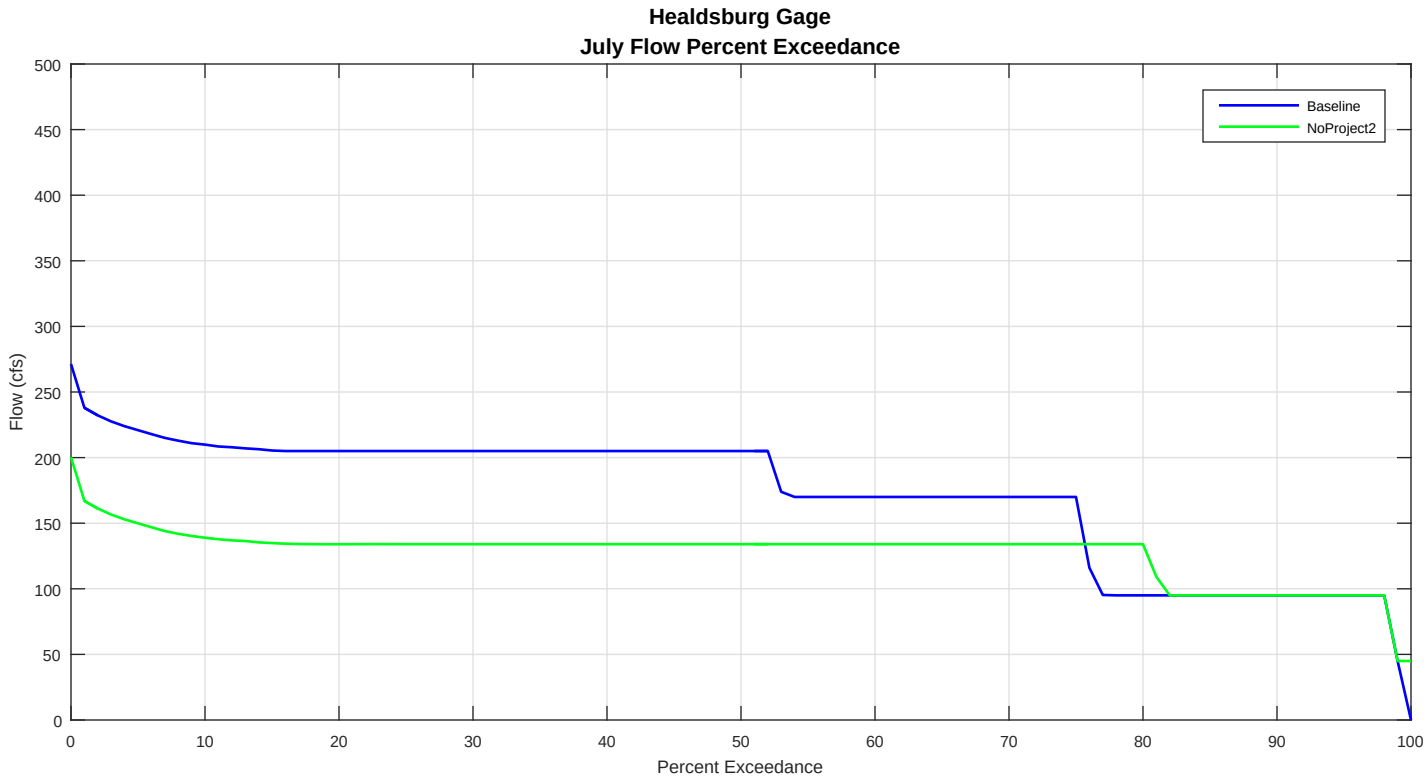
Healdsburg Gage
July Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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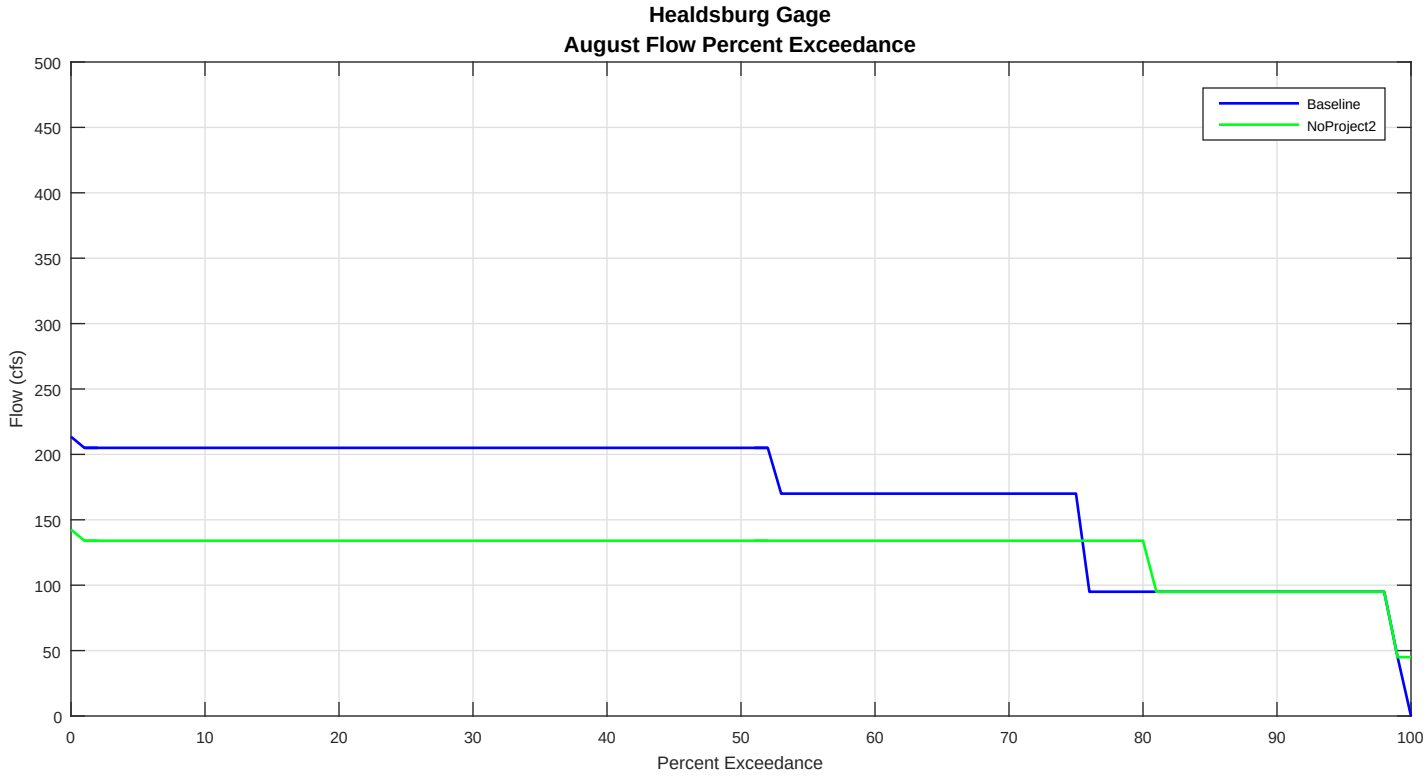
Healdsburg Gage
August Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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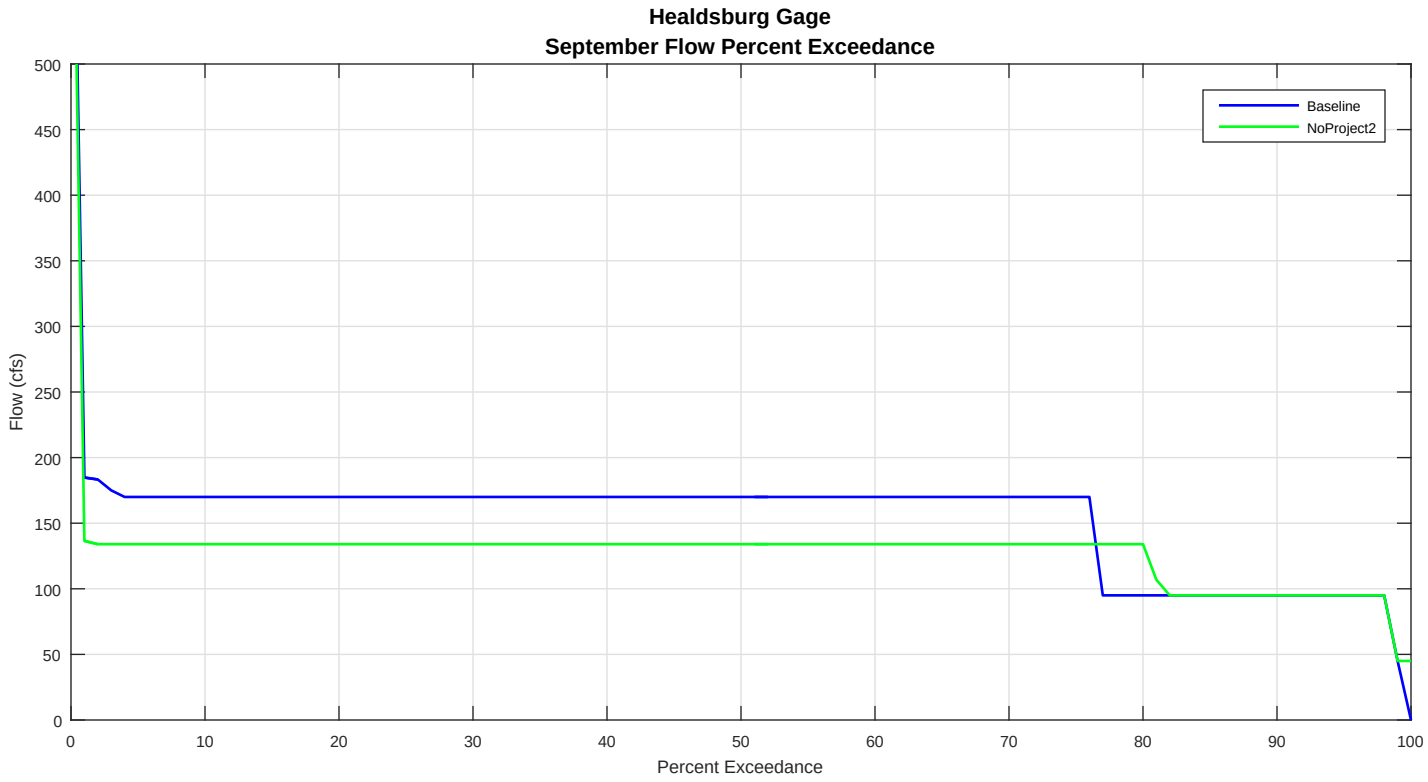
Healdsburg Gage
September Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
Baseline
NoProject2
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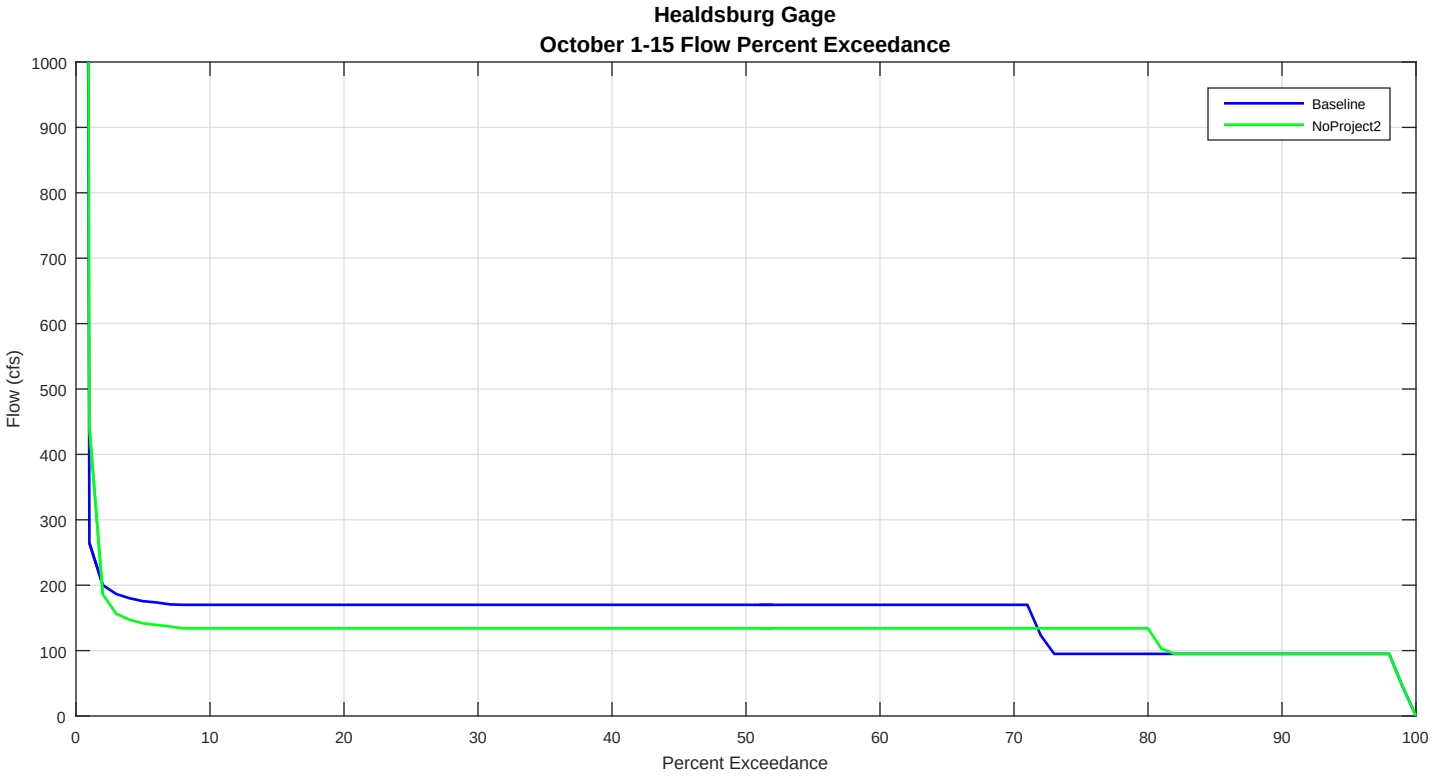
Healdsburg Gage
October 1-15 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
Baseline
NoProject2
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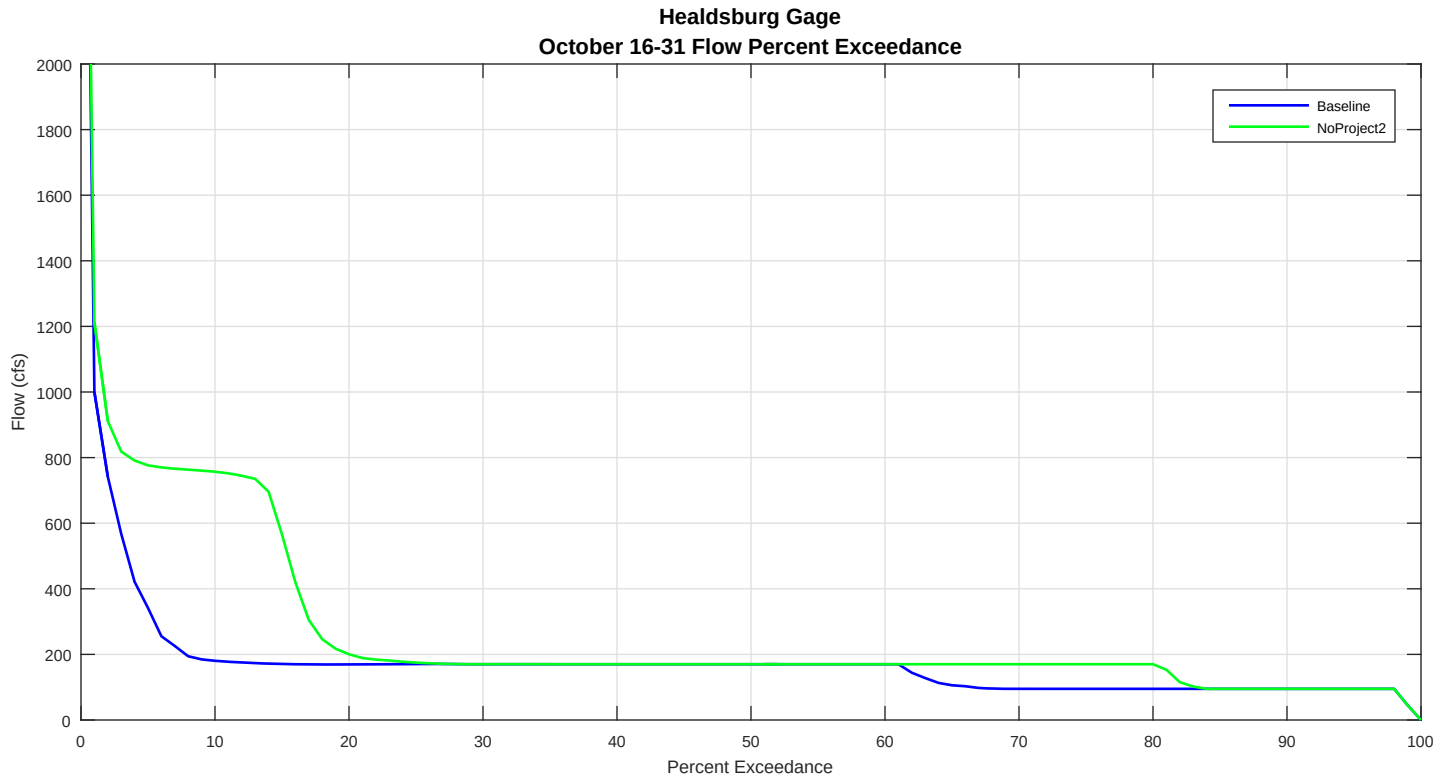
Healdsburg Gage
October 16-31 Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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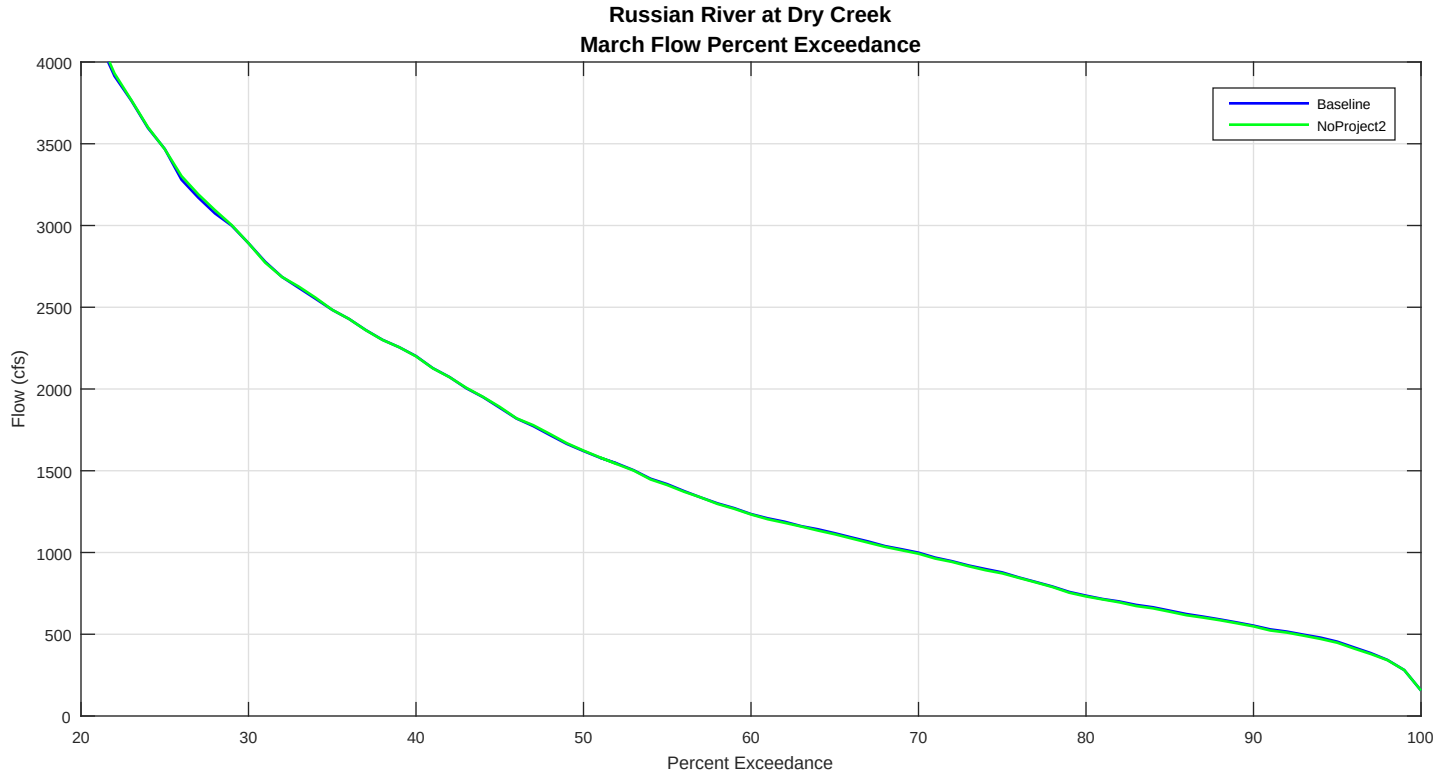
Russian River at Dry Creek
March Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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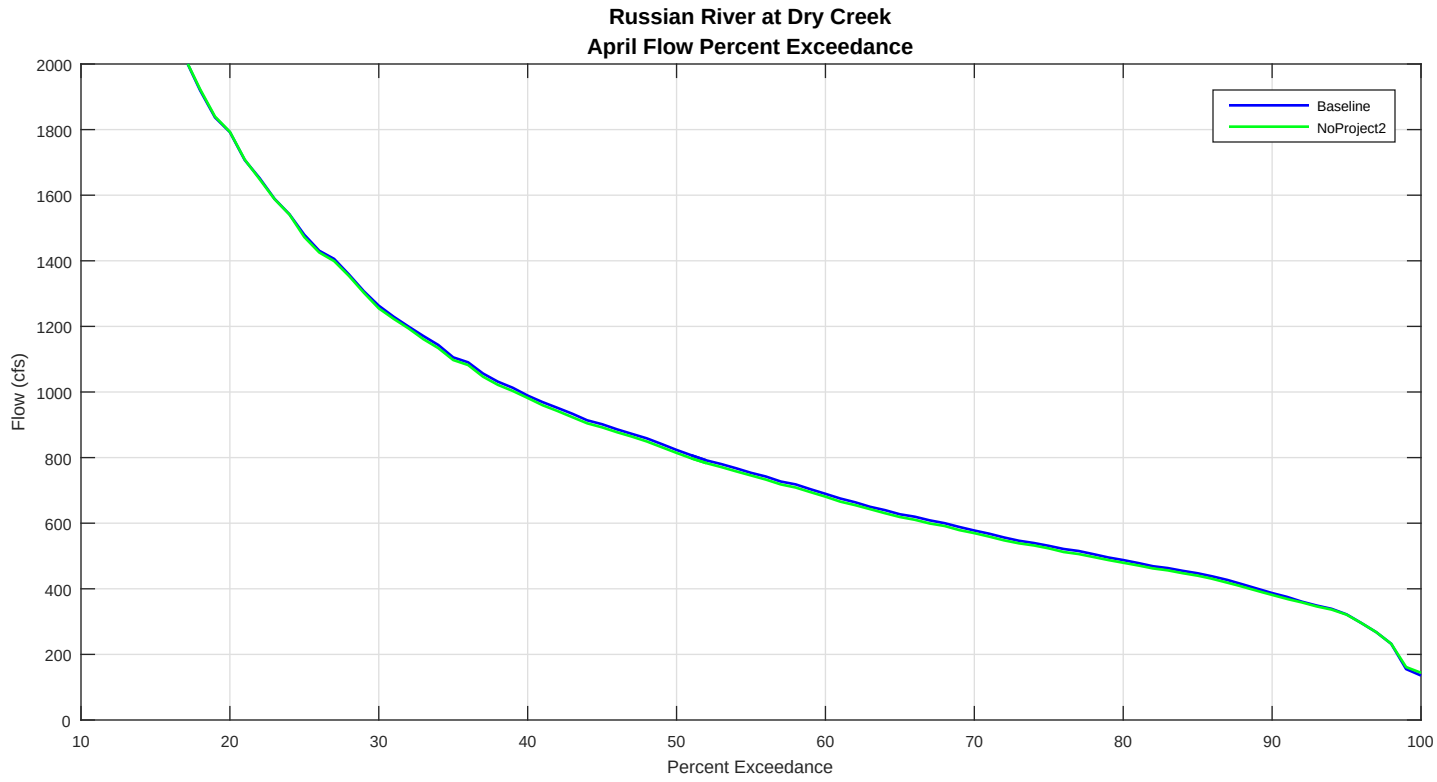
Russian River at Dry Creek
April Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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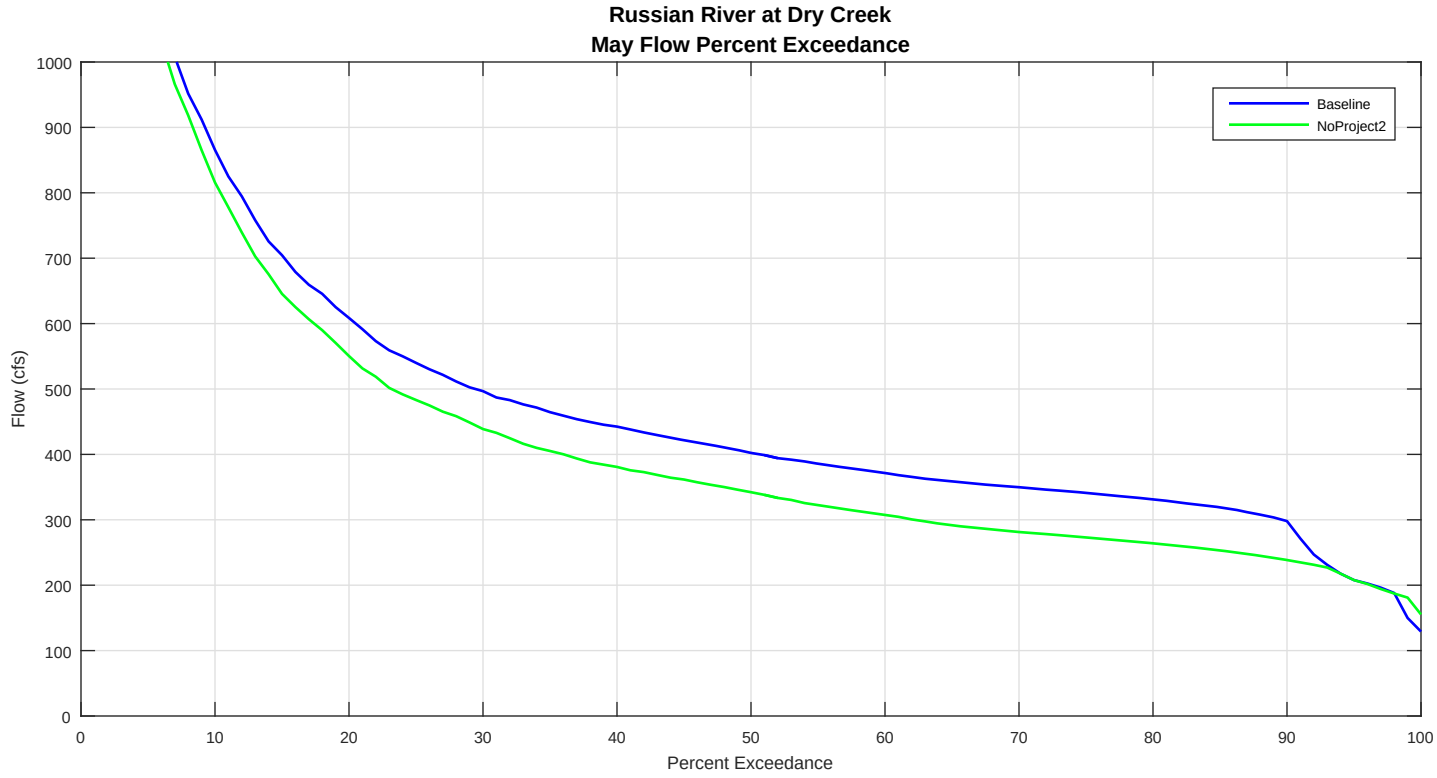
Russian River at Dry Creek
May Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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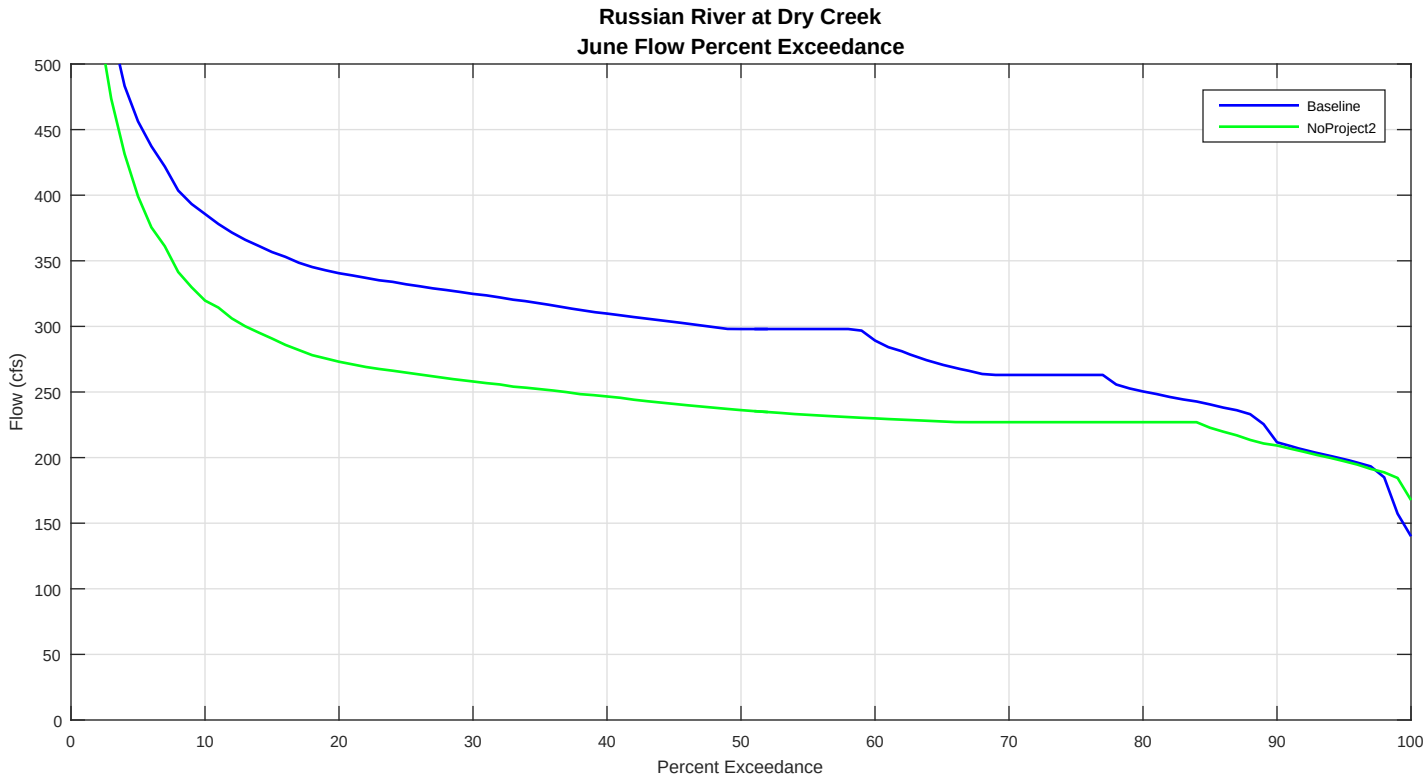
Russian River at Dry Creek
June Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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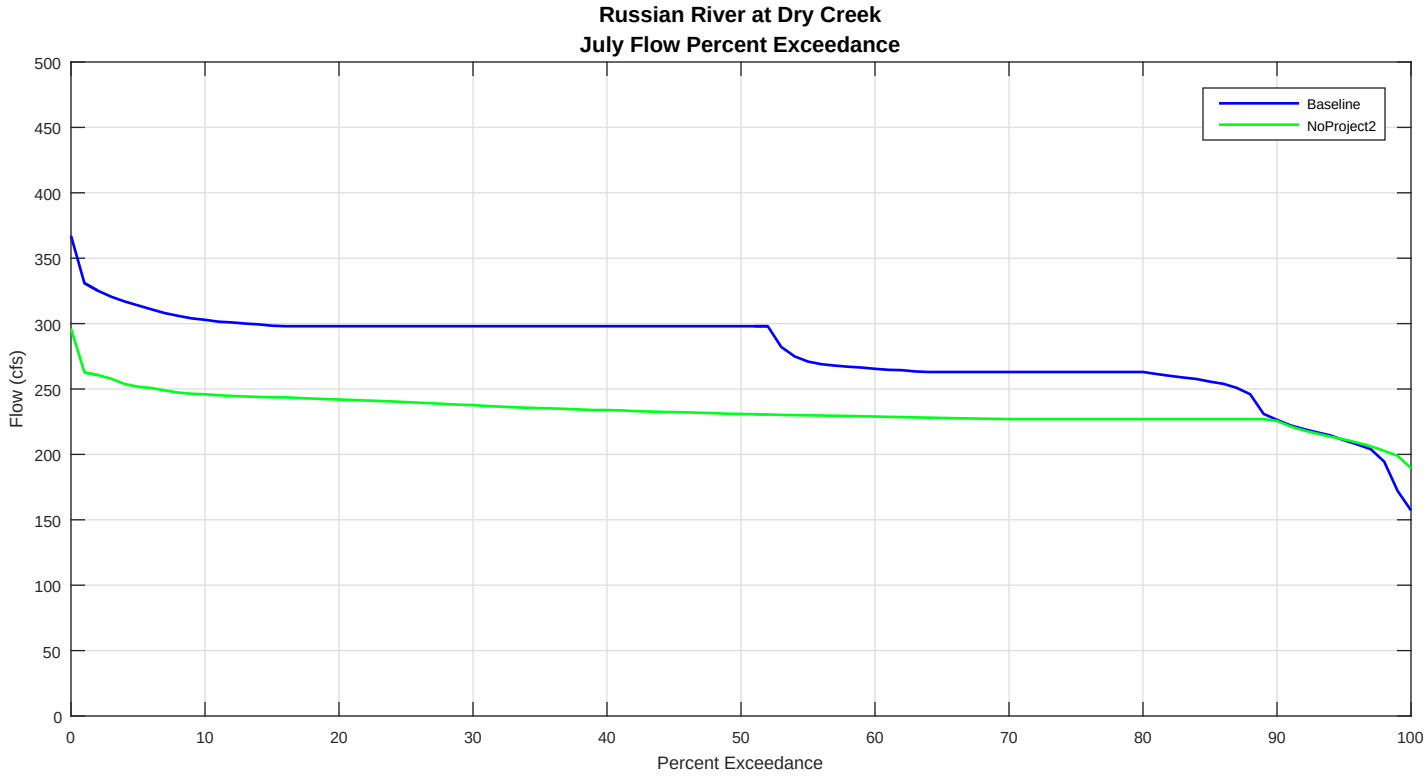
Russian River at Dry Creek
July Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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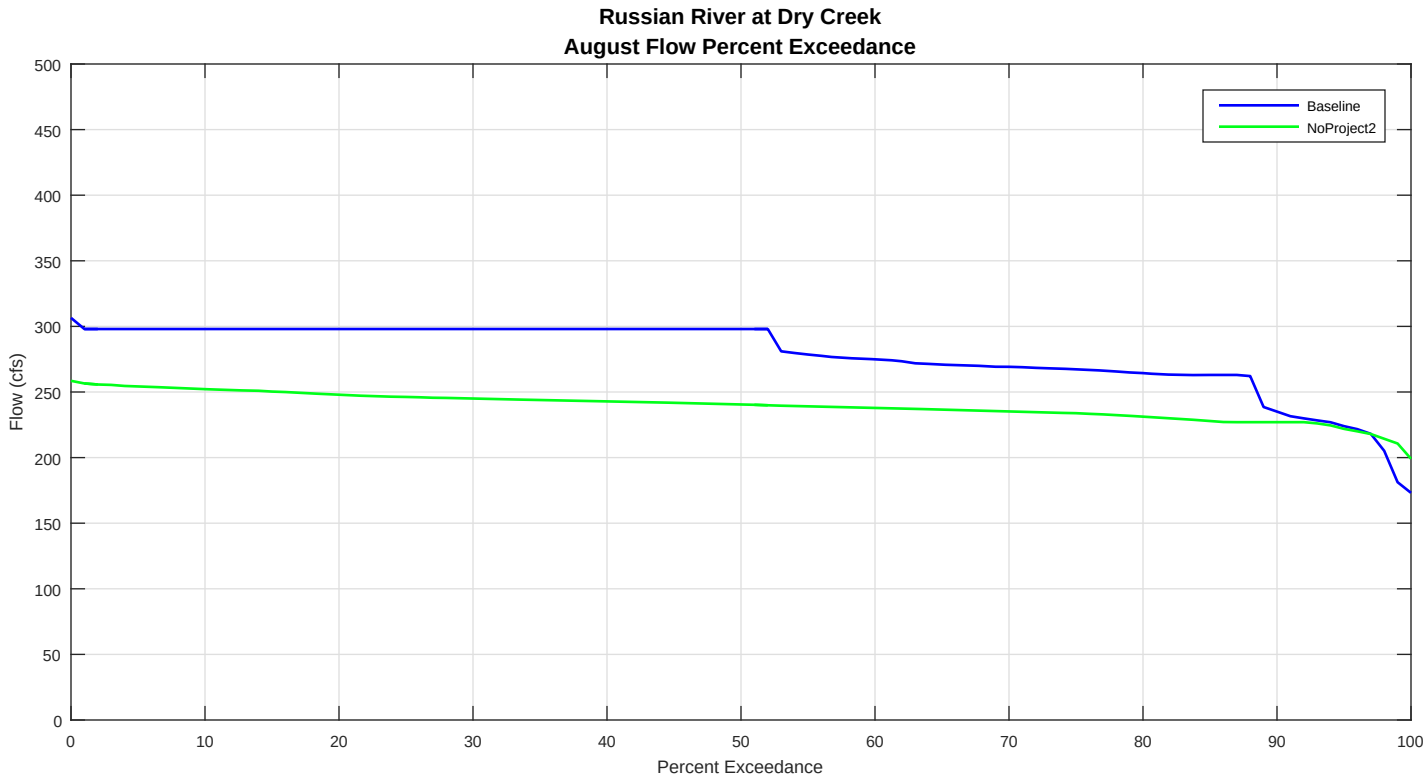
Russian River at Dry Creek
August Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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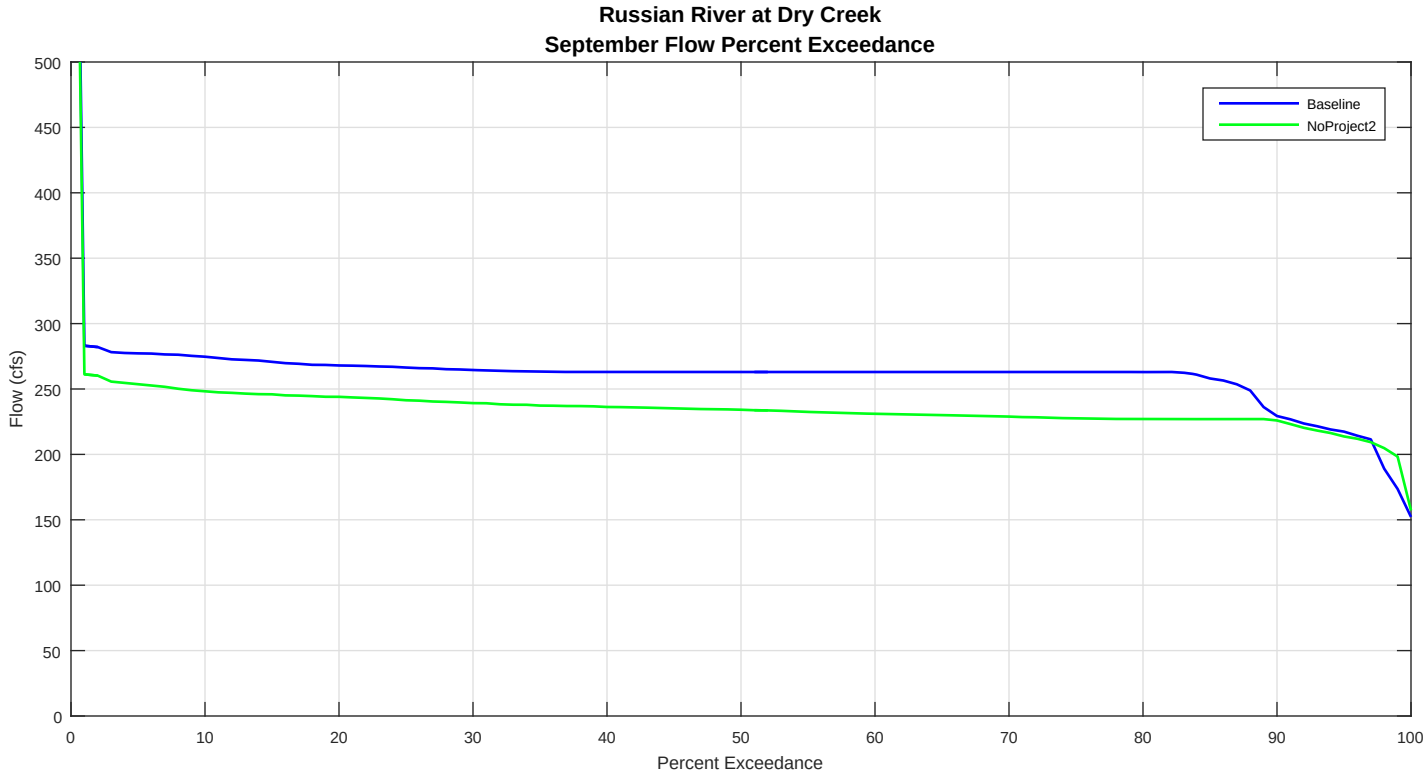
Russian River at Dry Creek
September Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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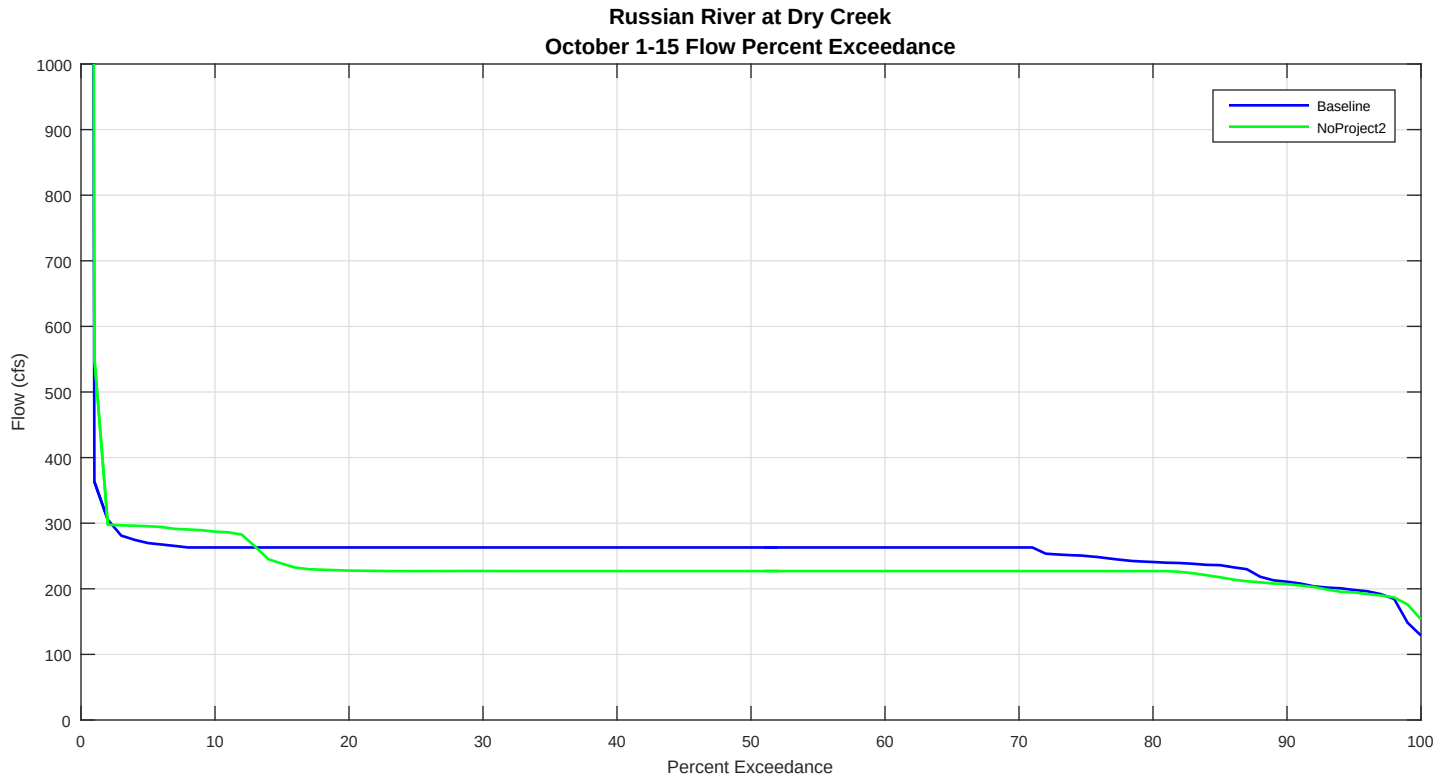
Russian River at Dry Creek
October 1-15 Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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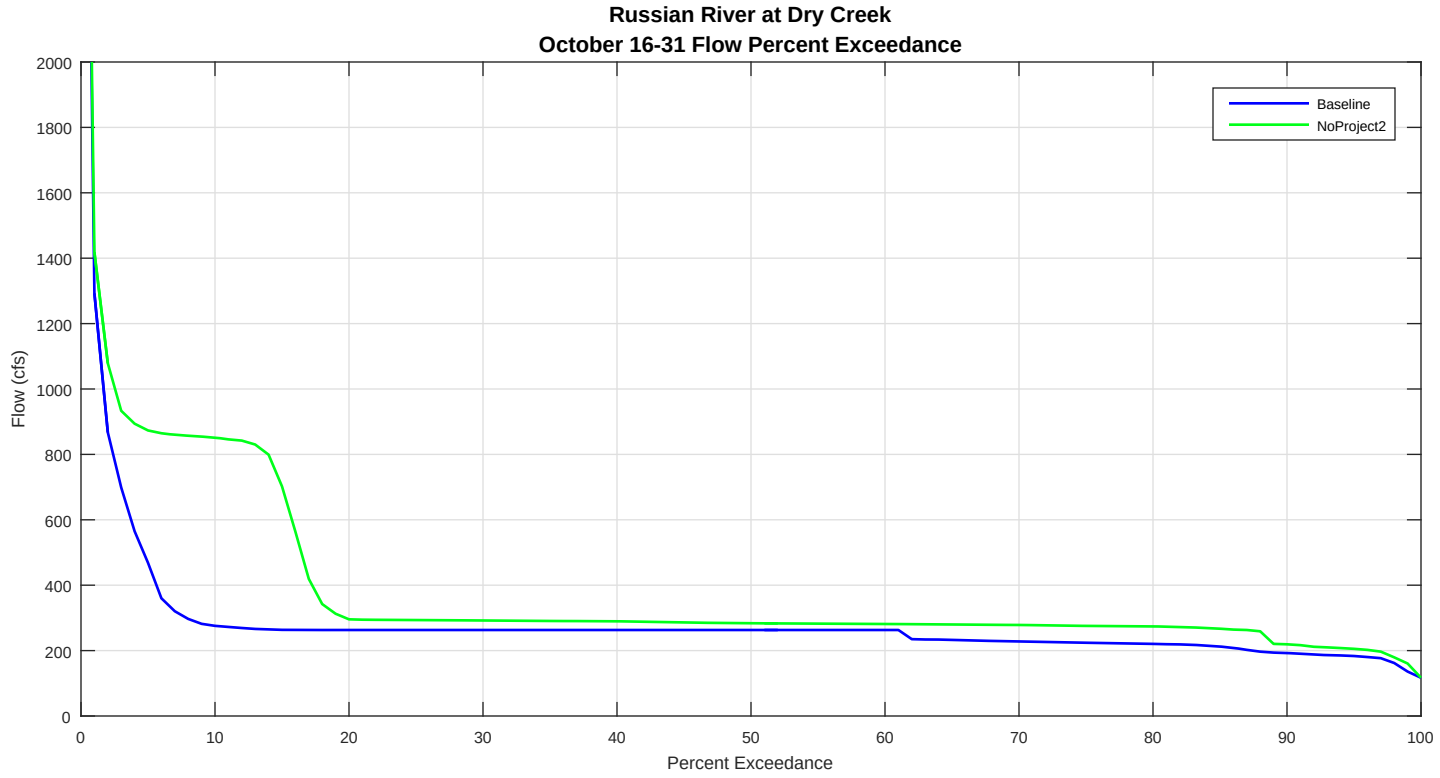
Russian River at Dry Creek
October 16-31 Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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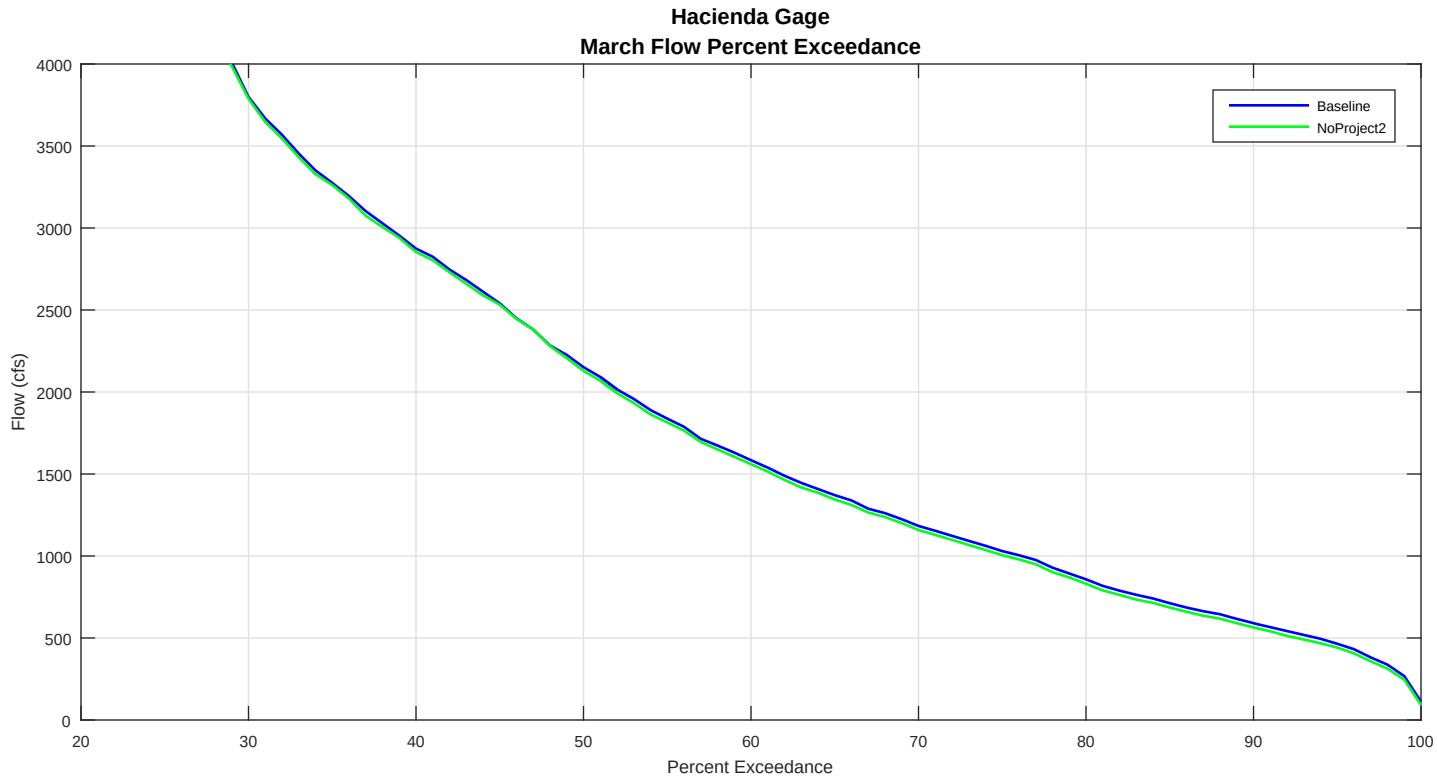
Hacienda Gage
March Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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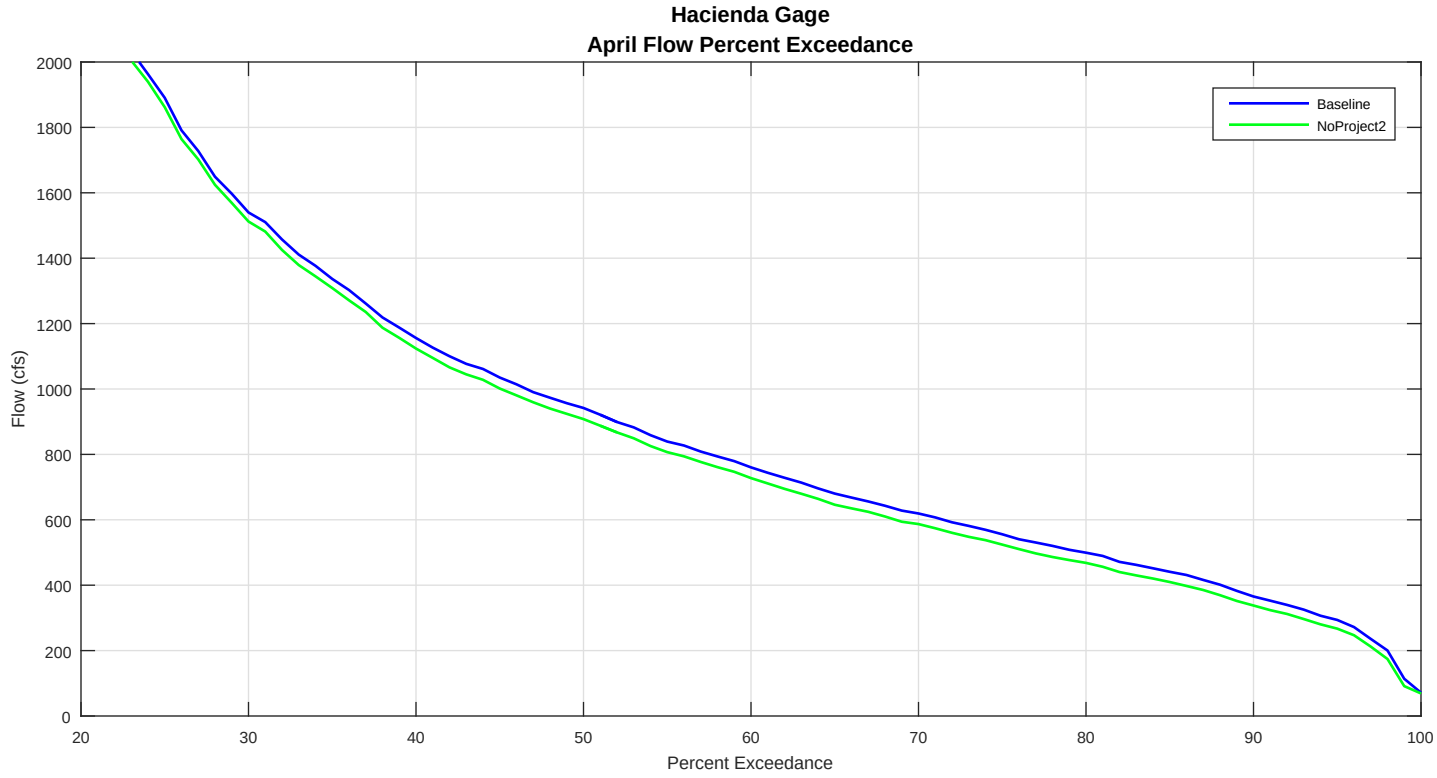
Hacienda Gage
April Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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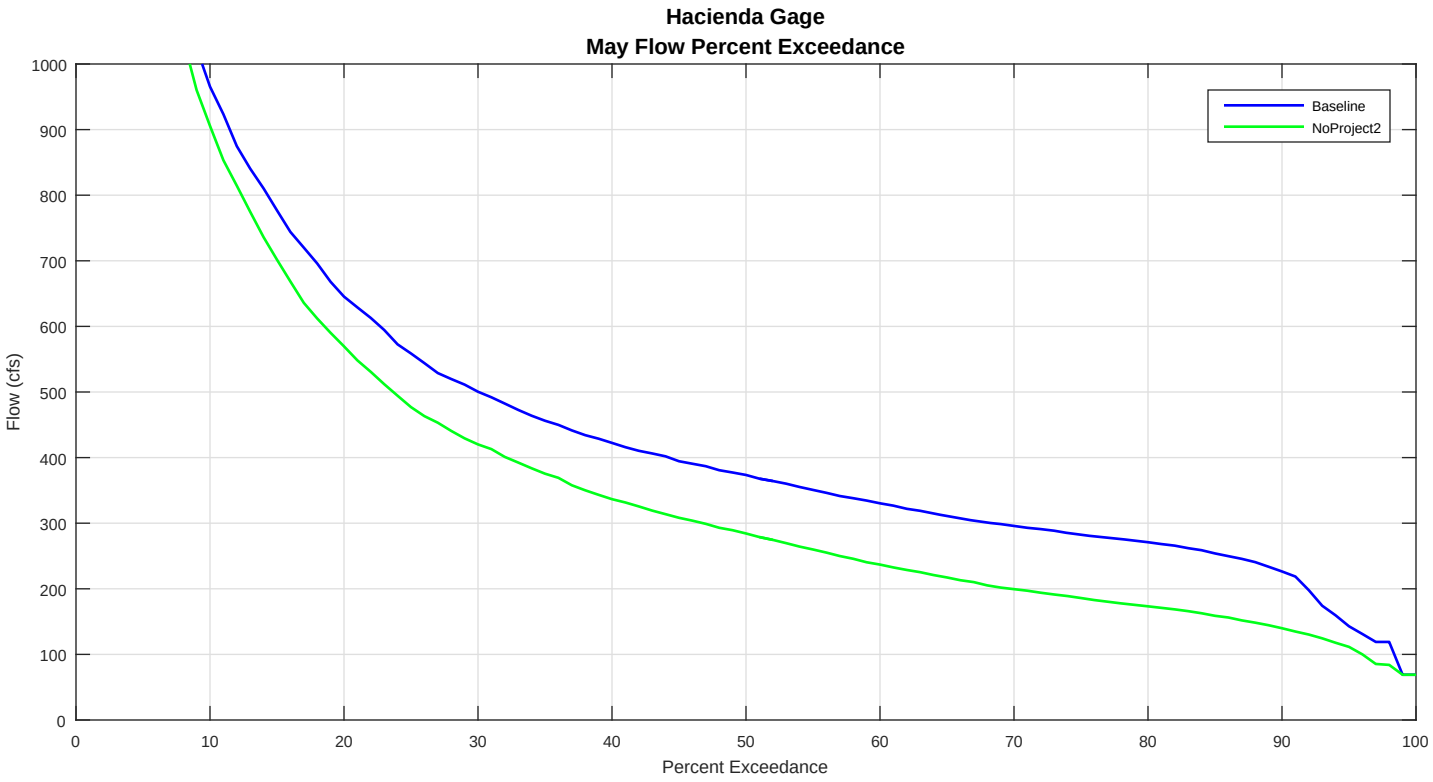
Hacienda Gage
May Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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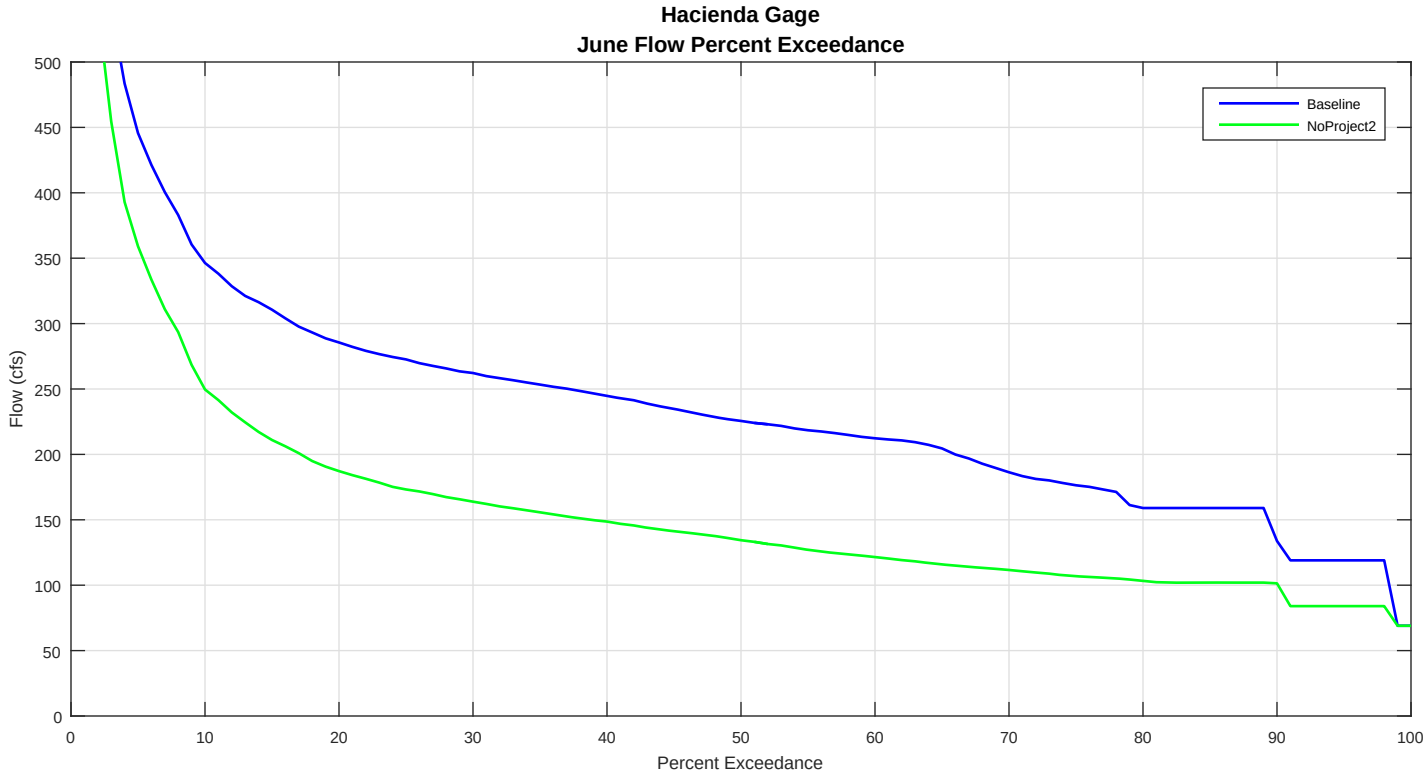
Hacienda Gage
June Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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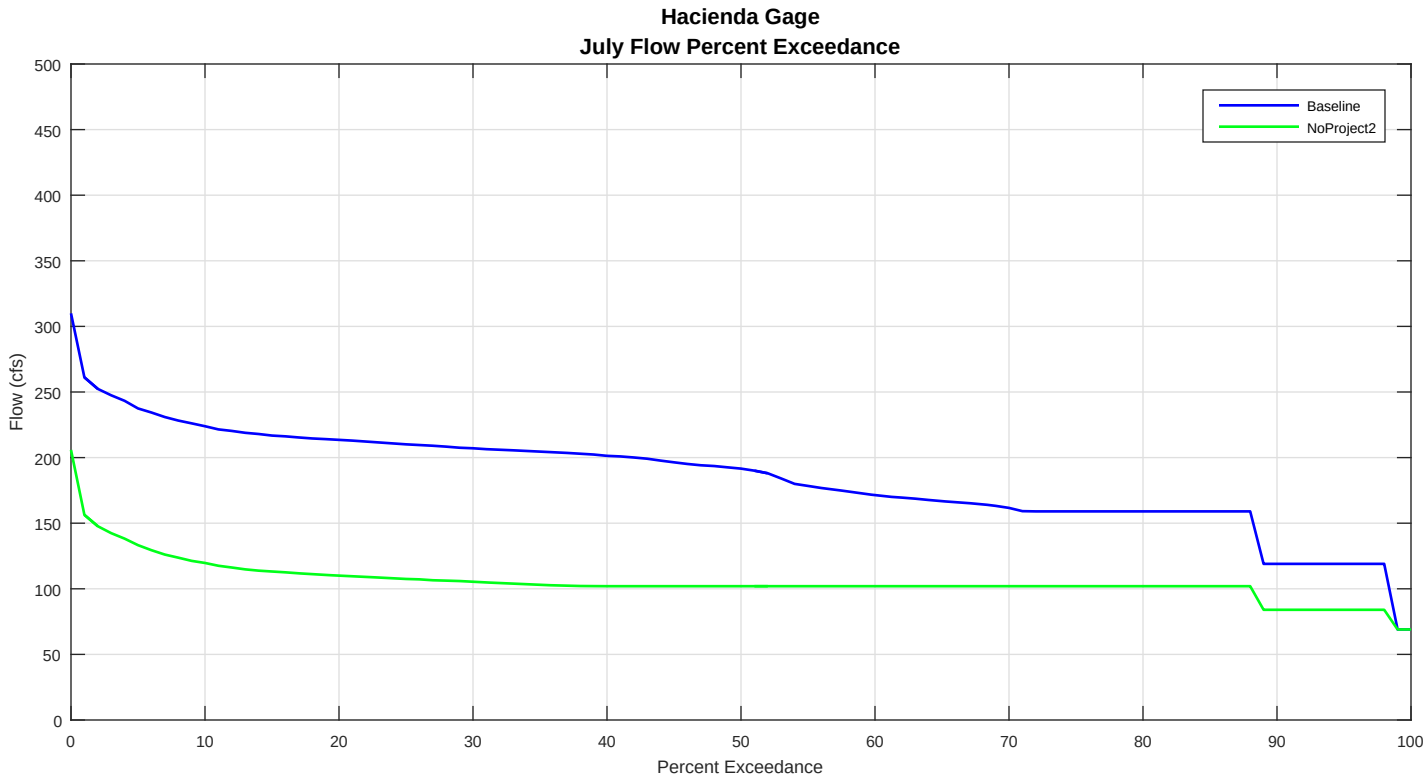
Hacienda Gage
July Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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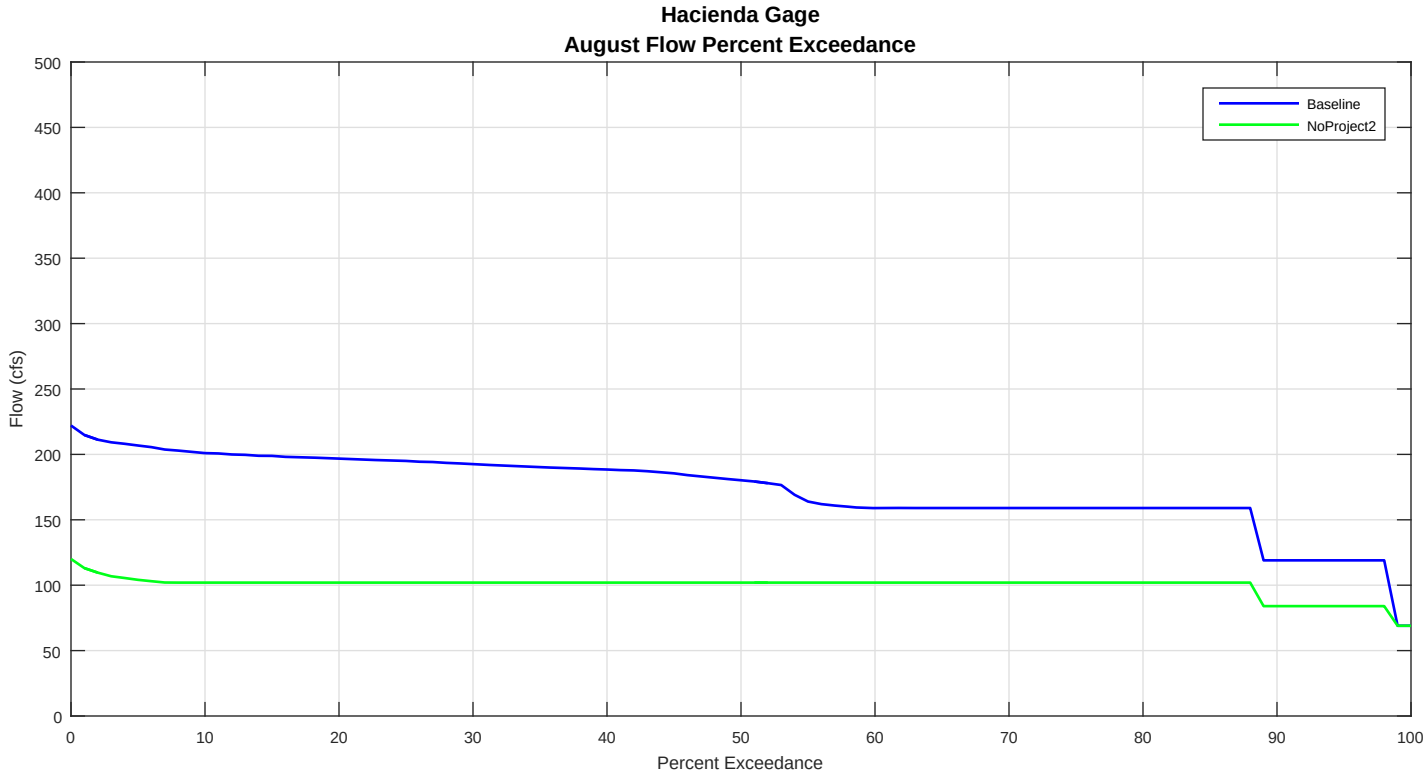
Hacienda Gage
August Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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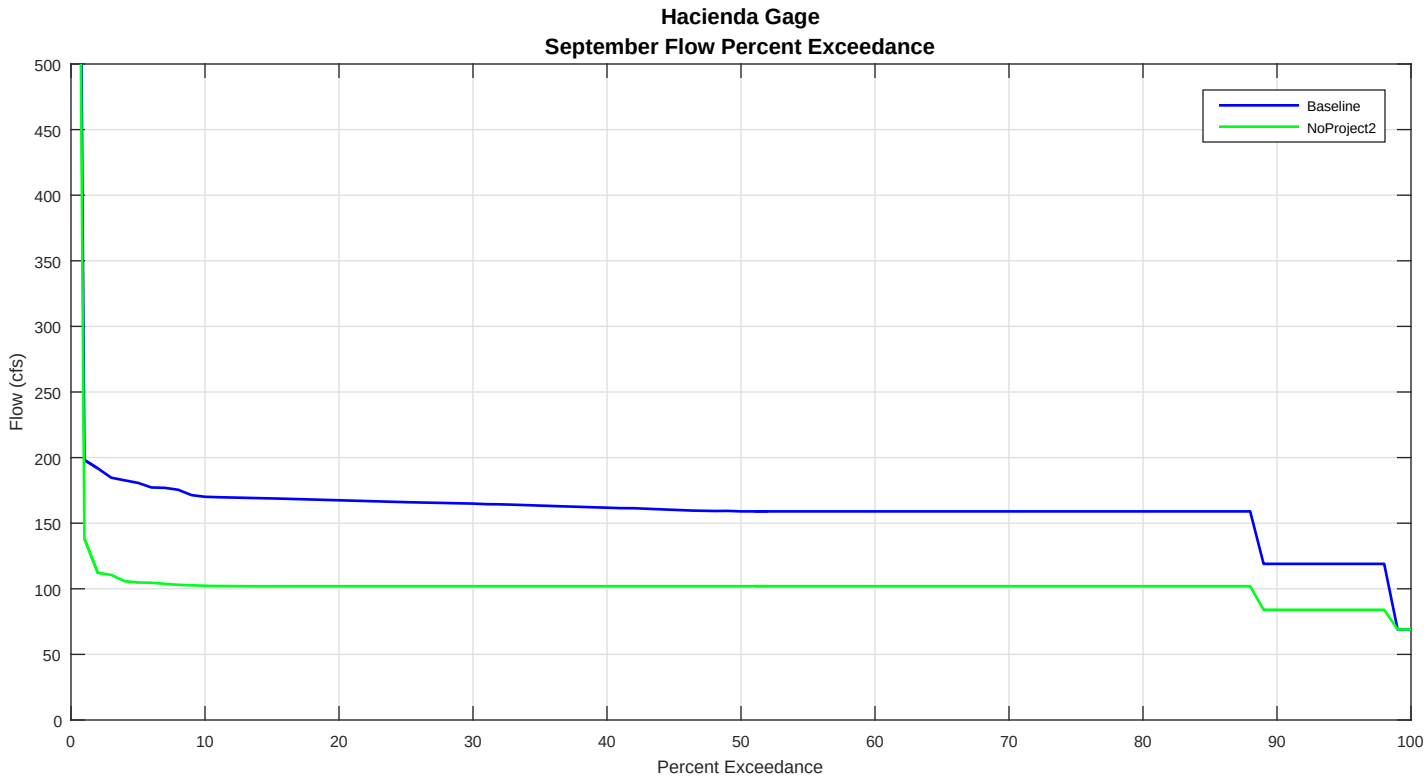
Hacienda Gage
September Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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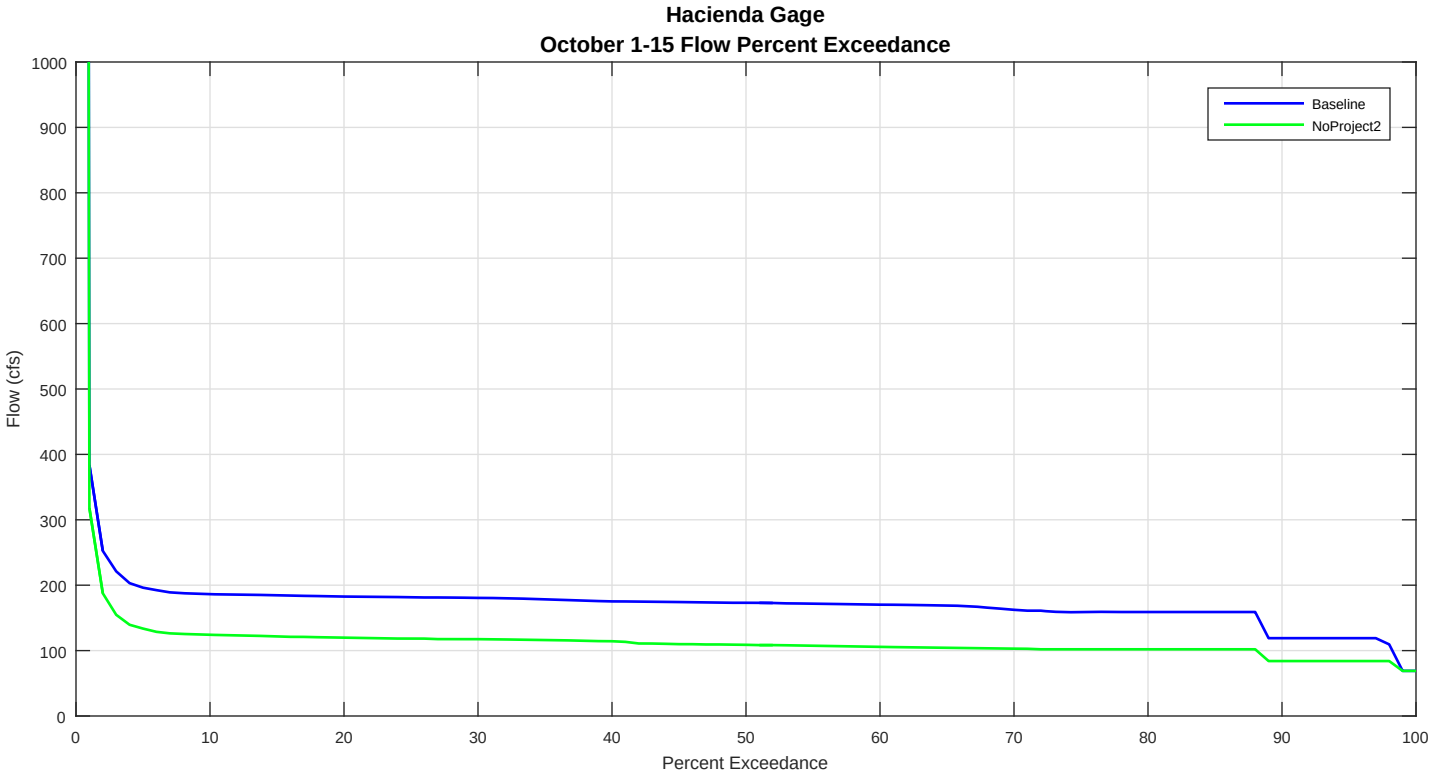
Hacienda Gage
October 1-15 Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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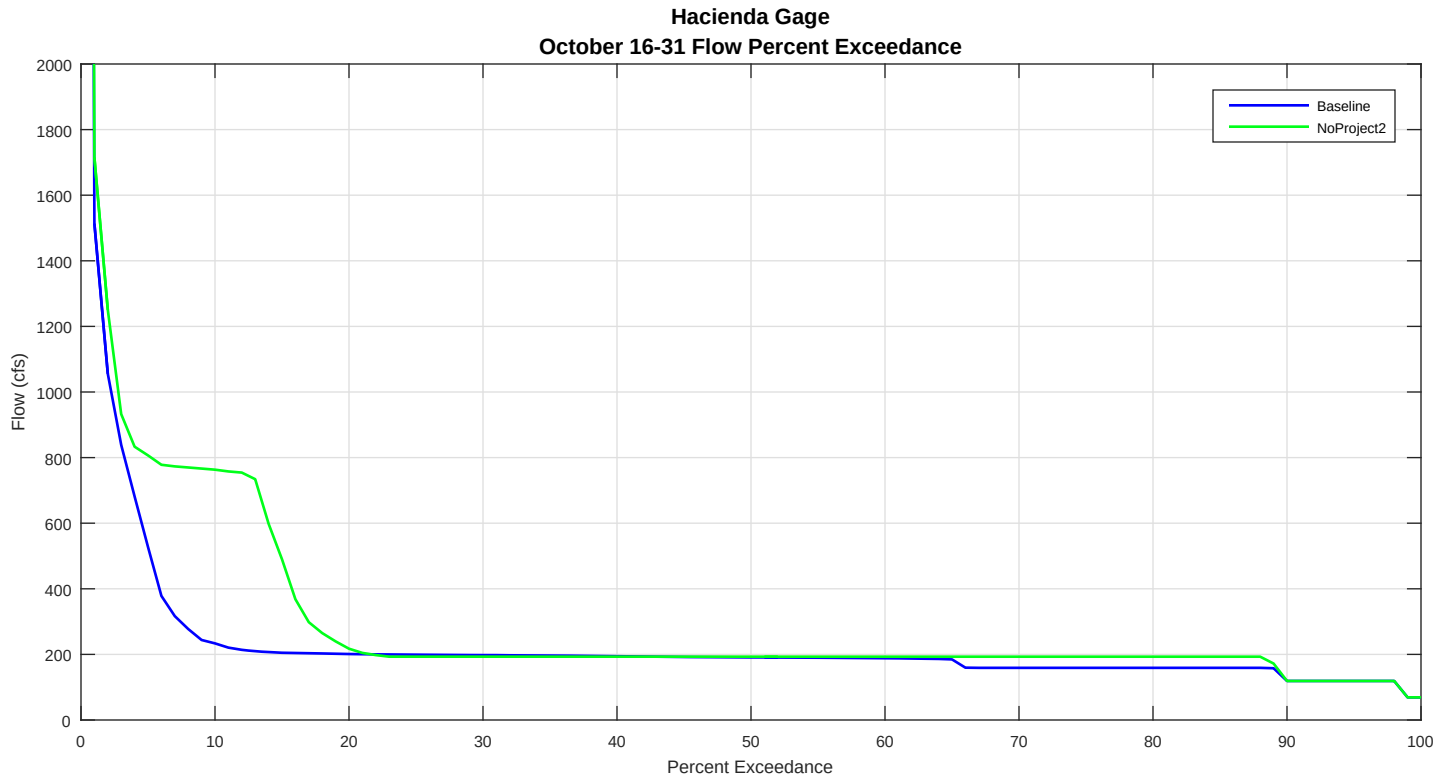
Hacienda Gage
October 16-31 Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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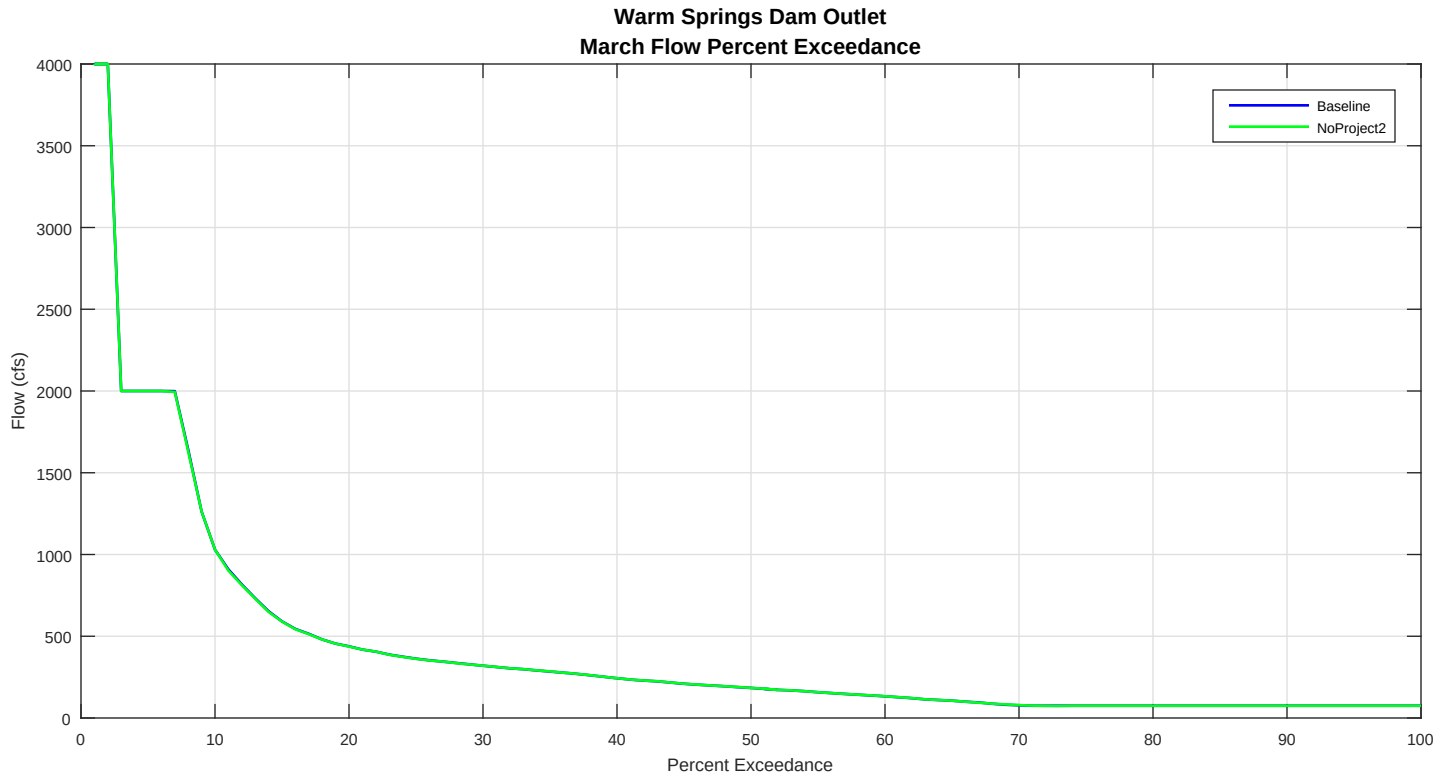
Warm Springs Dam Outlet
March Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
0
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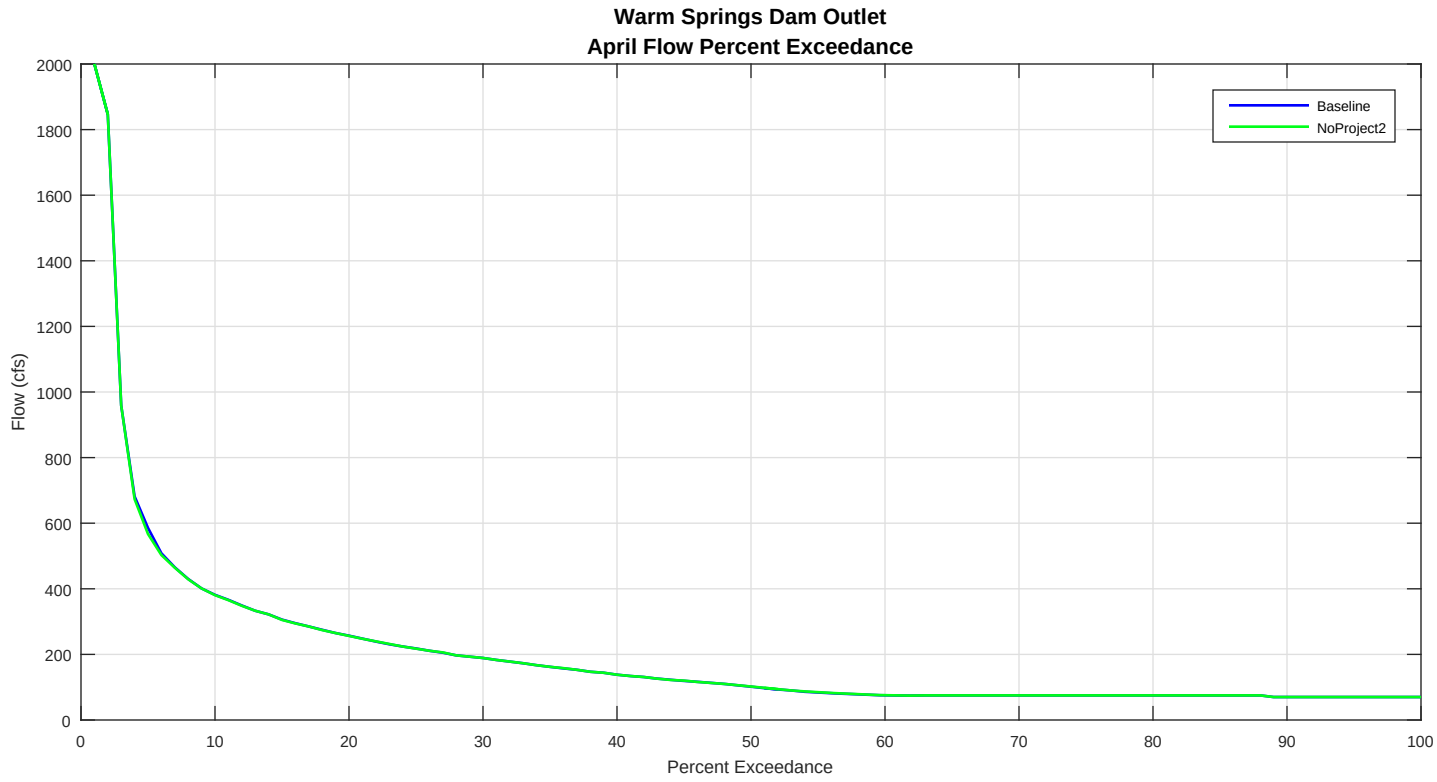
Warm Springs Dam Outlet
April Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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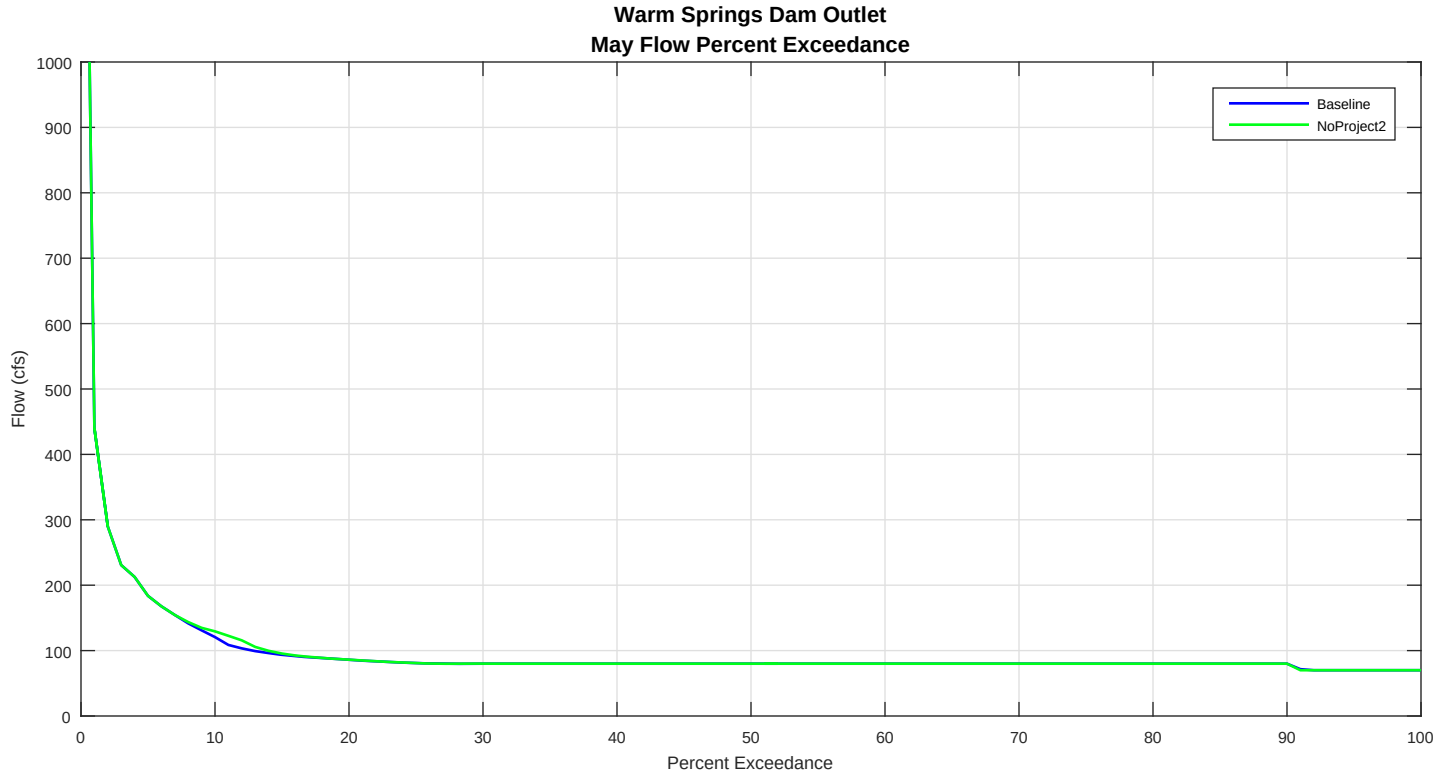
Warm Springs Dam Outlet
May Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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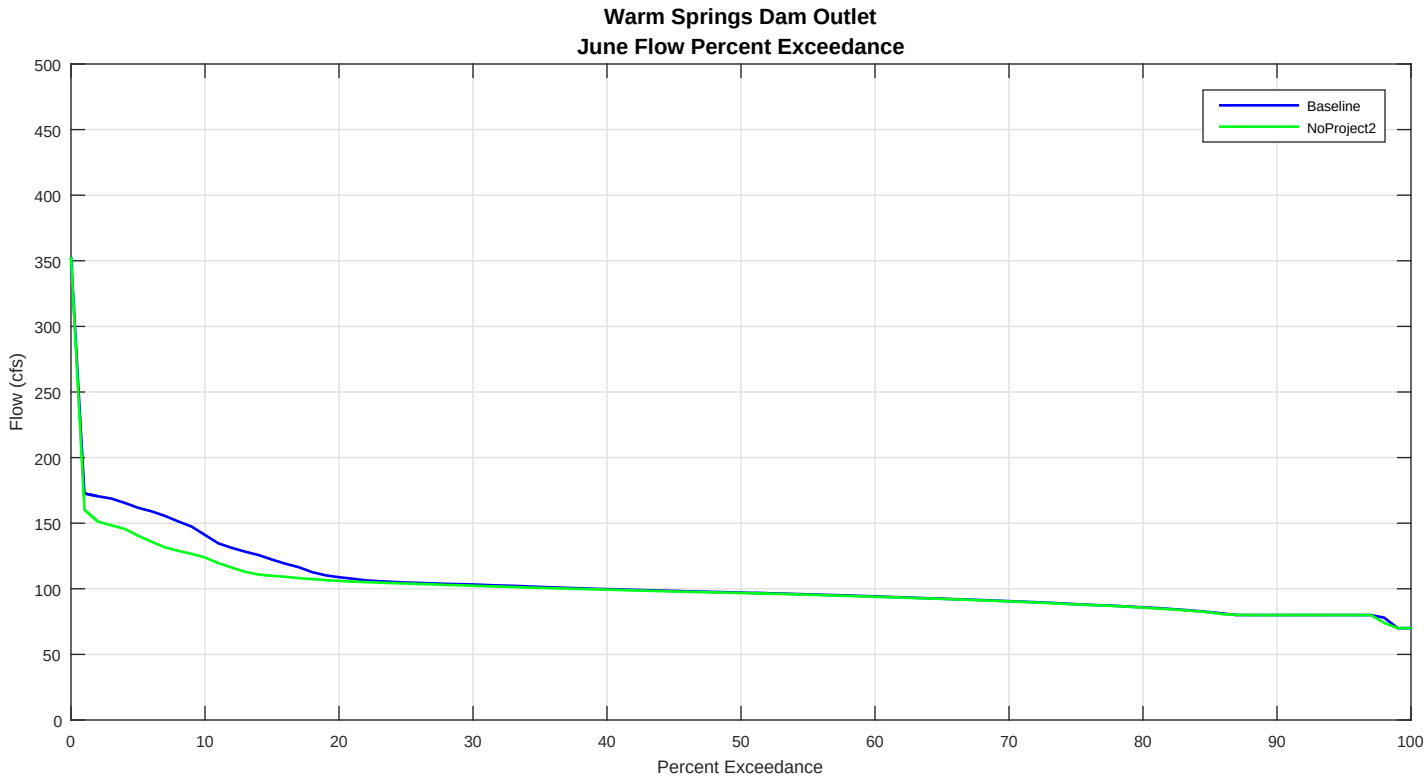
Warm Springs Dam Outlet
June Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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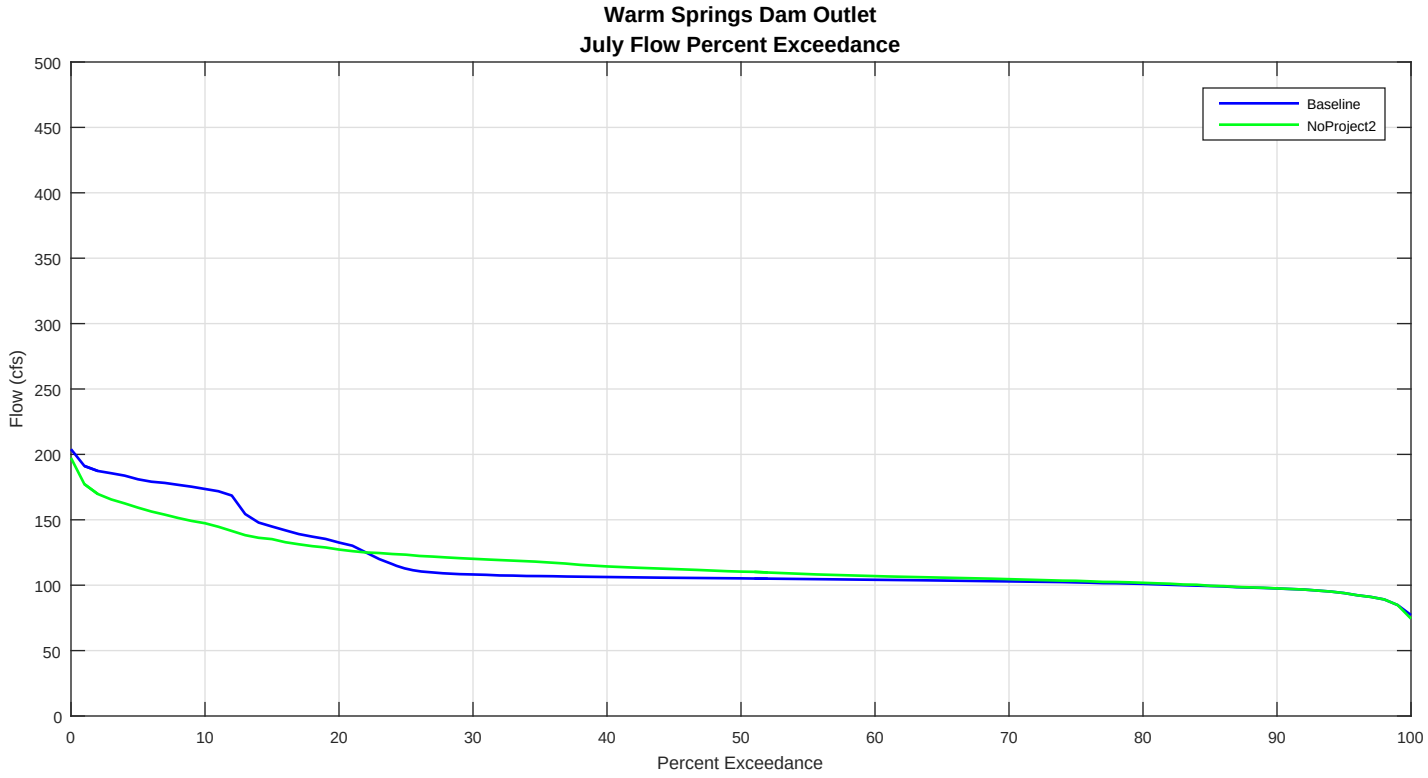
Warm Springs Dam Outlet
July Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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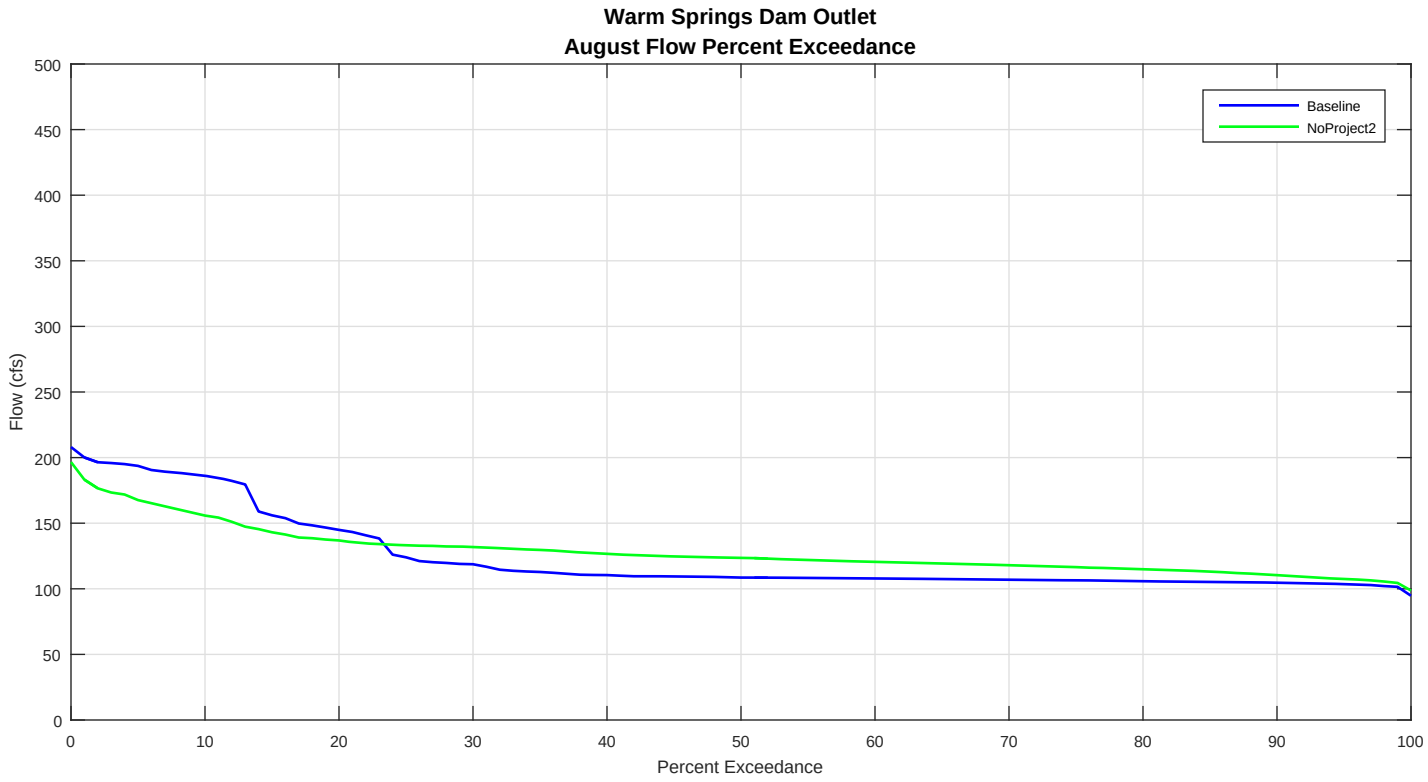
Warm Springs Dam Outlet
August Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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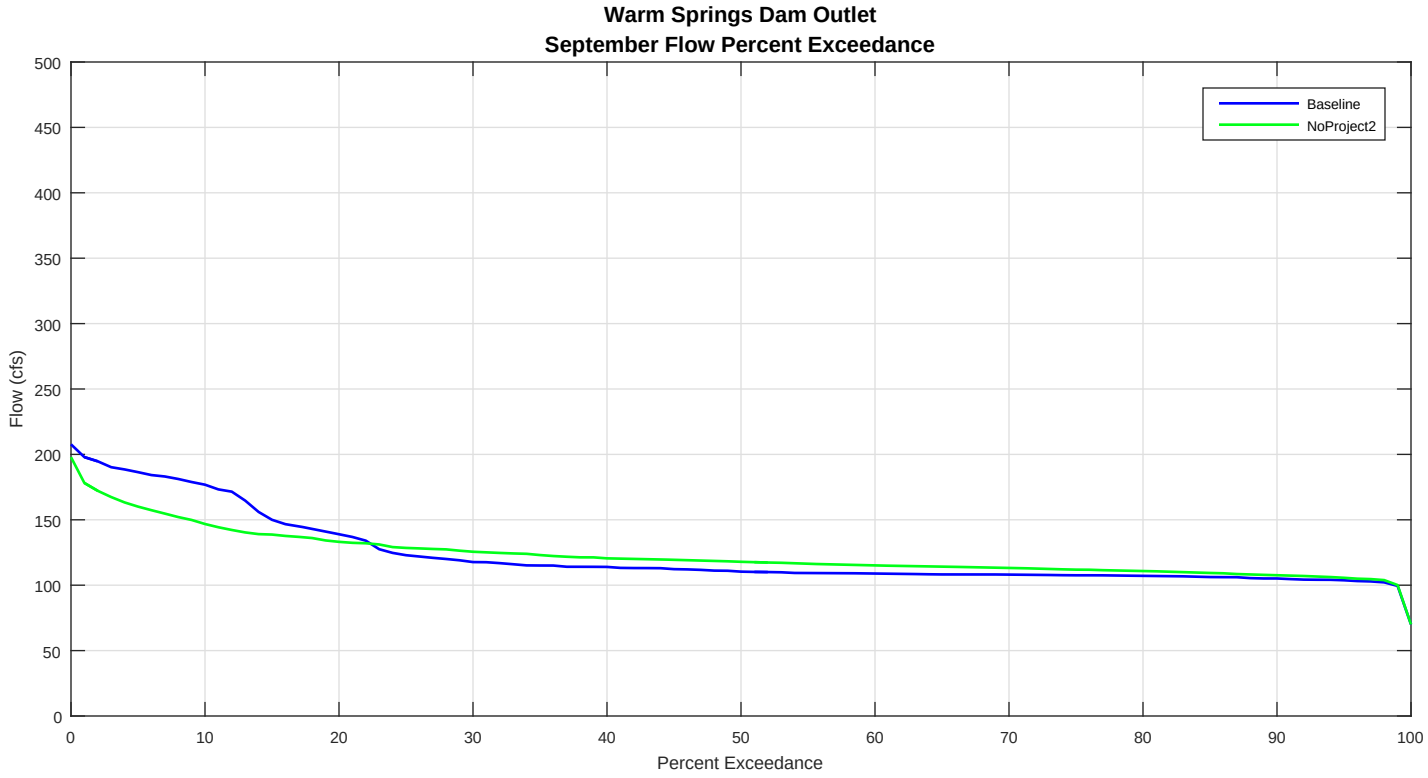
Warm Springs Dam Outlet
September Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
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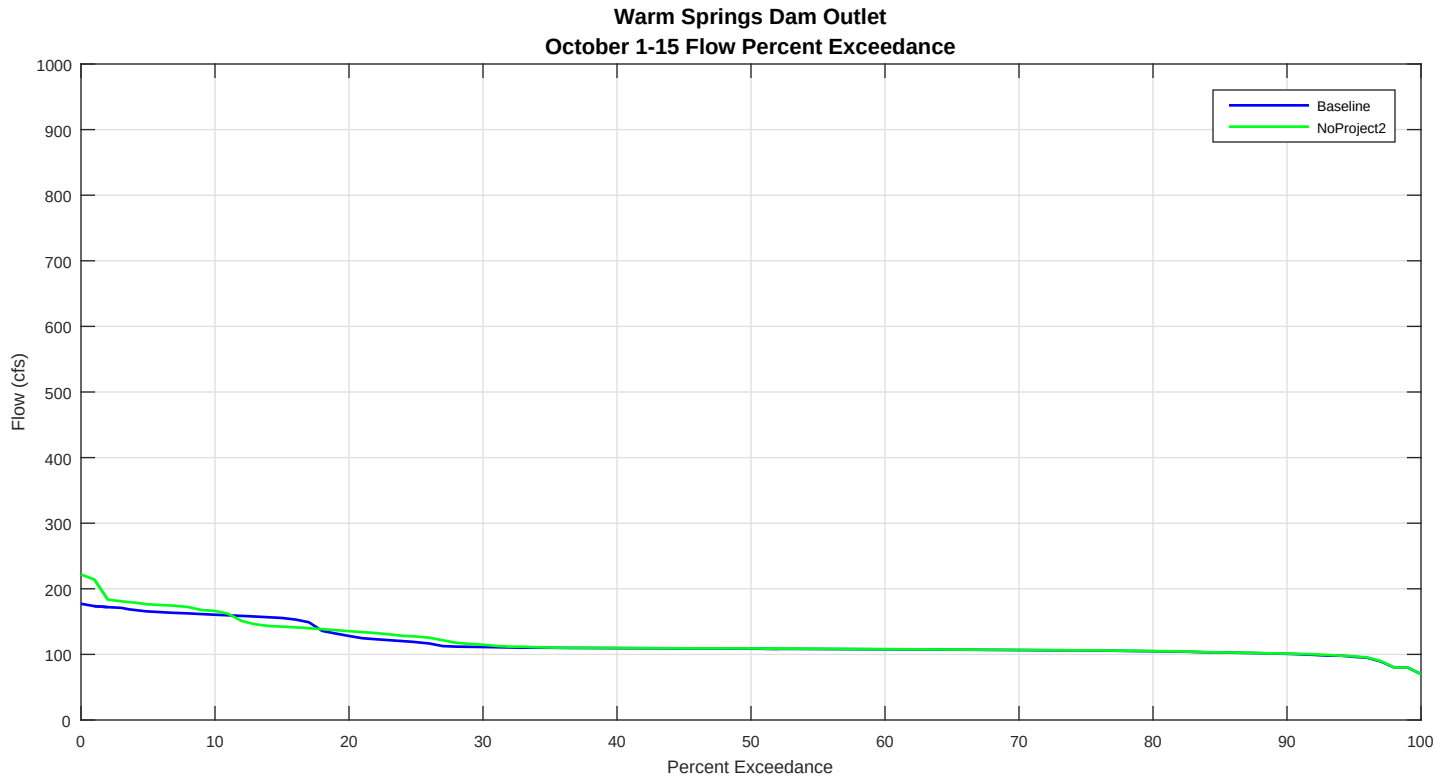
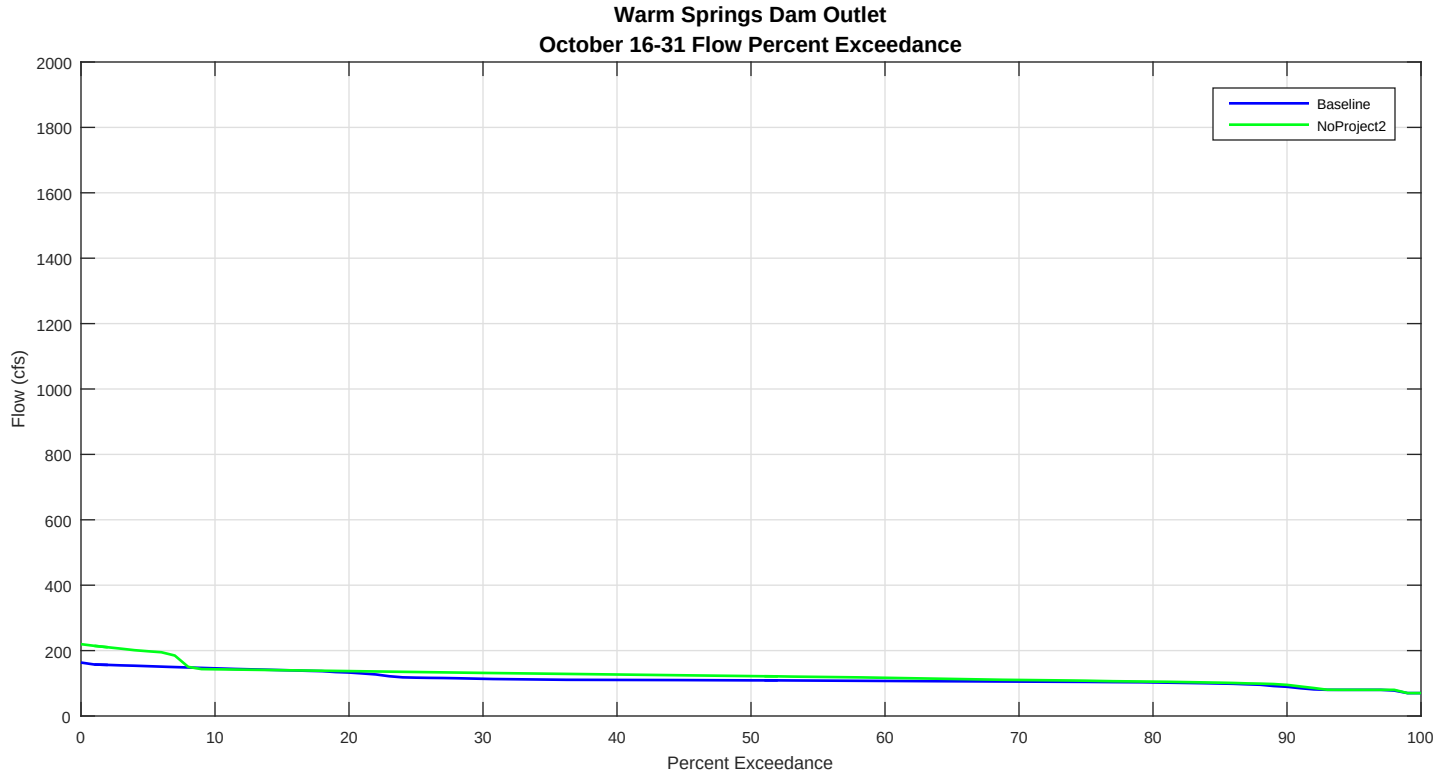
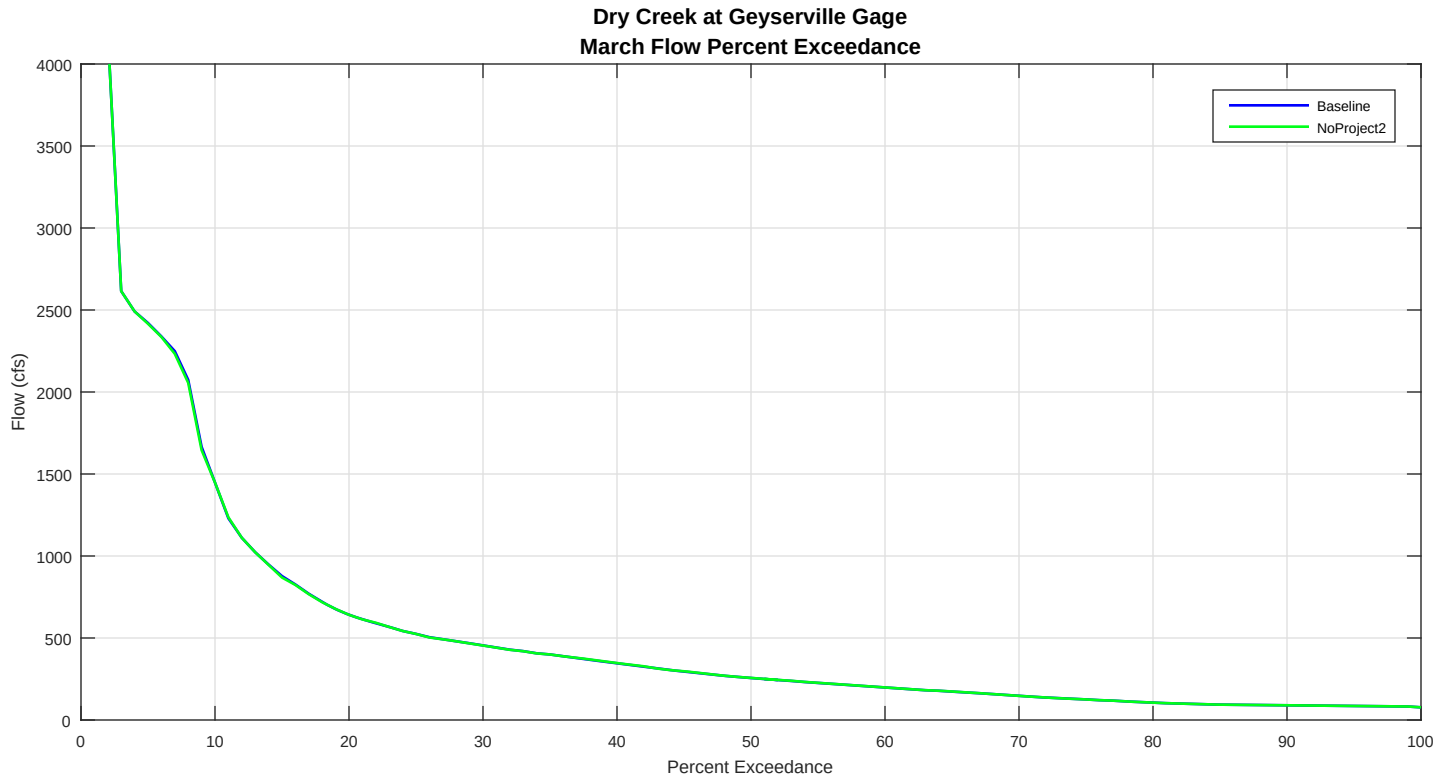
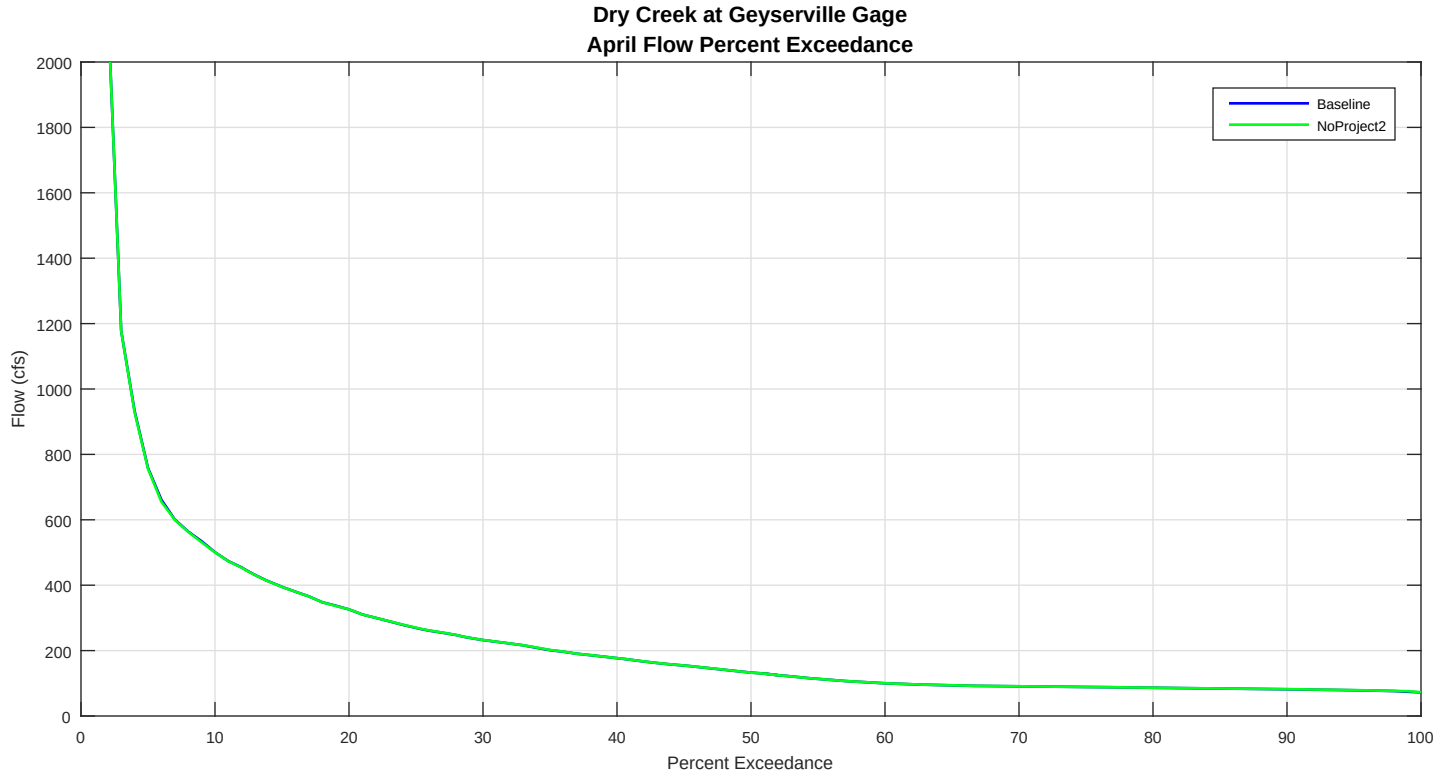
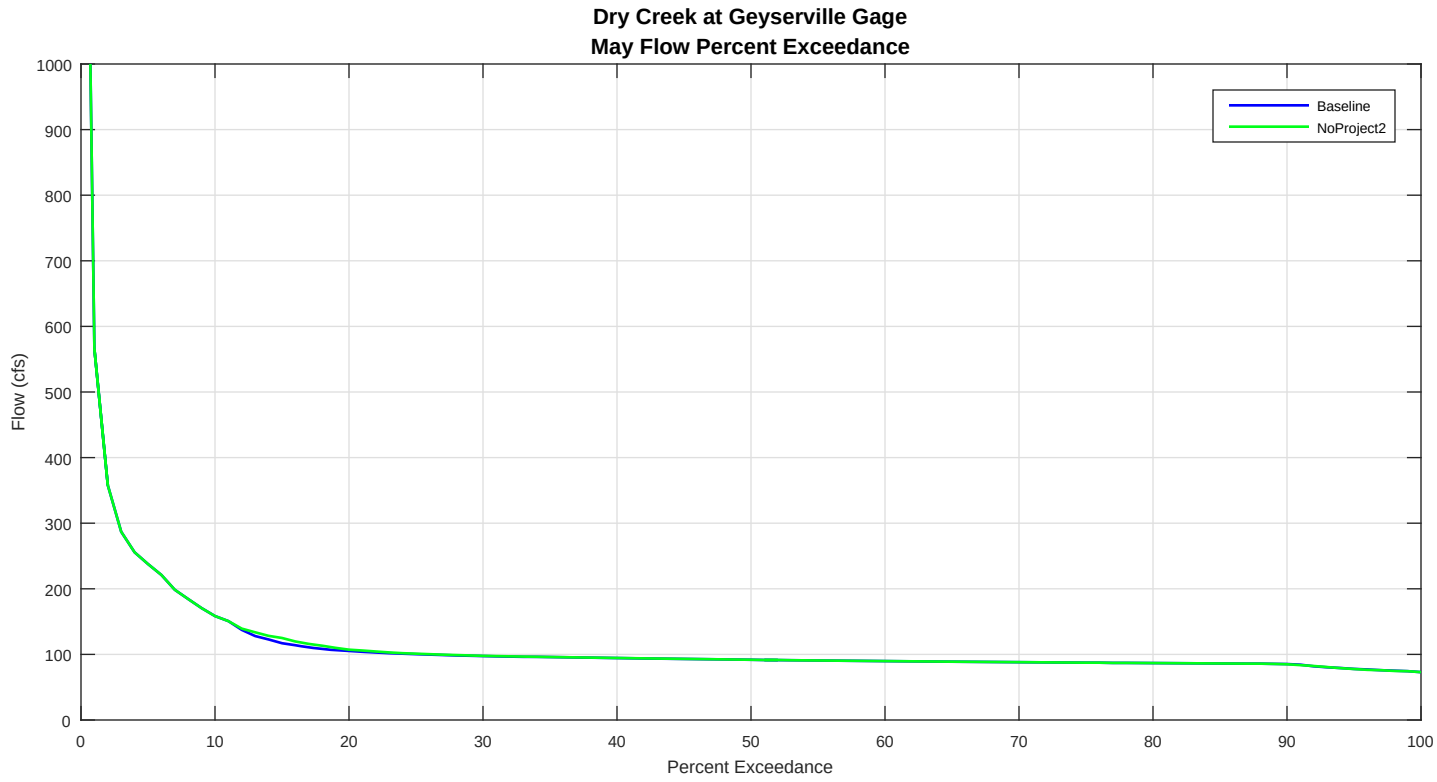
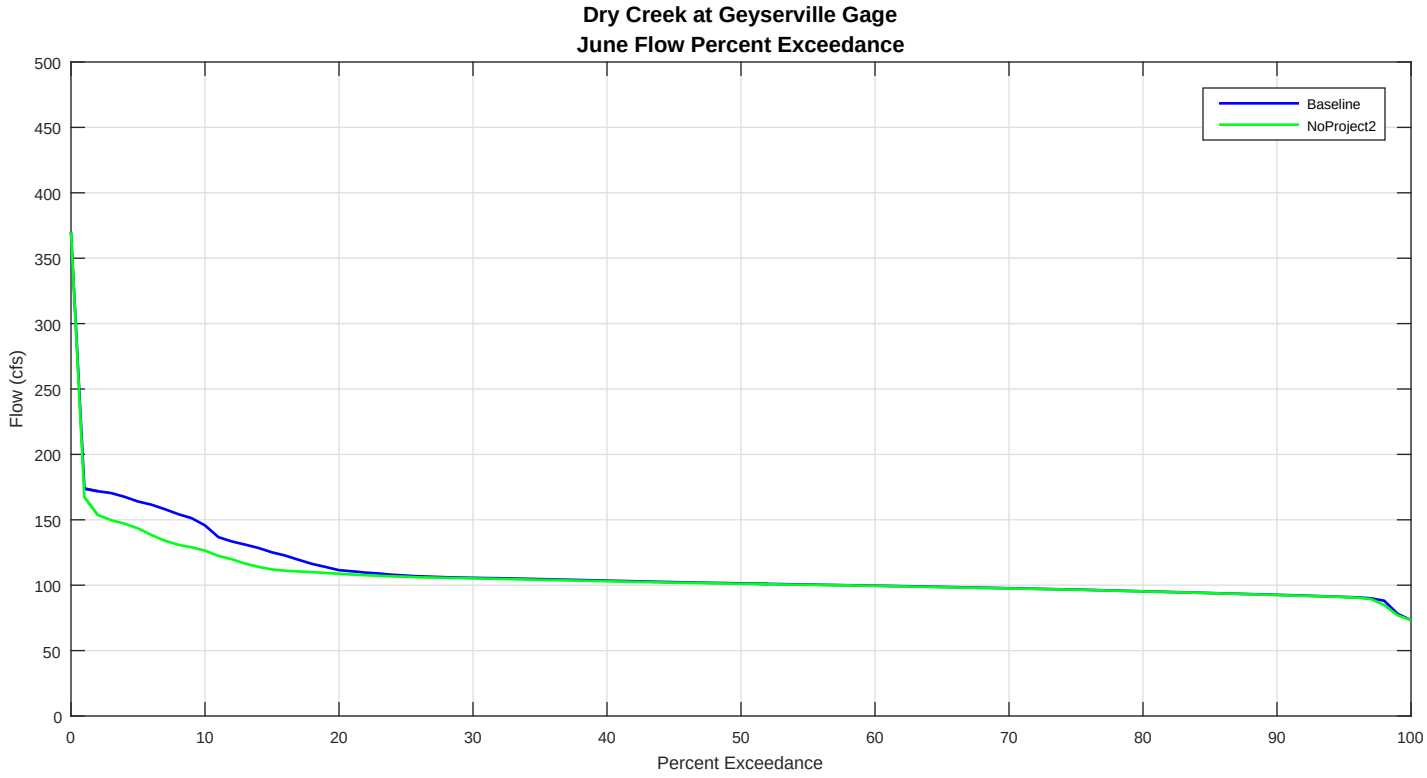

Warm Springs Dam Outlet
October 1-15 Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100

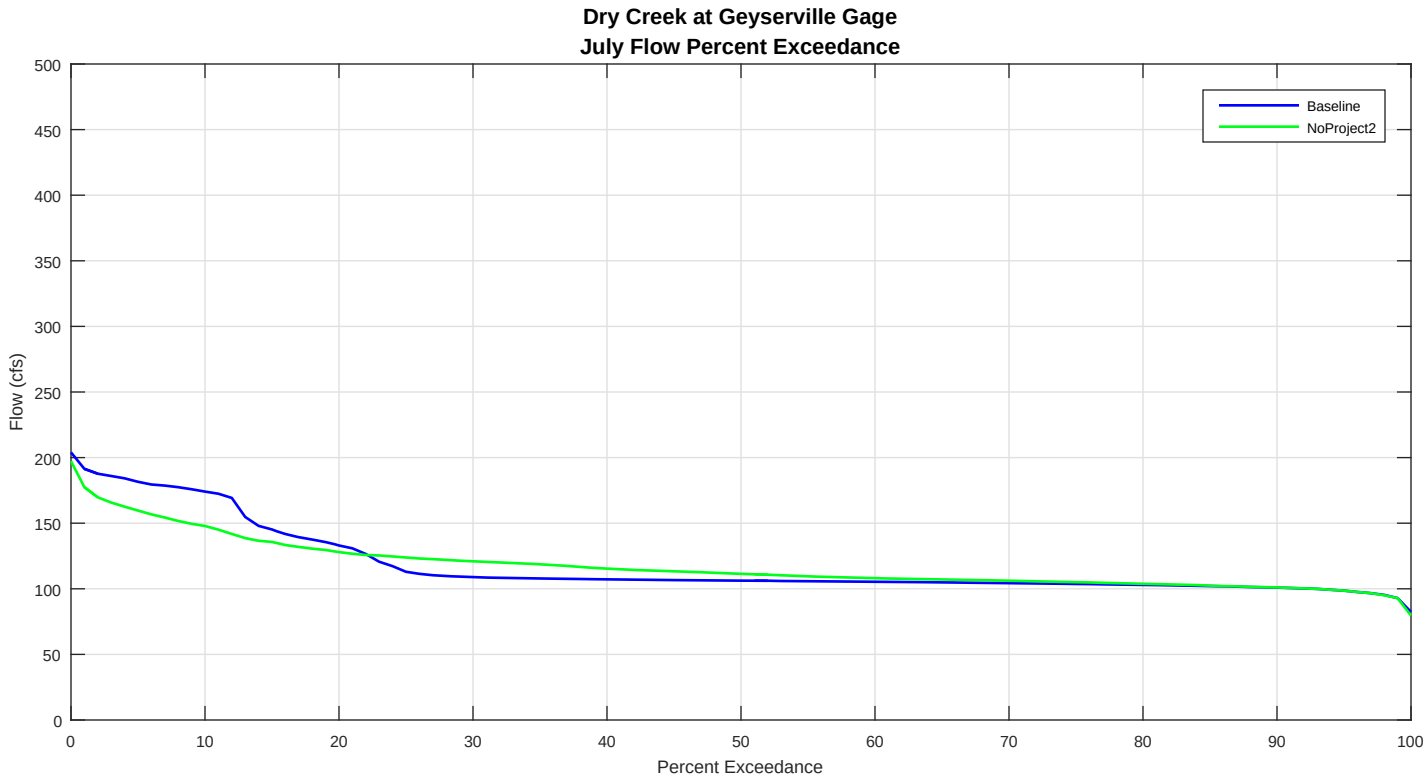

Warm Springs Dam Outlet
October 16-31 Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100

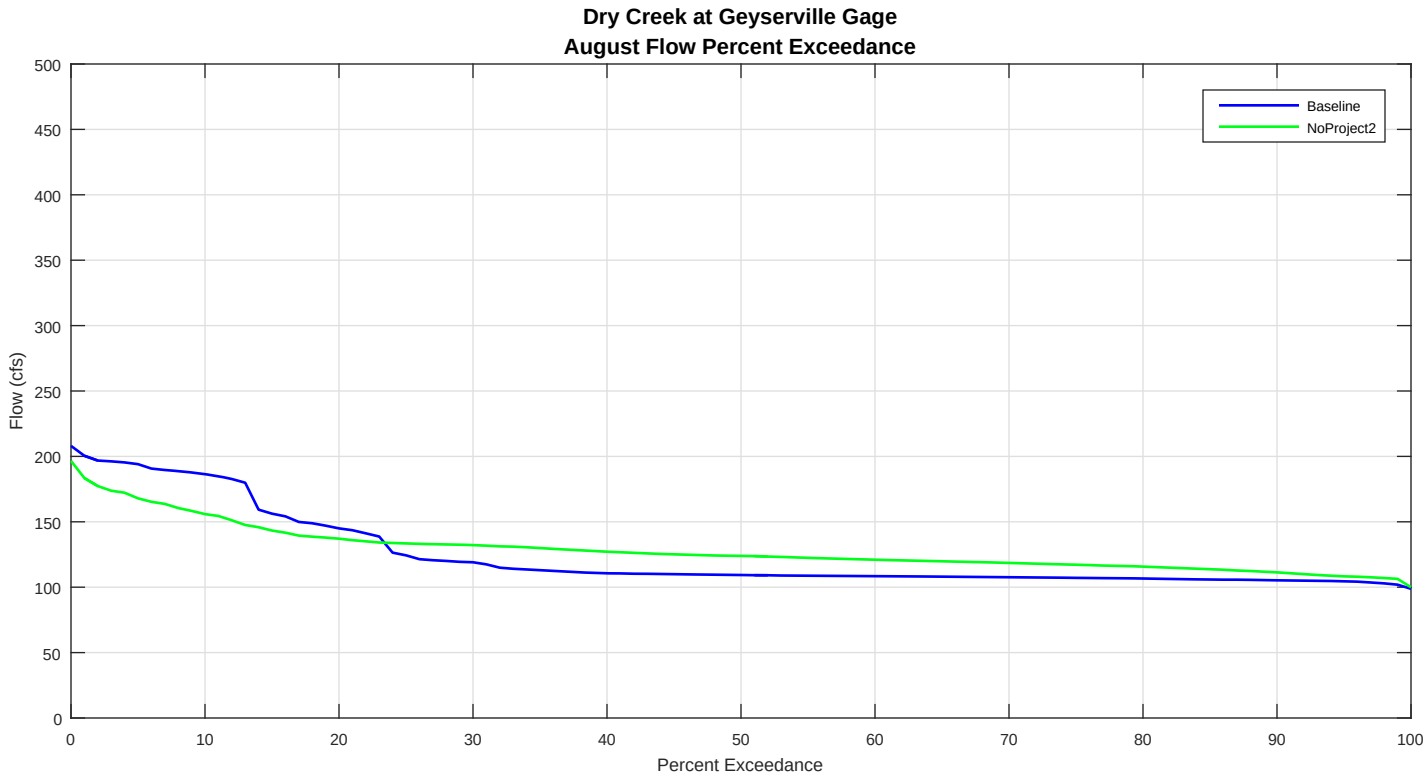

Dry Creek at Geyserville Gage
March Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
0
500
1000
1500
2000
2500
3000
3500
4000
0
10
20
30
40
50
60
70
80
90
100

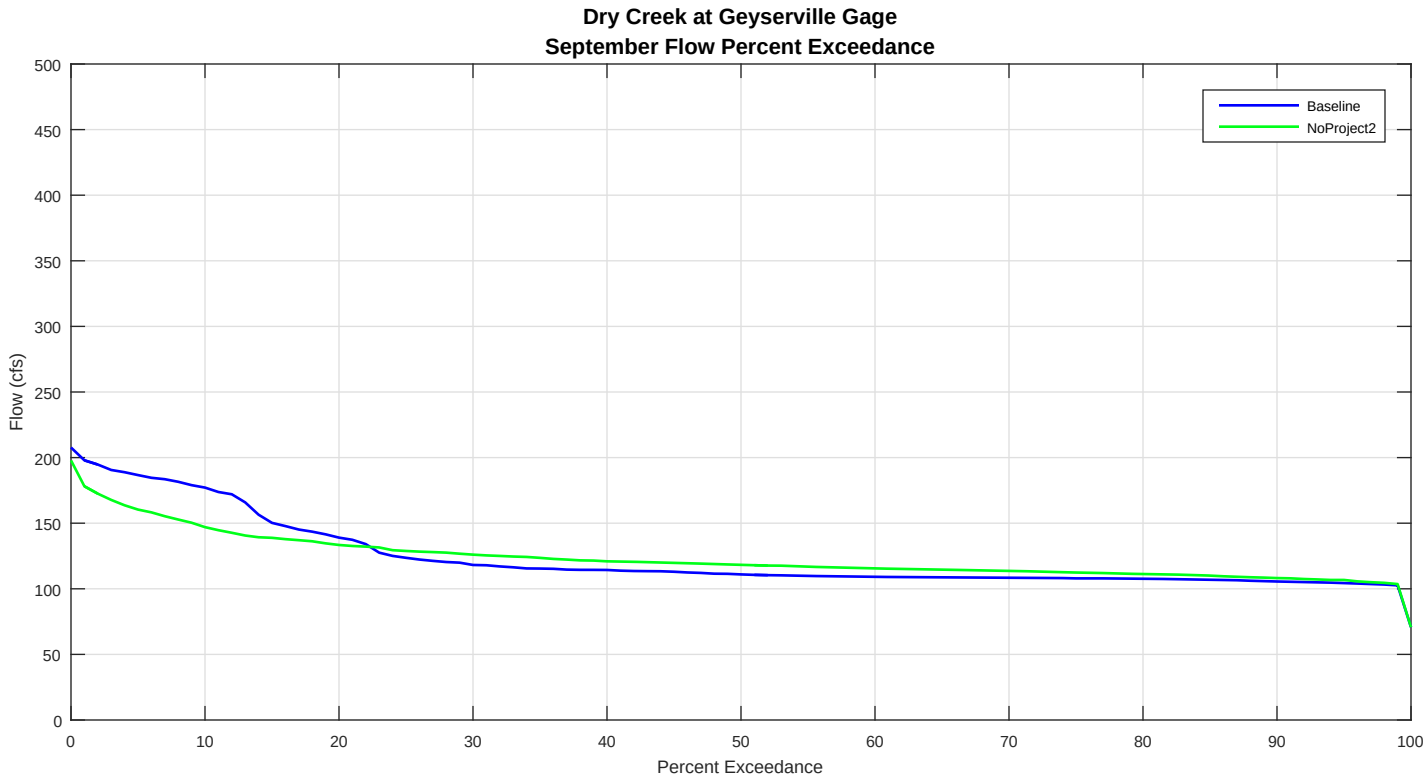

Dry Creek at Geyserville Gage
April Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100

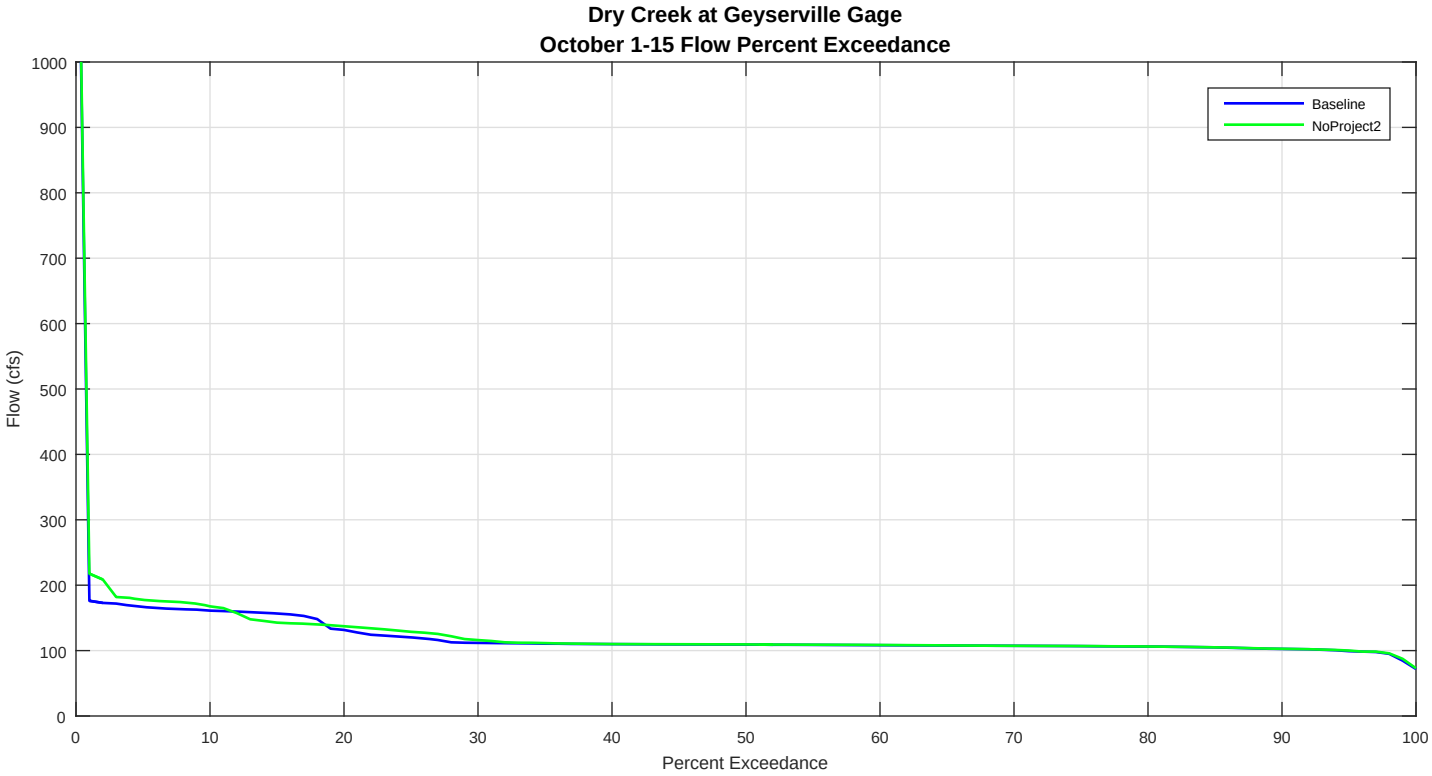

Dry Creek at Geyserville Gage
May Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100

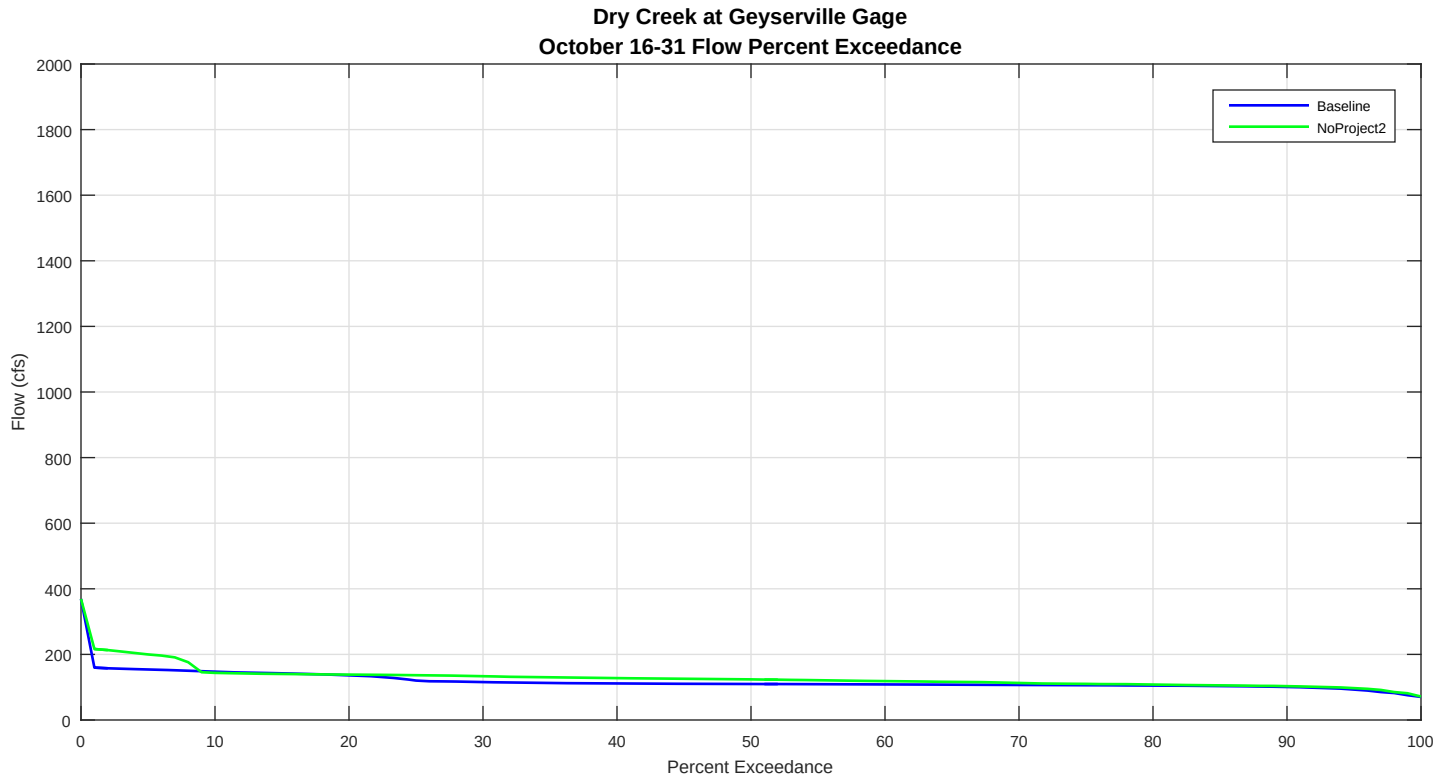

Dry Creek at Geyserville Gage
June Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

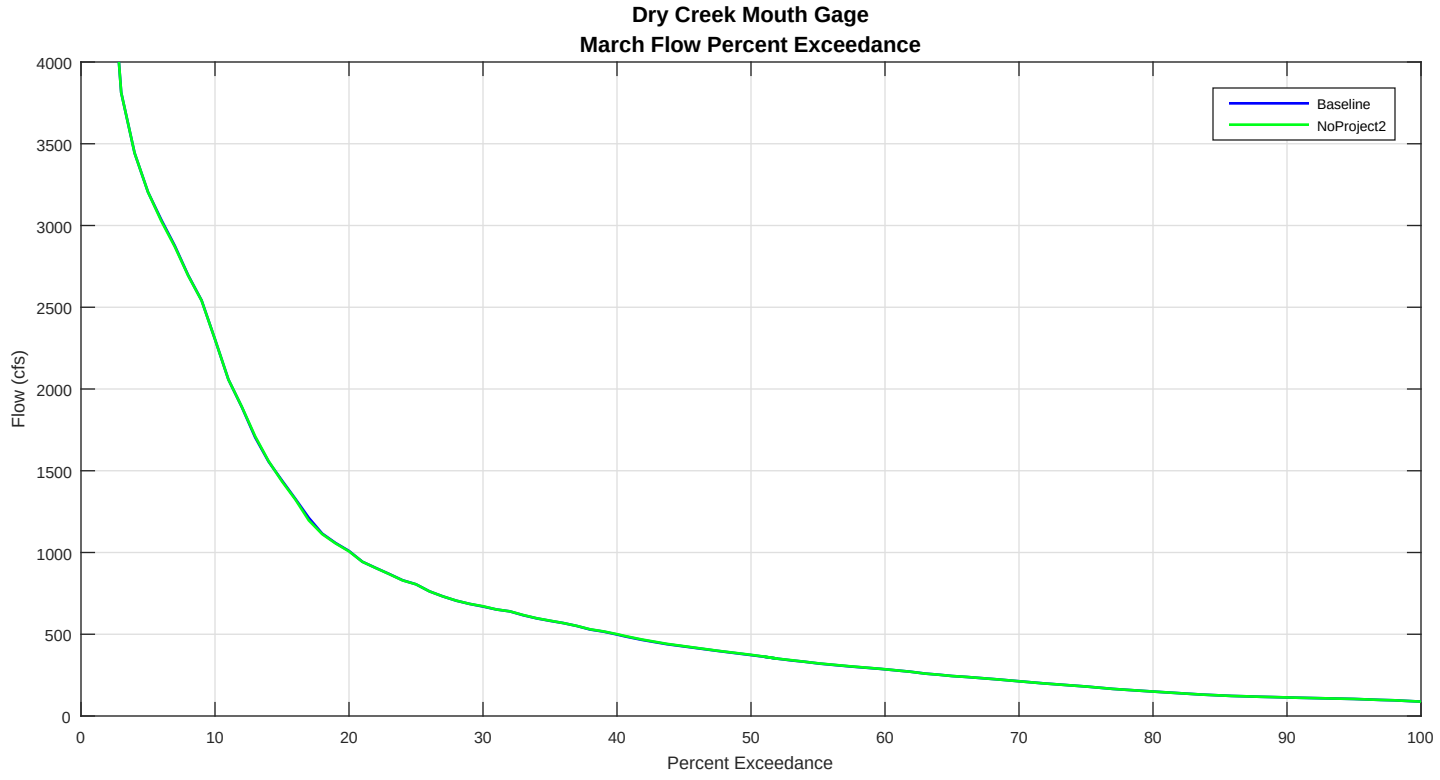

Dry Creek at Geyserville Gage
July Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

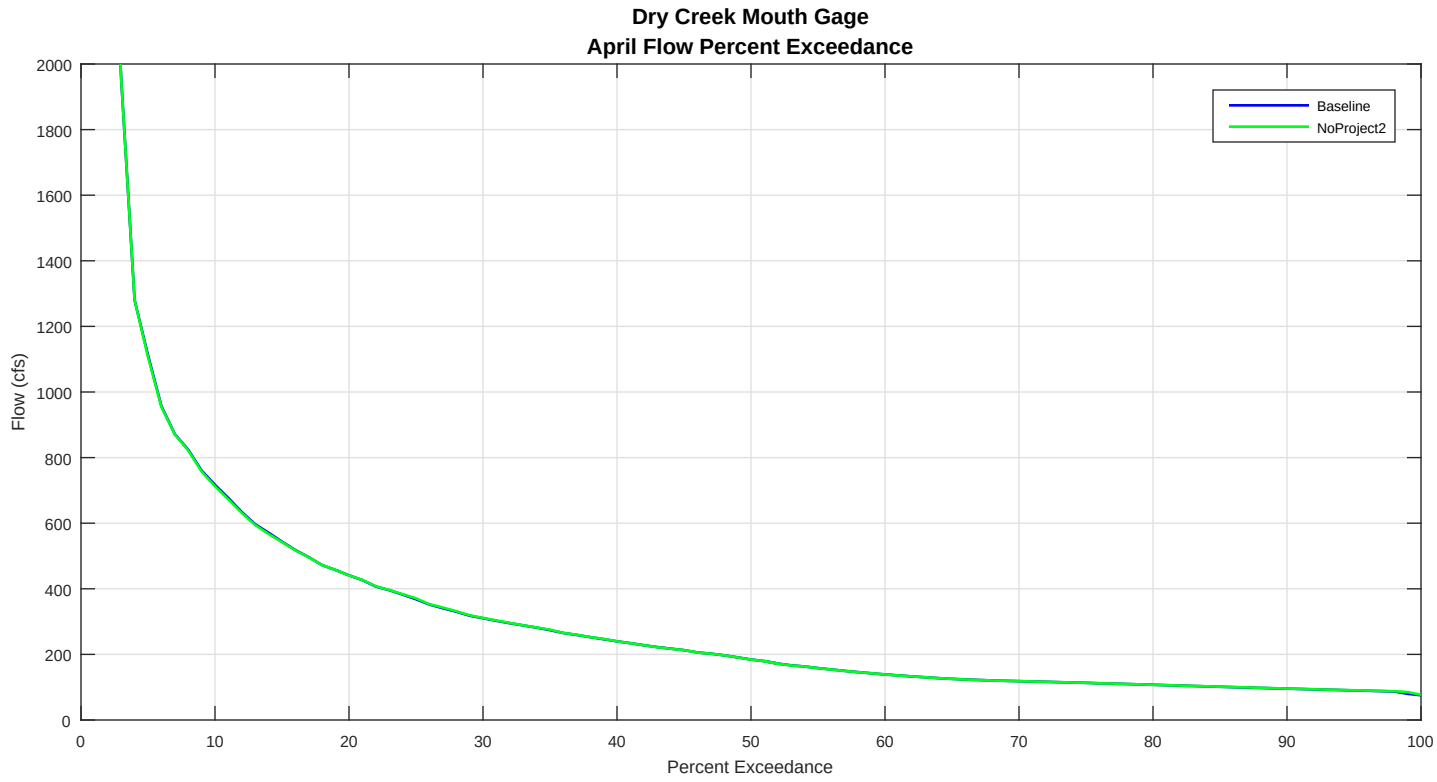

Dry Creek at Geyserville Gage
August Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

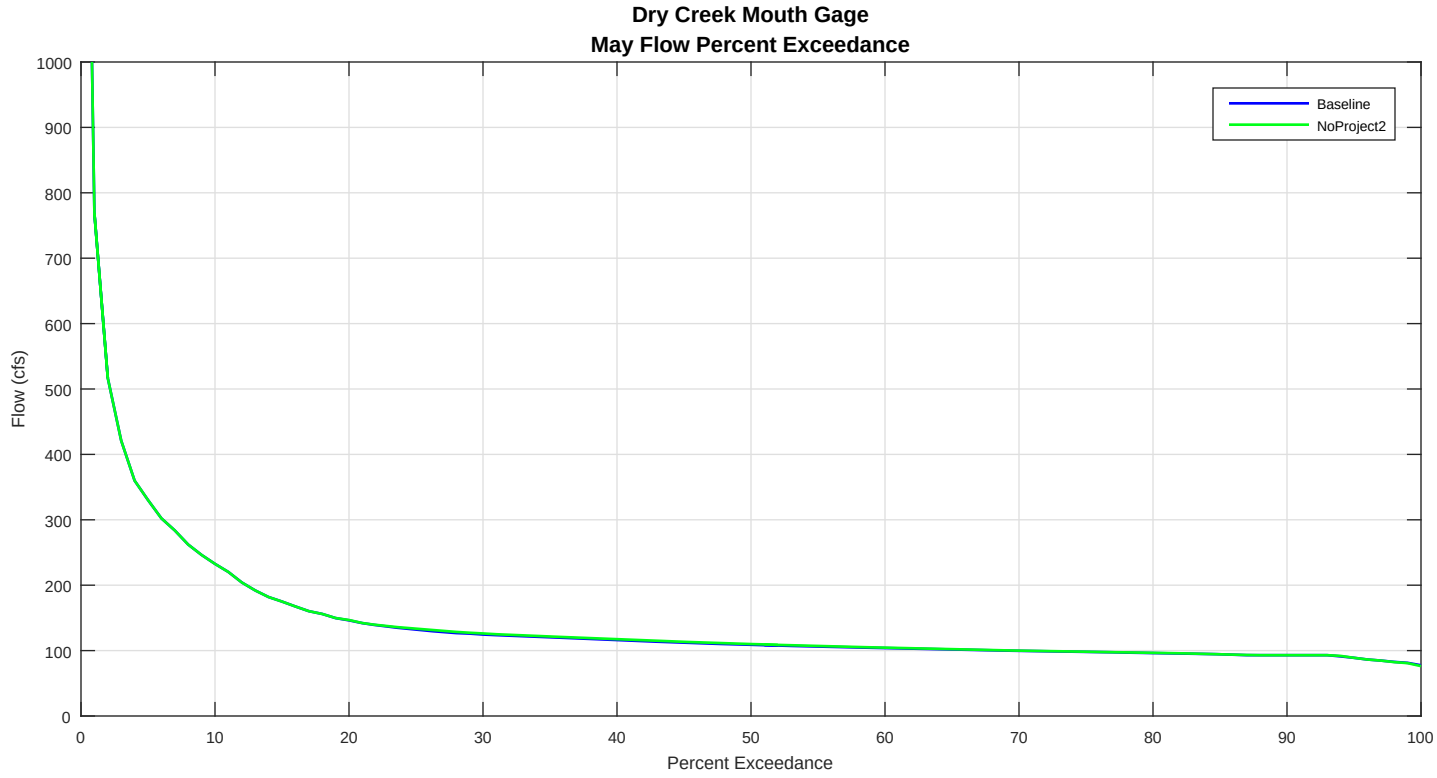

Dry Creek at Geyserville Gage
September Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

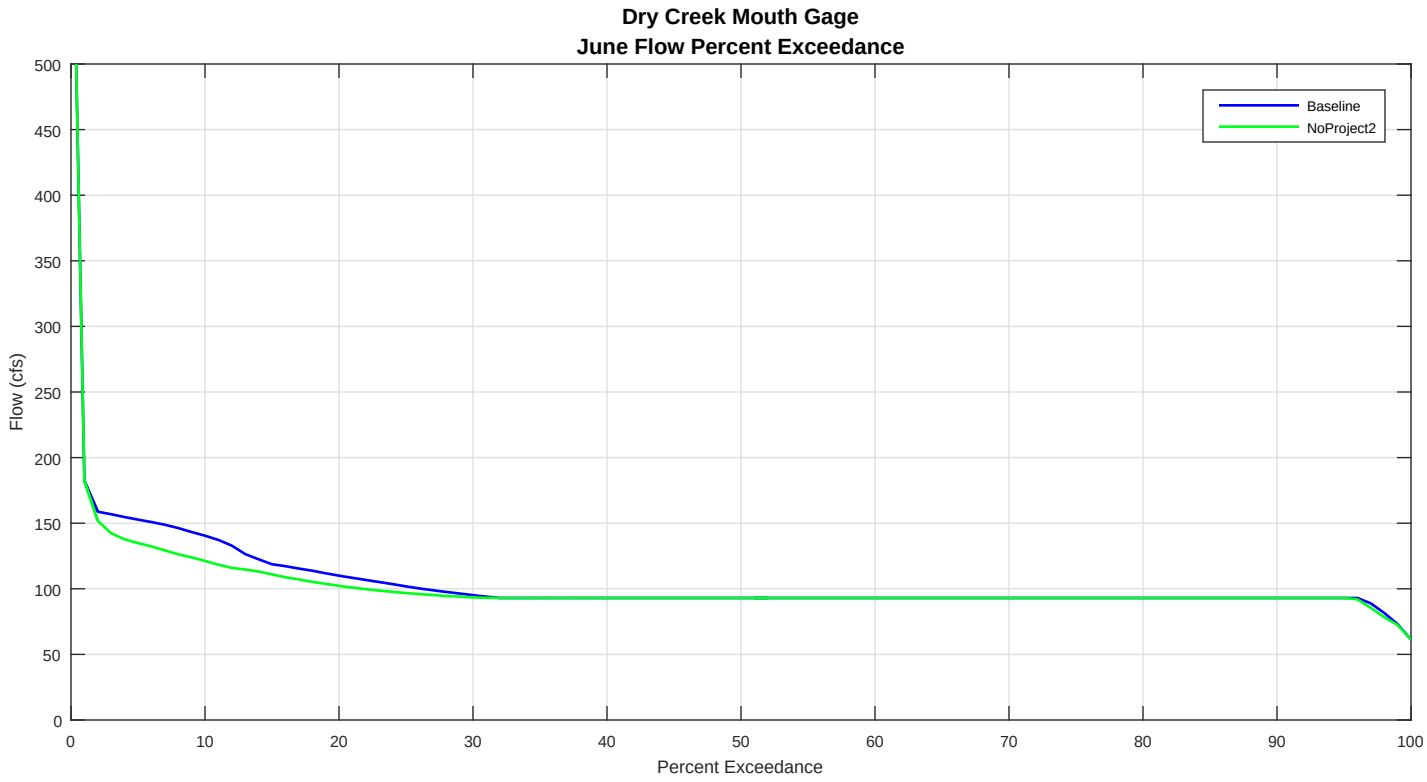

Dry Creek at Geyserville Gage
October 1-15 Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100

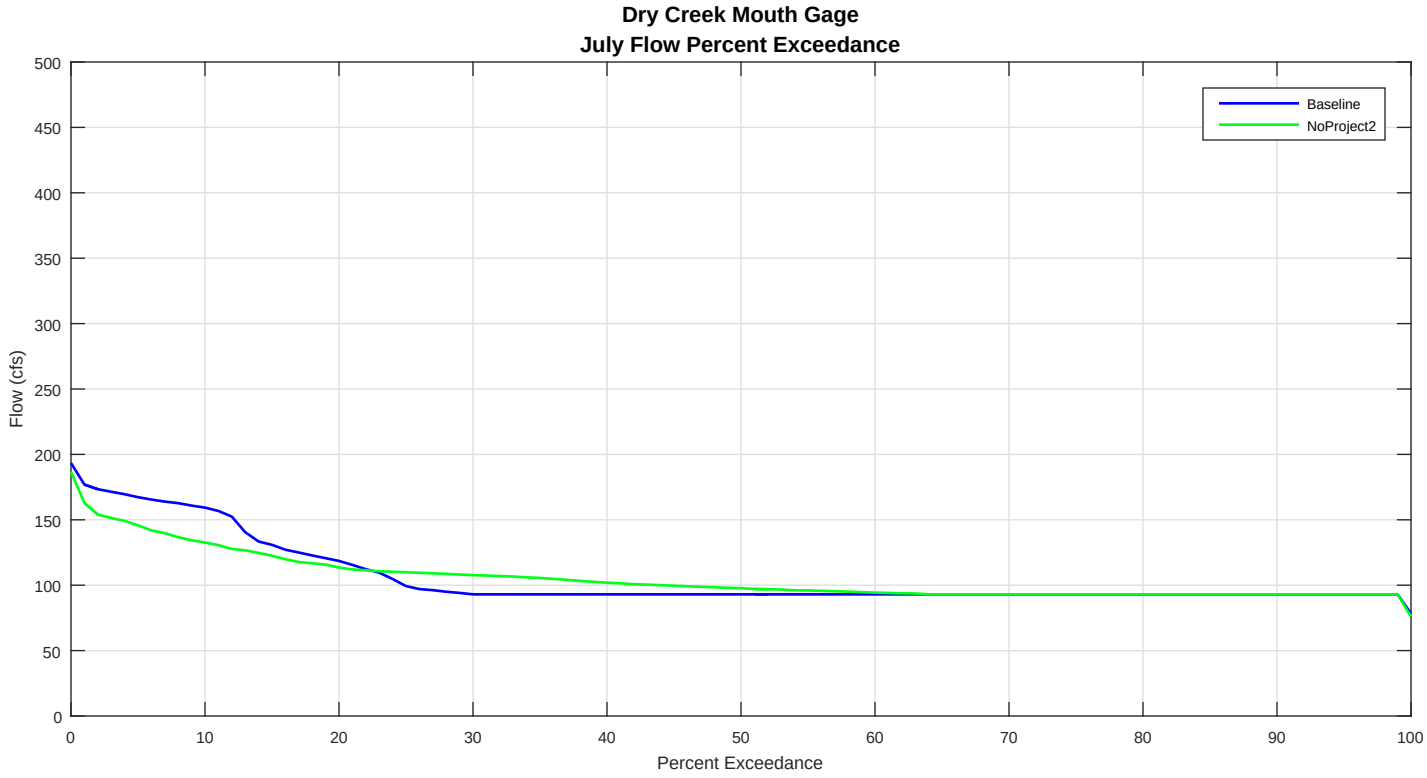

Dry Creek at Geyserville Gage
October 16-31 Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100

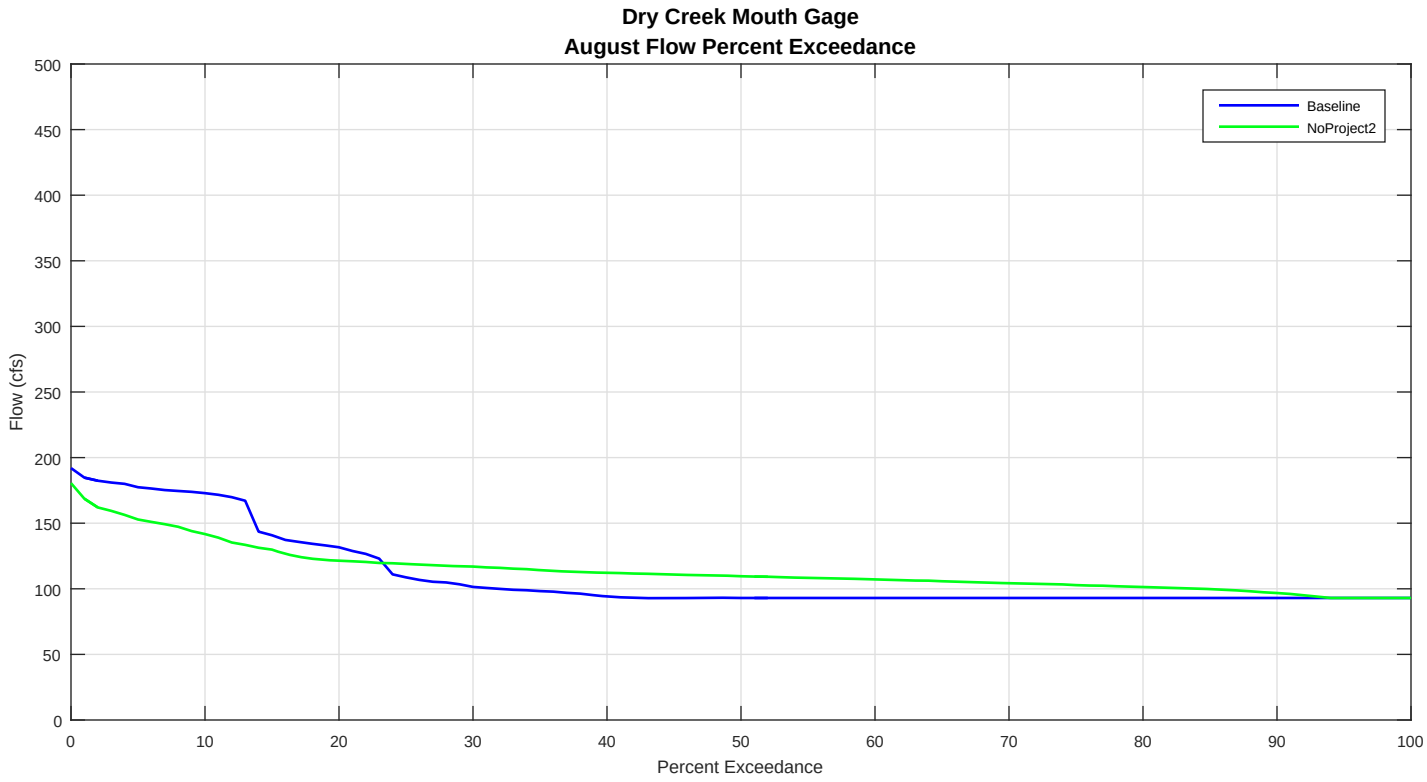

Dry Creek Mouth Gage
March Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
0
500
1000
1500
2000
2500
3000
3500
4000
0
10
20
30
40
50
60
70
80
90
100

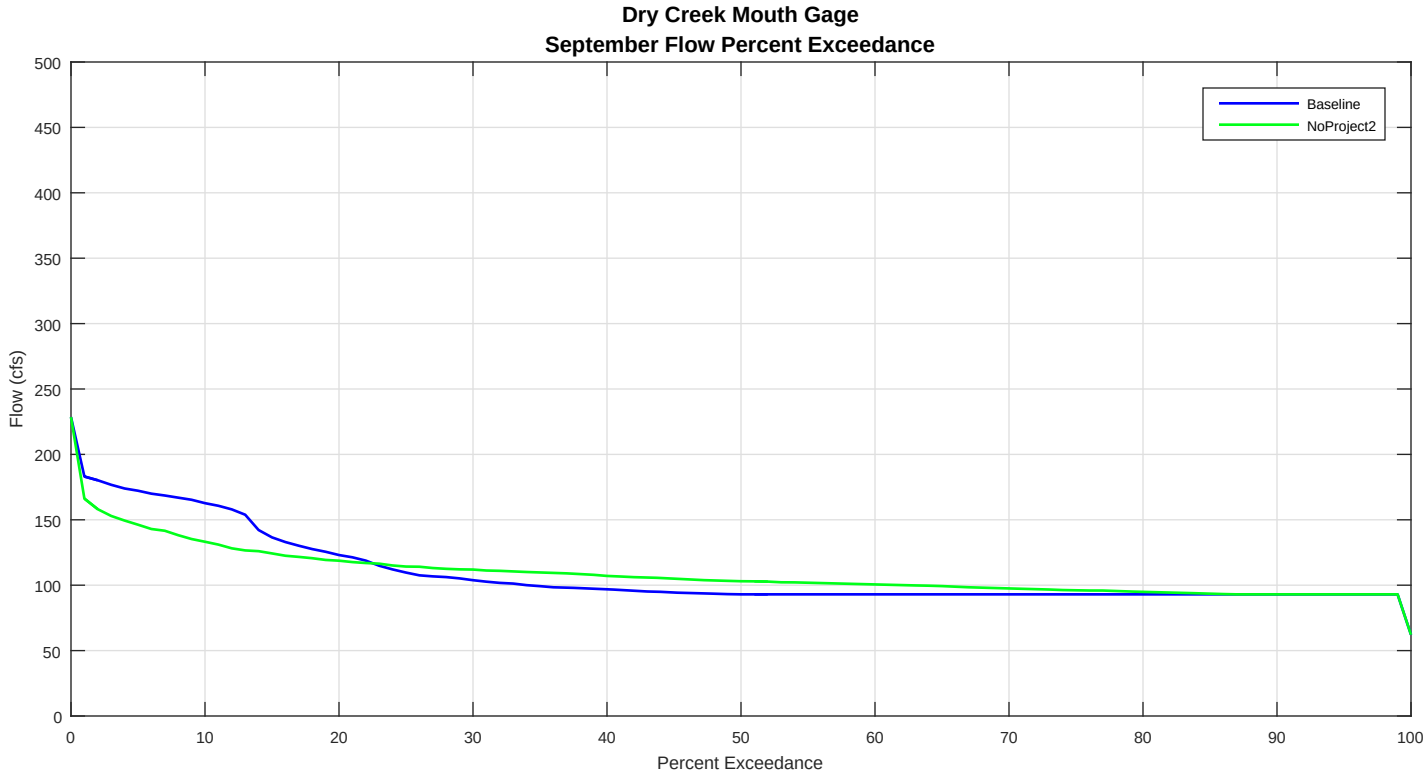

Dry Creek Mouth Gage
April Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100

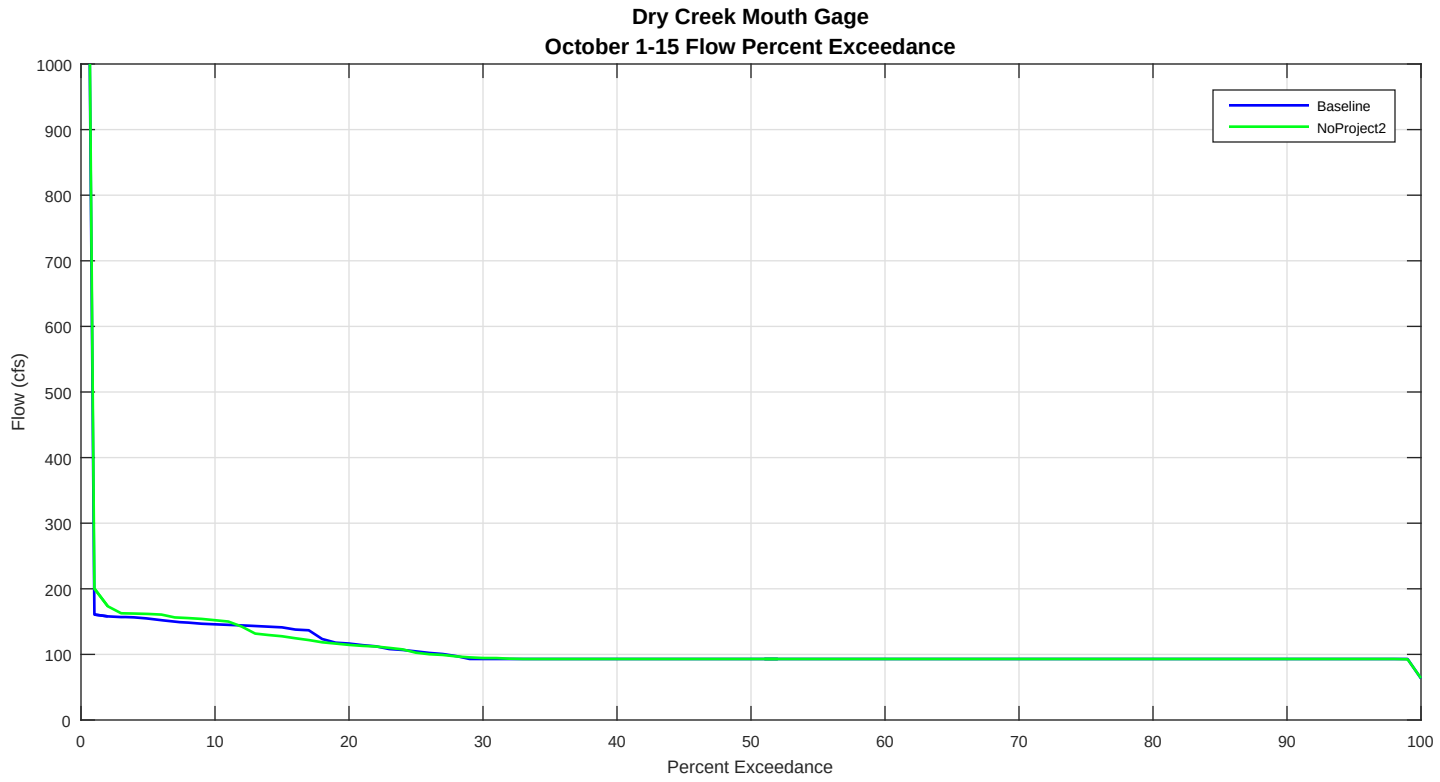

Dry Creek Mouth Gage
May Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100

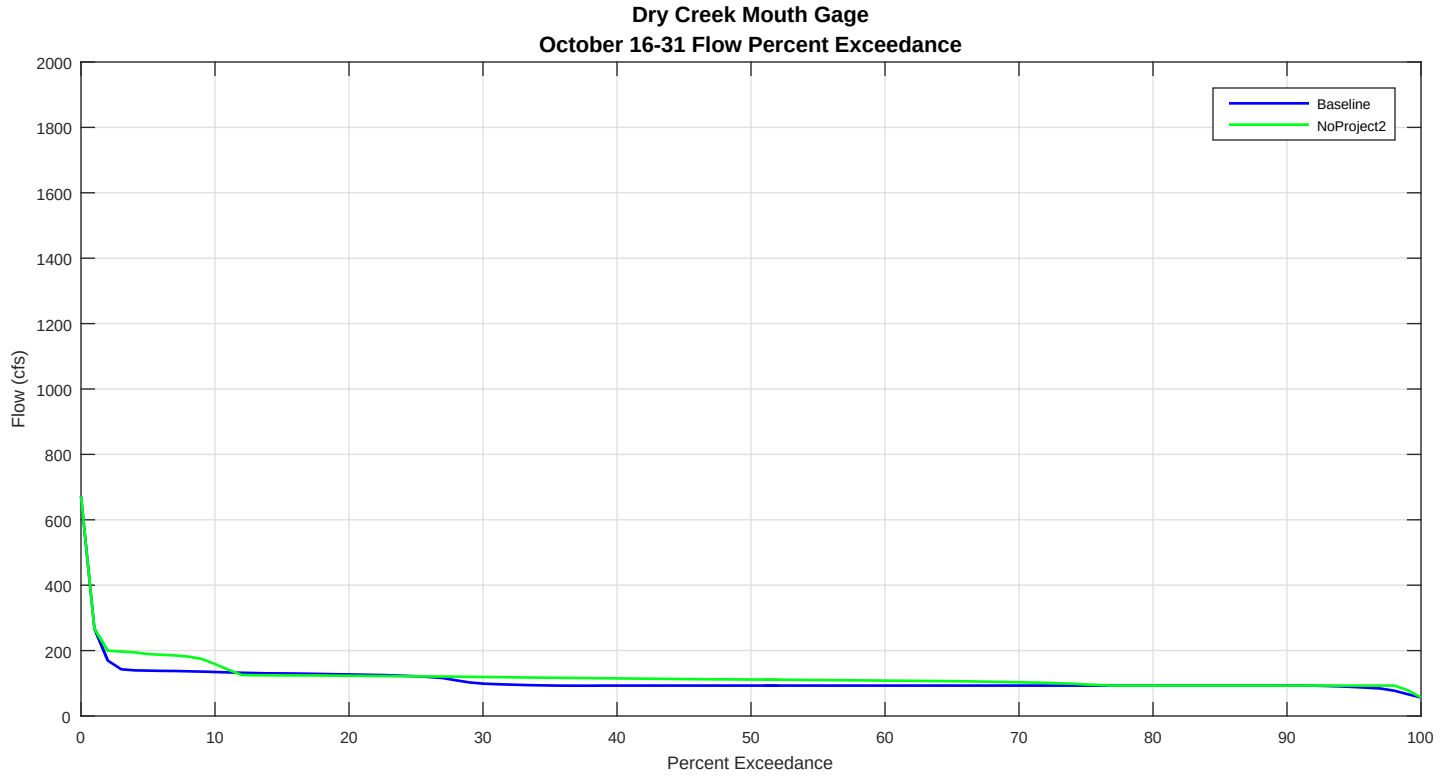

Dry Creek Mouth Gage
June Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

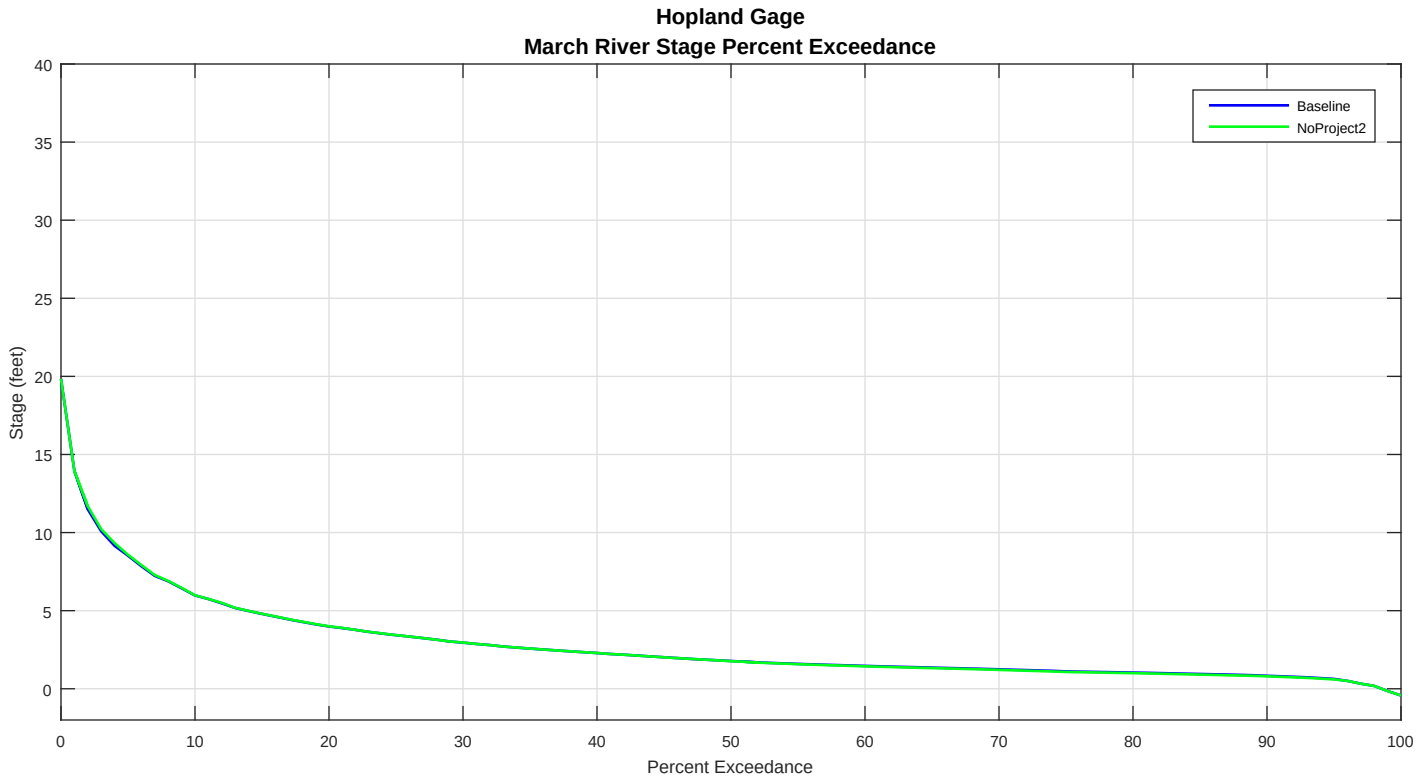

Dry Creek Mouth Gage
July Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

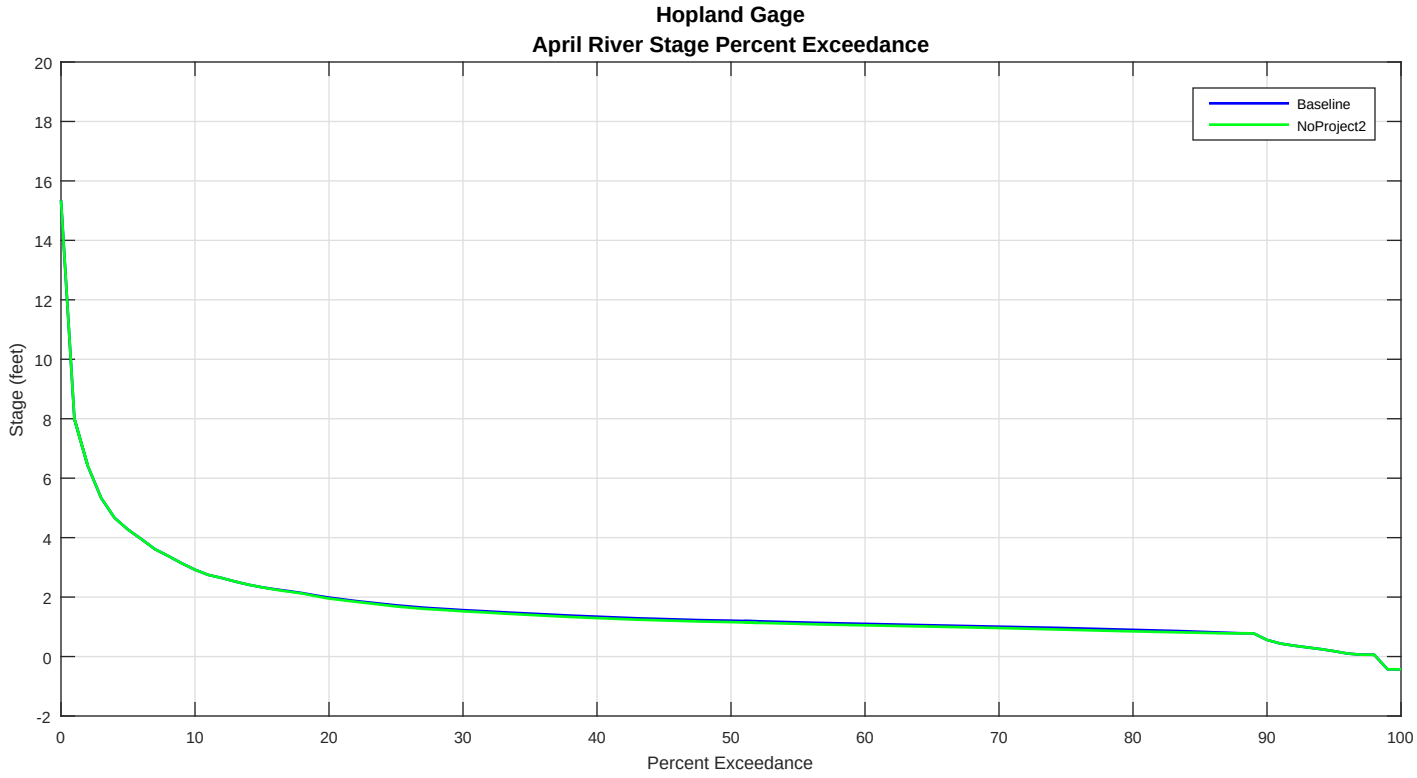

Dry Creek Mouth Gage
August Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

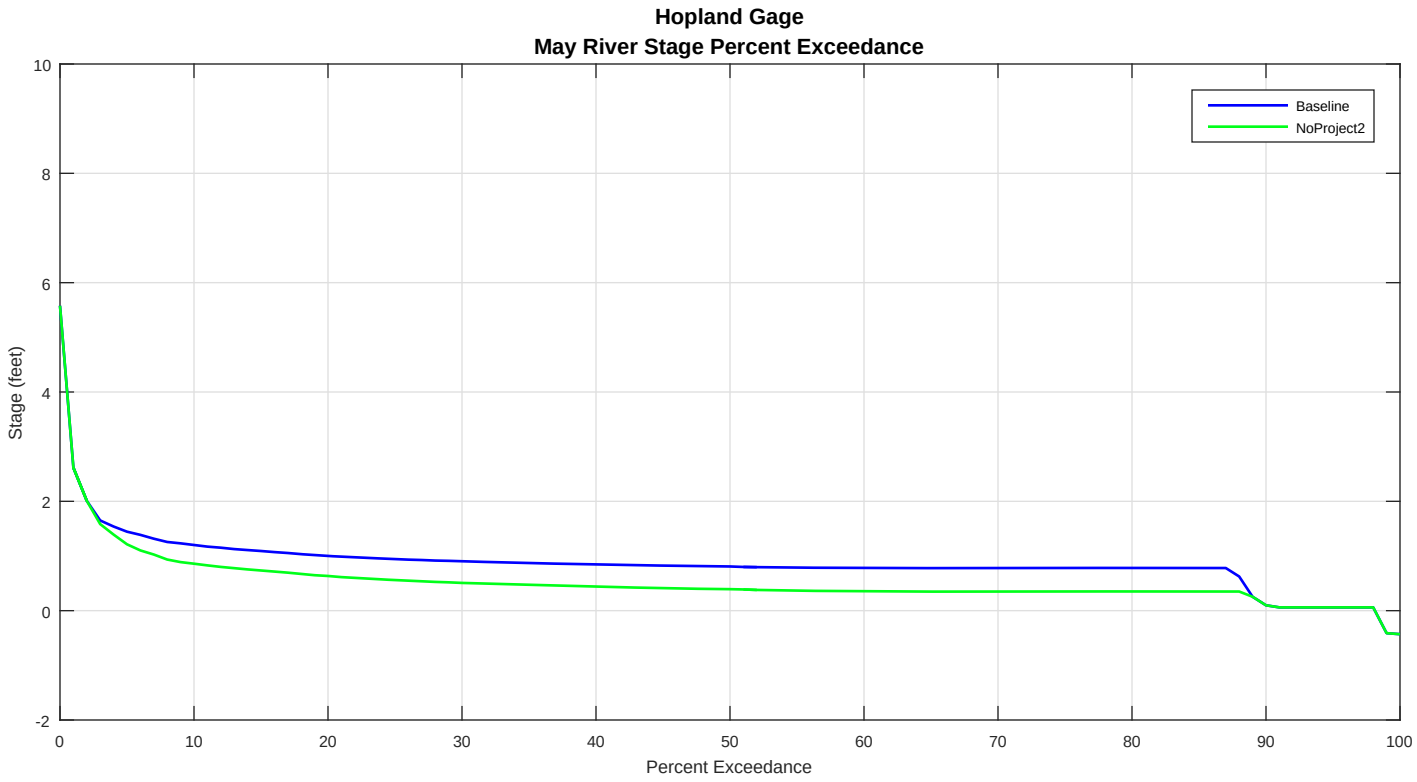

Dry Creek Mouth Gage
September Flow Percent Exceedance
Baseline
NoProject2
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

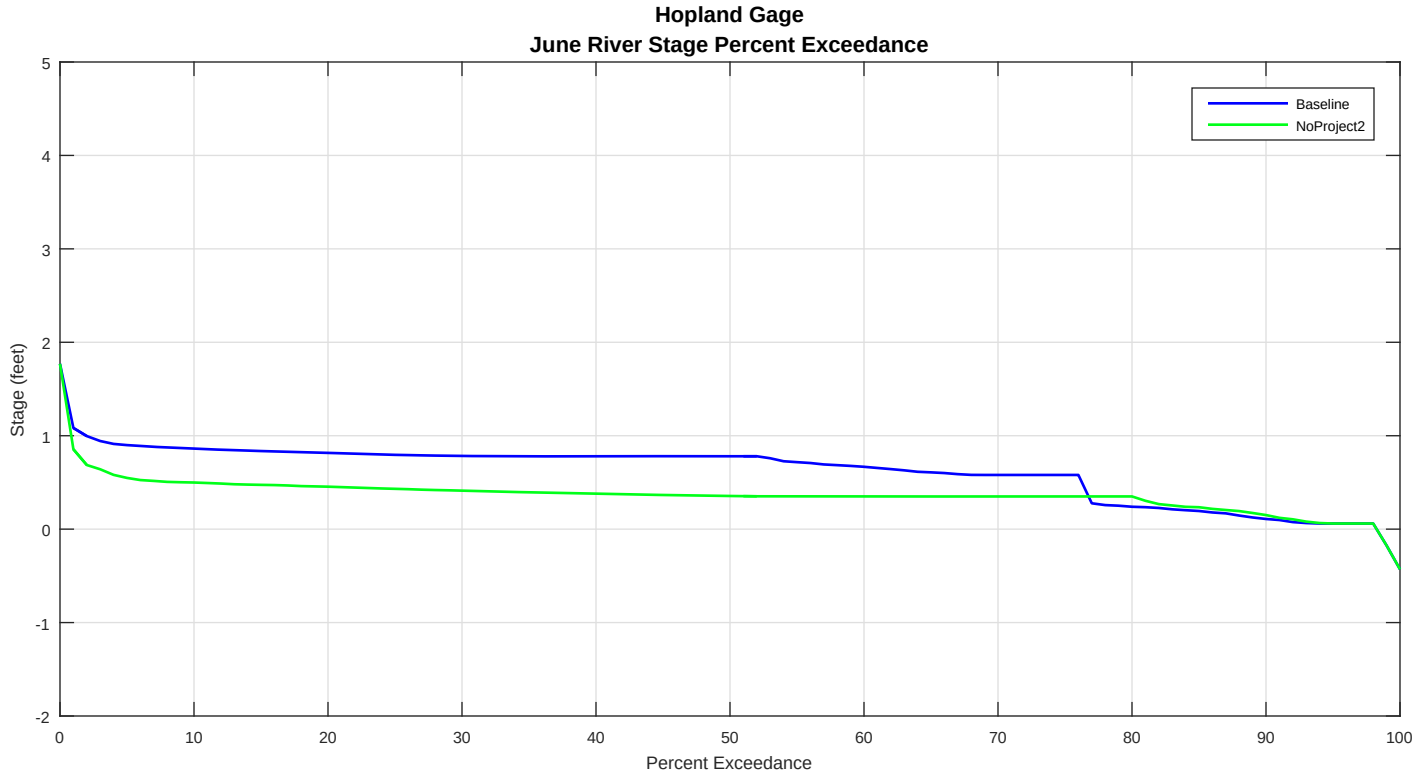

Dry Creek Mouth Gage
October 1-15 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
Baseline
NoProject2
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100

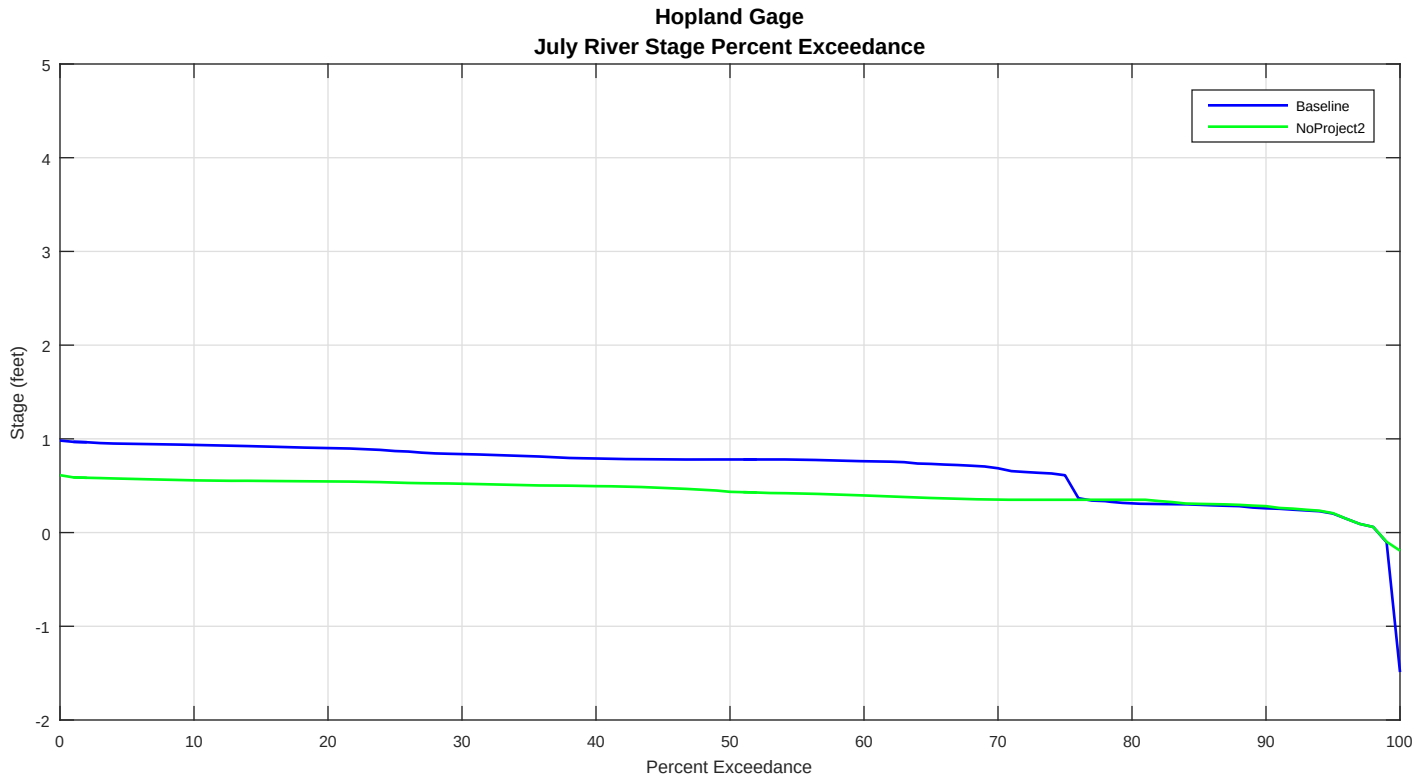

Dry Creek Mouth Gage
October 16-31 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
Baseline
NoProject2
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100

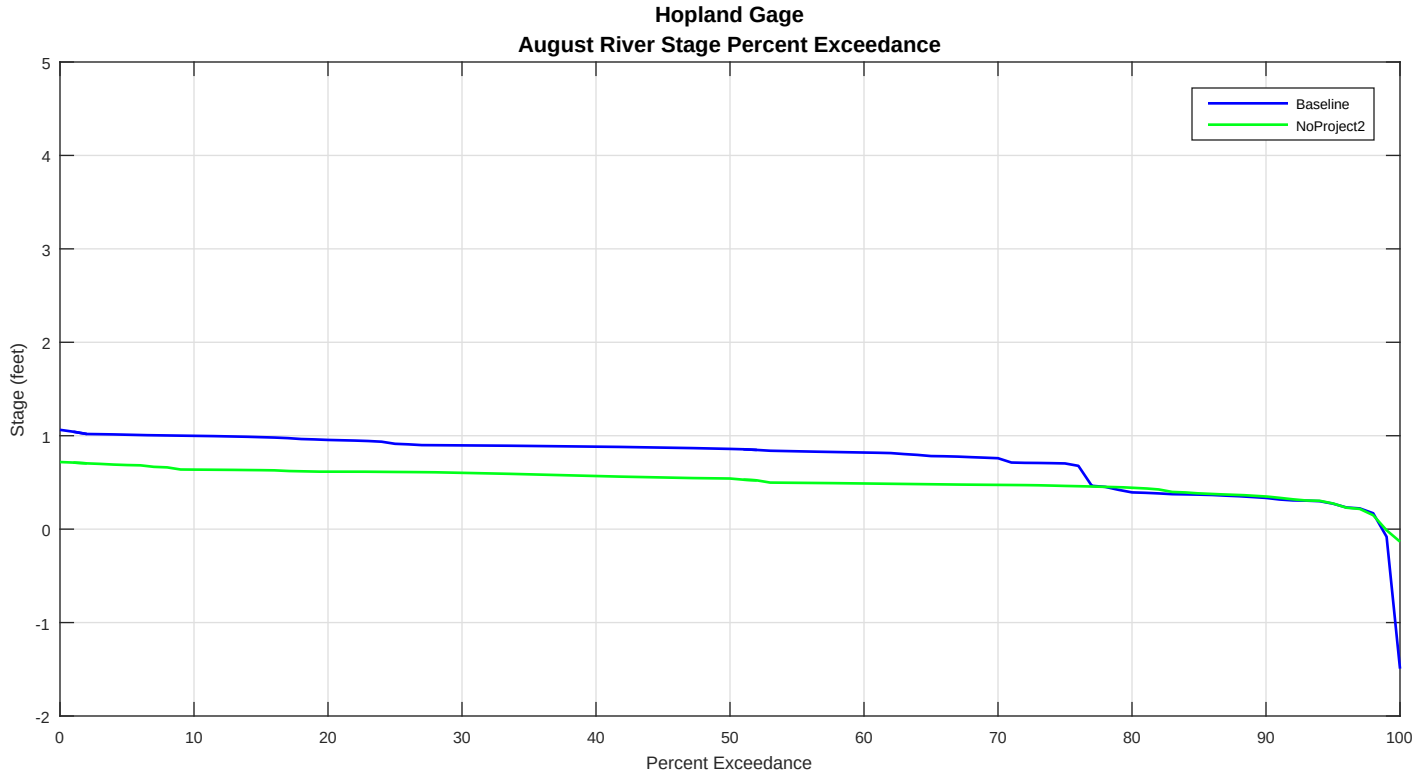

Hopland Gage
March River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100

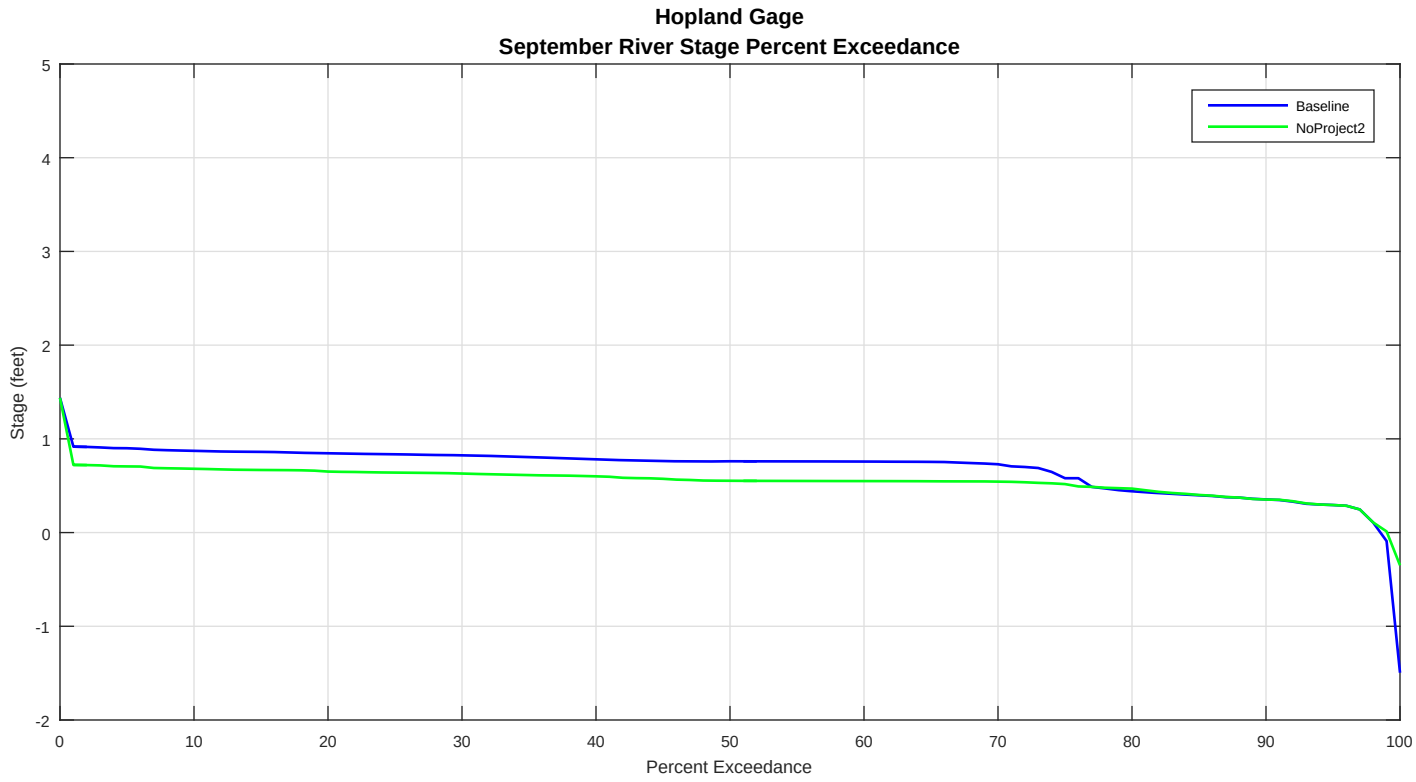

Hopland Gage
April River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
20
18
16
14
12
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

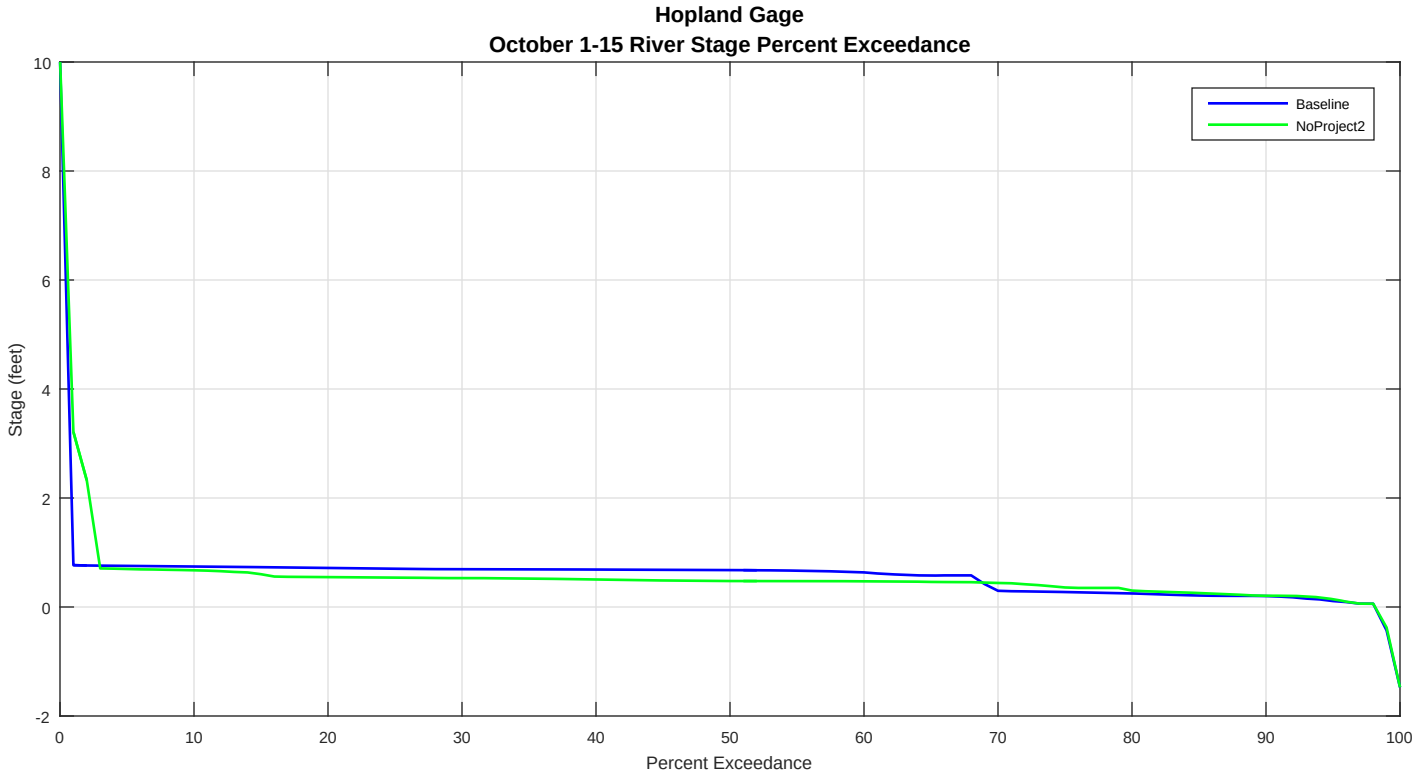

Hopland Gage
May River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

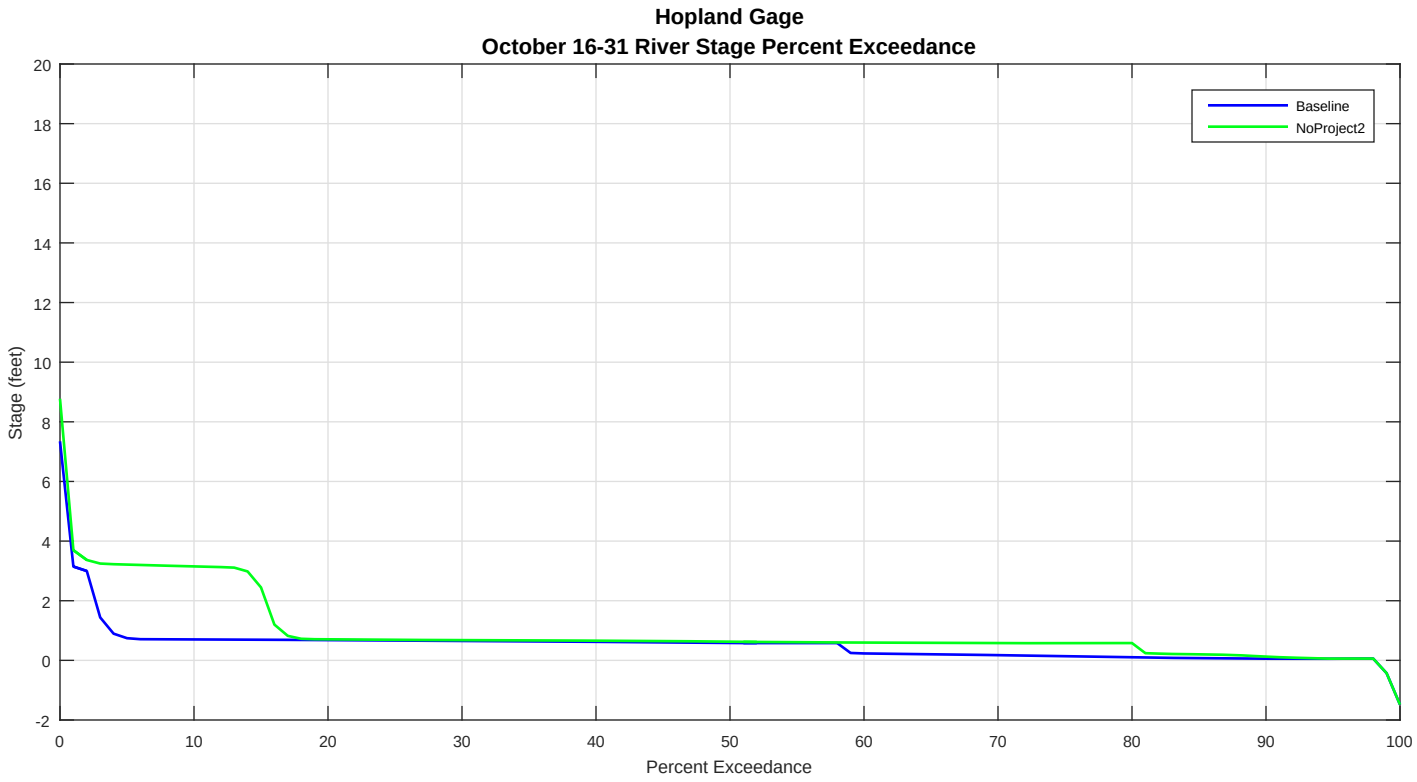

Hopland Gage
June River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

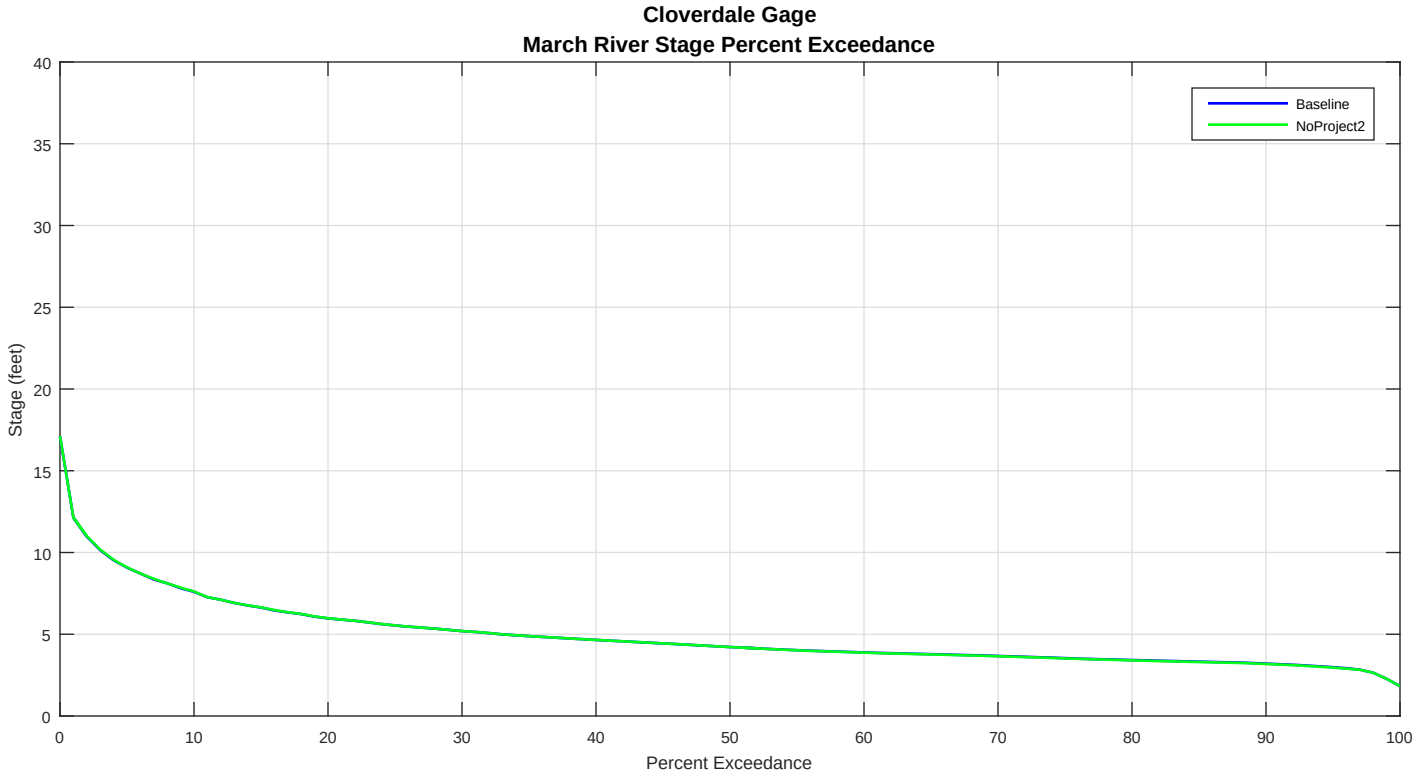

Hopland Gage
July River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

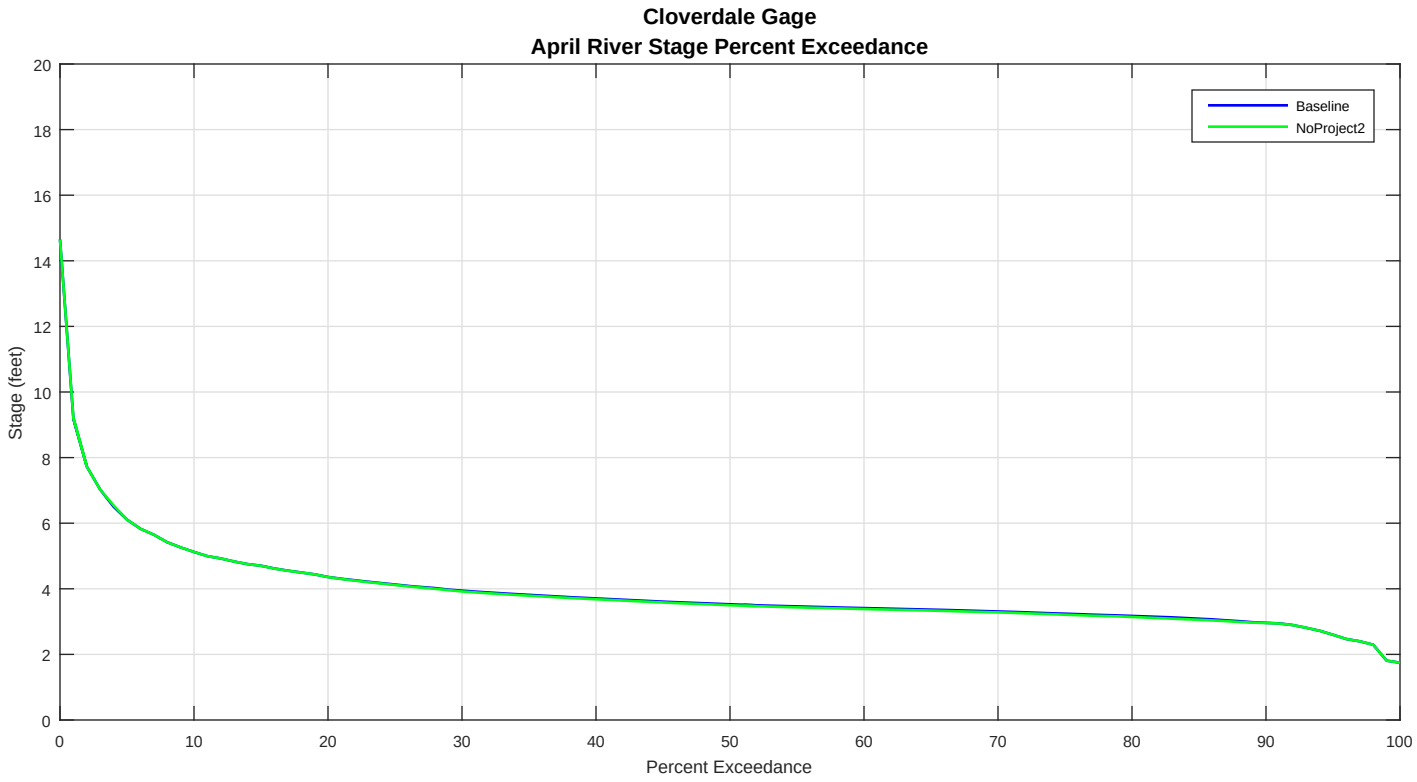

Hopland Gage
August River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

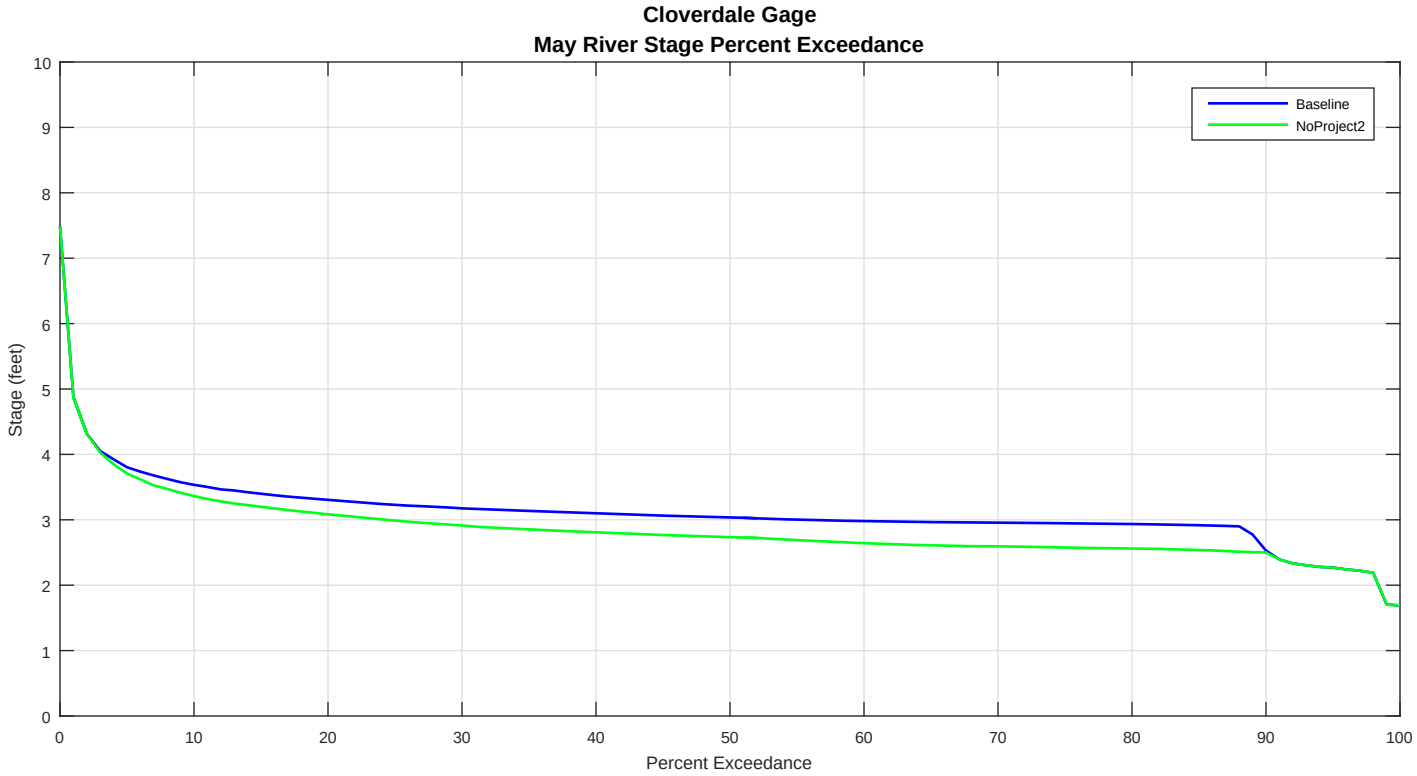

Hopland Gage
September River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

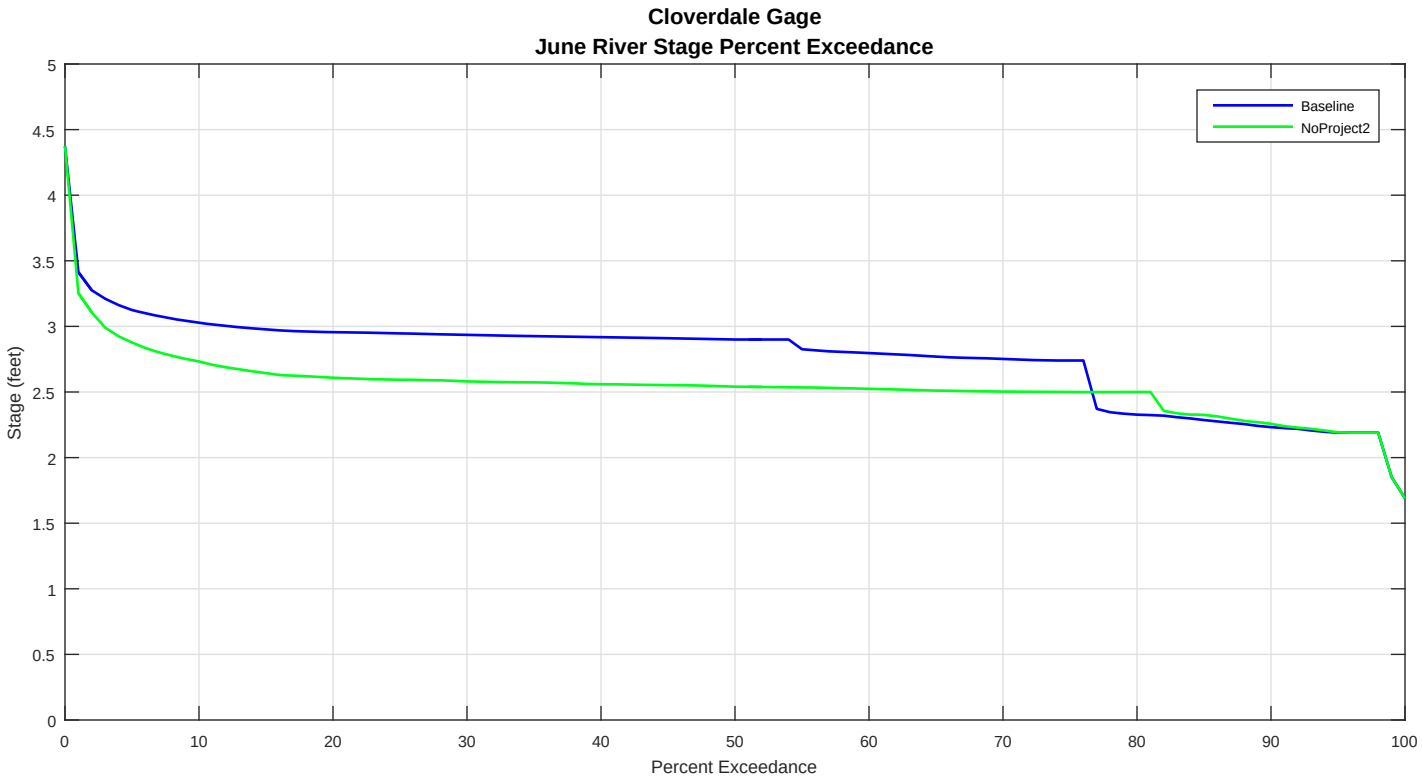

Hopland Gage
October 1-15 River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

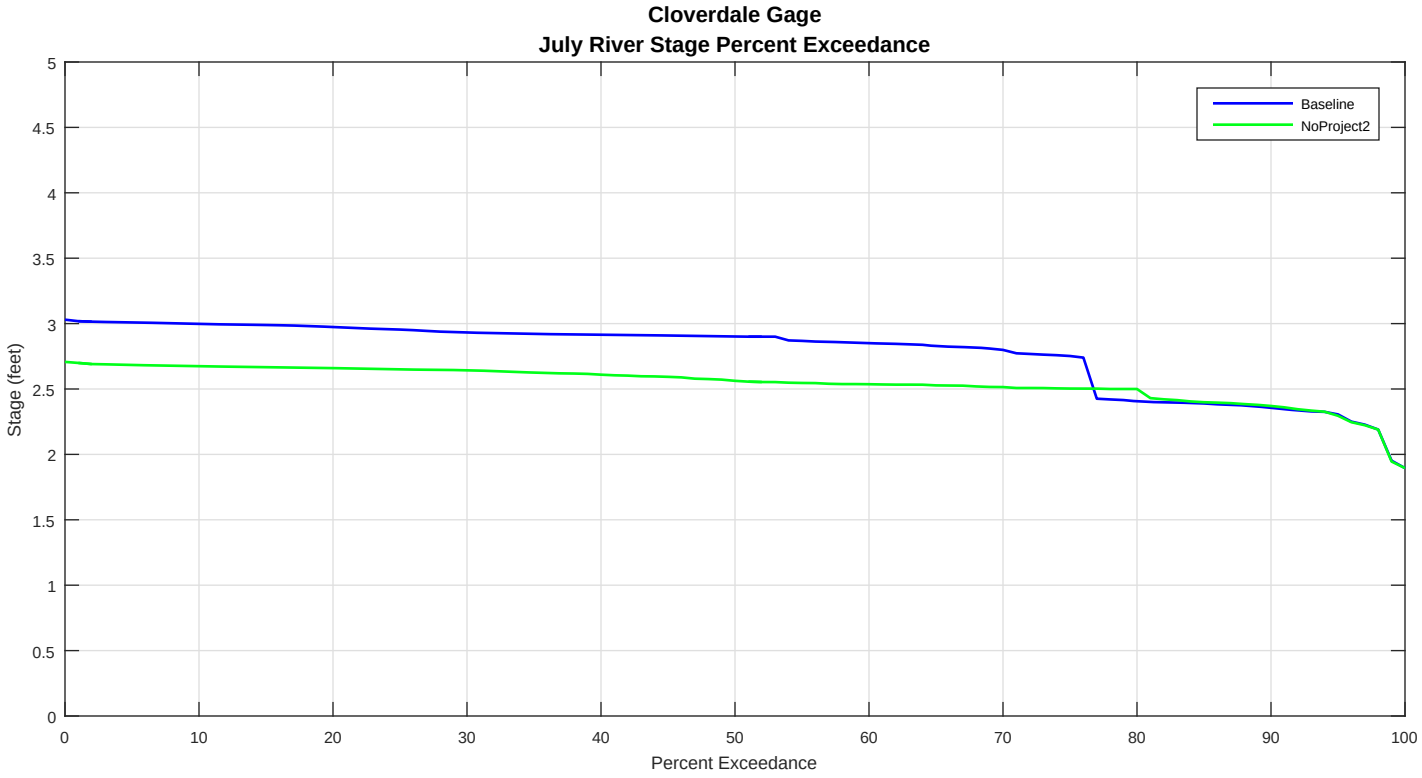

Hopland Gage
October 16-31 River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
20
18
16
14
12
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

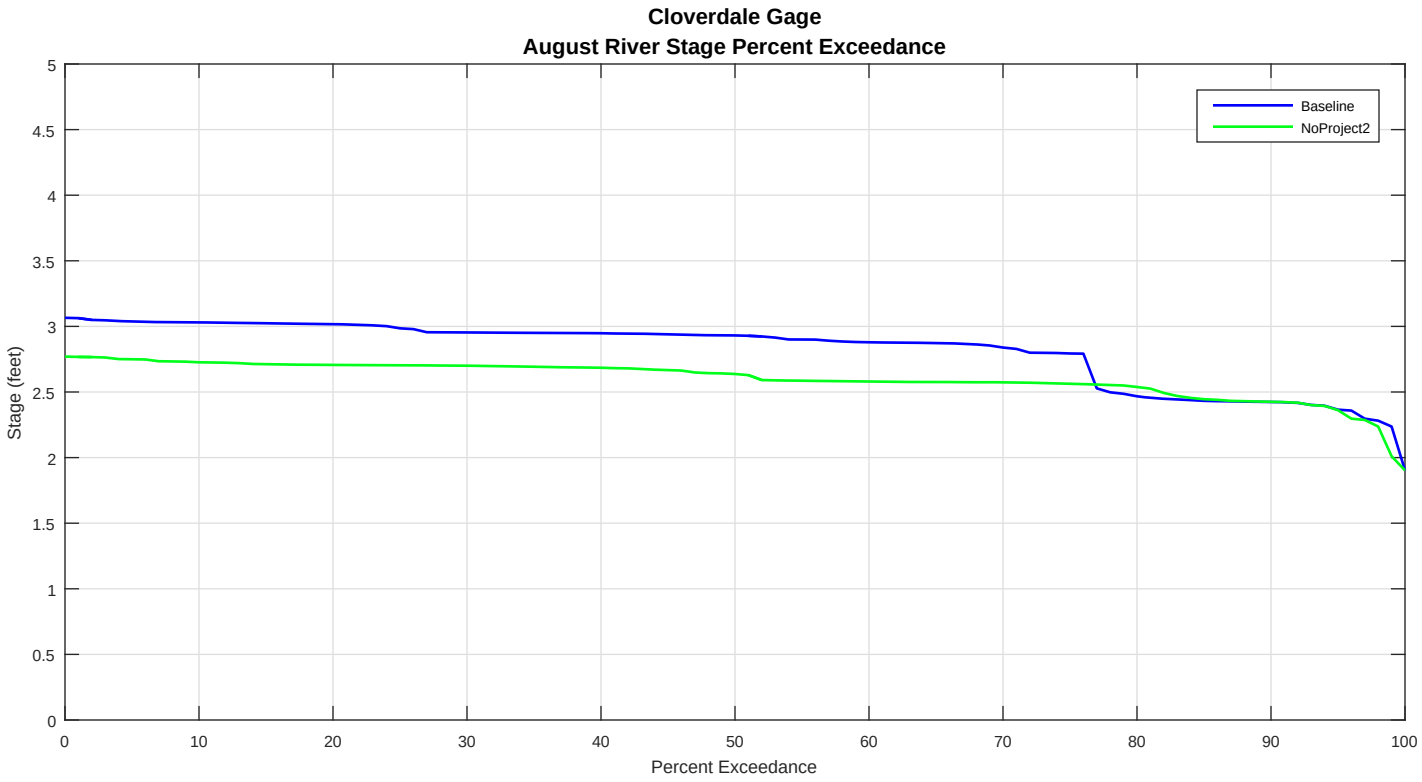

Cloverdale Gage
March River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100

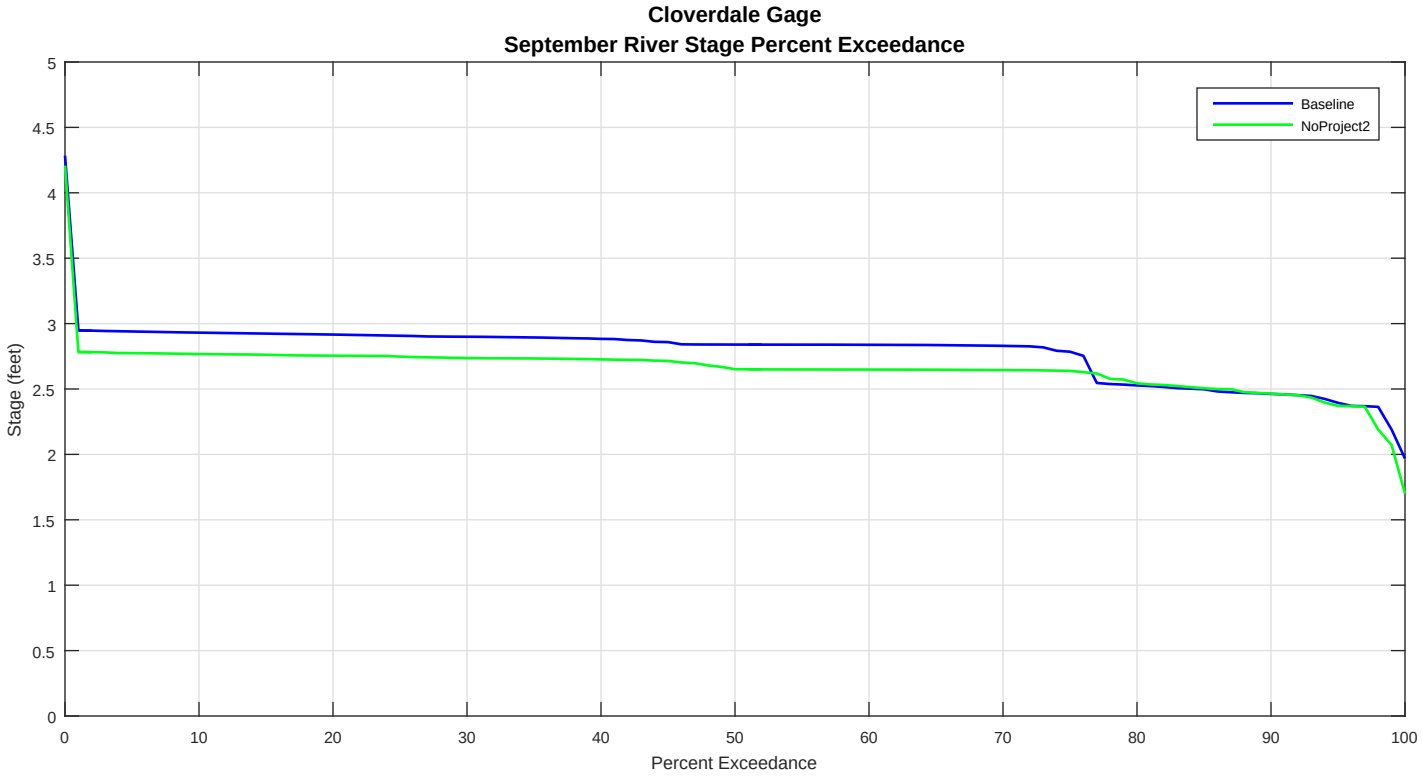

Cloverdale Gage
April River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

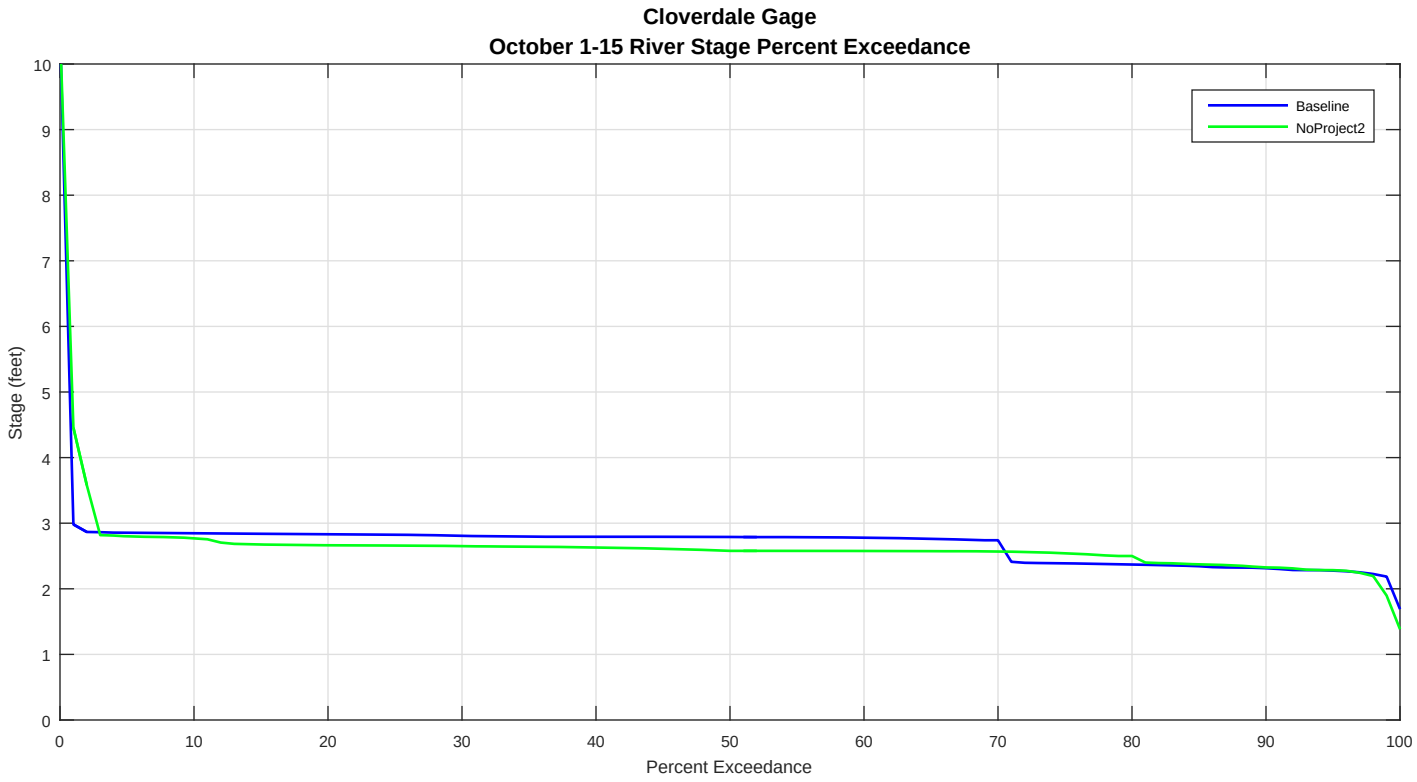

Cloverdale Gage
May River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

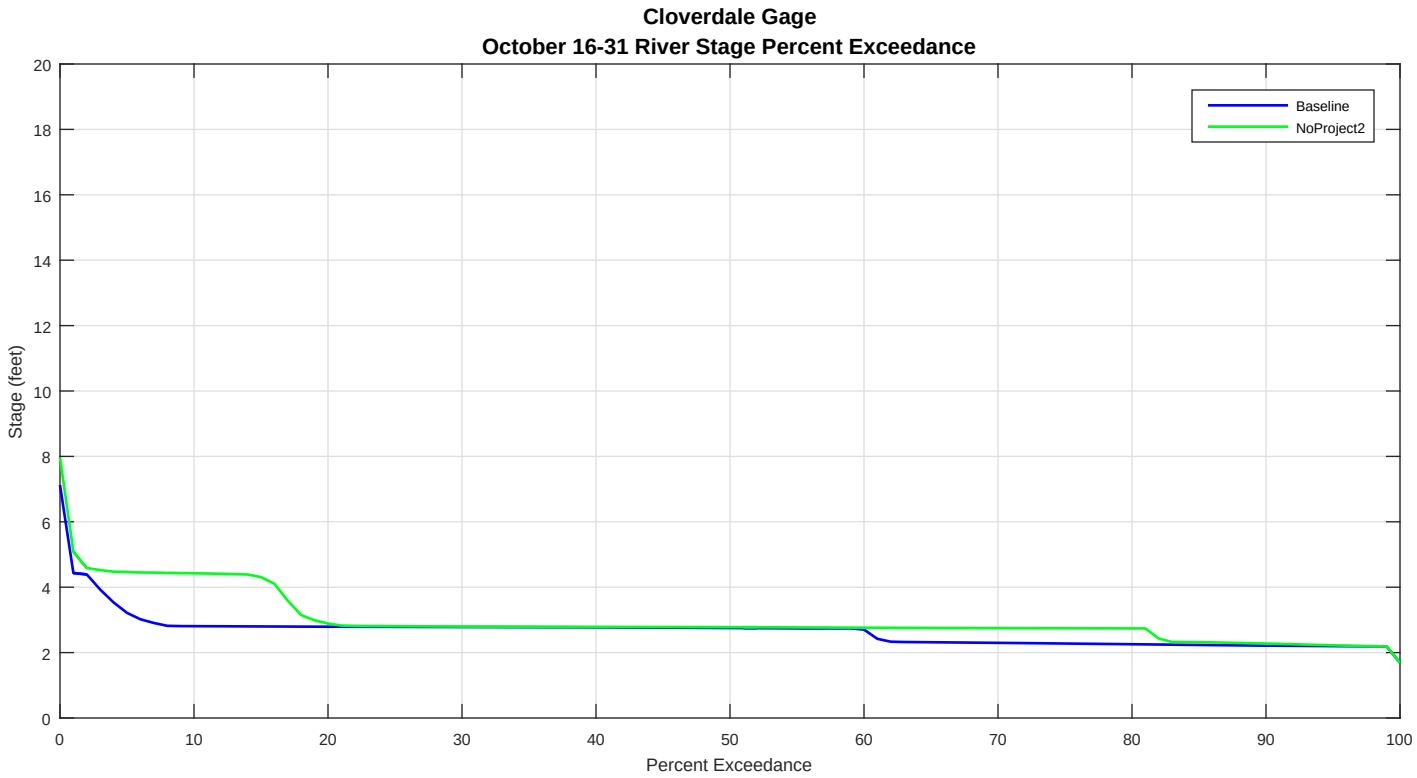

Cloverdale Gage
June River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

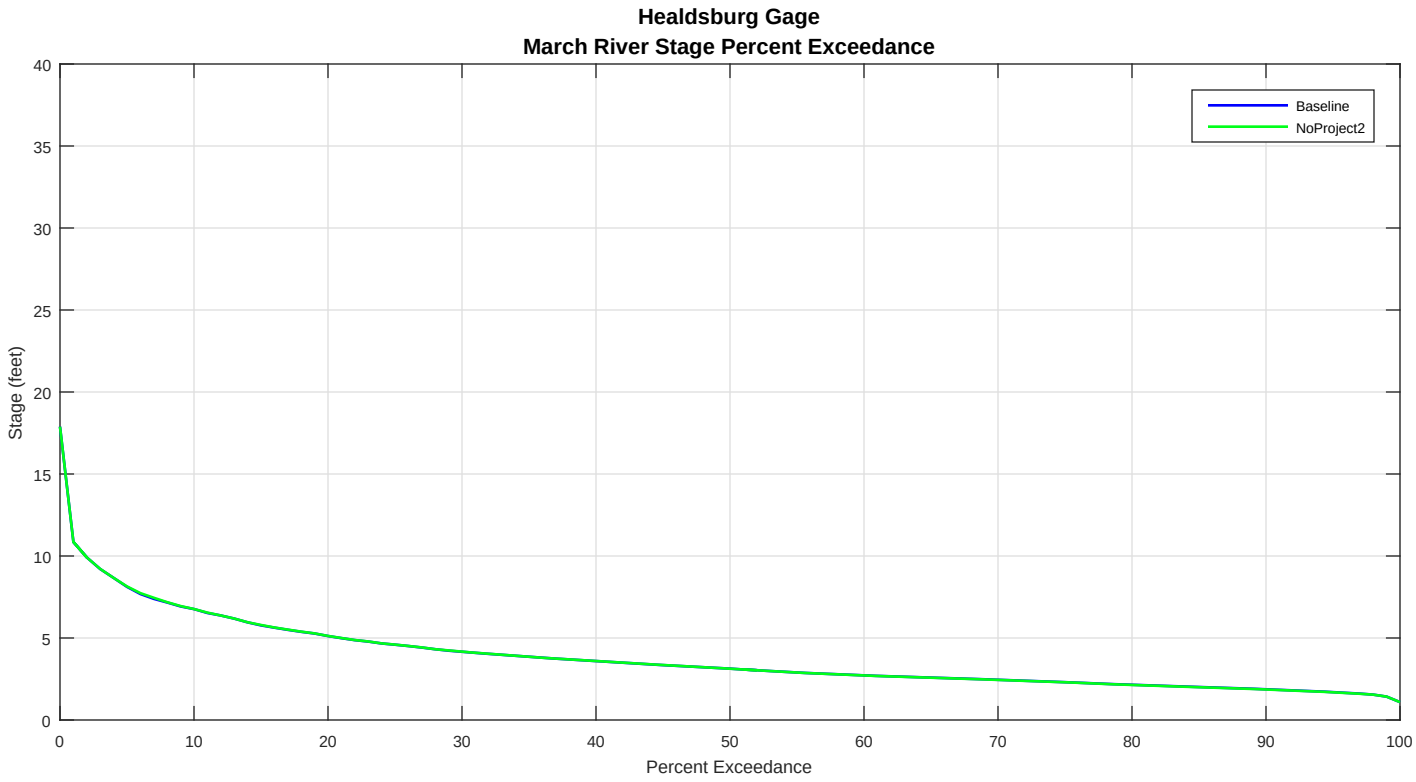

Cloverdale Gage
July River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

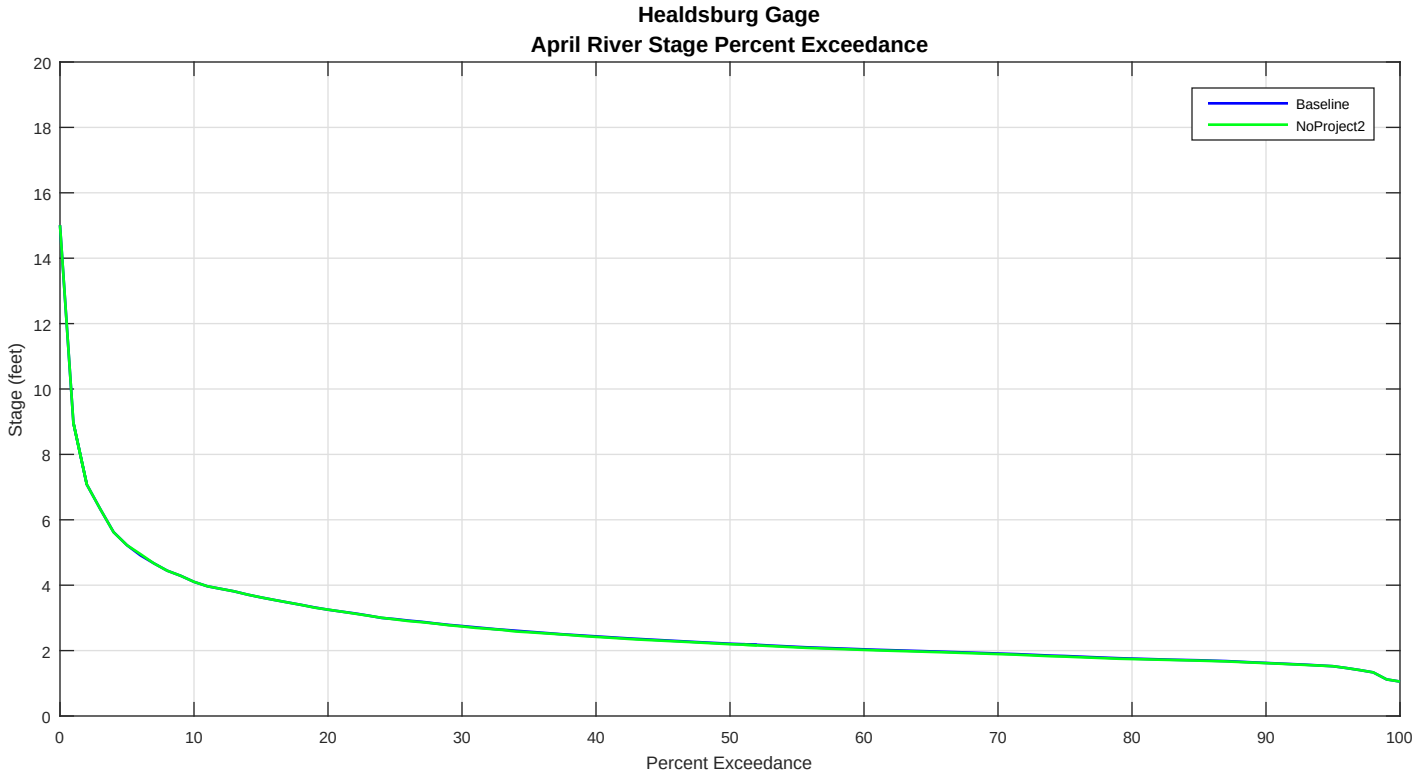

Cloverdale Gage
August River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

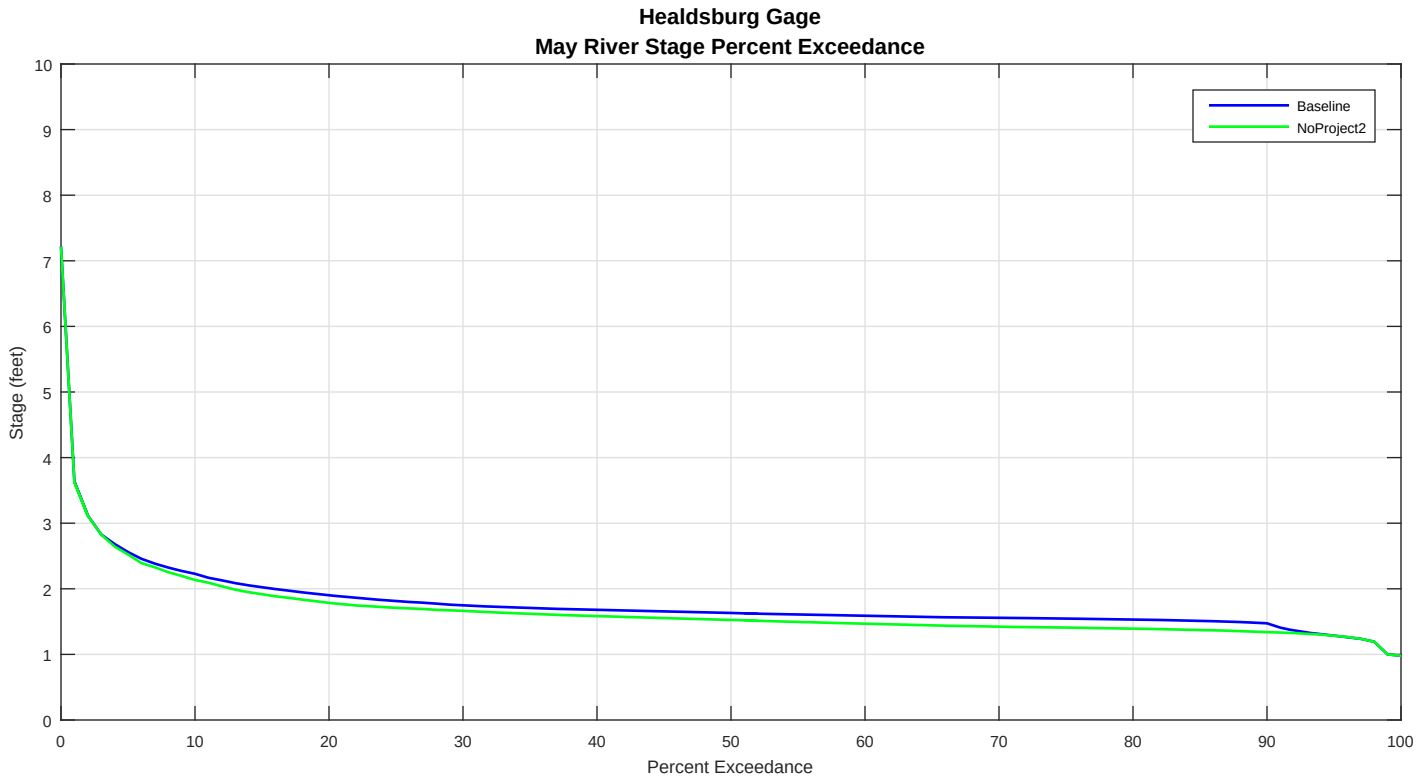

Cloverdale Gage
September River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

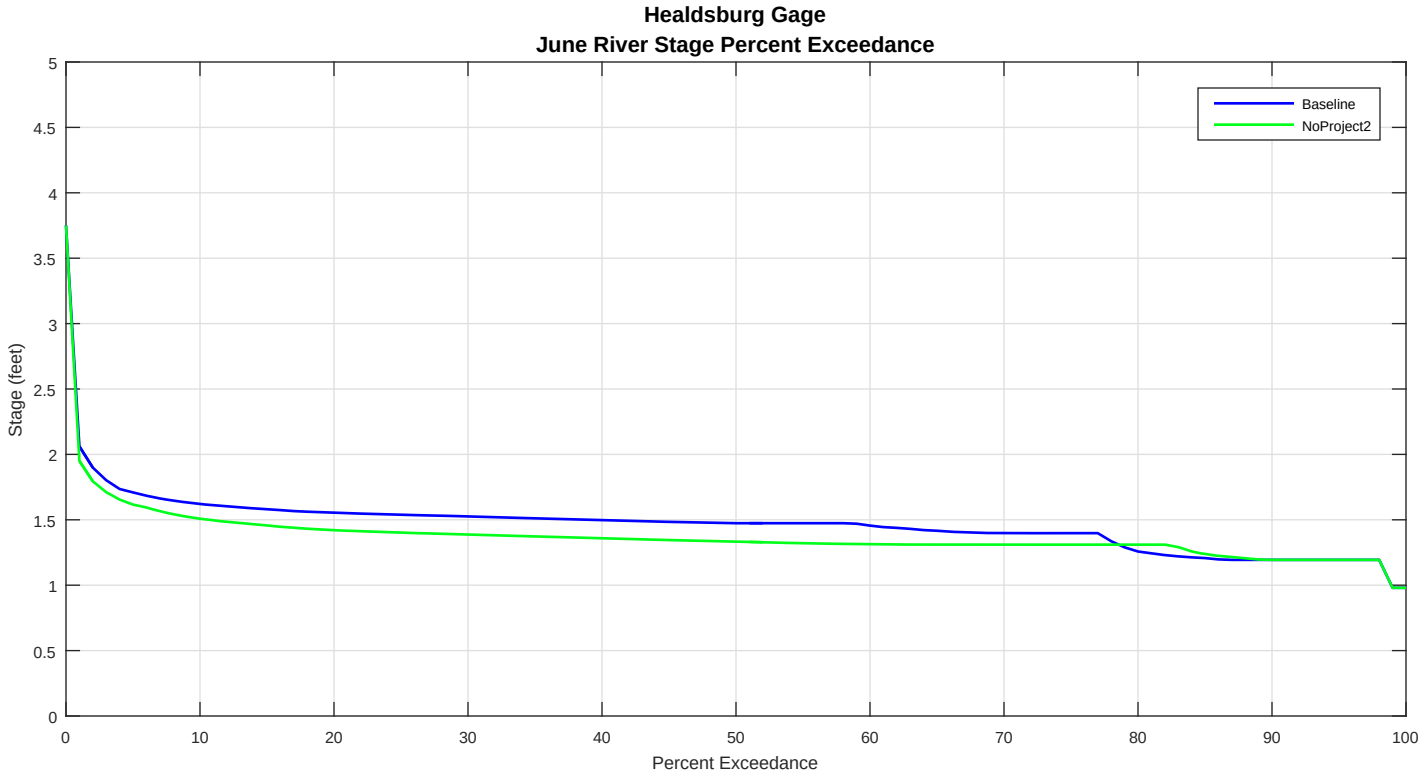

Cloverdale Gage
October 1-15 River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

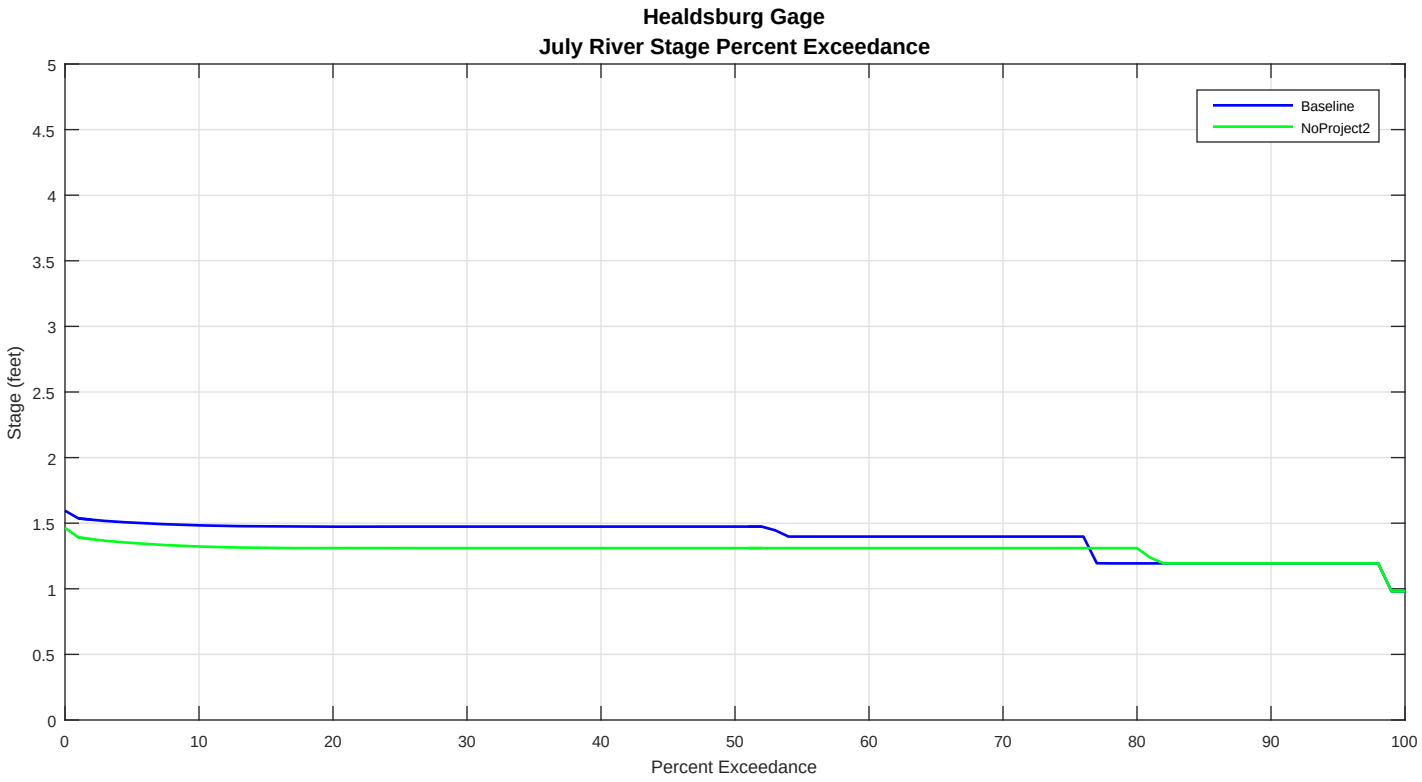

Cloverdale Gage
October 16-31 River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

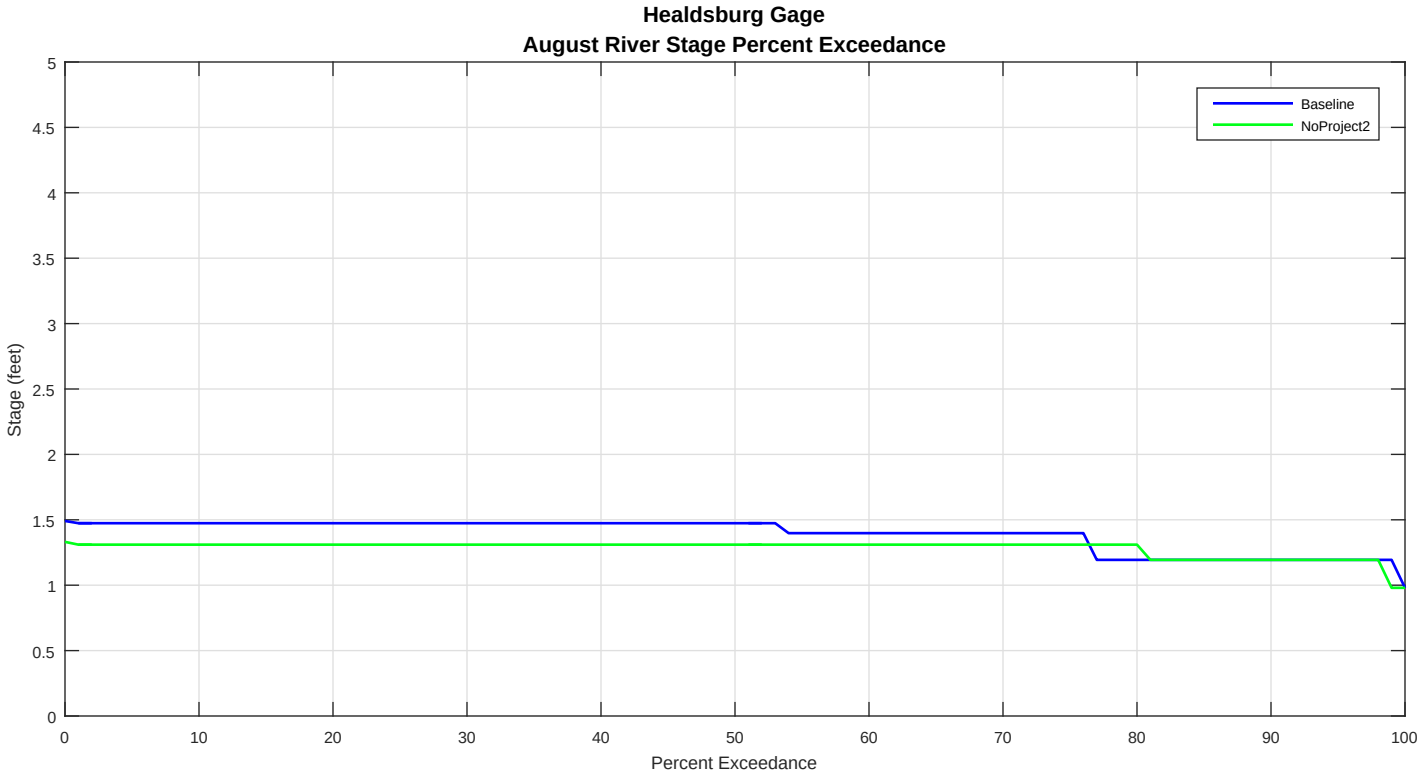

Healdsburg Gage
March River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80
90
100

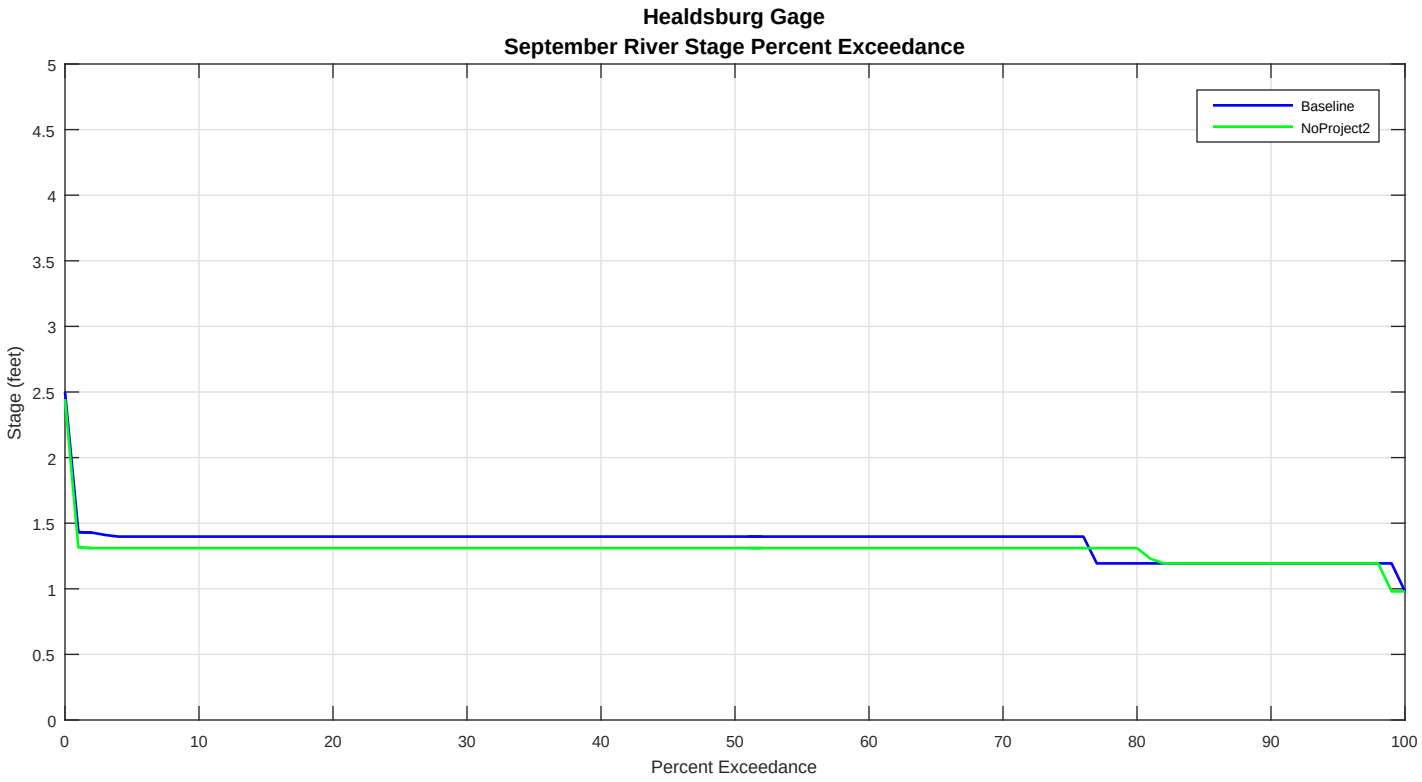

Healdsburg Gage
April River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

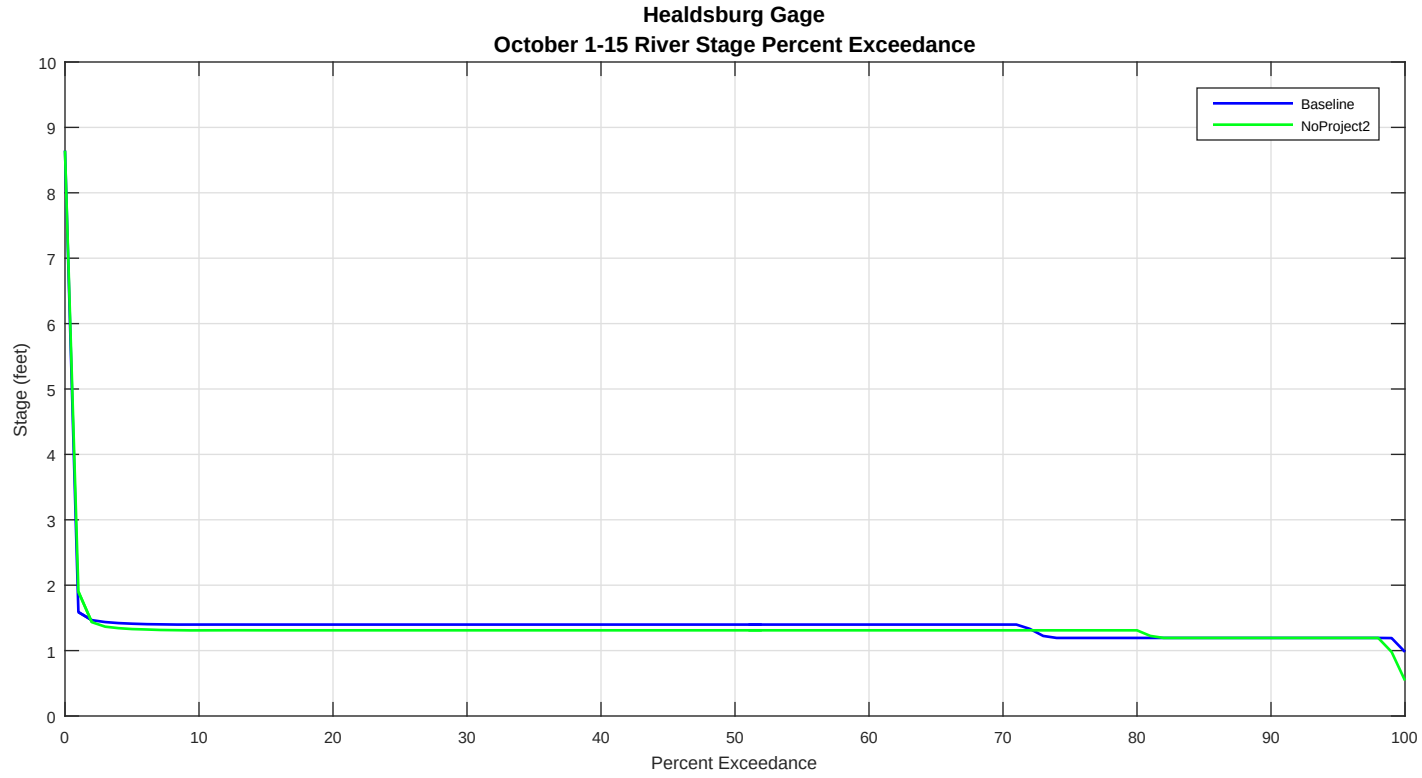

Healdsburg Gage
May River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

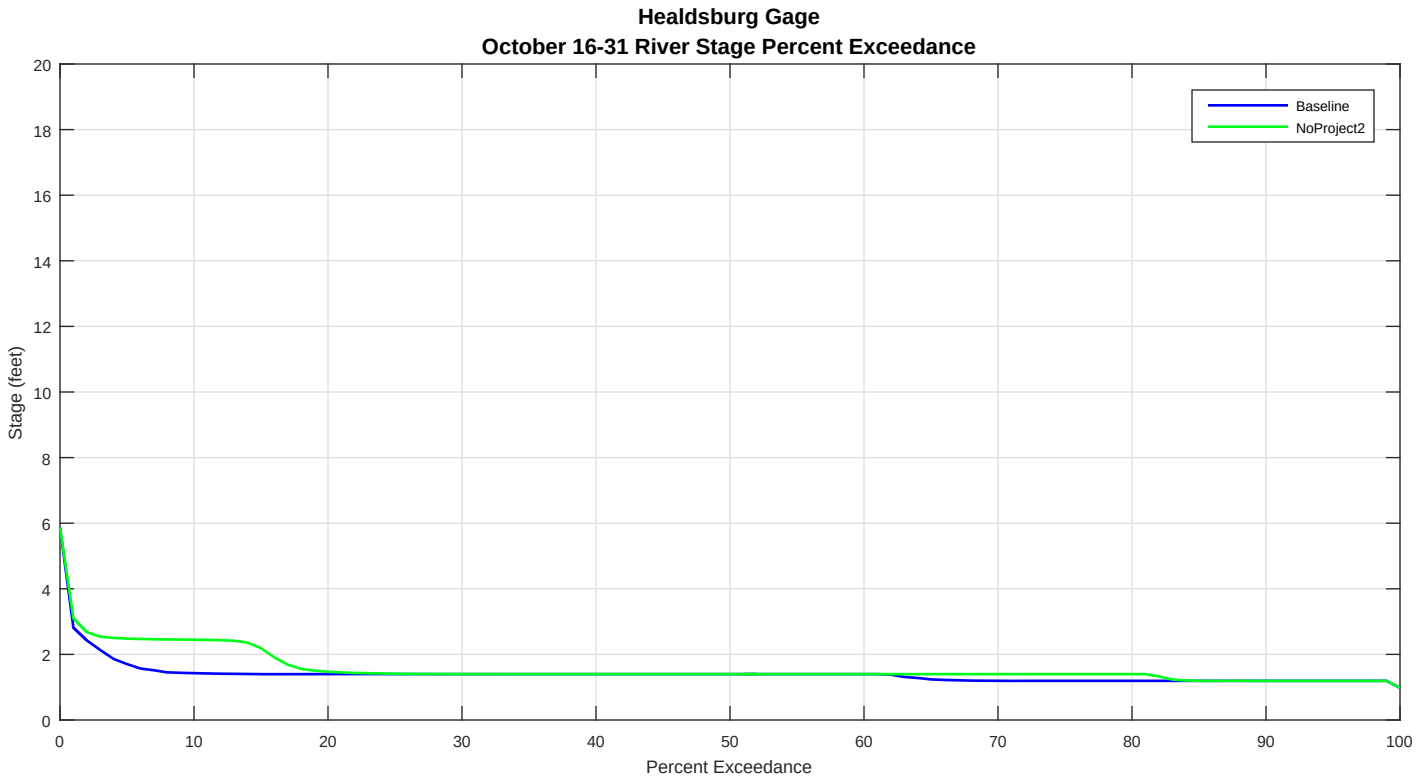

Healdsburg Gage
June River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

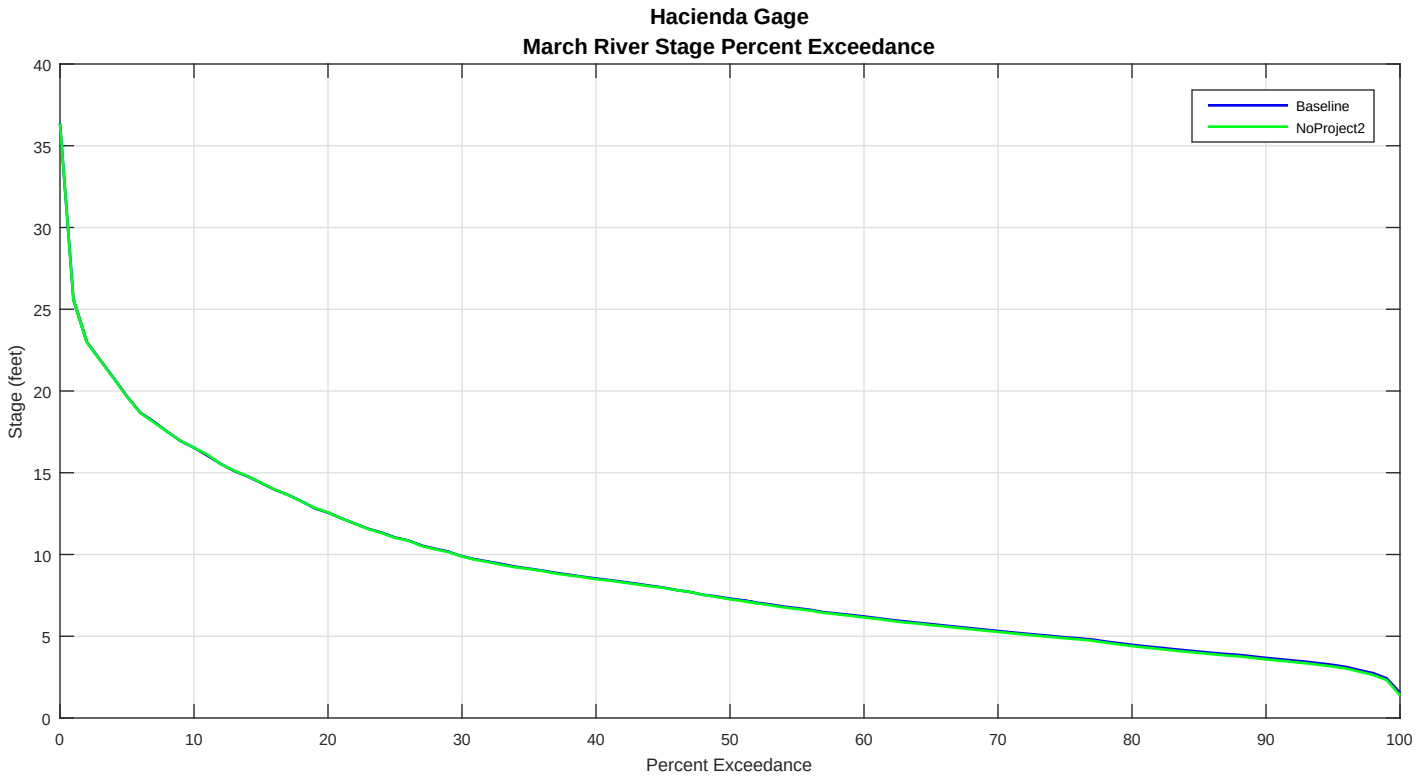

Healdsburg Gage
July River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

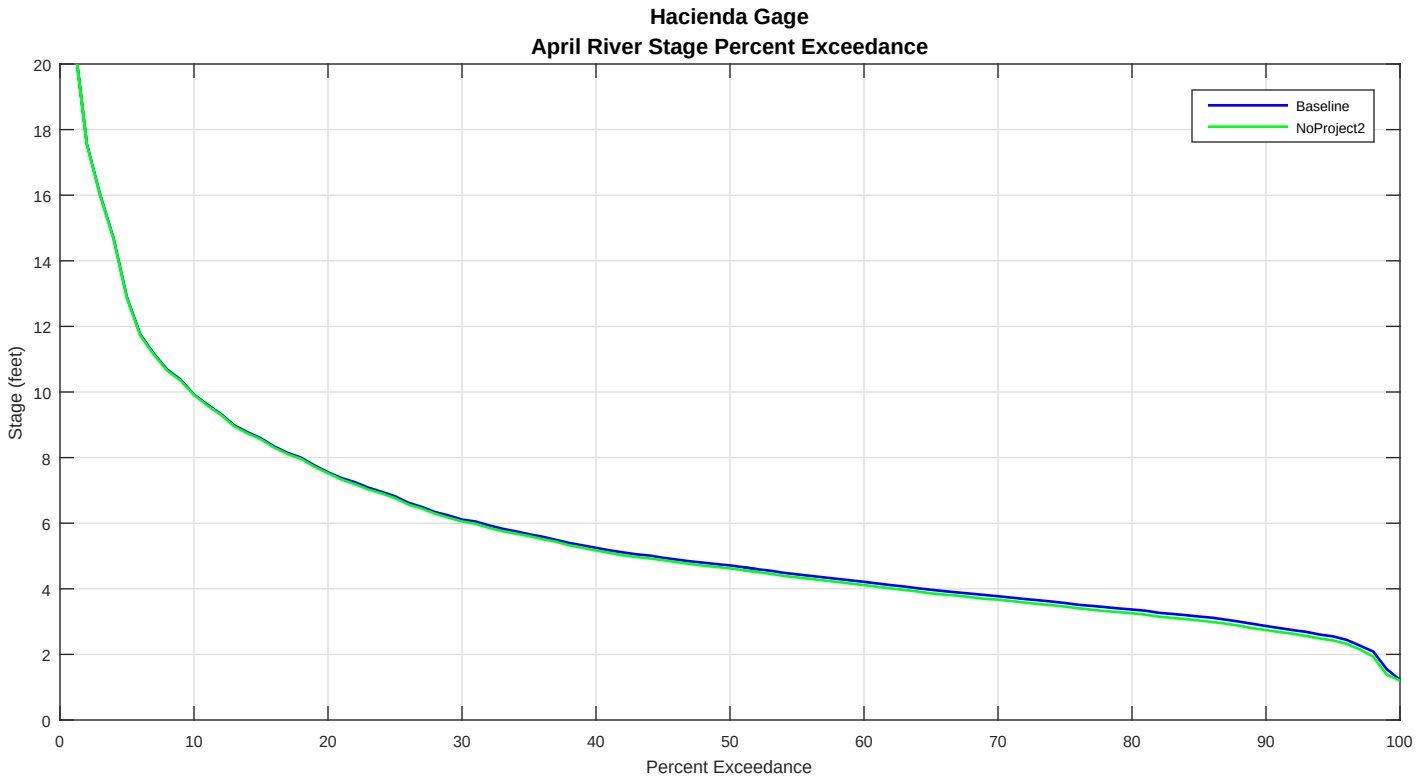

Healdsburg Gage
August River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

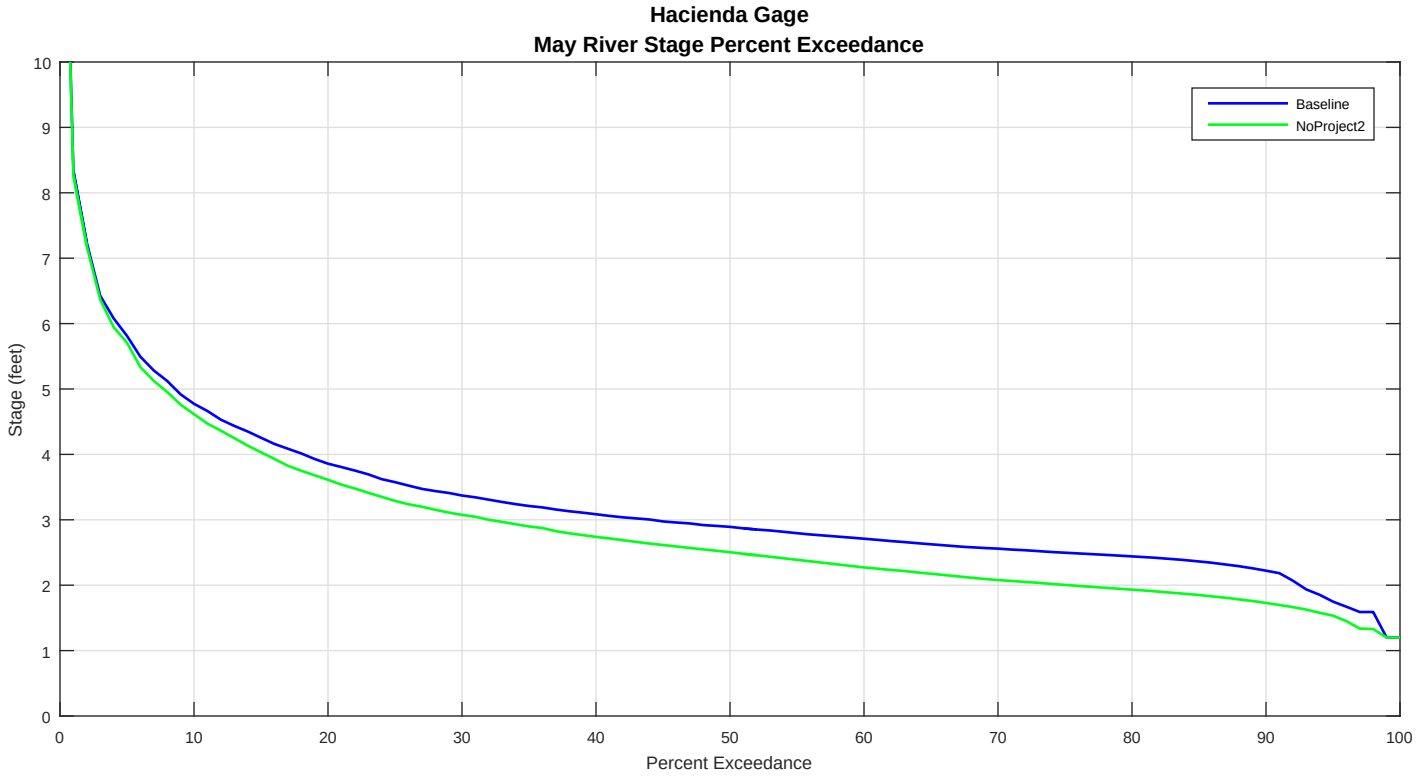

Healdsburg Gage
September River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

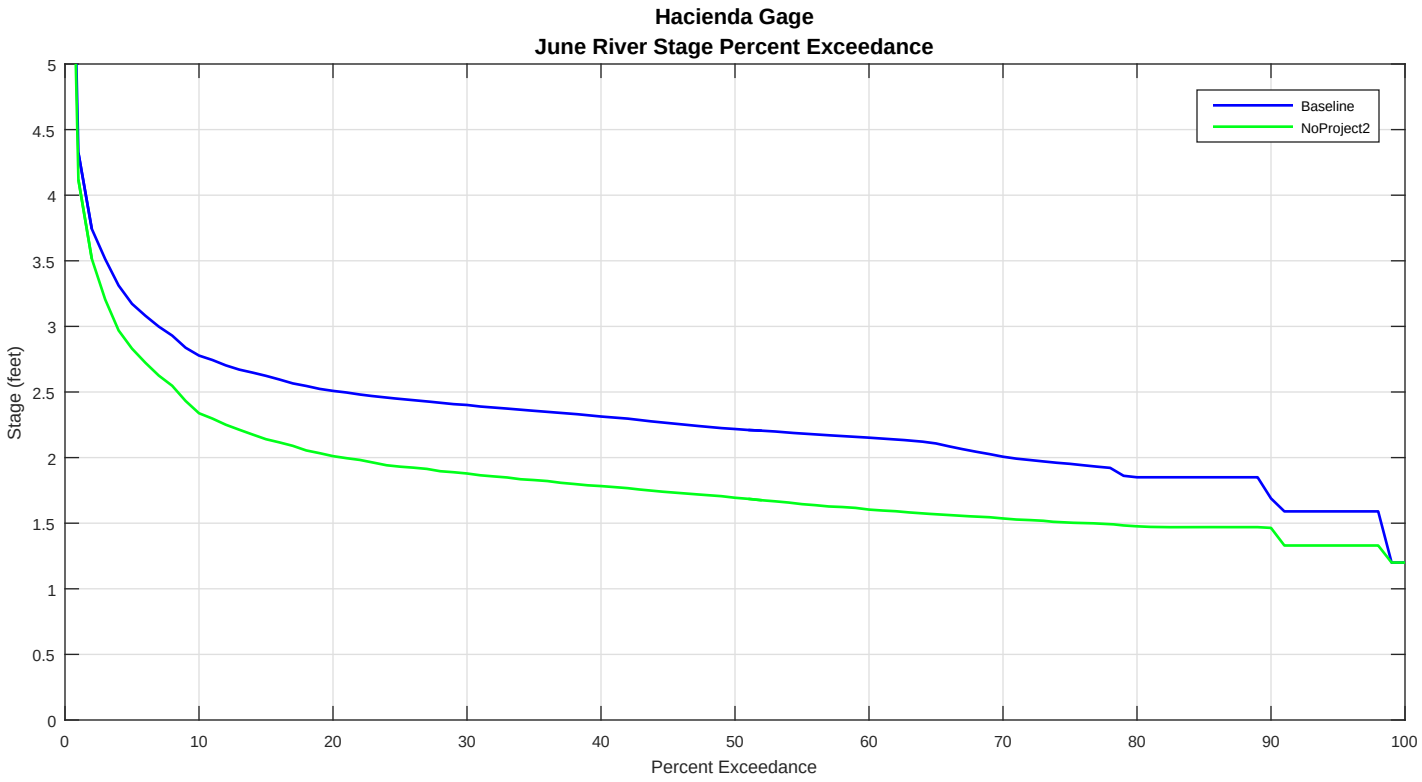

Healdsburg Gage
October 1-15 River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

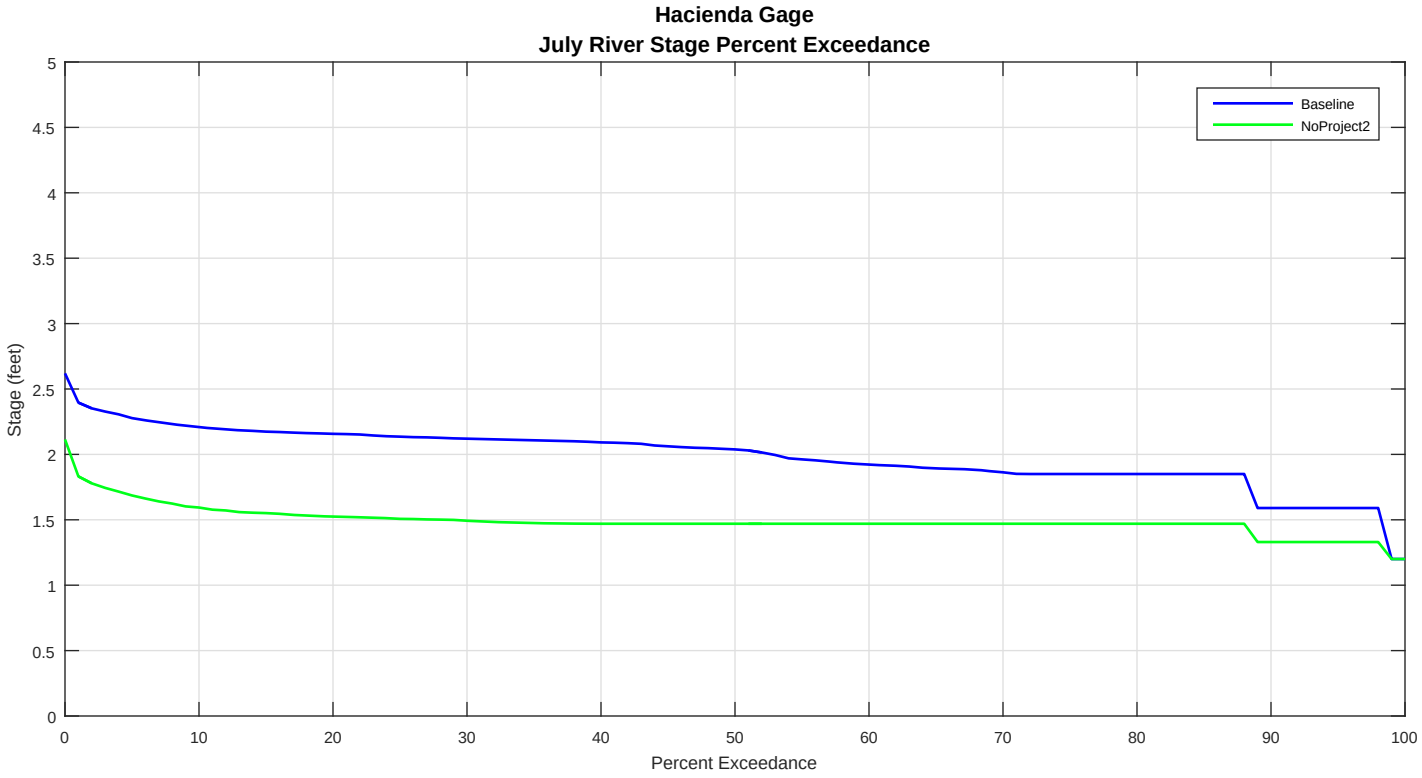

Healdsburg Gage
October 16-31 River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

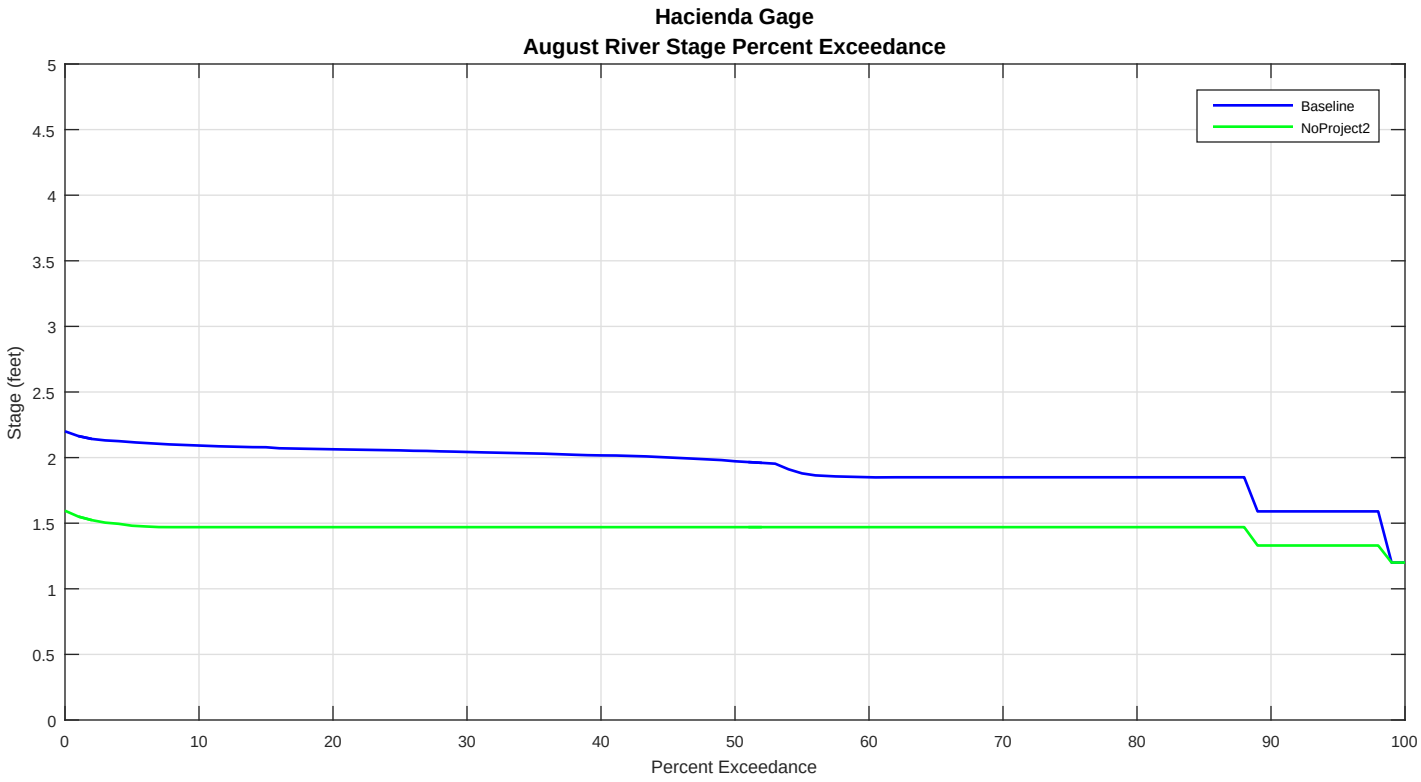

Hacienda Gage
March River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80
90
100

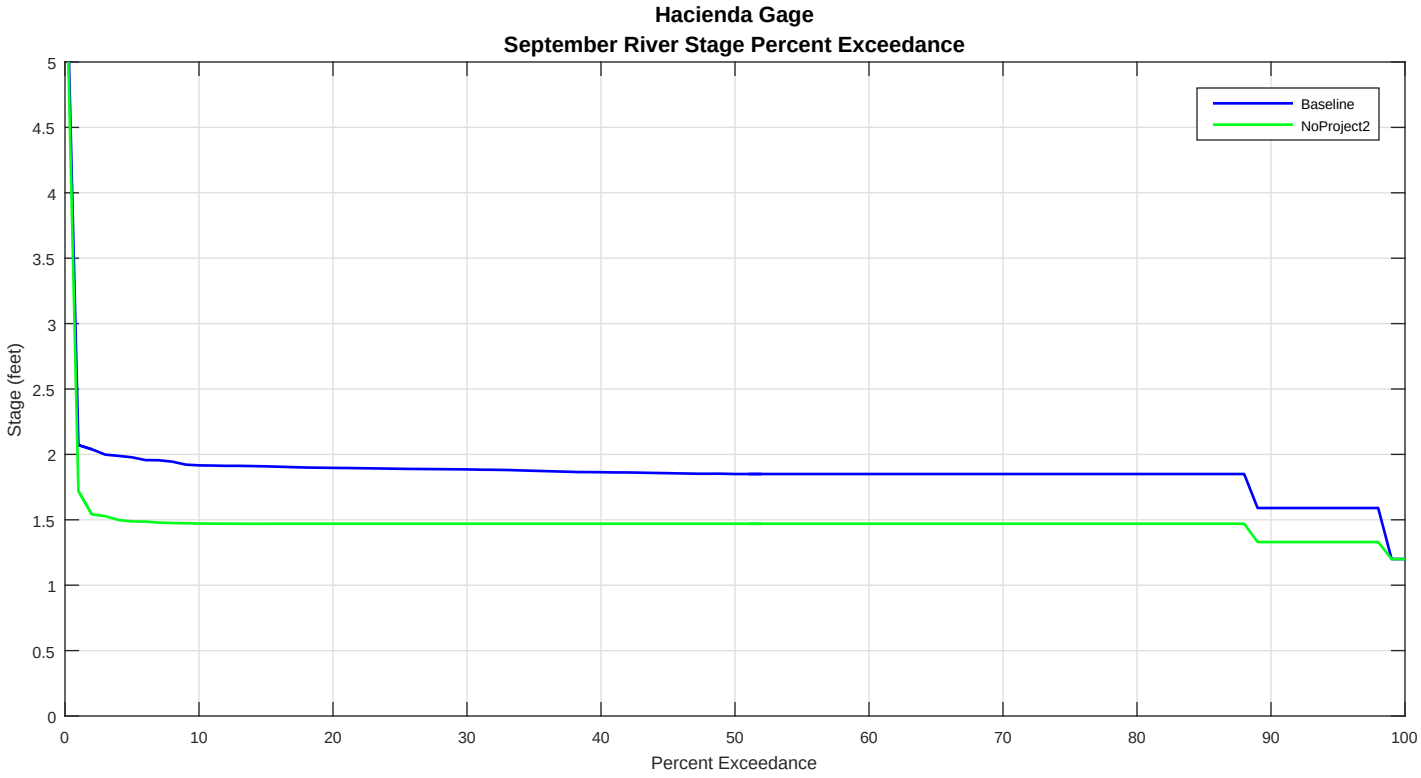

Hacienda Gage
April River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

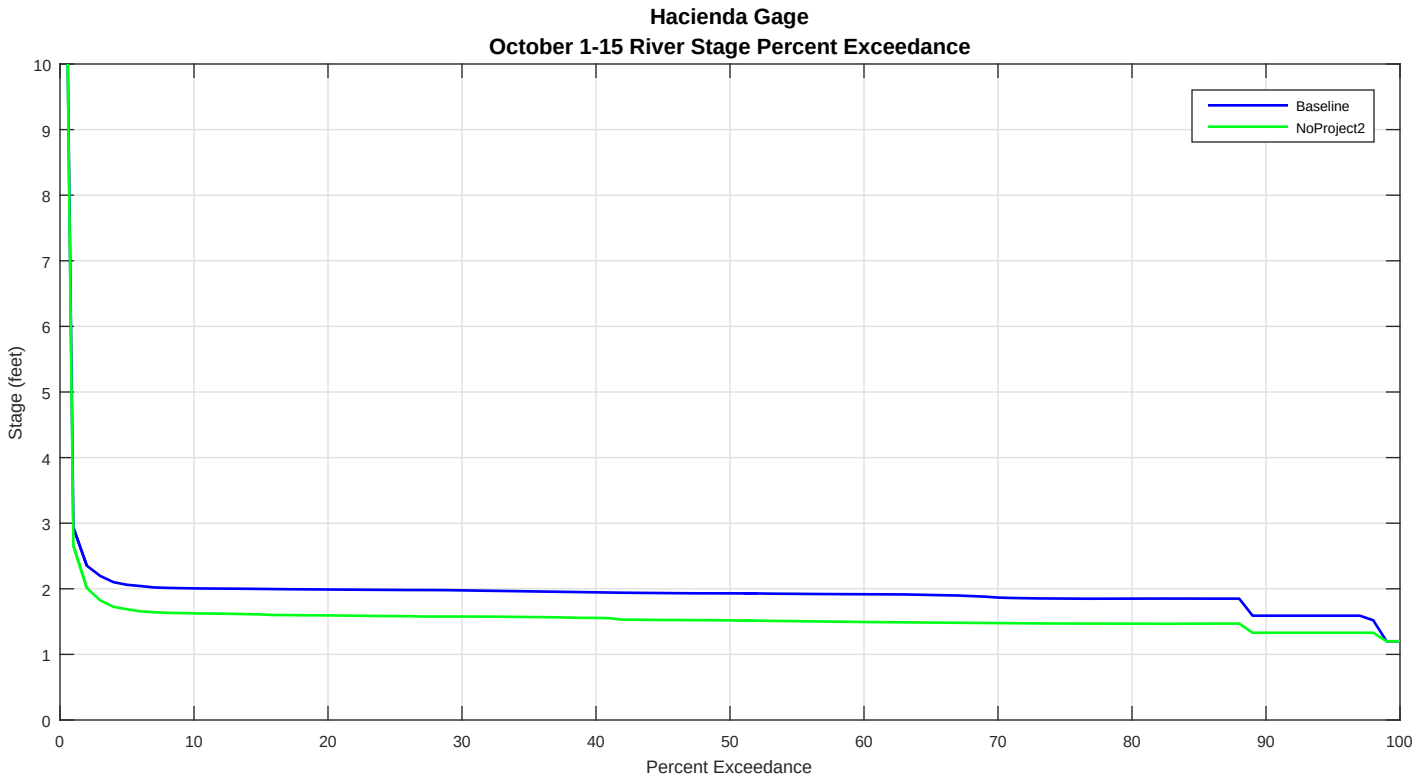

Hacienda Gage
May River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

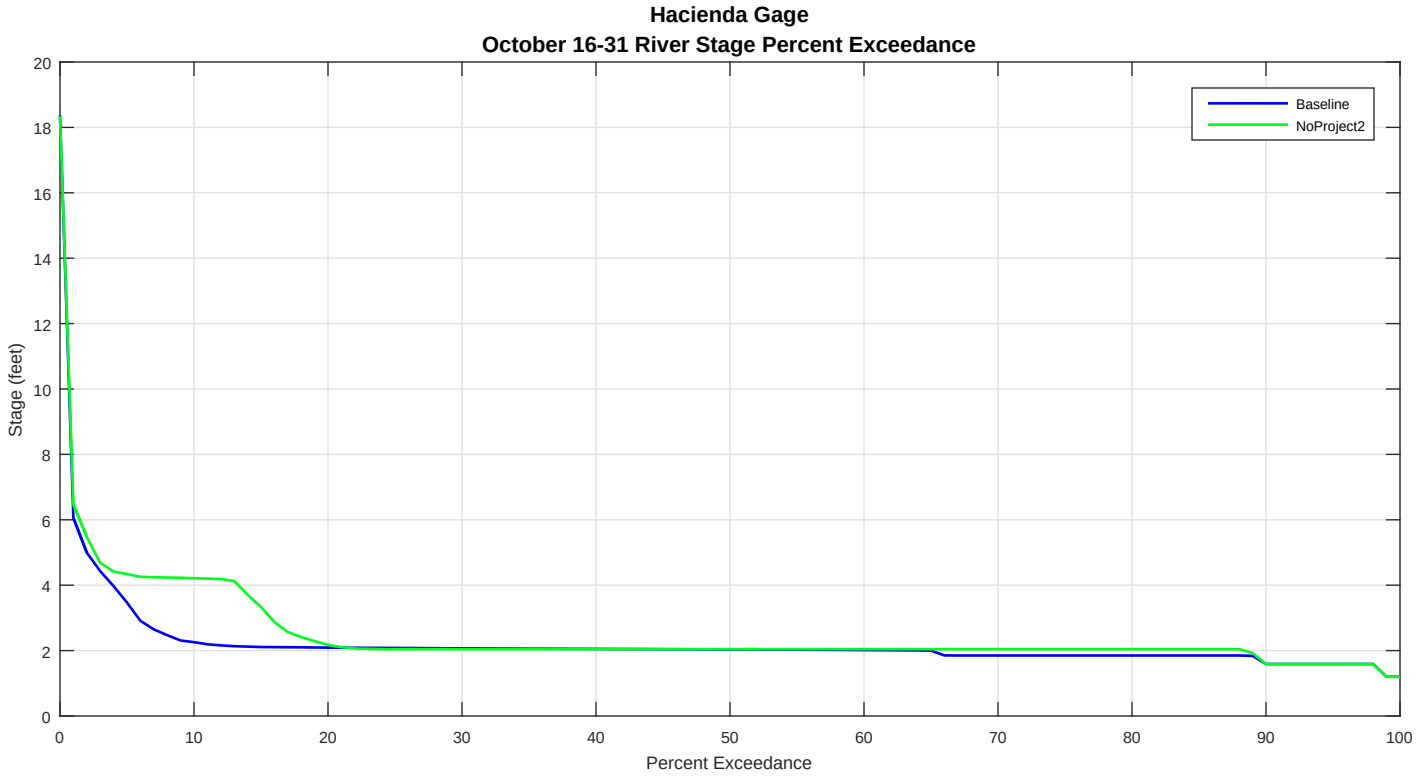

Hacienda Gage
June River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

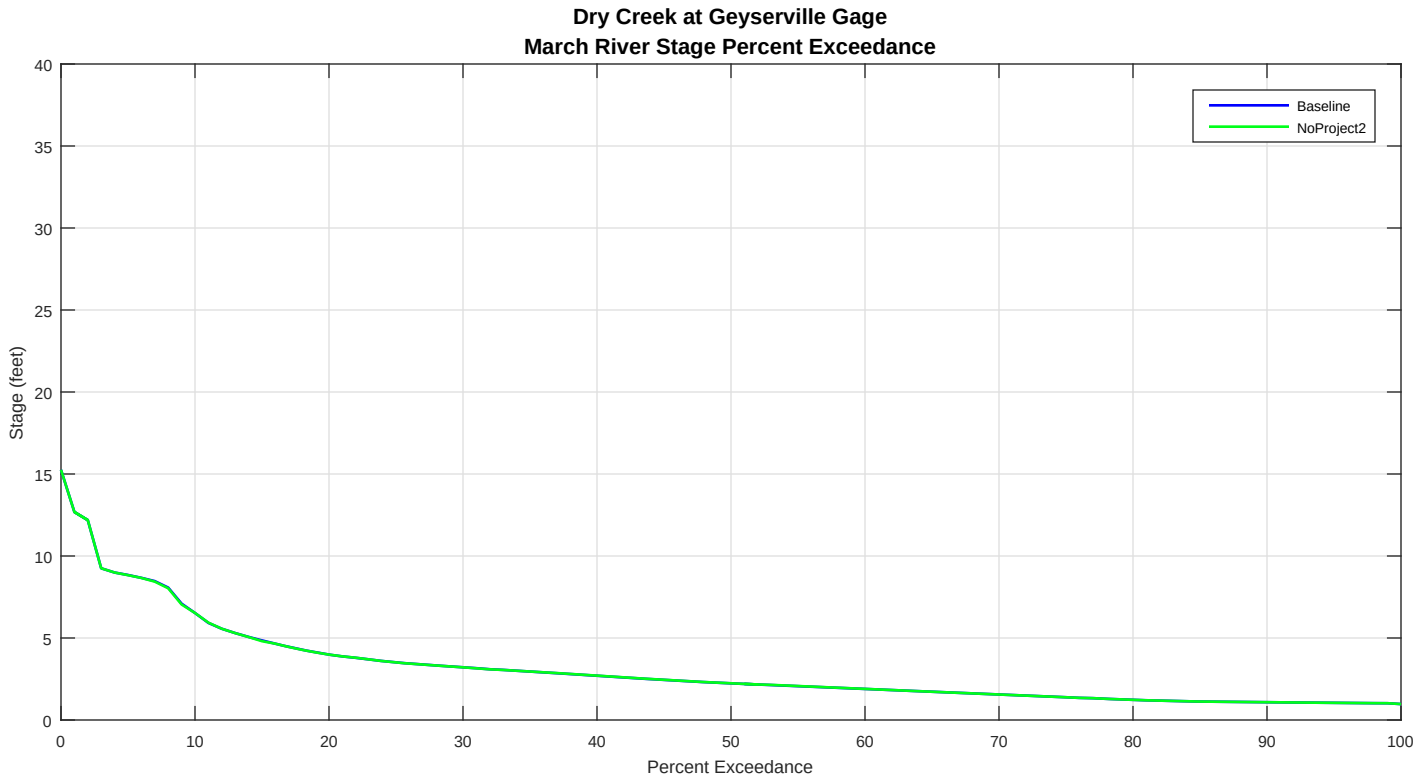

Hacienda Gage
July River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

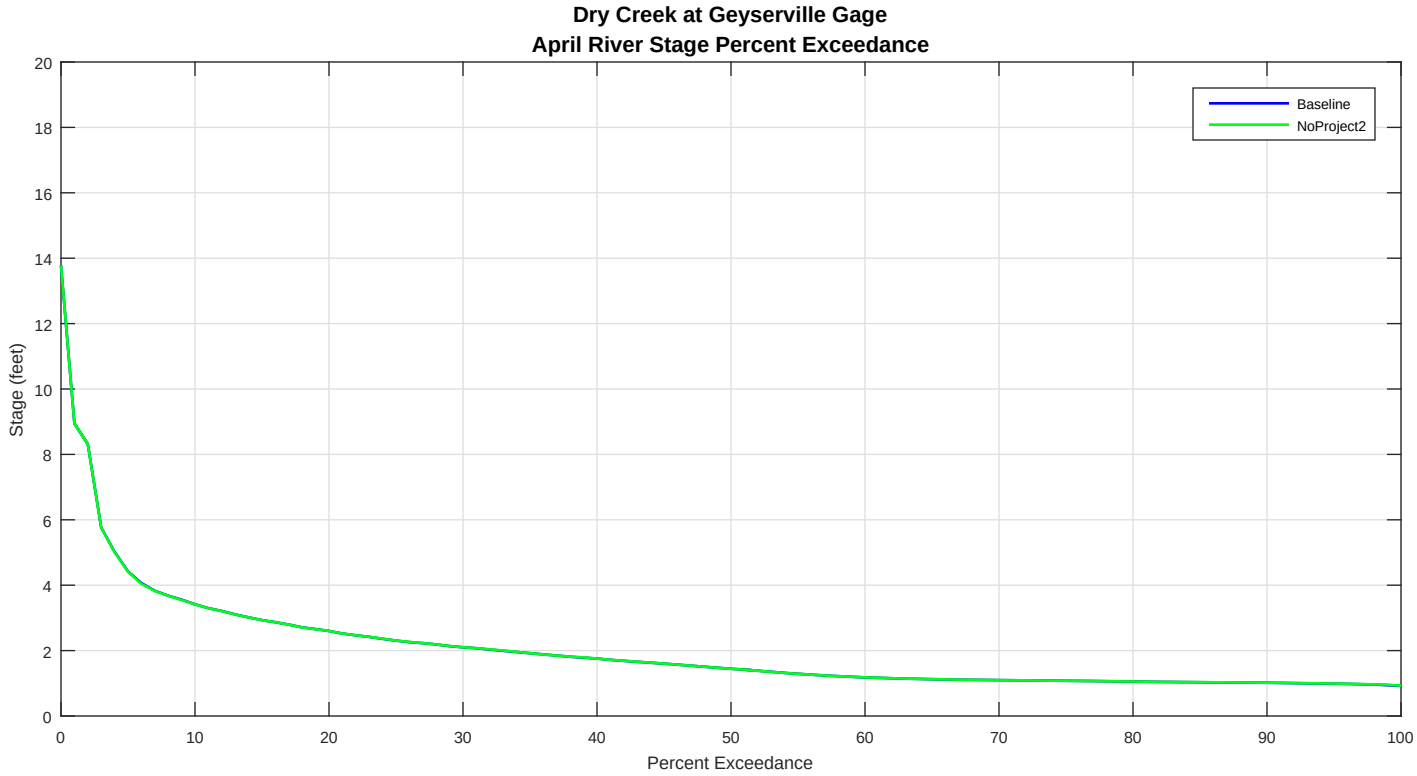

Hacienda Gage
August River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

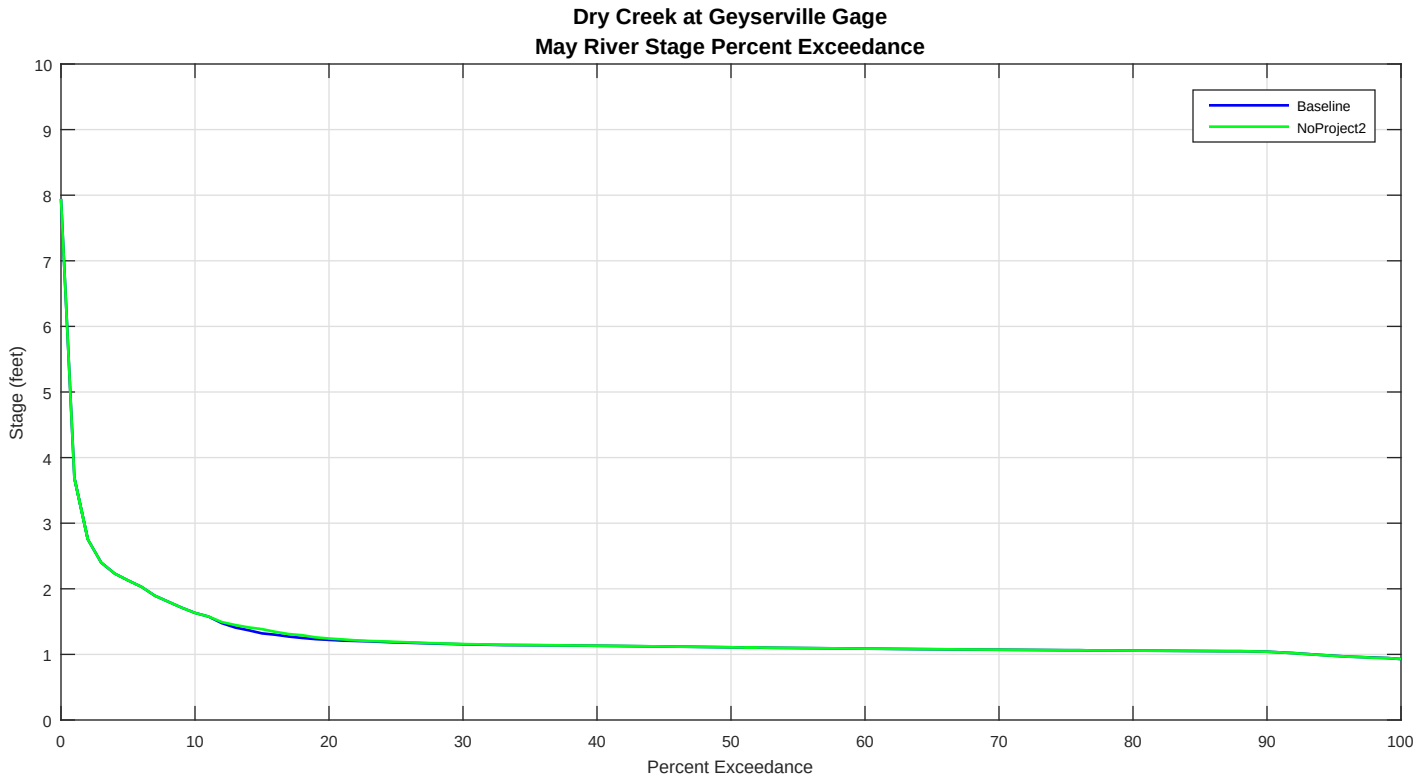

Hacienda Gage
September River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

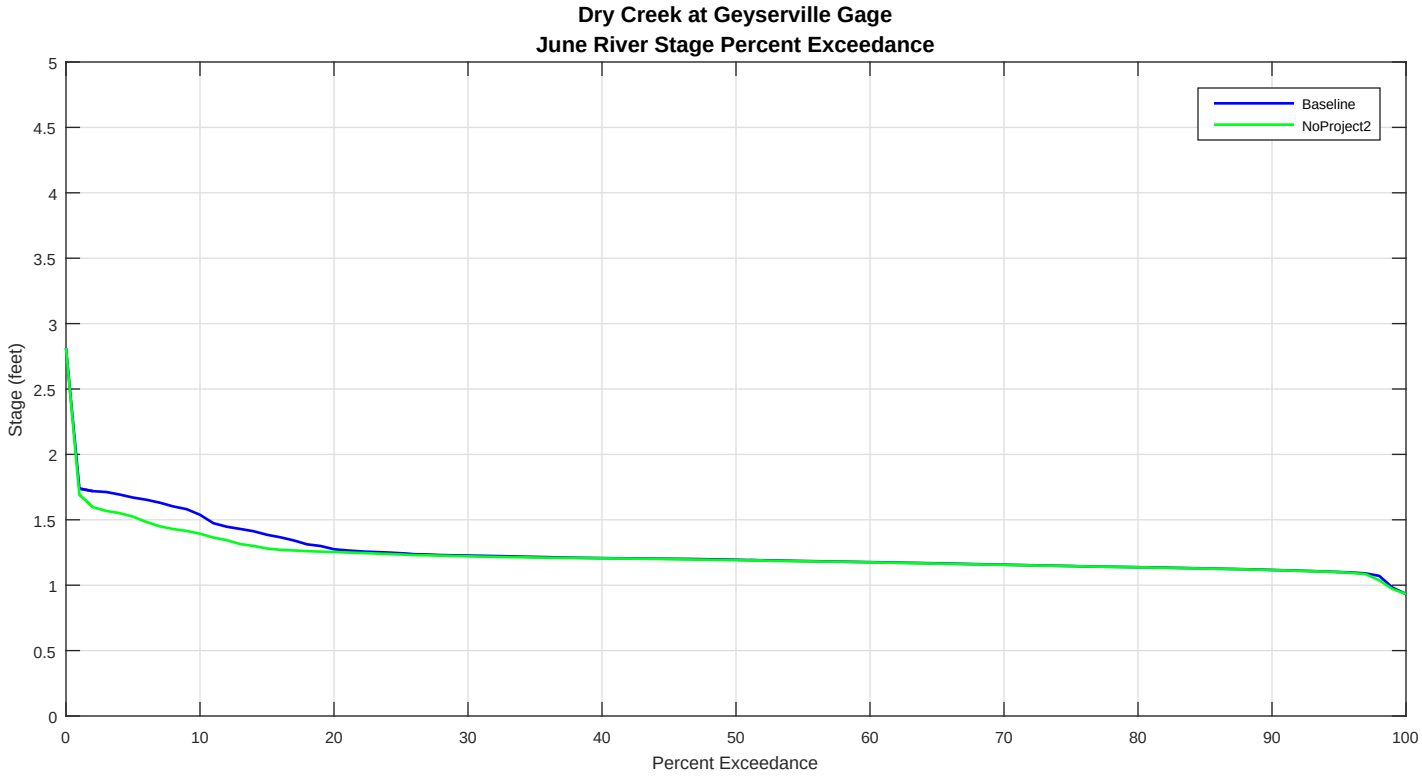

Hacienda Gage
October 1-15 River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

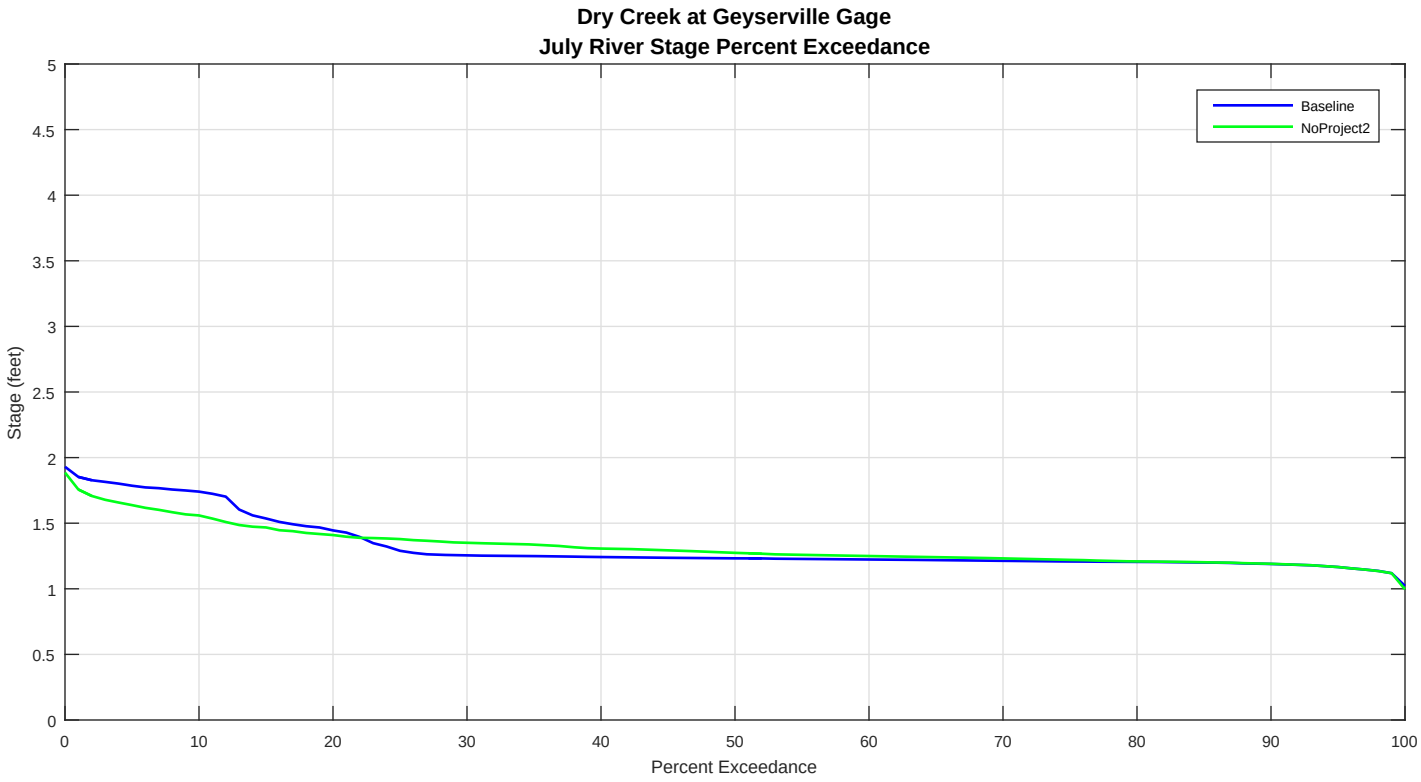

Hacienda Gage
October 16-31 River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

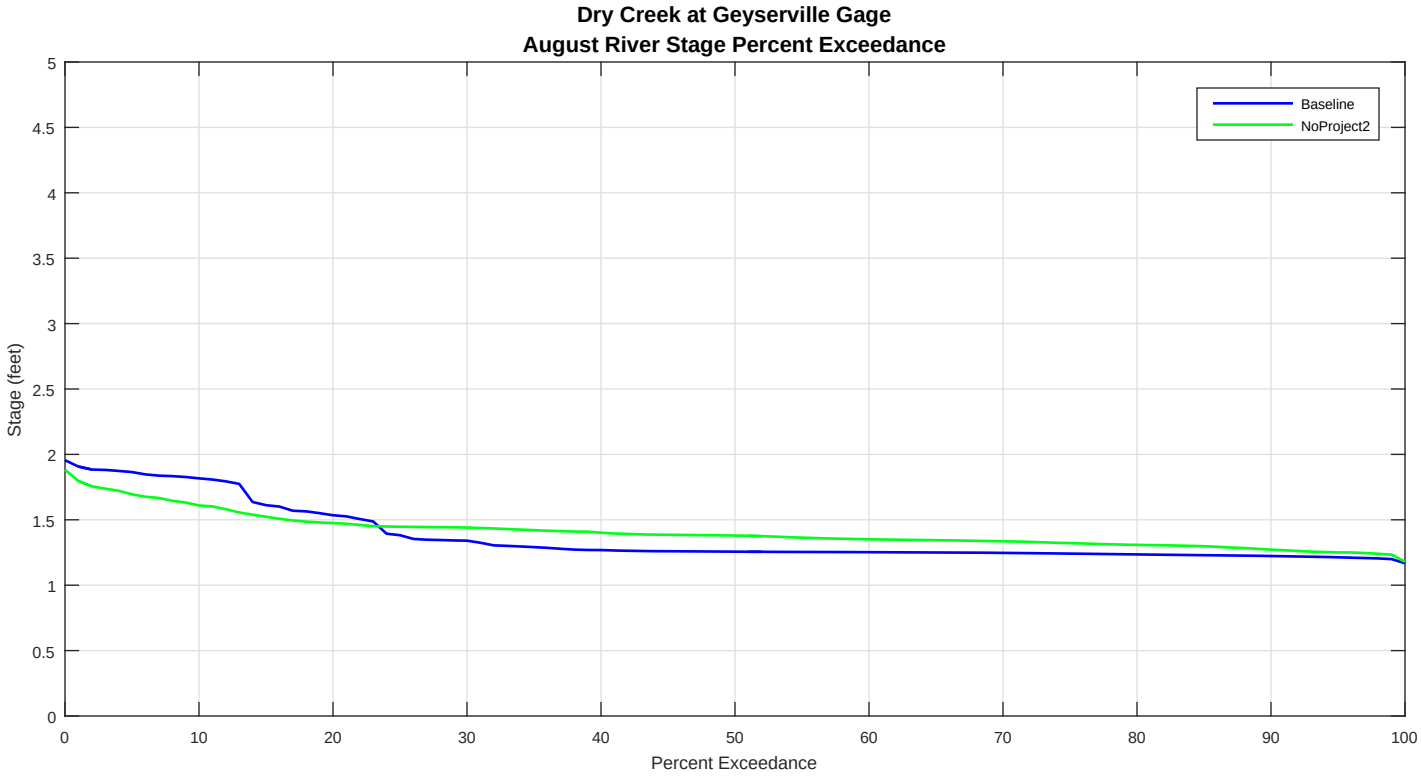

Dry Creek at Geyserville Gage
March River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80
90
100

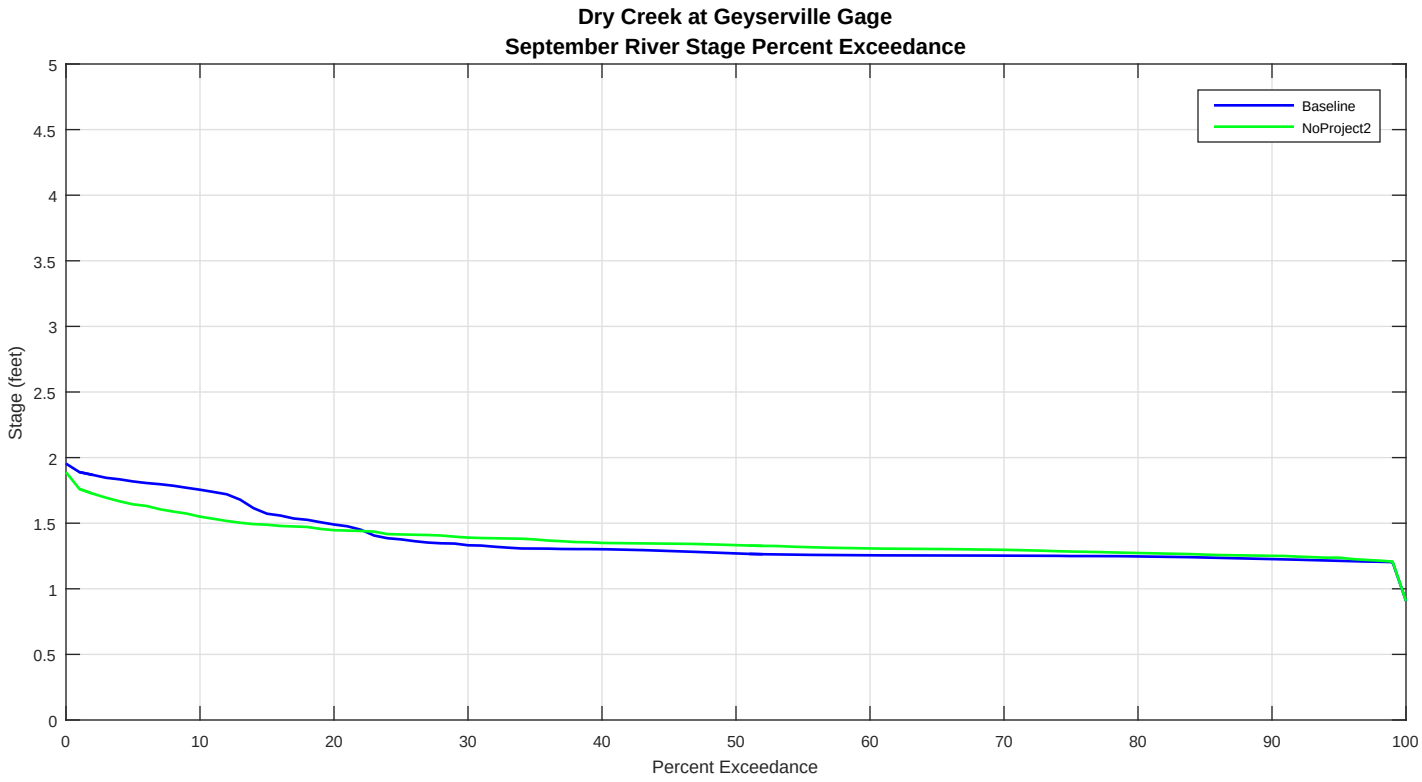

Dry Creek at Geyserville Gage
April River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

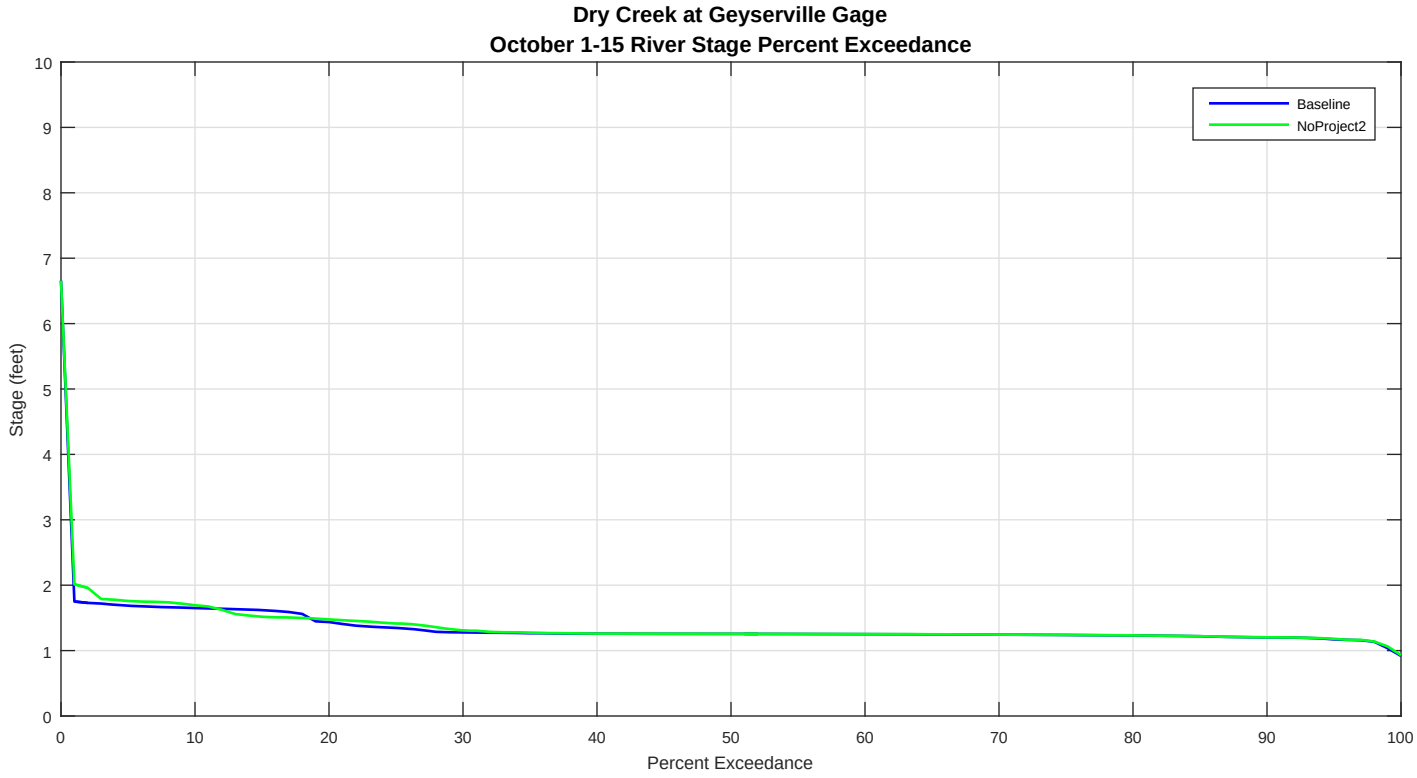

Dry Creek at Geyserville Gage
May River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

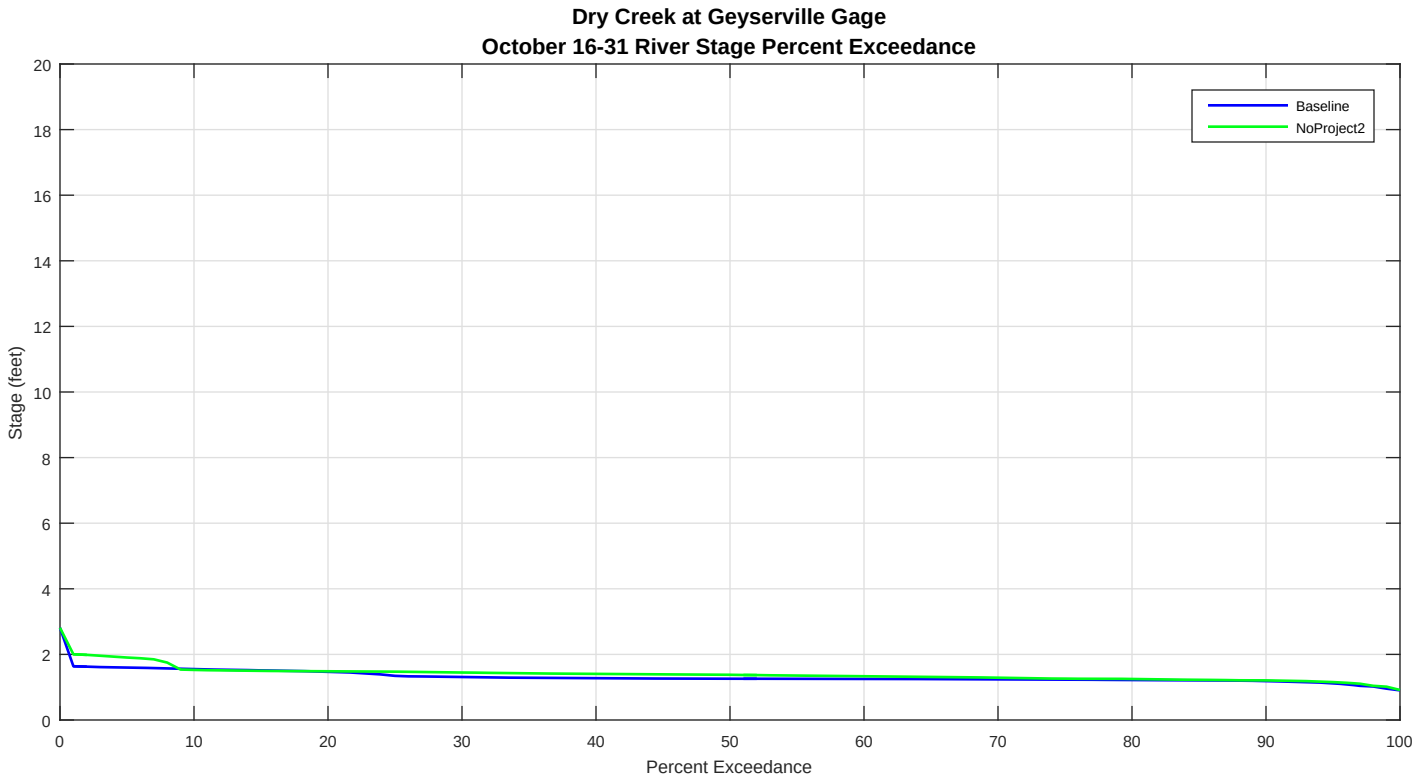

Dry Creek at Geyserville Gage
June River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

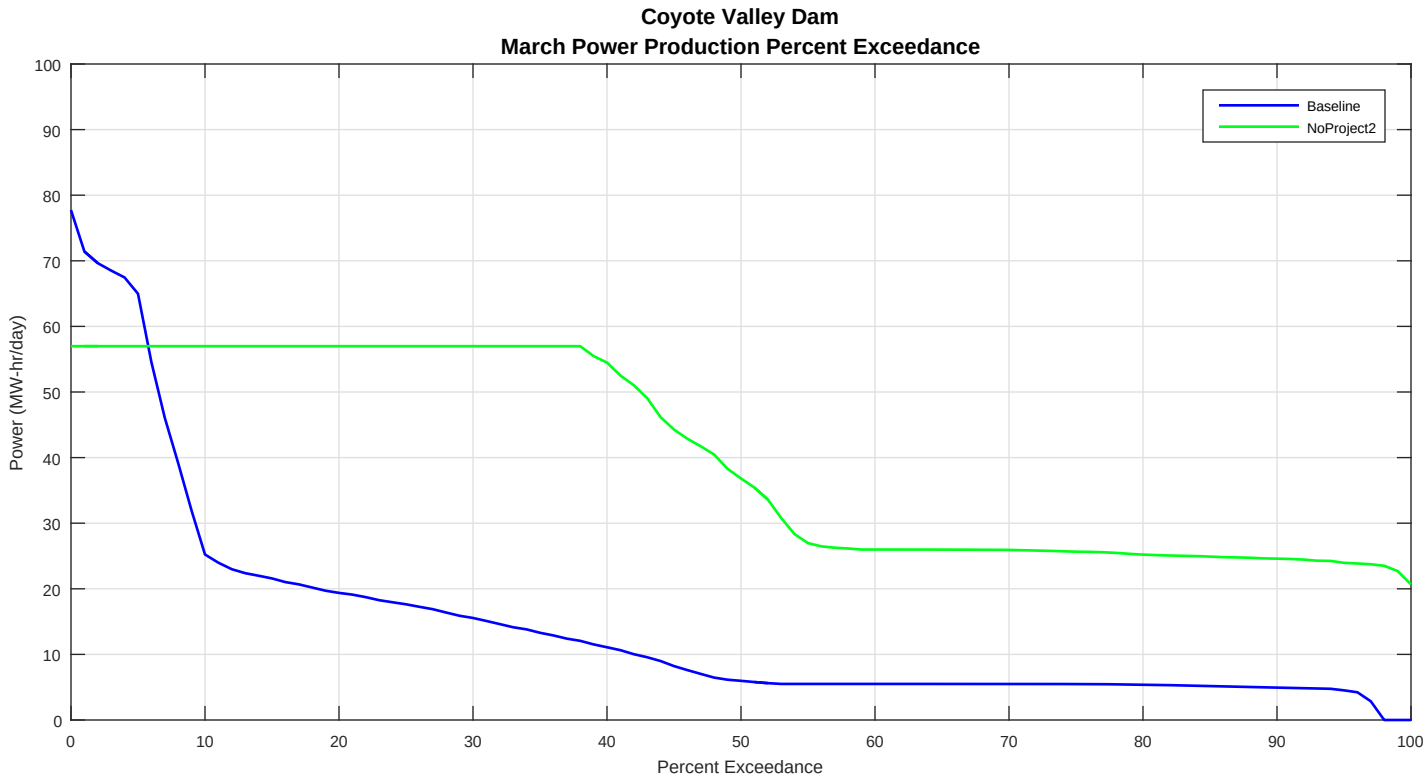

Dry Creek at Geyserville Gage
July River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

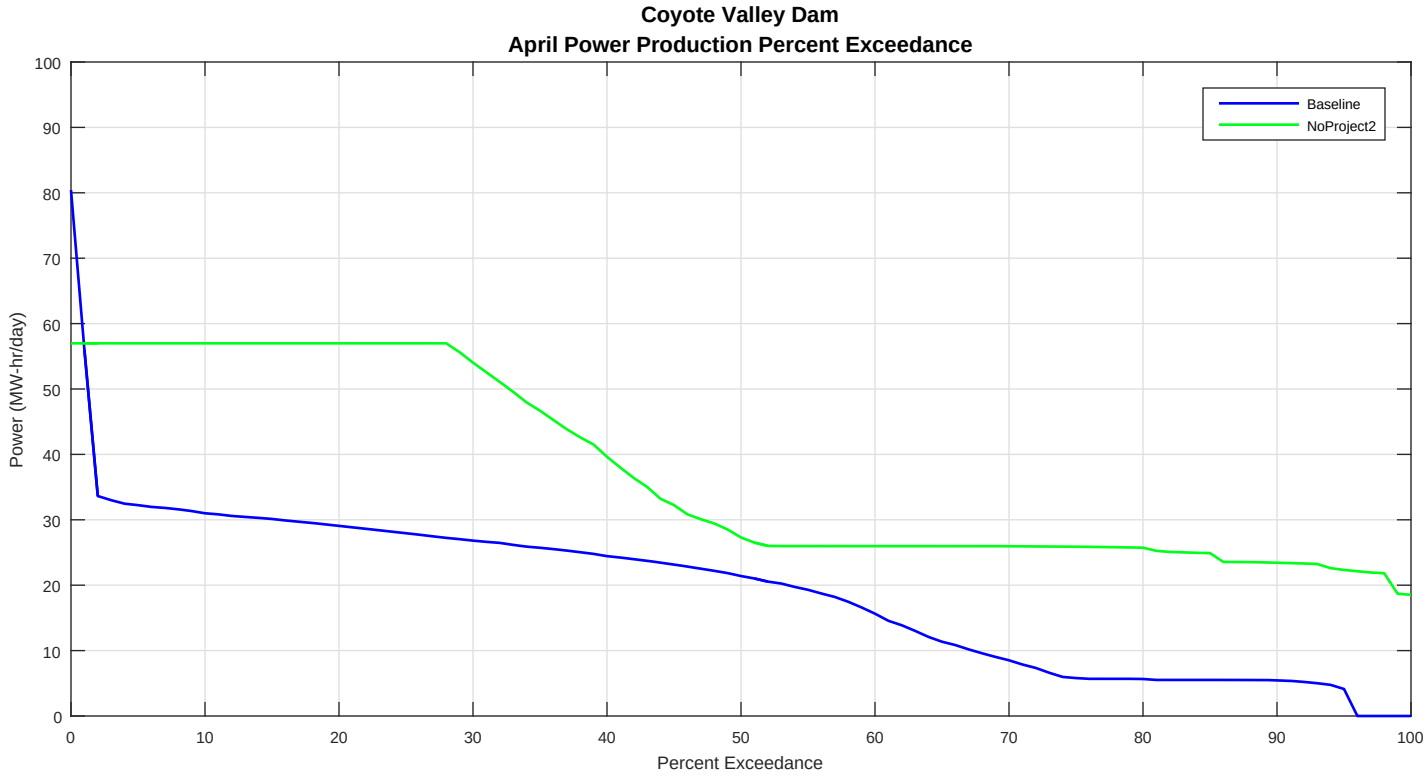

Dry Creek at Geyserville Gage
August River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

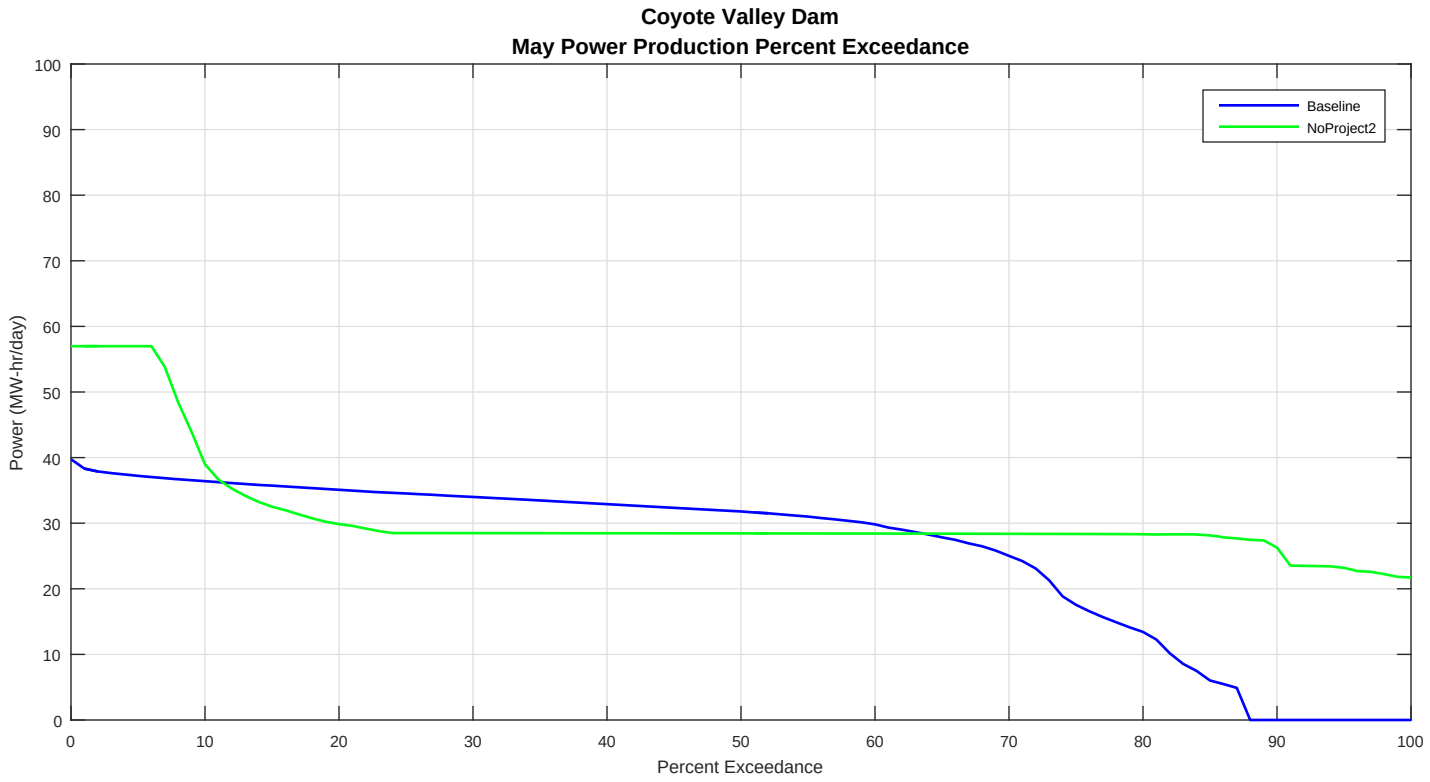

Dry Creek at Geyserville Gage
September River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

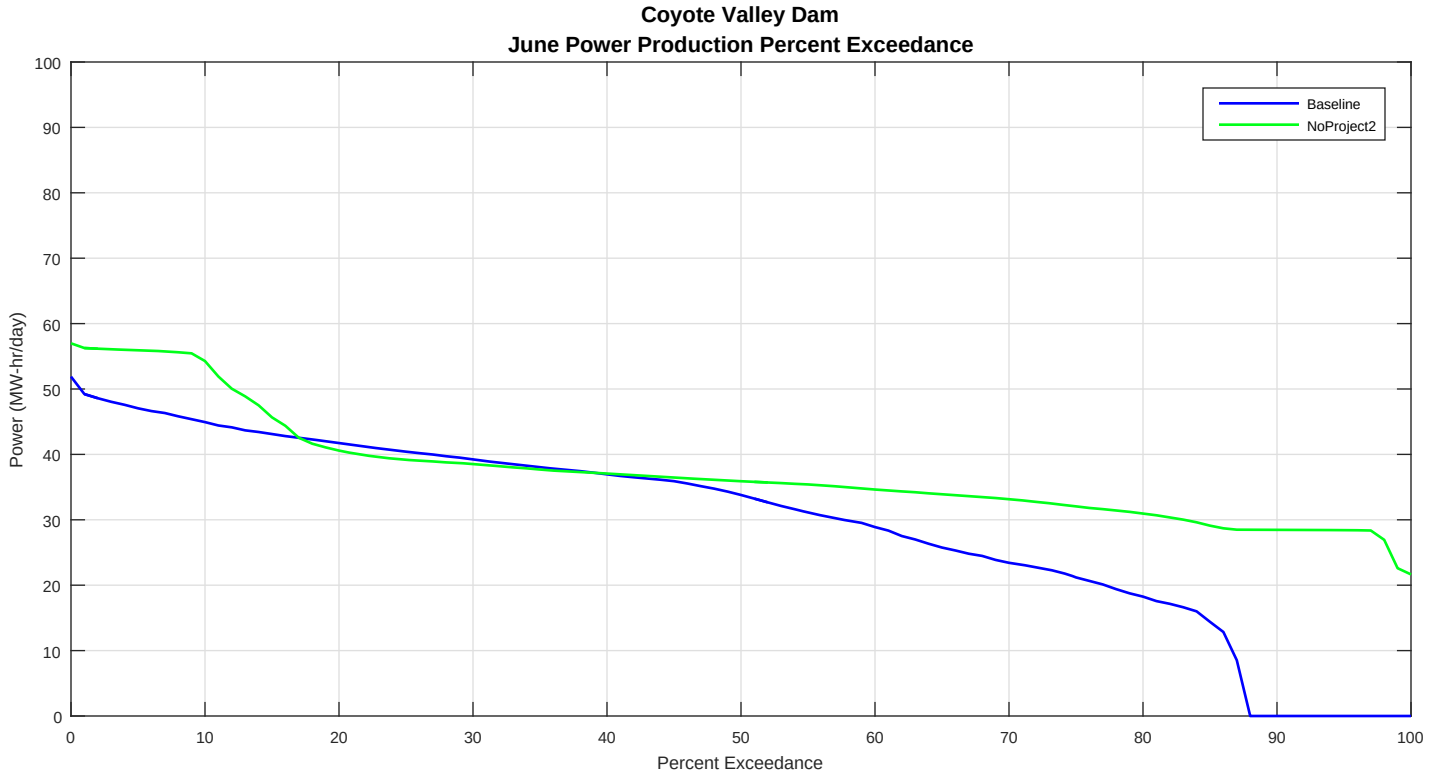

Dry Creek at Geyserville Gage
October 1-15 River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

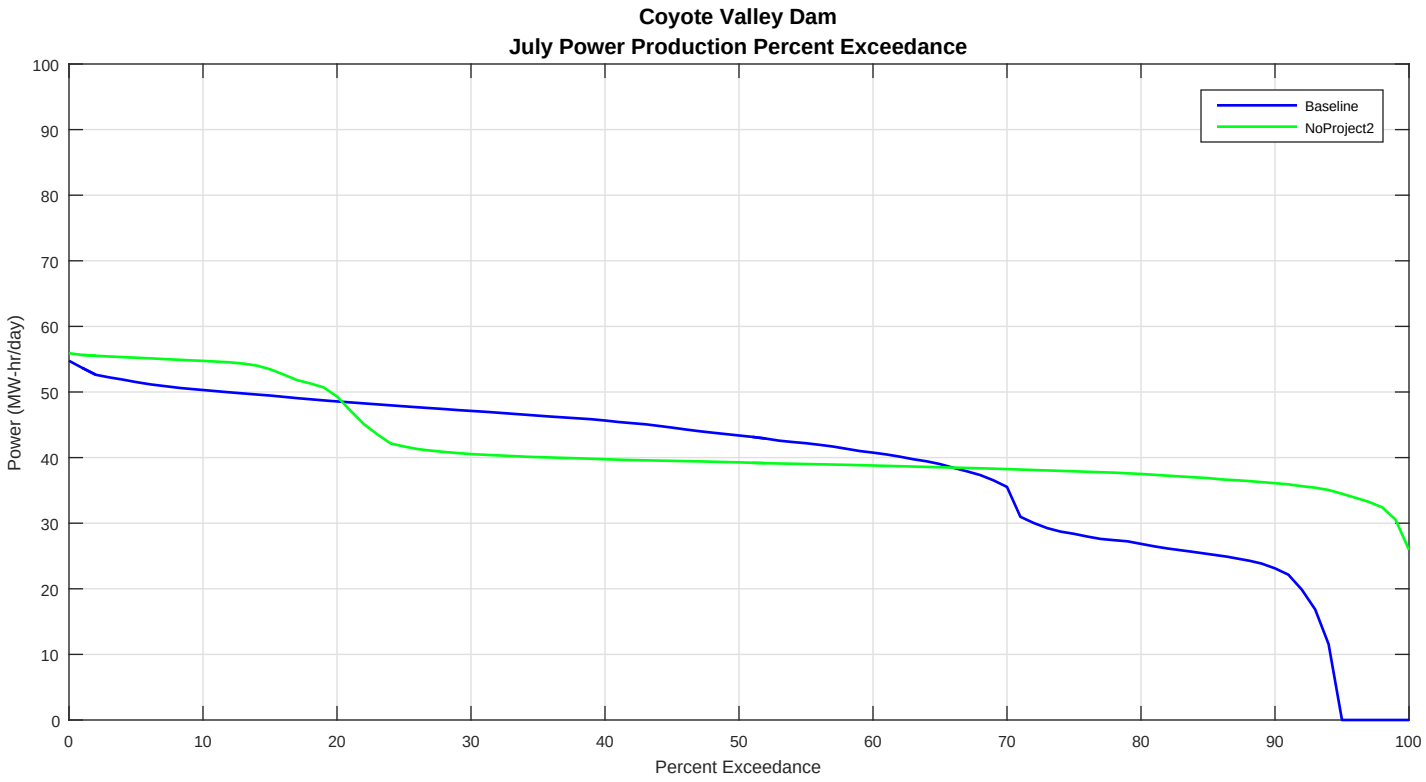

Dry Creek at Geyserville Gage
October 16-31 River Stage Percent Exceedance
Baseline
NoProject2
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

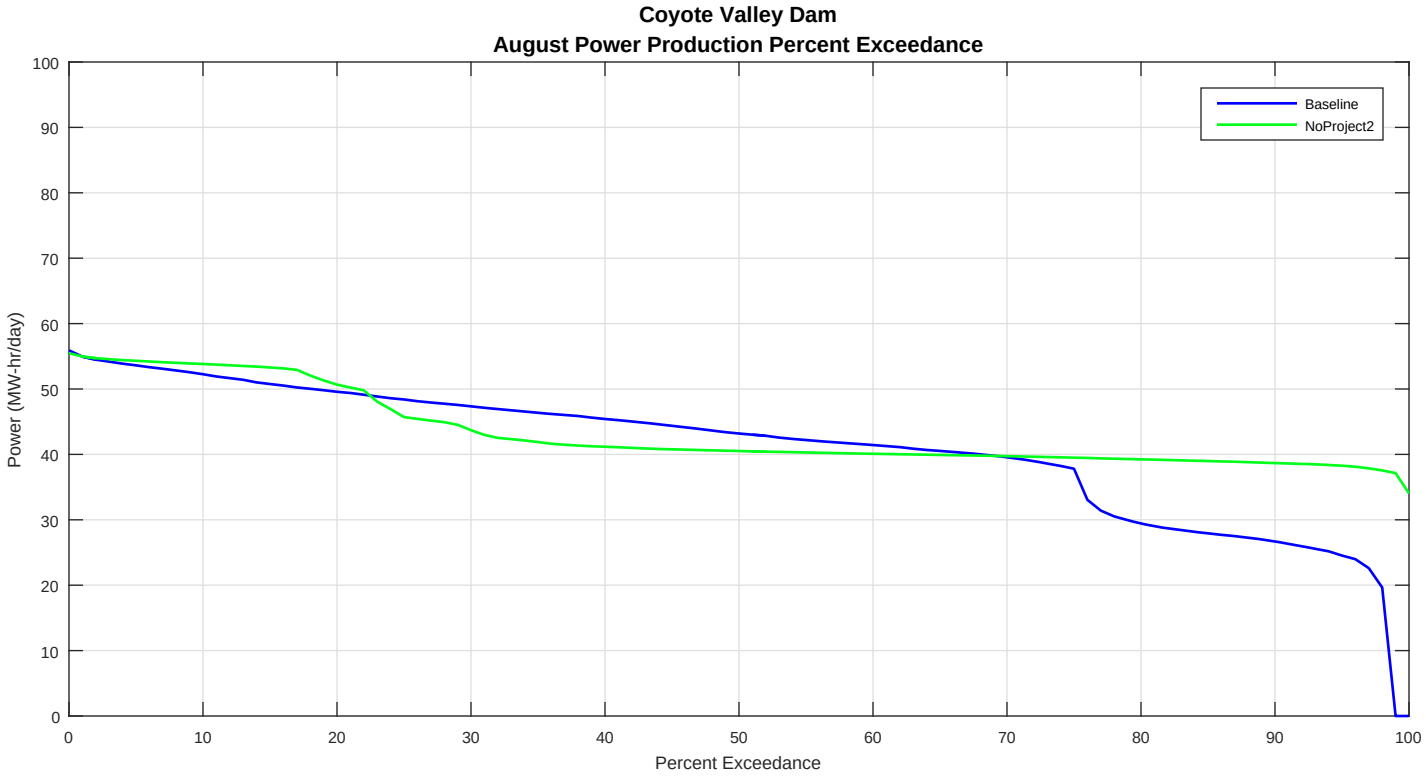

Coyote Valley Dam
March Power Production Percent Exceedance
Baseline
NoProject2
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam
April Power Production Percent Exceedance
Baseline
NoProject2
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam
May Power Production Percent Exceedance
Baseline
NoProject2
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam
June Power Production Percent Exceedance
Baseline
NoProject2
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam
July Power Production Percent Exceedance
Baseline
NoProject2
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam
August Power Production Percent Exceedance
Baseline
NoProject2
Power (MW-hr/day)
Percent Exceedance
0
10
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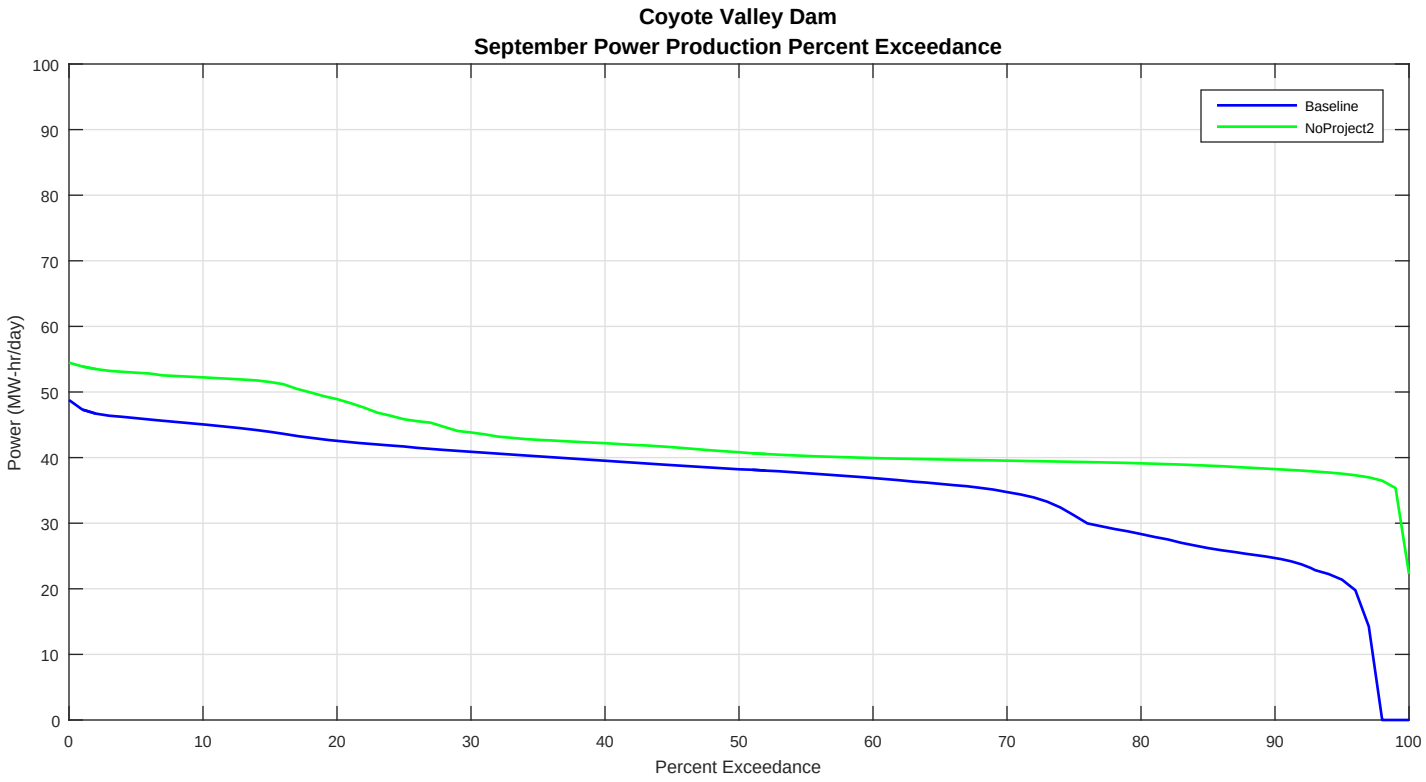
Coyote Valley Dam
September Power Production Percent Exceedance
Baseline
NoProject2
Power (MW-hr/day)
Percent Exceedance
0
10
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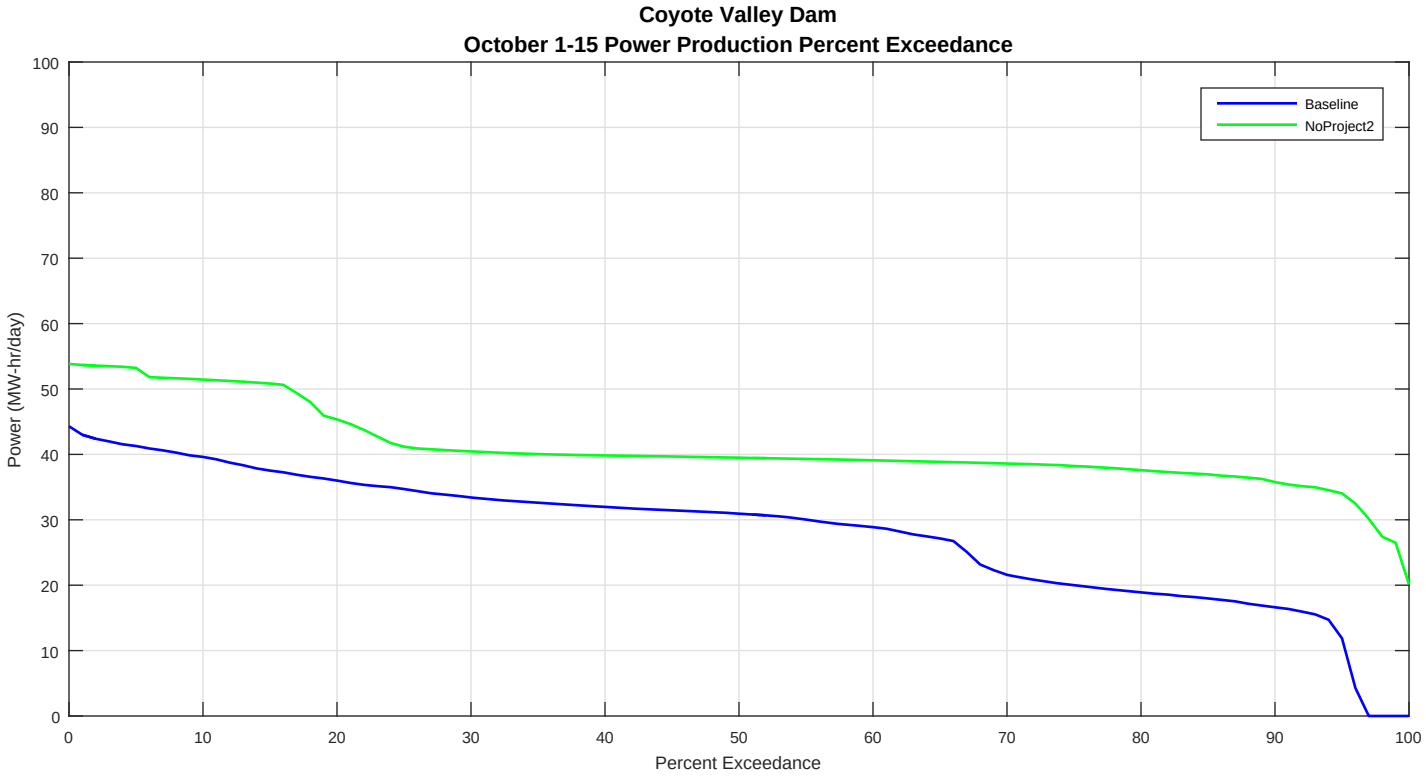
Coyote Valley Dam
October 1-15 Power Production Percent Exceedance
Baseline
NoProject2
Power (MW-hr/day)
Percent Exceedance
0
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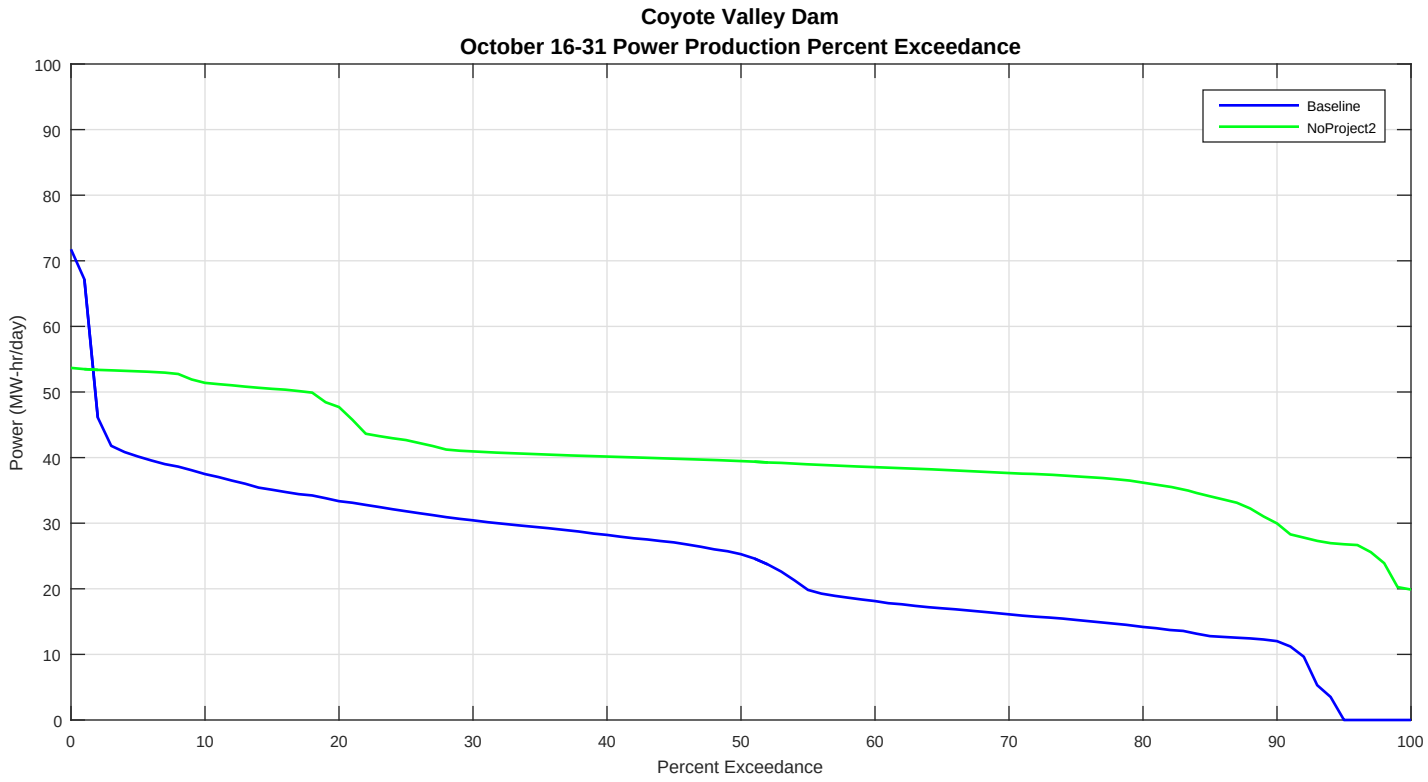
Coyote Valley Dam
October 16-31 Power Production Percent Exceedance
Baseline
NoProject2
Power (MW-hr/day)
Percent Exceedance
0
10
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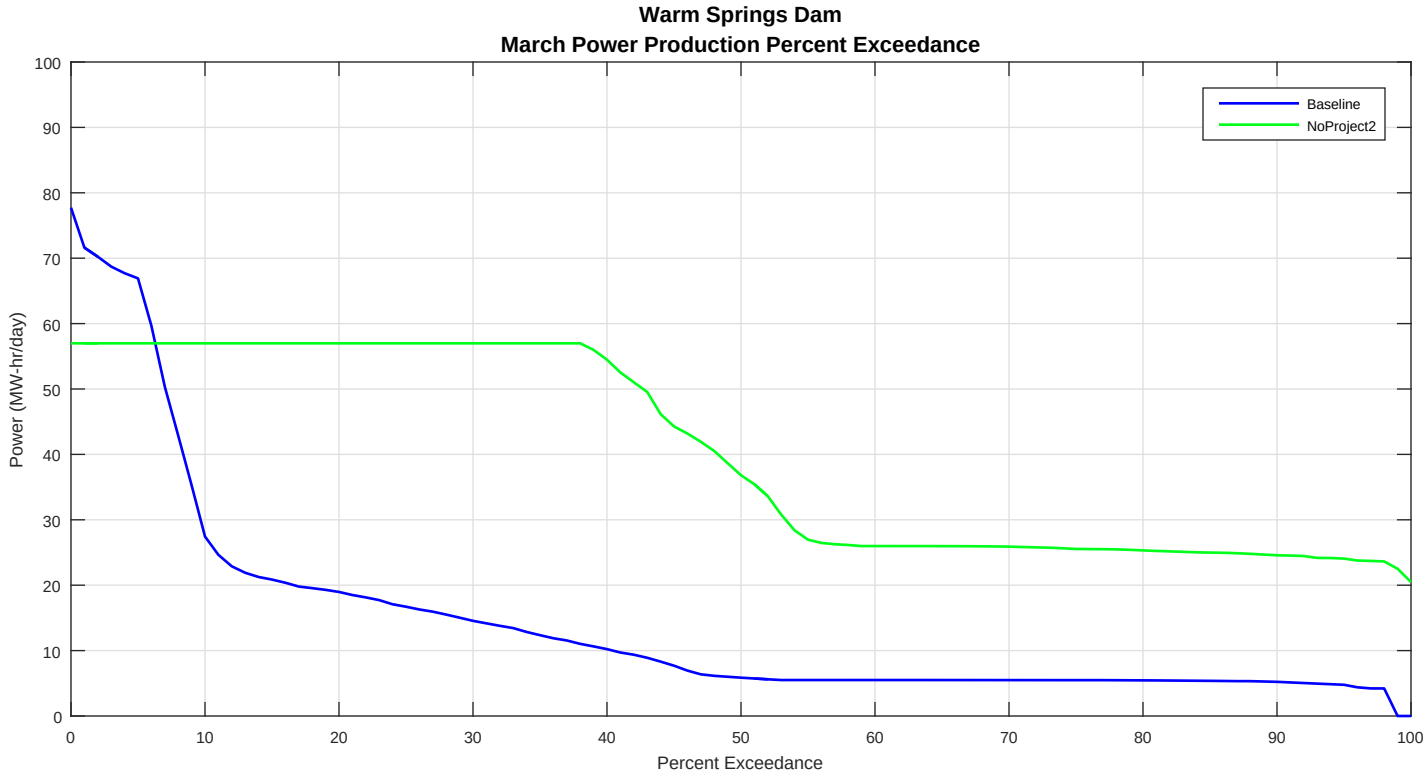
Warm Springs Dam
March Power Production Percent Exceedance
Baseline
NoProject2
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
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70
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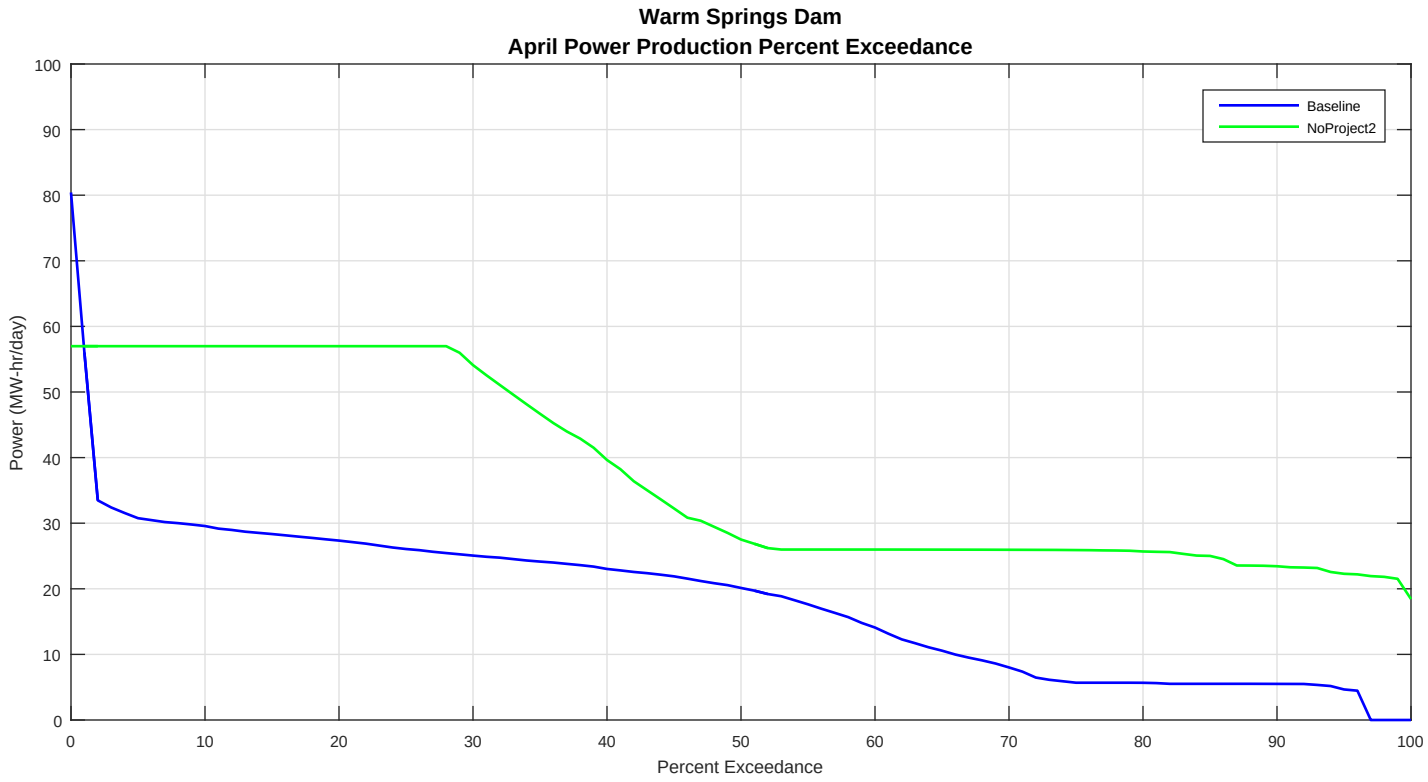
Warm Springs Dam
April Power Production Percent Exceedance
Baseline
NoProject2
Power (MW-hr/day)
Percent Exceedance
0
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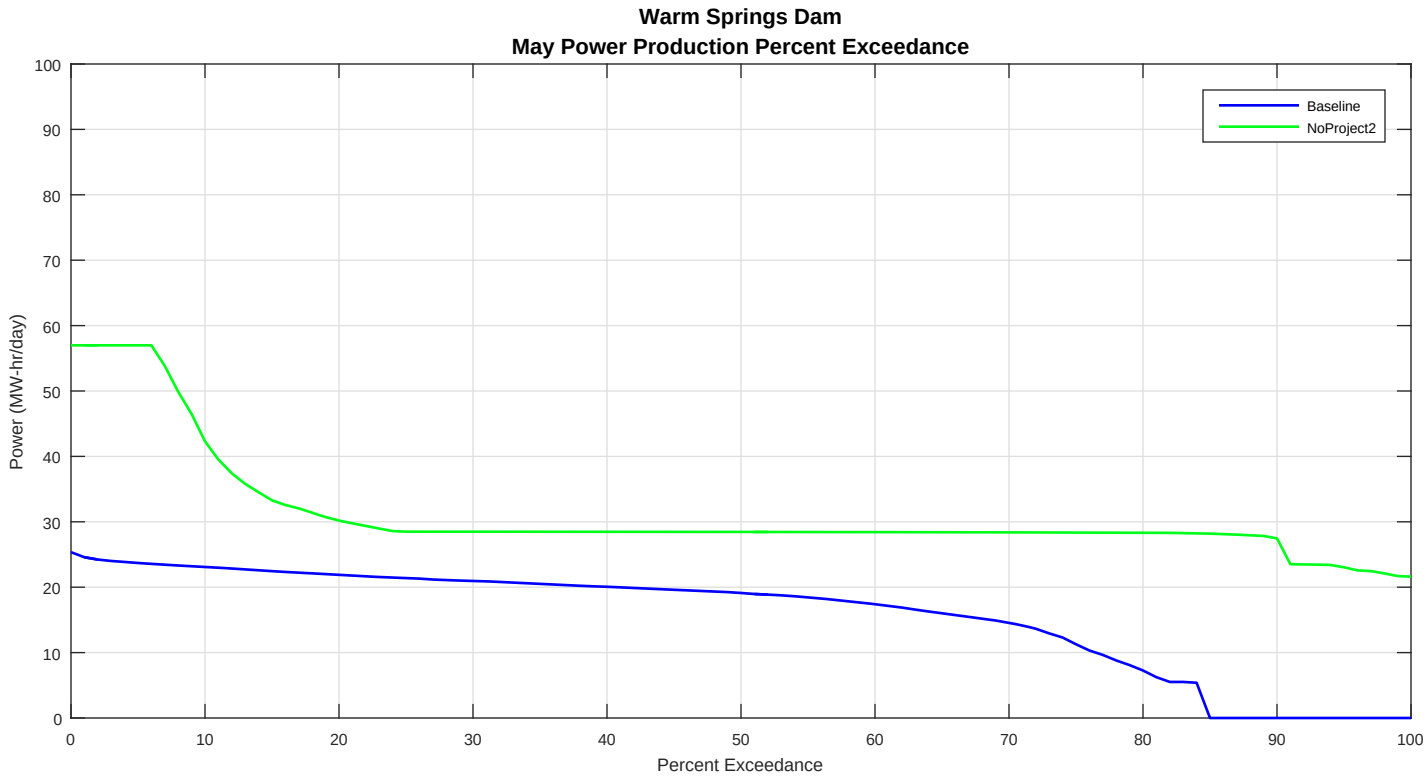
Warm Springs Dam
May Power Production Percent Exceedance
Baseline
NoProject2
Power (MW-hr/day)
Percent Exceedance
0
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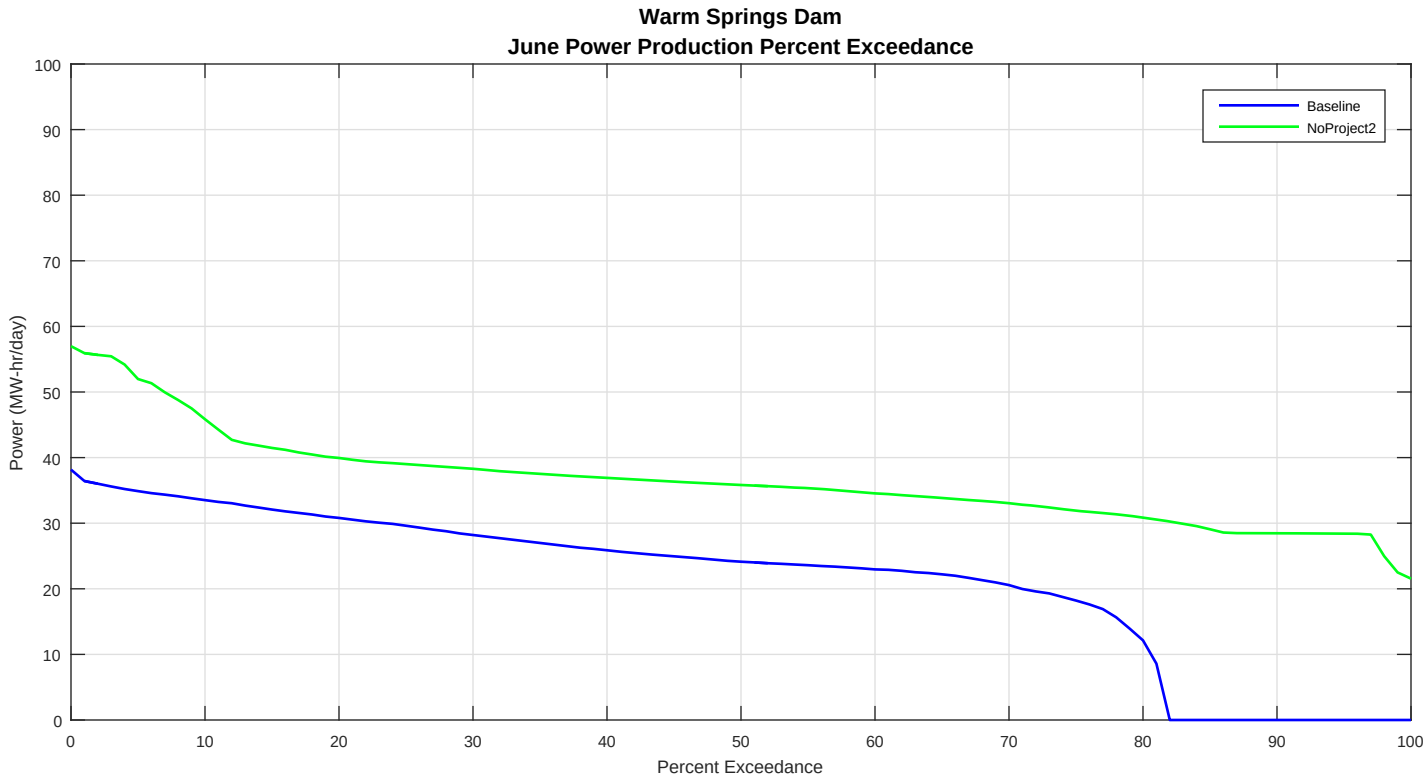
Warm Springs Dam
June Power Production Percent Exceedance
Baseline
NoProject2
Power (MW-hr/day)
Percent Exceedance
0
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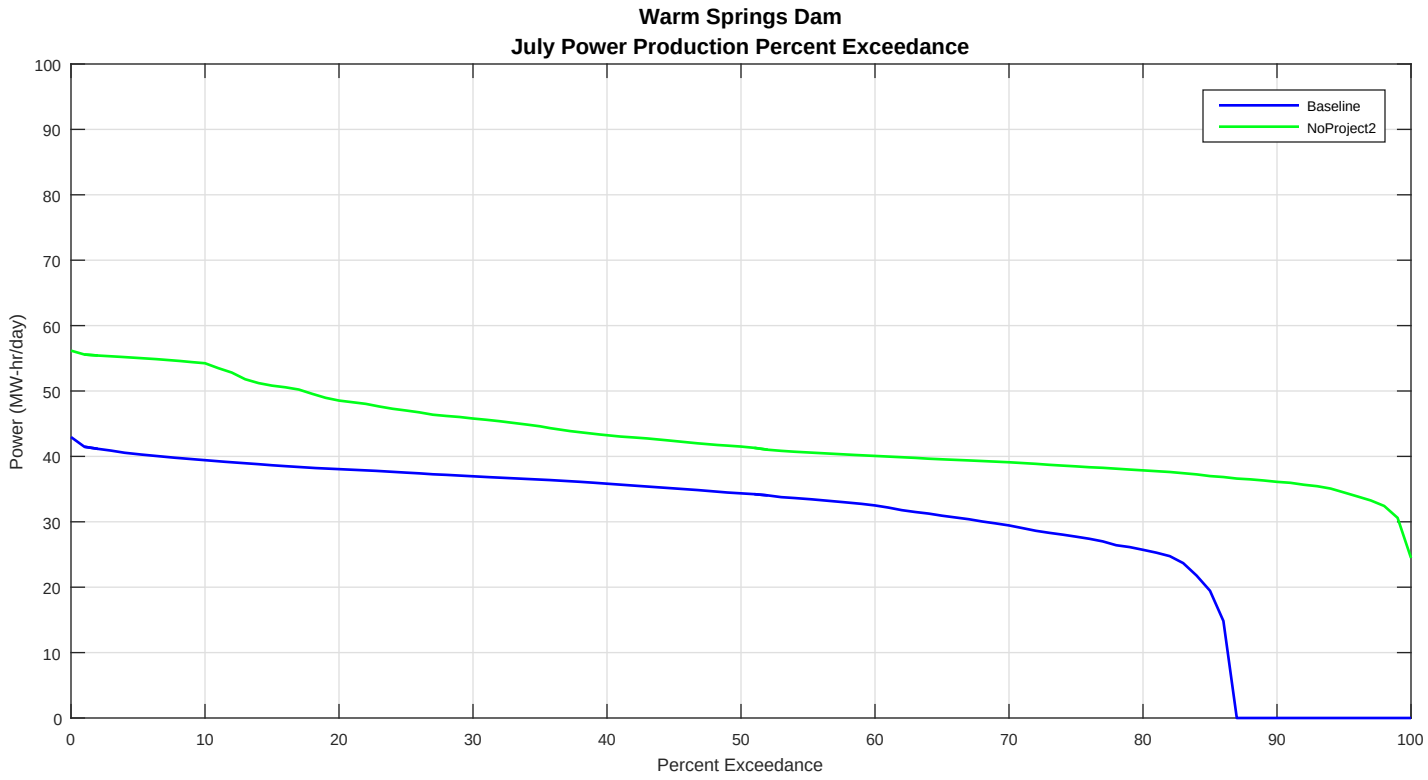
Warm Springs Dam
July Power Production Percent Exceedance
Baseline
NoProject2
Power (MW-hr/day)
Percent Exceedance
0
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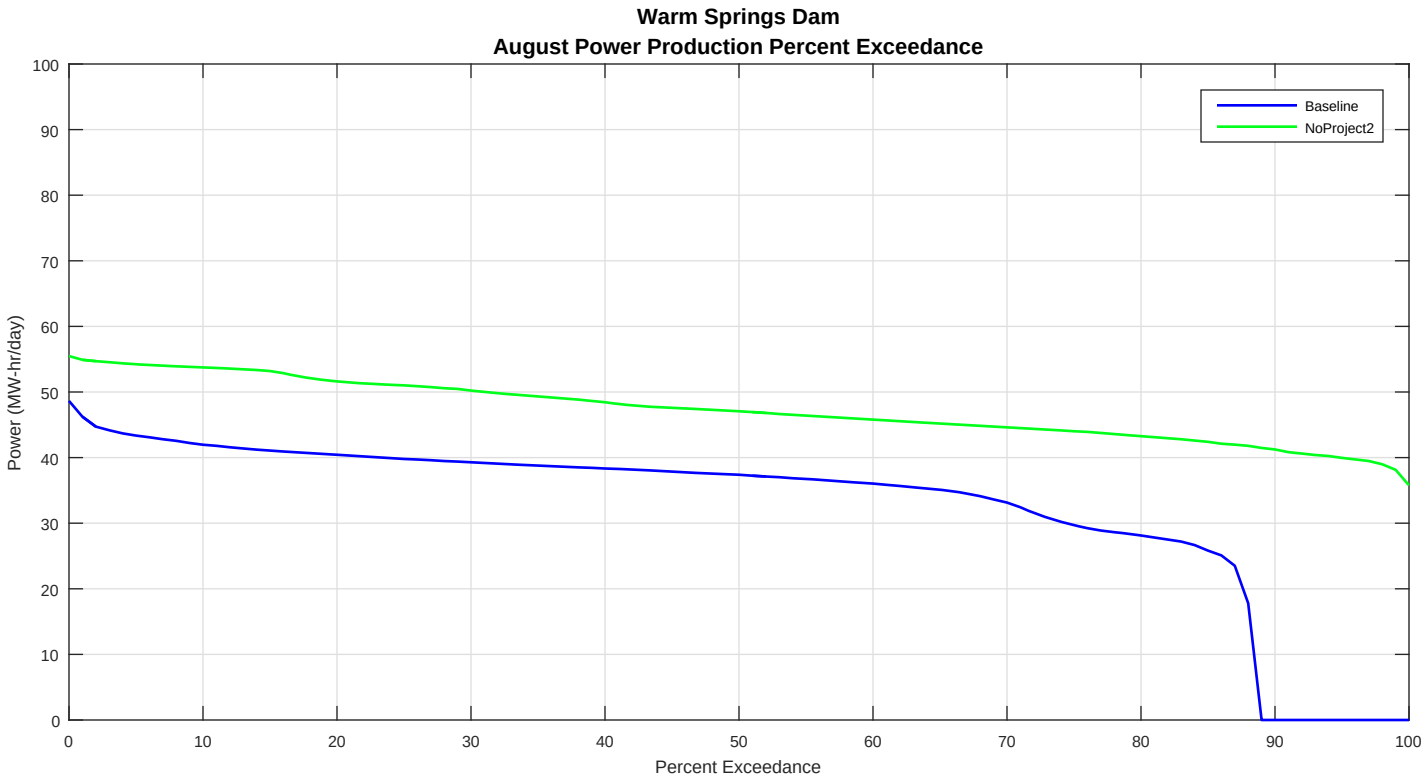
Warm Springs Dam
August Power Production Percent Exceedance
Baseline
NoProject2
Power (MW-hr/day)
Percent Exceedance
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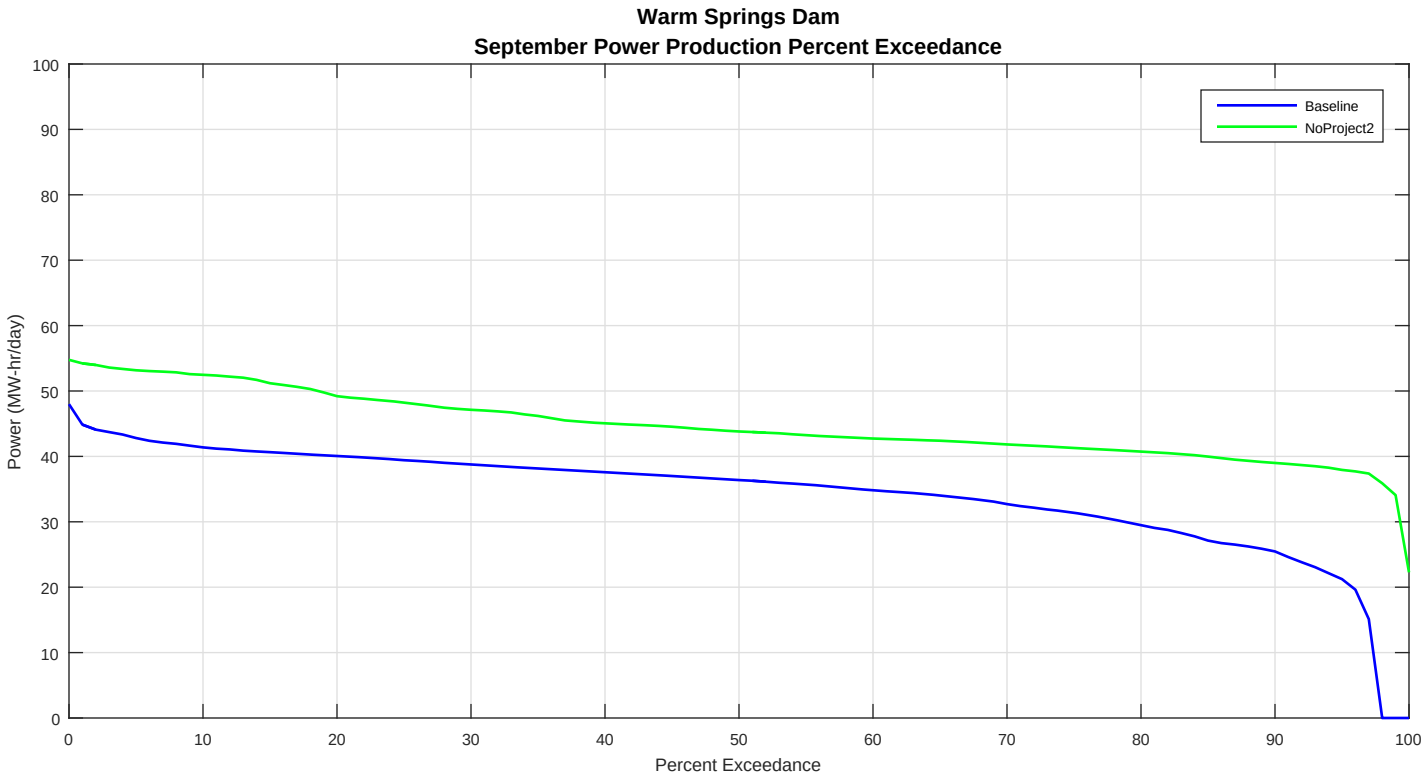
Warm Springs Dam
September Power Production Percent Exceedance
Baseline
NoProject2
Power (MW-hr/day)
Percent Exceedance
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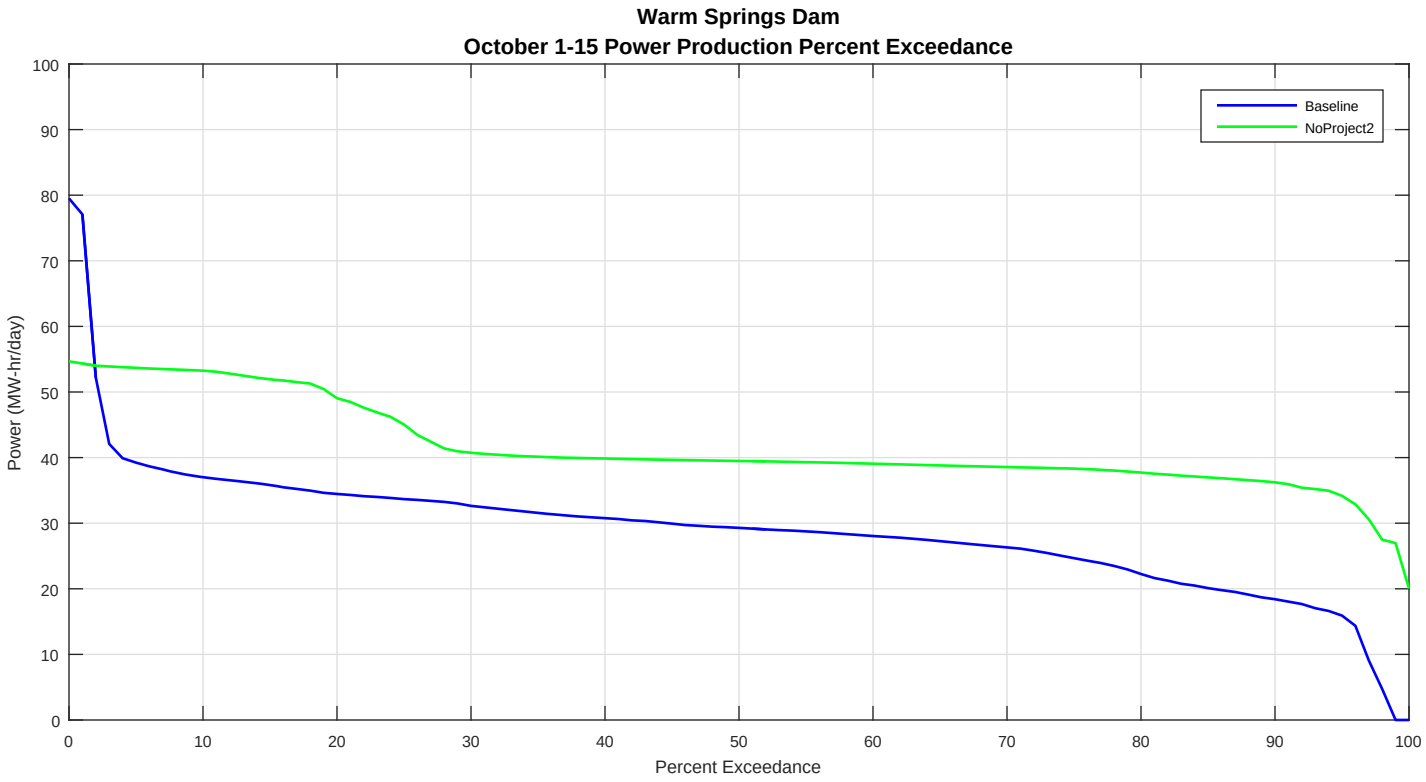
Warm Springs Dam
October 1-15 Power Production Percent Exceedance
Baseline
NoProject2
Power (MW-hr/day)
Percent Exceedance
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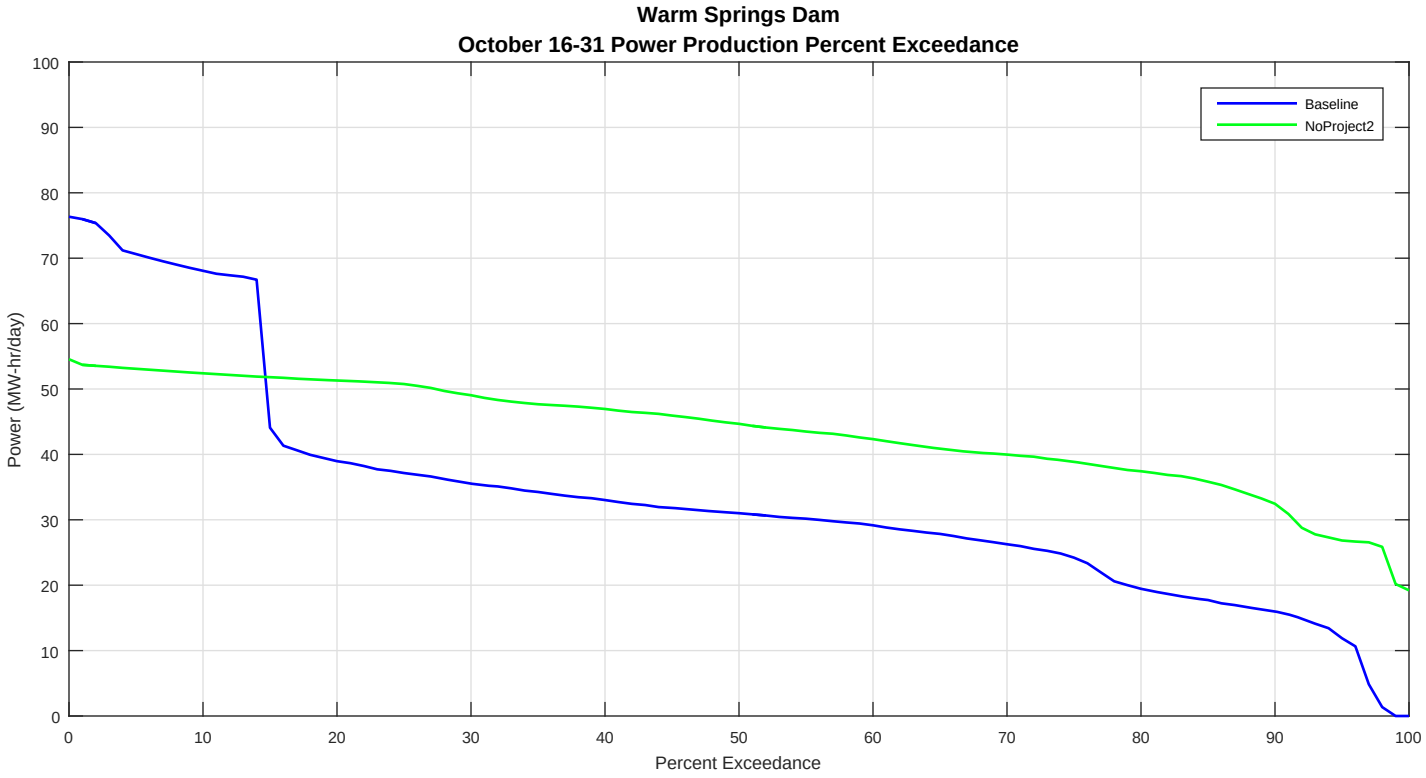
Warm Springs Dam
October 16-31 Power Production Percent Exceedance
Baseline
NoProject2
Power (MW-hr/day)
Percent Exceedance
0
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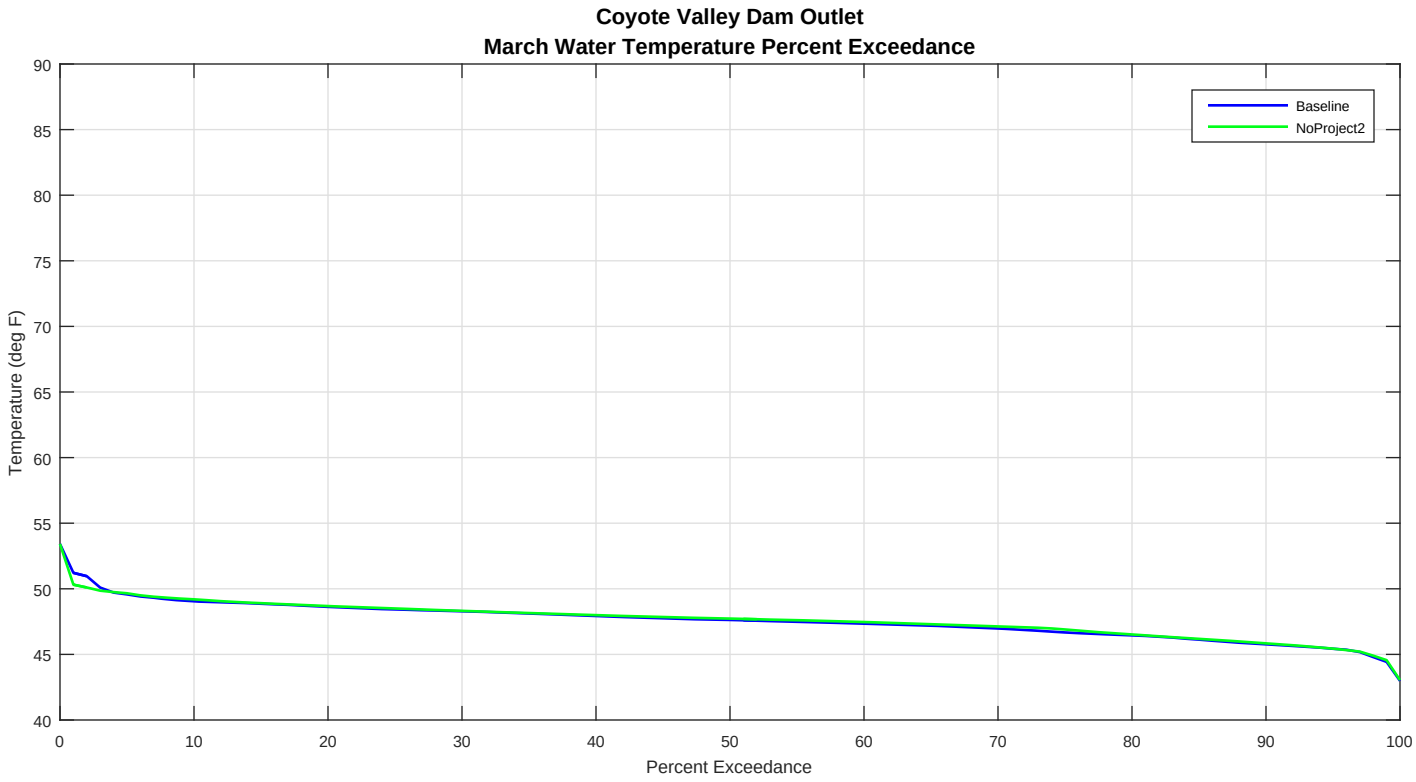
Coyote Valley Dam Outlet
March Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
85
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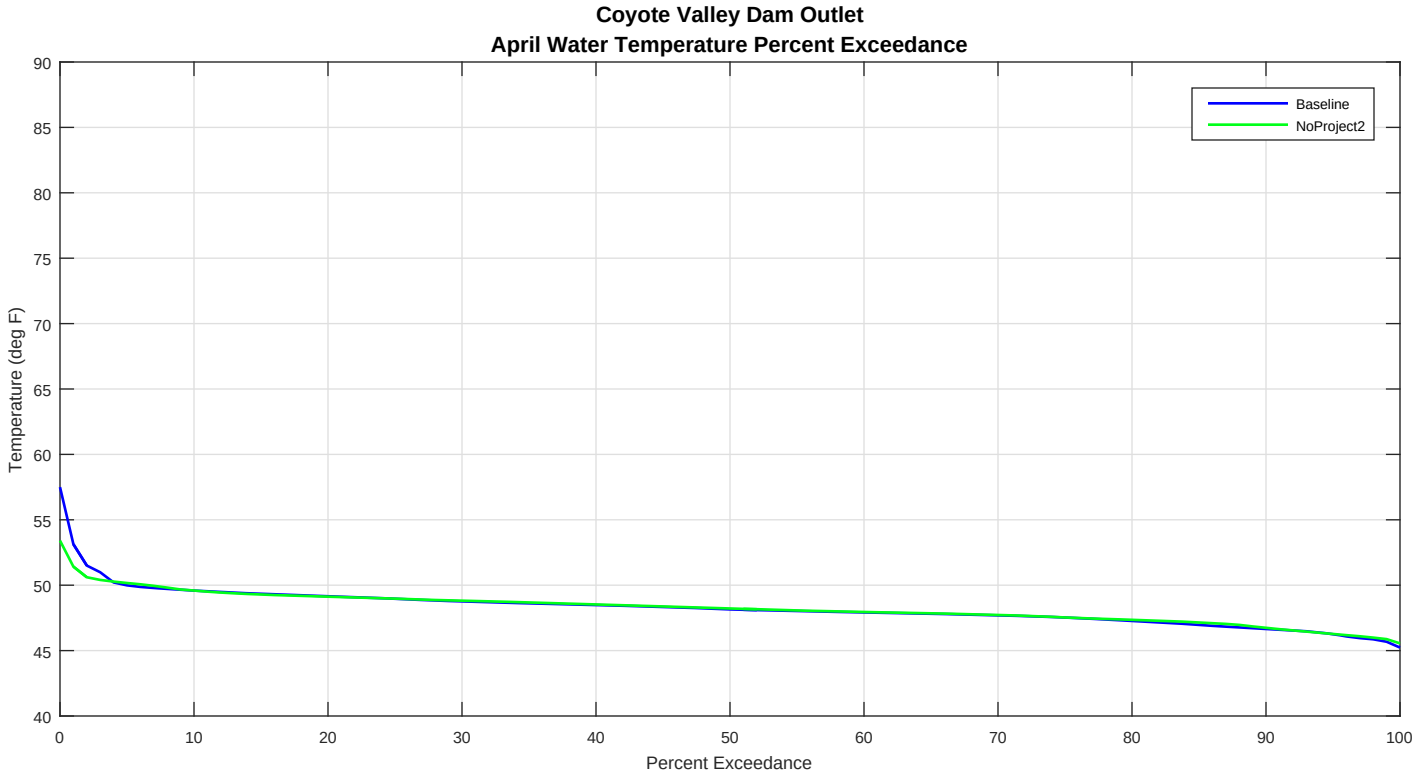
Coyote Valley Dam Outlet
April Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
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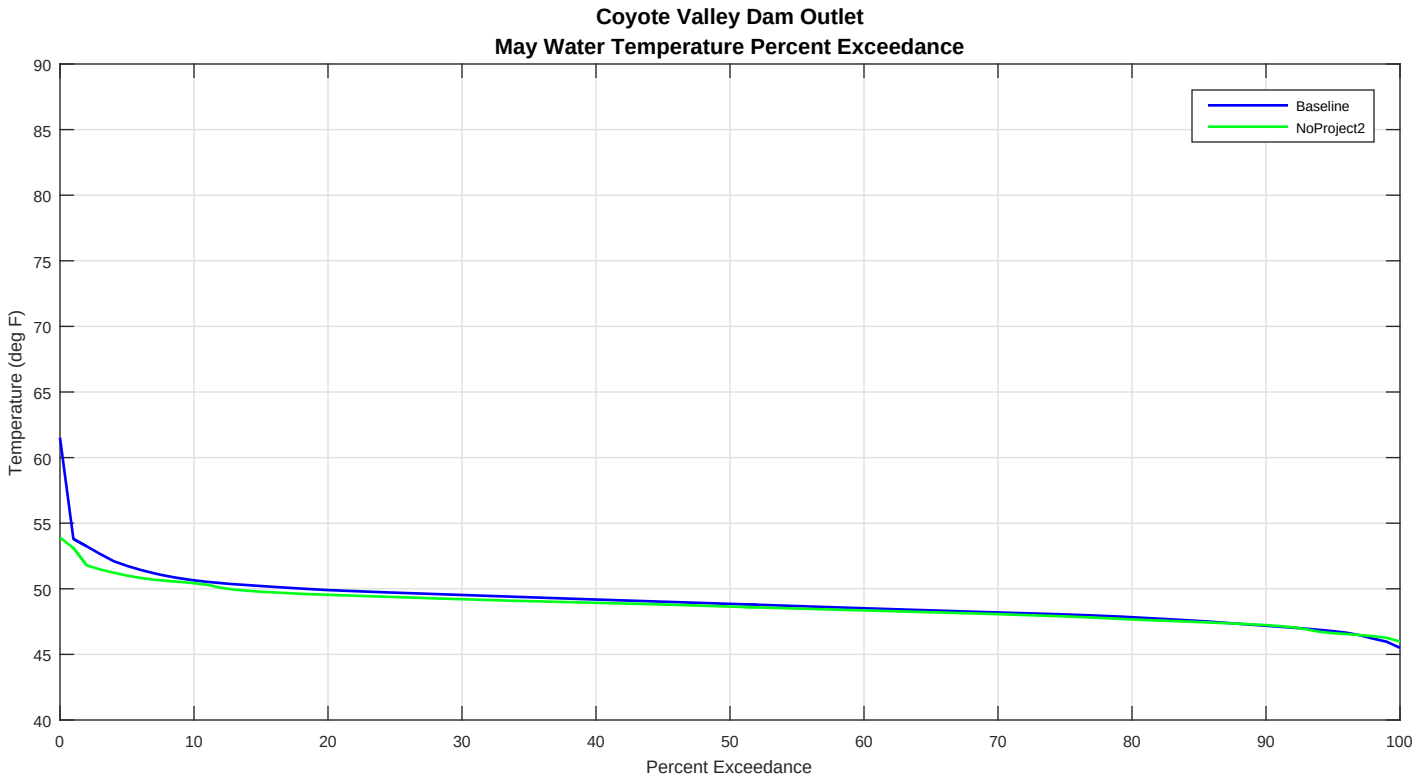
Coyote Valley Dam Outlet
May Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
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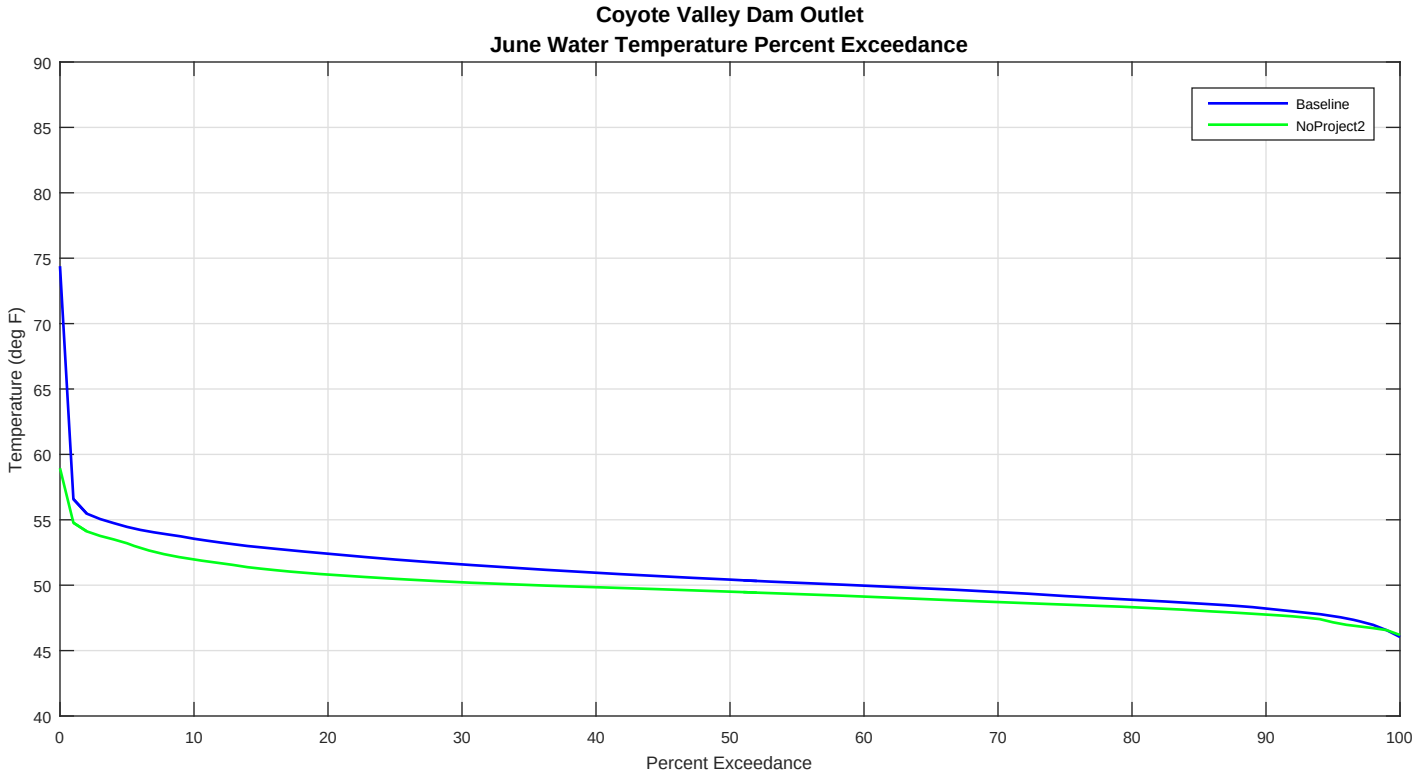
Coyote Valley Dam Outlet
June Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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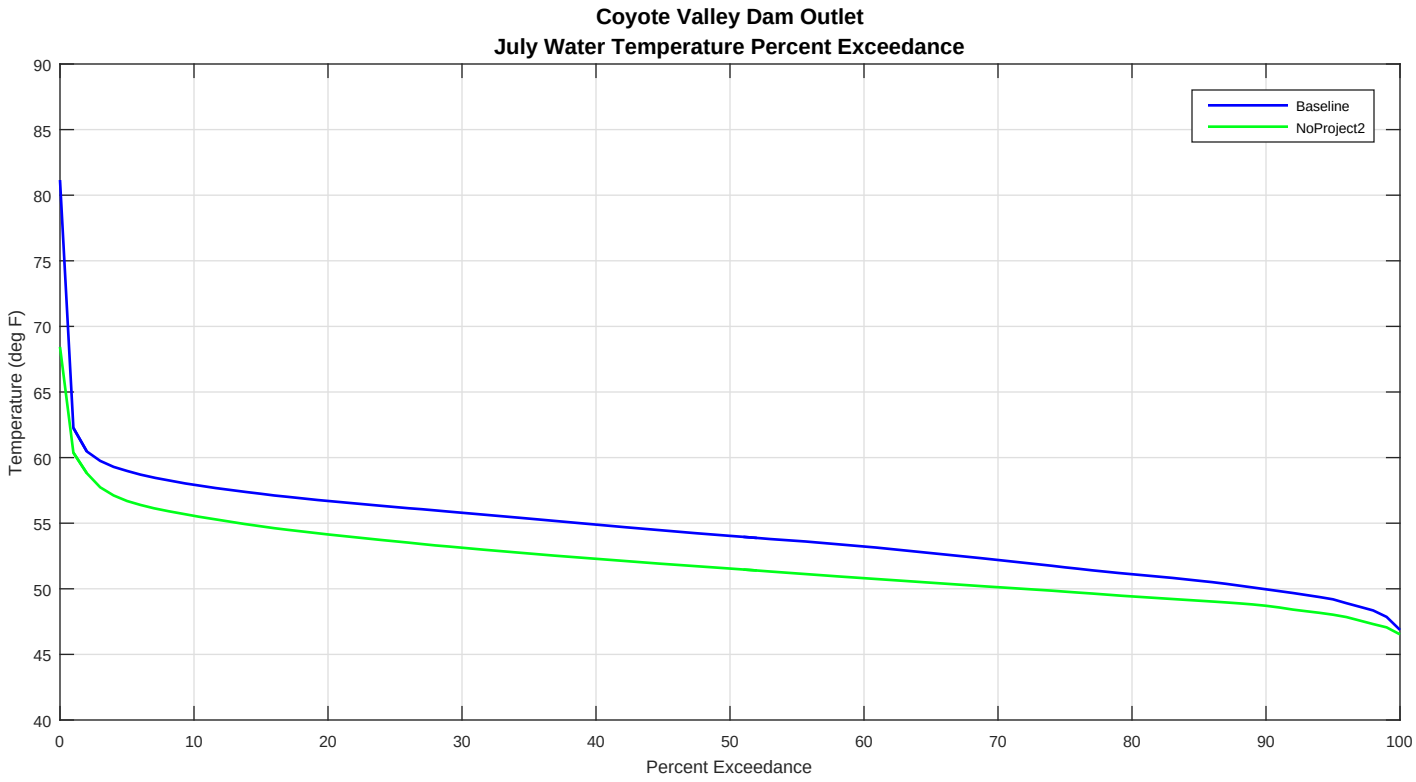
Coyote Valley Dam Outlet
July Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
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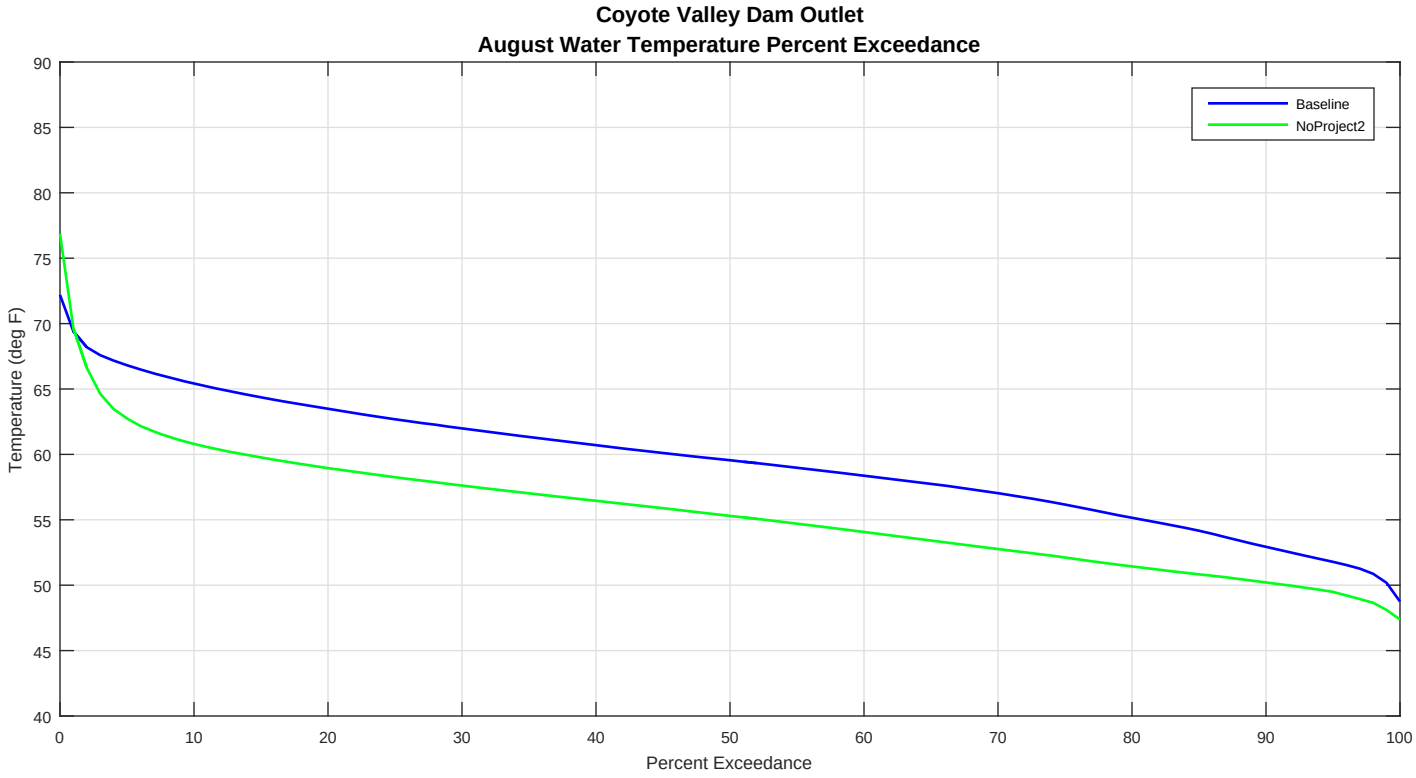
Coyote Valley Dam Outlet
August Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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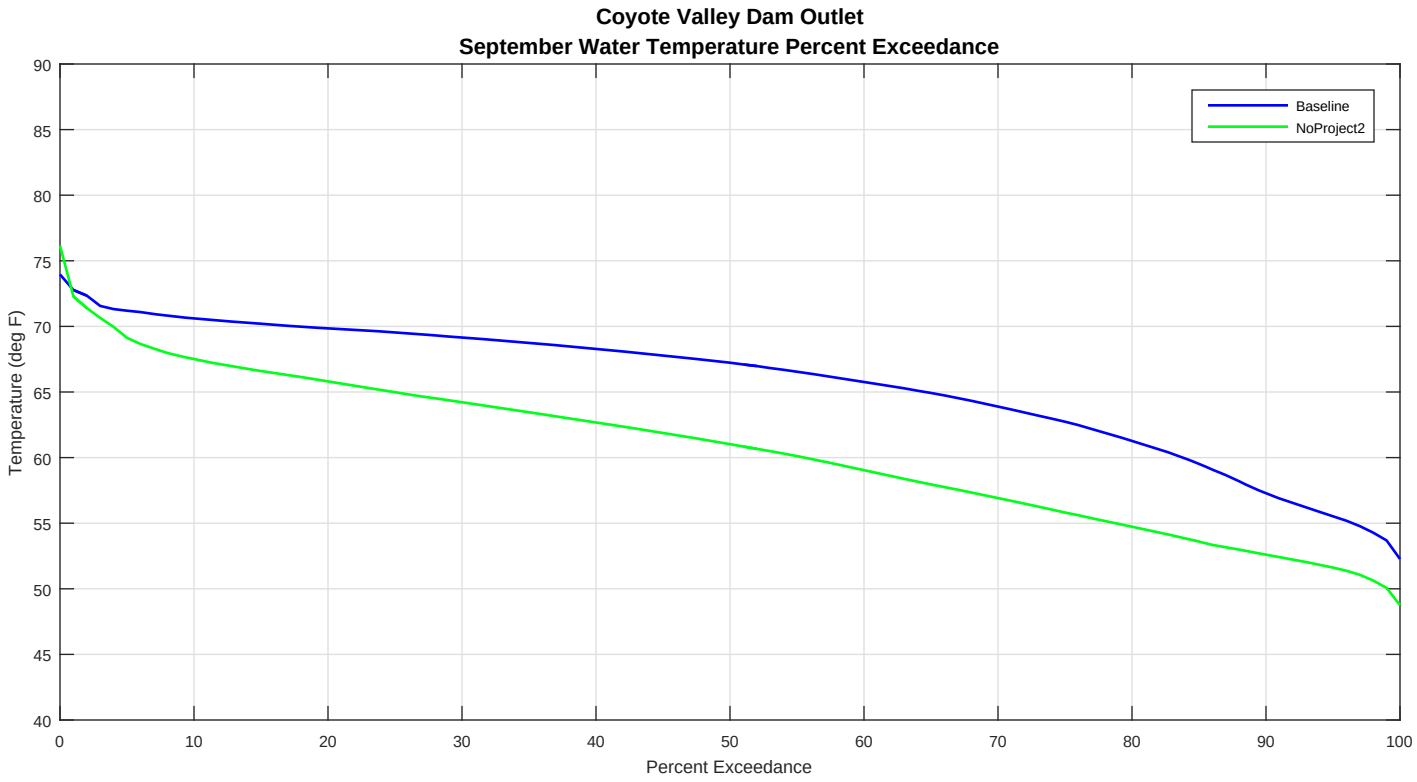
Coyote Valley Dam Outlet
September Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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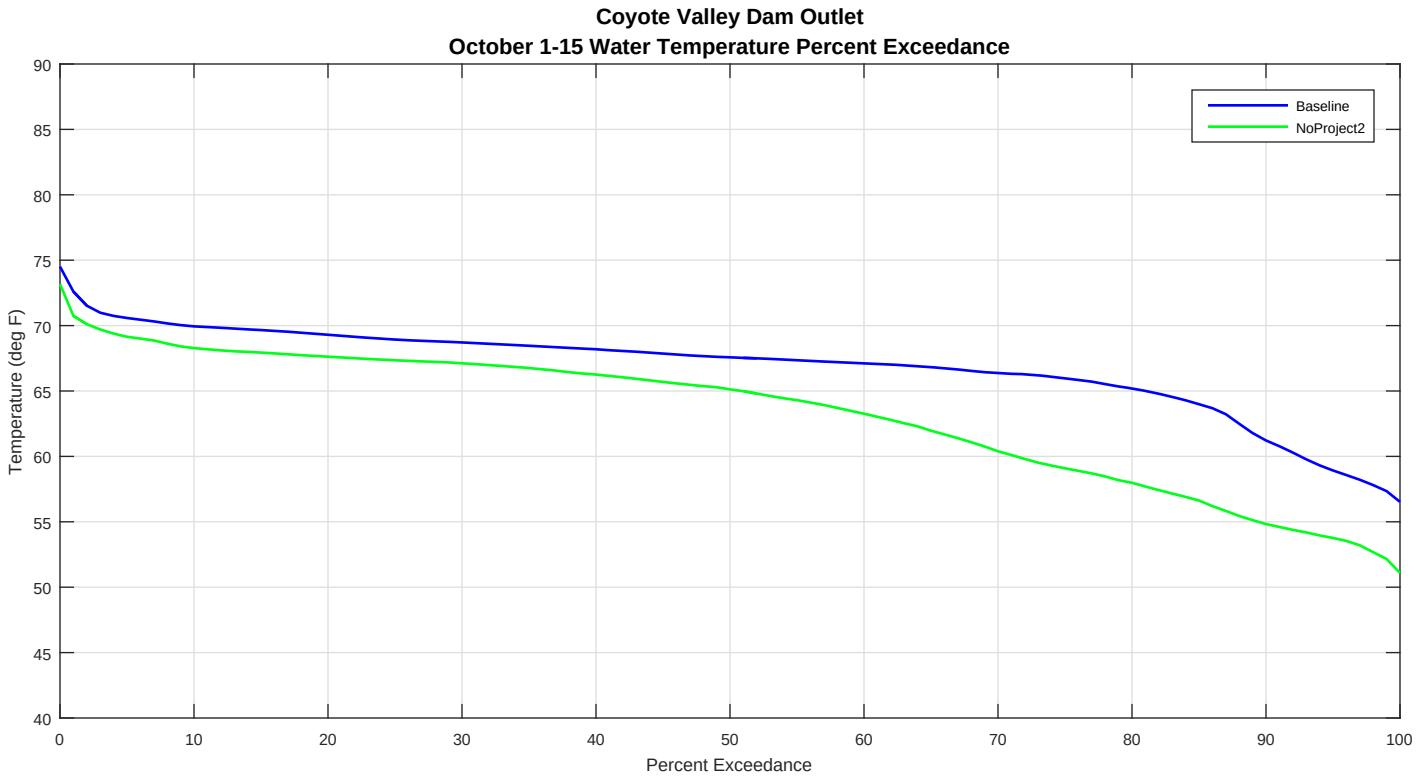
Coyote Valley Dam Outlet
October 1-15 Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
85
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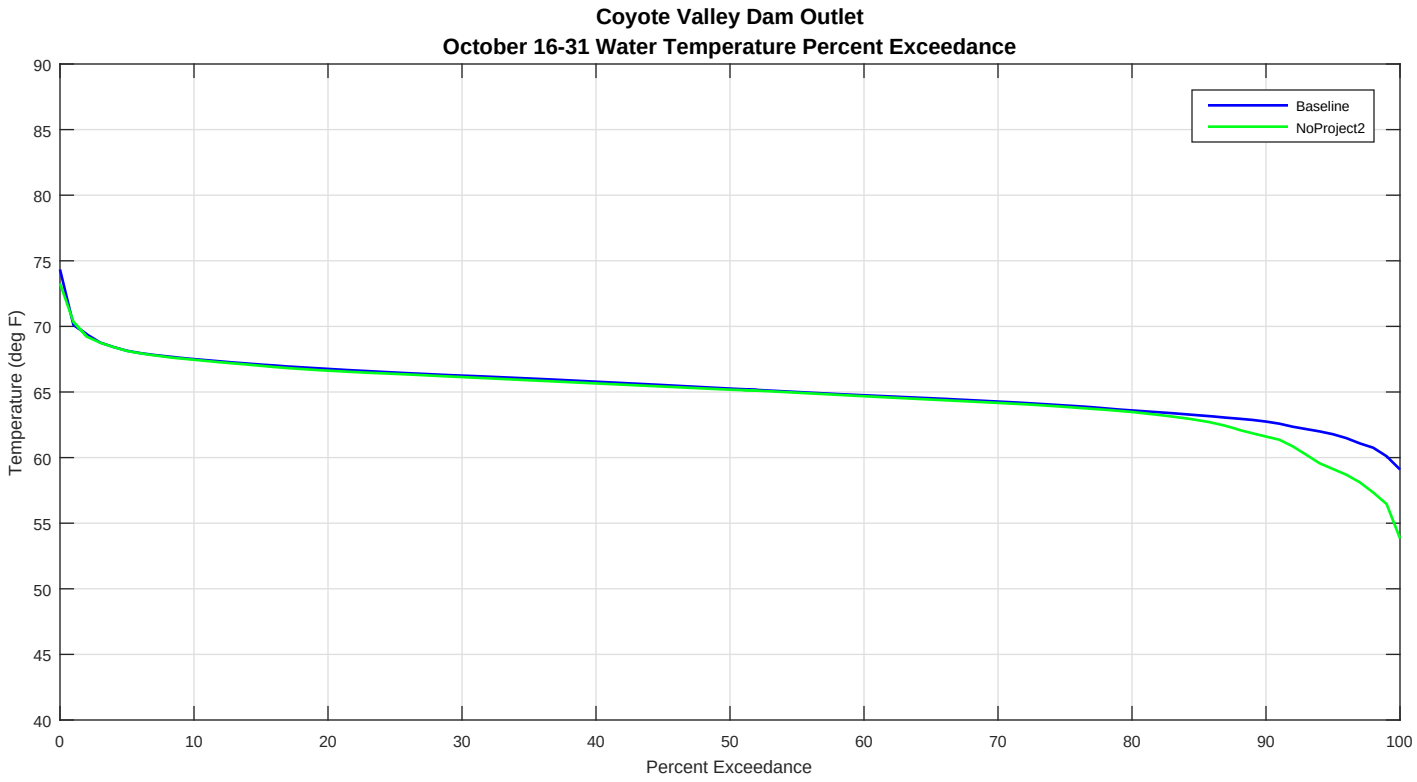
Coyote Valley Dam Outlet
October 16-31 Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
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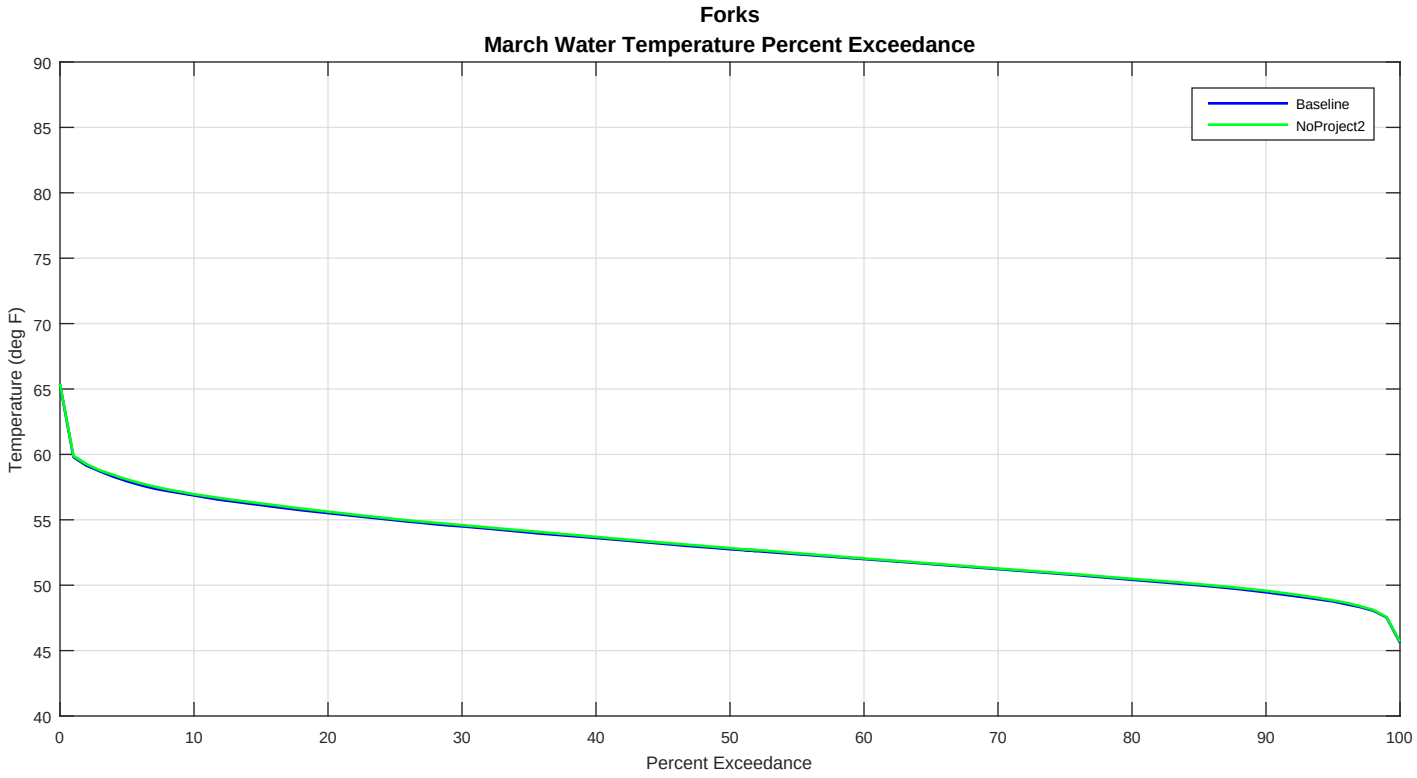
Forks
March Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
85
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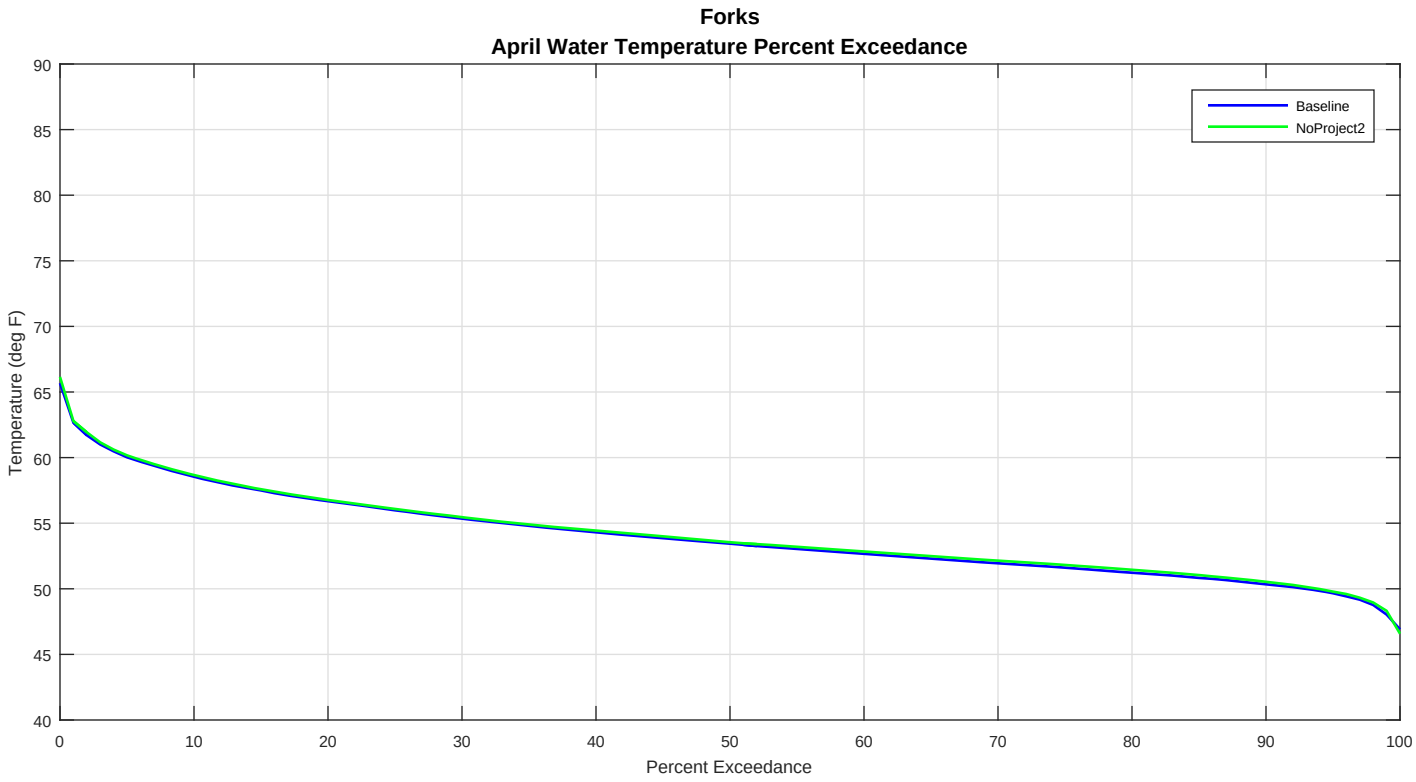
Forks
April Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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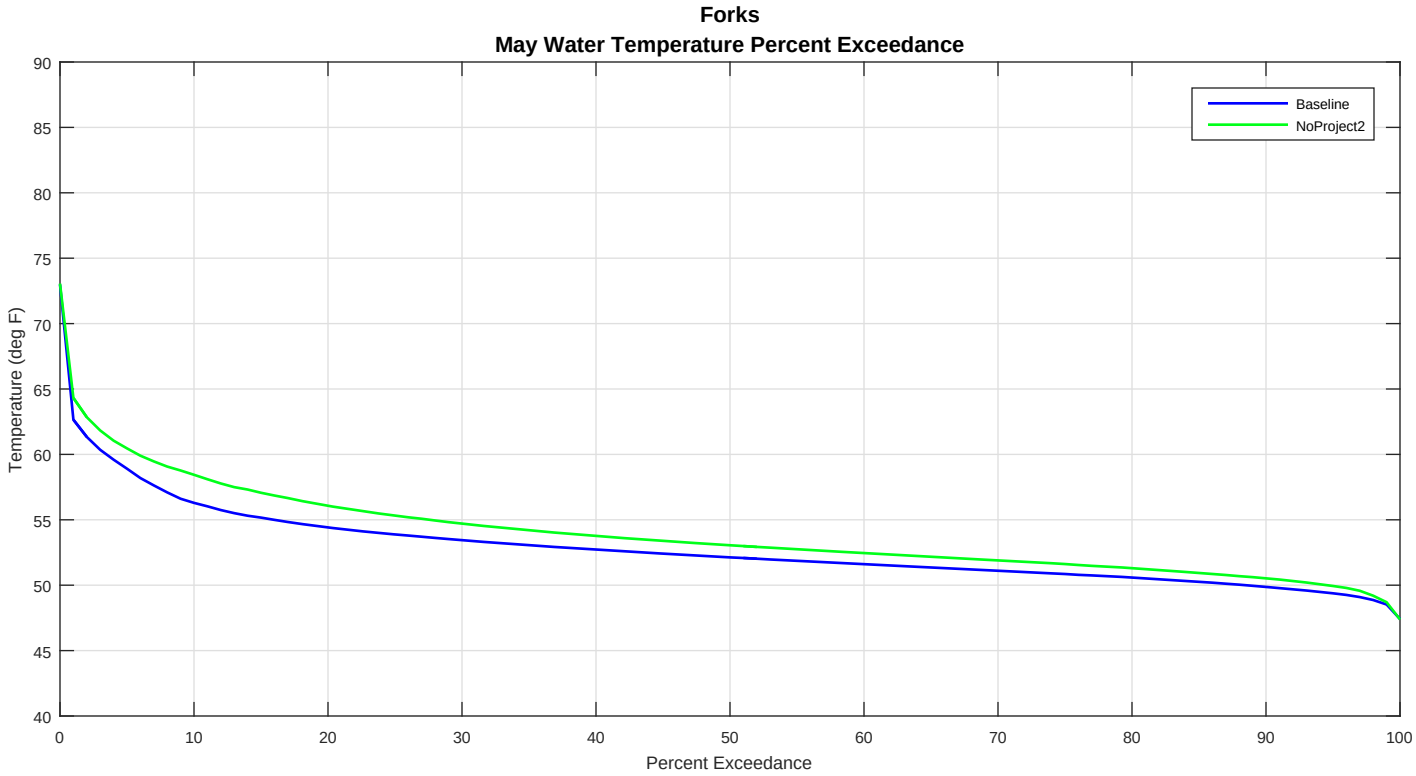
Forks
May Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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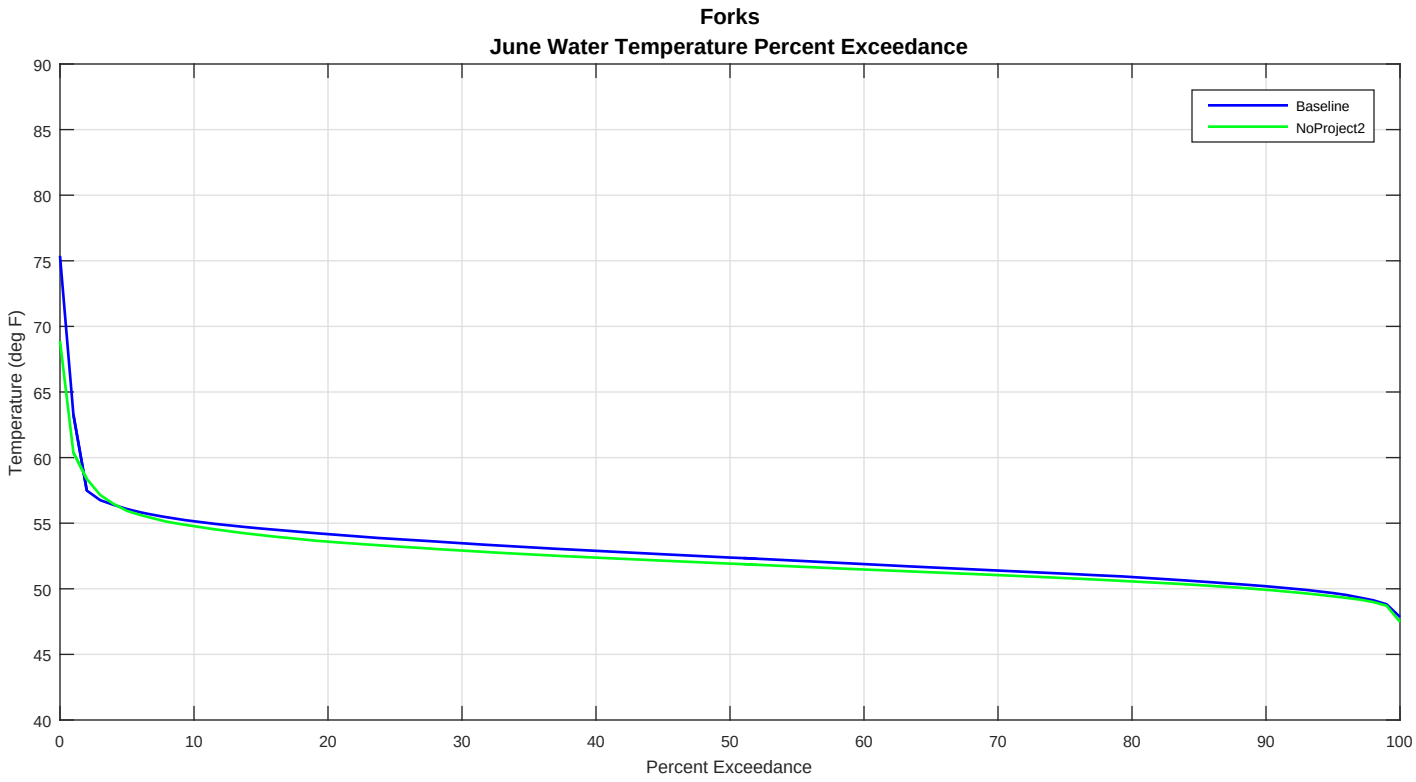
Forks
June Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
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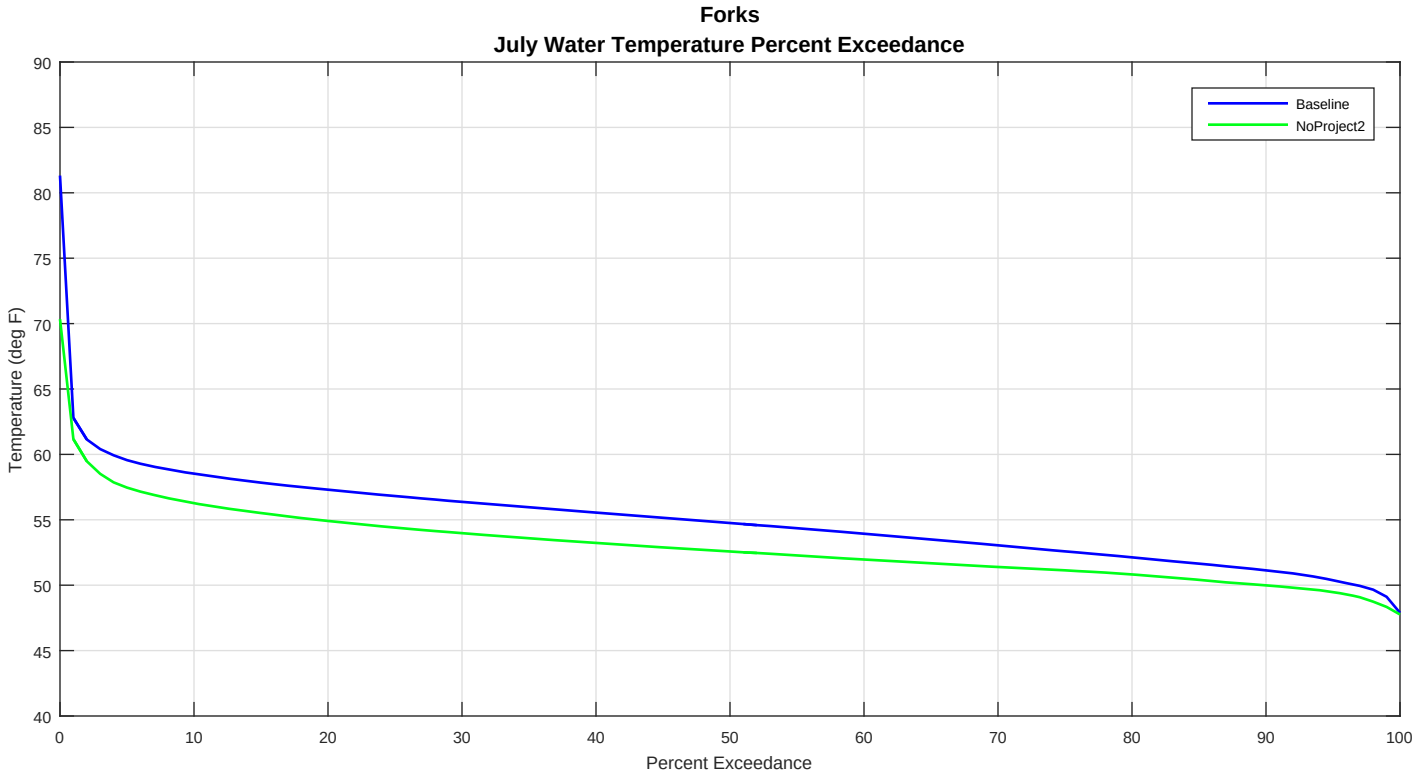
Forks
July Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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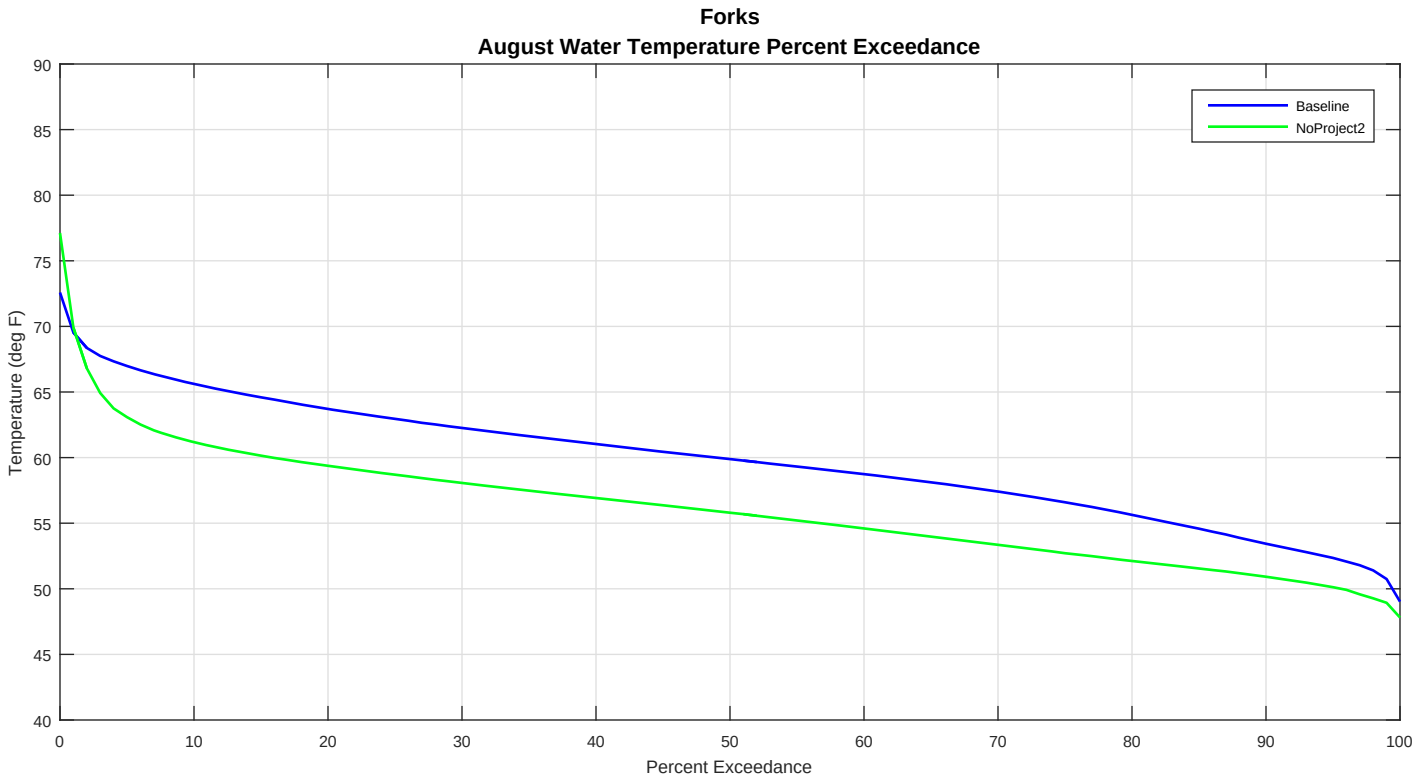
Forks
August Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
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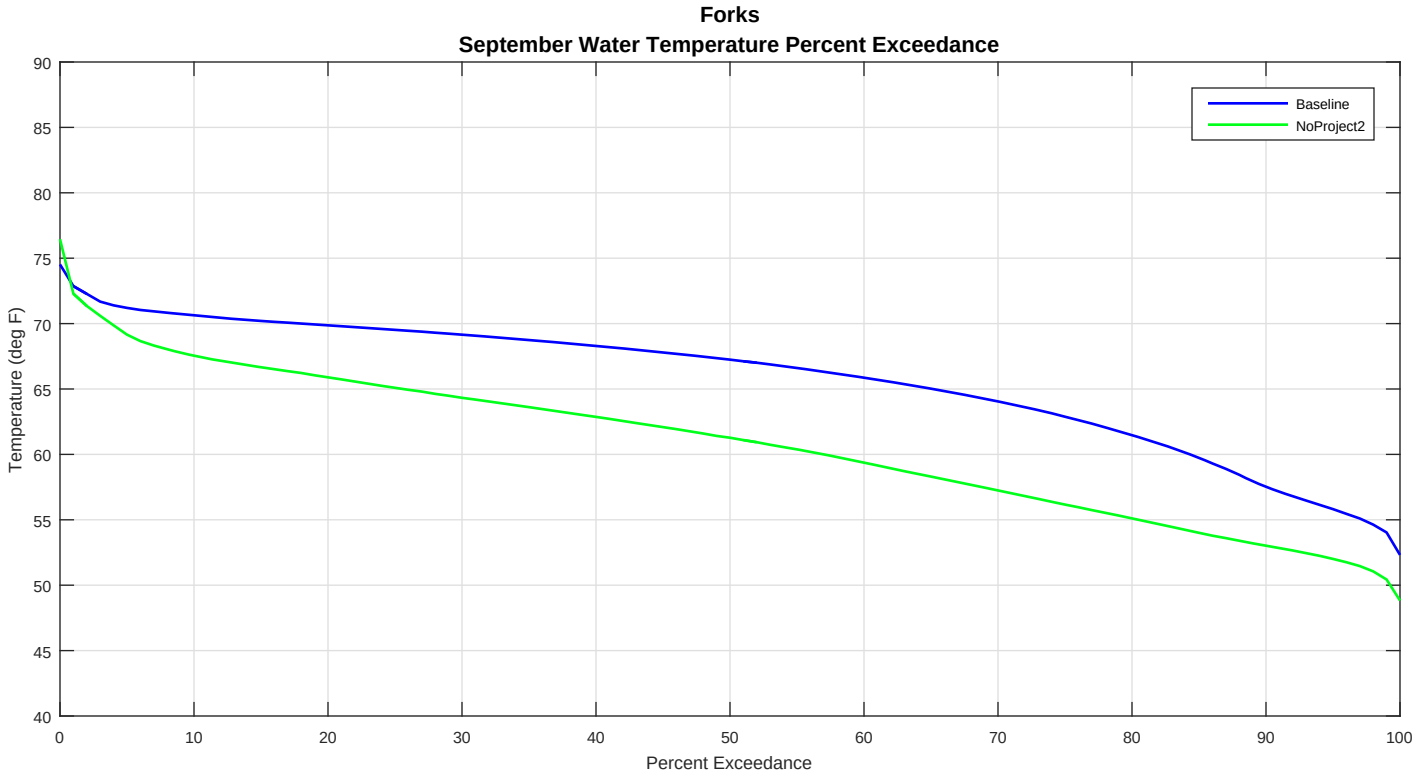
Forks
September Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
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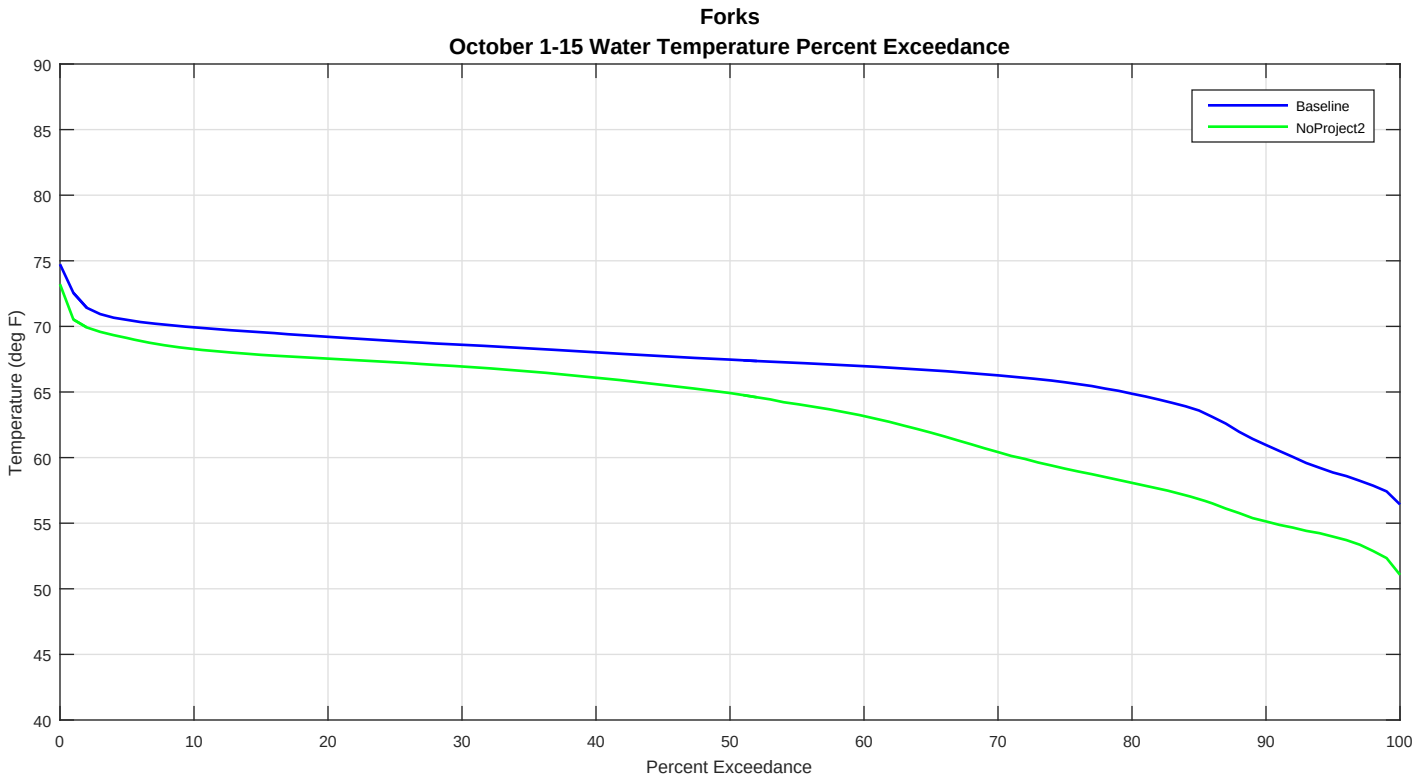
Forks
October 1-15 Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
85
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75
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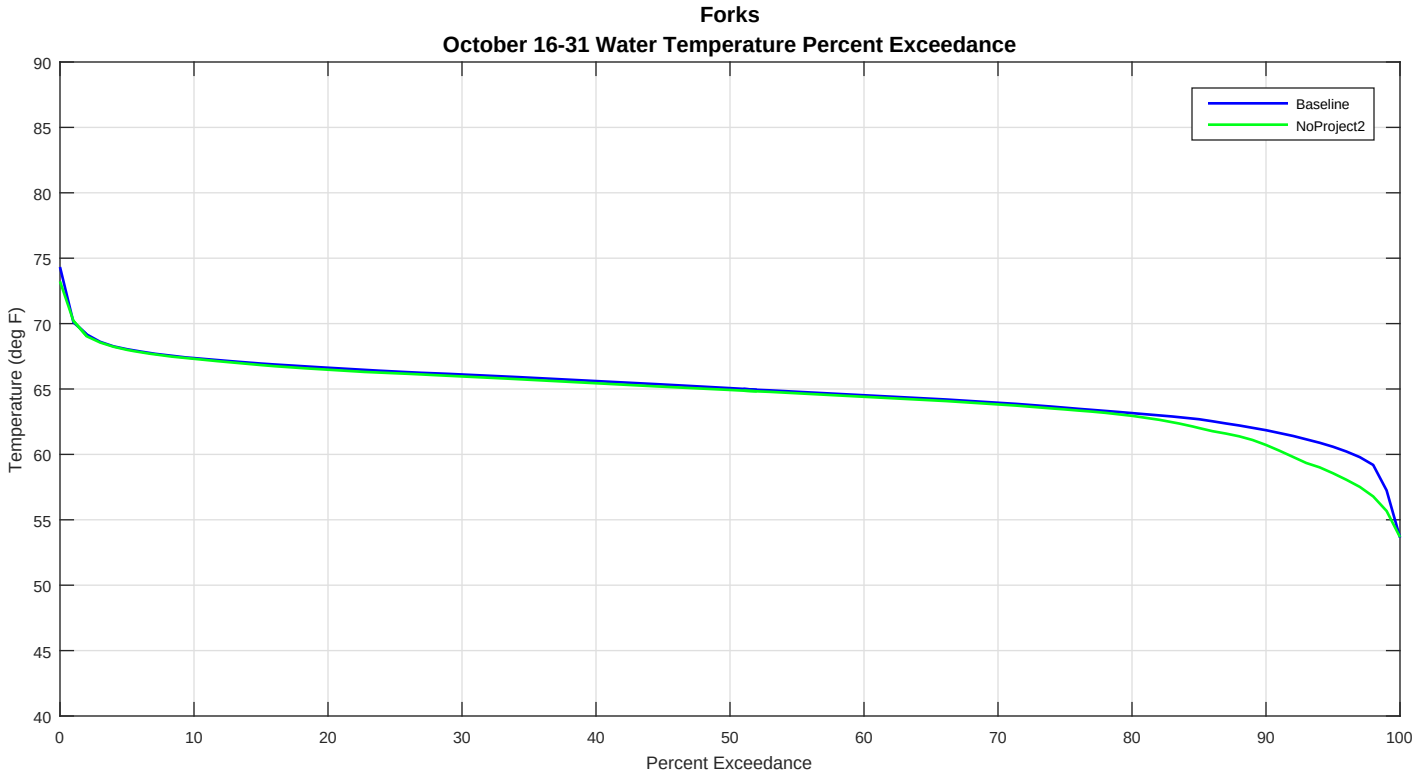
Forks
October 16-31 Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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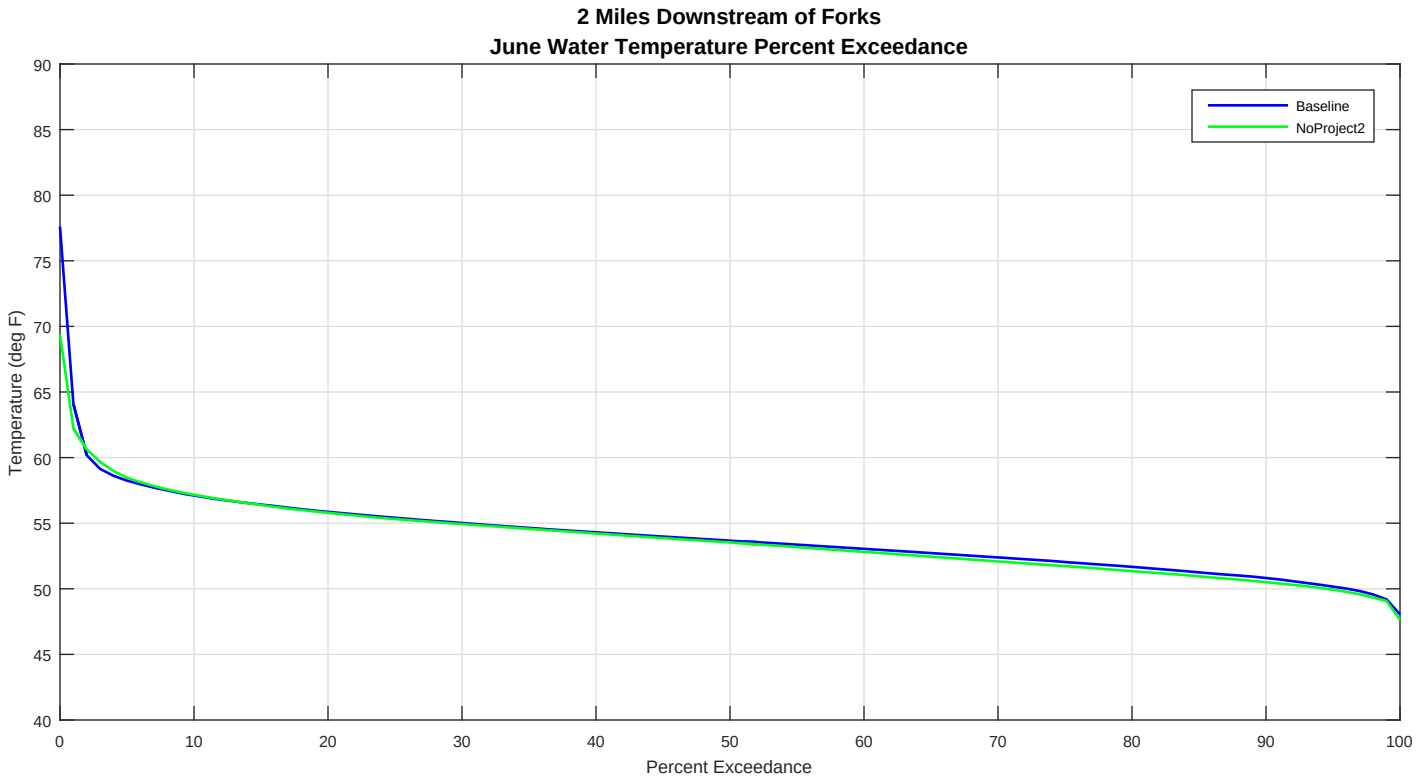
2 Miles Downstream of Forks
June Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
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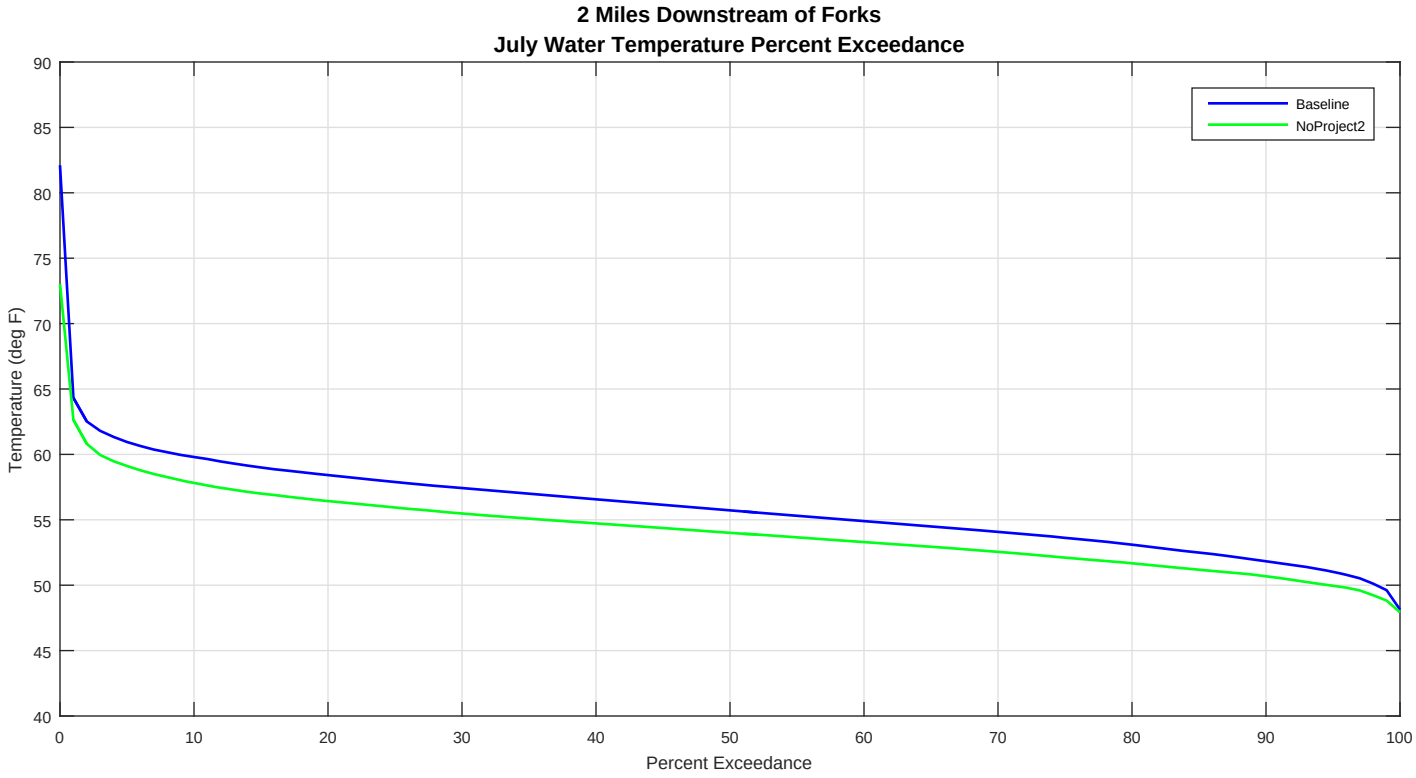
2 Miles Downstream of Forks
July Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
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60
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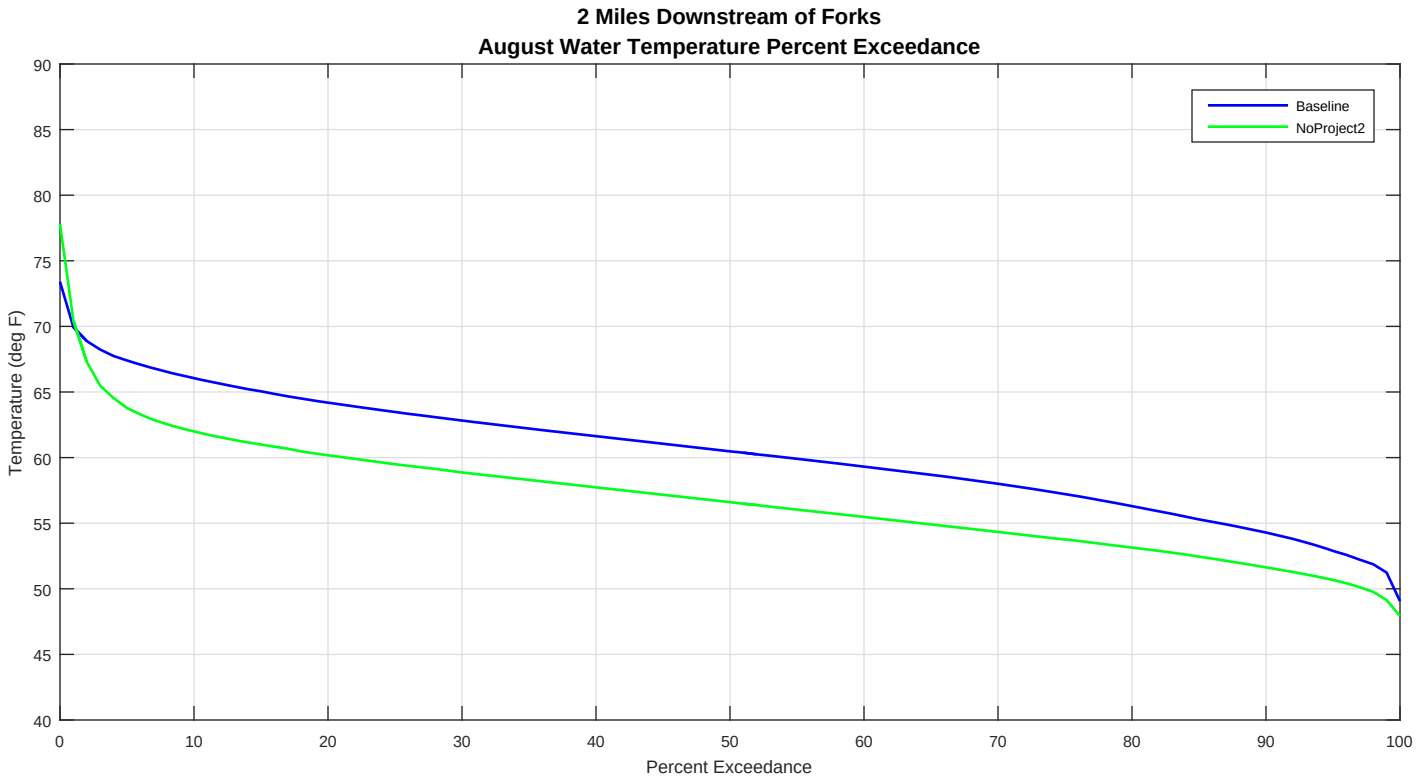
2 Miles Downstream of Forks
August Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
85
80
75
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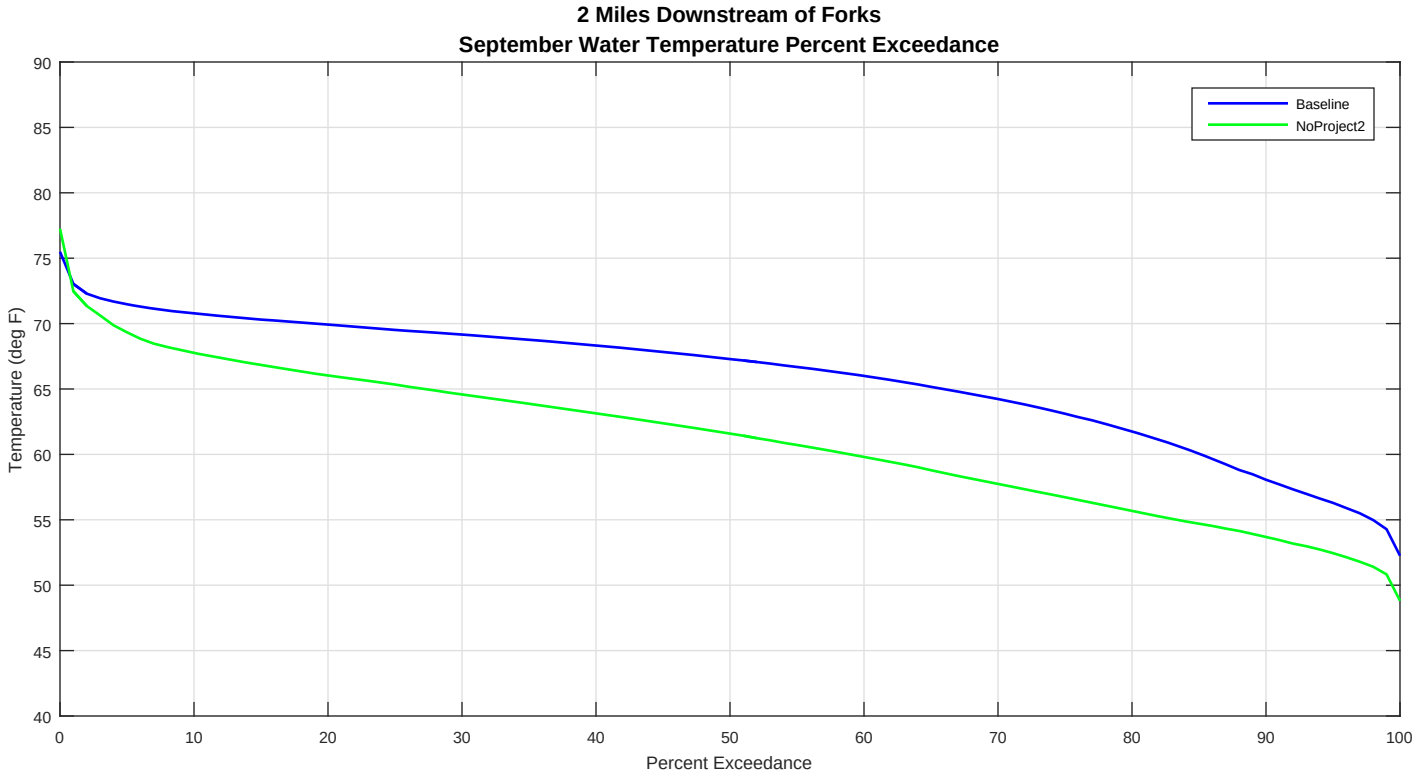
2 Miles Downstream of Forks
September Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
85
80
75
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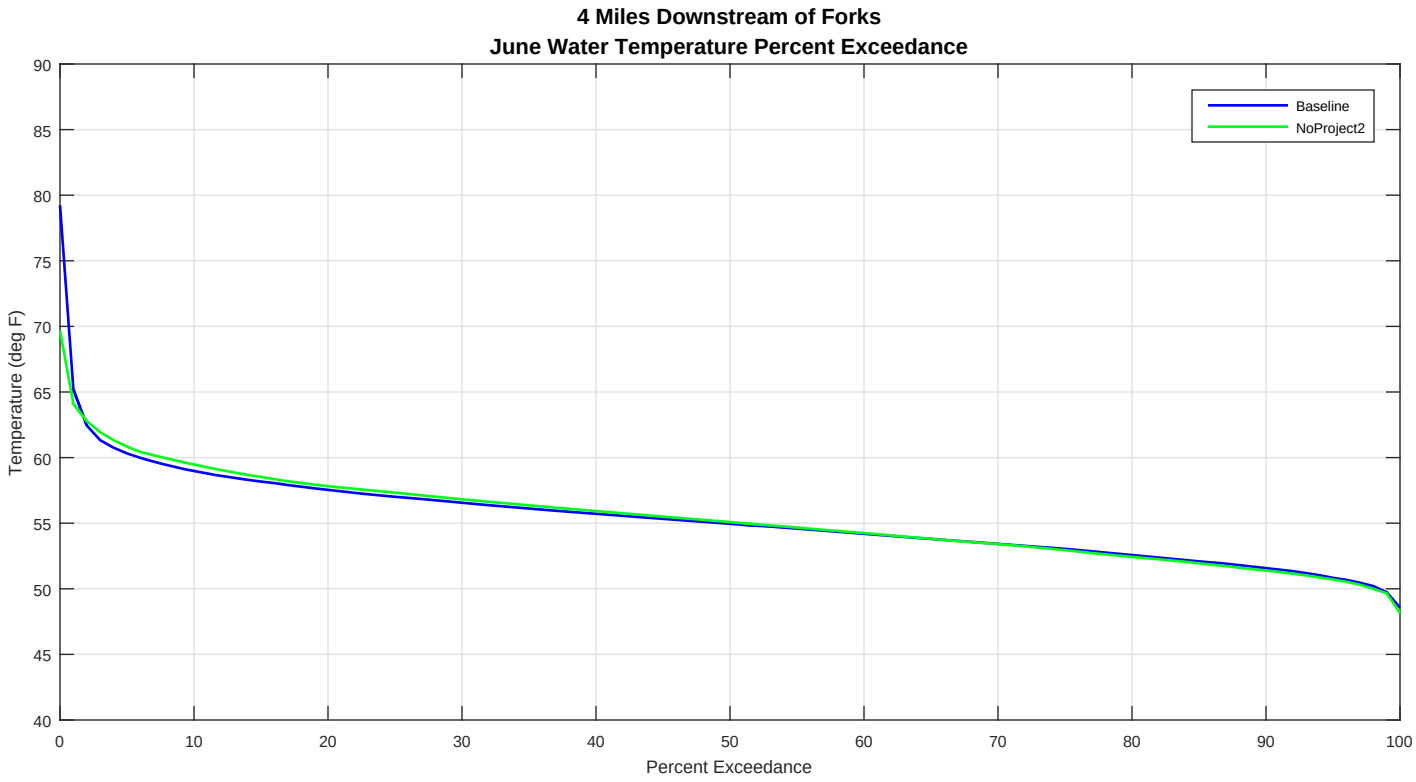
4 Miles Downstream of Forks
June Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
85
80
75
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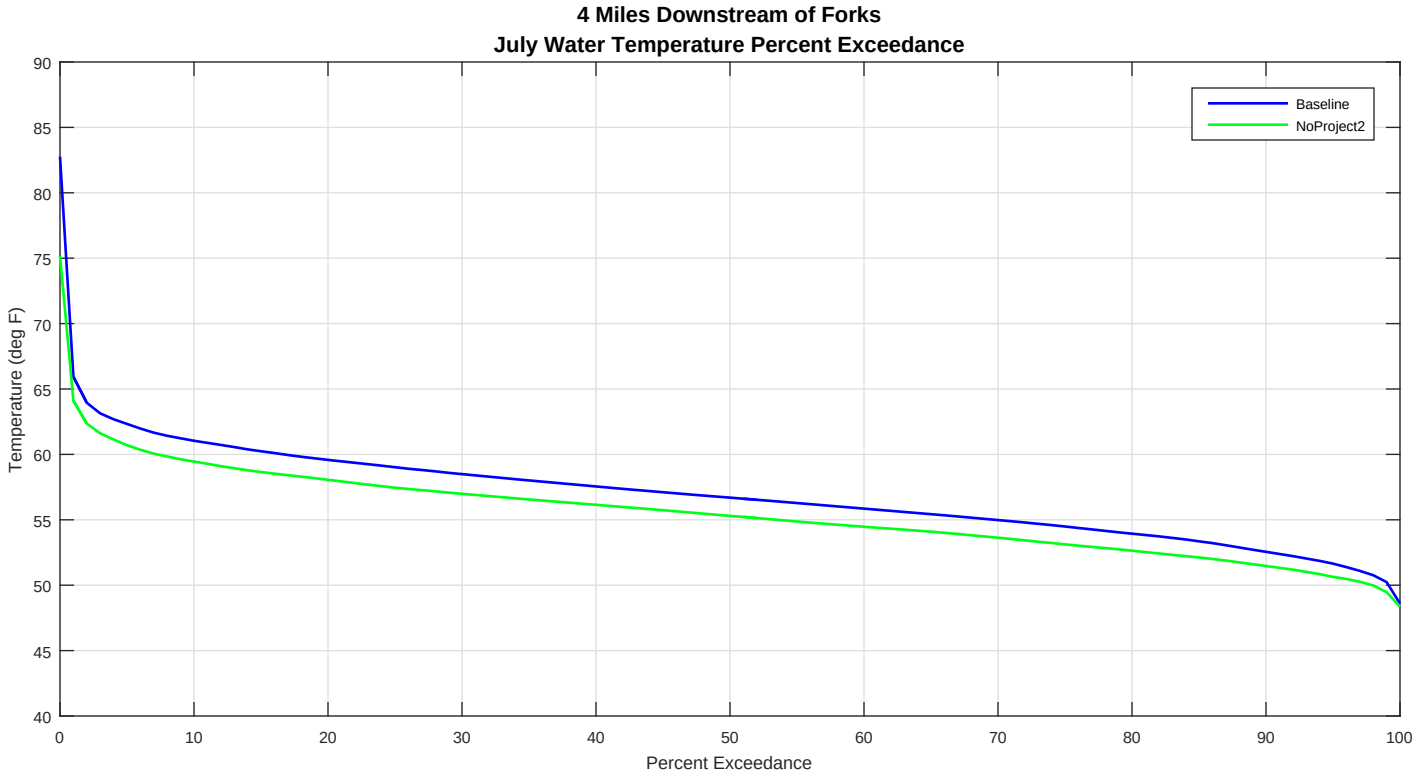
4 Miles Downstream of Forks
July Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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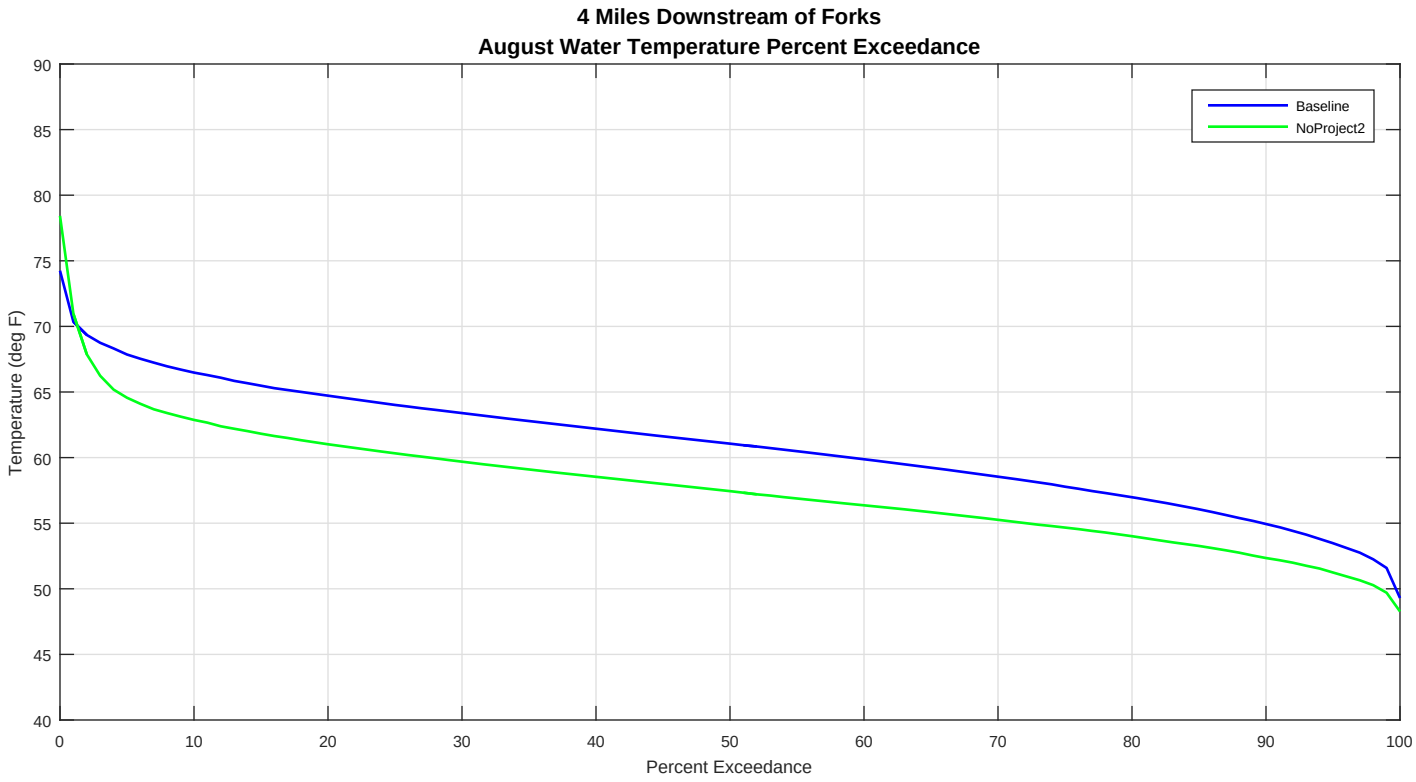
4 Miles Downstream of Forks
August Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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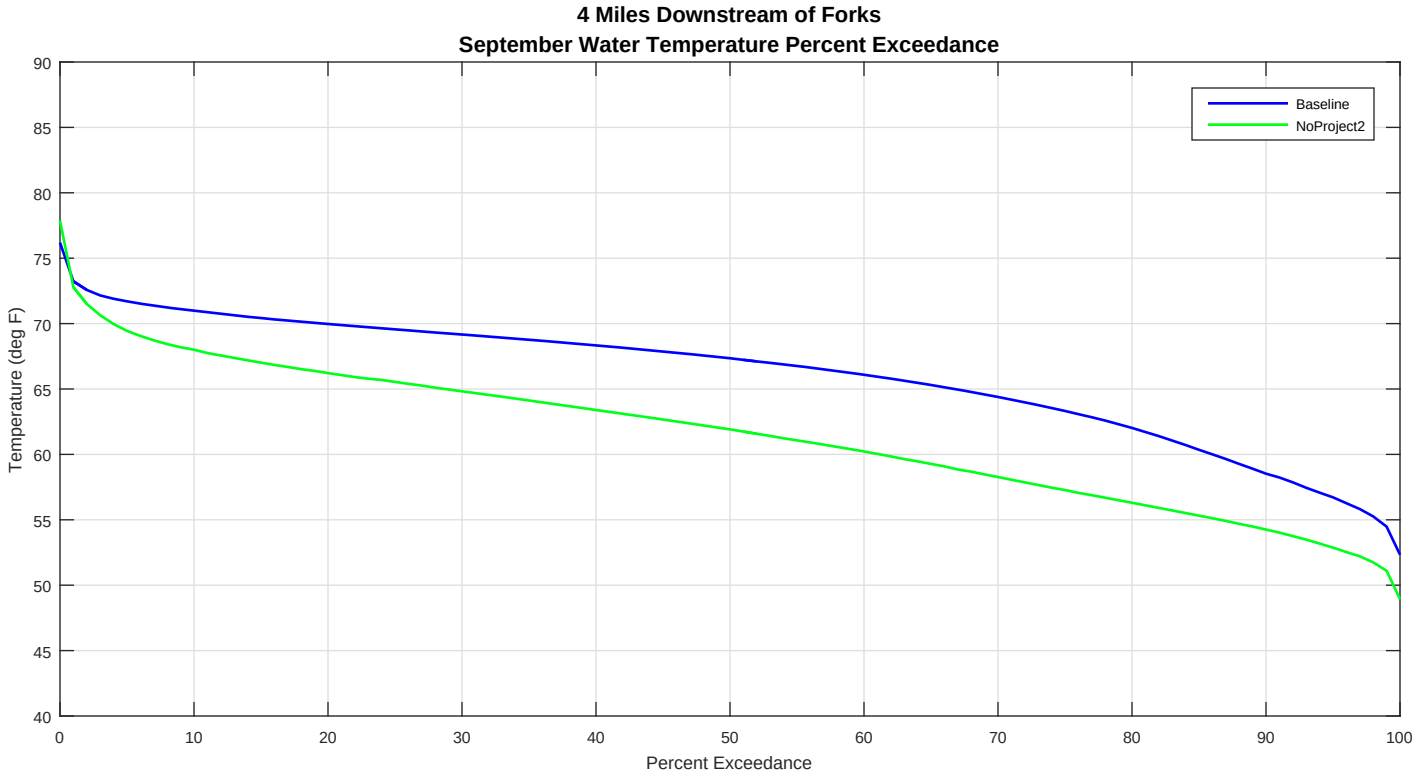
4 Miles Downstream of Forks
September Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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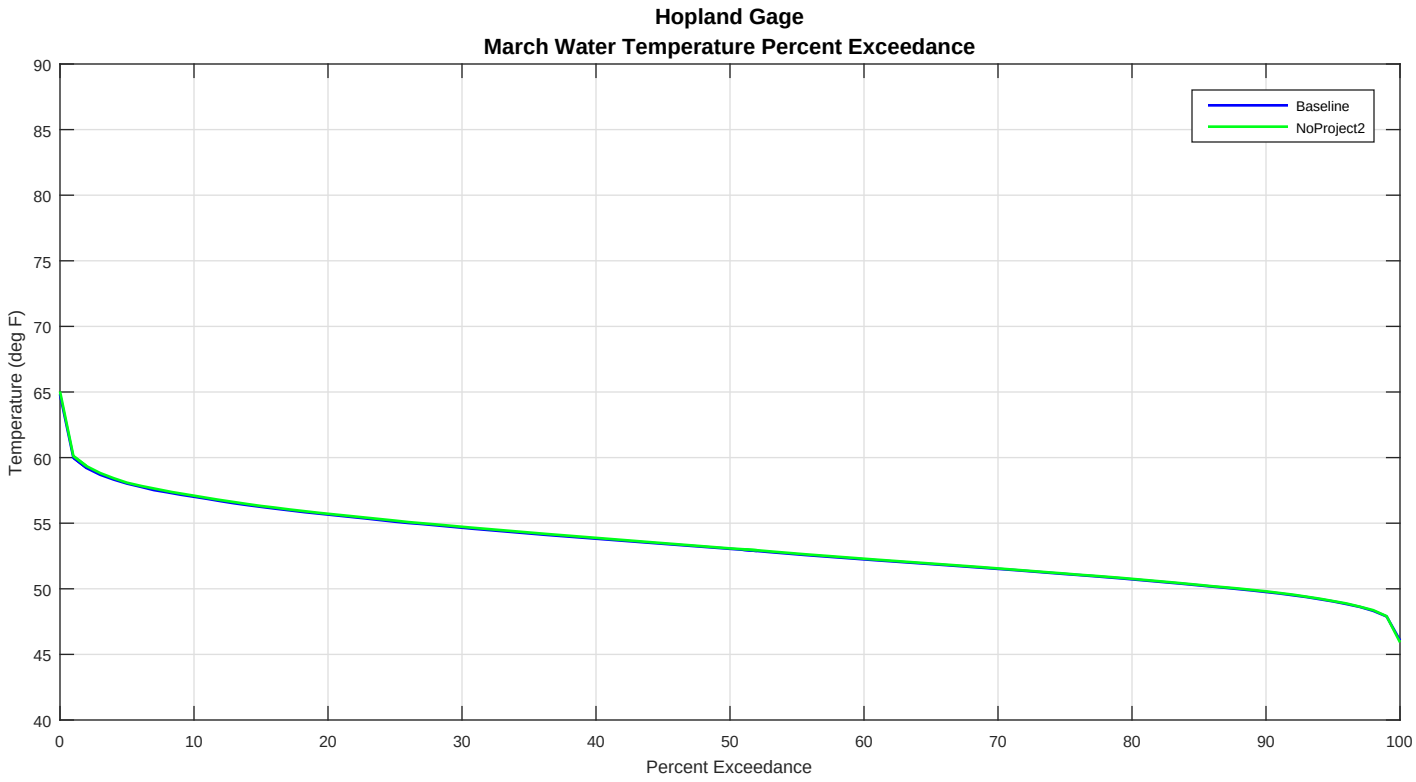
Hopland Gage
March Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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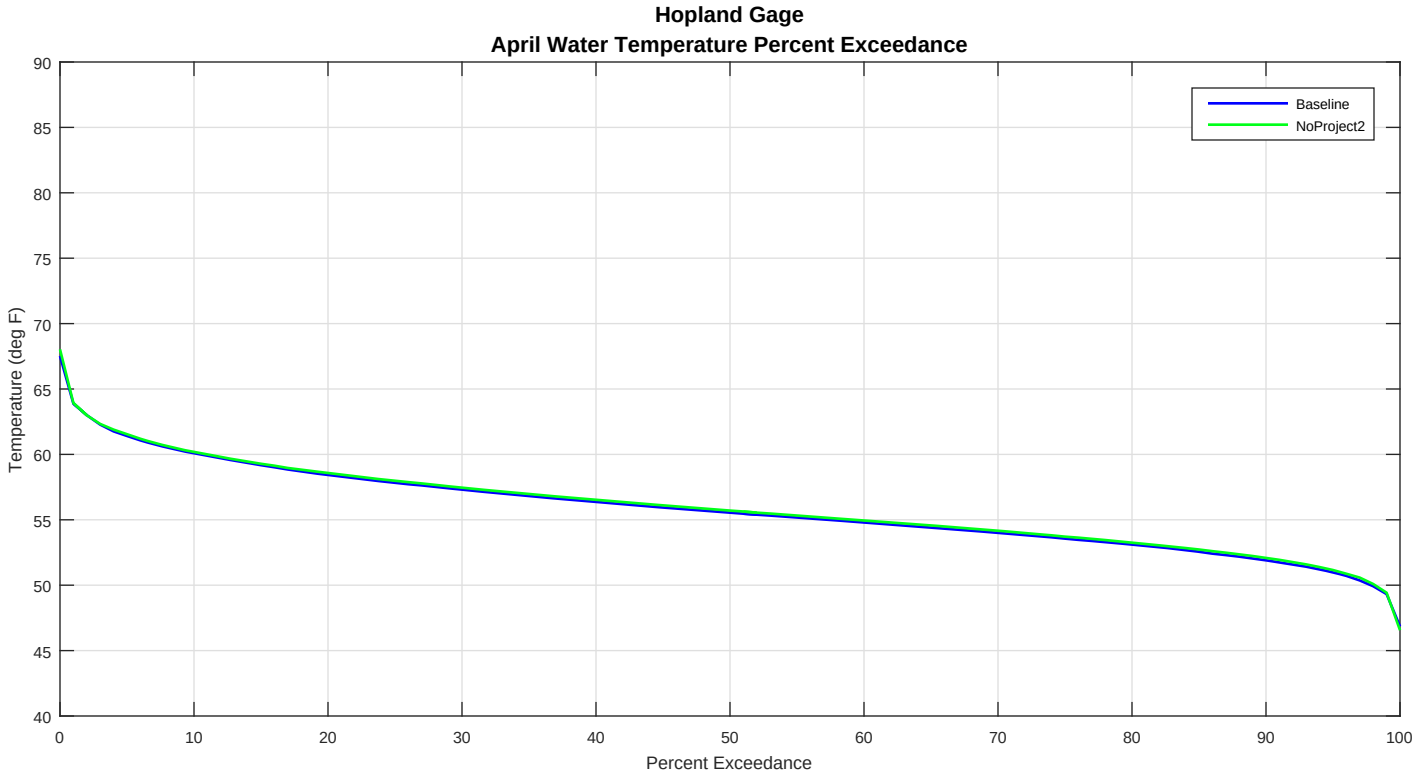
Hopland Gage
April Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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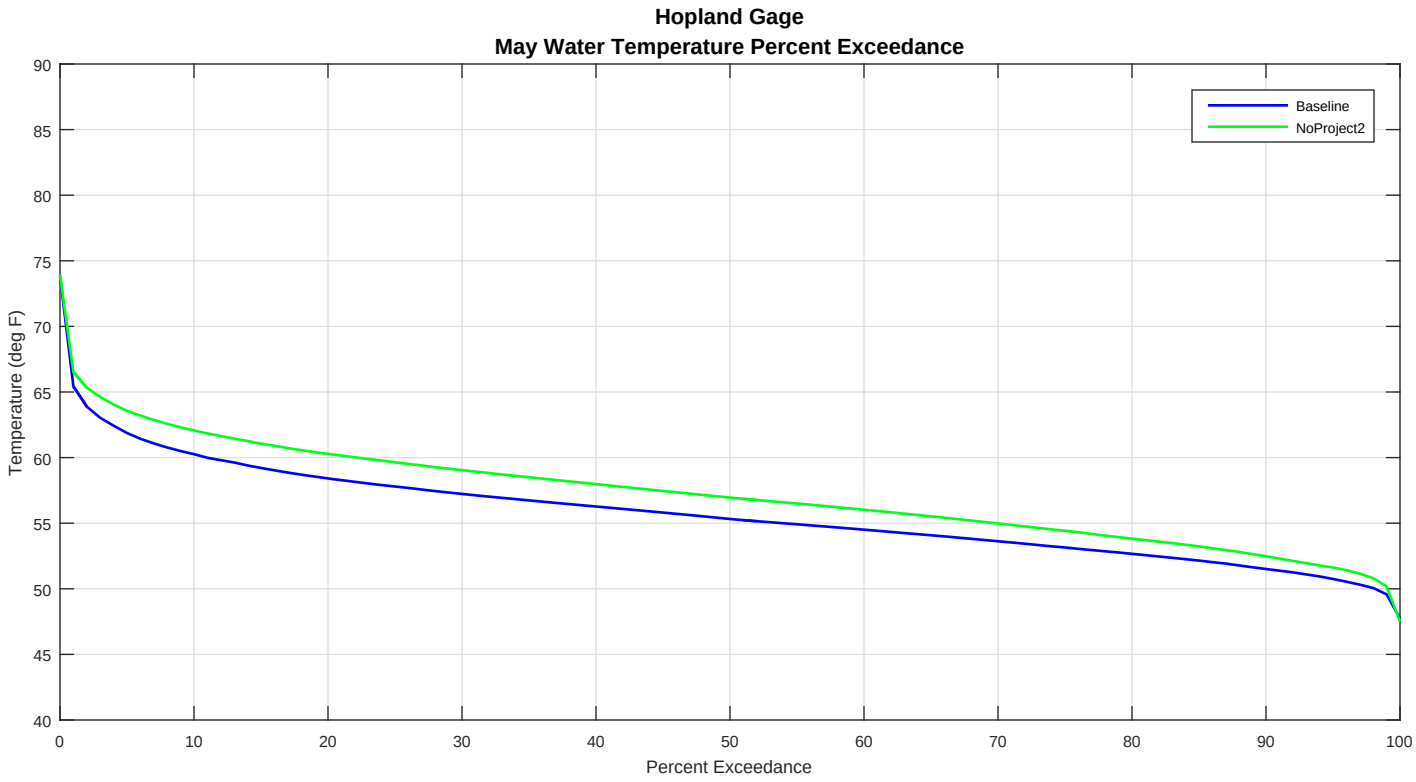
Hopland Gage
May Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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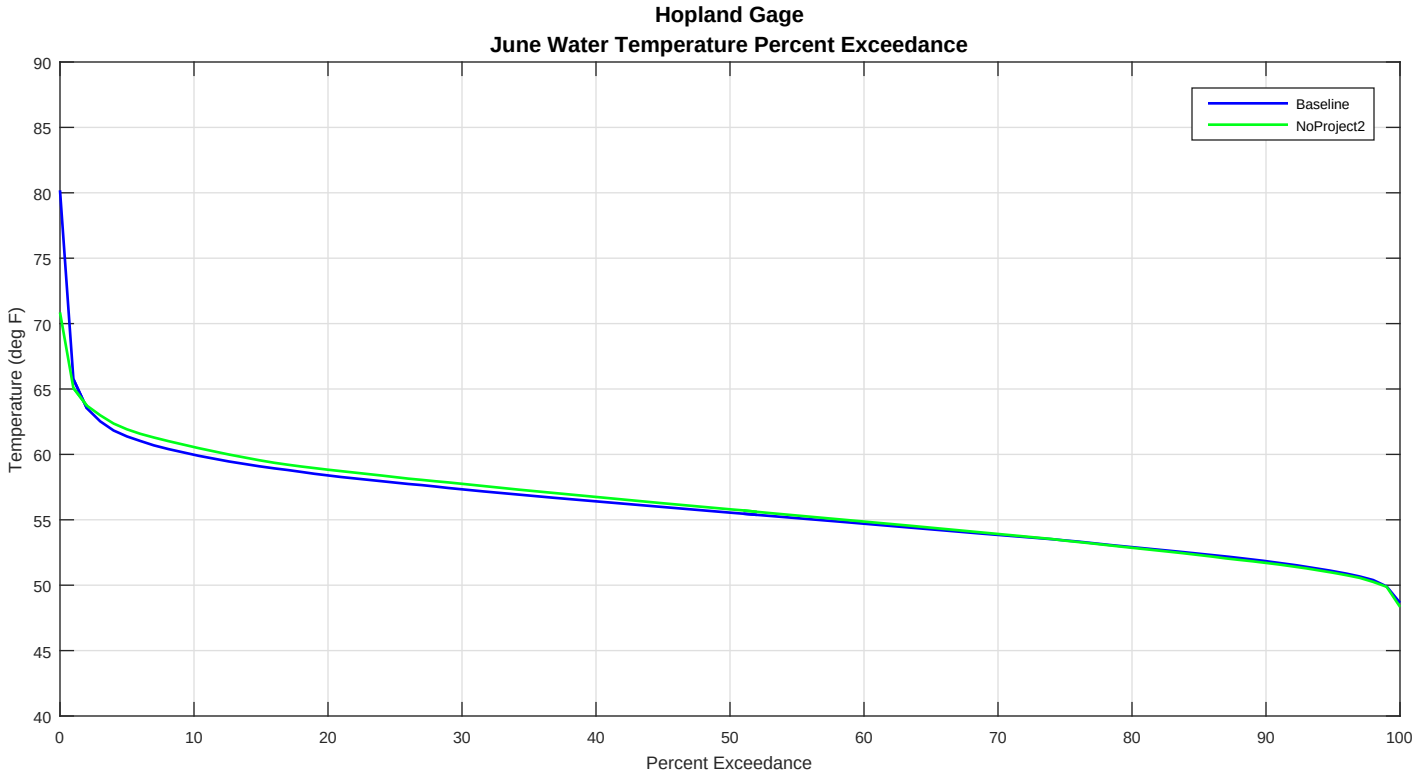
Hopland Gage
June Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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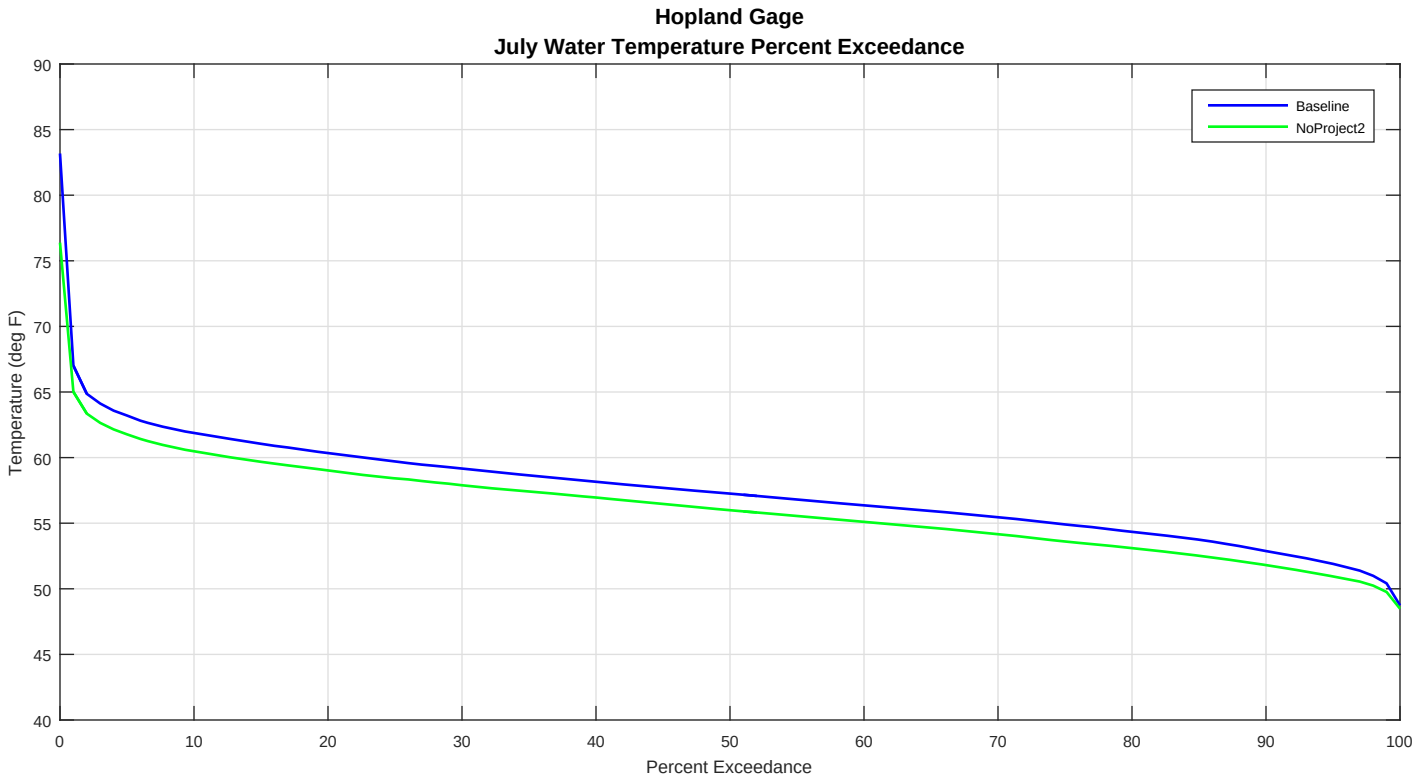
Hopland Gage
July Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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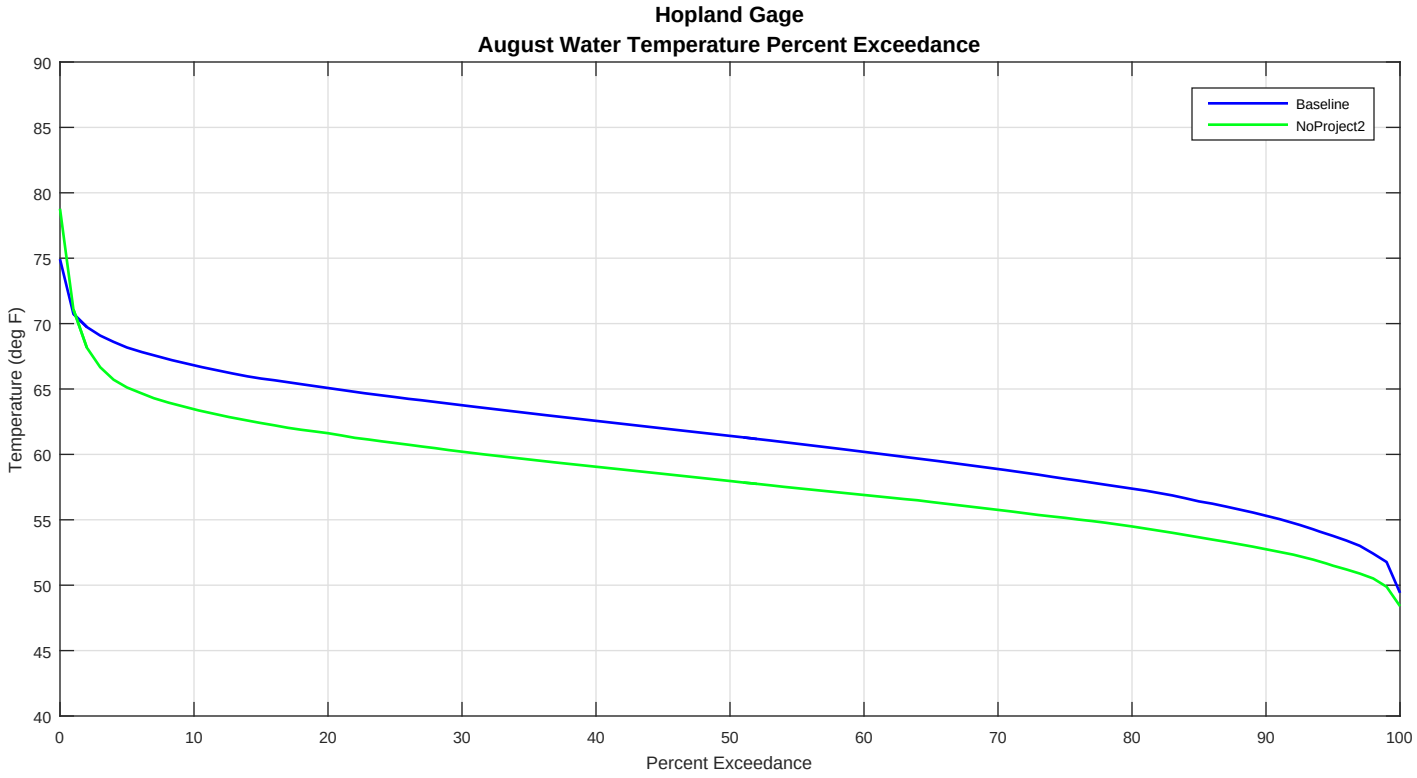
Hopland Gage
August Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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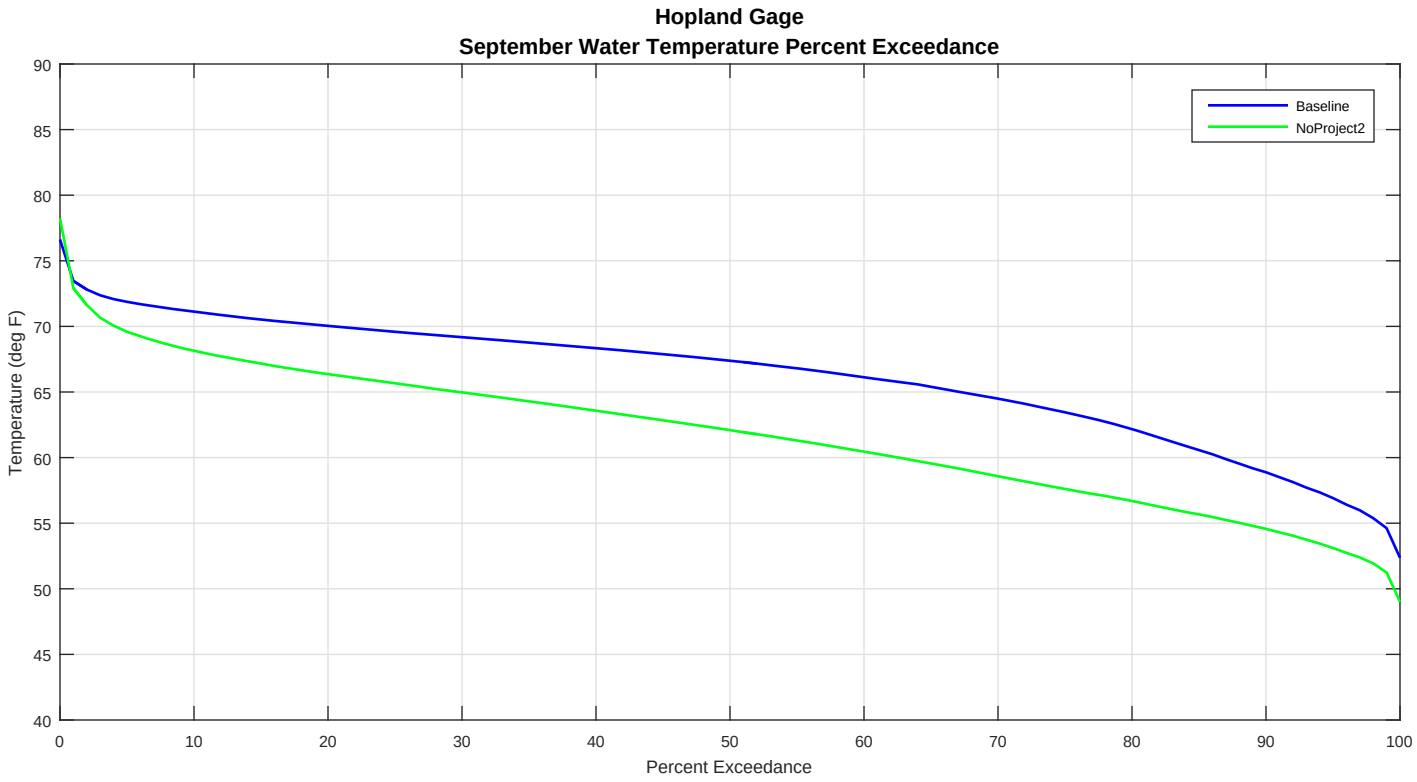
Hopland Gage
September Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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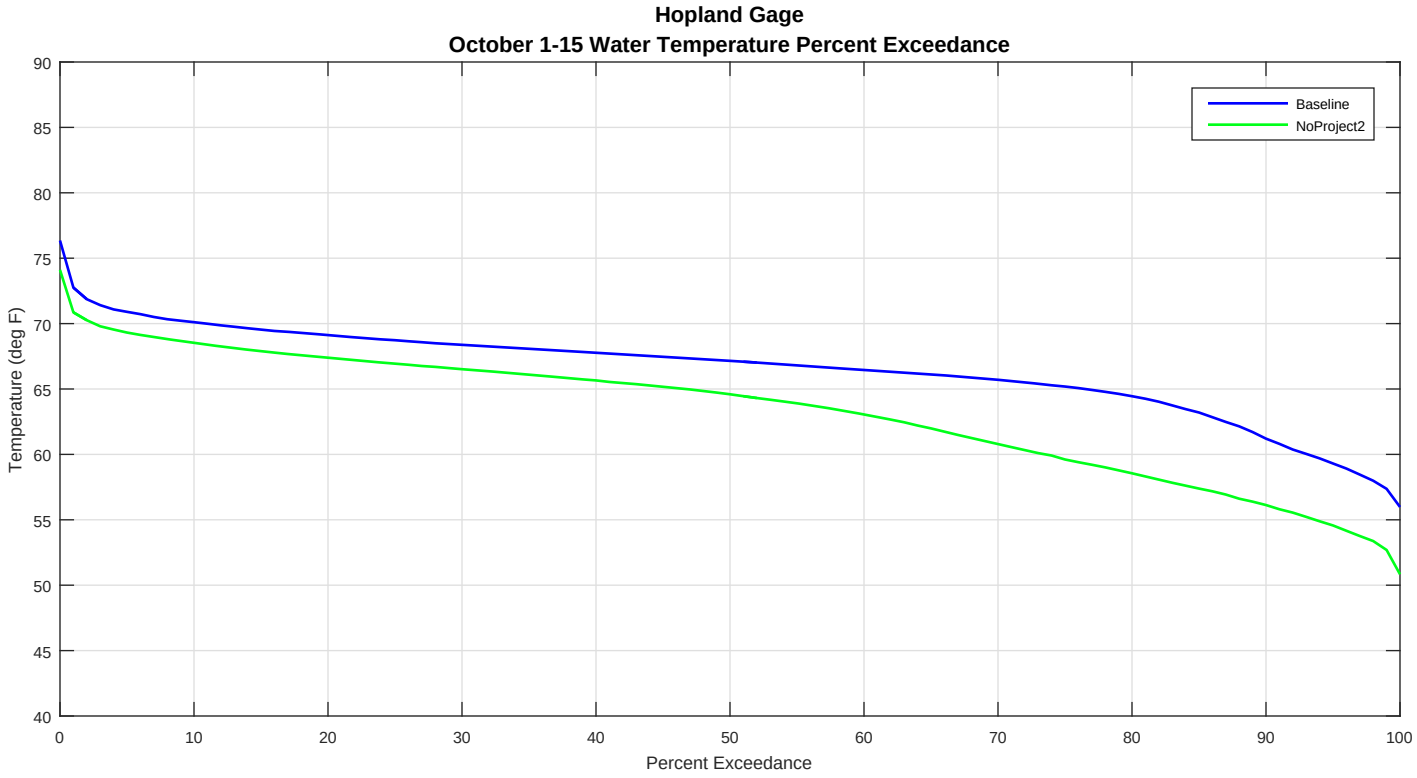
Hopland Gage
October 1-15 Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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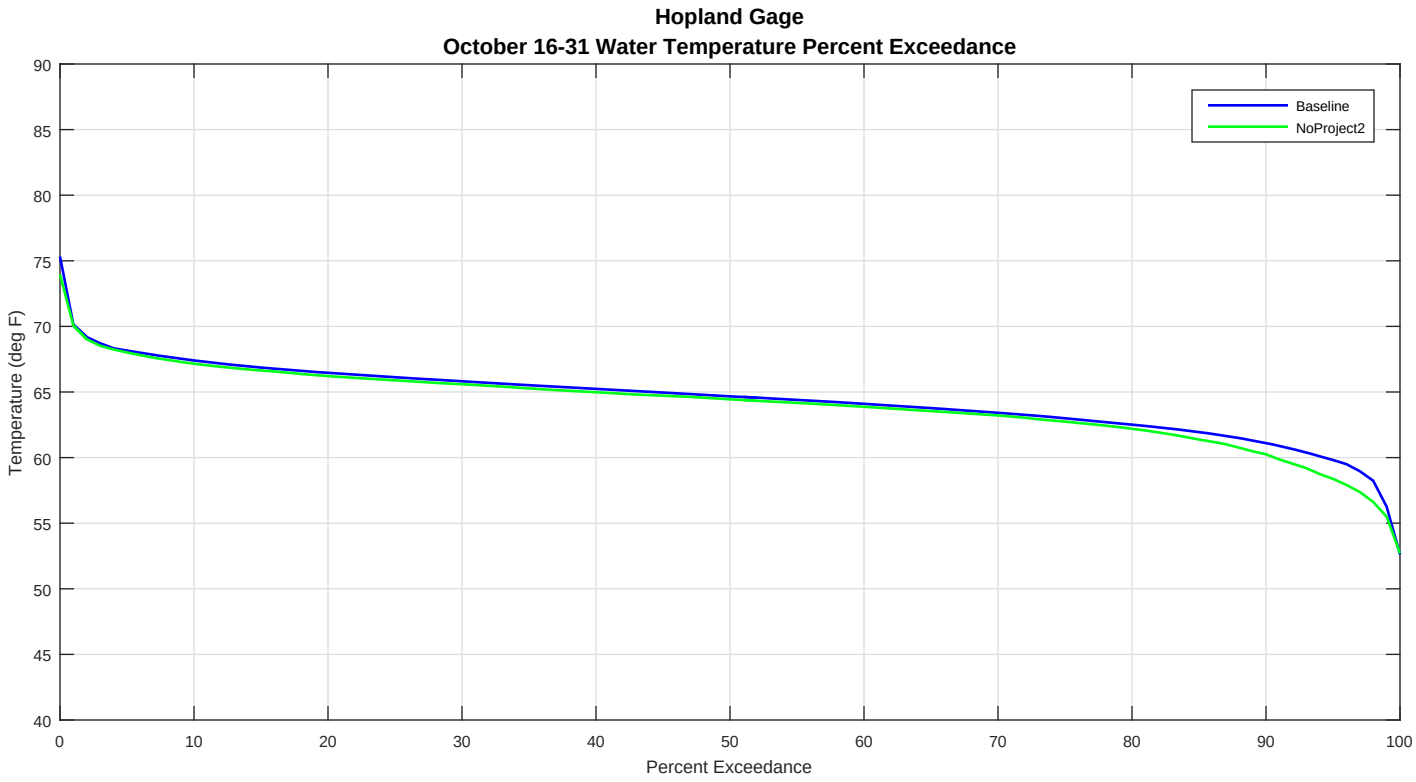
Hopland Gage
October 16-31 Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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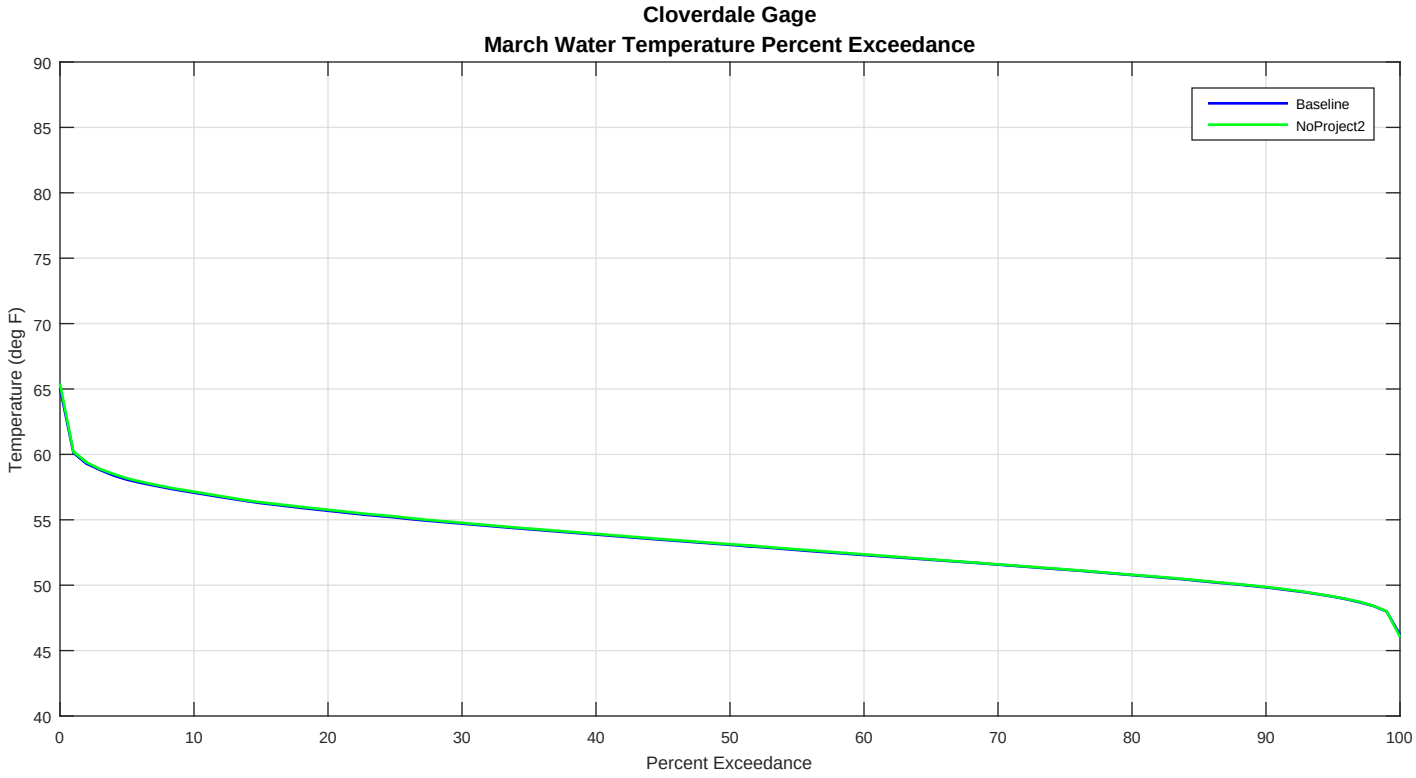
Cloverdale Gage
March Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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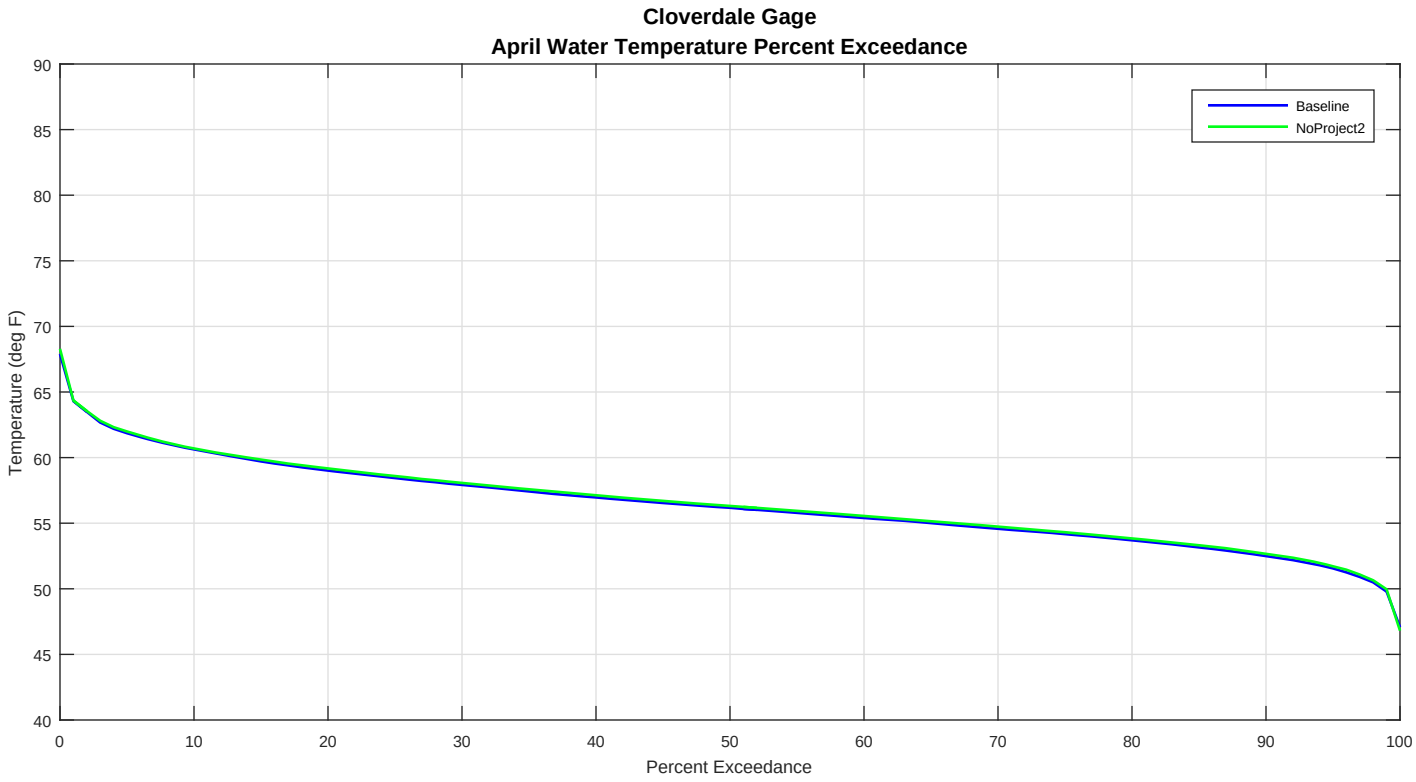
Cloverdale Gage
April Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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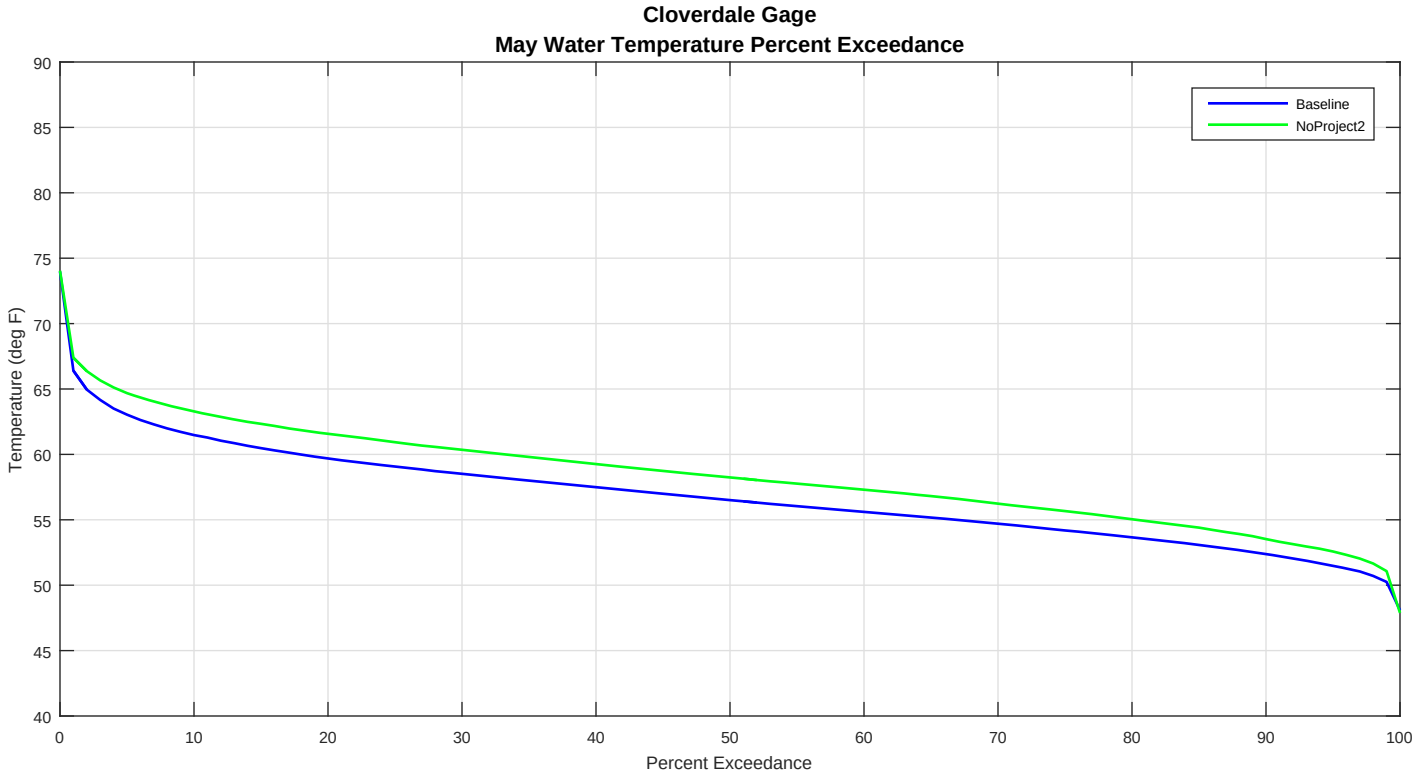
Cloverdale Gage
May Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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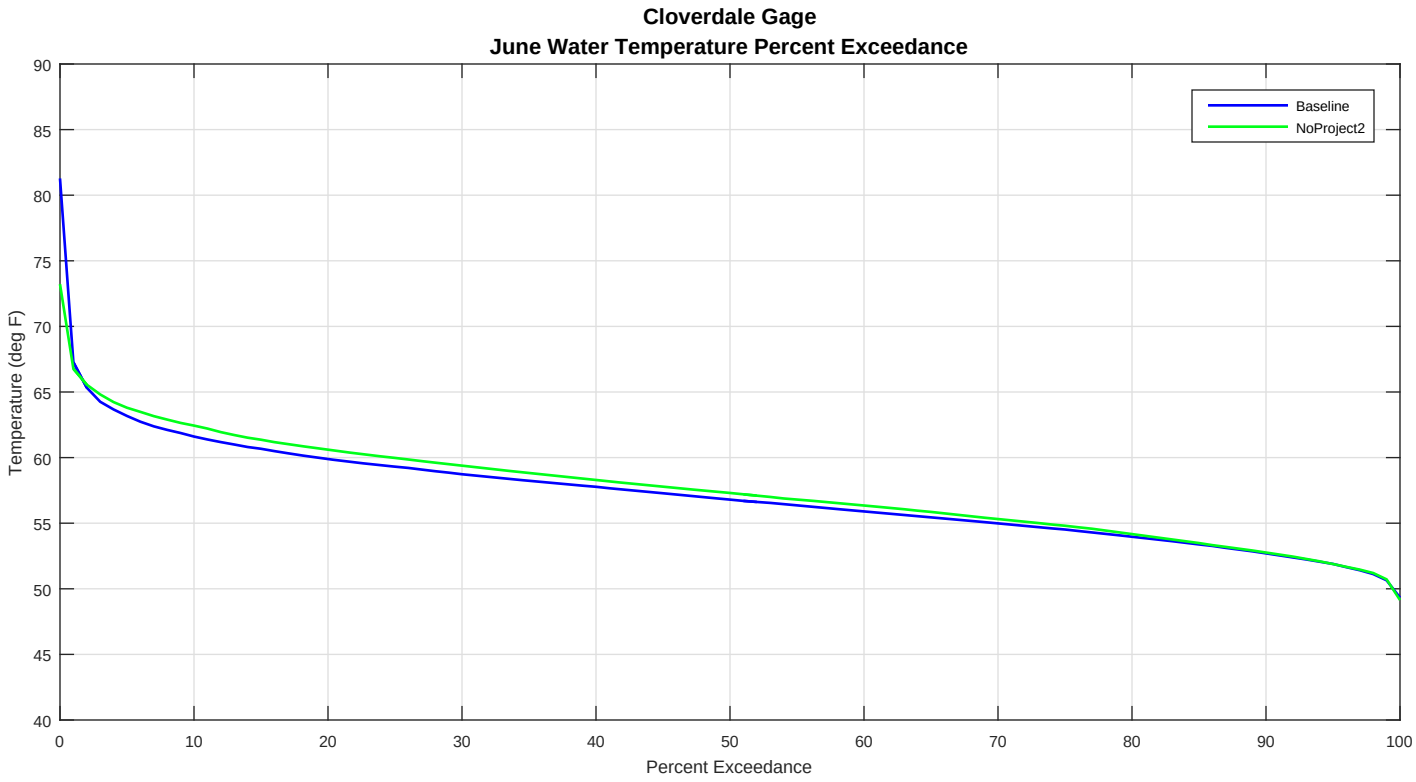
Cloverdale Gage
June Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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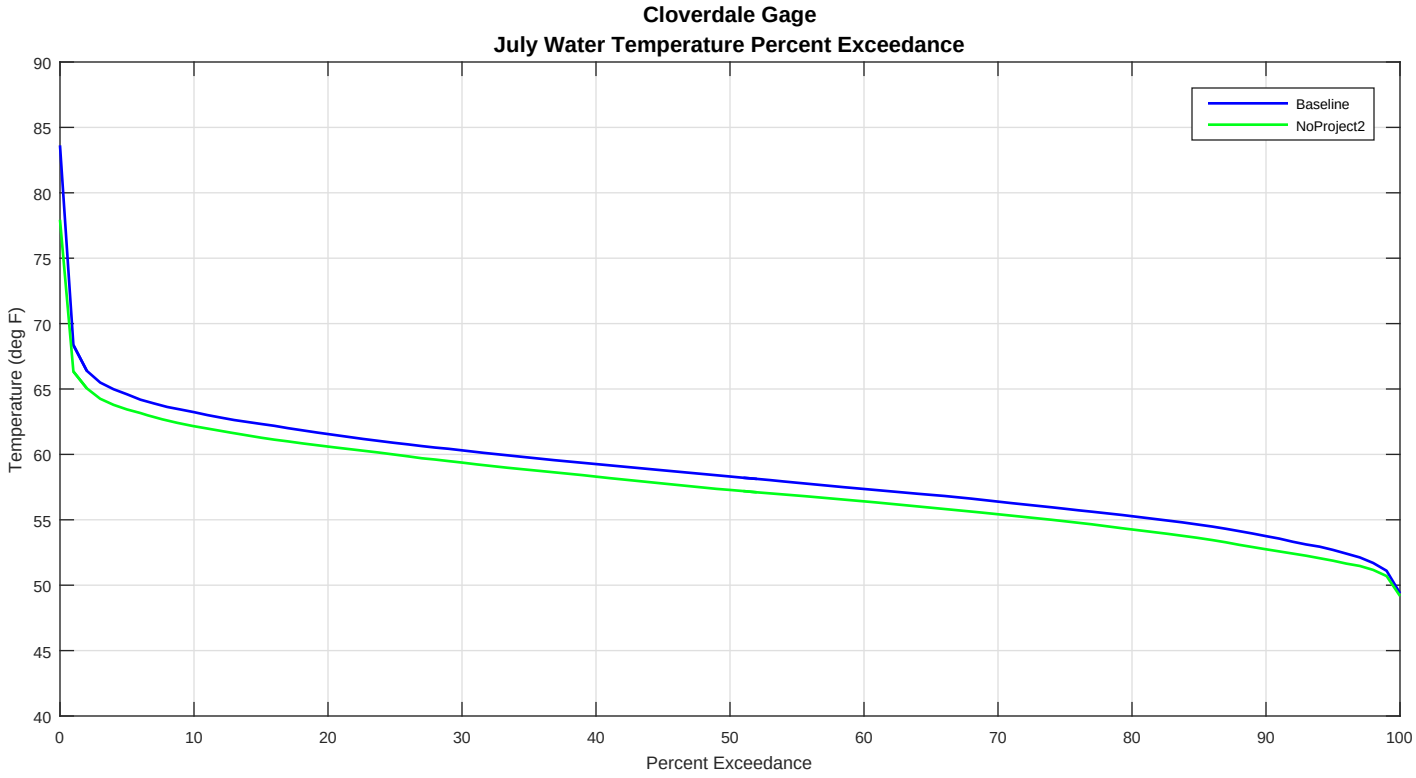
Cloverdale Gage
July Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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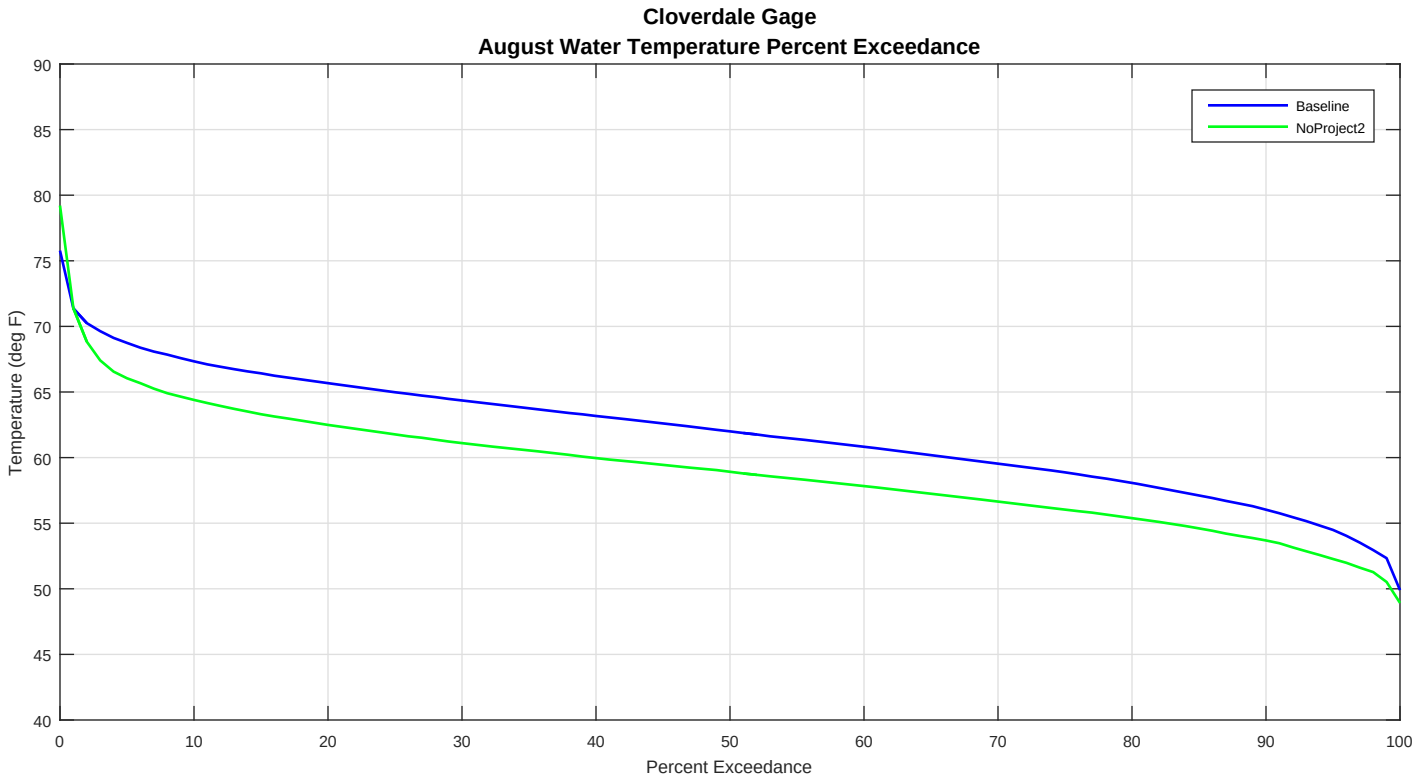
Cloverdale Gage
August Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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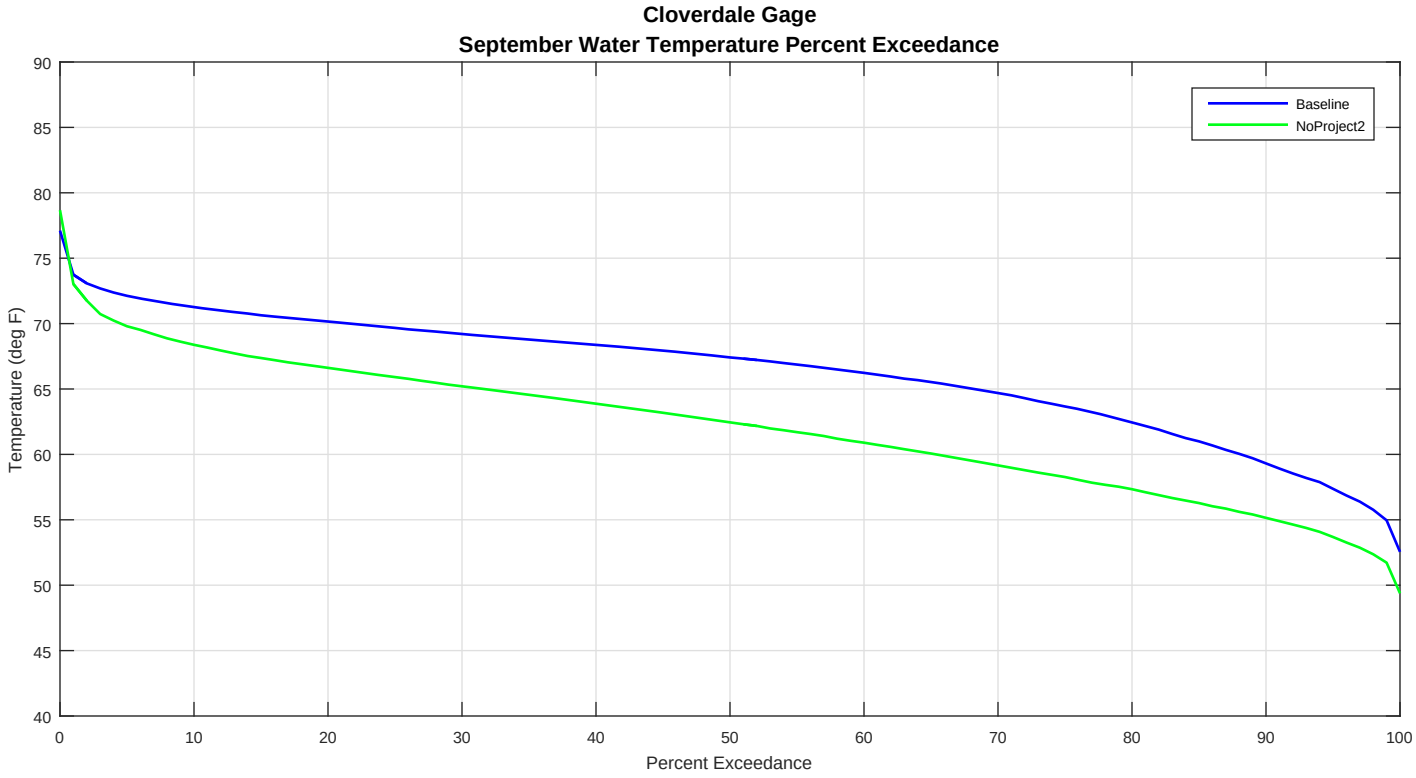
Cloverdale Gage
September Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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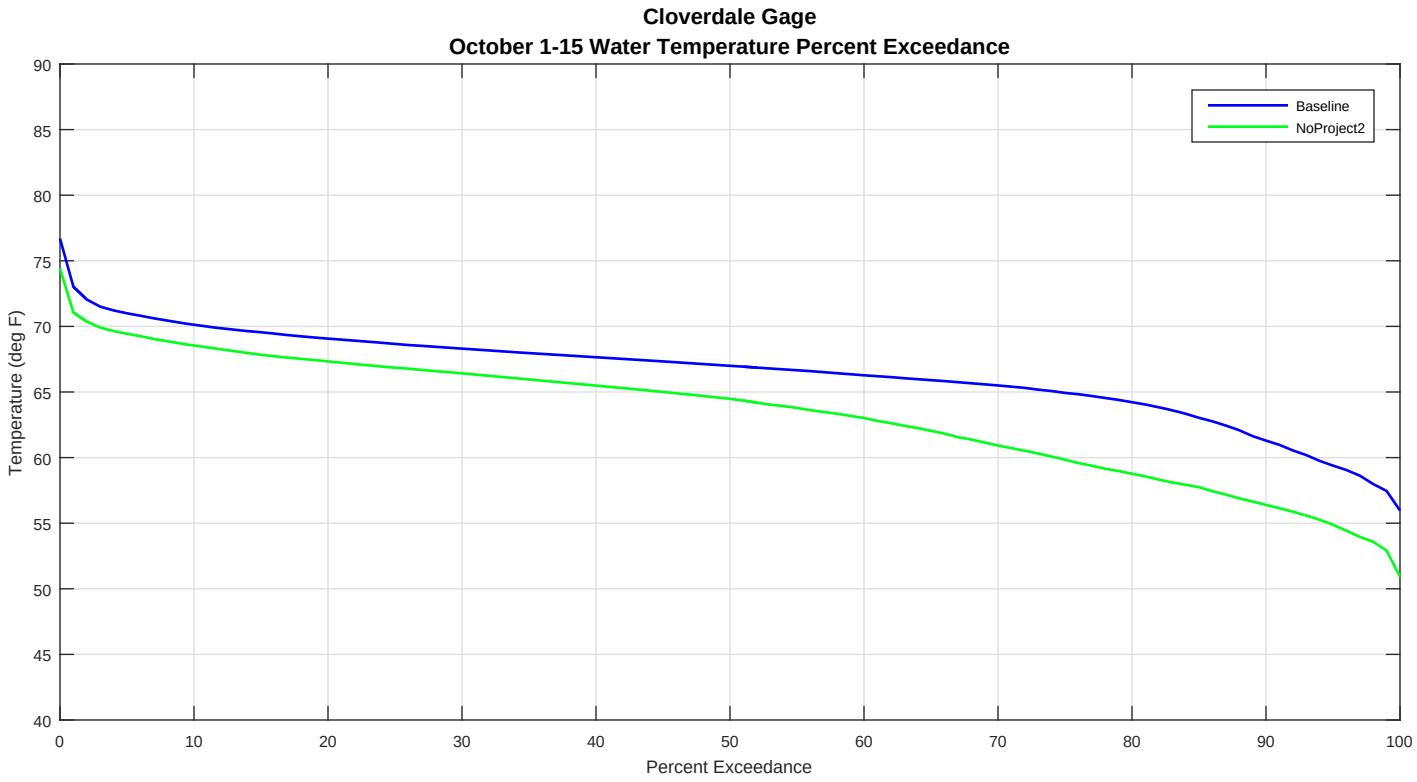
Cloverdale Gage
October 1-15 Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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Cloverdale Gage
October 16-31 Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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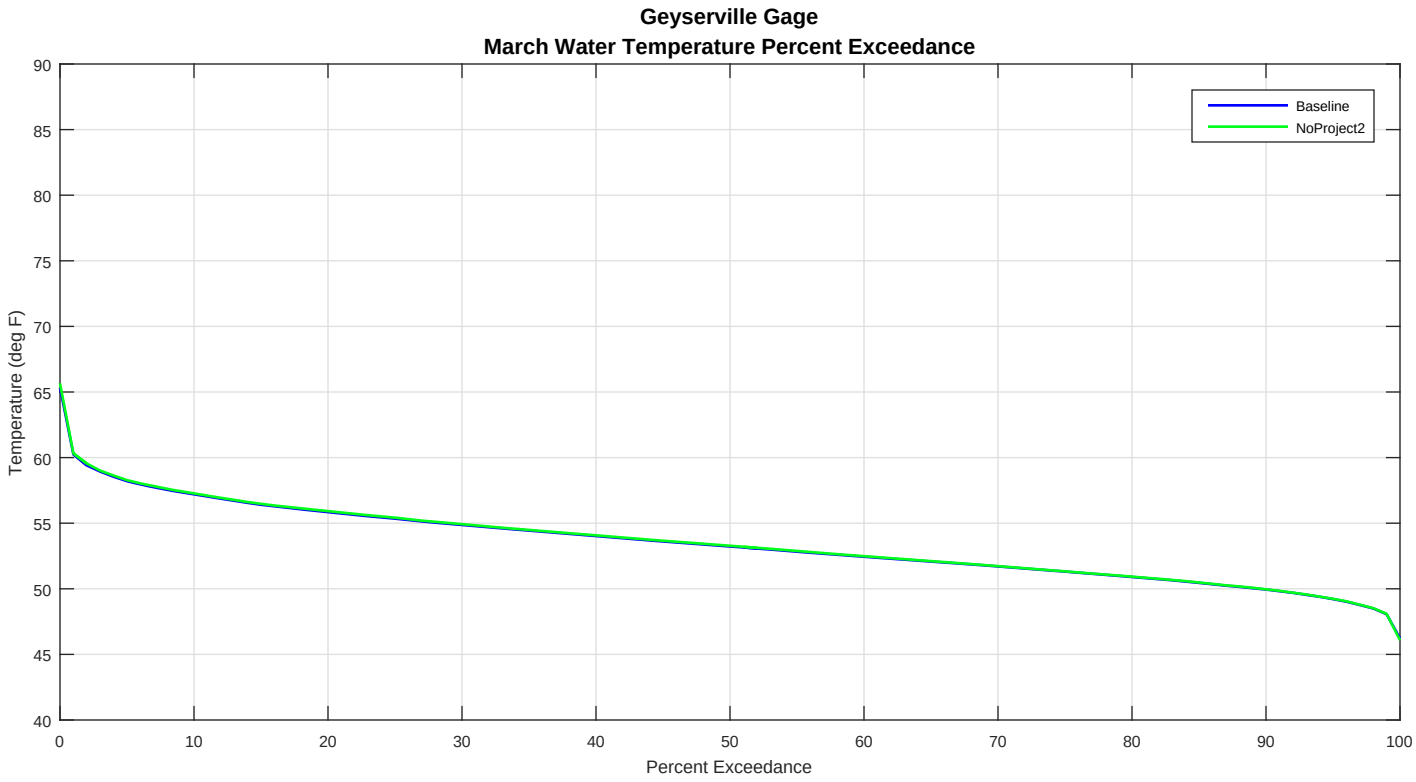
Geyserville Gage
March Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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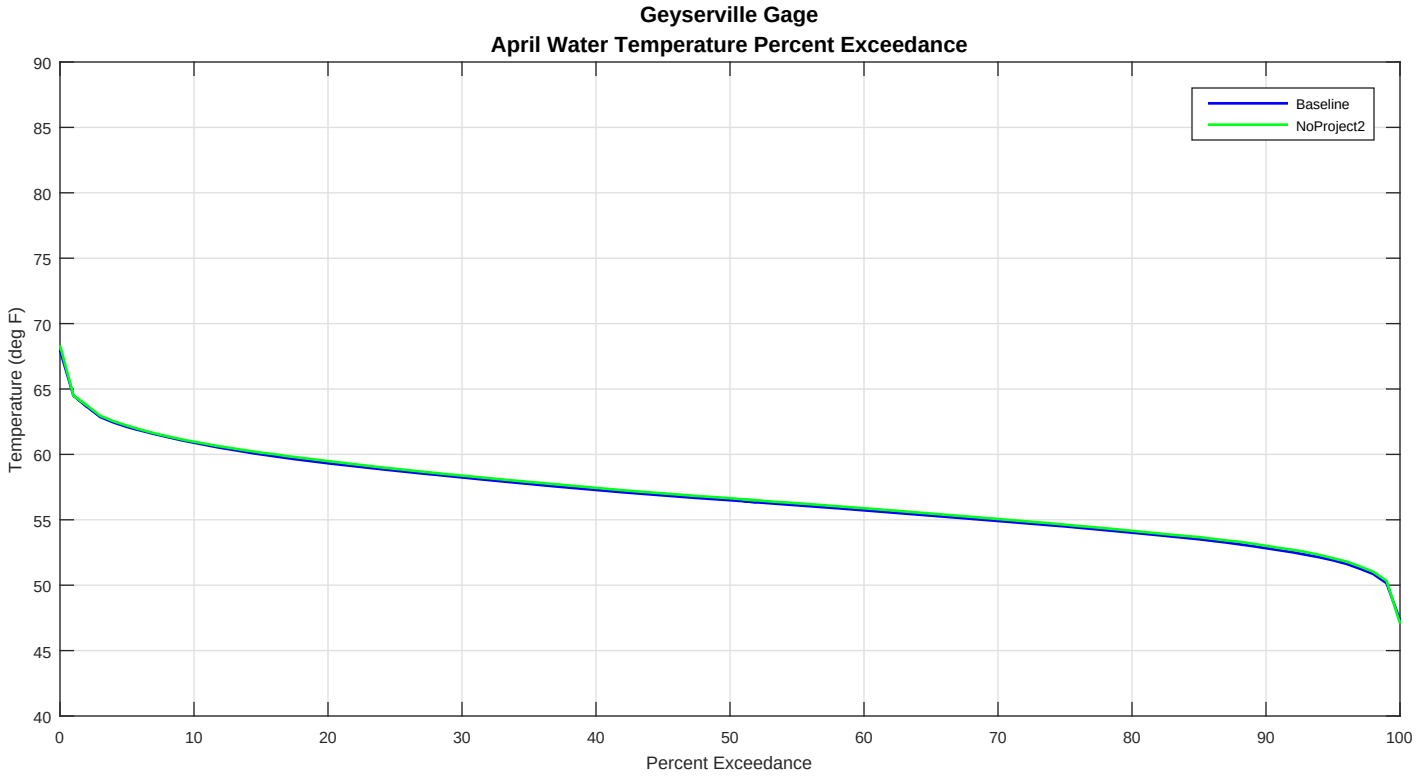
Geyserville Gage
April Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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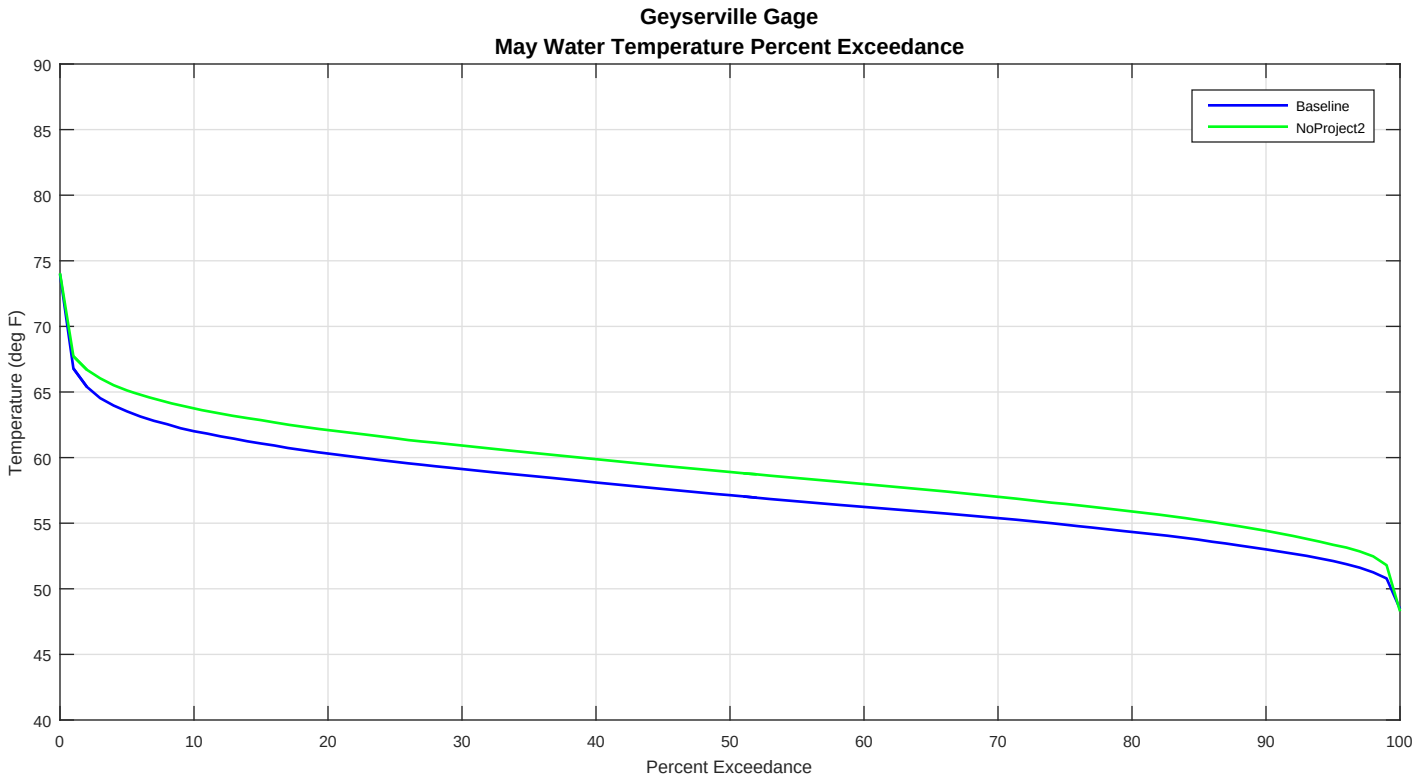
Geyserville Gage
May Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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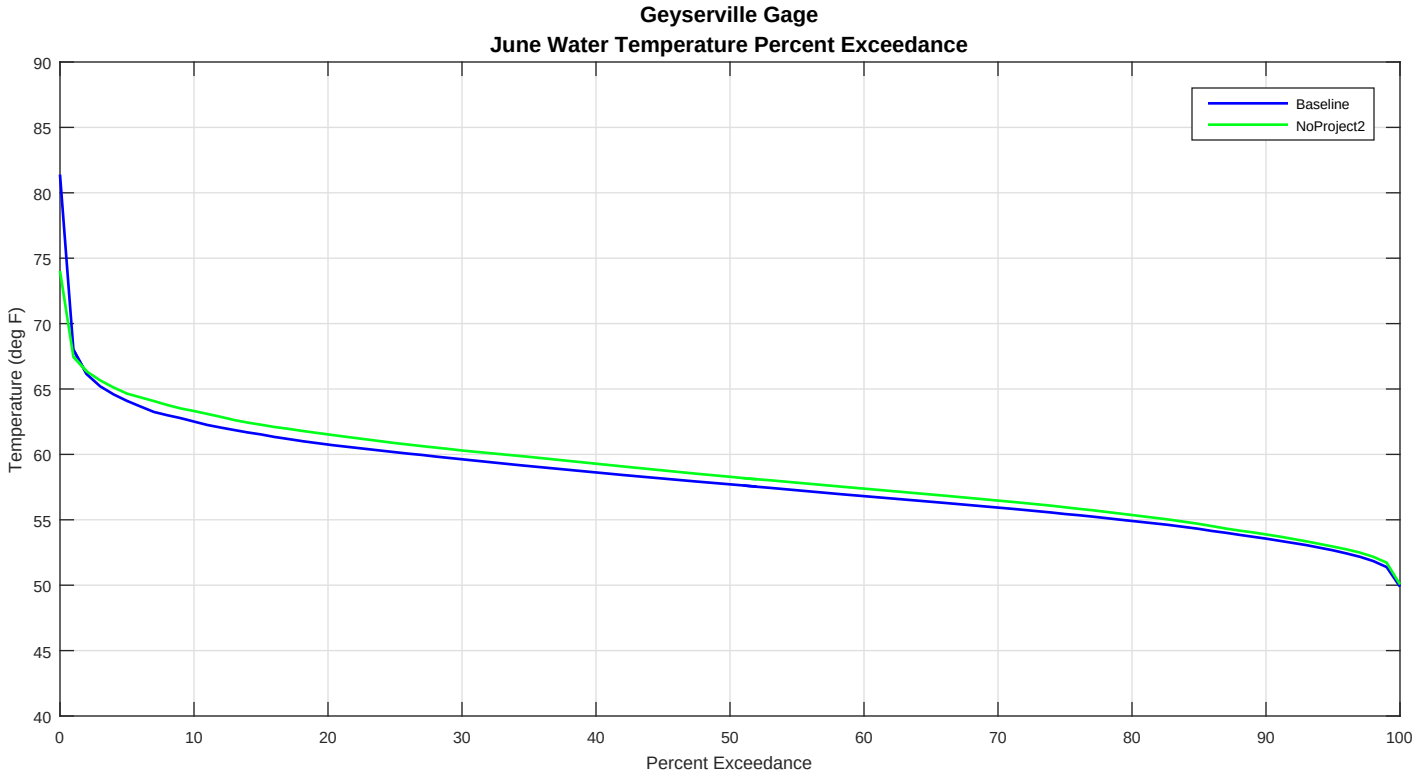
Geyserville Gage
June Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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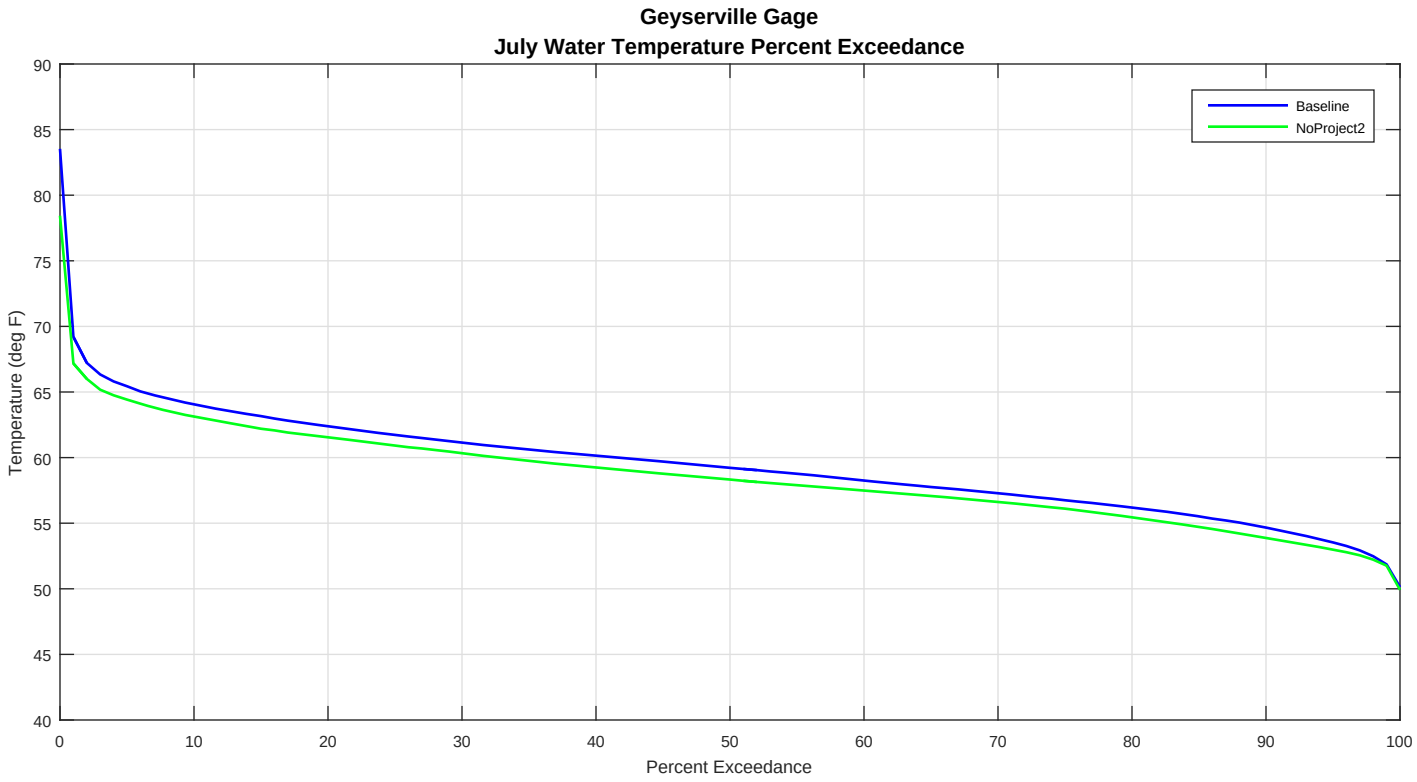
Geyserville Gage
July Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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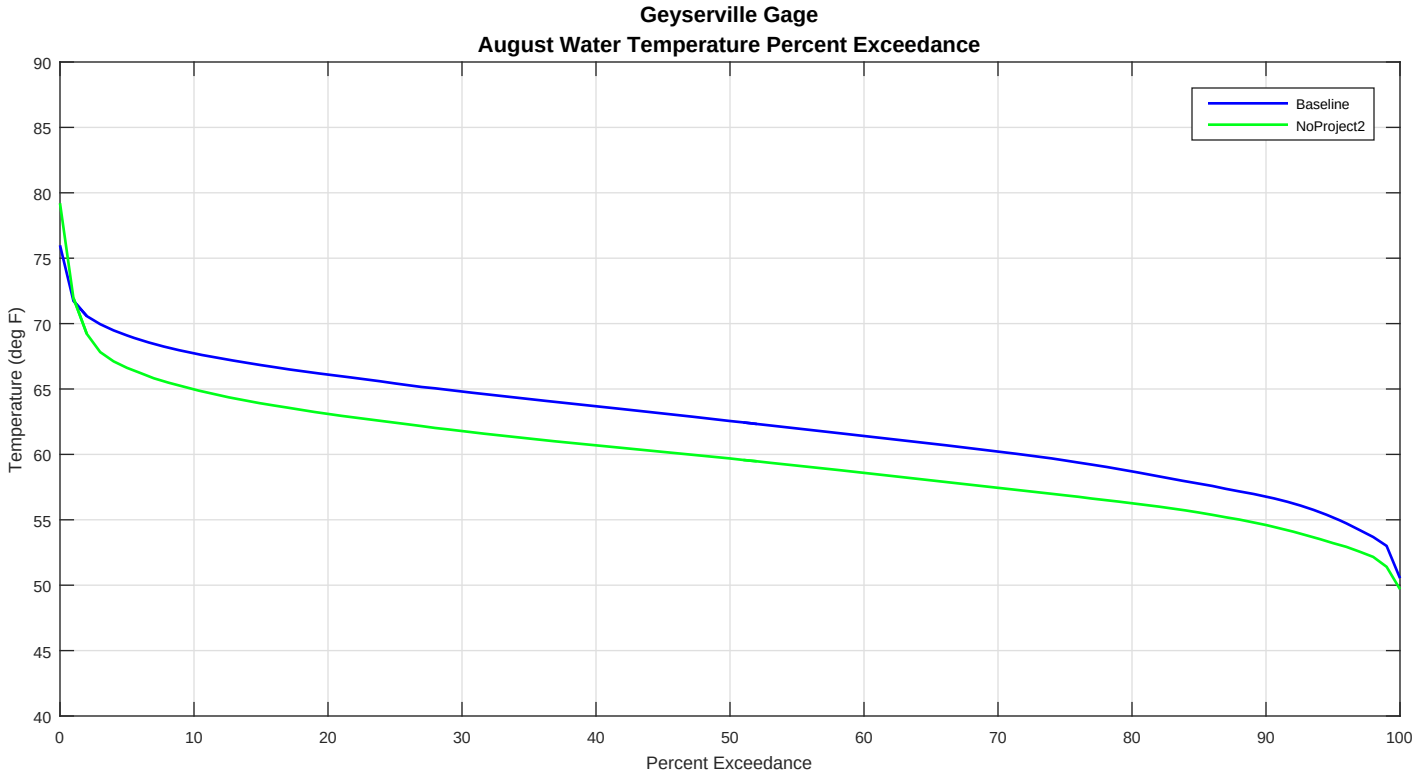
Geyserville Gage
August Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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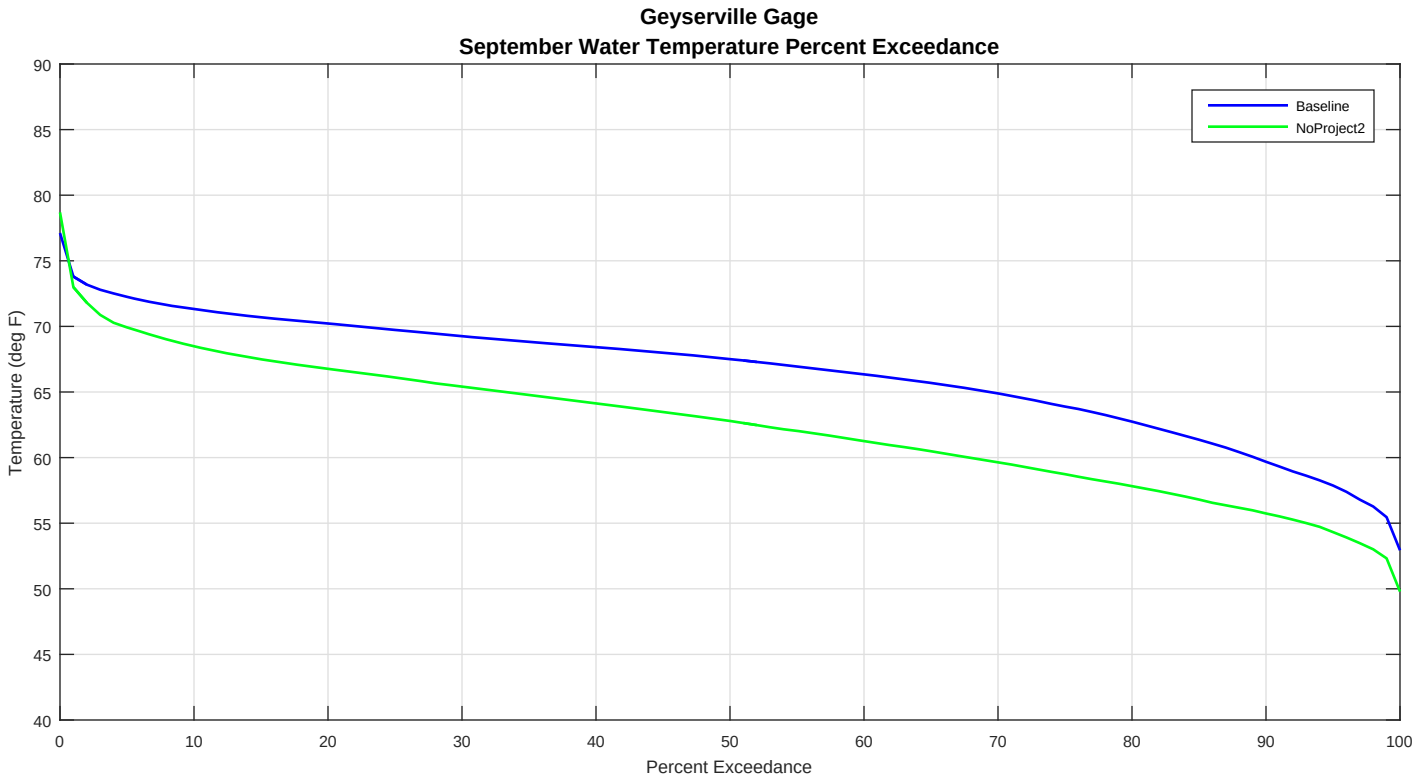
Geyserville Gage
September Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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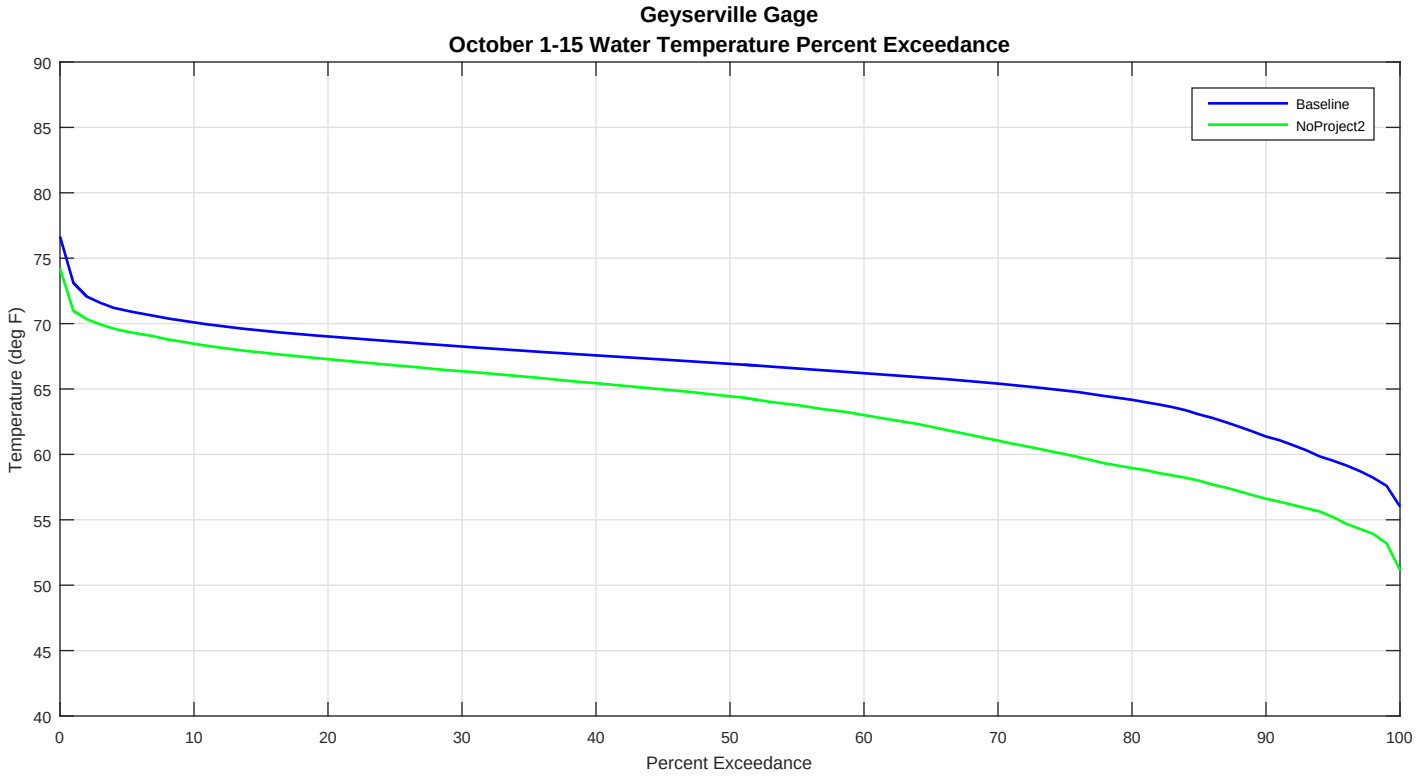
Geyserville Gage
October 1-15 Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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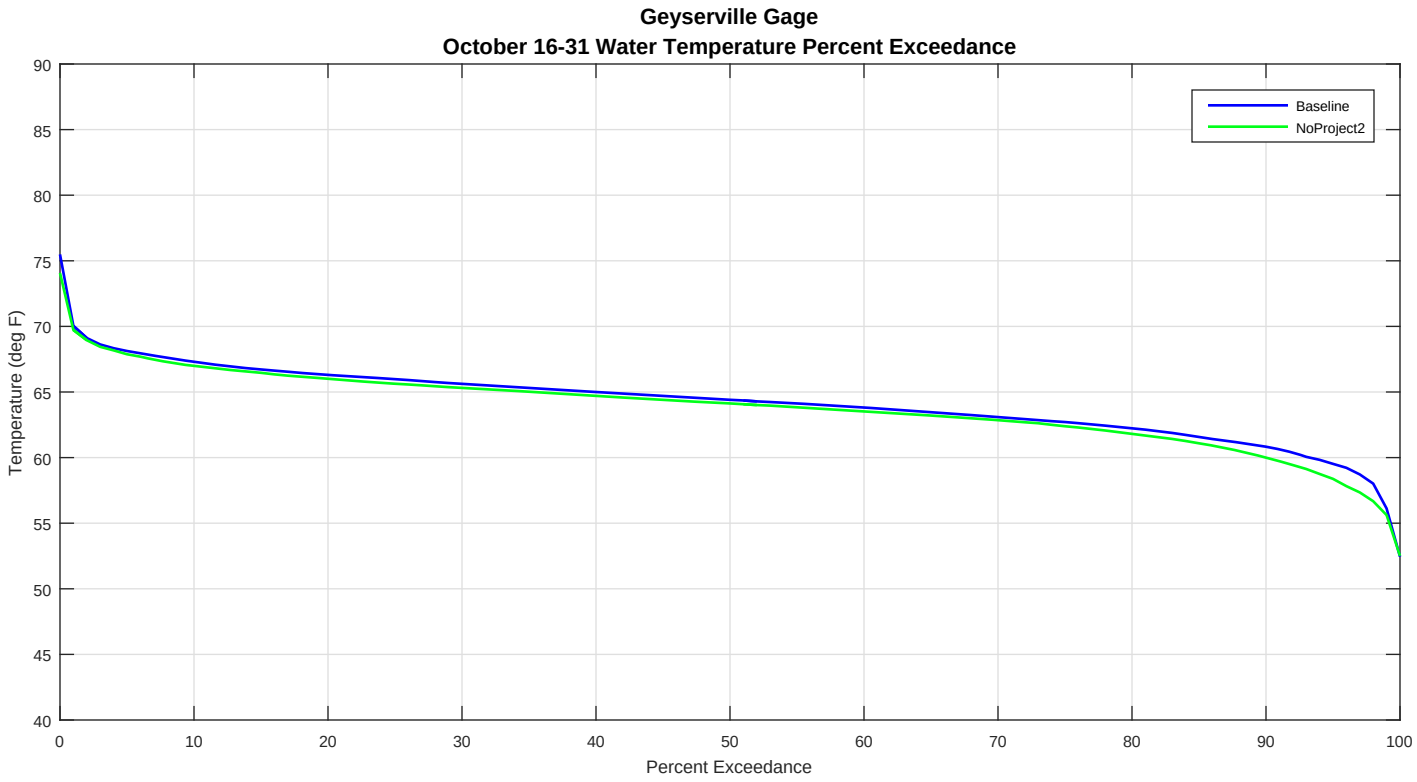
Geyserville Gage
October 16-31 Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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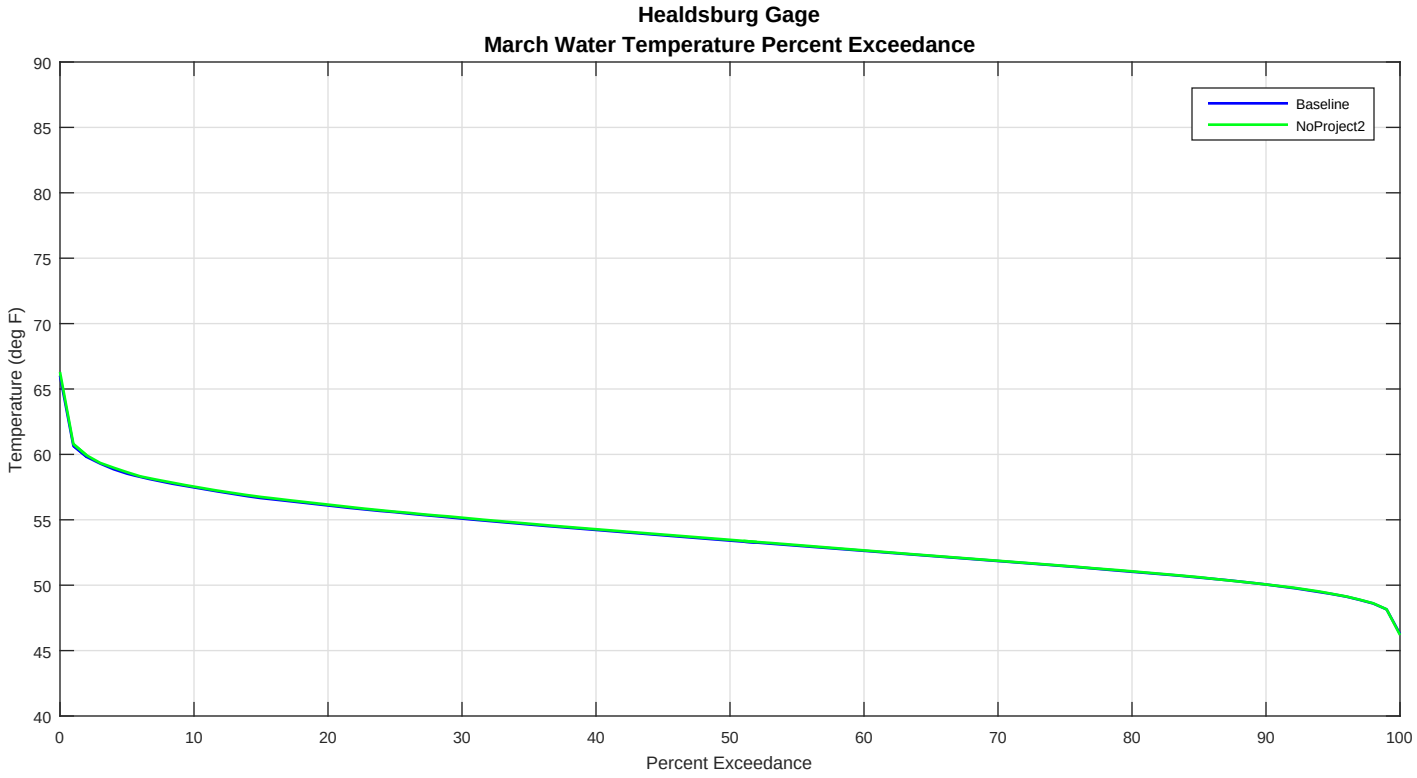
Healdsburg Gage
March Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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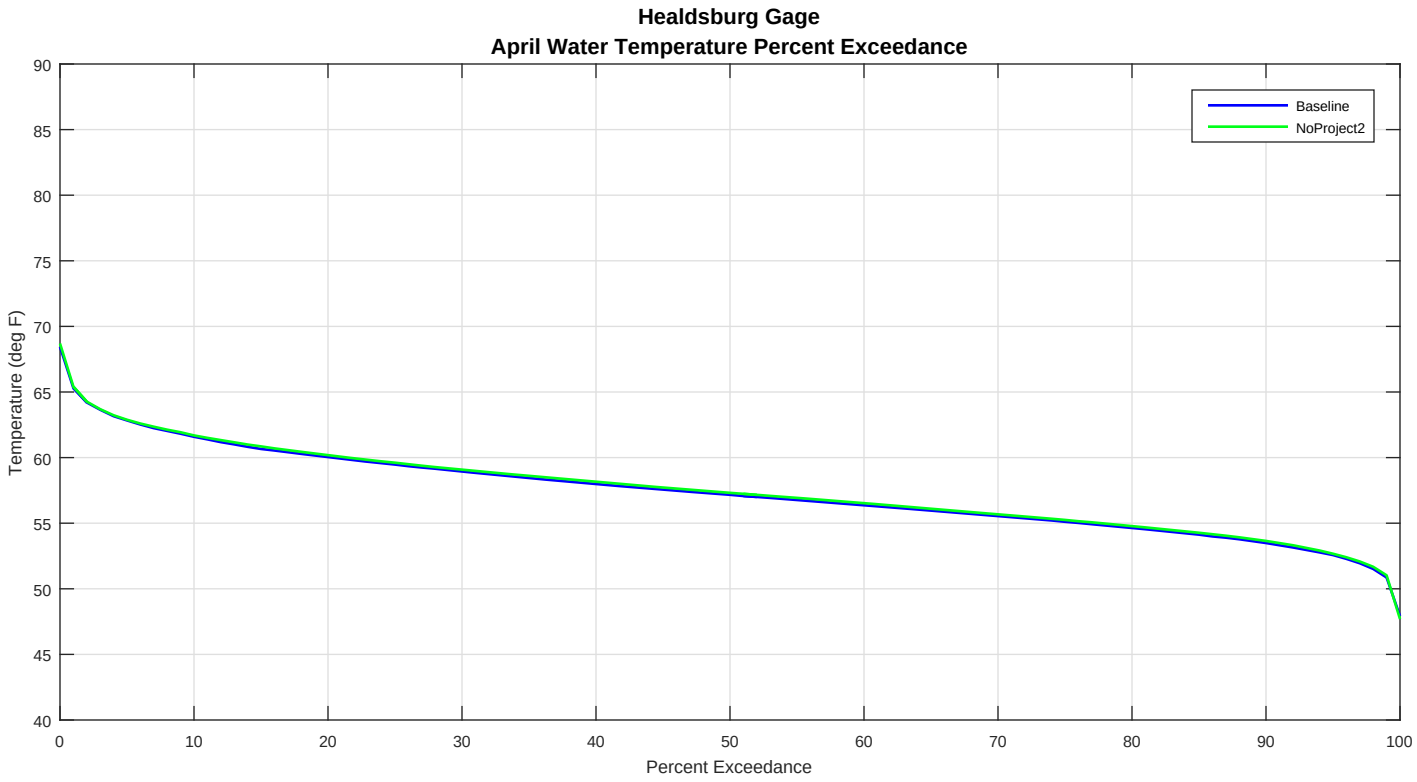
Healdsburg Gage
April Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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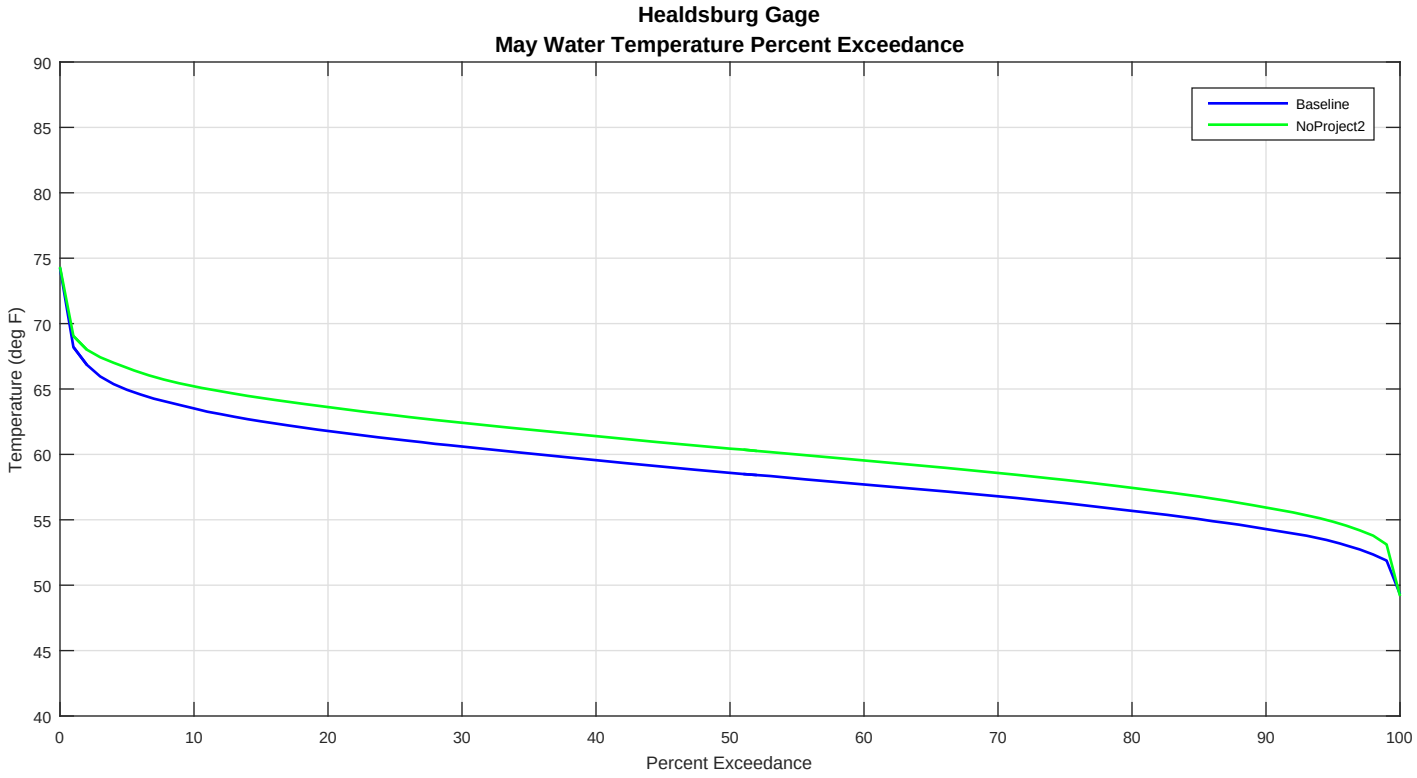
Healdsburg Gage
May Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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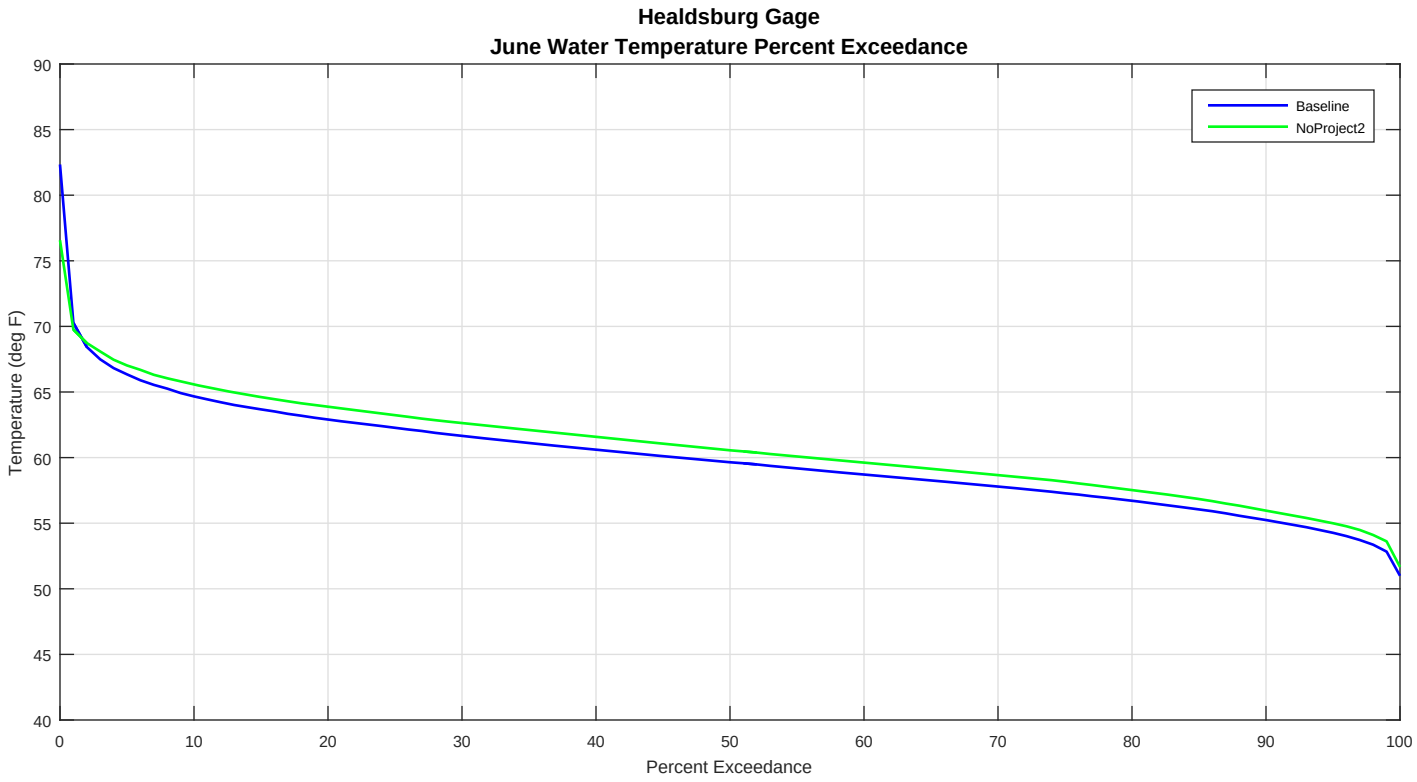
Healdsburg Gage
June Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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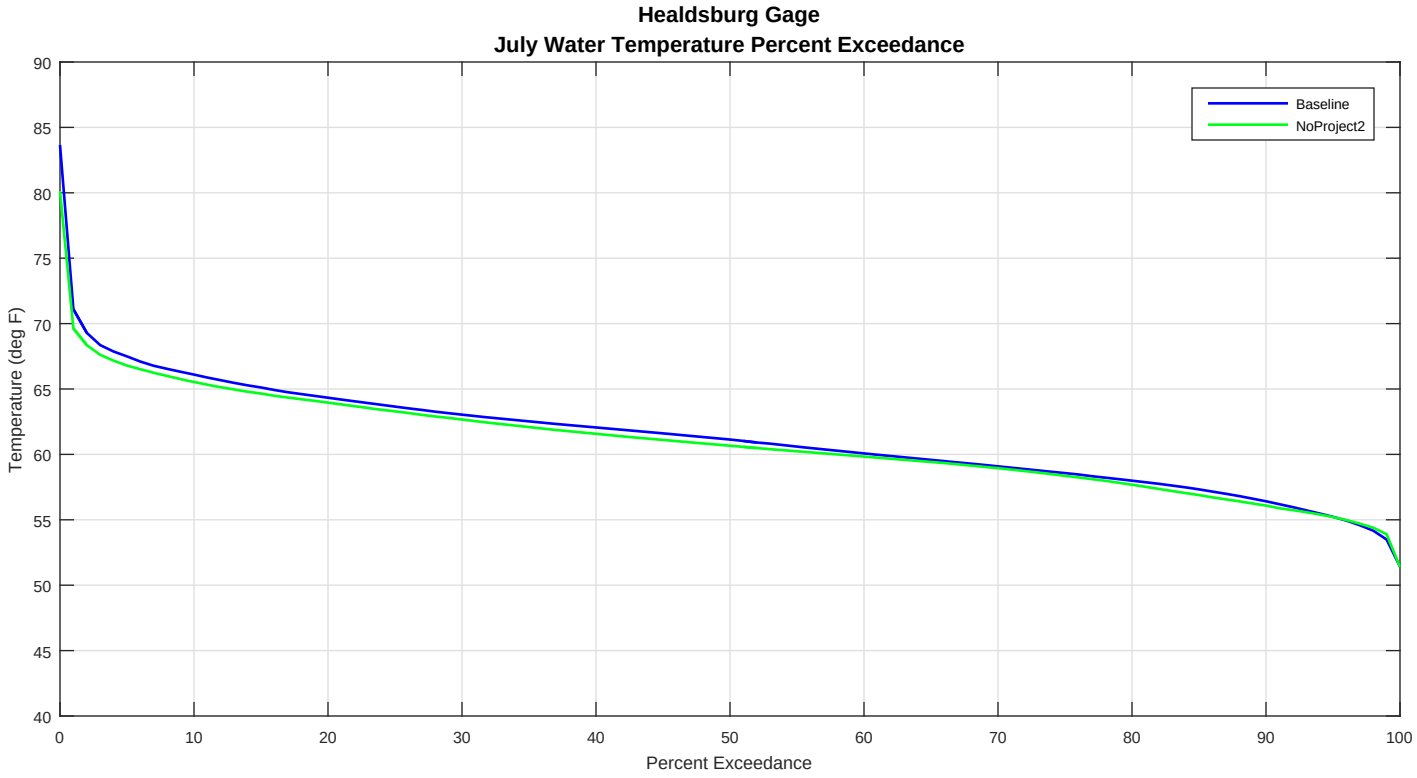
Healdsburg Gage
July Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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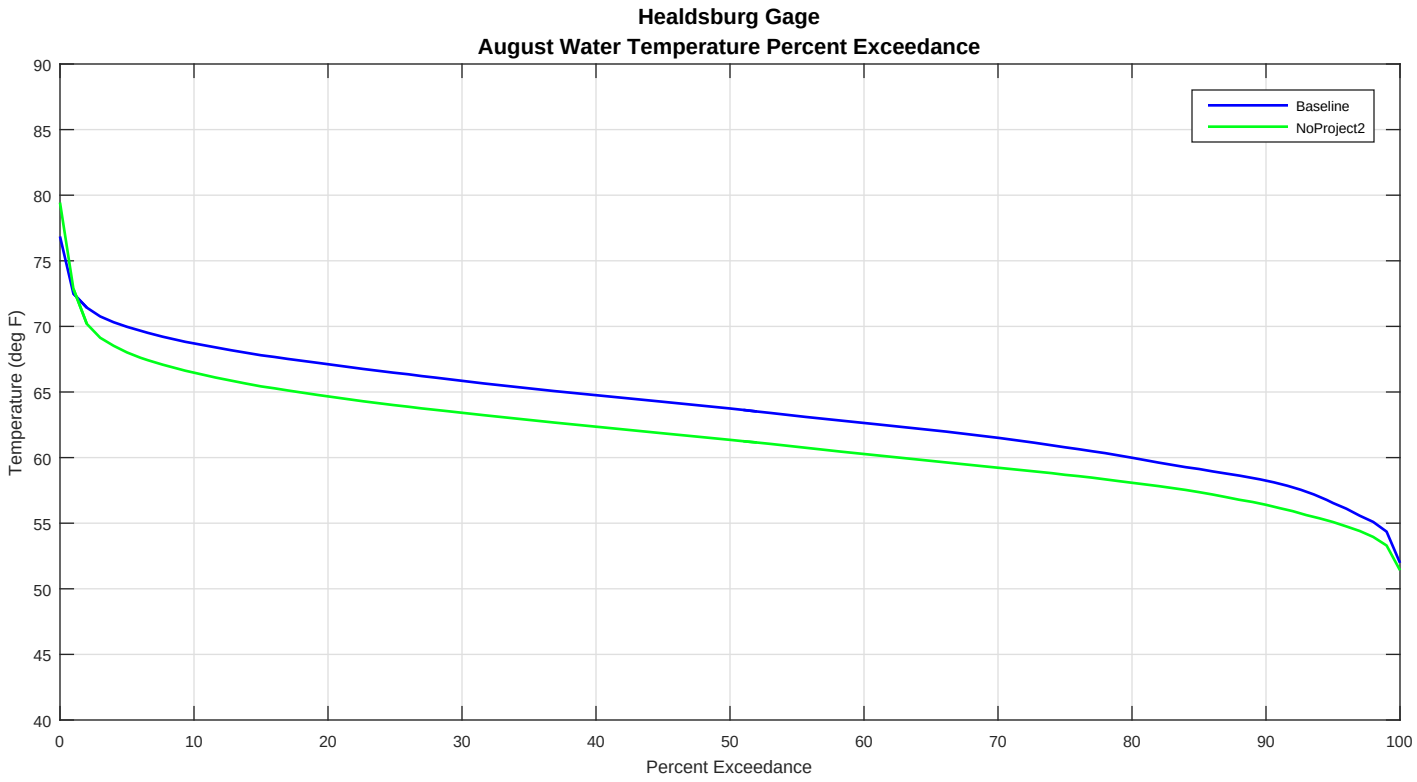
Healdsburg Gage
August Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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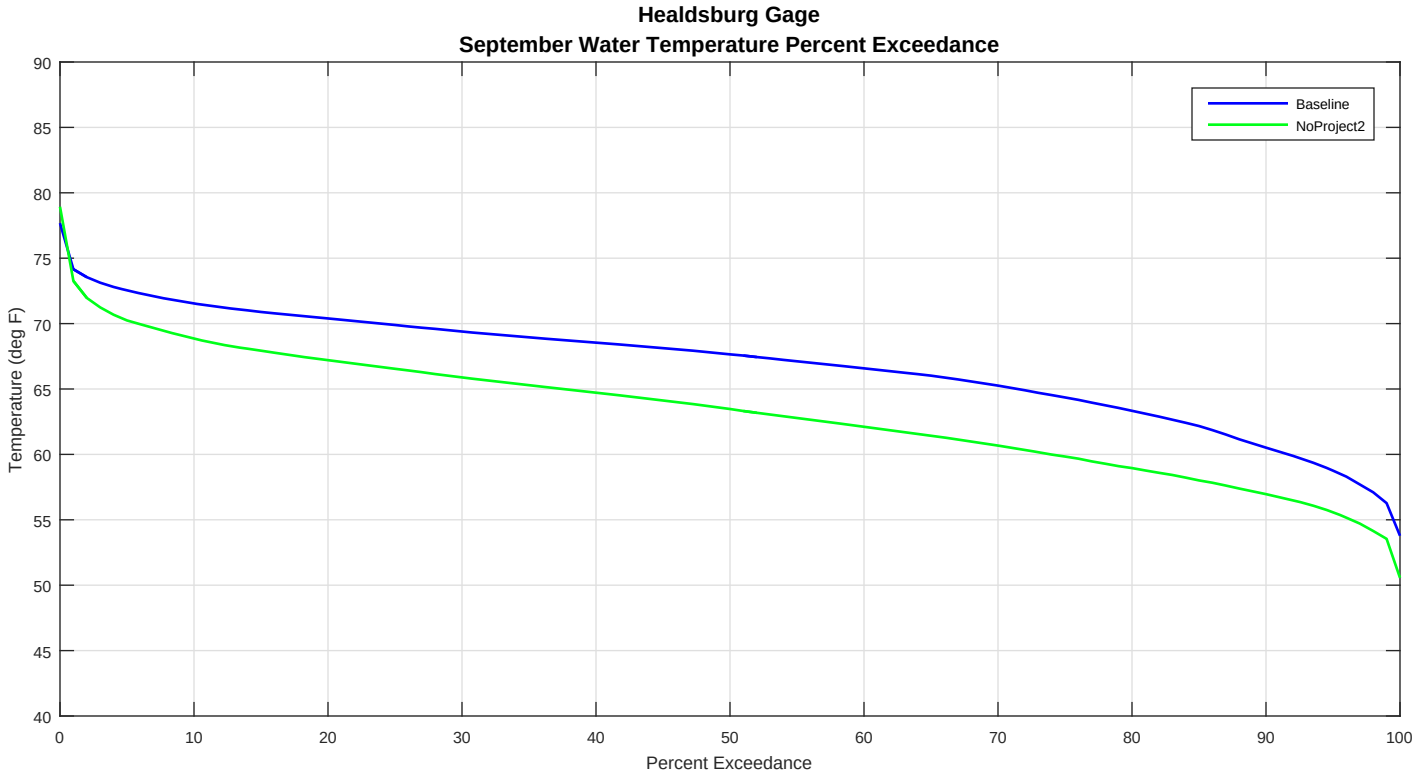
Healdsburg Gage
September Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
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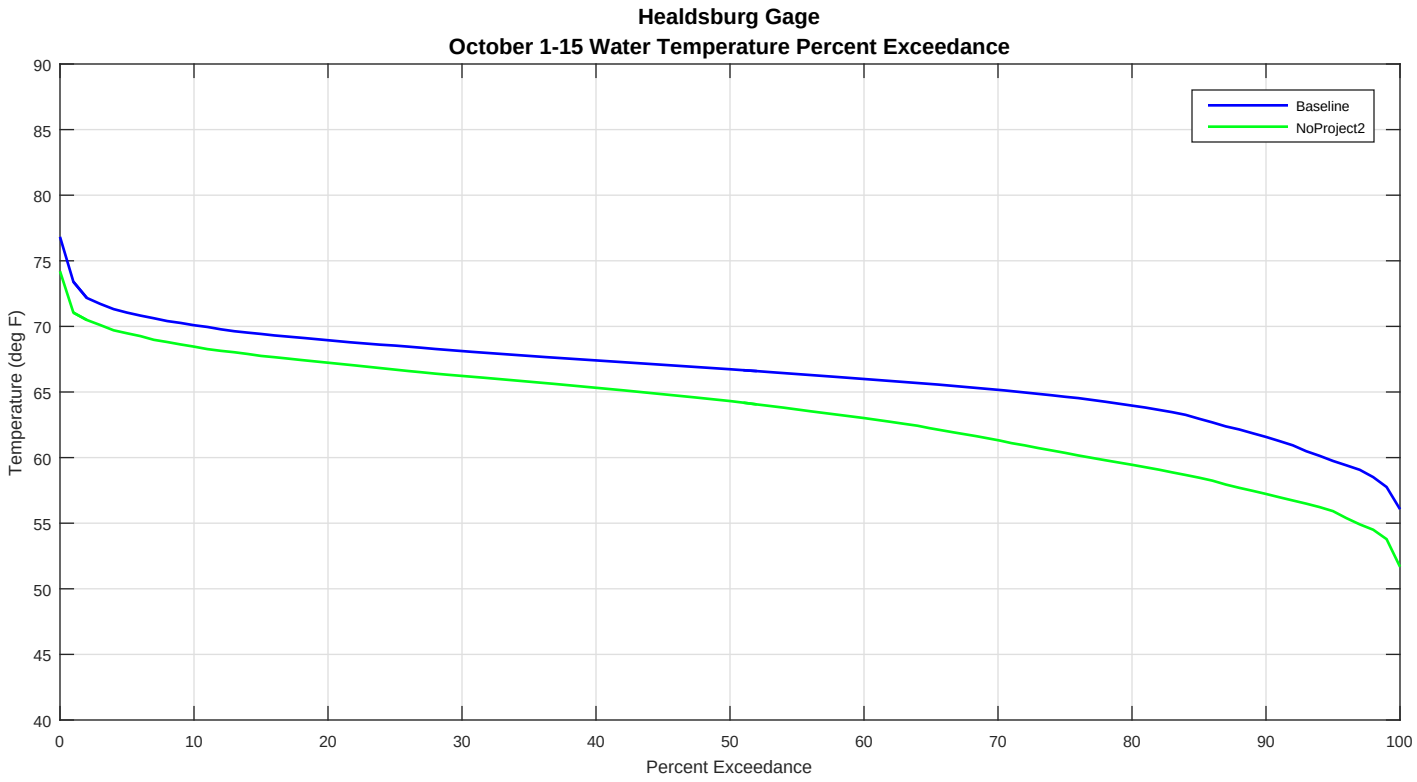
Healdsburg Gage
October 1-15 Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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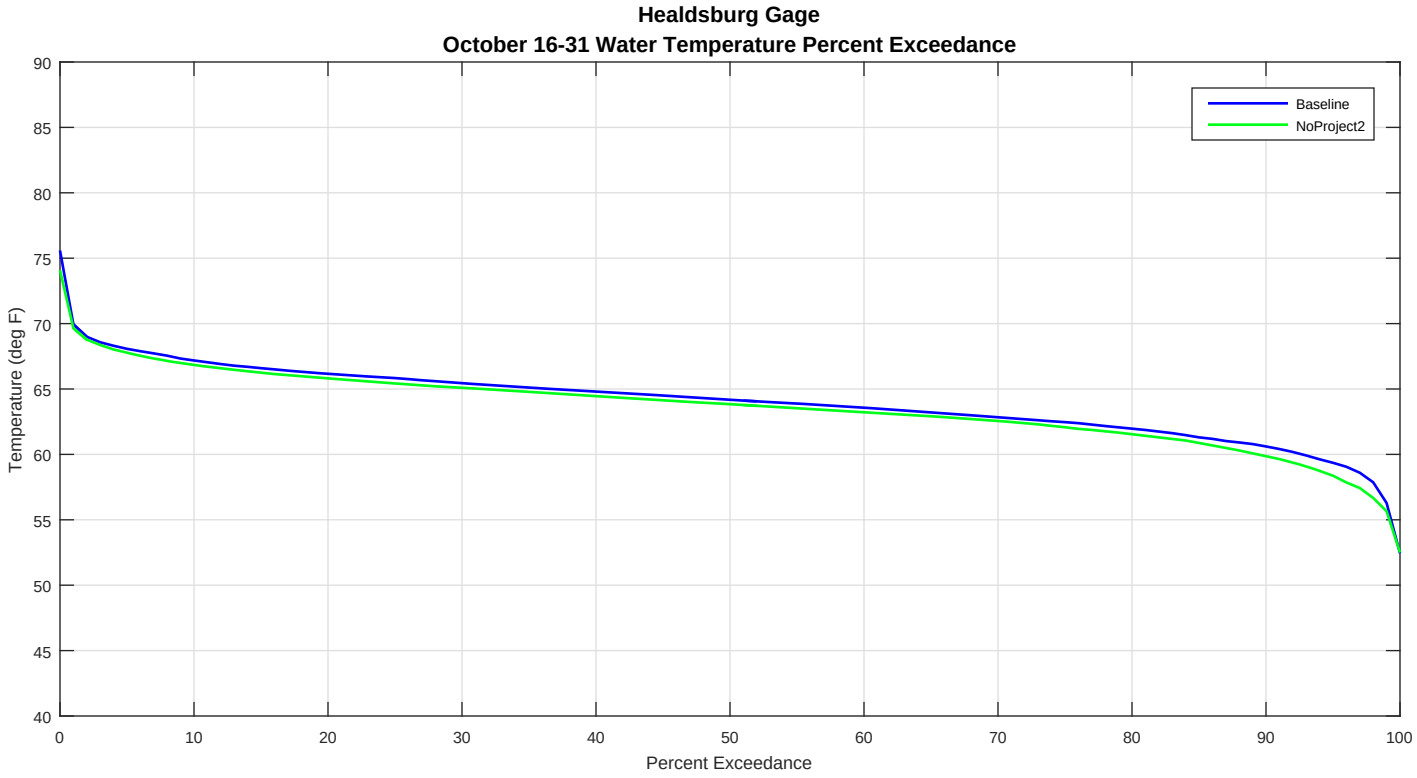
Healdsburg Gage
October 16-31 Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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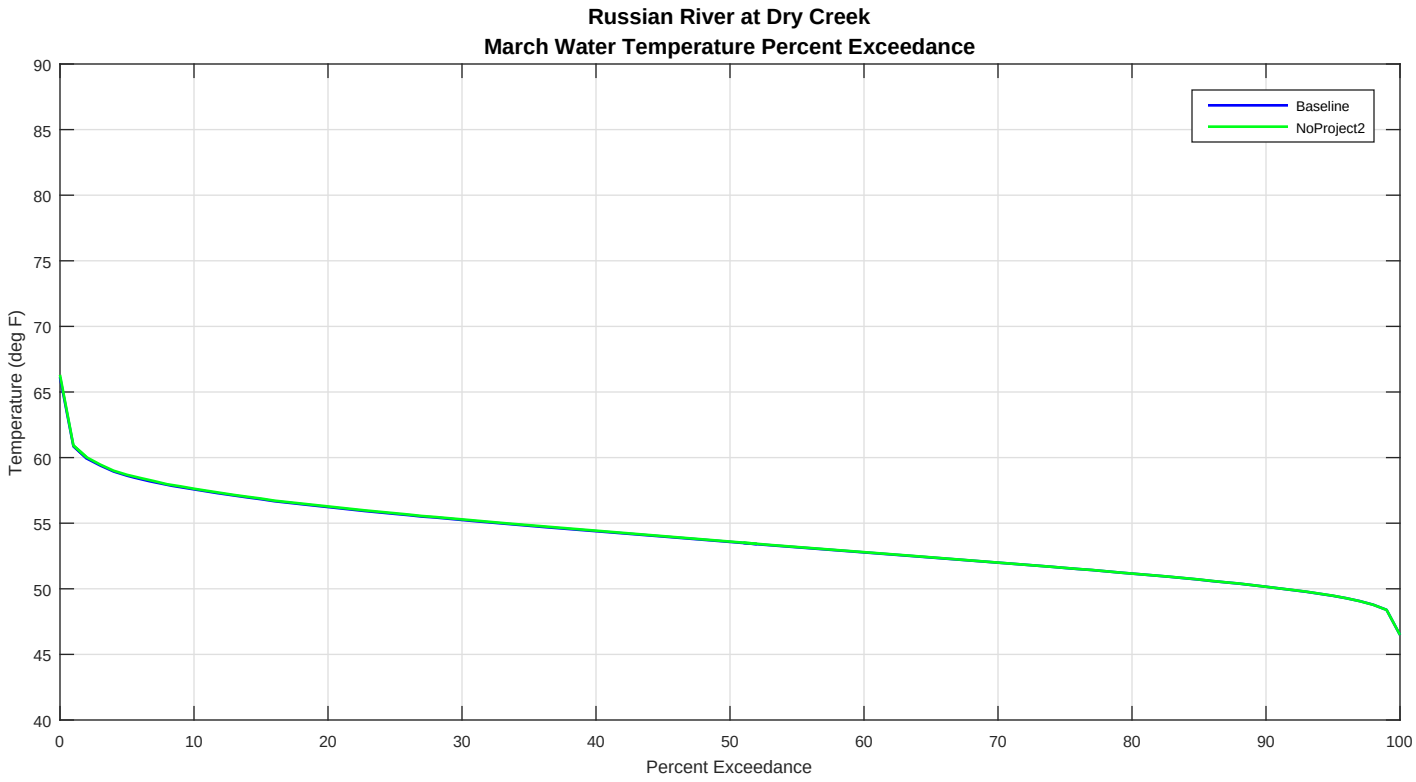
Russian River at Dry Creek
March Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
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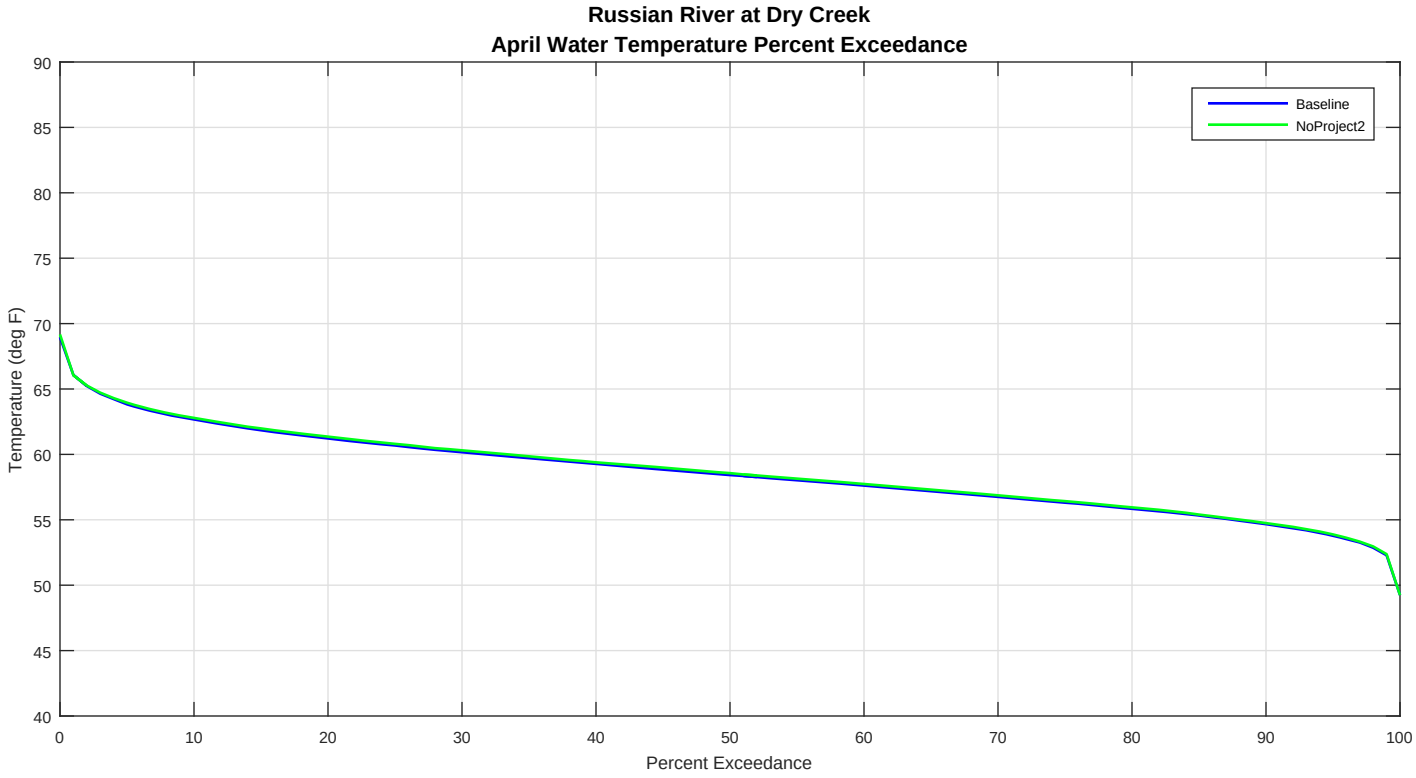
Russian River at Dry Creek
April Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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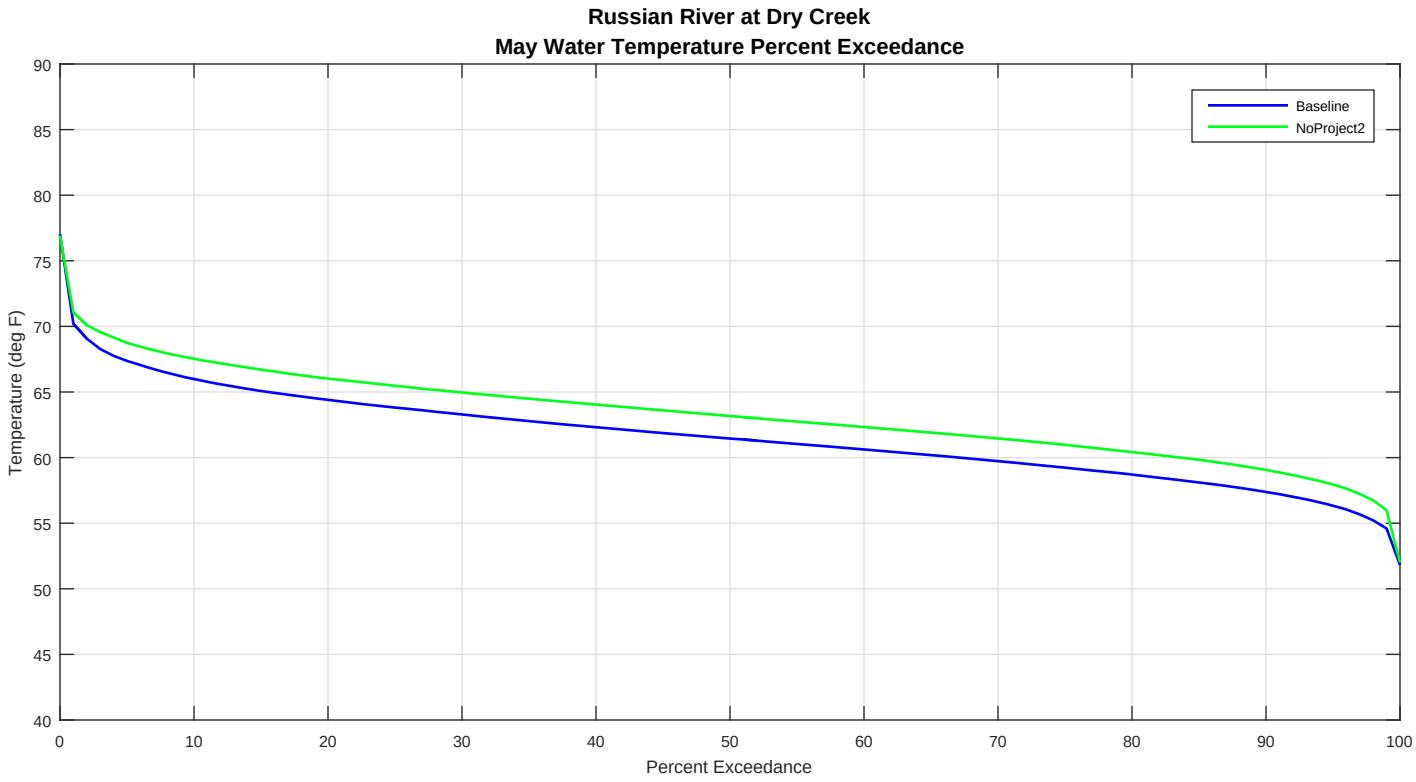
Russian River at Dry Creek
May Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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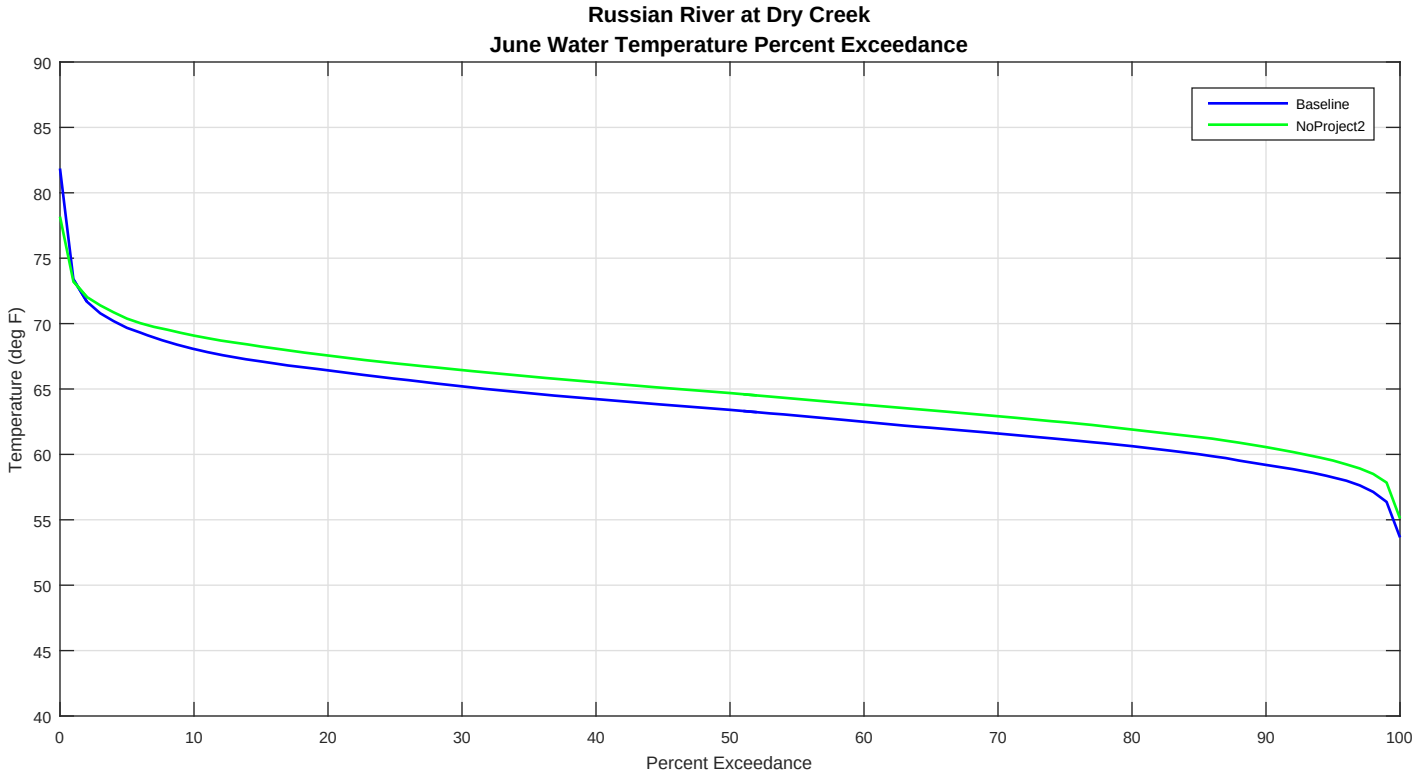
Russian River at Dry Creek
June Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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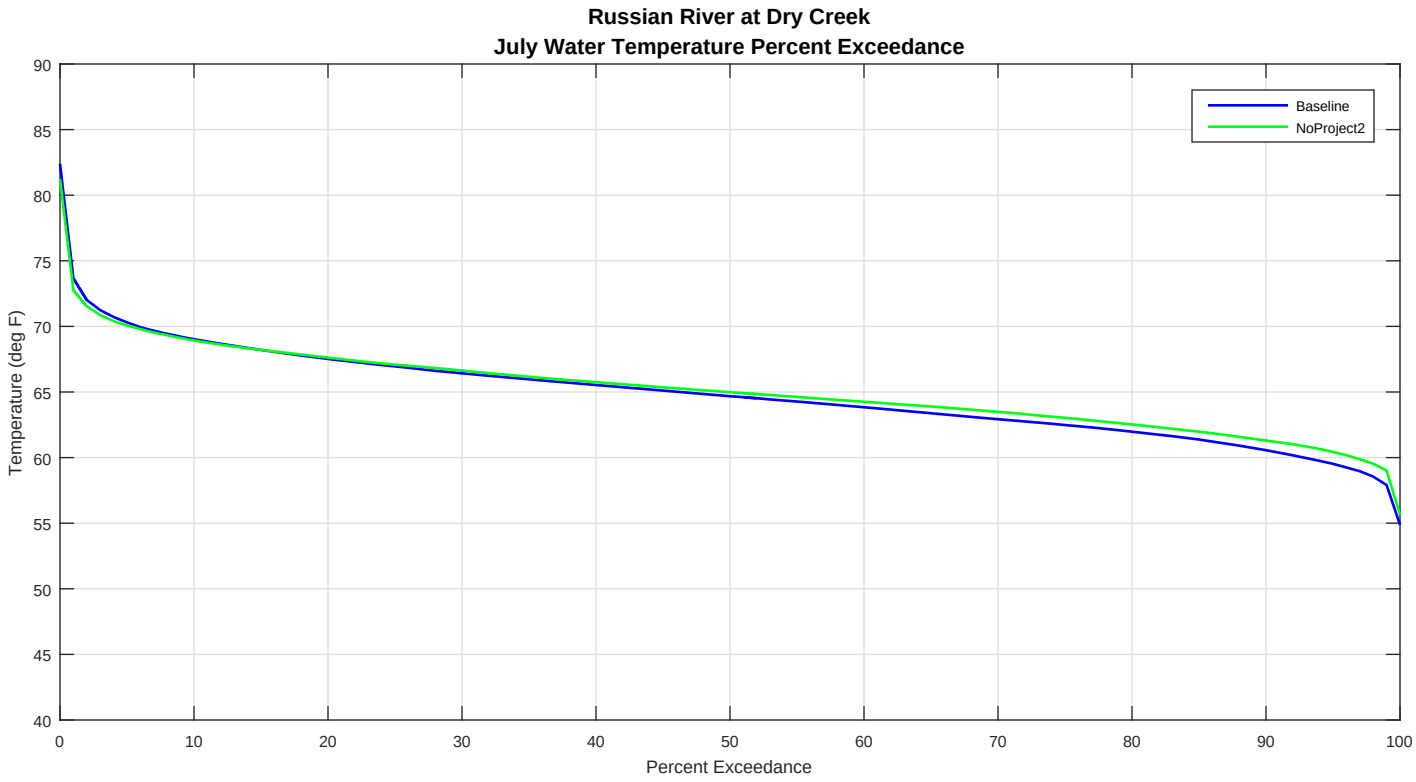
Russian River at Dry Creek
July Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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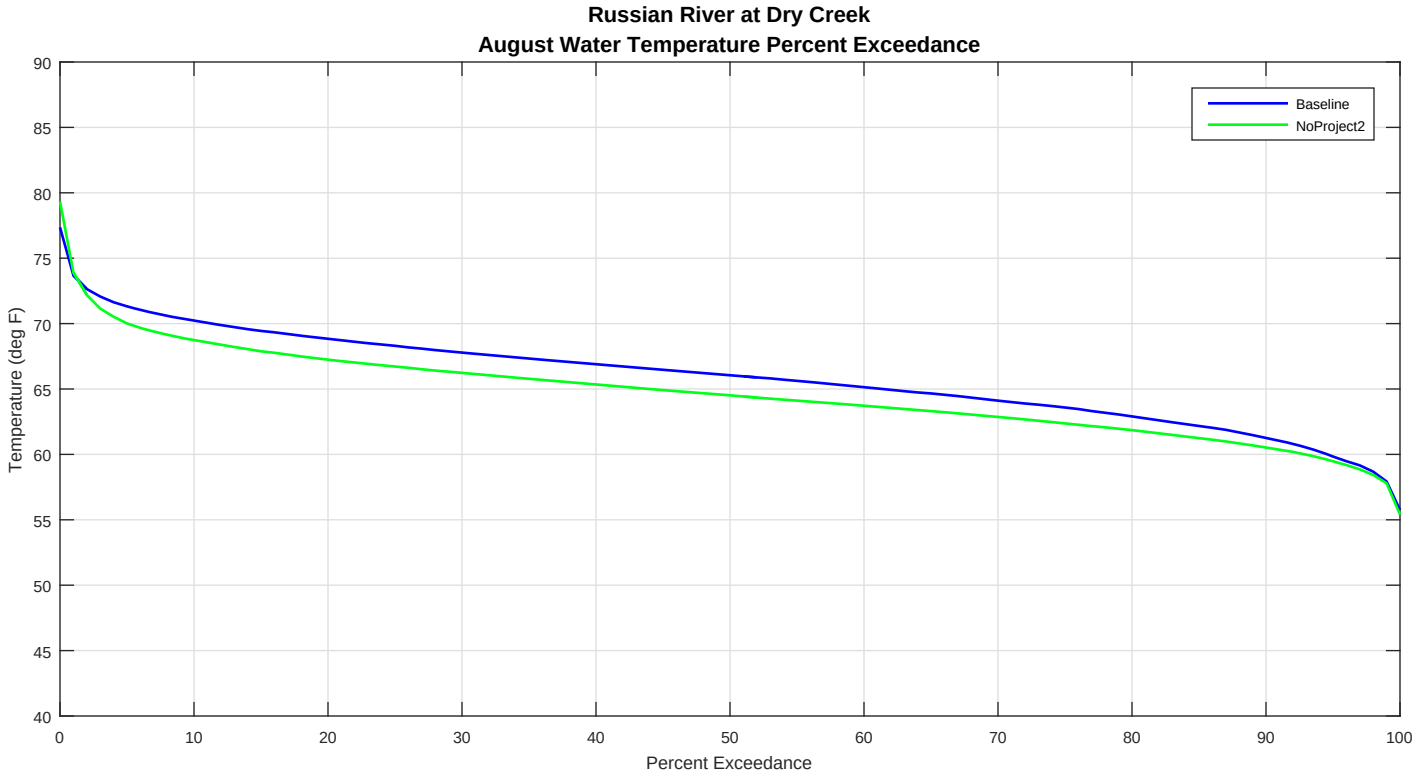
Russian River at Dry Creek
August Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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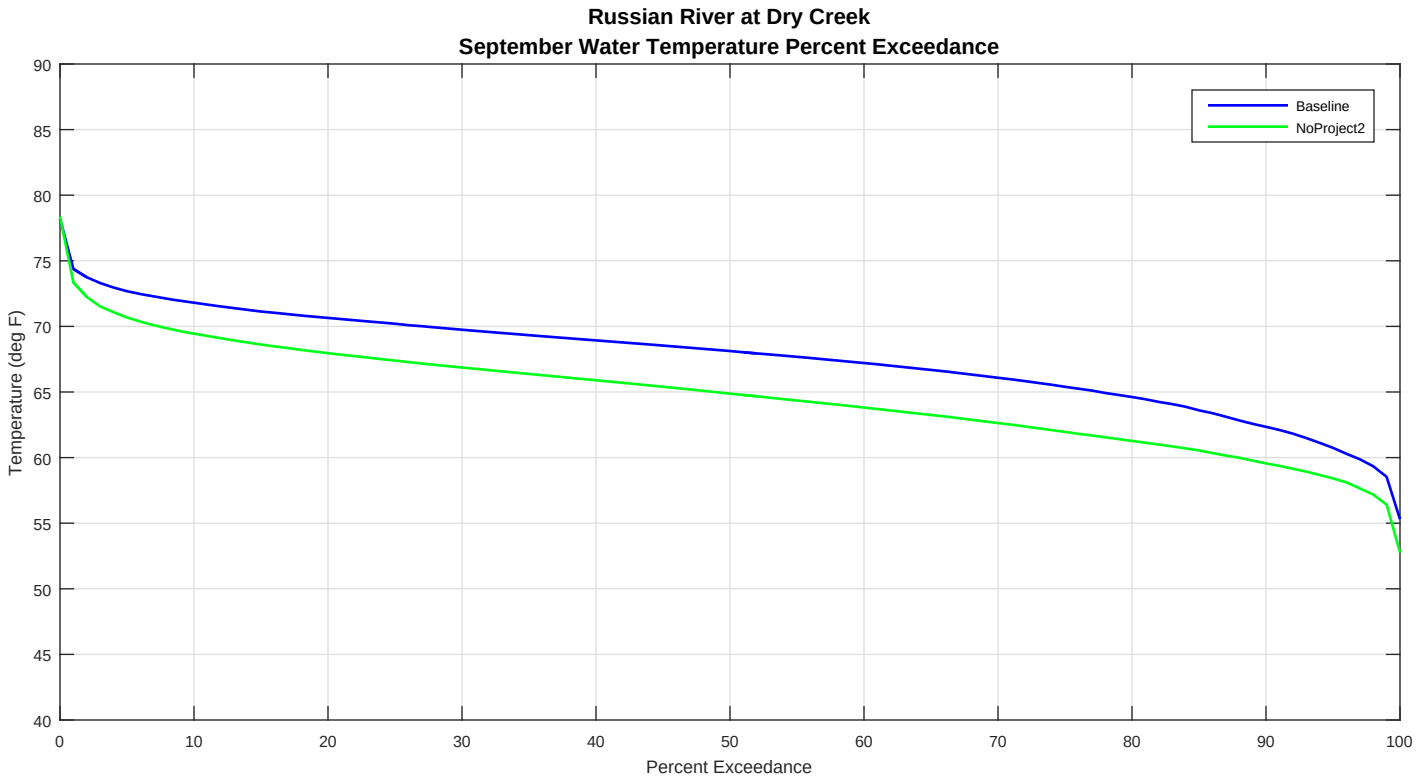
Russian River at Dry Creek
September Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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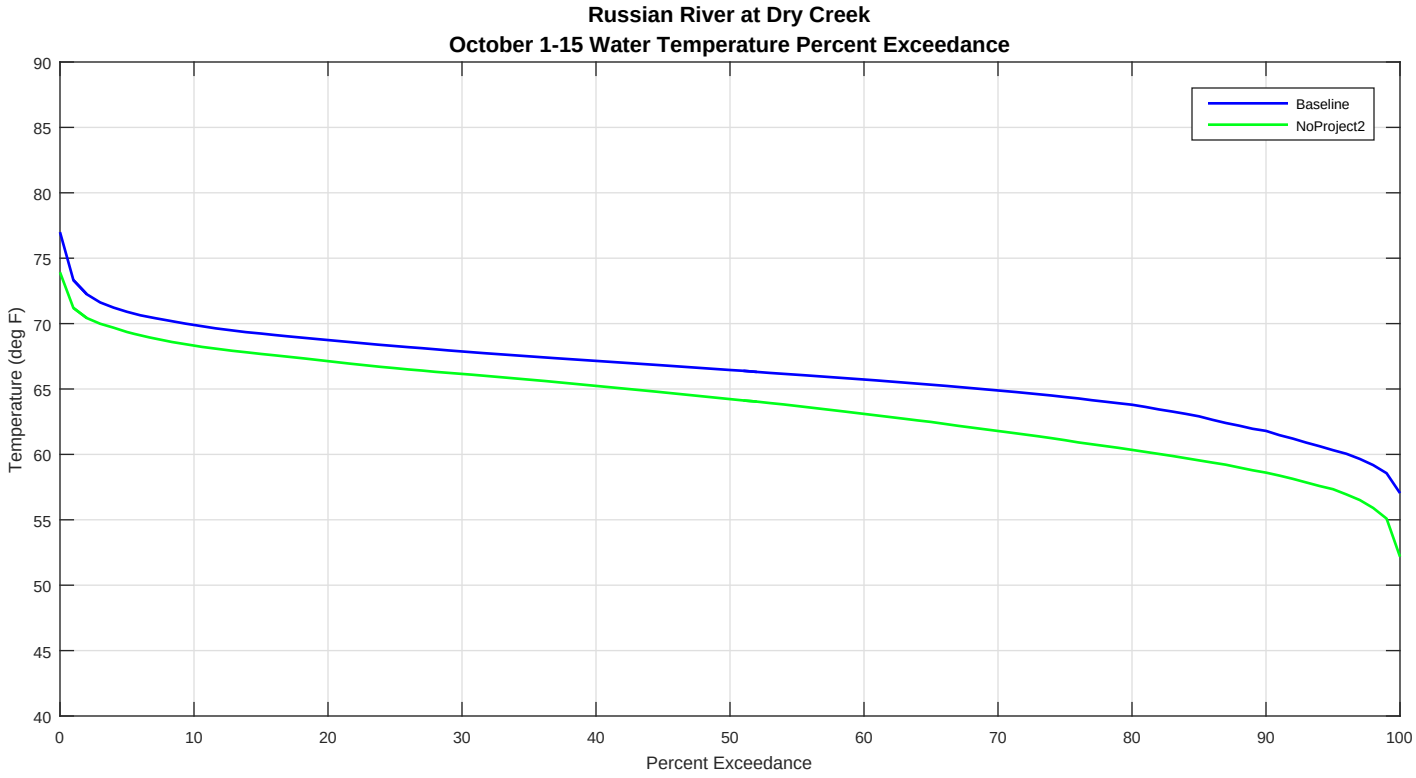
Russian River at Dry Creek
October 1-15 Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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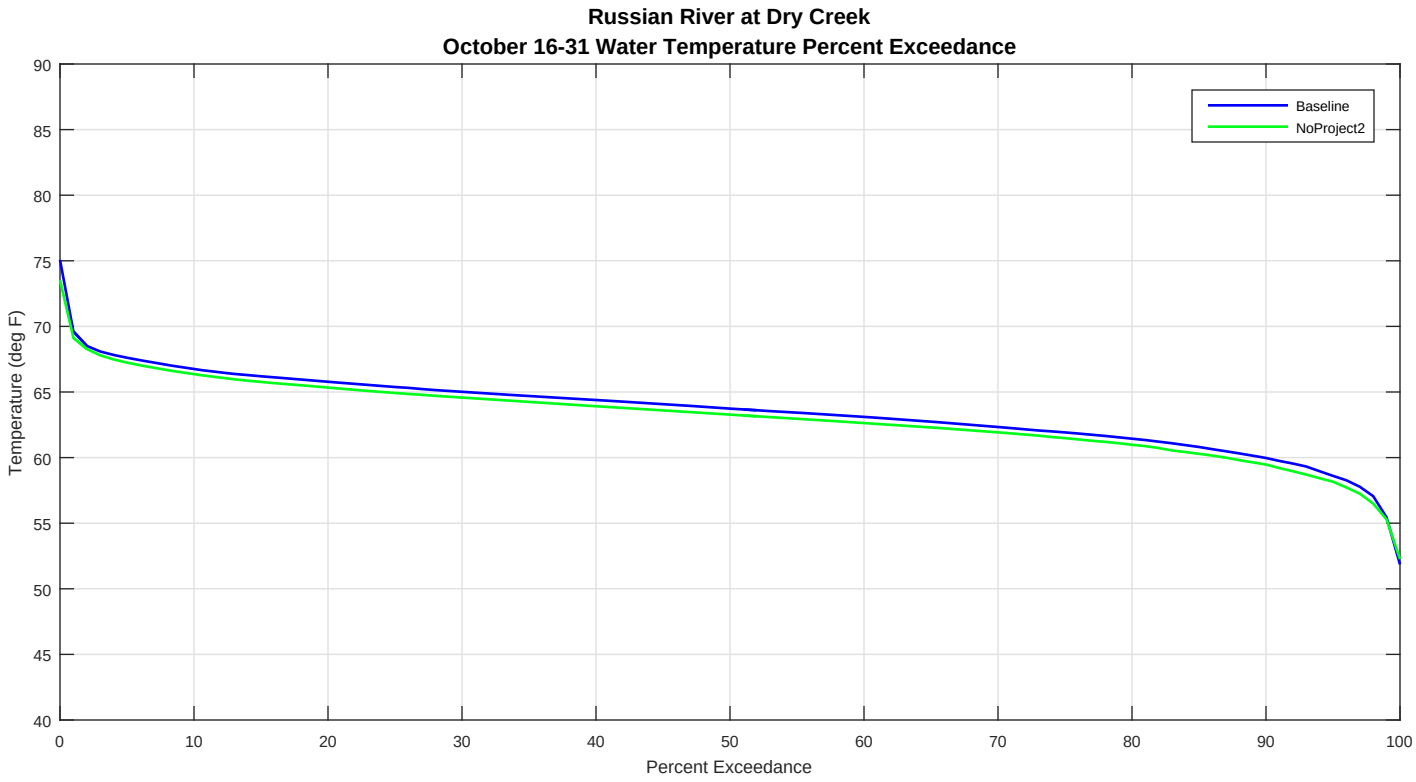
Russian River at Dry Creek
October 16-31 Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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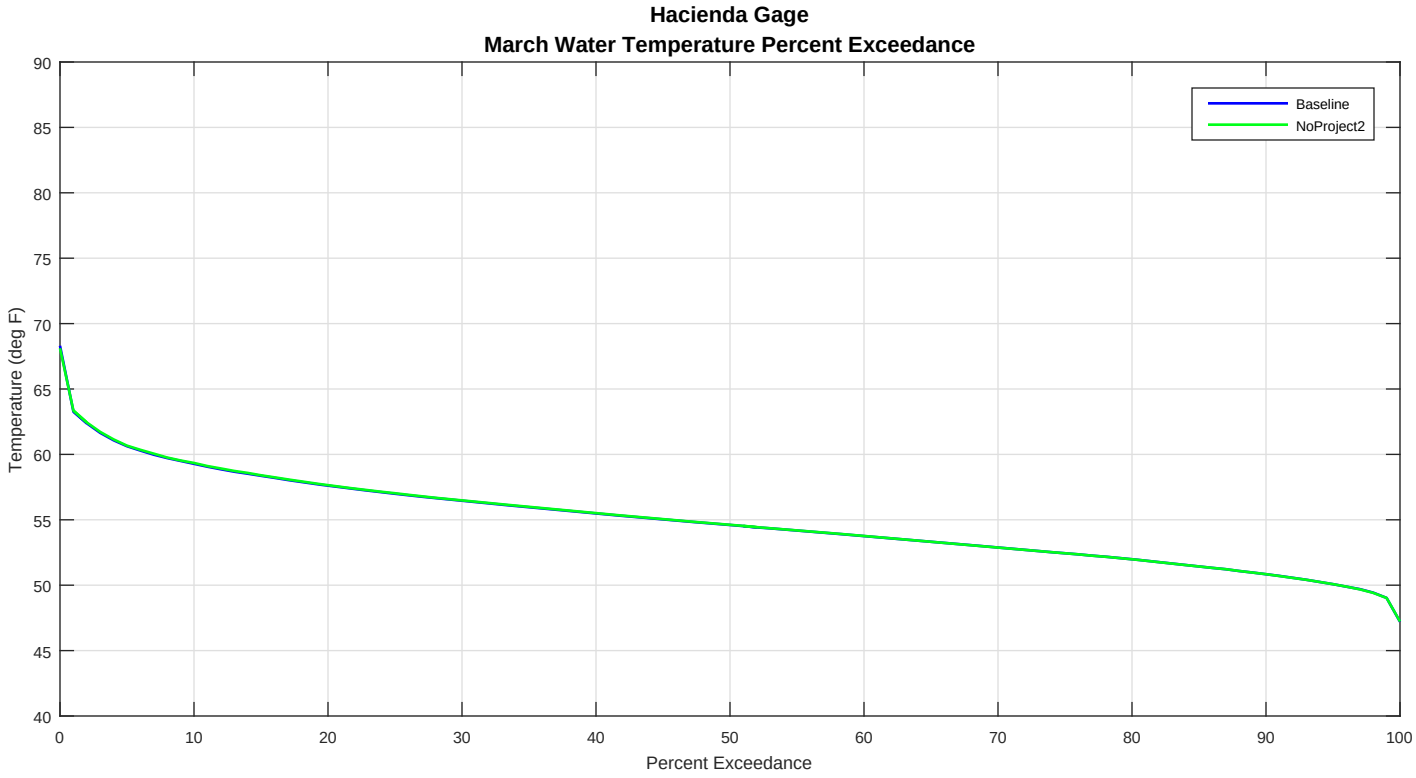
Hacienda Gage
March Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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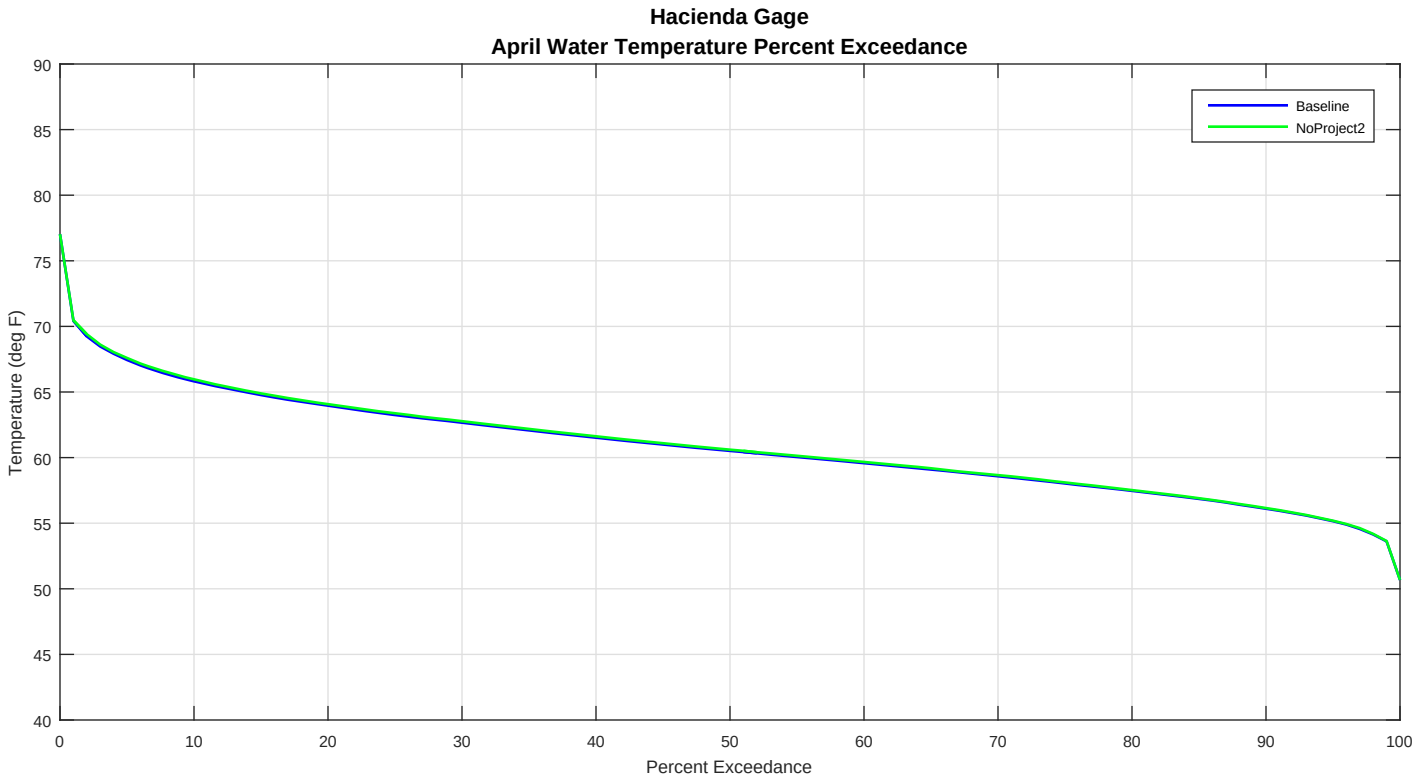
Hacienda Gage
April Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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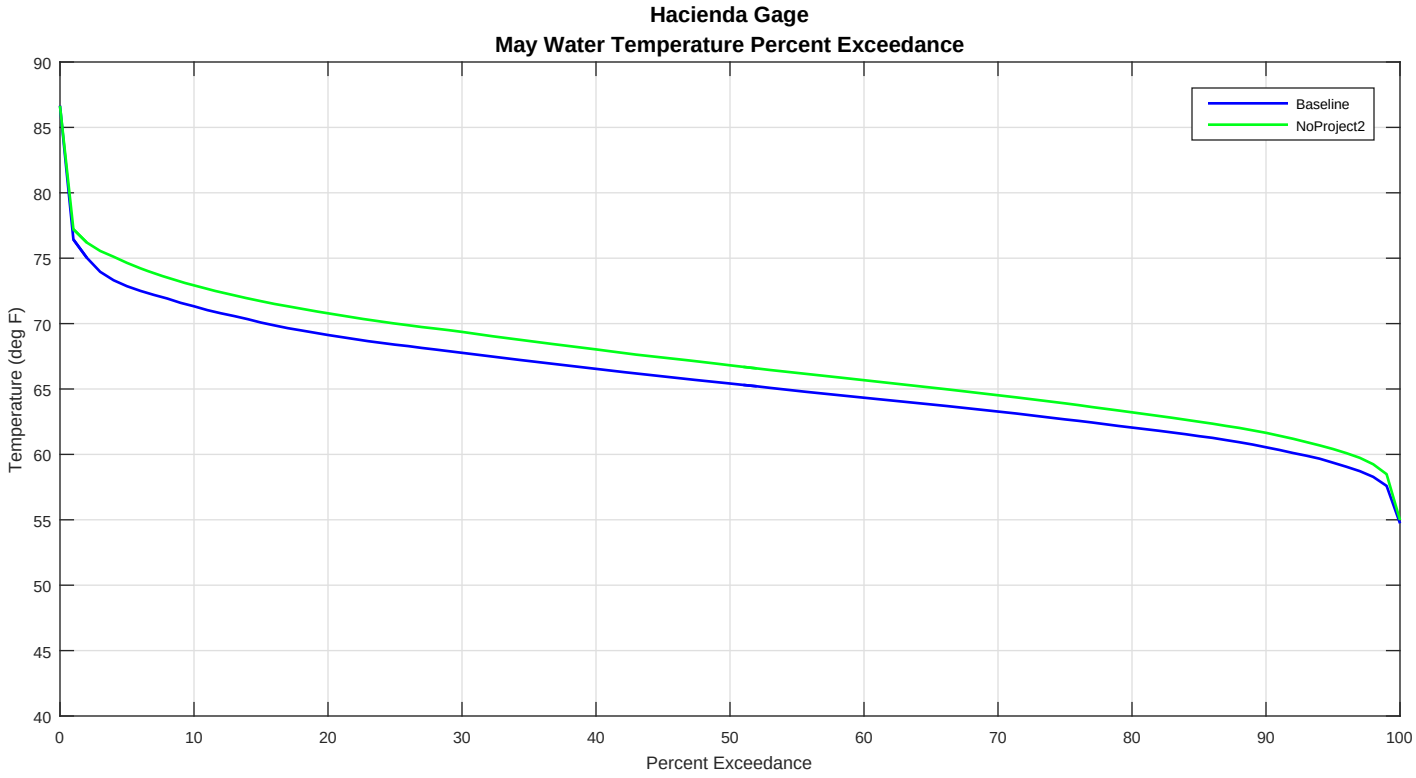
Hacienda Gage
May Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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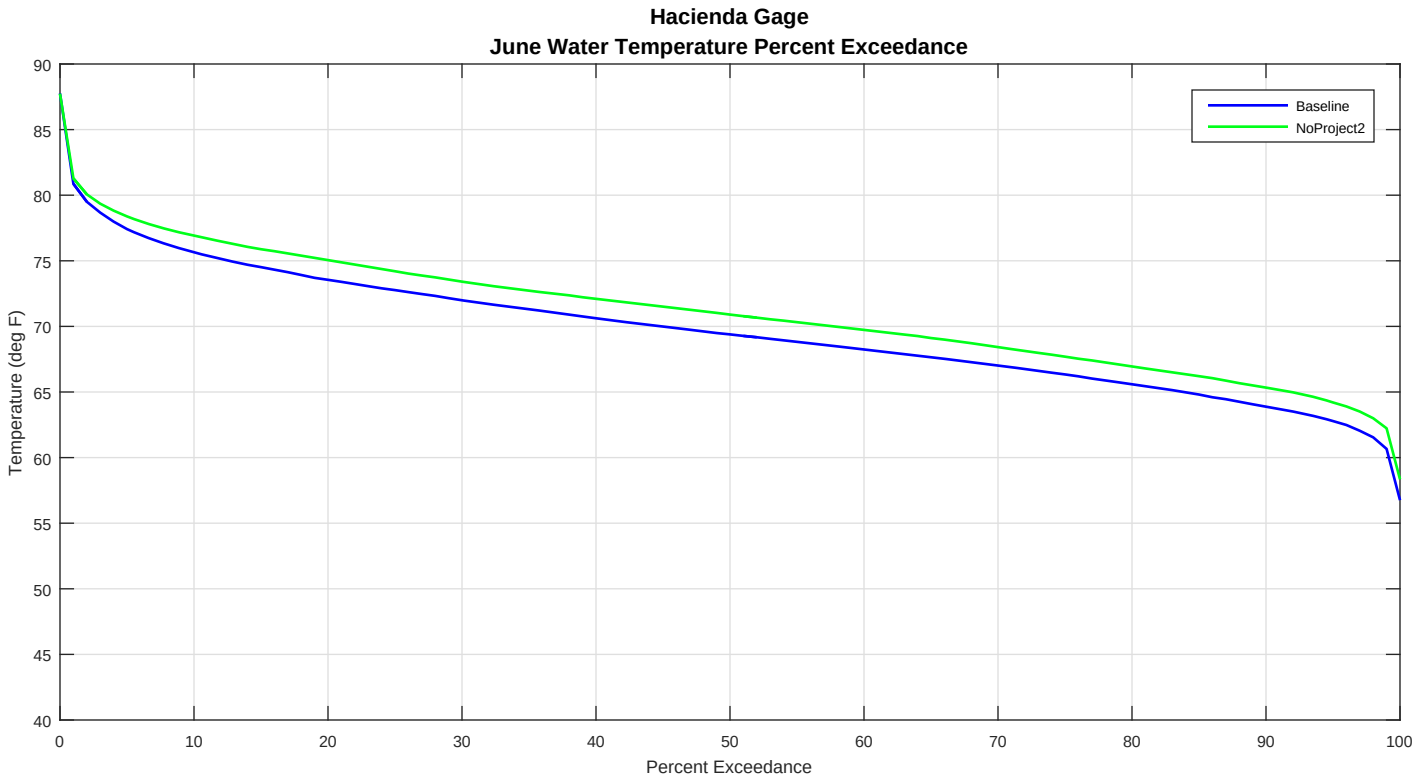
Hacienda Gage
June Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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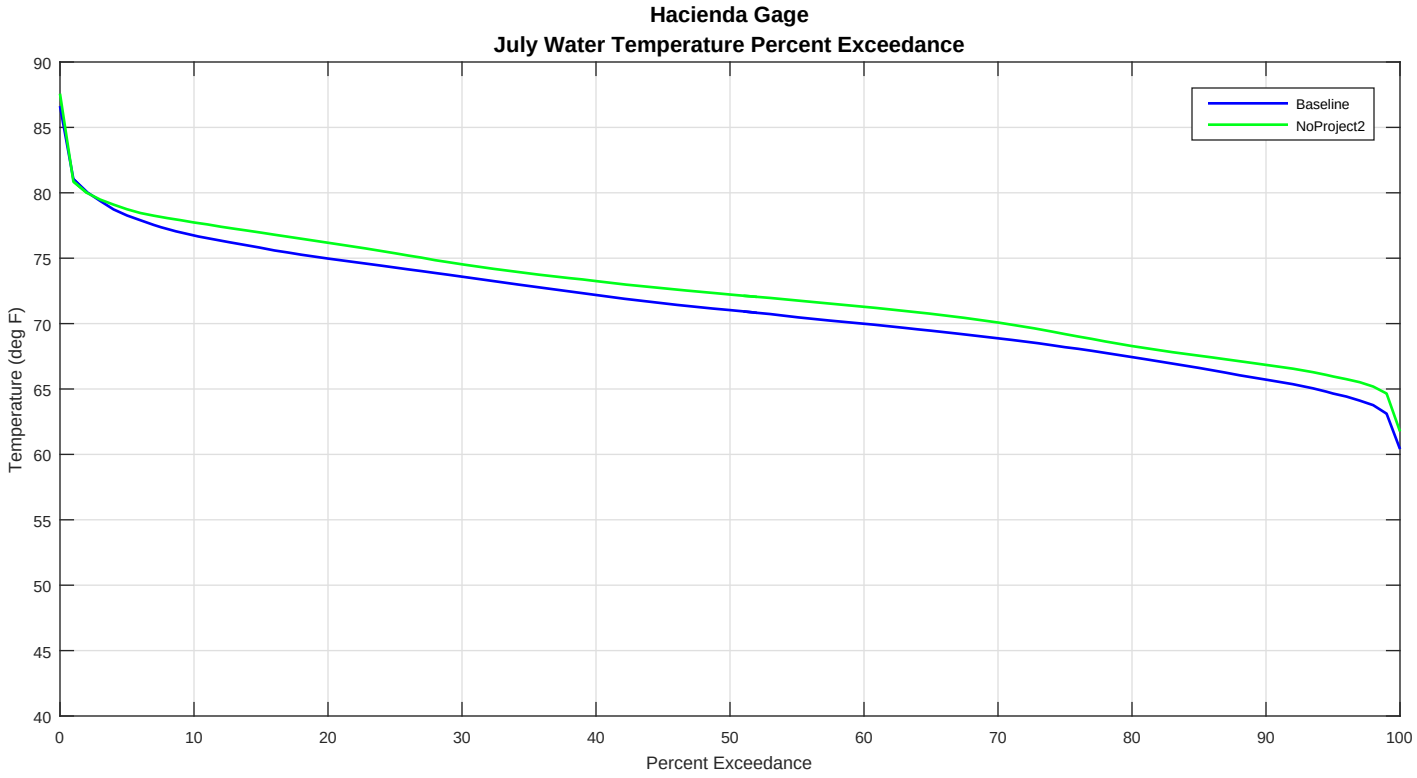
Hacienda Gage
July Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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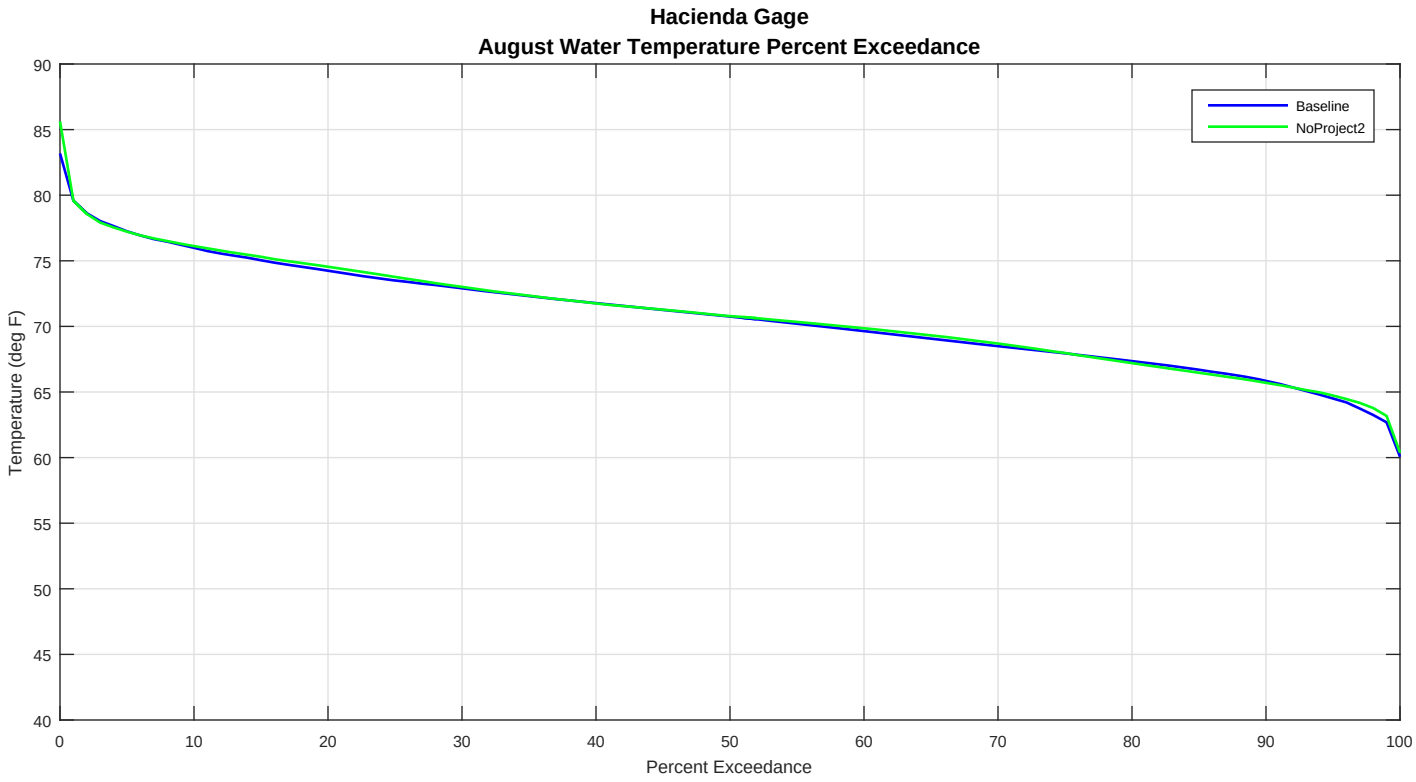
Hacienda Gage
August Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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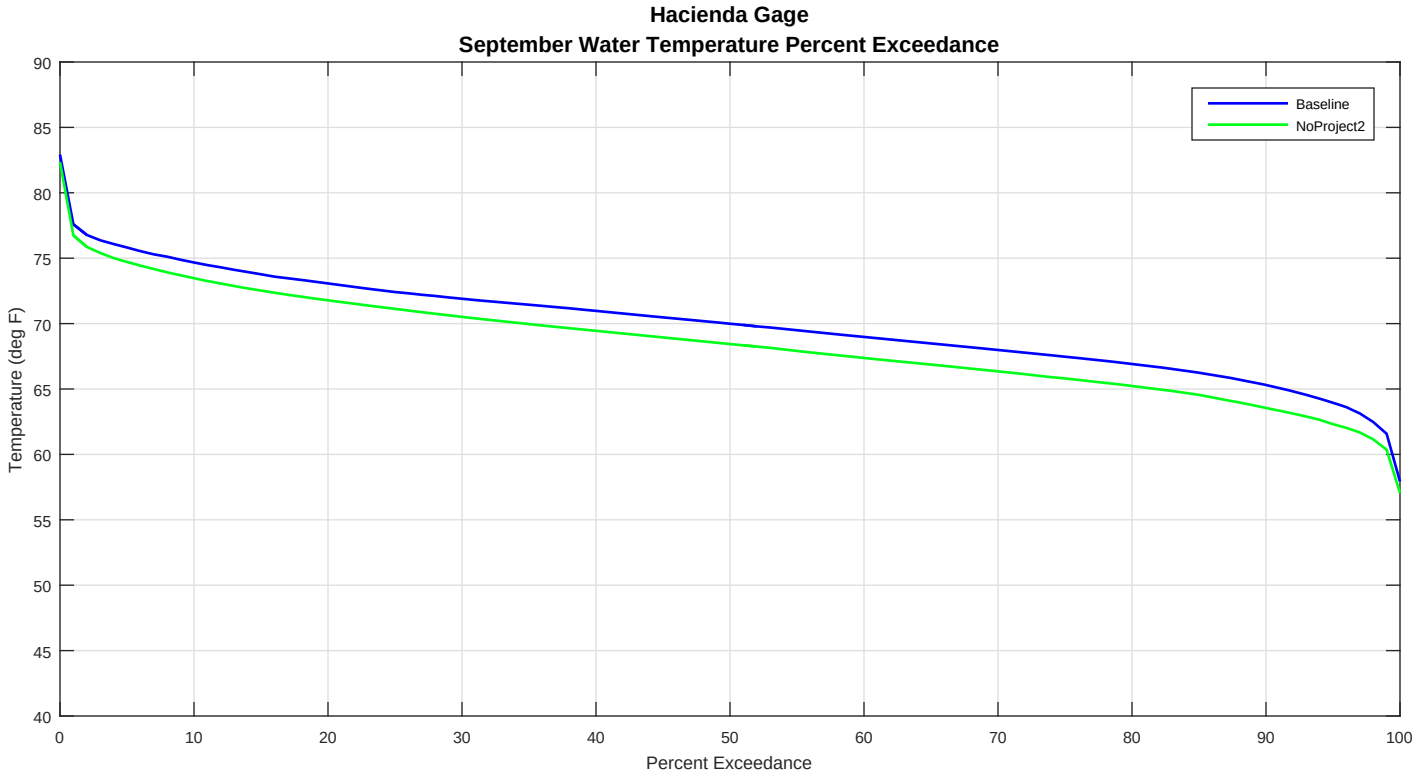
Hacienda Gage
September Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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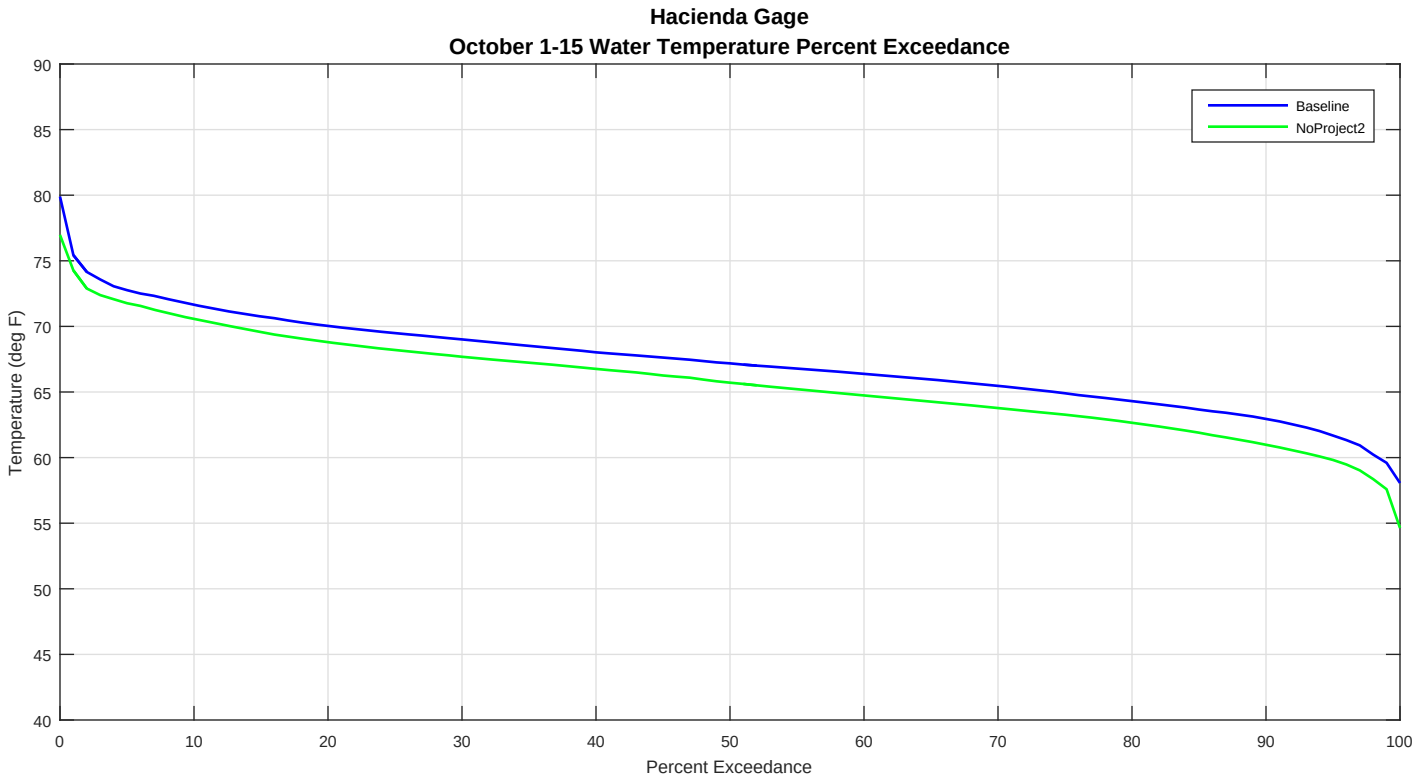
Hacienda Gage
October 1-15 Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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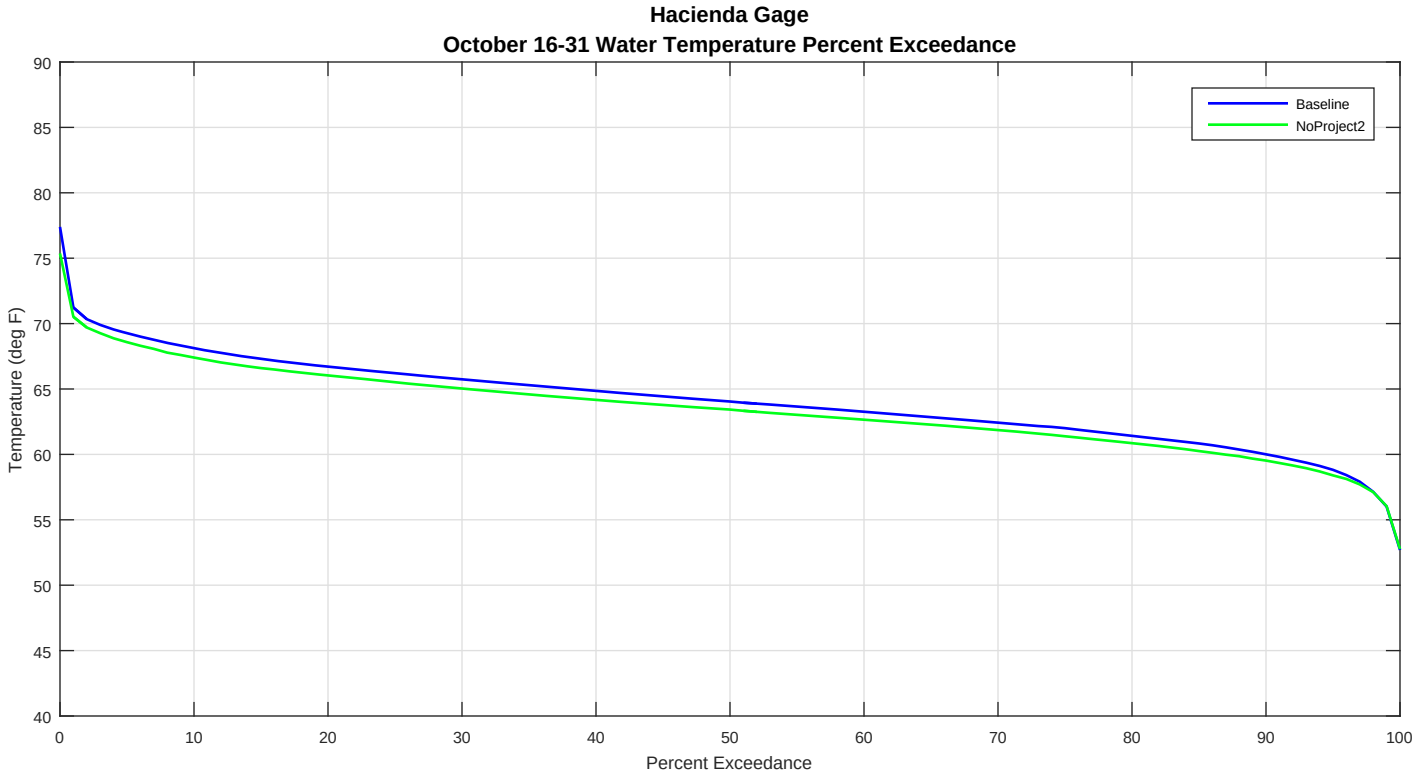
Hacienda Gage
October 16-31 Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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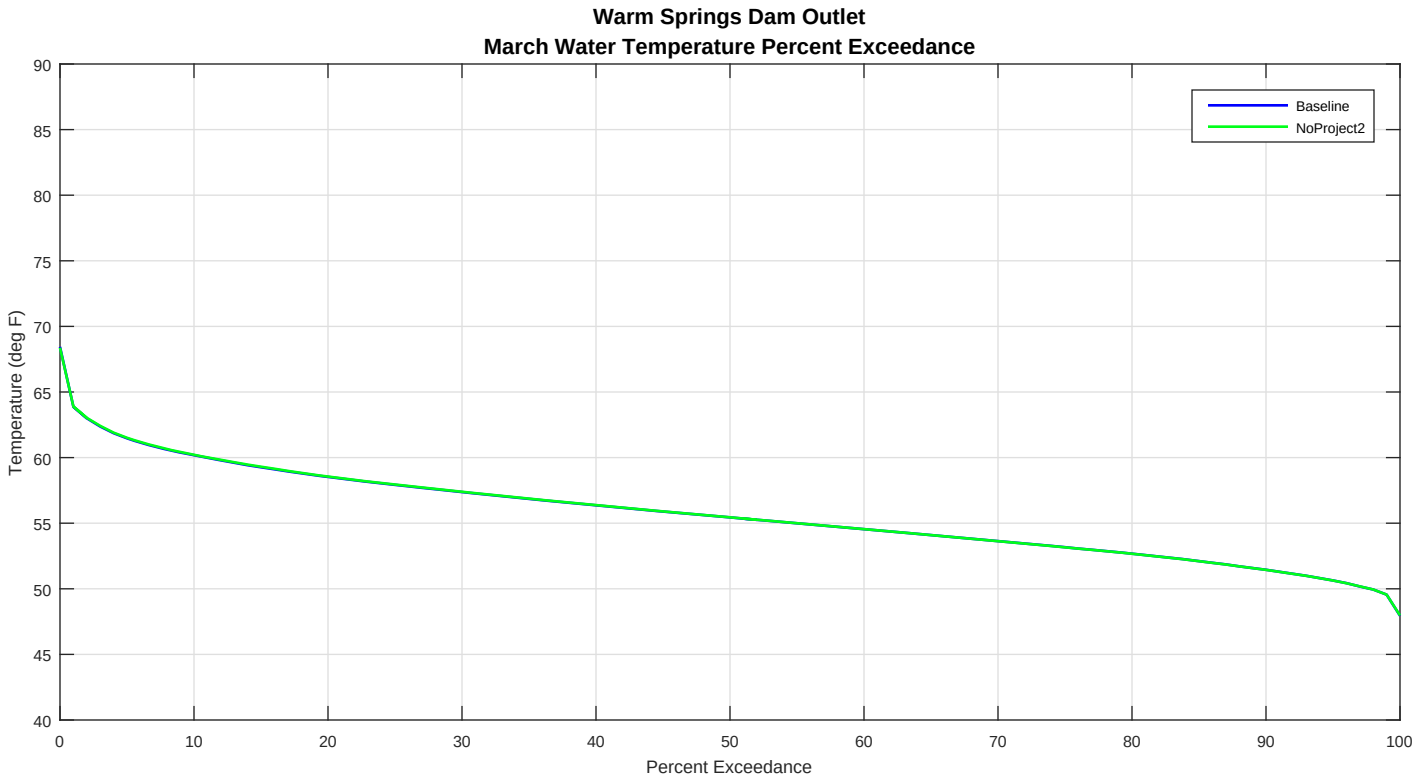
Warm Springs Dam Outlet
March Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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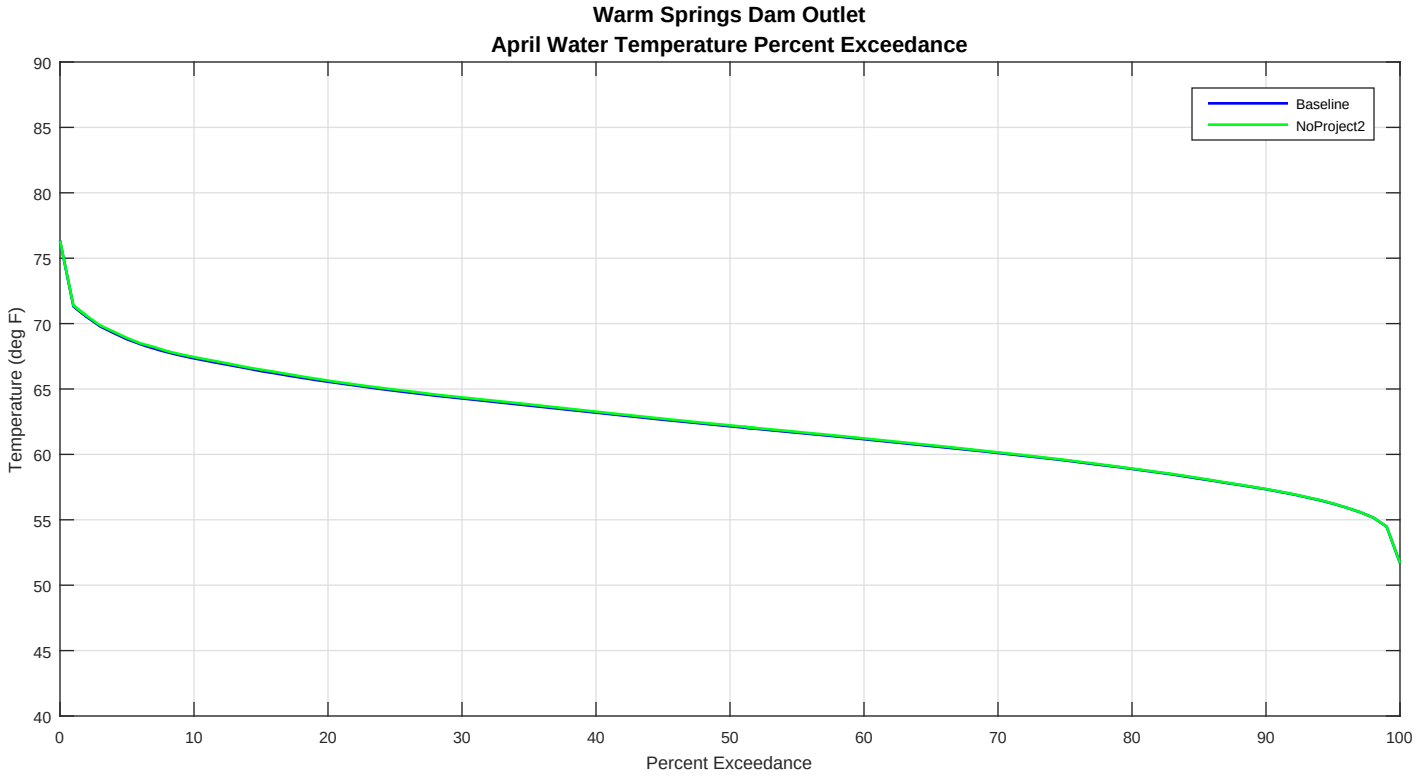
Warm Springs Dam Outlet
April Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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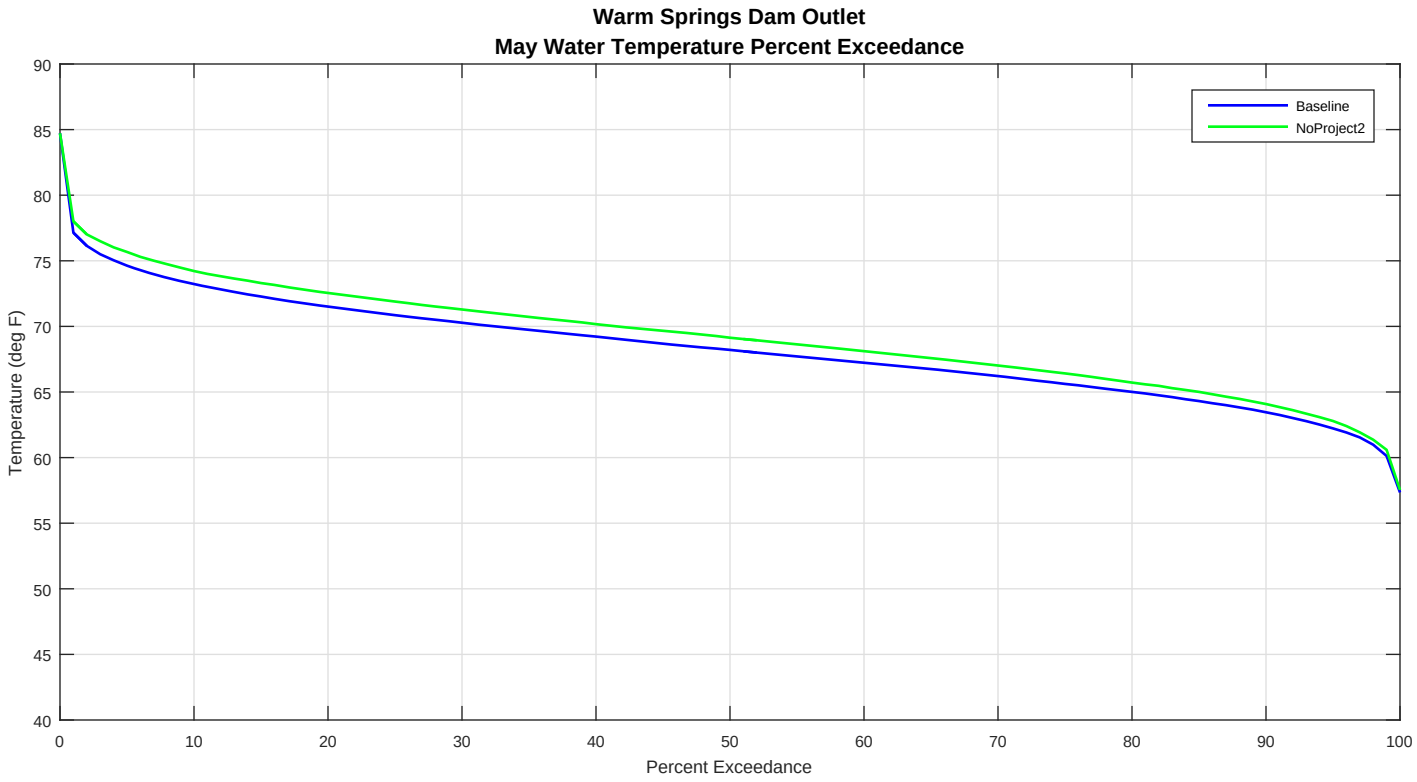
Warm Springs Dam Outlet
May Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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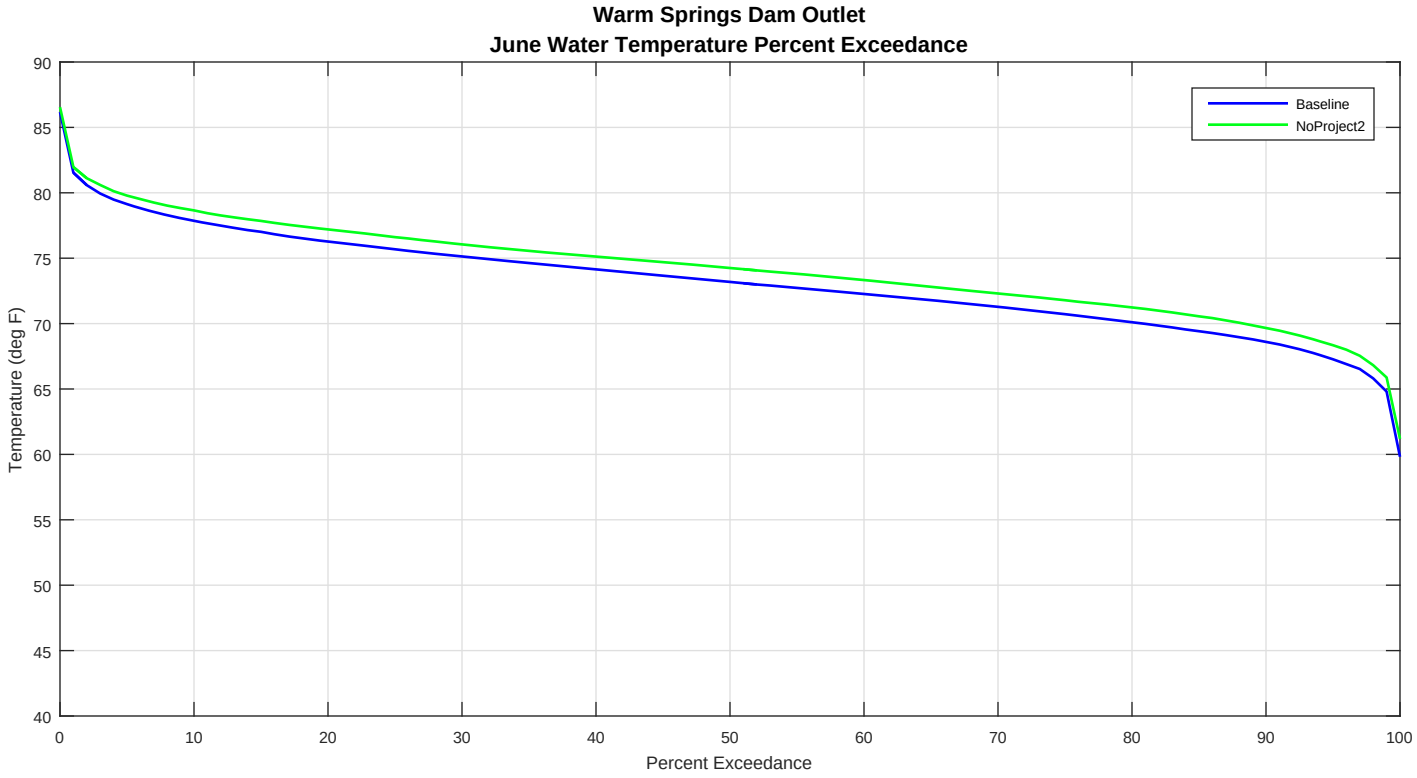
Warm Springs Dam Outlet
June Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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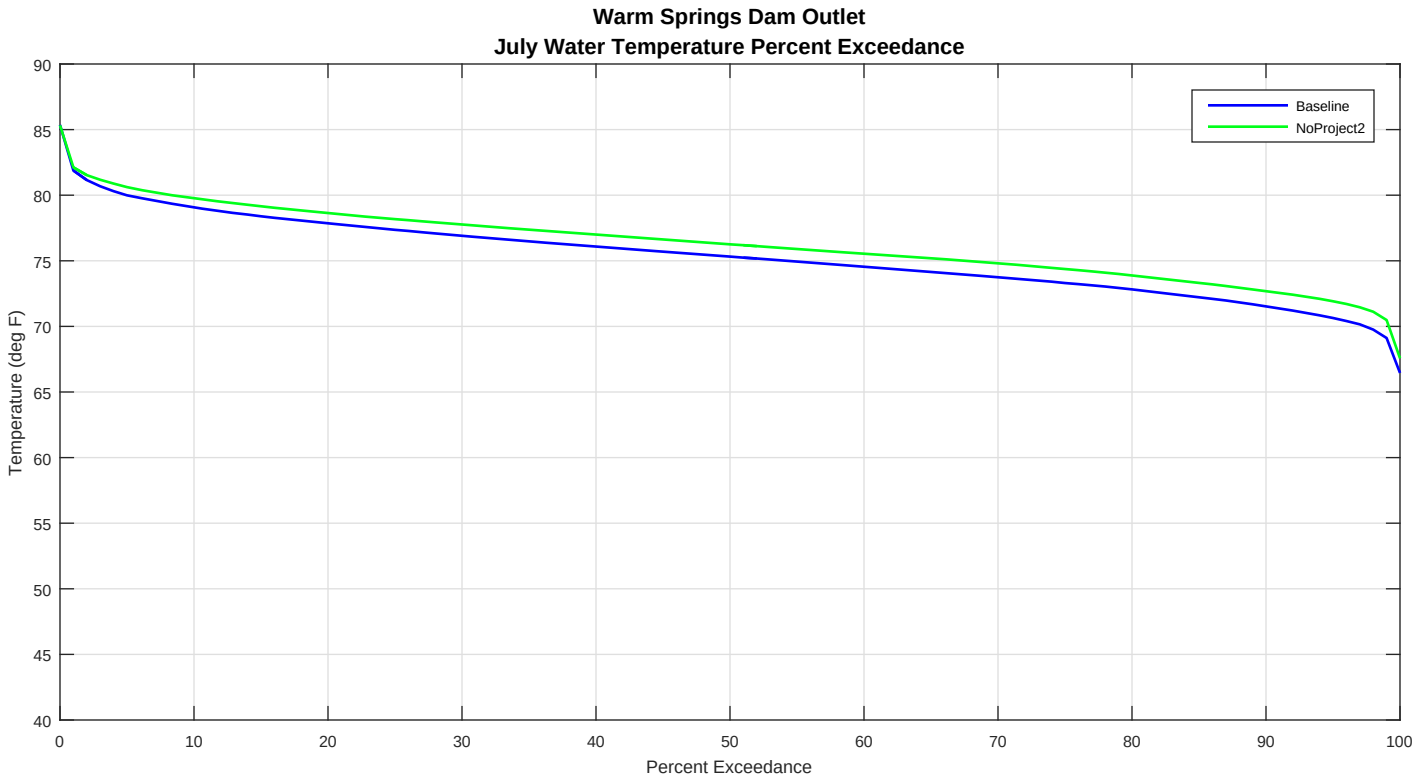
Warm Springs Dam Outlet
July Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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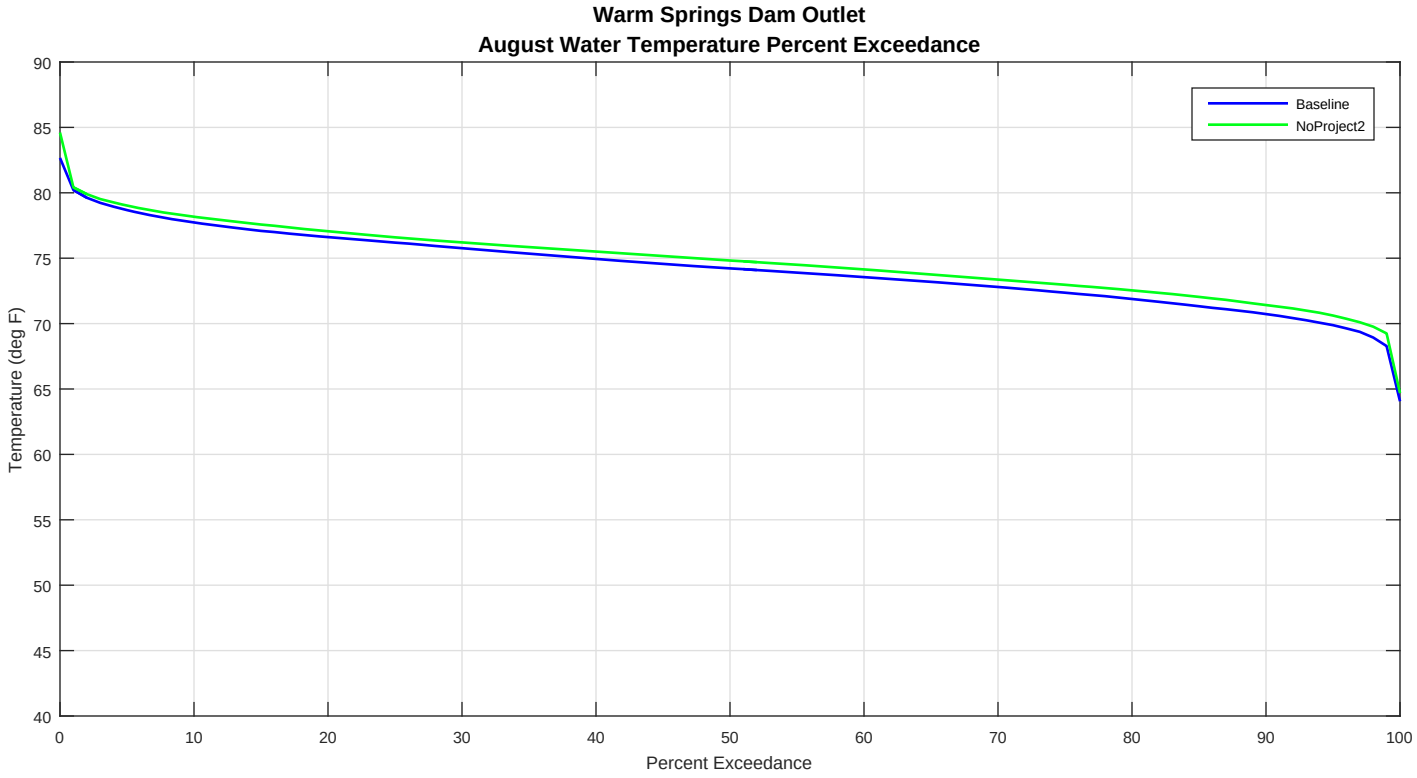
Warm Springs Dam Outlet
August Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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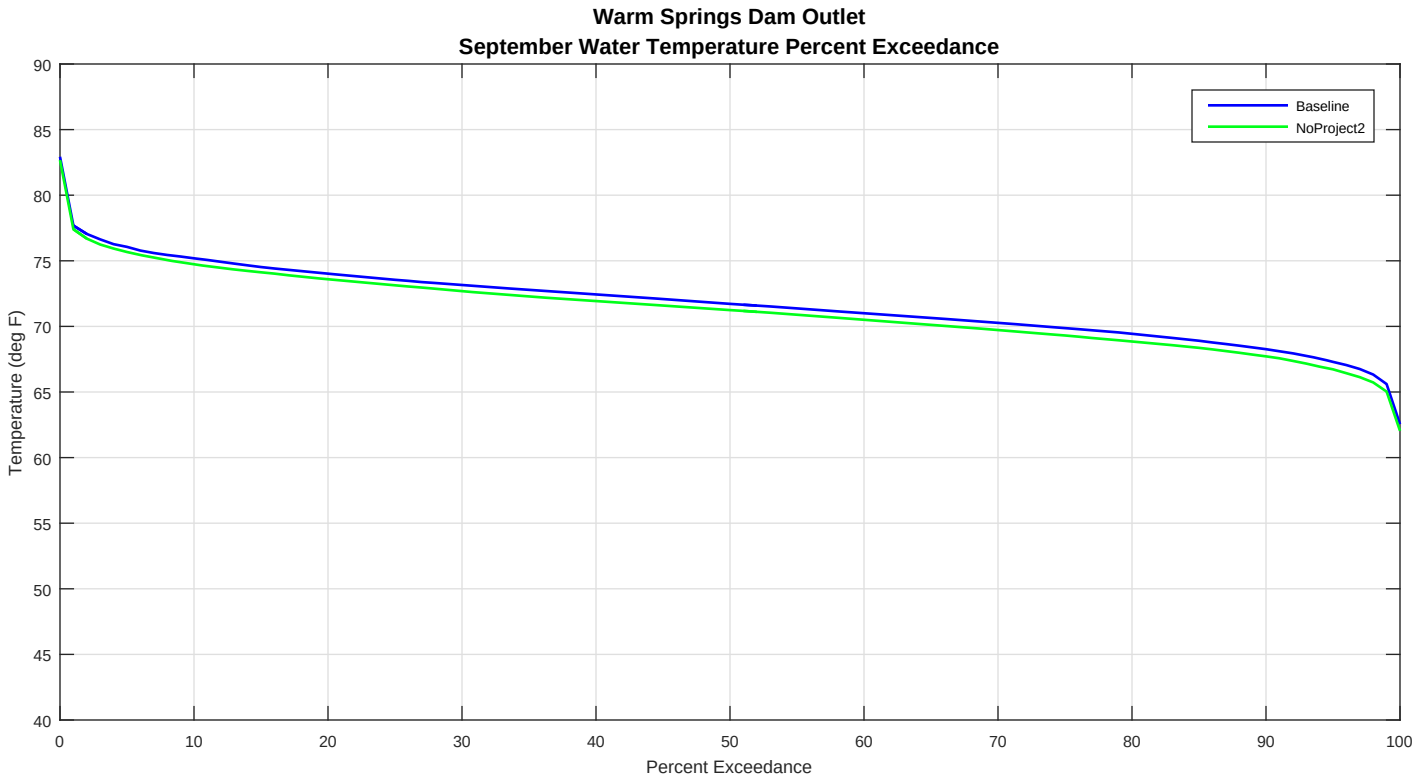
Warm Springs Dam Outlet
September Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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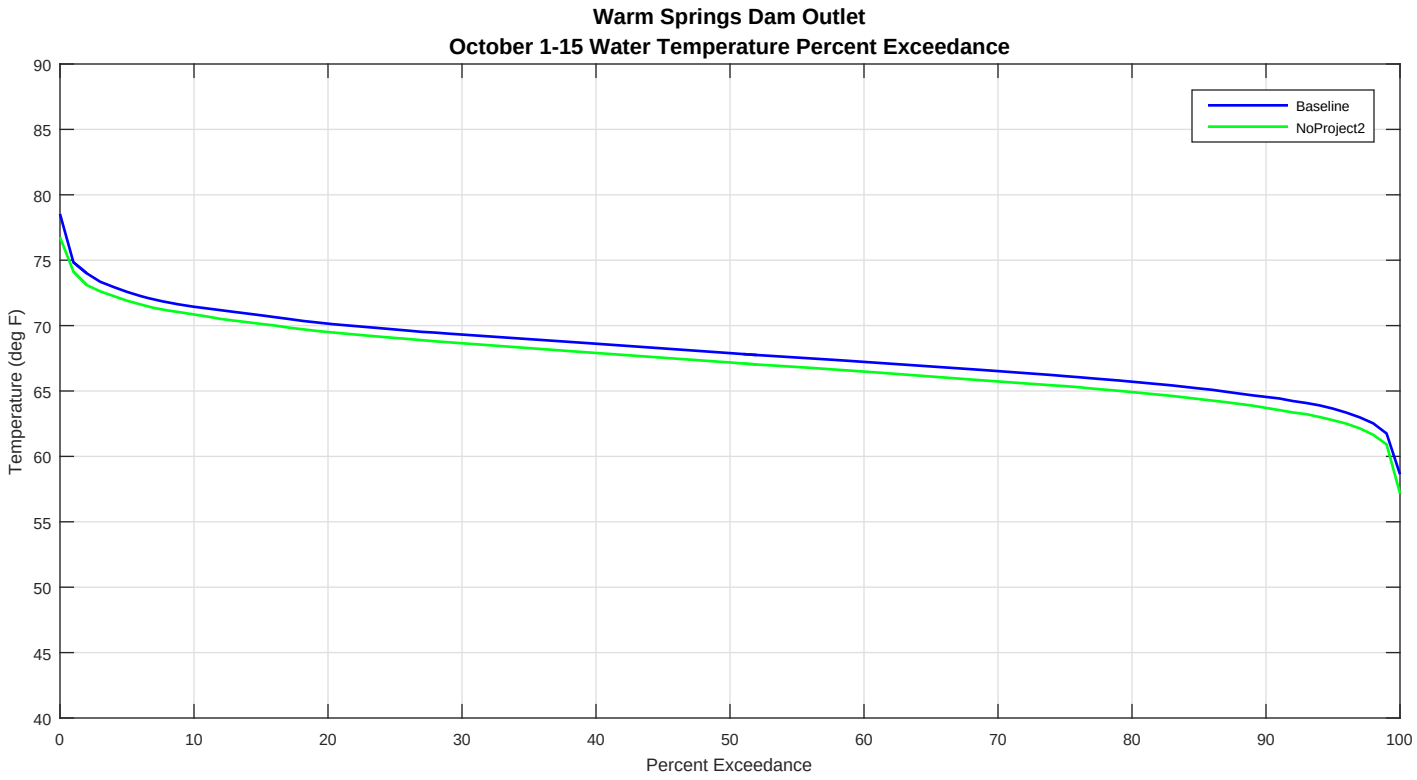
Warm Springs Dam Outlet
October 1-15 Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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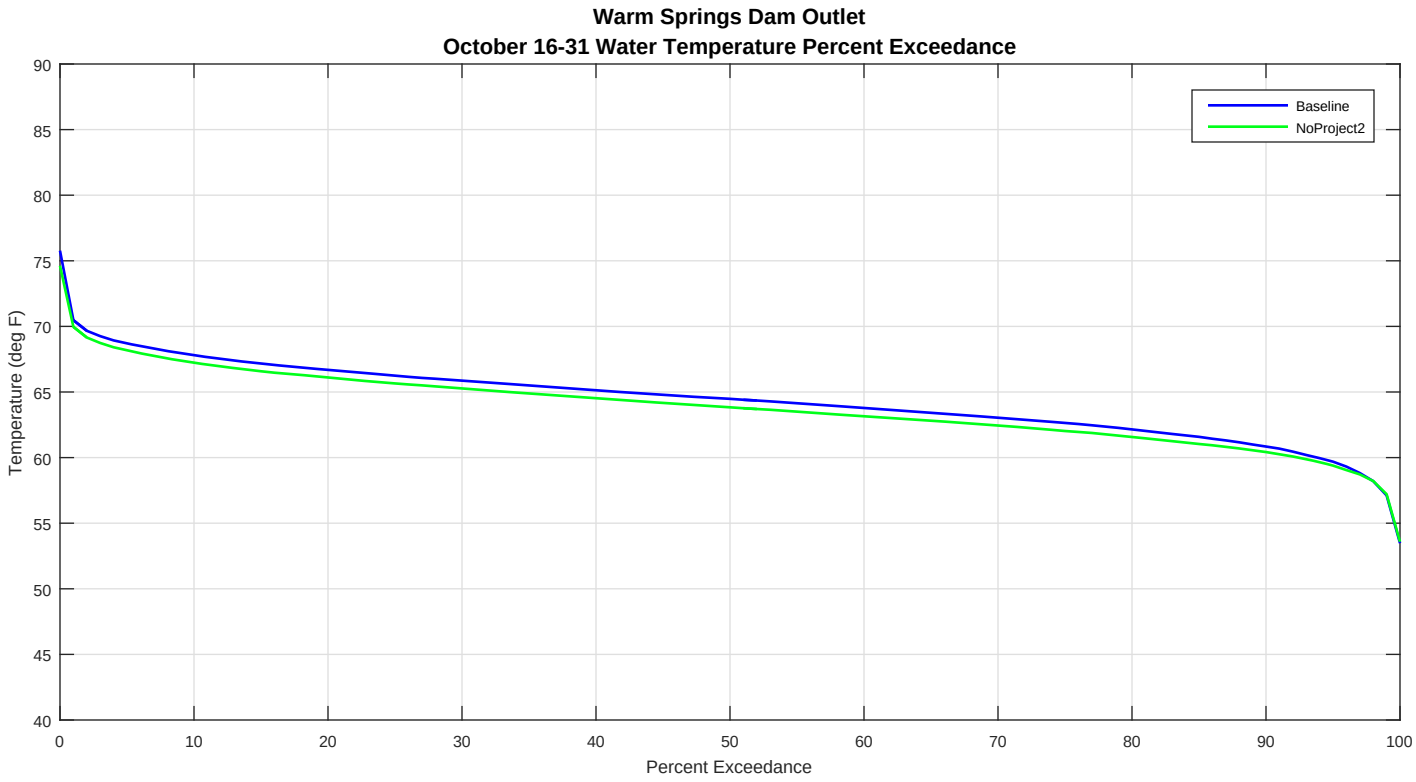
Warm Springs Dam Outlet
October 16-31 Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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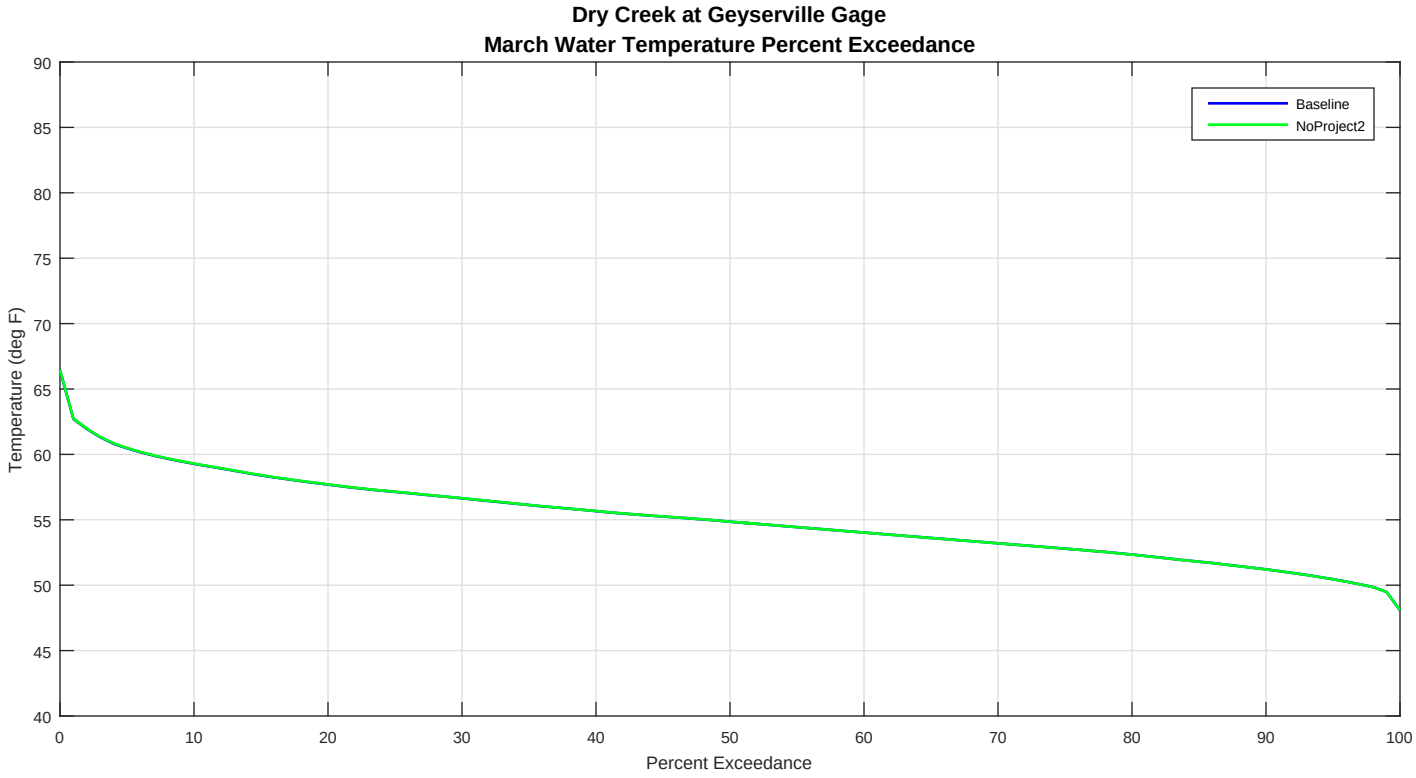
Dry Creek at Geyserville Gage
March Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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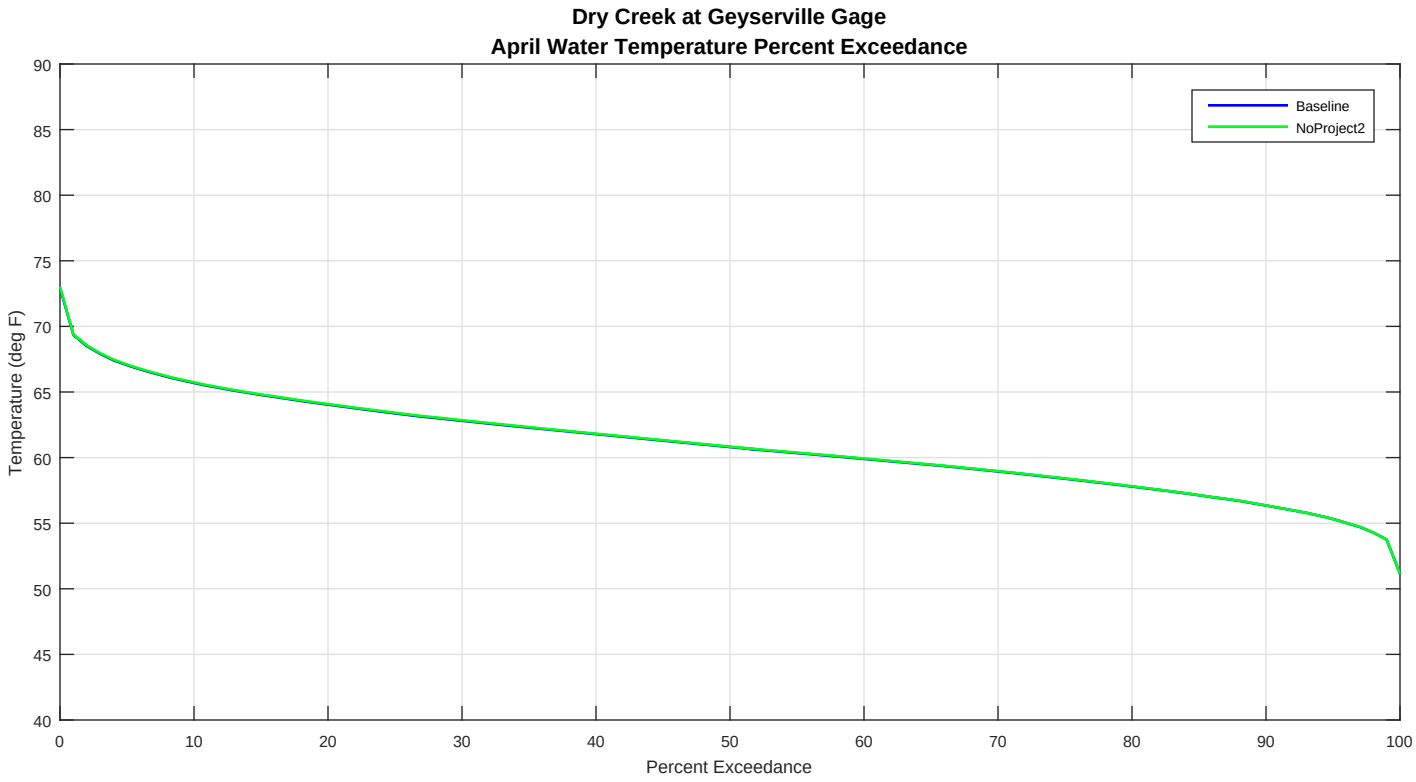
Dry Creek at Geyserville Gage
April Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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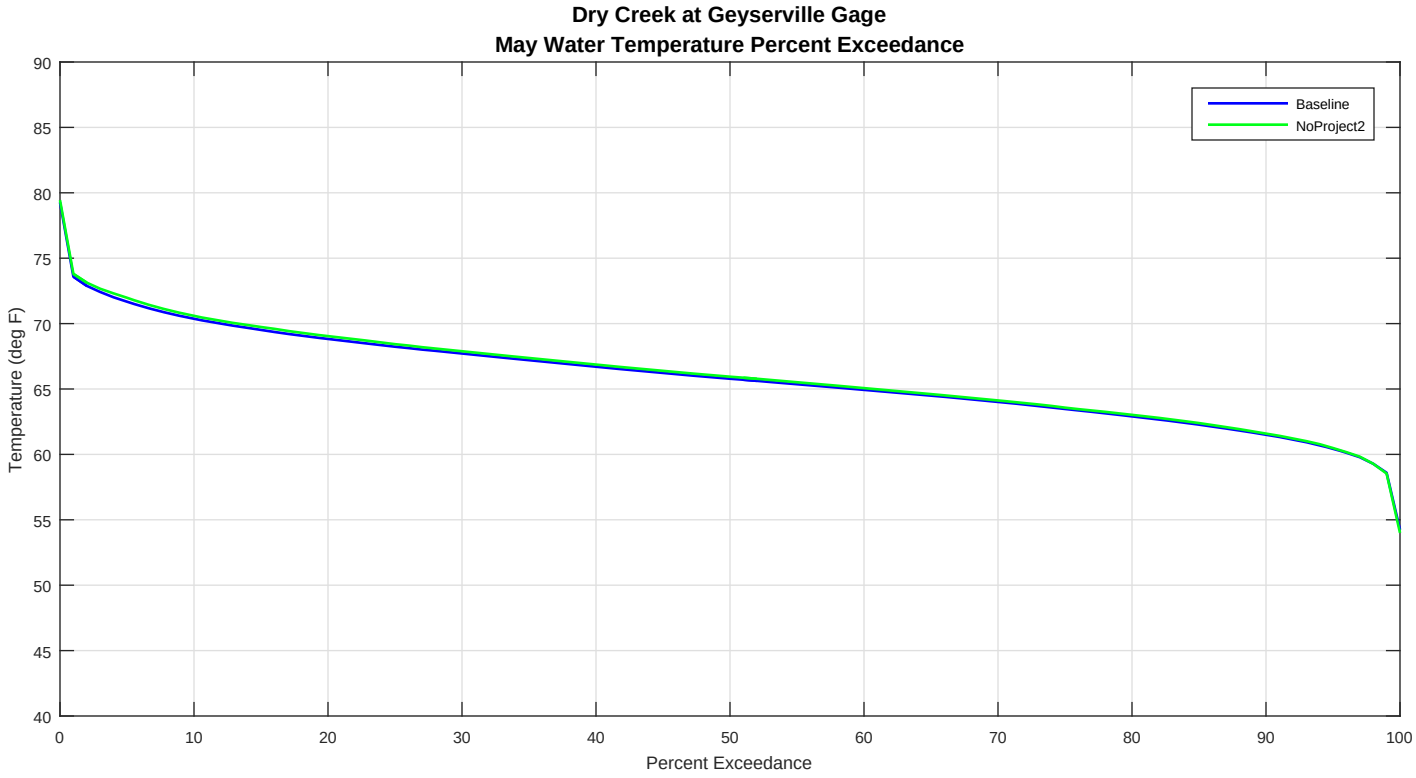
Dry Creek at Geyserville Gage
May Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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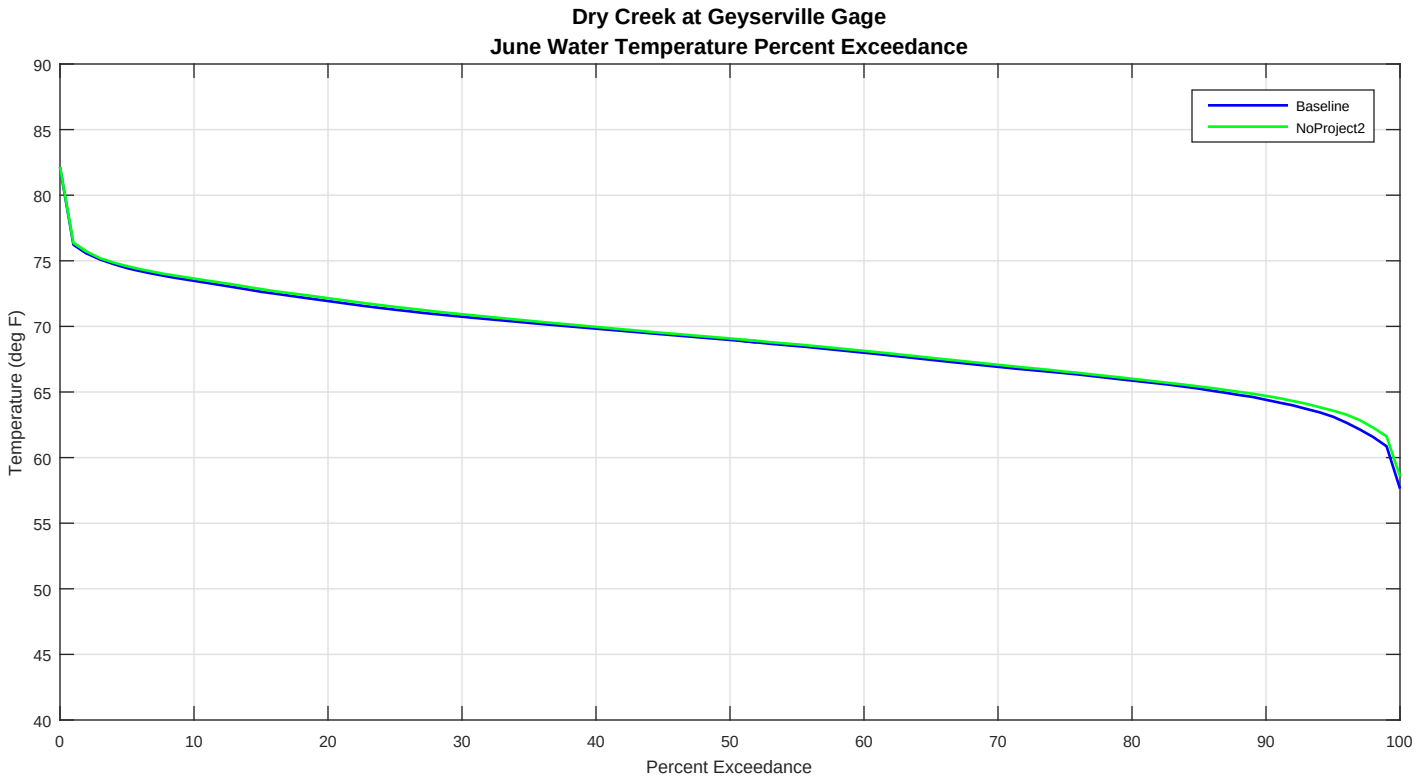
Dry Creek at Geyserville Gage
June Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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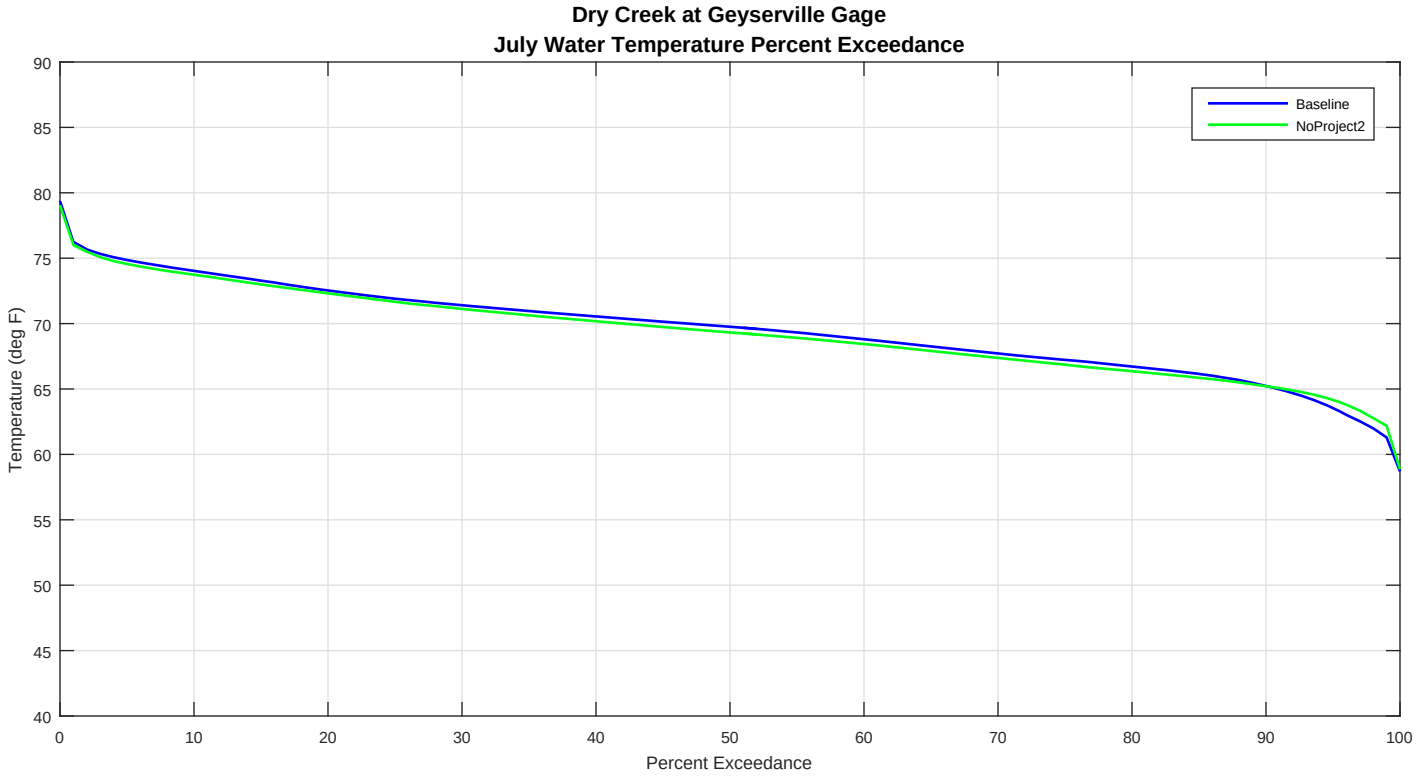
Dry Creek at Geyserville Gage
July Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
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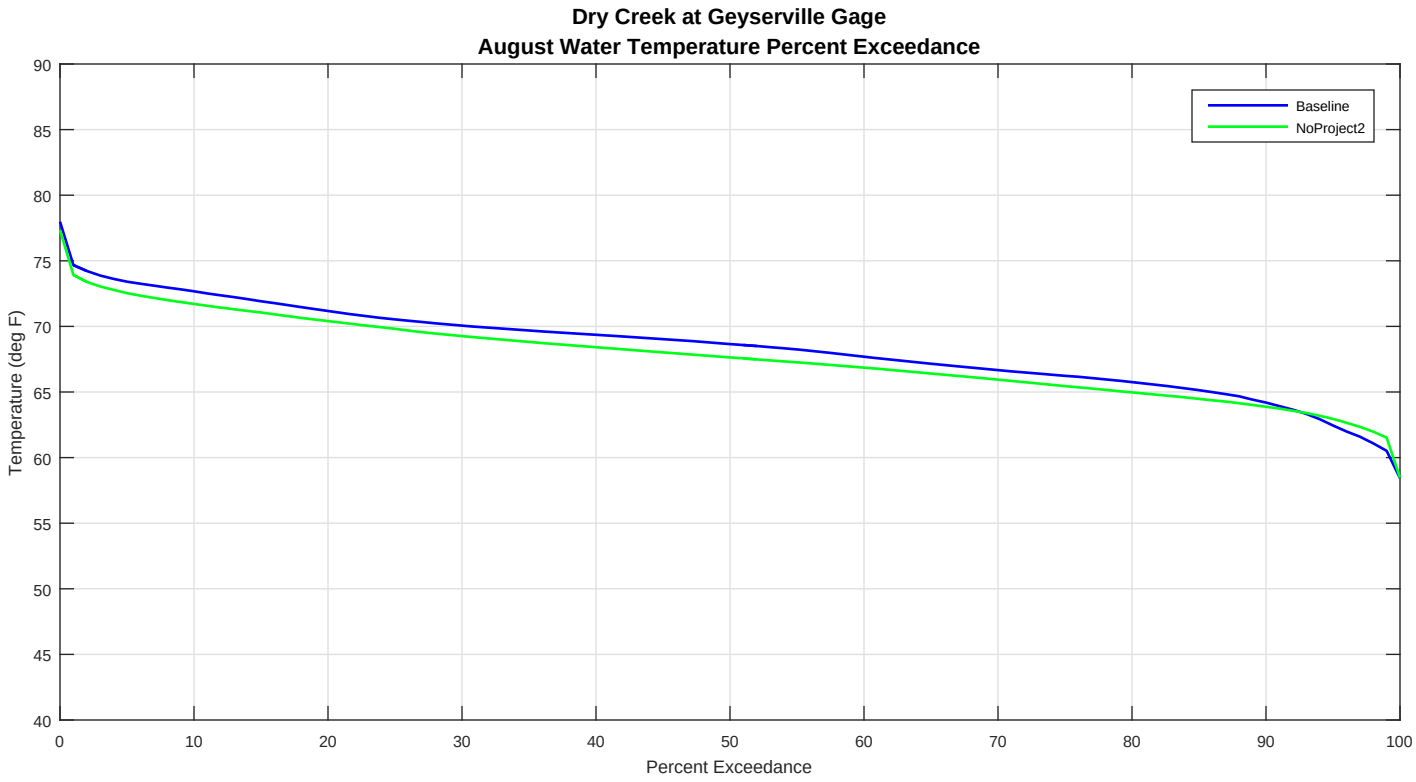
Dry Creek at Geyserville Gage
August Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
85
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75
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60
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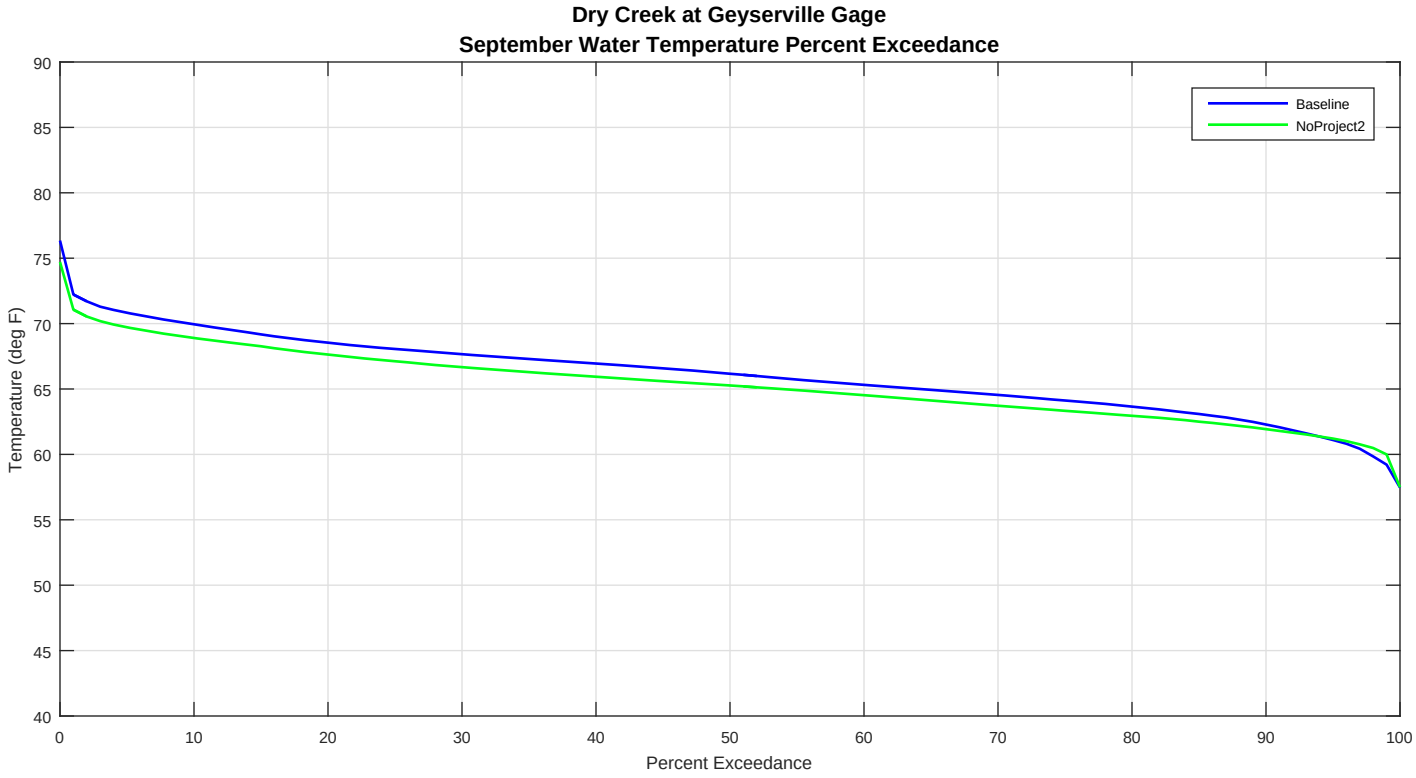
Dry Creek at Geyserville Gage
September Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
85
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75
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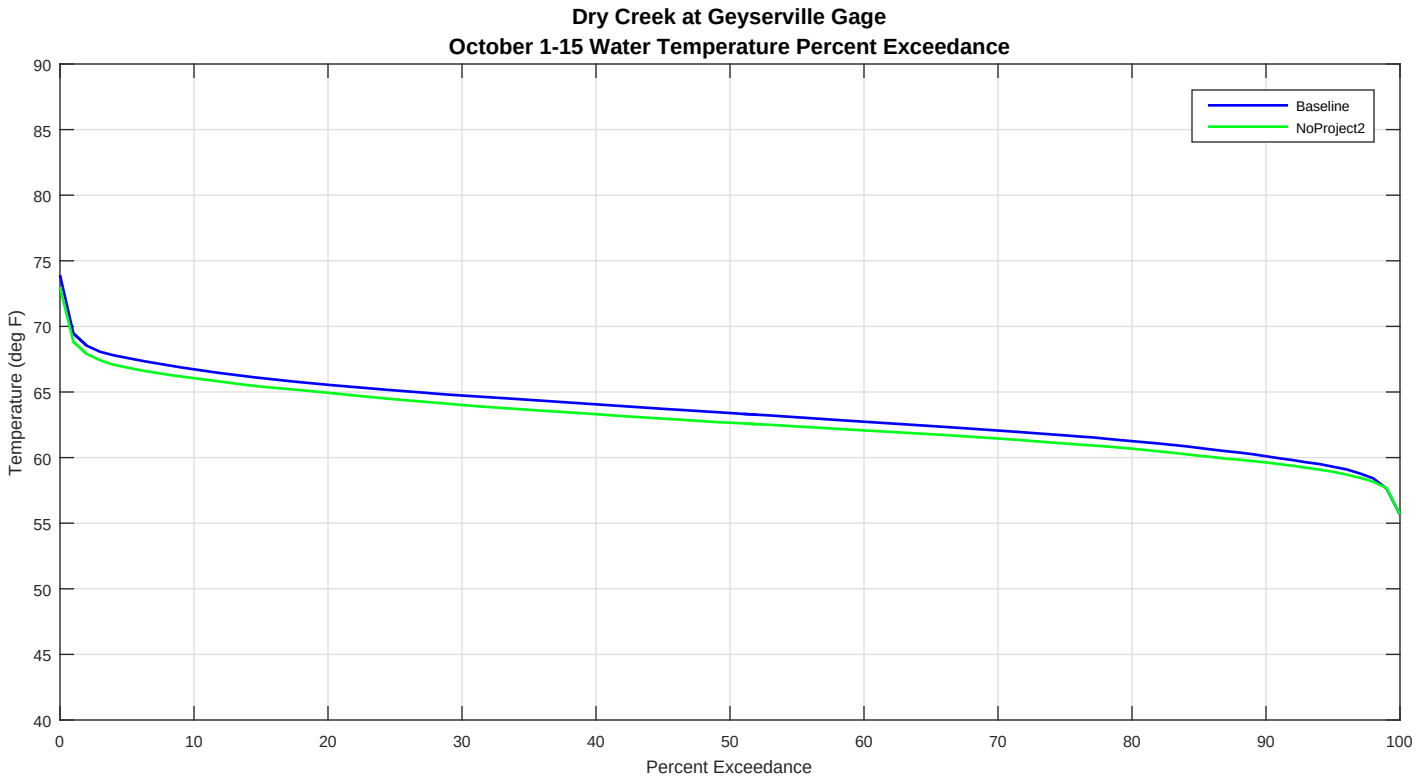
Dry Creek at Geyserville Gage
October 1-15 Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
85
80
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70
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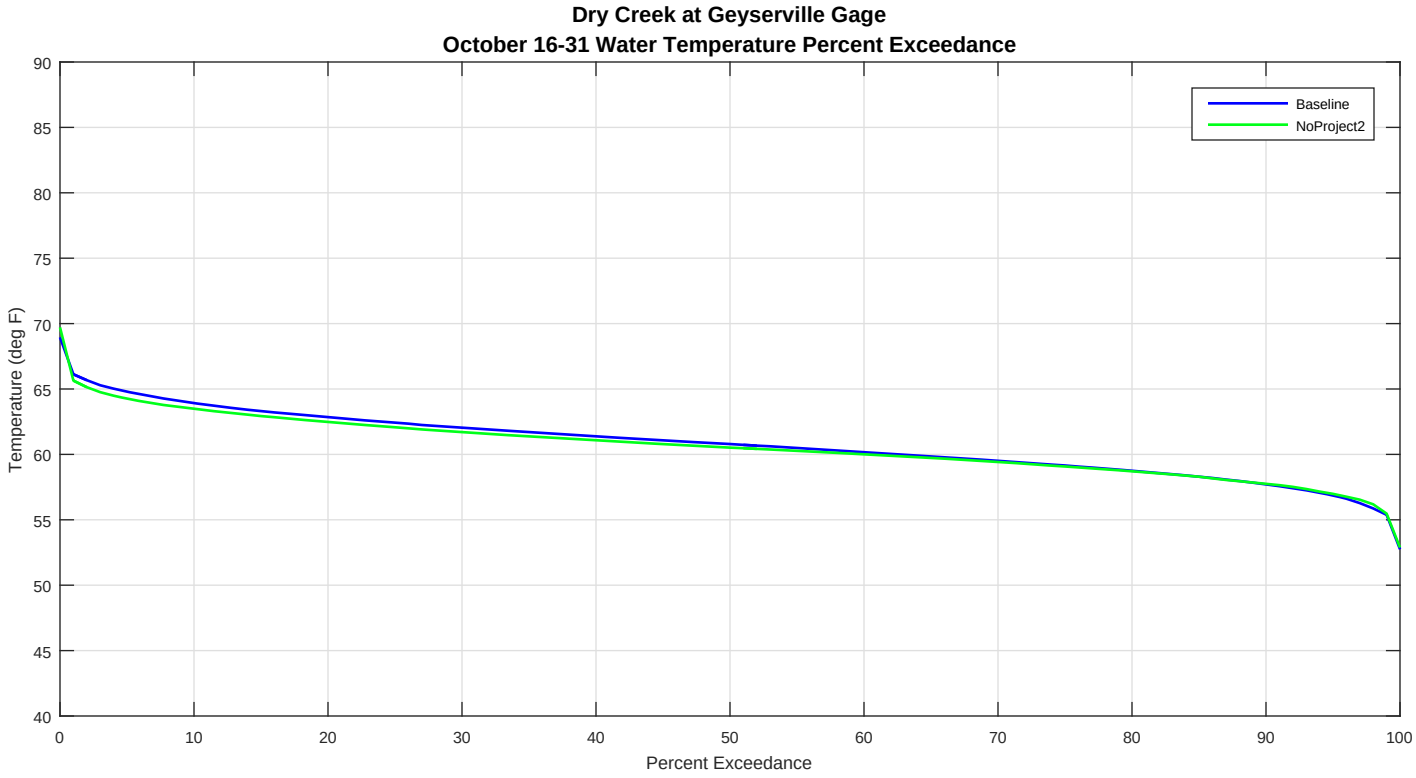
Dry Creek at Geyserville Gage
October 16-31 Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
85
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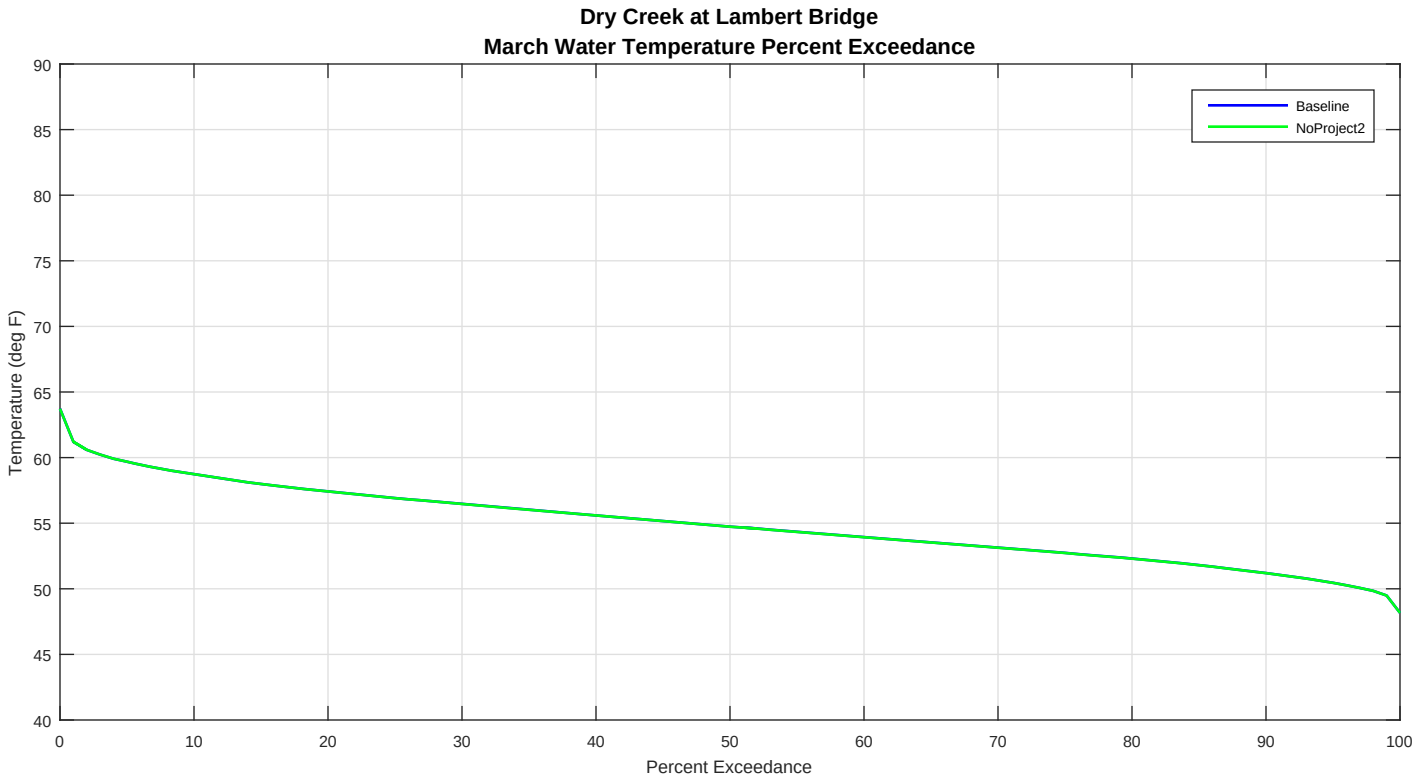
Dry Creek at Lambert Bridge
March Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
85
80
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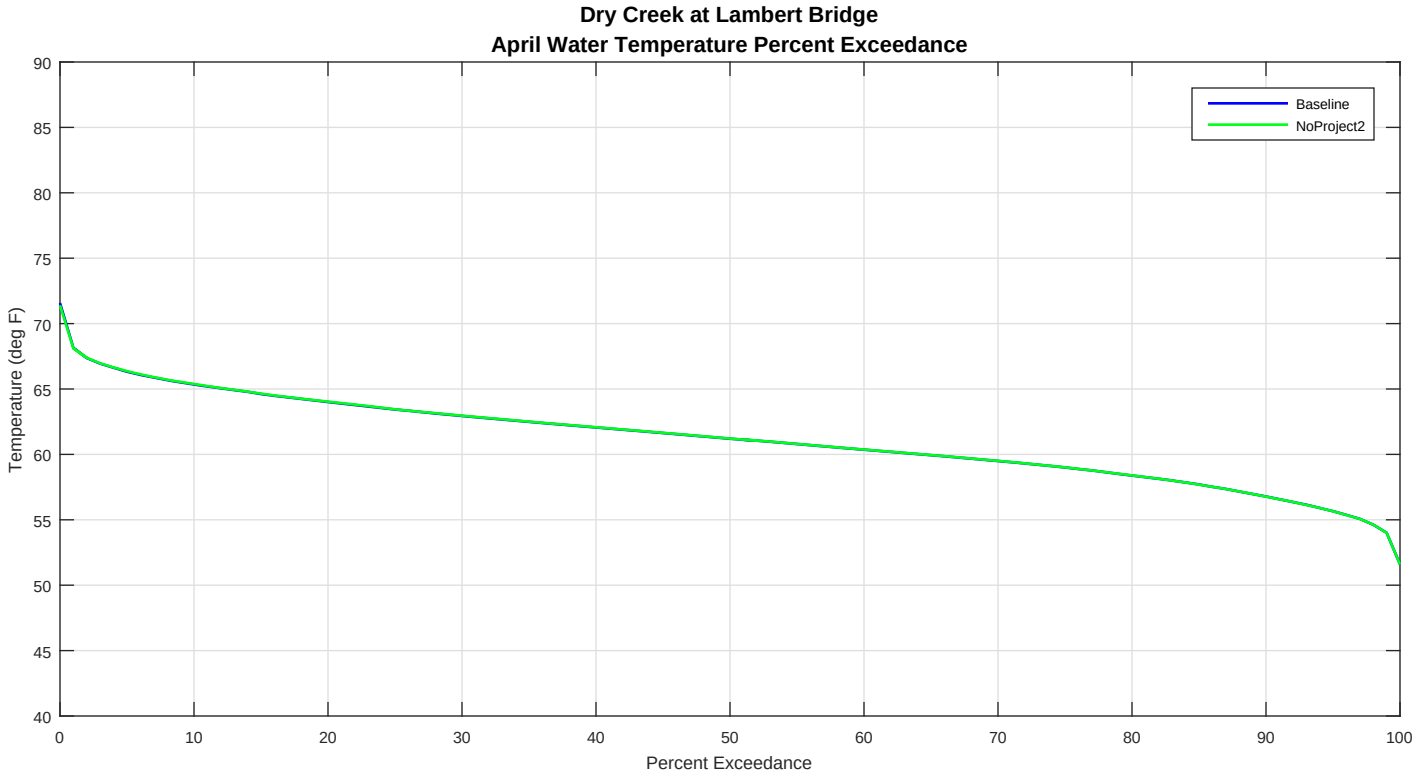
Dry Creek at Lambert Bridge
April Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
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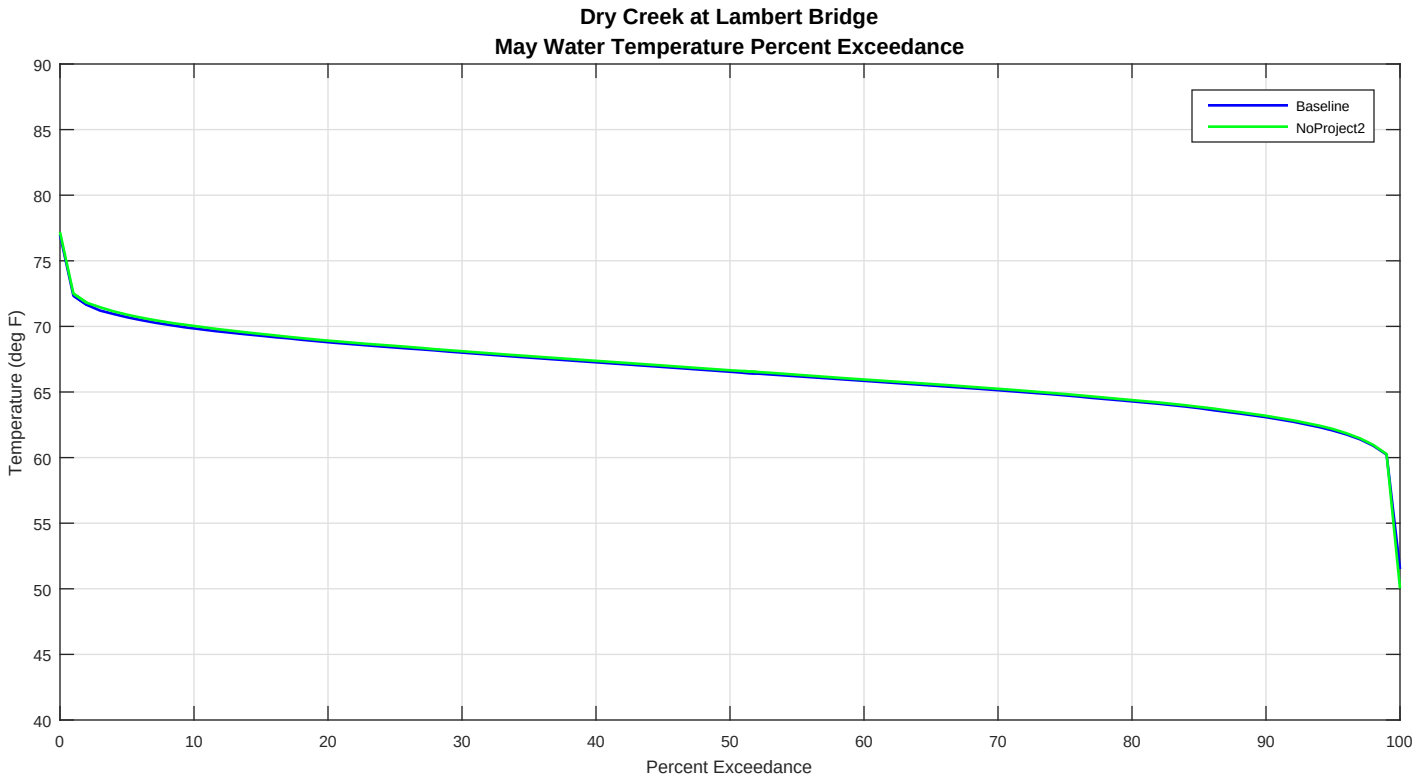
Dry Creek at Lambert Bridge
May Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
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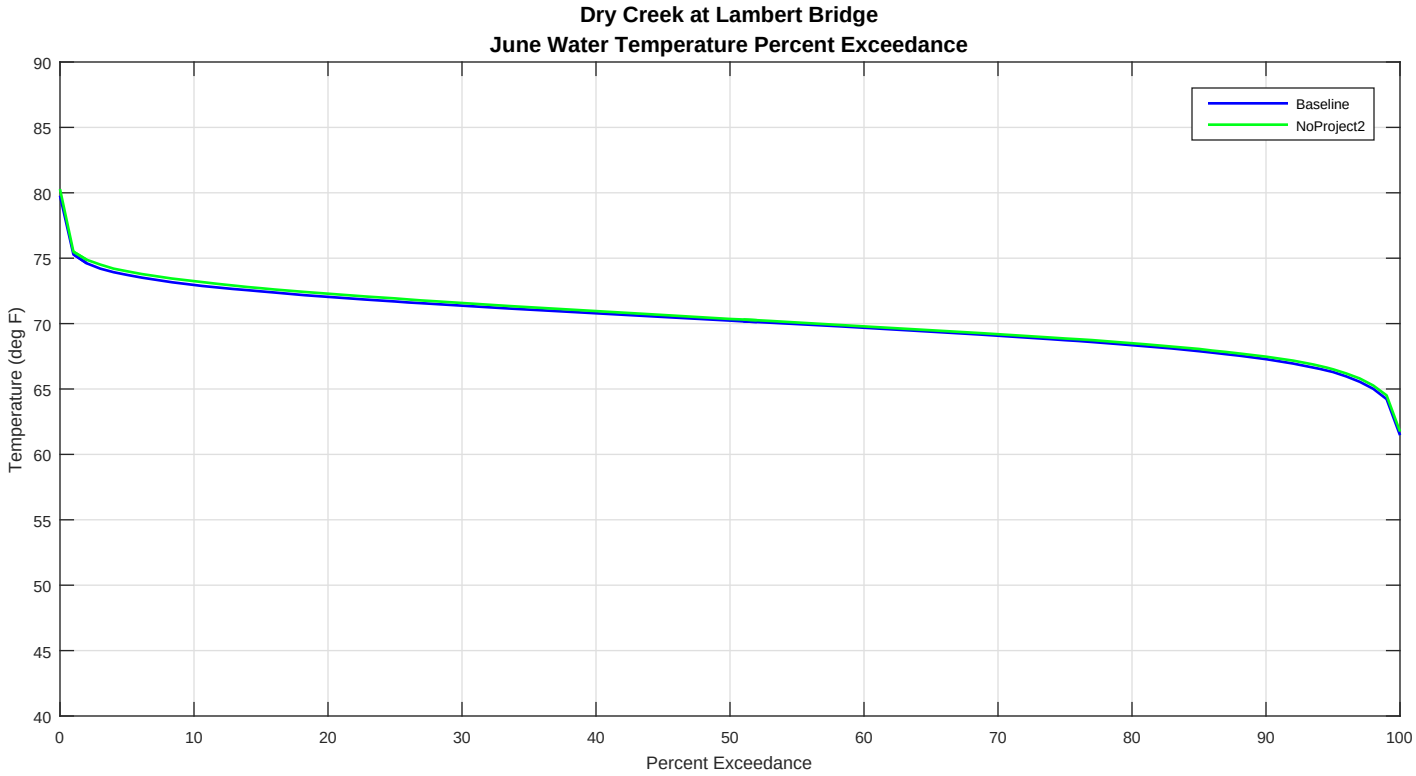
Dry Creek at Lambert Bridge
June Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
85
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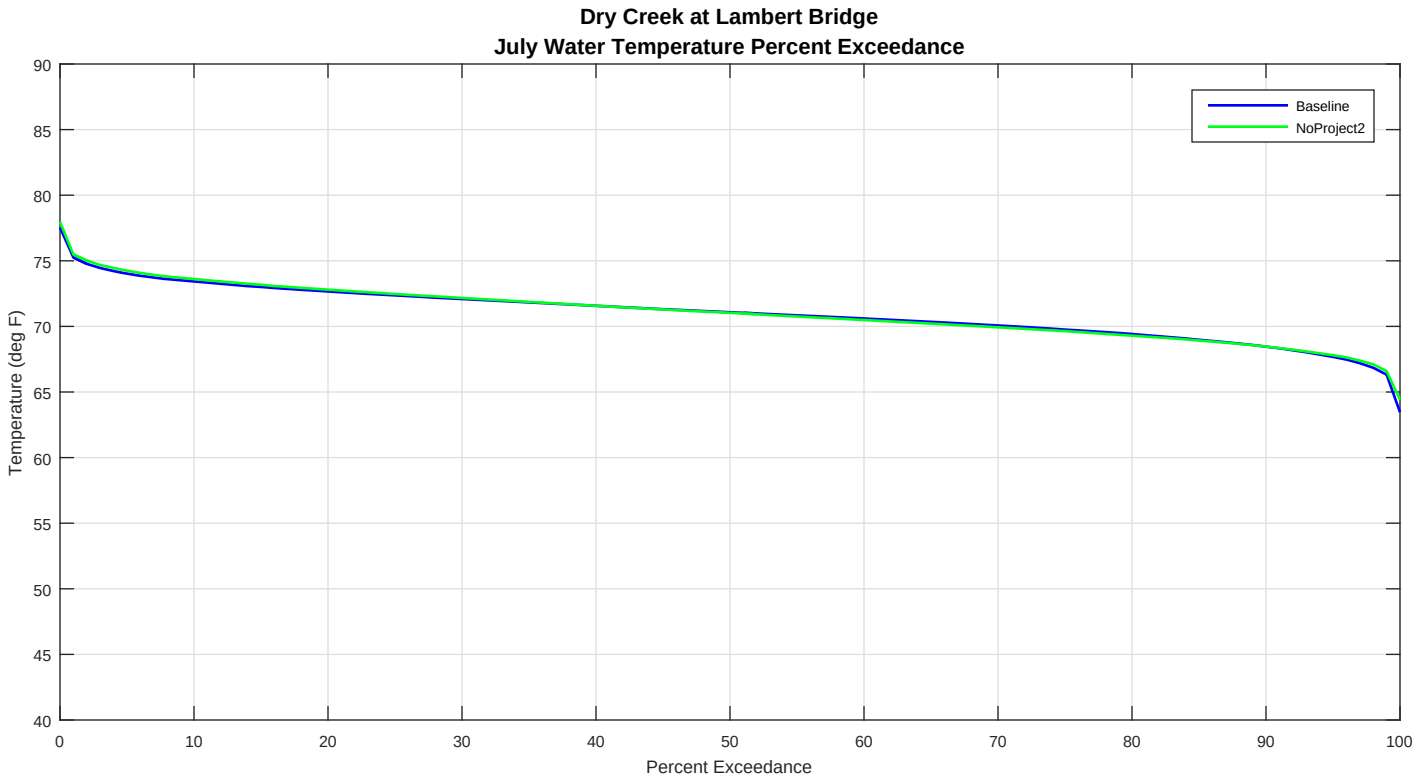
Dry Creek at Lambert Bridge
July Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
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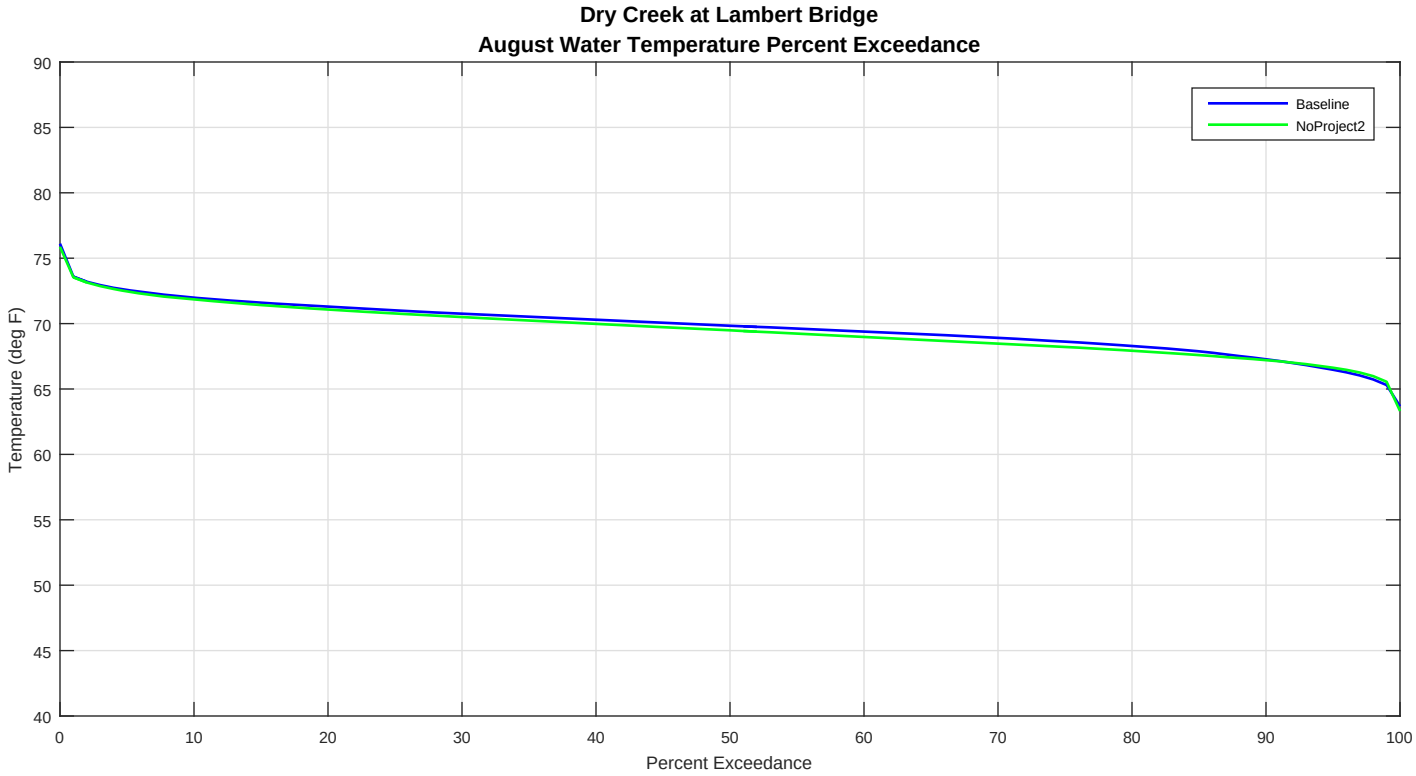
Dry Creek at Lambert Bridge
August Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
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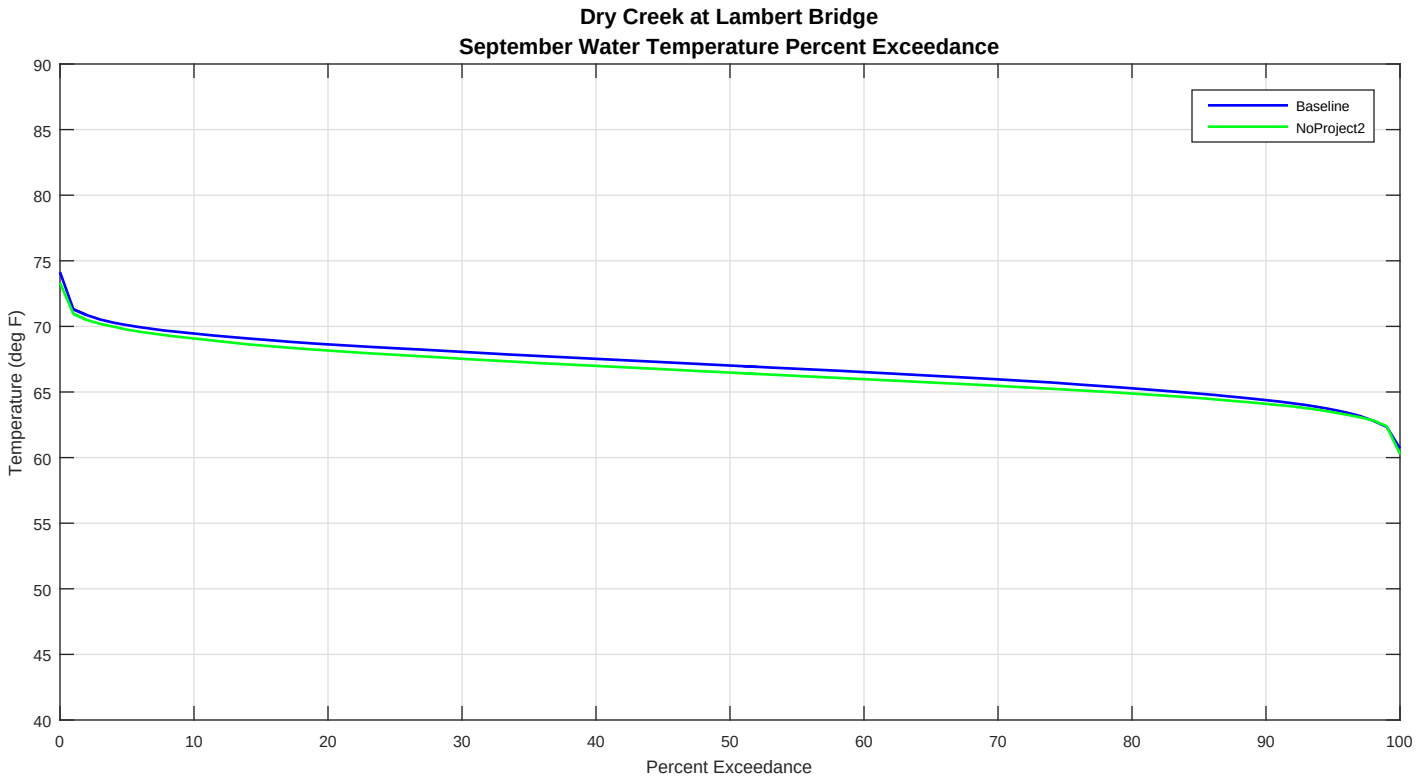
Dry Creek at Lambert Bridge
September Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
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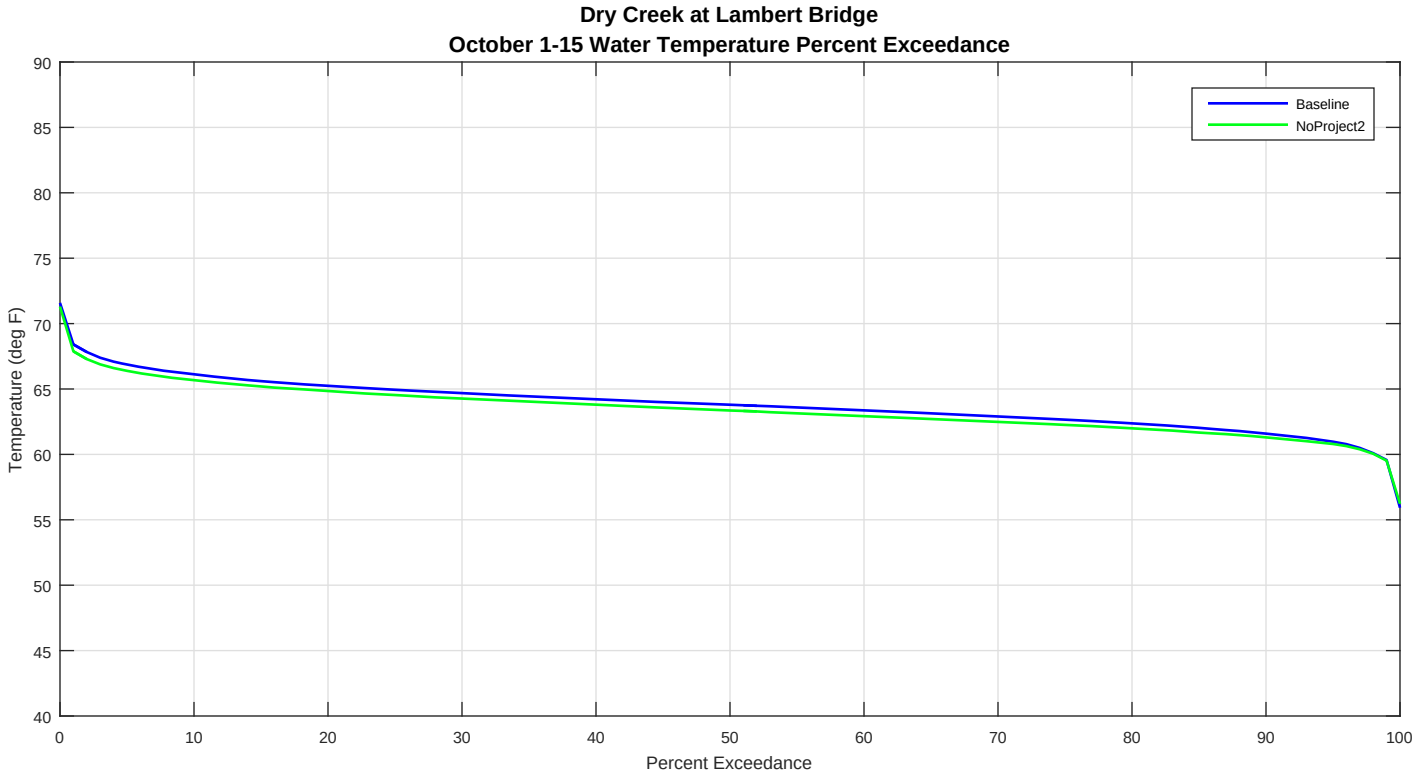
Dry Creek at Lambert Bridge
October 1-15 Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
85
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60
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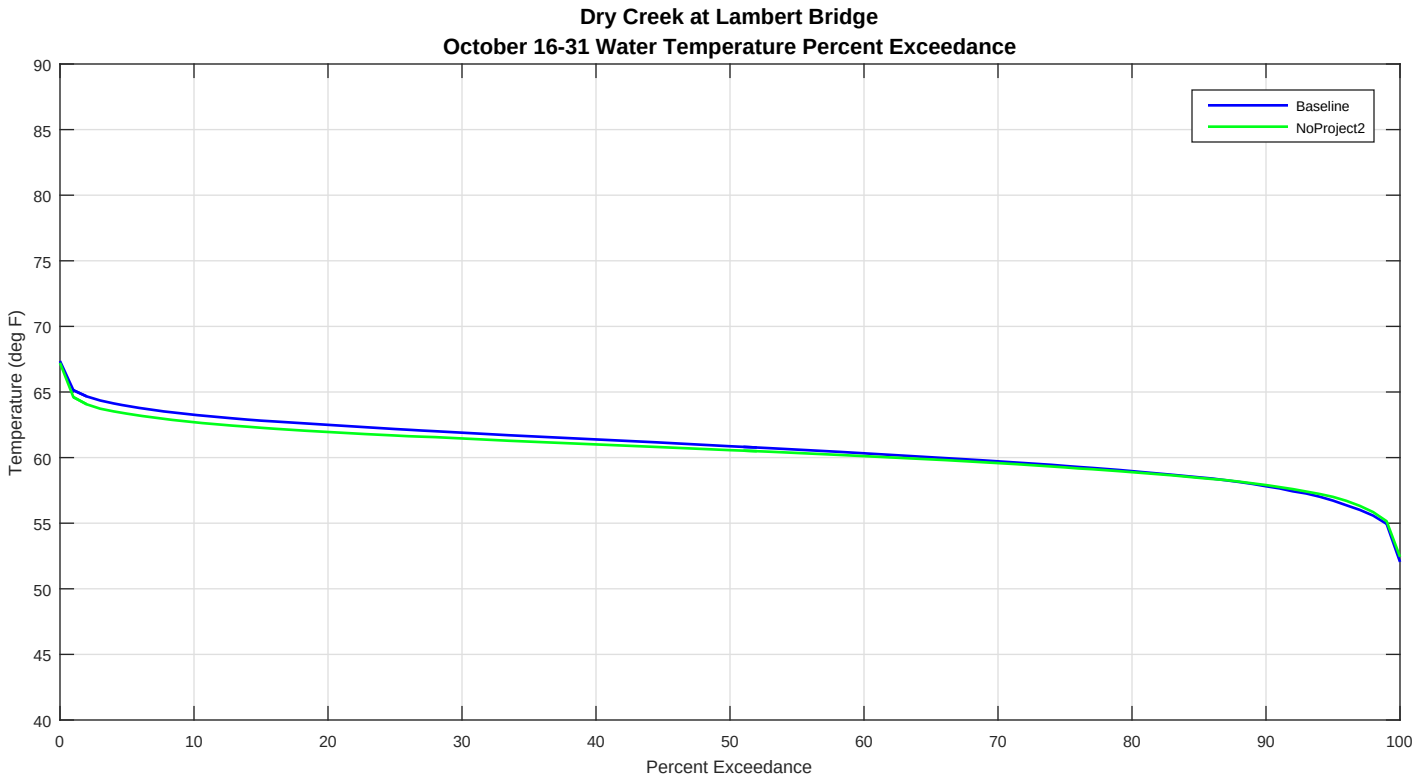
Dry Creek at Lambert Bridge
October 16-31 Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
85
80
75
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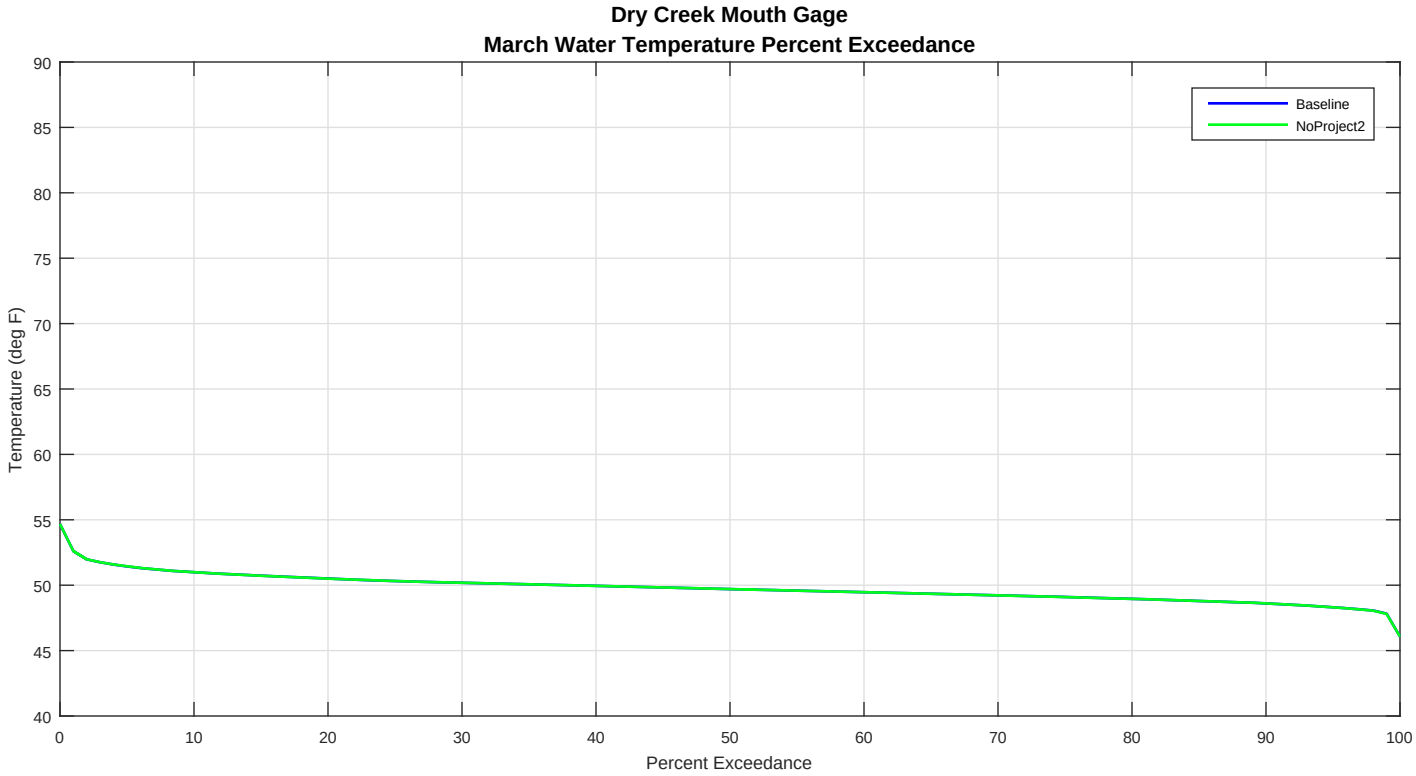
Dry Creek Mouth Gage
March Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
85
80
75
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60
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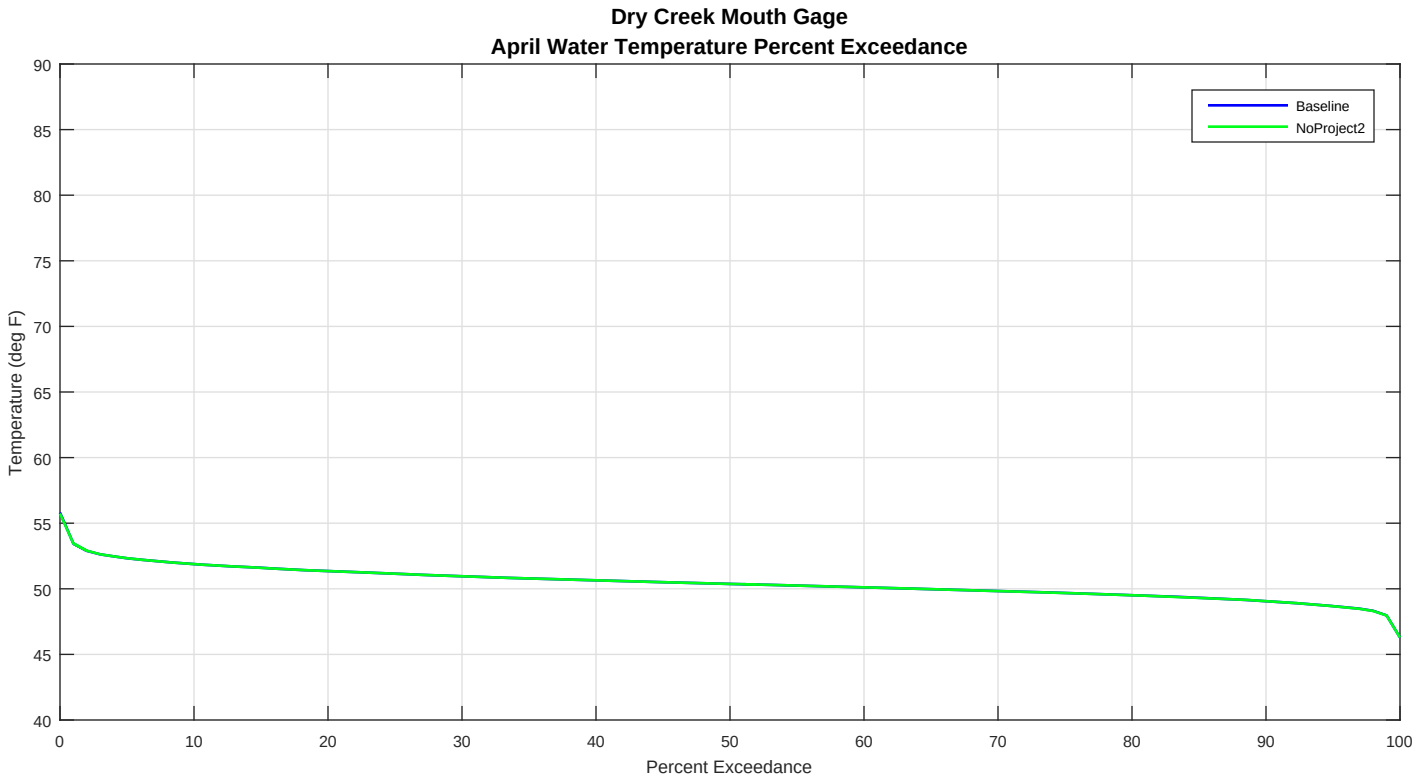
Dry Creek Mouth Gage
April Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
85
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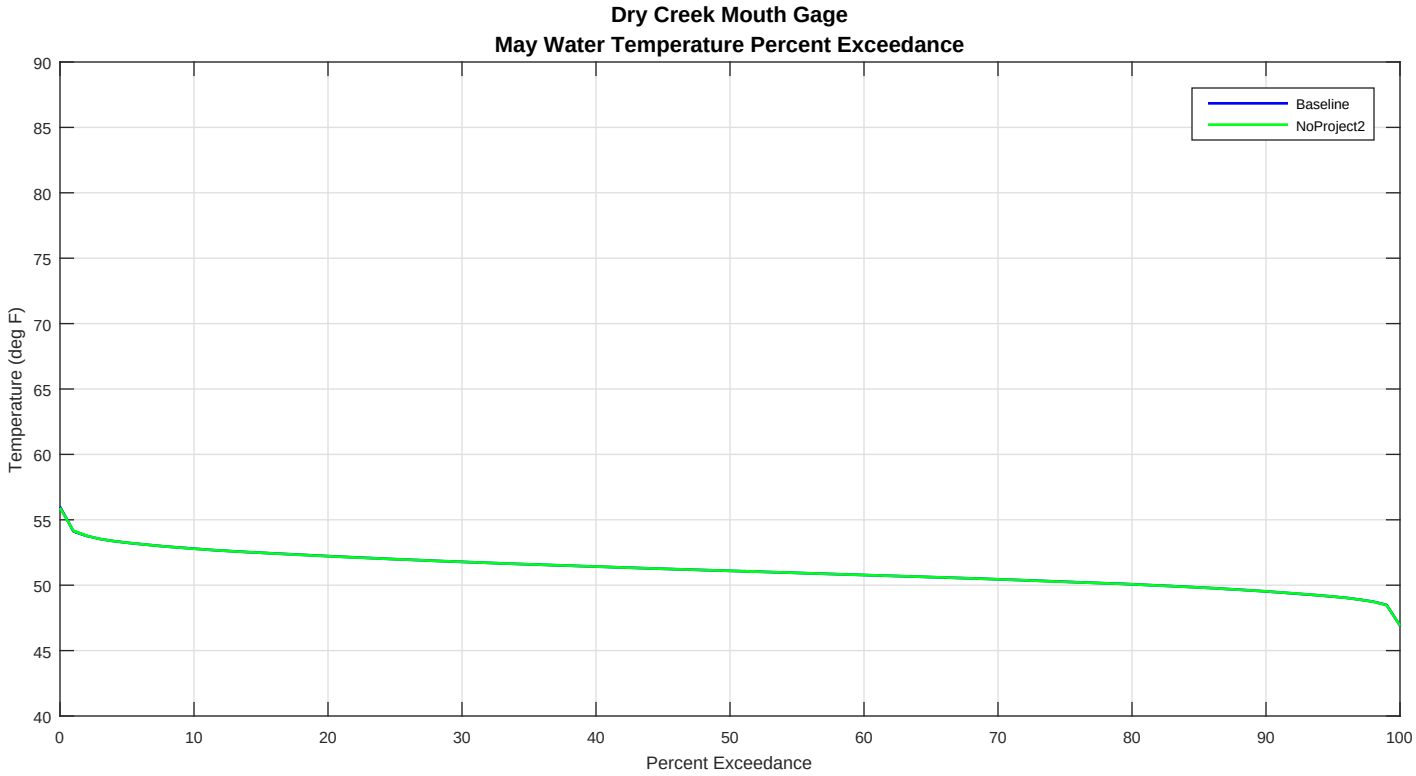
Dry Creek Mouth Gage
May Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
85
80
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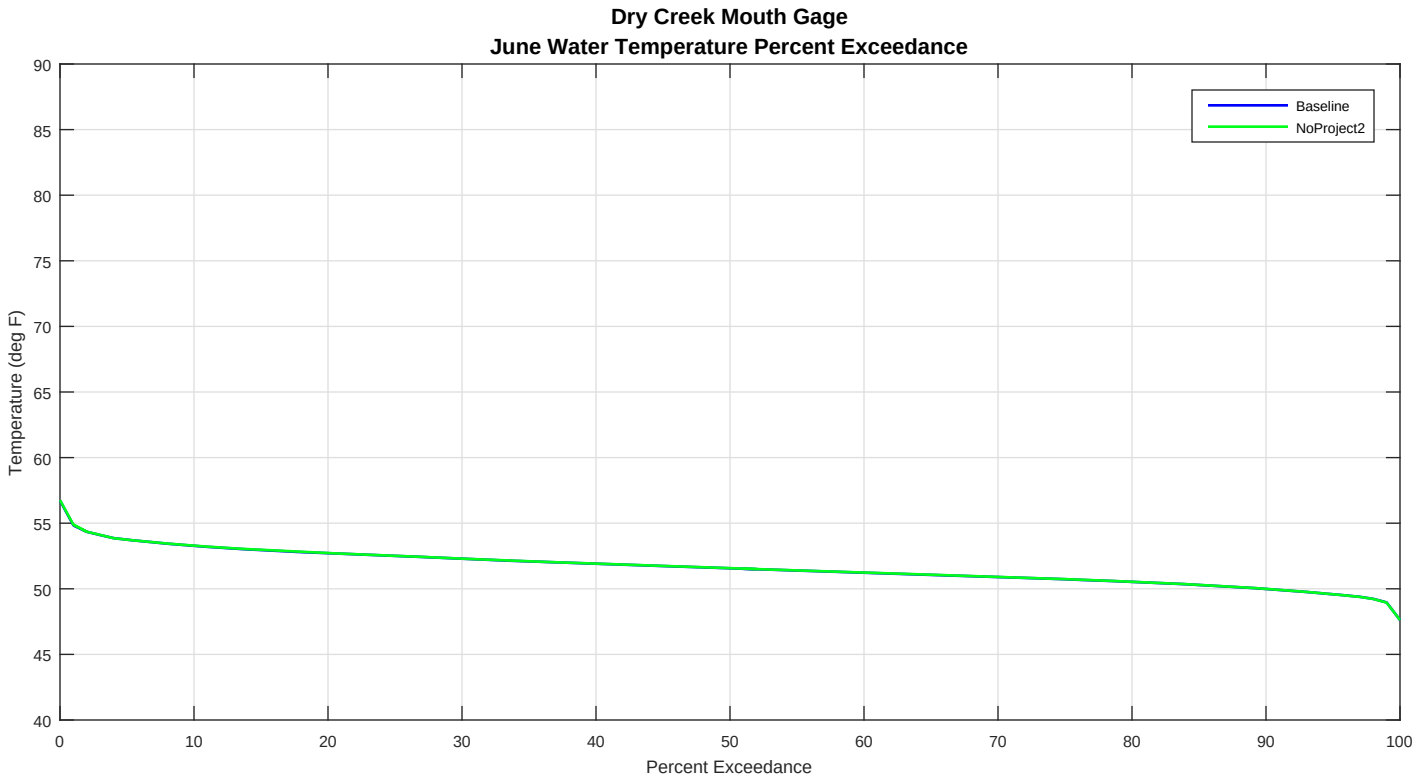
Dry Creek Mouth Gage
June Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
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60
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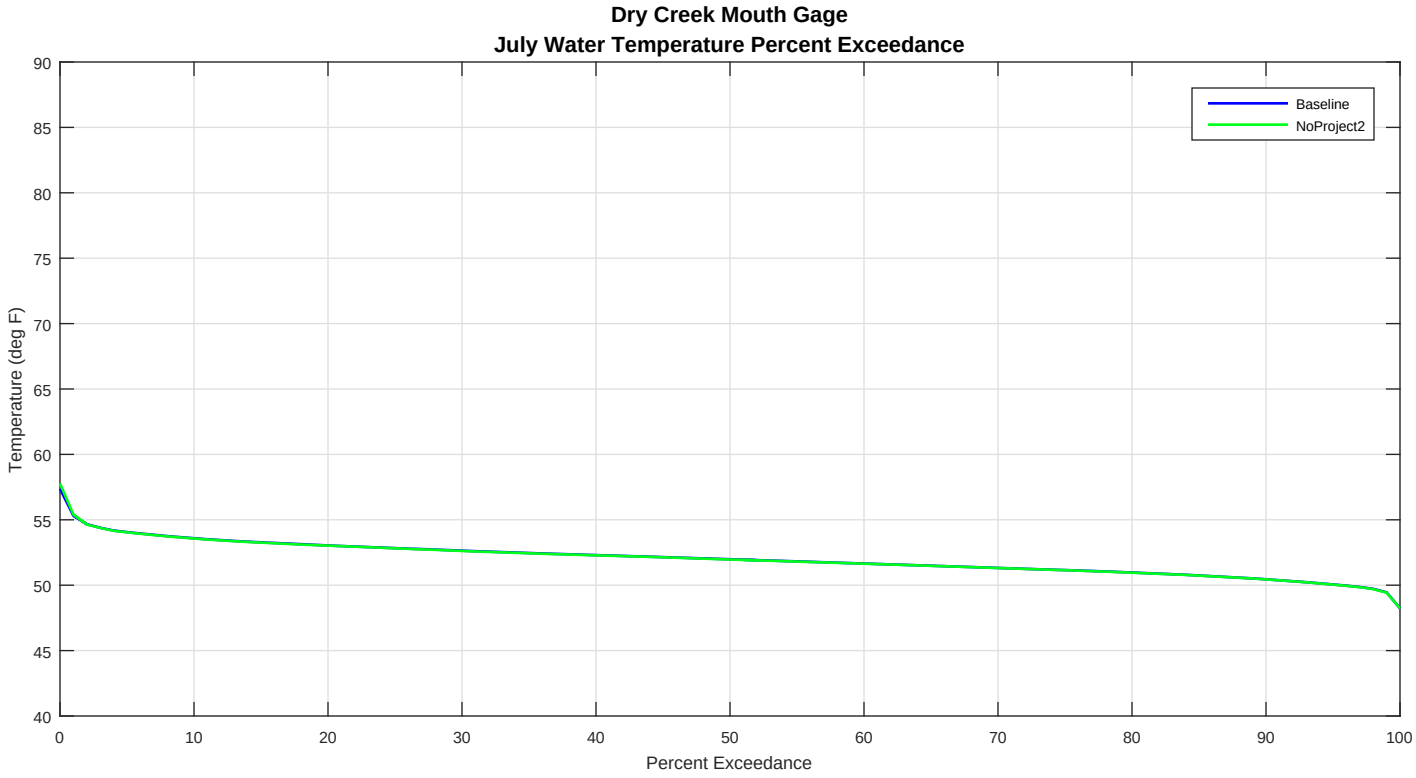
Dry Creek Mouth Gage
July Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
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60
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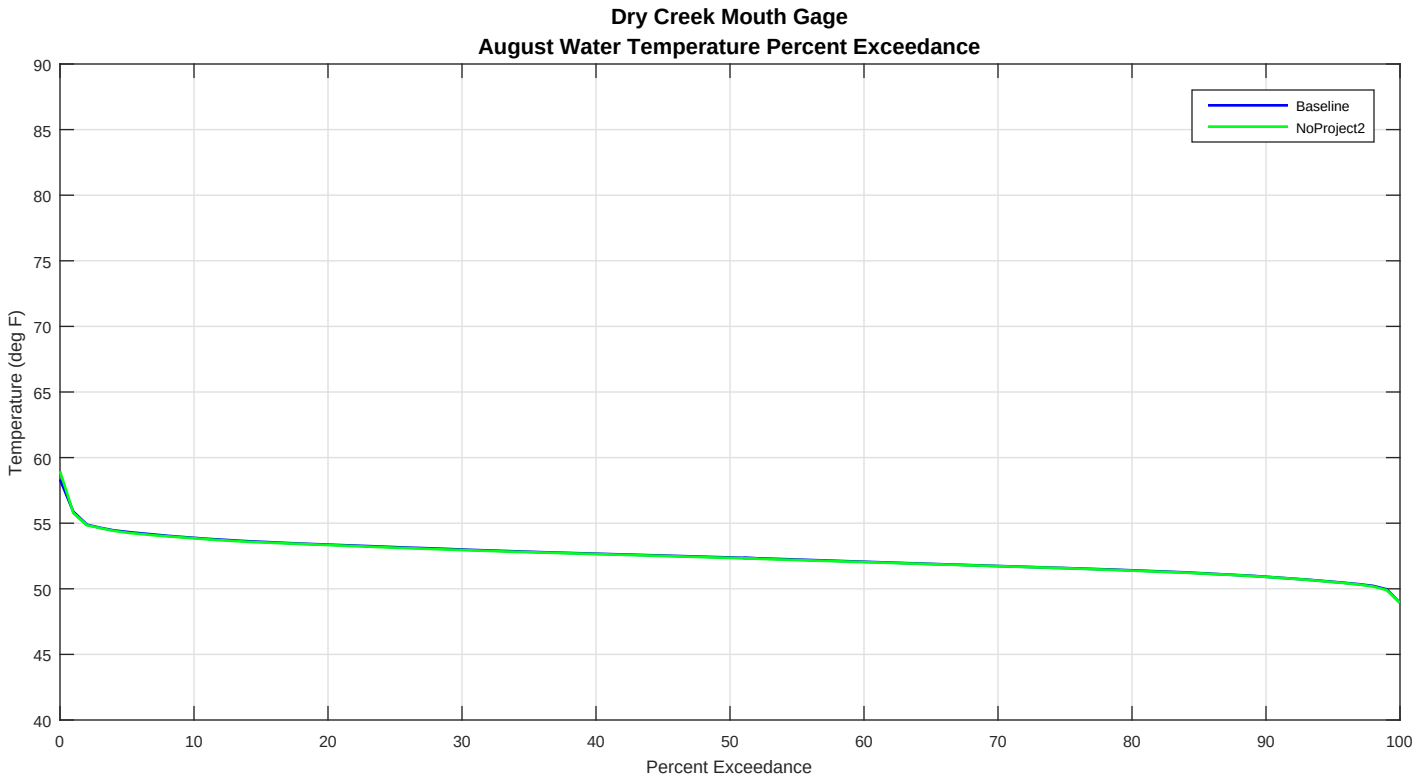
Dry Creek Mouth Gage
August Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
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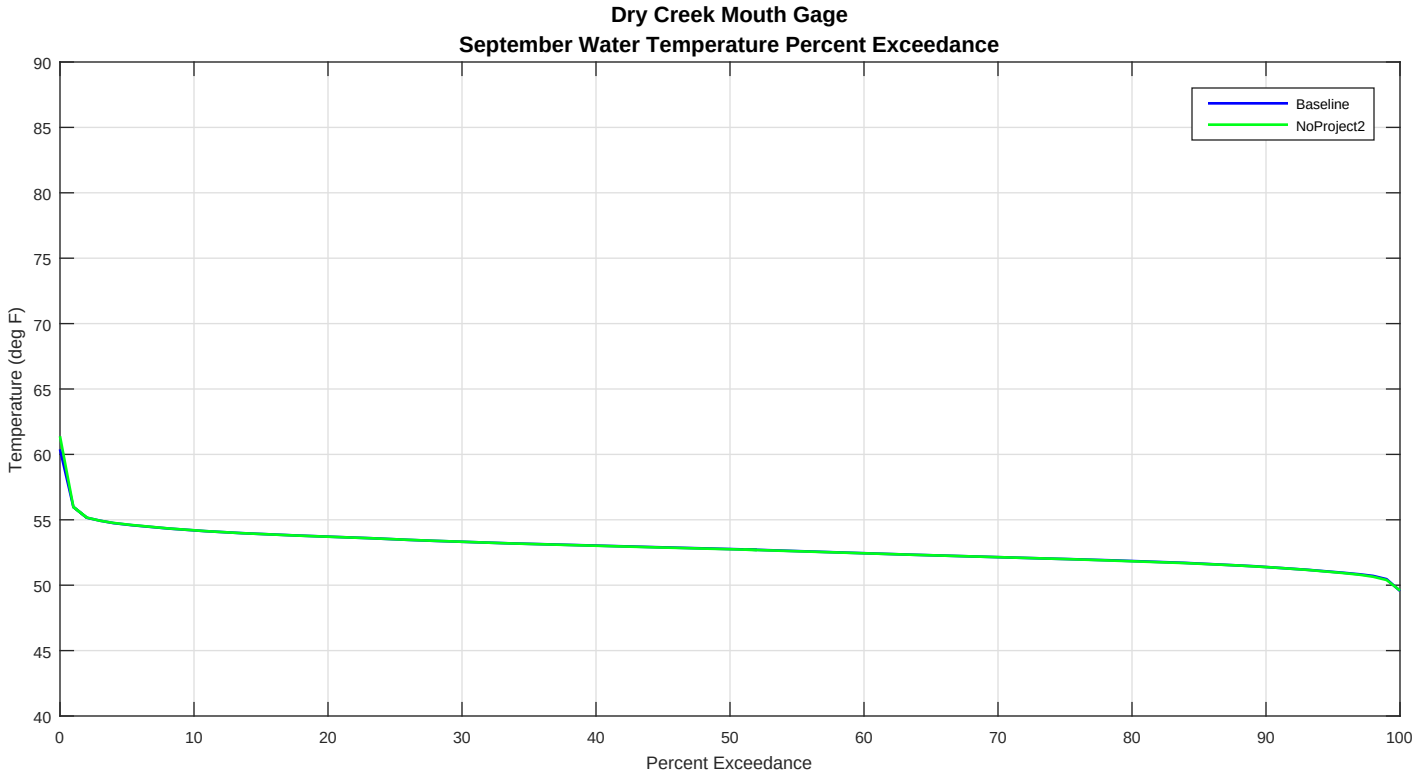
Dry Creek Mouth Gage
September Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
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20
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40
50
60
70
80
90
100

Dry Creek Mouth Gage
October 1-15 Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
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30
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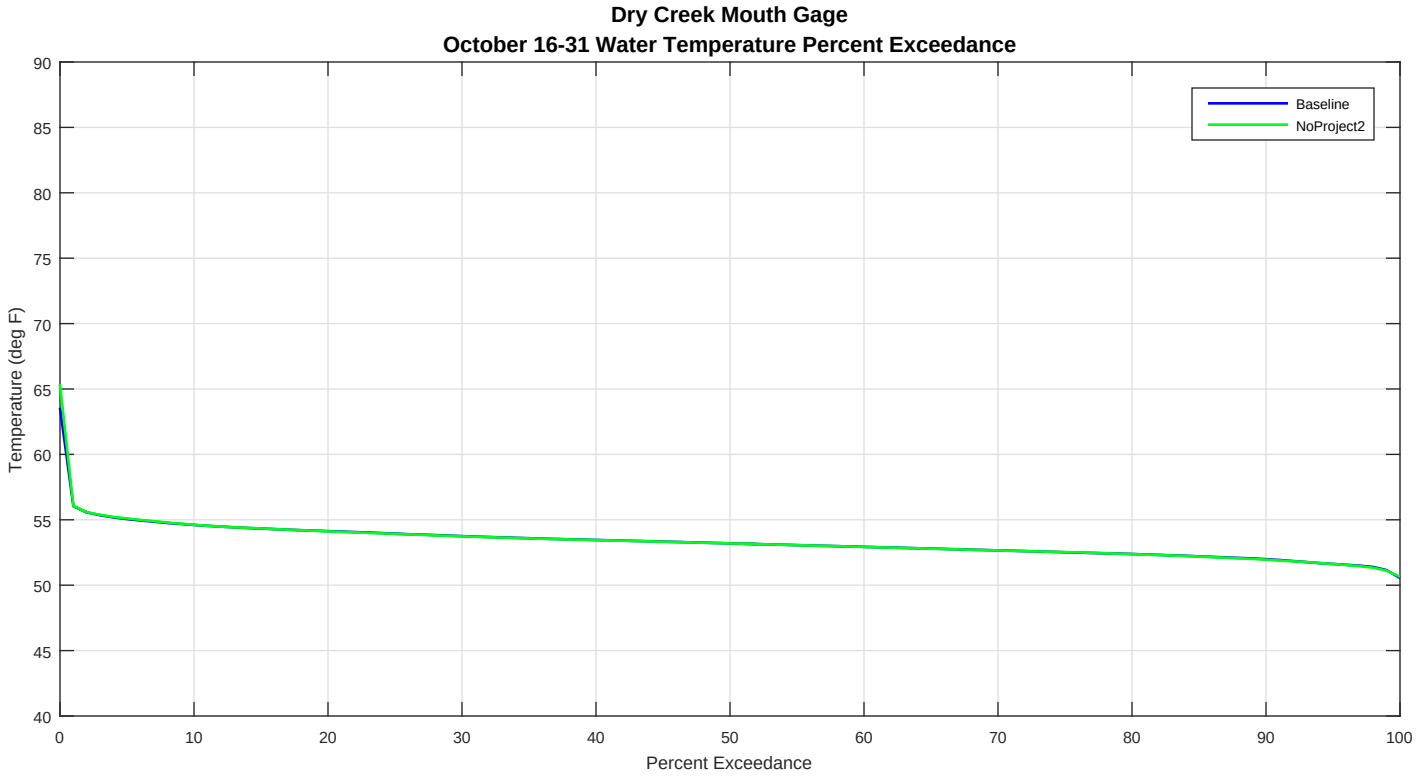
70
80
90
100


Dry Creek Mouth Gage
October 16-31 Water Temperature Percent Exceedance
Baseline
NoProject2
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
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30
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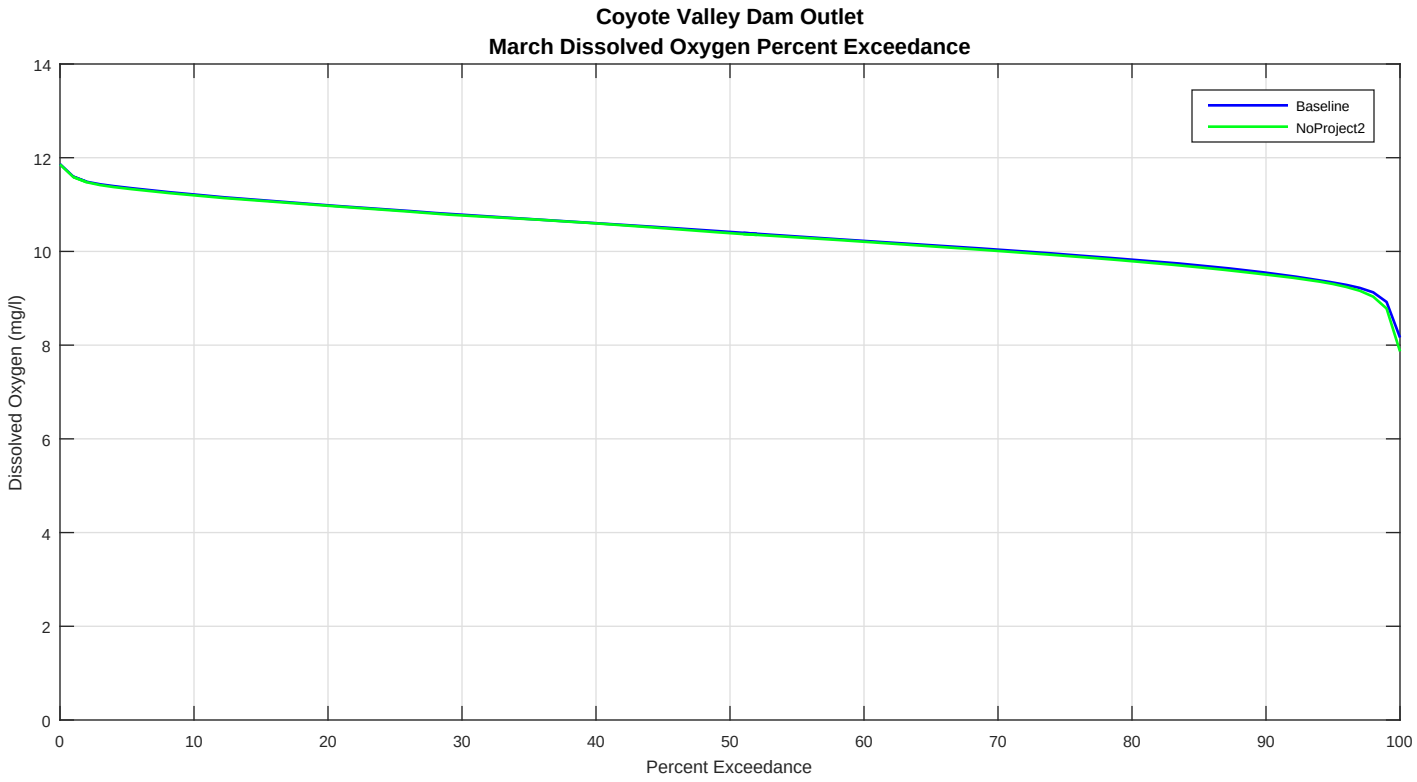
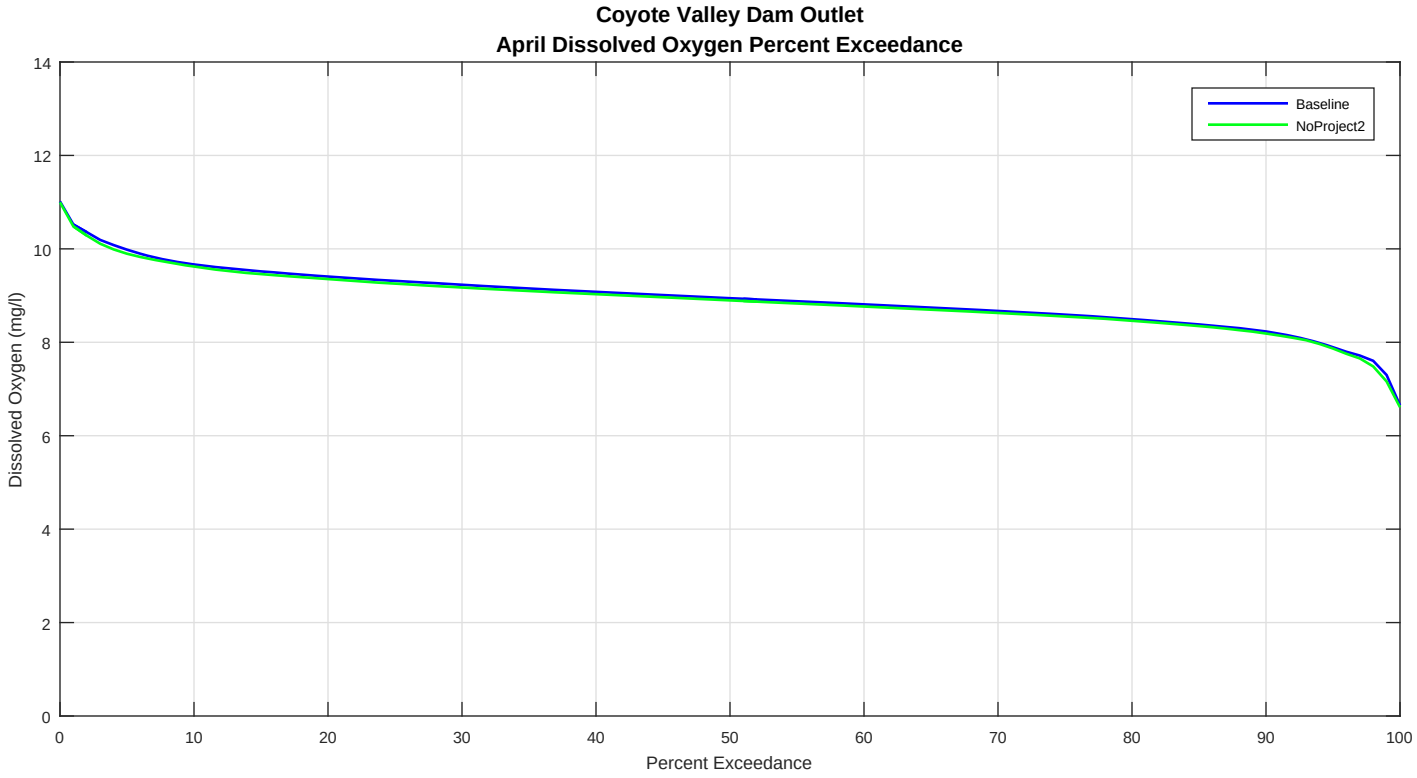
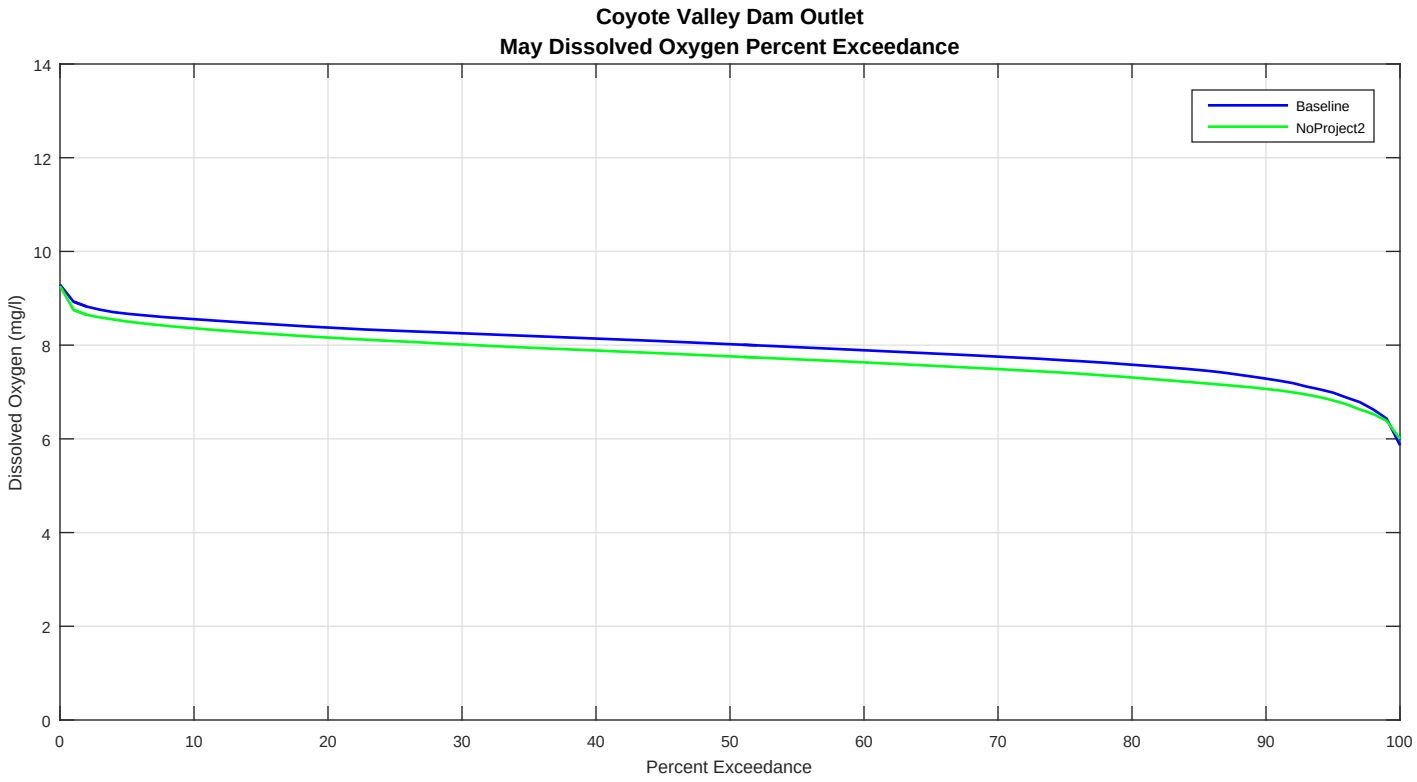
90
100


Coyote Valley Dam Outlet
March Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
April Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
May Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
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12
14
0
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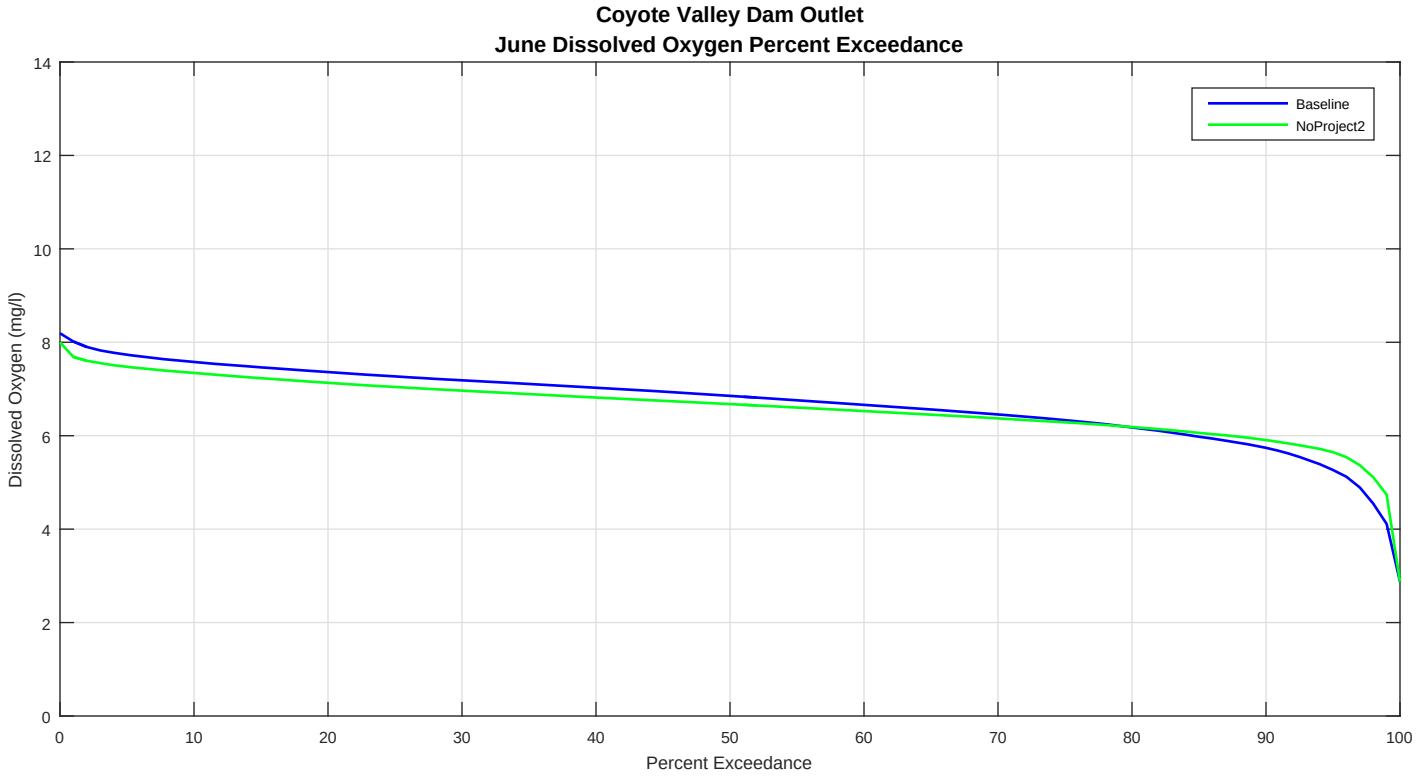
Coyote Valley Dam Outlet
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
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80
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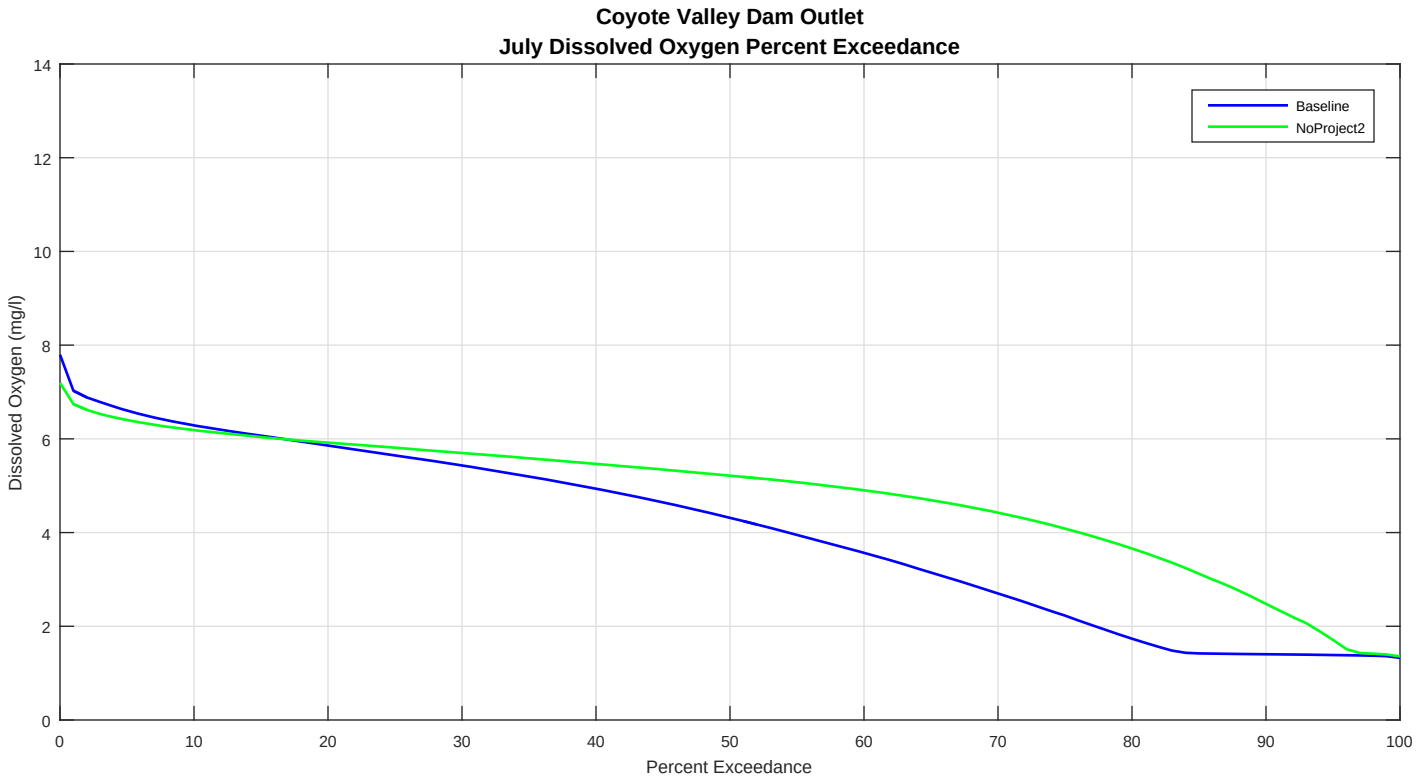
100


Coyote Valley Dam Outlet
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
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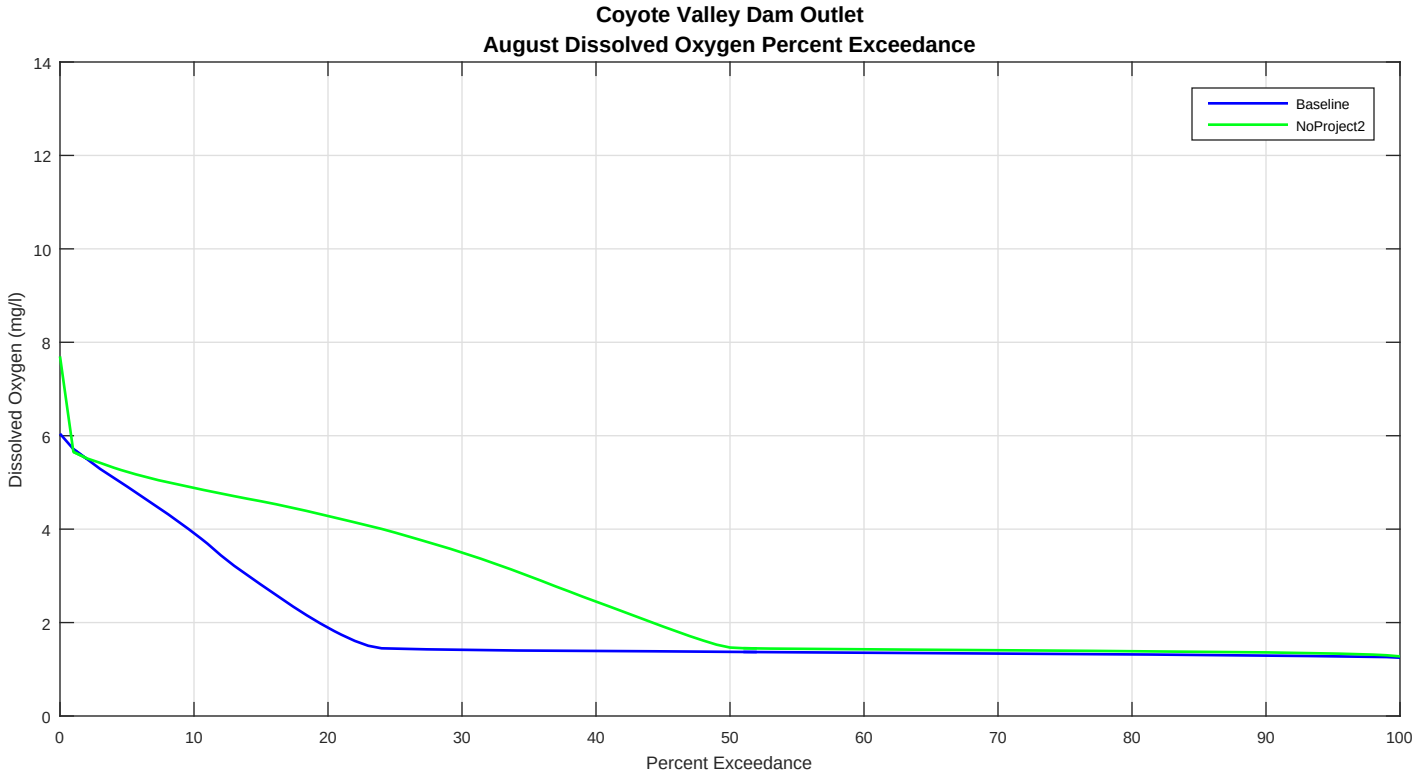
100


Coyote Valley Dam Outlet
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
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6
8
10
12
14
0
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20
30
40
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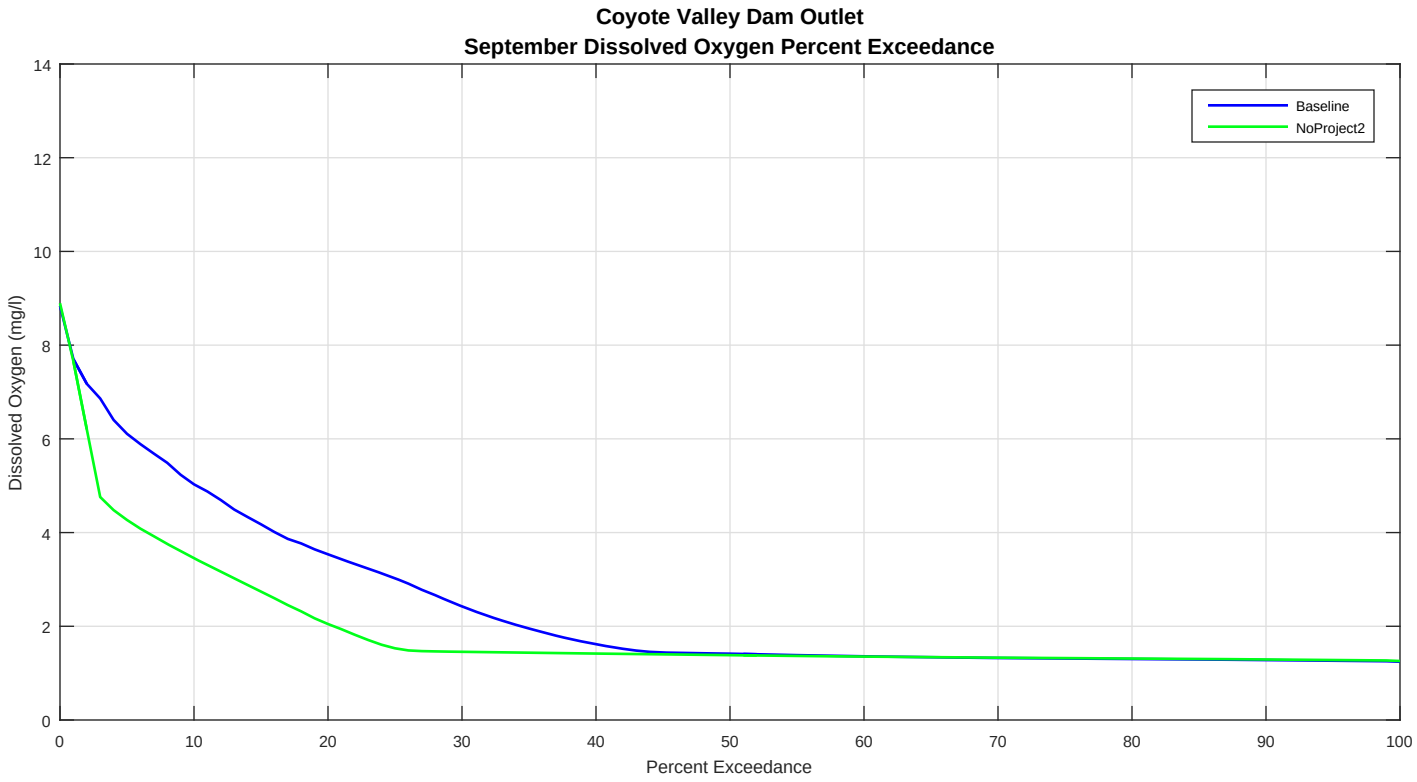
Coyote Valley Dam Outlet
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
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6
8
10
12
14
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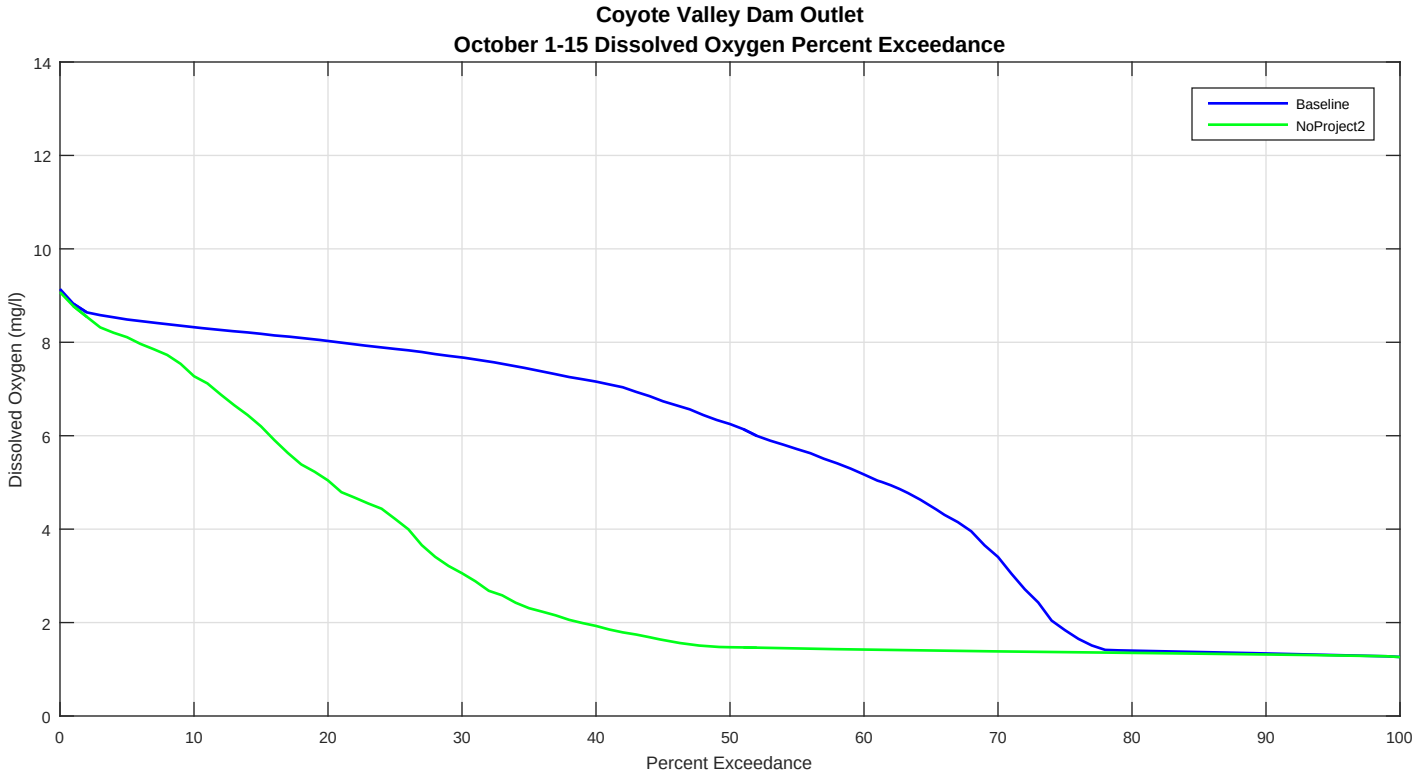
Coyote Valley Dam Outlet
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
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6
8
10
12
14
0
10
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30
40
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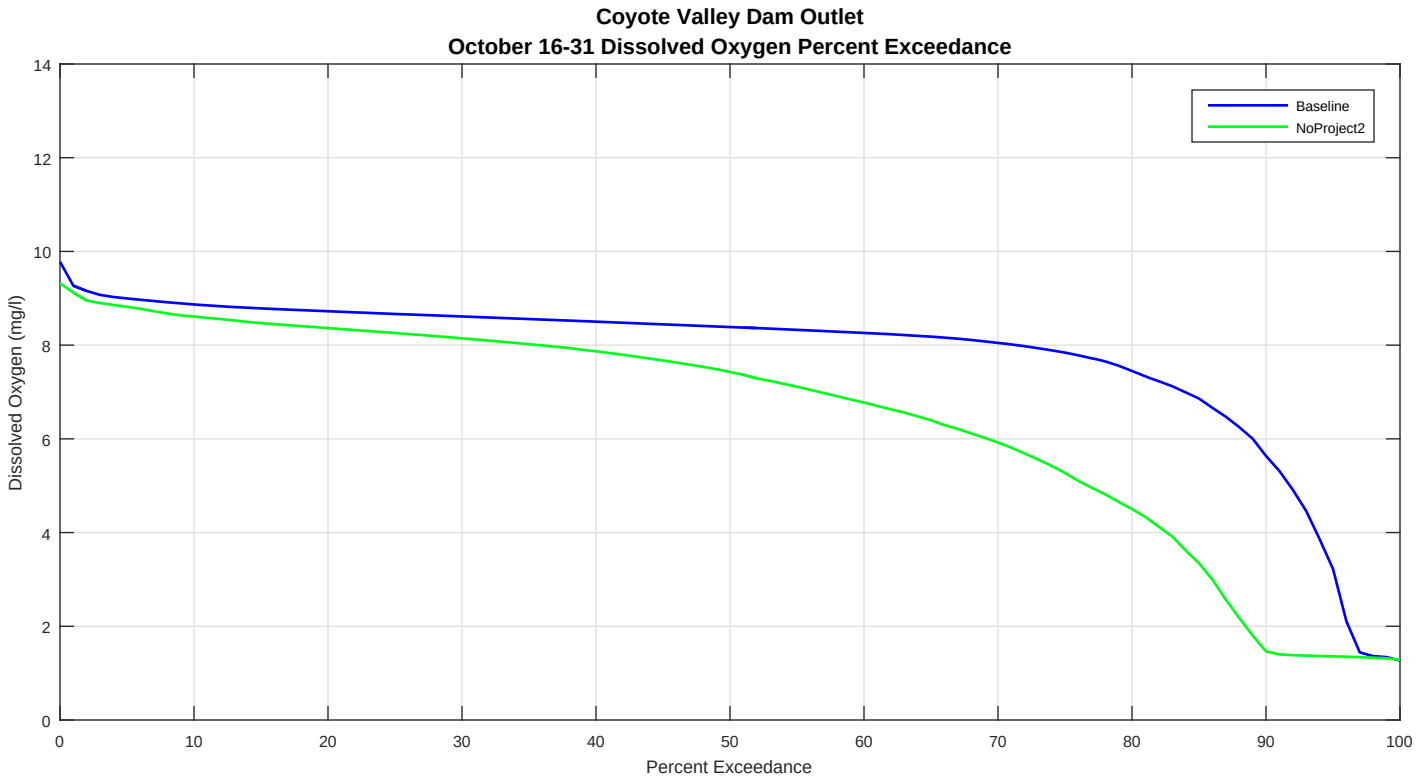
Coyote Valley Dam Outlet
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
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20
30
40
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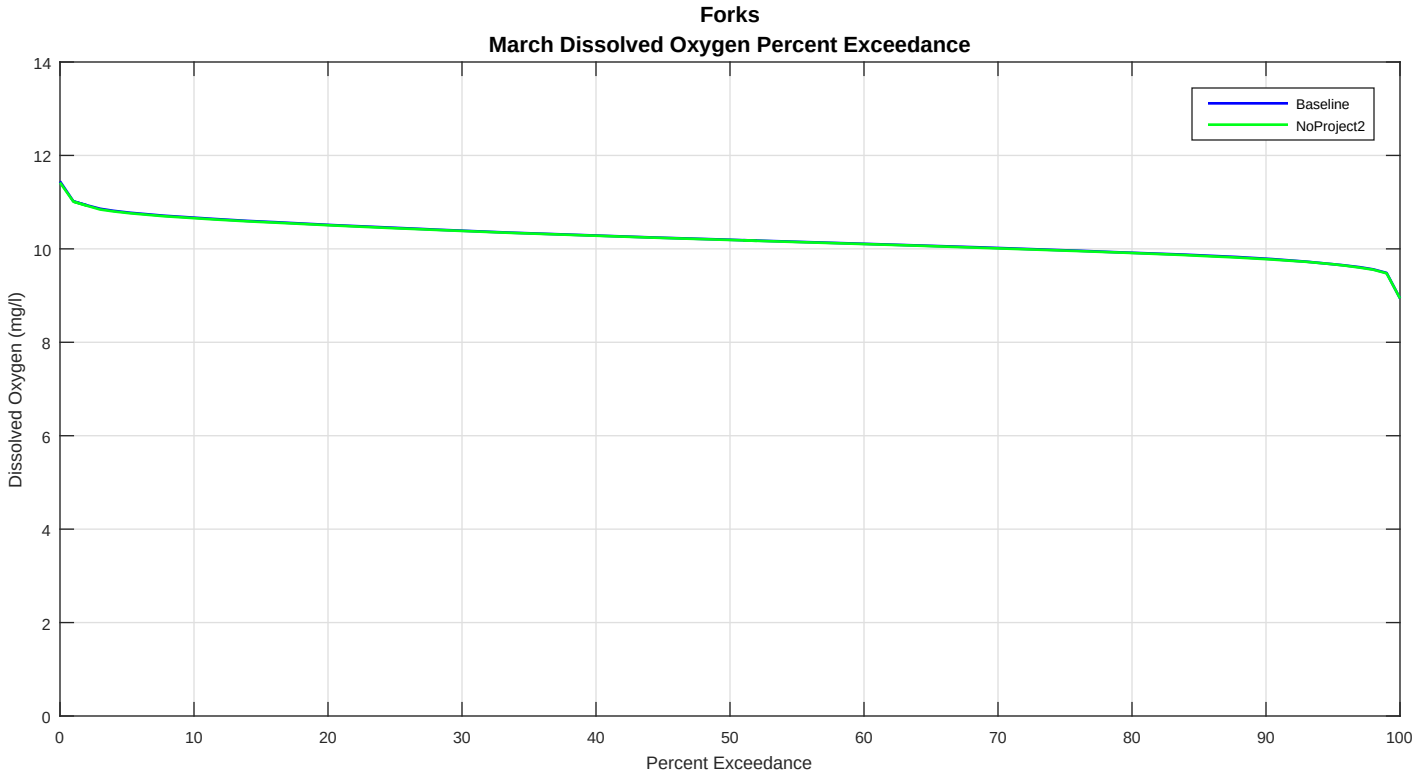
90
100


Forks
March Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
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20
30
40
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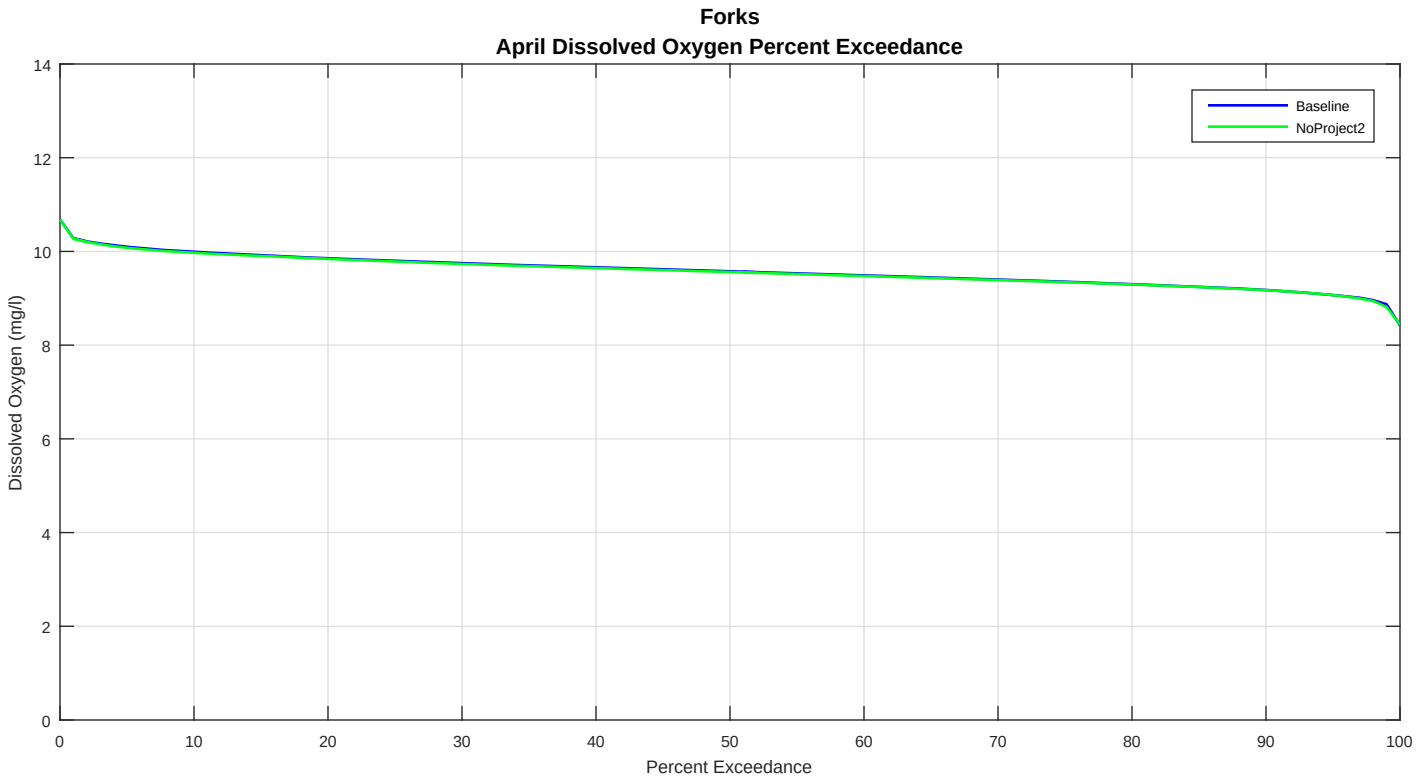
70
80
90
100


Forks
April Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
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6
8
10
12
14
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40
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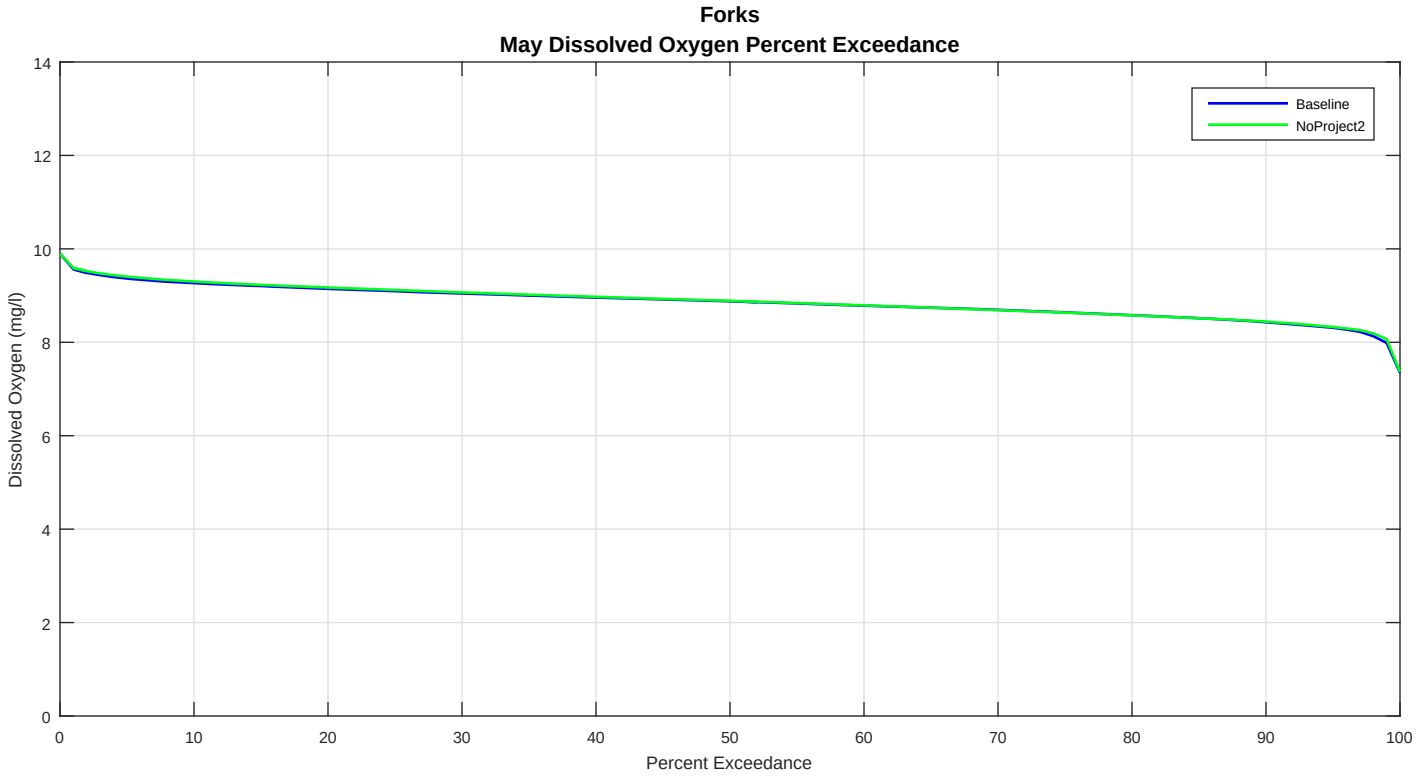
90
100


Forks
May Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
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6
8
10
12
14
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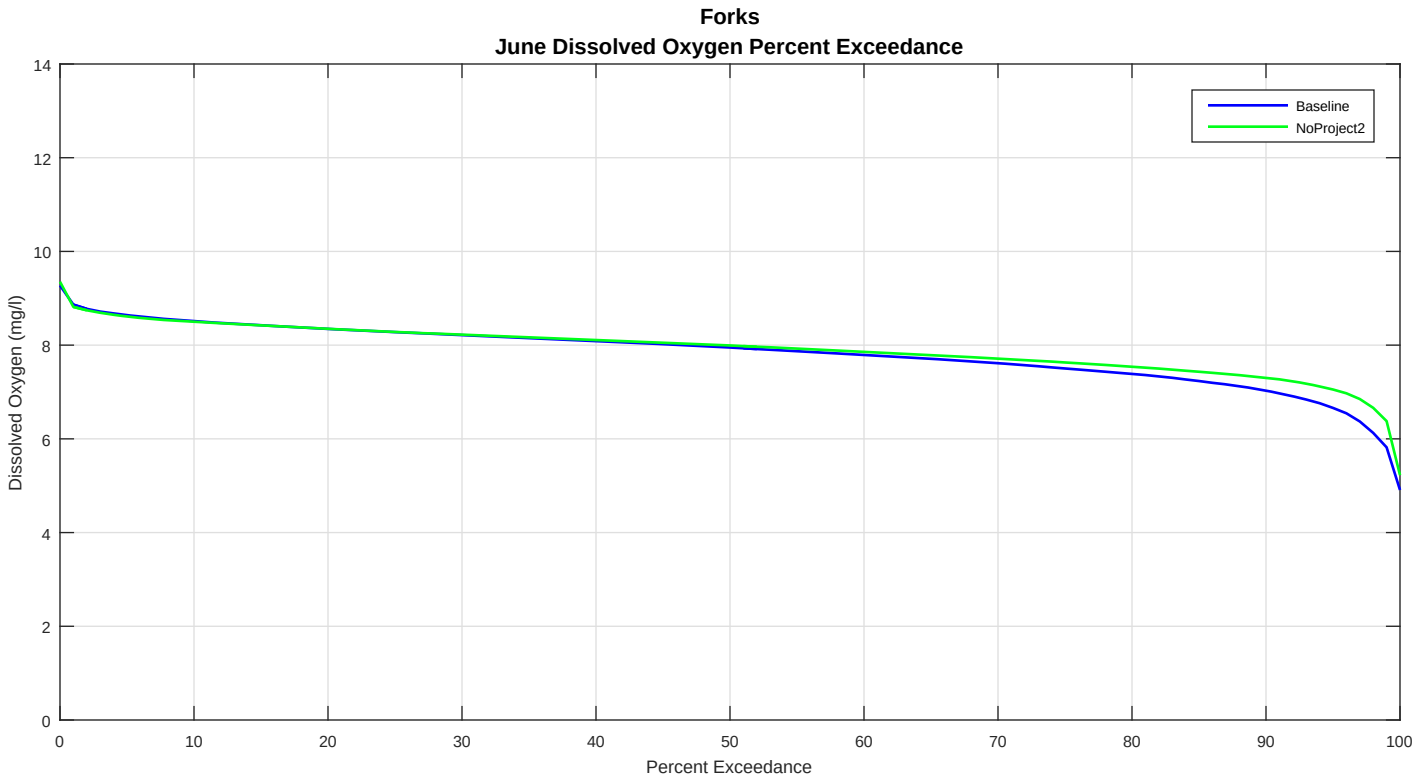
Forks
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
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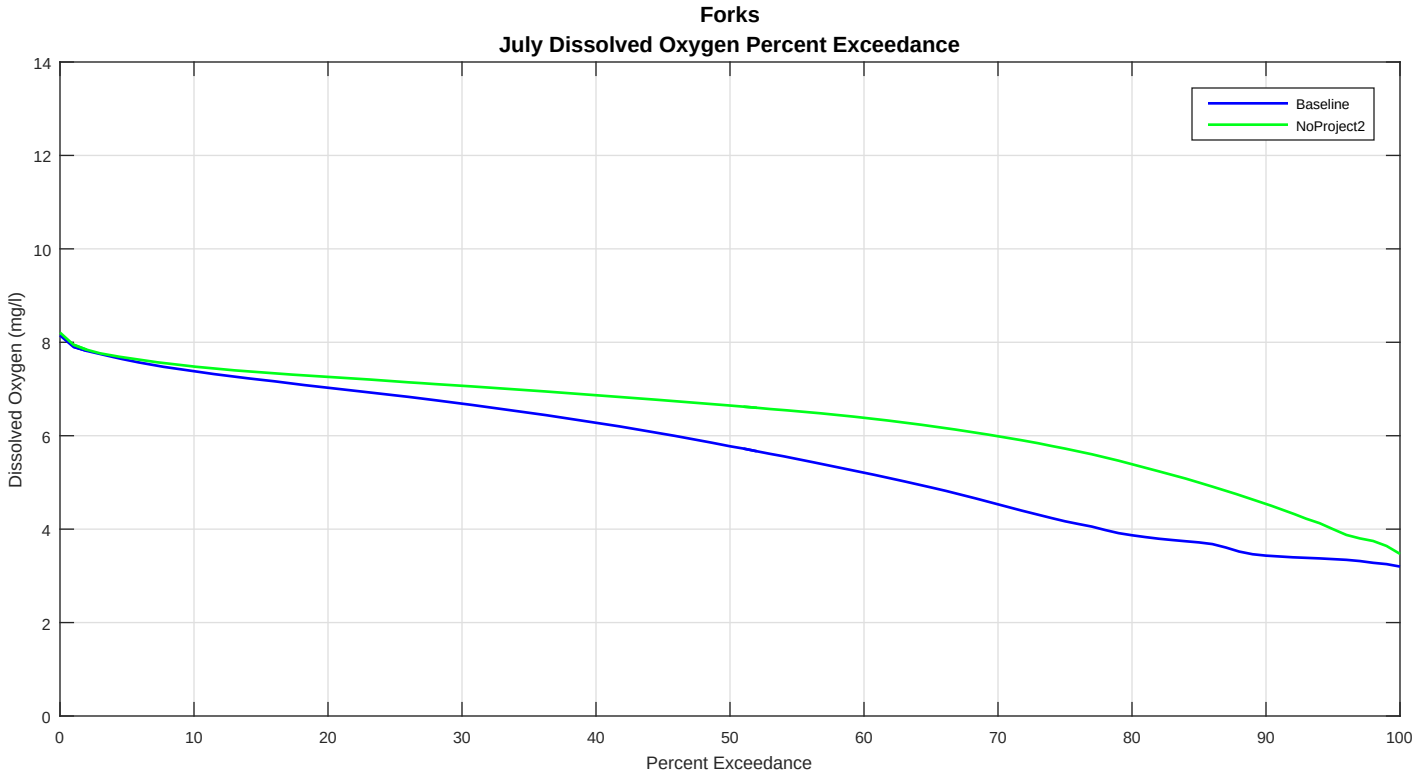
Forks
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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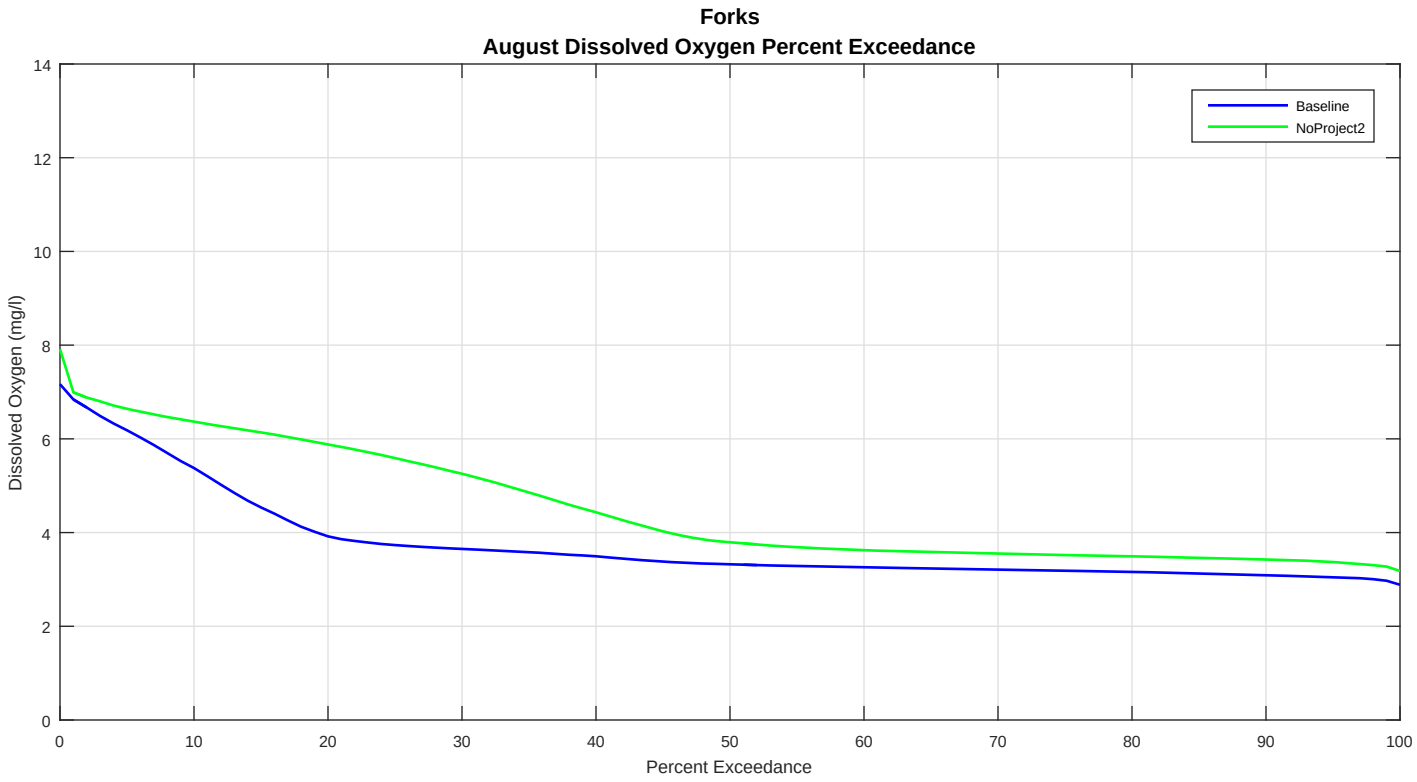
Forks
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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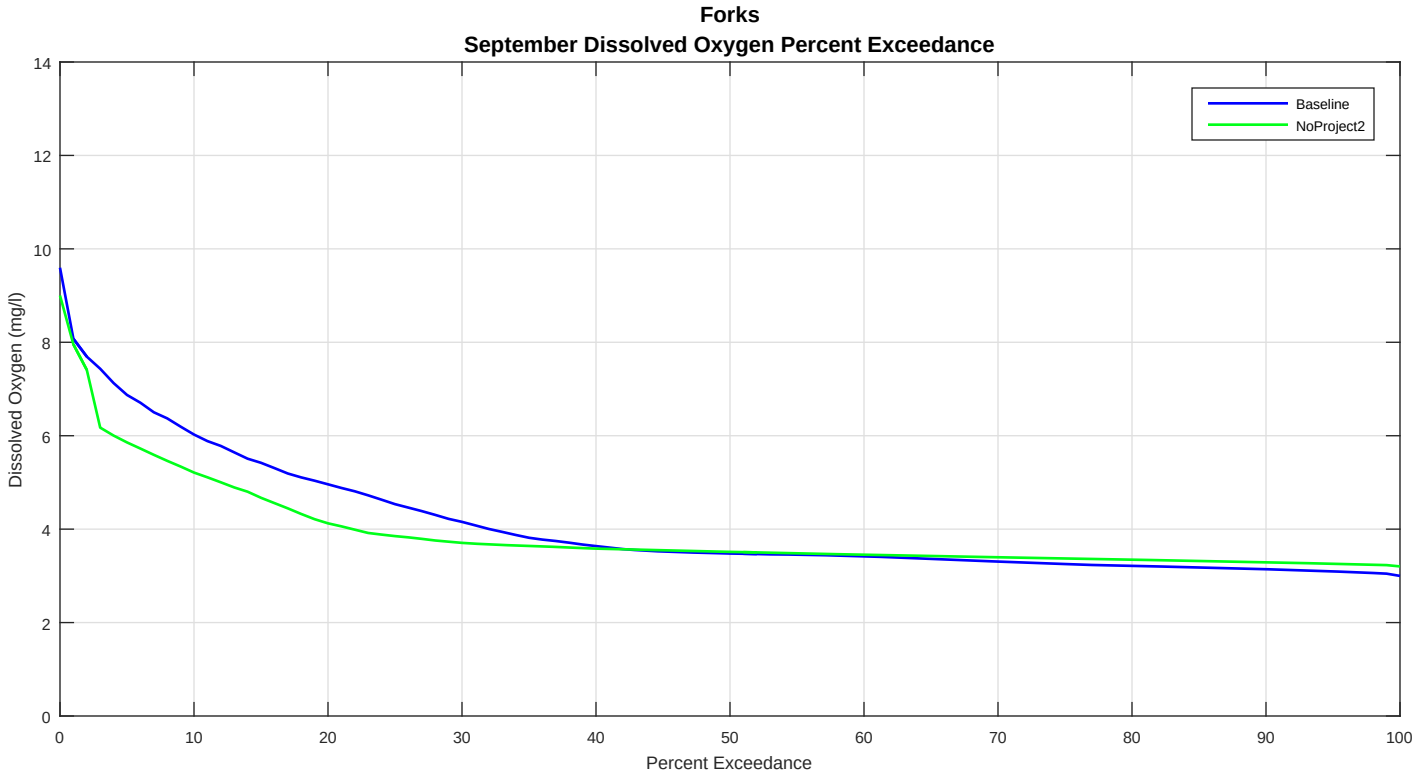
Forks
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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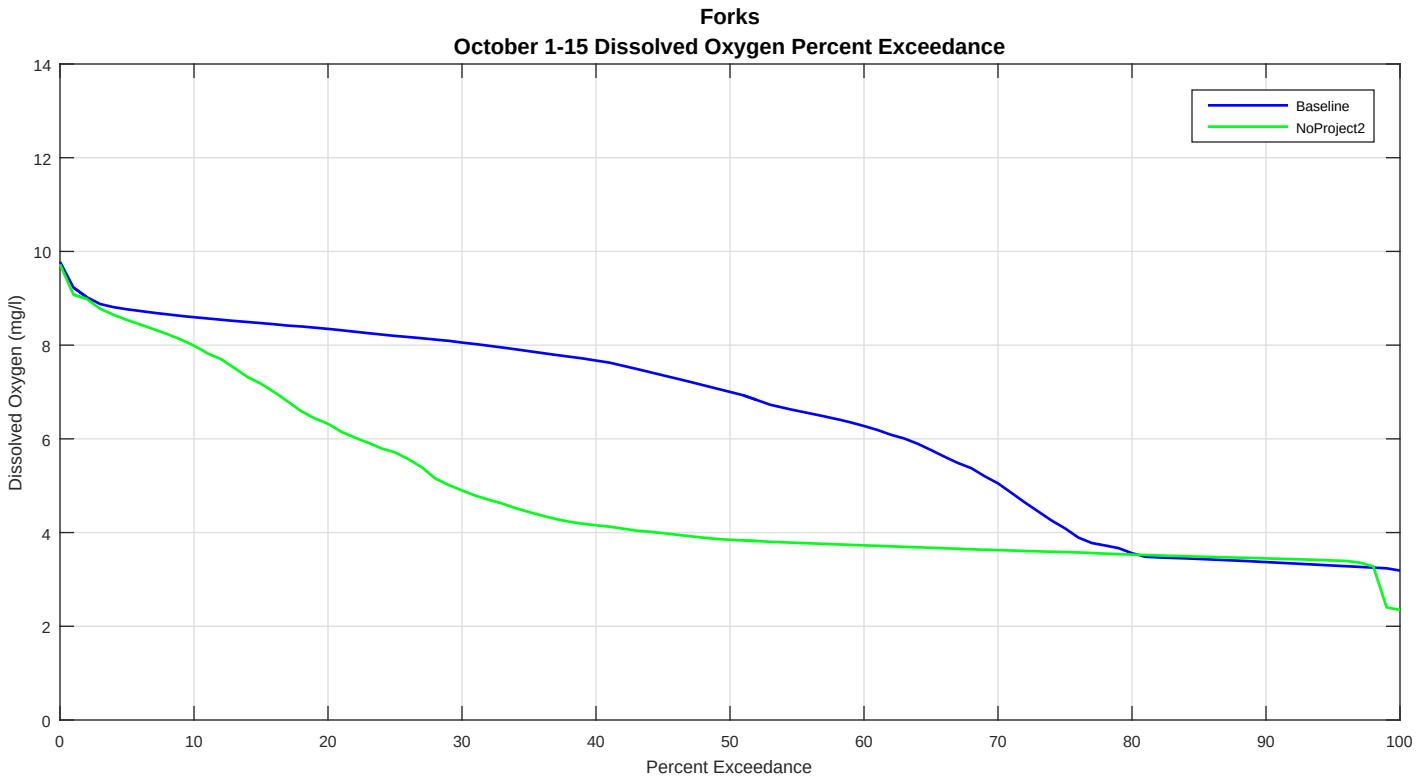
Forks
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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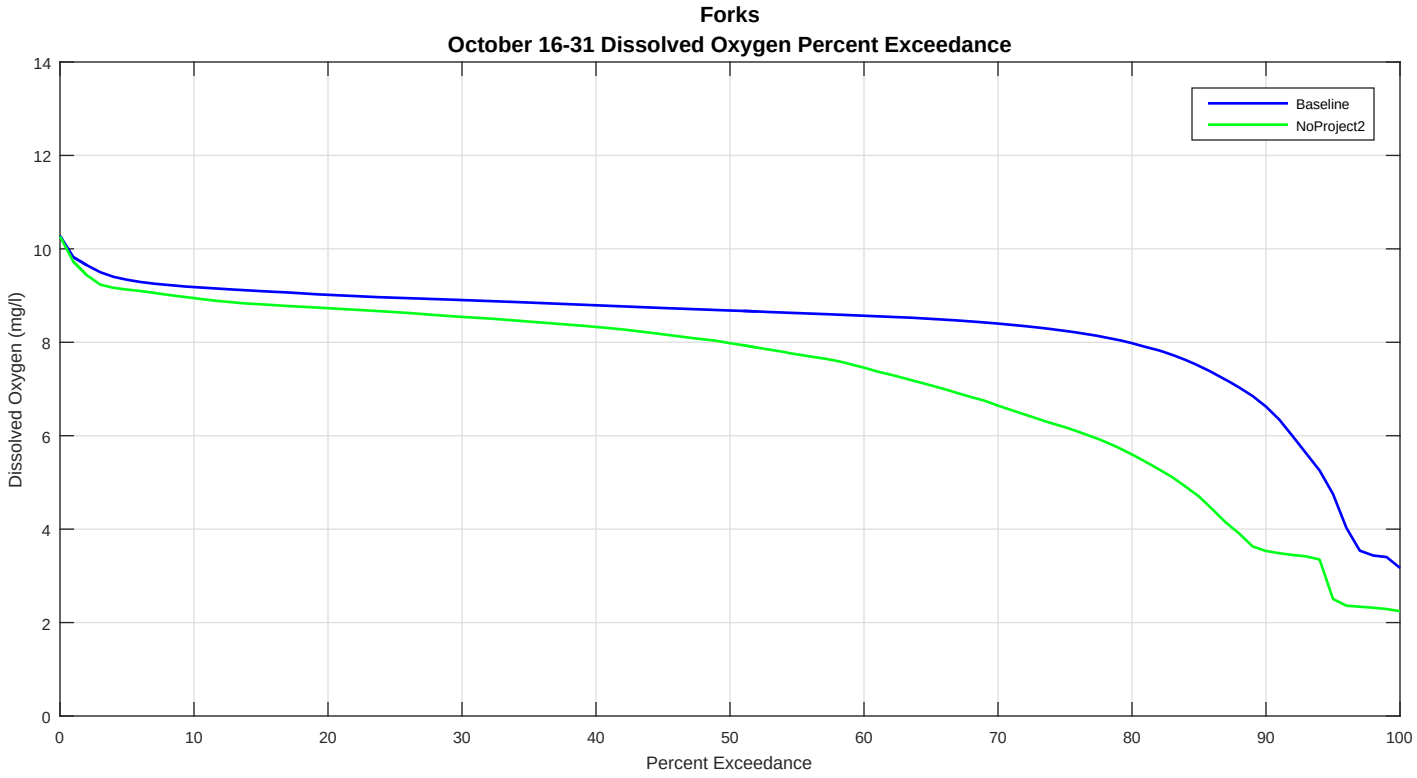
Forks
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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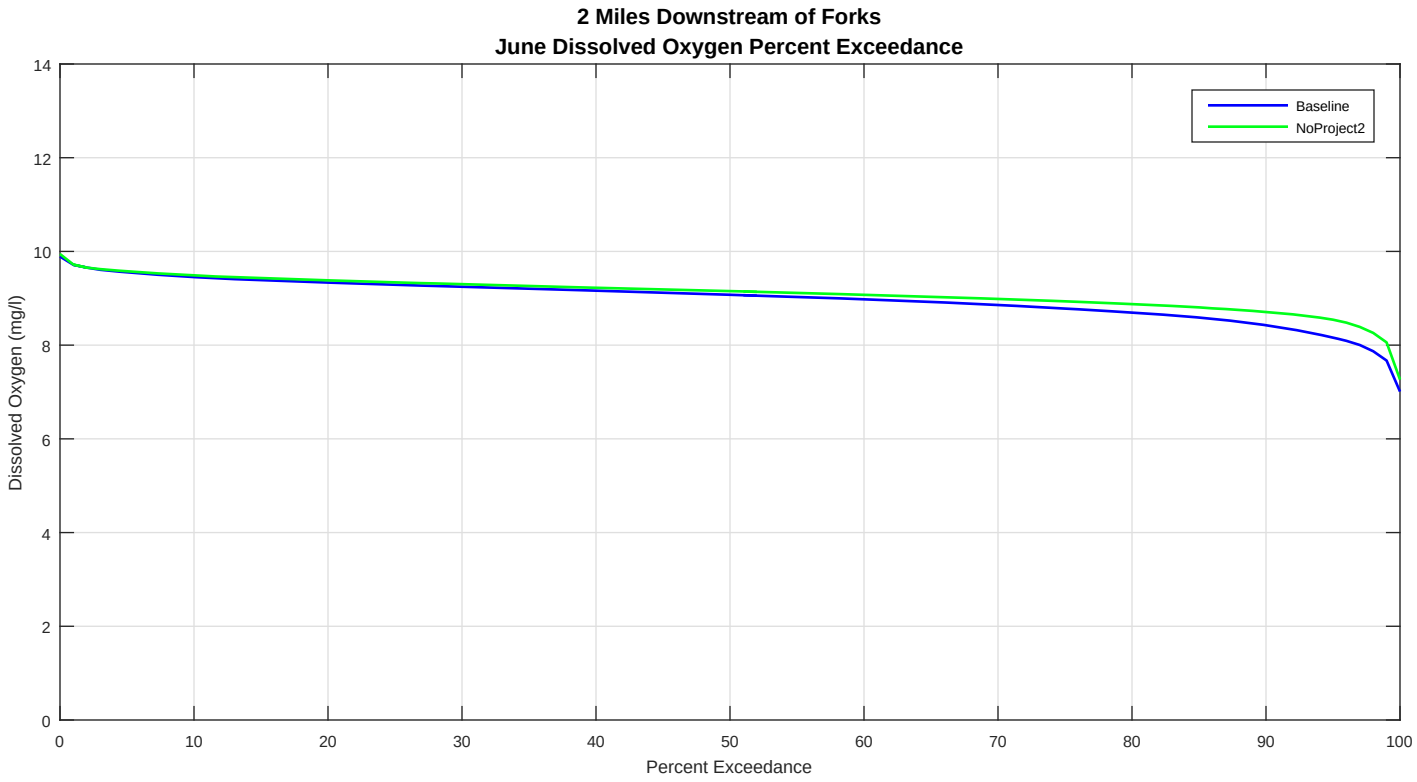
2 Miles Downstream of Forks
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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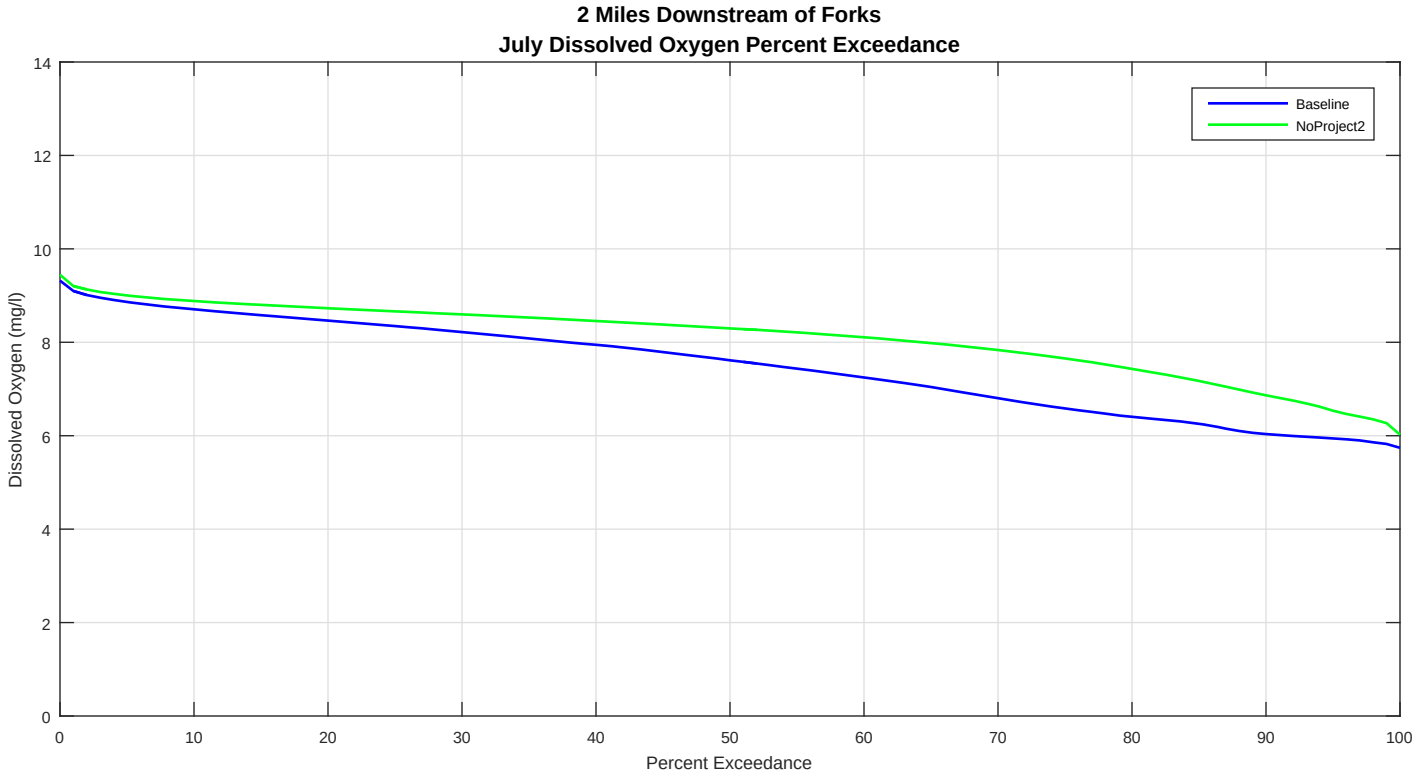
2 Miles Downstream of Forks
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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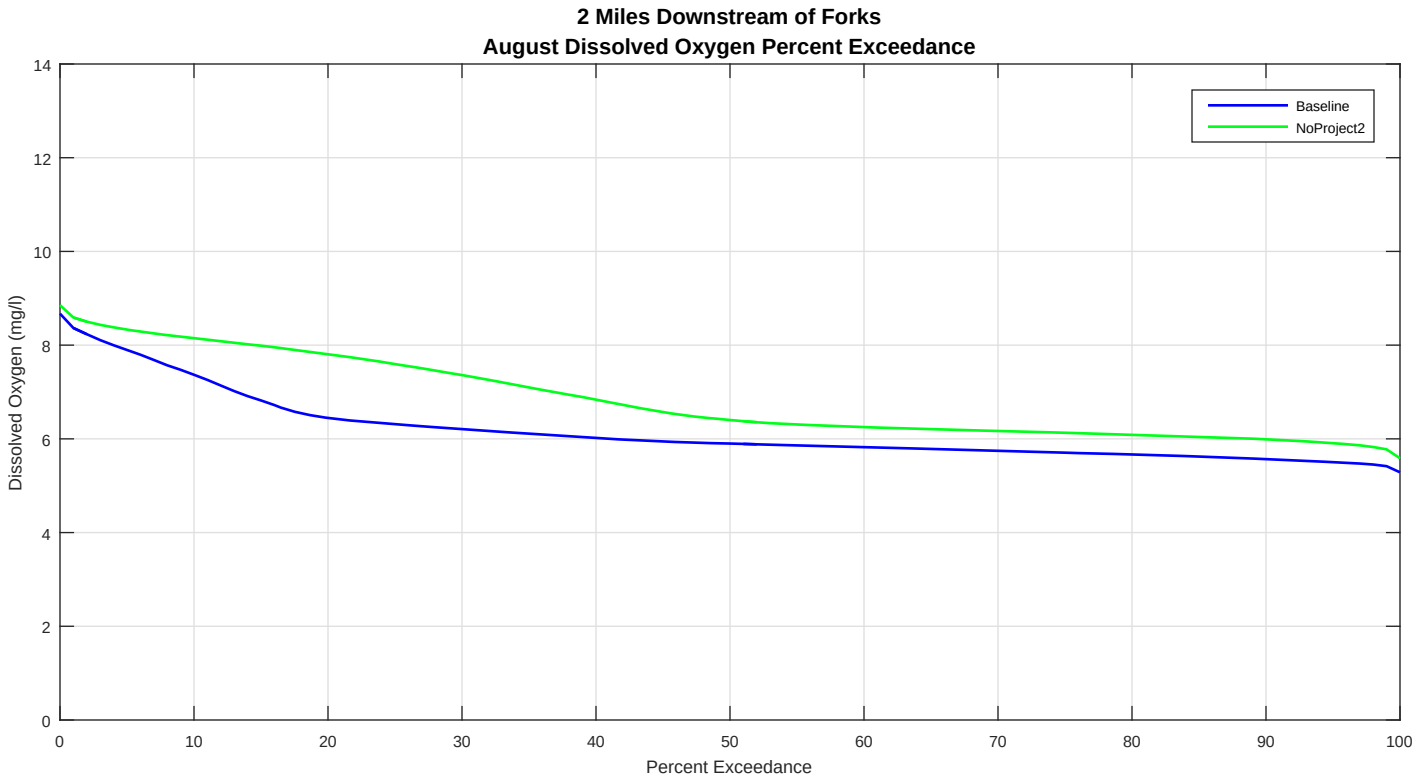
2 Miles Downstream of Forks
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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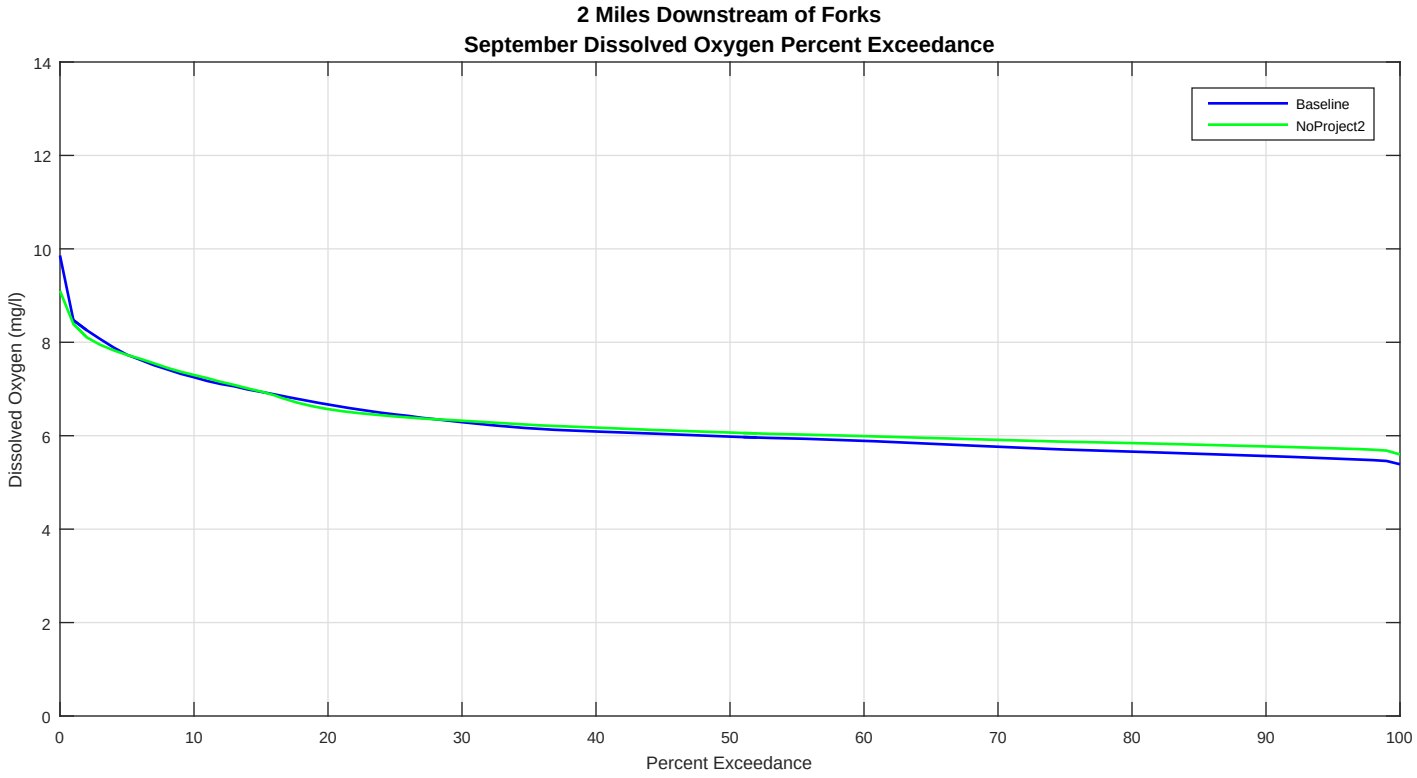
2 Miles Downstream of Forks
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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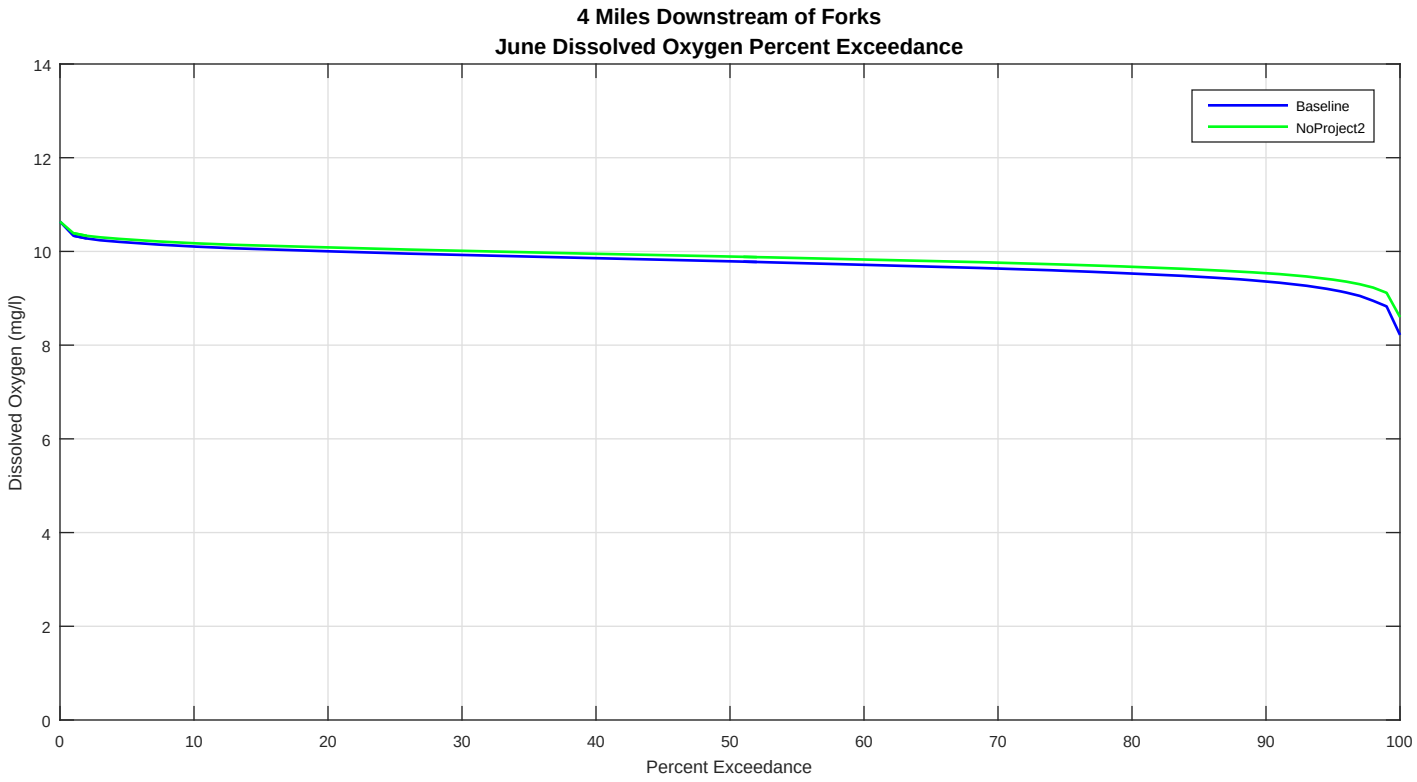
4 Miles Downstream of Forks
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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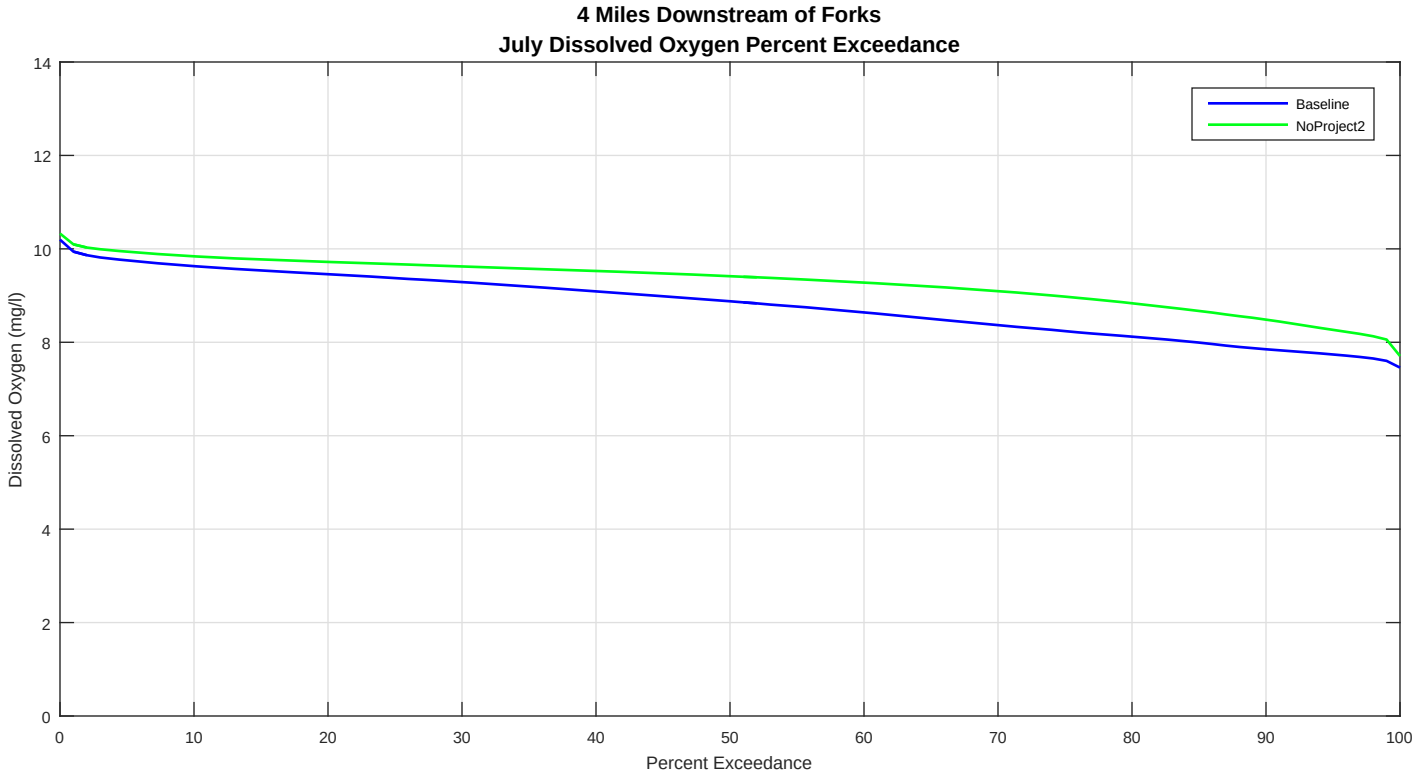
4 Miles Downstream of Forks
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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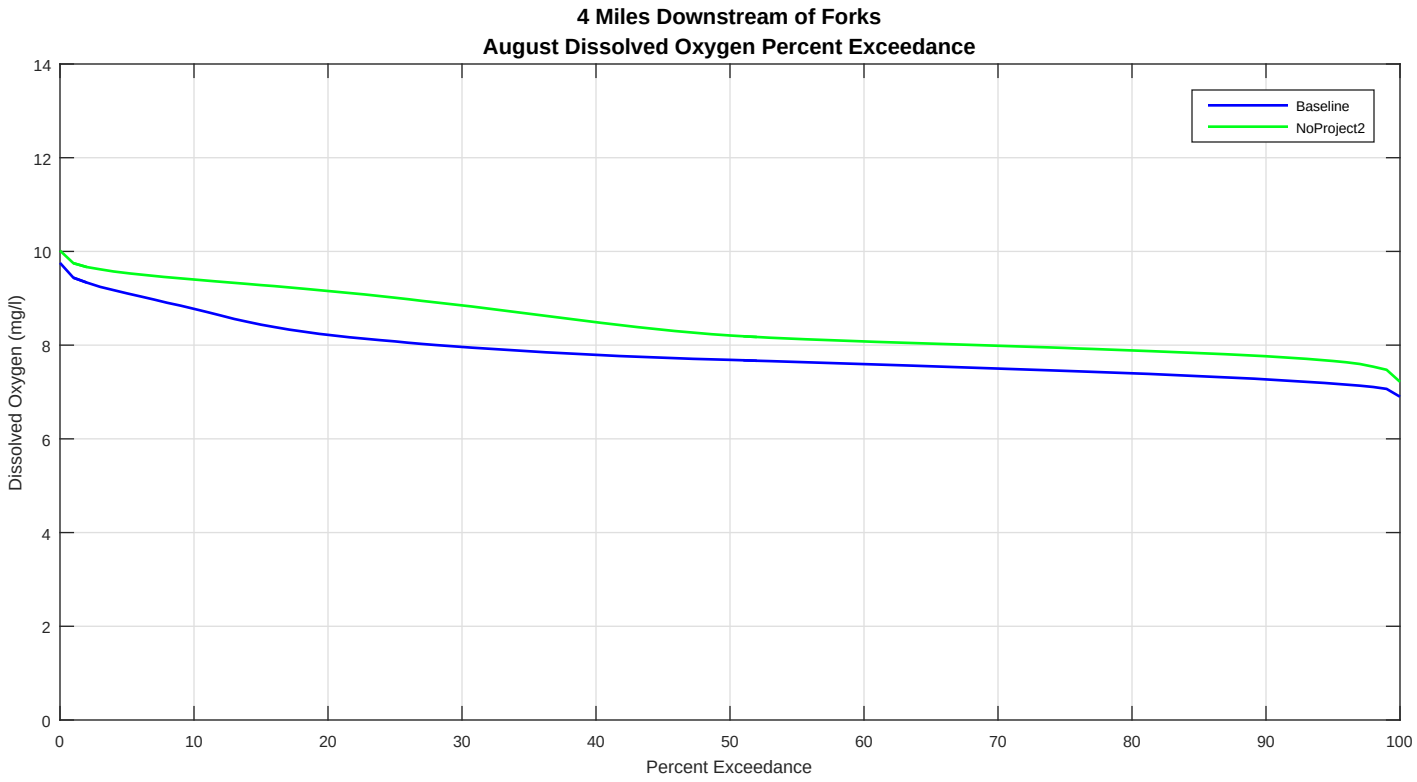
4 Miles Downstream of Forks
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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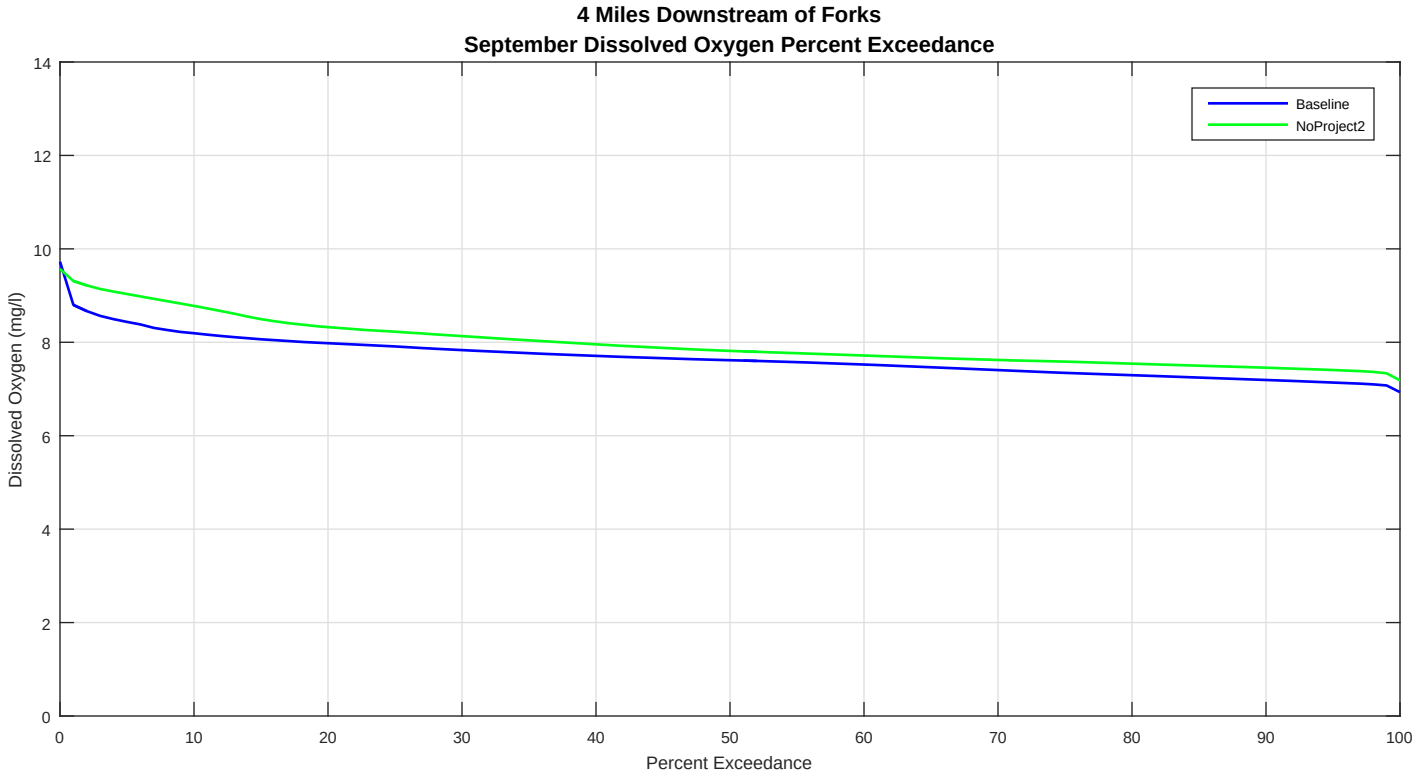
4 Miles Downstream of Forks
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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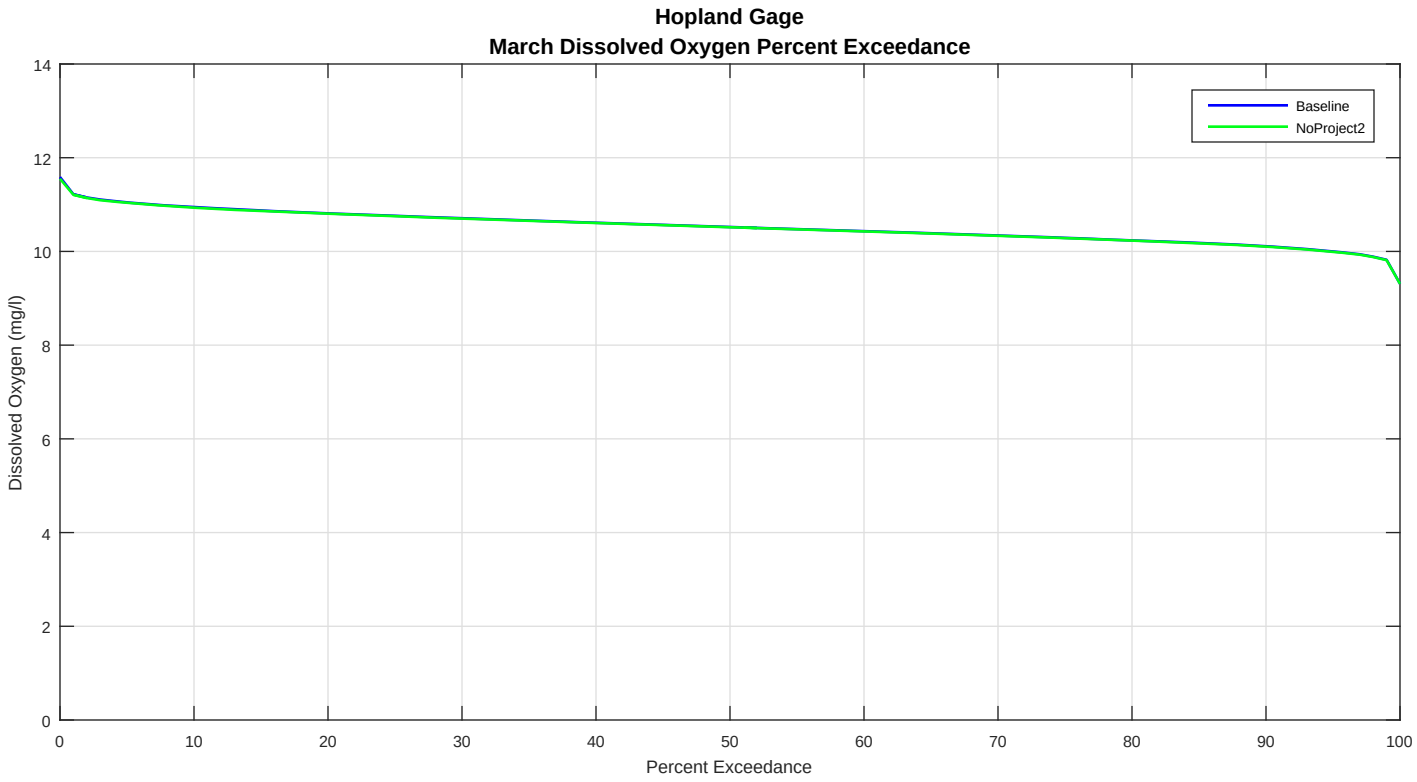
Hopland Gage
March Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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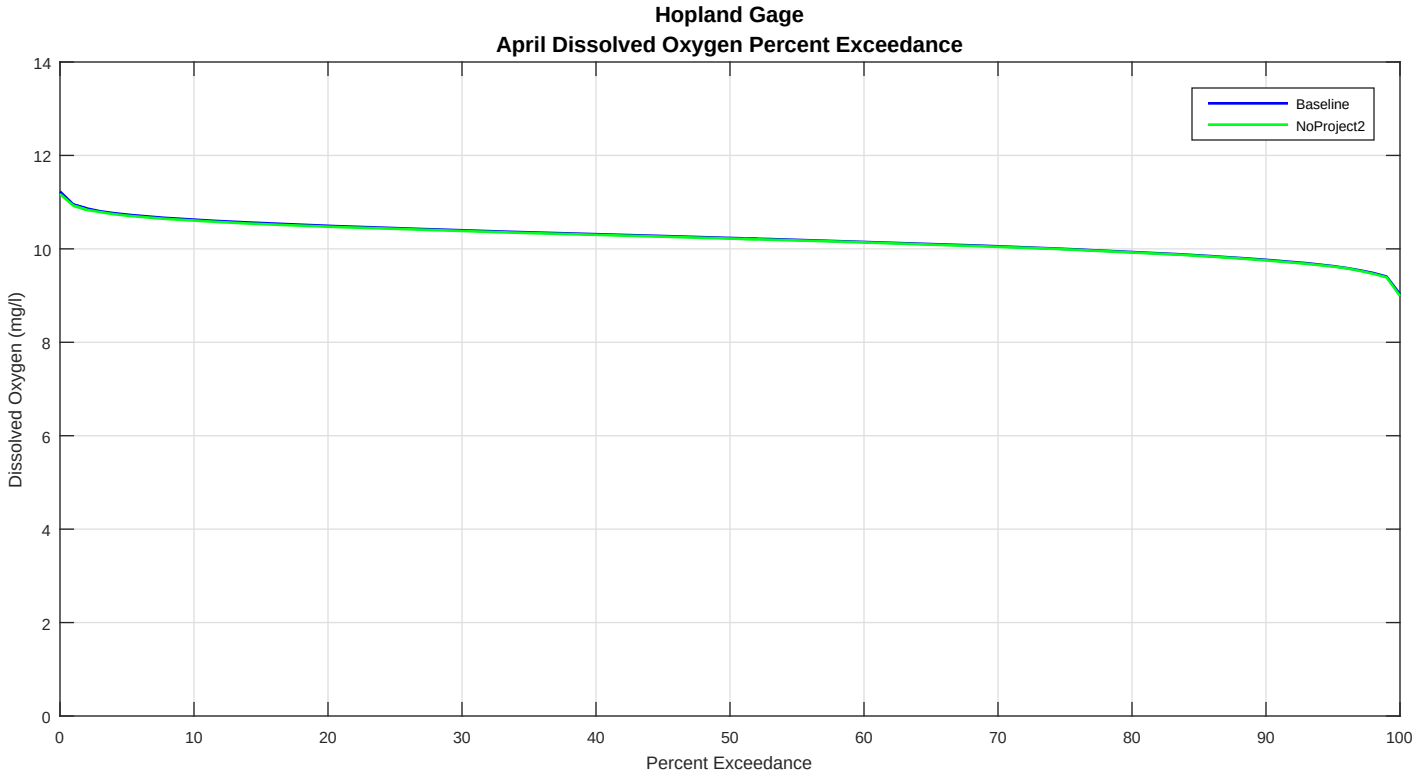
Hopland Gage
April Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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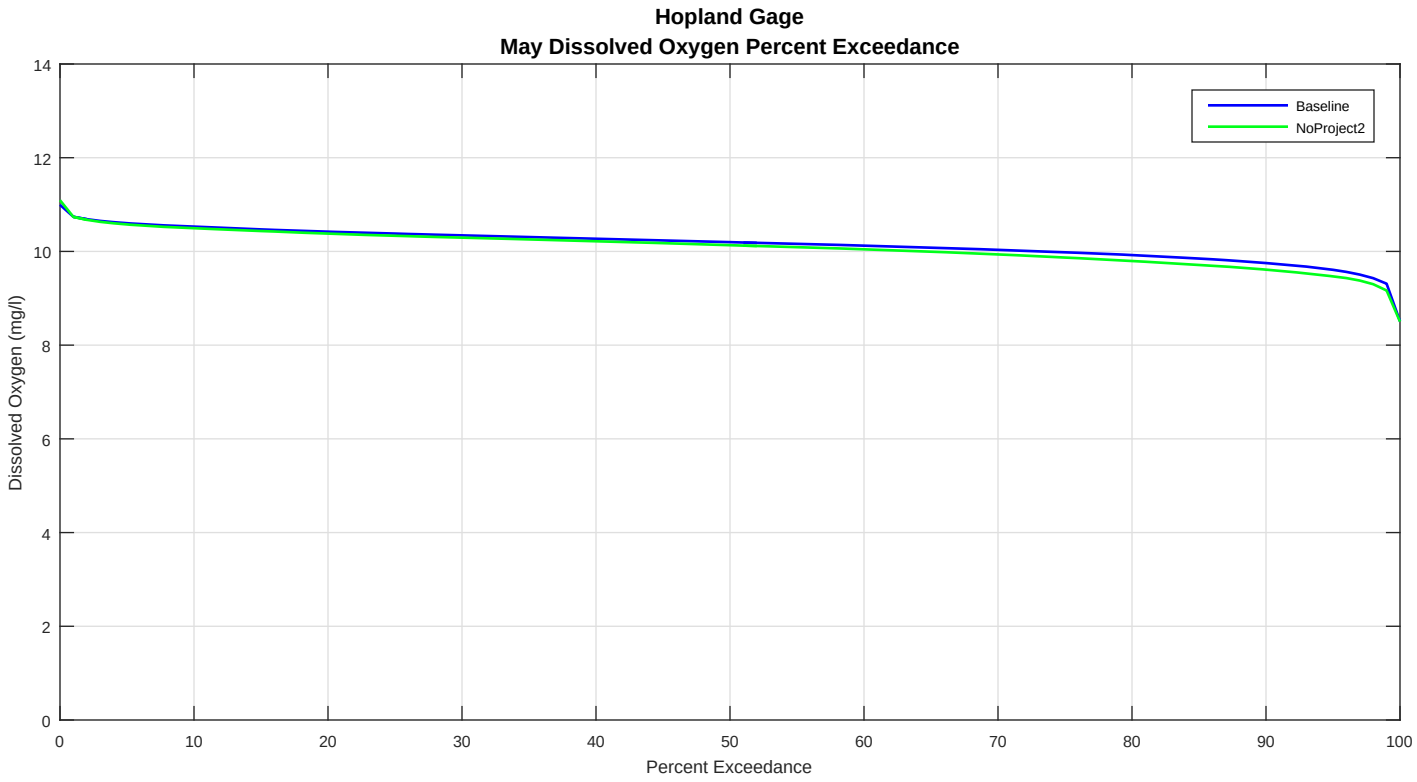
Hopland Gage
May Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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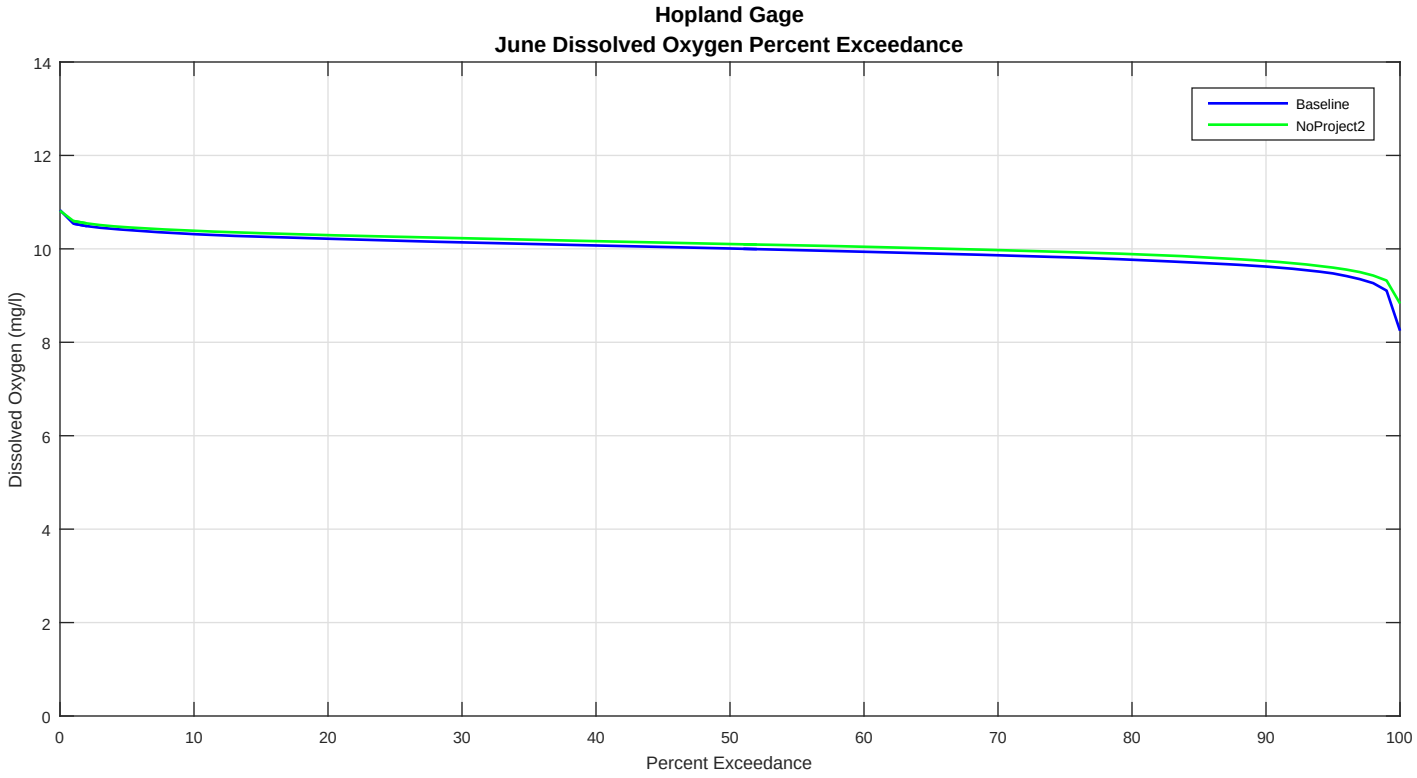
Hopland Gage
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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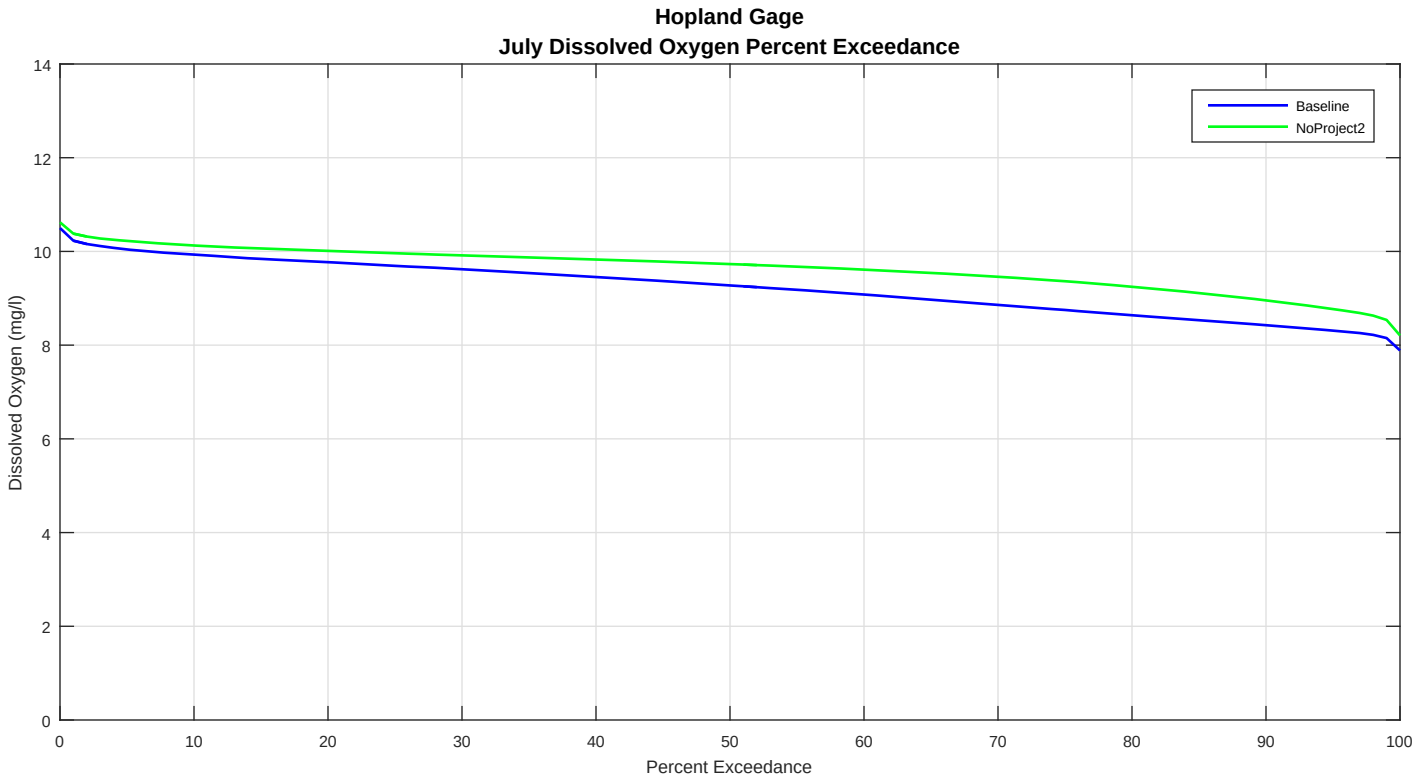
Hopland Gage
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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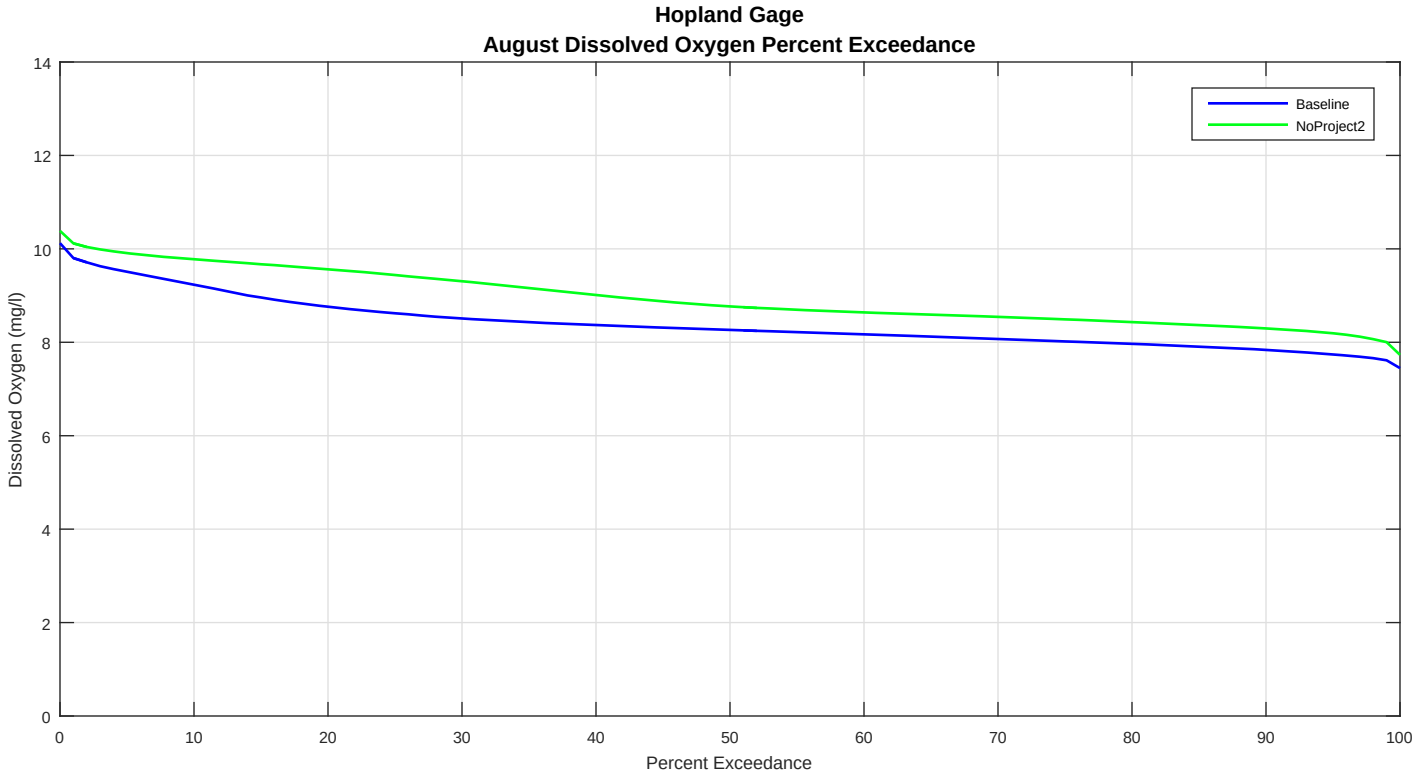
Hopland Gage
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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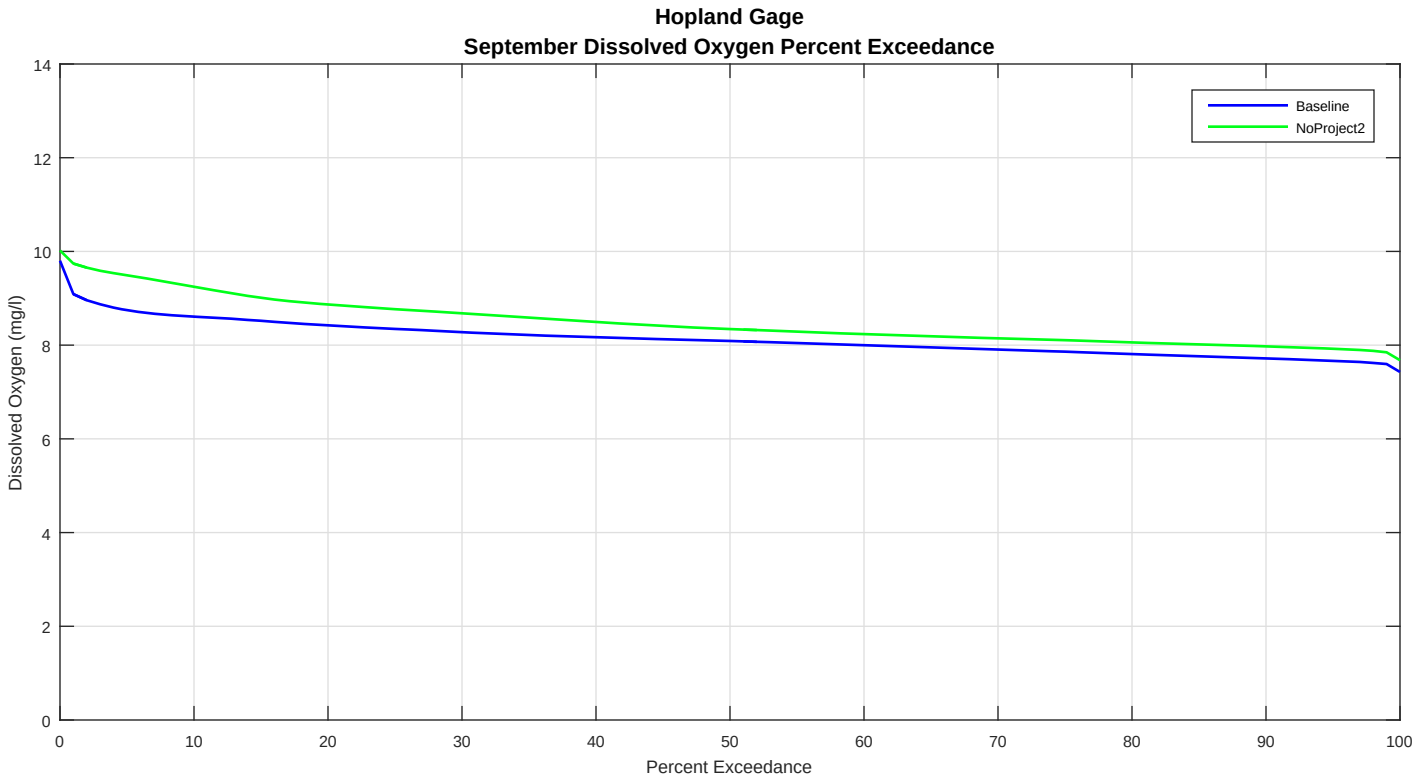
Hopland Gage
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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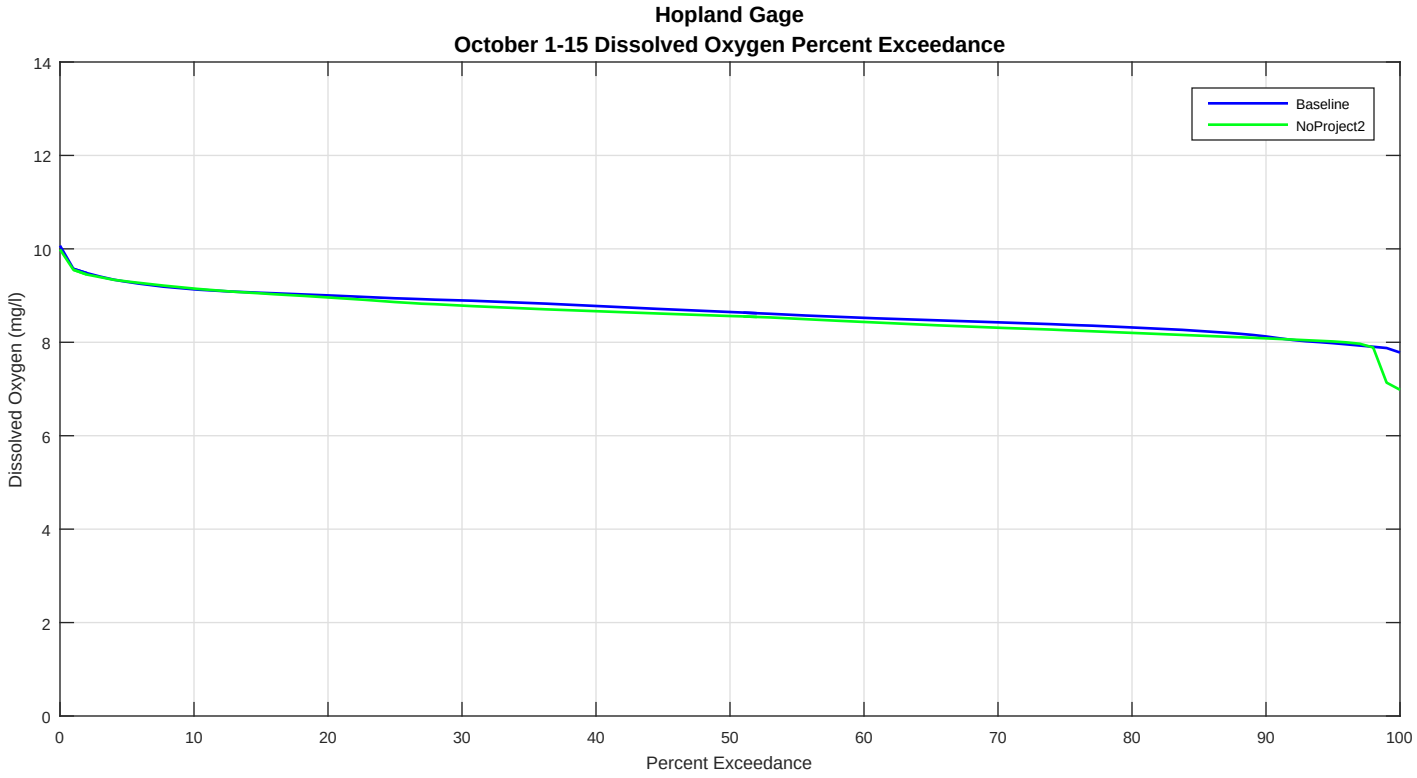
Hopland Gage
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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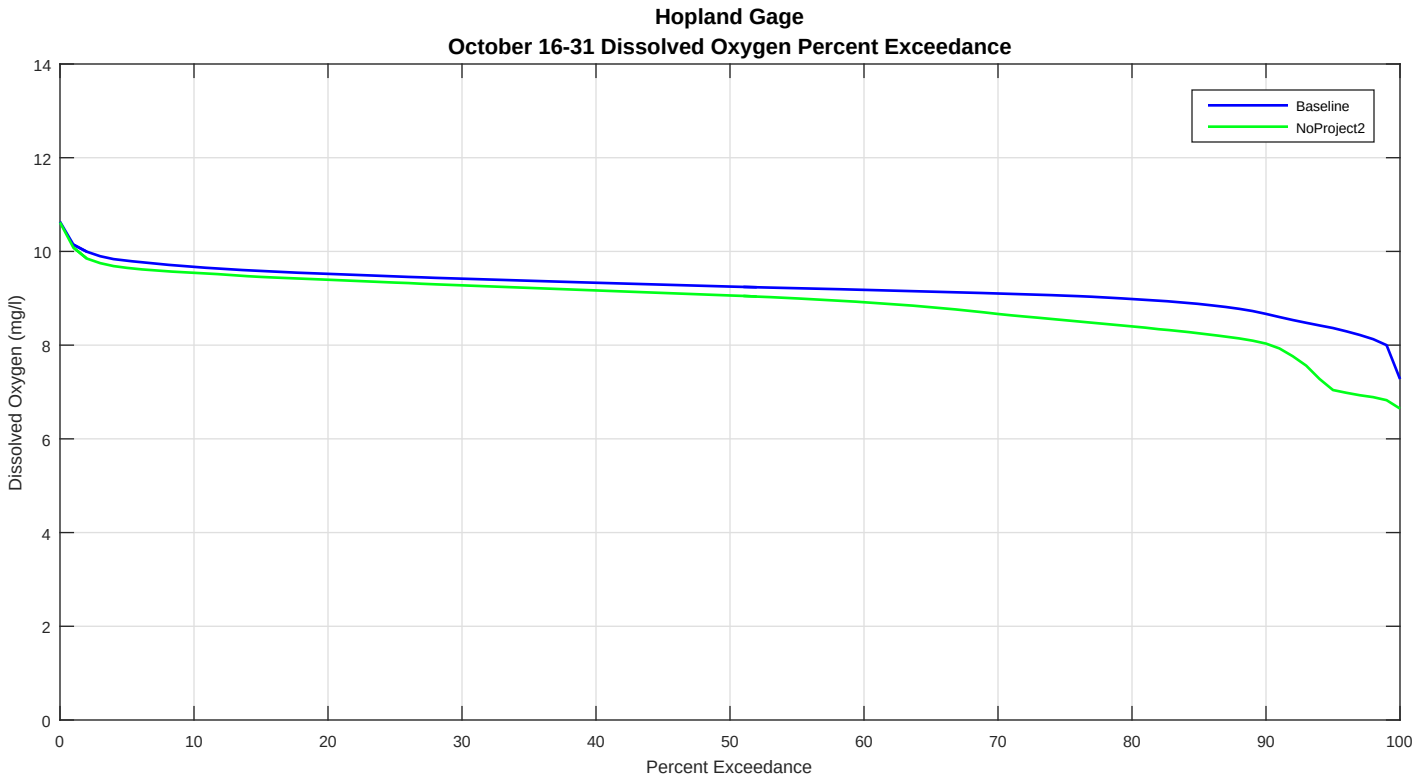
Hopland Gage
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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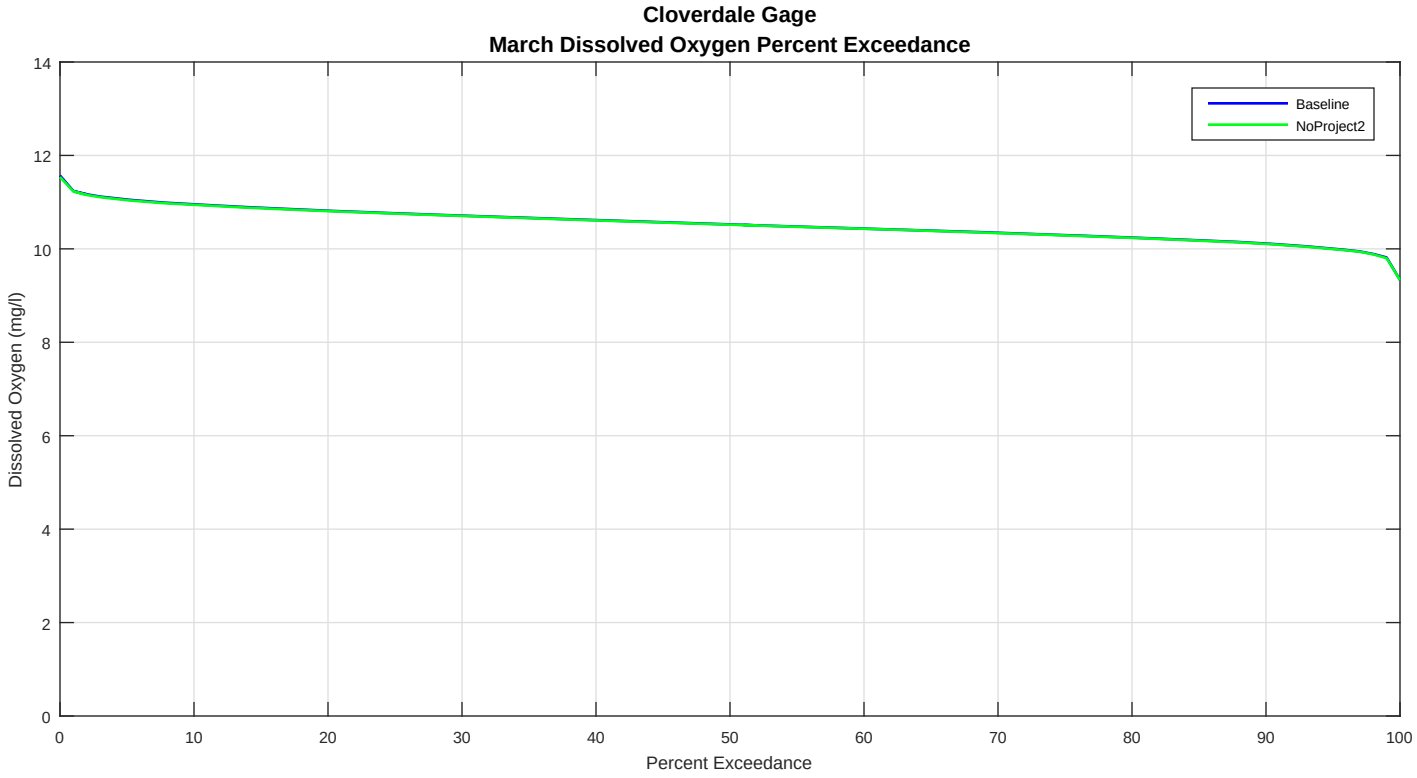
Cloverdale Gage
March Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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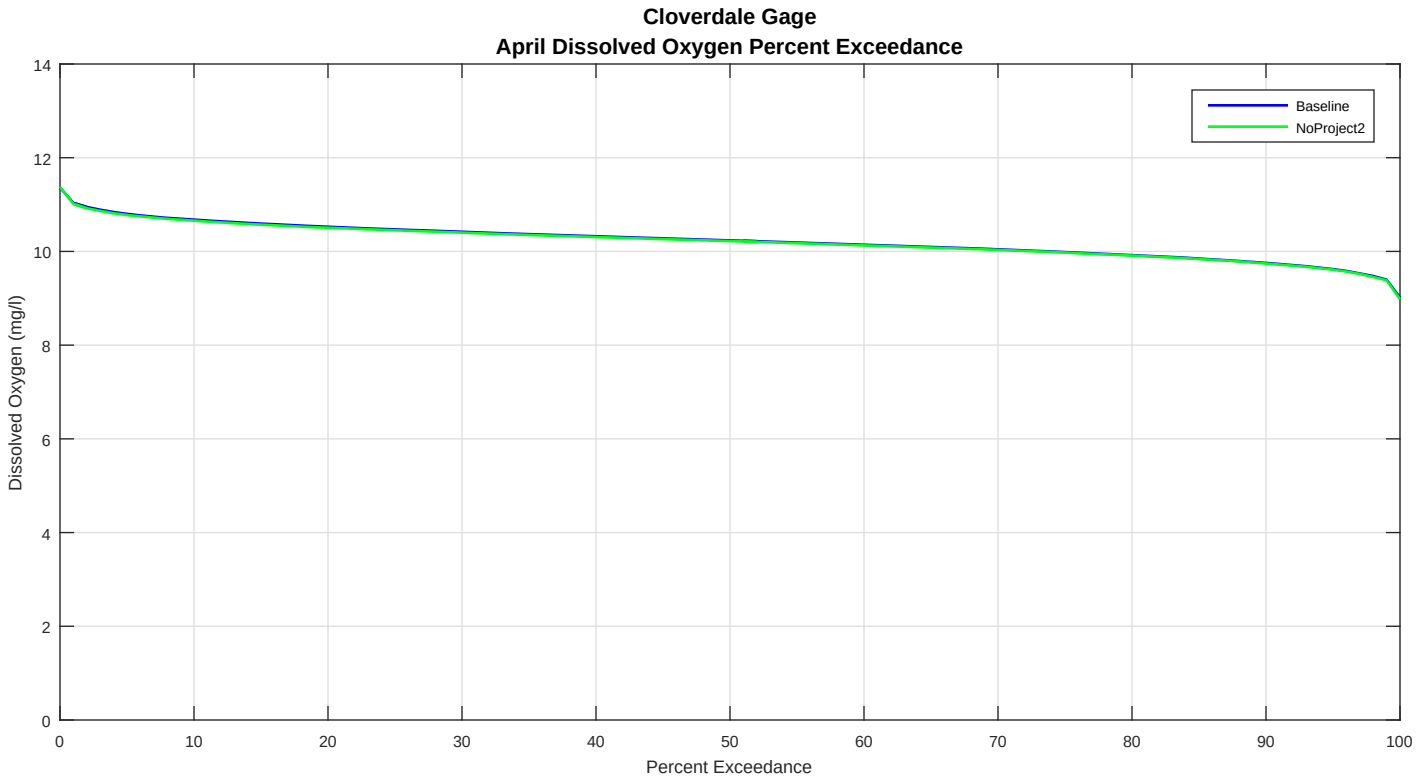
Cloverdale Gage
April Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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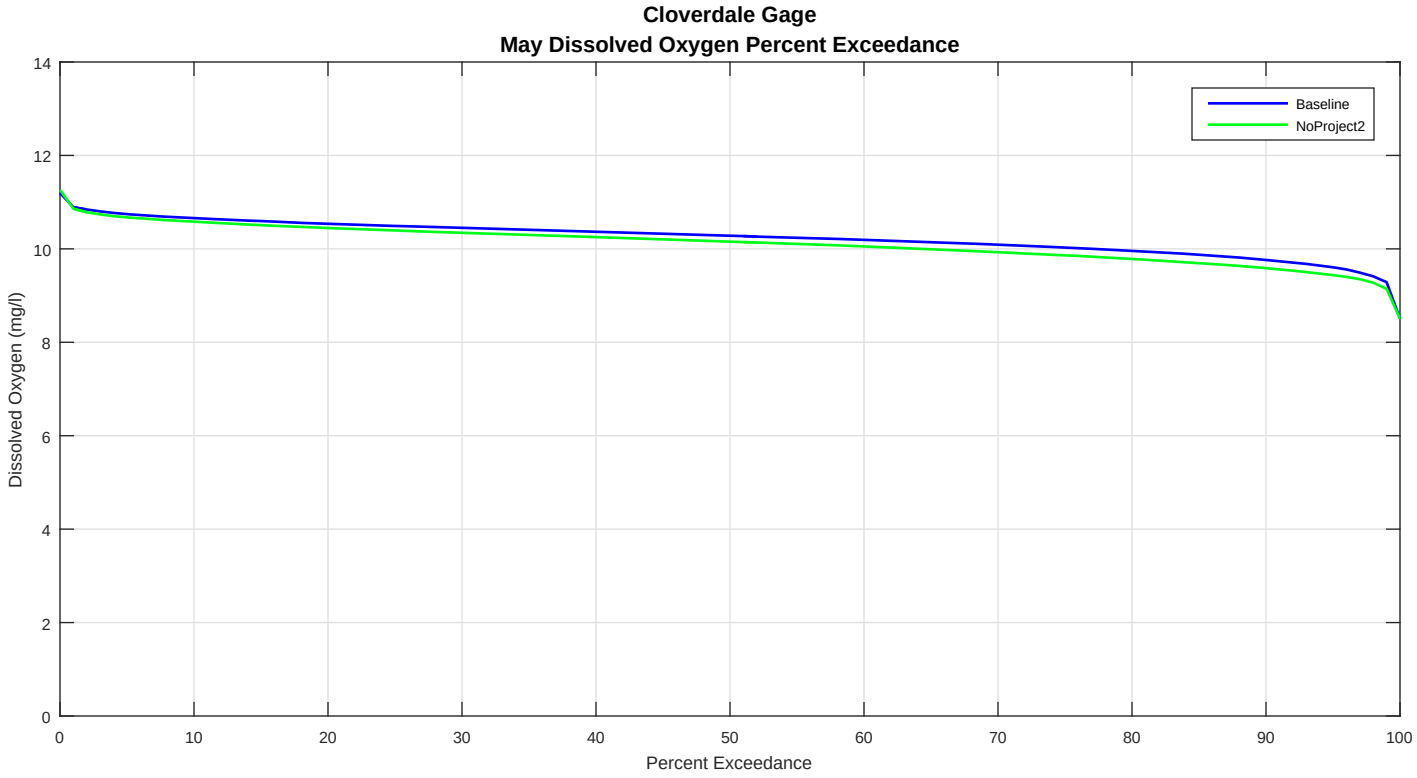
Cloverdale Gage
May Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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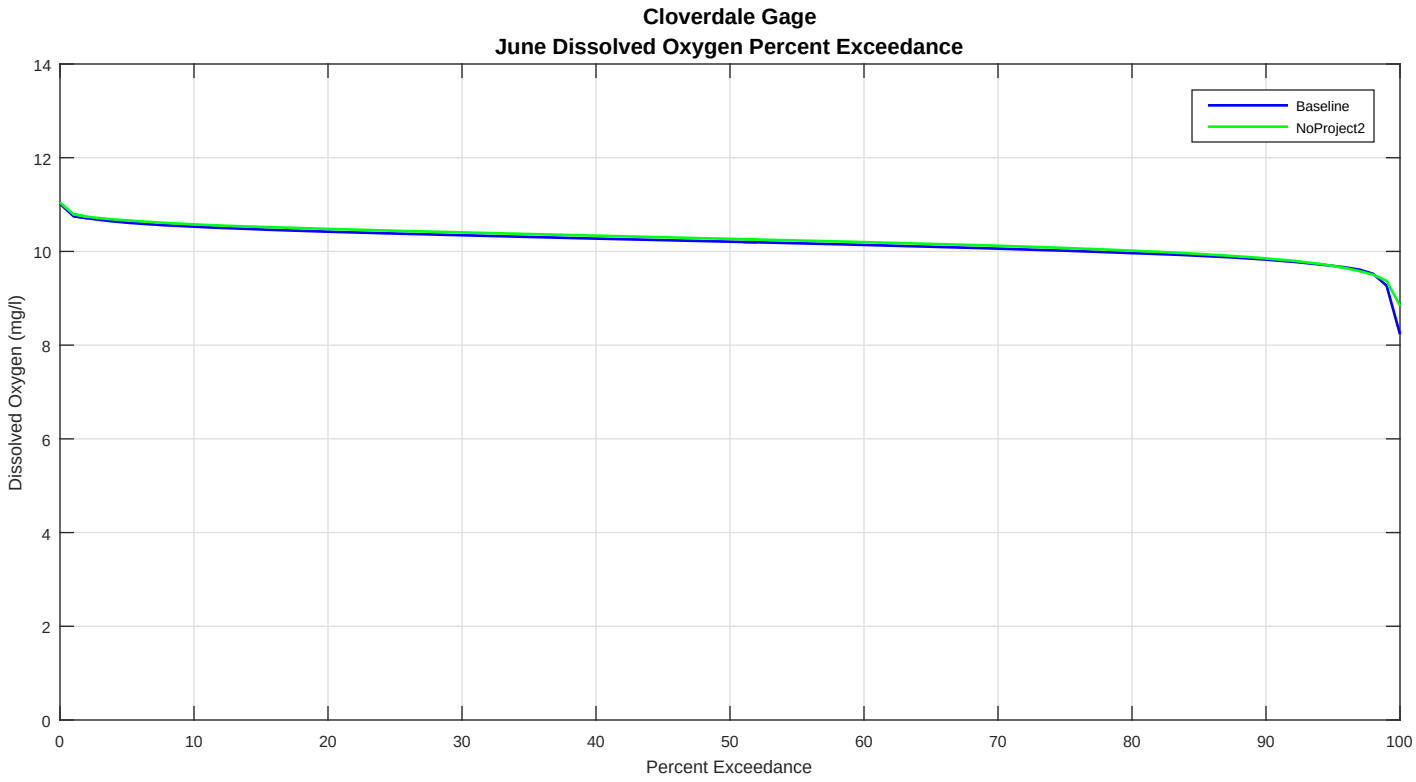
Cloverdale Gage
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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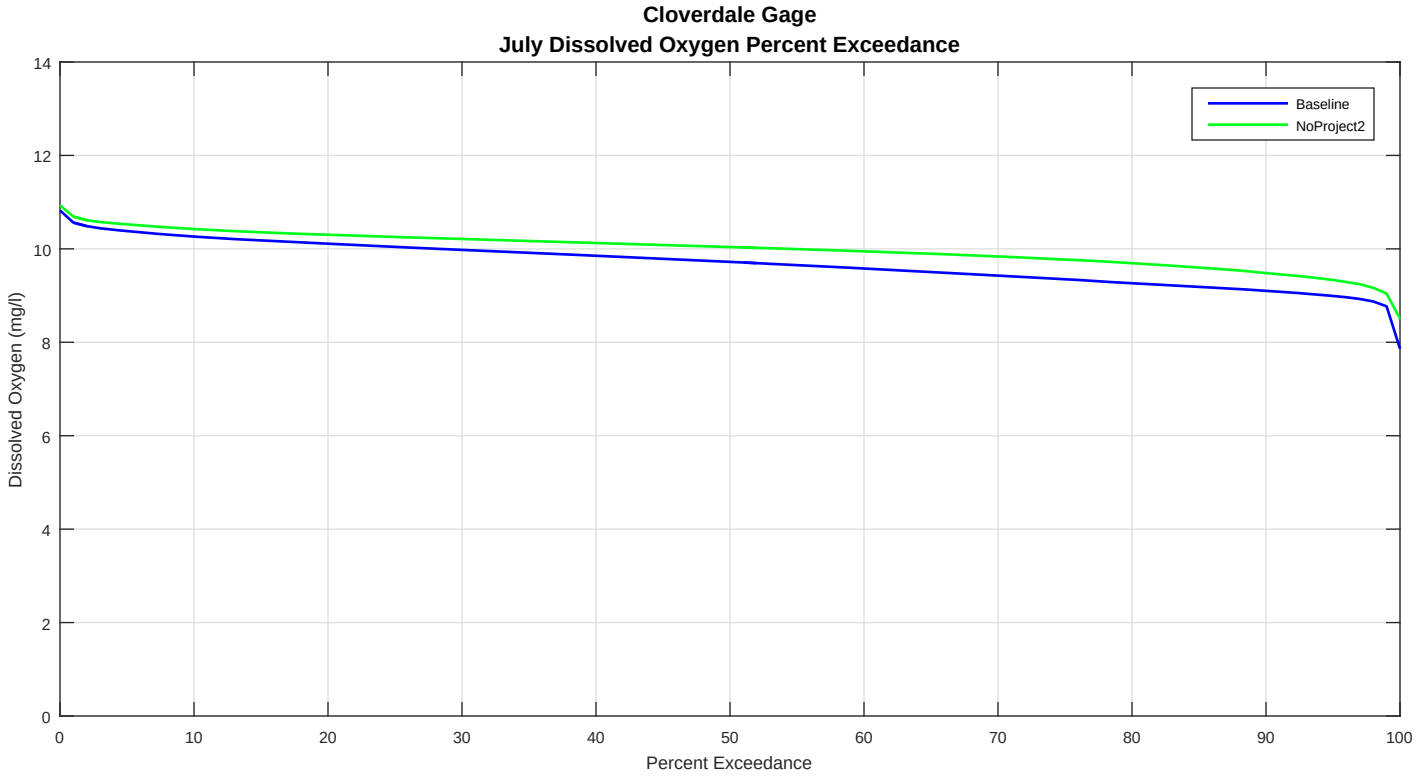
Cloverdale Gage
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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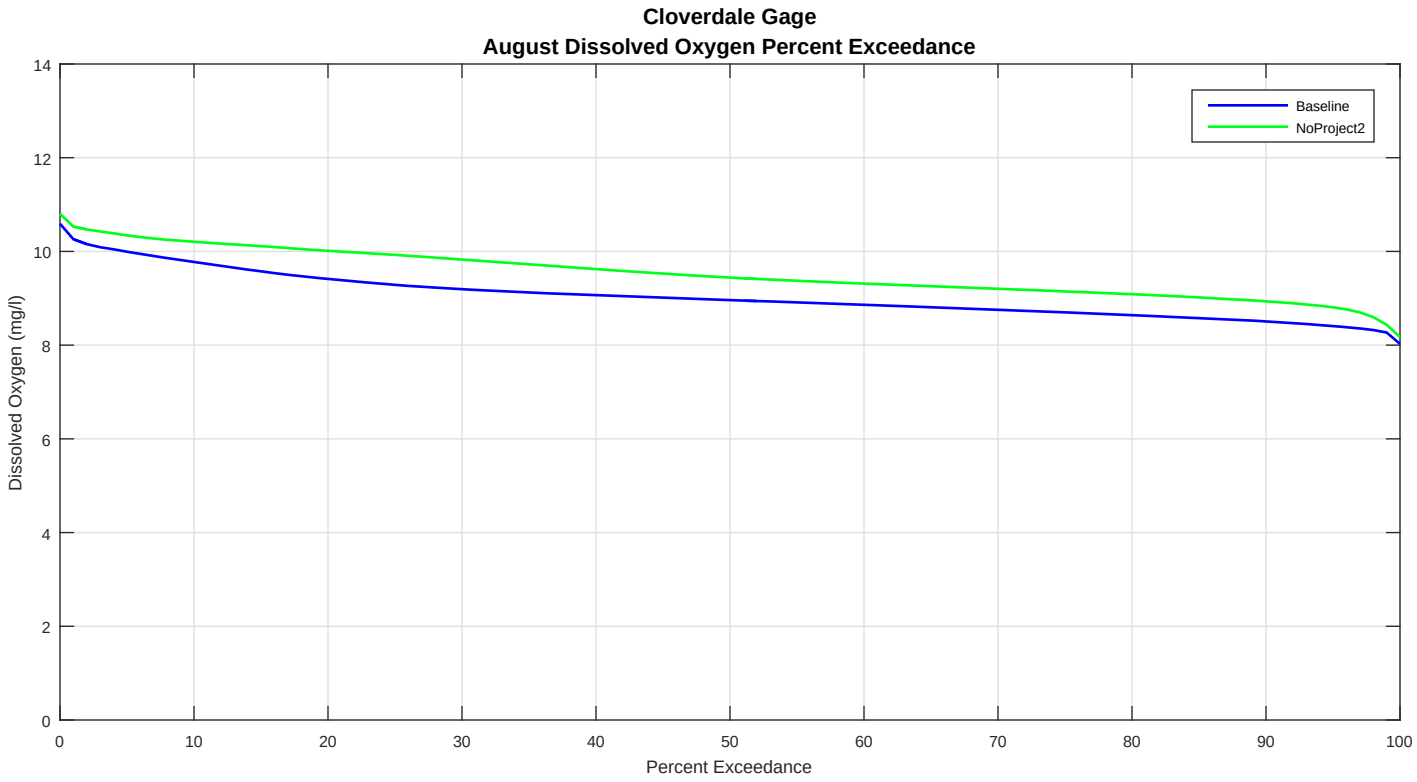
Cloverdale Gage
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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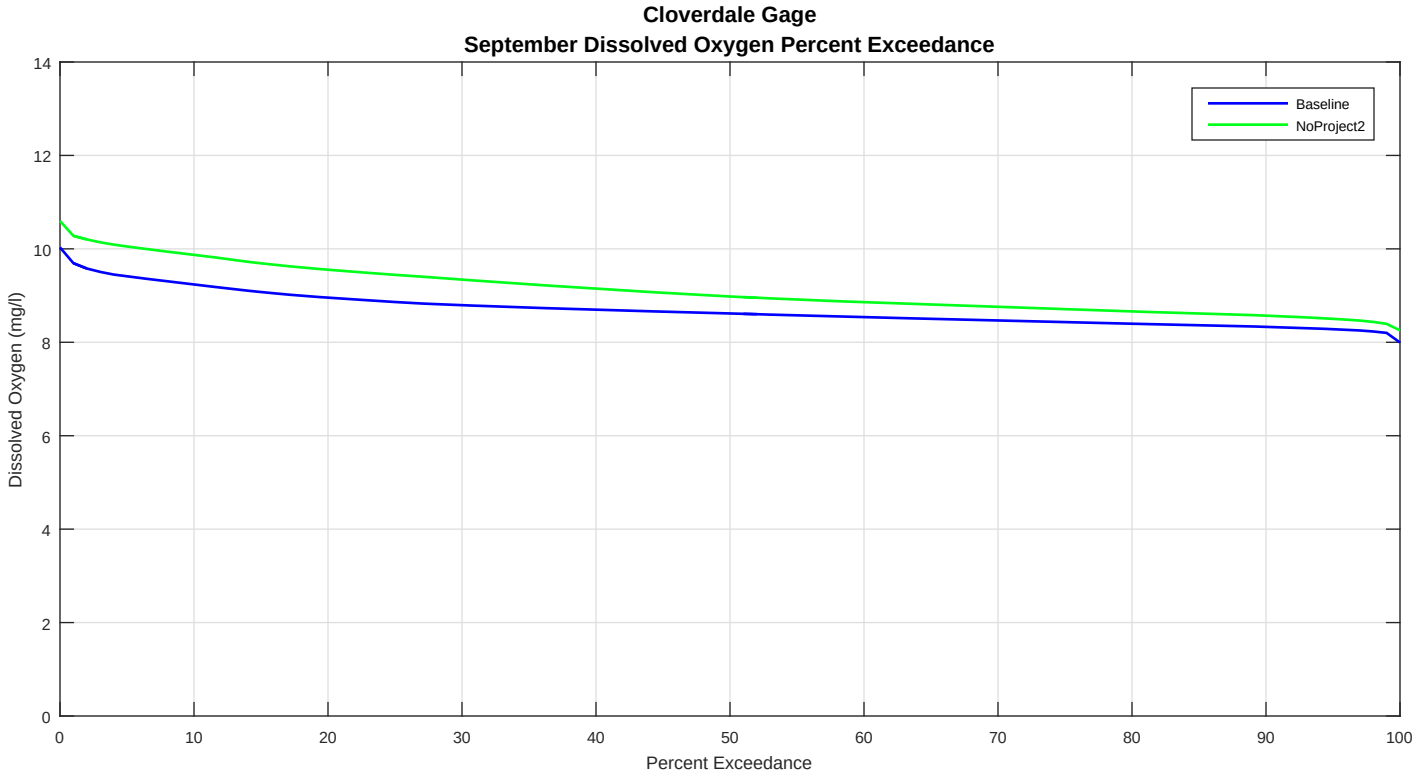
Cloverdale Gage
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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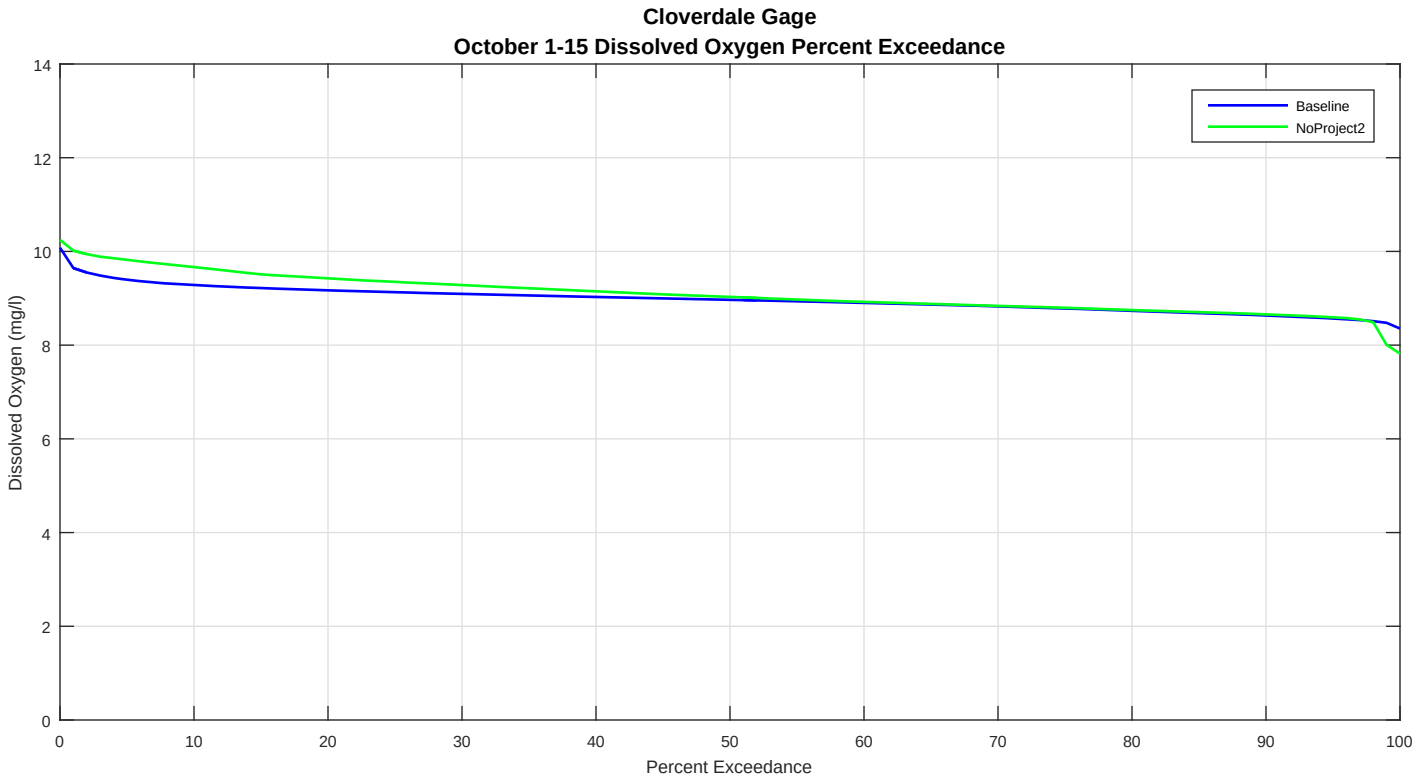
Cloverdale Gage
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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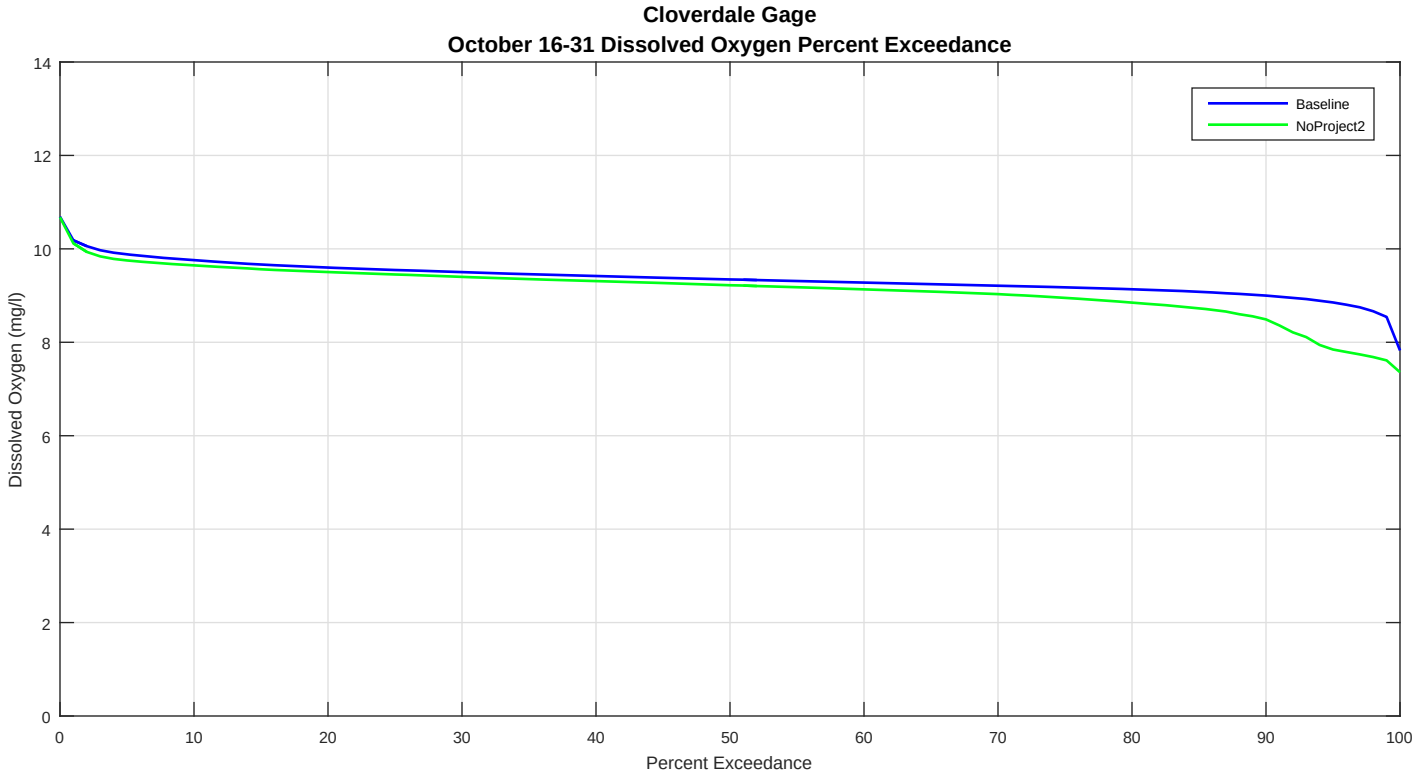
Cloverdale Gage
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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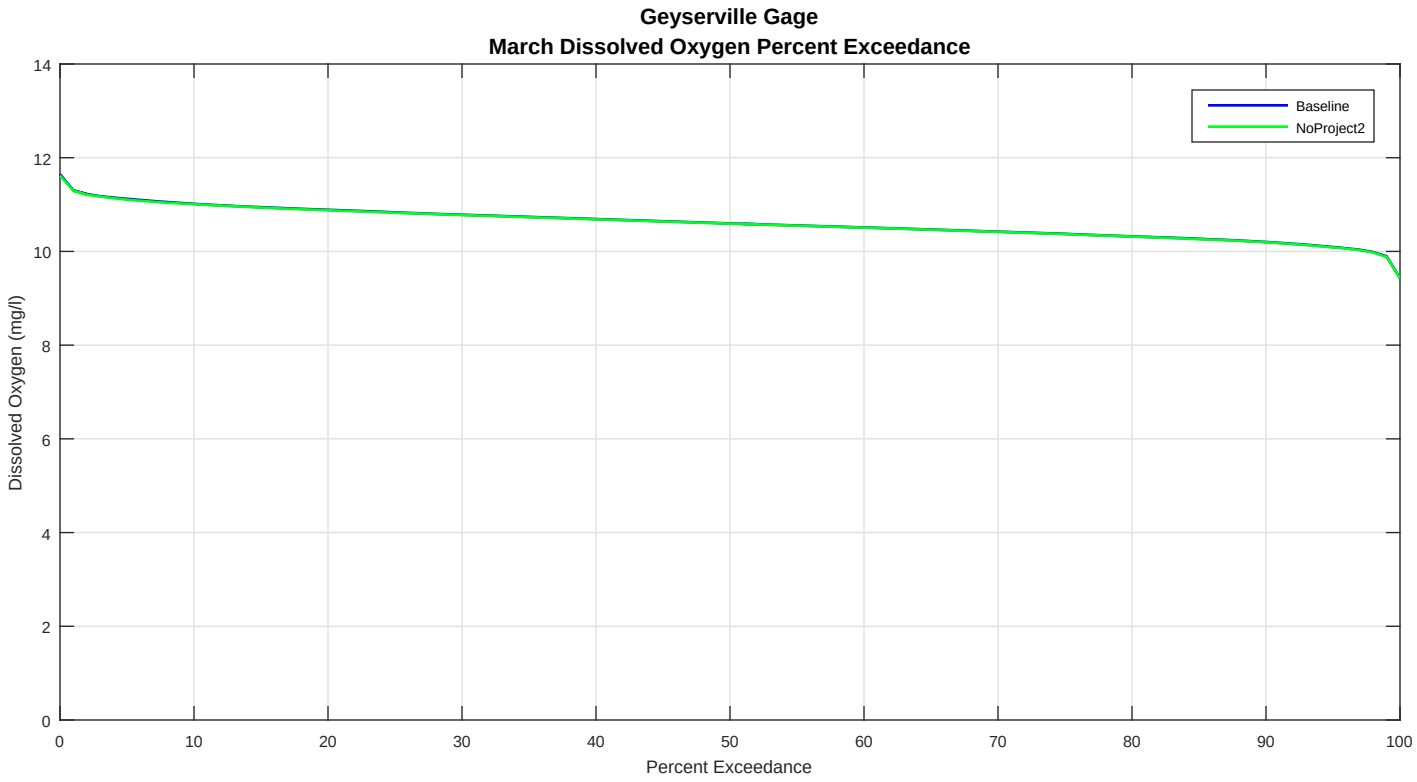
Geyserville Gage
March Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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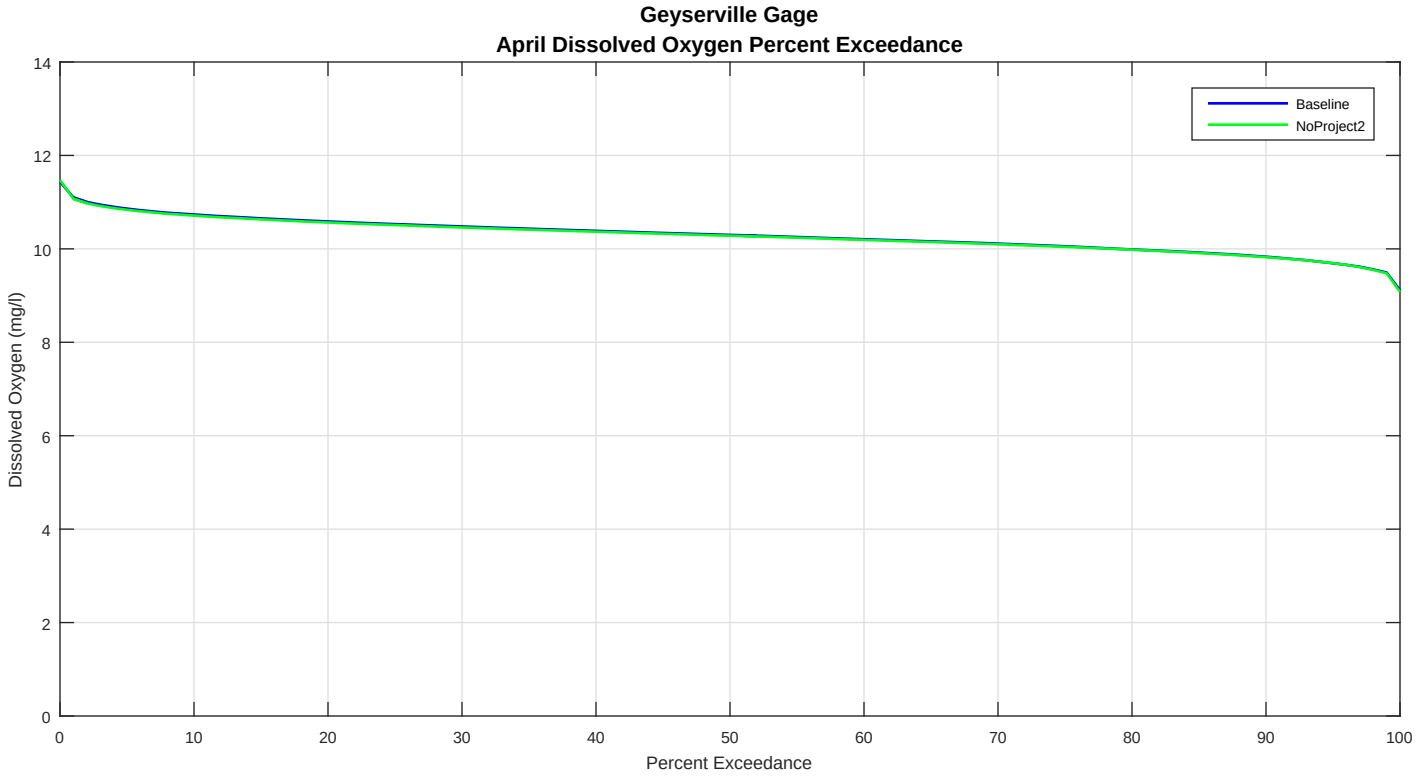
Geyserville Gage
April Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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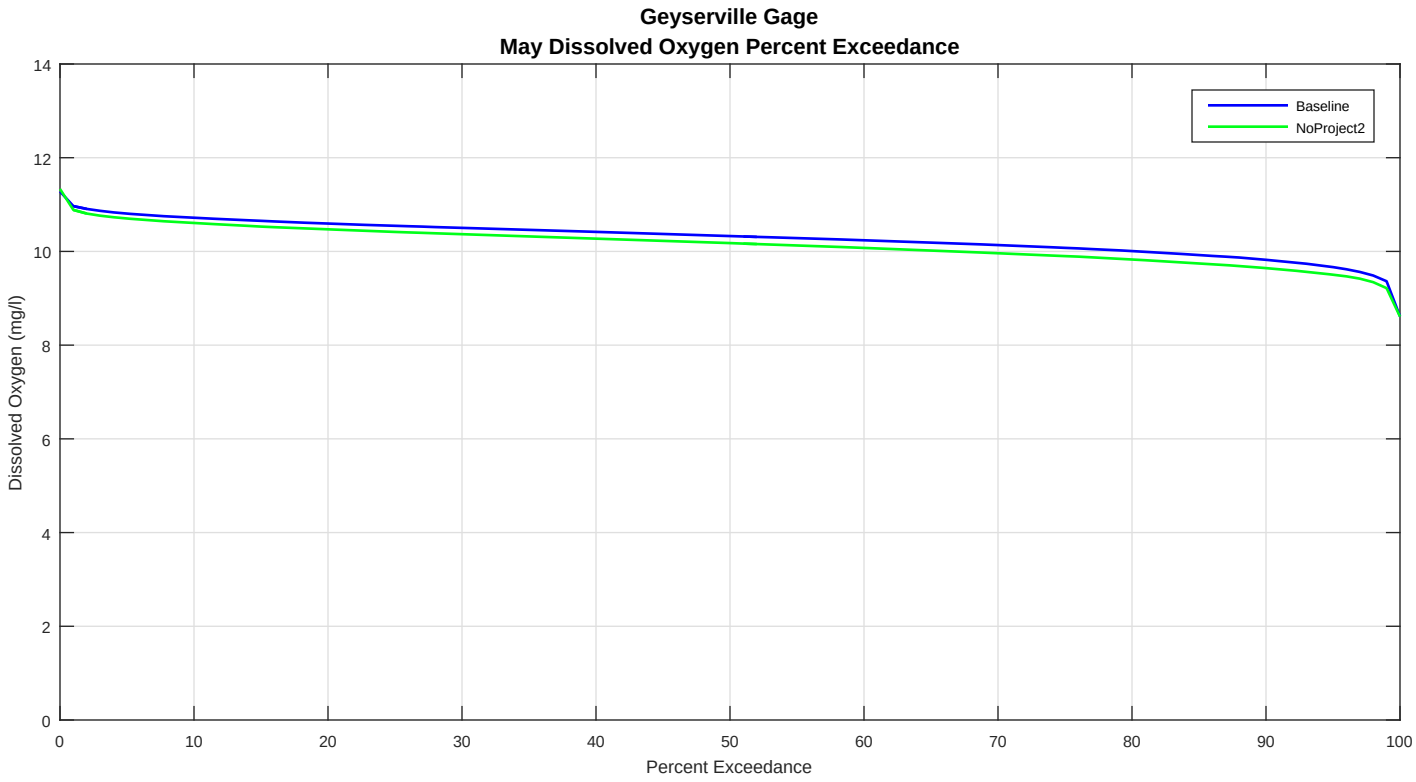
Geyserville Gage
May Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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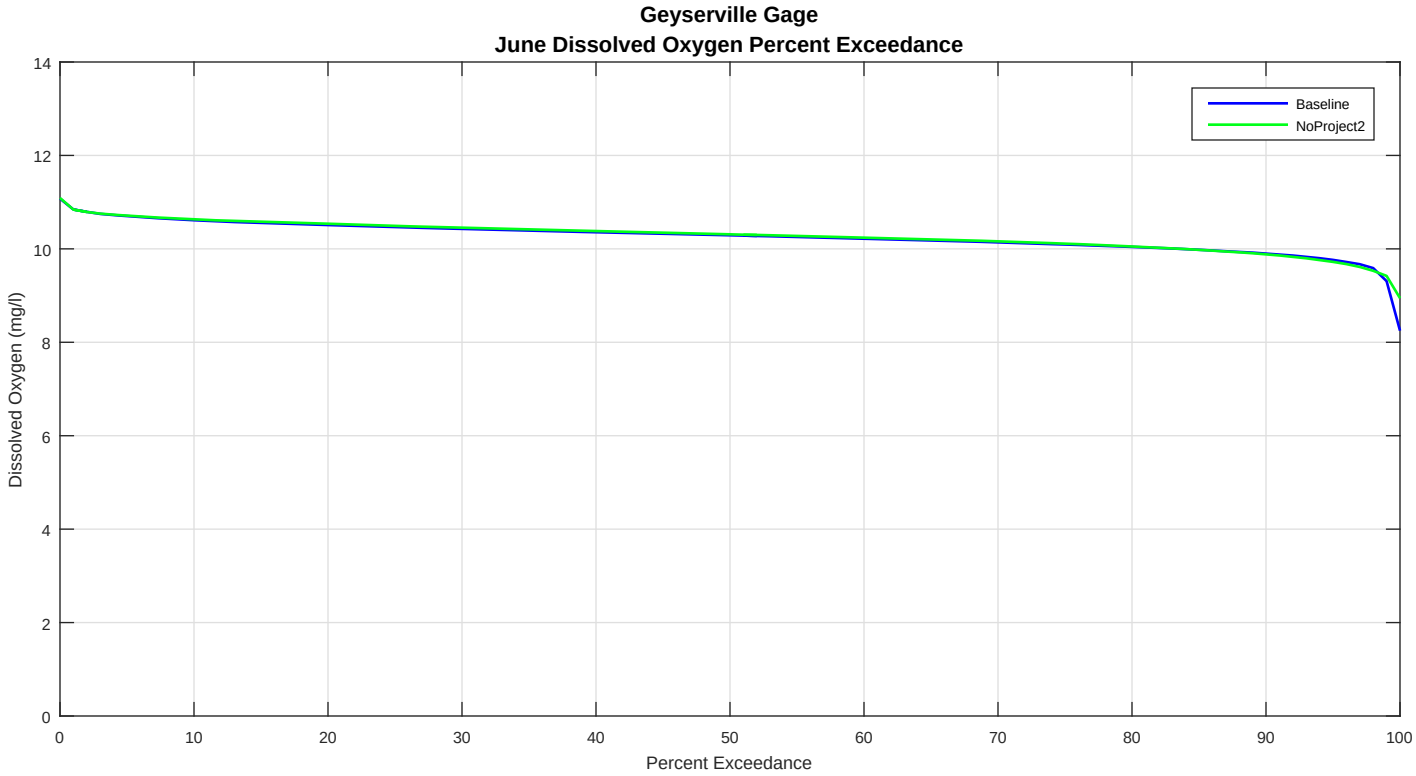
Geyserville Gage
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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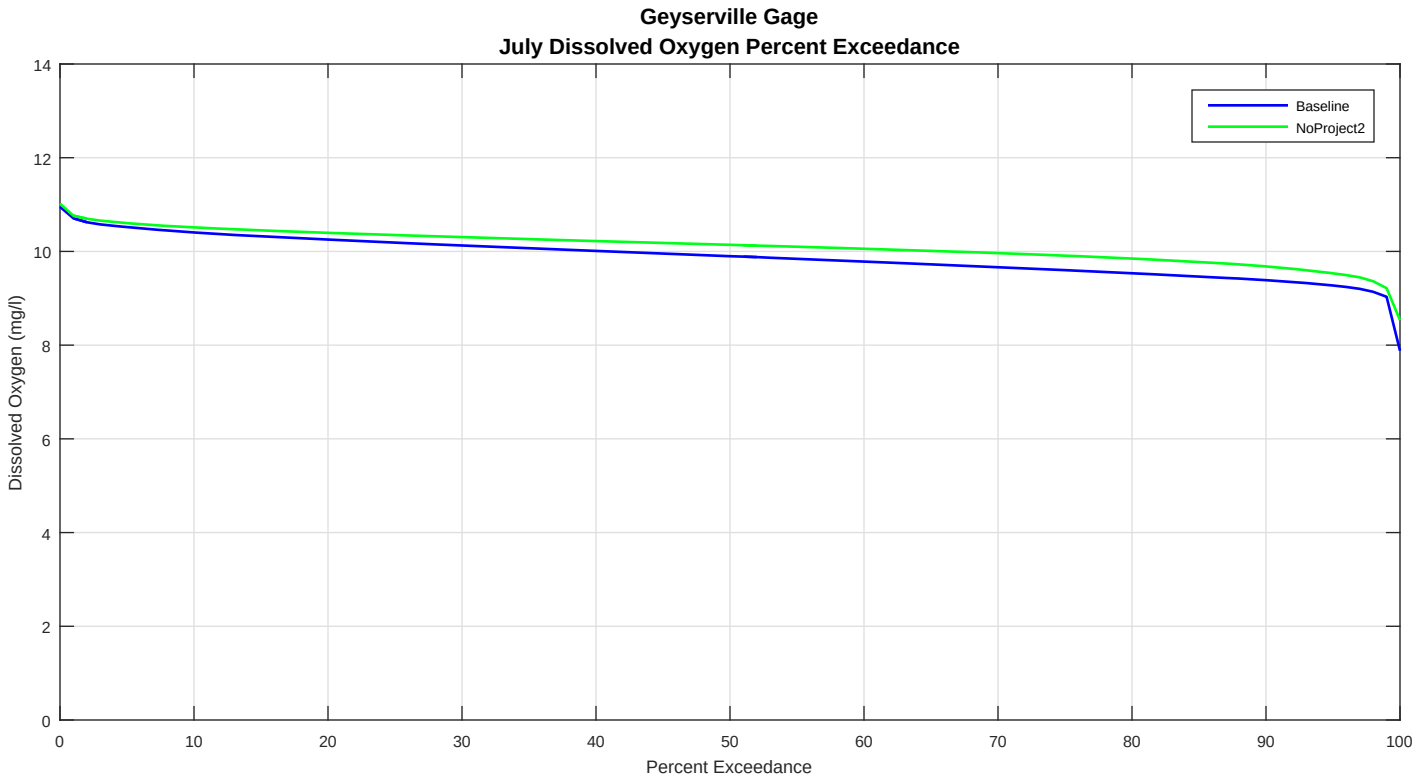
Geyserville Gage
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
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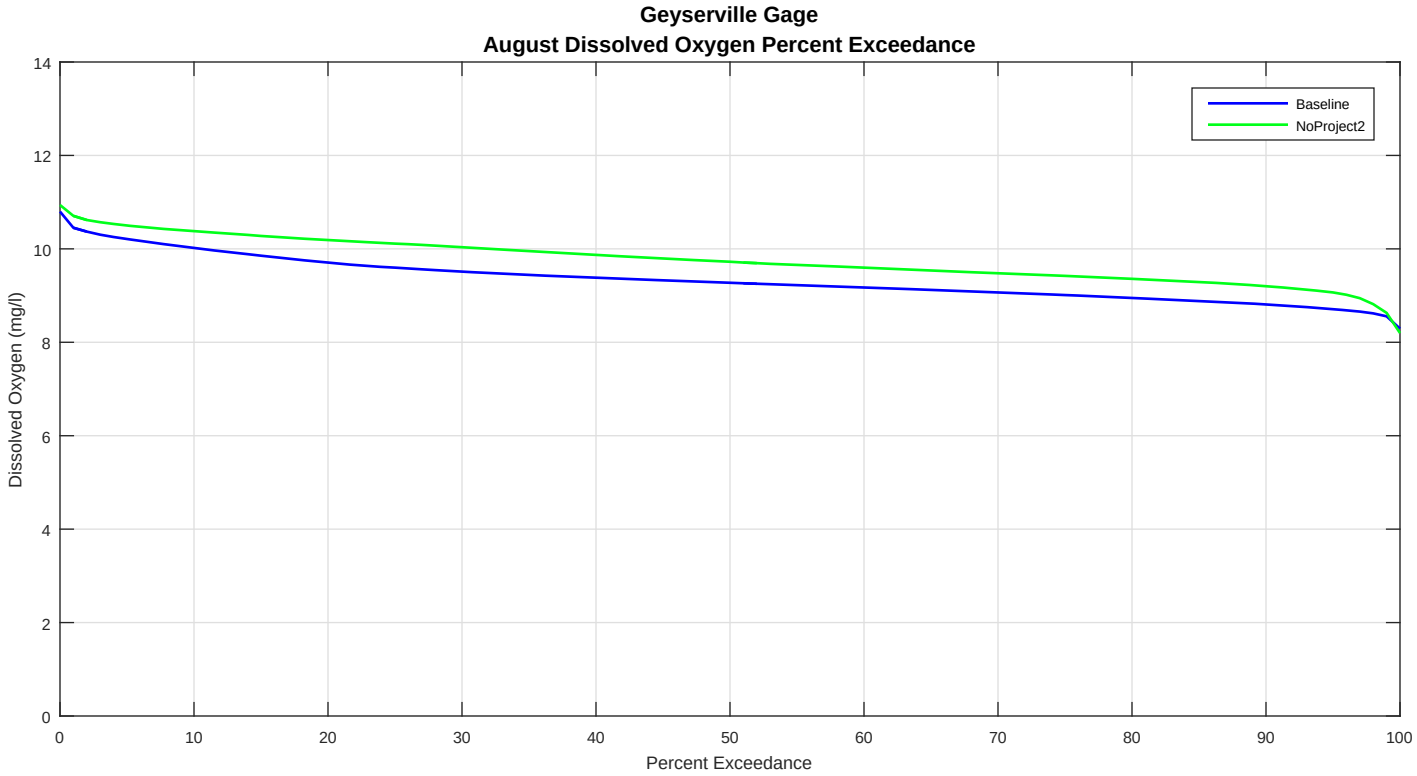
Geyserville Gage
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
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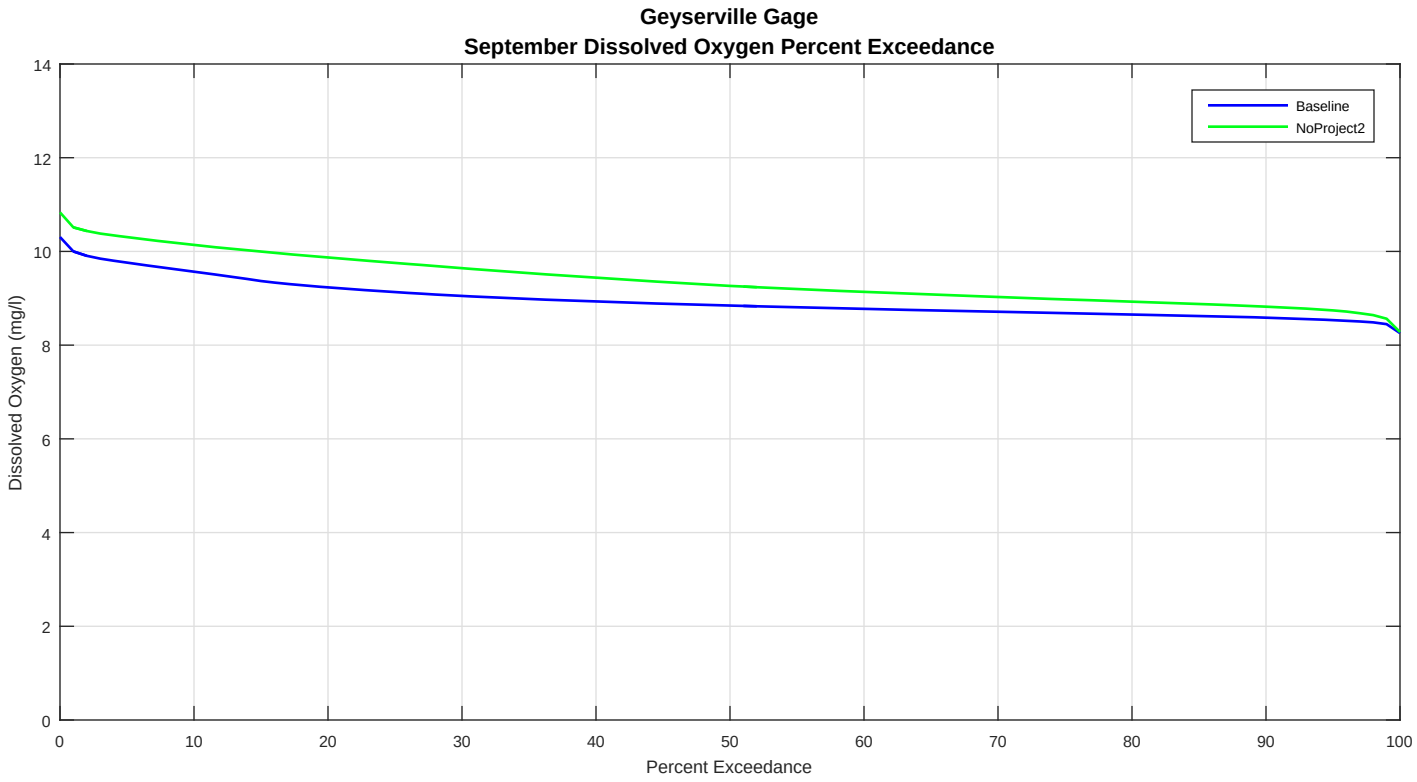
Geyserville Gage
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
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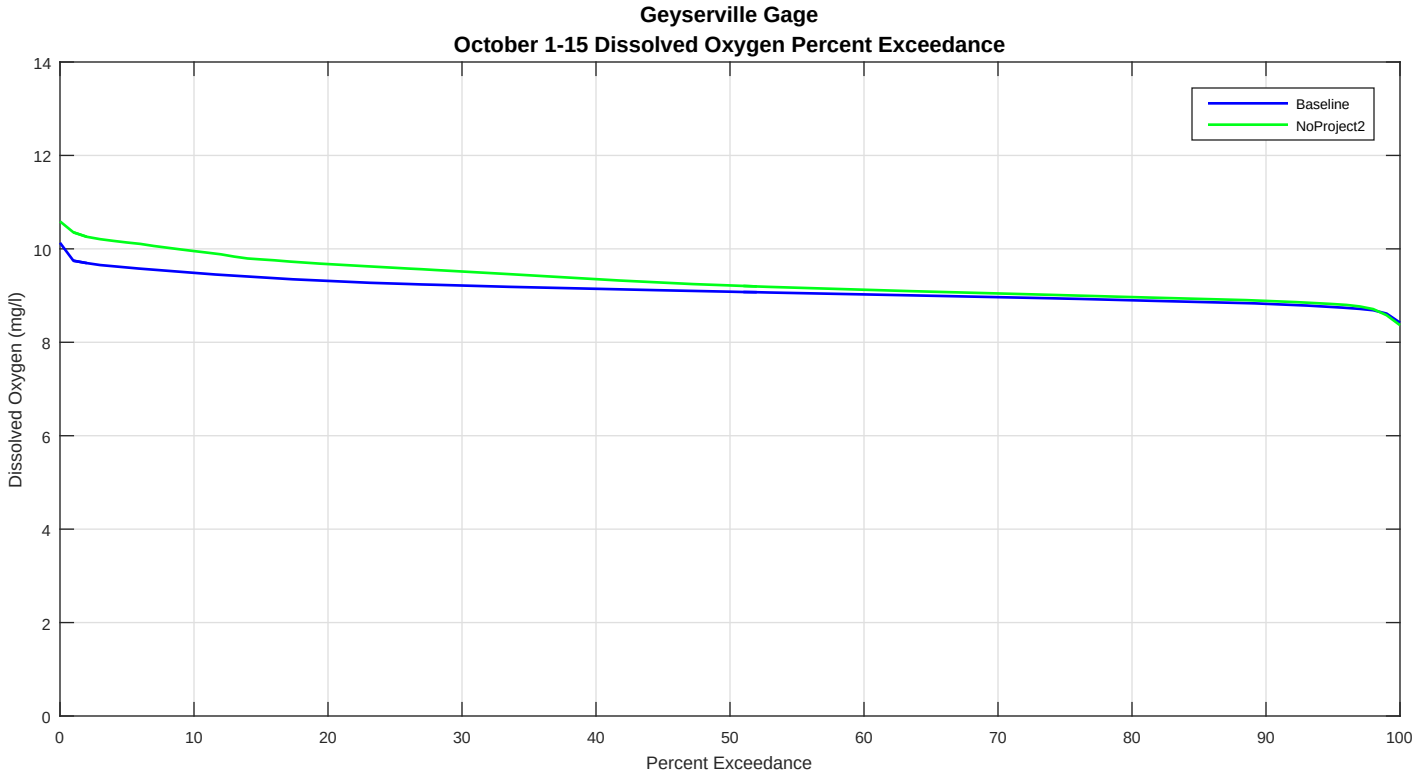
Geyserville Gage
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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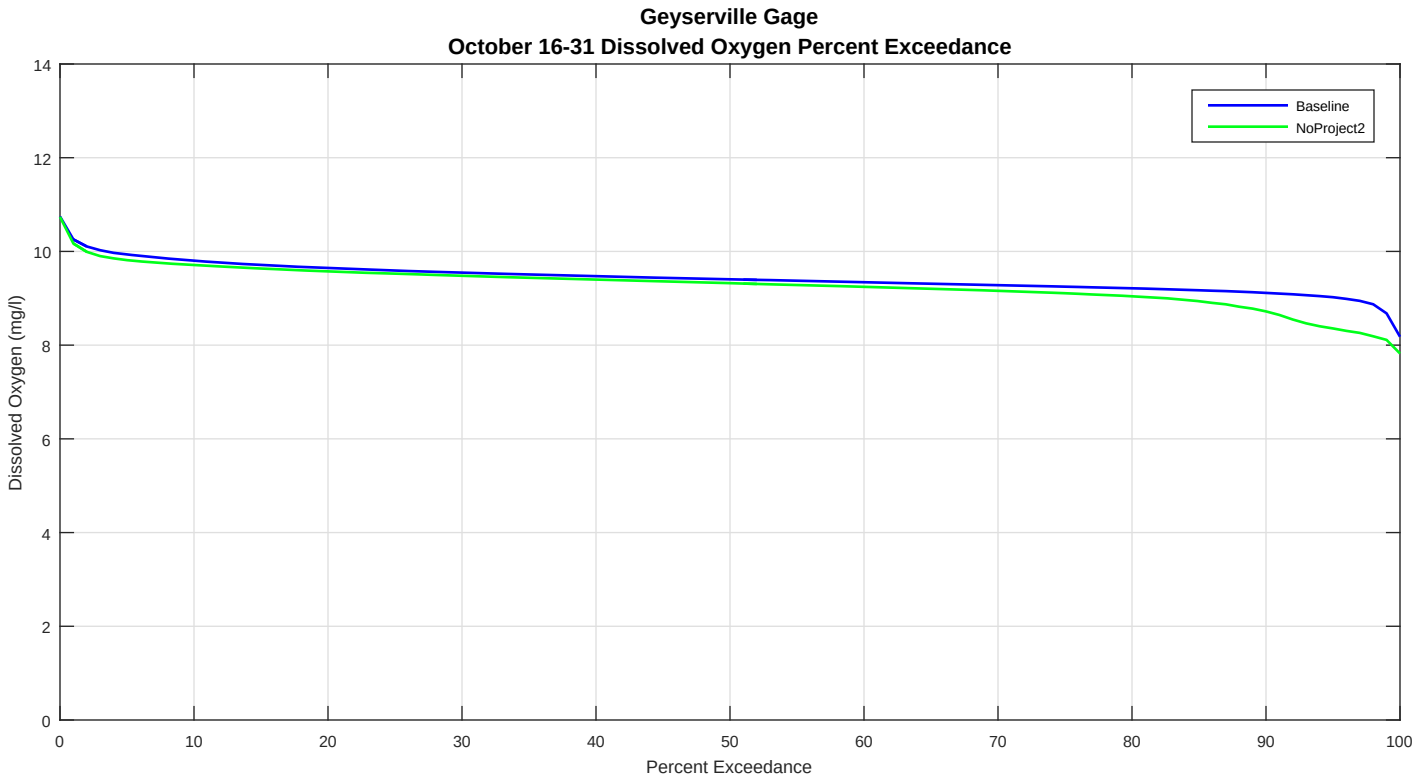
Geyserville Gage
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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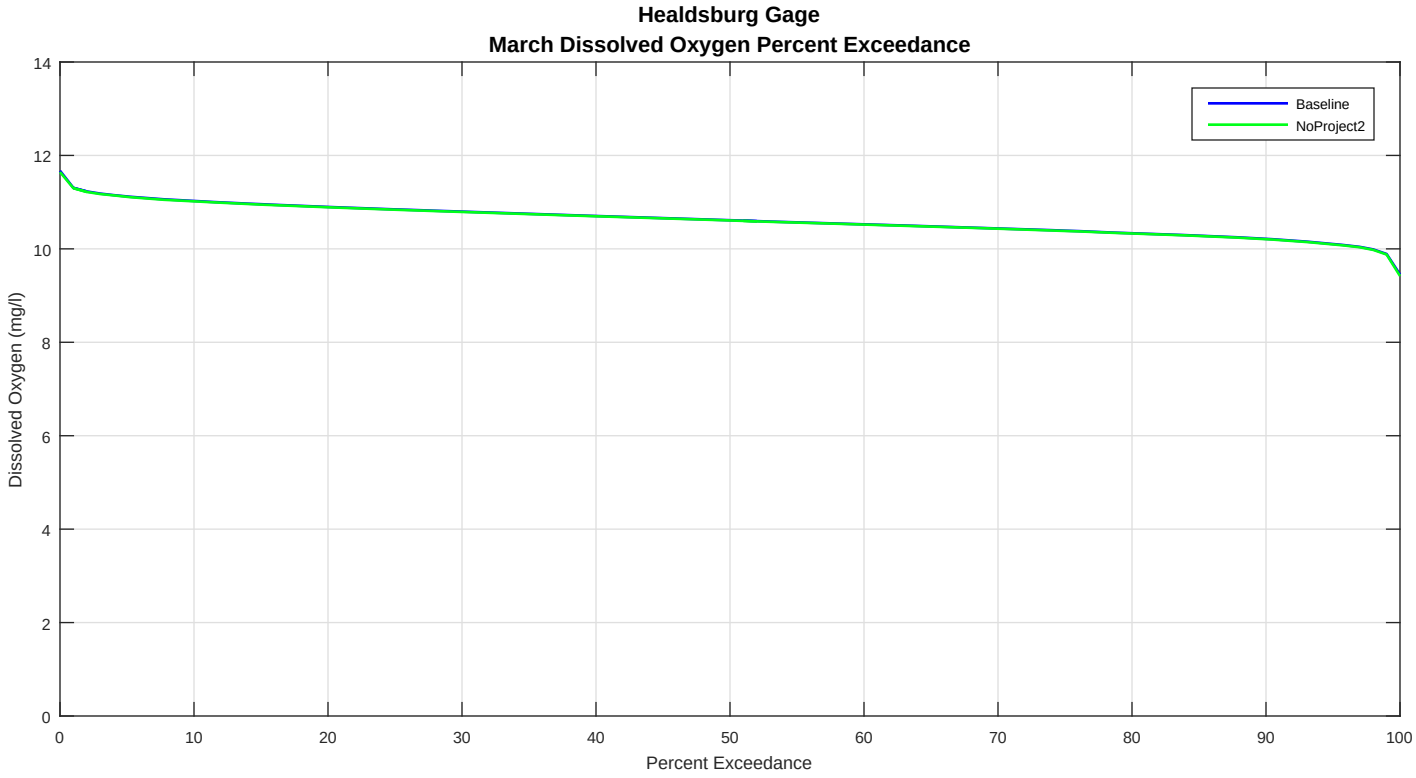
Healdsburg Gage
March Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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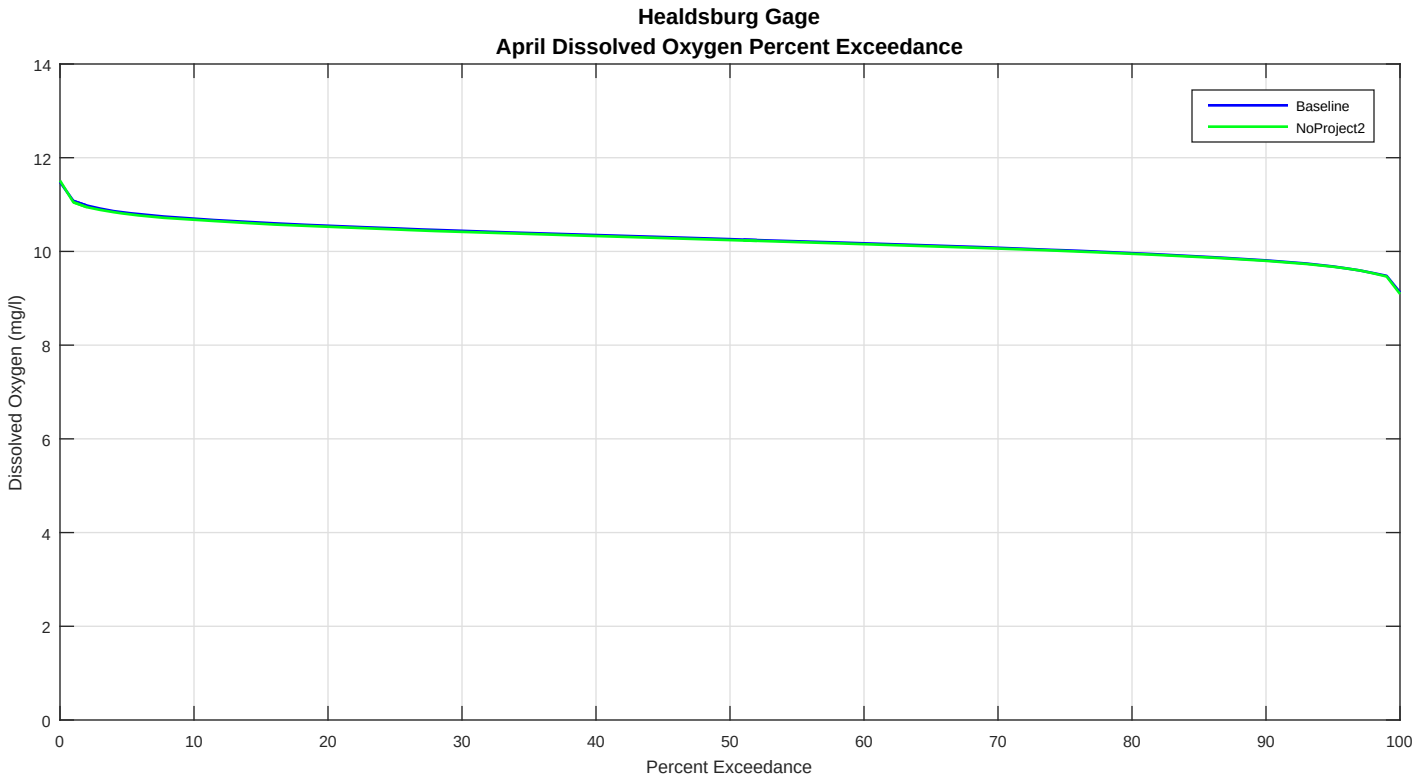
Healdsburg Gage
April Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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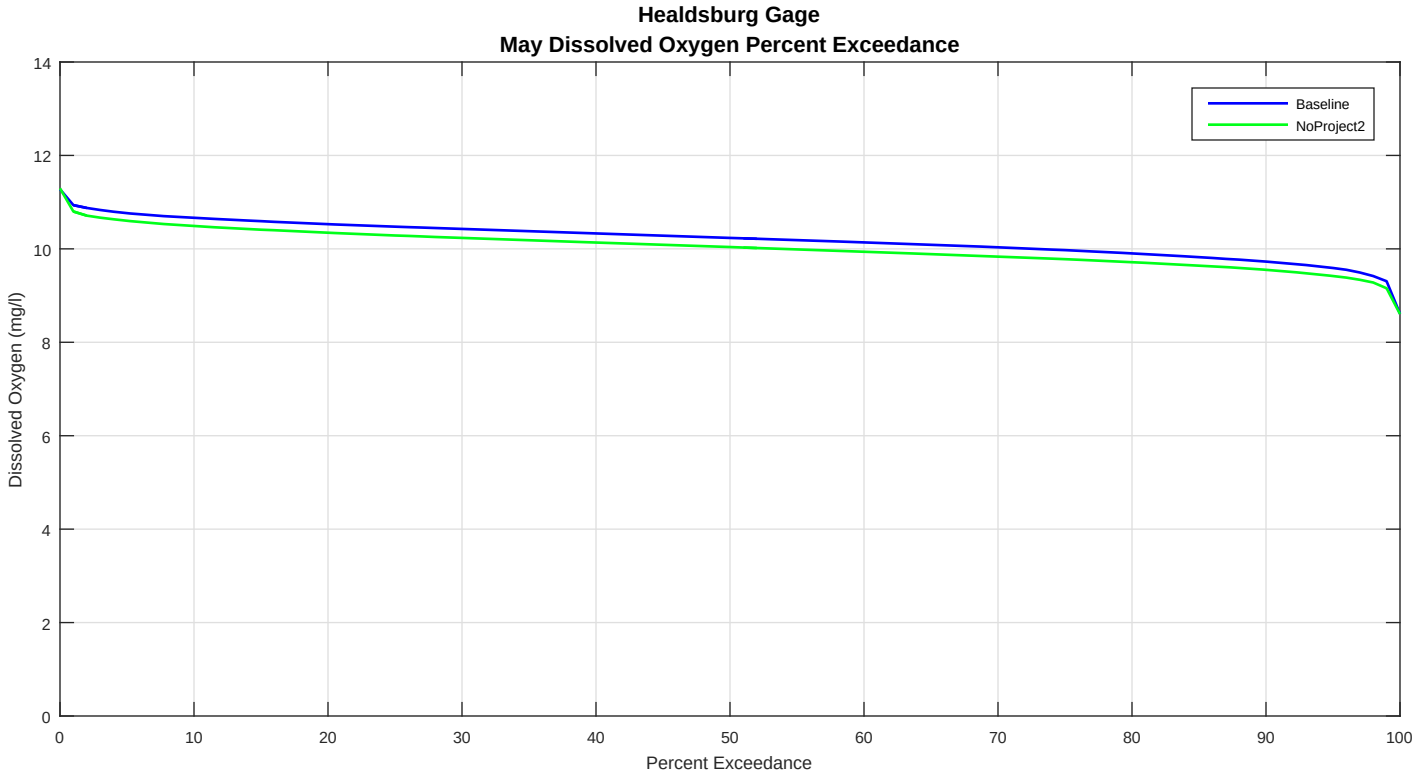
Healdsburg Gage
May Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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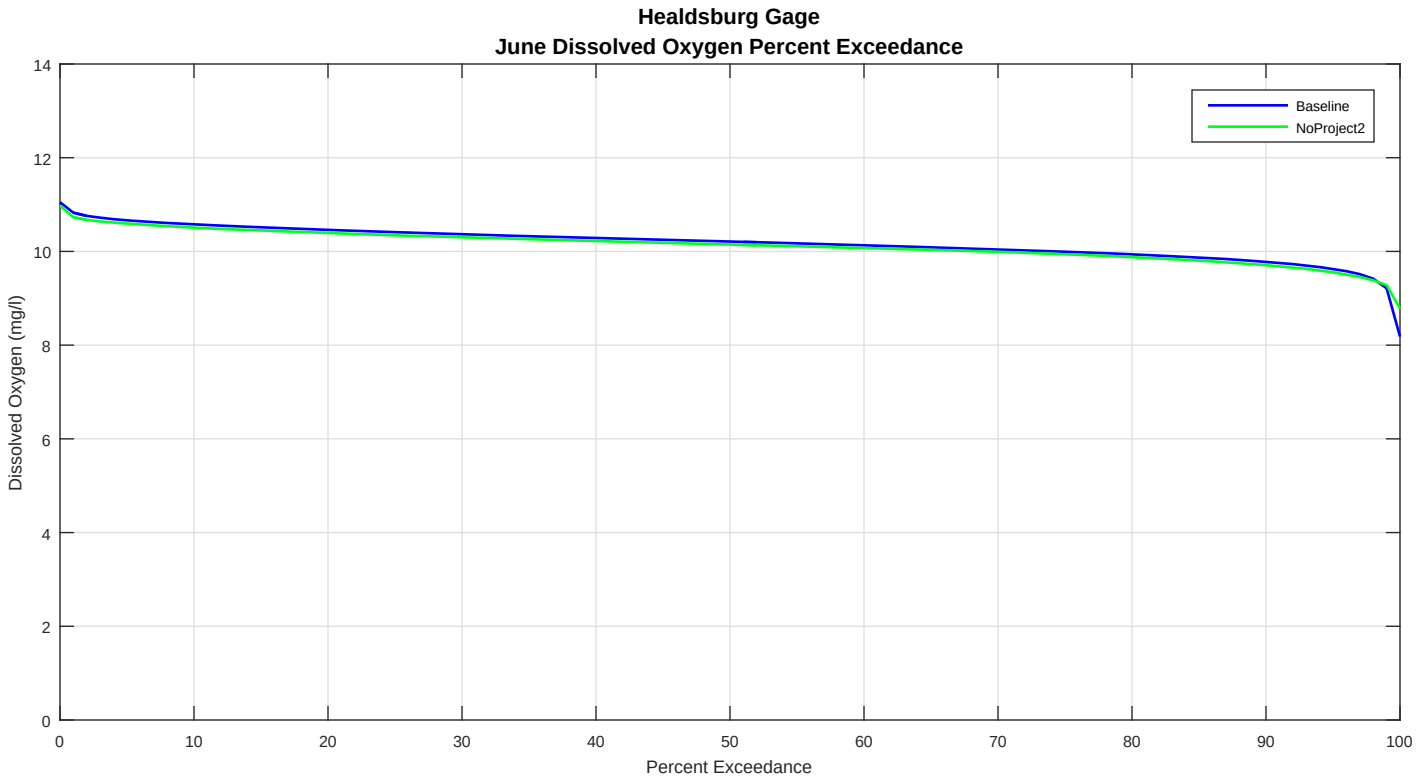
Healdsburg Gage
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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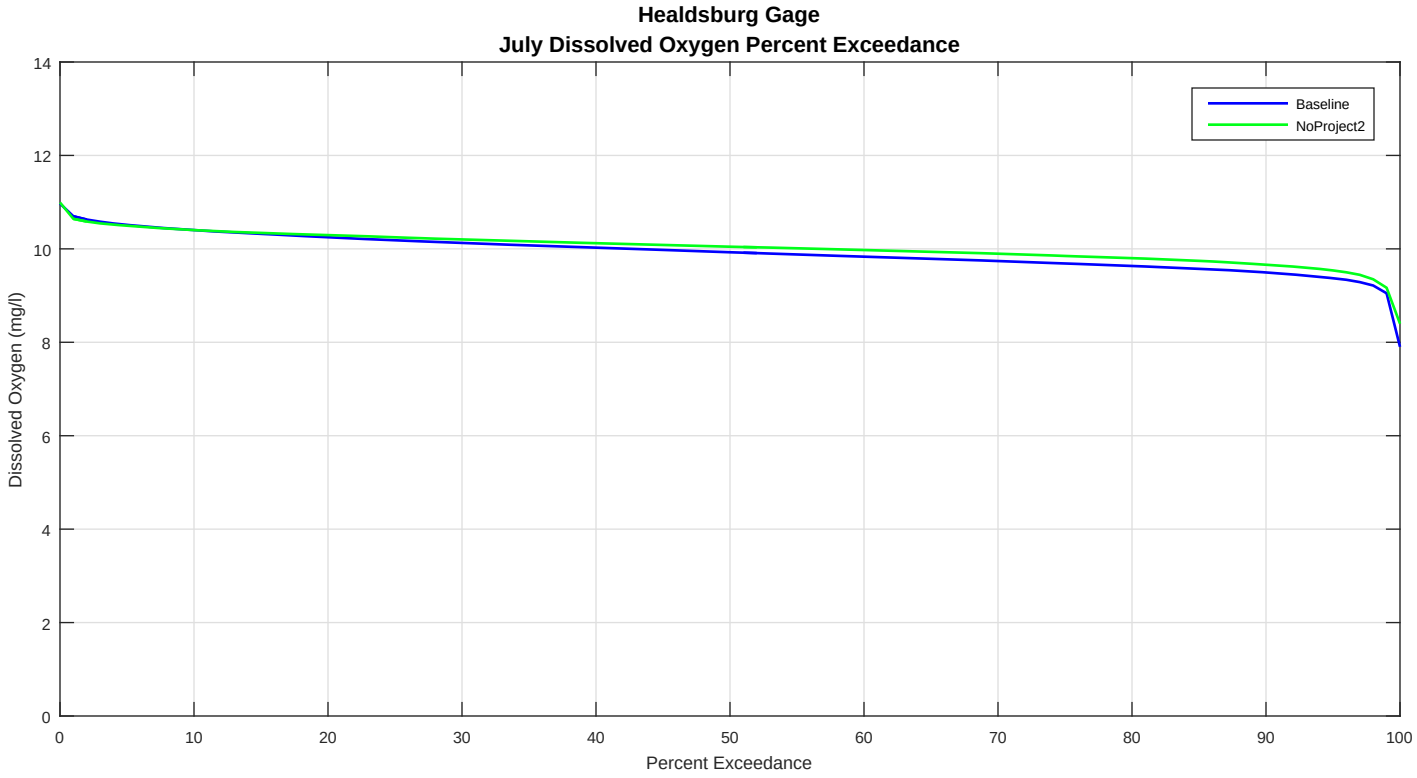
Healdsburg Gage
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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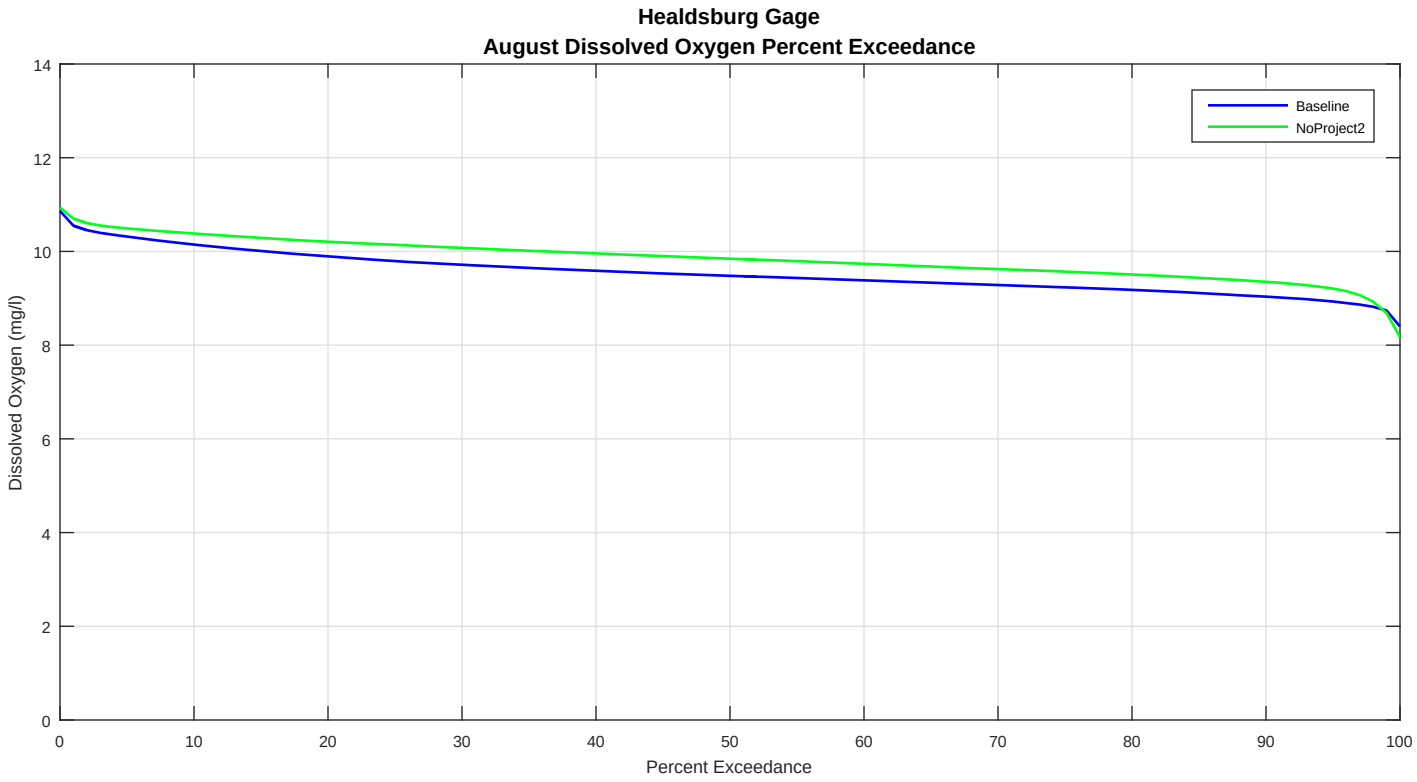
Healdsburg Gage
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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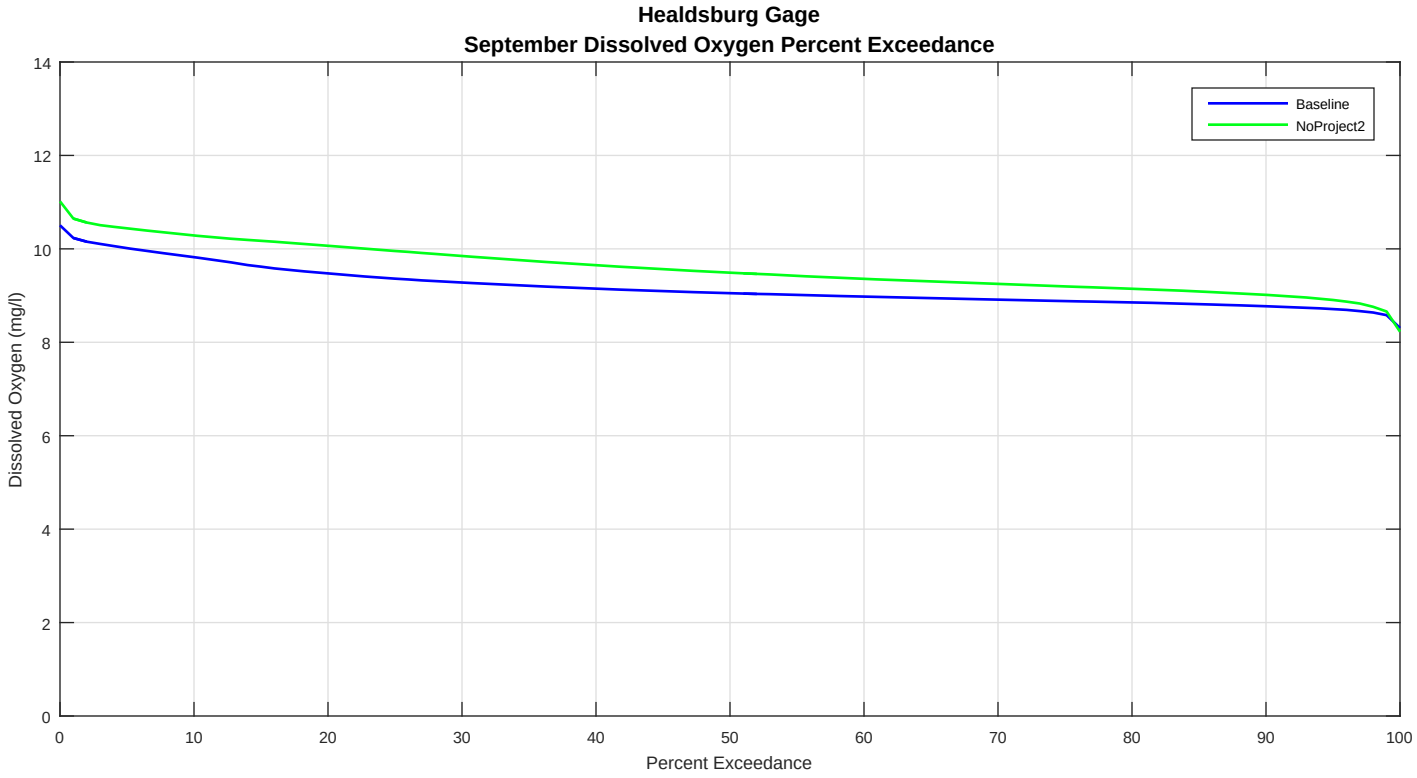
Healdsburg Gage
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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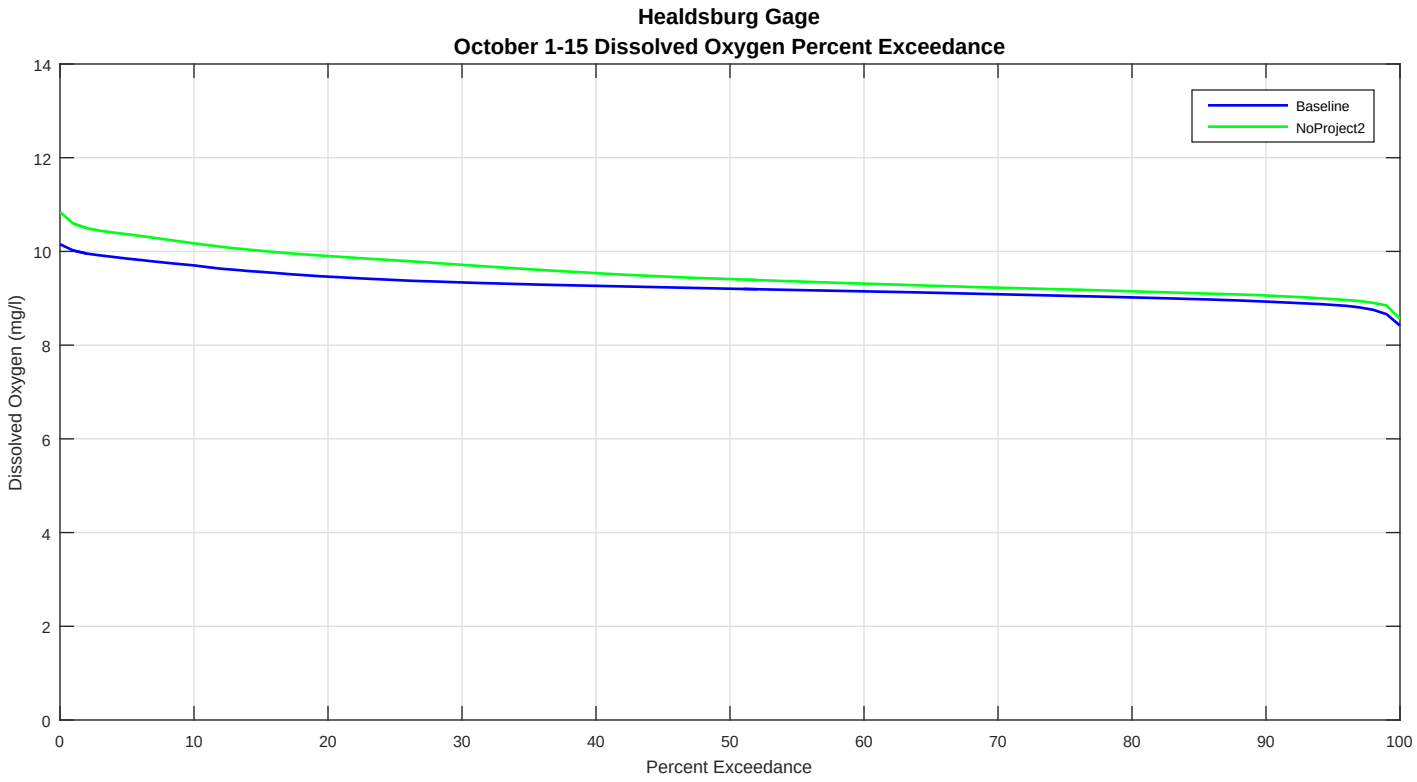
Healdsburg Gage
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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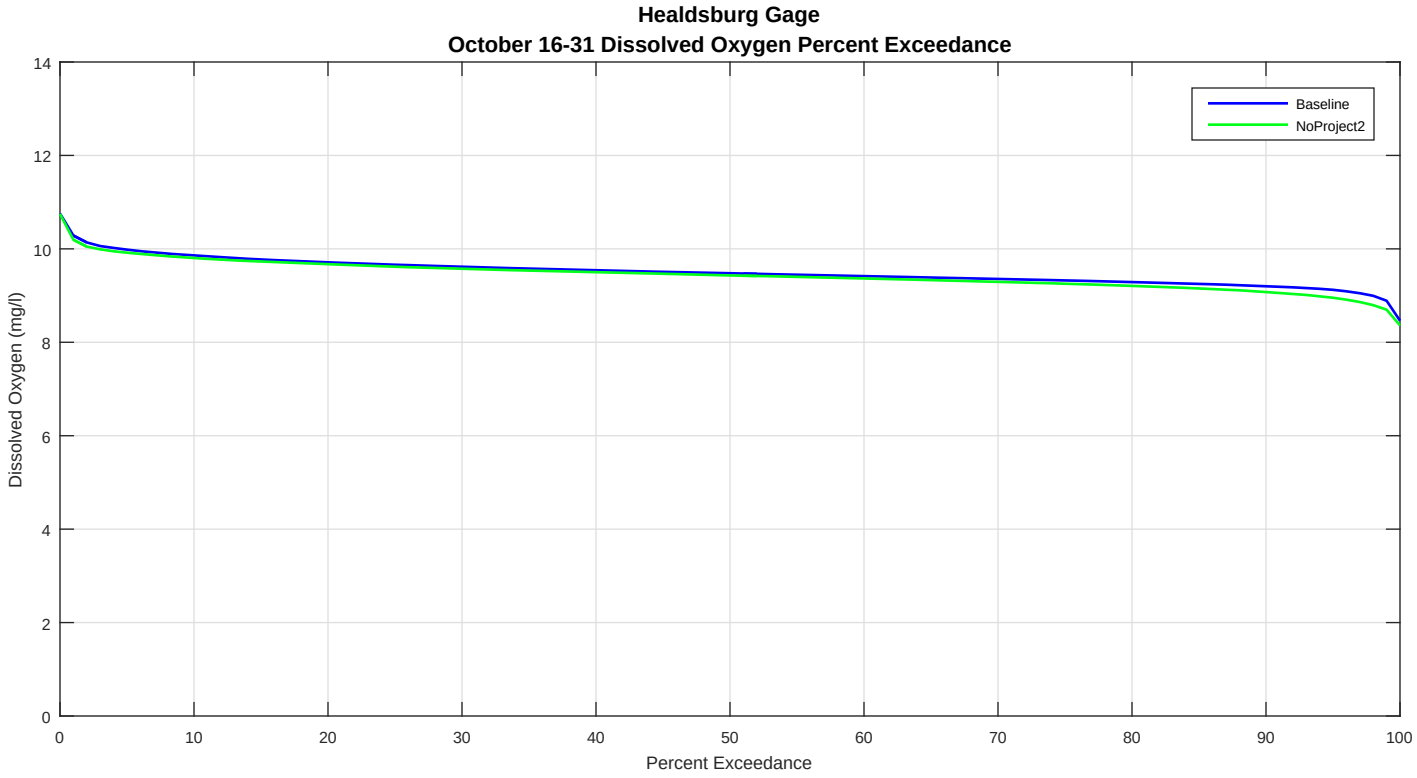
Healdsburg Gage
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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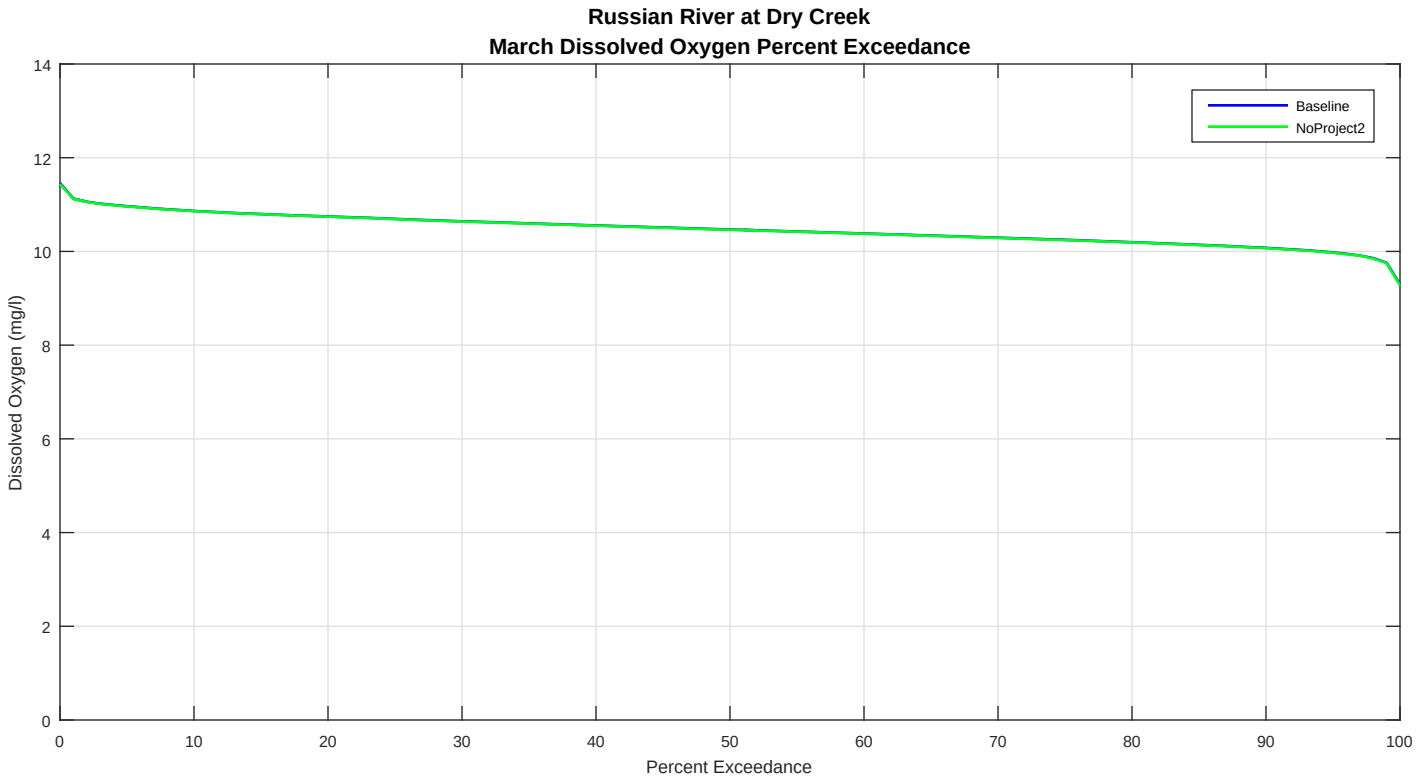
Russian River at Dry Creek
March Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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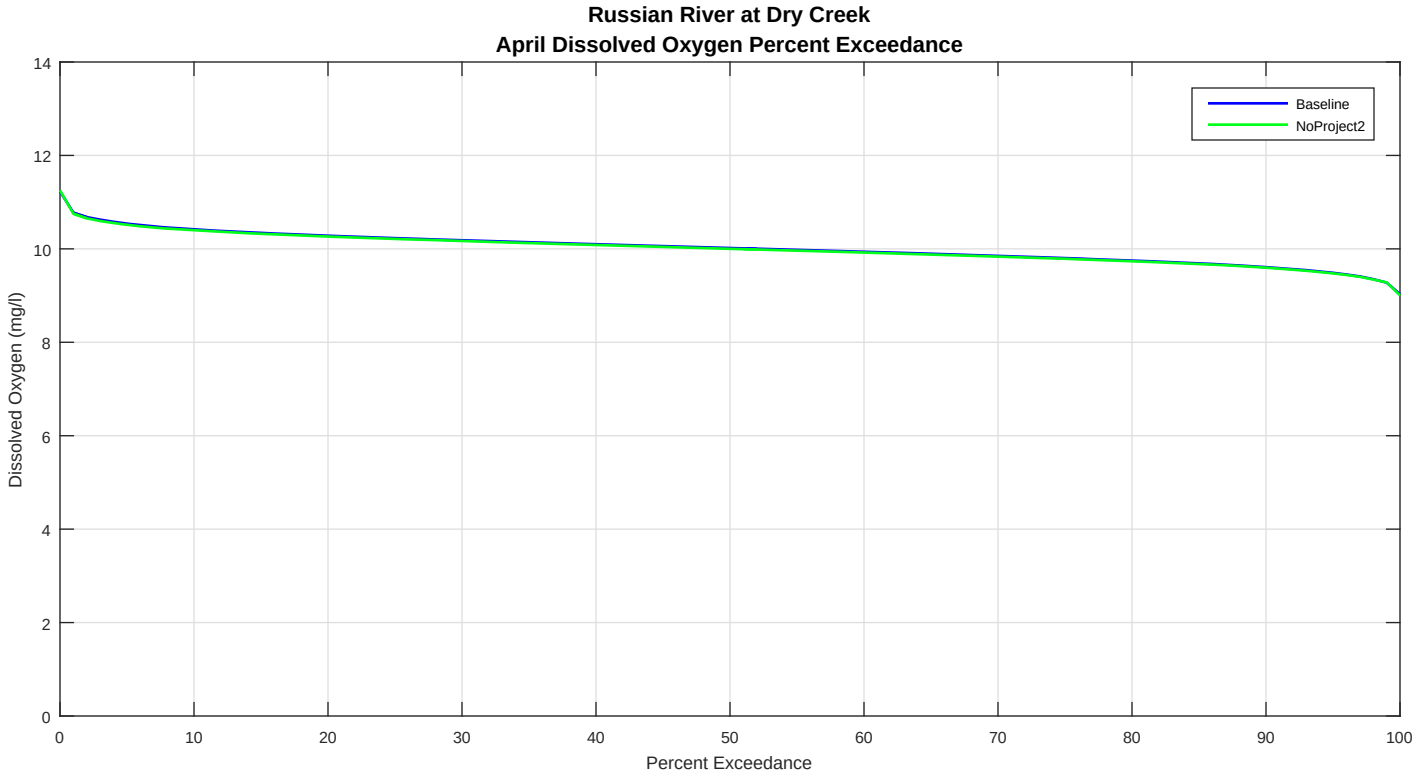
Russian River at Dry Creek
April Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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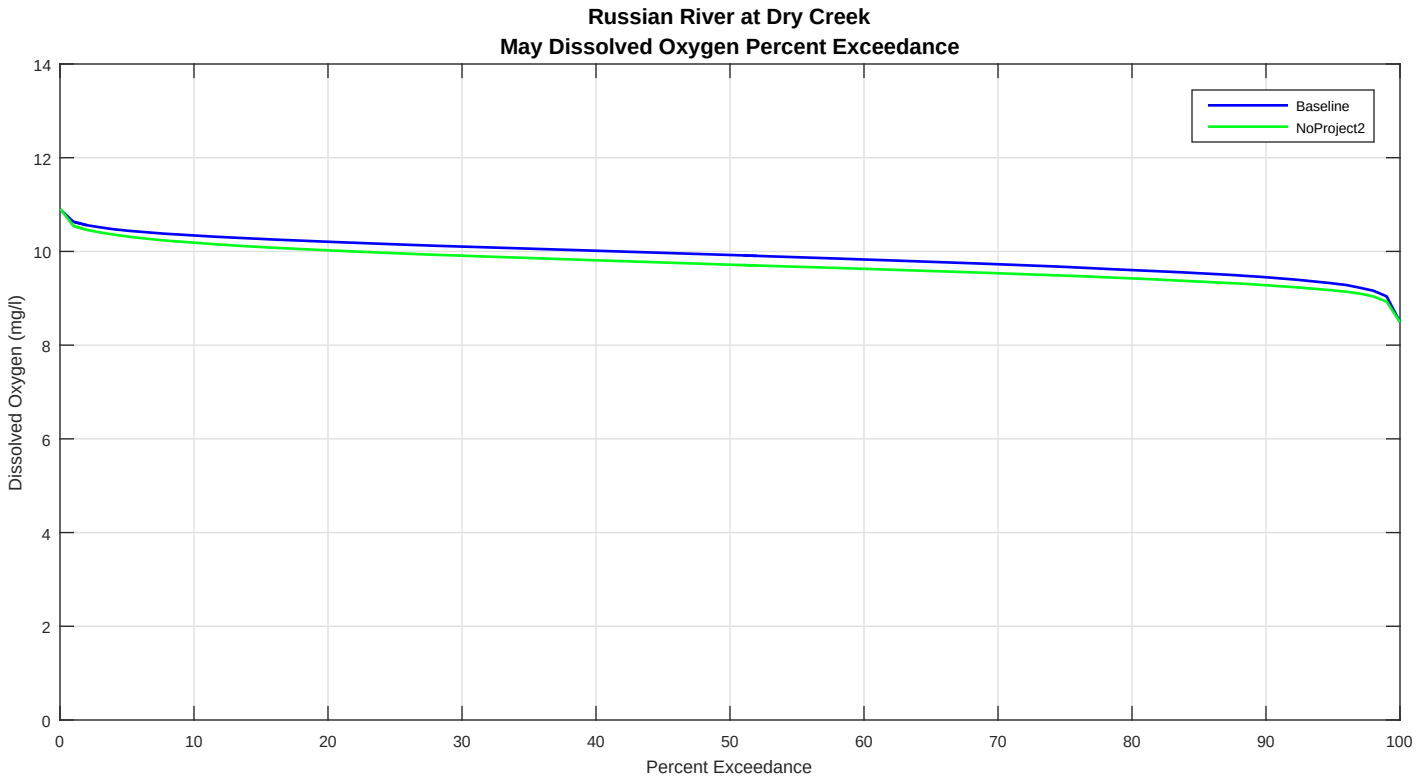
Russian River at Dry Creek
May Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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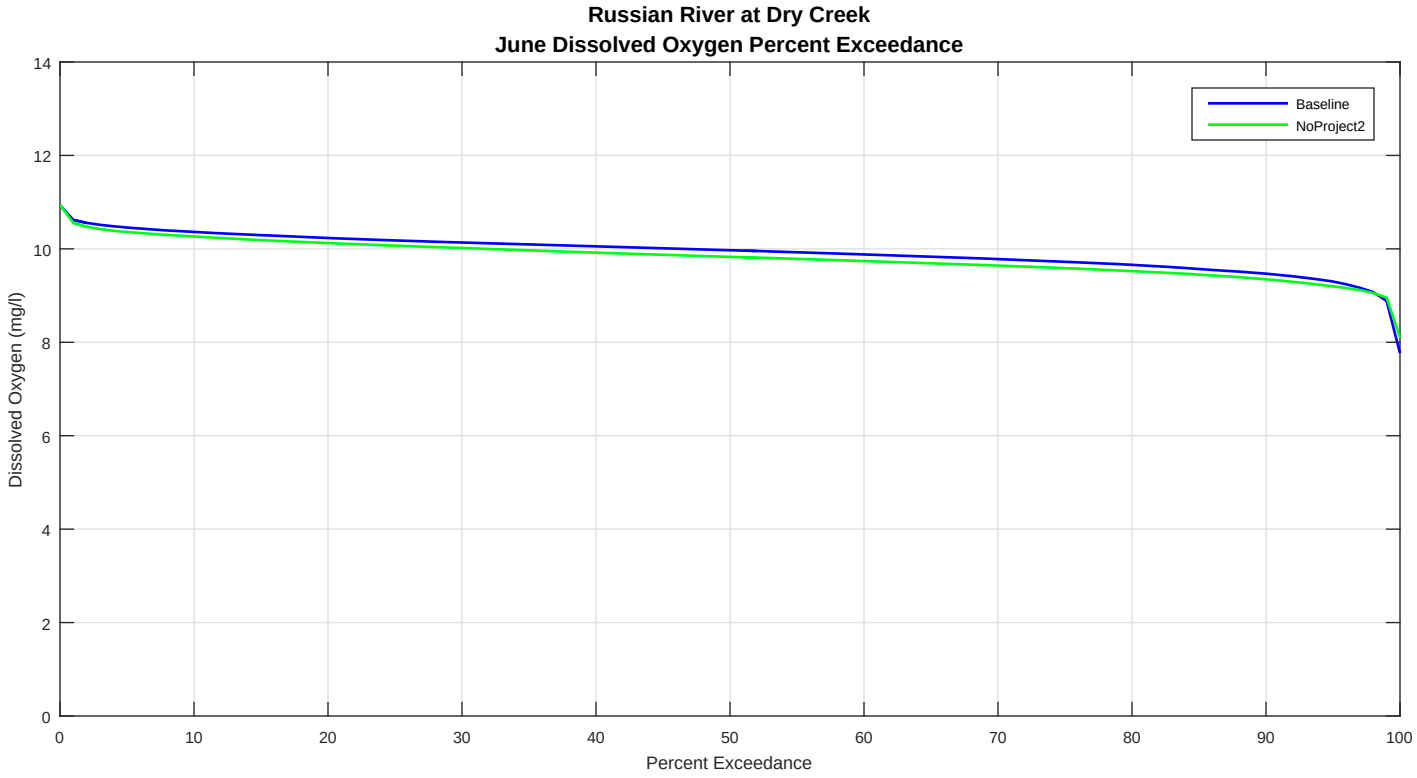
Russian River at Dry Creek
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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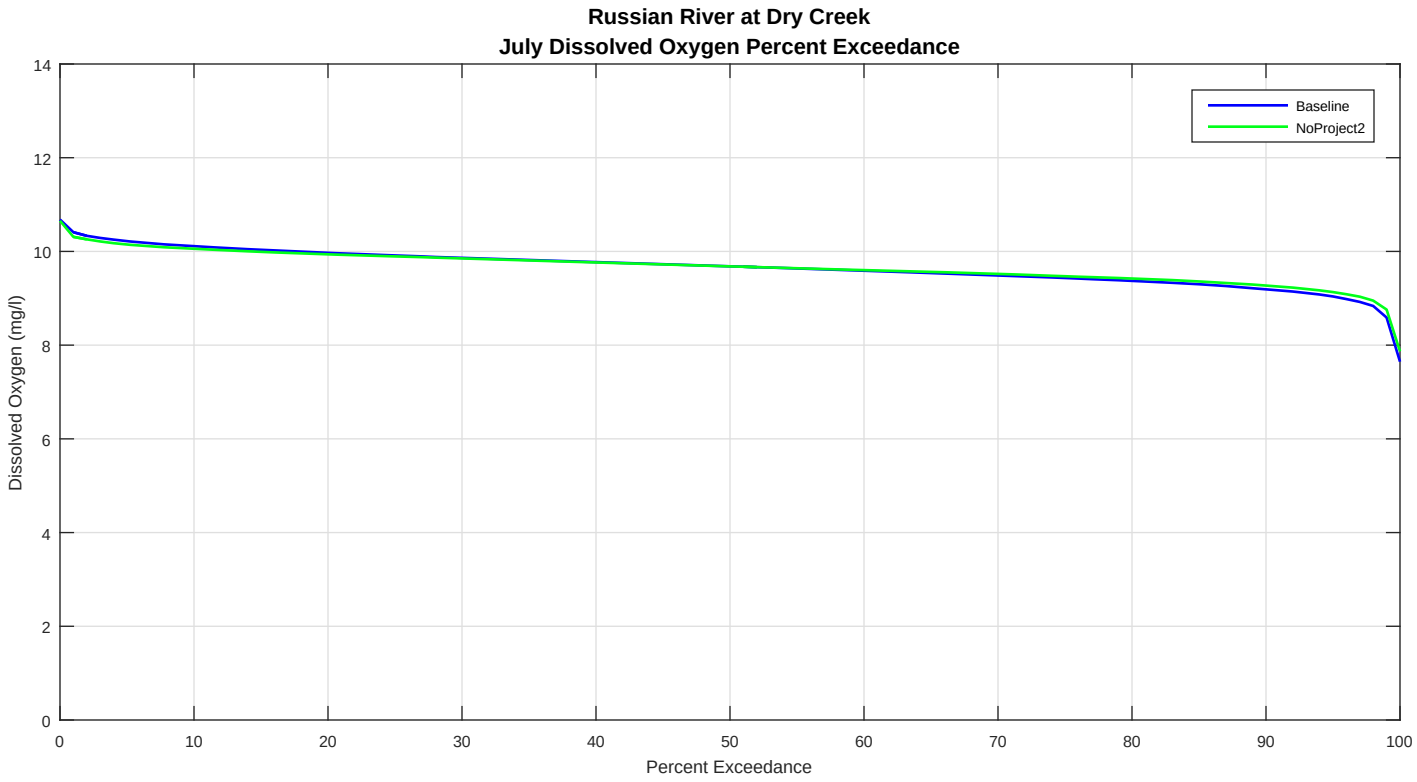
Russian River at Dry Creek
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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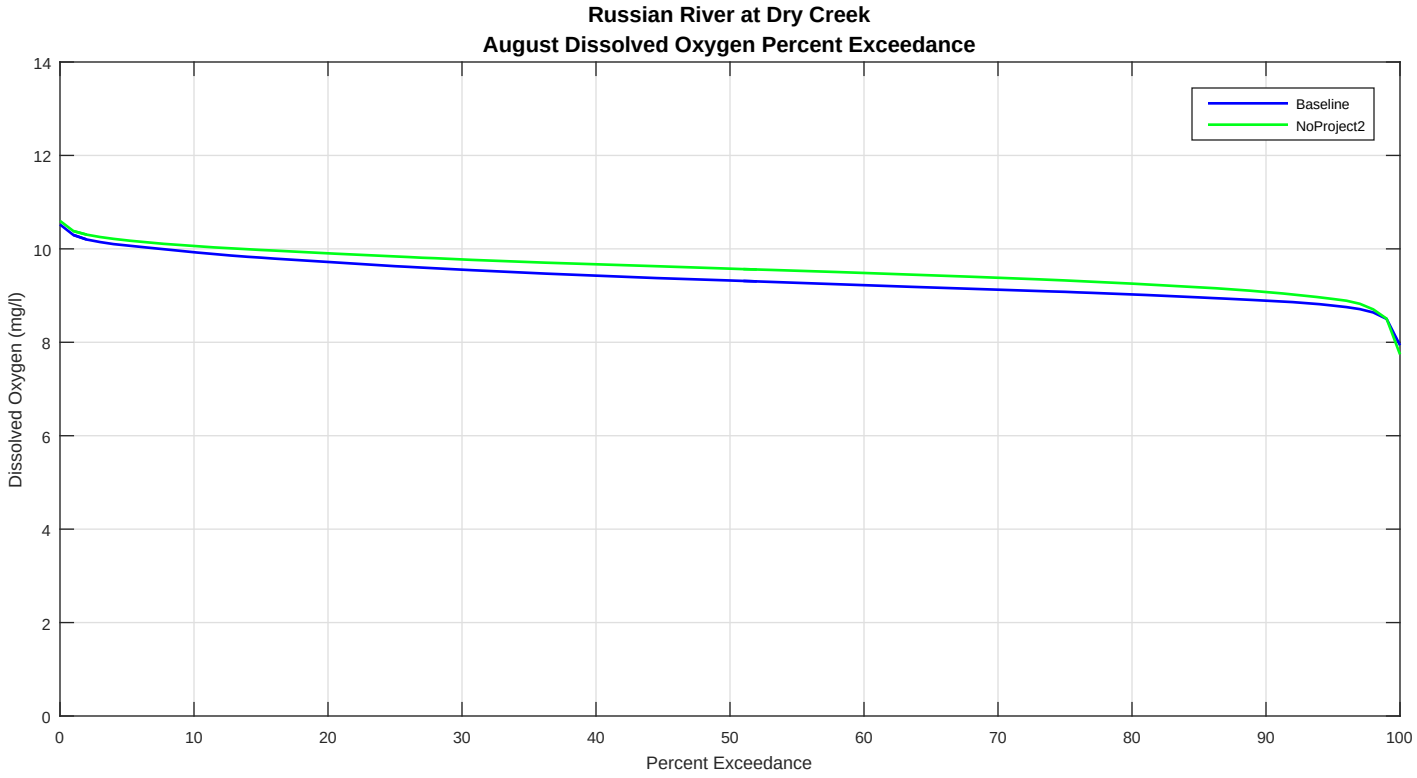
Russian River at Dry Creek
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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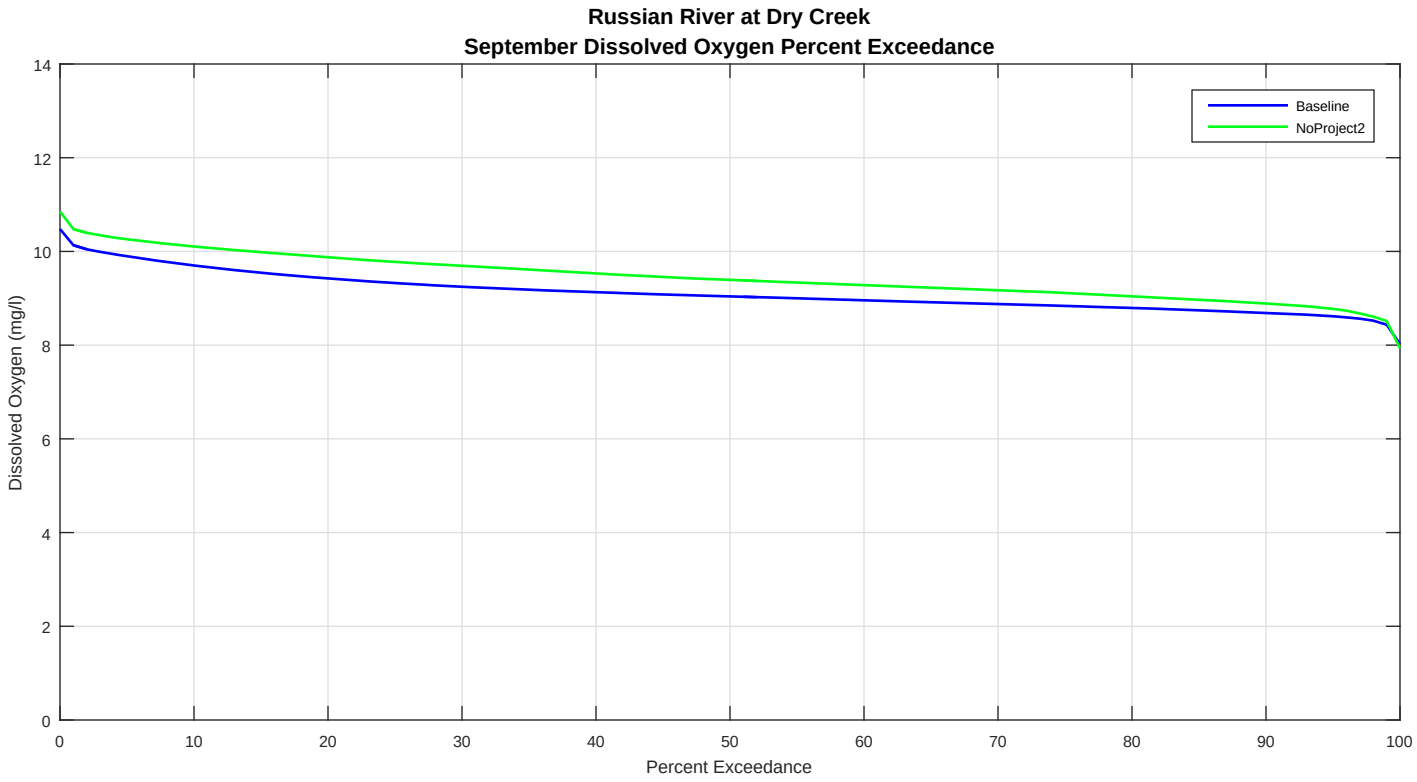
Russian River at Dry Creek
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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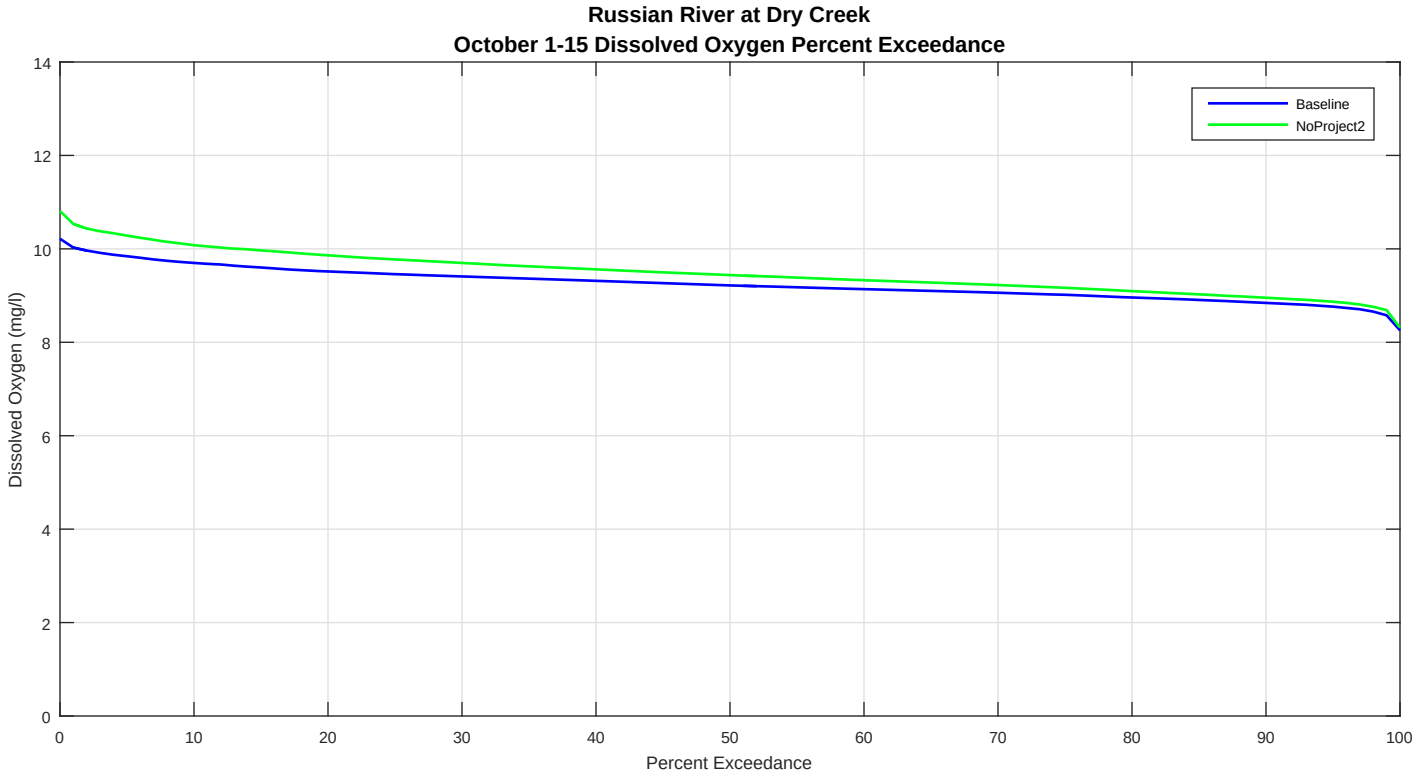
Russian River at Dry Creek
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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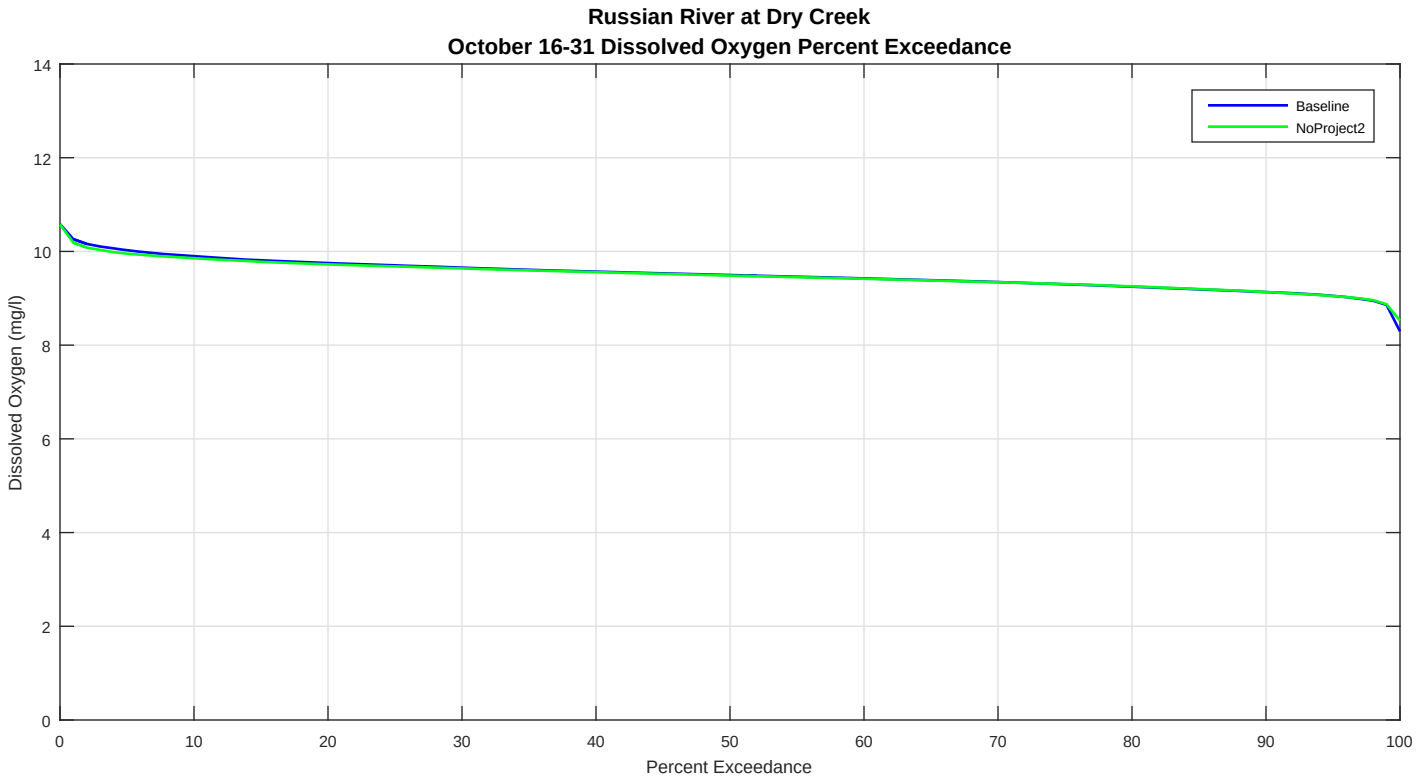
Russian River at Dry Creek
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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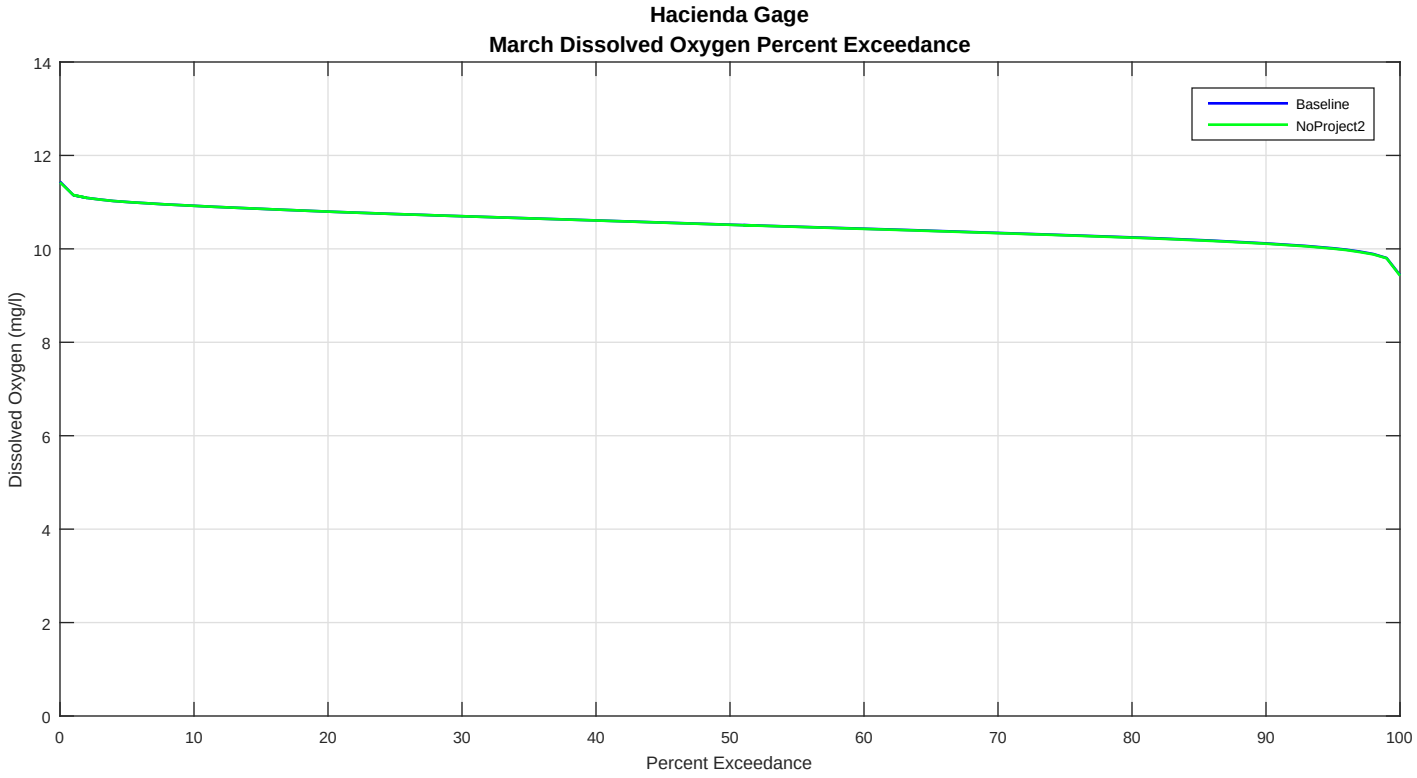
Hacienda Gage
March Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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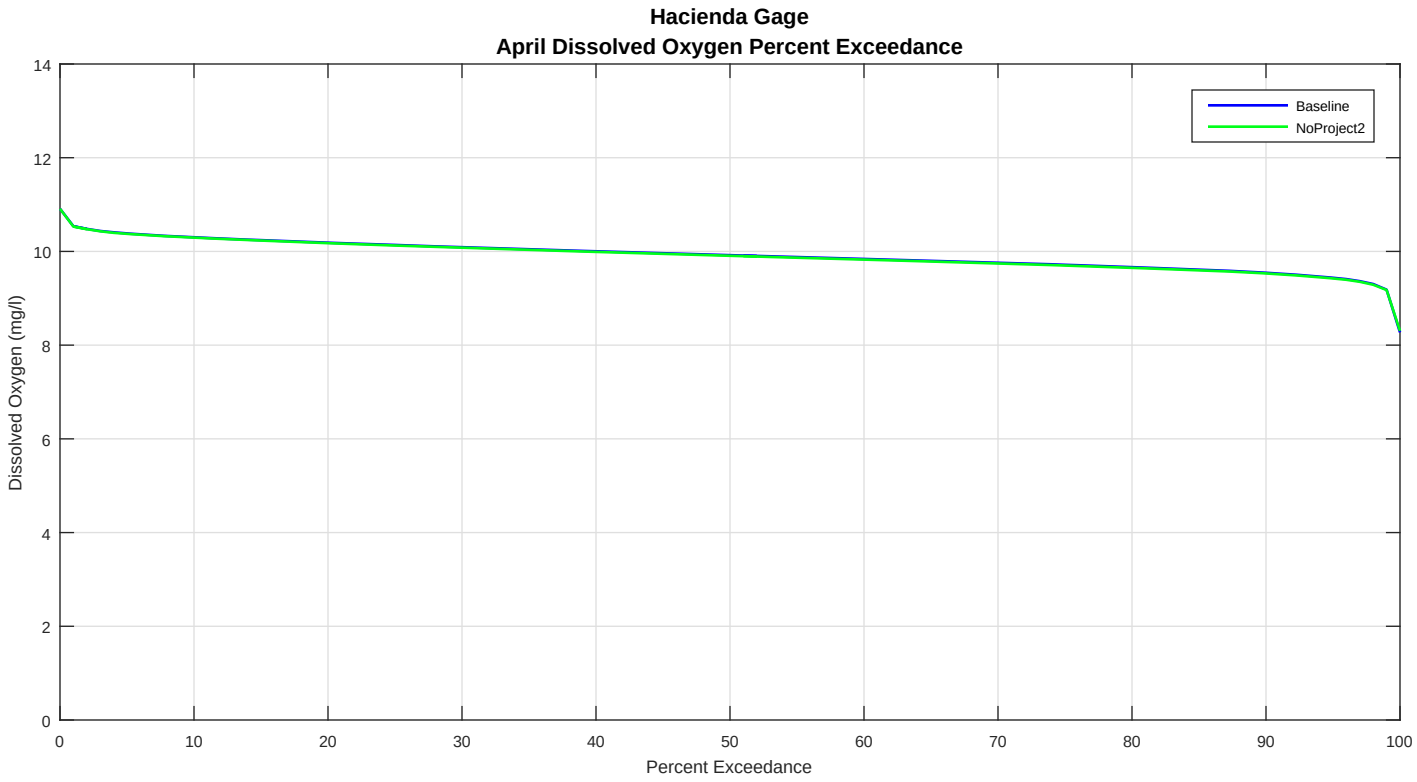
Hacienda Gage
April Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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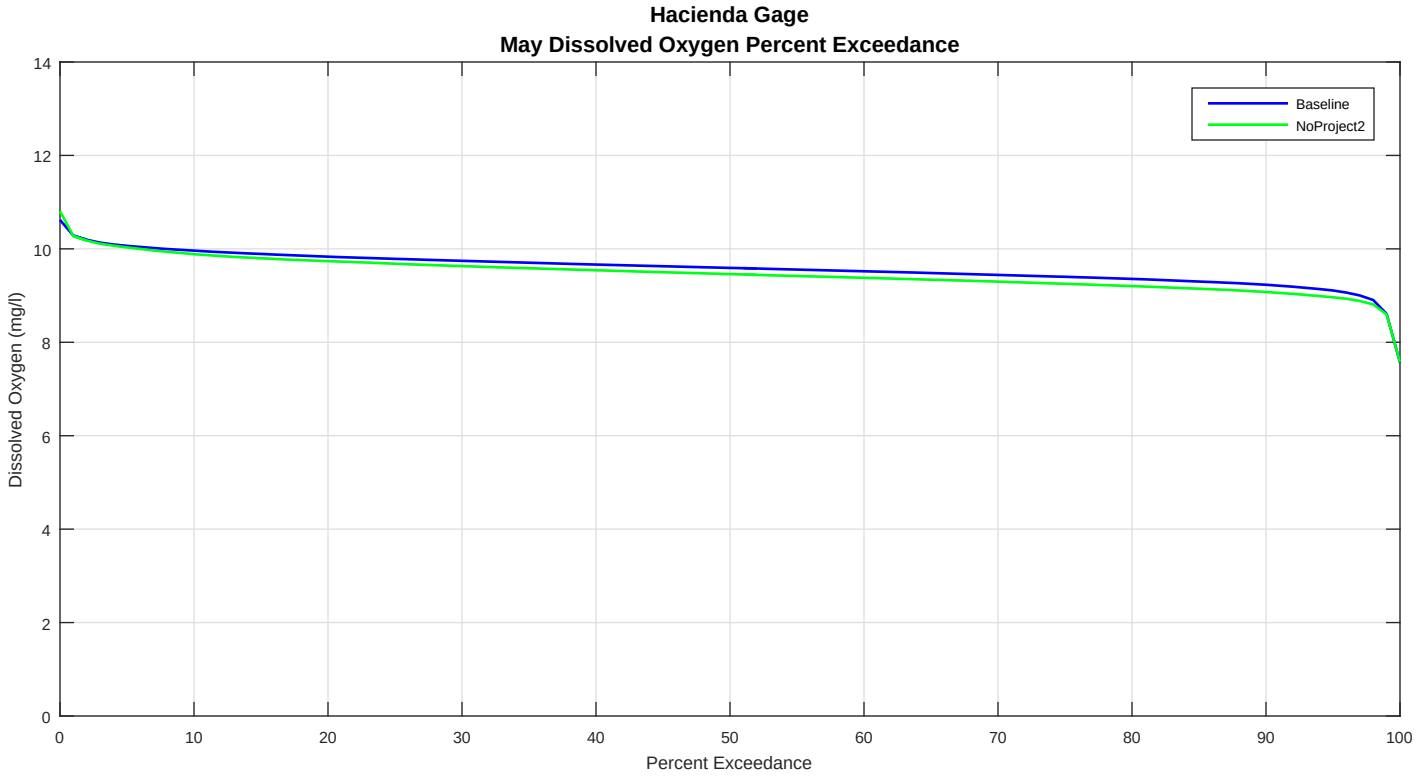
Hacienda Gage
May Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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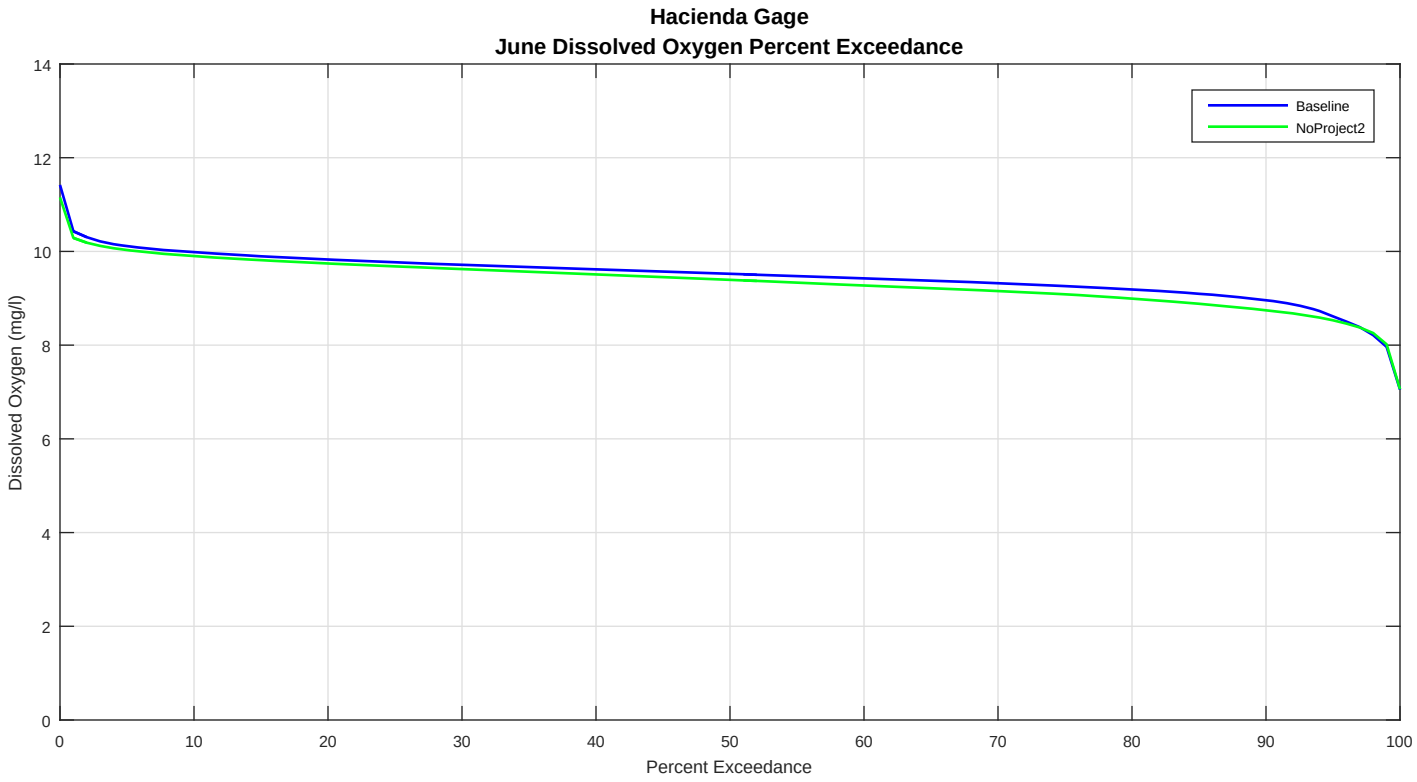
Hacienda Gage
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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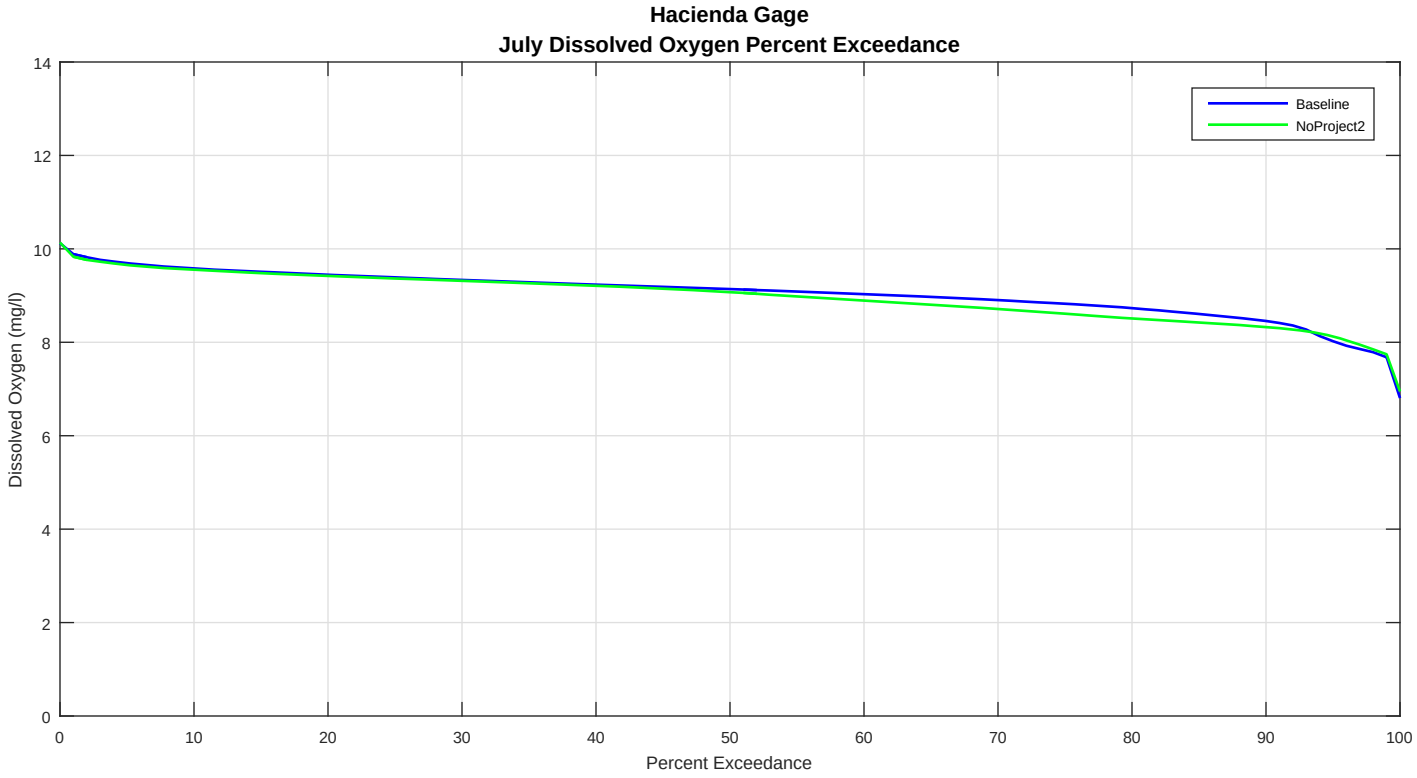
Hacienda Gage
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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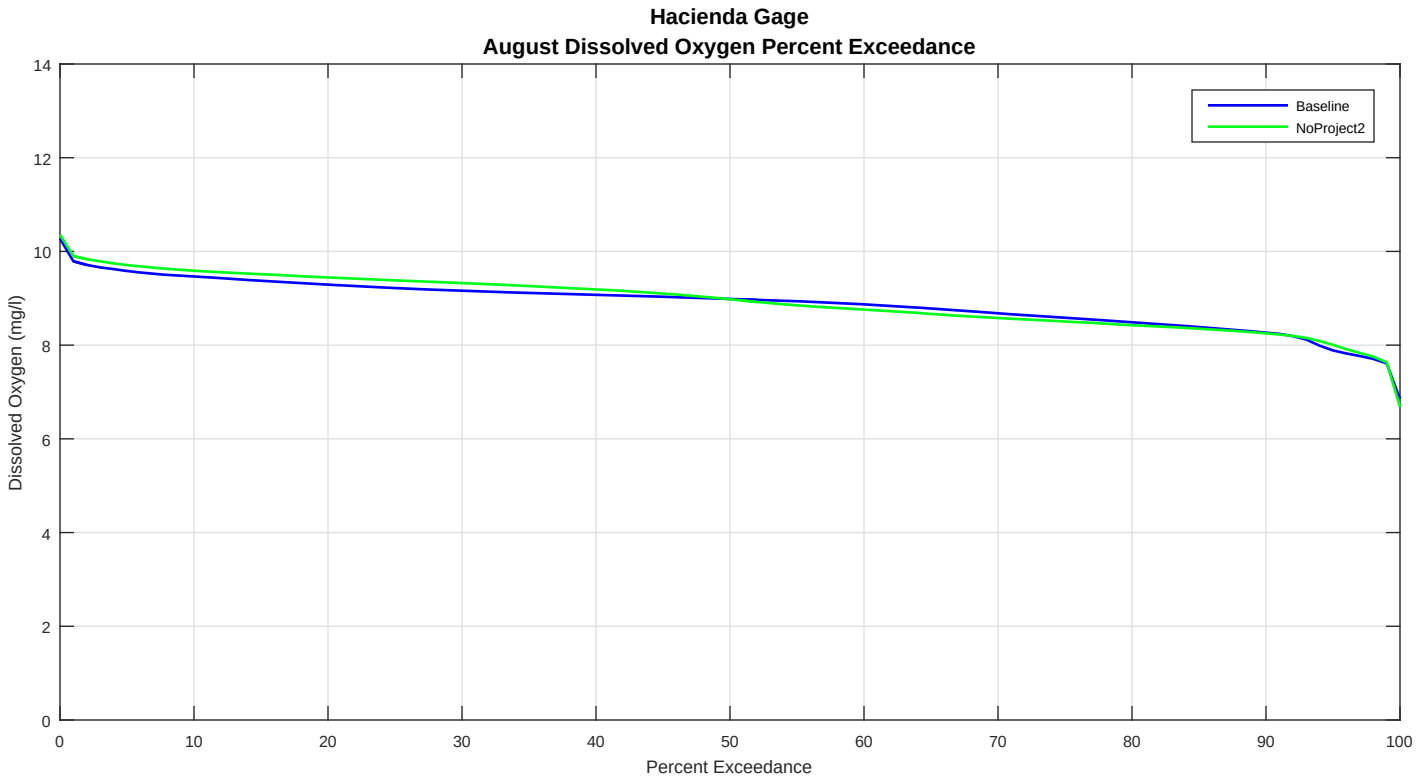
Hacienda Gage
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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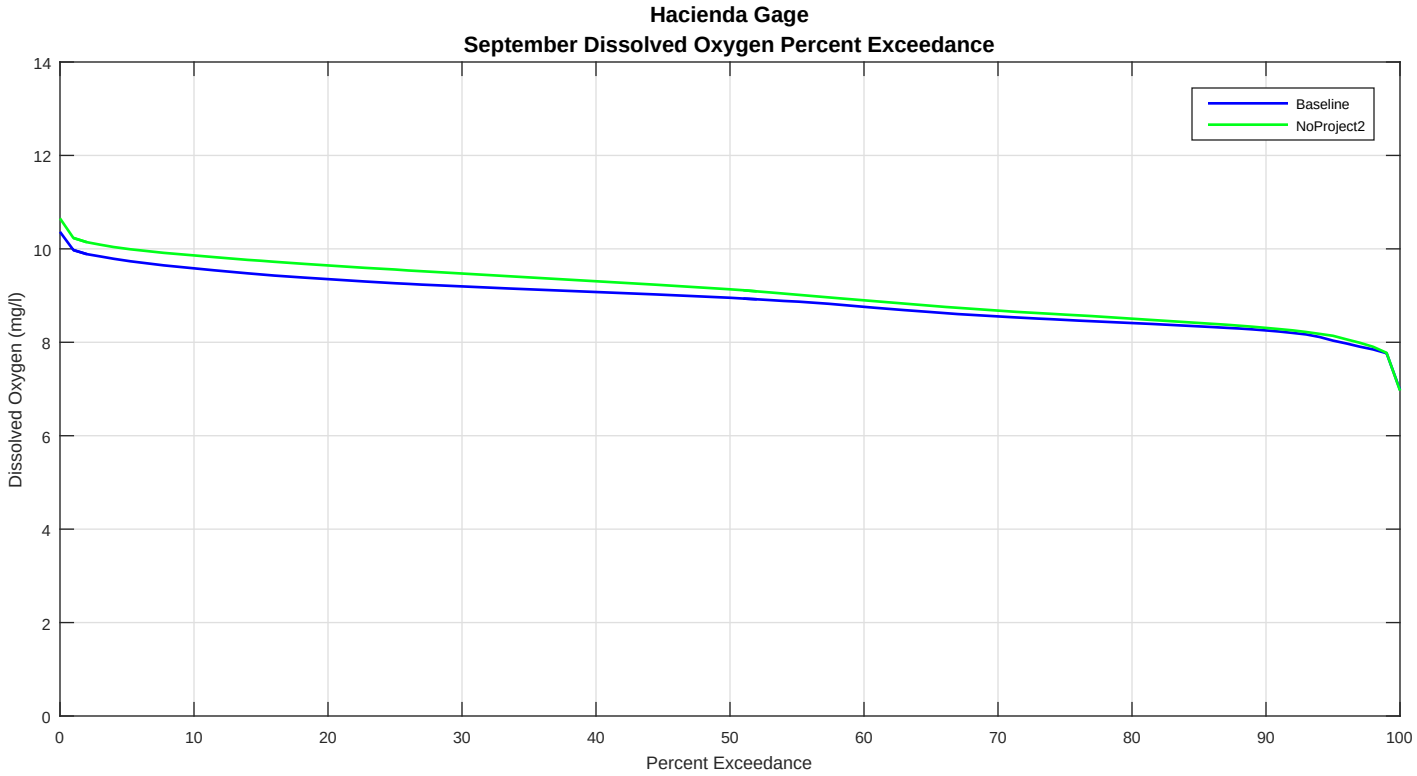
Hacienda Gage
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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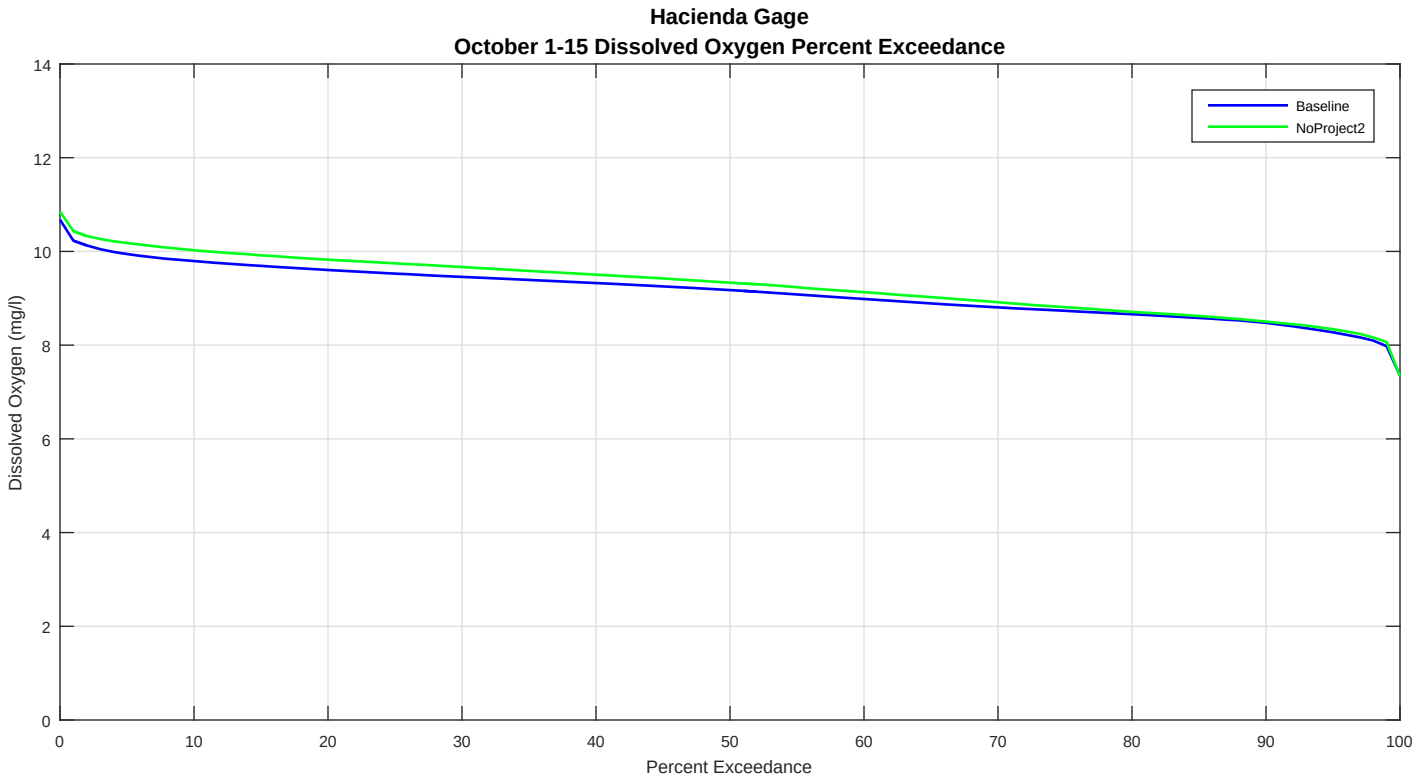
Hacienda Gage
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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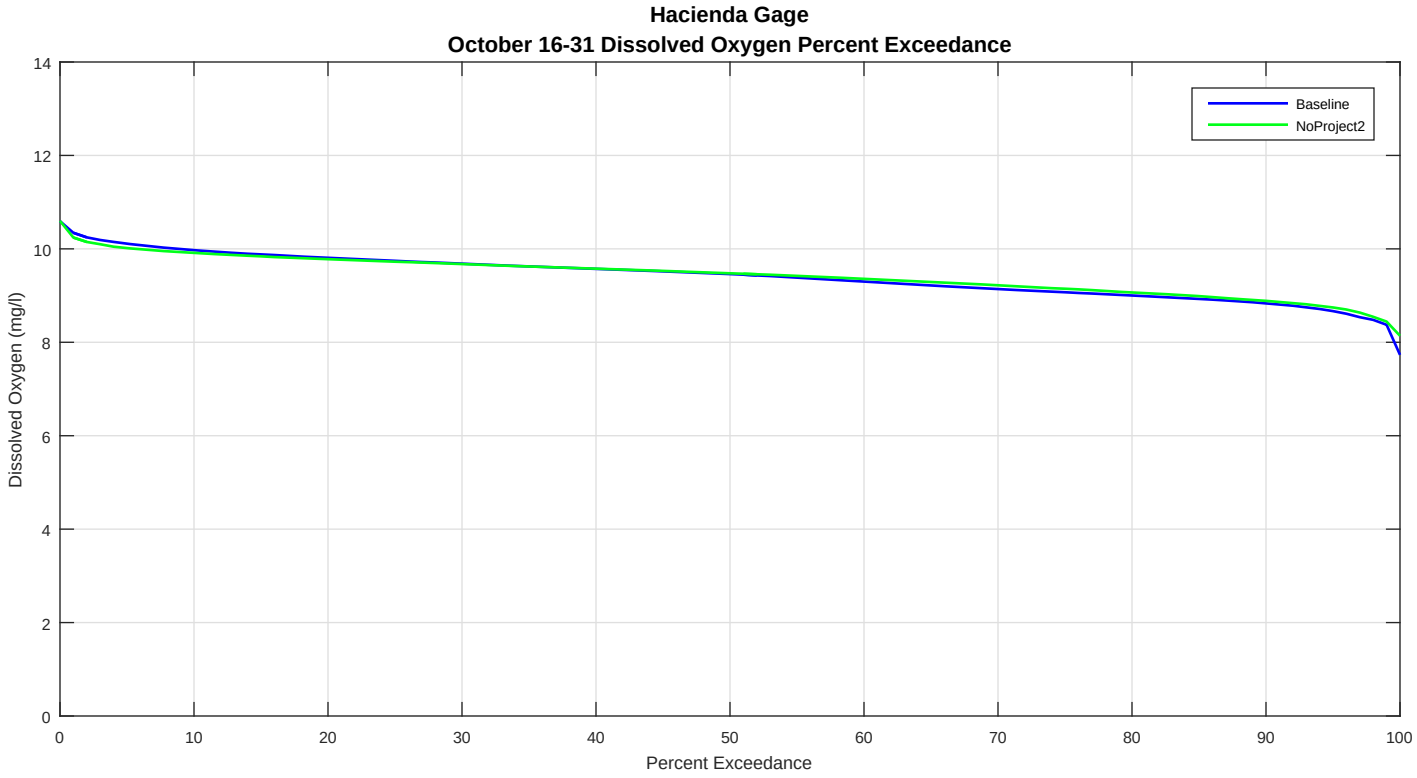
Hacienda Gage
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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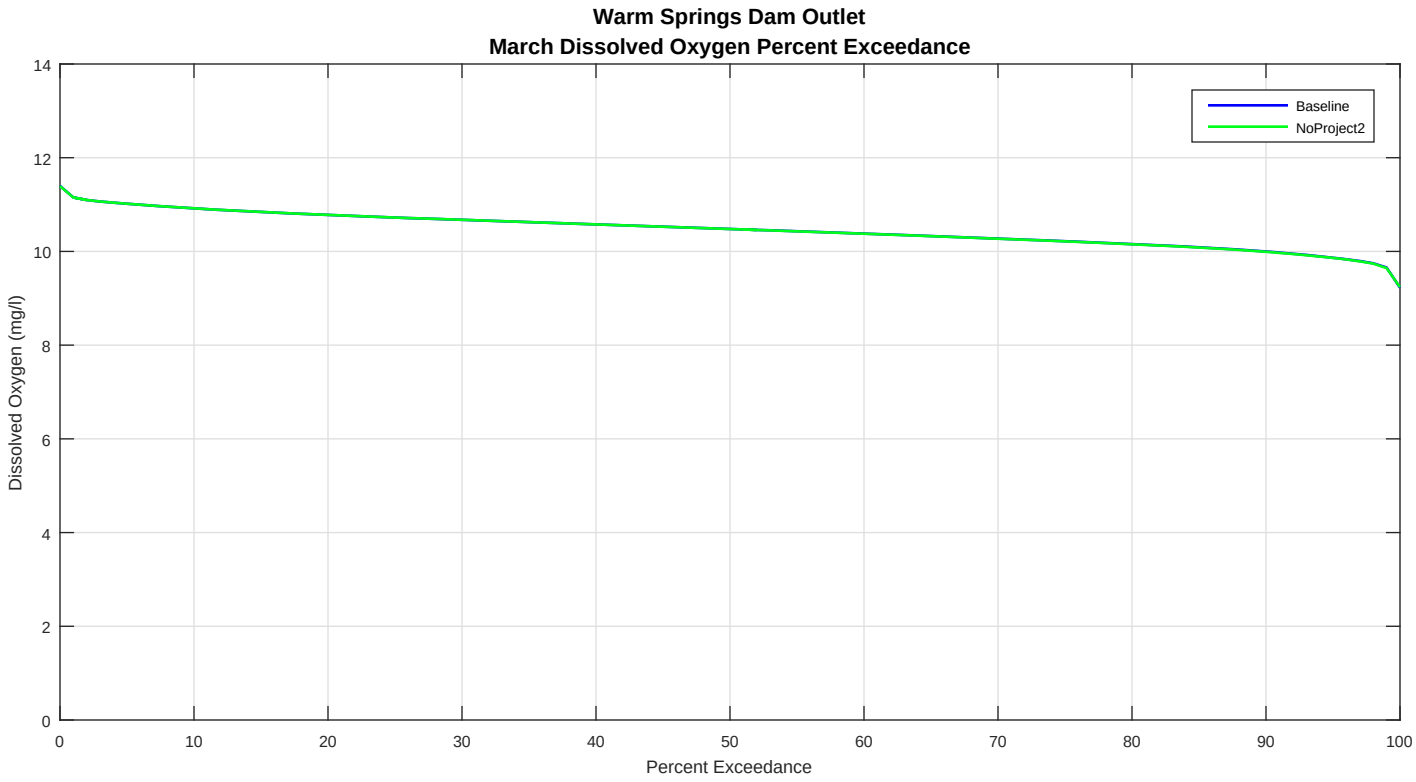
Warm Springs Dam Outlet
March Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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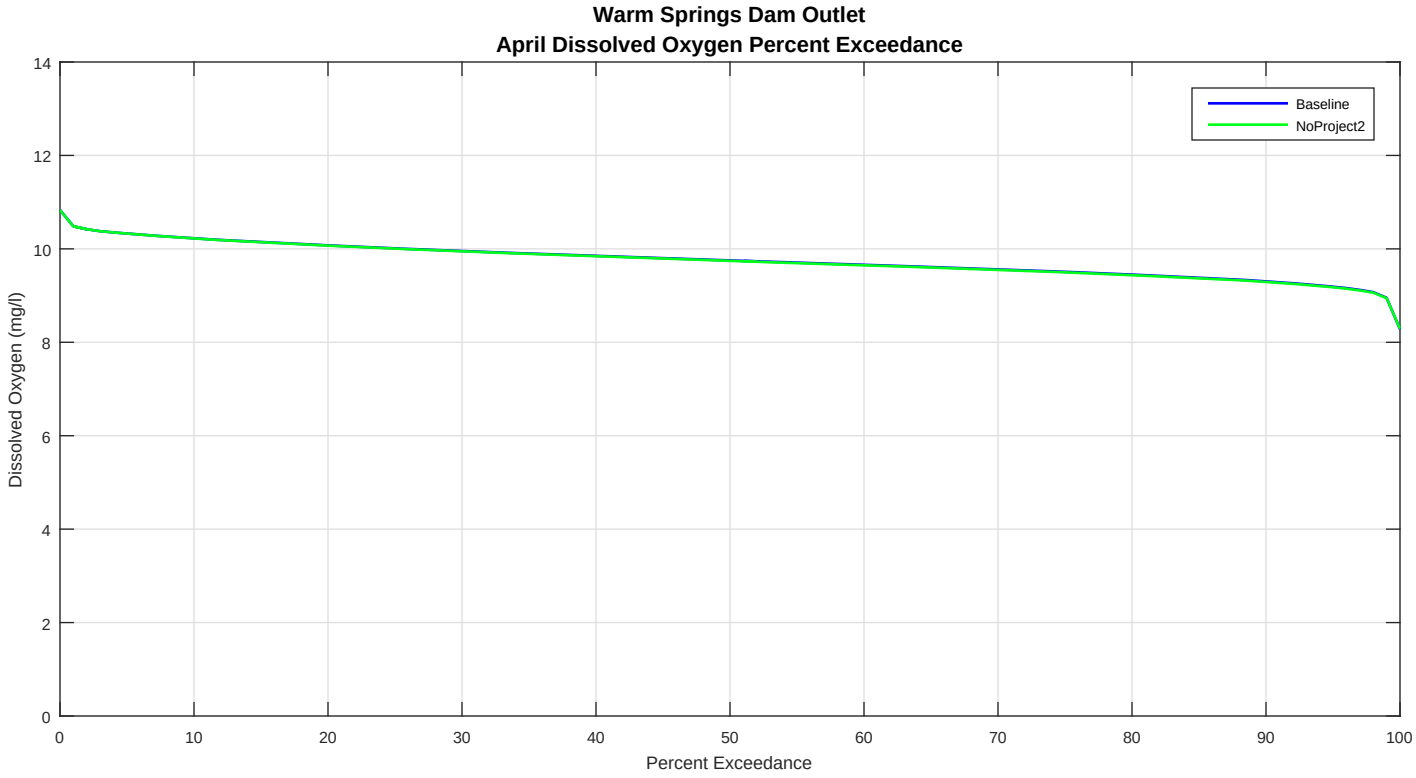
Warm Springs Dam Outlet
April Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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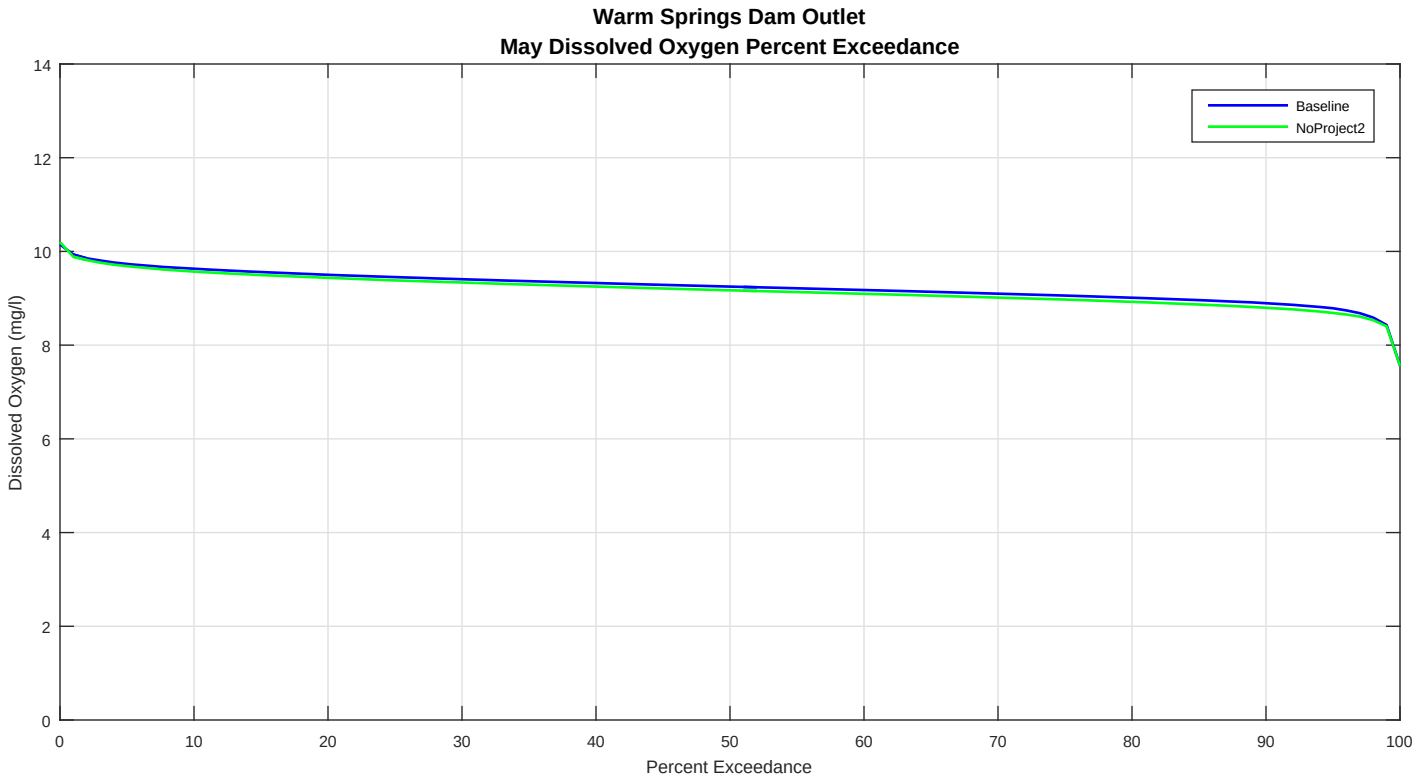
Warm Springs Dam Outlet
May Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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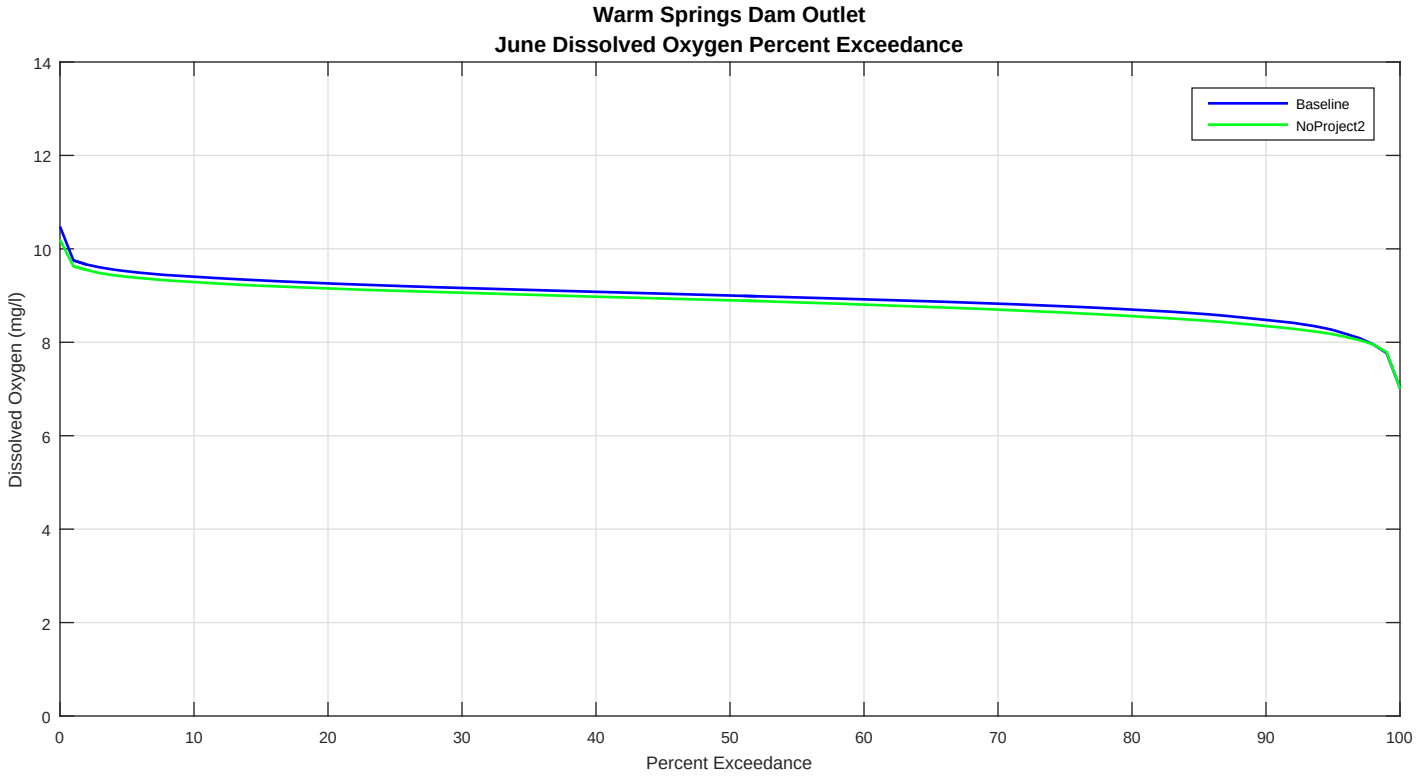
Warm Springs Dam Outlet
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
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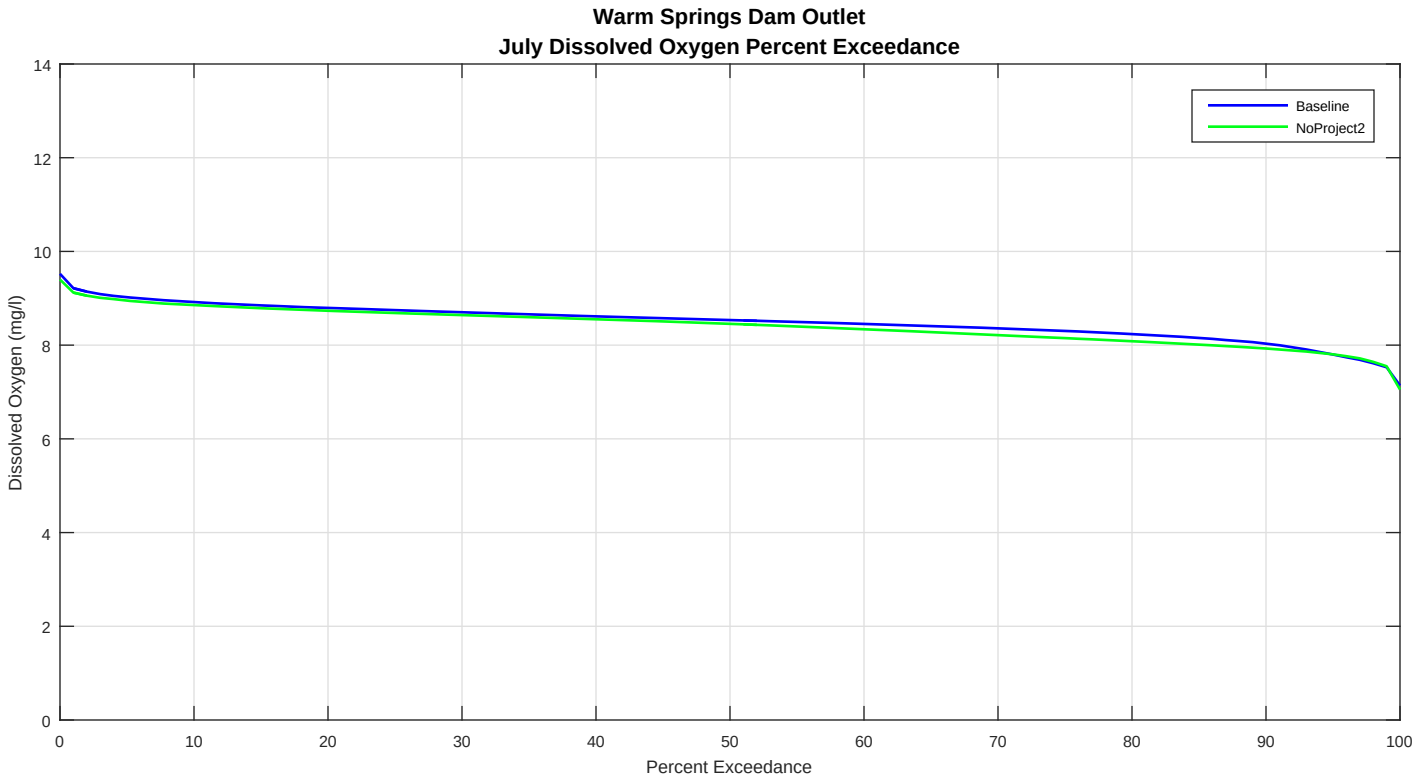
Warm Springs Dam Outlet
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
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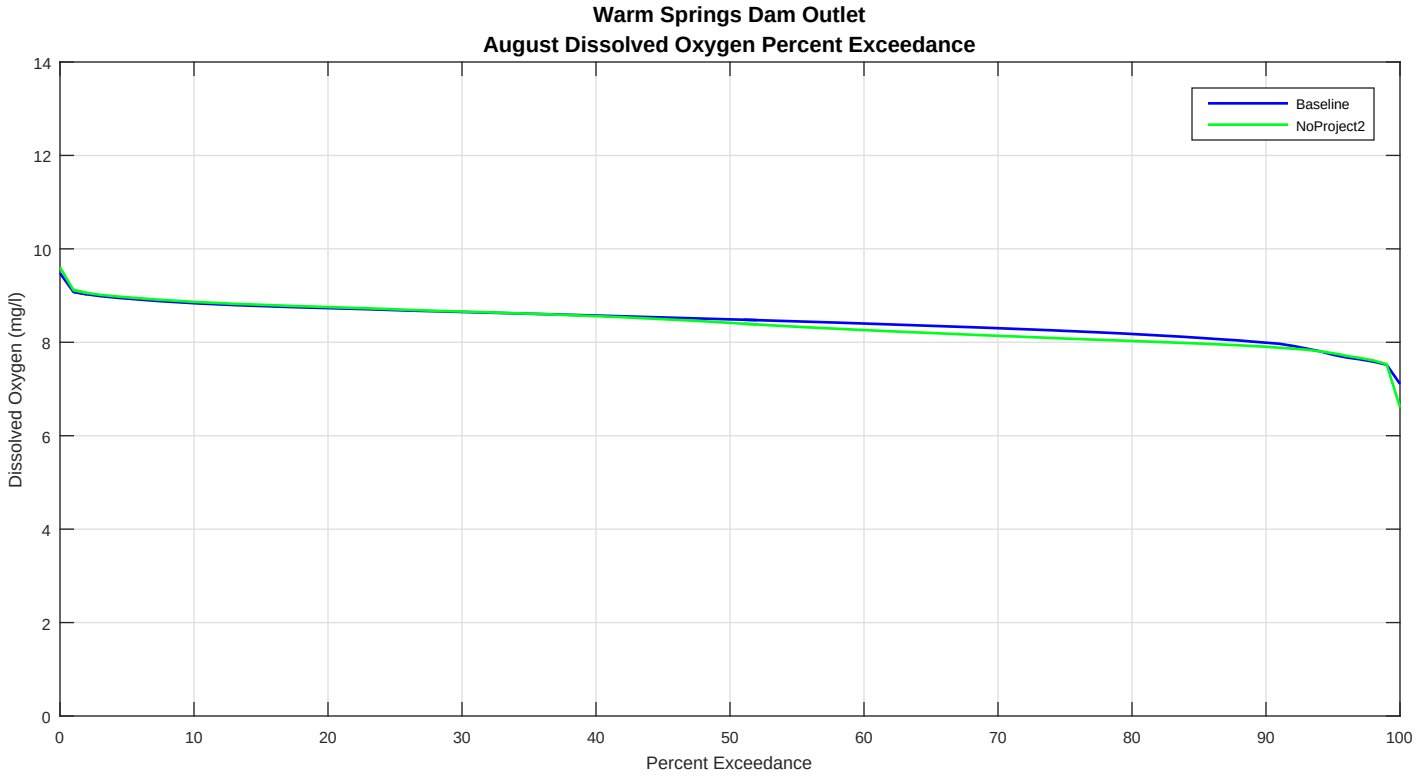
Warm Springs Dam Outlet
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
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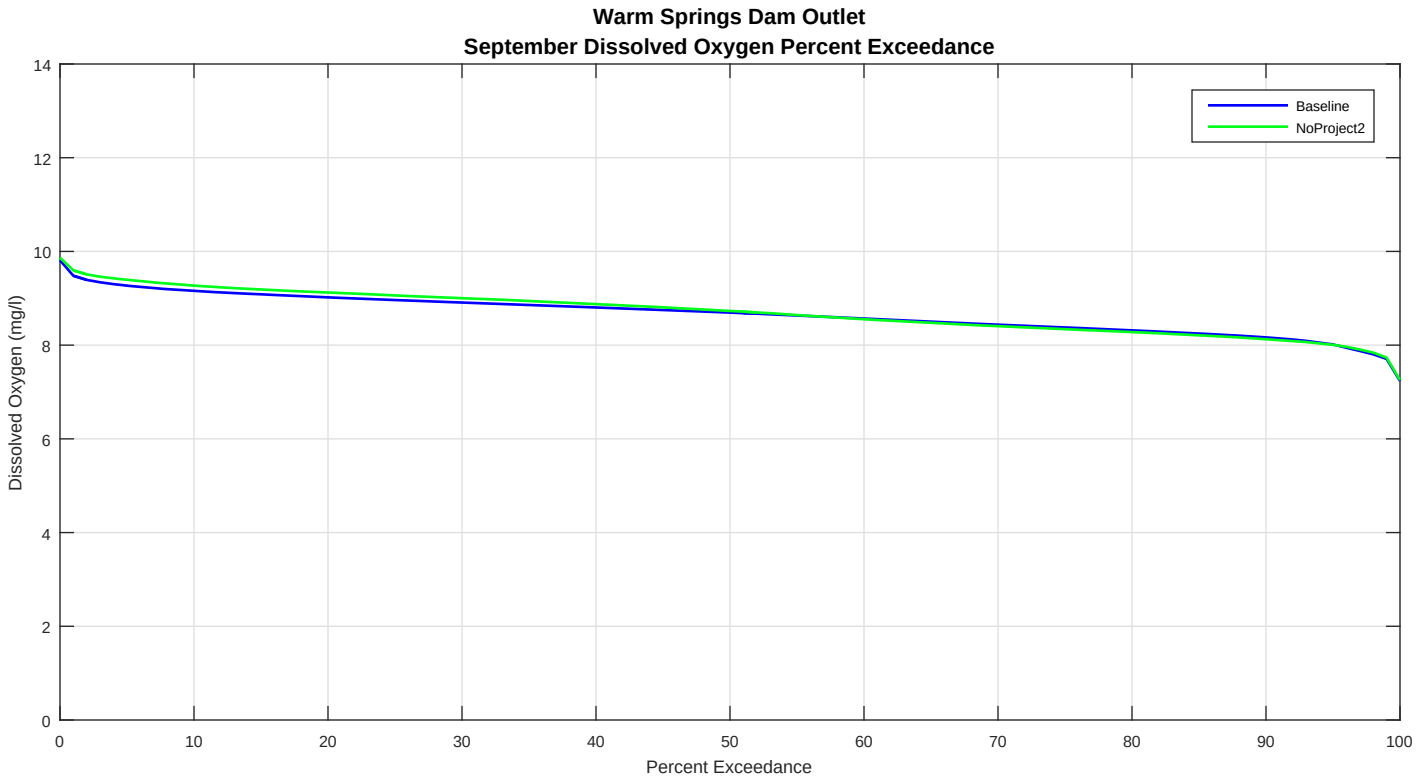
Warm Springs Dam Outlet
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
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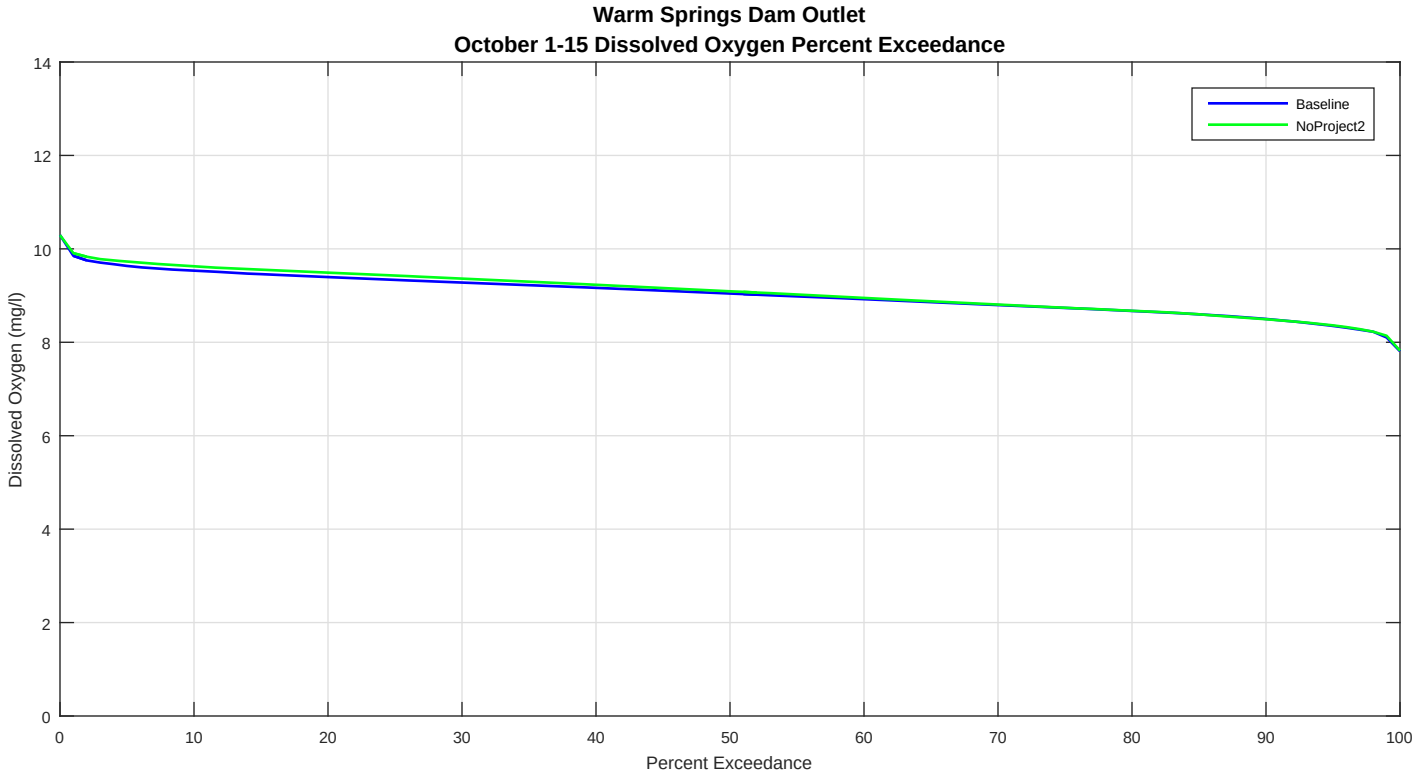
Warm Springs Dam Outlet
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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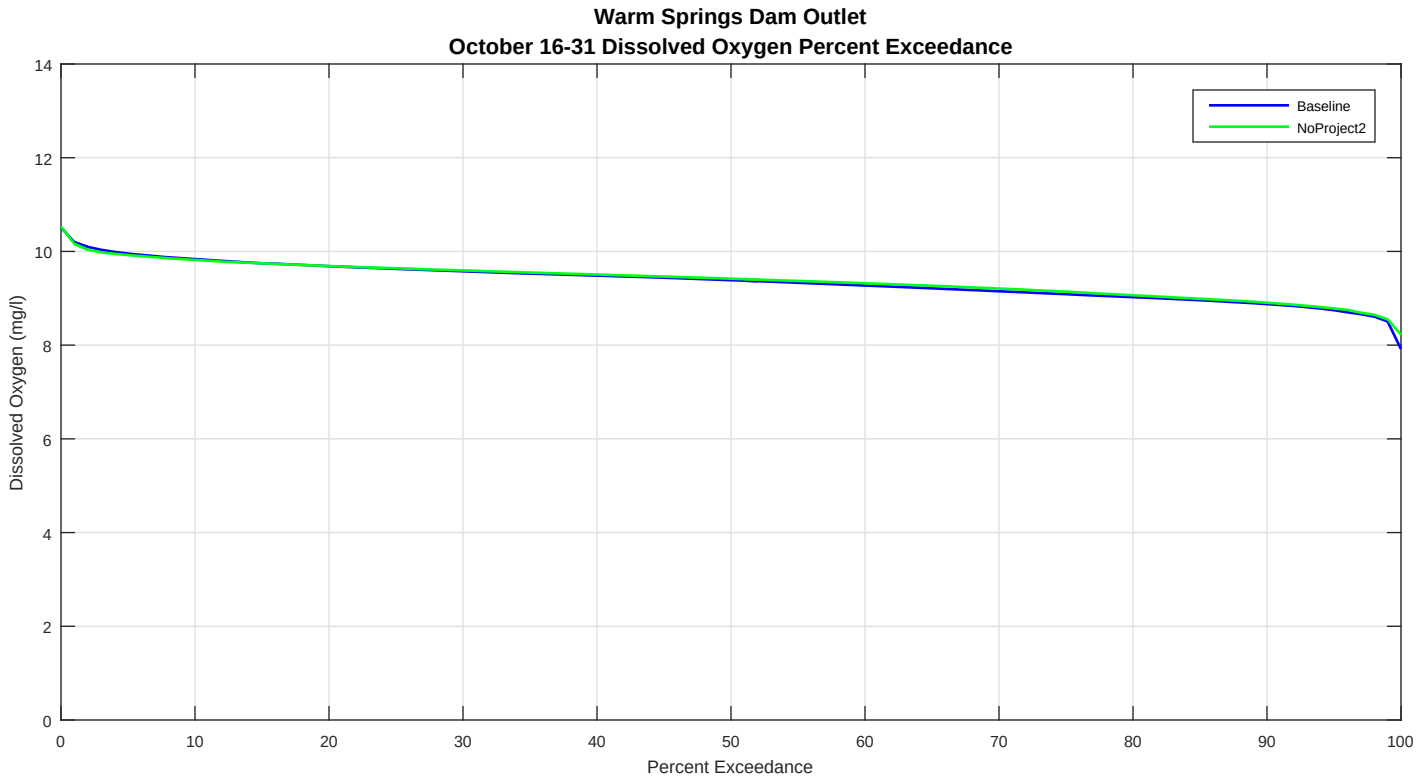
Warm Springs Dam Outlet
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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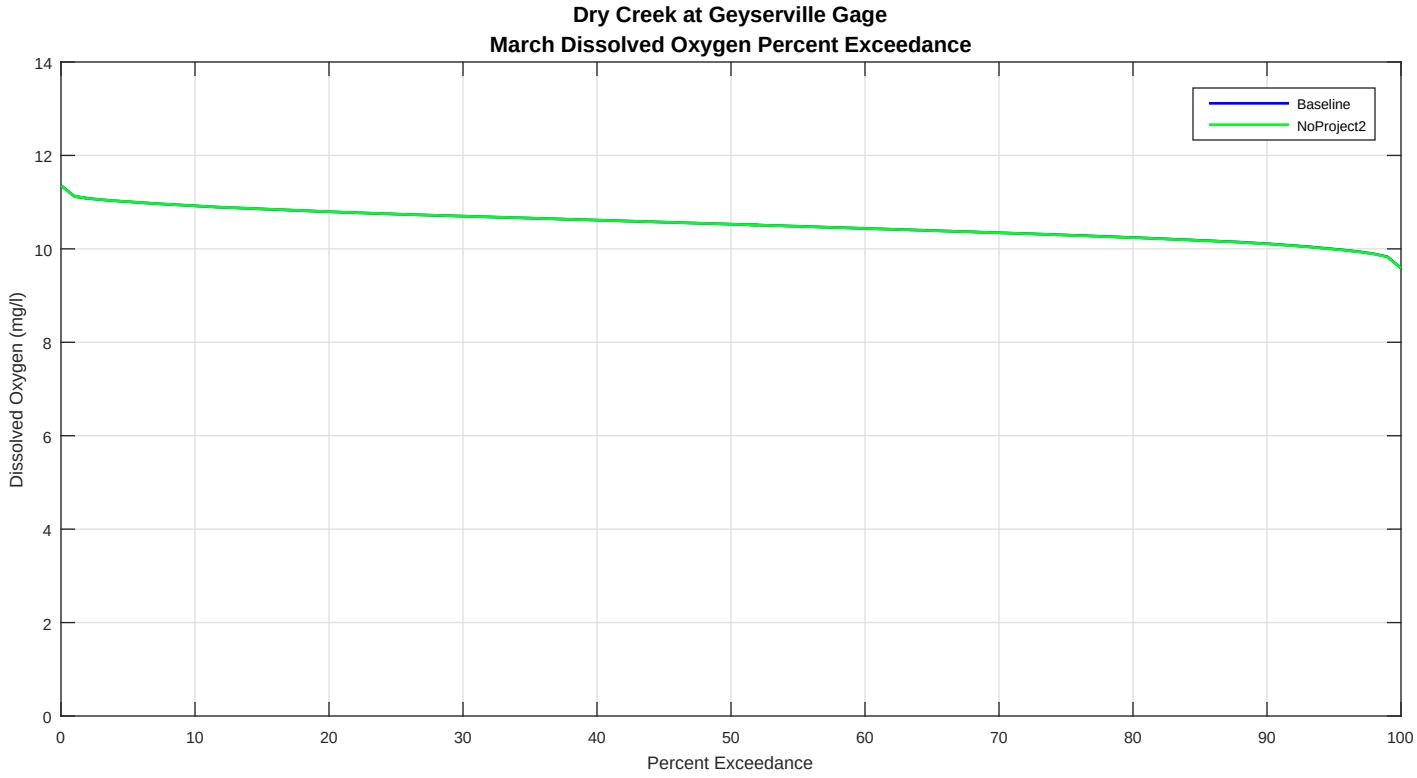
Dry Creek at Geyserville Gage
March Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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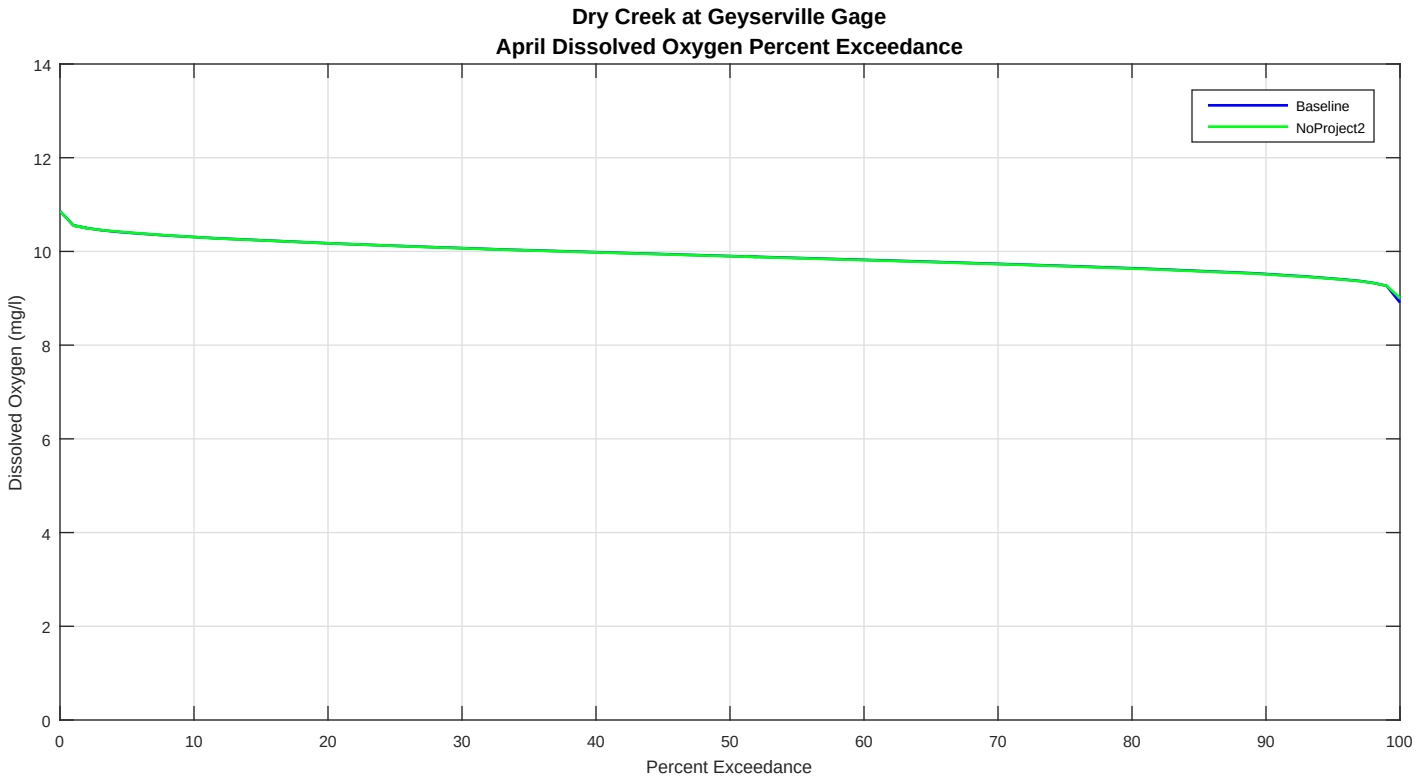
Dry Creek at Geyserville Gage
April Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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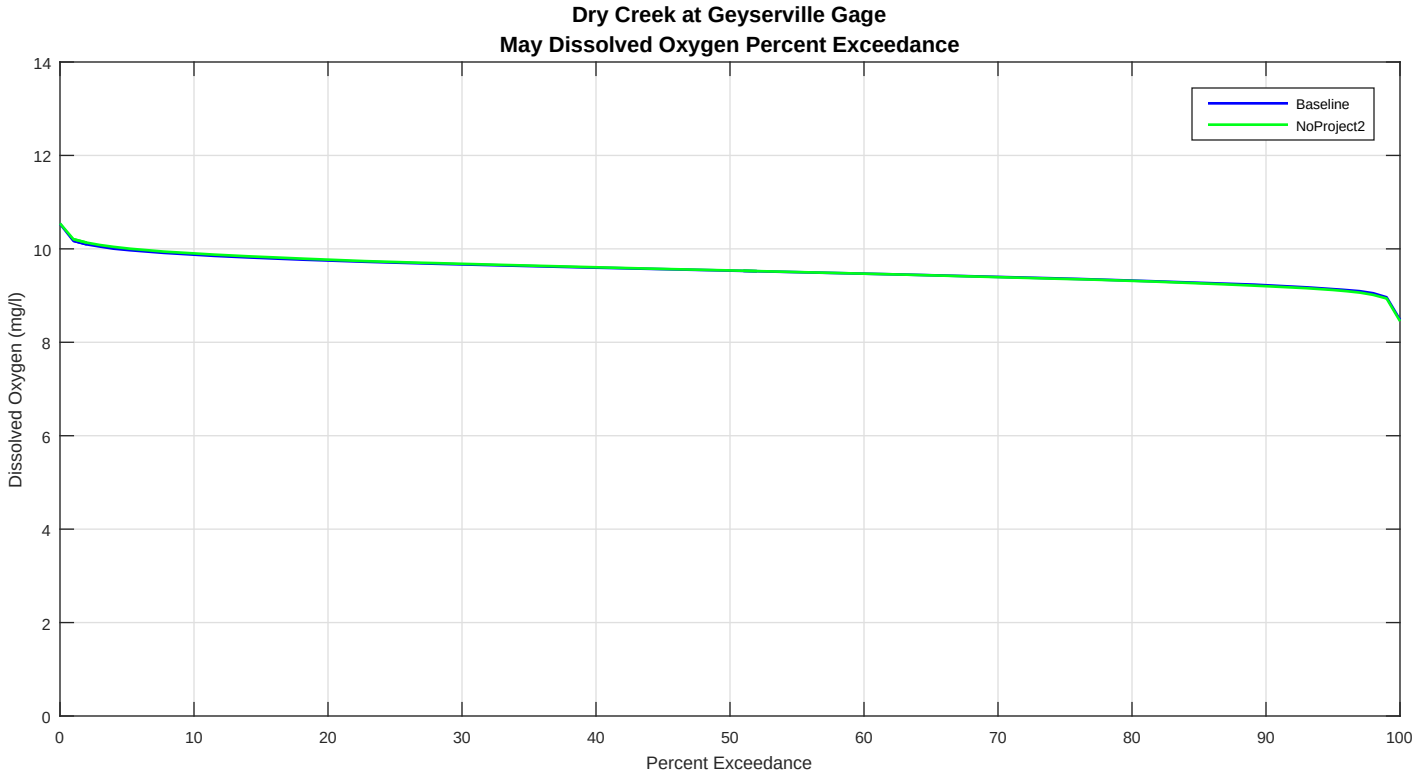
Dry Creek at Geyserville Gage
May Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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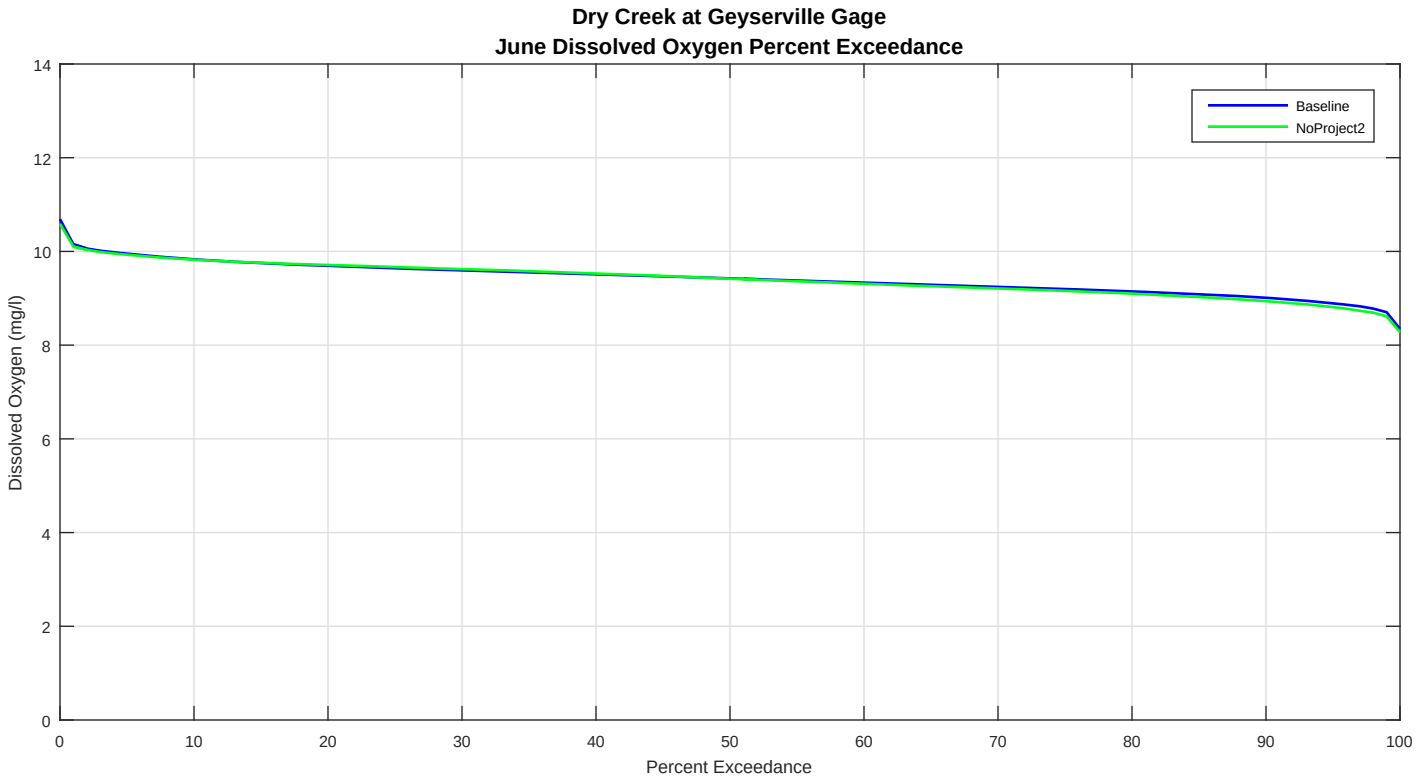
Dry Creek at Geyserville Gage
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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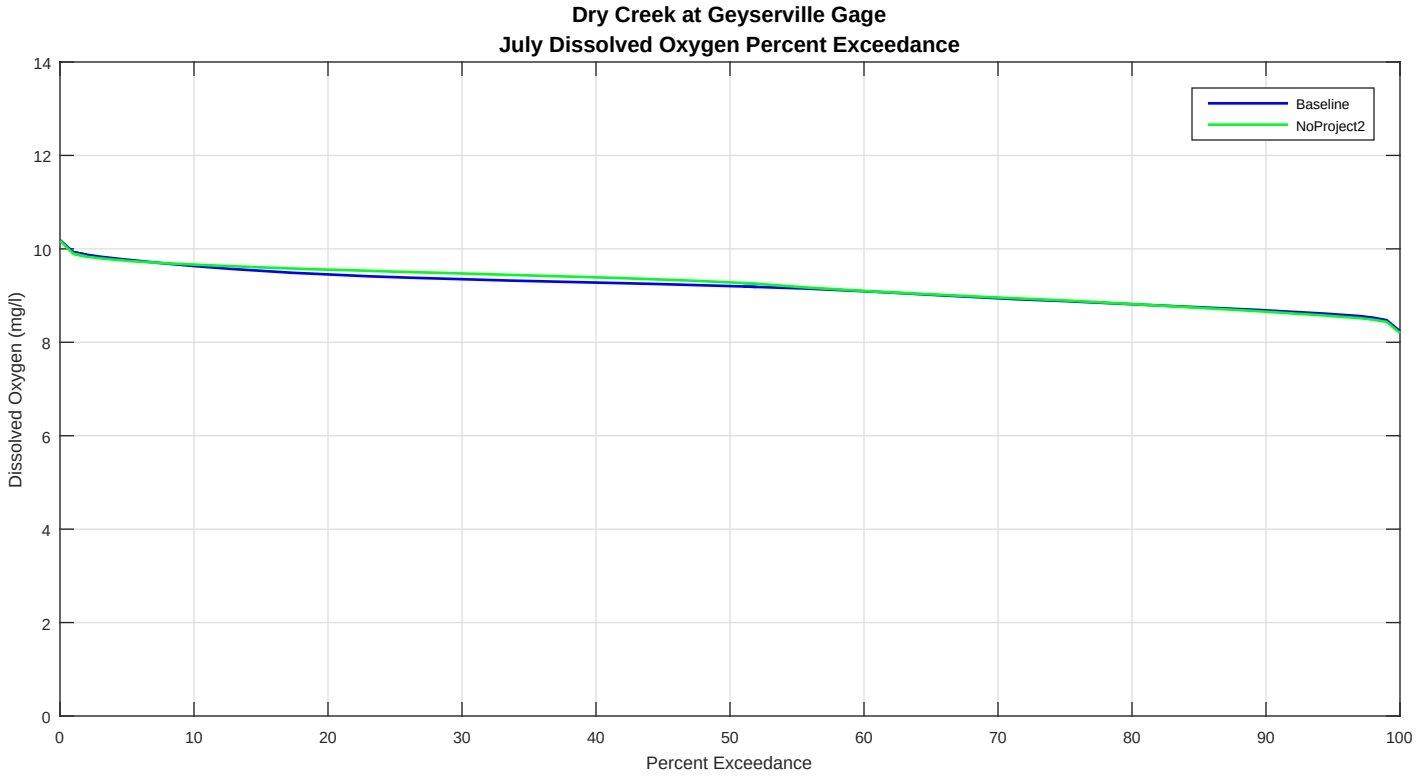
Dry Creek at Geyserville Gage
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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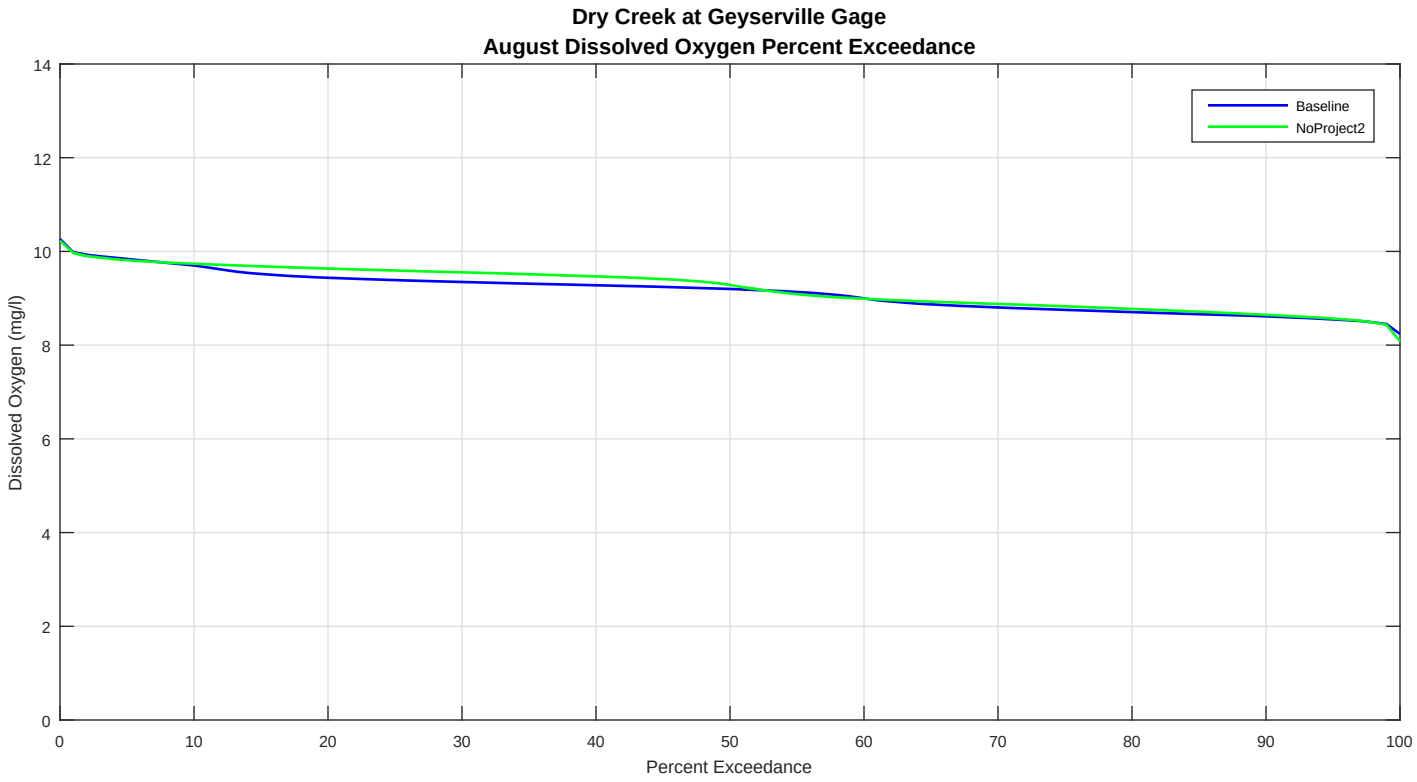
Dry Creek at Geyserville Gage
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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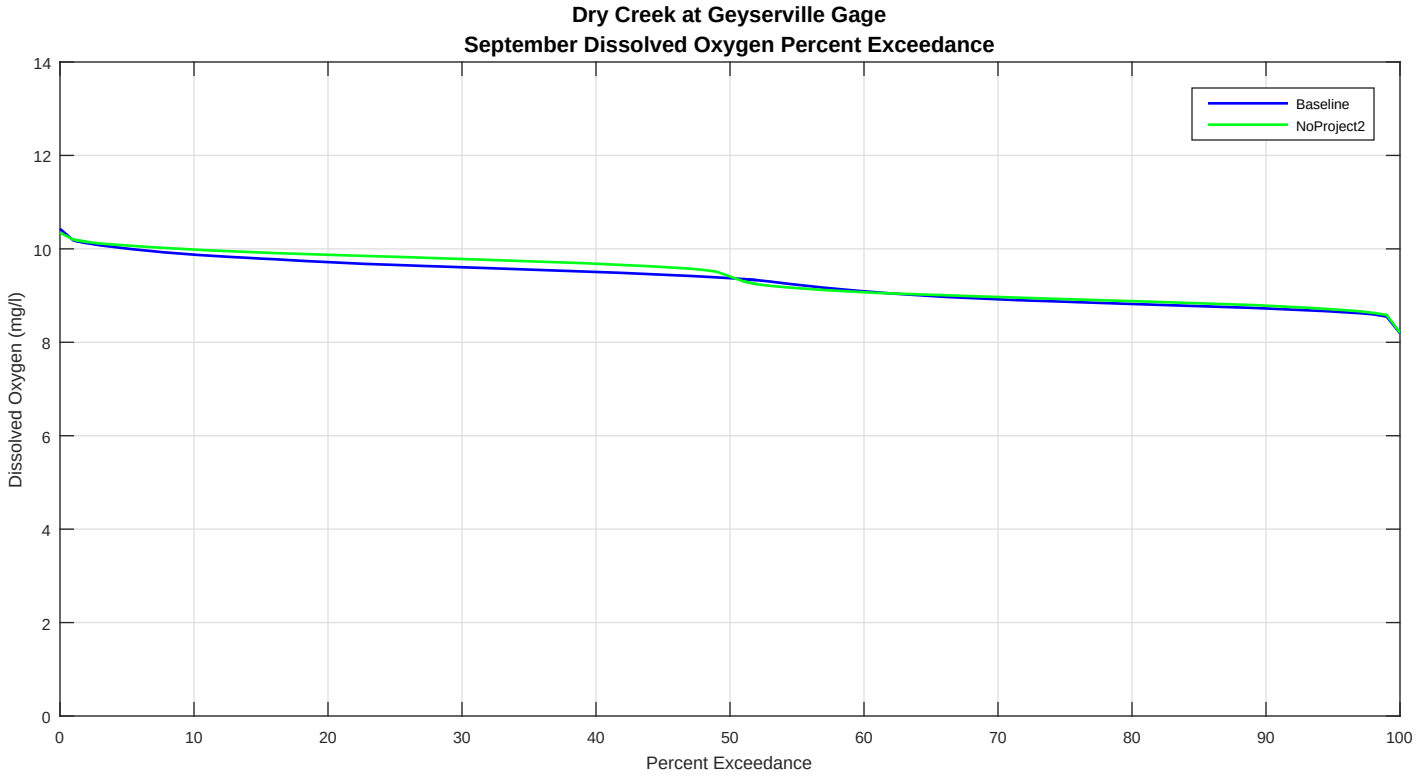
Dry Creek at Geyserville Gage
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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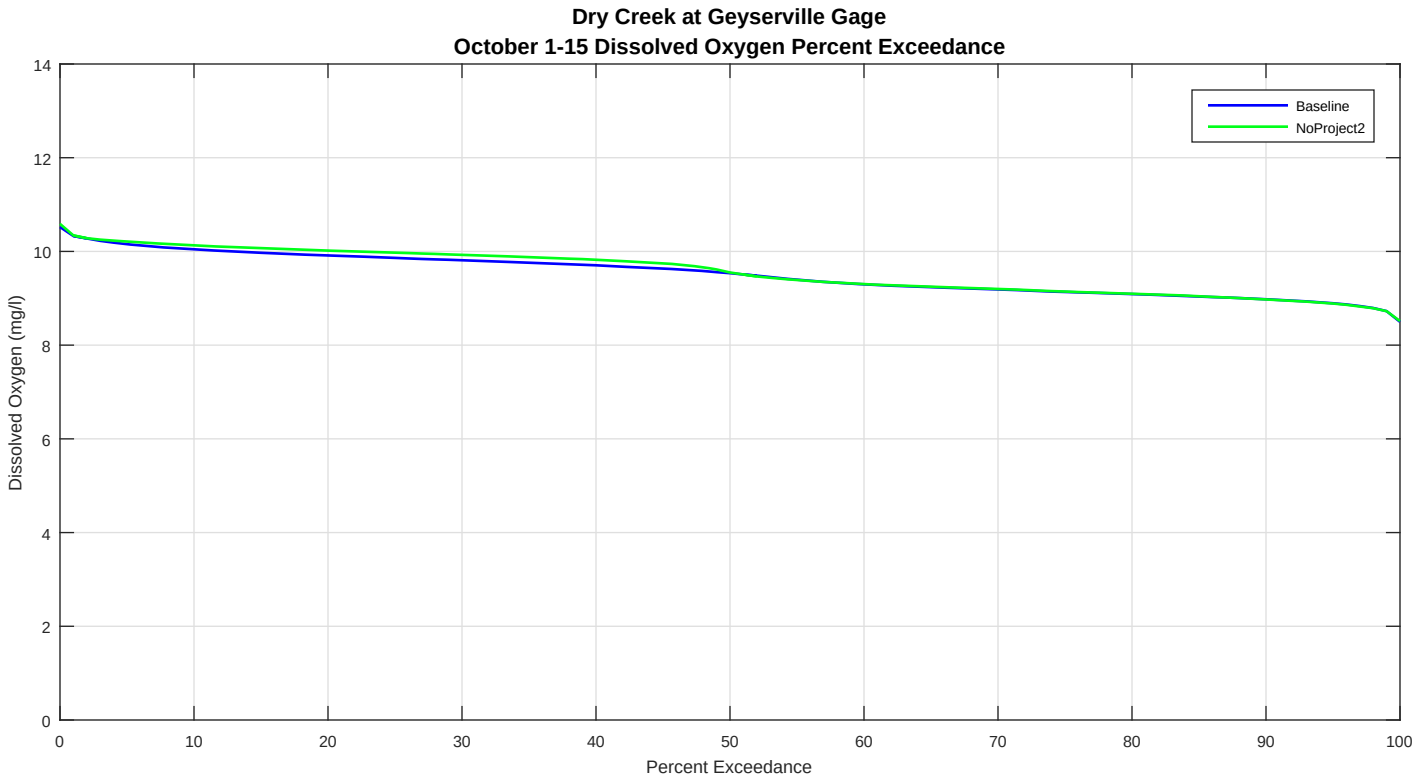
Dry Creek at Geyserville Gage
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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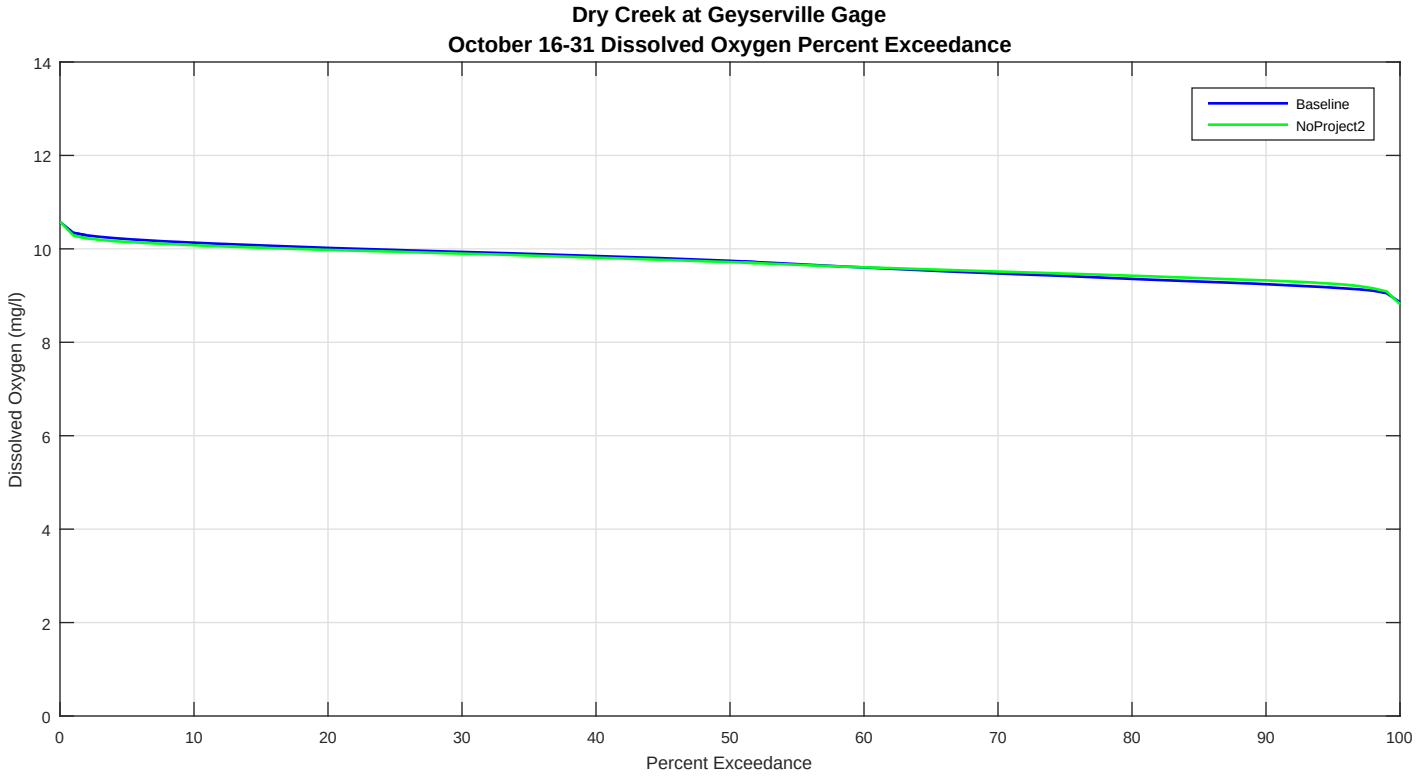
Dry Creek at Geyserville Gage
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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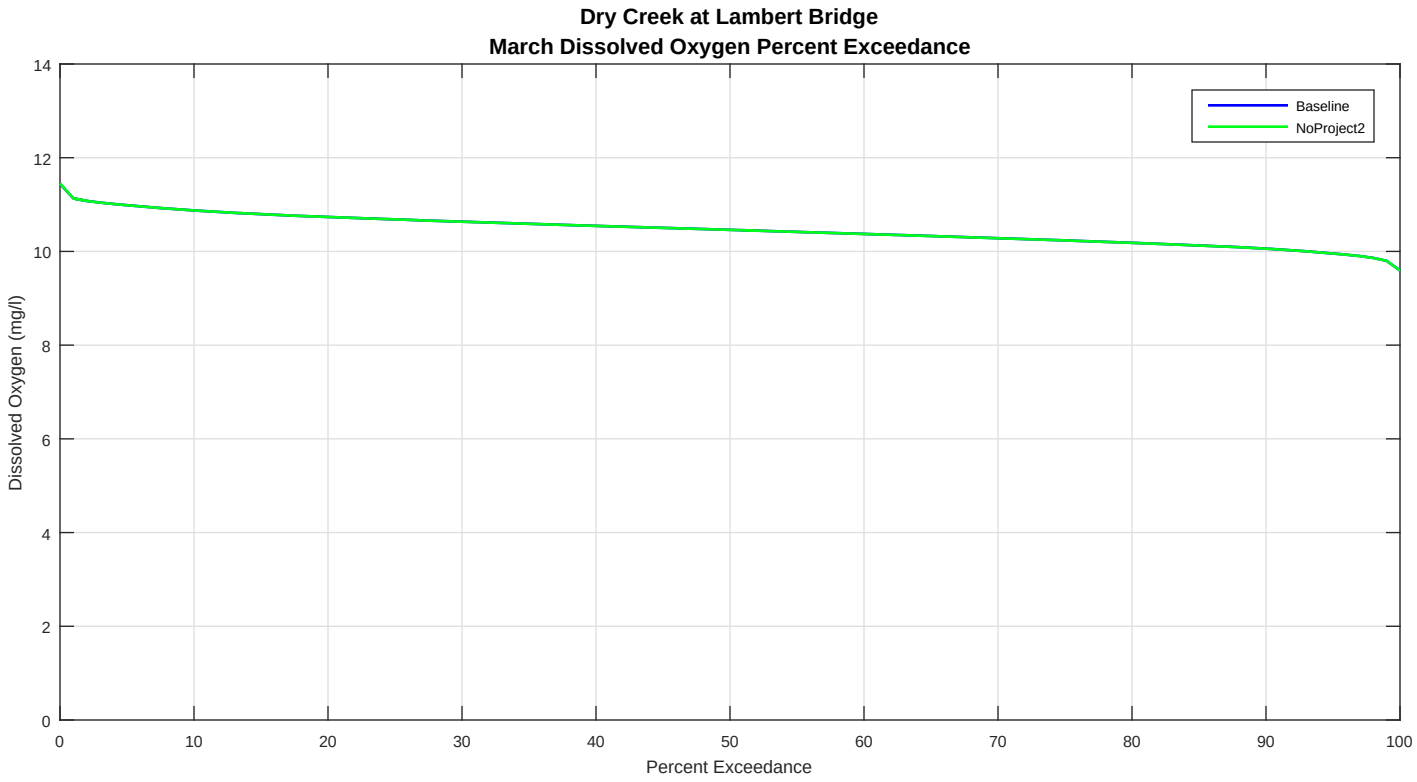
Dry Creek at Lambert Bridge
March Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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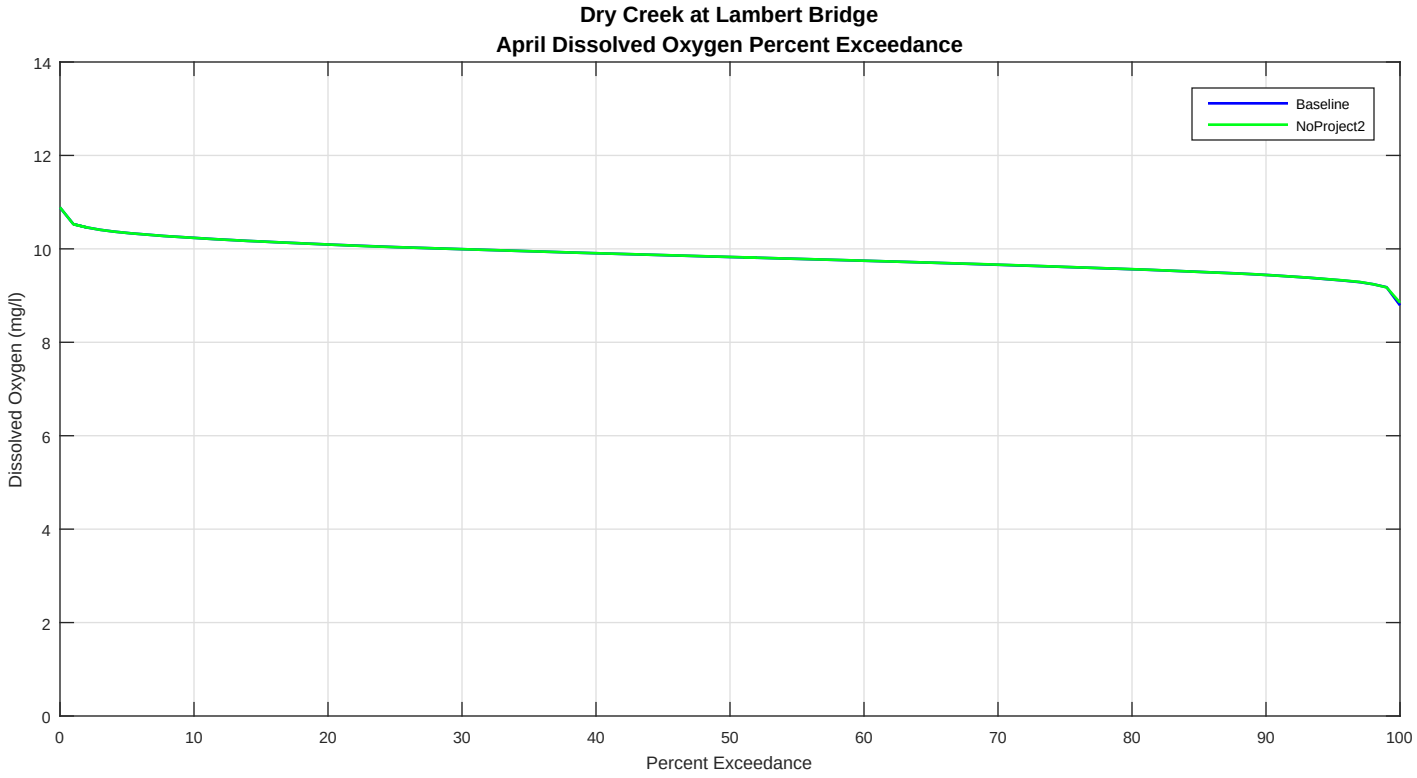
Dry Creek at Lambert Bridge
April Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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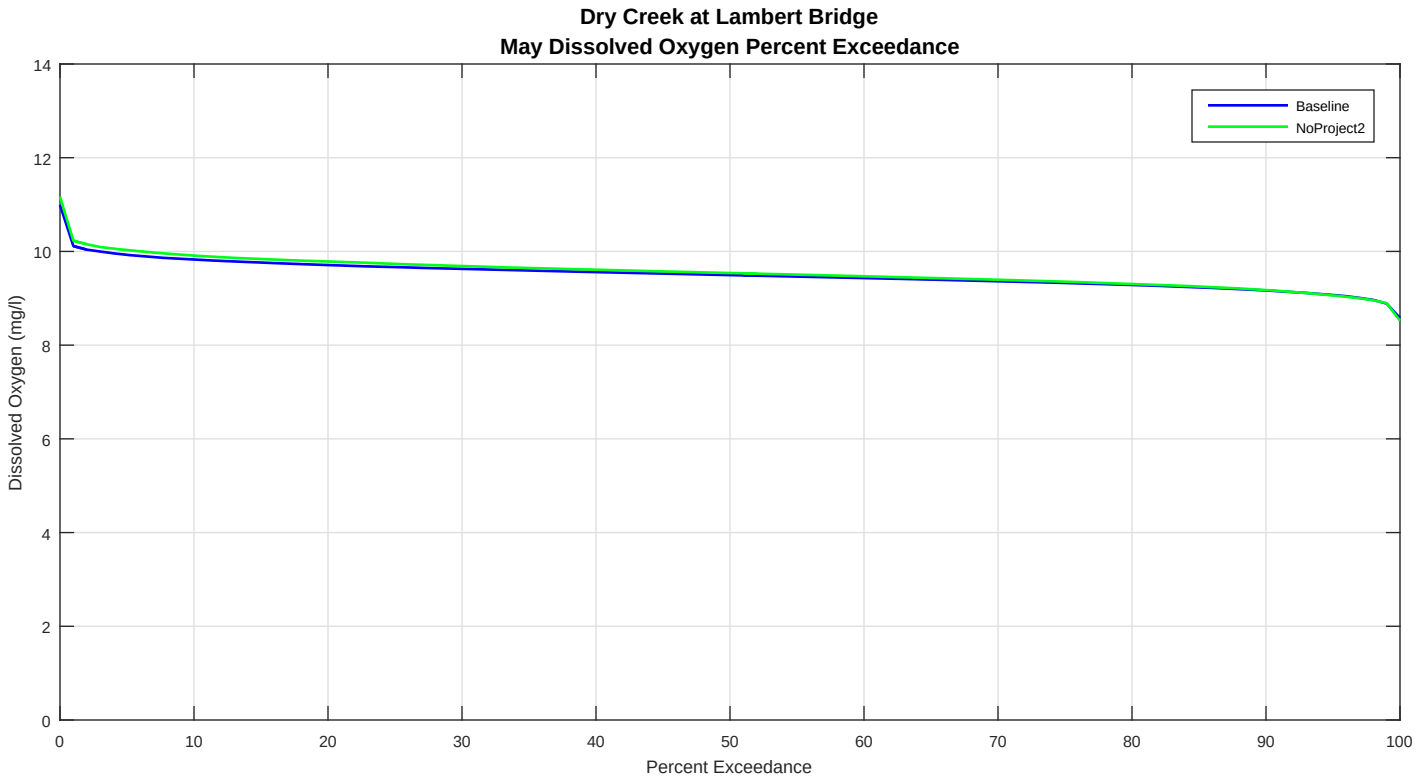
Dry Creek at Lambert Bridge
May Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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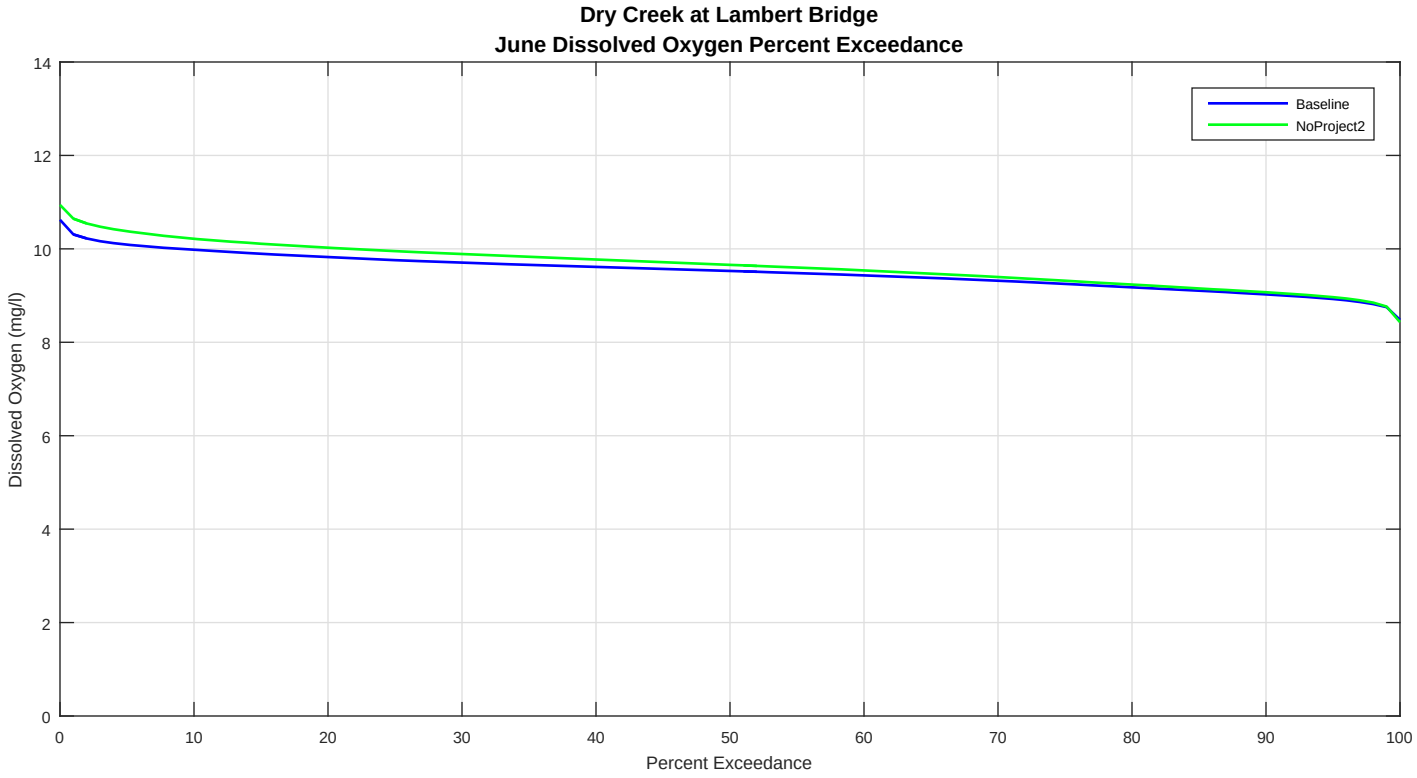
Dry Creek at Lambert Bridge
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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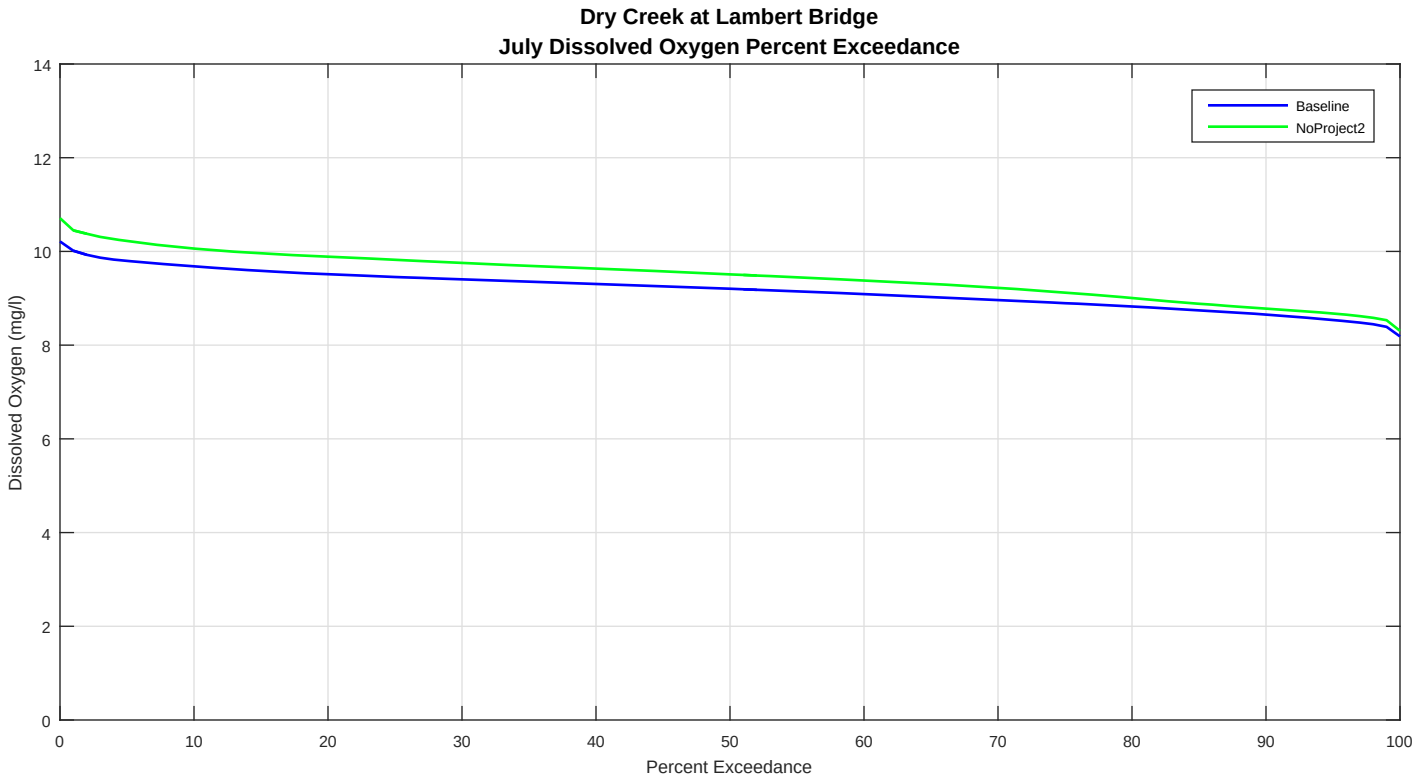
Dry Creek at Lambert Bridge
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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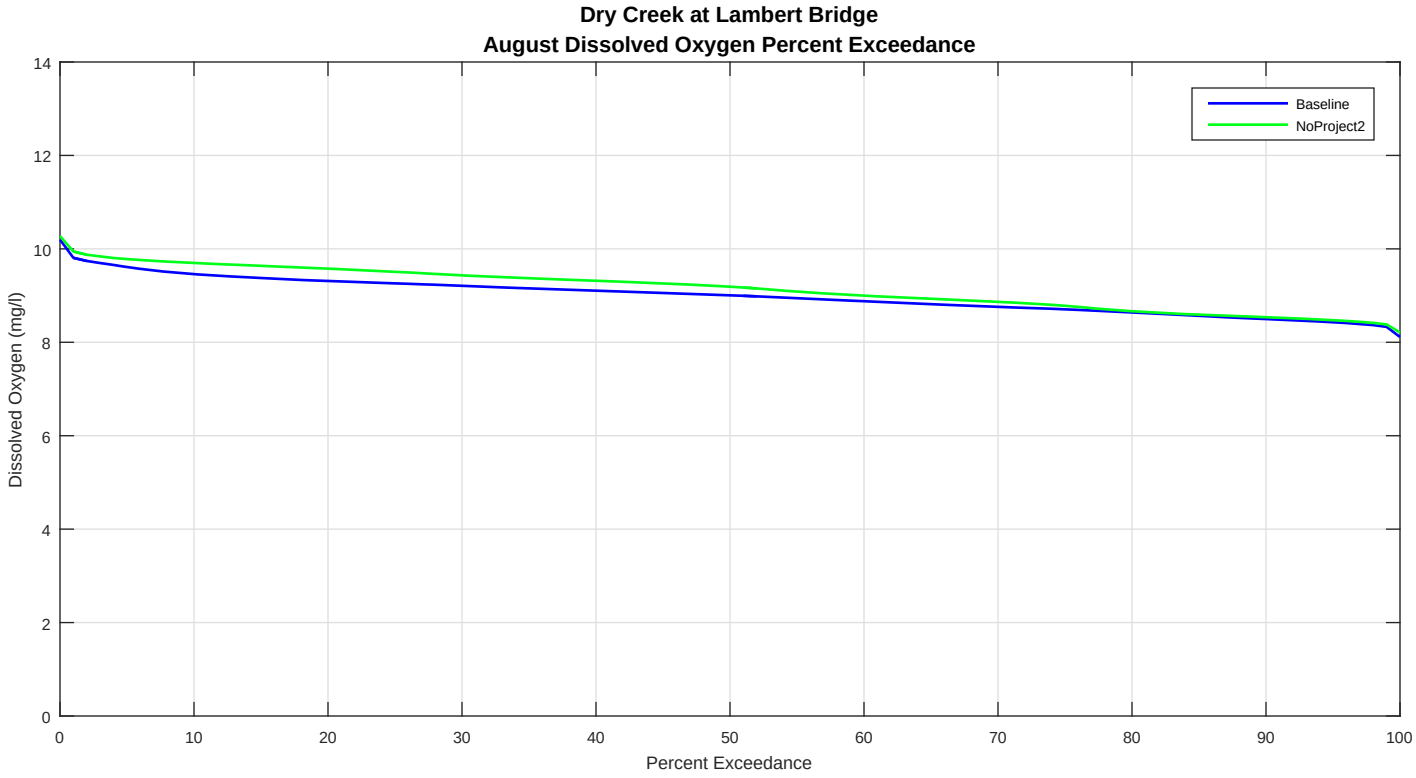
Dry Creek at Lambert Bridge
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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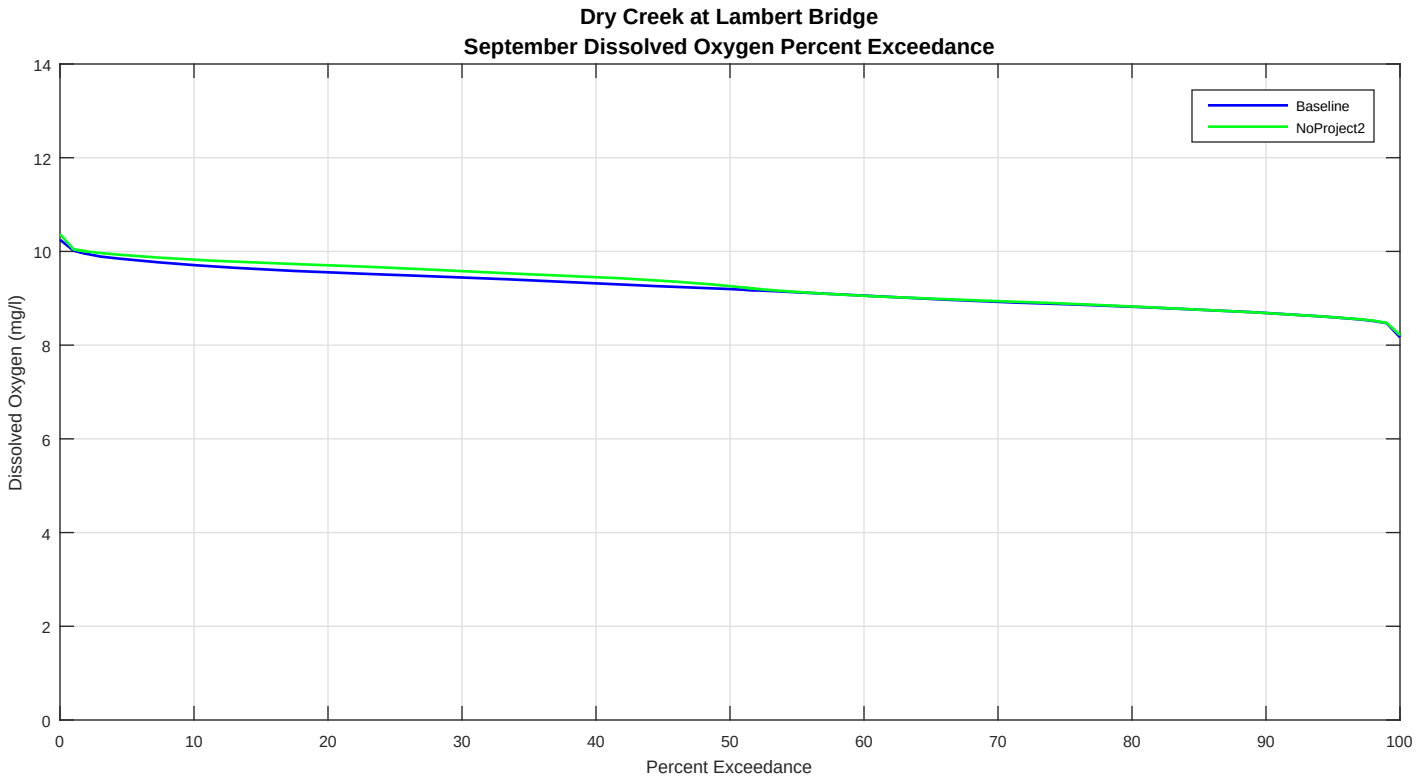
Dry Creek at Lambert Bridge
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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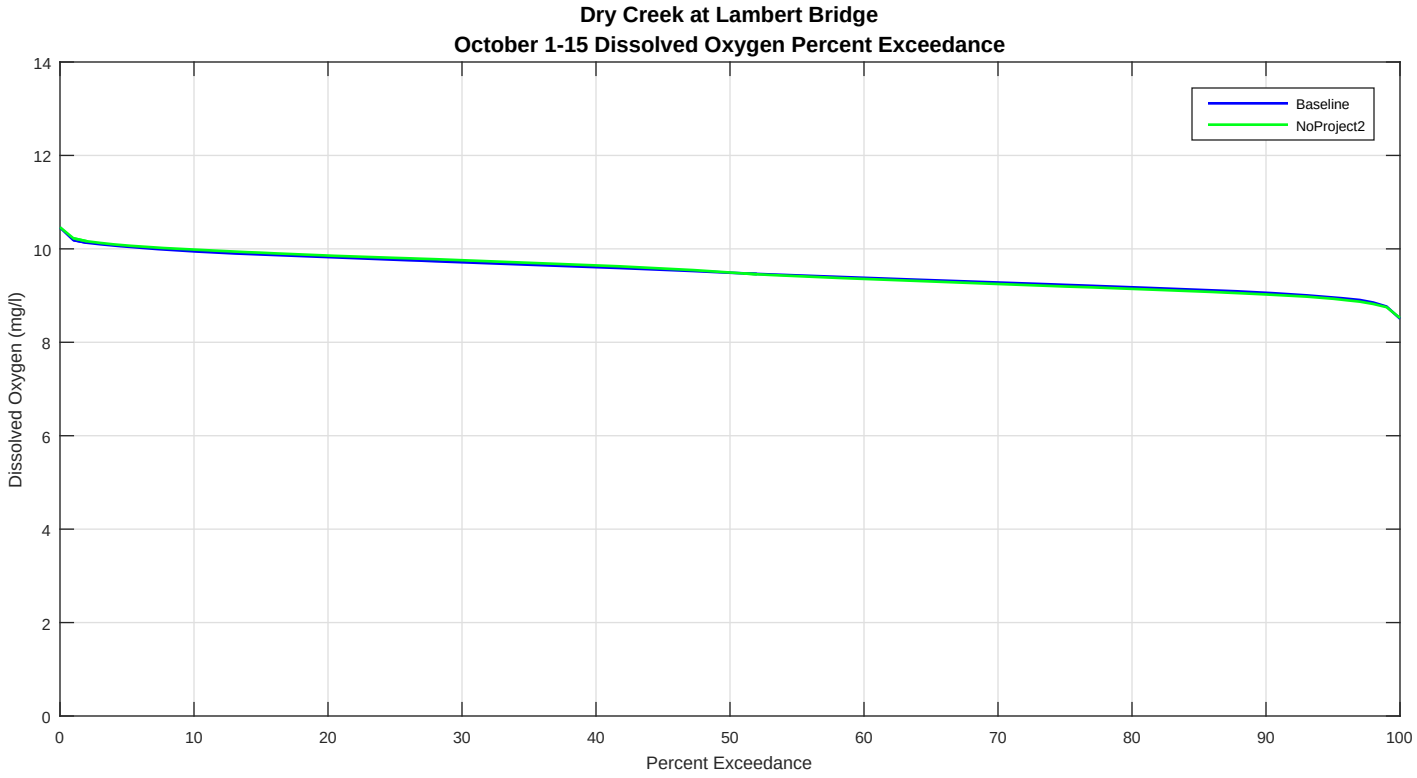
Dry Creek at Lambert Bridge
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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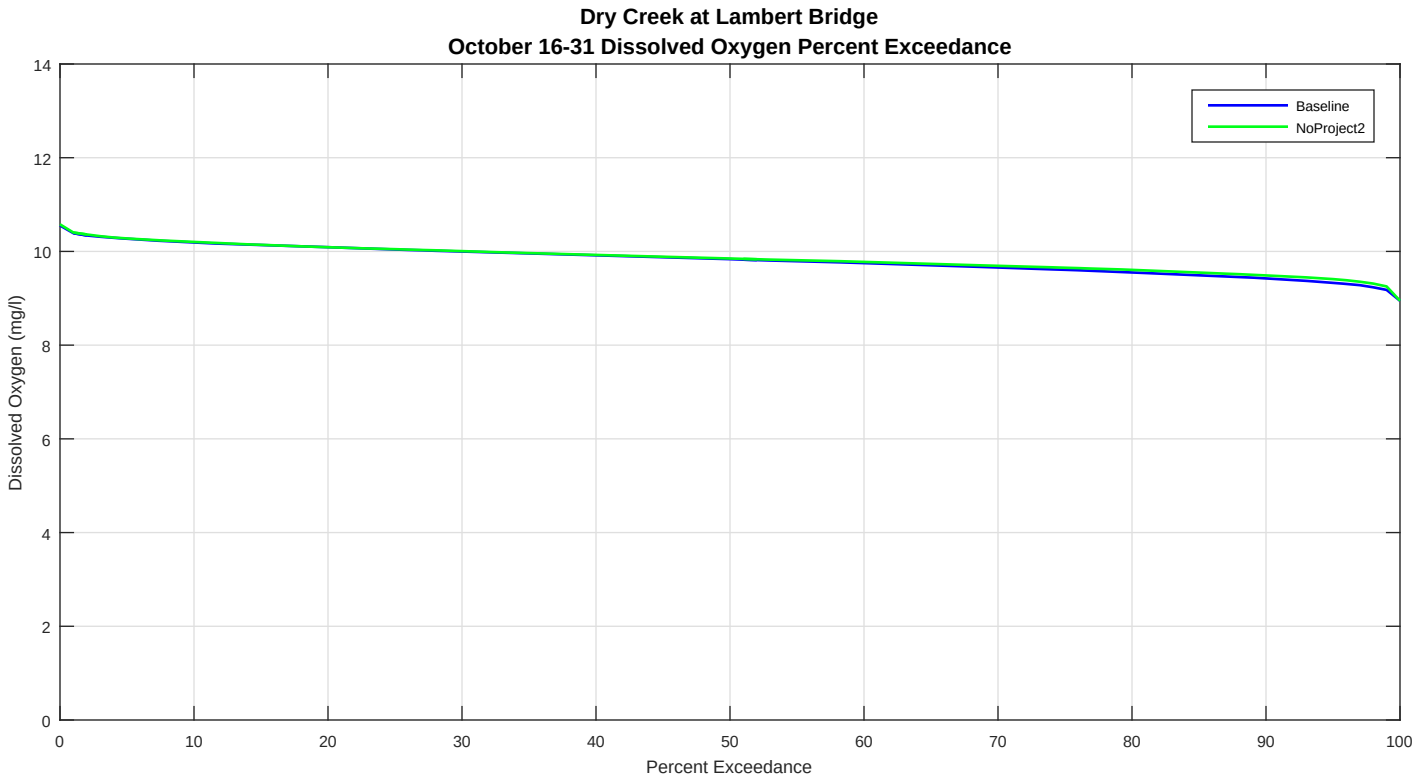
Dry Creek at Lambert Bridge
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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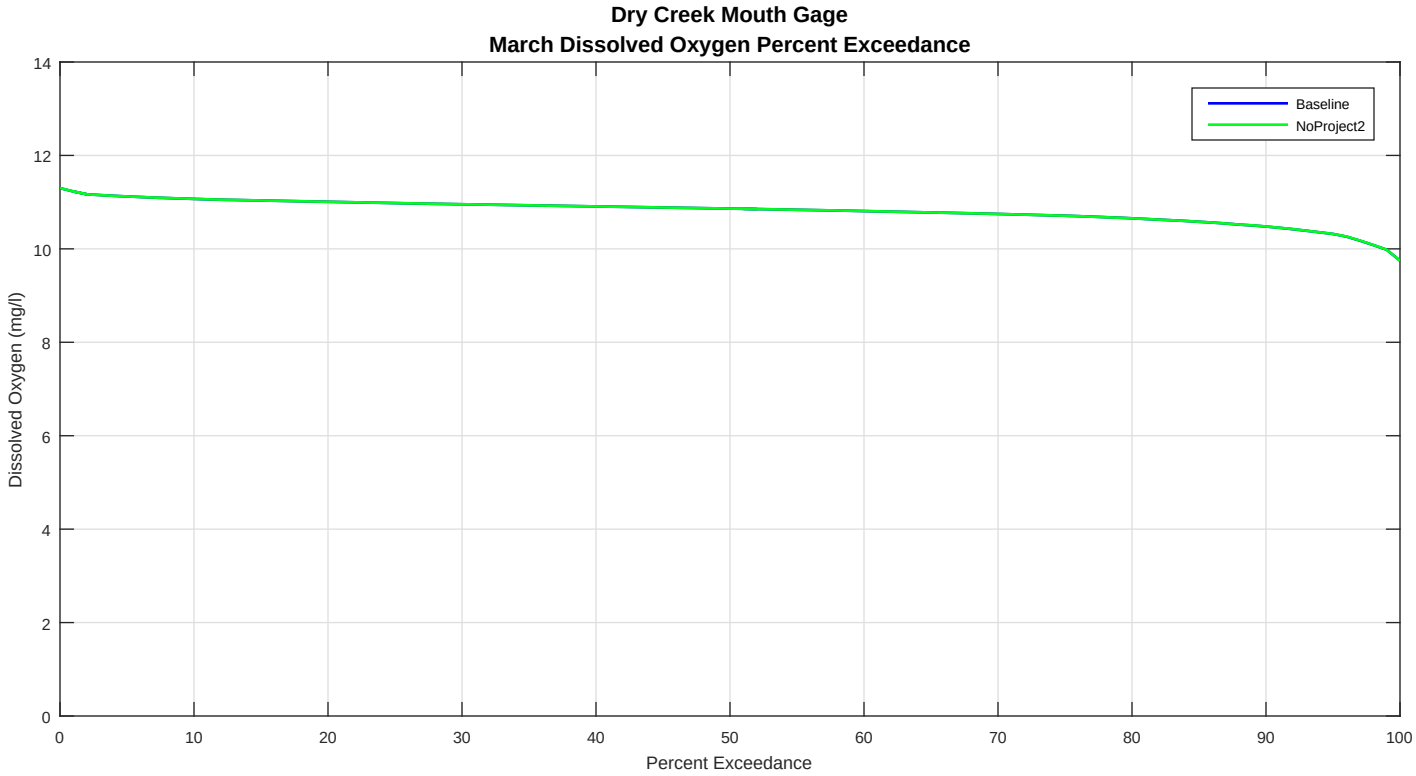
Dry Creek Mouth Gage
March Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
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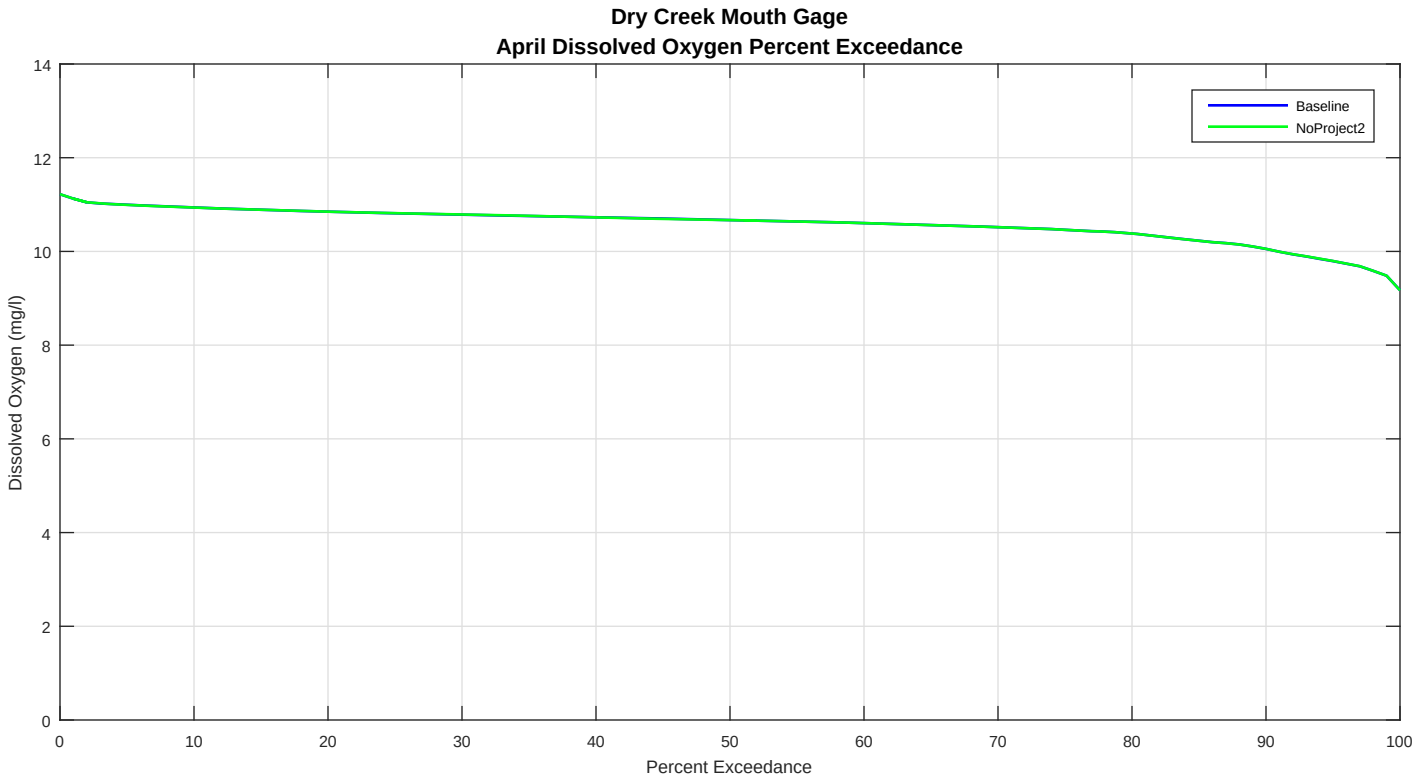
Dry Creek Mouth Gage
April Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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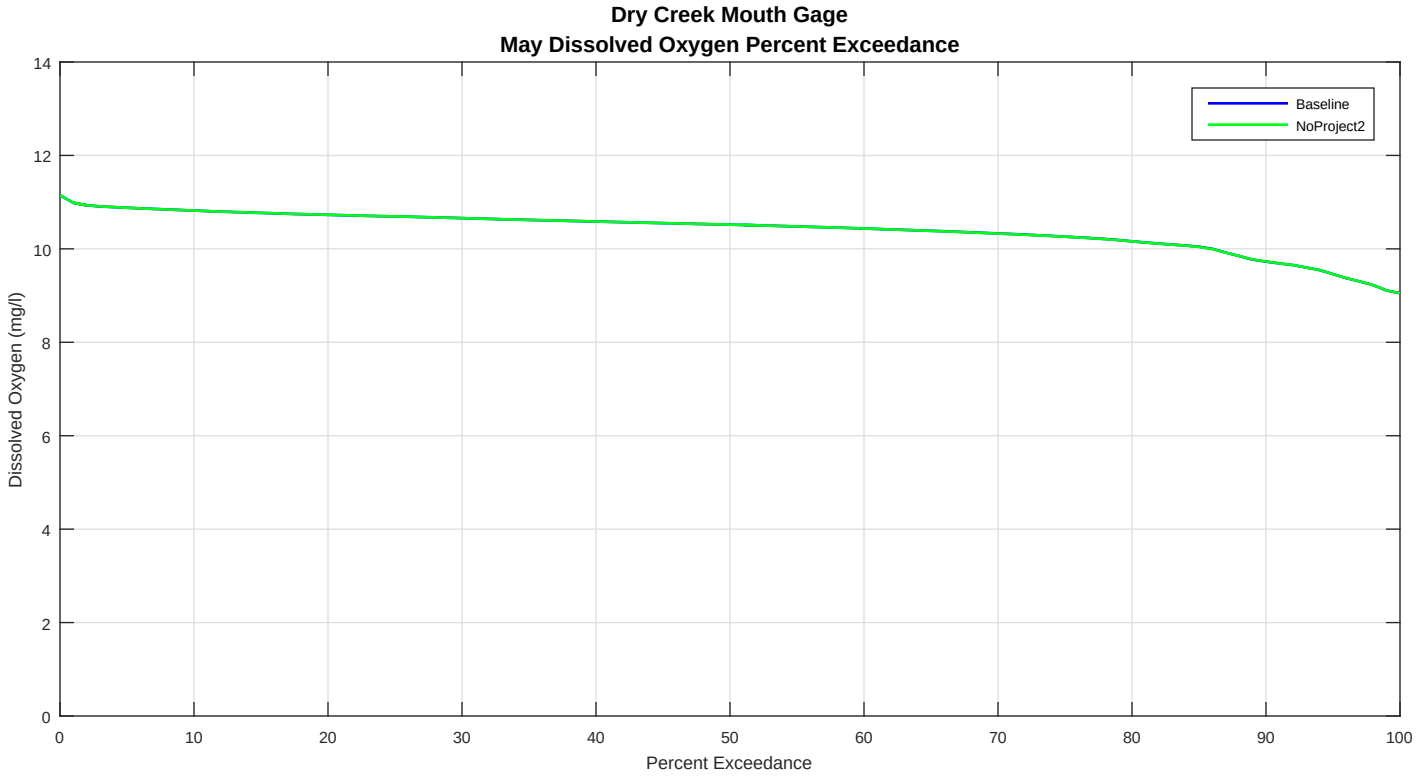
Dry Creek Mouth Gage
May Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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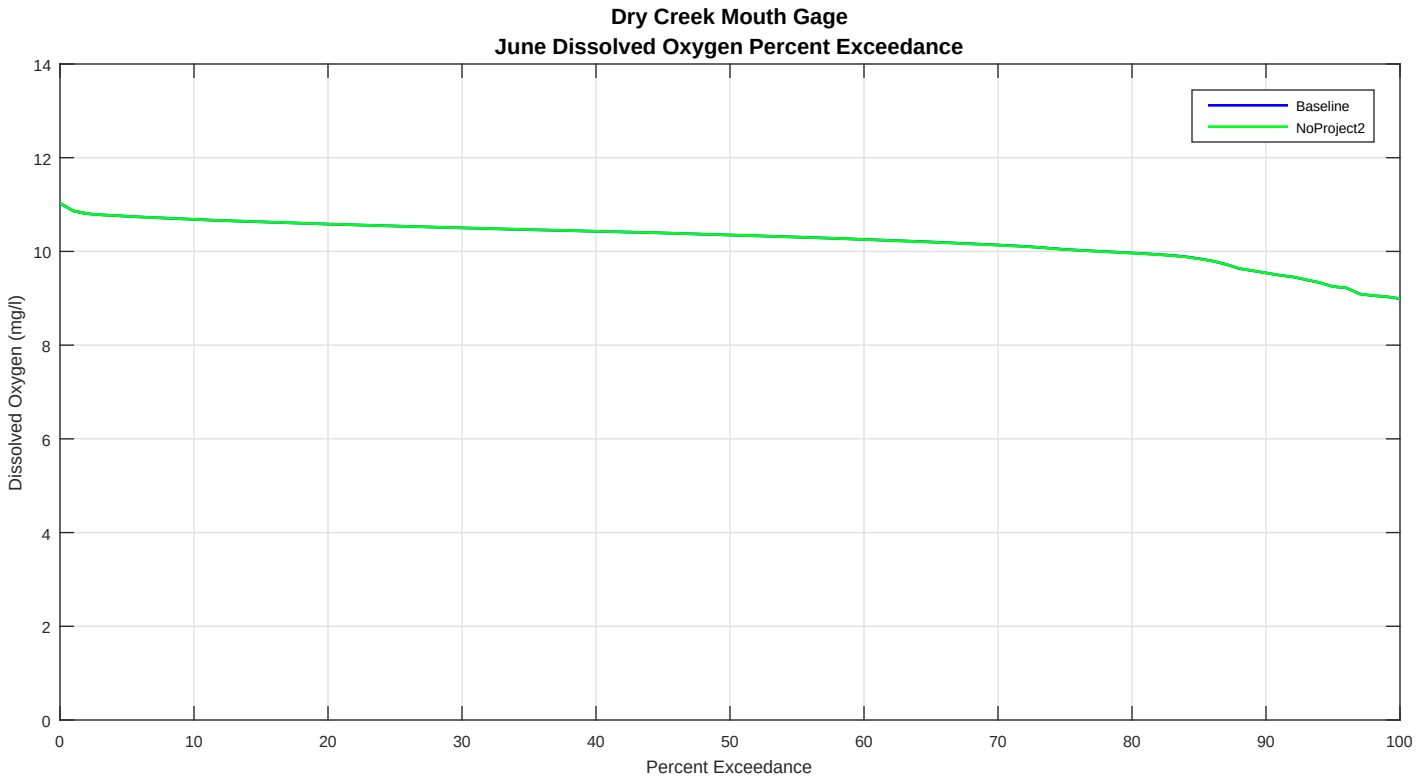
Dry Creek Mouth Gage
June Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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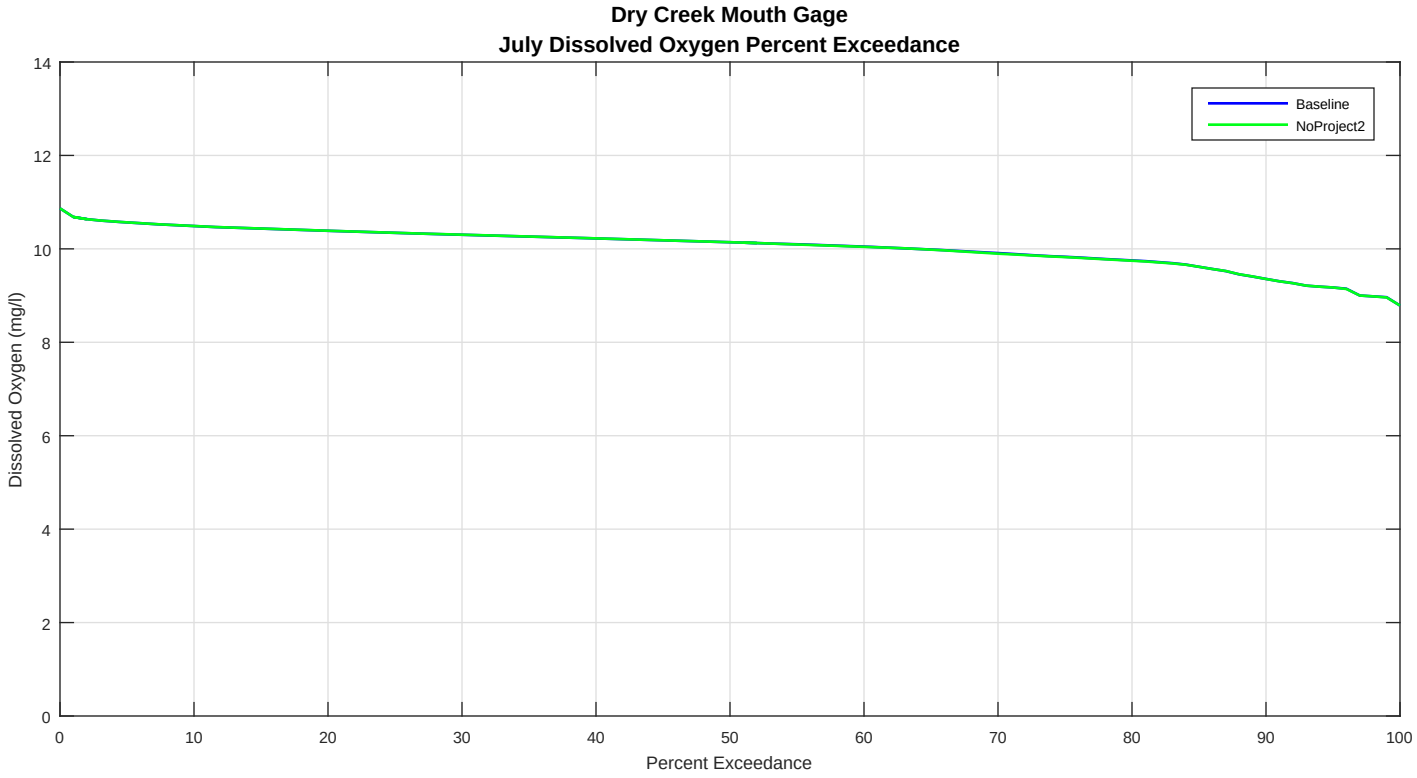
Dry Creek Mouth Gage
July Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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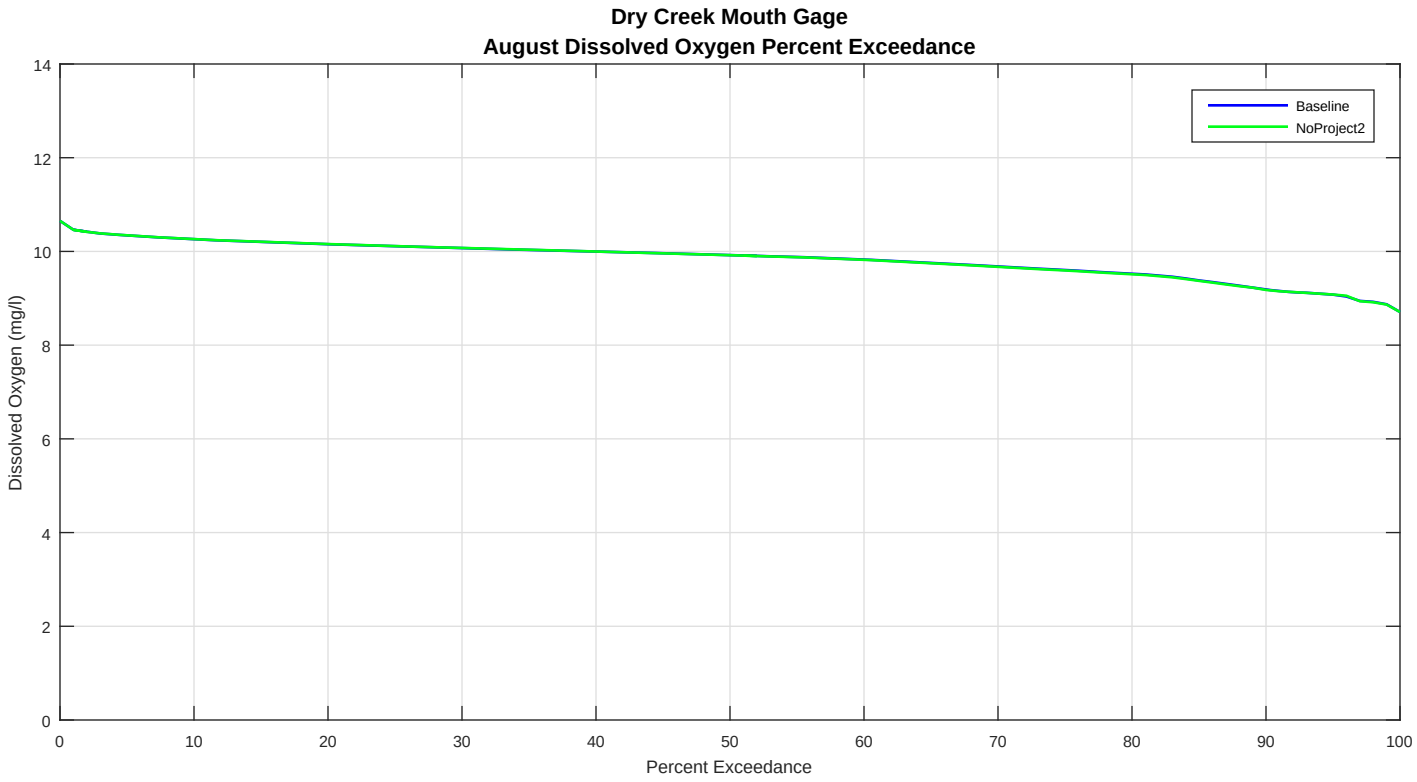
Dry Creek Mouth Gage
August Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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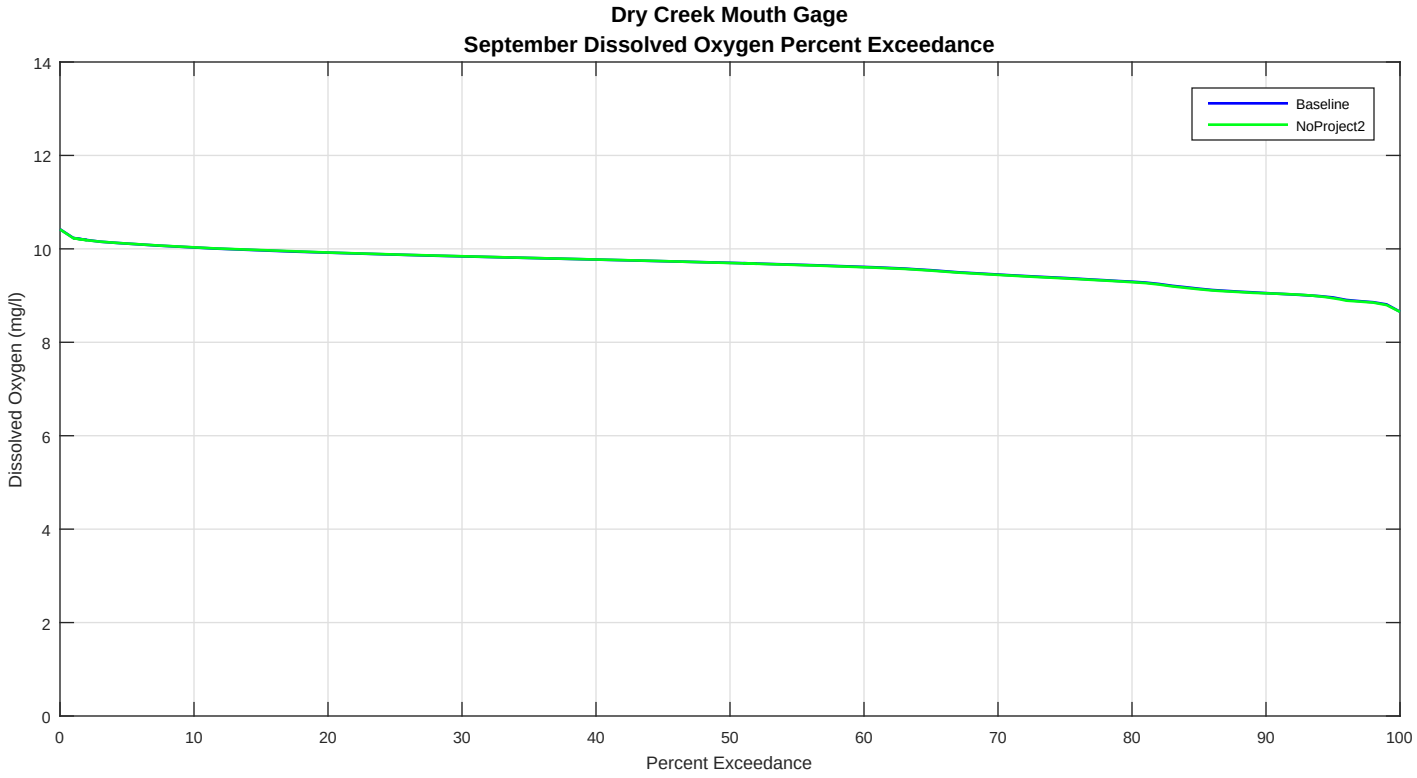
Dry Creek Mouth Gage
September Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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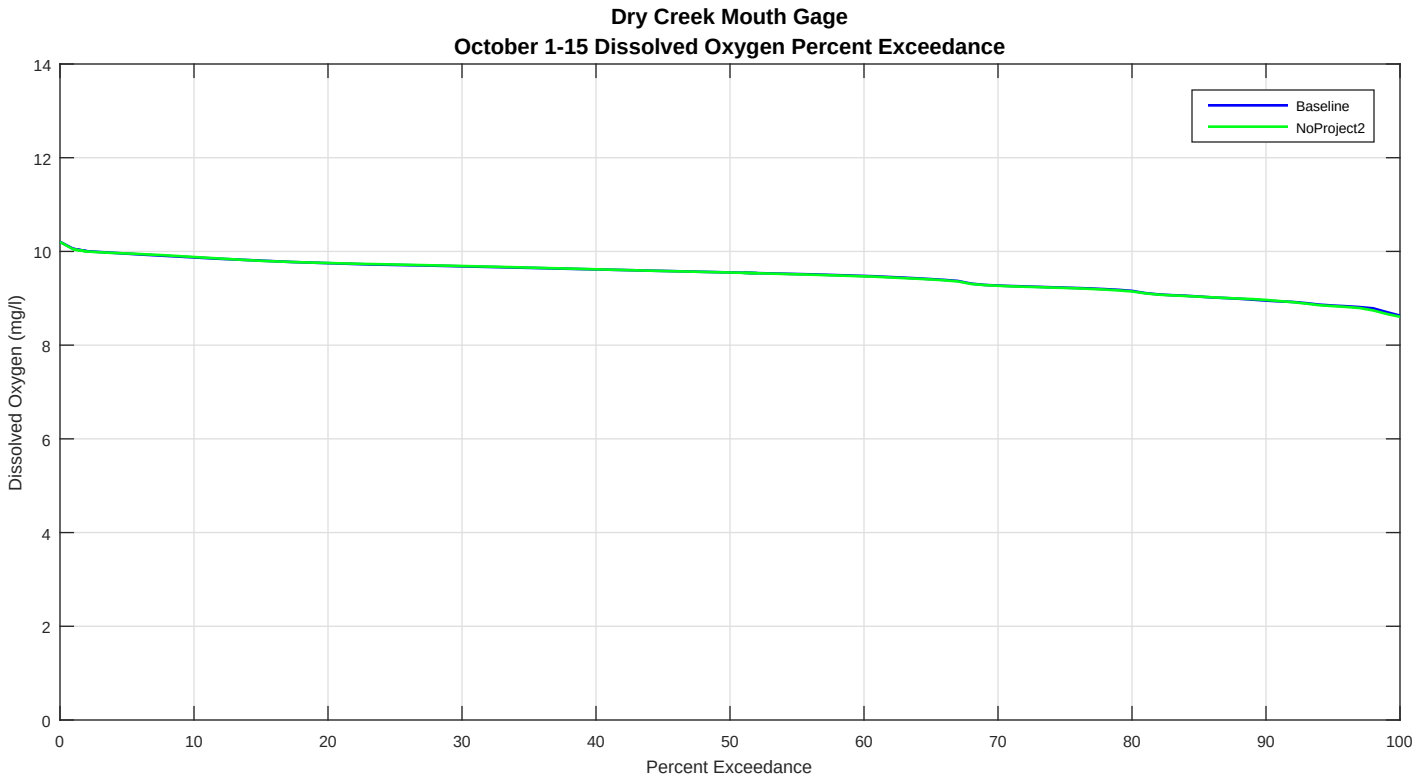
Dry Creek Mouth Gage
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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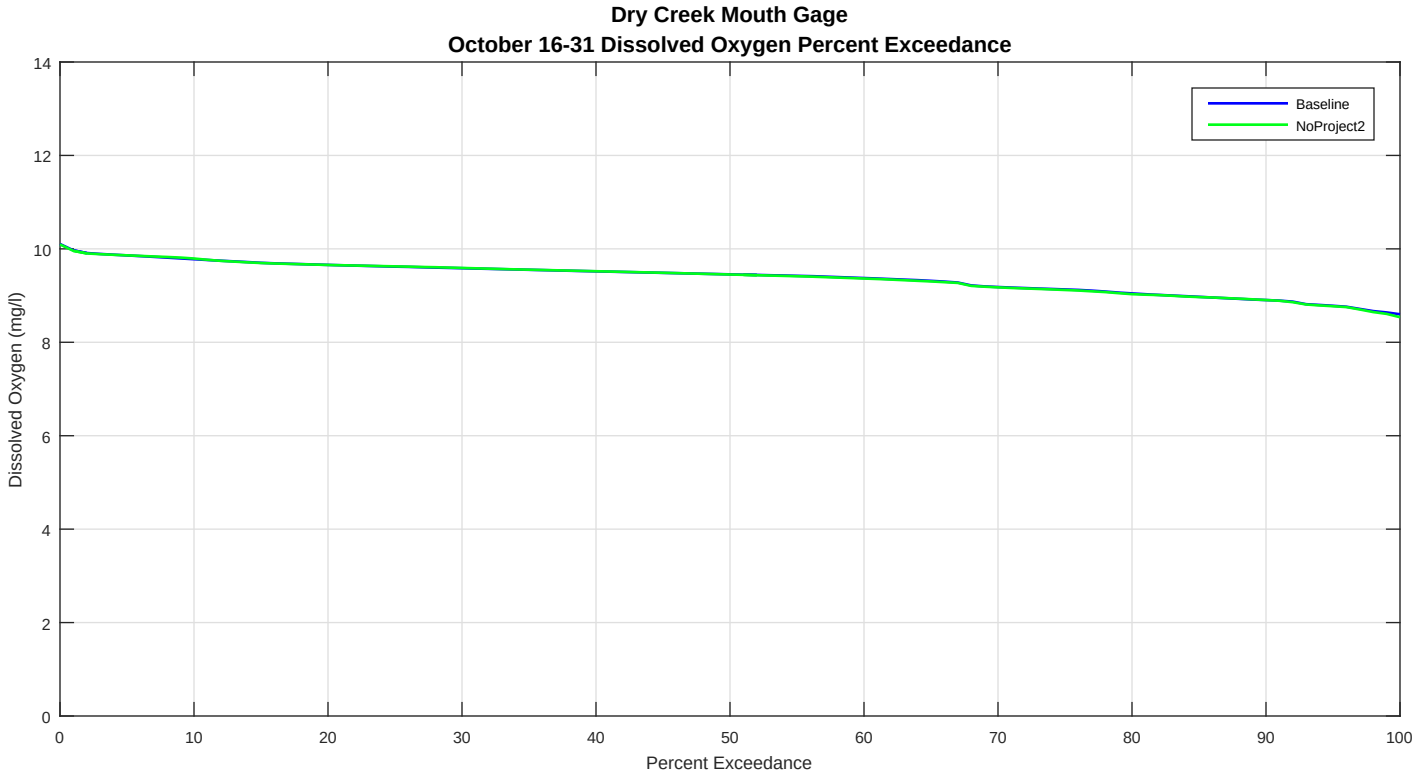
Dry Creek Mouth Gage
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
NoProject2
Dissolved Oxygen (mg/l)
Percent Exceedance
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Attachment 3: Proposed Project Scenario

D1610 Hydrologic Index and Proposed Hydrologic Index
Baseline and 5-Sched Flow18 Min Flows
Max Water Right Demand: 75K AF

PLOT LEGEND	Baseline	ProposedProject
Alt Name	225516Bs60	2275i61860
Sim Begin Date	2/1/1910	2/1/1910
Sim End Date	12/31/2013	12/31/2013
ResSim Network	Base v2.2	Base v2.2
LM Storage Curve	2001	2001
LS Storage Curve	1984	1984
WSD Hatchery Flow (cfs)	70	70
Local Flow	USGS6.0	USGS6.0
Distributed Loss	RR System Losses POR 10011909 to 12312013 v06302015.dss	RR System Losses POR 10011909 to 12312013 v06302015.dss
RRC Demand	RR System Losses POR 10011909 to 12312013 v06302015.dss	RR System Losses POR 10011909 to 12312013 v06302015.dss, SCWA Windsor 75K POR 10011909 to 12312013 v06302015.dss
RRC Vol (Ac-ft/yr)	3,623	5,639
Demand Year	2015	2035
Demand Desc	Baseline, Average 2009-2014, Steve Grinnell	Max Water Right Demand
SCWA Demand	RR System Losses POR 10011909 to 12312013 v06302015.dss	SCWA Windsor 75K POR 10011909 to 12312013 v06302015.dss
SCWA Vol (Ac-ft/yr)	51,588	69,361
Demand Year	2015	2035
Demand Desc	Baseline, Average 2009-2014, Steve Grinnell	Max Water Right Demand
PVP Simulation	150217_V25_E5_Sed2006_RPA-TS_150max	150217_V25_E5_Sed2006_RPA-TS_150max
LP Storage Curve	2006	2006
PVP Max Diversion	150	150
PVP Simulation Desc	Average operating conditions 10/1/2006 to 12/31/2014; Incorporated observed diversions and LP storage post 10/1/2006	Average operating conditions 10/1/2006 to 12/31/2014; Incorporated observed diversions and LP storage post 10/1/2006
Hydrologic Index	D1610	HI6
Index Desc	Cum Lake Pillsbury Inflow	Cum LM Inflow Jan-Sep + LM Stor Cond Jun-De
Min Flows UR	D1610	SCWA6
Min Flow Desc	Decision 1610	Flows derived from sensitivity analysis
Min Flows LR	D1610	LR6
Min Flow Desc	Decision 1610	Flows derived from sensitivity analysis

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2 Miles Downstream of Forks

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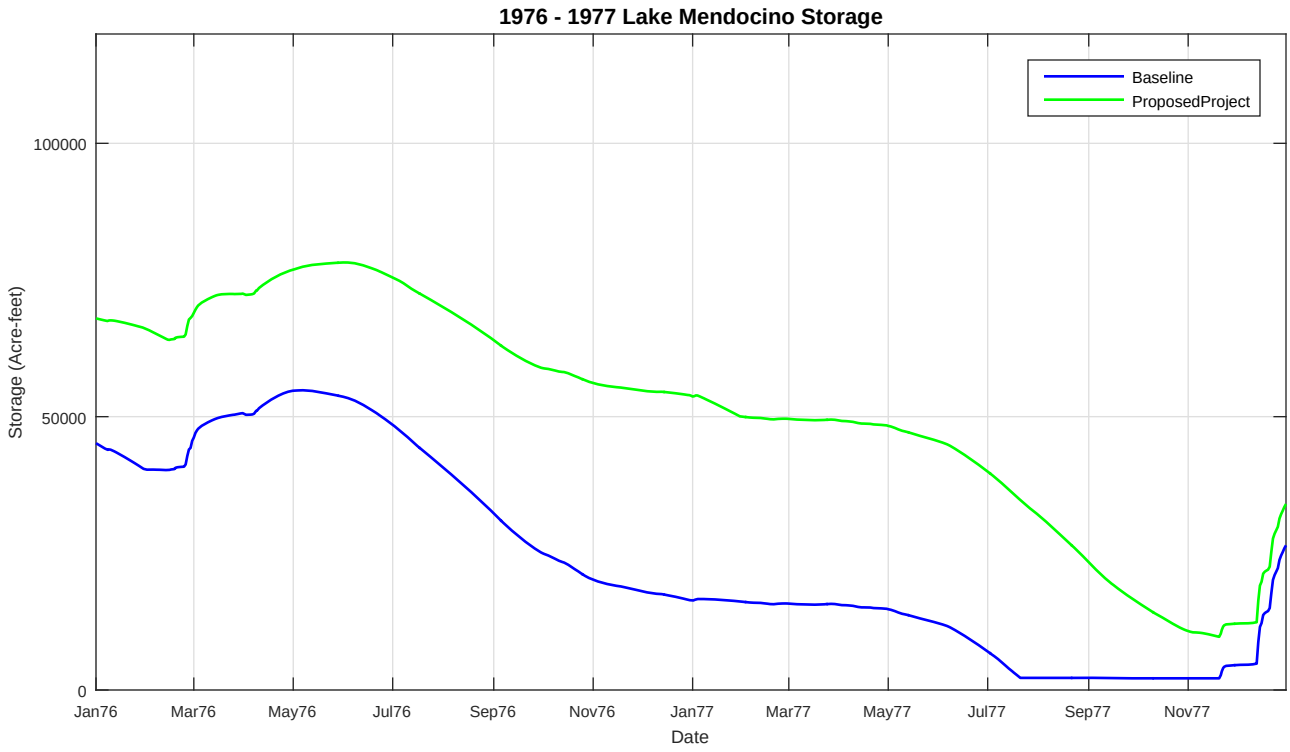
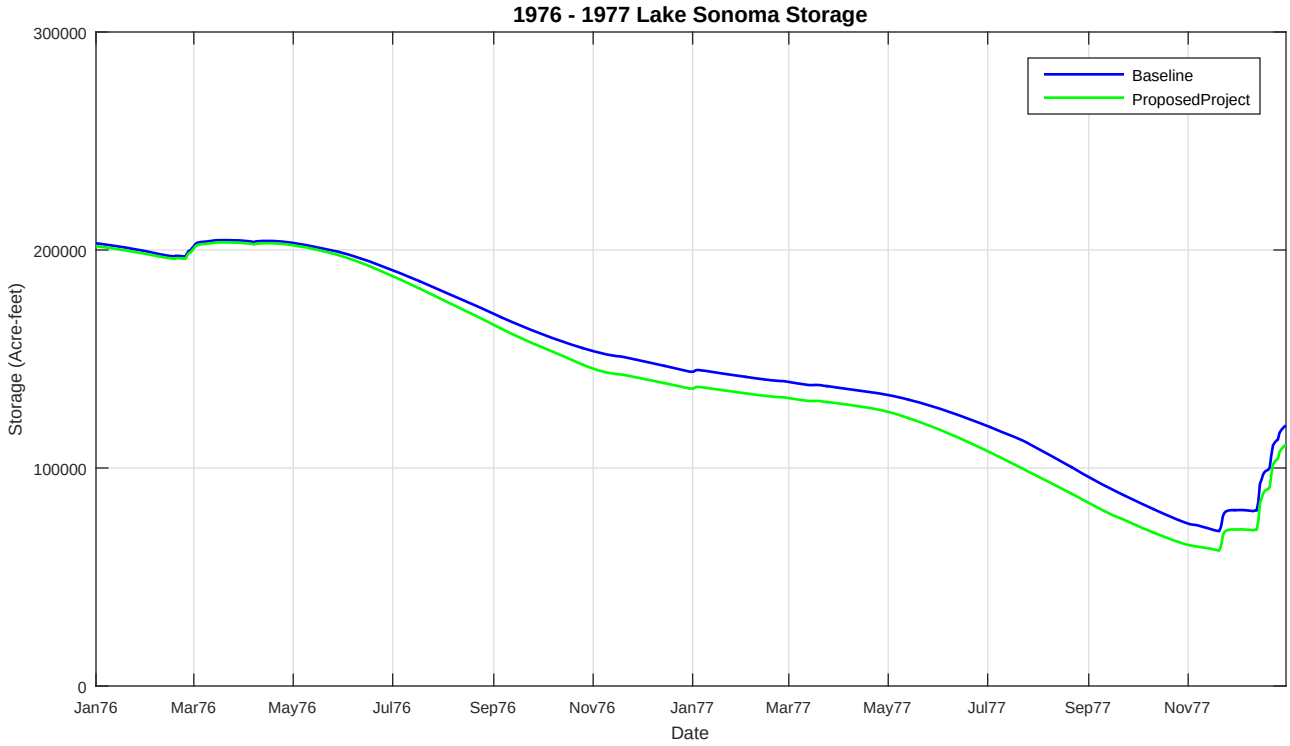
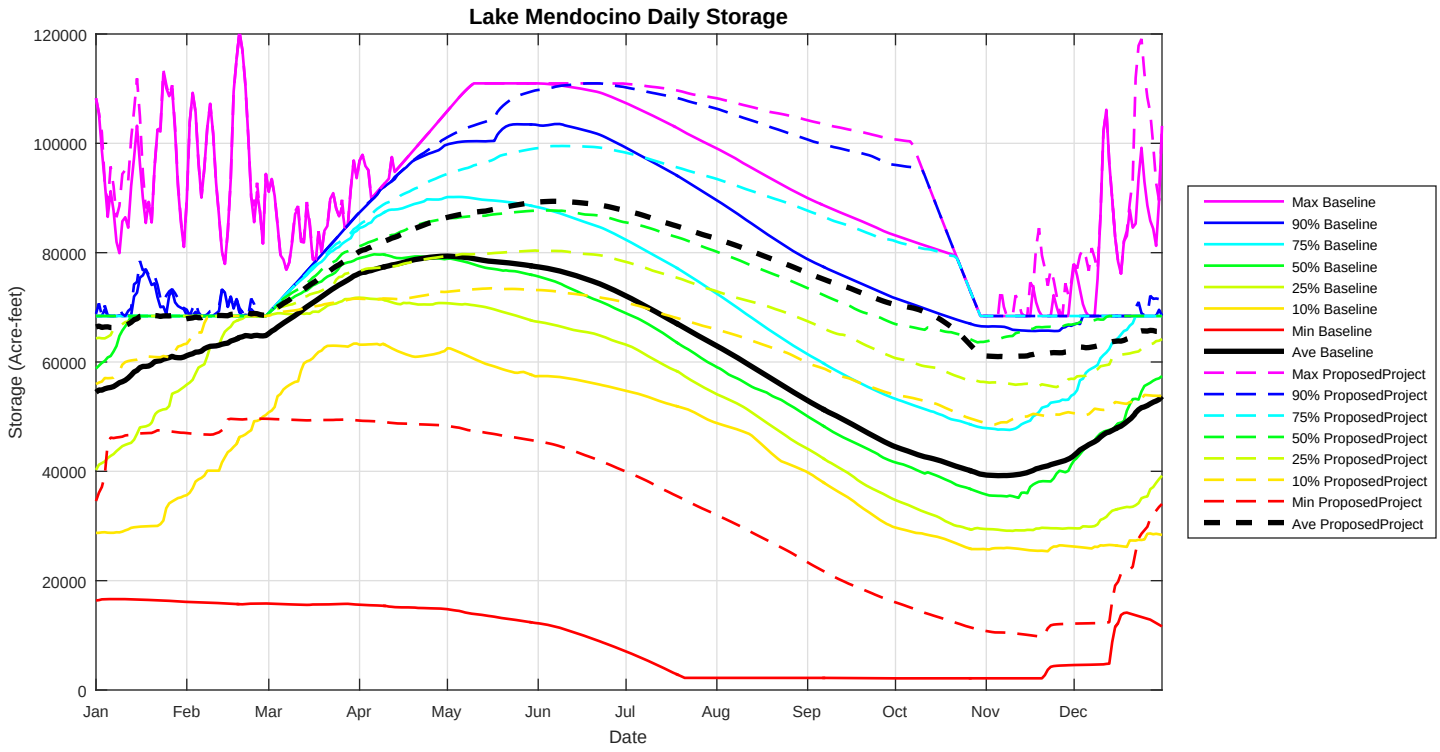
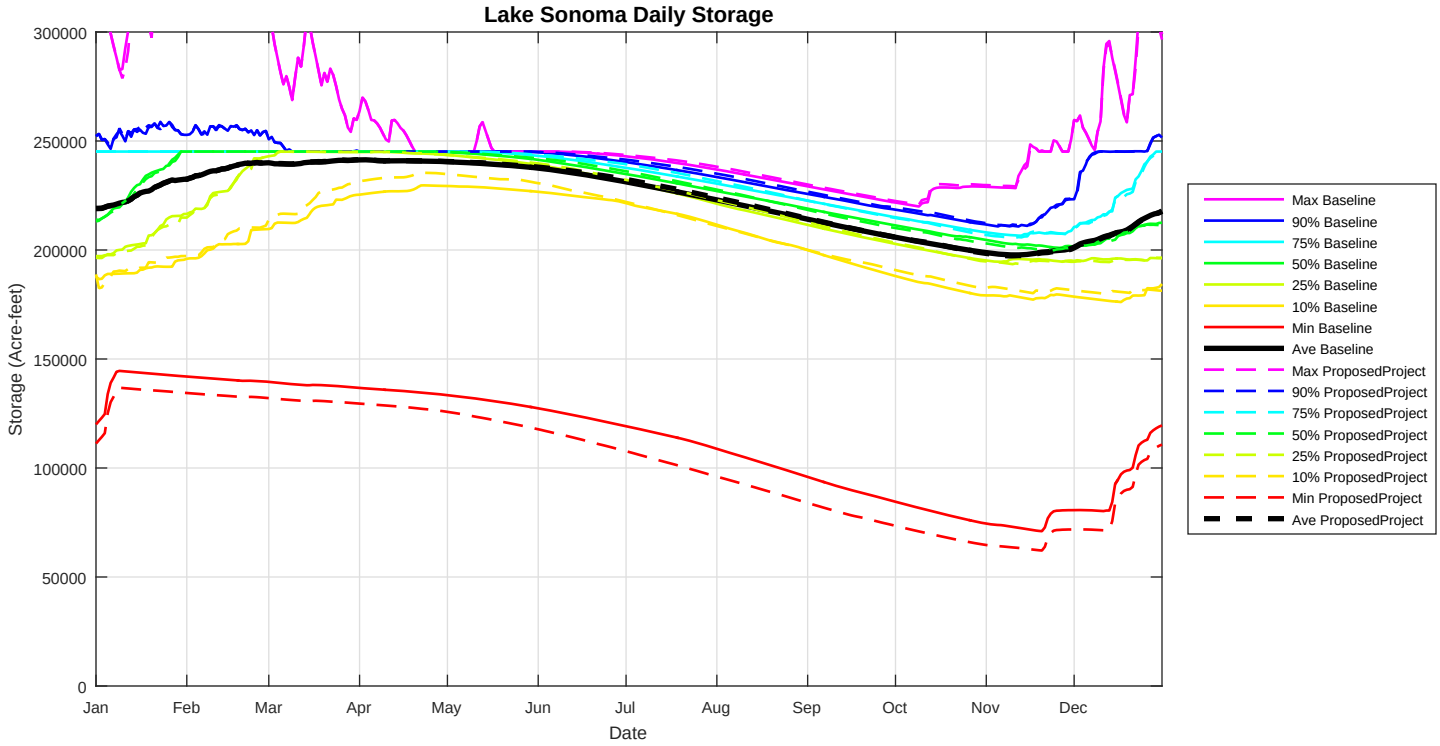
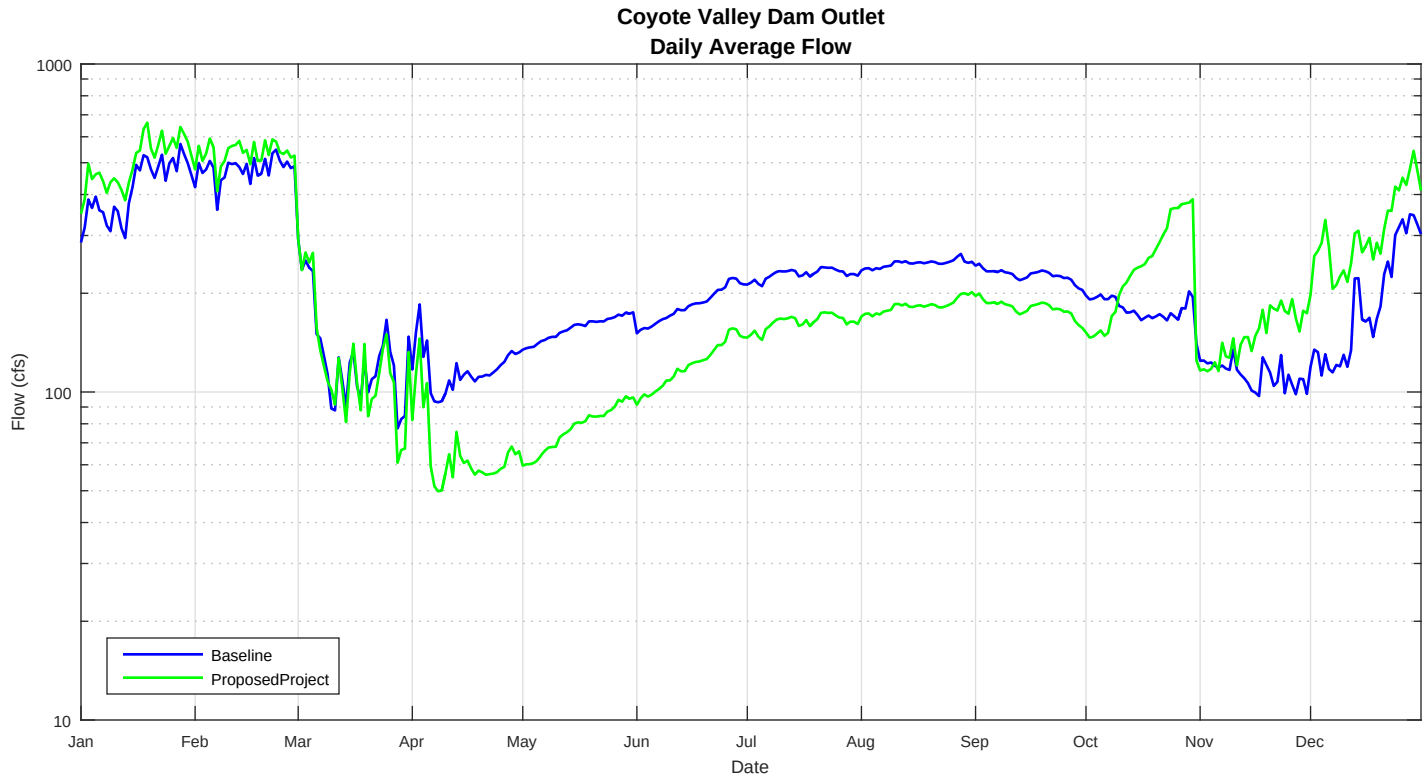
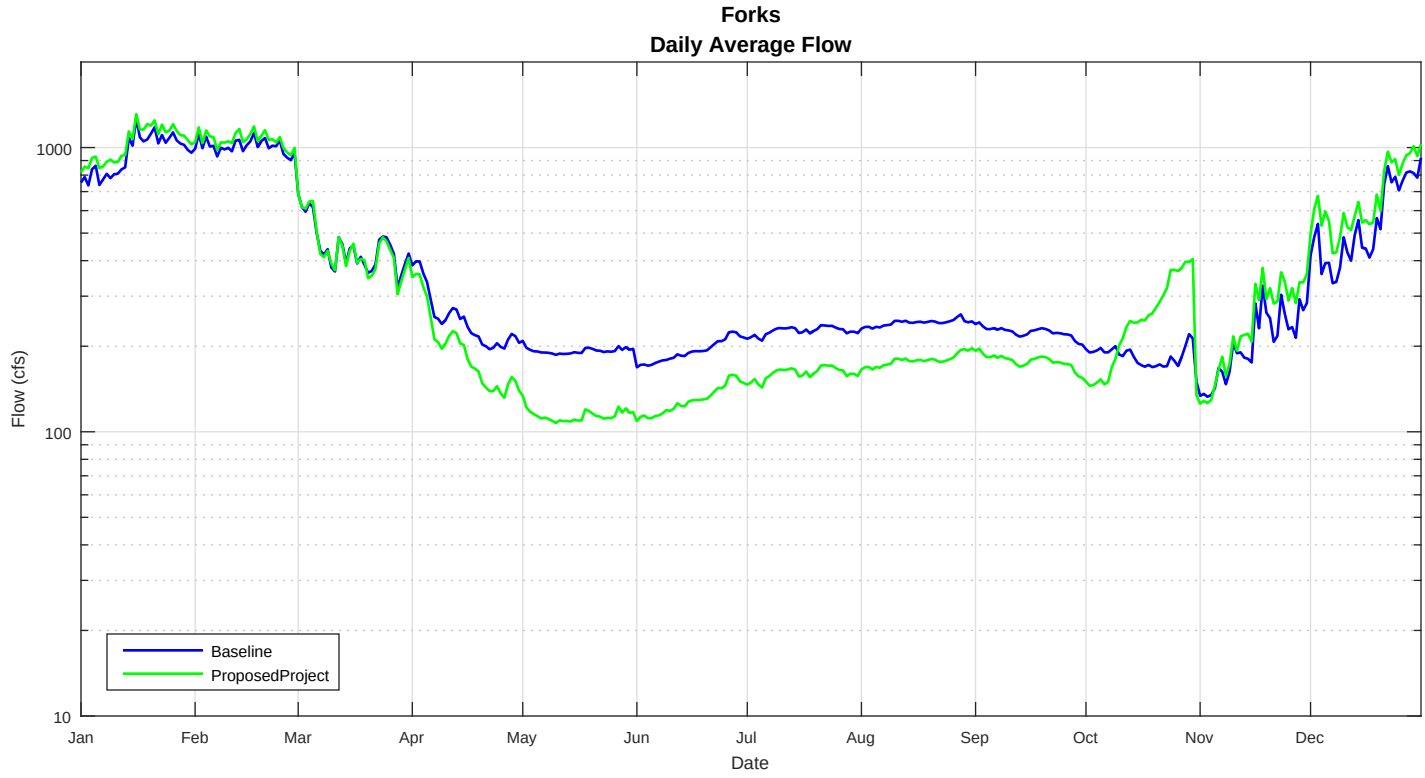

1976 - 1977 Lake Mendocino Storage
Baseline
ProposedProject
Storage (Acre-feet)
100000
50000
0
Jan76
Mar76
May76
Jul76
Sep76
Nov76
Jan77
Mar77
May77
Jul77
Sep77
Nov77
Date

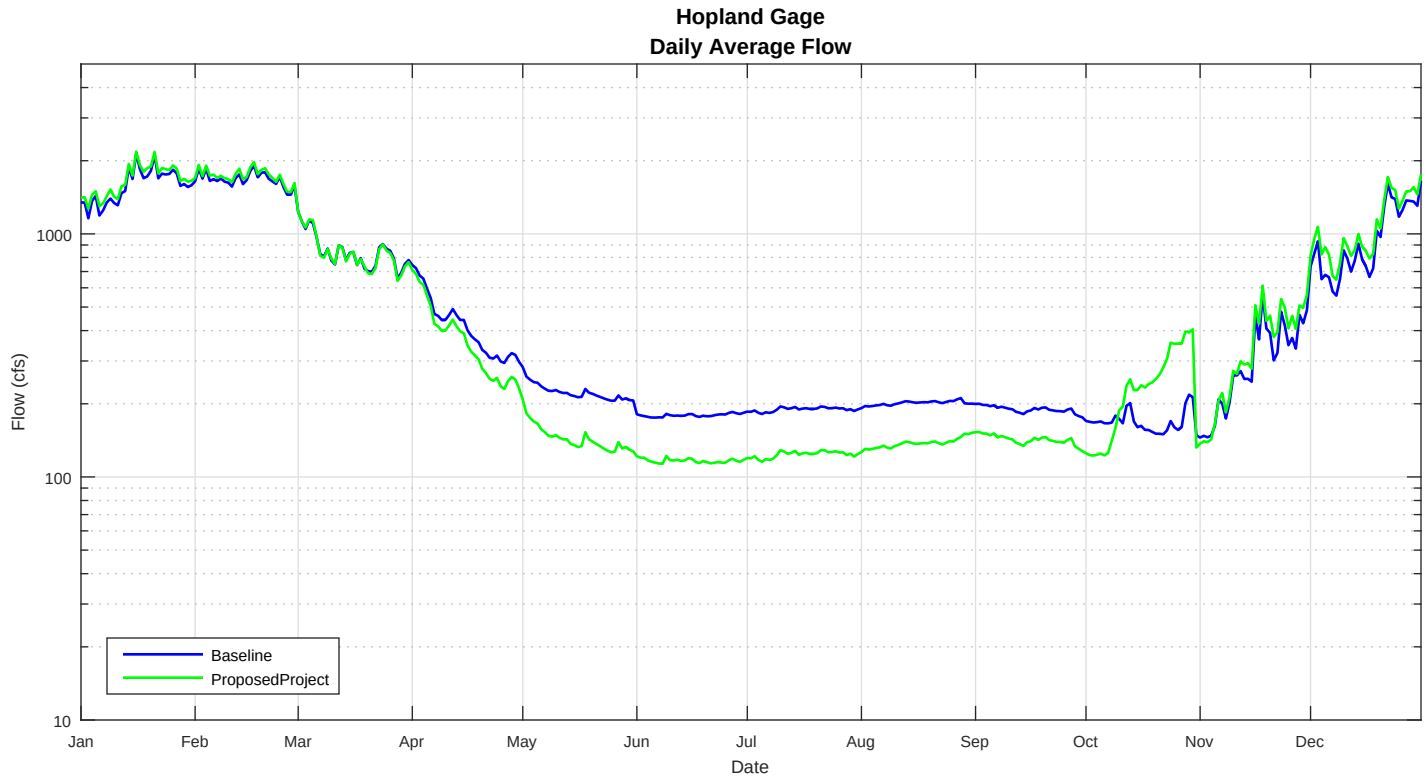

1976 - 1977 Lake Sonoma Storage
Baseline
ProposedProject
Storage (Acre-feet)
300000
200000
100000
0
Jan76
Mar76
May76
Jul76
Sep76
Nov76
Jan77
Mar77
May77
Jul77
Sep77
Nov77
Date

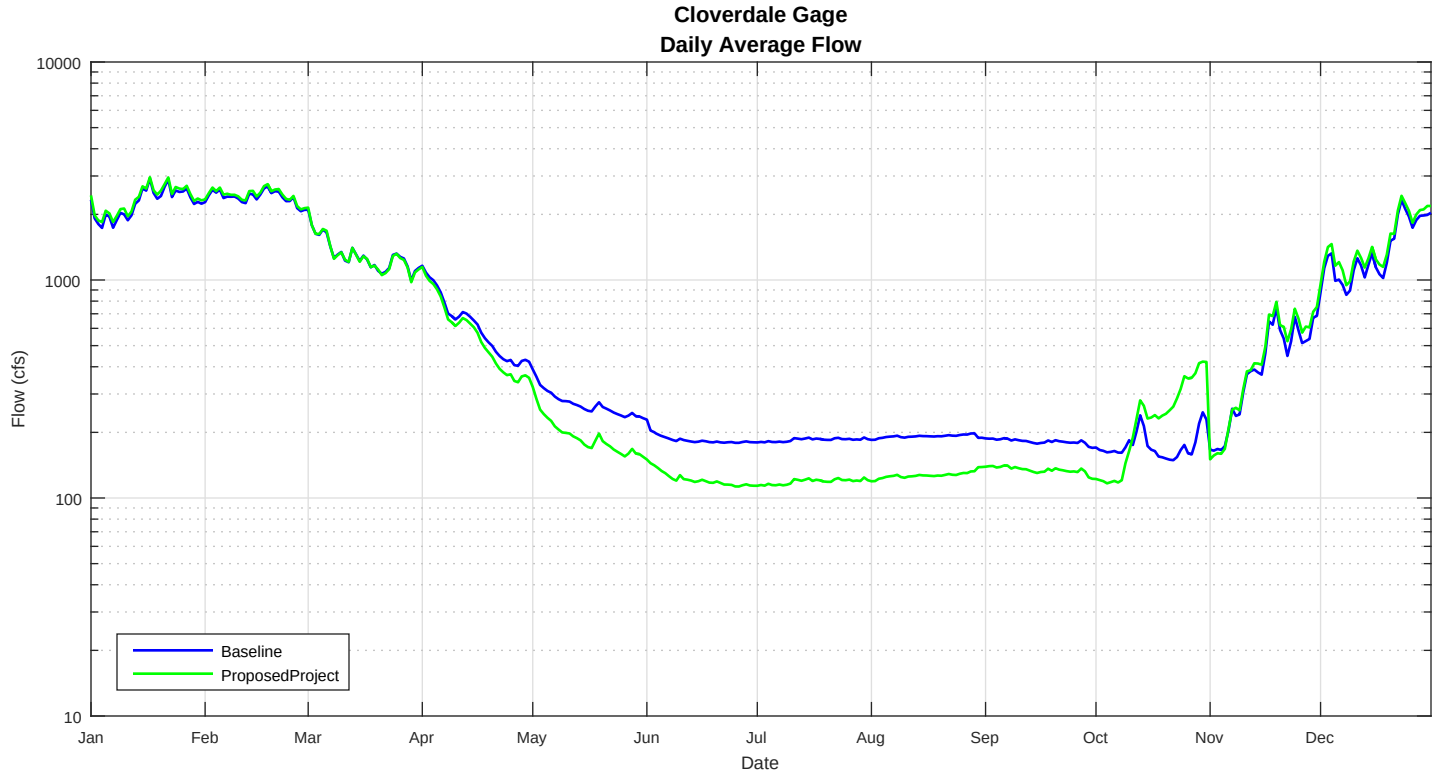

Lake Mendocino Daily Storage
Storage (Acre-feet)
120000
100000
80000
60000
40000
20000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Max Baseline
90% Baseline
75% Baseline
50% Baseline
25% Baseline
10% Baseline
Min Baseline
Ave Baseline
Max ProposedProject
90% ProposedProject
75% ProposedProject
50% ProposedProject
25% ProposedProject
10% ProposedProject
Min ProposedProject
Ave ProposedProject

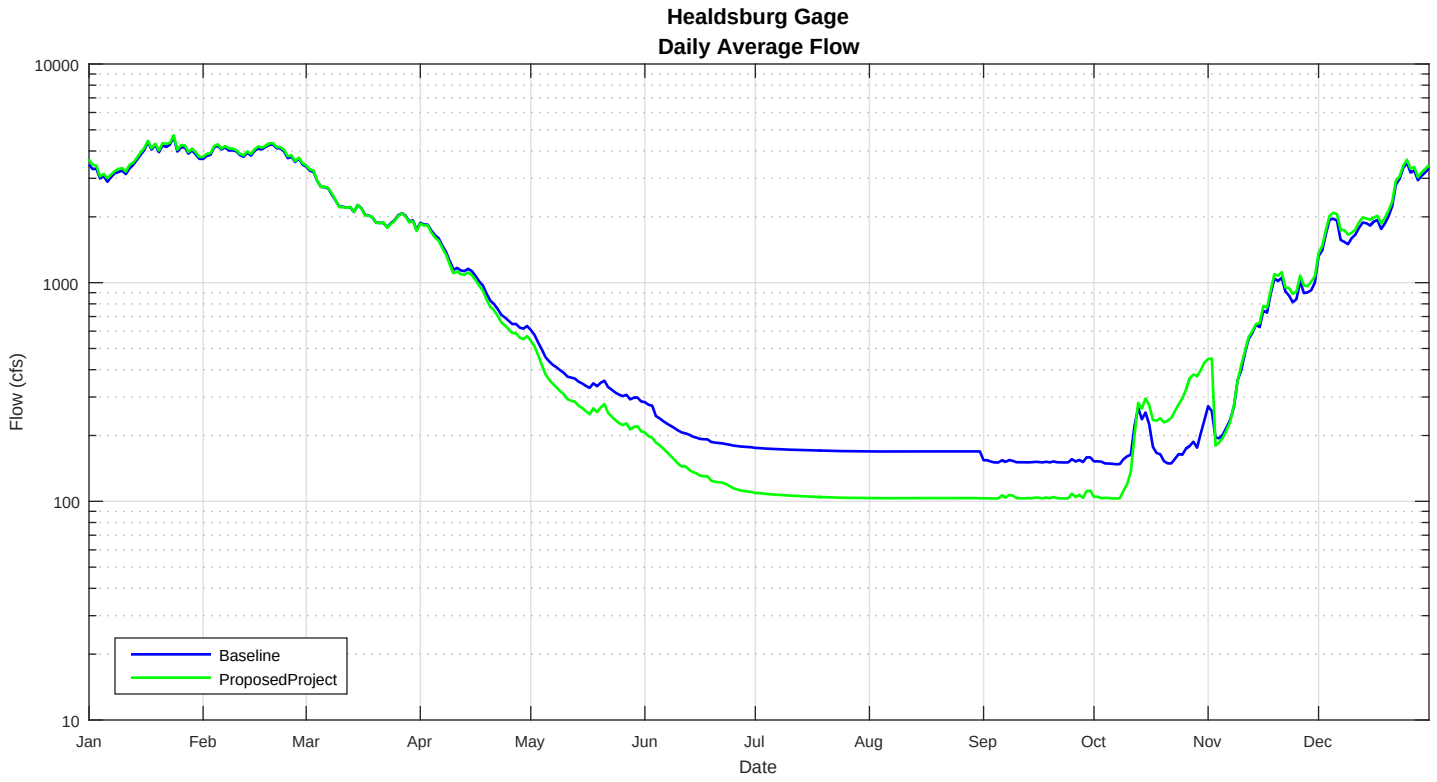

Lake Sonoma Daily Storage
Storage (Acre-feet)
300000
250000
200000
150000
100000
50000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Max Baseline
90% Baseline
75% Baseline
50% Baseline
25% Baseline
10% Baseline
Min Baseline
Ave Baseline
Max ProposedProject
90% ProposedProject
75% ProposedProject
50% ProposedProject
25% ProposedProject
10% ProposedProject
Min ProposedProject
Ave ProposedProject

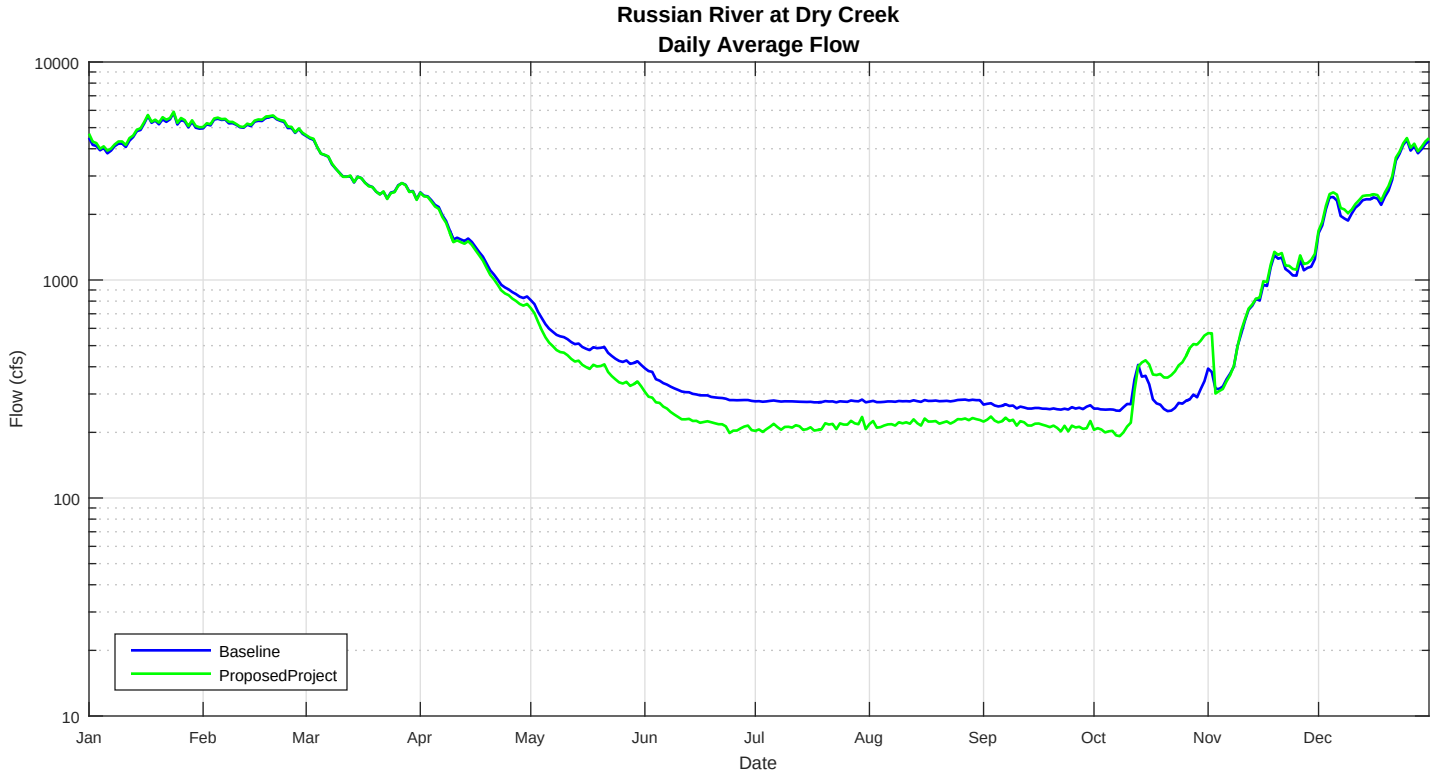

Coyote Valley Dam Outlet
Daily Average Flow
1000
100
10
Flow (cfs)
Baseline
ProposedProject
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

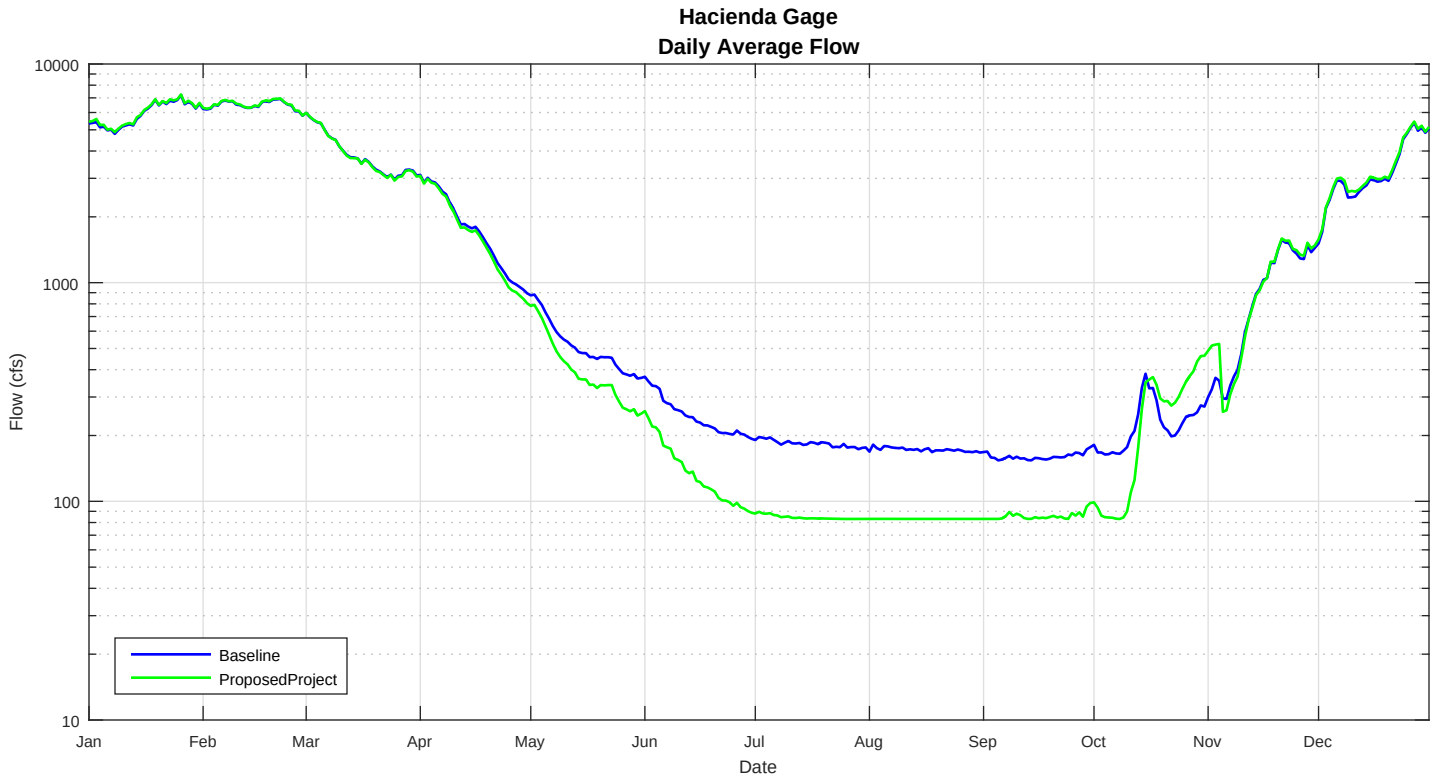

Forks
Daily Average Flow
1000
100
10
Flow (cfs)
Baseline
ProposedProject
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

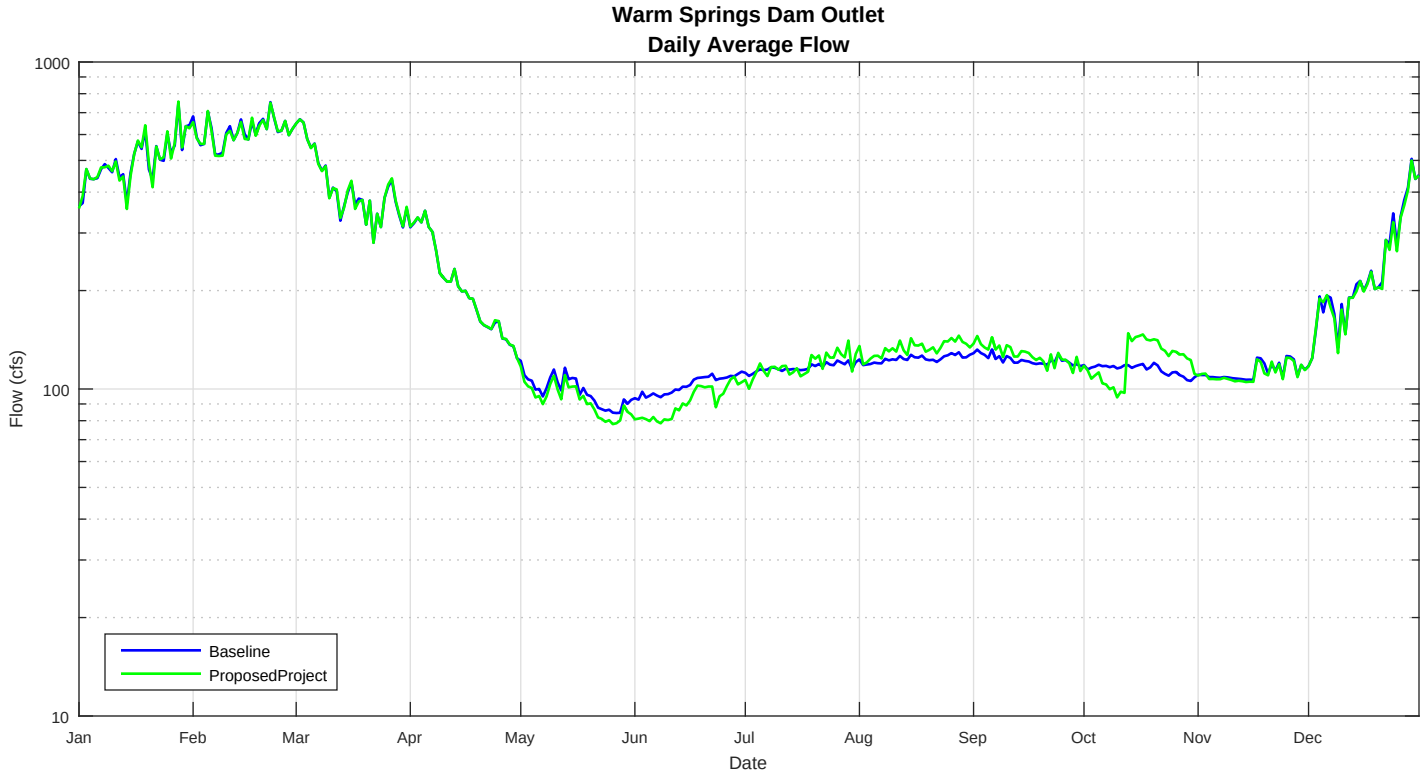

Hopland Gage
Daily Average Flow
Flow (cfs)
1000
100
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Baseline
ProposedProject

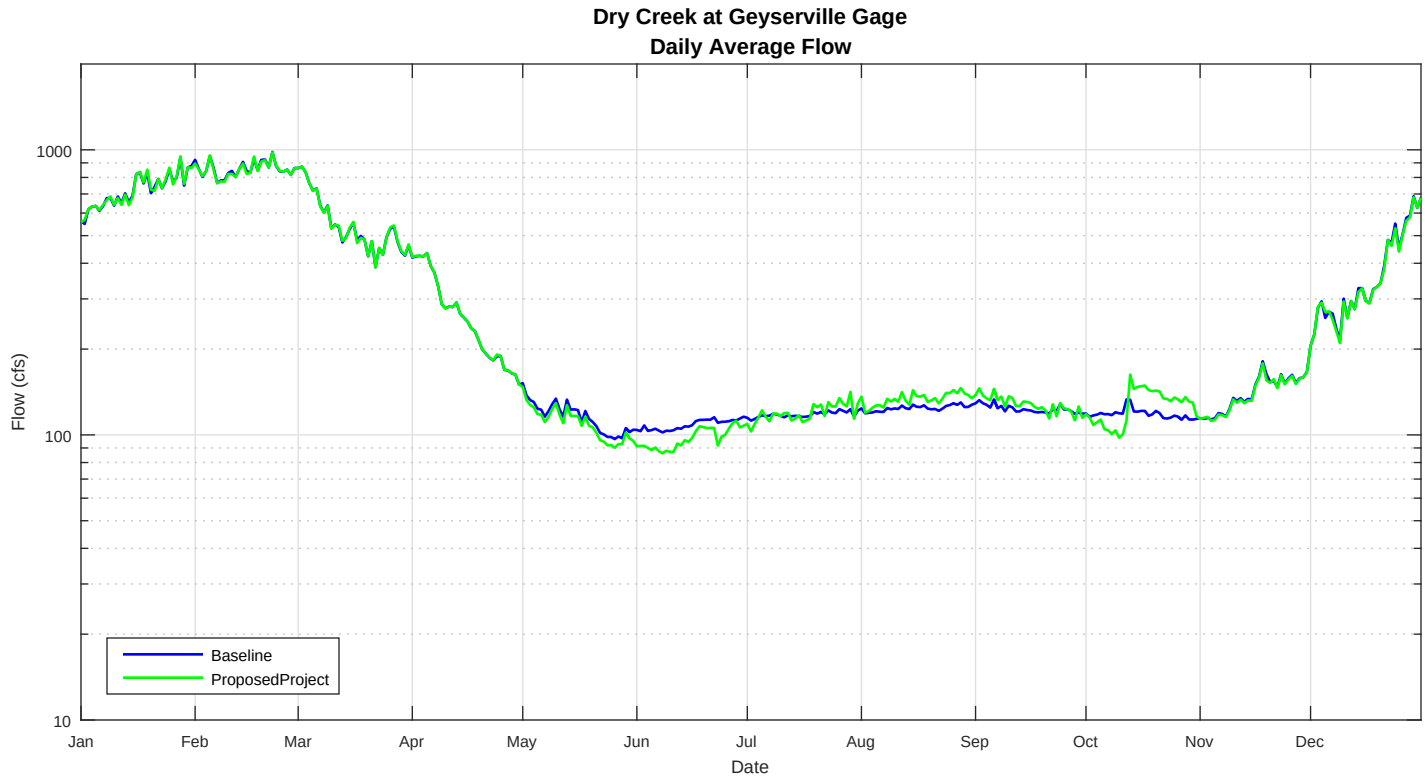

Cloverdale Gage
Daily Average Flow
Flow (cfs)
10000
1000
100
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Baseline
ProposedProject

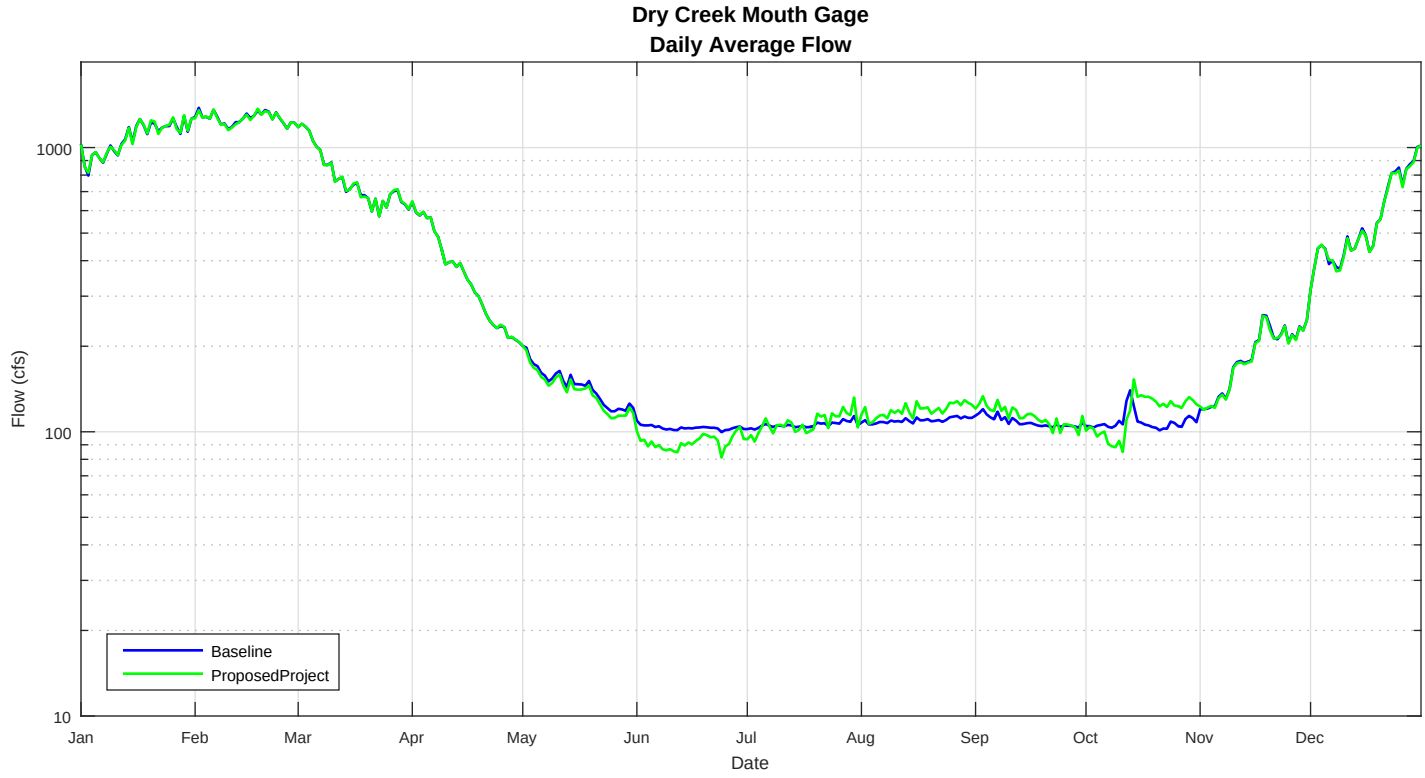

Healdsburg Gage
Daily Average Flow
10000
1000
100
10
Flow (cfs)
Baseline
ProposedProject
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

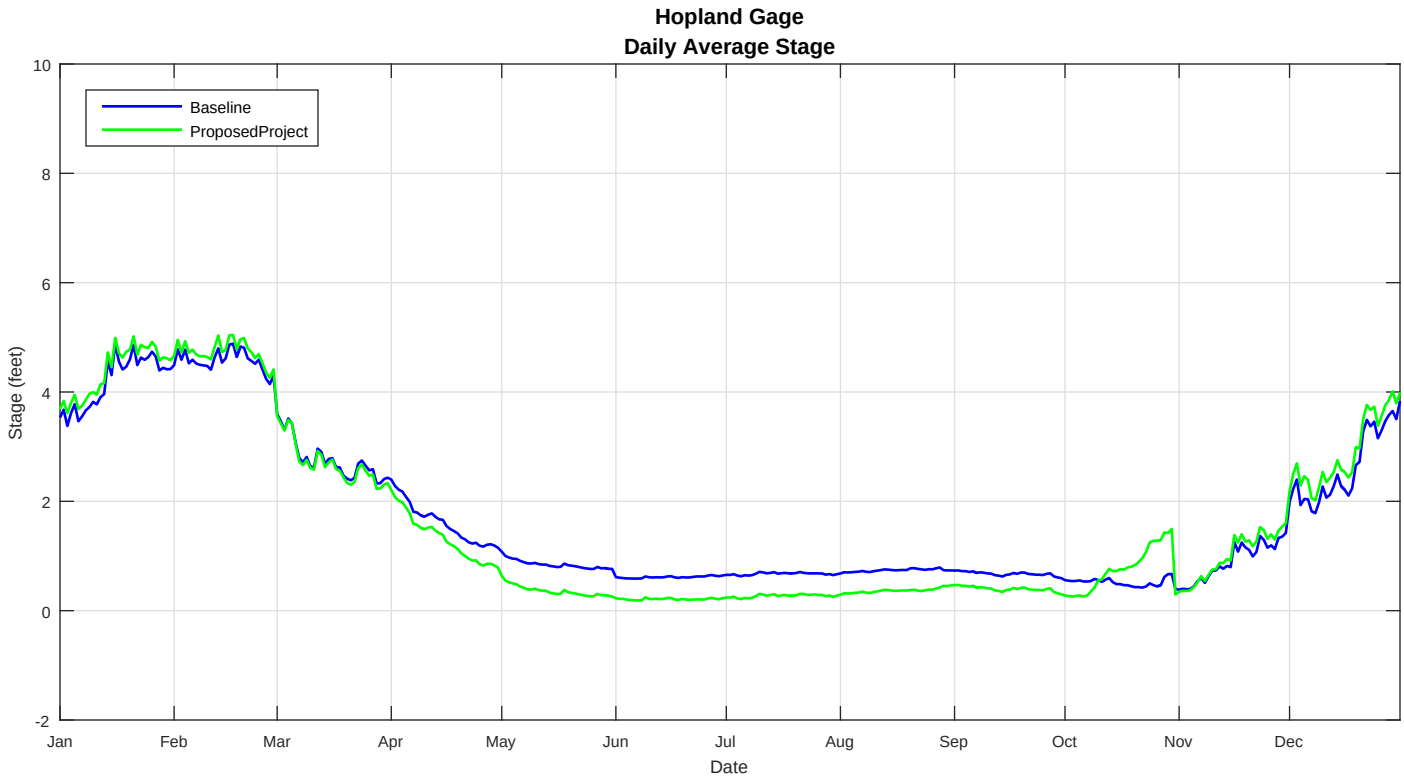

Russian River at Dry Creek
Daily Average Flow
10000
1000
100
10
Flow (cfs)
Baseline
ProposedProject
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

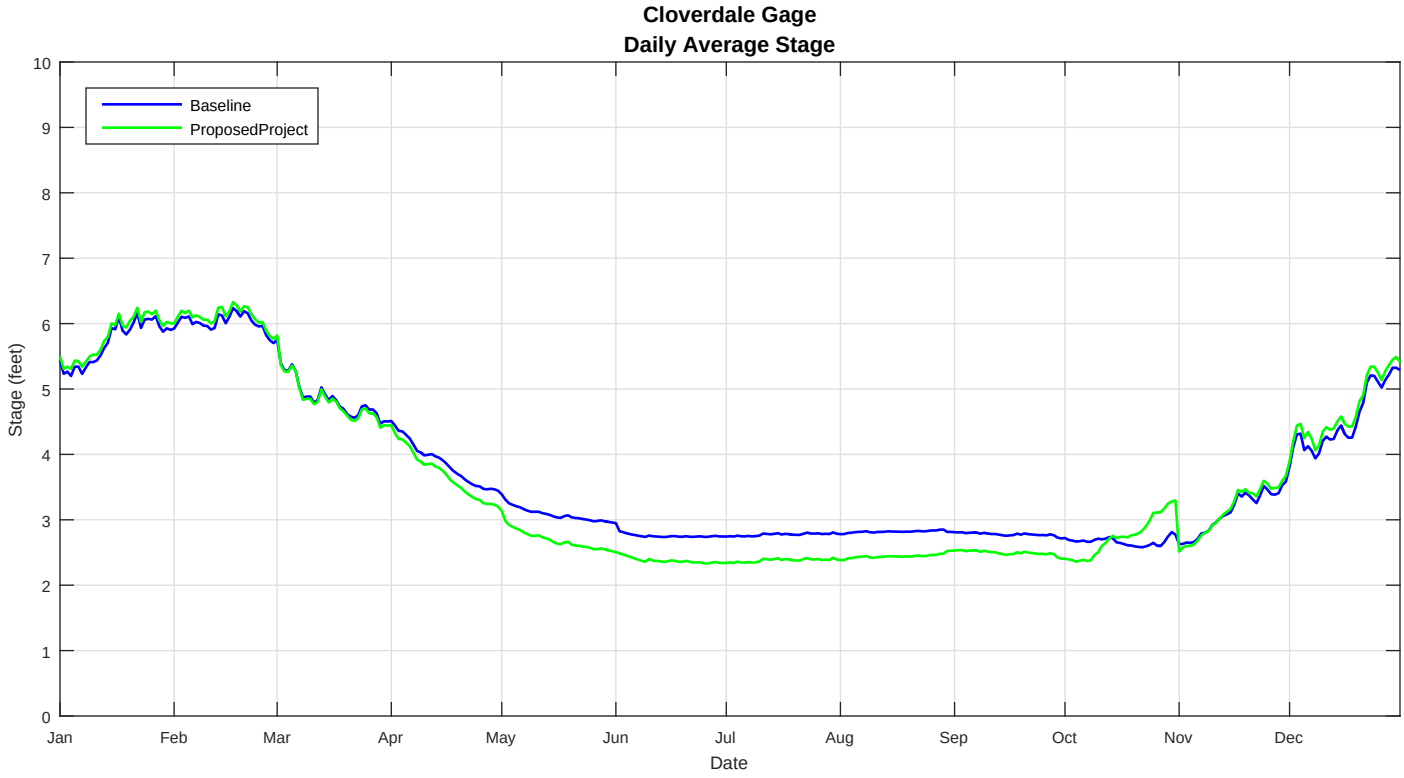

Hacienda Gage
Daily Average Flow
10000
1000
100
10
Flow (cfs)
Baseline
ProposedProject
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

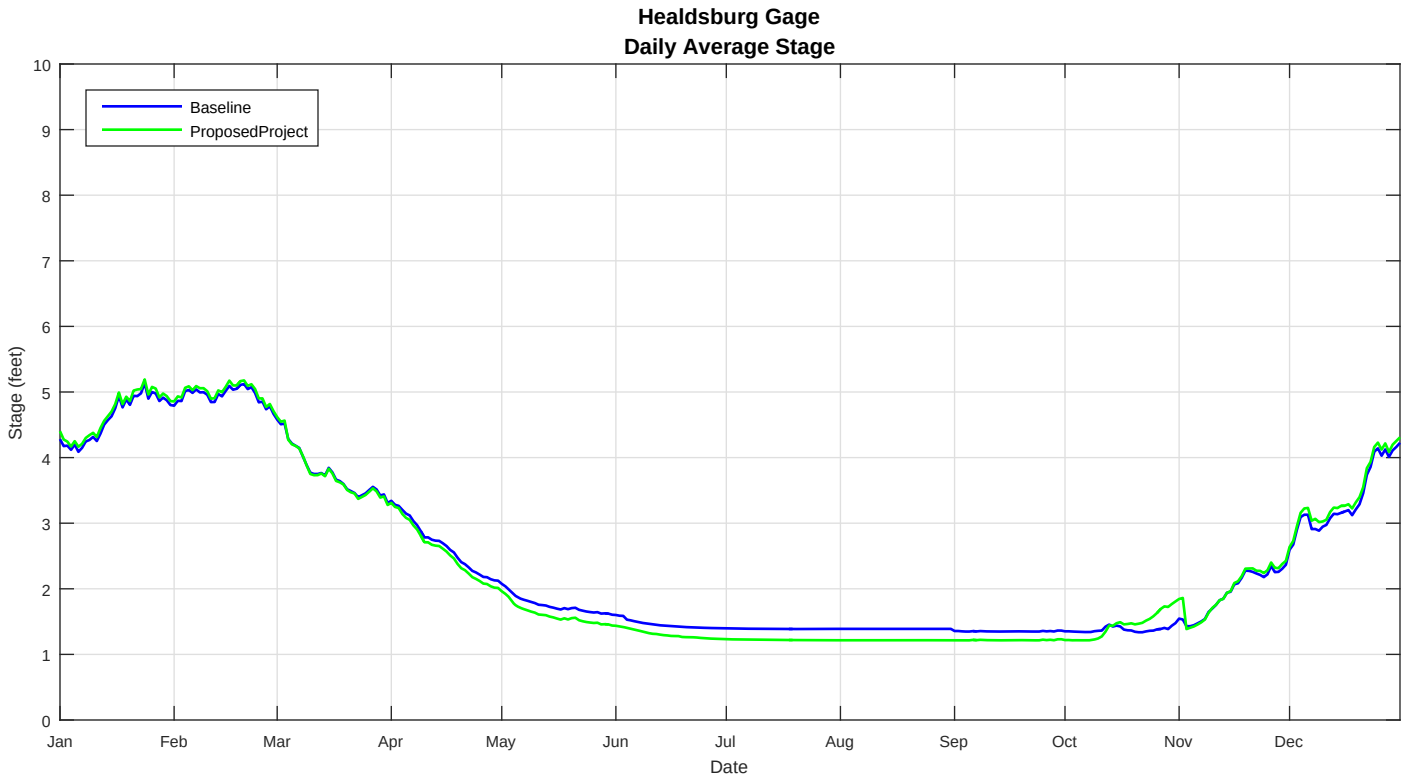

Warm Springs Dam Outlet
Daily Average Flow
1000
100
10
Flow (cfs)
Baseline
ProposedProject
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

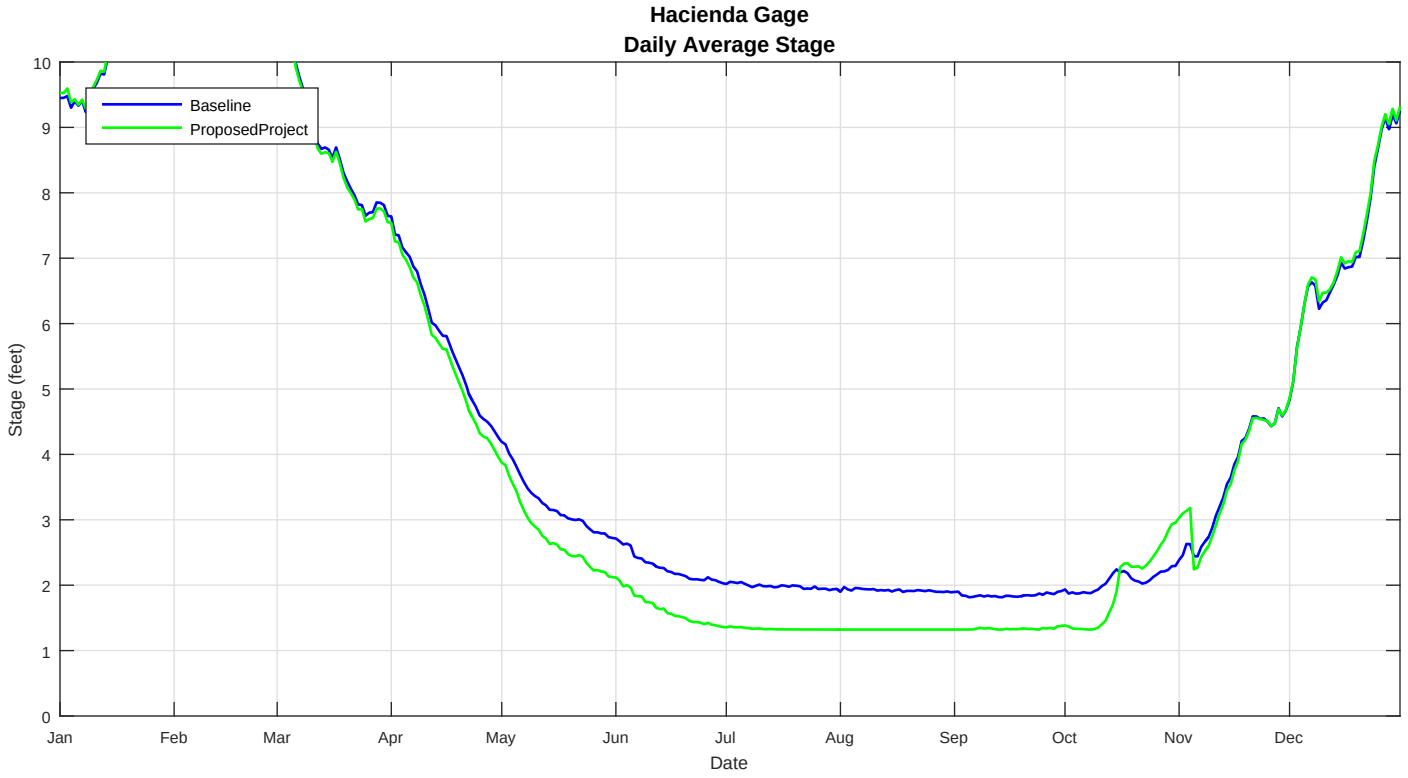

Dry Creek at Geyserville Gage
Daily Average Flow
Flow (cfs)
1000
100
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Baseline
ProposedProject

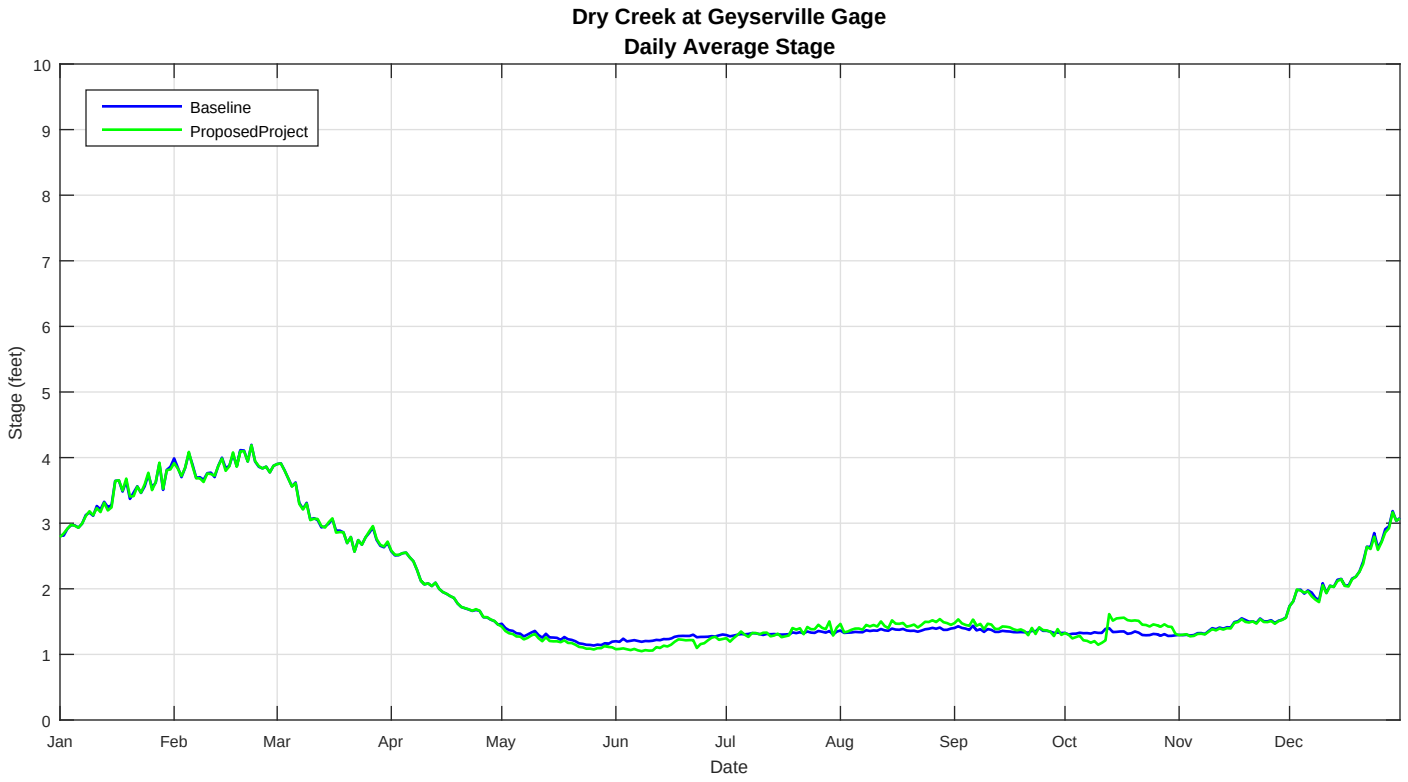

Dry Creek Mouth Gage
Daily Average Flow
Flow (cfs)
1000
100
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Baseline
ProposedProject

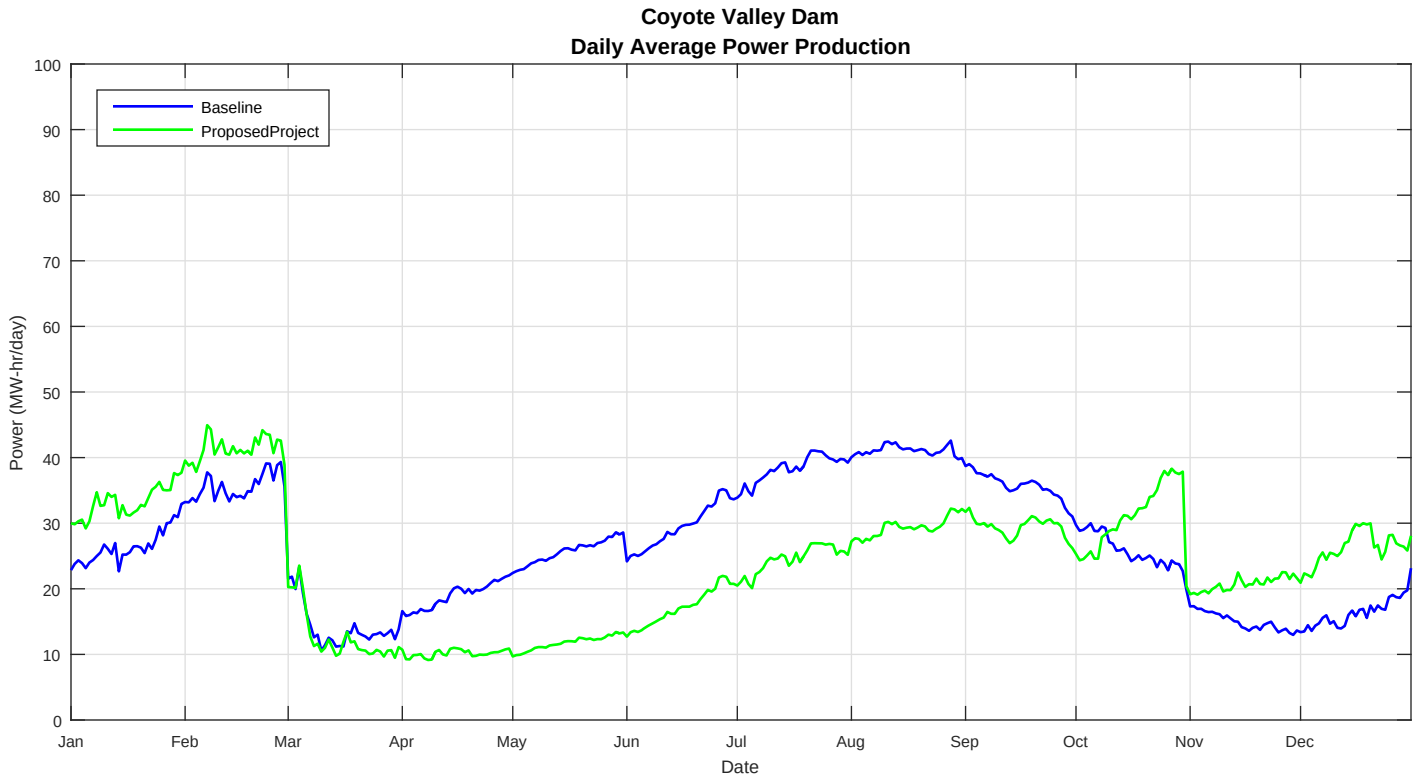

Hopland Gage
Daily Average Stage
Baseline
ProposedProject
Stage (feet)
10
8
6
4
2
0
-2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

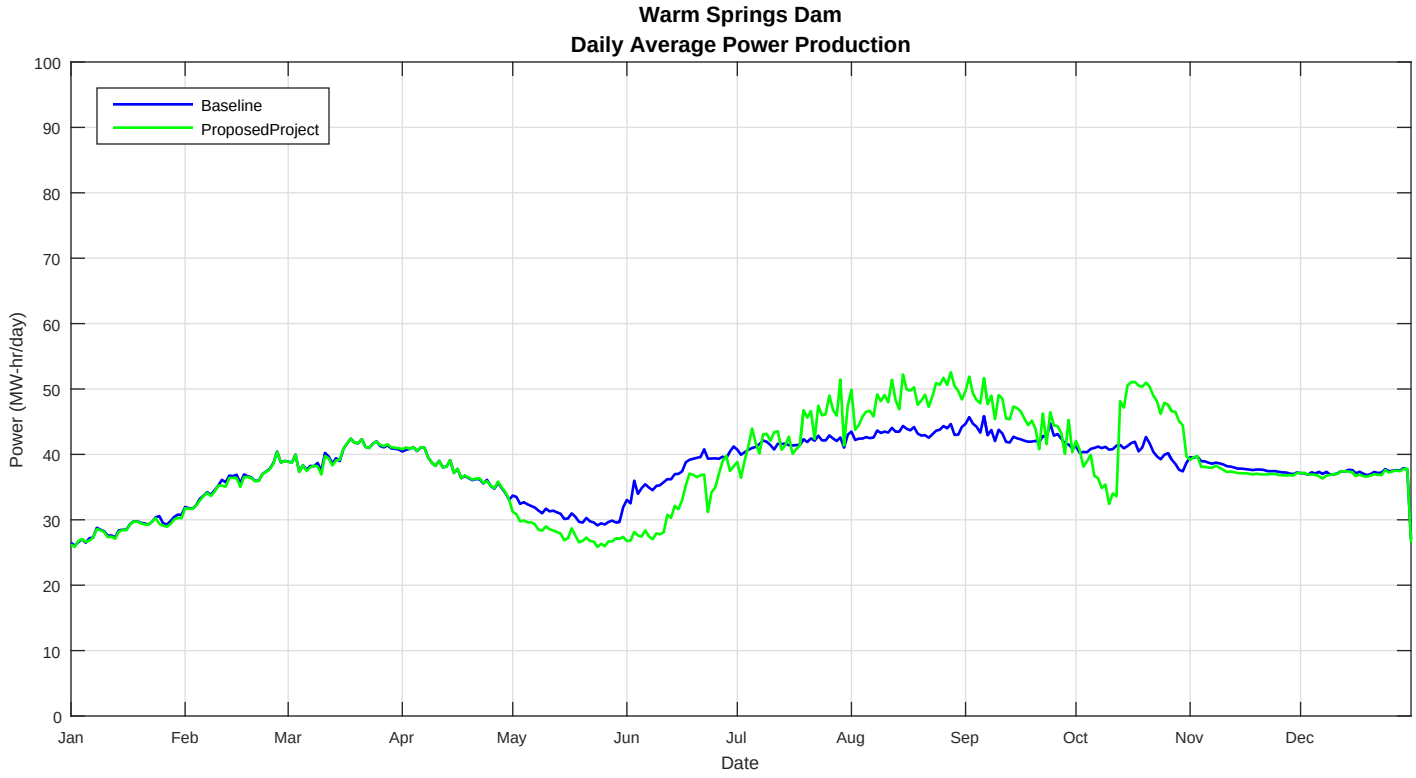

Cloverdale Gage
Daily Average Stage
Baseline
ProposedProject
Stage (feet)
10
9
8
7
6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

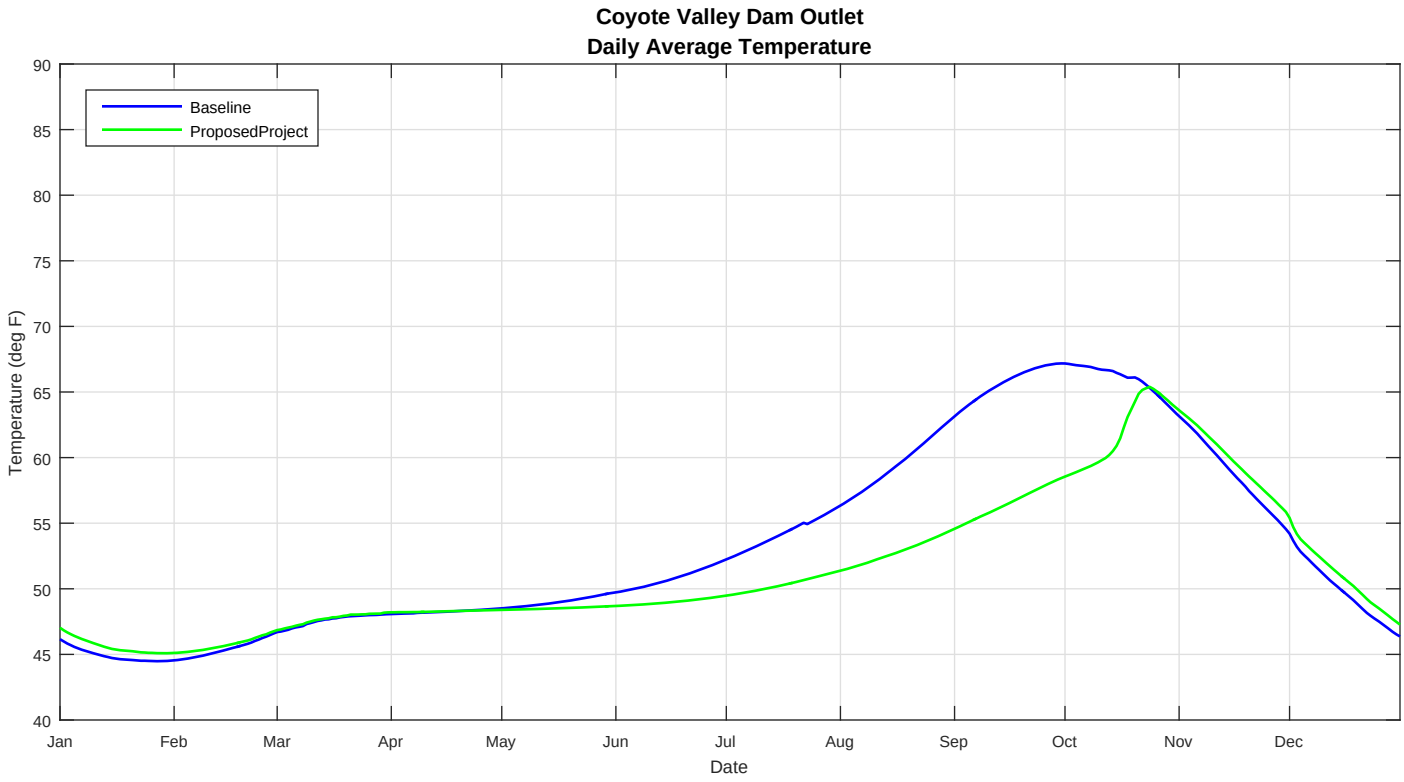

Healdsburg Gage
Daily Average Stage
Baseline
ProposedProject
Stage (feet)
0
1
2
3
4
5
6
7
8
9
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

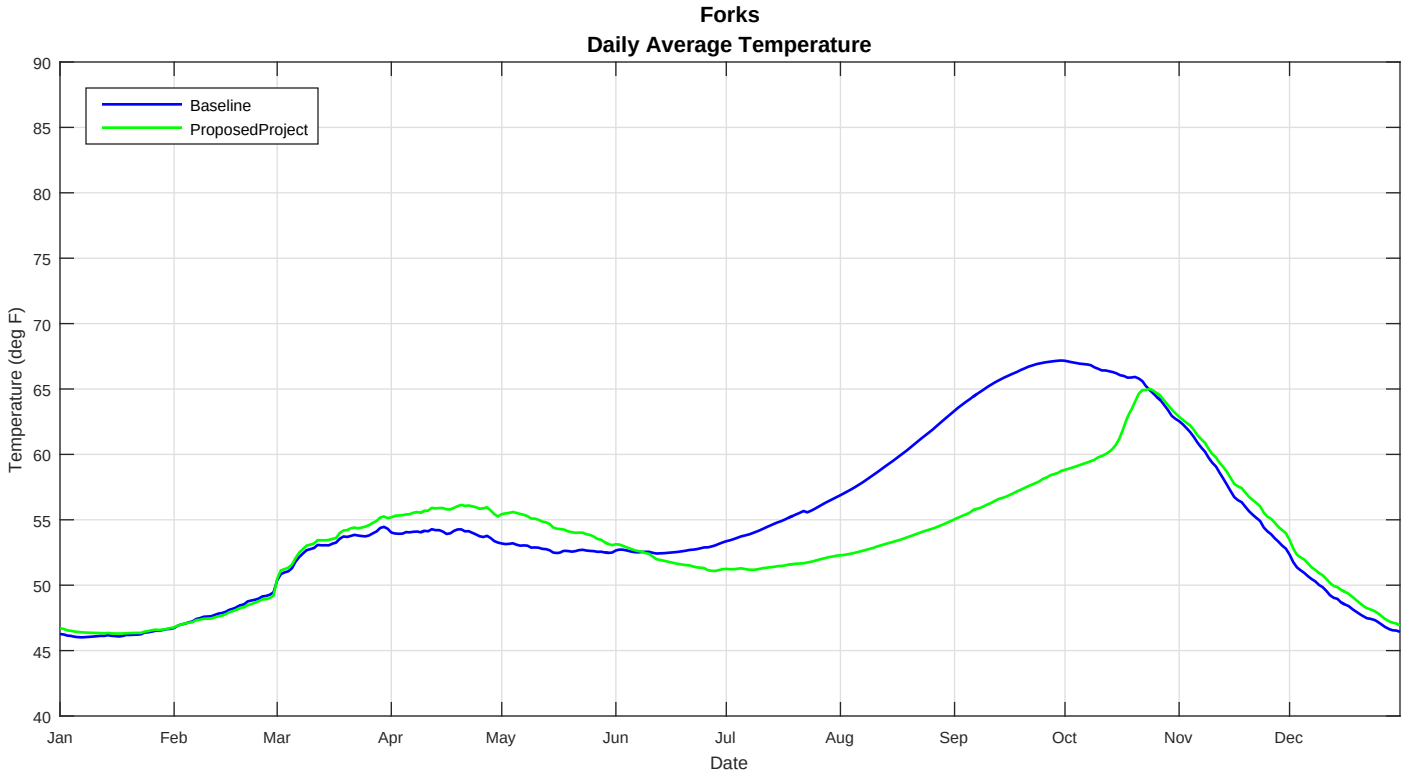

Hacienda Gage
Daily Average Stage
Baseline
ProposedProject
Stage (feet)
0
1
2
3
4
5
6
7
8
9
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

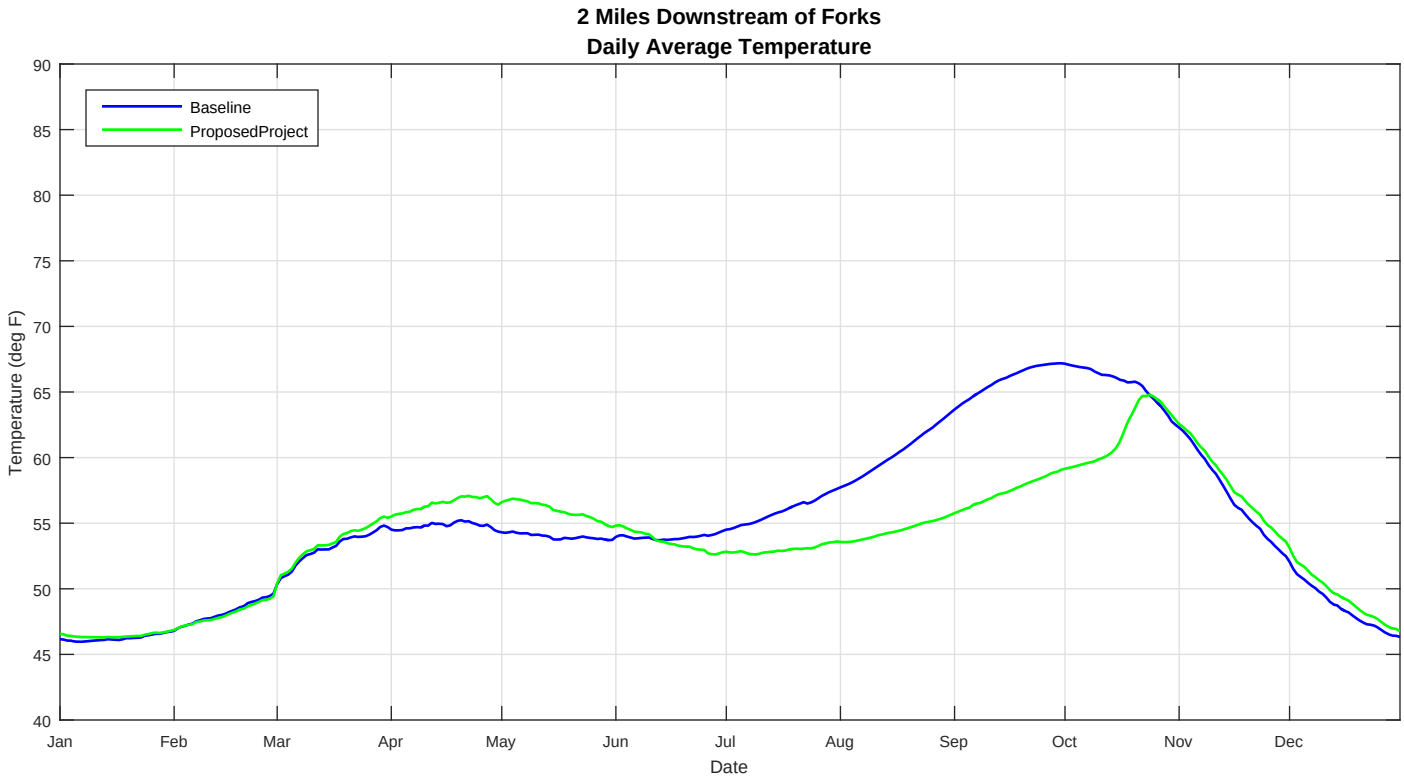

Dry Creek at Geyserville Gage
Daily Average Stage
Baseline
ProposedProject
Stage (feet)
0
1
2
3
4
5
6
7
8
9
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

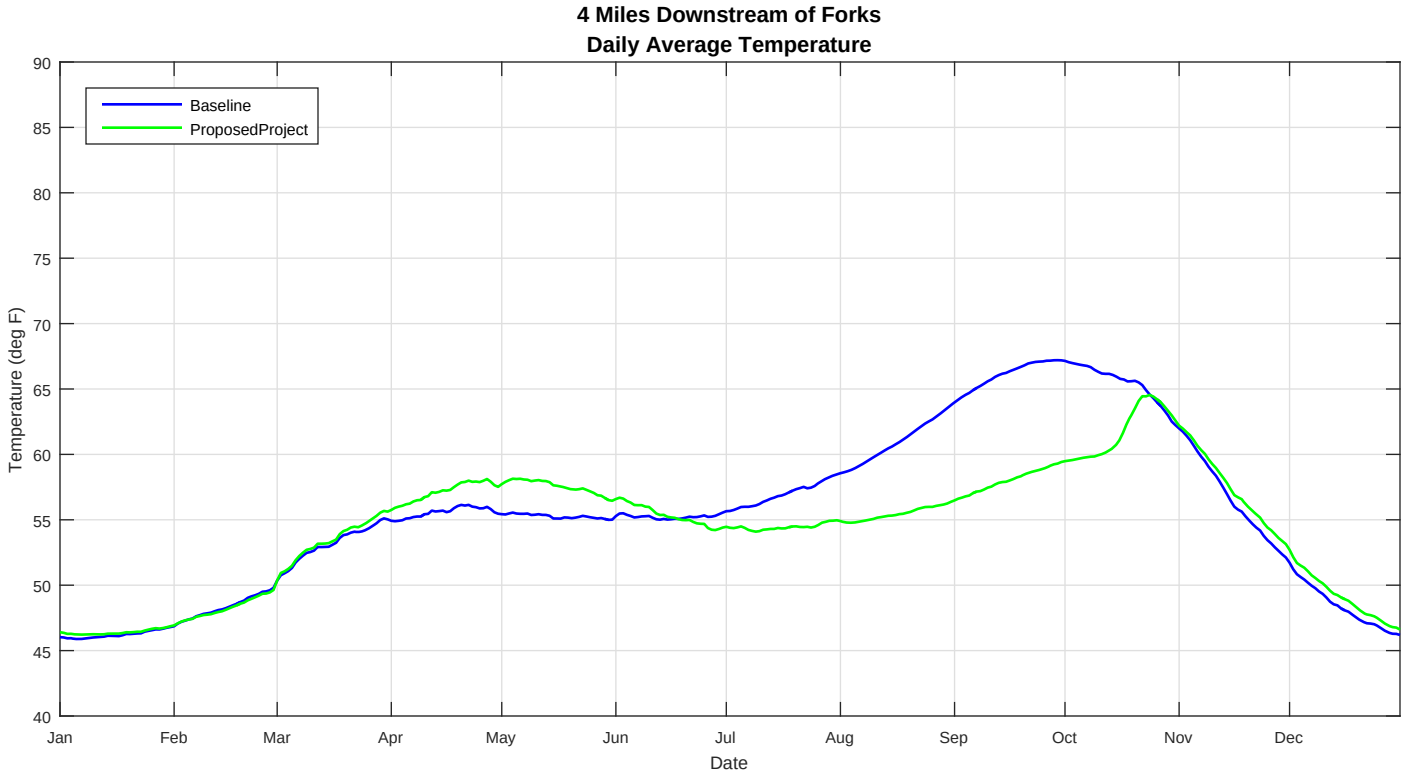

Coyote Valley Dam
Daily Average Power Production
Baseline
ProposedProject
Power (MW-hr/day)
0
10
20
30
40
50
60
70
80
90
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

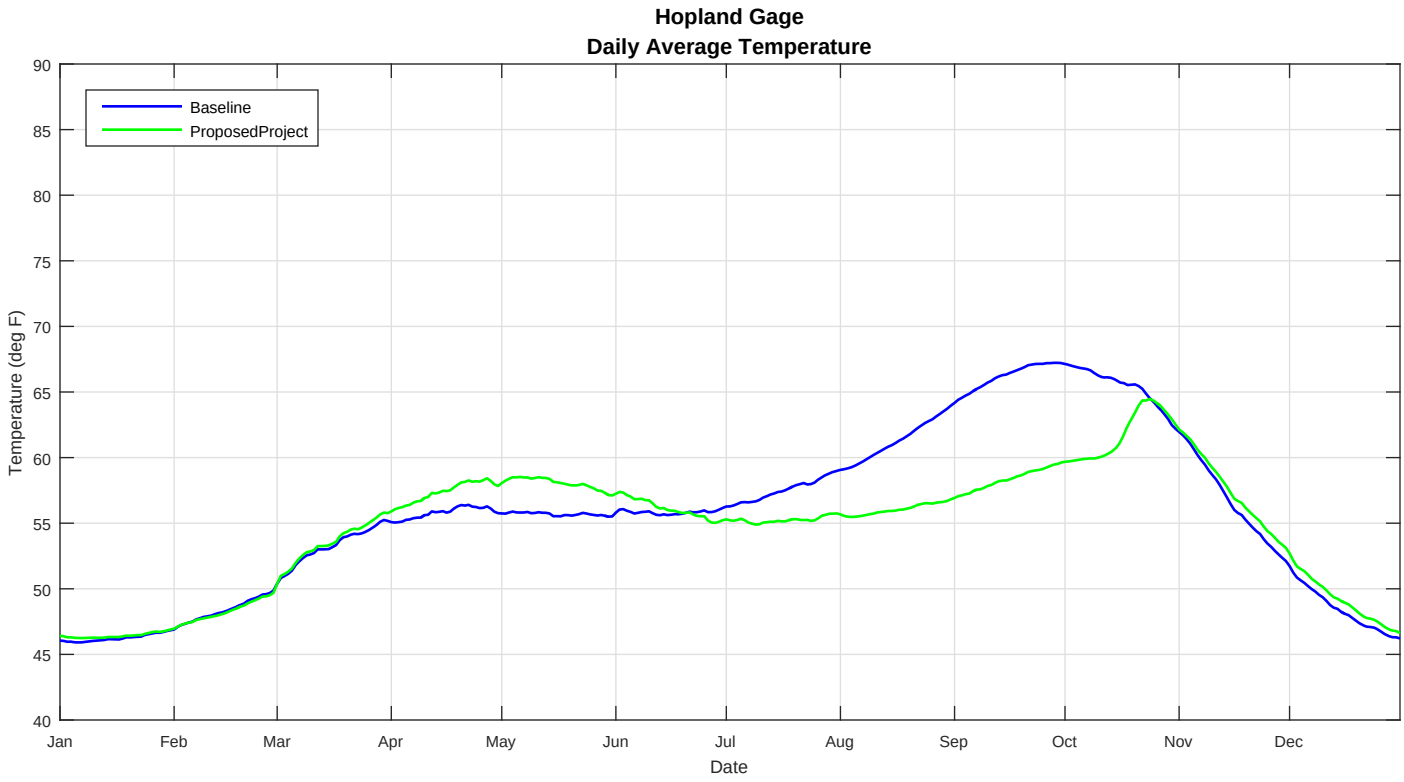

Warm Springs Dam
Daily Average Power Production
Baseline
ProposedProject
Power (MW-hr/day)
0
10
20
30
40
50
60
70
80
90
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

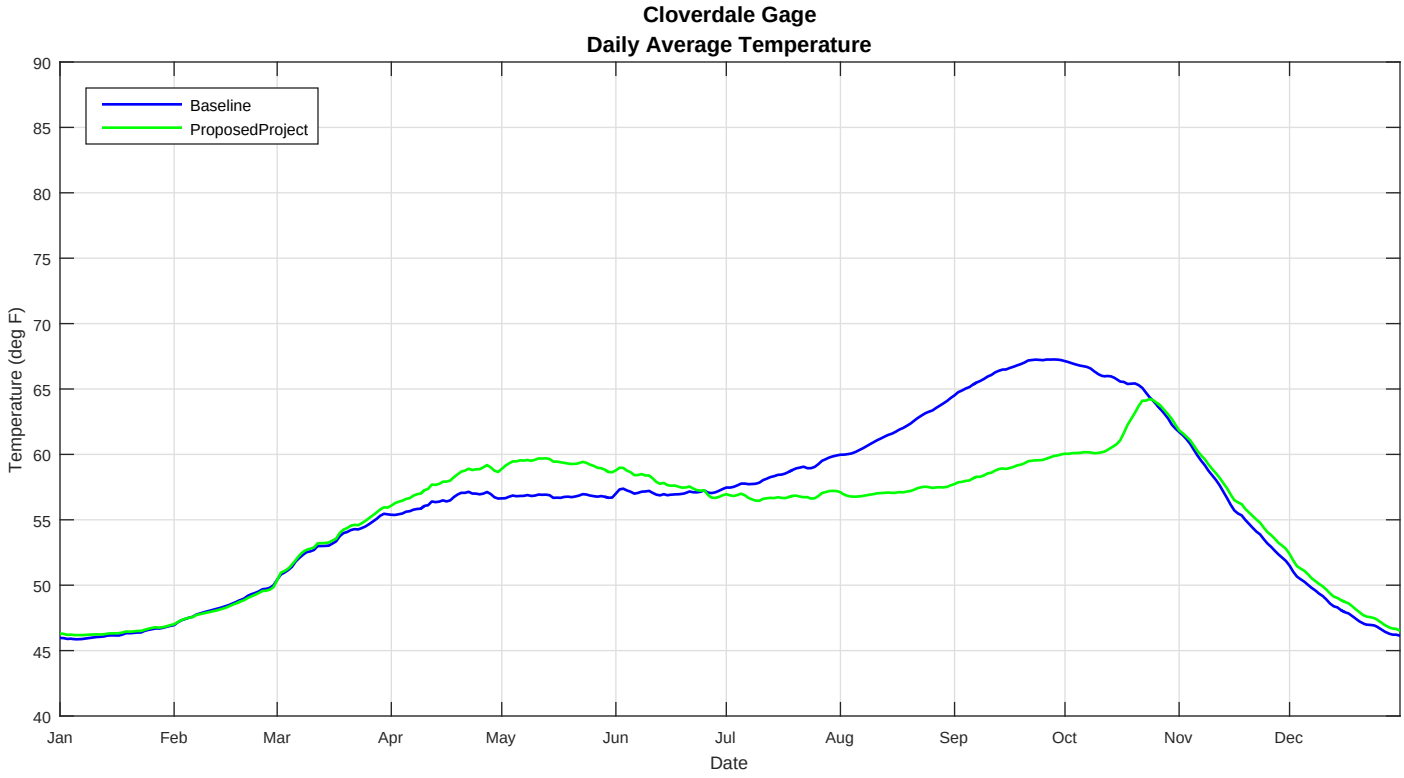

Coyote Valley Dam Outlet
Daily Average Temperature
Baseline
ProposedProject
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

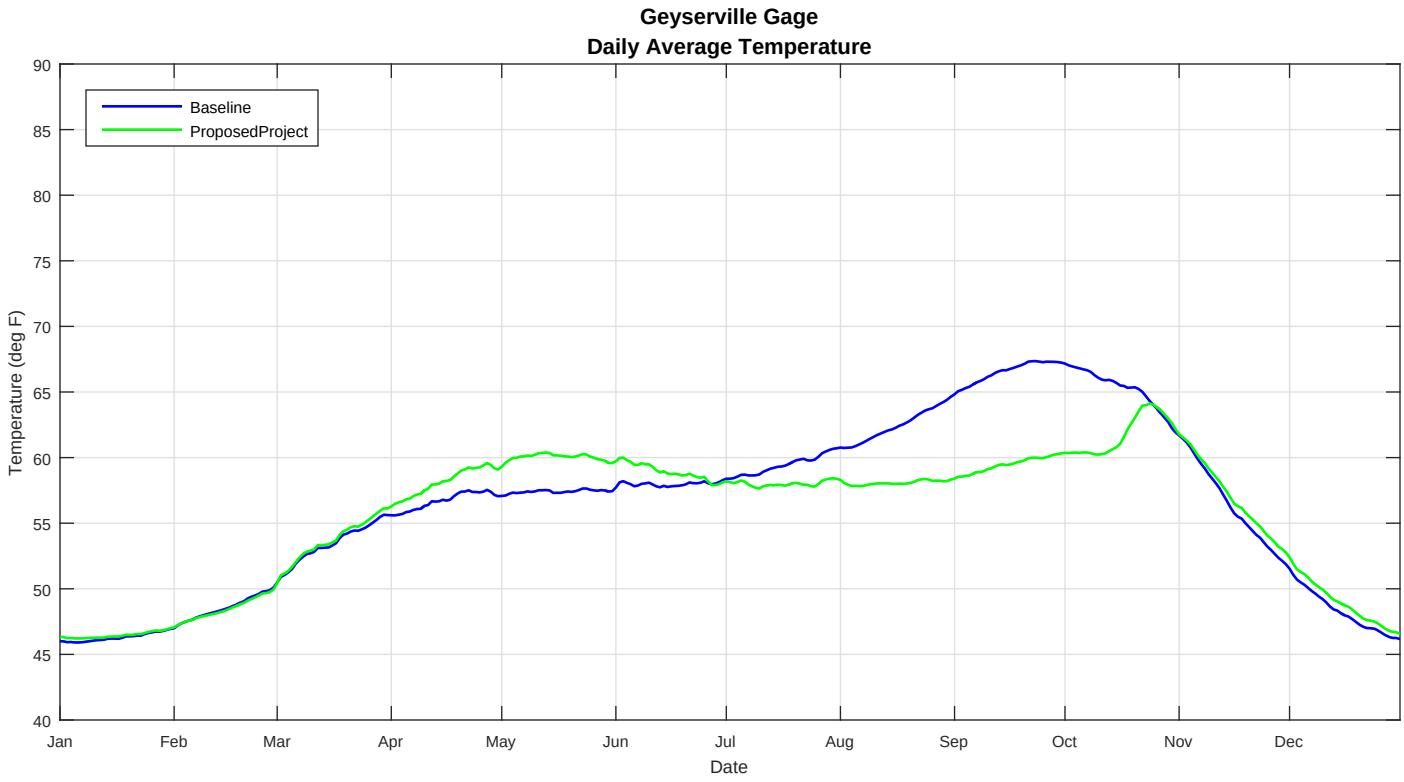

Forks
Daily Average Temperature
Baseline
ProposedProject
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

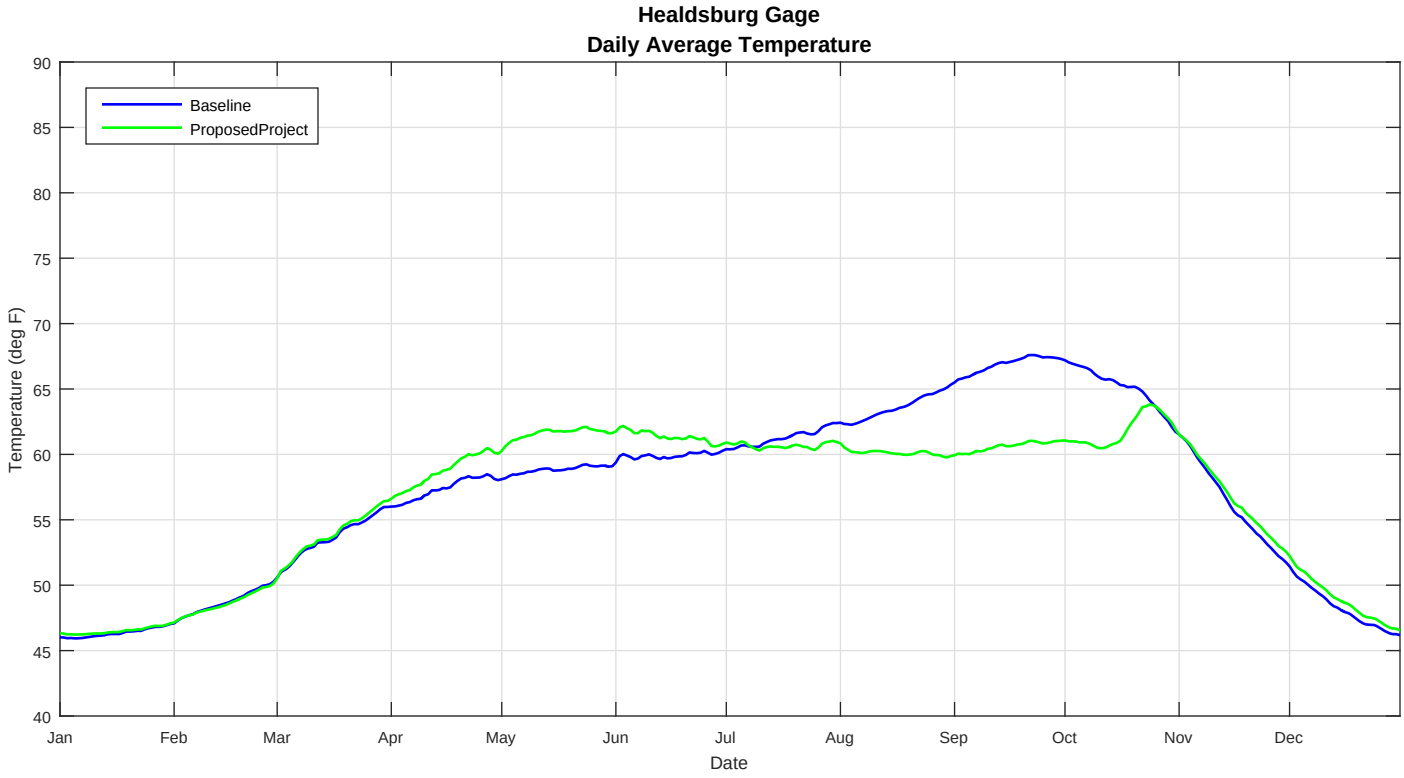

2 Miles Downstream of Forks
Daily Average Temperature
Baseline
ProposedProject
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

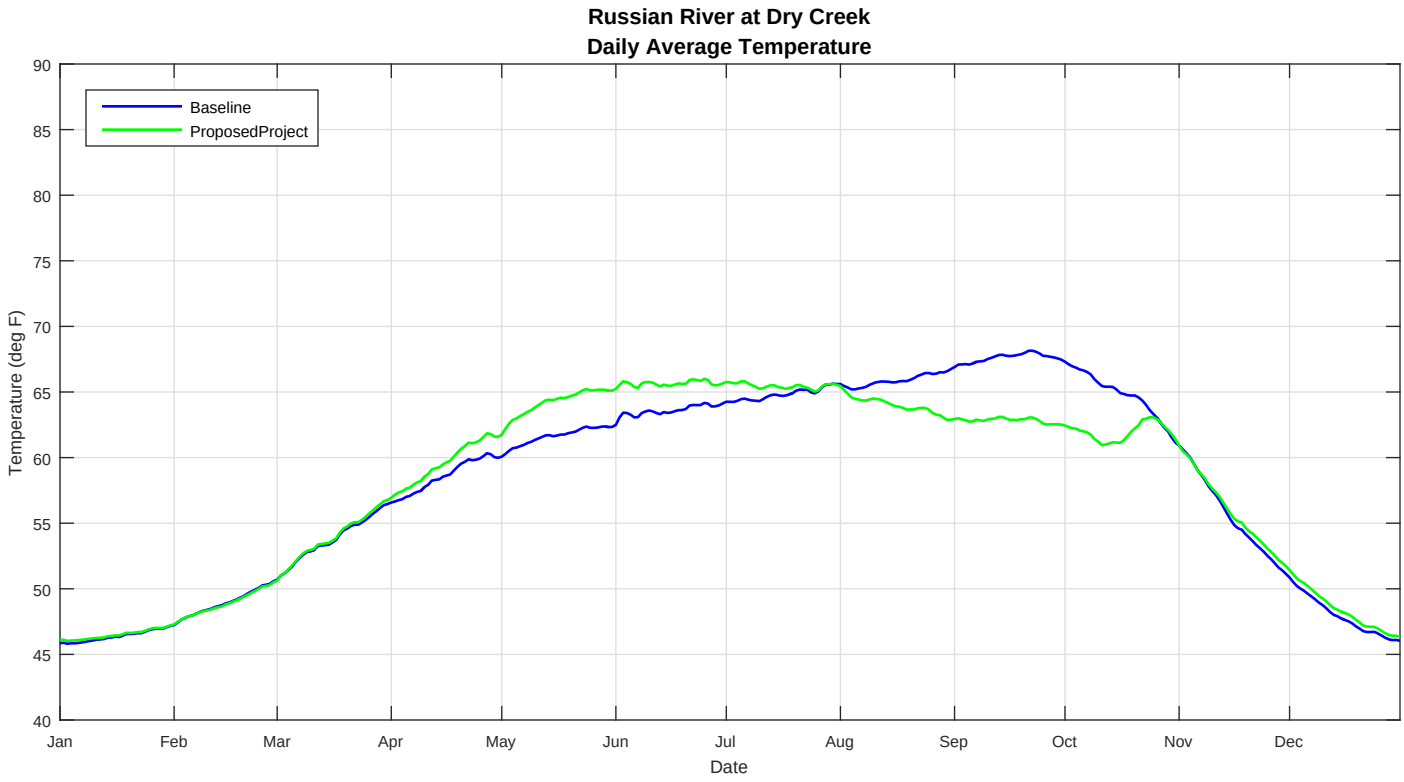

4 Miles Downstream of Forks
Daily Average Temperature
Baseline
ProposedProject
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

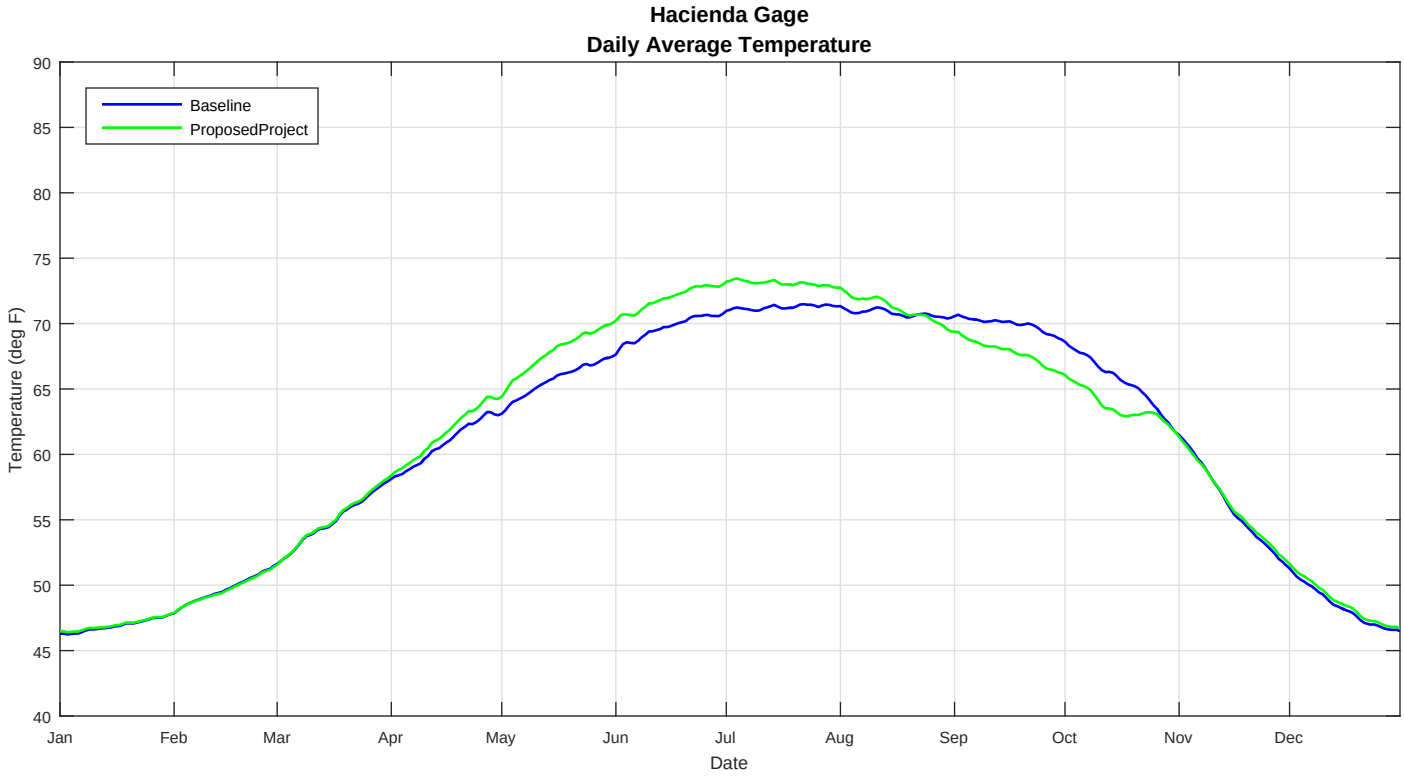

Hopland Gage
Daily Average Temperature
Baseline
ProposedProject
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

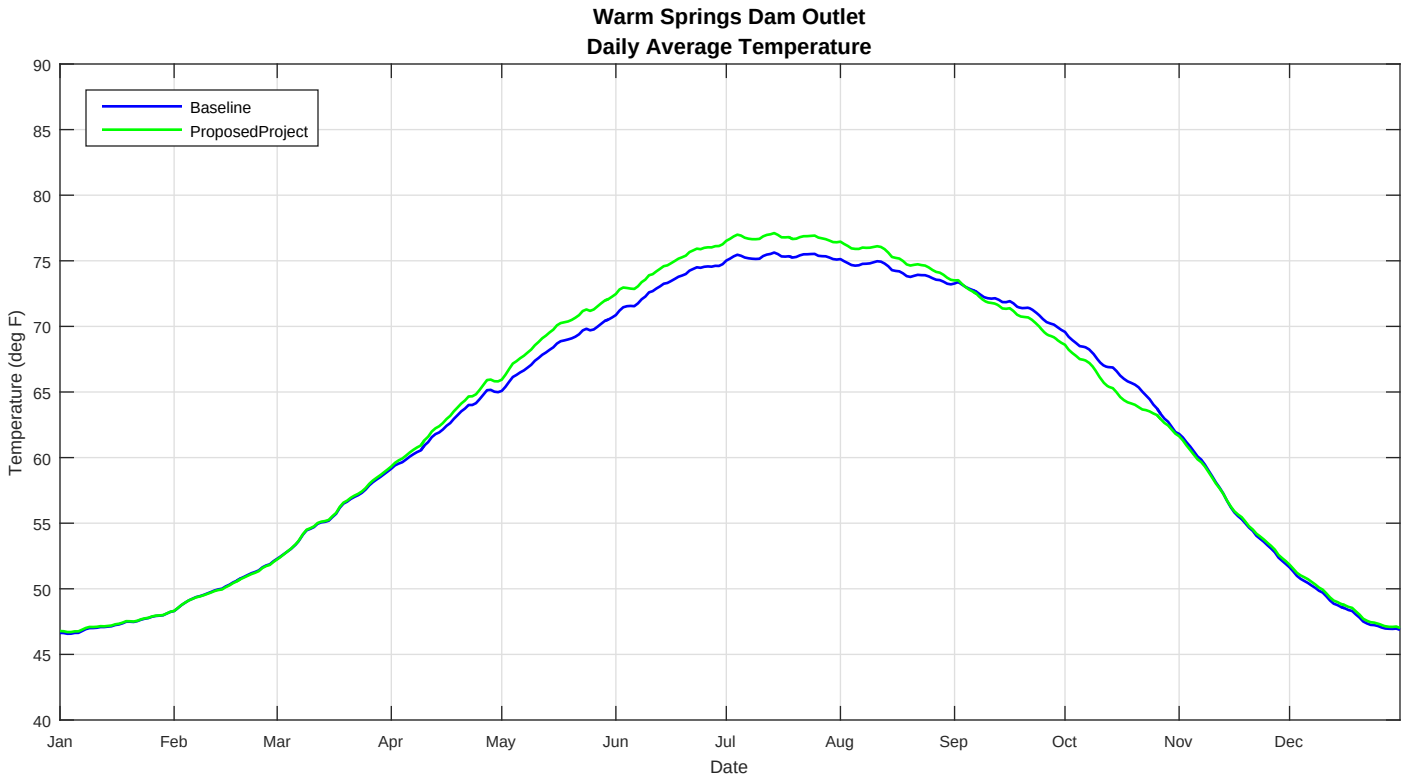

Cloverdale Gage
Daily Average Temperature
Baseline
ProposedProject
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

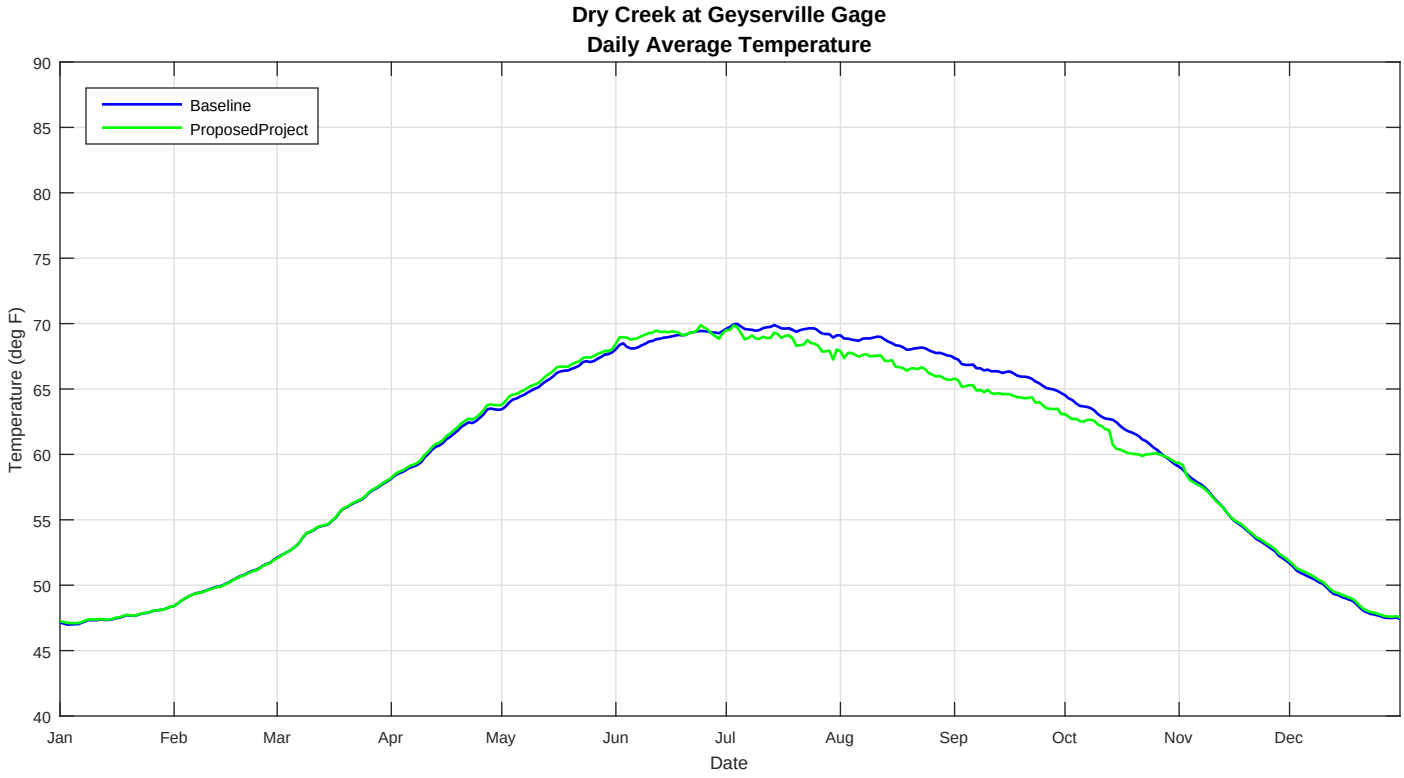

Geyserville Gage
Daily Average Temperature
Baseline
ProposedProject
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

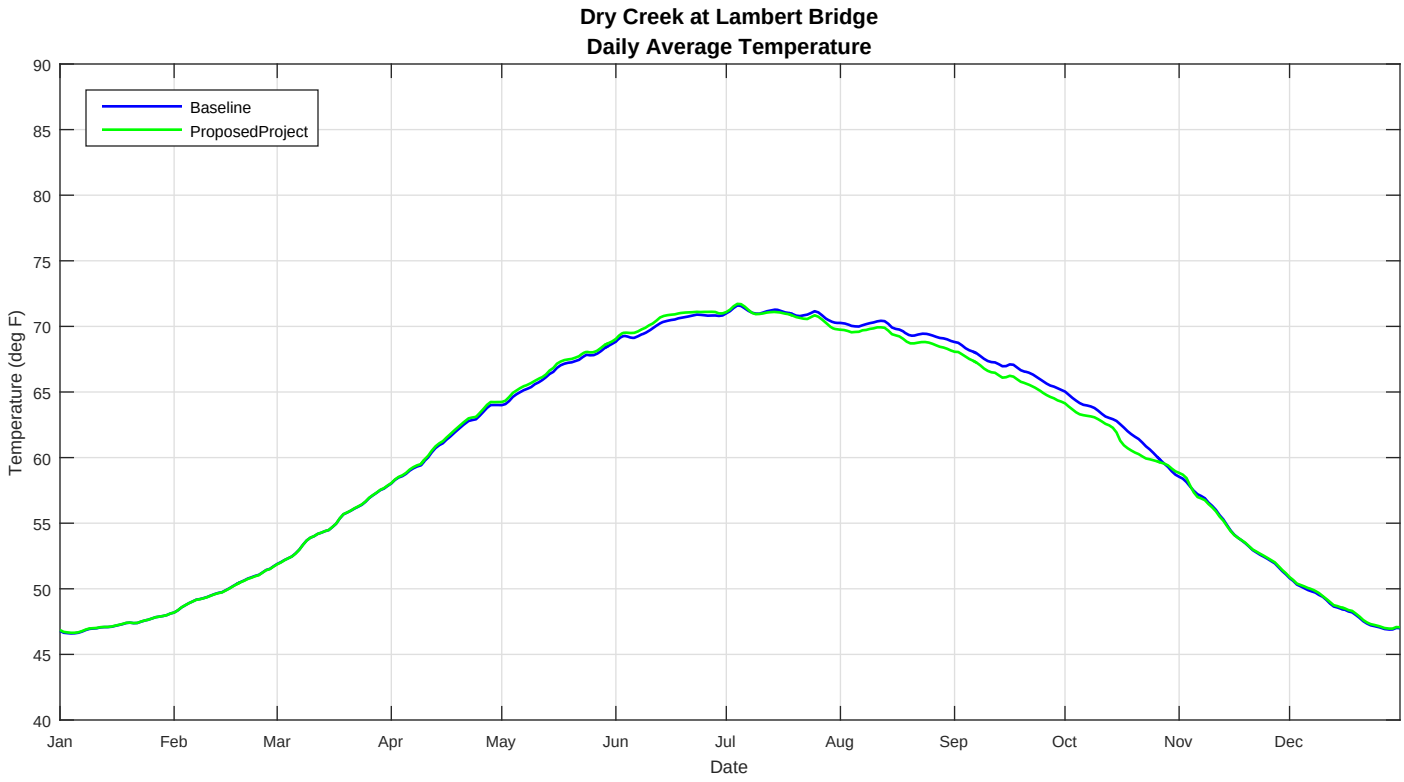

Healdsburg Gage
Daily Average Temperature
Baseline
ProposedProject
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

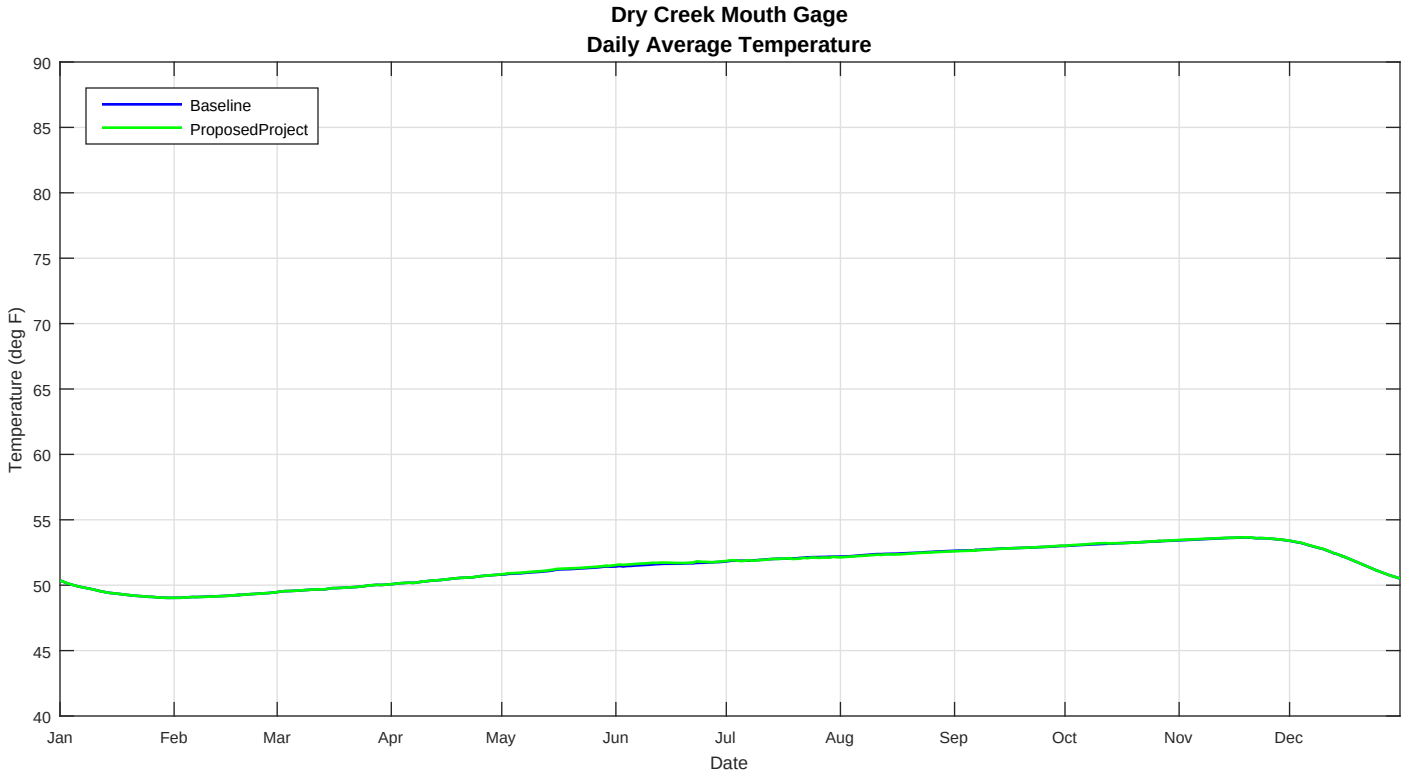

Russian River at Dry Creek
Daily Average Temperature
Baseline
ProposedProject
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

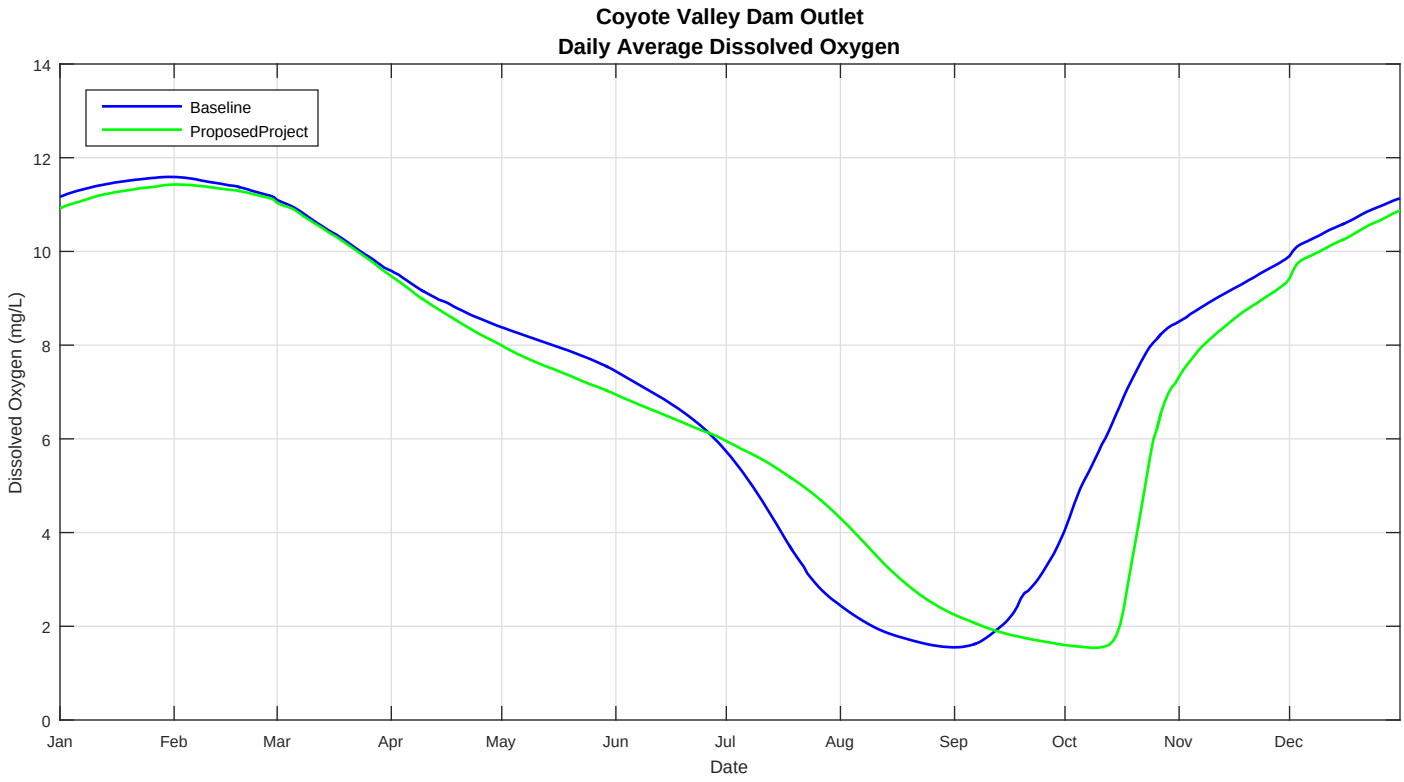

Hacienda Gage
Daily Average Temperature
Baseline
ProposedProject
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

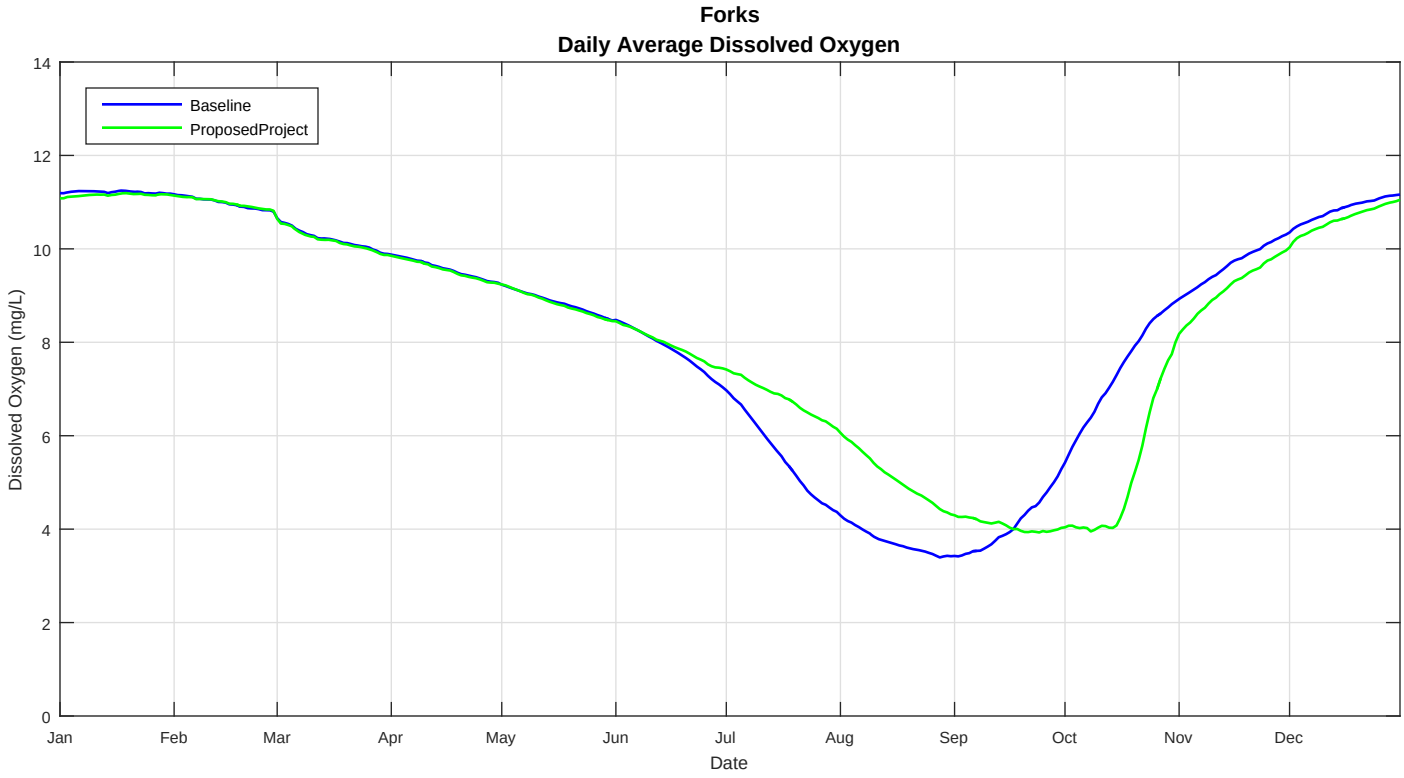

Warm Springs Dam Outlet
Daily Average Temperature
Baseline
ProposedProject
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

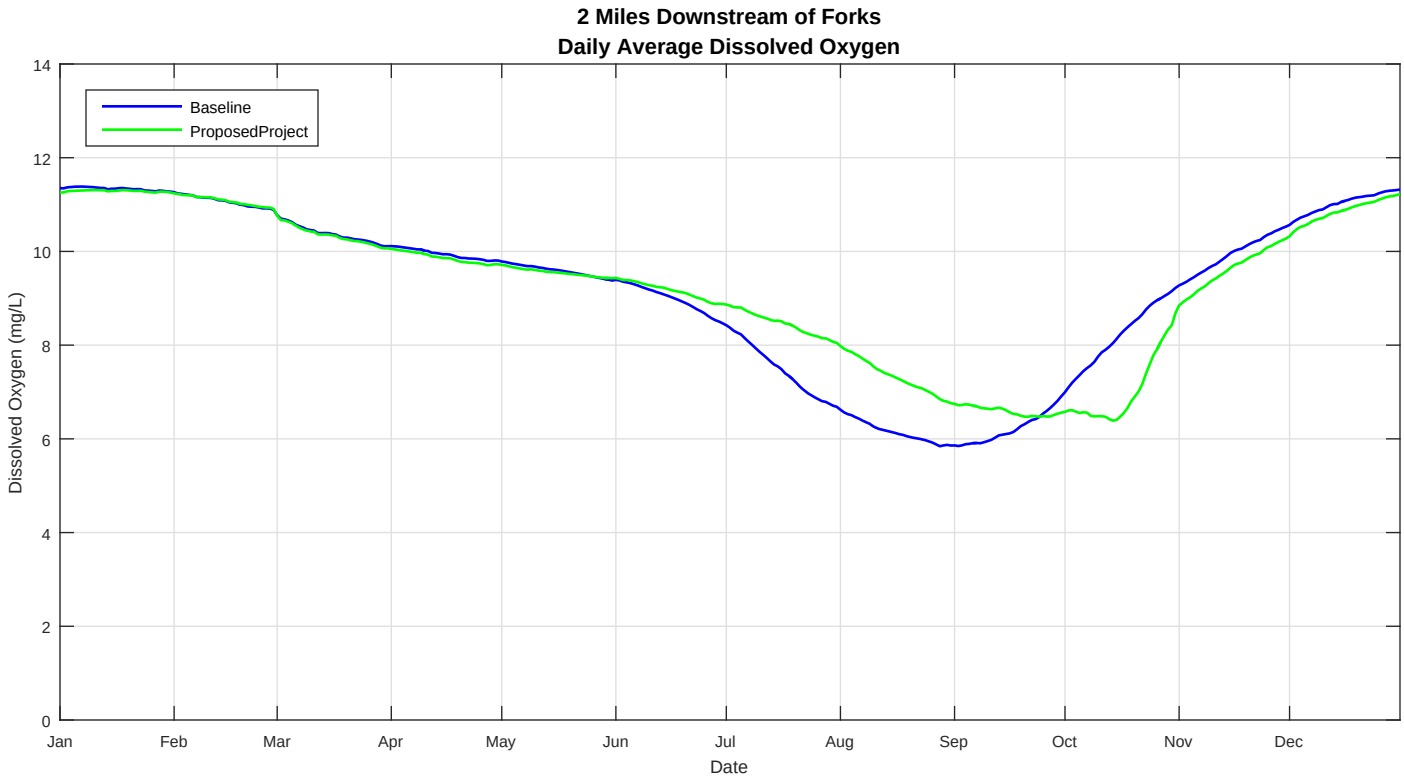

Dry Creek at Geyserville Gage
Daily Average Temperature
Baseline
ProposedProject
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

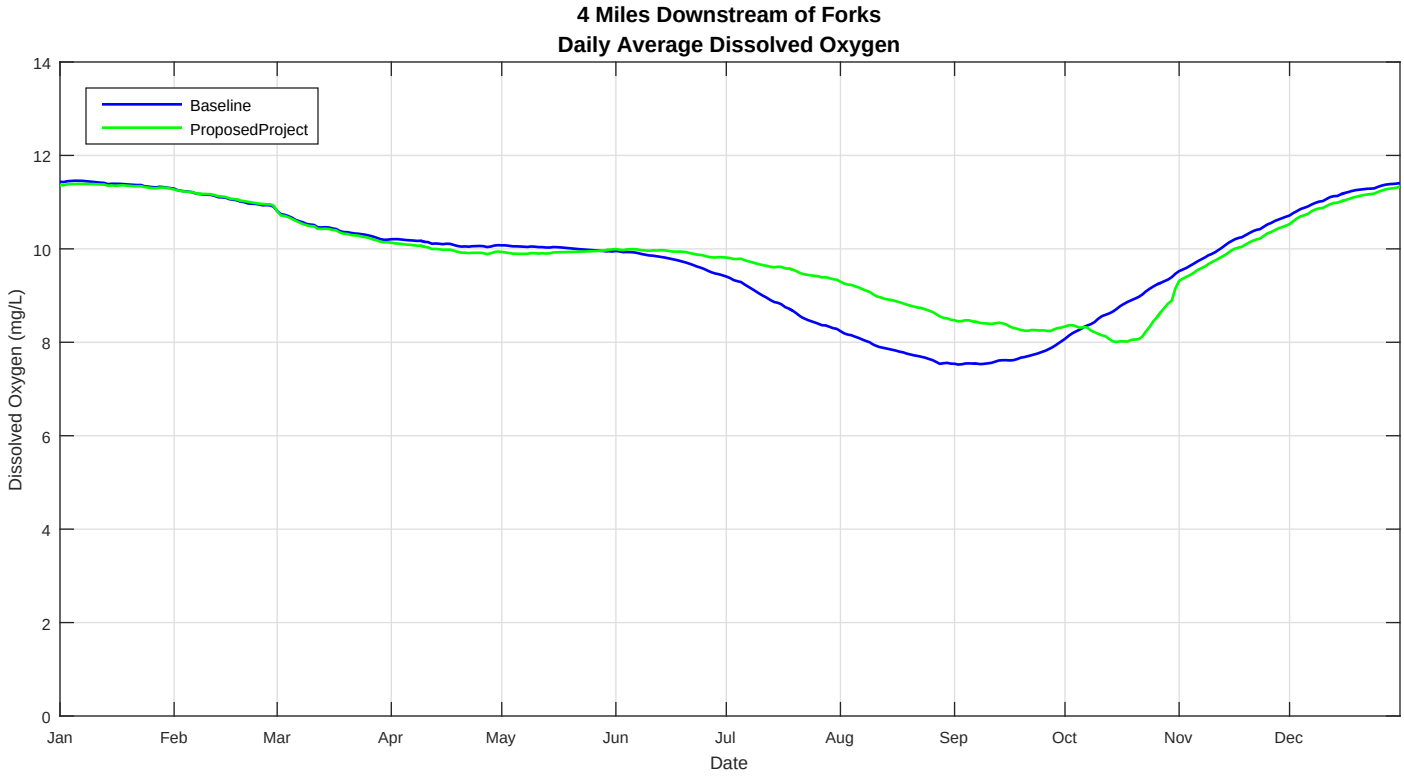

Dry Creek at Lambert Bridge
Daily Average Temperature
Baseline
ProposedProject
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

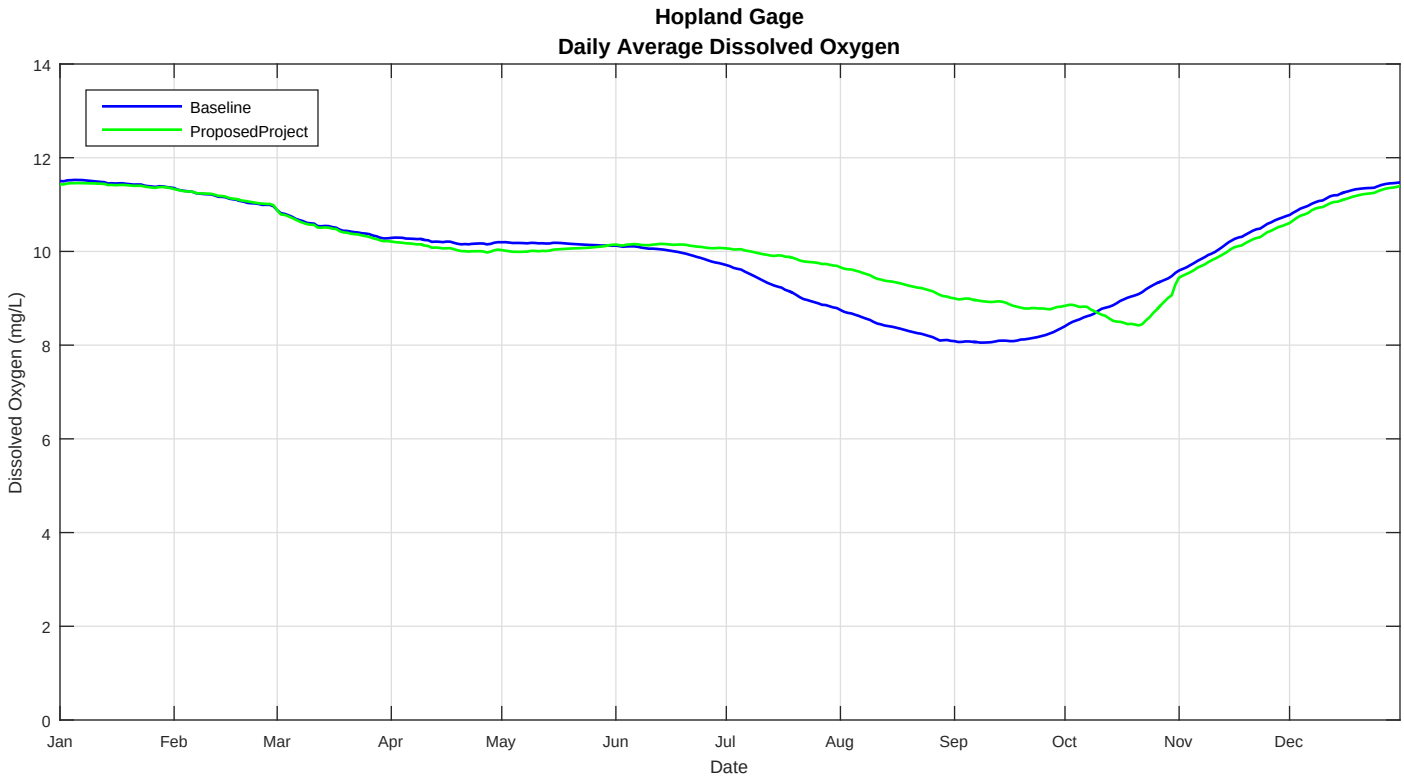

Dry Creek Mouth Gage
Daily Average Temperature
Baseline
ProposedProject
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

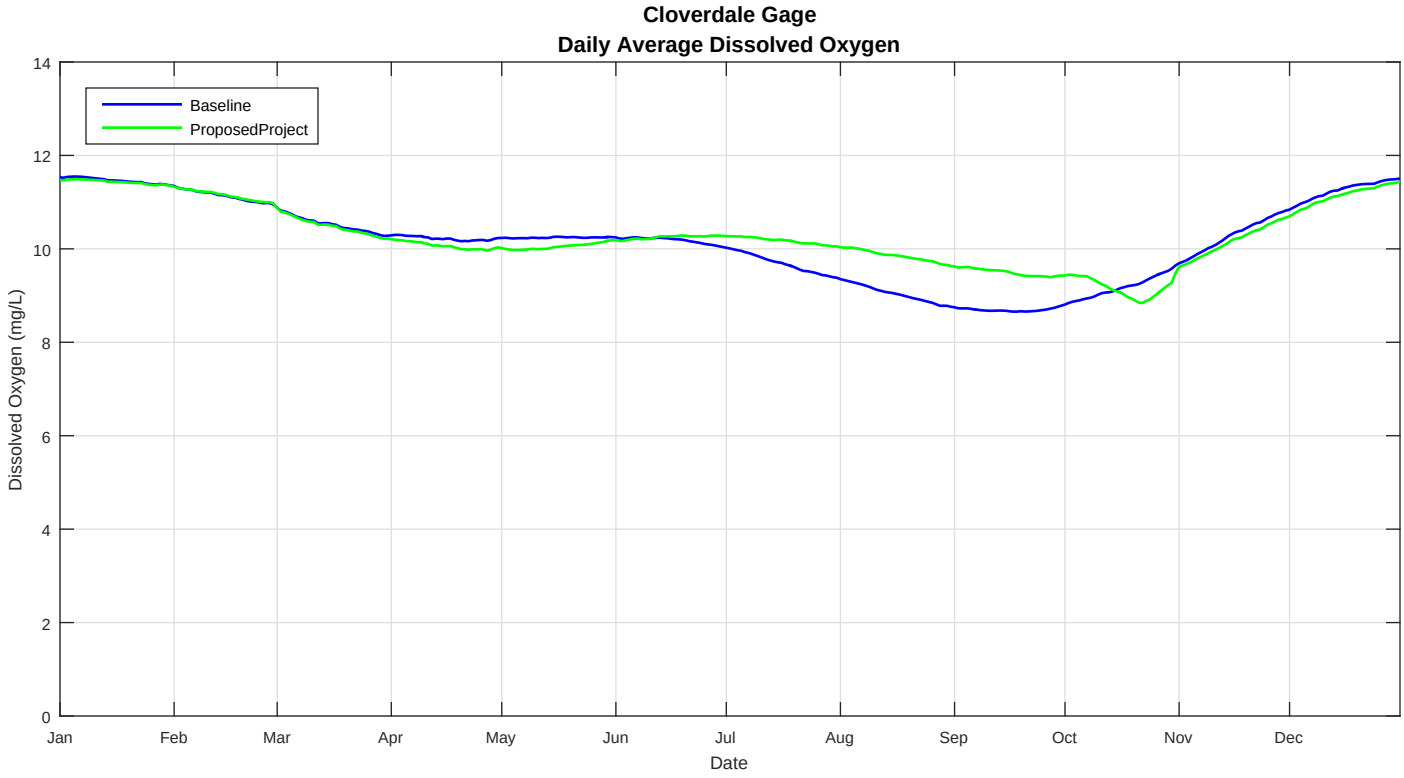

Coyote Valley Dam Outlet
Daily Average Dissolved Oxygen
Baseline
ProposedProject
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

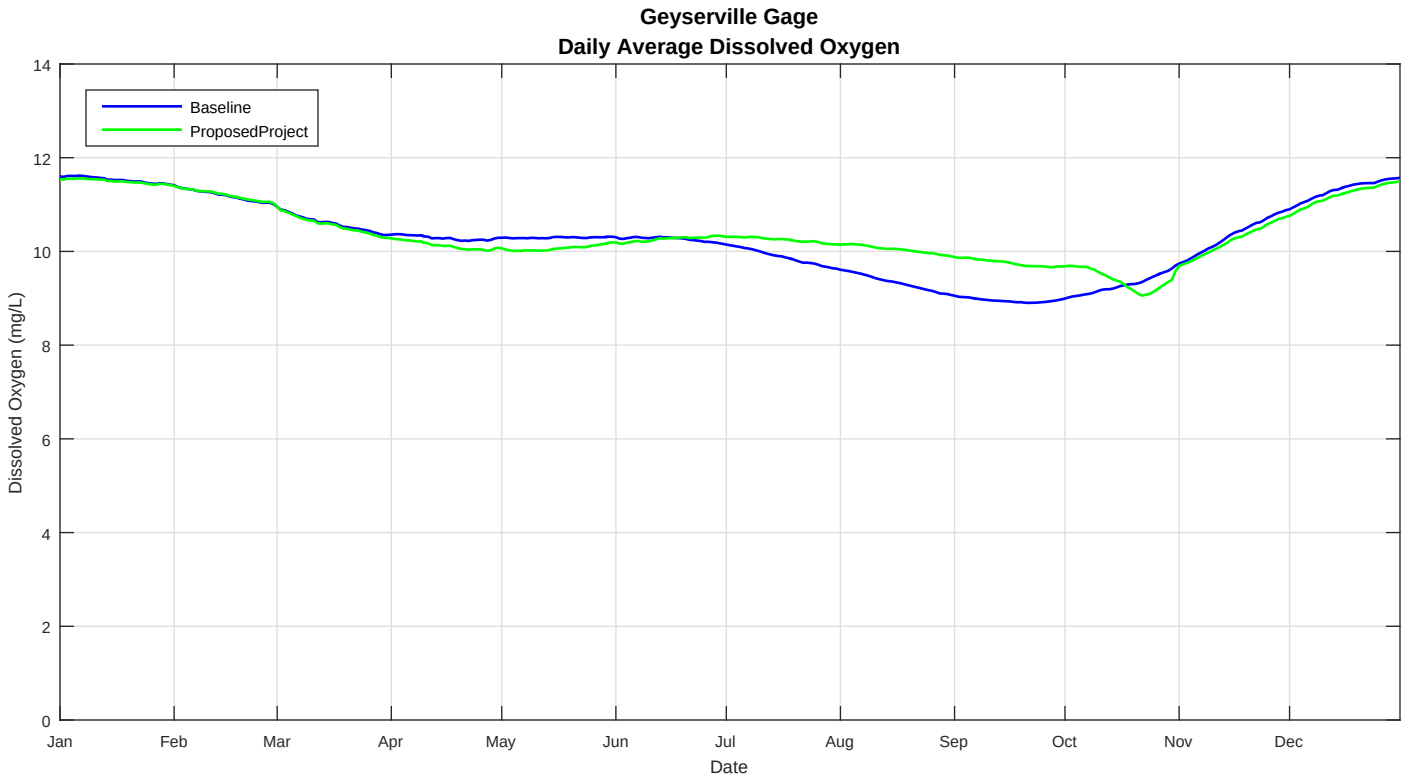

Forks
Daily Average Dissolved Oxygen
Baseline
ProposedProject
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

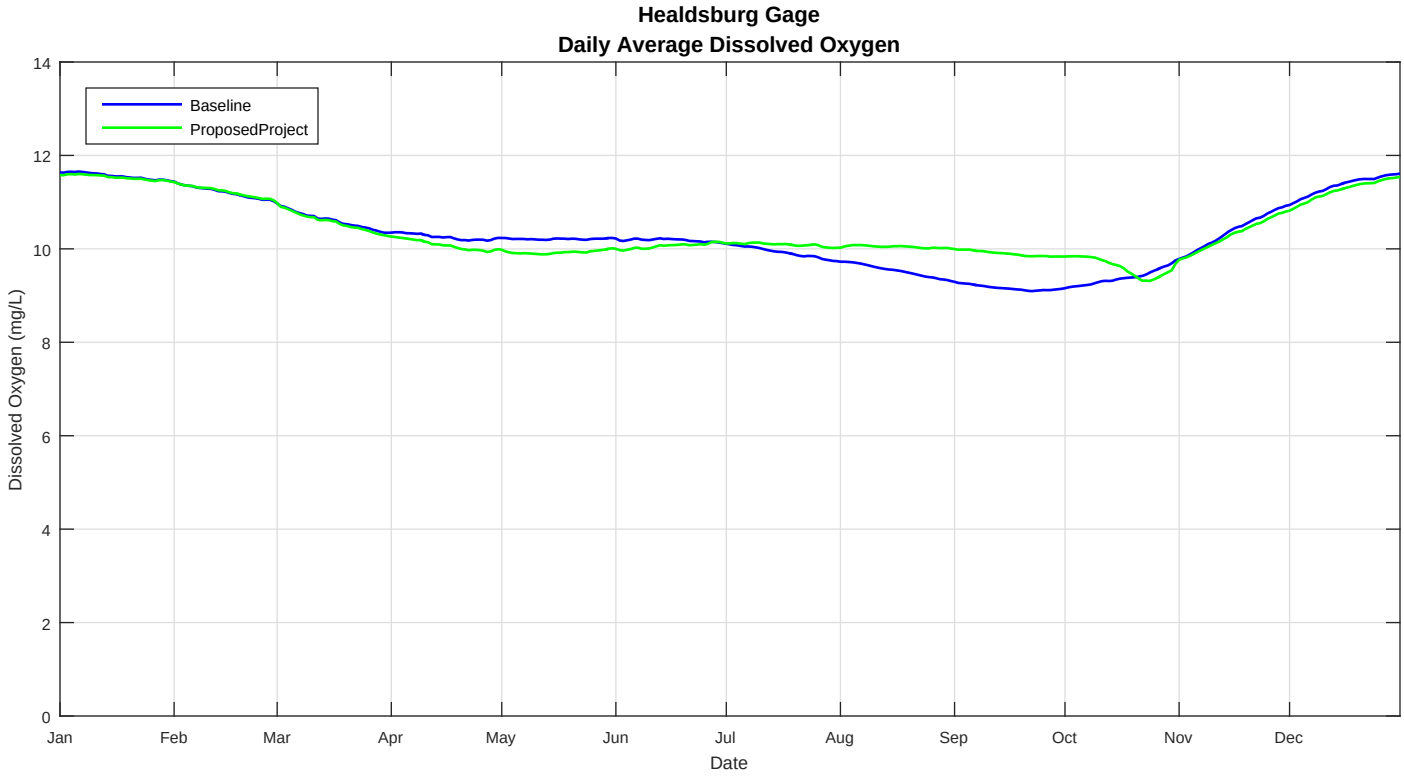

2 Miles Downstream of Forks
Daily Average Dissolved Oxygen
Baseline
ProposedProject
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

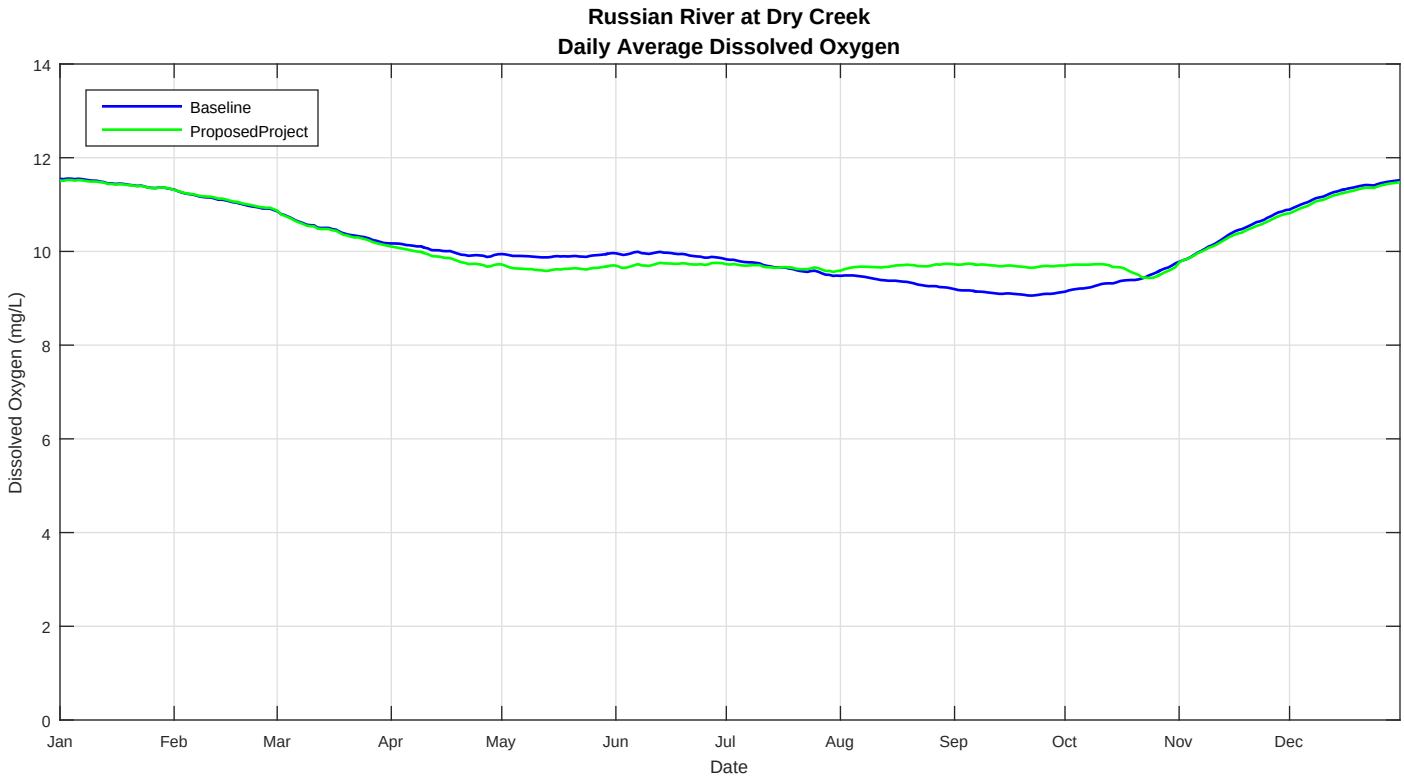

4 Miles Downstream of Forks
Daily Average Dissolved Oxygen
Baseline
ProposedProject
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

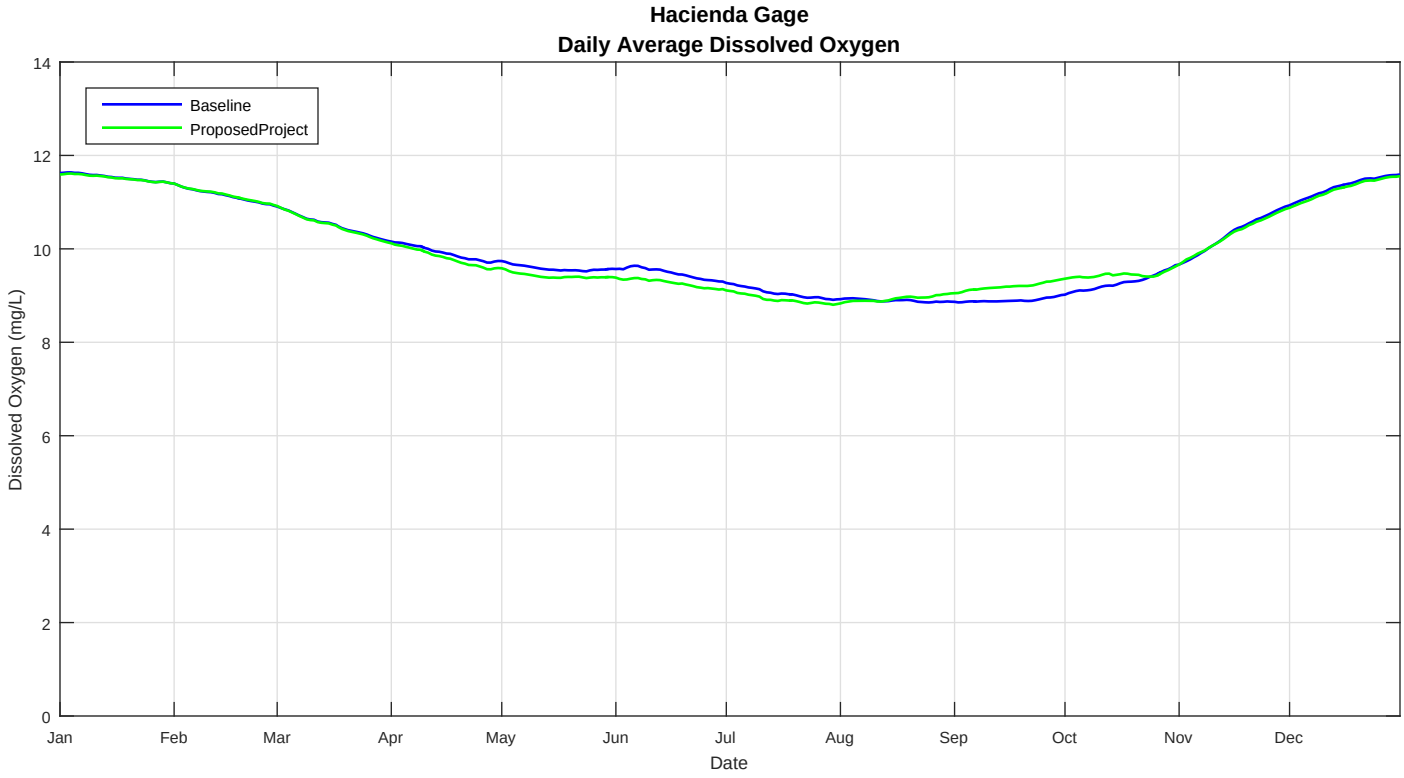

Hopland Gage
Daily Average Dissolved Oxygen
Baseline
ProposedProject
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

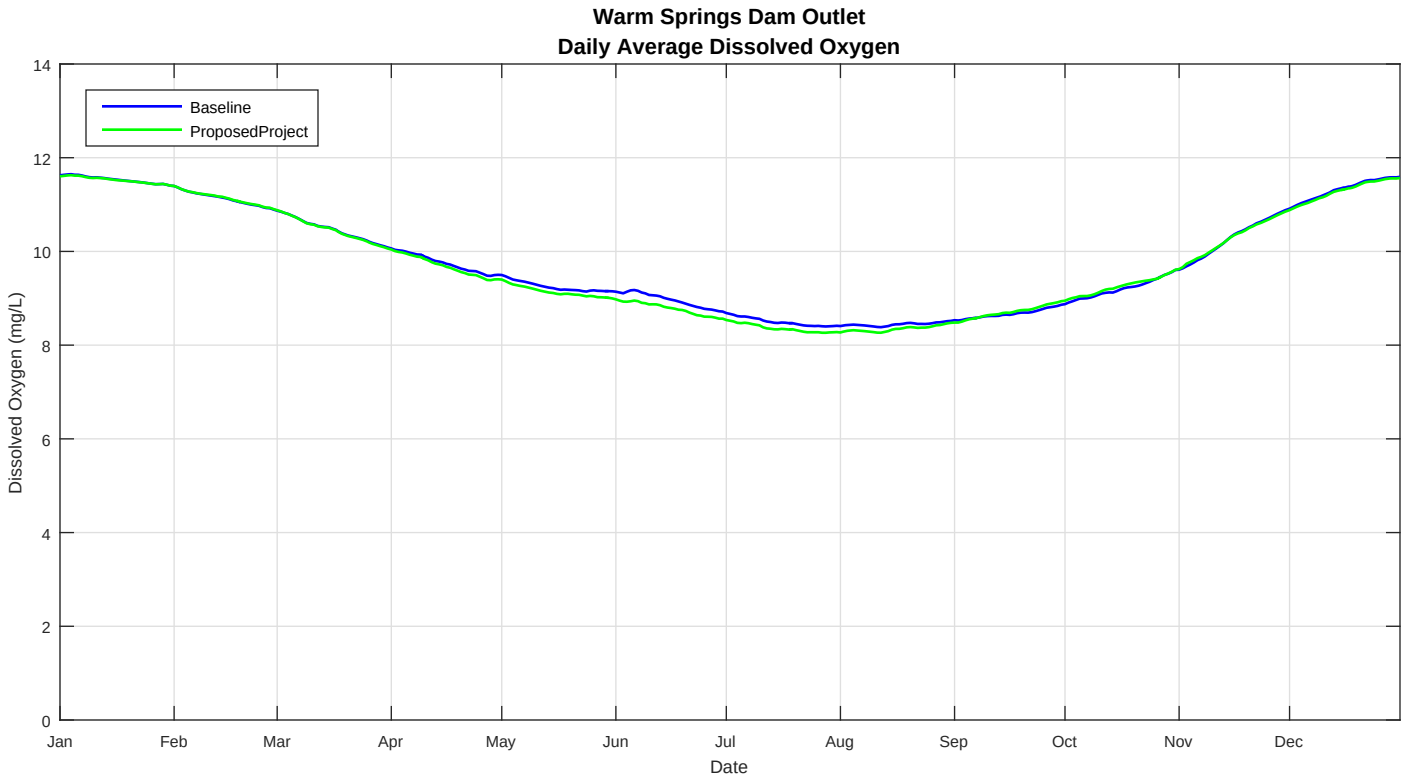

Cloverdale Gage
Daily Average Dissolved Oxygen
Baseline
ProposedProject
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

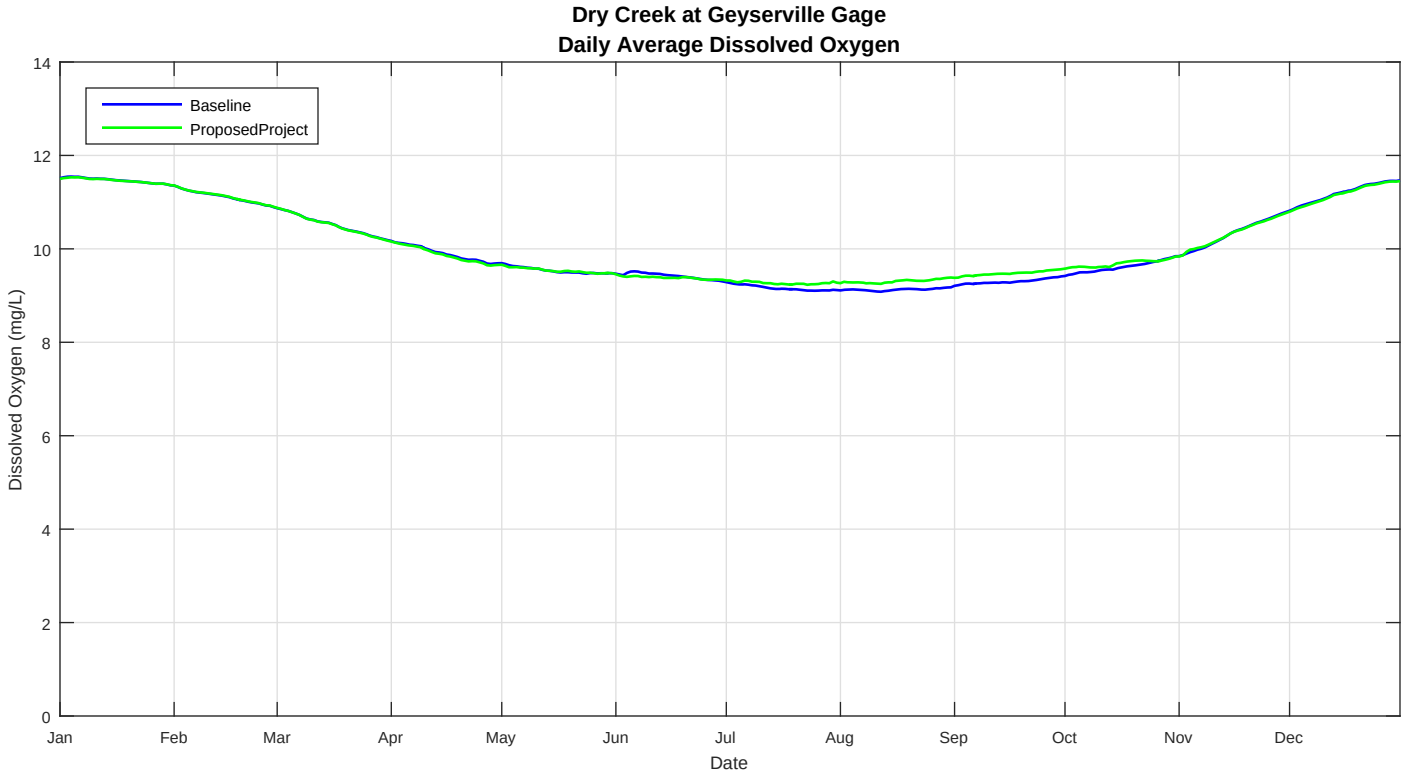

Geyserville Gage
Daily Average Dissolved Oxygen
Baseline
ProposedProject
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

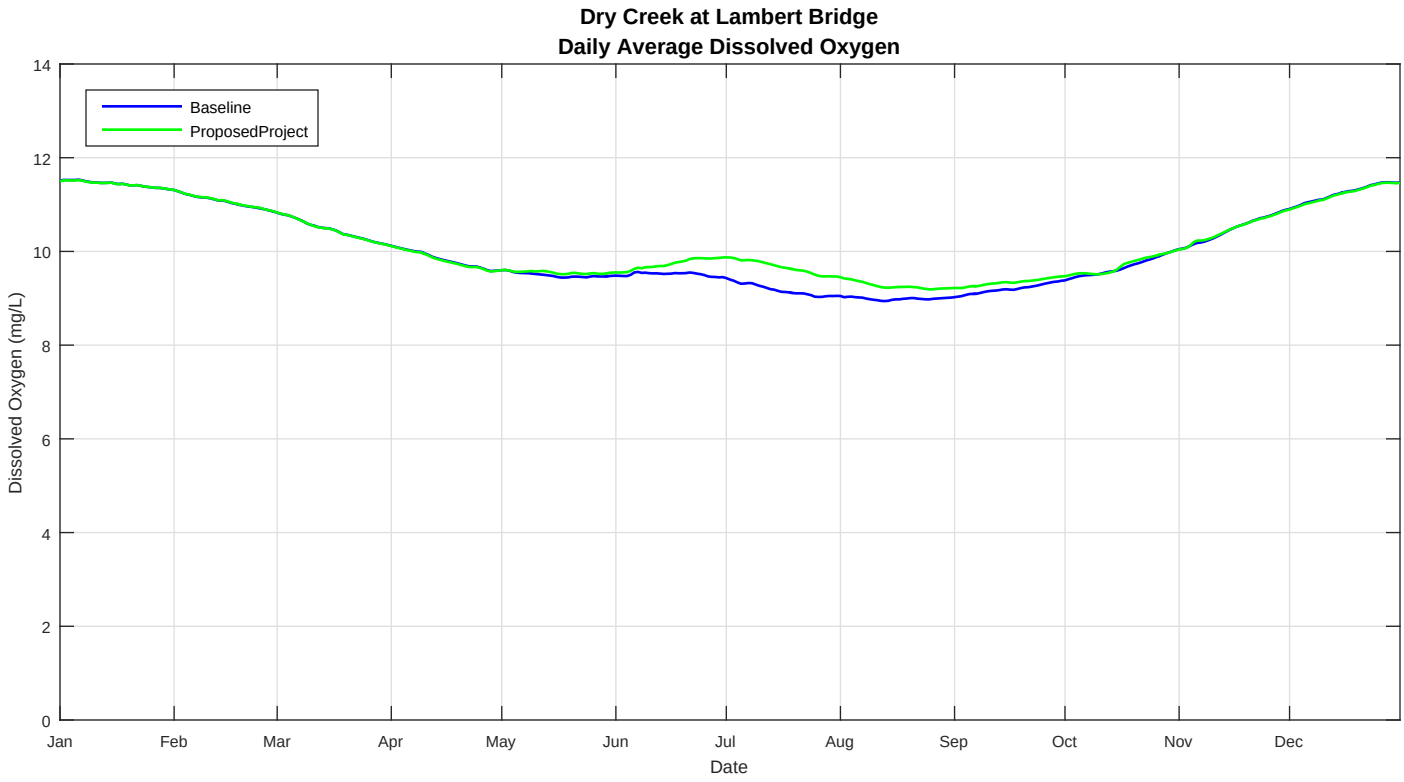

Healdsburg Gage
Daily Average Dissolved Oxygen
Baseline
ProposedProject
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

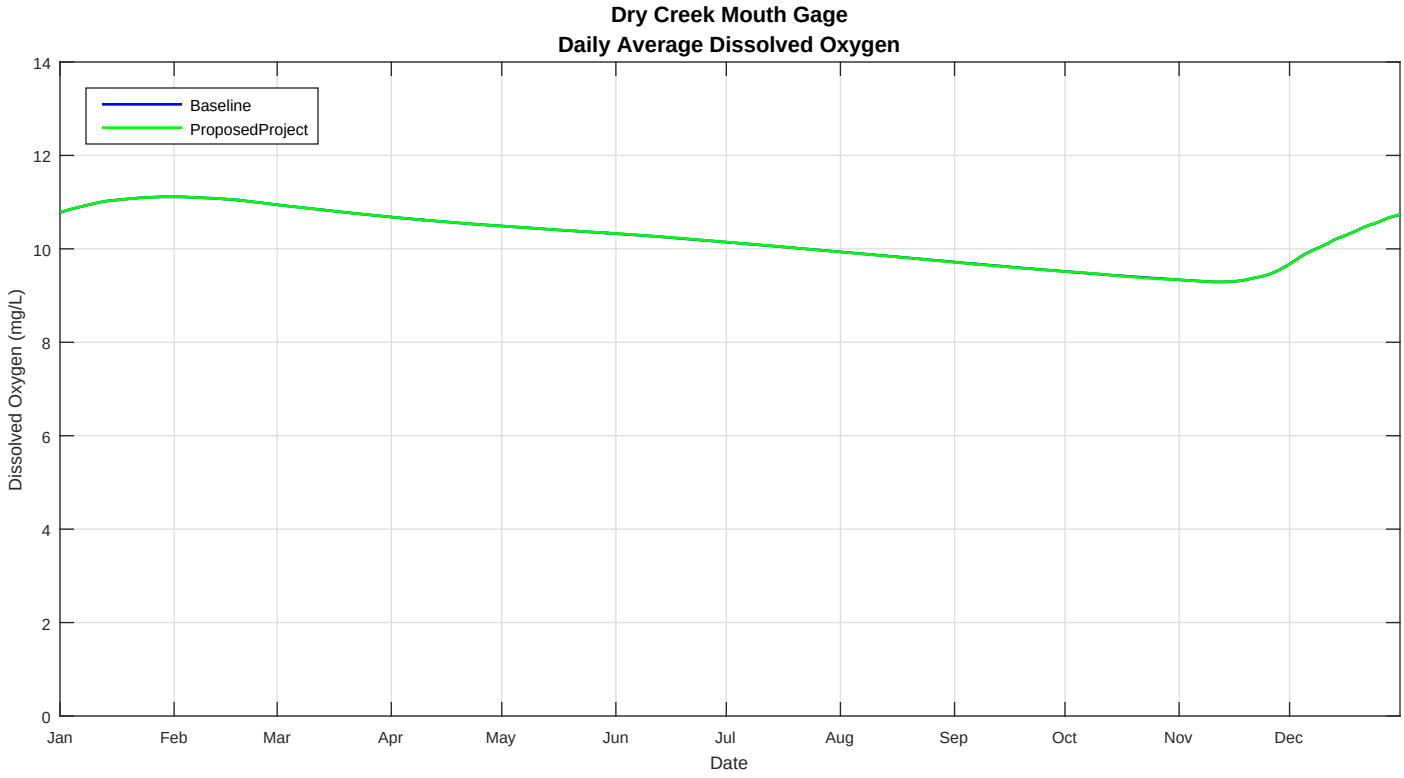

Russian River at Dry Creek
Daily Average Dissolved Oxygen
Baseline
ProposedProject
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

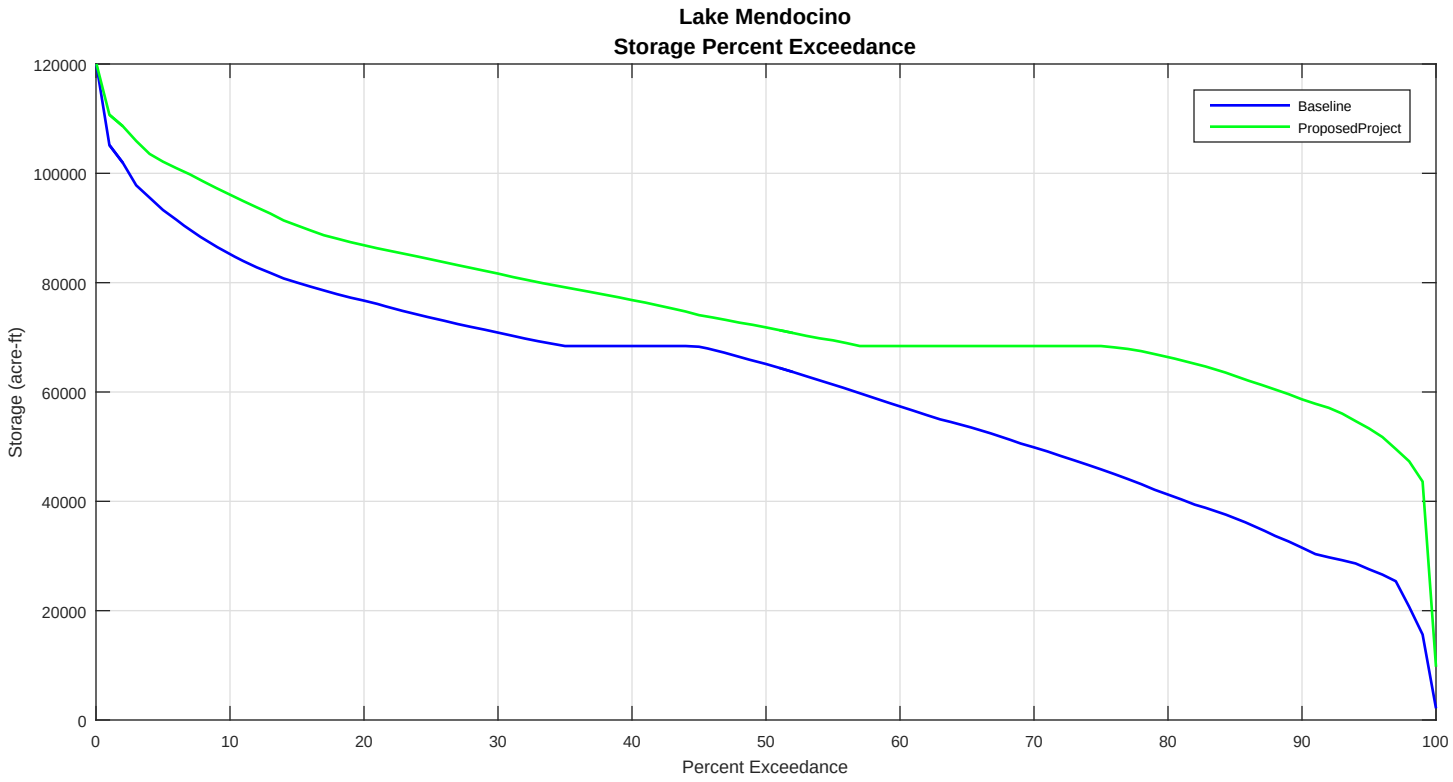

Hacienda Gage
Daily Average Dissolved Oxygen
Baseline
ProposedProject
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

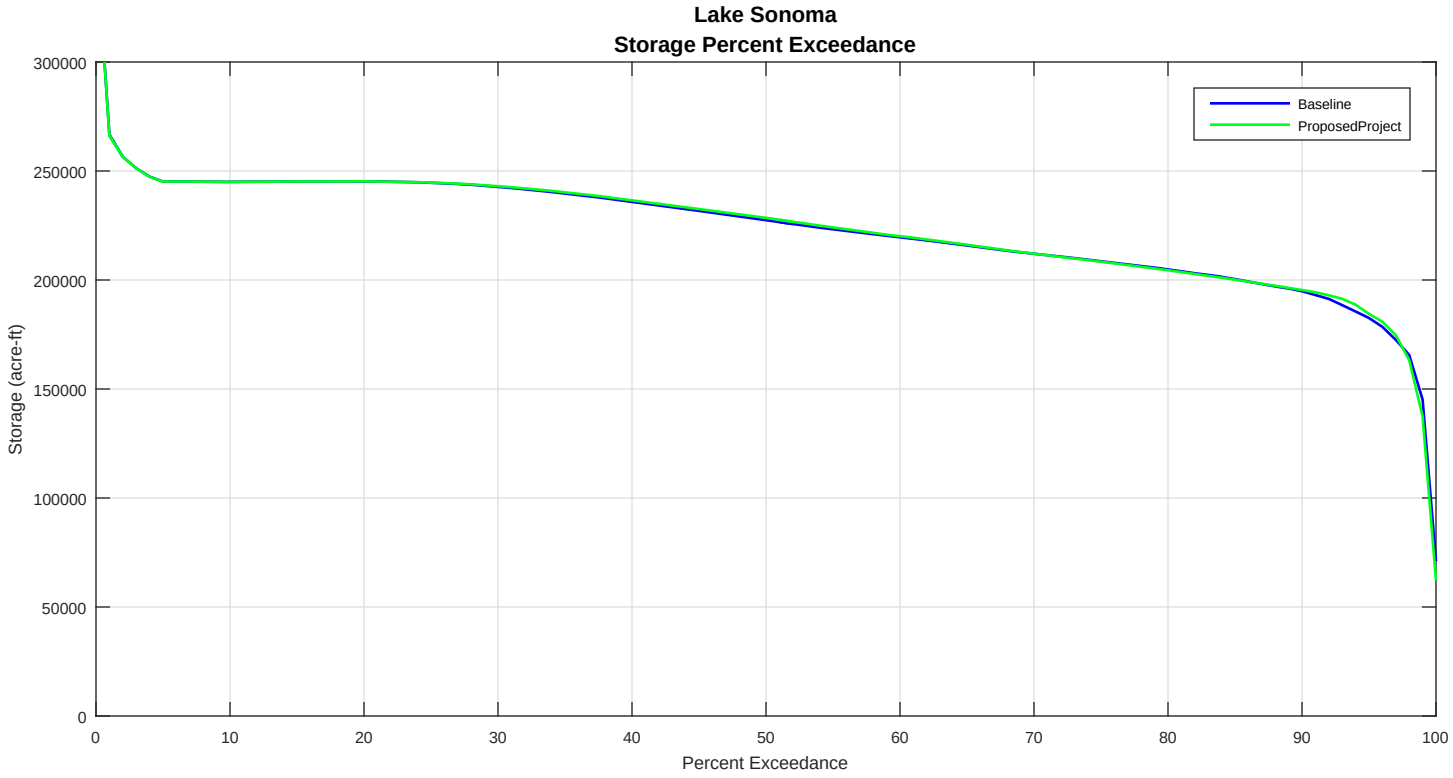

Warm Springs Dam Outlet
Daily Average Dissolved Oxygen
Baseline
ProposedProject
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

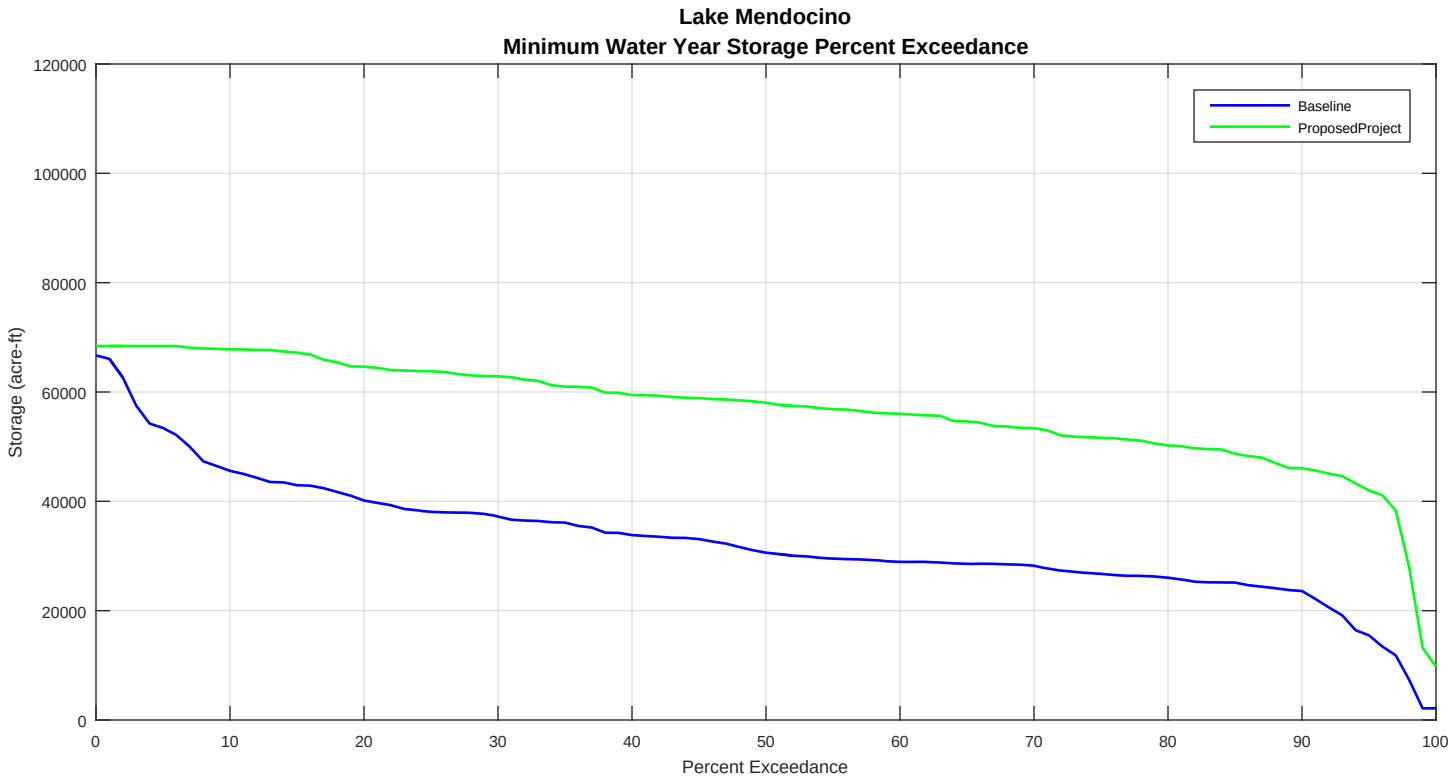

Dry Creek at Geyserville Gage
Daily Average Dissolved Oxygen
Baseline
ProposedProject
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

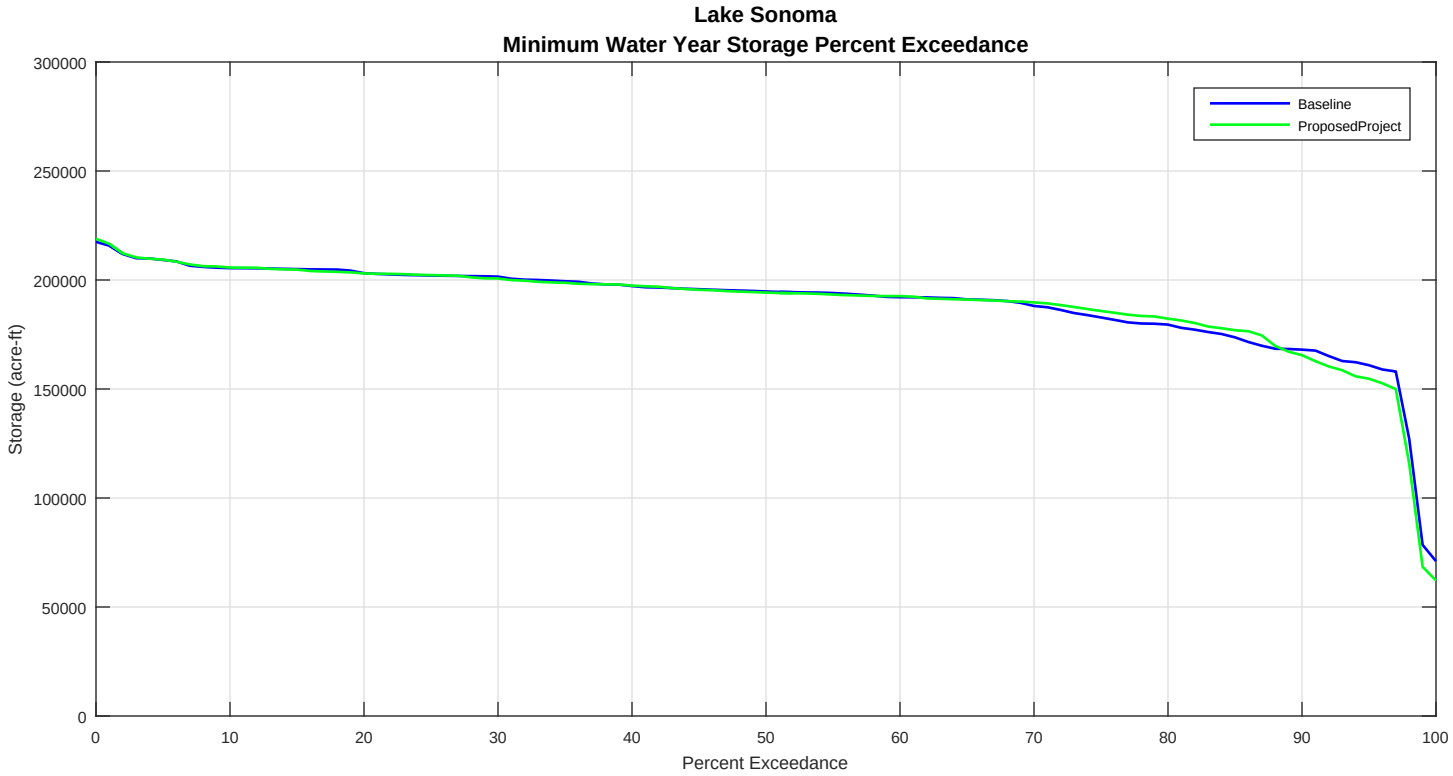

Dry Creek at Lambert Bridge
Daily Average Dissolved Oxygen
Baseline
ProposedProject
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

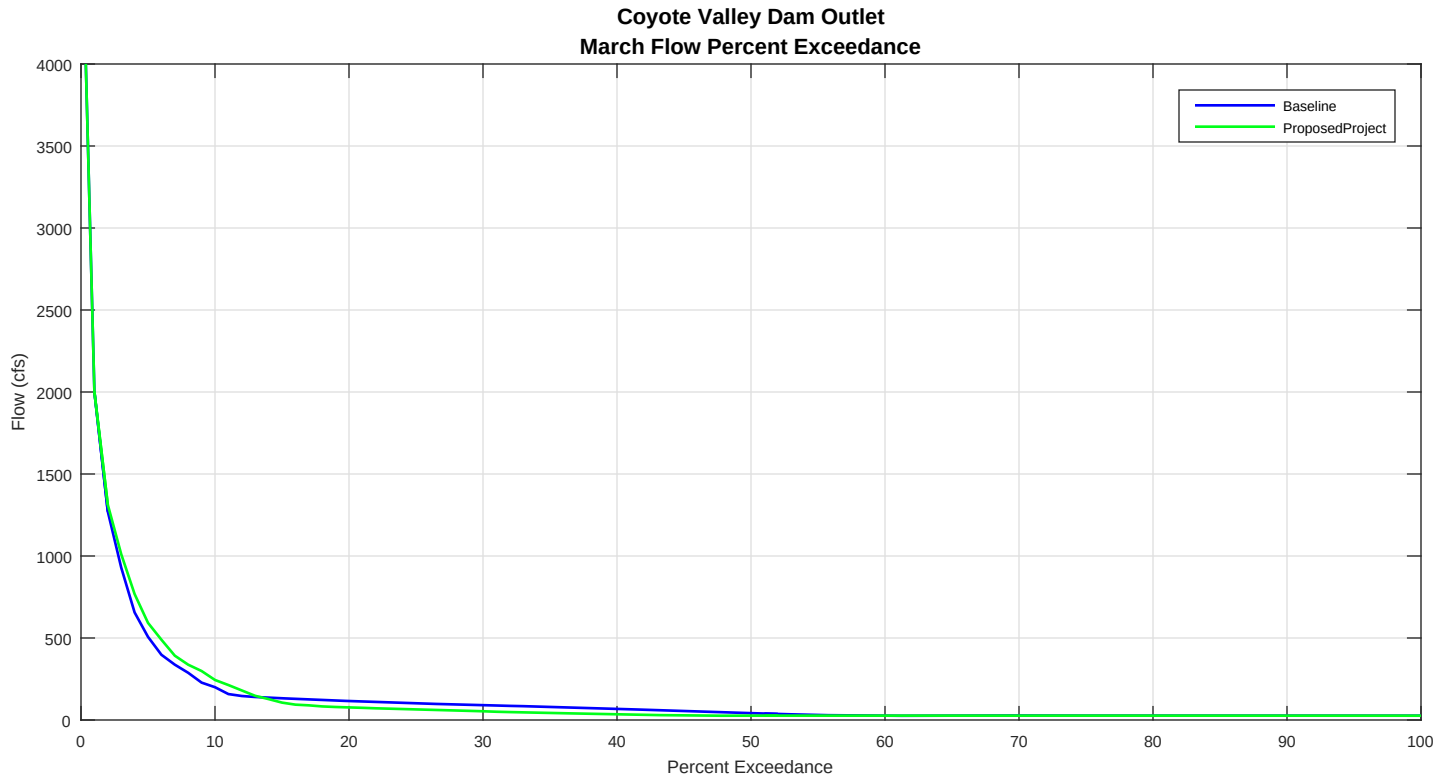

Dry Creek Mouth Gage
Daily Average Dissolved Oxygen
Baseline
ProposedProject
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

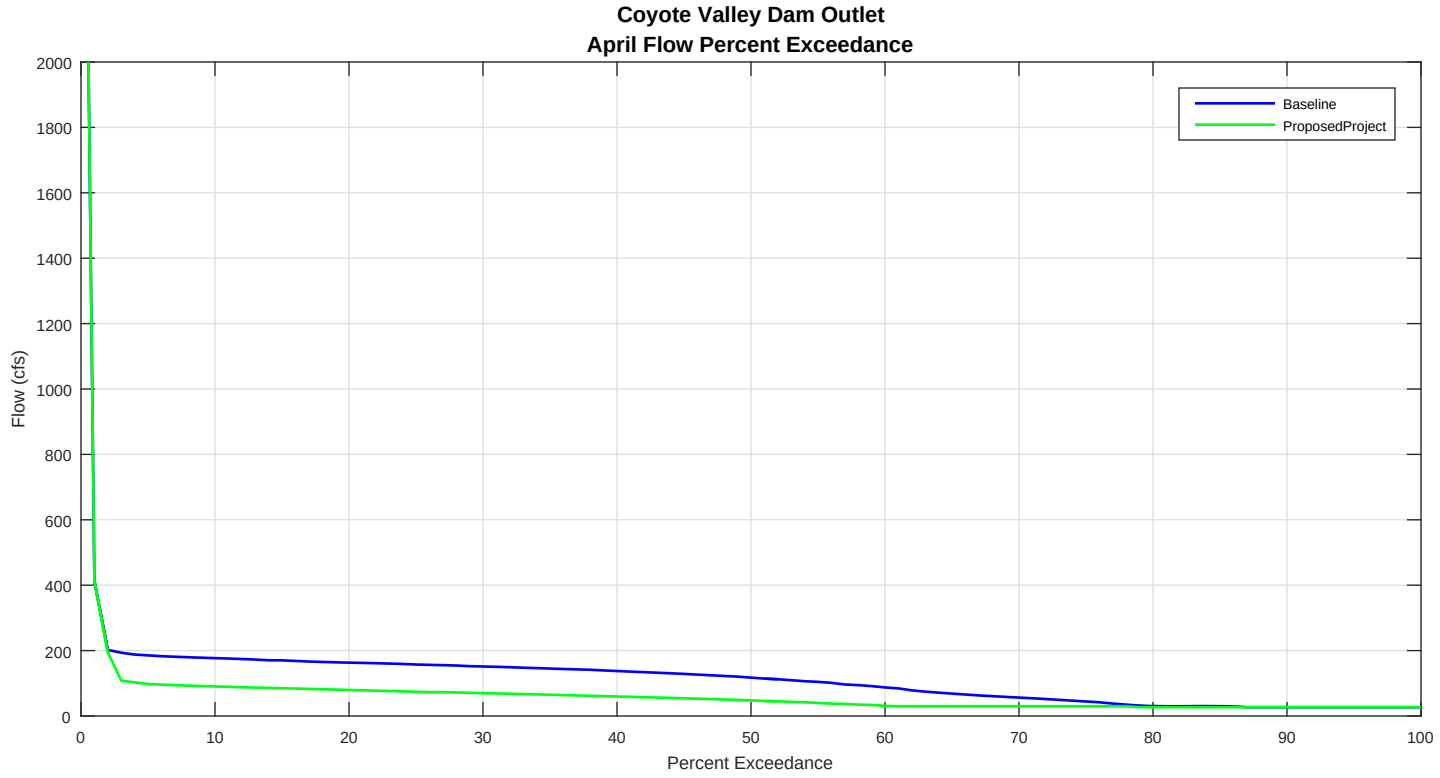

Lake Mendocino
Storage Percent Exceedance
Baseline
ProposedProject
Storage (acre-ft)
Percent Exceedance
0
20000
40000
60000
80000
100000
120000
0
10
20
30
40
50
60
70
80
90
100

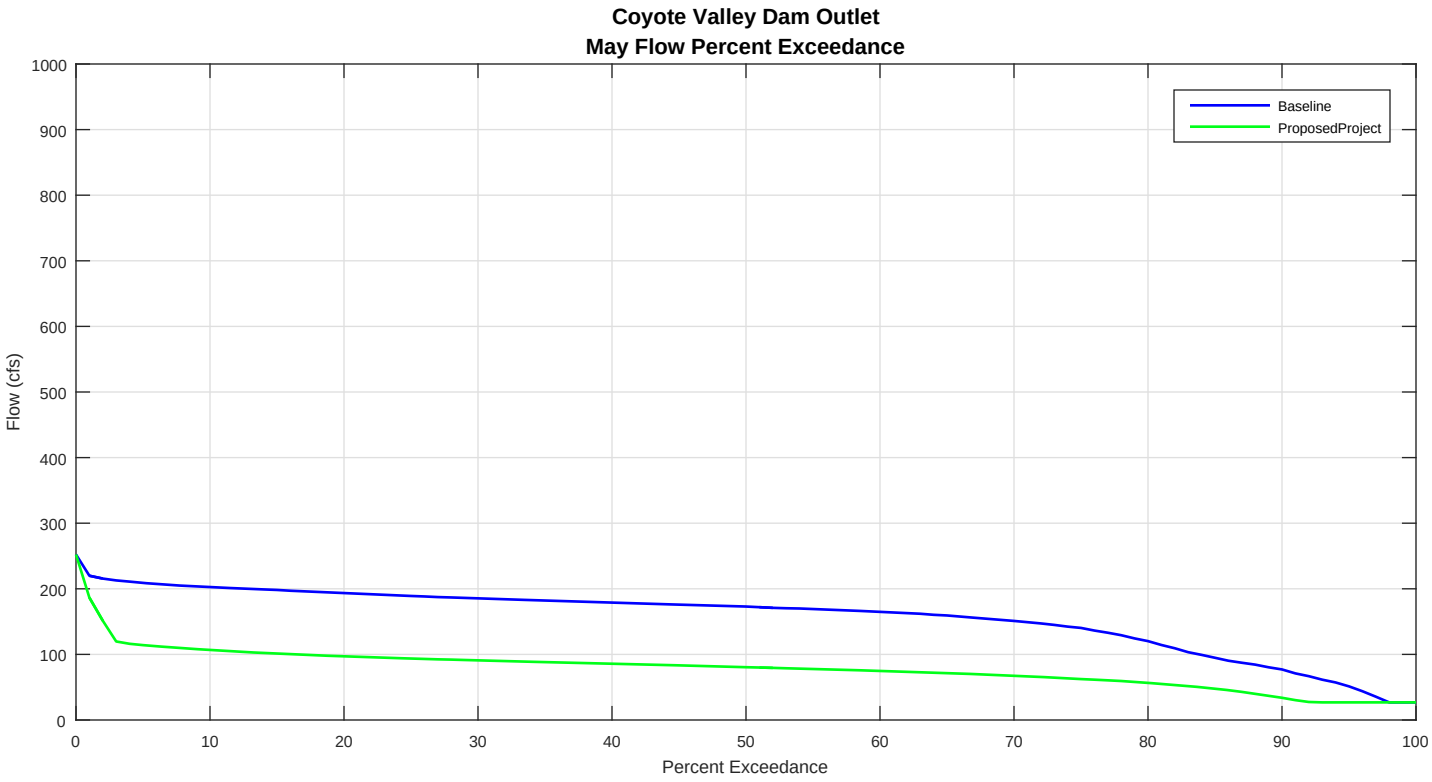

Lake Sonoma
Storage Percent Exceedance
Baseline
ProposedProject
Storage (acre-ft)
Percent Exceedance
0
50000
100000
150000
200000
250000
300000
0
10
20
30
40
50
60
70
80
90
100

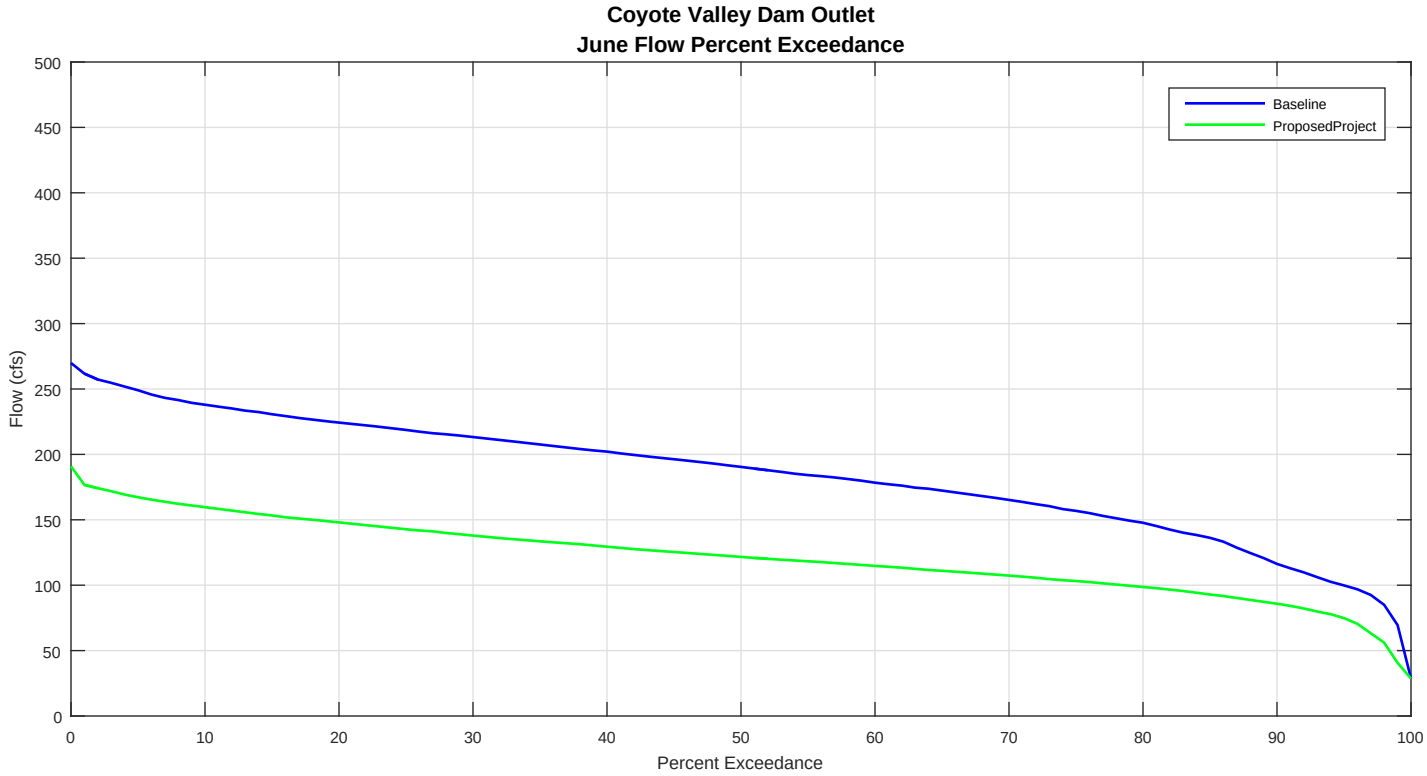

Lake Mendocino
Minimum Water Year Storage Percent Exceedance
Baseline
ProposedProject
Storage (acre-ft)
Percent Exceedance
0
20000
40000
60000
80000
100000
120000
0
10
20
30
40
50
60
70
80
90
100

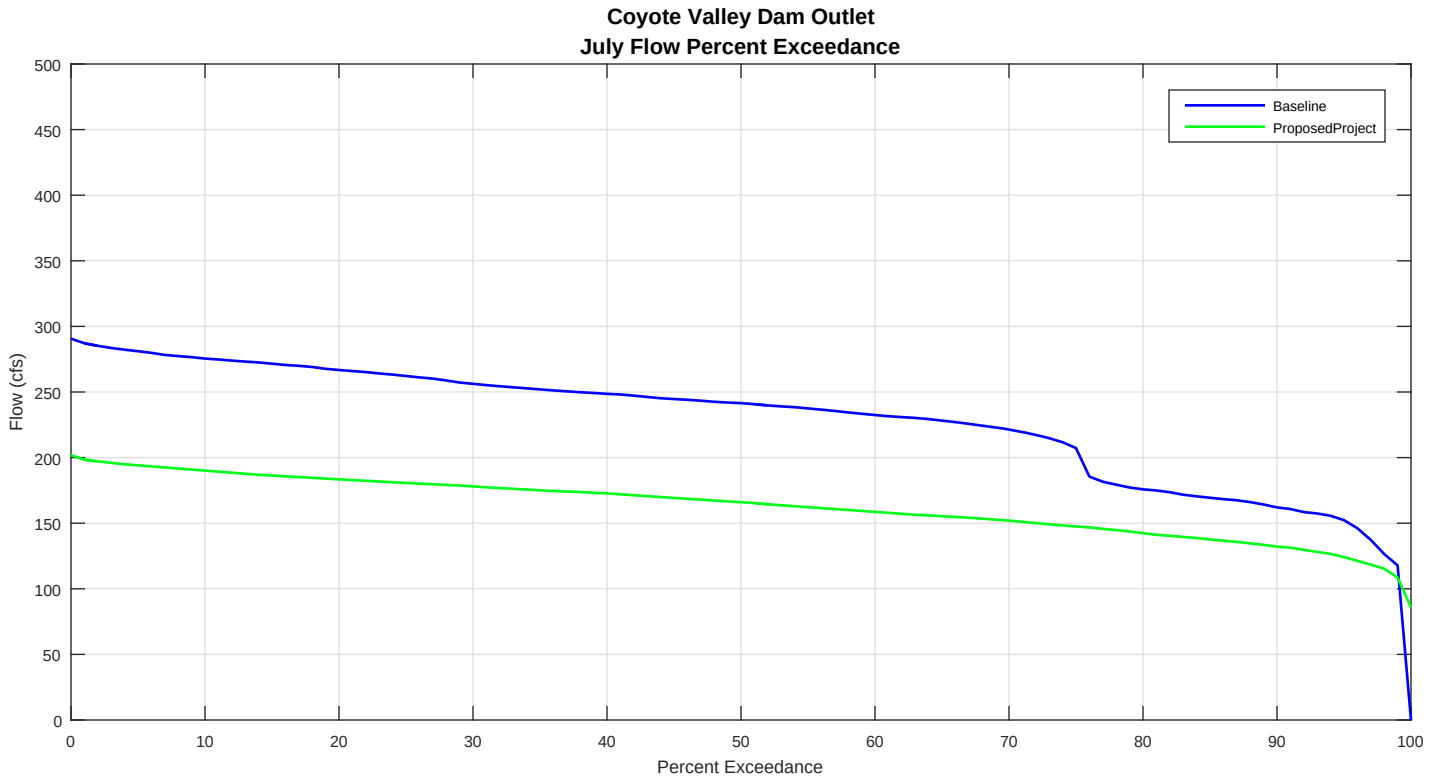

Lake Sonoma
Minimum Water Year Storage Percent Exceedance
Baseline
ProposedProject
Storage (acre-ft)
Percent Exceedance
0
50000
100000
150000
200000
250000
300000
0
10
20
30
40
50
60
70
80
90
100

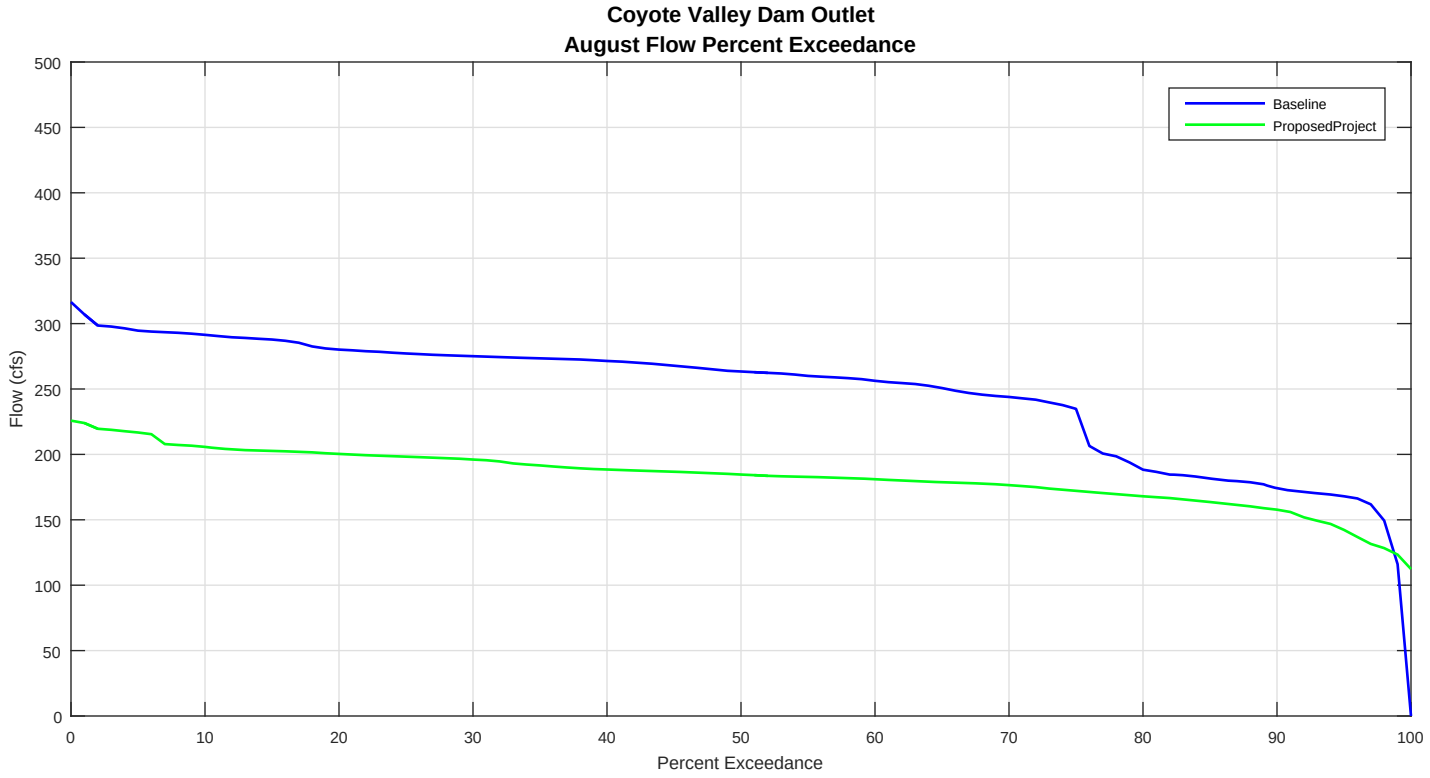

Coyote Valley Dam Outlet
March Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
0
500
1000
1500
2000
2500
3000
3500
4000
0
10
20
30
40
50
60
70
80
90
100

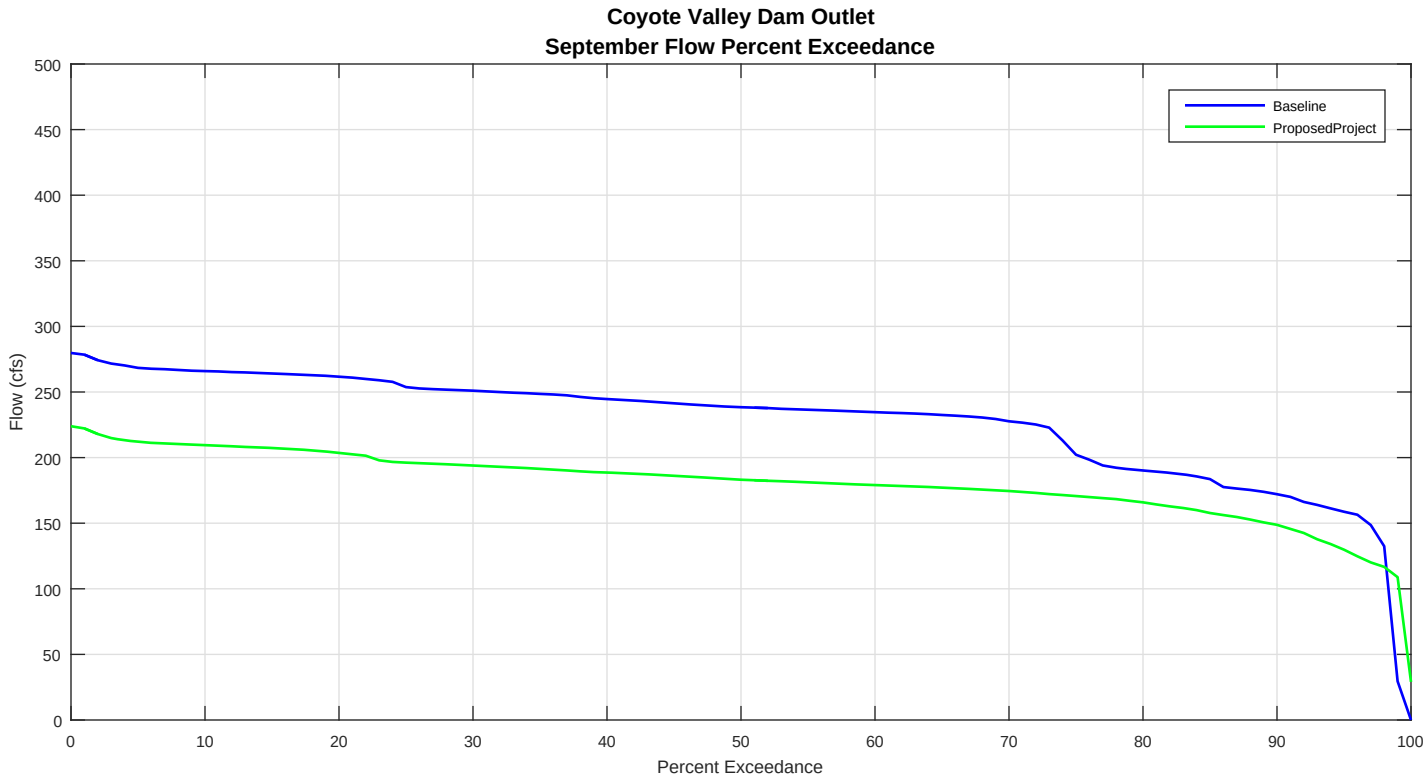

Coyote Valley Dam Outlet
April Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100

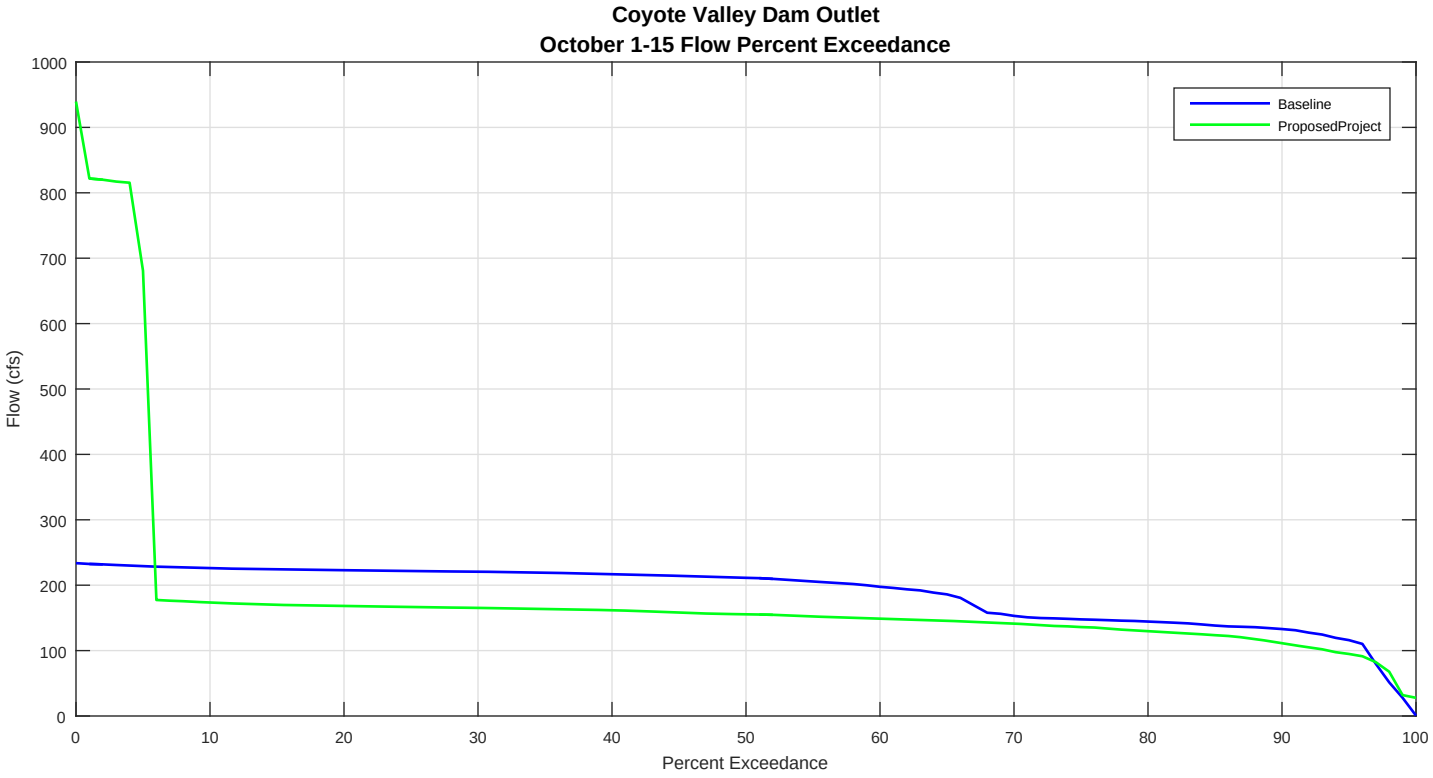

Coyote Valley Dam Outlet
May Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100

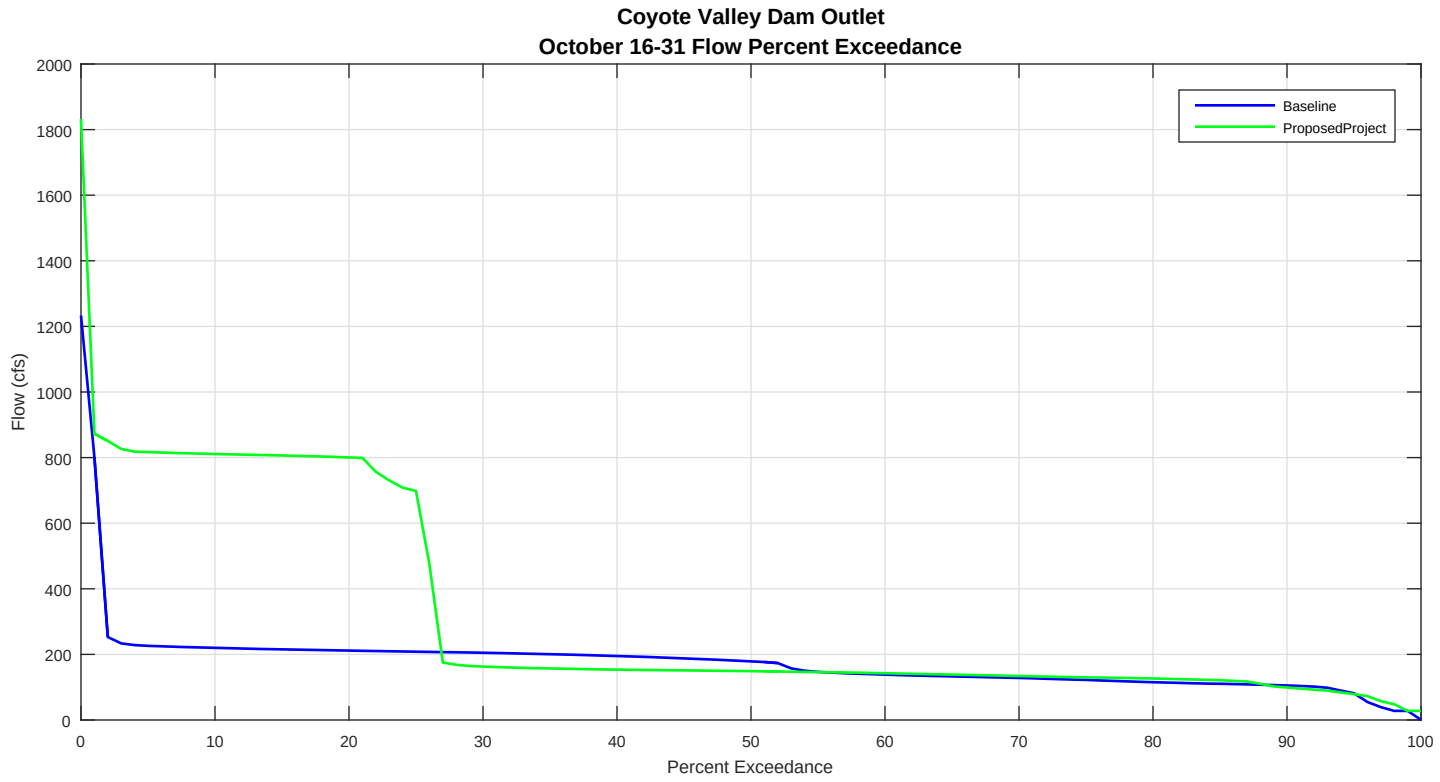

Coyote Valley Dam Outlet
June Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

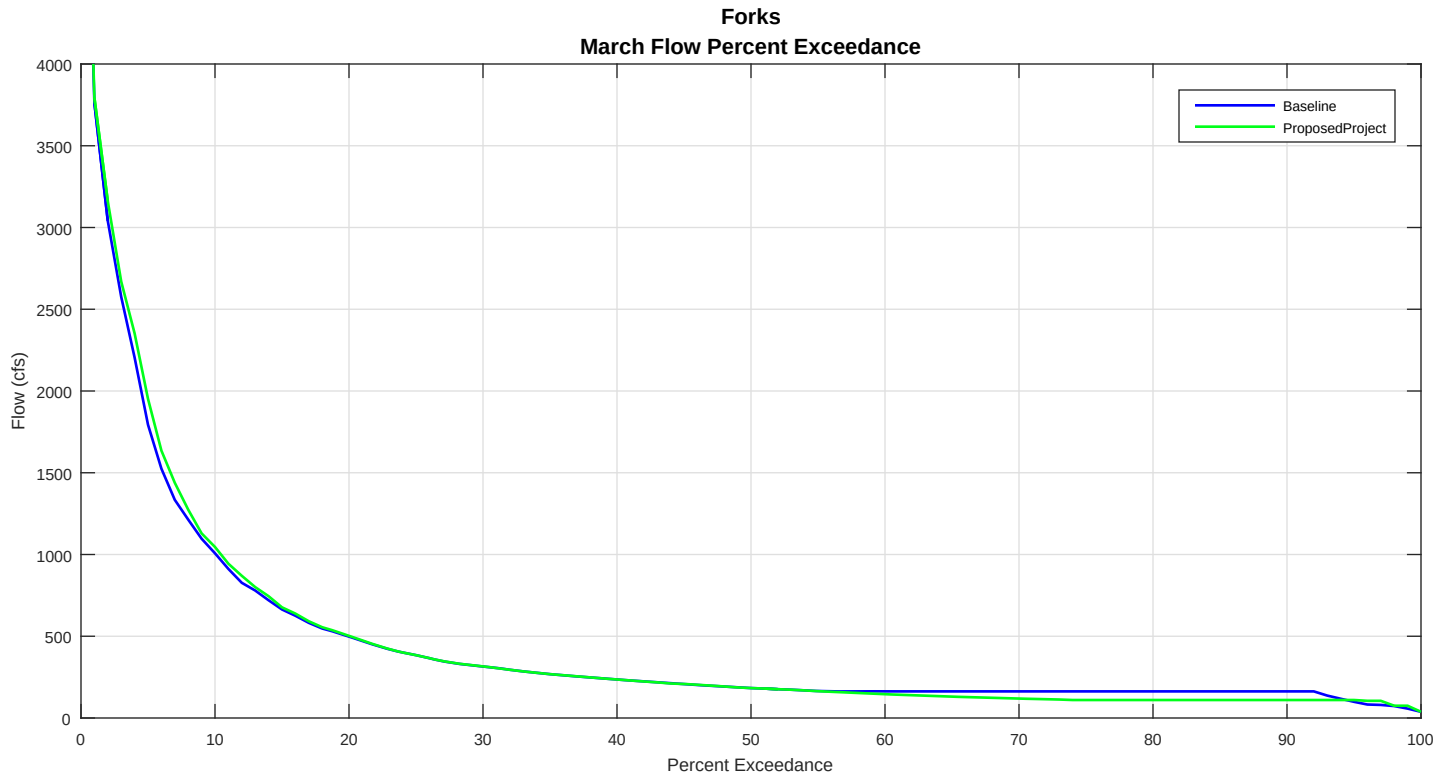

Coyote Valley Dam Outlet
July Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

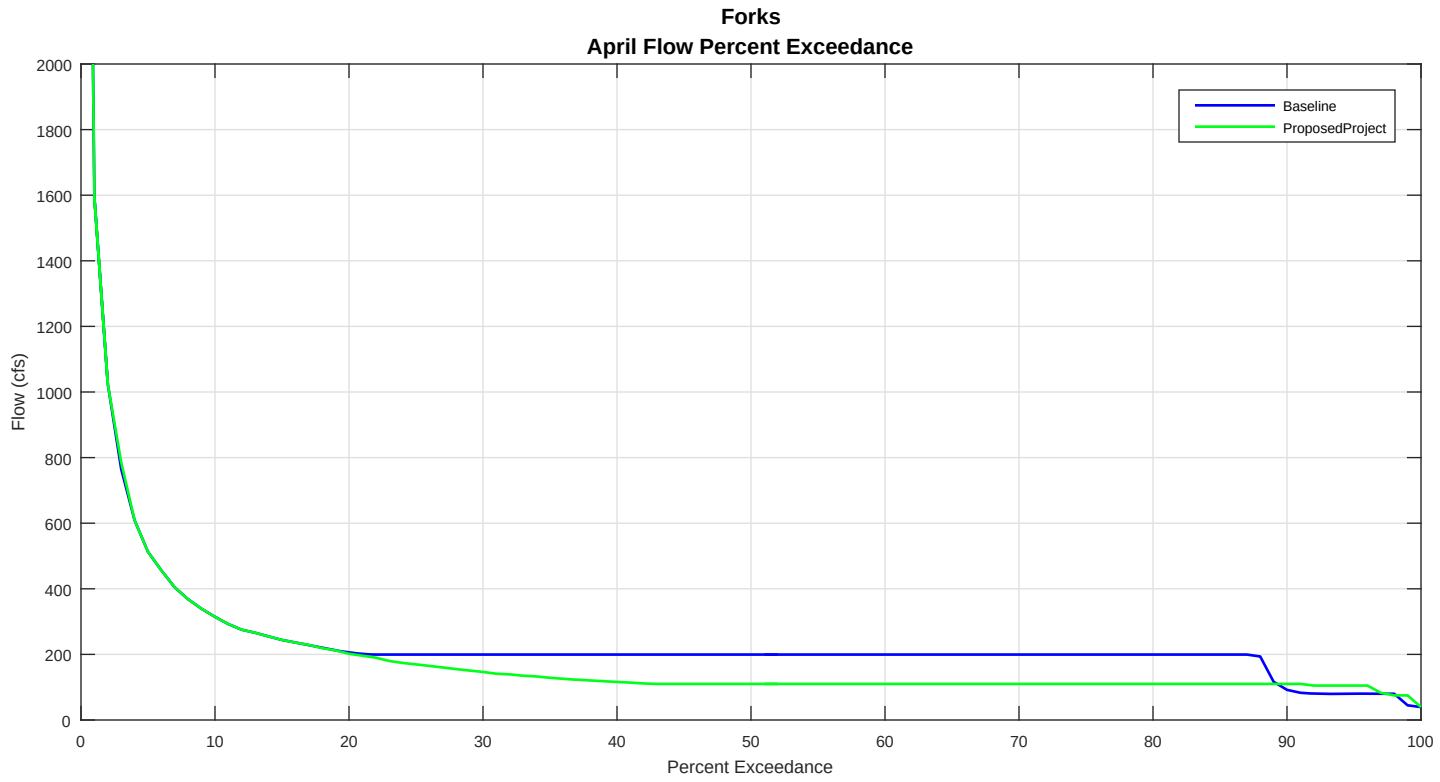

Coyote Valley Dam Outlet
August Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

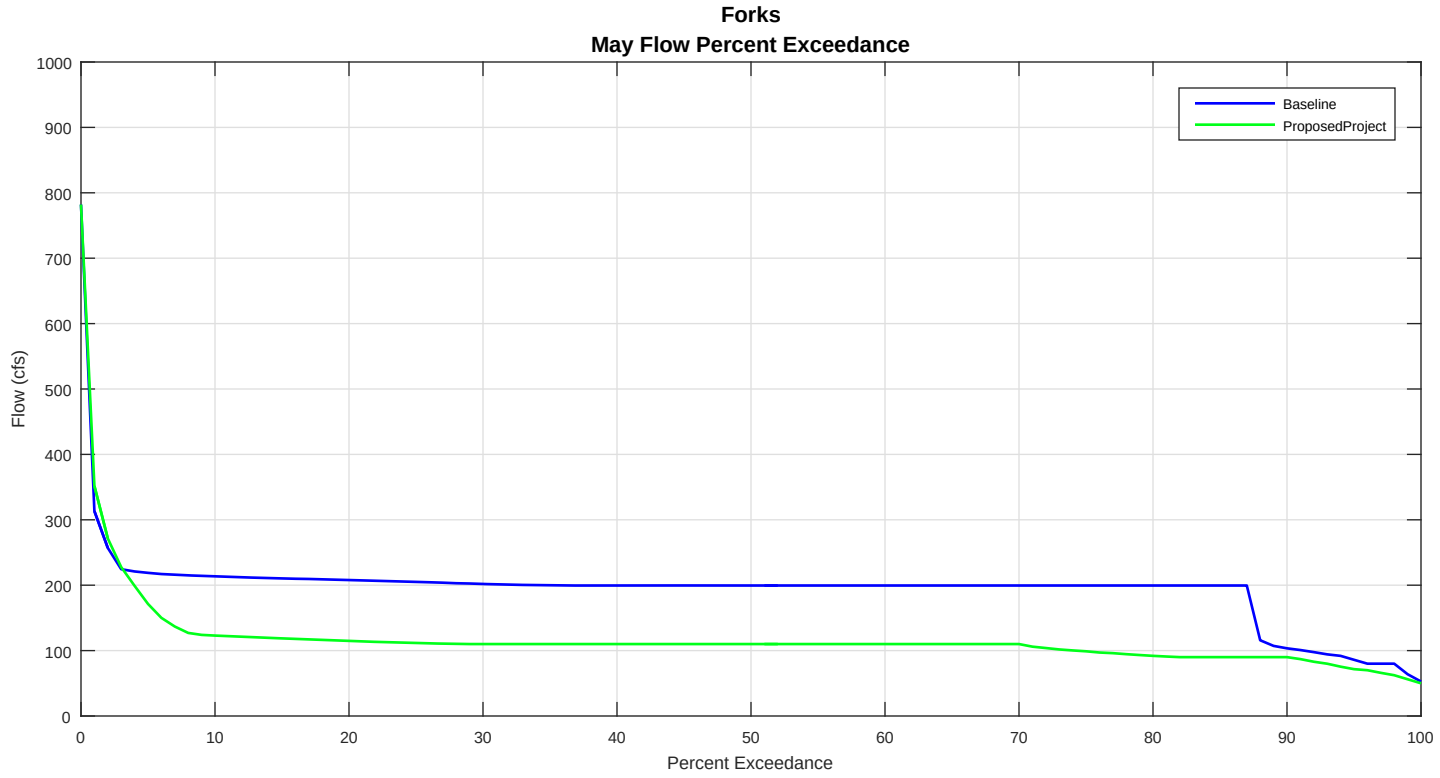

Coyote Valley Dam Outlet
September Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

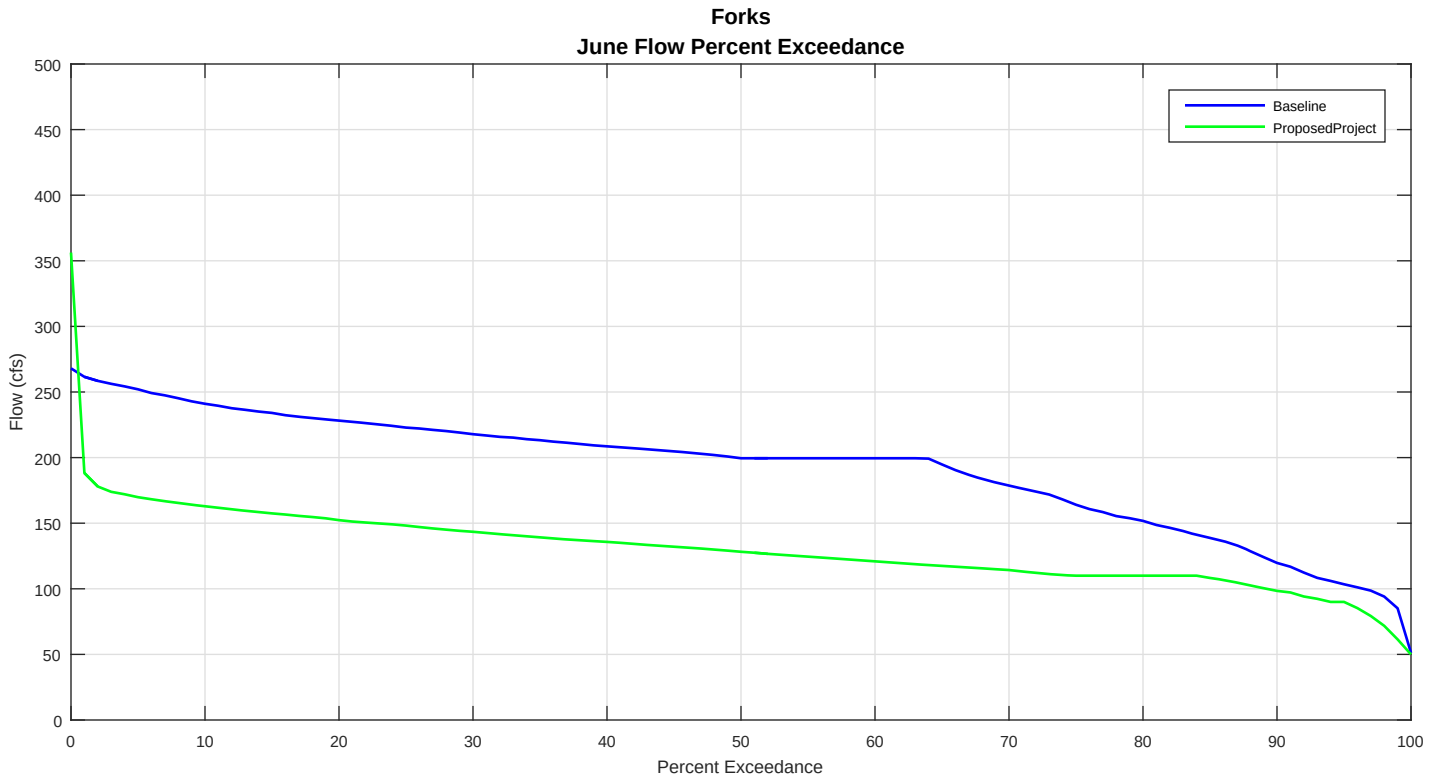

Coyote Valley Dam Outlet
October 1-15 Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100

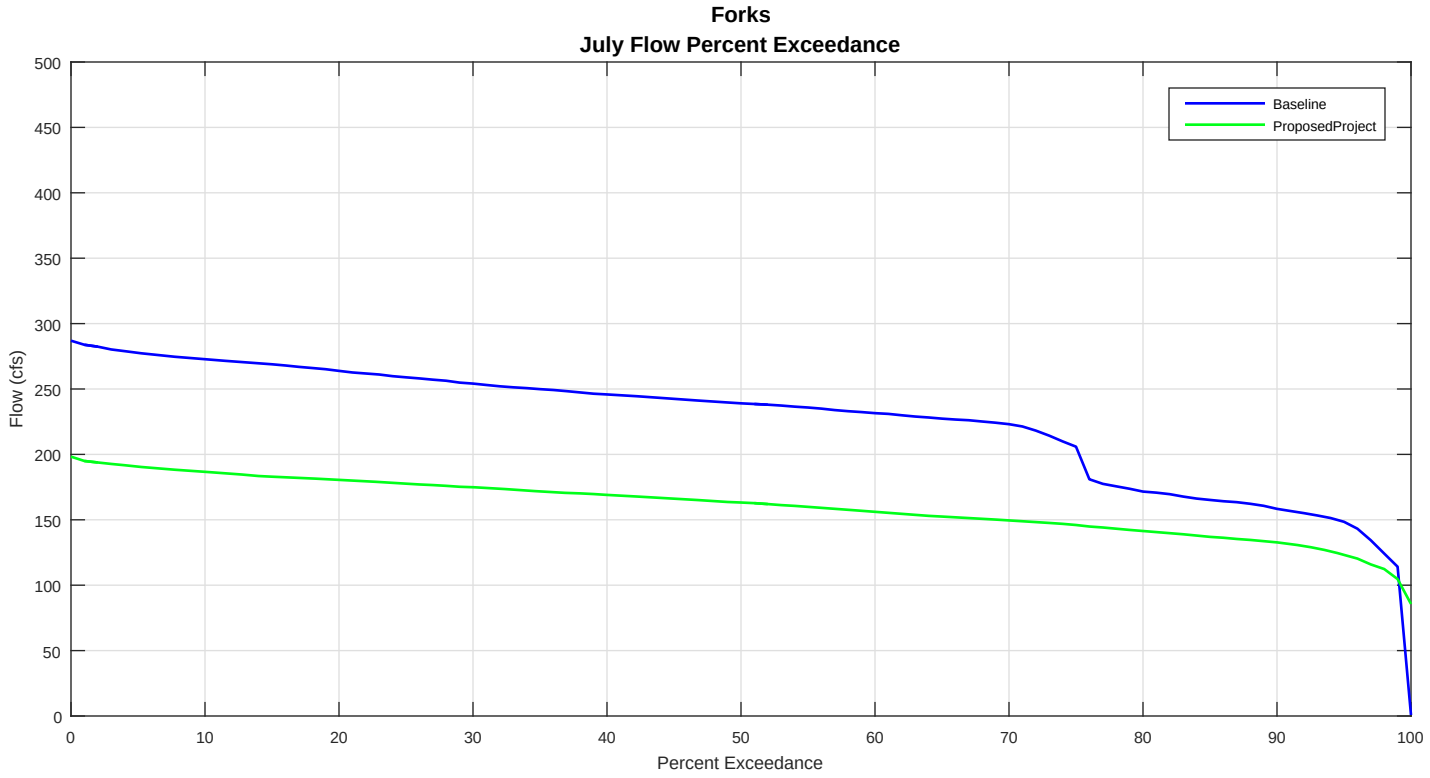

Coyote Valley Dam Outlet
October 16-31 Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100

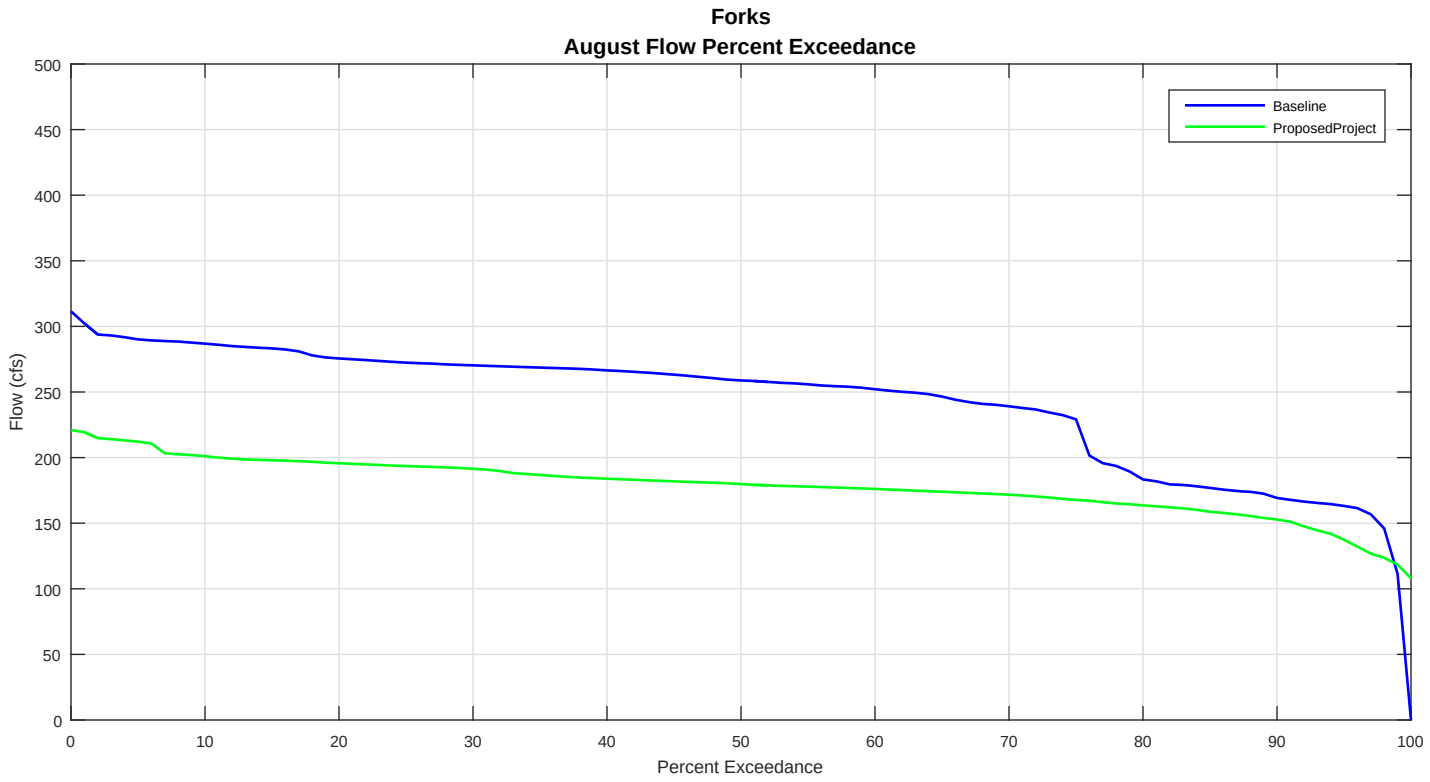

Forks
March Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
0
500
1000
1500
2000
2500
3000
3500
4000
0
10
20
30
40
50
60
70
80
90
100


Forks
April Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100


Forks
May Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100


Forks
June Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100


Forks
July Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100


Forks
August Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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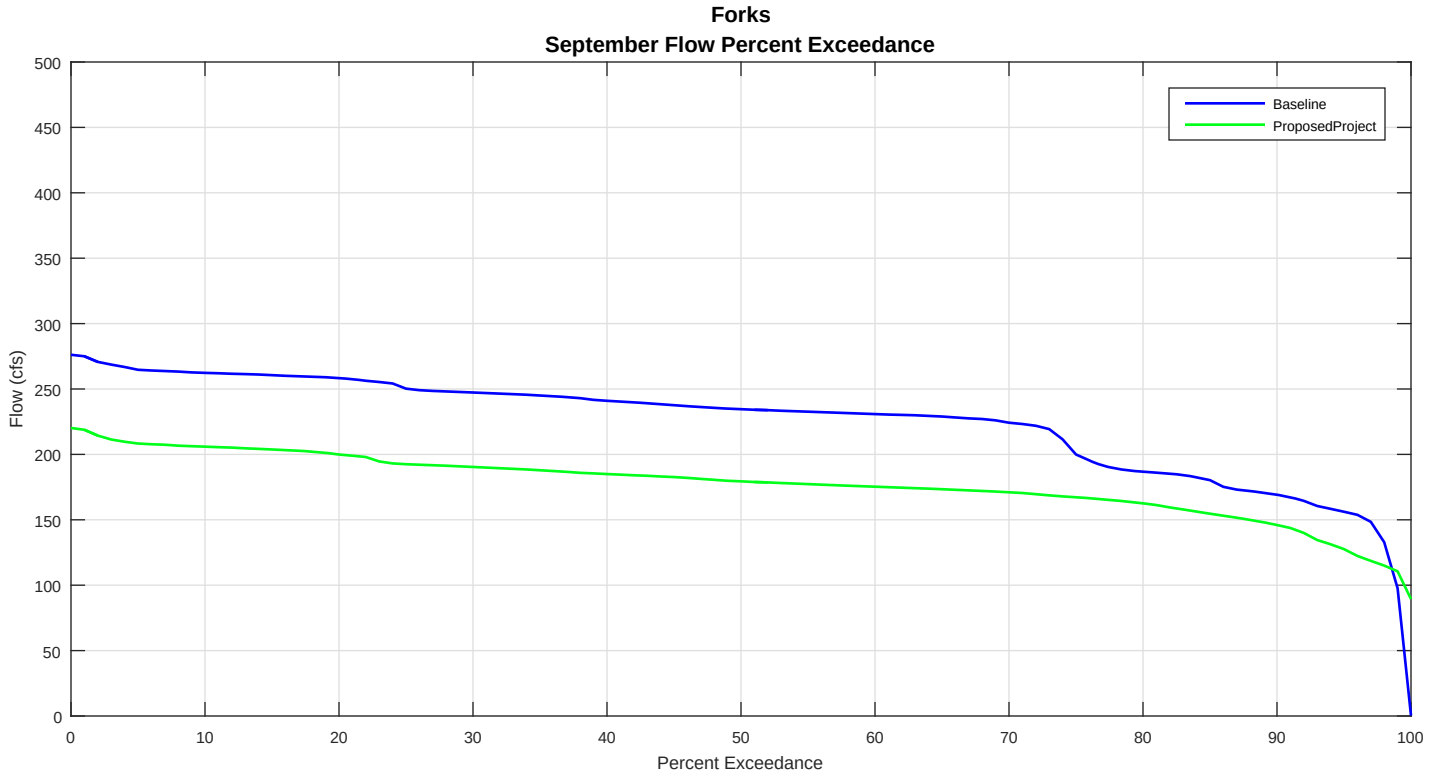
Forks
September Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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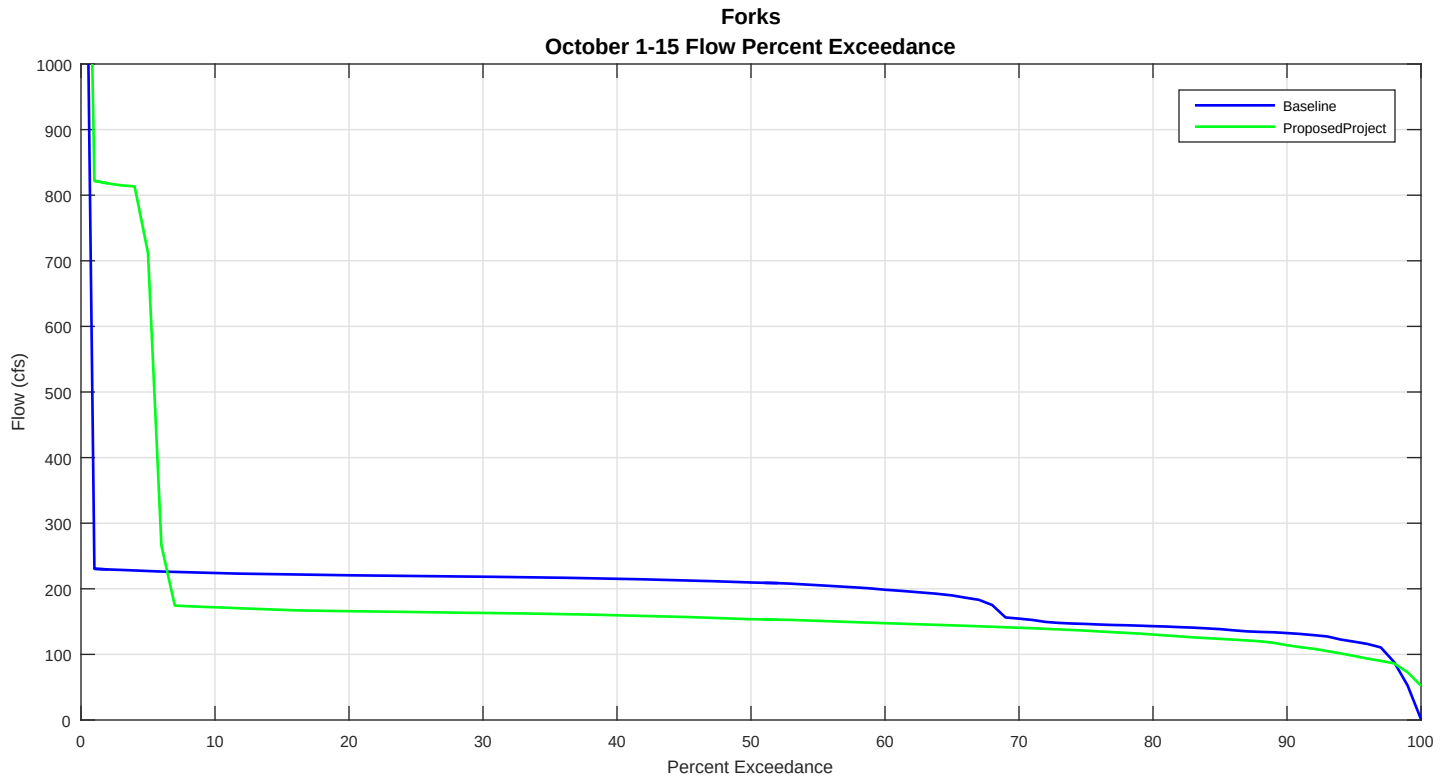
Forks
October 1-15 Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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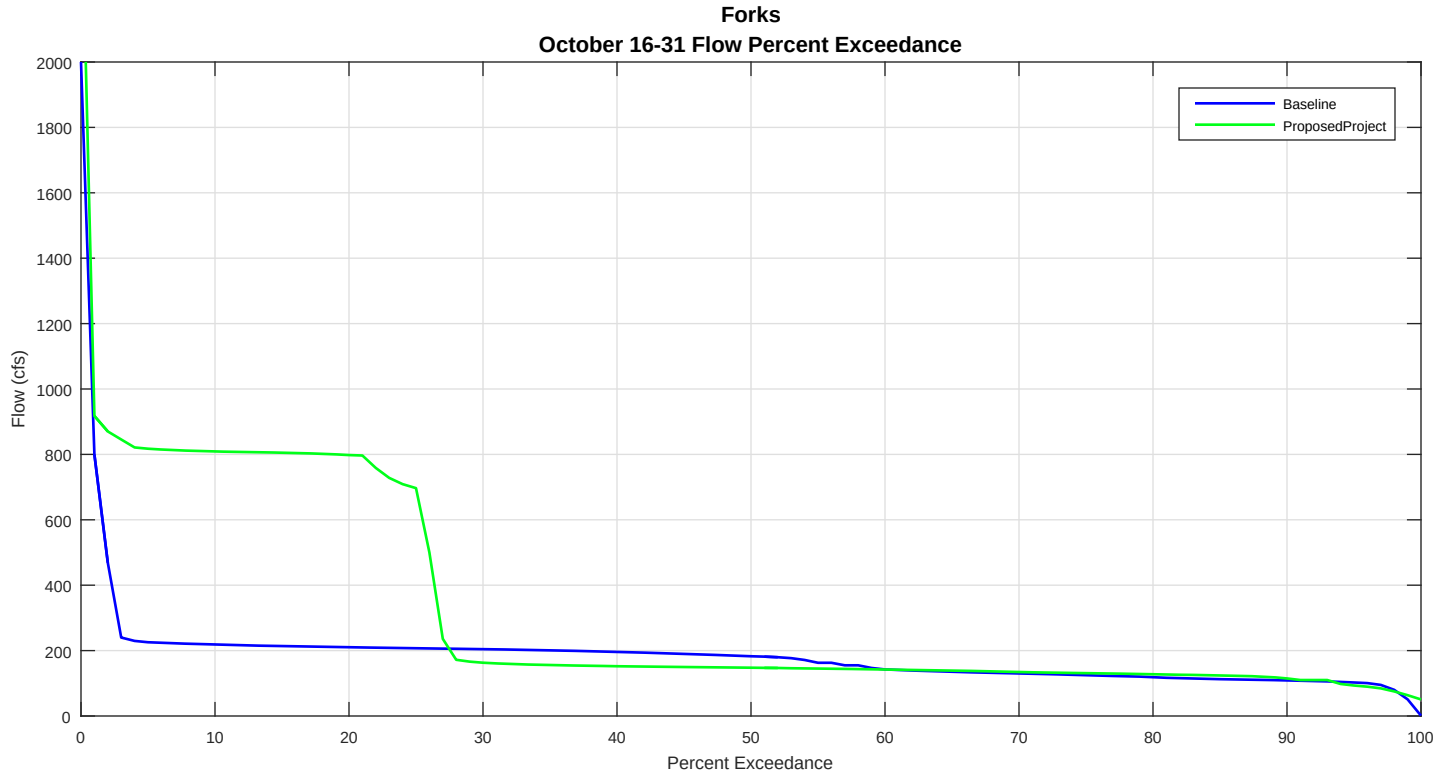
Forks
October 16-31 Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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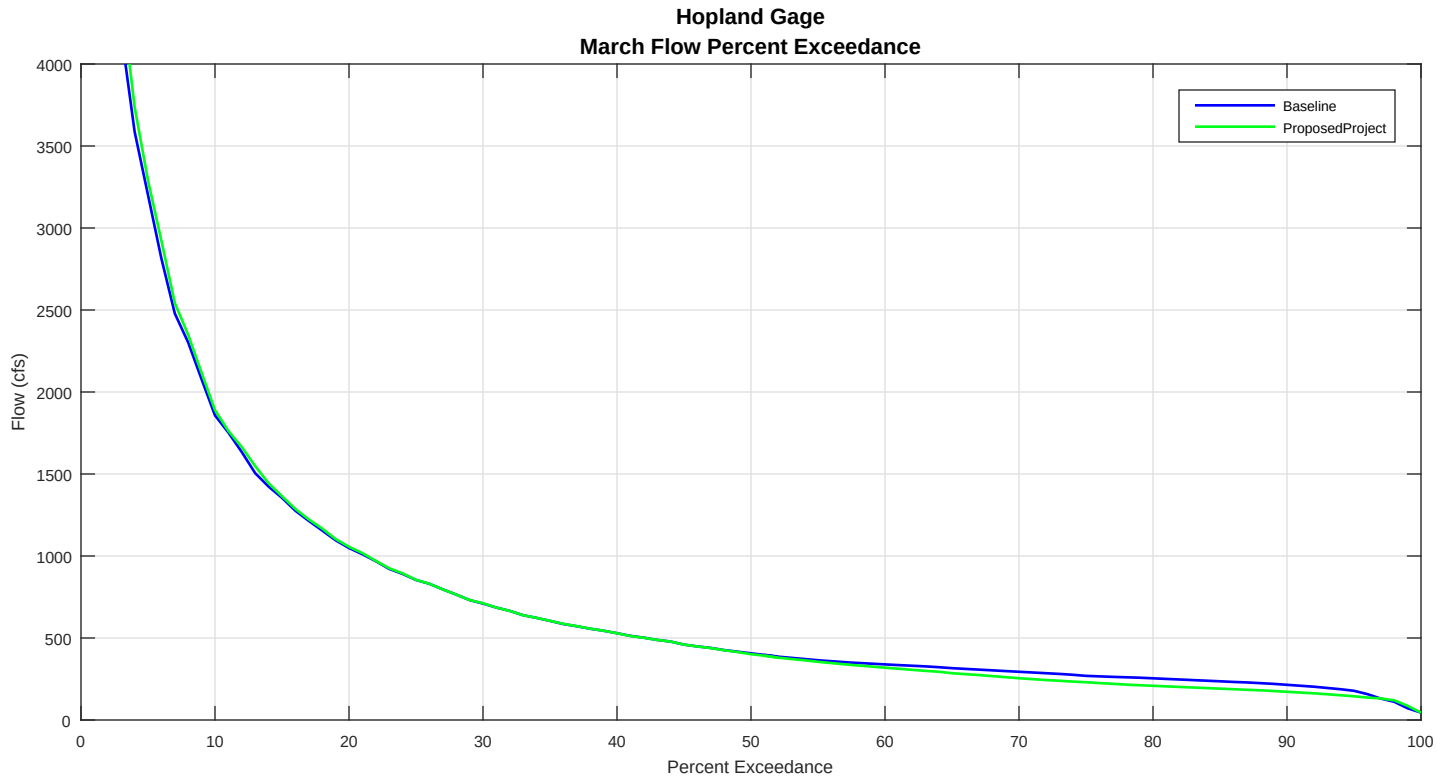
Hopland Gage
March Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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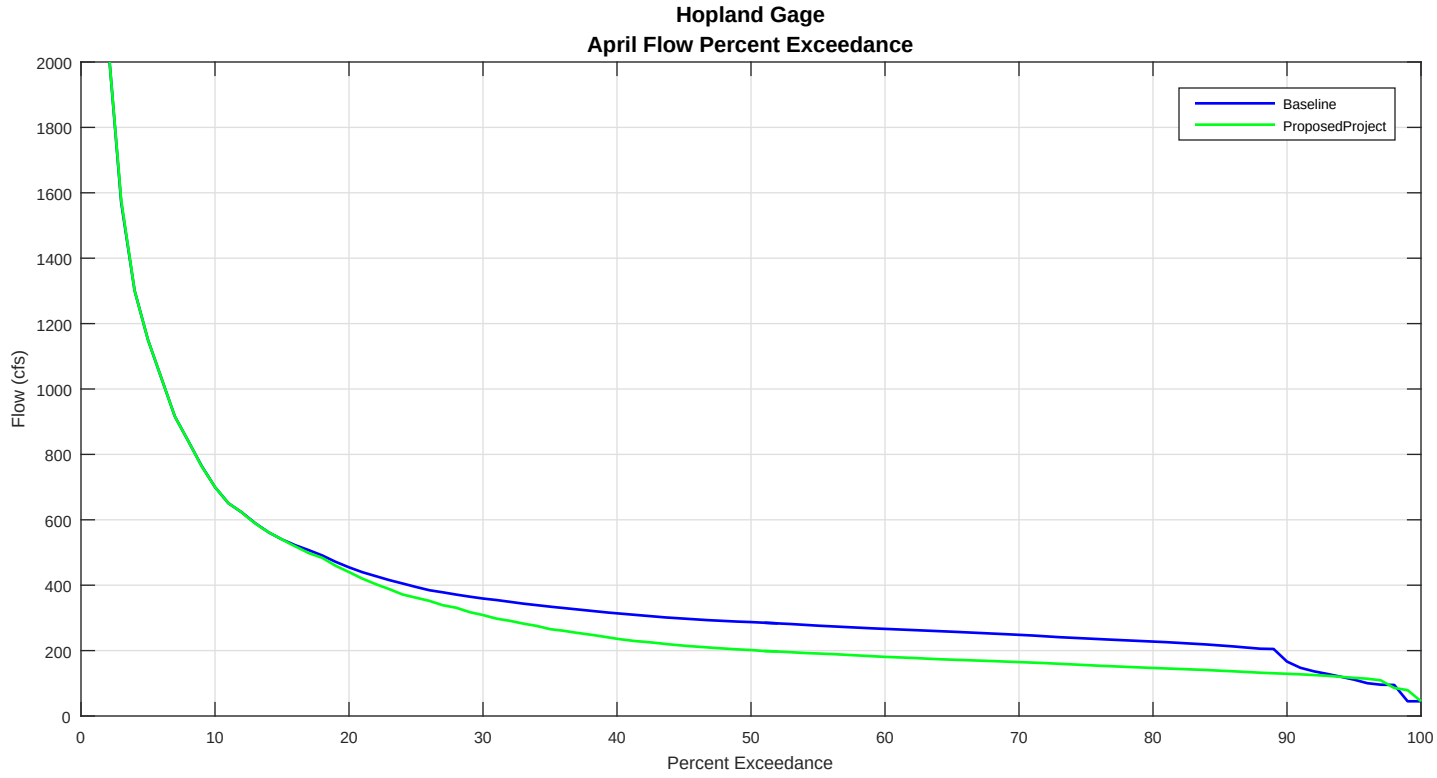
Hopland Gage
April Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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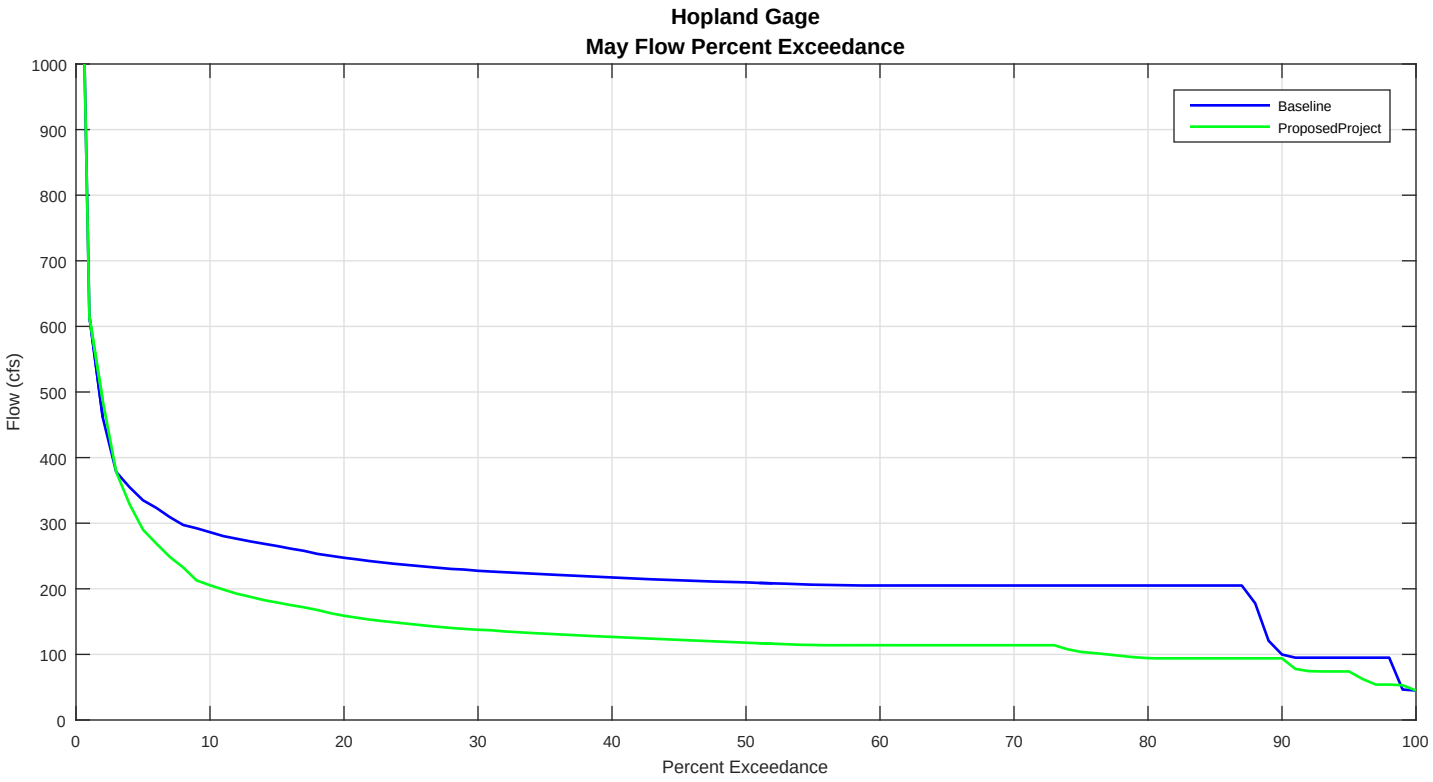
Hopland Gage
May Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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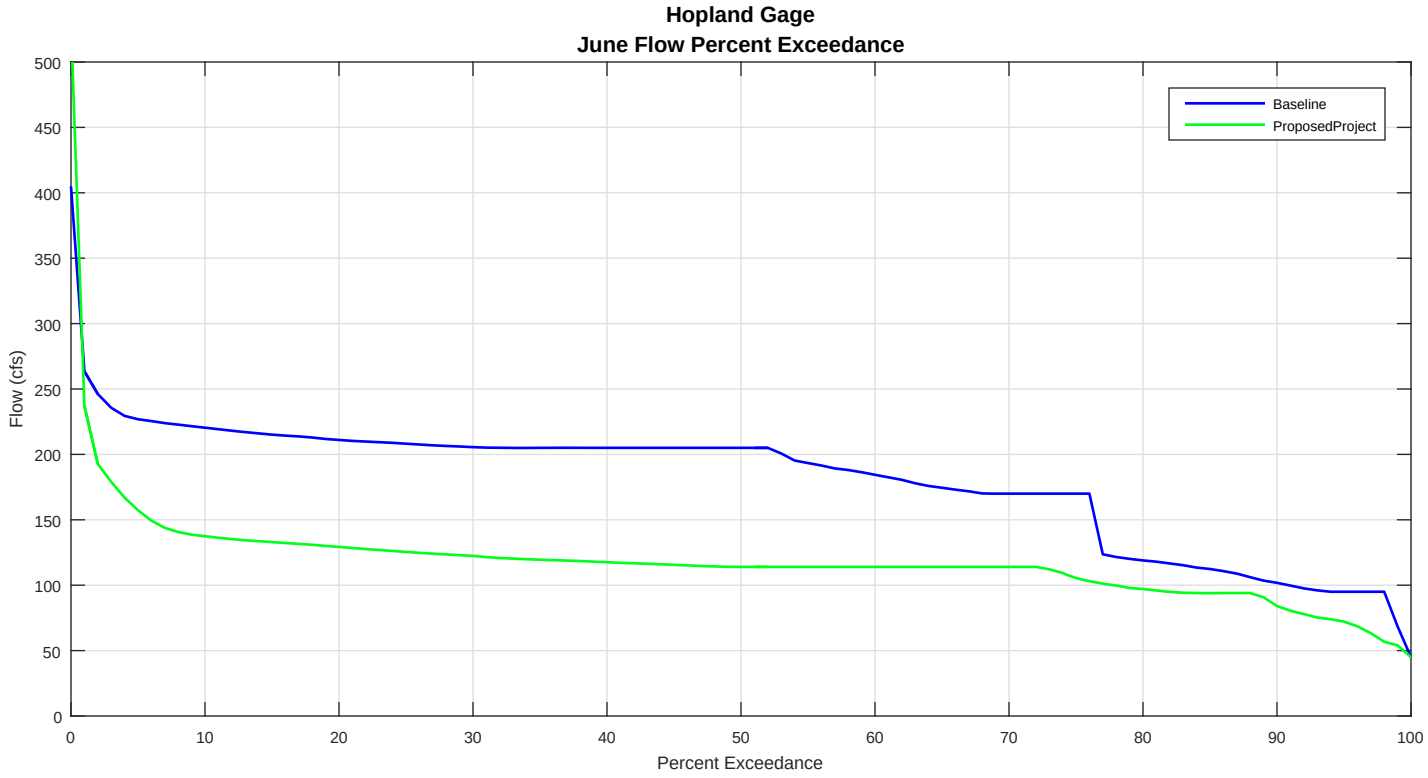
Hopland Gage
June Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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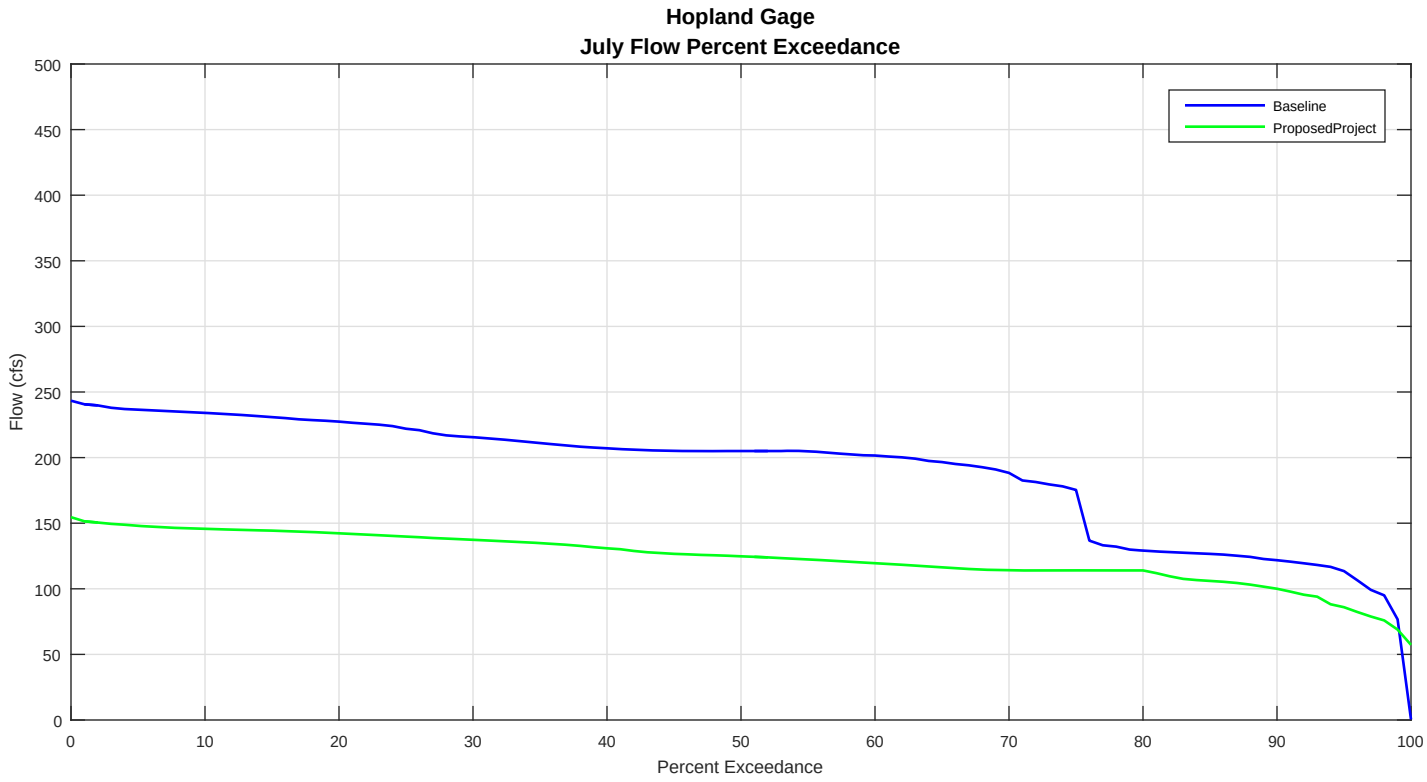
Hopland Gage
July Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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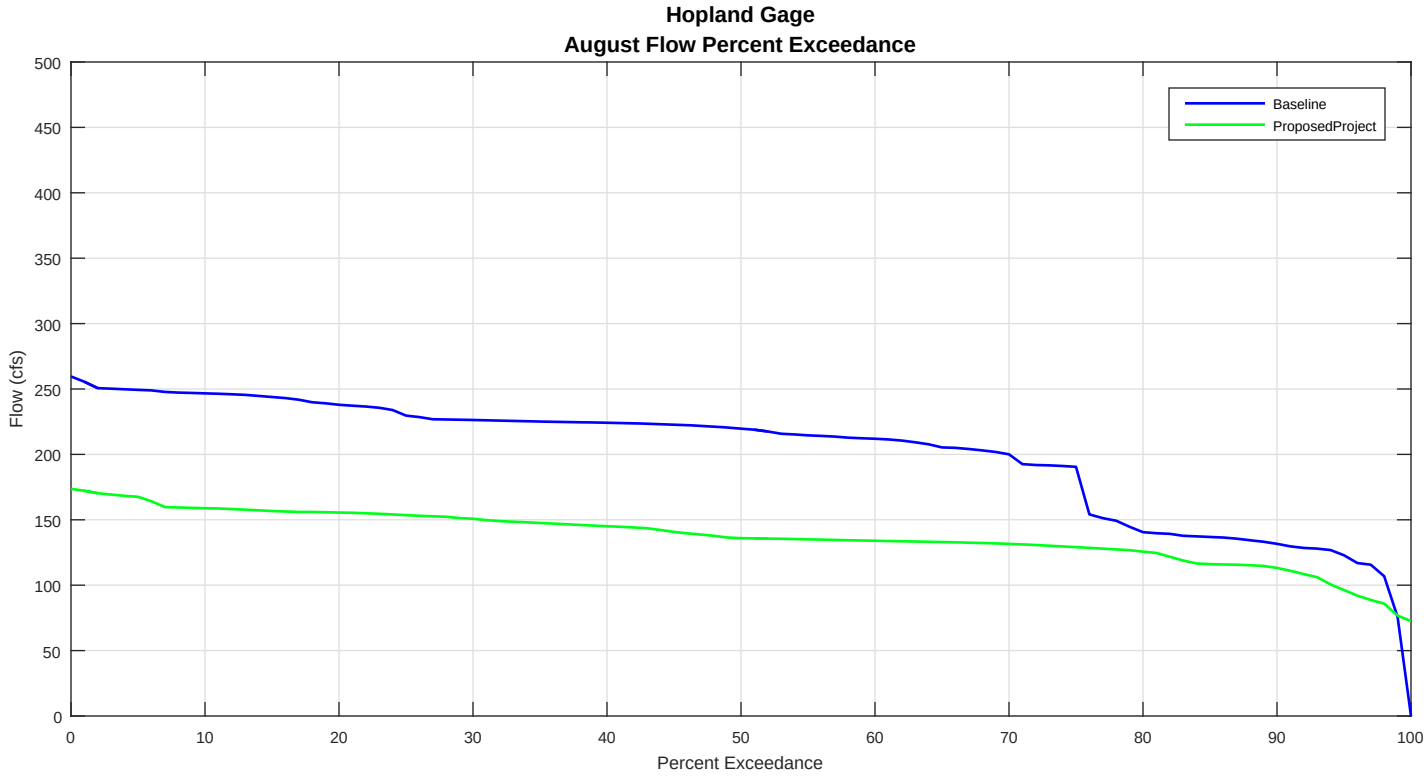
Hopland Gage
August Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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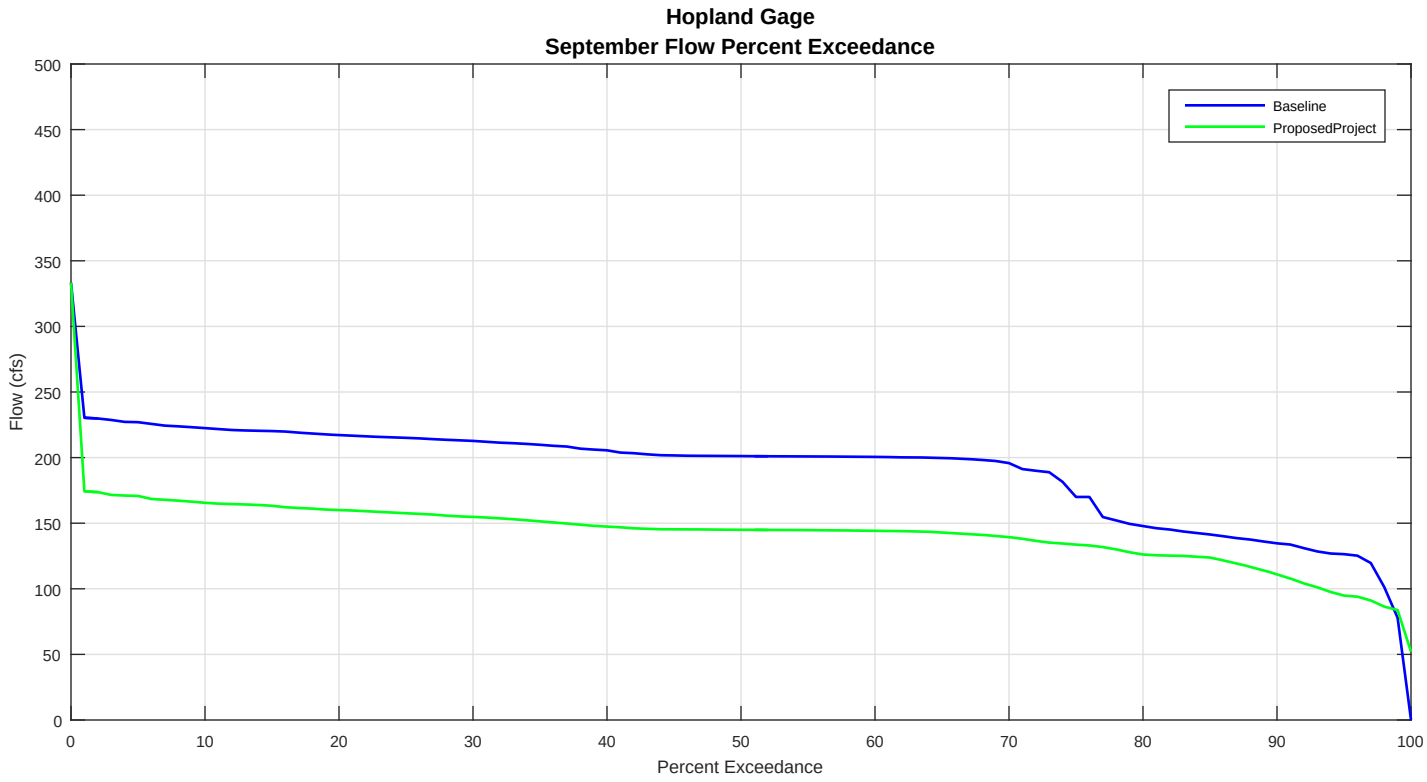
Hopland Gage
September Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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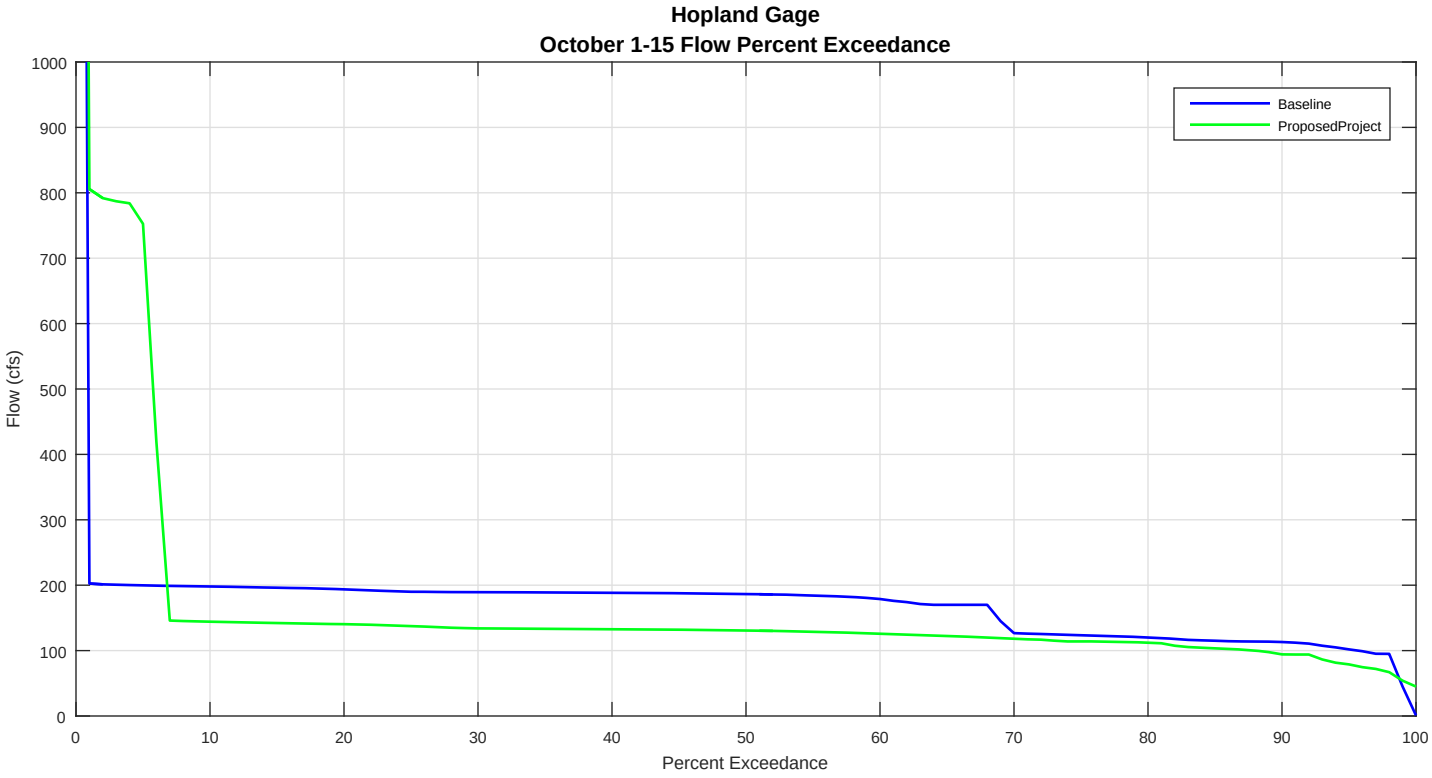
Hopland Gage
October 1-15 Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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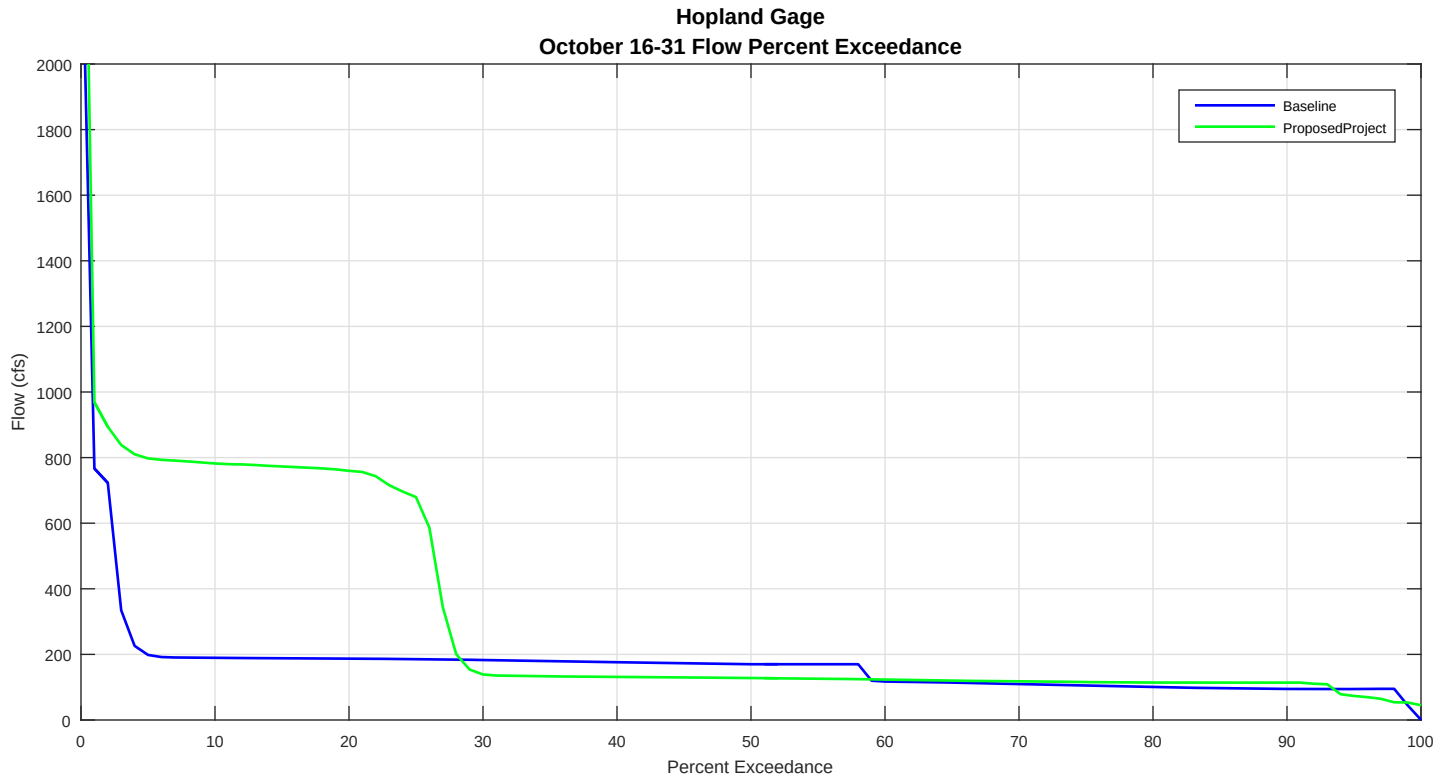
Hopland Gage
October 16-31 Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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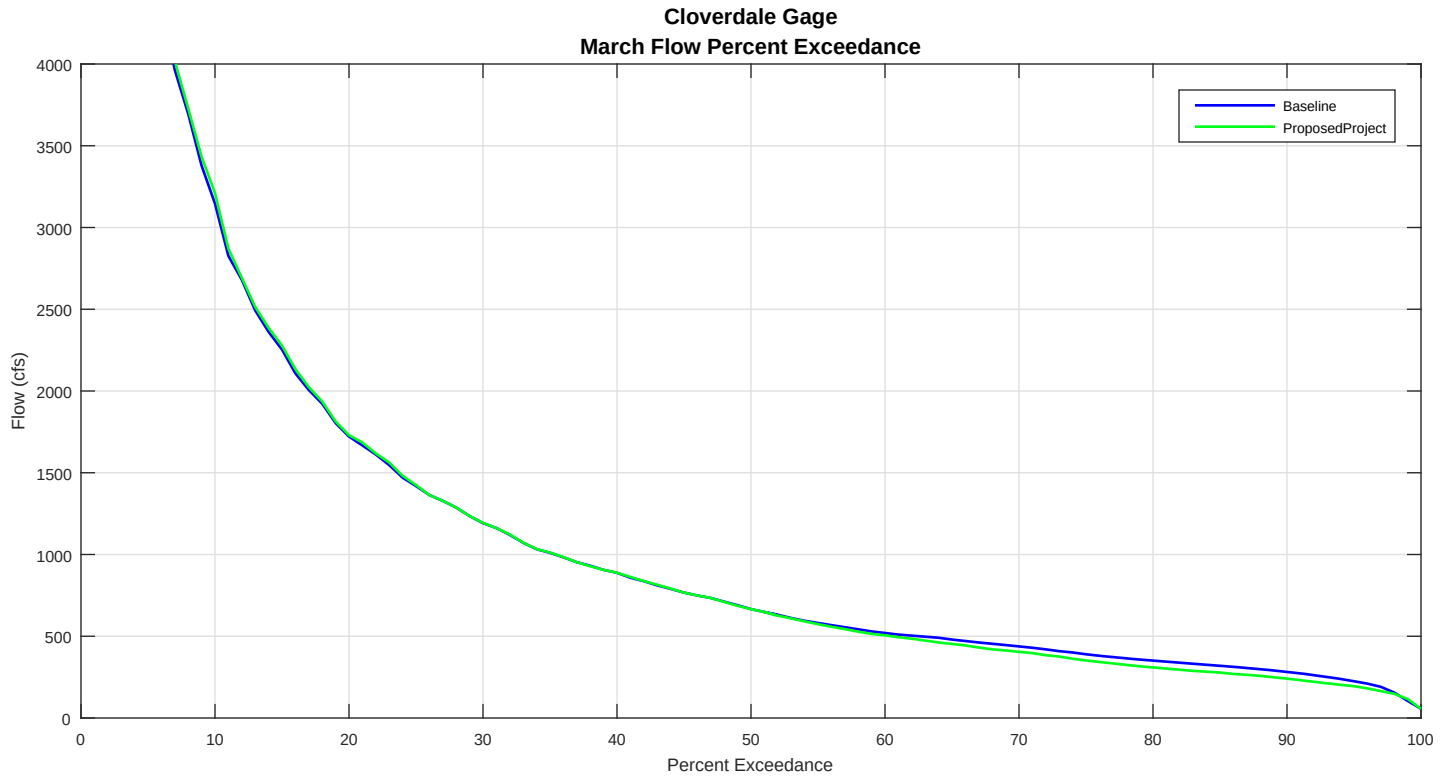
Cloverdale Gage
March Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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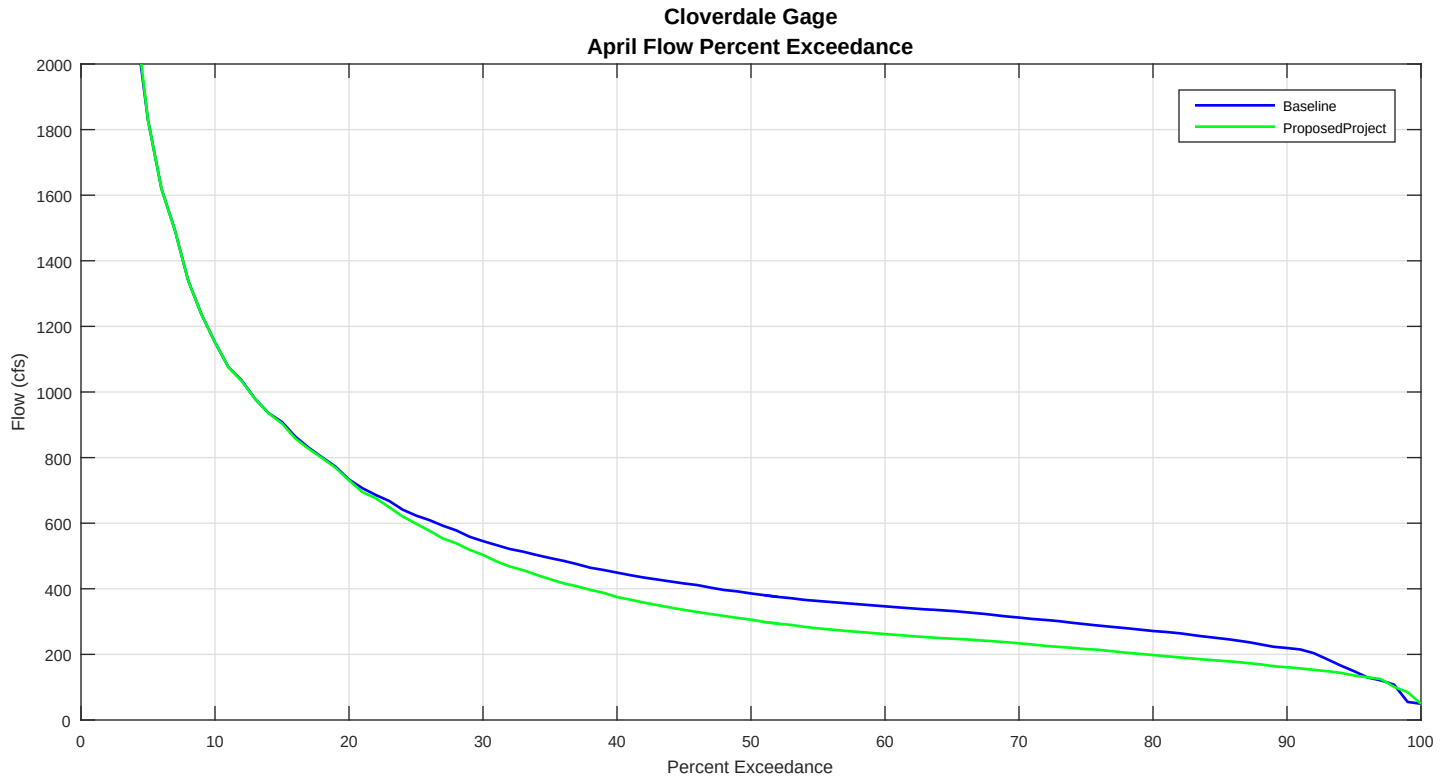
Cloverdale Gage
April Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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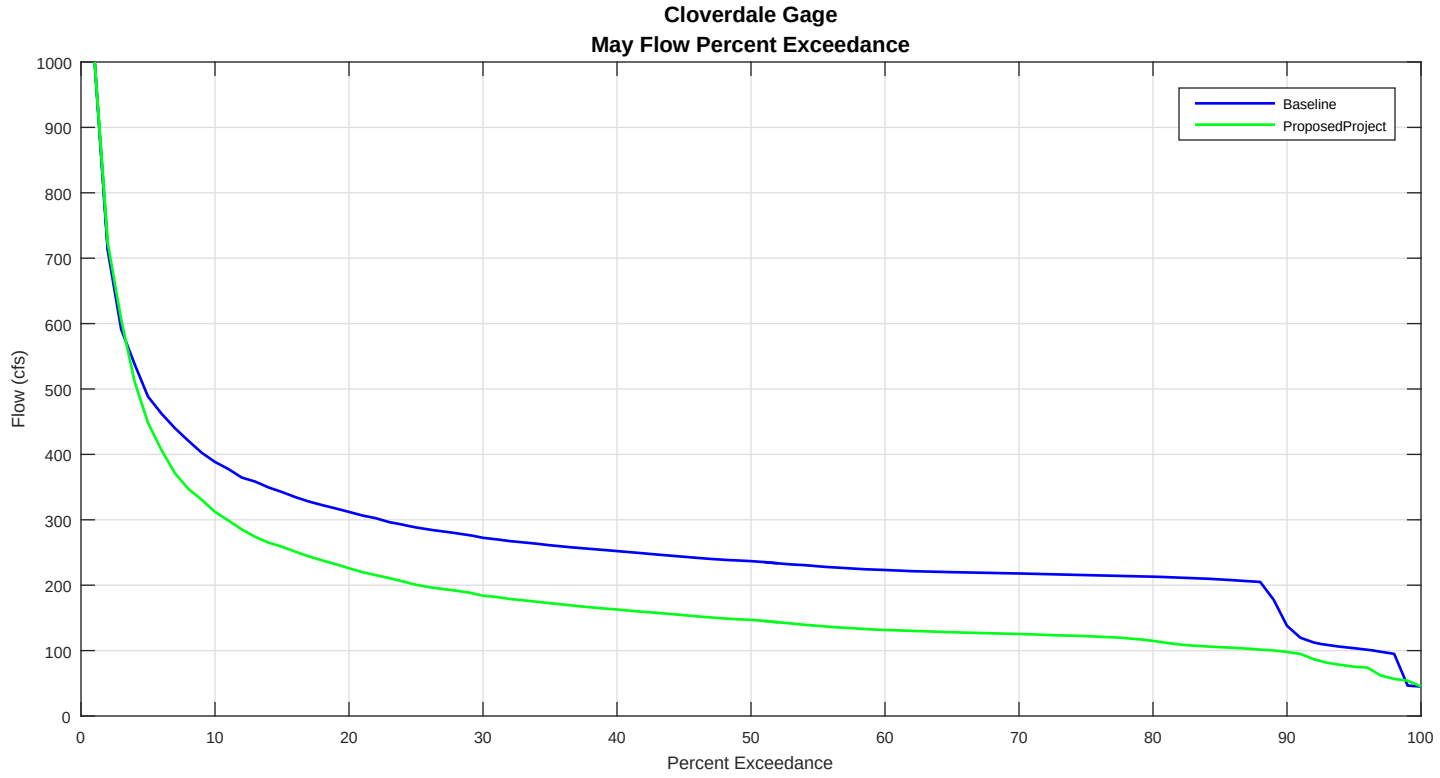
Cloverdale Gage
May Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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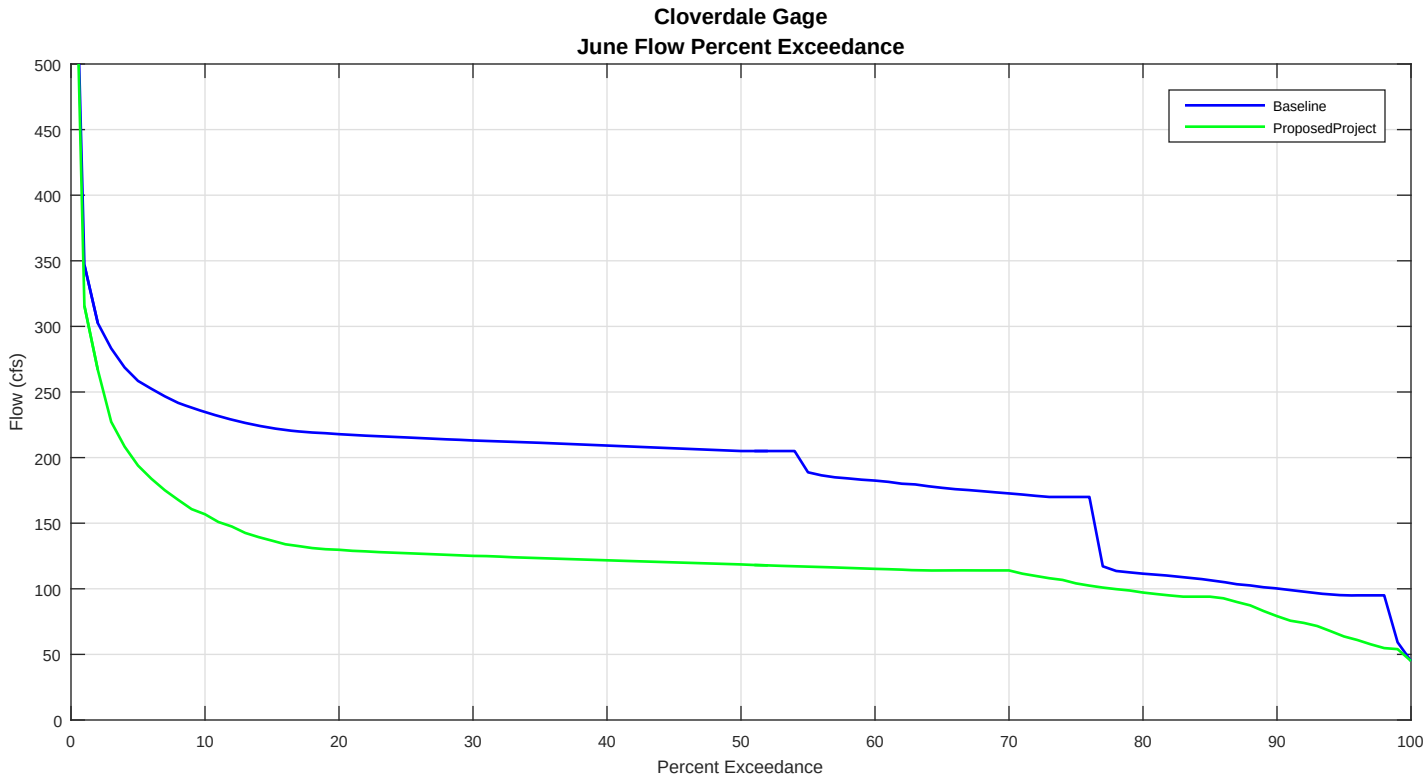
Cloverdale Gage
June Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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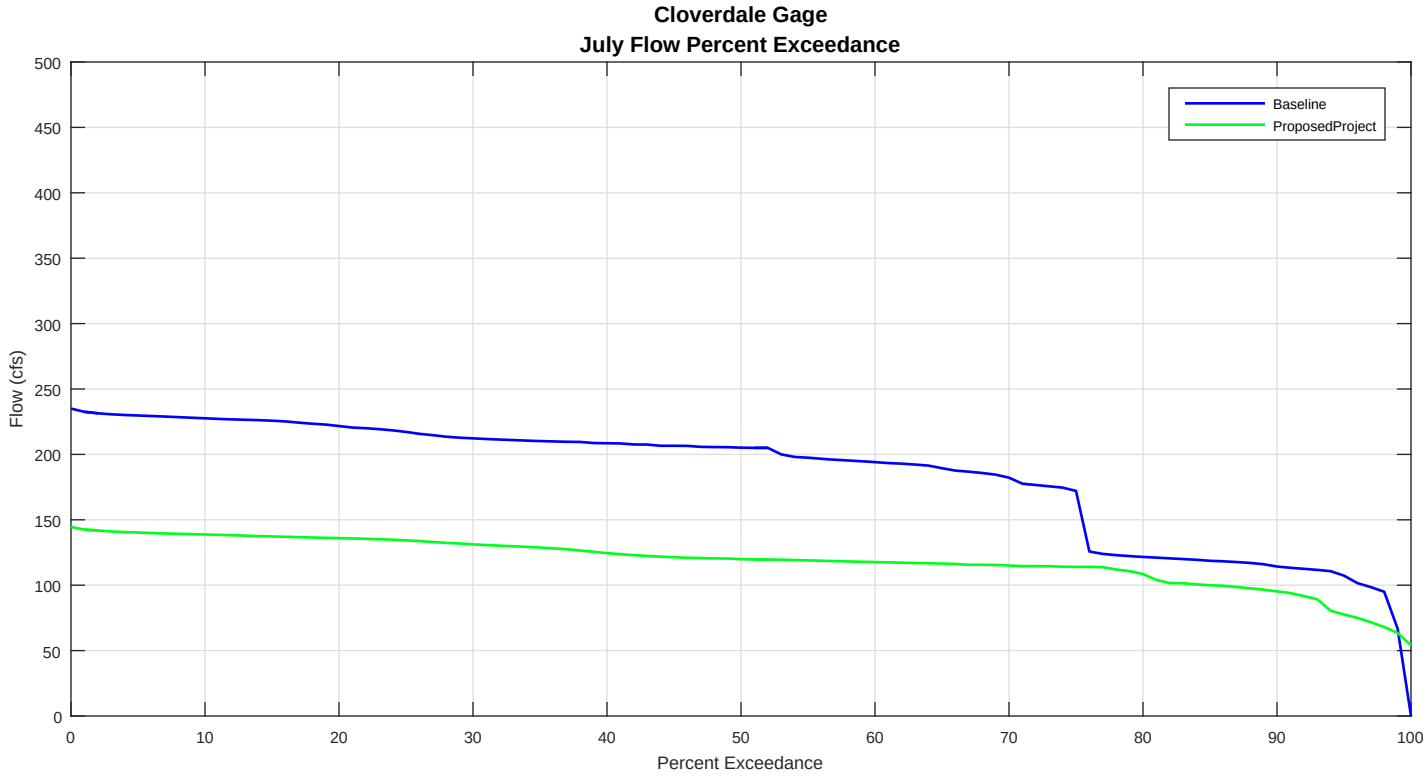
Cloverdale Gage
July Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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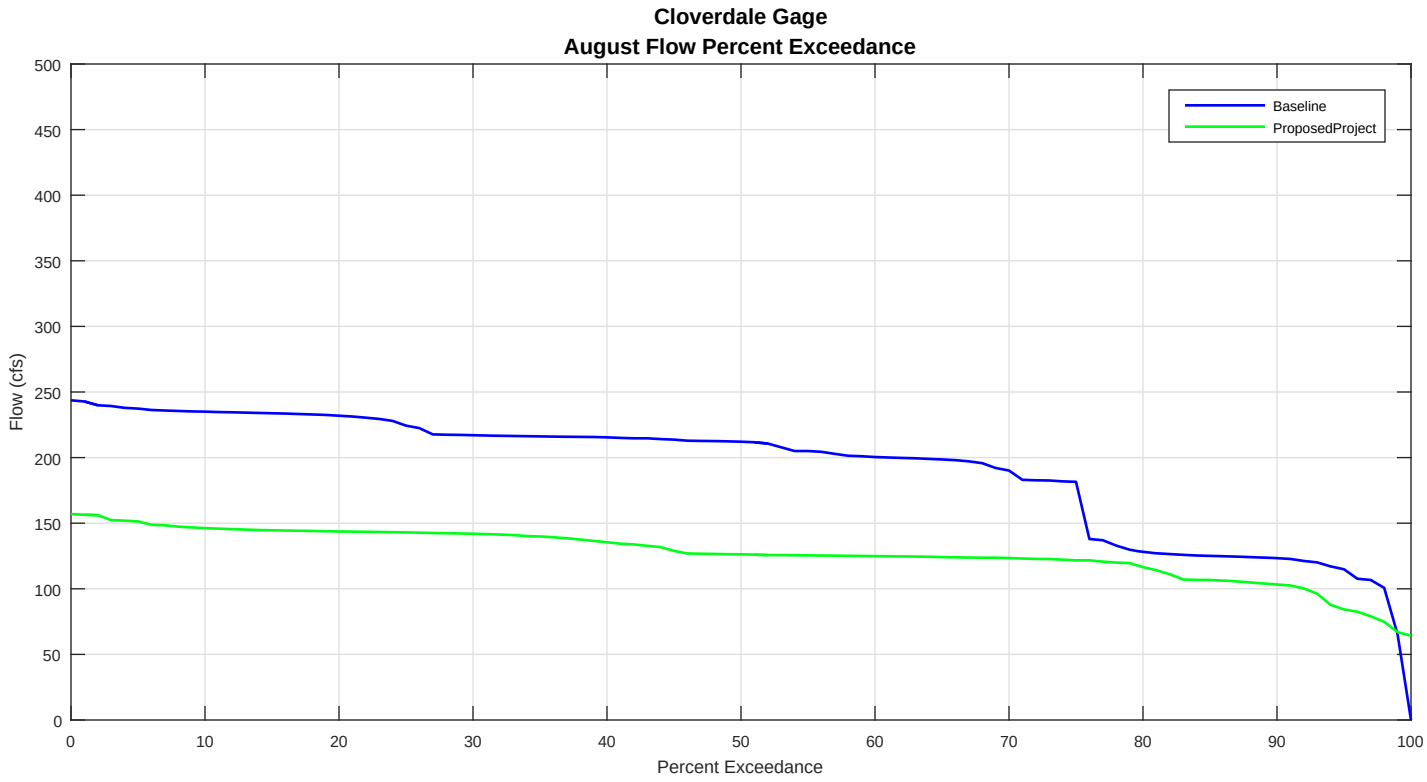
Cloverdale Gage
August Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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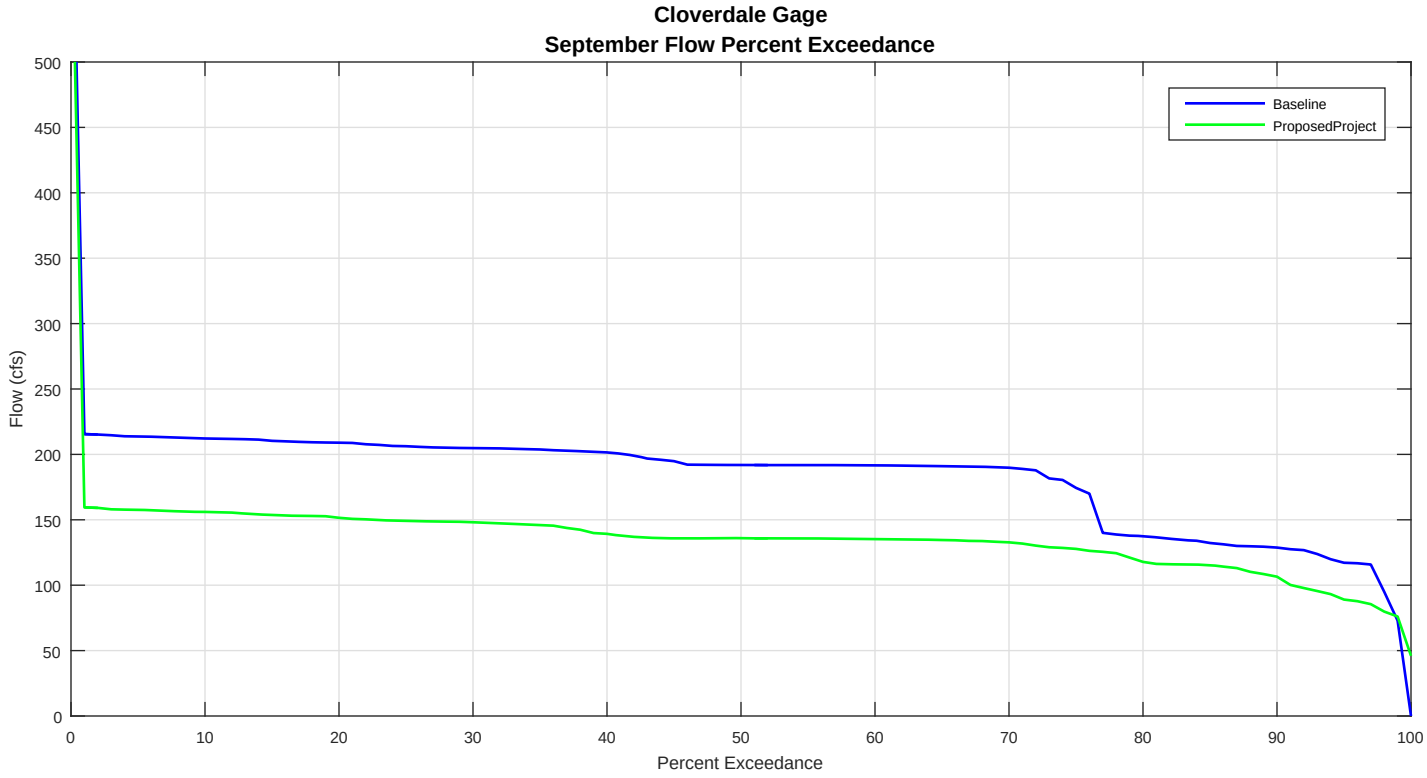
Cloverdale Gage
September Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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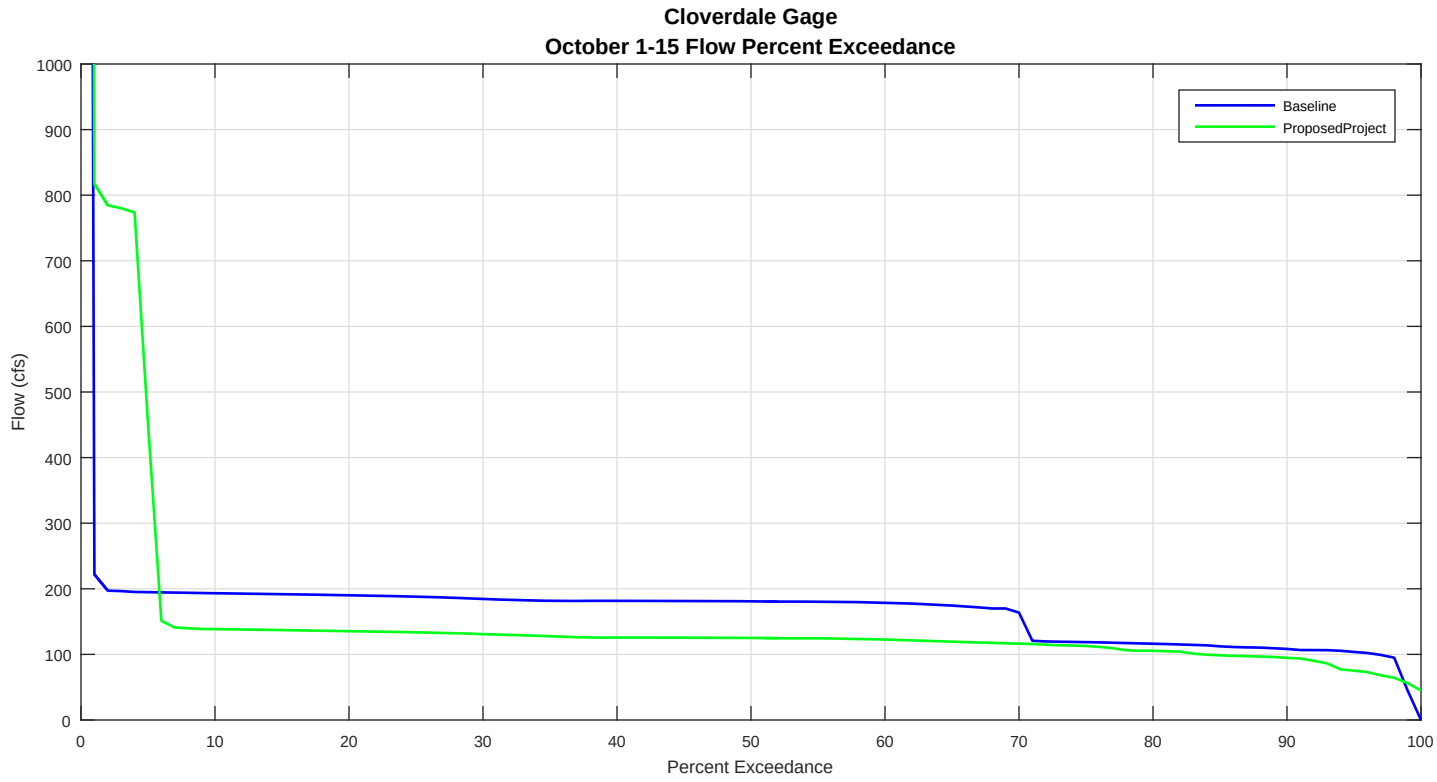
Cloverdale Gage
October 1-15 Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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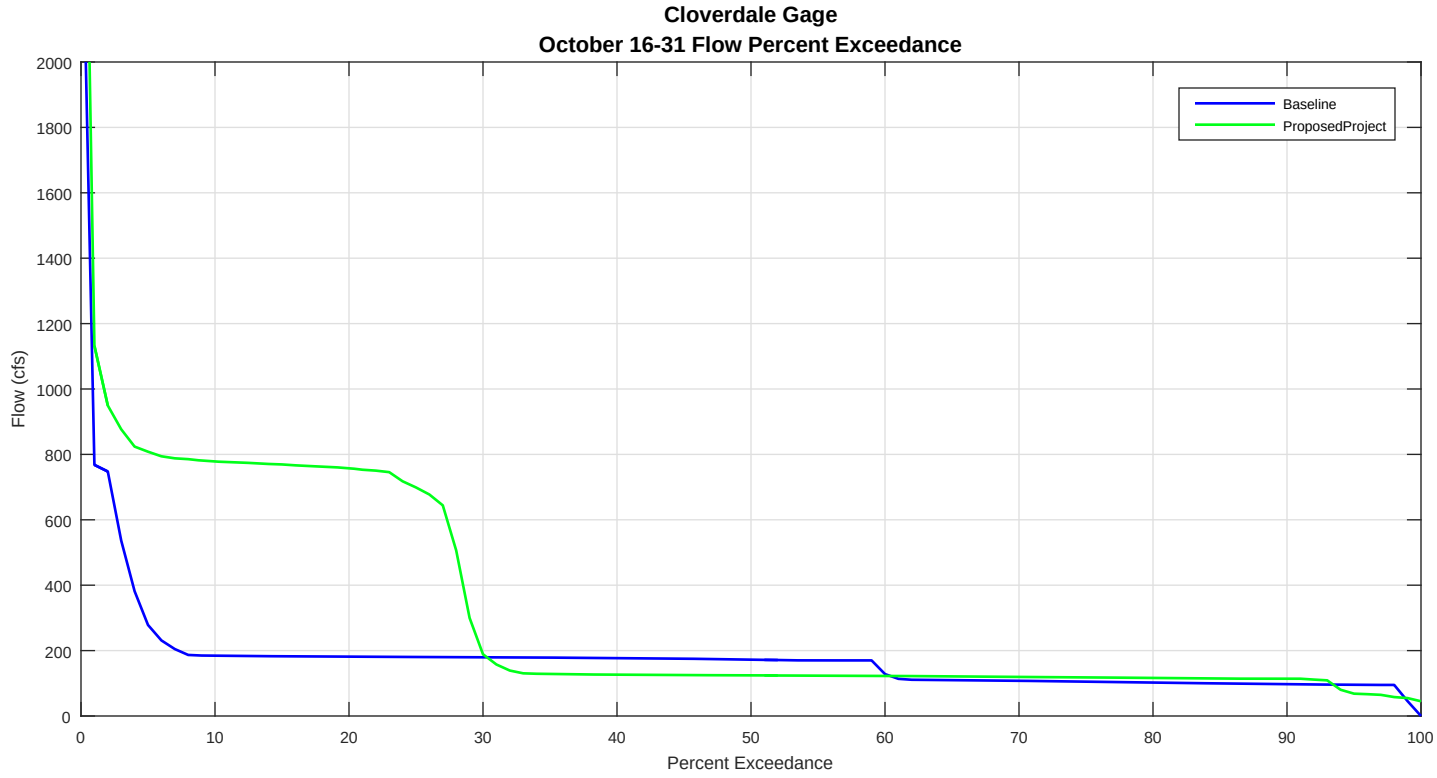
Cloverdale Gage
October 16-31 Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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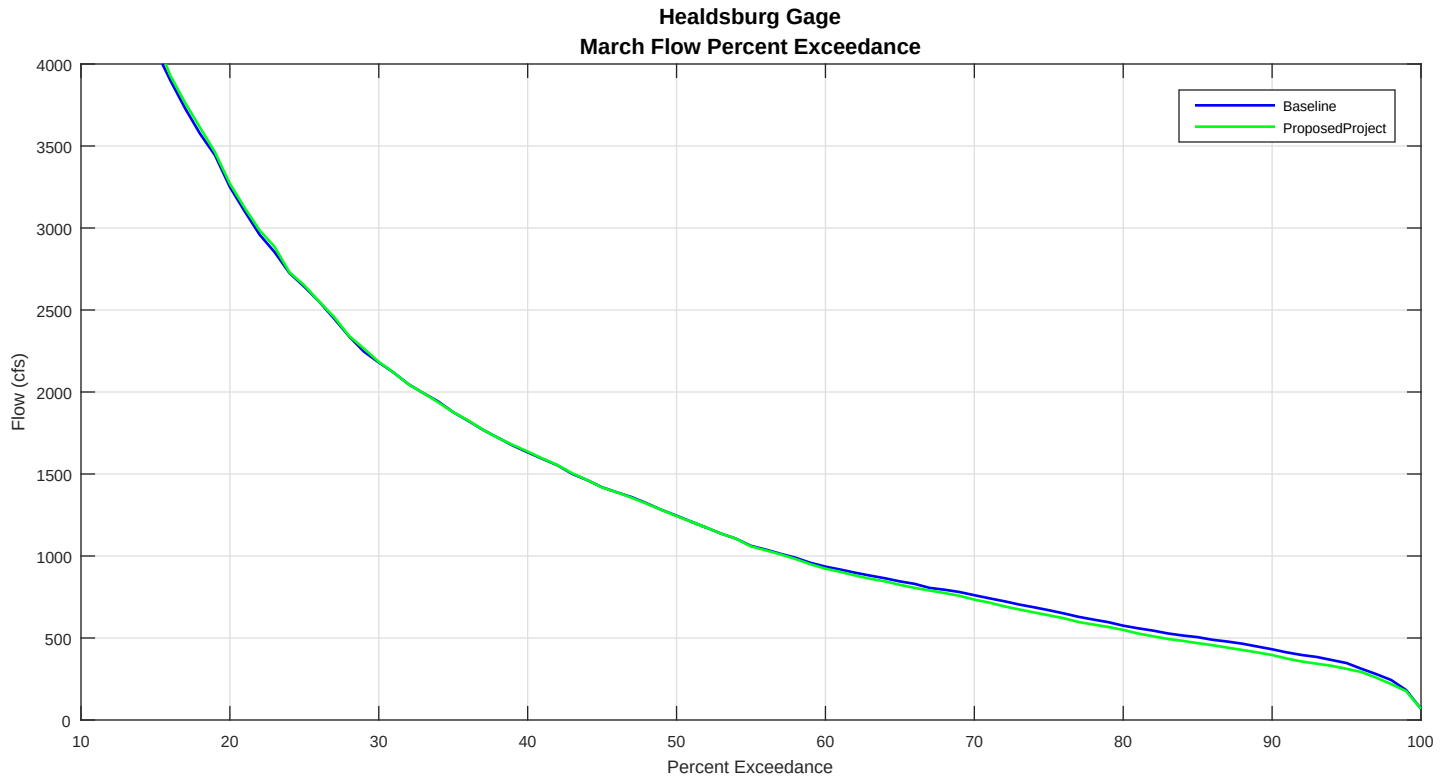
Healdsburg Gage
March Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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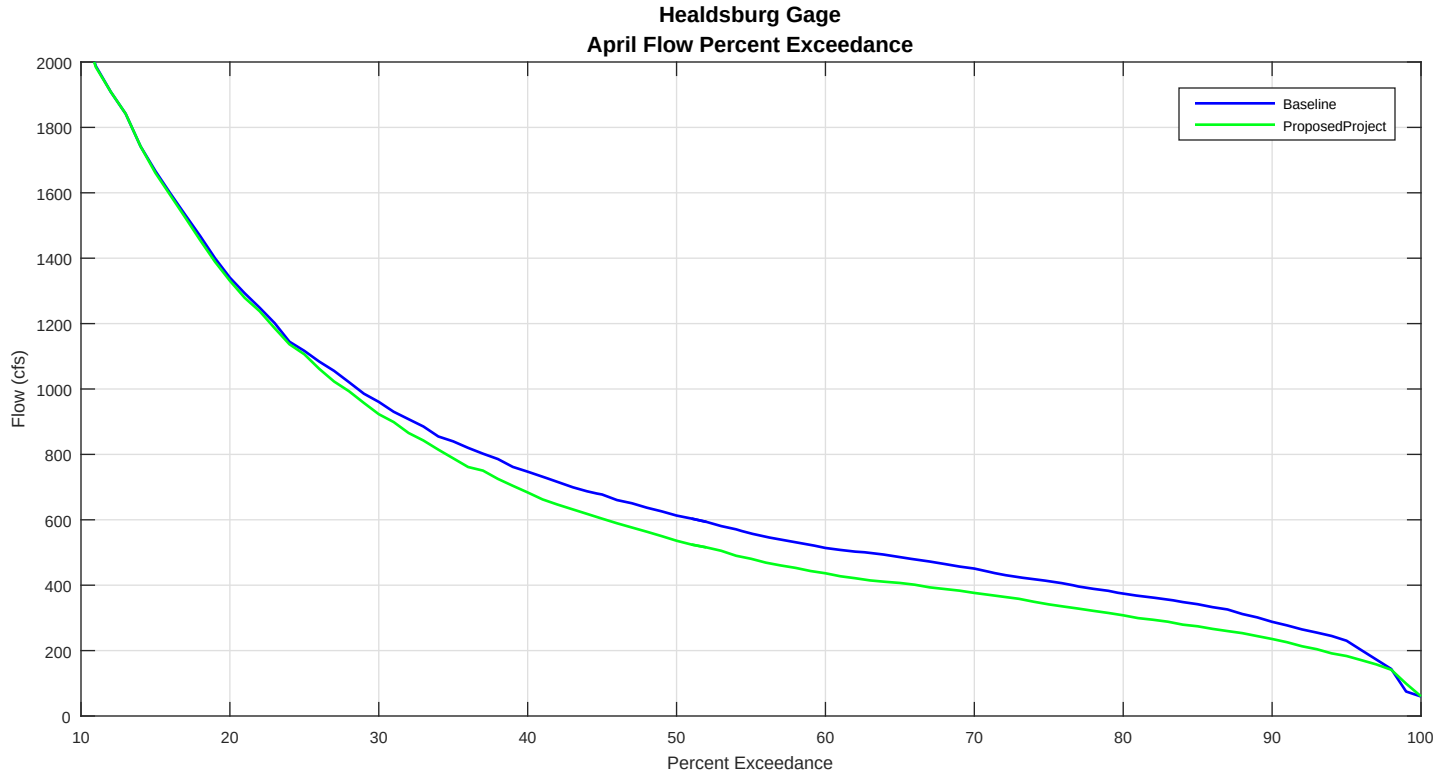
Healdsburg Gage
April Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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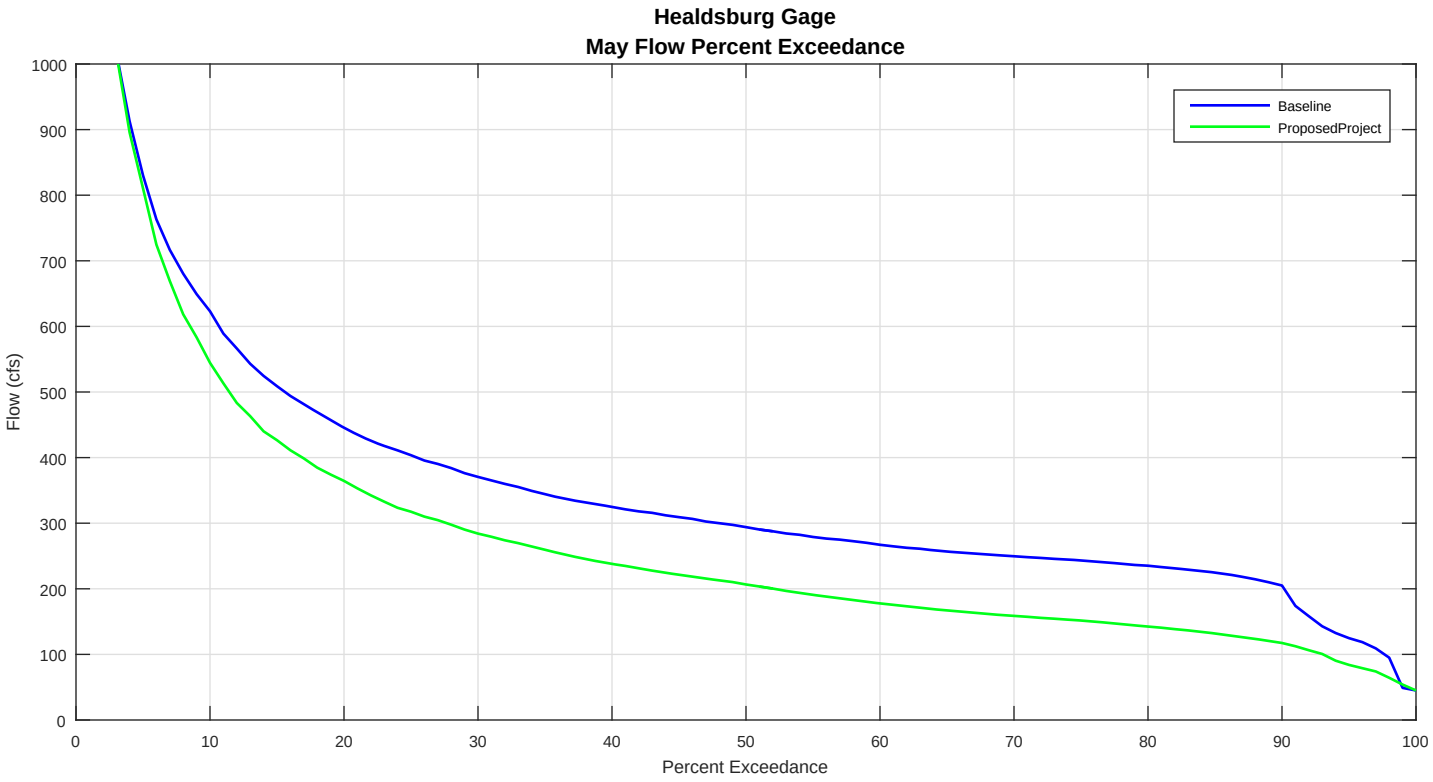
Healdsburg Gage
May Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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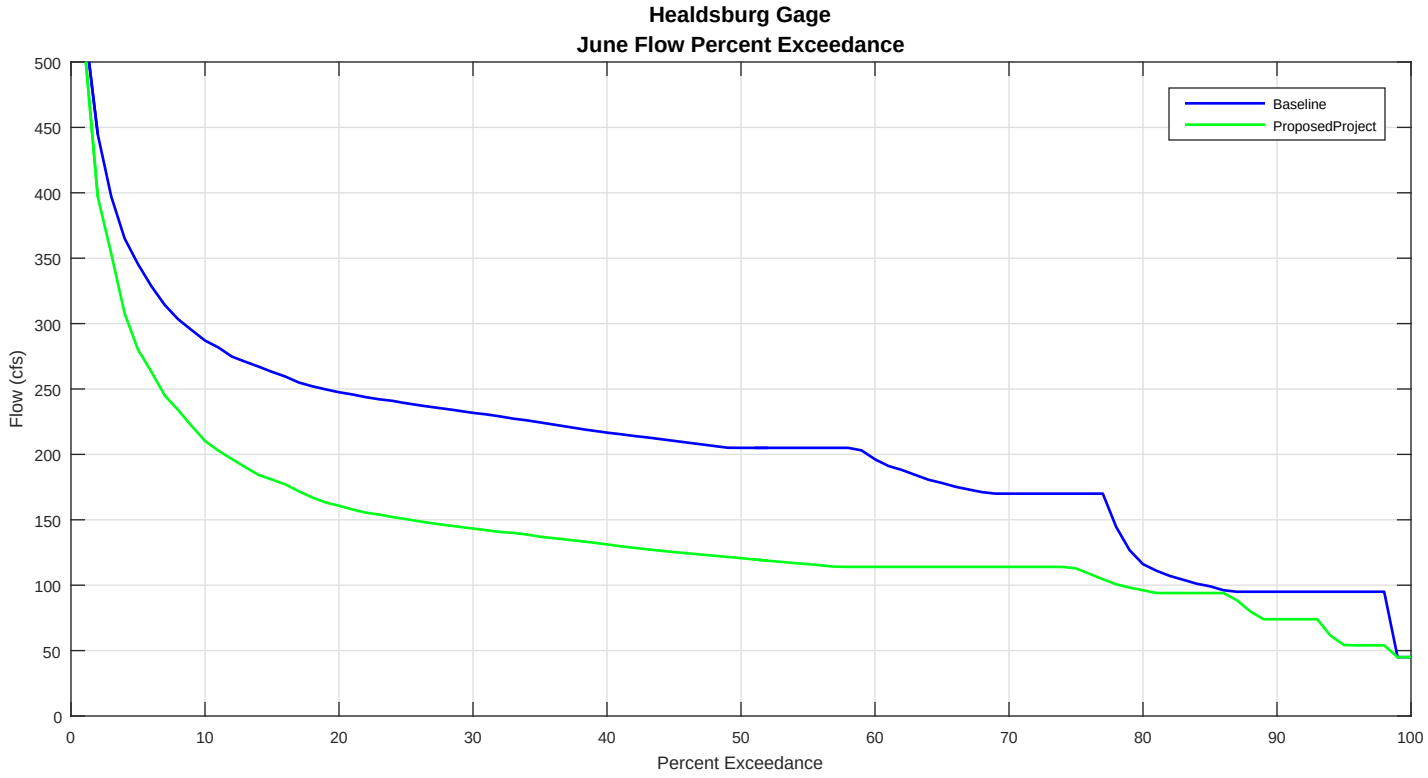
Healdsburg Gage
June Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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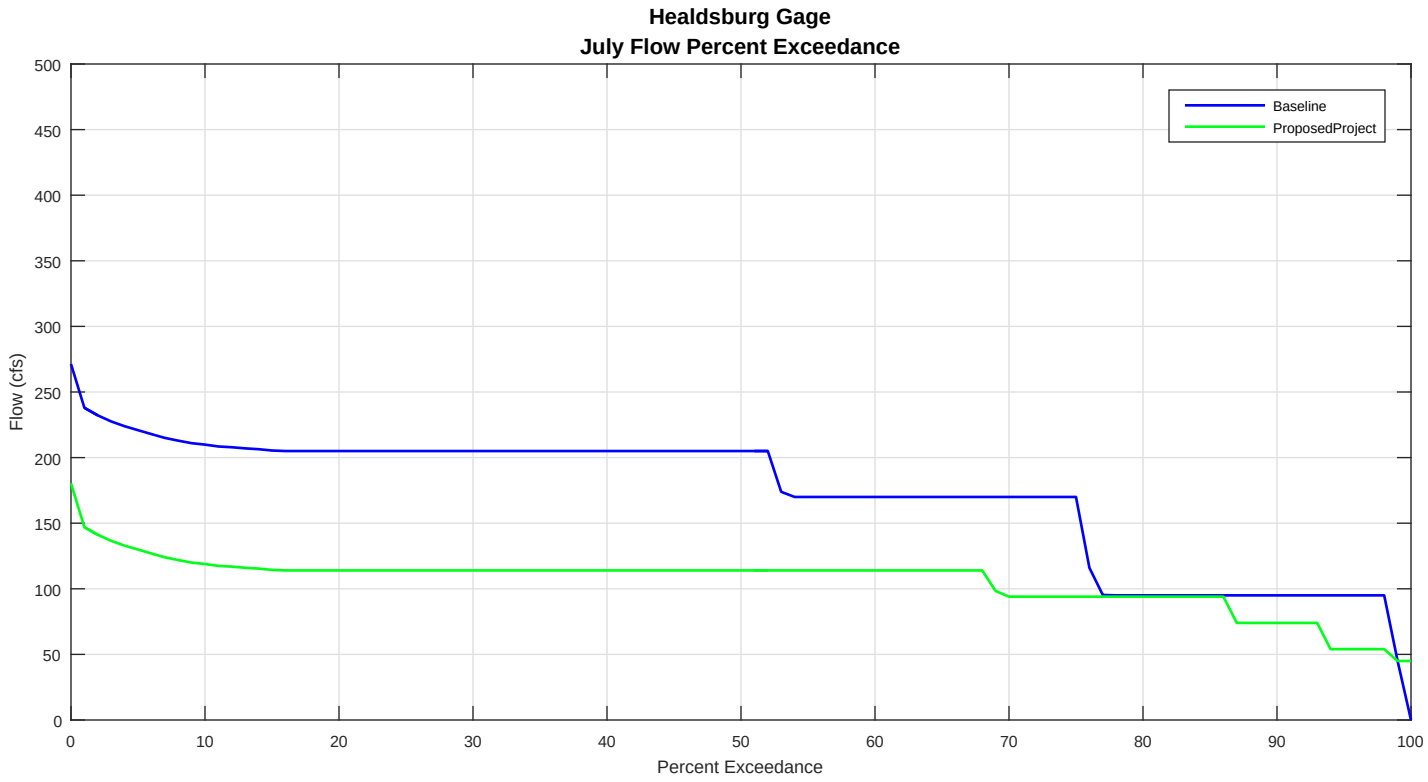
Healdsburg Gage
July Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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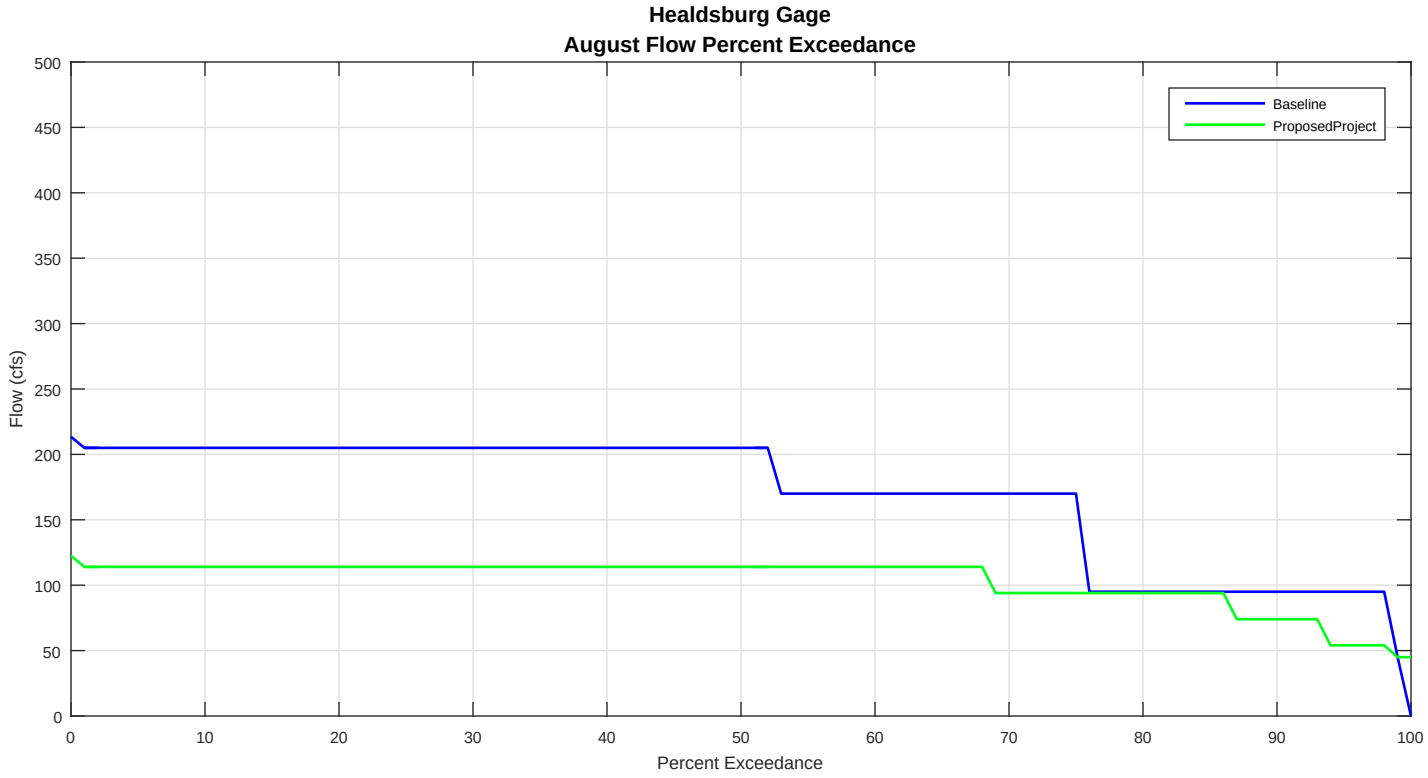
Healdsburg Gage
August Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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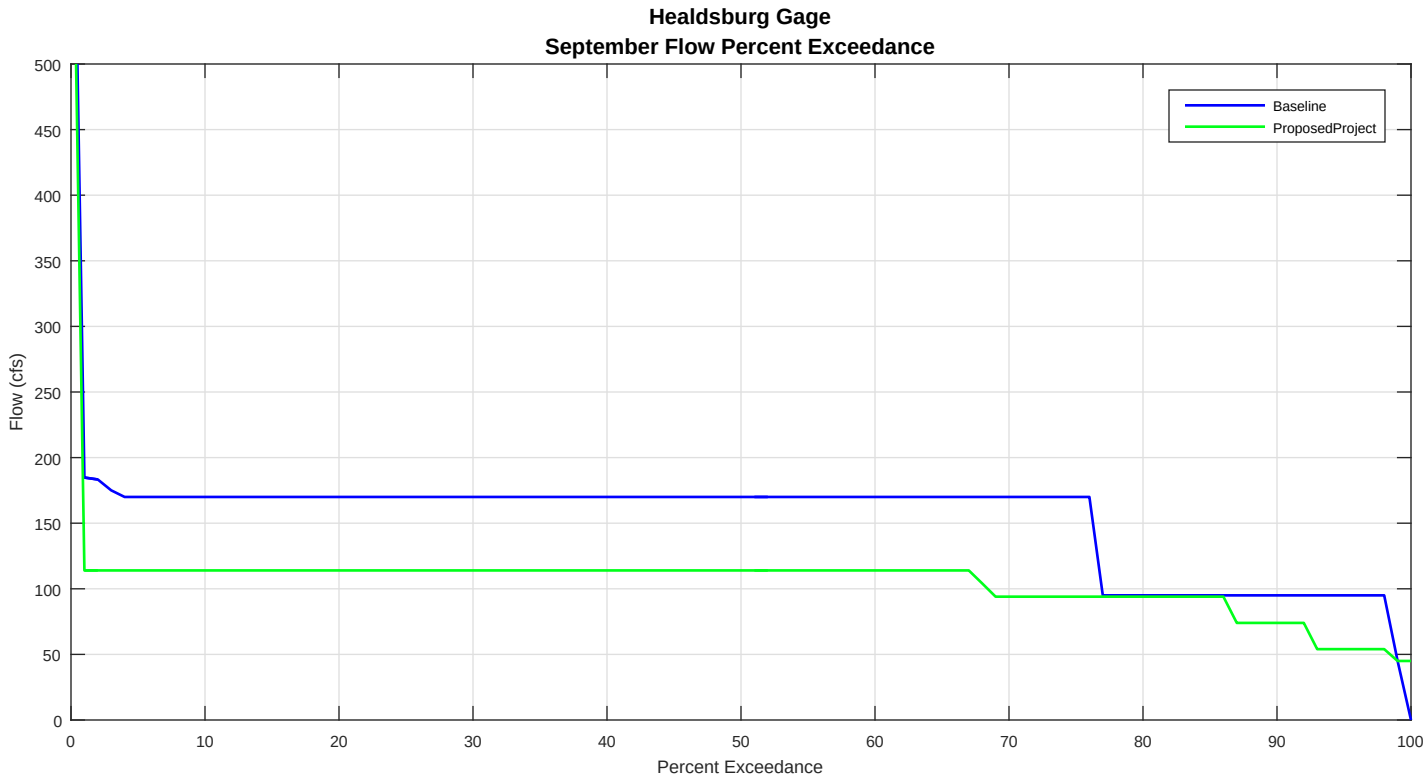
Healdsburg Gage
September Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
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ProposedProject
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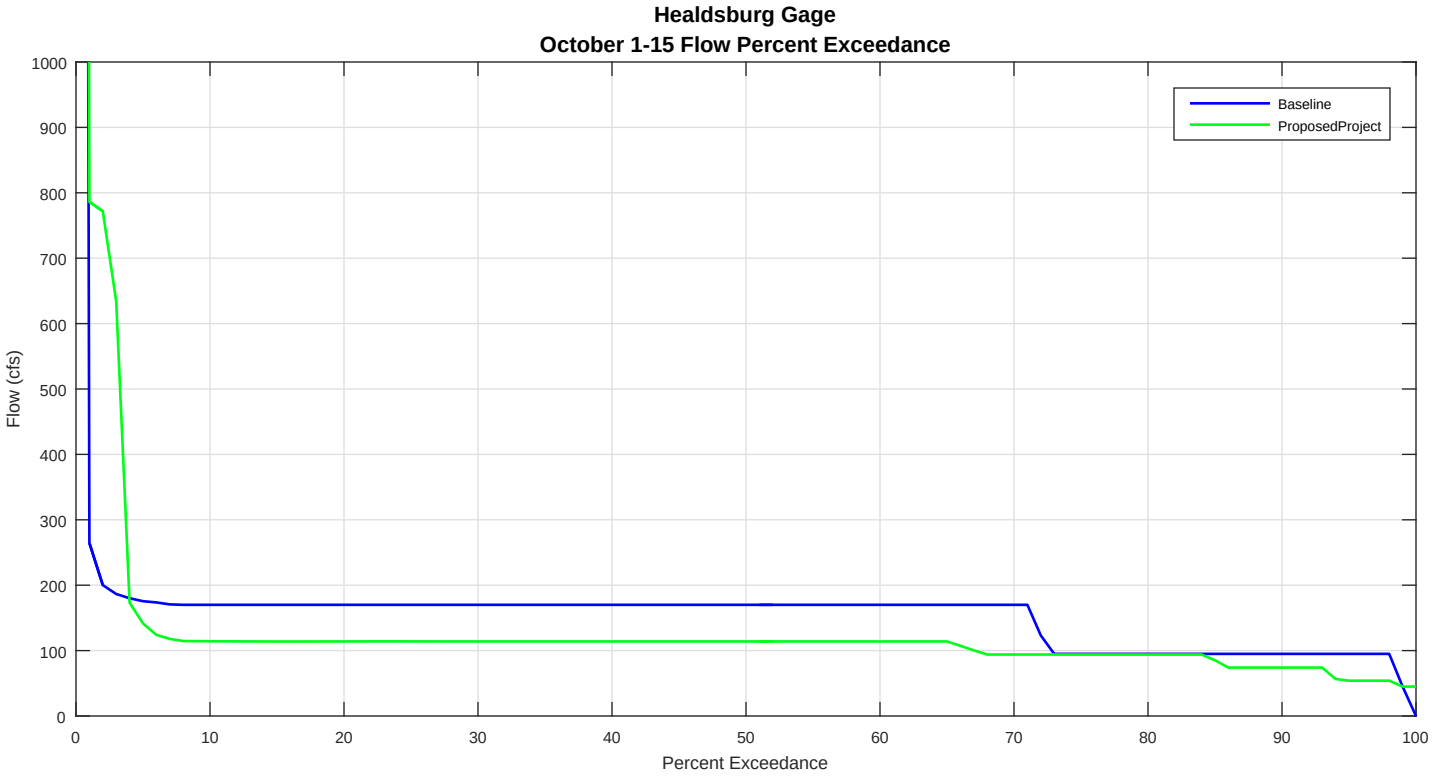
Healdsburg Gage
October 1-15 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
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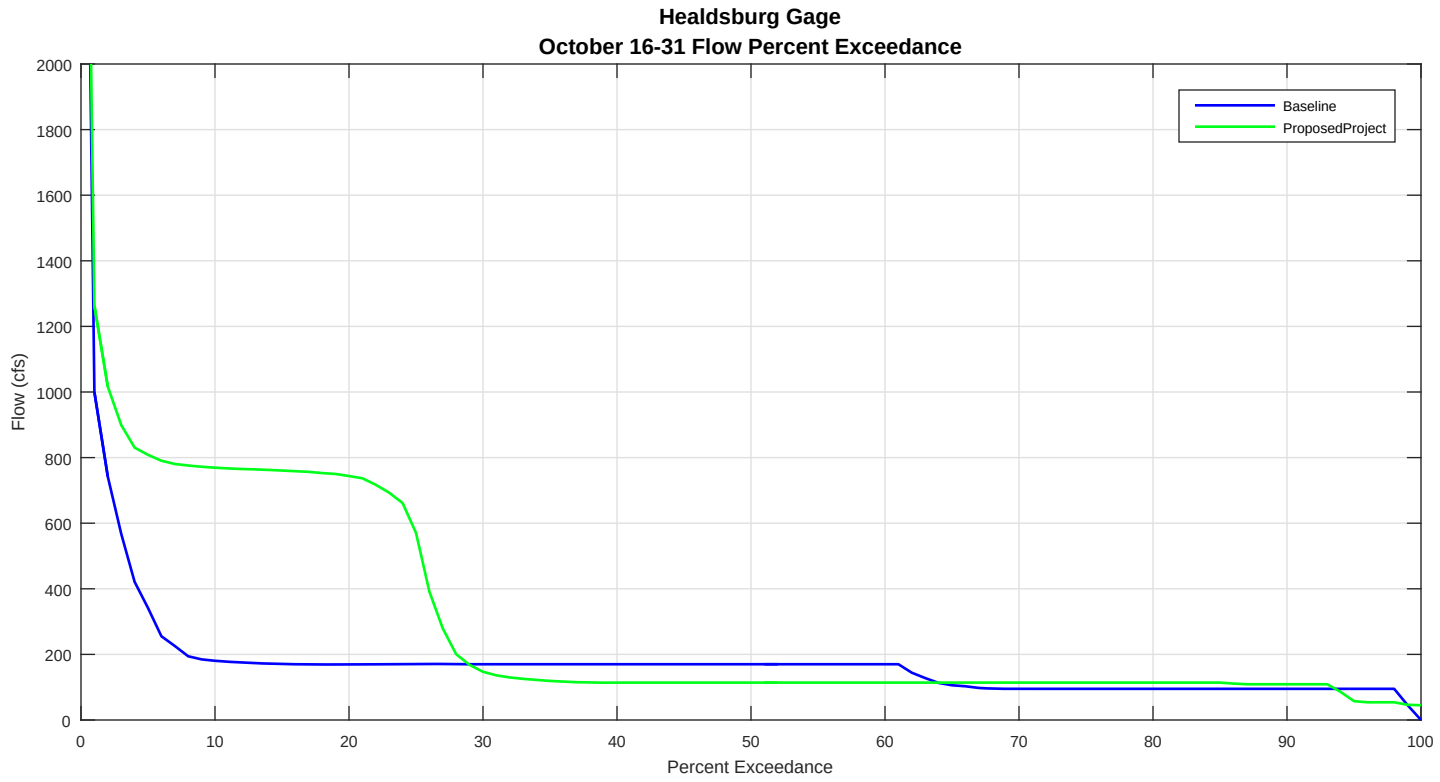
Healdsburg Gage
October 16-31 Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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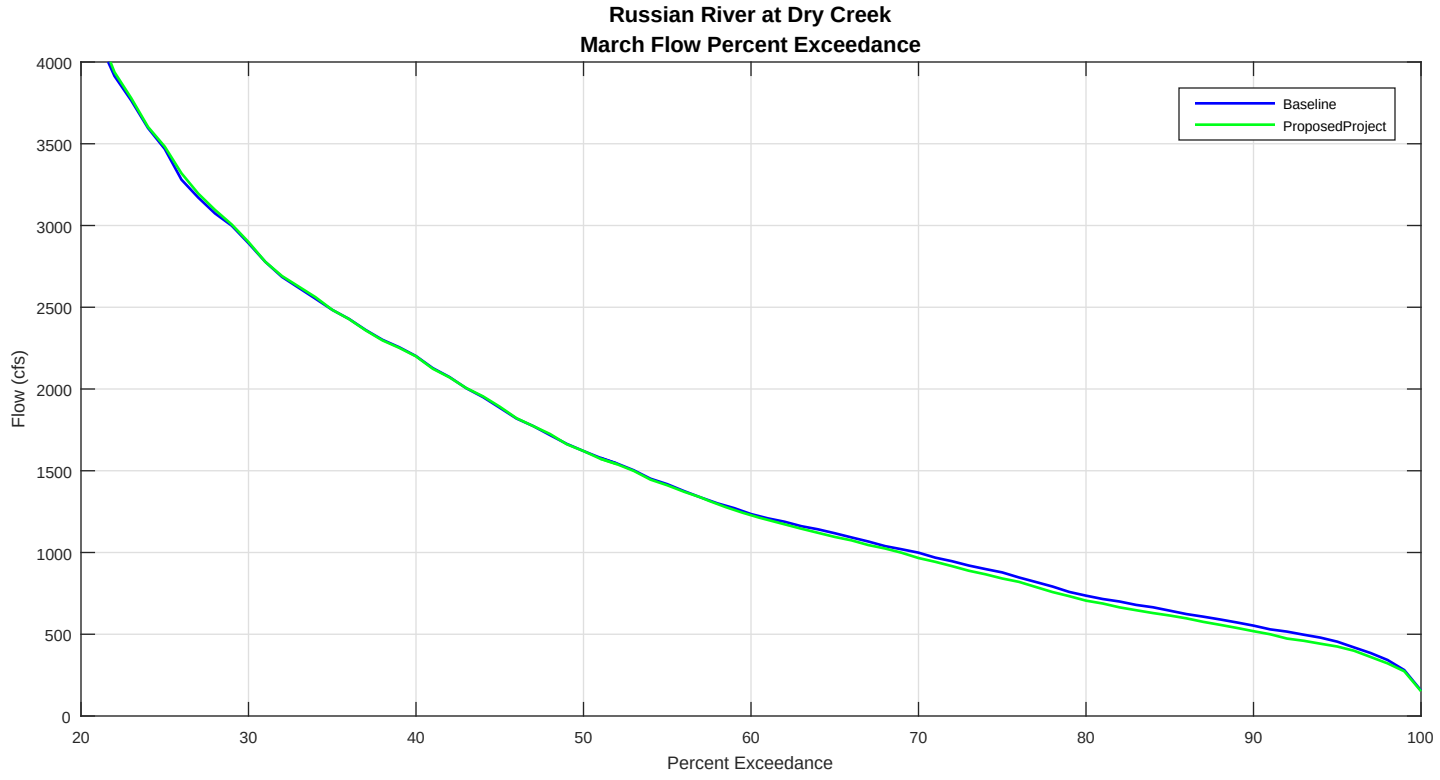
Russian River at Dry Creek
March Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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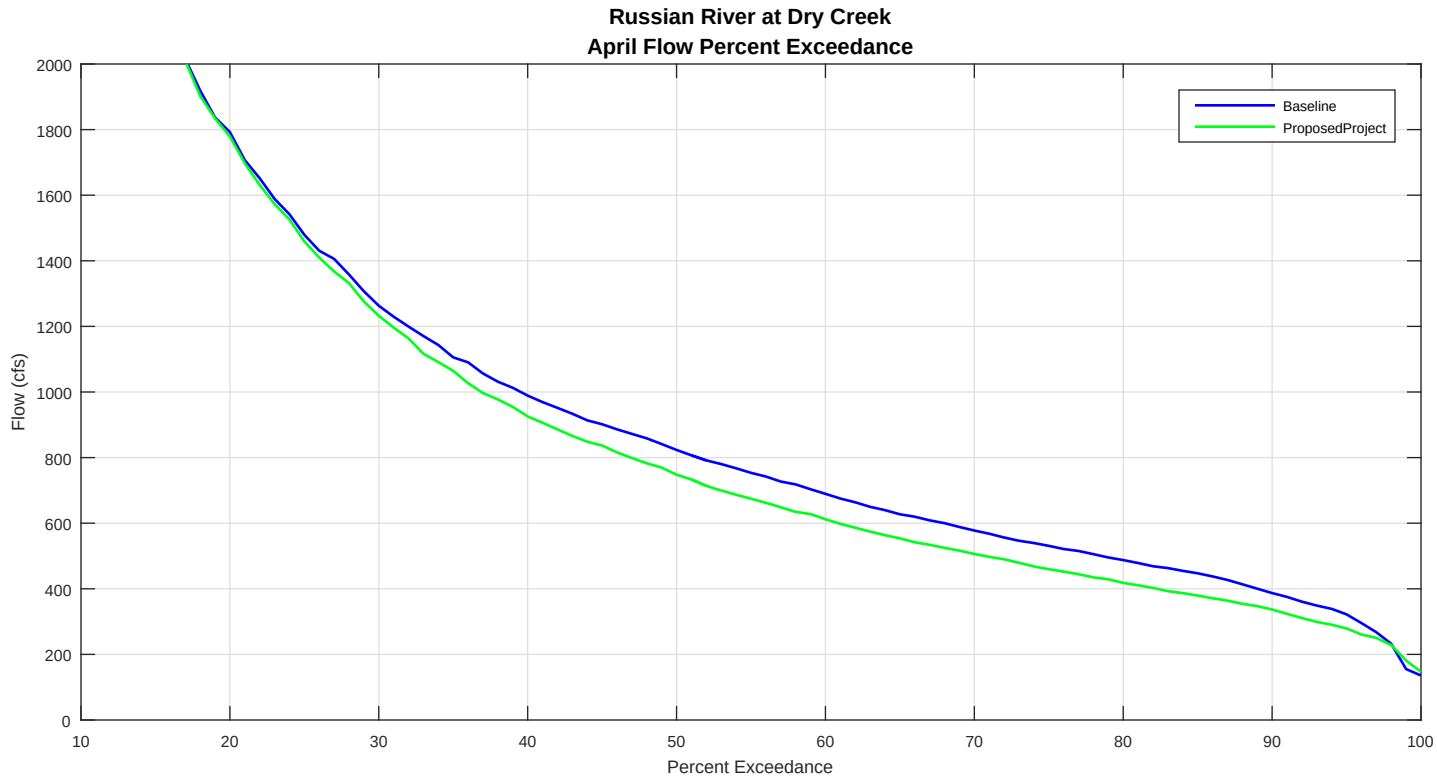
Russian River at Dry Creek
April Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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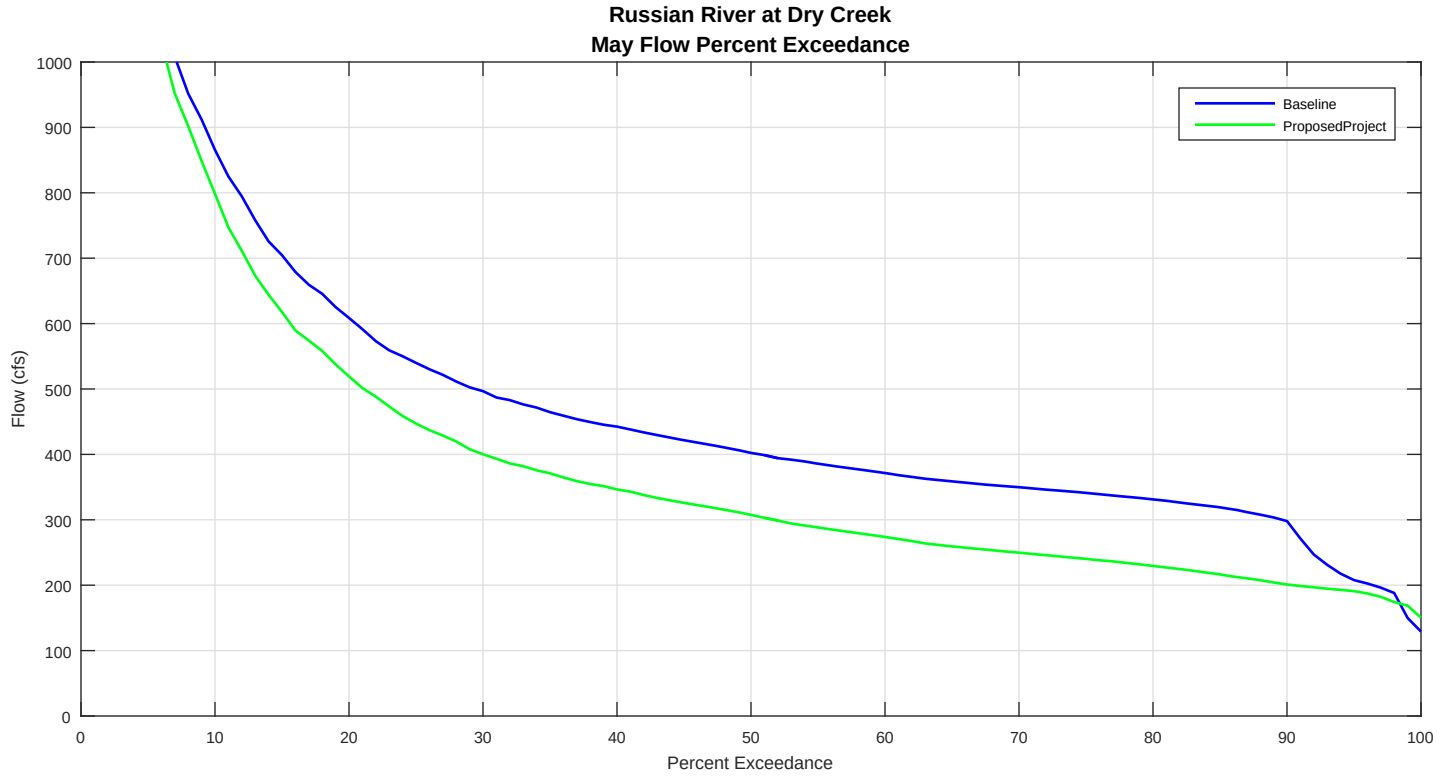
Russian River at Dry Creek
May Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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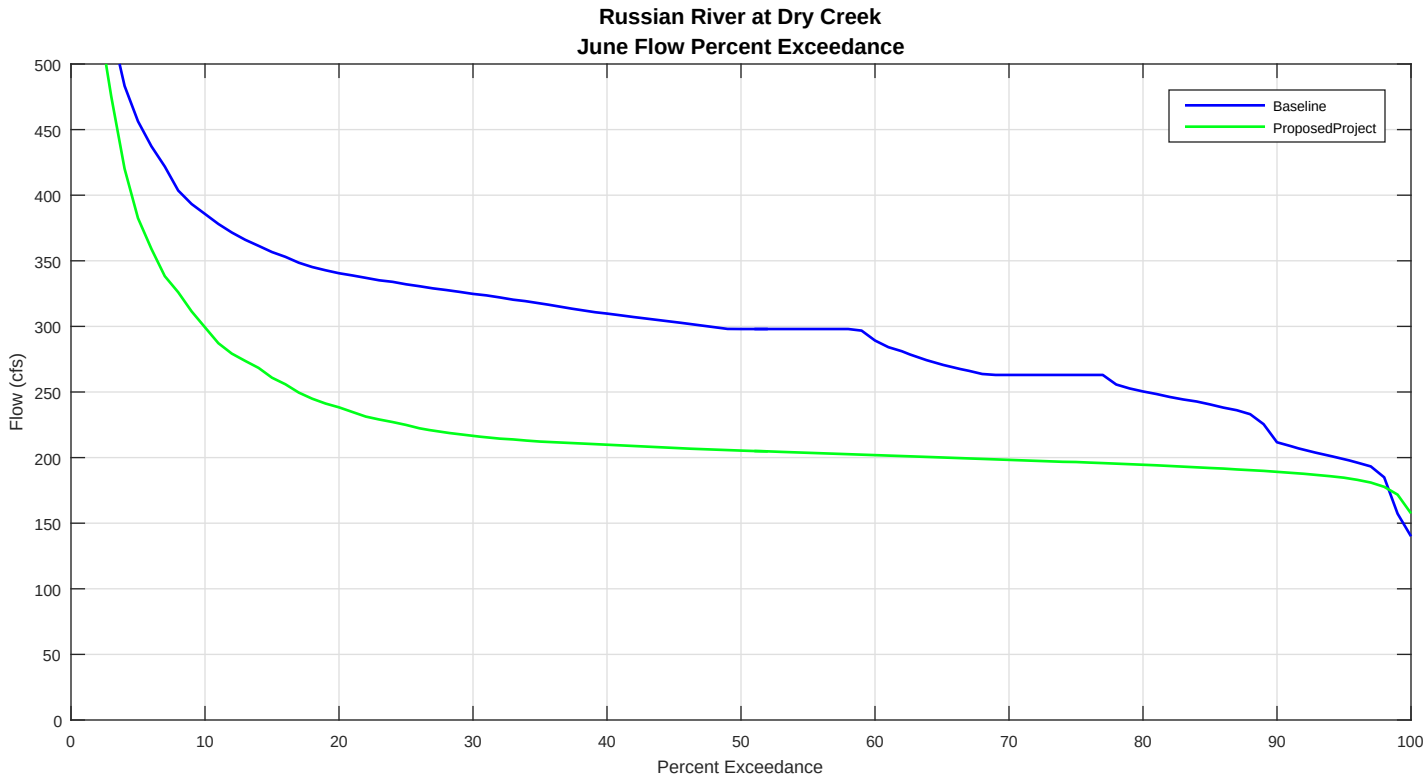
Russian River at Dry Creek
June Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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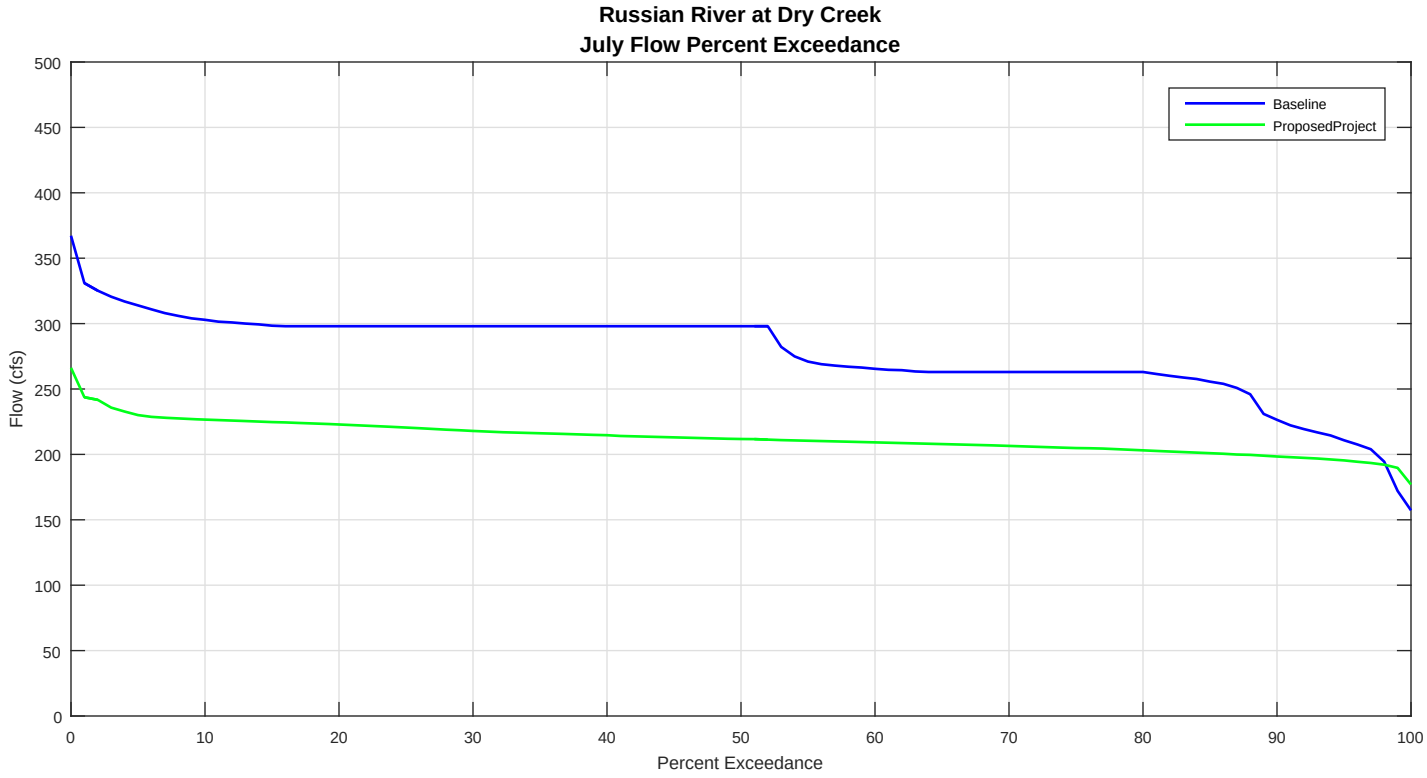
Russian River at Dry Creek
July Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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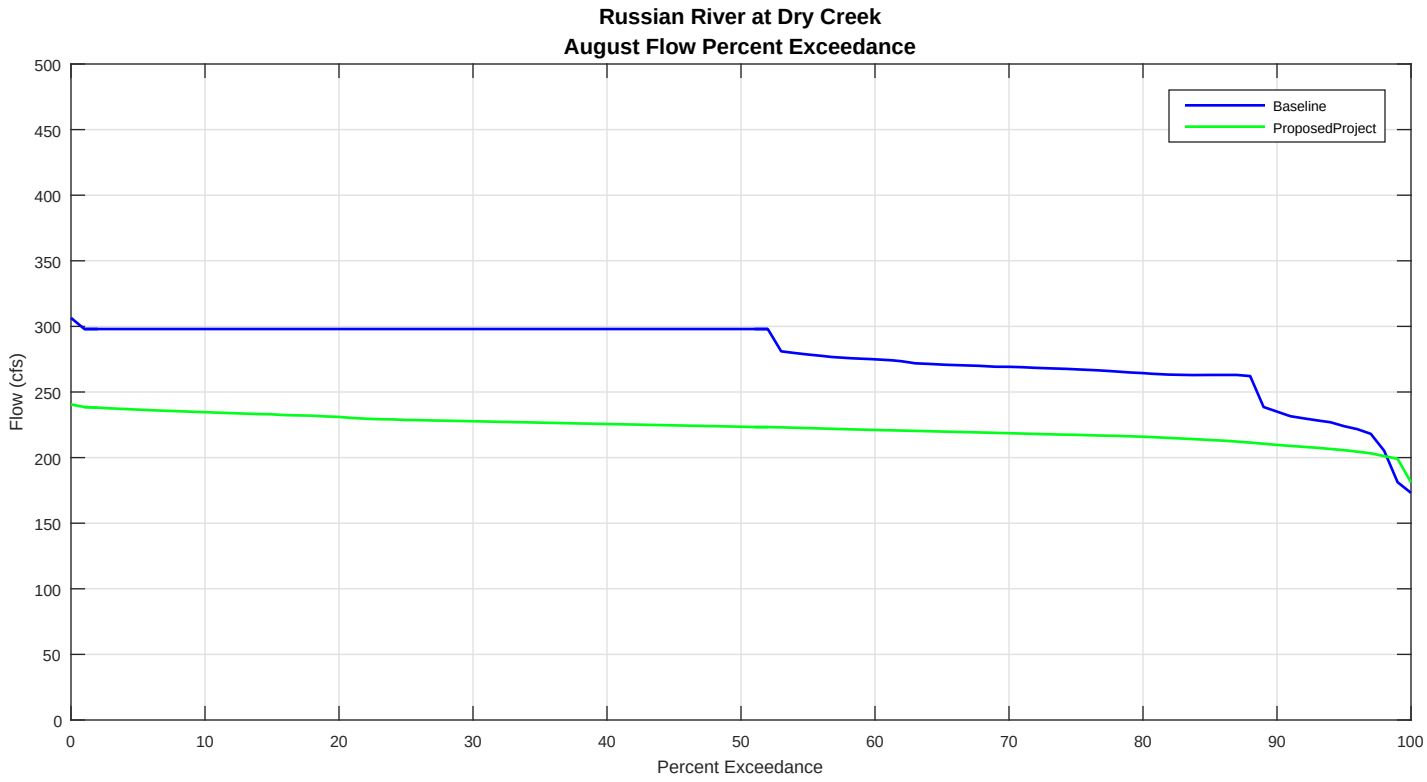
Russian River at Dry Creek
August Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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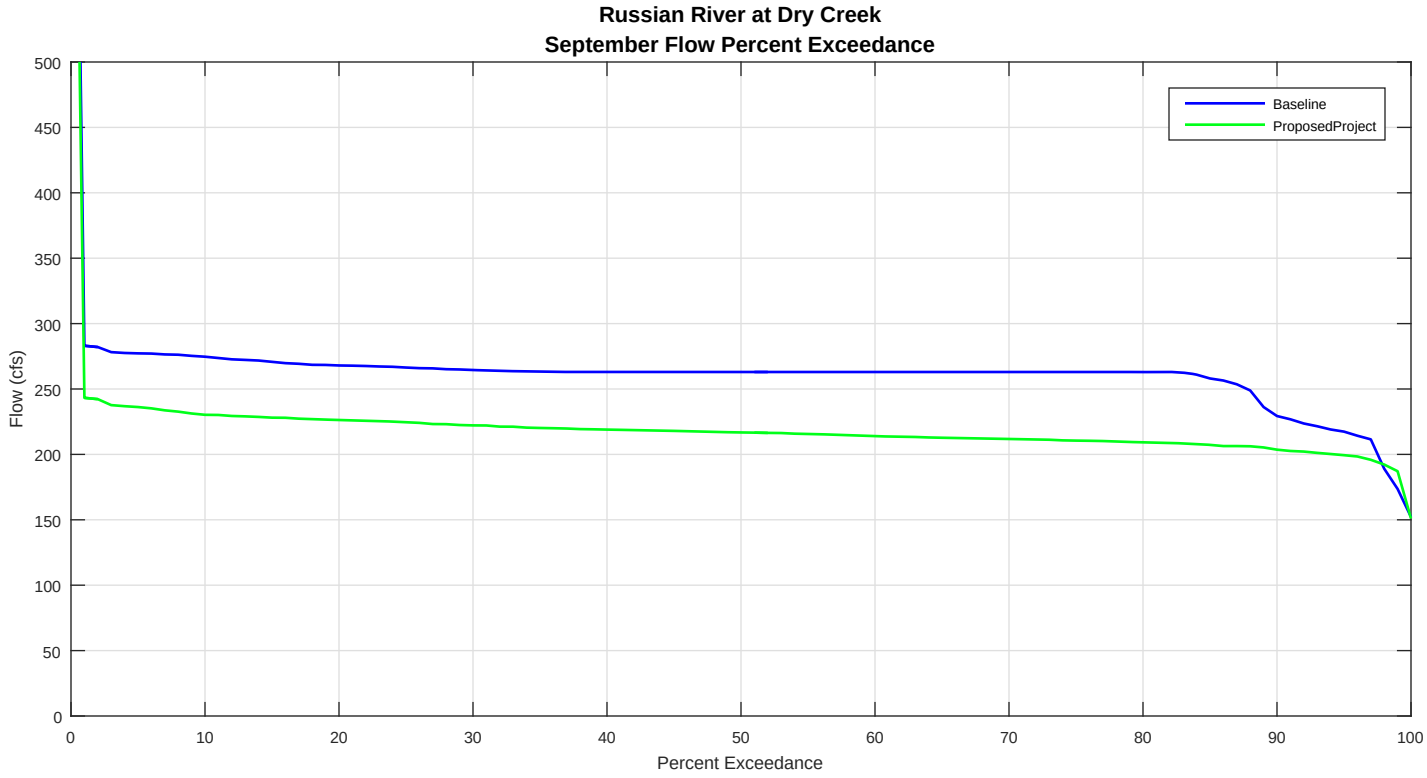
Russian River at Dry Creek
September Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
0
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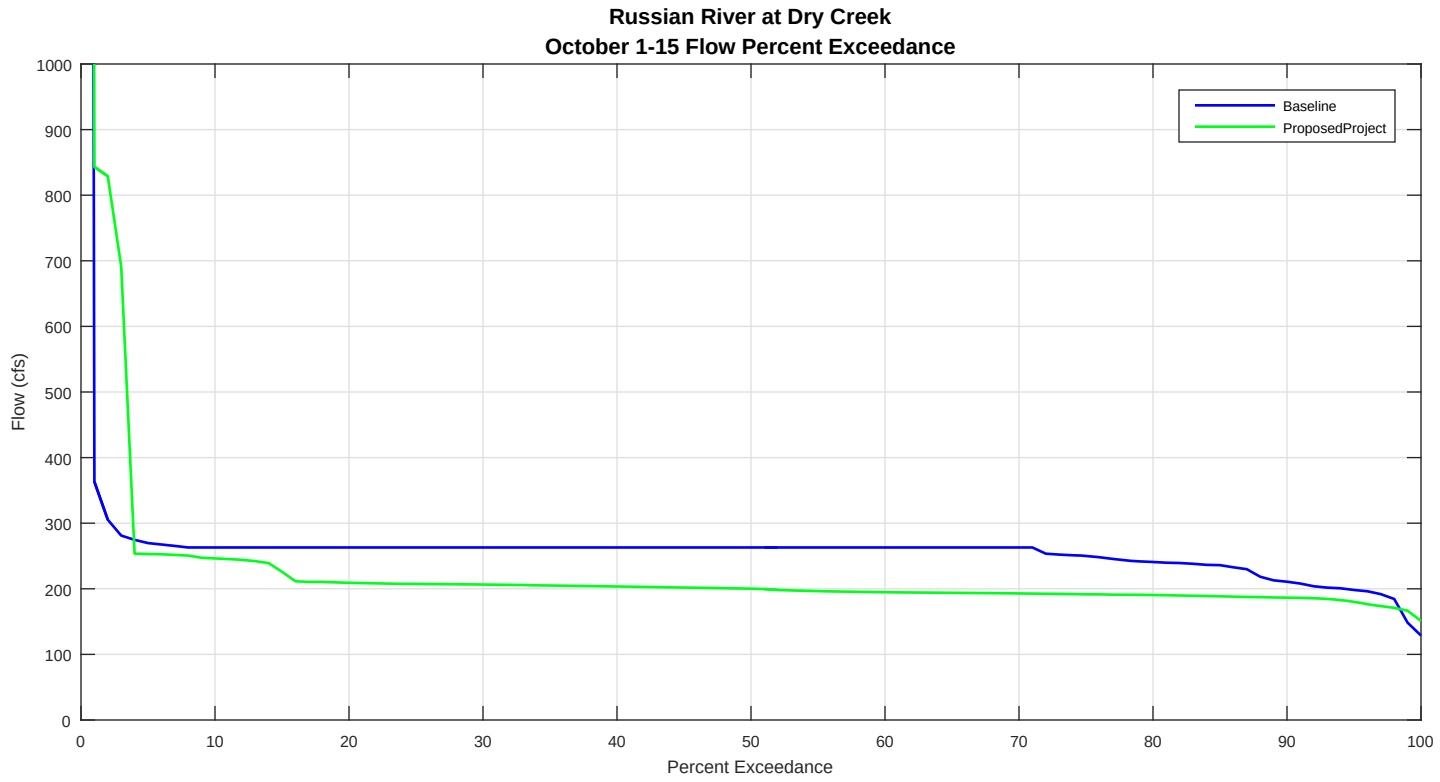
Russian River at Dry Creek
October 1-15 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
Baseline
ProposedProject
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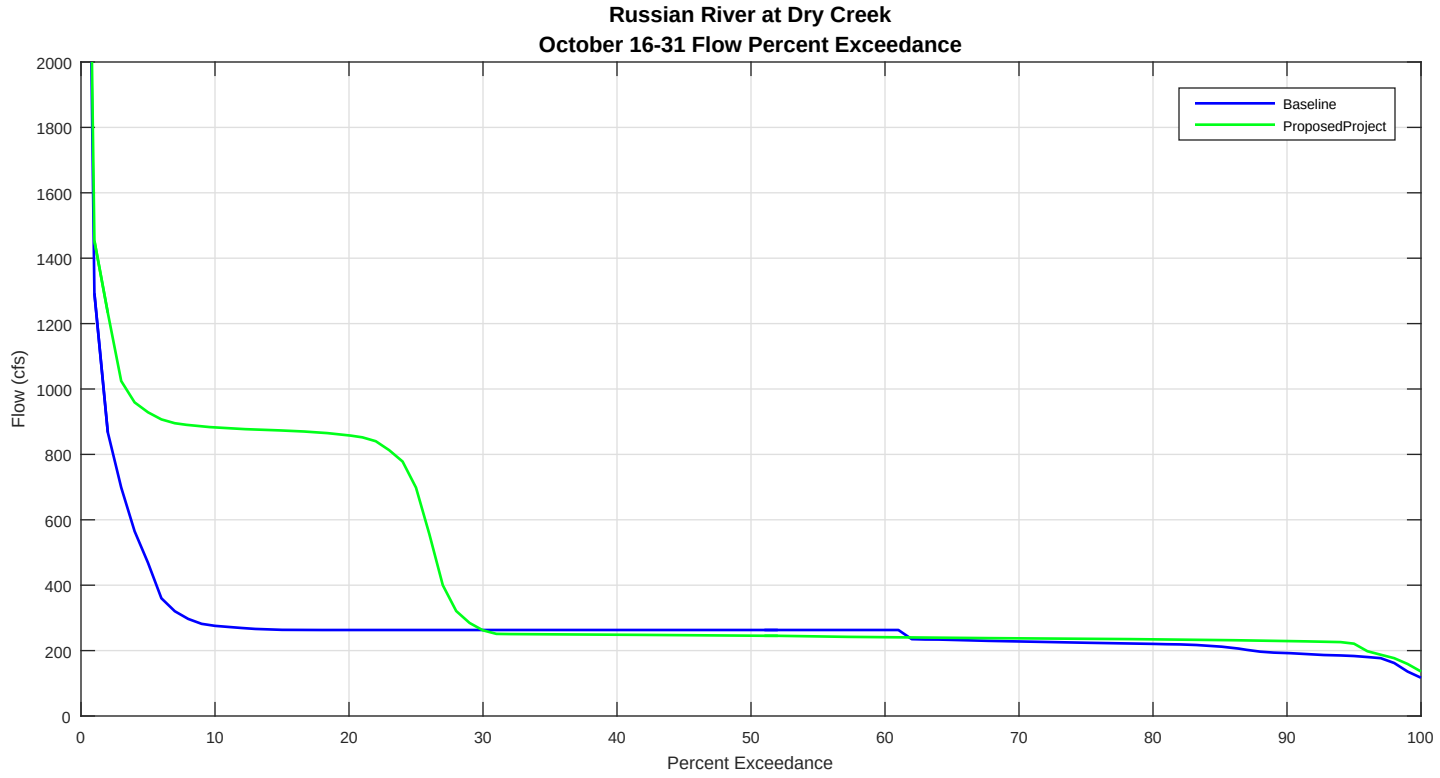
Russian River at Dry Creek
October 16-31 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
Baseline
ProposedProject
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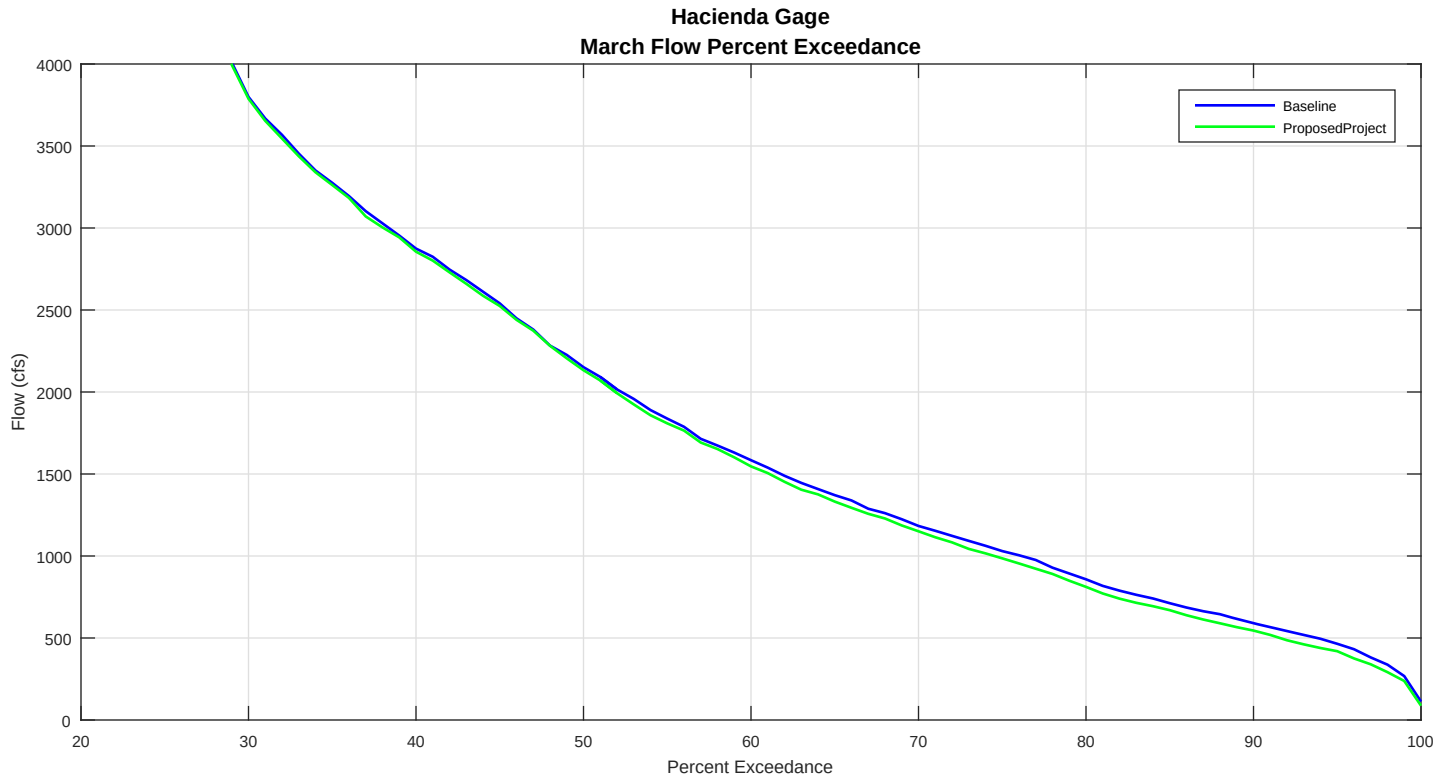
Hacienda Gage
March Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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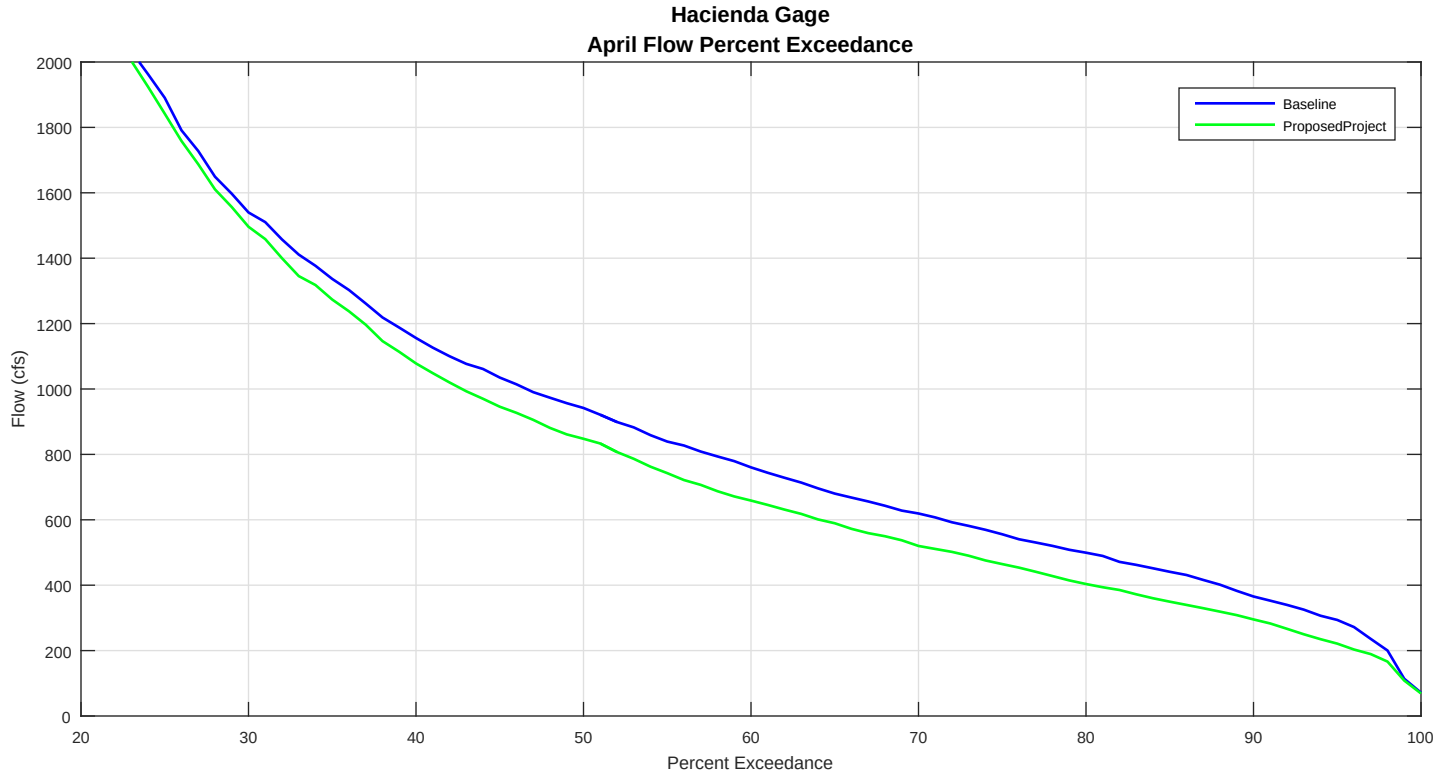
Hacienda Gage
April Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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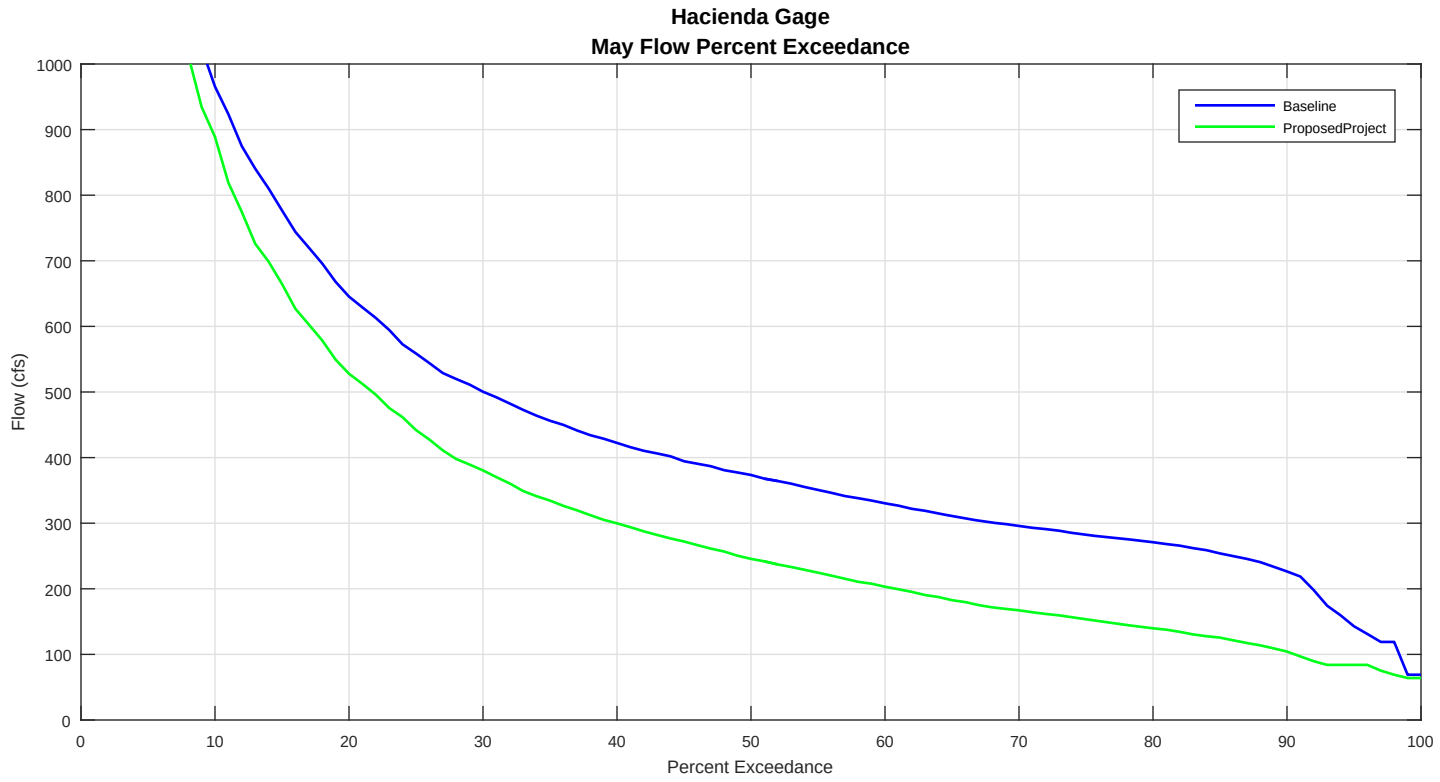
Hacienda Gage
May Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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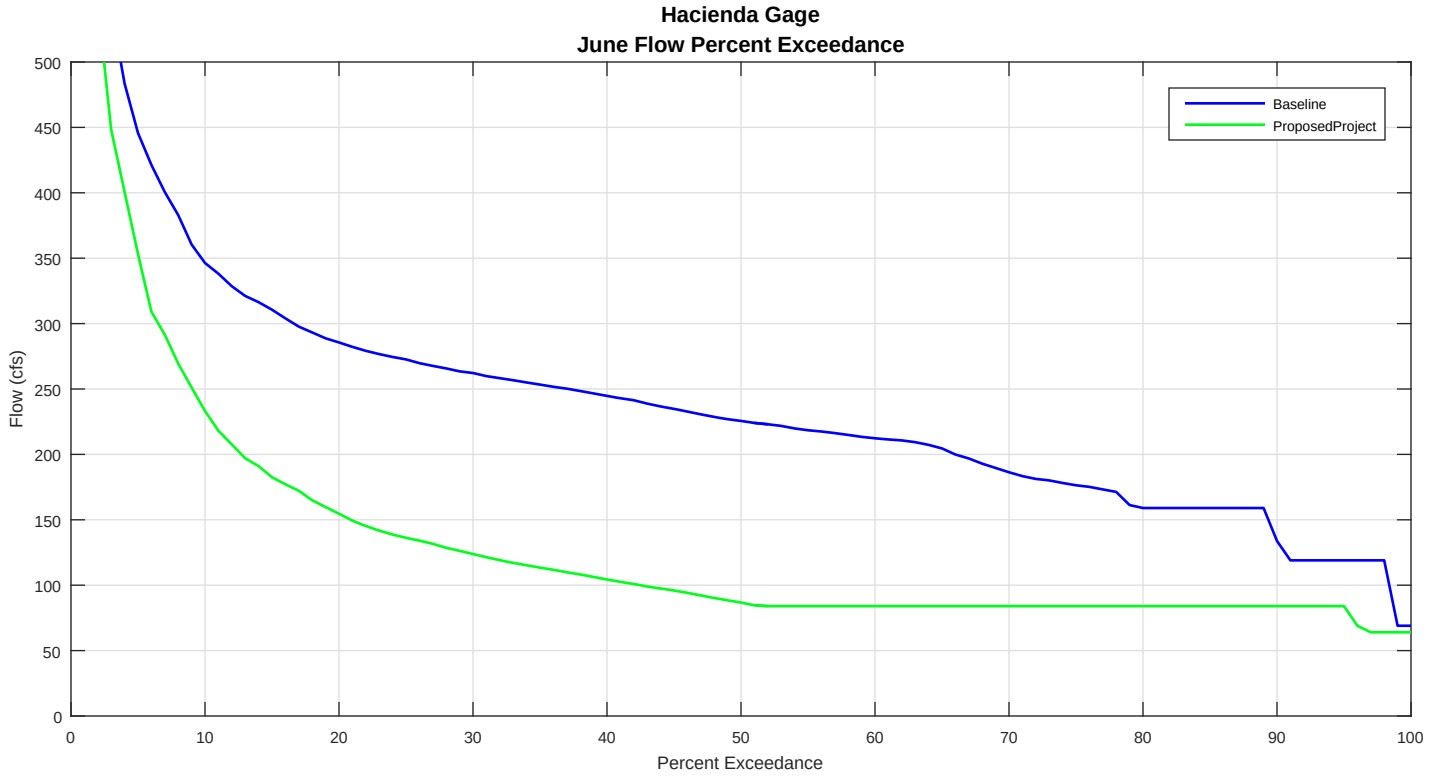
Hacienda Gage
June Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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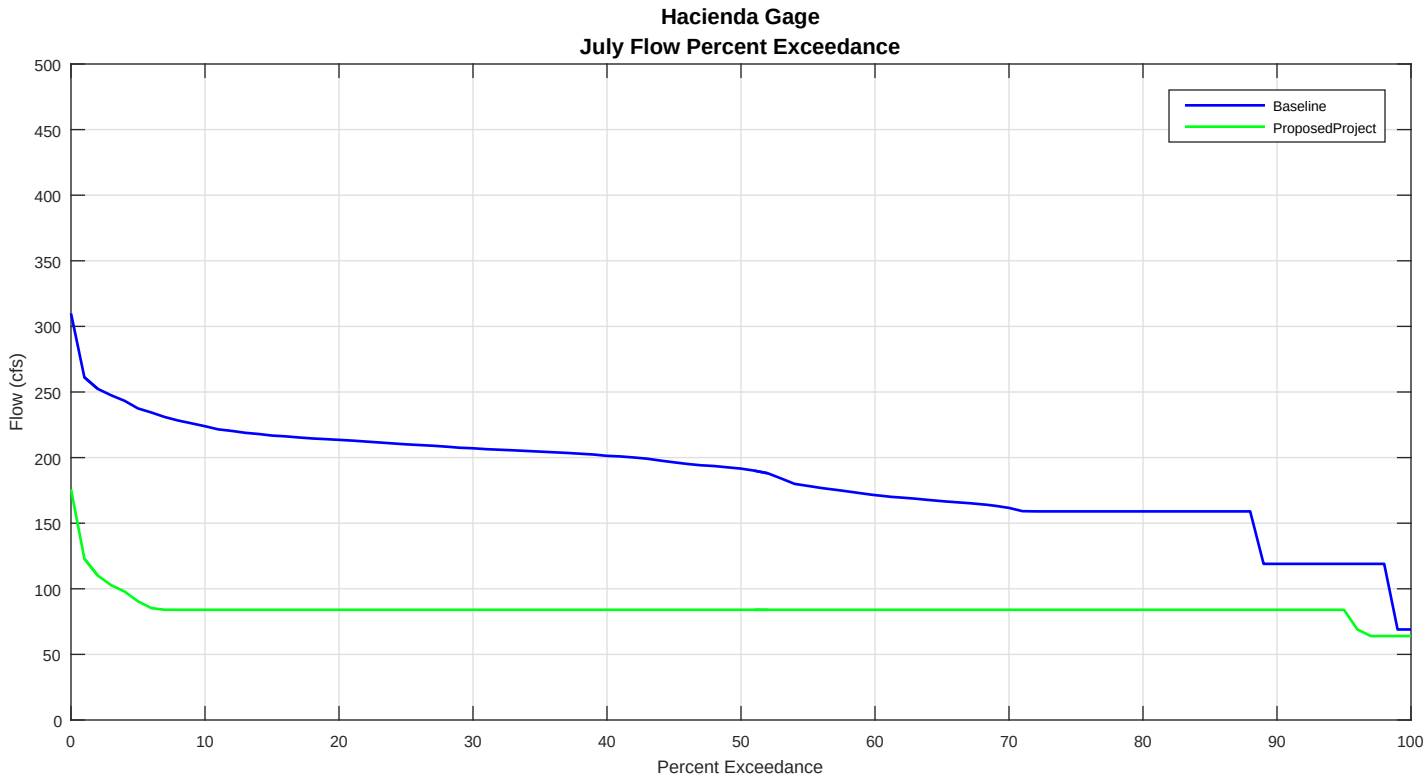
Hacienda Gage
July Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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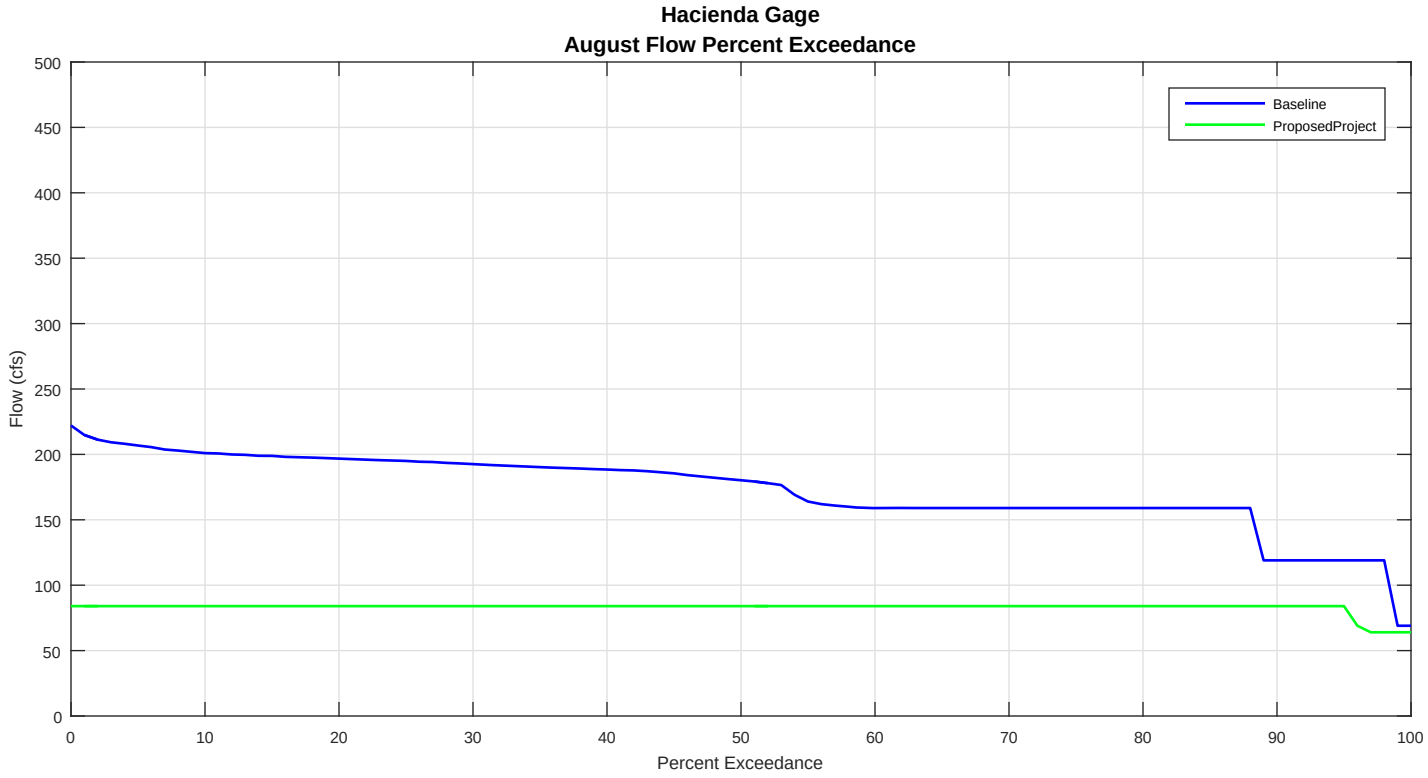
Hacienda Gage
August Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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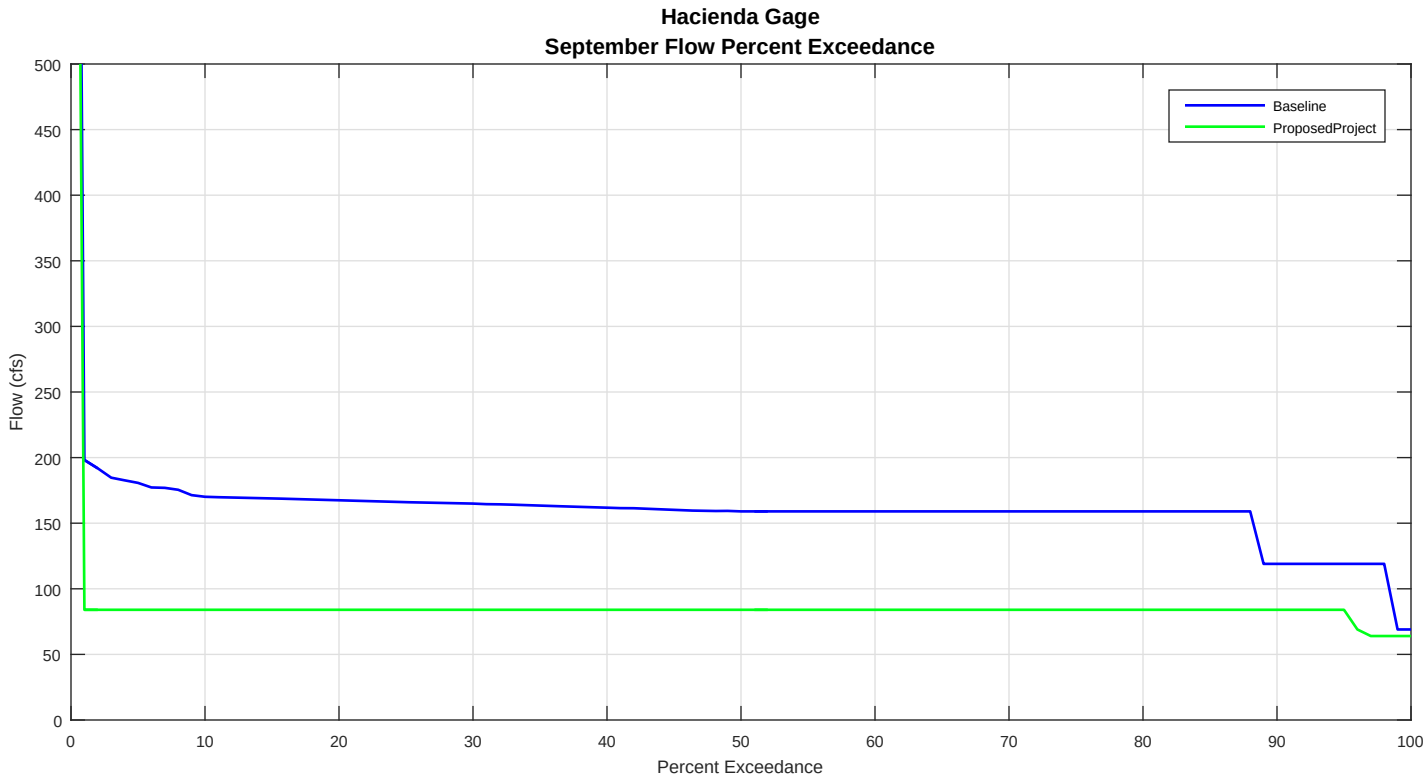
Hacienda Gage
September Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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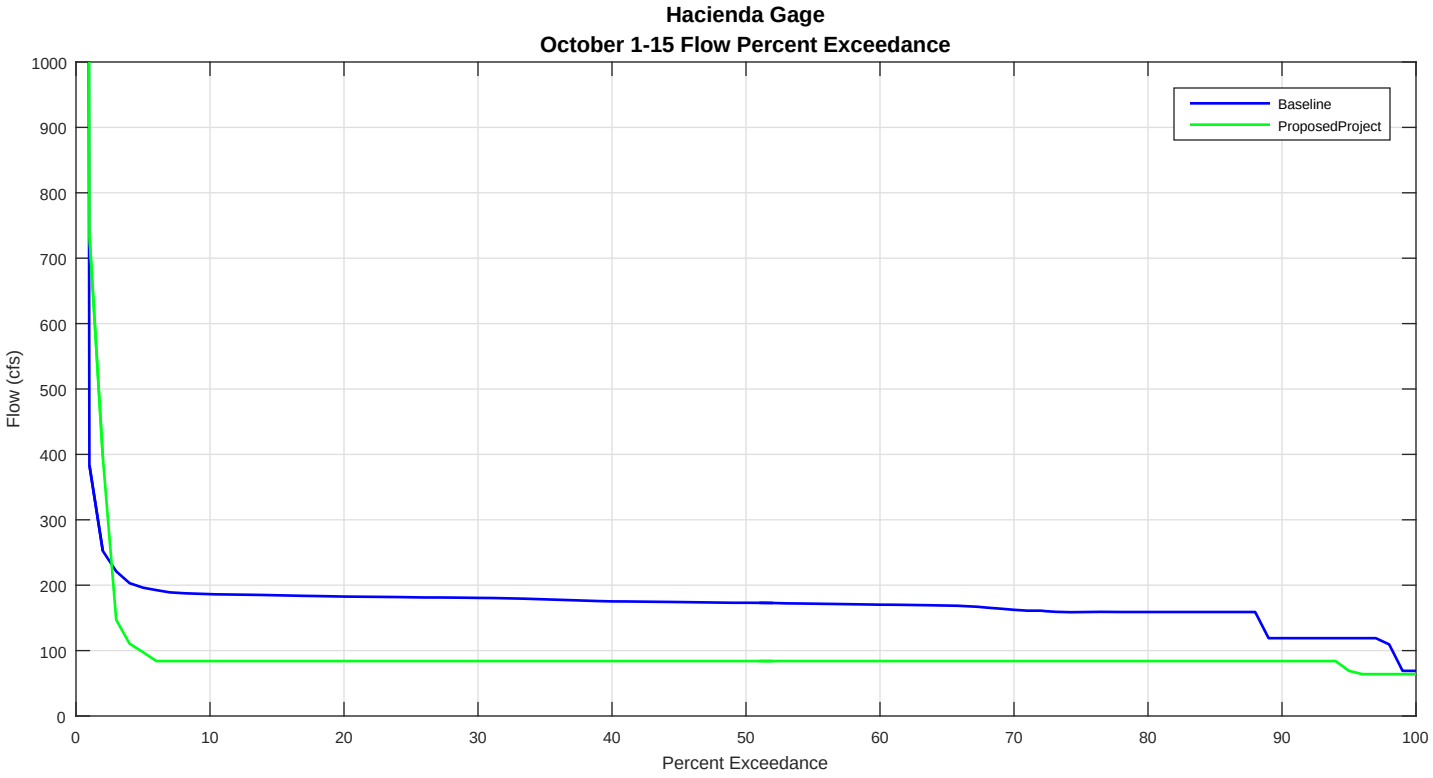
Hacienda Gage
October 1-15 Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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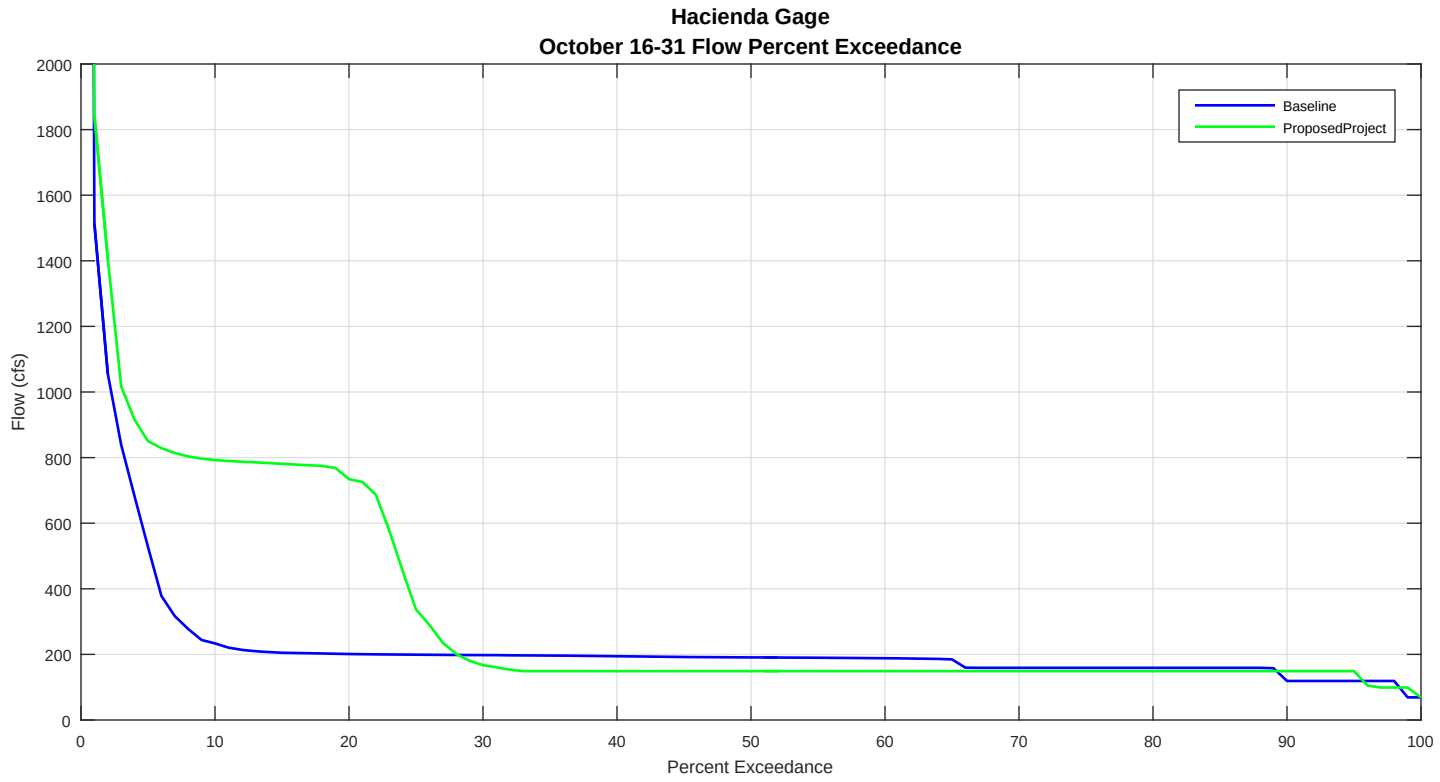
Hacienda Gage
October 16-31 Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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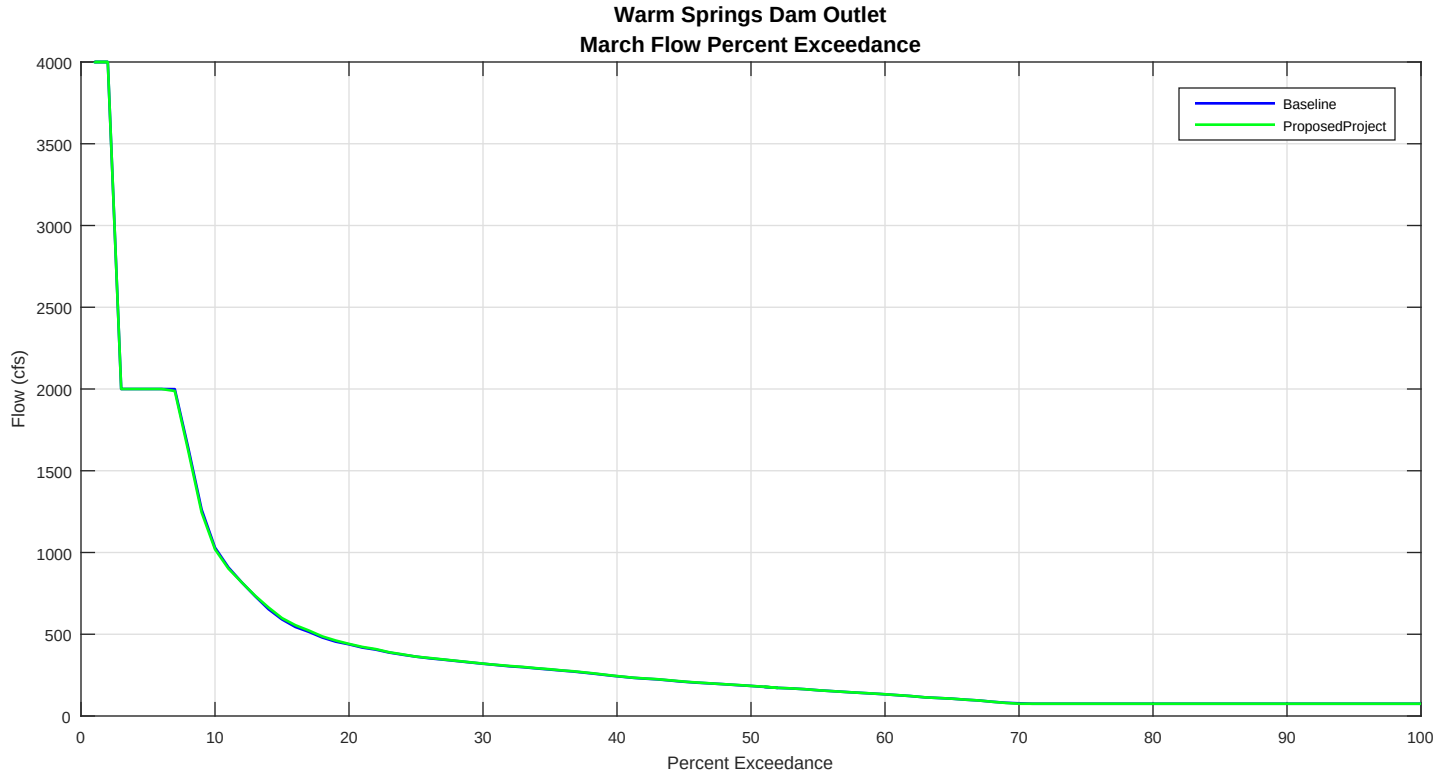
Warm Springs Dam Outlet
March Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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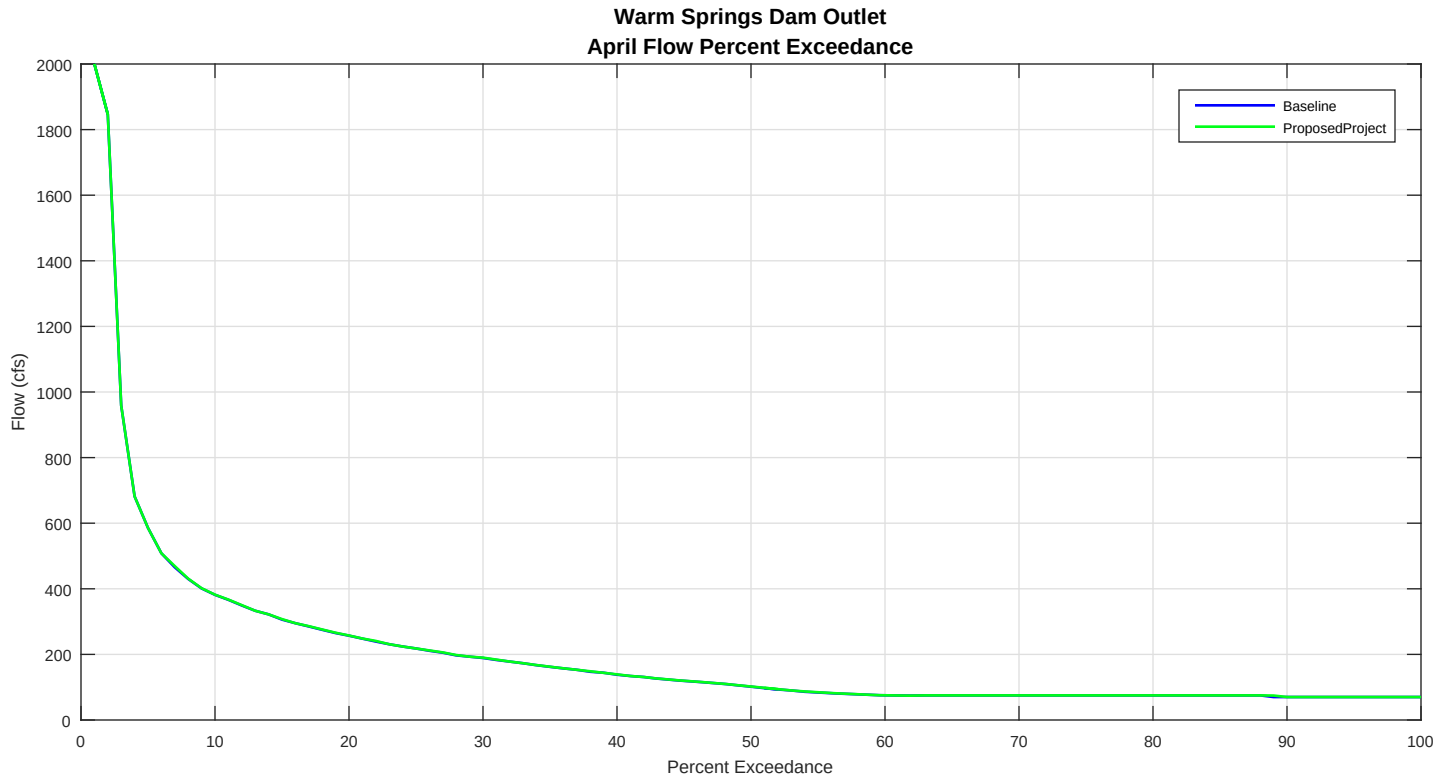
Warm Springs Dam Outlet
April Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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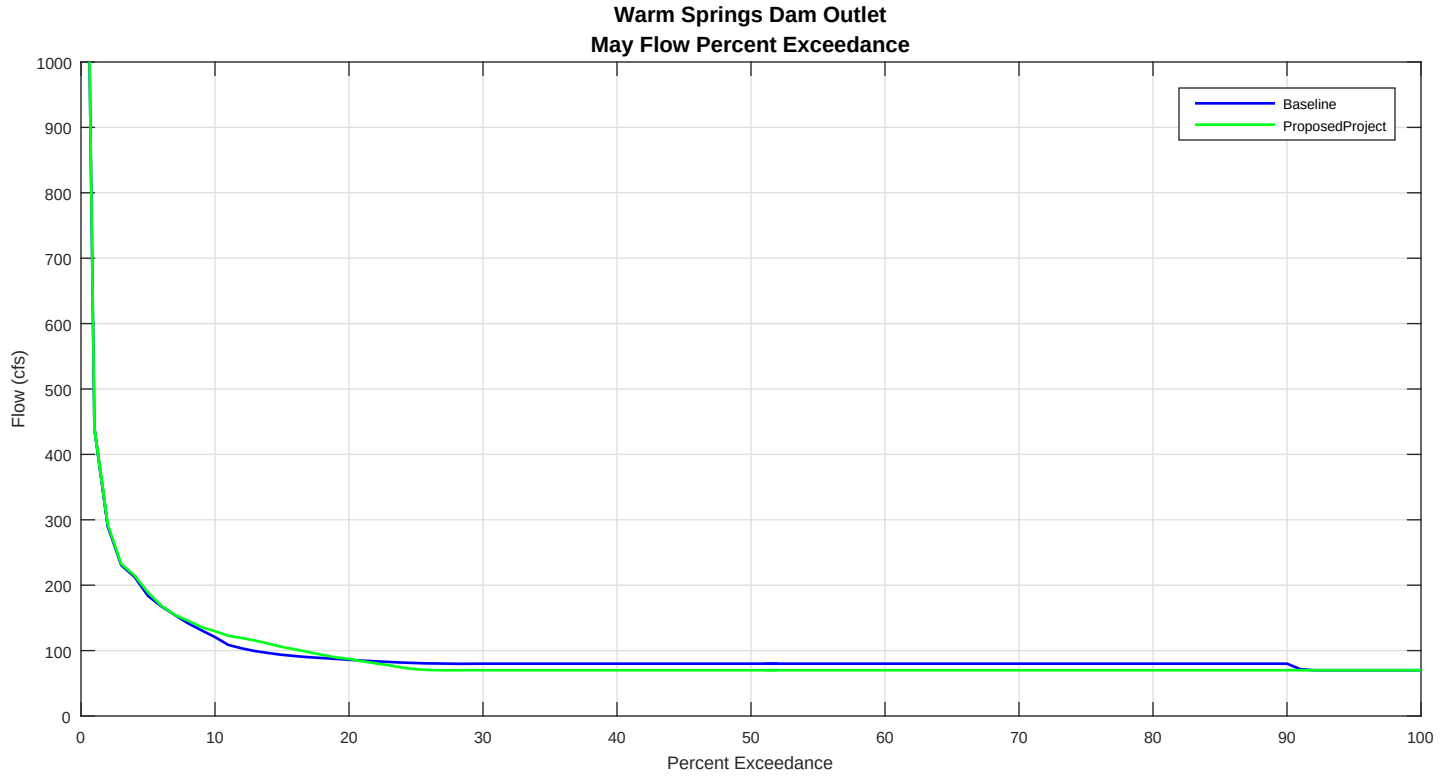
Warm Springs Dam Outlet
May Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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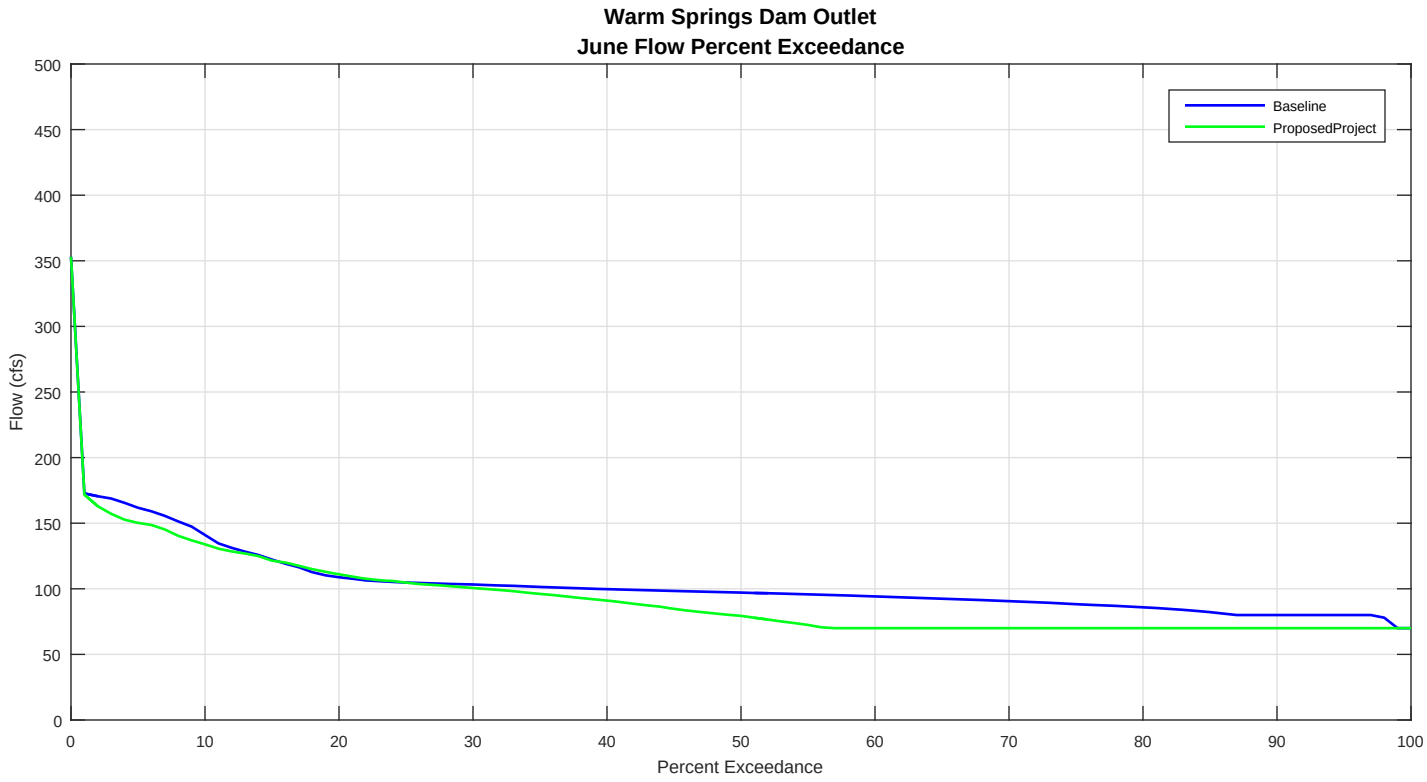
Warm Springs Dam Outlet
June Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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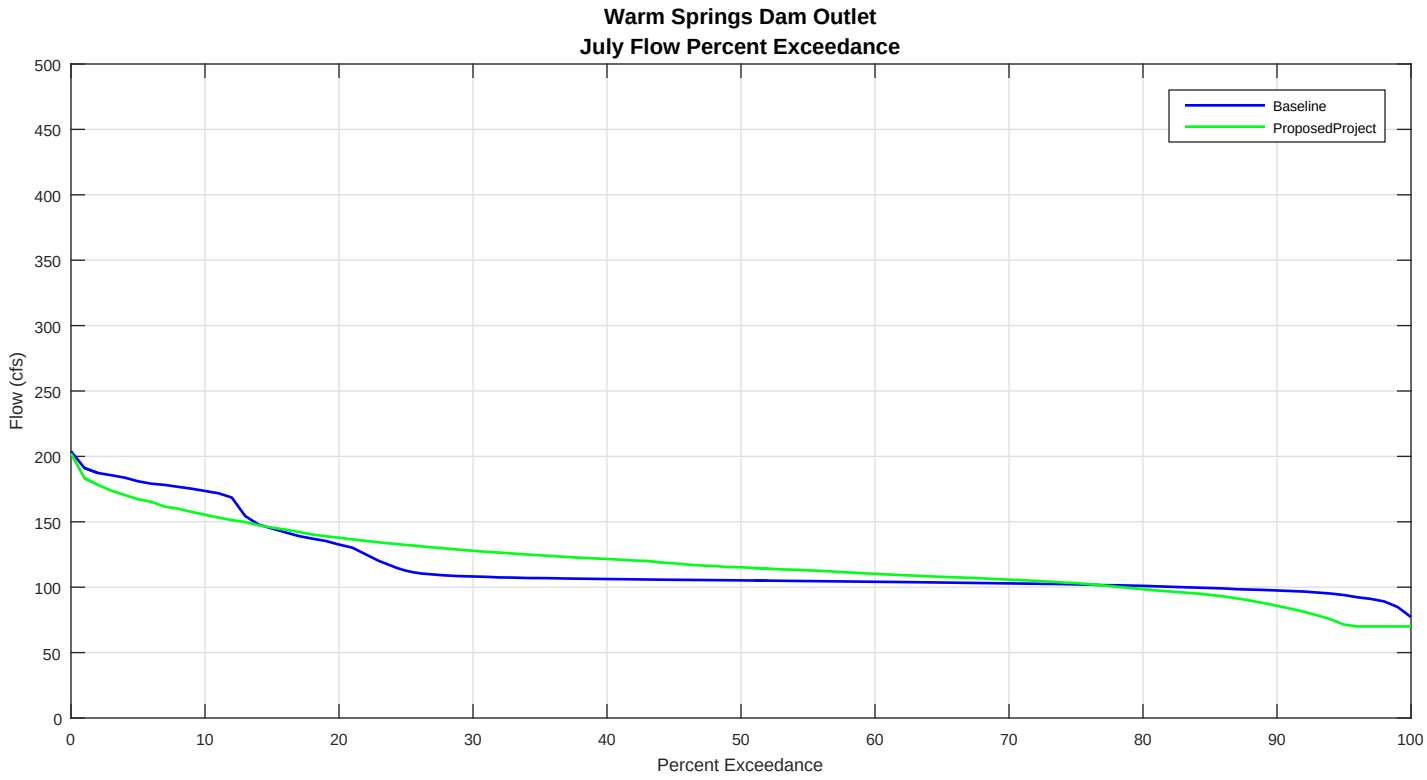
Warm Springs Dam Outlet
July Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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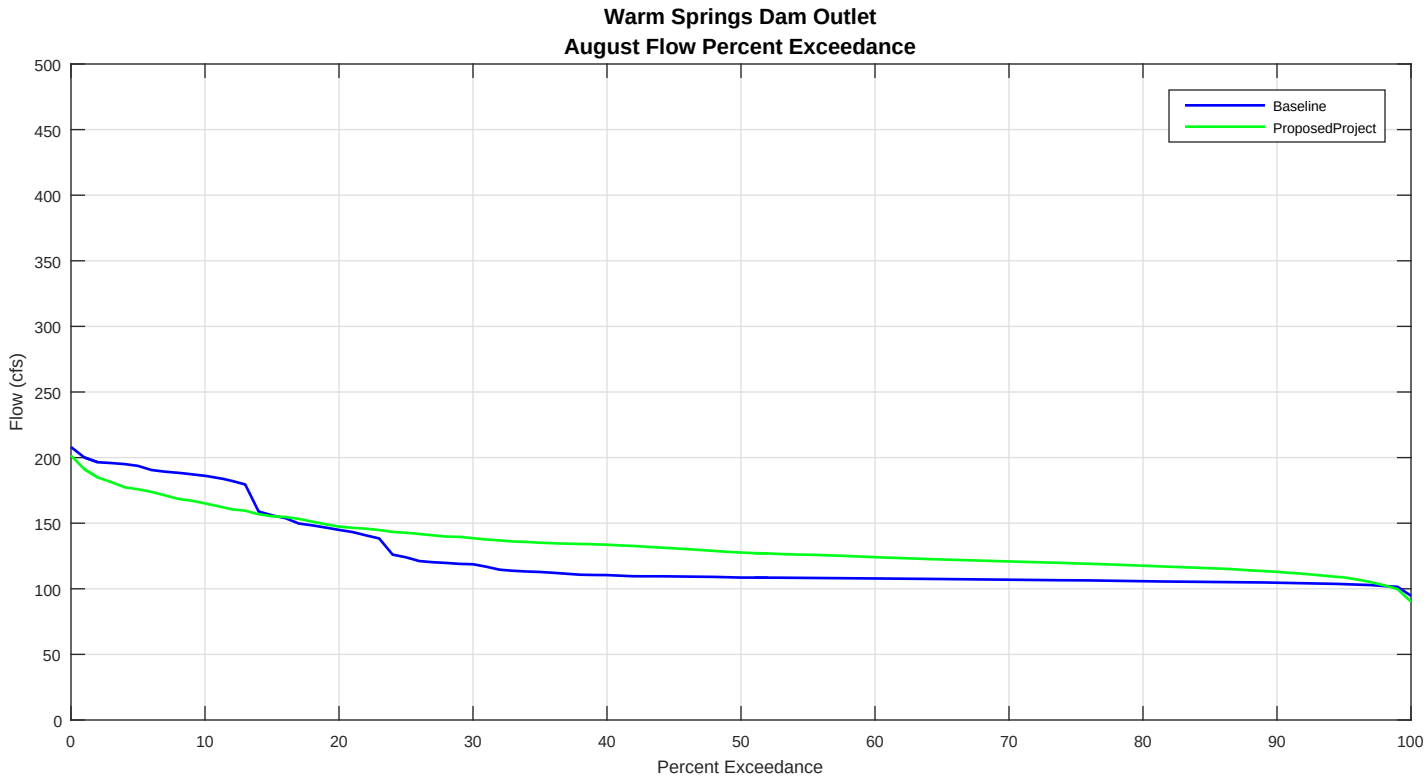
Warm Springs Dam Outlet
August Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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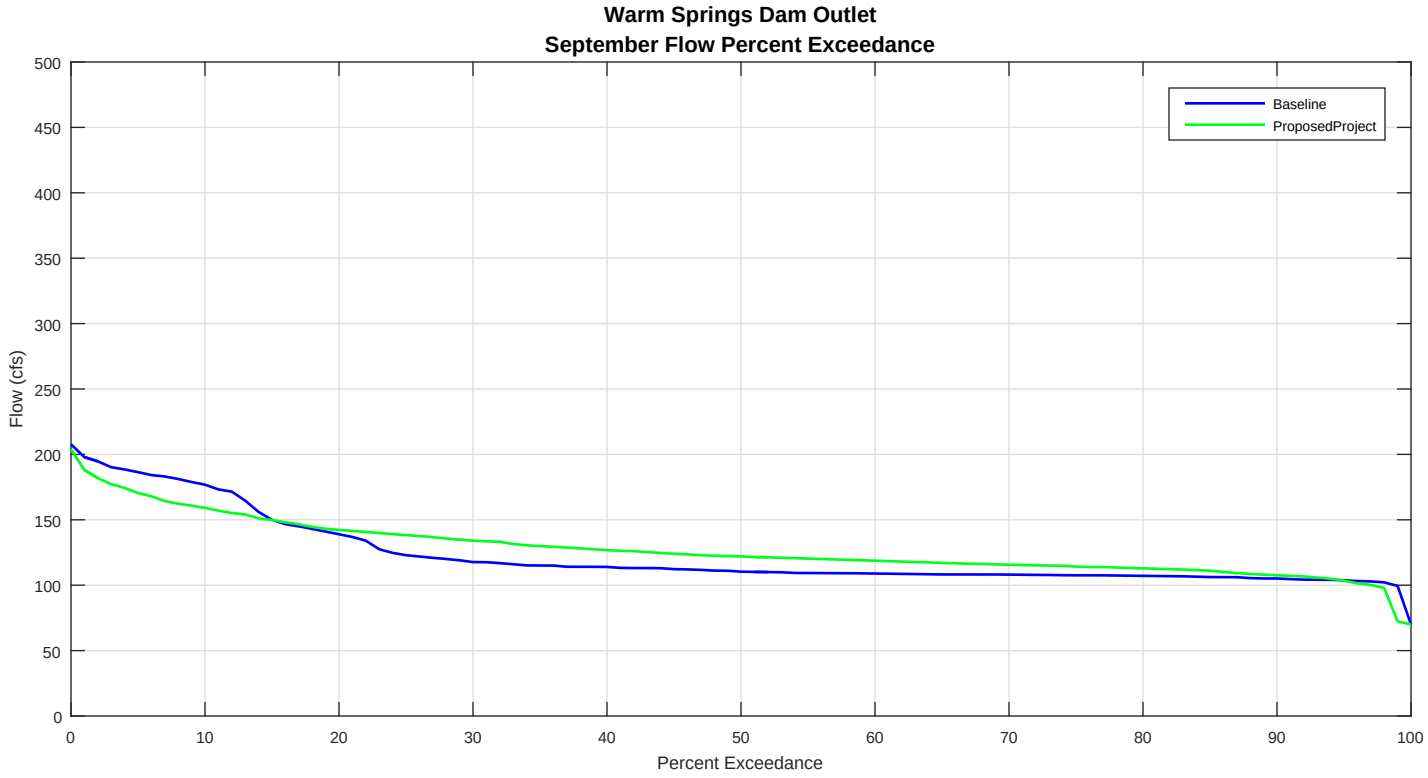
Warm Springs Dam Outlet
September Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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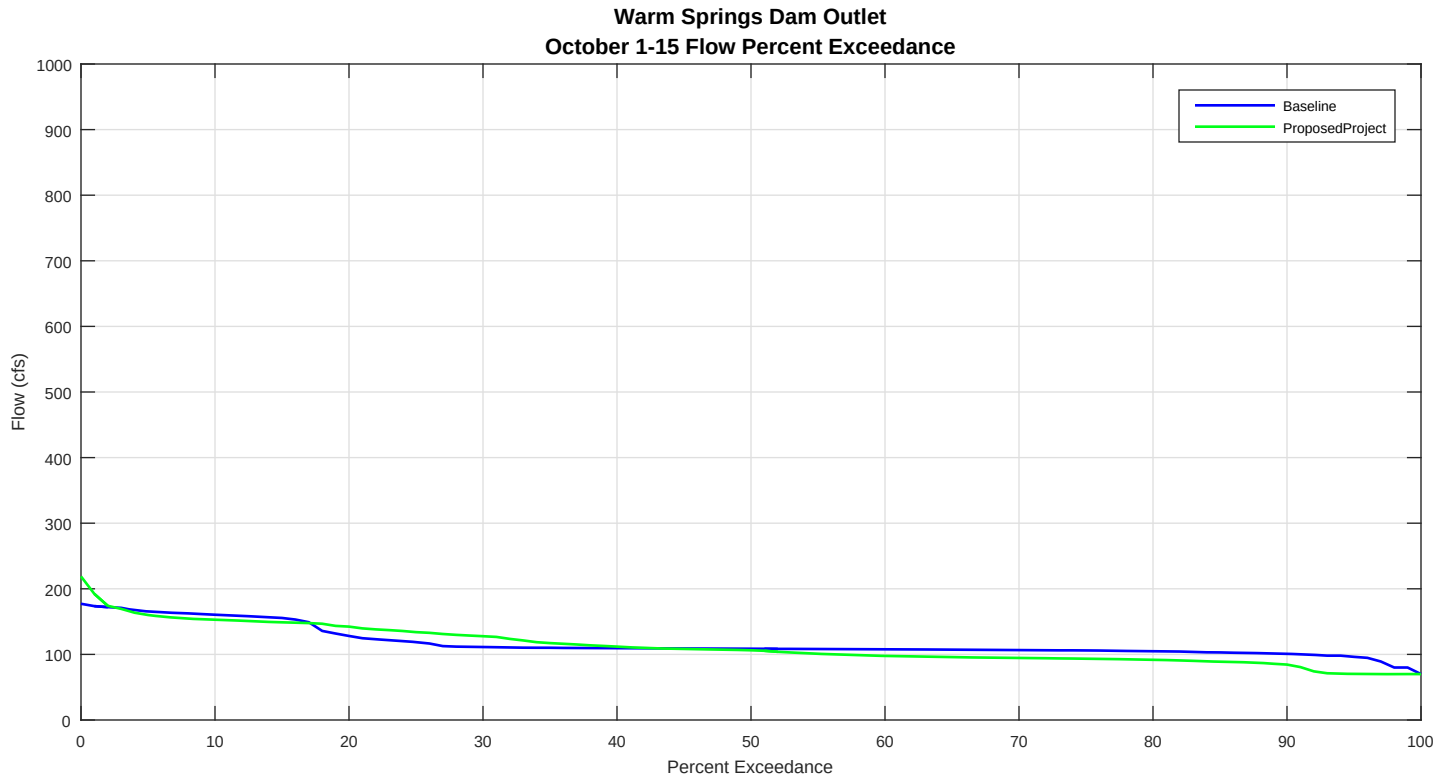
Warm Springs Dam Outlet
October 1-15 Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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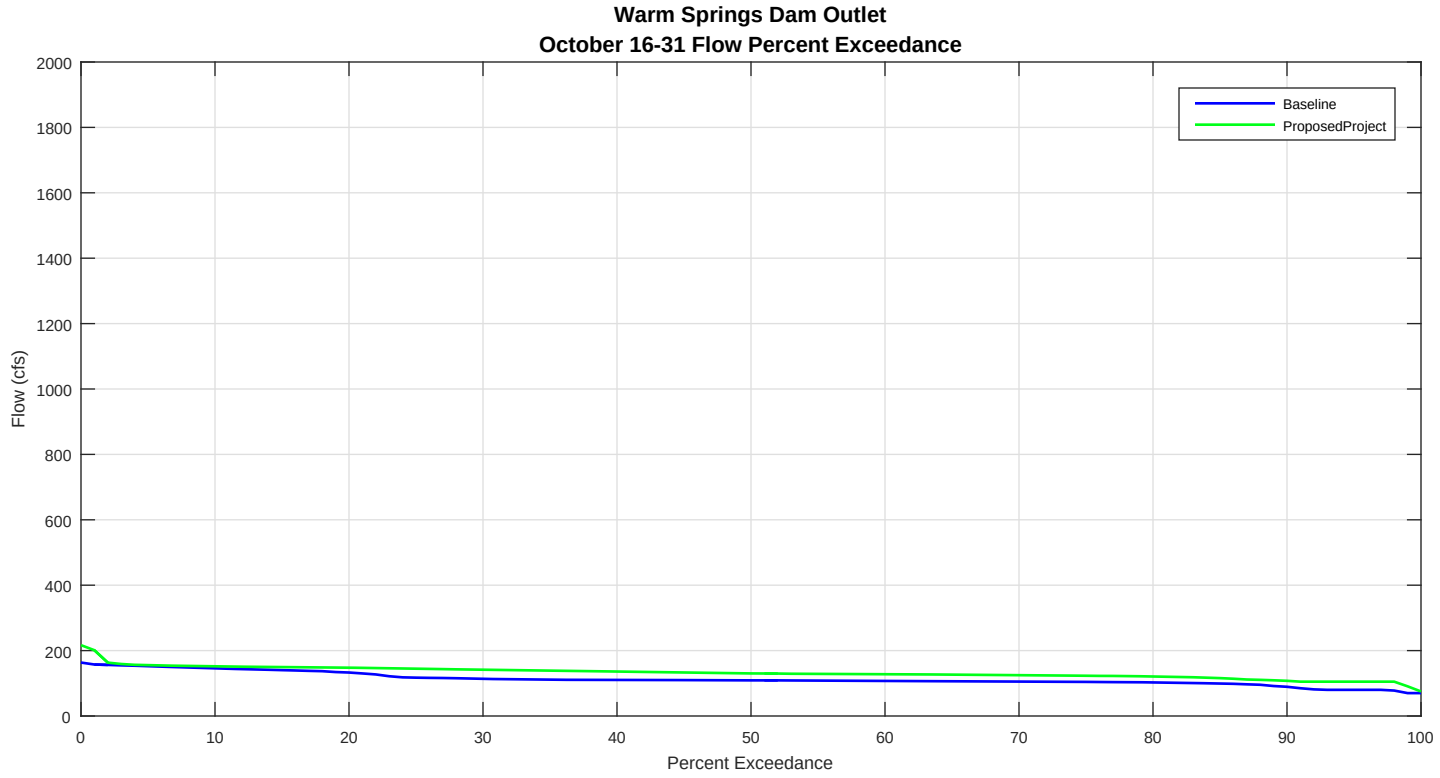
Warm Springs Dam Outlet
October 16-31 Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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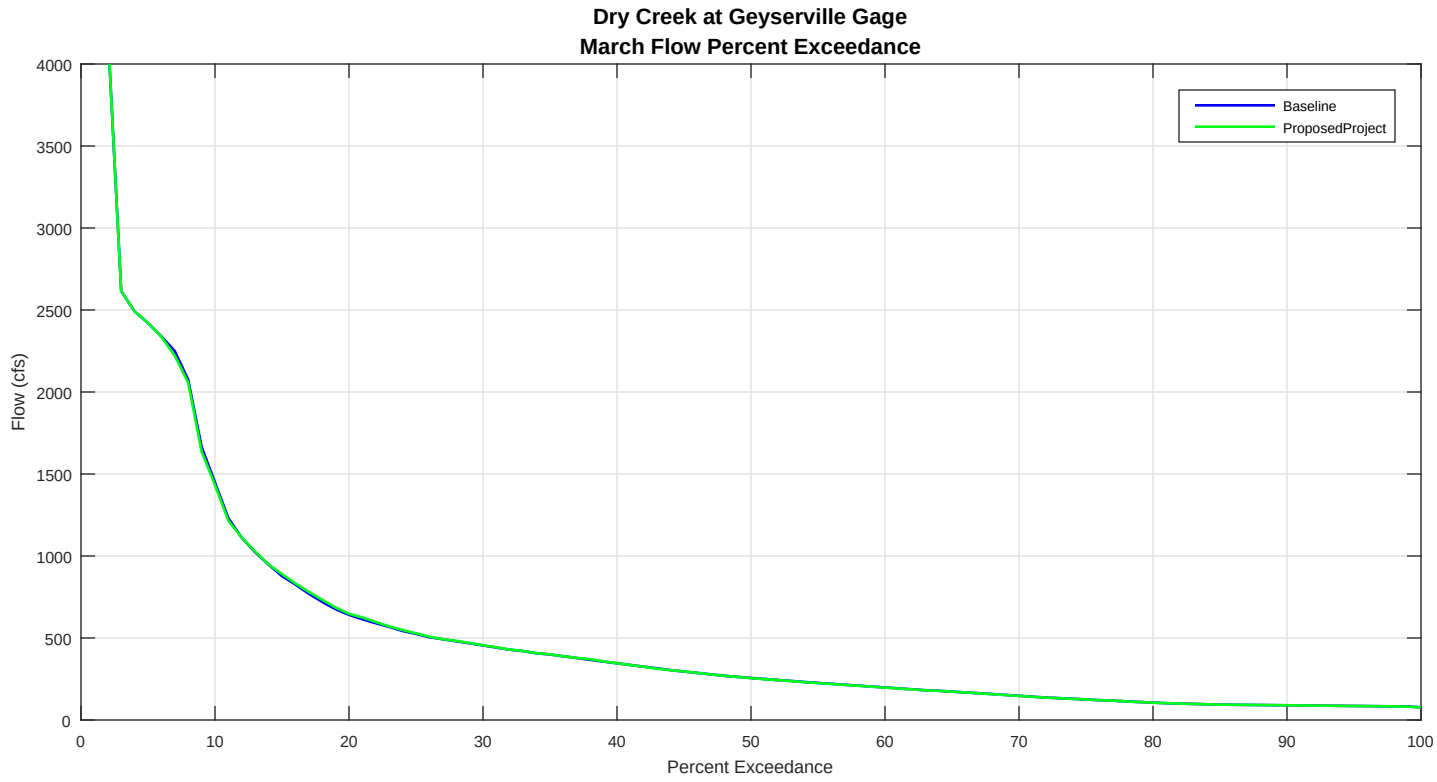
Dry Creek at Geyserville Gage
March Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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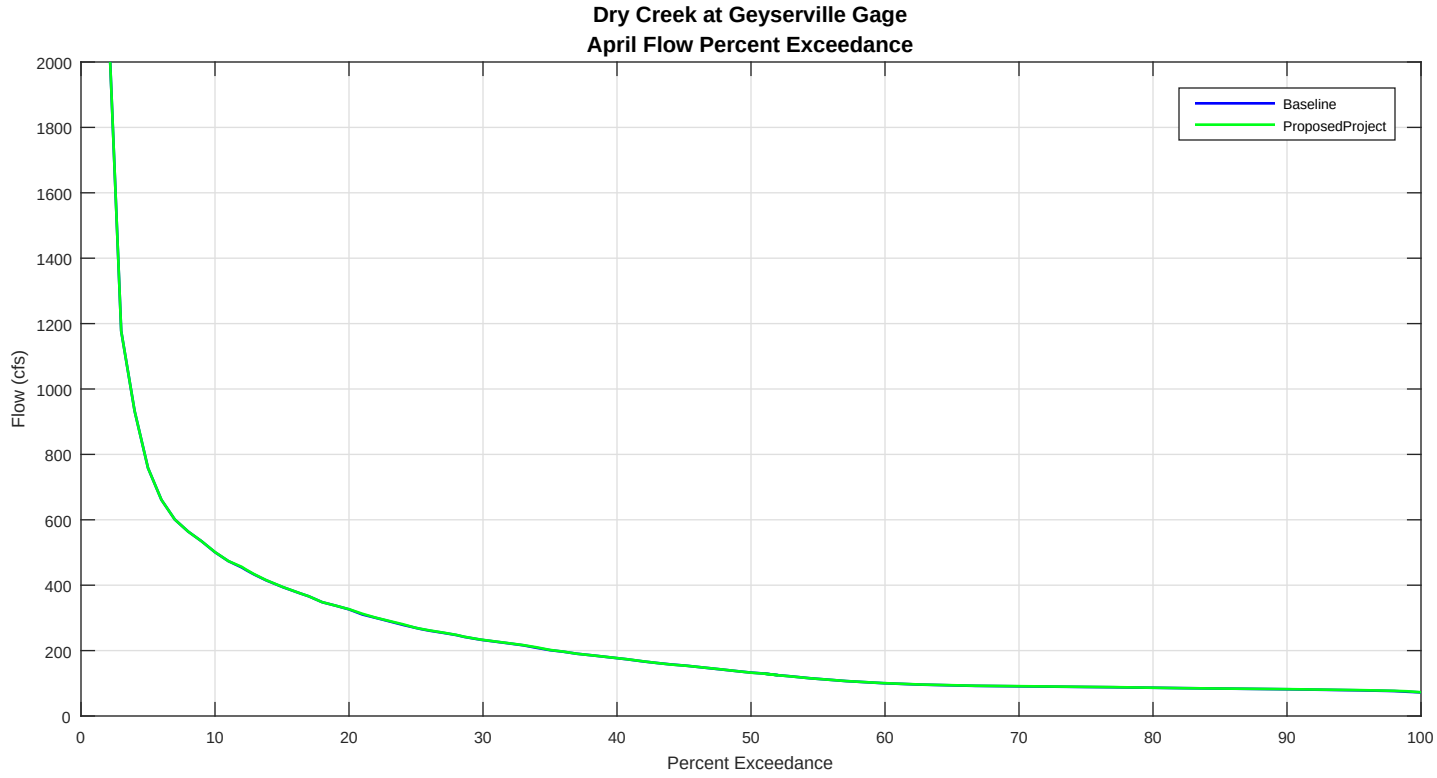
Dry Creek at Geyserville Gage
April Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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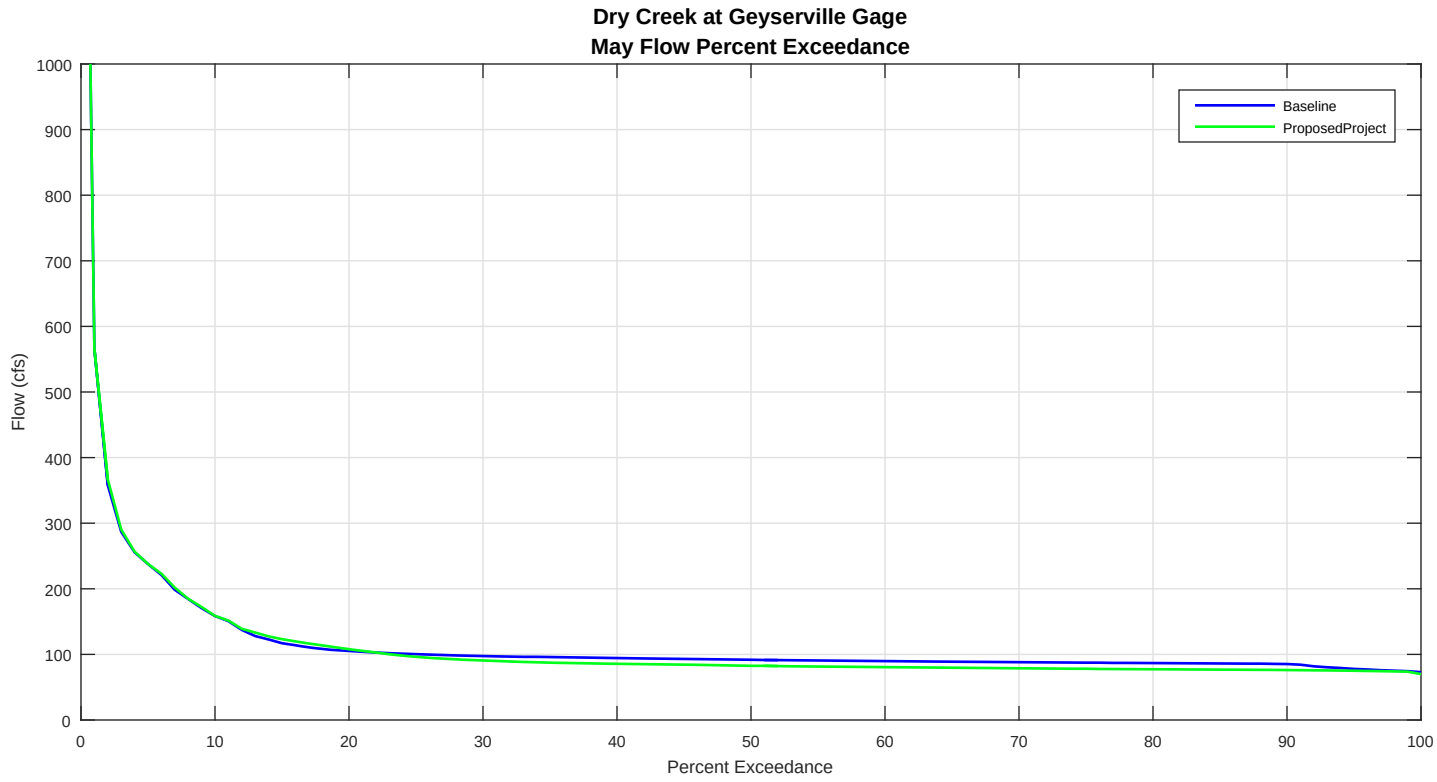
Dry Creek at Geyserville Gage
May Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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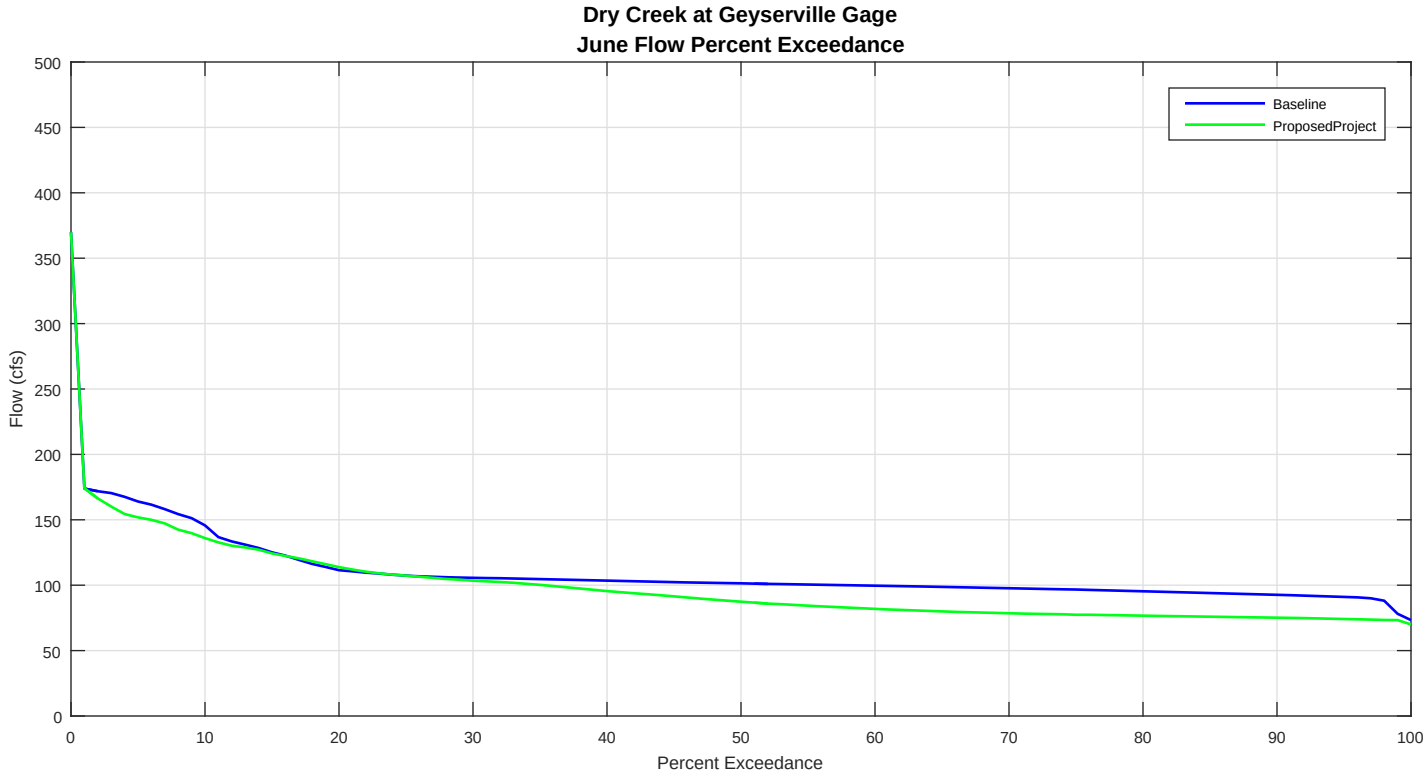
Dry Creek at Geyserville Gage
June Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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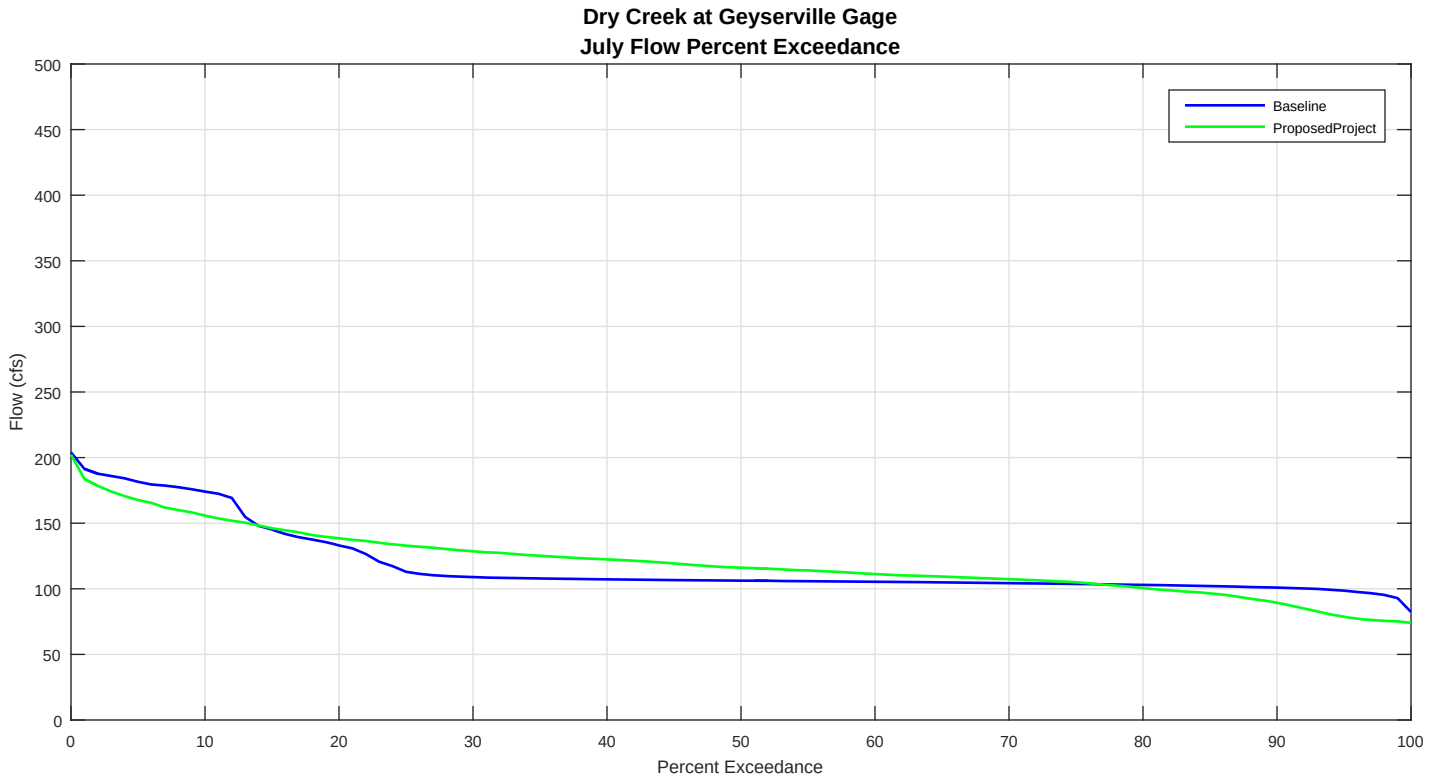
Dry Creek at Geyserville Gage
July Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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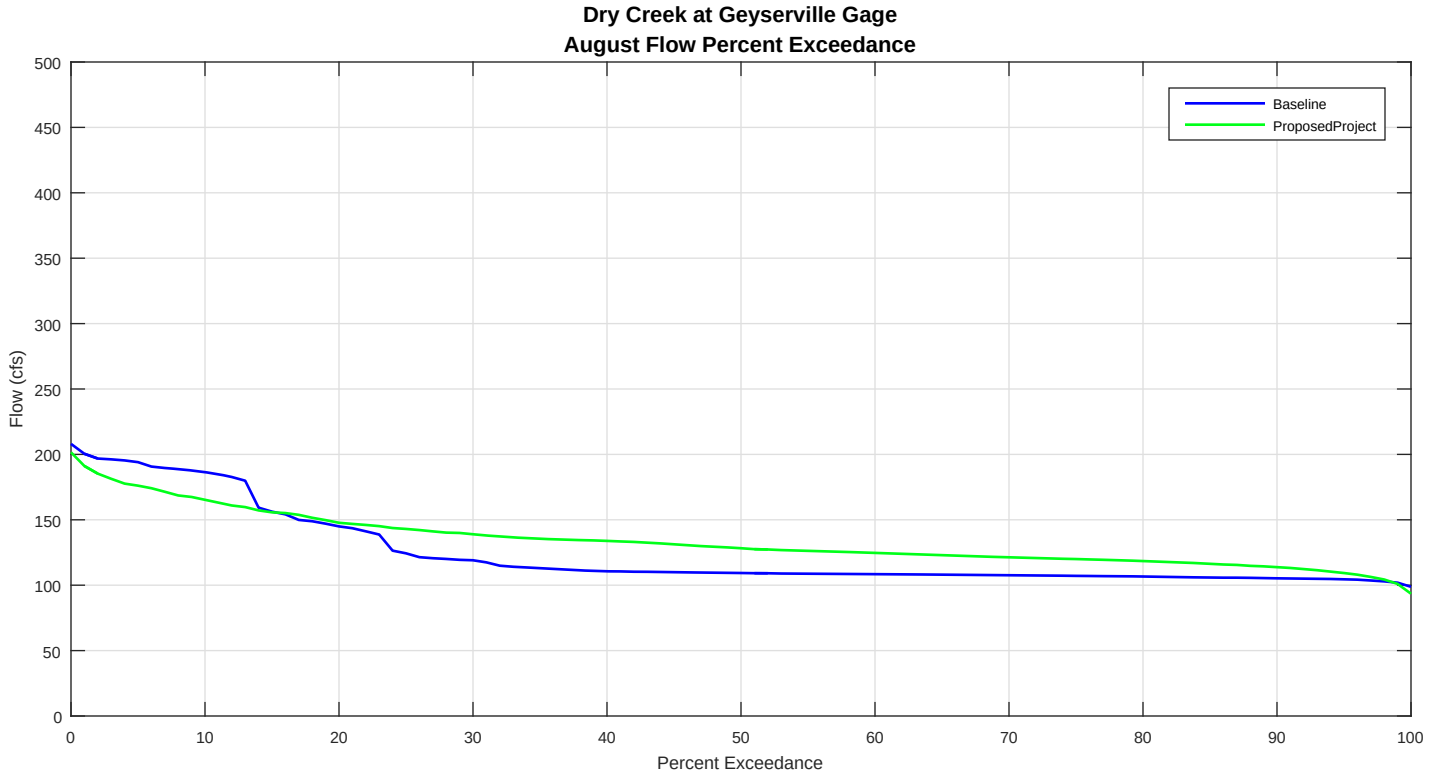
Dry Creek at Geyserville Gage
August Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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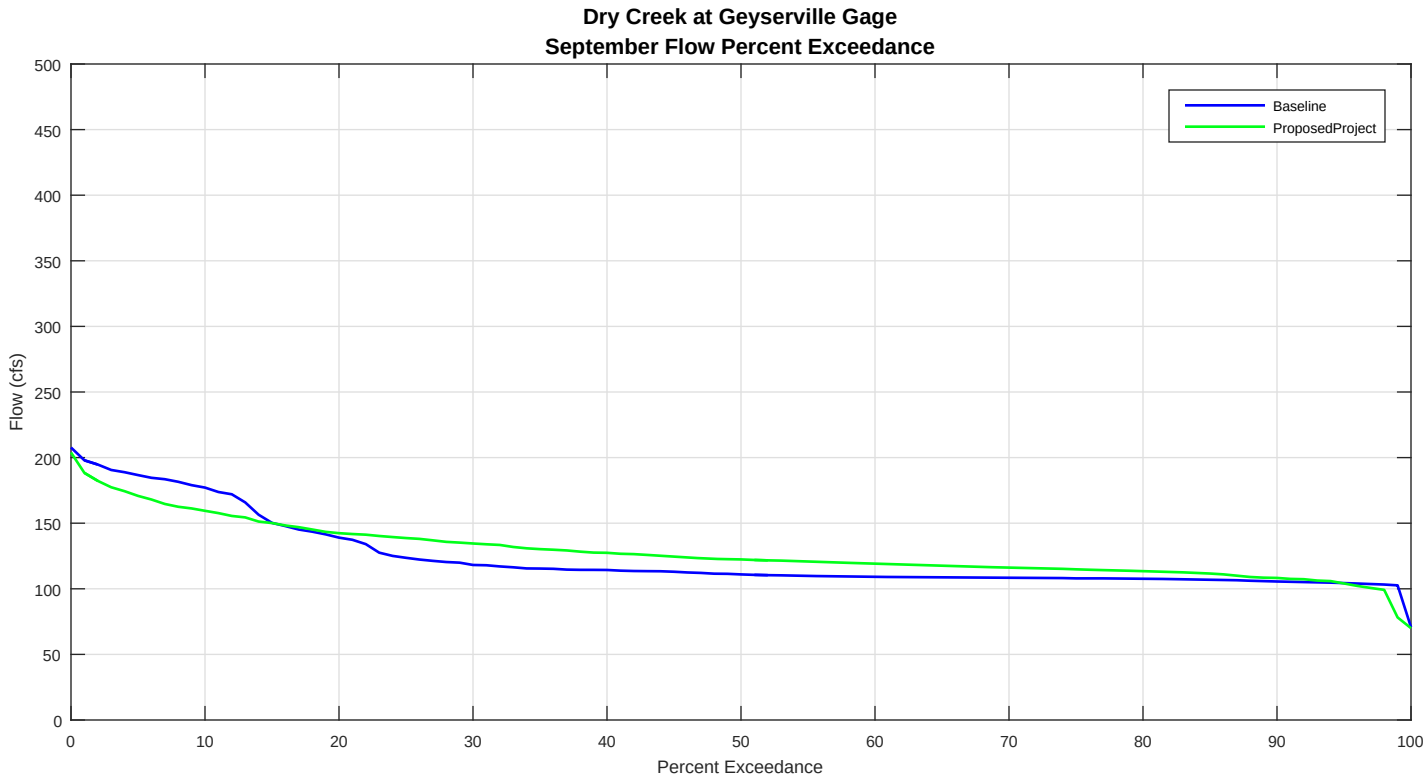
Dry Creek at Geyserville Gage
September Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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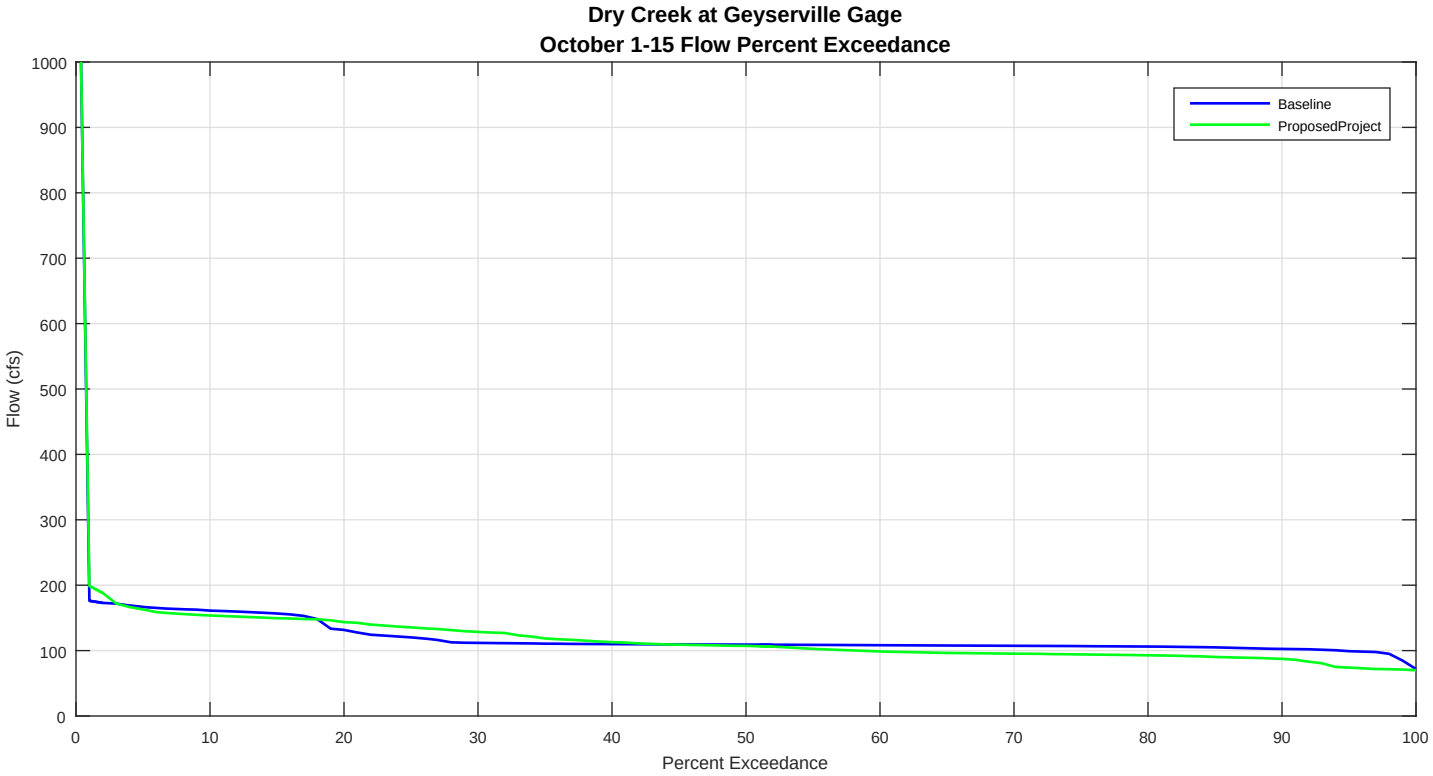
Dry Creek at Geyserville Gage
October 1-15 Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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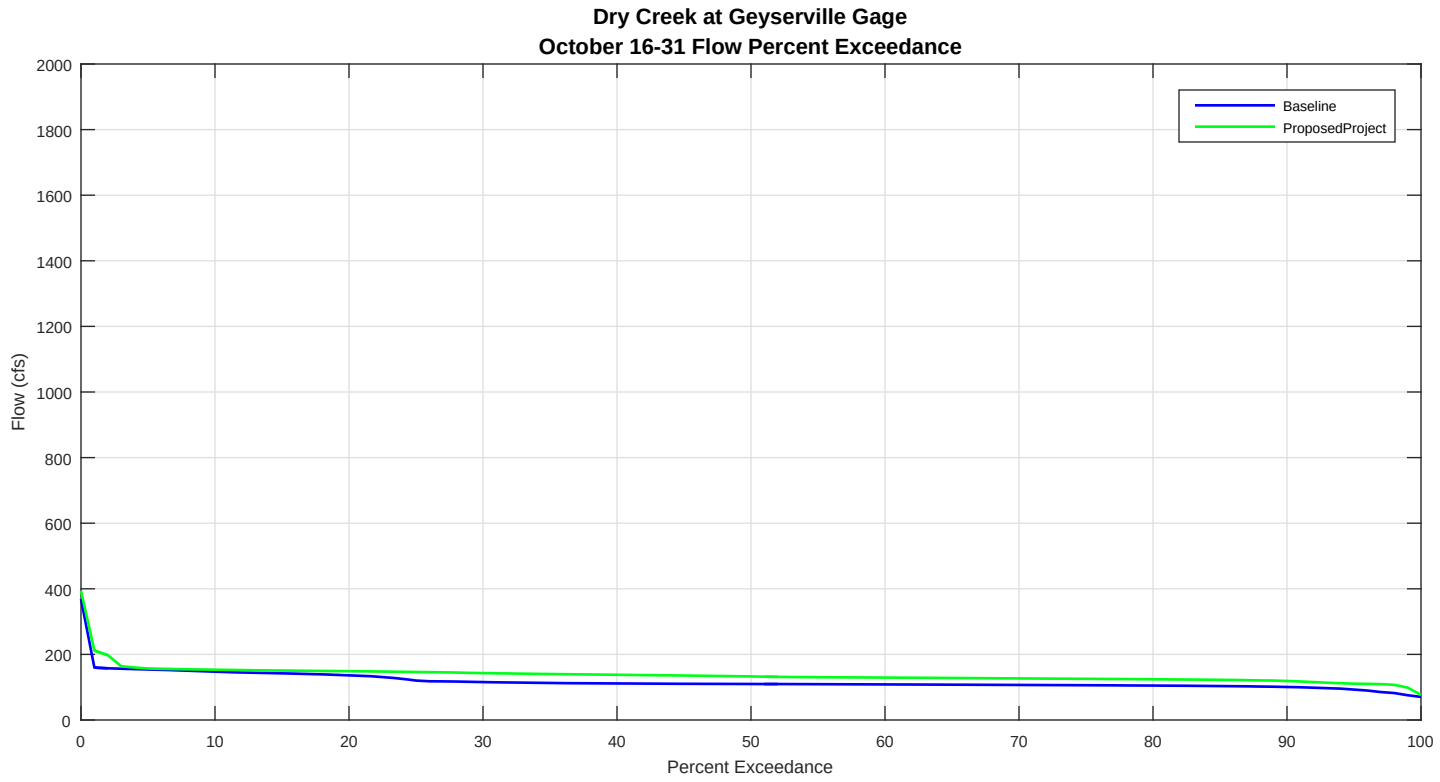
Dry Creek at Geyserville Gage
October 16-31 Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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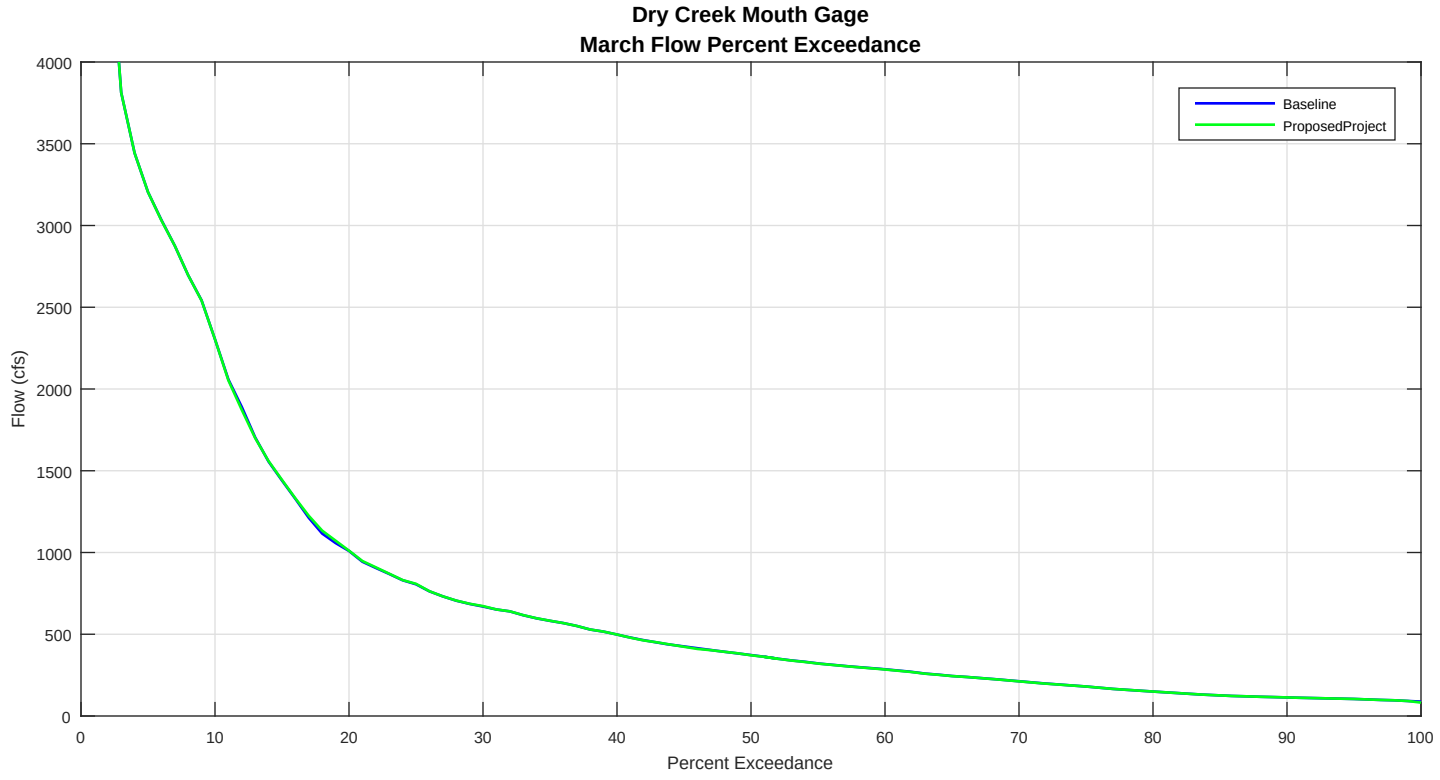
Dry Creek Mouth Gage
March Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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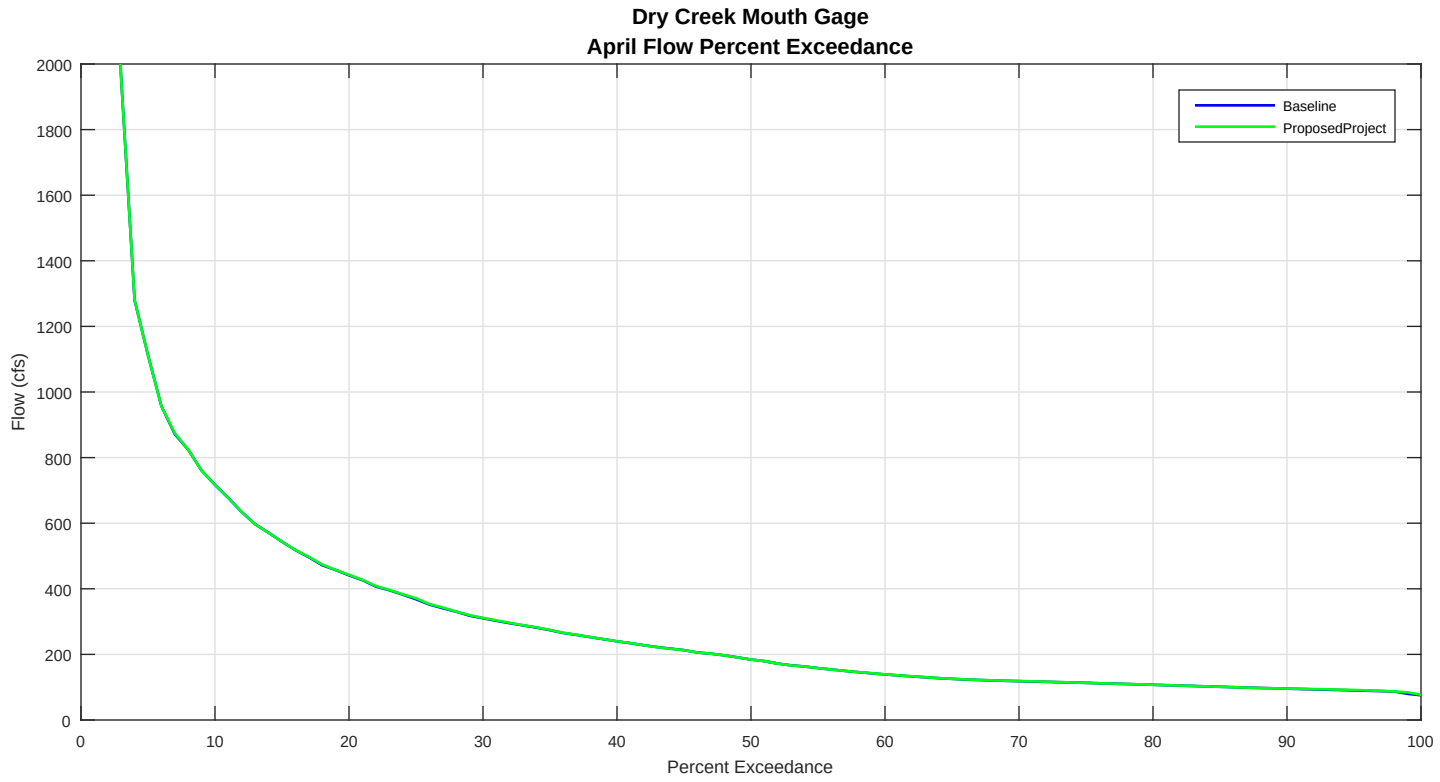
Dry Creek Mouth Gage
April Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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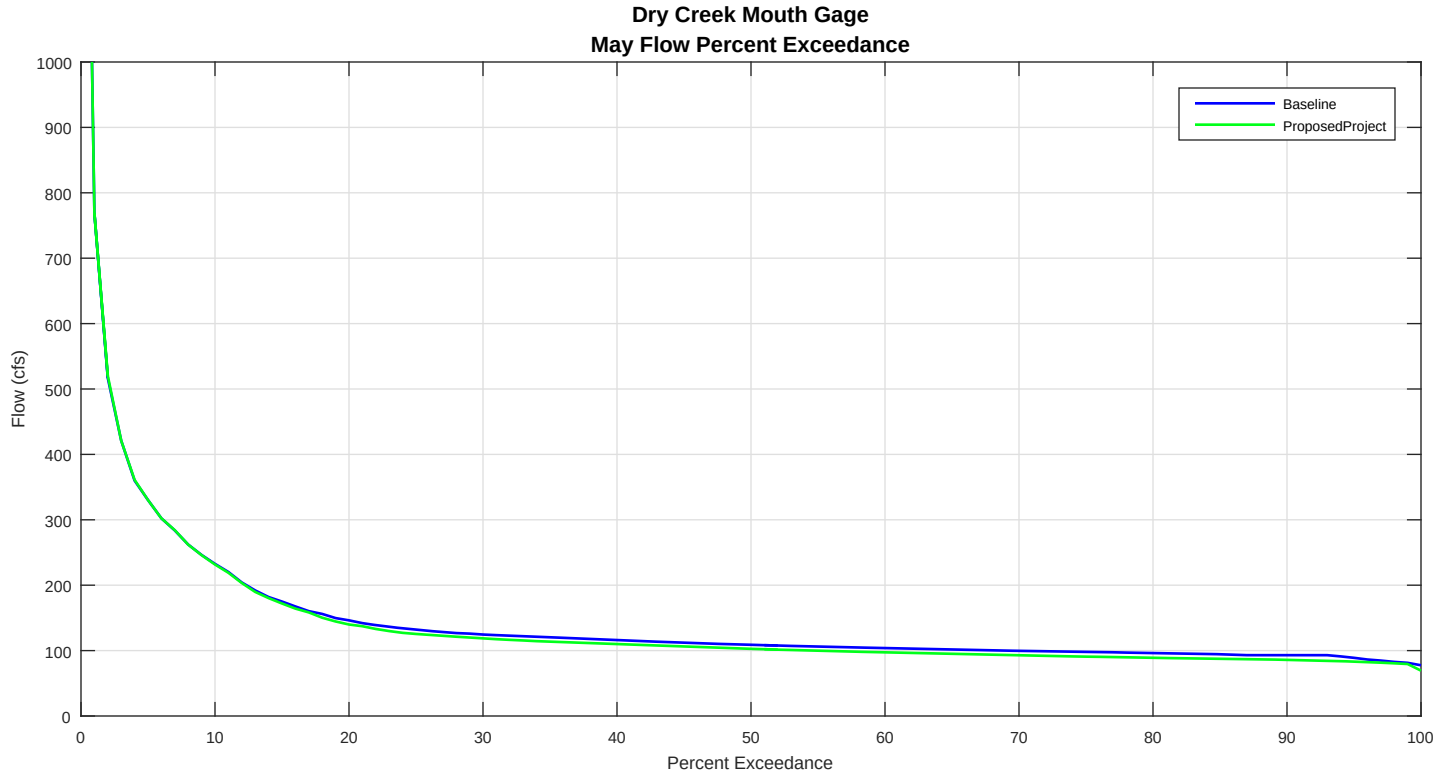
Dry Creek Mouth Gage
May Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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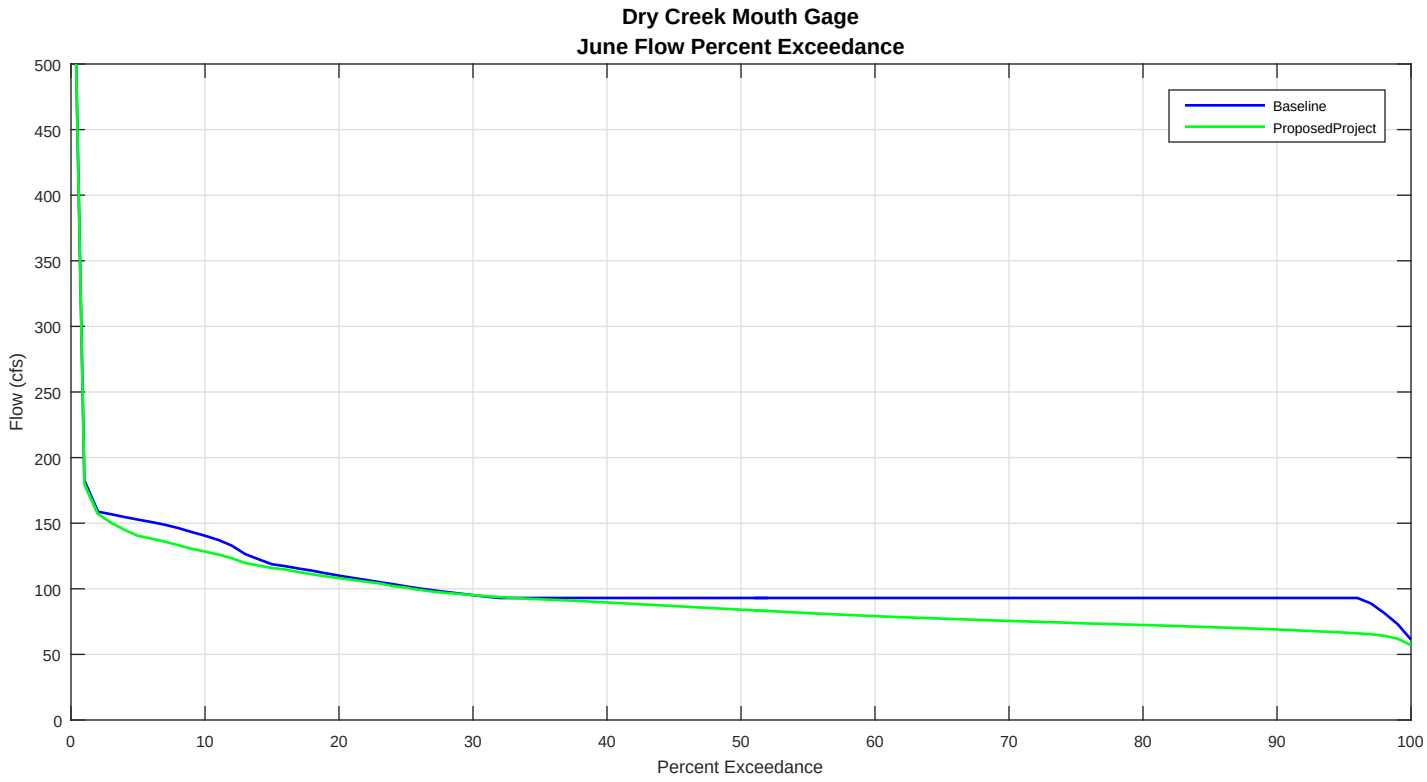
Dry Creek Mouth Gage
June Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
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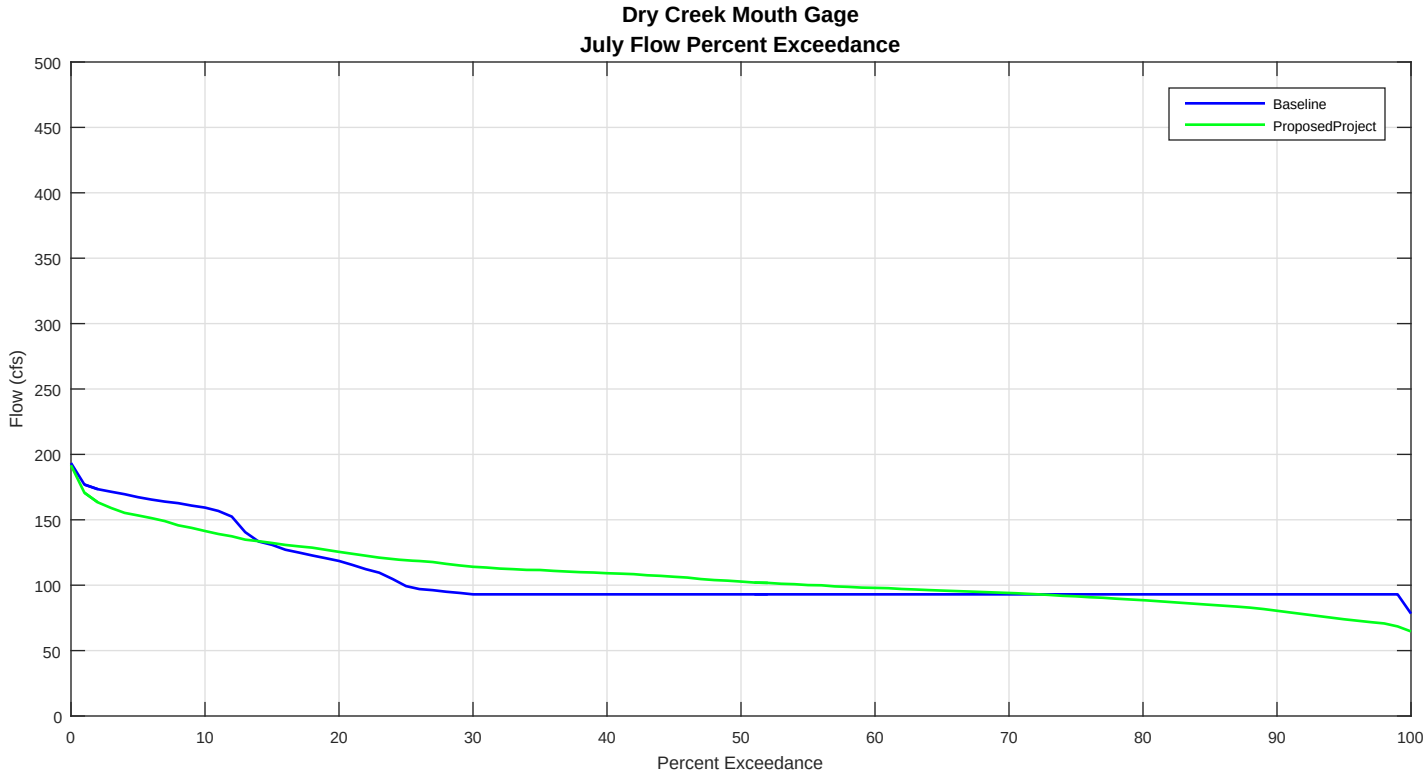
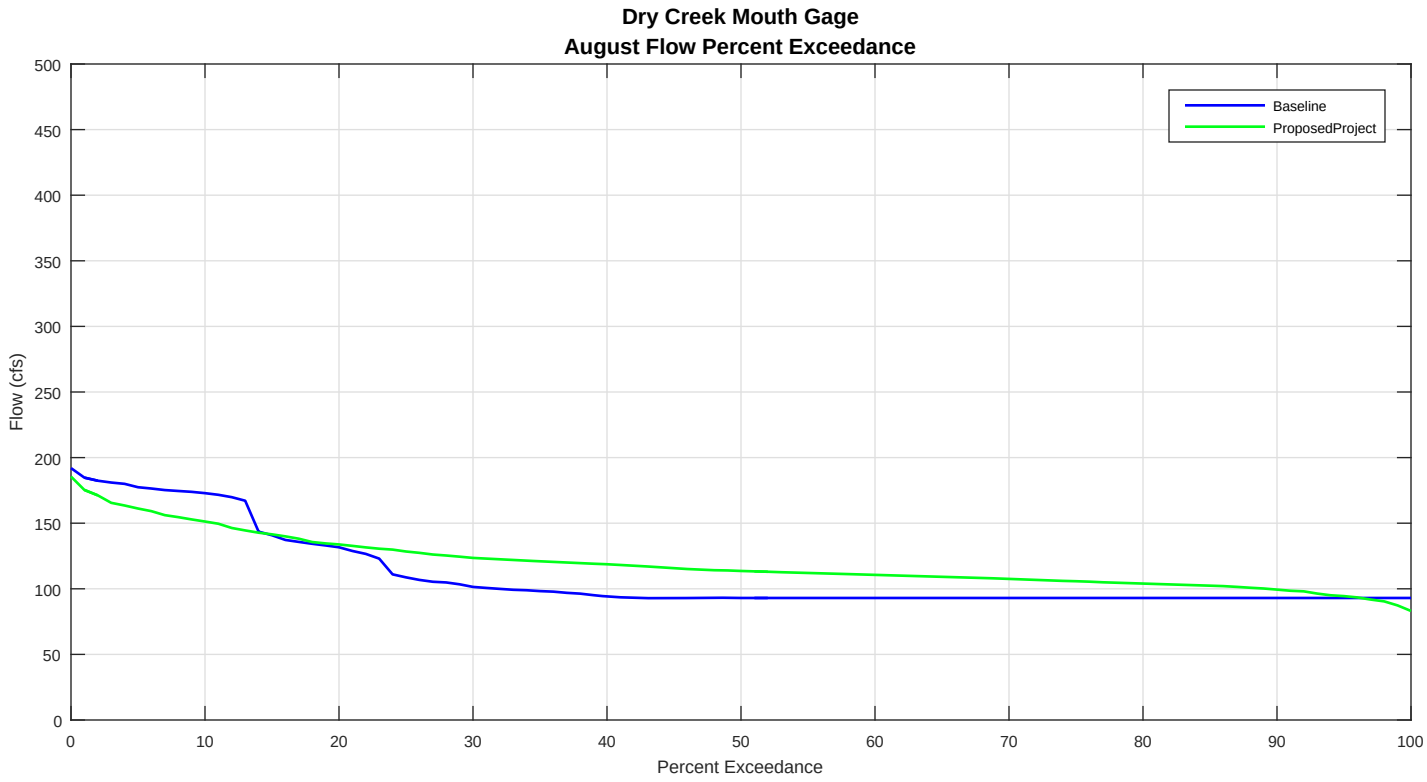
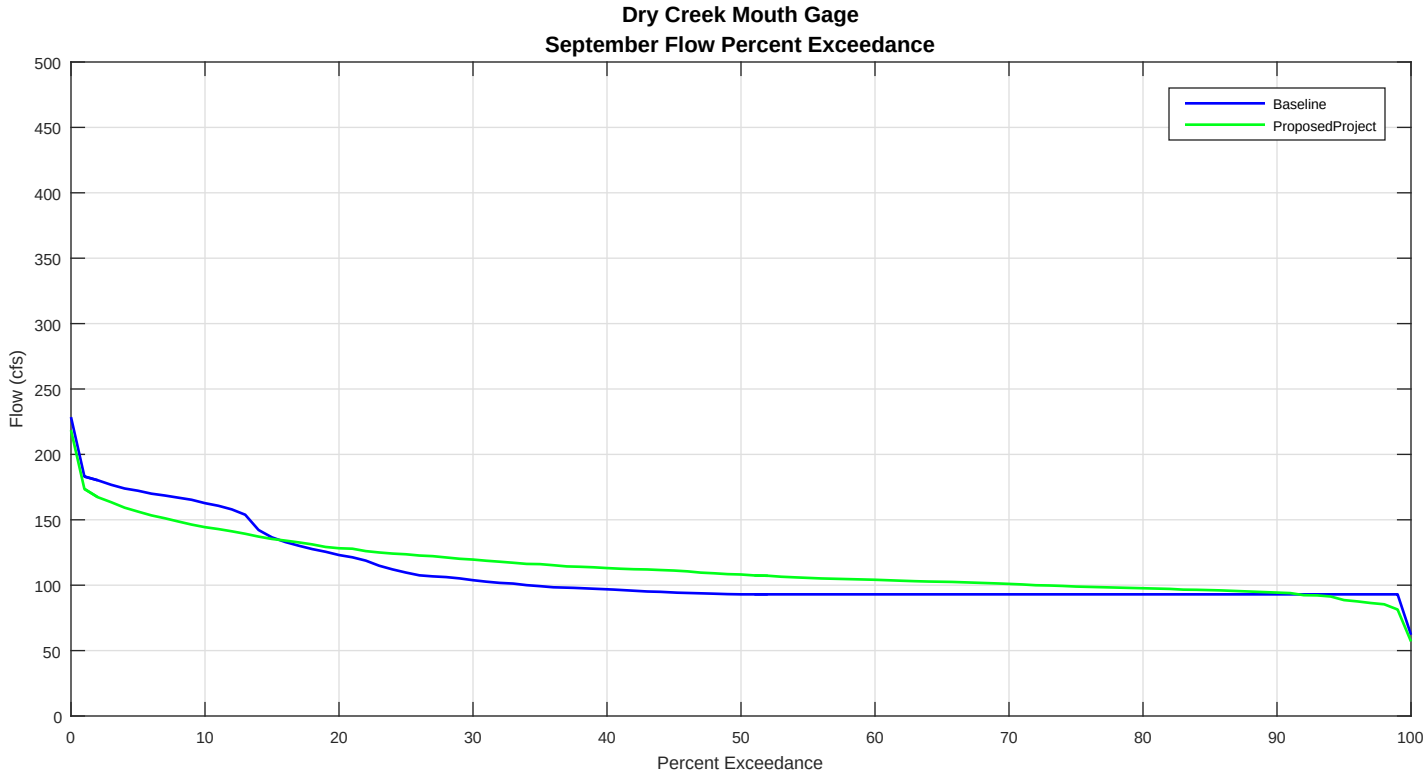
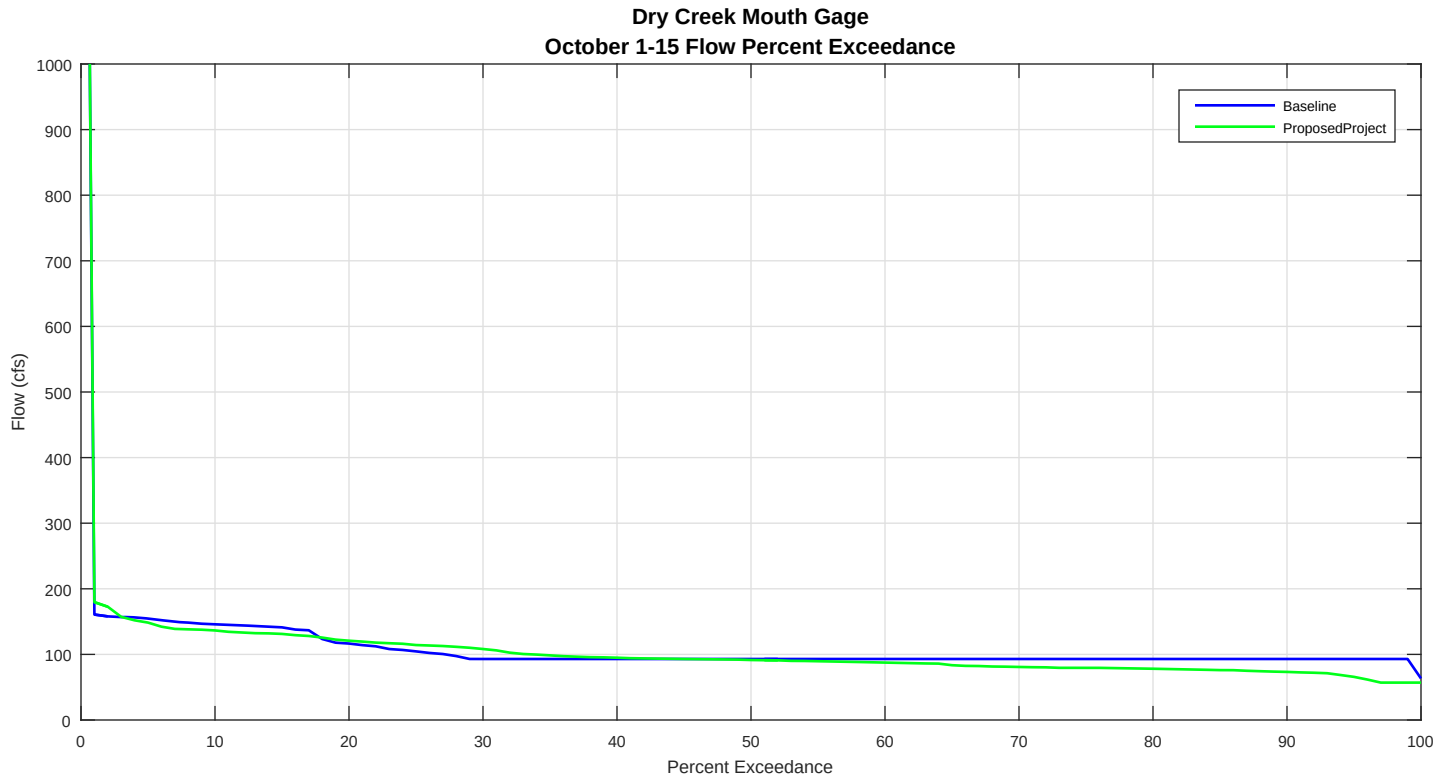
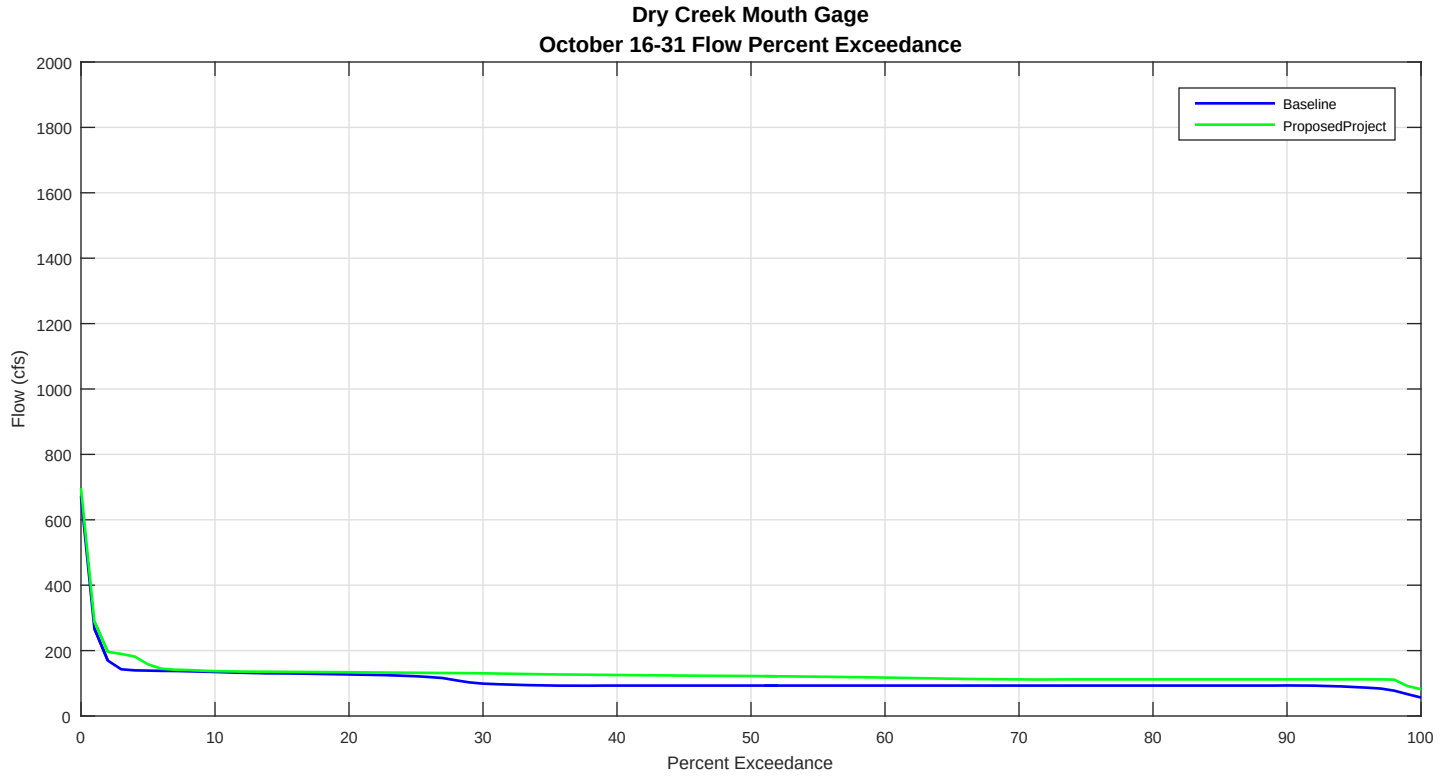
90
100

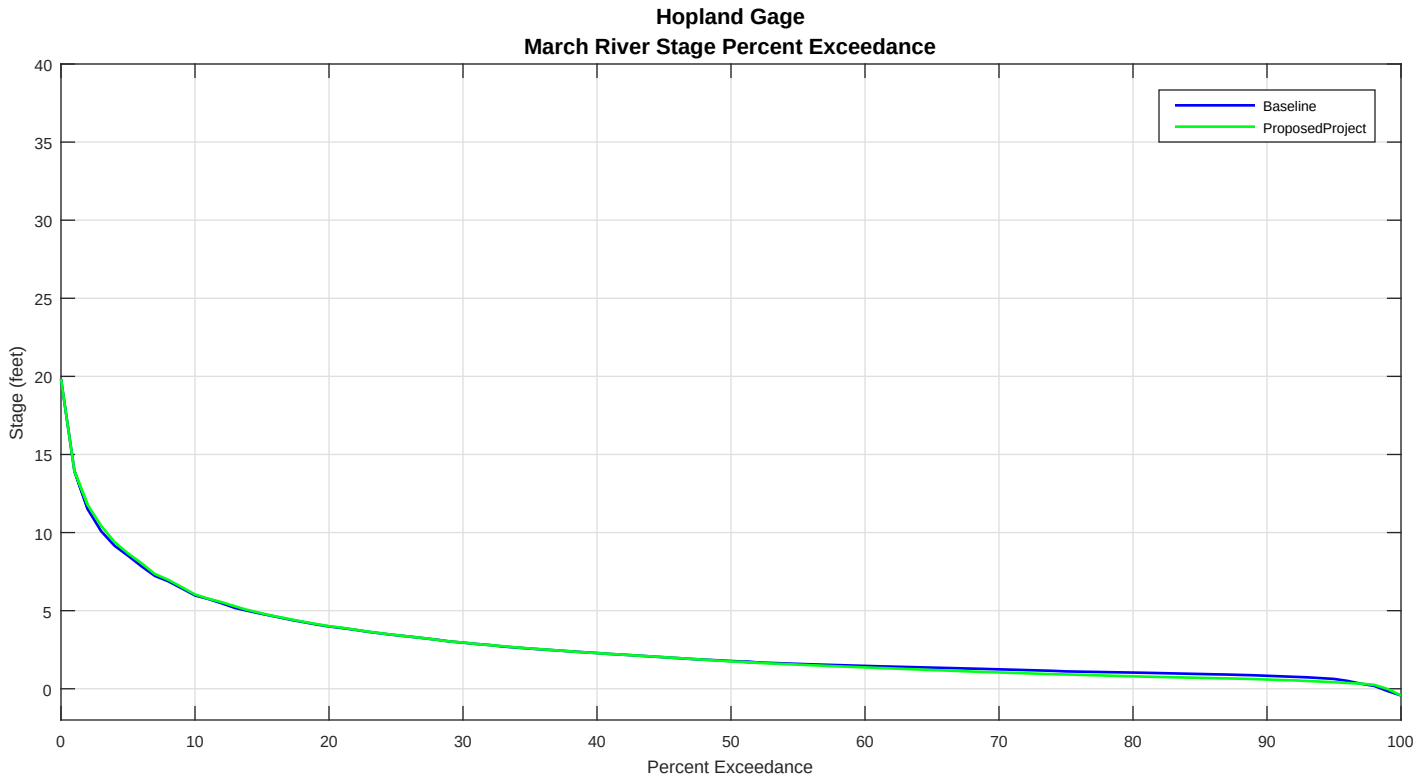

Dry Creek Mouth Gage
July Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

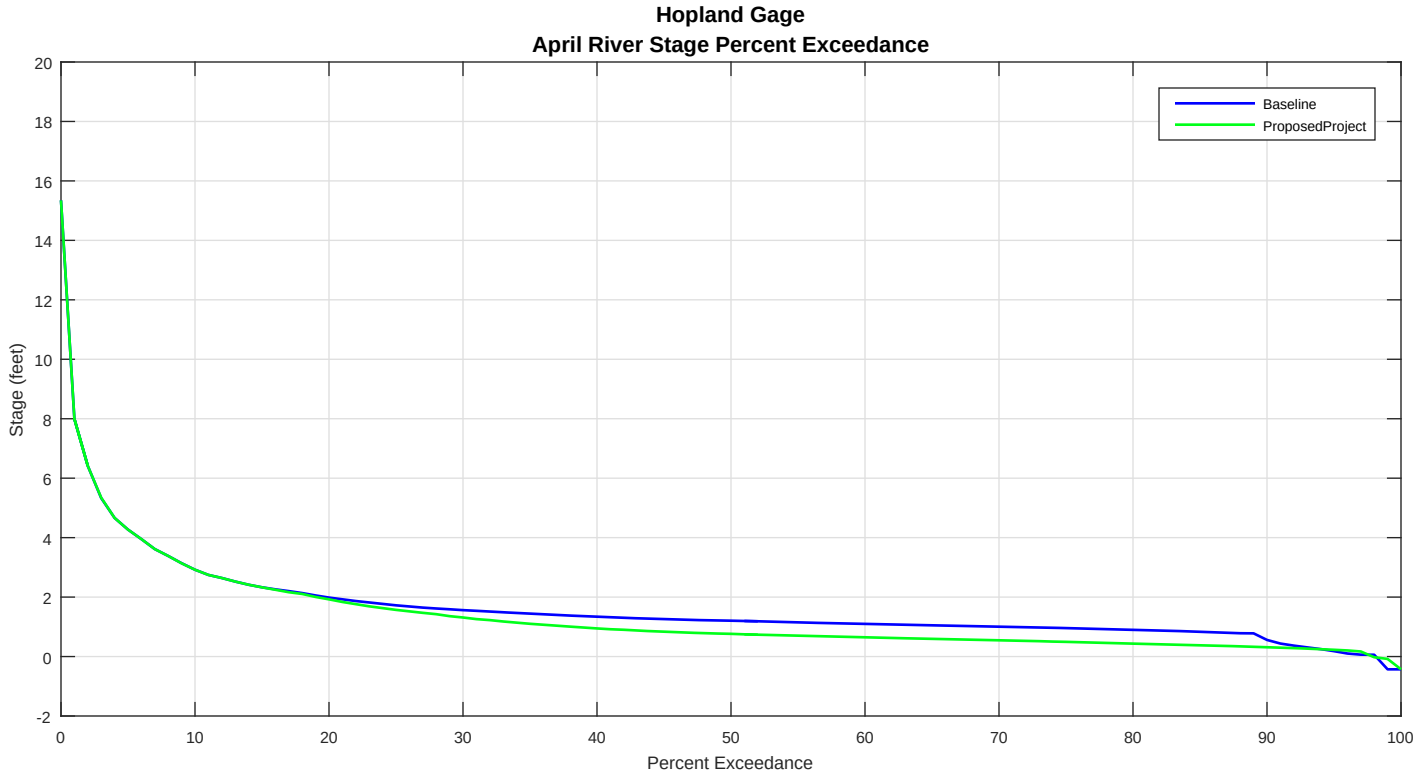

Dry Creek Mouth Gage
August Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

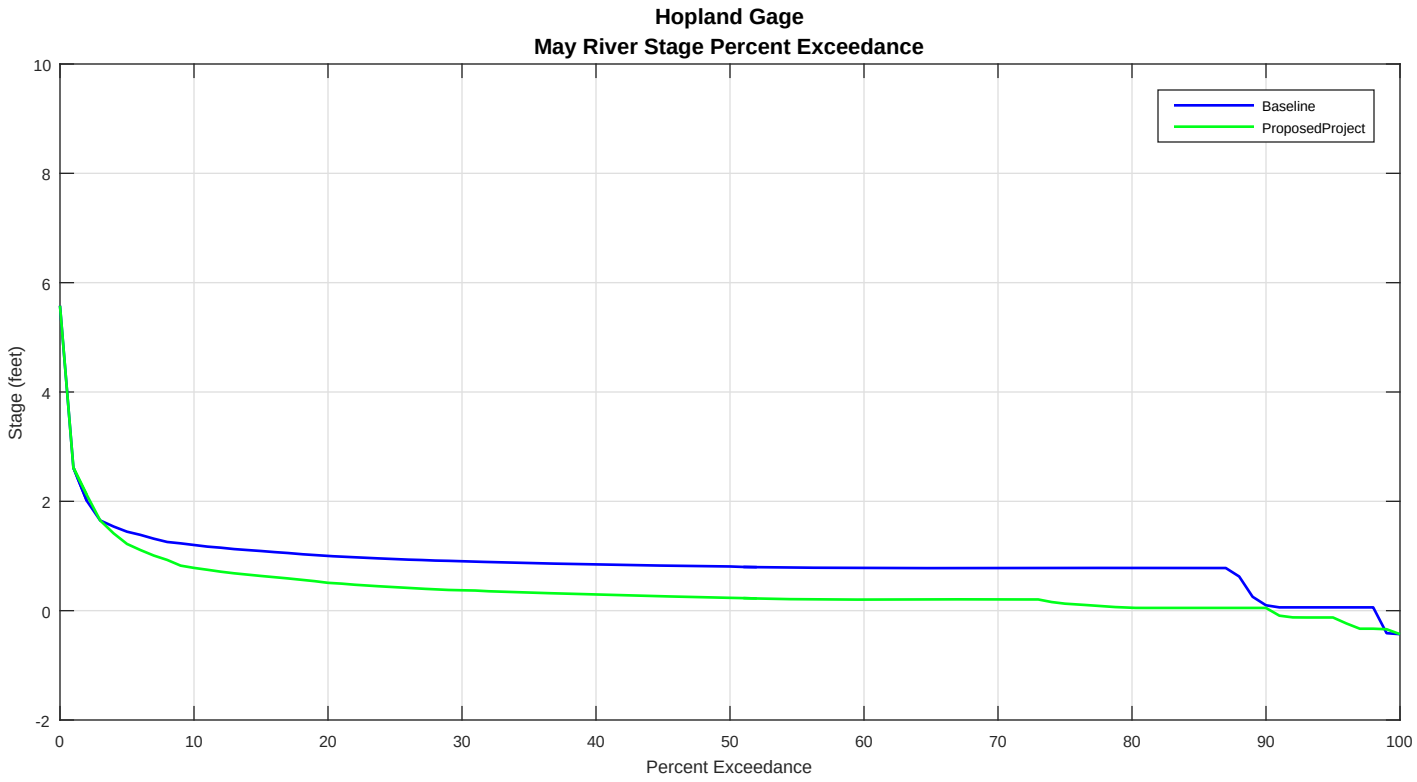

Dry Creek Mouth Gage
September Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

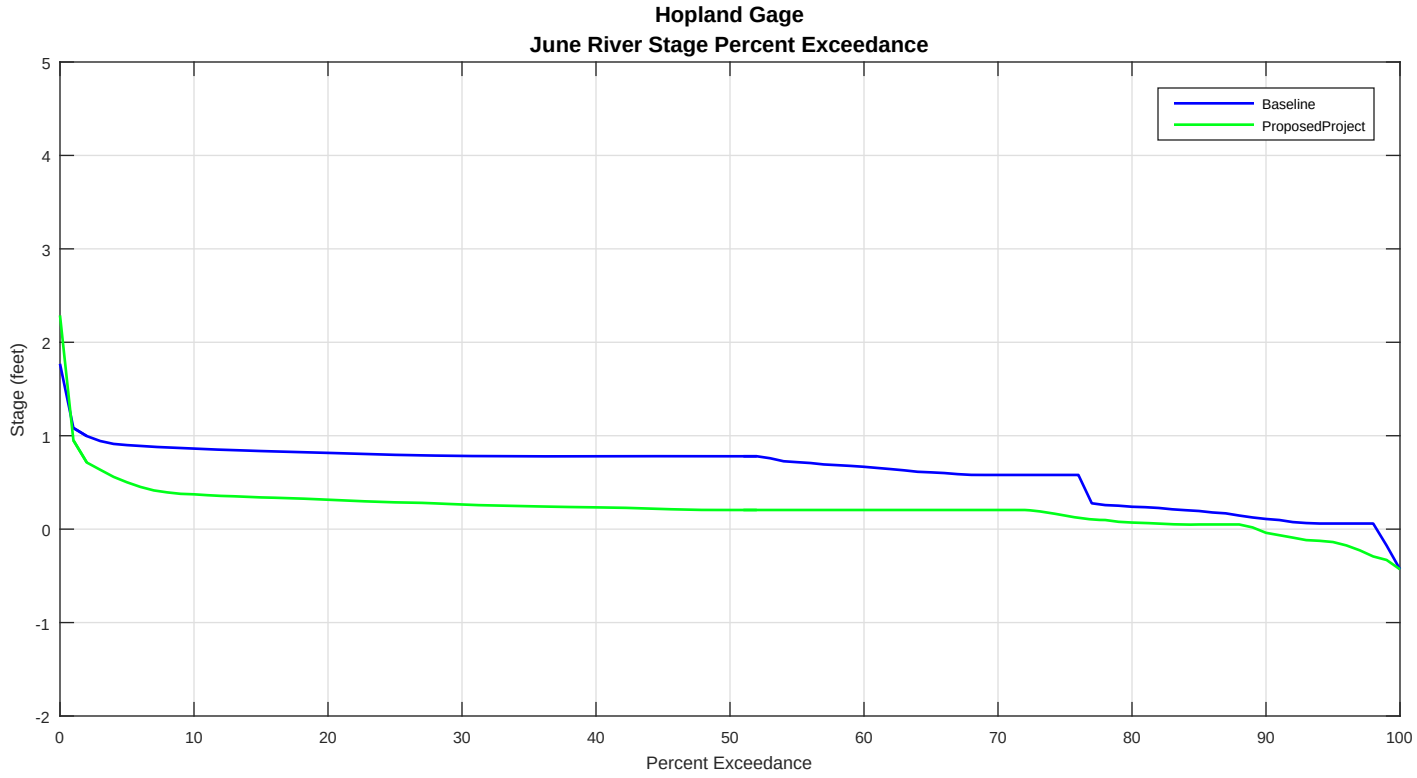

Dry Creek Mouth Gage
October 1-15 Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100

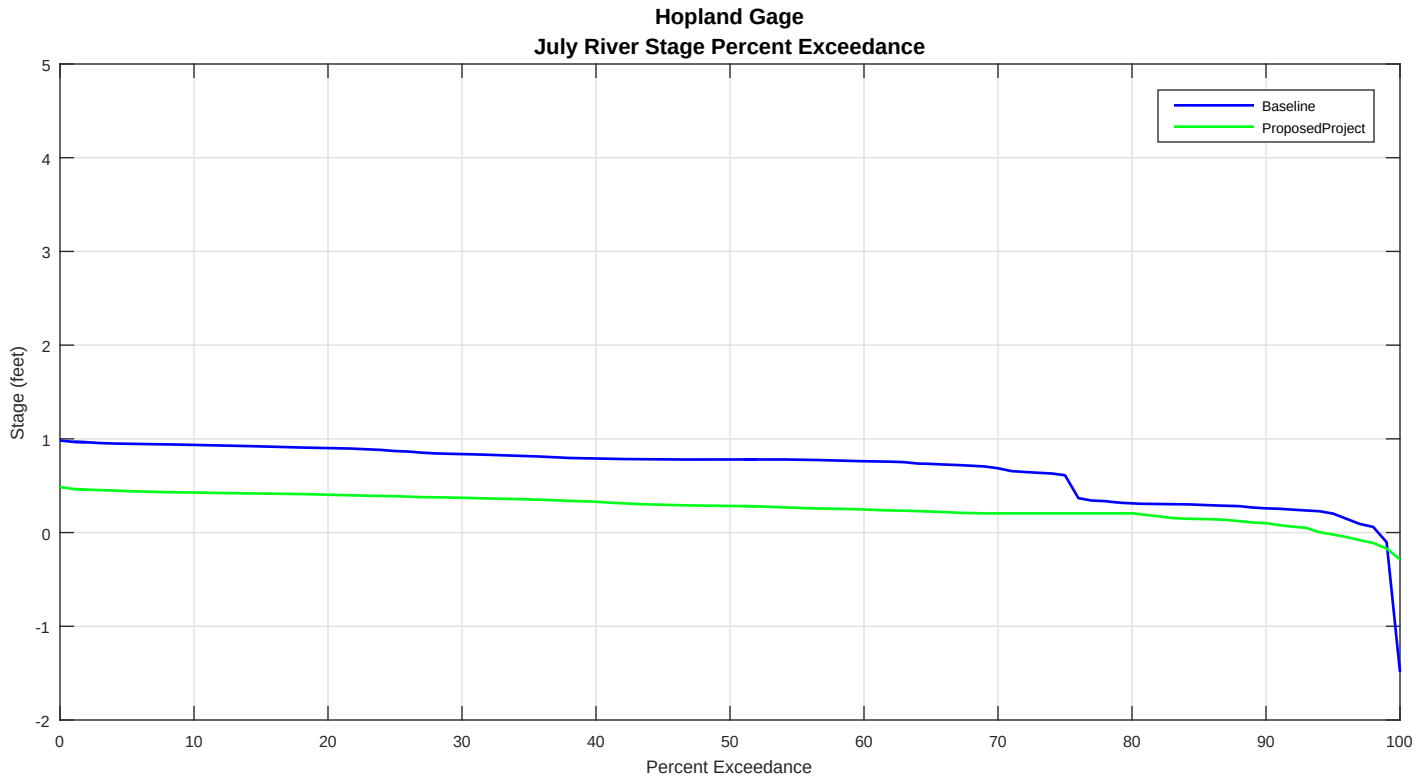

Dry Creek Mouth Gage
October 16-31 Flow Percent Exceedance
Baseline
ProposedProject
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100

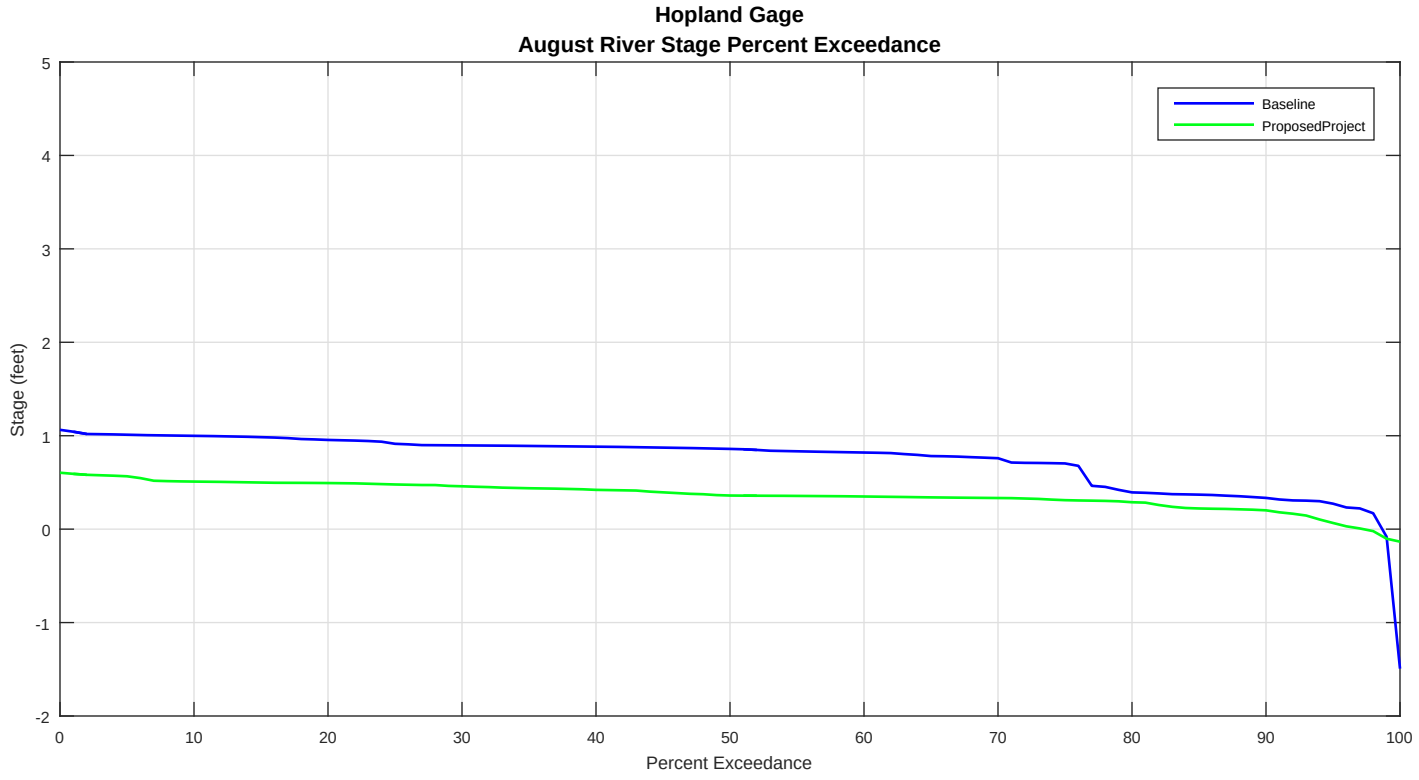

Hopland Gage
March River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100

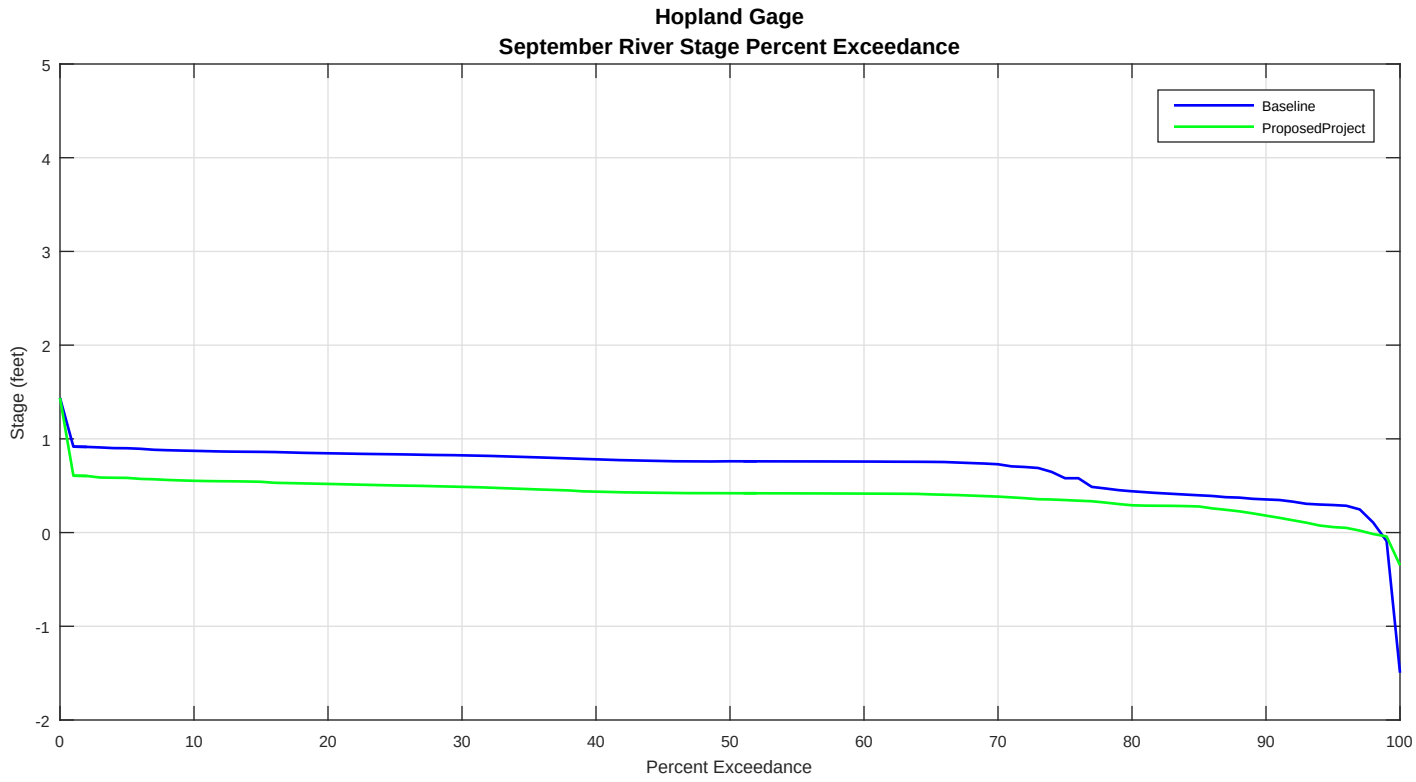

Hopland Gage
April River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
20
18
16
14
12
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

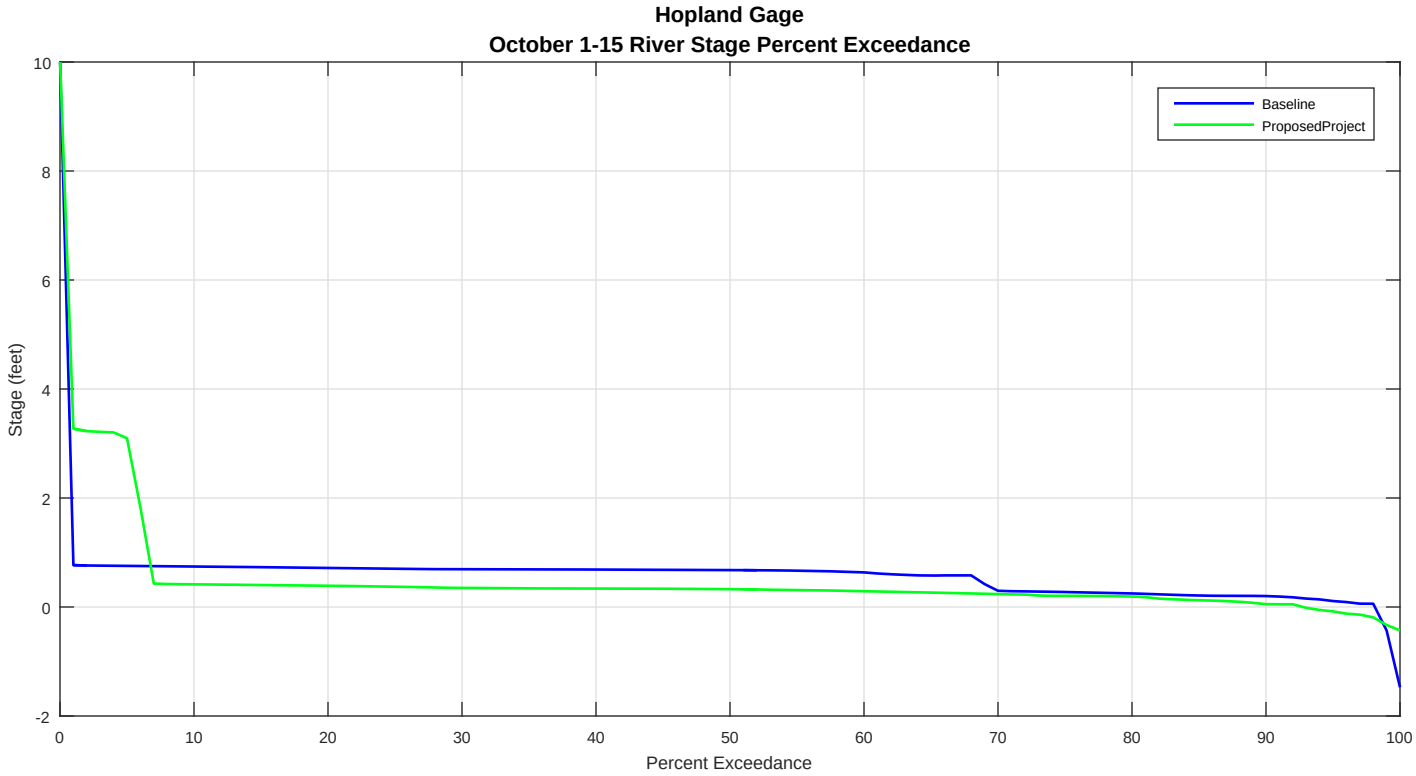

Hopland Gage
May River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

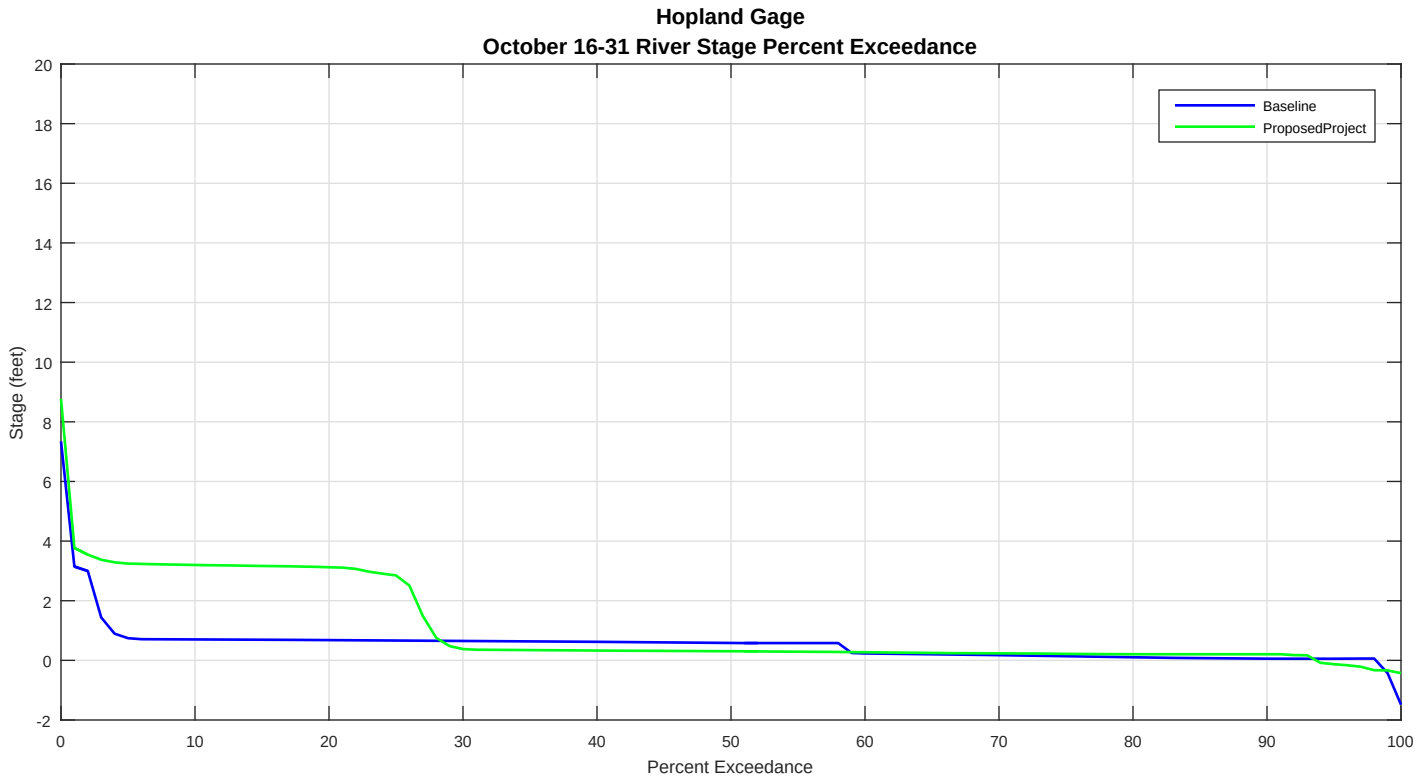

Hopland Gage
June River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

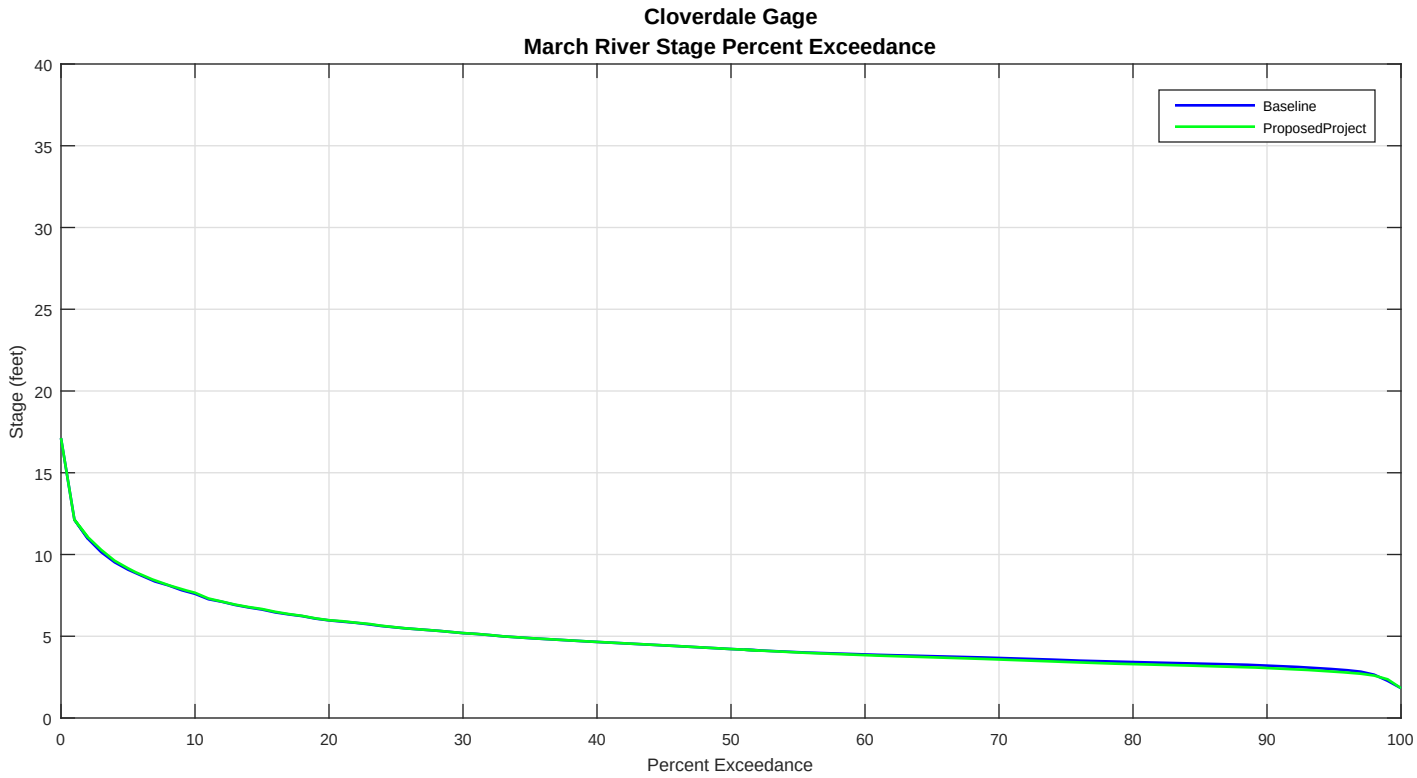

Hopland Gage
July River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

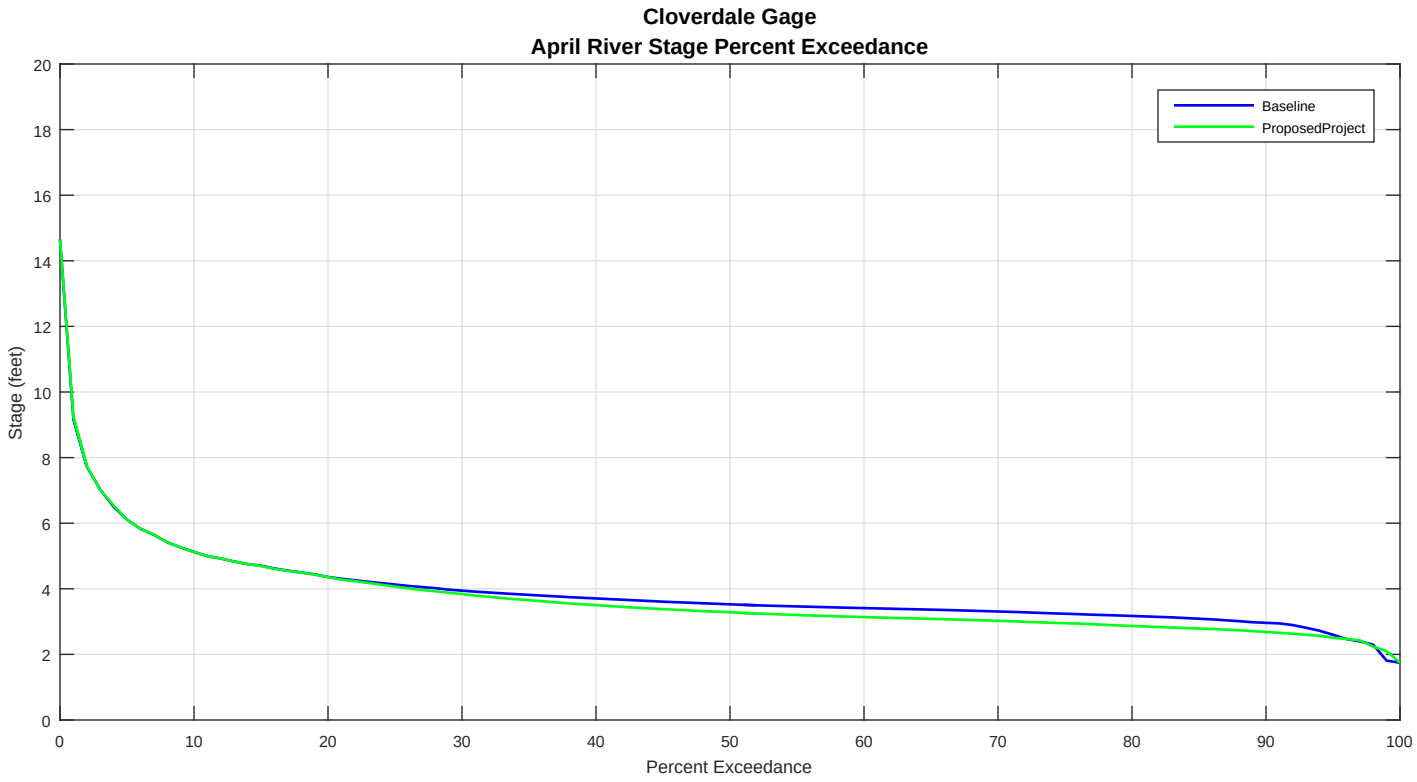

Hopland Gage
August River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

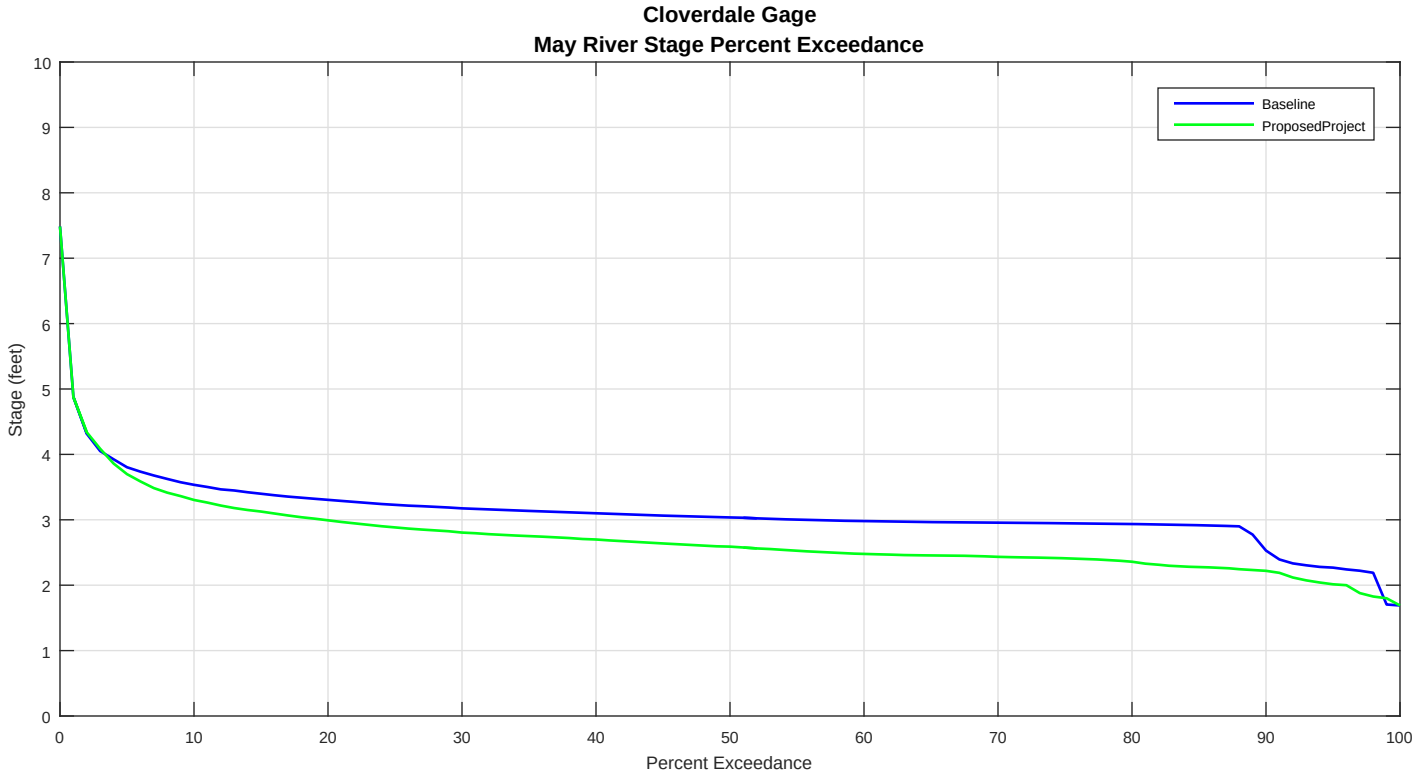

Hopland Gage
September River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

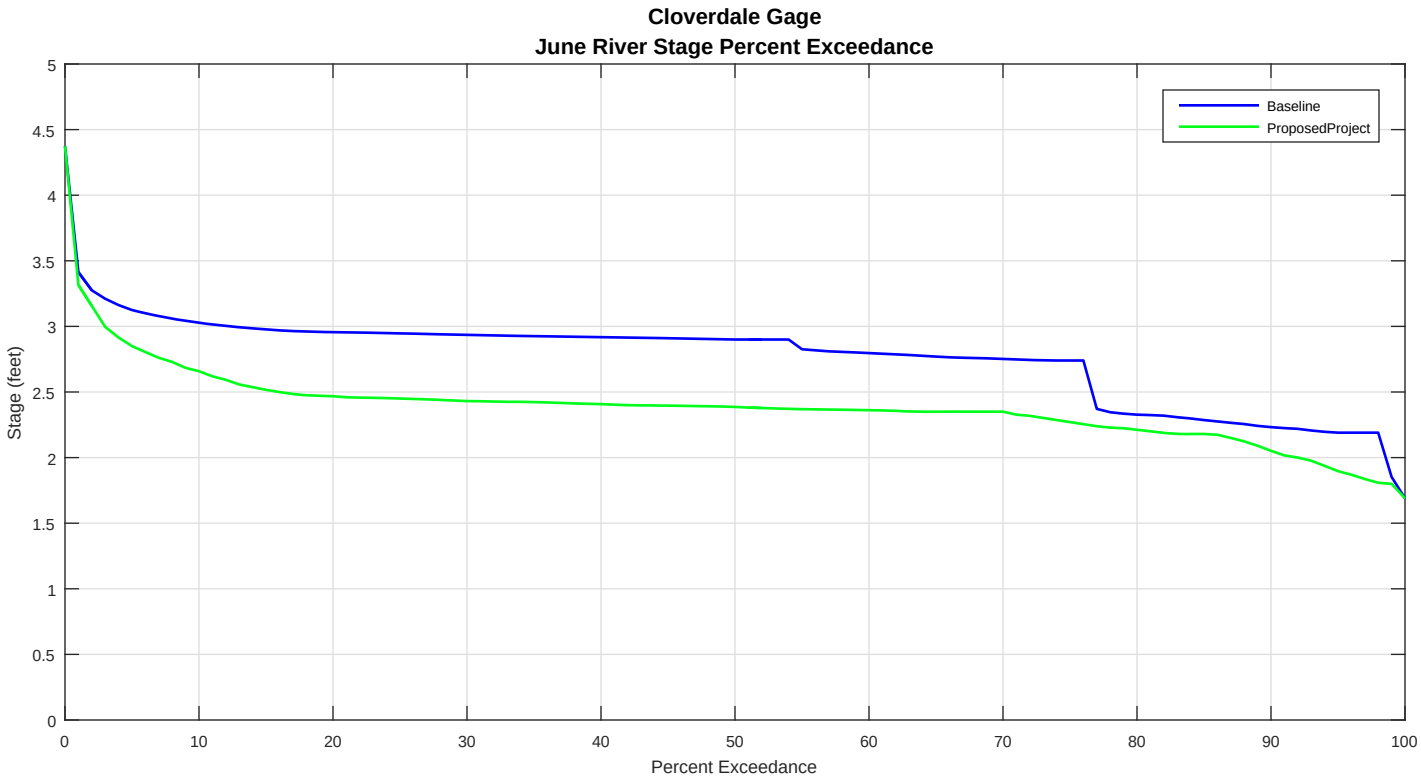

Hopland Gage
October 1-15 River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

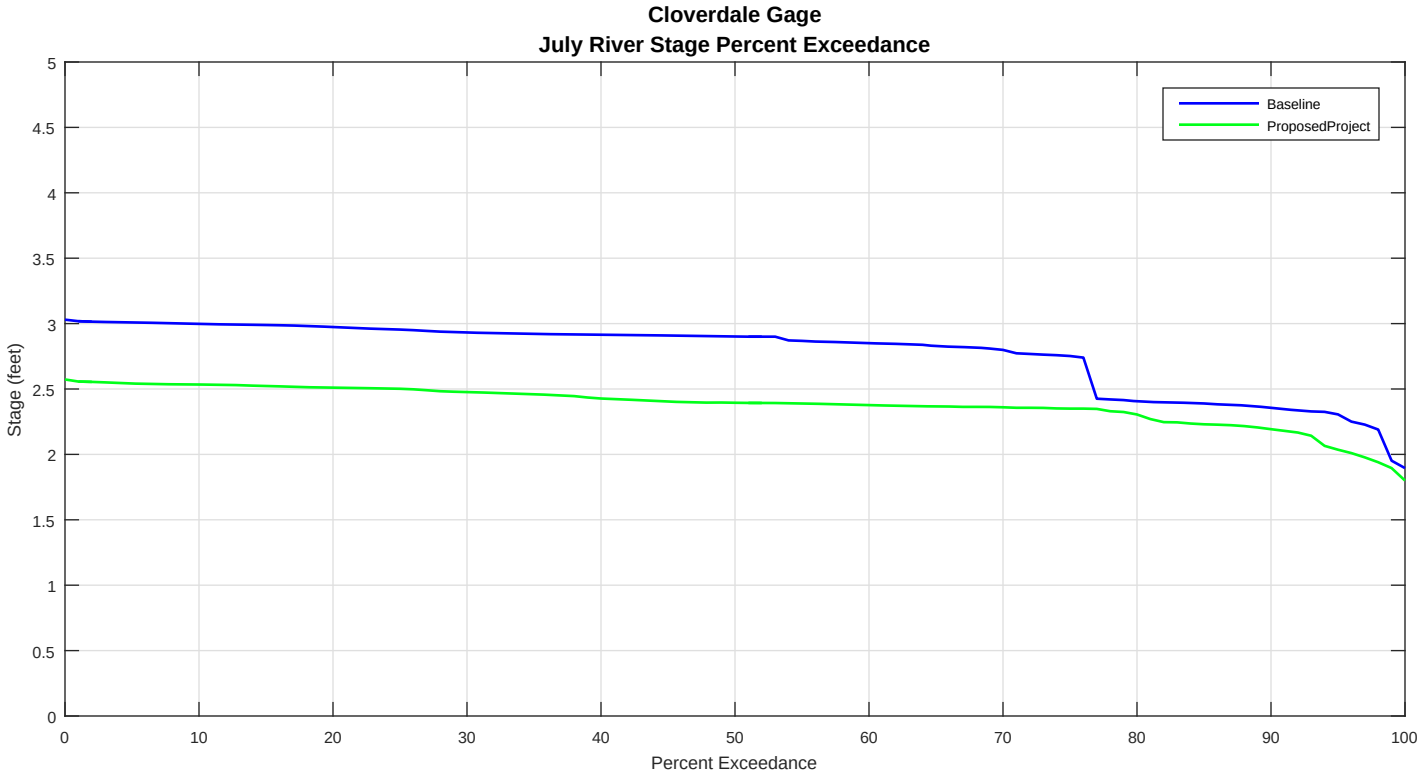

Hopland Gage
October 16-31 River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
20
18
16
14
12
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

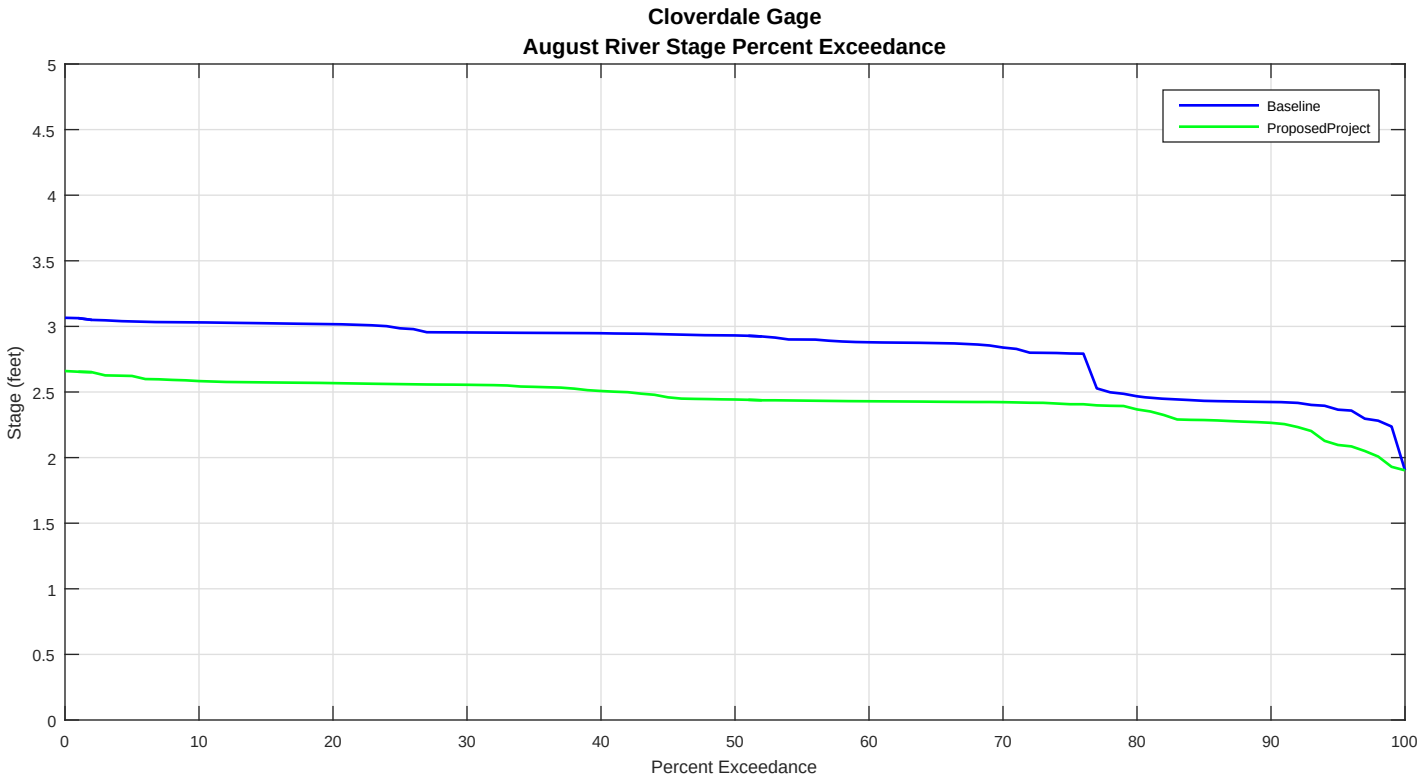

Cloverdale Gage
March River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100

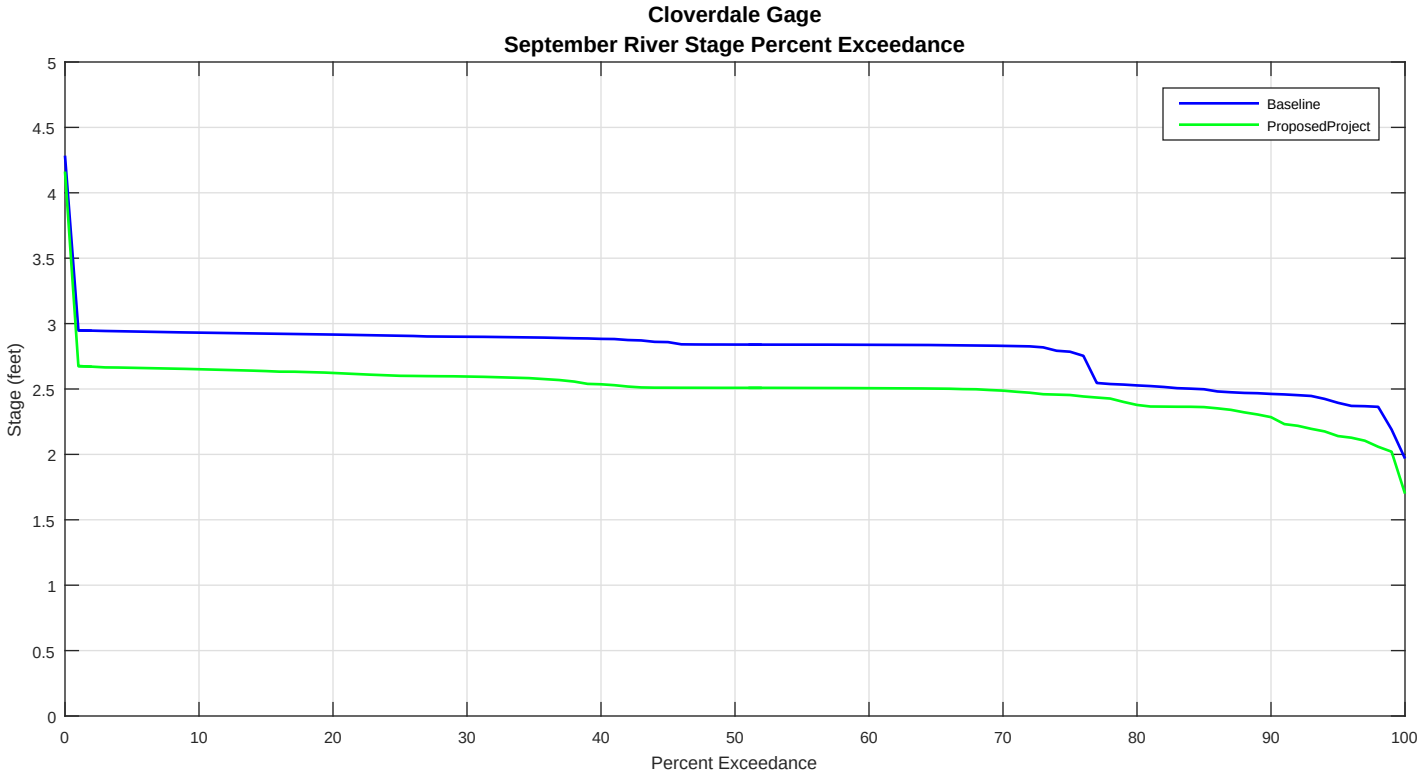

Cloverdale Gage
April River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

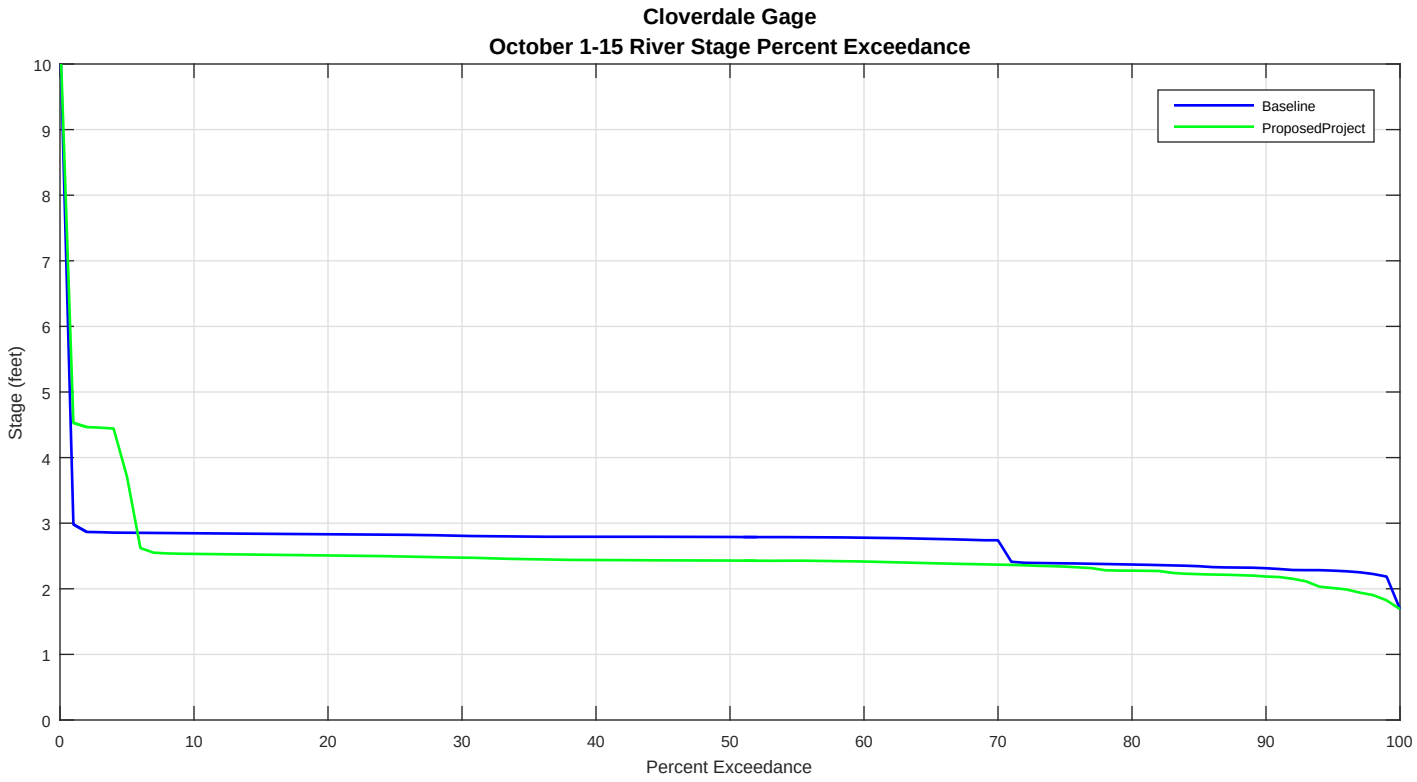

Cloverdale Gage
May River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

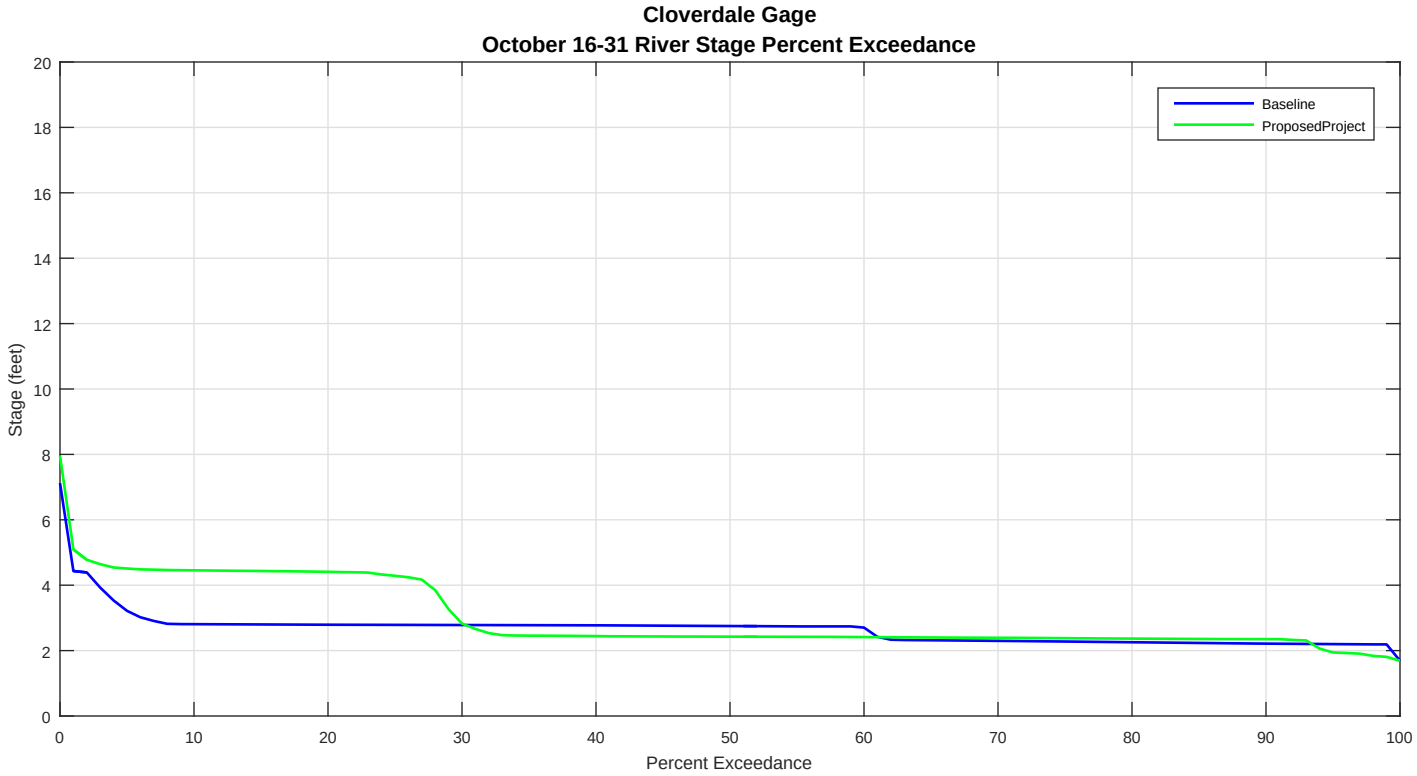

Cloverdale Gage
June River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

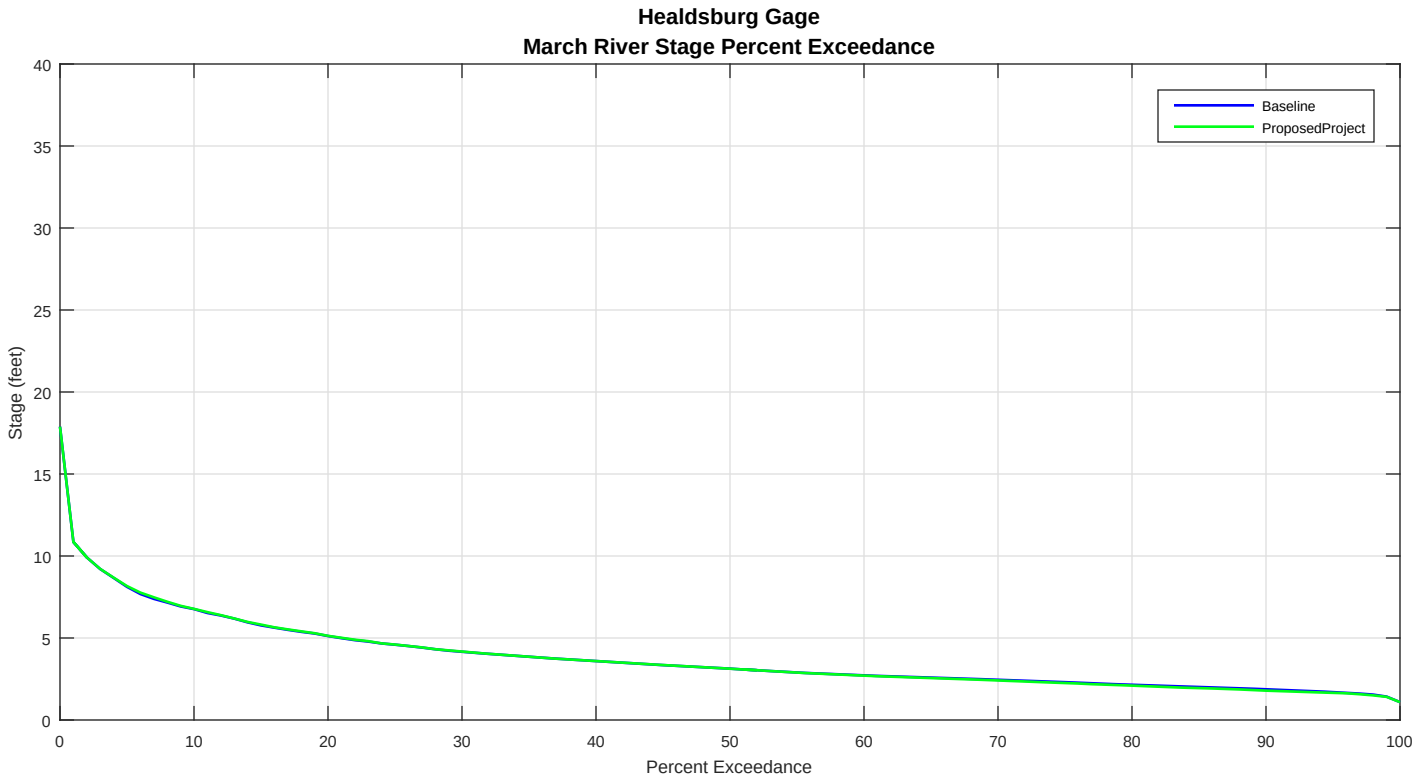

Cloverdale Gage
July River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

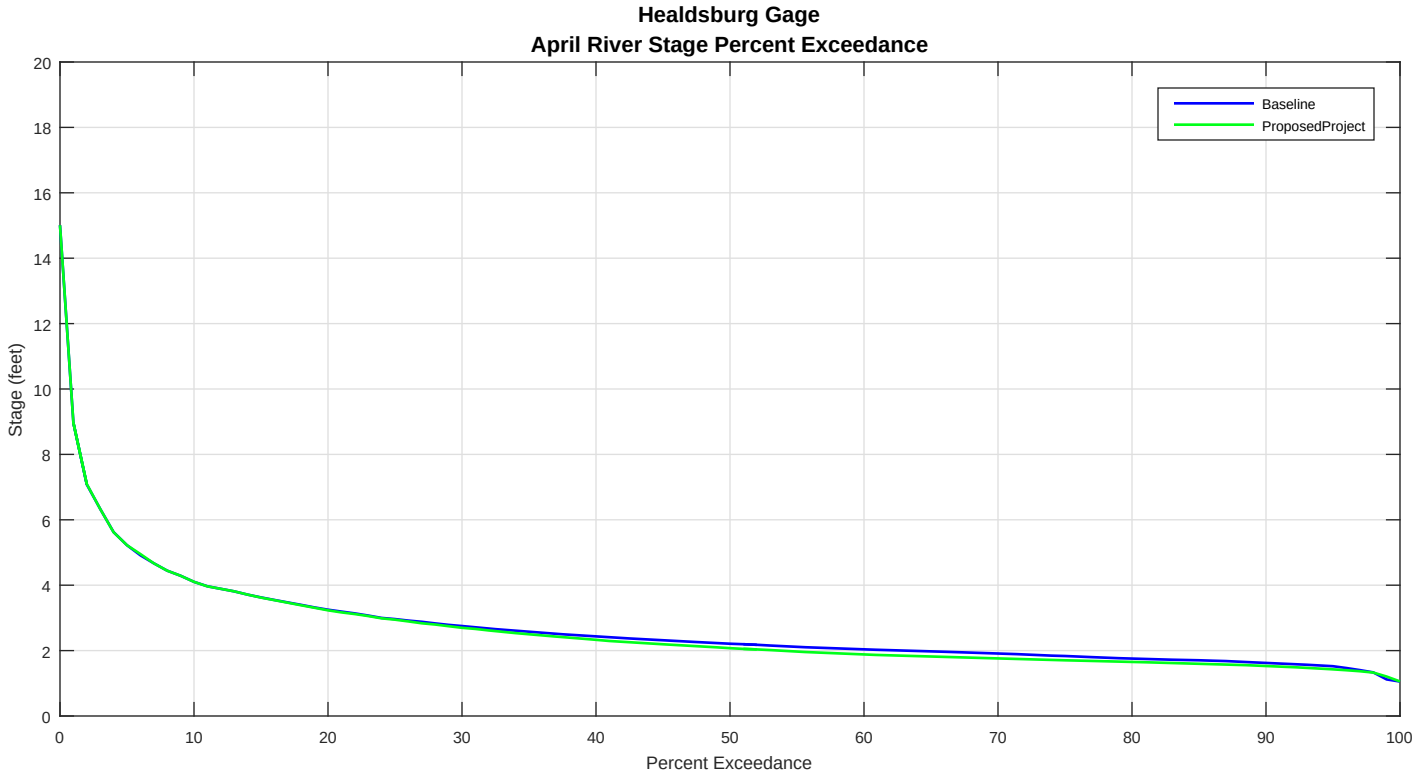

Cloverdale Gage
August River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

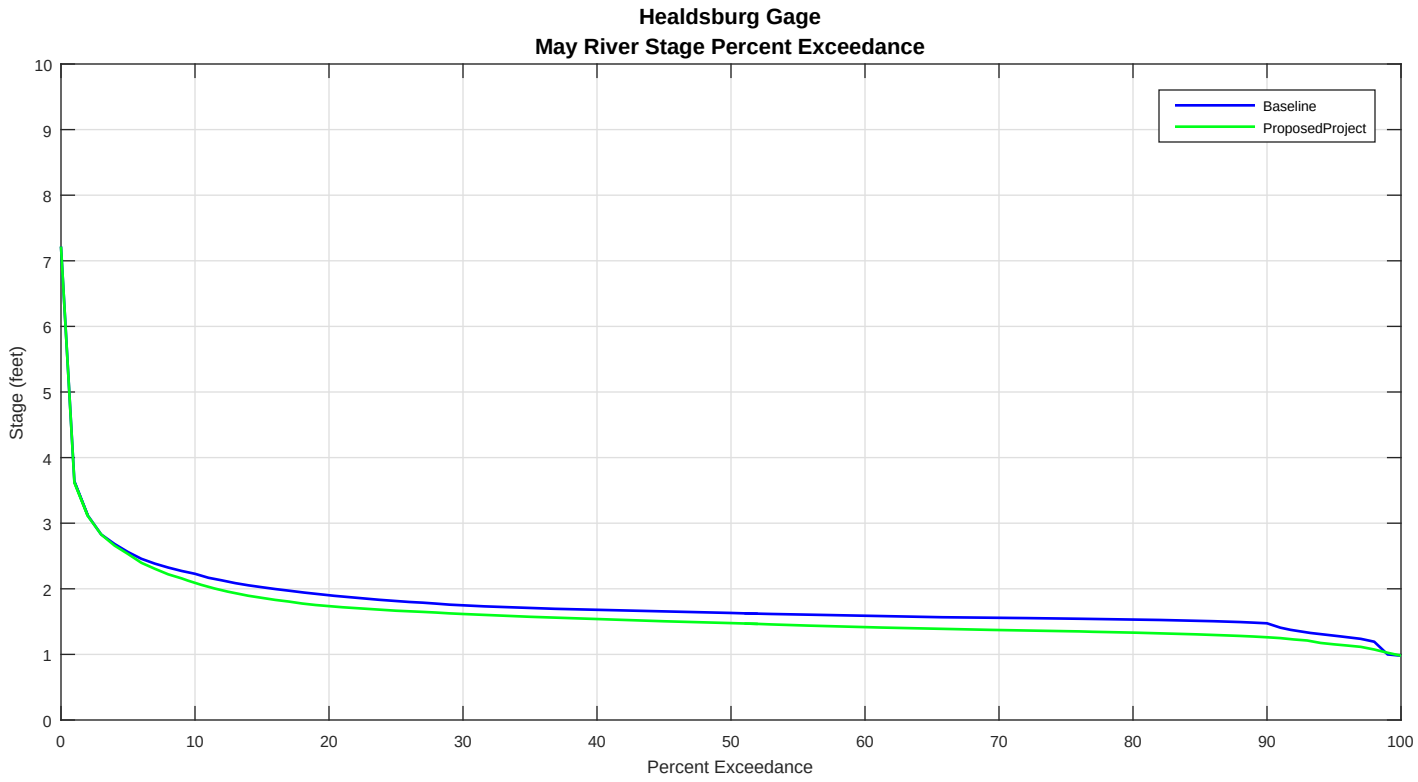

Cloverdale Gage
September River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

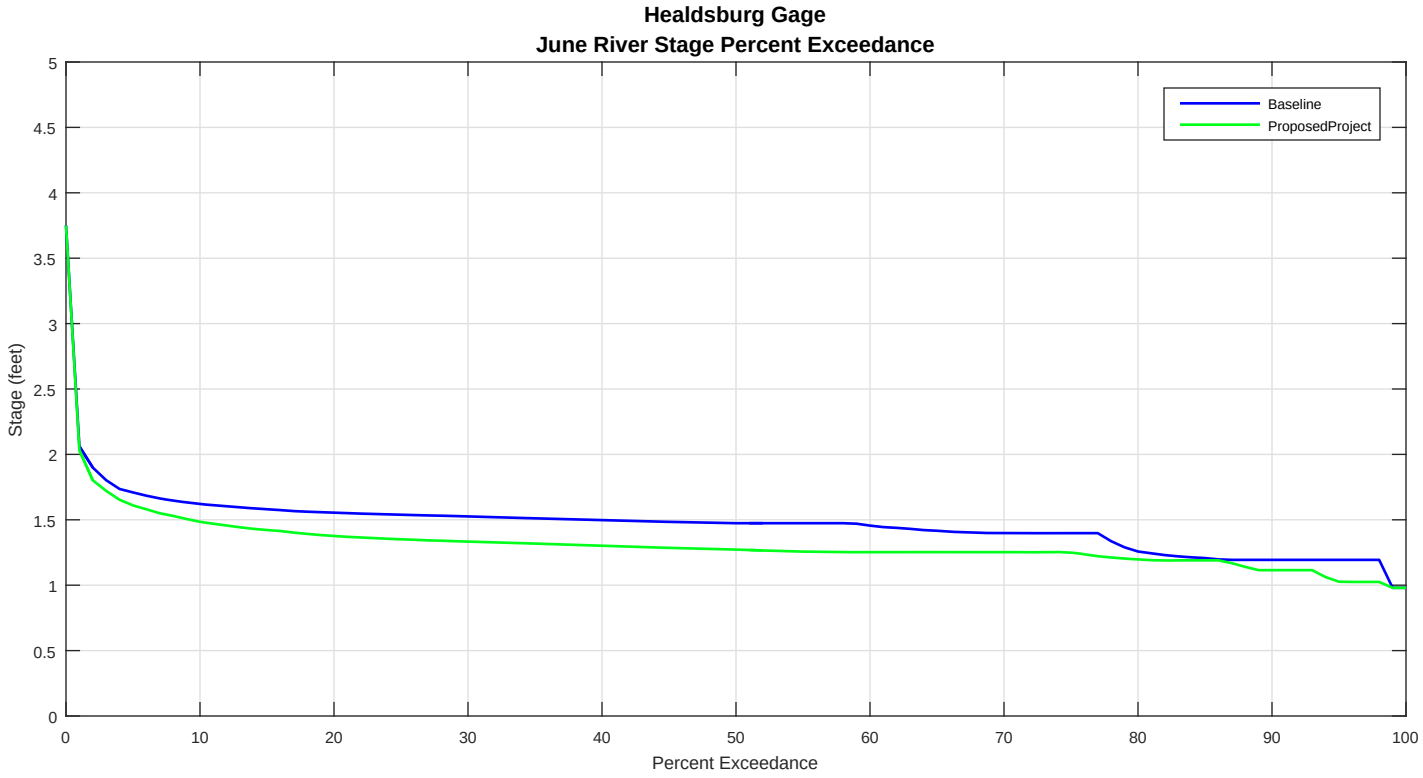

Cloverdale Gage
October 1-15 River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

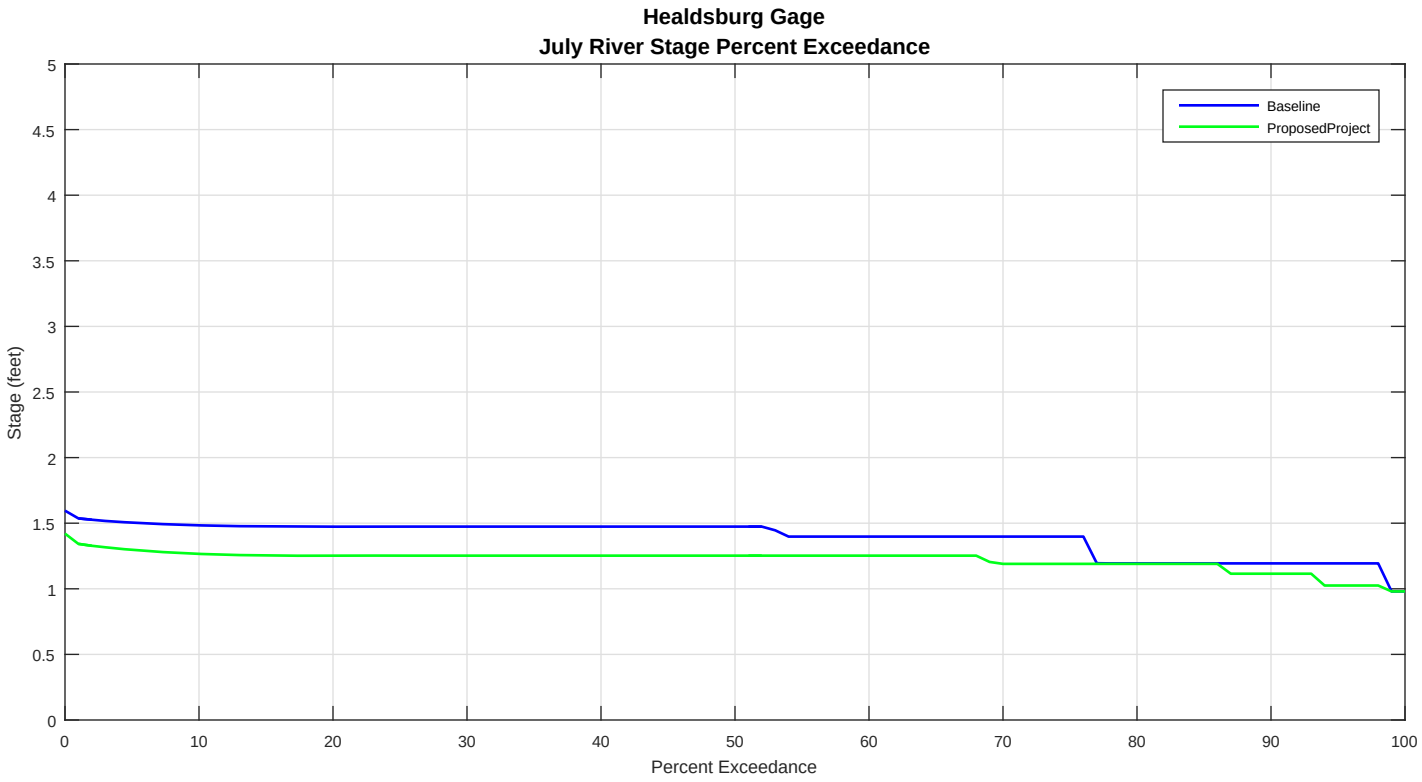

Cloverdale Gage
October 16-31 River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

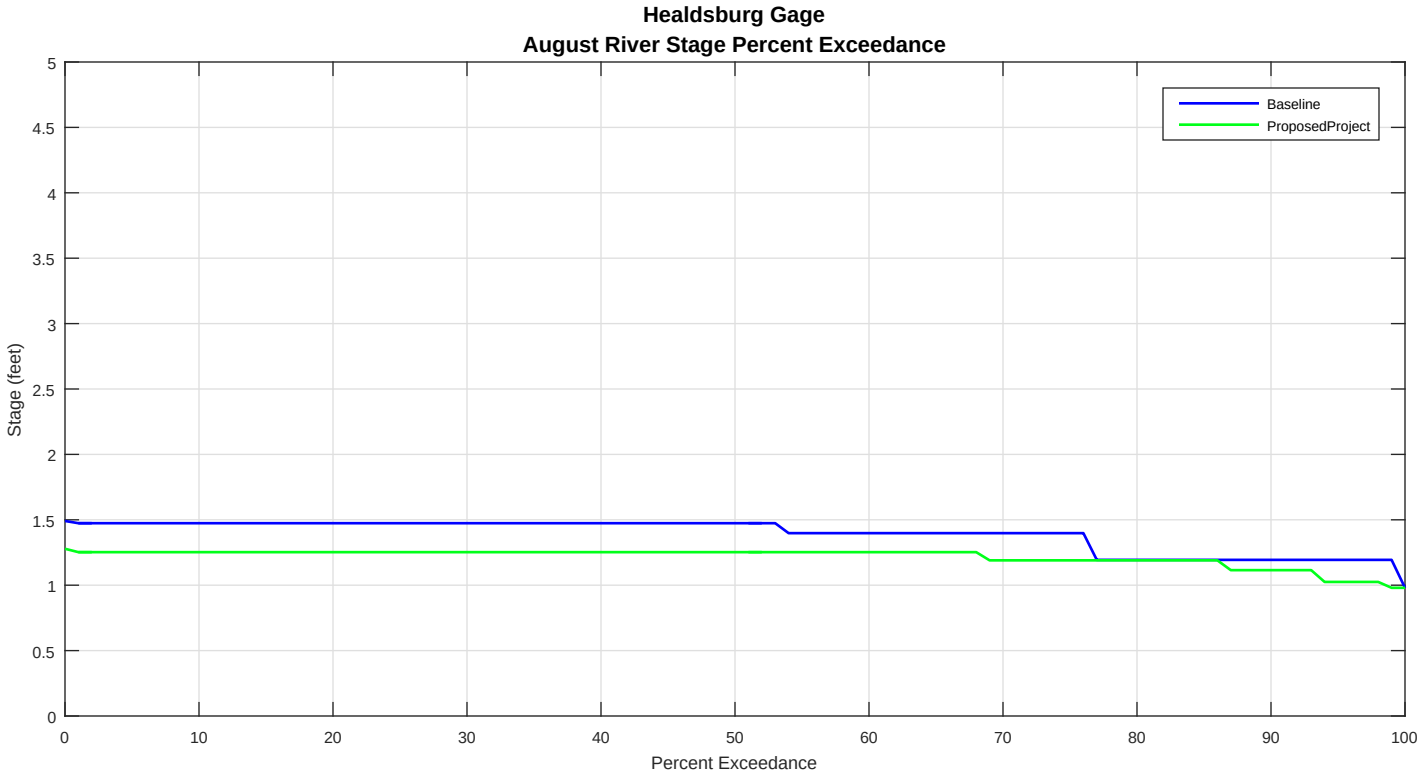

Healdsburg Gage
March River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80
90
100

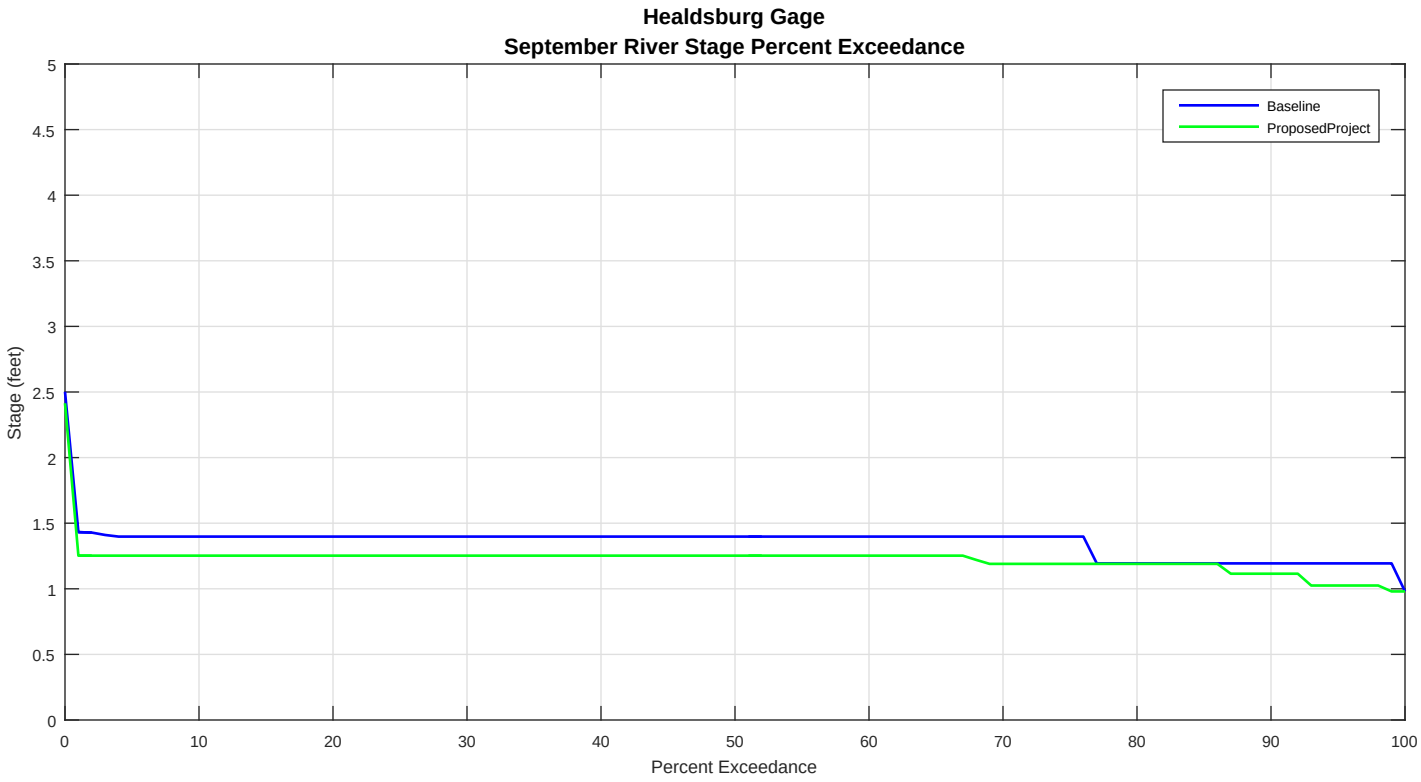

Healdsburg Gage
April River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

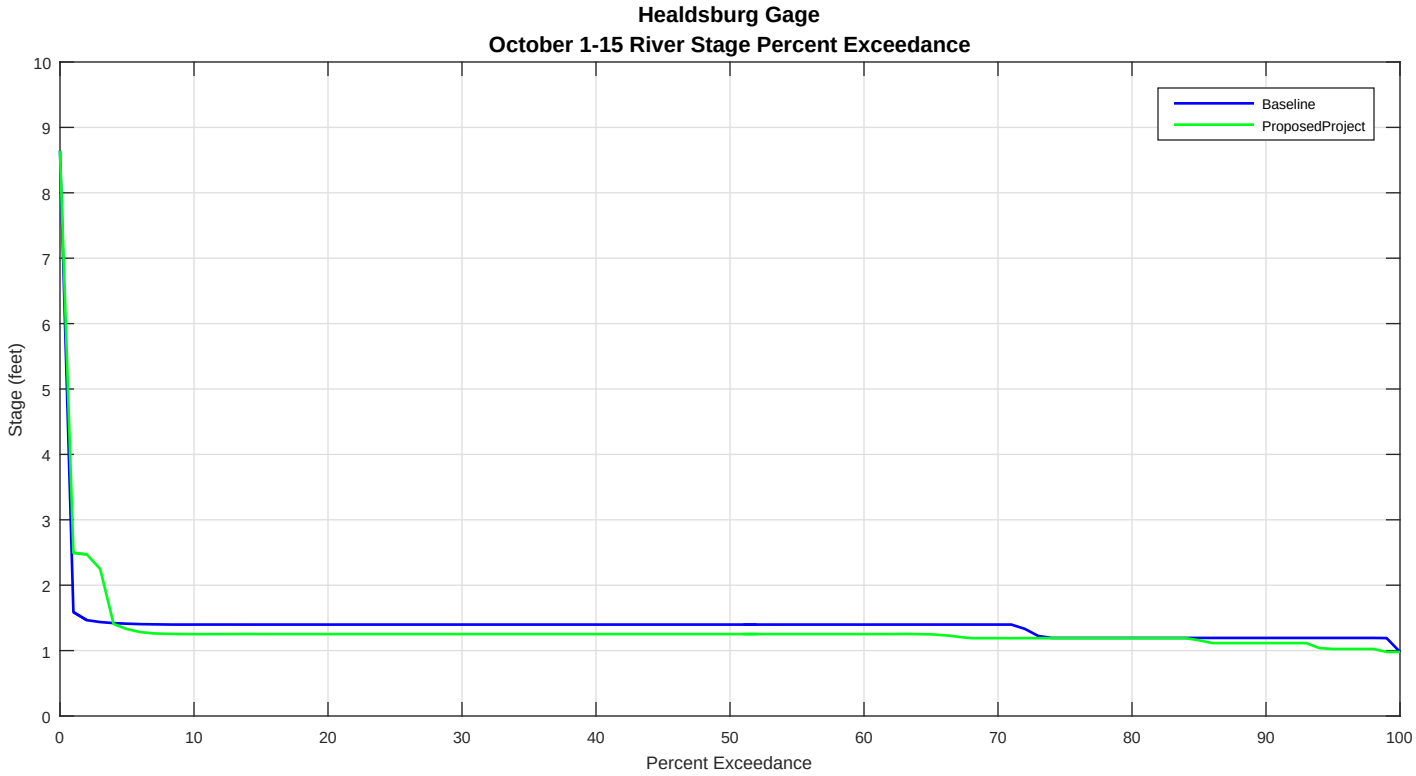

Healdsburg Gage
May River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

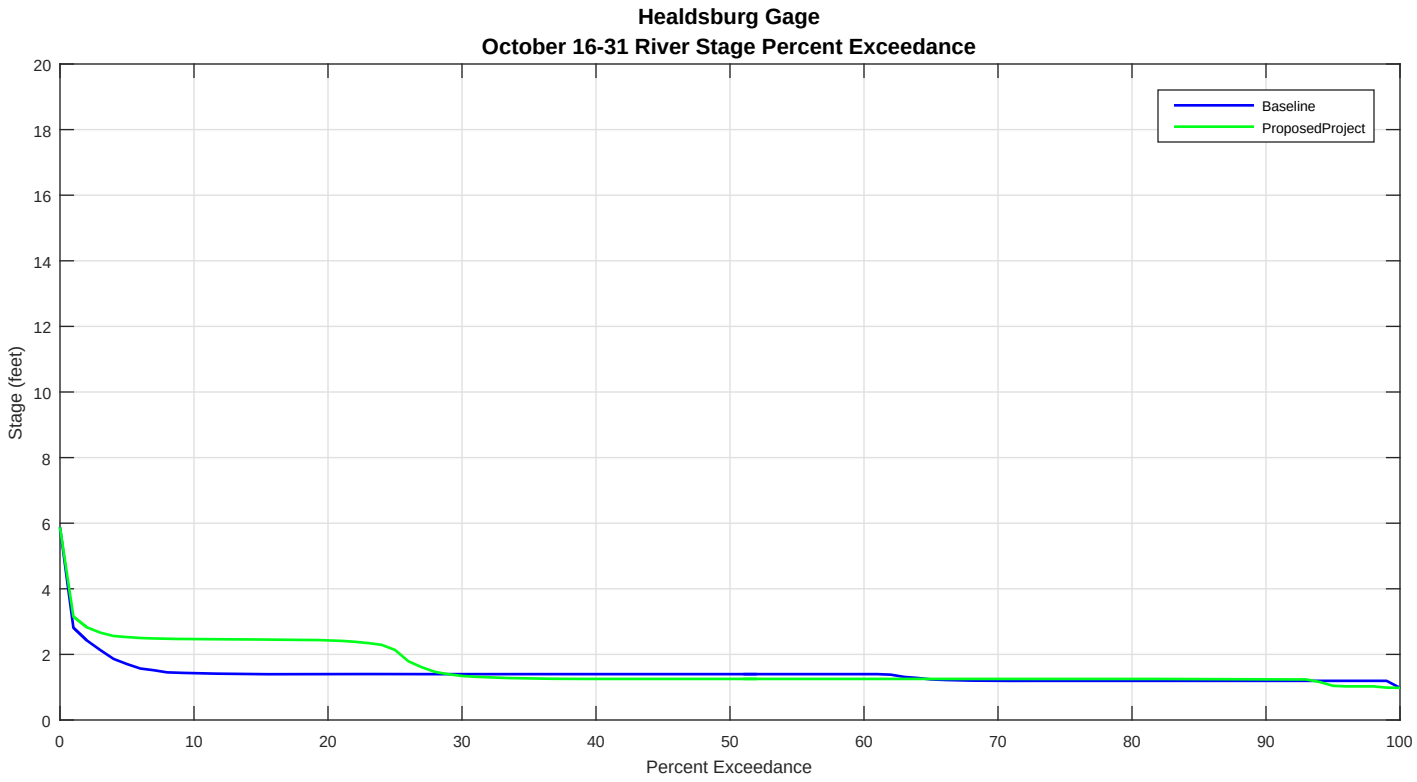

Healdsburg Gage
June River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

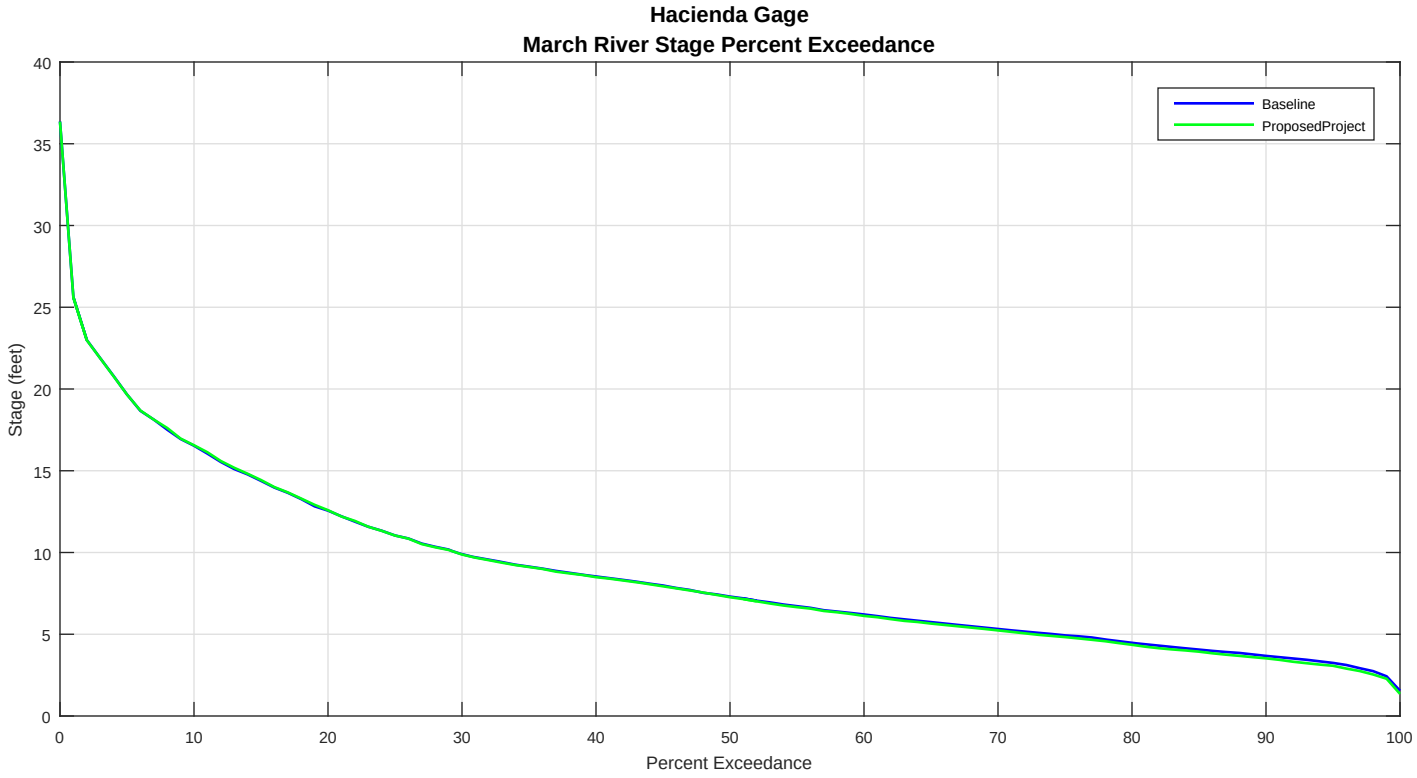

Healdsburg Gage
July River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

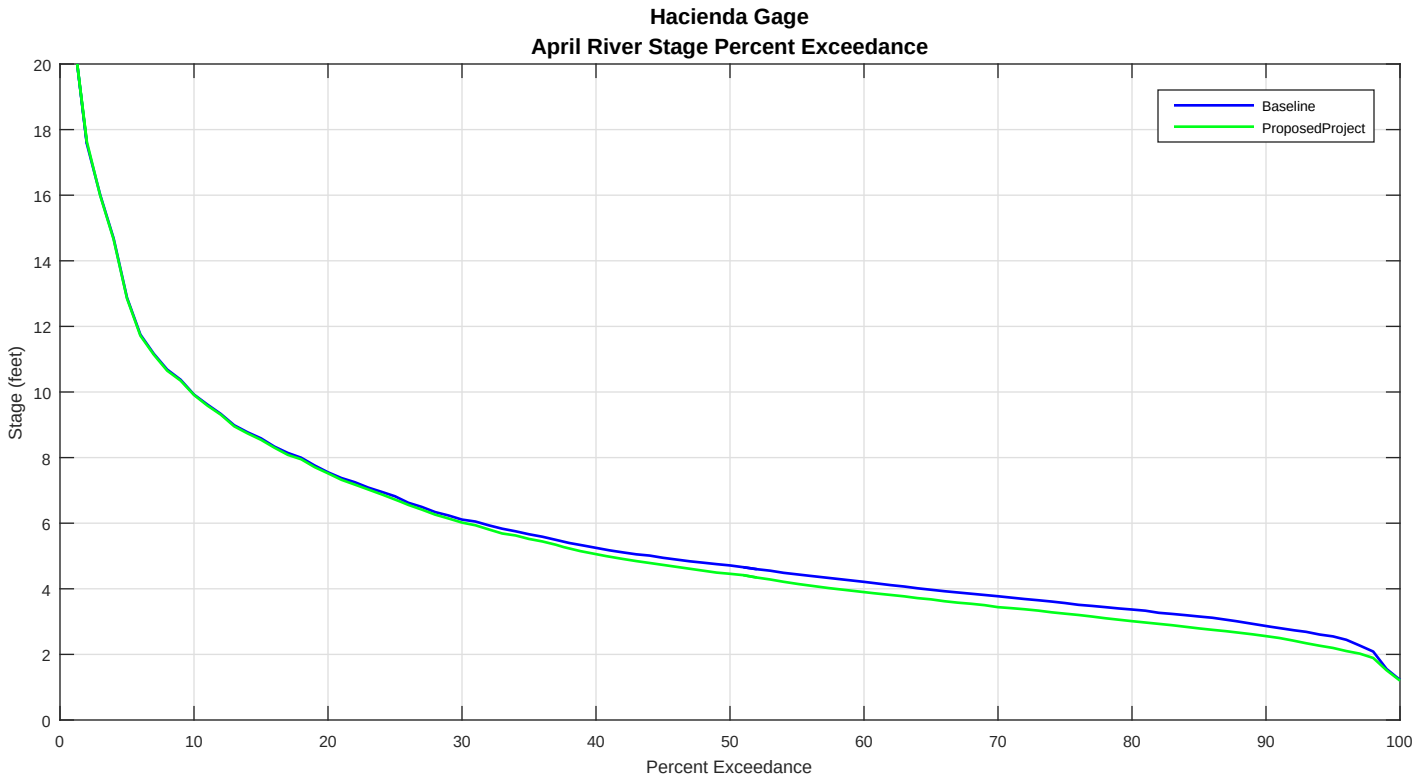

Healdsburg Gage
August River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

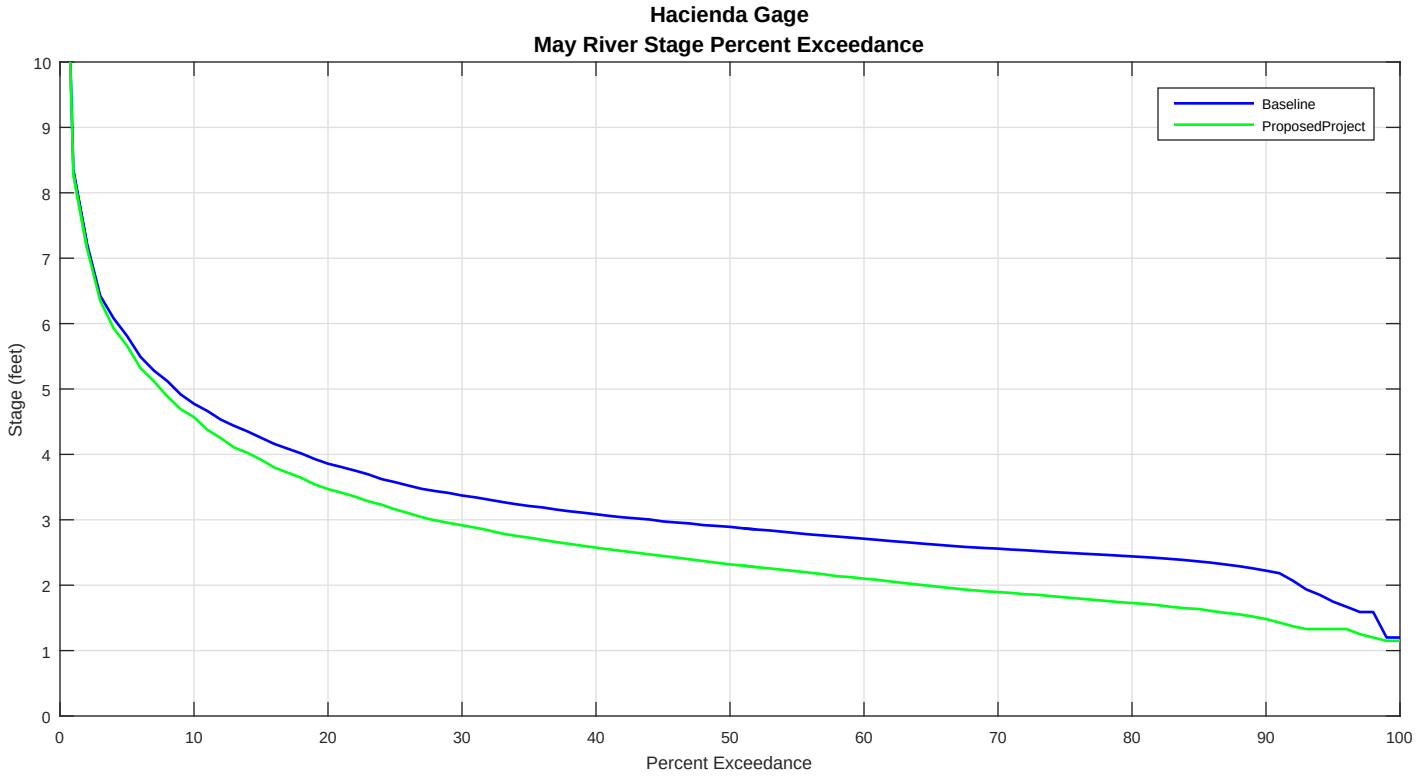

Healdsburg Gage
September River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

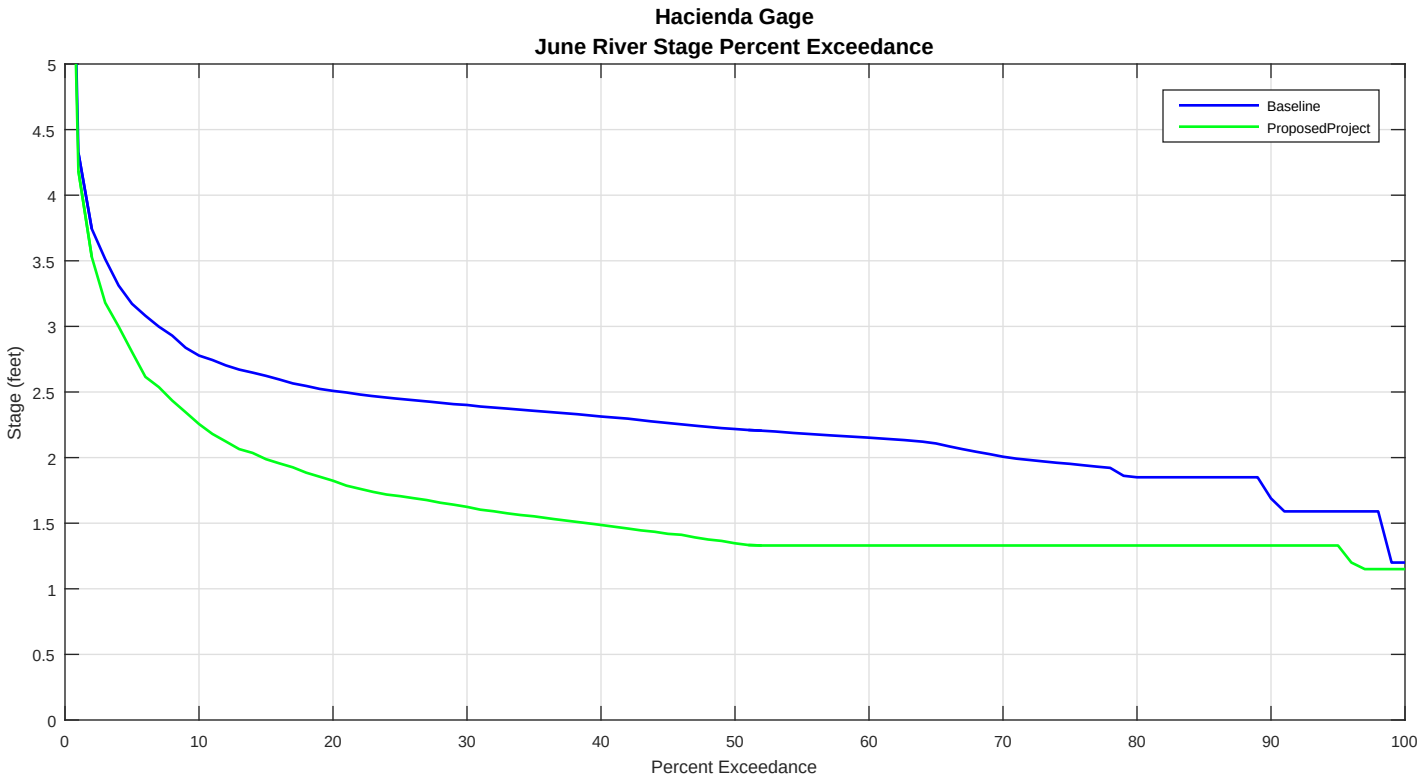

Healdsburg Gage
October 1-15 River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

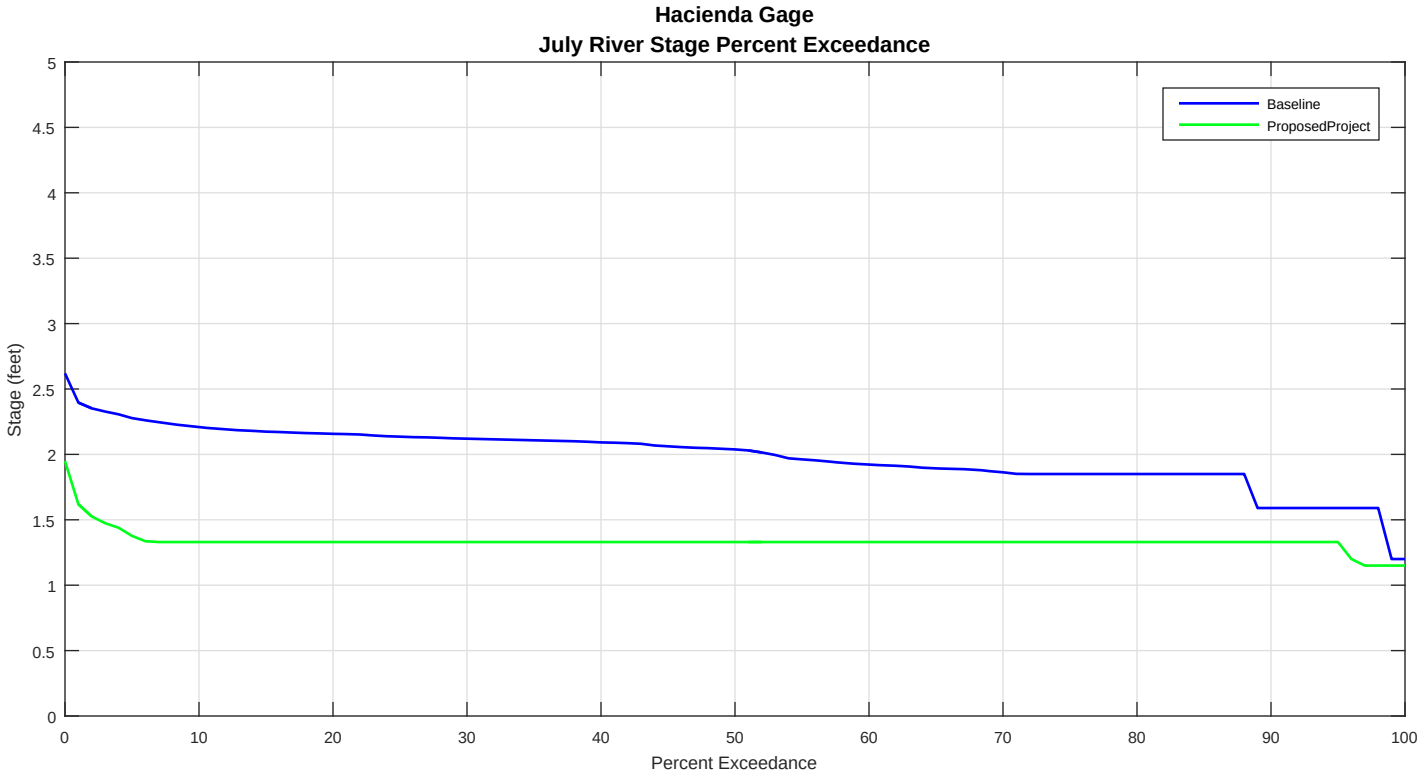

Healdsburg Gage
October 16-31 River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

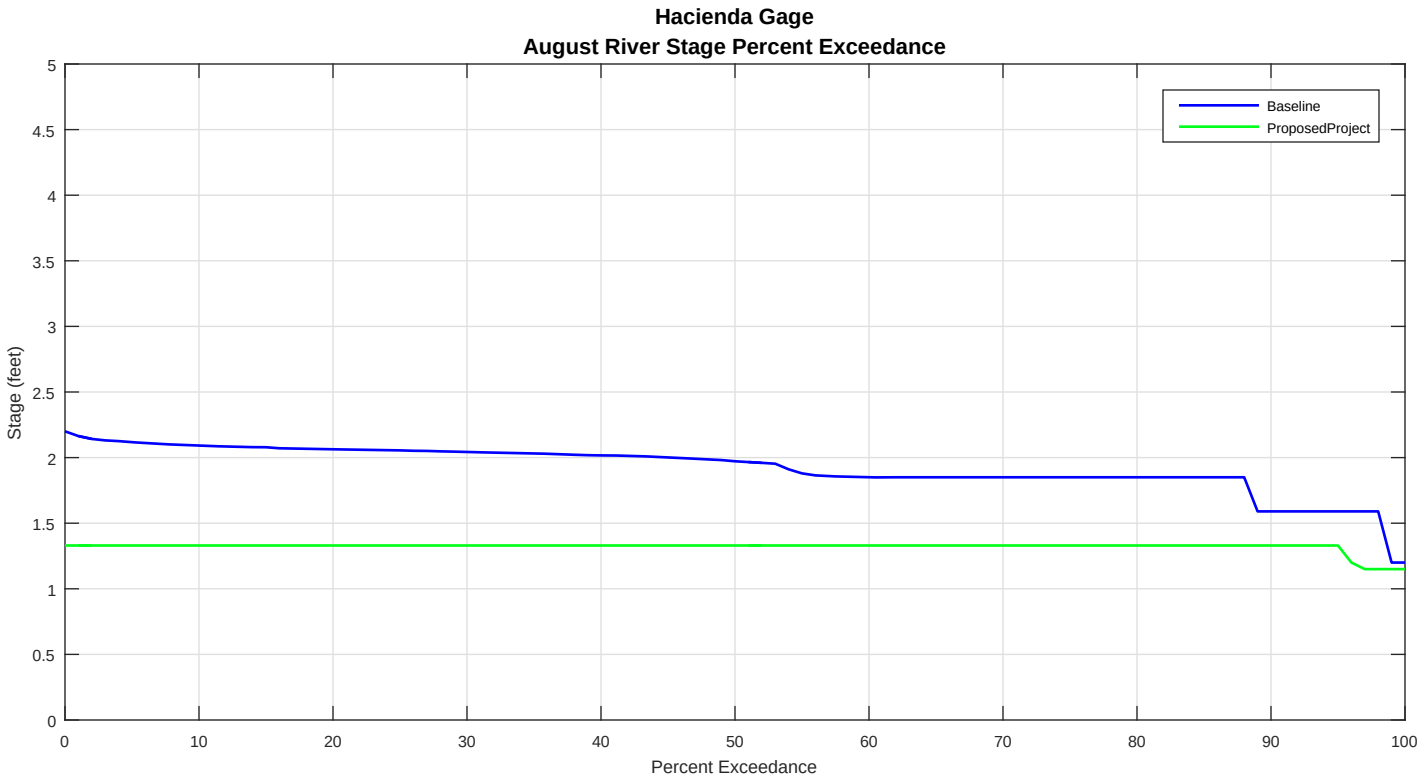

Hacienda Gage
March River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80
90
100

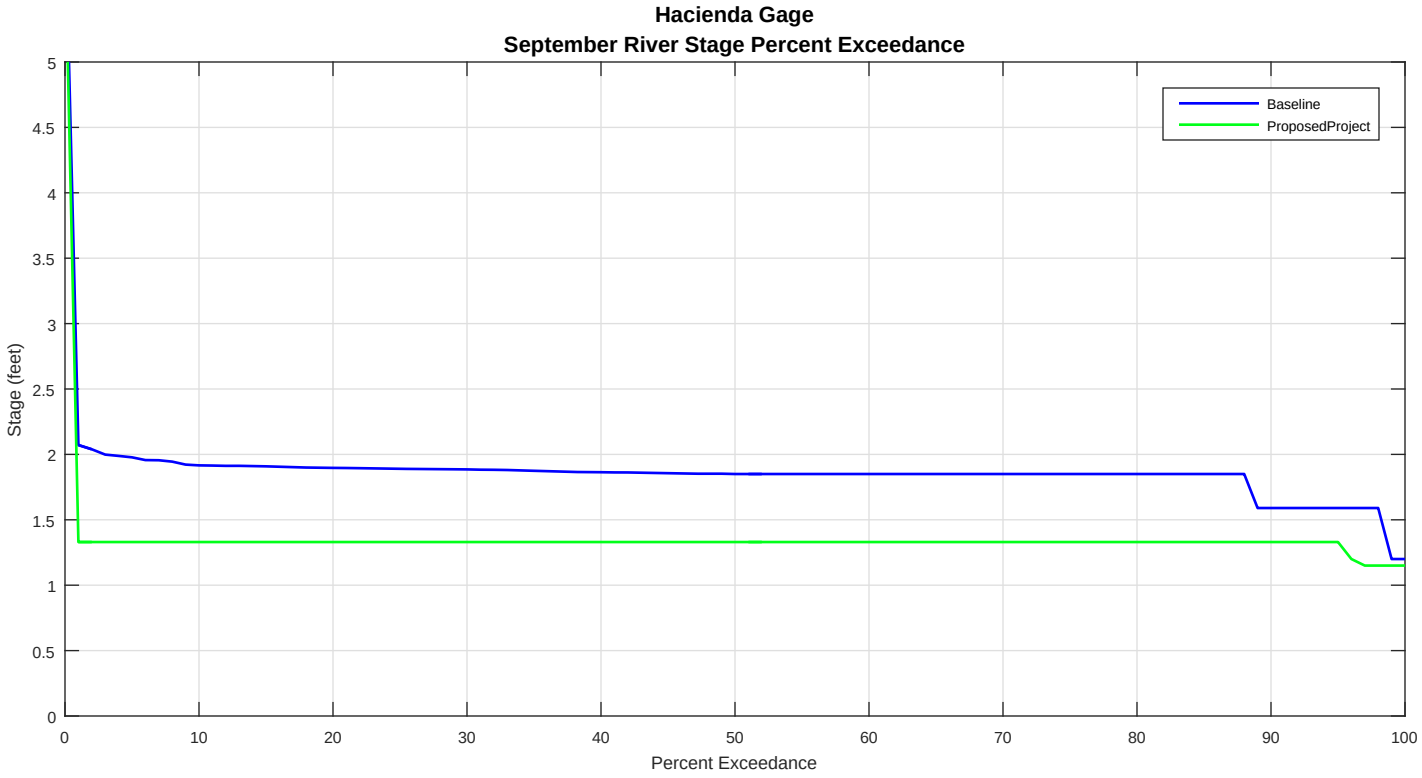

Hacienda Gage
April River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

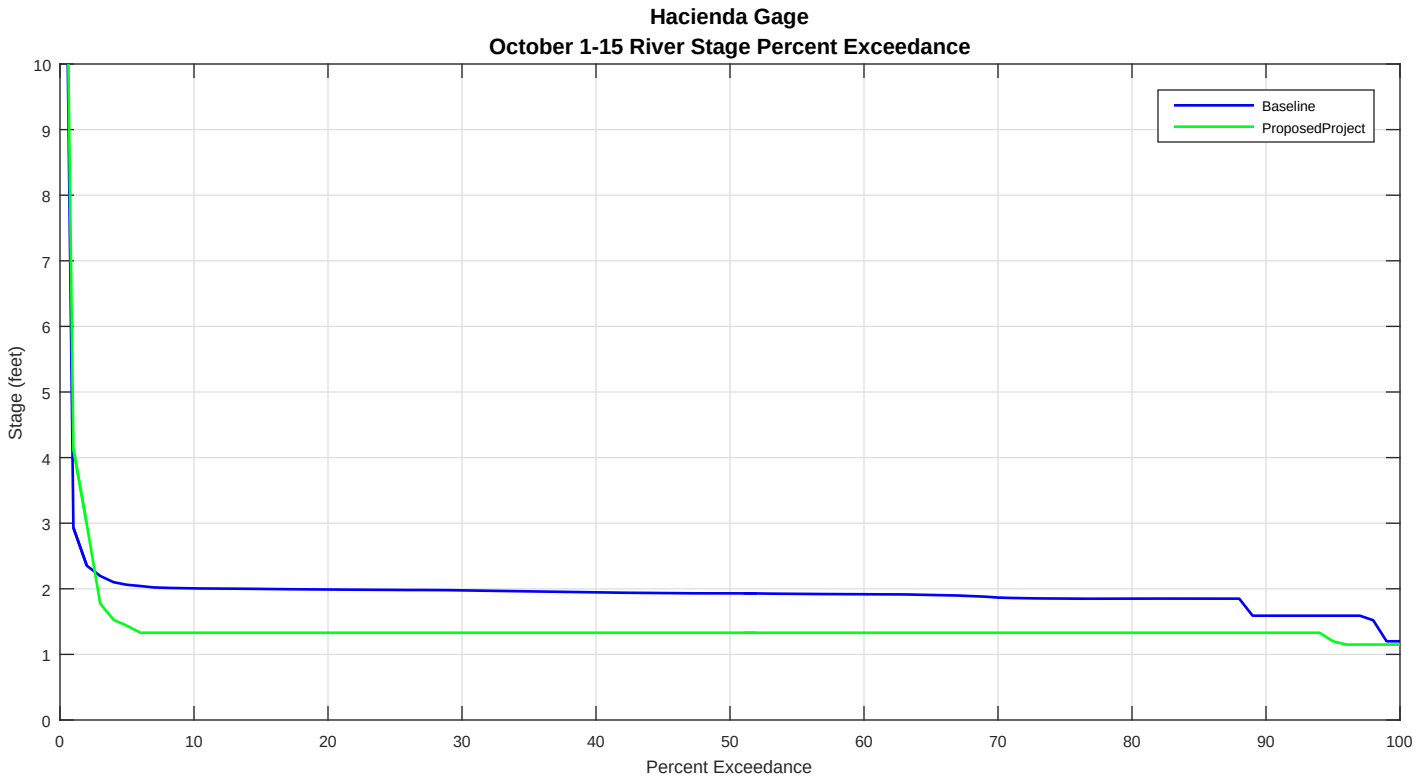

Hacienda Gage
May River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

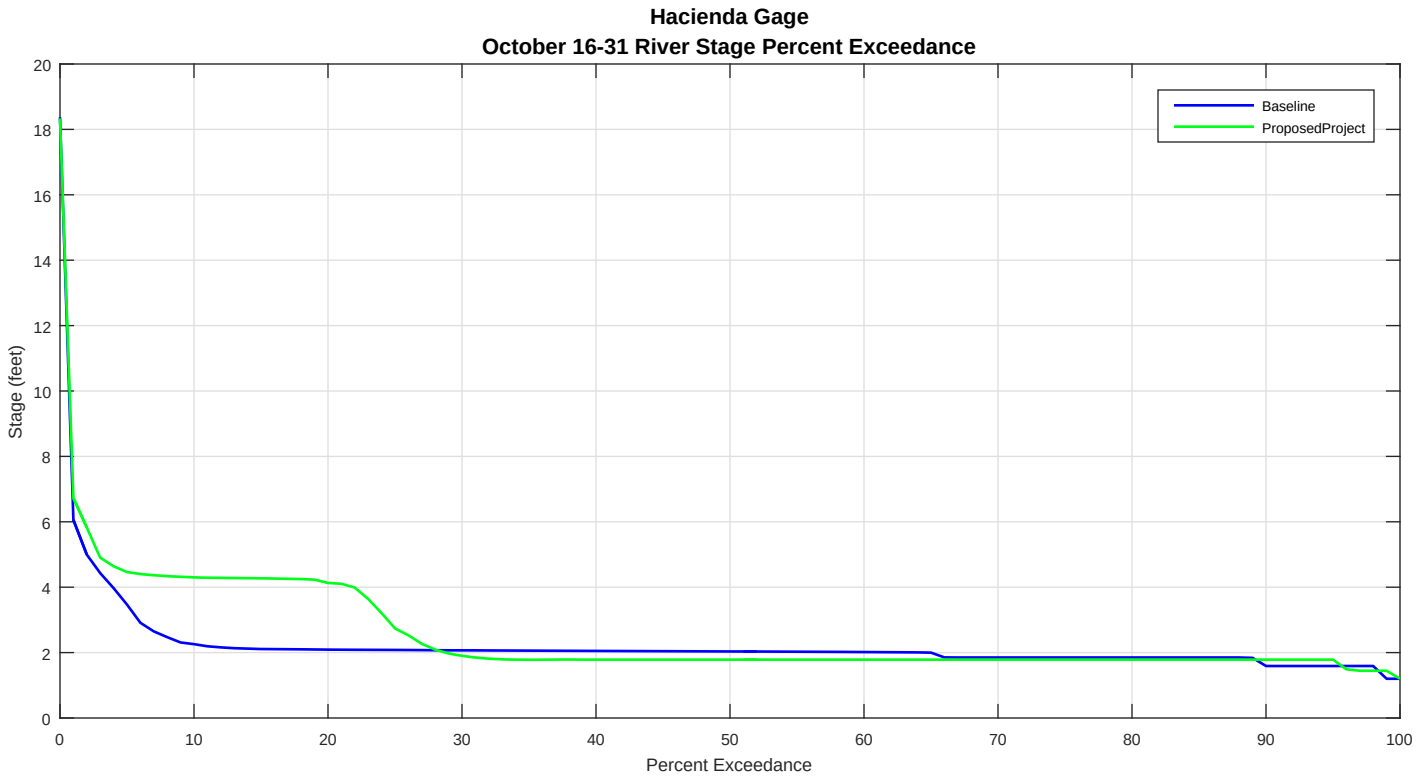

Hacienda Gage
June River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

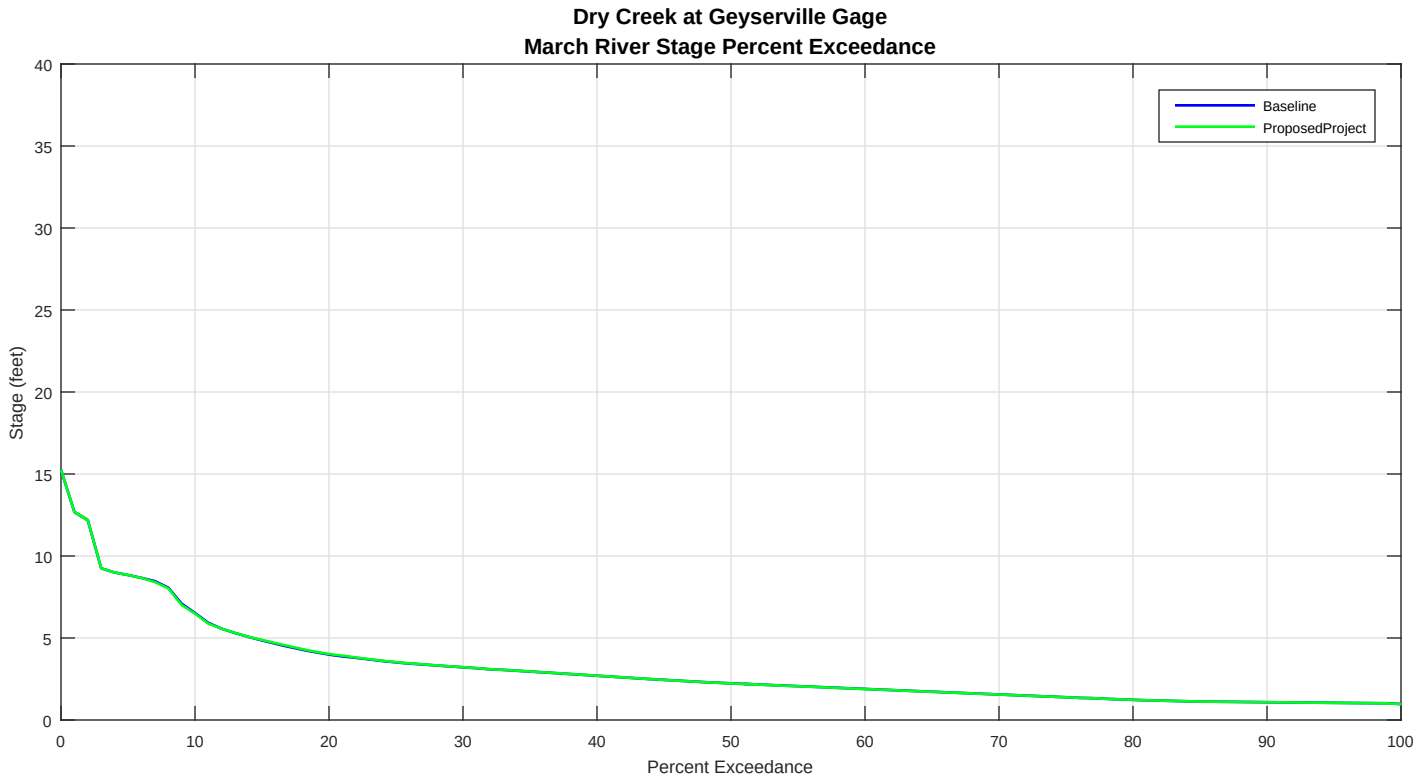

Hacienda Gage
July River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

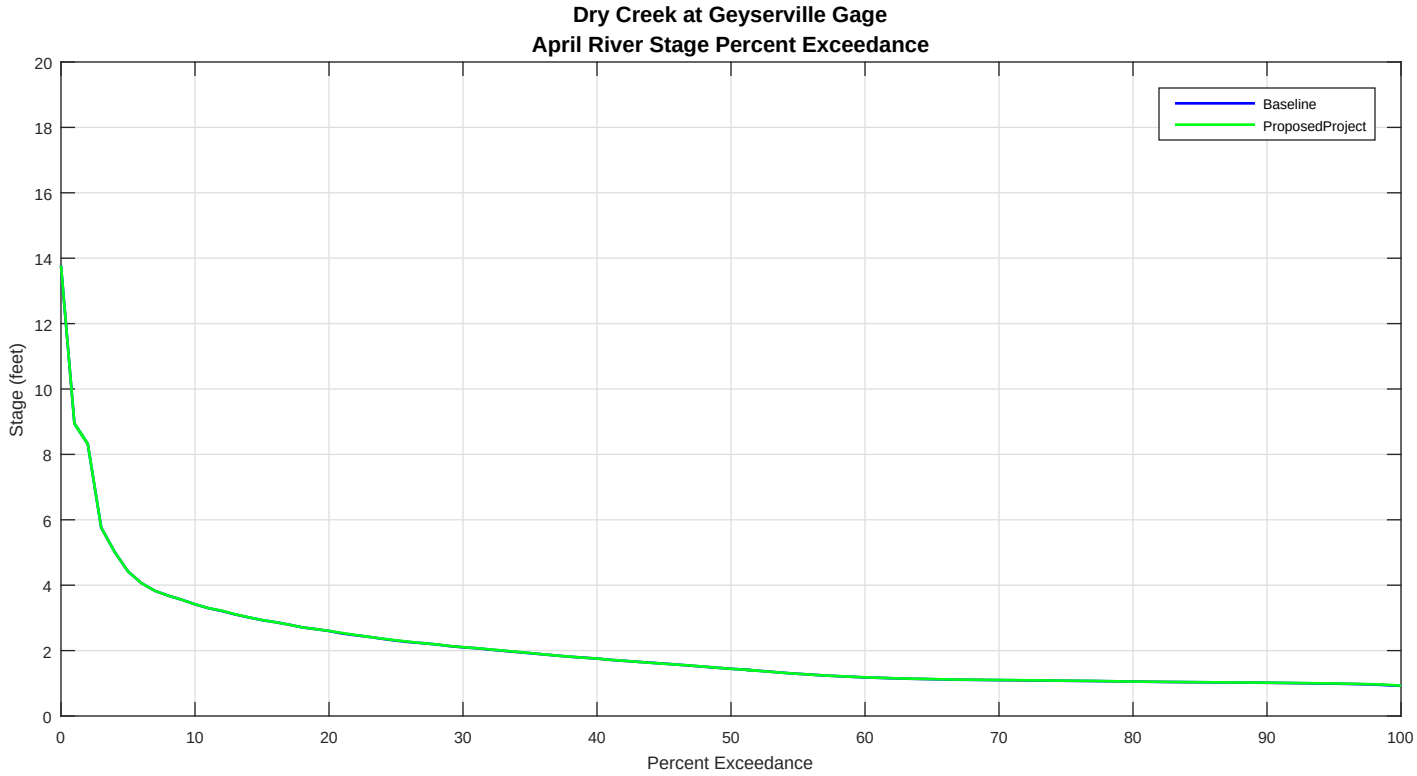

Hacienda Gage
August River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

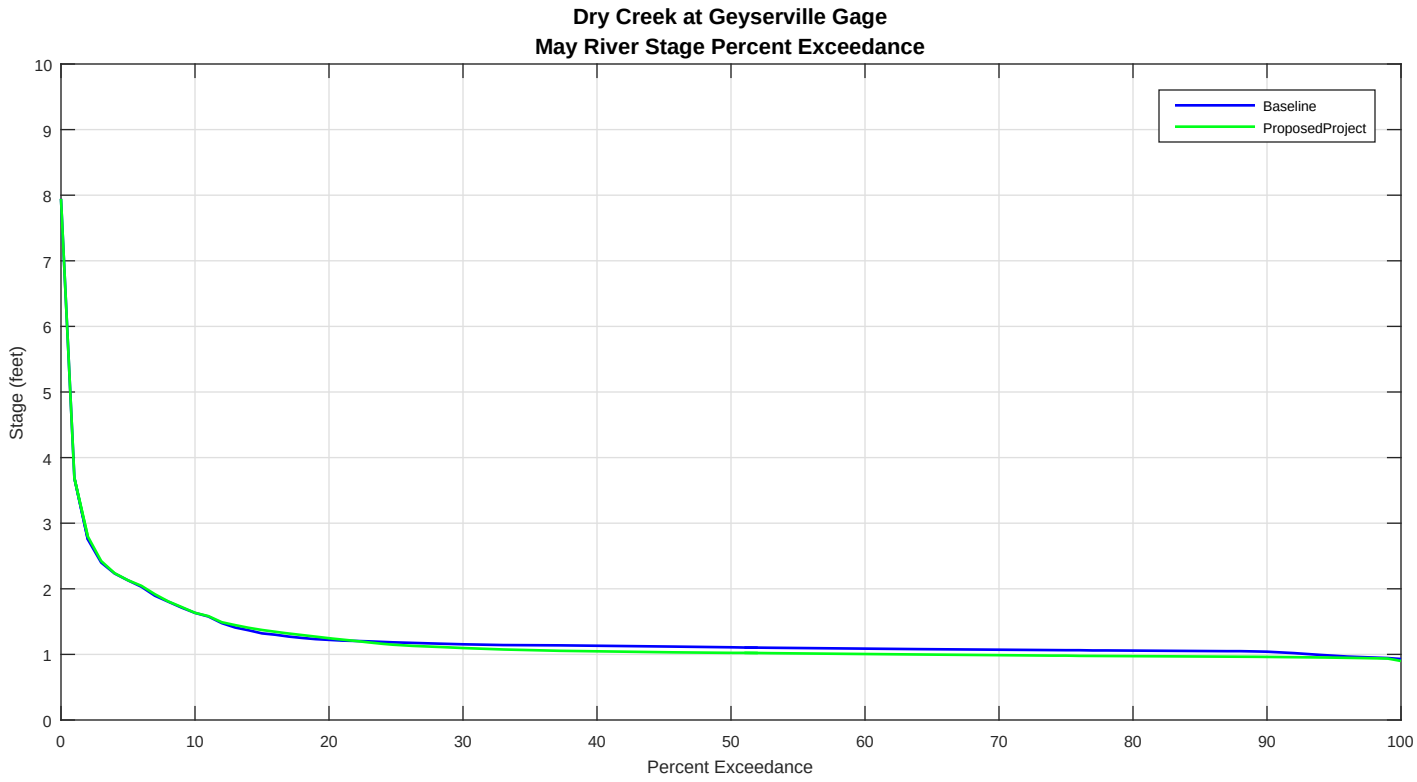

Hacienda Gage
September River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

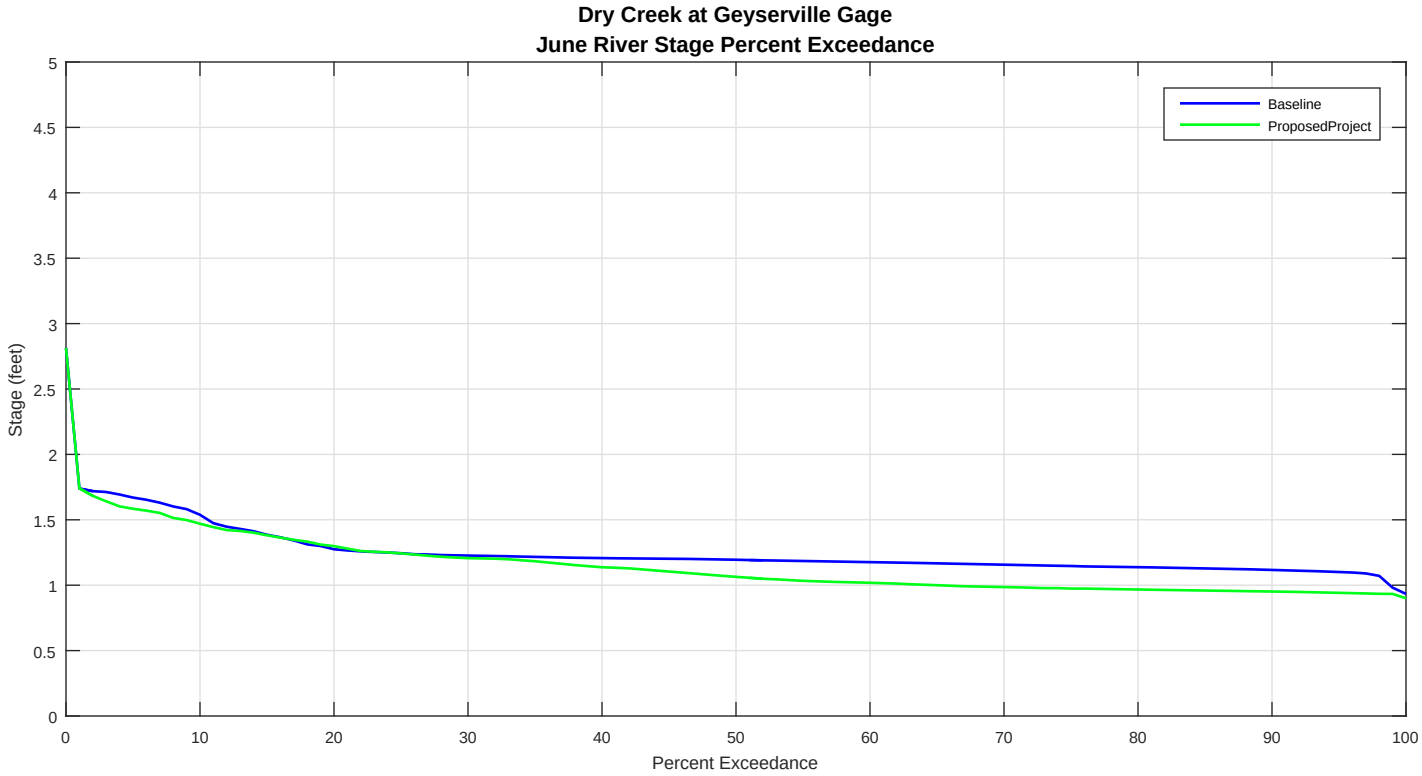

Hacienda Gage
October 1-15 River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

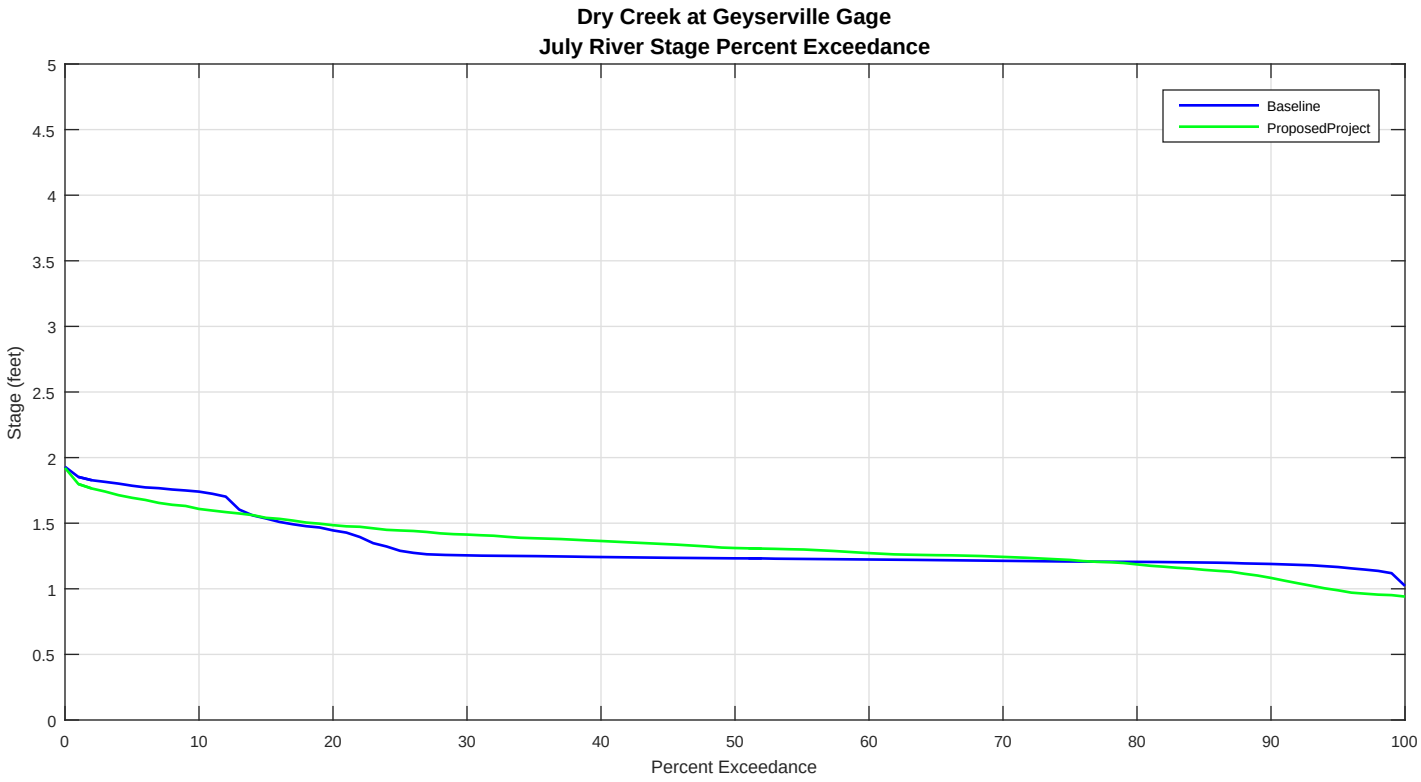

Hacienda Gage
October 16-31 River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

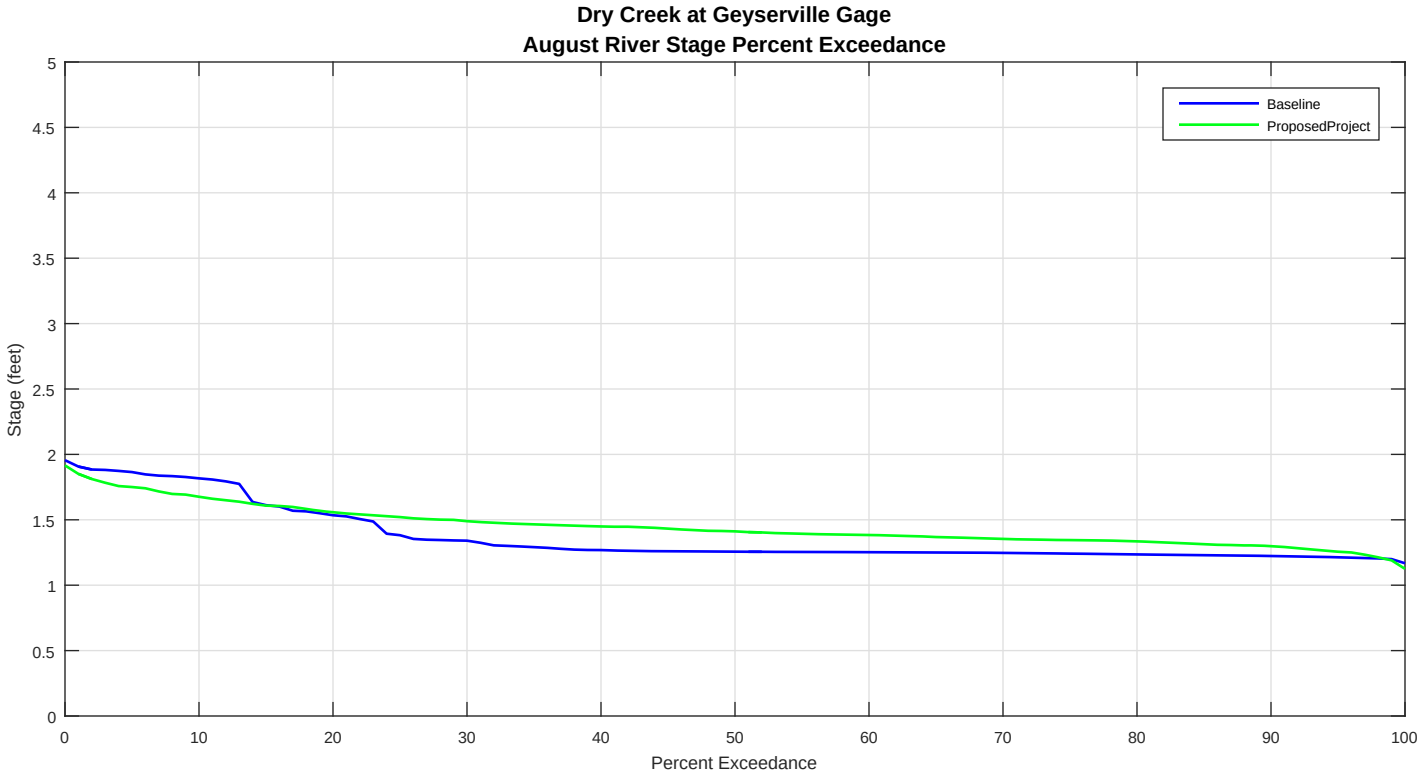

Dry Creek at Geyserville Gage
March River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80
90
100

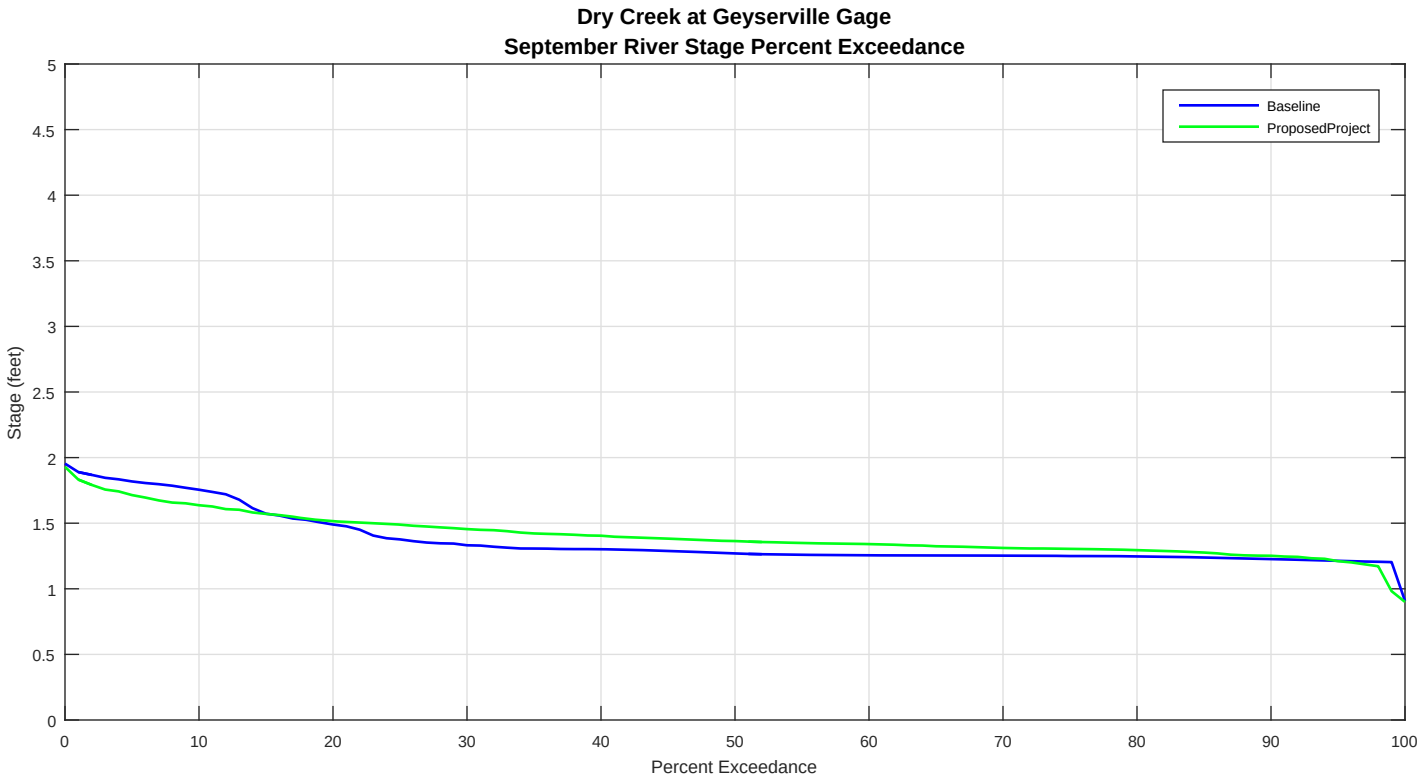

Dry Creek at Geyserville Gage
April River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

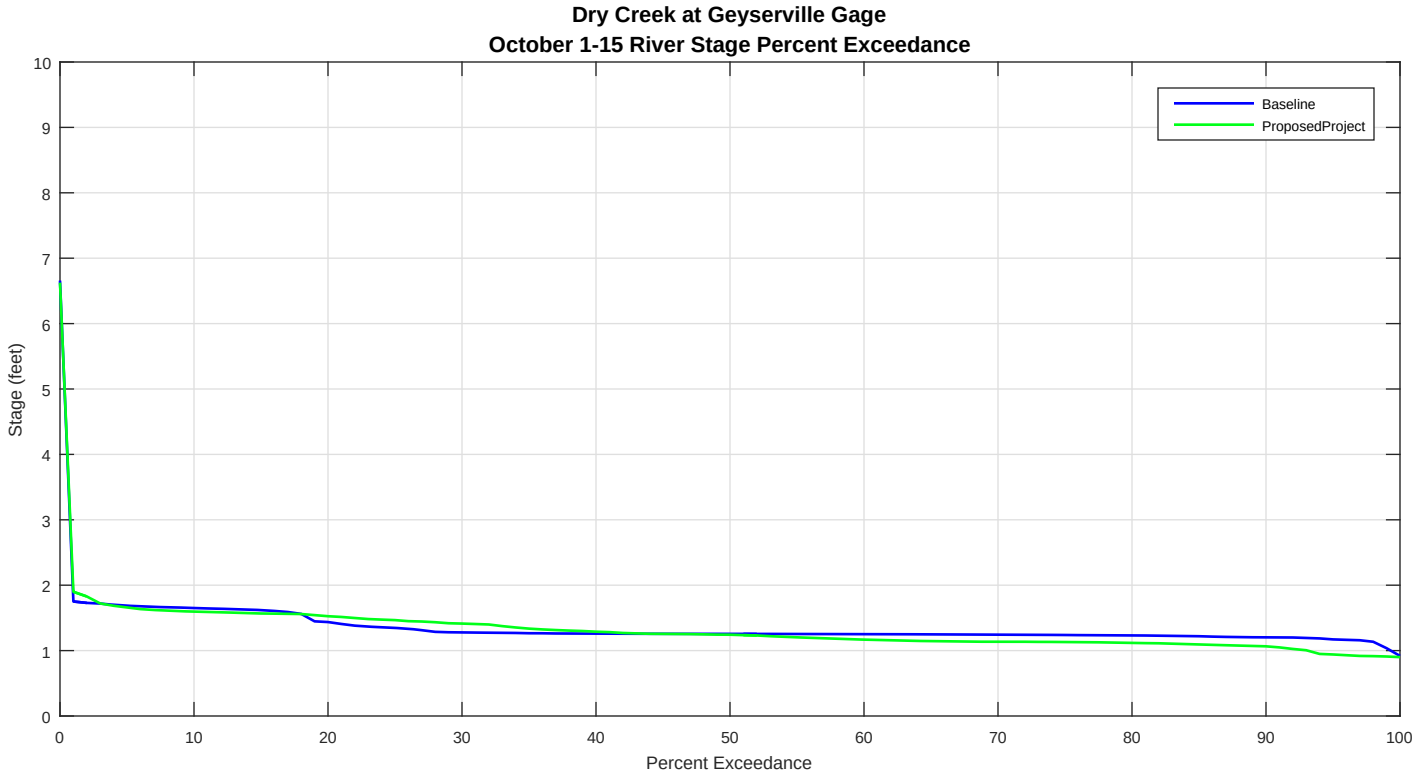

Dry Creek at Geyserville Gage
May River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

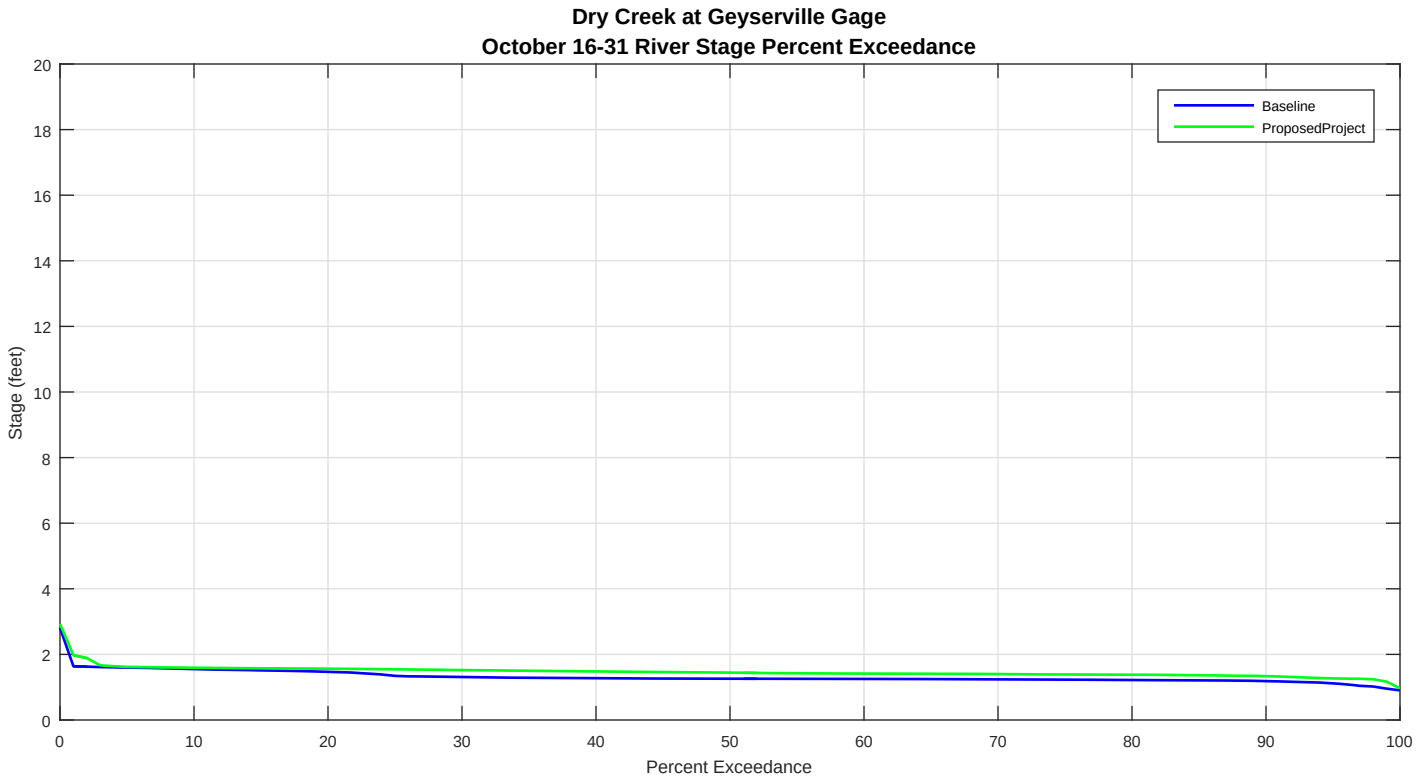

Dry Creek at Geyserville Gage
June River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

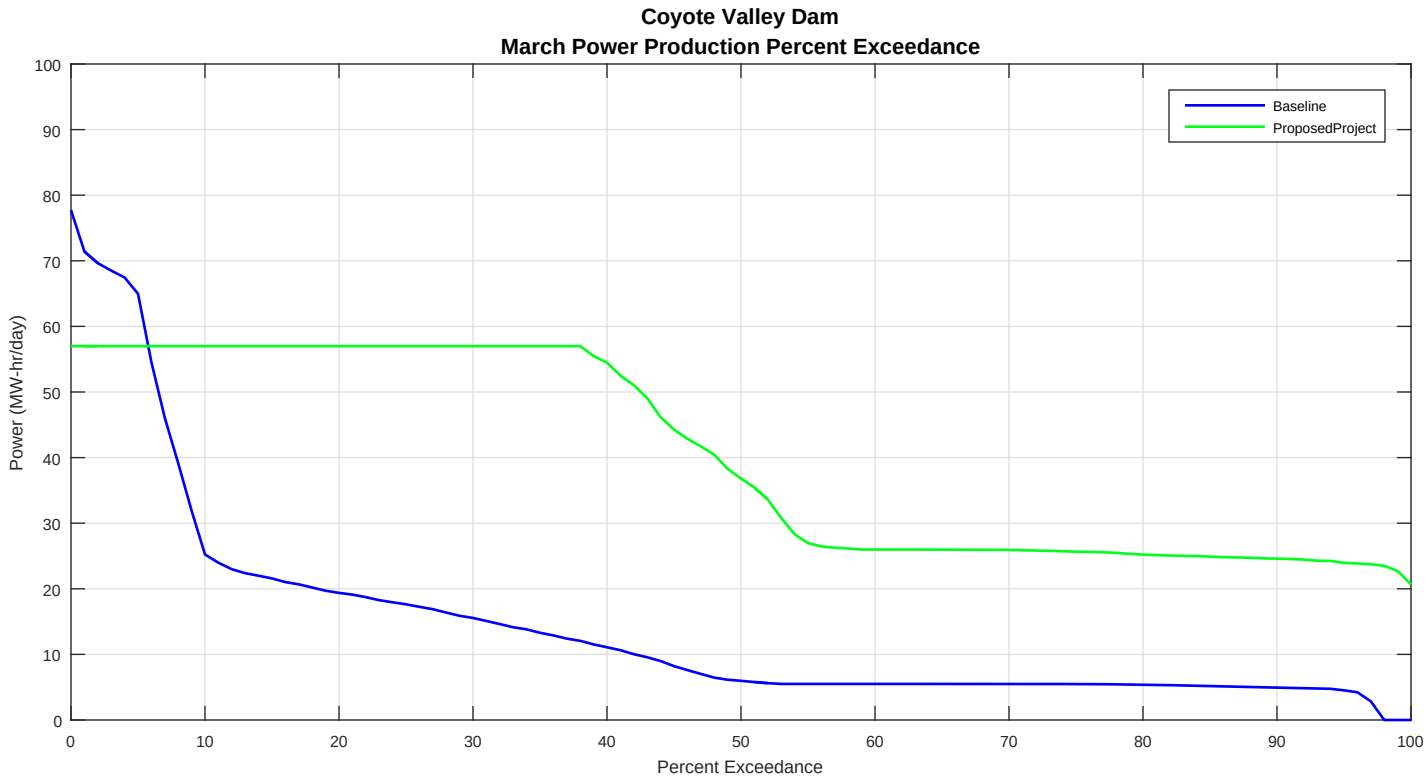

Dry Creek at Geyserville Gage
July River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

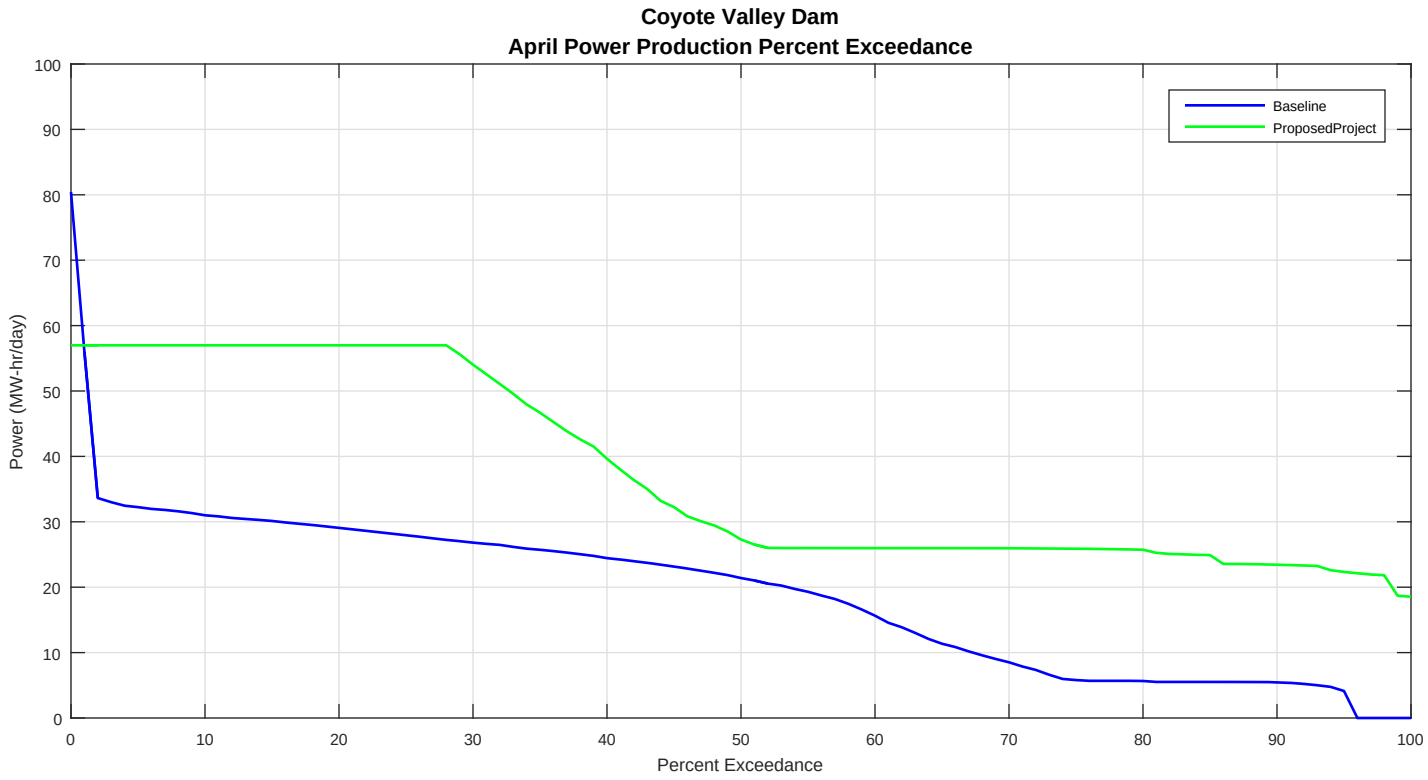

Dry Creek at Geyserville Gage
August River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

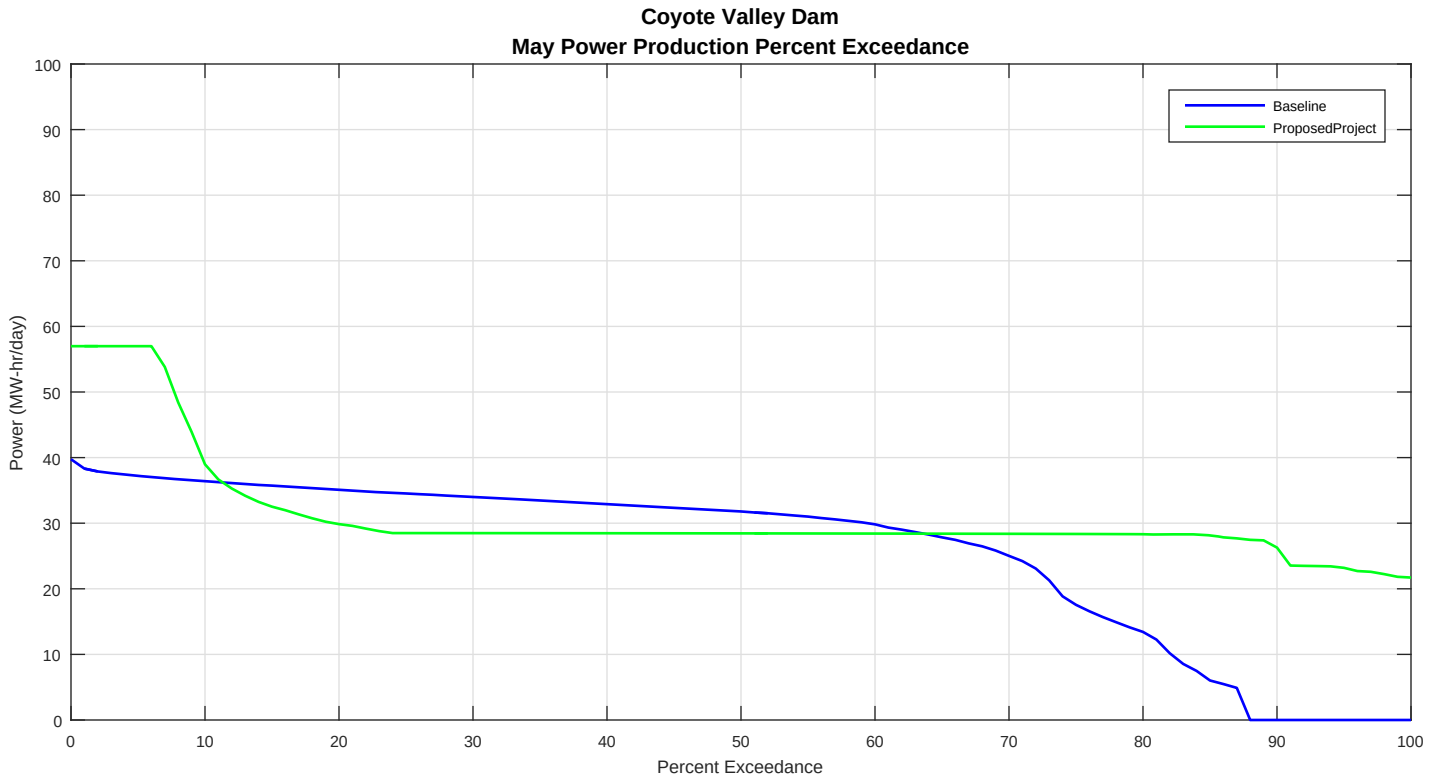

Dry Creek at Geyserville Gage
September River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

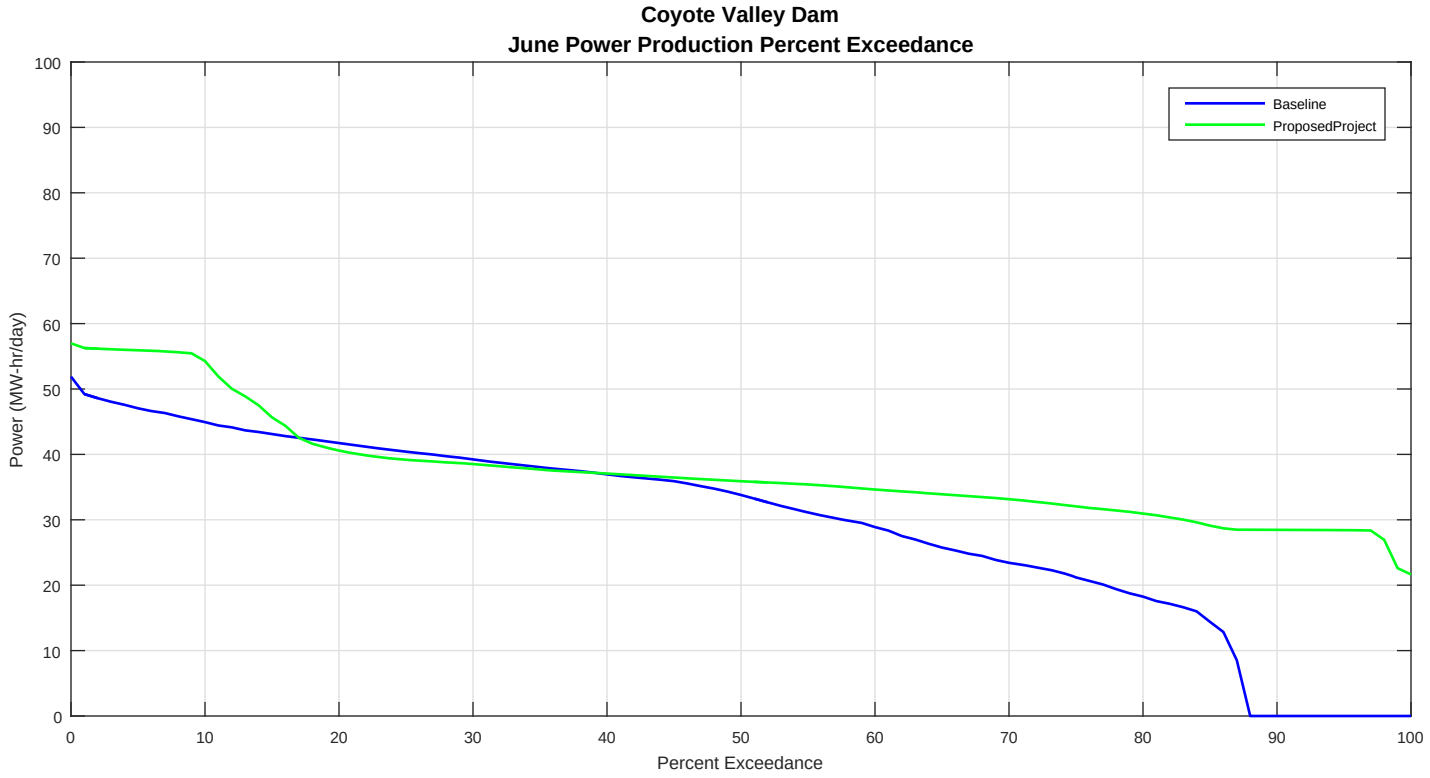

Dry Creek at Geyserville Gage
October 1-15 River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

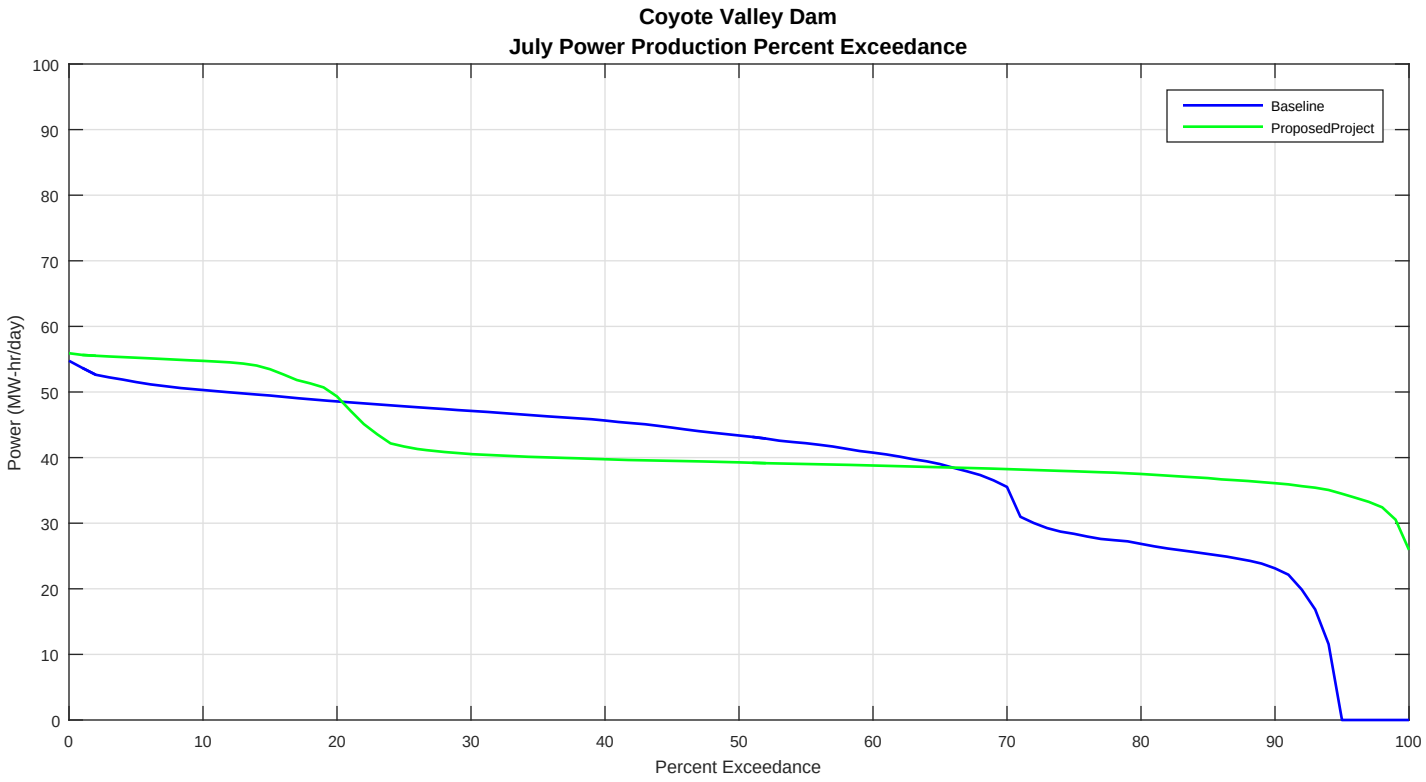

Dry Creek at Geyserville Gage
October 16-31 River Stage Percent Exceedance
Baseline
ProposedProject
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

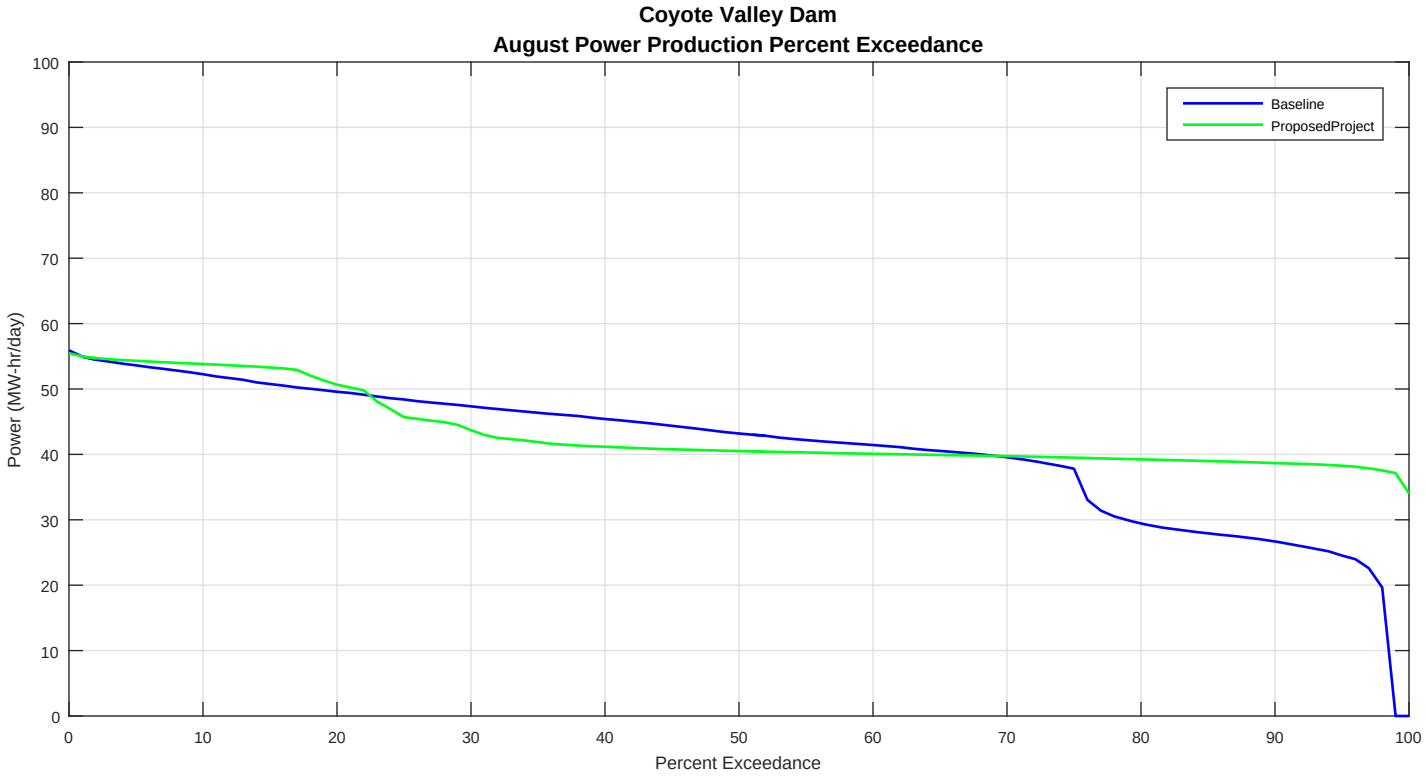

Coyote Valley Dam
March Power Production Percent Exceedance
Baseline
ProposedProject
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

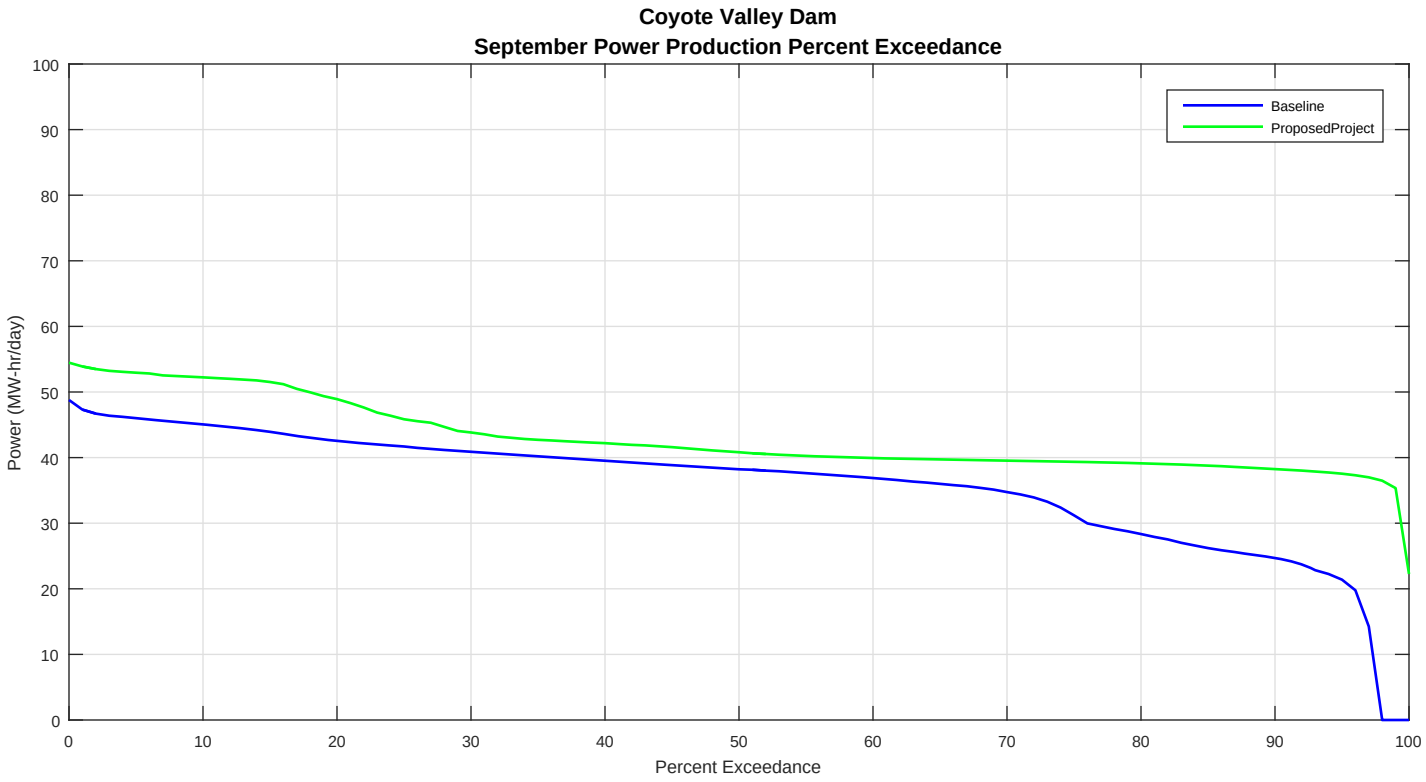

Coyote Valley Dam
April Power Production Percent Exceedance
Baseline
ProposedProject
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

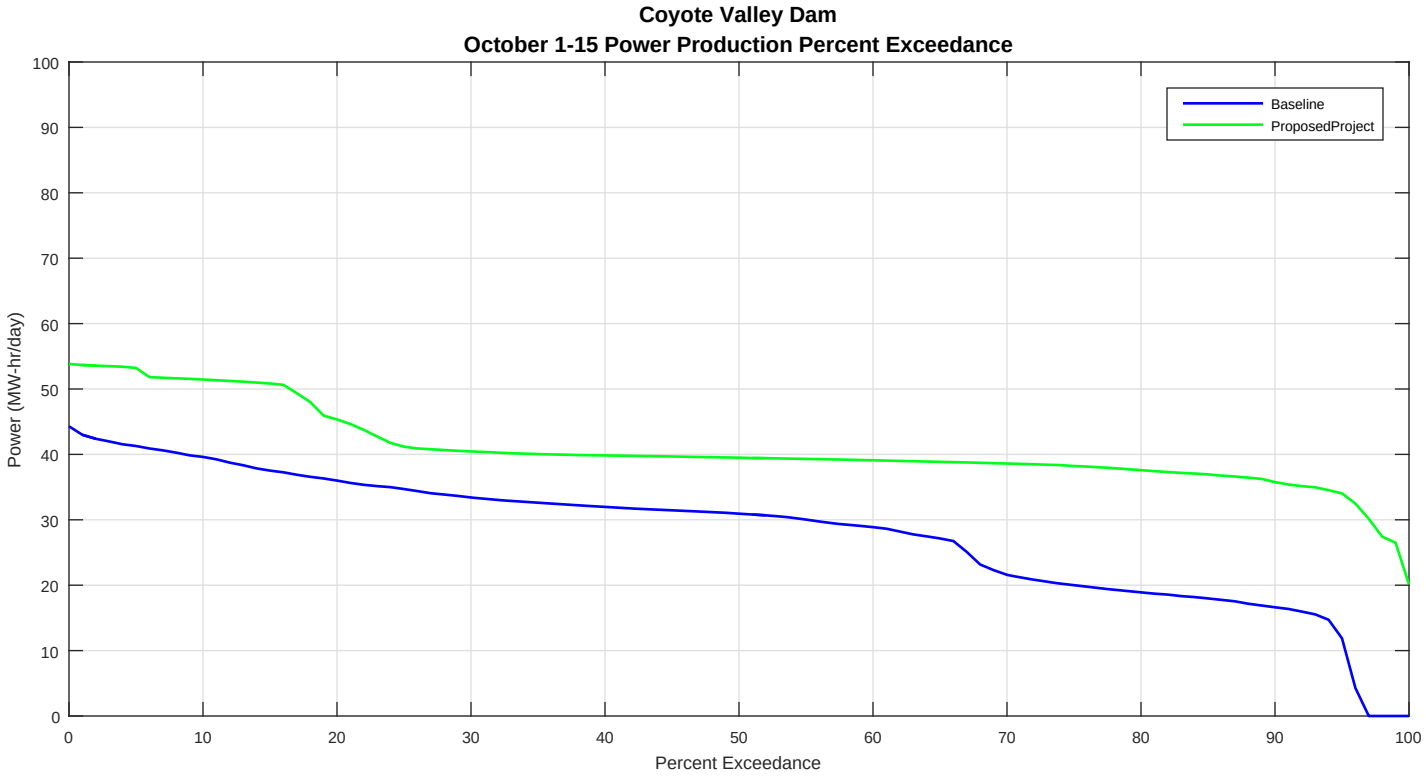

Coyote Valley Dam
May Power Production Percent Exceedance
Baseline
ProposedProject
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

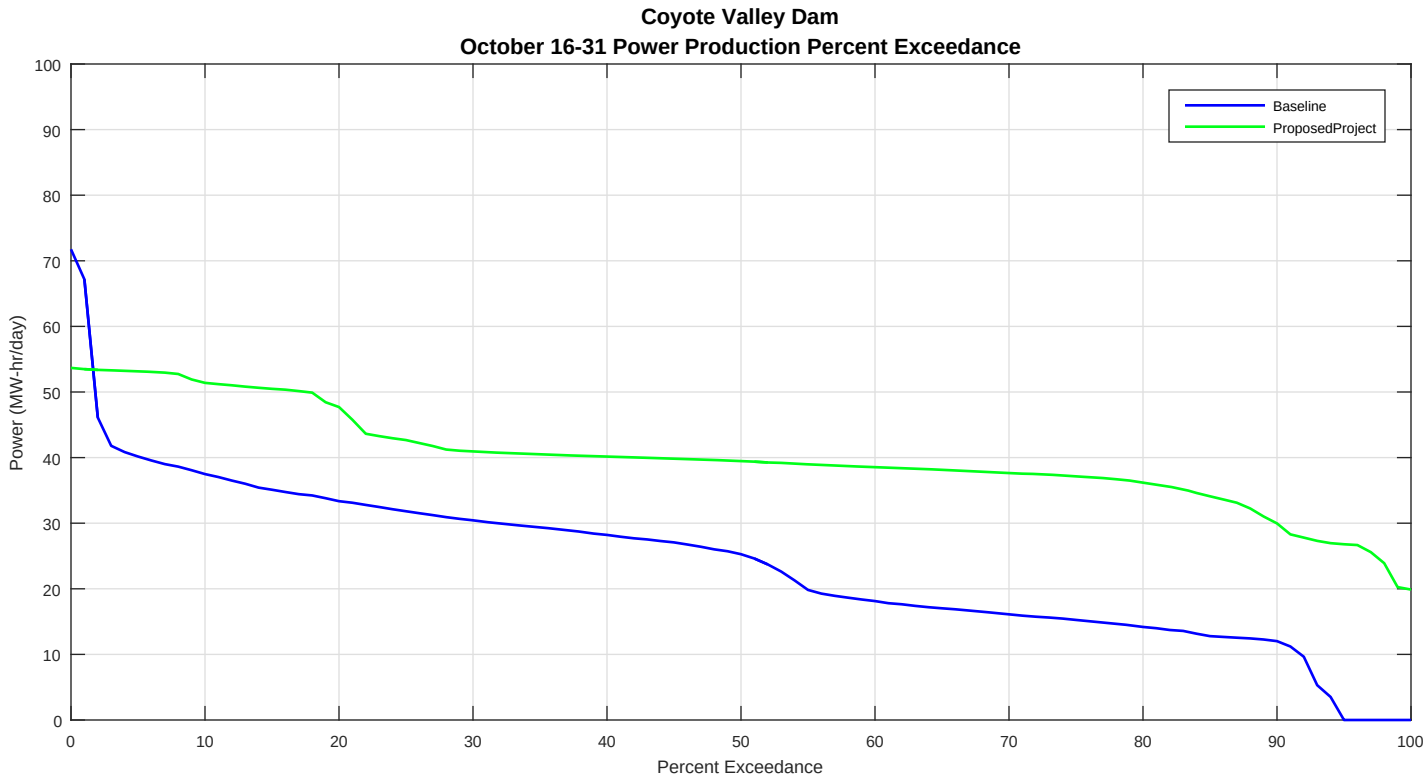

Coyote Valley Dam
June Power Production Percent Exceedance
Baseline
ProposedProject
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

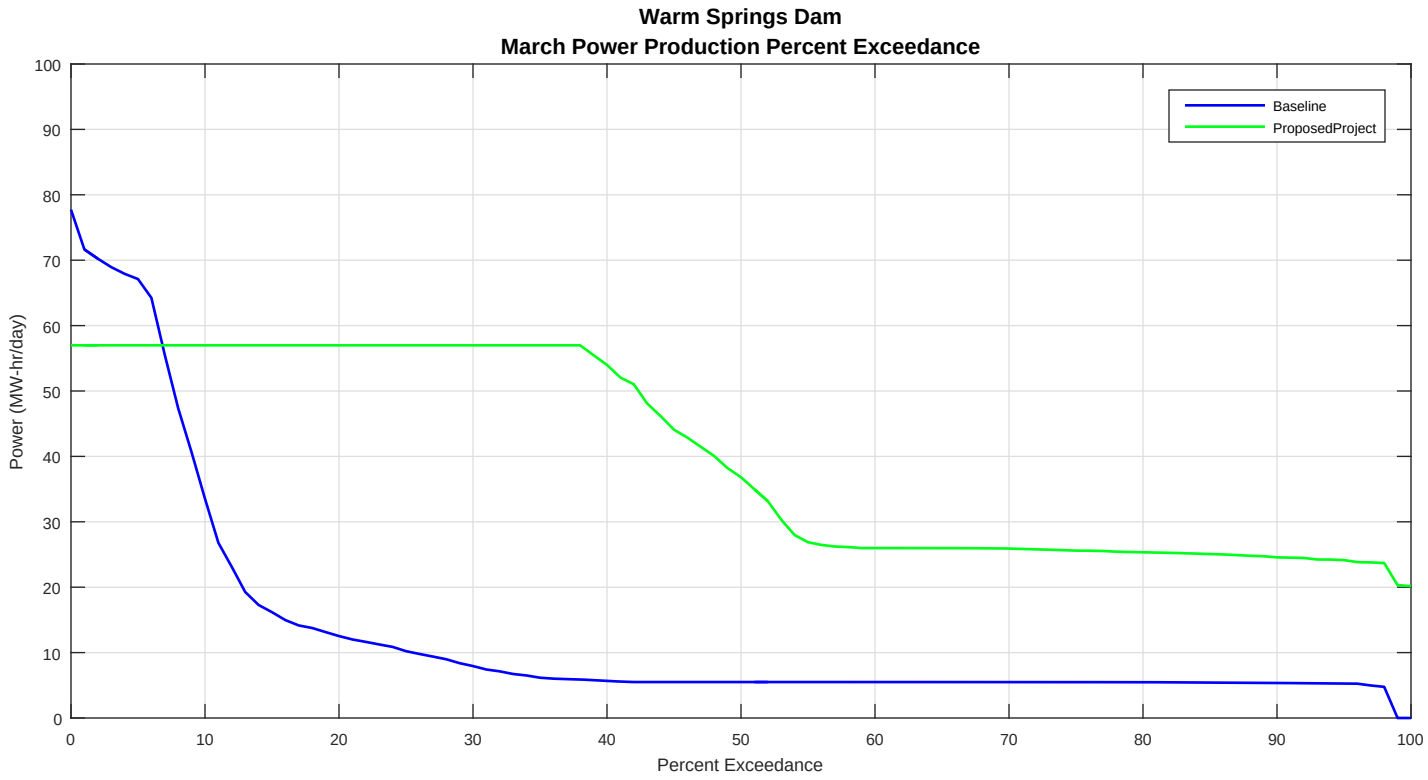

Coyote Valley Dam
July Power Production Percent Exceedance
Baseline
ProposedProject
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

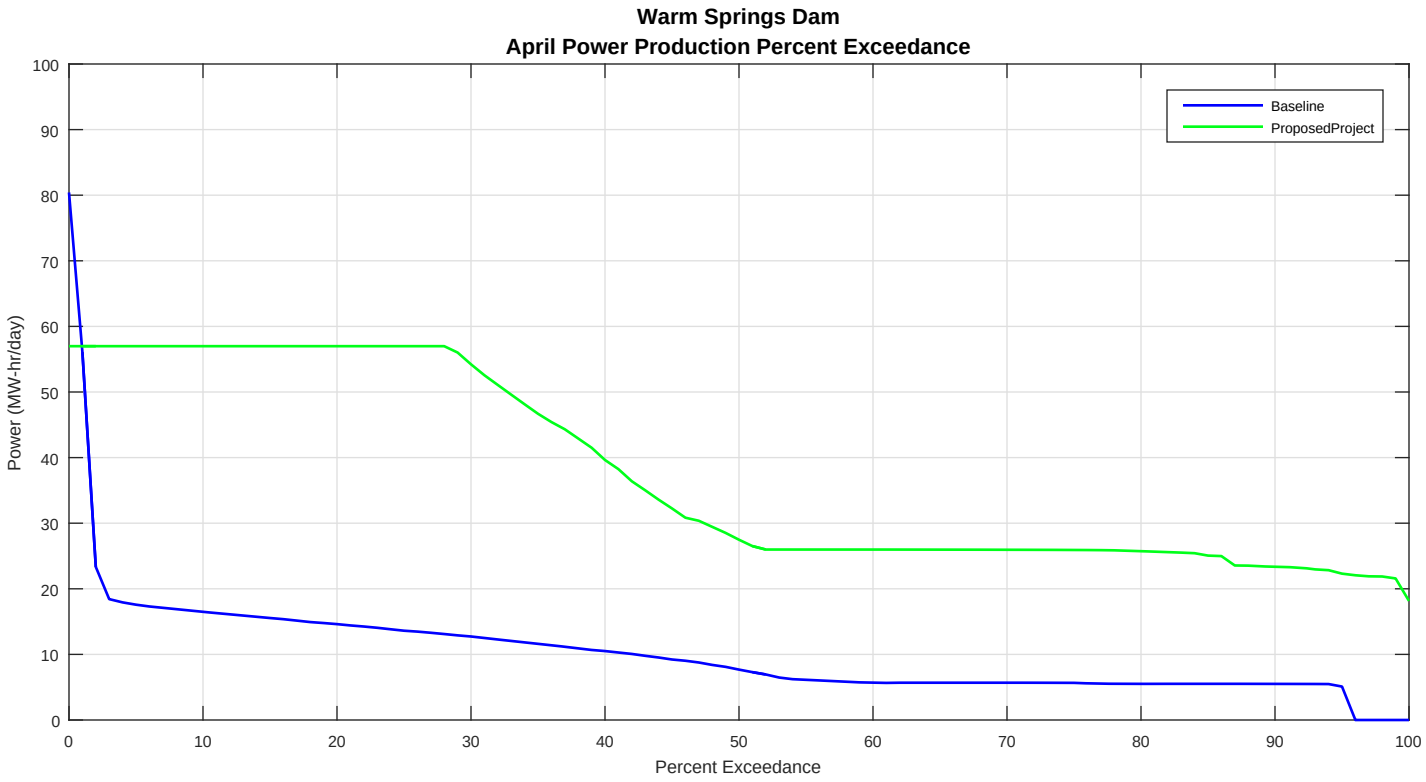

Coyote Valley Dam
August Power Production Percent Exceedance
Baseline
ProposedProject
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

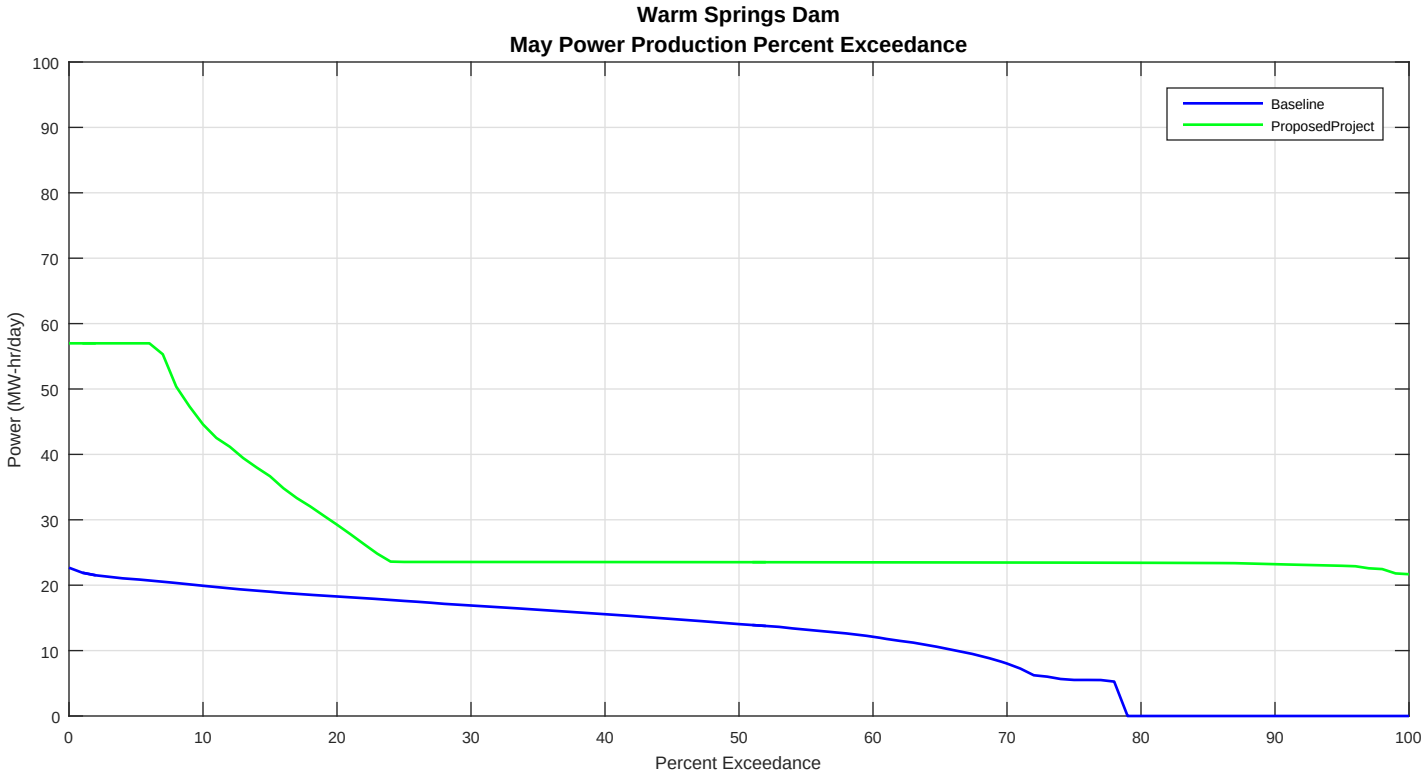

Coyote Valley Dam
September Power Production Percent Exceedance
Baseline
ProposedProject
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

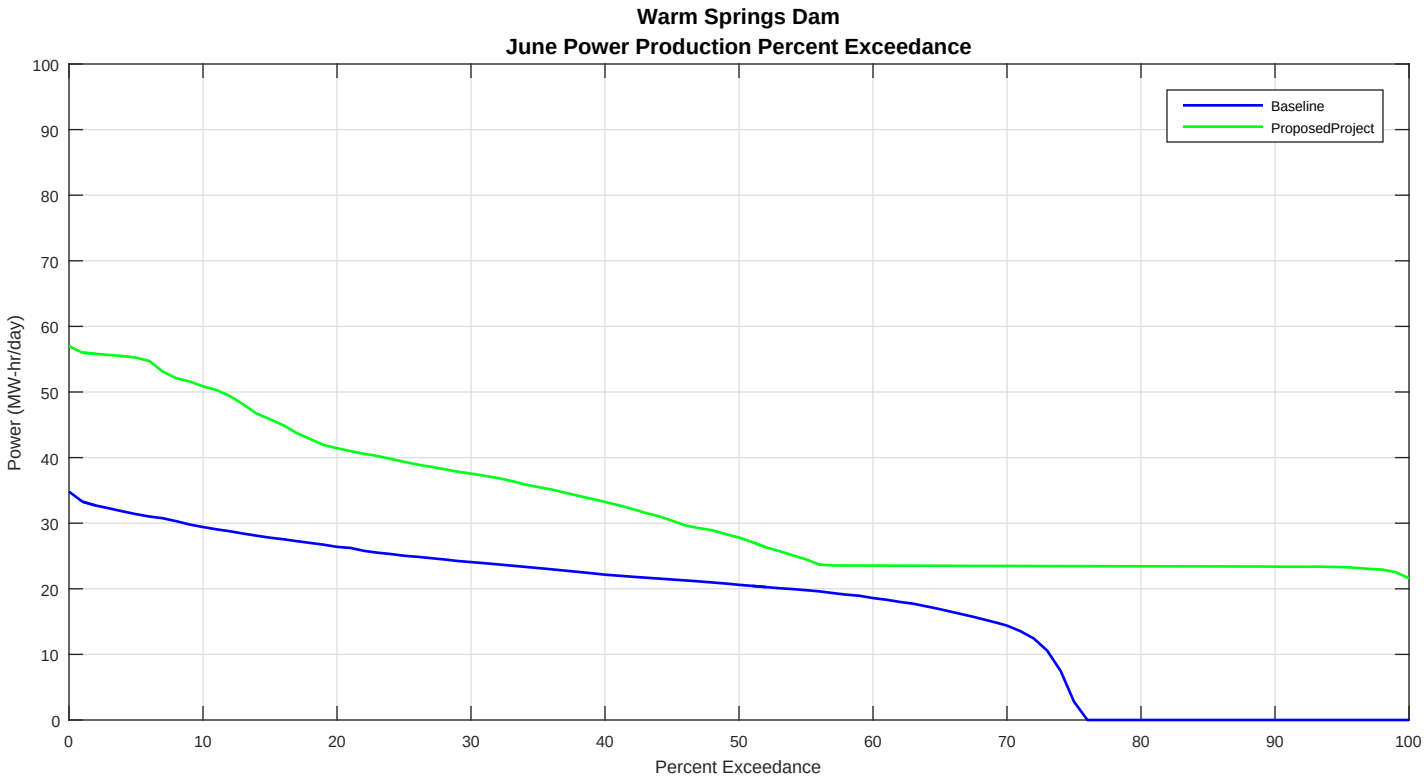

Coyote Valley Dam
October 1-15 Power Production Percent Exceedance
Baseline
ProposedProject
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

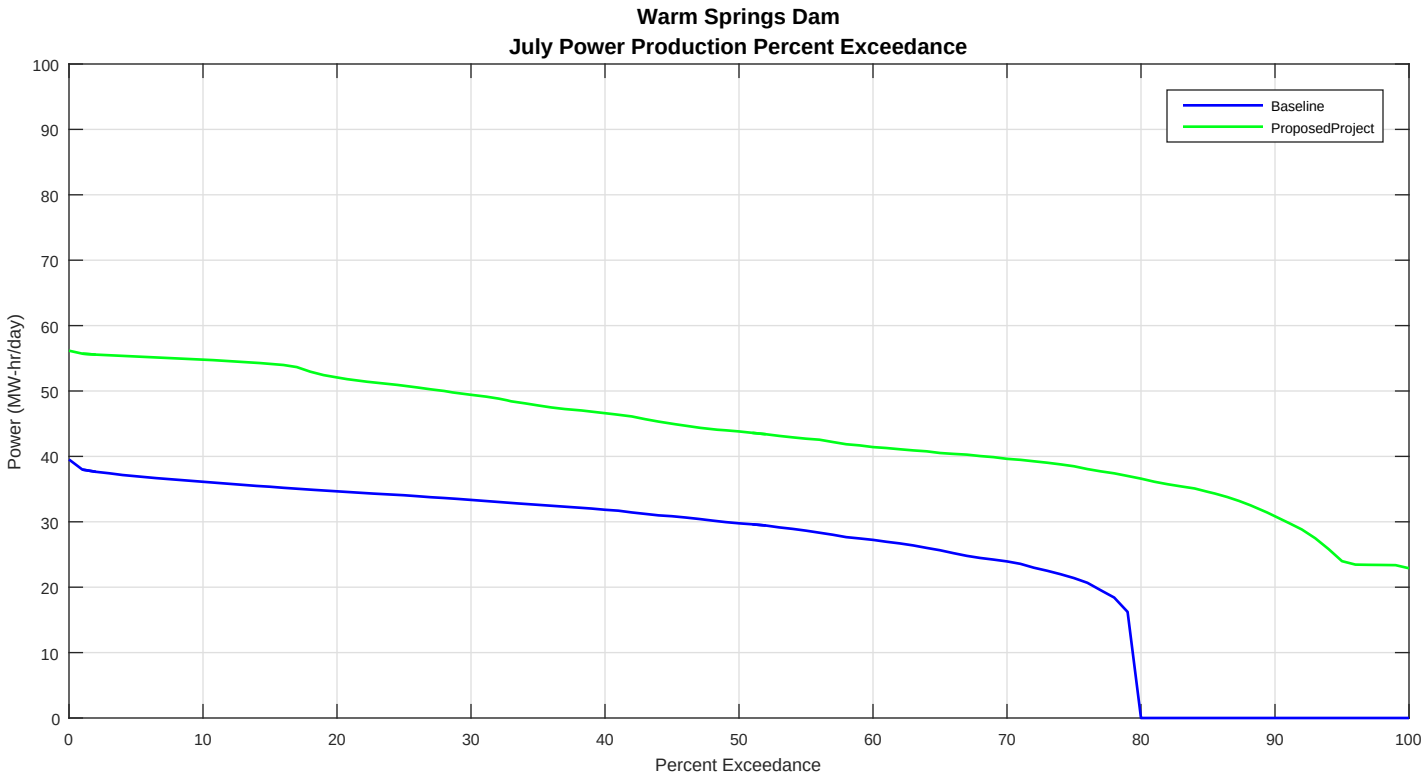

Coyote Valley Dam
October 16-31 Power Production Percent Exceedance
Baseline
ProposedProject
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

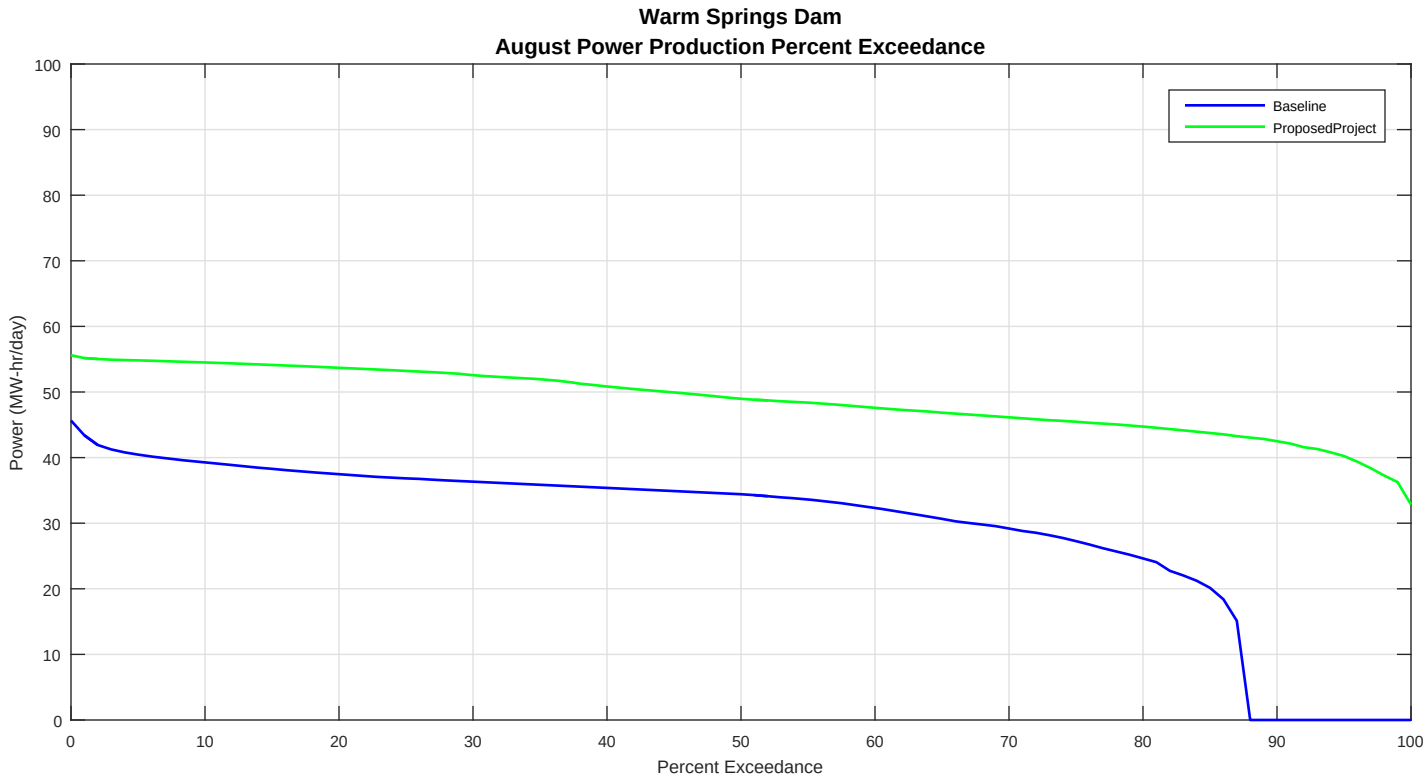

Warm Springs Dam
March Power Production Percent Exceedance
Baseline
ProposedProject
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

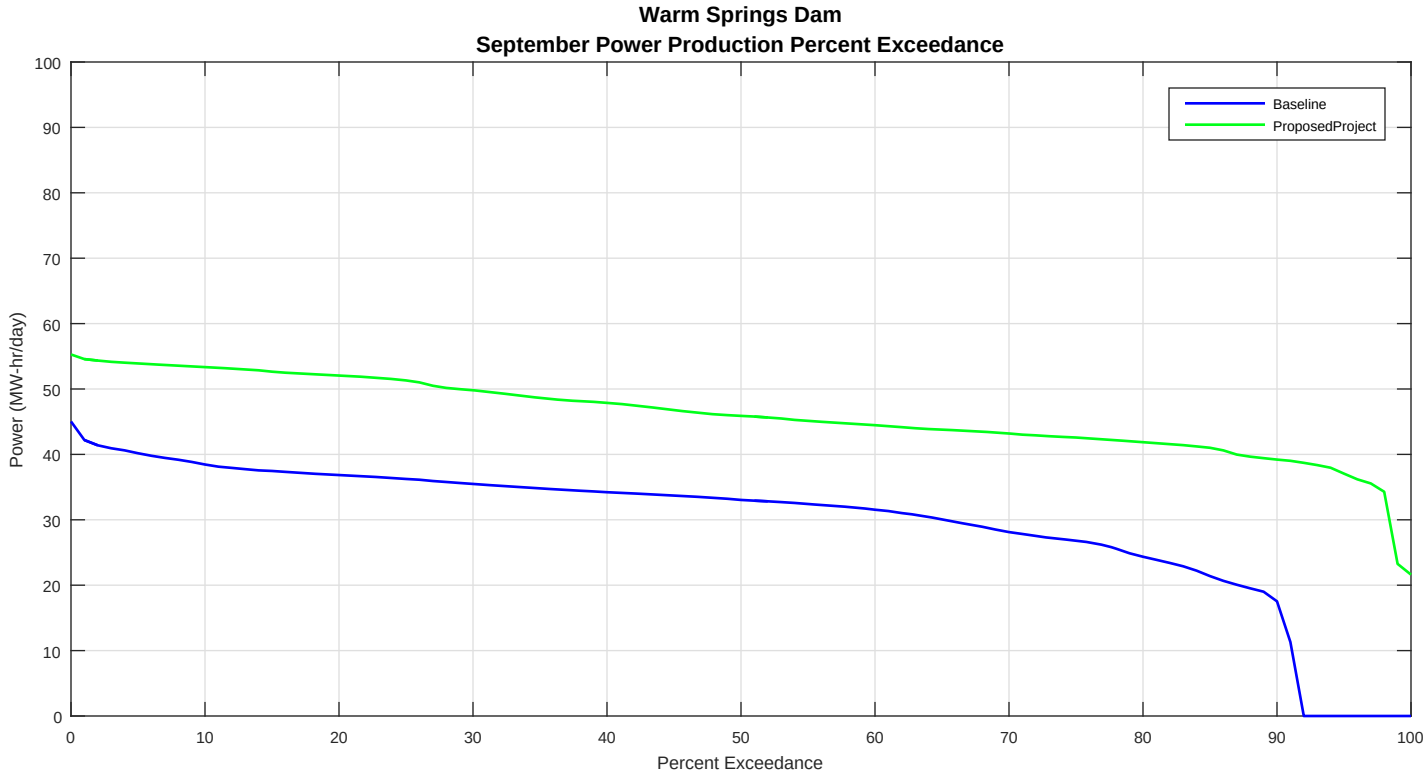

Warm Springs Dam
April Power Production Percent Exceedance
Baseline
ProposedProject
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

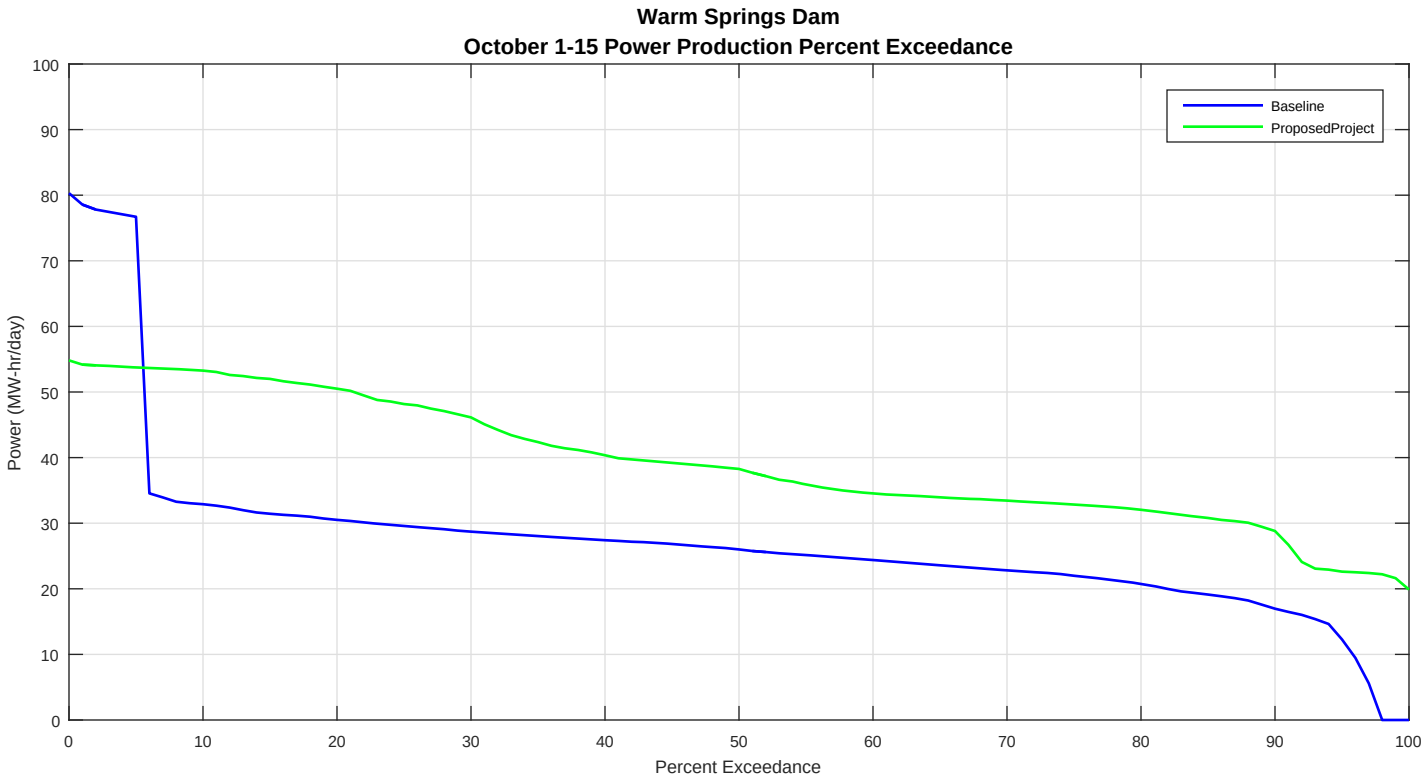

Warm Springs Dam
May Power Production Percent Exceedance
Baseline
ProposedProject
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

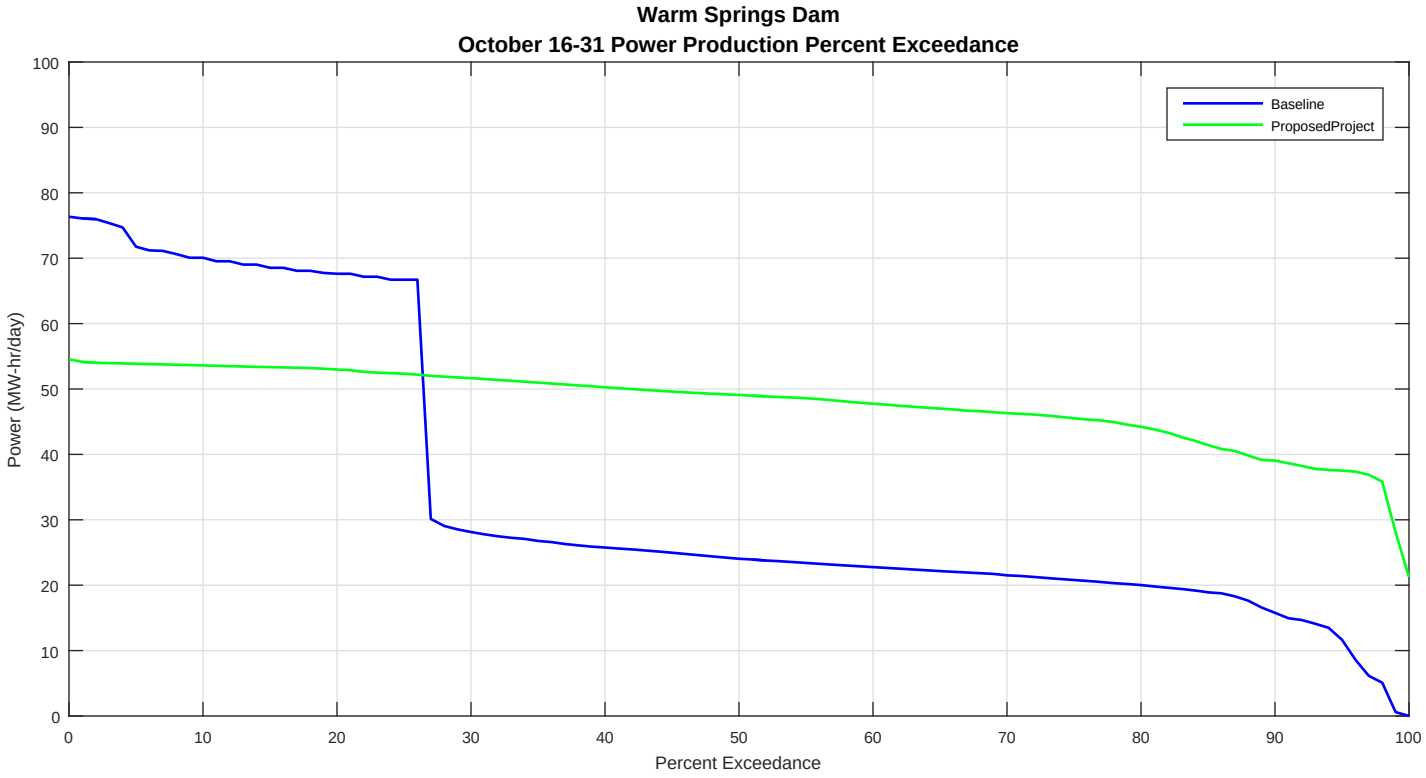

Warm Springs Dam
June Power Production Percent Exceedance
Baseline
ProposedProject
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

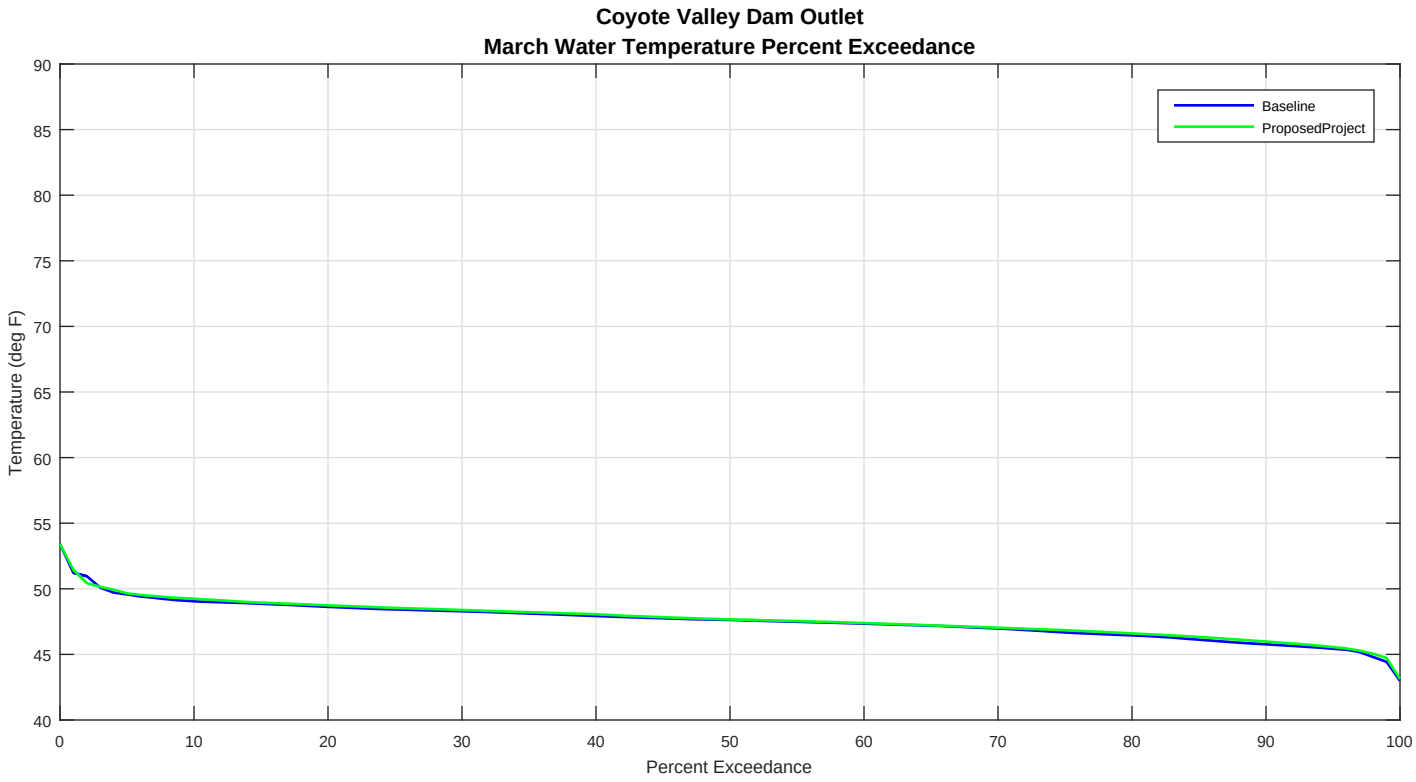

Warm Springs Dam
July Power Production Percent Exceedance
Baseline
ProposedProject
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

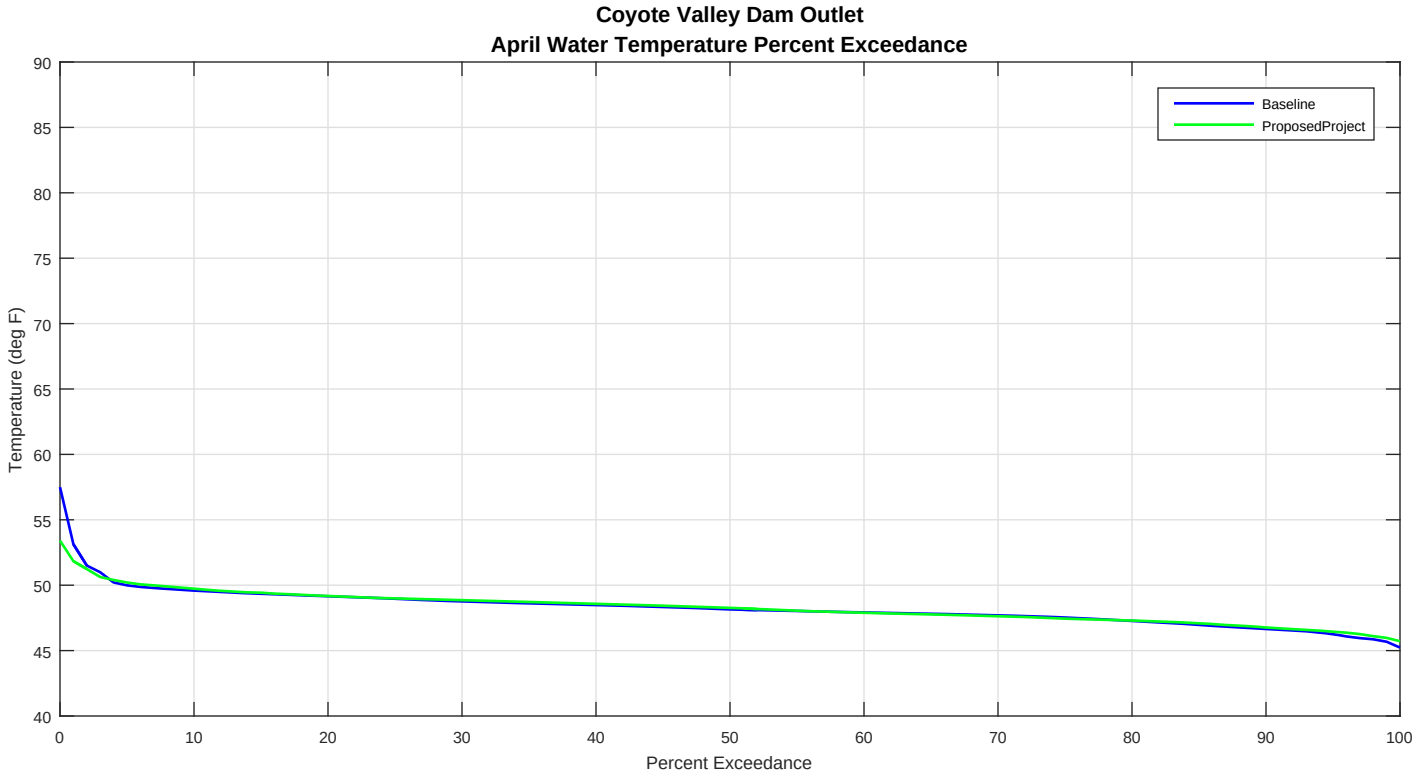

Warm Springs Dam
August Power Production Percent Exceedance
Baseline
ProposedProject
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

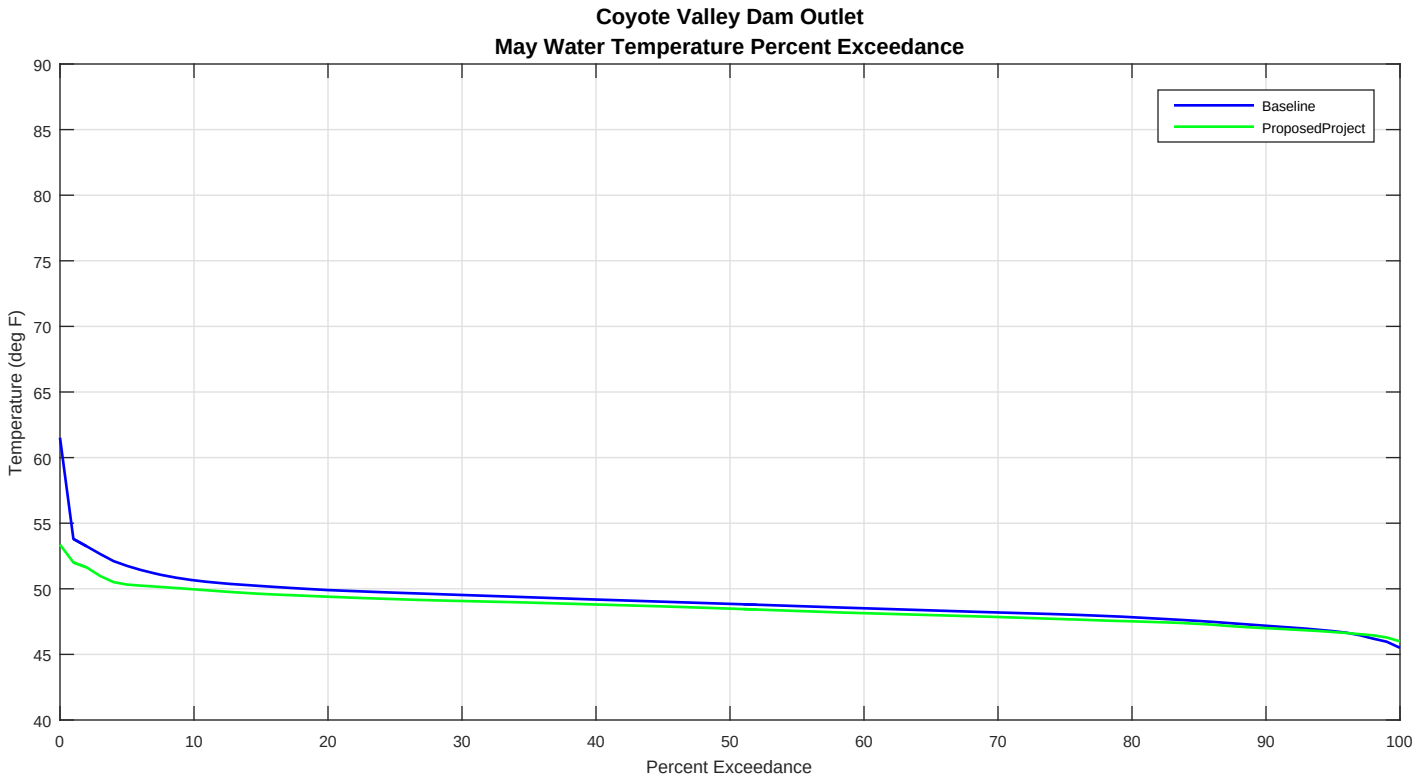

Warm Springs Dam
September Power Production Percent Exceedance
Baseline
ProposedProject
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

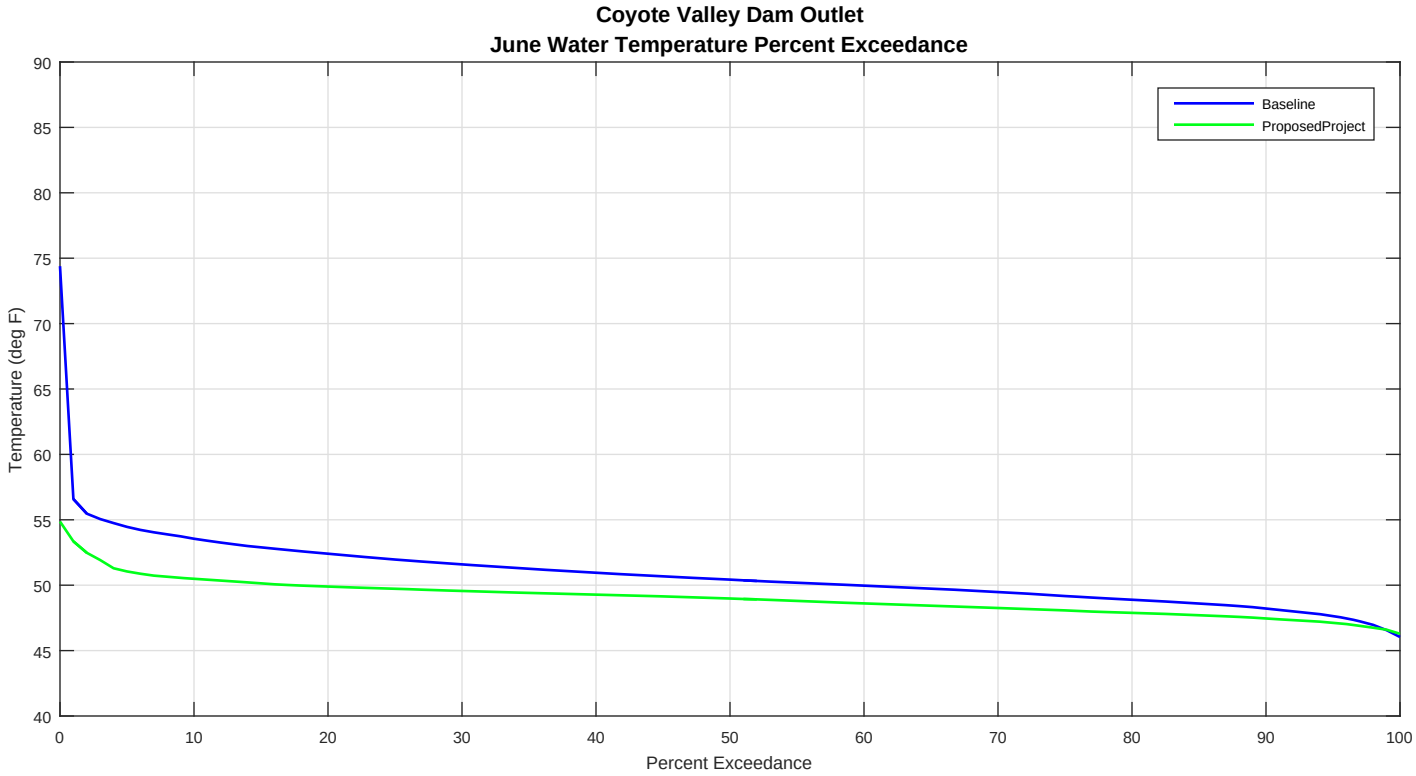

Warm Springs Dam
October 1-15 Power Production Percent Exceedance
Baseline
ProposedProject
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

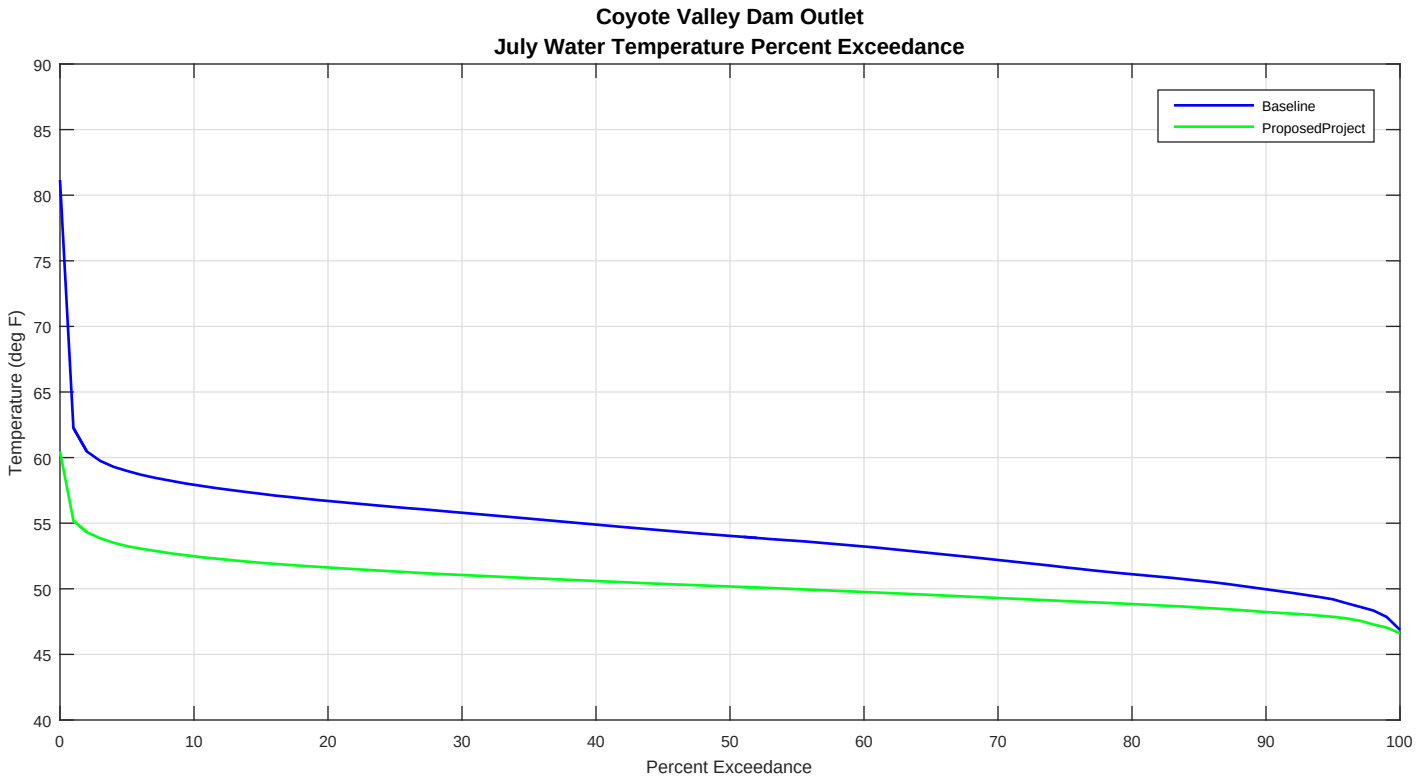

Warm Springs Dam
October 16-31 Power Production Percent Exceedance
Baseline
ProposedProject
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
March Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
April Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
May Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
June Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
July Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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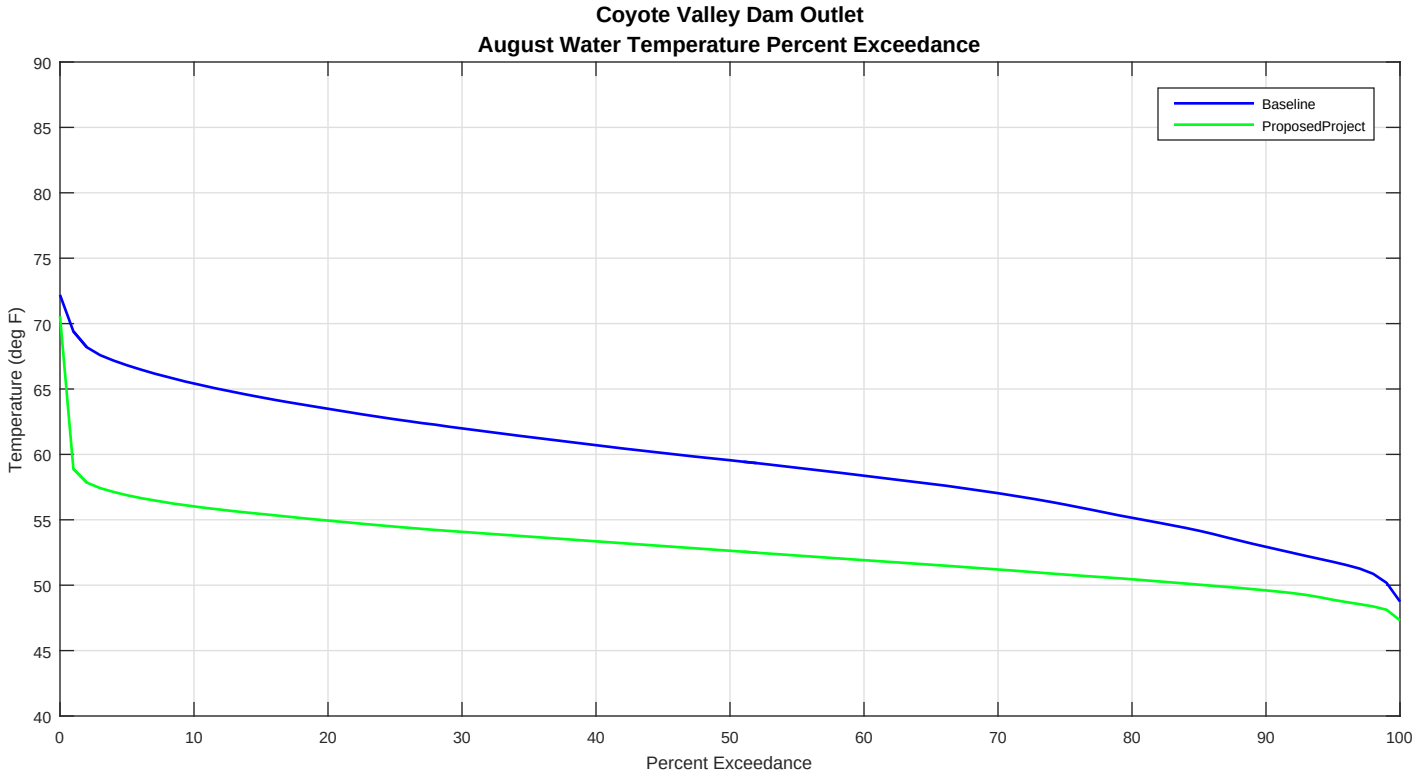
Coyote Valley Dam Outlet
August Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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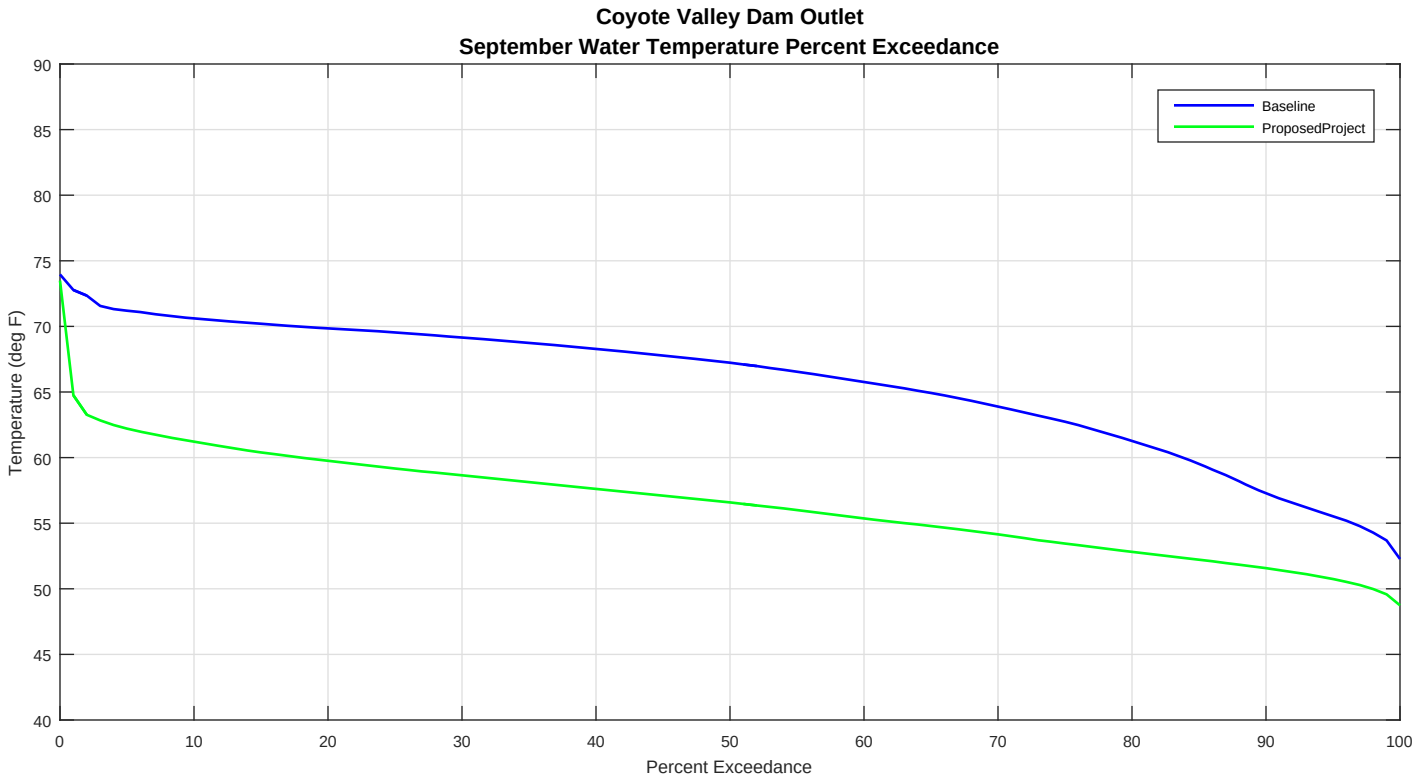
Coyote Valley Dam Outlet
September Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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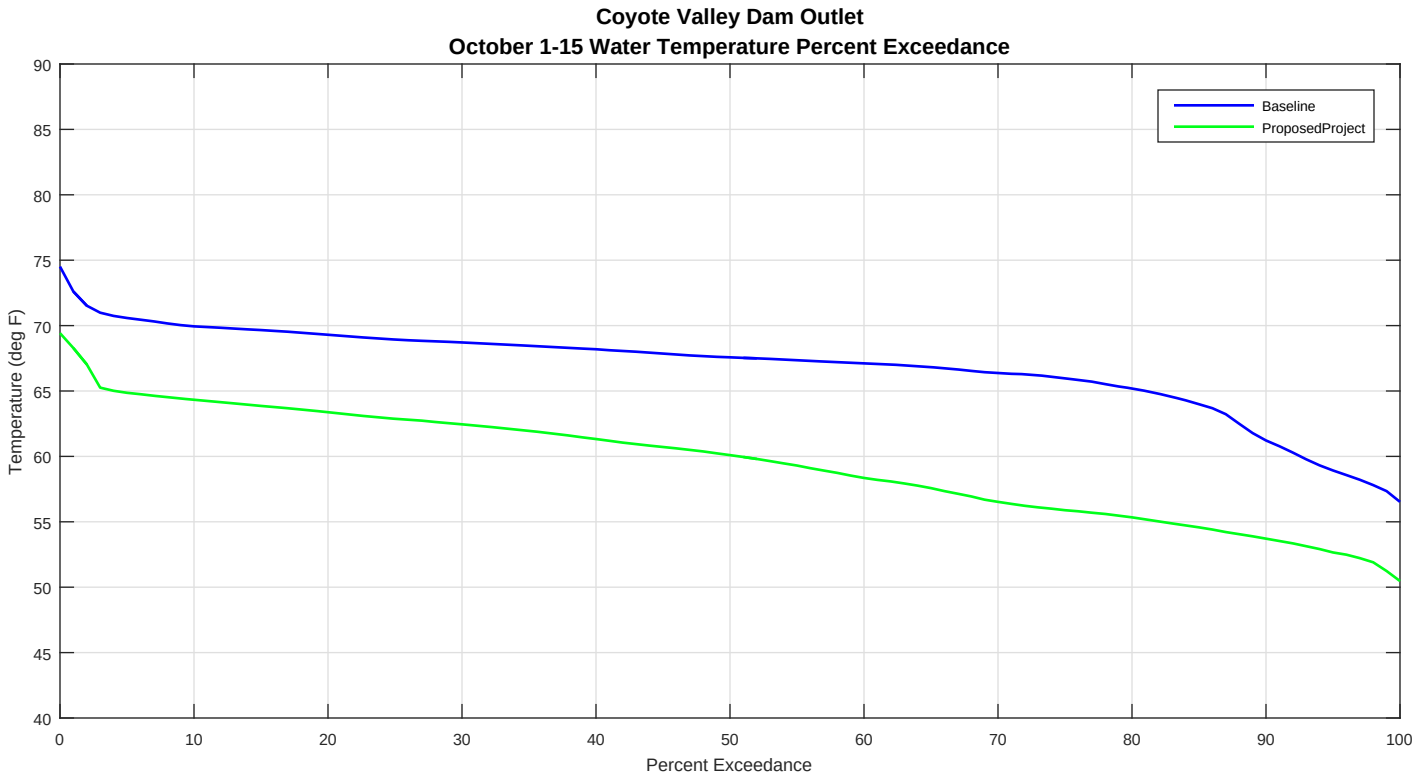
Coyote Valley Dam Outlet
October 1-15 Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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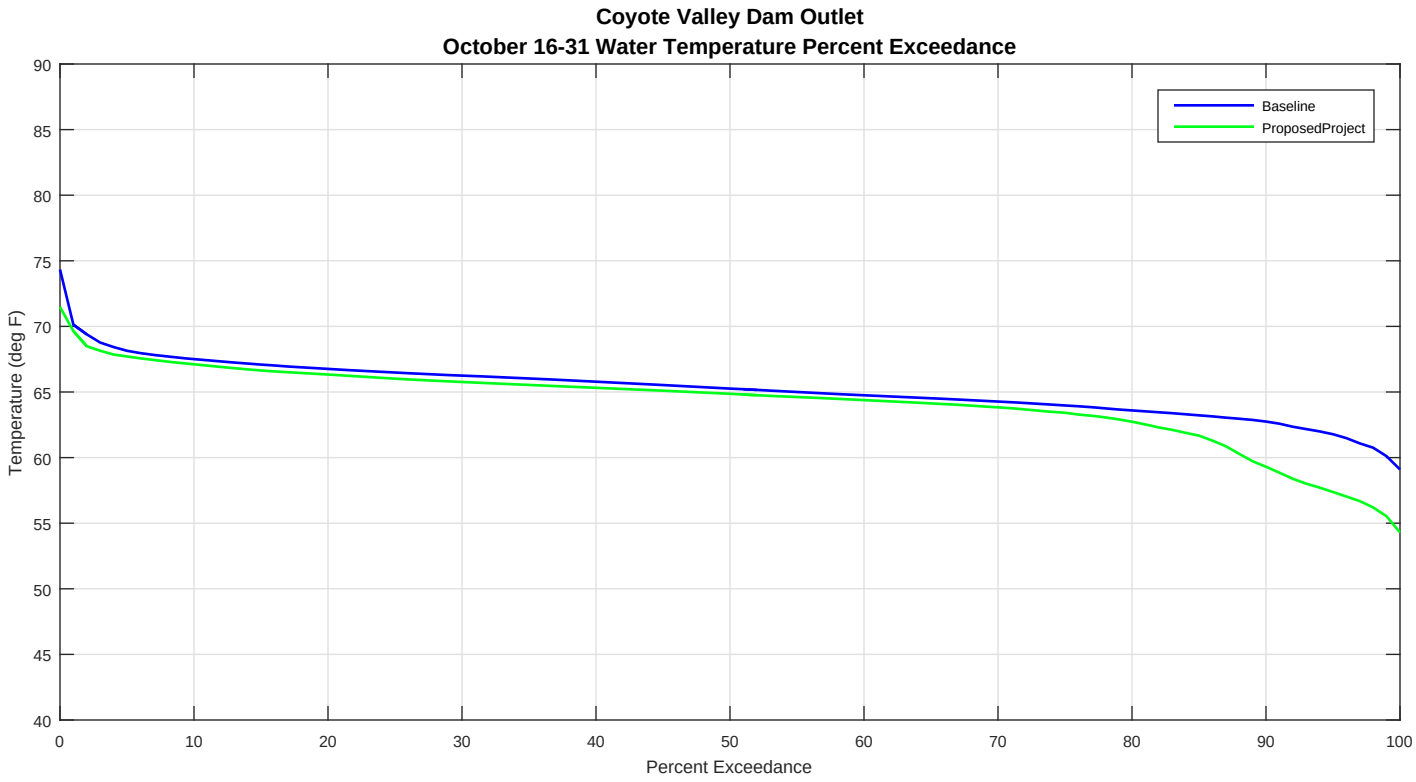
Coyote Valley Dam Outlet
October 16-31 Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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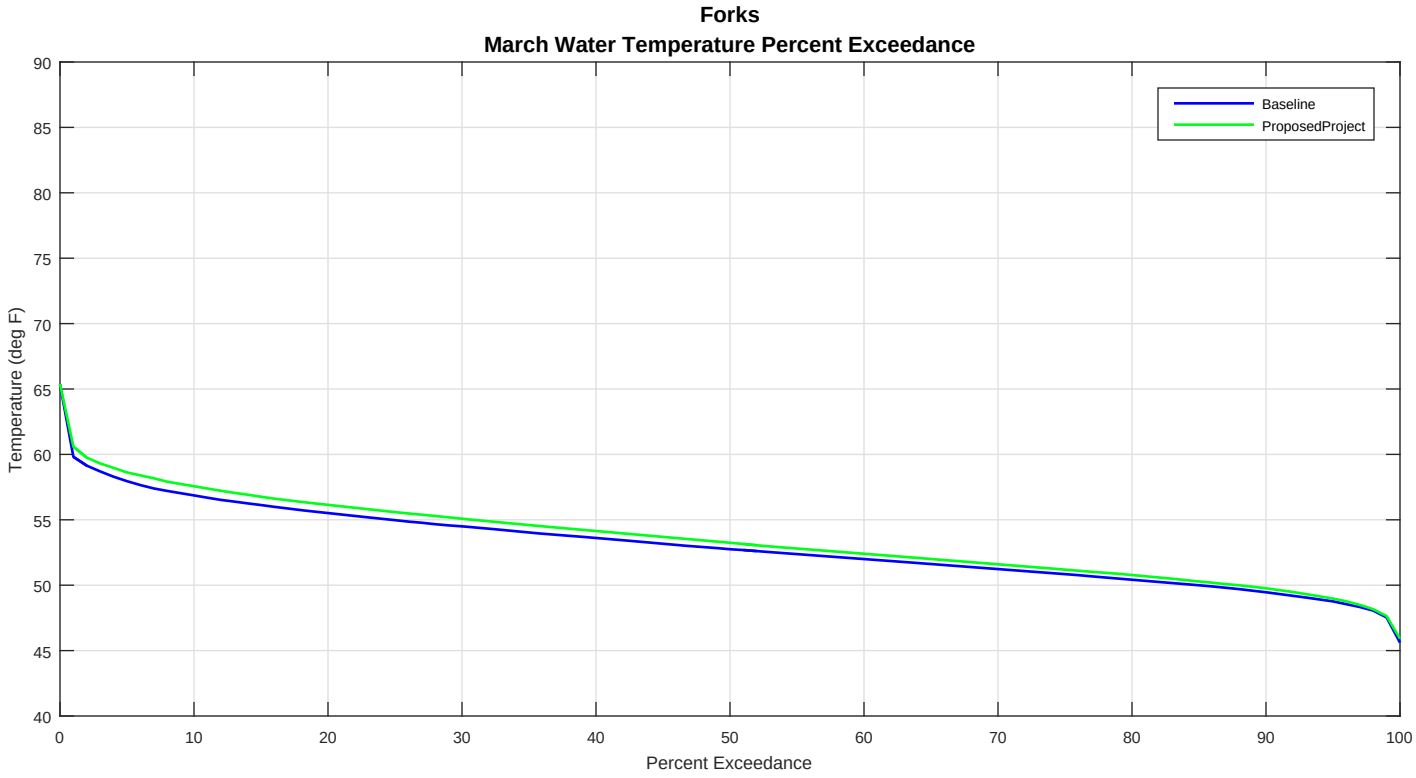
Forks
March Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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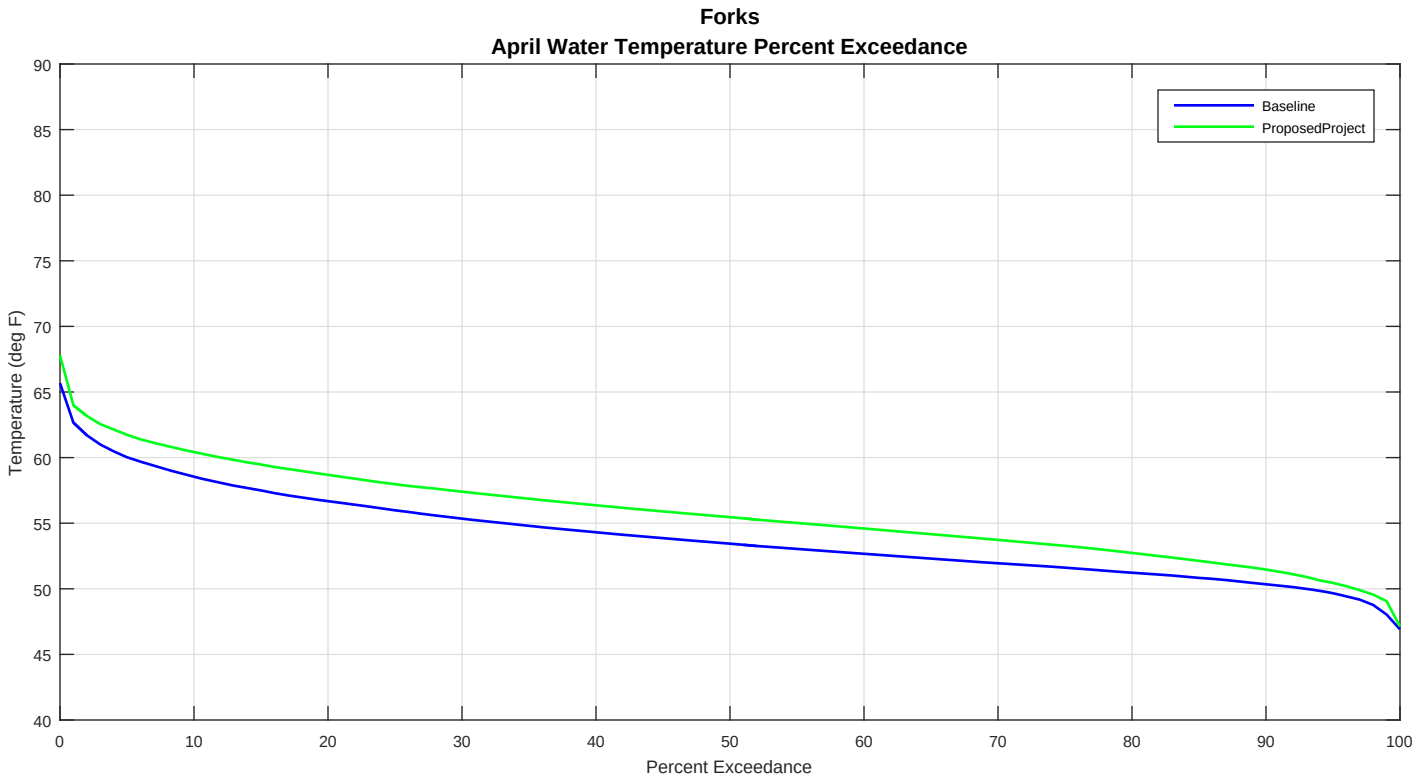
Forks
April Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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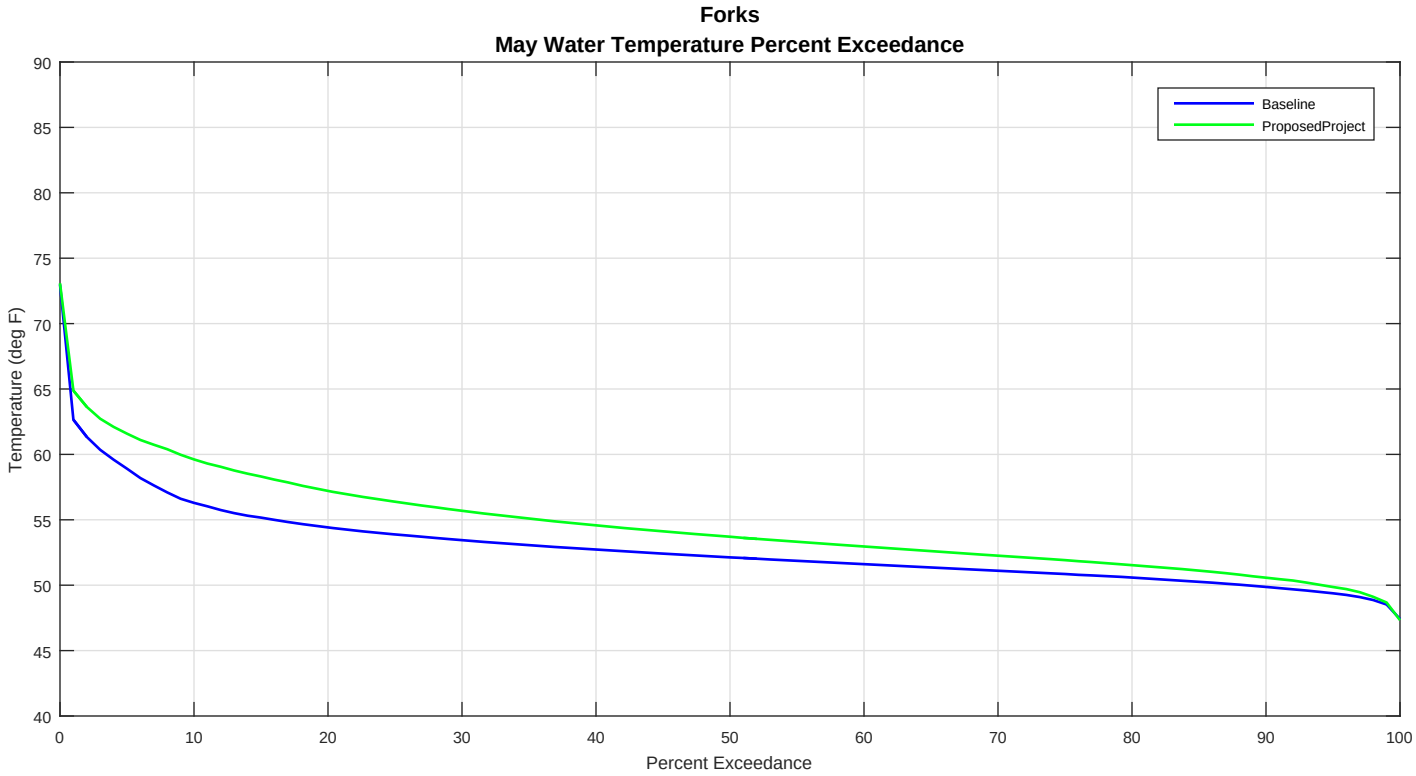
Forks
May Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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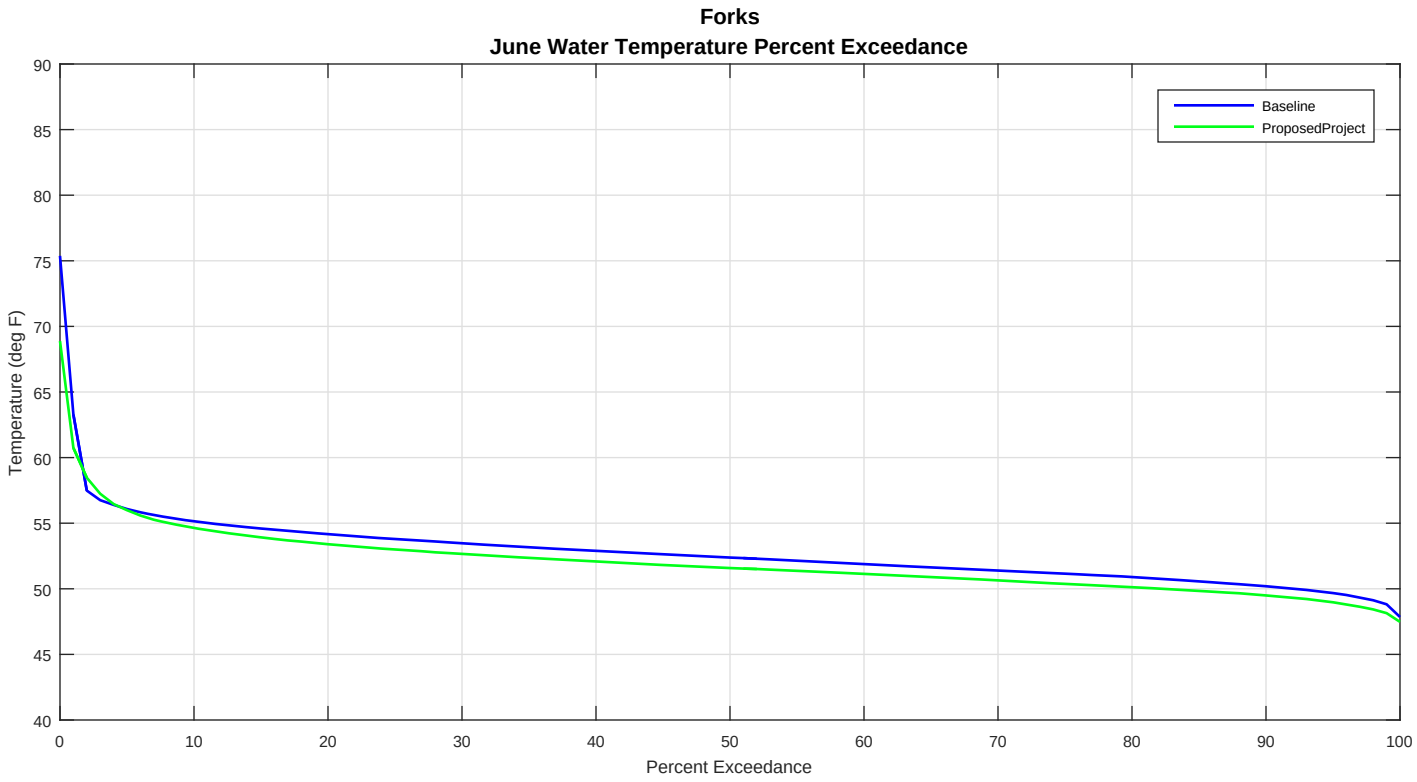
Forks
June Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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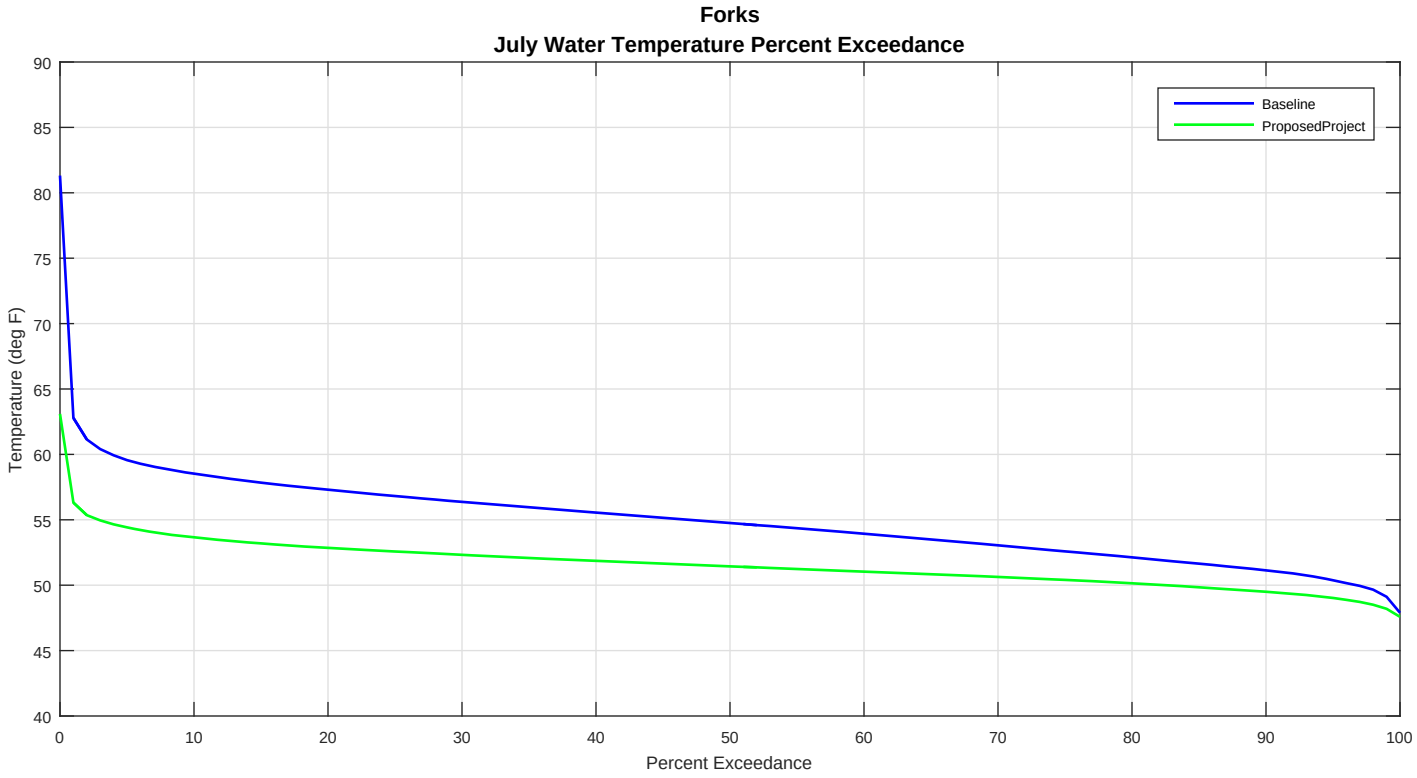
Forks
July Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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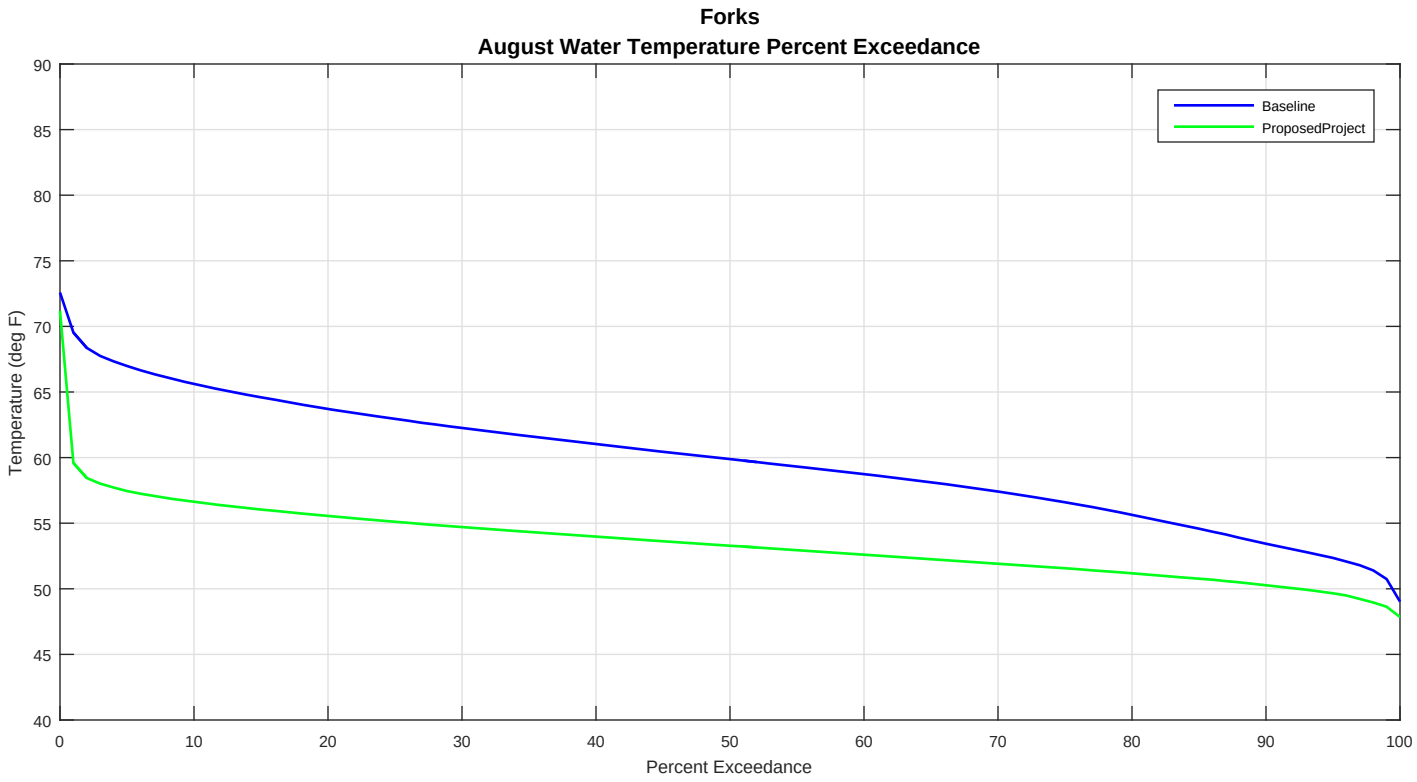
Forks
August Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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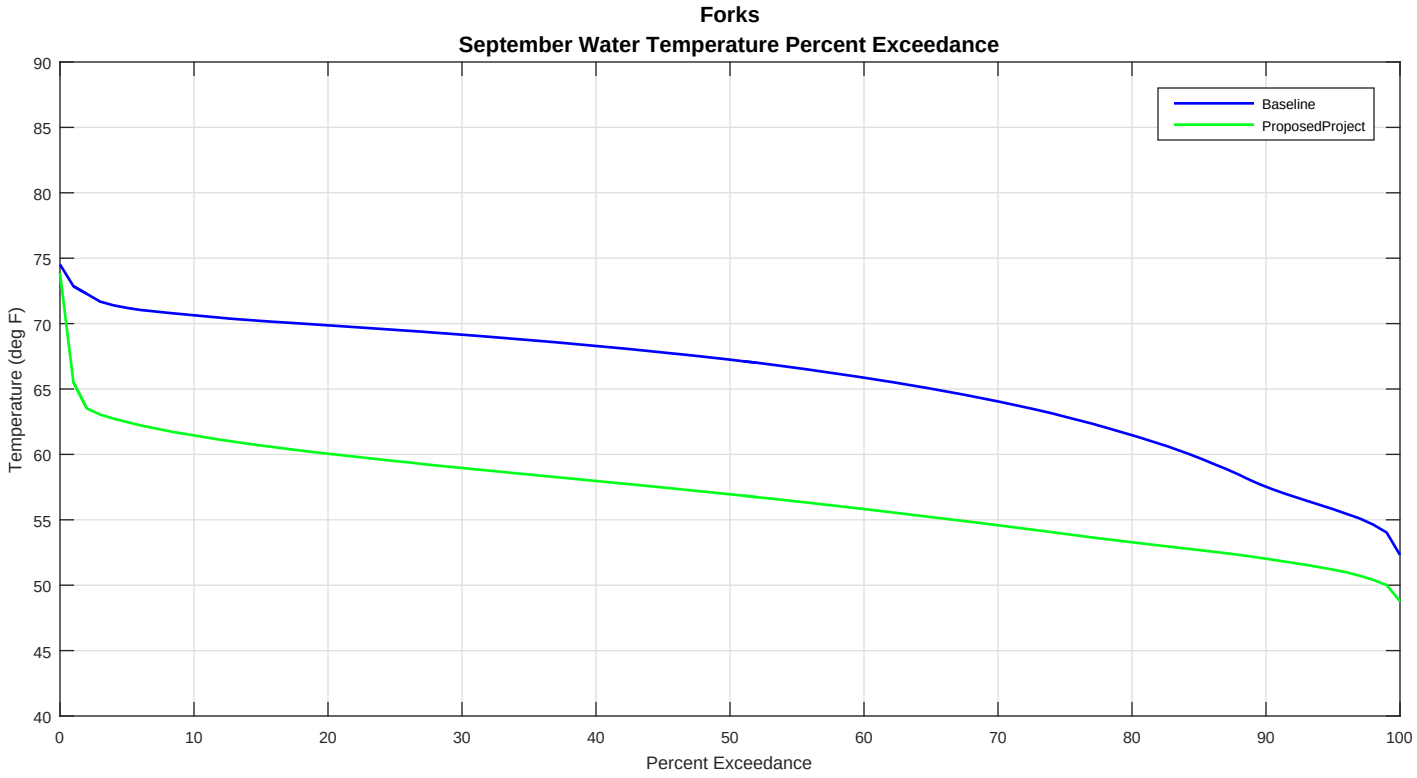
Forks
September Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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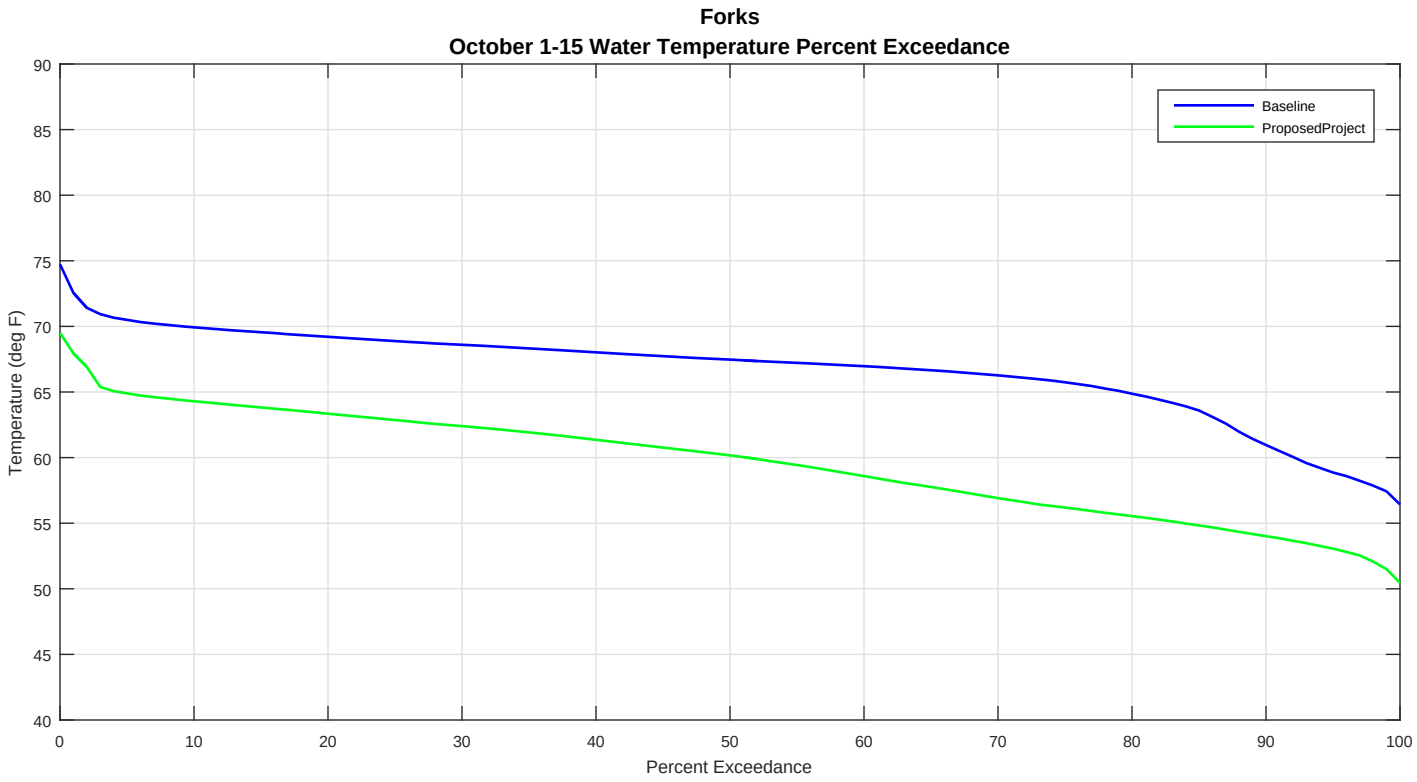
Forks
October 1-15 Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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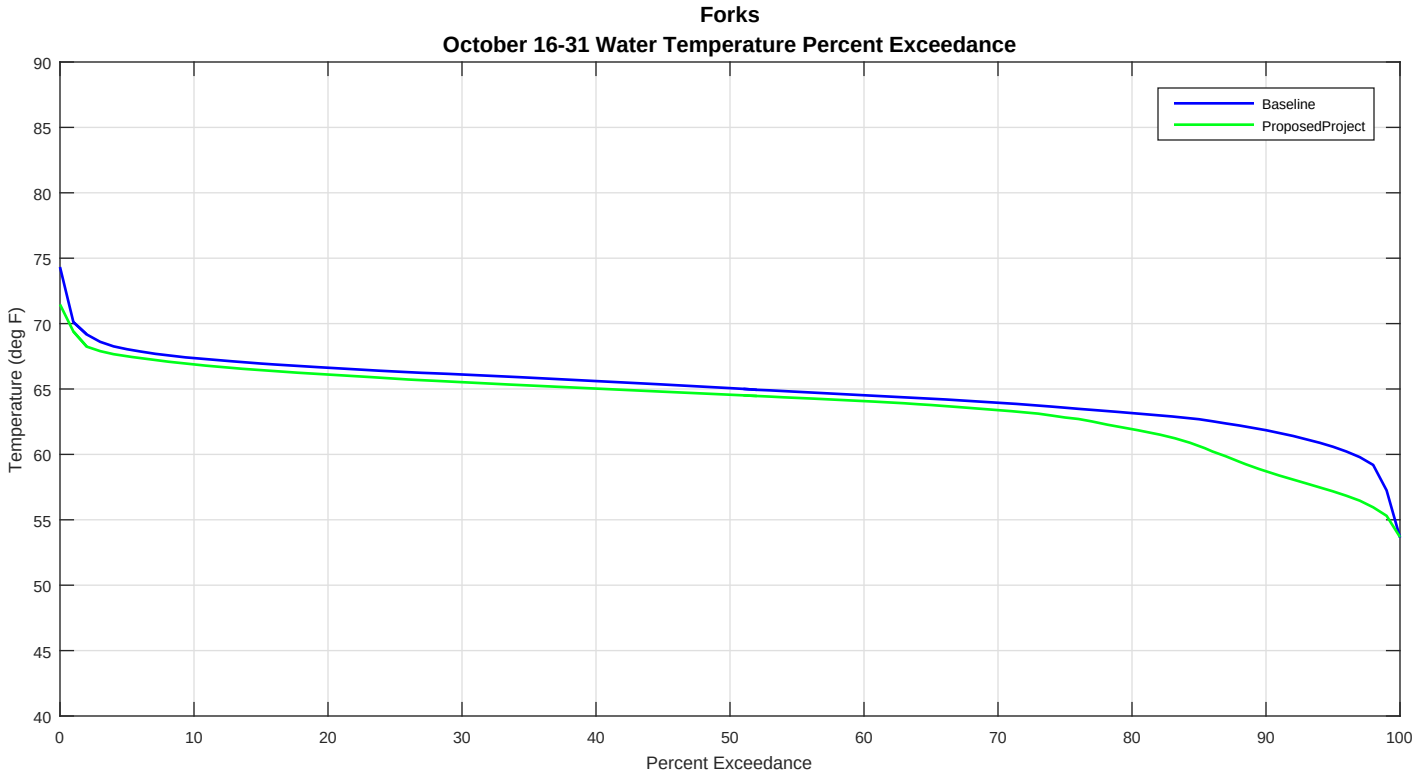
Forks
October 16-31 Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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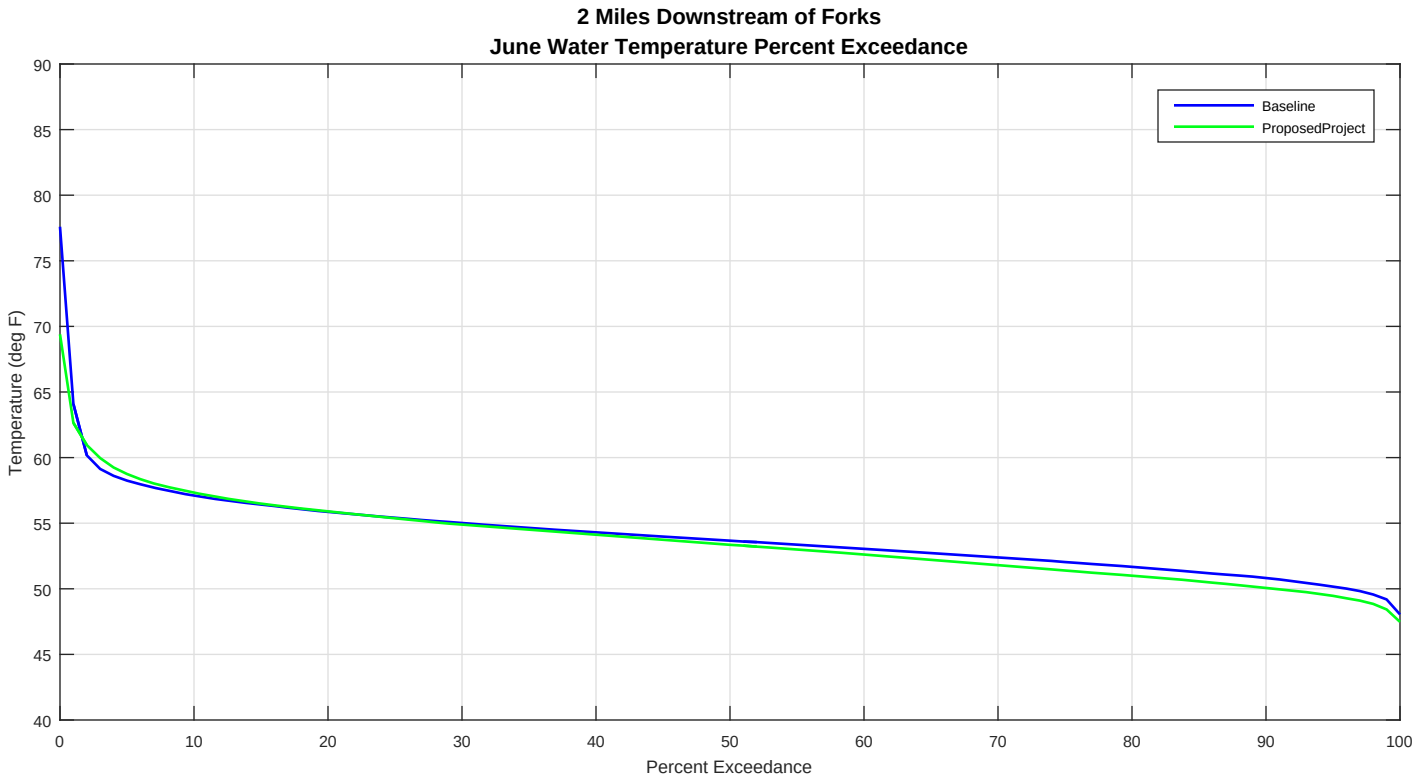
2 Miles Downstream of Forks
June Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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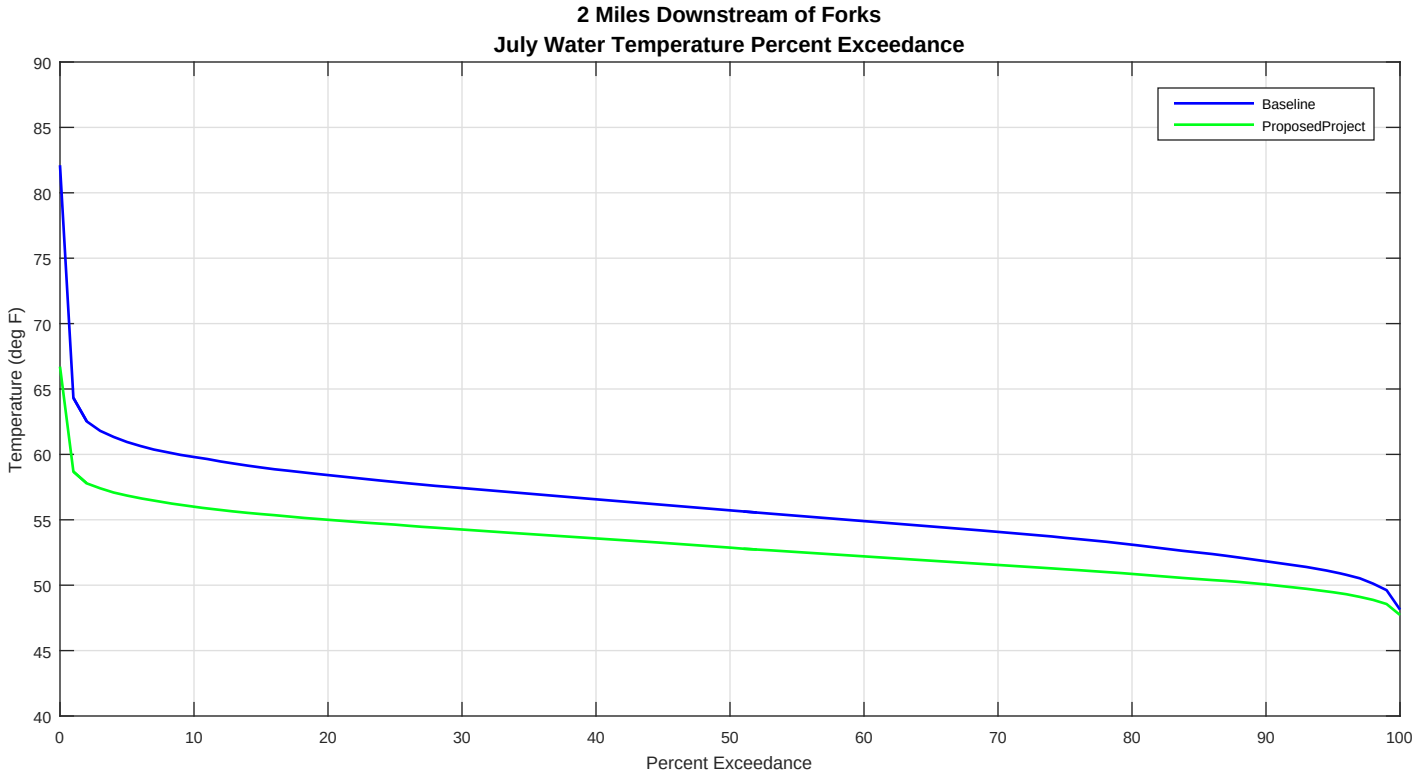
2 Miles Downstream of Forks
July Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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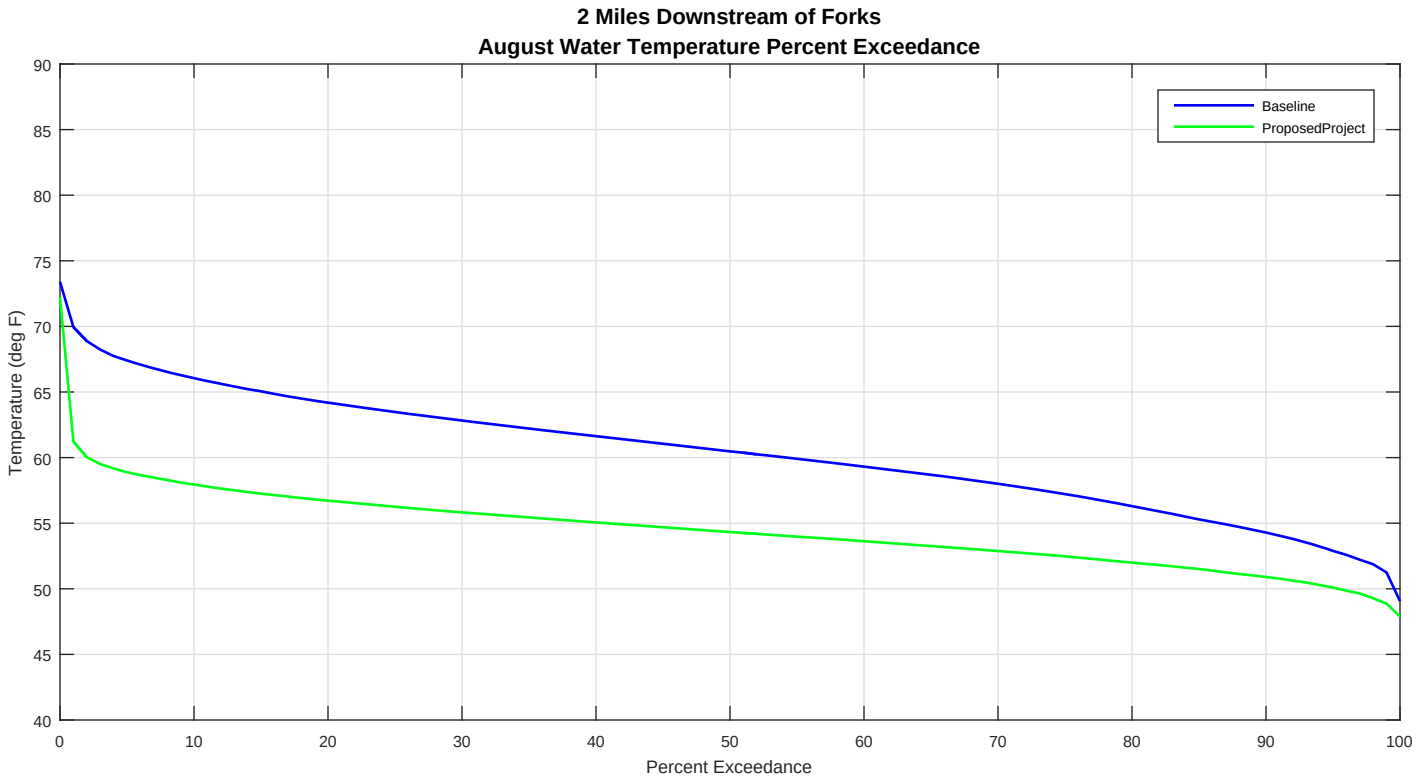
2 Miles Downstream of Forks
August Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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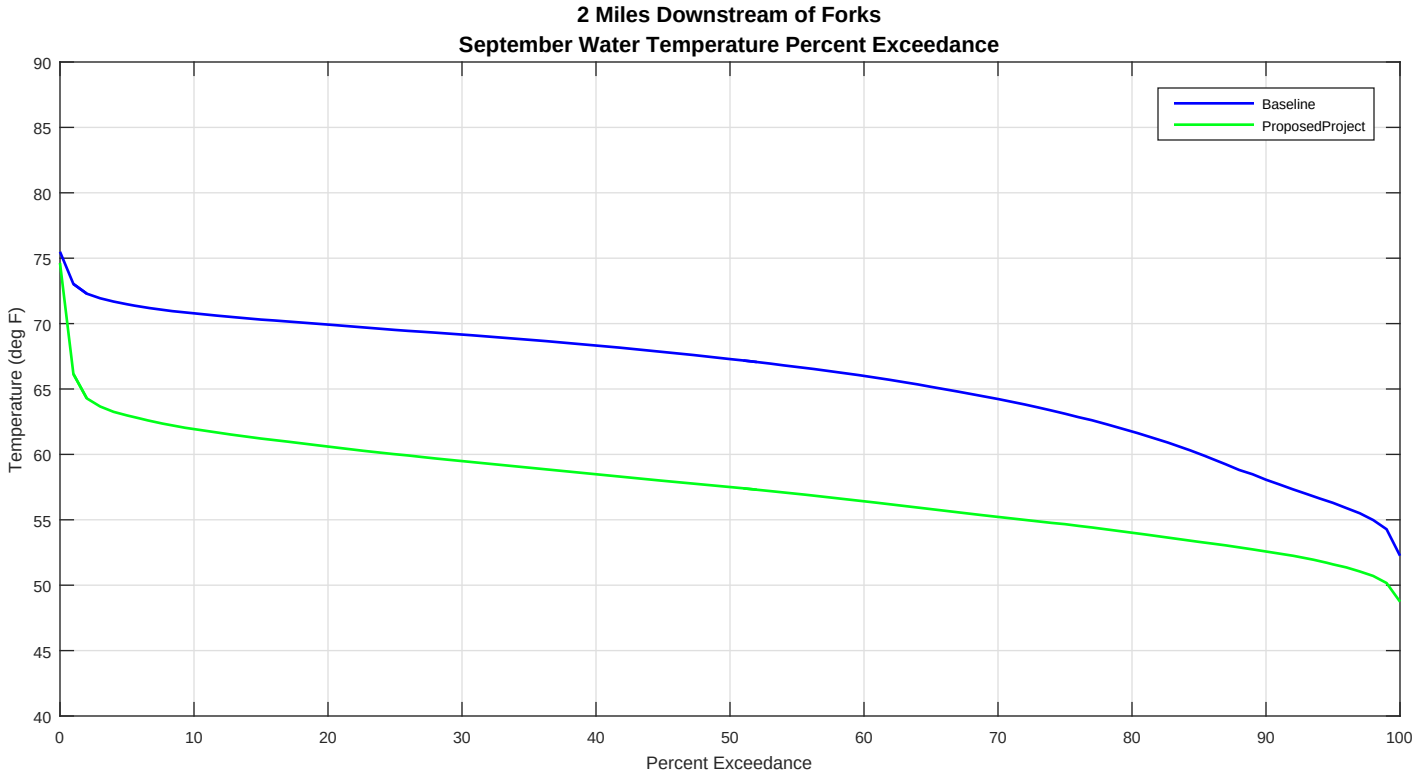
2 Miles Downstream of Forks
September Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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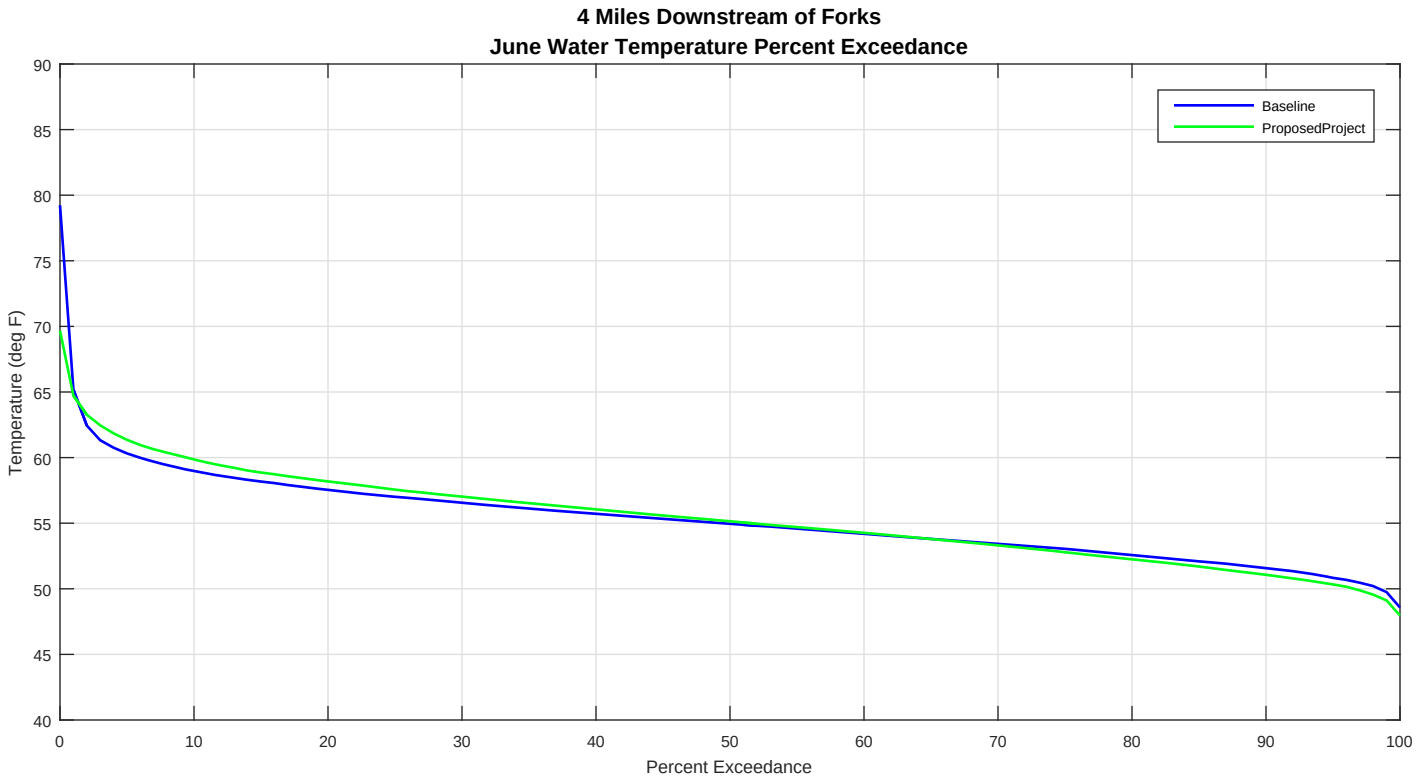
4 Miles Downstream of Forks
June Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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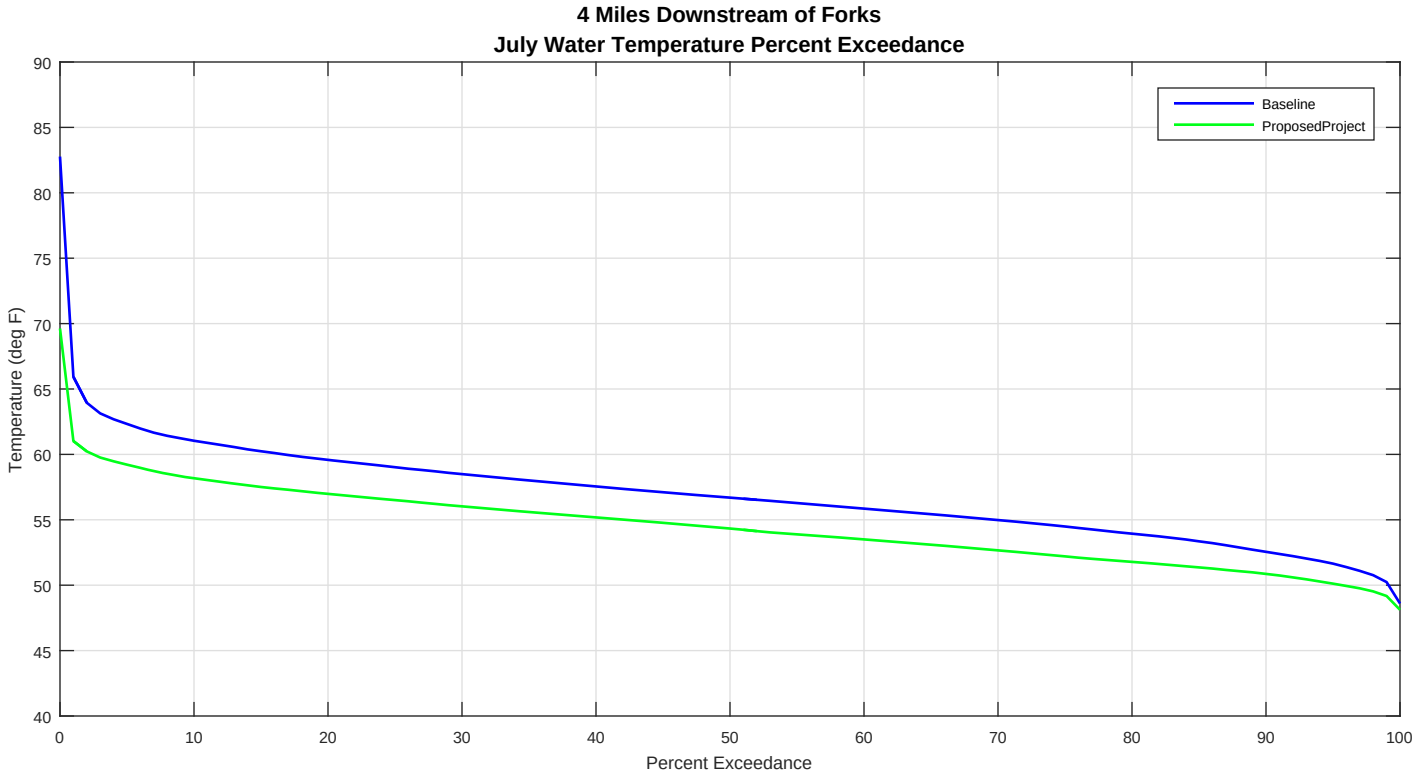
4 Miles Downstream of Forks
July Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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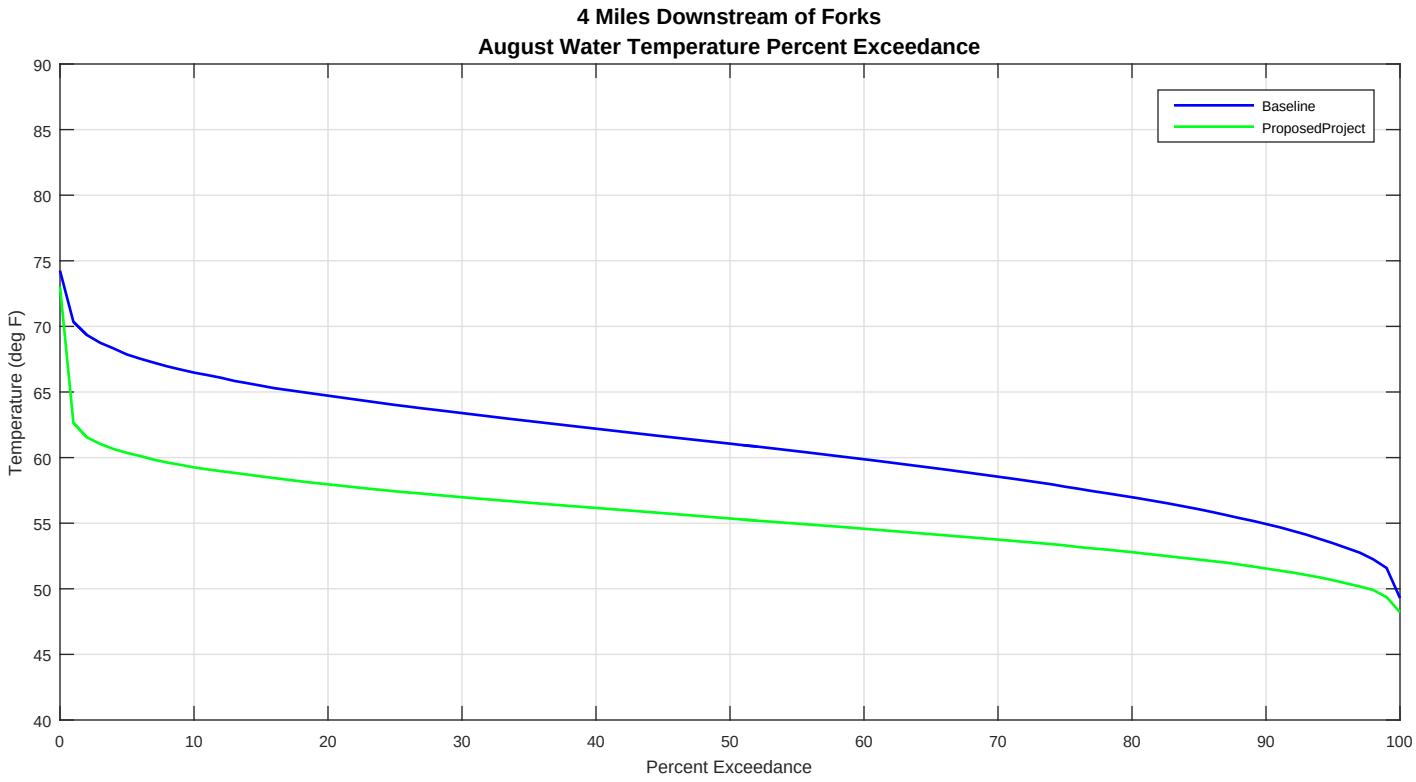
4 Miles Downstream of Forks
August Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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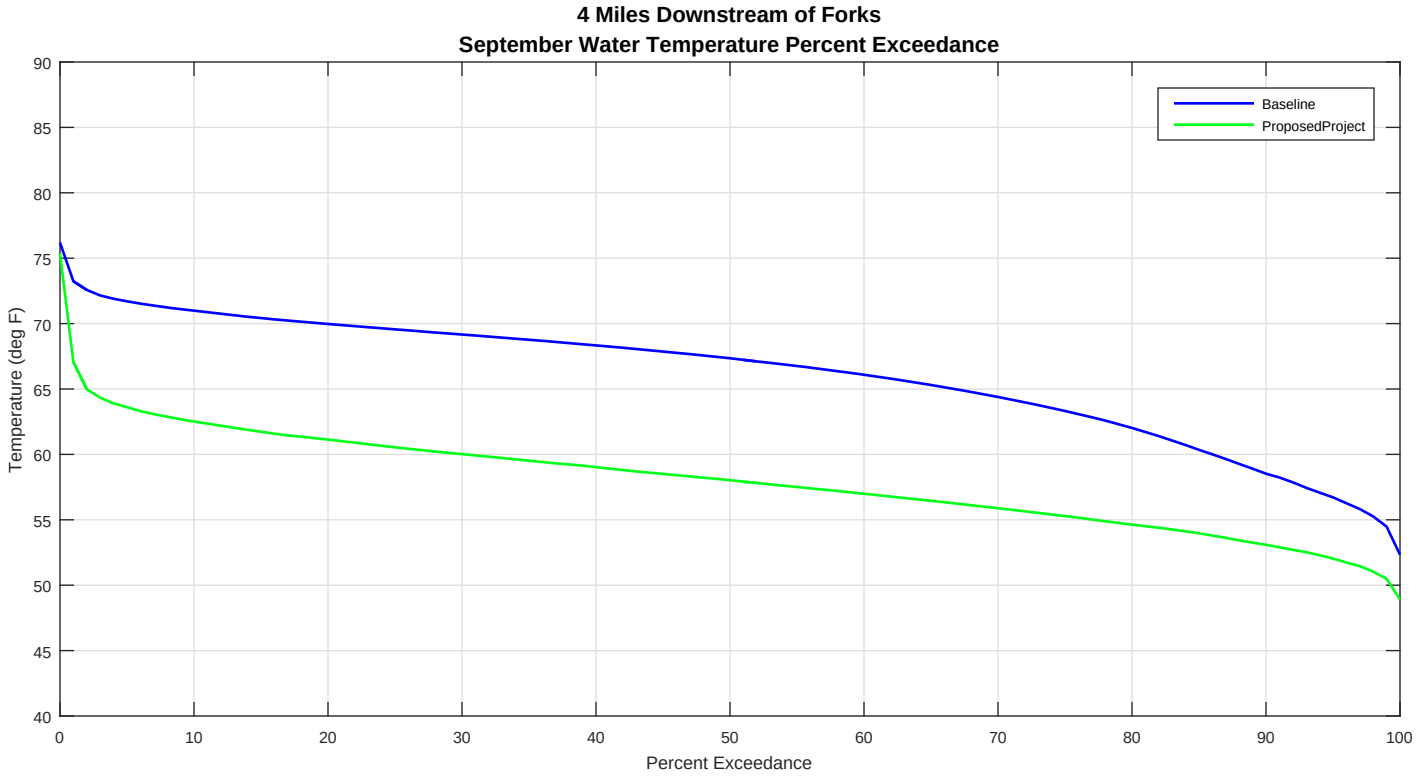
4 Miles Downstream of Forks
September Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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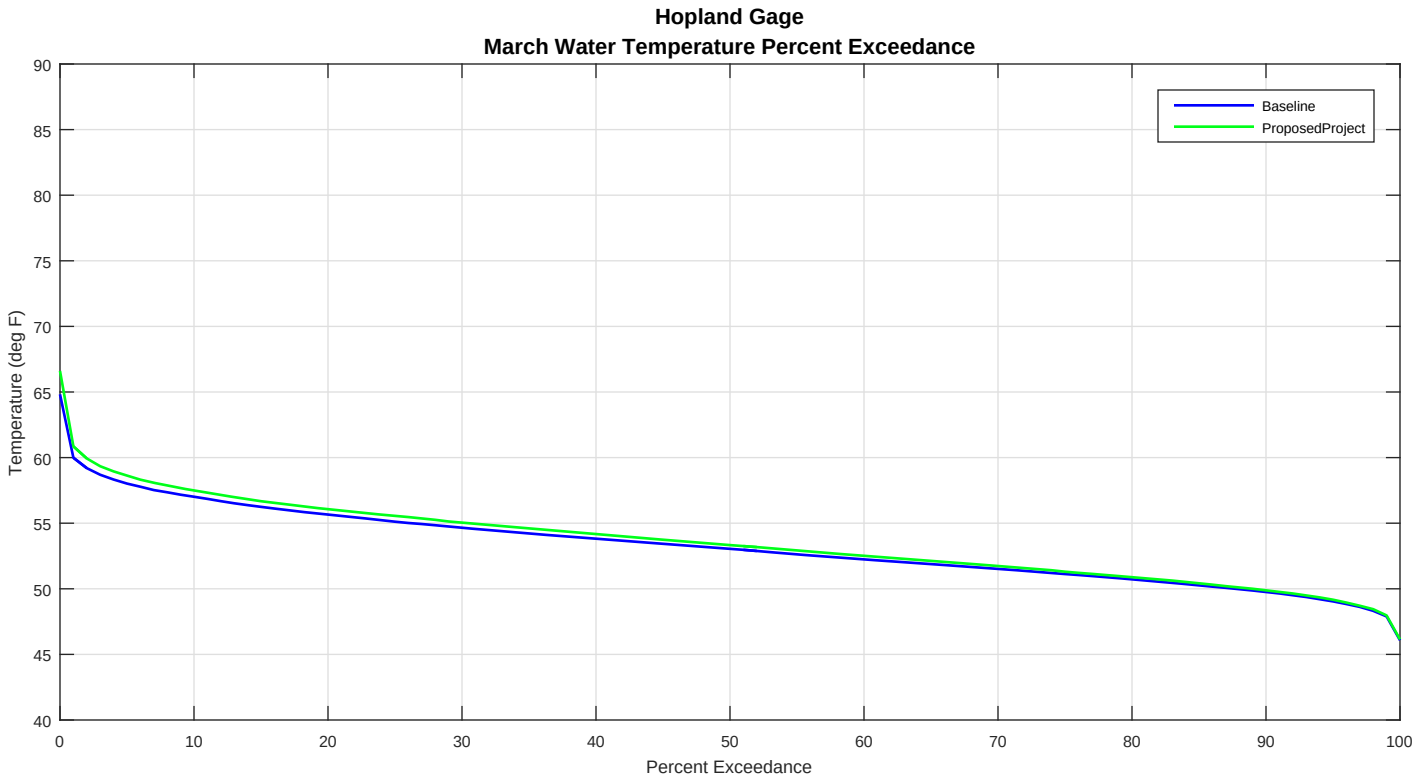
Hopland Gage
March Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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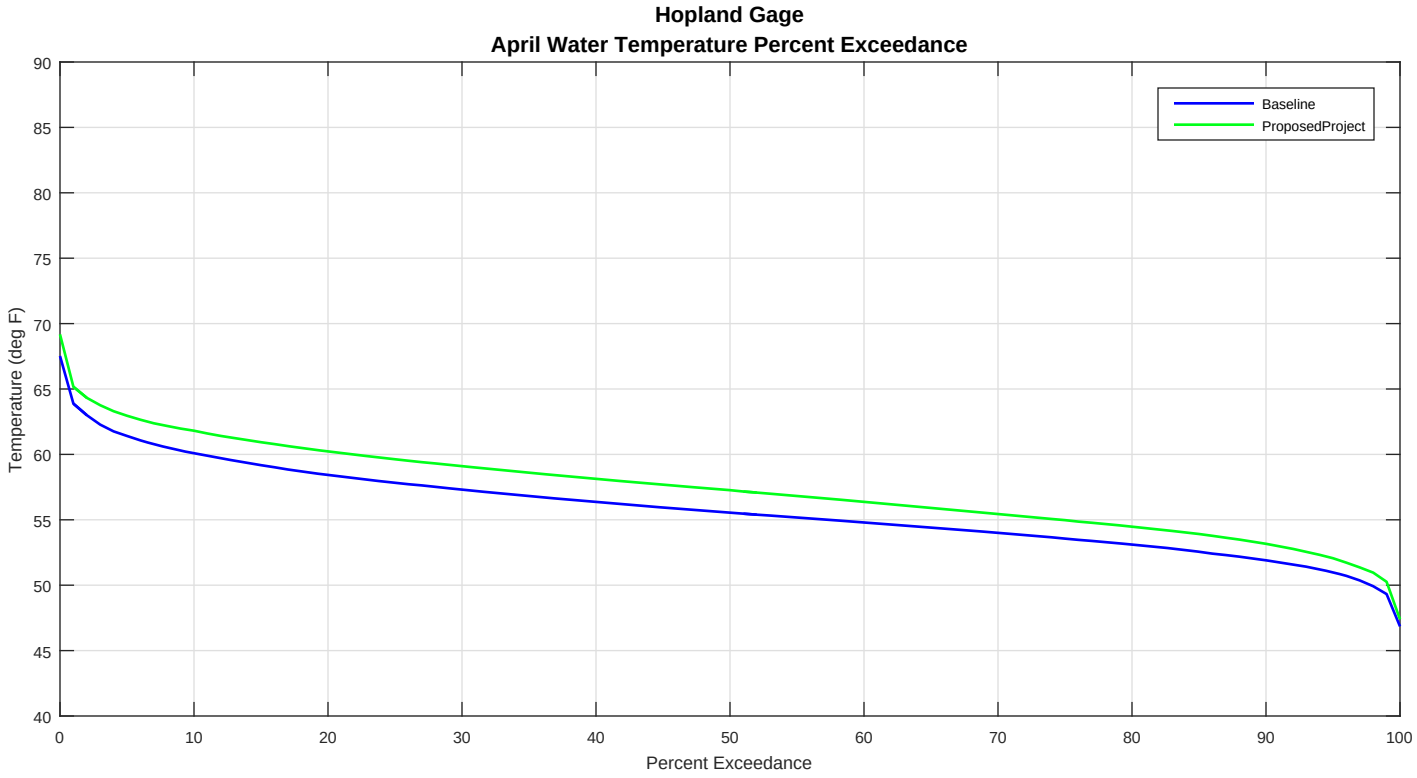
Hopland Gage
April Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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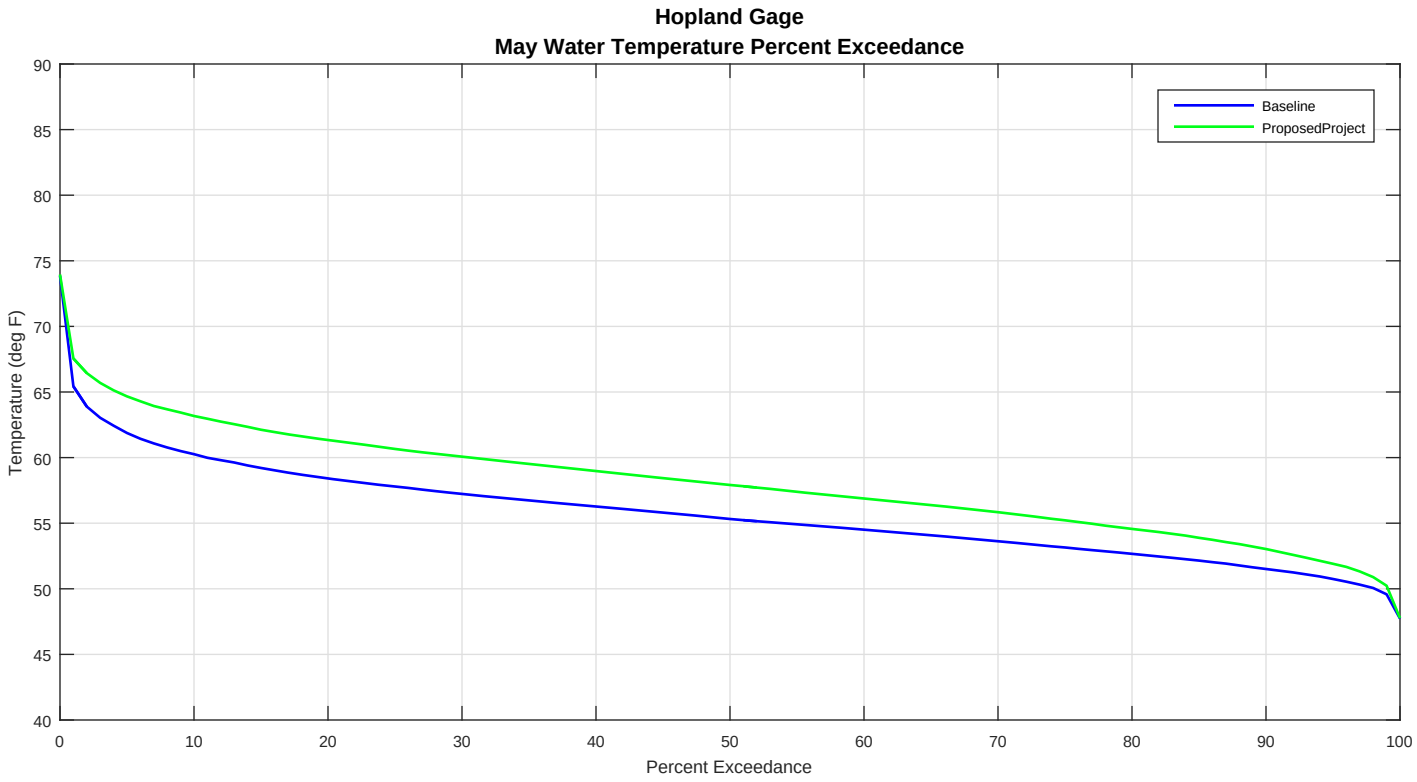
Hopland Gage
May Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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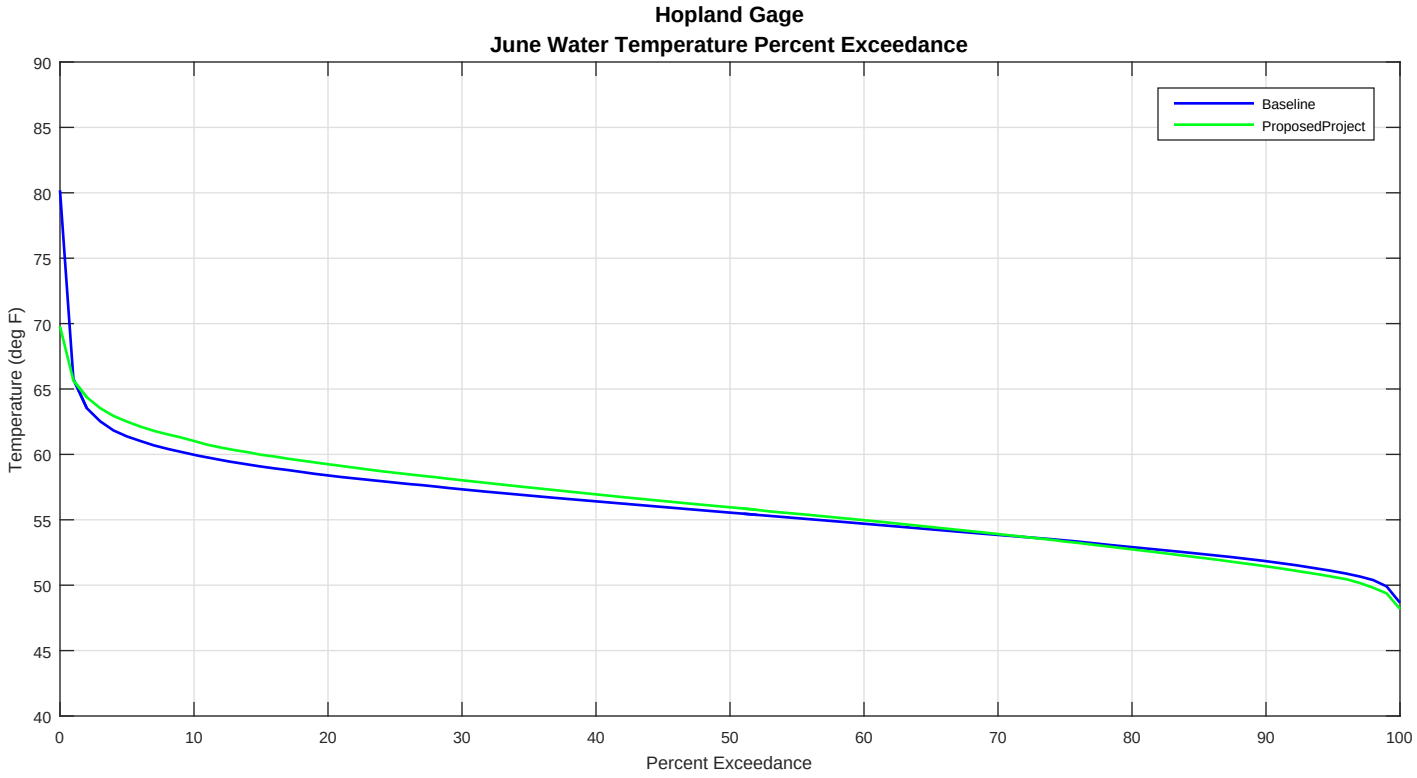
Hopland Gage
June Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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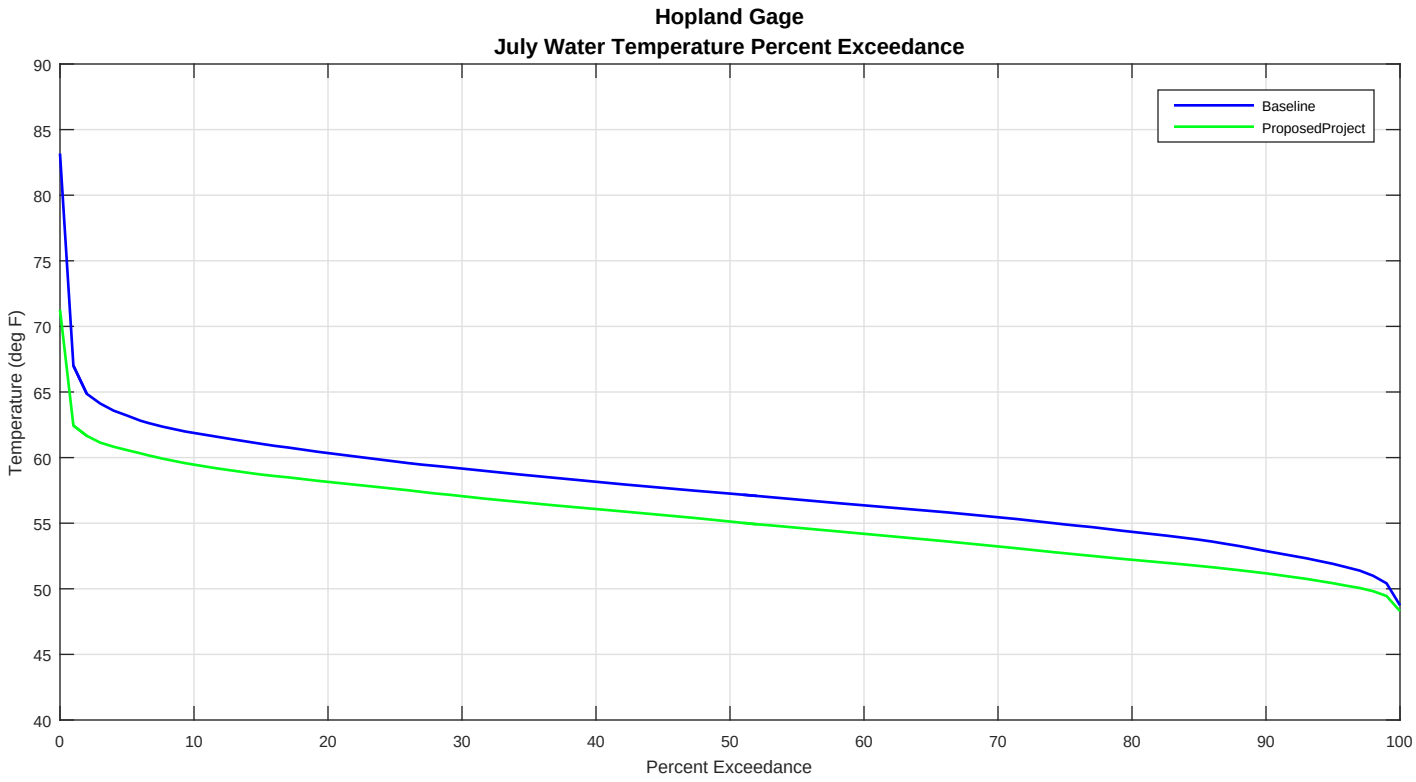
Hopland Gage
July Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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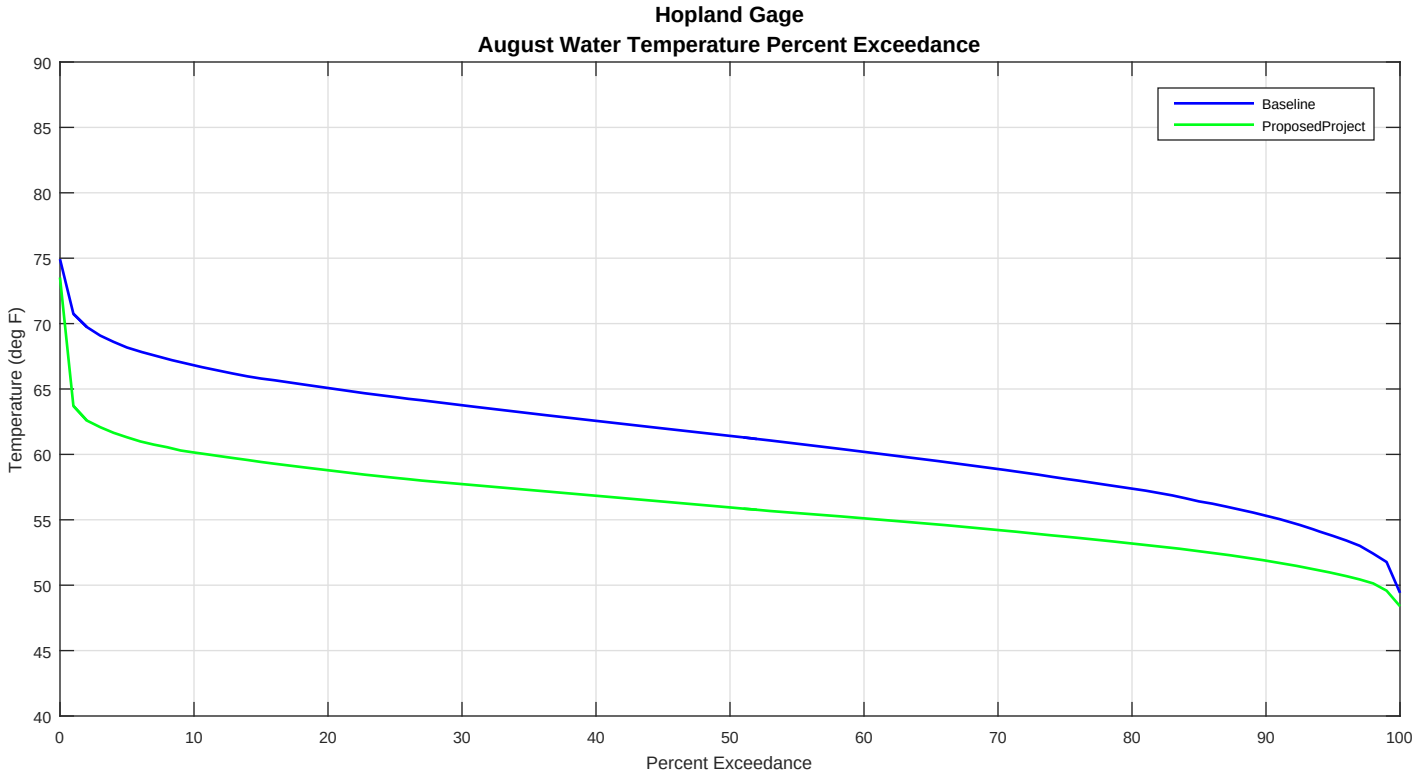
Hopland Gage
August Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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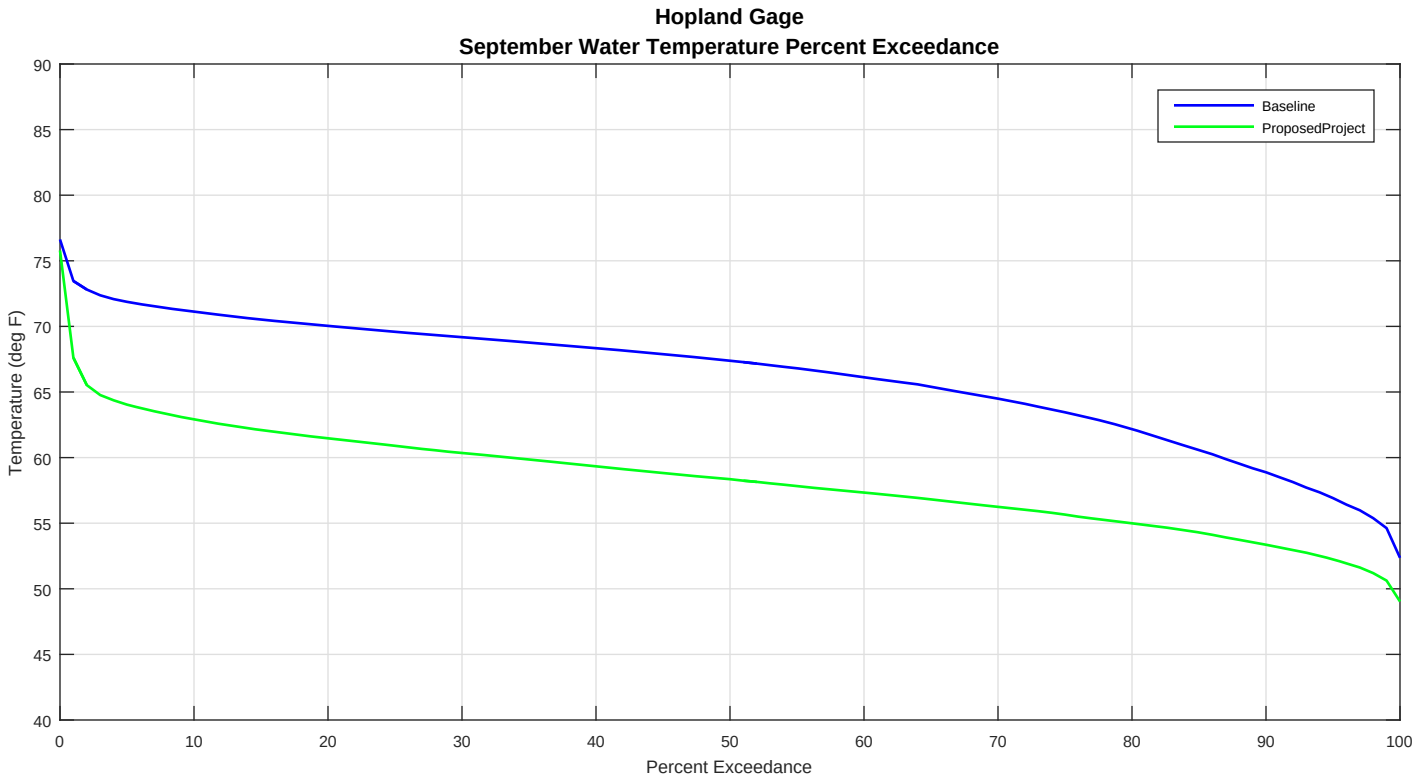
Hopland Gage
September Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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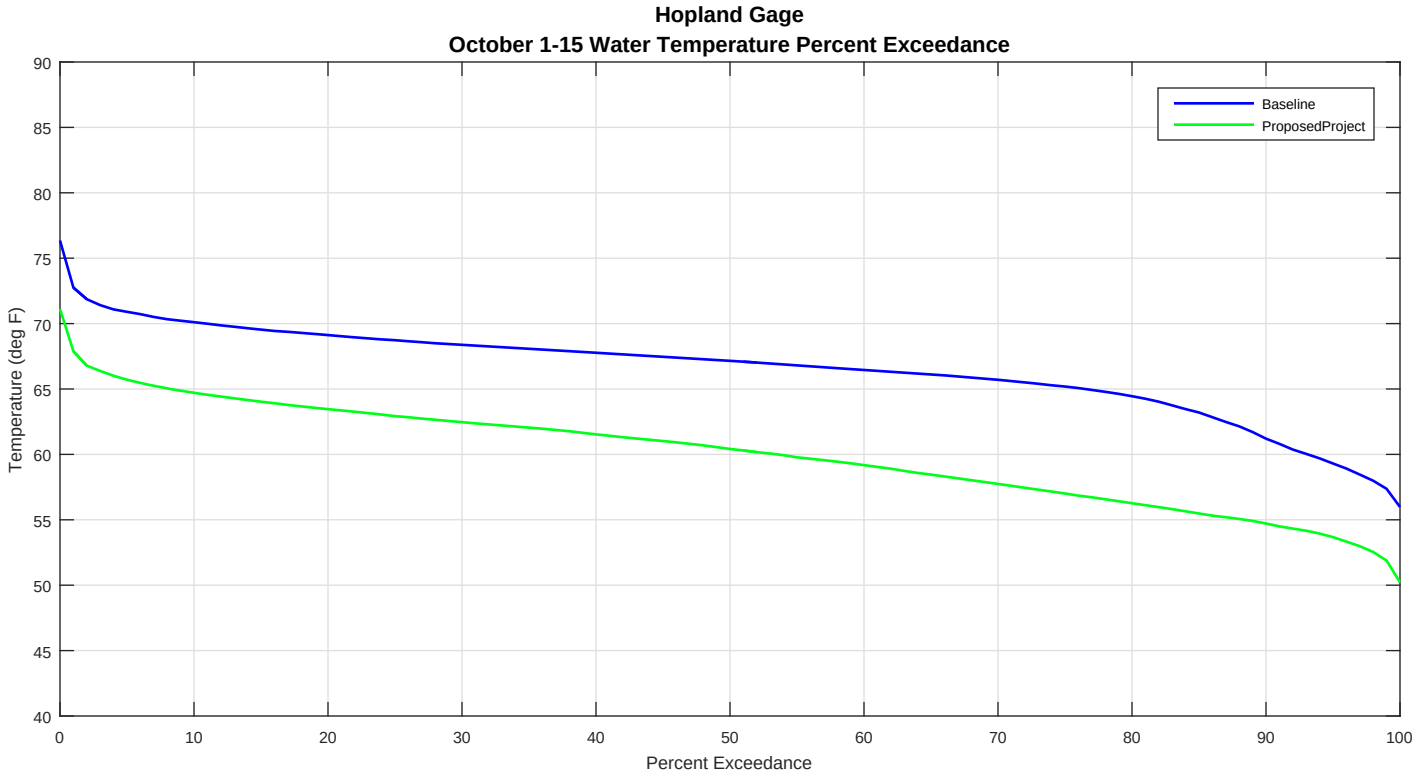
Hopland Gage
October 1-15 Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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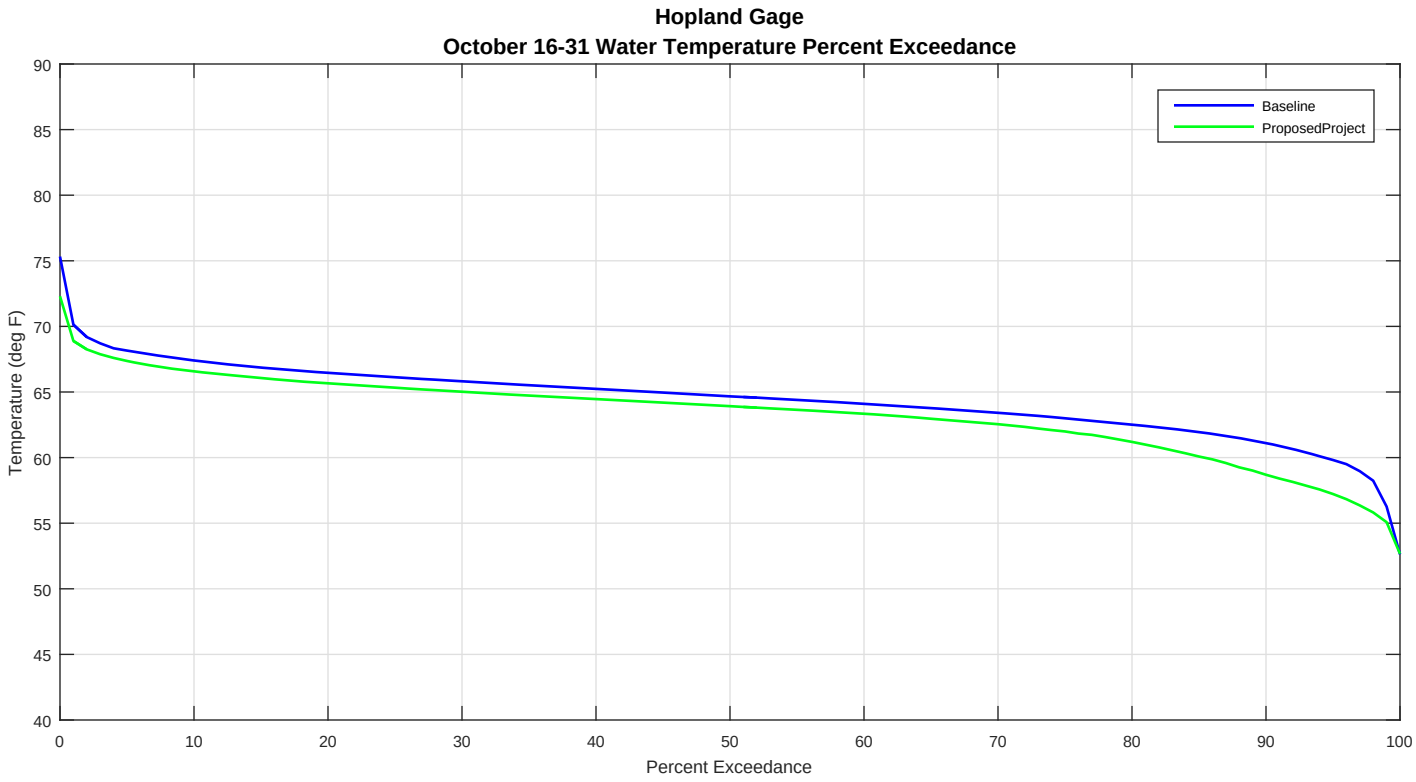
Hopland Gage
October 16-31 Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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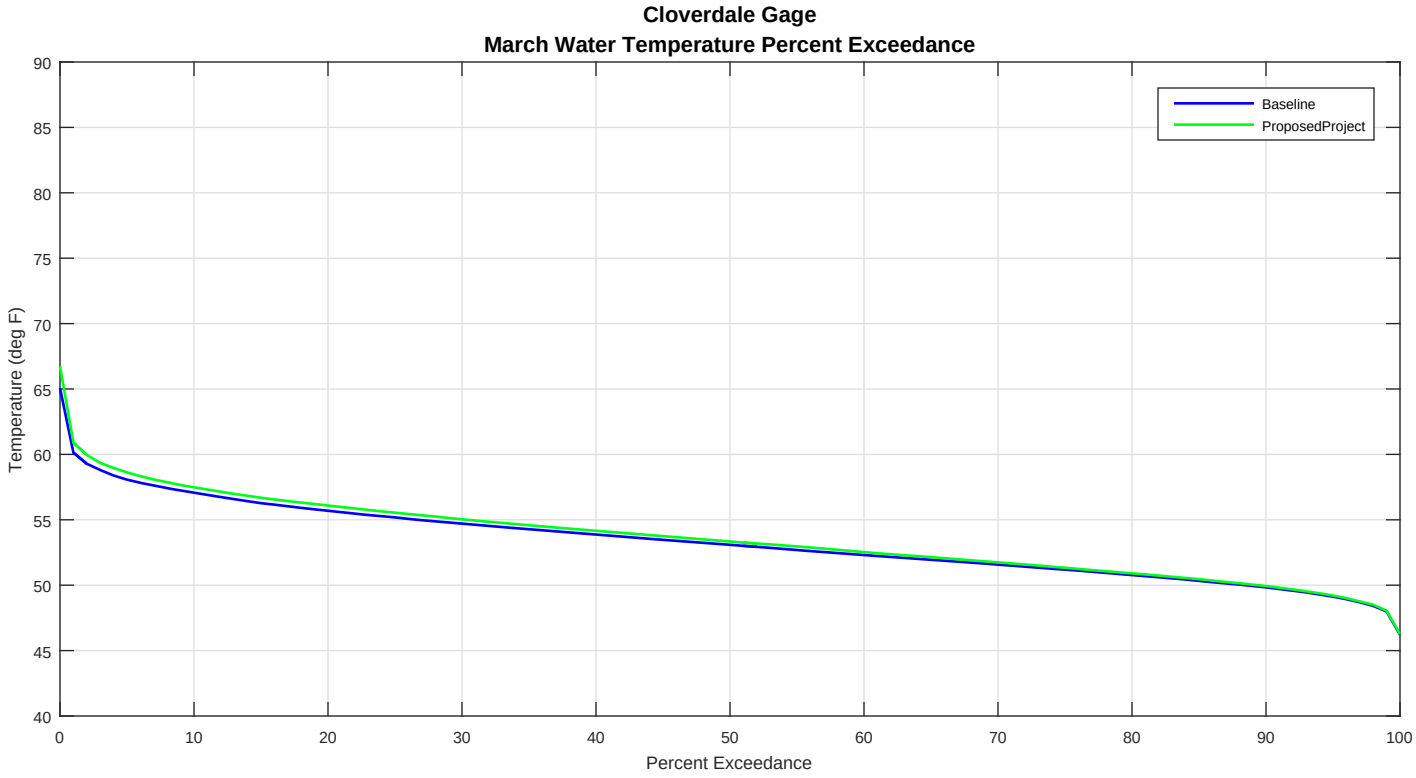
Cloverdale Gage
March Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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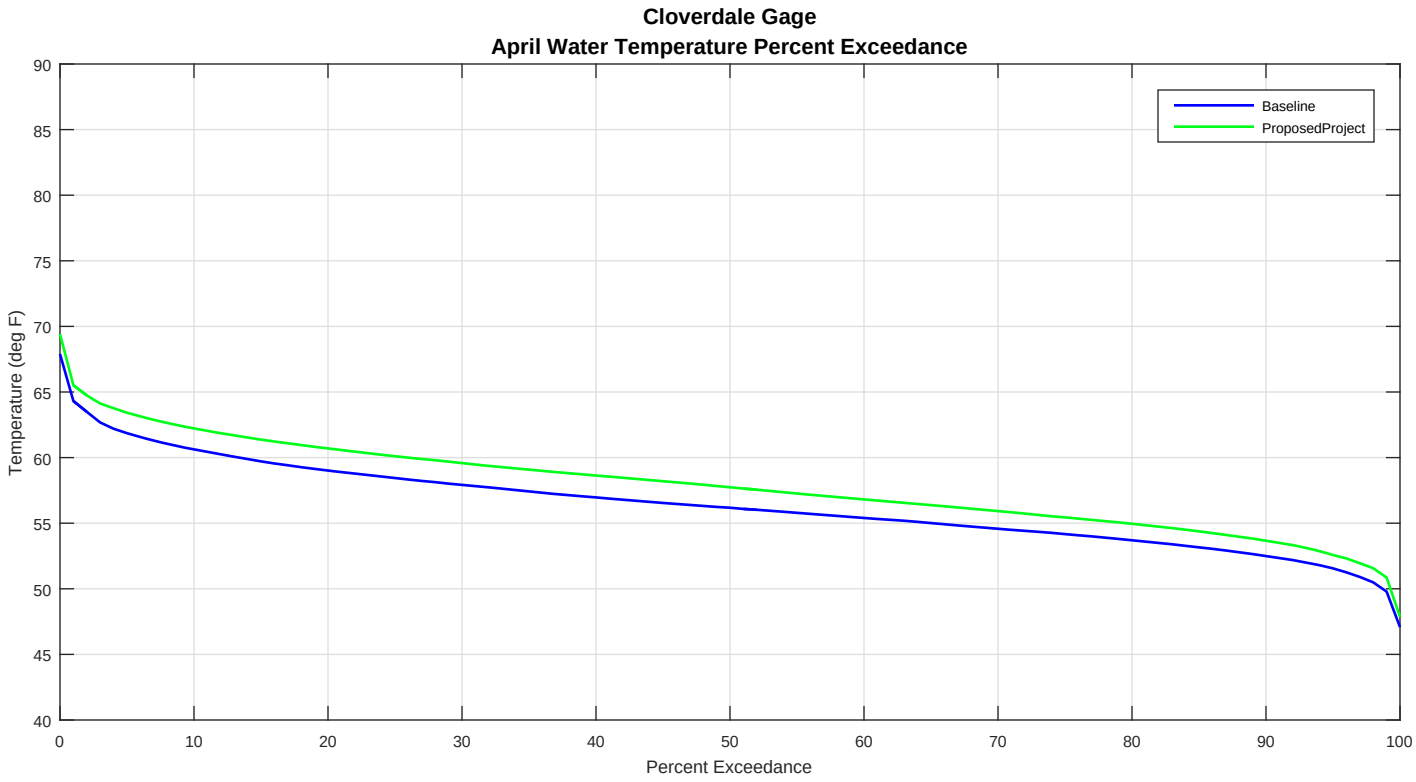
Cloverdale Gage
April Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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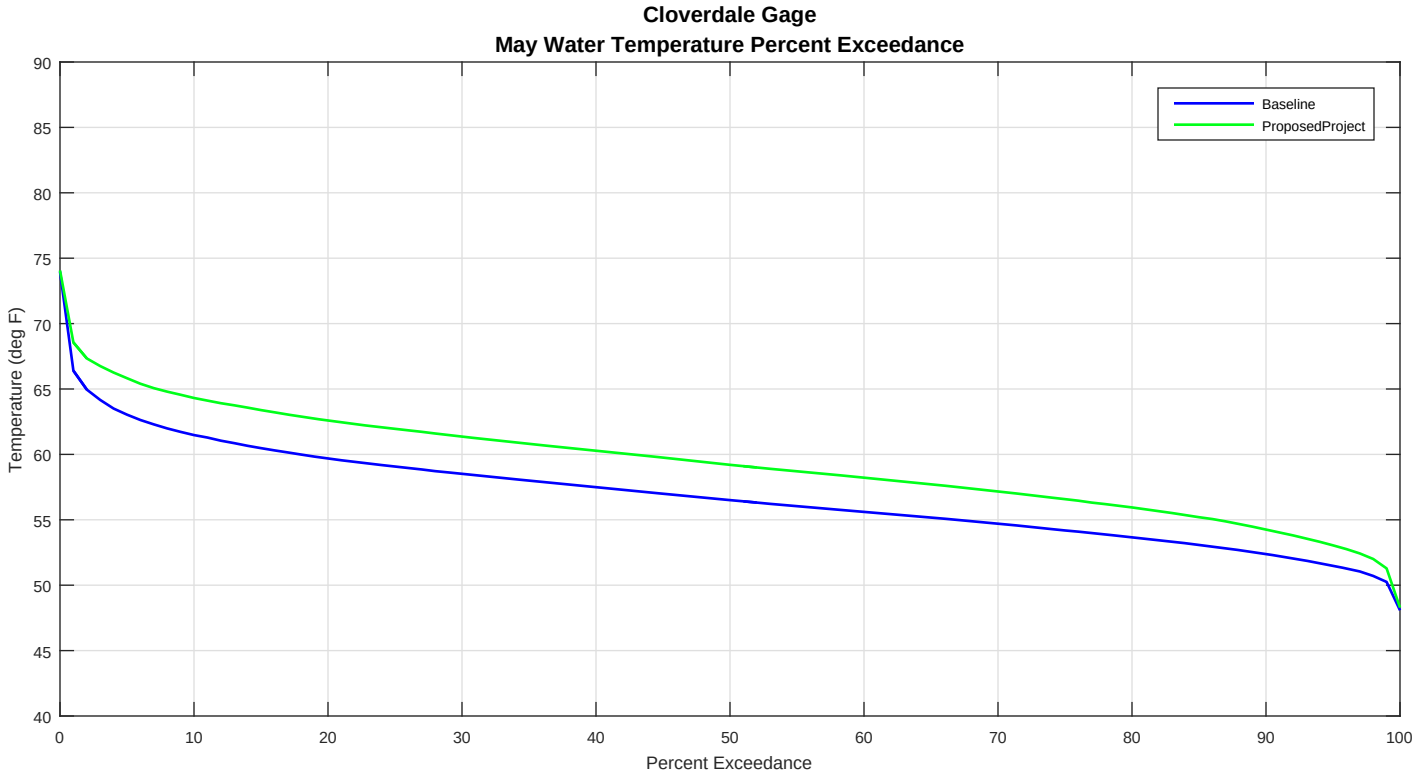
Cloverdale Gage
May Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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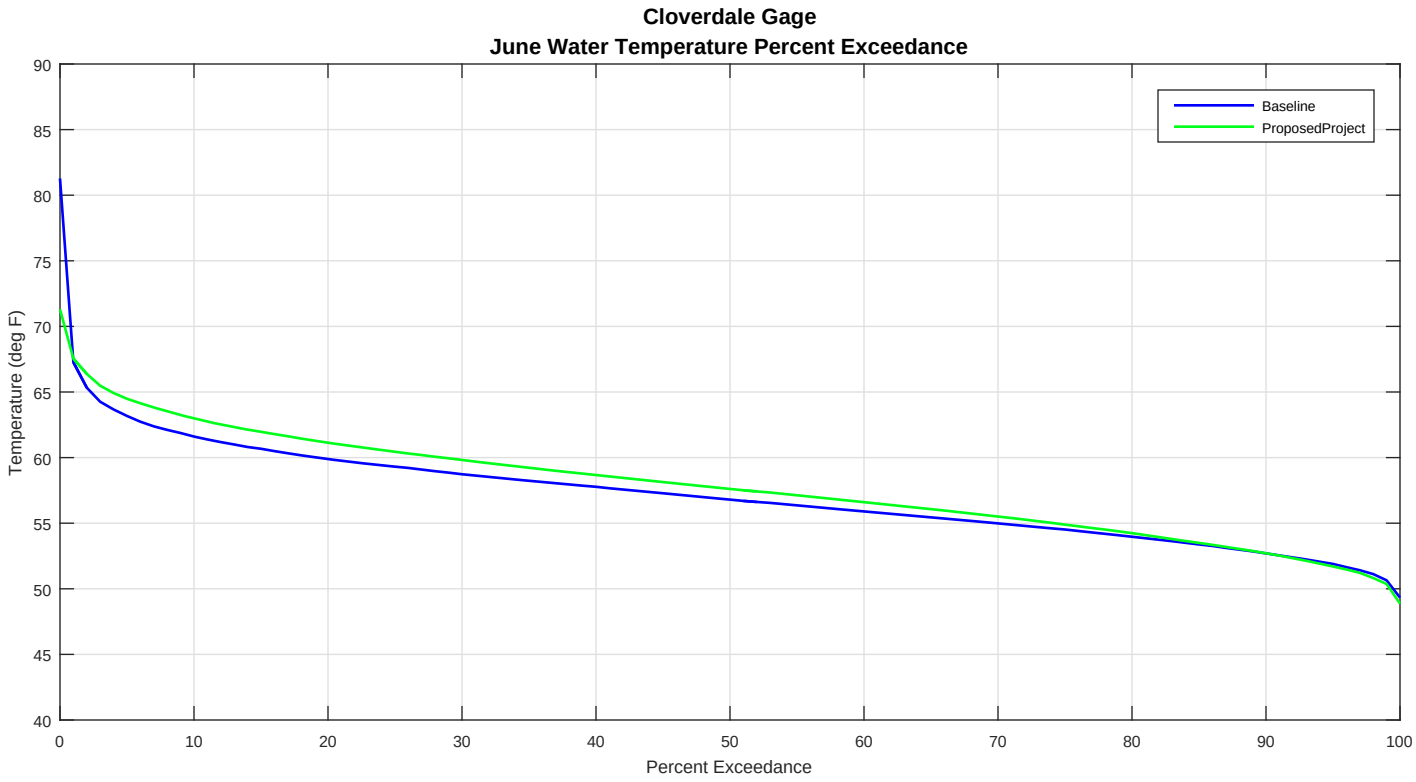
Cloverdale Gage
June Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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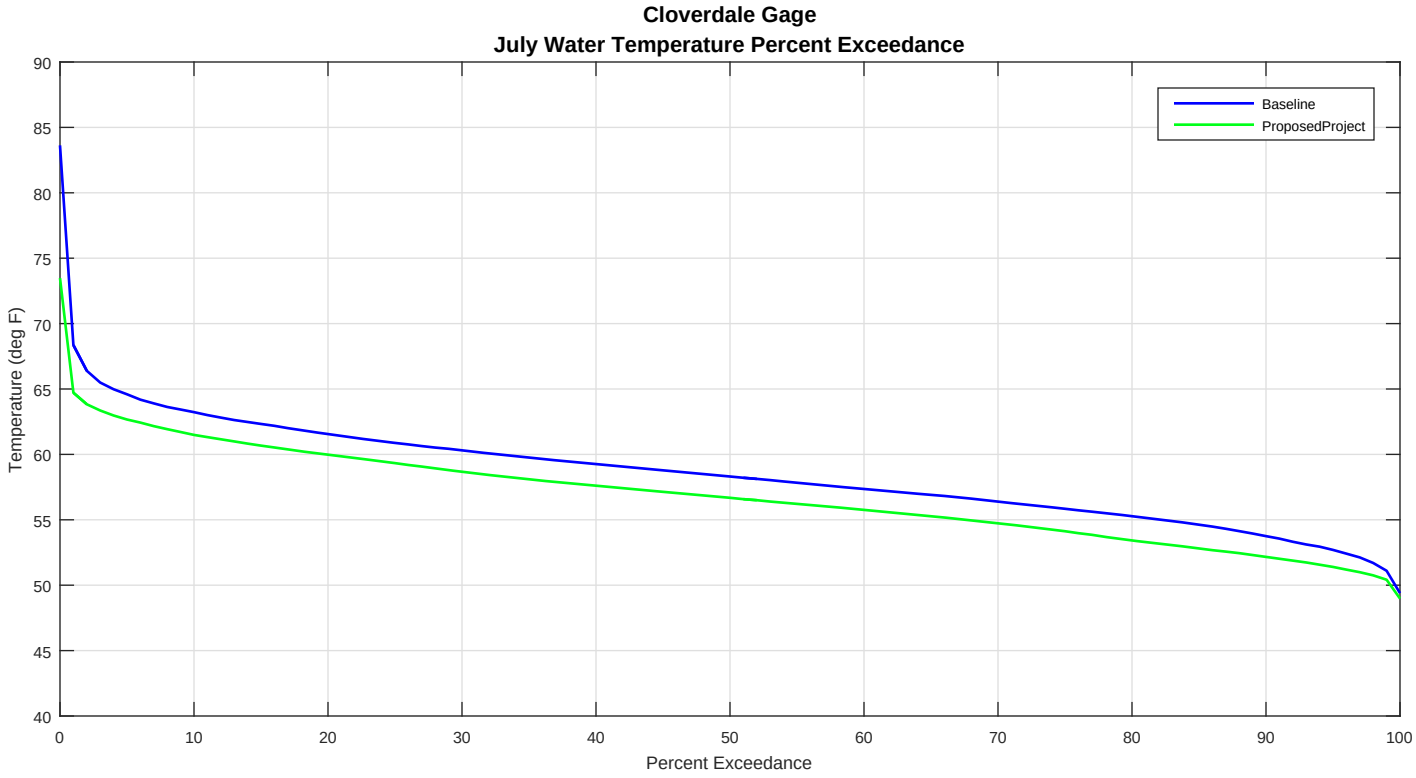
Cloverdale Gage
July Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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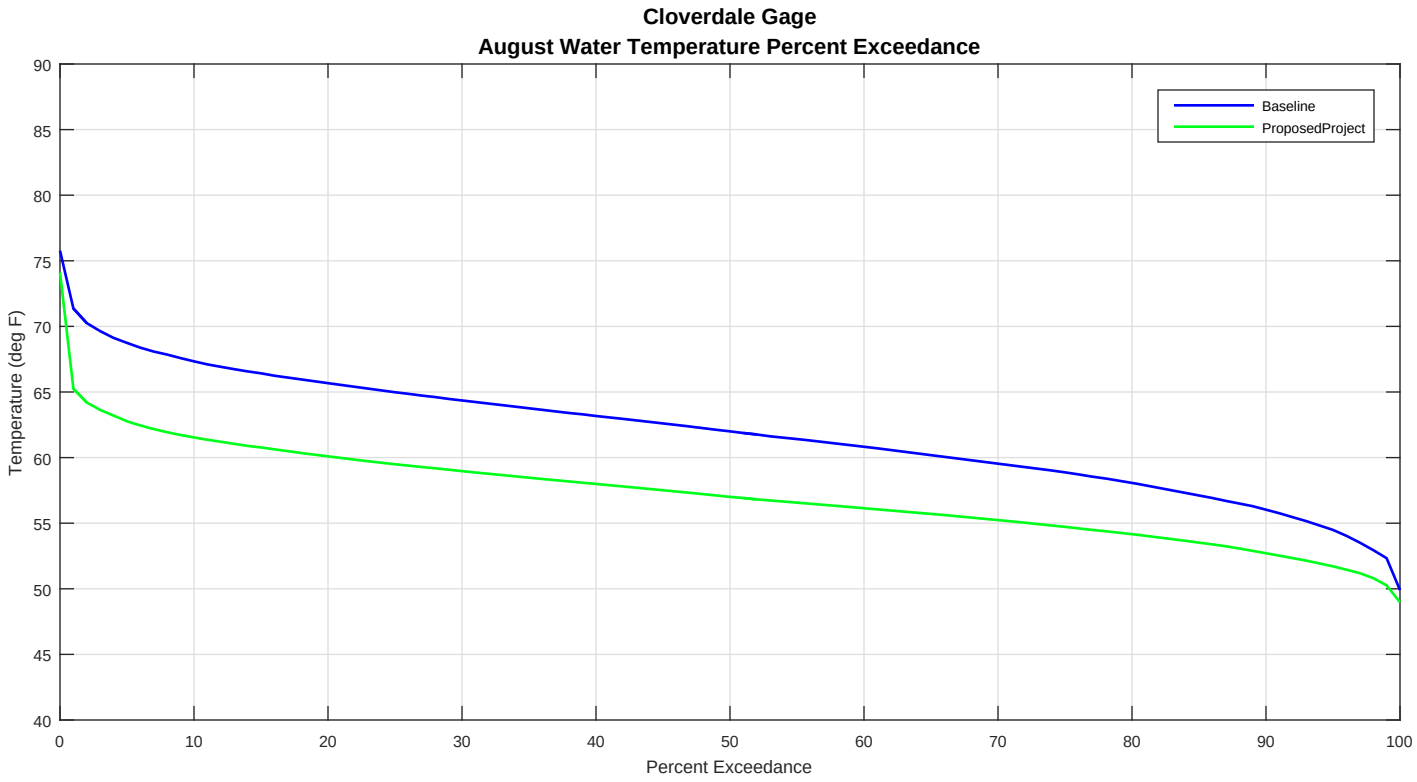
Cloverdale Gage
August Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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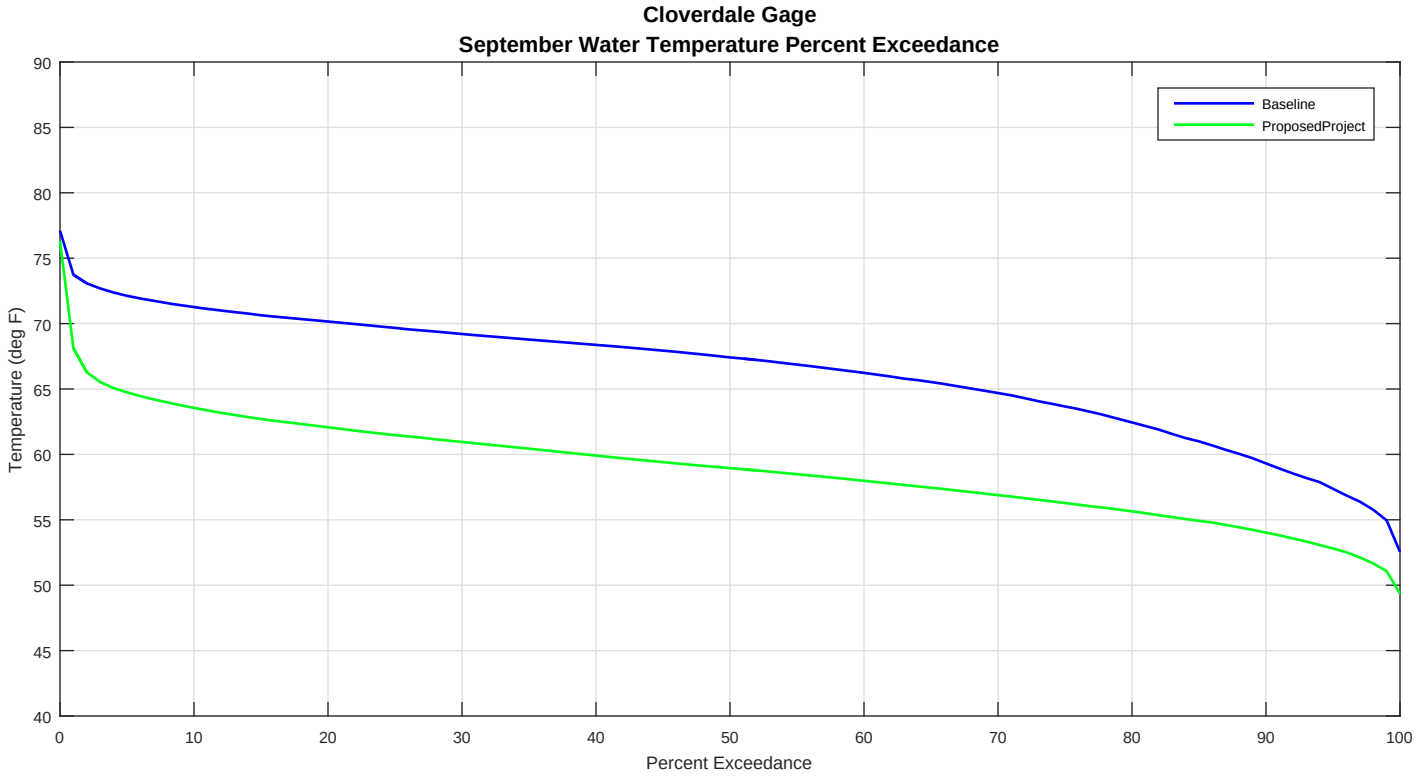
Cloverdale Gage
September Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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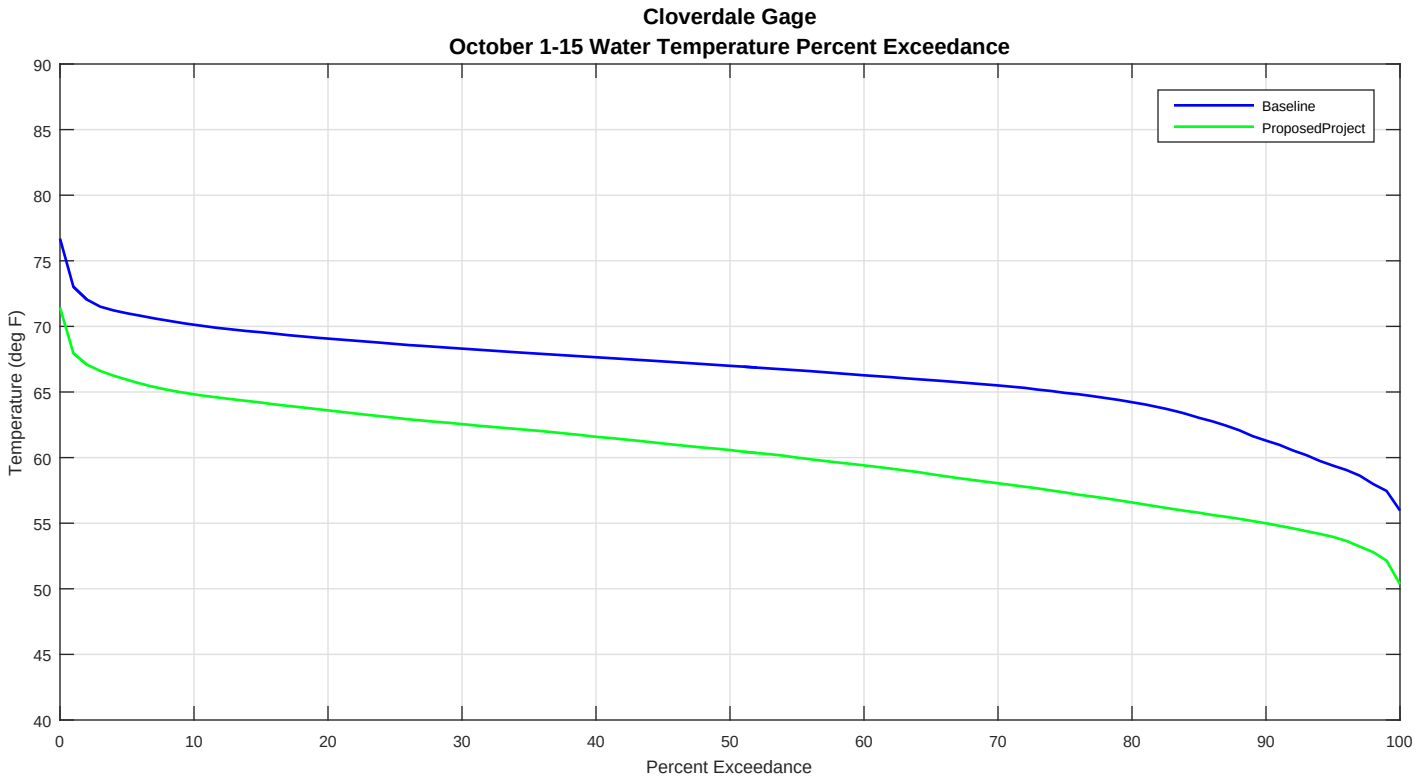
Cloverdale Gage
October 1-15 Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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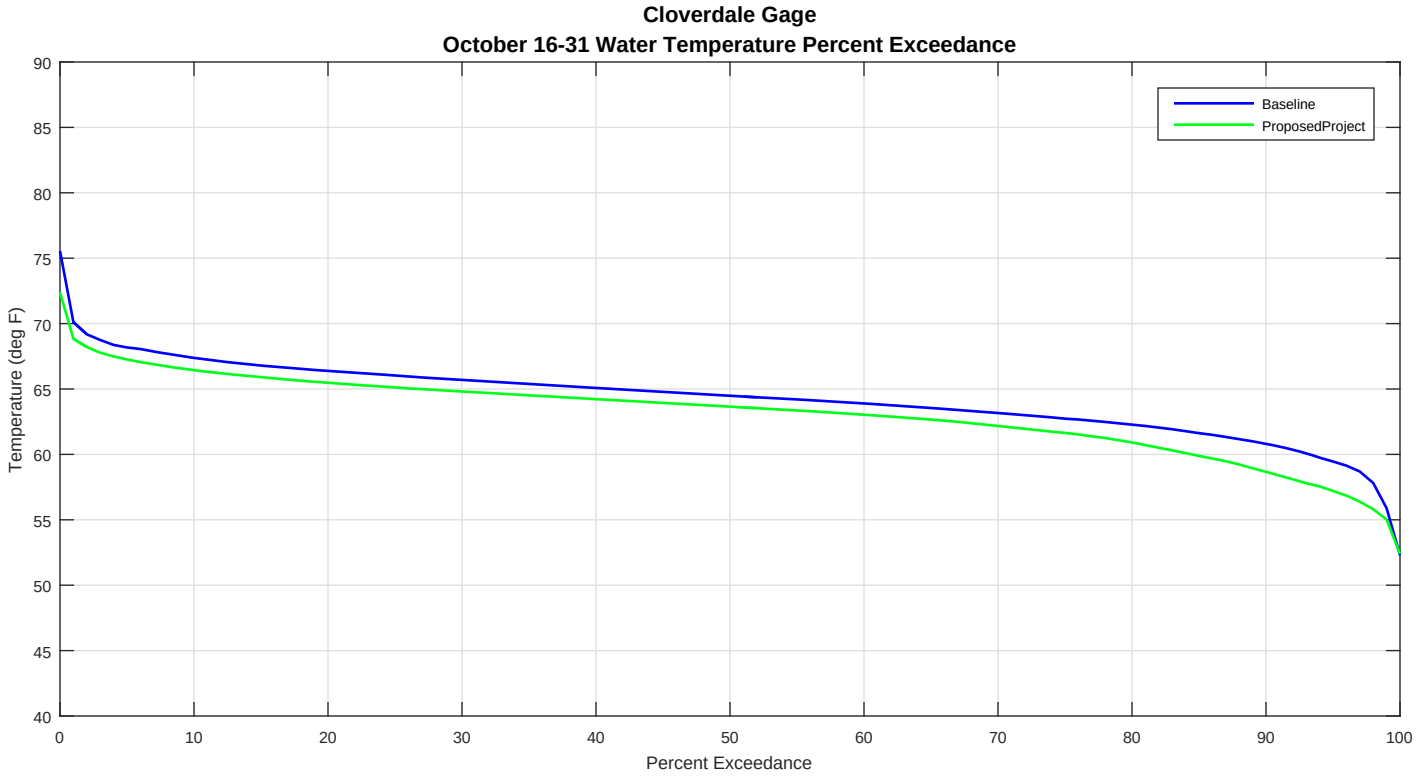
Cloverdale Gage
October 16-31 Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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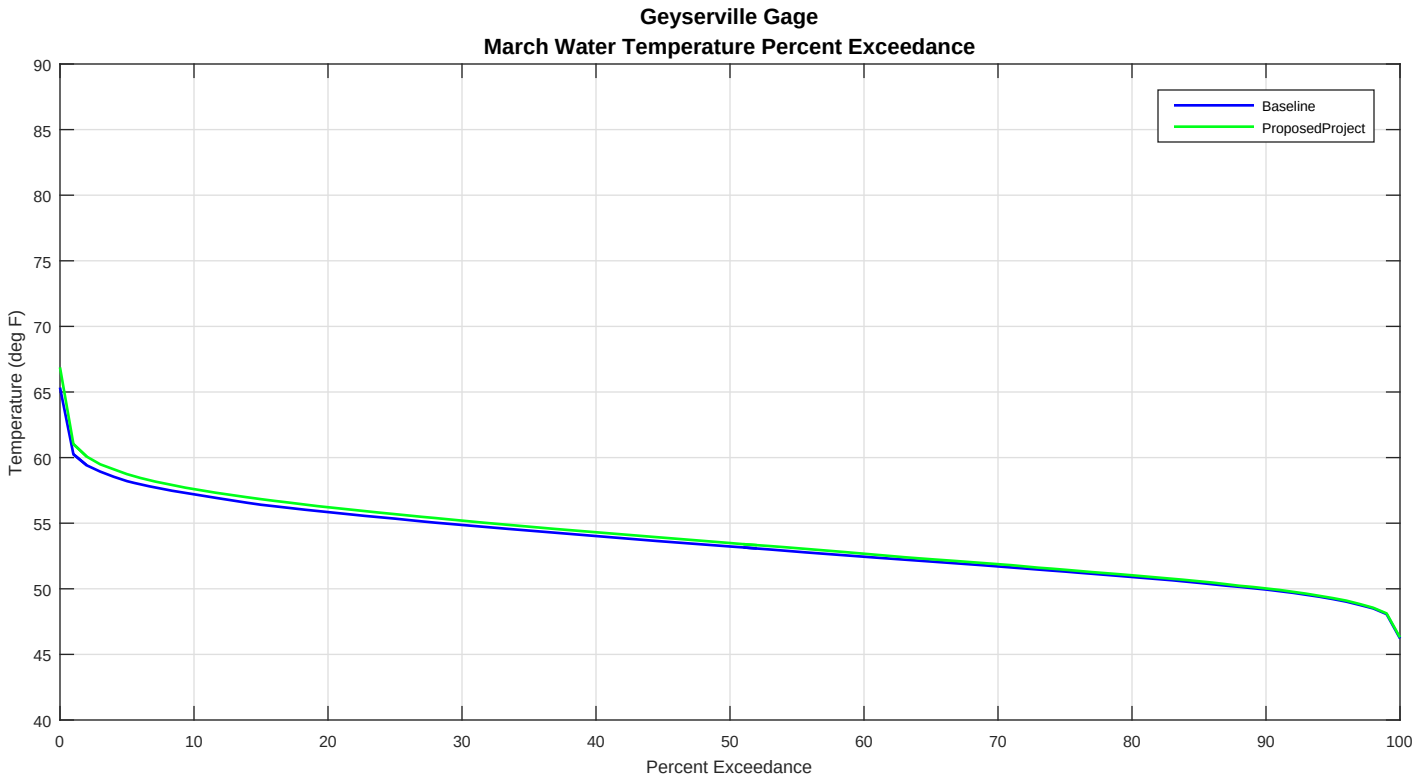
Geyserville Gage
March Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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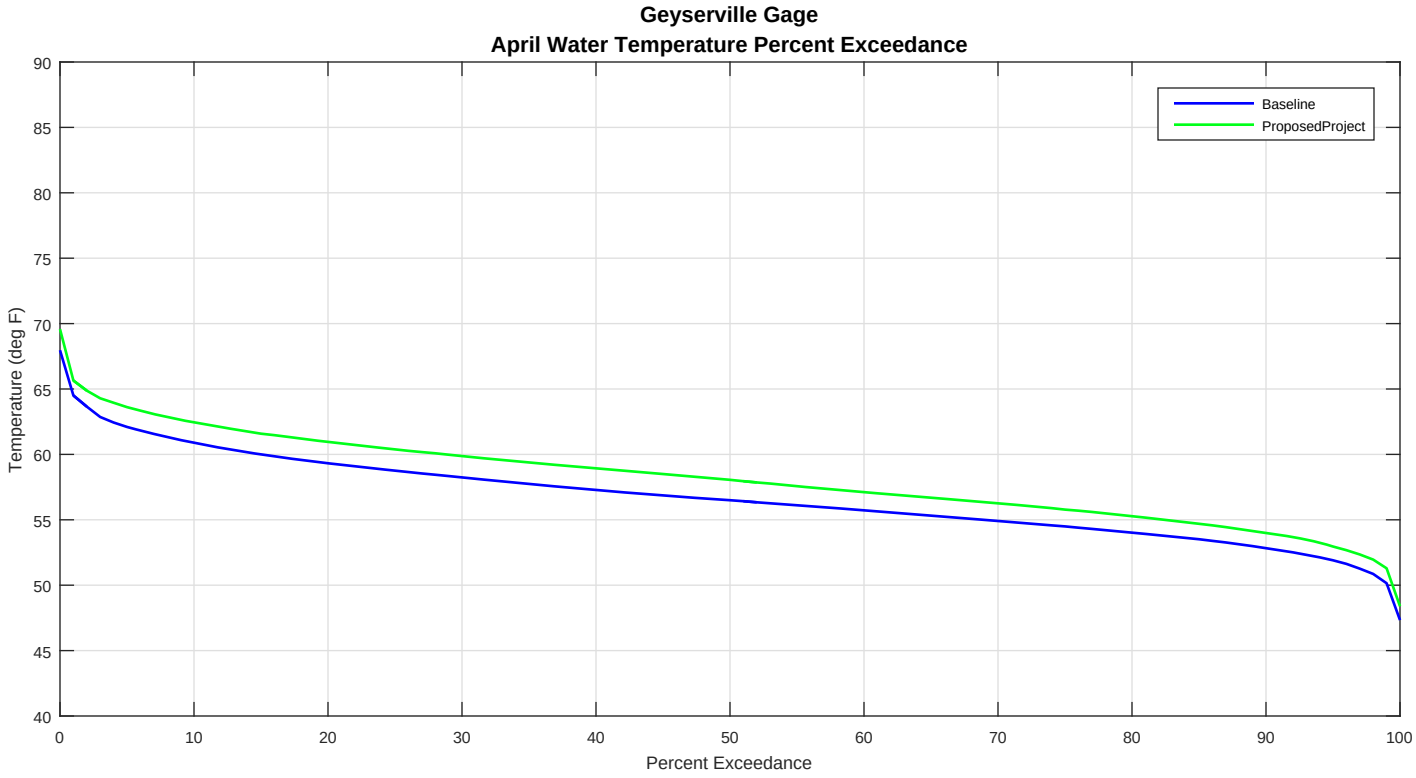
Geyserville Gage
April Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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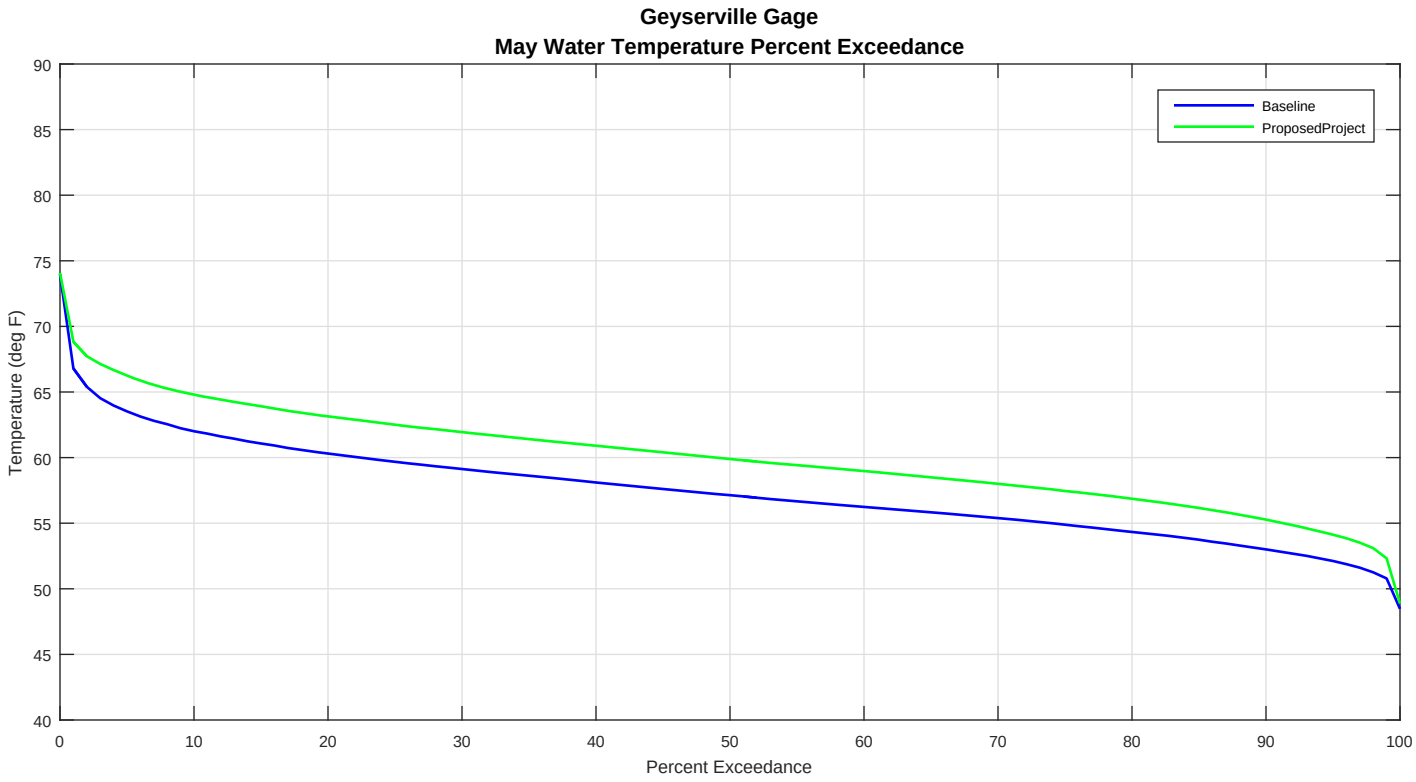
Geyserville Gage
May Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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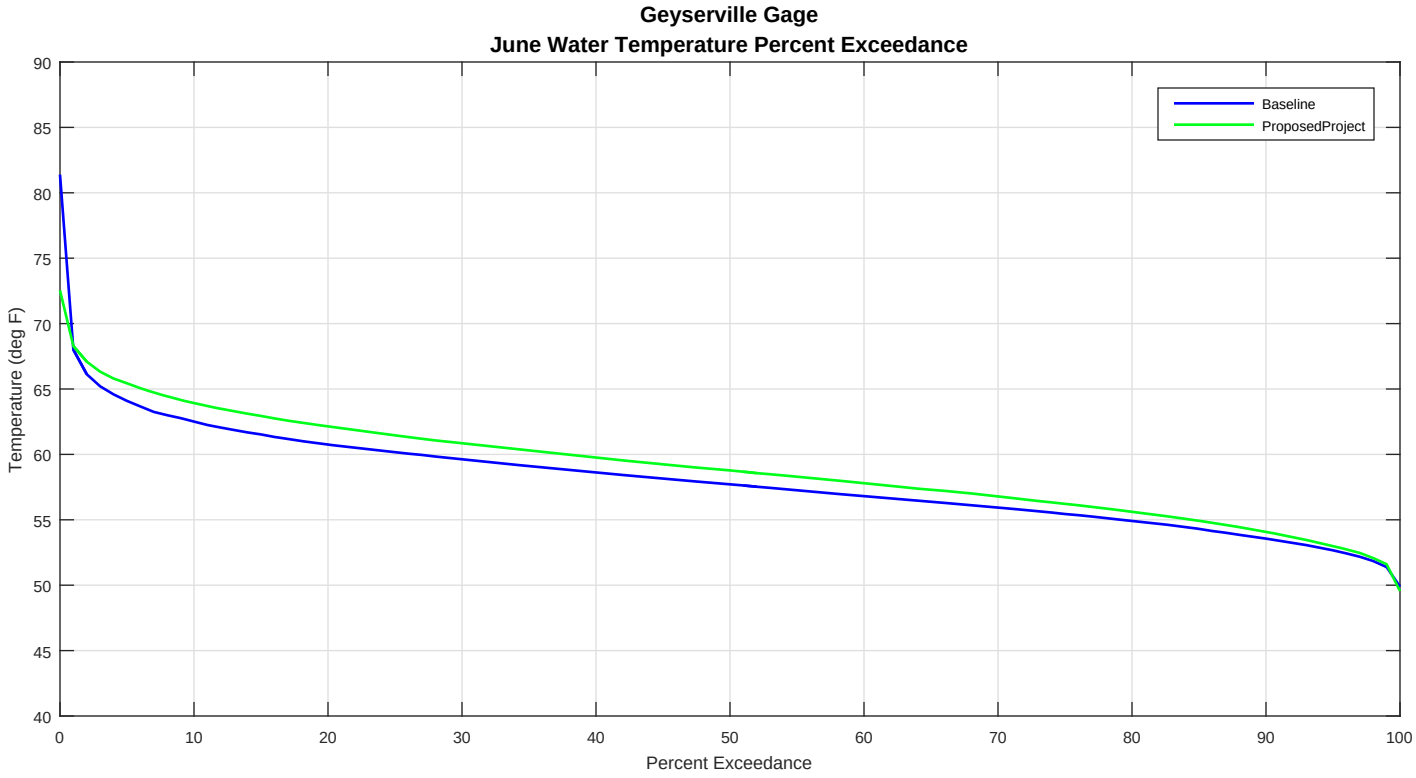
Geyserville Gage
June Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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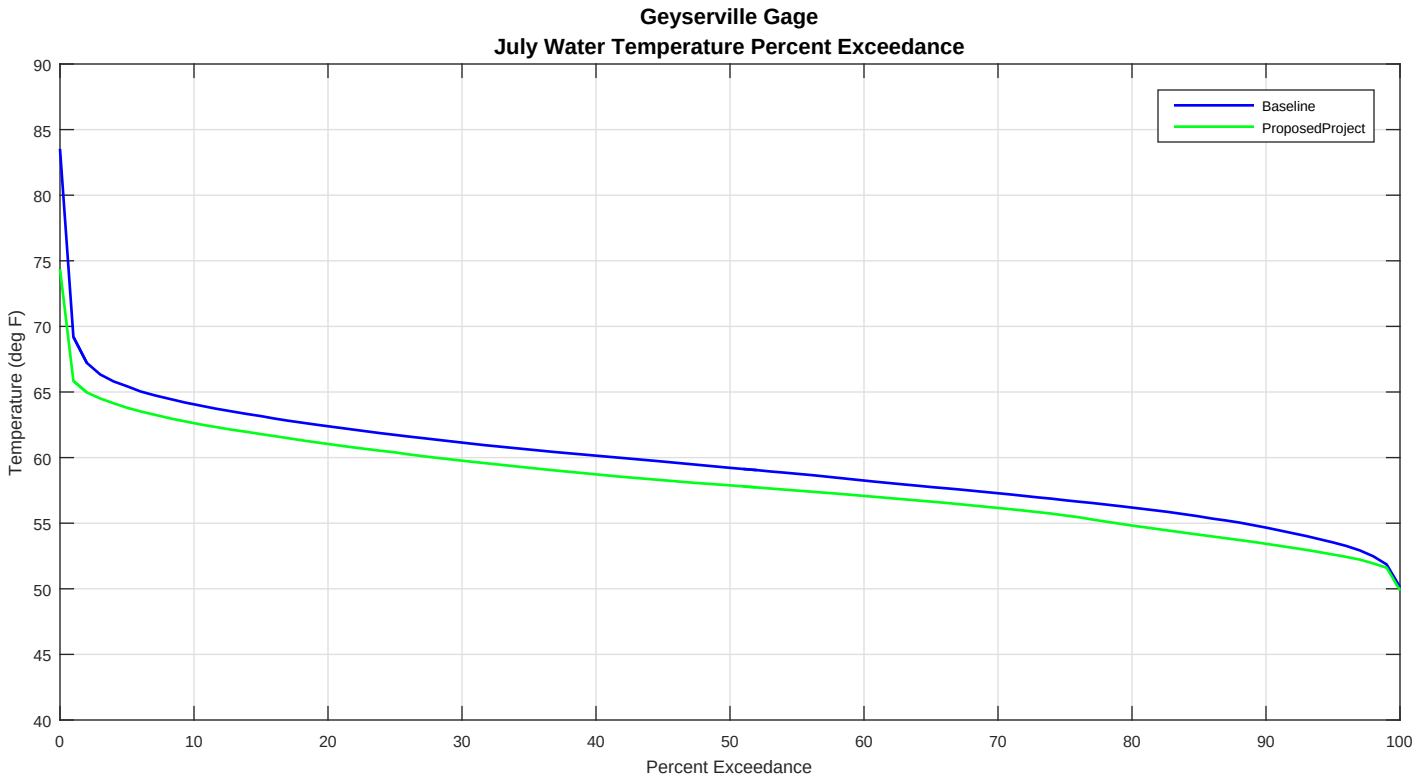
Geyserville Gage
July Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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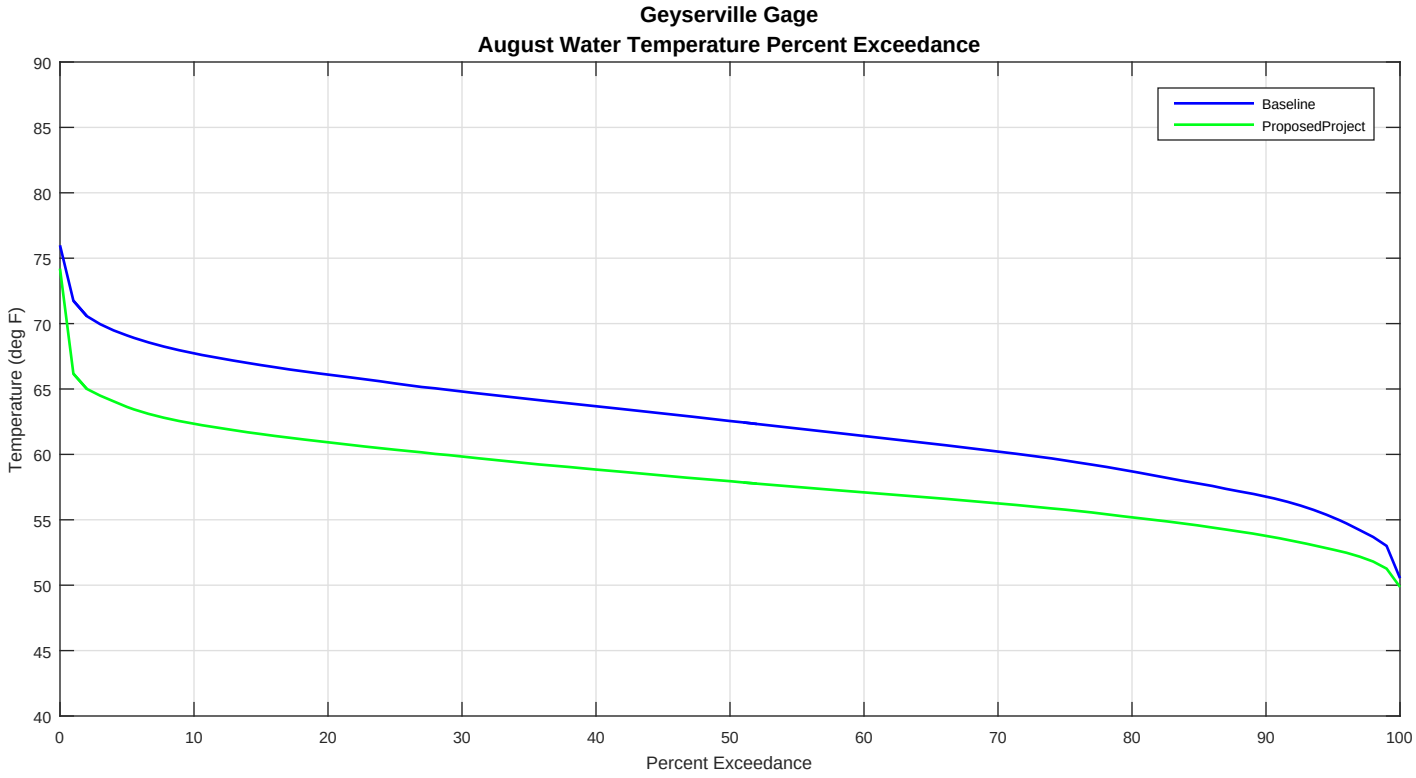
Geyserville Gage
August Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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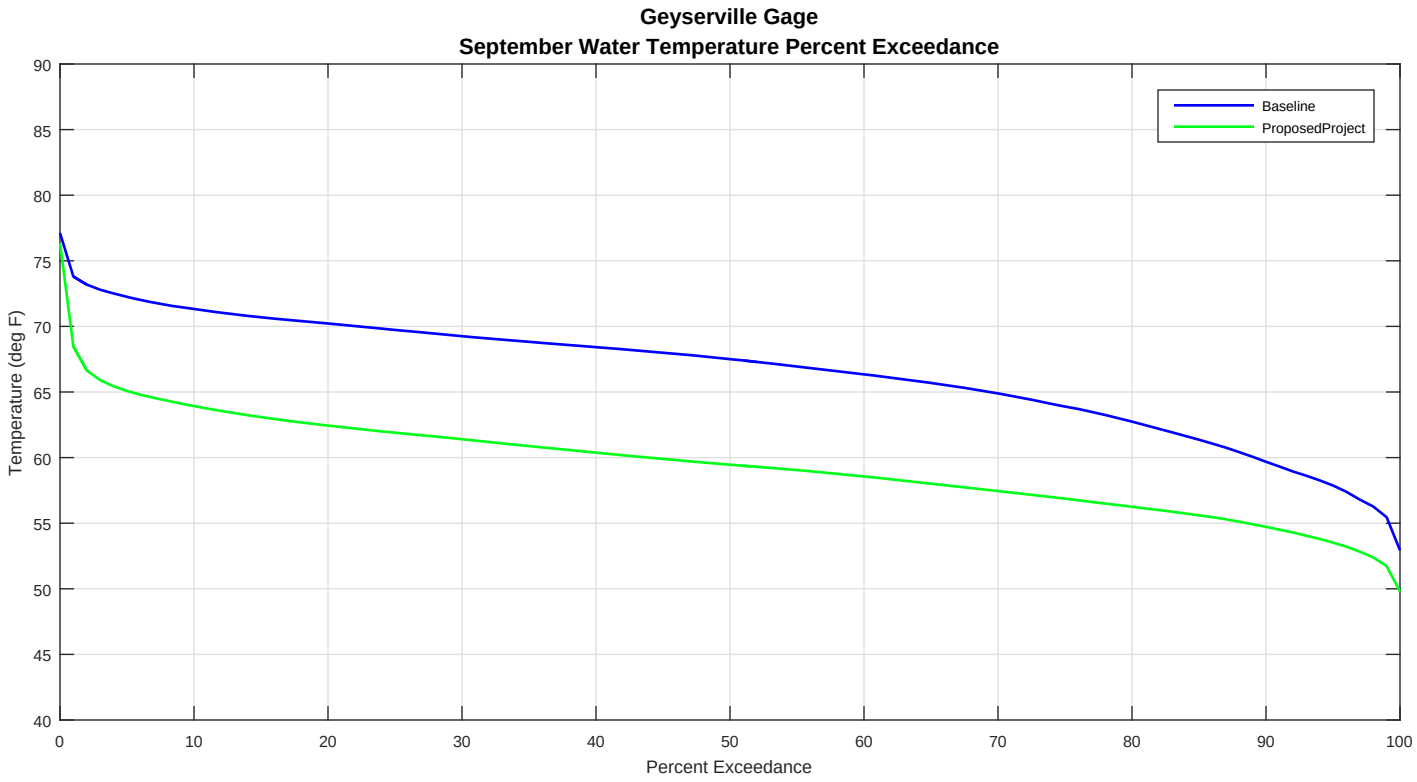
Geyserville Gage
September Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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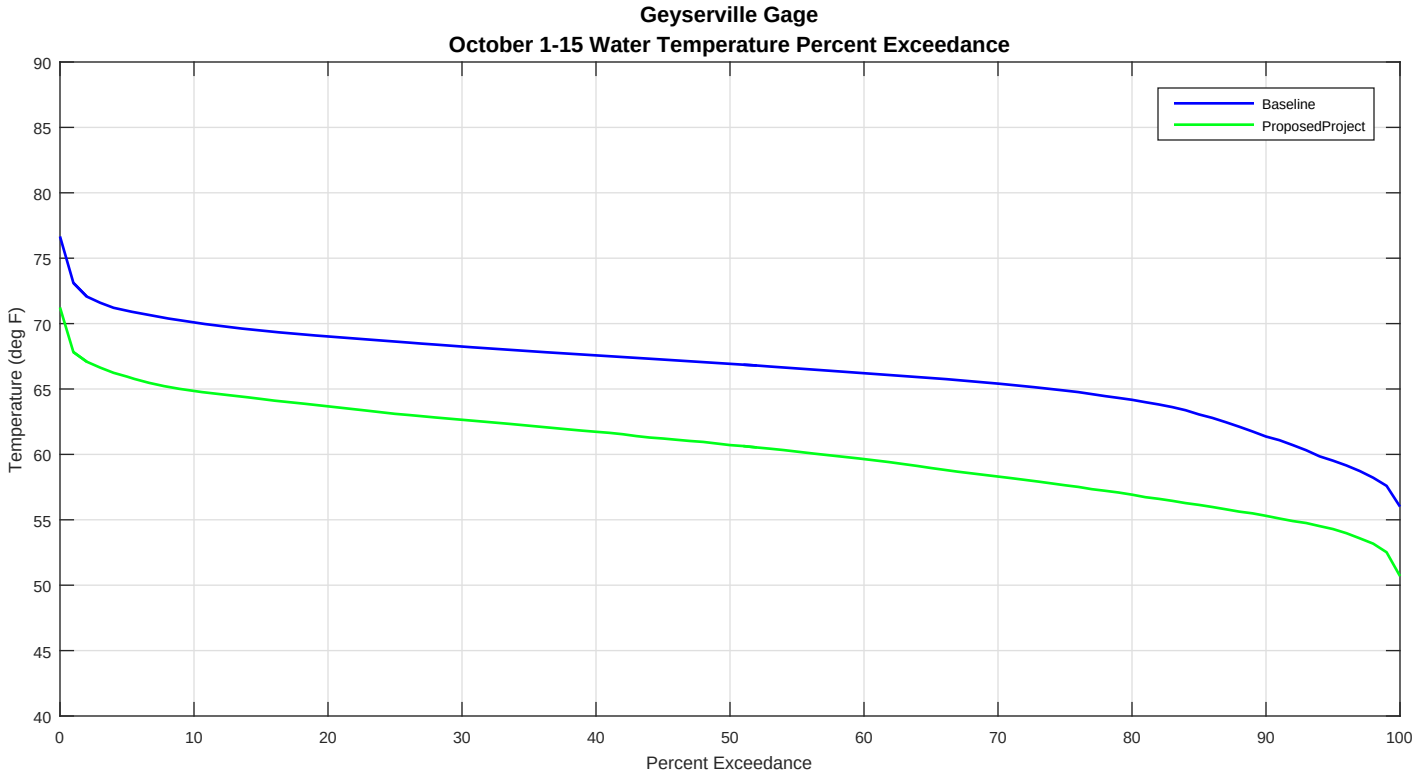
Geyserville Gage
October 1-15 Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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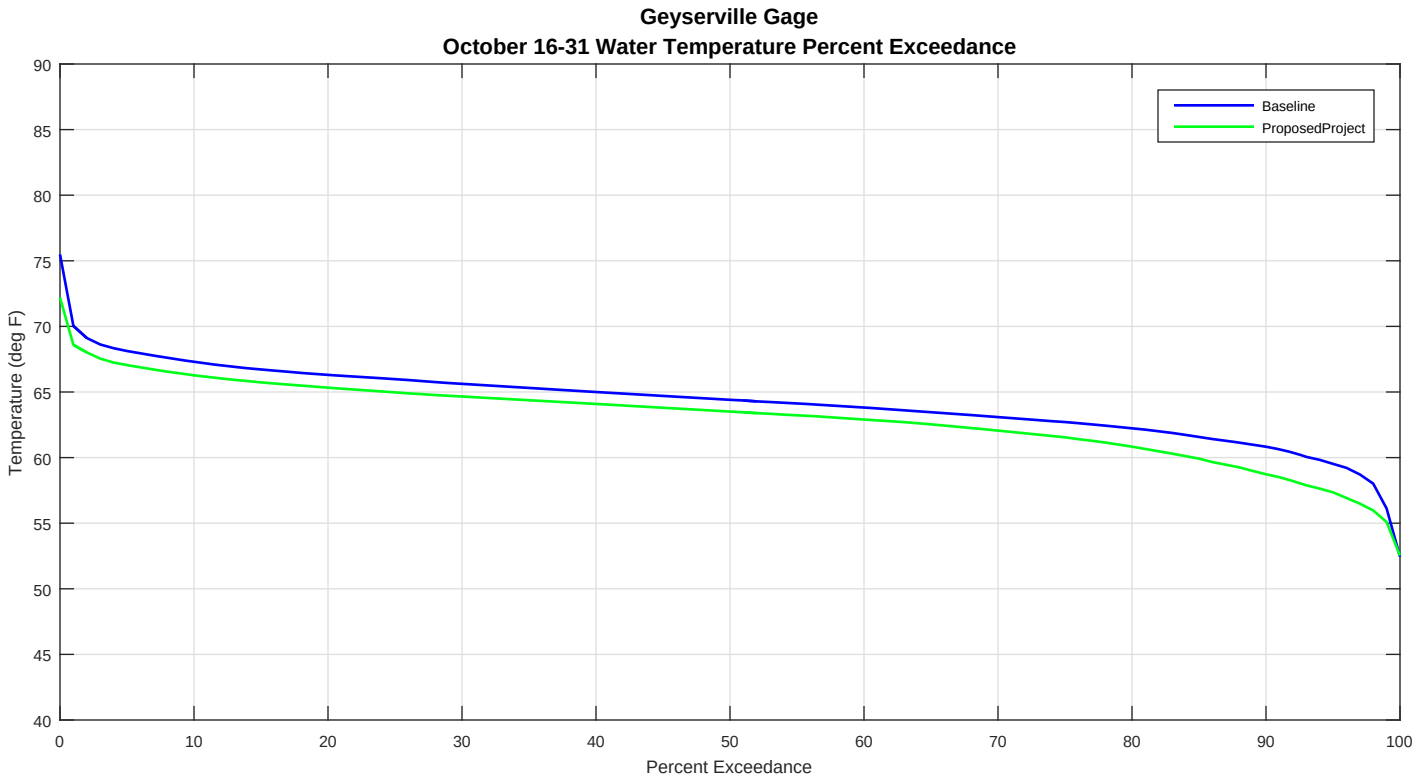
Geyserville Gage
October 16-31 Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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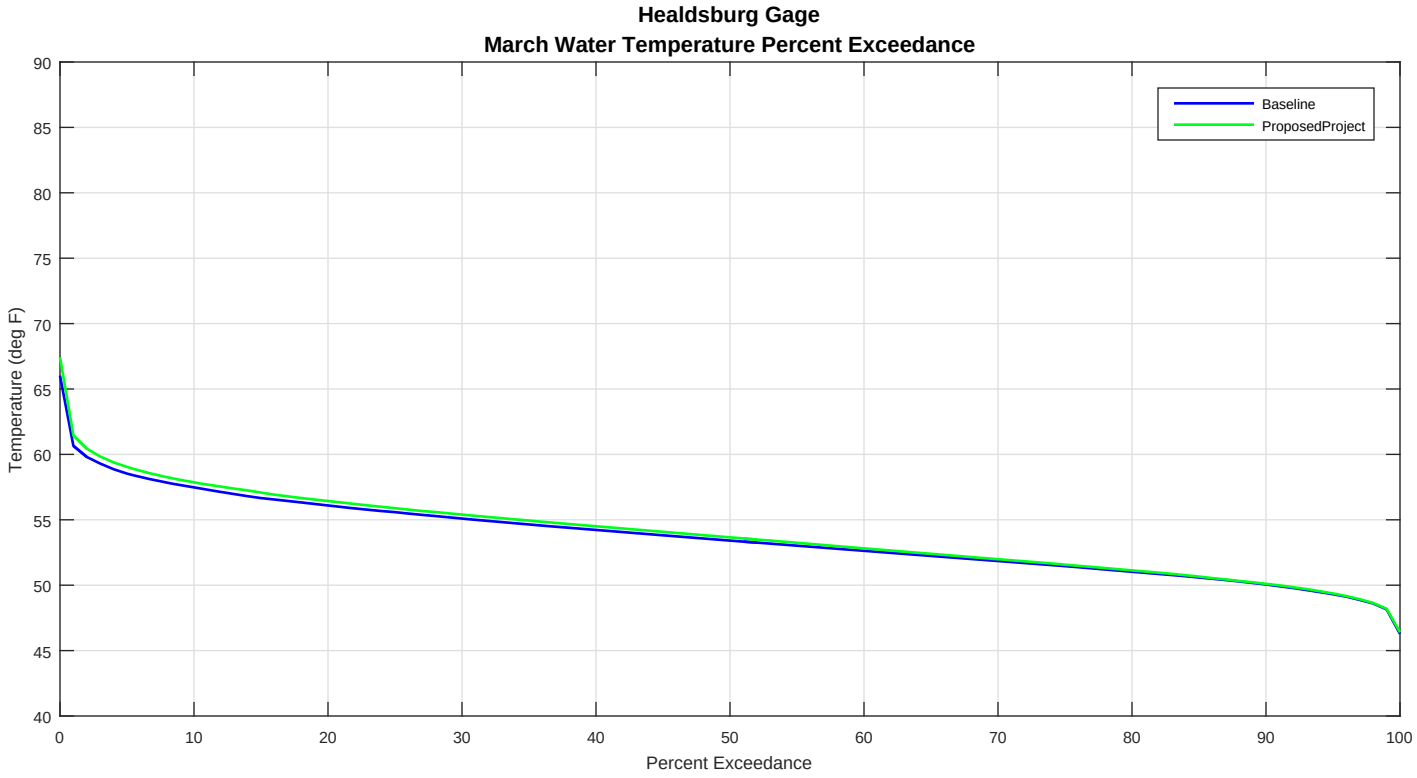
Healdsburg Gage
March Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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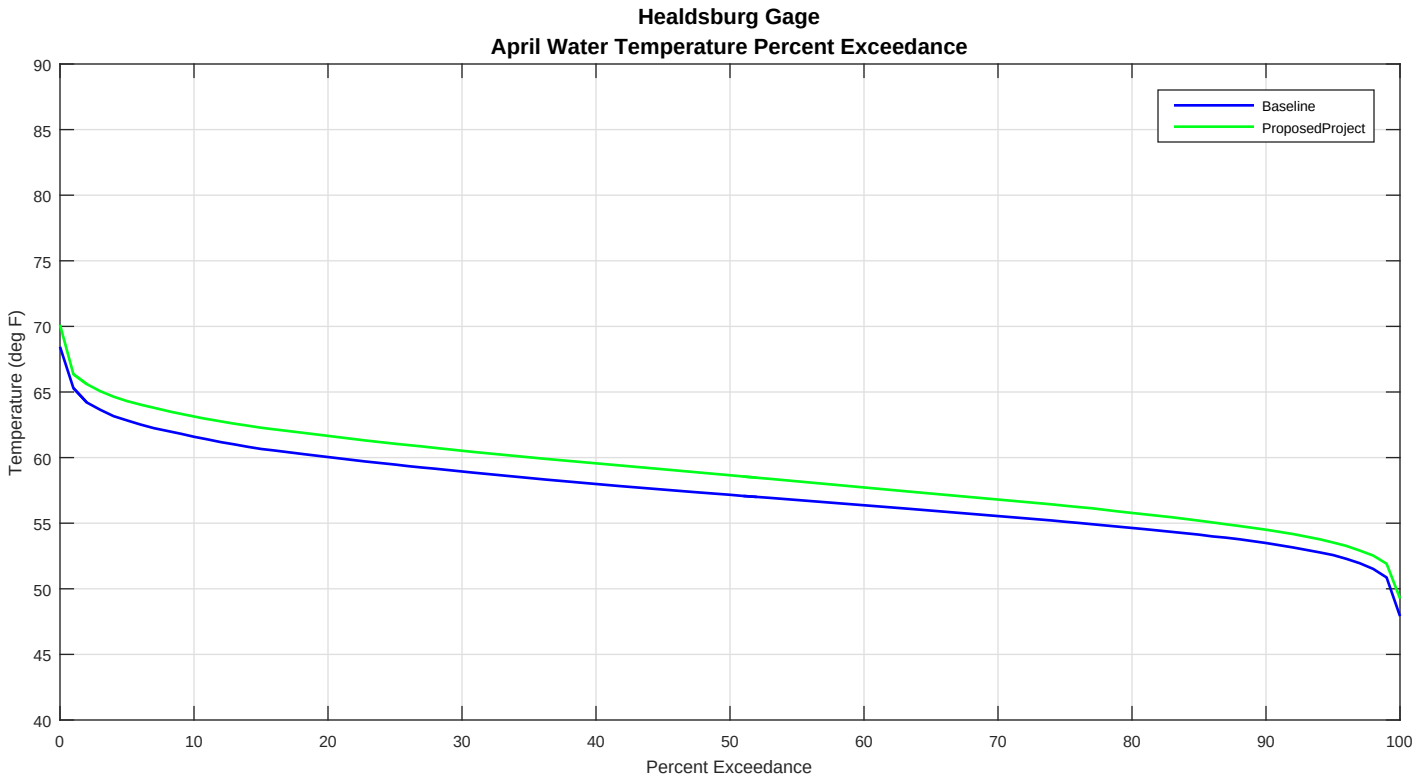
Healdsburg Gage
April Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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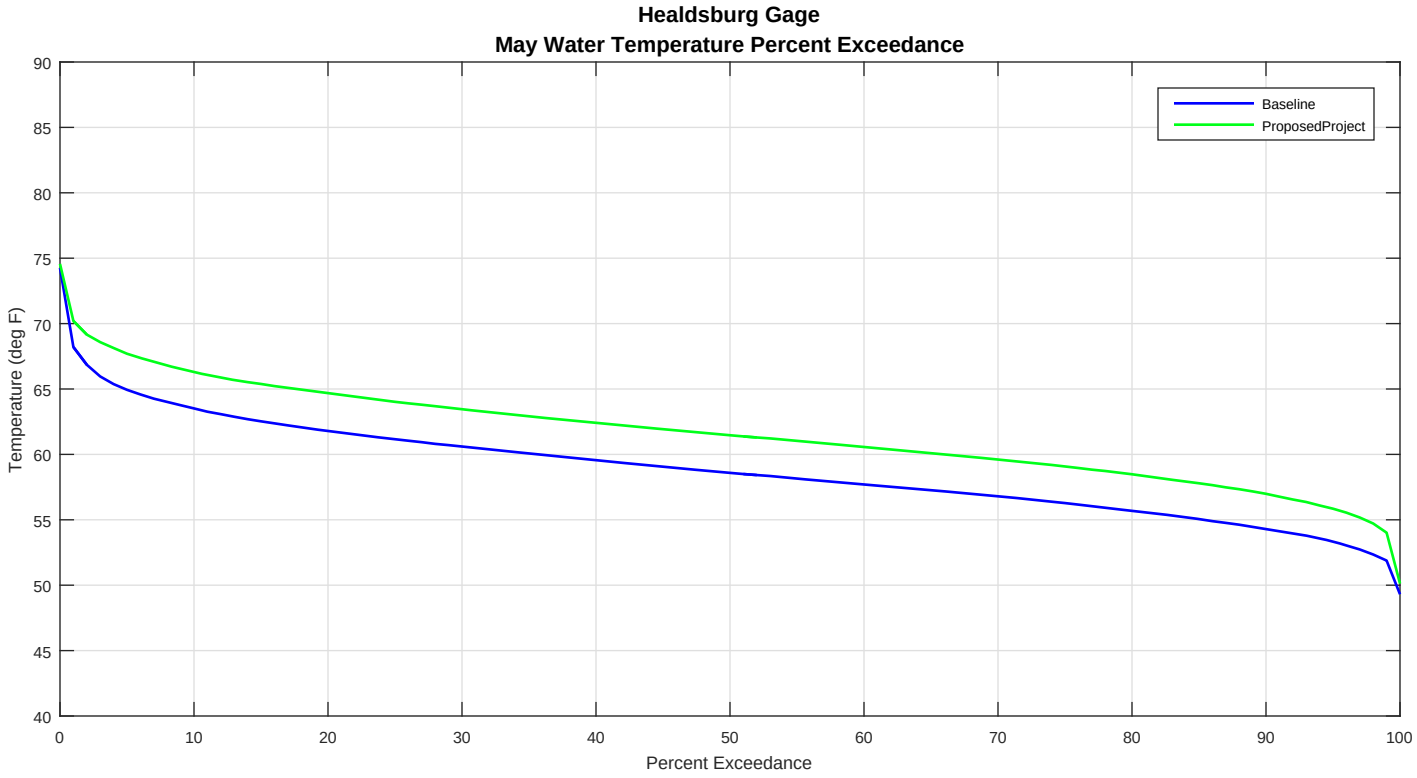
Healdsburg Gage
May Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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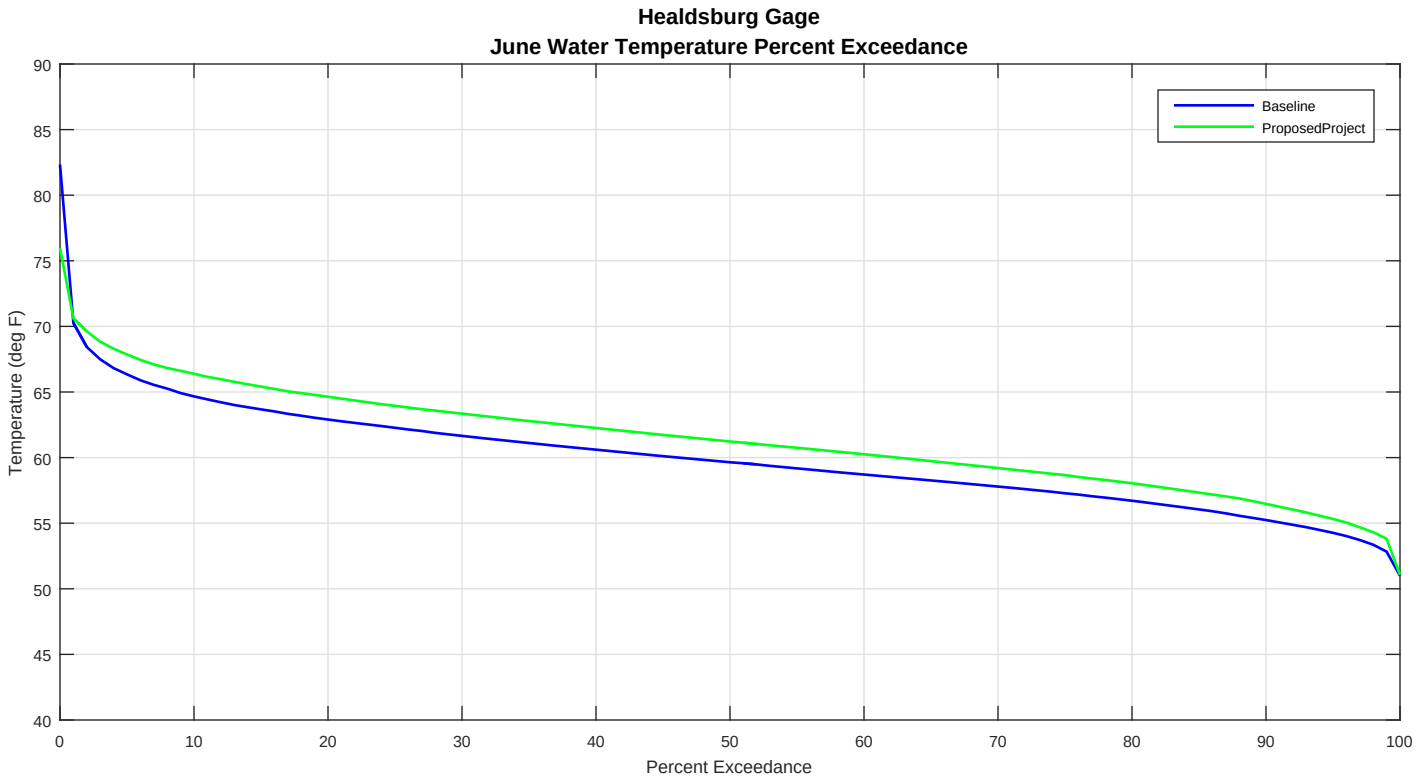
Healdsburg Gage
June Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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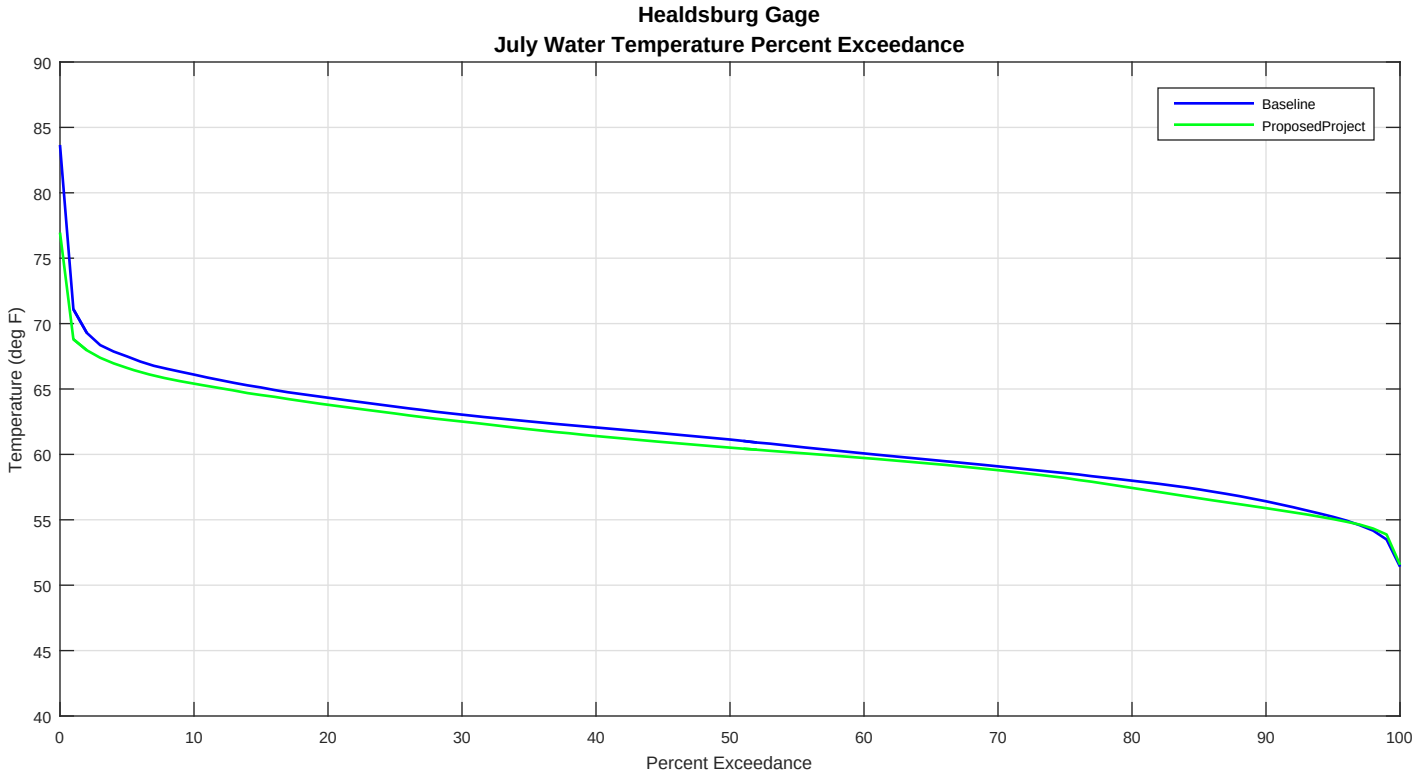
Healdsburg Gage
July Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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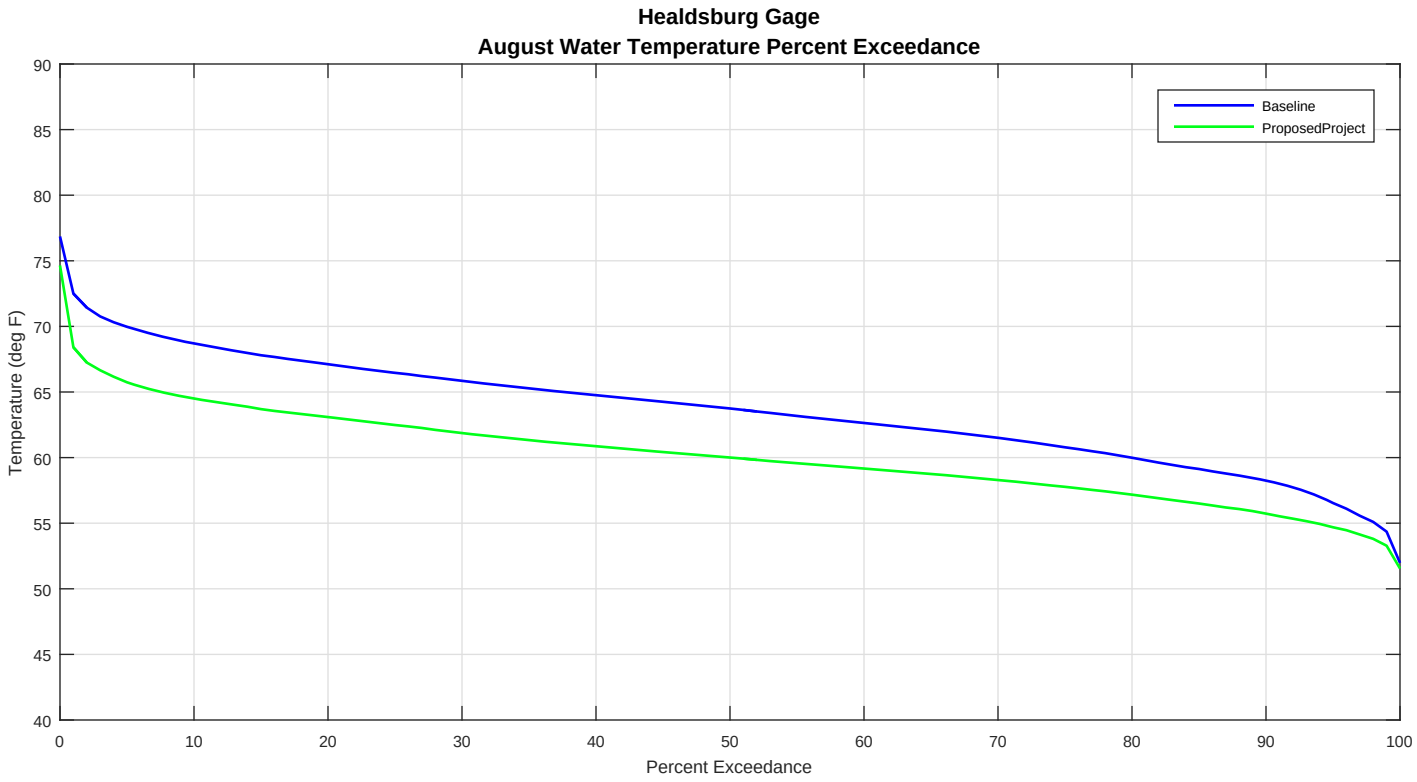
Healdsburg Gage
August Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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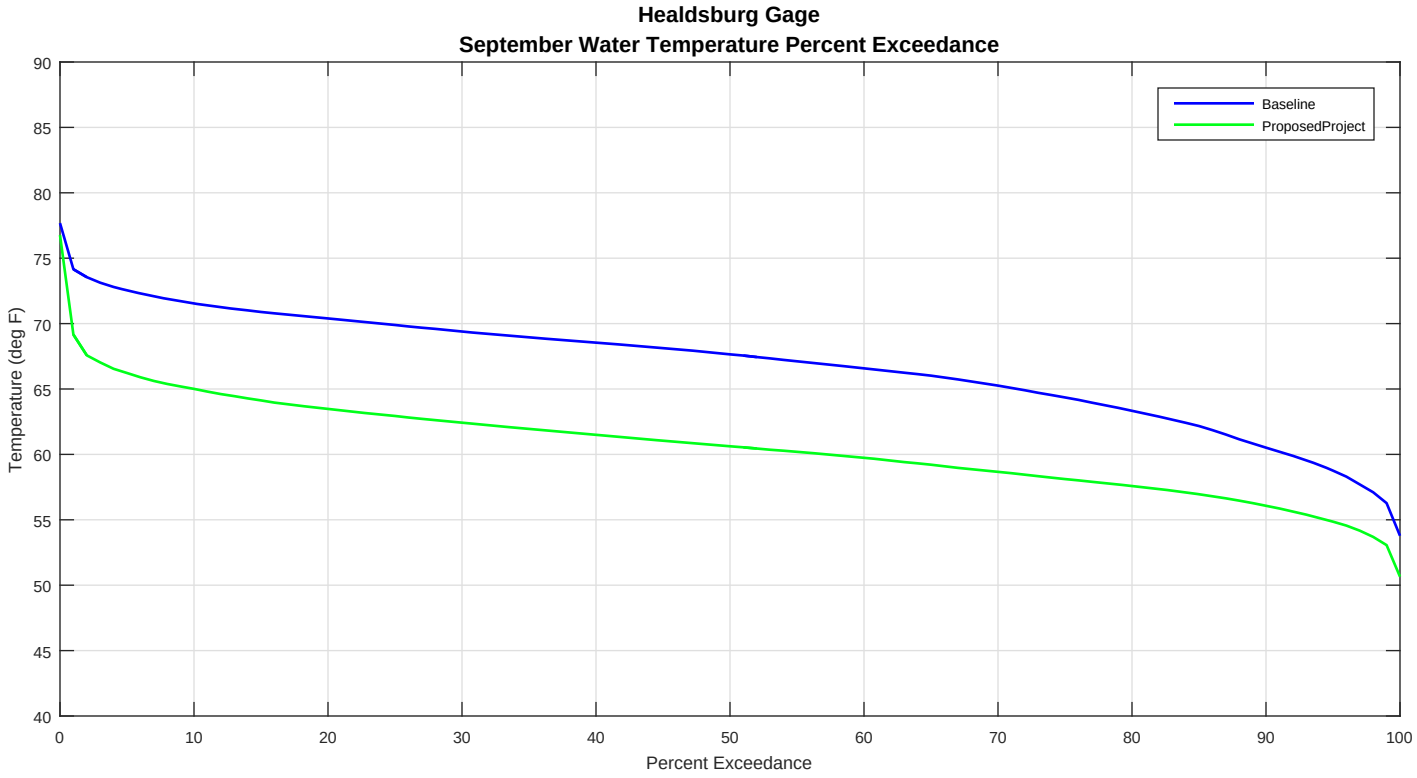
Healdsburg Gage
September Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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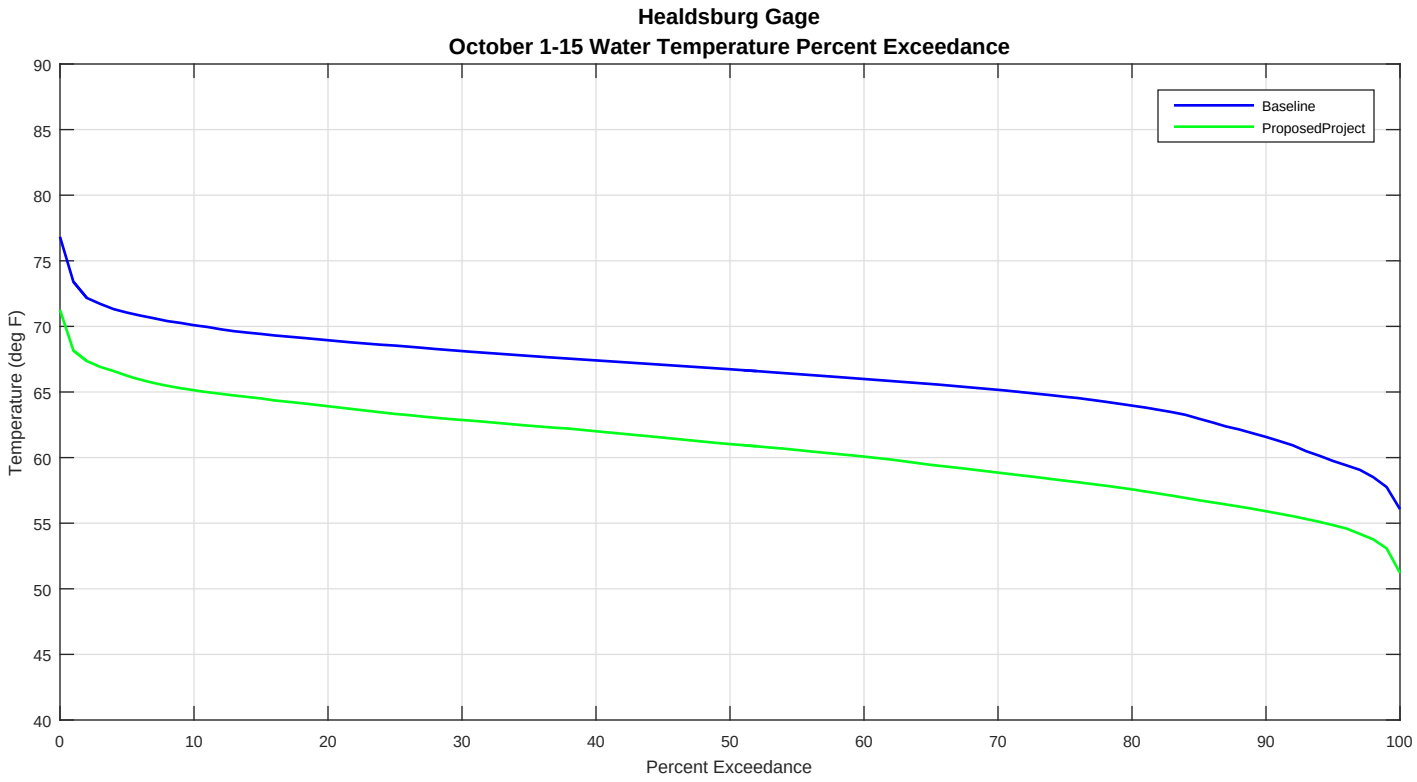
Healdsburg Gage
October 1-15 Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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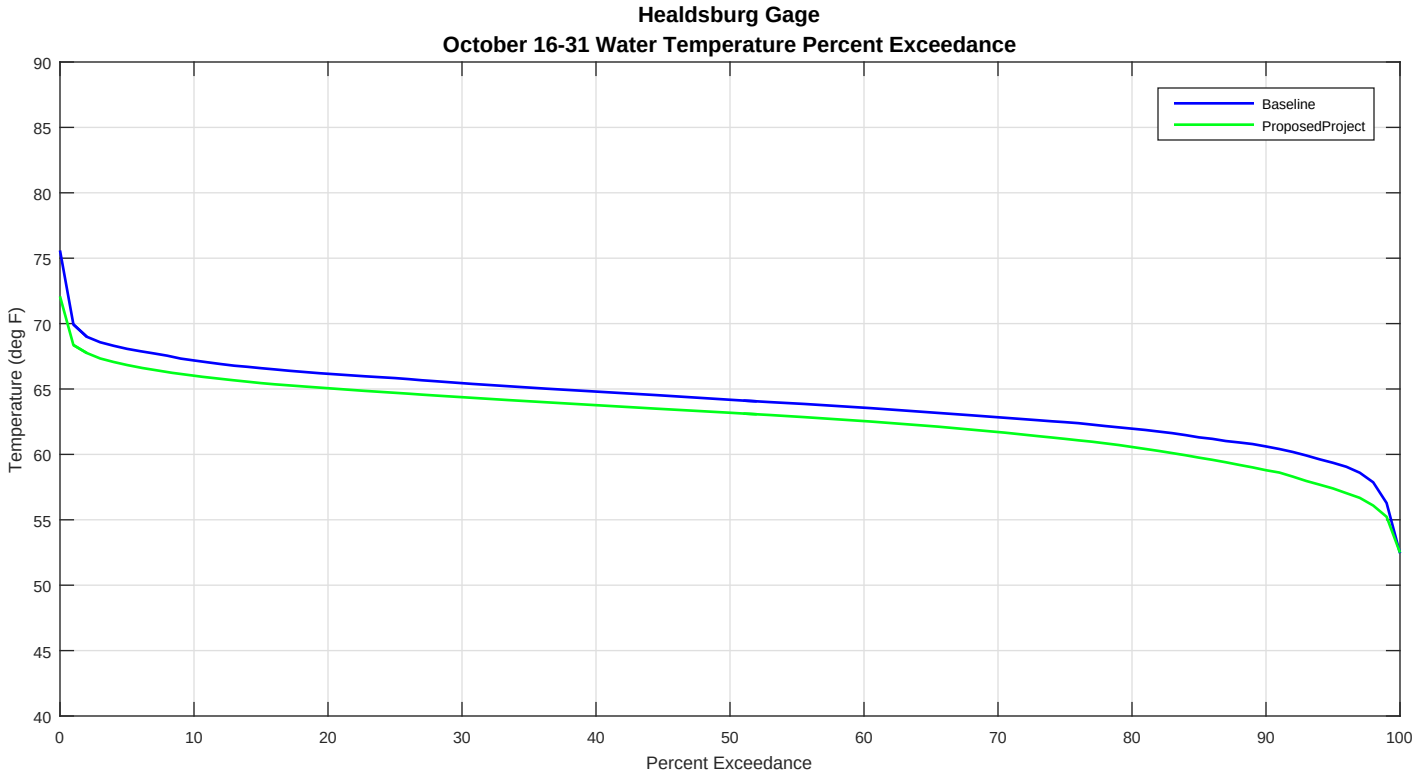
Healdsburg Gage
October 16-31 Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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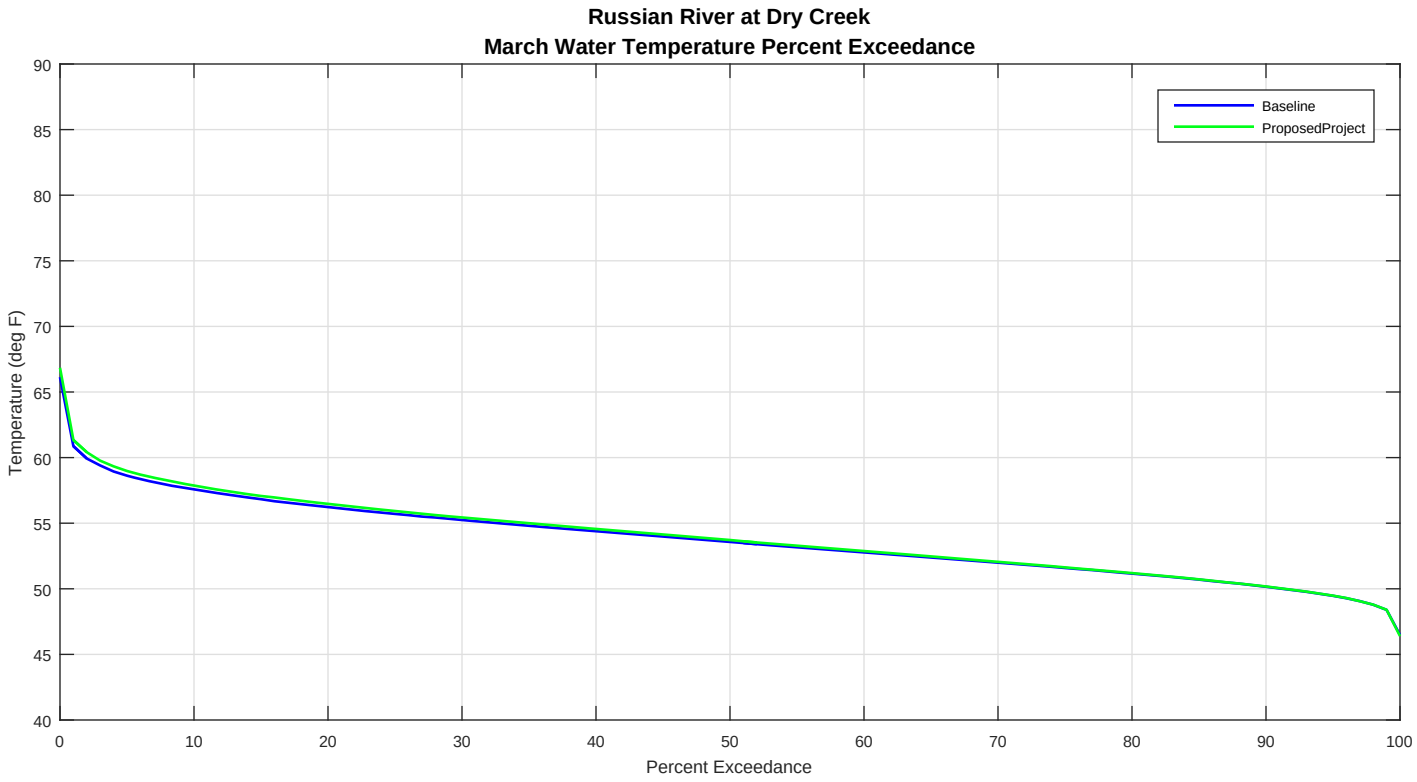
Russian River at Dry Creek
March Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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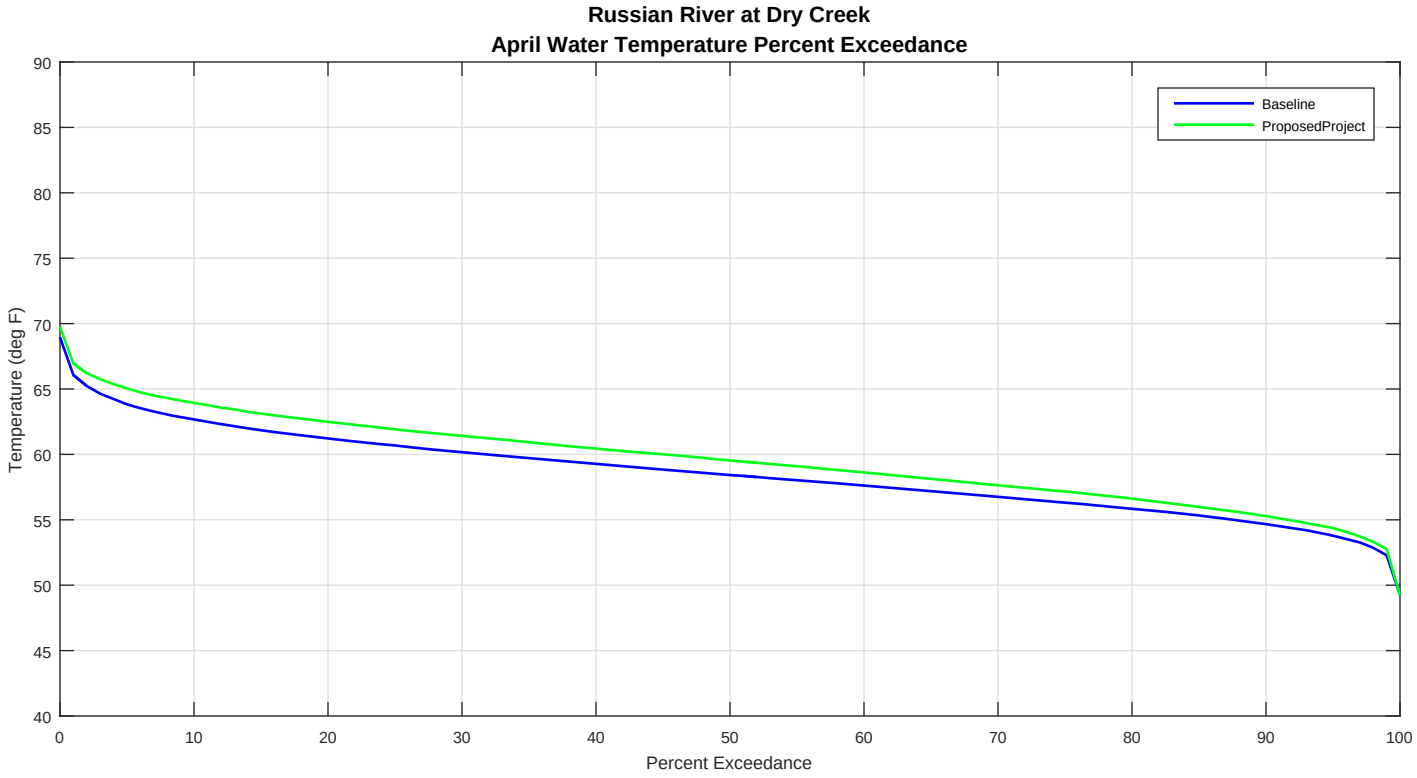
Russian River at Dry Creek
April Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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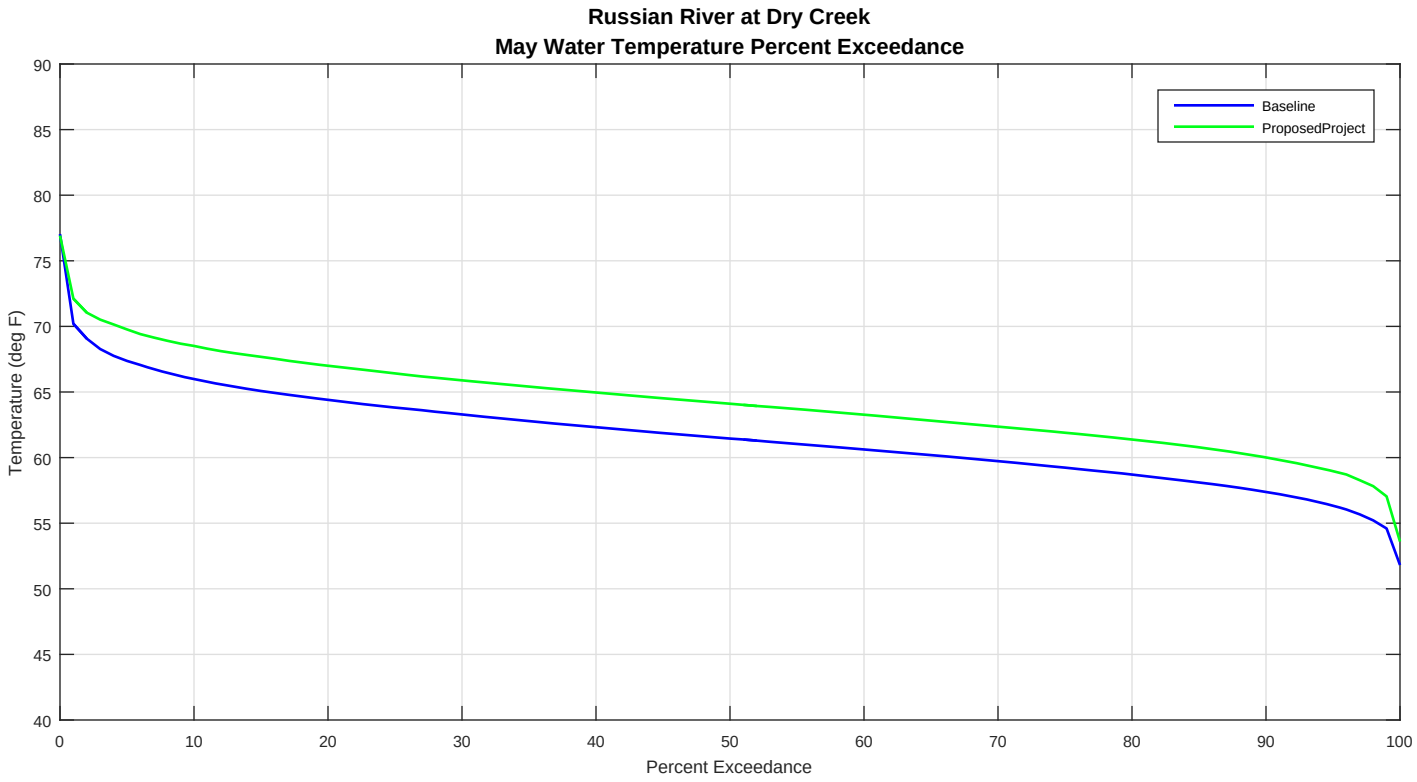
Russian River at Dry Creek
May Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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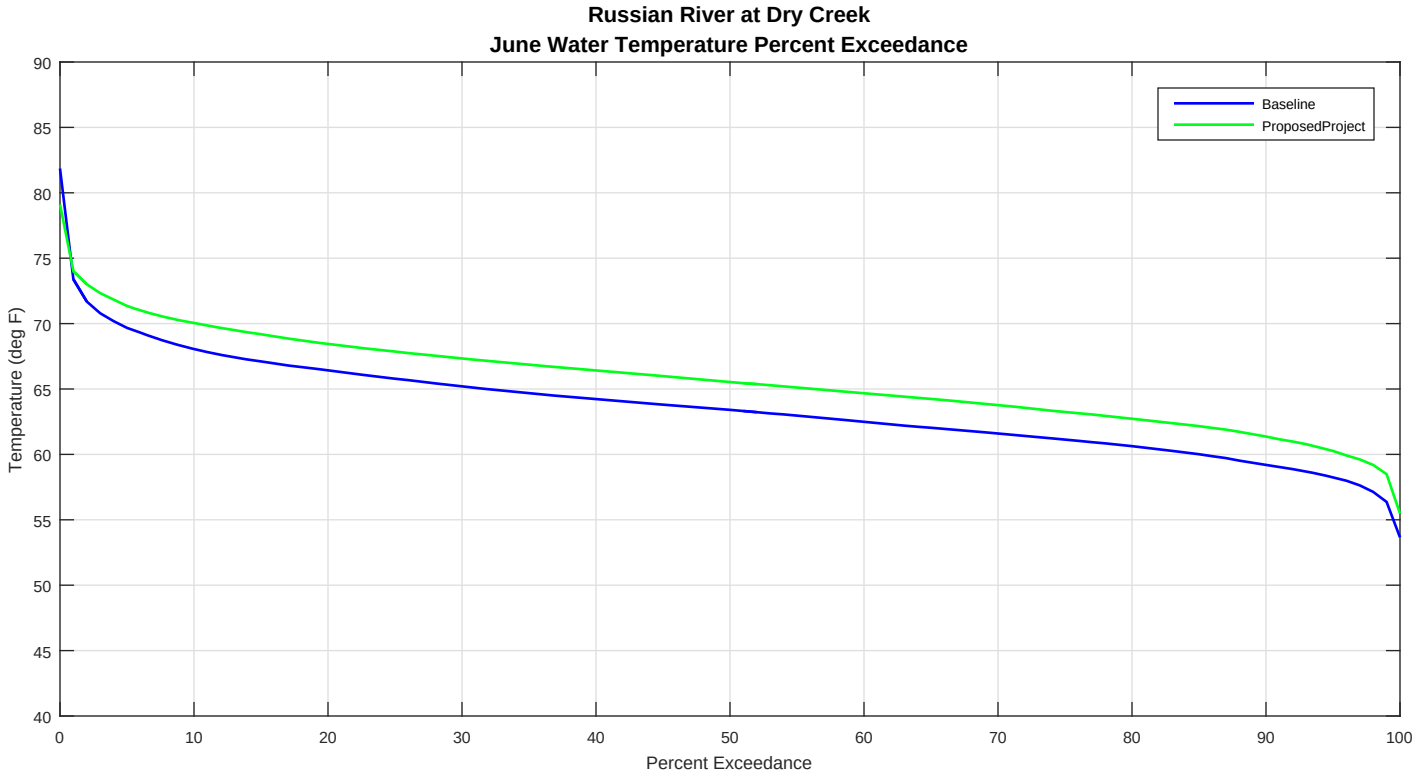
Russian River at Dry Creek
June Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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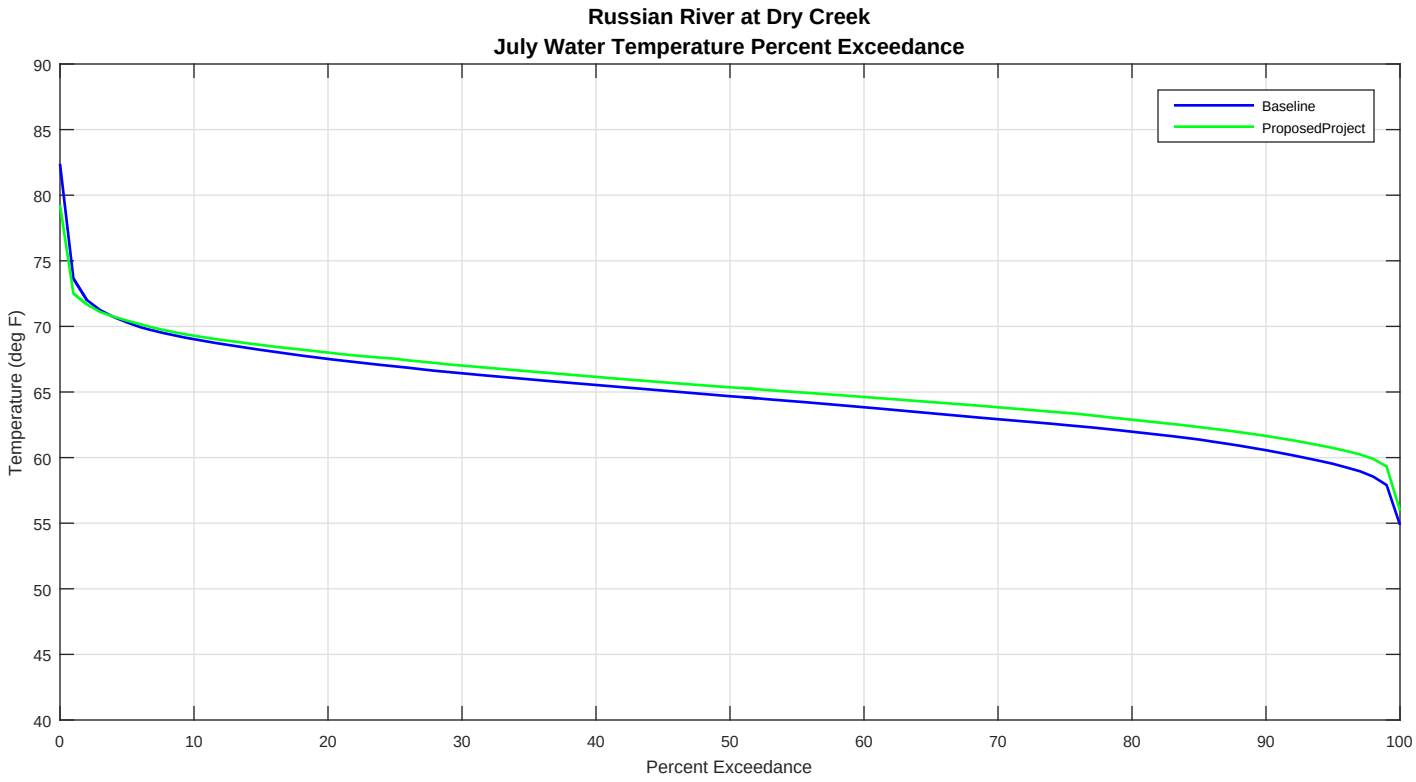
Russian River at Dry Creek
July Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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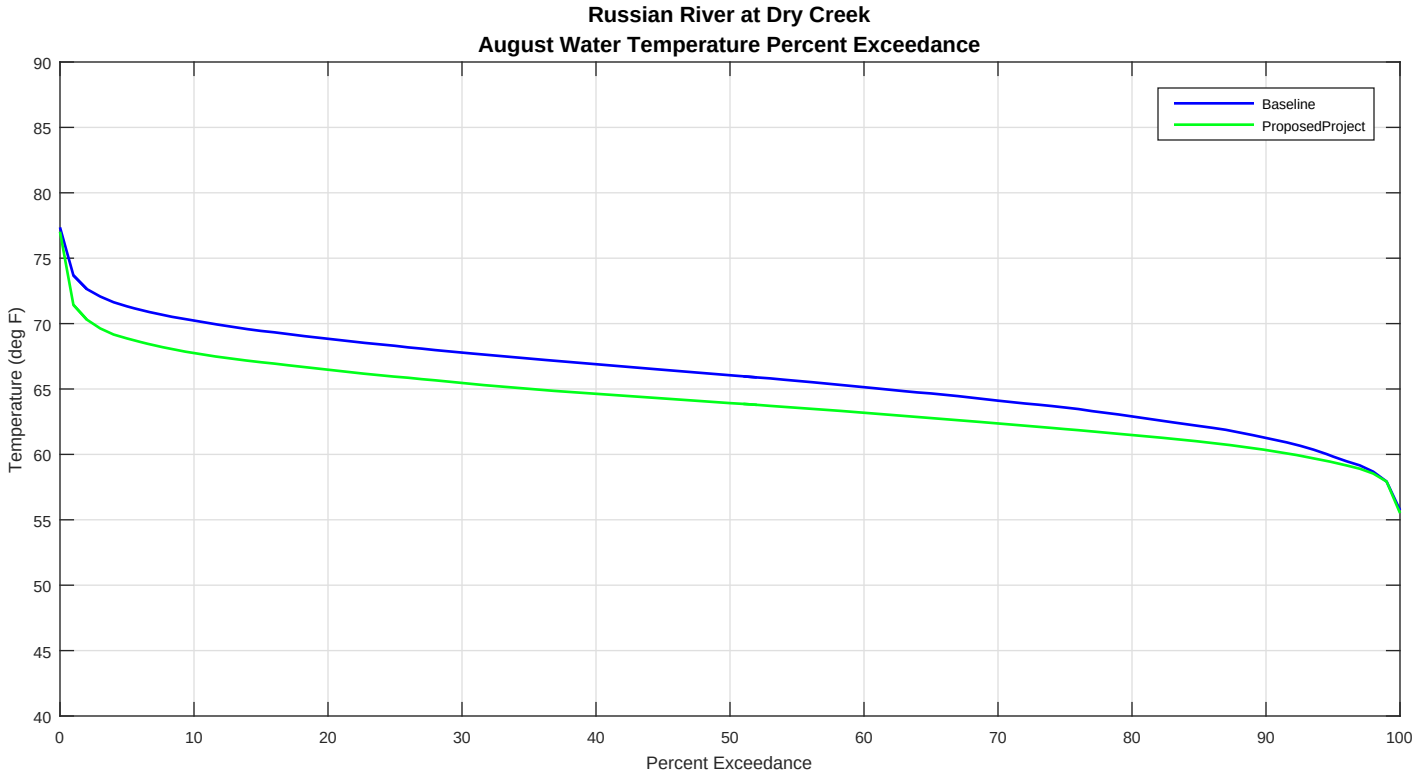
Russian River at Dry Creek
August Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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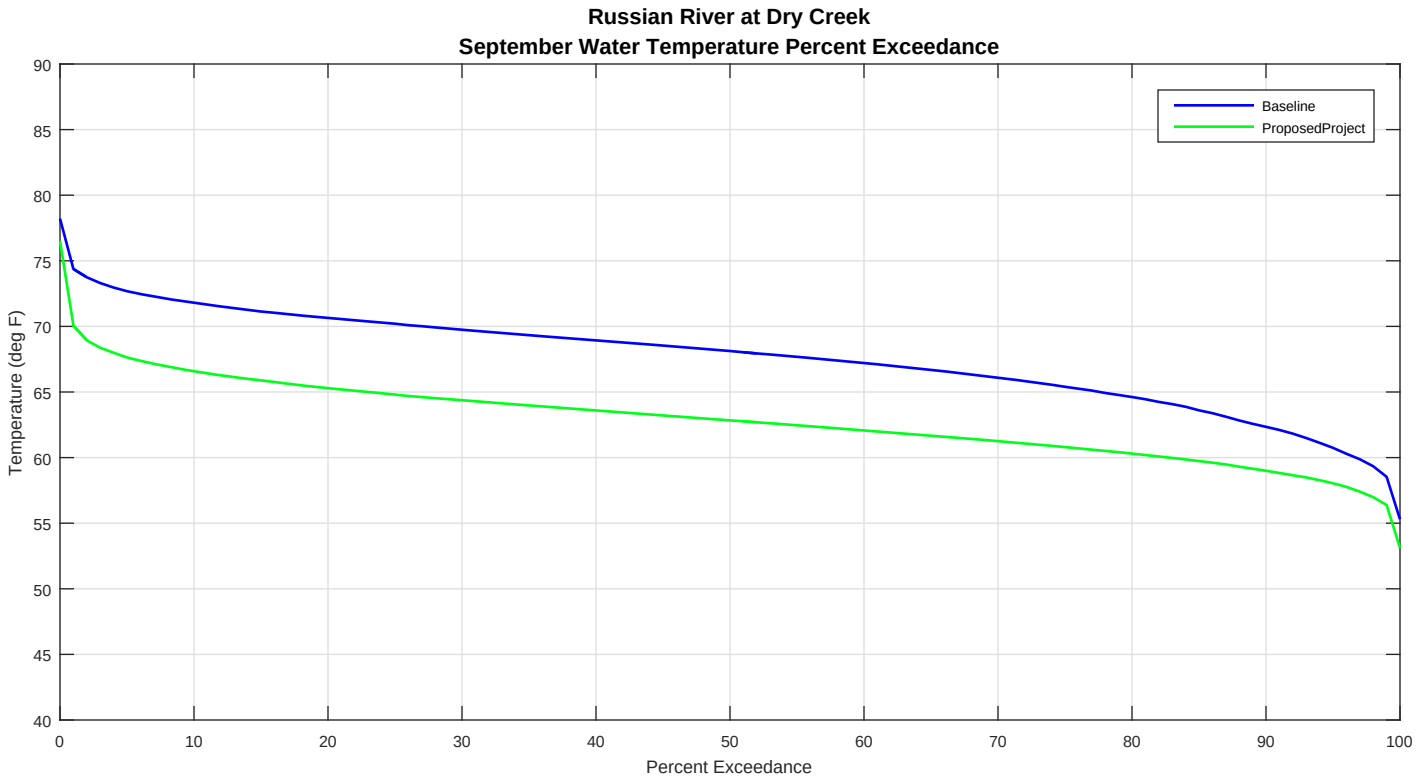
Russian River at Dry Creek
September Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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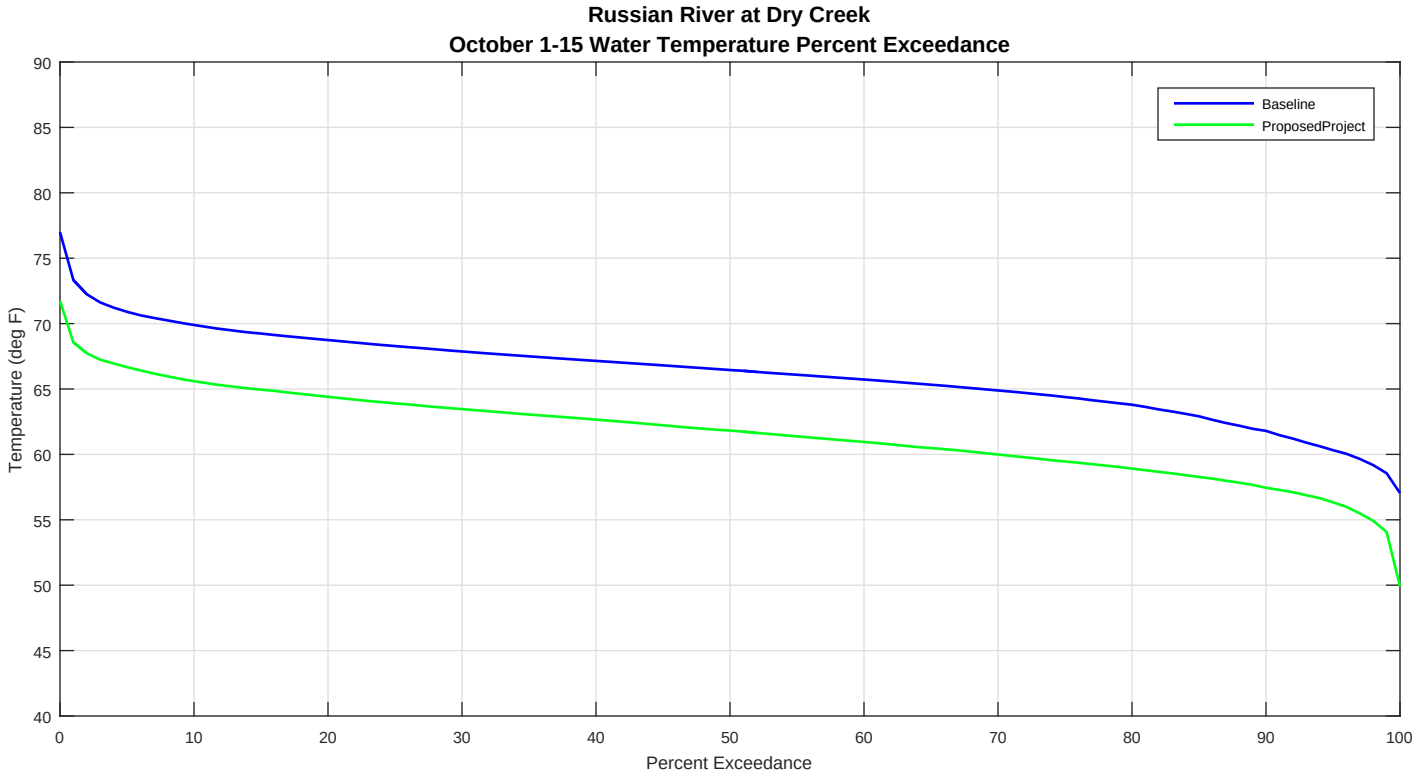
Russian River at Dry Creek
October 1-15 Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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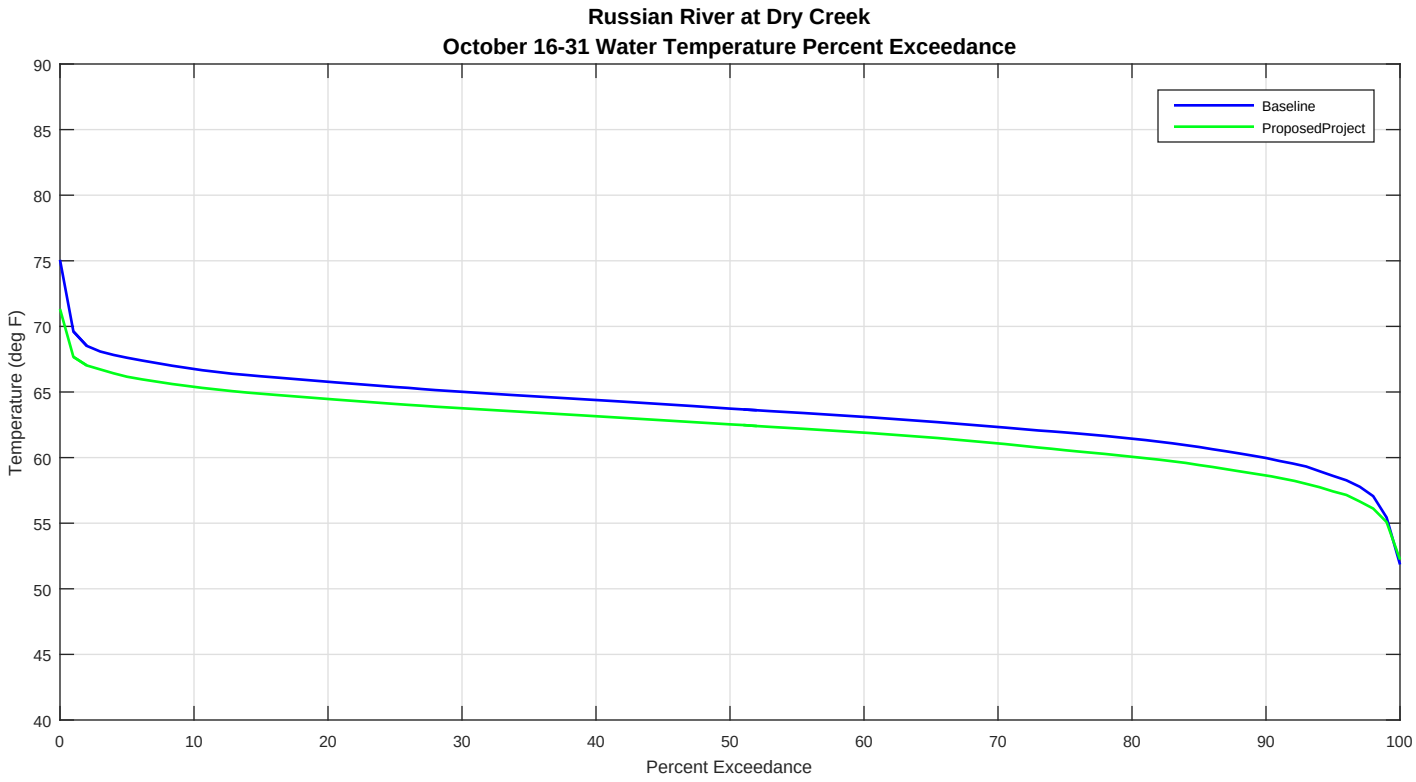
Russian River at Dry Creek
October 16-31 Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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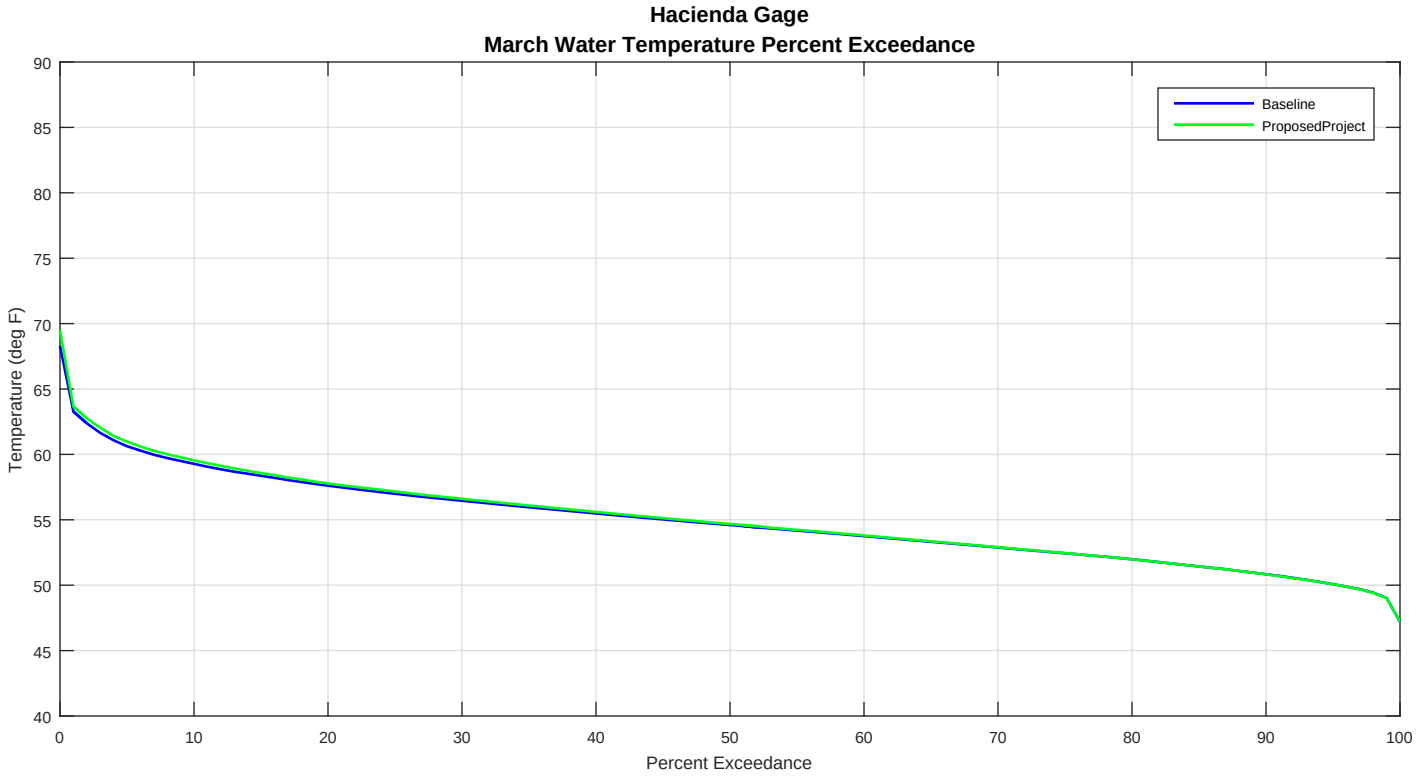
Hacienda Gage
March Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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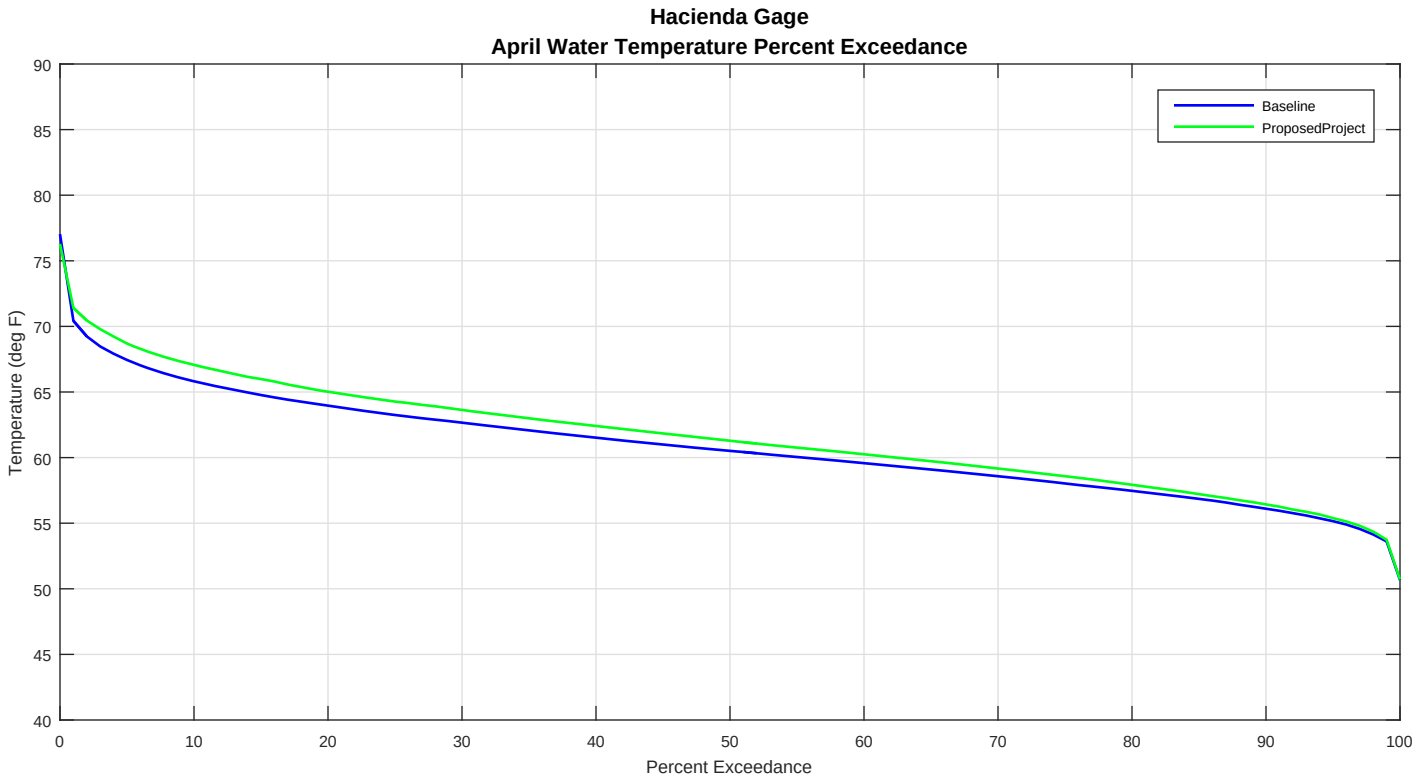
Hacienda Gage
April Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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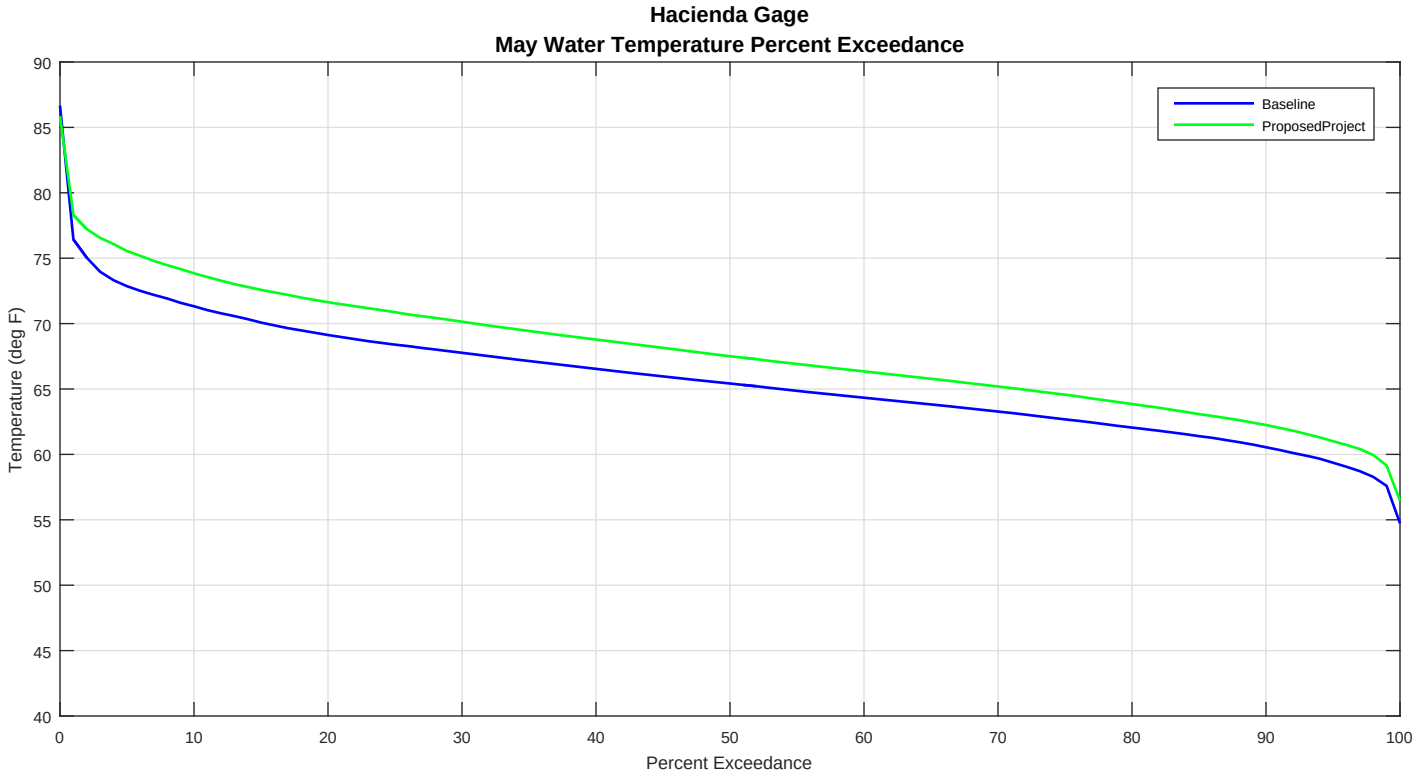
Hacienda Gage
May Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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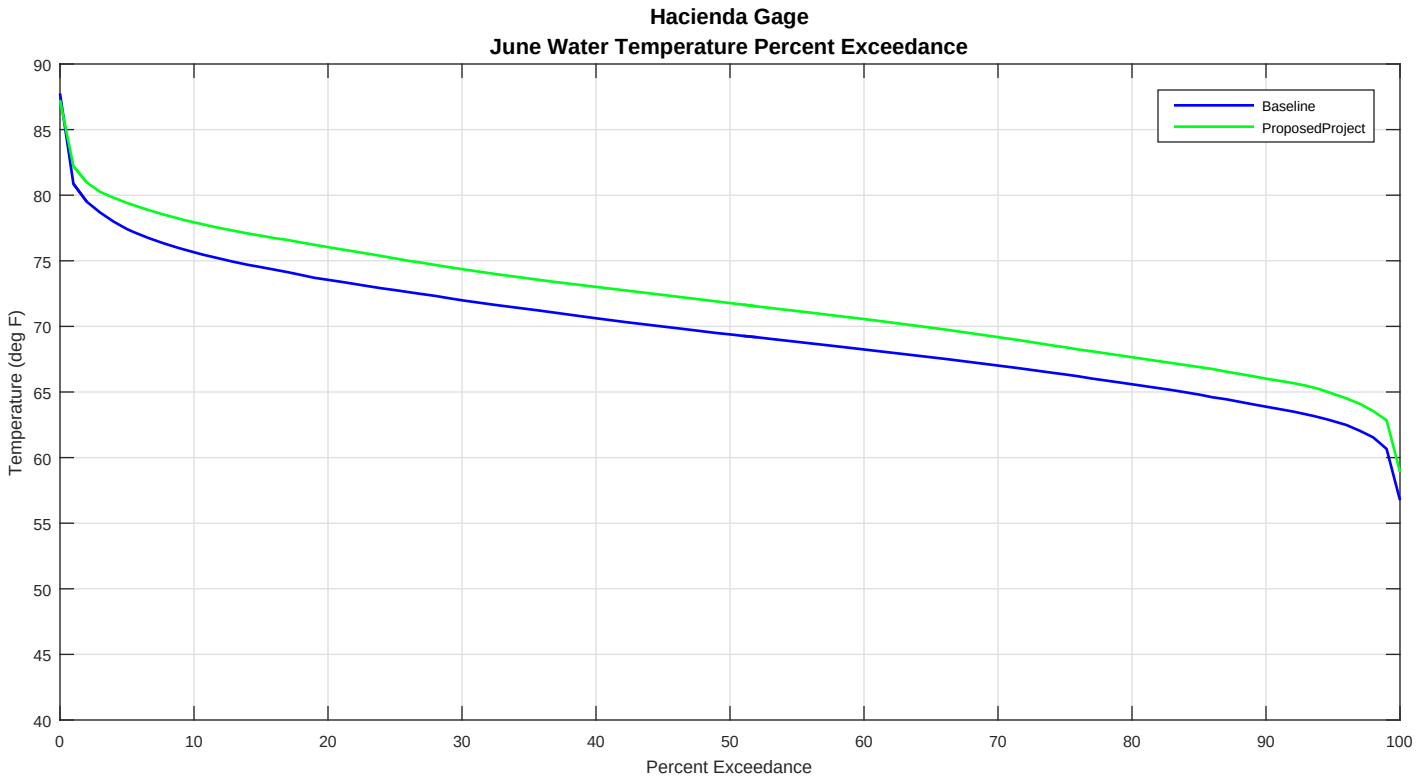
Hacienda Gage
June Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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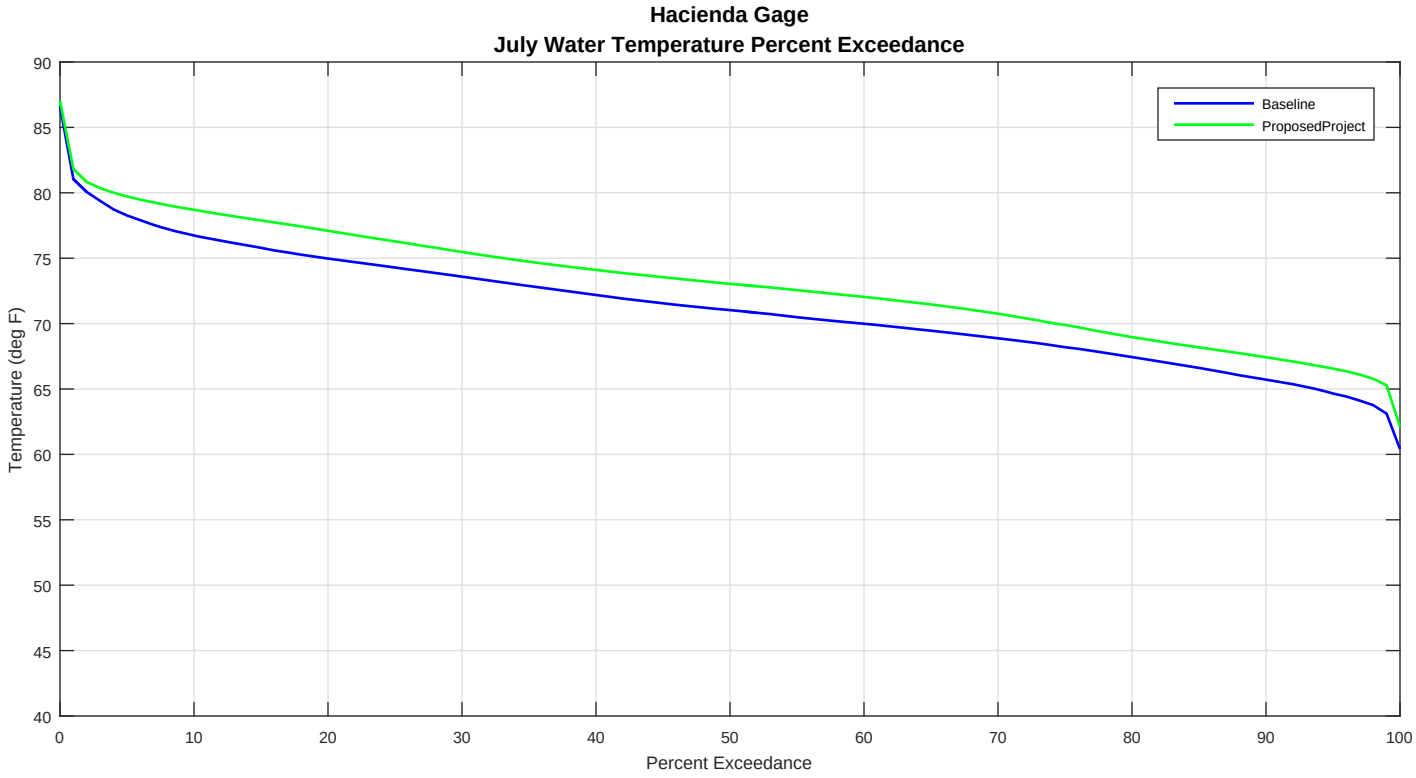
Hacienda Gage
July Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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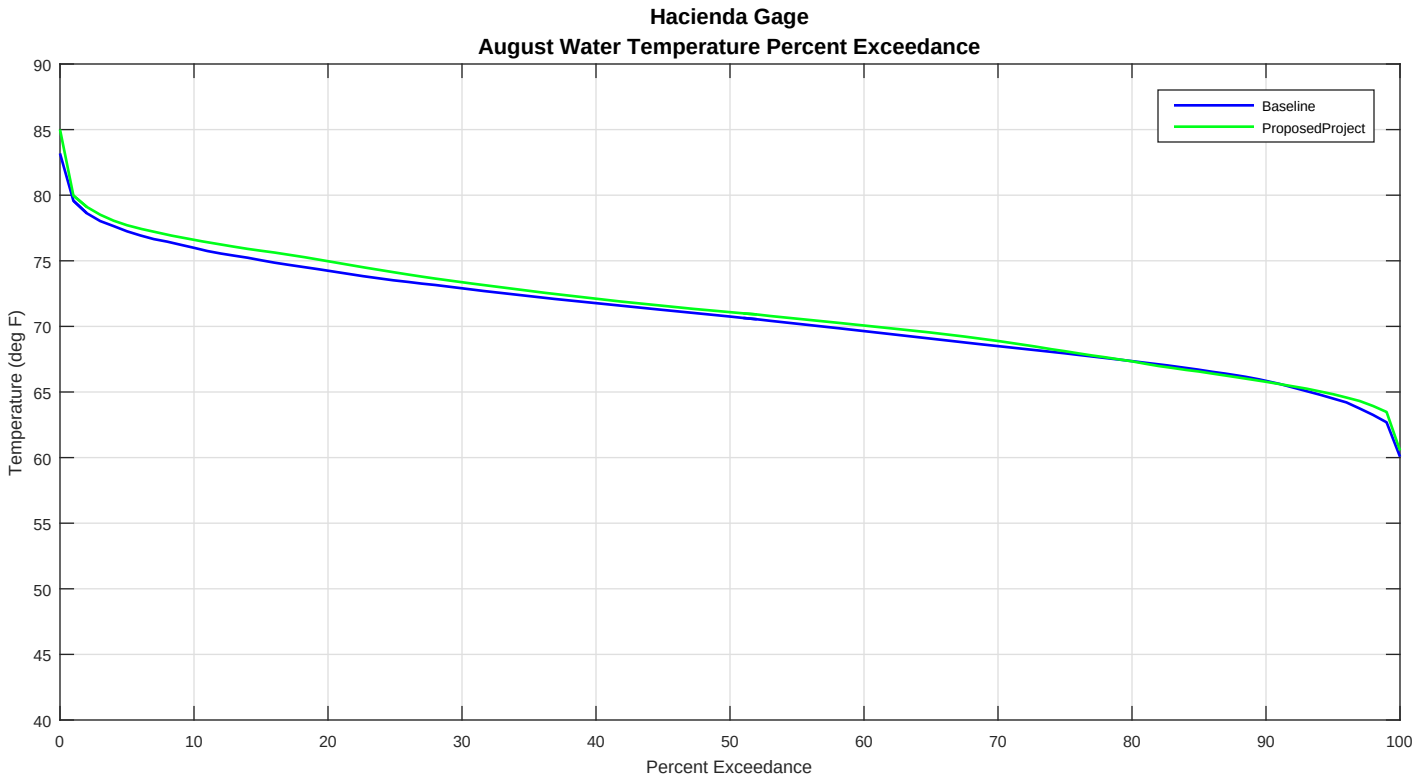
Hacienda Gage
August Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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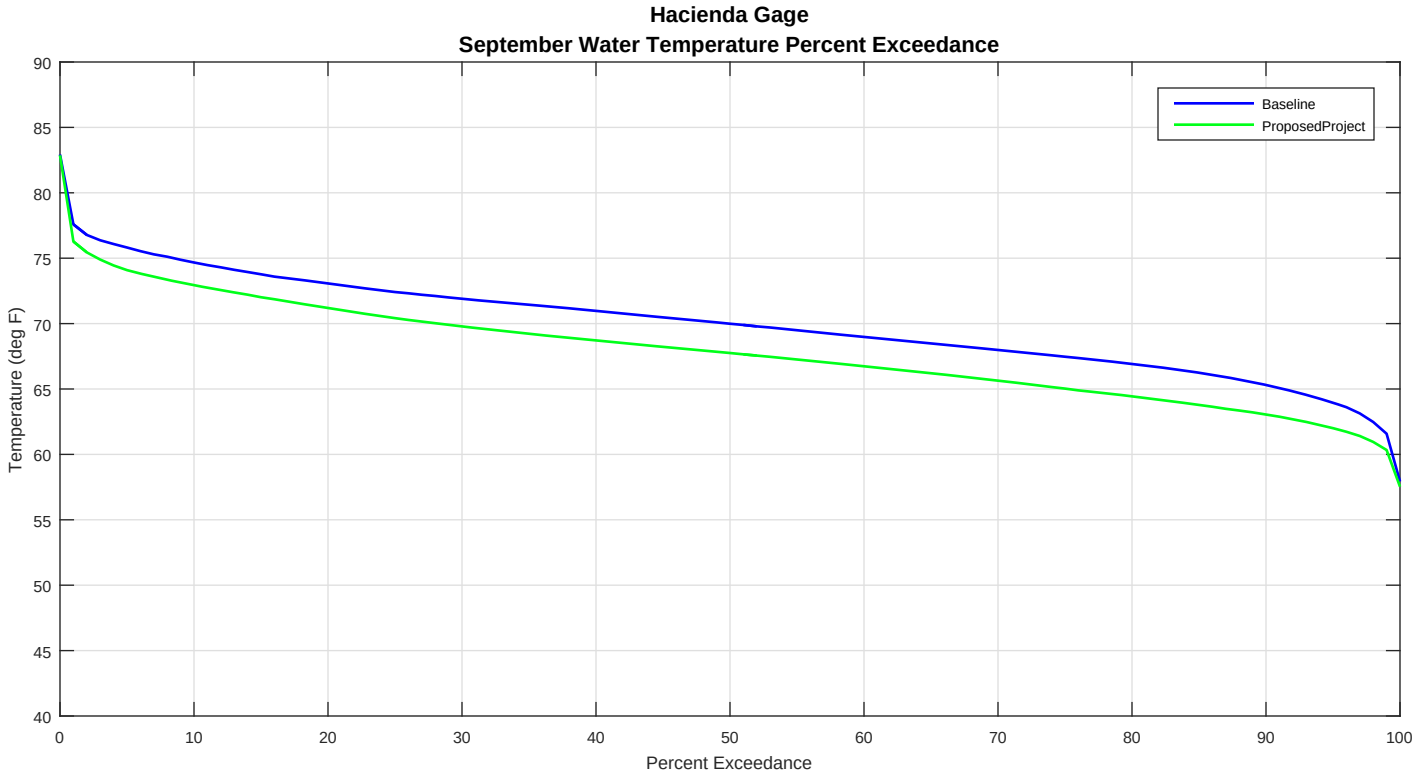
Hacienda Gage
September Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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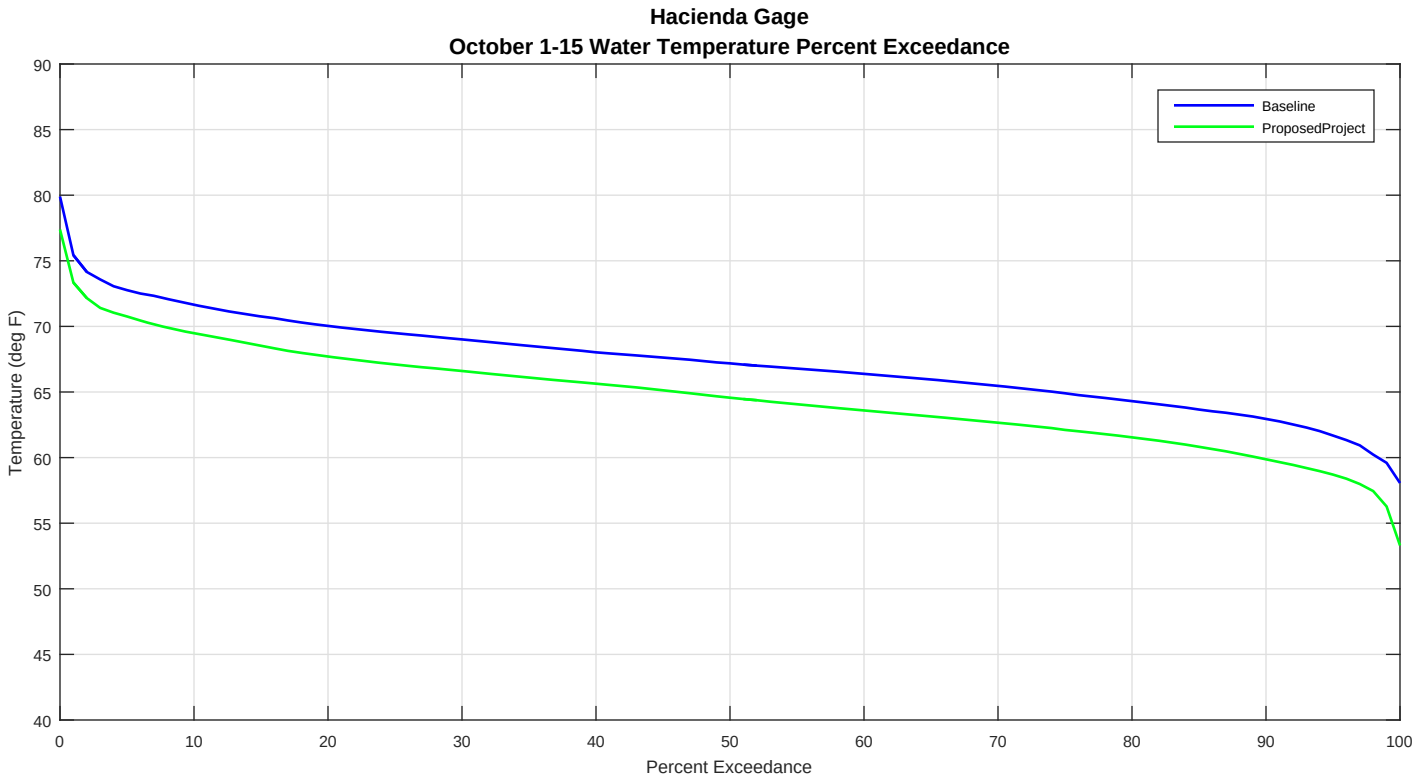
Hacienda Gage
October 1-15 Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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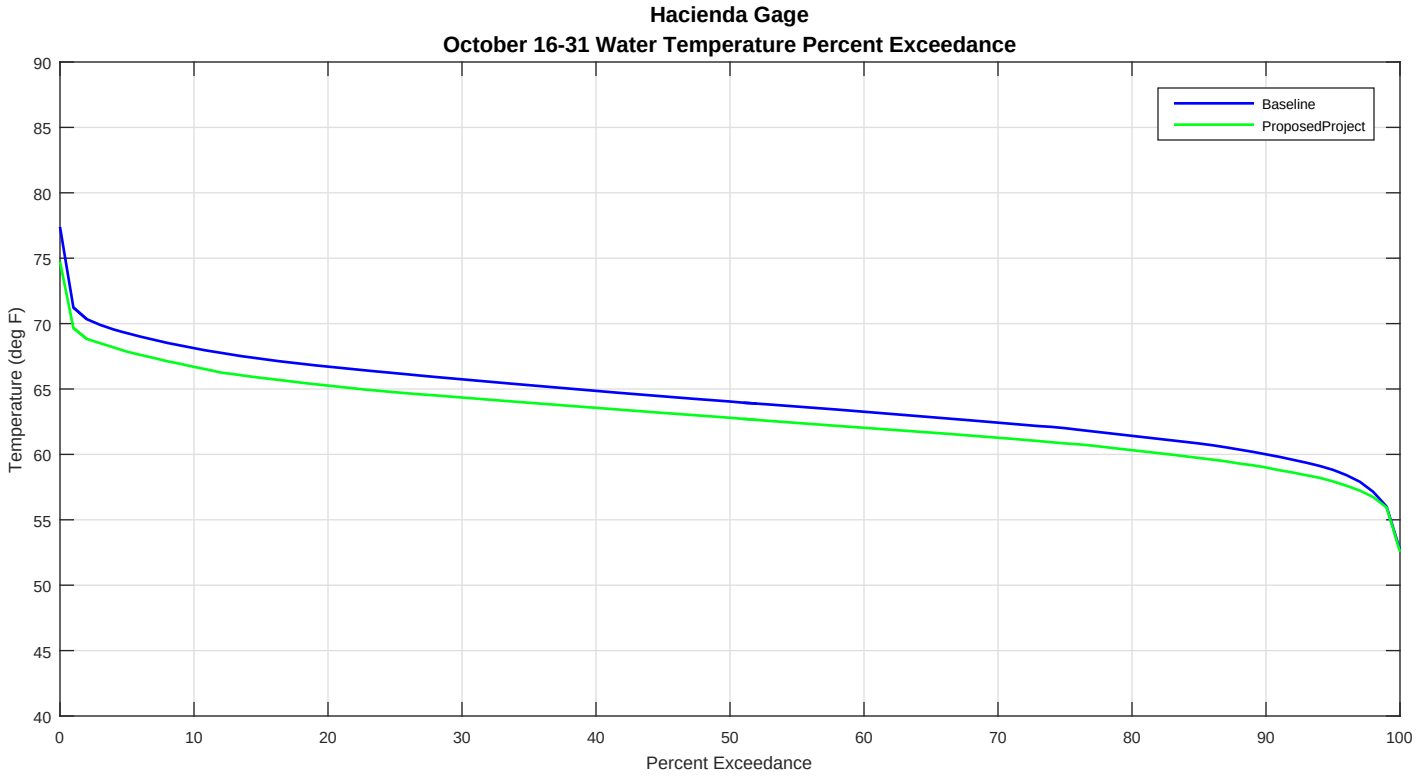
Hacienda Gage
October 16-31 Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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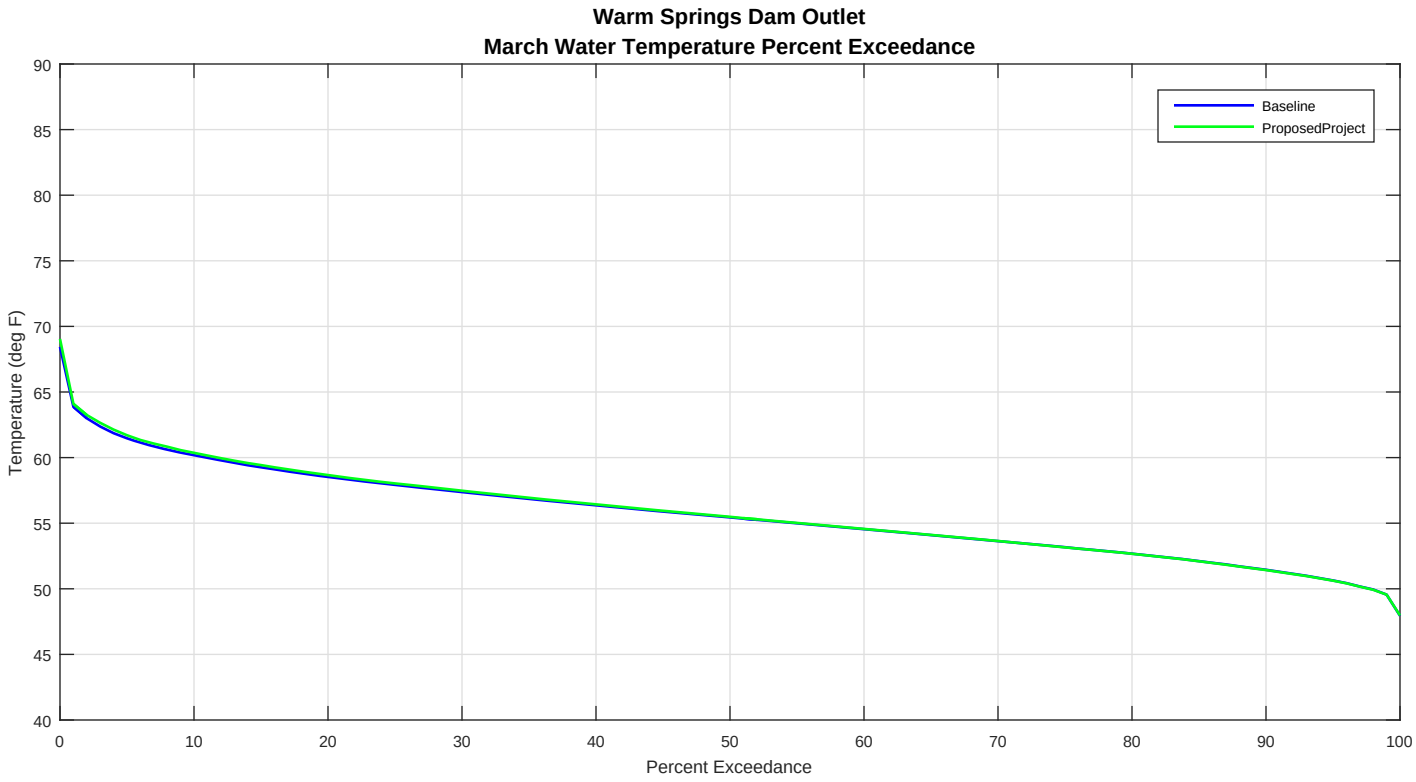
Warm Springs Dam Outlet
March Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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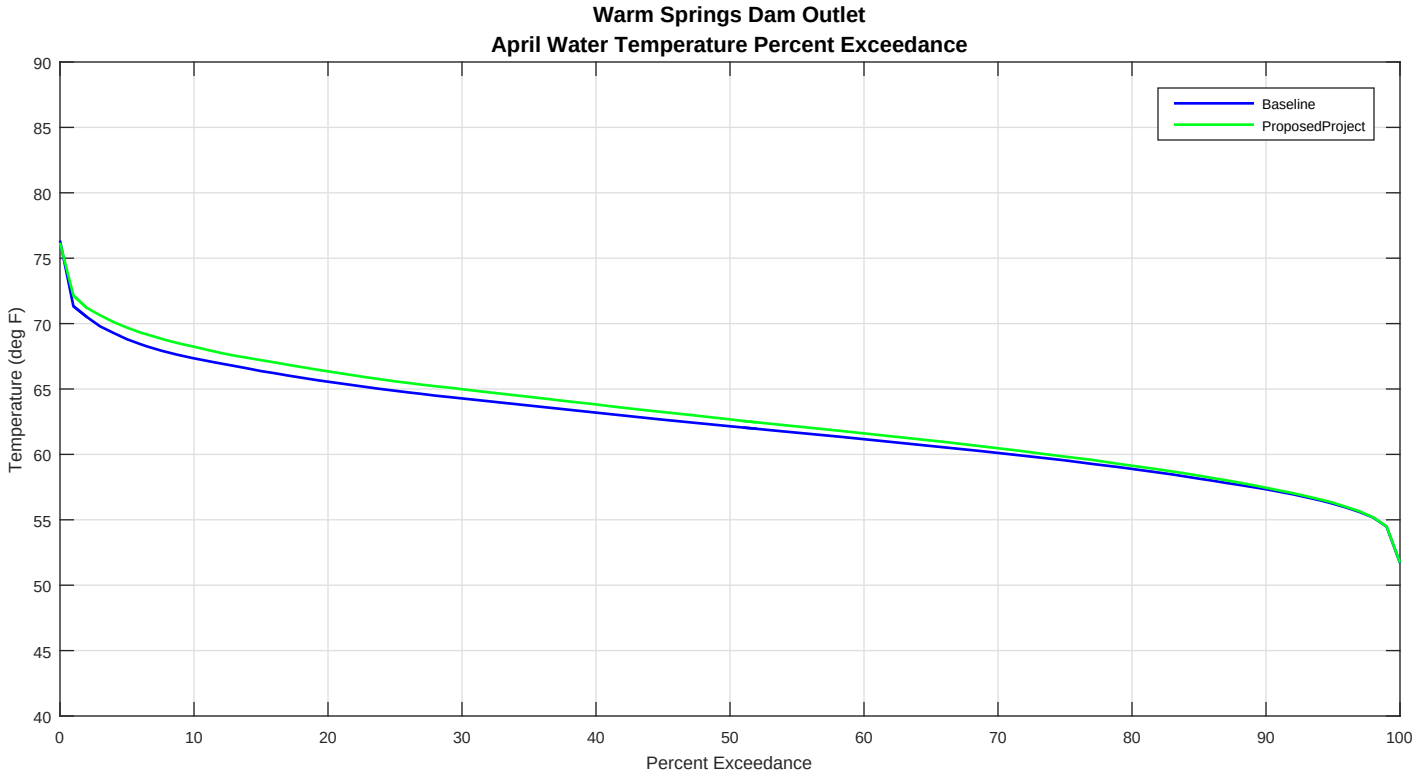
Warm Springs Dam Outlet
April Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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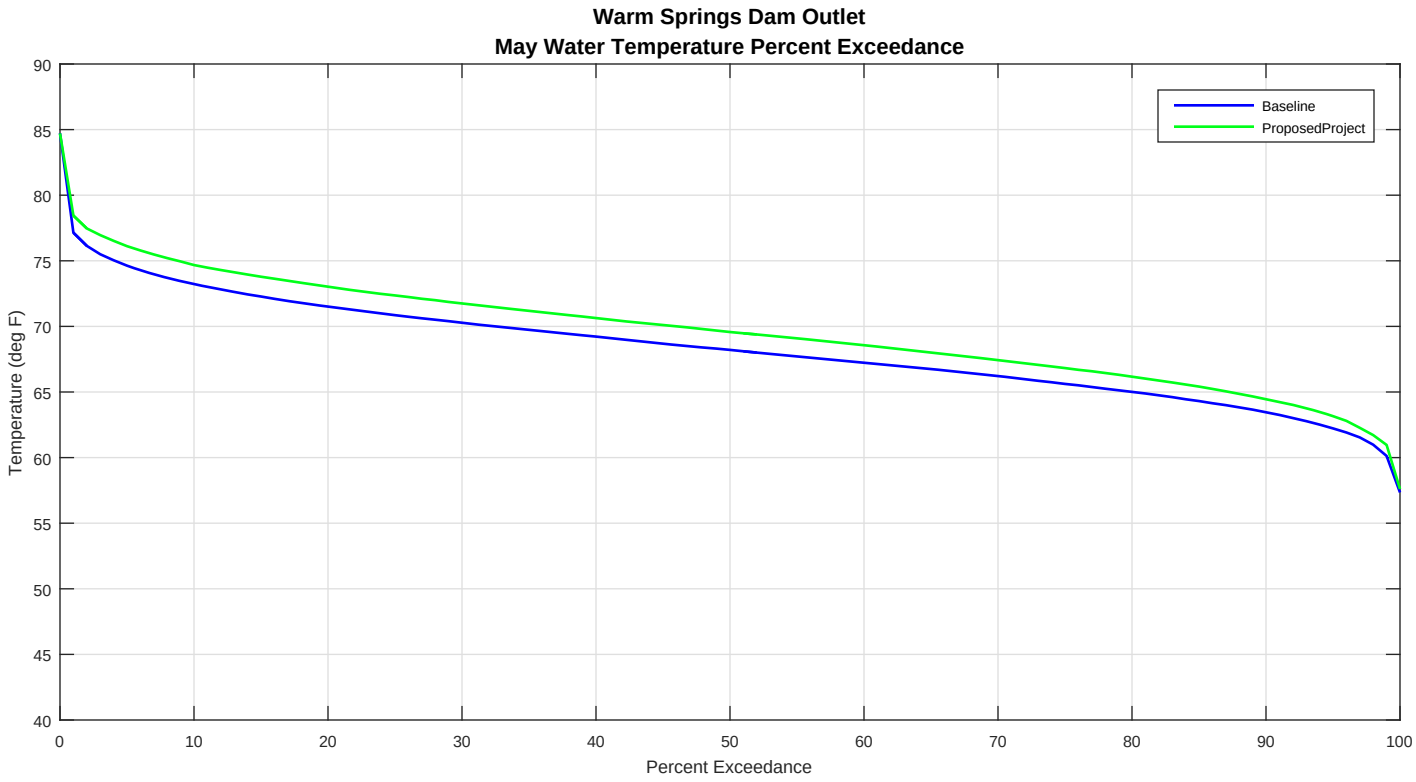
Warm Springs Dam Outlet
May Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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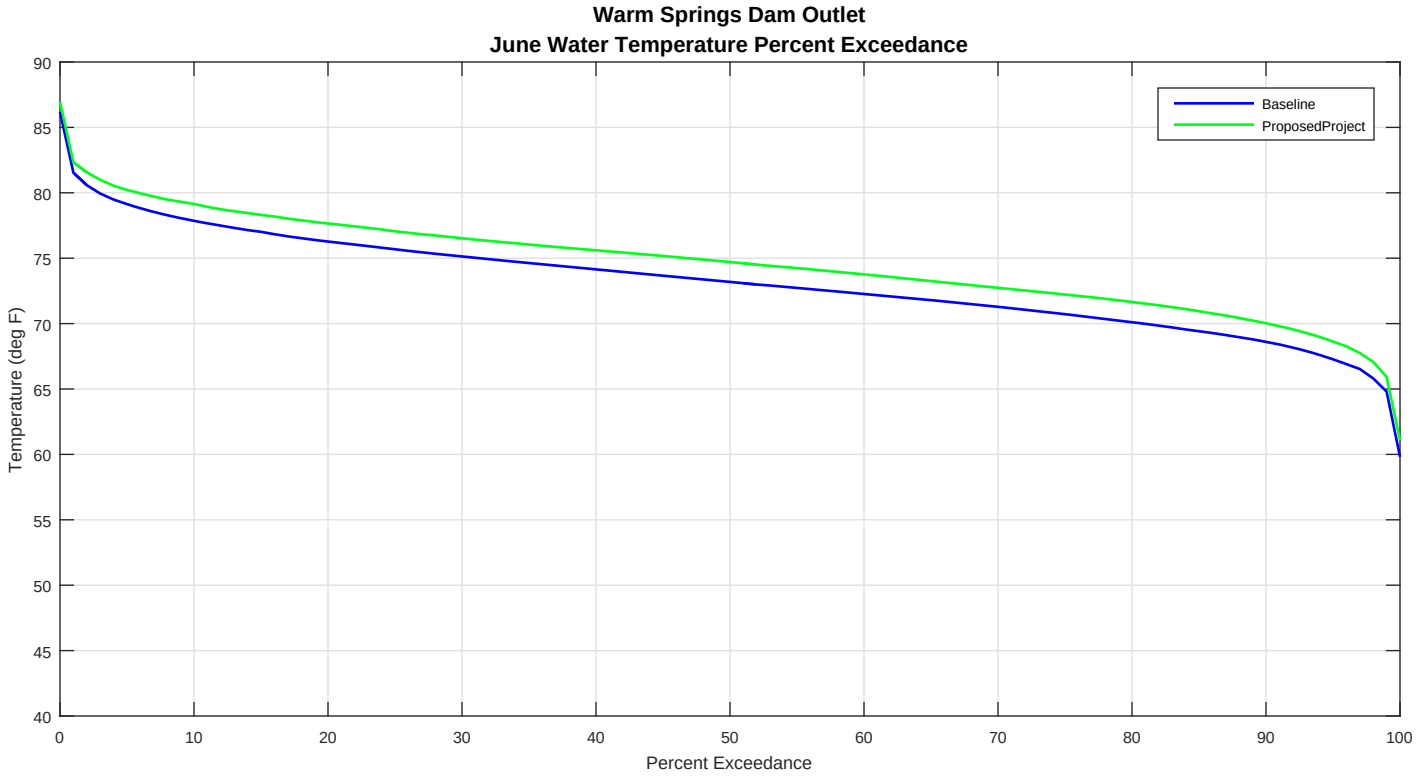
Warm Springs Dam Outlet
June Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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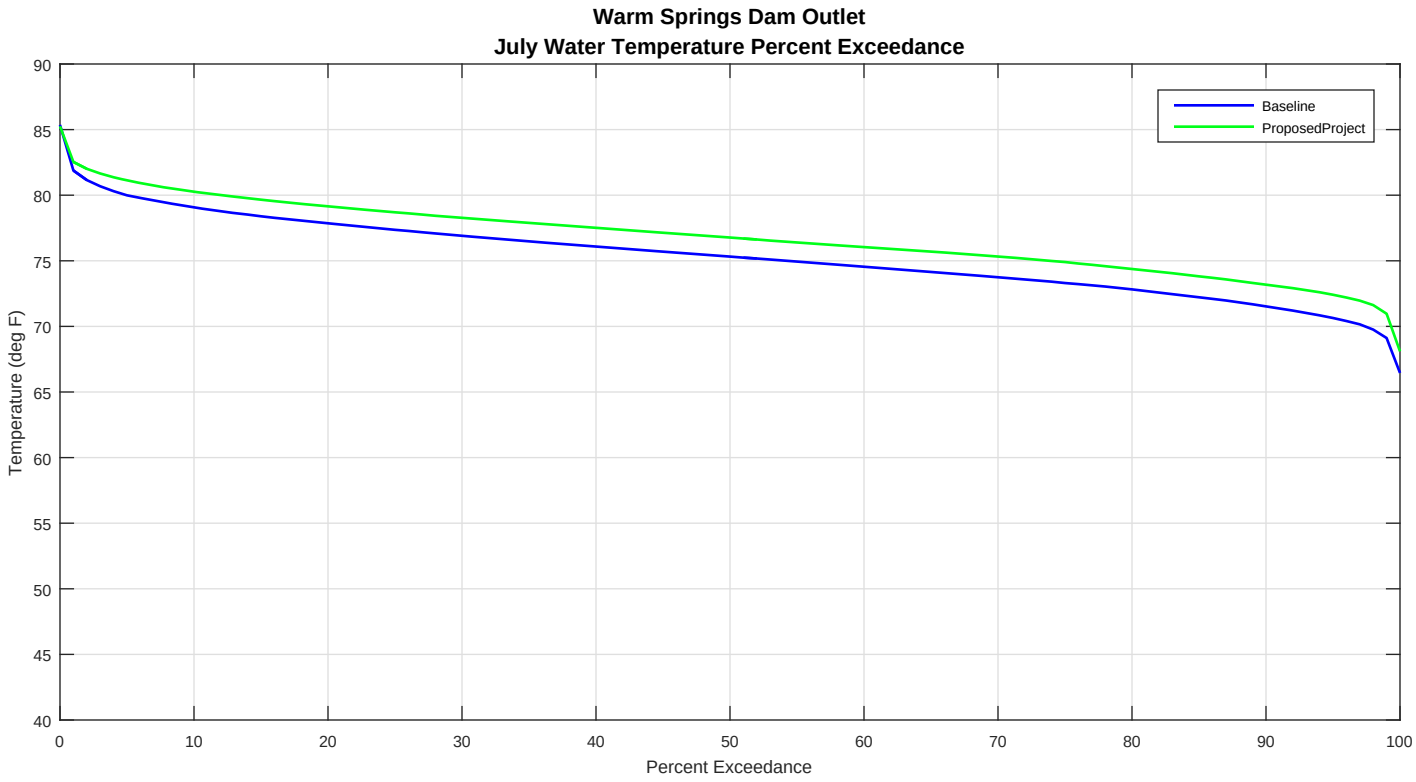
Warm Springs Dam Outlet
July Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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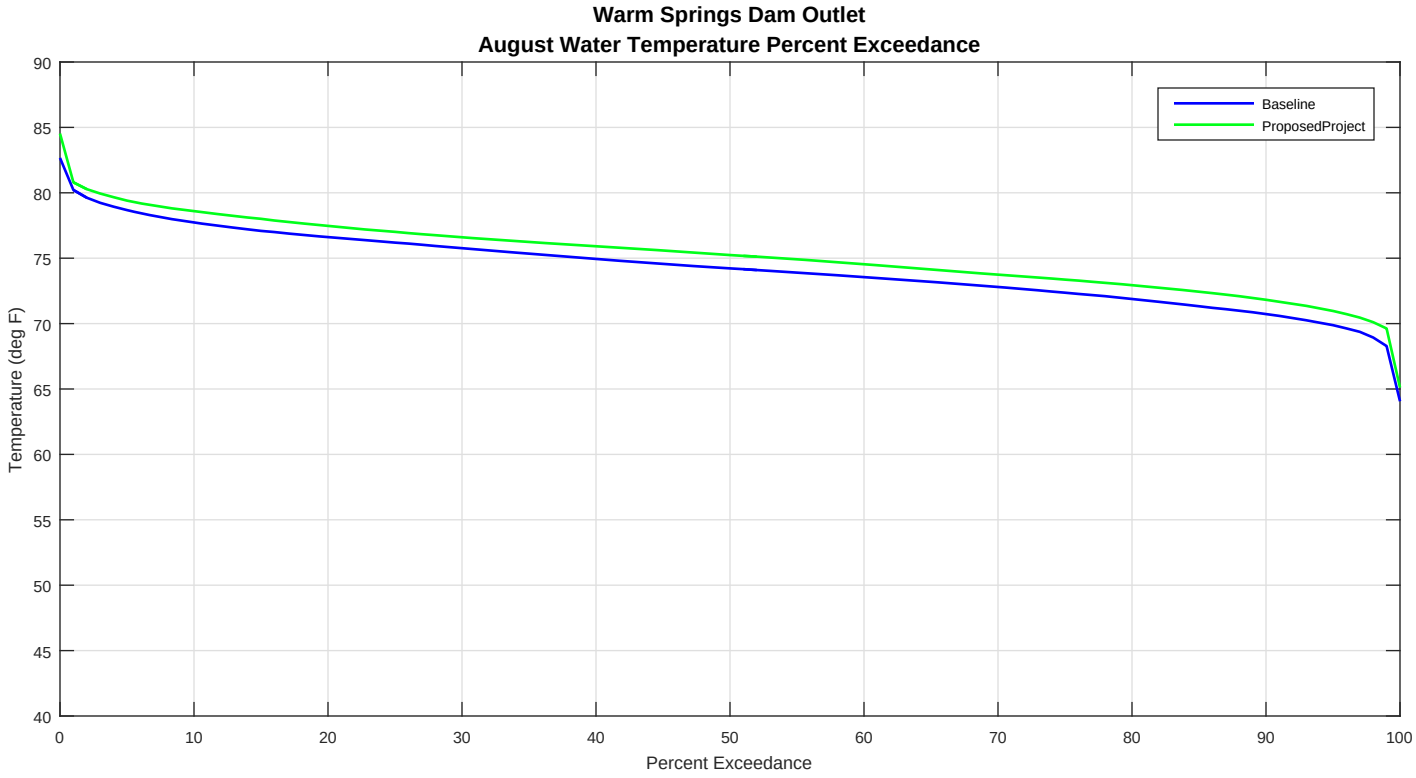
Warm Springs Dam Outlet
August Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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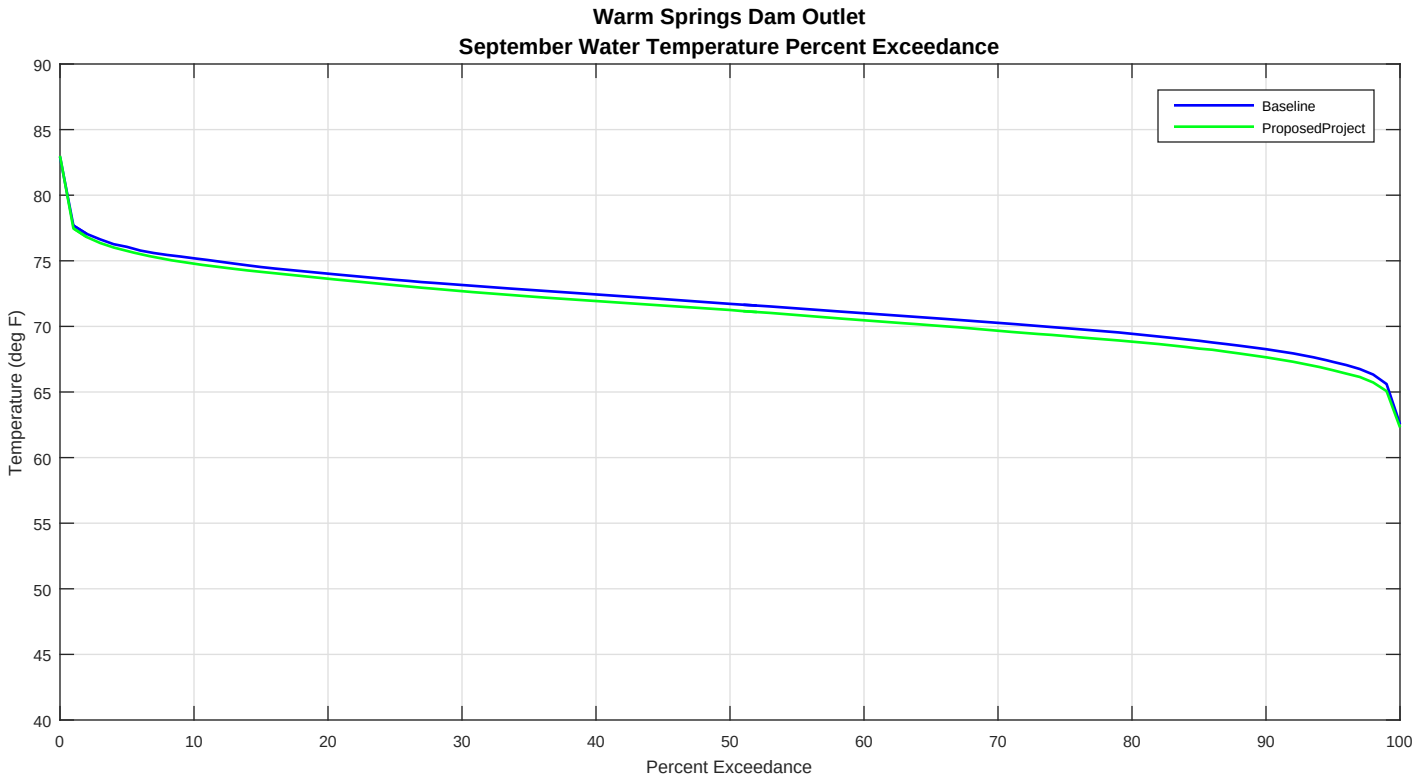
Warm Springs Dam Outlet
September Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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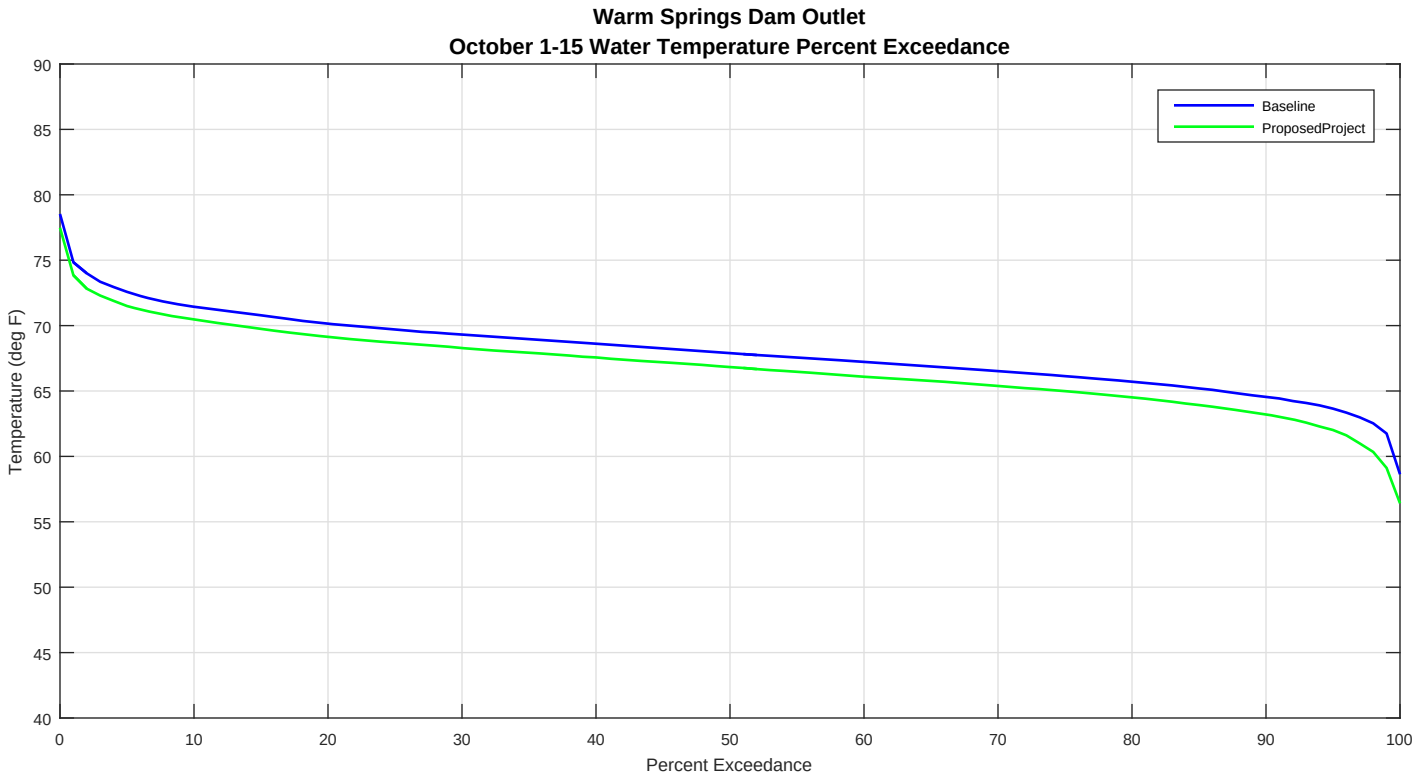
Warm Springs Dam Outlet
October 1-15 Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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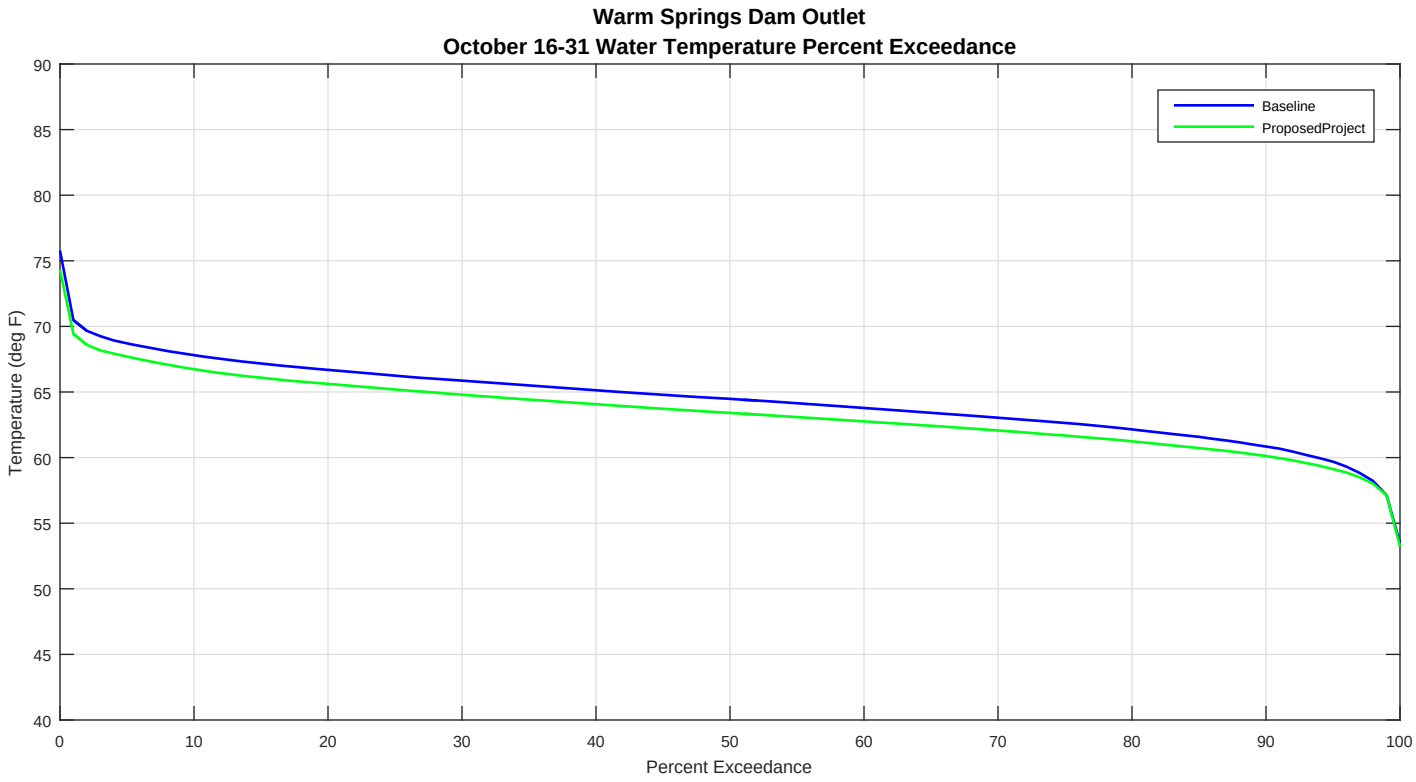
Warm Springs Dam Outlet
October 16-31 Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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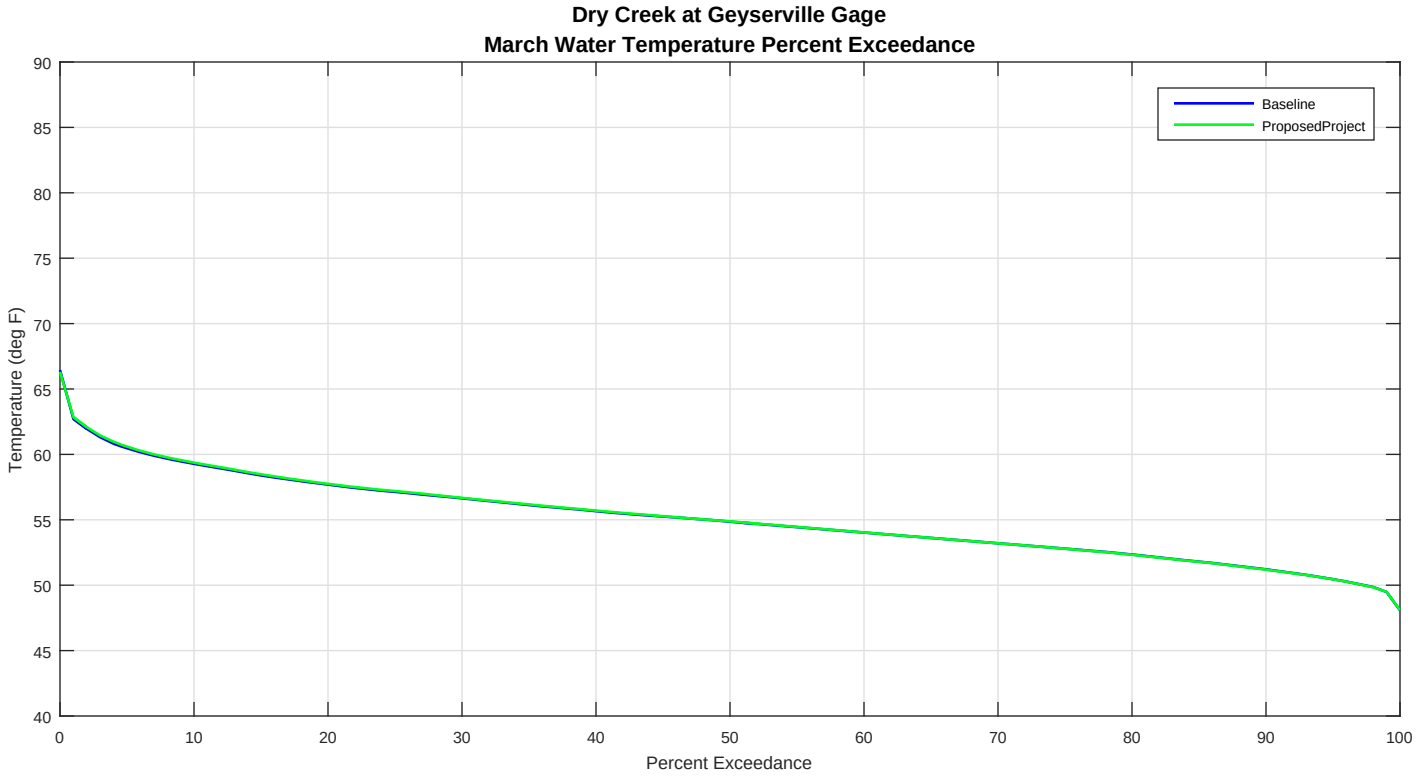
Dry Creek at Geyserville Gage
March Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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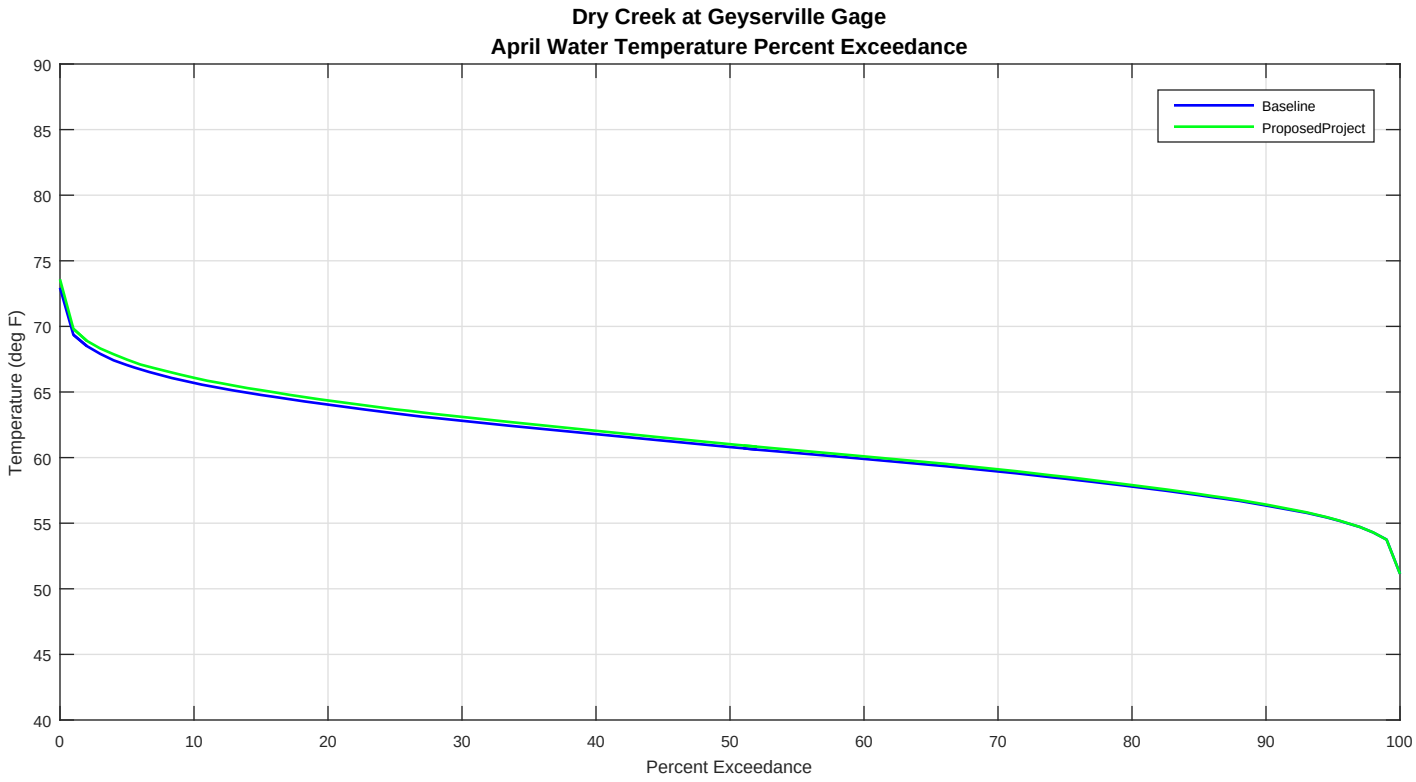
Dry Creek at Geyserville Gage
April Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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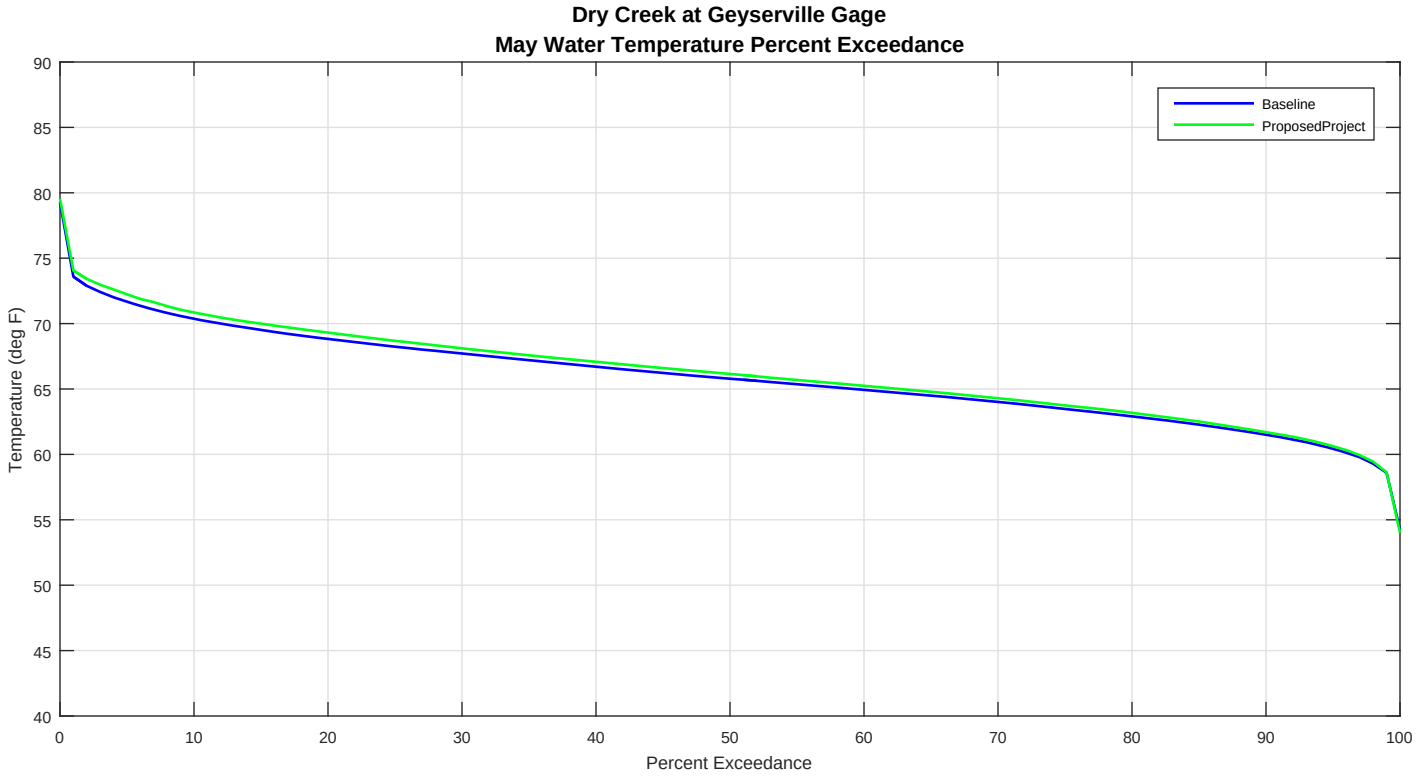
Dry Creek at Geyserville Gage
May Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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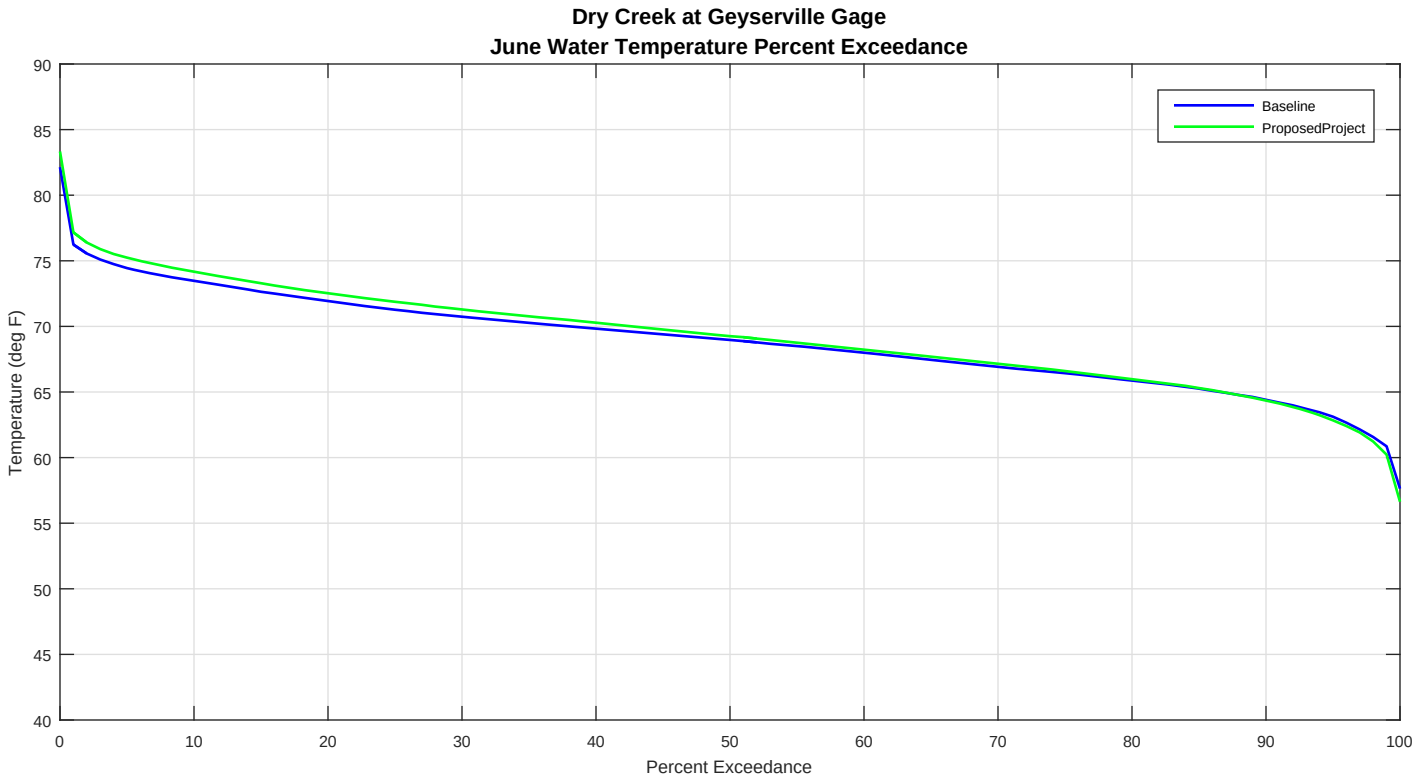
Dry Creek at Geyserville Gage
June Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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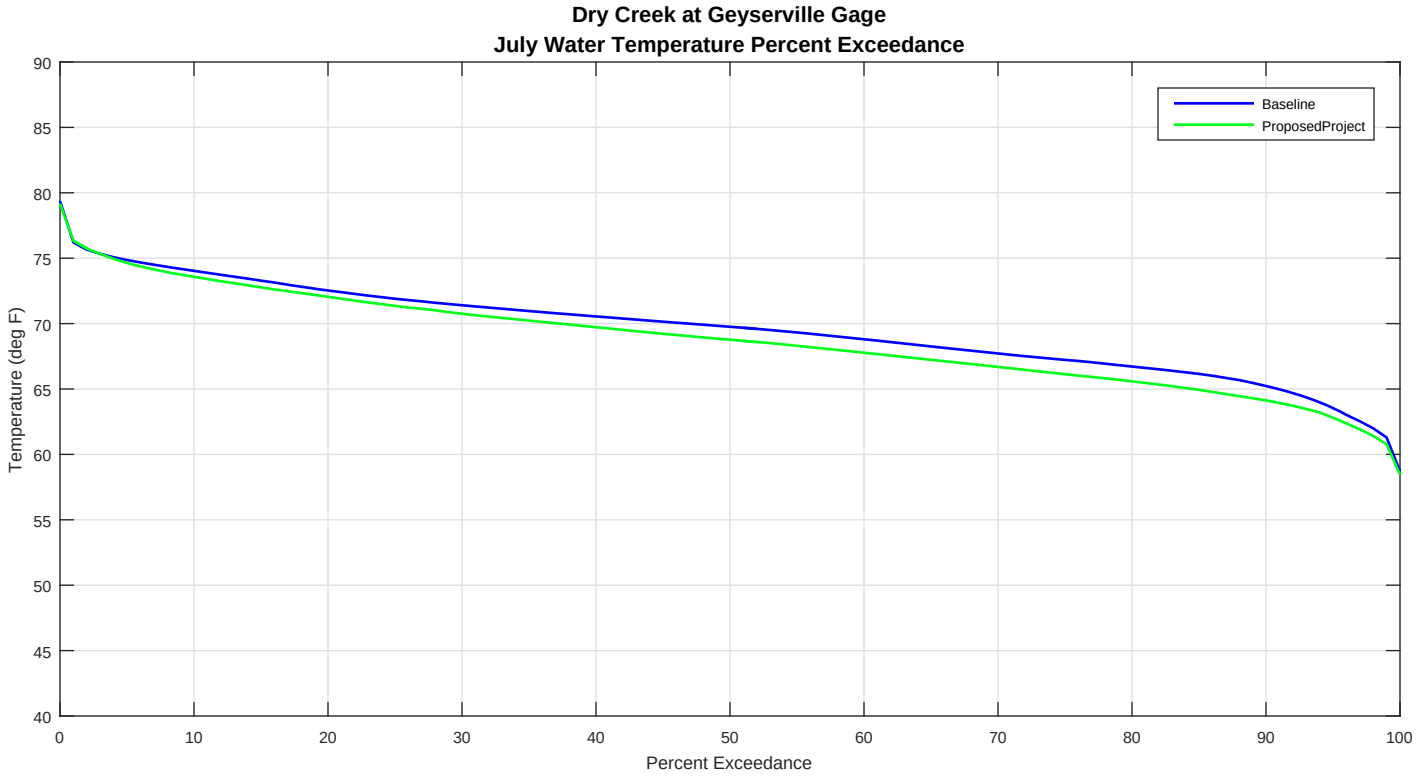
Dry Creek at Geyserville Gage
July Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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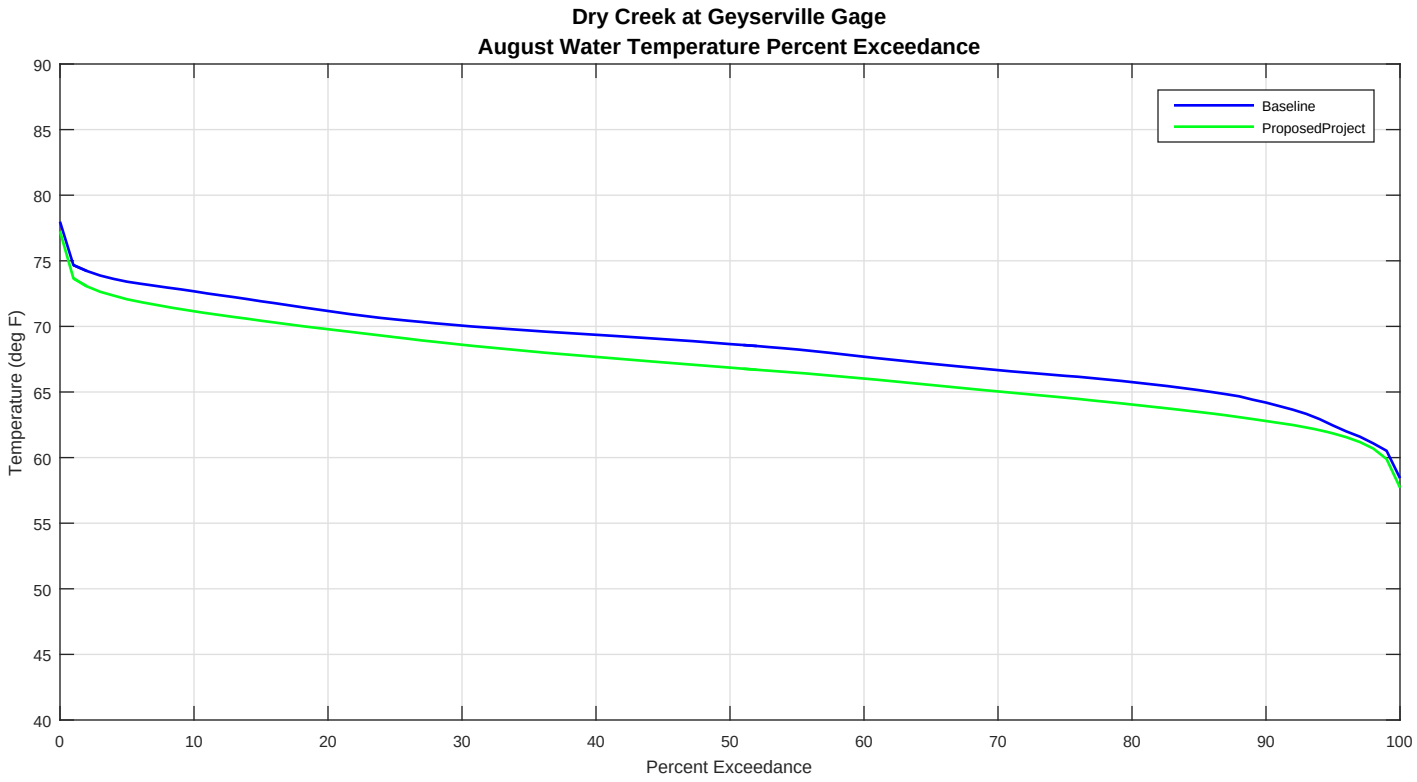
Dry Creek at Geyserville Gage
August Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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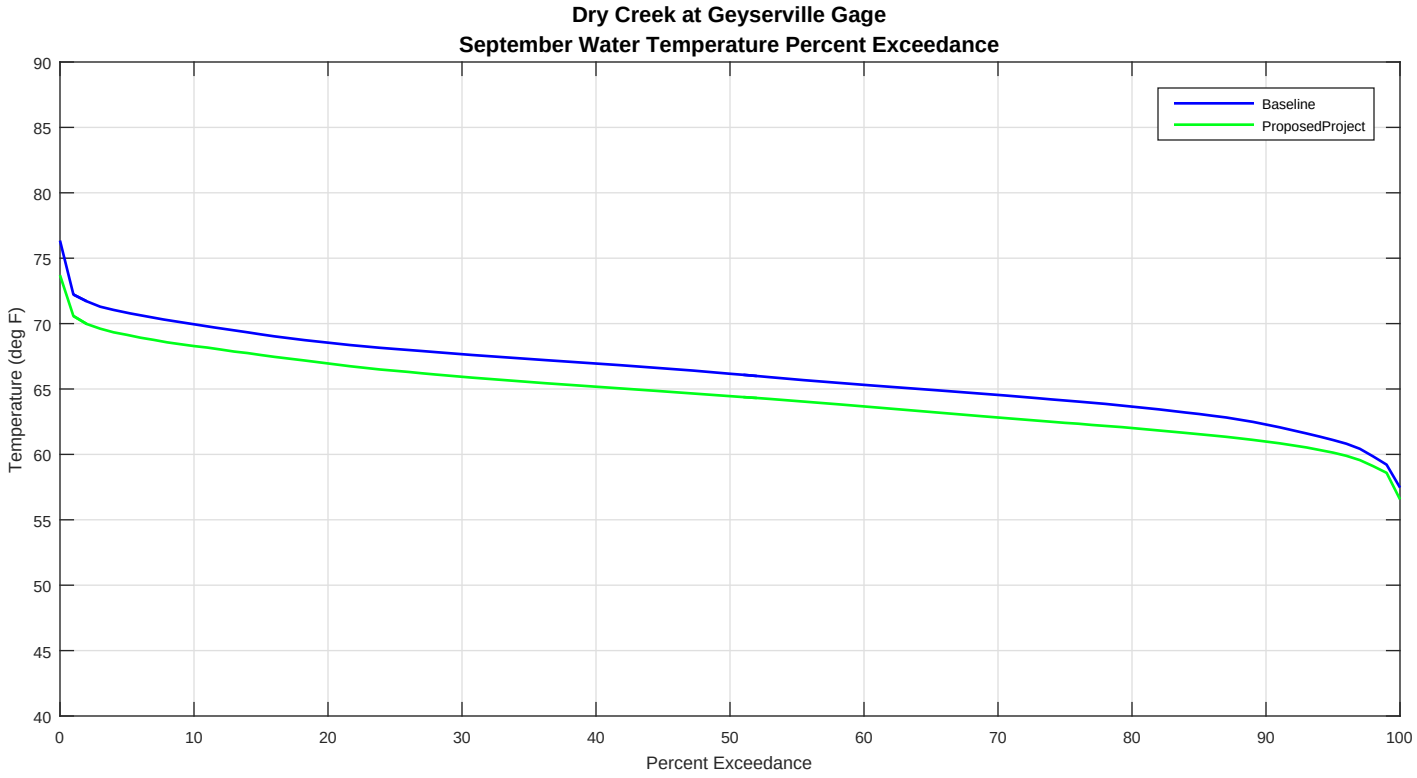
Dry Creek at Geyserville Gage
September Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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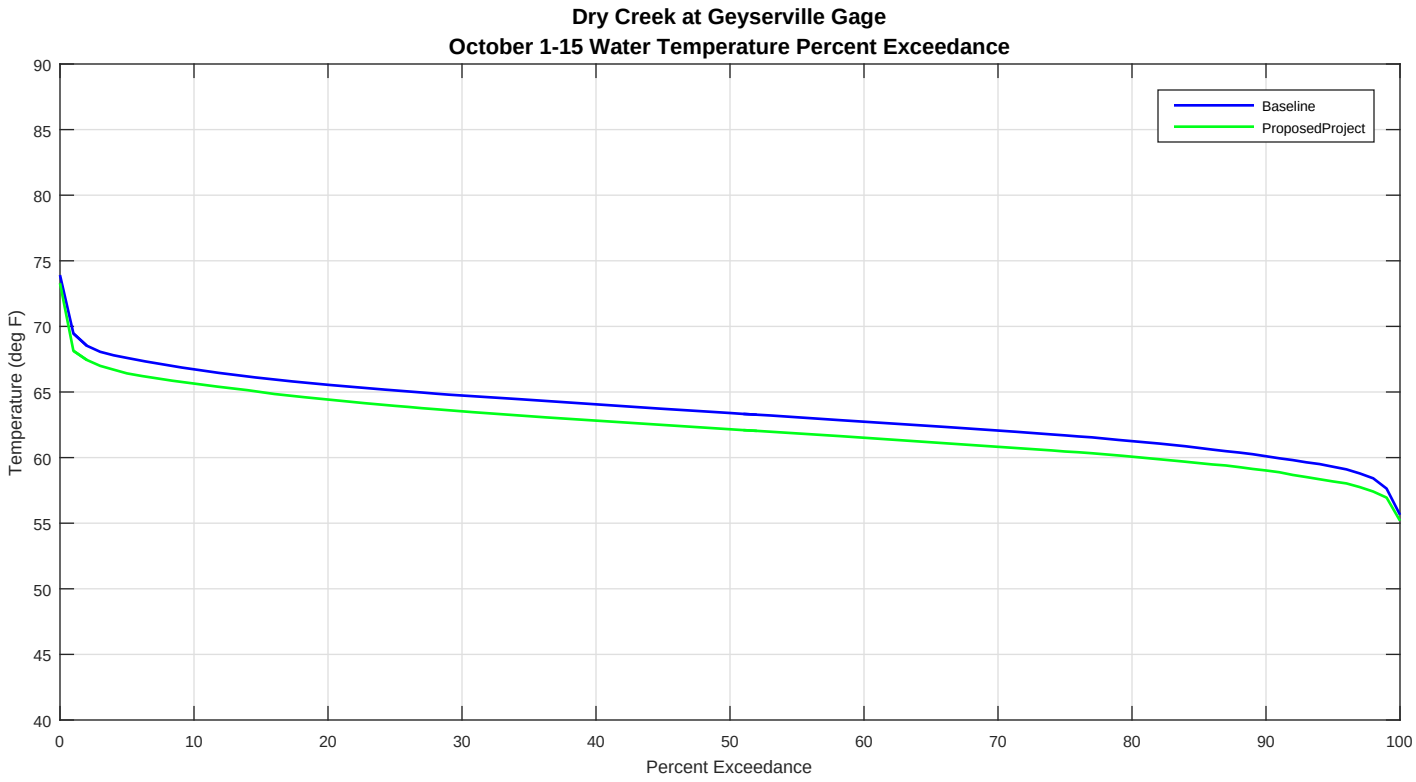
Dry Creek at Geyserville Gage
October 1-15 Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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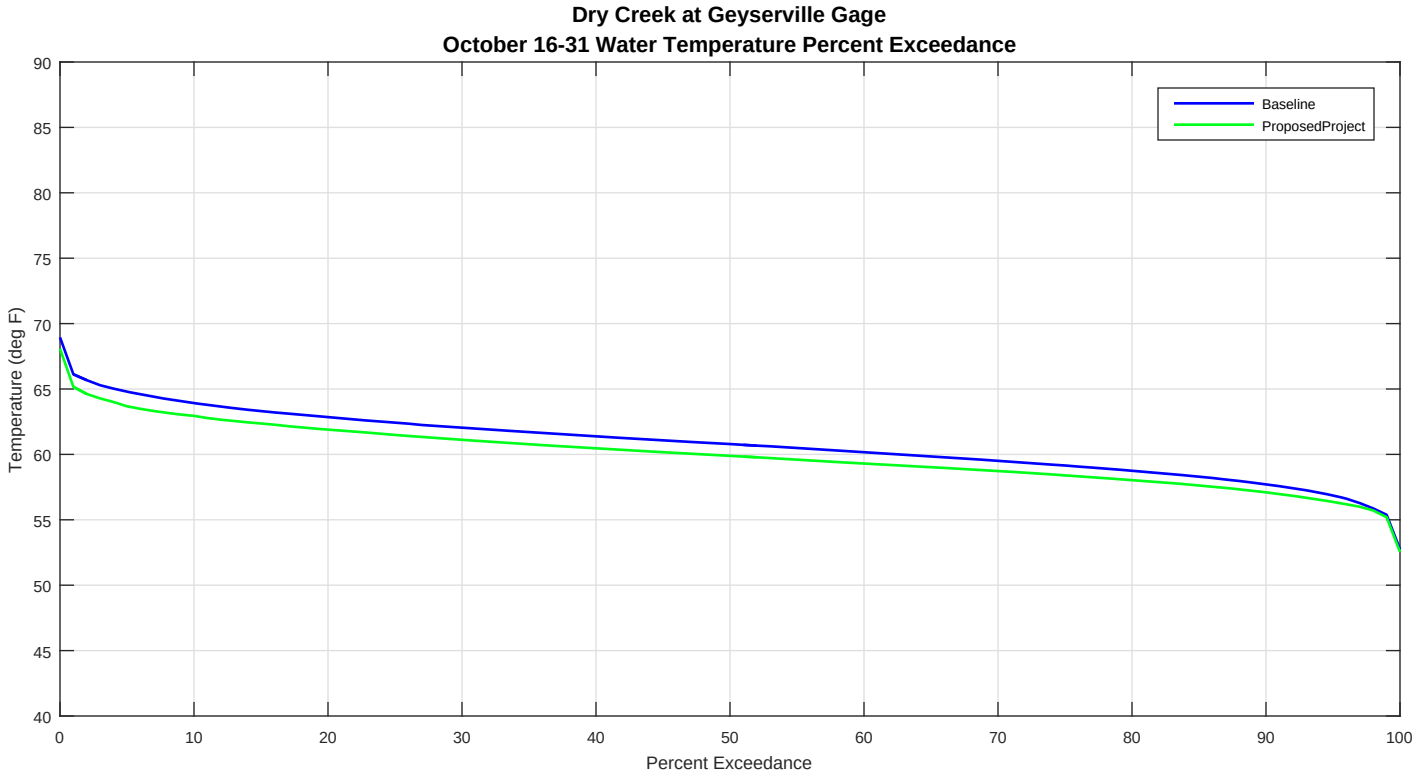
Dry Creek at Geyserville Gage
October 16-31 Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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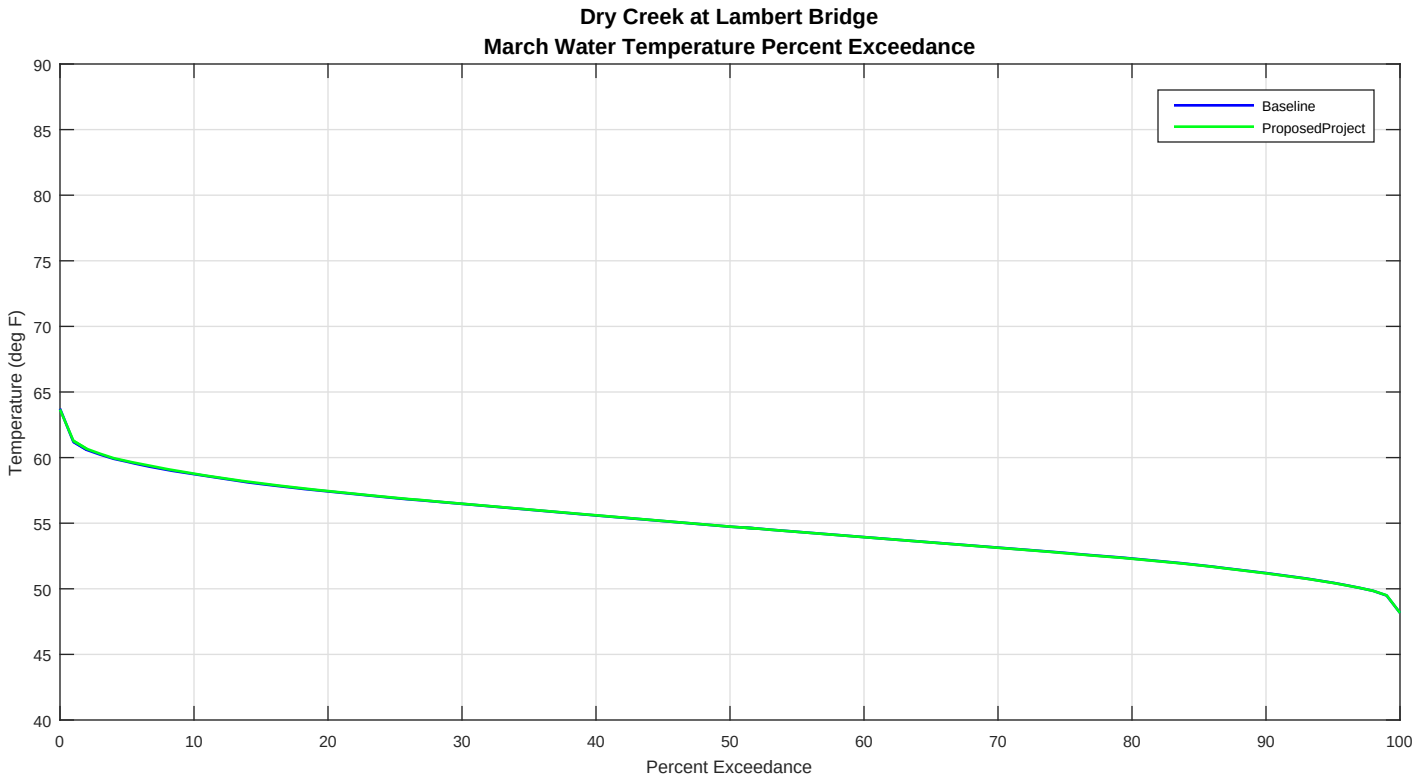
Dry Creek at Lambert Bridge
March Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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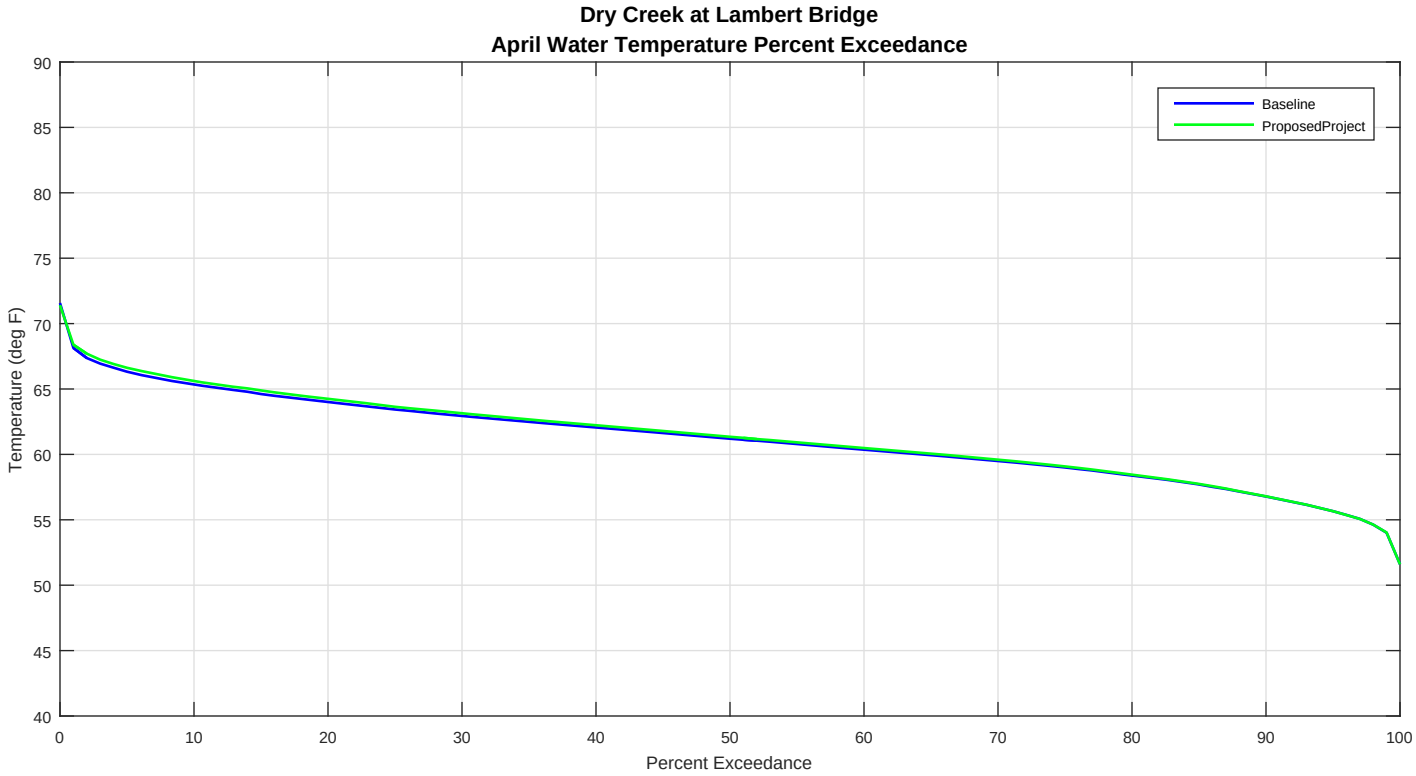
Dry Creek at Lambert Bridge
April Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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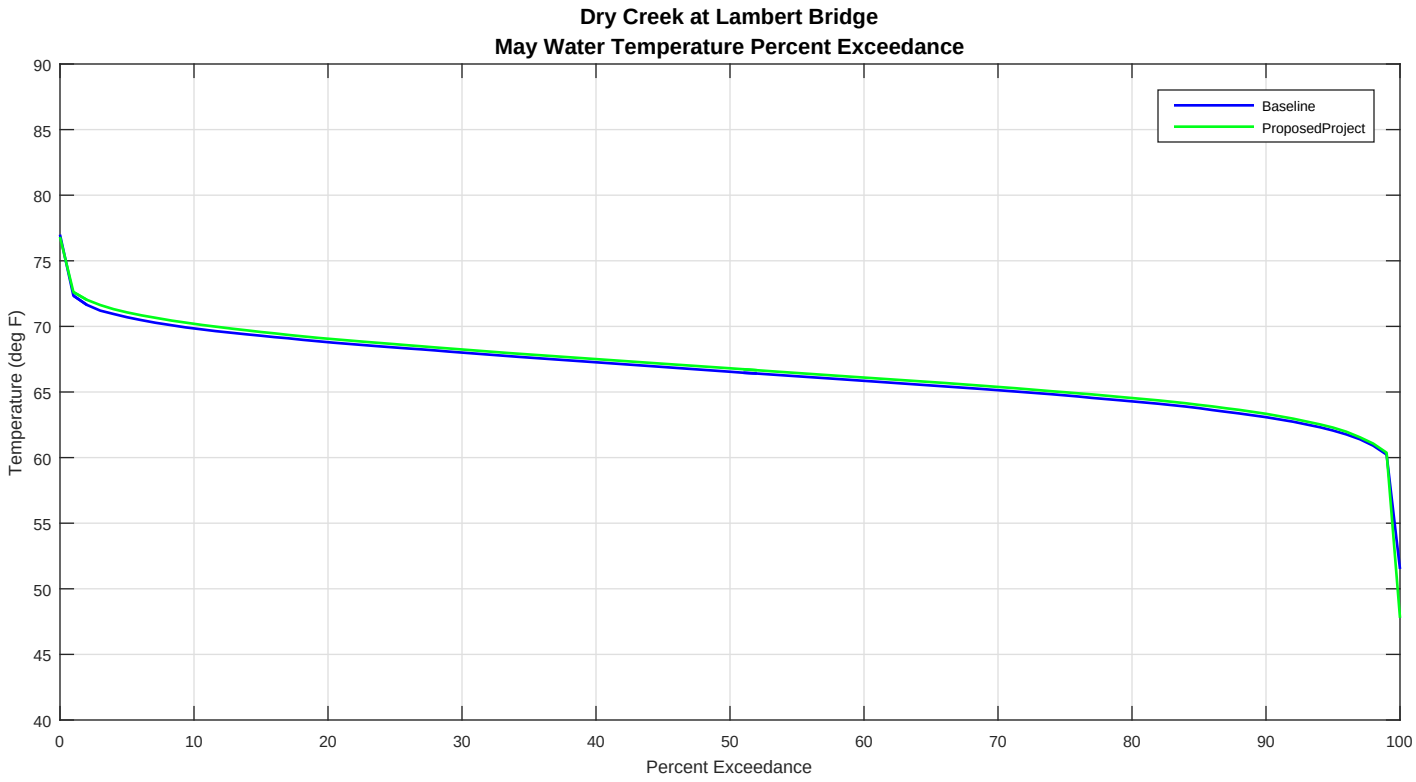
Dry Creek at Lambert Bridge
May Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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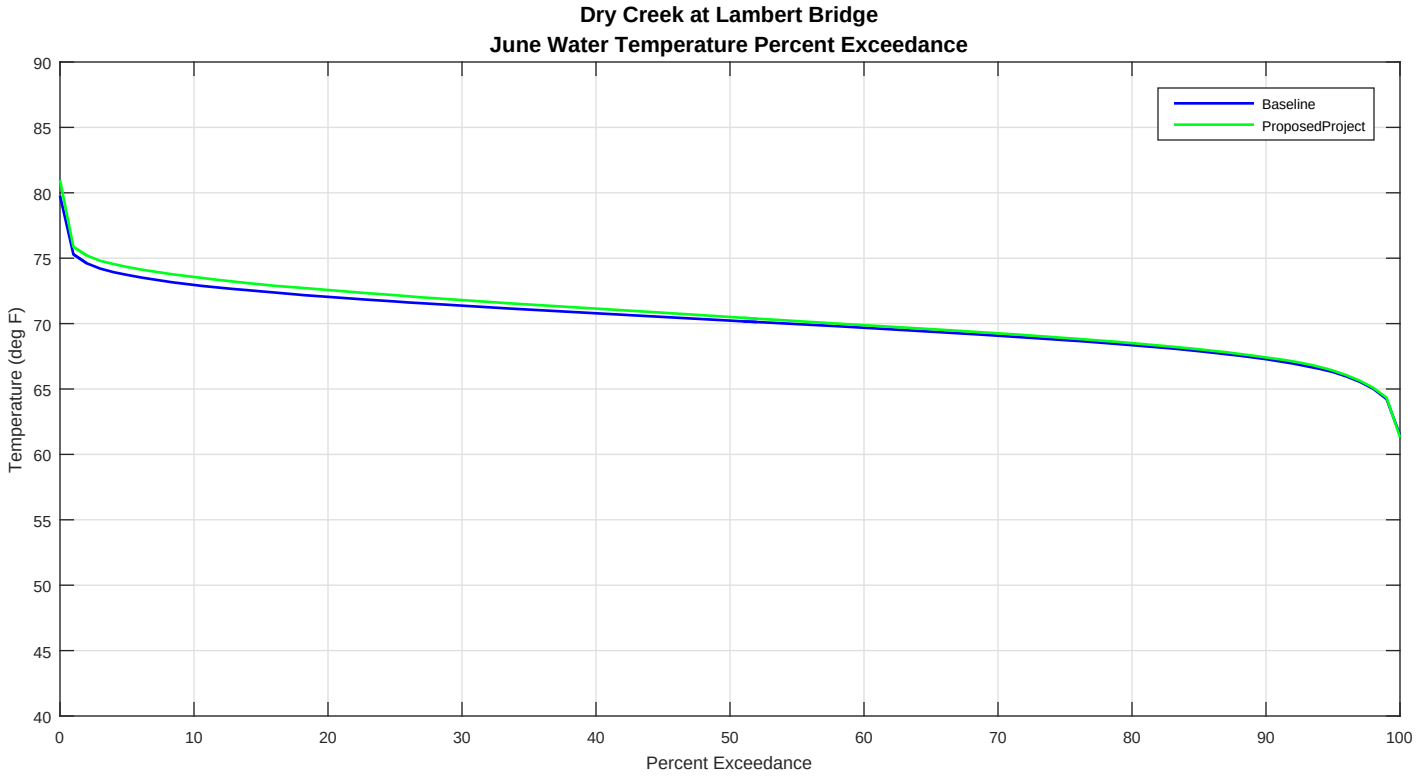
Dry Creek at Lambert Bridge
June Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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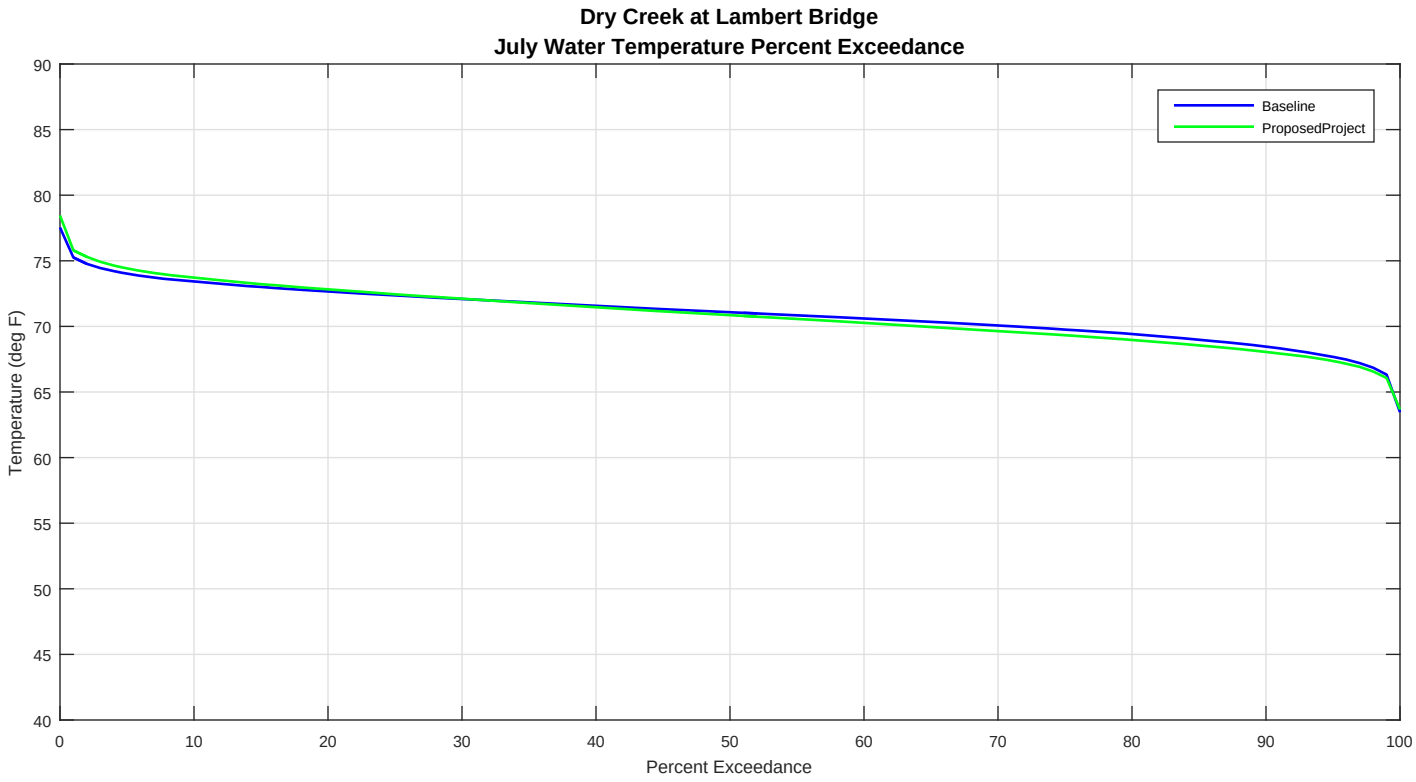
Dry Creek at Lambert Bridge
July Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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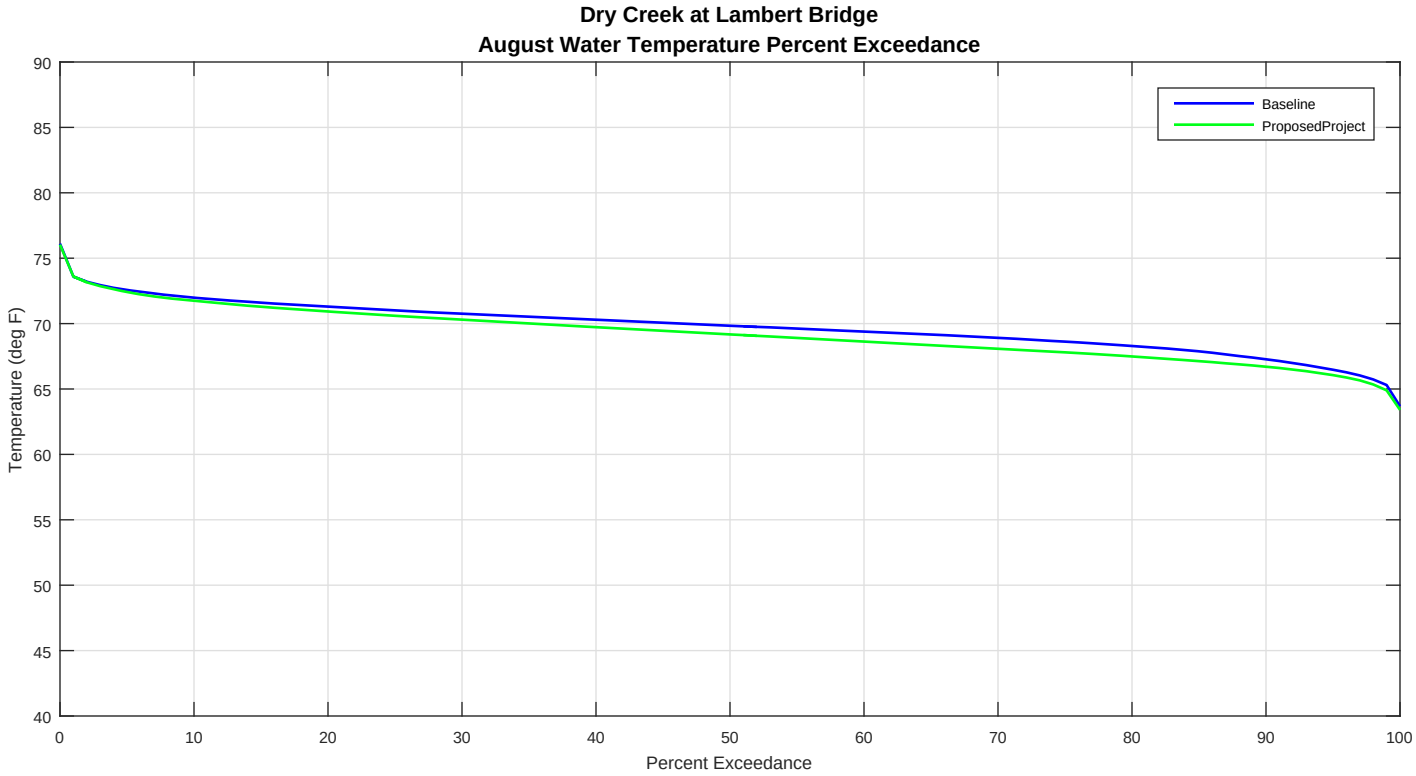
Dry Creek at Lambert Bridge
August Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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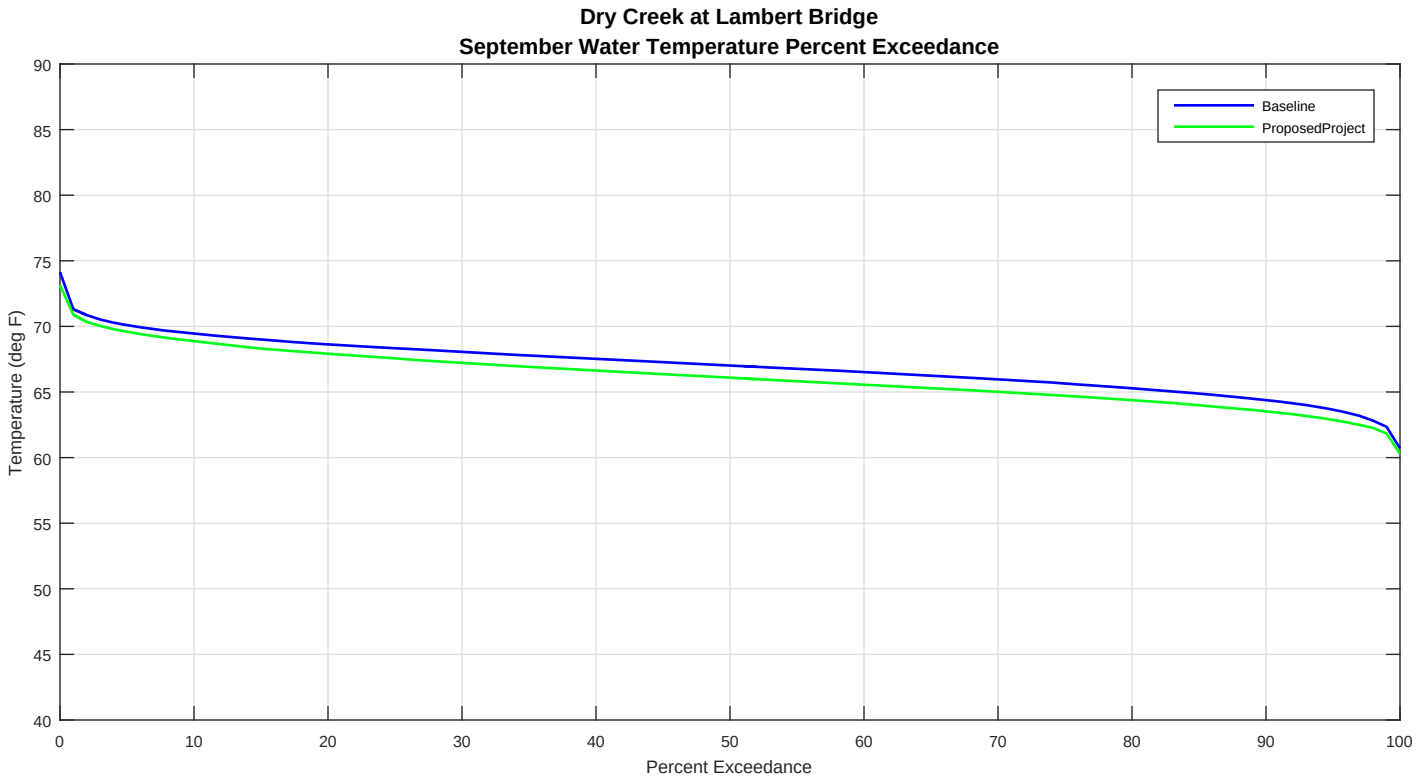
Dry Creek at Lambert Bridge
September Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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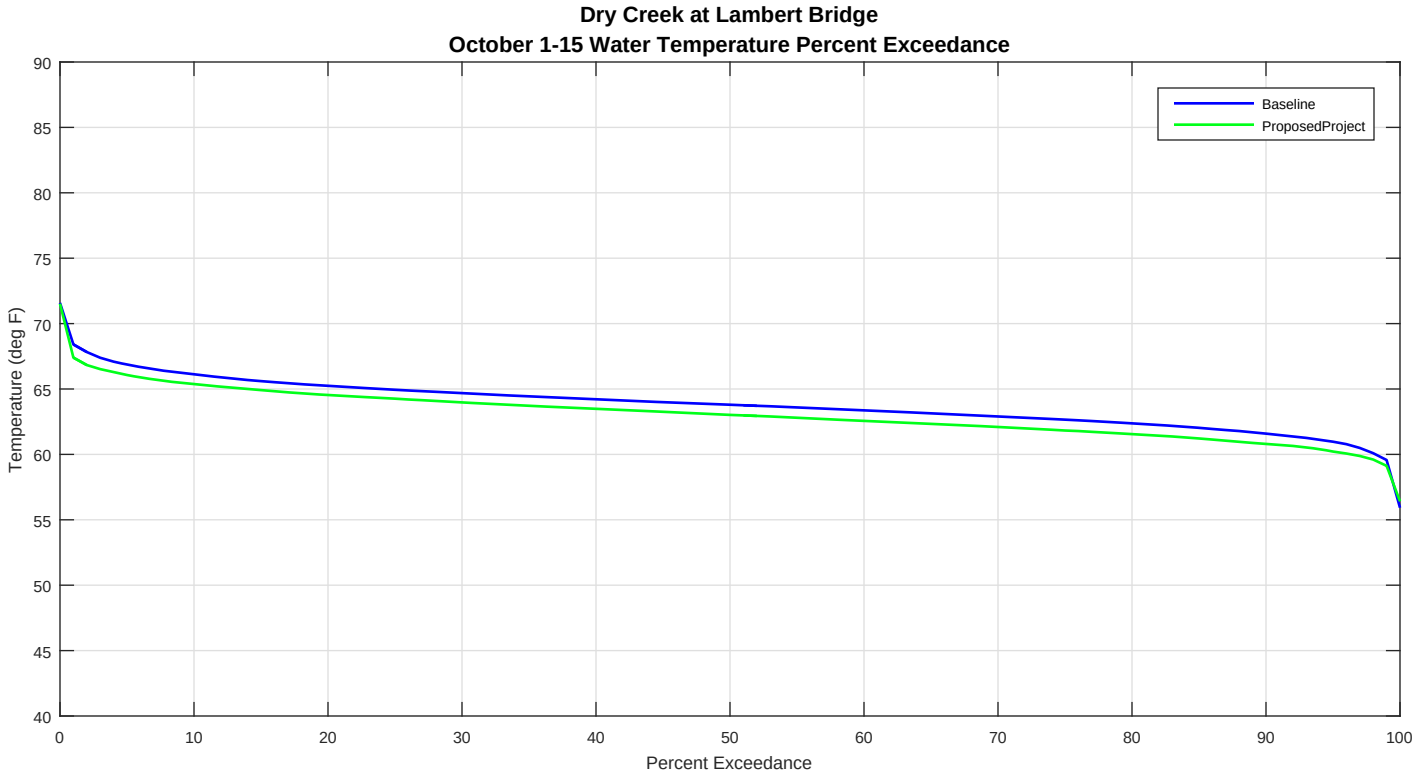
Dry Creek at Lambert Bridge
October 1-15 Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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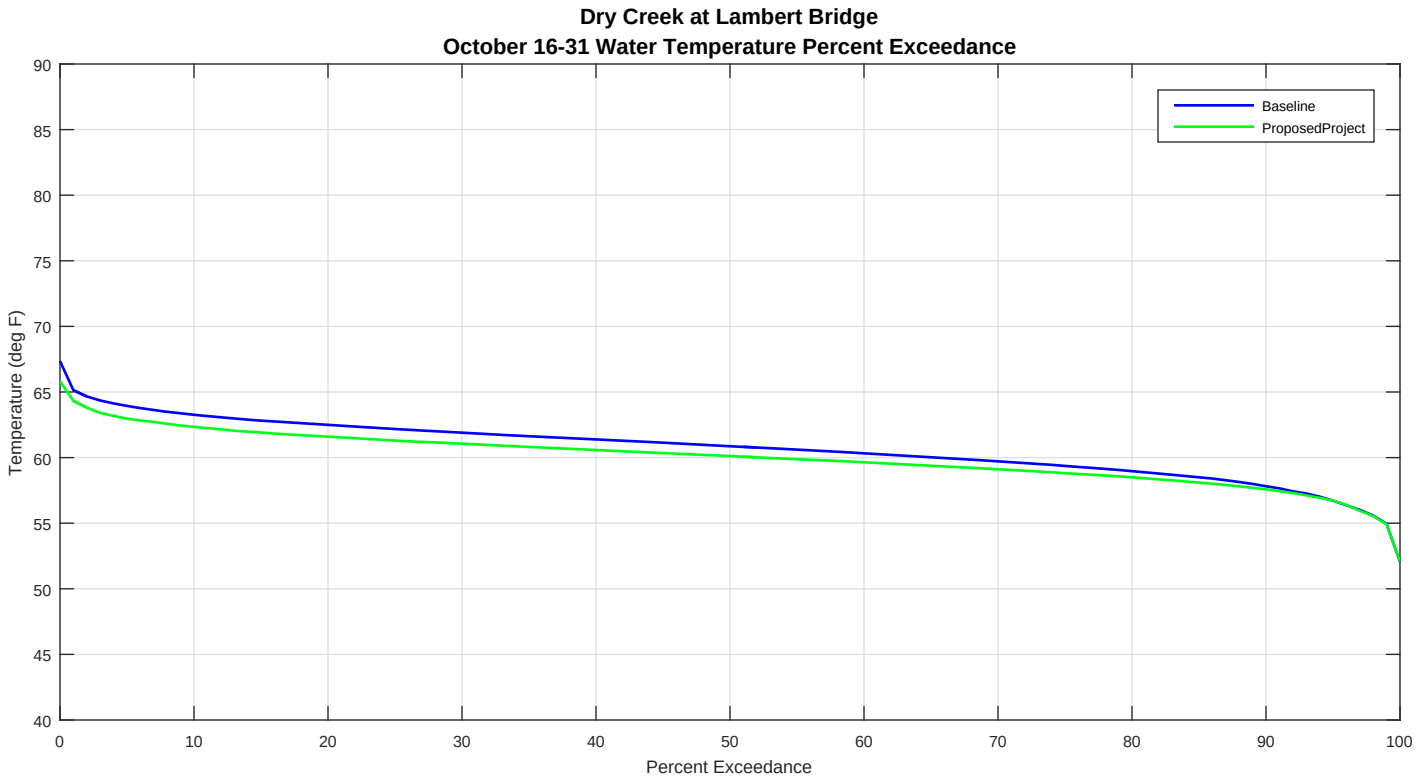
Dry Creek at Lambert Bridge
October 16-31 Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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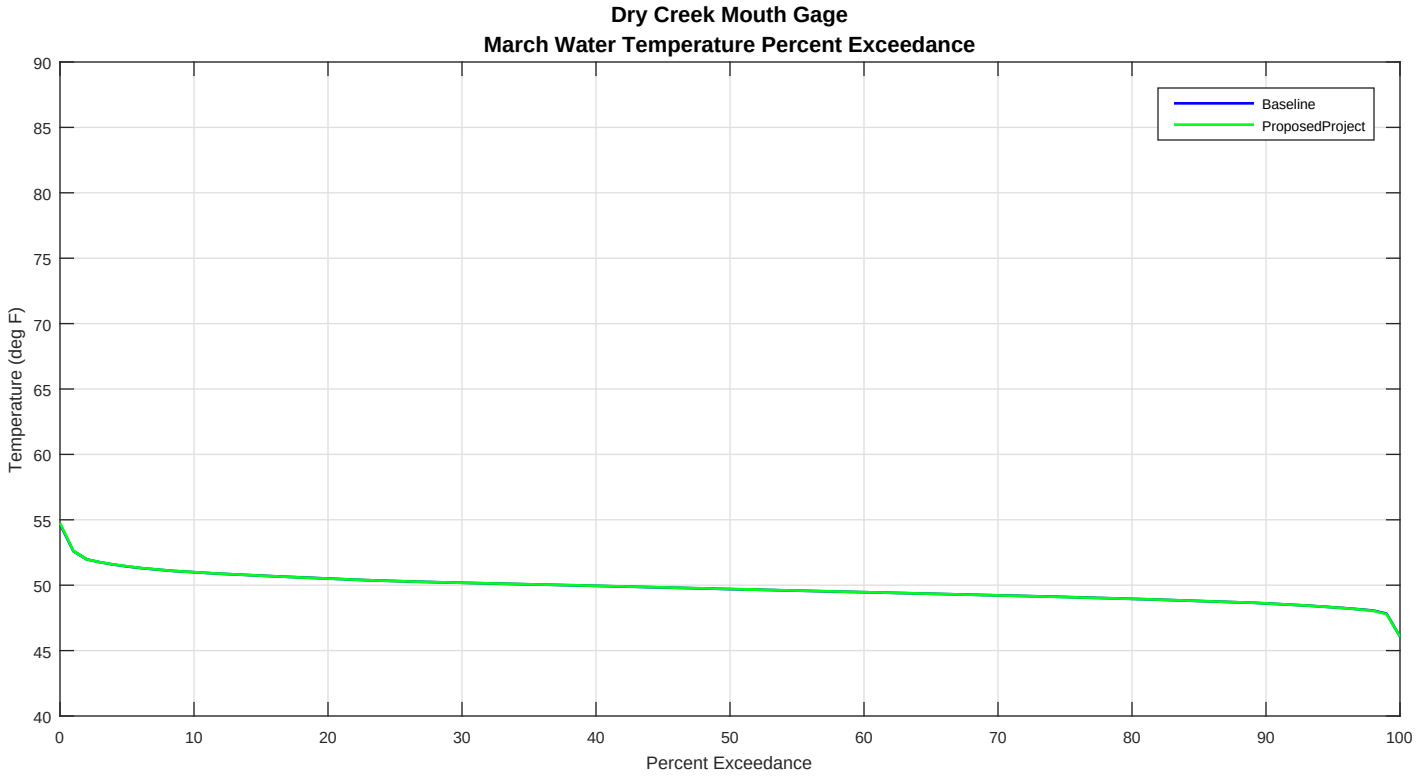
Dry Creek Mouth Gage
March Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
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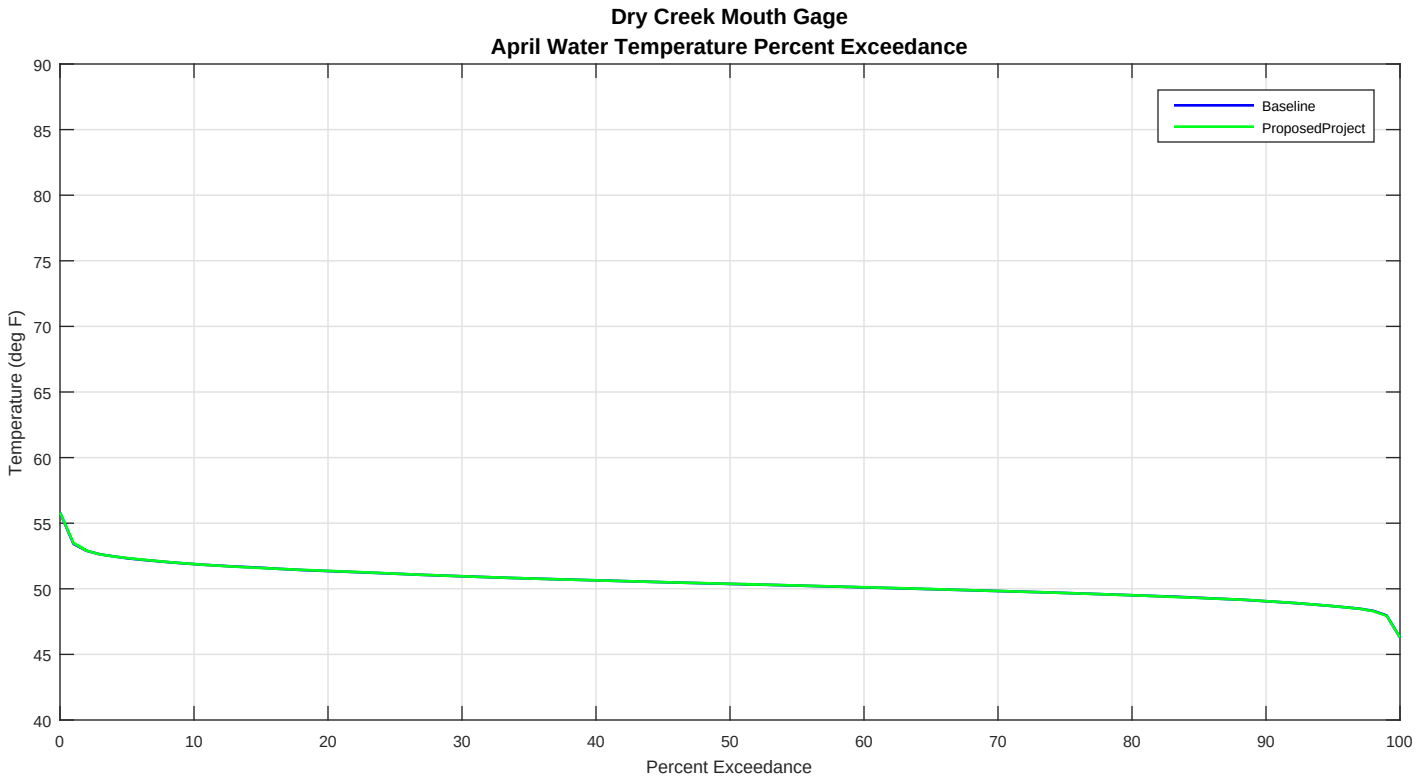
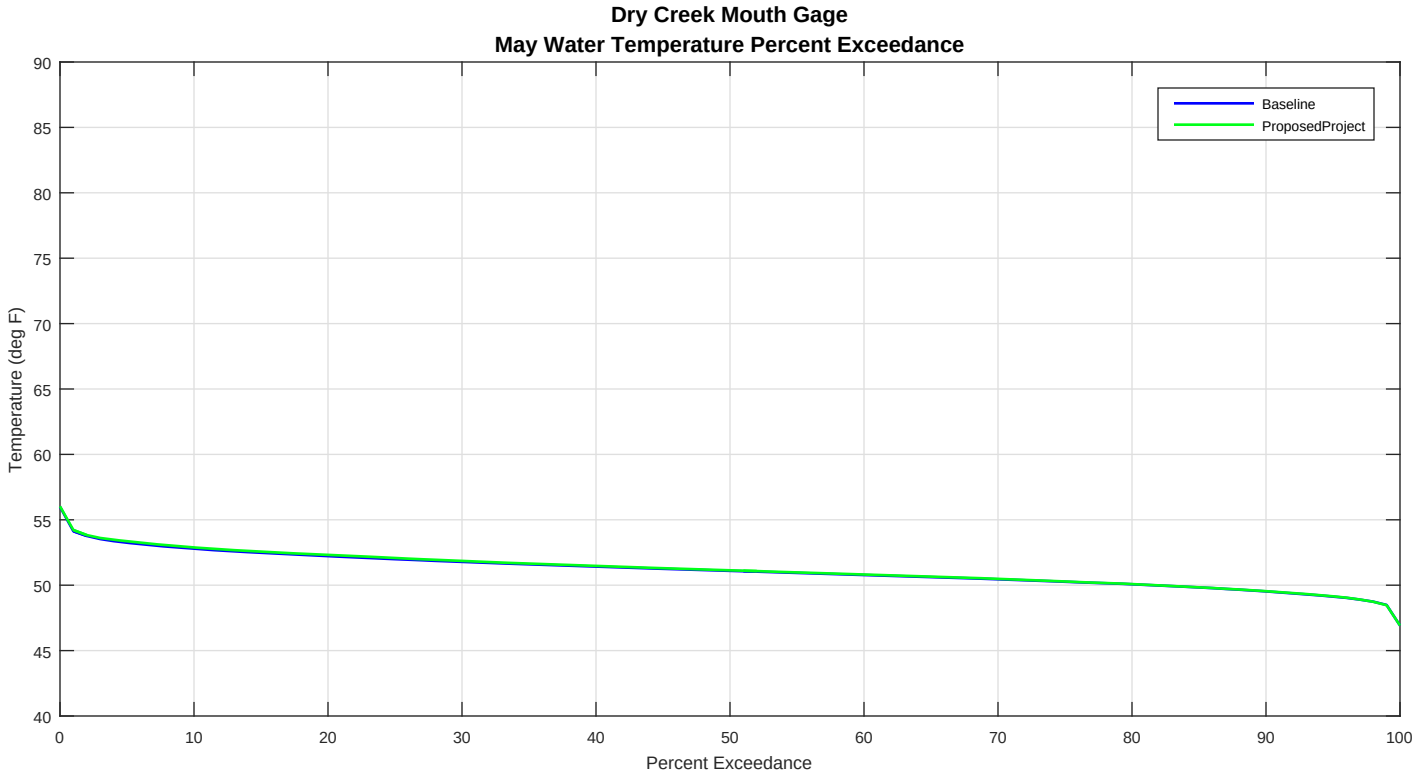

Dry Creek Mouth Gage
April Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
May Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
10
20
30
40
50
60
70
80
90
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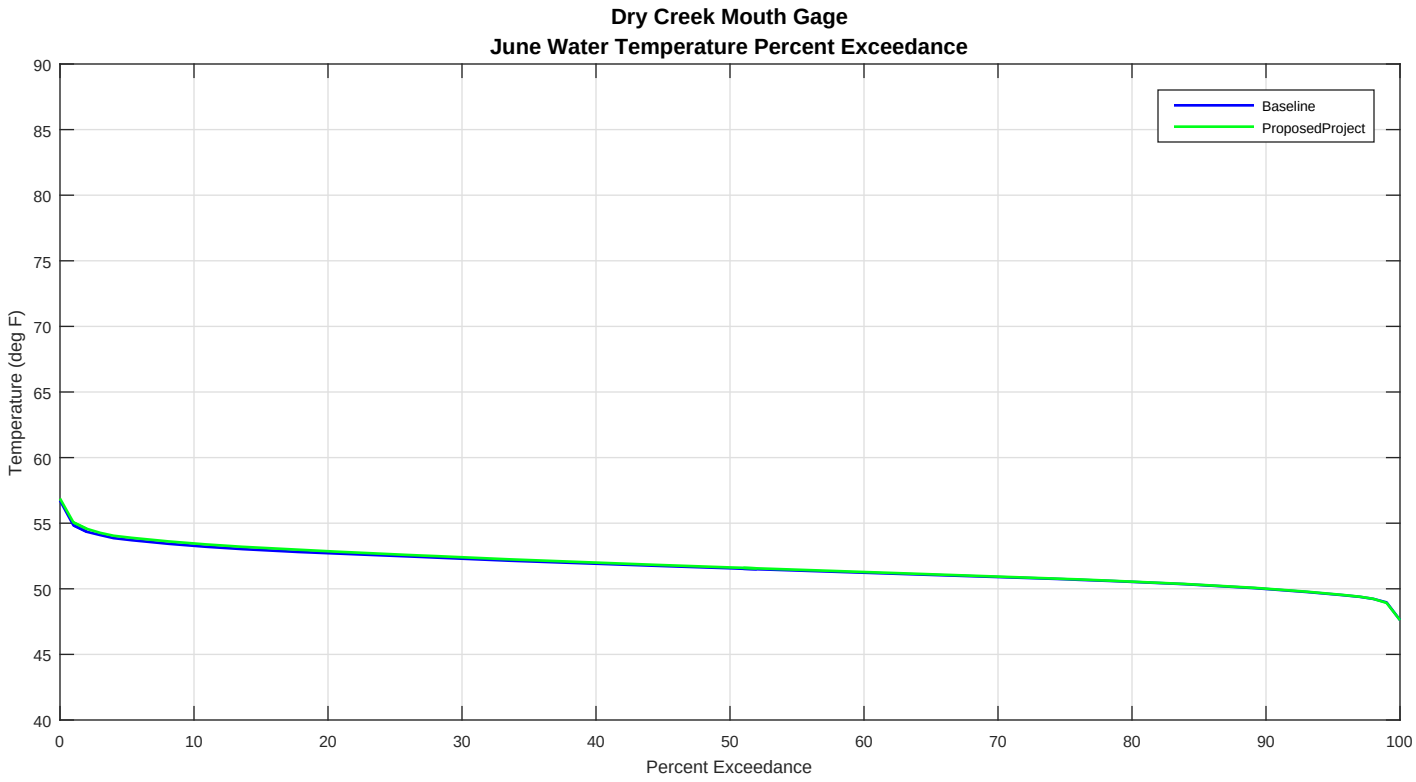
Dry Creek Mouth Gage
June Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
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30
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60
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90
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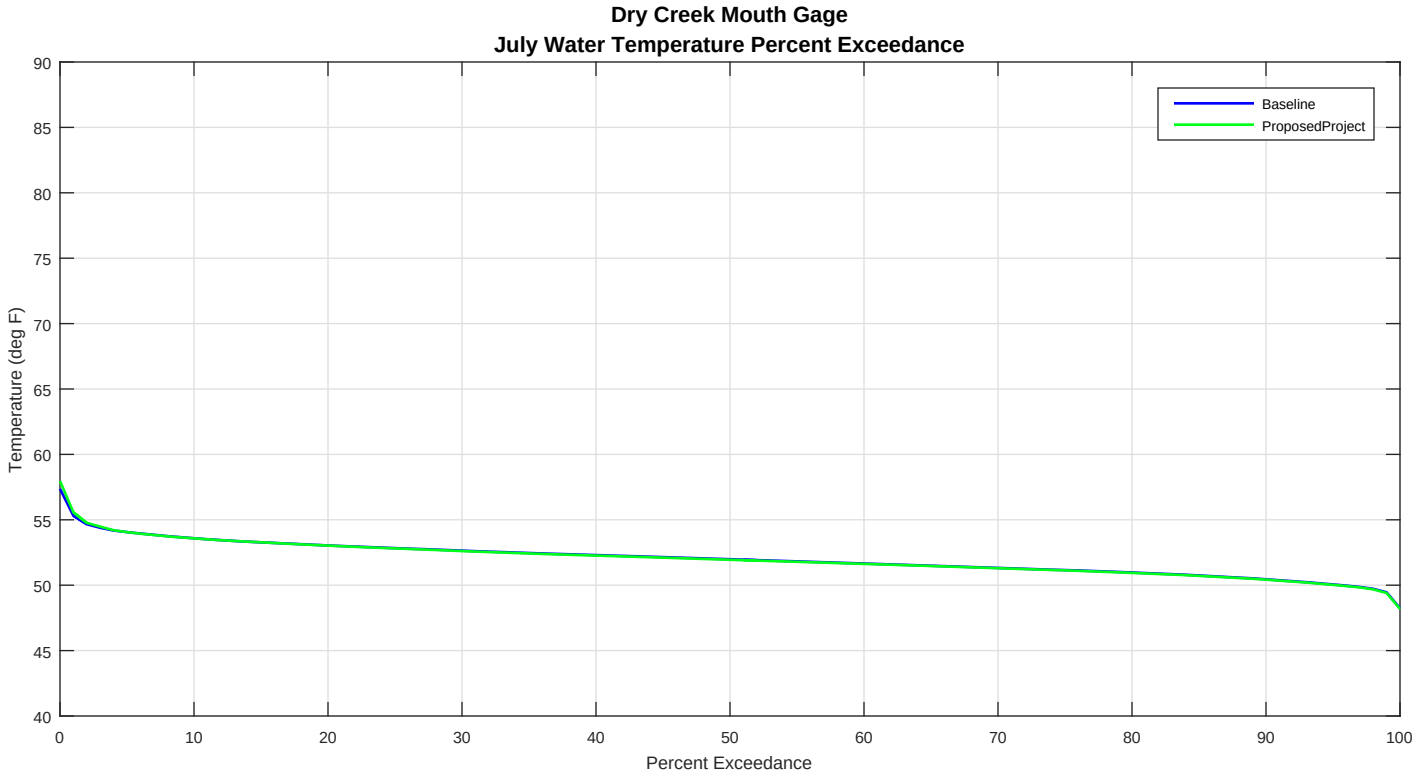
Dry Creek Mouth Gage
July Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
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20
30
40
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60
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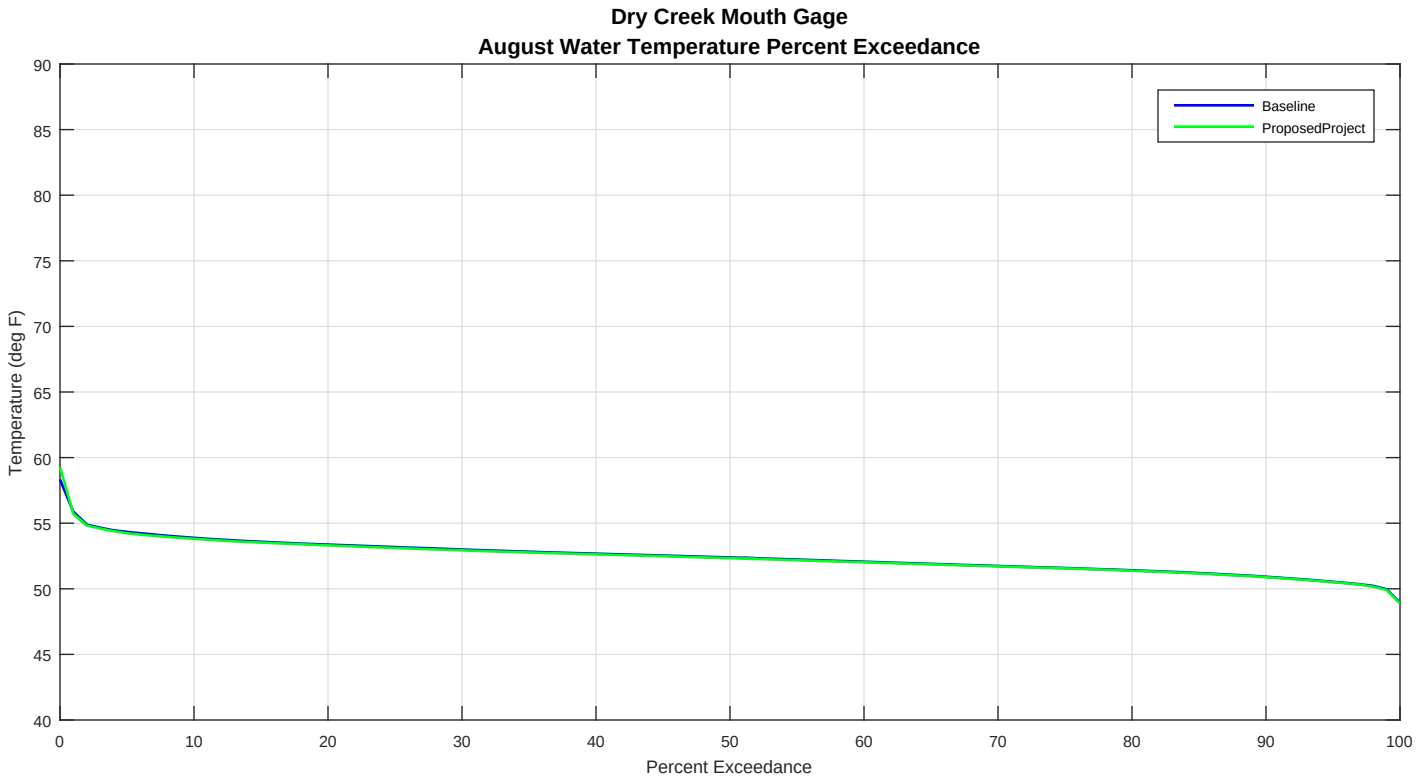
80
90
100


Dry Creek Mouth Gage
August Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
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20
30
40
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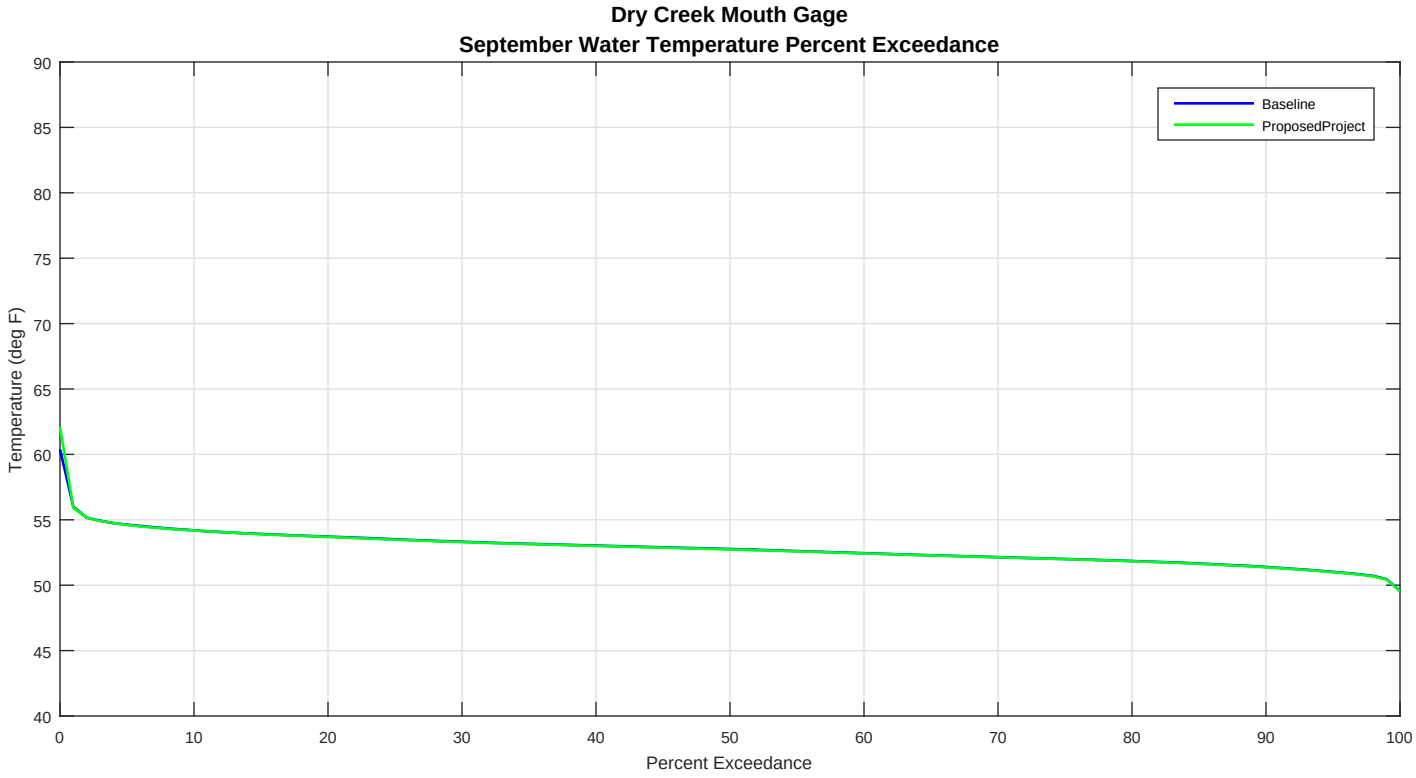
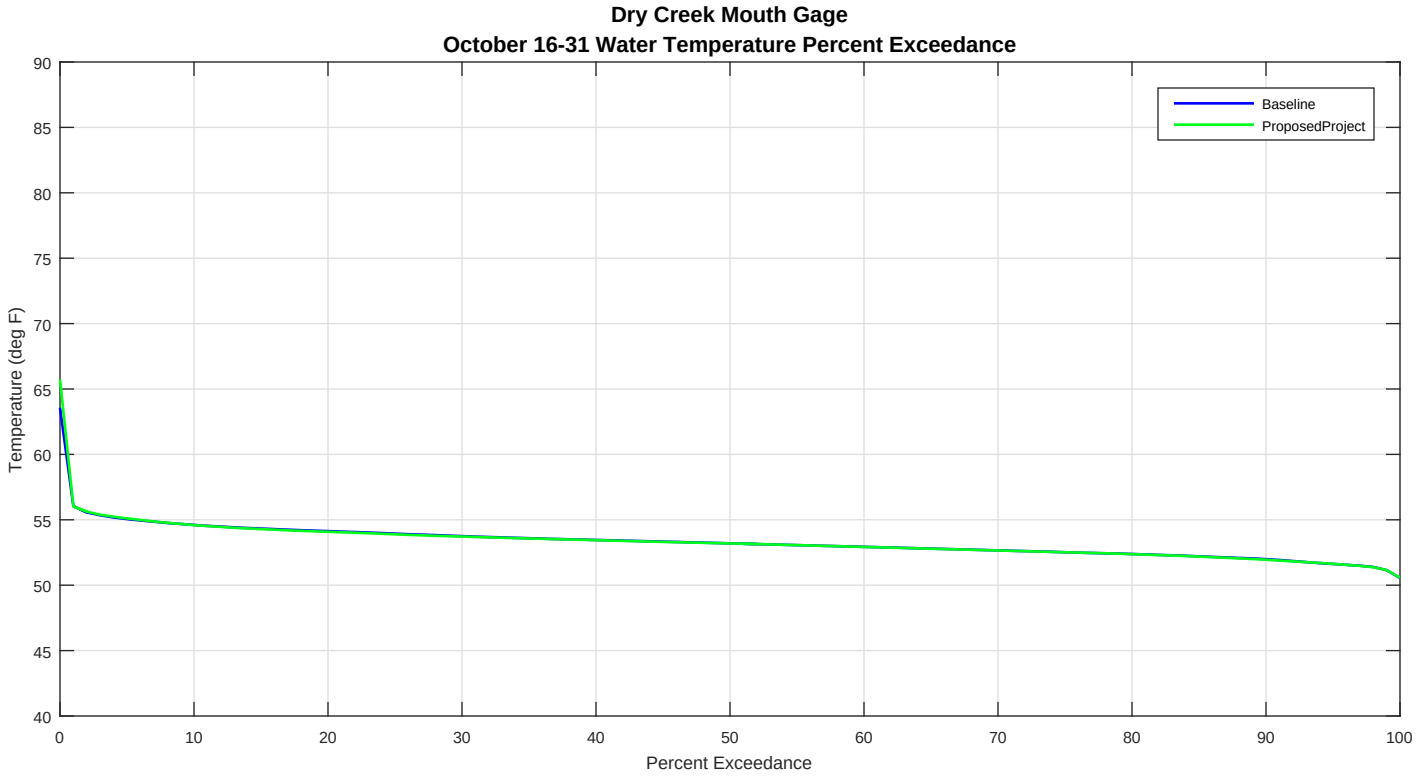

Dry Creek Mouth Gage
September Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
10
20
30
40
50
60
70
80
90
100

Dry Creek Mouth Gage
October 1-15 Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
October 16-31 Water Temperature Percent Exceedance
Baseline
ProposedProject
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
10
20
30
40
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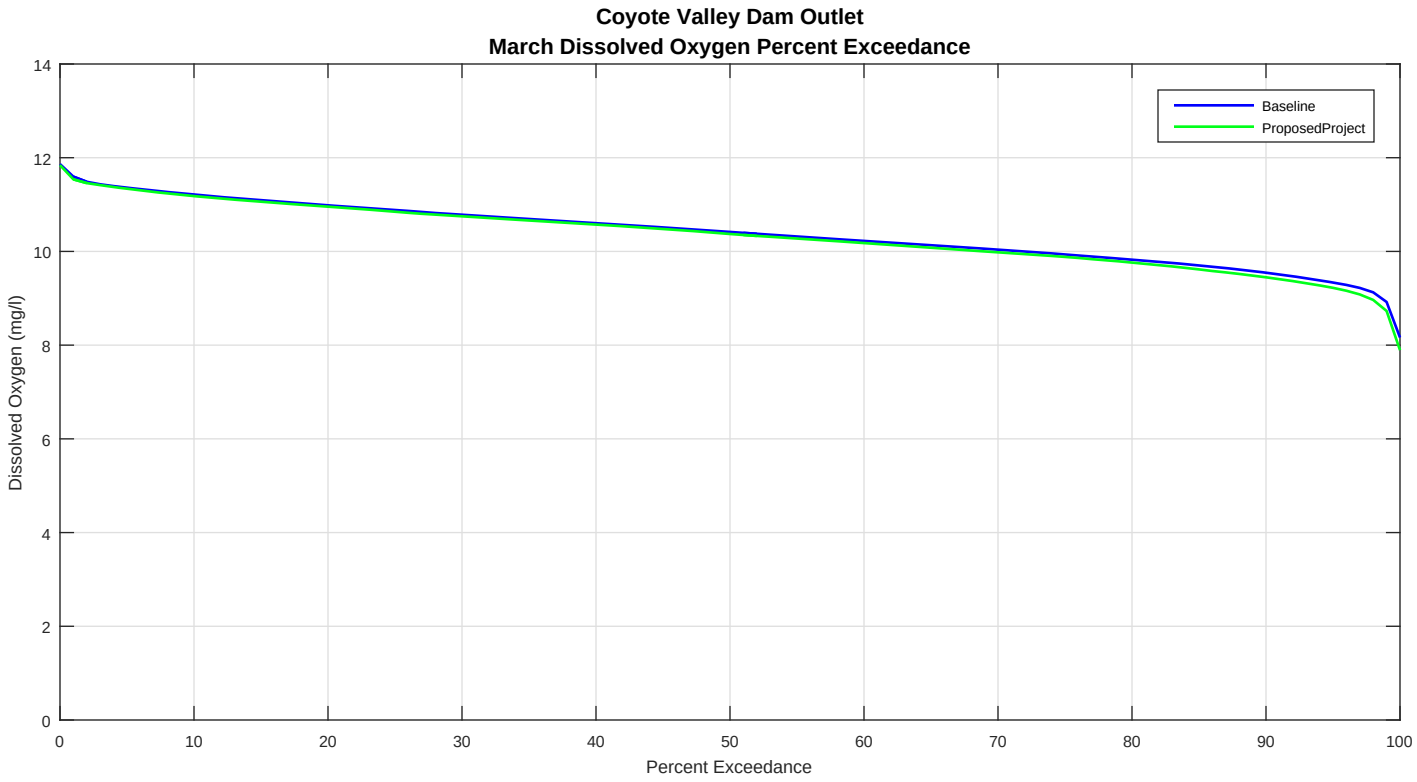
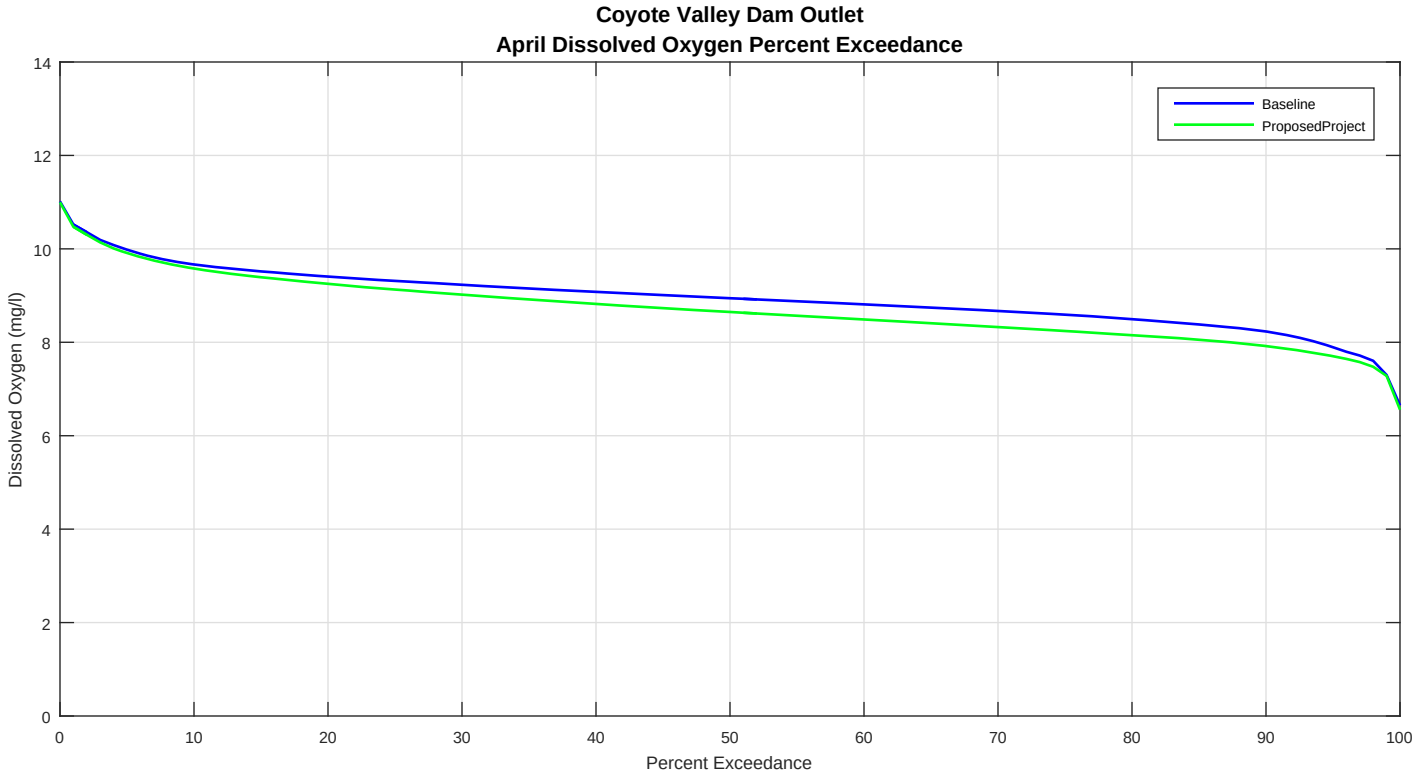
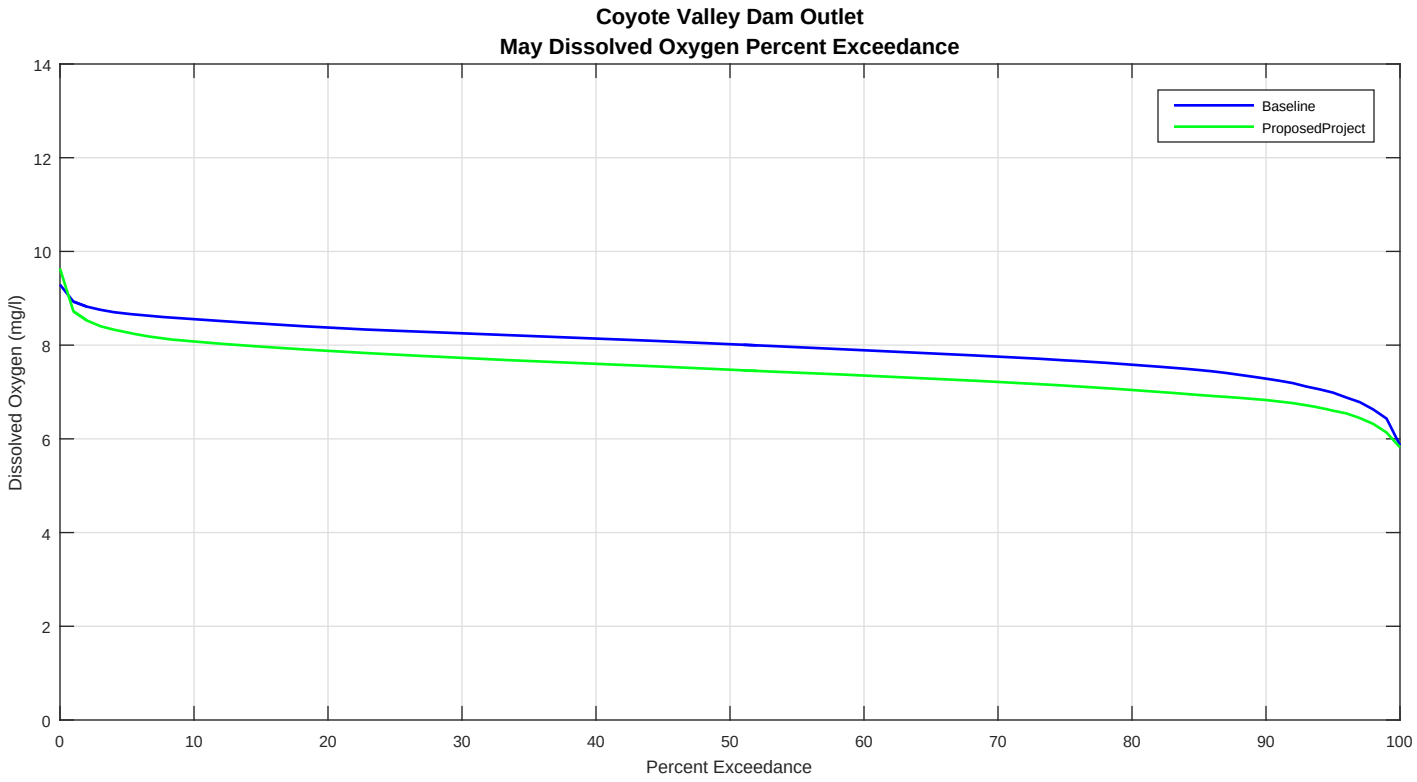
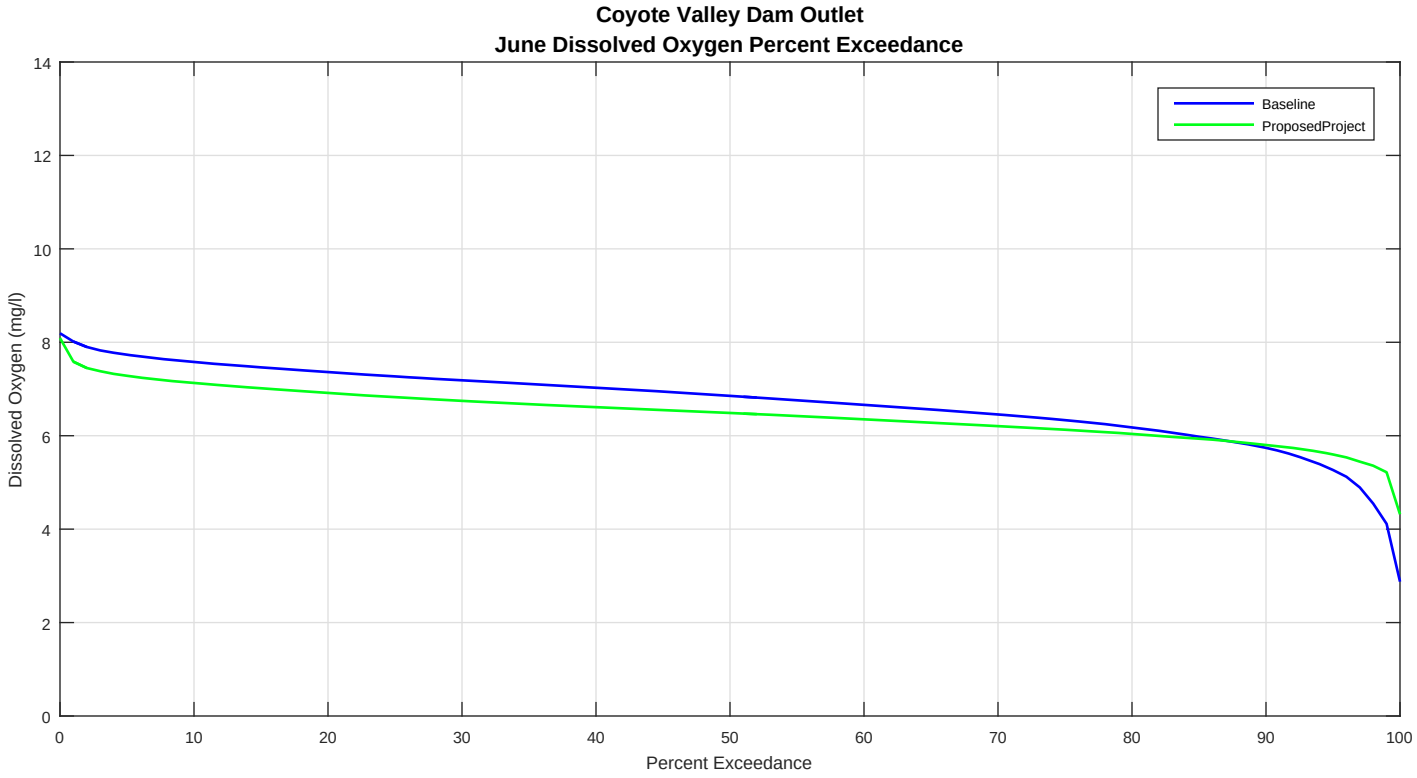
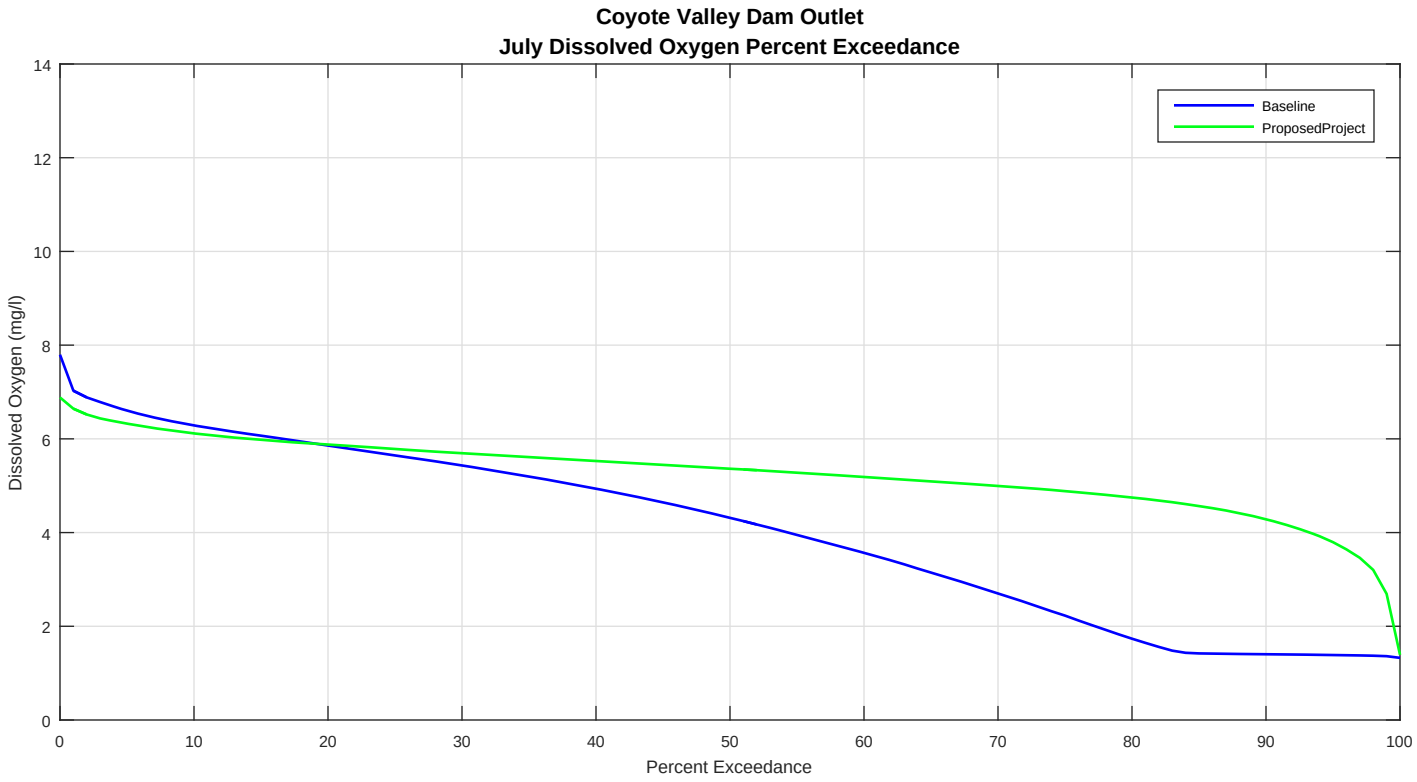
60
70
80
90
100

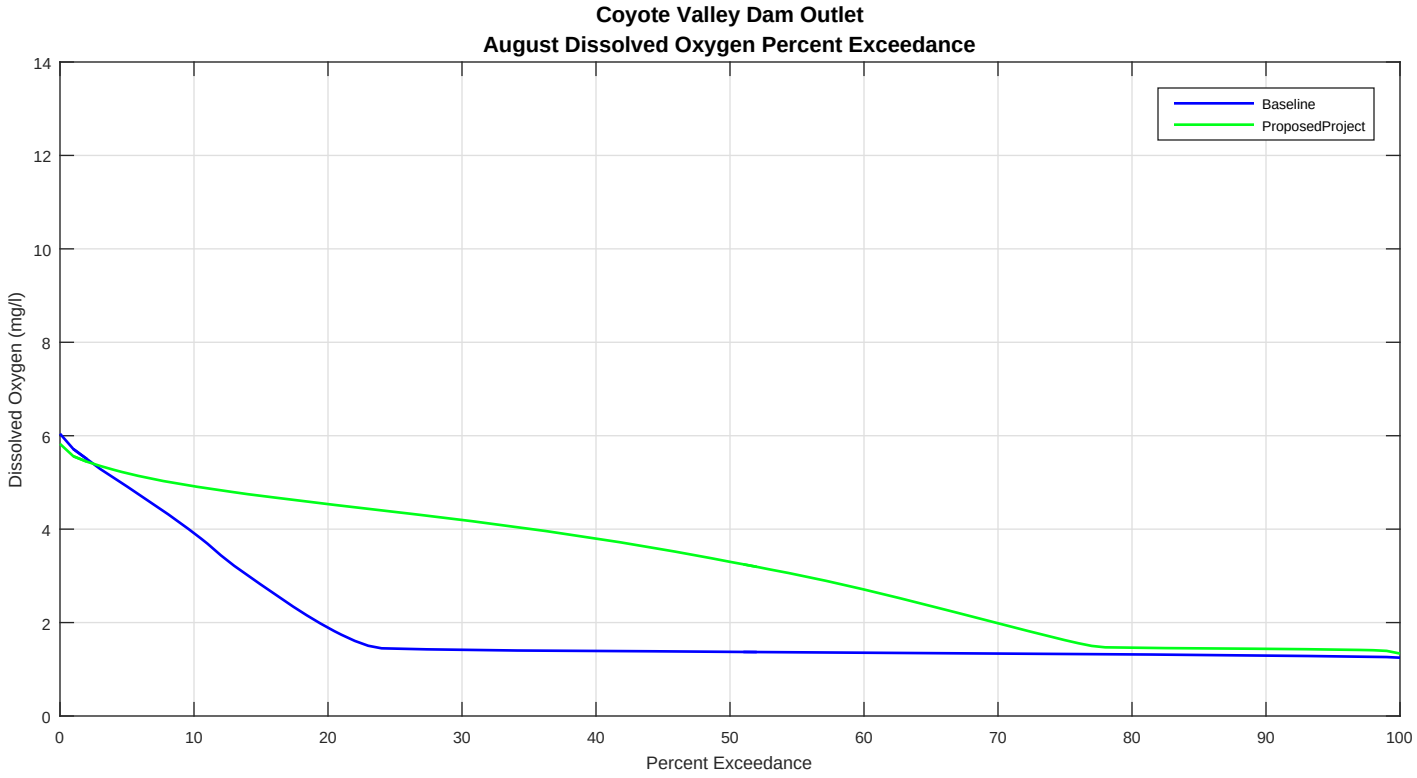

Coyote Valley Dam Outlet
March Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

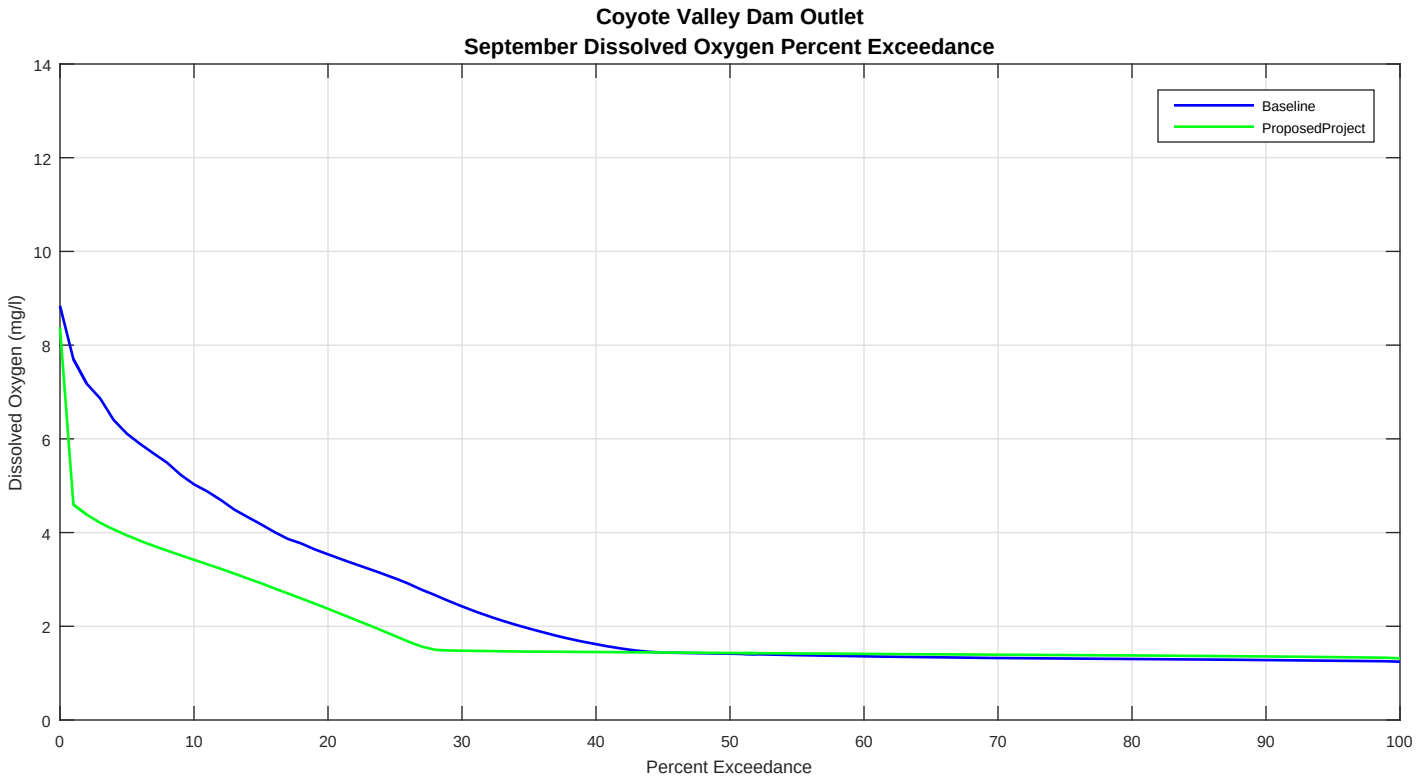

Coyote Valley Dam Outlet
April Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
May Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
June Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
July Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
August Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
September Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
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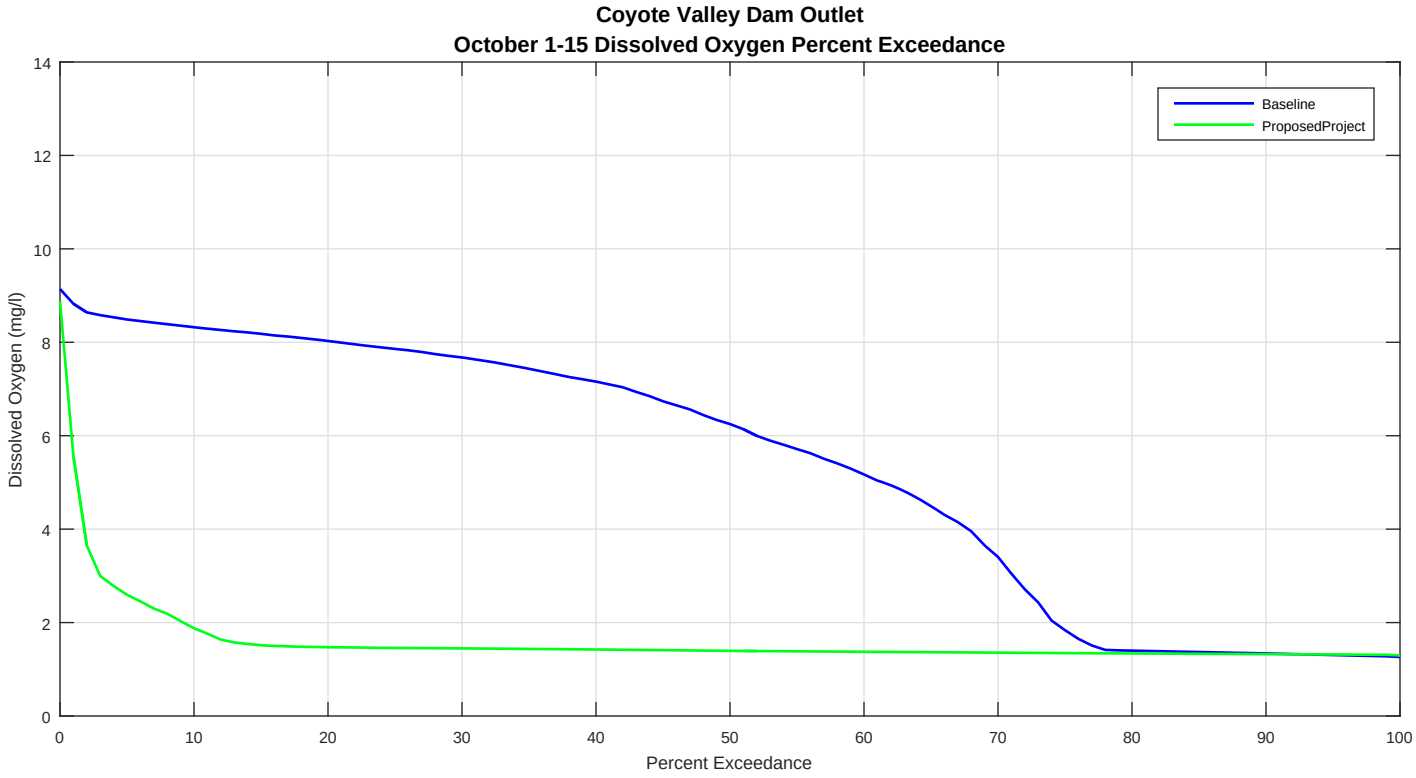
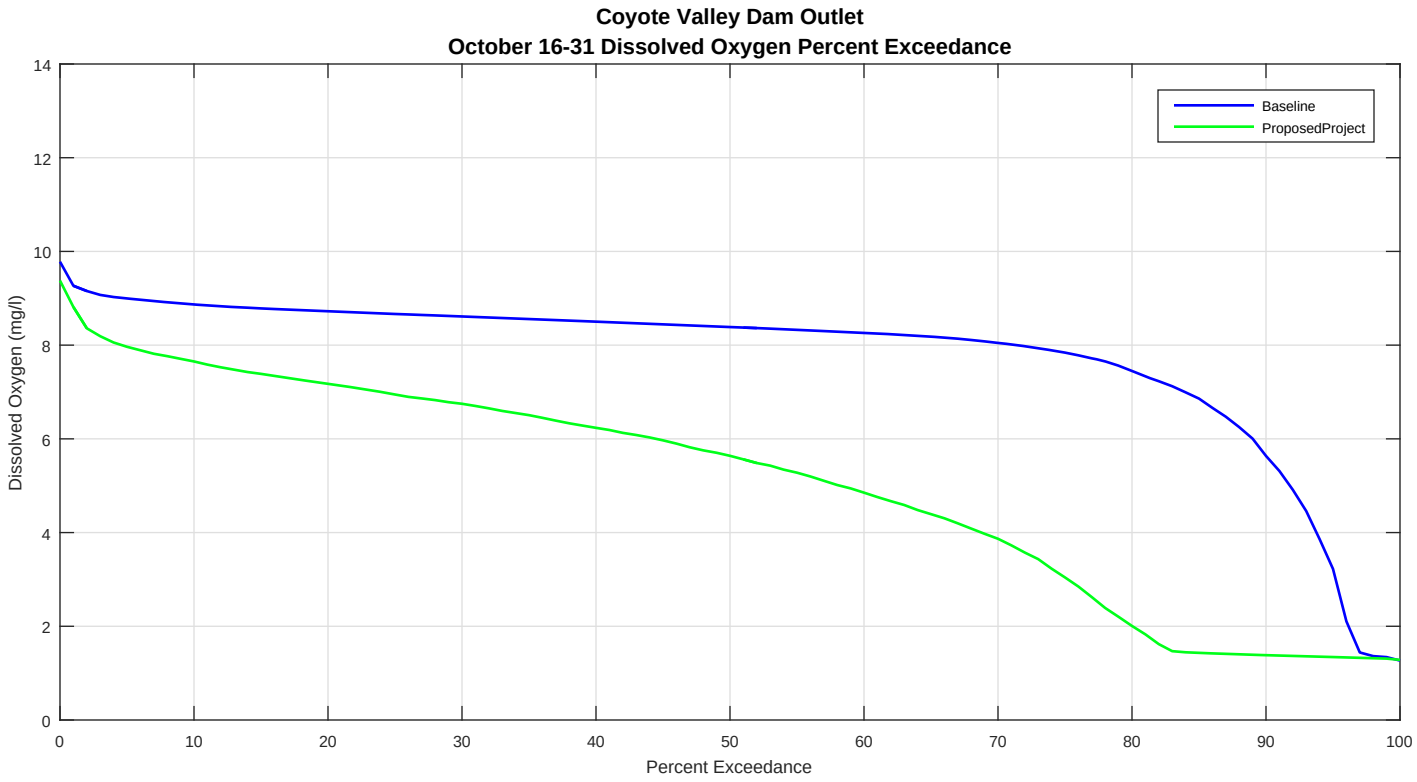
100


Coyote Valley Dam Outlet
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
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70
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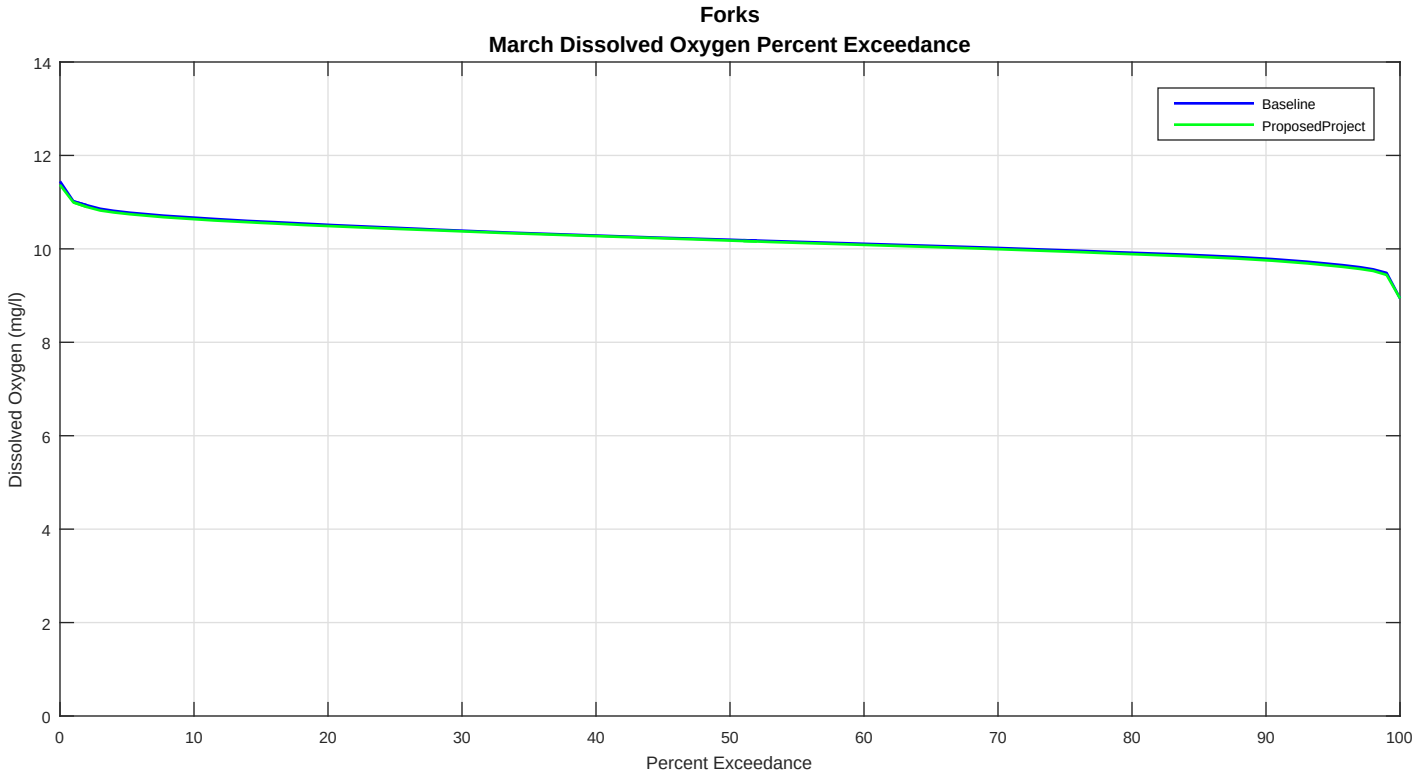
90
100


Forks
March Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
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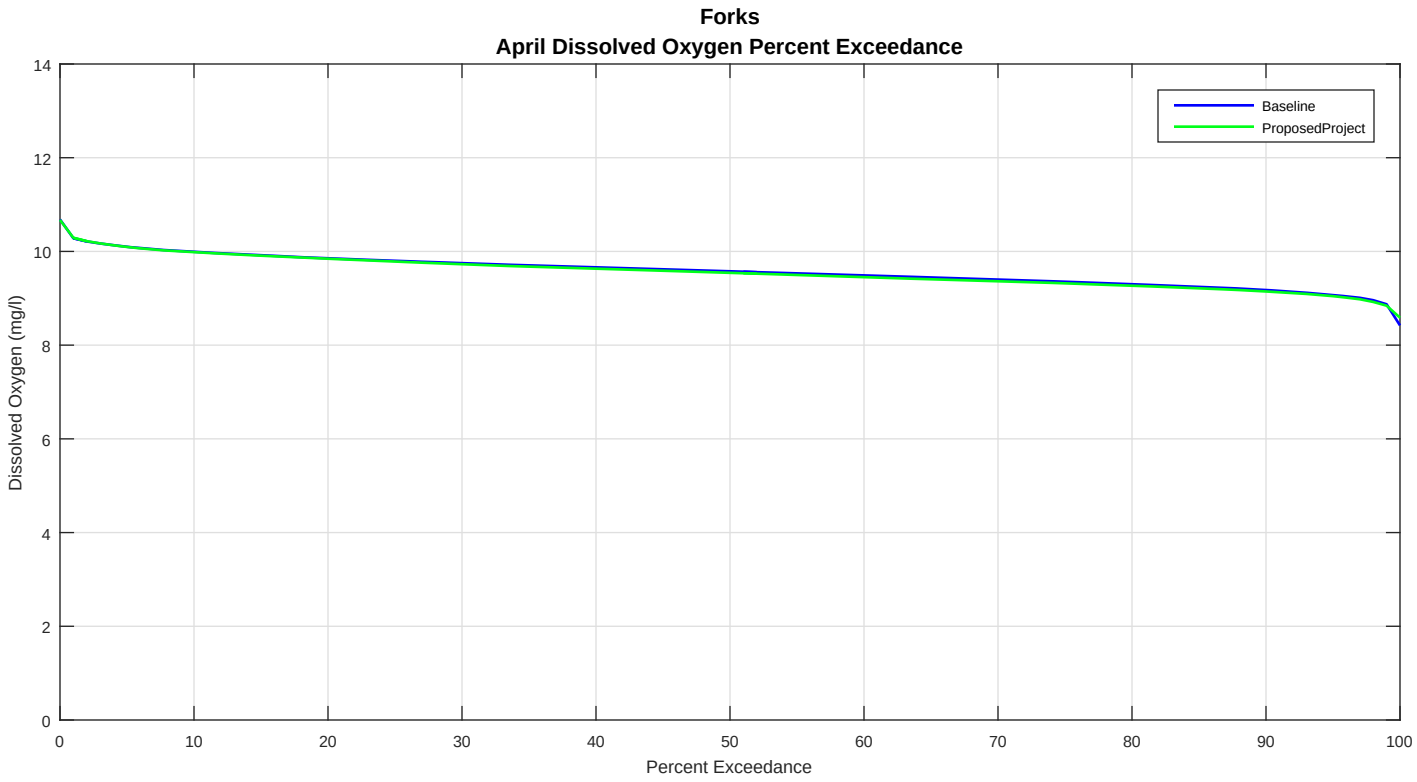
70
80
90
100


Forks
April Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
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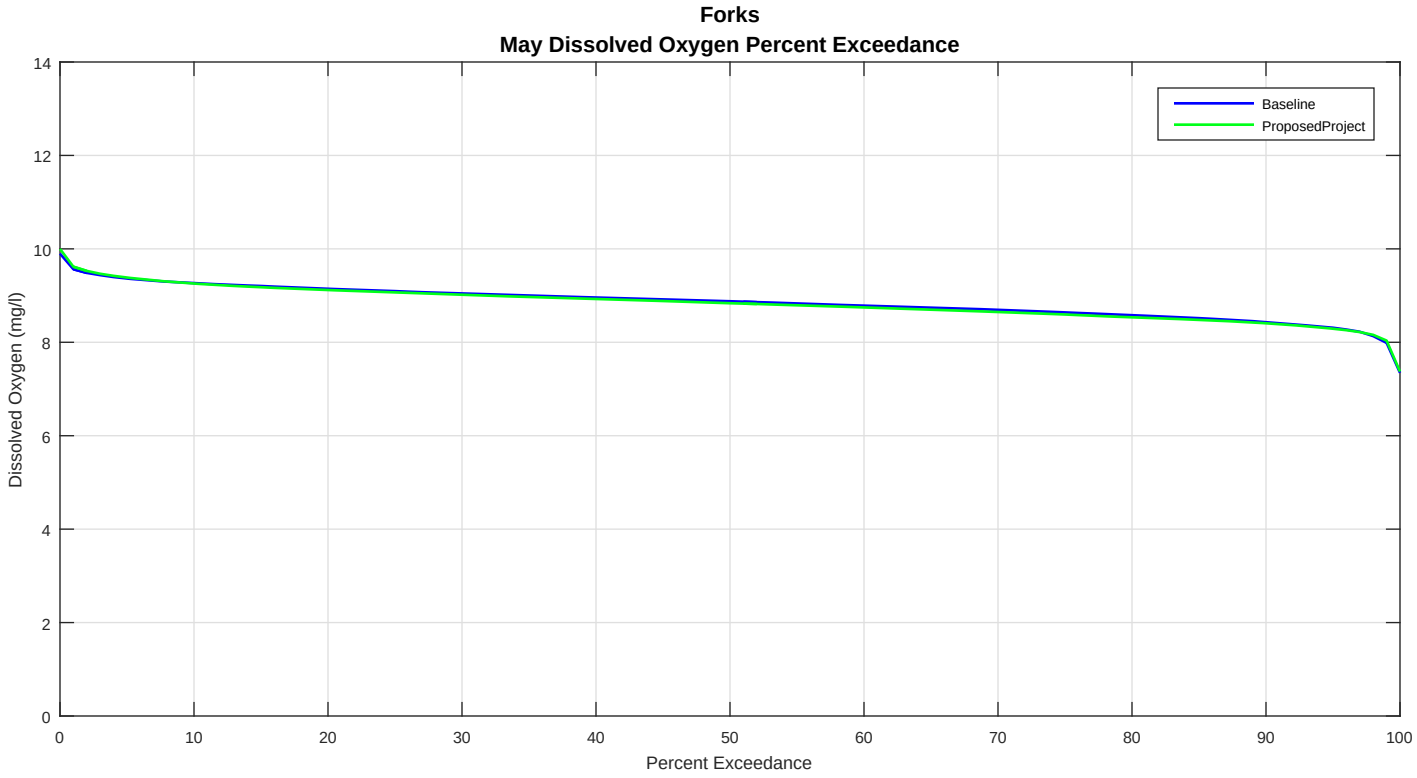
Forks
May Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
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6
8
10
12
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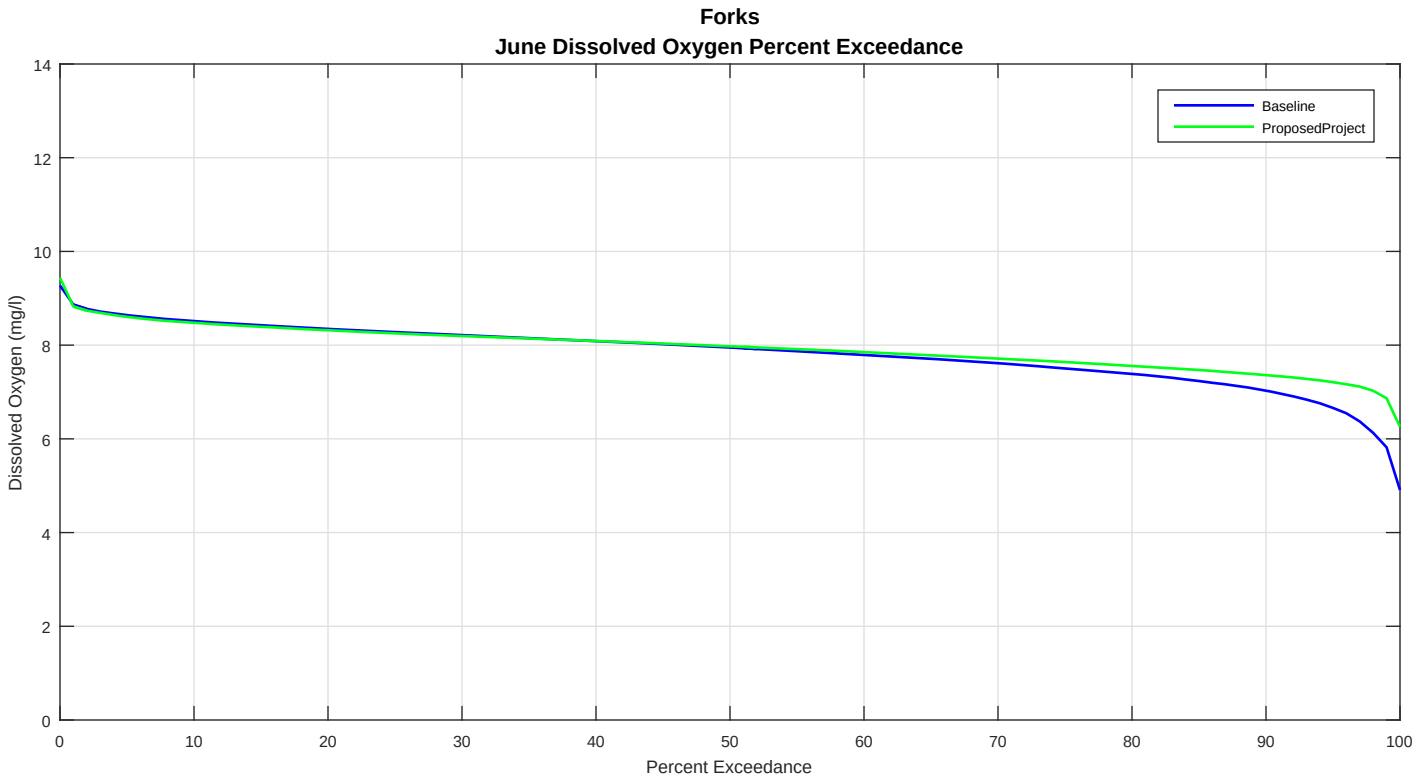
Forks
June Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
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30
40
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90
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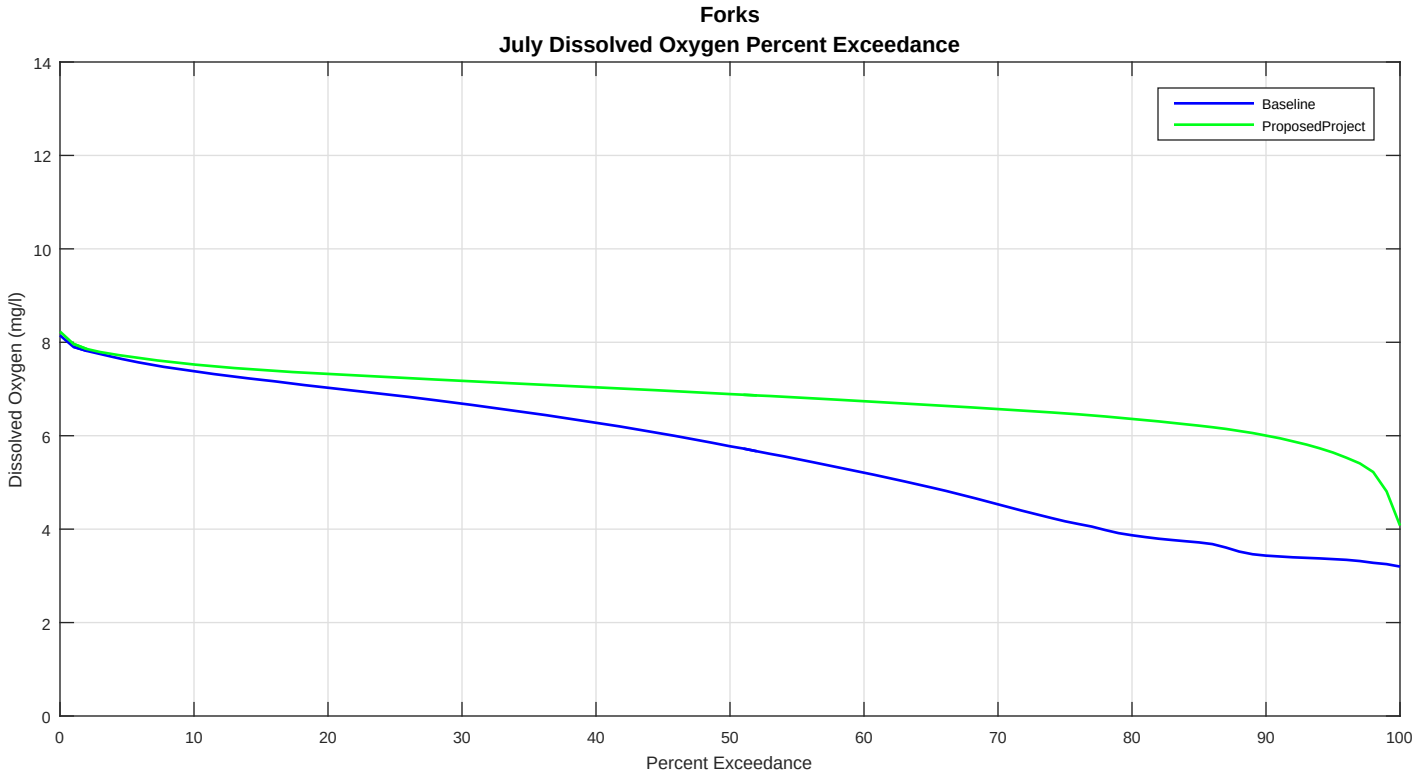
Forks
July Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
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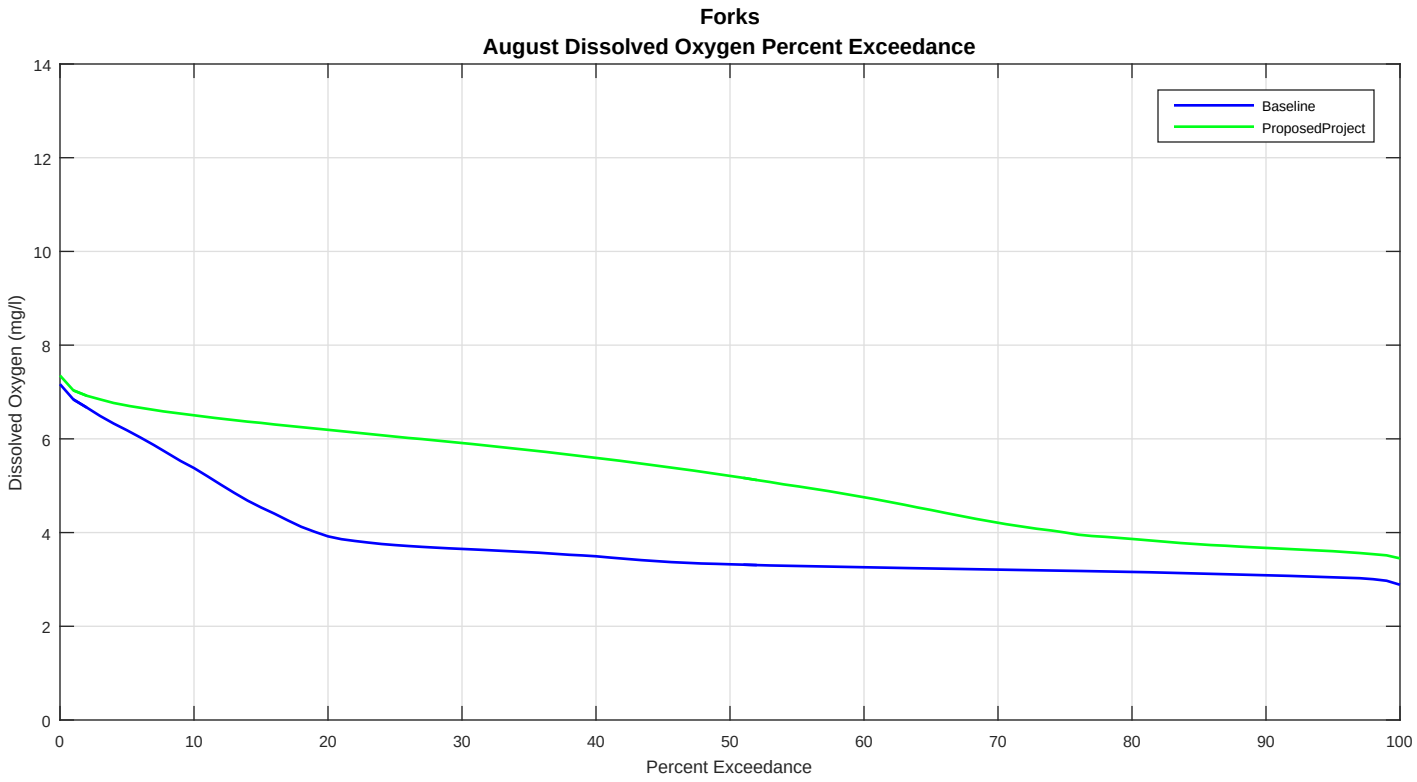
80
90
100


Forks
August Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
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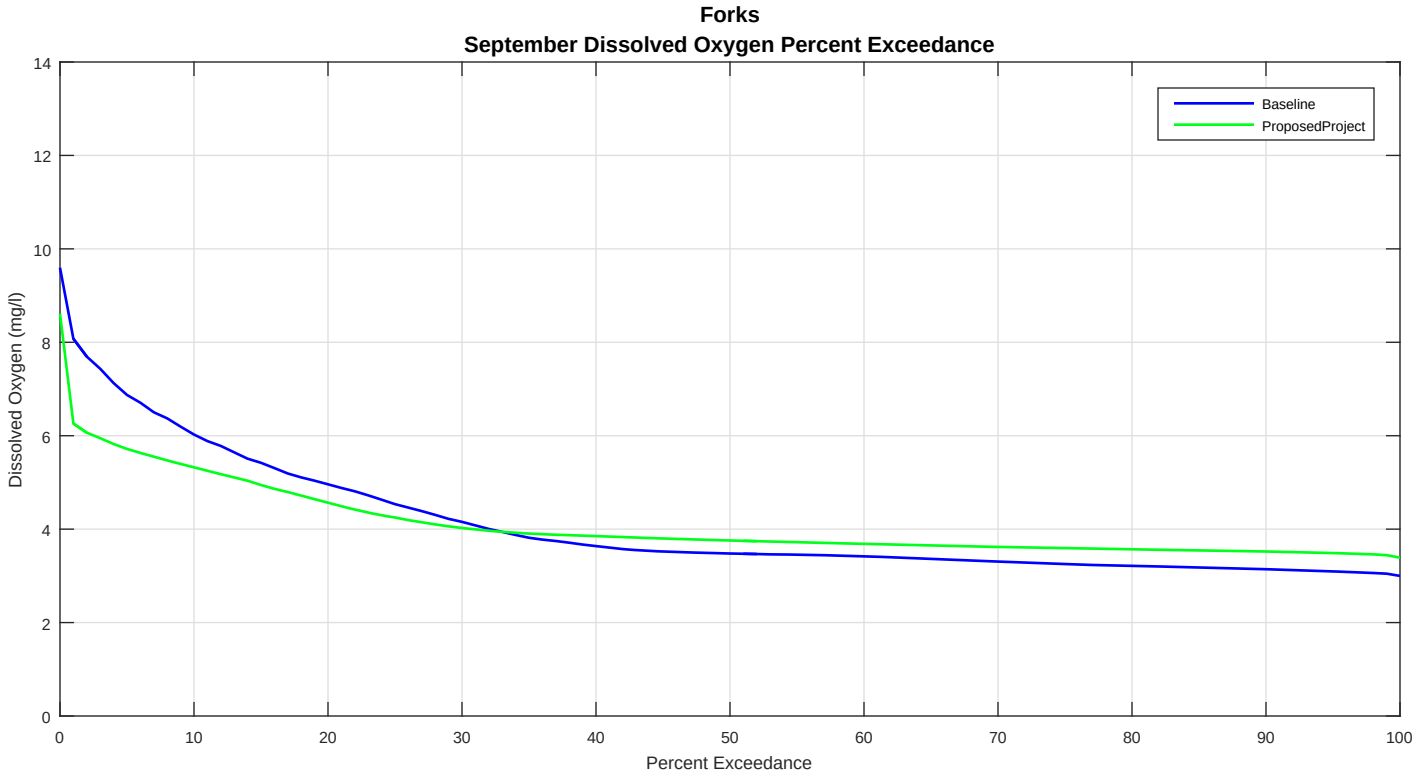
90
100


Forks
September Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
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30
40
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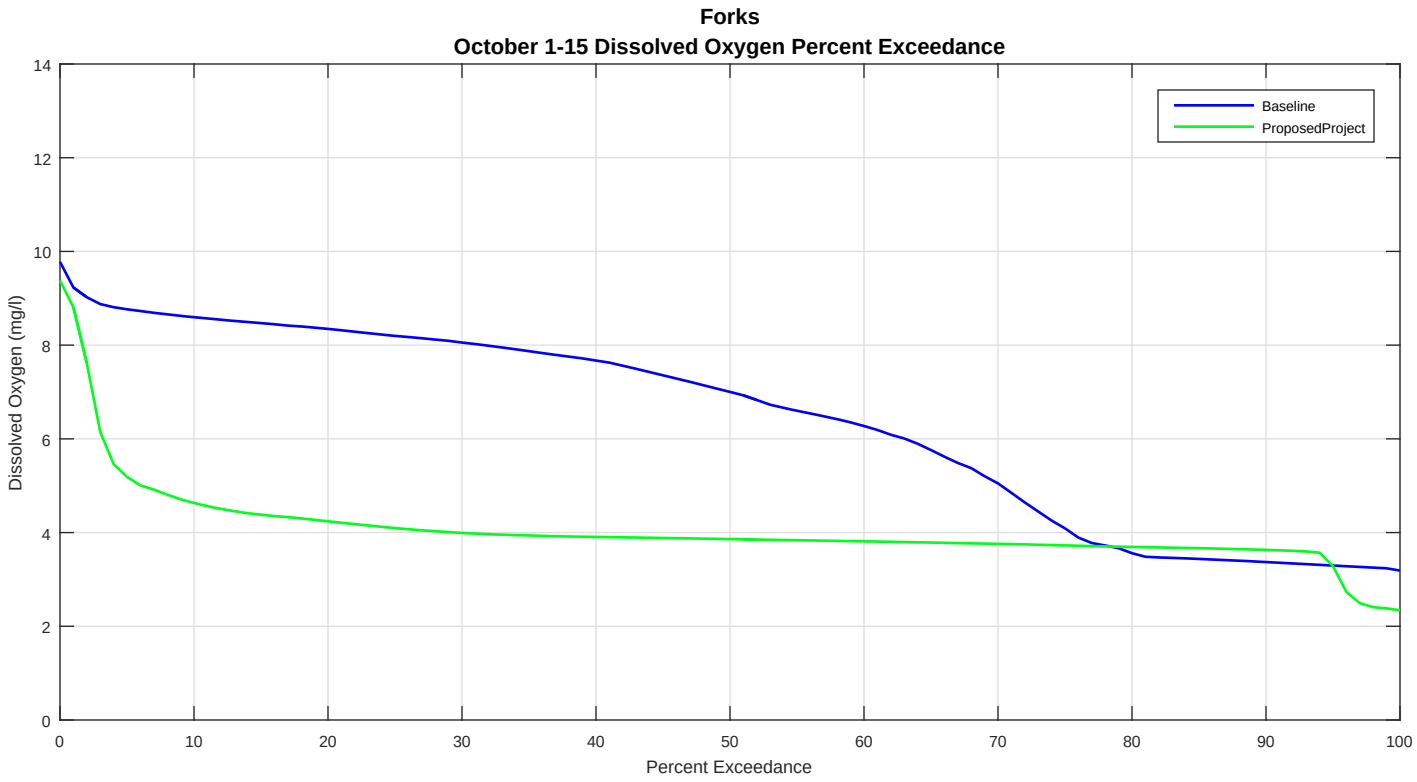
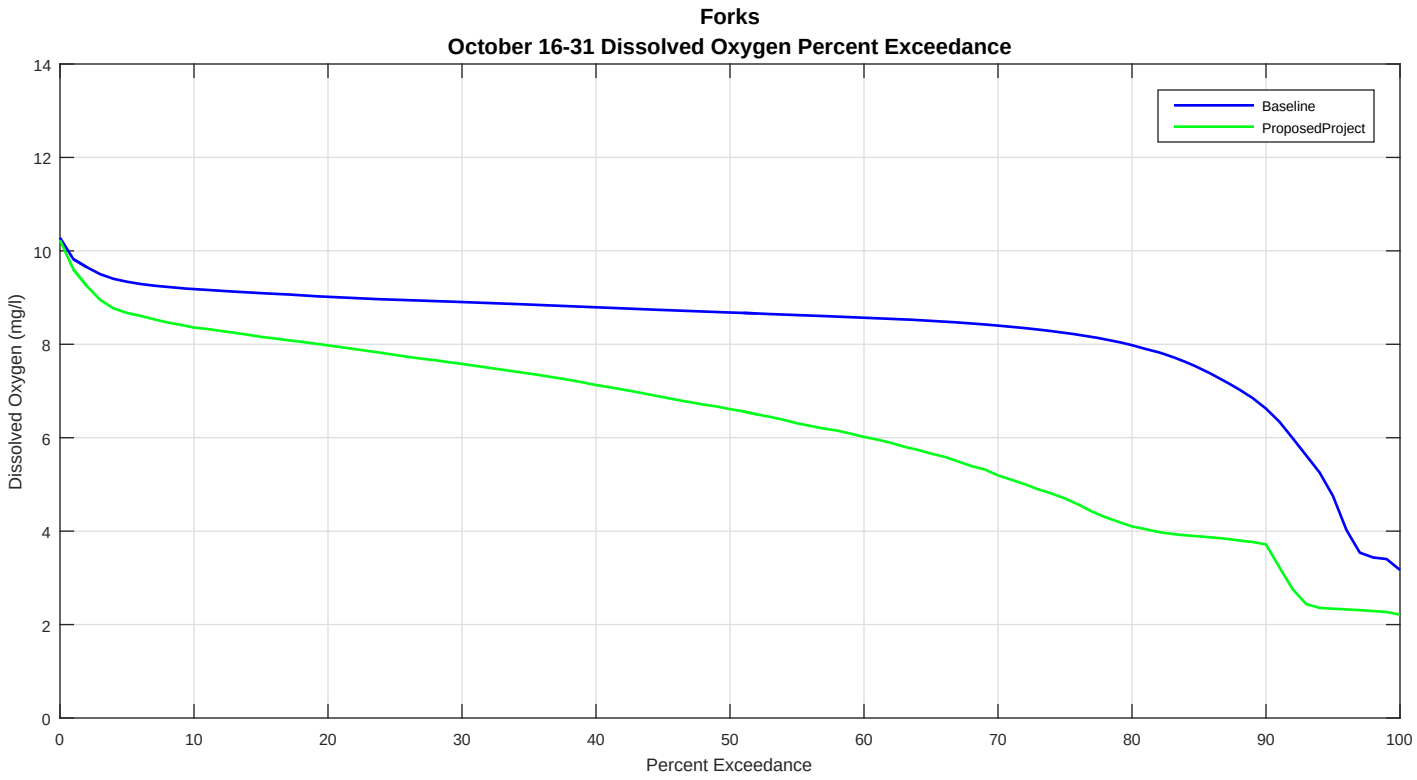
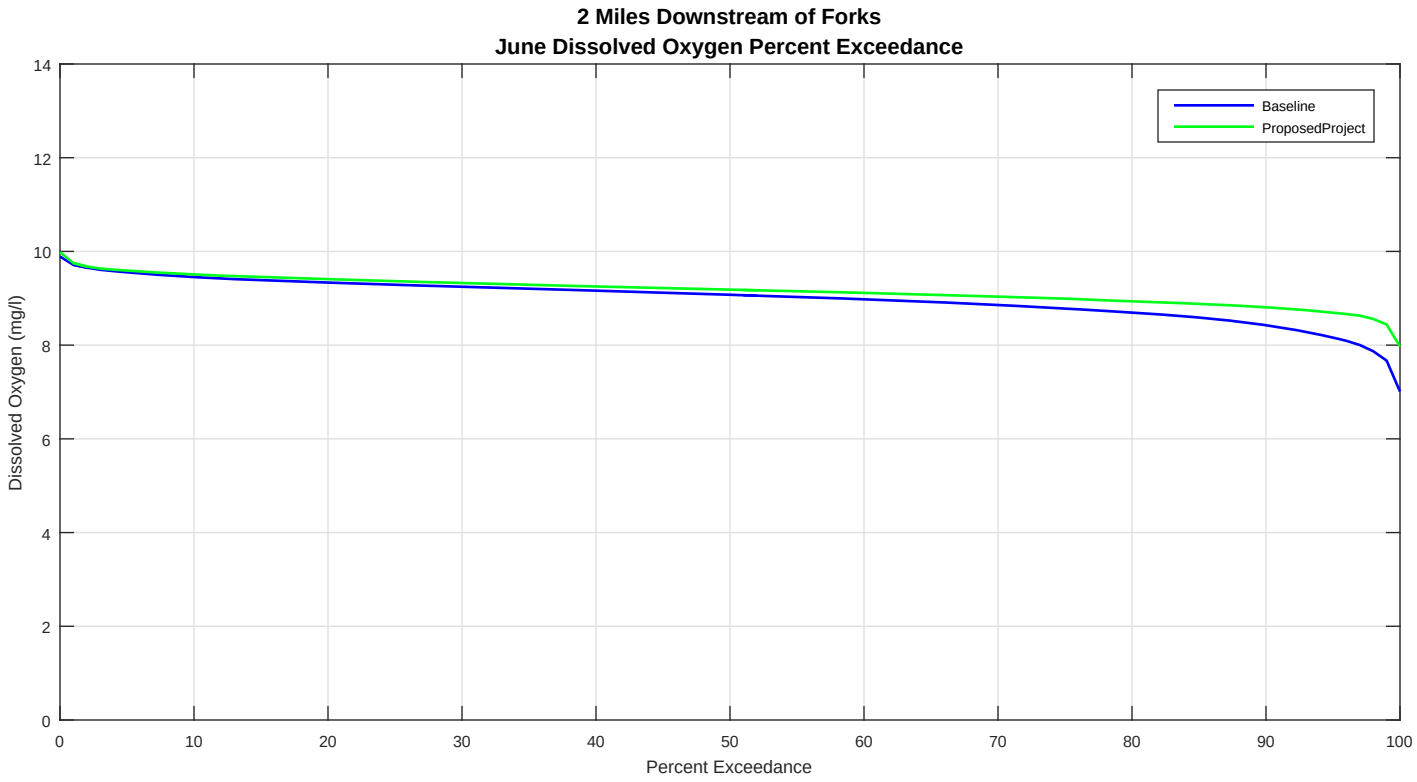
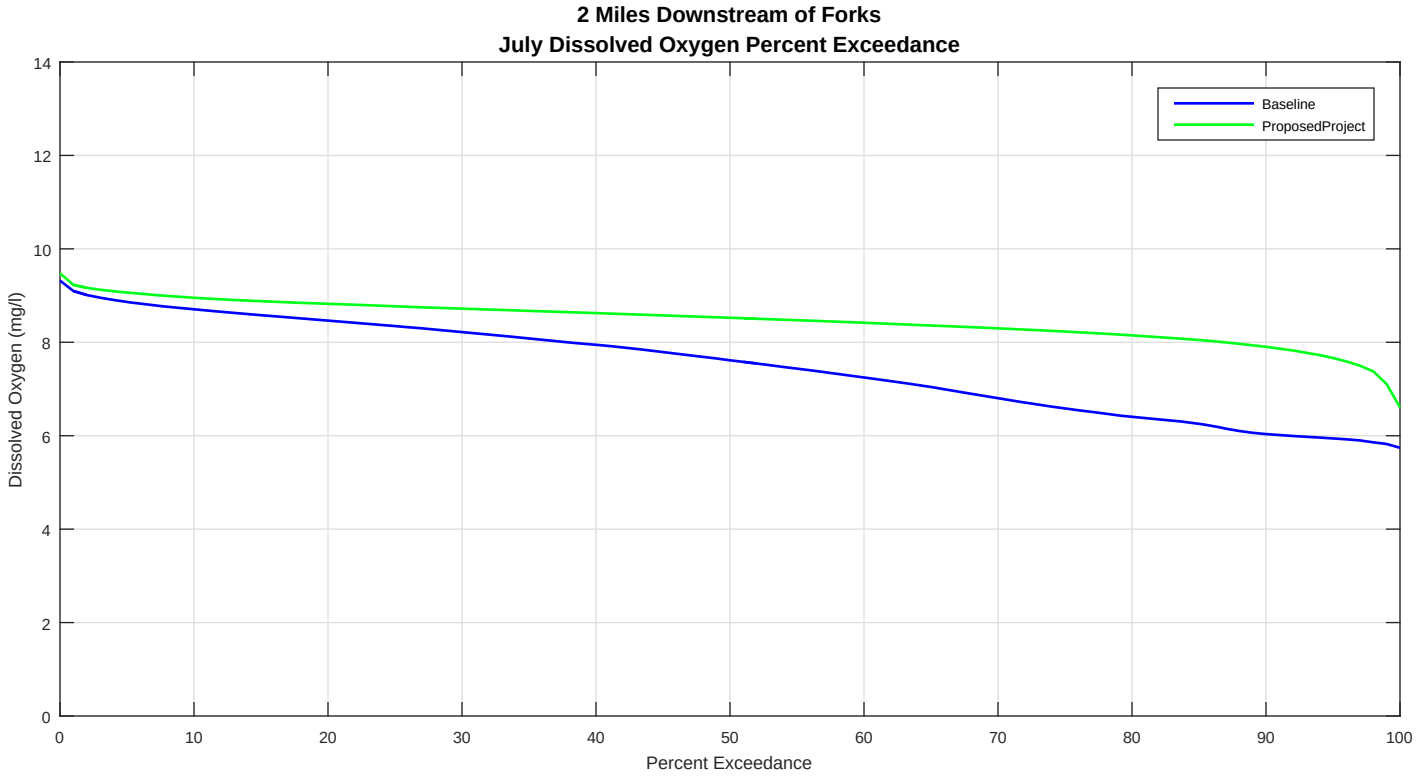
90
100


Forks
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Forks
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


2 Miles Downstream of Forks
June Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


2 Miles Downstream of Forks
July Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
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20
30
40
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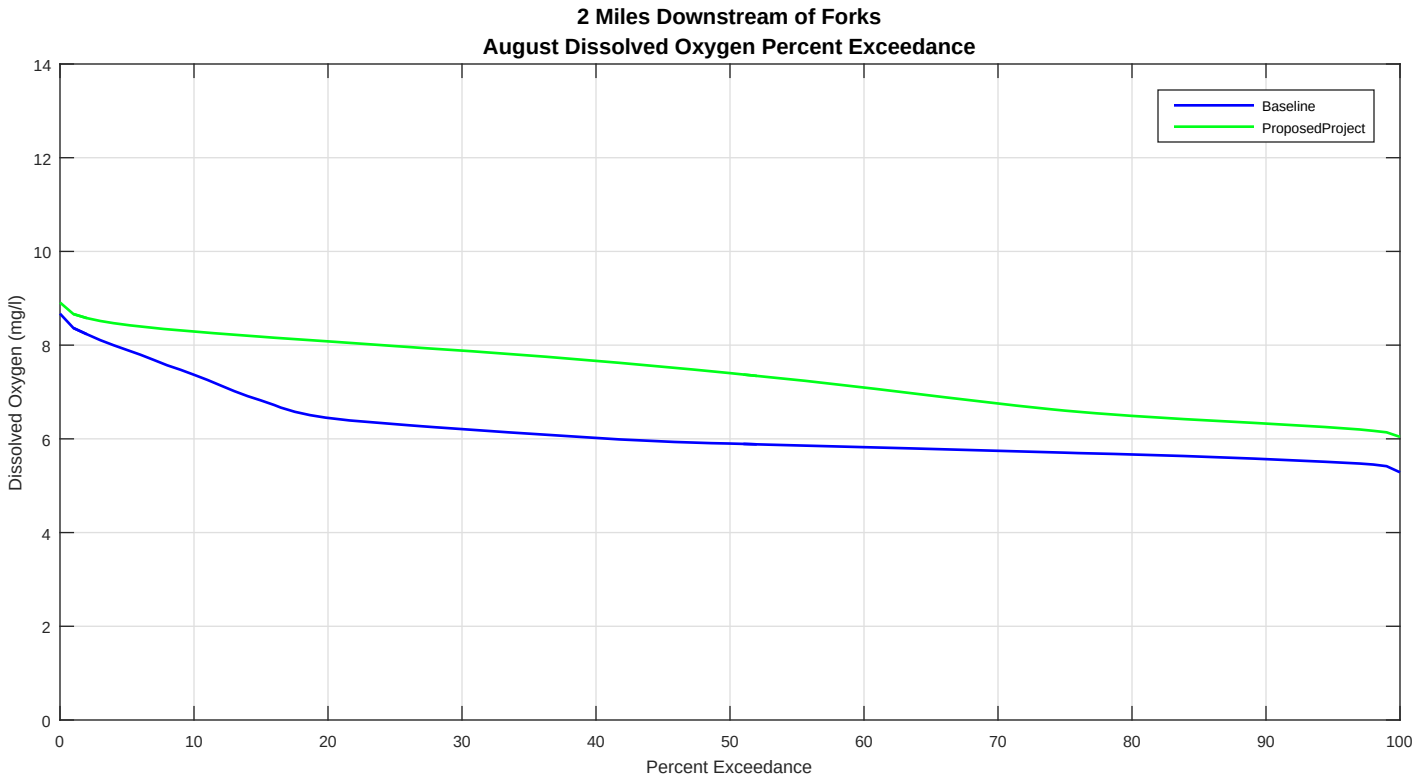
70
80
90
100


2 Miles Downstream of Forks
August Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
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20
30
40
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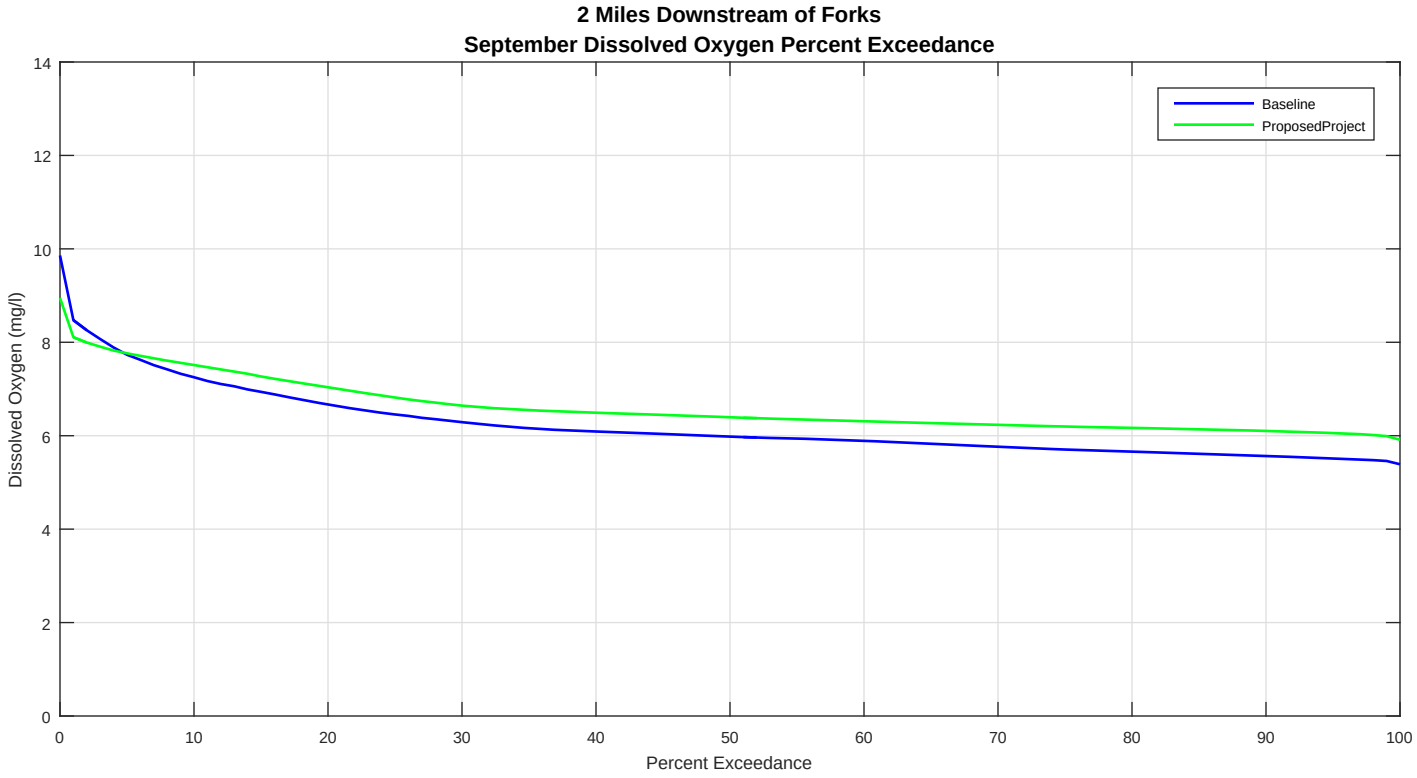
90
100


2 Miles Downstream of Forks
September Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
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6
8
10
12
14
0
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30
40
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90
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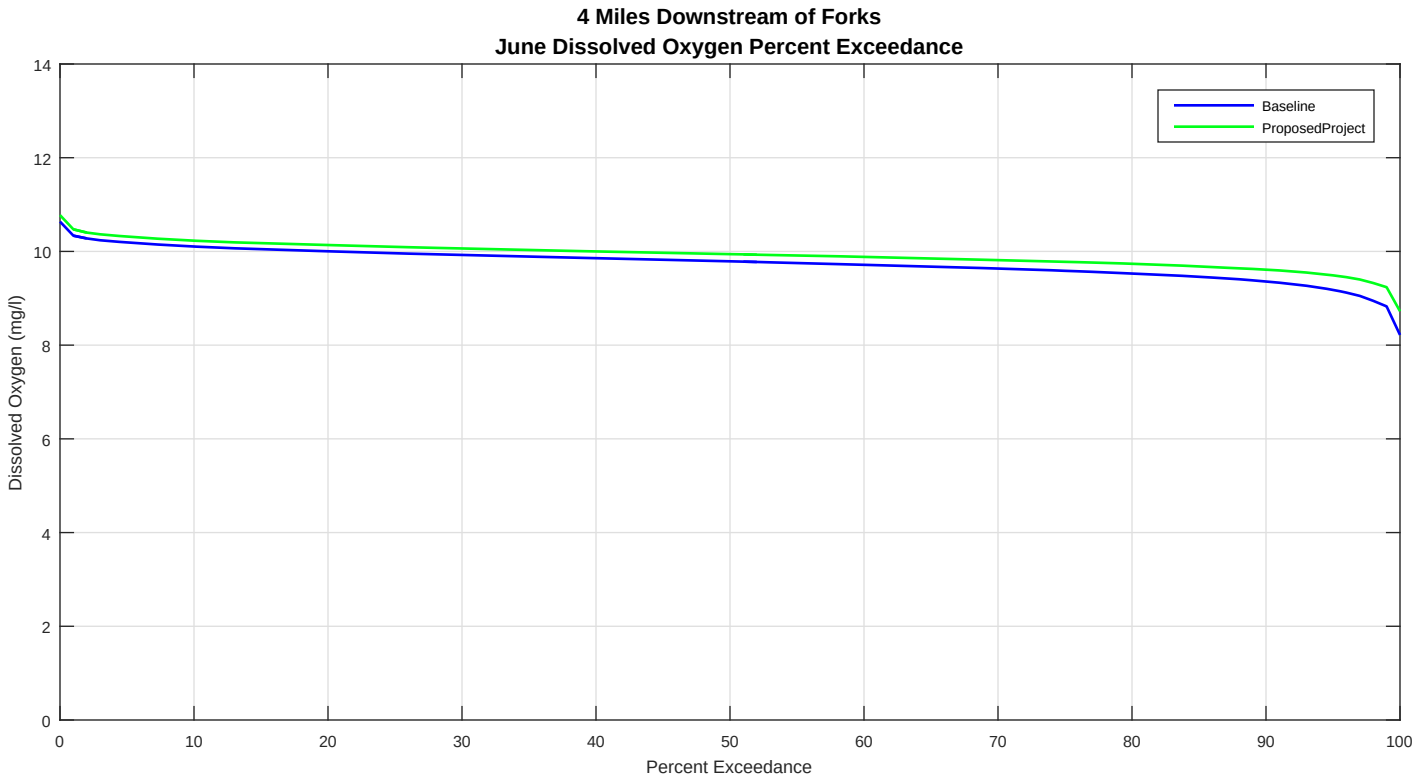
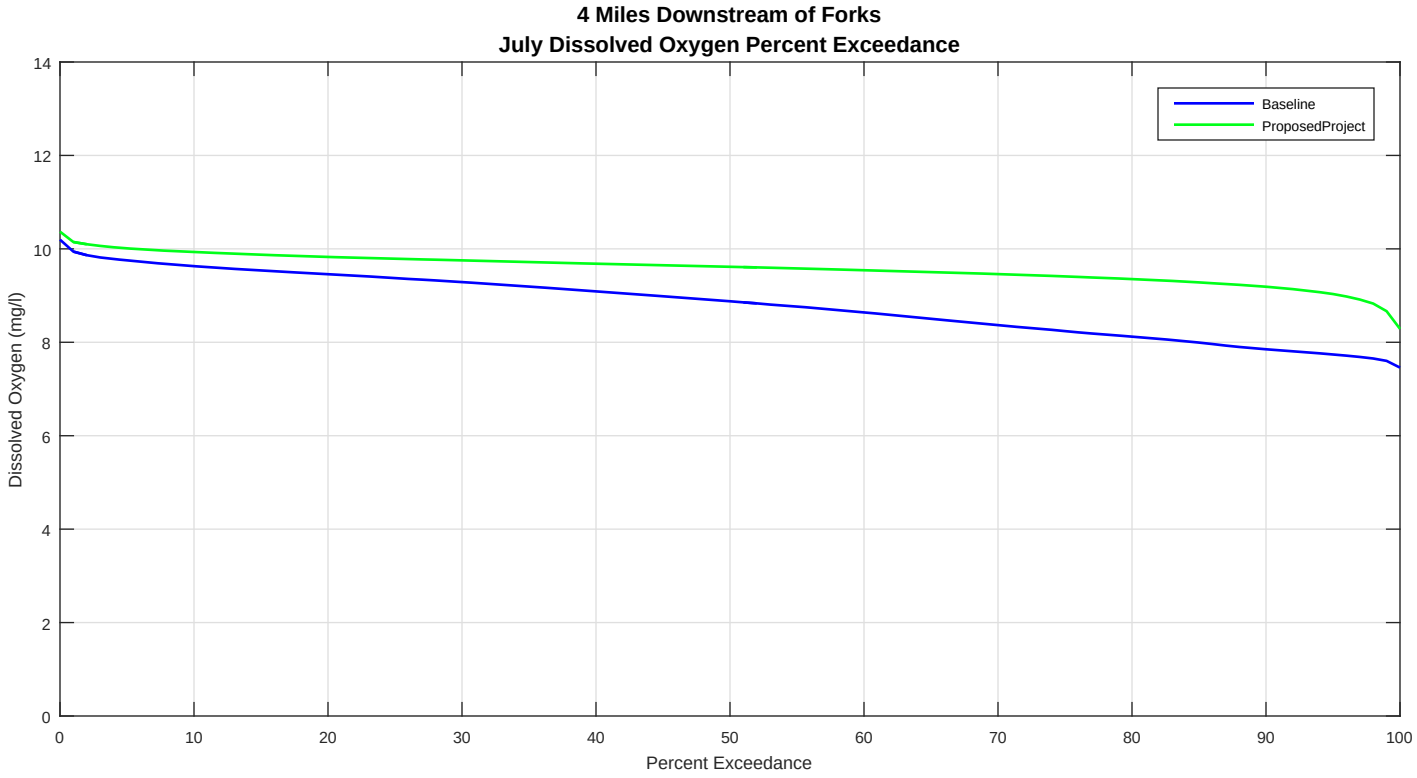
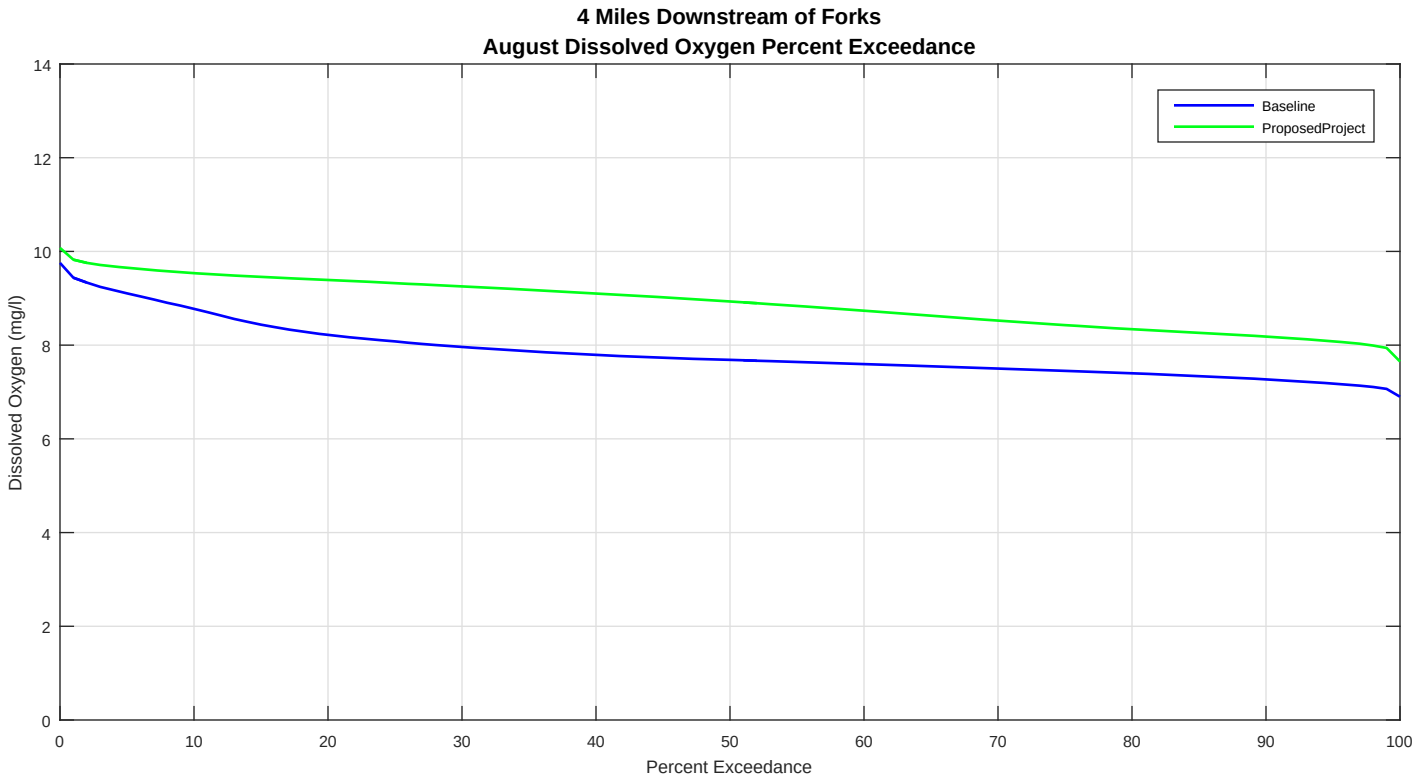
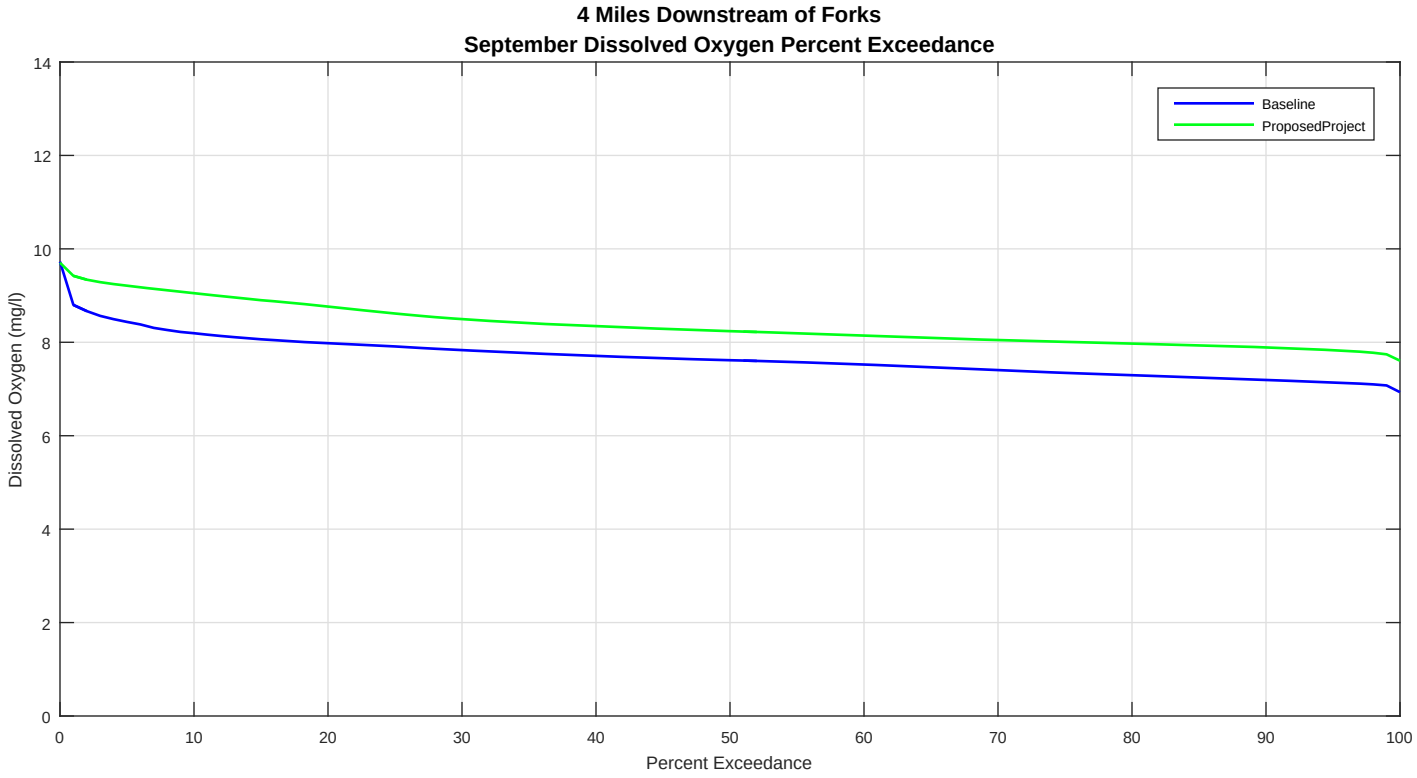

4 Miles Downstream of Forks
June Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


4 Miles Downstream of Forks
July Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


4 Miles Downstream of Forks
August Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


4 Miles Downstream of Forks
September Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
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20
30
40
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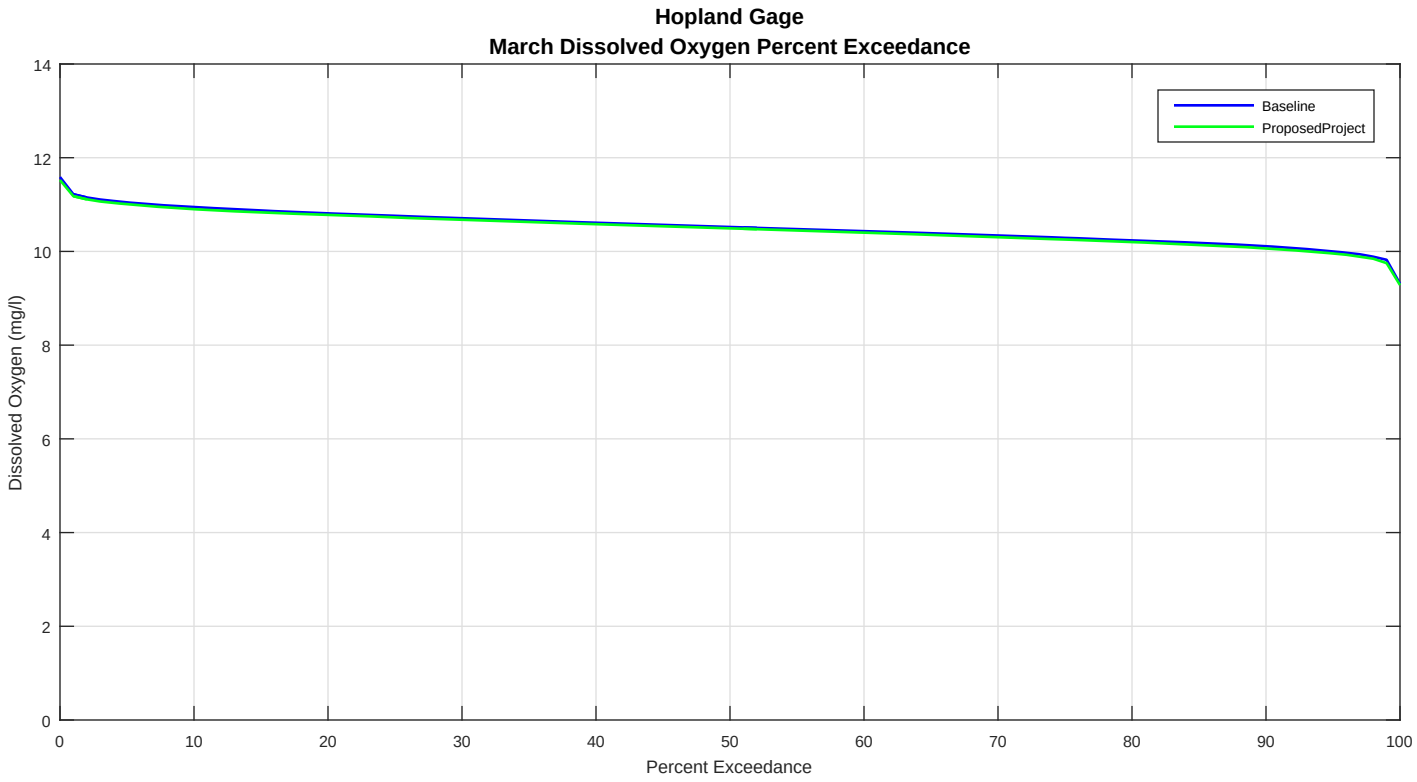
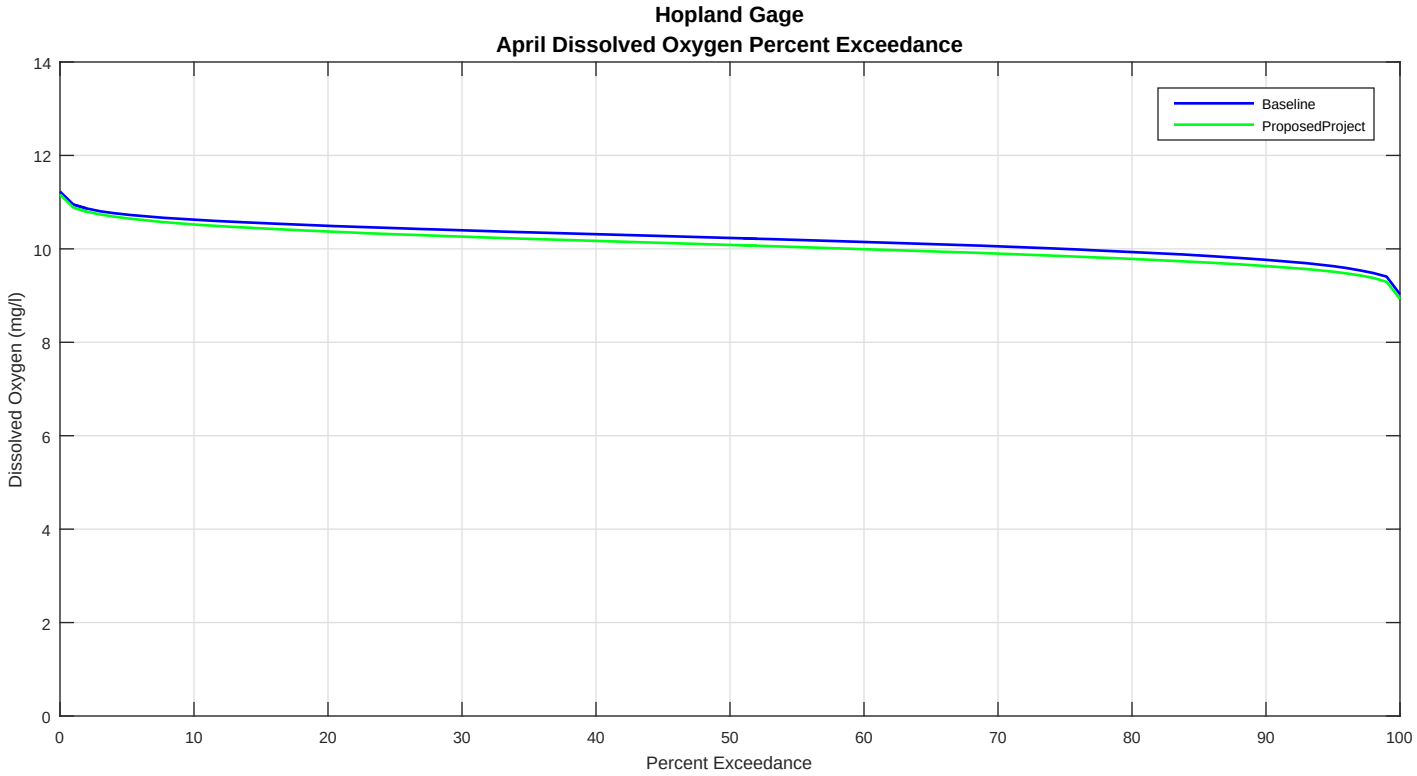
80
90
100


Hopland Gage
March Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Hopland Gage
April Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
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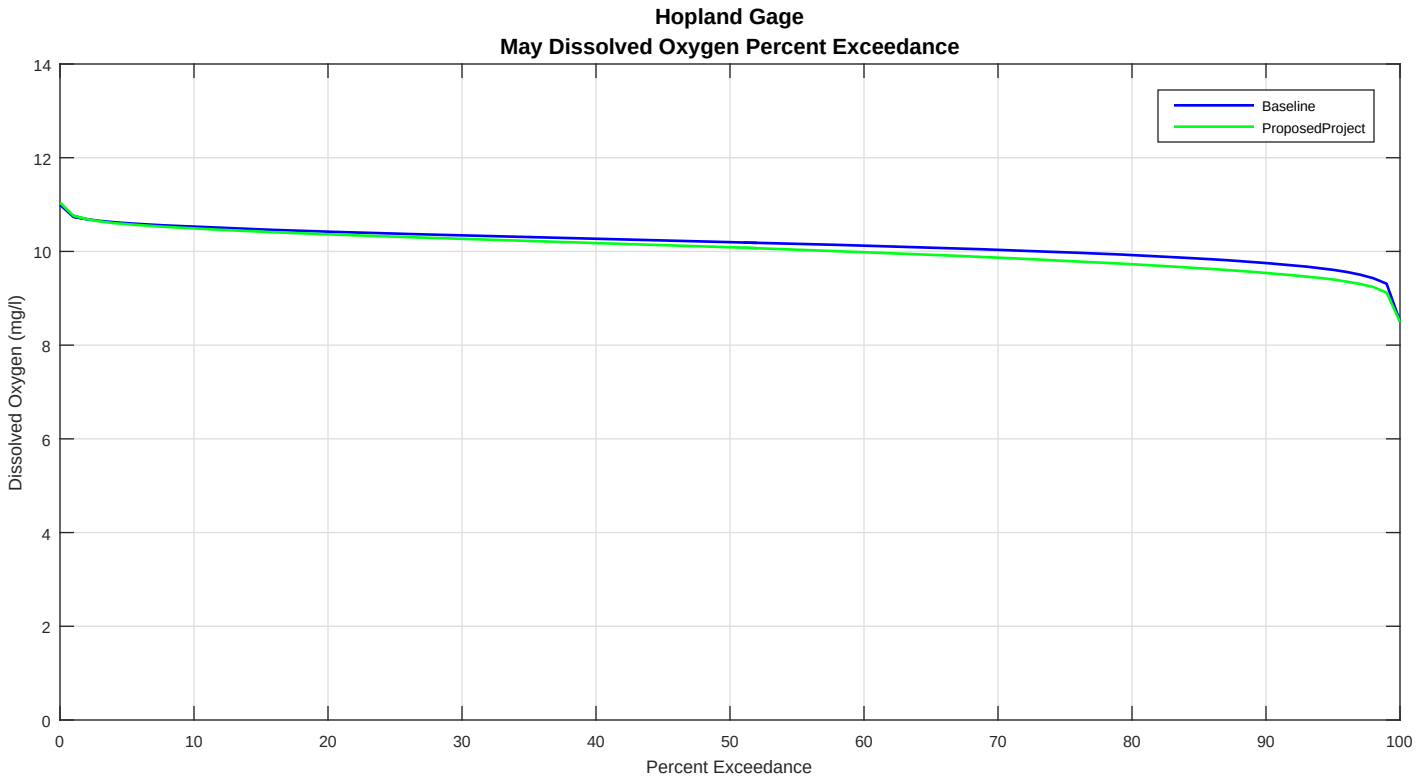
Hopland Gage
May Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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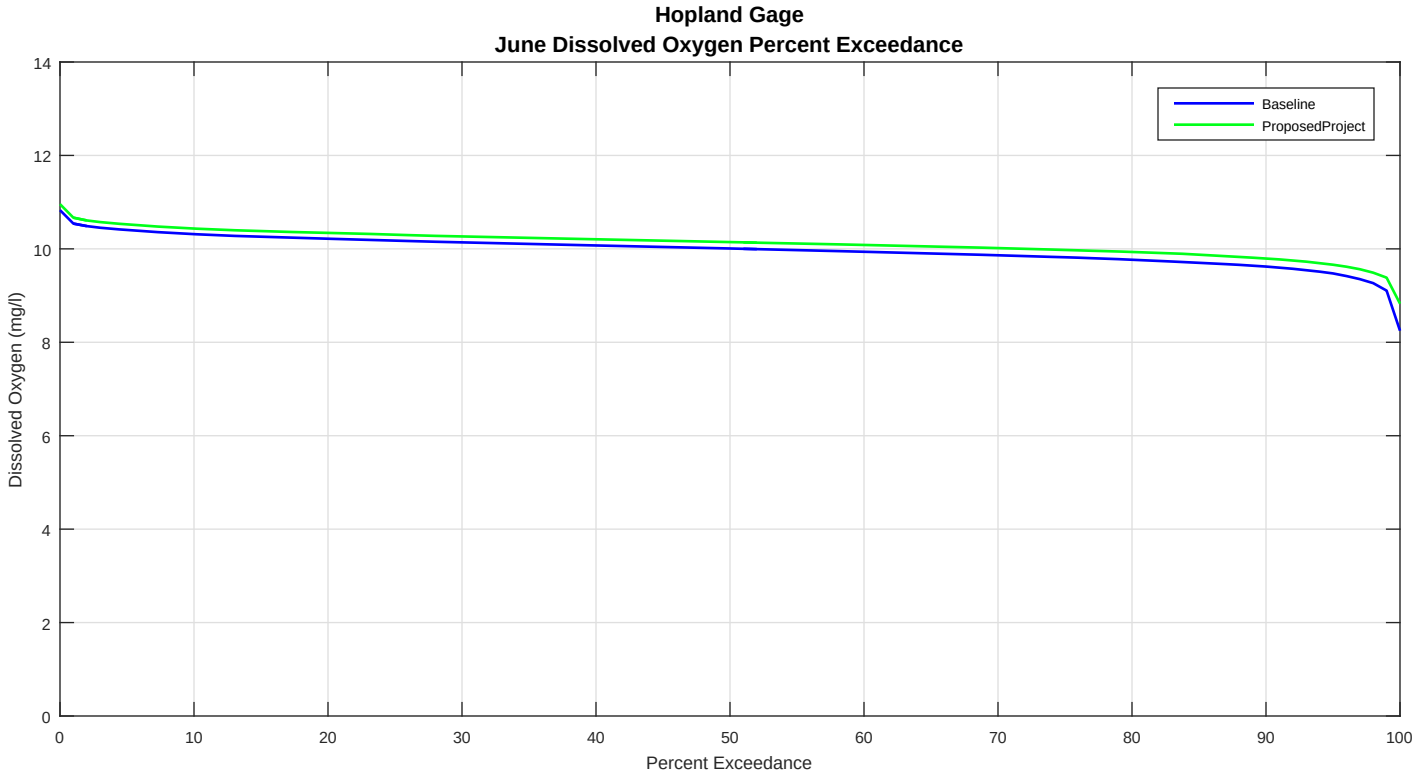
Hopland Gage
June Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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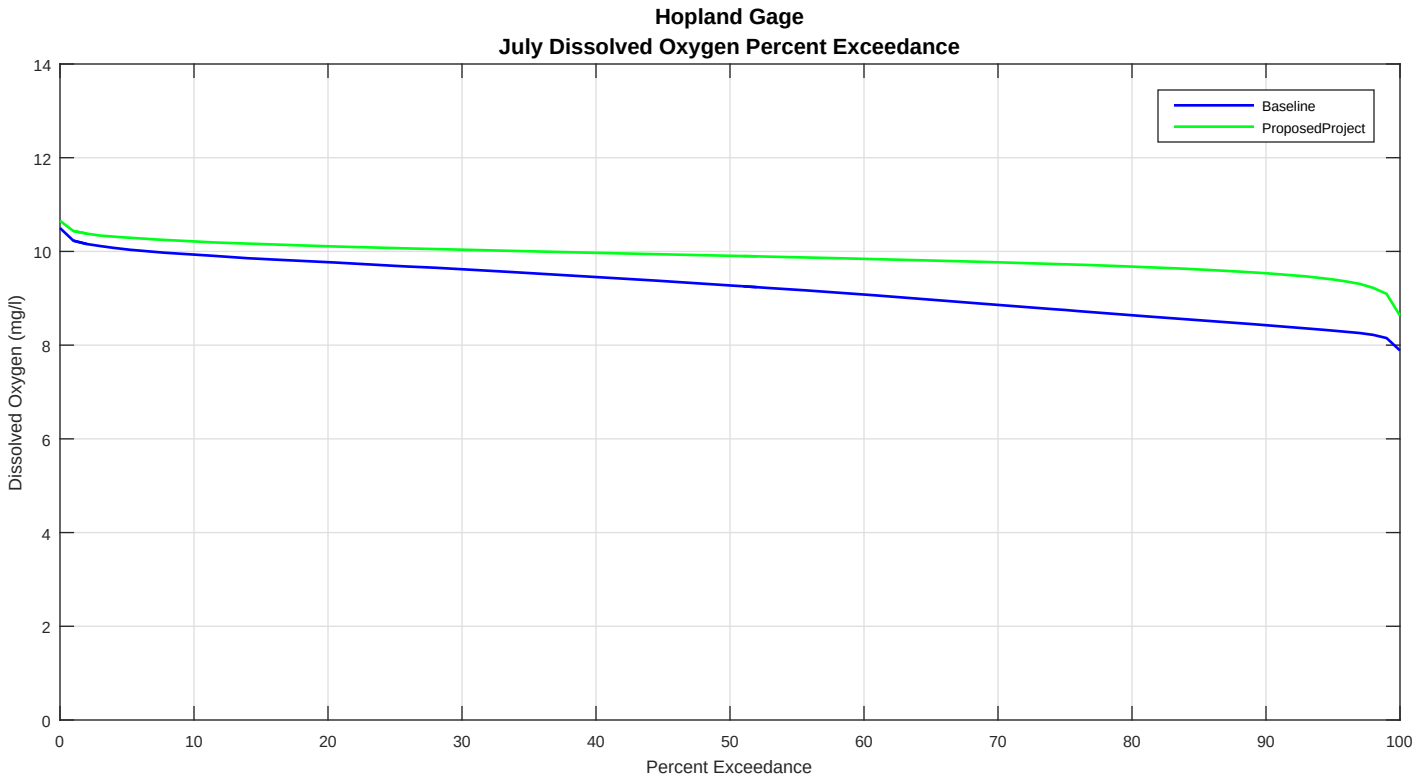
Hopland Gage
July Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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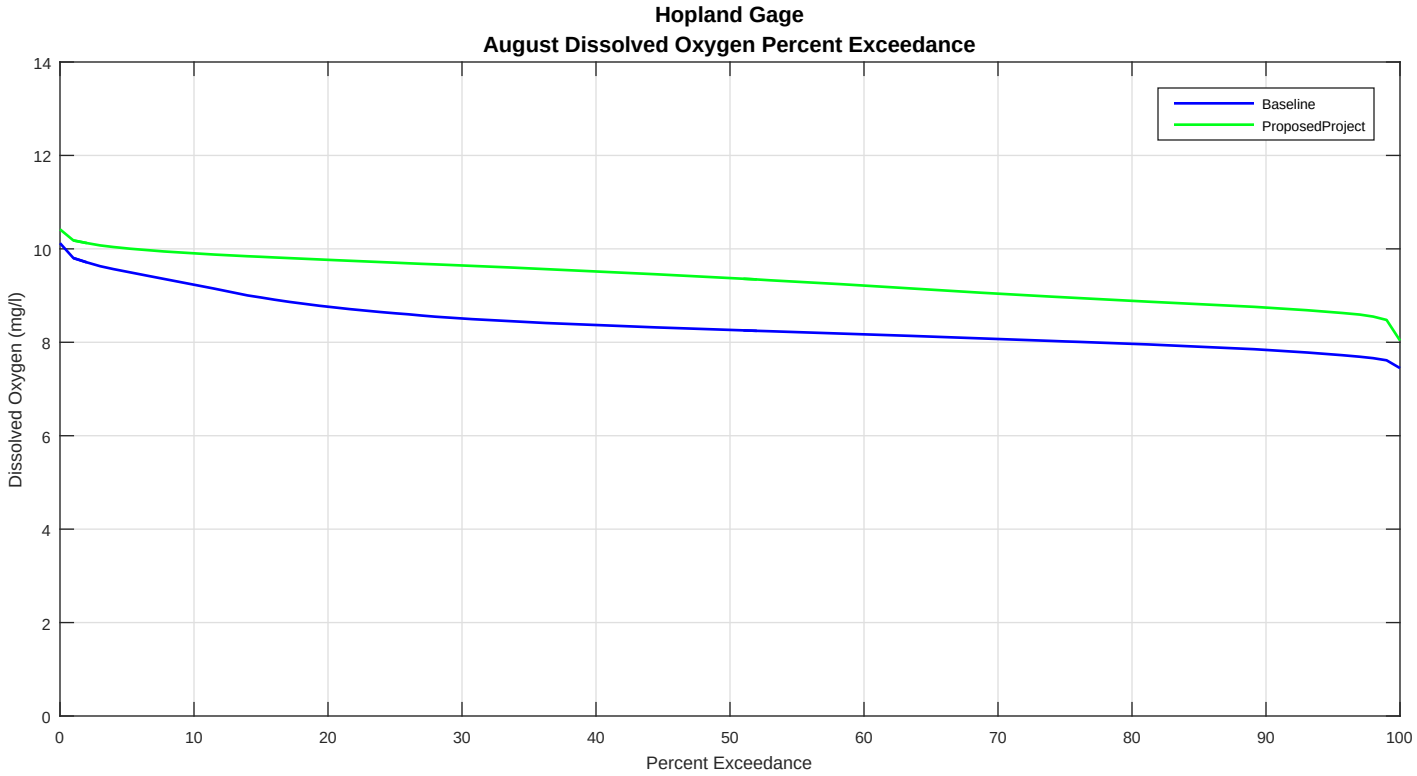
Hopland Gage
August Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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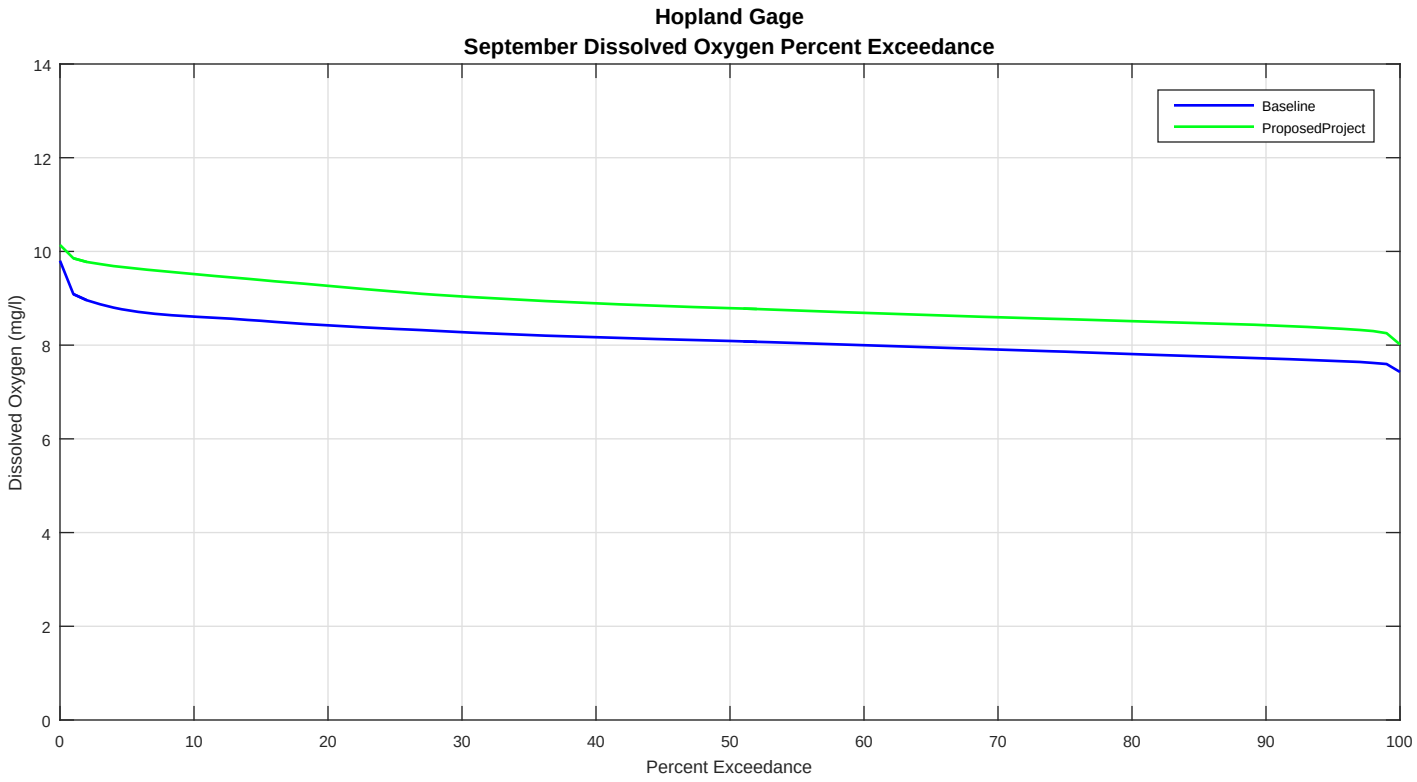
Hopland Gage
September Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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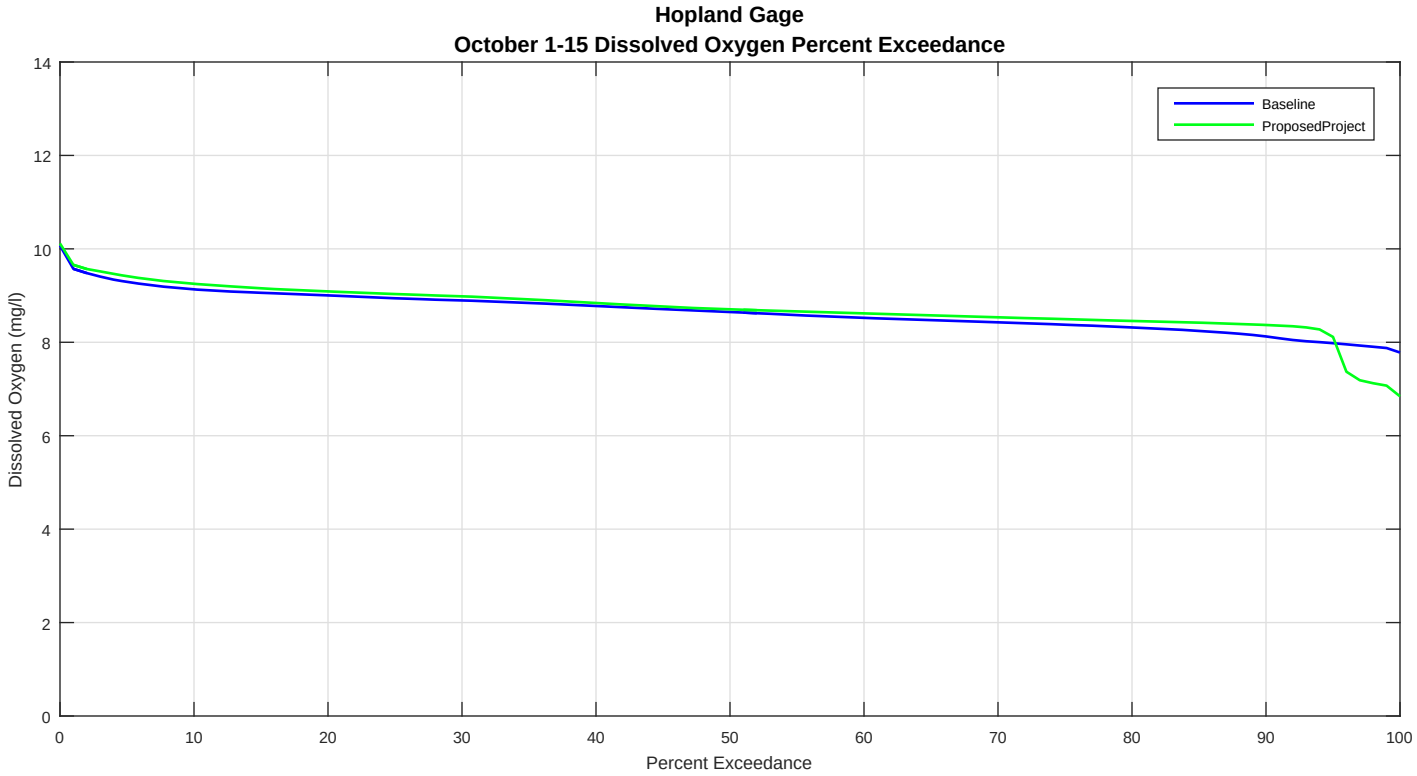
Hopland Gage
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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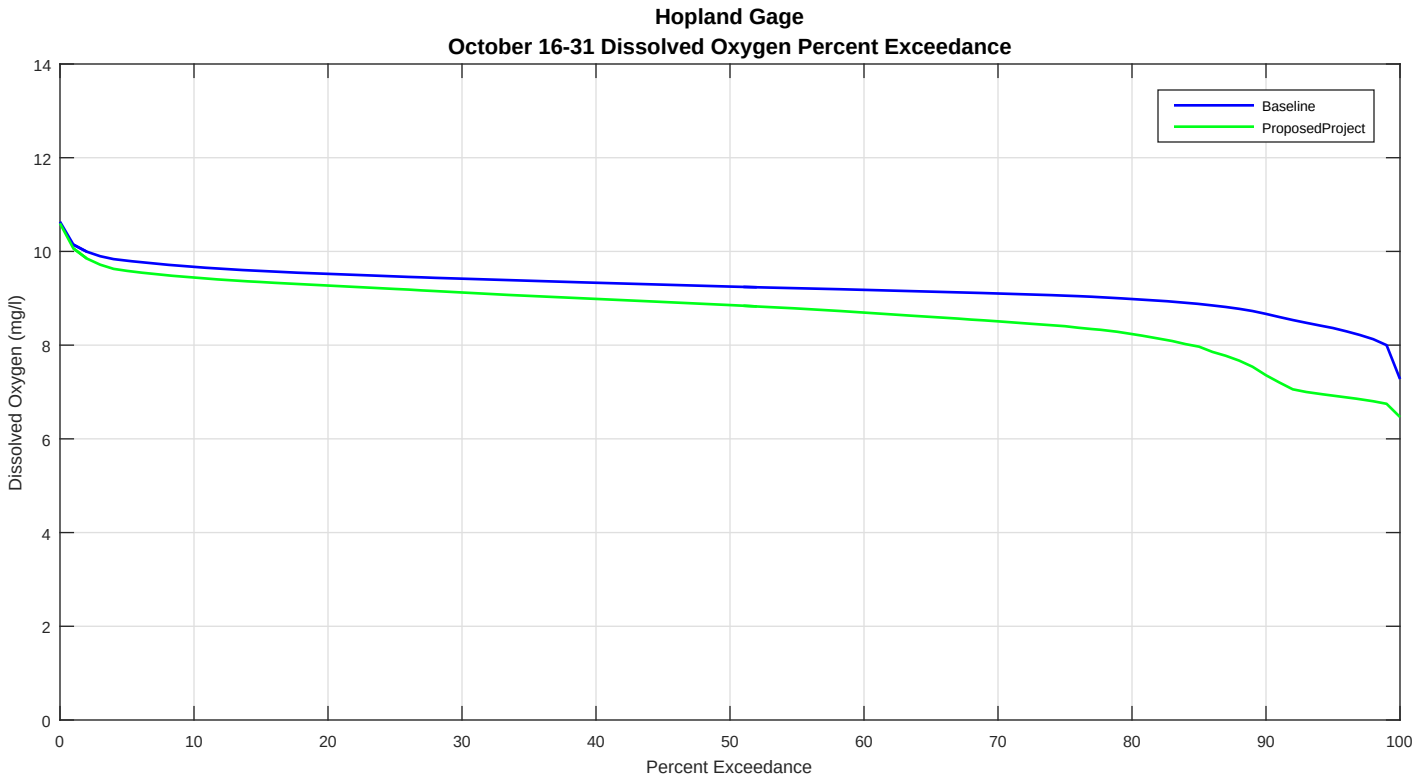
Hopland Gage
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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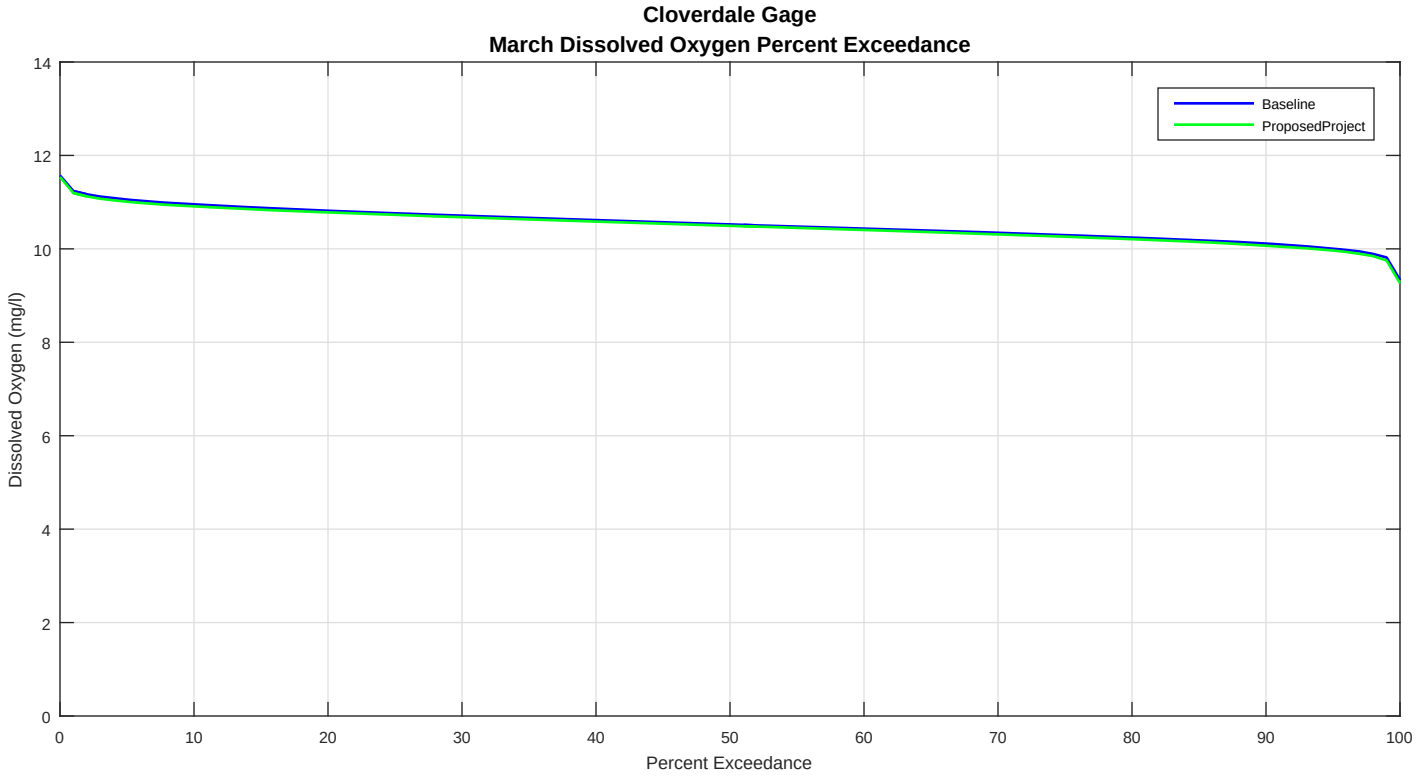
Cloverdale Gage
March Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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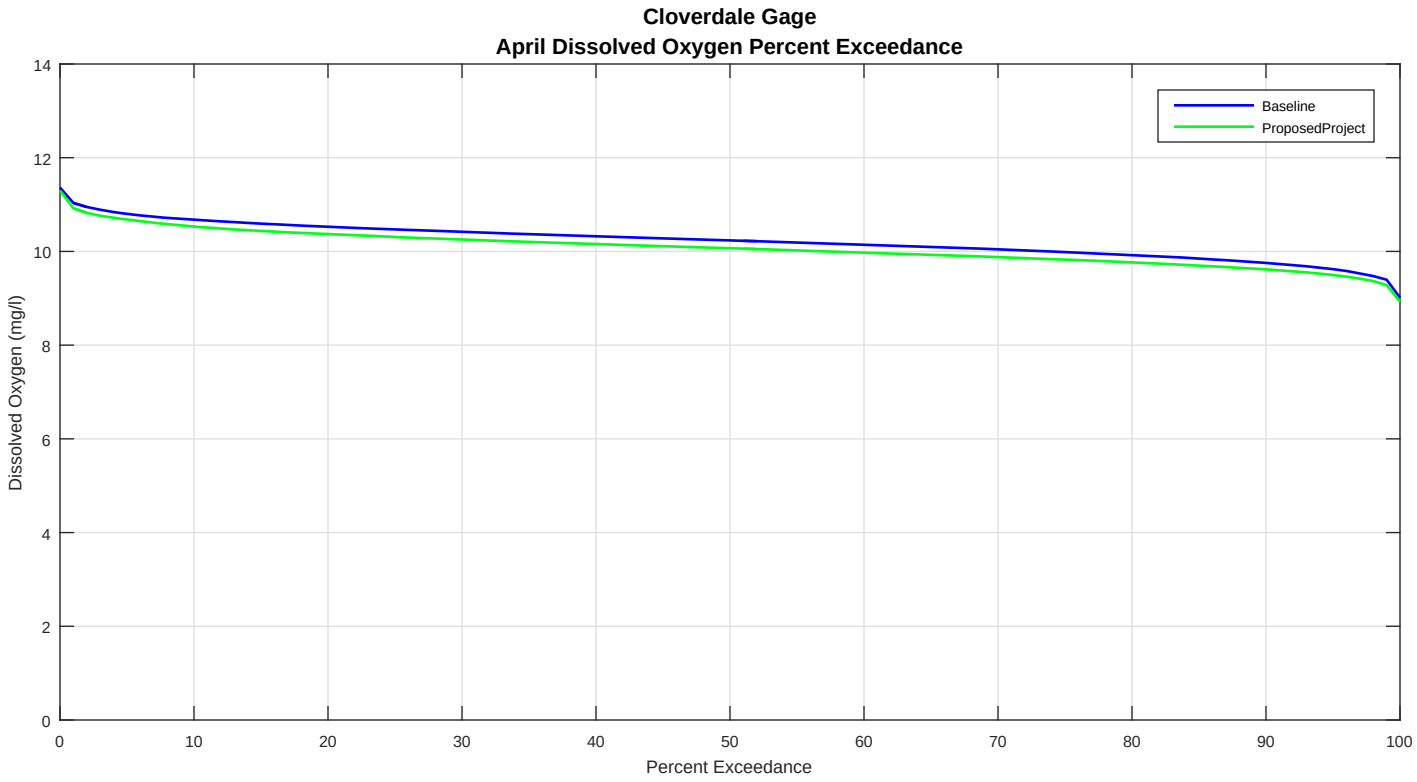
Cloverdale Gage
April Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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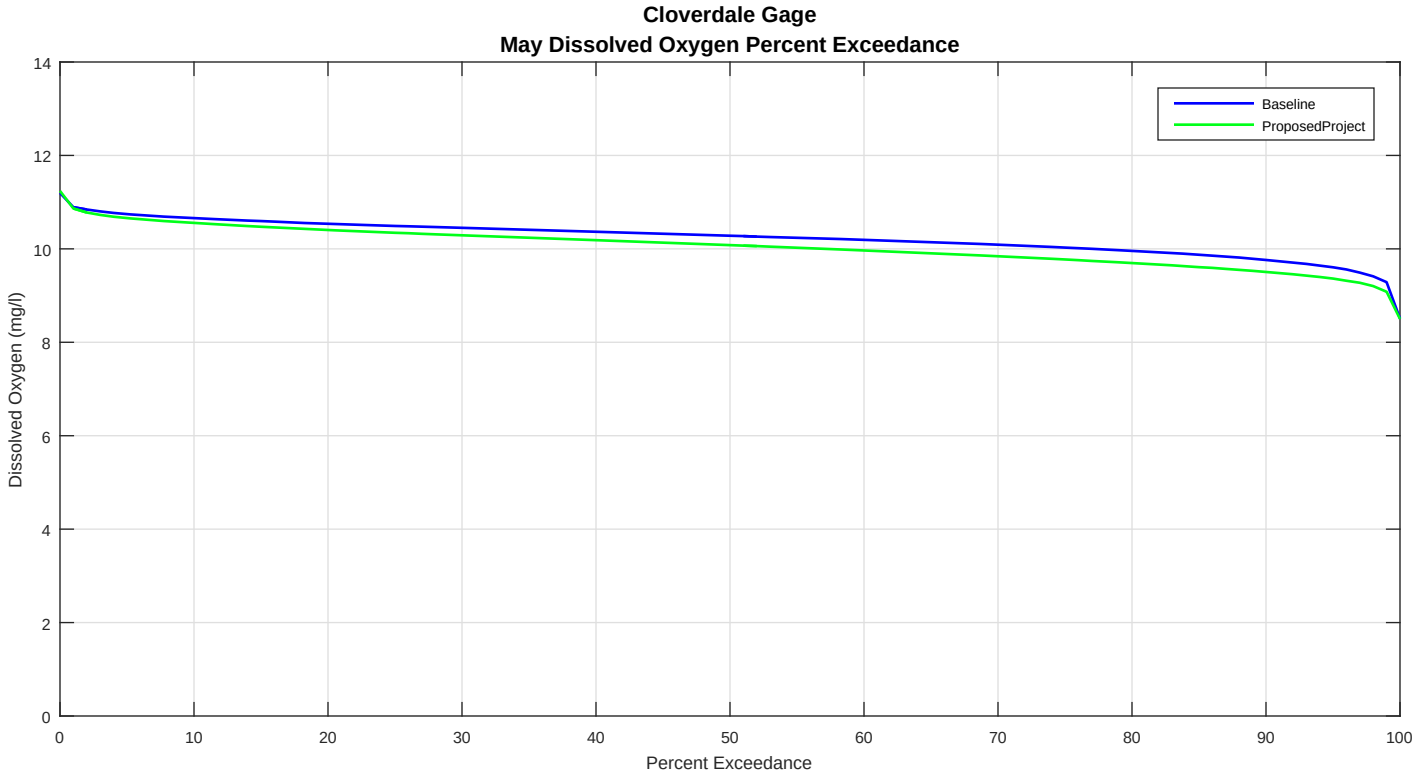
Cloverdale Gage
May Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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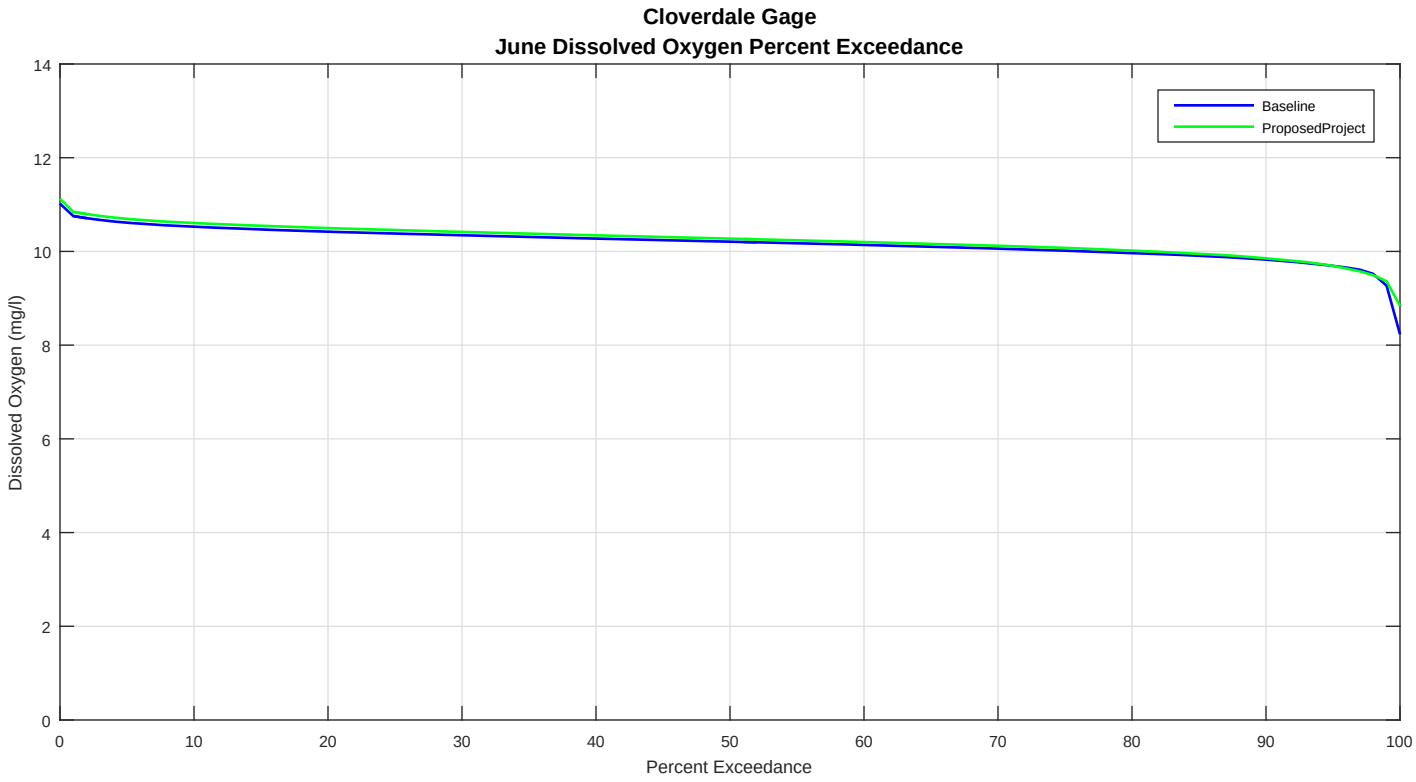
Cloverdale Gage
June Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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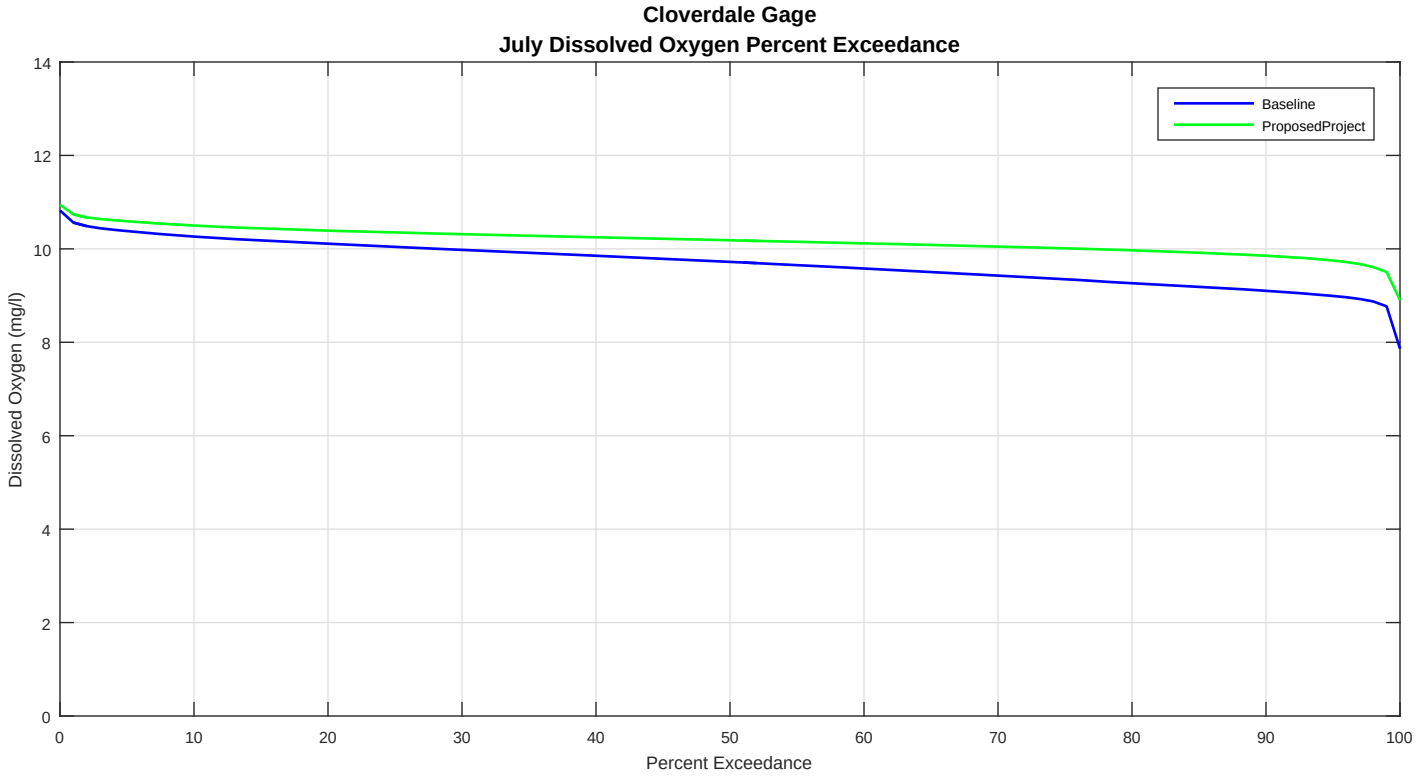
Cloverdale Gage
July Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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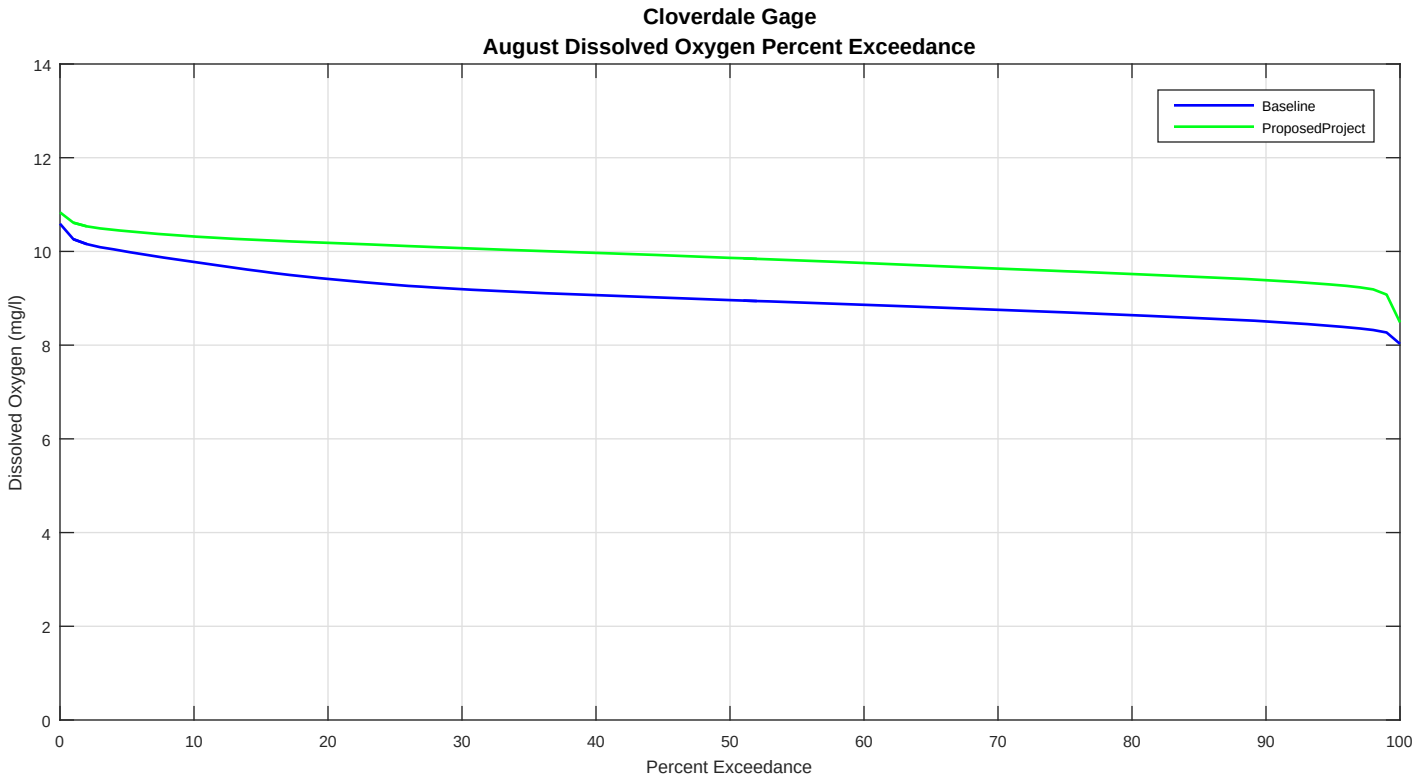
Cloverdale Gage
August Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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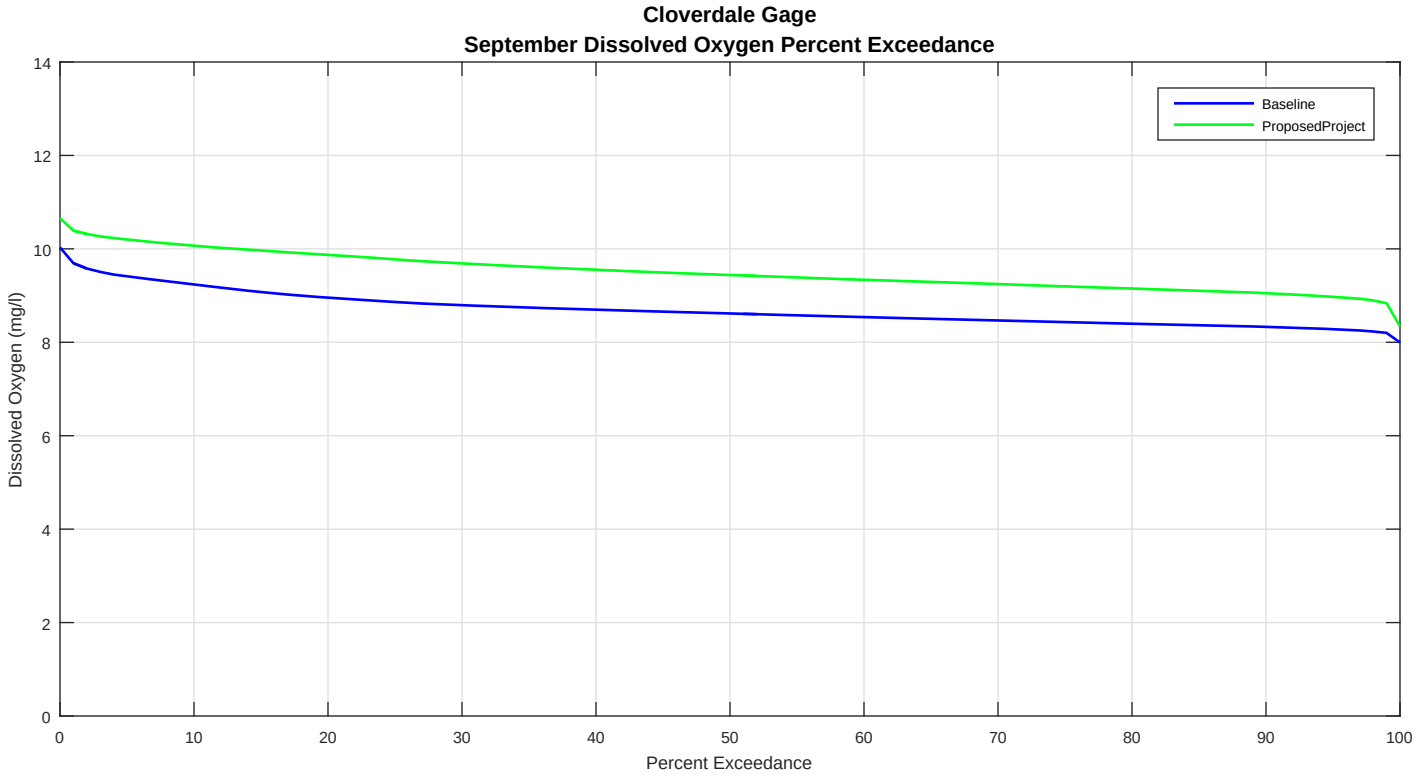
Cloverdale Gage
September Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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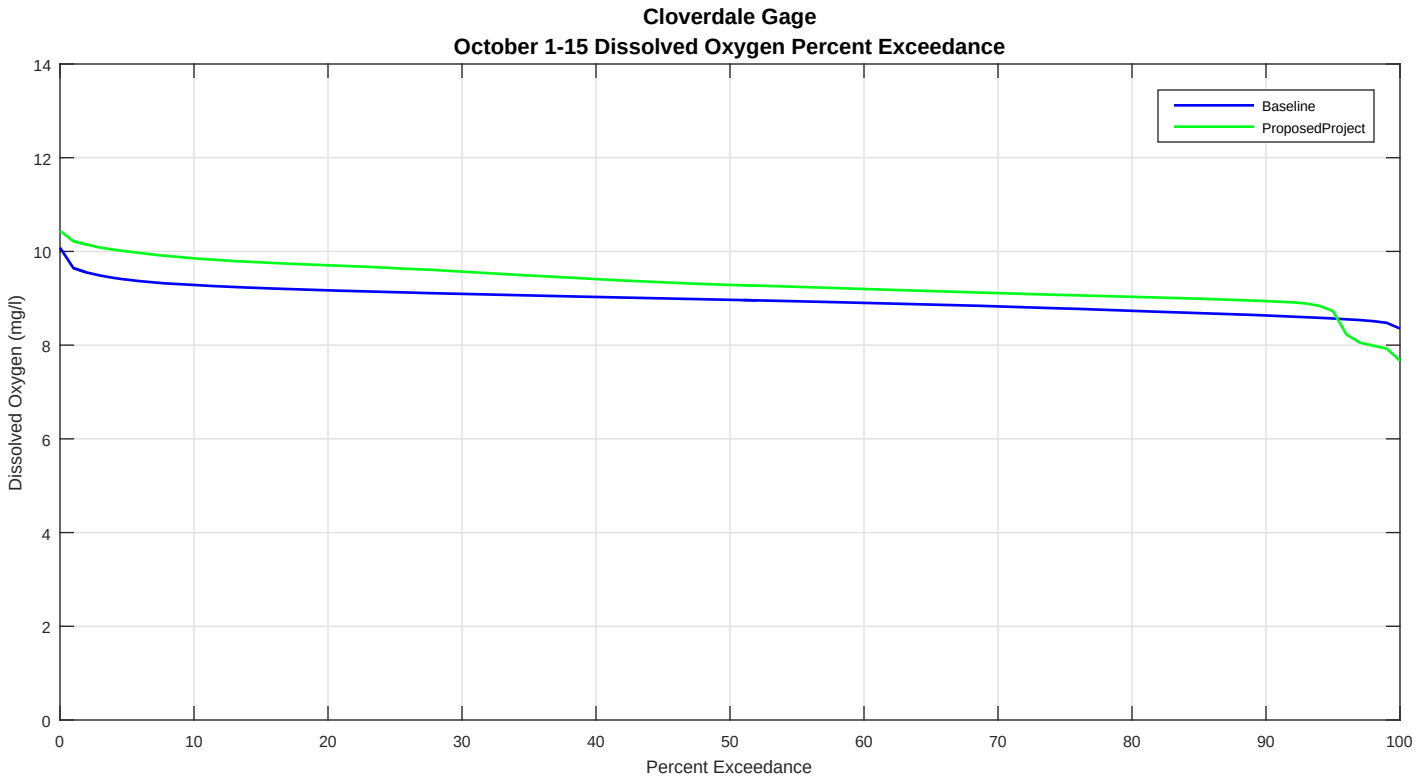
Cloverdale Gage
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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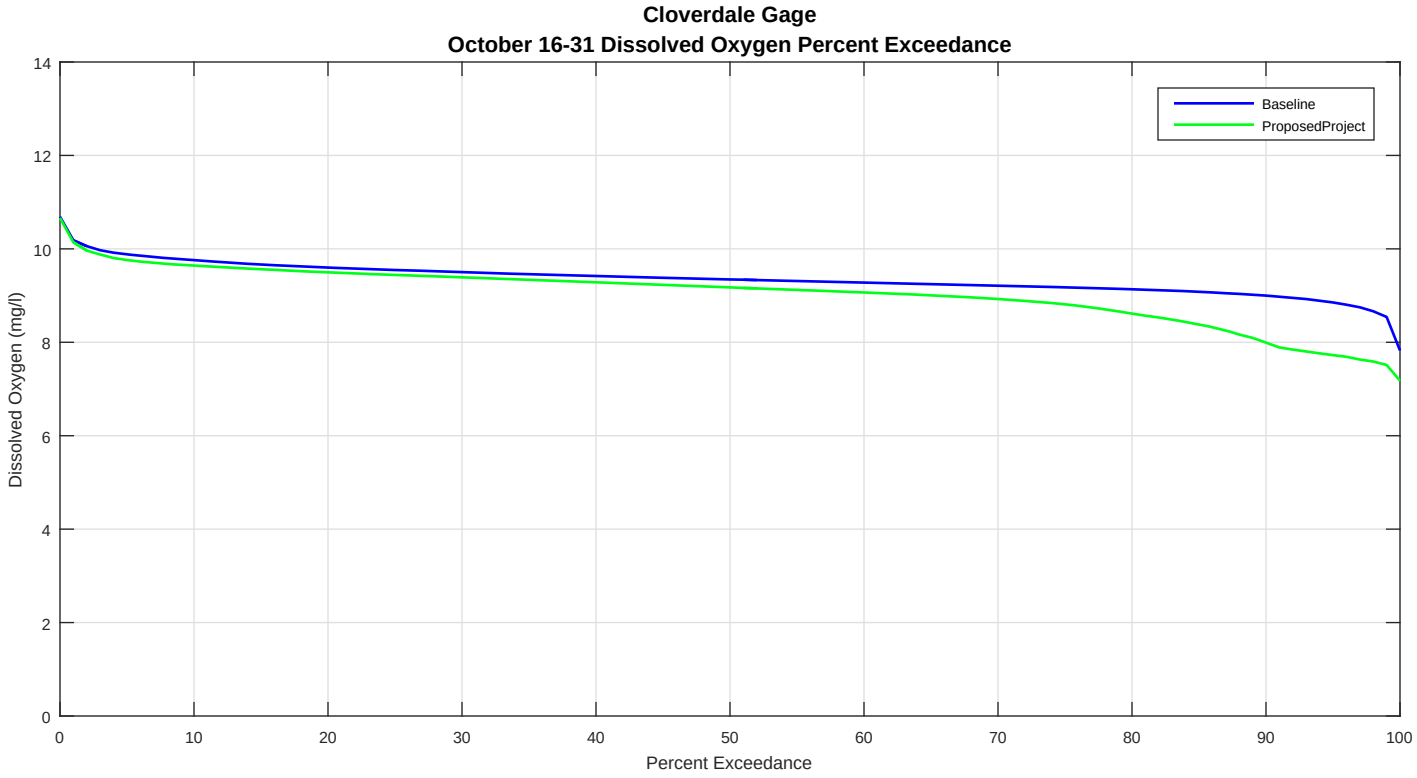
Cloverdale Gage
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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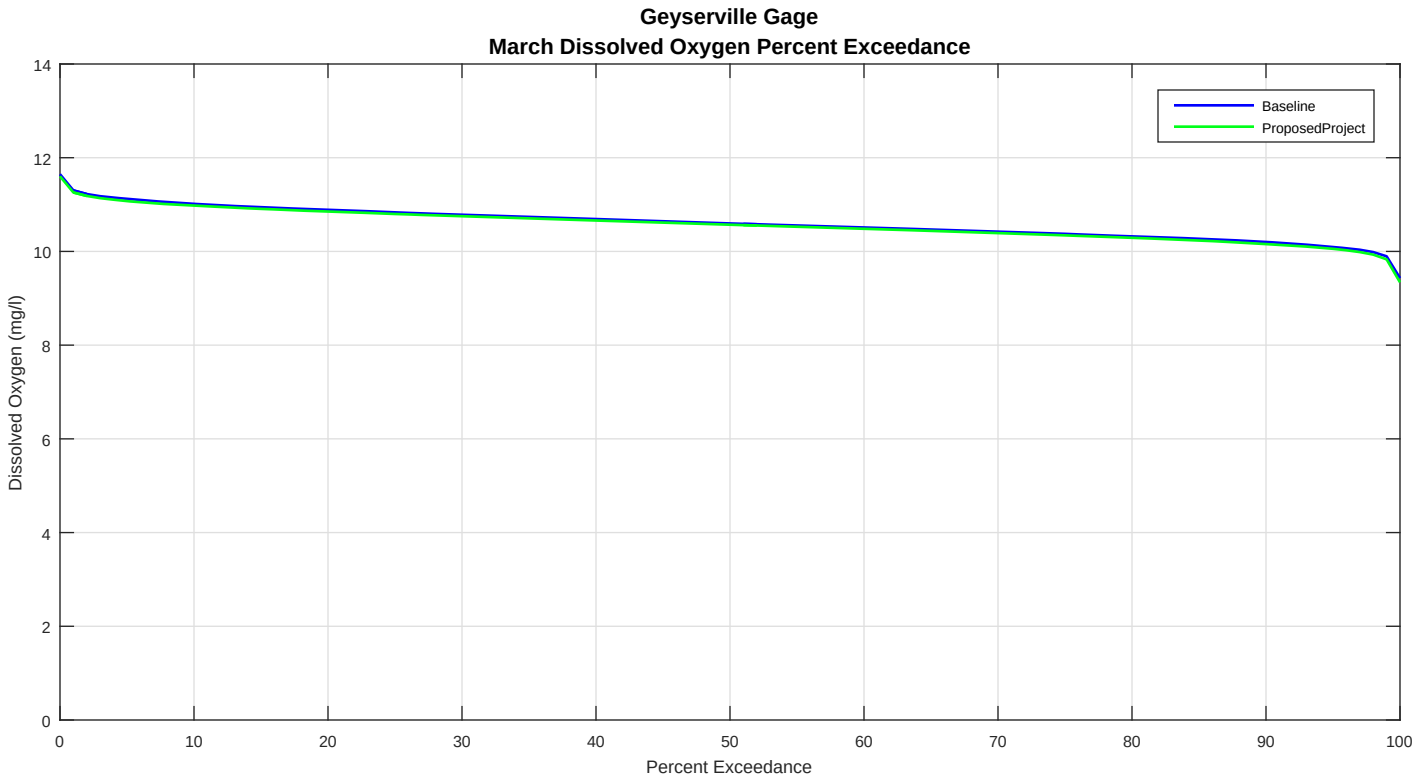
Geyserville Gage
March Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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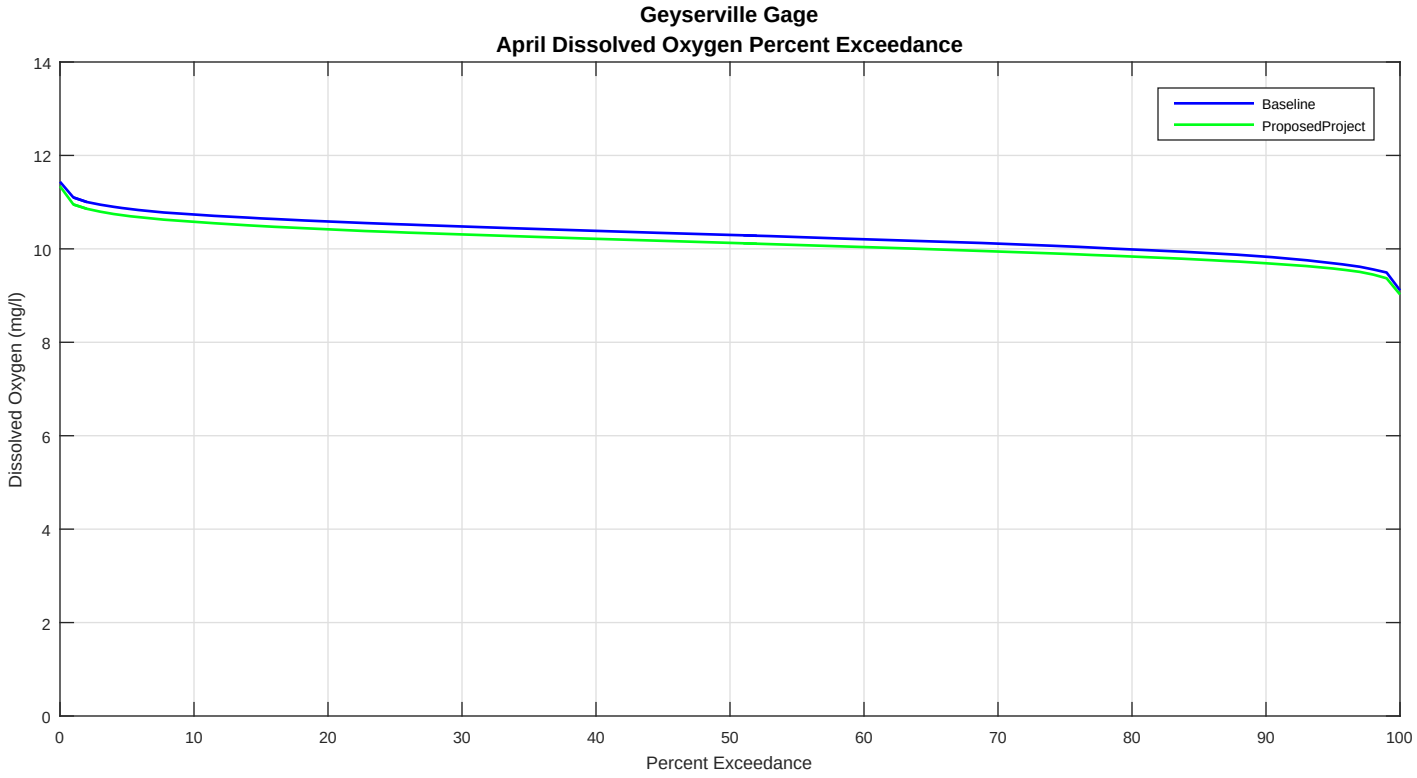
Geyserville Gage
April Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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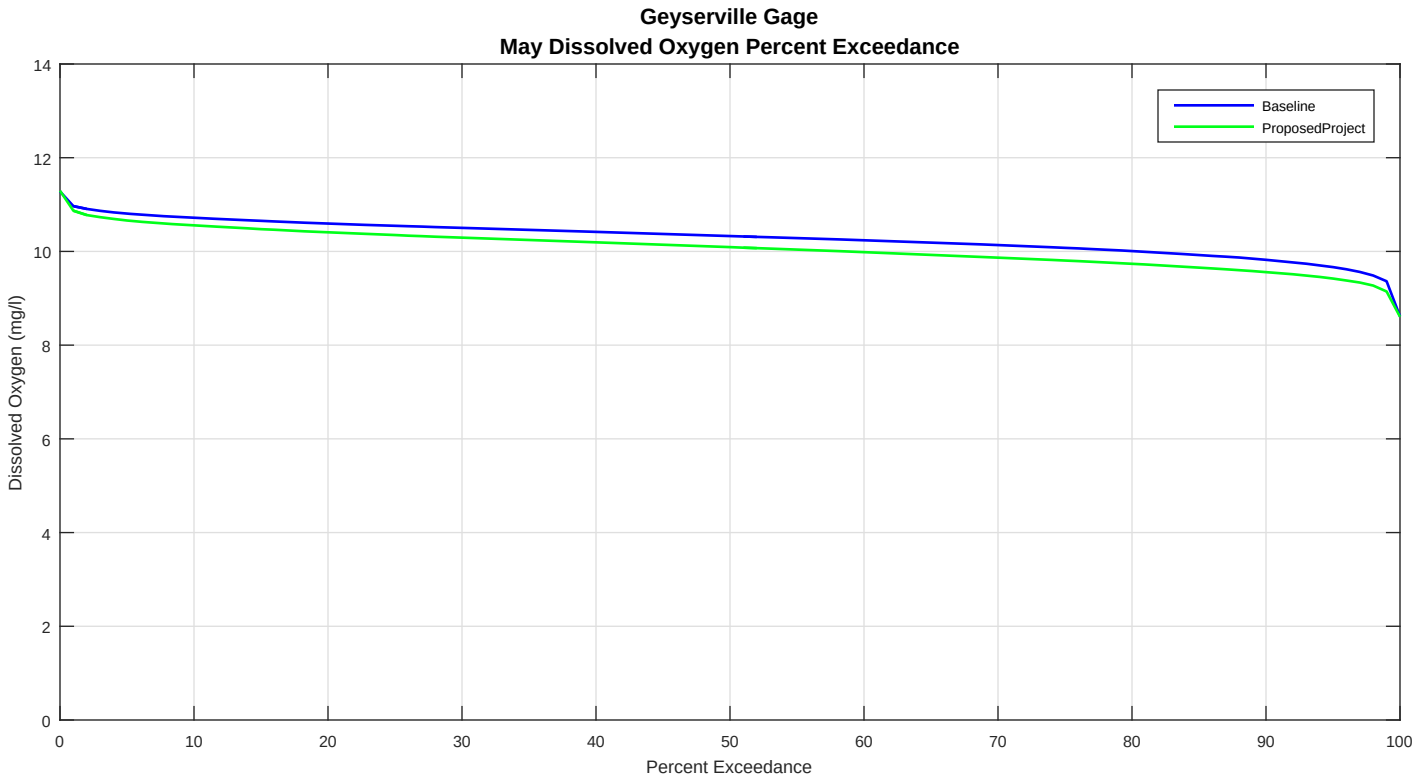
Geyserville Gage
May Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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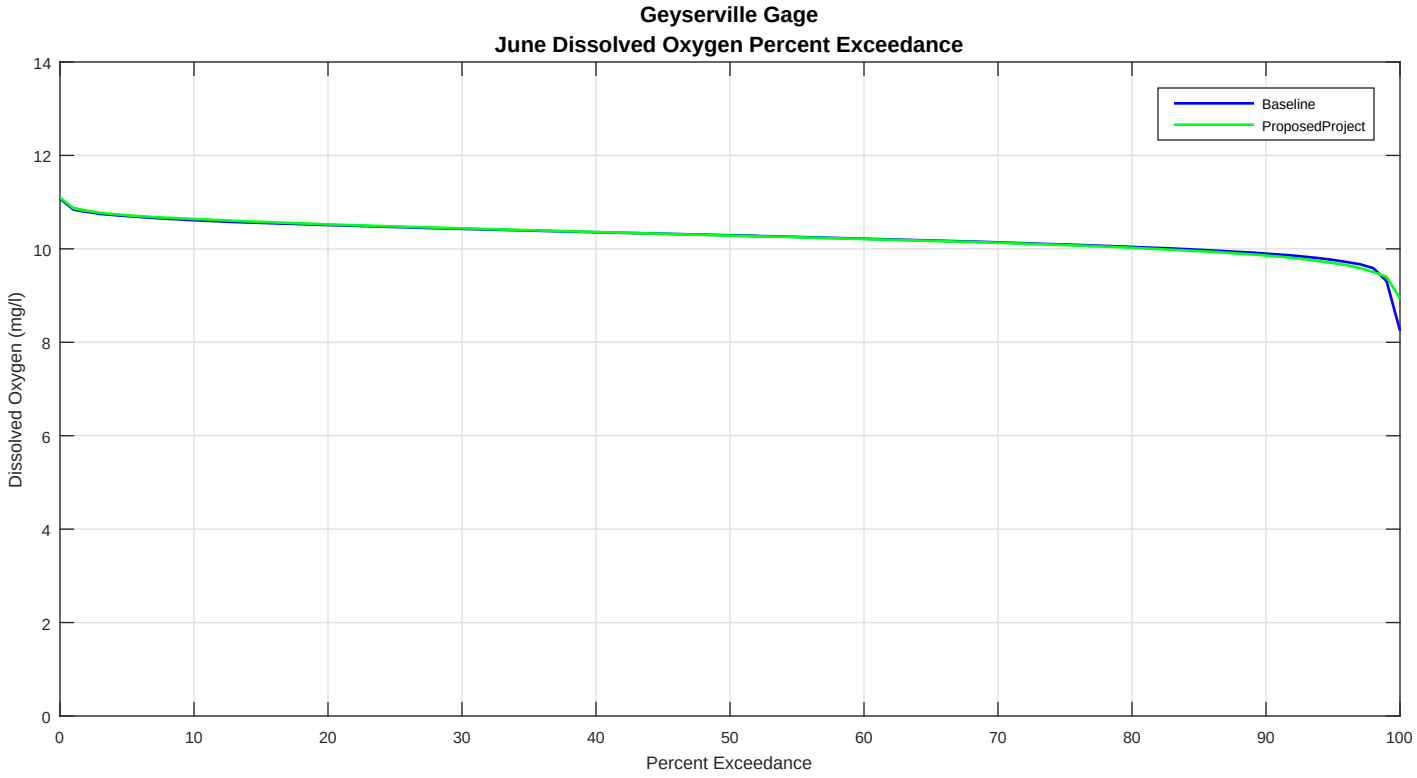
Geyserville Gage
June Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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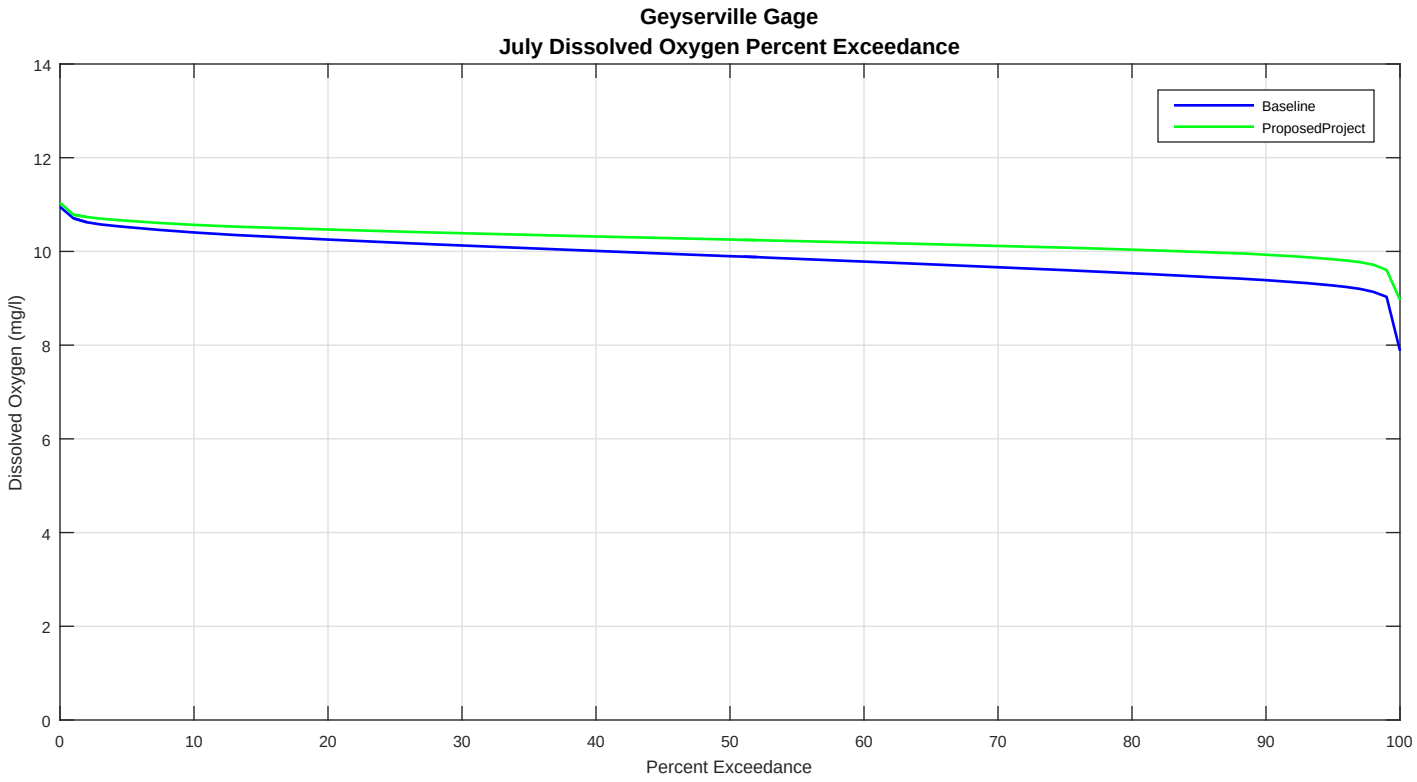
Geyserville Gage
July Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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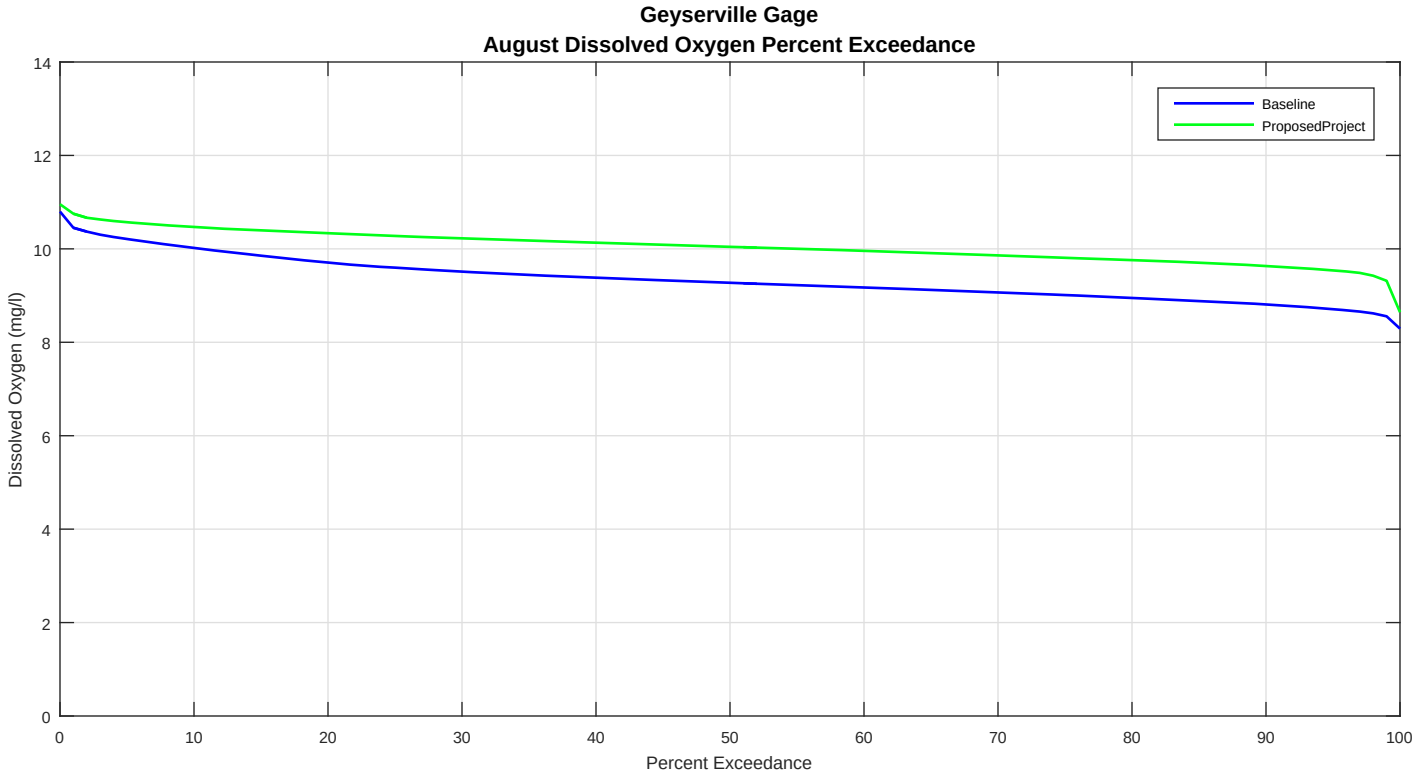
Geyserville Gage
August Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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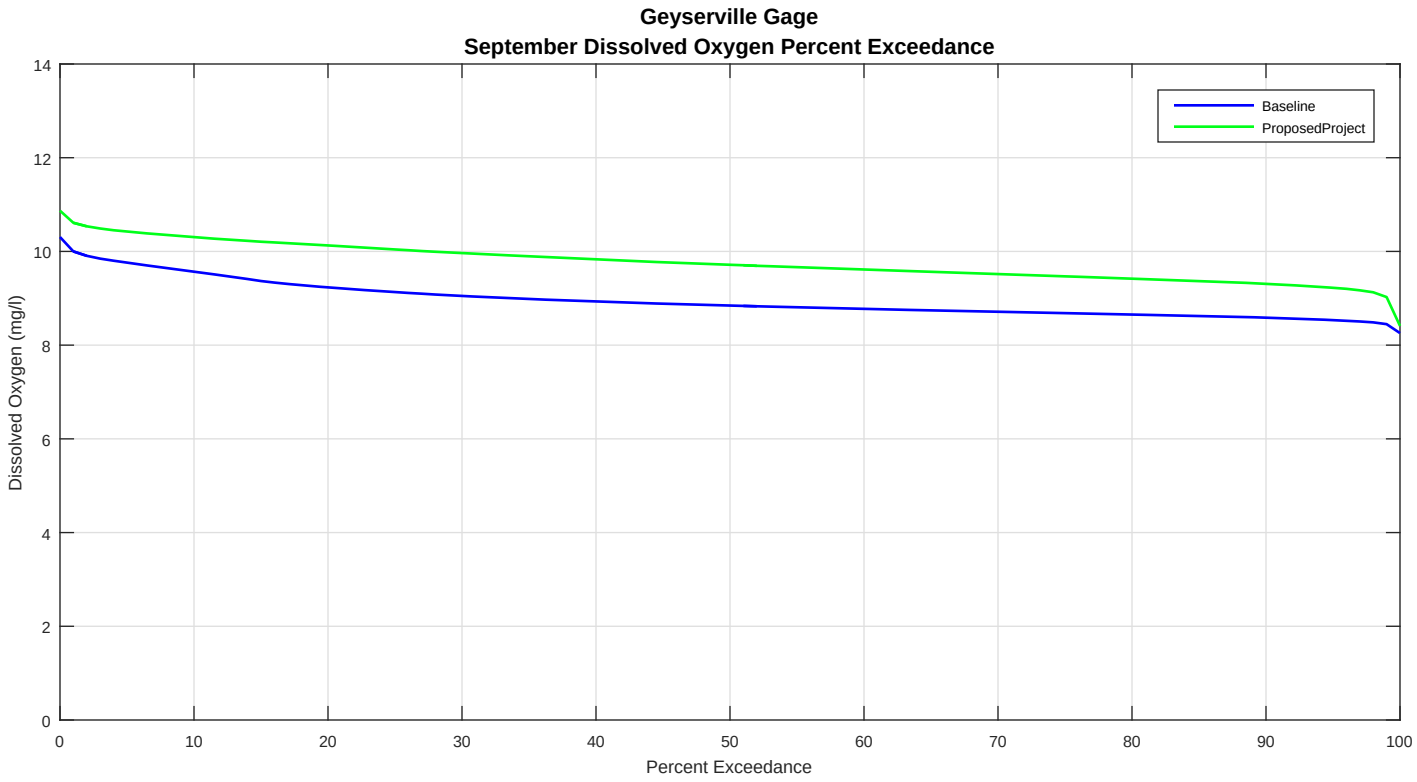
Geyserville Gage
September Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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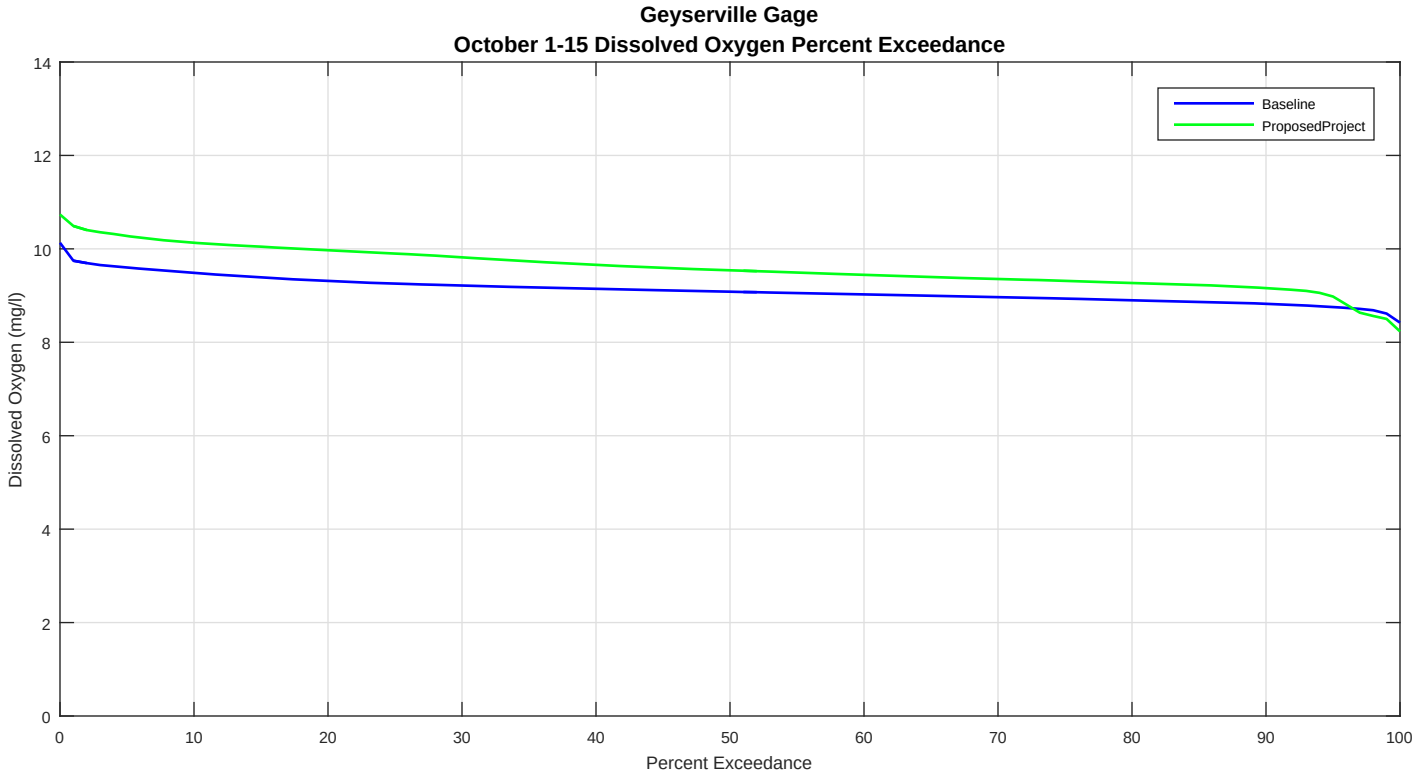
Geyserville Gage
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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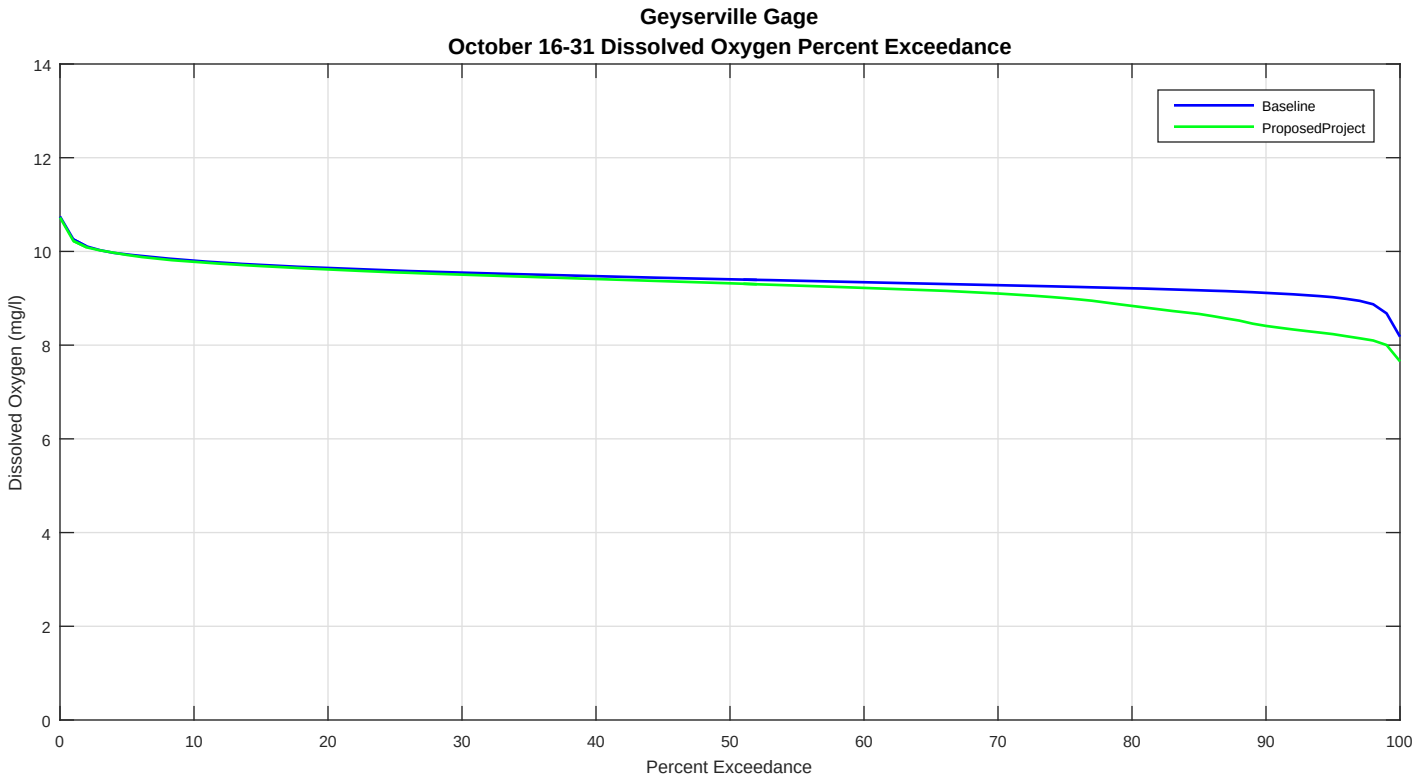
Geyserville Gage
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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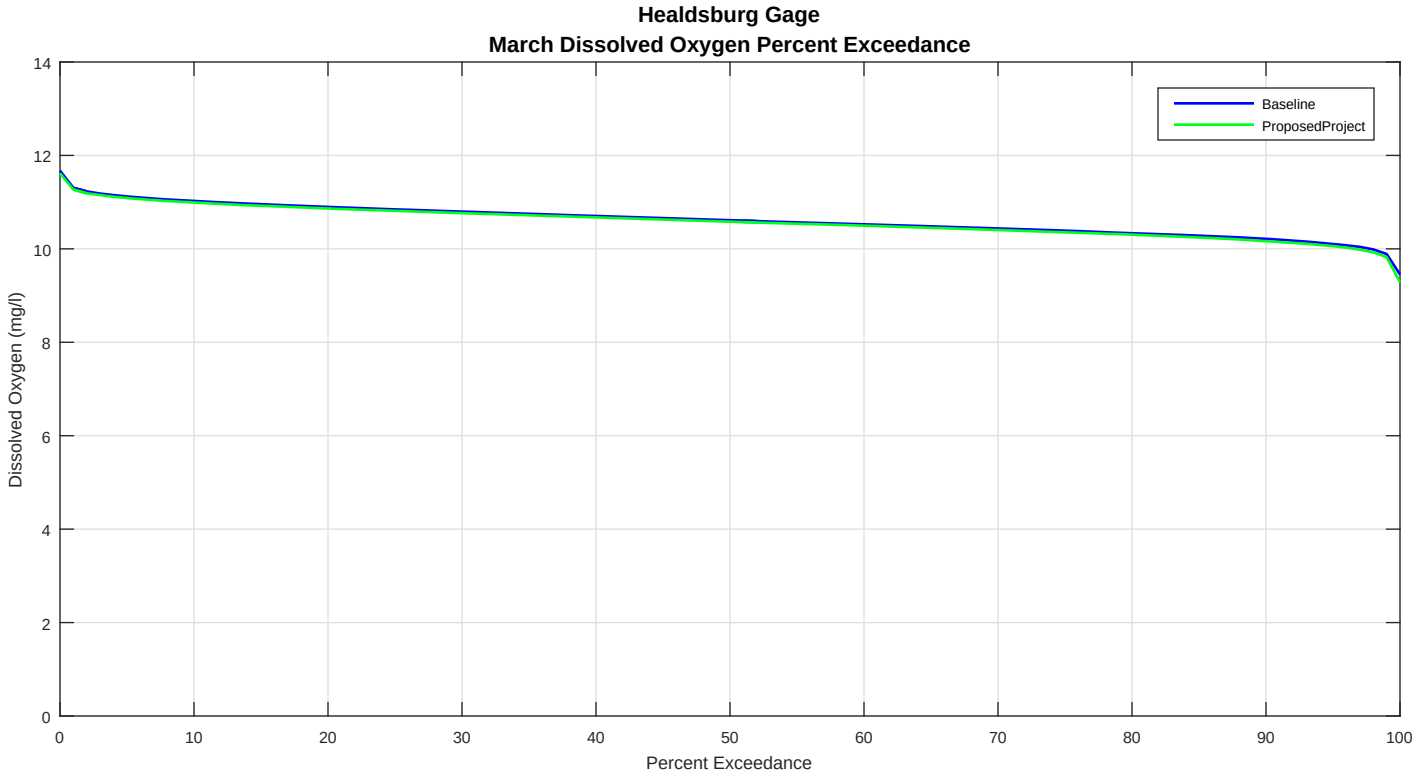
Healdsburg Gage
March Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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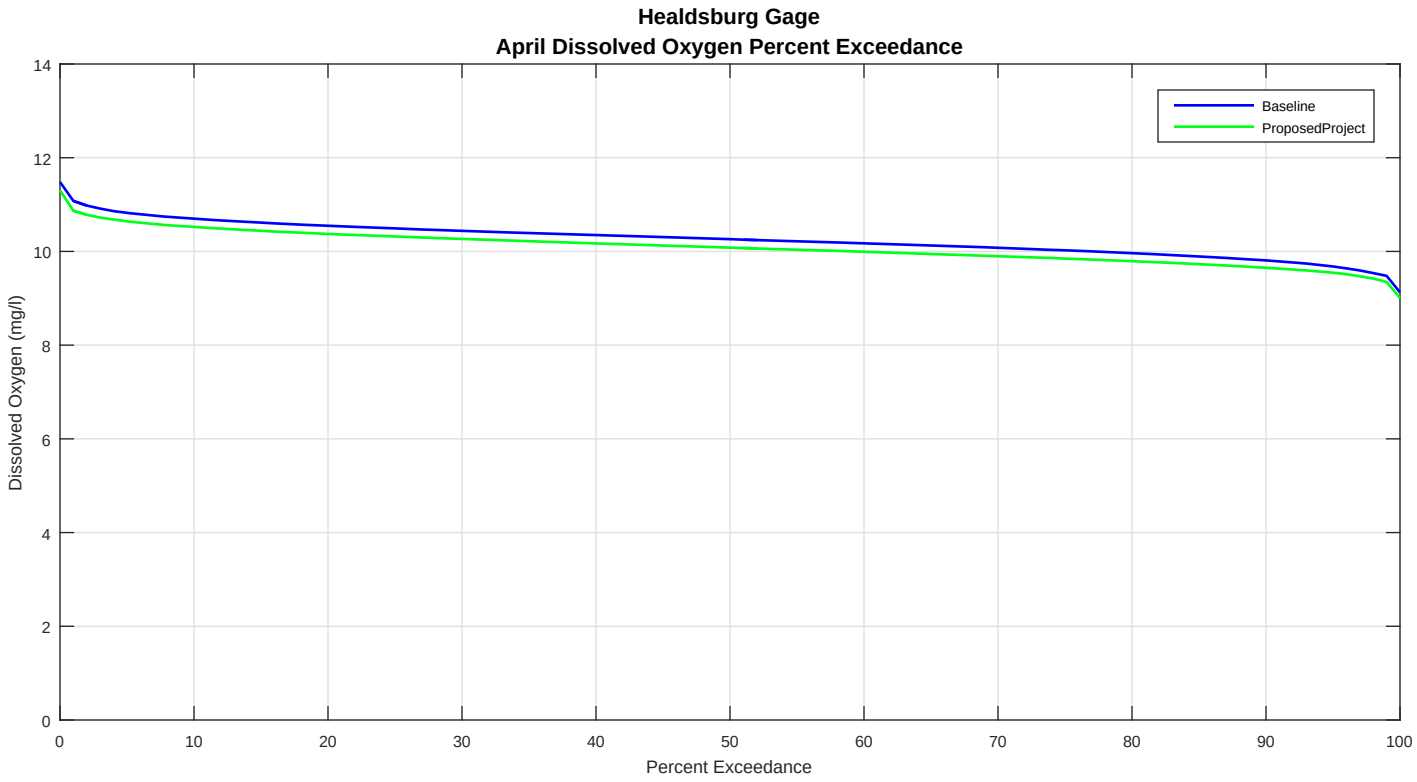
Healdsburg Gage
April Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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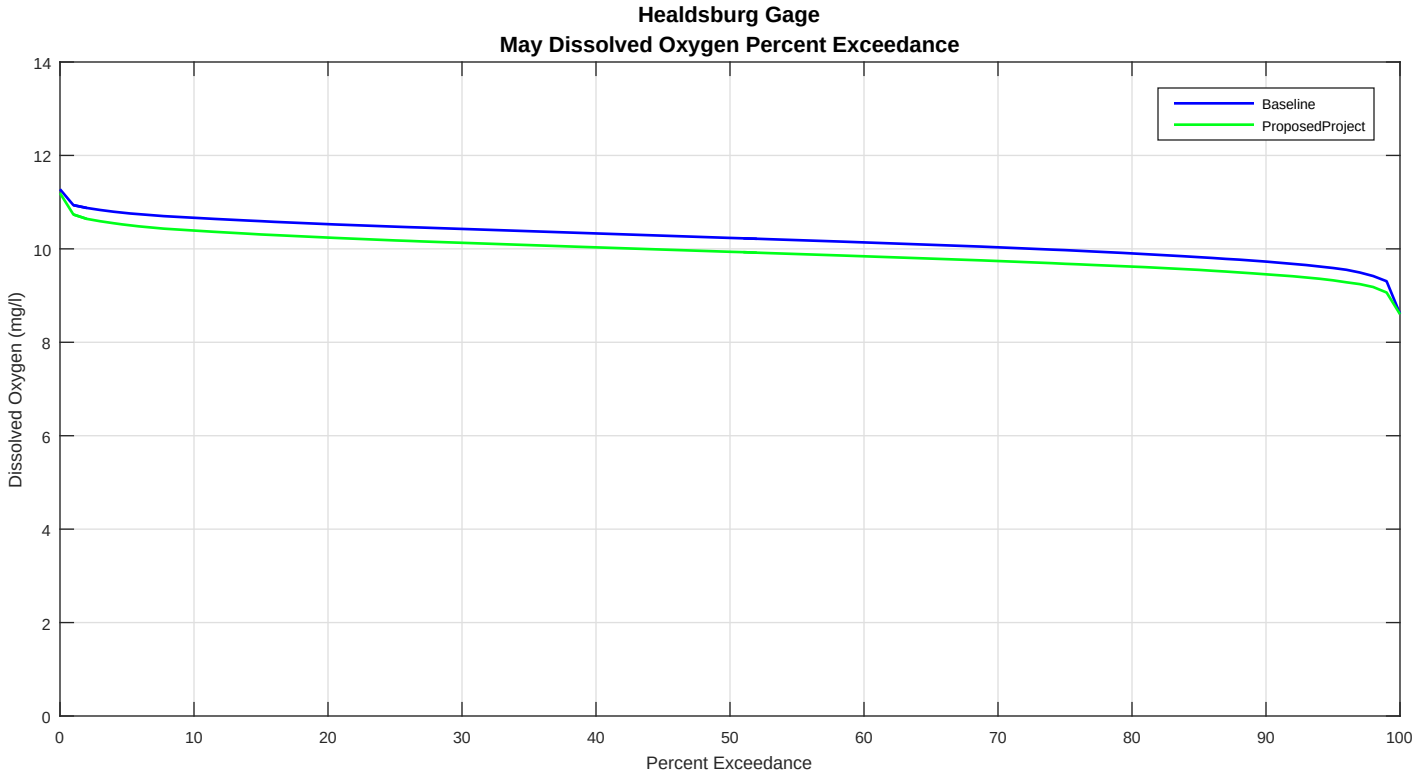
Healdsburg Gage
May Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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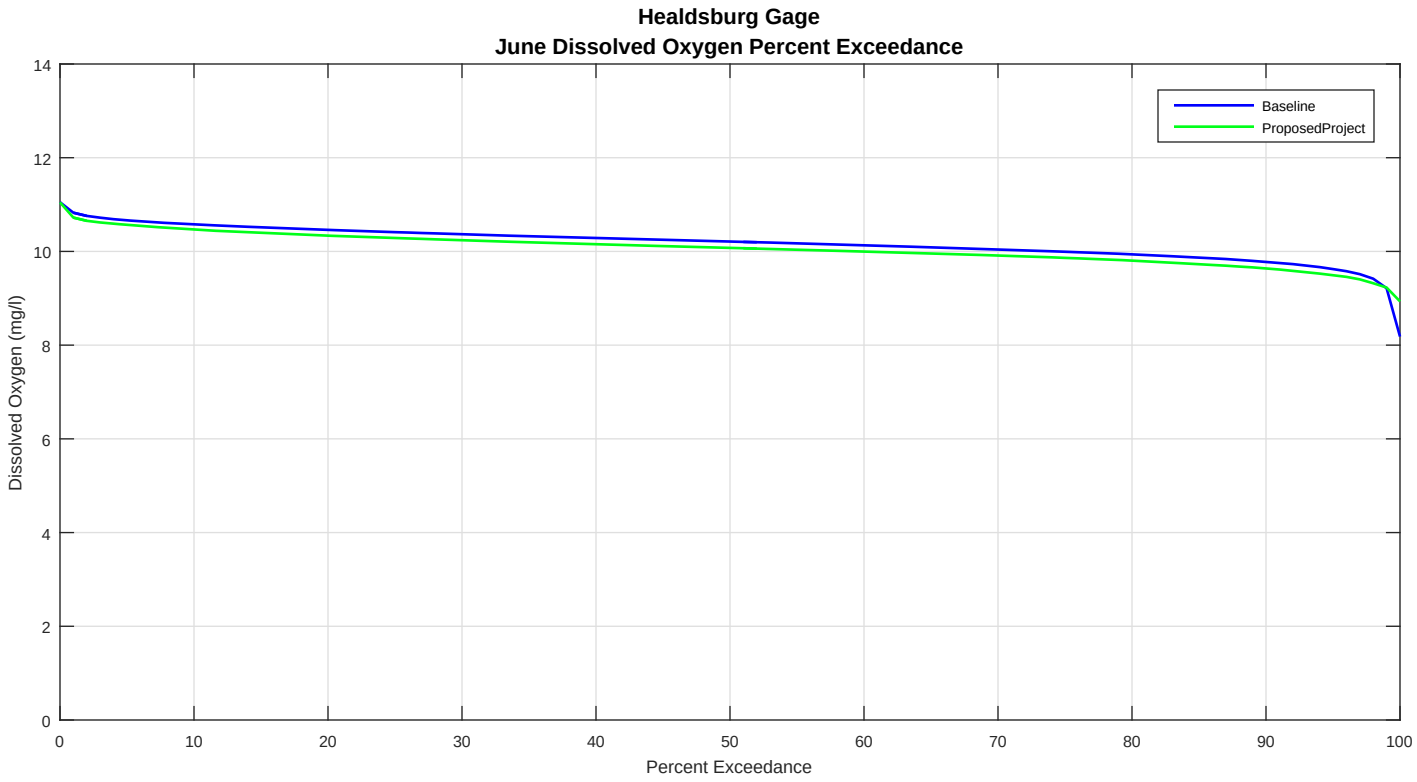
Healdsburg Gage
June Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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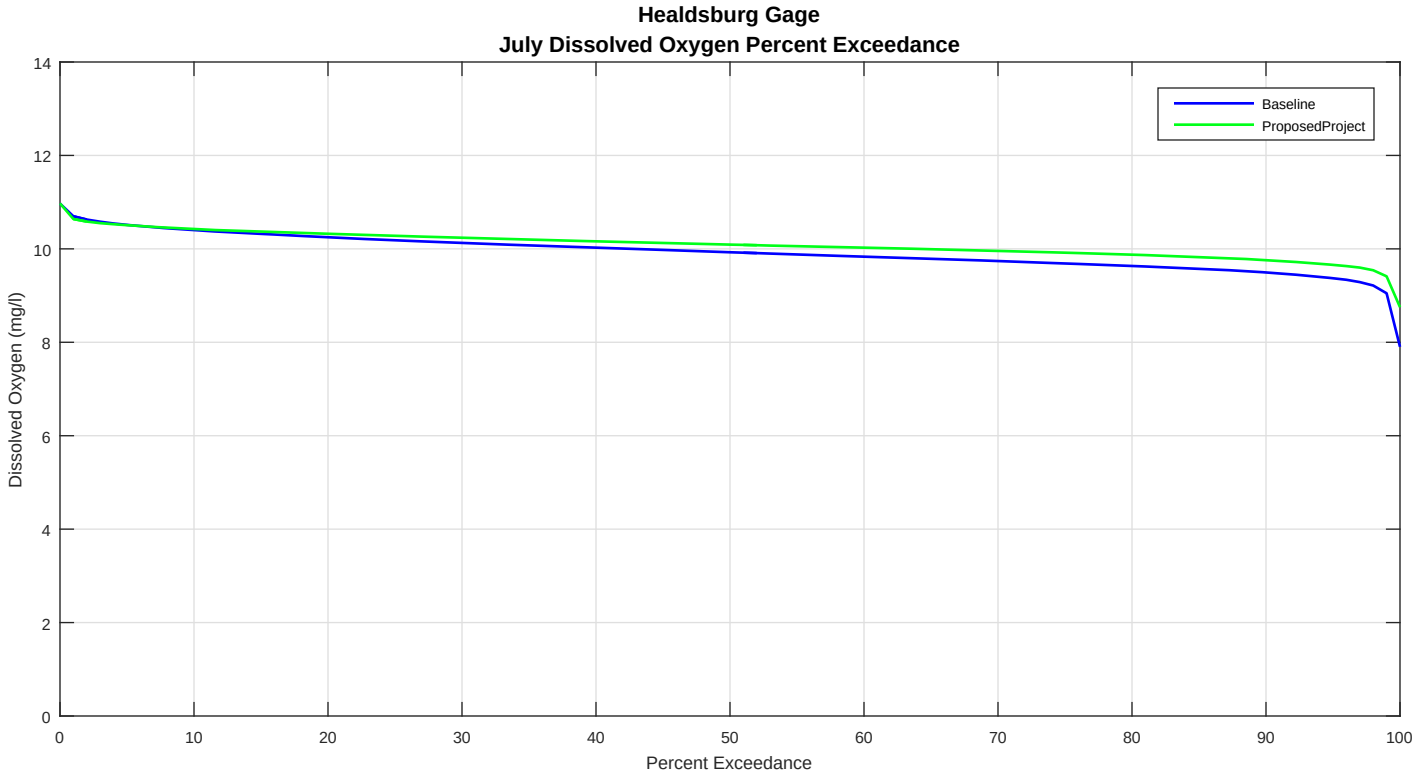
Healdsburg Gage
July Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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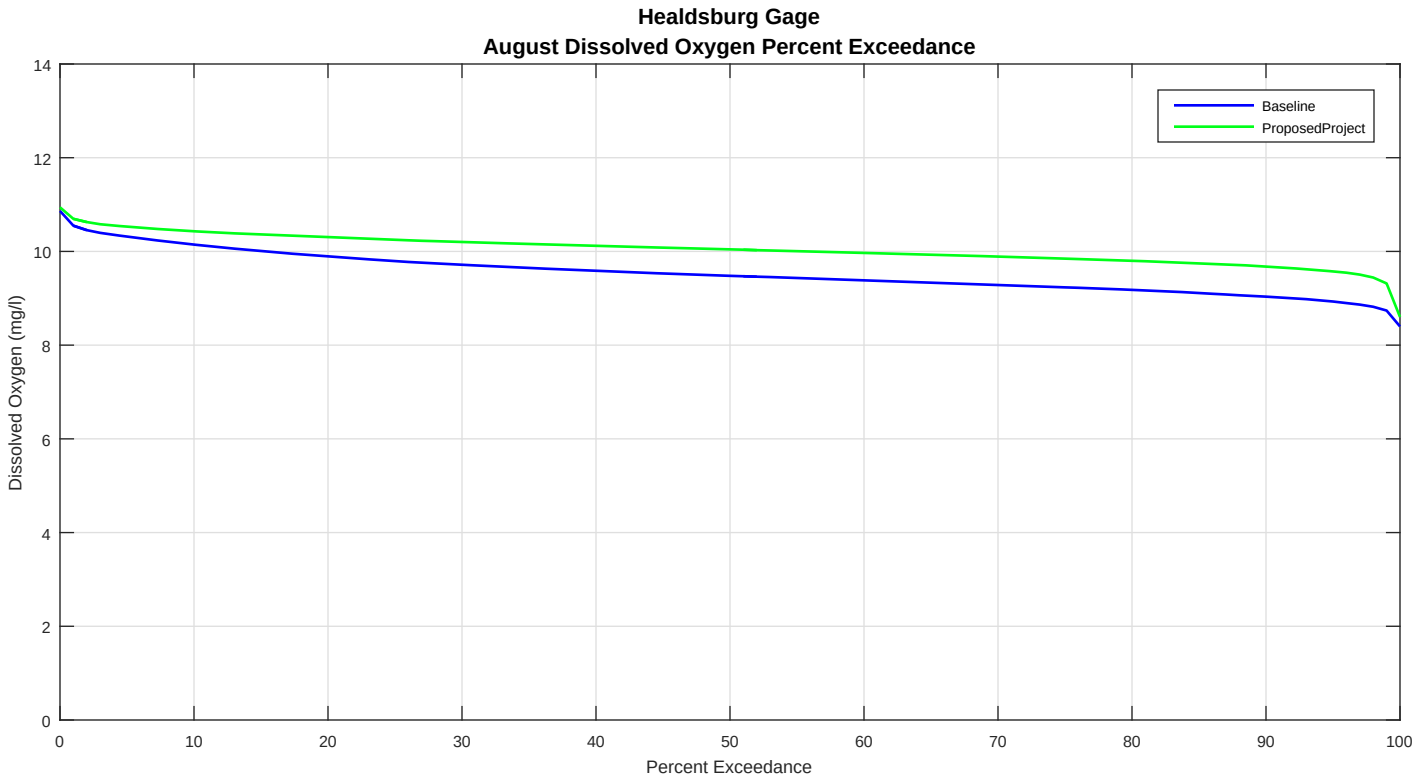
Healdsburg Gage
August Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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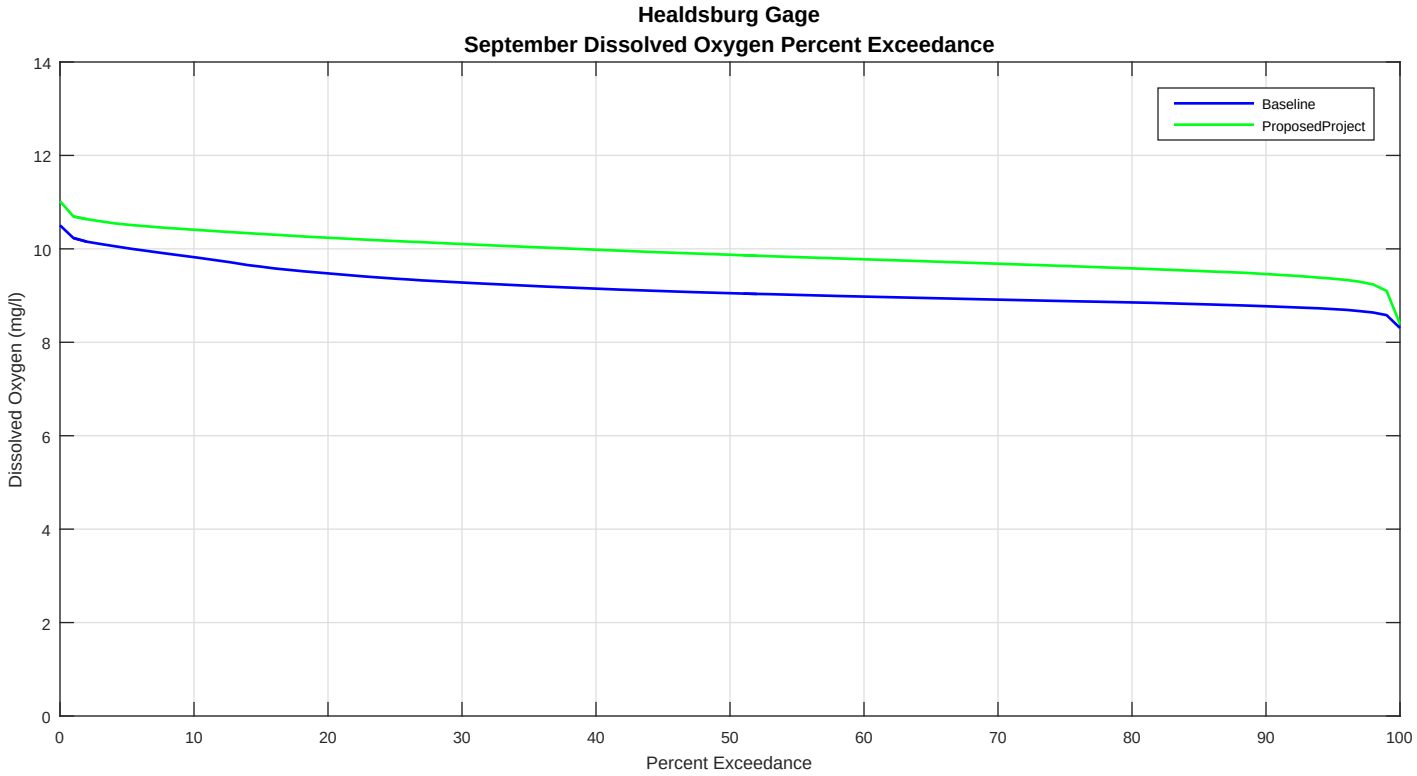
Healdsburg Gage
September Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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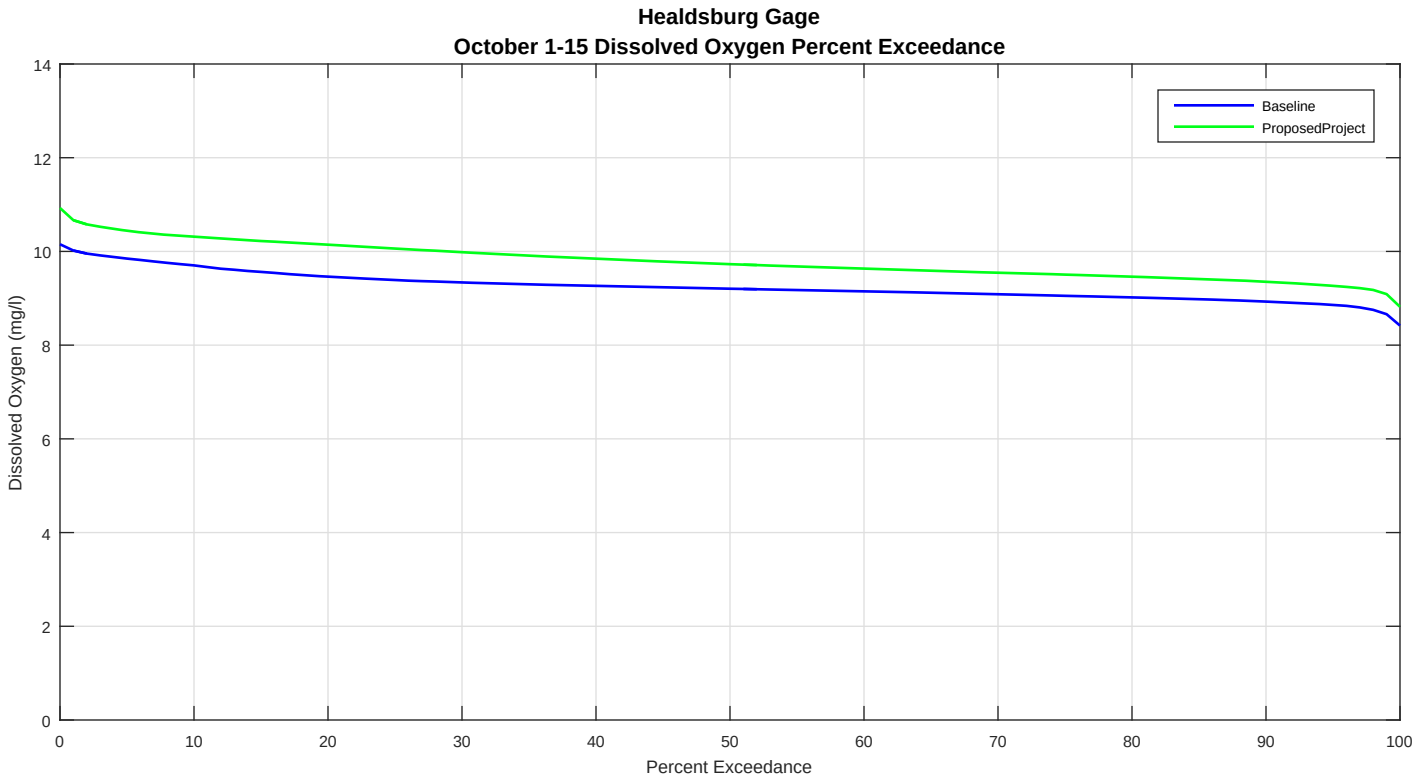
Healdsburg Gage
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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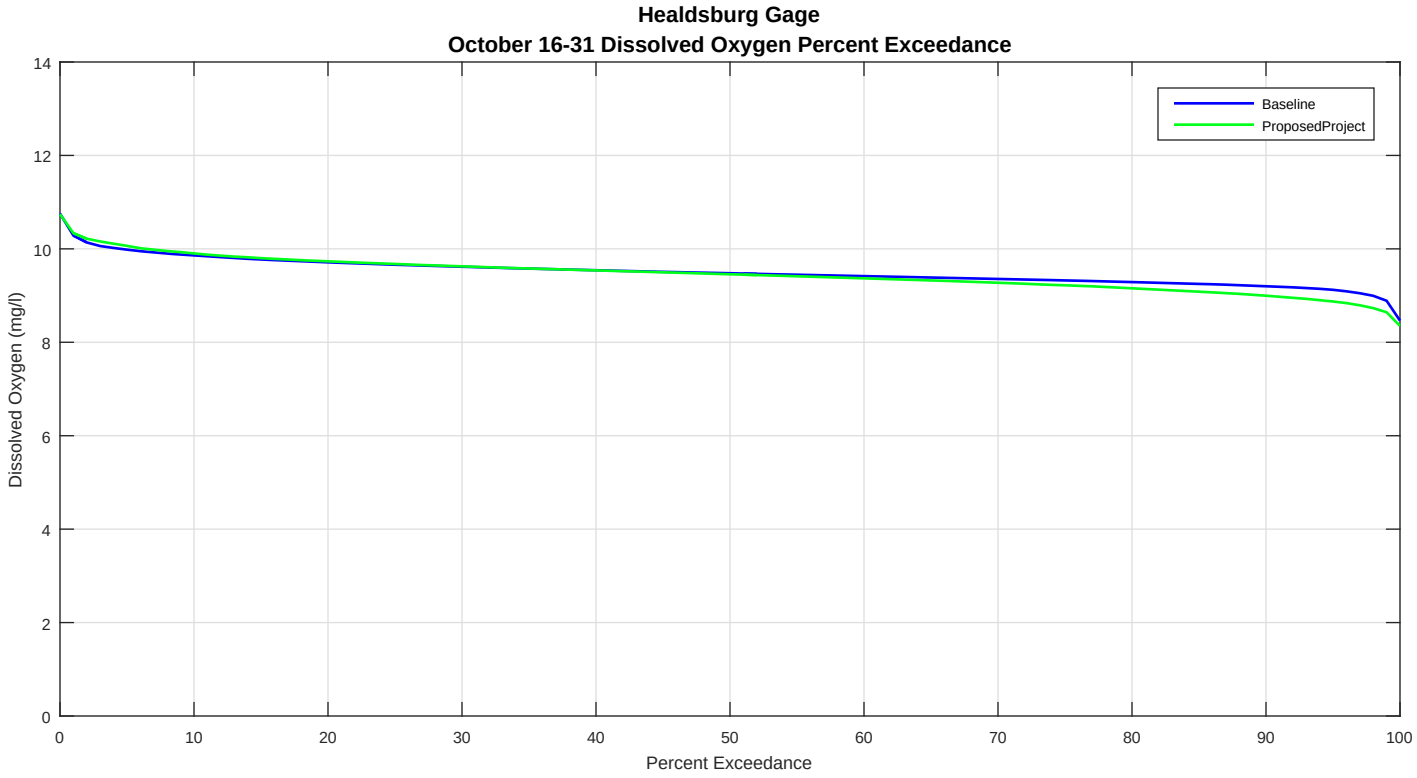
Healdsburg Gage
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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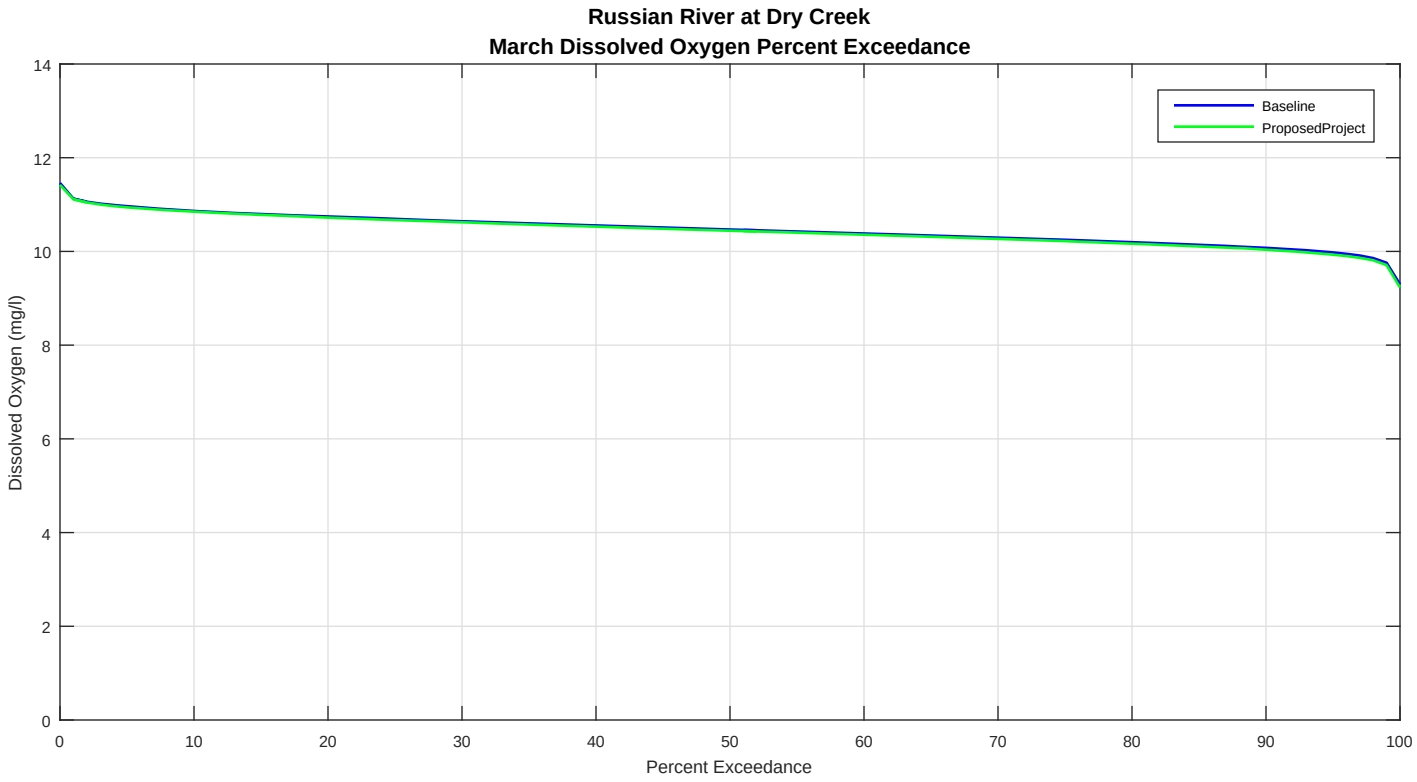
Russian River at Dry Creek
March Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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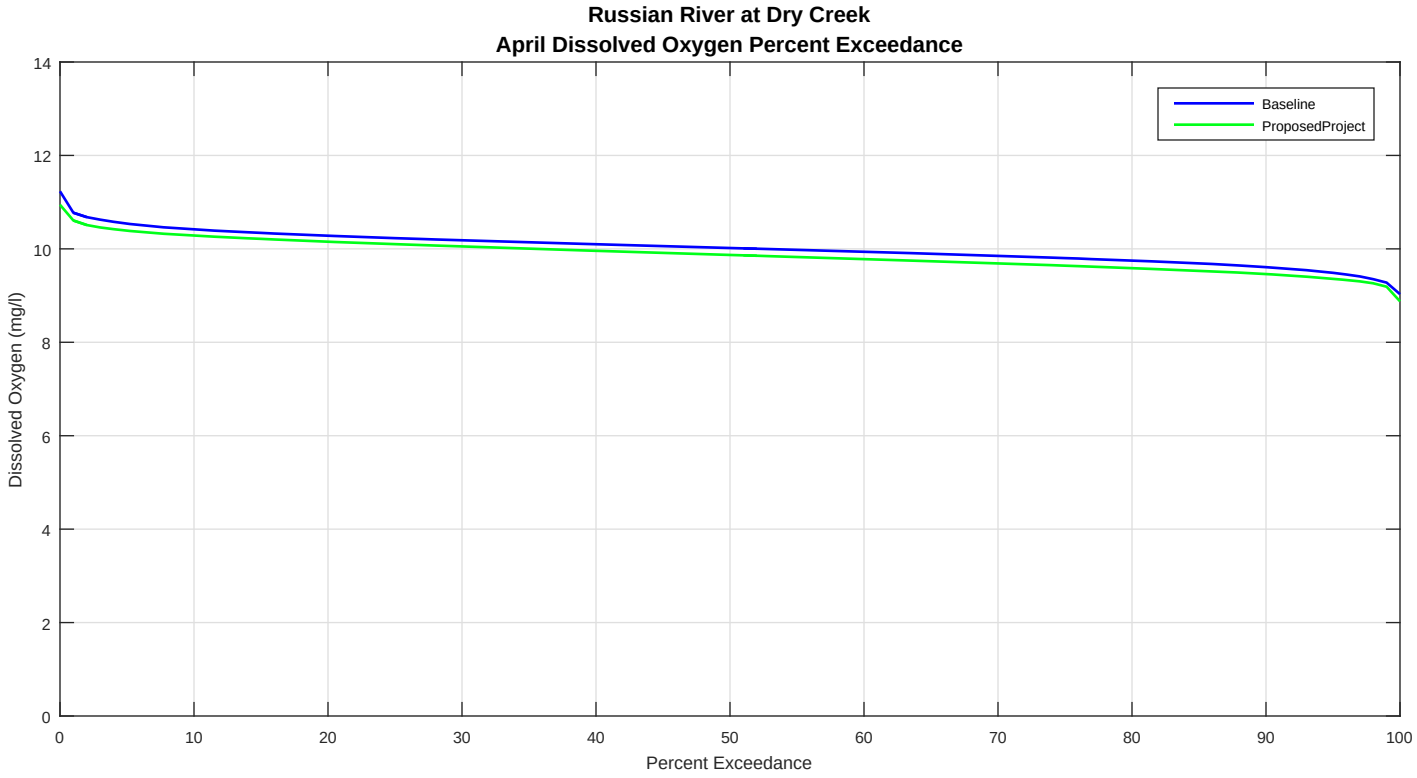
Russian River at Dry Creek
April Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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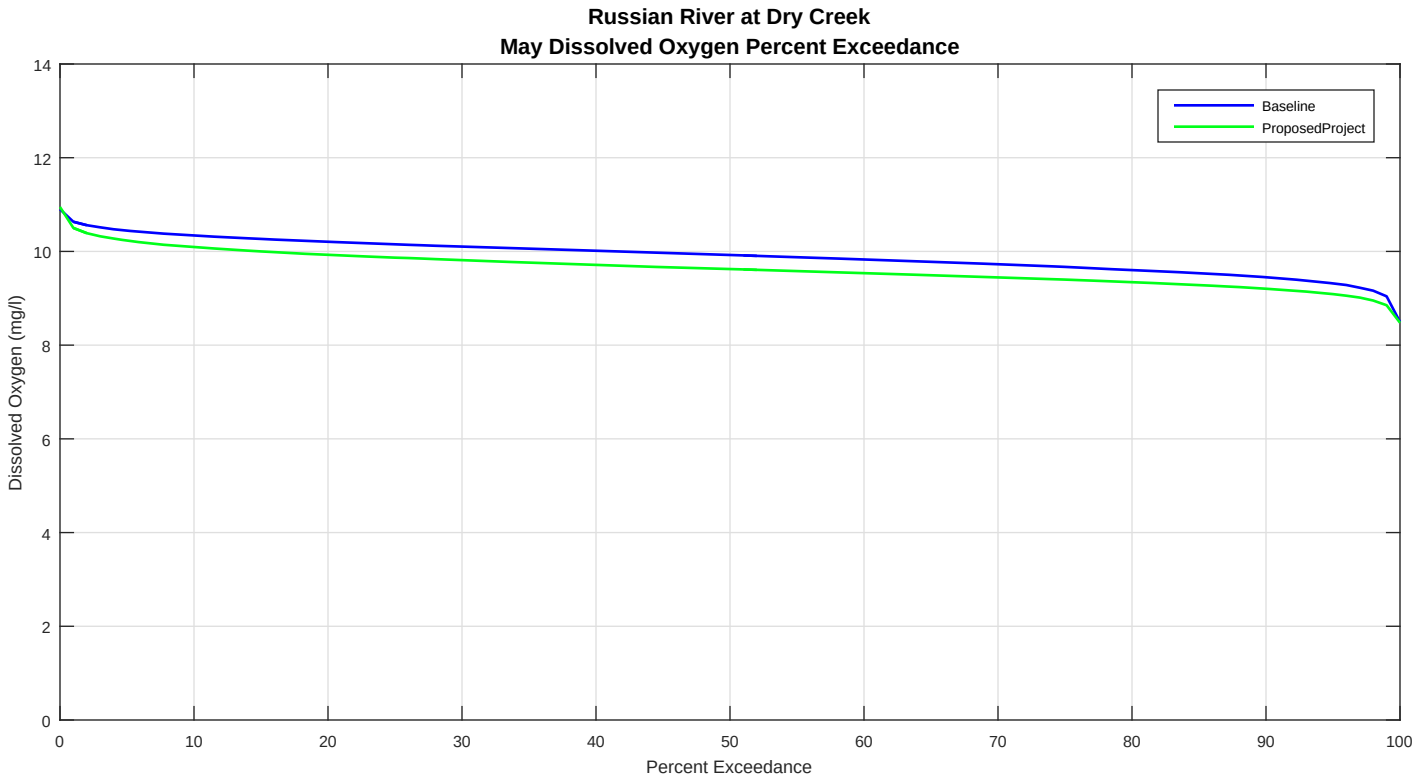
Russian River at Dry Creek
May Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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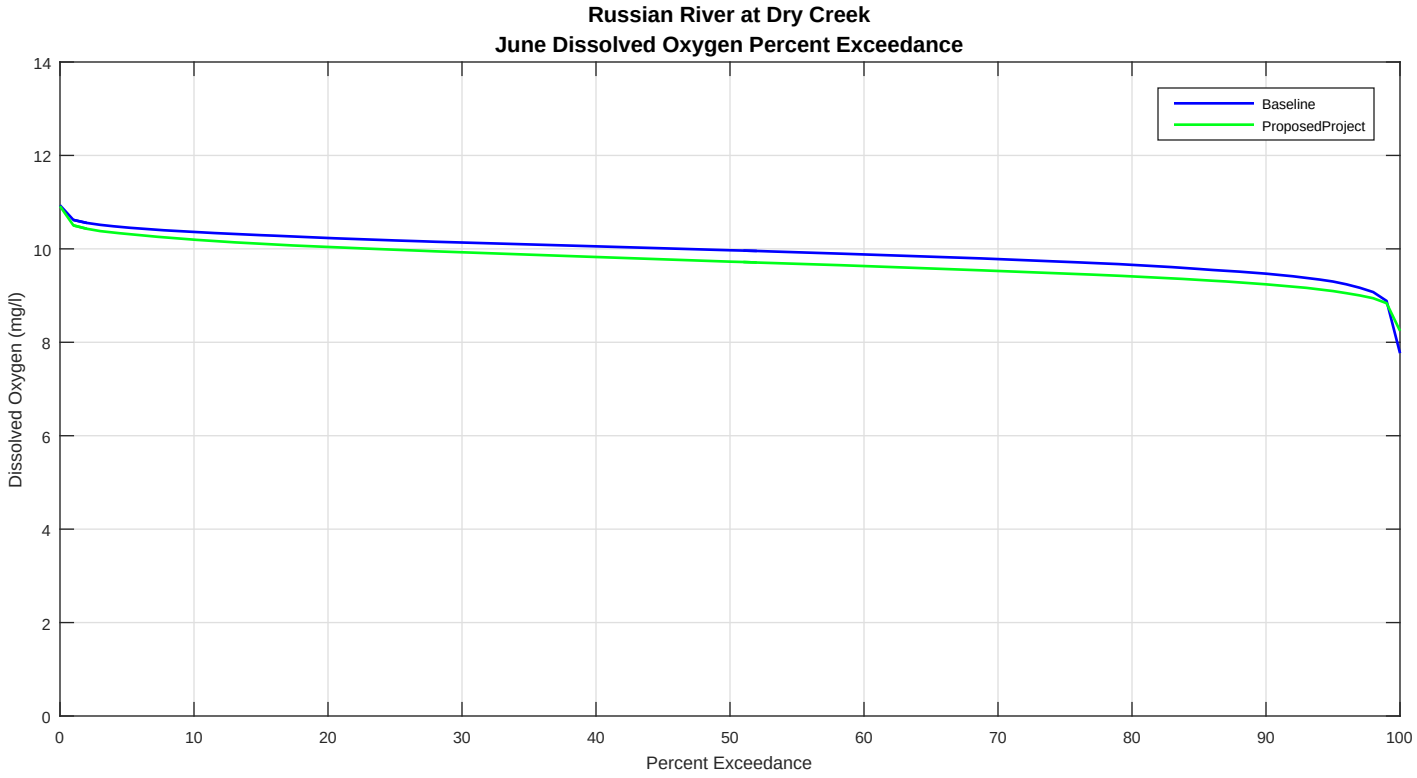
Russian River at Dry Creek
June Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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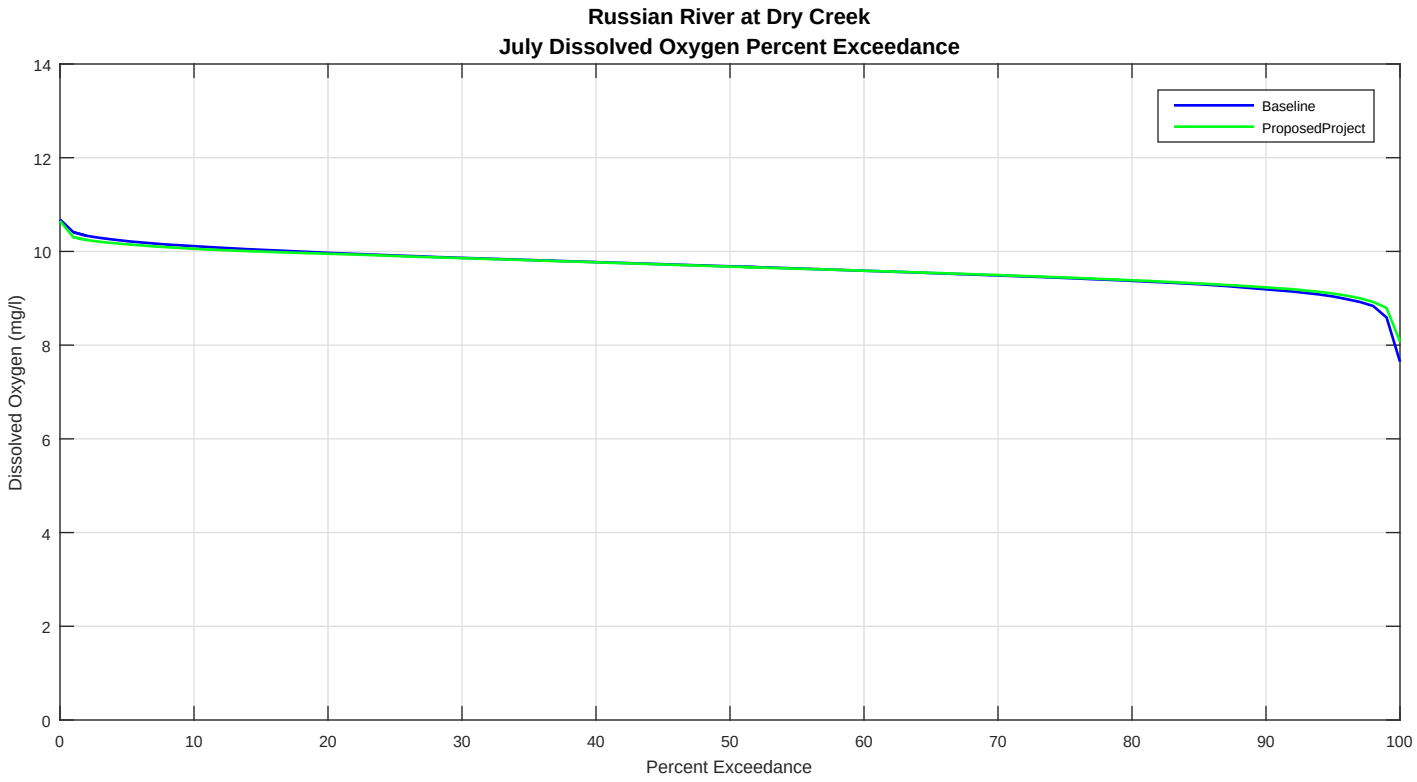
Russian River at Dry Creek
July Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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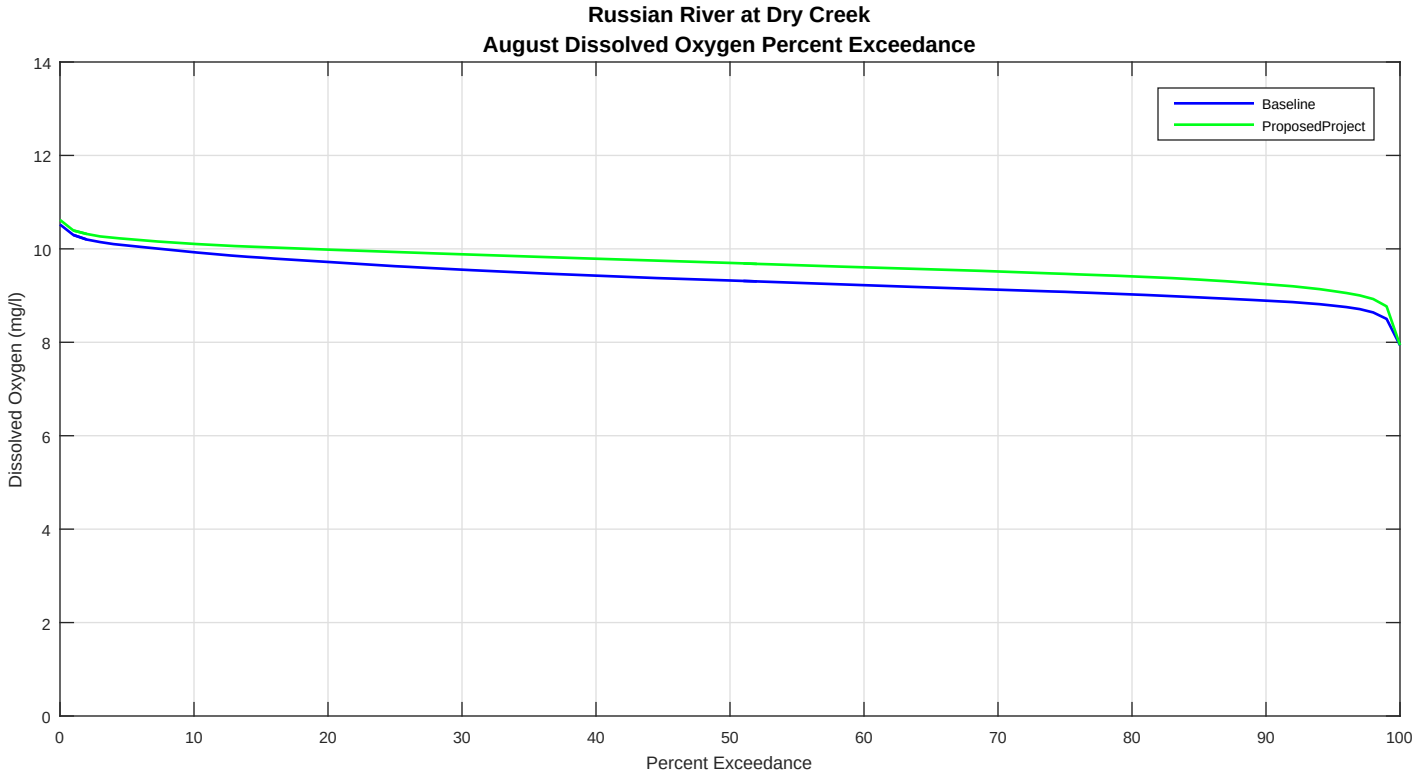
Russian River at Dry Creek
August Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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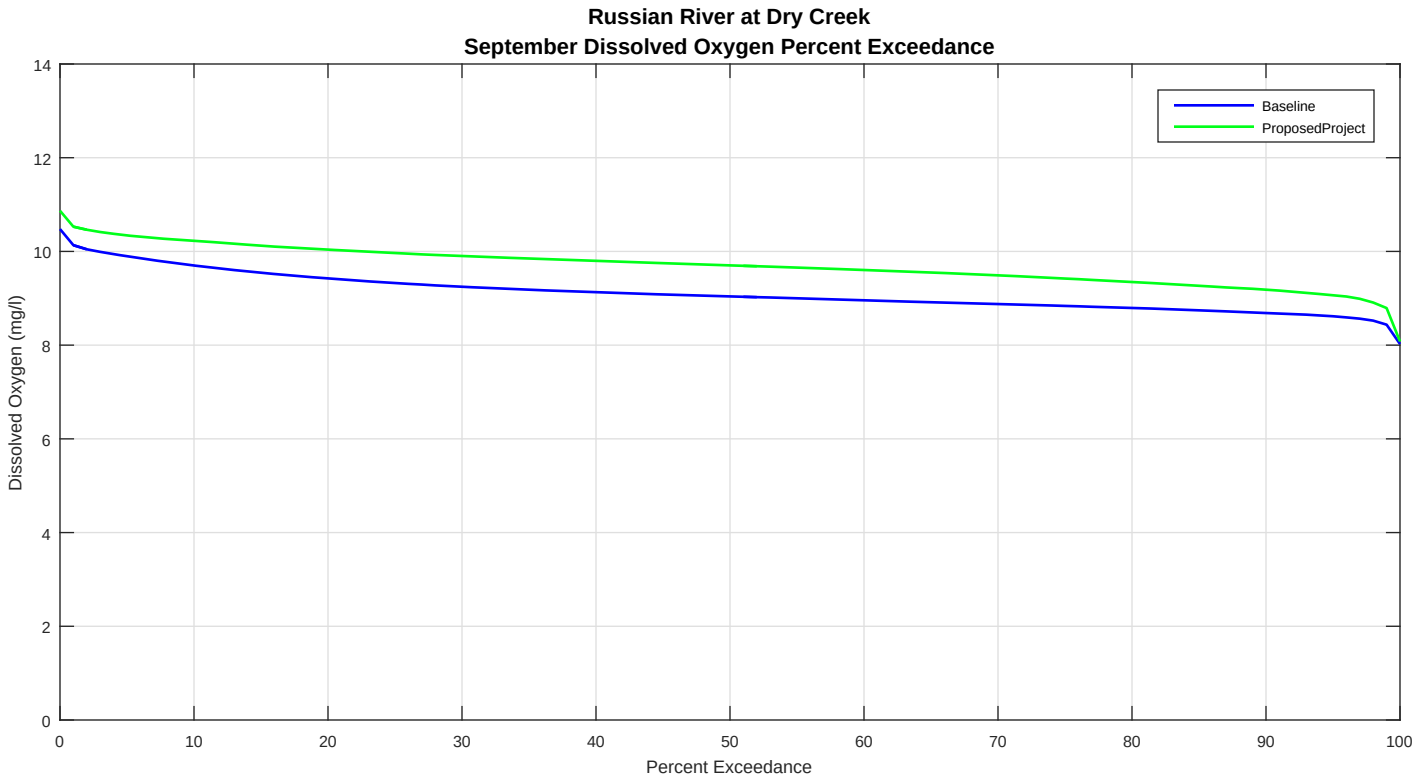
Russian River at Dry Creek
September Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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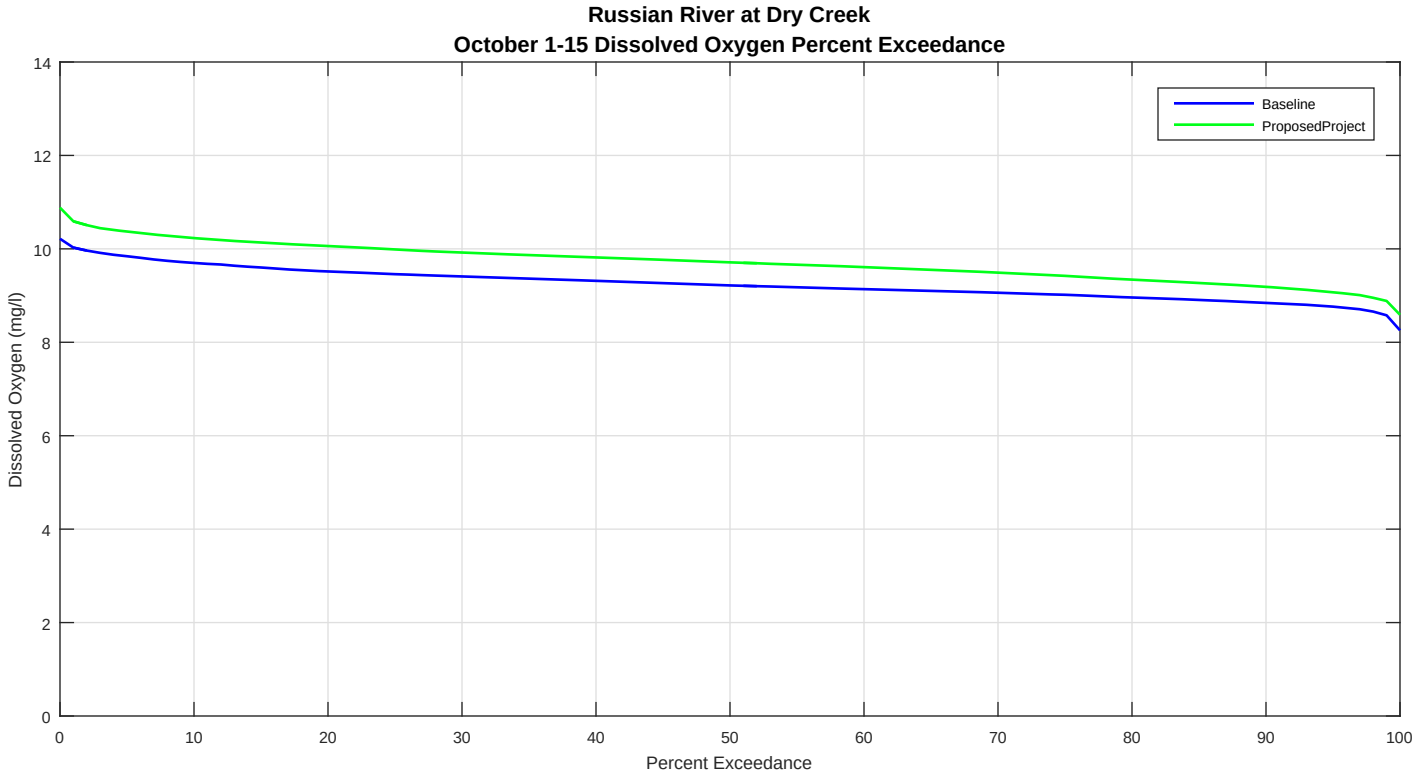
Russian River at Dry Creek
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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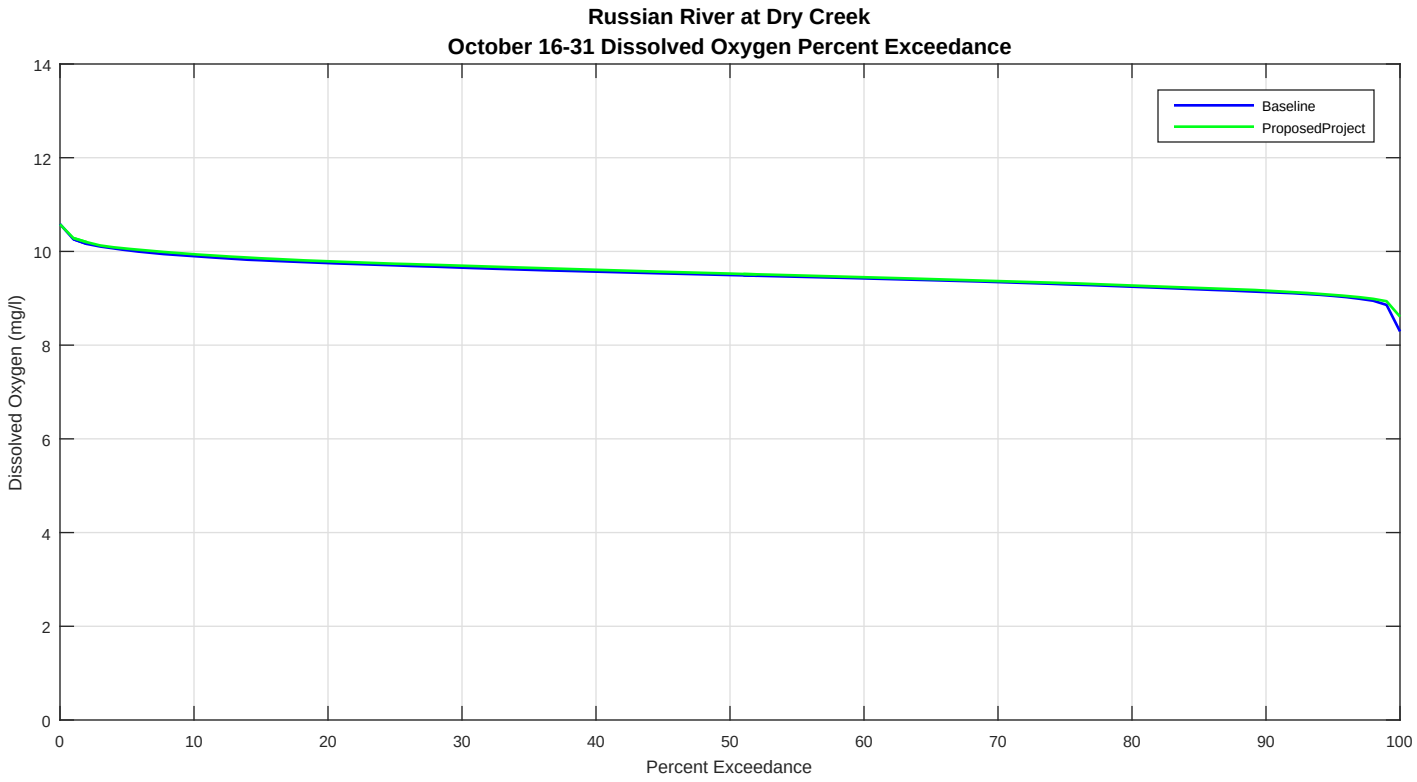
Russian River at Dry Creek
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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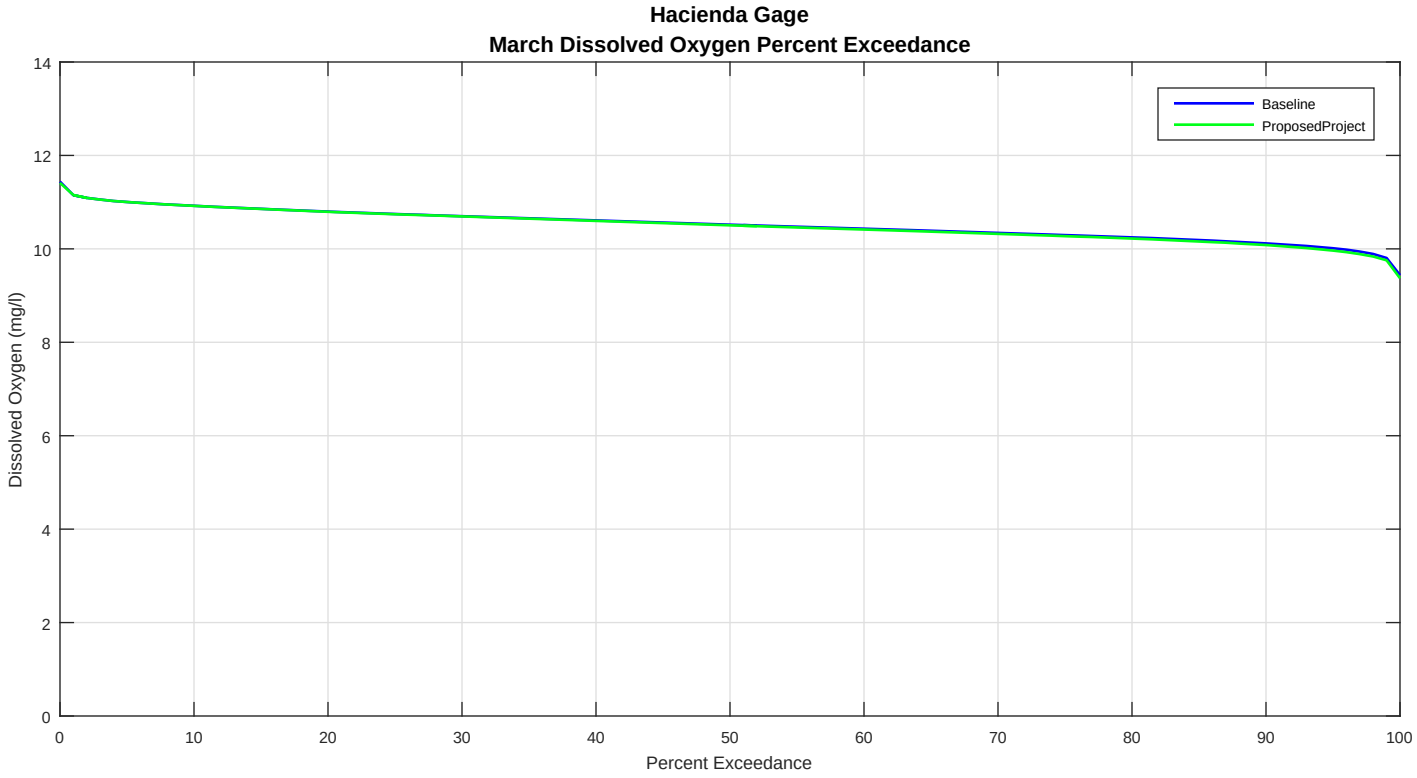
Hacienda Gage
March Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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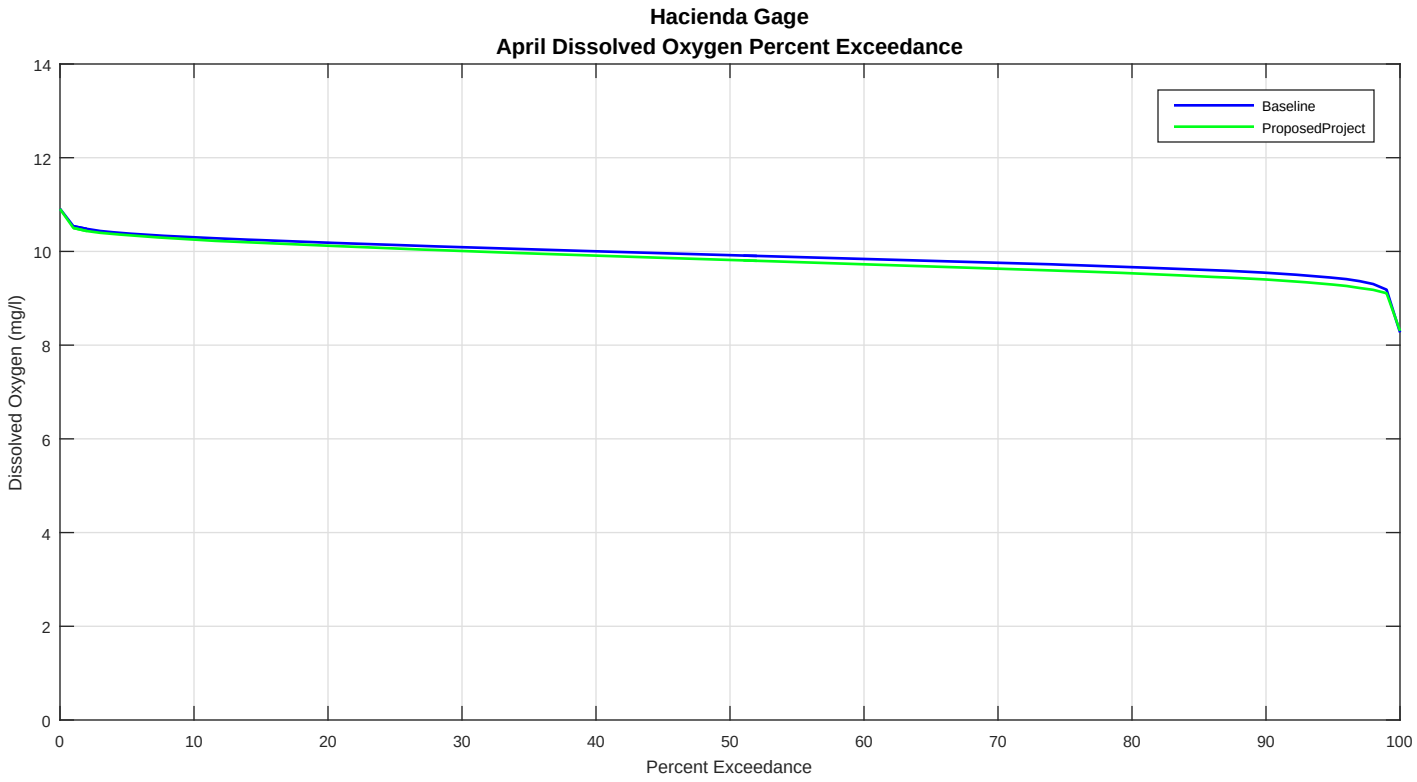
Hacienda Gage
April Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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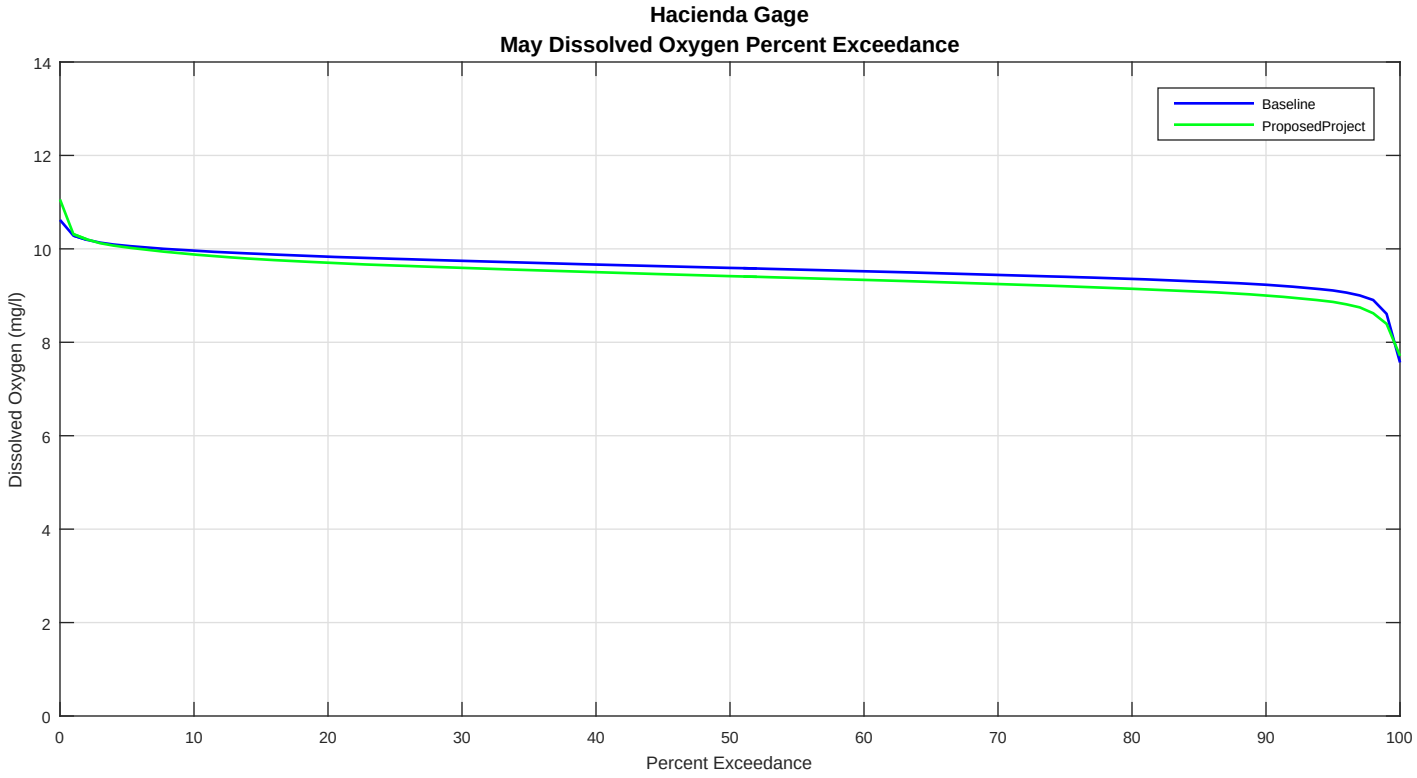
Hacienda Gage
May Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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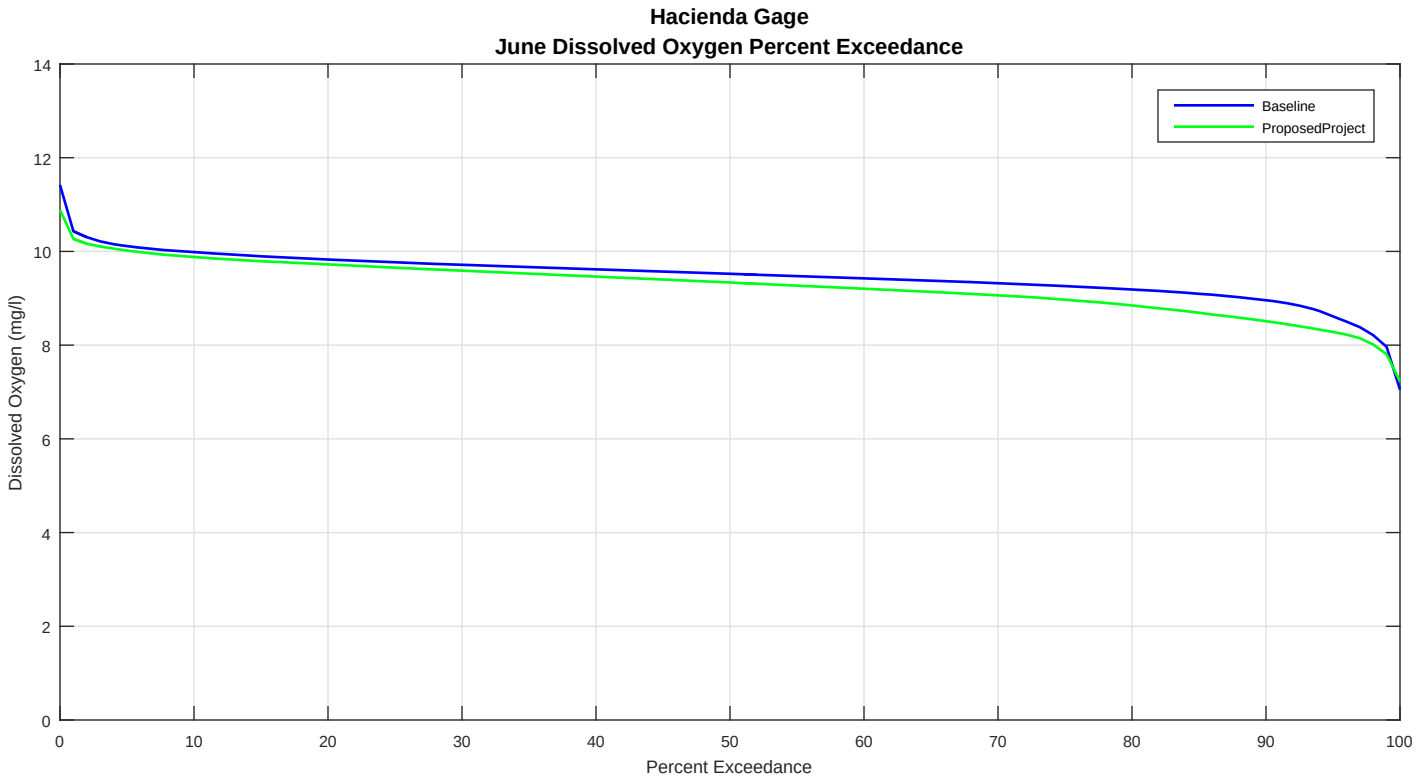
Hacienda Gage
June Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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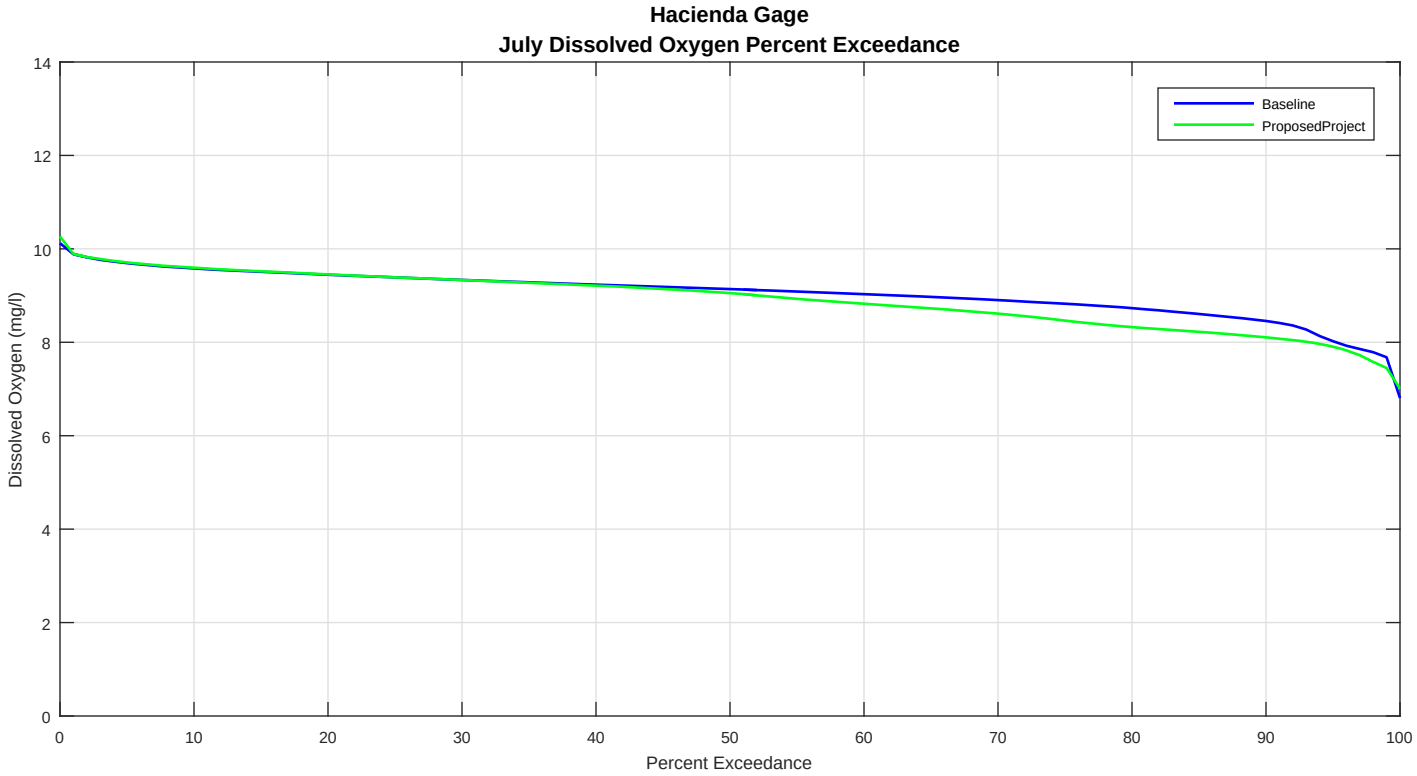
Hacienda Gage
July Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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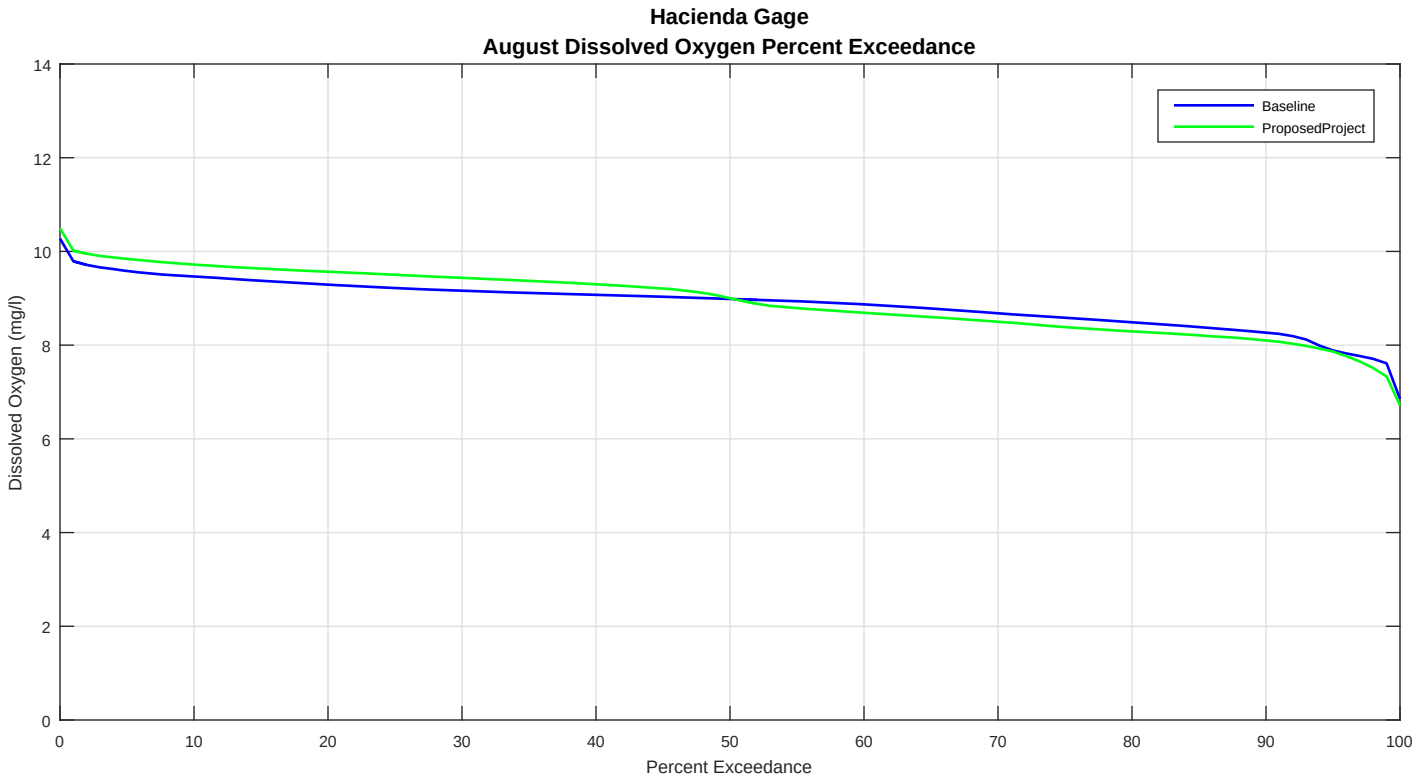
Hacienda Gage
August Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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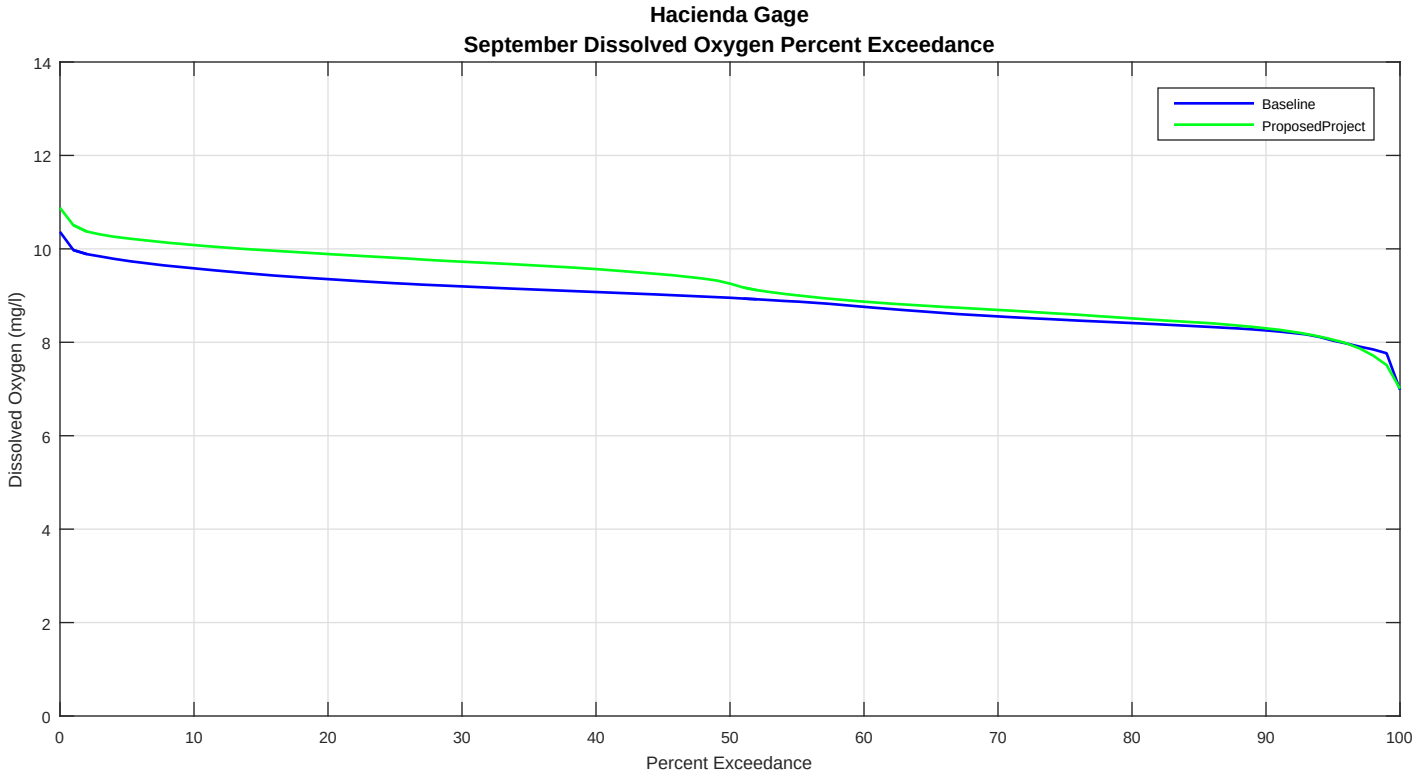
Hacienda Gage
September Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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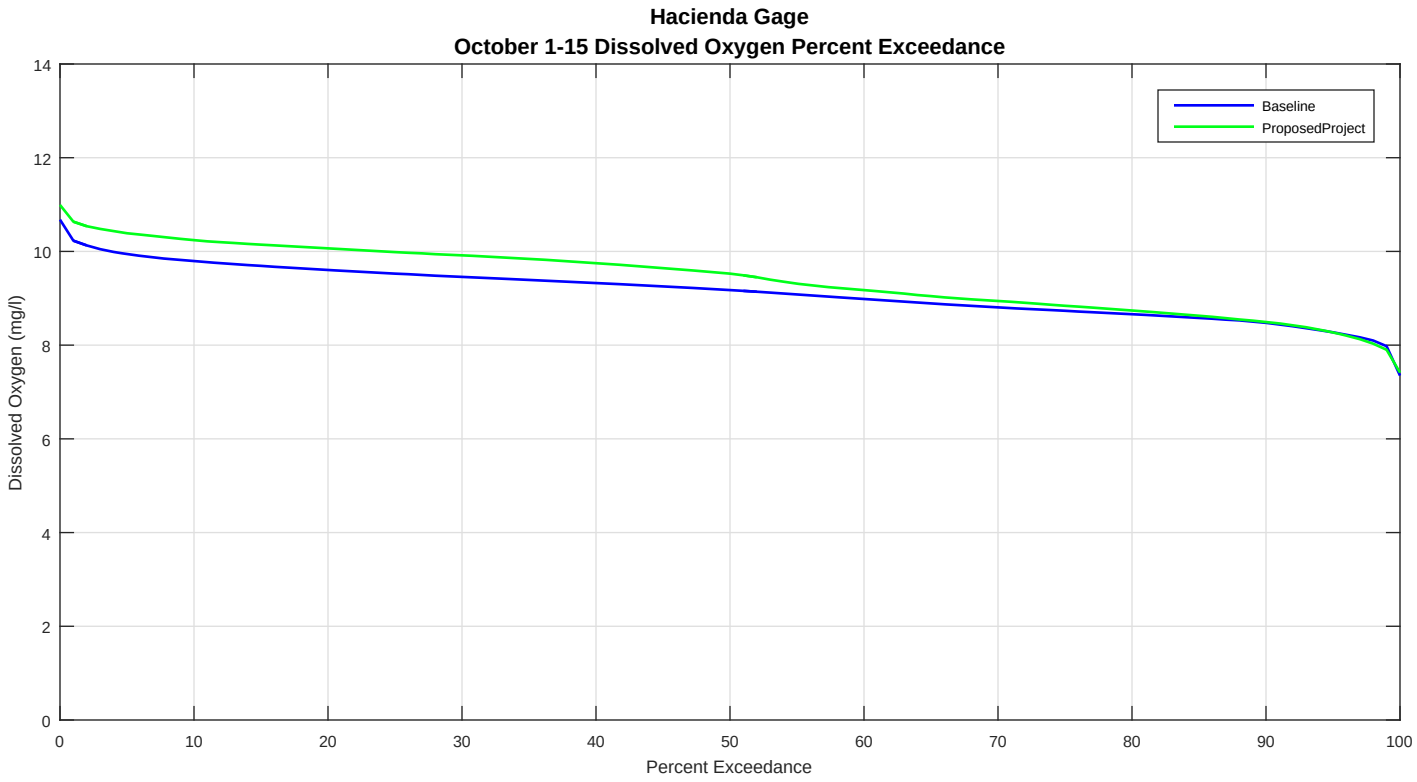
Hacienda Gage
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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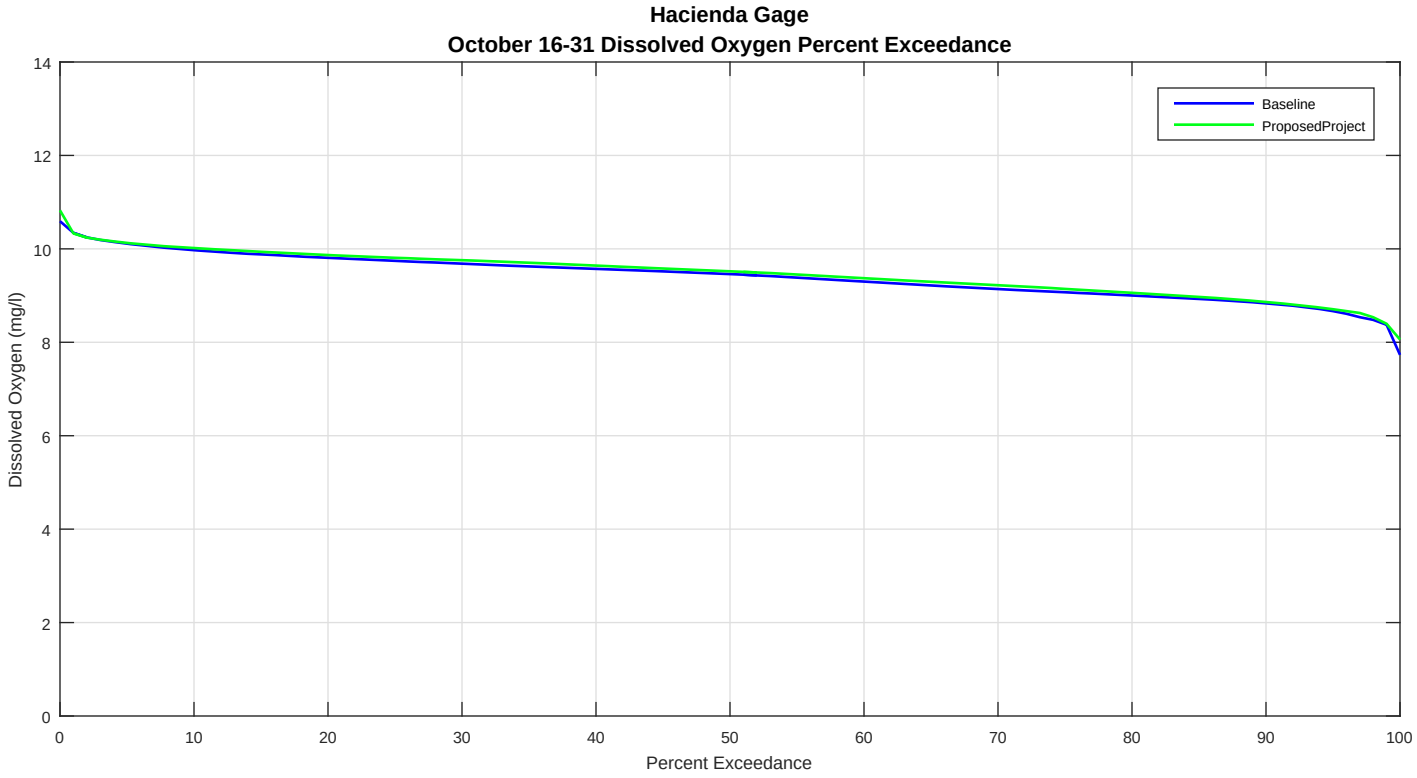
Hacienda Gage
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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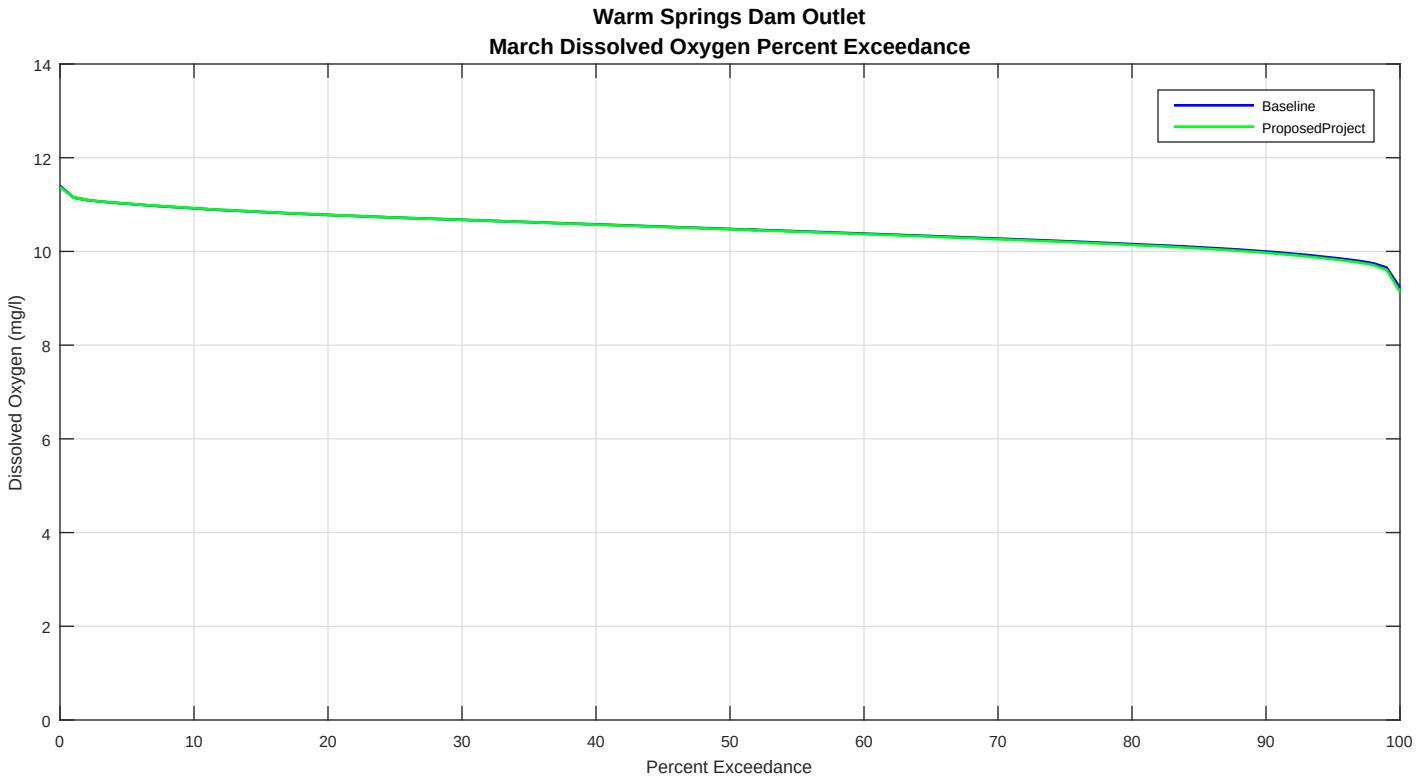
Warm Springs Dam Outlet
March Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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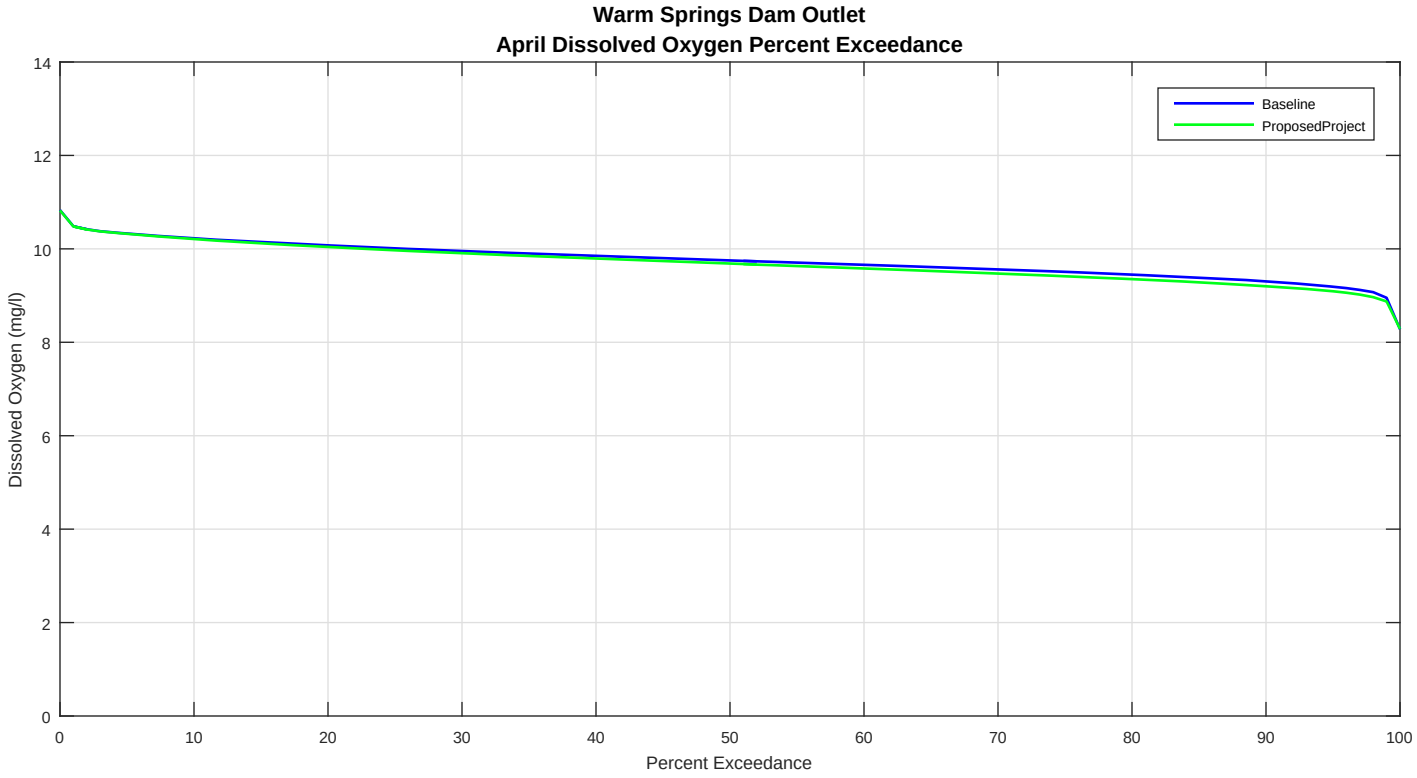
Warm Springs Dam Outlet
April Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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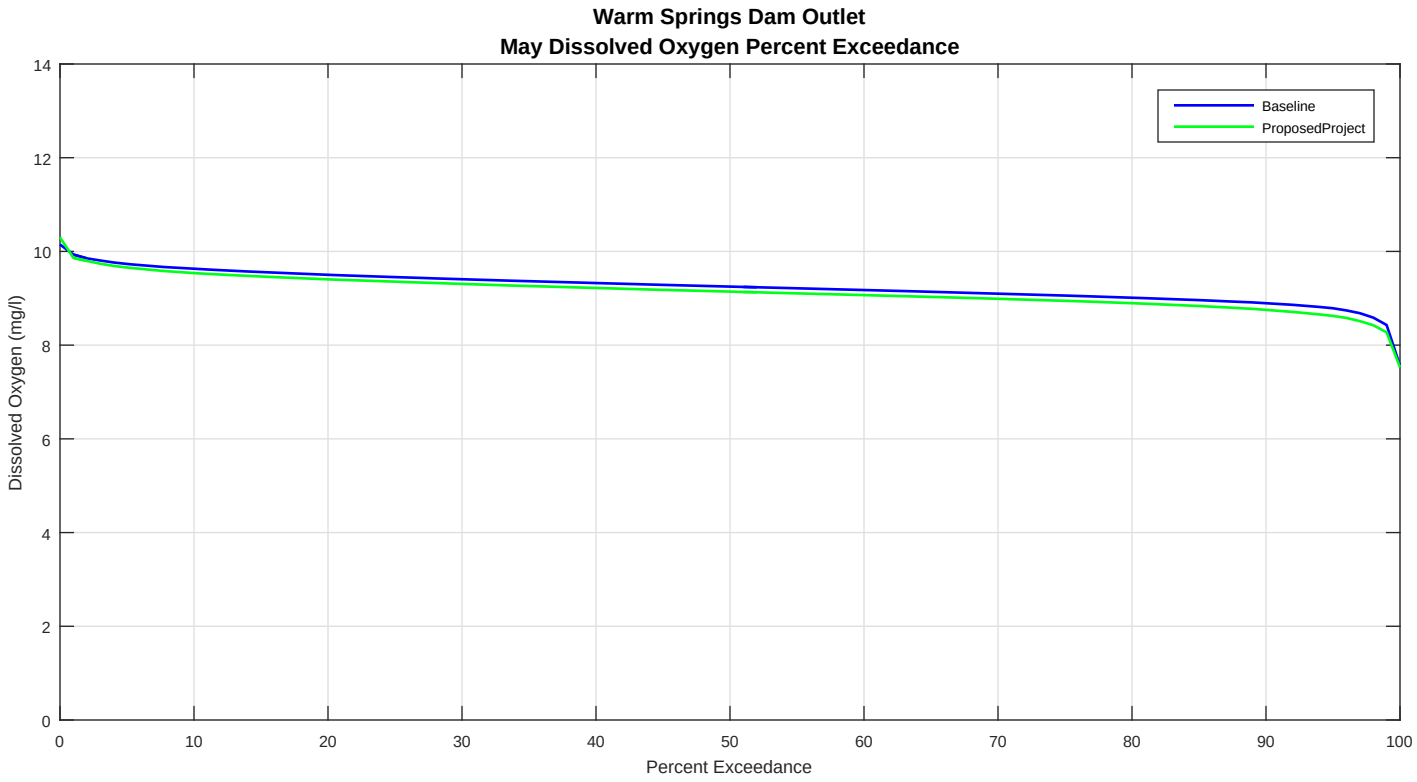
Warm Springs Dam Outlet
May Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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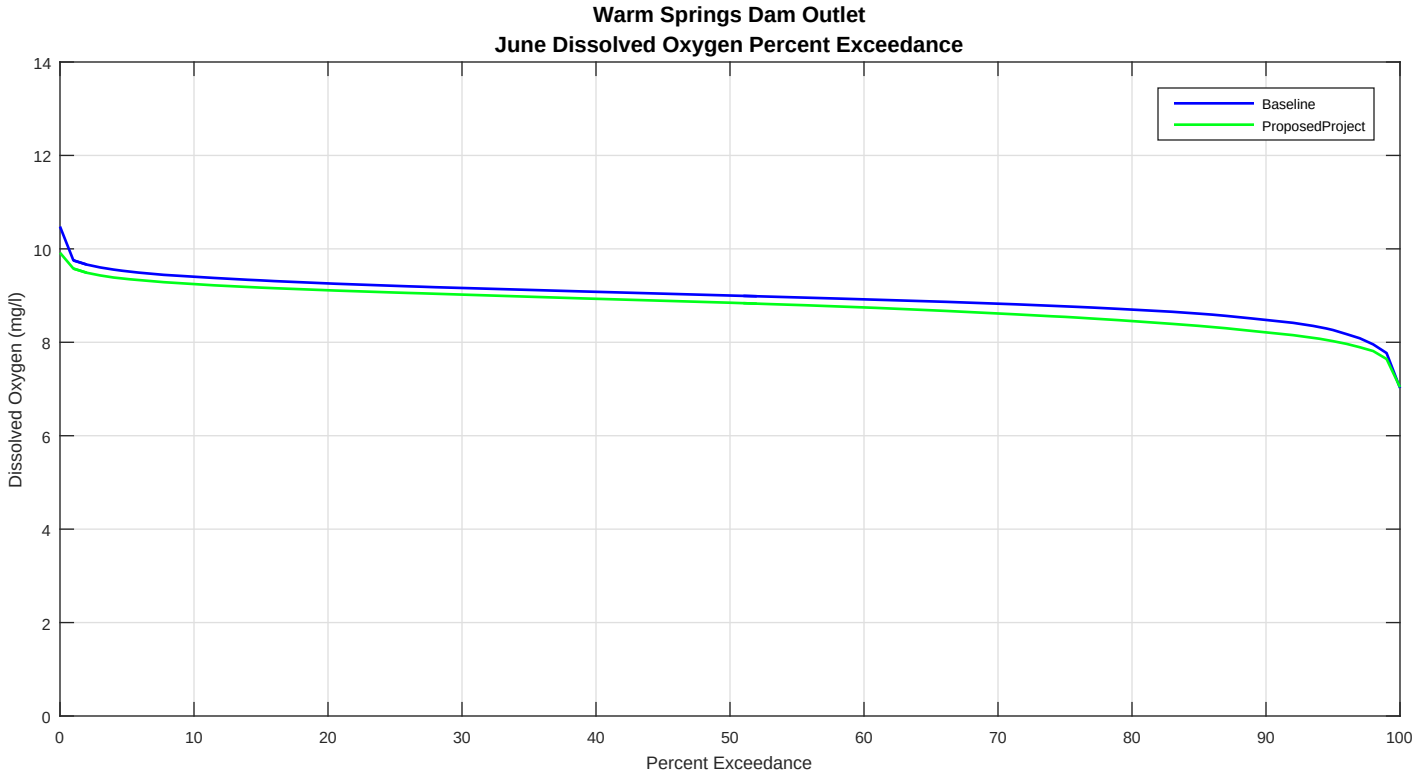
Warm Springs Dam Outlet
June Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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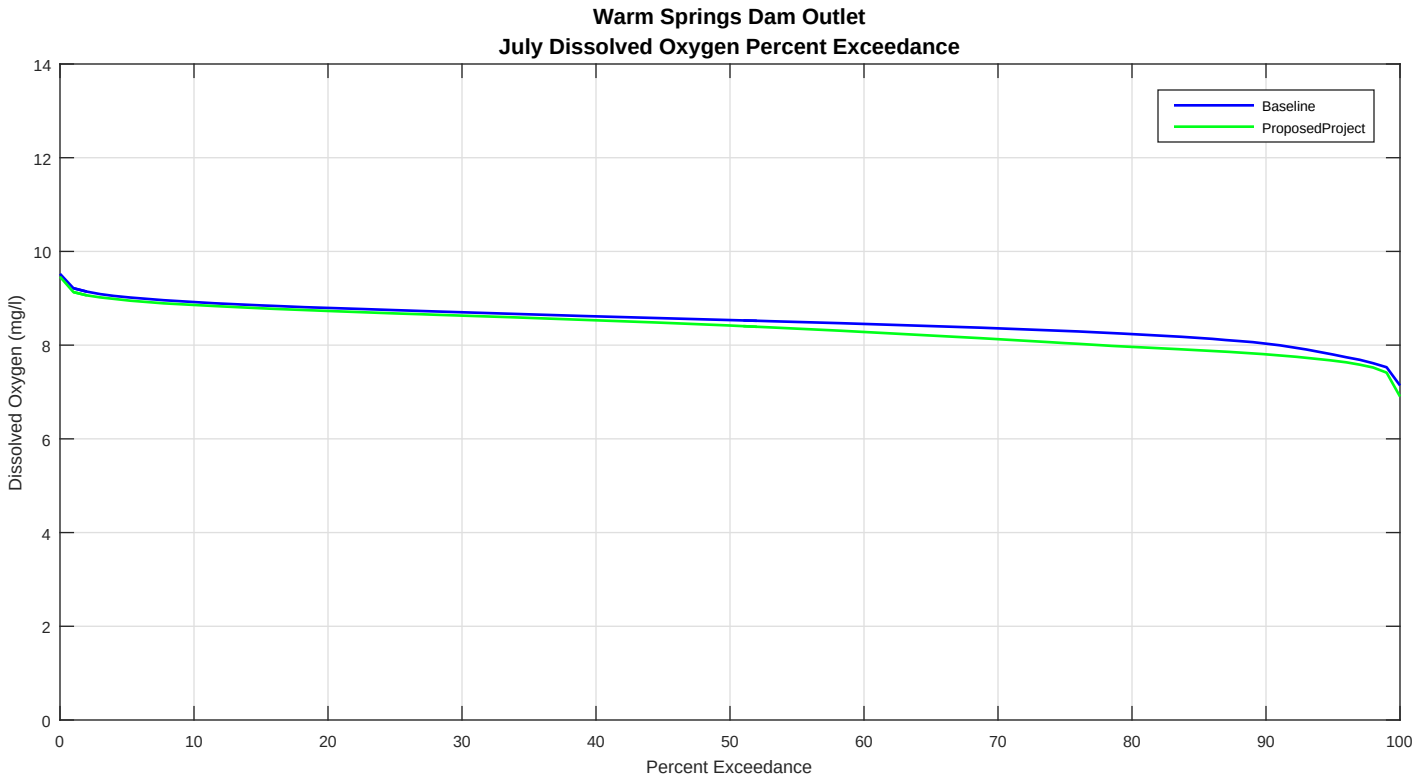
Warm Springs Dam Outlet
July Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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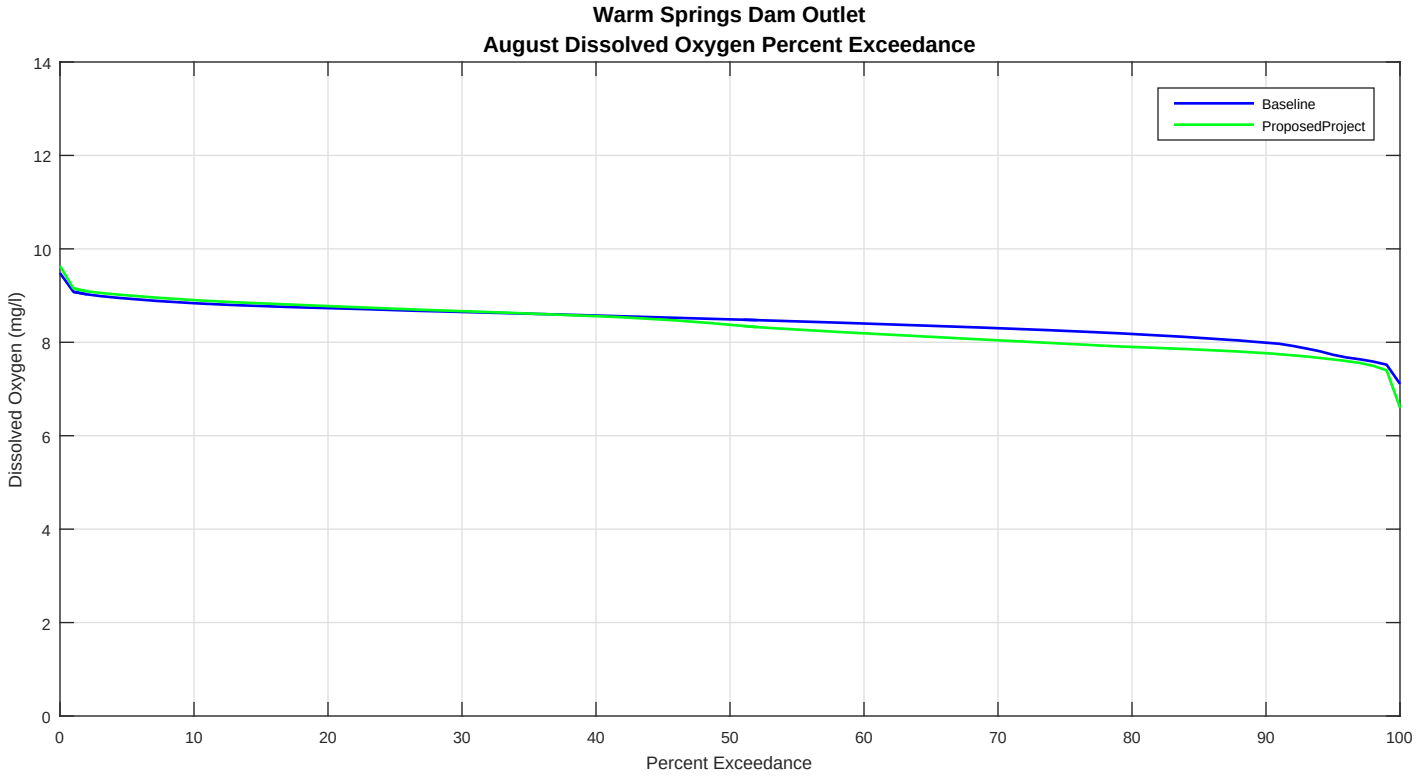
Warm Springs Dam Outlet
August Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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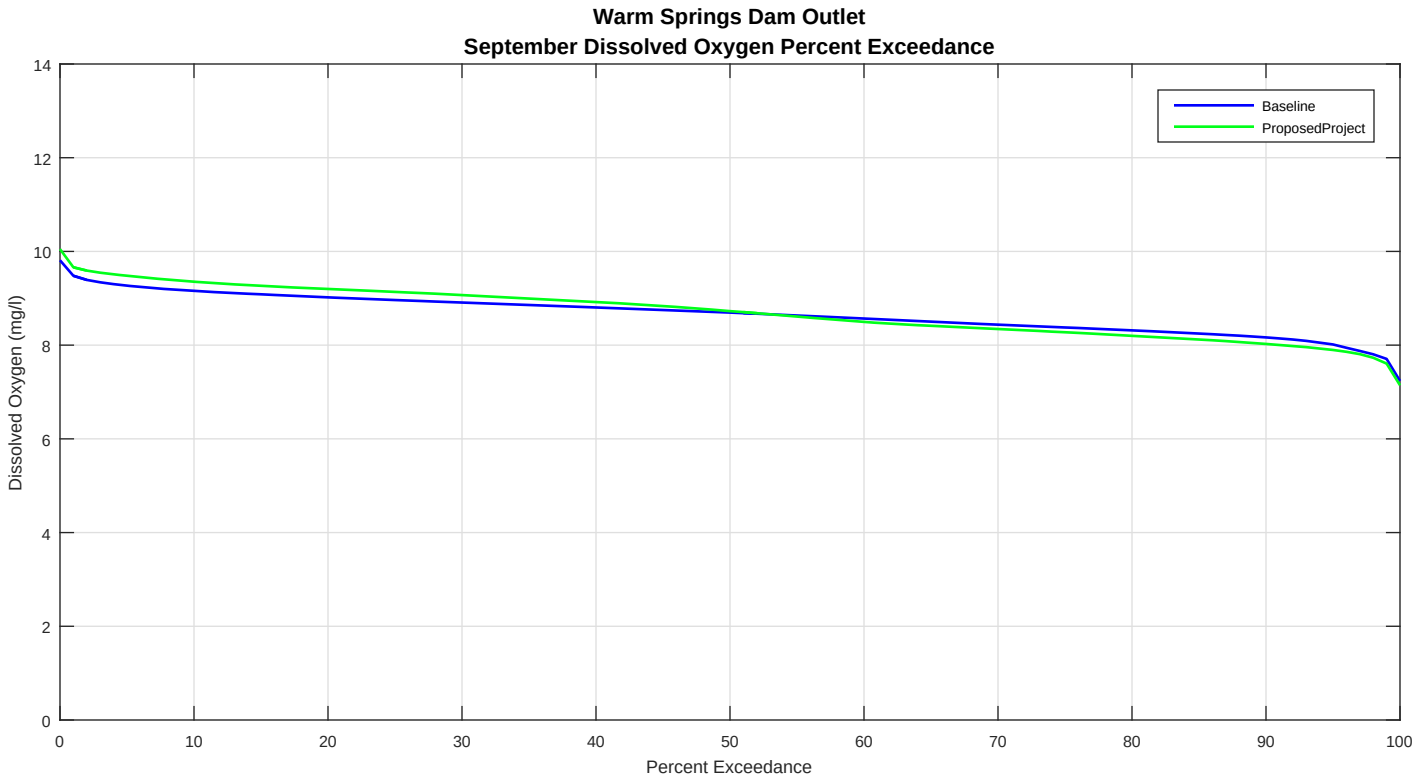
Warm Springs Dam Outlet
September Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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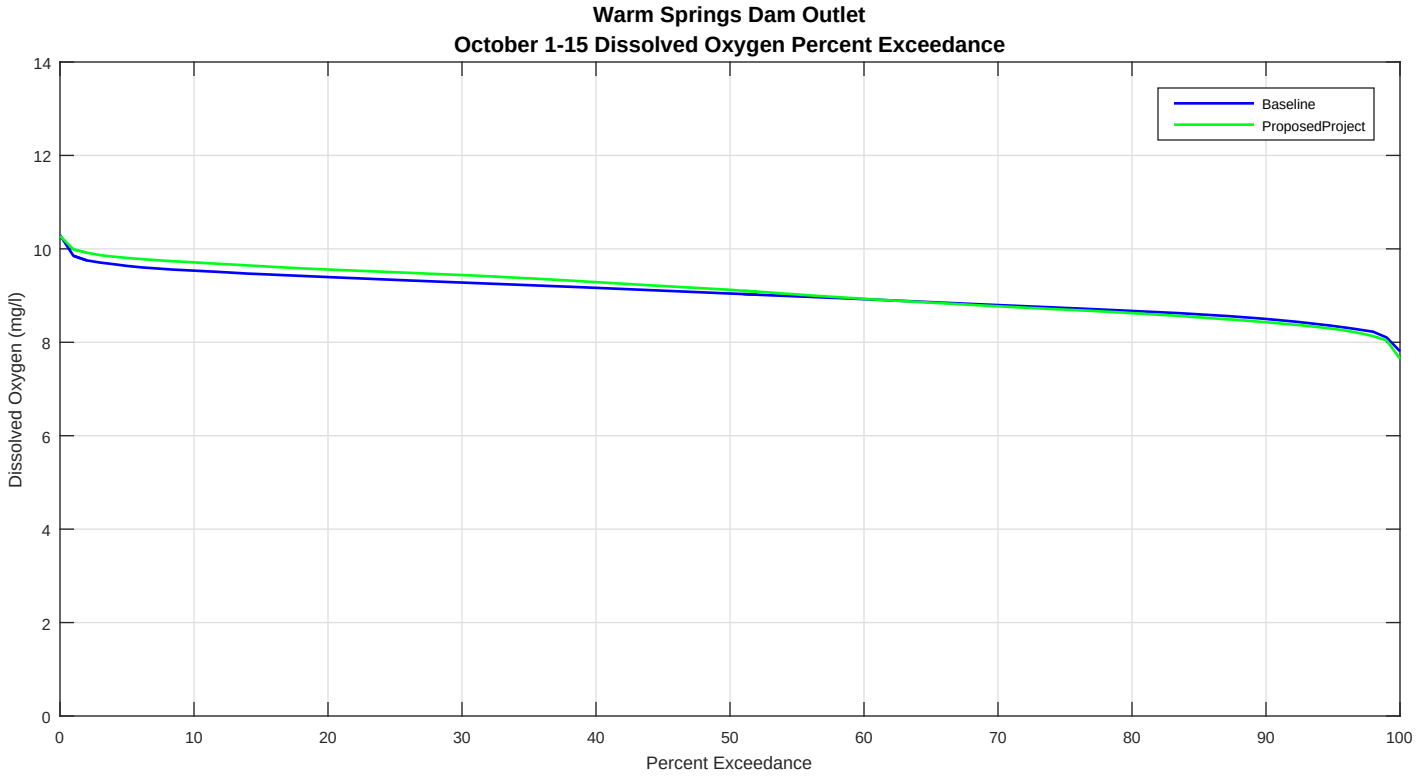
Warm Springs Dam Outlet
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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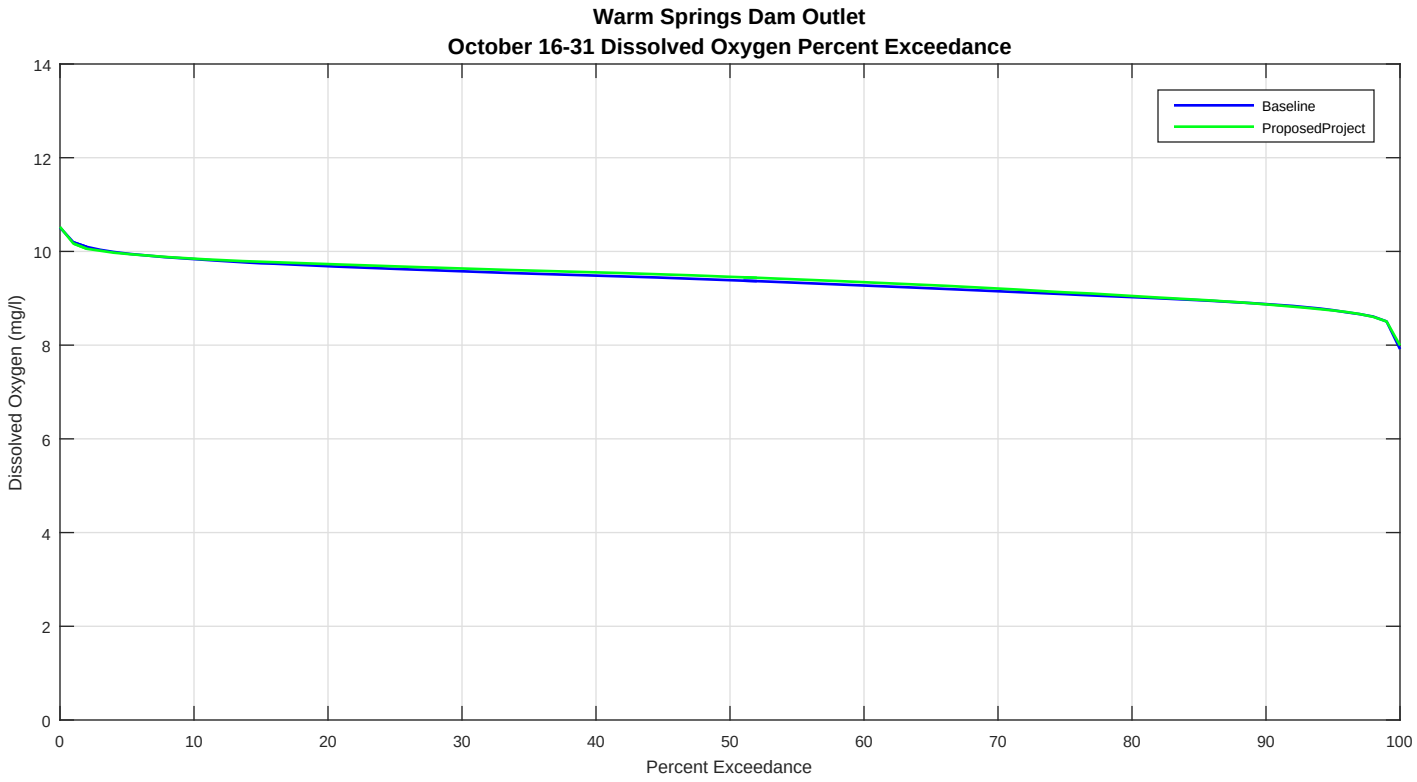
Warm Springs Dam Outlet
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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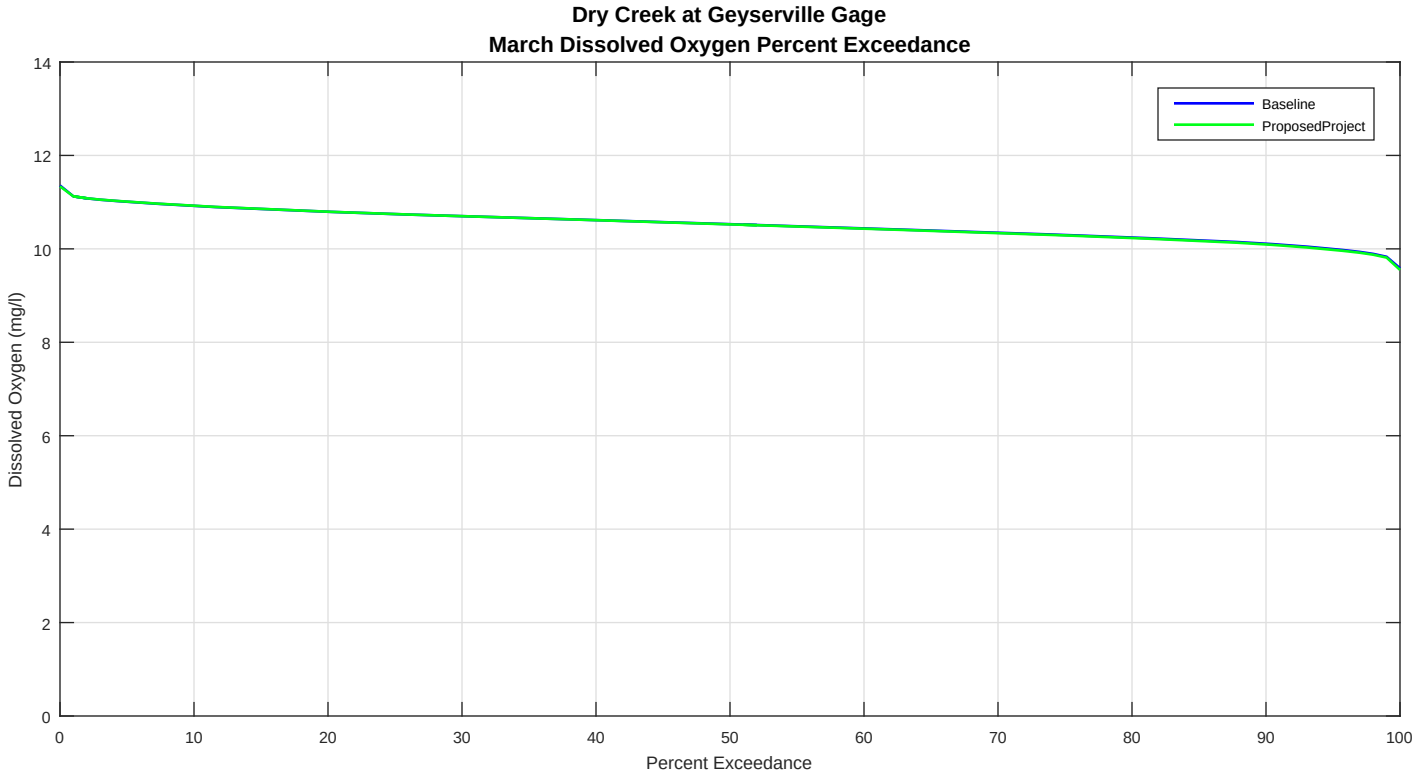
Dry Creek at Geyserville Gage
March Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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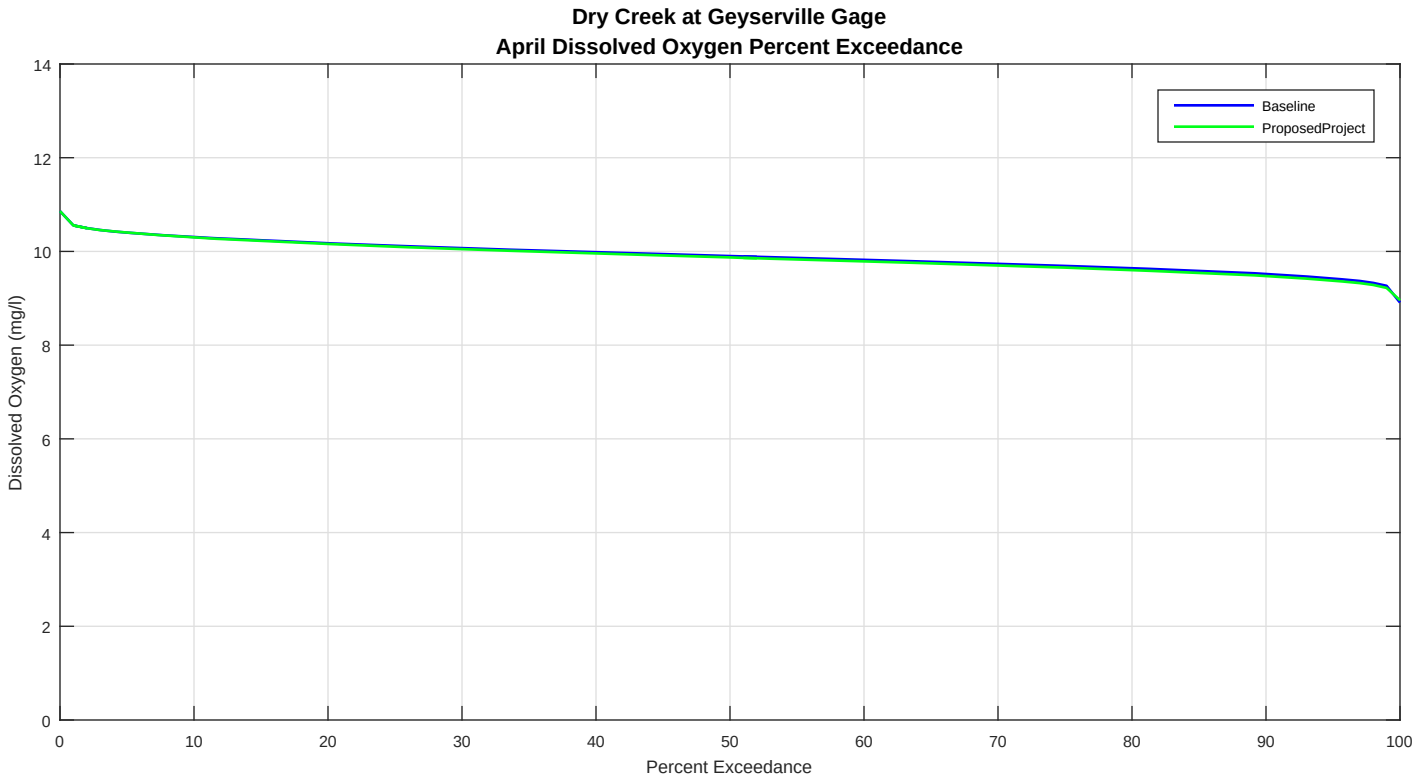
Dry Creek at Geyserville Gage
April Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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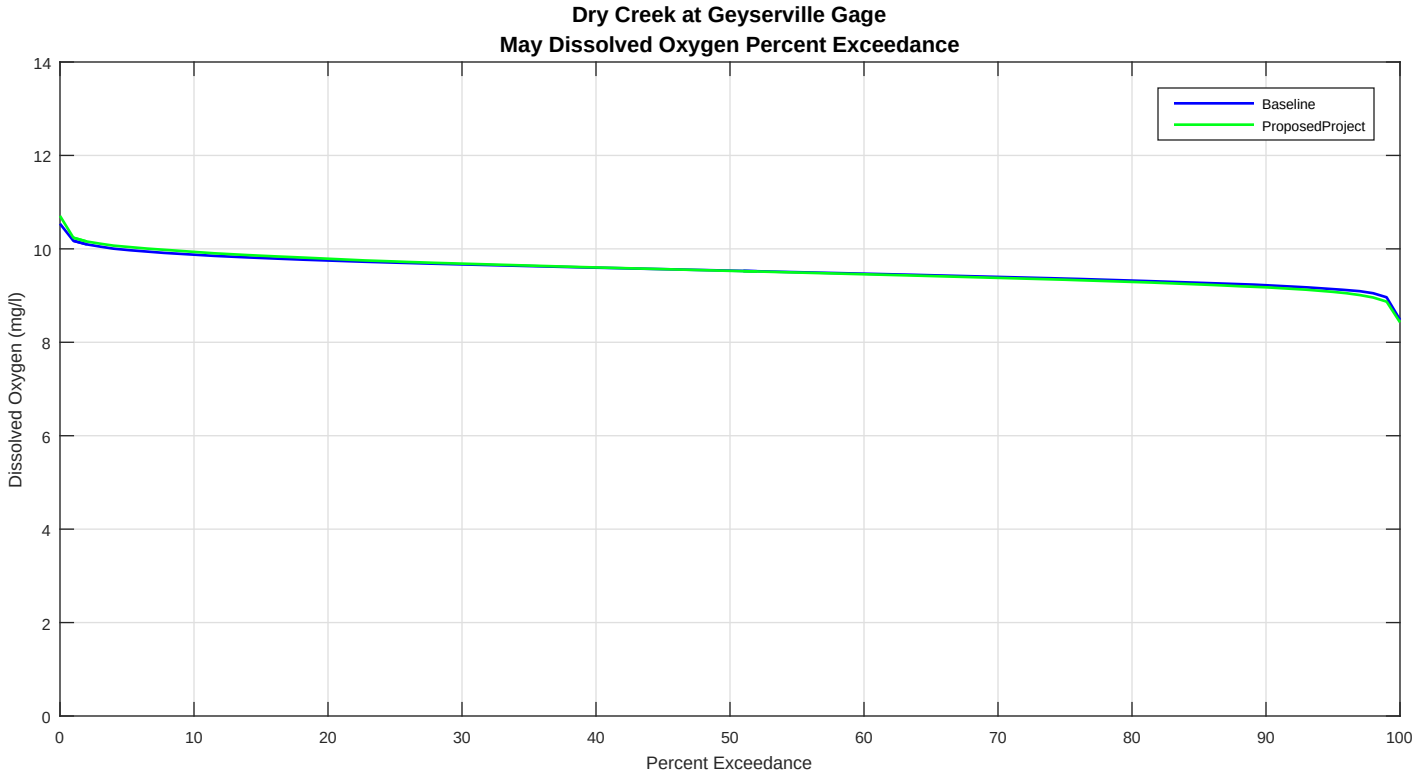
Dry Creek at Geyserville Gage
May Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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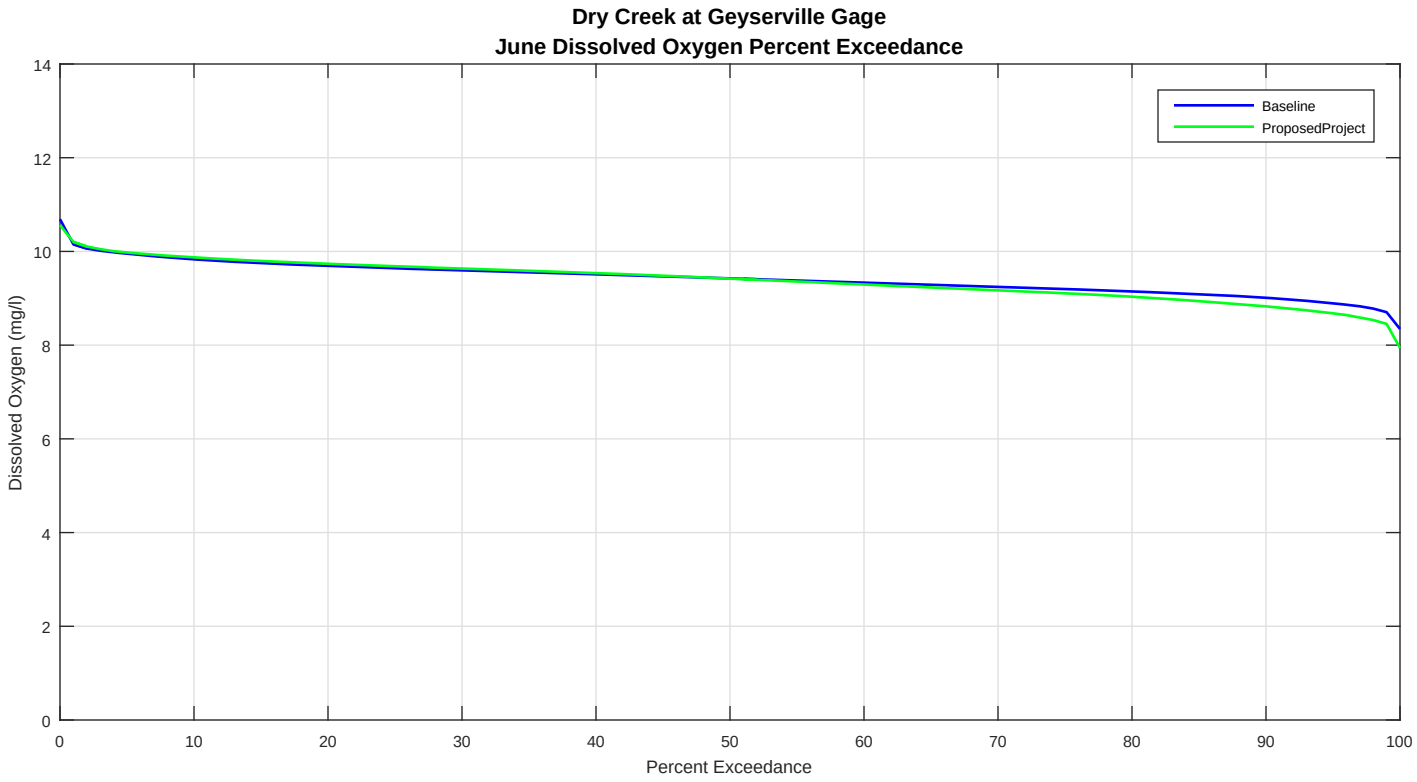
Dry Creek at Geyserville Gage
June Dissolved Oxygen Percent Exceedance
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ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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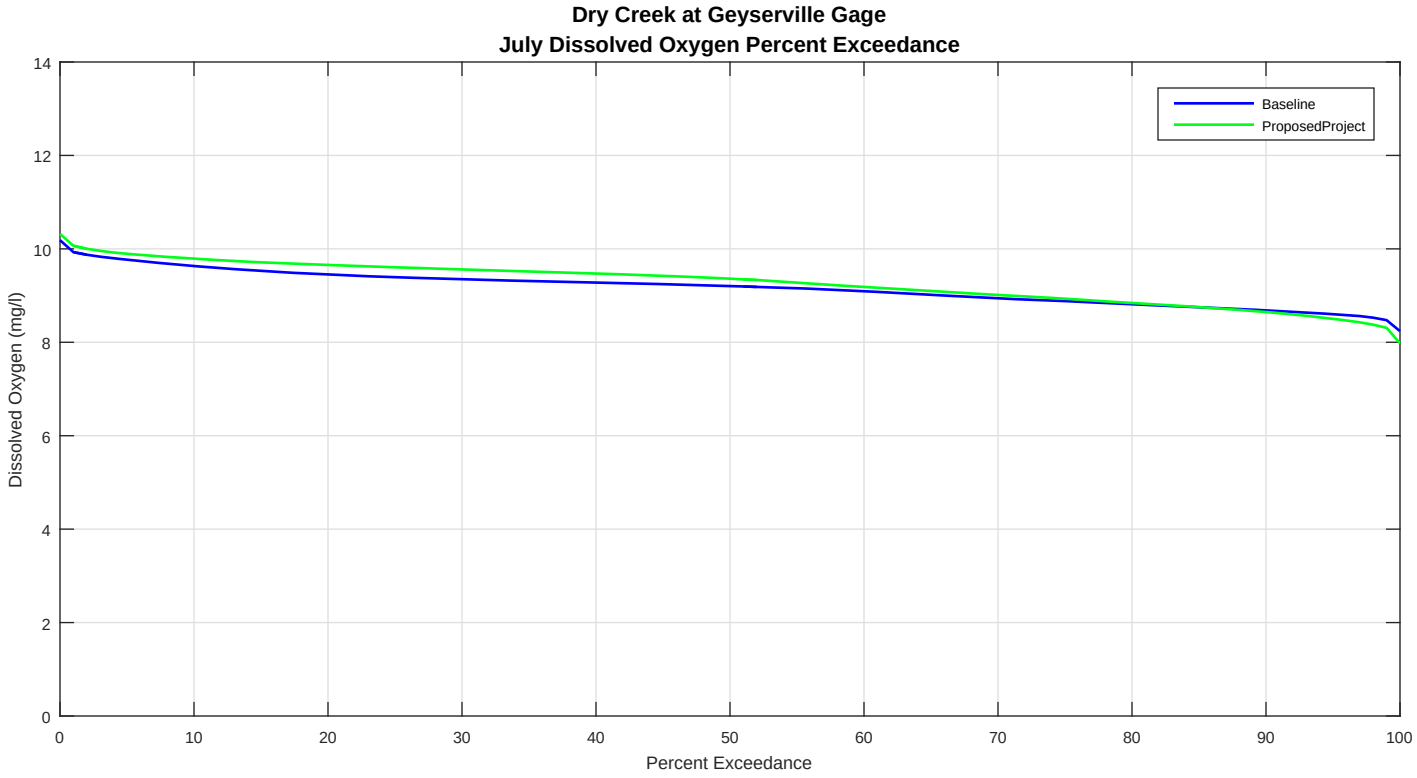
Dry Creek at Geyserville Gage
July Dissolved Oxygen Percent Exceedance
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ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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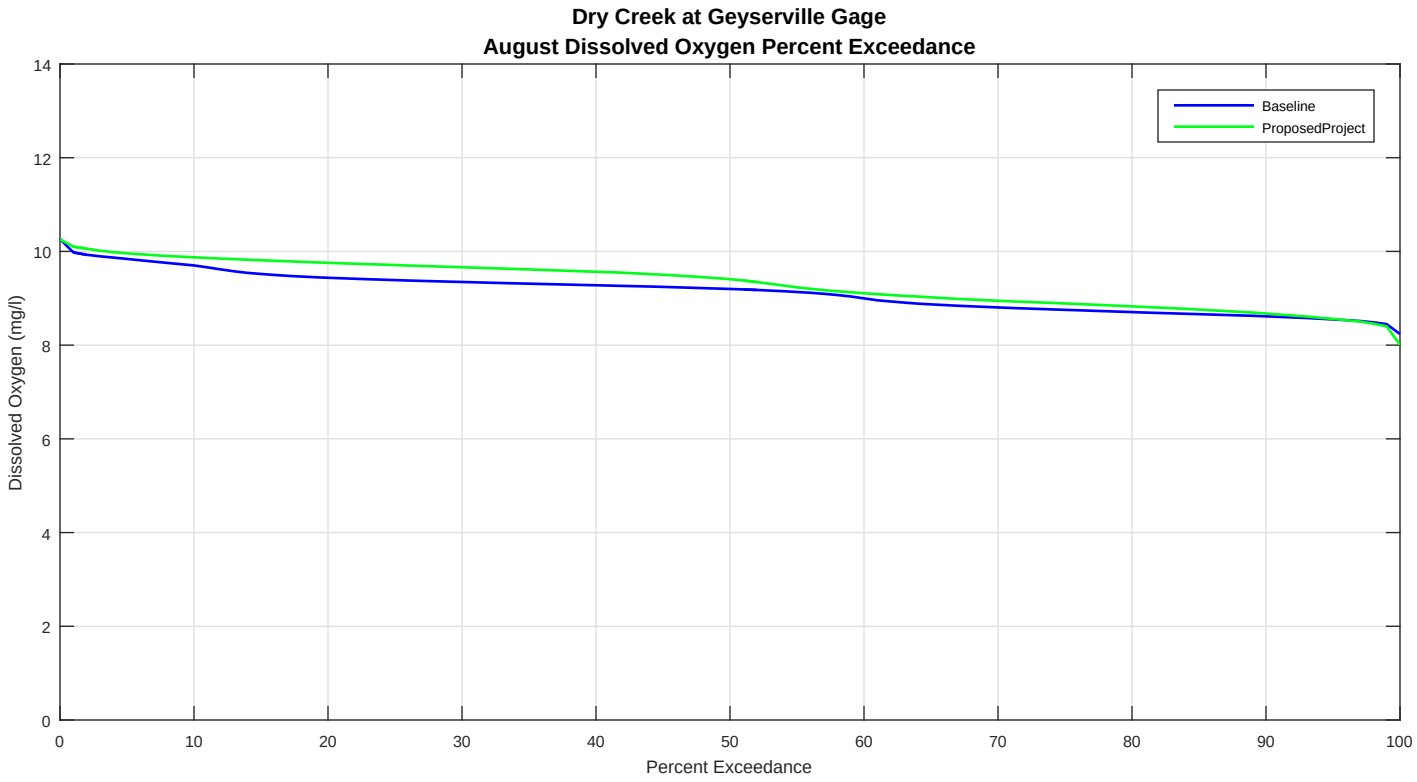
Dry Creek at Geyserville Gage
August Dissolved Oxygen Percent Exceedance
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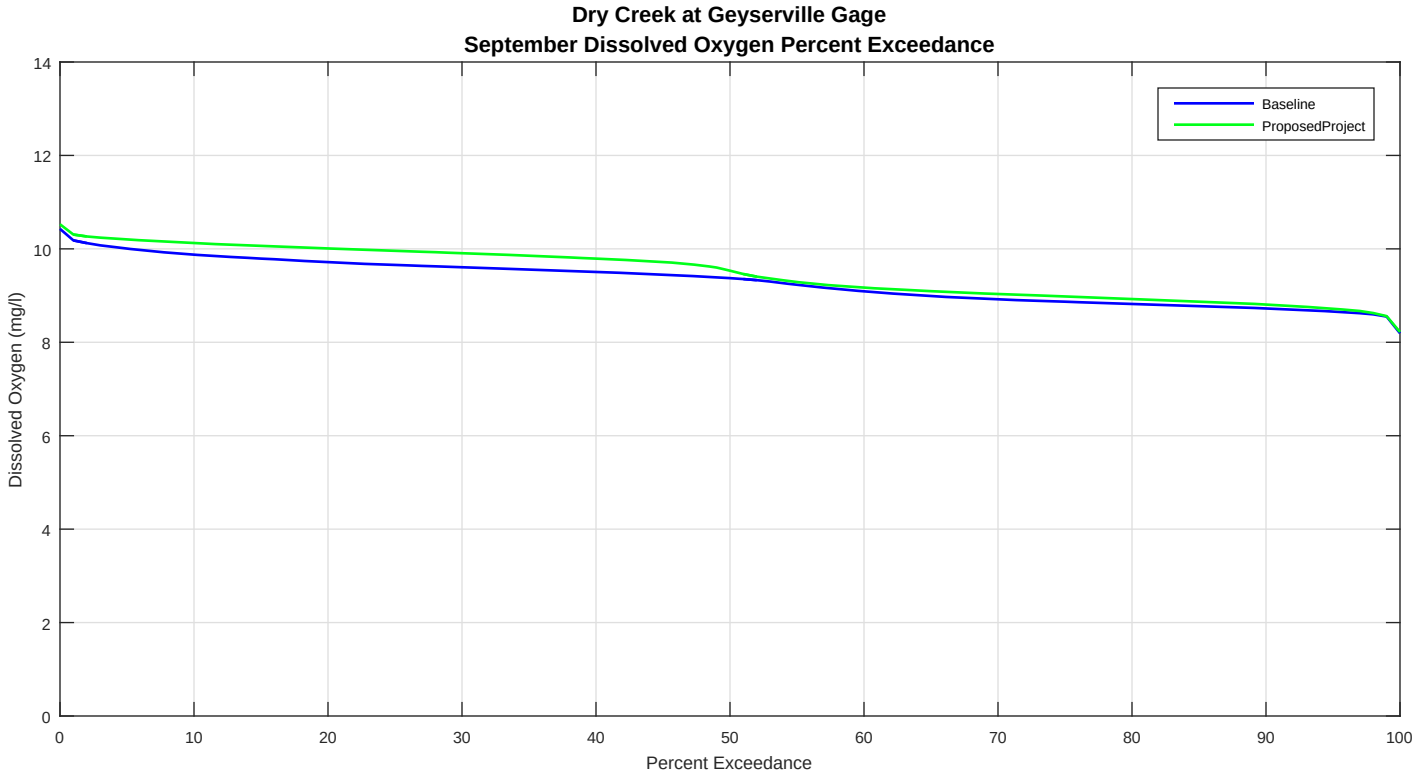
Dry Creek at Geyserville Gage
September Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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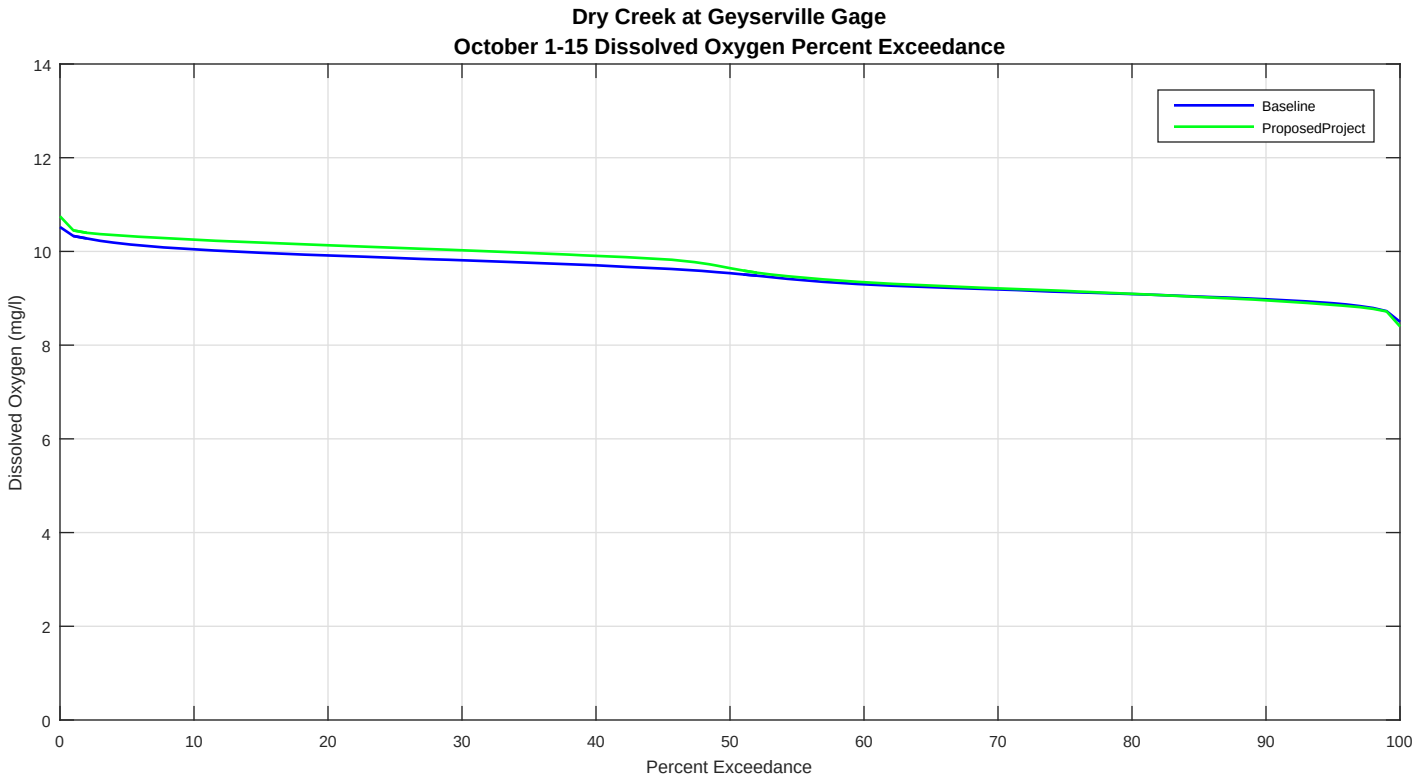
Dry Creek at Geyserville Gage
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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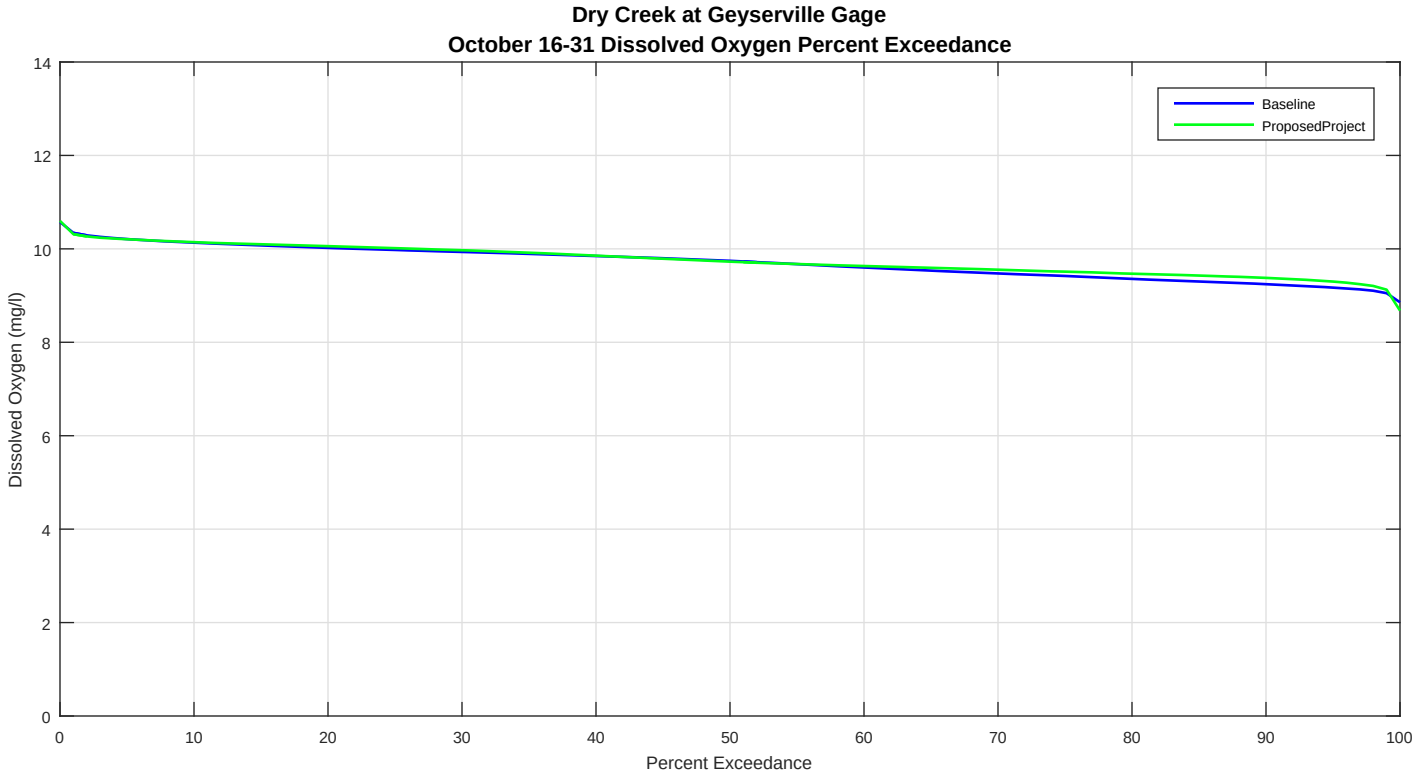
Dry Creek at Geyserville Gage
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
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90
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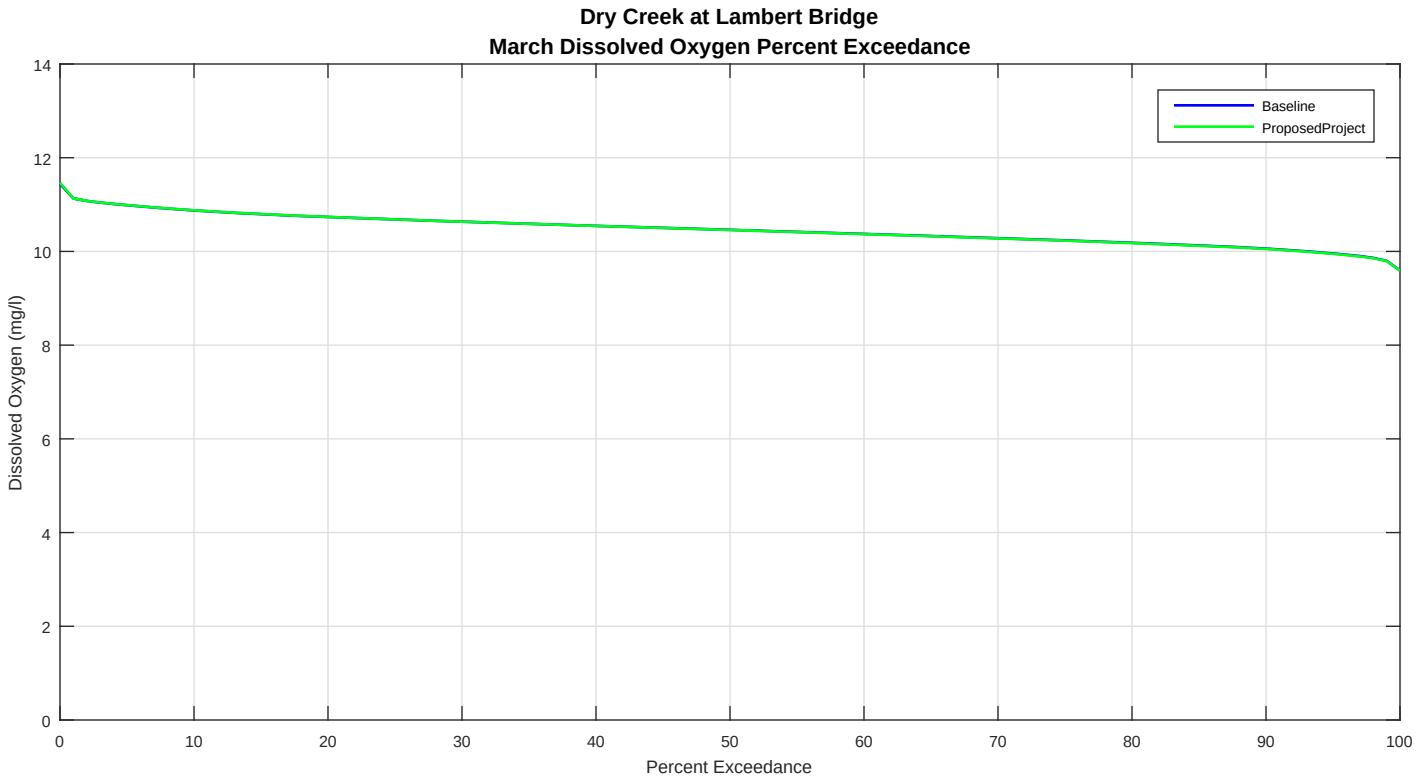
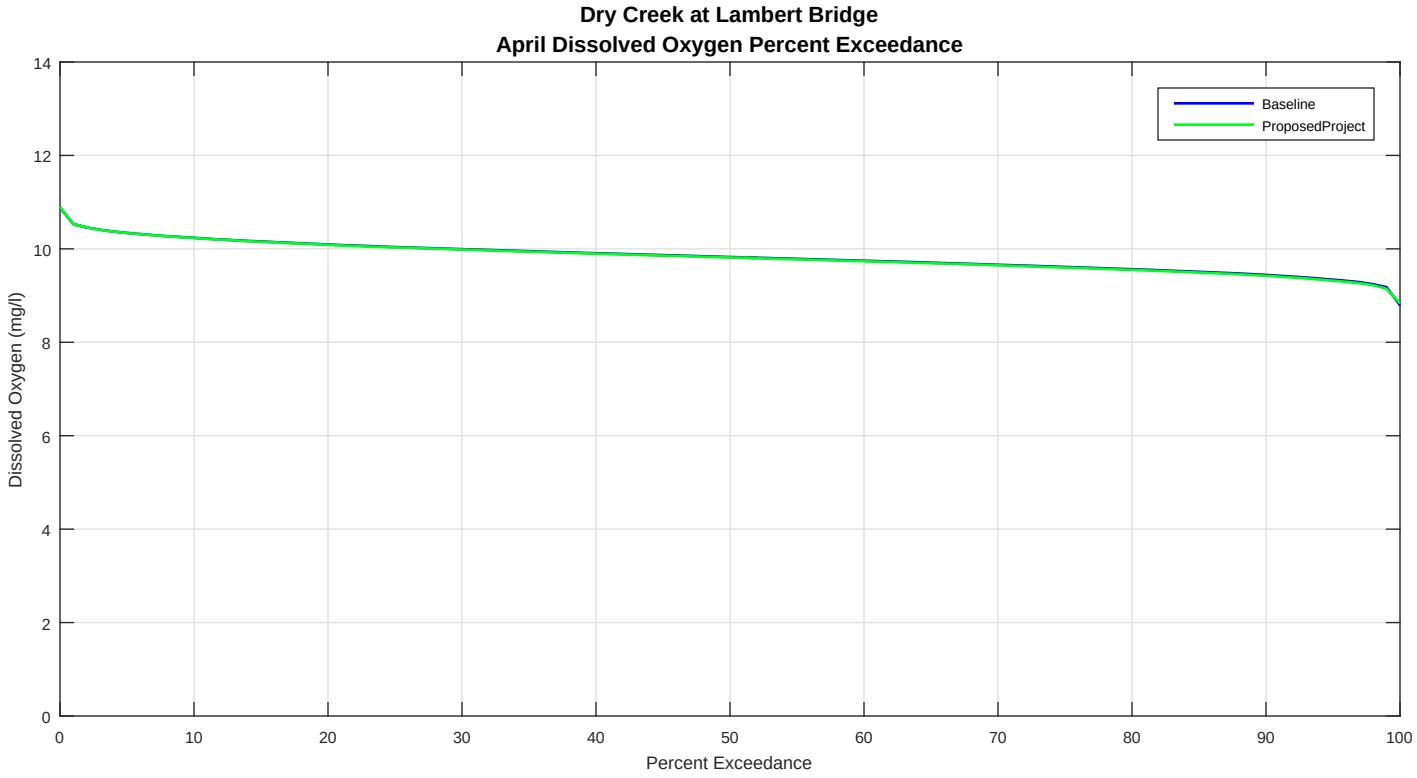

Dry Creek at Lambert Bridge
March Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Dry Creek at Lambert Bridge
April Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
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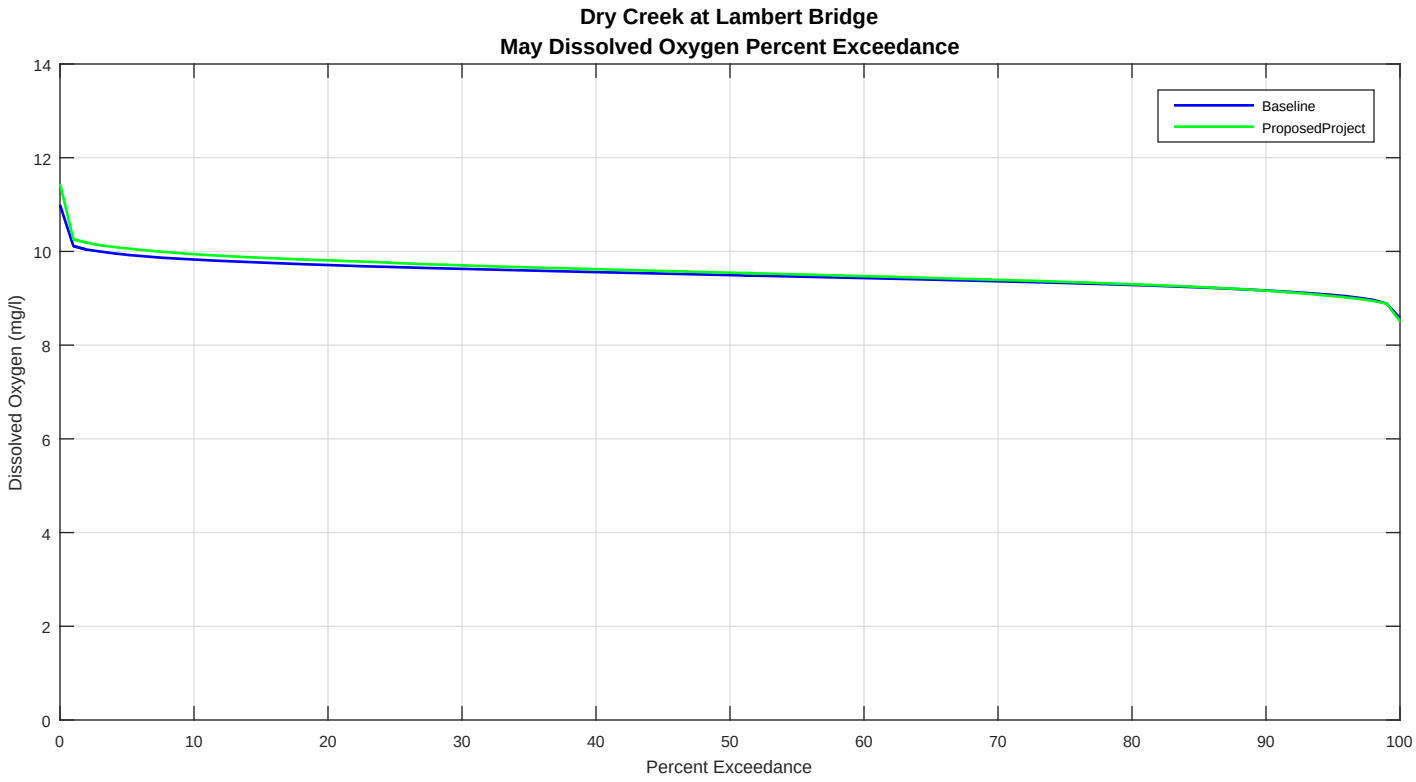
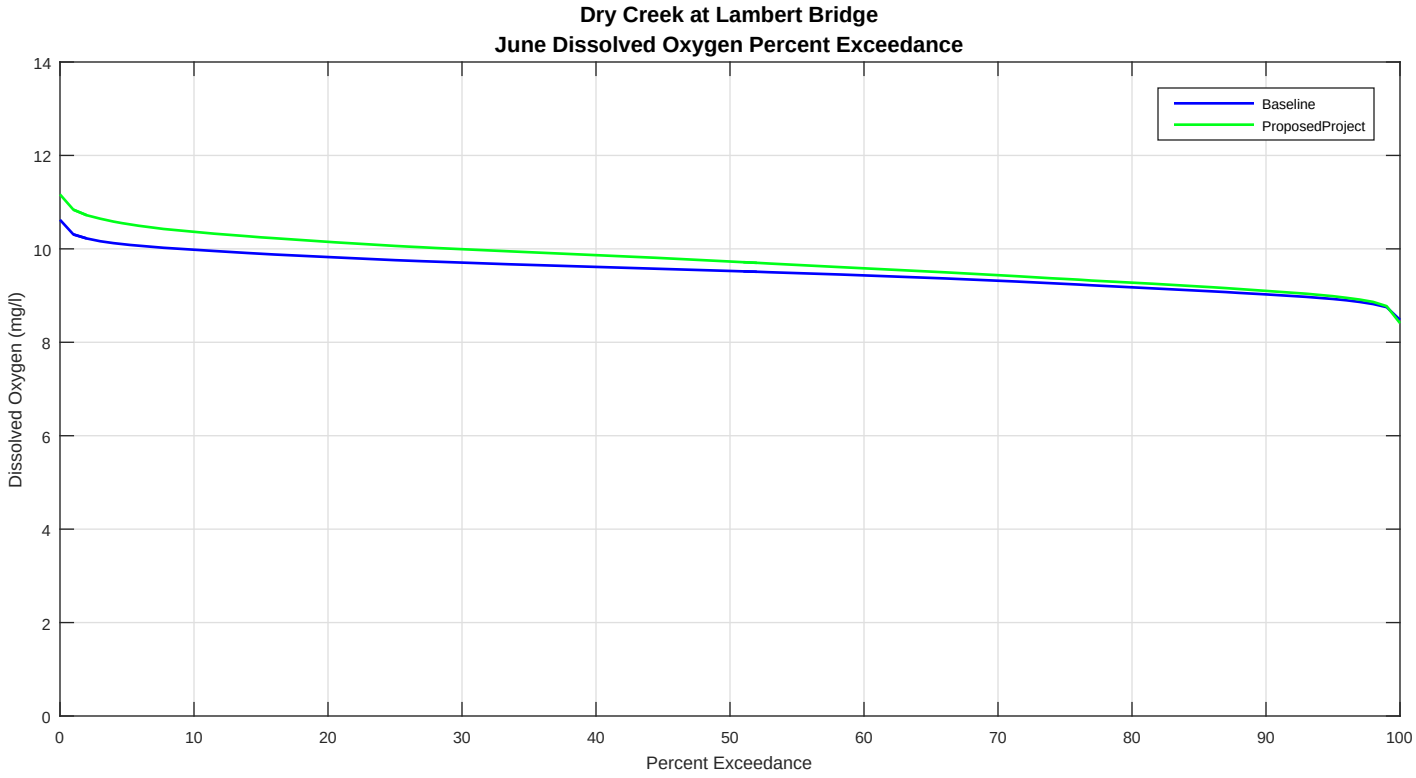
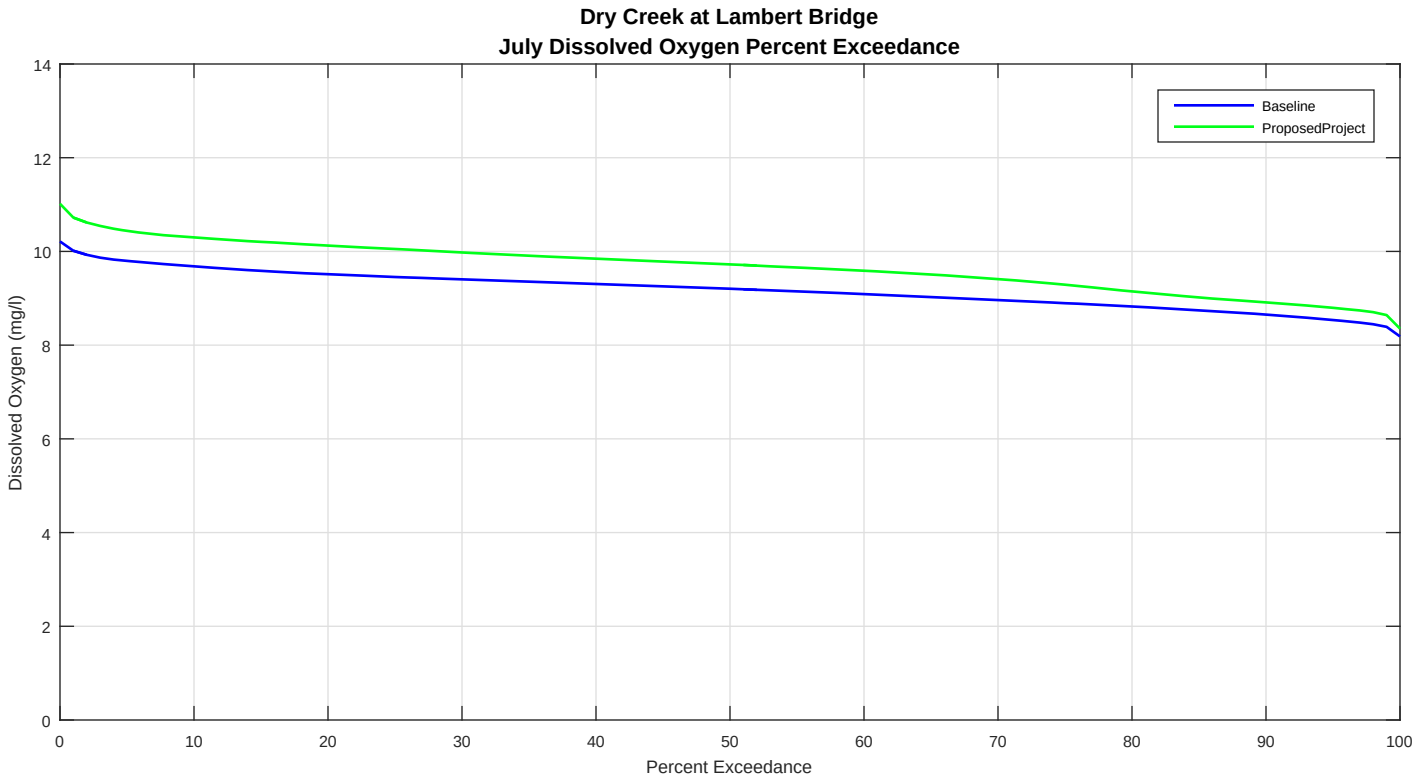
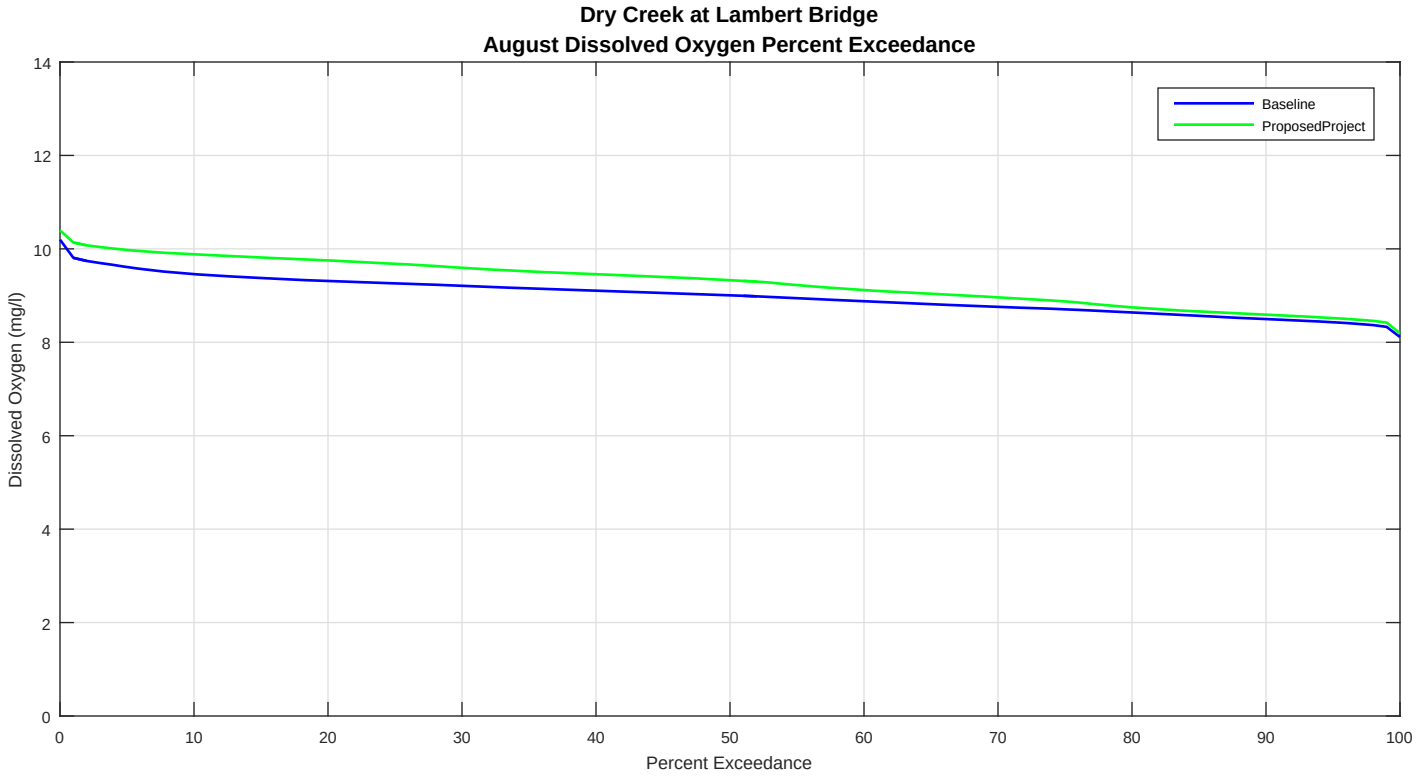
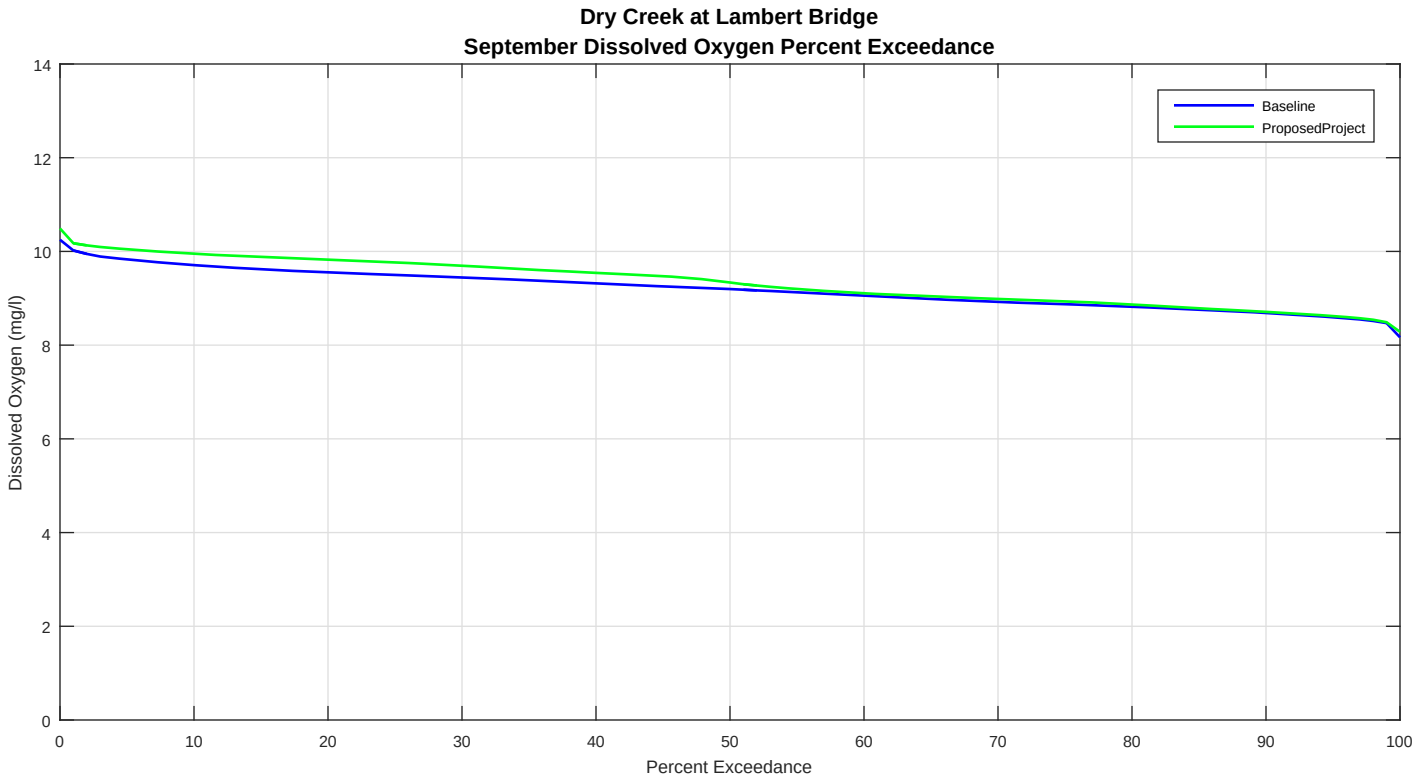
60
70
80
90
100

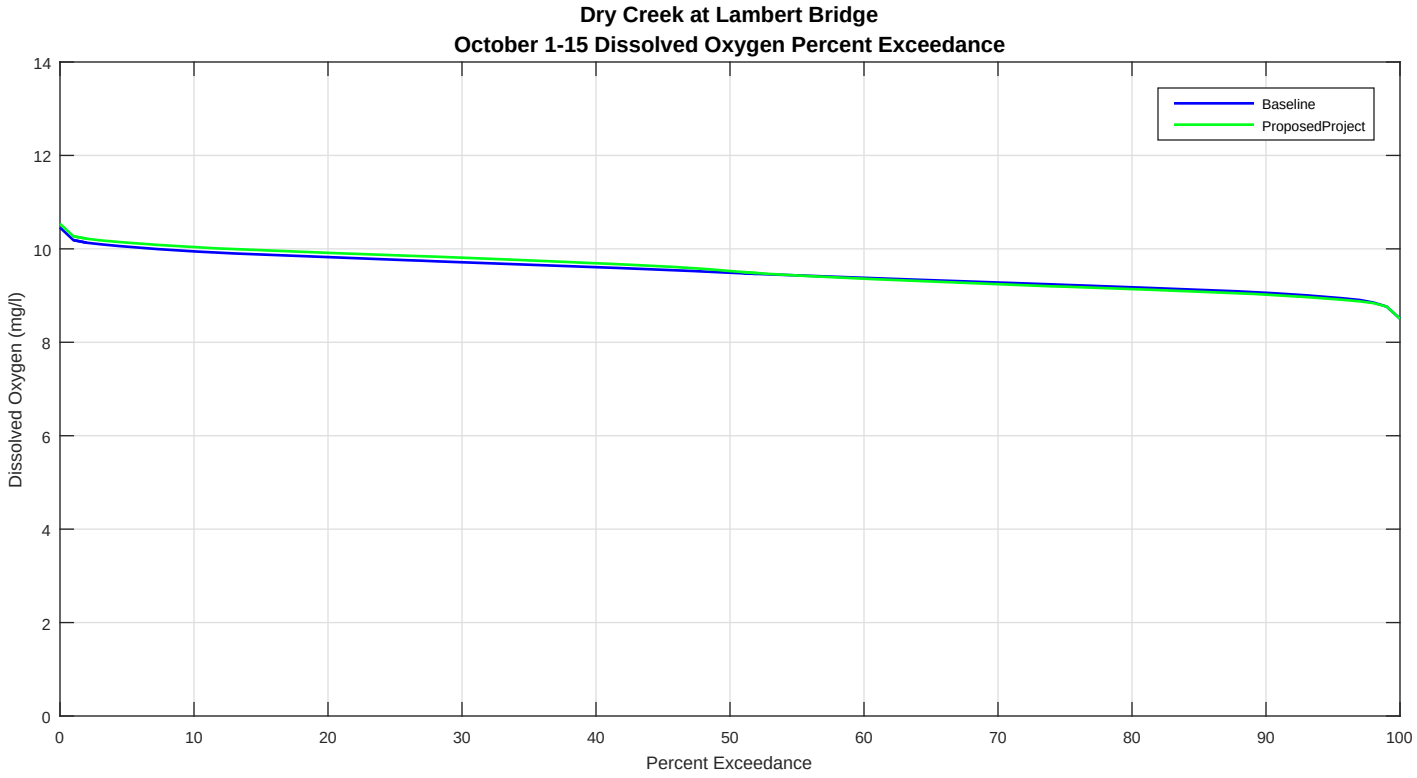

Dry Creek at Lambert Bridge
May Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

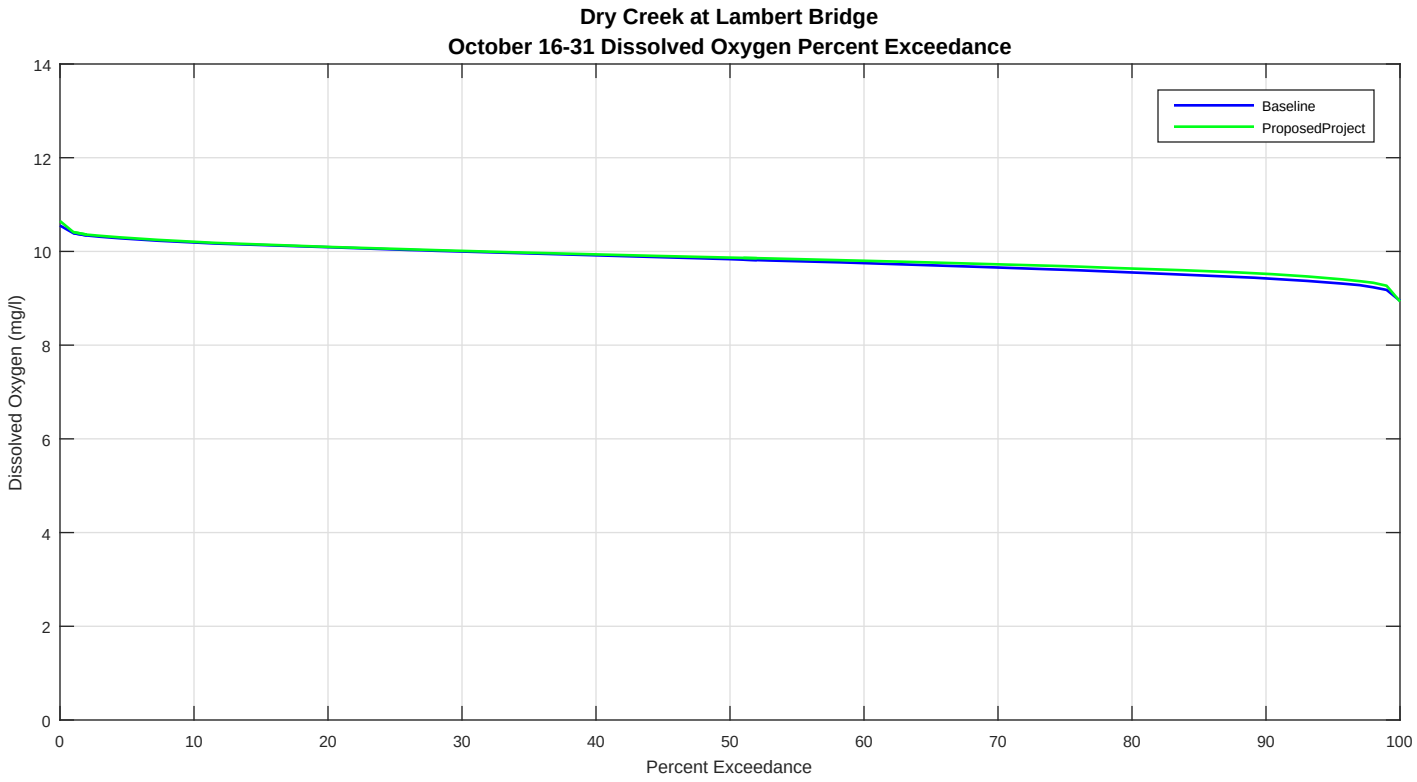

Dry Creek at Lambert Bridge
June Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

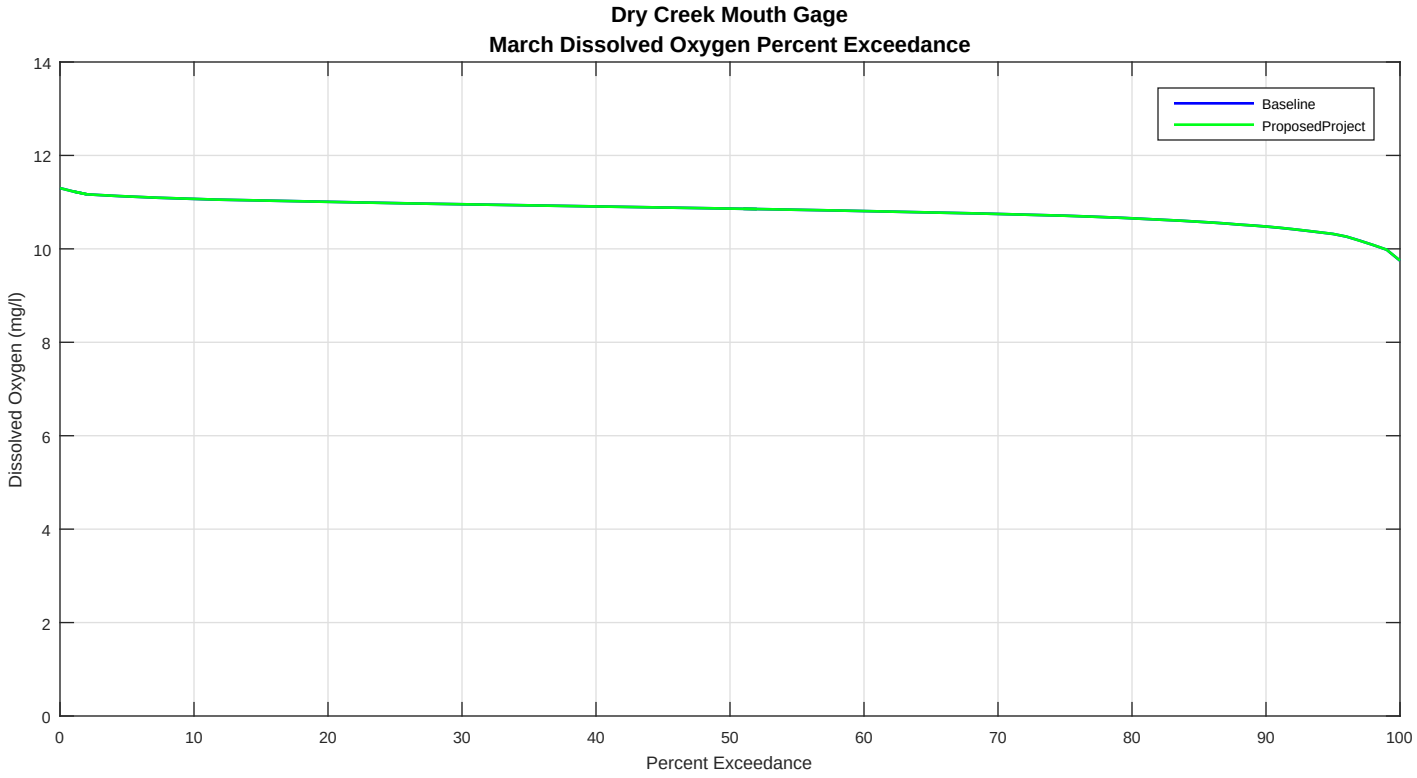

Dry Creek at Lambert Bridge
July Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

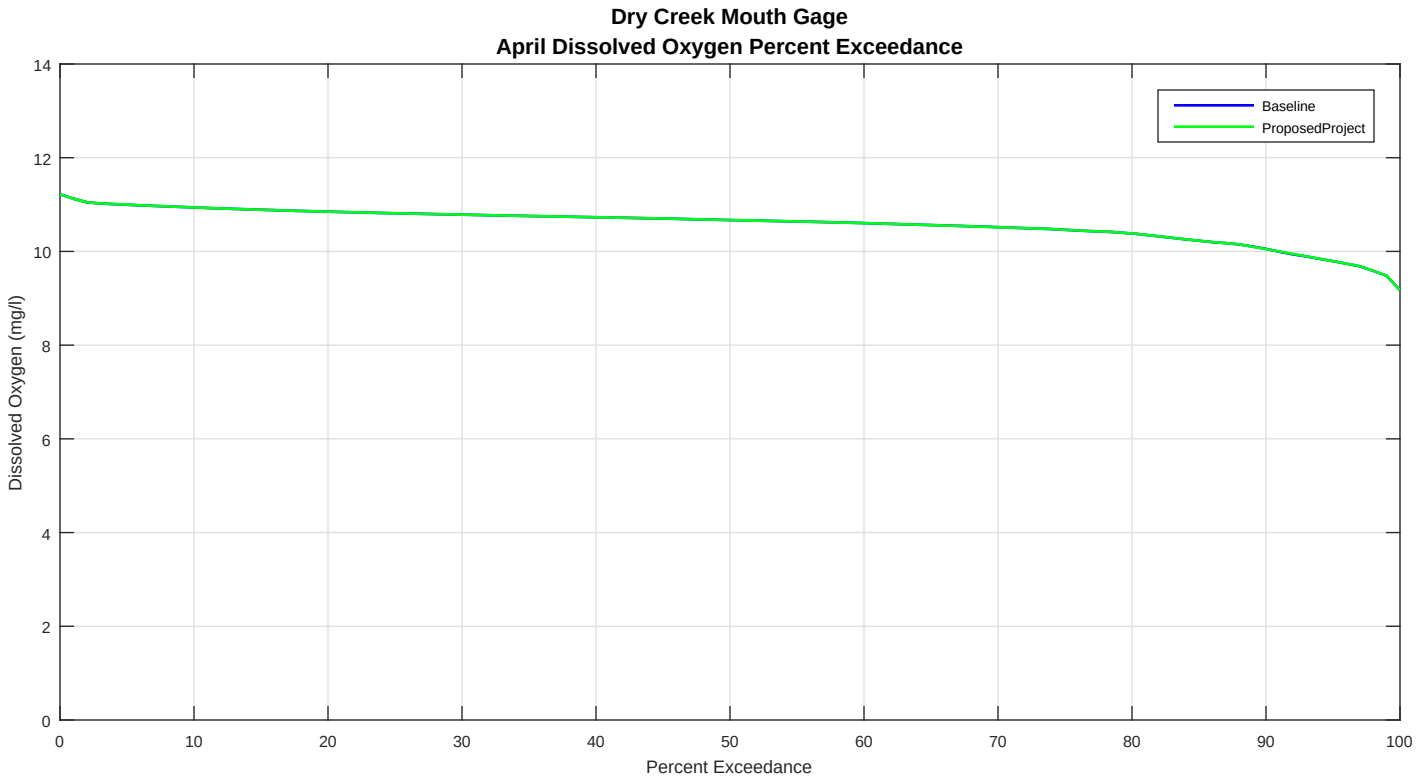

Dry Creek at Lambert Bridge
August Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

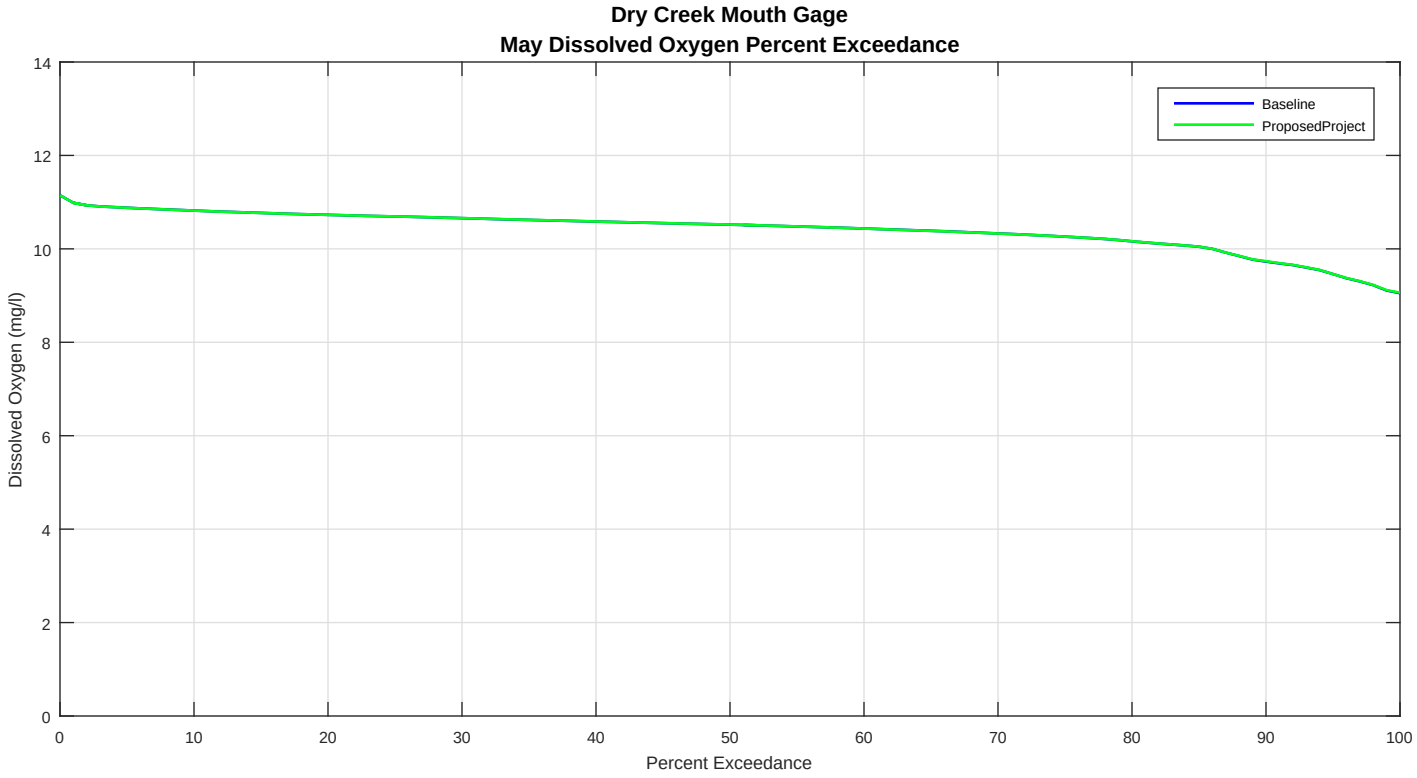

Dry Creek at Lambert Bridge
September Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

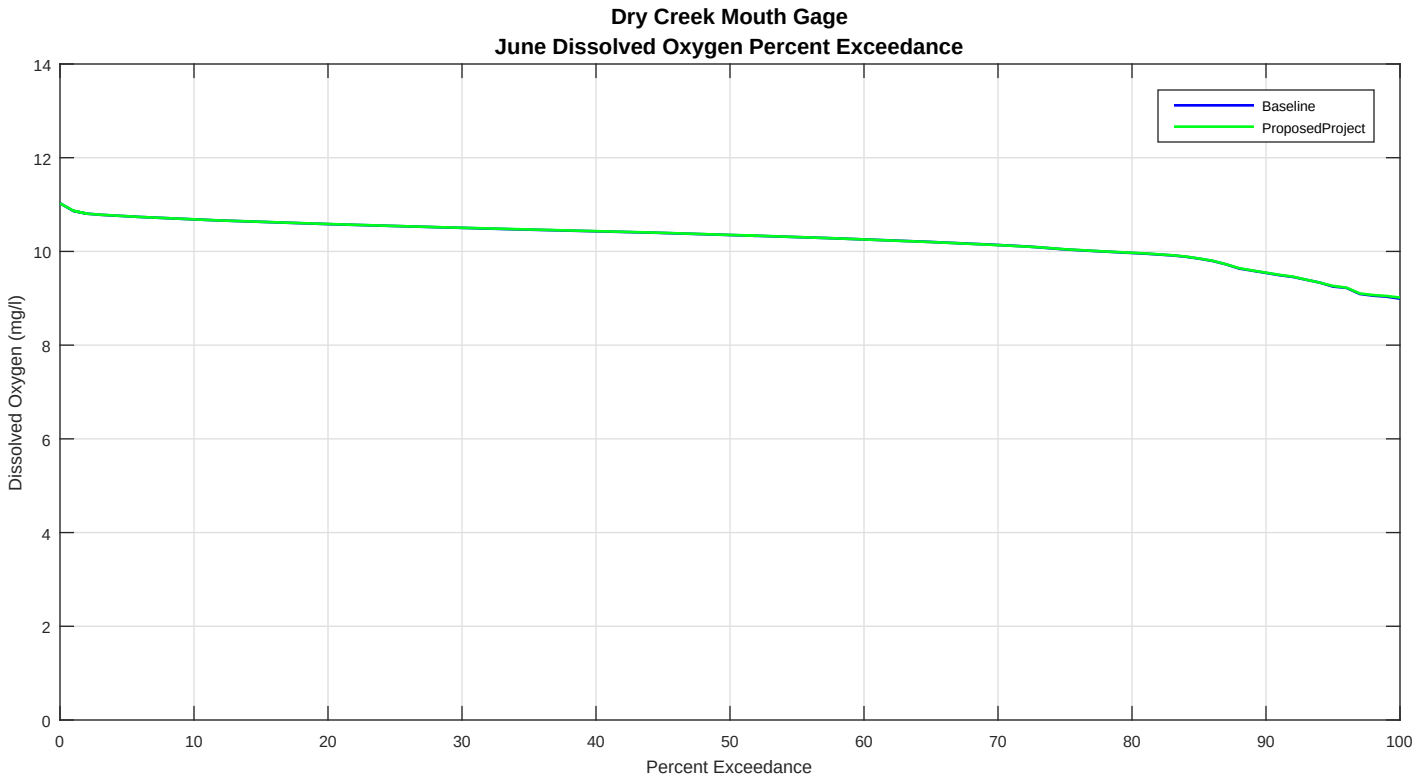

Dry Creek at Lambert Bridge
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

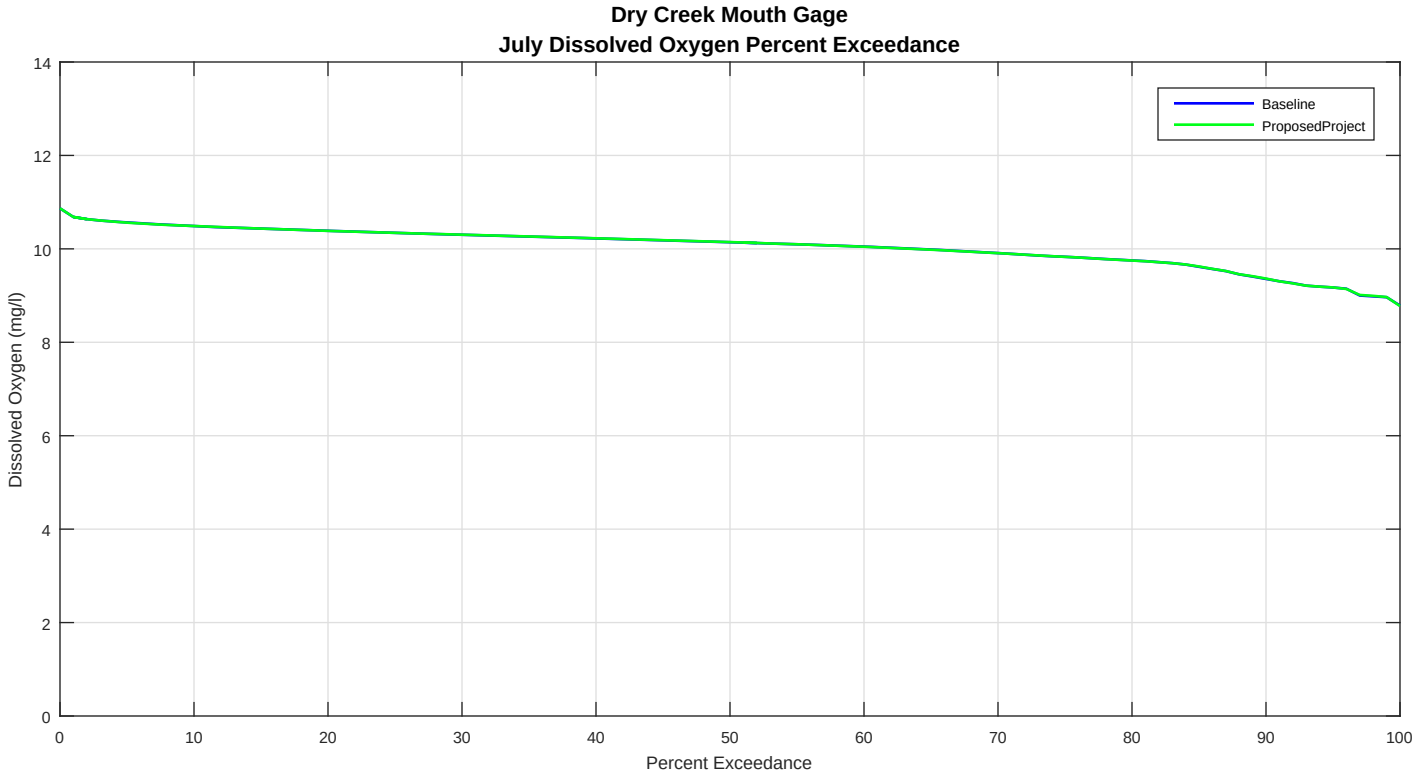

Dry Creek at Lambert Bridge
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

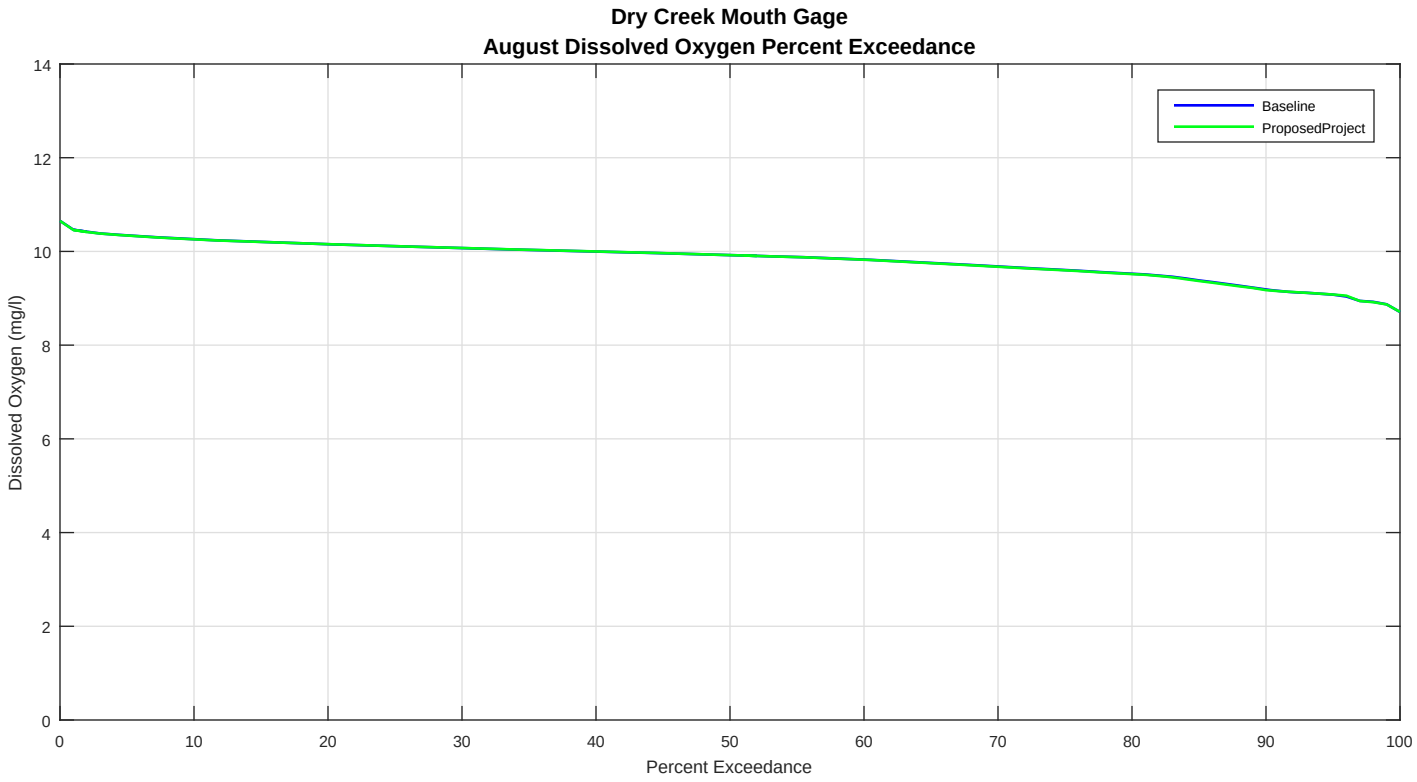

Dry Creek Mouth Gage
March Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

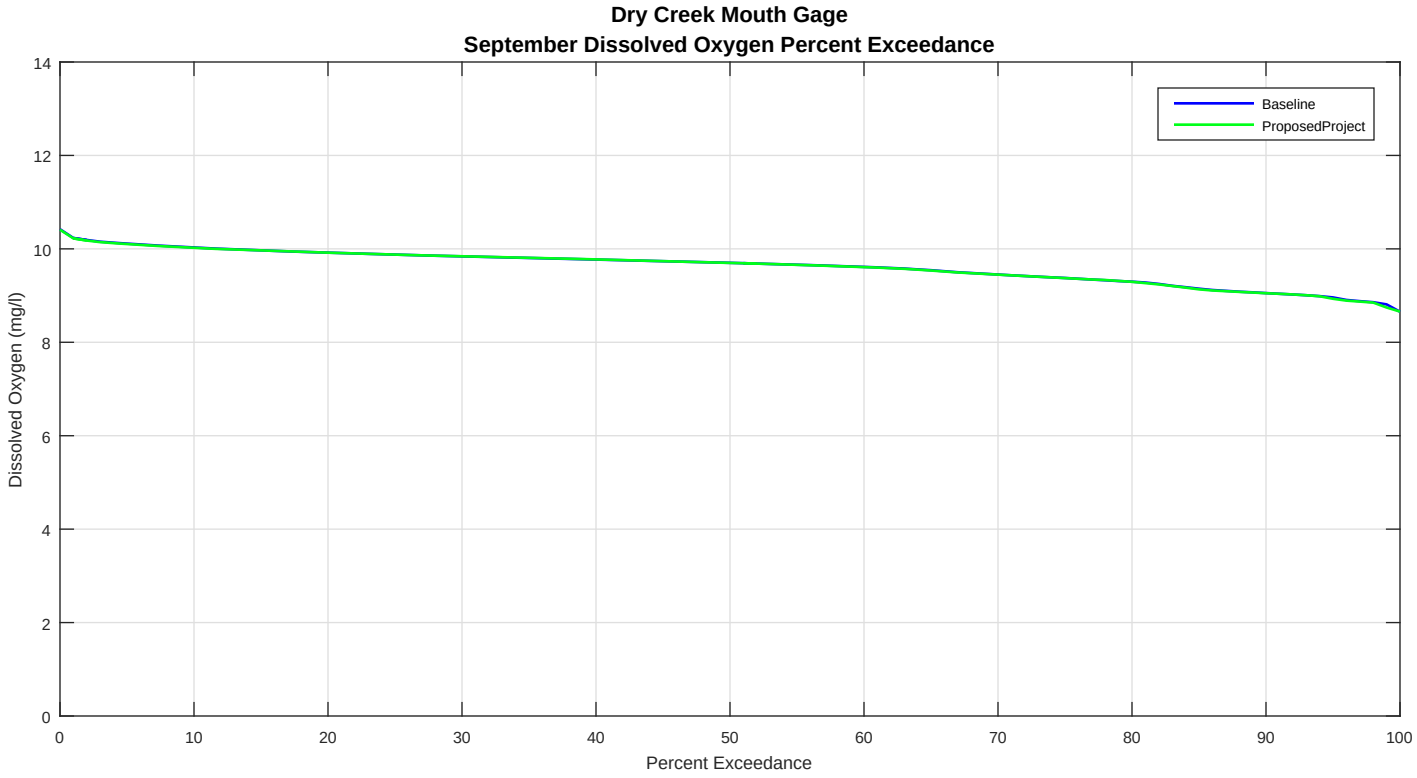

Dry Creek Mouth Gage
April Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

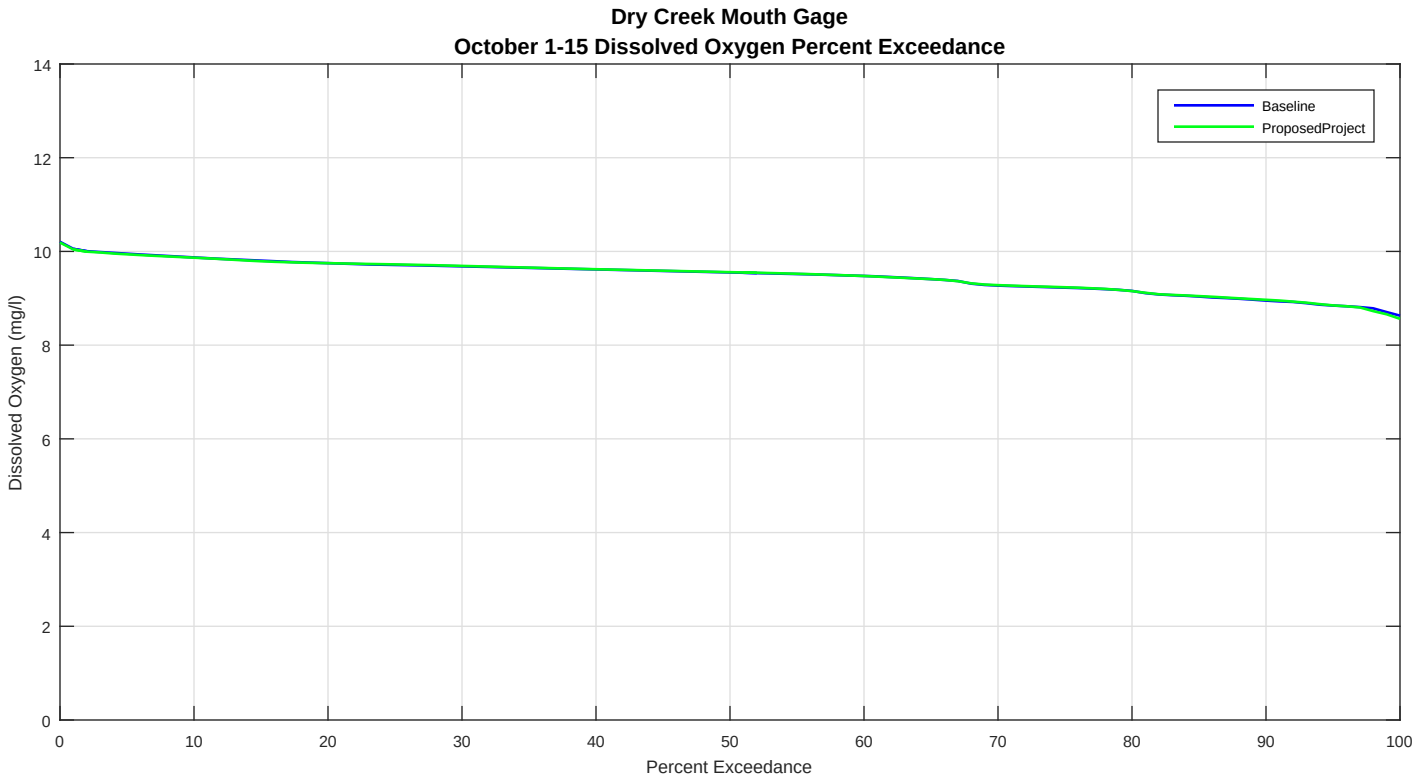

Dry Creek Mouth Gage
May Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

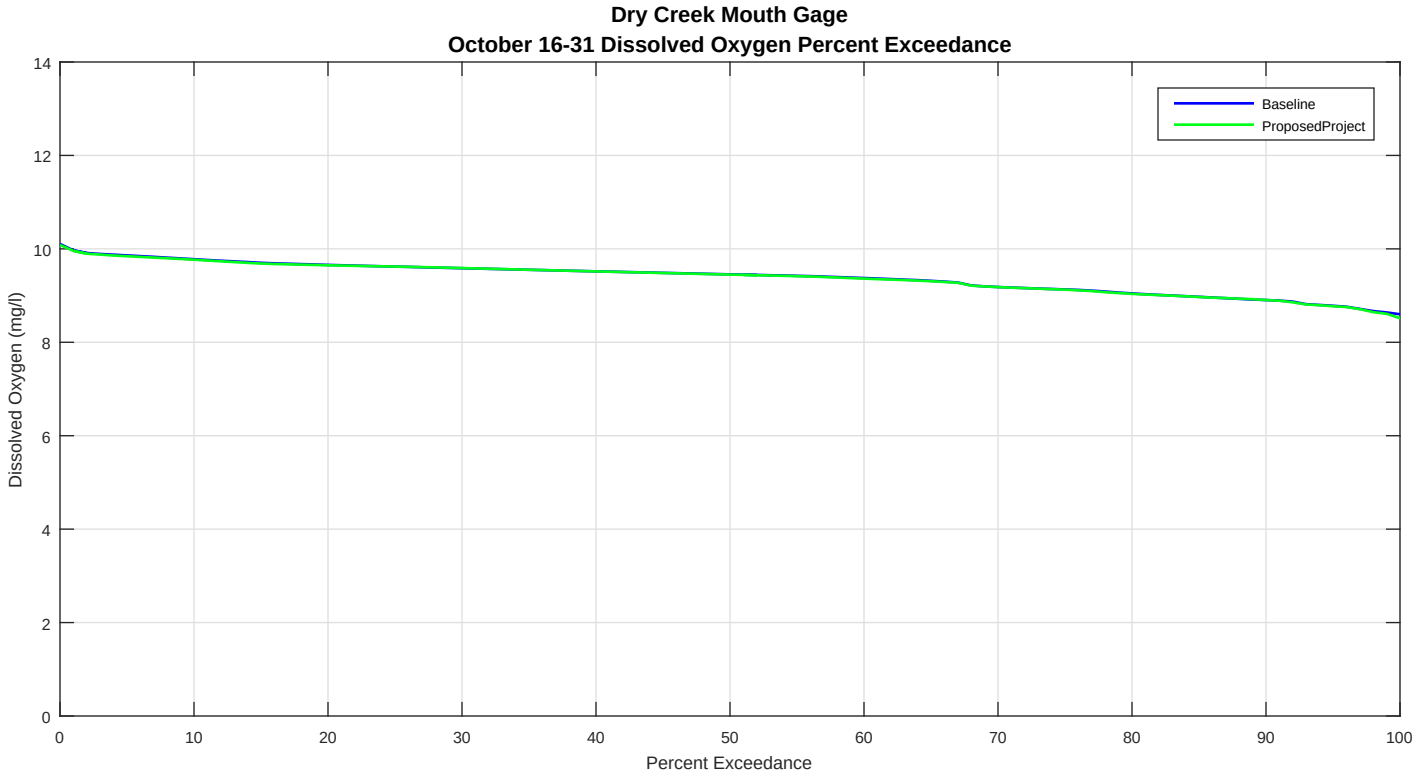

Dry Creek Mouth Gage
June Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
July Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
August Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
September Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
October 1-15 Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
October 16-31 Dissolved Oxygen Percent Exceedance
Baseline
ProposedProject
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

Attachment 4: Model Results, Cumulative 1 Scenario

FISH FLOWS EIR
RR ResSim Modeling Results Summary Report

Cumulative Analysis No PVP Imports
Proposed Hydrologic Index
5-Sched Flow18 Min Flows
Max Water Right Demand: 75K AF

PLOT LEGEND	ProposedProject	CumulativeScenario1
Alt Name	2275i61860	2275i61860
Sim Begin Date	2/1/1910	2/1/1910
Sim End Date	12/31/2013	12/31/2013
ResSim Network	Base v2.2	Base v2.2
LM Storage Curve	2001	2001
LS Storage Curve	1984	1984
WSD Hatchery Flow (cfs)	70	70
Local Flow	USGS6.0	USGS6.0
Distributed Loss	RR System Losses POR 10011909 to 12312013 v06302015.dss	RR System Losses POR 10011909 to 12312013 v06302015.dss
RRC Demand	RR System Losses POR 10011909 to 12312013 v06302015.dss, SCWA Windsor 75K POR 10011909 to 12312013 v06302015.dss	RR System Losses POR 10011909 to 12312013 v06302015.dss, SCWA Windsor 75K POR 10011909 to 12312013 v06302015.dss
RRC Vol (Ac-ft/yr)	5,639	5,639
Demand Year	2035	2035
Demand Desc	Max Water Right Demand	Max Water Right Demand
SCWA Demand	SCWA Windsor 75K POR 10011909 to 12312013 v06302015.dss	SCWA Windsor 75K POR 10011909 to 12312013 v06302015.dss
SCWA Vol (Ac-ft/yr)	69,361	69,361
Demand Year	2035	2035
Demand Desc	Max Water Right Demand	Max Water Right Demand
PVP Simulation	150217_V25_E5_Sed2006_RPA-TS_150max	150217_V25_E5_Sed2006_RPA-TS_0max
LP Storage Curve	2006	2006
PVP Max Diversion	150	0
PVP Simulation Desc	Average operating conditions 10/1/2006 to 12/31/2014; Incorporated observed diversions and LP storage post 10/1/2006	0 Pvp Flows
Hydrologic Index	HI6	HI6
Index Desc	Cum LM Inflow Jan-Sep + LM Stor Cond Jun-De	Cum LM Inflow Jan-Sep + LM Stor Cond Jun-De
Min Flows UR	SCWA6	SCWA6
Min Flow Desc	Flows derived from sensitivity analysis	Flows derived from sensitivity analysis
Min Flows LR	LR6	LR6
Min Flow Desc	Flows derived from sensitivity analysis	Flows derived from sensitivity analysis

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Daily Storage… 3

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Minimum Water Year Storage Exceedances… 28

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Daily Average Stages… 9

Daily Average Power Production… 12

Daily Average Temperature… 13

Daily Average Dissolved Oxygen… 20

Coyote Valley Dam Outlet

Monthly Flow Exceedance Frequency… 29

Monthly Temperature Exceedance Frequency… 106

Monthly D.O. Exceedance Frequency… 164

Forks

Monthly Flow Exceedance Frequency… 33

Monthly Temperature Exceedance Frequency… 110

Monthly D.O. Exceedance Frequency… 168

2 Miles Downstream of Forks

Monthly Temperature Exceedance Frequency… 115

Monthly D.O. Exceedance Frequency… 173

4 Miles Downstream of Forks

Monthly Temperature Exceedance Frequency… 117

Monthly D.O. Exceedance Frequency… 175

Hopland

Monthly Flow Exceedance Frequency… 38

Monthly Stage Exceedance Frequency… 74

Monthly Temperature Exceedance Frequency… 119

Monthly D.O. Exceedance Frequency… 177

Cloverdale

Monthly Flow Exceedance Frequency… 42

Monthly Stage Exceedance Frequency… 78

Monthly Temperature Exceedance Frequency… 123

Monthly D.O. Exceedance Frequency… 181

Geyserville

Monthly Temperature Exceedance Frequency… 128

Monthly D.O. Exceedance Frequency… 186

Healdsburg

Monthly Flow Exceedance Frequency… 47

Monthly Stage Exceedance Frequency… 83

Monthly Temperature Exceedance Frequency… 132

Monthly D.O. Exceedance Frequency… 190

Russian River at Dry Creek

Monthly Flow Exceedance Frequency… 51

Monthly Temperature Exceedance Frequency… 137

Monthly D.O. Exceedance Frequency… 195

Hacienda

Monthly Flow Exceedance Frequency… 56

Monthly Stage Exceedance Frequency… 87

Monthly Temperature Exceedance Frequency… 141

Monthly D.O. Exceedance Frequency… 199

Warm Springs Dam Outlet

Monthly Flow Exceedance Frequency… 60

Monthly Temperature Exceedance Frequency… 146

Monthly D.O. Exceedance Frequency… 204

Dry Creek at Geyserville Gage

Monthly Flow Exceedance Frequency… 65

Monthly Stage Exceedance Frequency… 92

Monthly Temperature Exceedance Frequency… 150

Monthly D.O. Exceedance Frequency… 208

Dry Creek at Lambert Bridge

Monthly Temperature Exceedance Frequency… 155

Monthly D.O. Exceedance Frequency… 213

Dry Creek Mouth

Monthly Flow Exceedance Frequency… 69

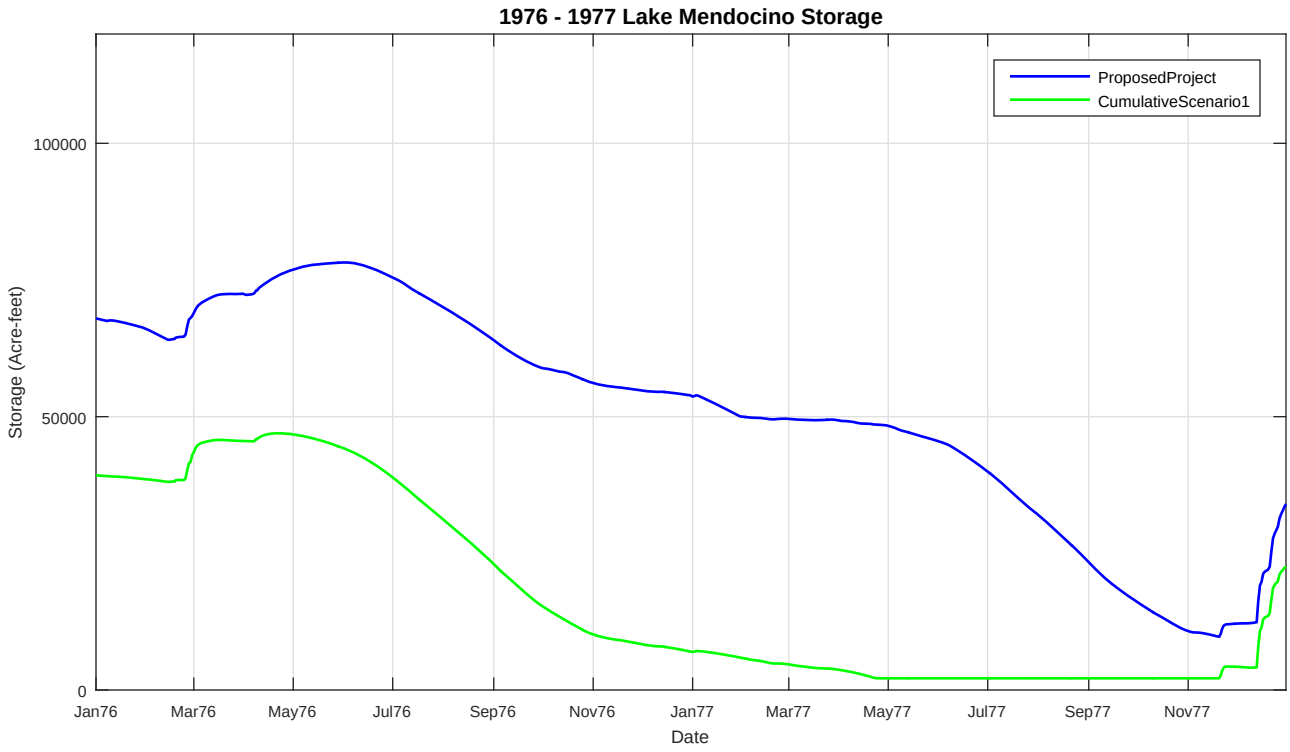
Monthly Temperature Exceedance Frequency… 159

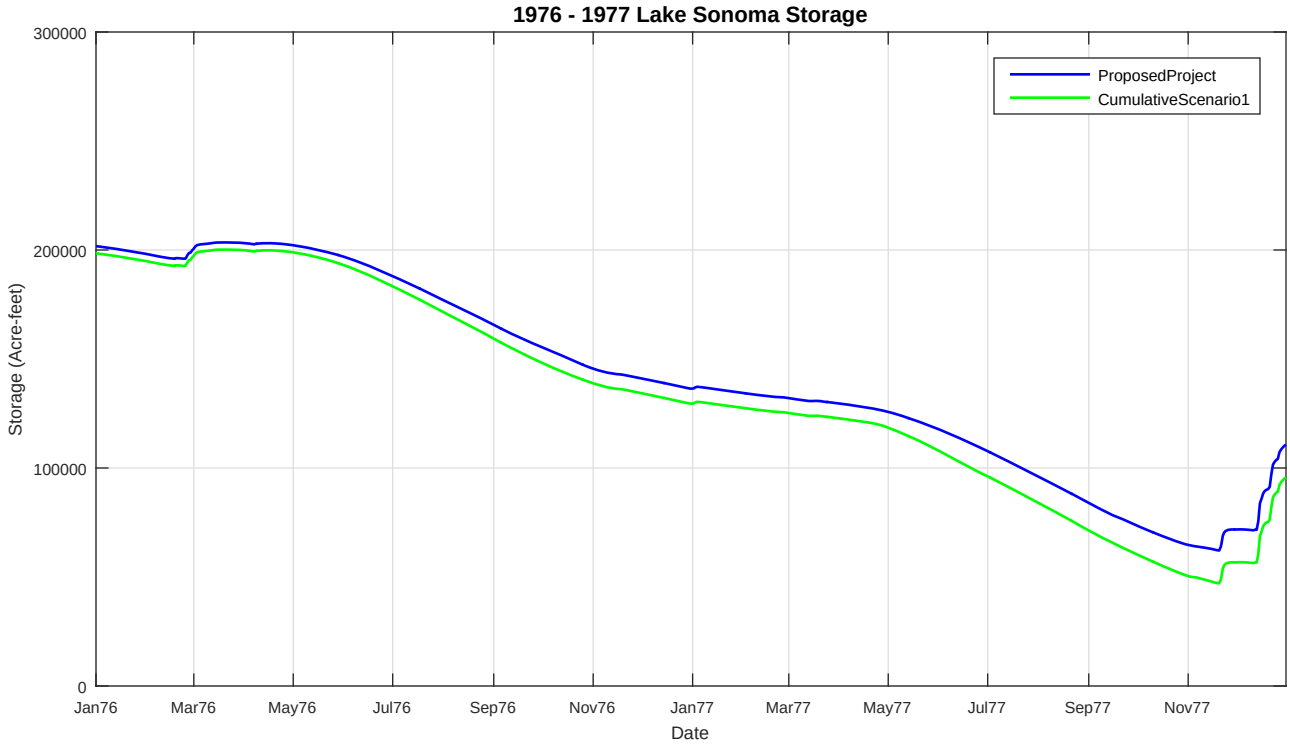
Monthly D.O. Exceedance Frequency… 217

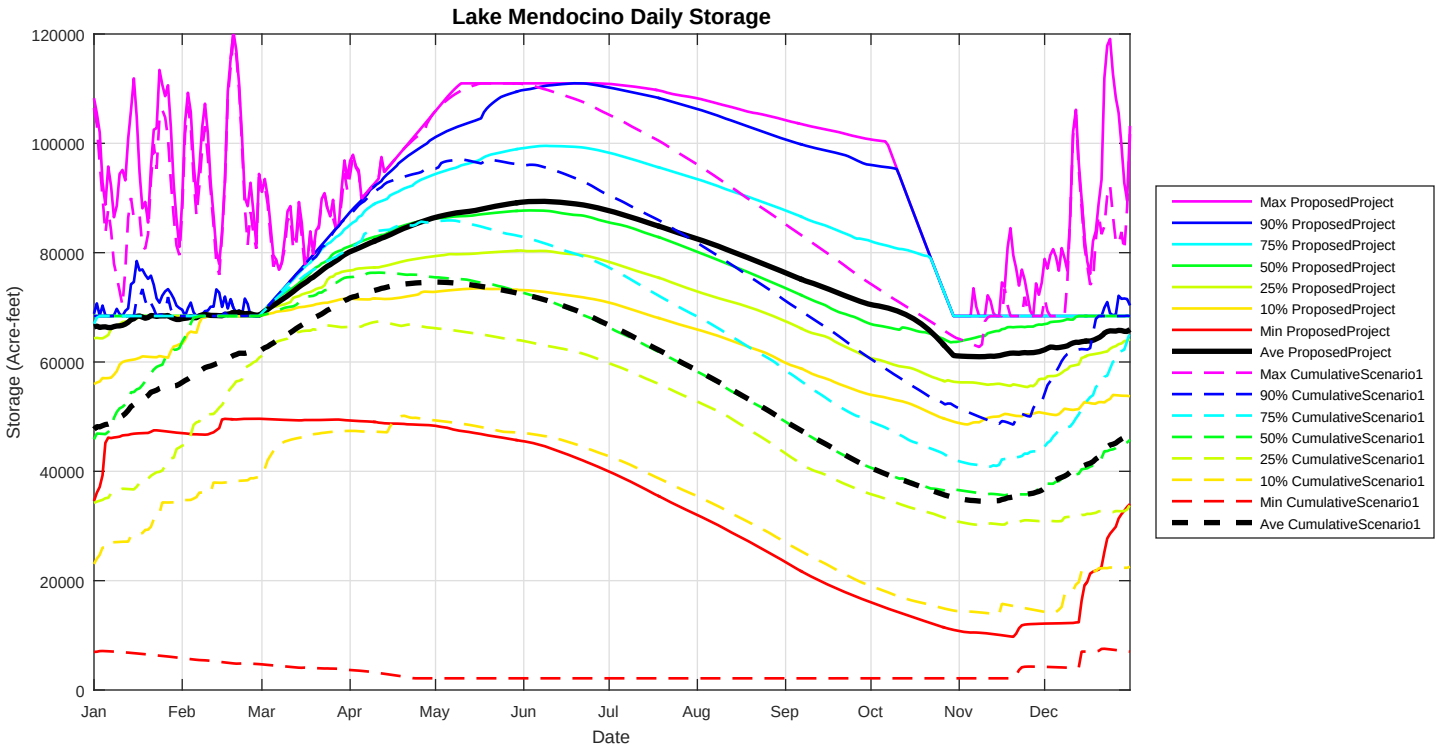
Monthly Power Production Exceedance Frequencies

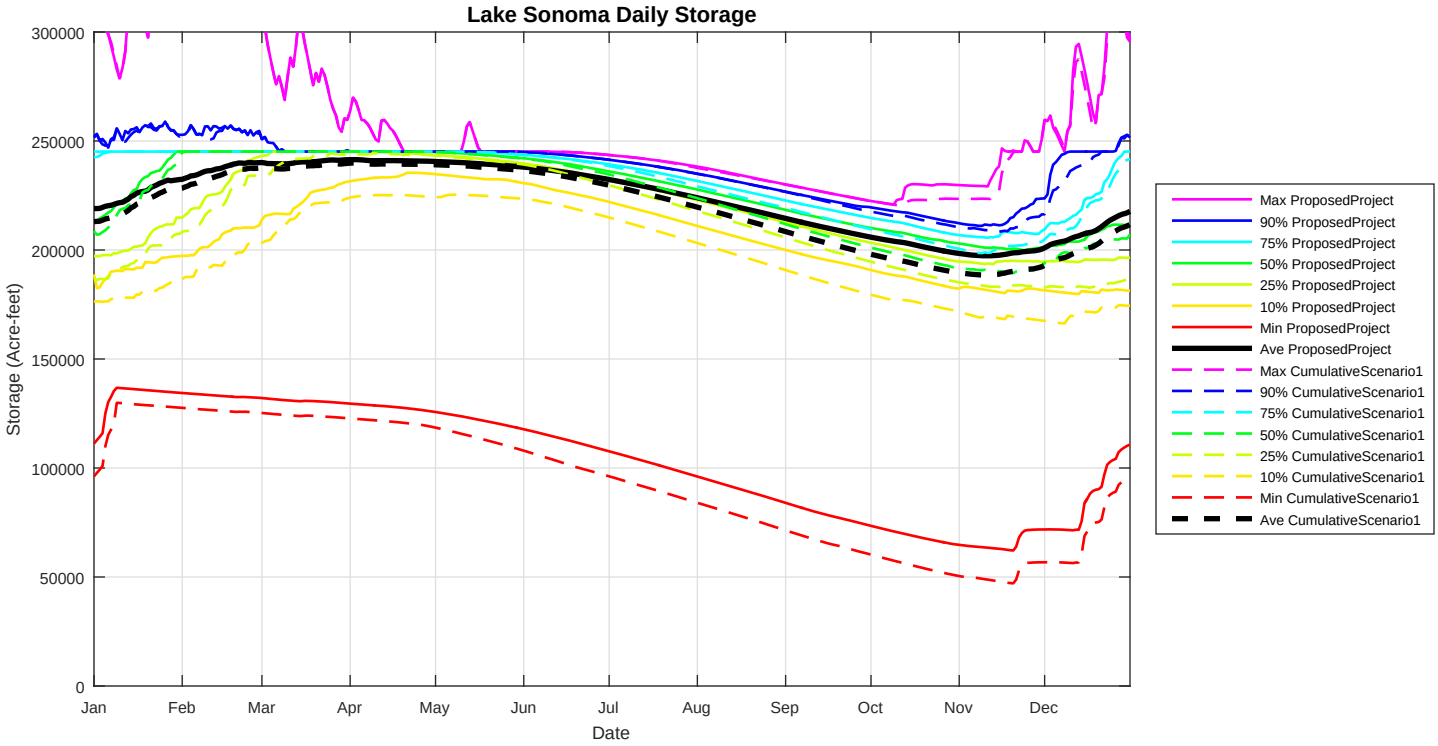
Coyote Valley Dam… 97

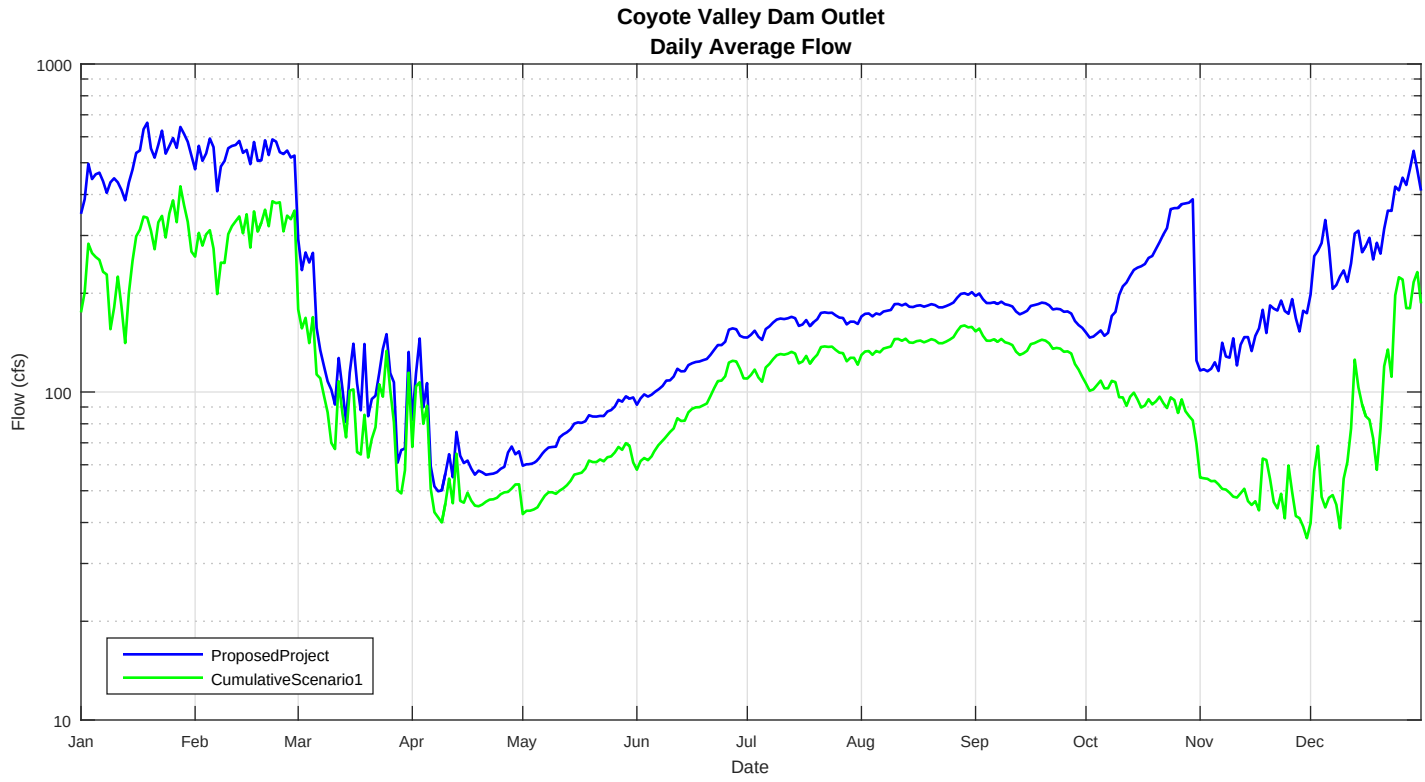
Warm Springs Dam… 101

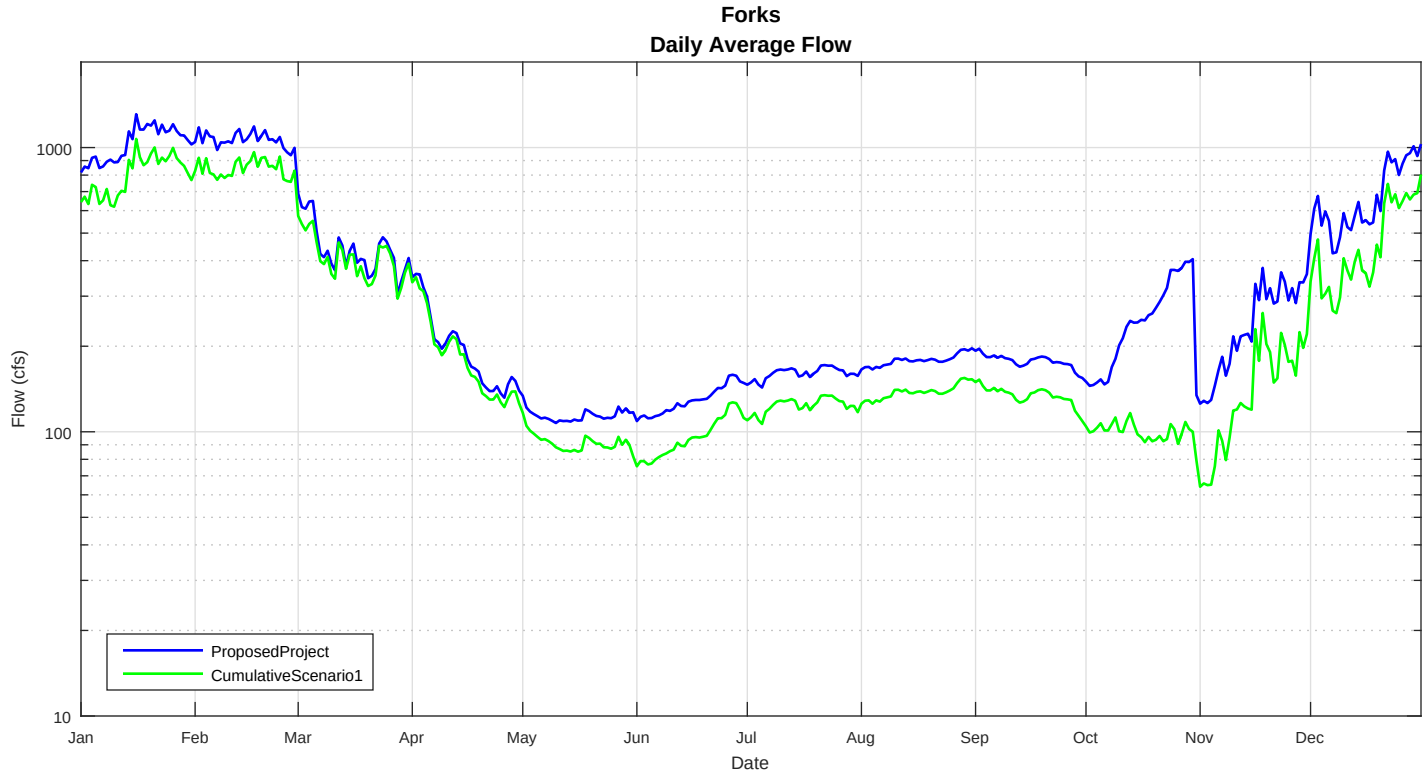

1976 - 1977 Lake Mendocino Storage
ProposedProject
CumulativeScenario1
Storage (Acre-feet)
100000
50000
0
Jan76
Mar76
May76
Jul76
Sep76
Nov76
Jan77
Mar77
May77
Jul77
Sep77
Nov77
Date

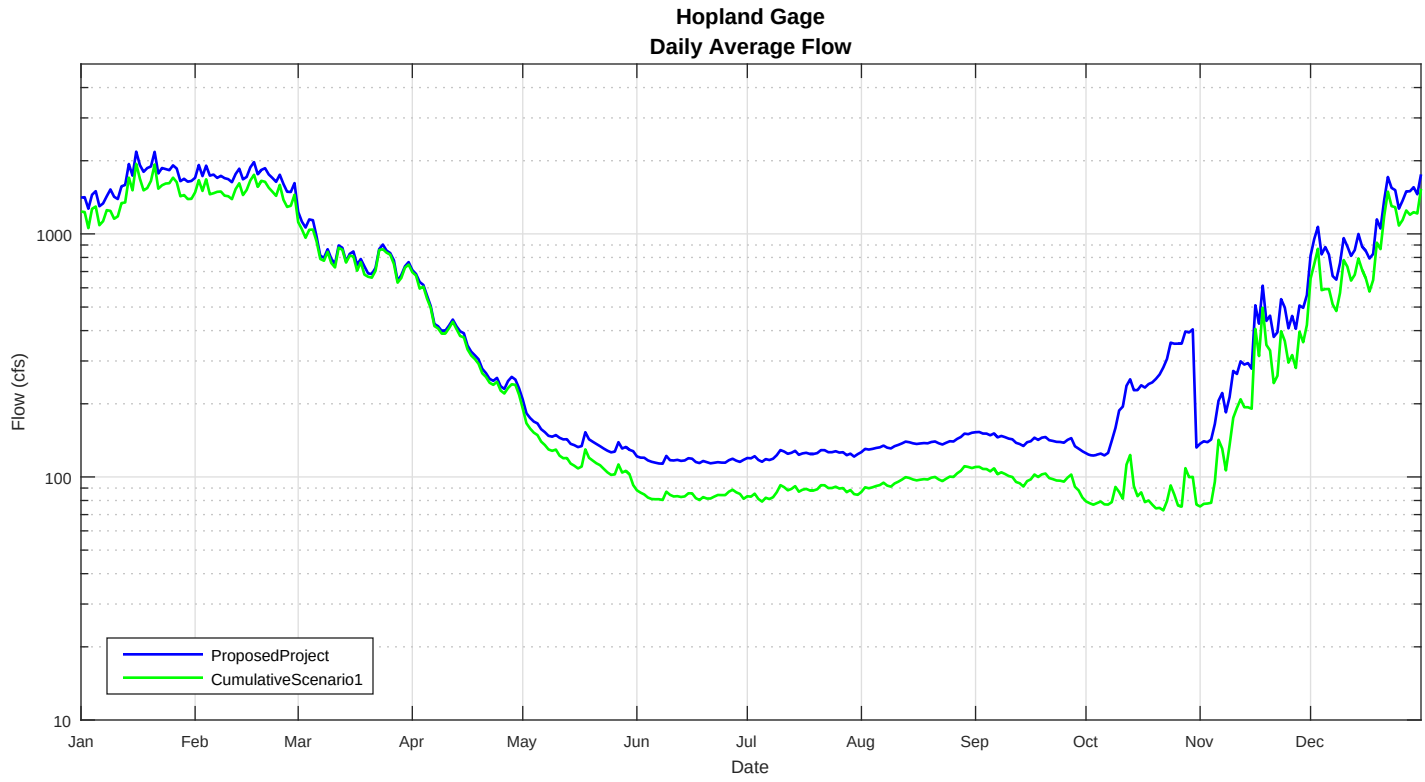

1976 - 1977 Lake Sonoma Storage
ProposedProject
CumulativeScenario1
Storage (Acre-feet)
300000
200000
100000
0
Jan76
Mar76
May76
Jul76
Sep76
Nov76
Jan77
Mar77
May77
Jul77
Sep77
Nov77
Date

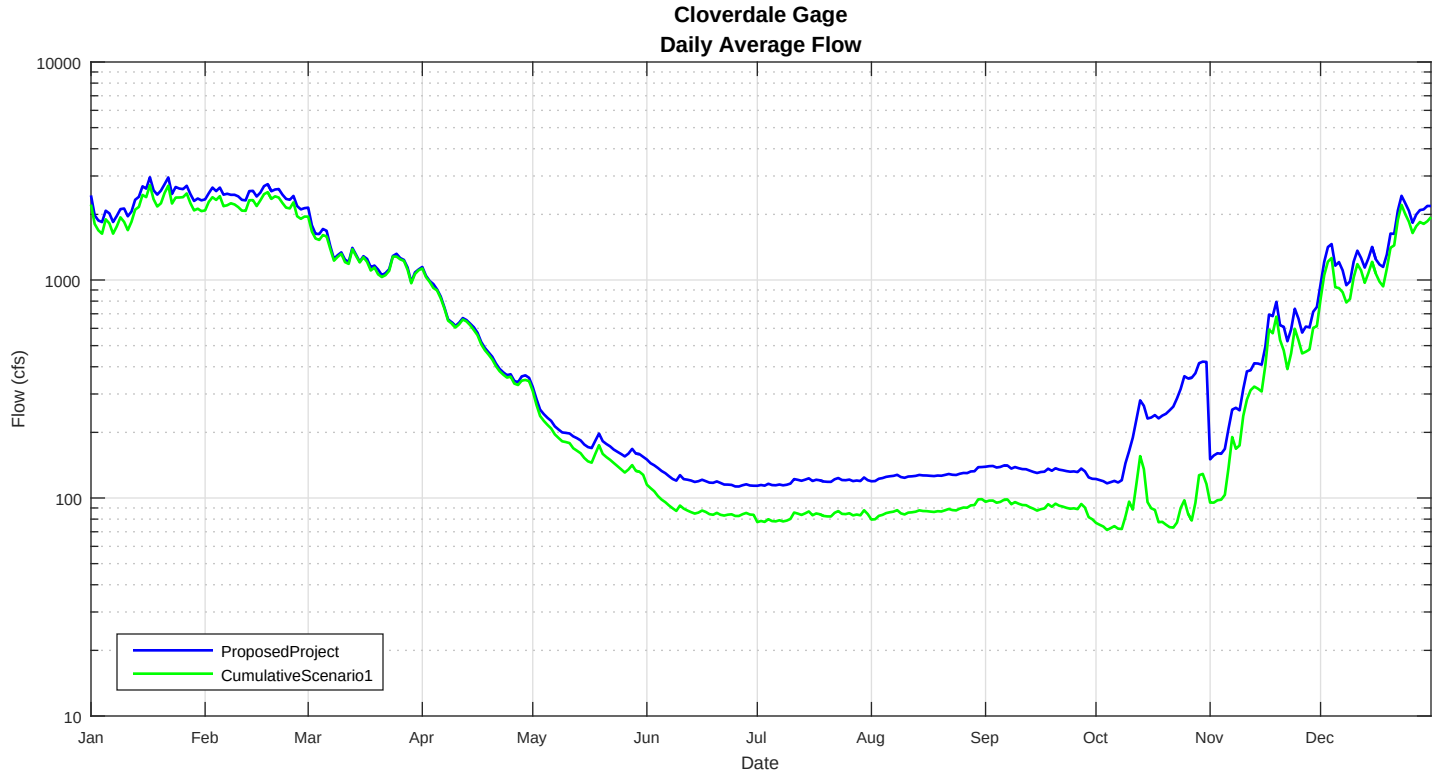

Lake Mendocino Daily Storage
Storage (Acre-feet)
120000
100000
80000
60000
40000
20000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Max ProposedProject
90% ProposedProject
75% ProposedProject
50% ProposedProject
25% ProposedProject
10% ProposedProject
Min ProposedProject
Ave ProposedProject
Max CumulativeScenario1
90% CumulativeScenario1
75% CumulativeScenario1
50% CumulativeScenario1
25% CumulativeScenario1
10% CumulativeScenario1
Min CumulativeScenario1
Ave CumulativeScenario1

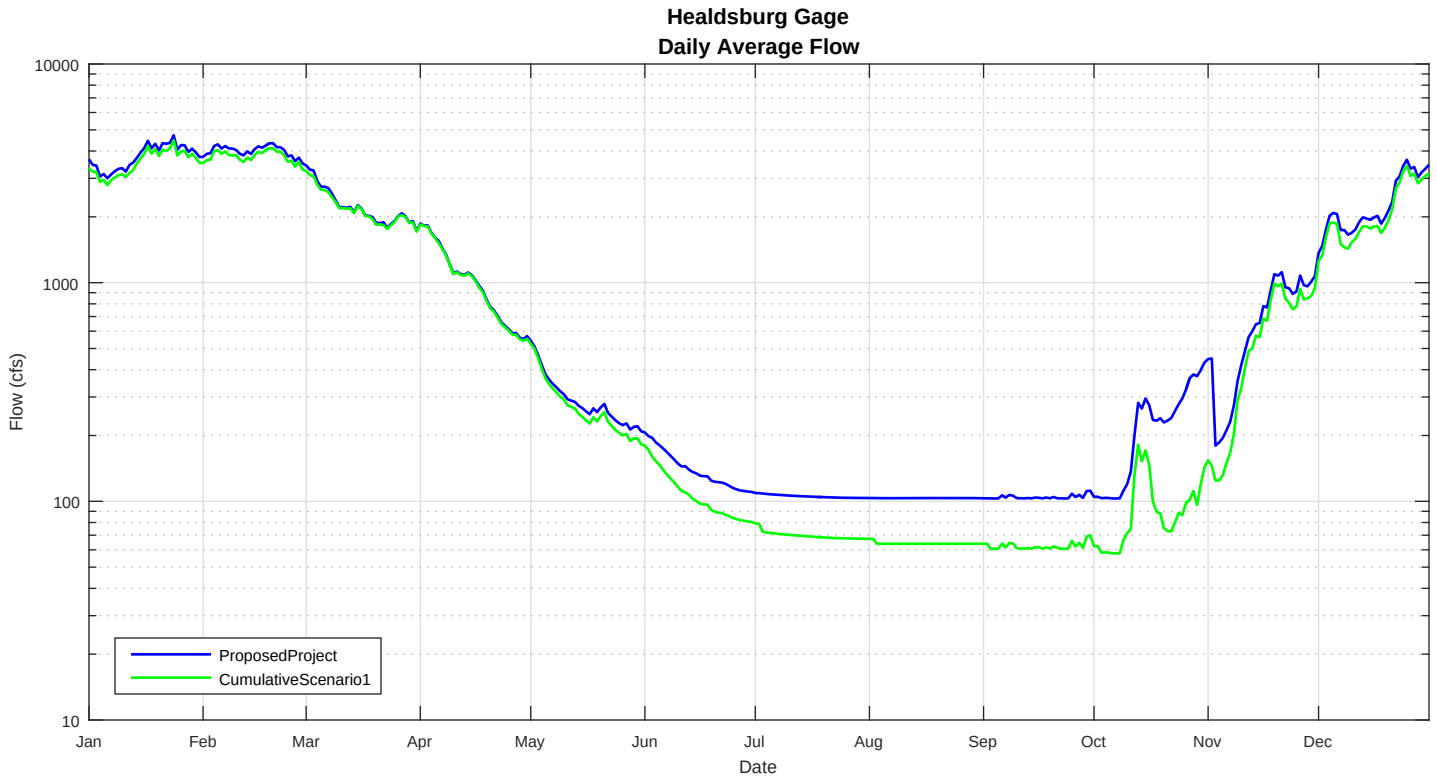

Lake Sonoma Daily Storage
Storage (Acre-feet)
300000
250000
200000
150000
100000
50000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Max ProposedProject
90% ProposedProject
75% ProposedProject
50% ProposedProject
25% ProposedProject
10% ProposedProject
Min ProposedProject
Ave ProposedProject
Max CumulativeScenario1
90% CumulativeScenario1
75% CumulativeScenario1
50% CumulativeScenario1
25% CumulativeScenario1
10% CumulativeScenario1
Min CumulativeScenario1
Ave CumulativeScenario1

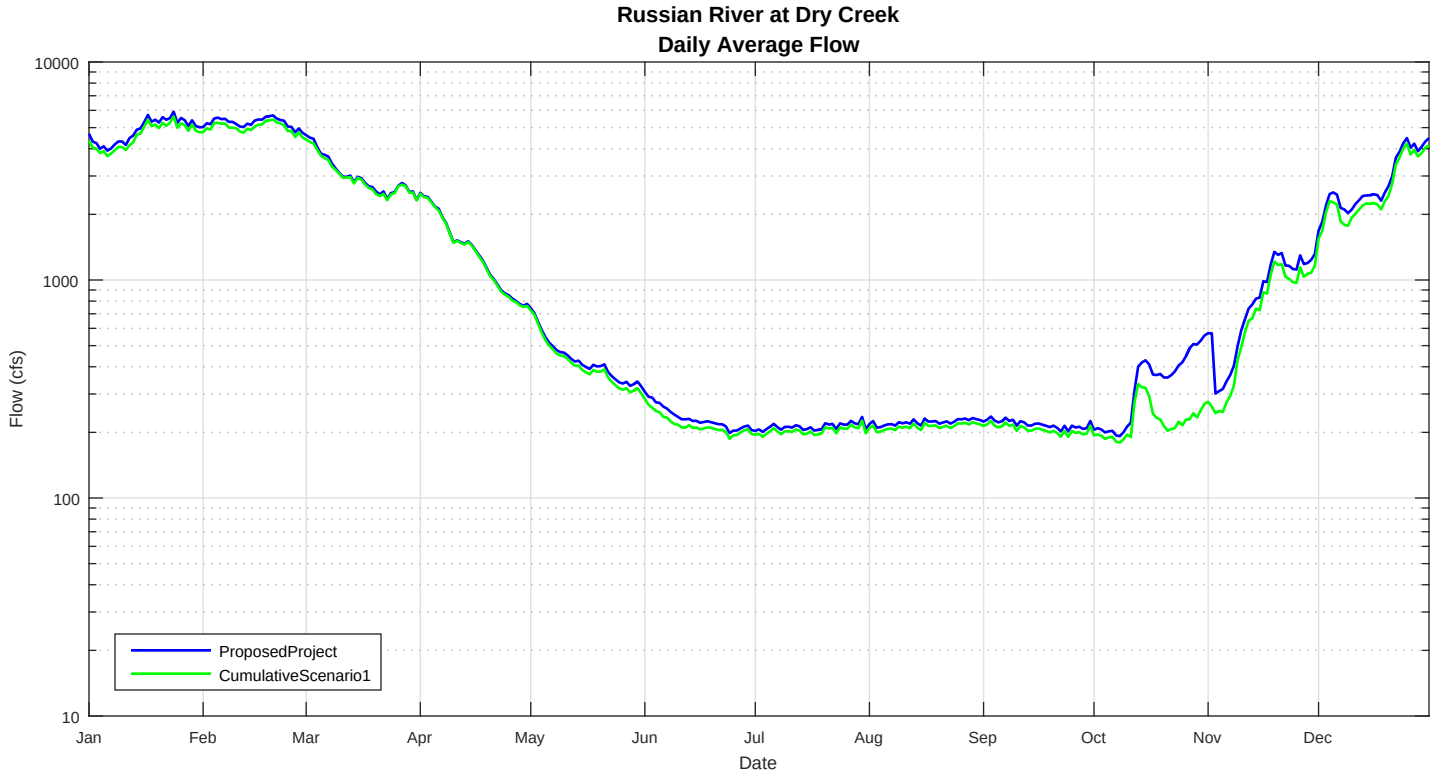

Coyote Valley Dam Outlet
Daily Average Flow
1000
100
10
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario1

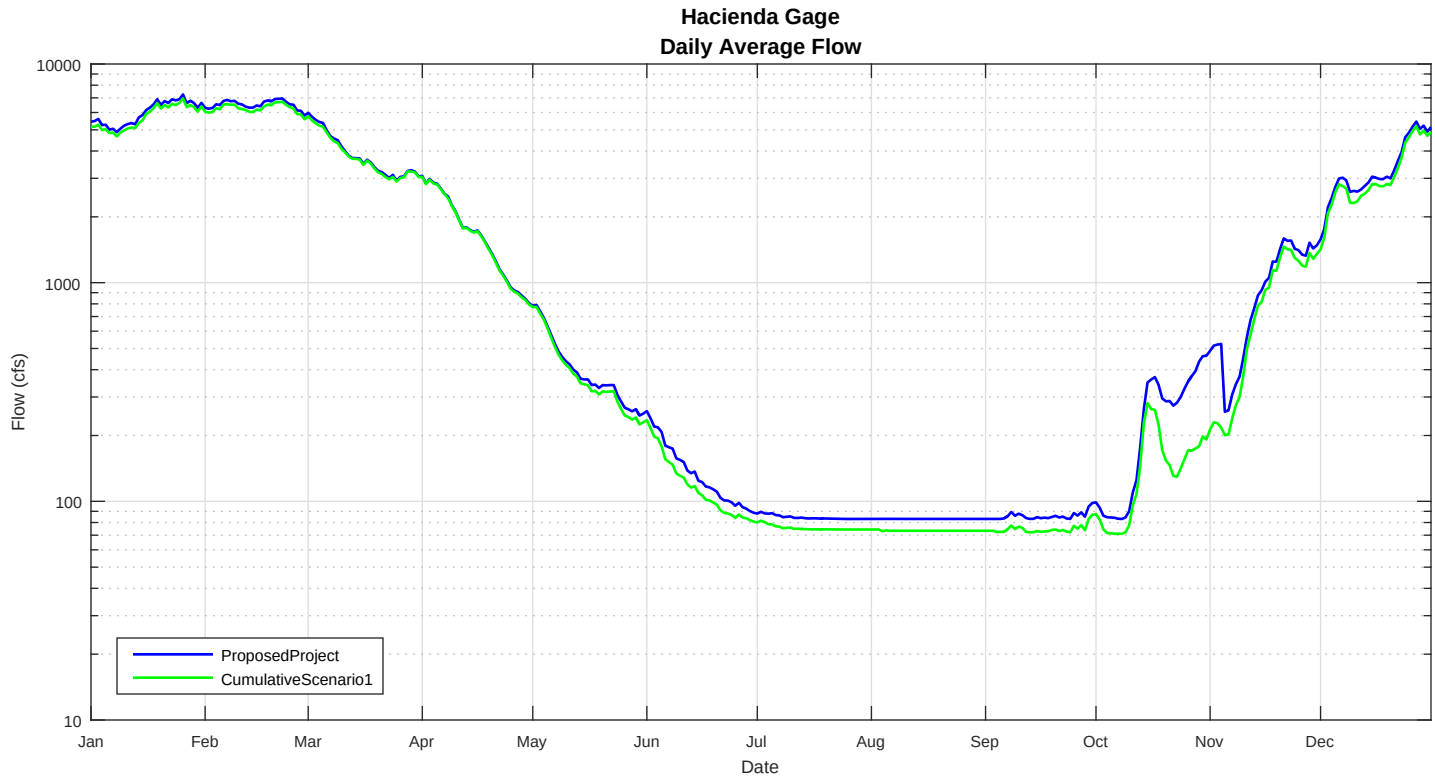

Forks
Daily Average Flow
1000
100
10
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario1

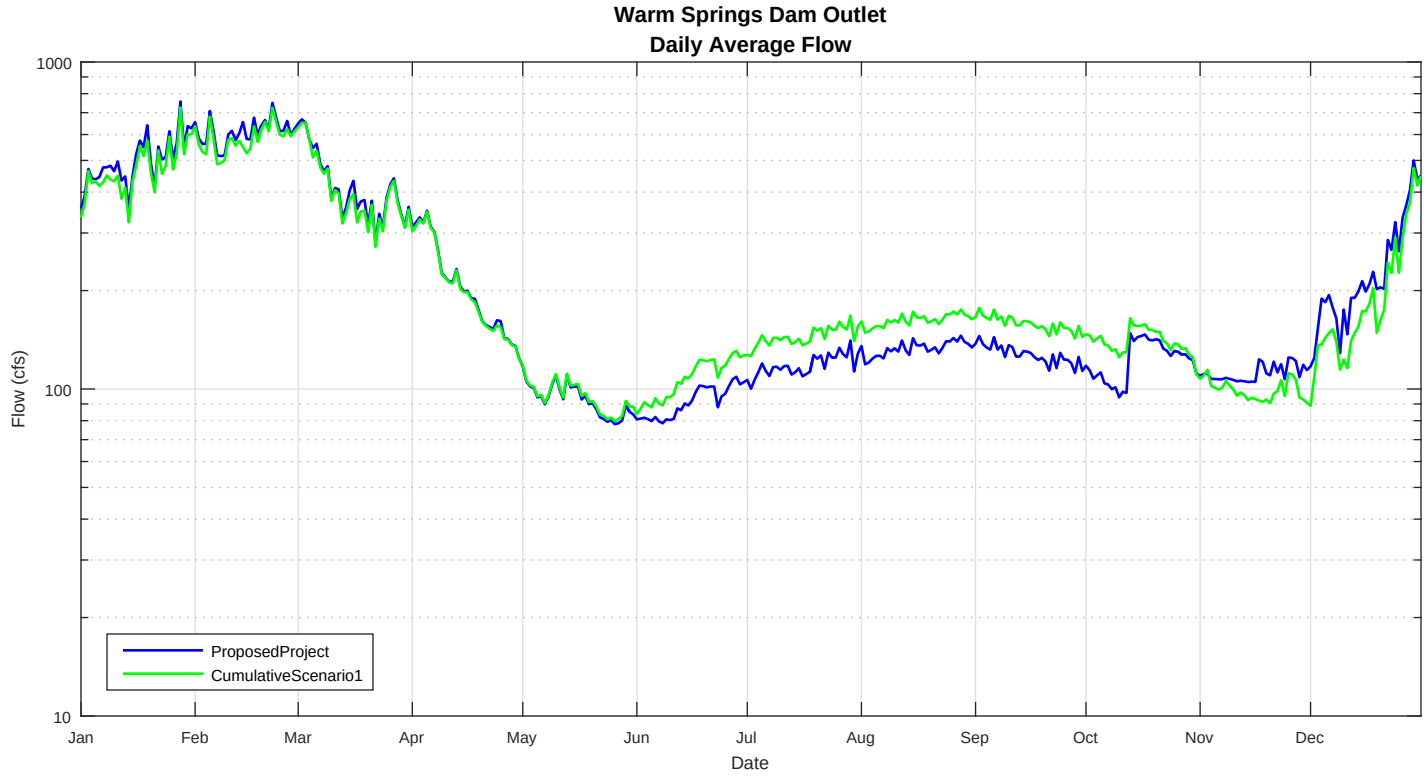

Hopland Gage
Daily Average Flow
Flow (cfs)
1000
100
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario1

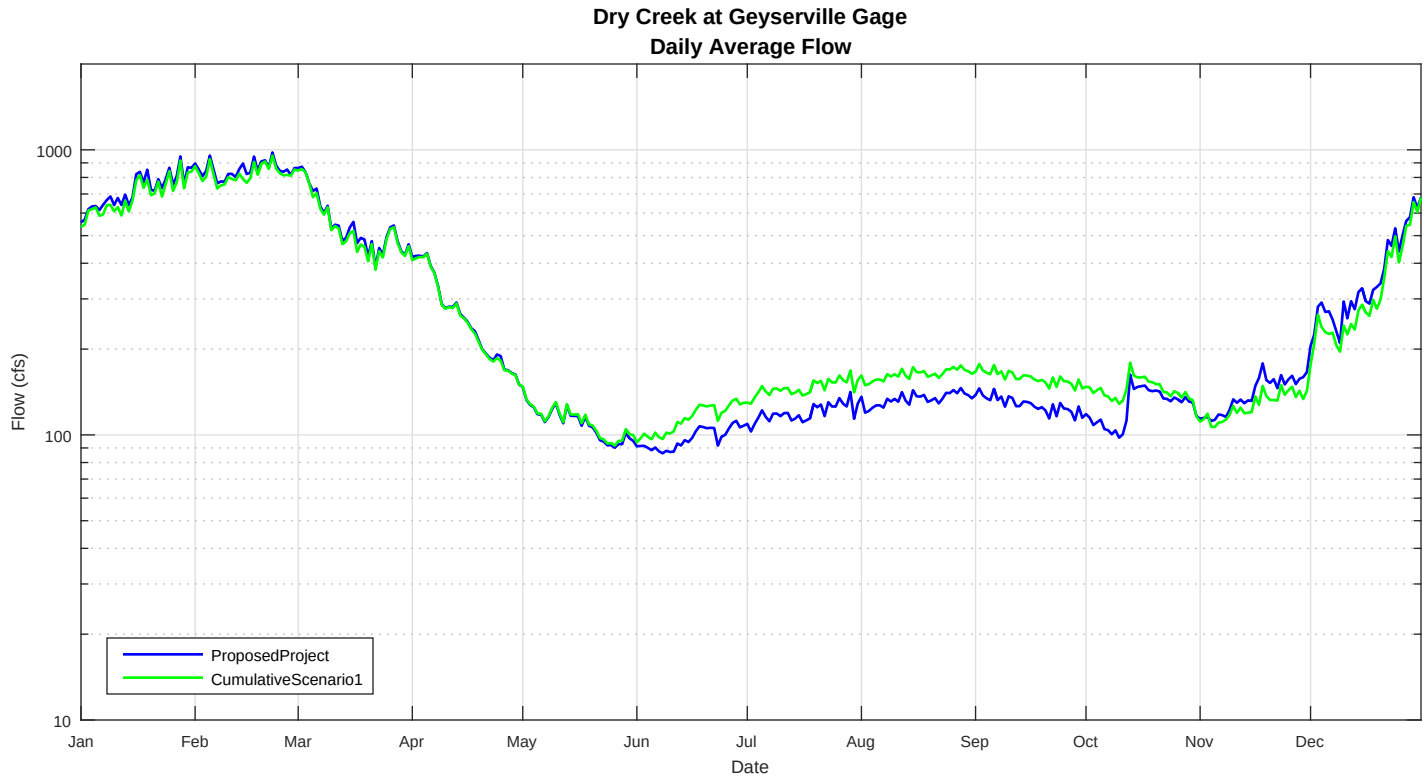

Cloverdale Gage
Daily Average Flow
Flow (cfs)
10000
1000
100
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario1

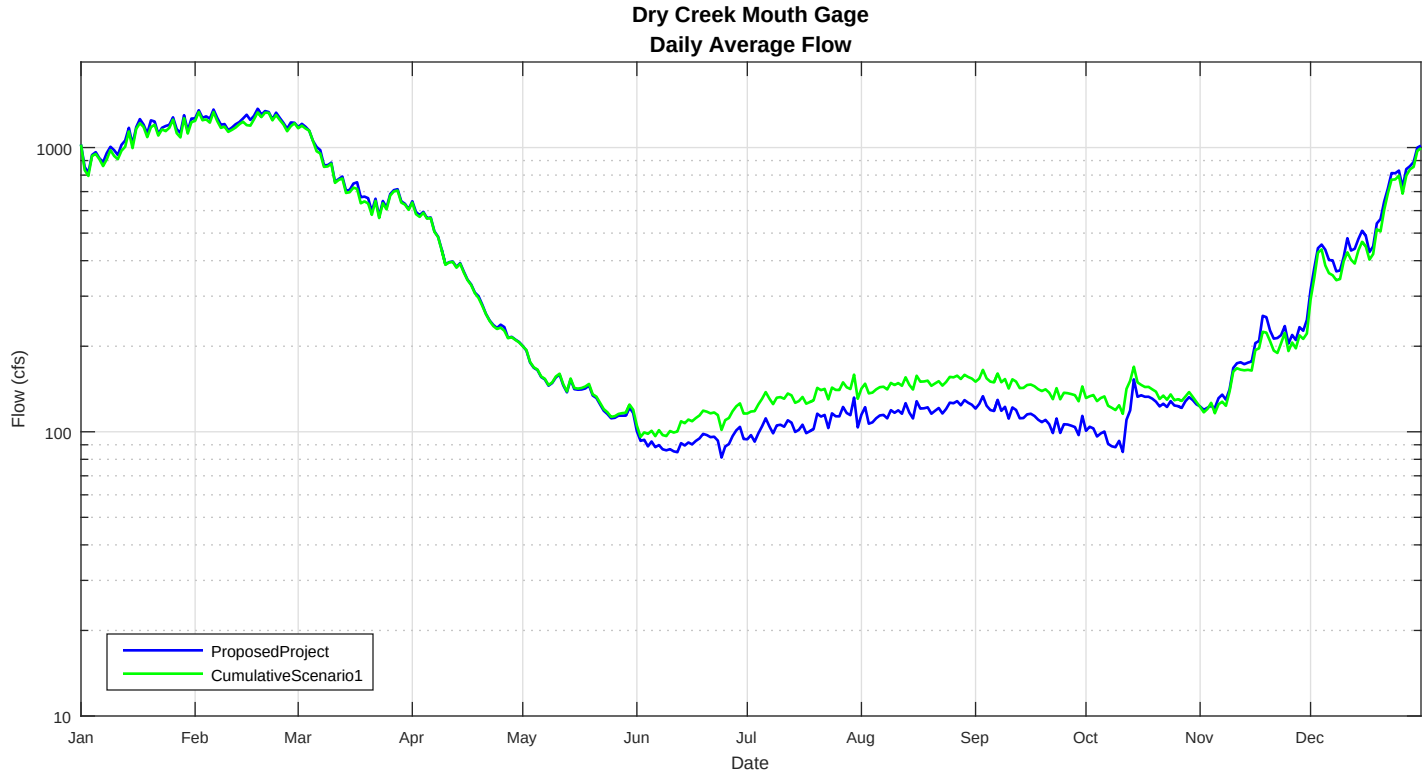

Healdsburg Gage
Daily Average Flow
10000
1000
100
10
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario1

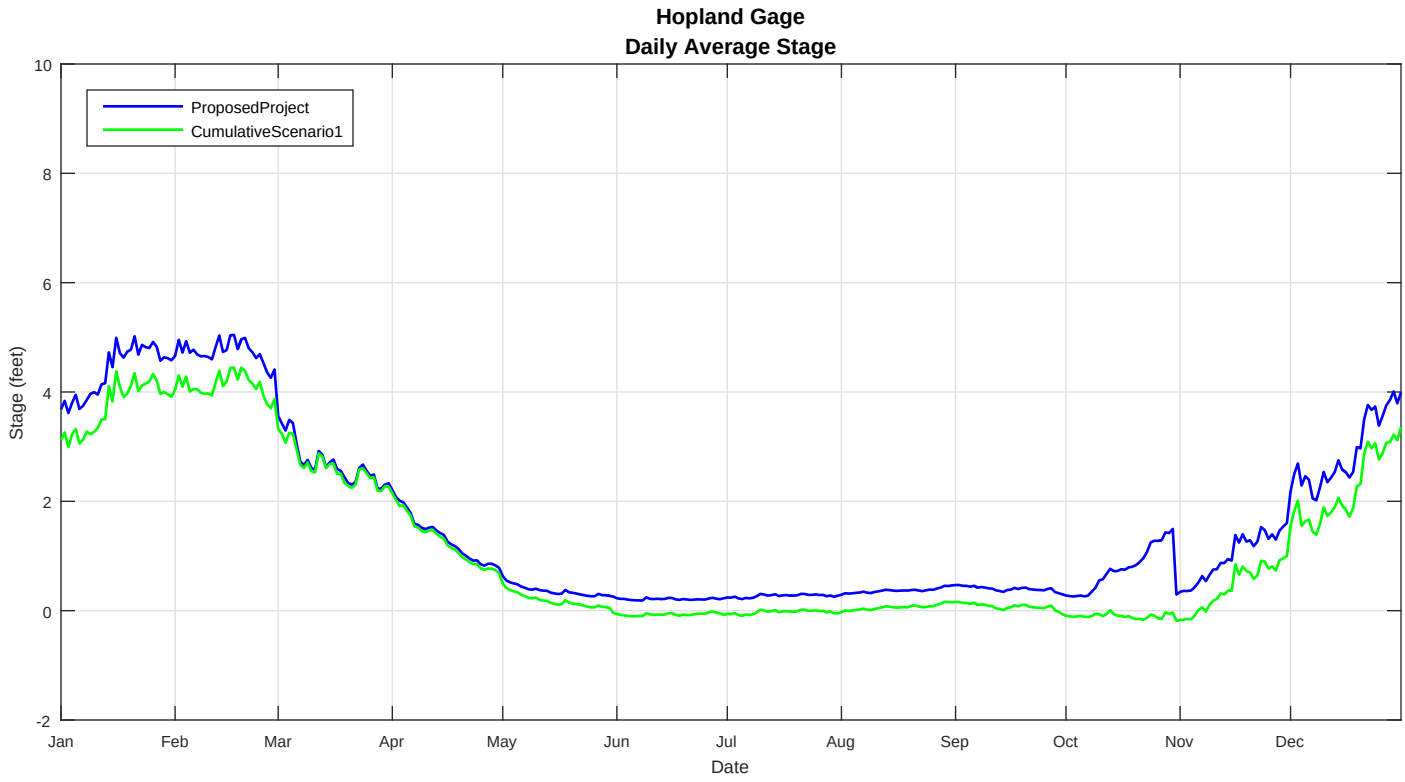

Russian River at Dry Creek
Daily Average Flow
10000
1000
100
10
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario1

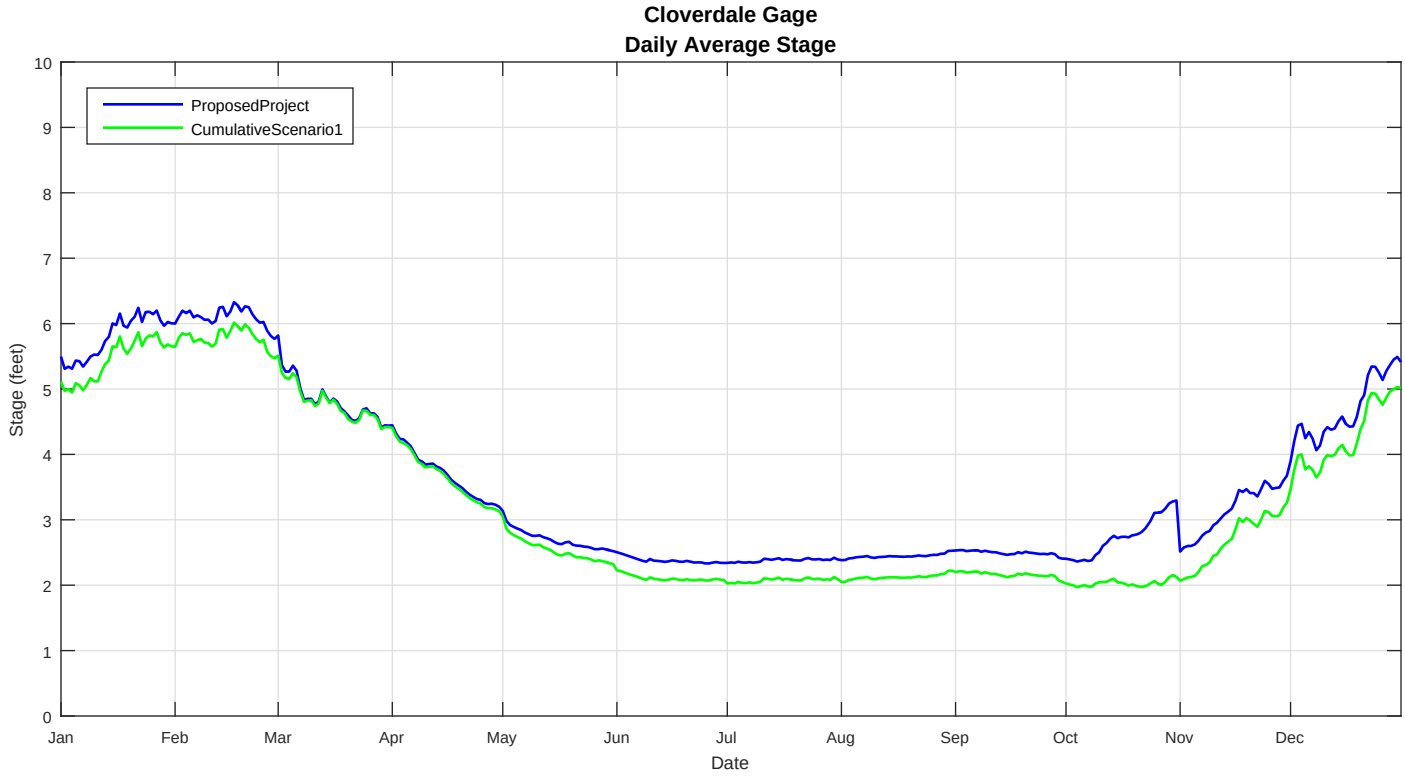

Hacienda Gage
Daily Average Flow
10000
1000
100
10
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario1

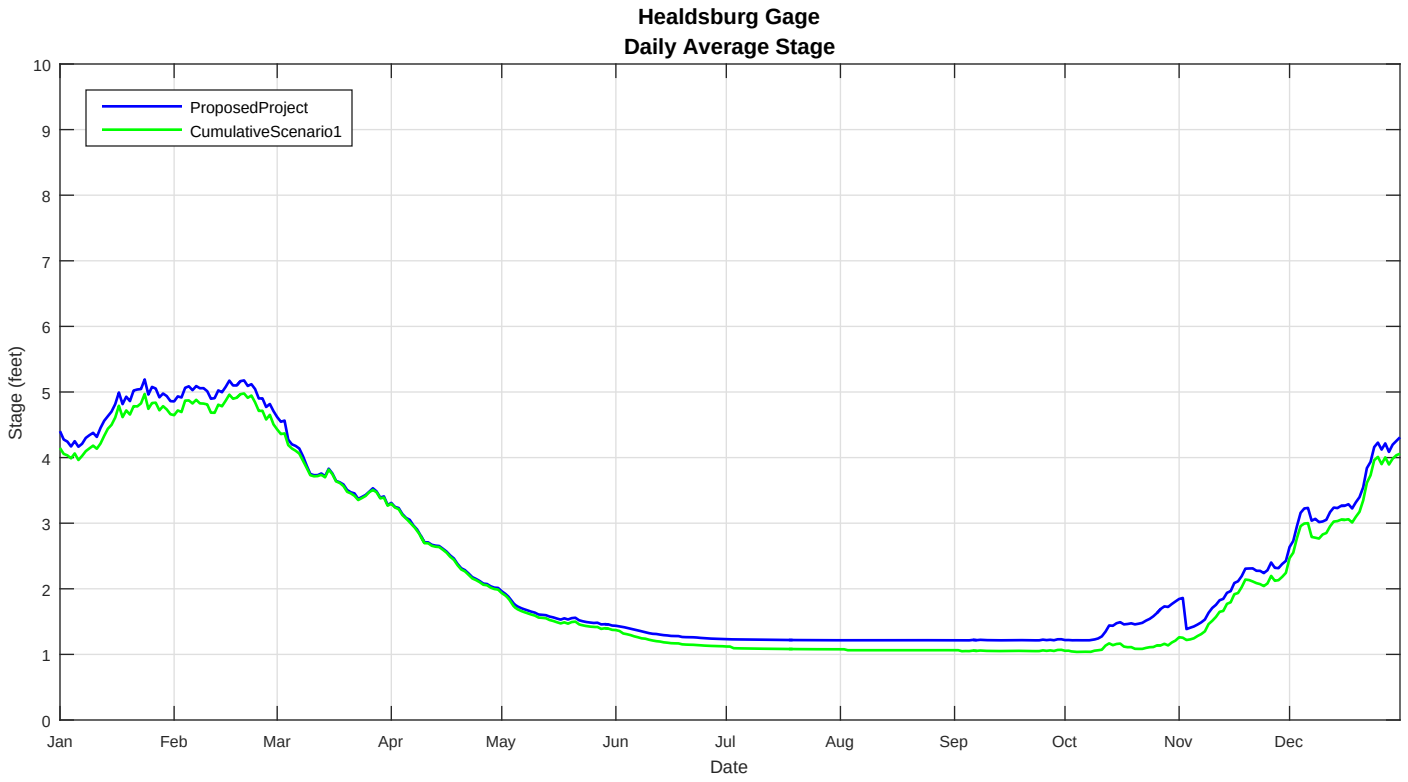

Warm Springs Dam Outlet
Daily Average Flow
1000
100
10
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario1

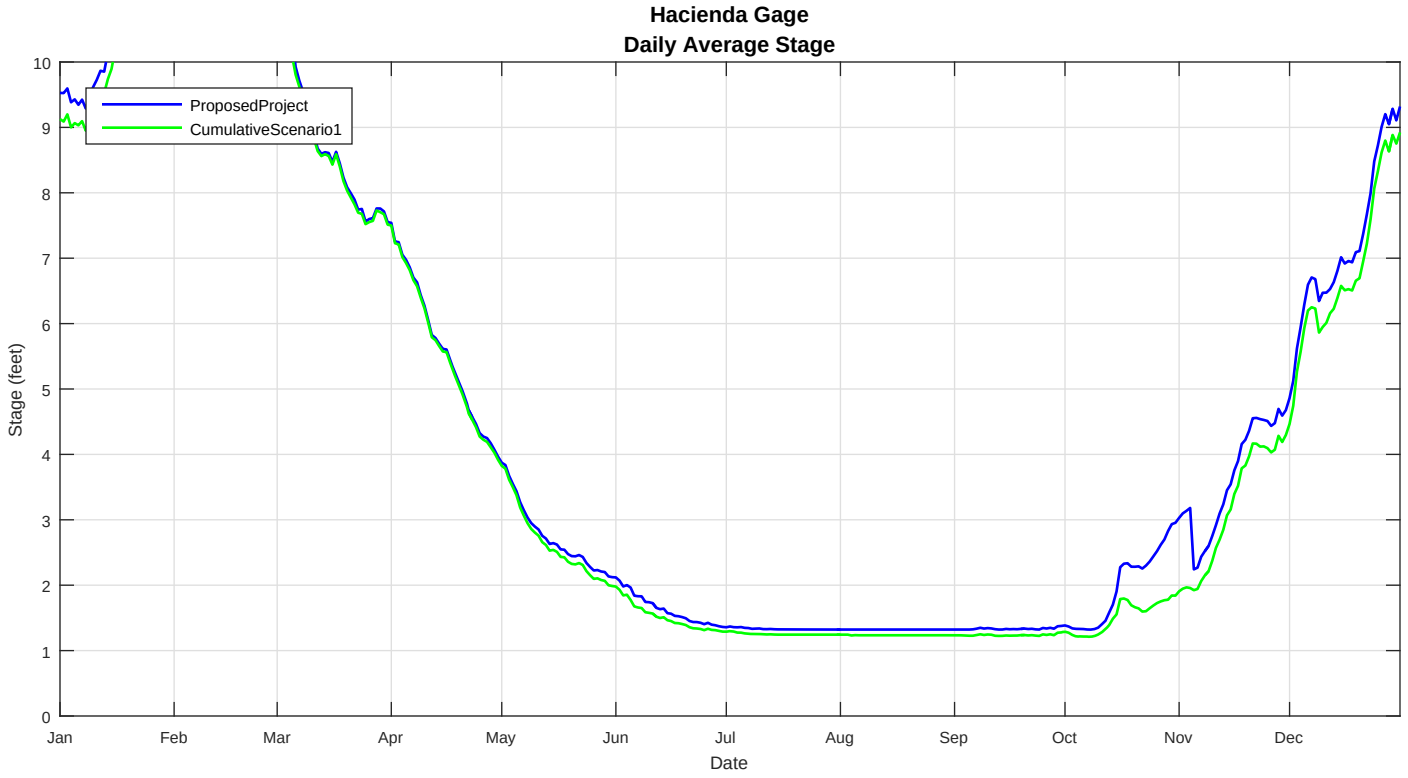

Dry Creek at Geyserville Gage
Daily Average Flow
Flow (cfs)
1000
100
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario1

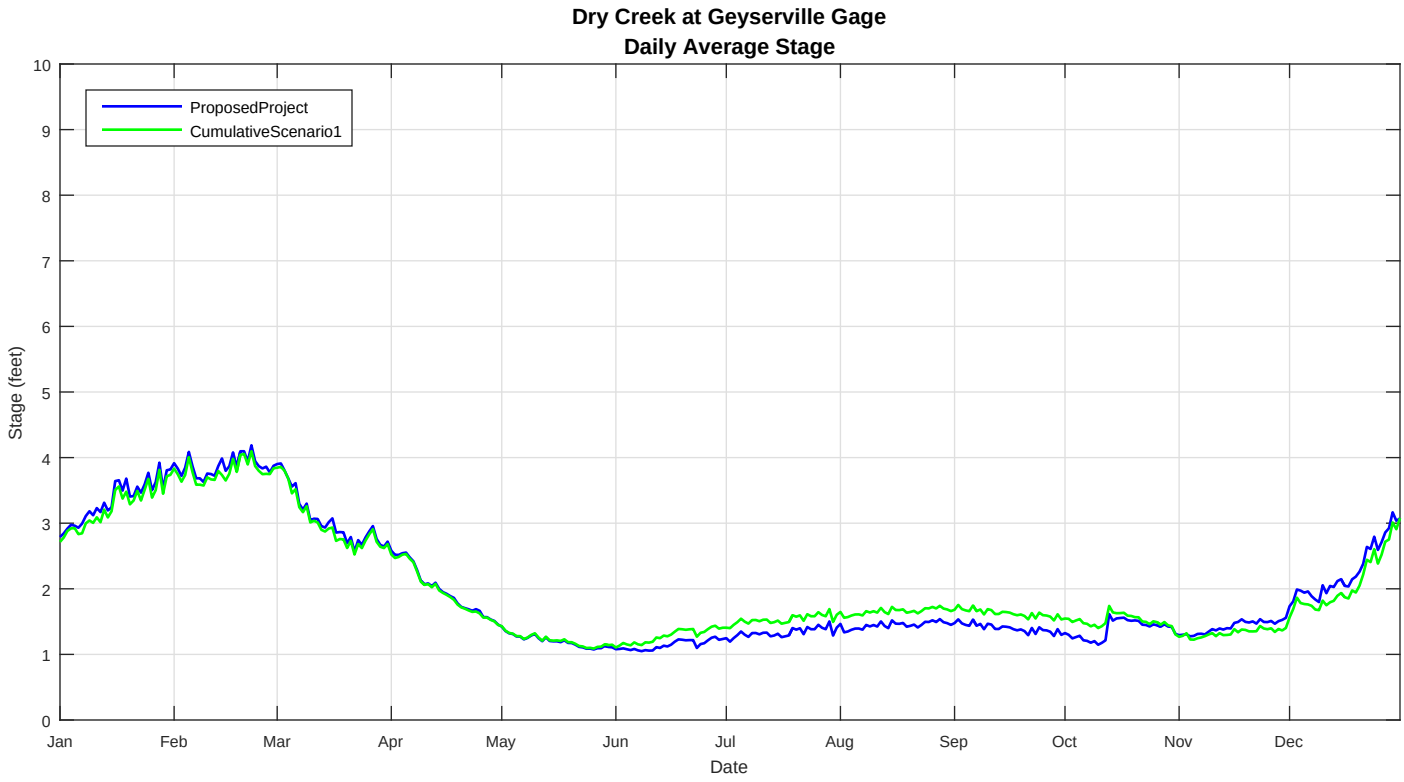

Dry Creek Mouth Gage
Daily Average Flow
Flow (cfs)
1000
100
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario1

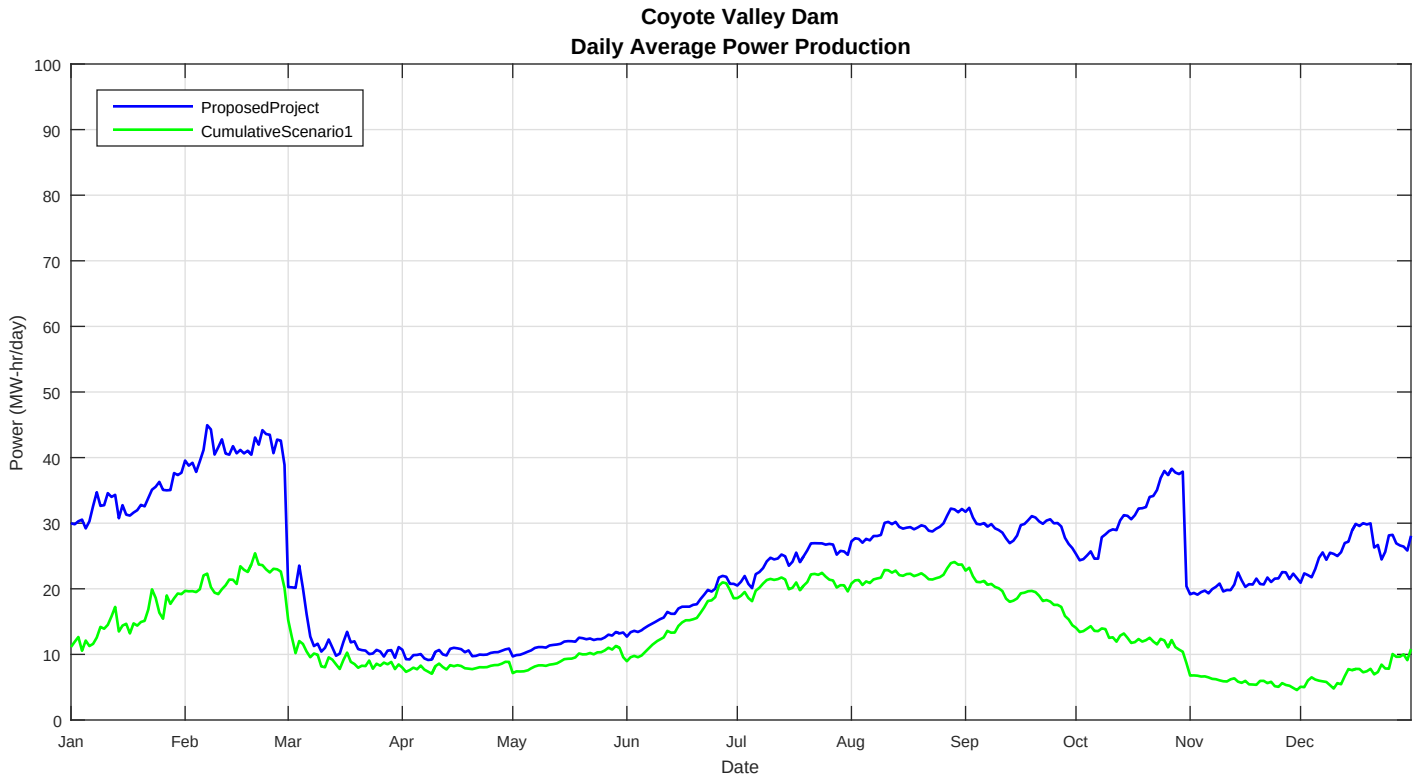

Hopland Gage
Daily Average Stage
ProposedProject
CumulativeScenario1
Stage (feet)
10
8
6
4
2
0
-2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

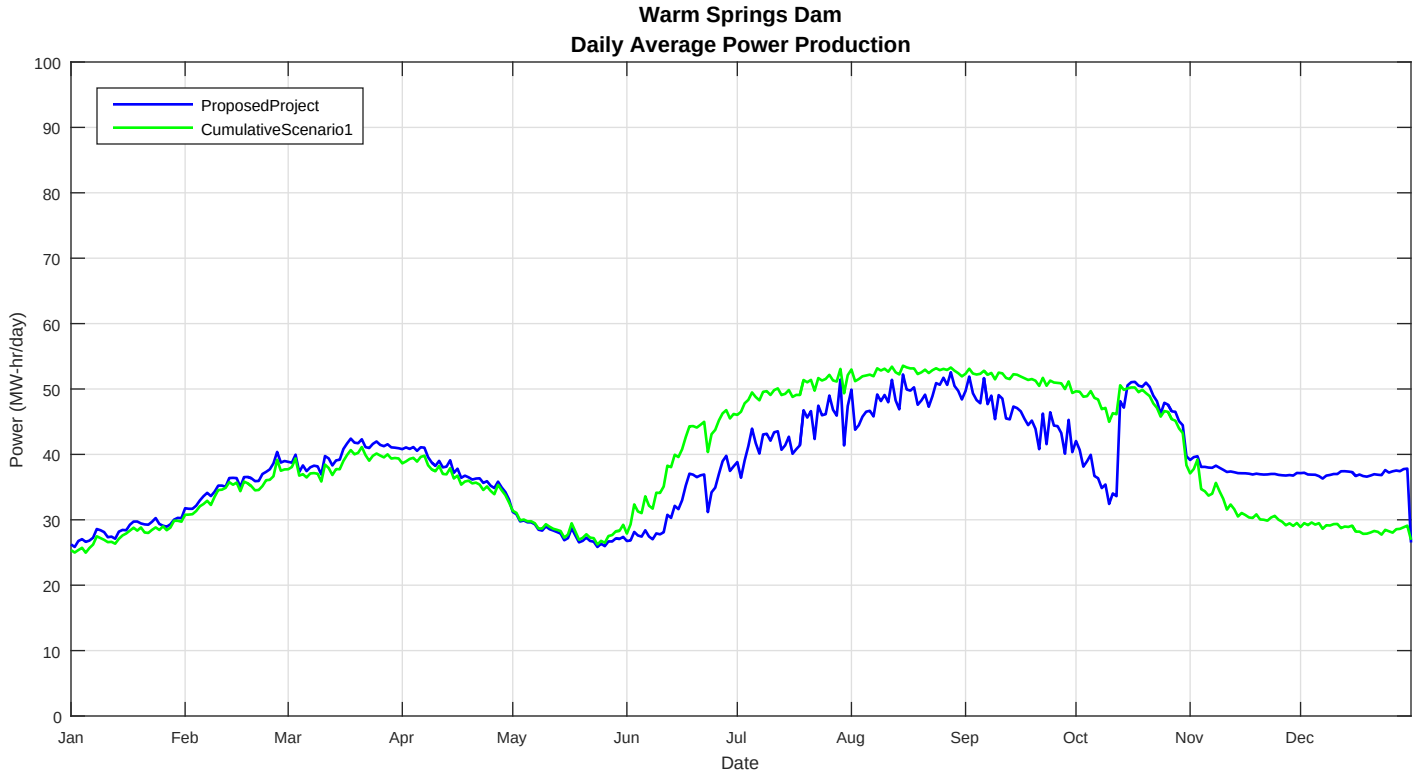

Cloverdale Gage
Daily Average Stage
ProposedProject
CumulativeScenario1
Stage (feet)
10
9
8
7
6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

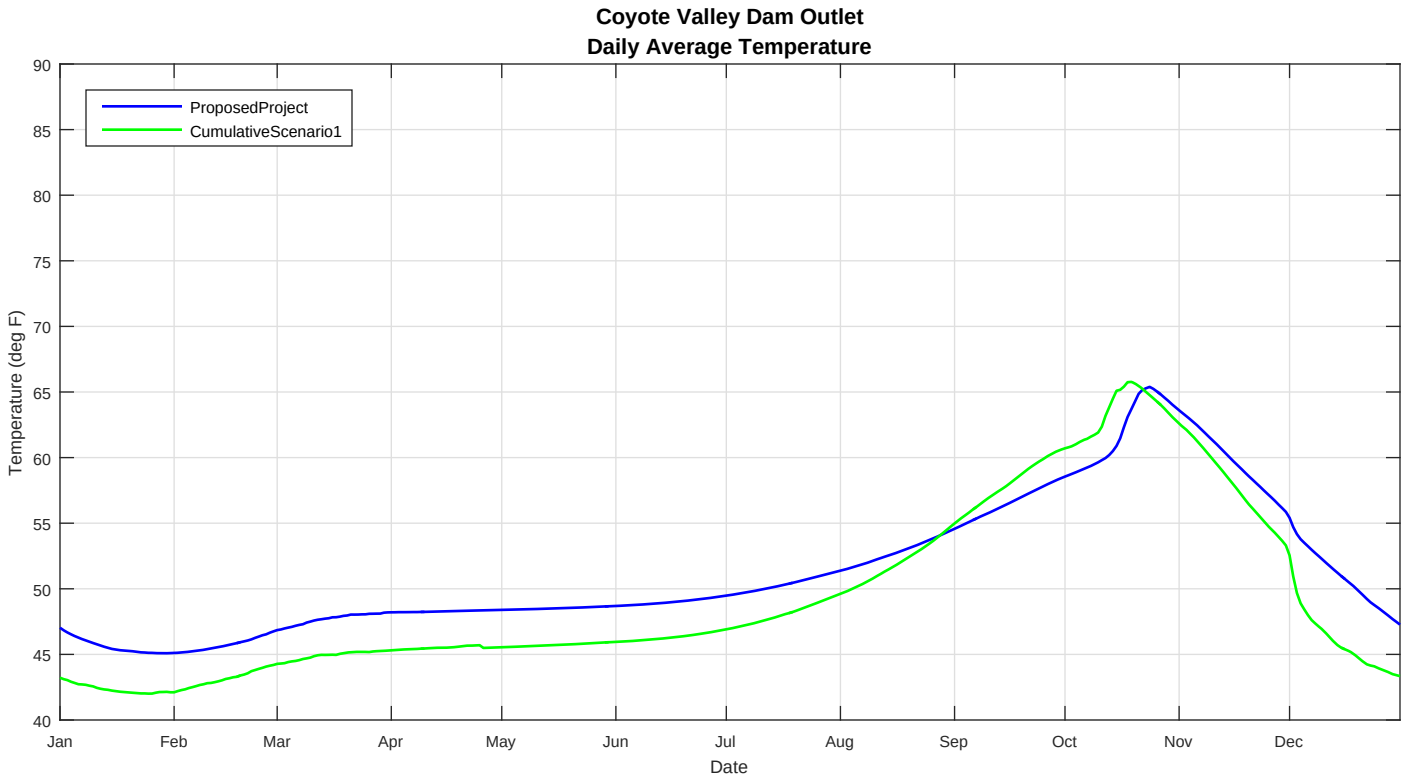

Healdsburg Gage
Daily Average Stage
ProposedProject
CumulativeScenario1
Stage (feet)
0
1
2
3
4
5
6
7
8
9
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

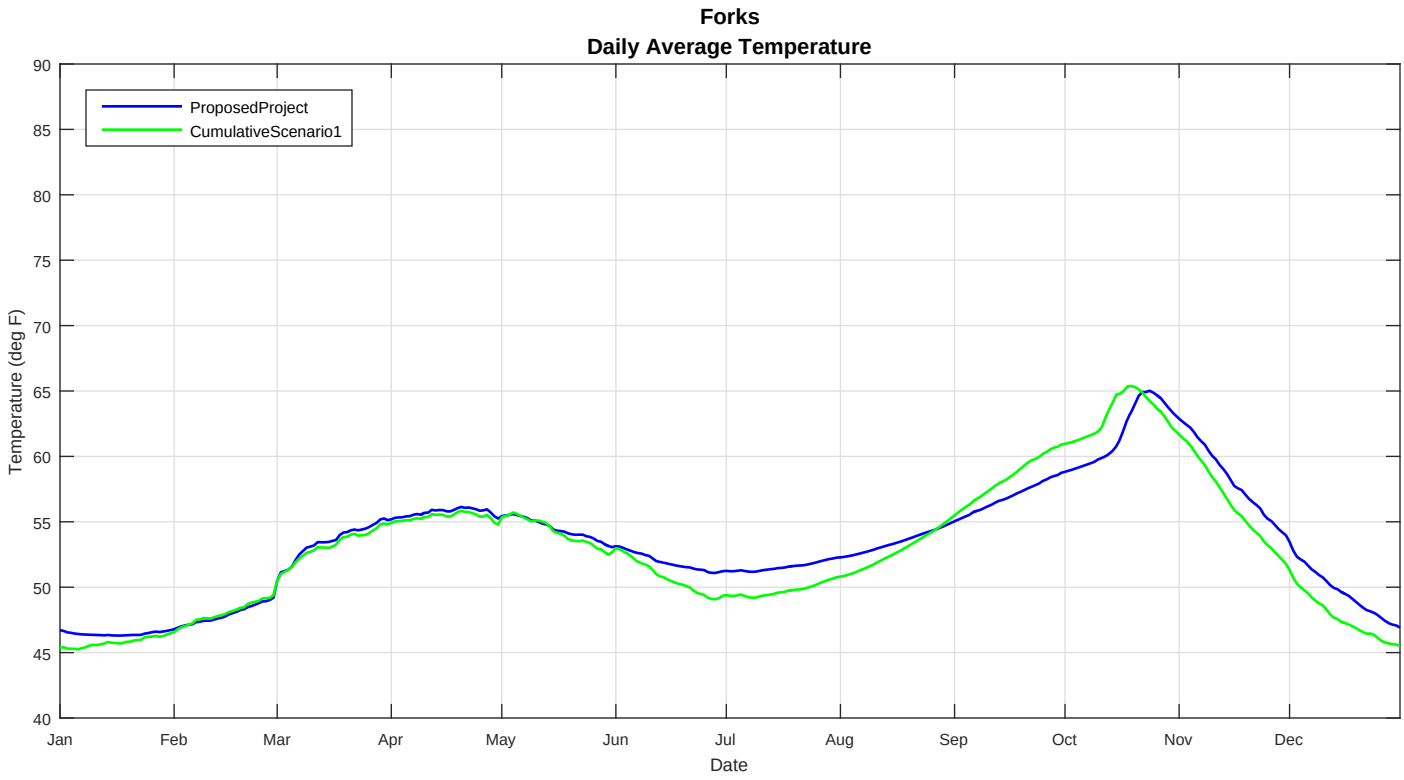

Hacienda Gage
Daily Average Stage
ProposedProject
CumulativeScenario1
Stage (feet)
0
1
2
3
4
5
6
7
8
9
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

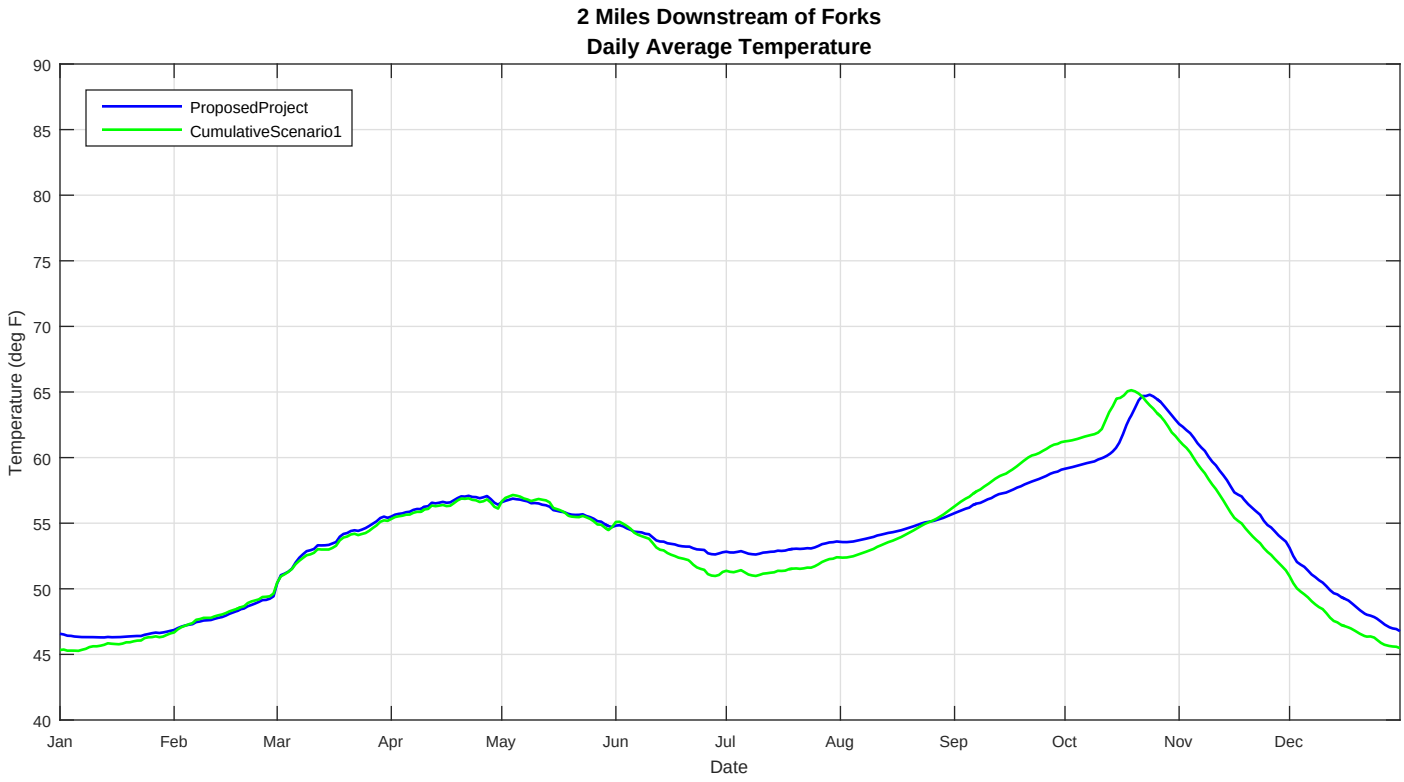

Dry Creek at Geyserville Gage
Daily Average Stage
ProposedProject
CumulativeScenario1
Stage (feet)
0
1
2
3
4
5
6
7
8
9
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

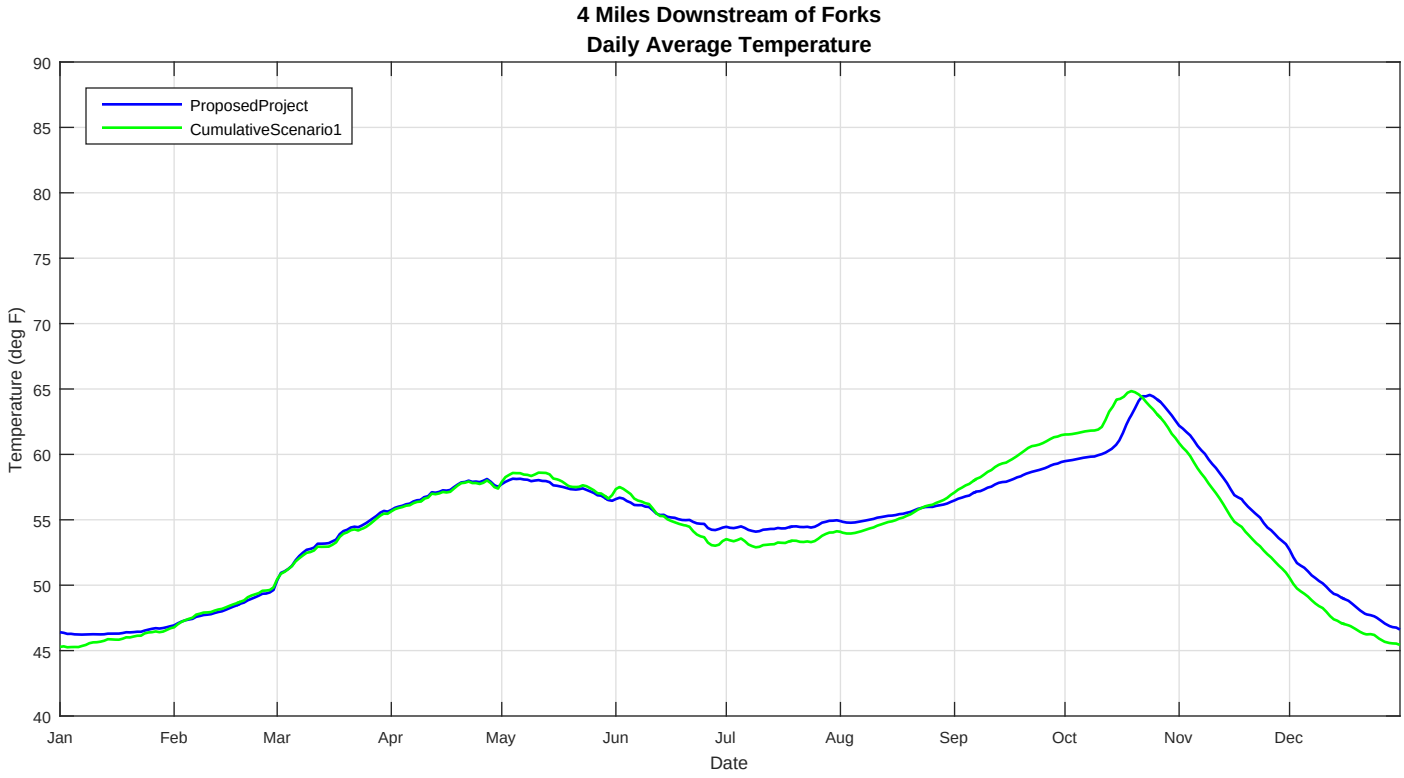

Coyote Valley Dam
Daily Average Power Production
ProposedProject
CumulativeScenario1
Power (MW-hr/day)
0
10
20
30
40
50
60
70
80
90
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

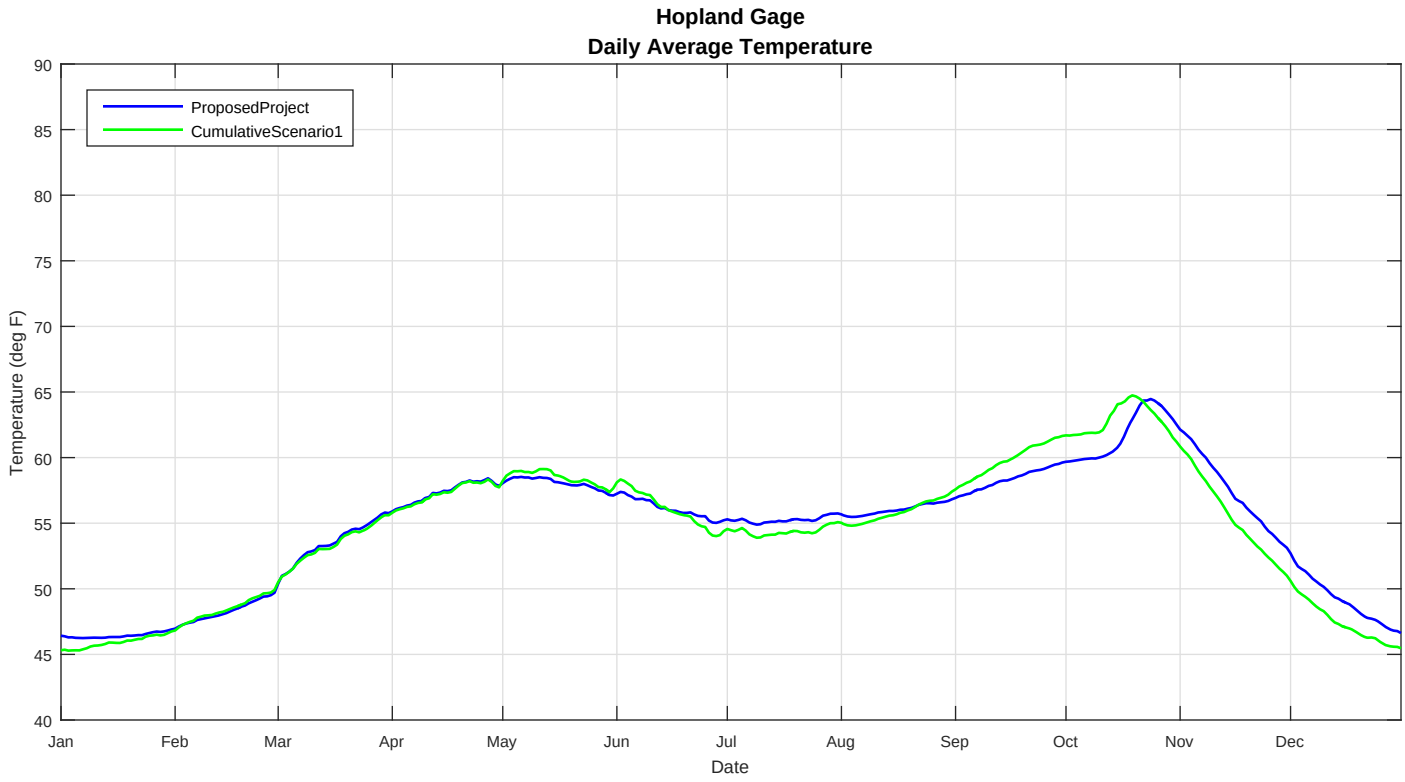

Warm Springs Dam
Daily Average Power Production
ProposedProject
CumulativeScenario1
Power (MW-hr/day)
0
10
20
30
40
50
60
70
80
90
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

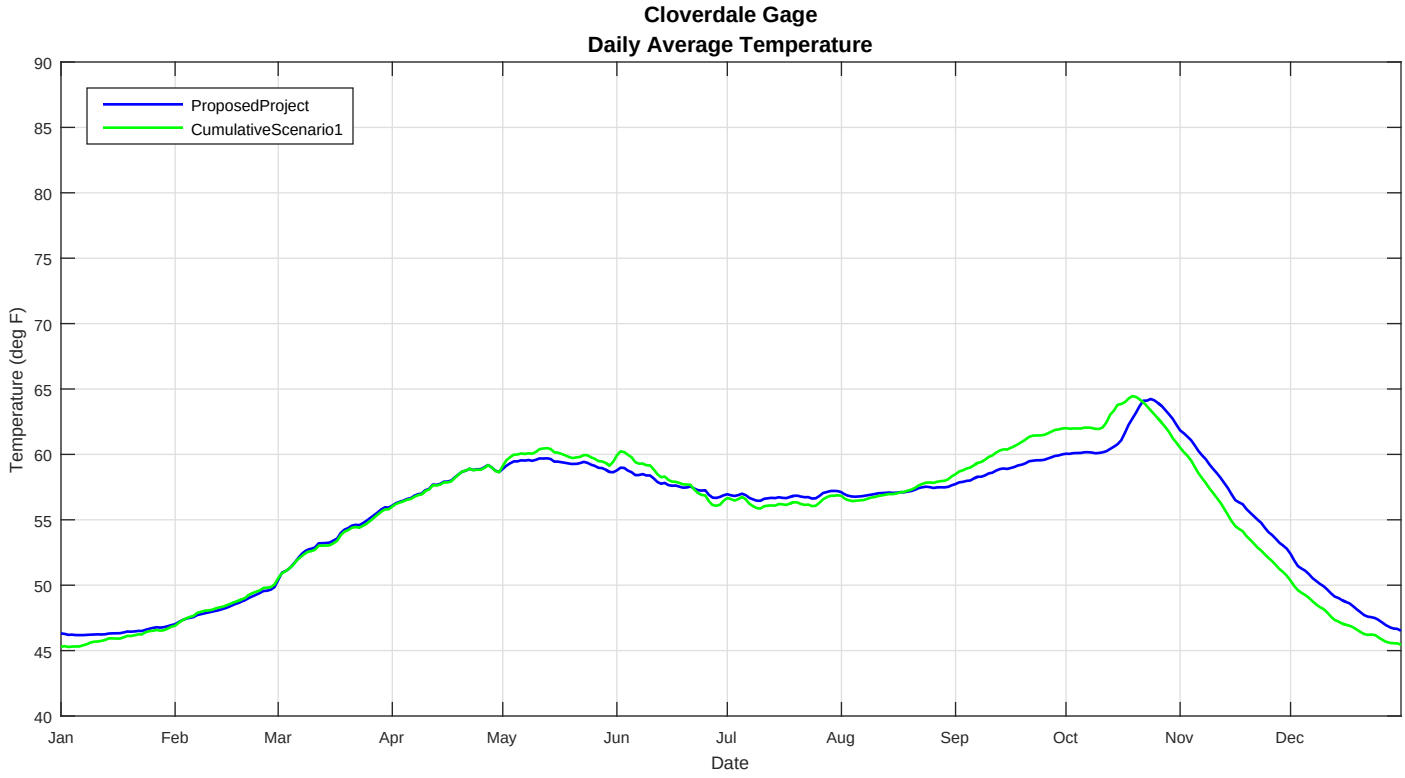

Coyote Valley Dam Outlet
Daily Average Temperature
ProposedProject
CumulativeScenario1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

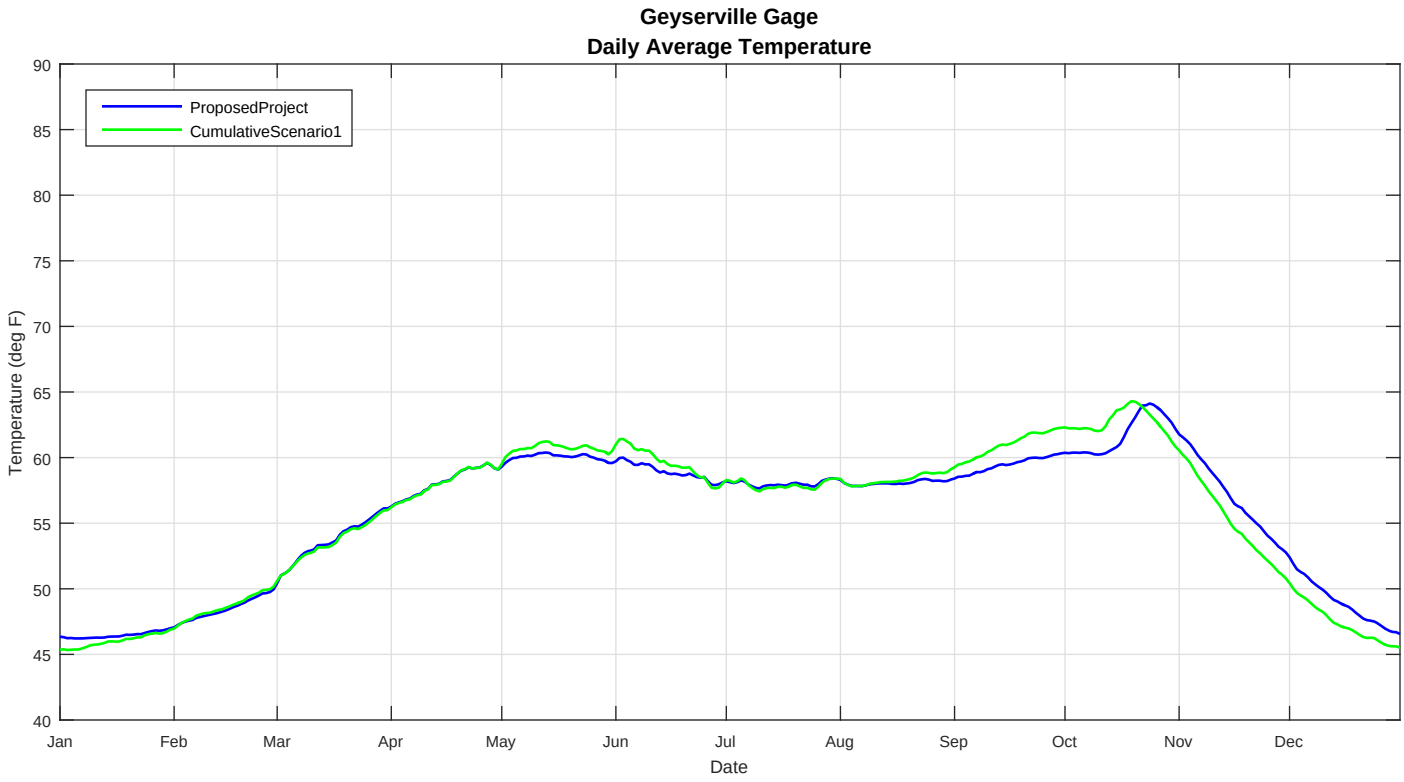

Forks
Daily Average Temperature
ProposedProject
CumulativeScenario1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

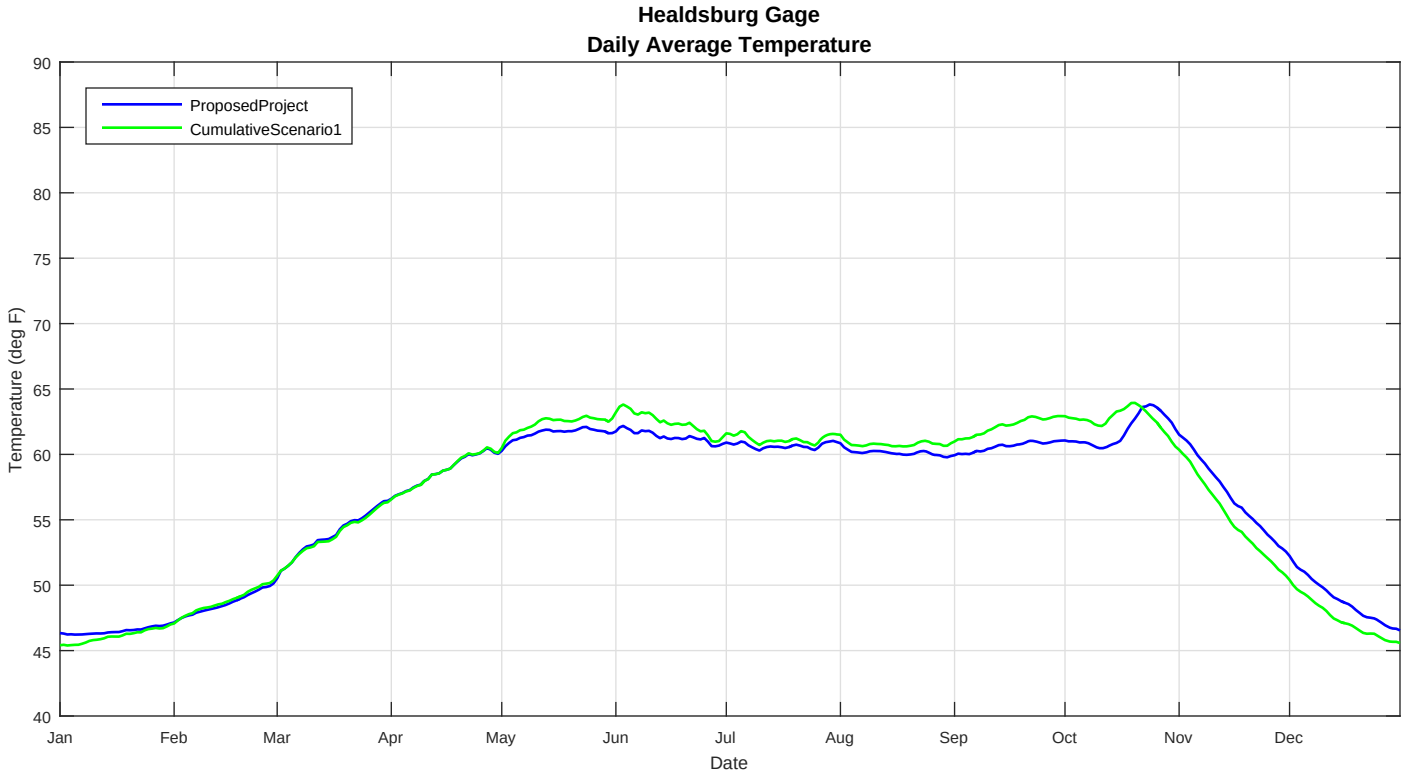

2 Miles Downstream of Forks
Daily Average Temperature
ProposedProject
CumulativeScenario1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

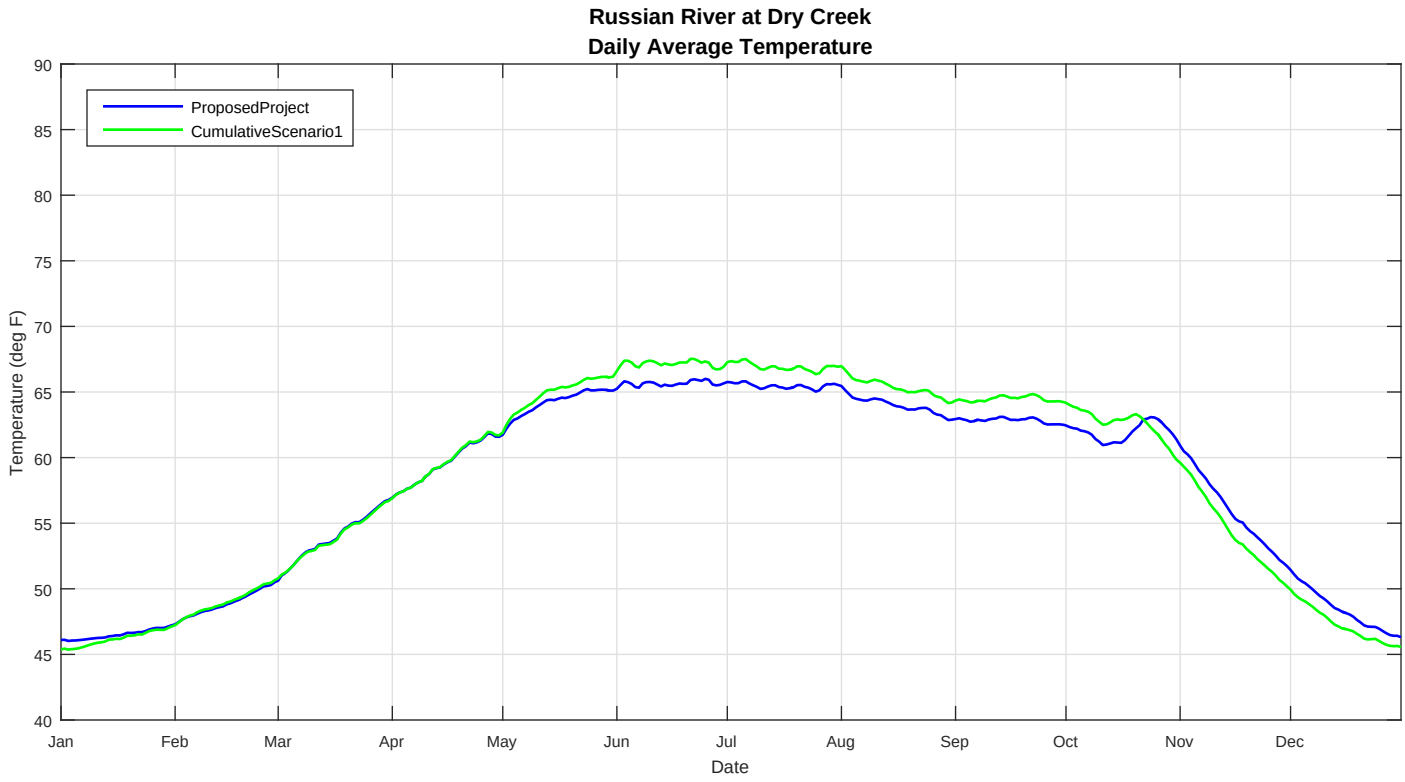

4 Miles Downstream of Forks
Daily Average Temperature
ProposedProject
CumulativeScenario1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

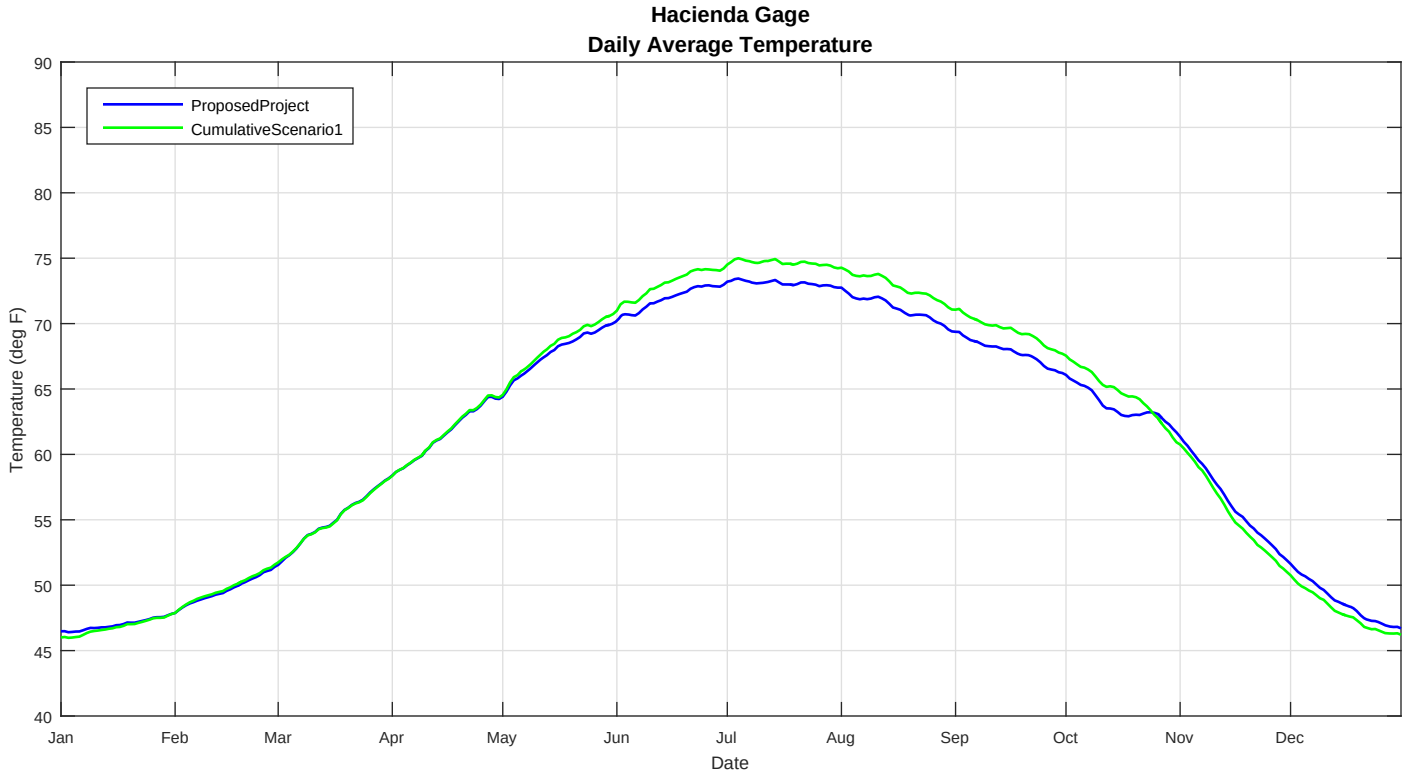

Hopland Gage
Daily Average Temperature
ProposedProject
CumulativeScenario1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

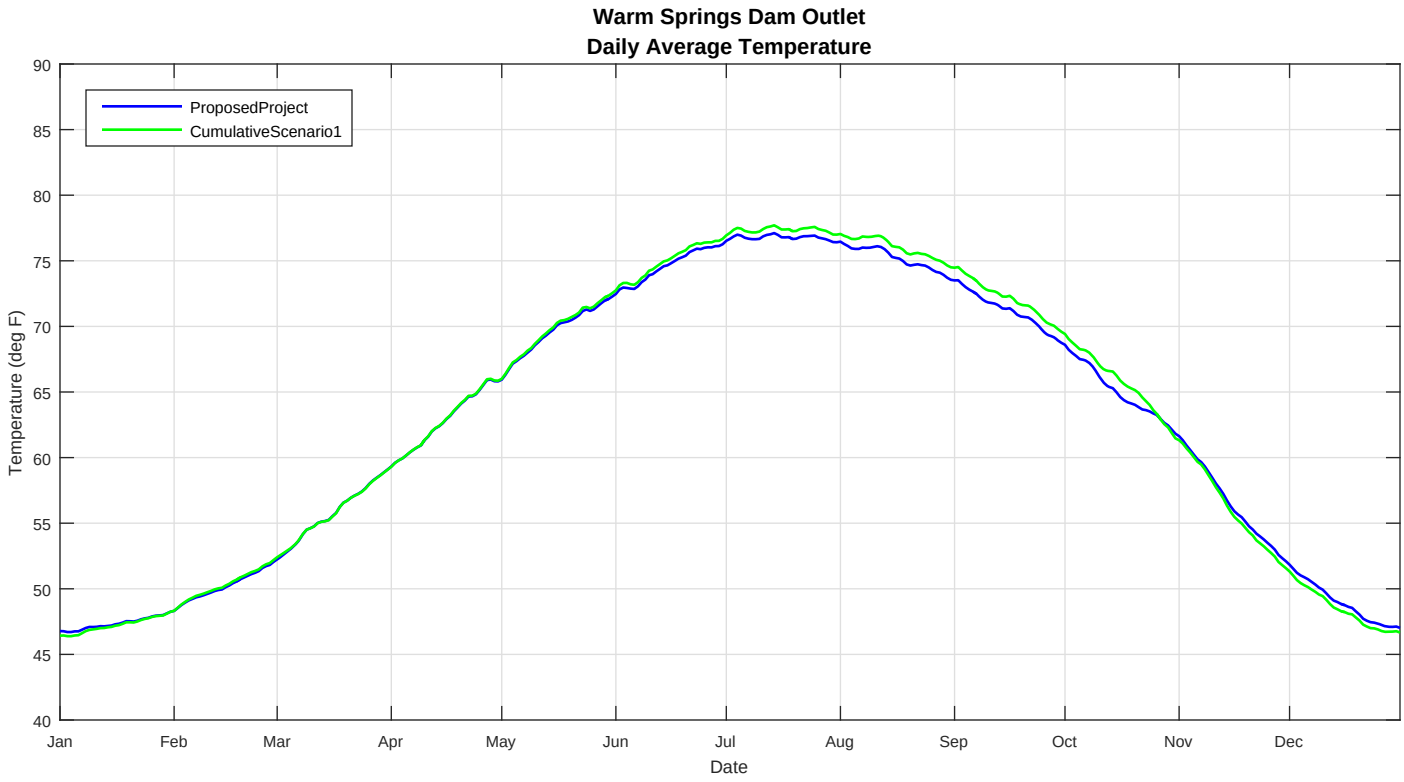

Cloverdale Gage
Daily Average Temperature
ProposedProject
CumulativeScenario1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

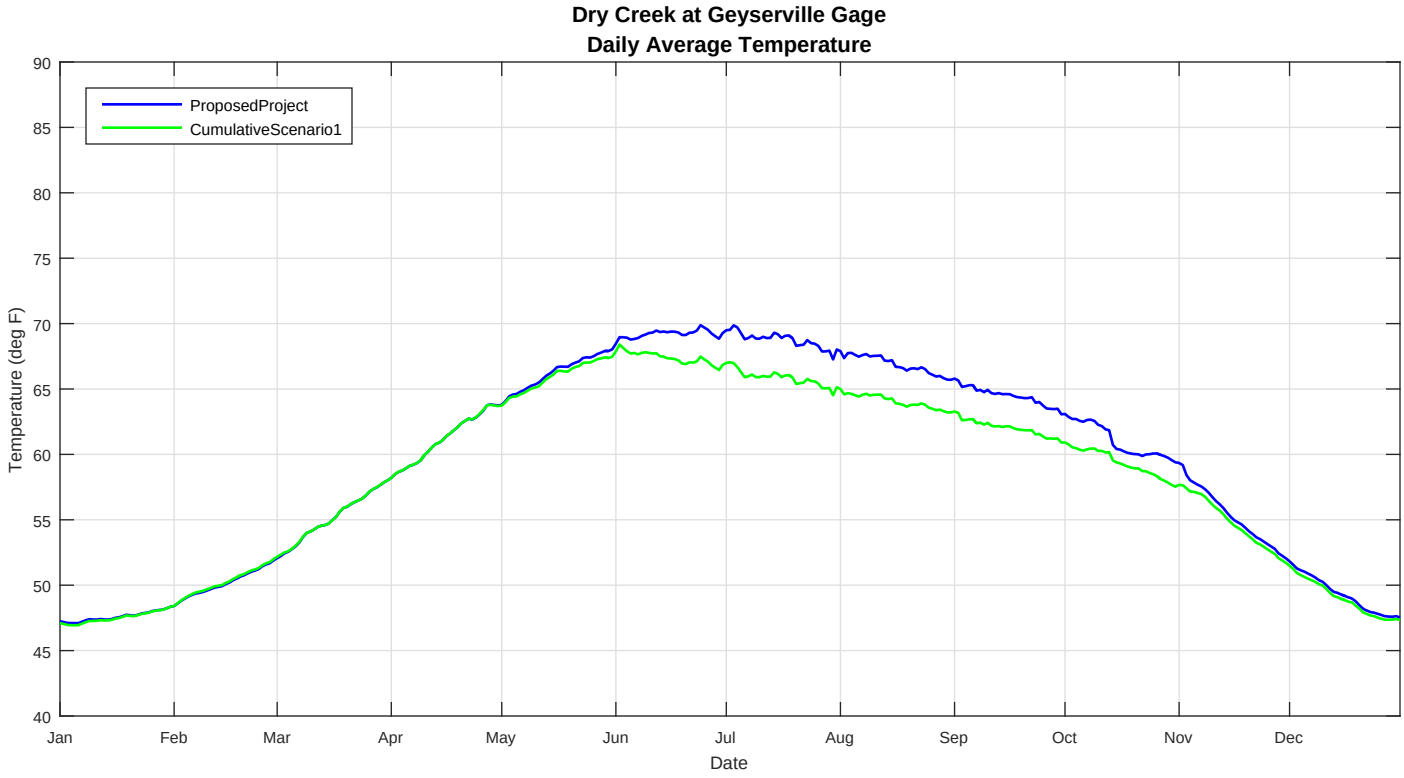

Geyserville Gage
Daily Average Temperature
ProposedProject
CumulativeScenario1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

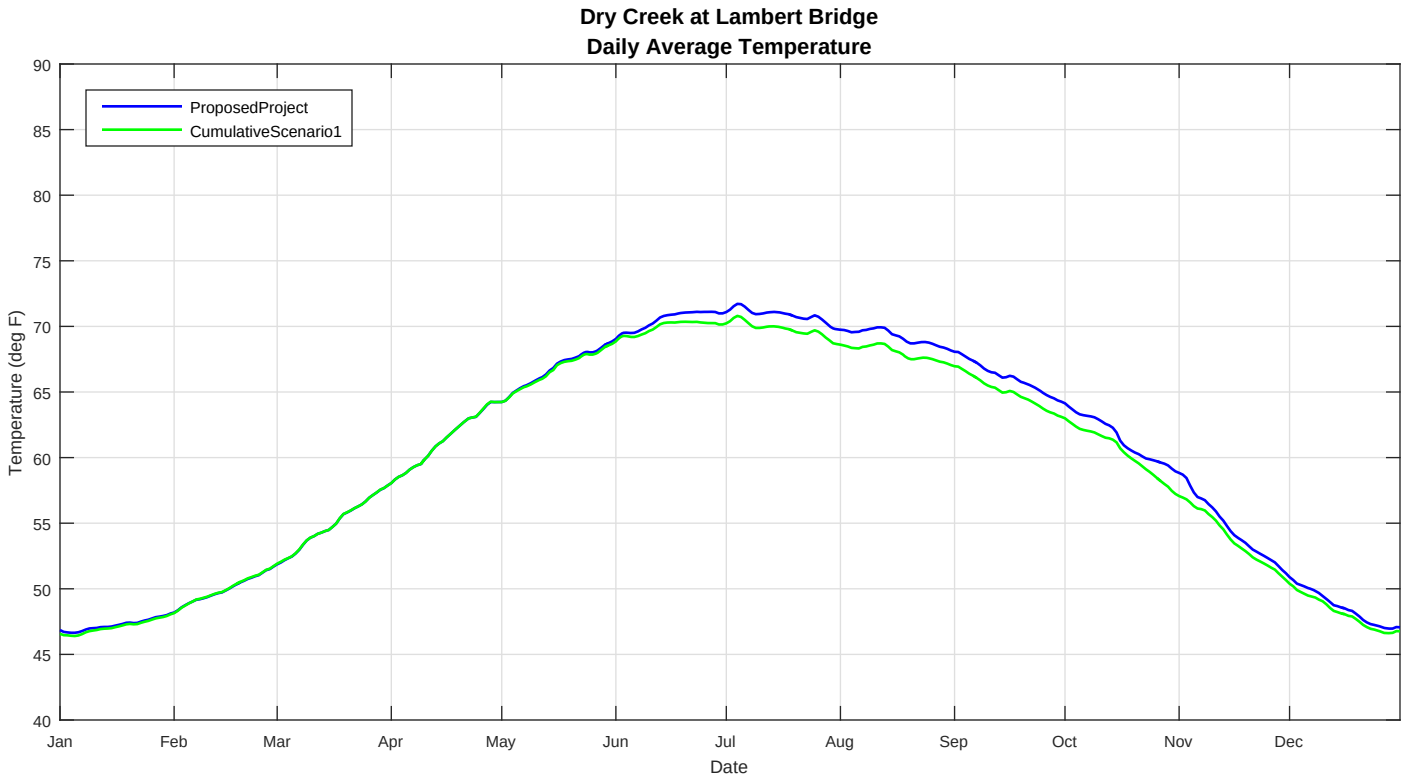

Healdsburg Gage
Daily Average Temperature
ProposedProject
CumulativeScenario1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

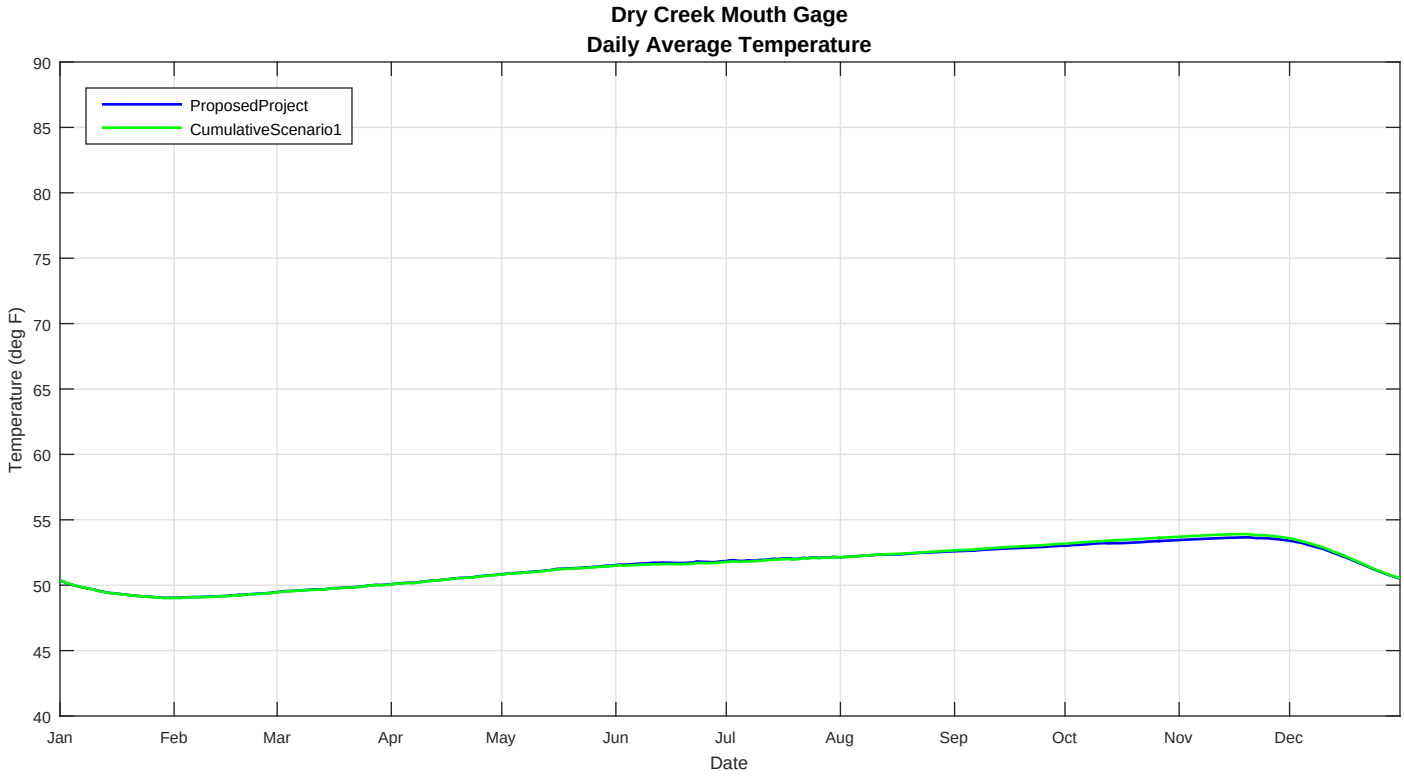

Russian River at Dry Creek
Daily Average Temperature
ProposedProject
CumulativeScenario1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

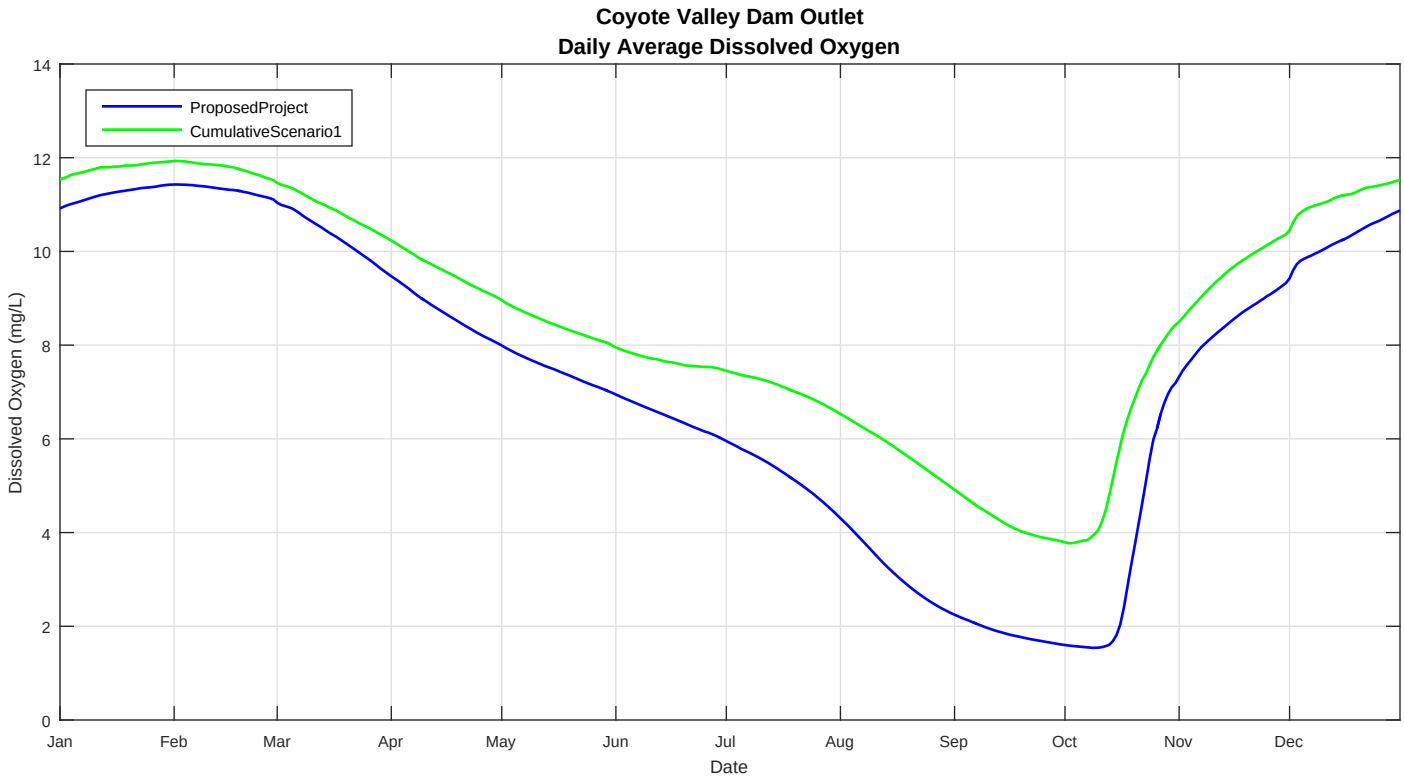

Hacienda Gage
Daily Average Temperature
ProposedProject
CumulativeScenario1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

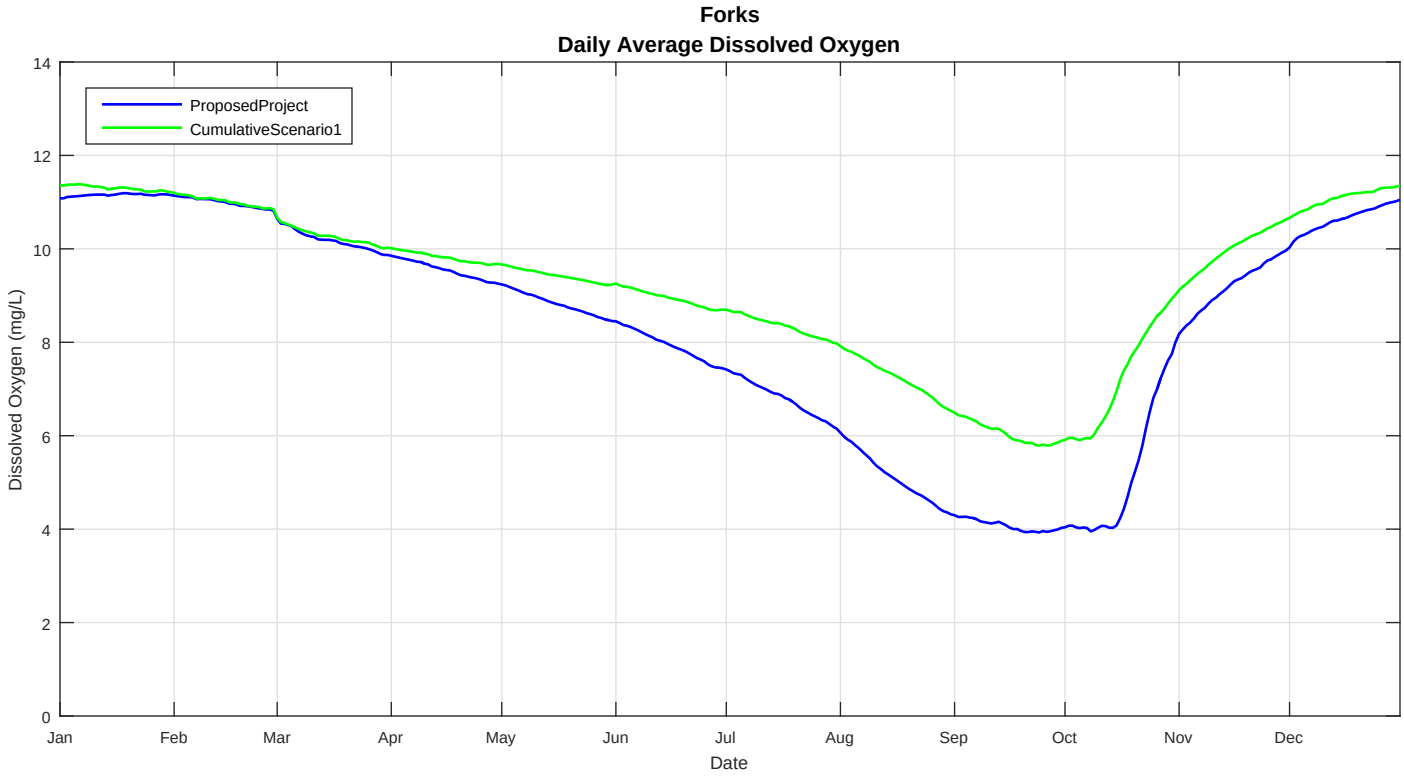

Warm Springs Dam Outlet
Daily Average Temperature
ProposedProject
CumulativeScenario1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

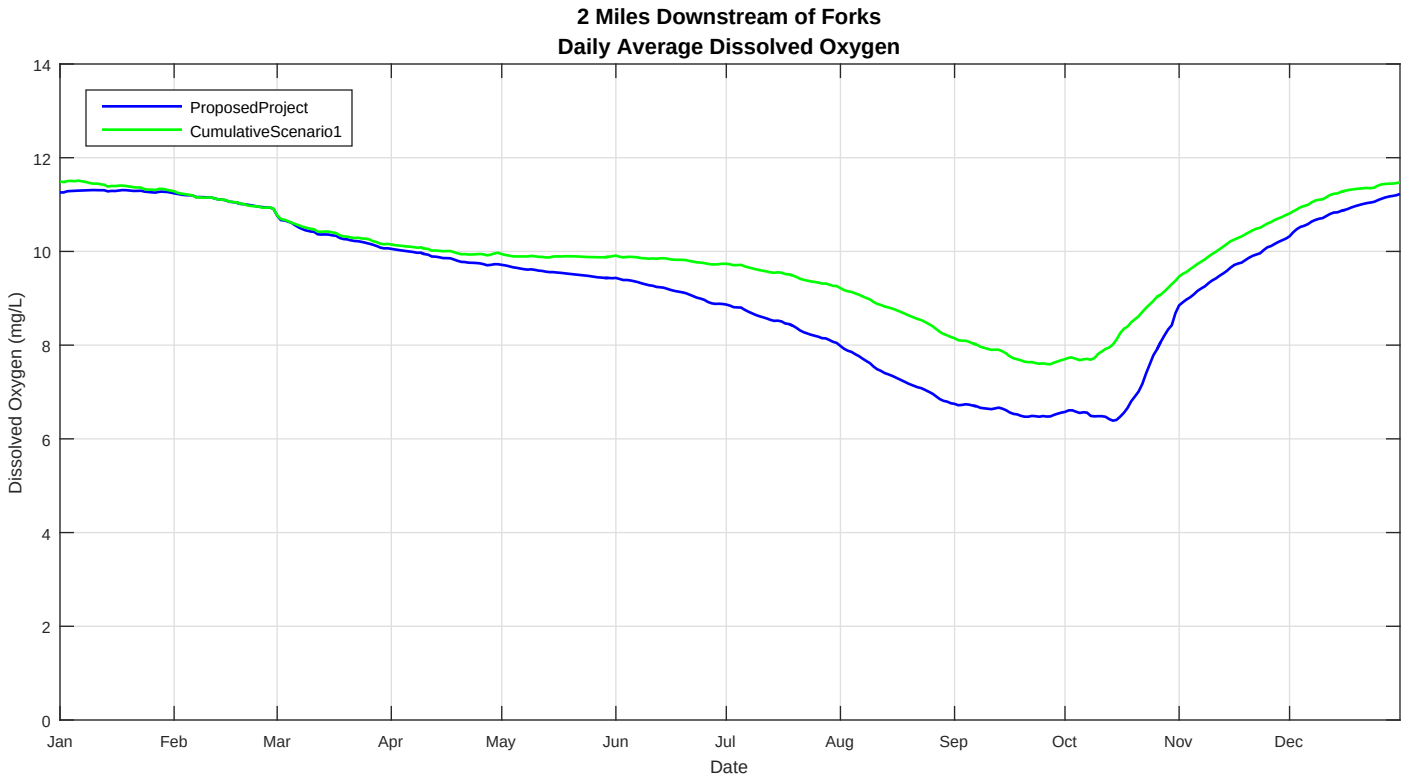

Dry Creek at Geyserville Gage
Daily Average Temperature
ProposedProject
CumulativeScenario1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

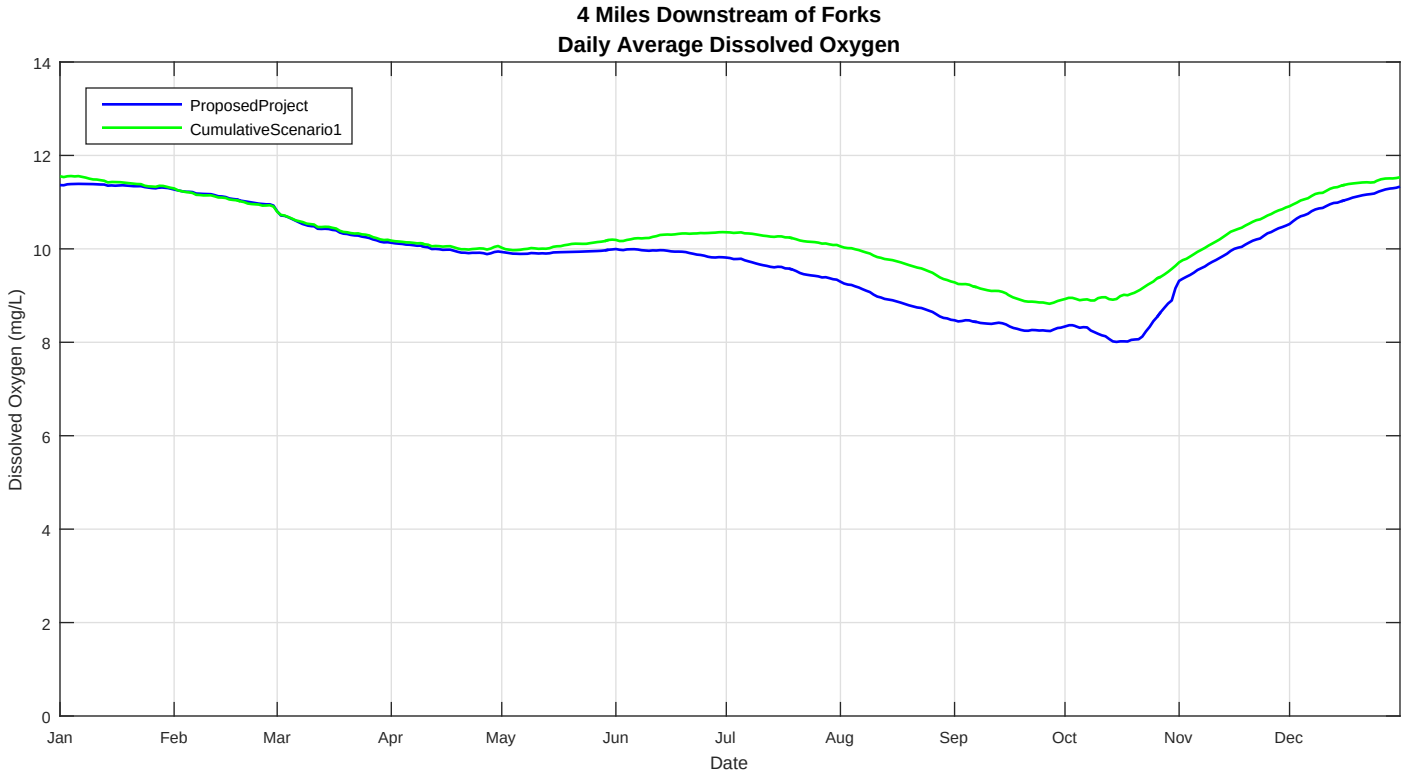

Dry Creek at Lambert Bridge
Daily Average Temperature
ProposedProject
CumulativeScenario1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

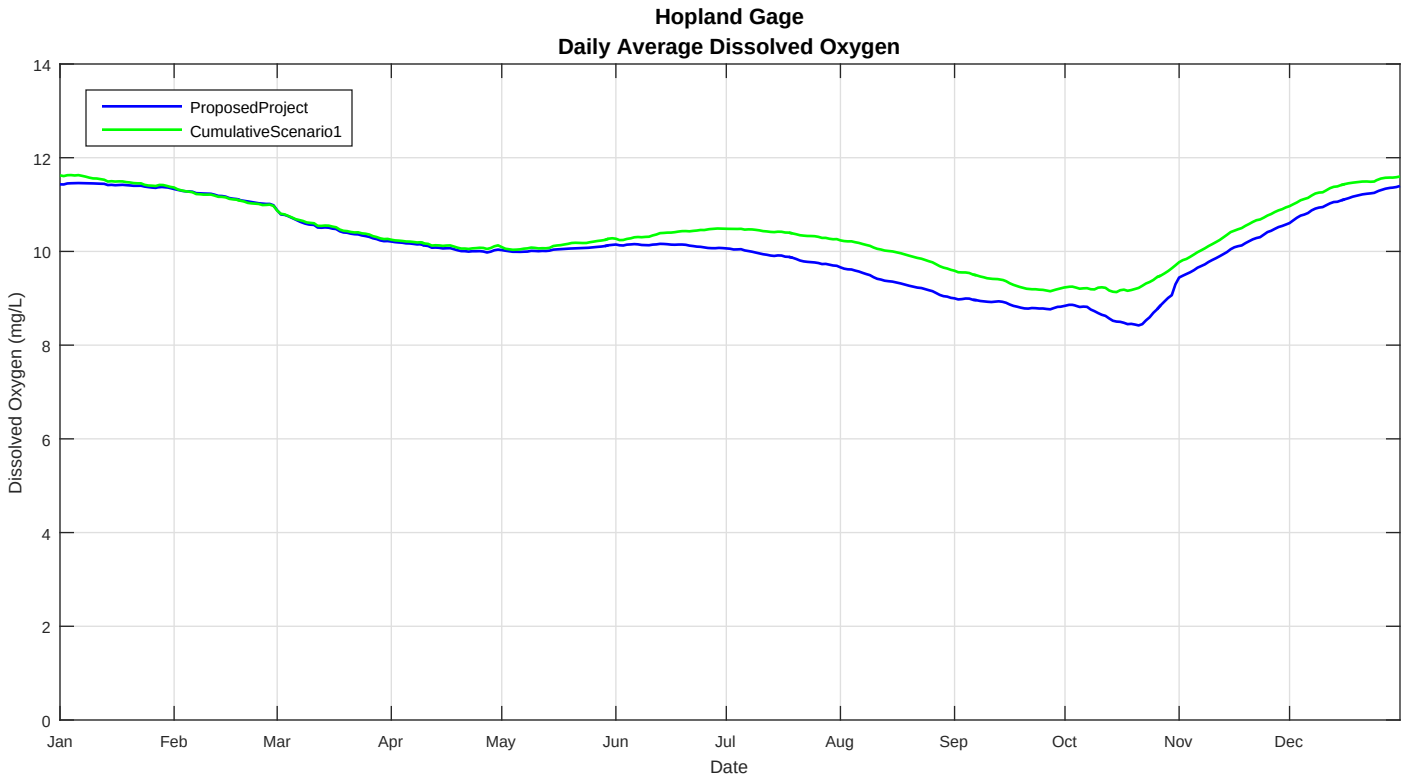

Dry Creek Mouth Gage
Daily Average Temperature
ProposedProject
CumulativeScenario1
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

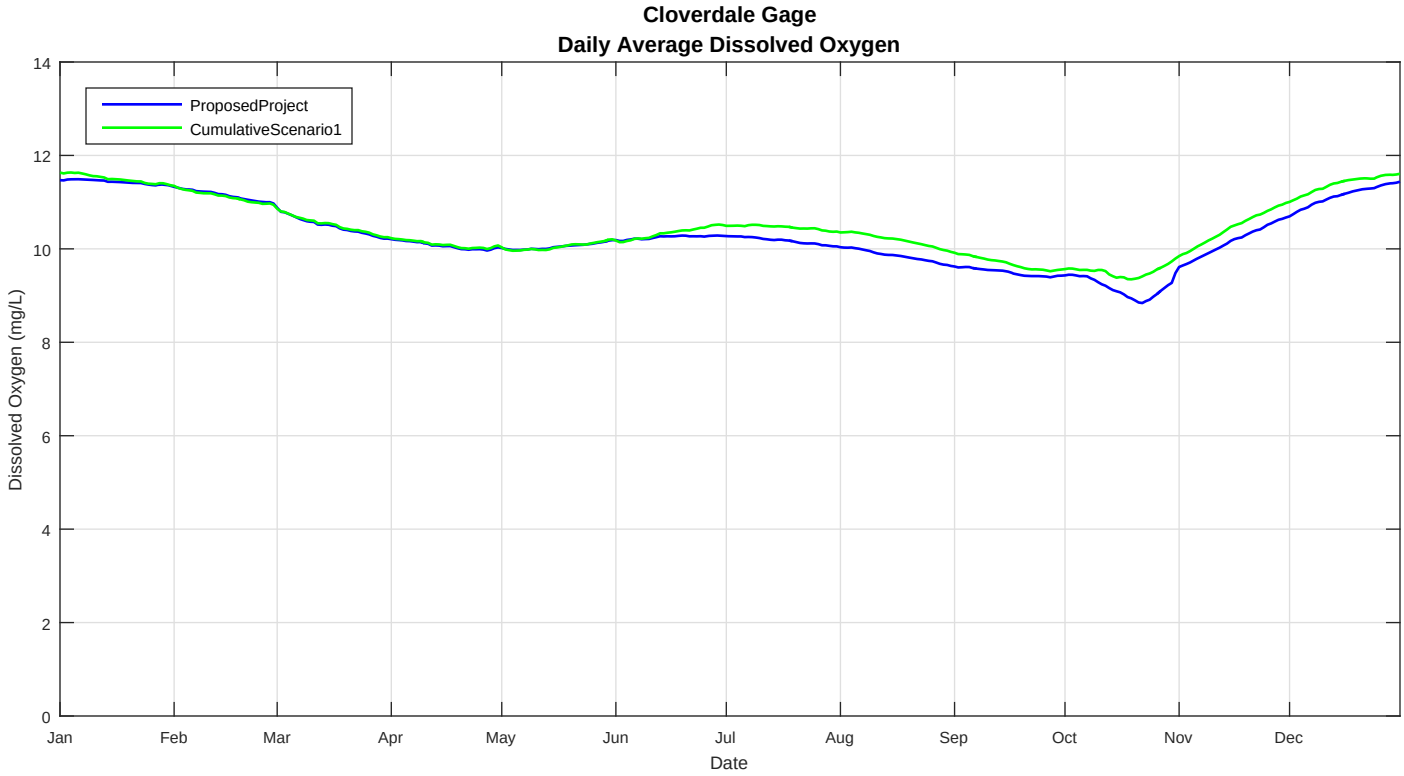

Coyote Valley Dam Outlet
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

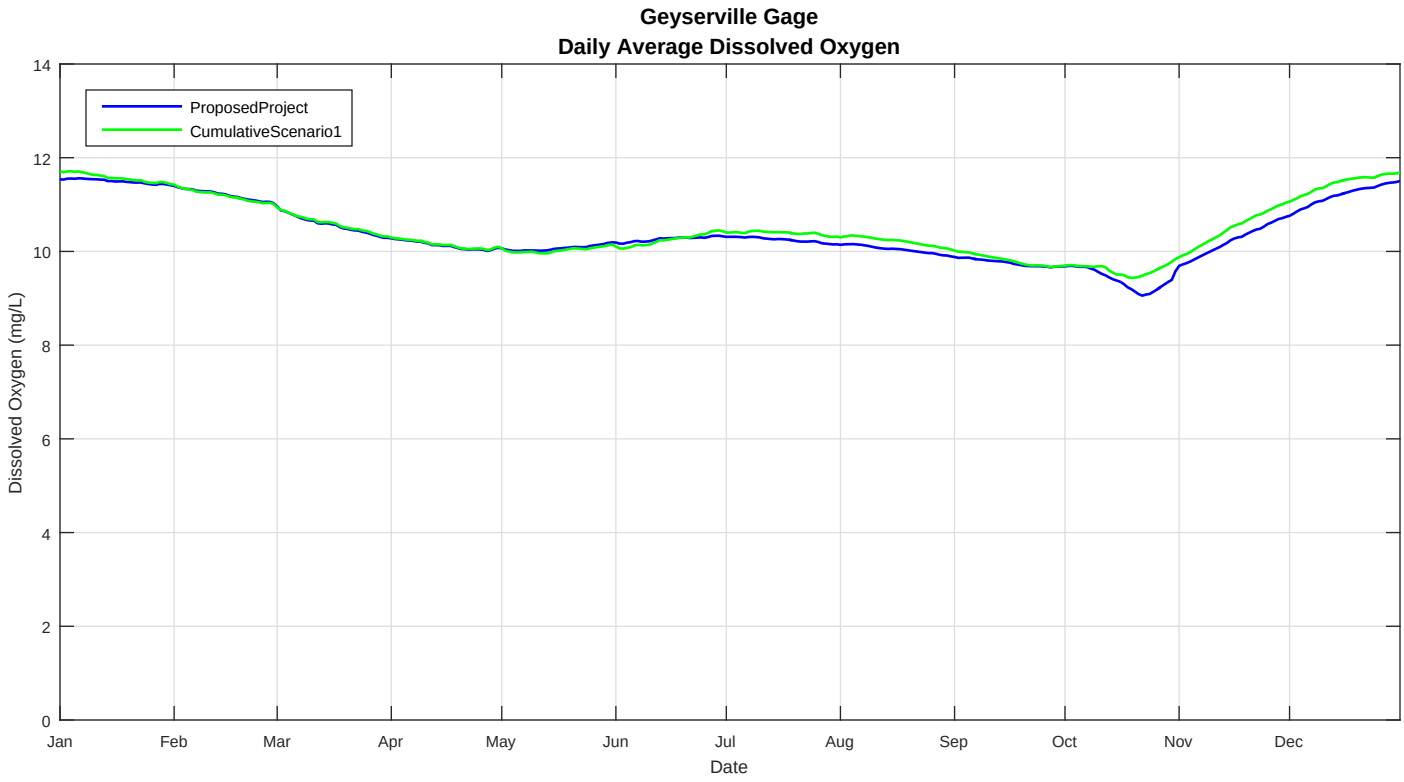

Forks
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

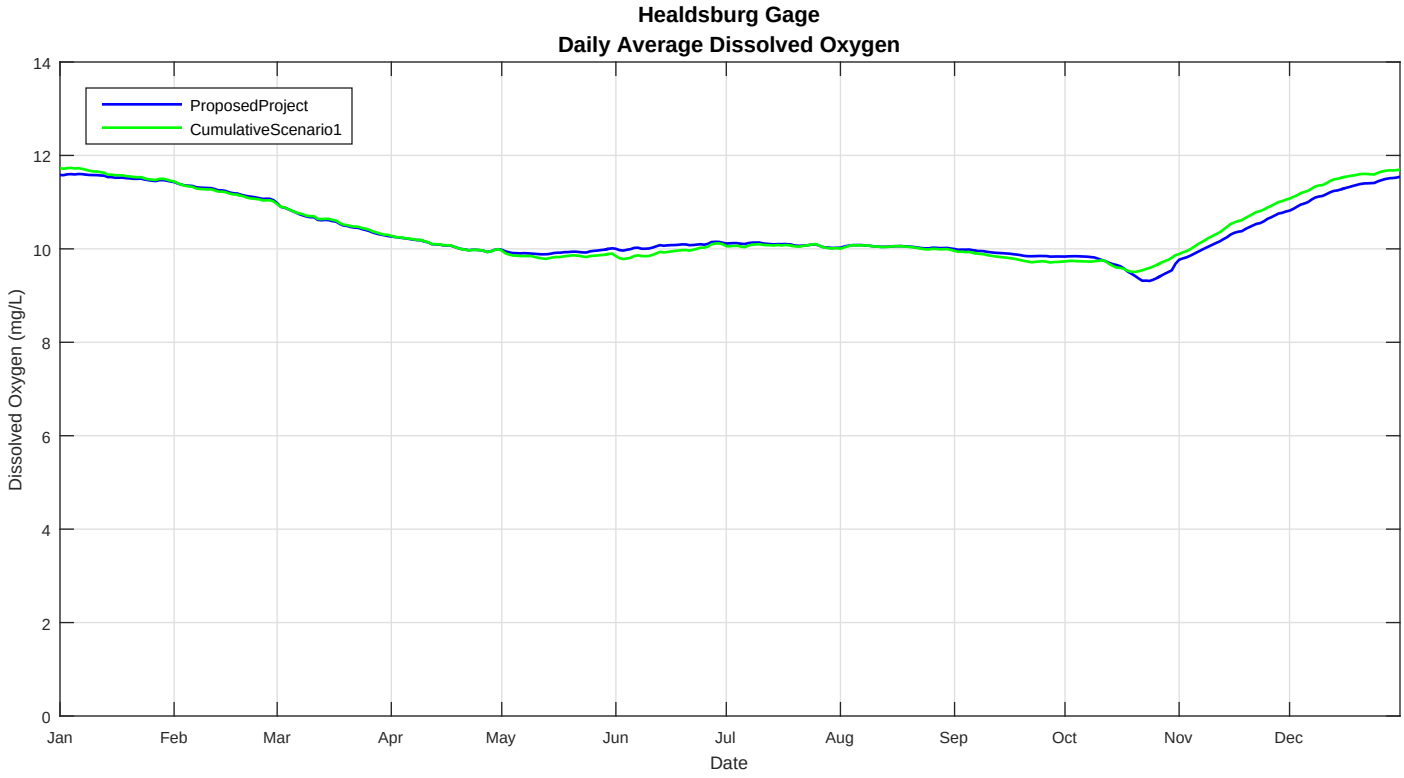

2 Miles Downstream of Forks
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

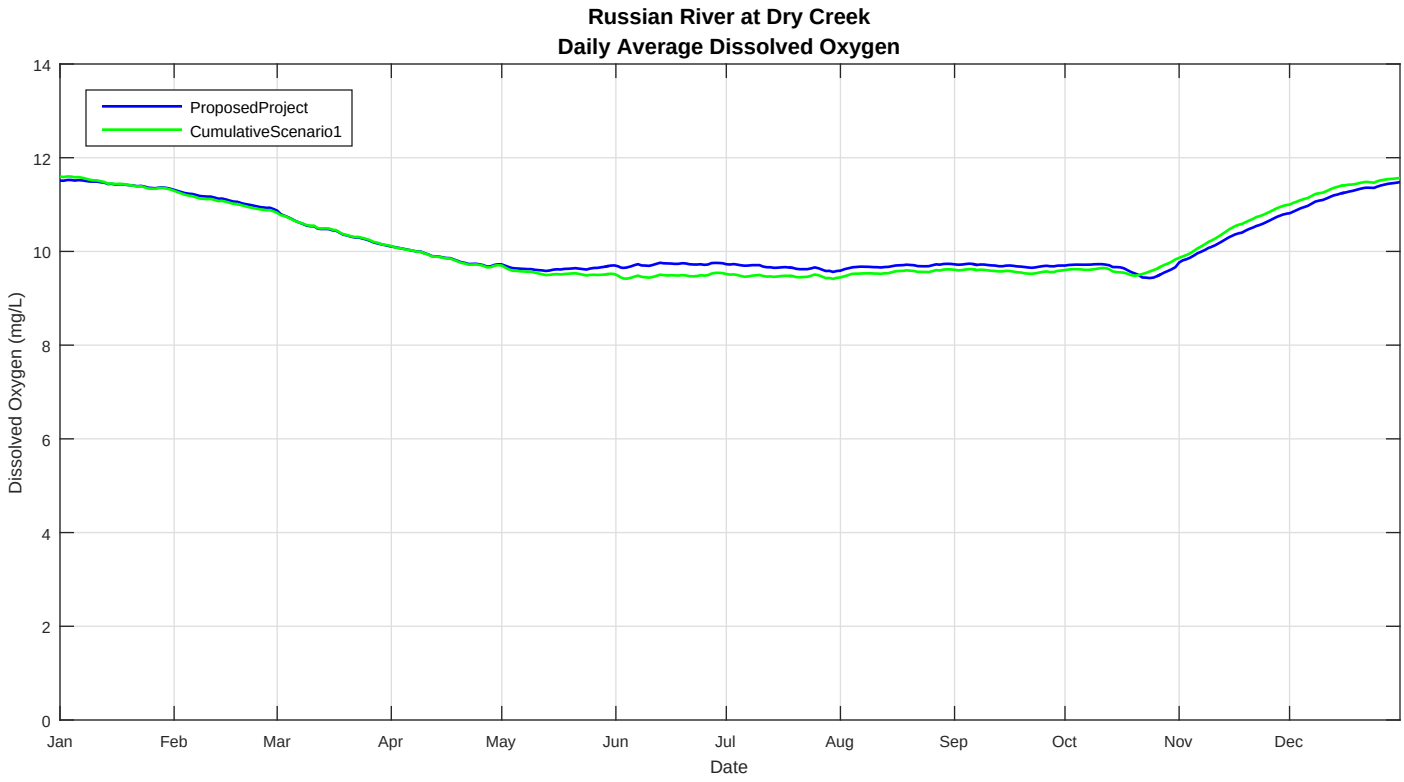

4 Miles Downstream of Forks
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

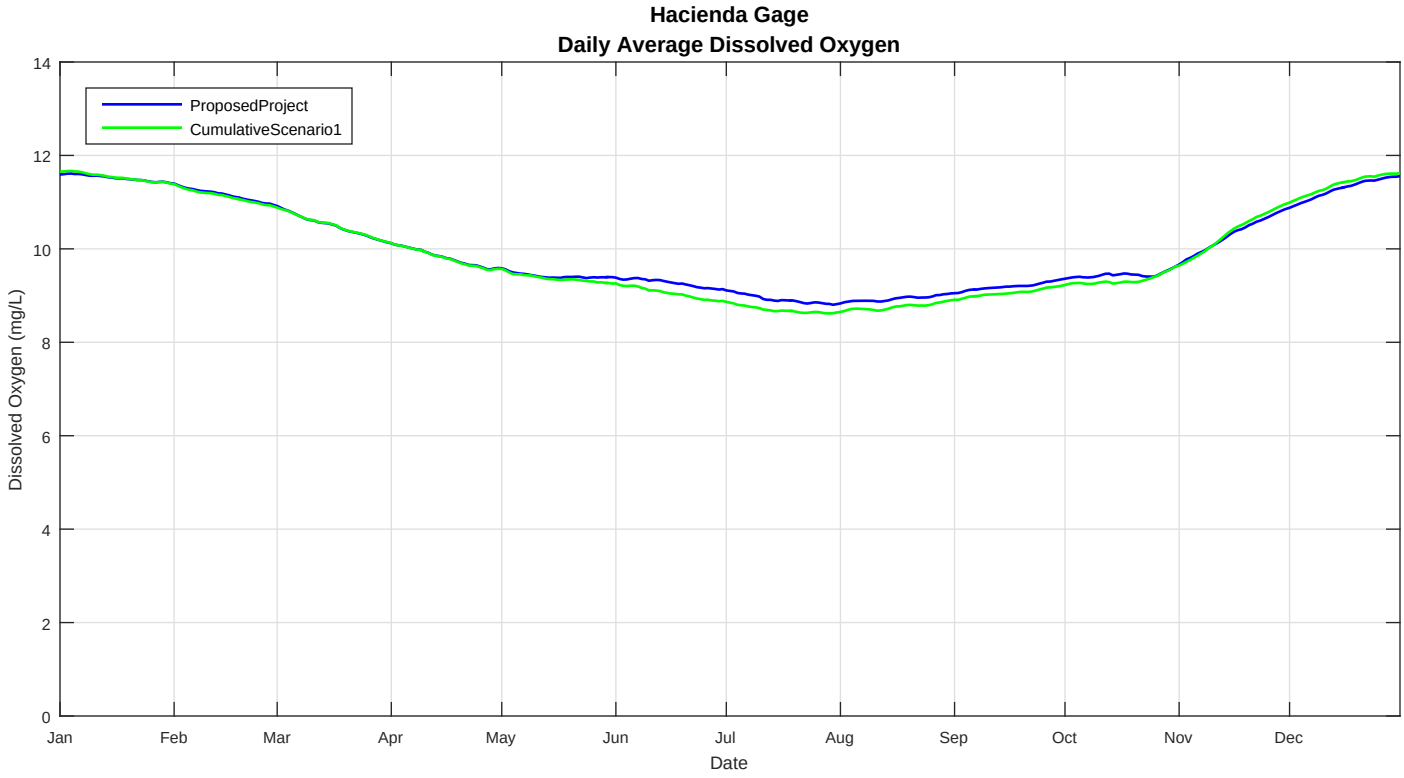

Hopland Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

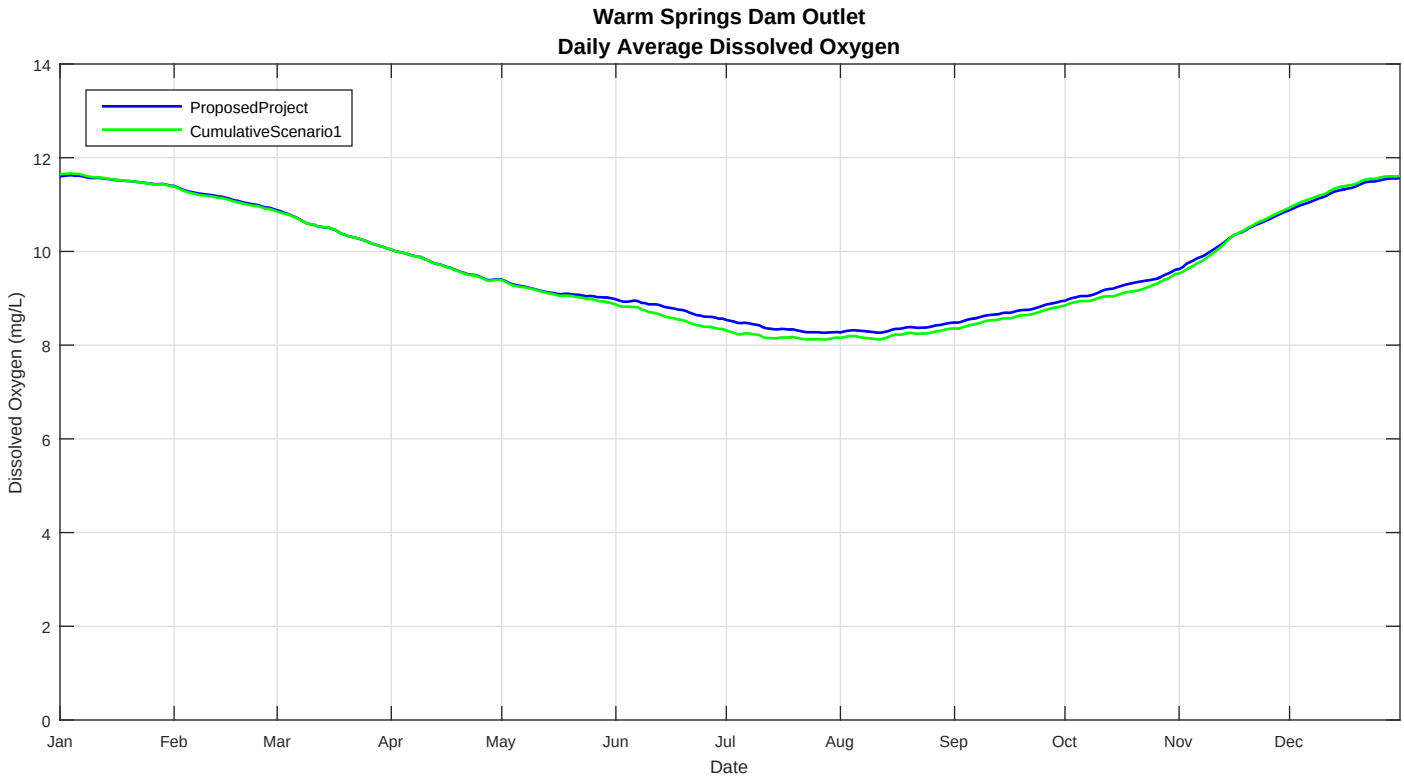

Cloverdale Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

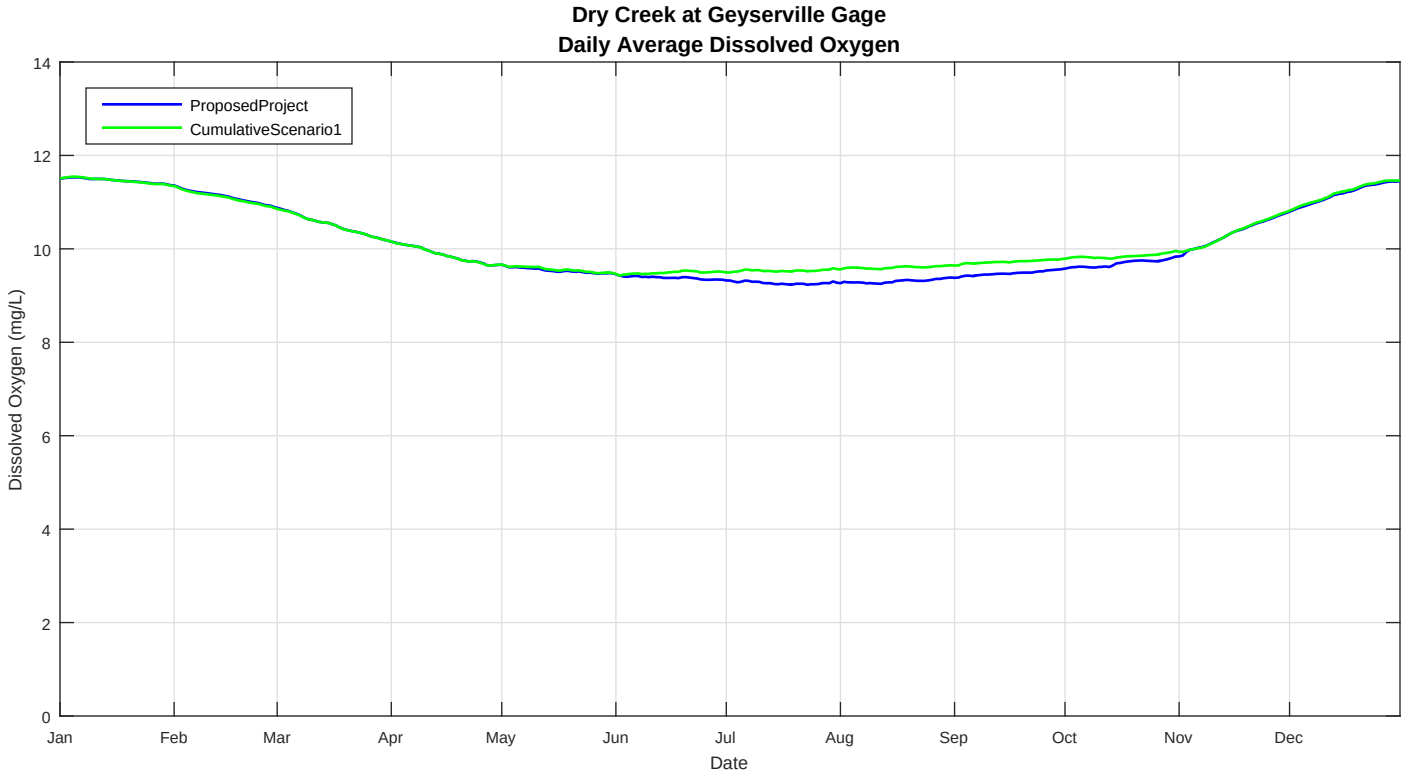

Geyserville Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

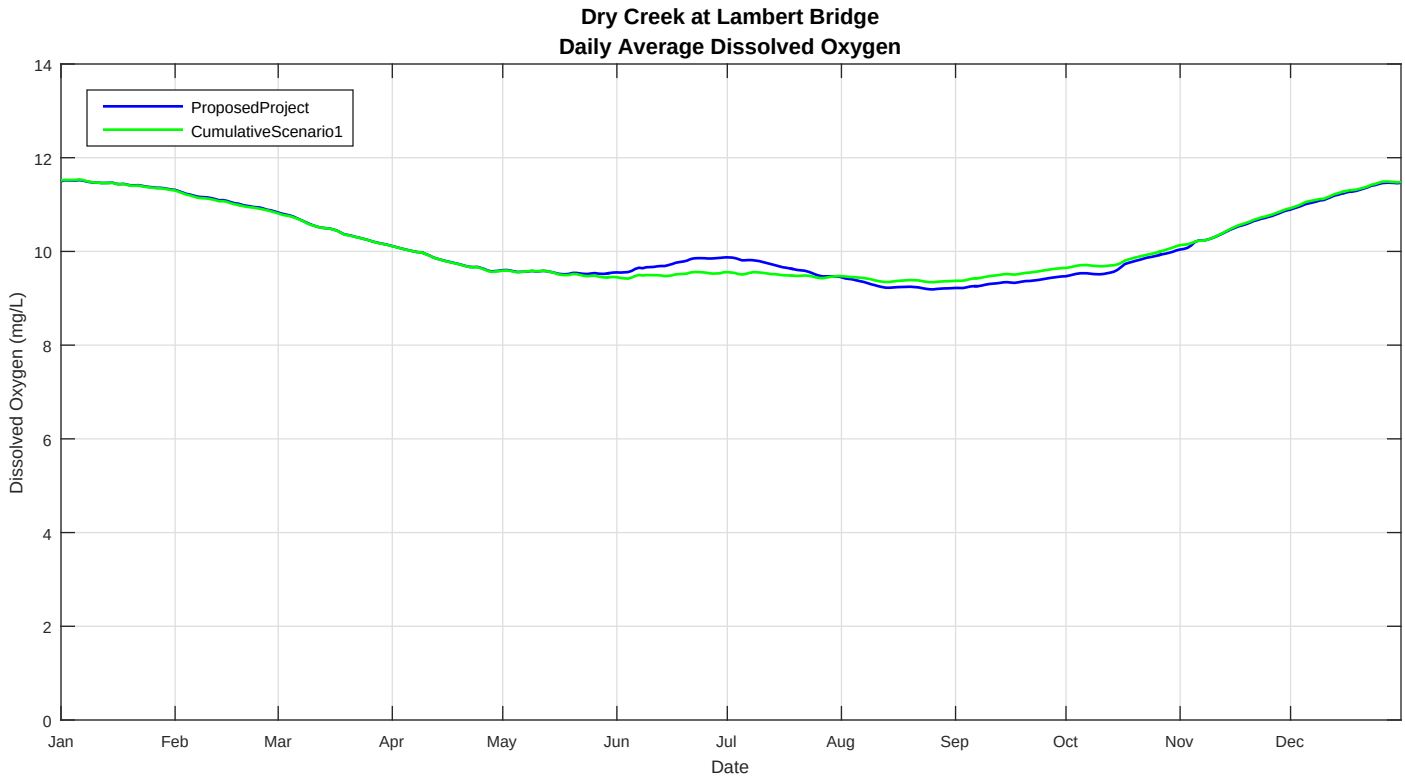

Healdsburg Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

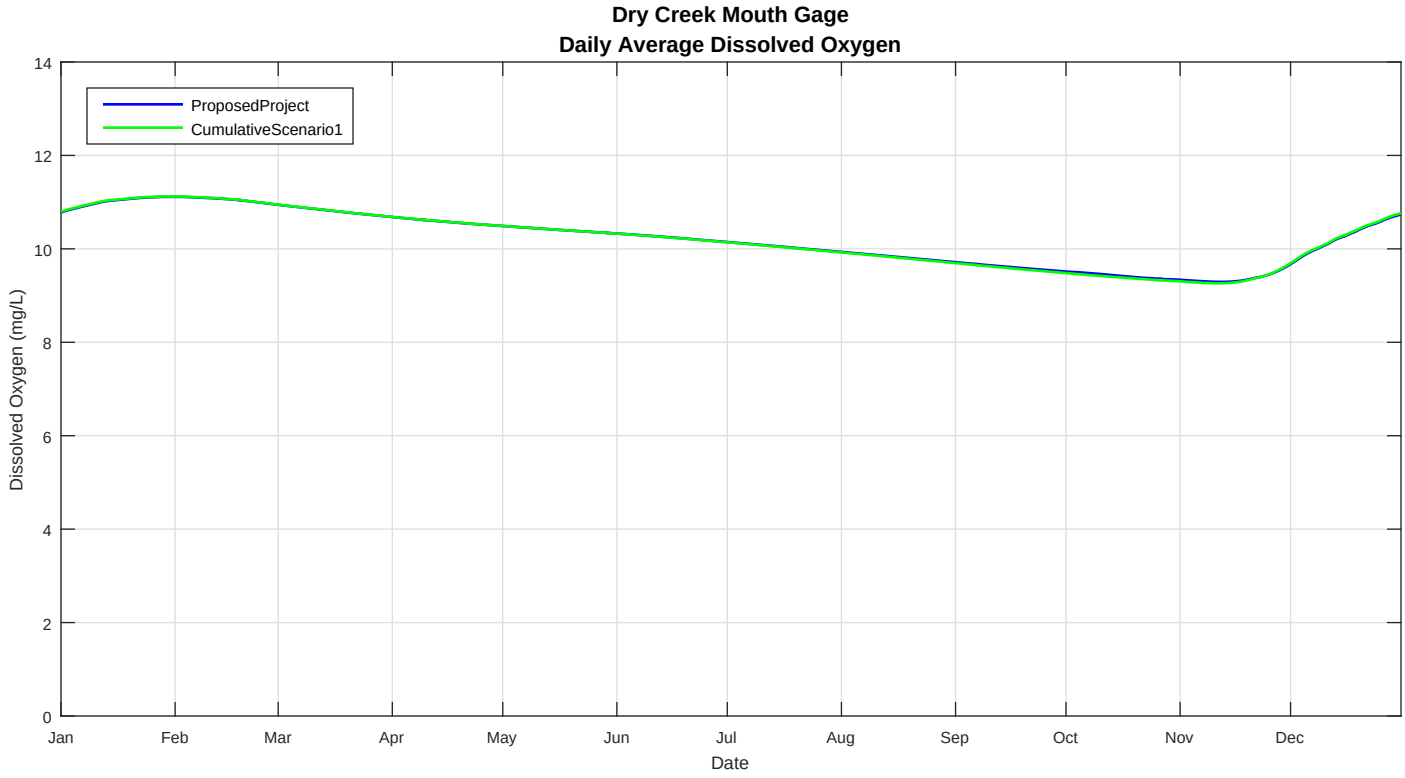

Russian River at Dry Creek
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

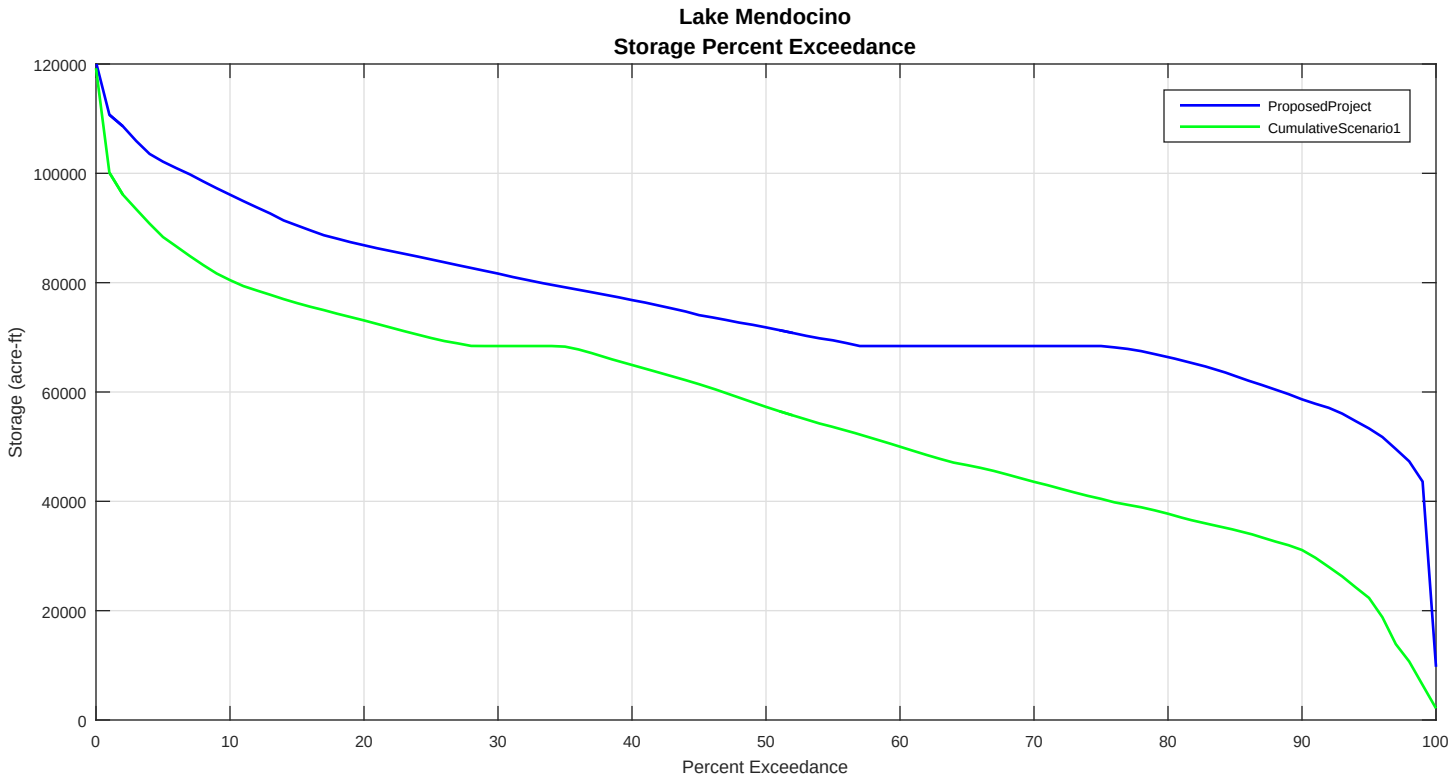

Hacienda Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

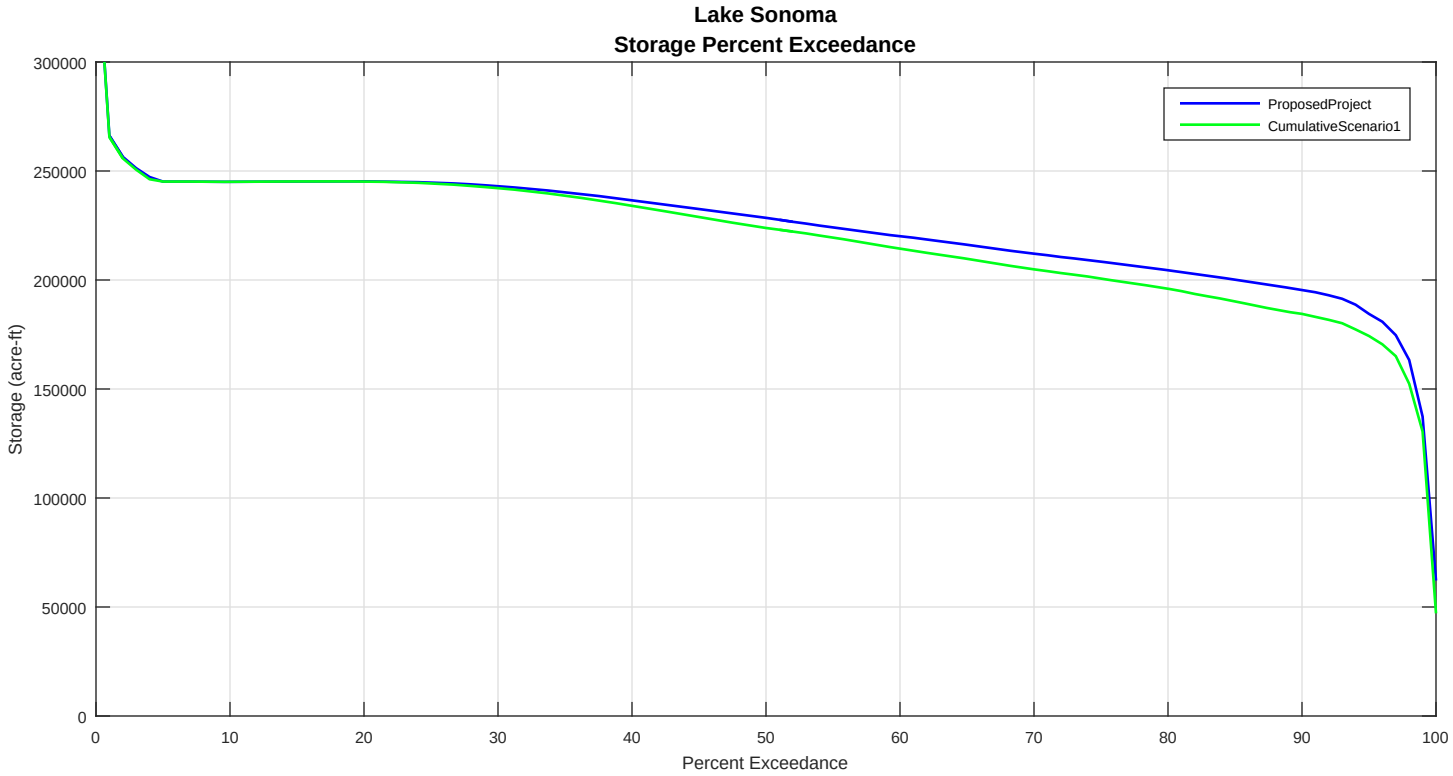

Warm Springs Dam Outlet
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

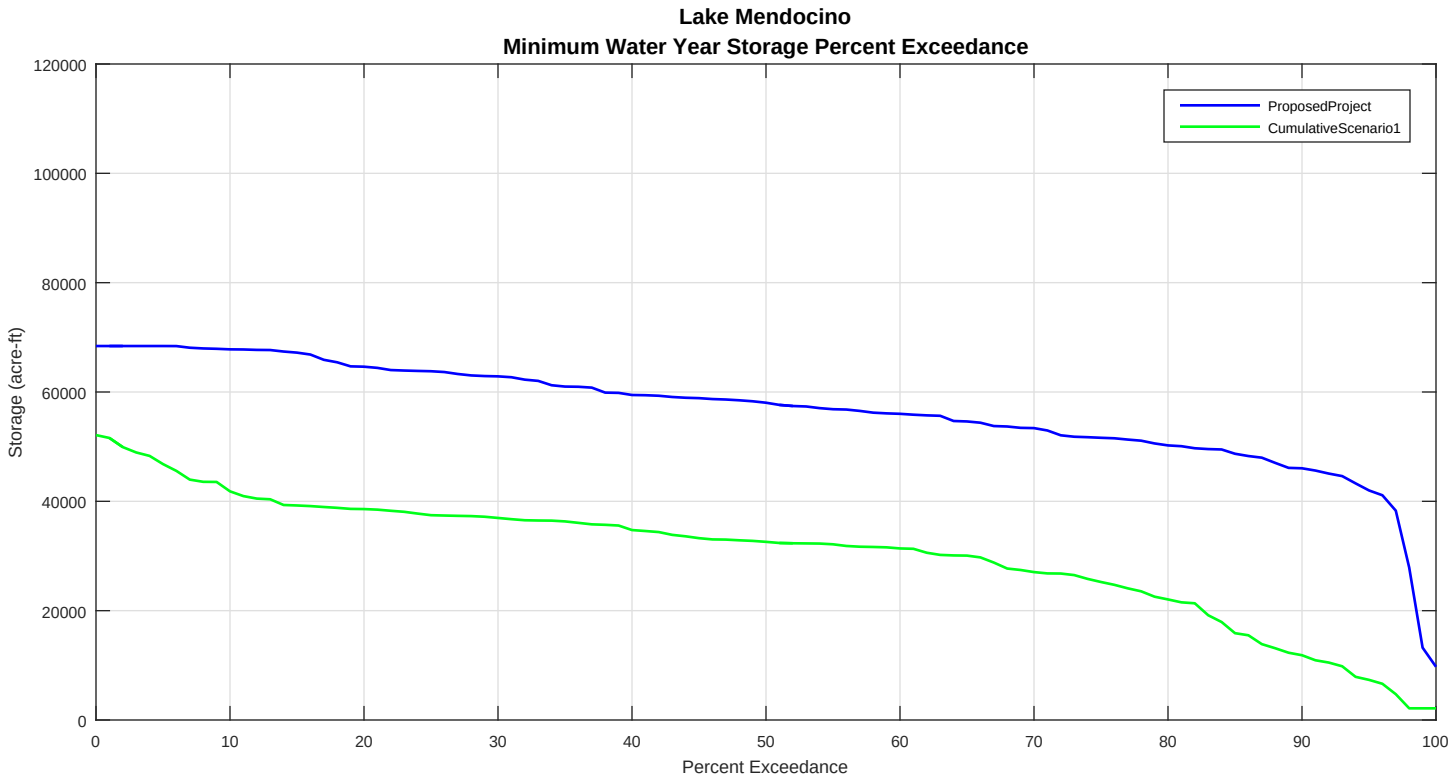

Dry Creek at Geyserville Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

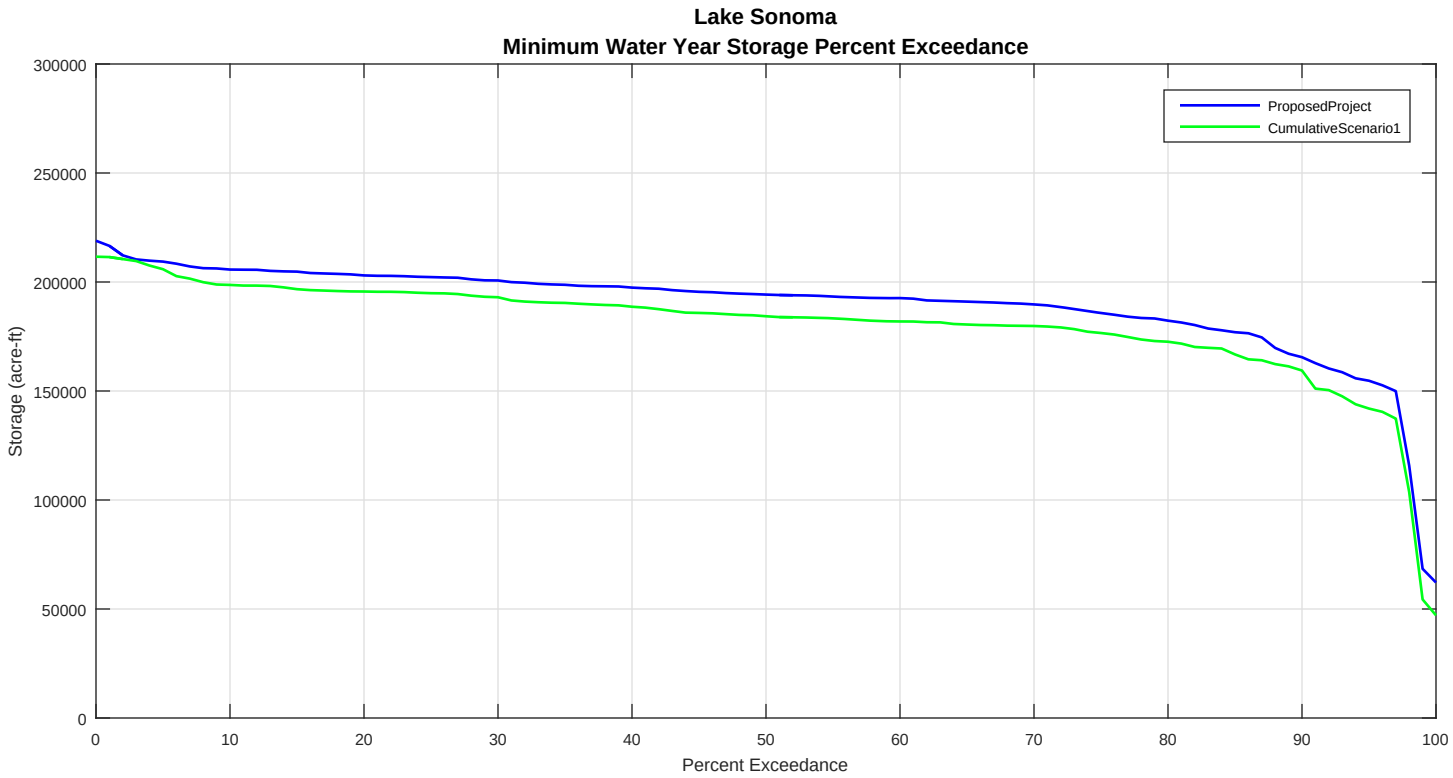

Dry Creek at Lambert Bridge
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

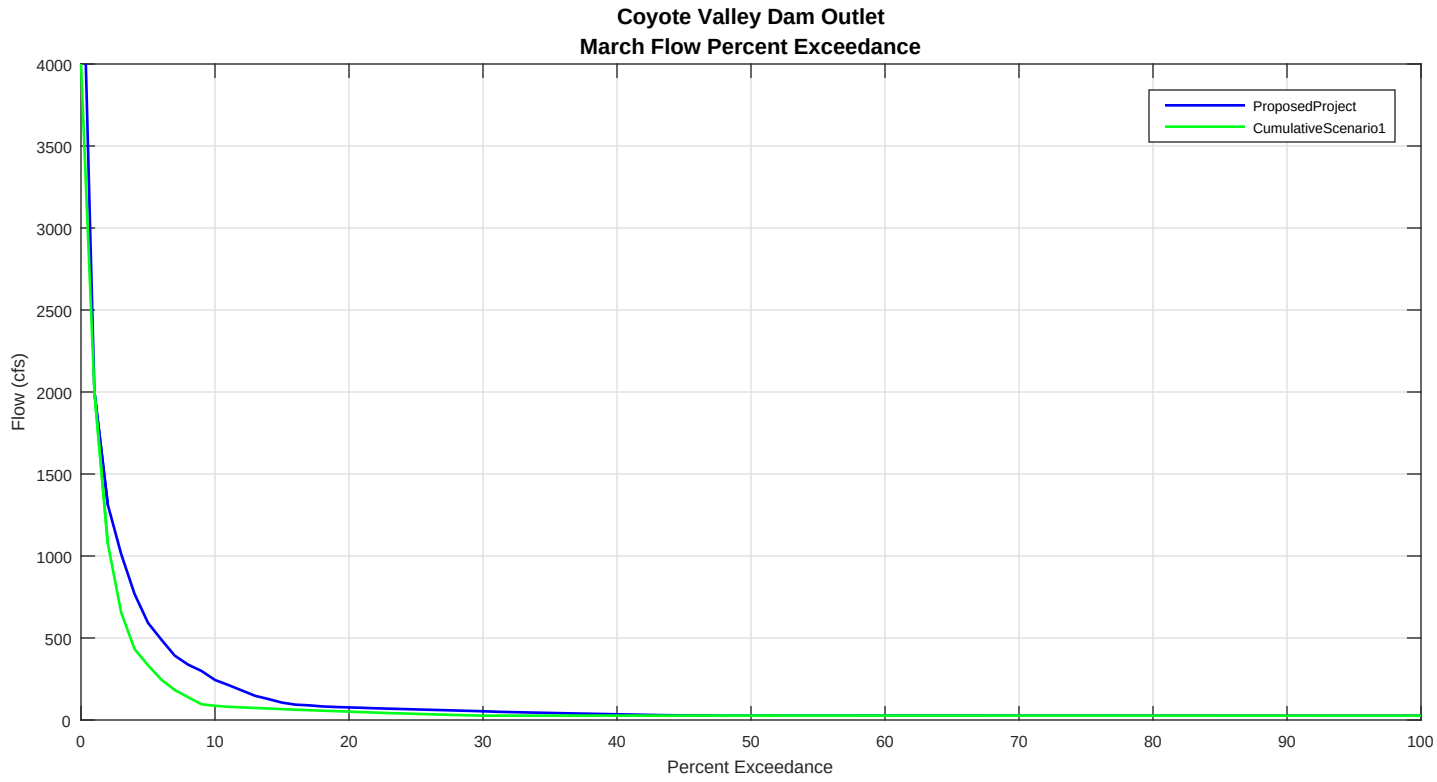

Dry Creek Mouth Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

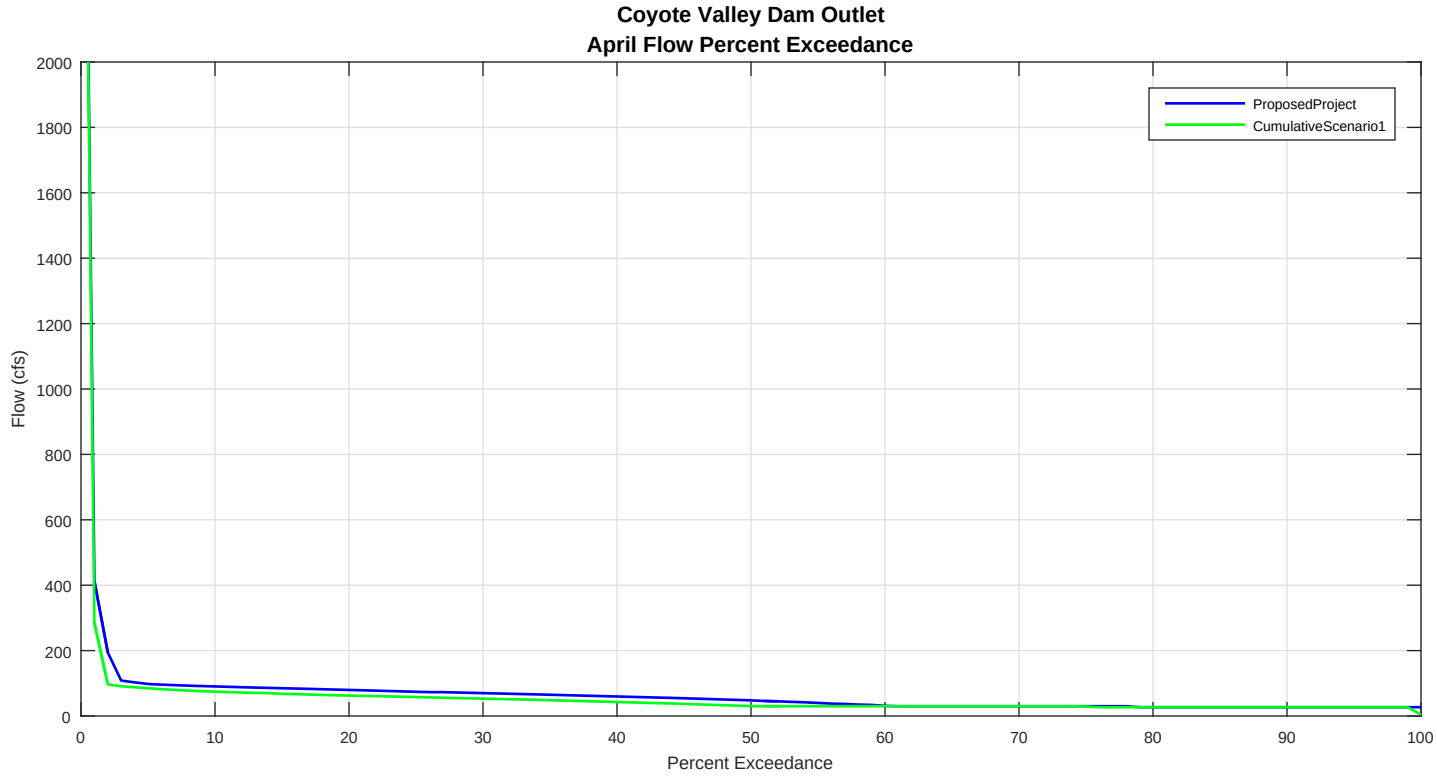

Lake Mendocino
Storage Percent Exceedance
Storage (acre-ft)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
20000
40000
60000
80000
100000
120000
0
10
20
30
40
50
60
70
80
90
100

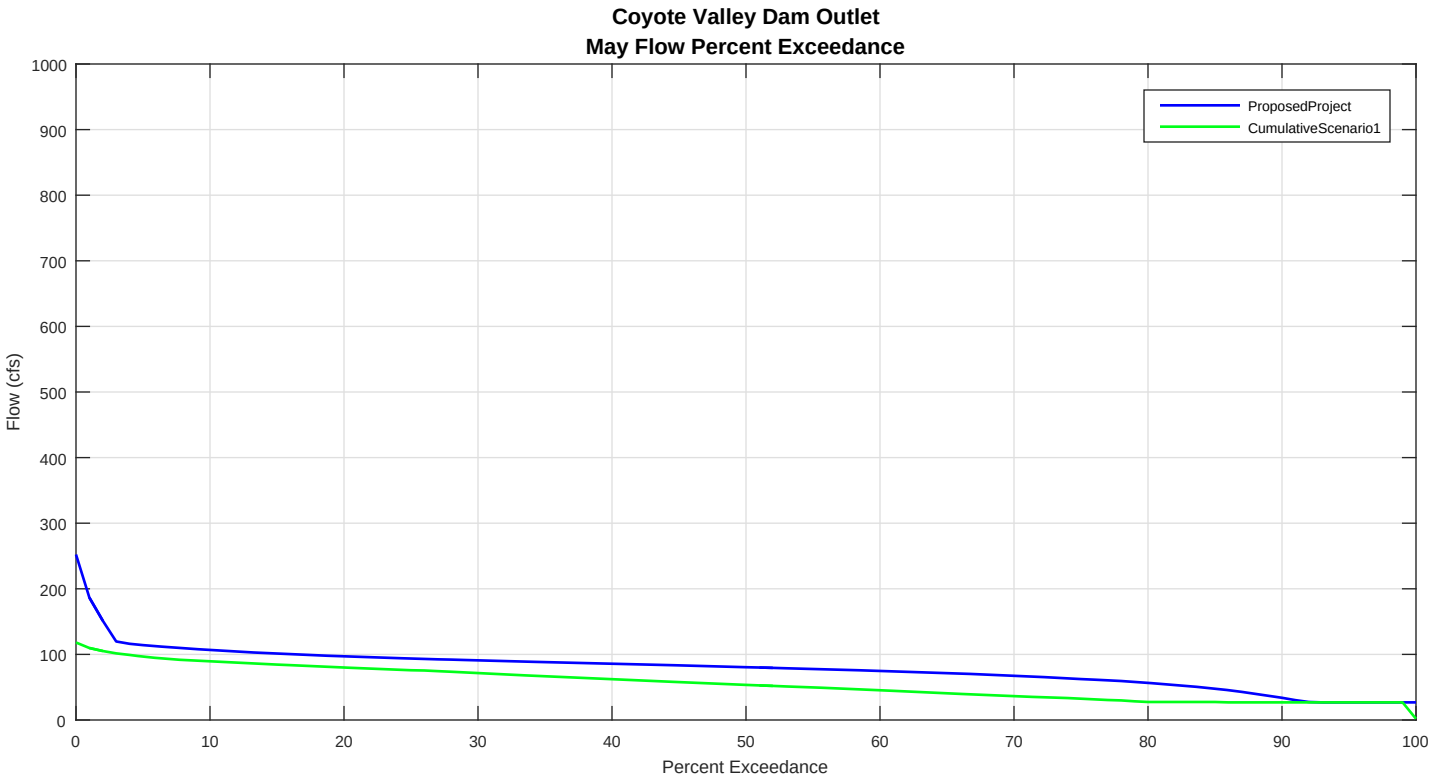

Lake Sonoma
Storage Percent Exceedance
Storage (acre-ft)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
50000
100000
150000
200000
250000
300000
0
10
20
30
40
50
60
70
80
90
100

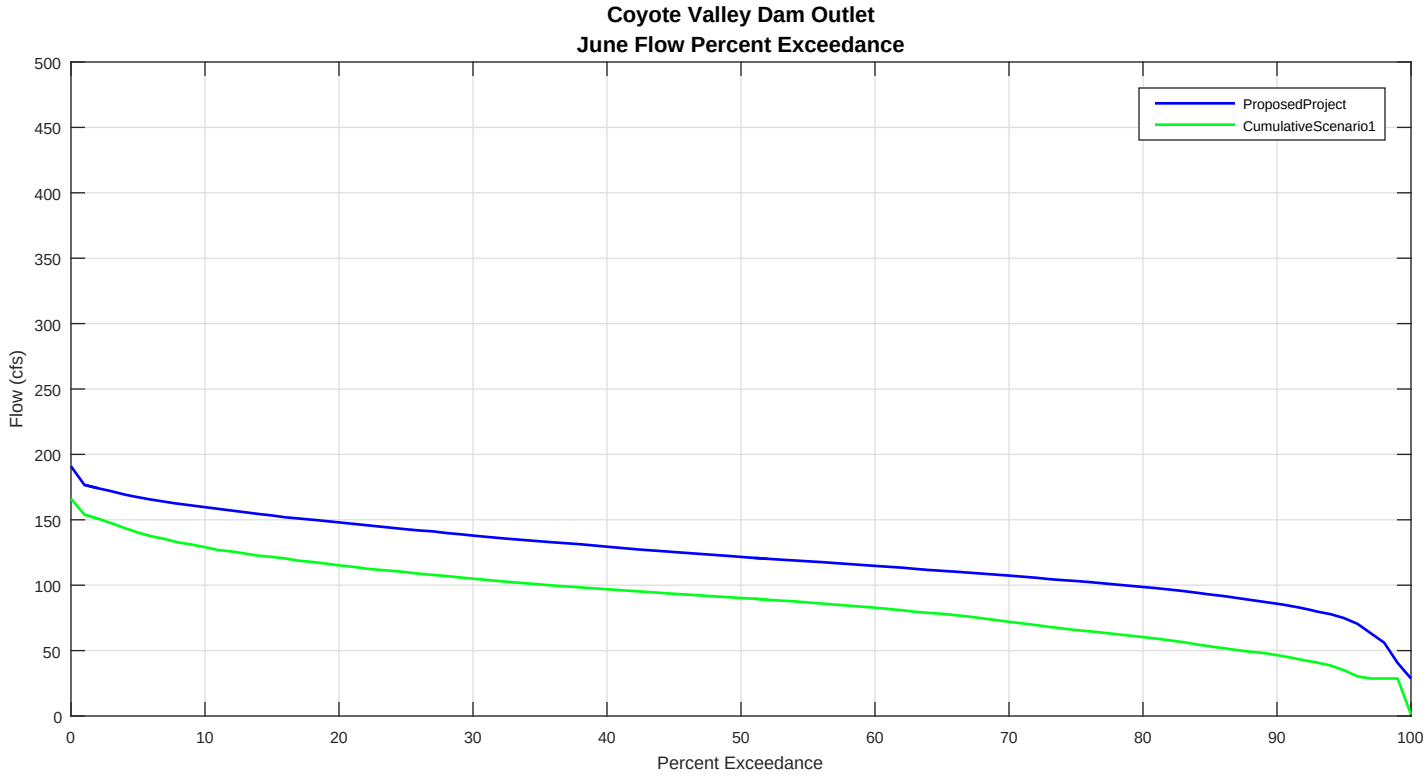

Lake Mendocino
Minimum Water Year Storage Percent Exceedance
ProposedProject
CumulativeScenario1
Storage (acre-ft)
Percent Exceedance
0
20000
40000
60000
80000
100000
120000
0
10
20
30
40
50
60
70
80
90
100

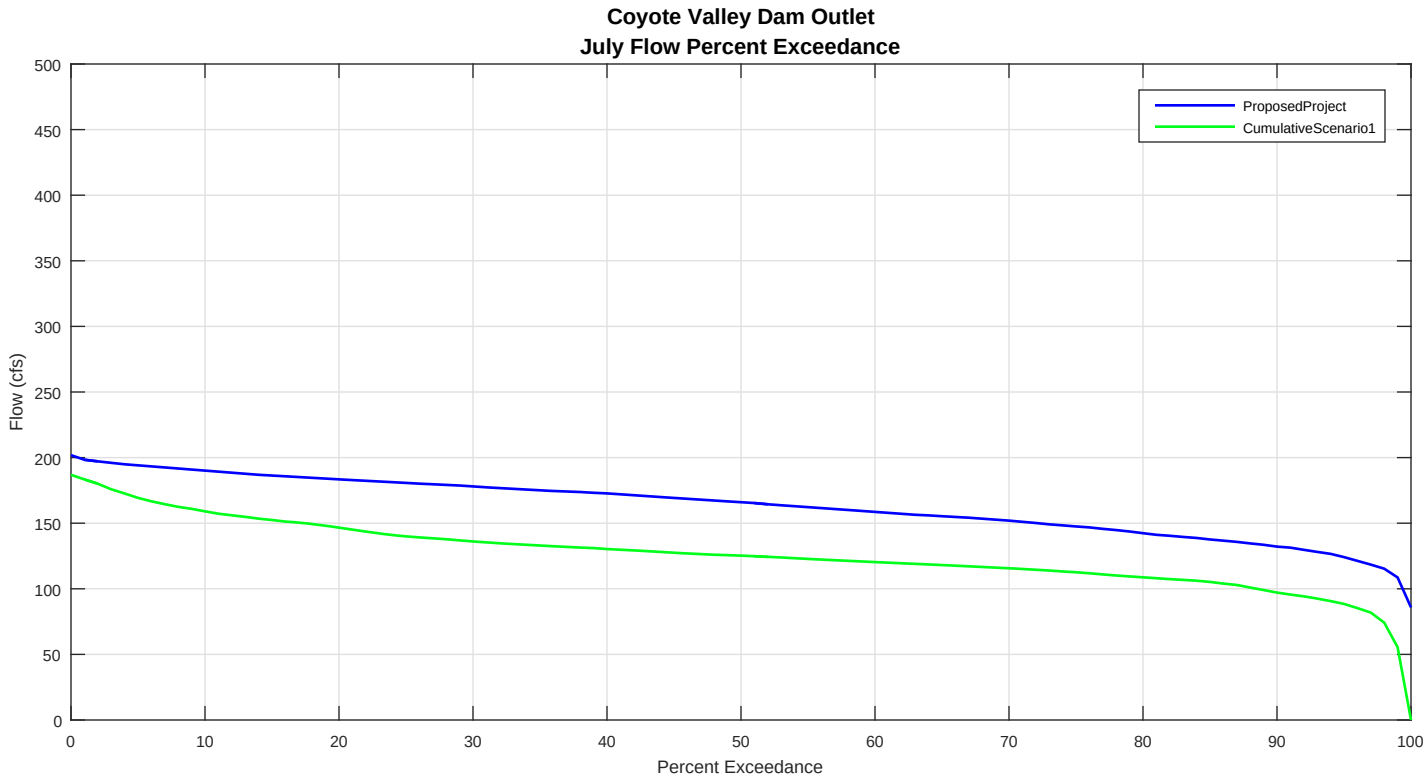

Lake Sonoma
Minimum Water Year Storage Percent Exceedance
ProposedProject
CumulativeScenario1
Storage (acre-ft)
Percent Exceedance
0
50000
100000
150000
200000
250000
300000
0
10
20
30
40
50
60
70
80
90
100

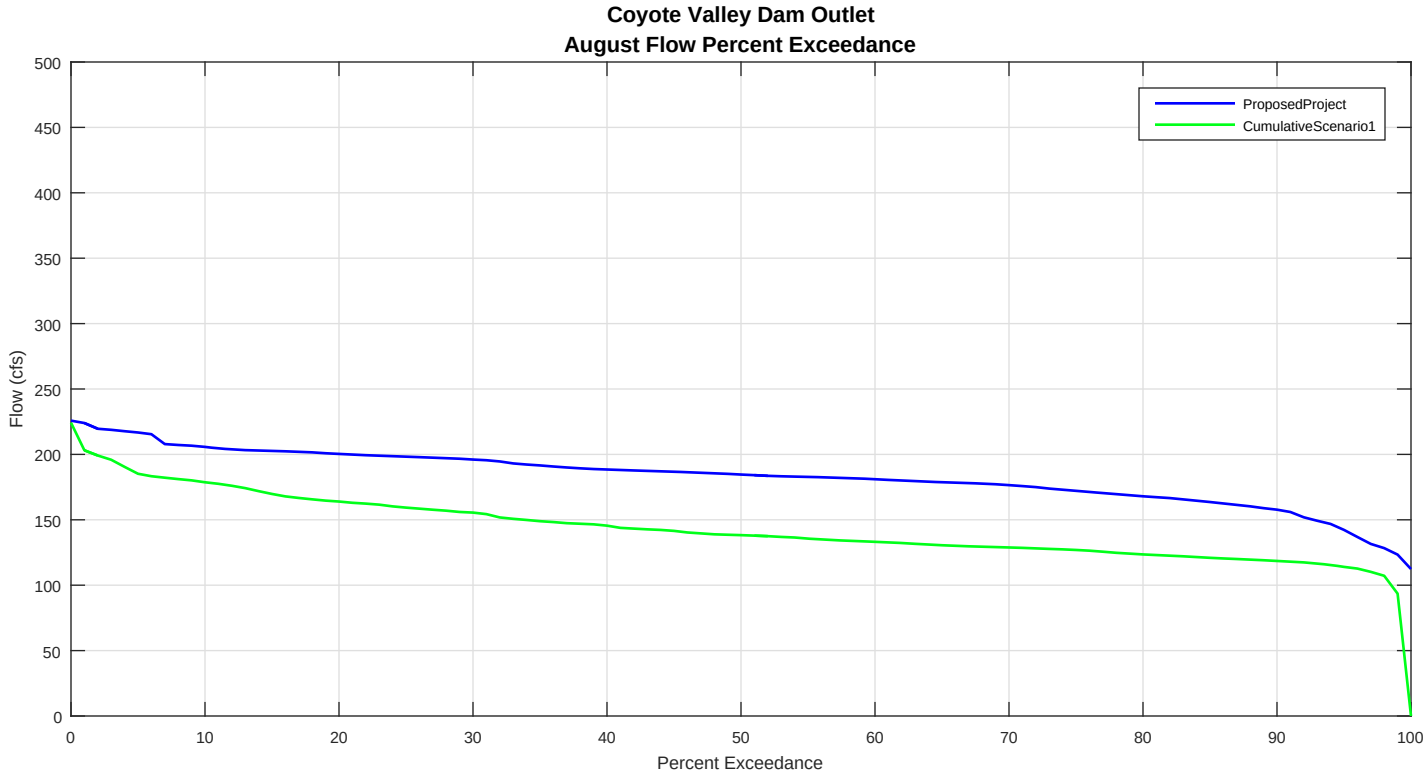

Coyote Valley Dam Outlet
March Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
500
1000
1500
2000
2500
3000
3500
4000
0
10
20
30
40
50
60
70
80
90
100

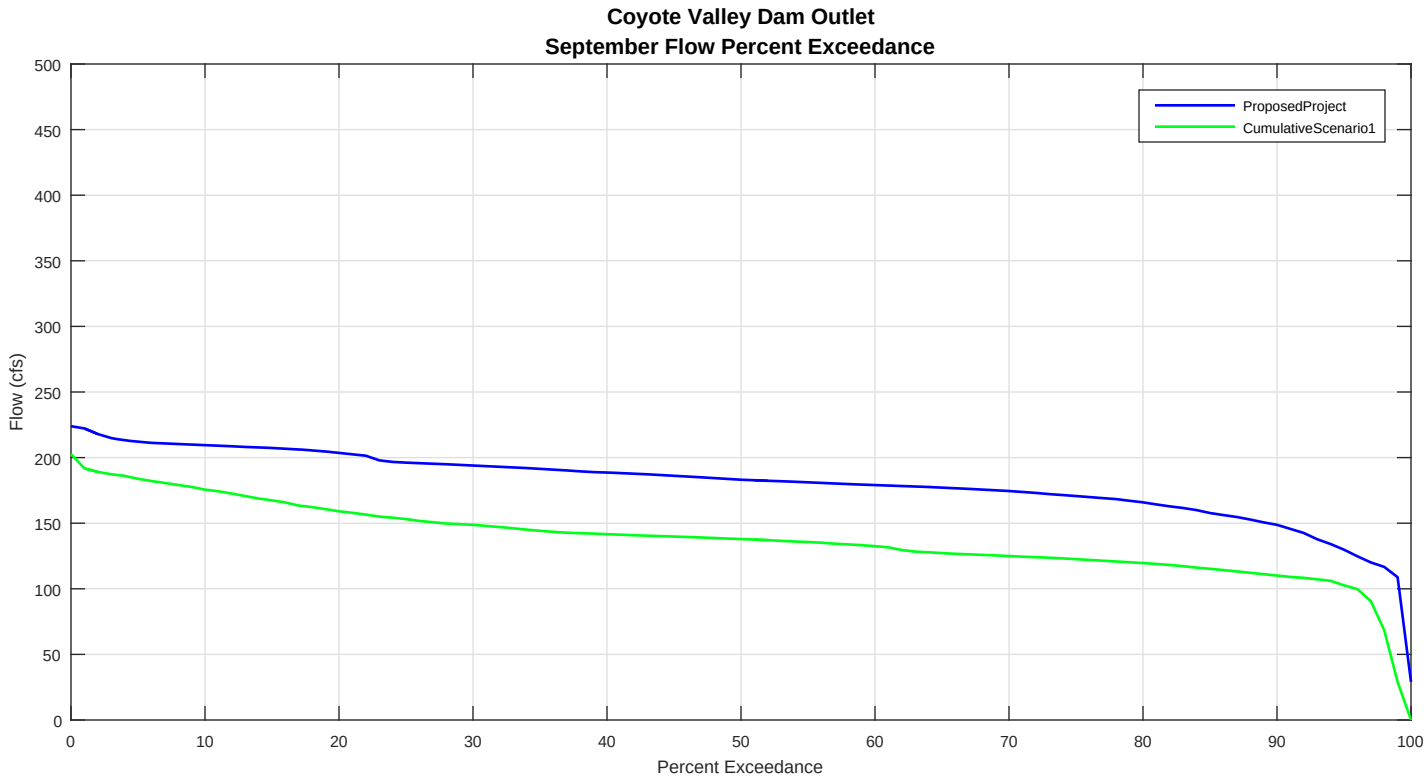

Coyote Valley Dam Outlet
April Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100

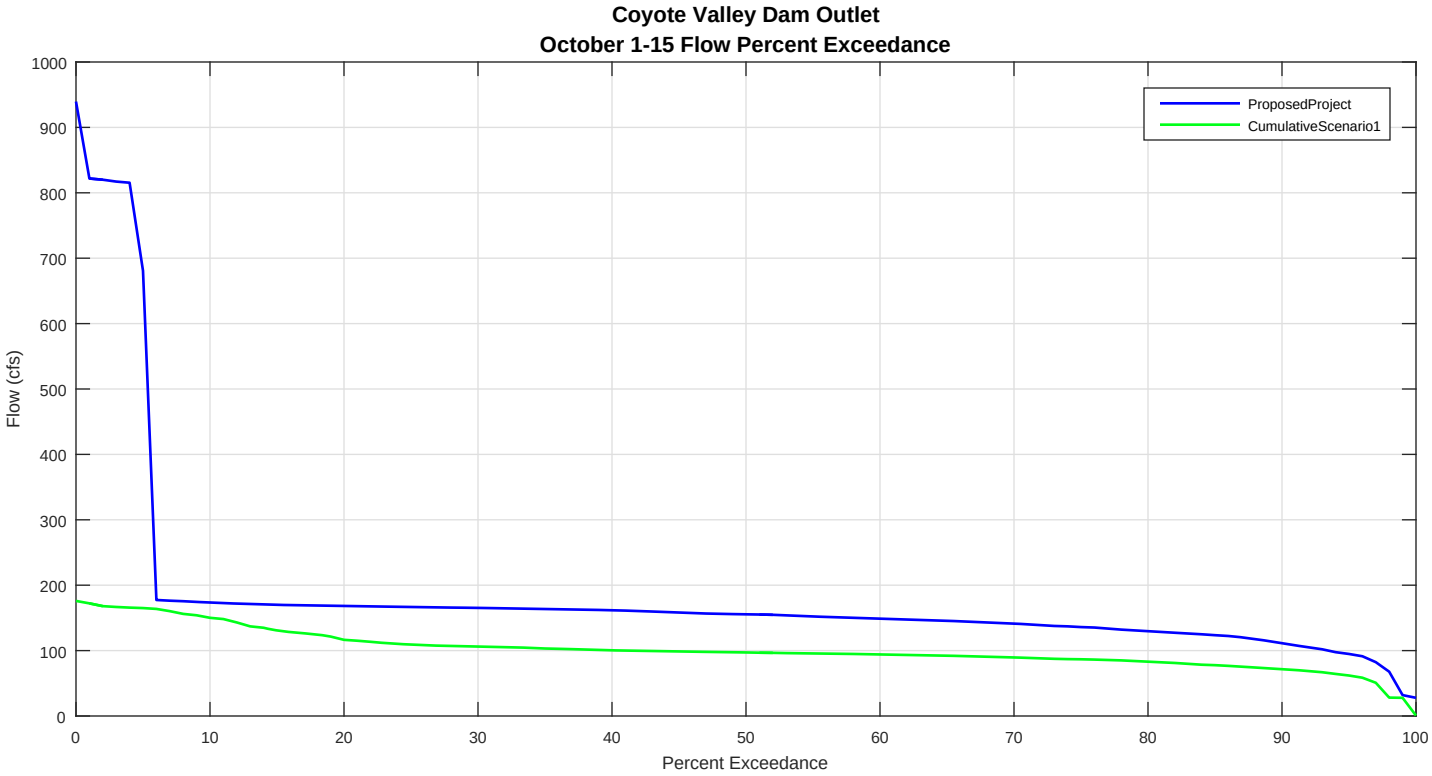

Coyote Valley Dam Outlet
May Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100

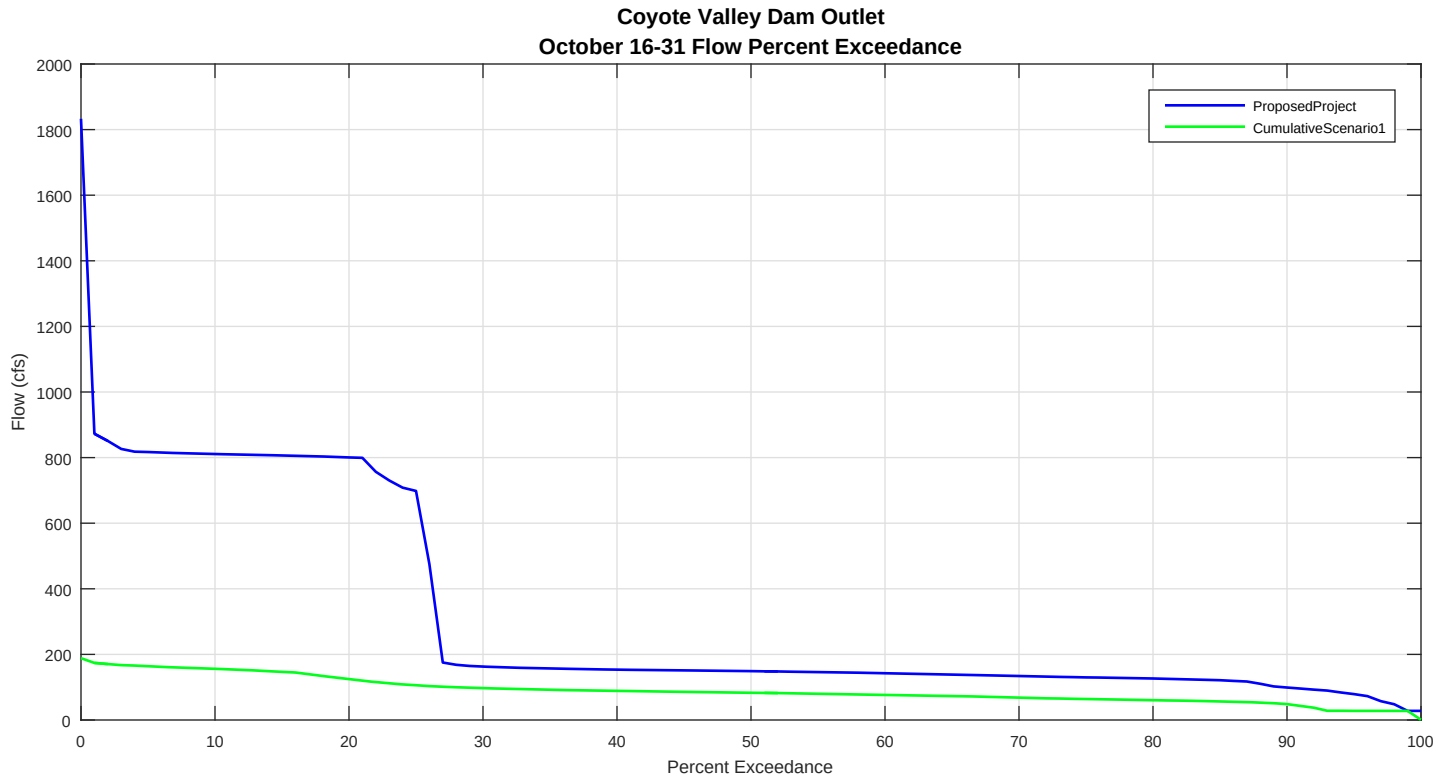

Coyote Valley Dam Outlet
June Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

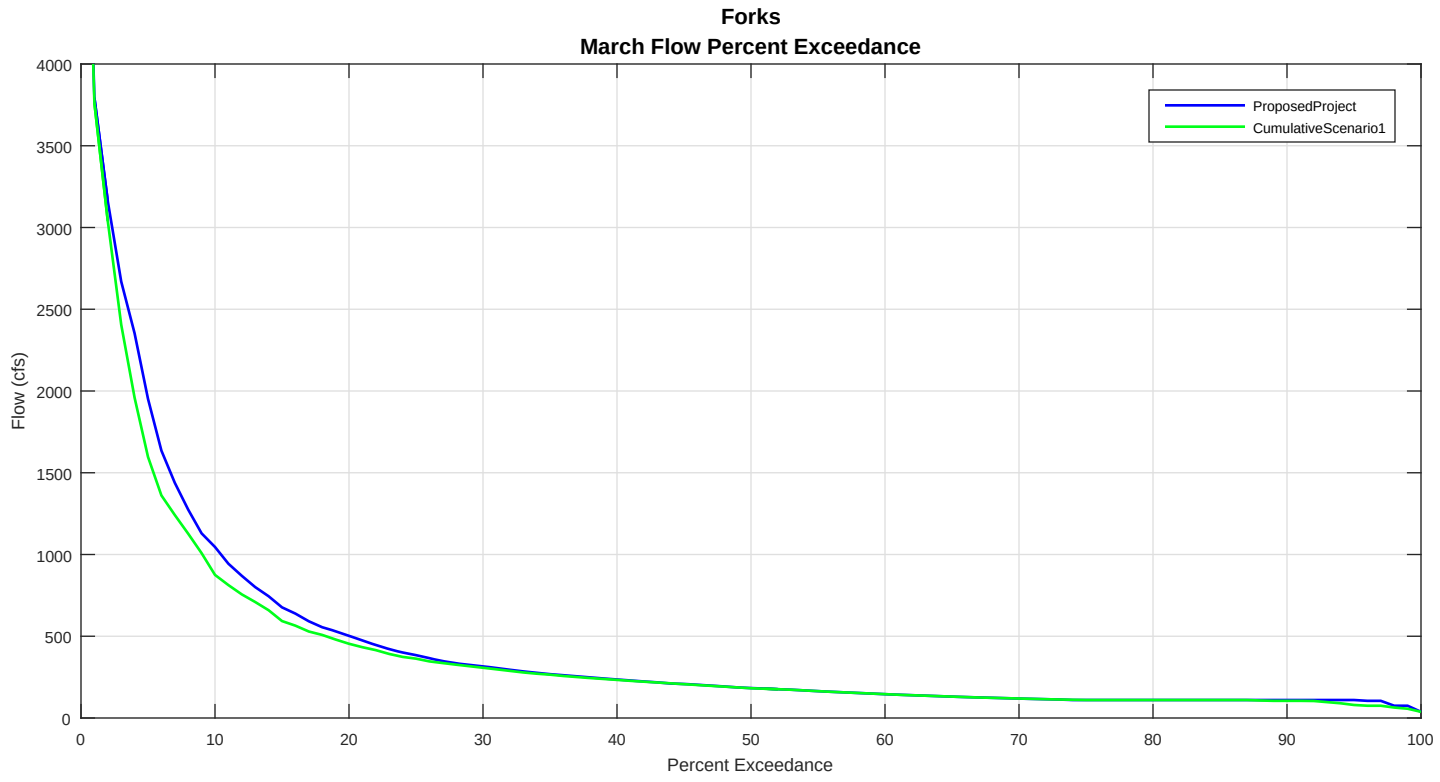

Coyote Valley Dam Outlet
July Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

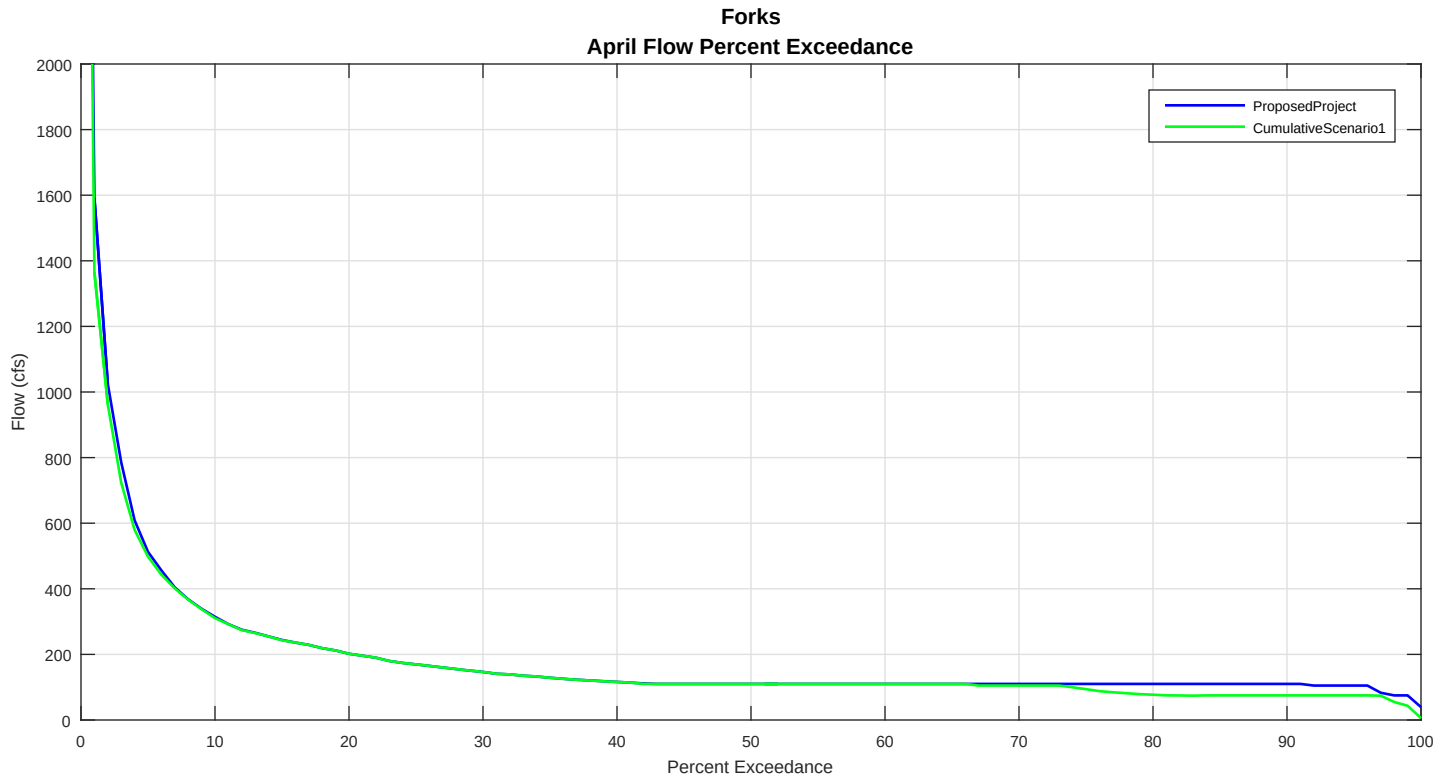

Coyote Valley Dam Outlet
August Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

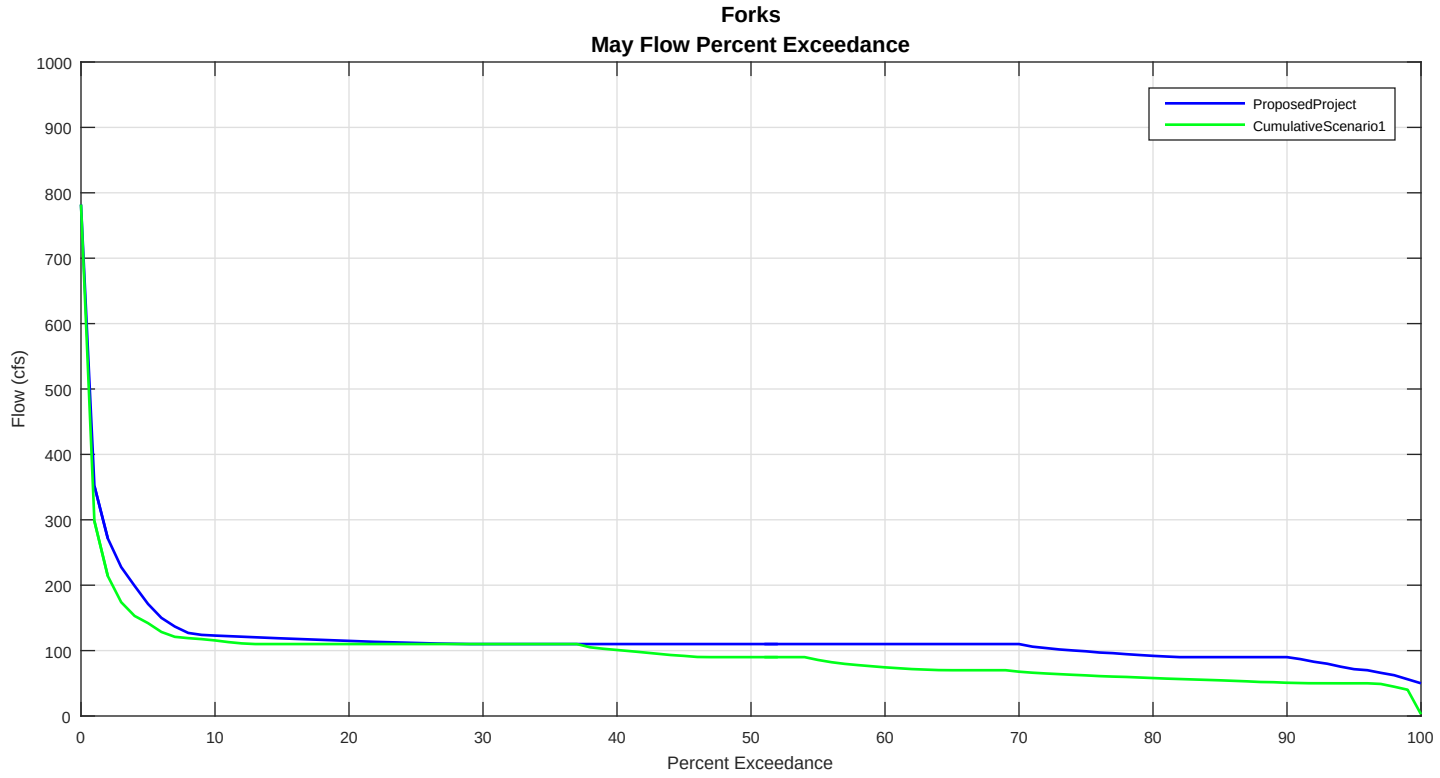

Coyote Valley Dam Outlet
September Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
October 1-15 Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100


Forks
March Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
500
1000
1500
2000
2500
3000
3500
4000
0
10
20
30
40
50
60
70
80
90
100


Forks
April Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100


Forks
May Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
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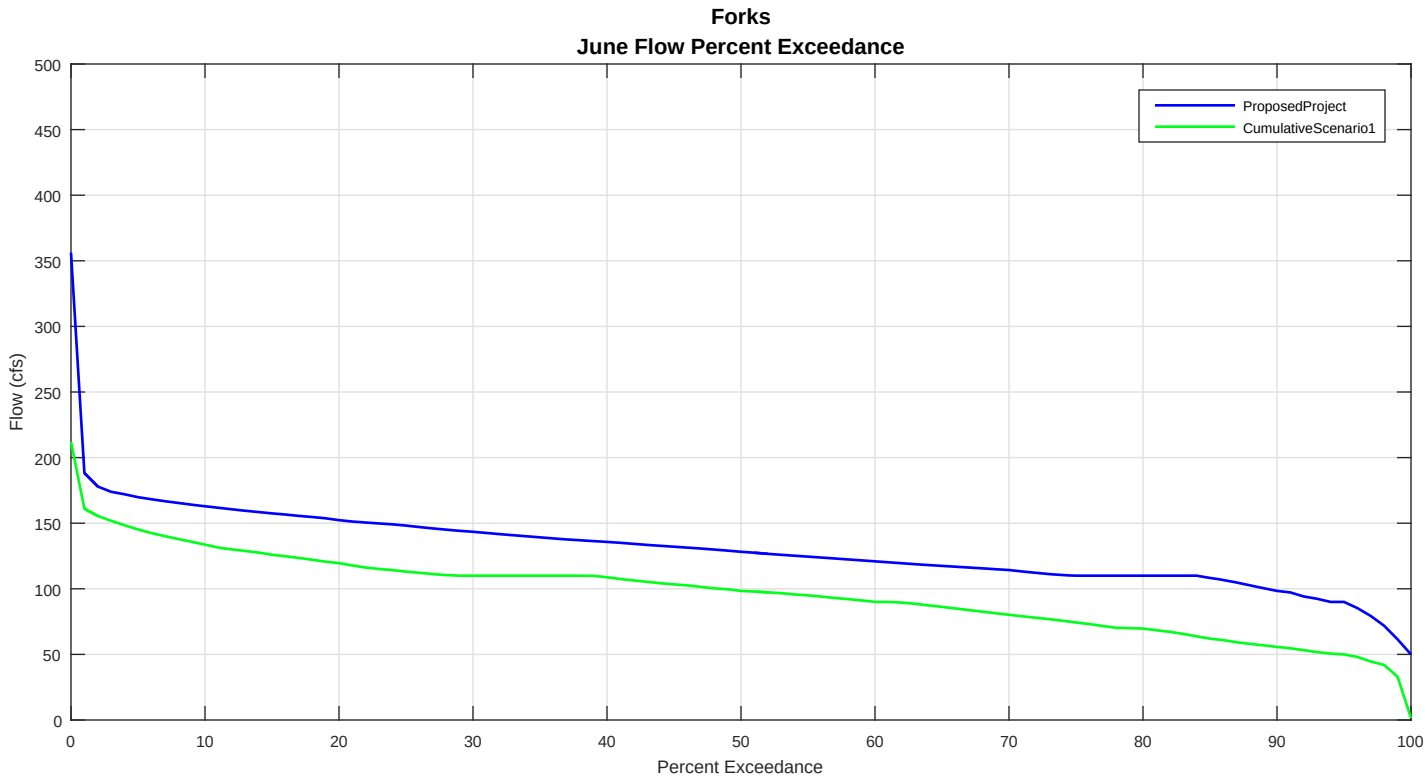
70
80
90
100


Forks
June Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
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70
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90
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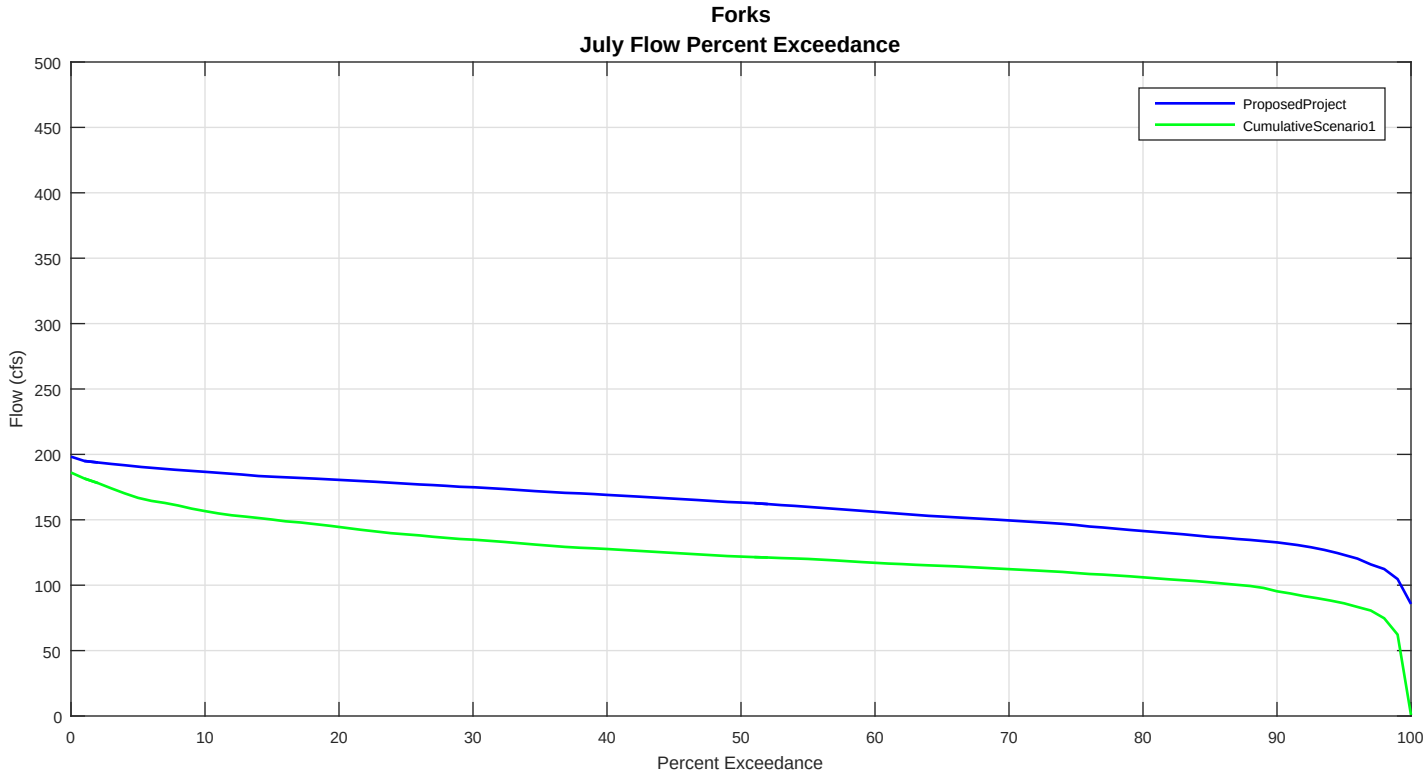
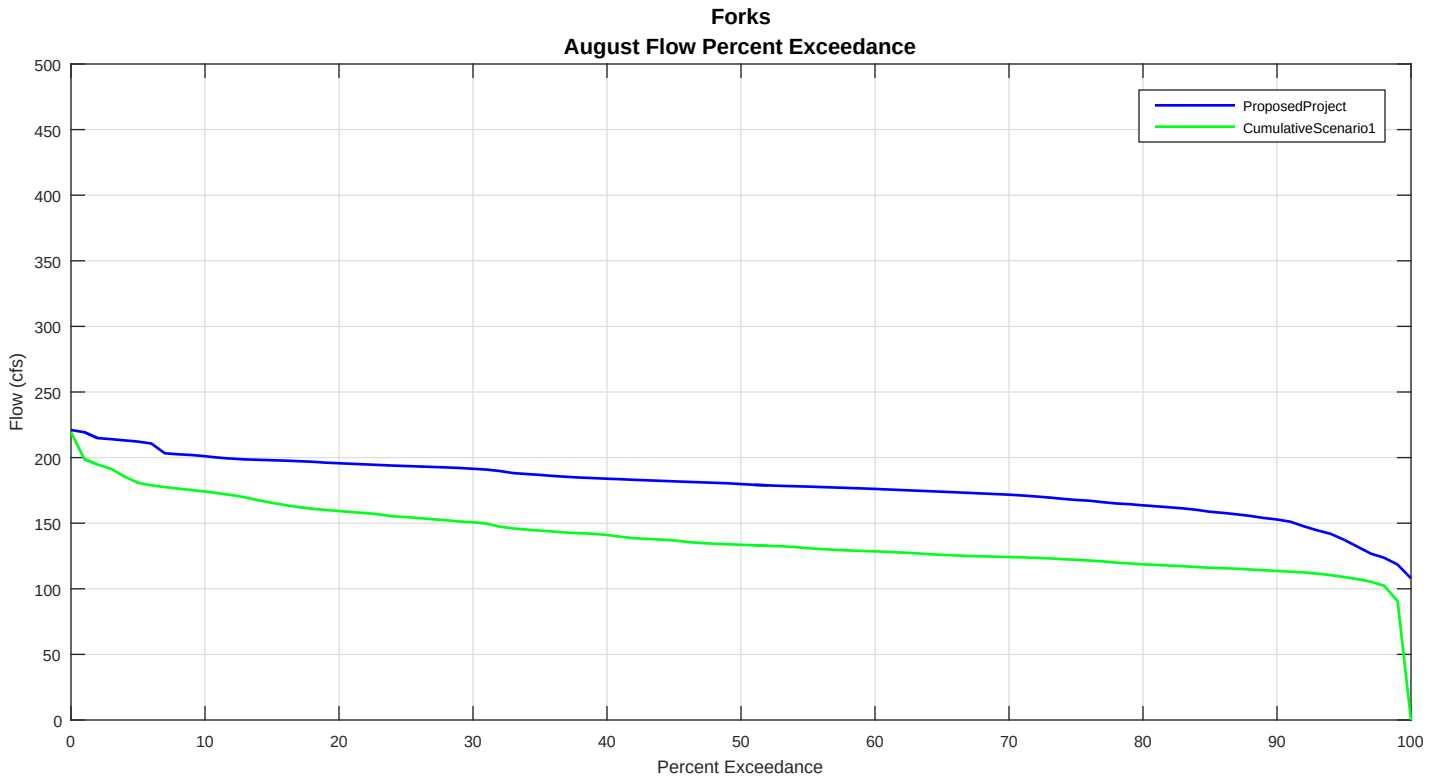
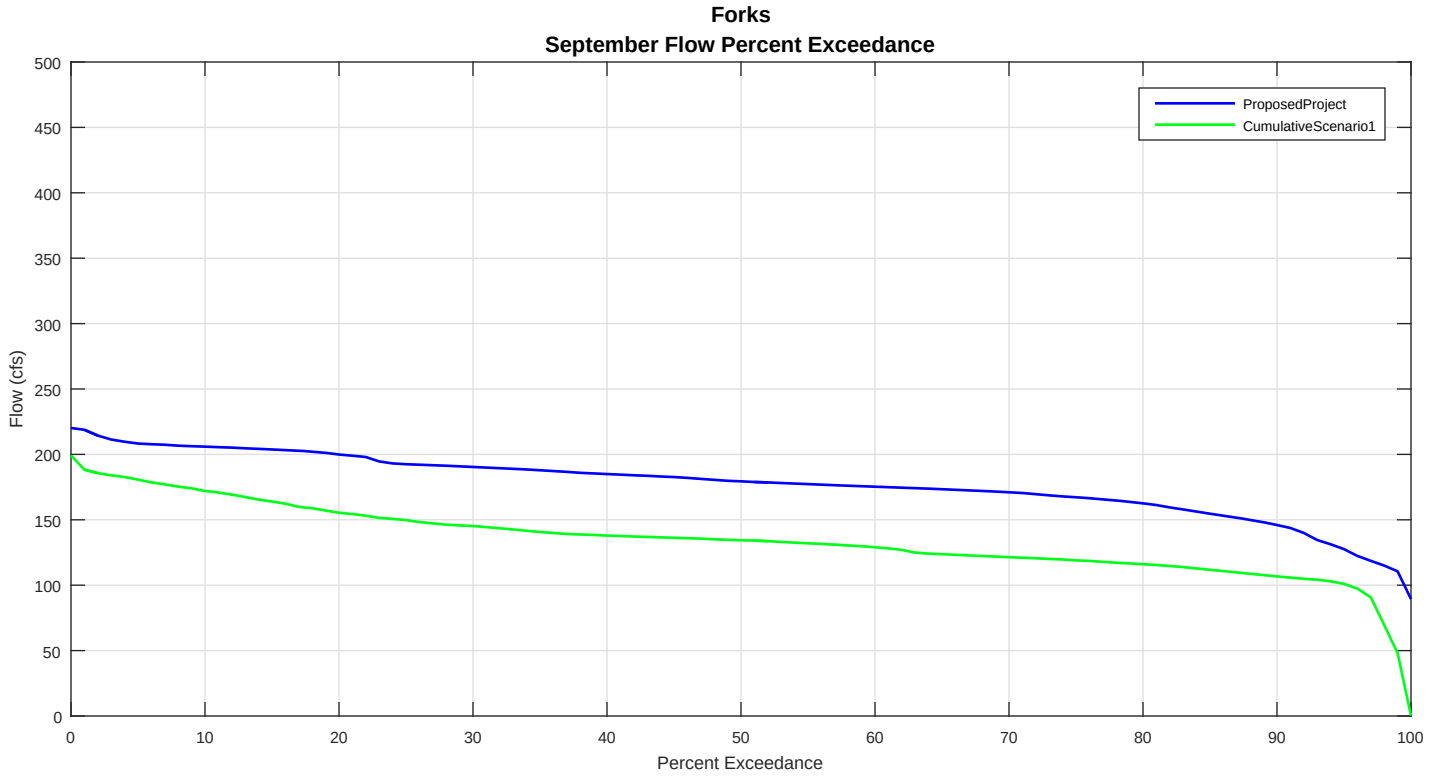
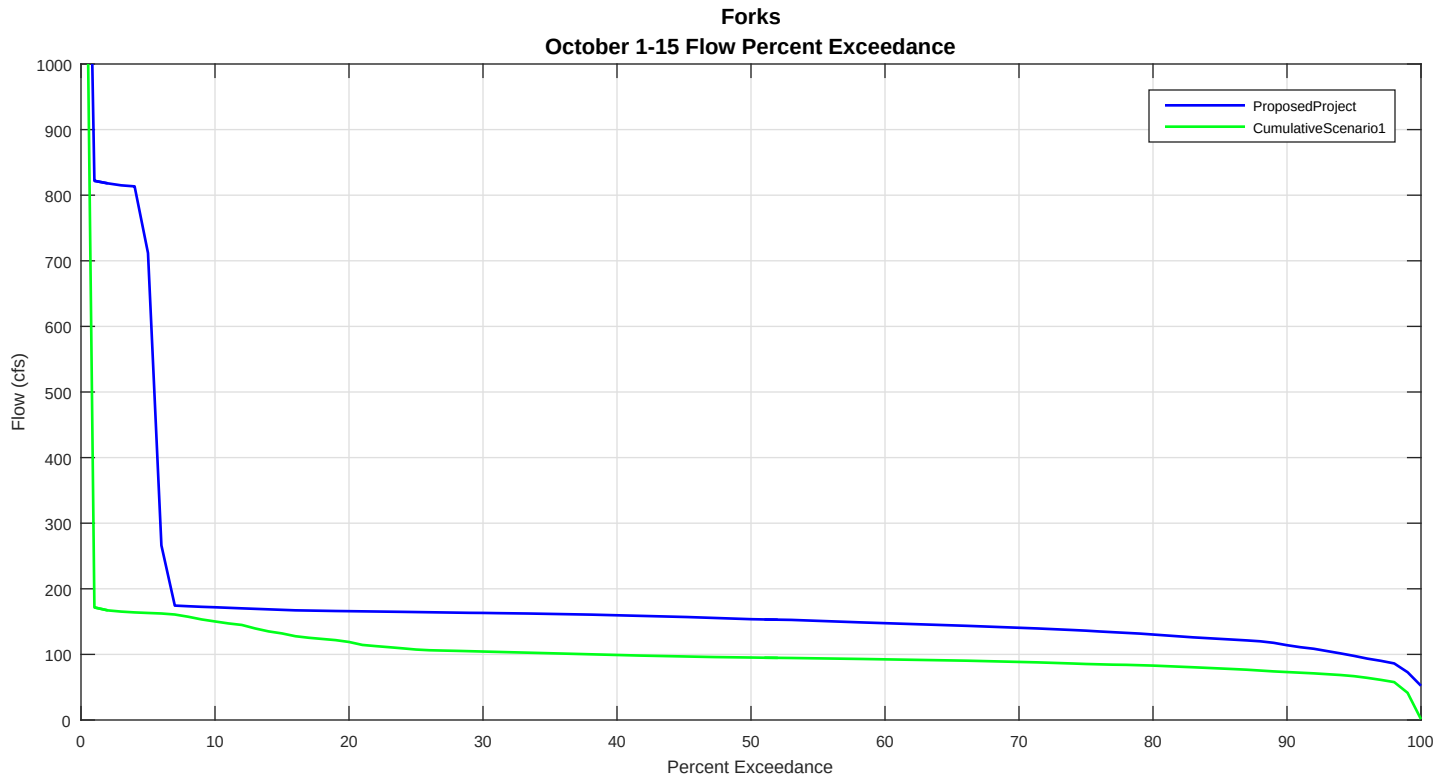
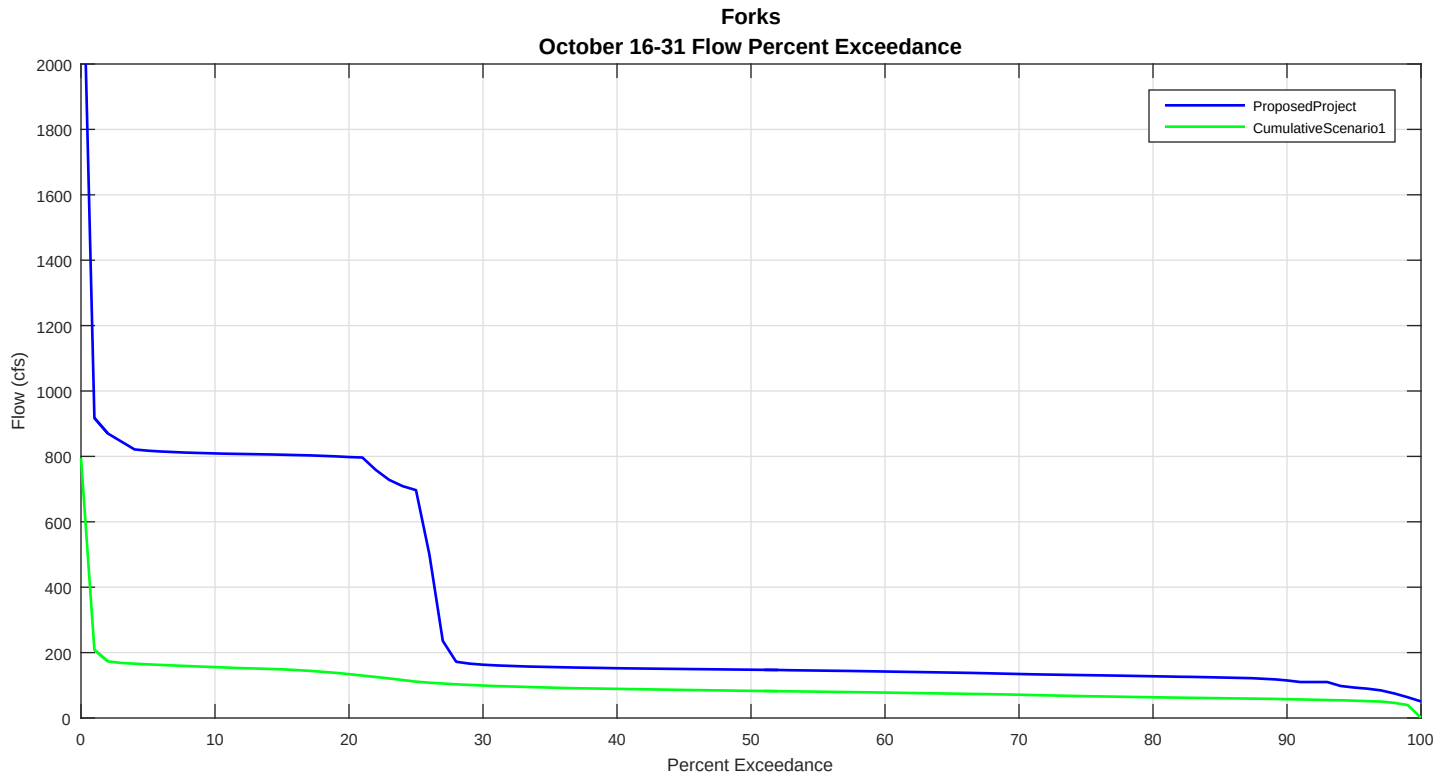
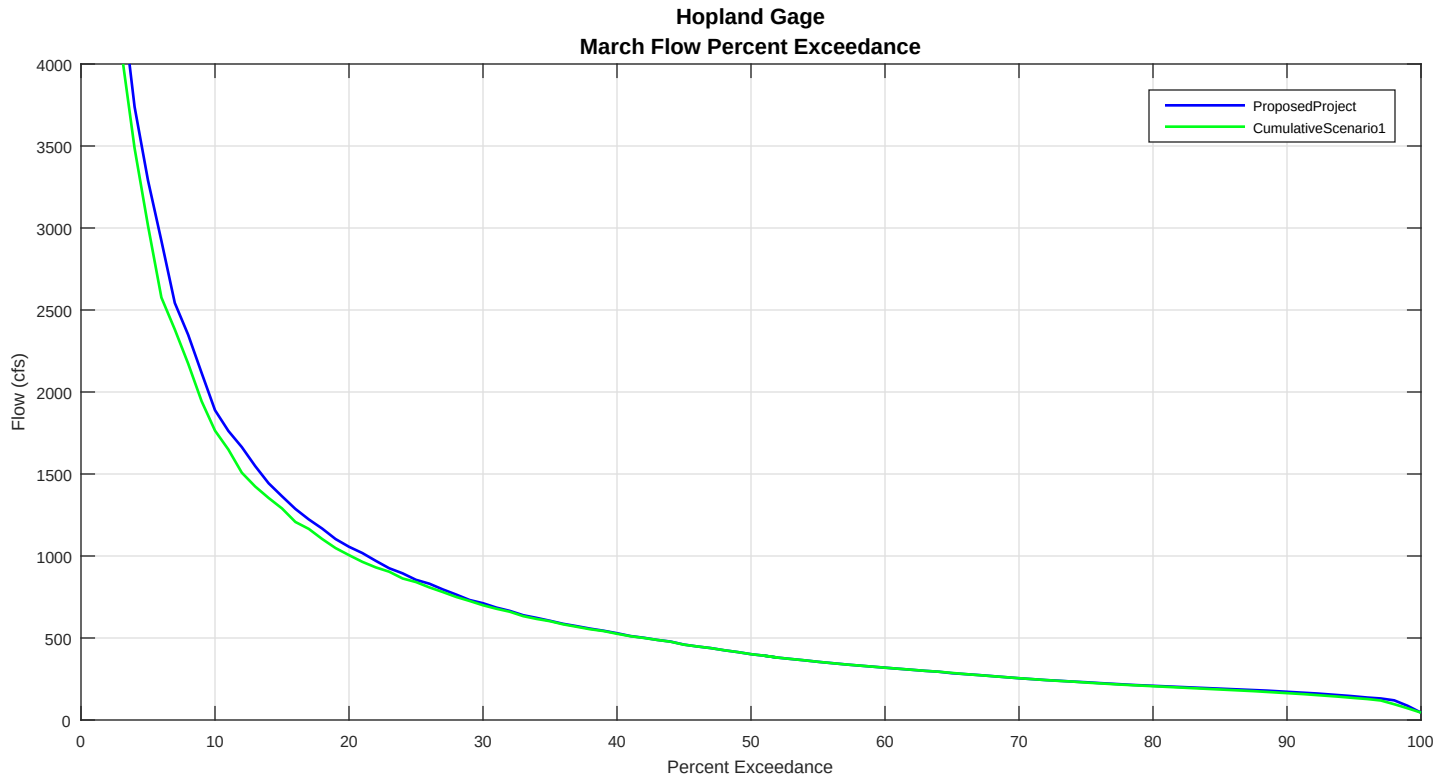

Forks
July Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

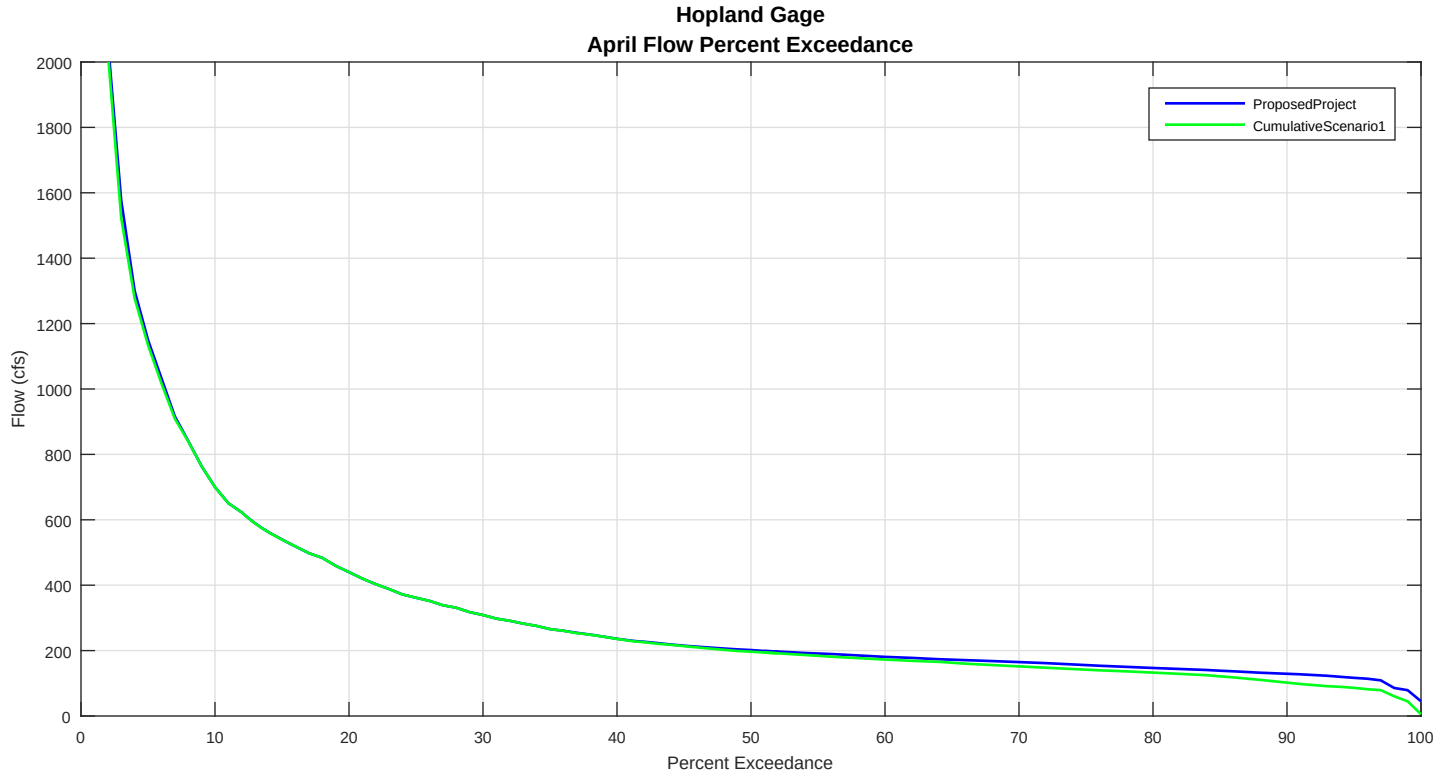

Forks
August Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

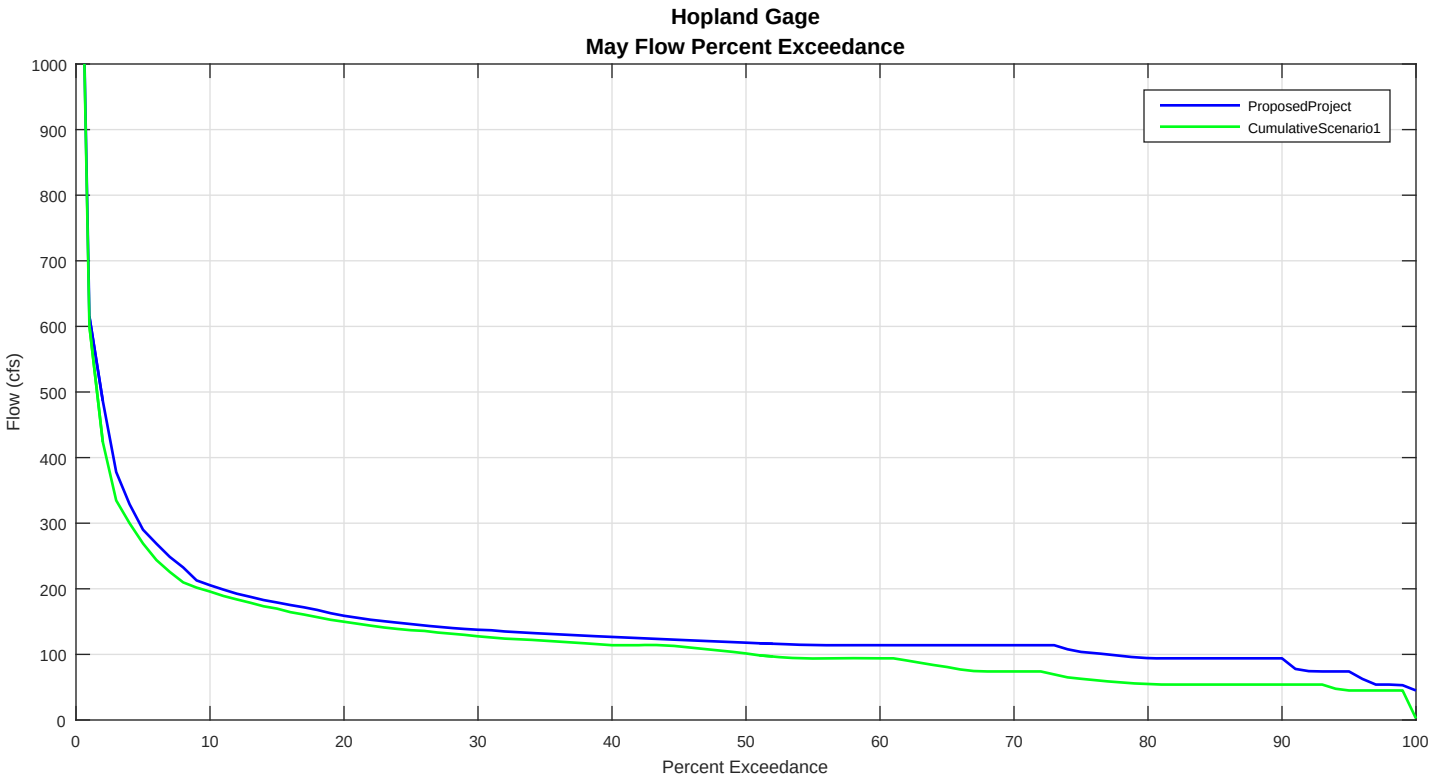

Forks
September Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100


Forks
October 1-15 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100


Forks
October 16-31 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100


Hopland Gage
March Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
500
1000
1500
2000
2500
3000
3500
4000
0
10
20
30
40
50
60
70
80
90
100


Hopland Gage
April Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100


Hopland Gage
May Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
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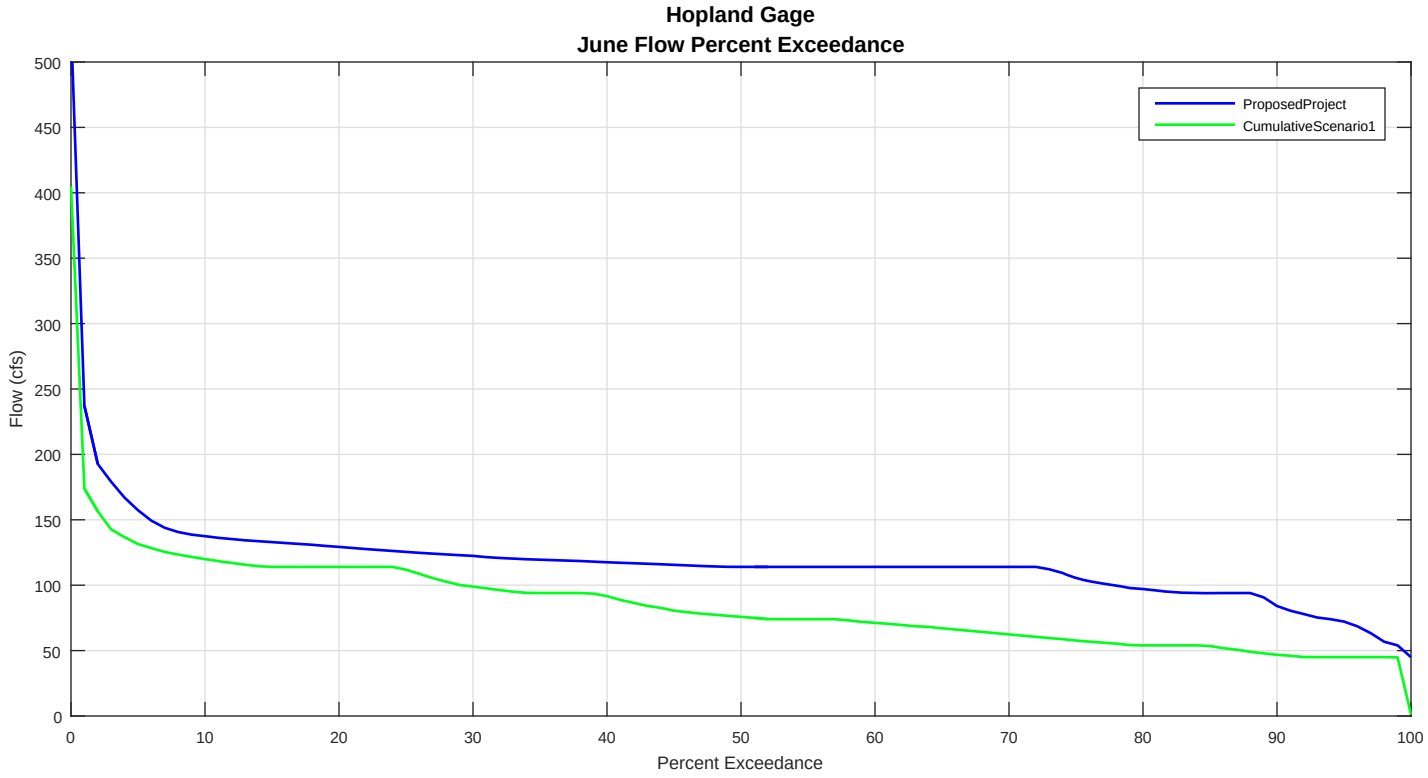
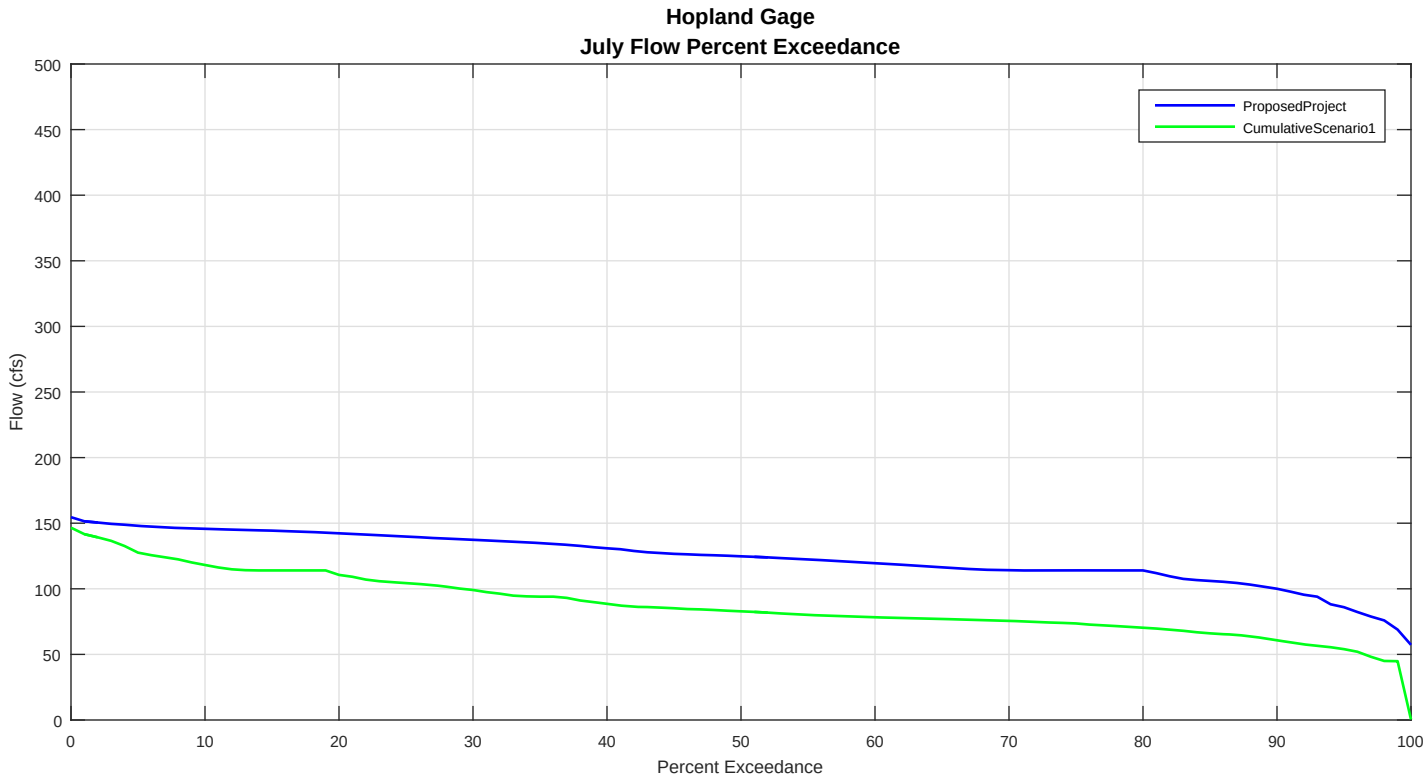
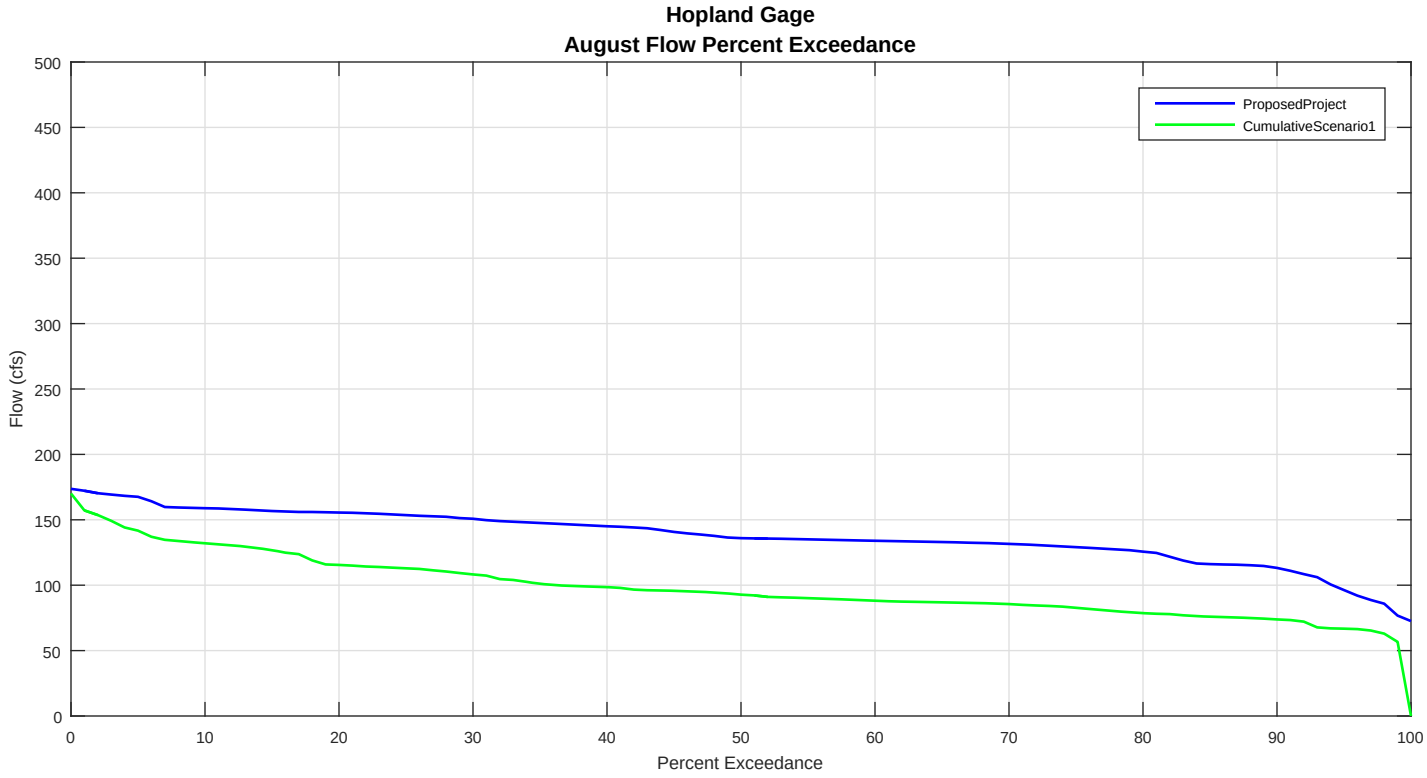
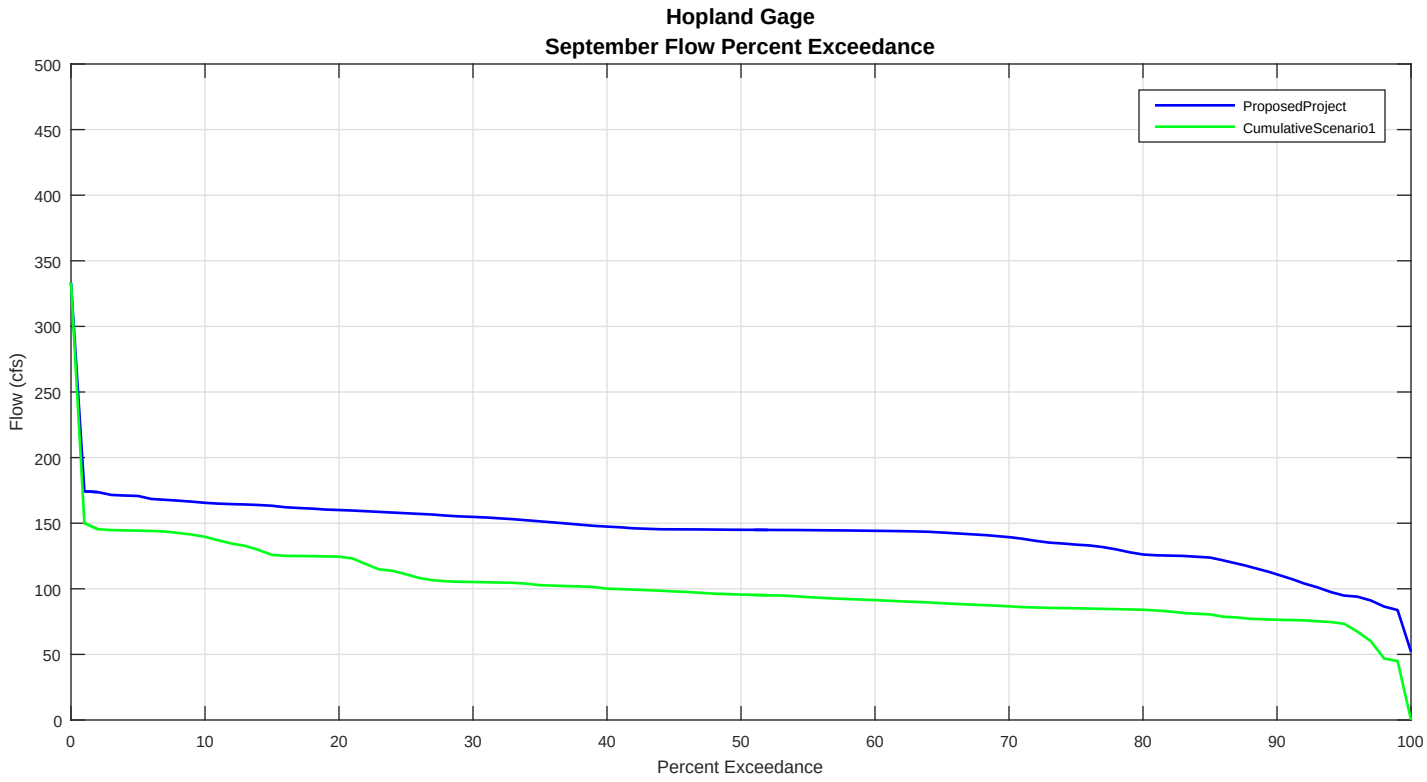
70
80
90
100


Hopland Gage
June Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100


Hopland Gage
July Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100


Hopland Gage
August Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100


Hopland Gage
September Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
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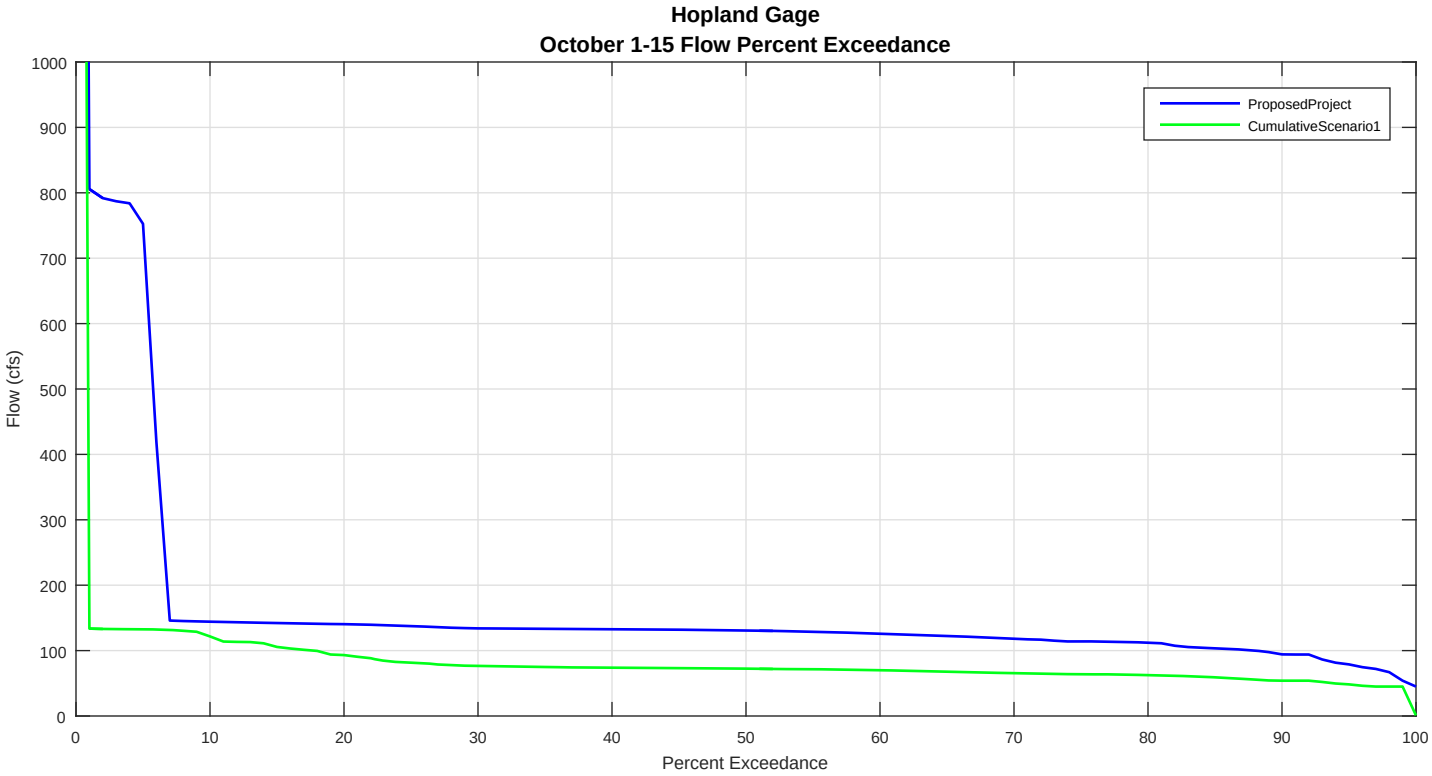
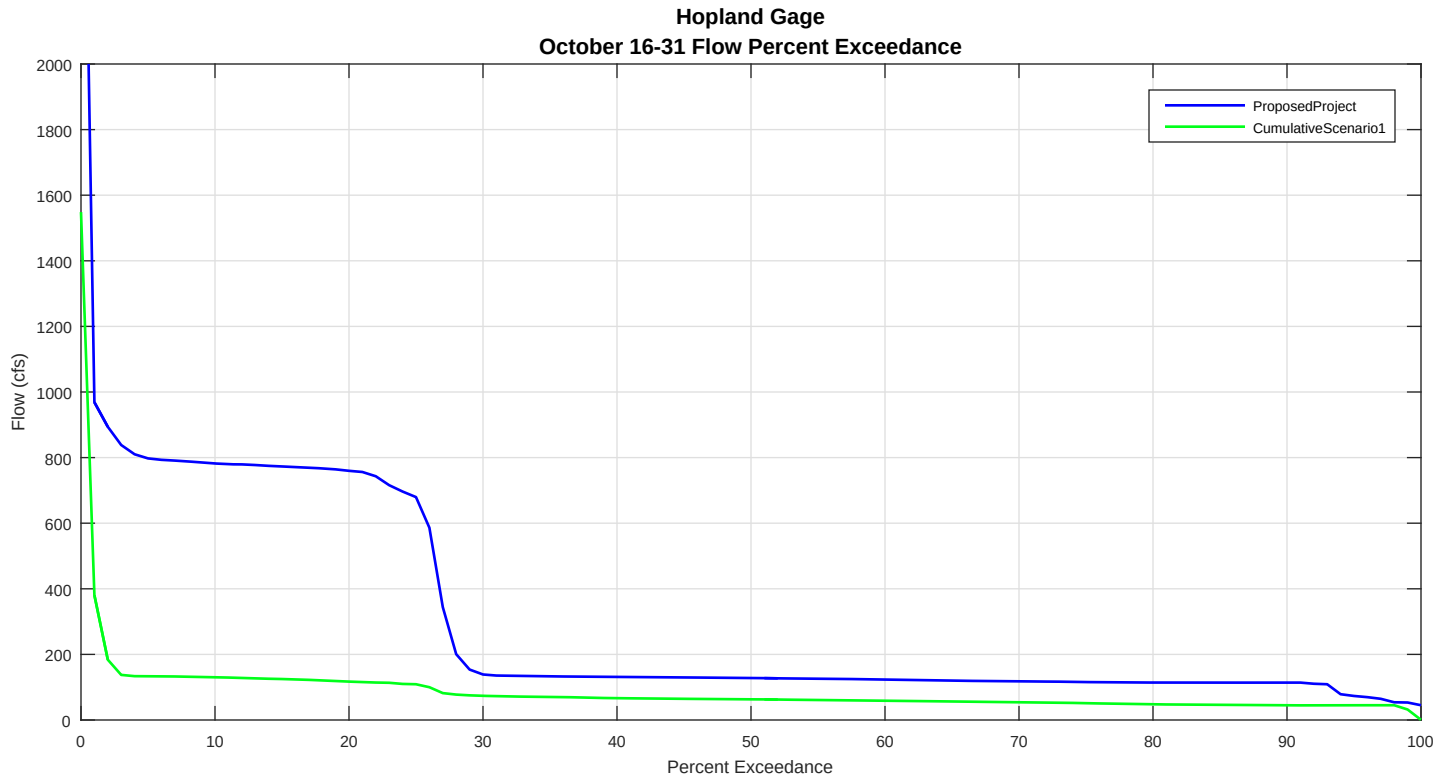
70
80
90
100


Hopland Gage
October 1-15 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100


Hopland Gage
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
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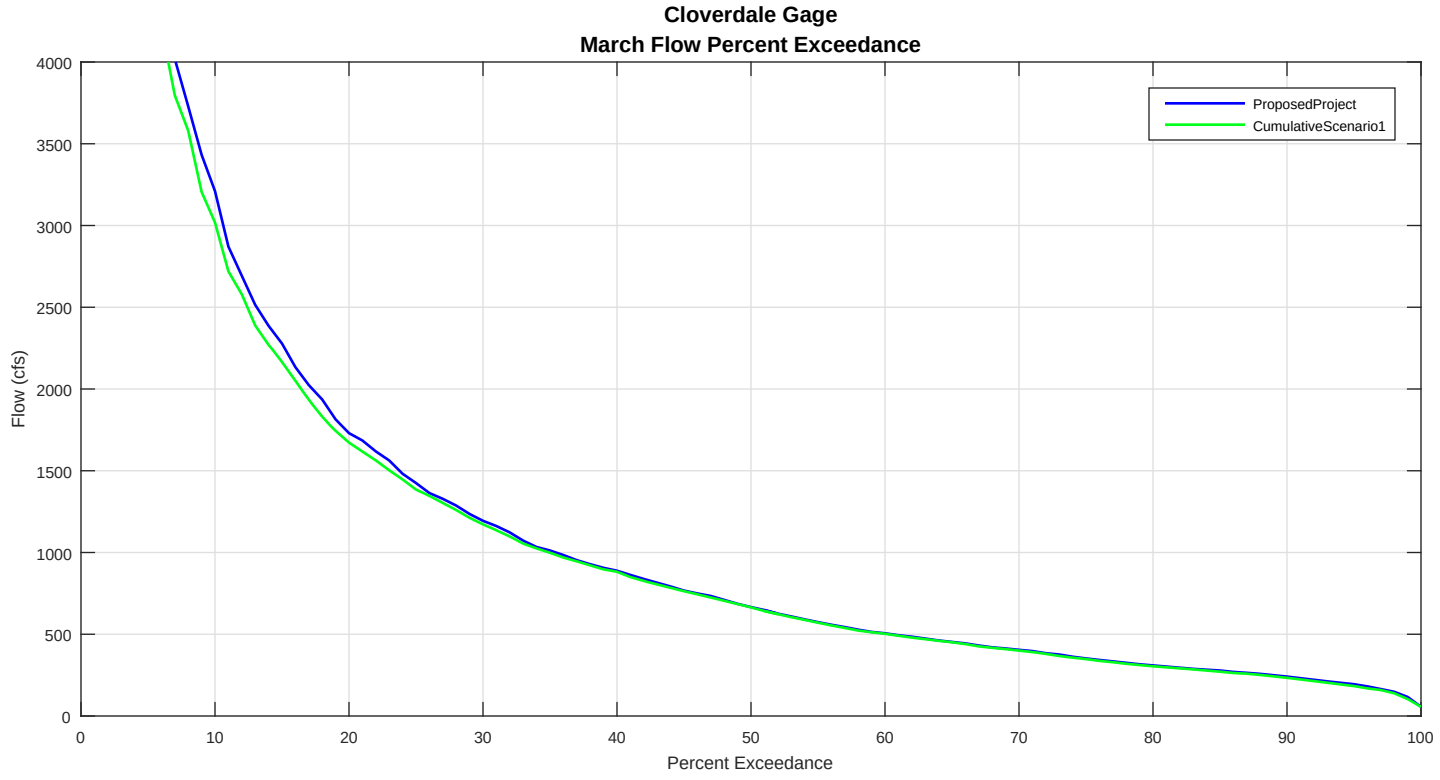
Cloverdale Gage
March Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
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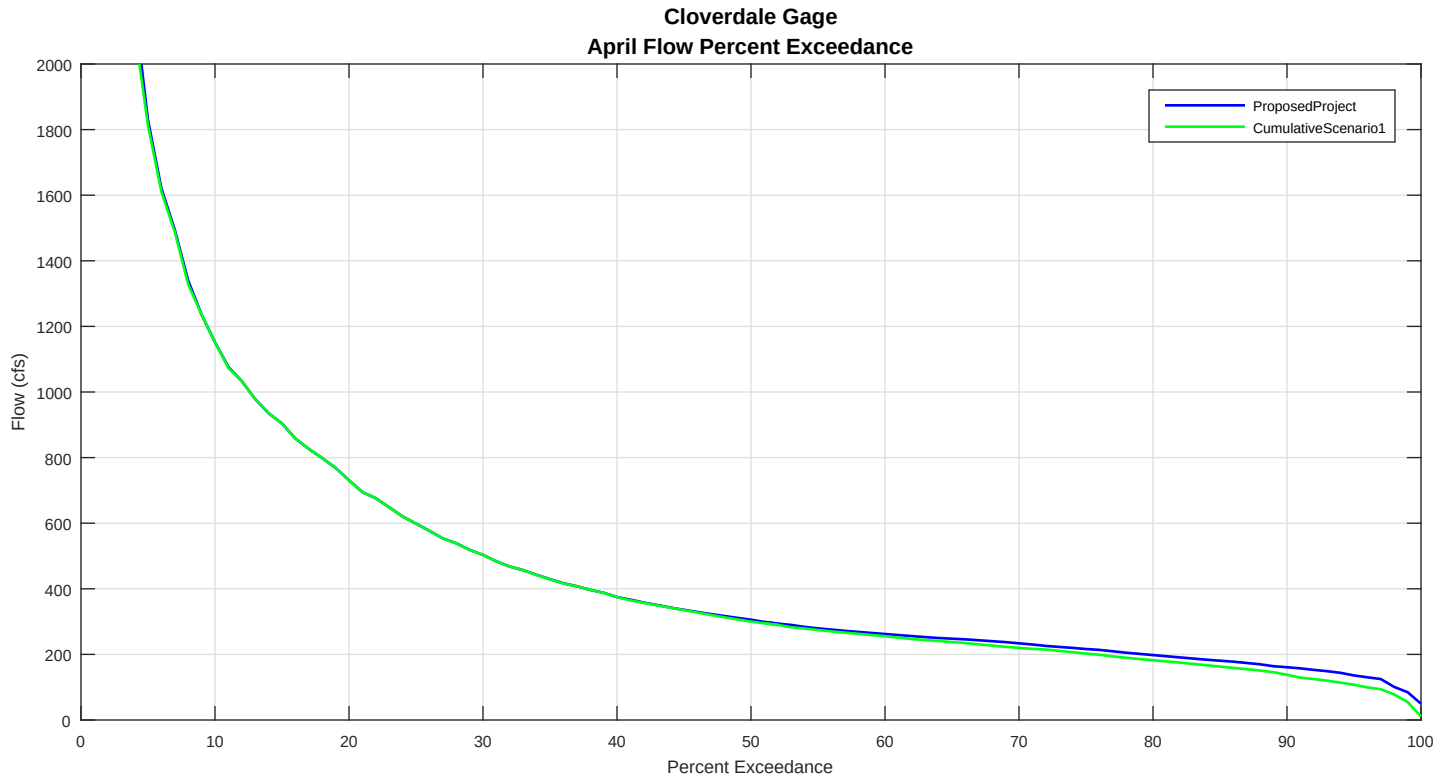
Cloverdale Gage
April Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
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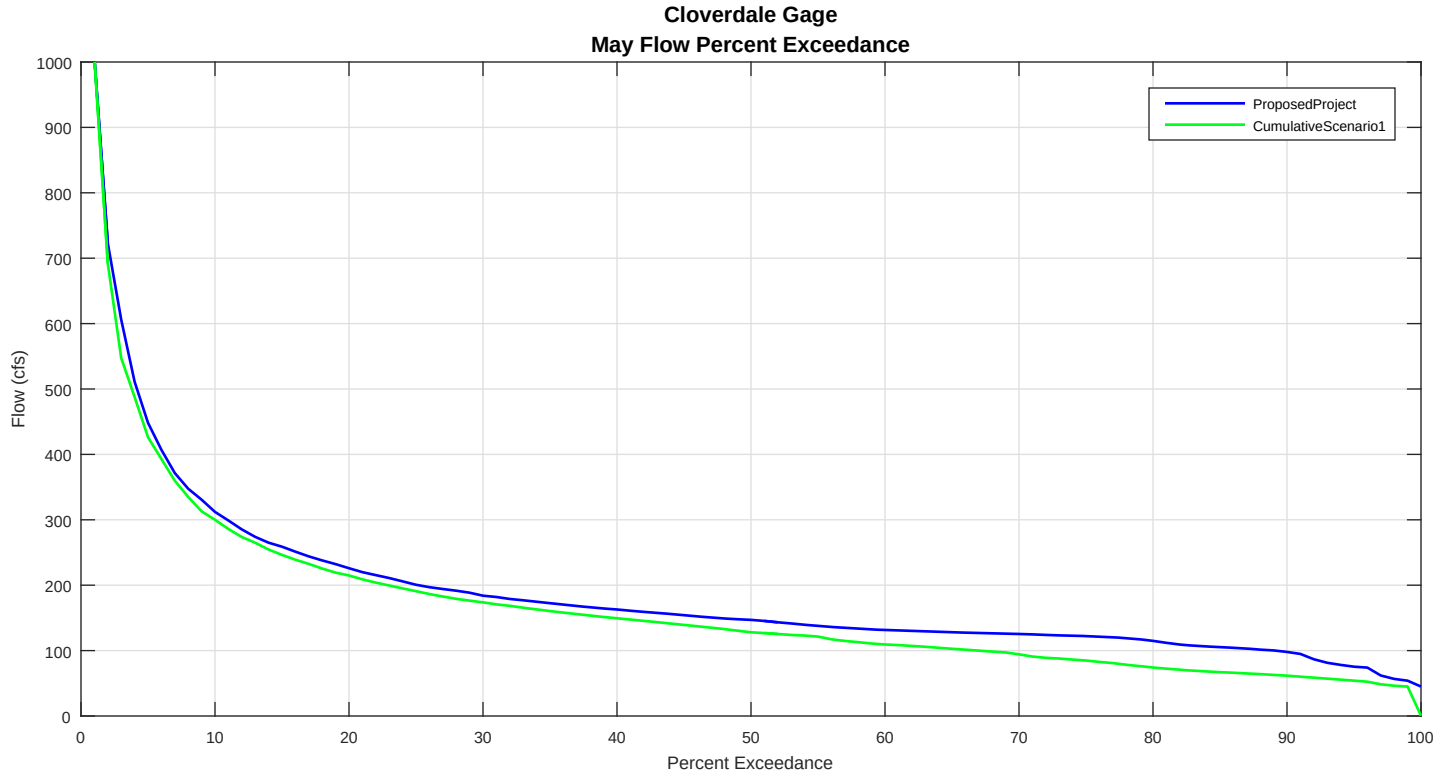
Cloverdale Gage
May Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
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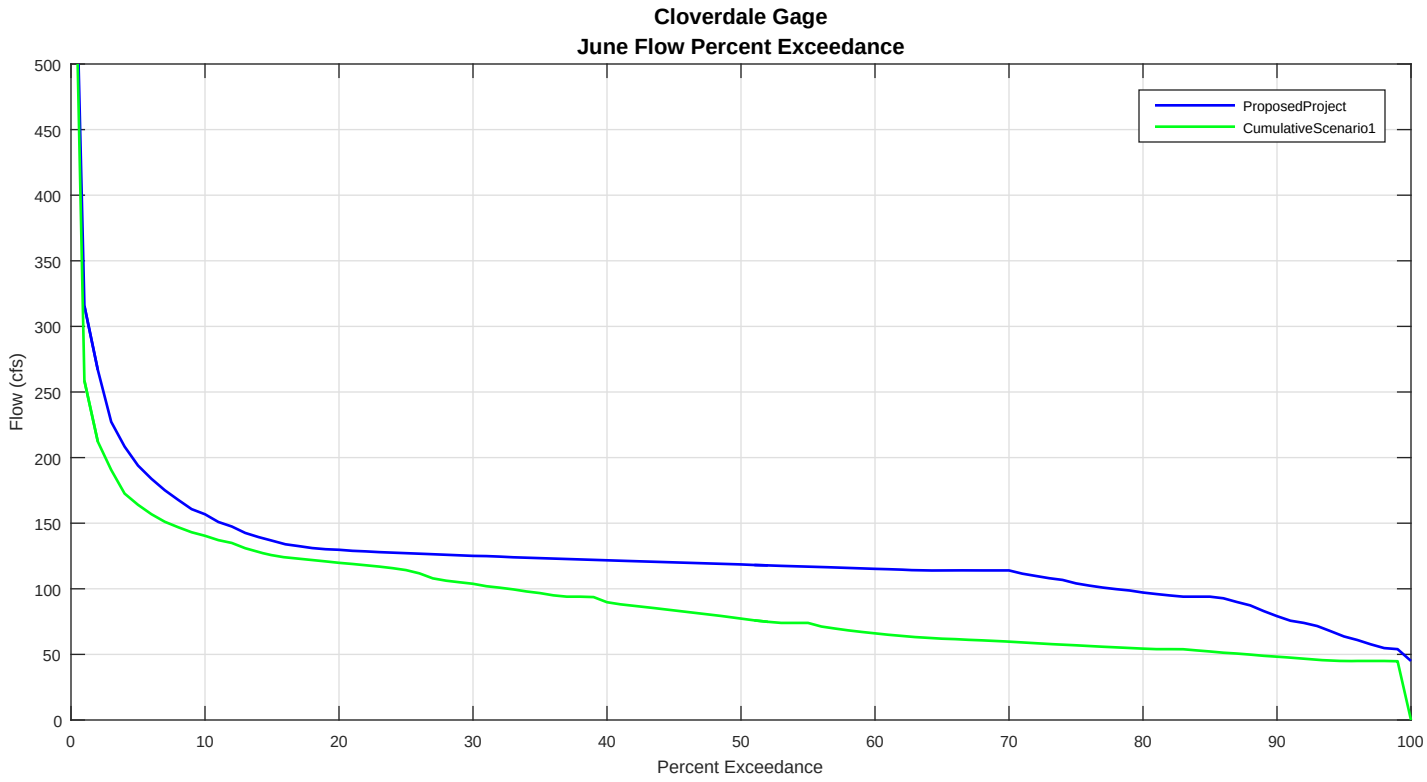
Cloverdale Gage
June Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
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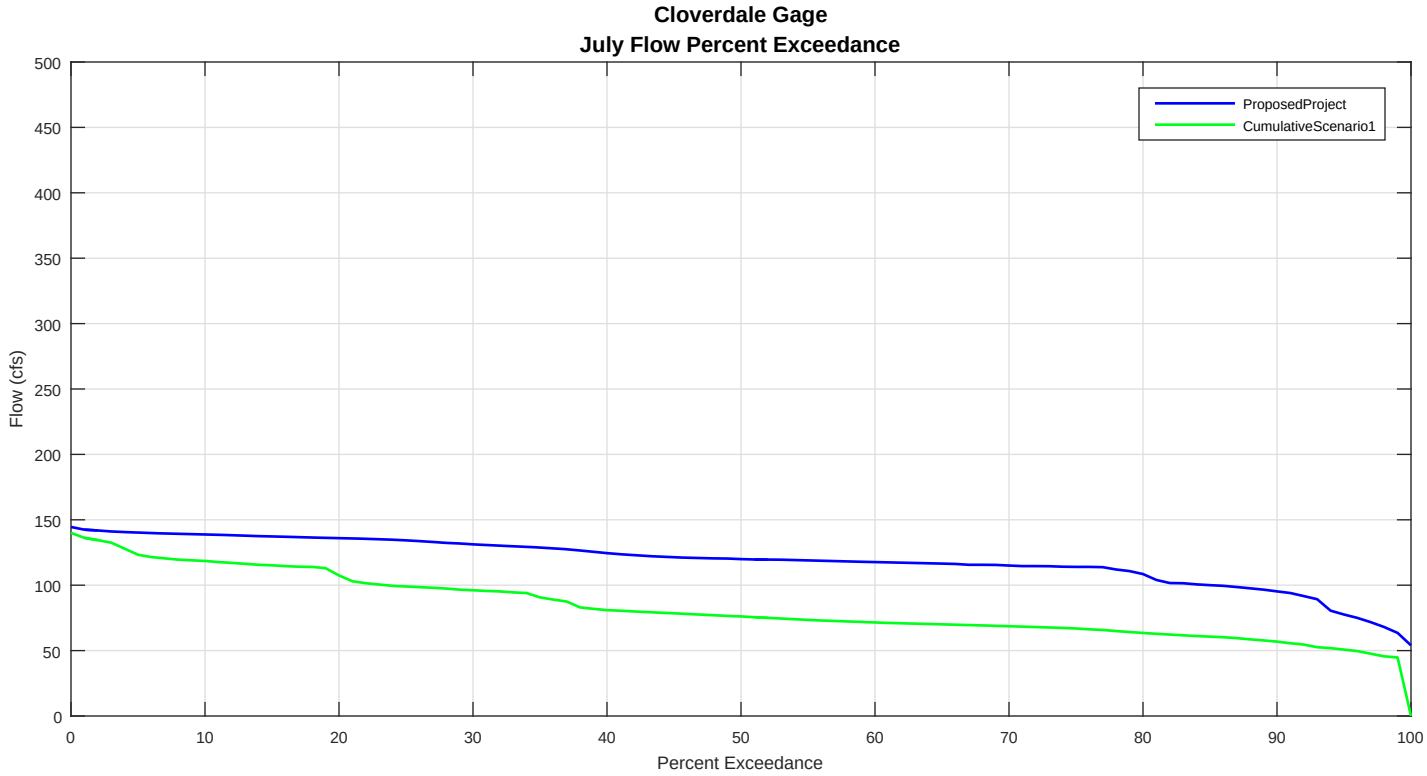
Cloverdale Gage
July Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
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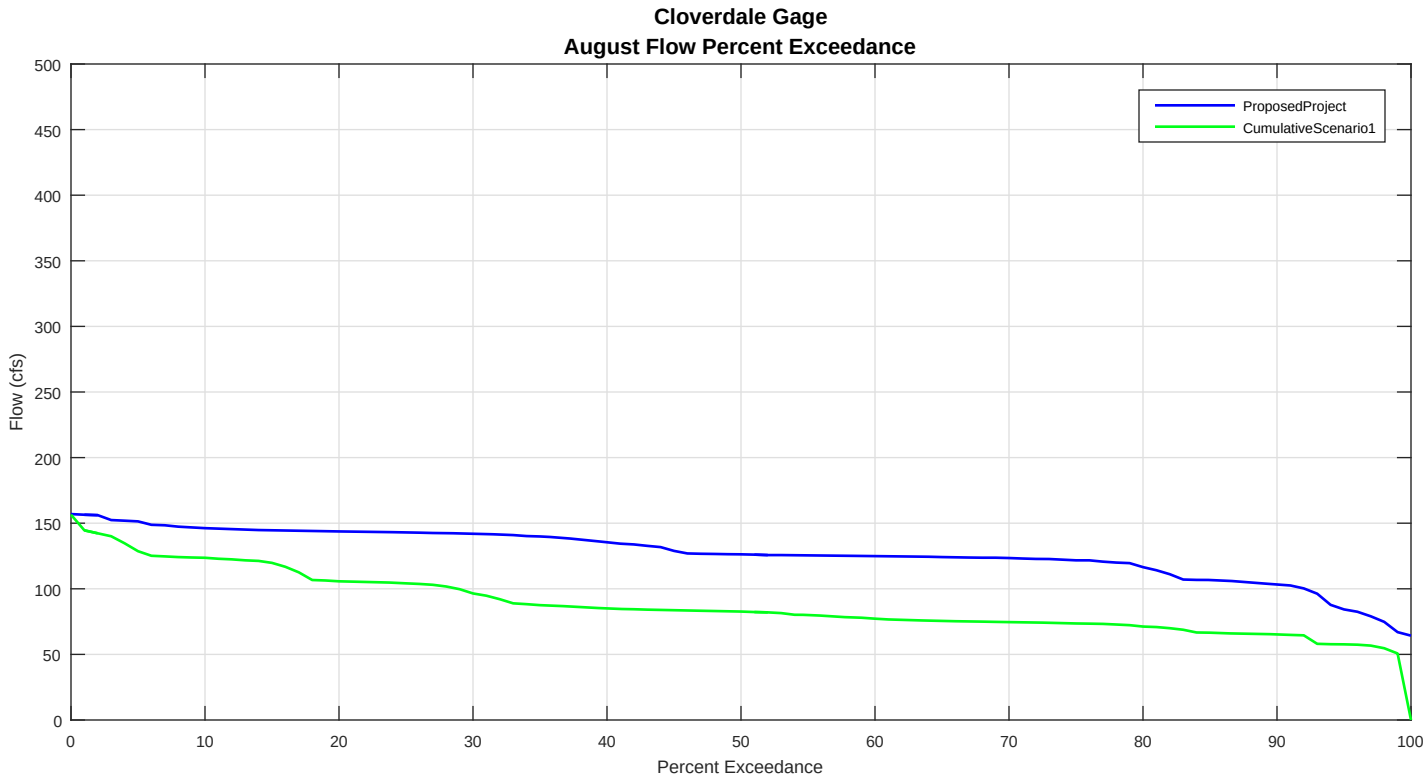
Cloverdale Gage
August Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
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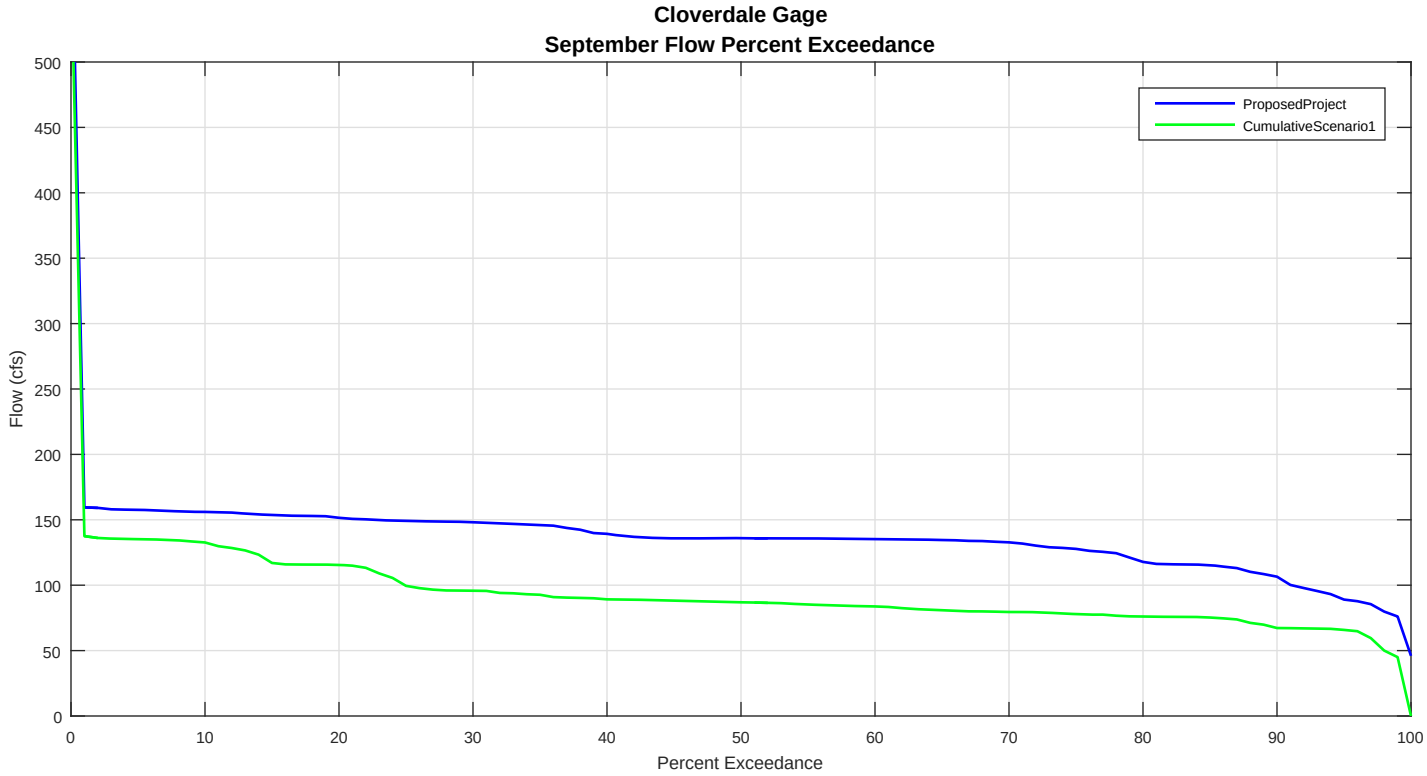
Cloverdale Gage
September Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
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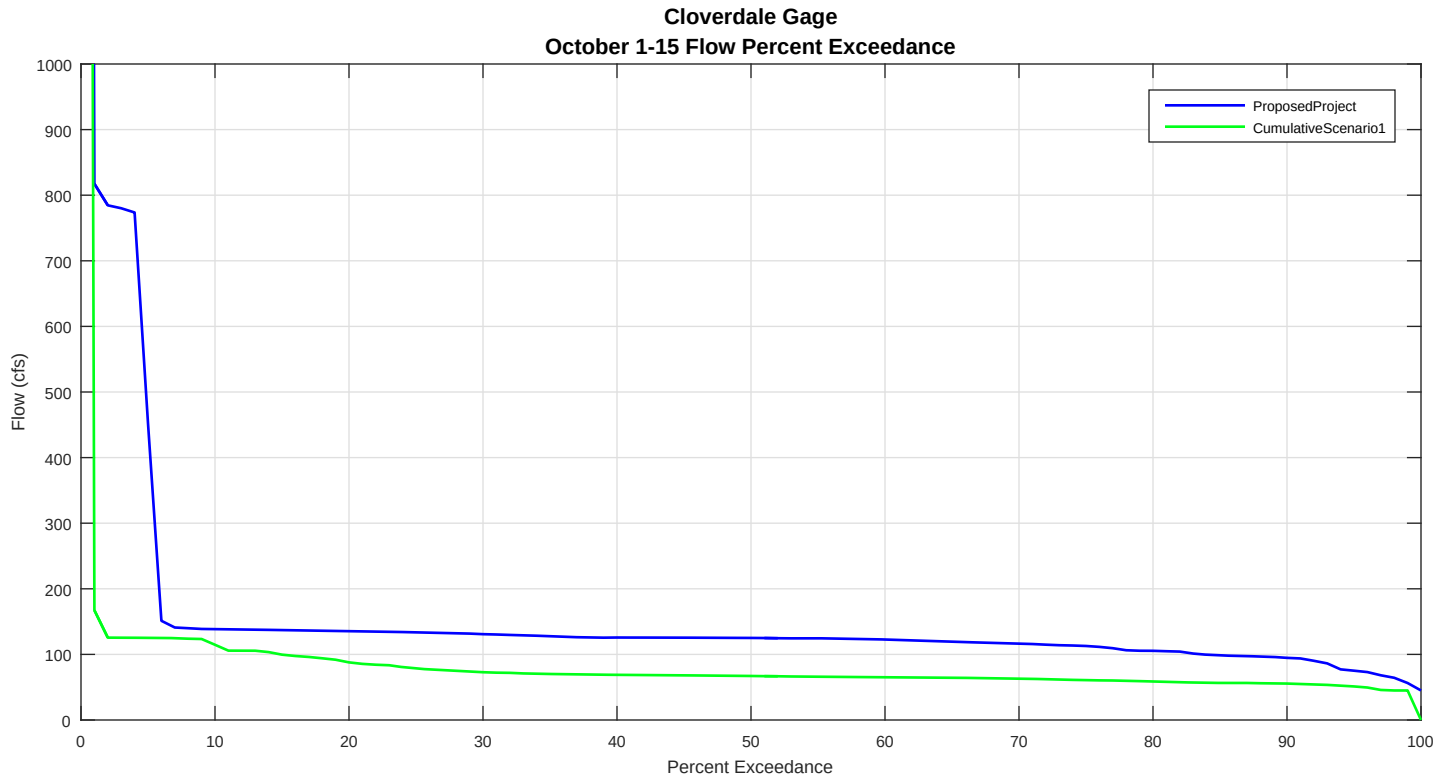
Cloverdale Gage
October 1-15 Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
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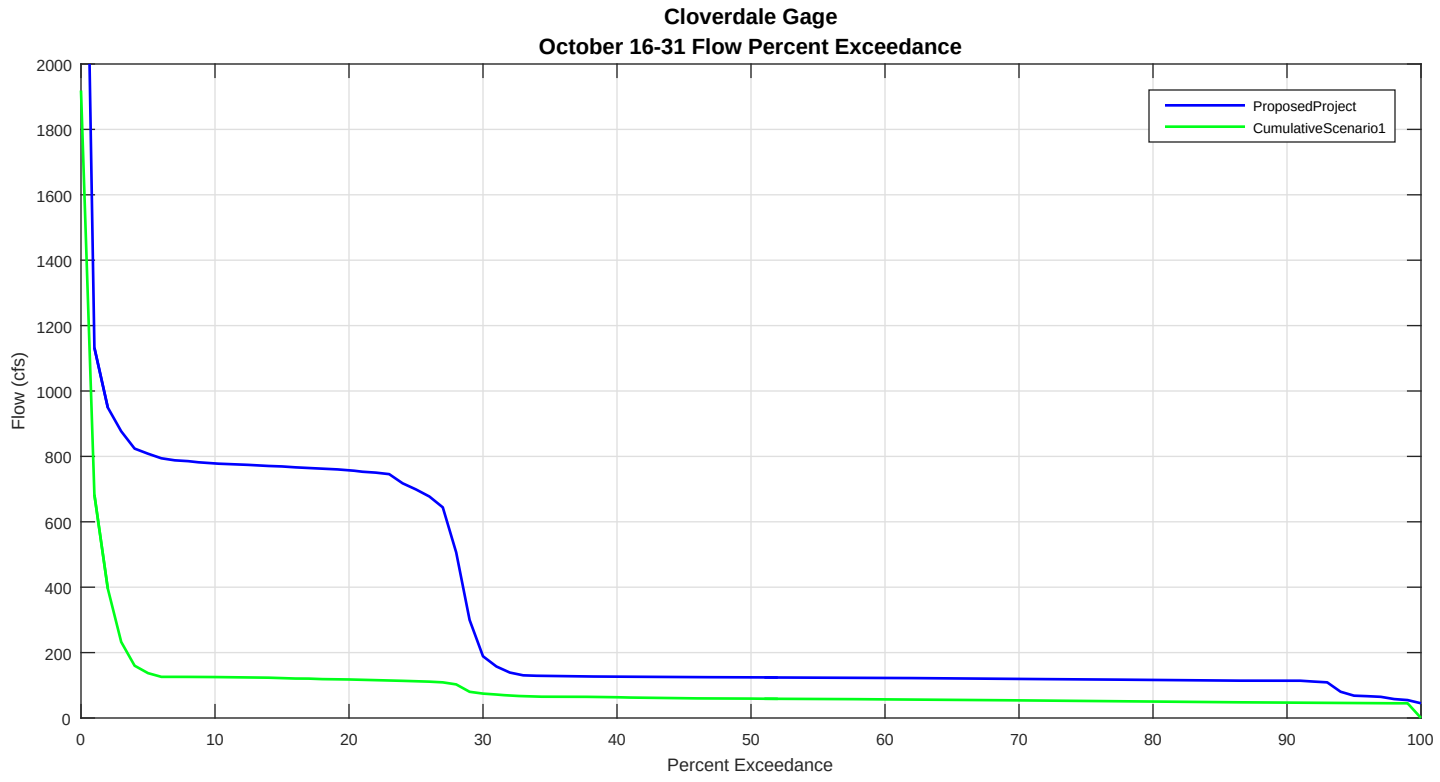
Cloverdale Gage
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
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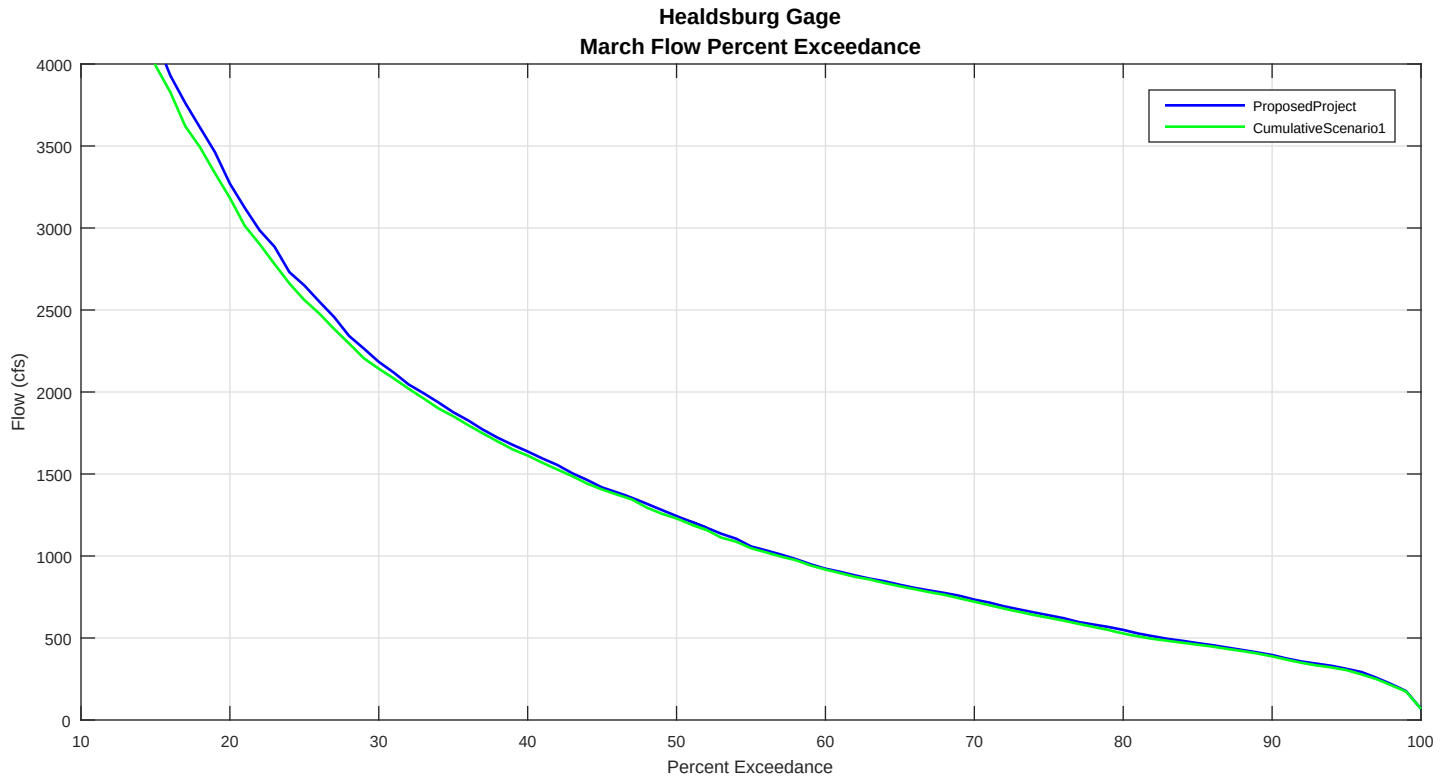
Healdsburg Gage
March Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
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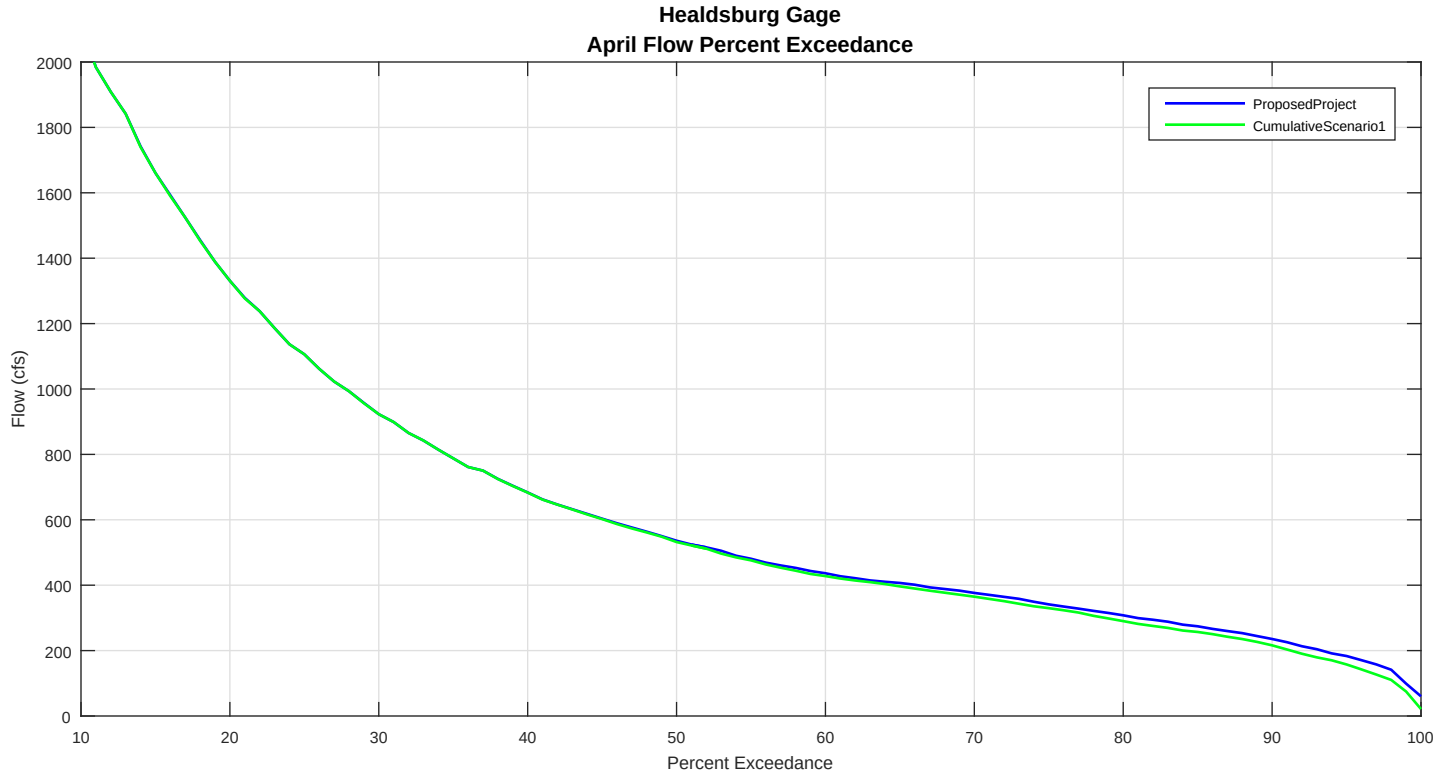
Healdsburg Gage
April Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
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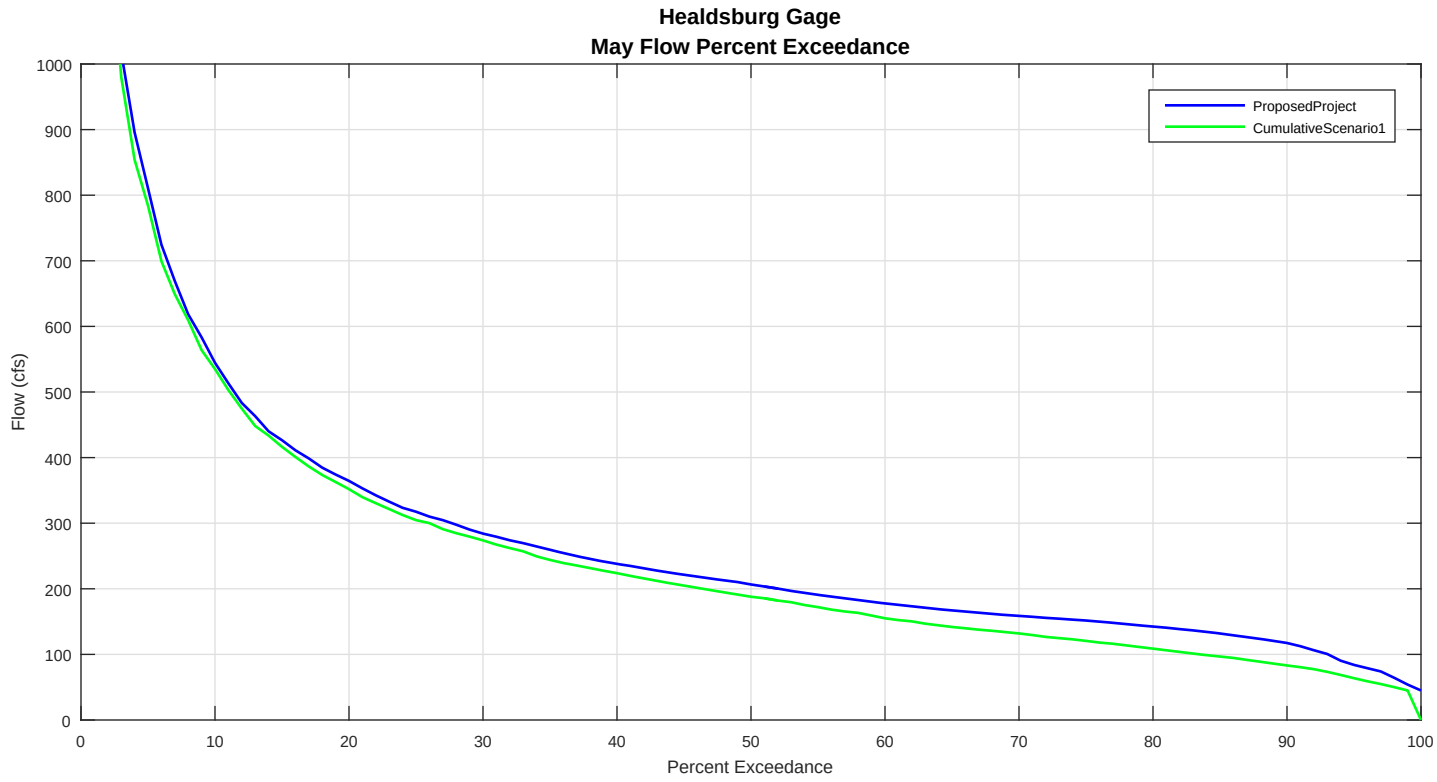
Healdsburg Gage
May Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
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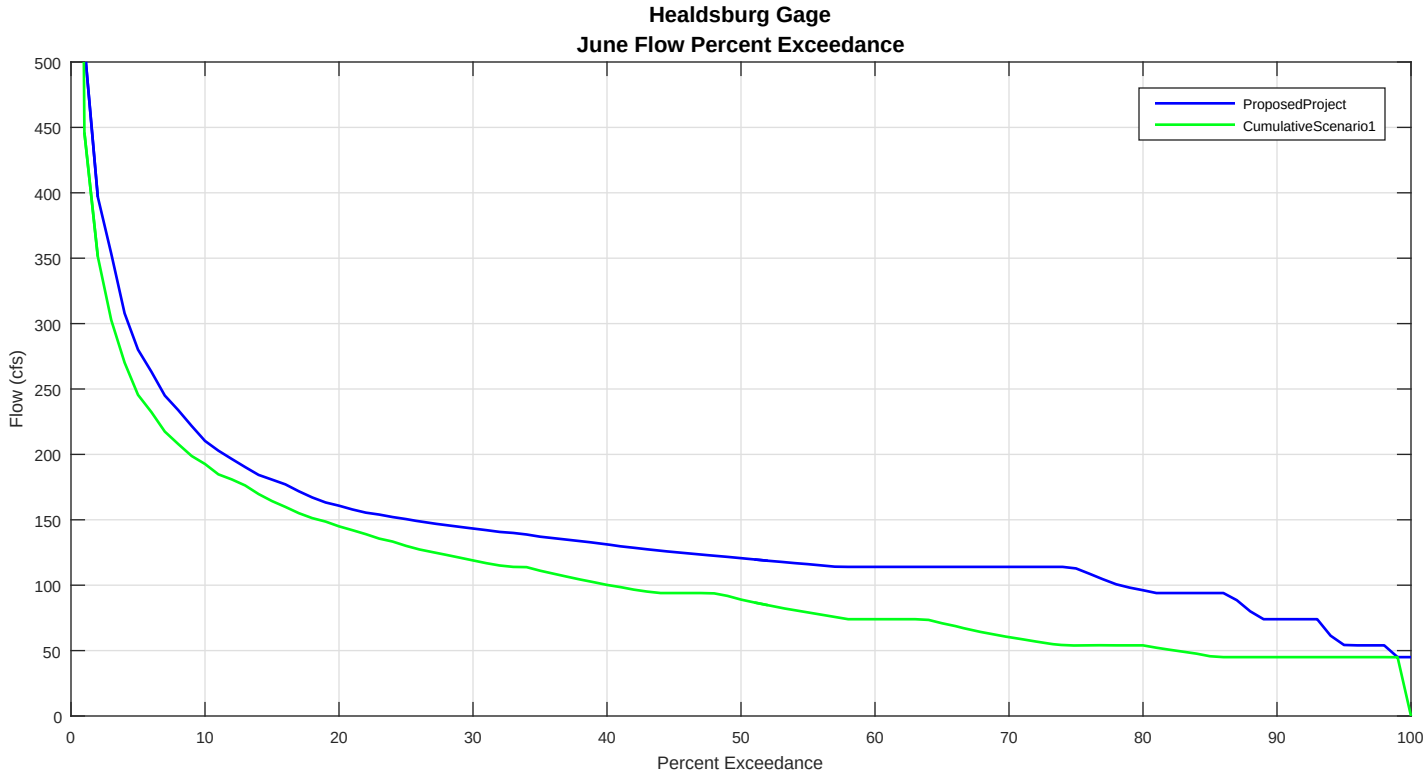
Healdsburg Gage
June Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
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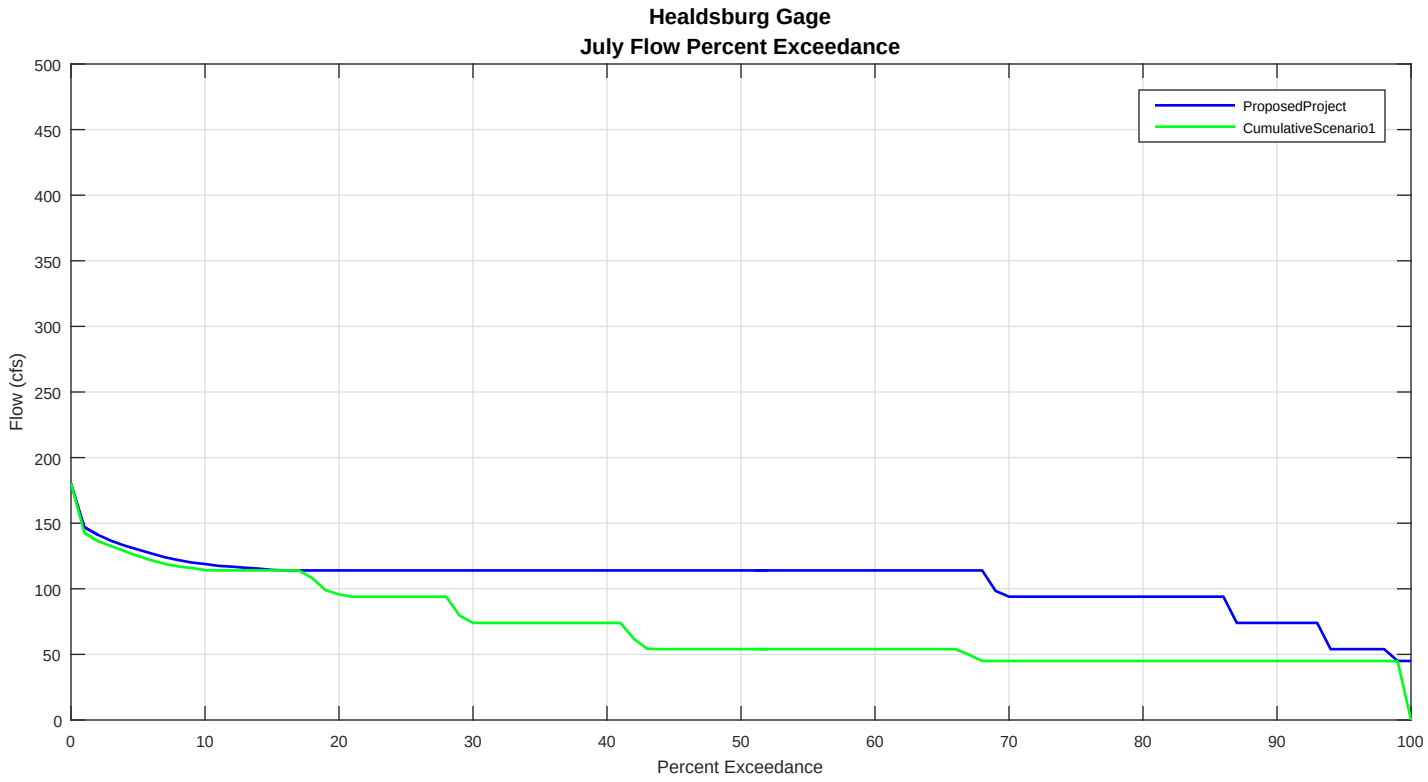
Healdsburg Gage
July Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
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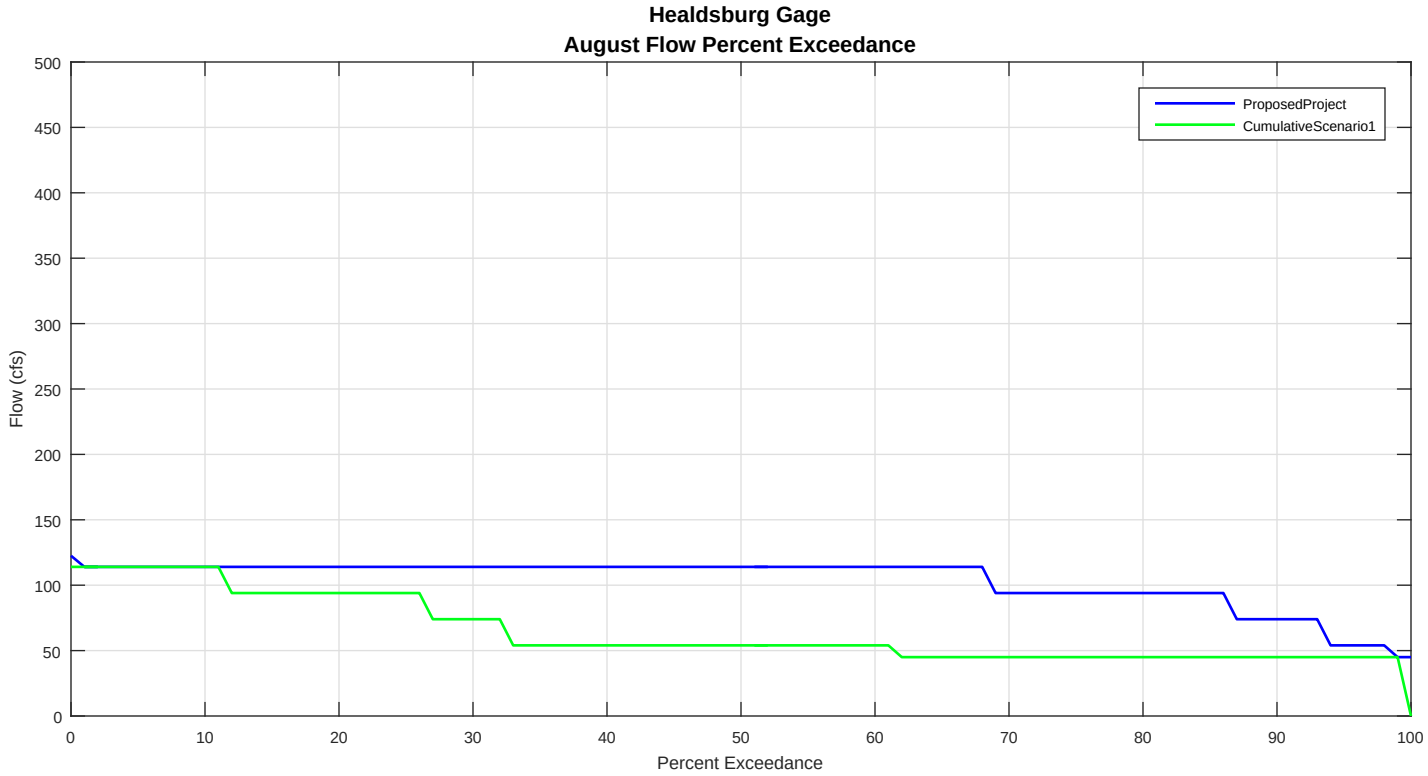
Healdsburg Gage
August Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
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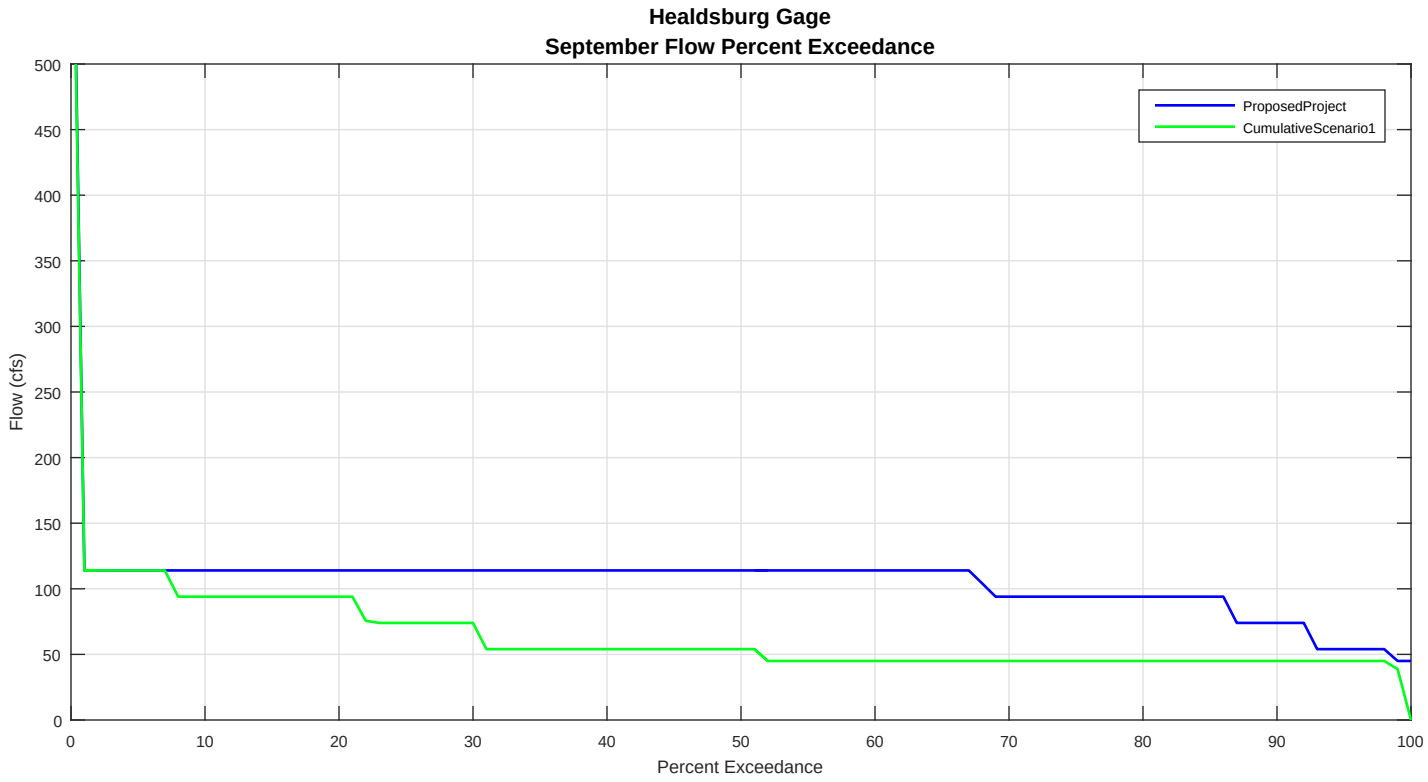
Healdsburg Gage
September Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
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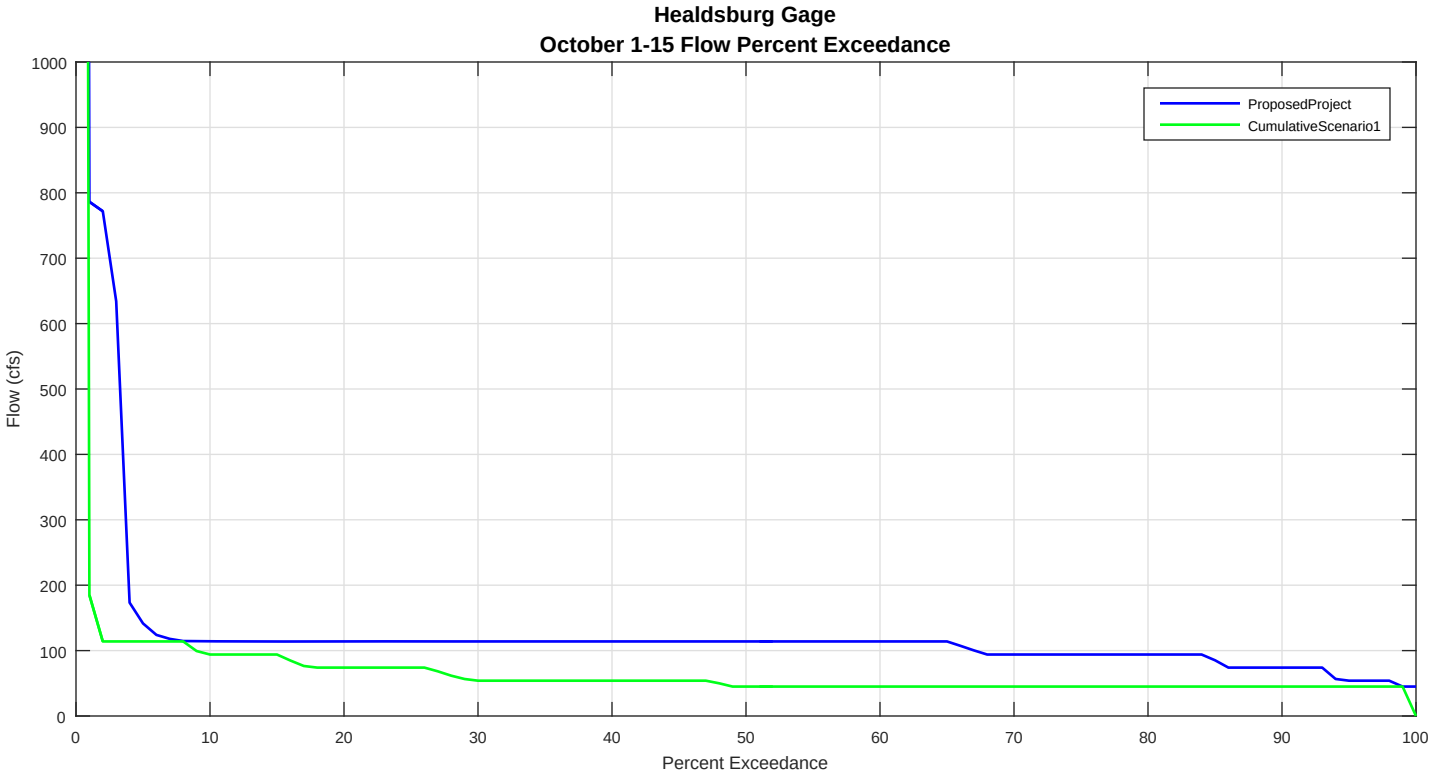
Healdsburg Gage
October 1-15 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
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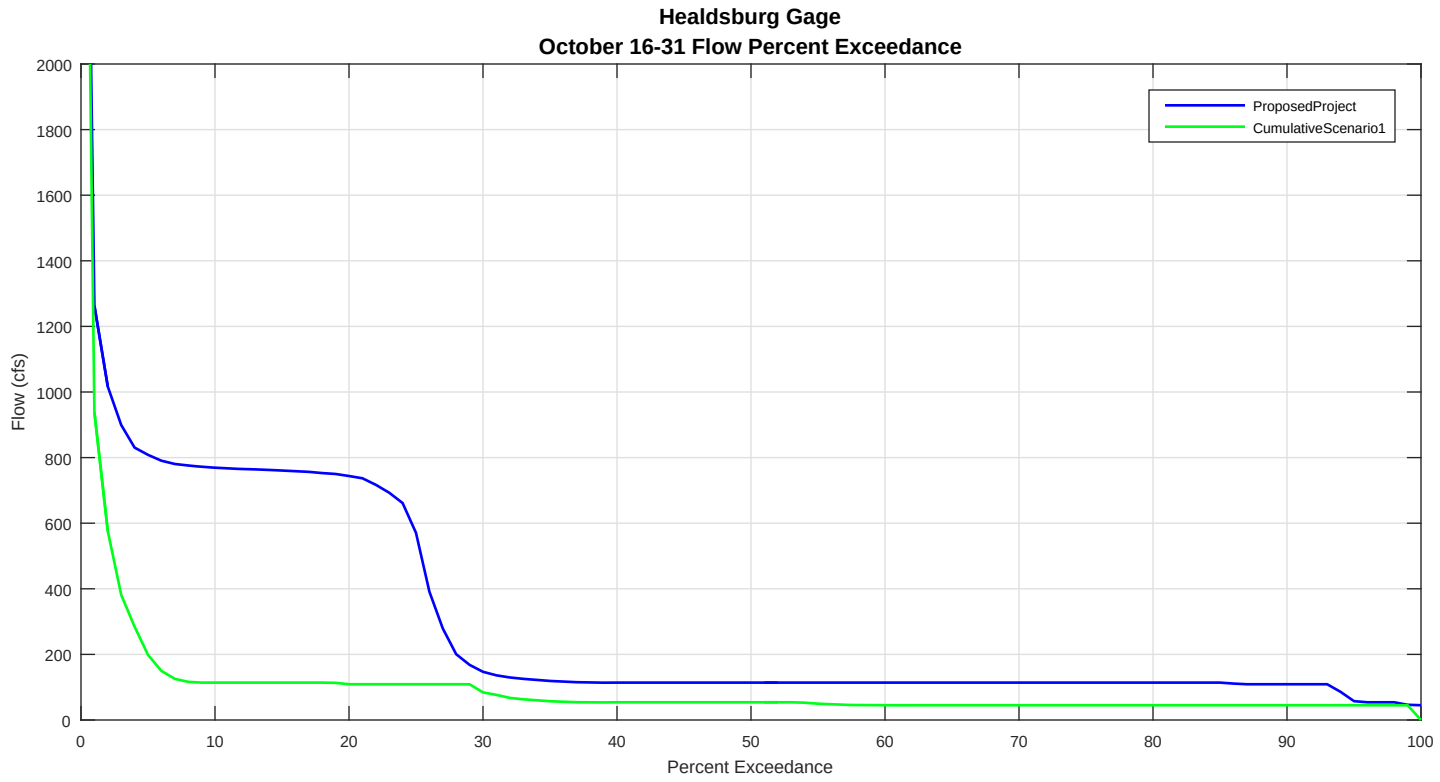
Healdsburg Gage
October 16-31 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
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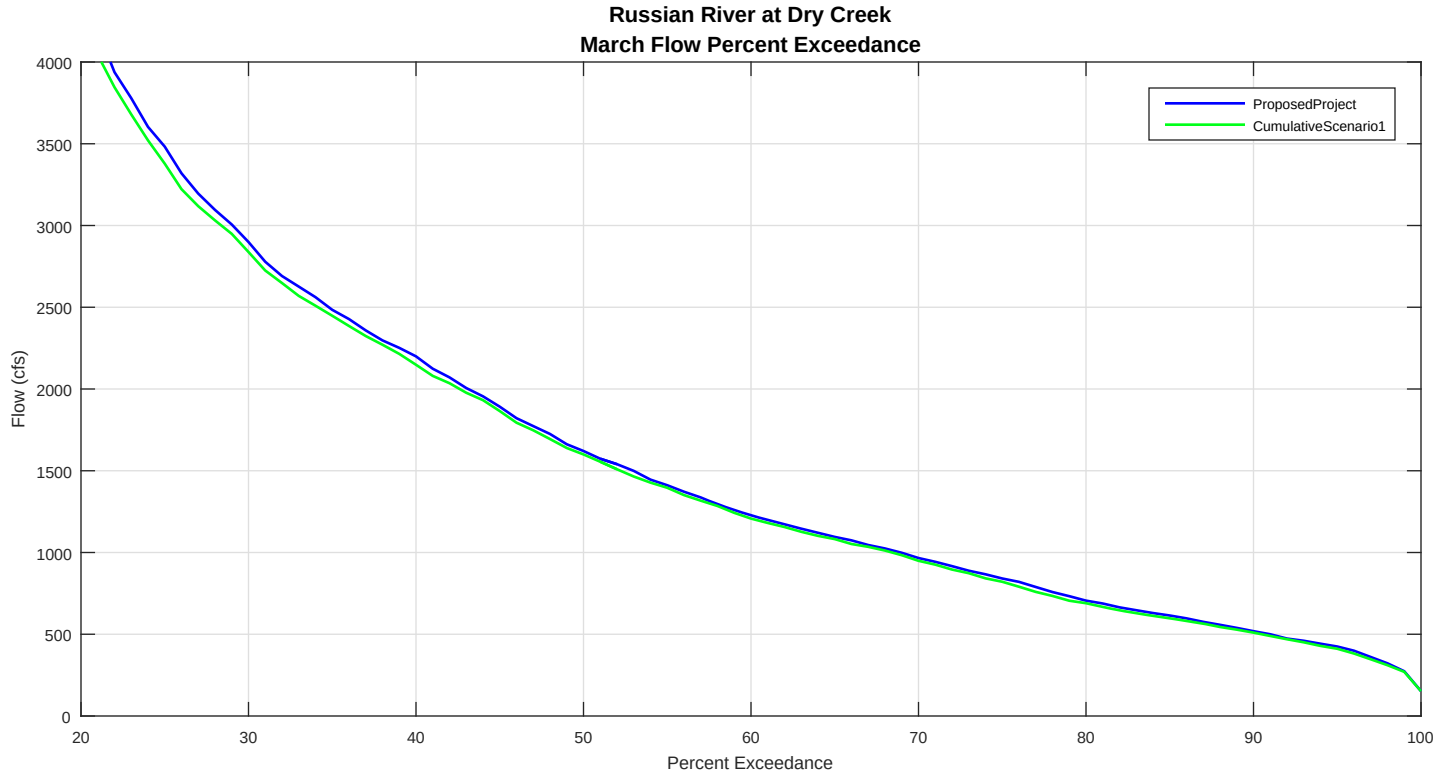
Russian River at Dry Creek
March Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
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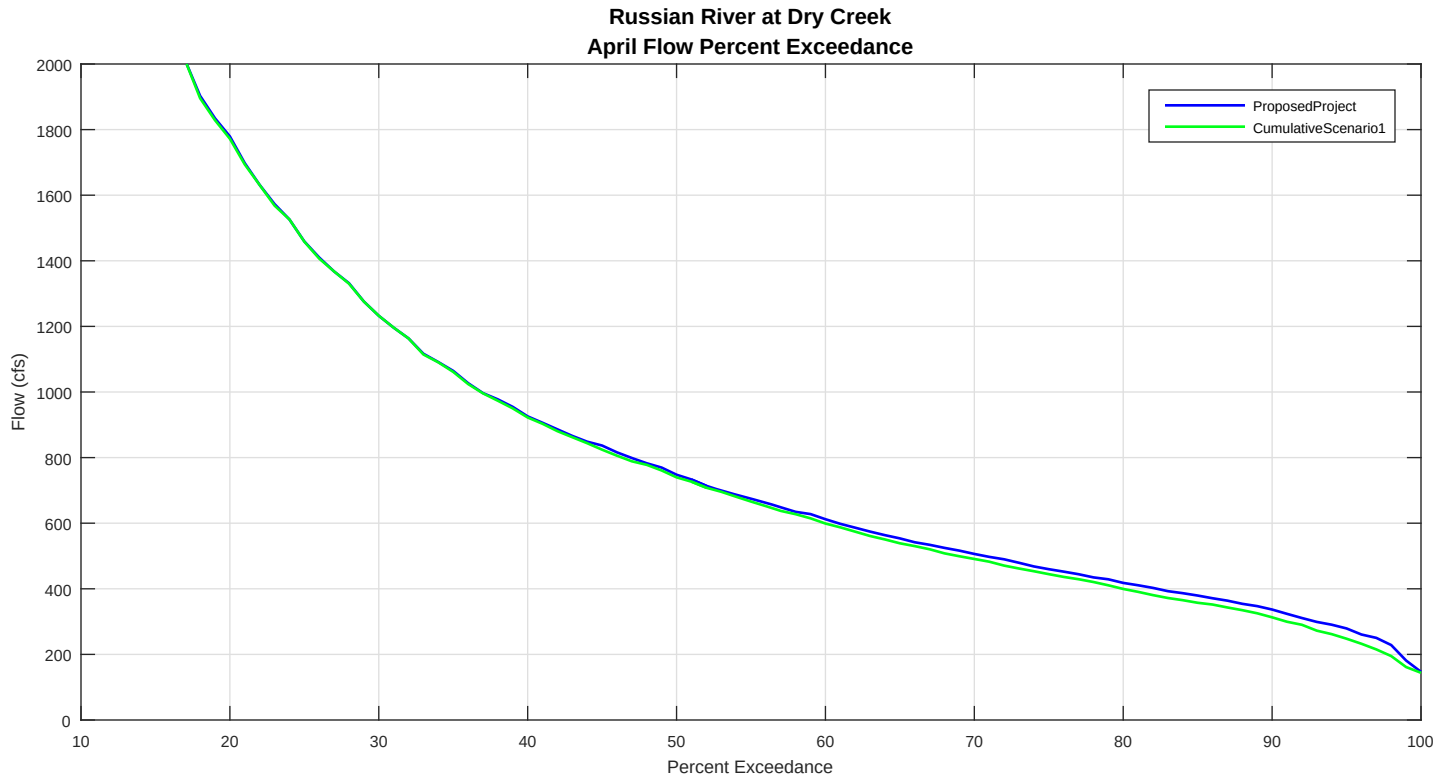
Russian River at Dry Creek
April Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
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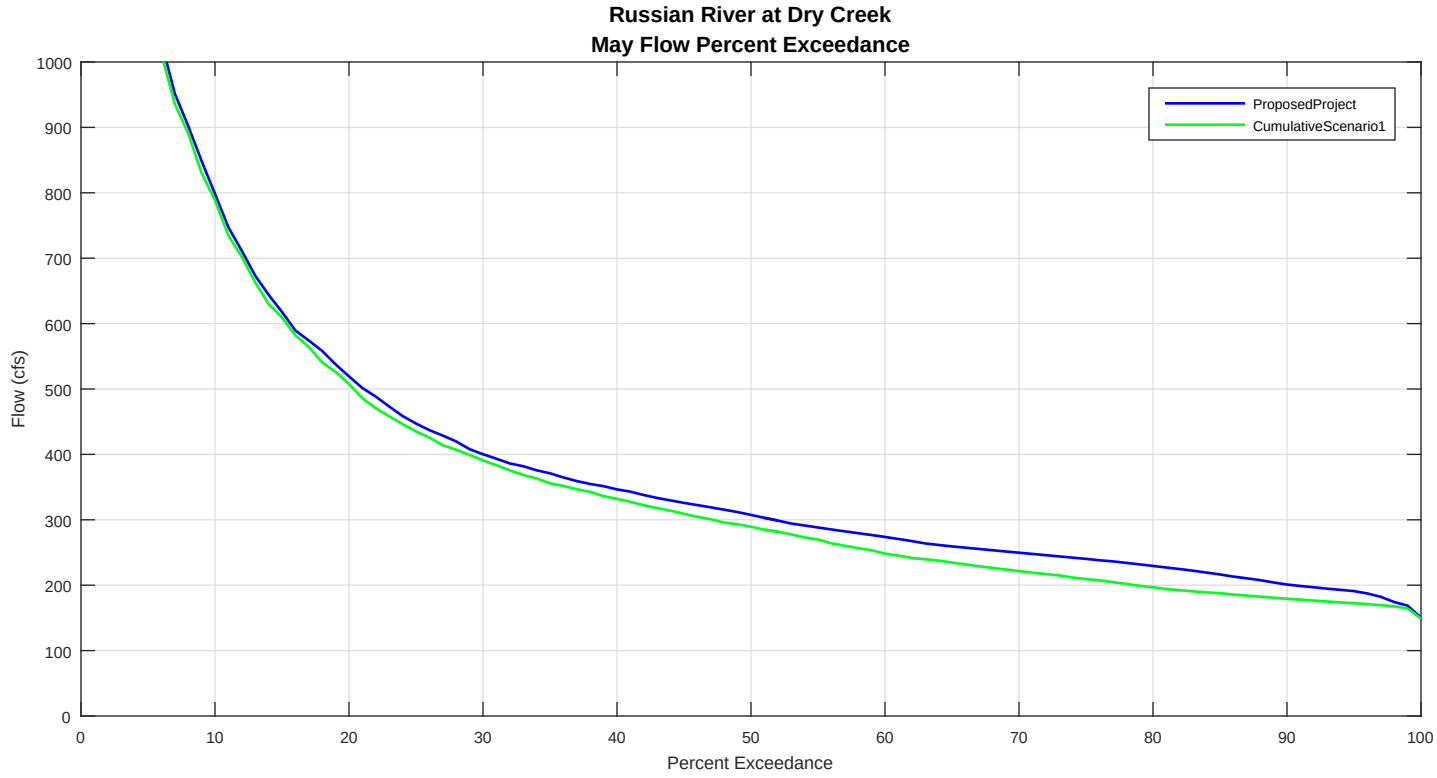
Russian River at Dry Creek
May Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
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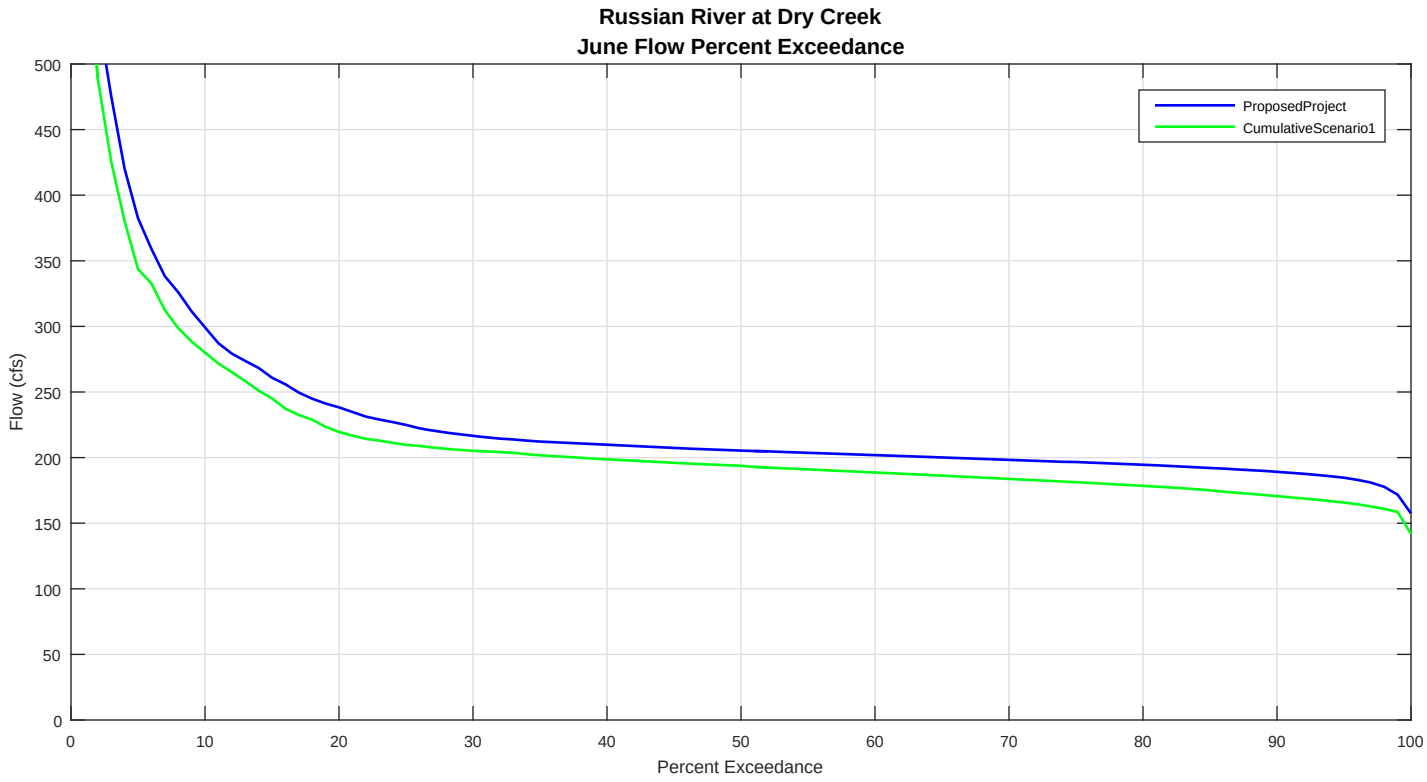
Russian River at Dry Creek
June Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
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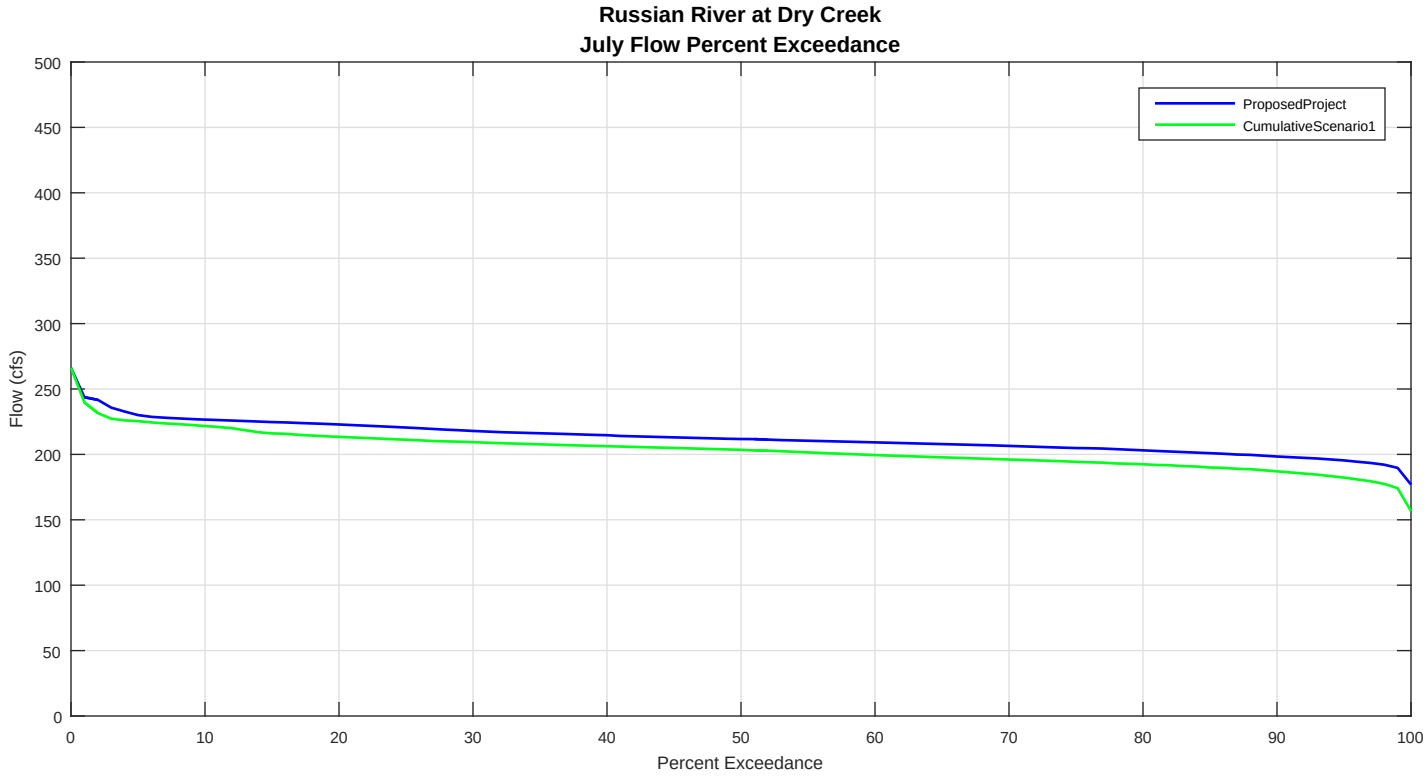
Russian River at Dry Creek
July Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
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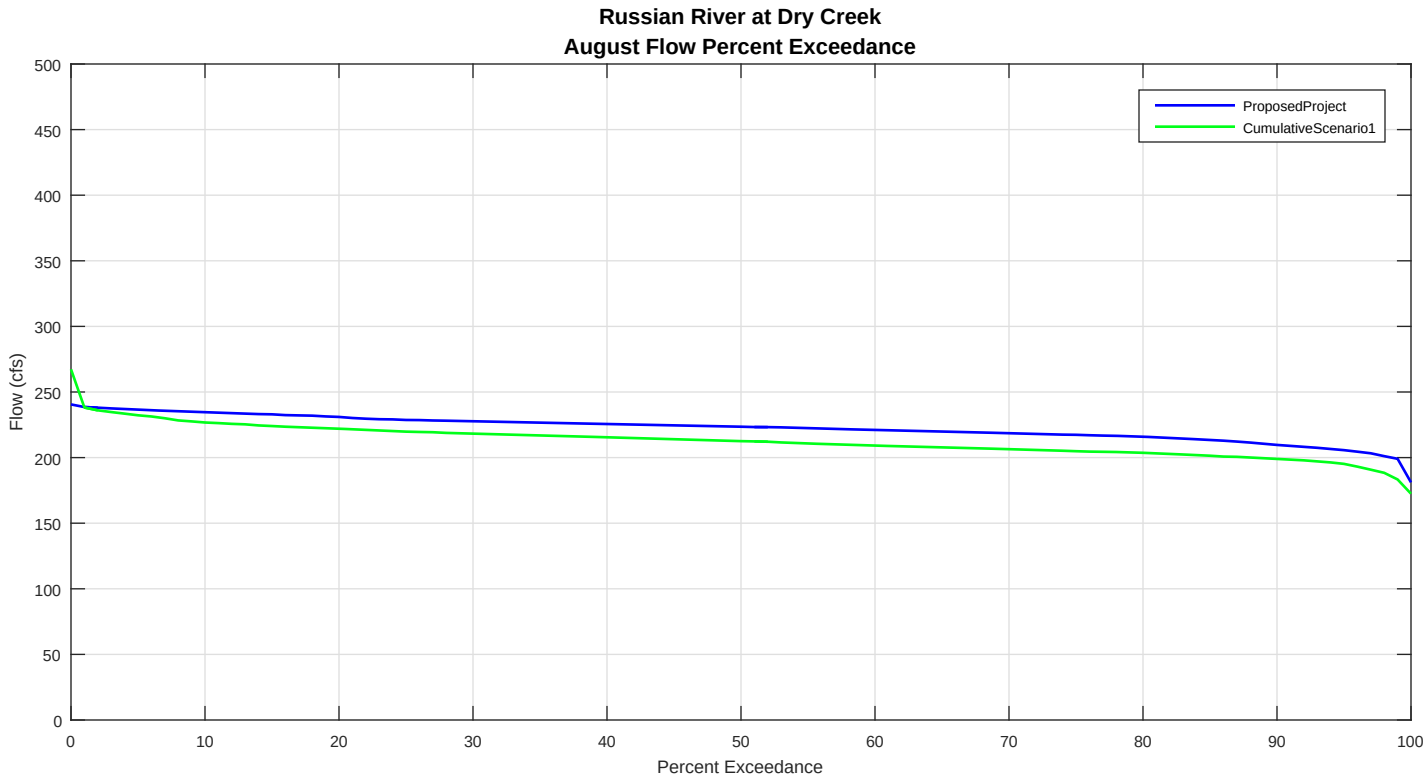
Russian River at Dry Creek
August Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
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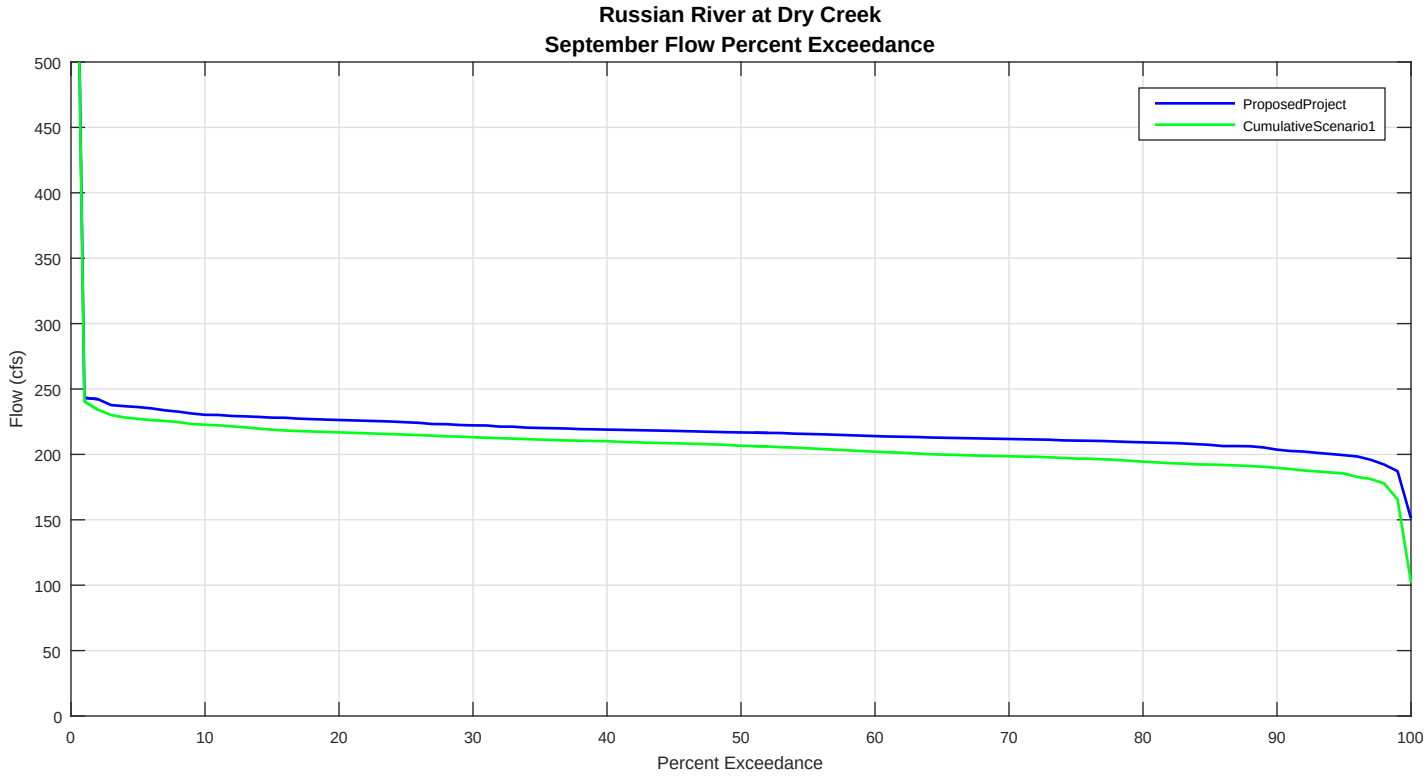
Russian River at Dry Creek
September Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
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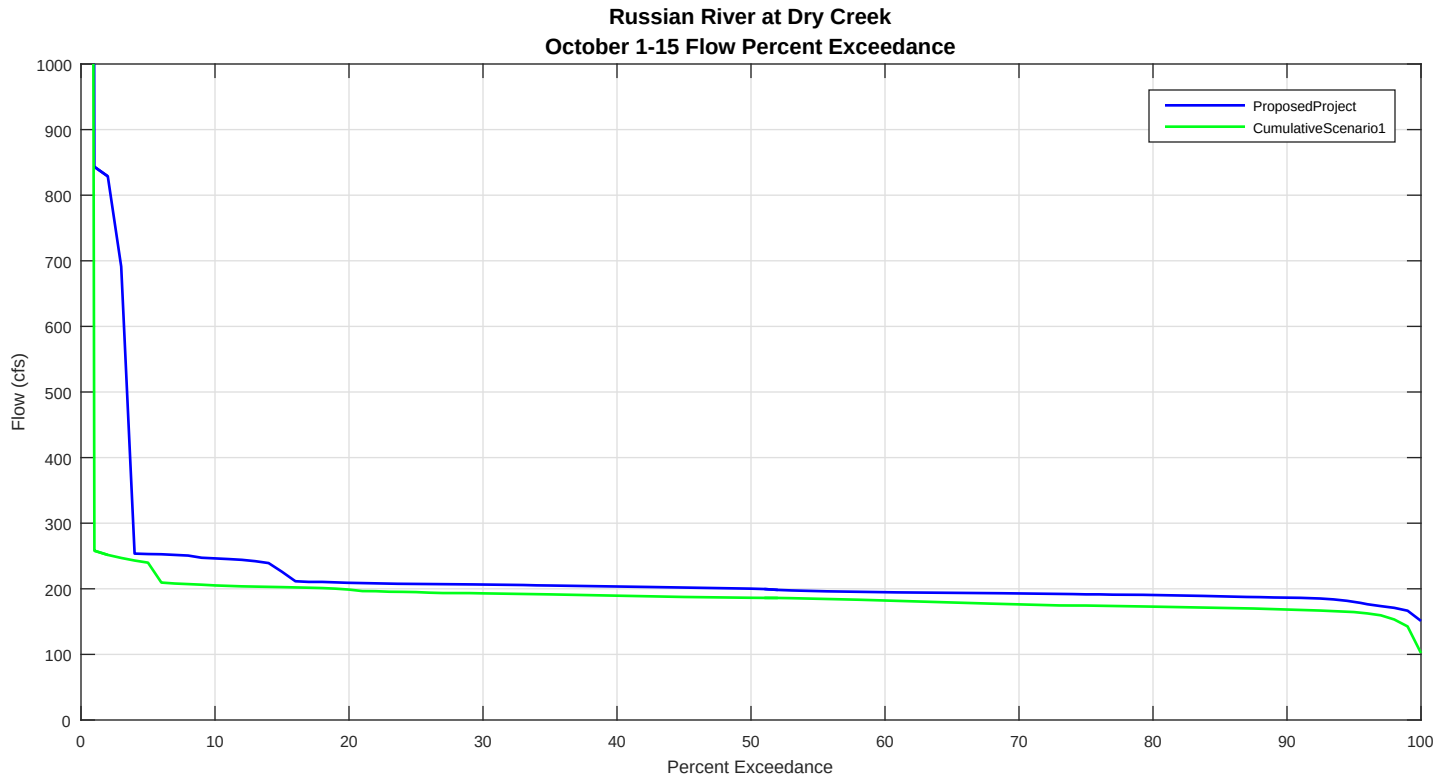
Russian River at Dry Creek
October 1-15 Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
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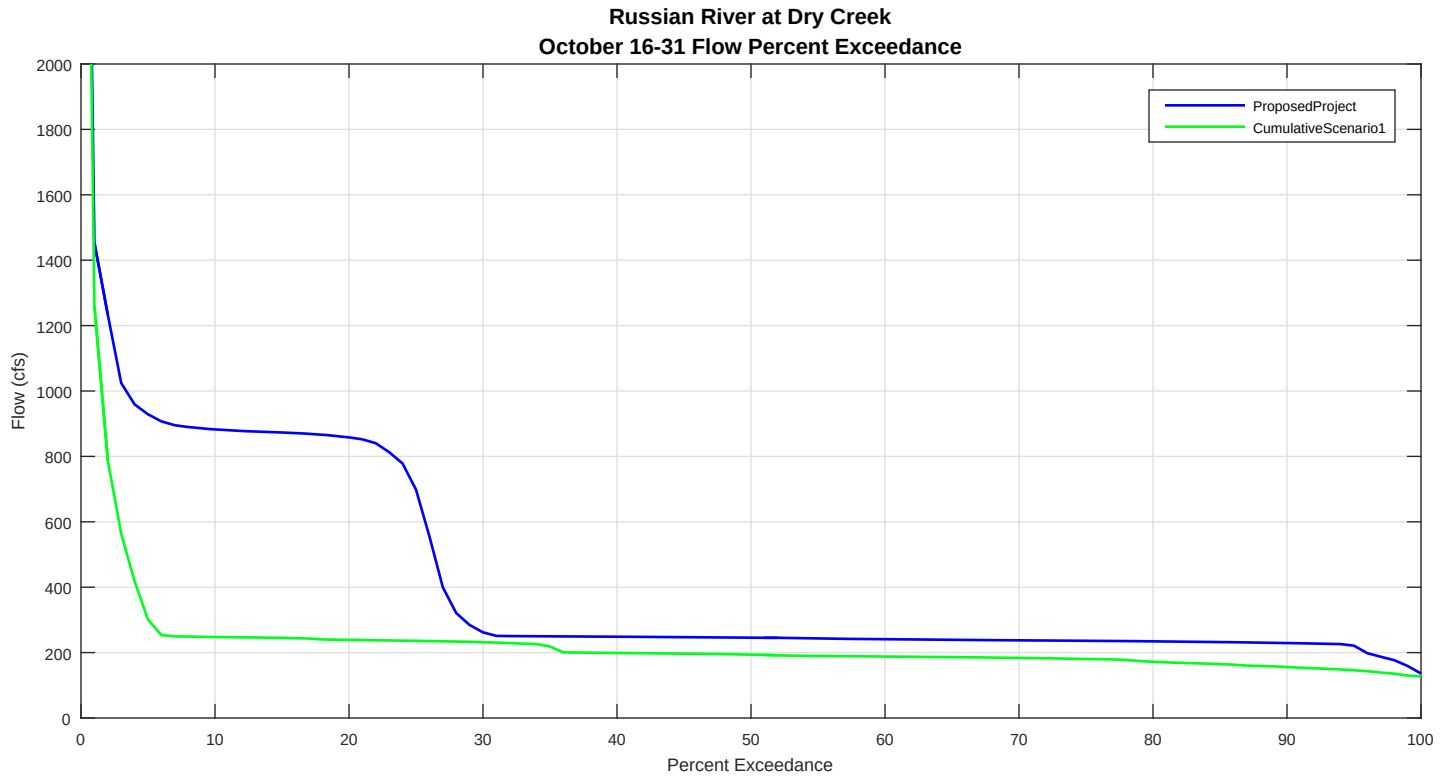
Russian River at Dry Creek
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
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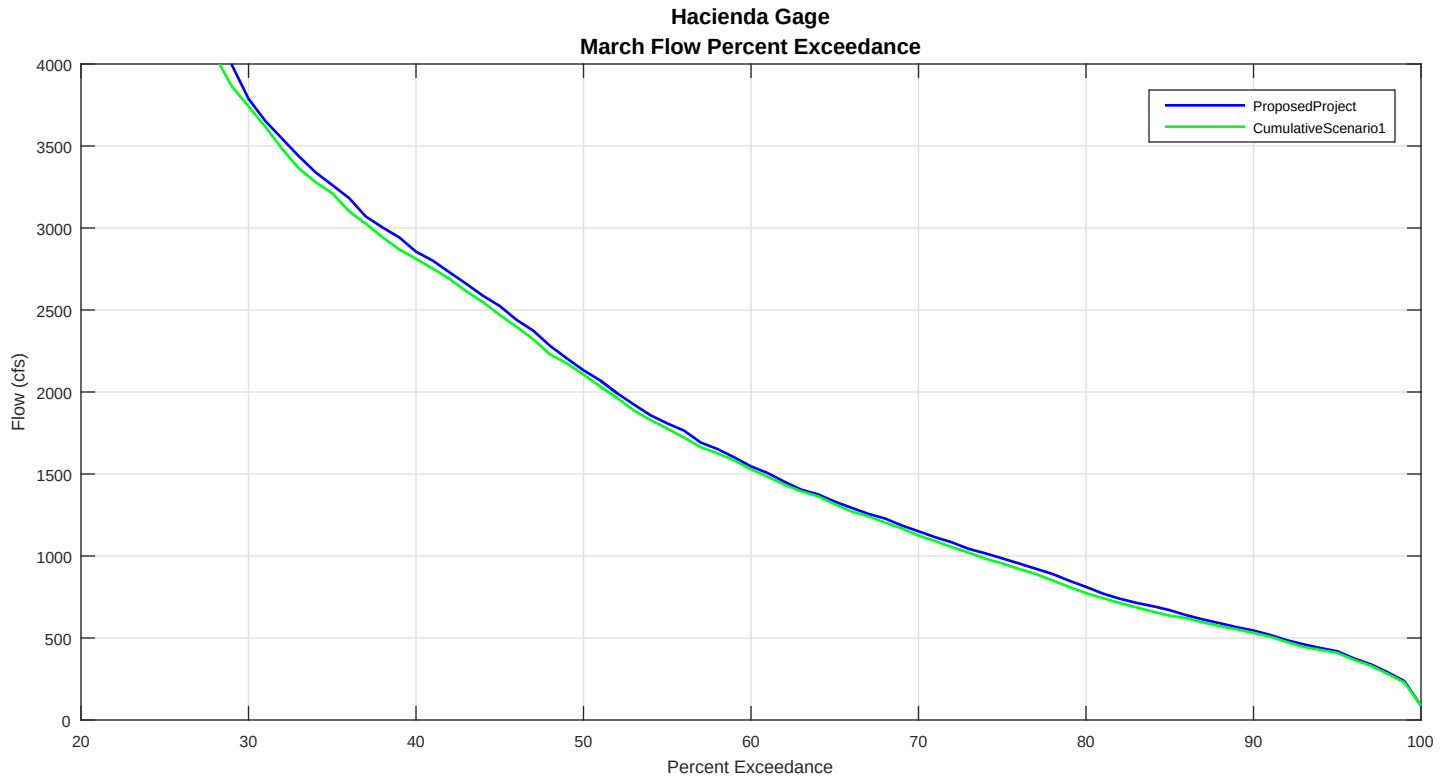
Hacienda Gage
March Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
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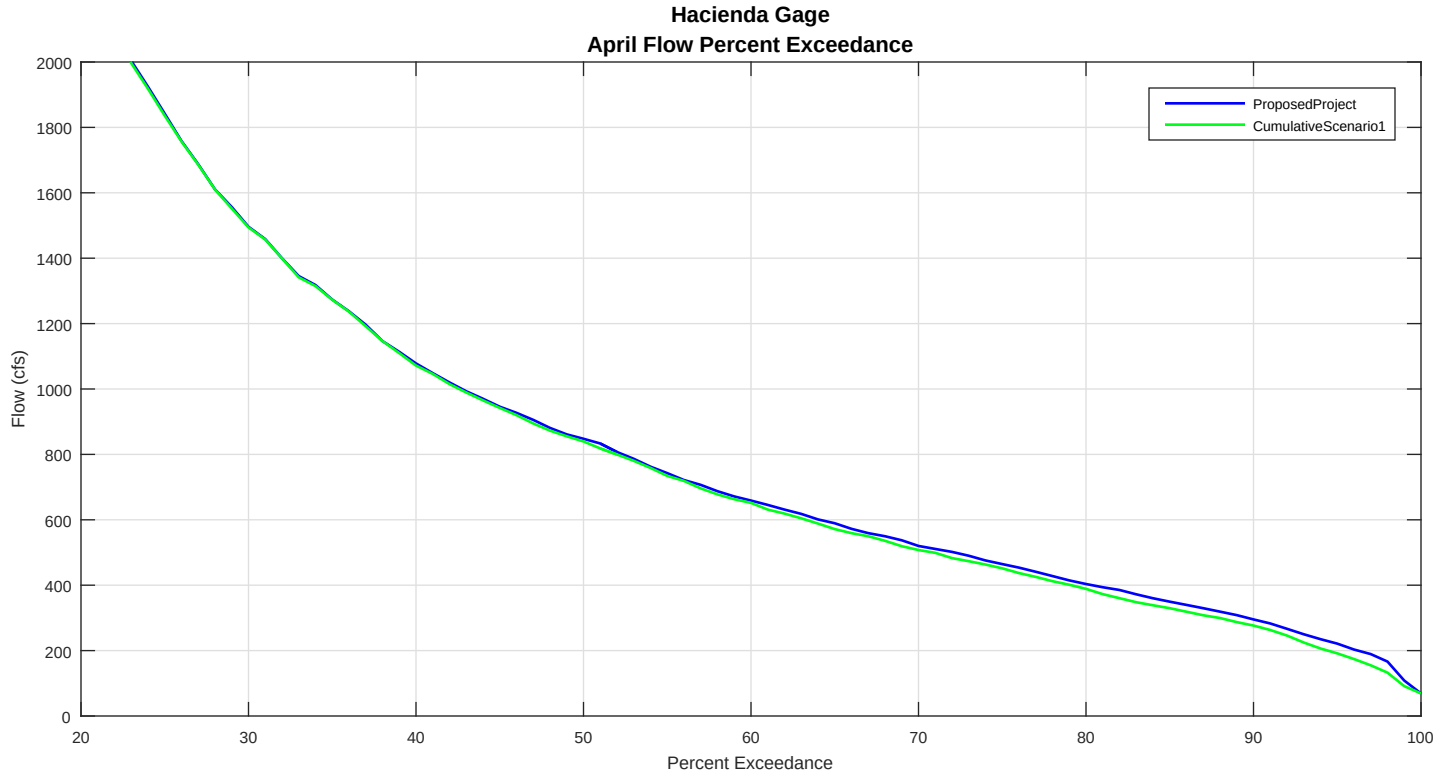
Hacienda Gage
April Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
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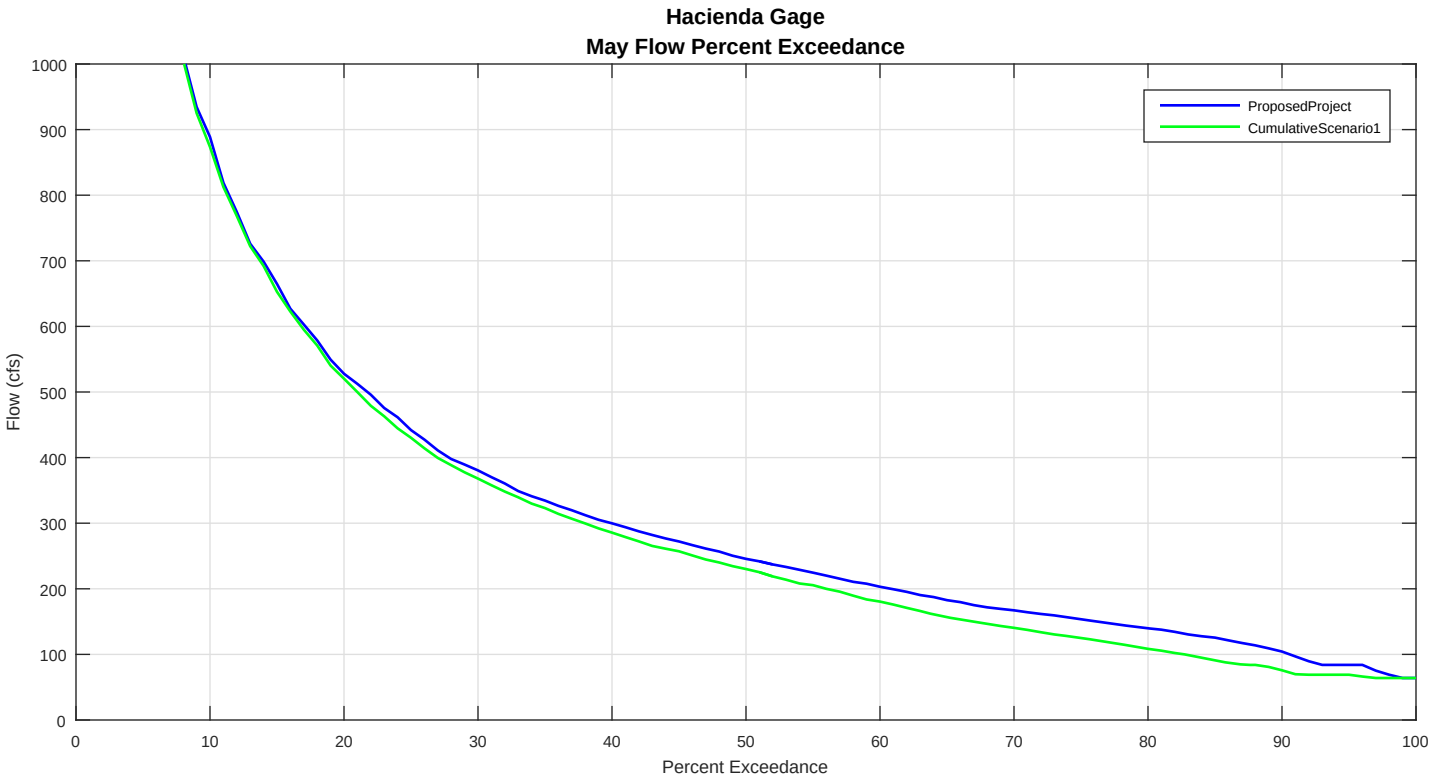
Hacienda Gage
May Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
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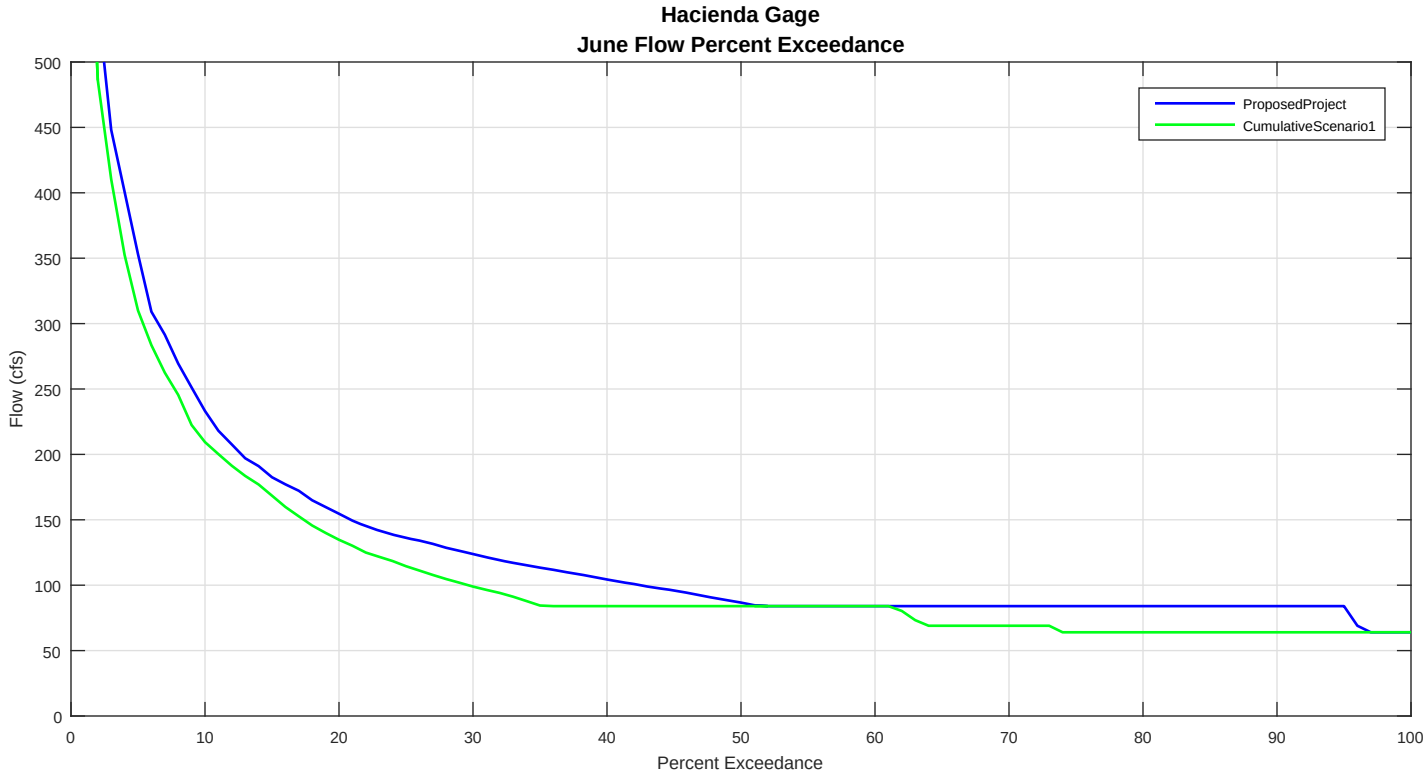
Hacienda Gage
June Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
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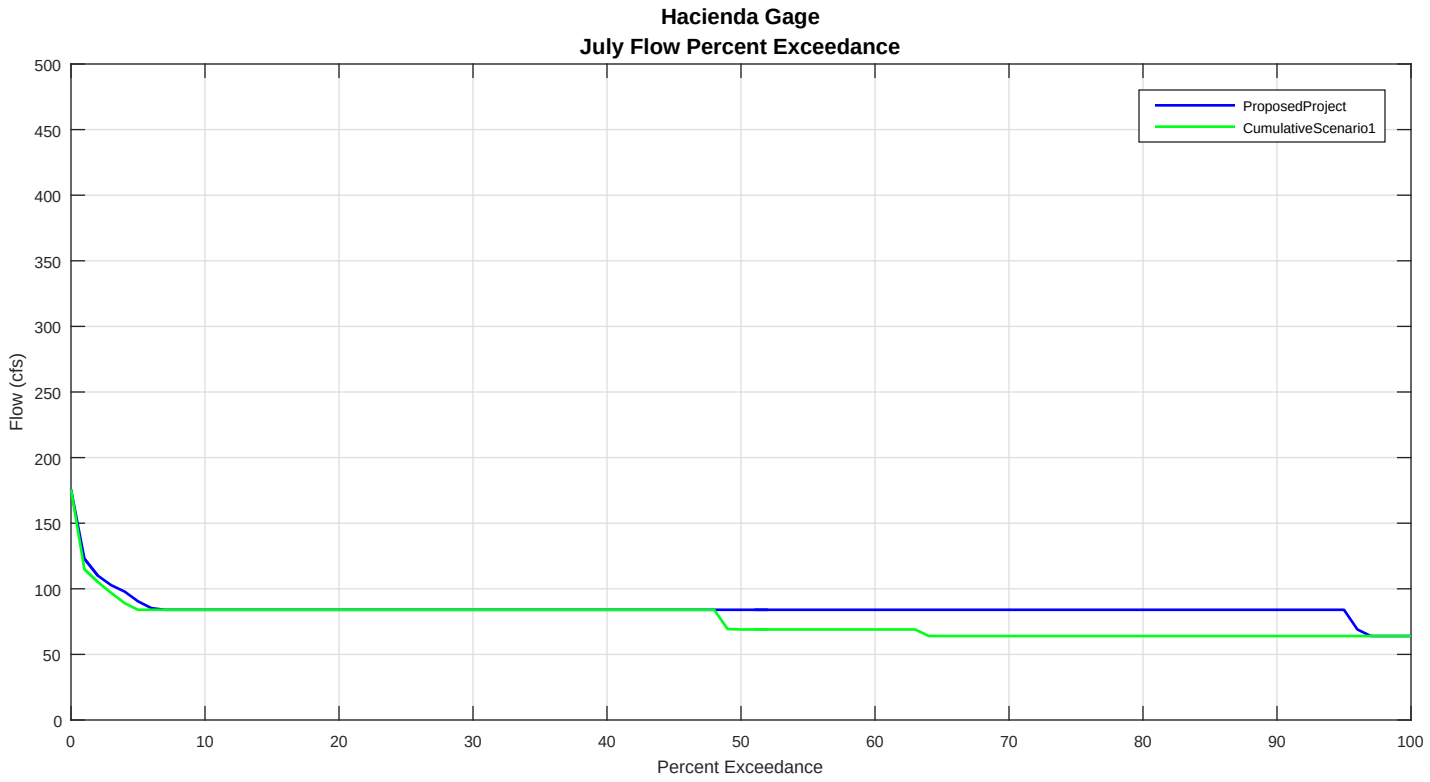
Hacienda Gage
July Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
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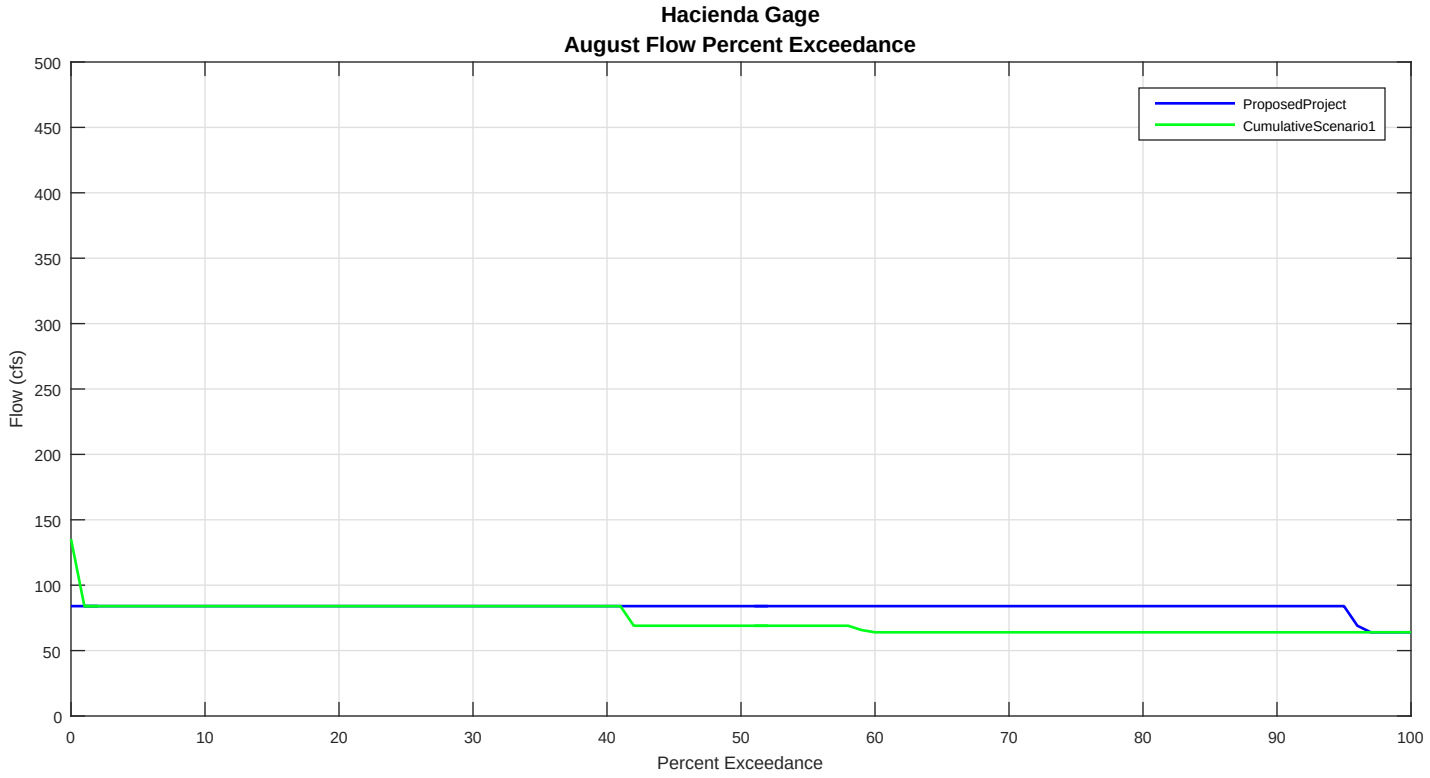
Hacienda Gage
August Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
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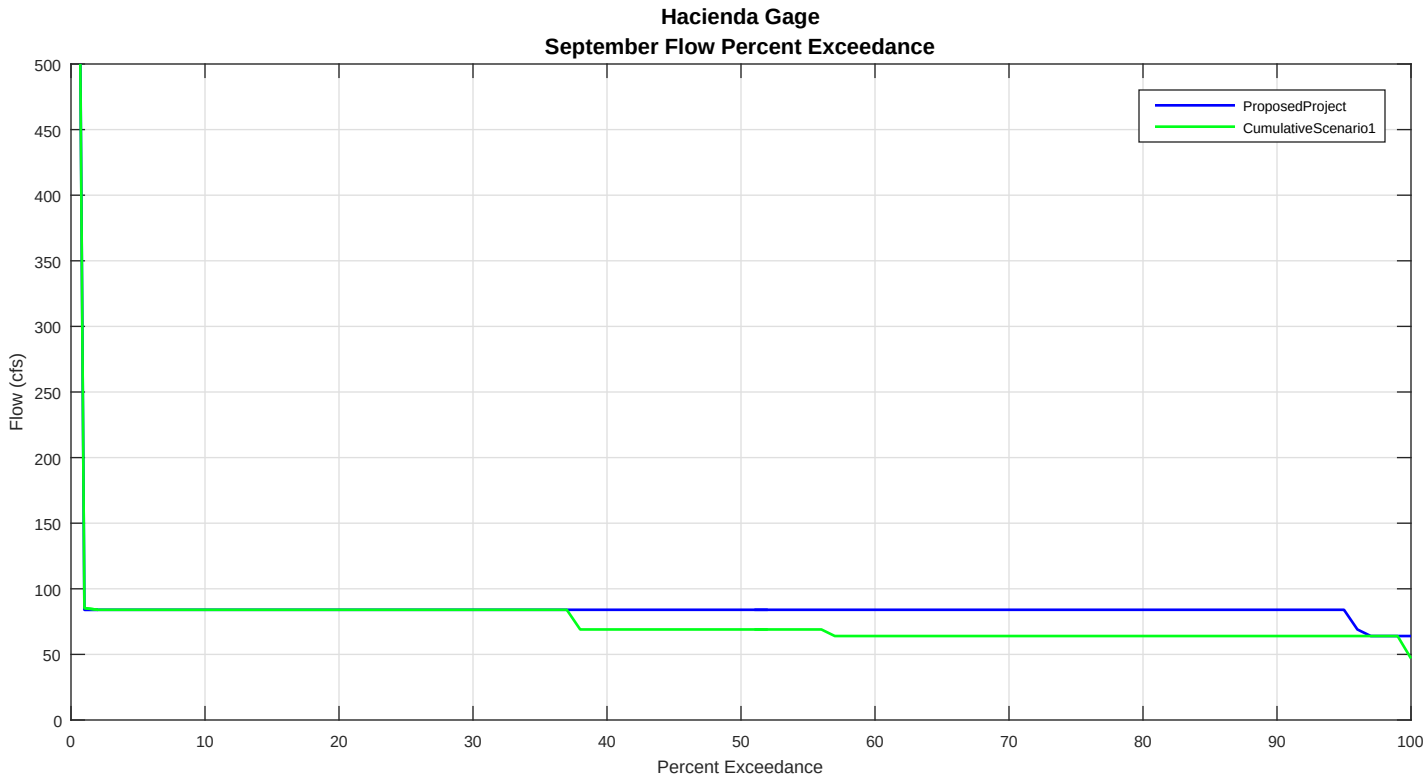
Hacienda Gage
September Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
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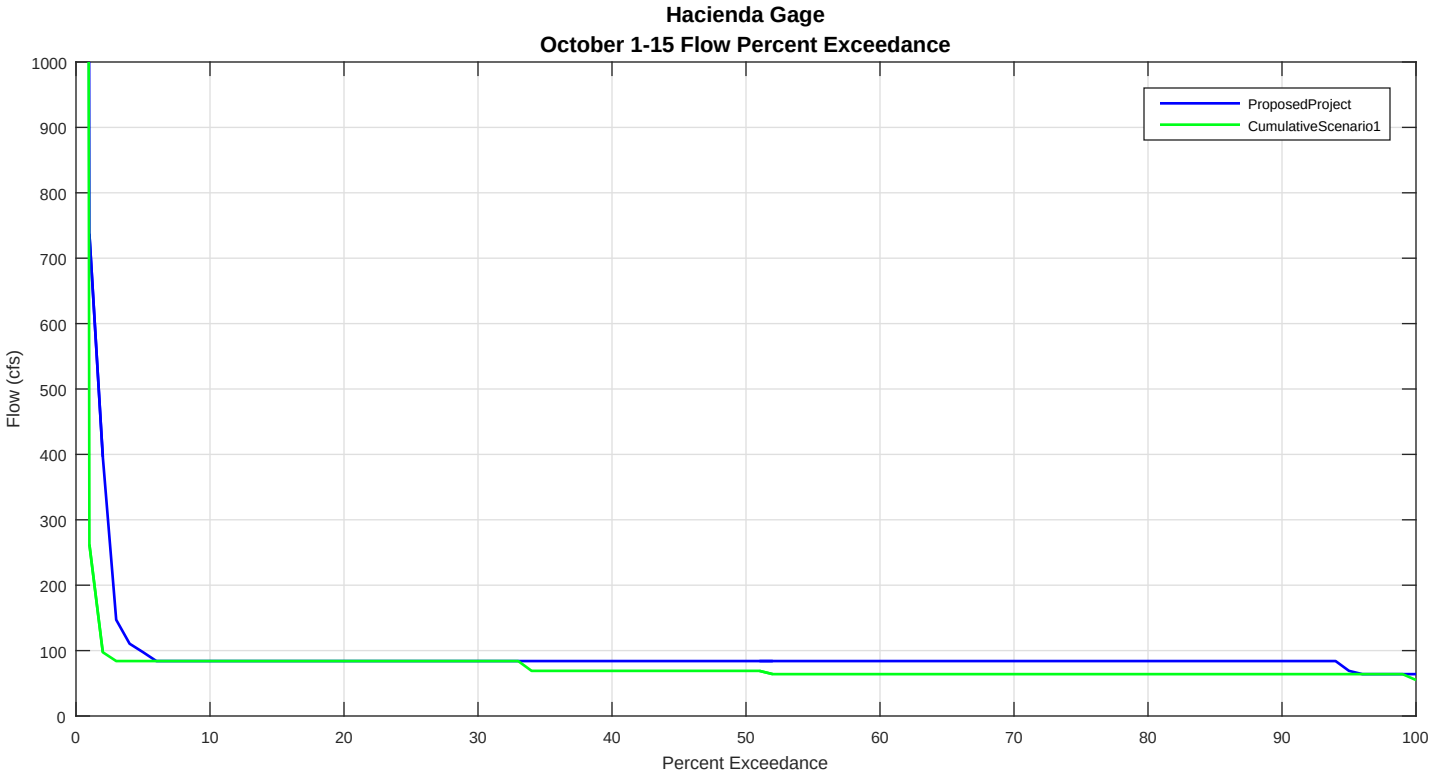
Hacienda Gage
October 1-15 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
100
200
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600
700
800
900
1000
0
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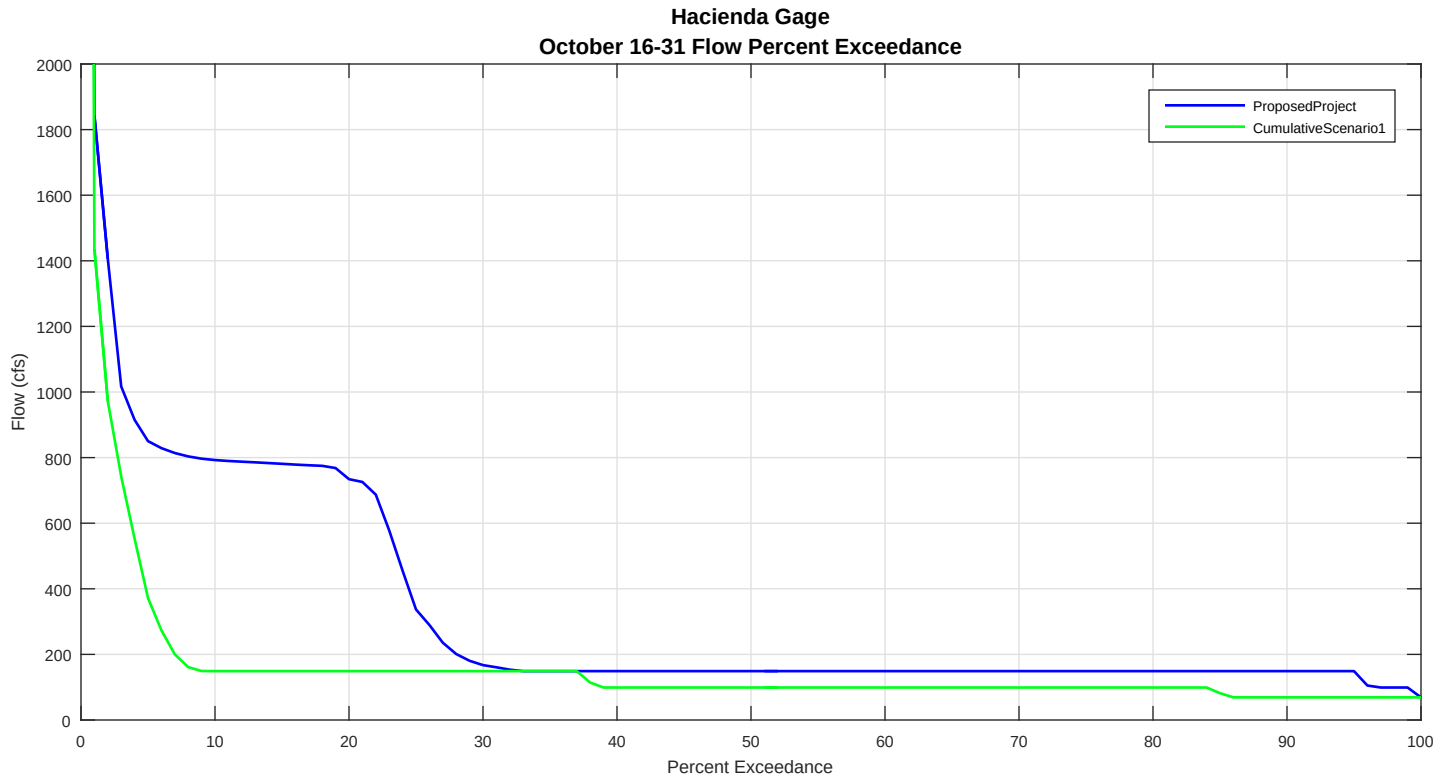
100


Hacienda Gage
October 16-31 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
200
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1600
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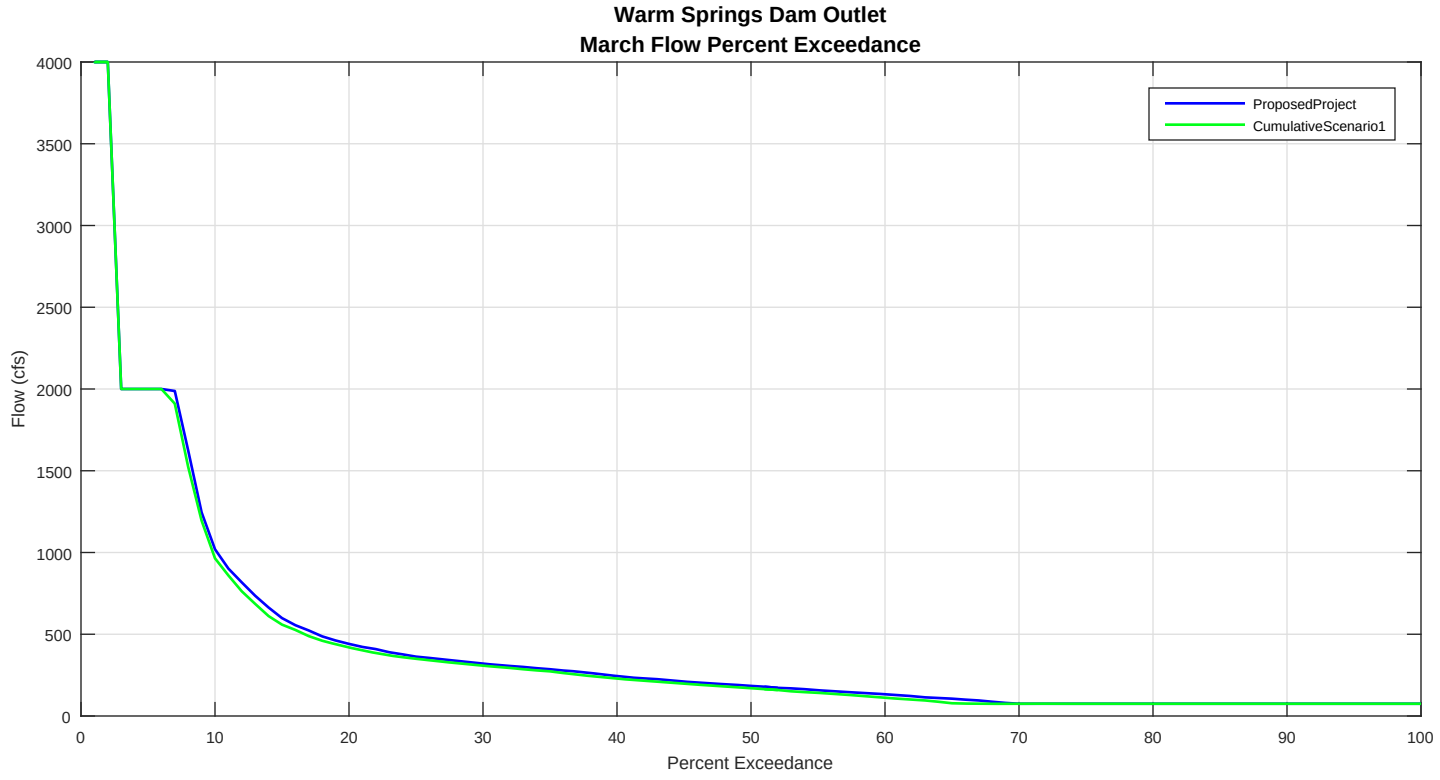
Warm Springs Dam Outlet
March Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
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2500
3000
3500
4000
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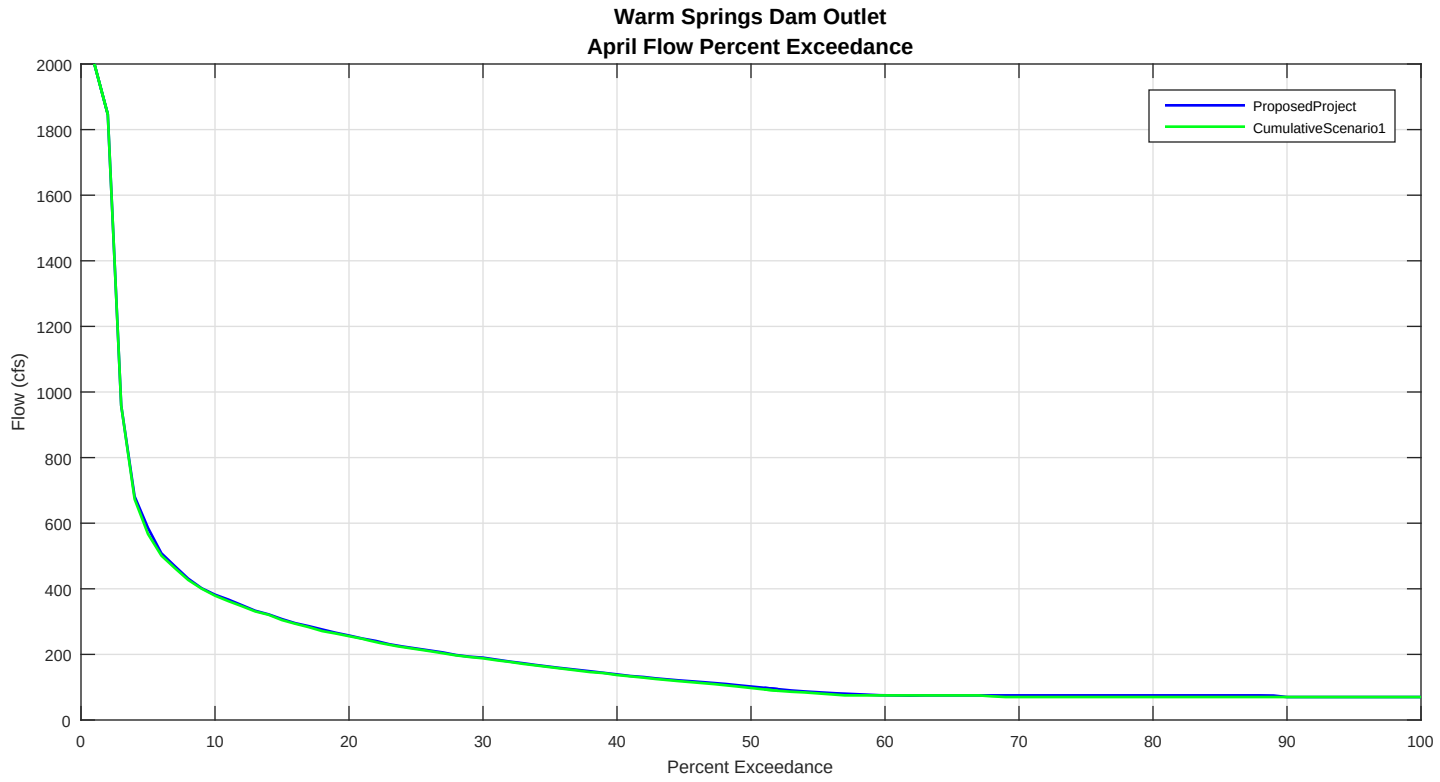
Warm Springs Dam Outlet
April Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
200
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1200
1400
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1800
2000
0
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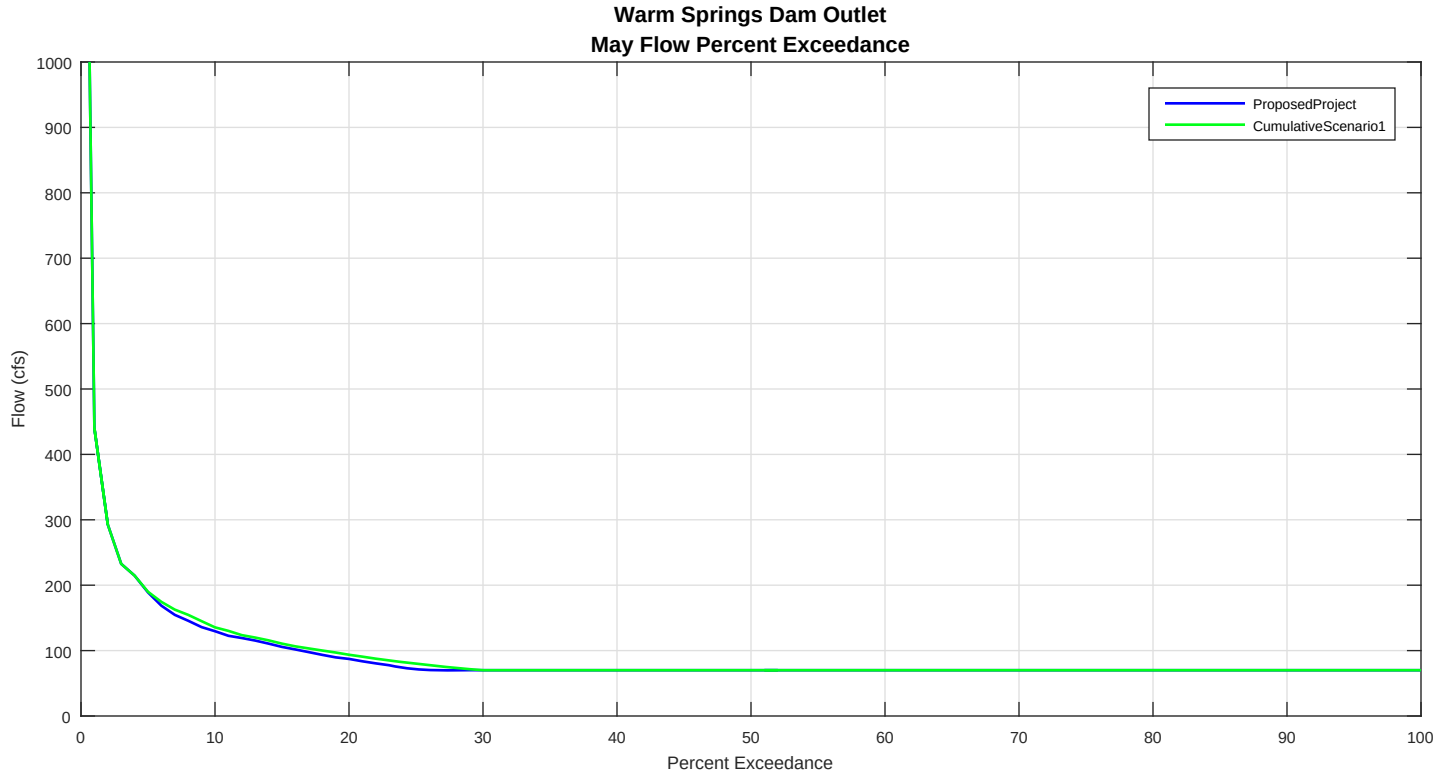
Warm Springs Dam Outlet
May Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
100
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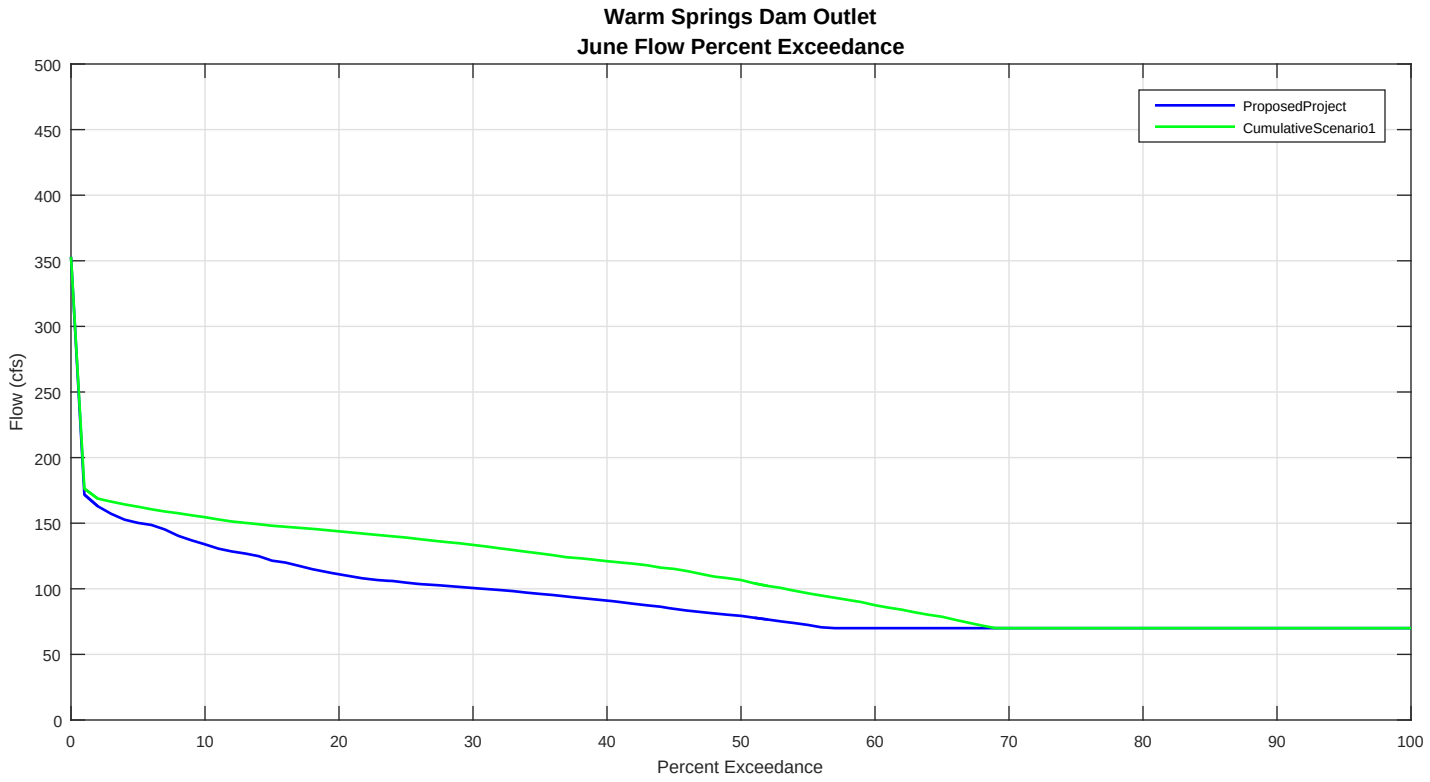
Warm Springs Dam Outlet
June Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
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350
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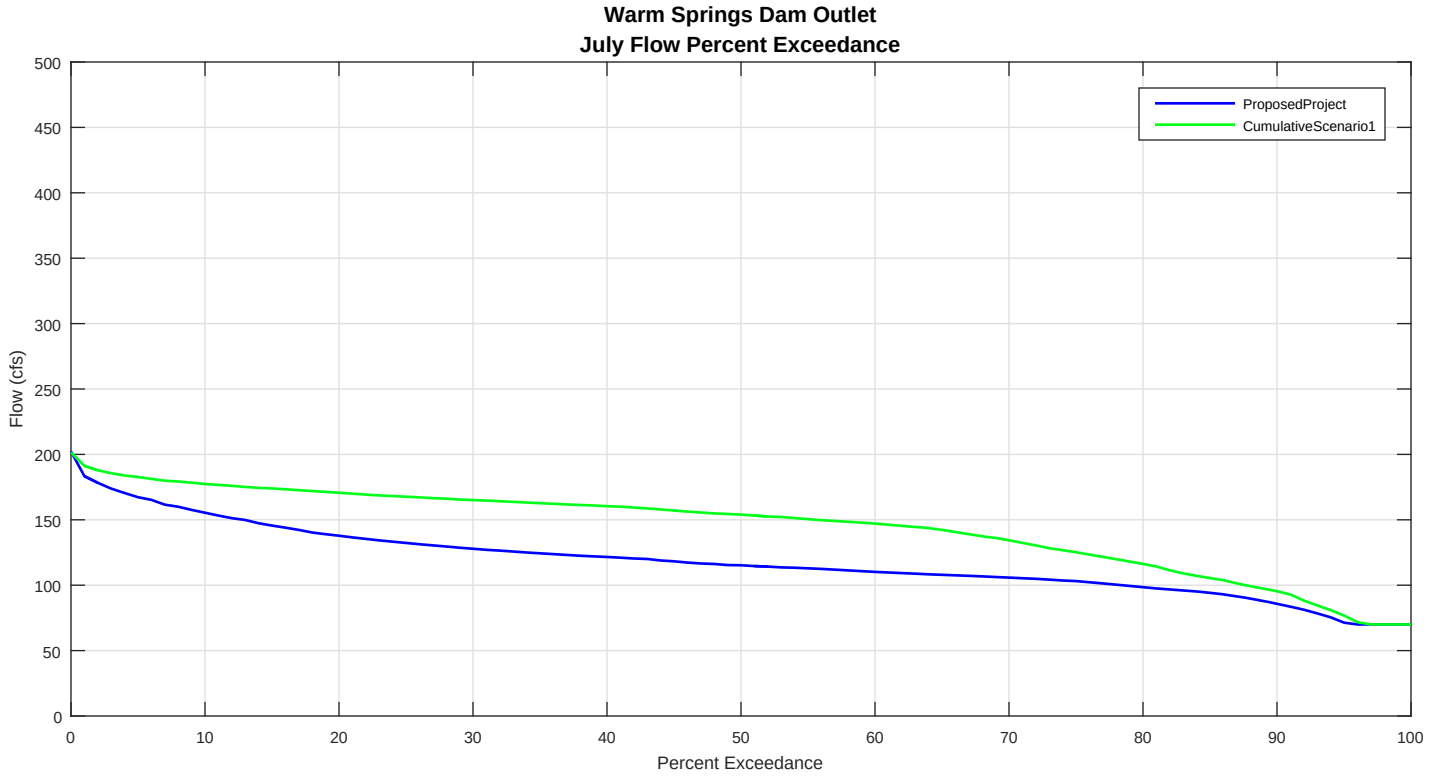
Warm Springs Dam Outlet
July Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
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500
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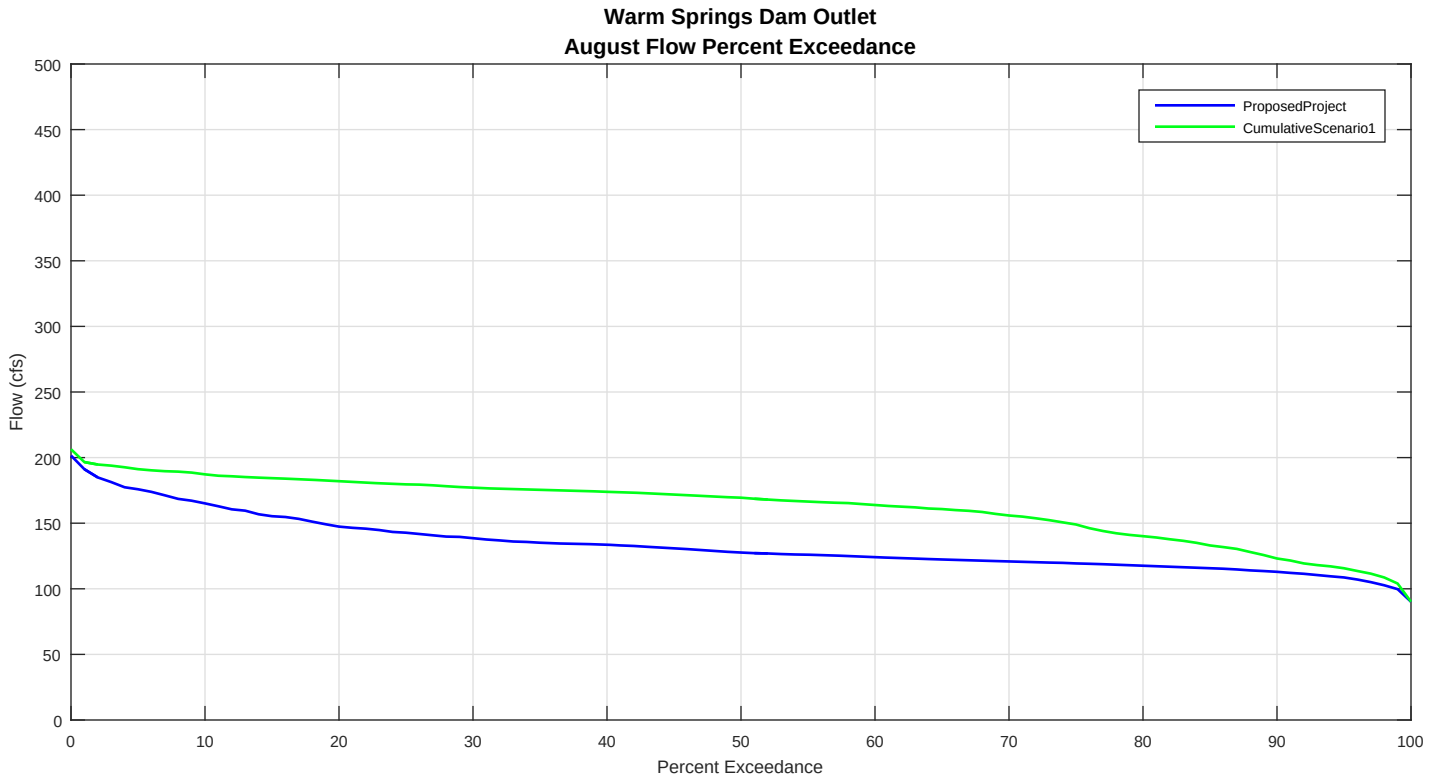
Warm Springs Dam Outlet
August Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
50
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450
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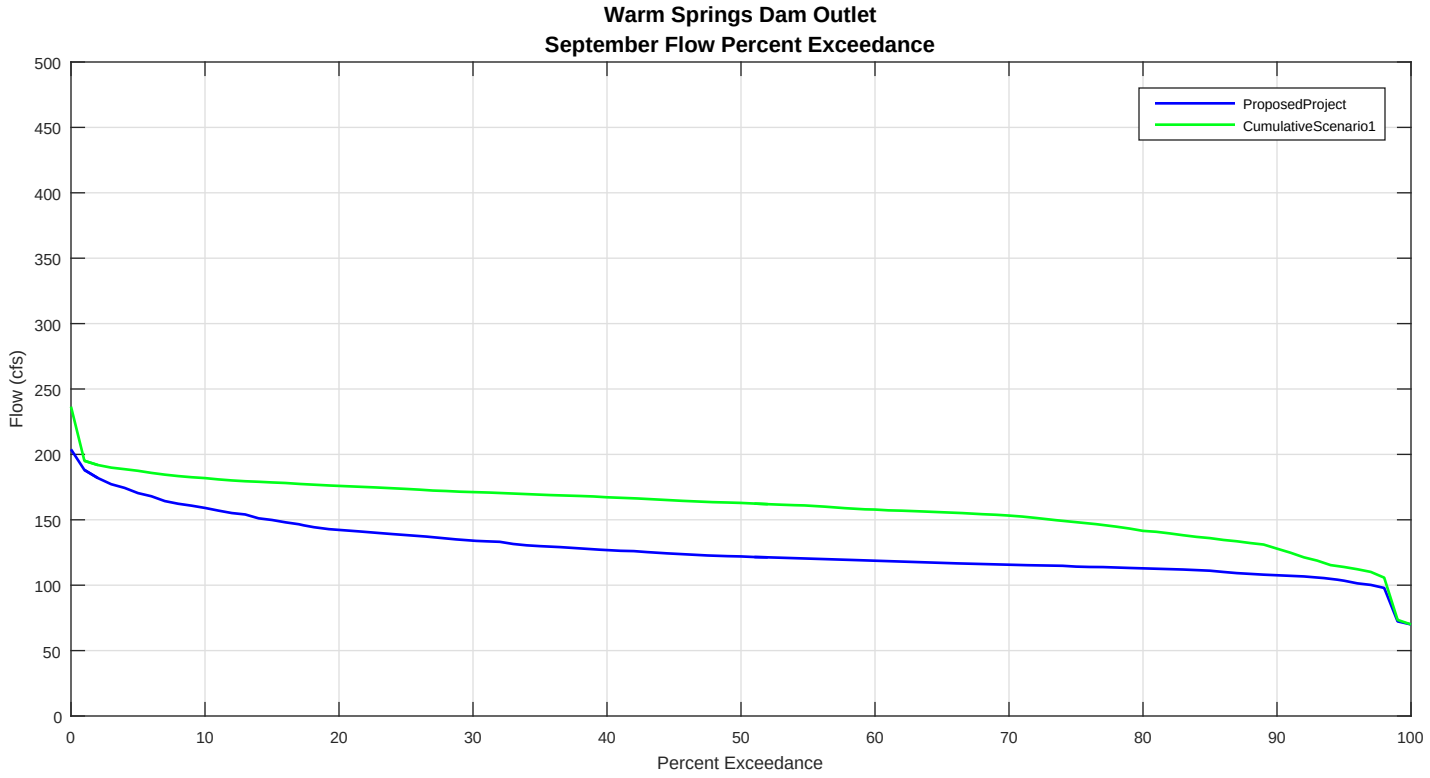
Warm Springs Dam Outlet
September Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
50
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500
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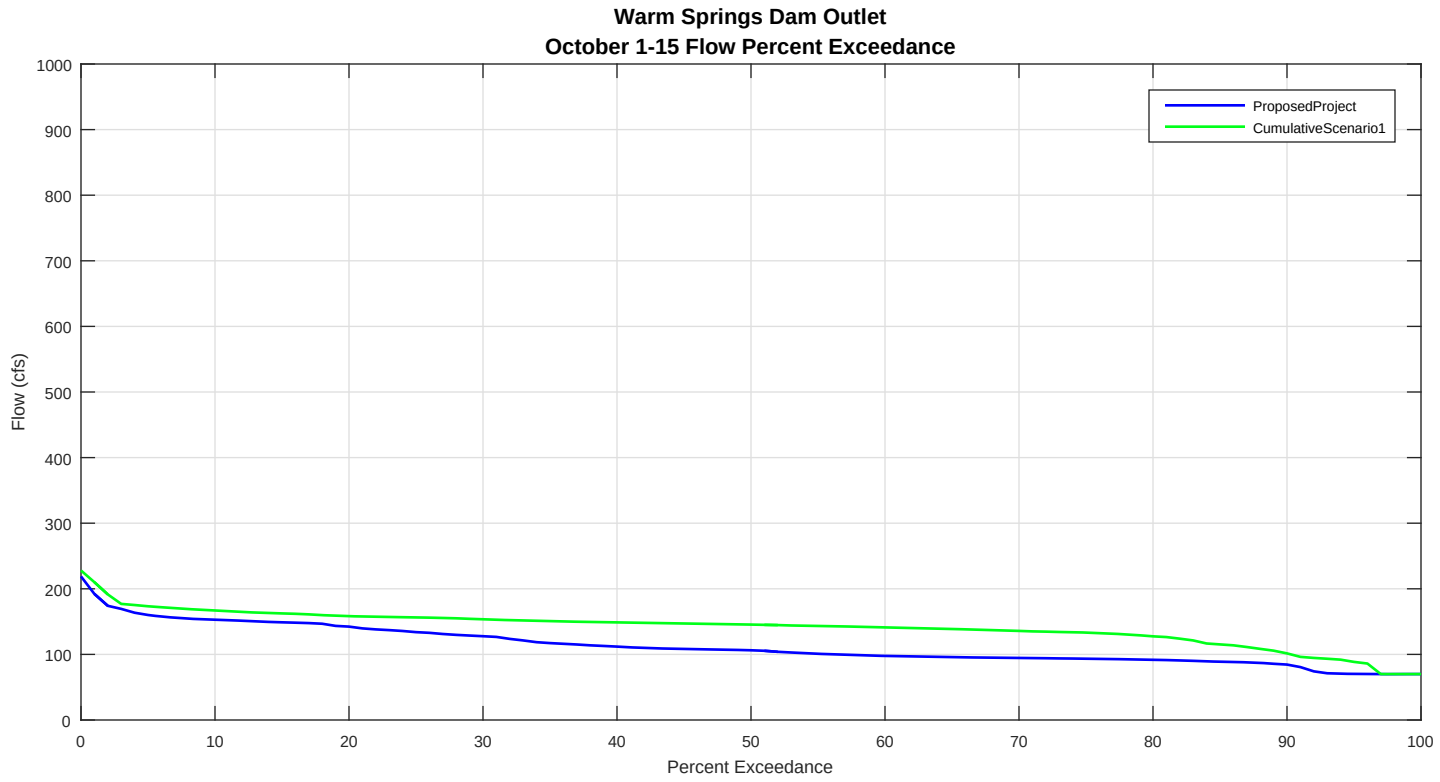
Warm Springs Dam Outlet
October 1-15 Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
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1000
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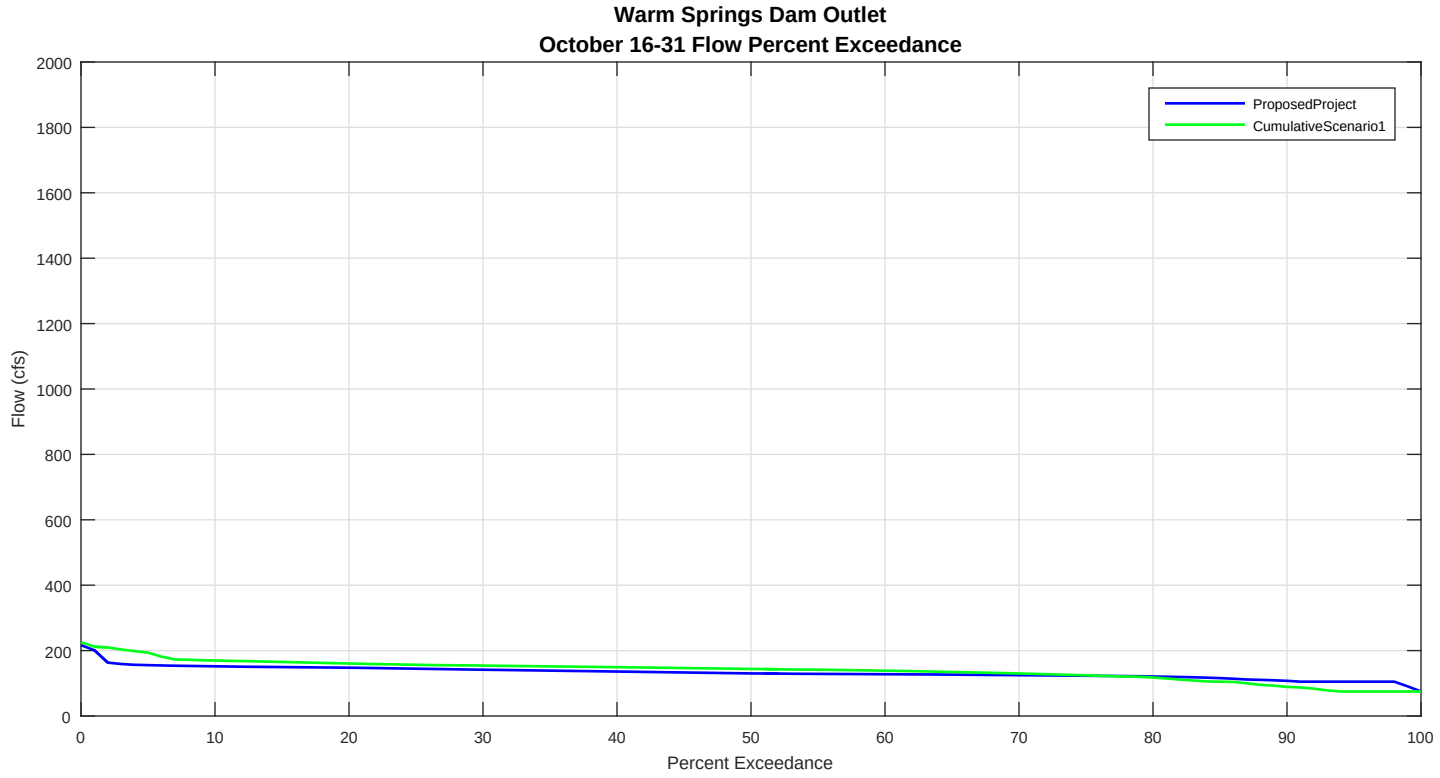
Warm Springs Dam Outlet
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
200
400
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800
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1200
1400
1600
1800
2000
0
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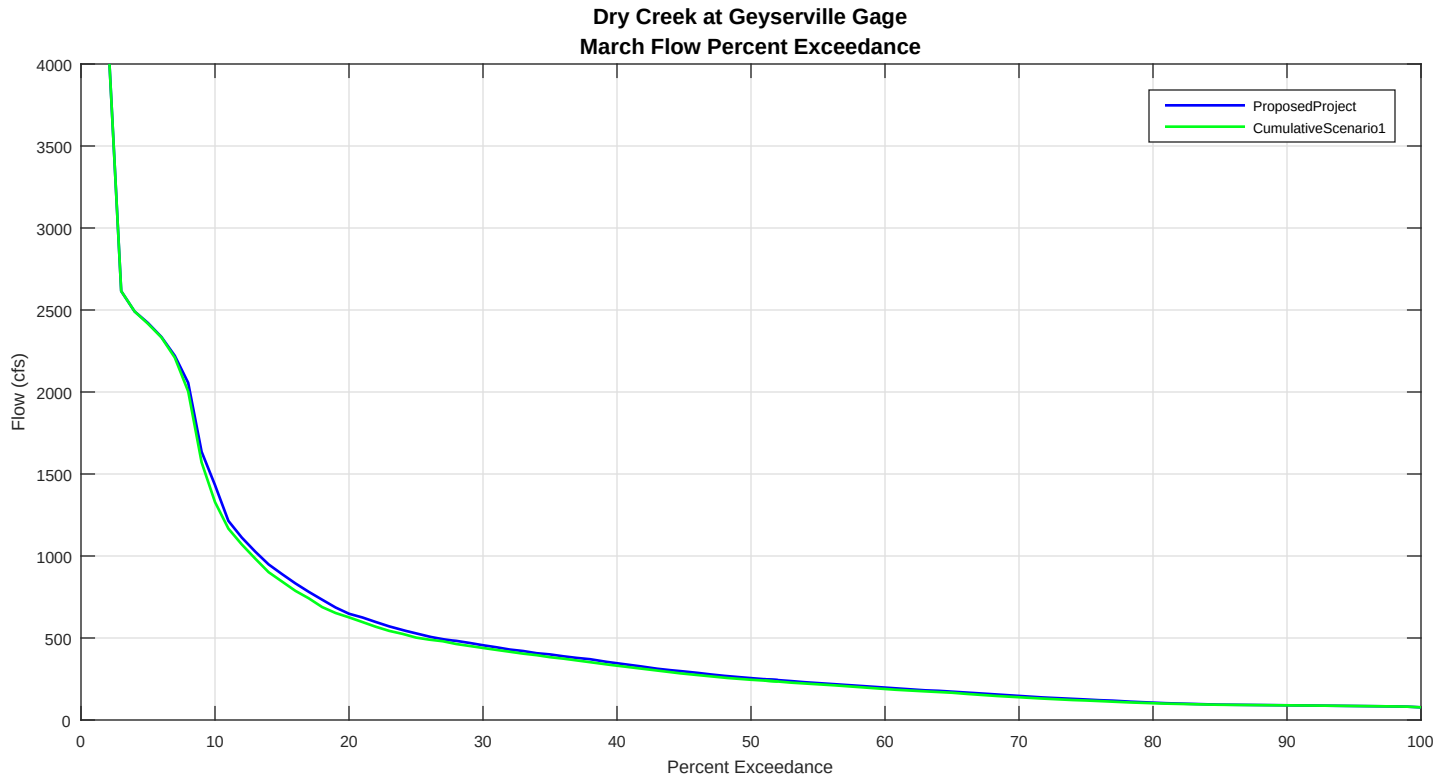
Dry Creek at Geyserville Gage
March Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
500
1000
1500
2000
2500
3000
3500
4000
0
10
20
30
40
50
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70
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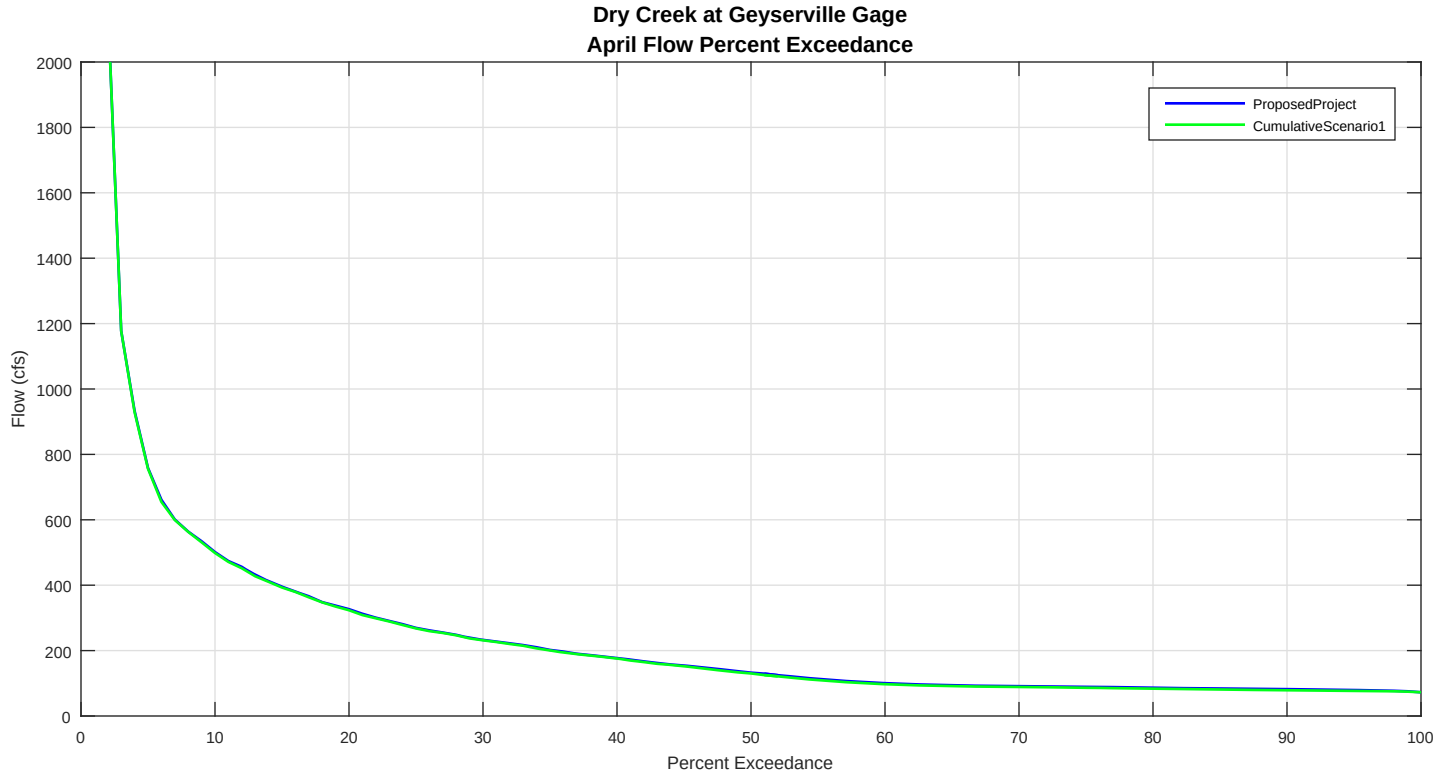
100


Dry Creek at Geyserville Gage
April Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
200
400
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800
1000
1200
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1800
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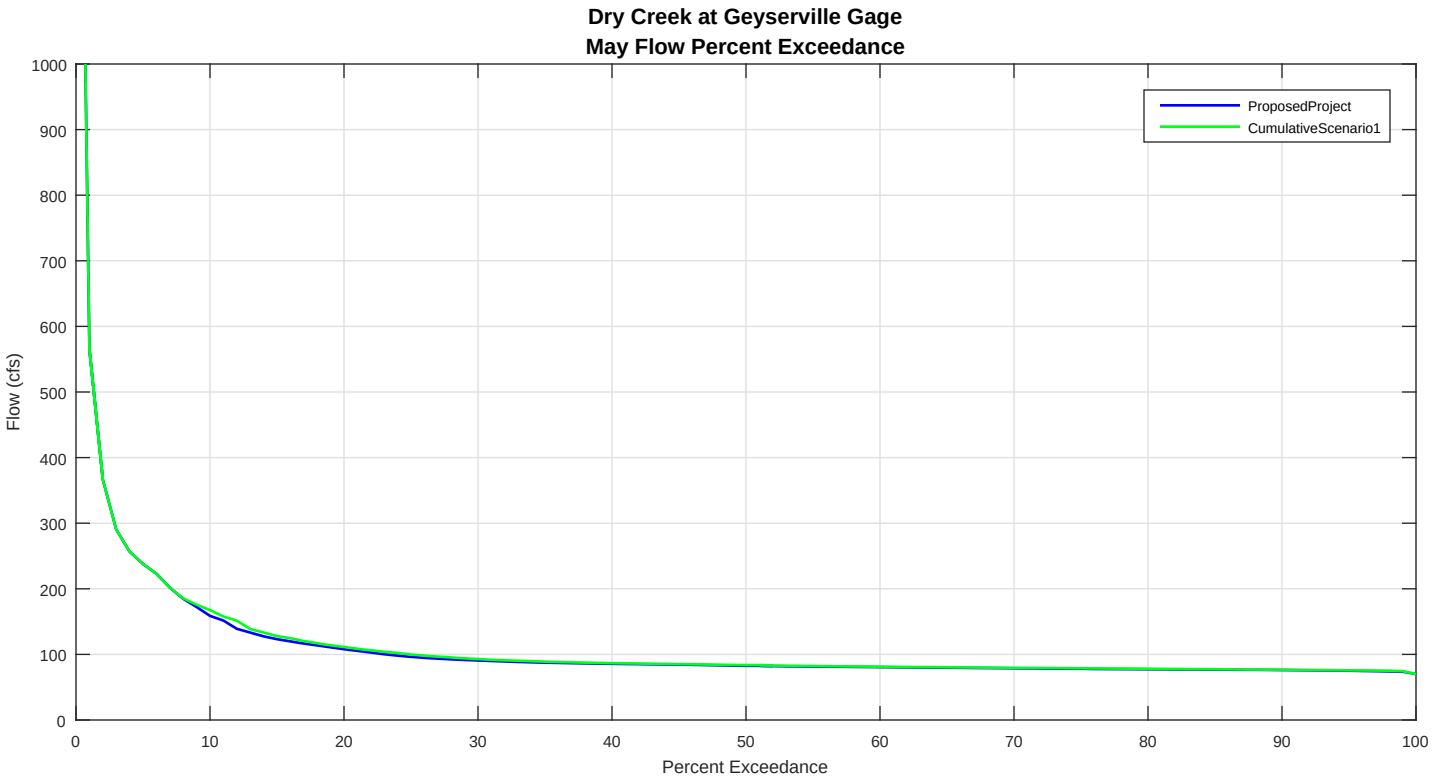
Dry Creek at Geyserville Gage
May Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
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400
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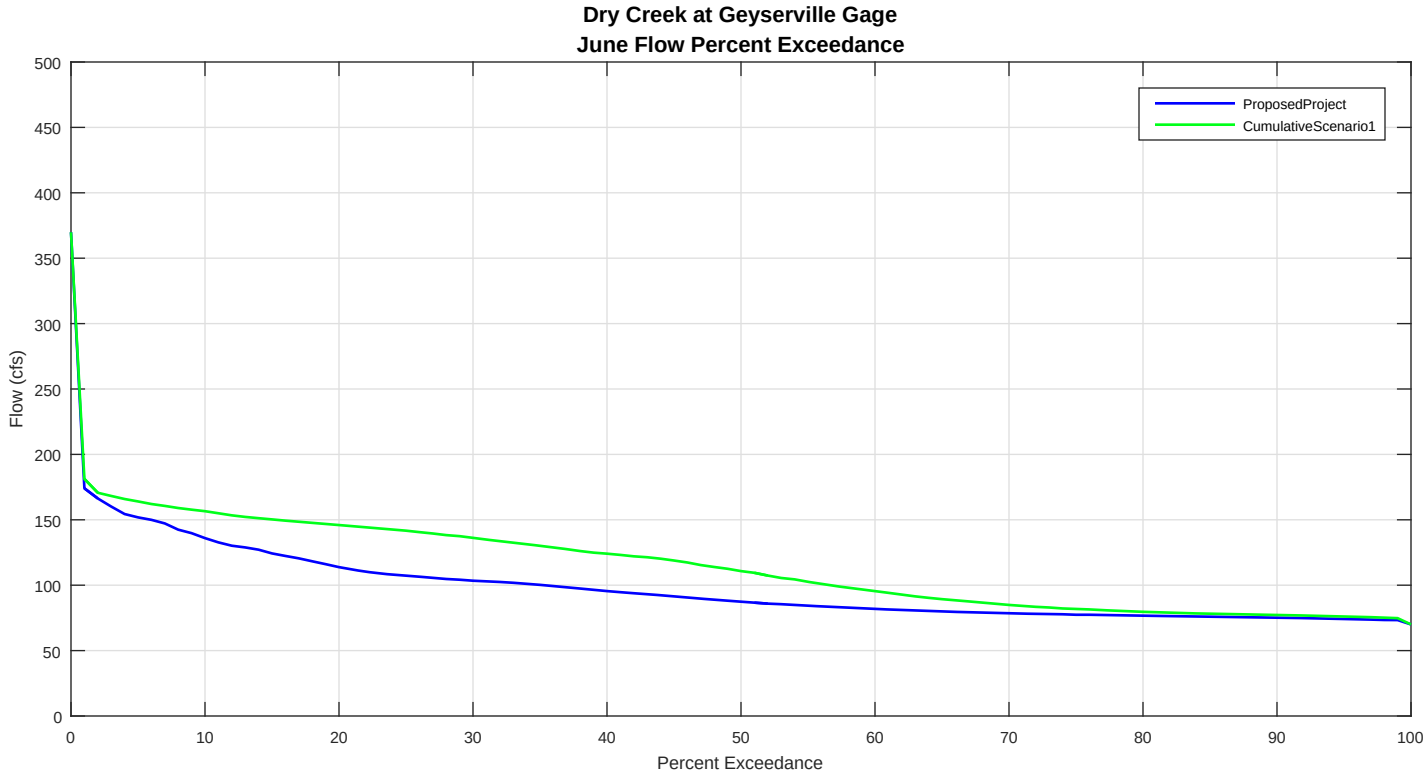
Dry Creek at Geyserville Gage
June Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
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100
150
200
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300
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400
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500
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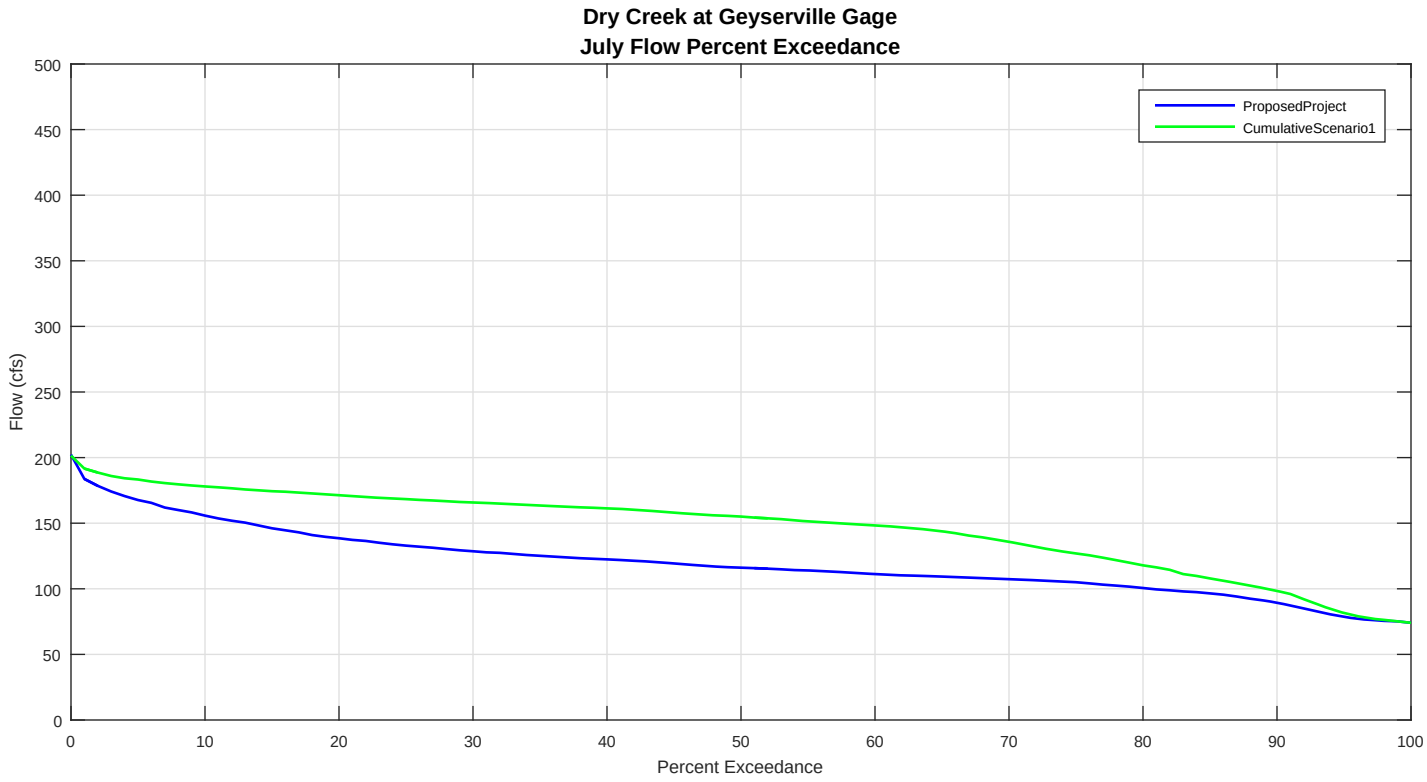
Dry Creek at Geyserville Gage
July Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
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150
200
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300
350
400
450
500
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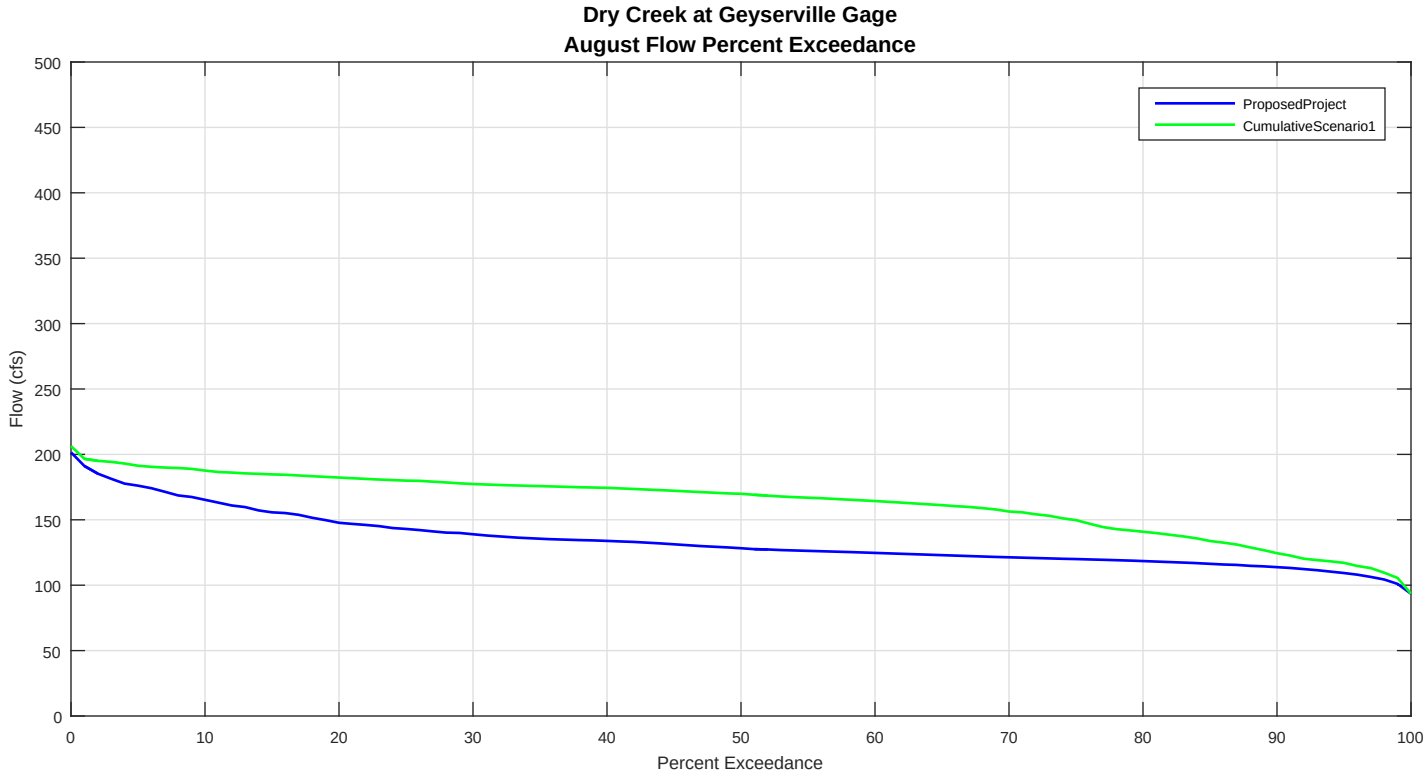
Dry Creek at Geyserville Gage
August Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
50
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200
250
300
350
400
450
500
0
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30
40
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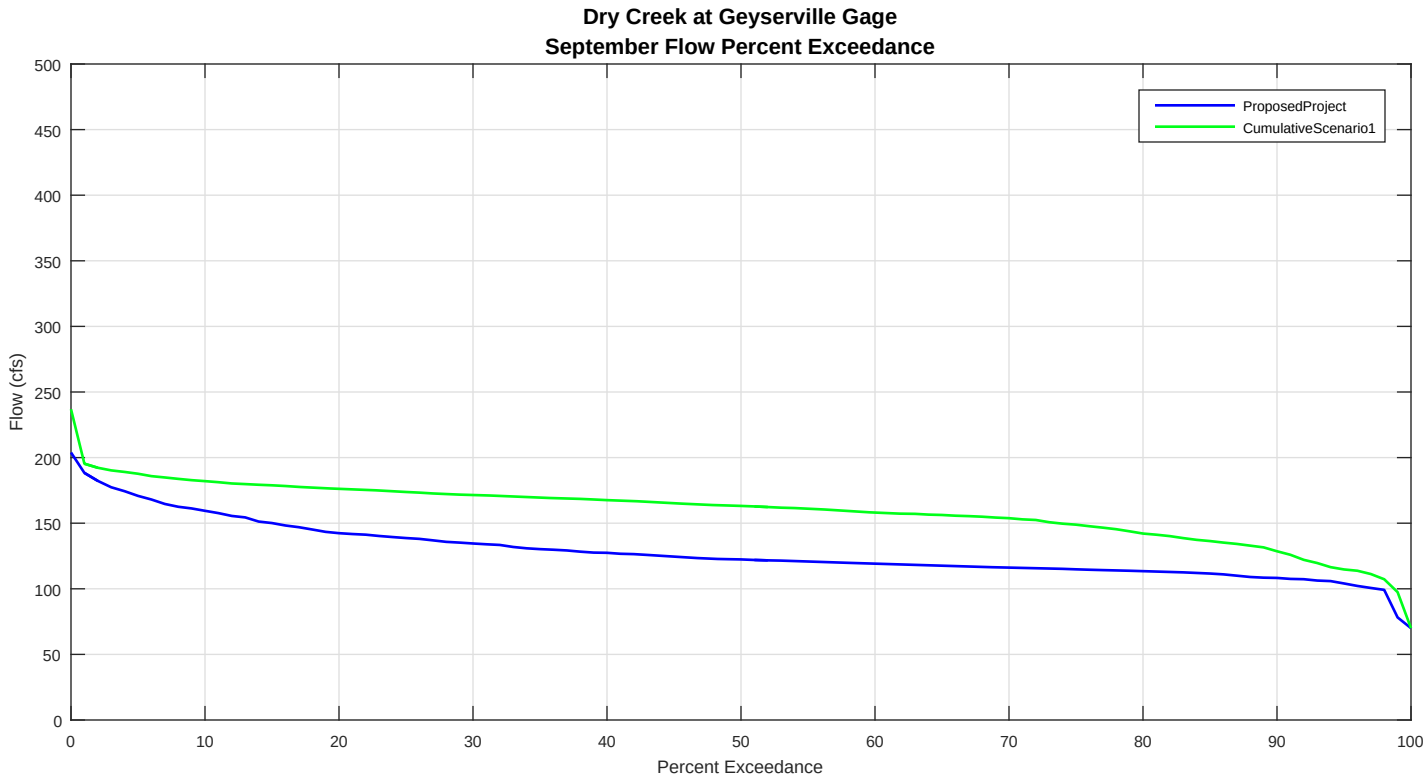
100


Dry Creek at Geyserville Gage
September Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
50
100
150
200
250
300
350
400
450
500
0
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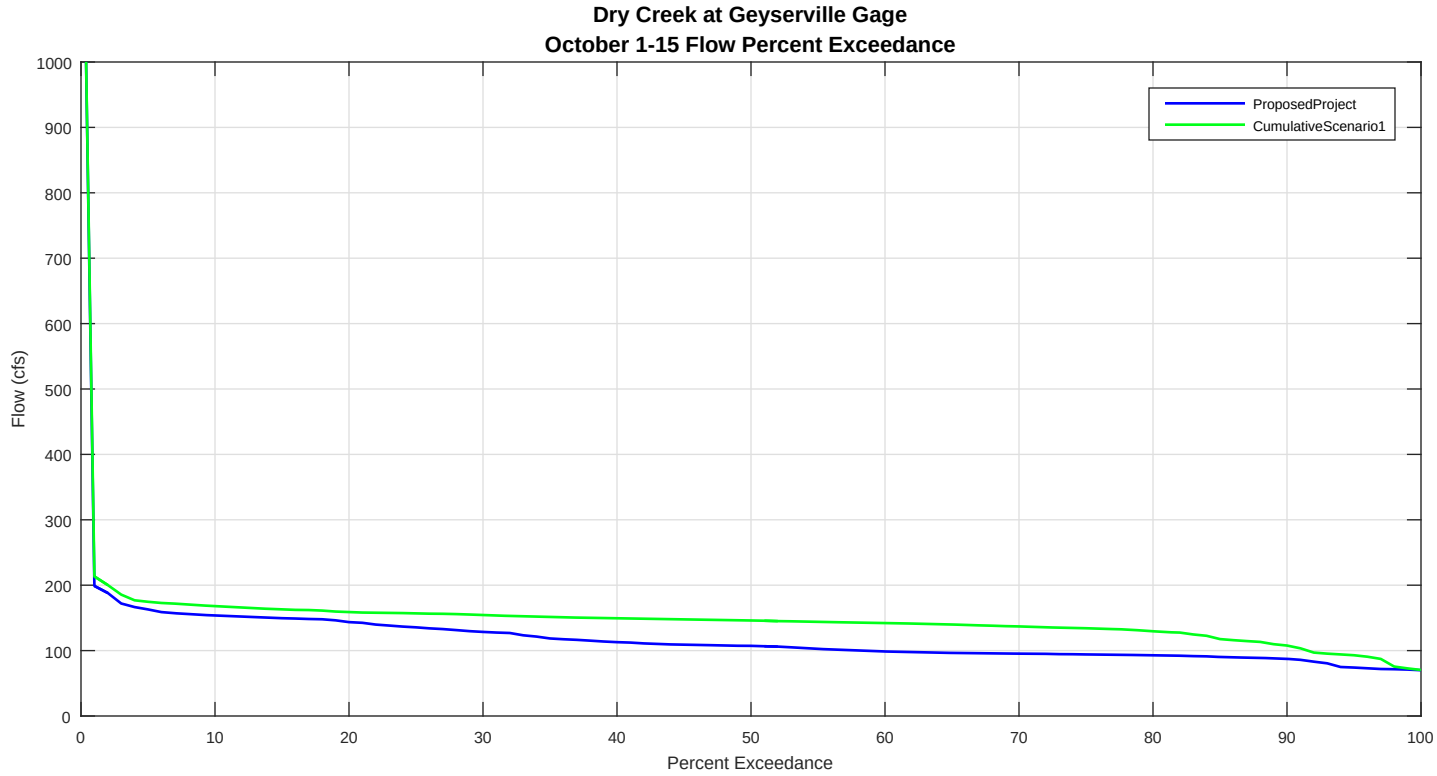
Dry Creek at Geyserville Gage
October 1-15 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
100
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300
400
500
600
700
800
900
1000
0
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20
30
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90
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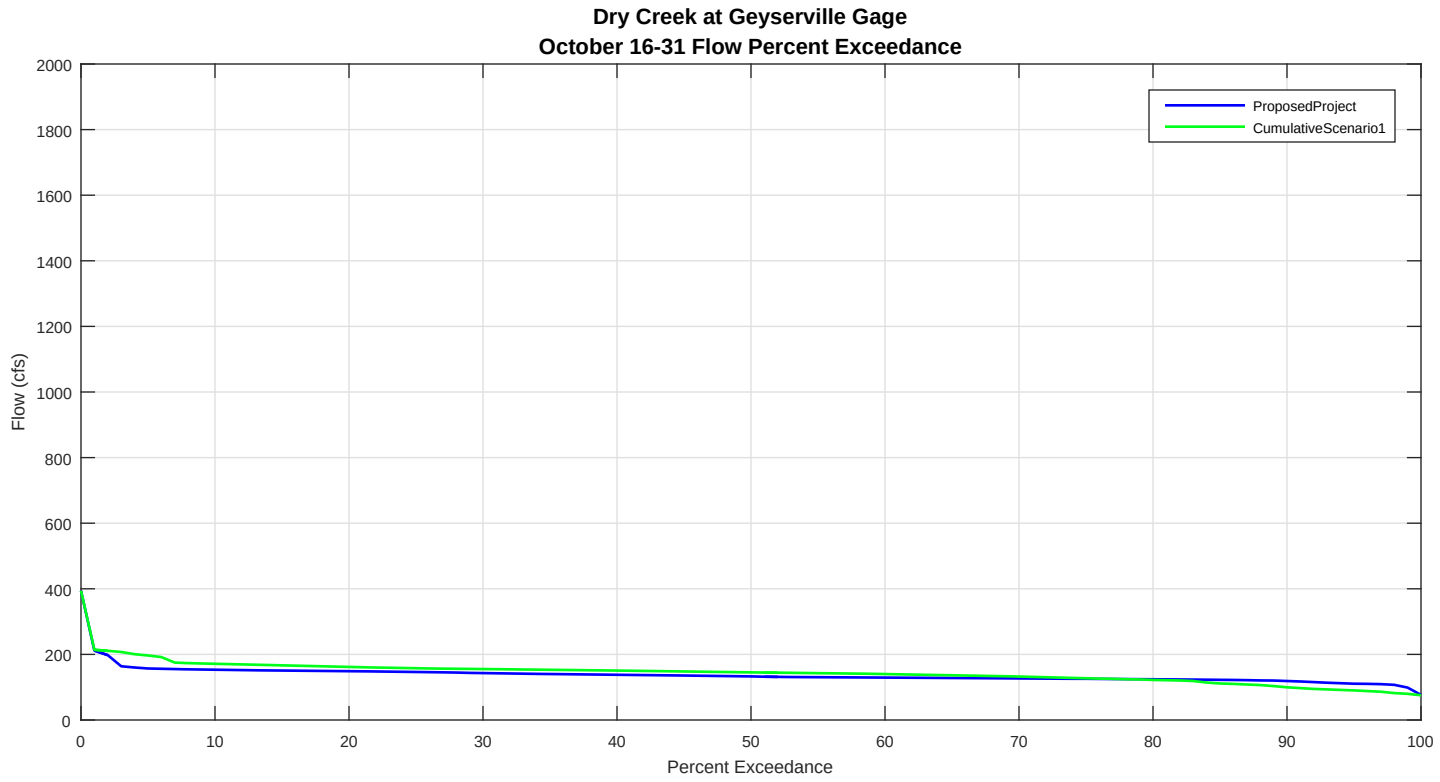
Dry Creek at Geyserville Gage
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
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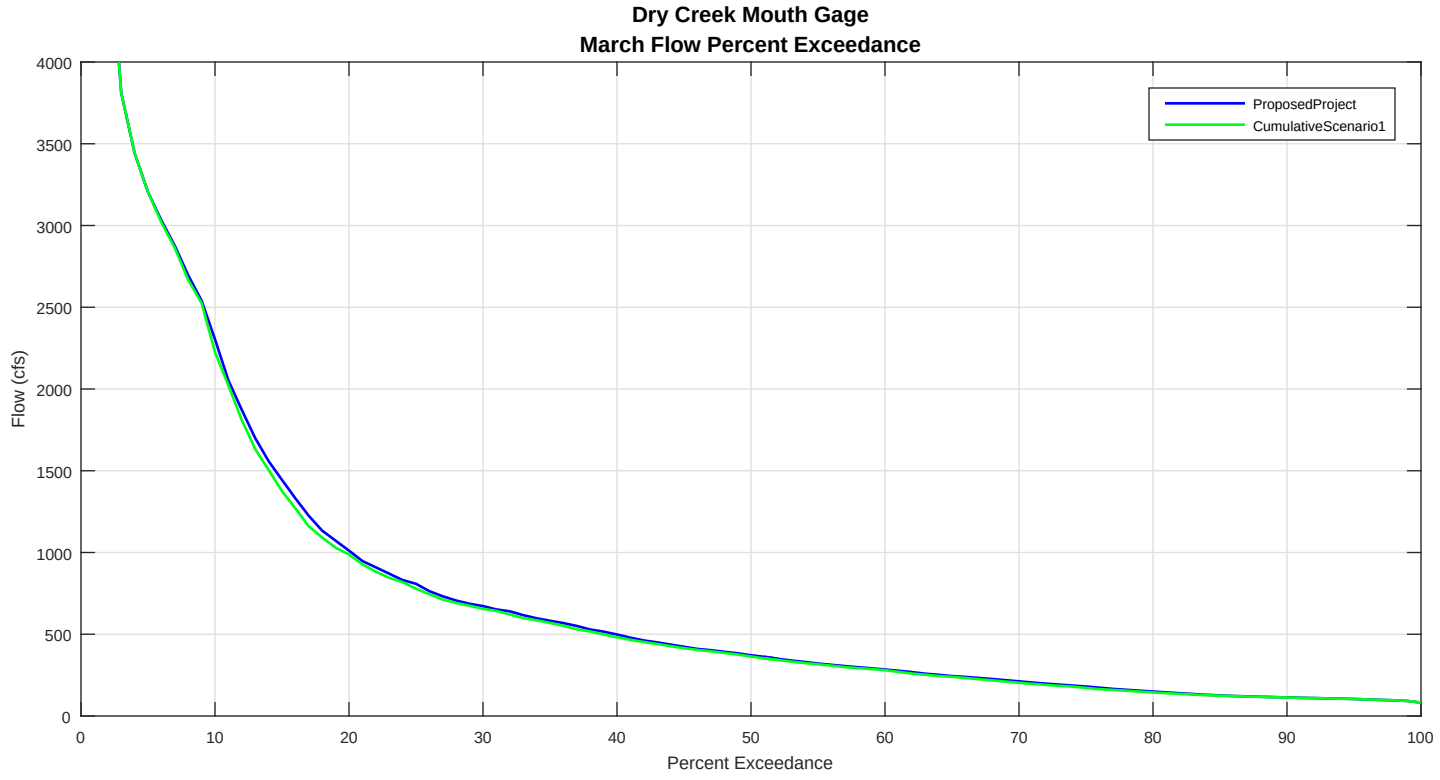
90
100


Dry Creek Mouth Gage
March Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
500
1000
1500
2000
2500
3000
3500
4000
0
10
20
30
40
50
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70
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90
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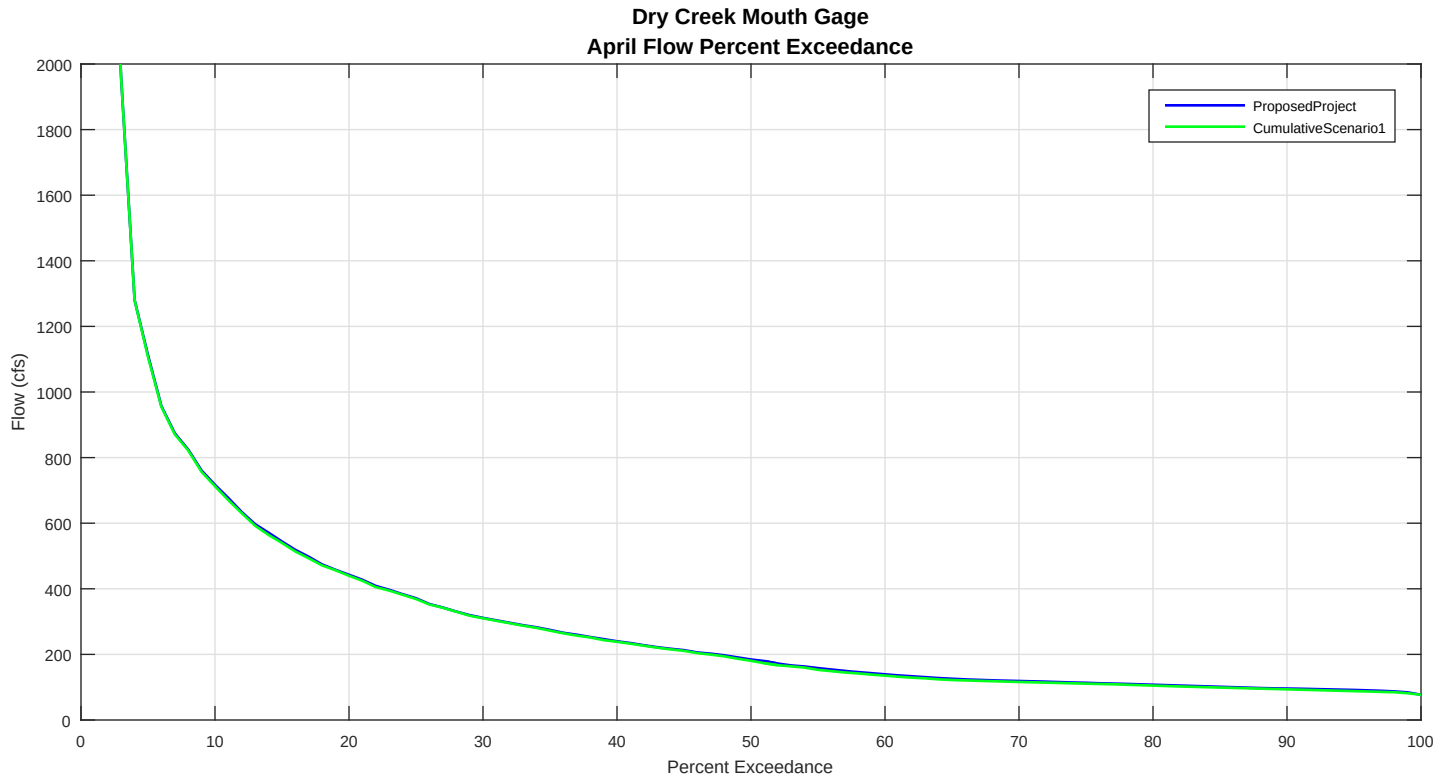
Dry Creek Mouth Gage
April Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
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30
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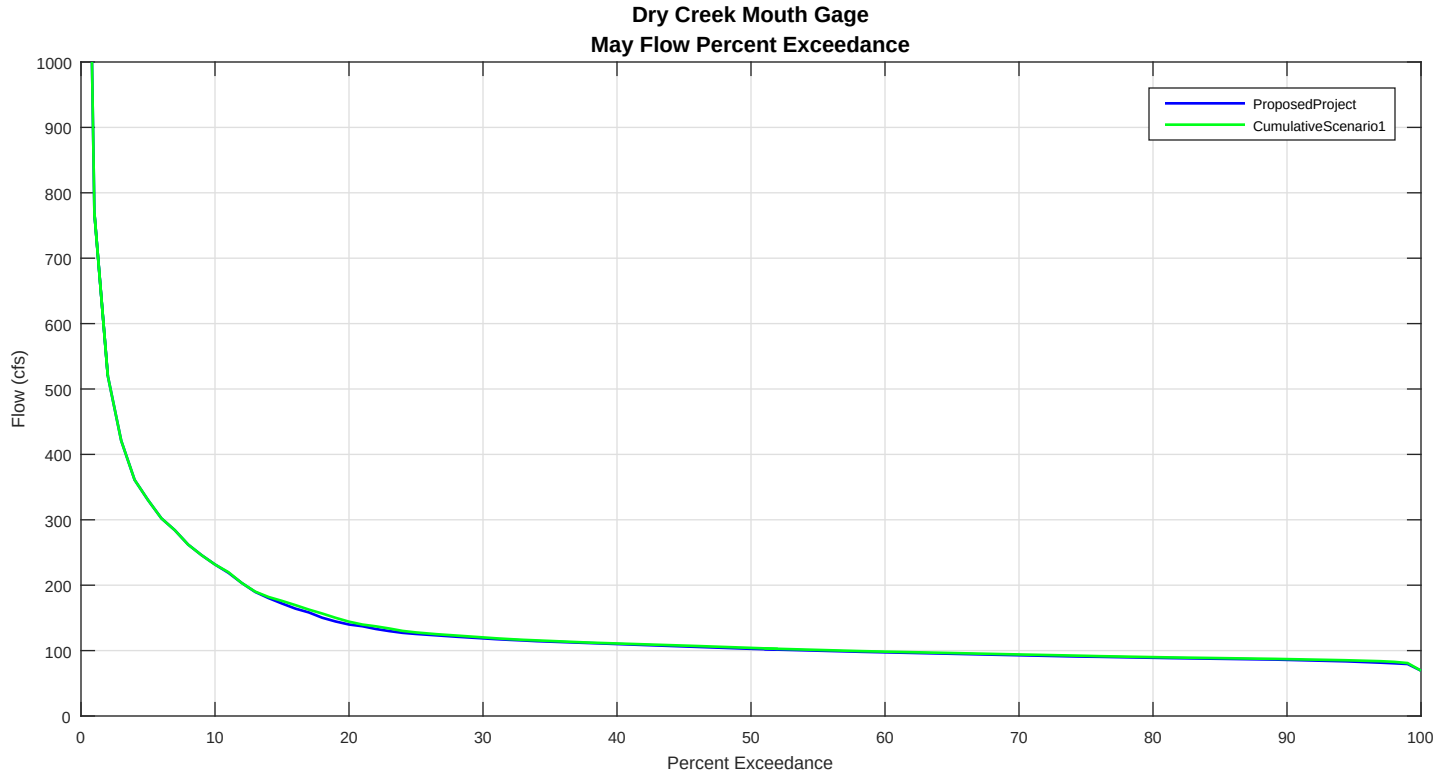
Dry Creek Mouth Gage
May Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
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300
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500
600
700
800
900
1000
0
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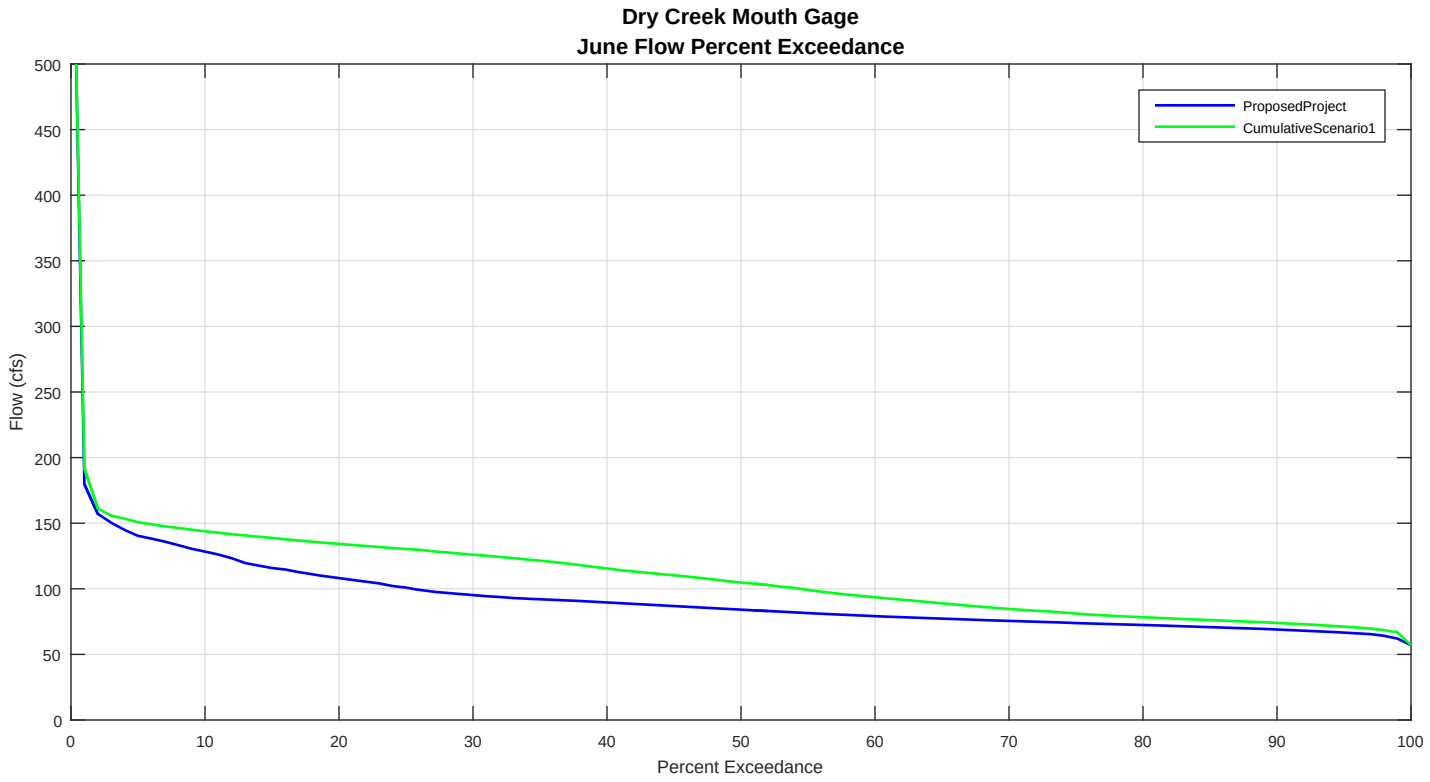
Dry Creek Mouth Gage
June Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
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70
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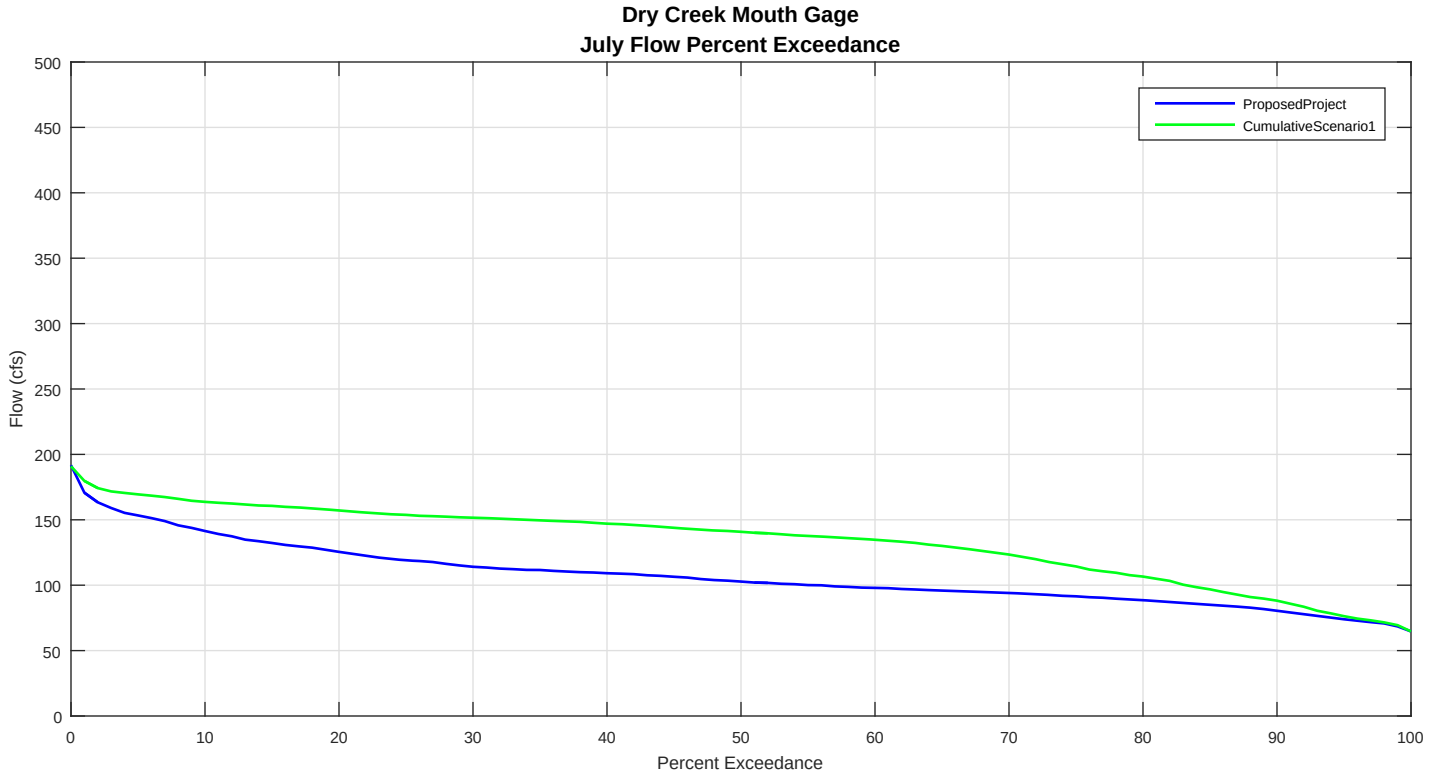
90
100


Dry Creek Mouth Gage
July Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
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70
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90
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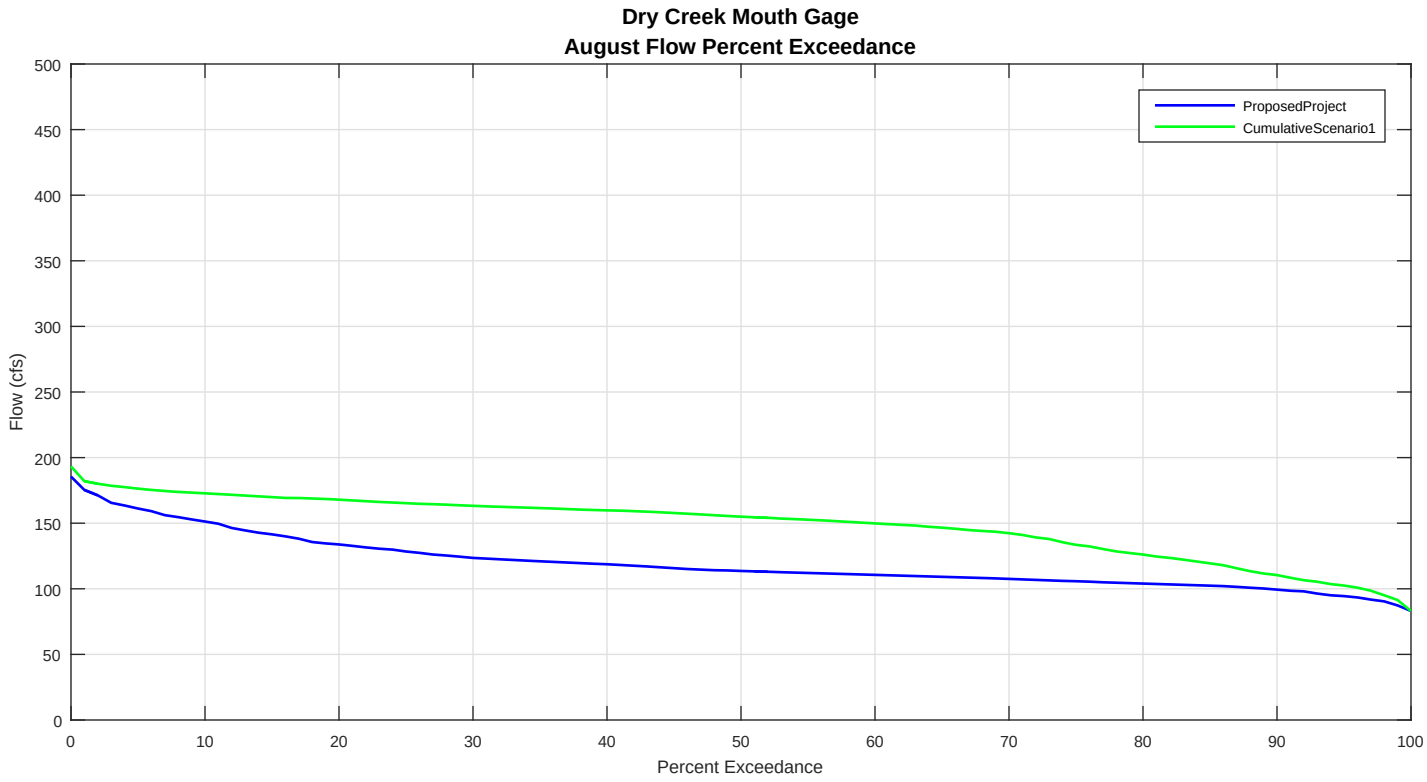
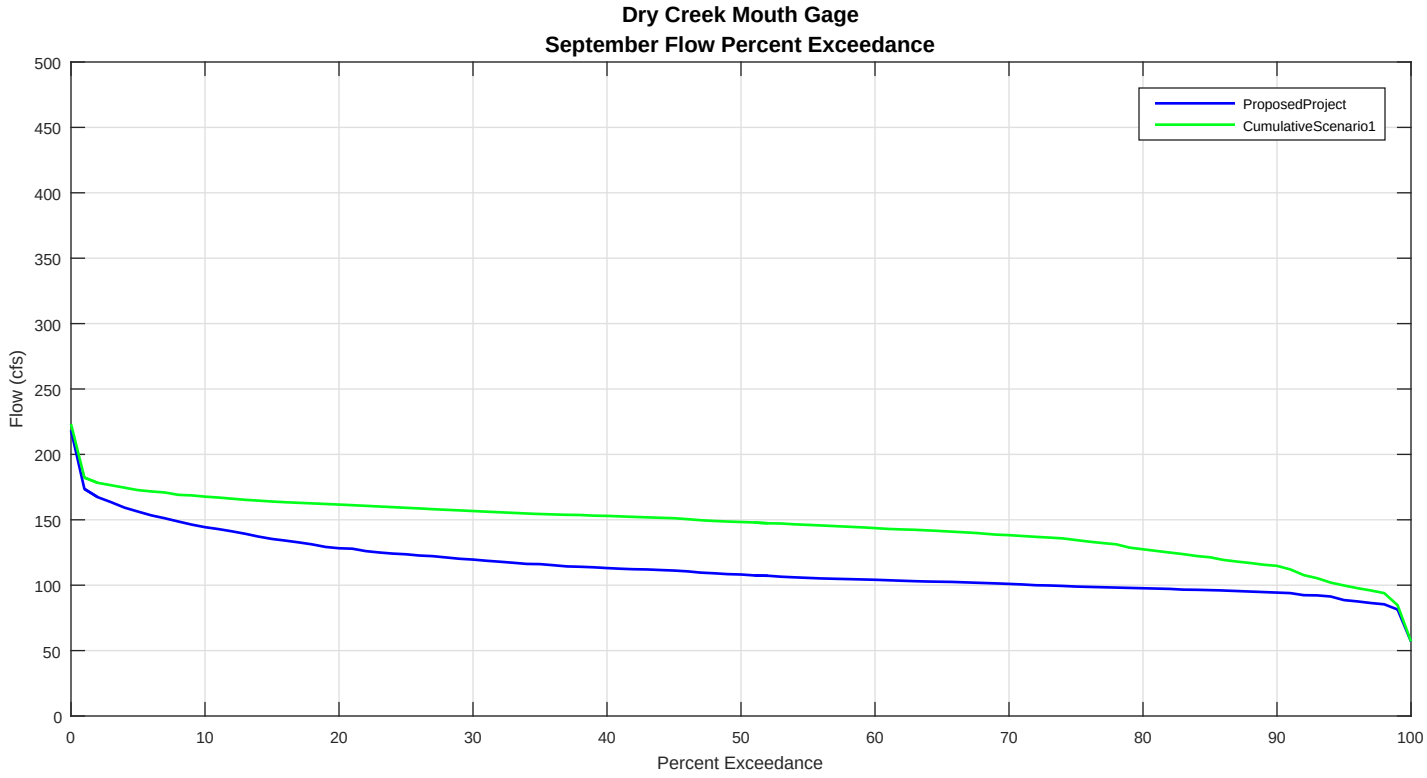
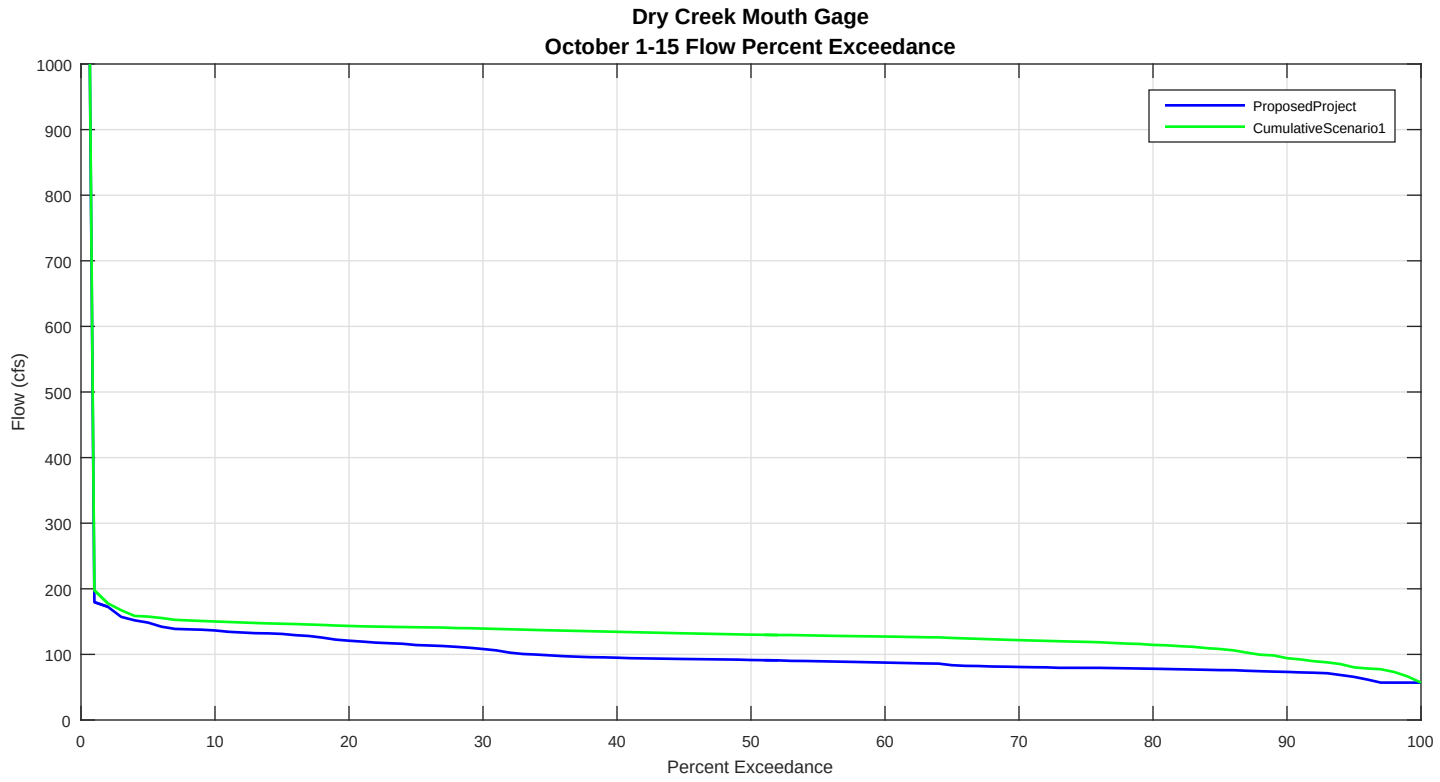

Dry Creek Mouth Gage
August Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
September Flow Percent Exceedance
ProposedProject
CumulativeScenario1
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
October 1-15 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
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90
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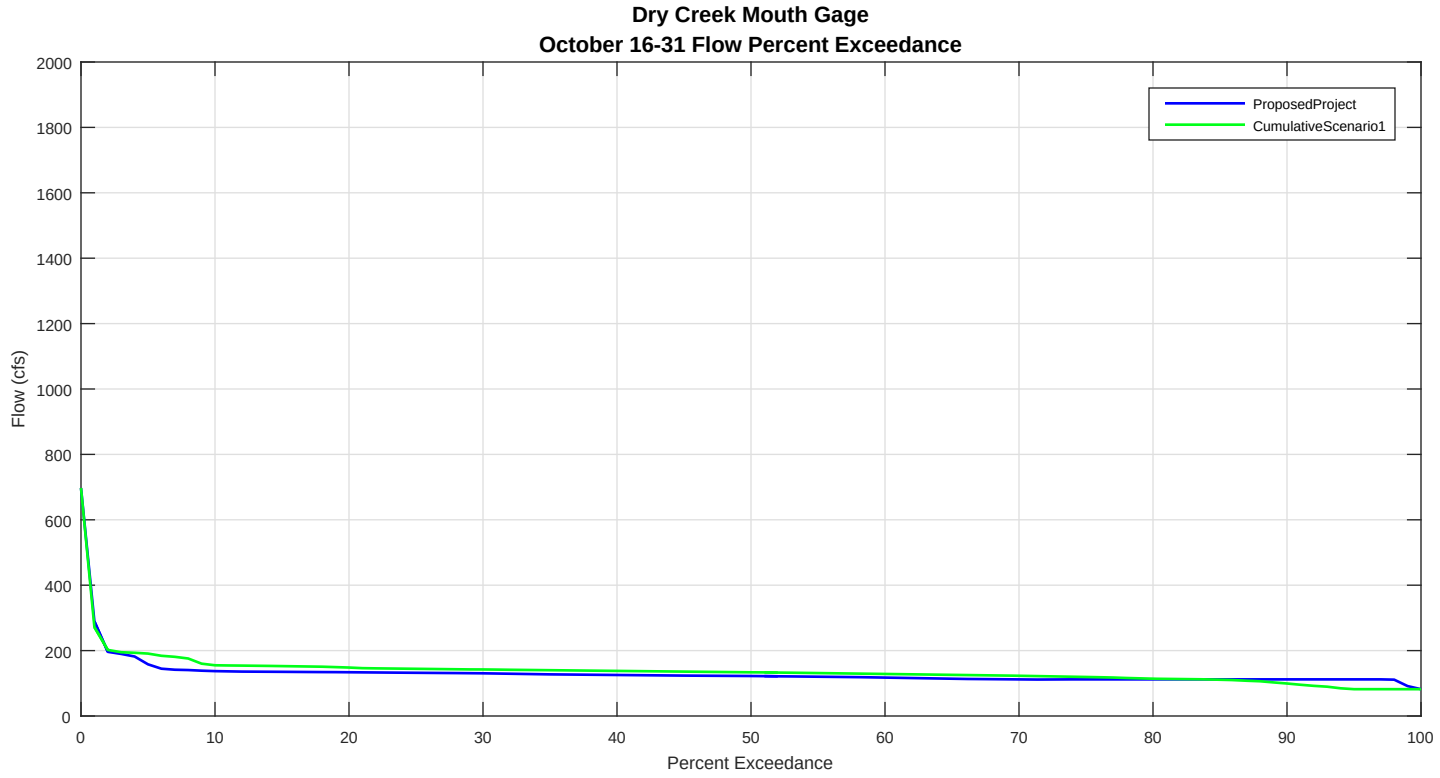
Dry Creek Mouth Gage
October 16-31 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
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90
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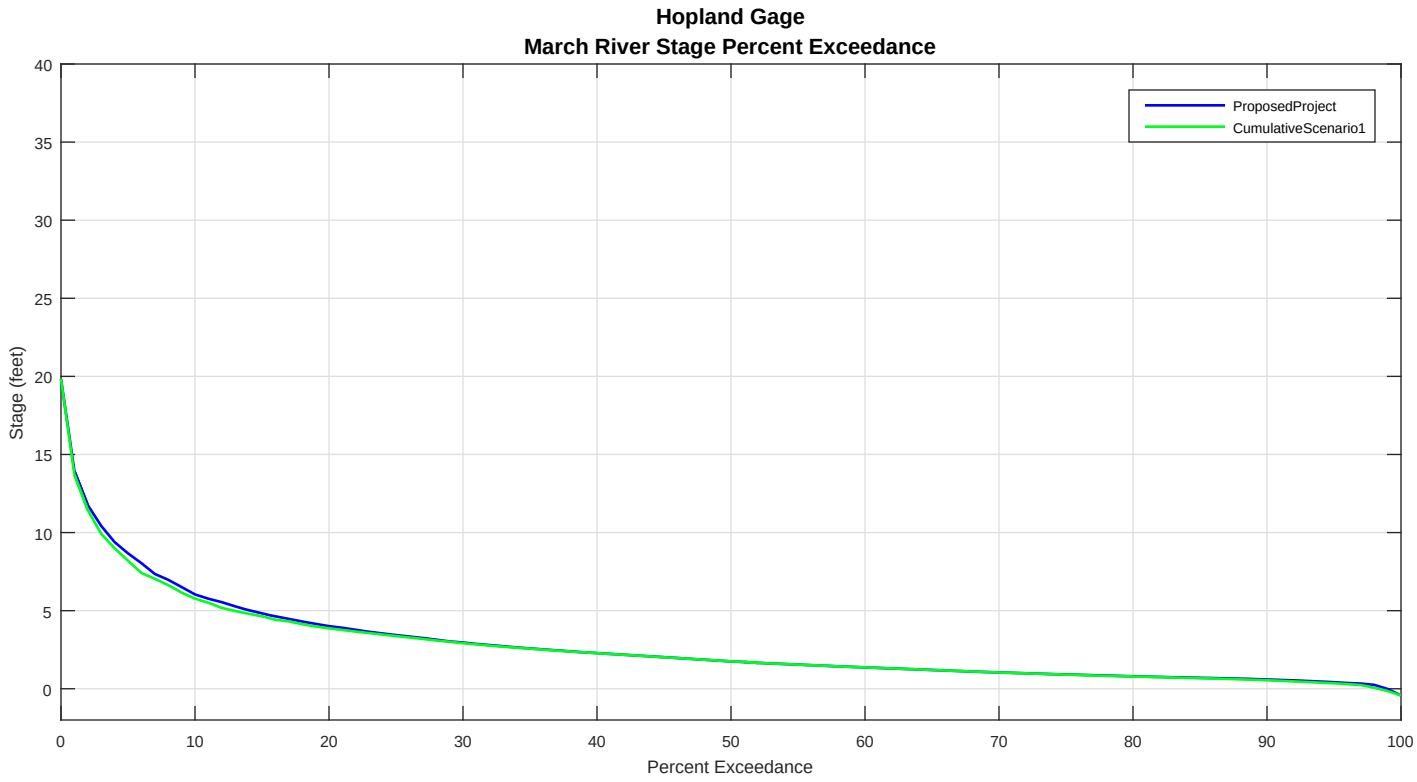
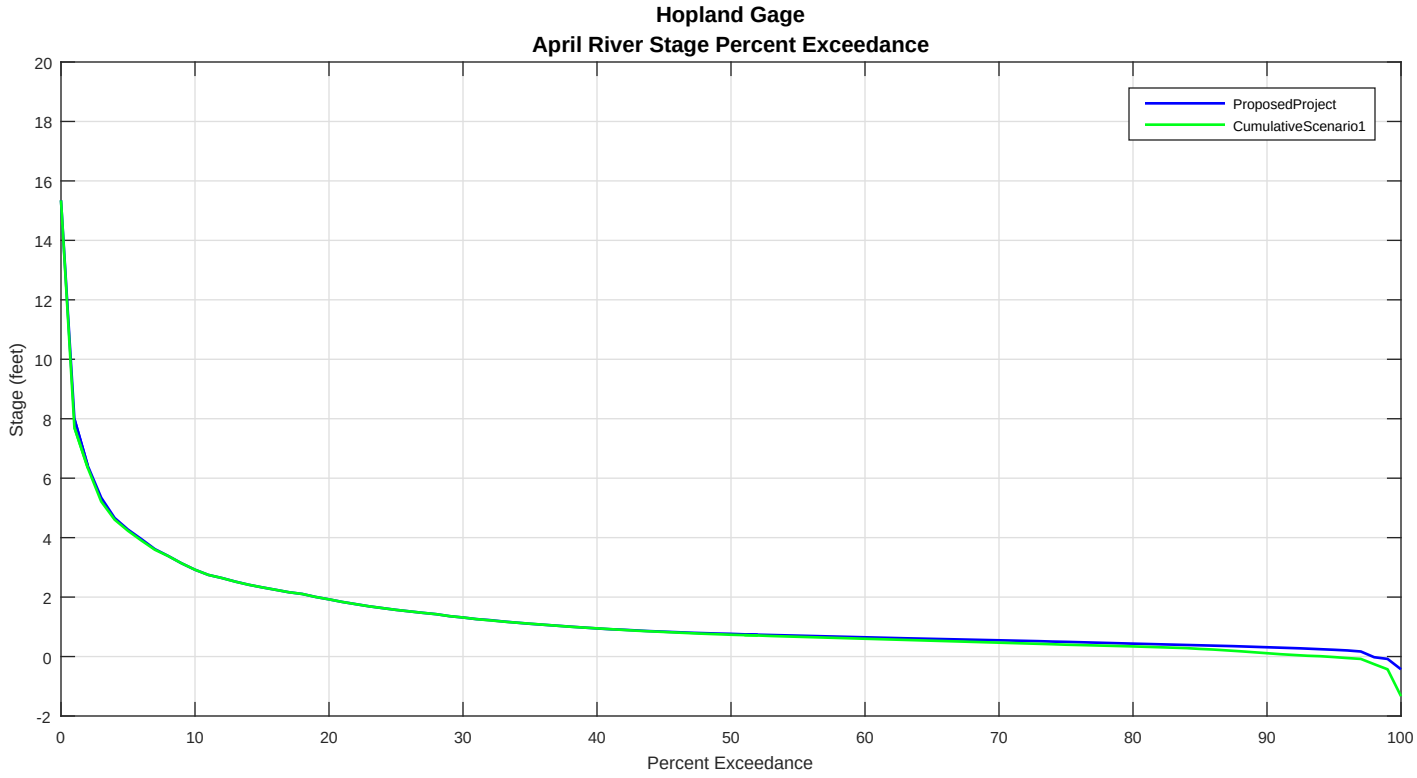
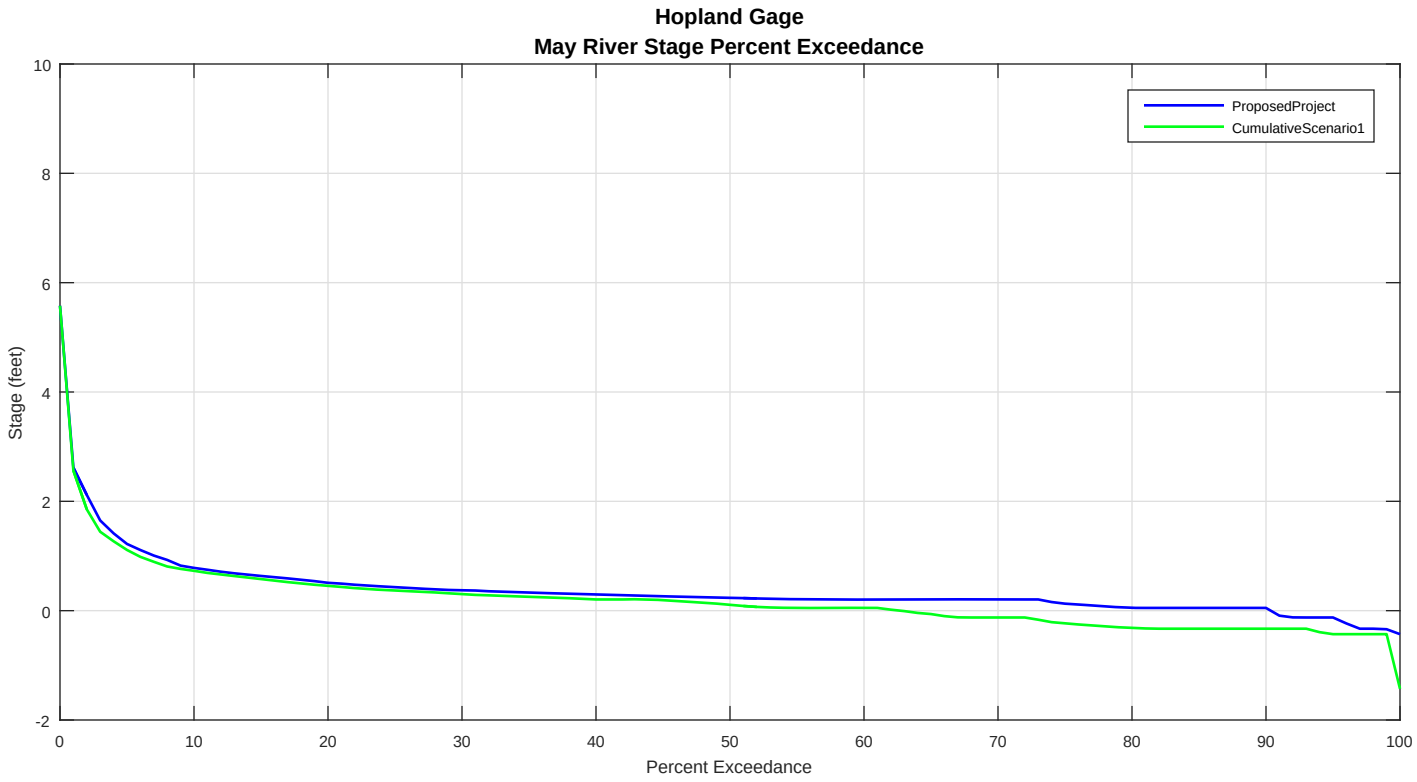
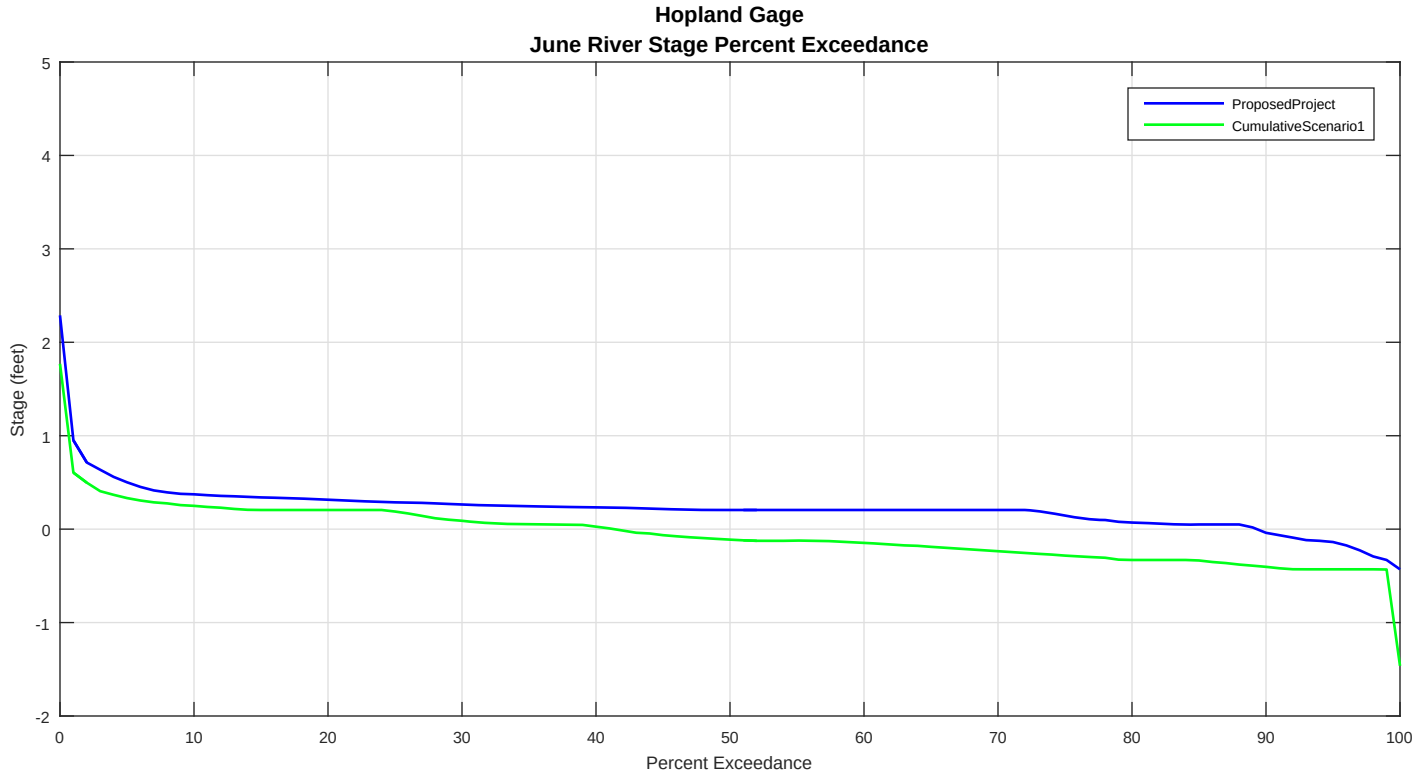
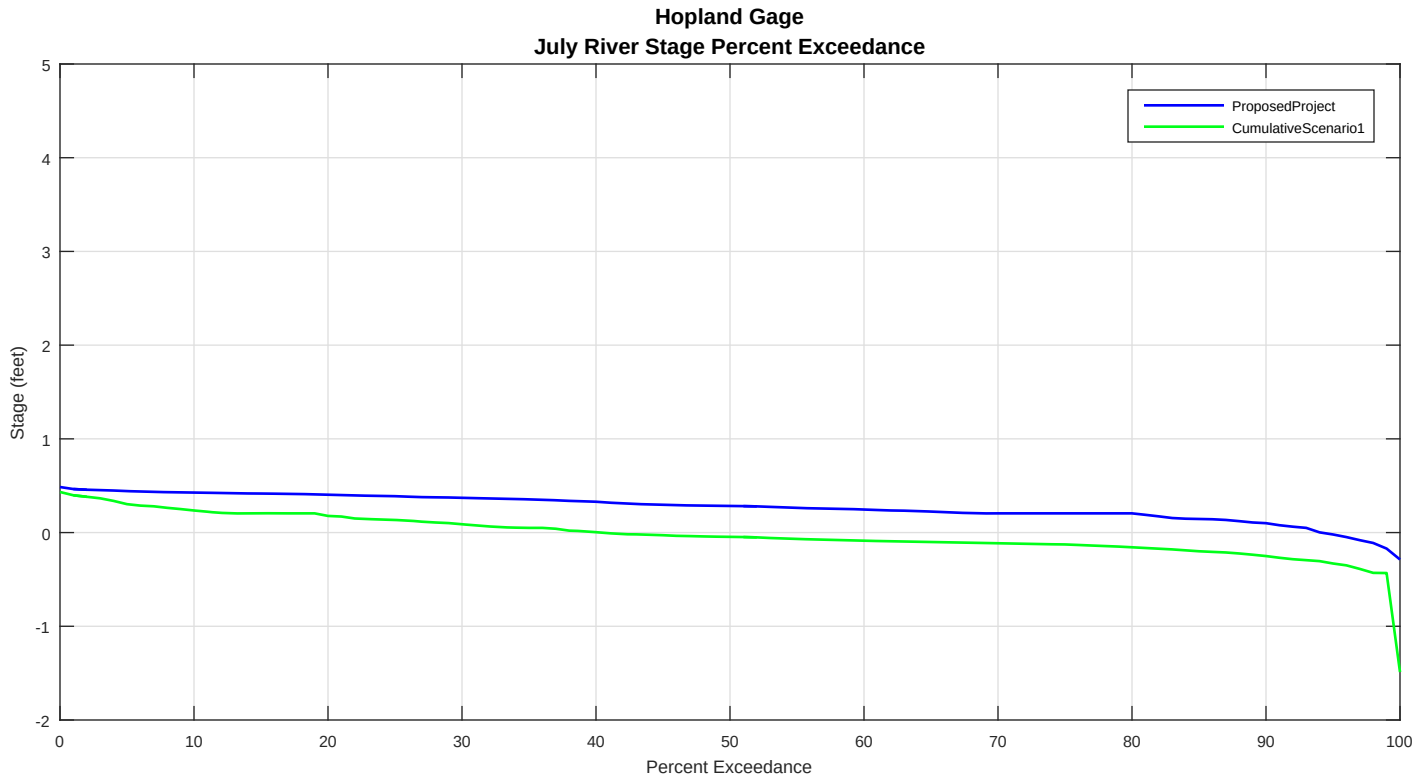
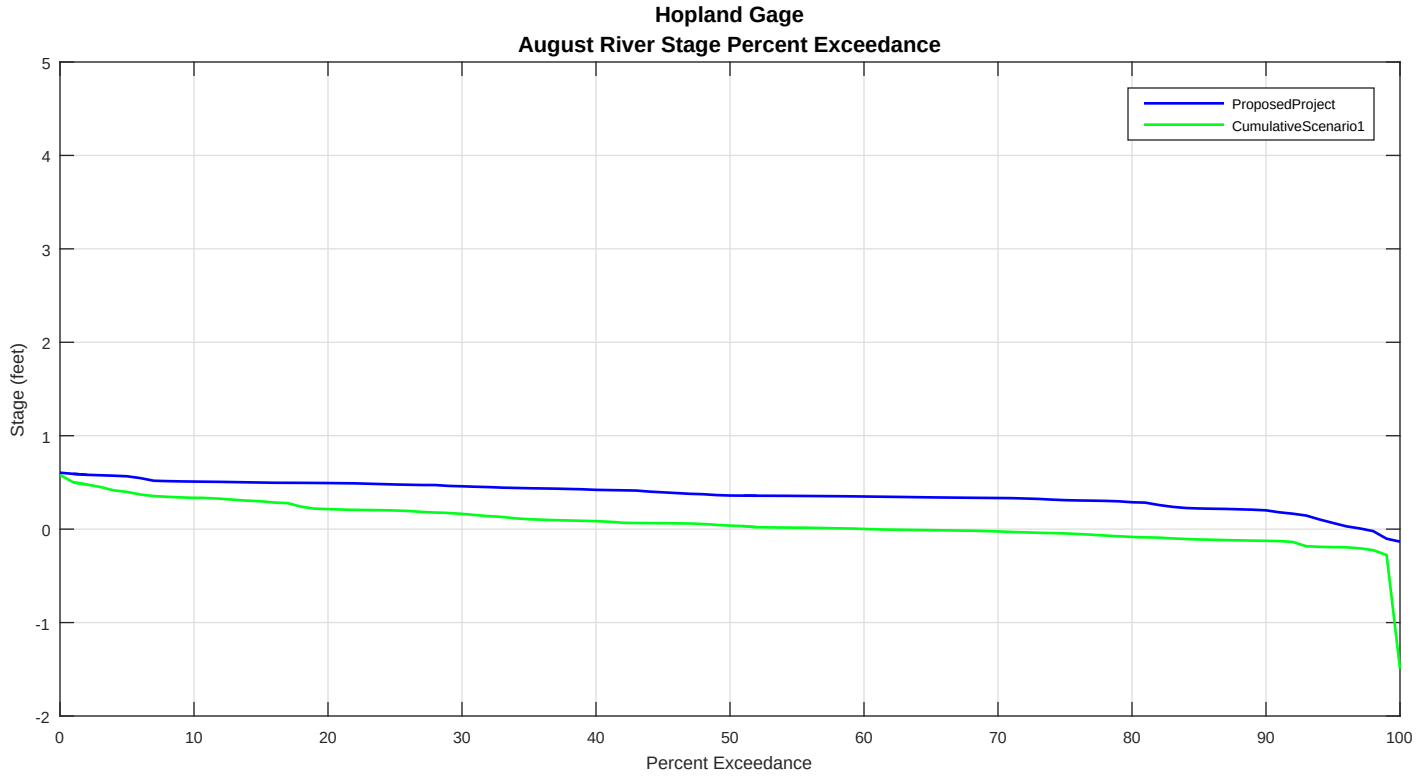

Hopland Gage
March River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100

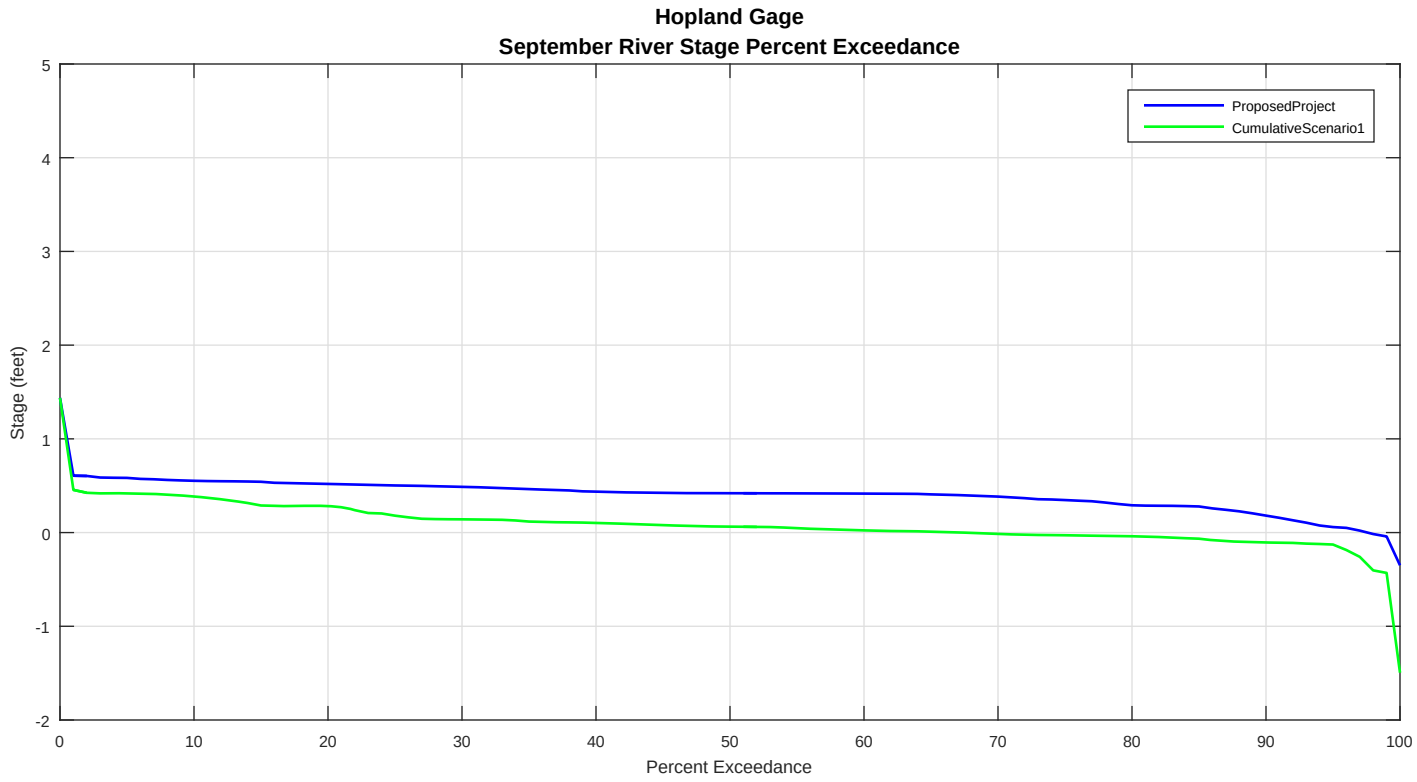

Hopland Gage
April River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
20
18
16
14
12
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

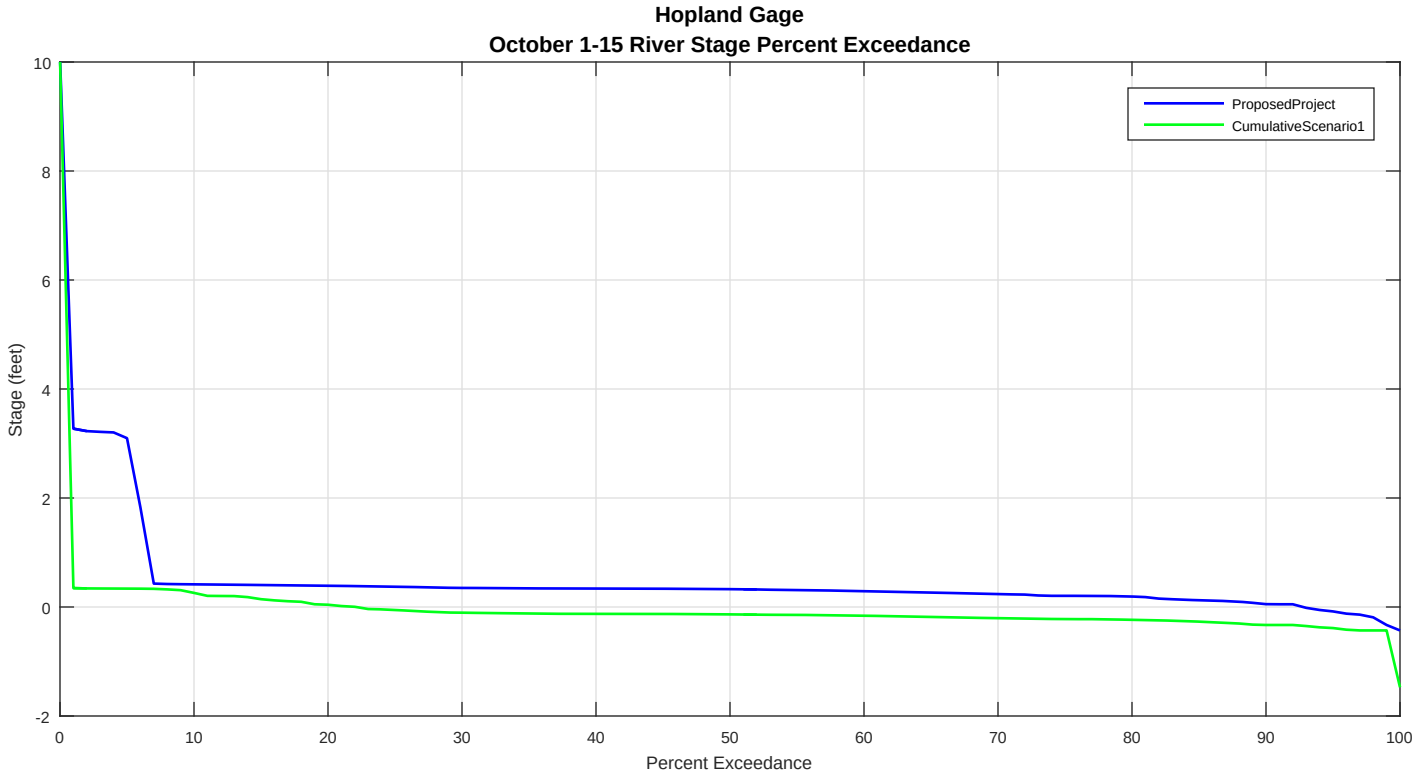

Hopland Gage
May River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

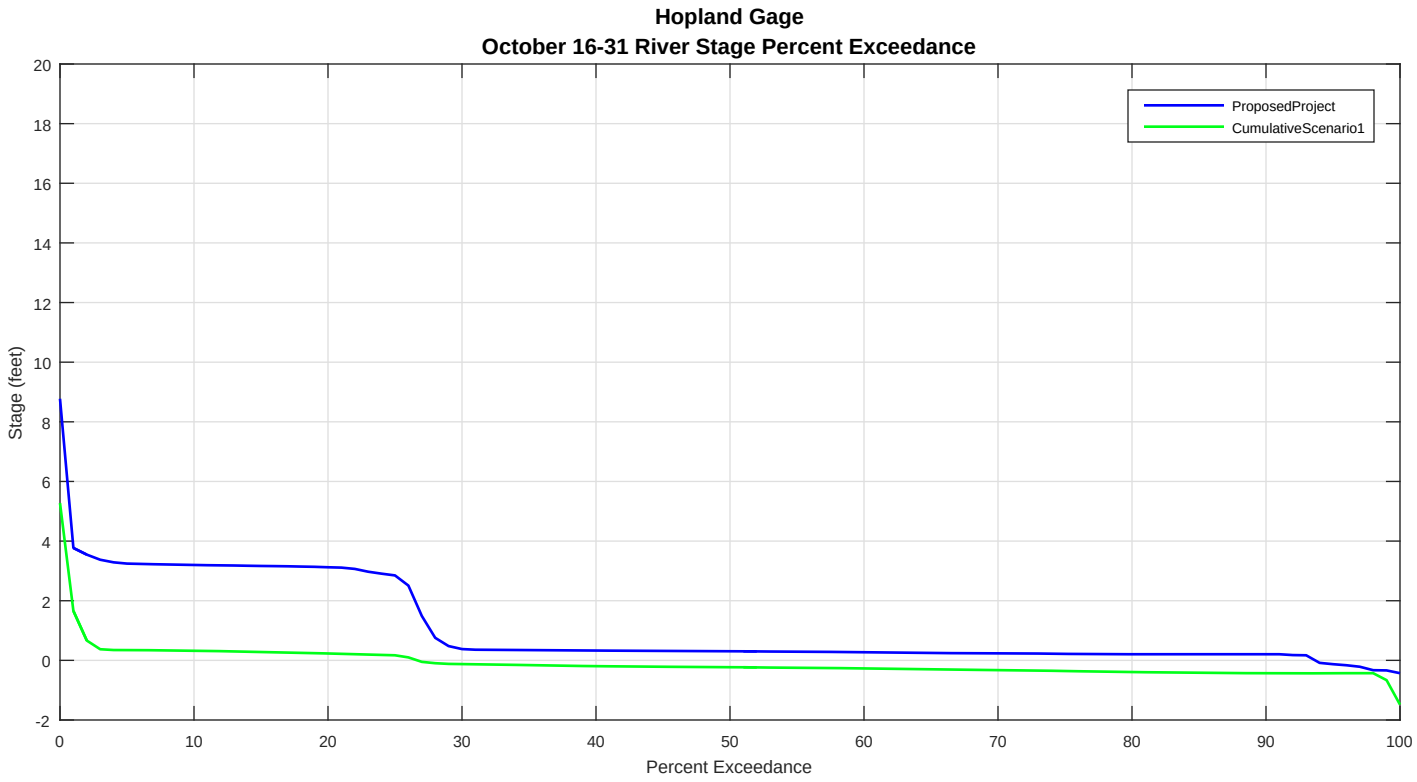

Hopland Gage
June River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

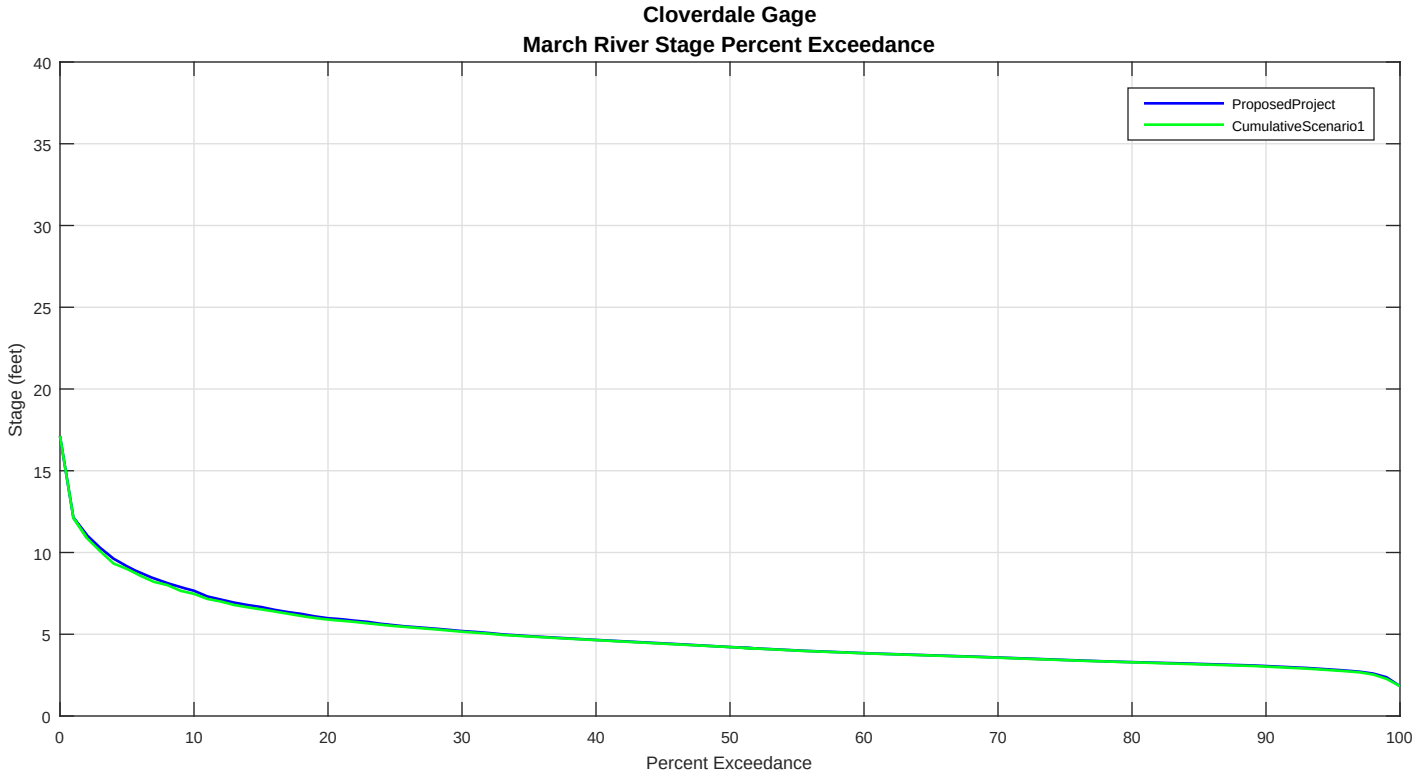

Hopland Gage
July River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

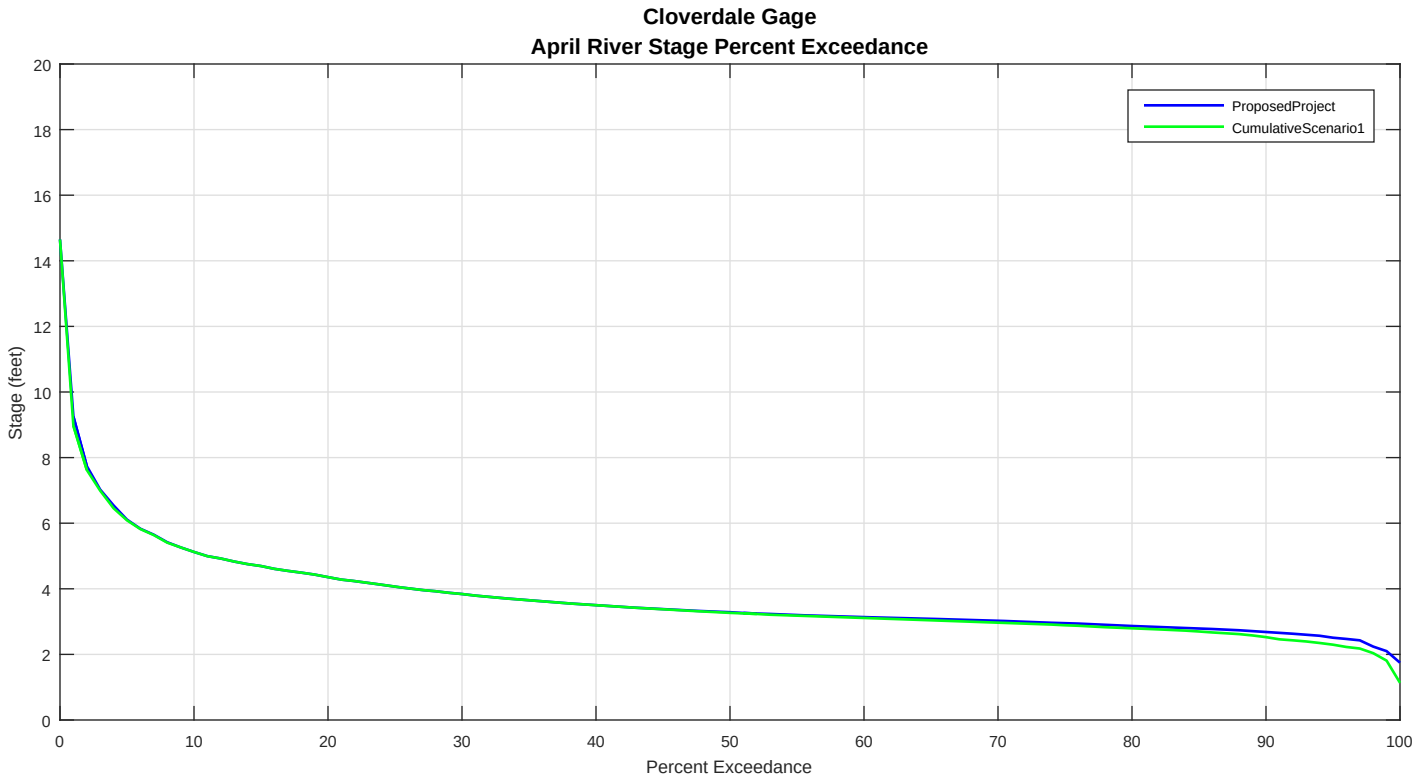

Hopland Gage
August River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

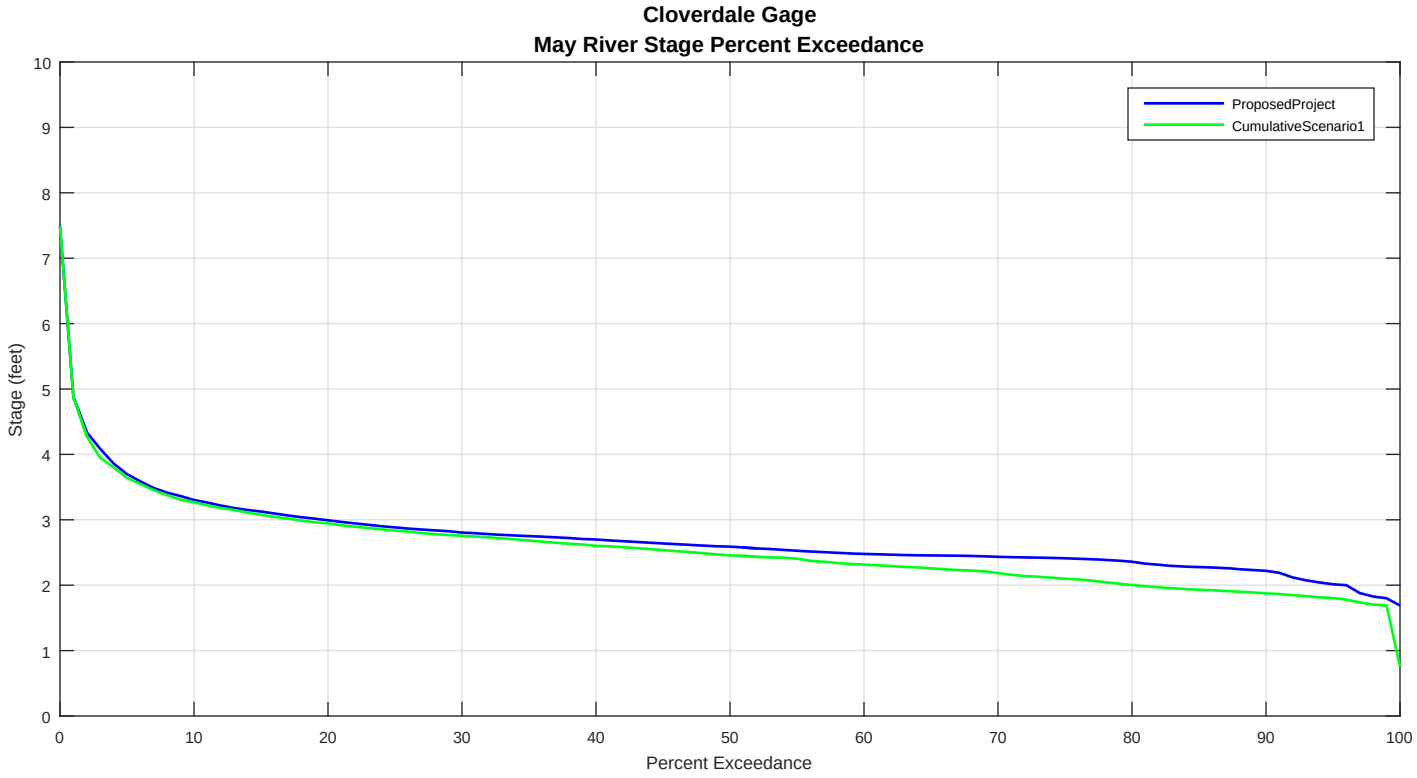

Hopland Gage
September River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

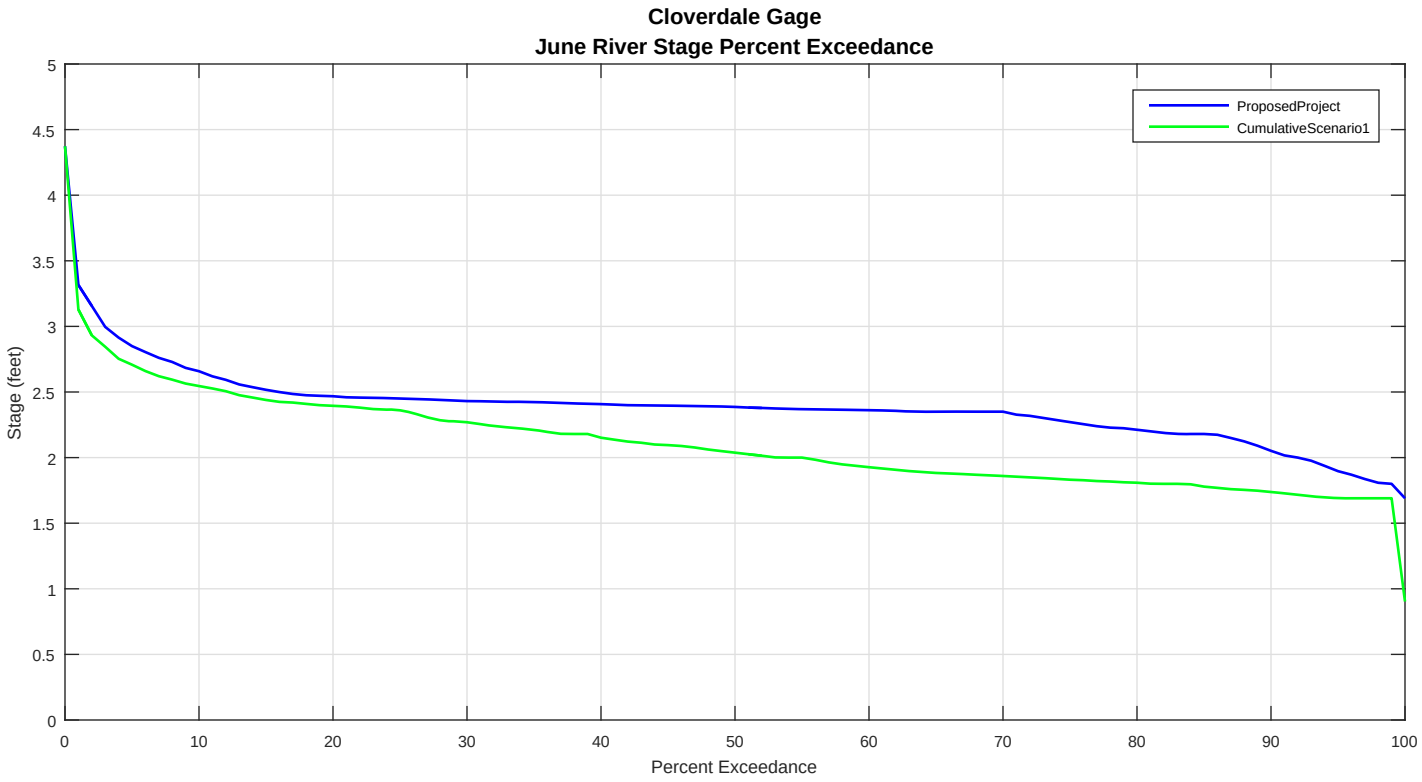

Hopland Gage
October 1-15 River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

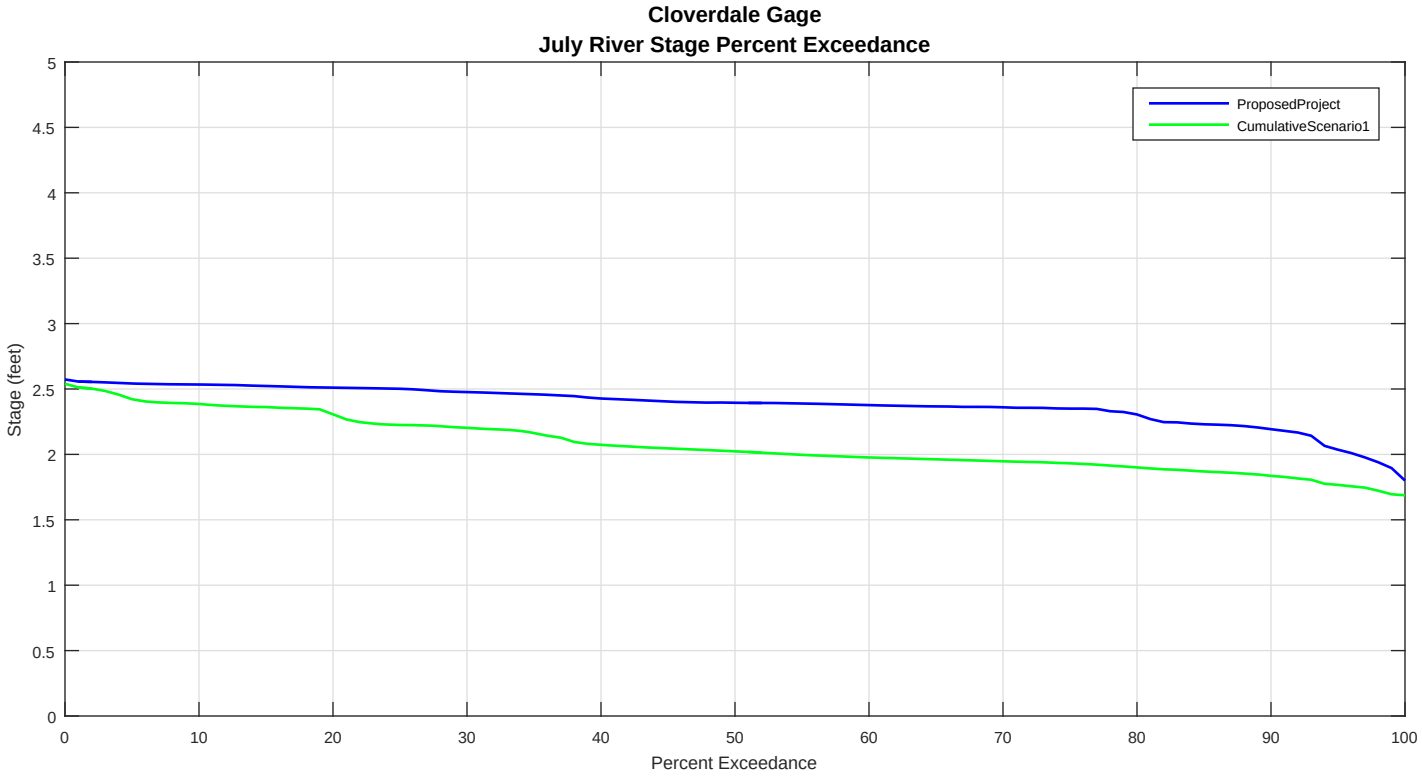

Hopland Gage
October 16-31 River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
20
18
16
14
12
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

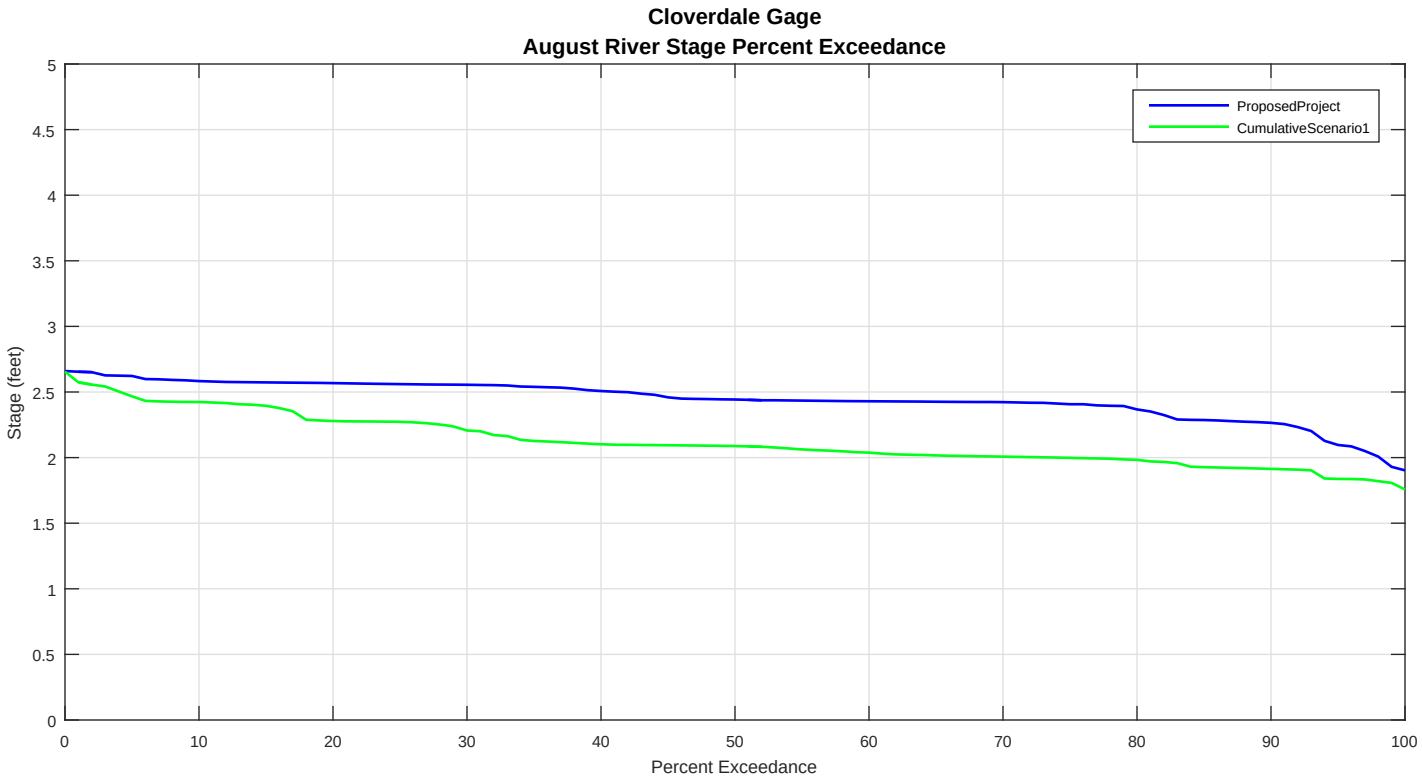

Cloverdale Gage
March River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100

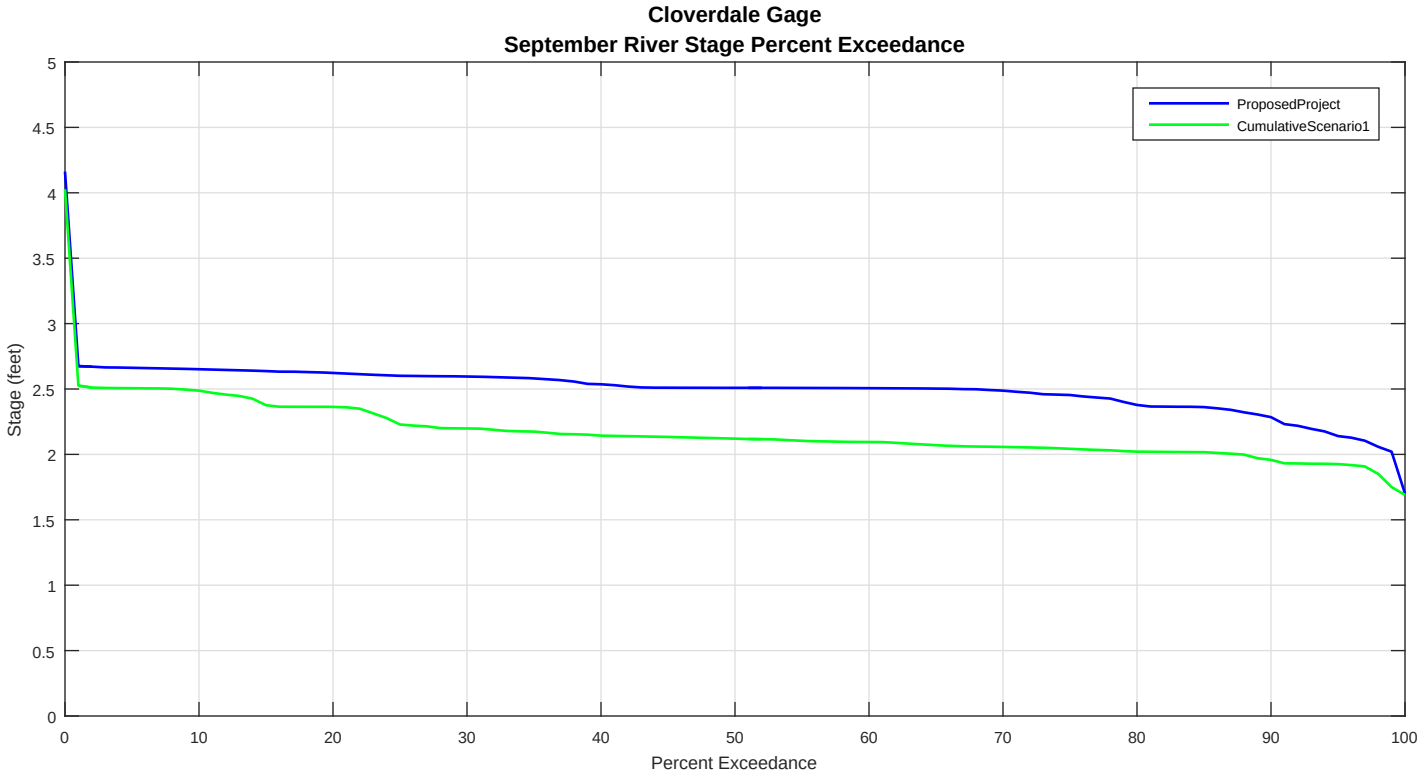

Cloverdale Gage
April River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

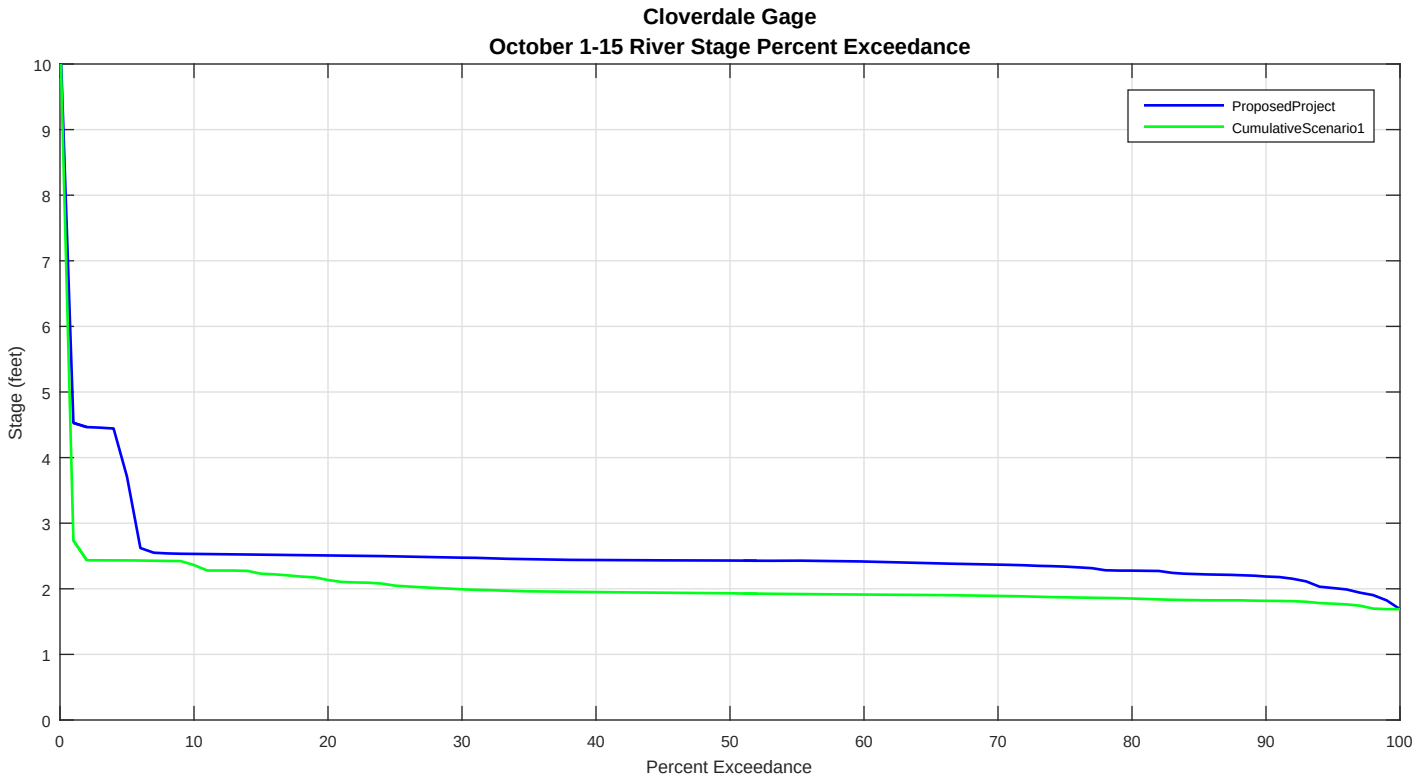

Cloverdale Gage
May River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

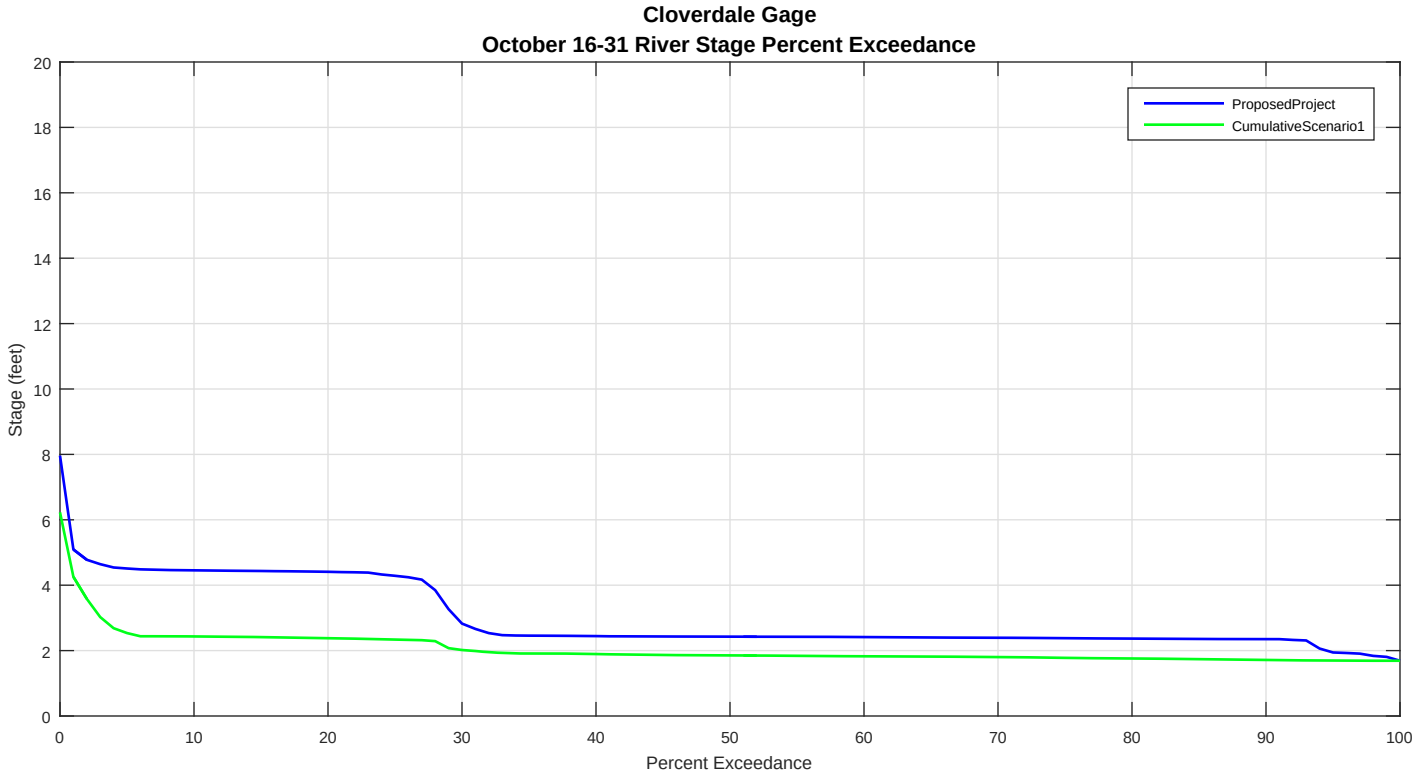

Cloverdale Gage
June River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

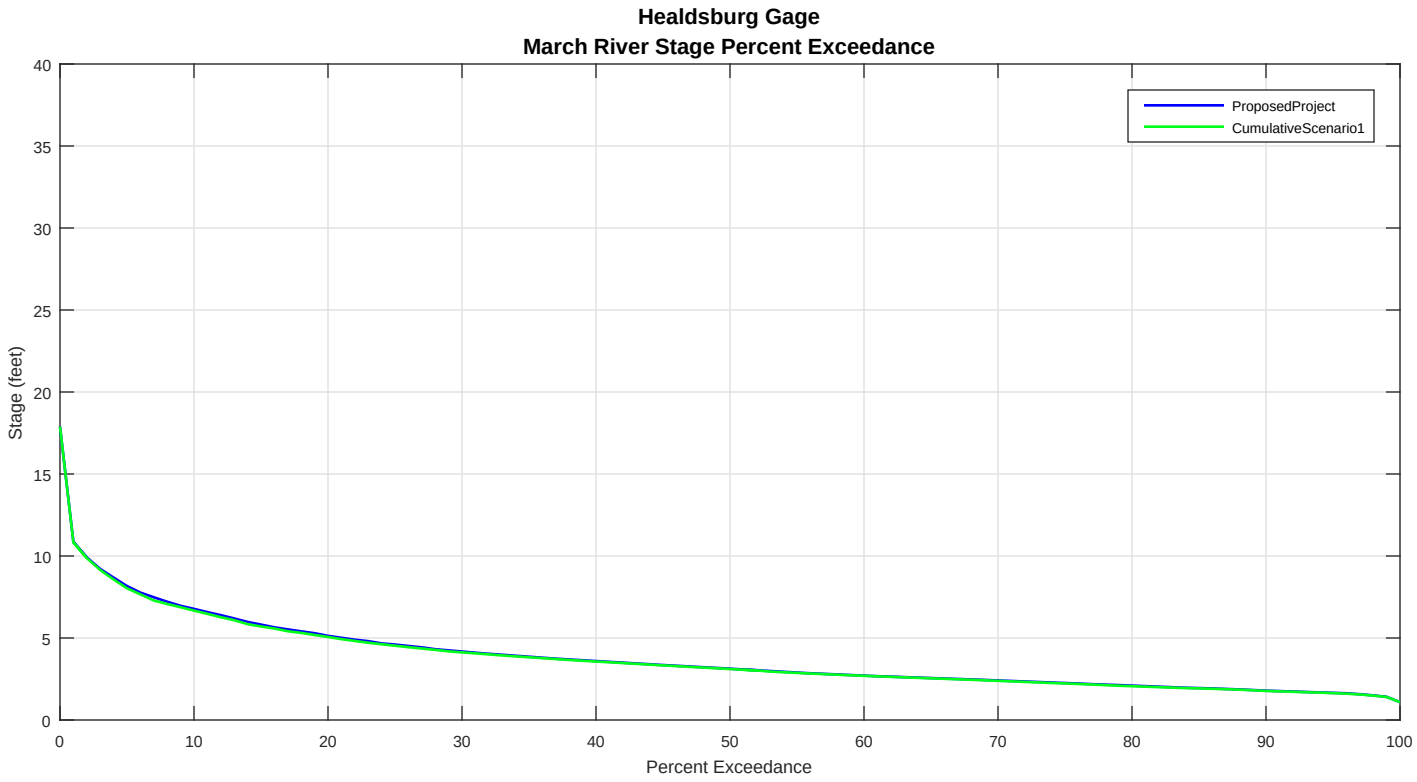

Cloverdale Gage
July River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

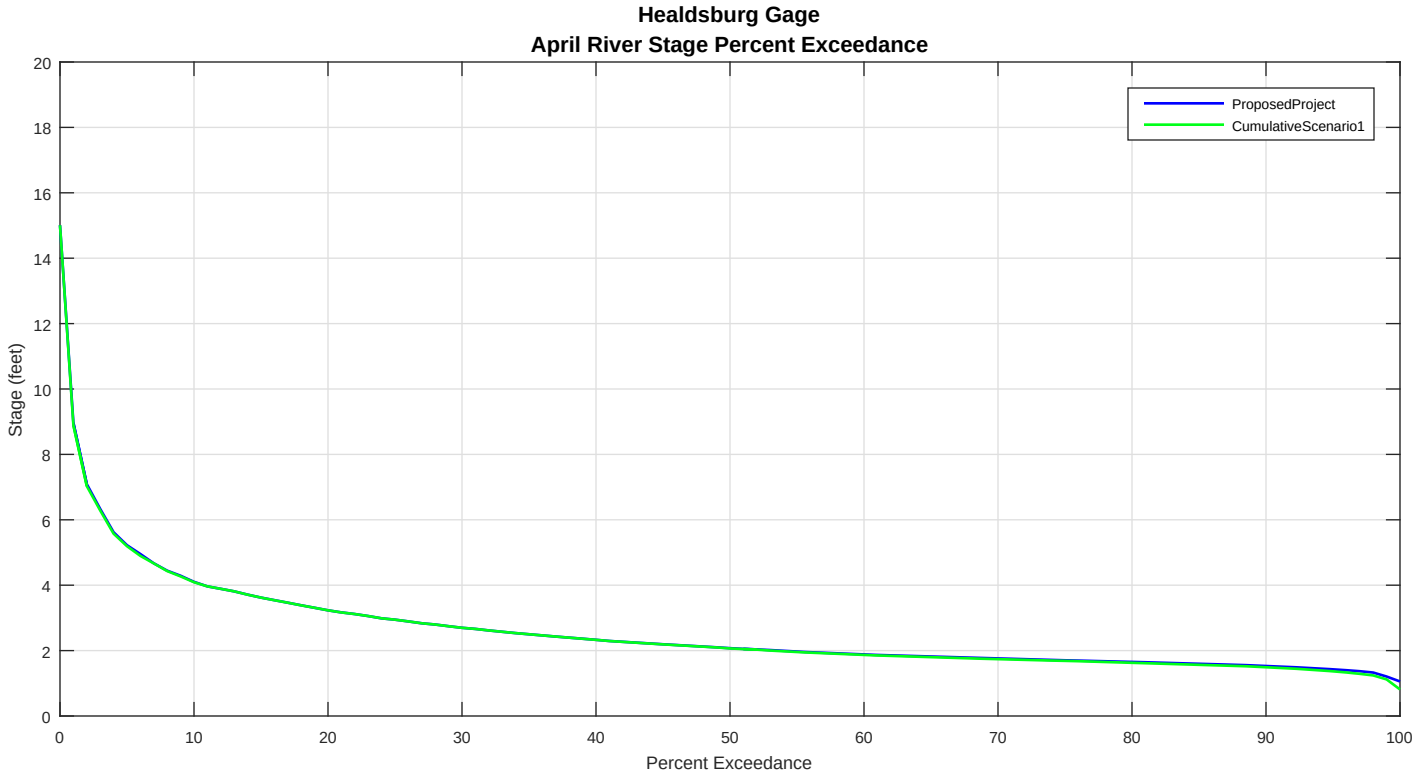

Cloverdale Gage
August River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

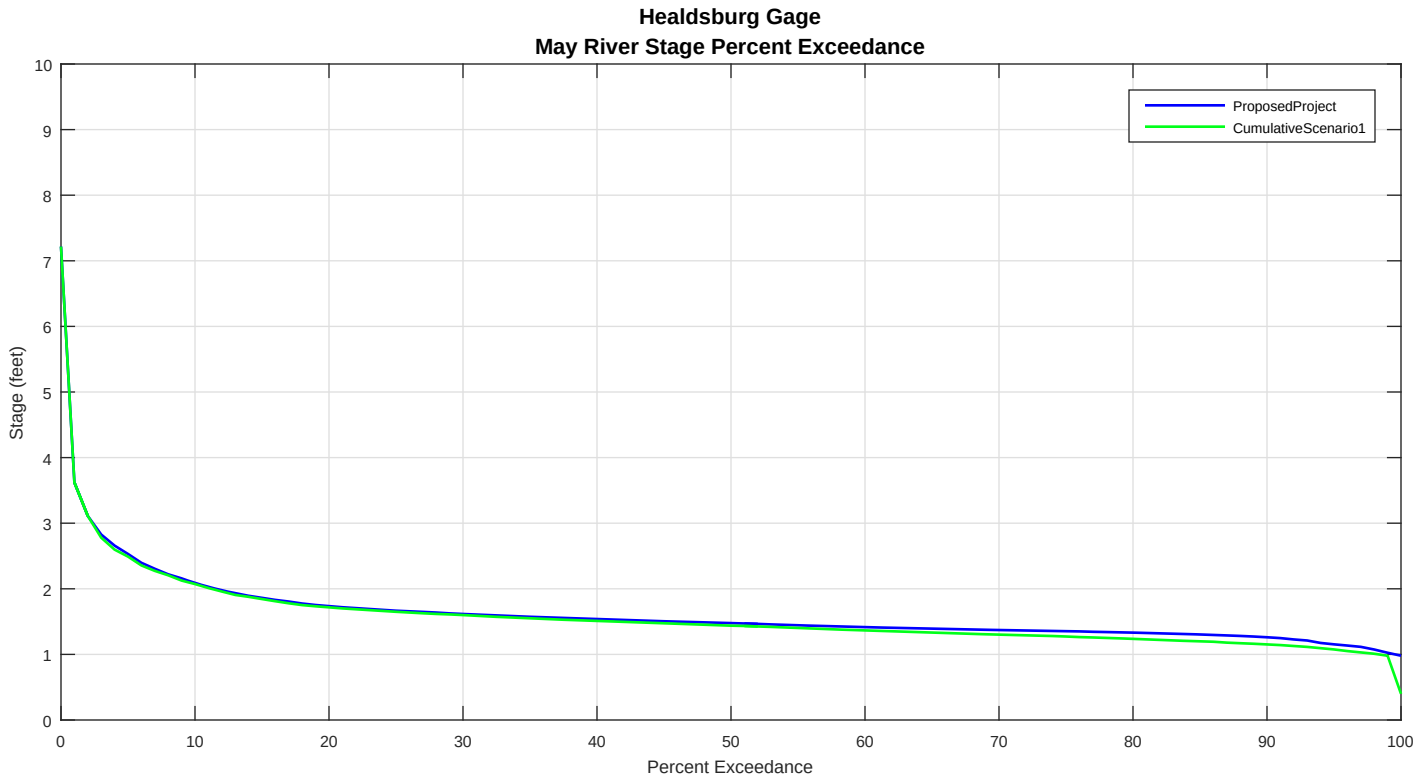

Cloverdale Gage
September River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

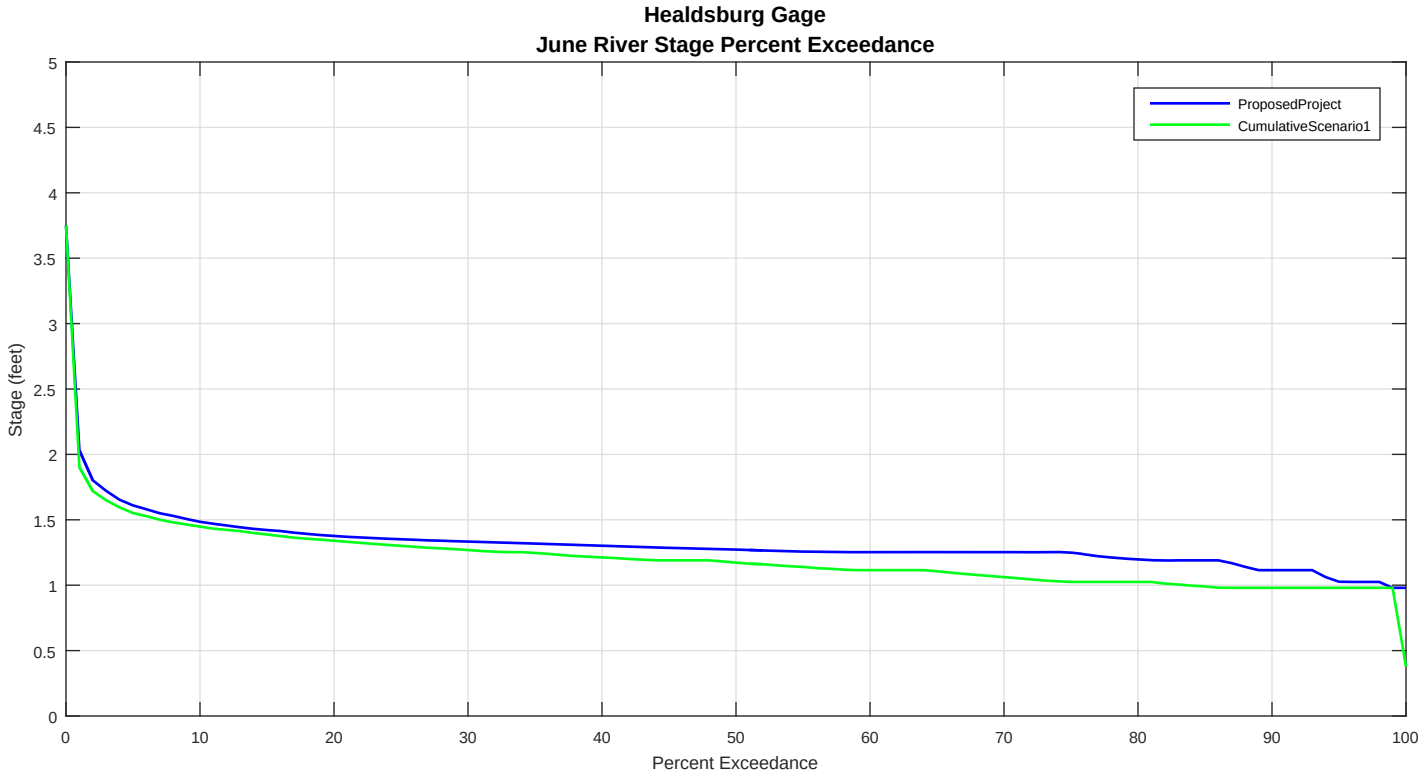

Cloverdale Gage
October 1-15 River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

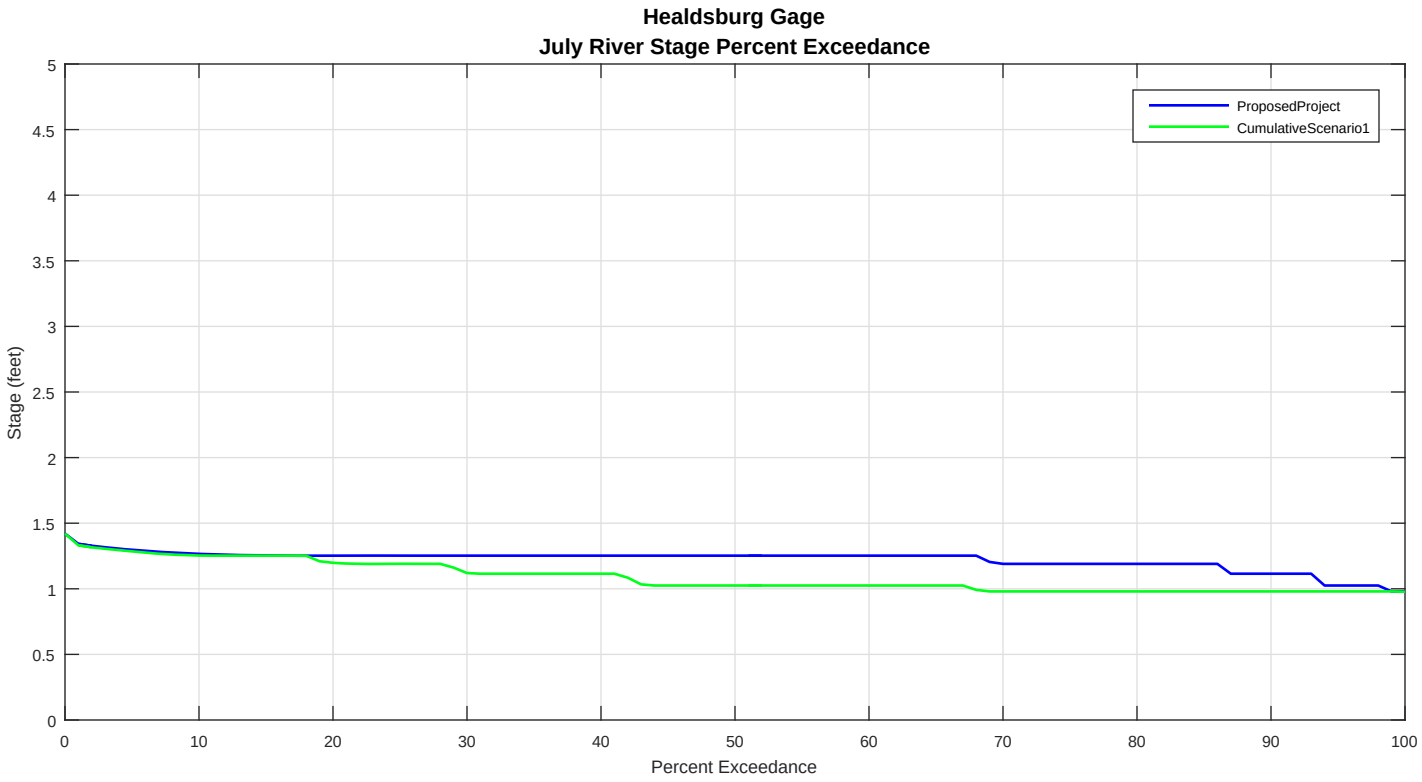

Cloverdale Gage
October 16-31 River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

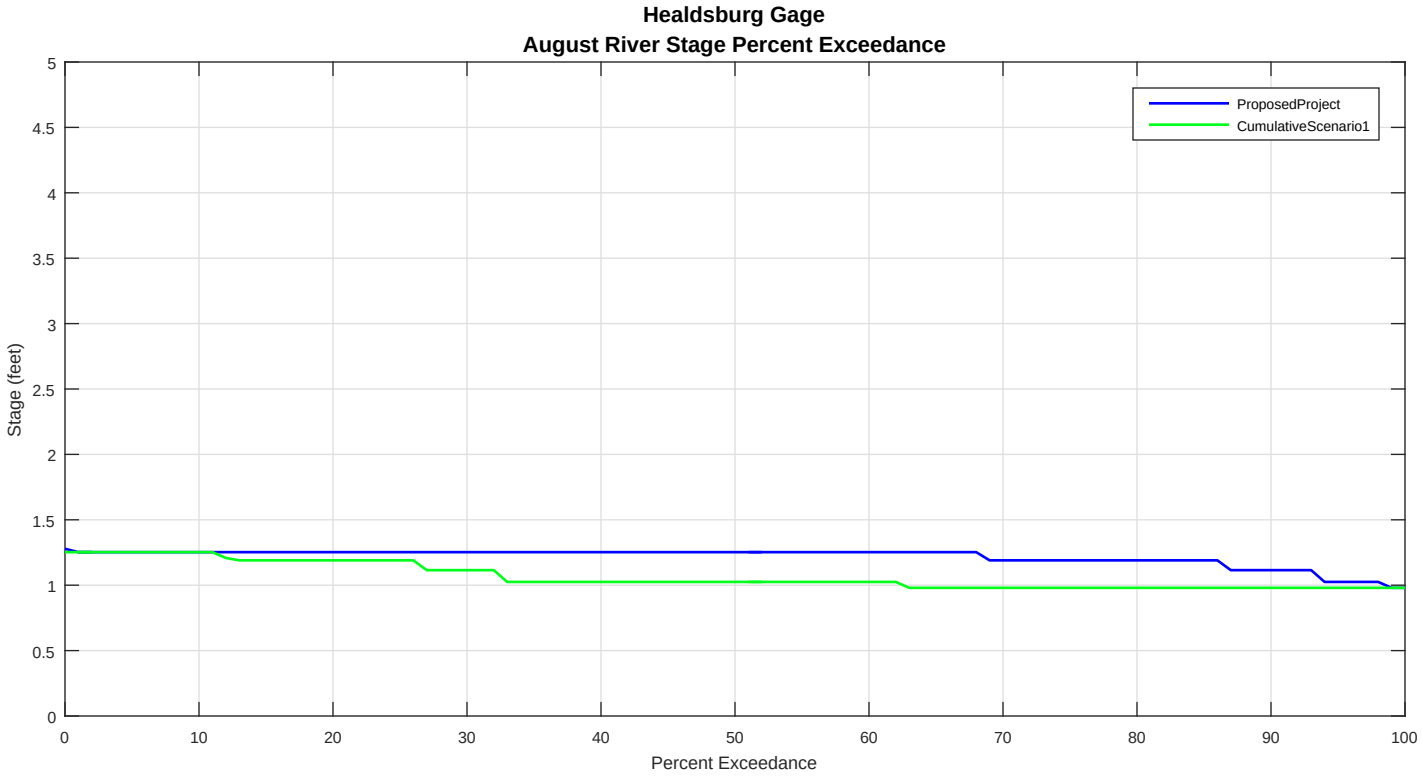

Healdsburg Gage
March River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80
90
100

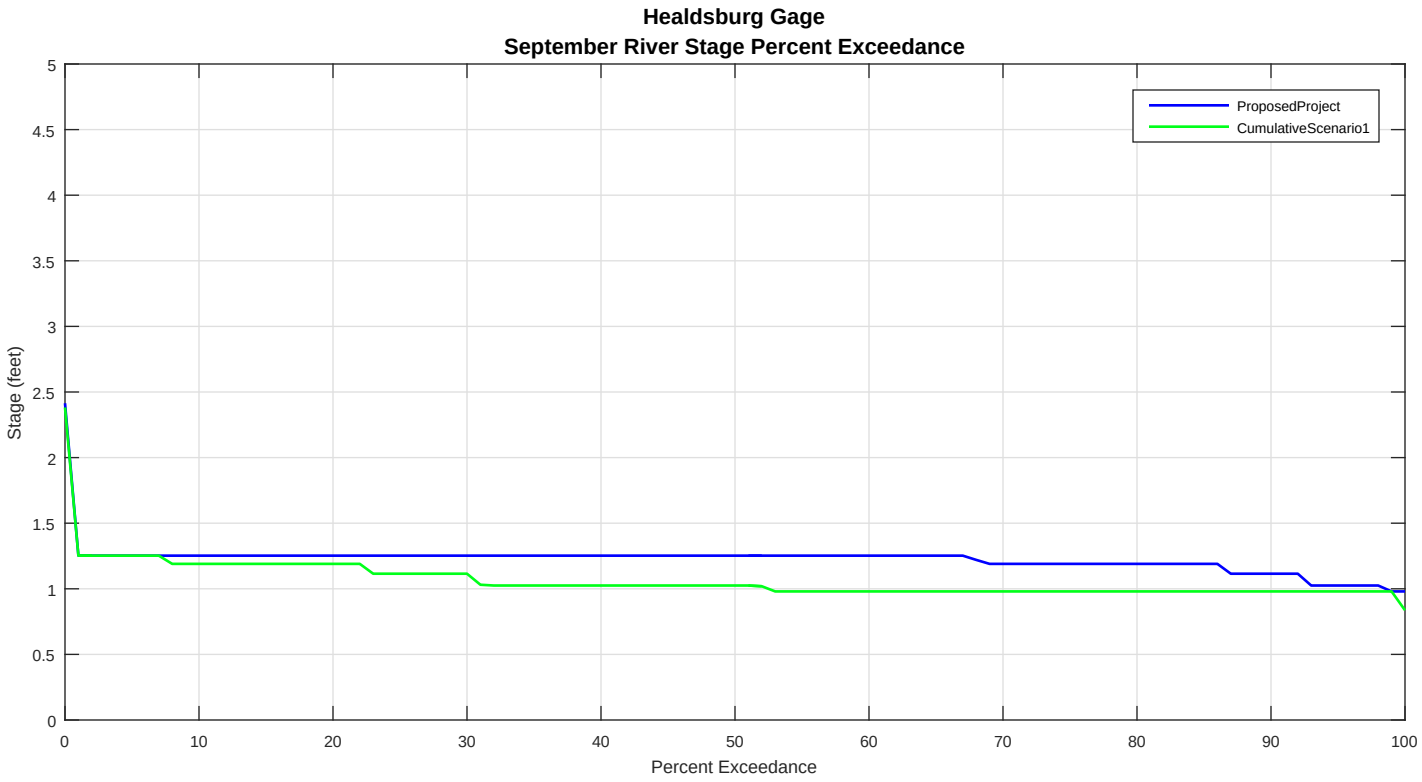

Healdsburg Gage
April River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

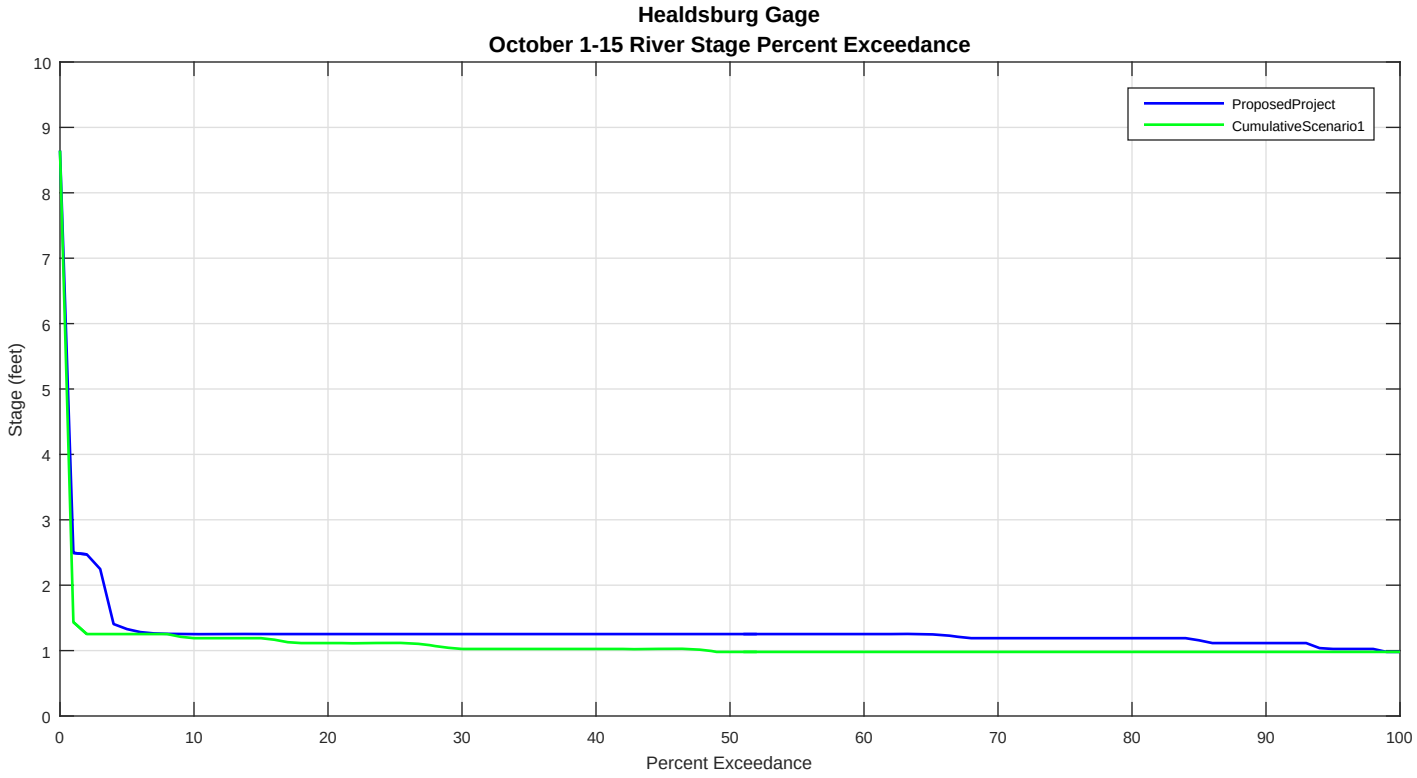

Healdsburg Gage
May River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

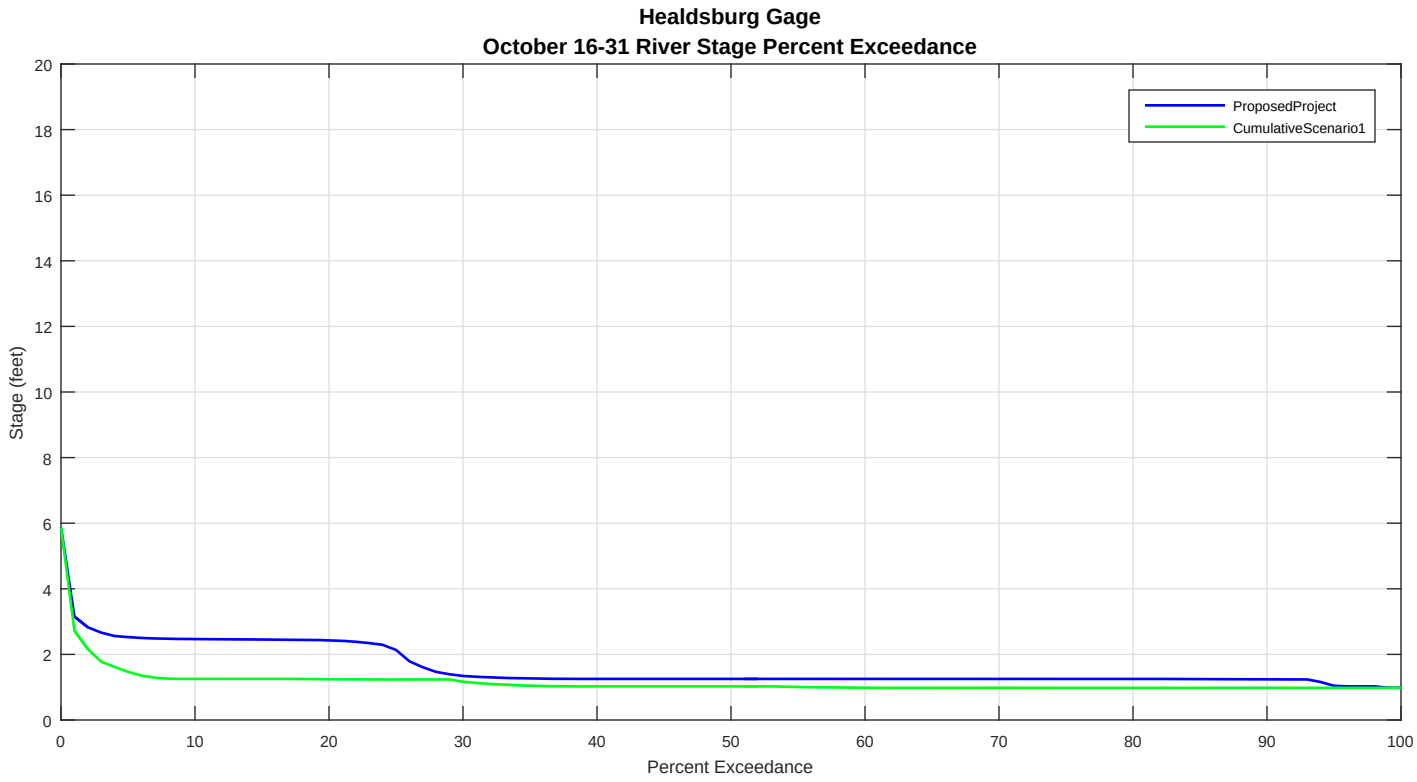

Healdsburg Gage
June River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

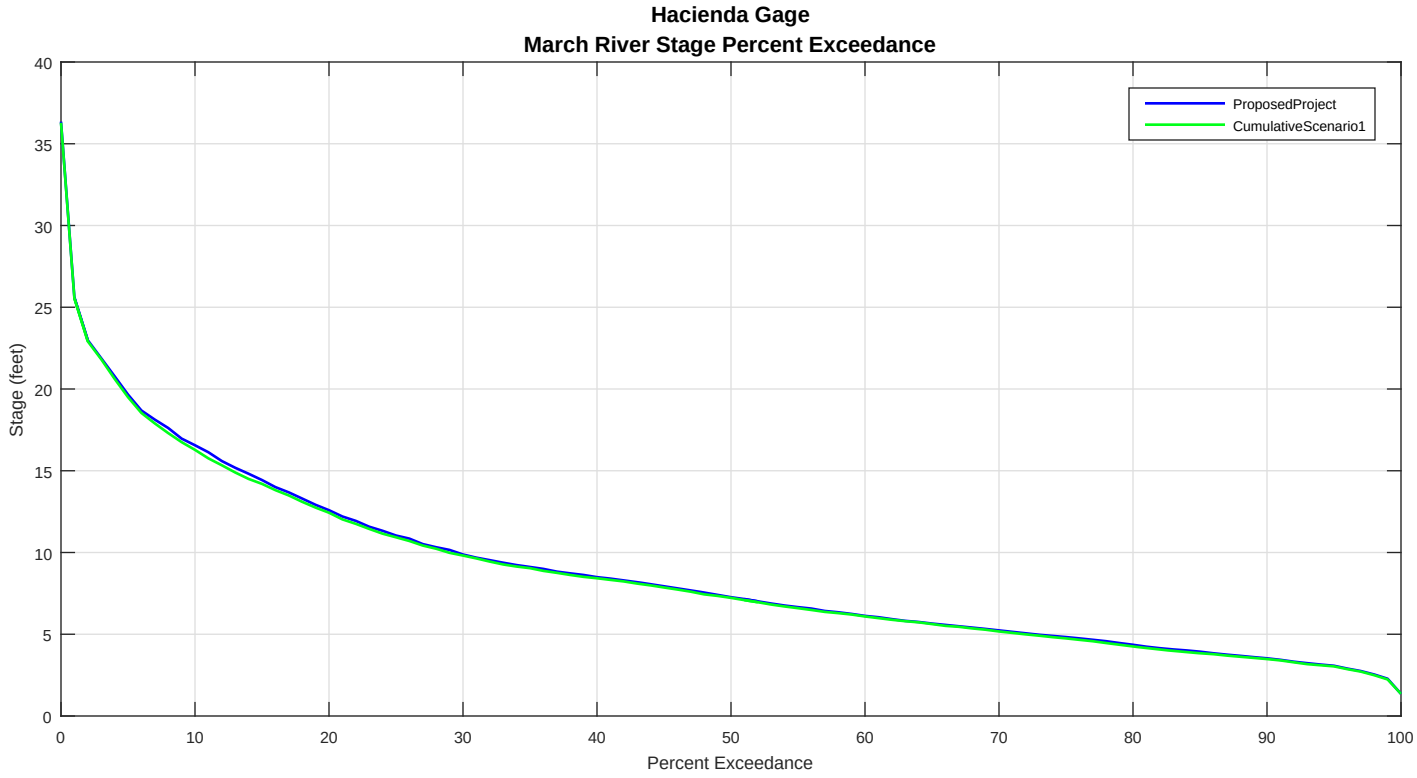

Healdsburg Gage
July River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

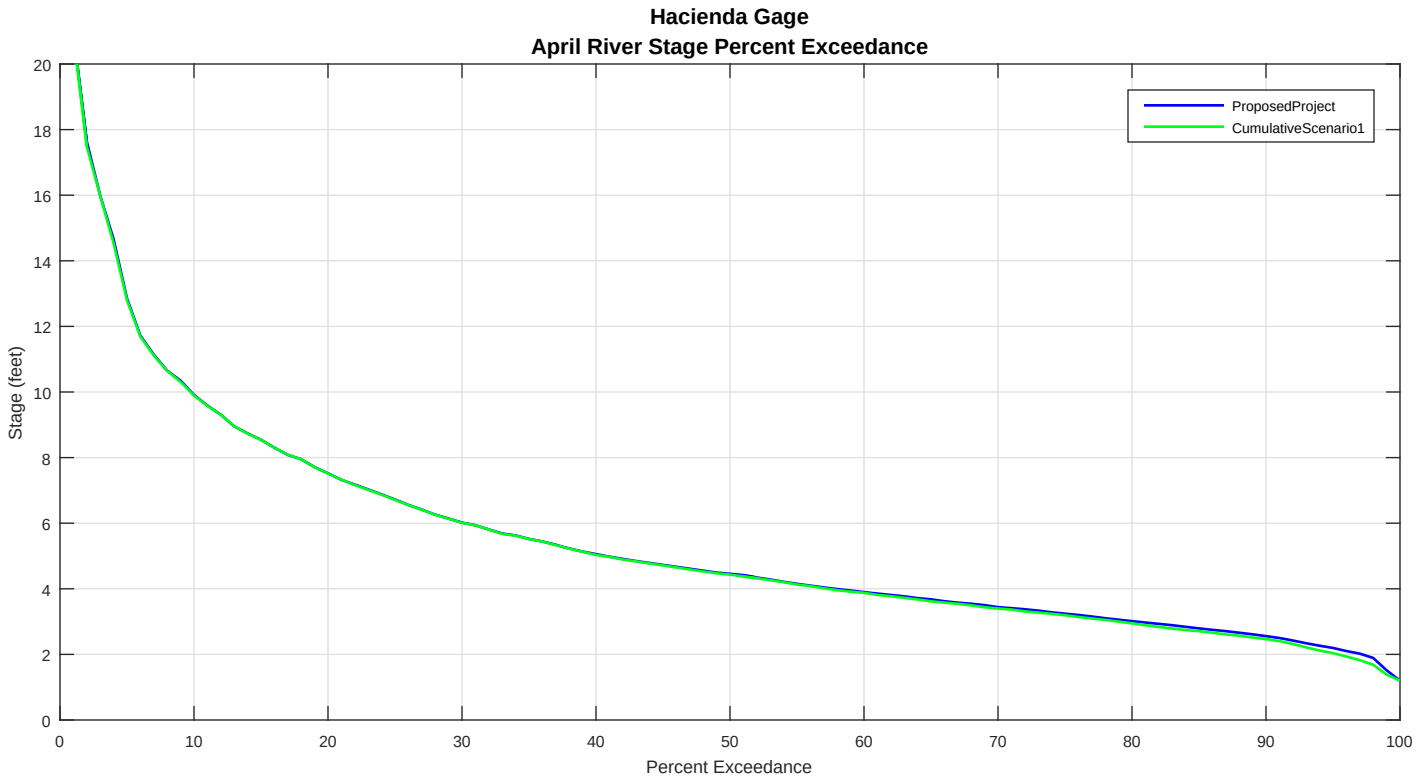

Healdsburg Gage
August River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

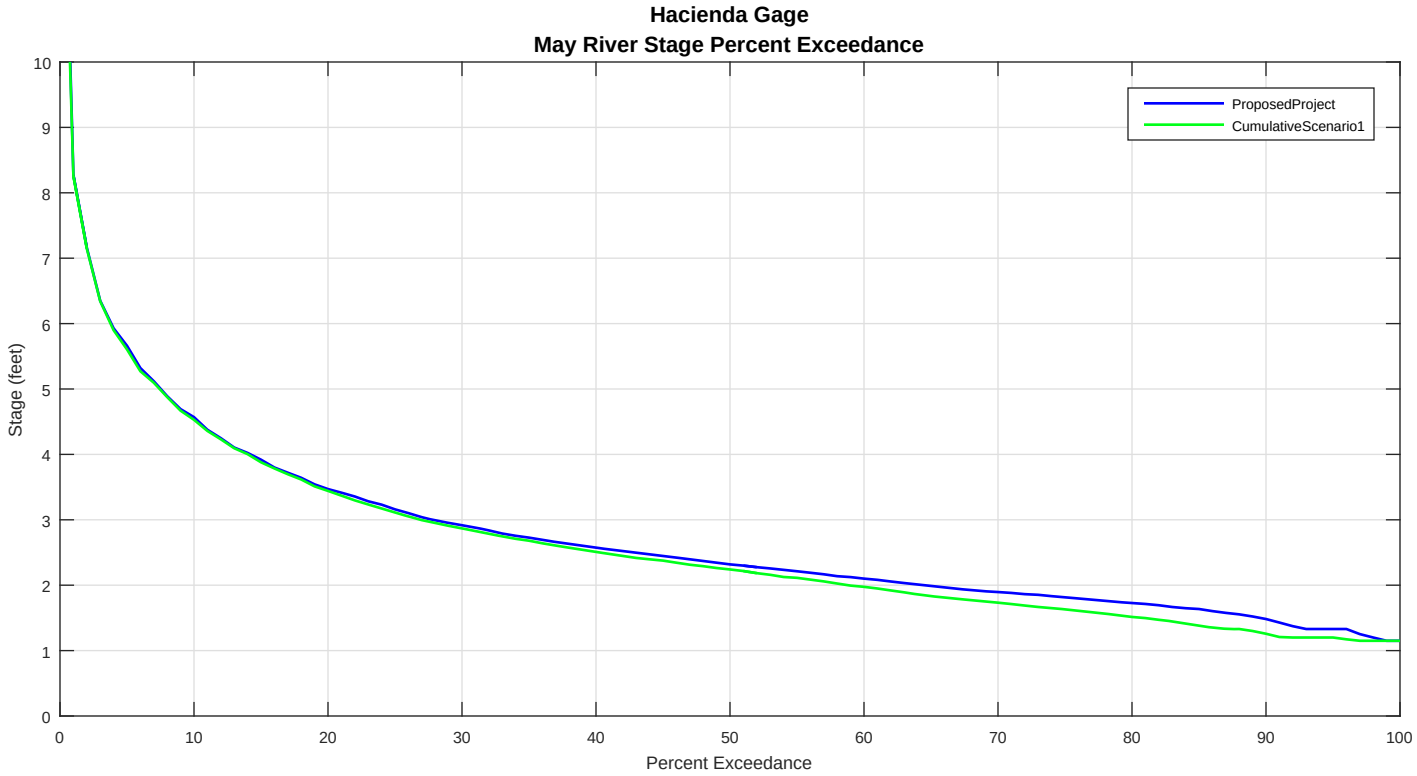

Healdsburg Gage
September River Stage Percent Exceedance
Stage (feet)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

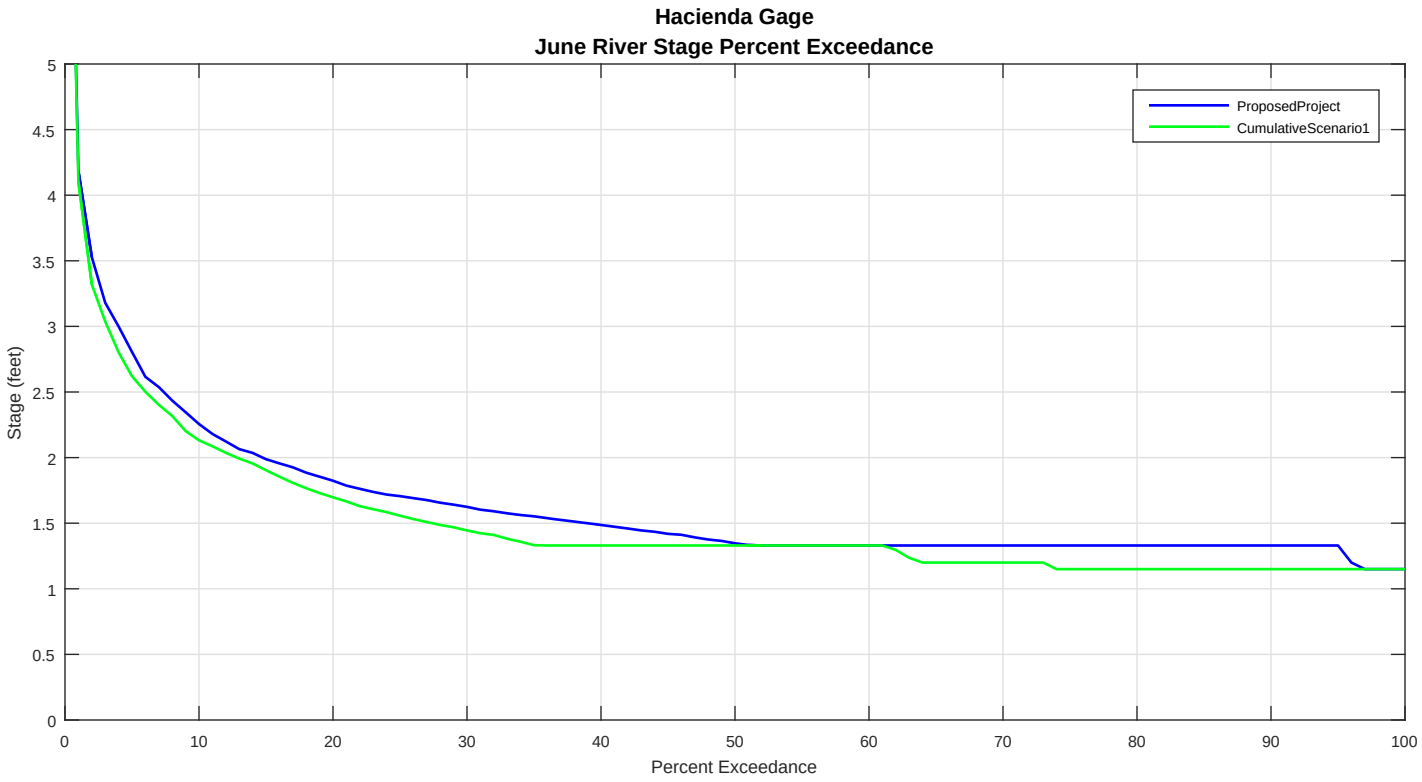

Healdsburg Gage
October 1-15 River Stage Percent Exceedance
Stage (feet)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

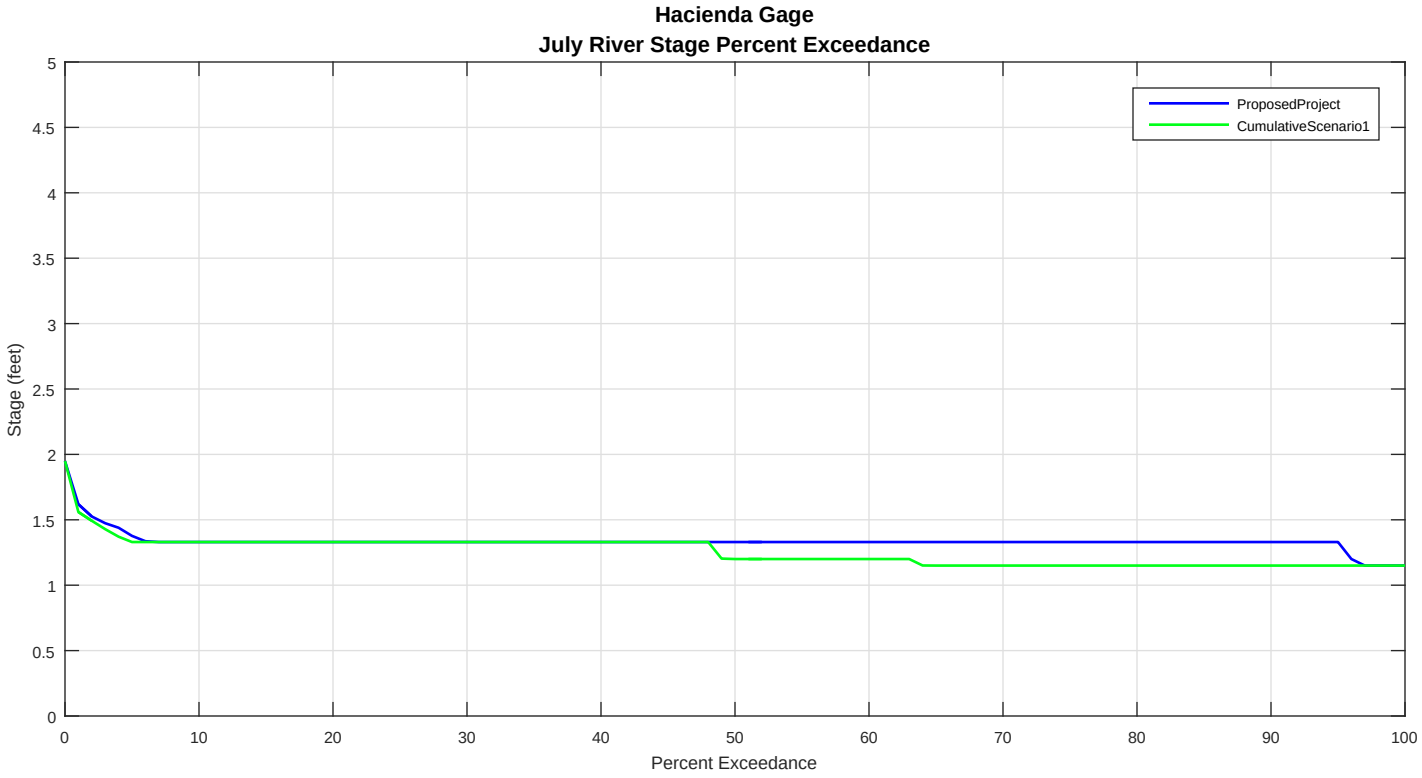

Healdsburg Gage
October 16-31 River Stage Percent Exceedance
Stage (feet)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

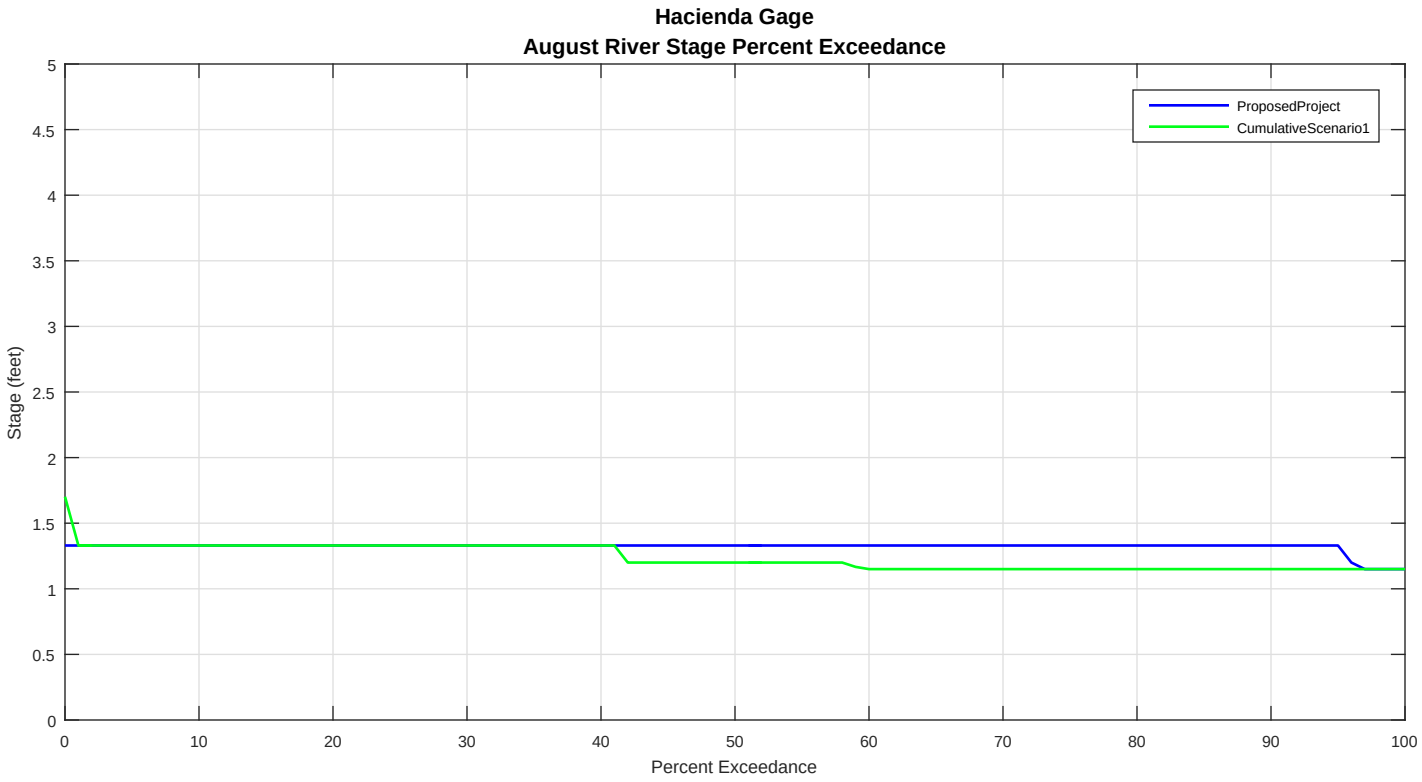

Hacienda Gage
March River Stage Percent Exceedance
Stage (feet)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80
90
100

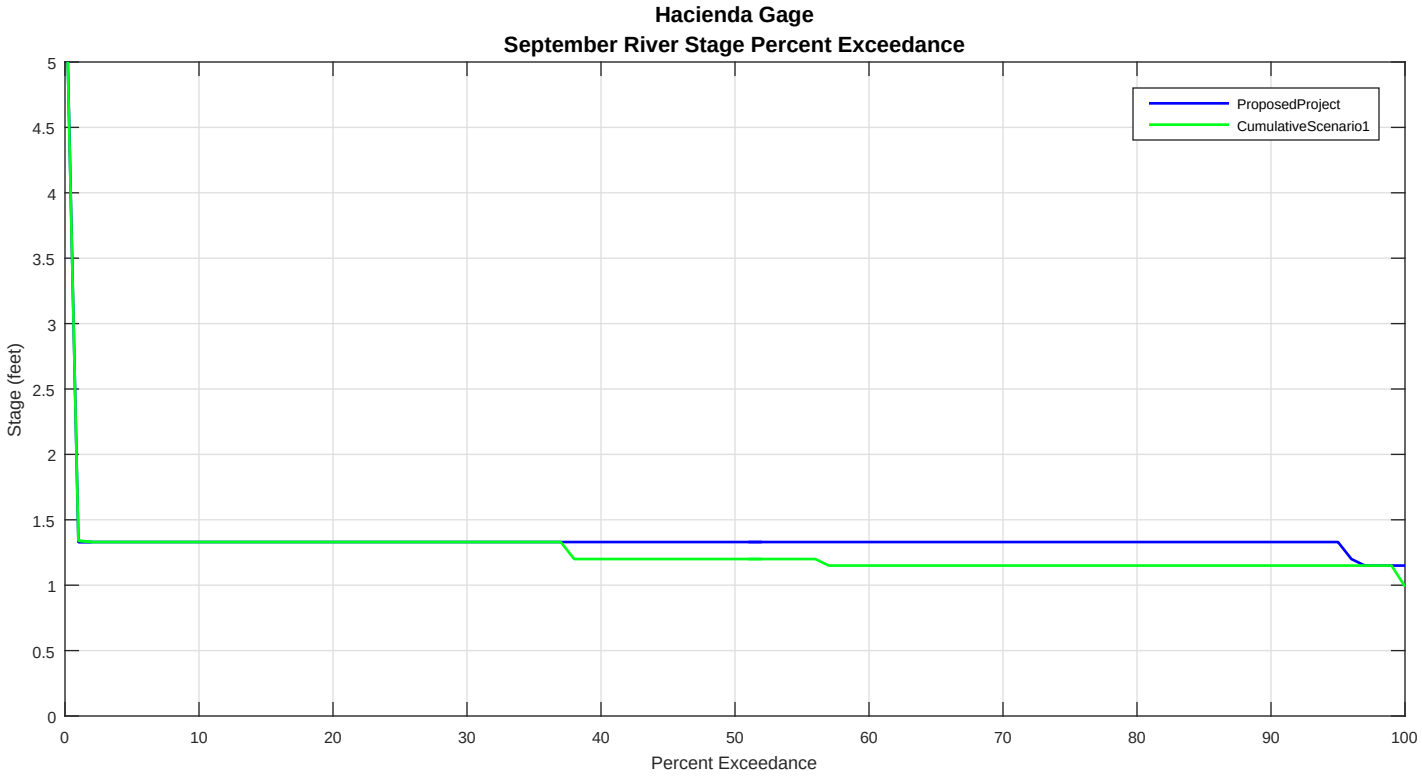

Hacienda Gage
April River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

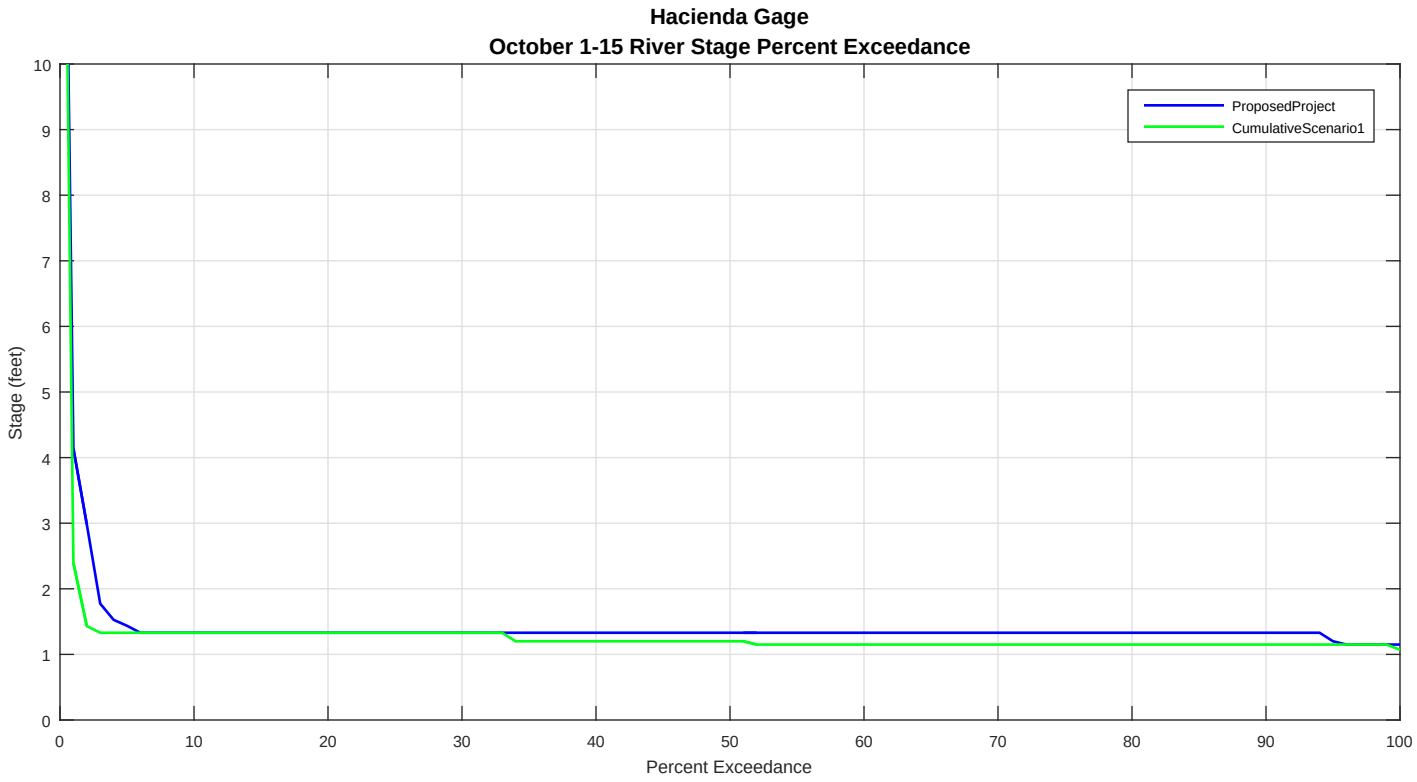

Hacienda Gage
May River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

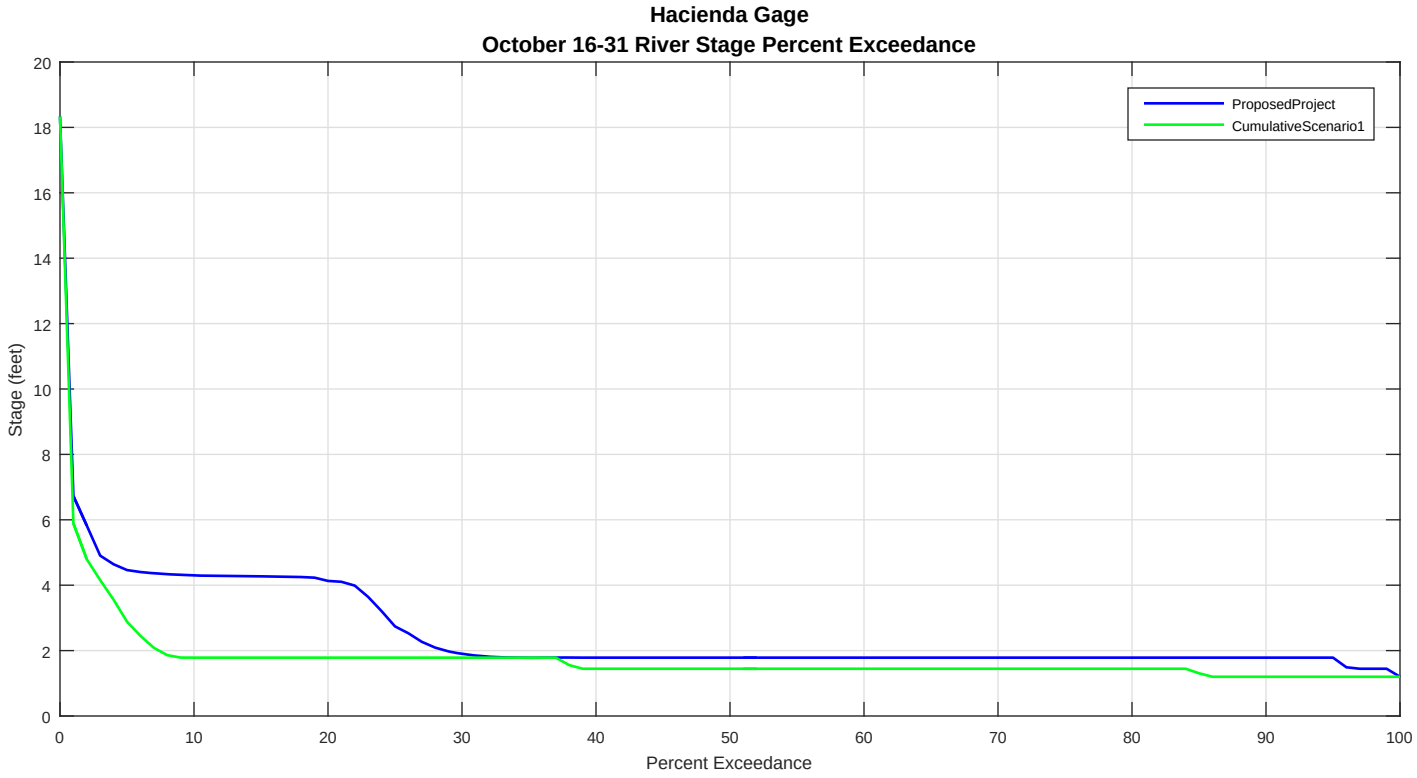

Hacienda Gage
June River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

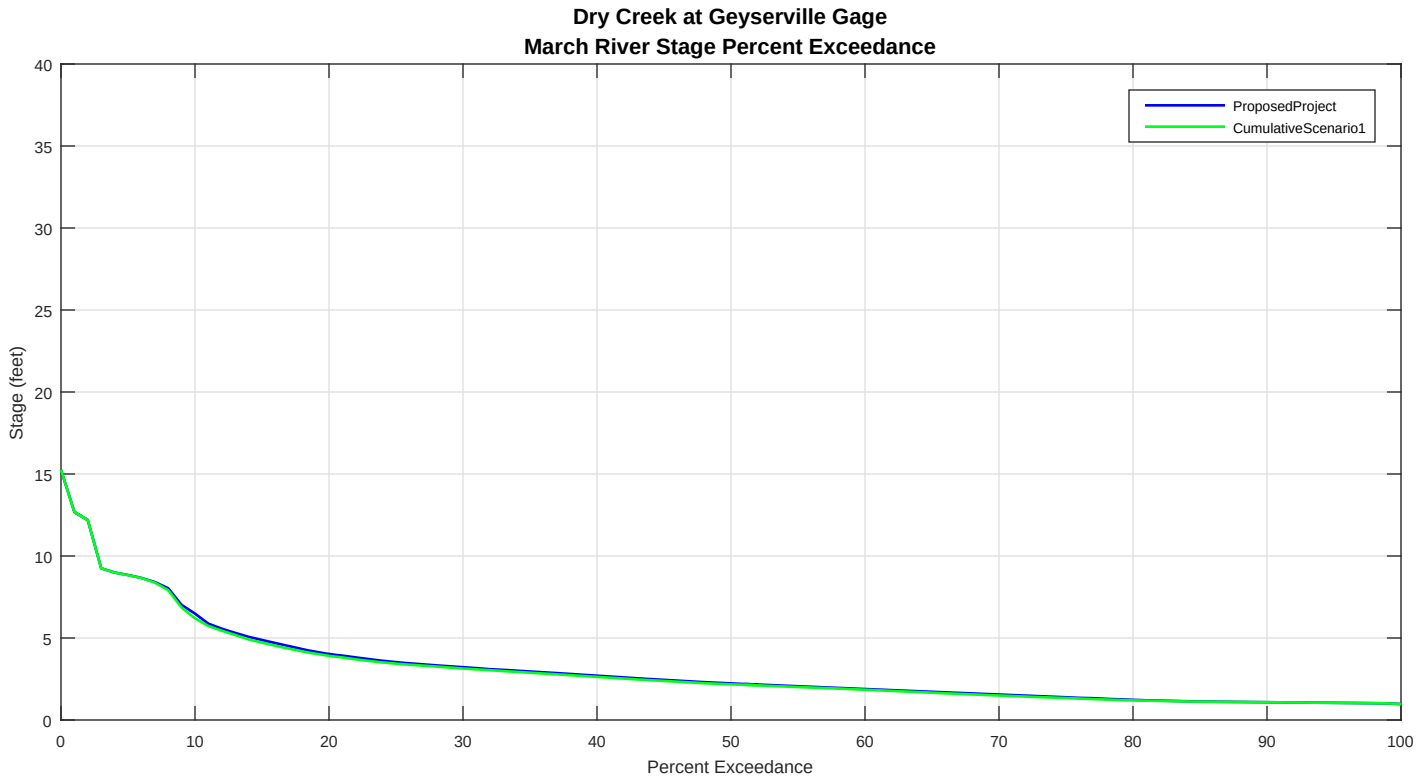

Hacienda Gage
July River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

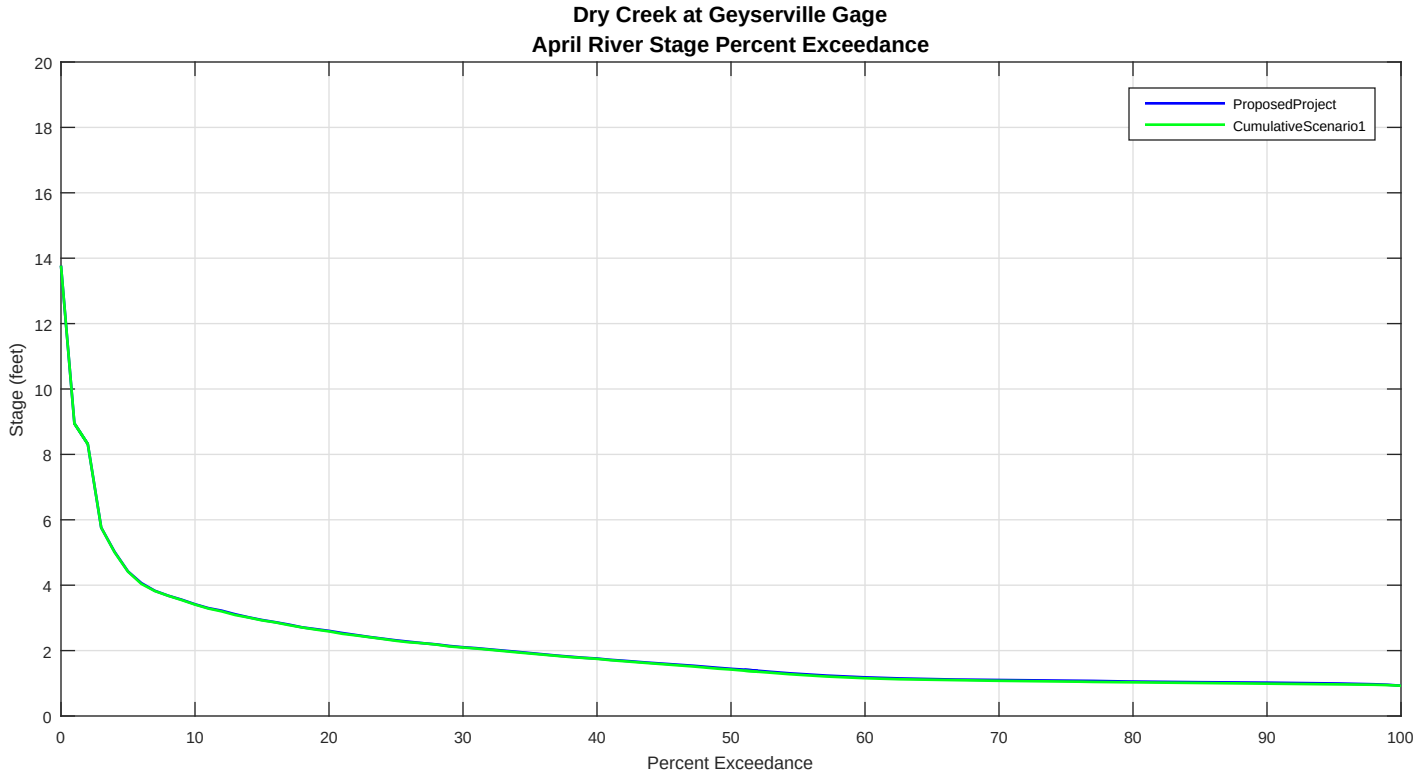

Hacienda Gage
August River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

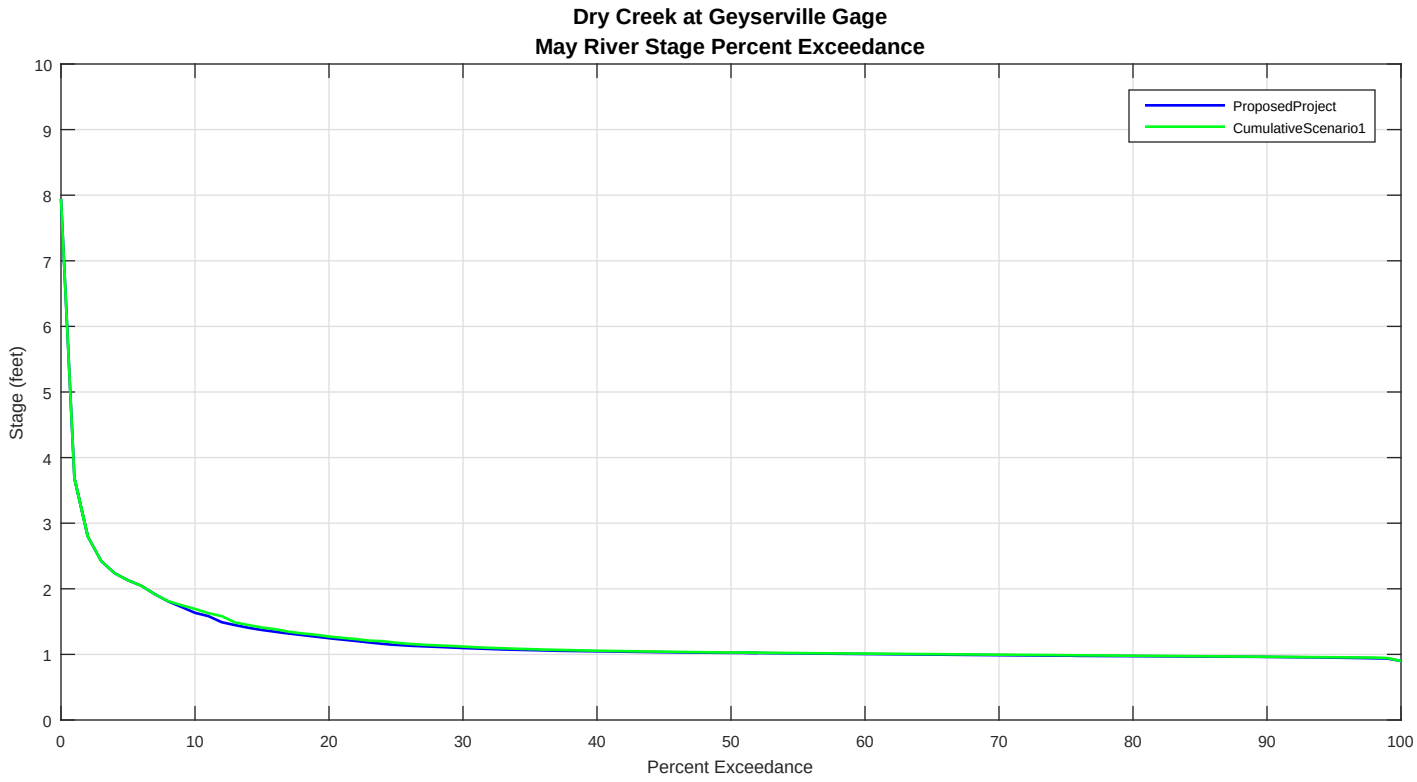

Hacienda Gage
September River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

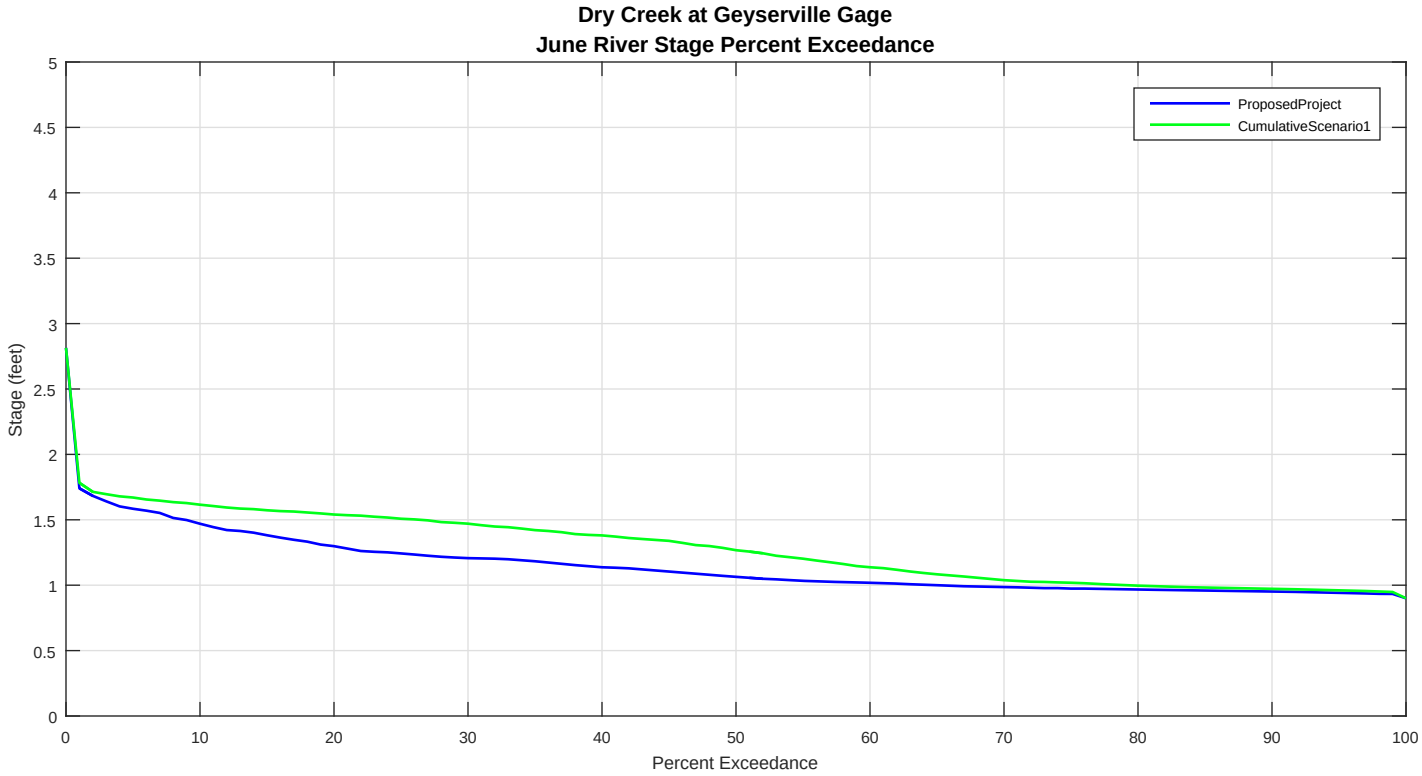

Hacienda Gage
October 1-15 River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

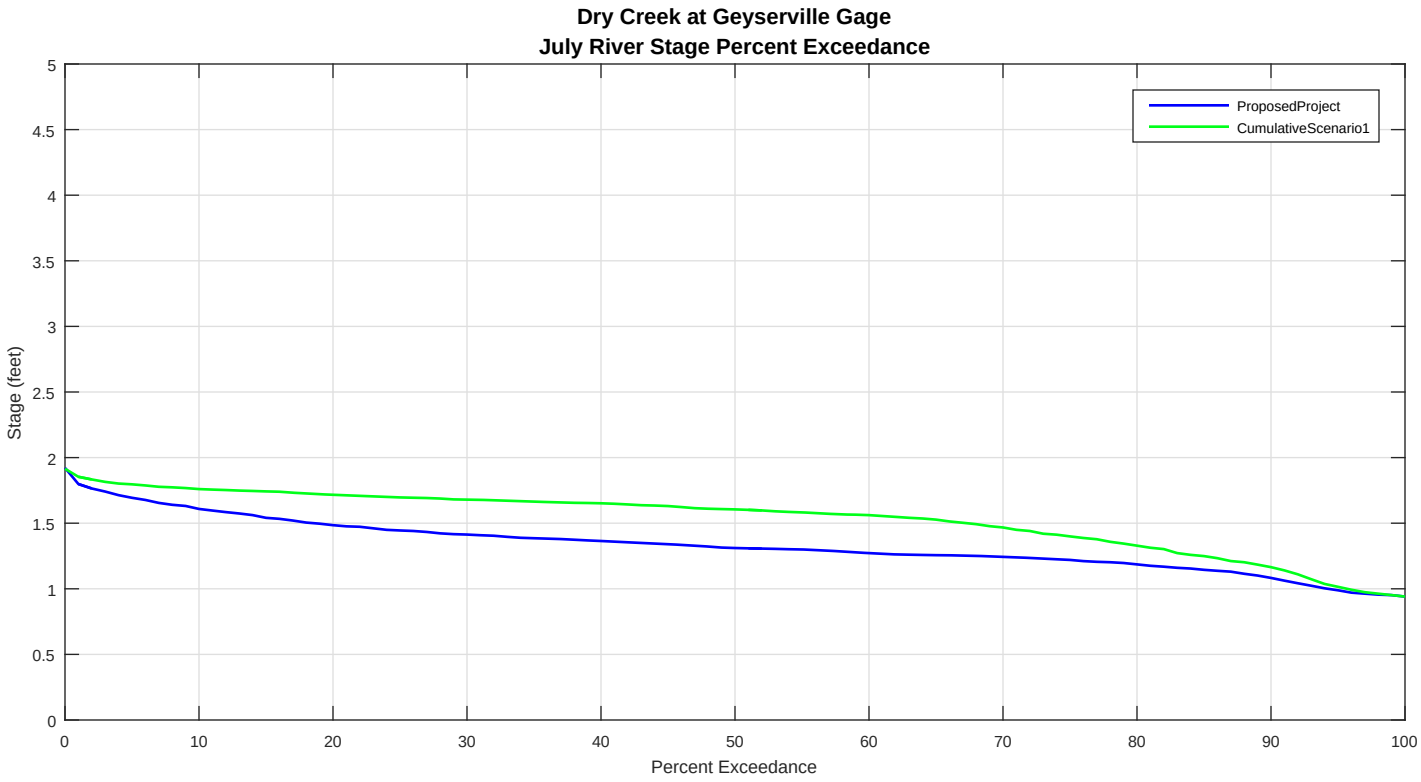

Hacienda Gage
October 16-31 River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

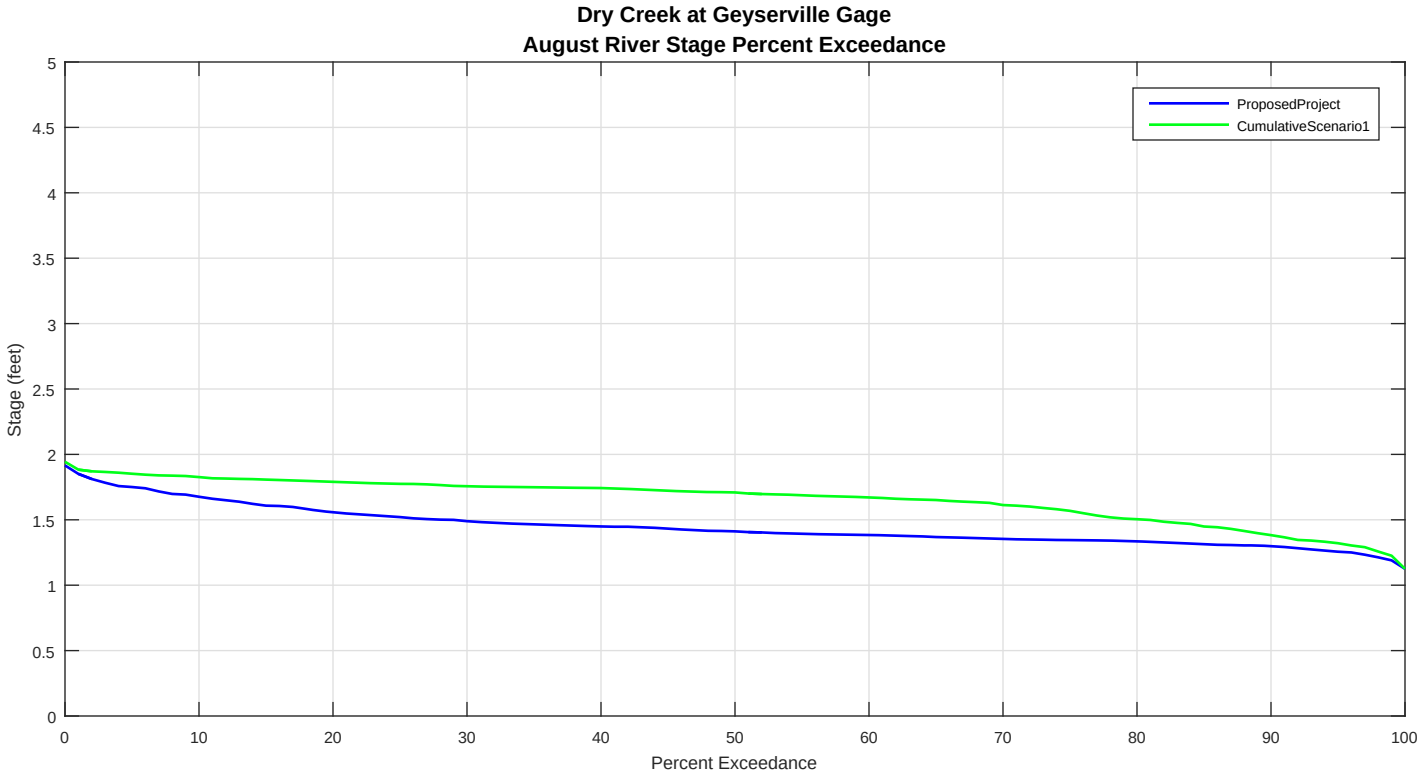

Dry Creek at Geyserville Gage
March River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80
90
100

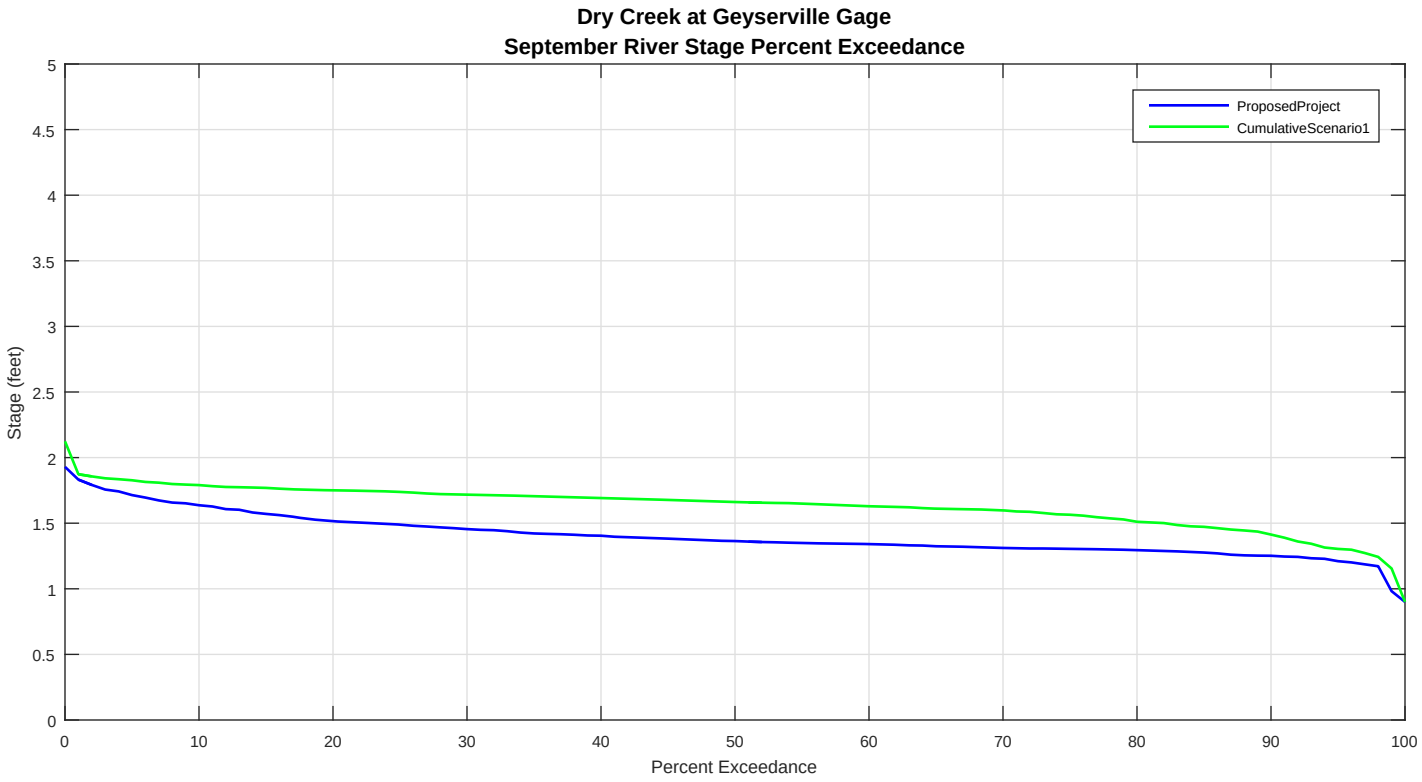

Dry Creek at Geyserville Gage
April River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

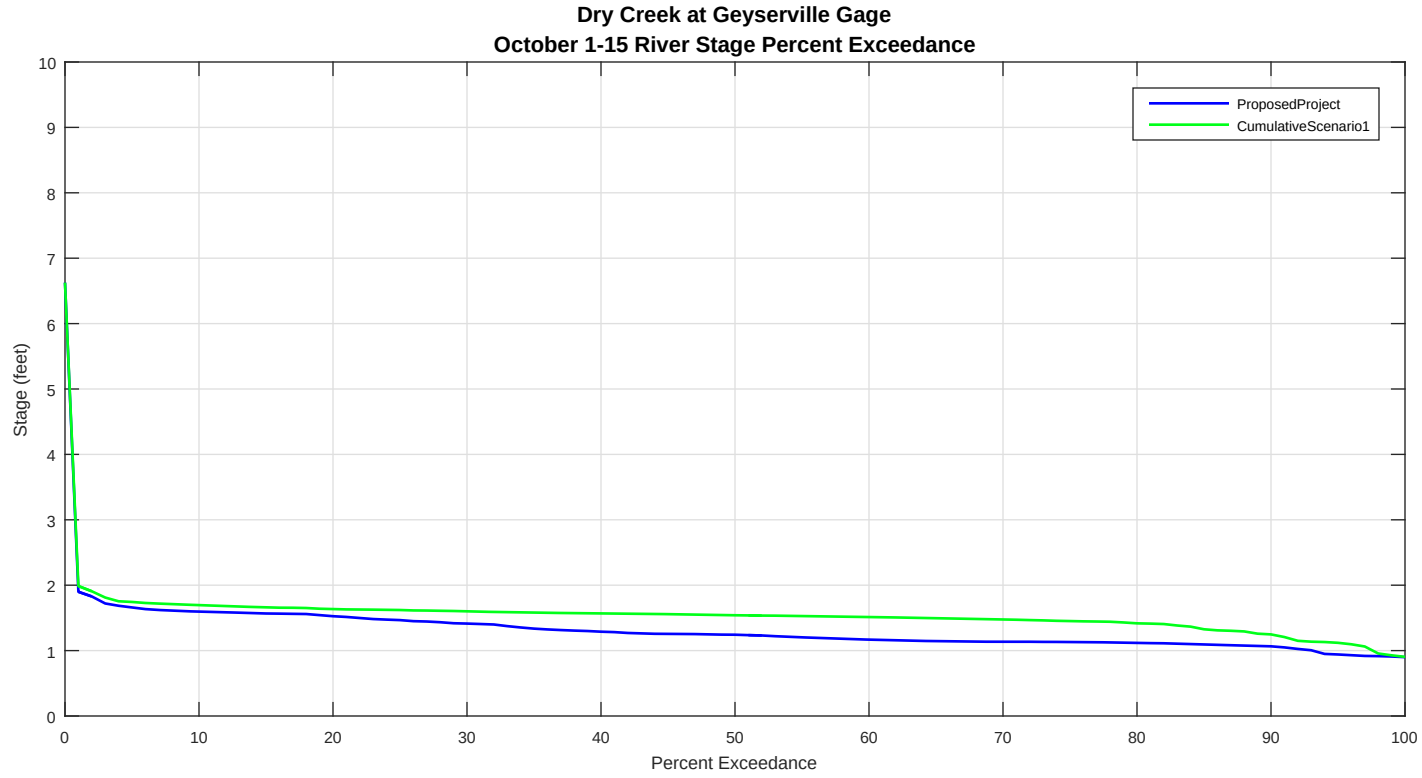

Dry Creek at Geyserville Gage
May River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

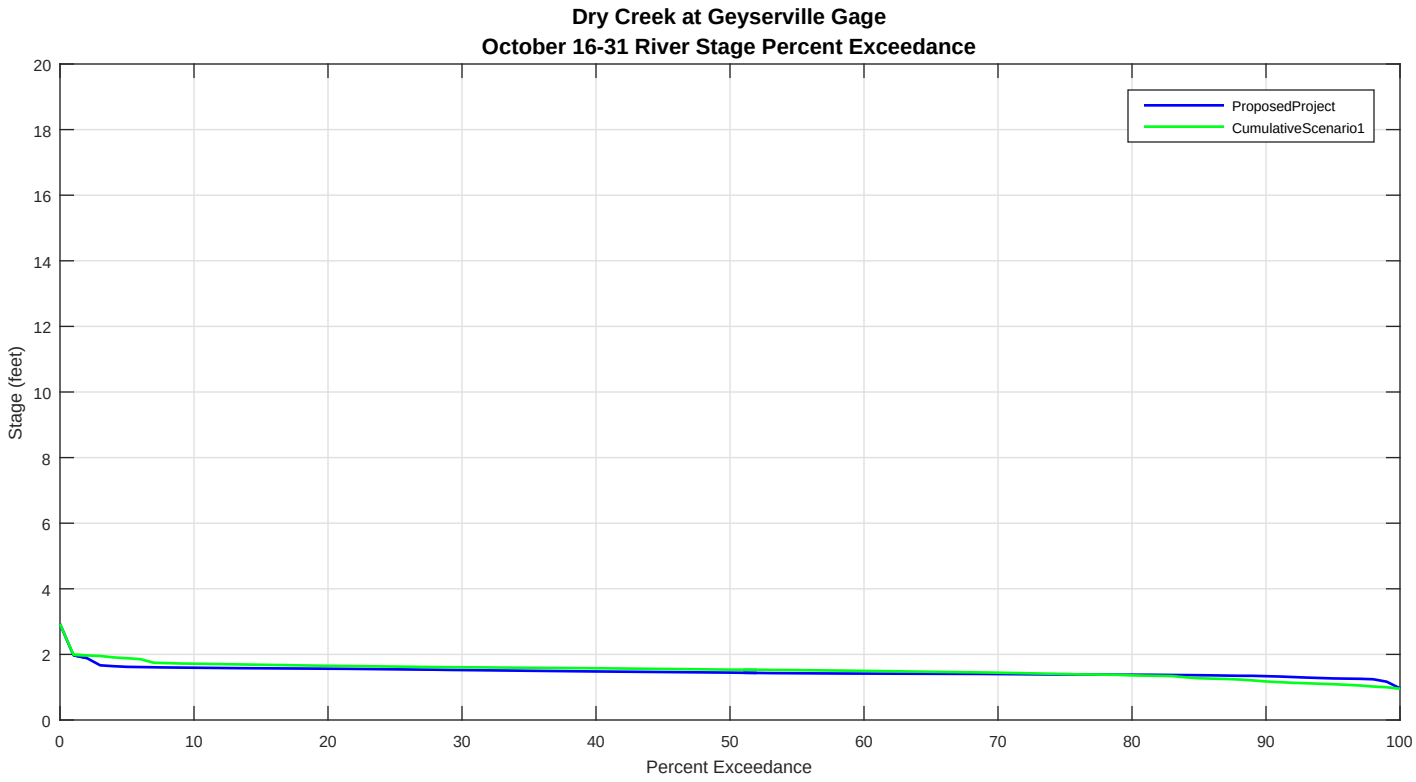

Dry Creek at Geyserville Gage
June River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100


Dry Creek at Geyserville Gage
July River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100


Dry Creek at Geyserville Gage
August River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100


Dry Creek at Geyserville Gage
September River Stage Percent Exceedance
Stage (feet)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100


Dry Creek at Geyserville Gage
October 1-15 River Stage Percent Exceedance
Stage (feet)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100


Dry Creek at Geyserville Gage
October 16-31 River Stage Percent Exceedance
ProposedProject
CumulativeScenario1
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
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90
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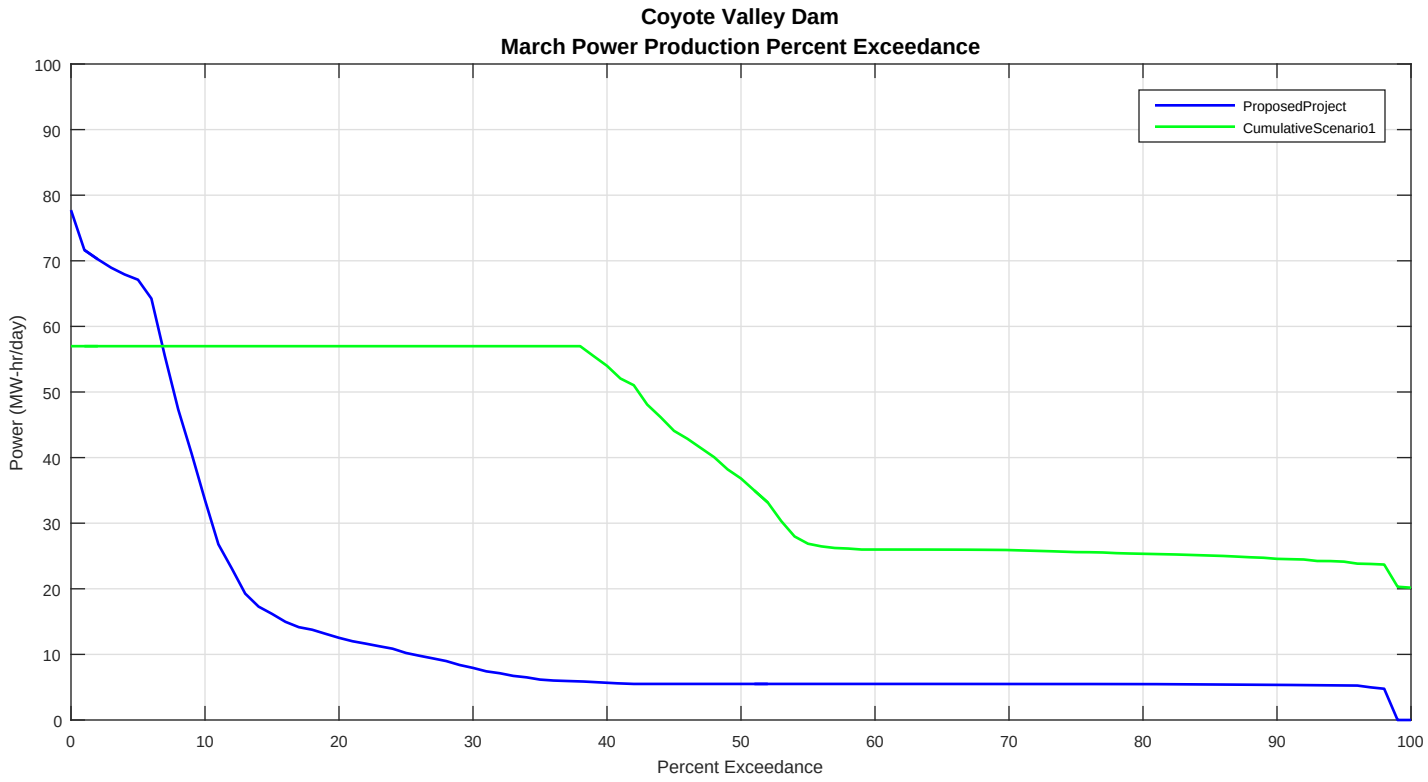
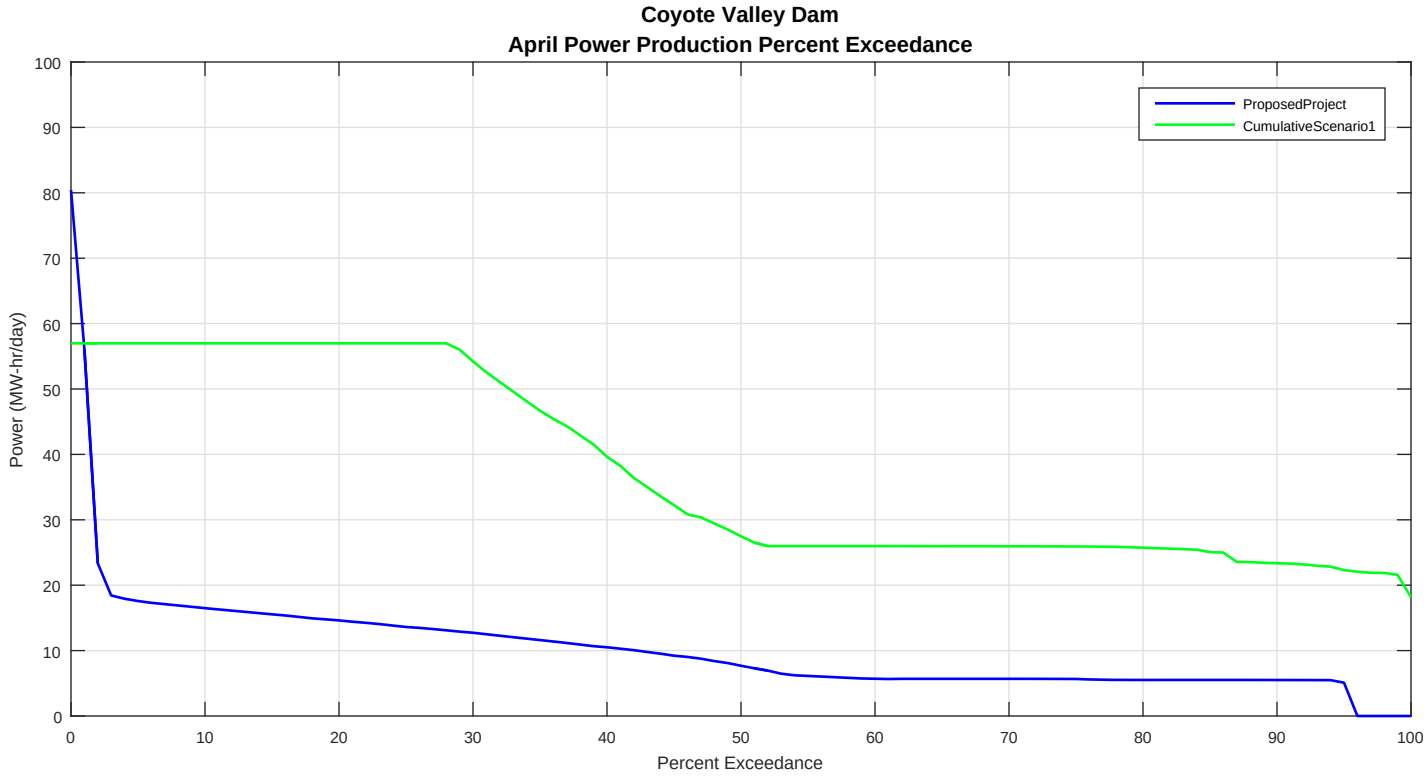

Coyote Valley Dam
March Power Production Percent Exceedance
ProposedProject
CumulativeScenario1
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam
April Power Production Percent Exceedance
ProposedProject
CumulativeScenario1
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
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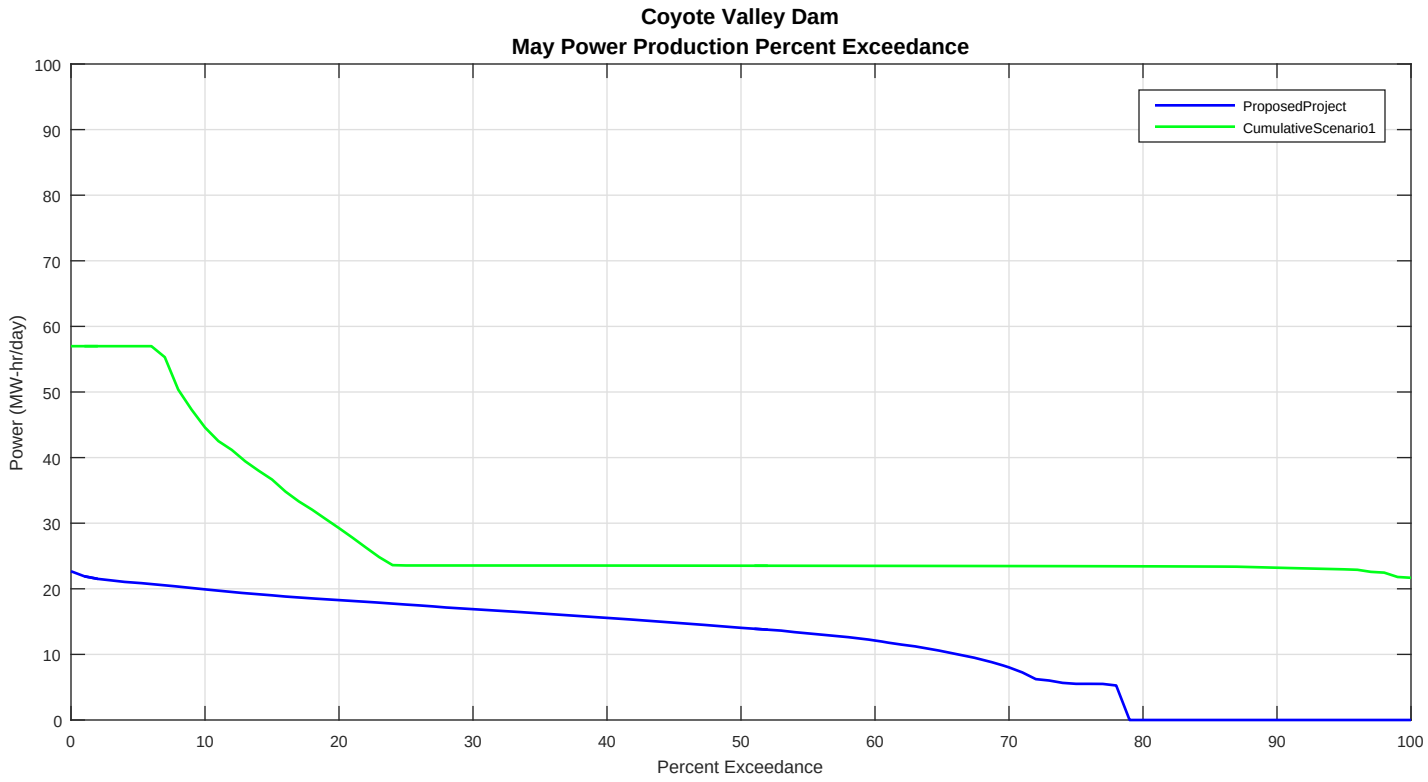
Coyote Valley Dam
May Power Production Percent Exceedance
ProposedProject
CumulativeScenario1
Power (MW-hr/day)
Percent Exceedance
0
10
20
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40
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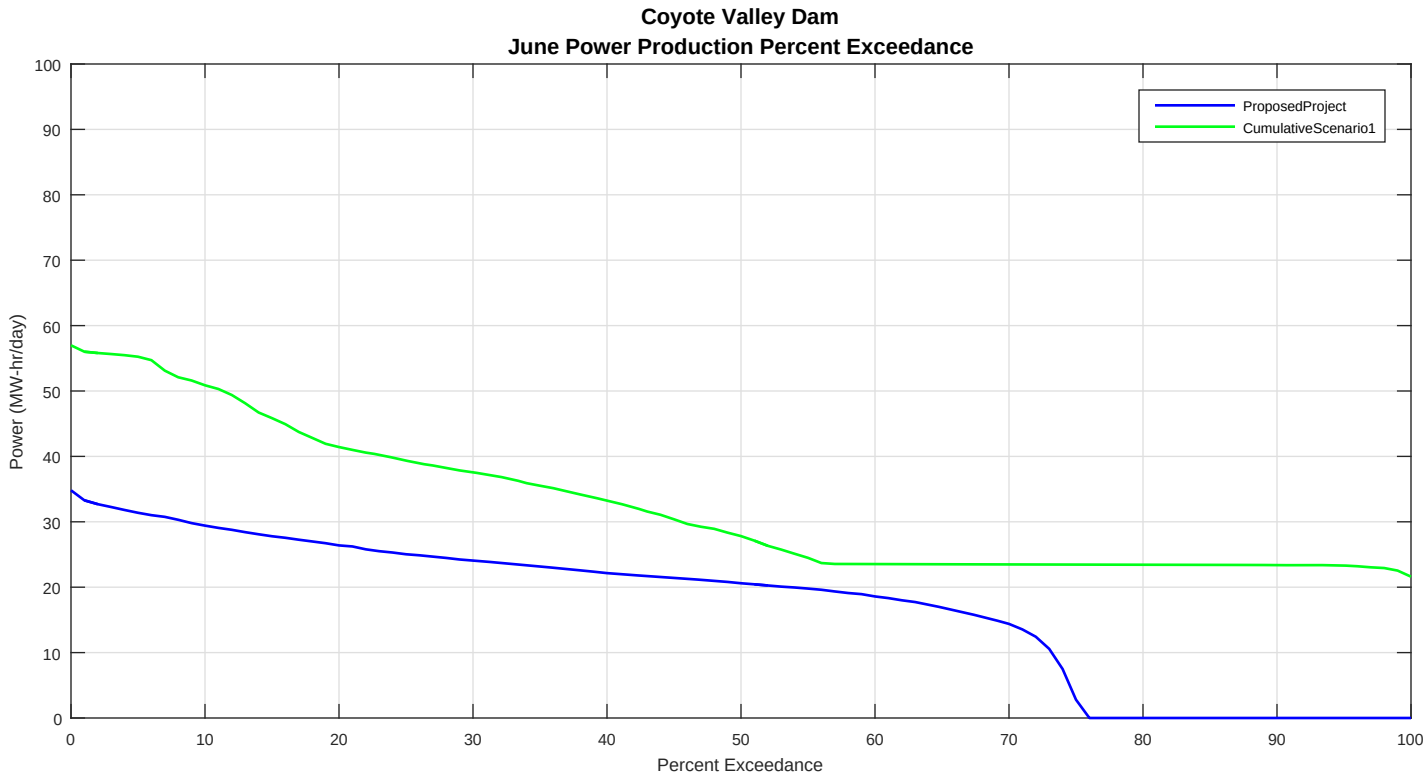
90
100


Coyote Valley Dam
June Power Production Percent Exceedance
ProposedProject
CumulativeScenario1
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
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70
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90
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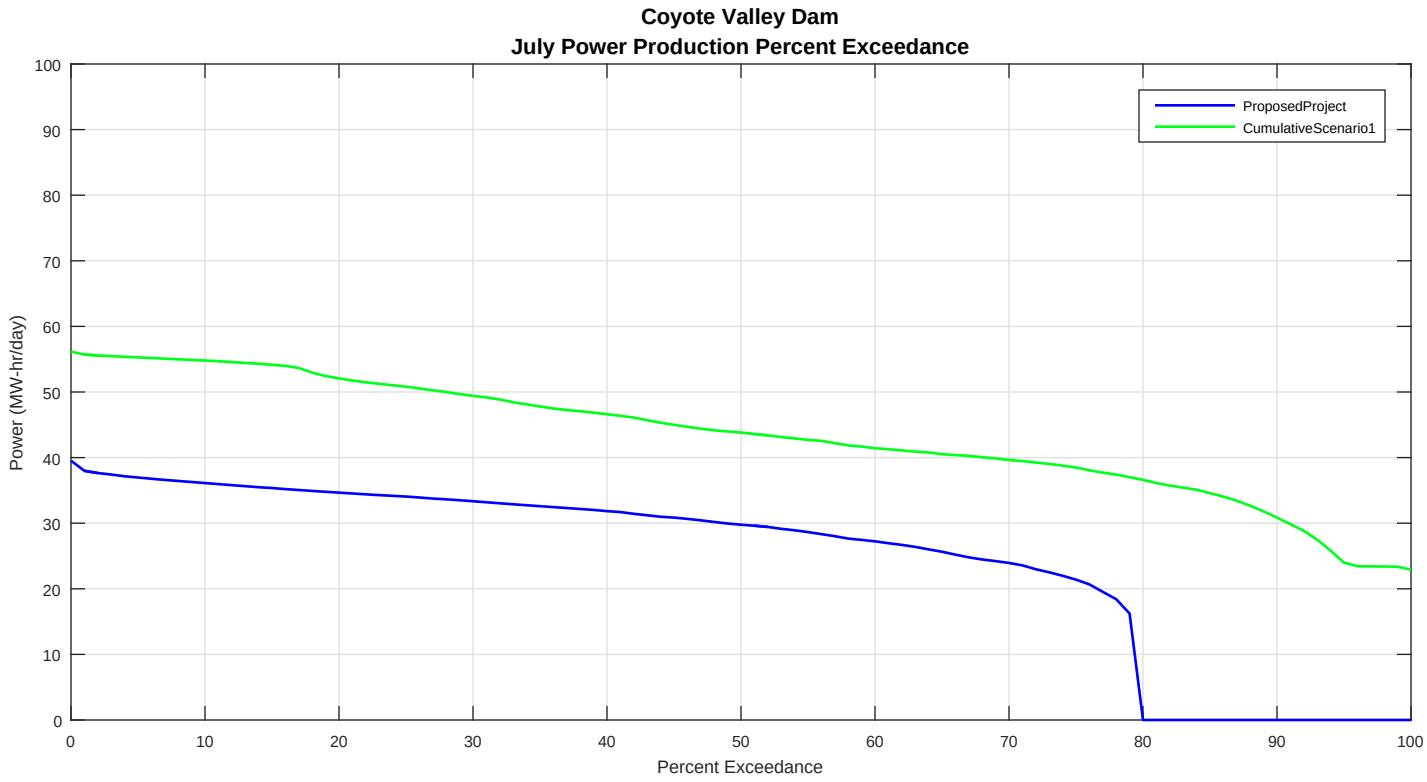
Coyote Valley Dam
July Power Production Percent Exceedance
ProposedProject
CumulativeScenario1
Power (MW-hr/day)
Percent Exceedance
0
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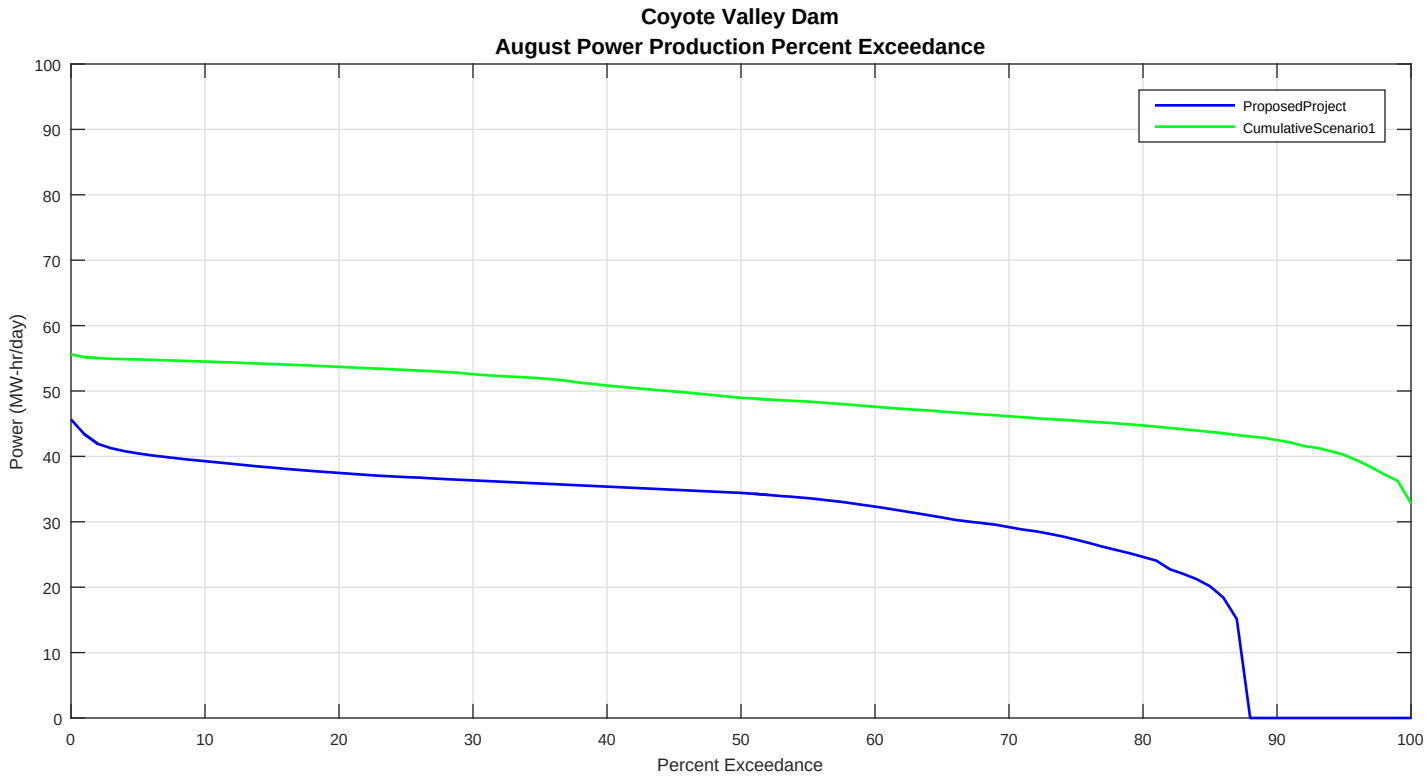
Coyote Valley Dam
August Power Production Percent Exceedance
ProposedProject
CumulativeScenario1
Power (MW-hr/day)
Percent Exceedance
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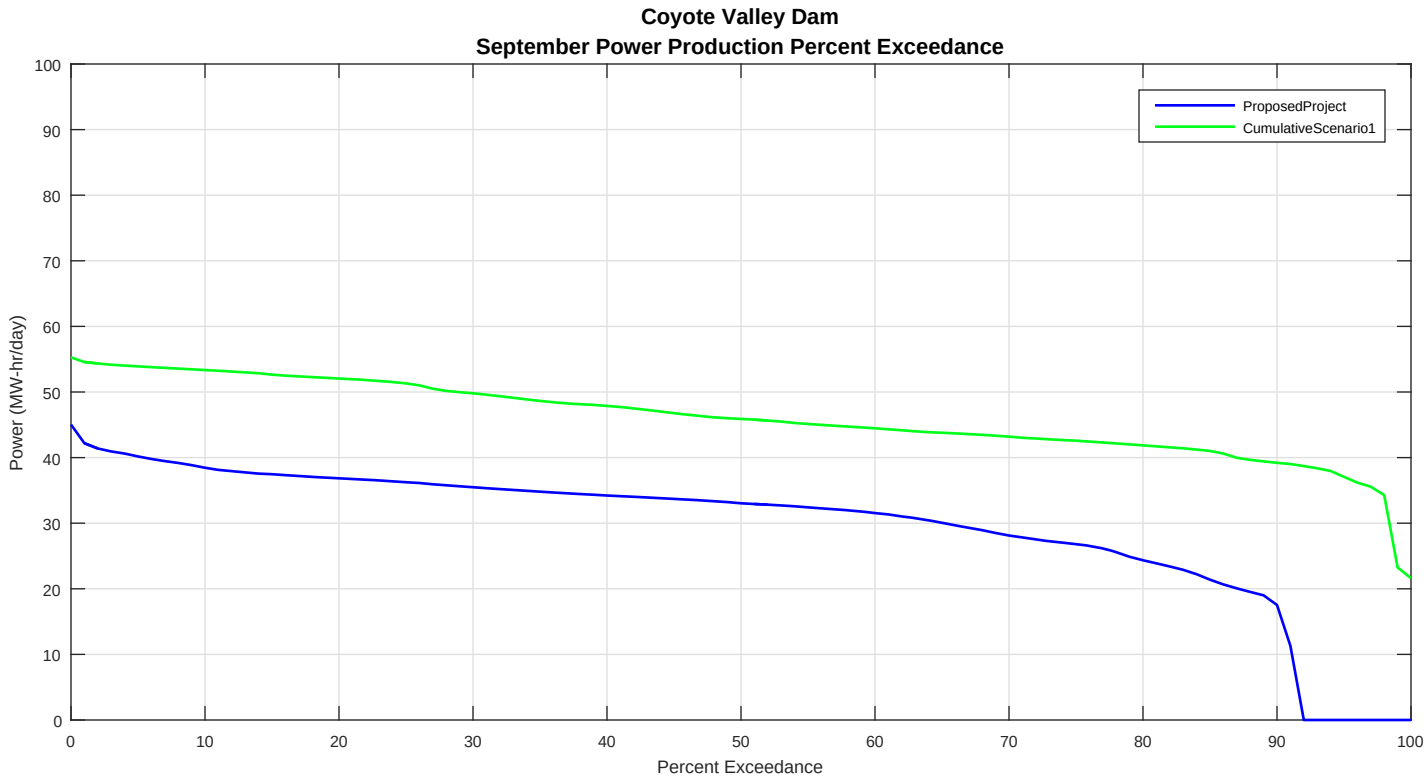
Coyote Valley Dam
September Power Production Percent Exceedance
ProposedProject
CumulativeScenario1
Power (MW-hr/day)
Percent Exceedance
0
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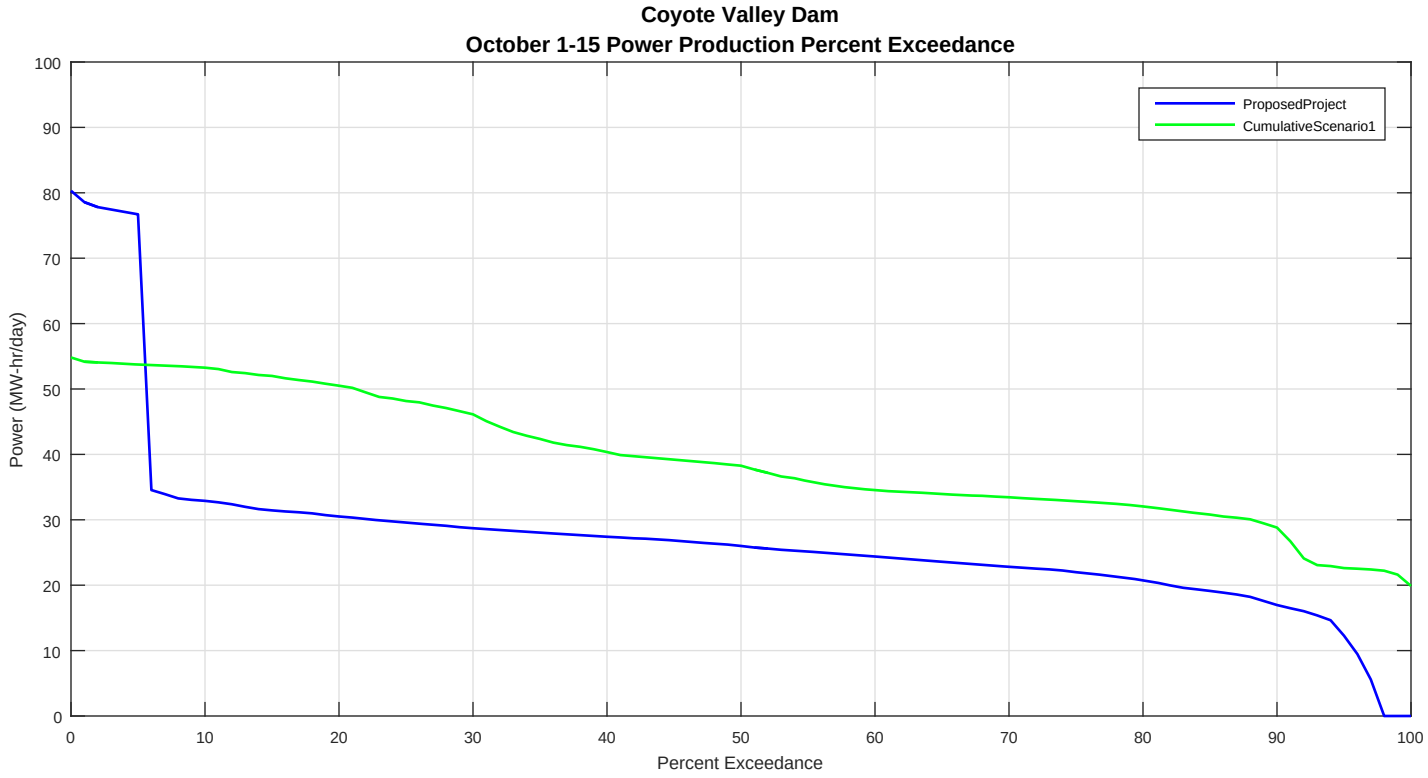
Coyote Valley Dam
October 1-15 Power Production Percent Exceedance
ProposedProject
CumulativeScenario1
Power (MW-hr/day)
Percent Exceedance
0
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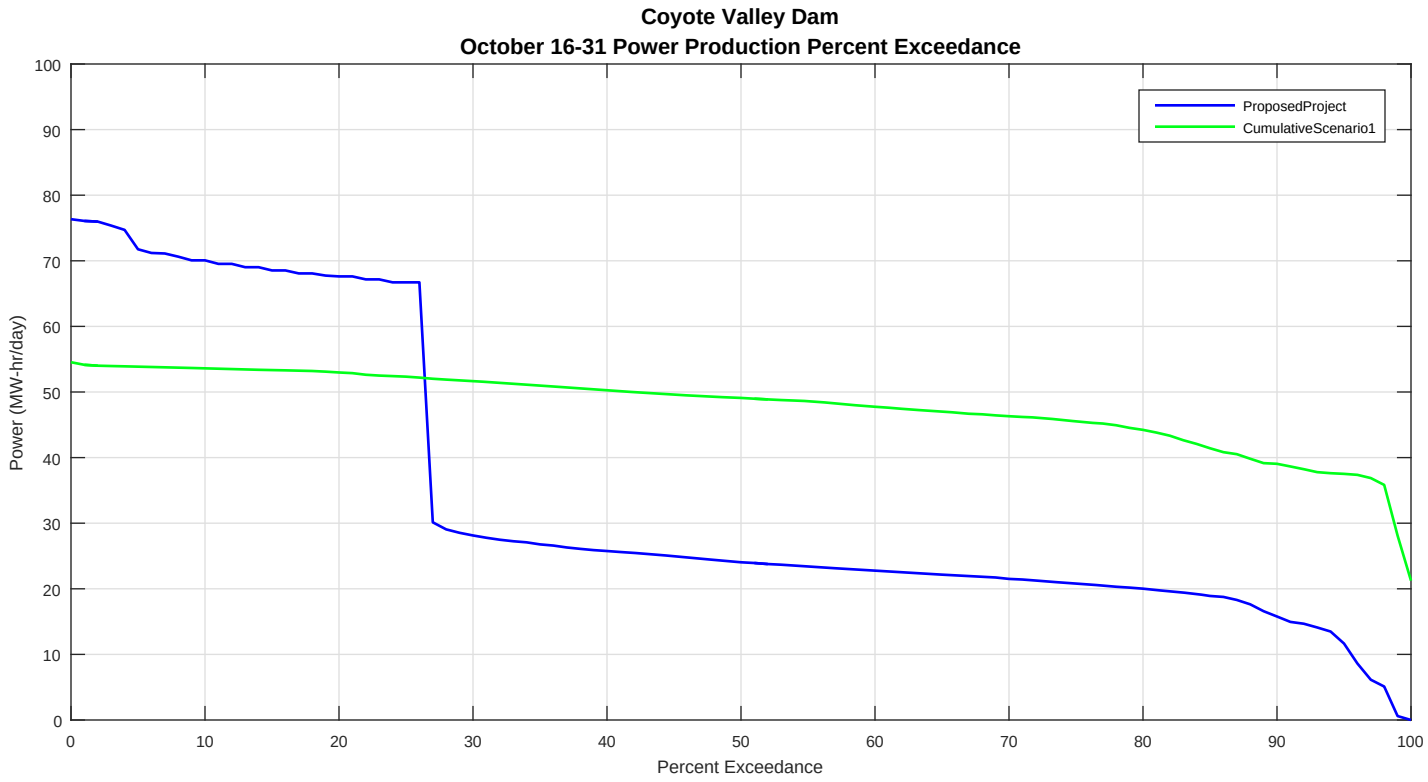
Coyote Valley Dam
October 16-31 Power Production Percent Exceedance
ProposedProject
CumulativeScenario1
Power (MW-hr/day)
Percent Exceedance
0
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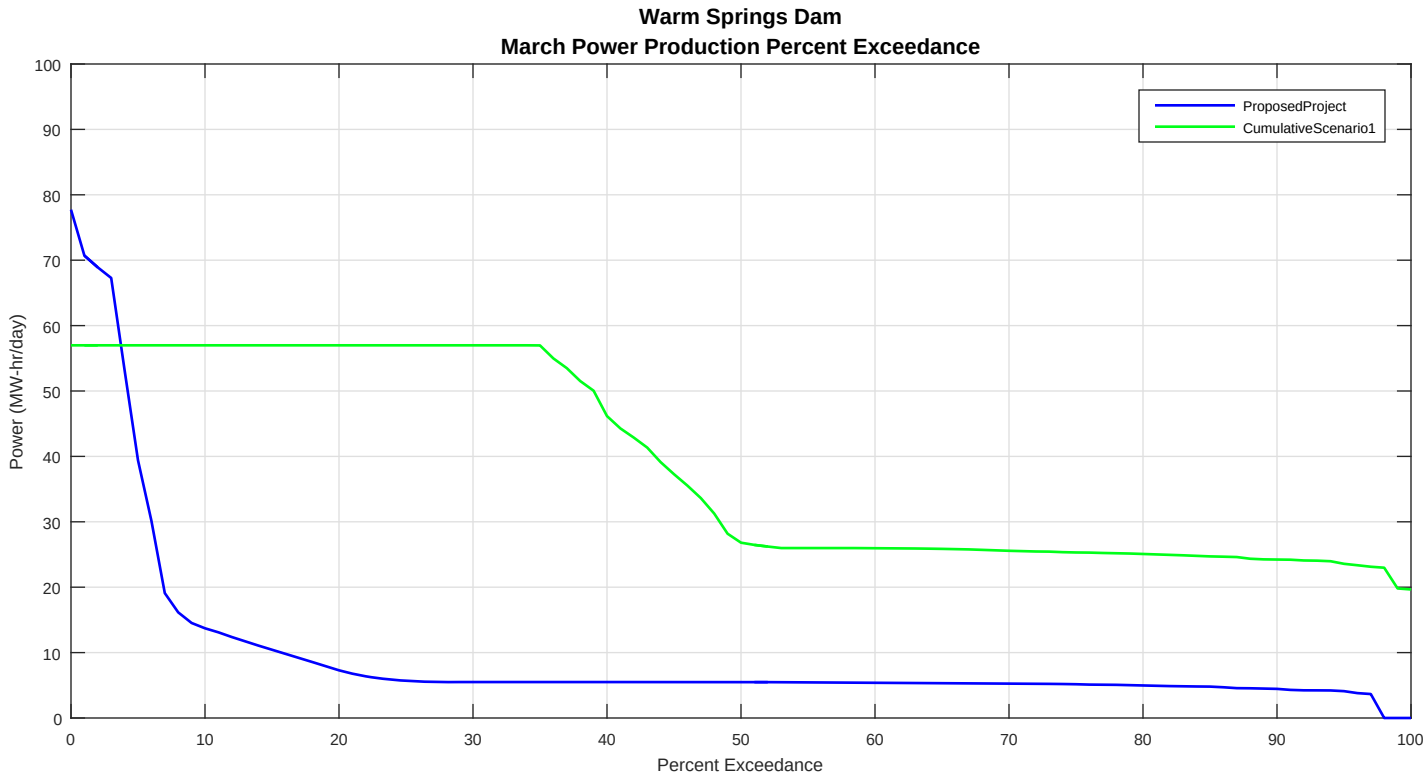
Warm Springs Dam
March Power Production Percent Exceedance
ProposedProject
CumulativeScenario1
Power (MW-hr/day)
Percent Exceedance
0
10
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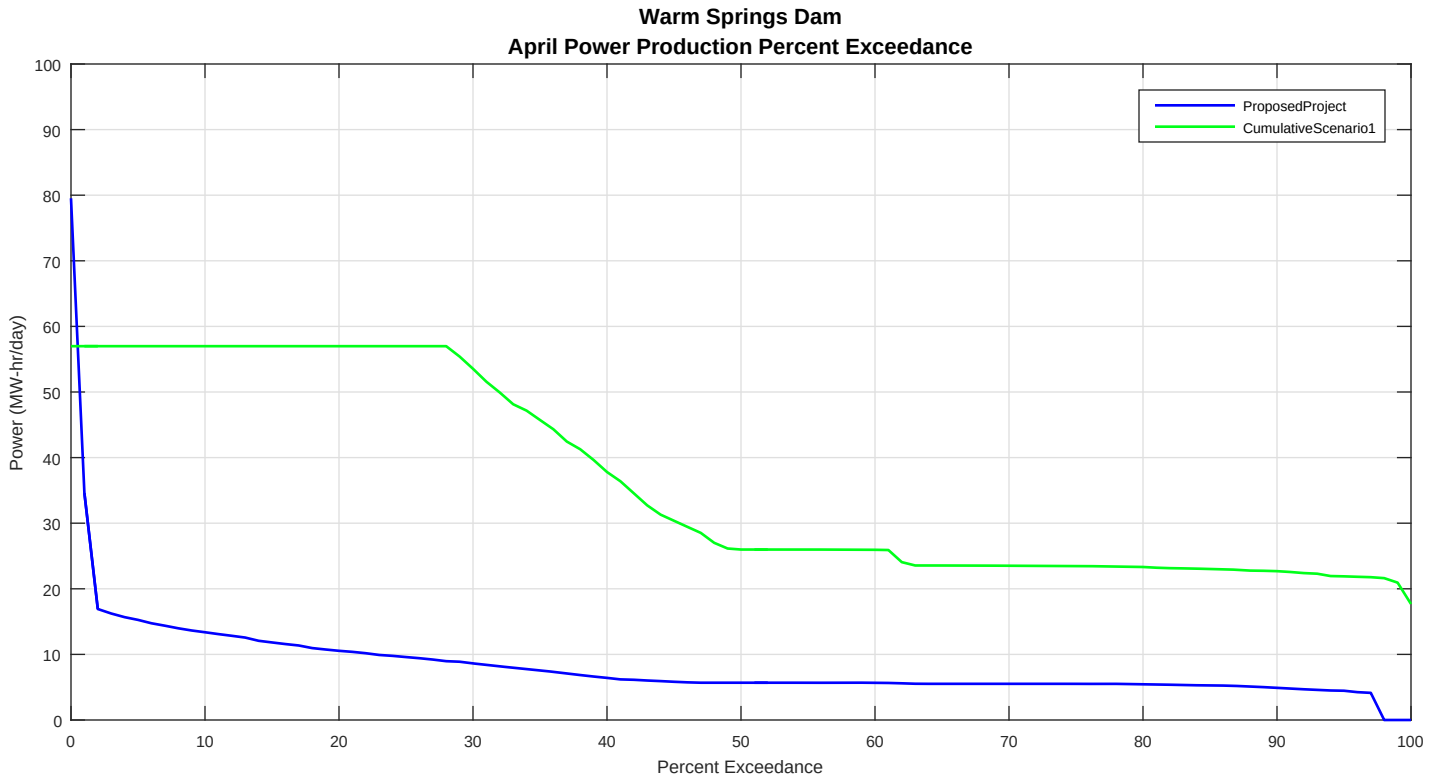
Warm Springs Dam
April Power Production Percent Exceedance
Power (MW-hr/day)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
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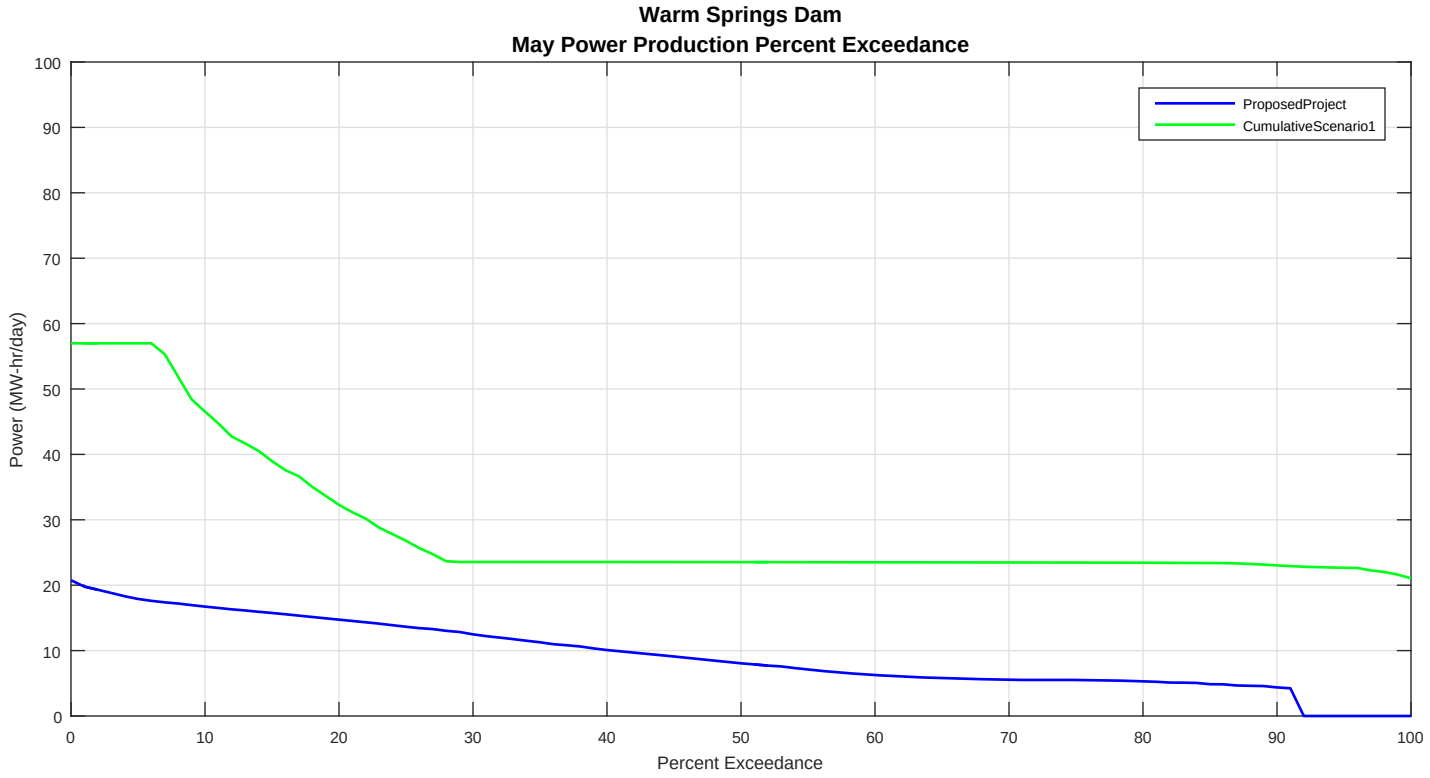
Warm Springs Dam
May Power Production Percent Exceedance
Power (MW-hr/day)
Percent Exceedance
ProposedProject
CumulativeScenario1
0
10
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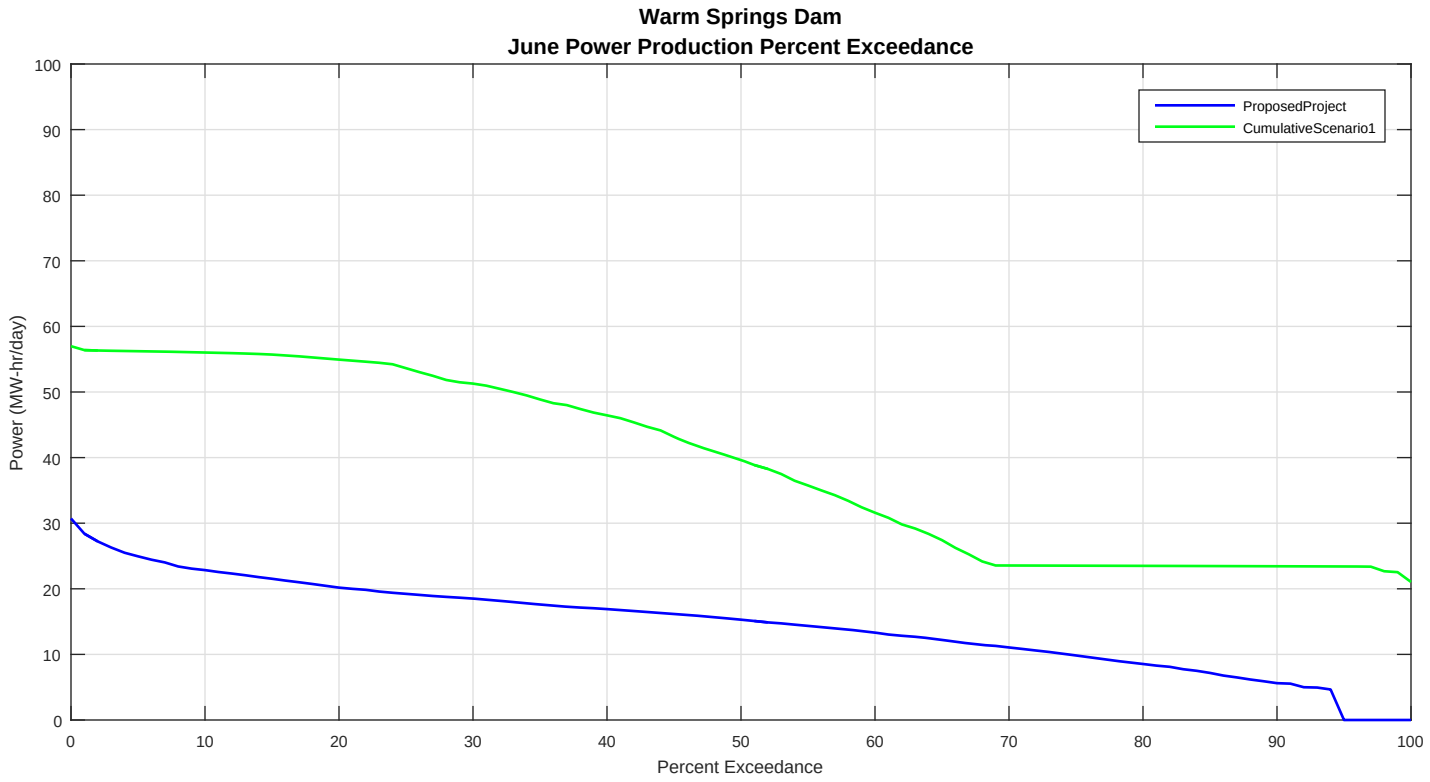
Warm Springs Dam
June Power Production Percent Exceedance
ProposedProject
CumulativeScenario1
Power (MW-hr/day)
Percent Exceedance
0
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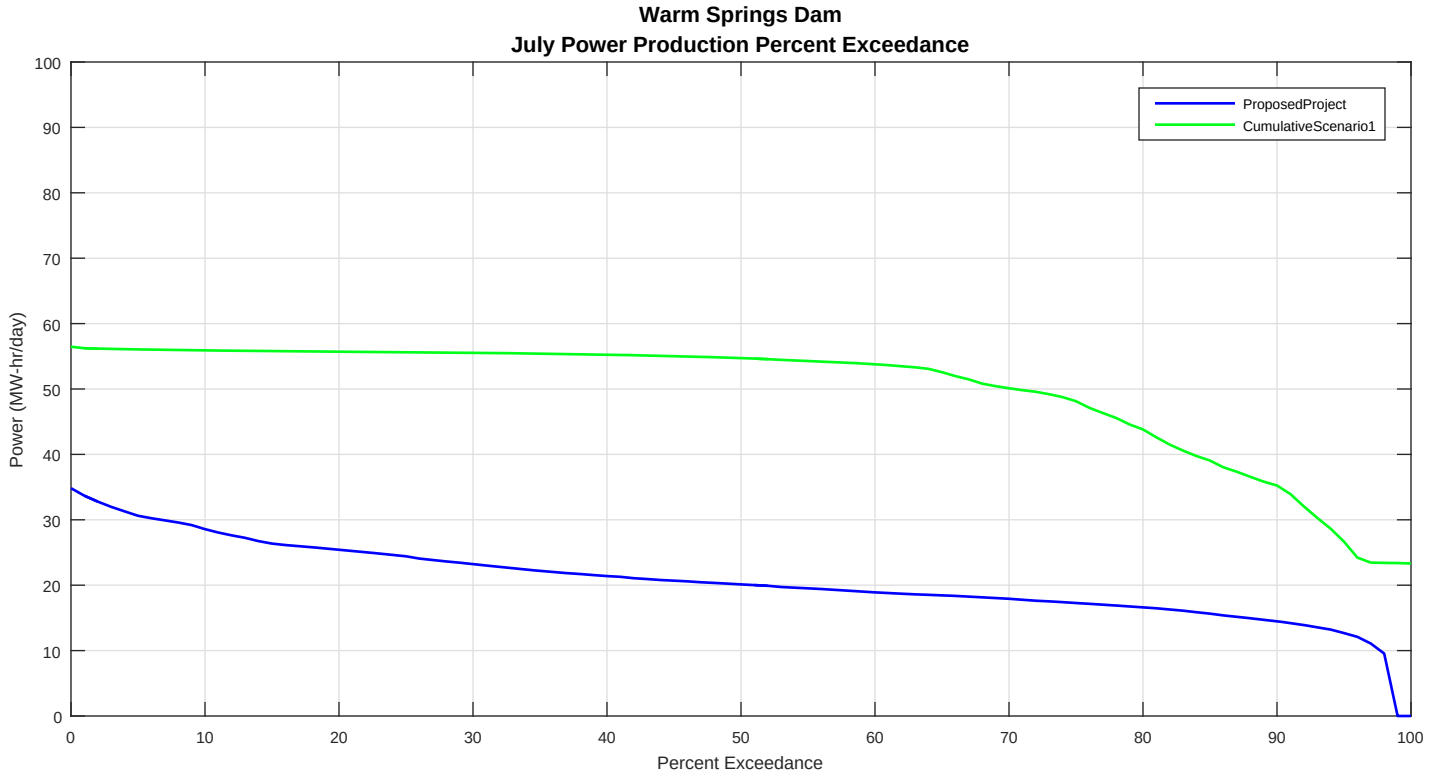
Warm Springs Dam
July Power Production Percent Exceedance
ProposedProject
CumulativeScenario1
Power (MW-hr/day)
Percent Exceedance
0
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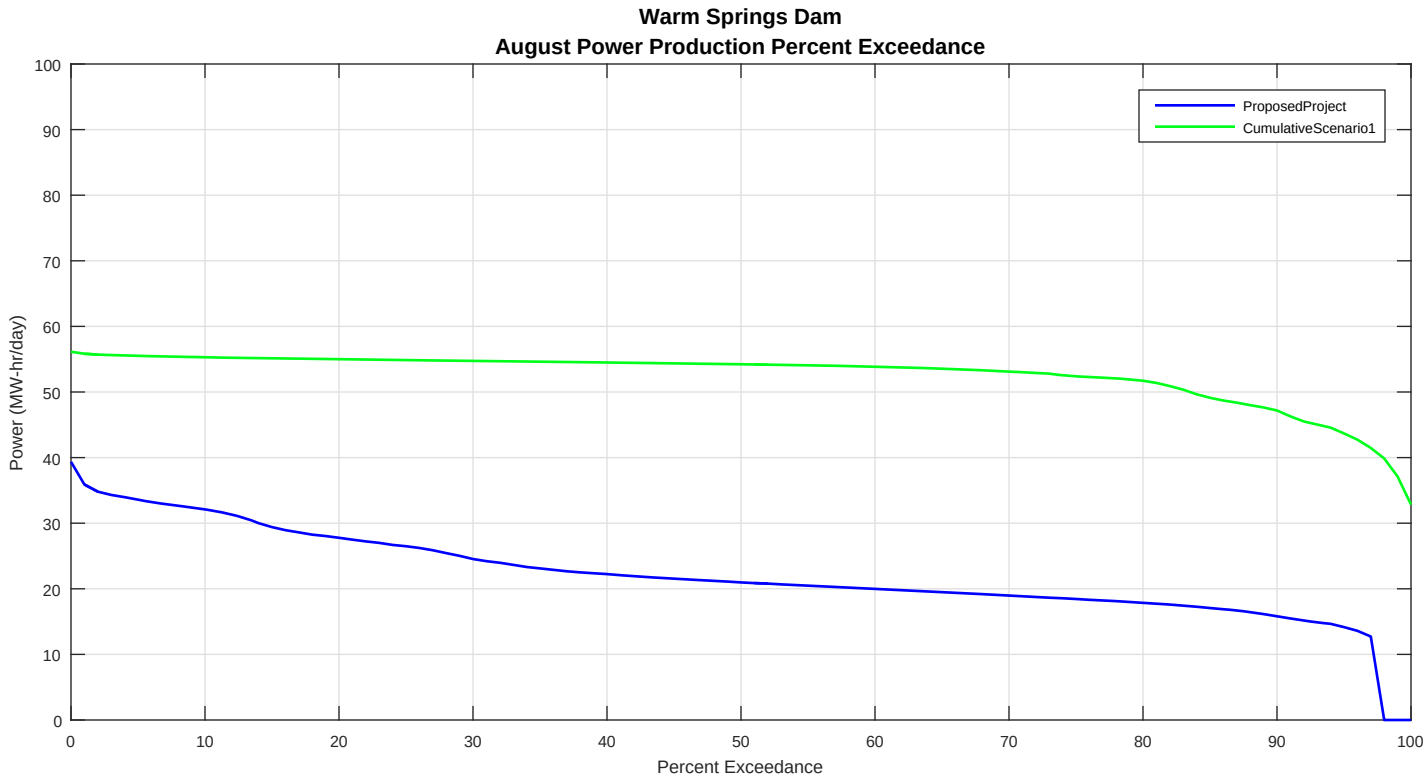
Warm Springs Dam
August Power Production Percent Exceedance
ProposedProject
CumulativeScenario1
Power (MW-hr/day)
Percent Exceedance
0
10
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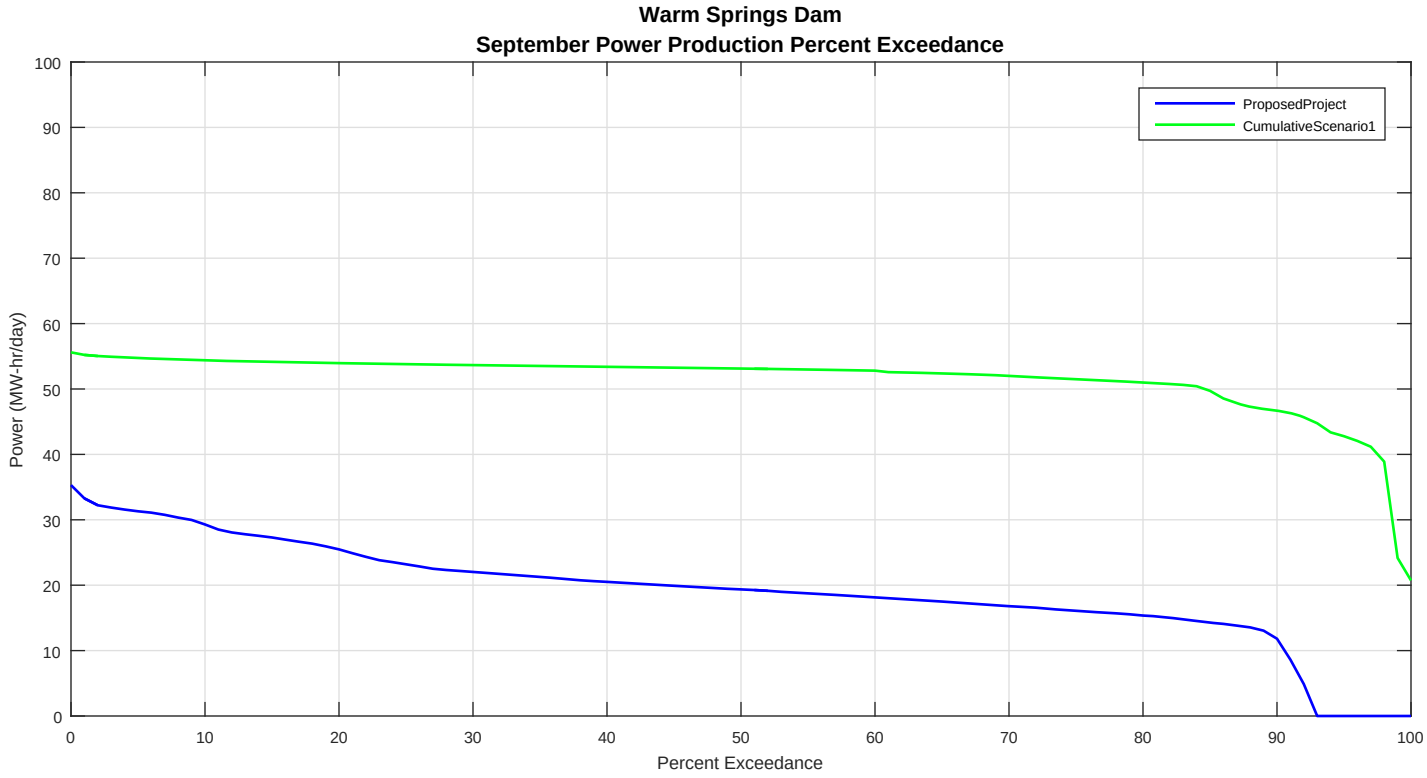
100


Warm Springs Dam
September Power Production Percent Exceedance
ProposedProject
CumulativeScenario1
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
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90
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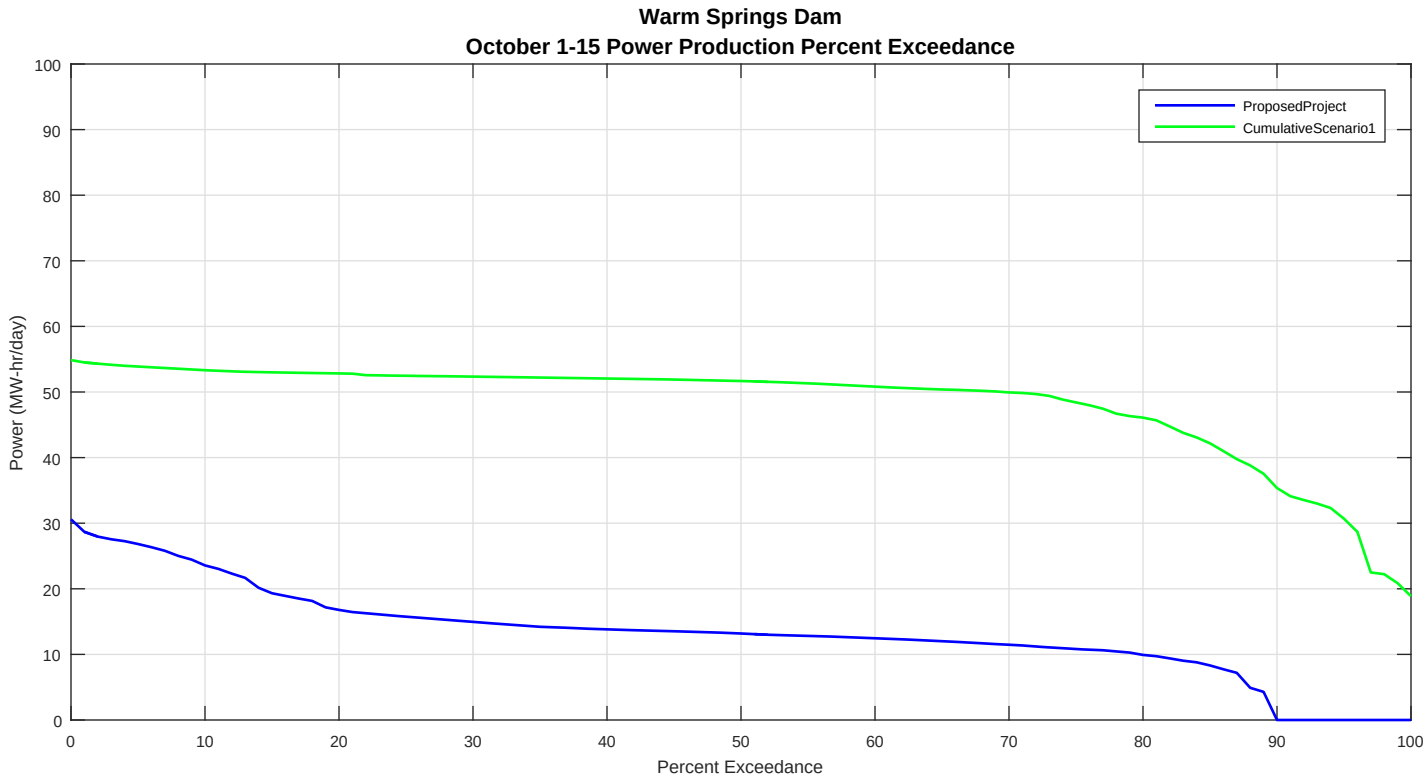
Warm Springs Dam
October 1-15 Power Production Percent Exceedance
ProposedProject
CumulativeScenario1
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
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70
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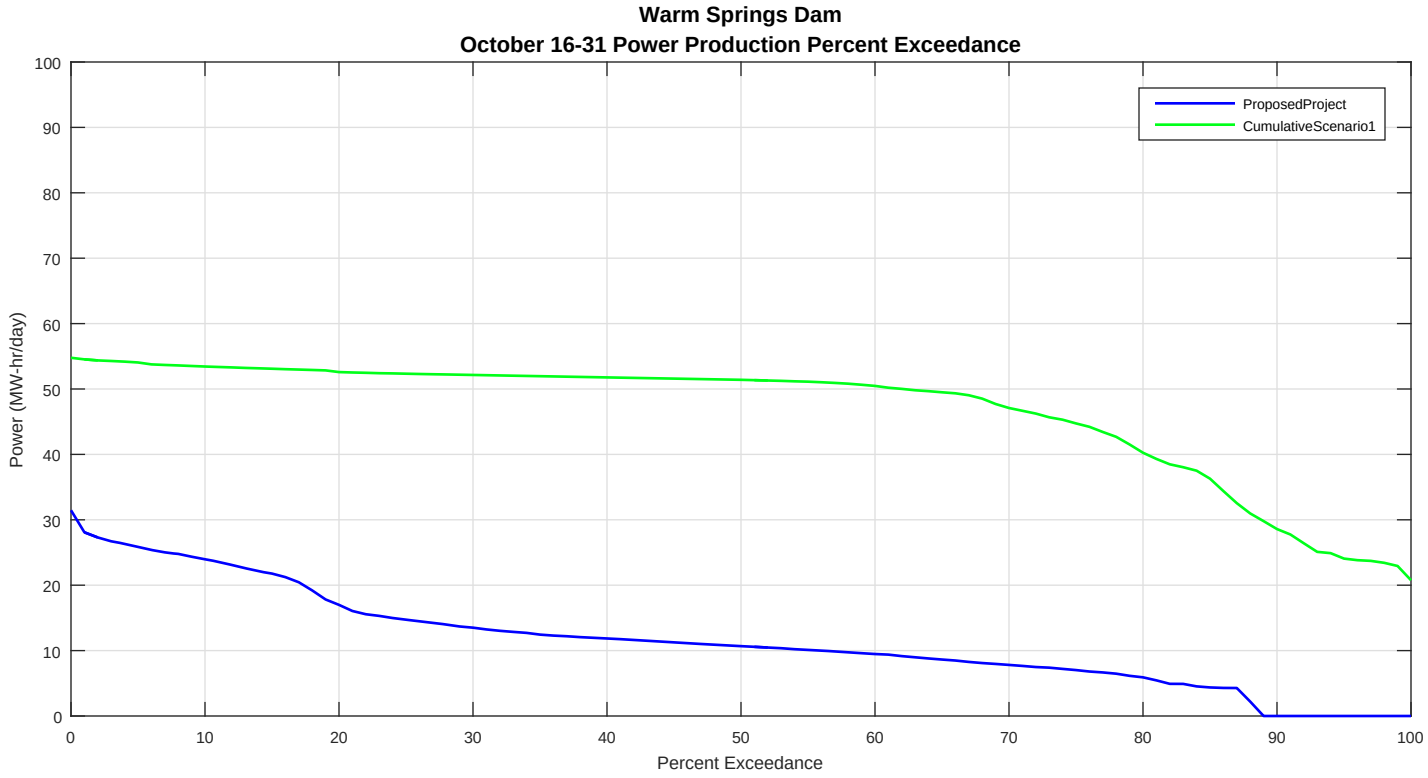
90
100


Warm Springs Dam
October 16-31 Power Production Percent Exceedance
ProposedProject
CumulativeScenario1
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
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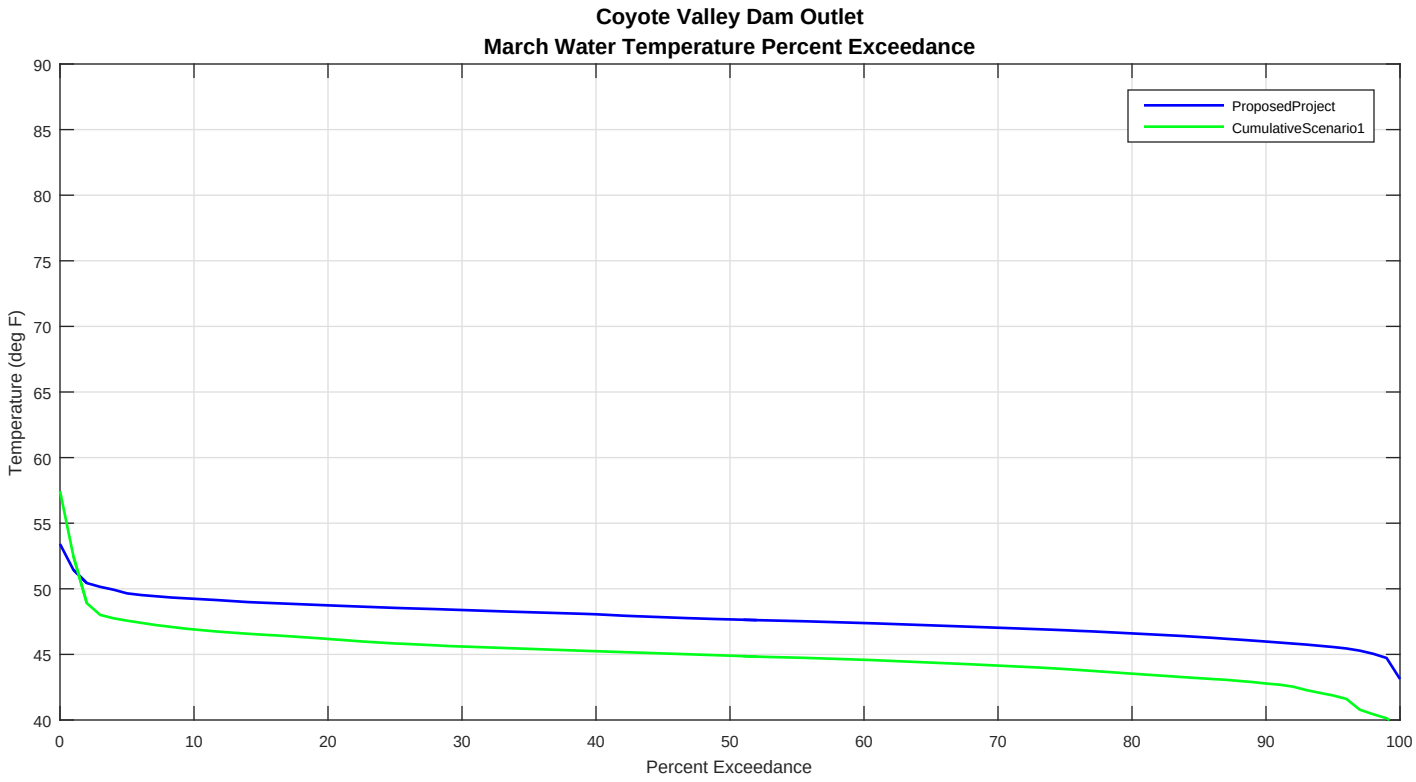
100


Coyote Valley Dam Outlet
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
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20
30
40
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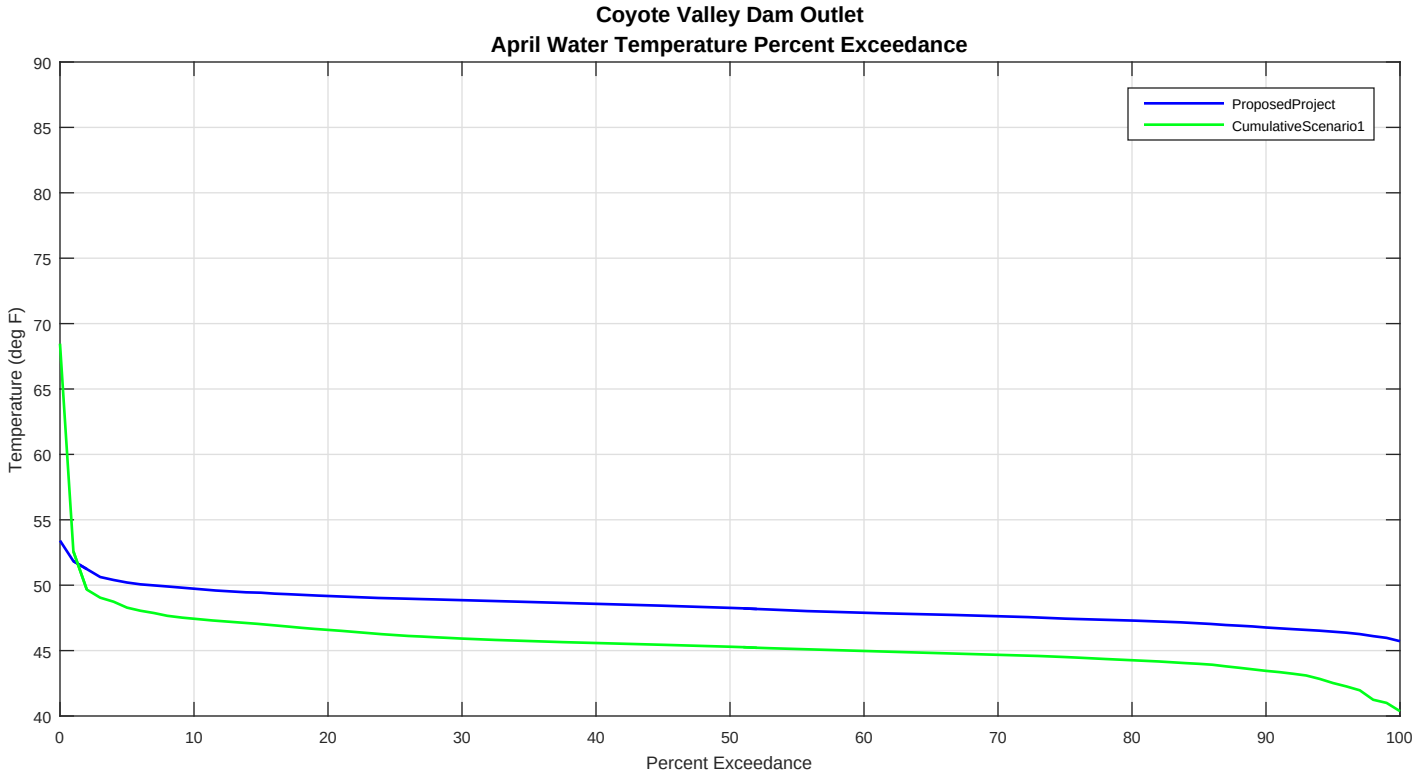
70
80
90
100


Coyote Valley Dam Outlet
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
90
85
80
75
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65
60
55
50
45
40
0
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20
30
40
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70
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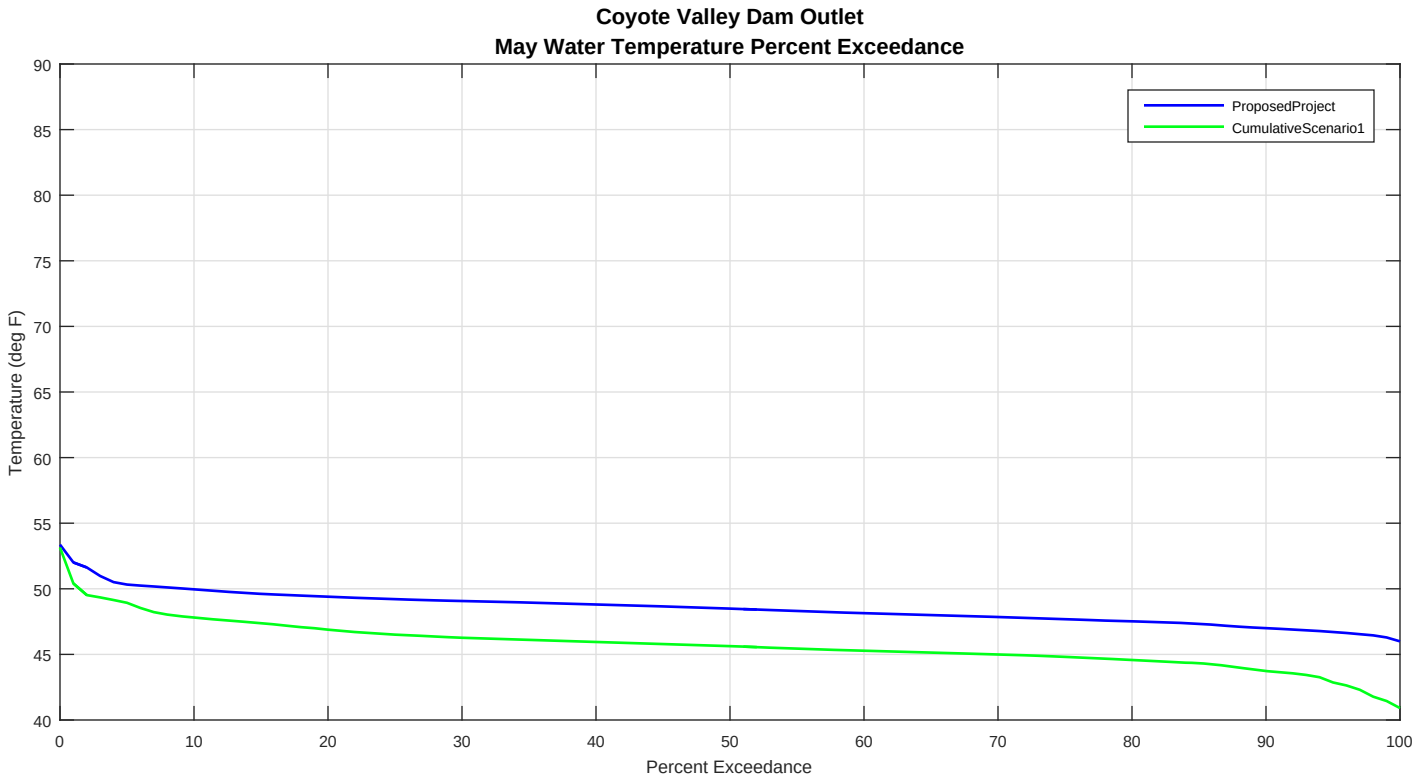
90
100


Coyote Valley Dam Outlet
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
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60
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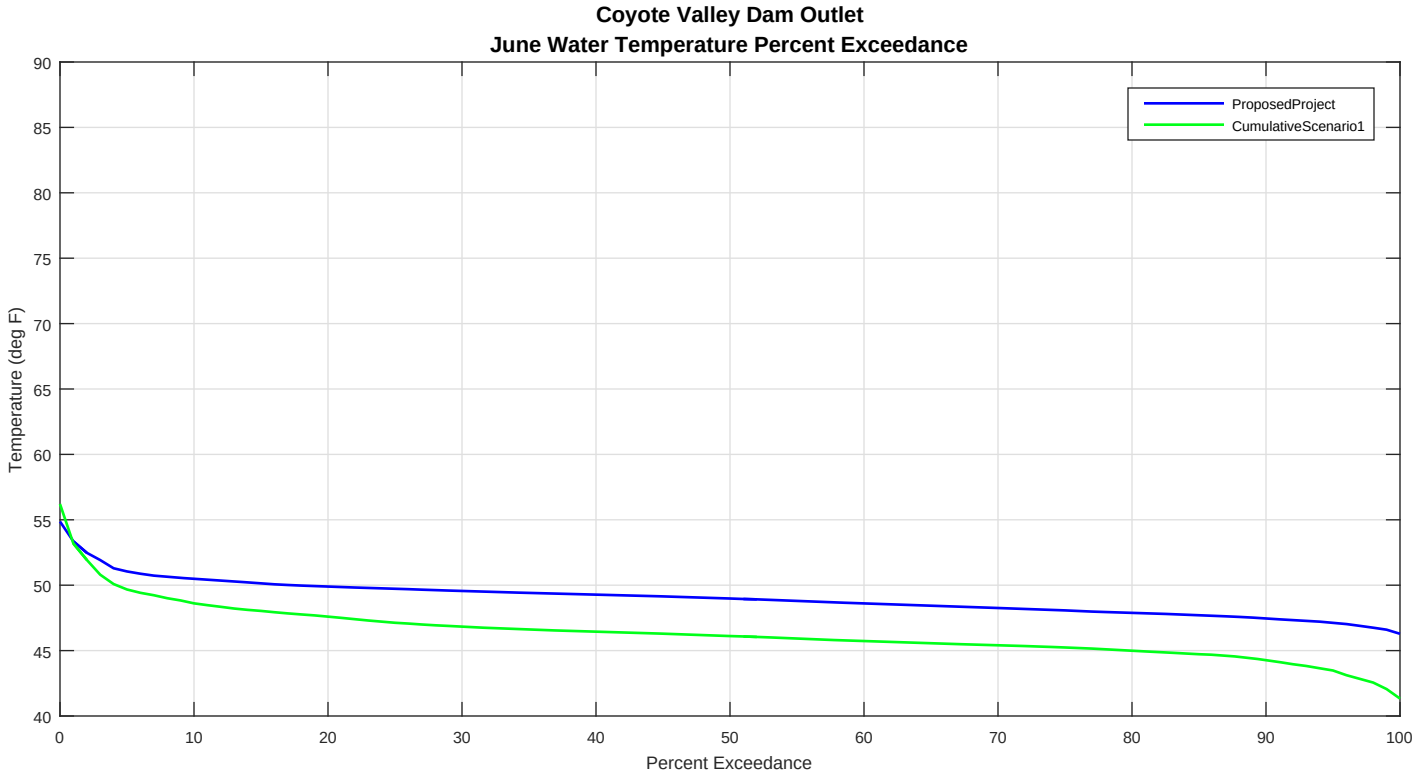
Coyote Valley Dam Outlet
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
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20
30
40
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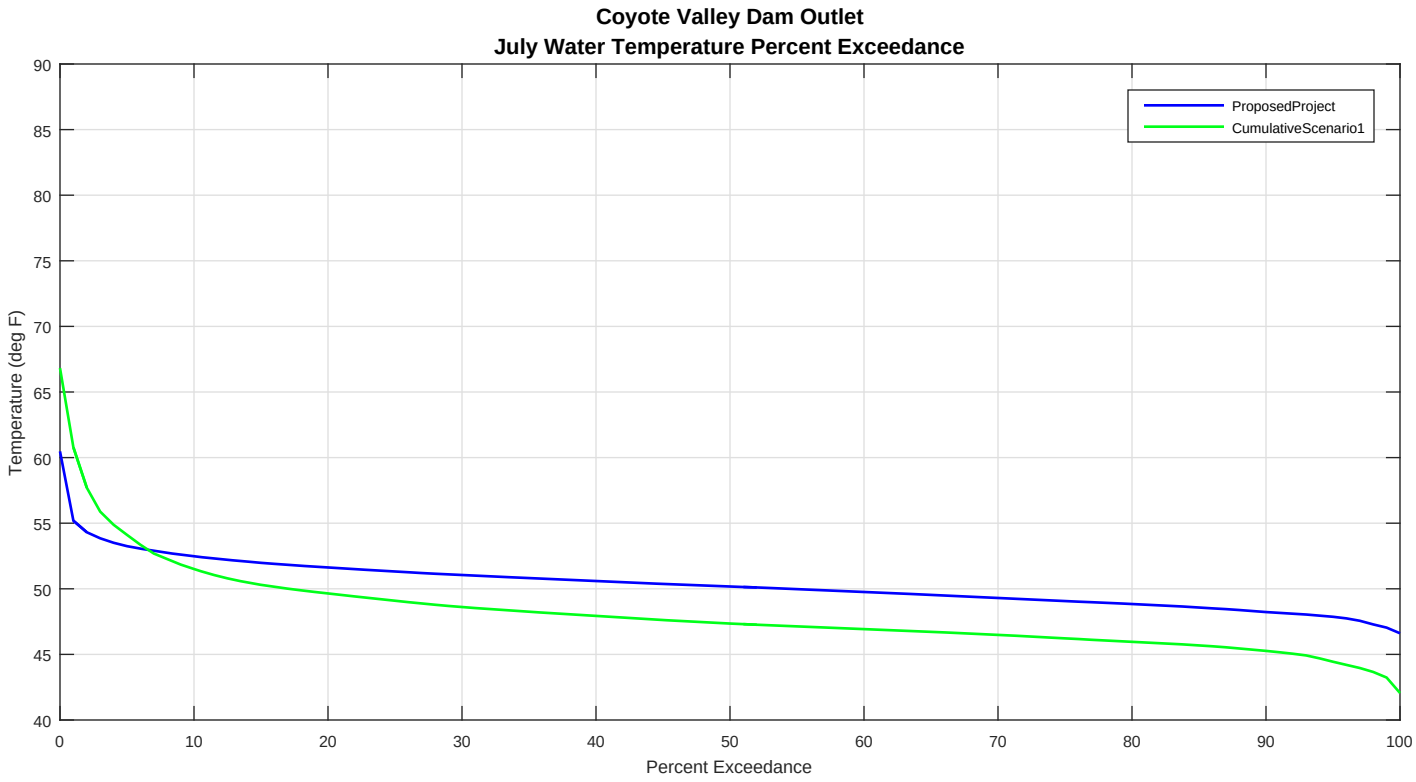
70
80
90
100


Coyote Valley Dam Outlet
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
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20
30
40
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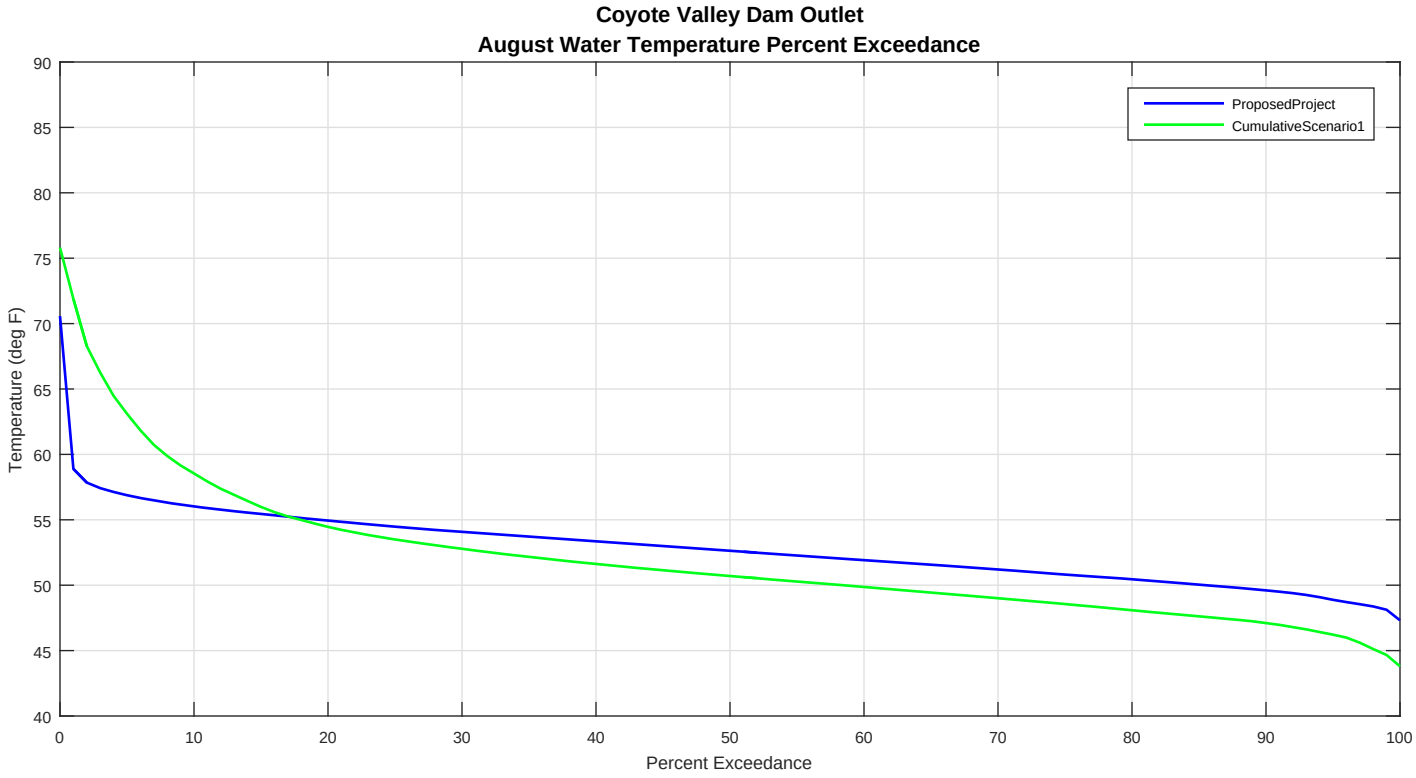
Coyote Valley Dam Outlet
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
90
85
80
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70
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60
55
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40
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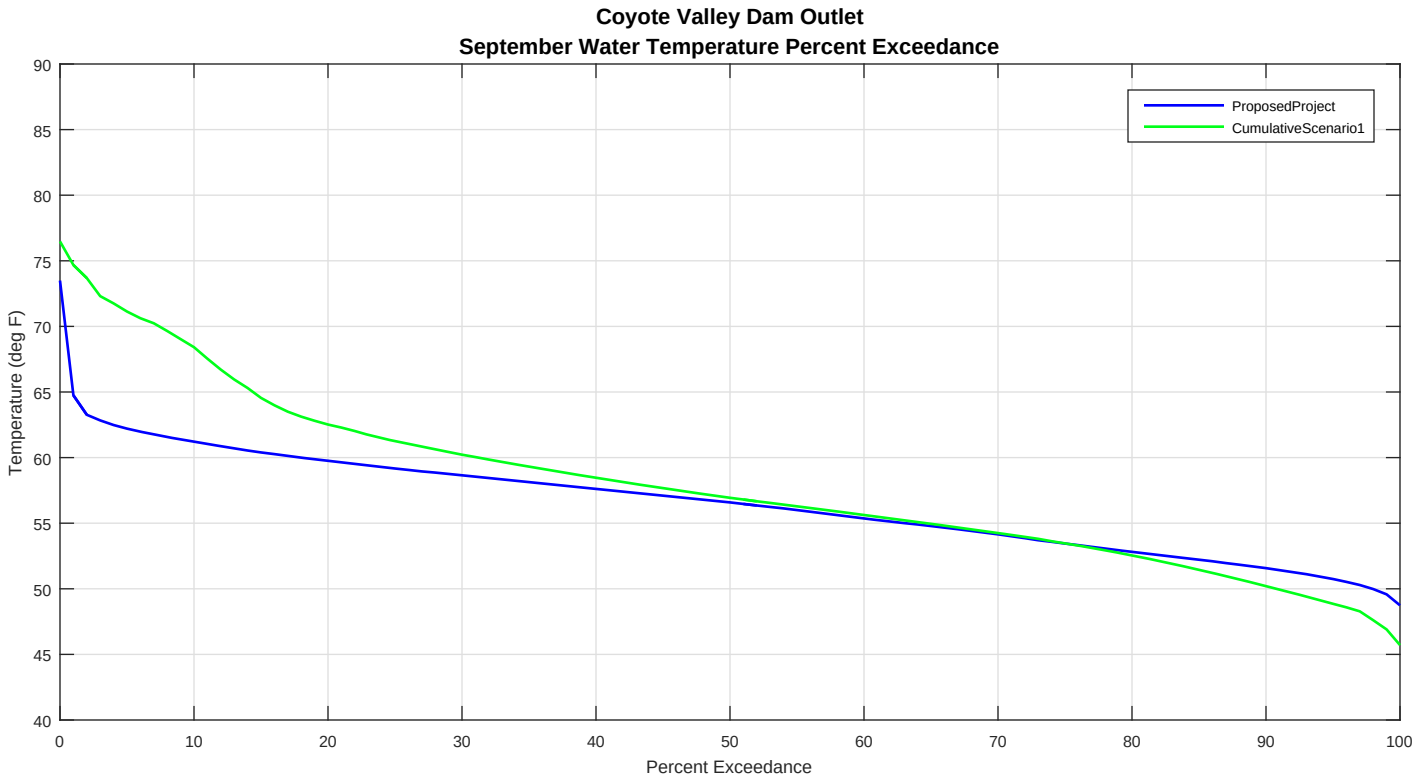
Coyote Valley Dam Outlet
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
90
85
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75
70
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60
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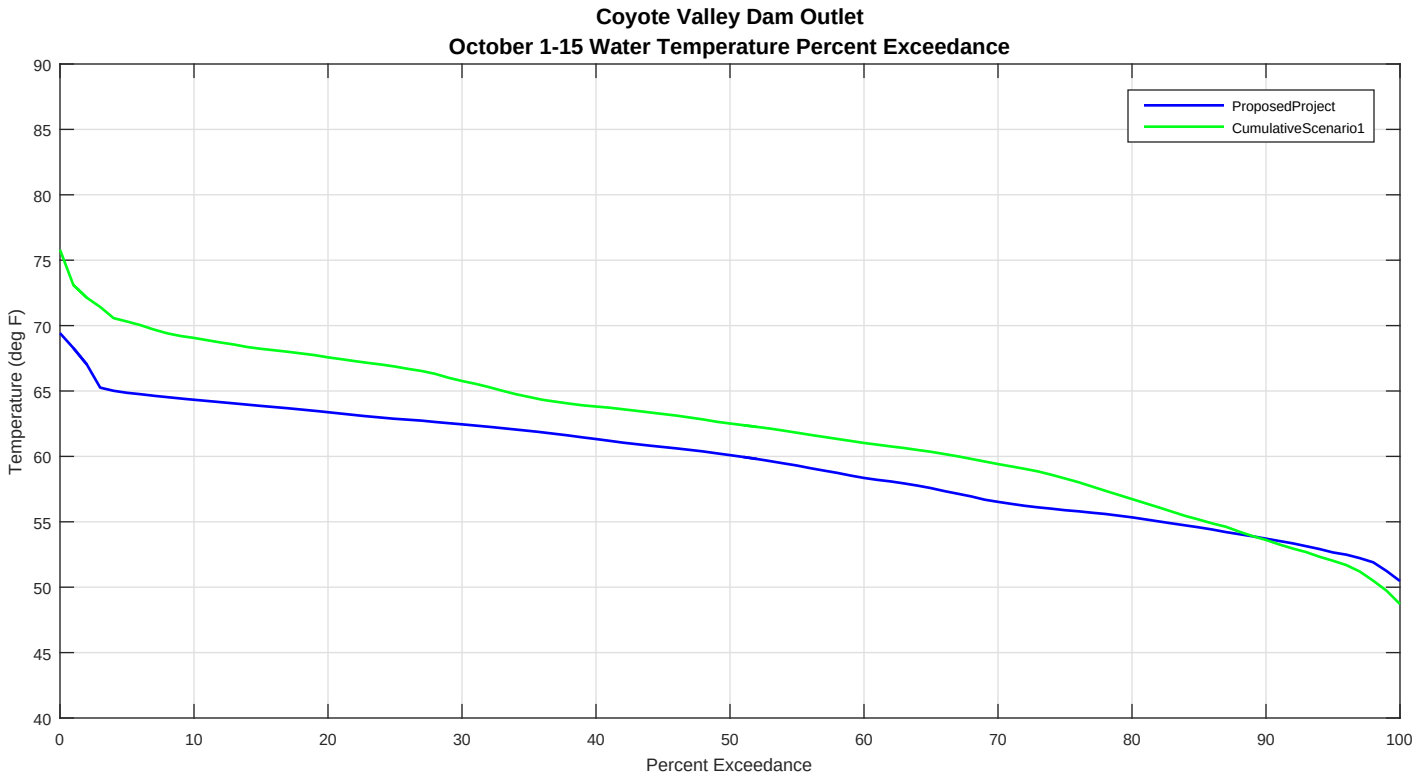
Coyote Valley Dam Outlet
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
90
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75
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60
55
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40
0
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30
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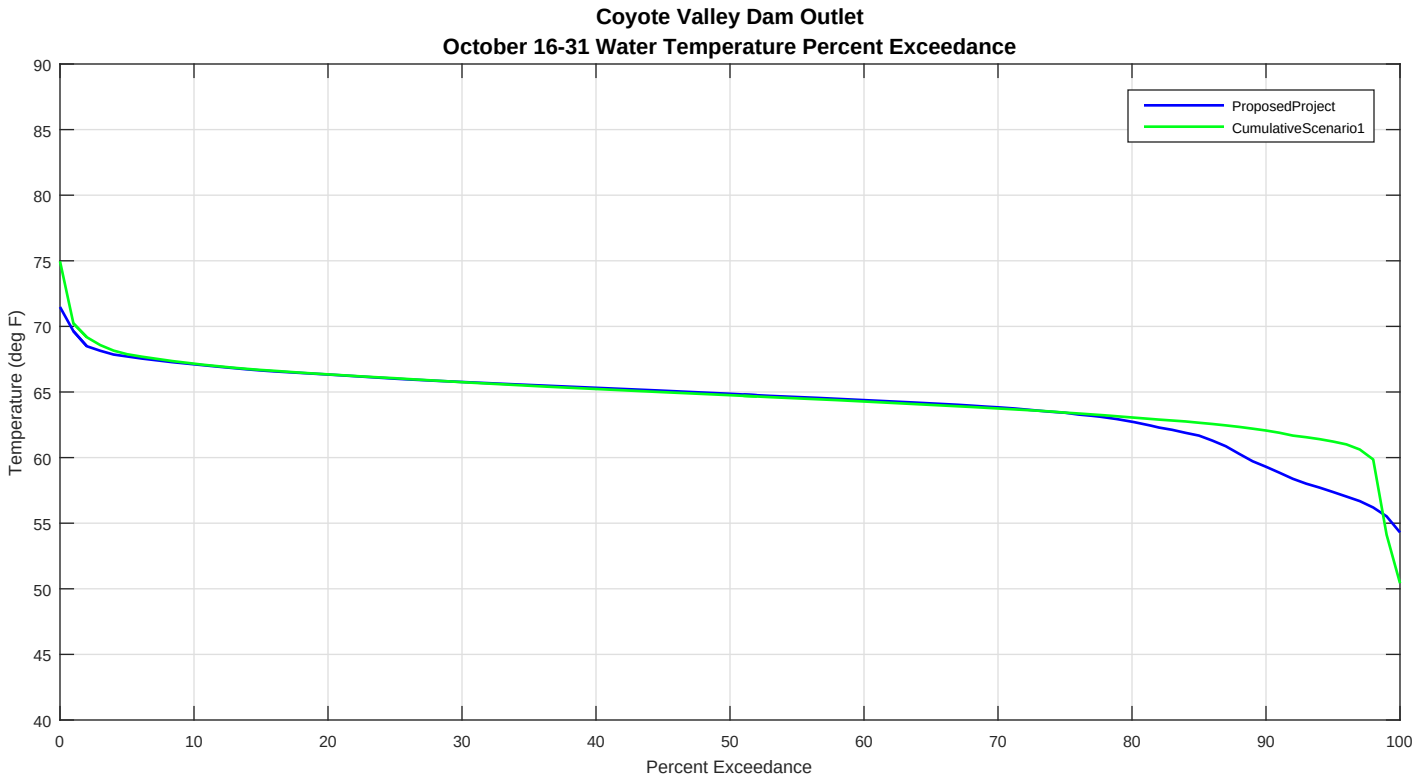
Coyote Valley Dam Outlet
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
90
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75
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60
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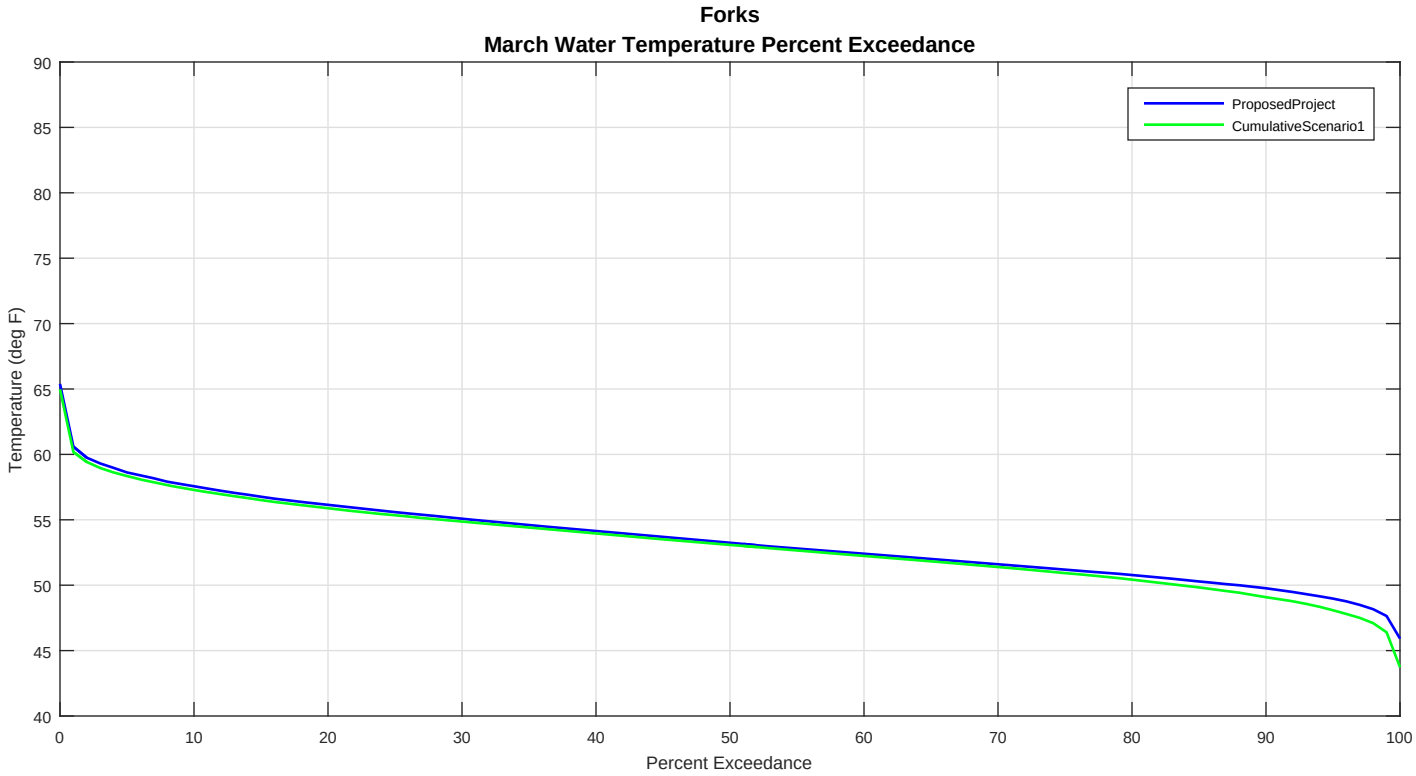
Forks
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
90
85
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75
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60
55
50
45
40
0
10
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30
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90
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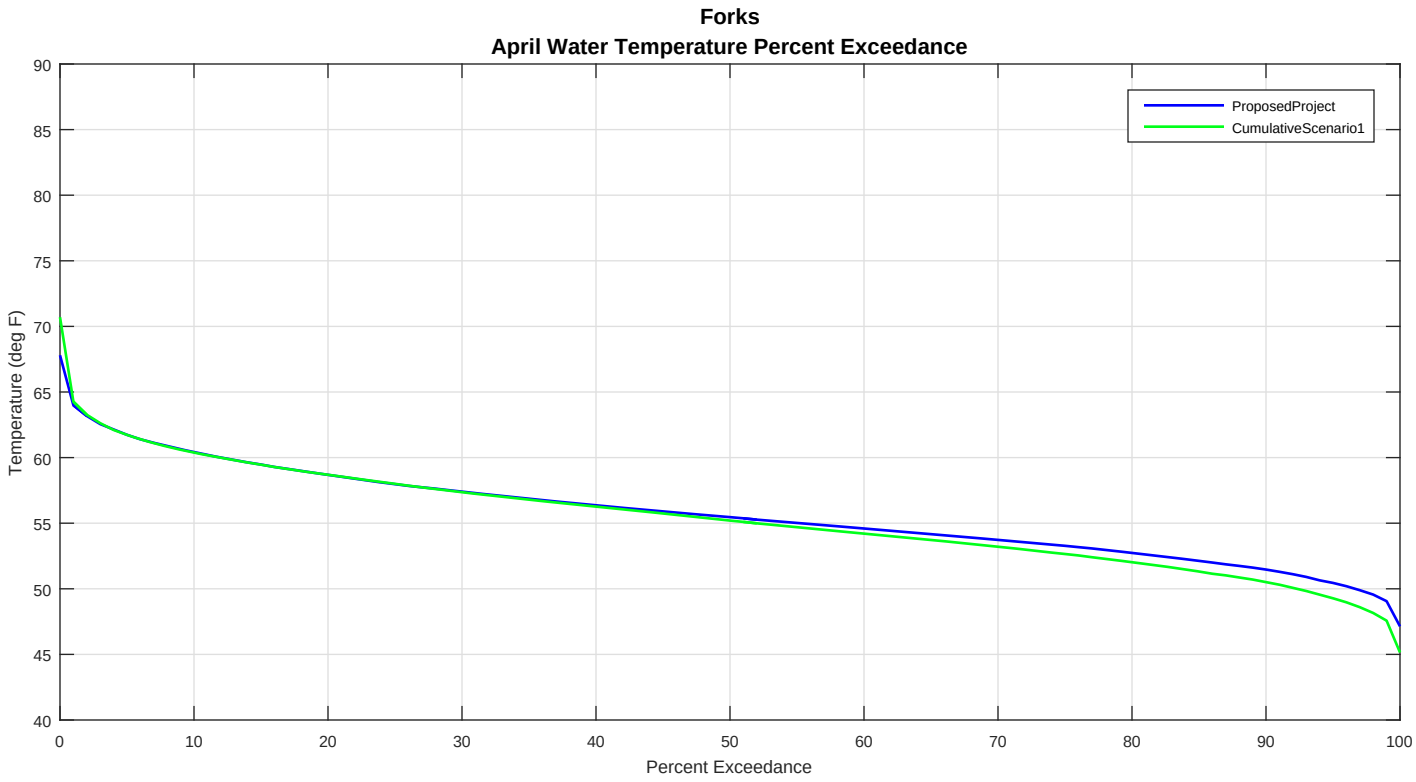
Forks
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
90
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75
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60
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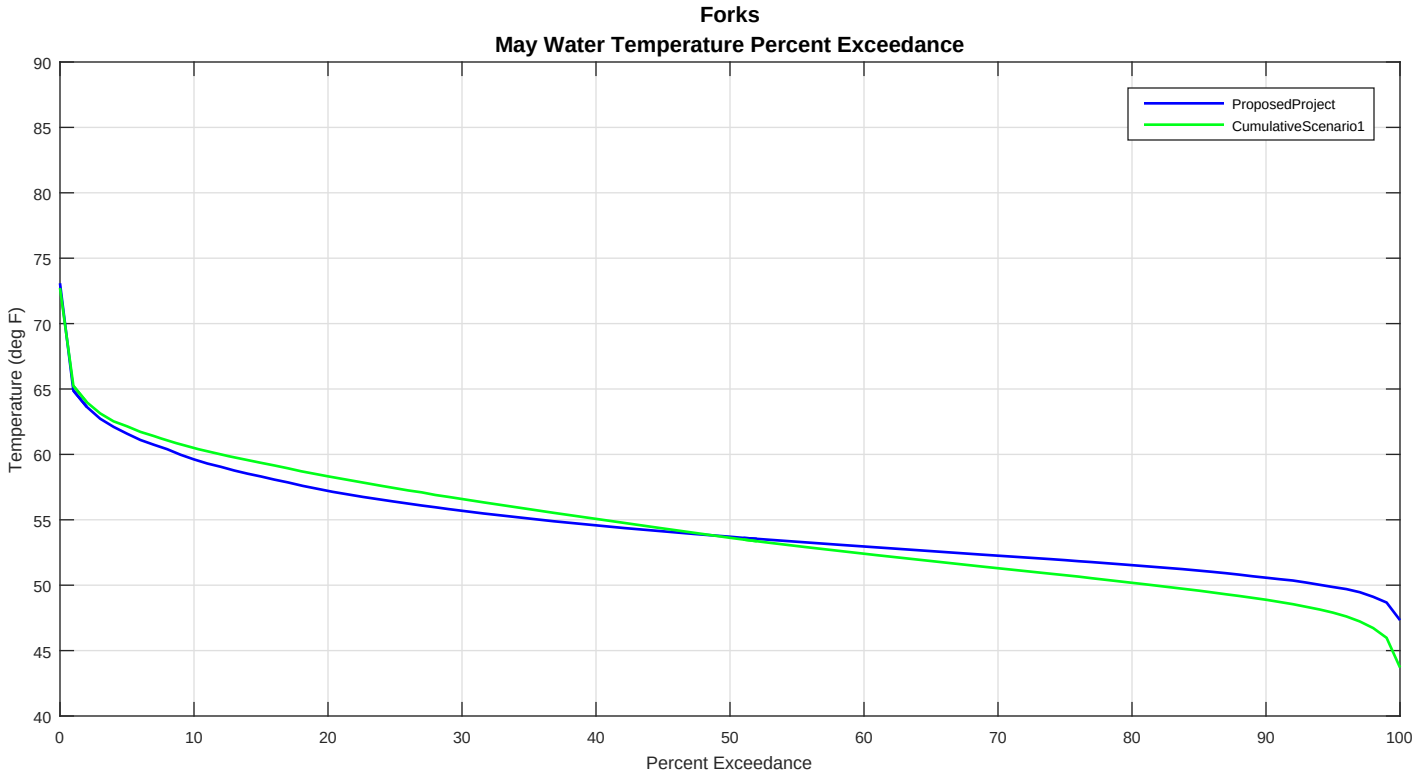
Forks
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
90
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75
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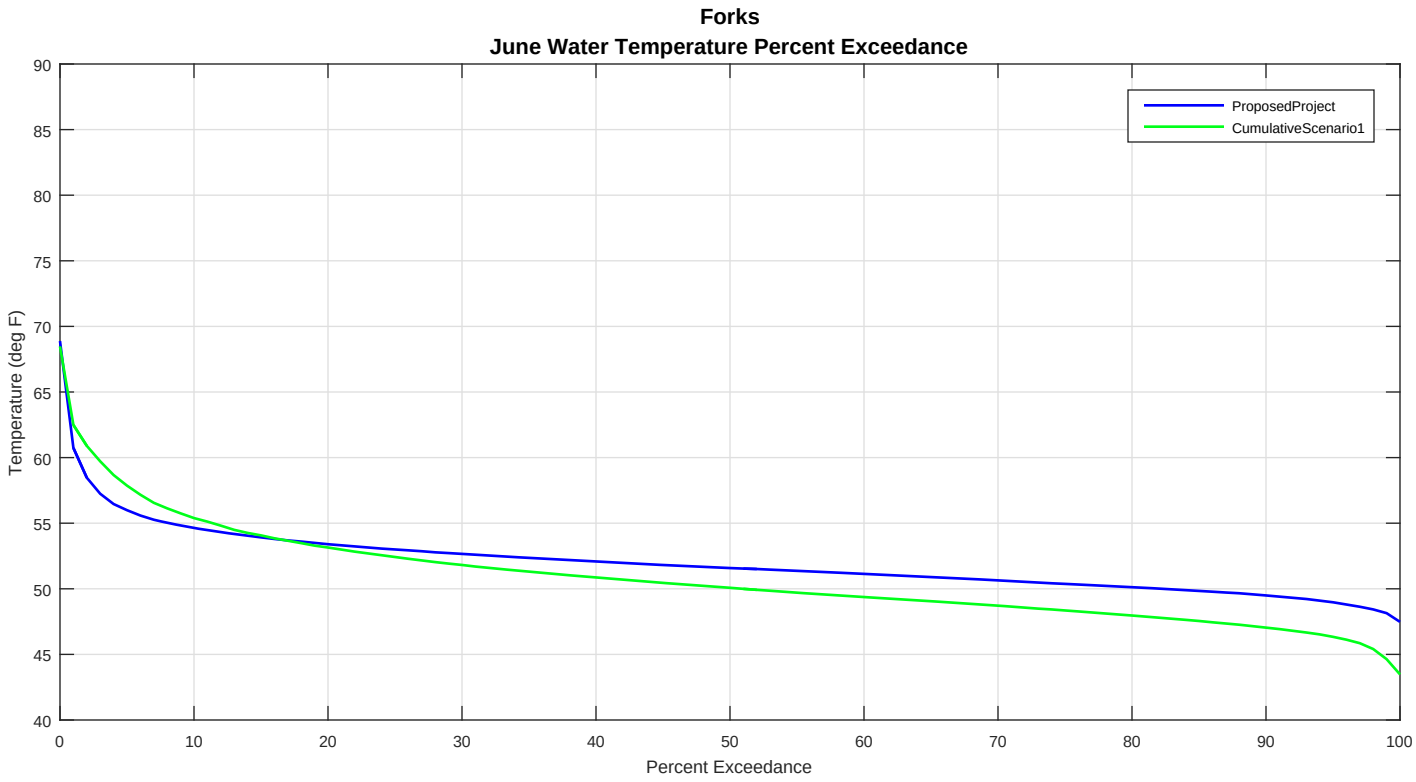
Forks
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
90
85
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75
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60
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45
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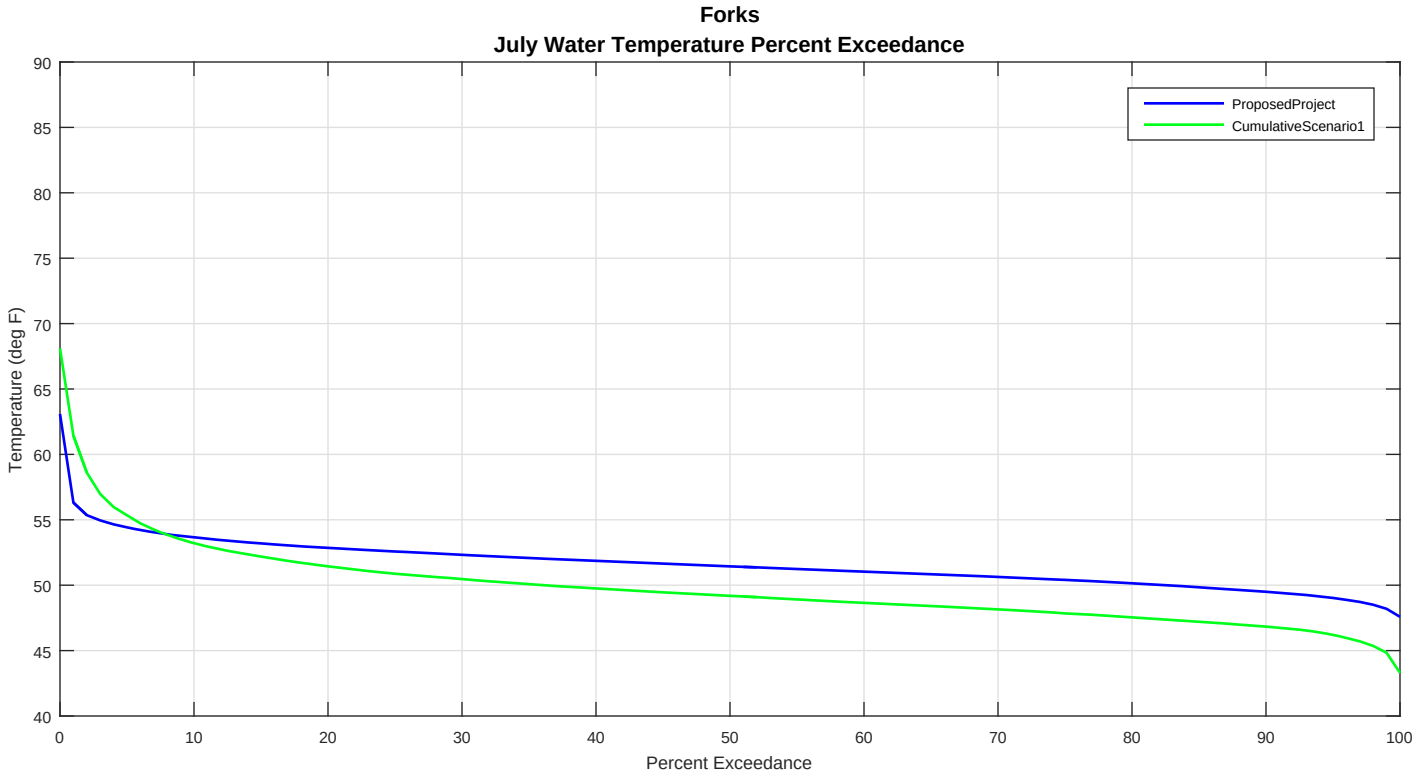
Forks
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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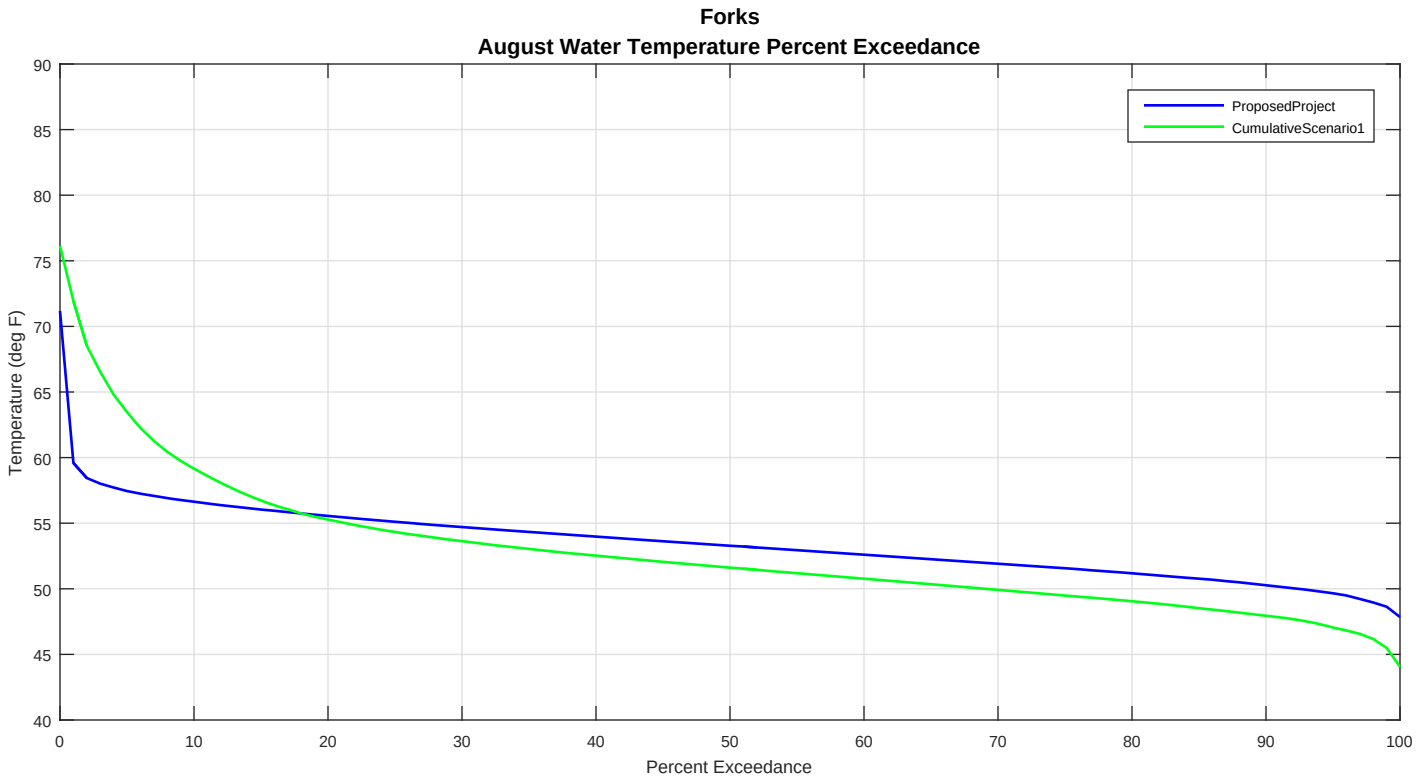
Forks
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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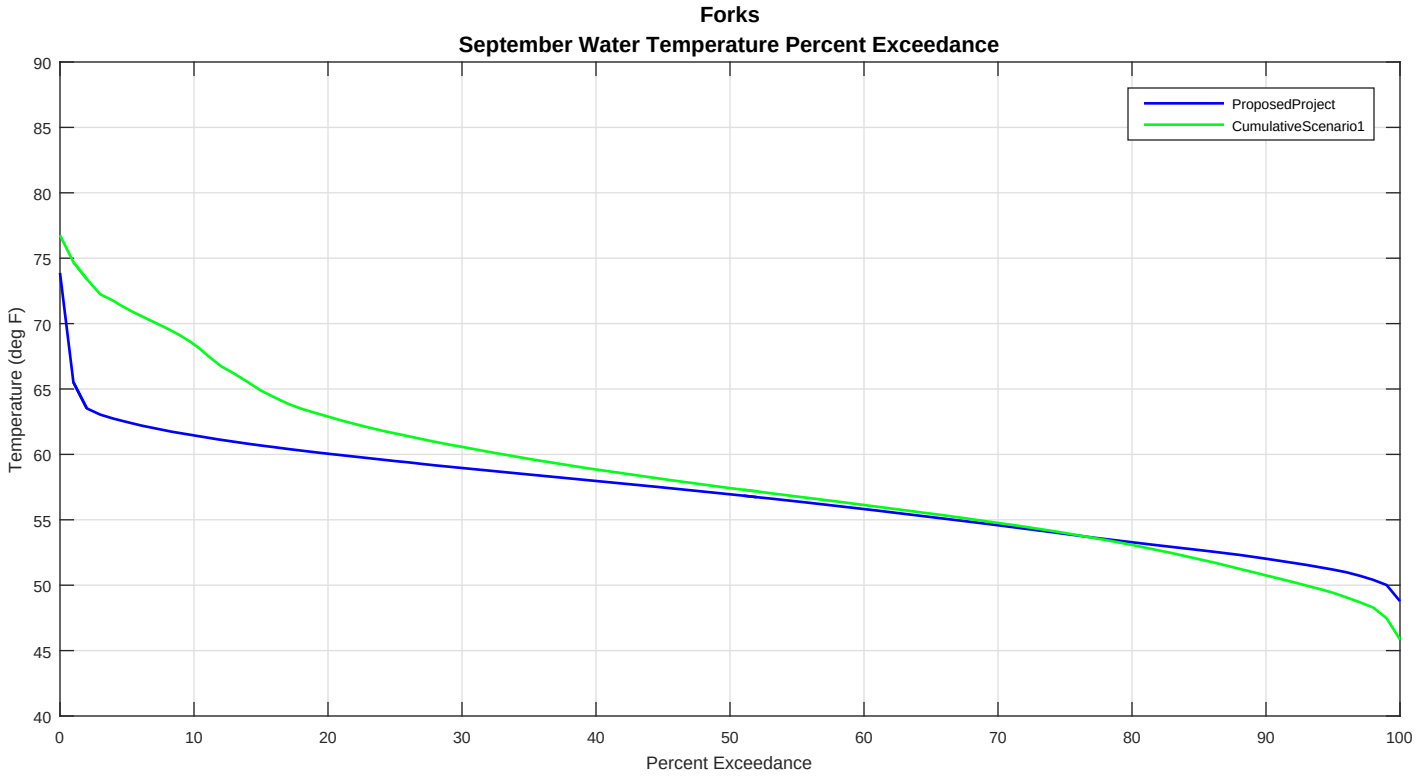
Forks
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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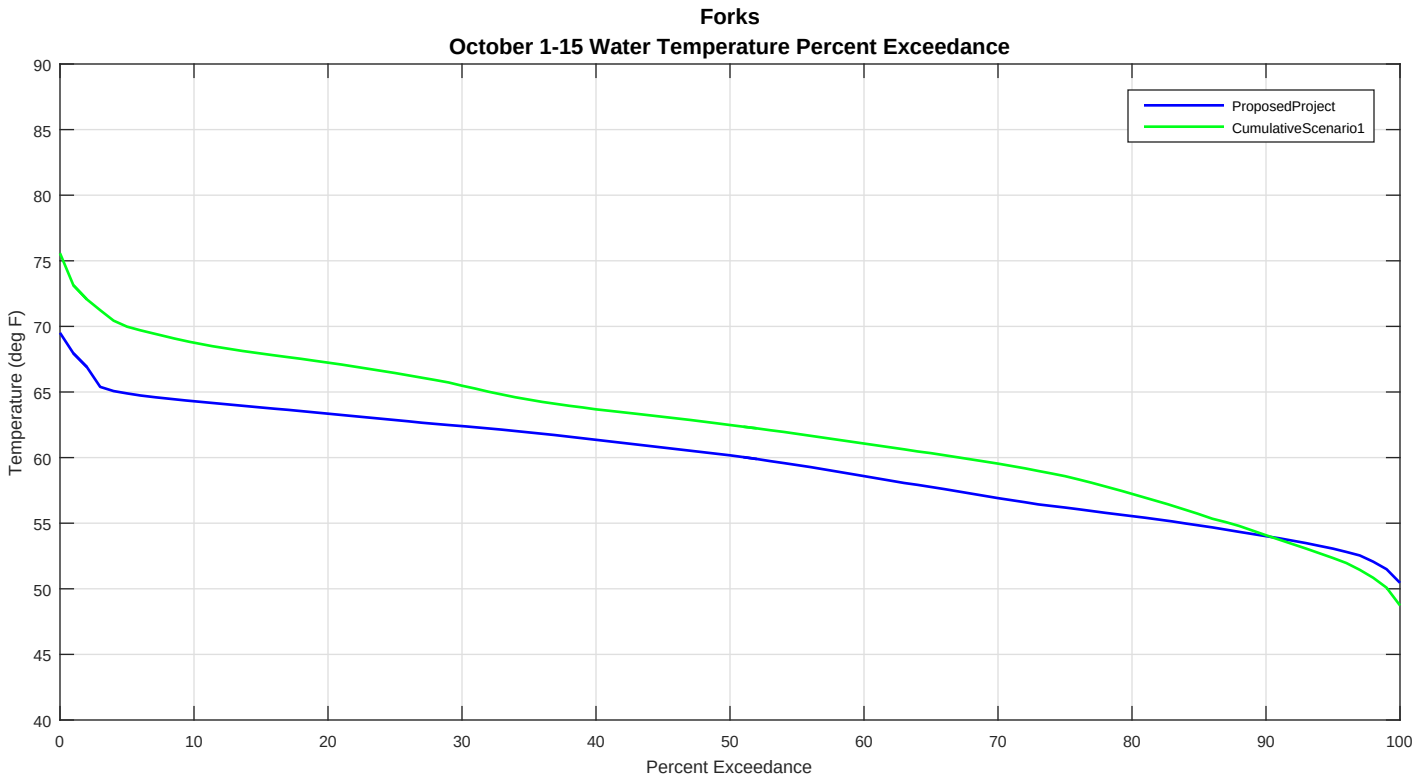
Forks
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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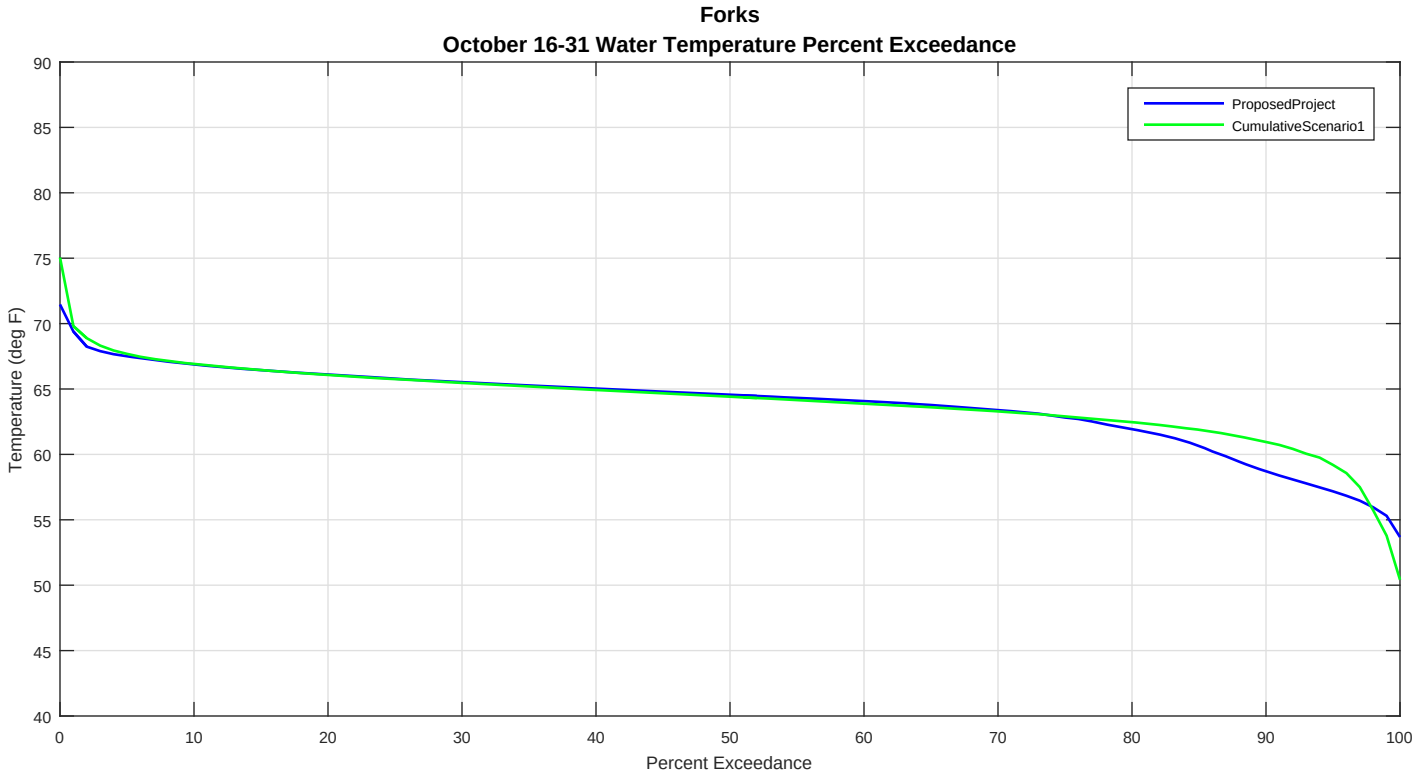
Forks
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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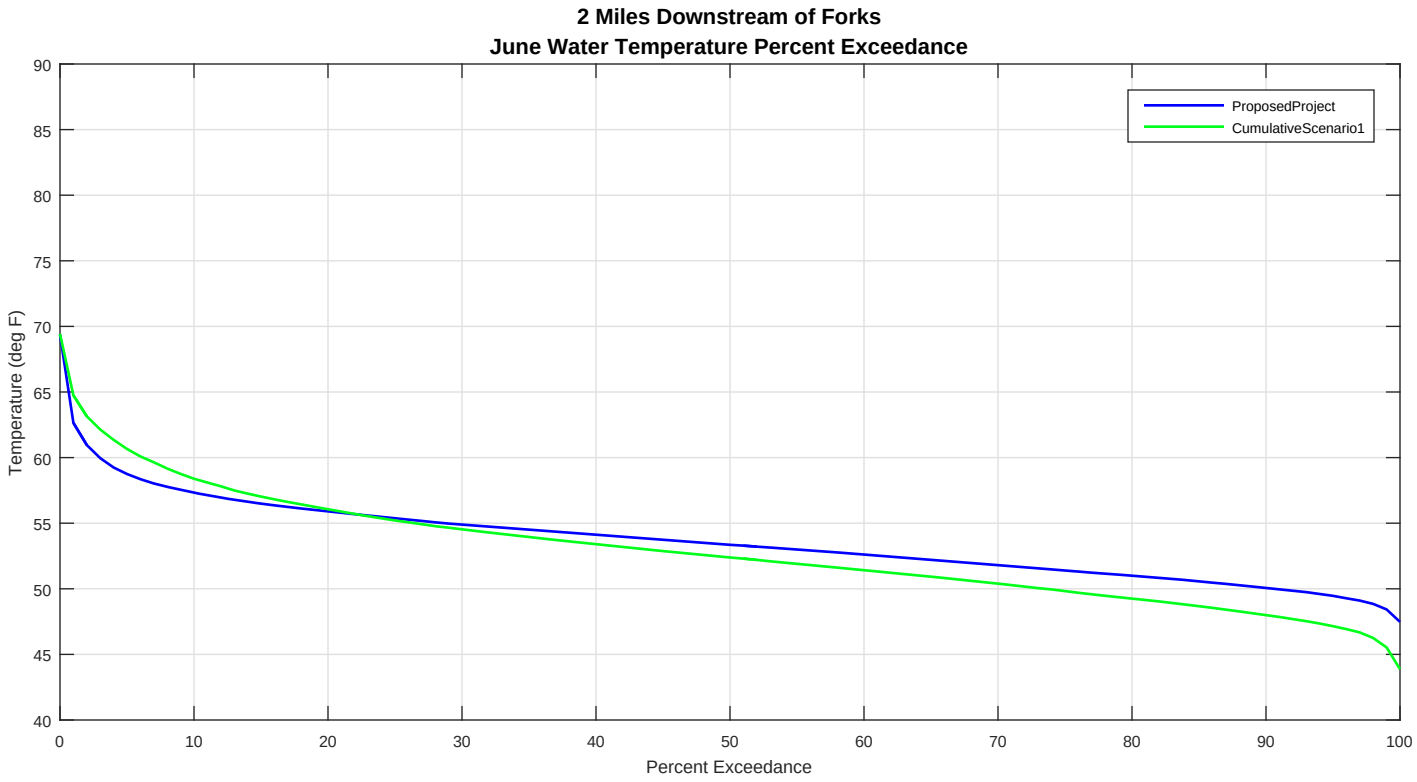
2 Miles Downstream of Forks
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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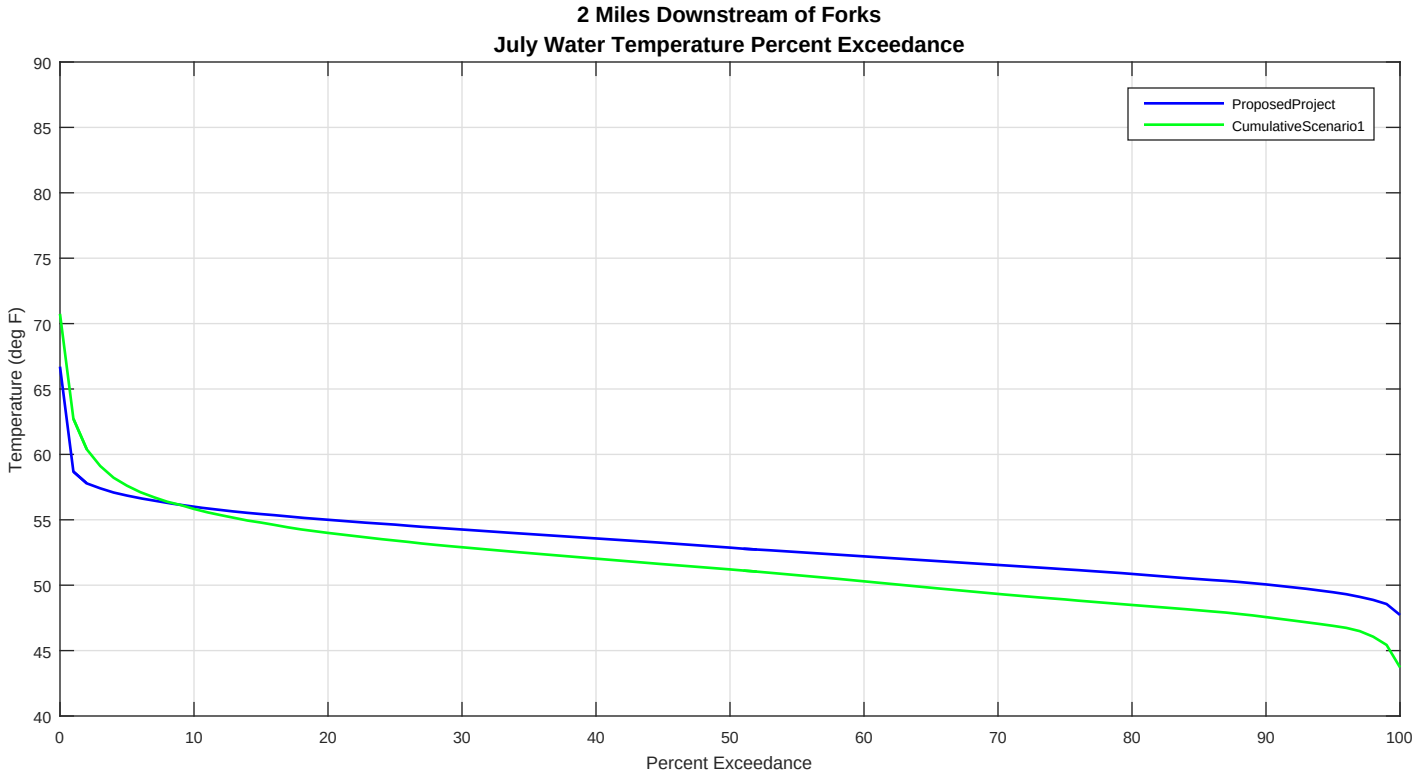
2 Miles Downstream of Forks
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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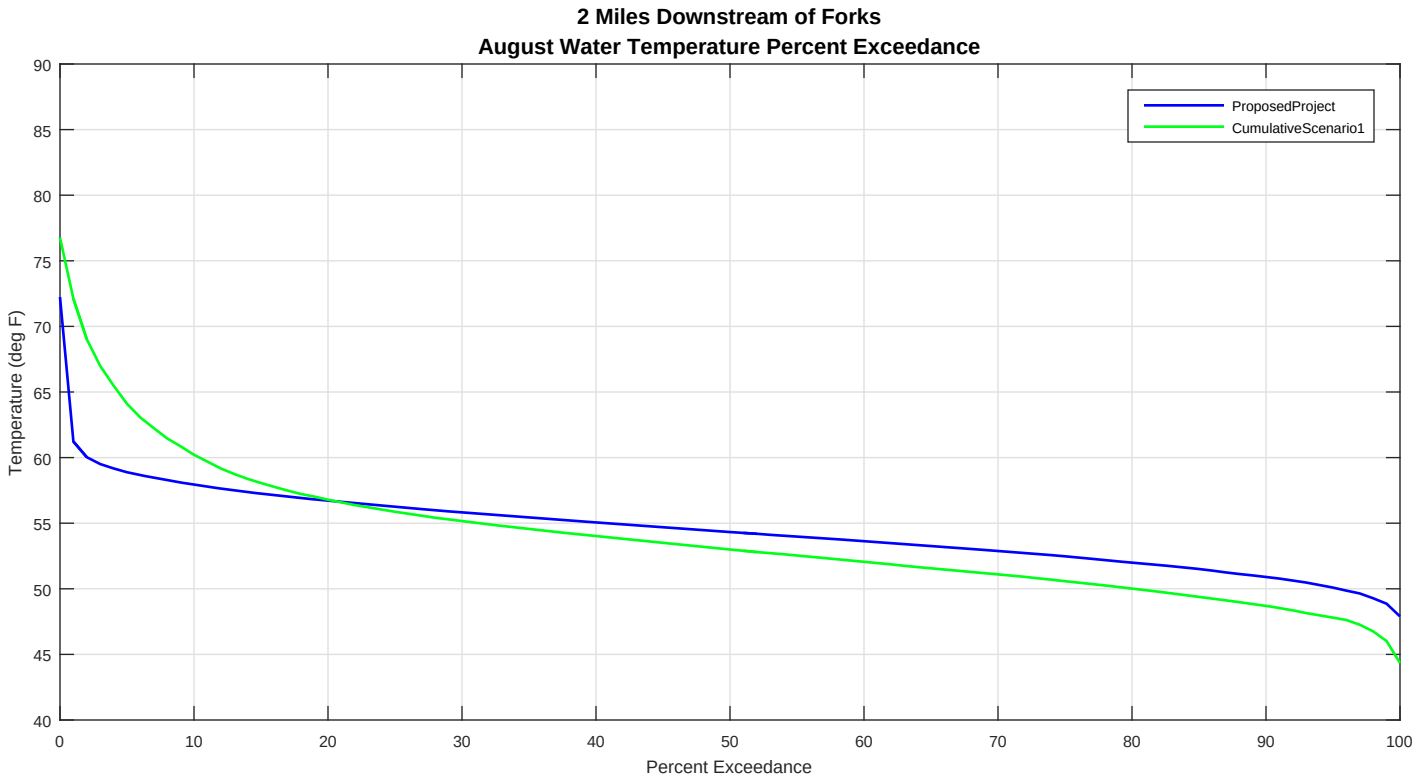
2 Miles Downstream of Forks
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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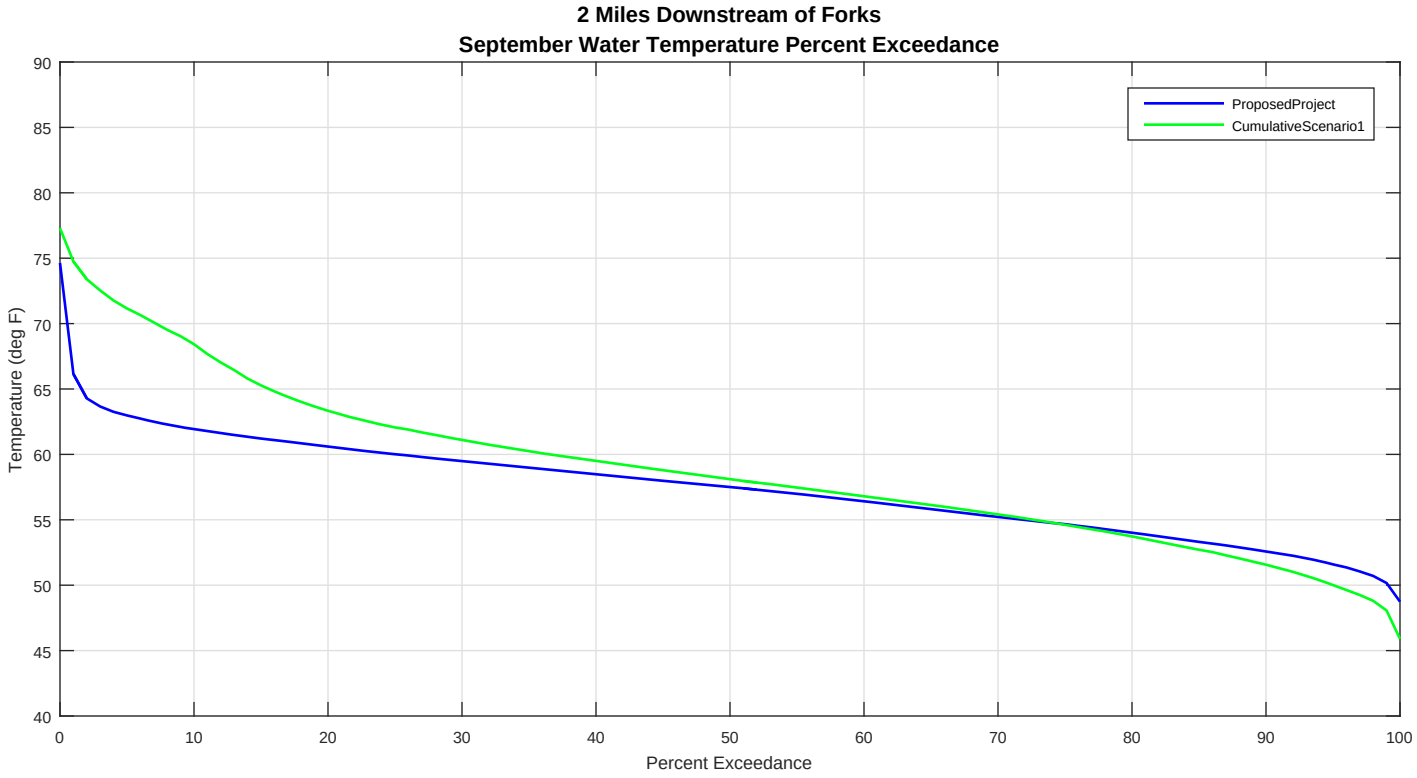
2 Miles Downstream of Forks
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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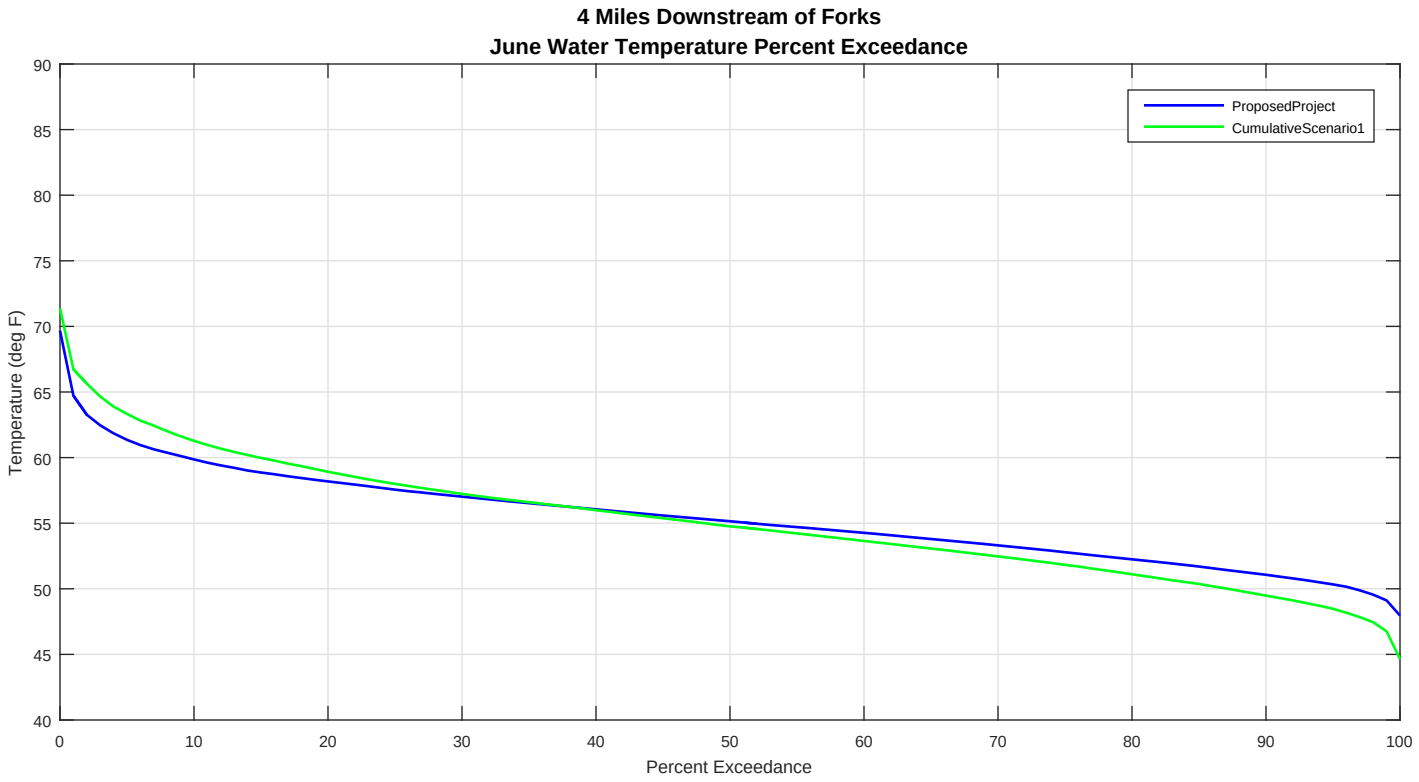
4 Miles Downstream of Forks
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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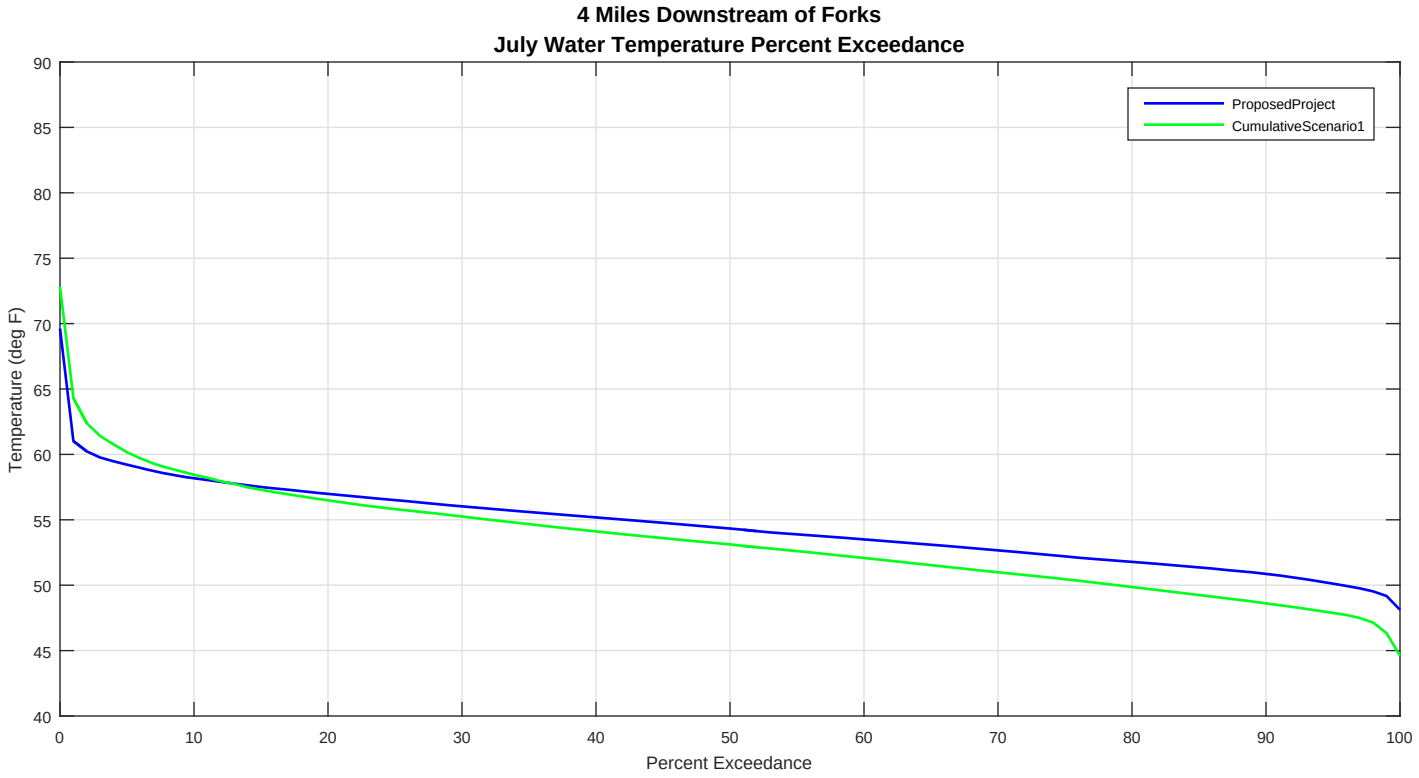
4 Miles Downstream of Forks
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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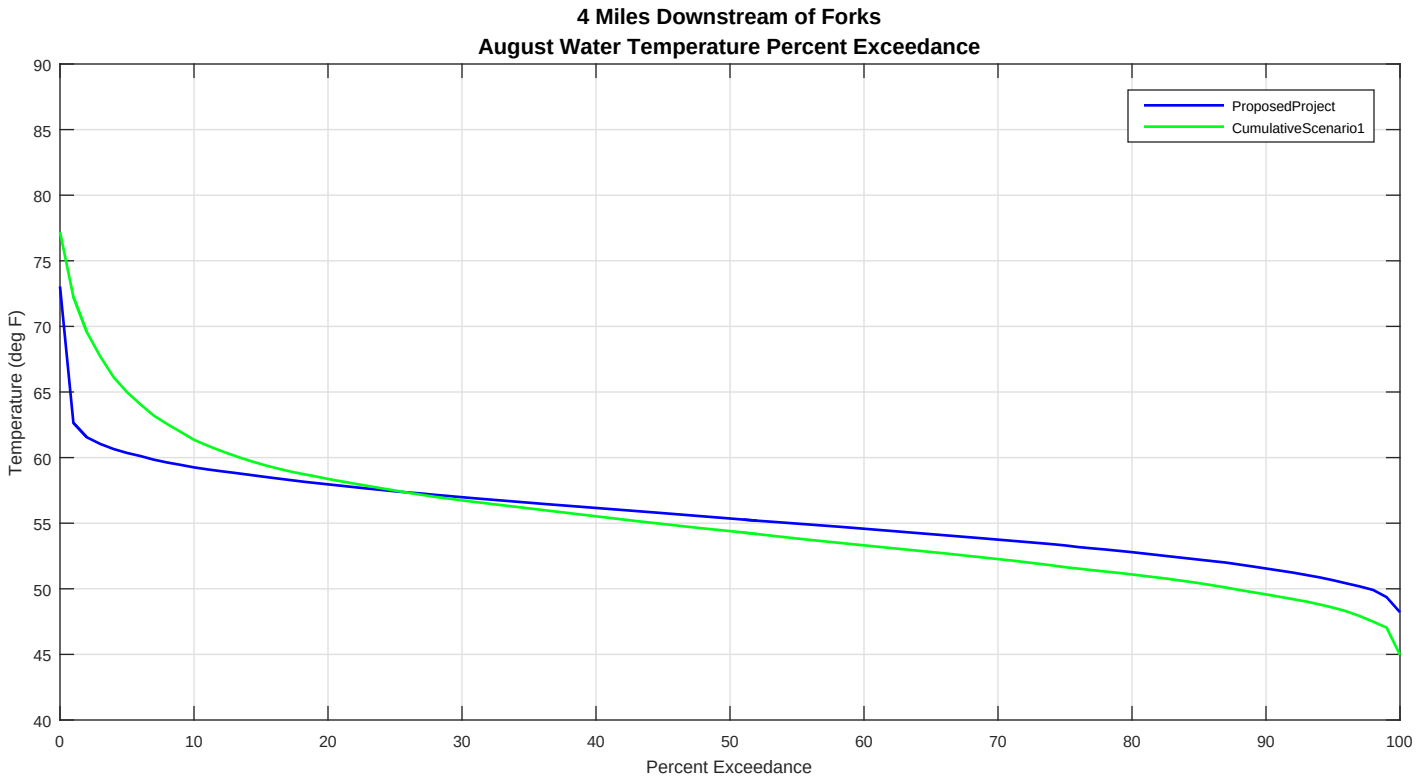
4 Miles Downstream of Forks
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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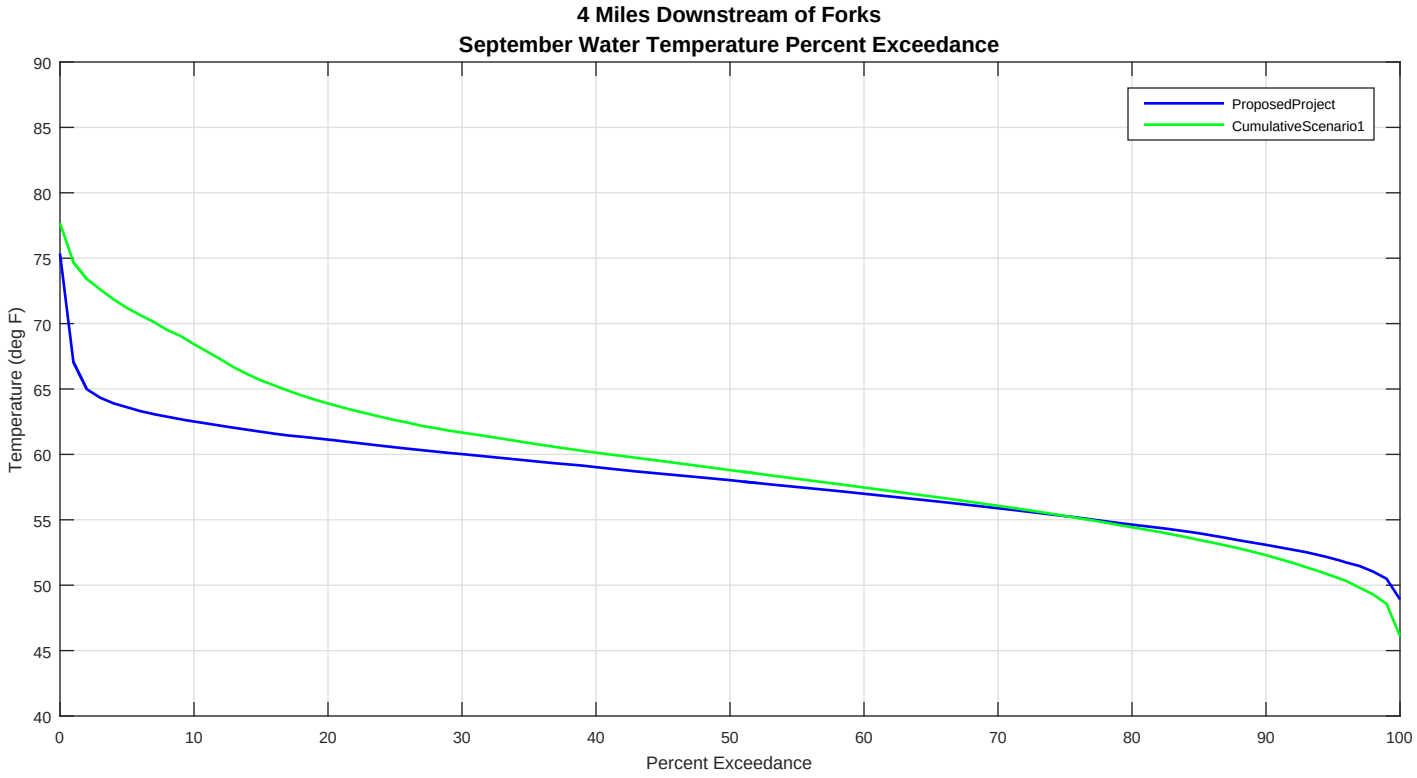
4 Miles Downstream of Forks
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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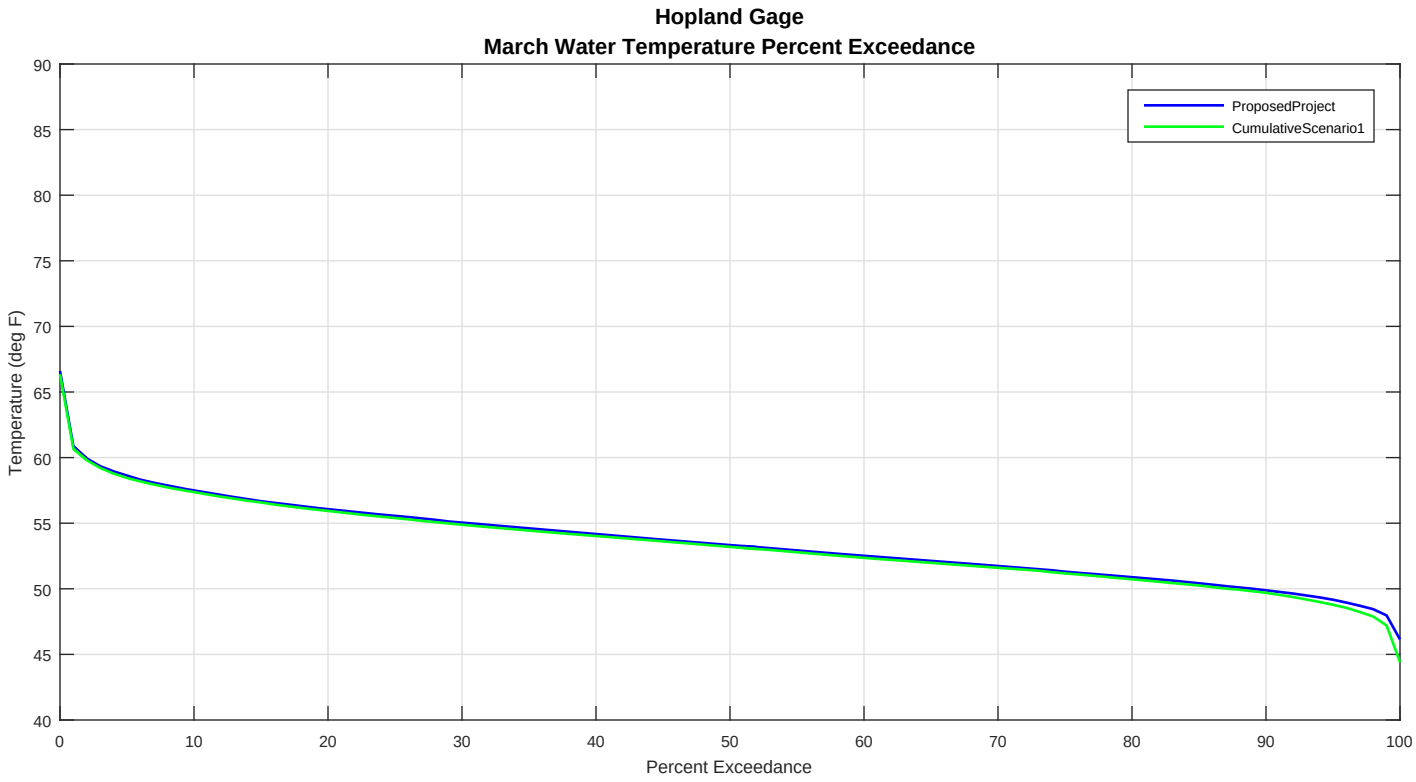
Hopland Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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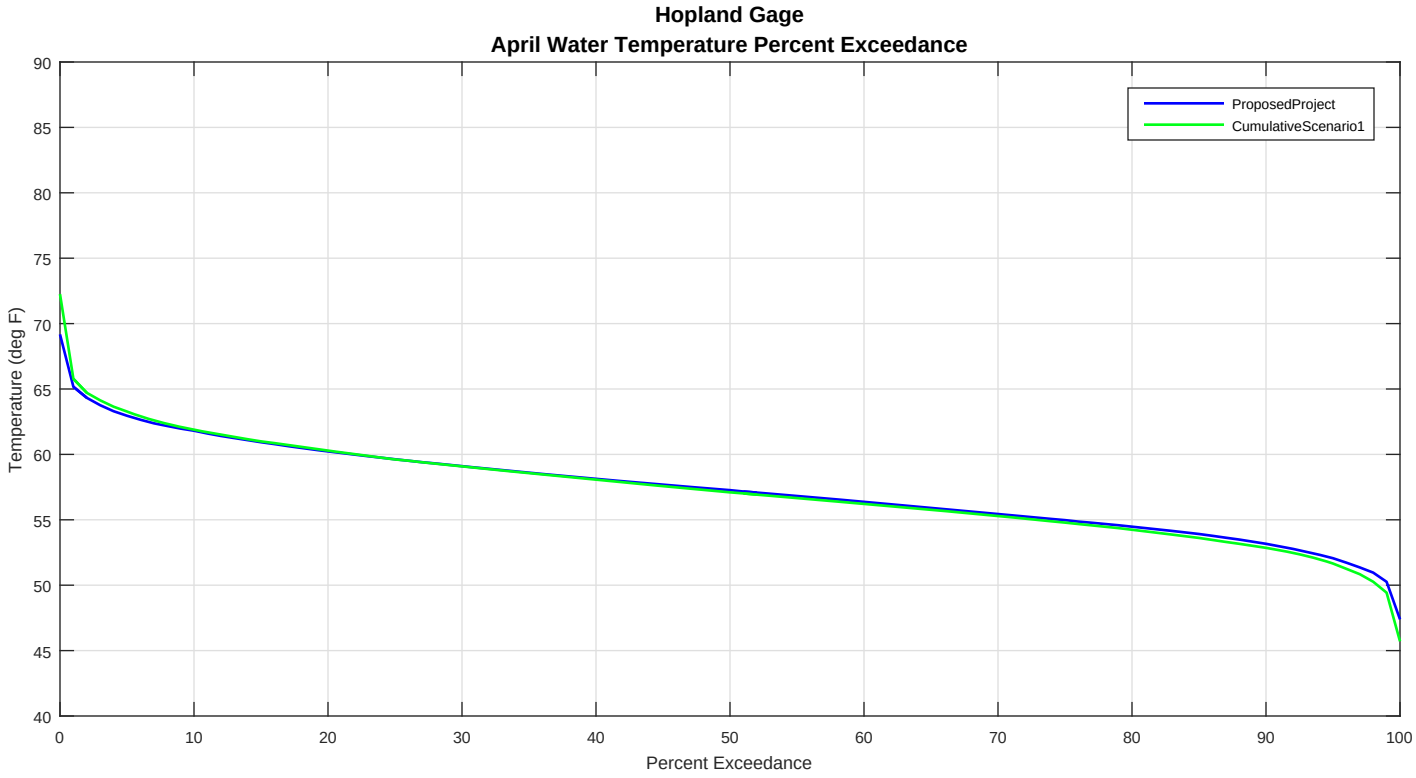
Hopland Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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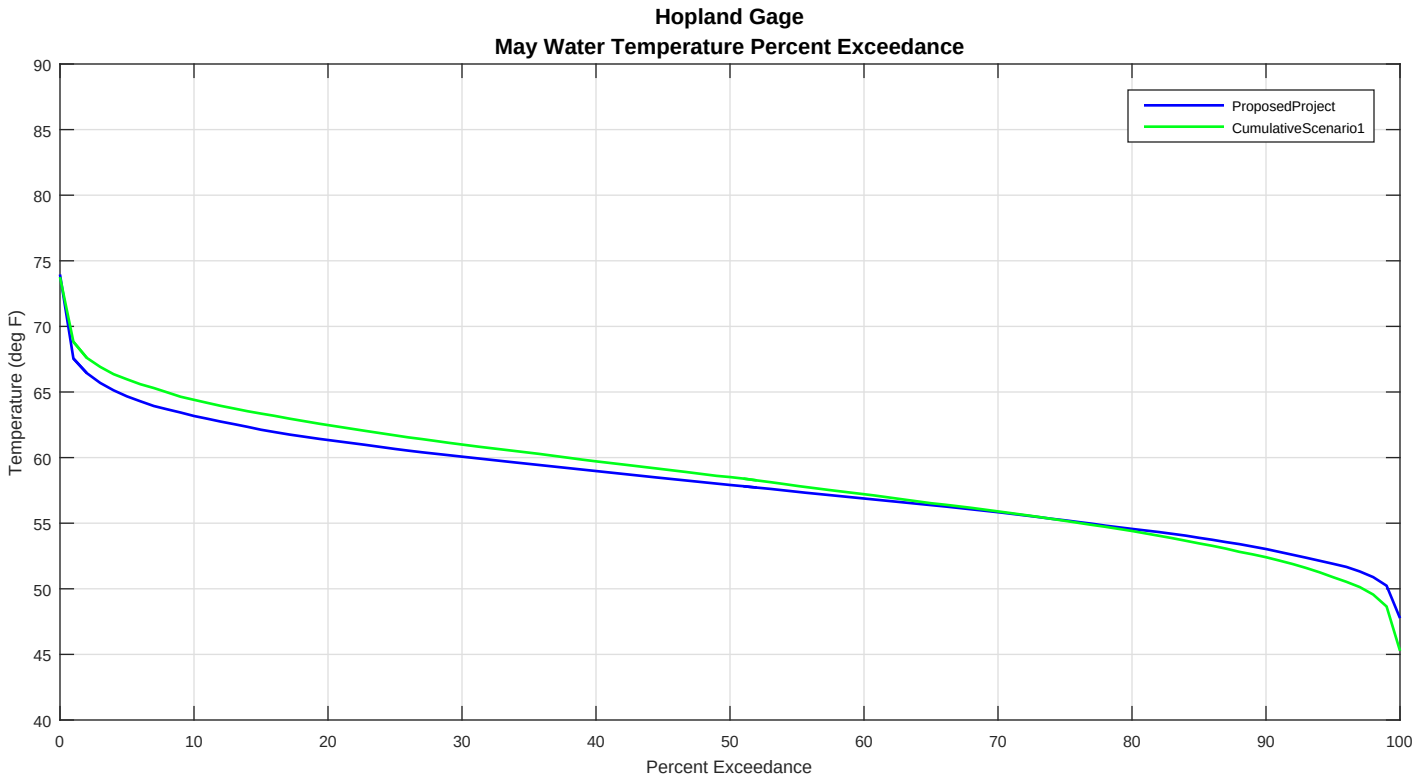
Hopland Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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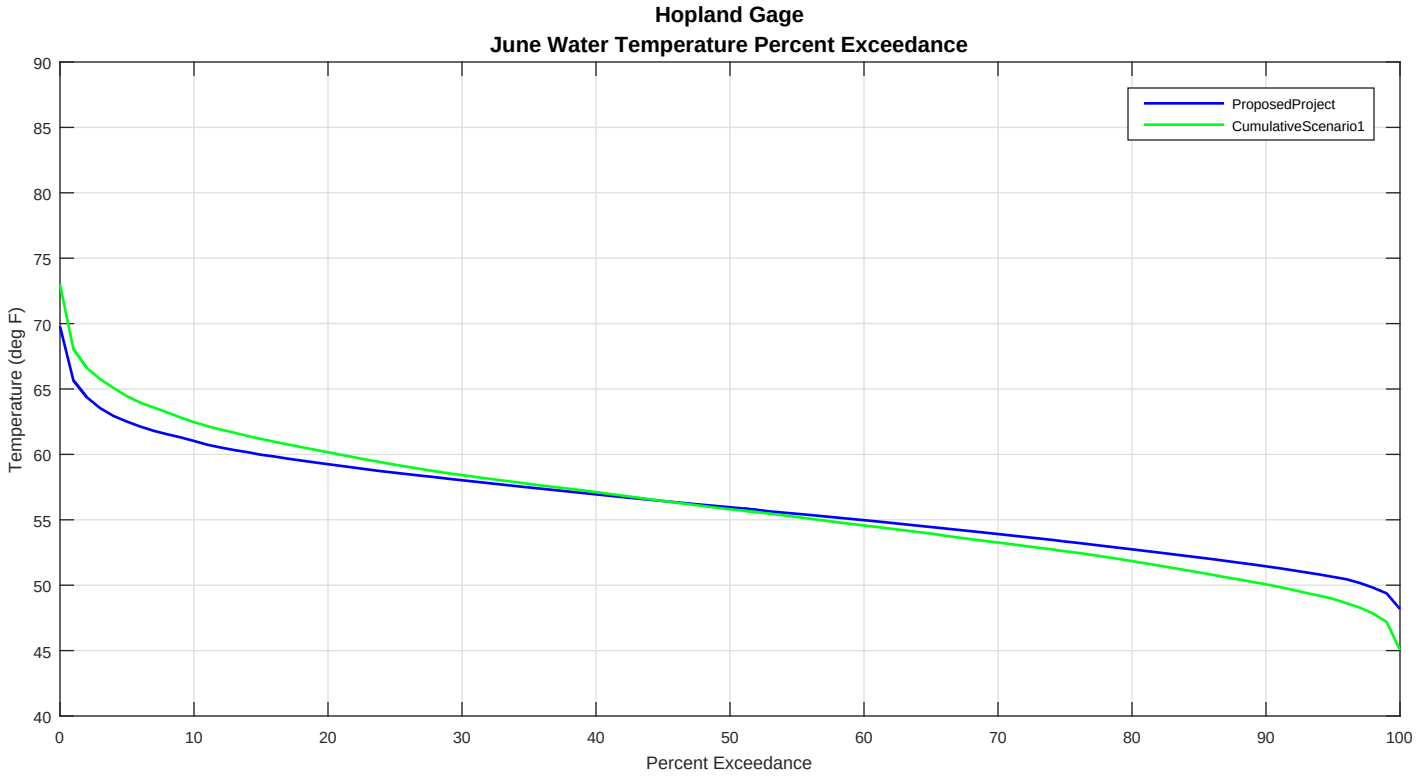
Hopland Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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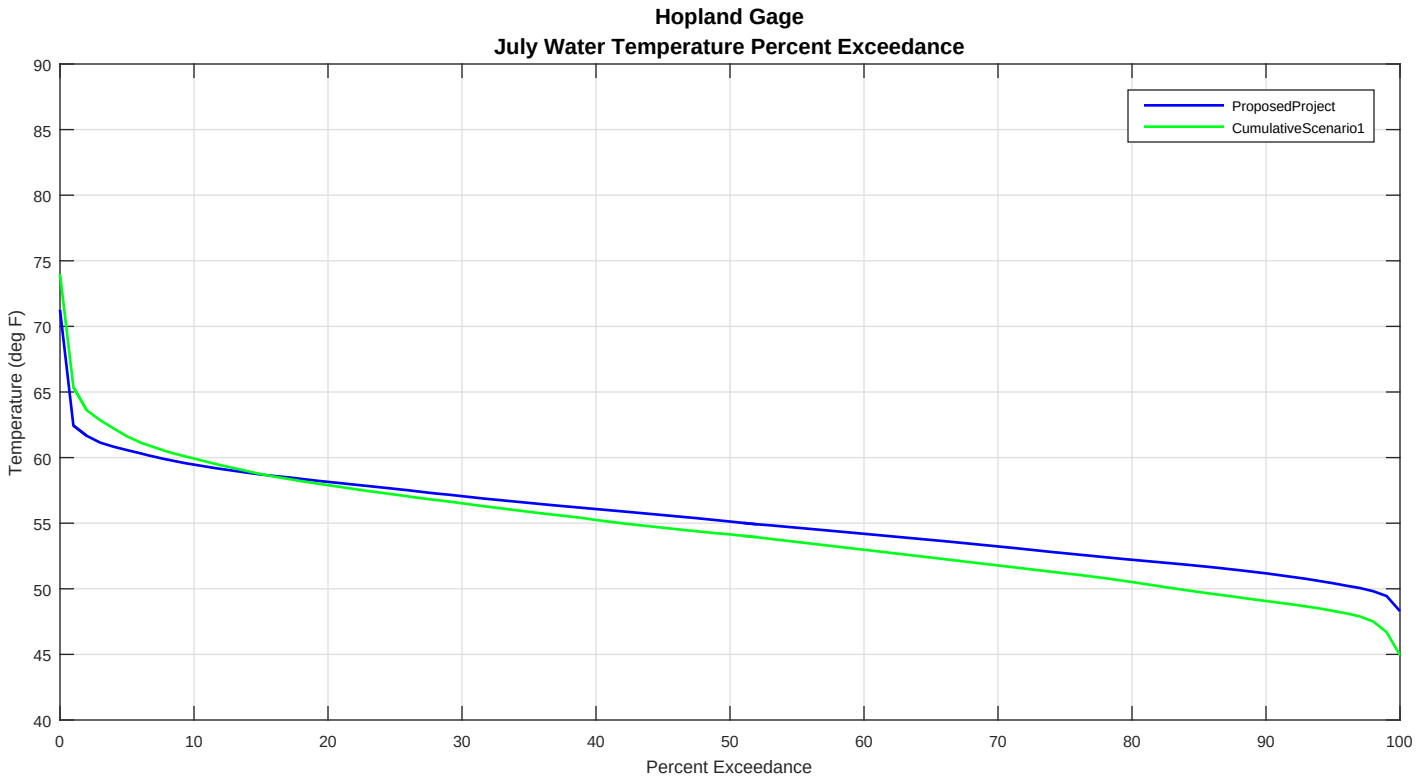
Hopland Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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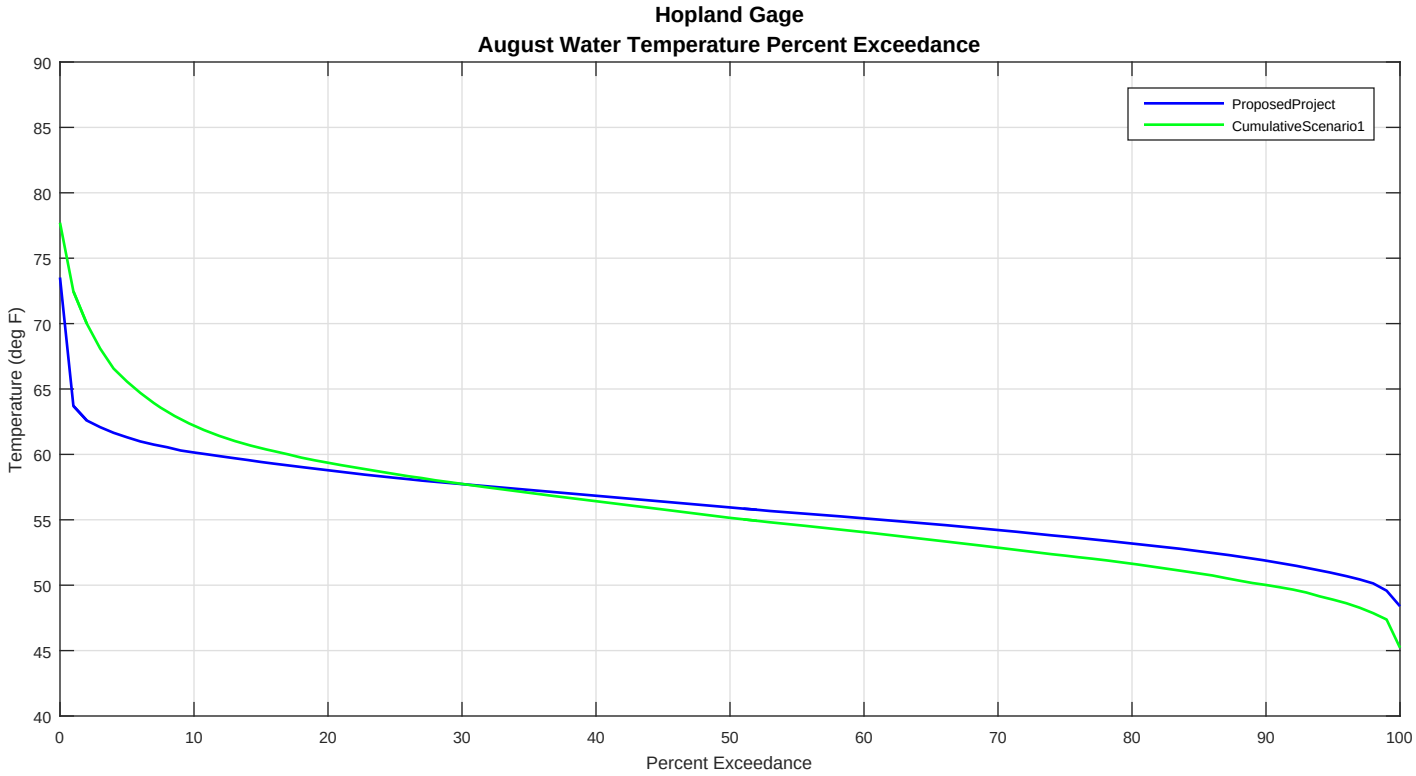
Hopland Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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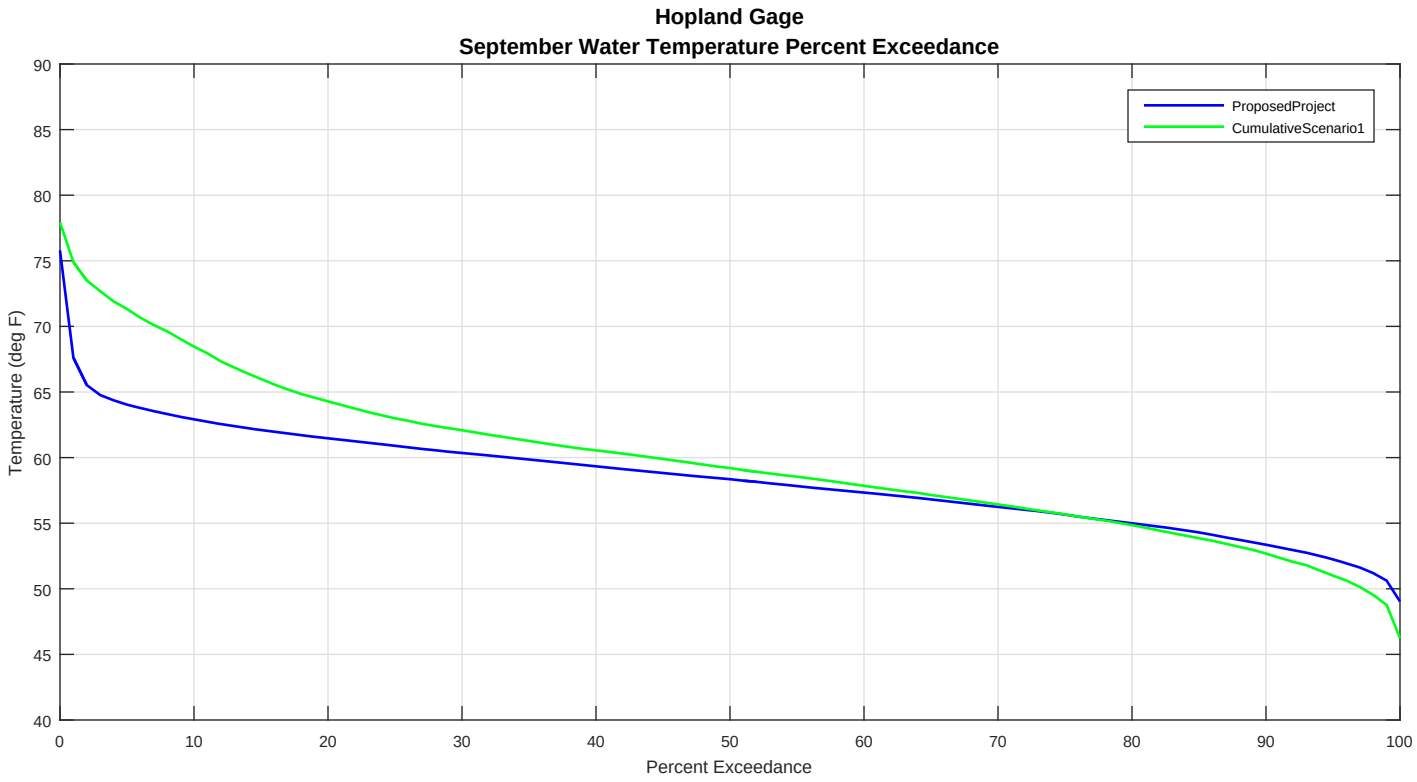
Hopland Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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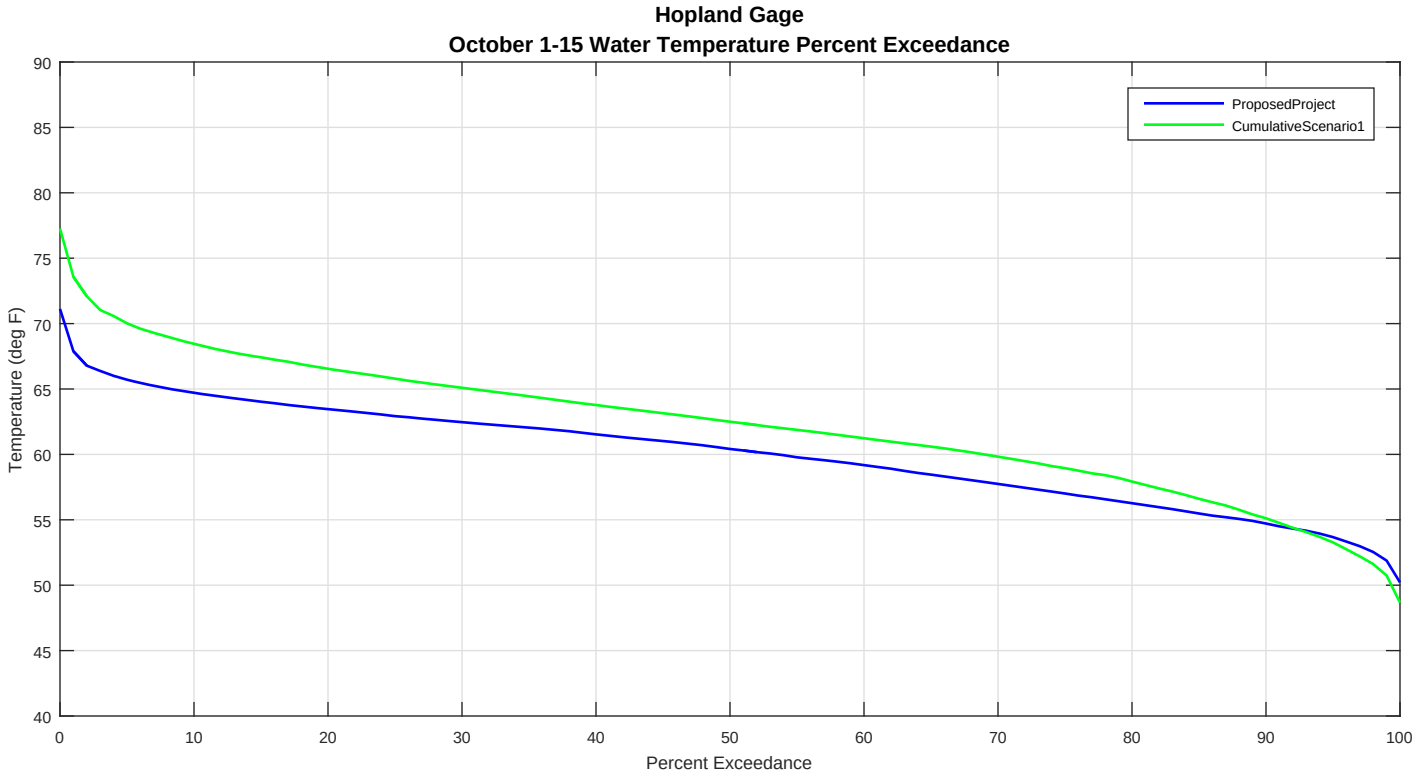
Hopland Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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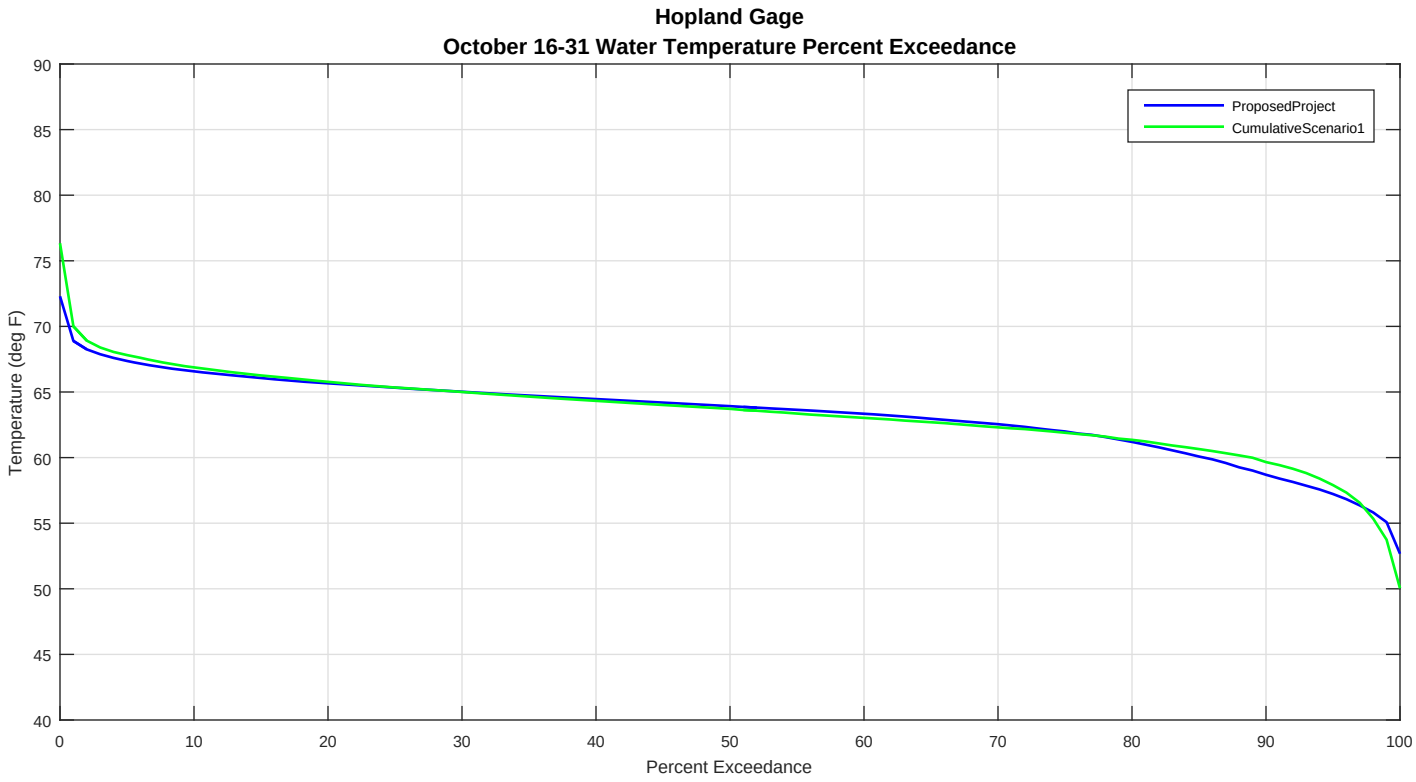
Hopland Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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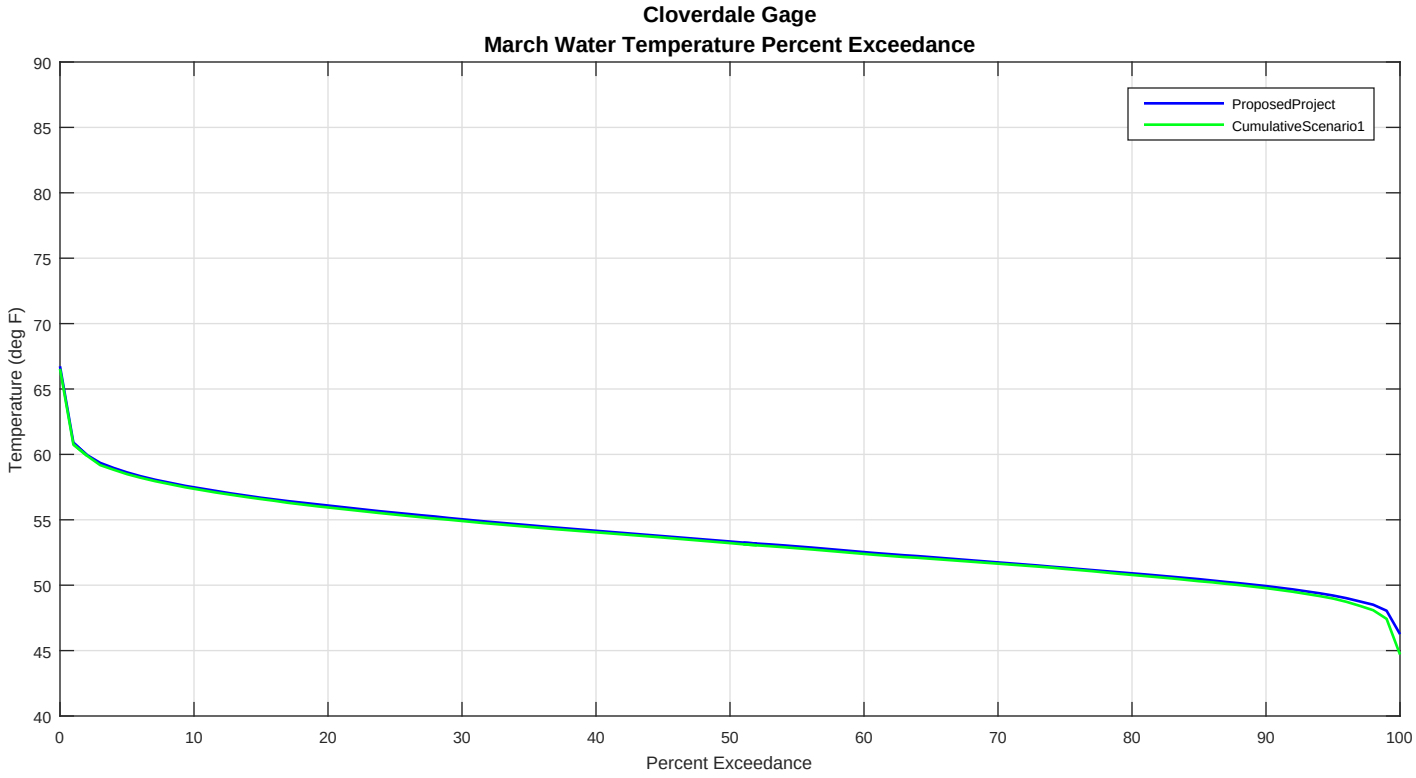
Cloverdale Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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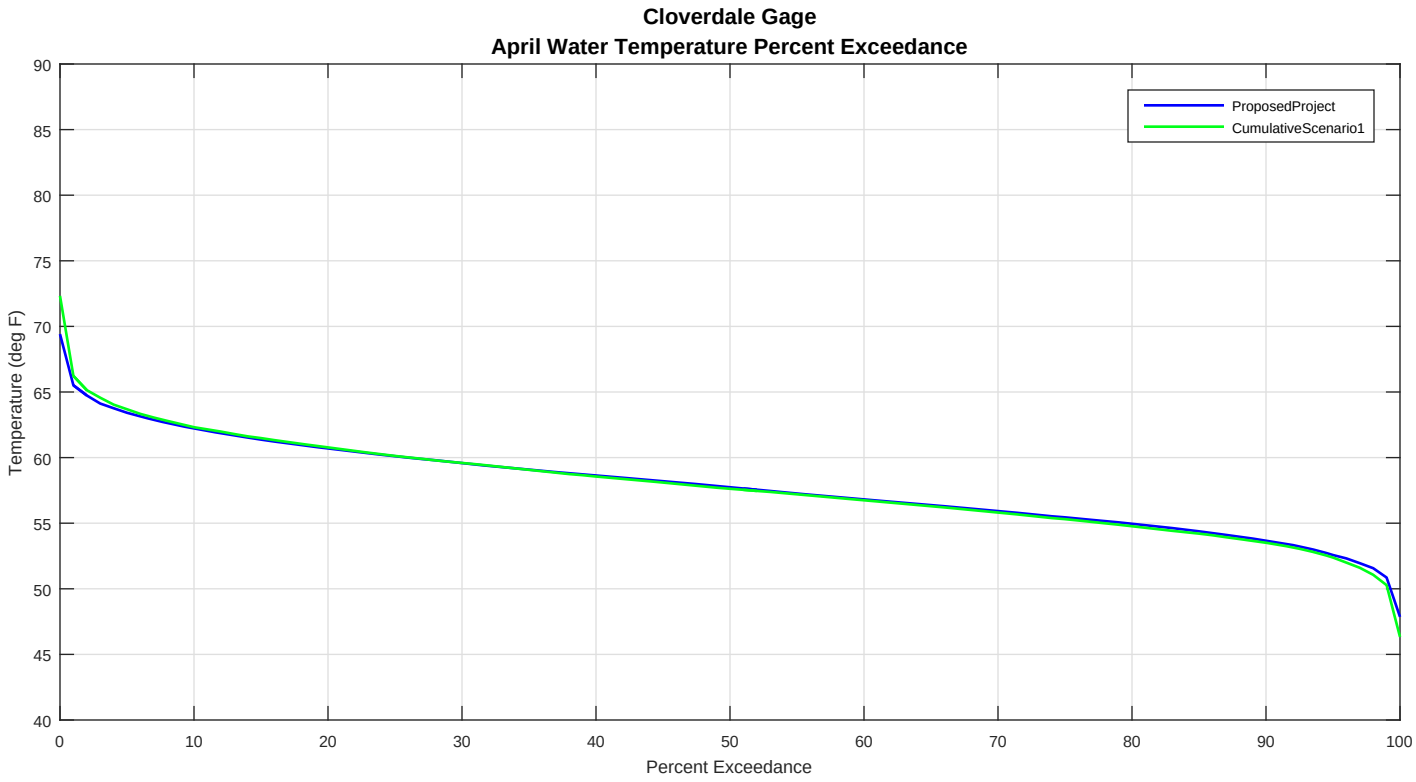
Cloverdale Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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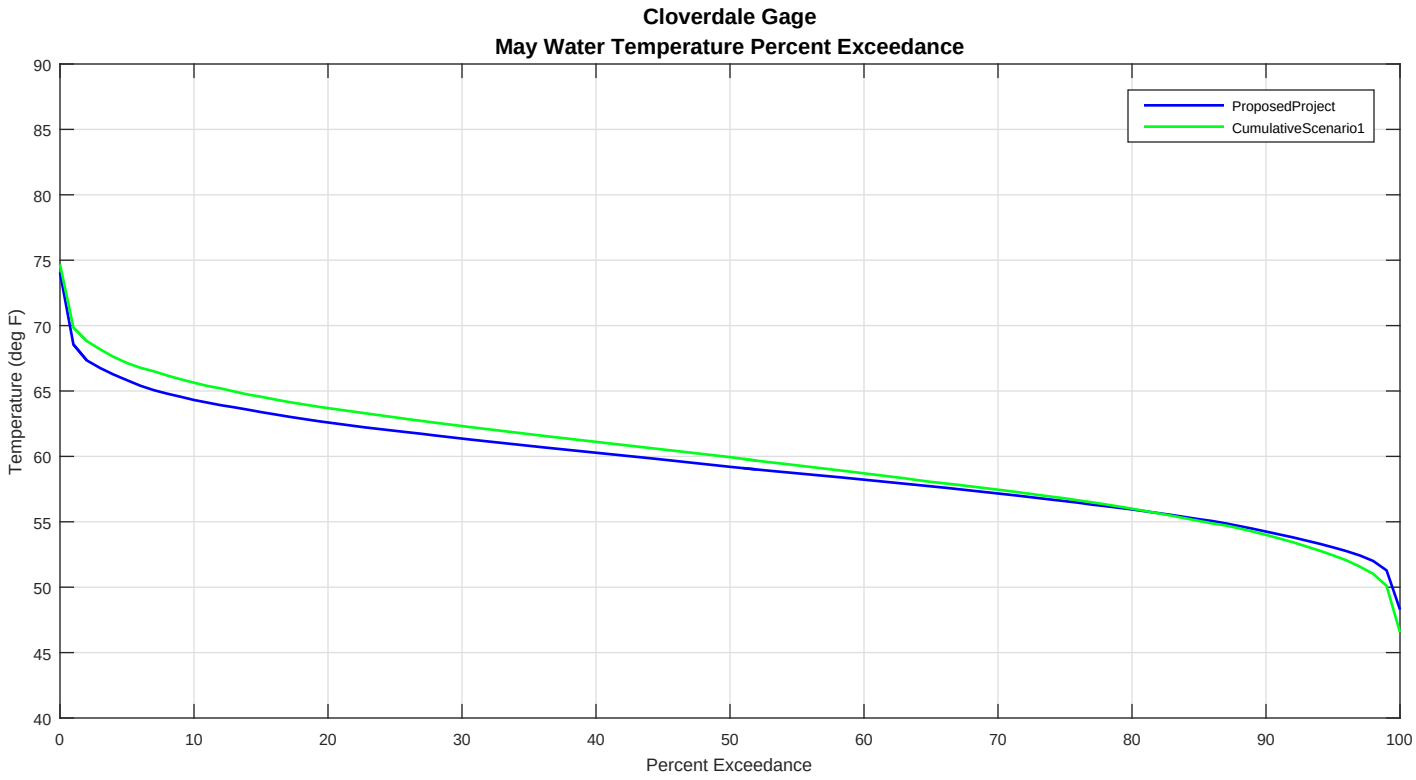
Cloverdale Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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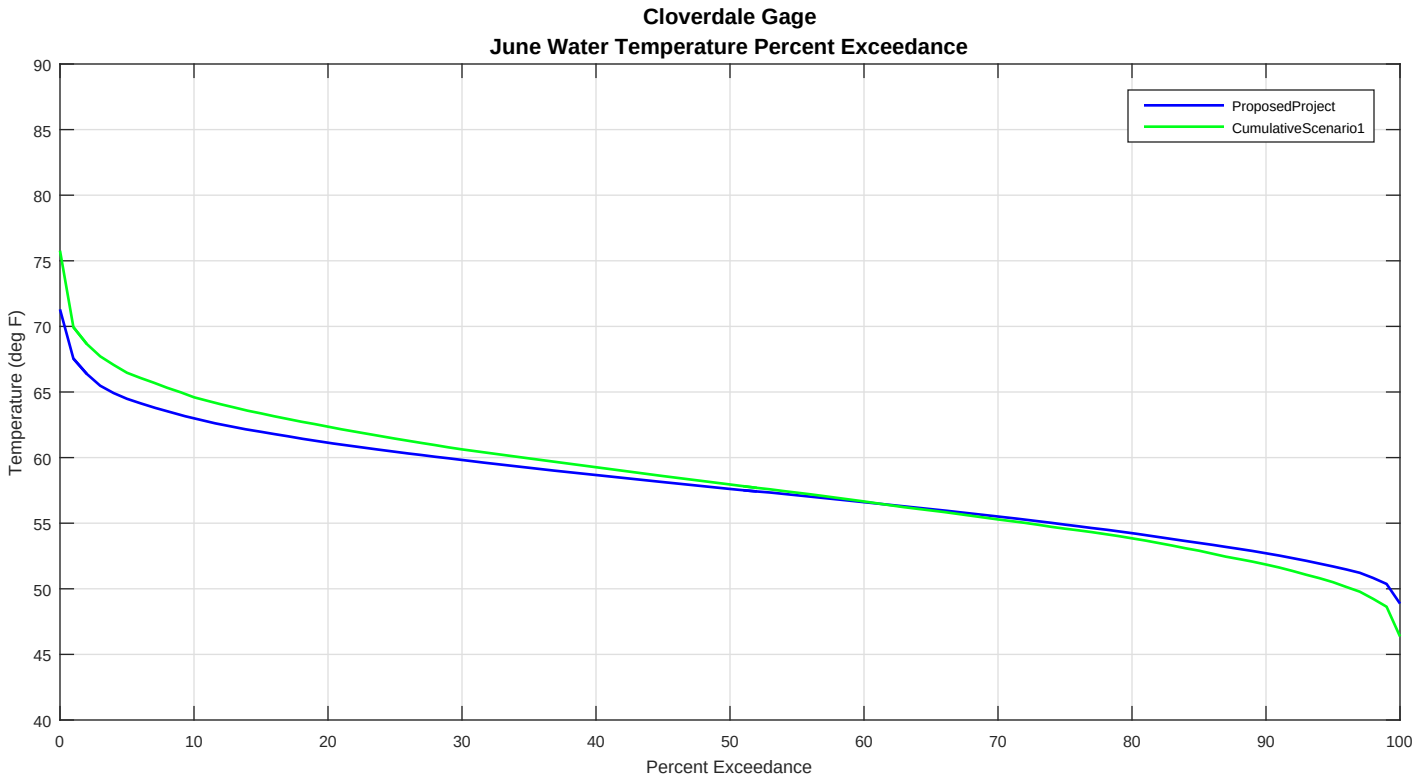
Cloverdale Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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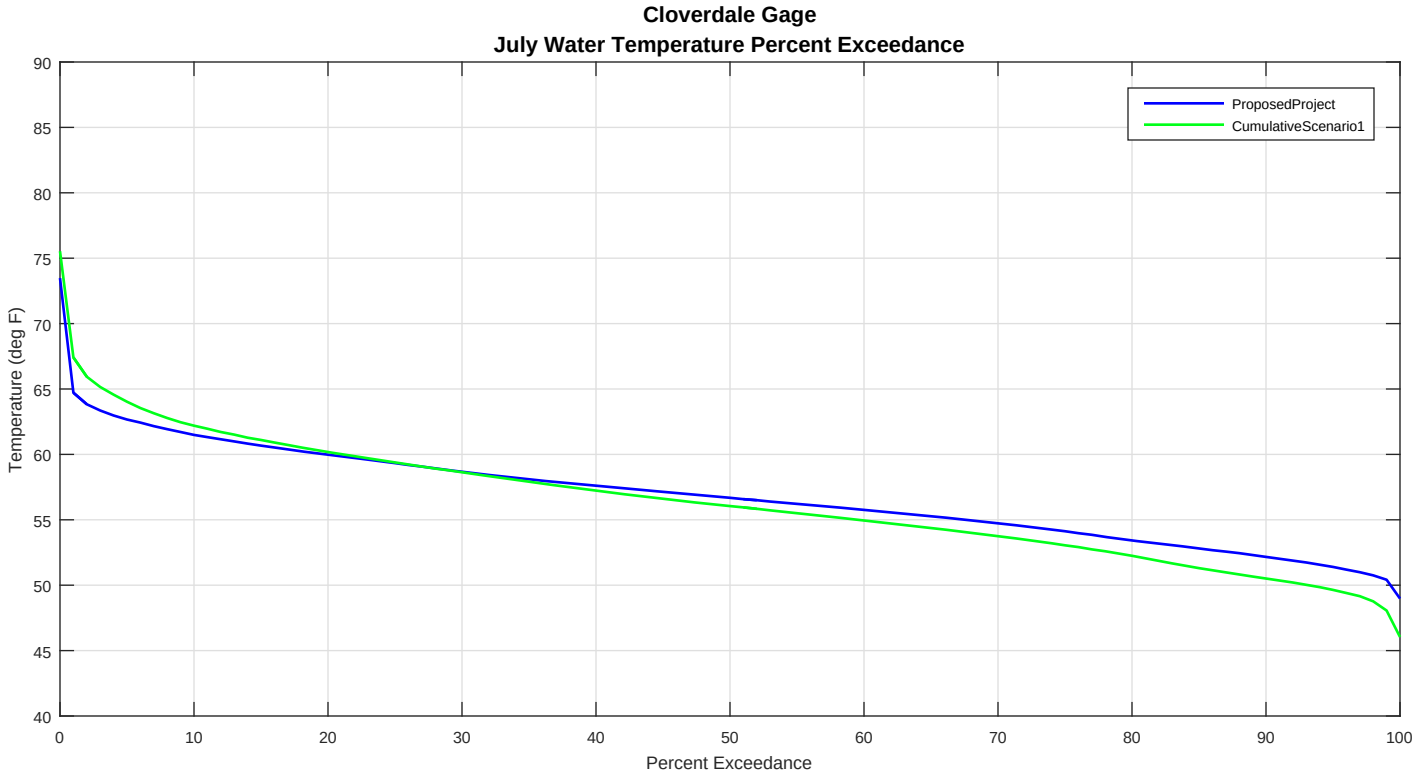
Cloverdale Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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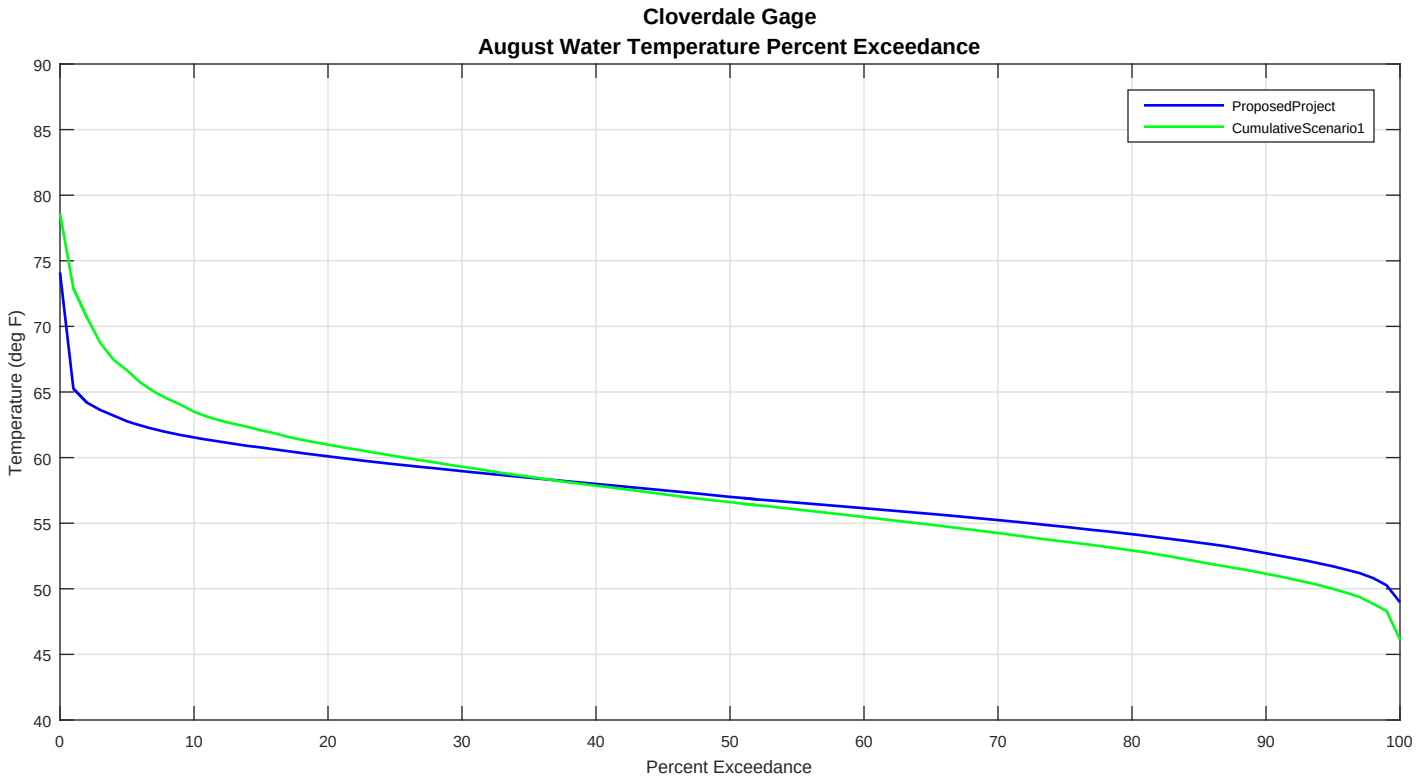
Cloverdale Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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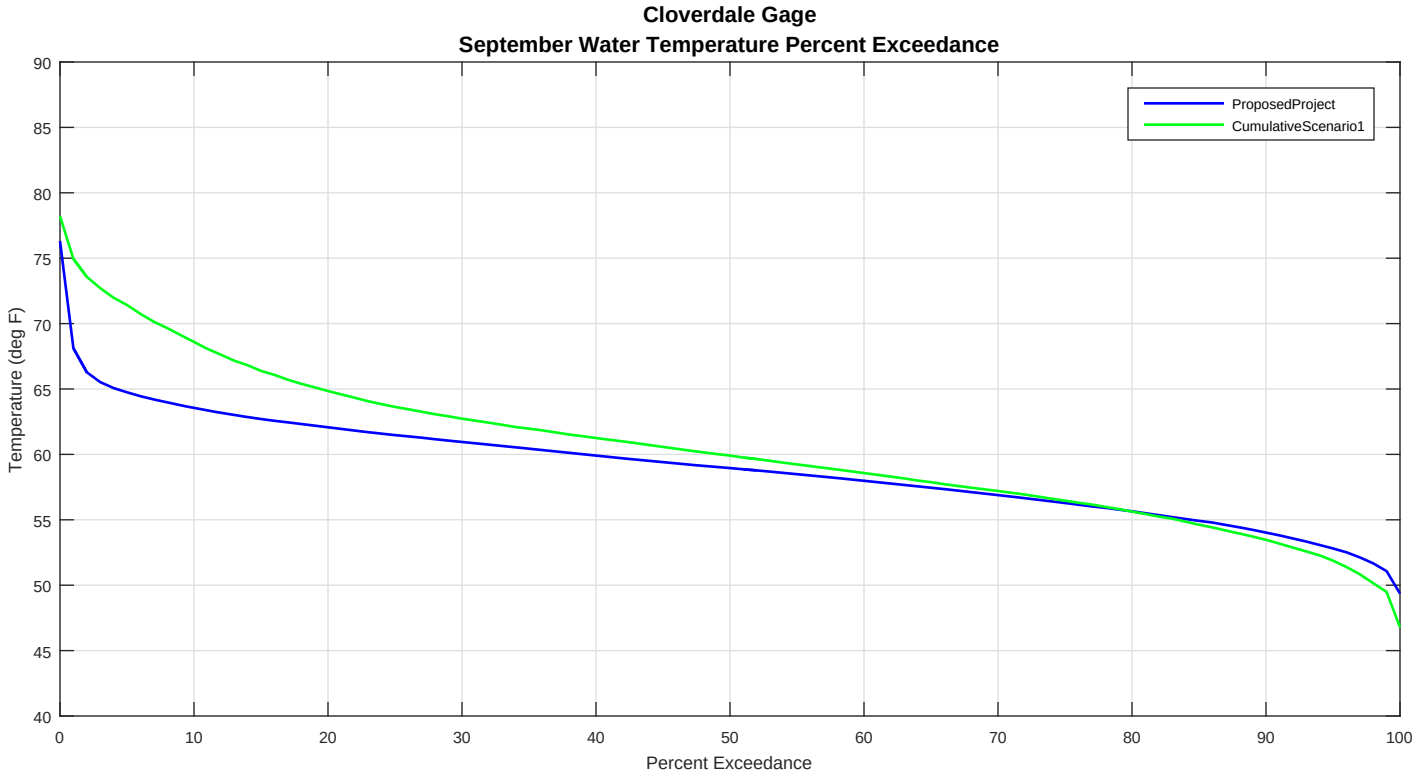
Cloverdale Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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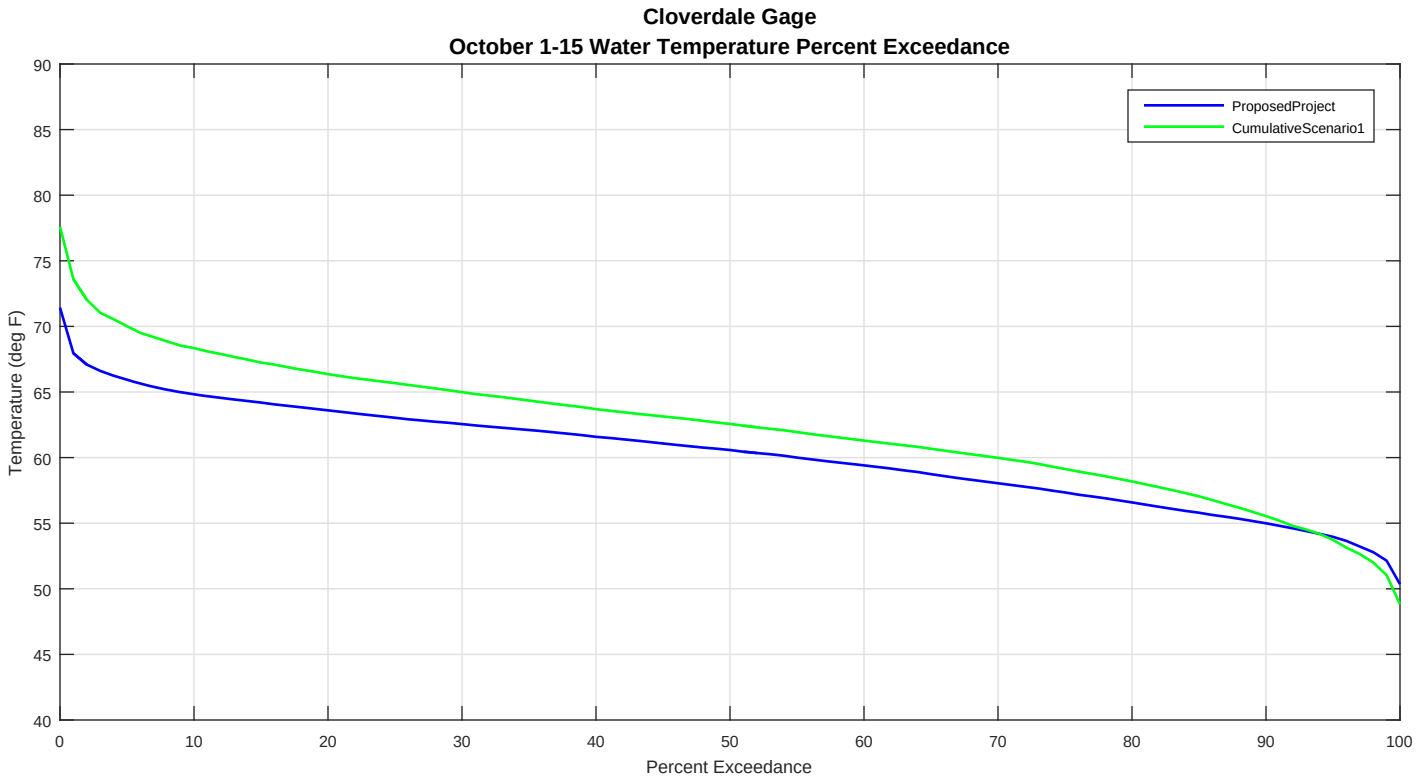
Cloverdale Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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Cloverdale Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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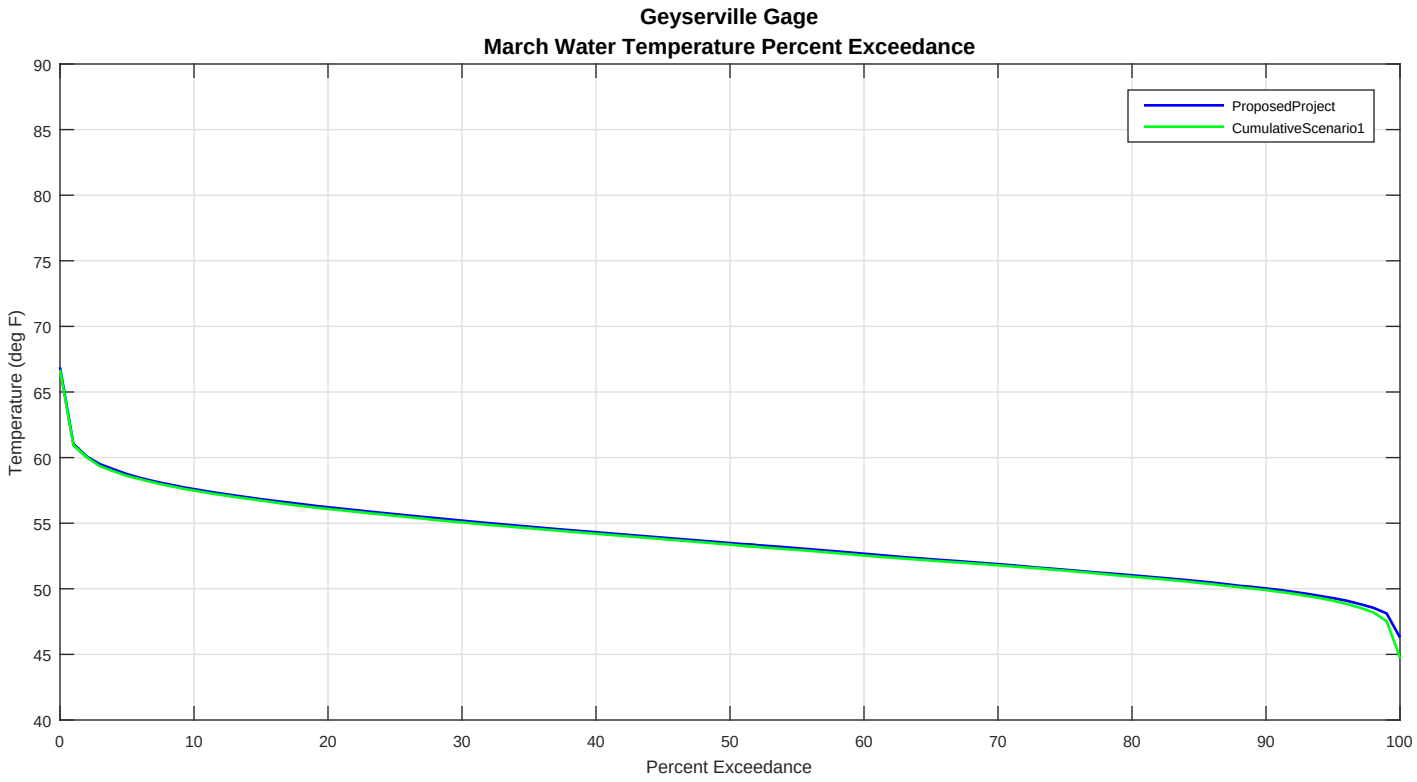
Geyserville Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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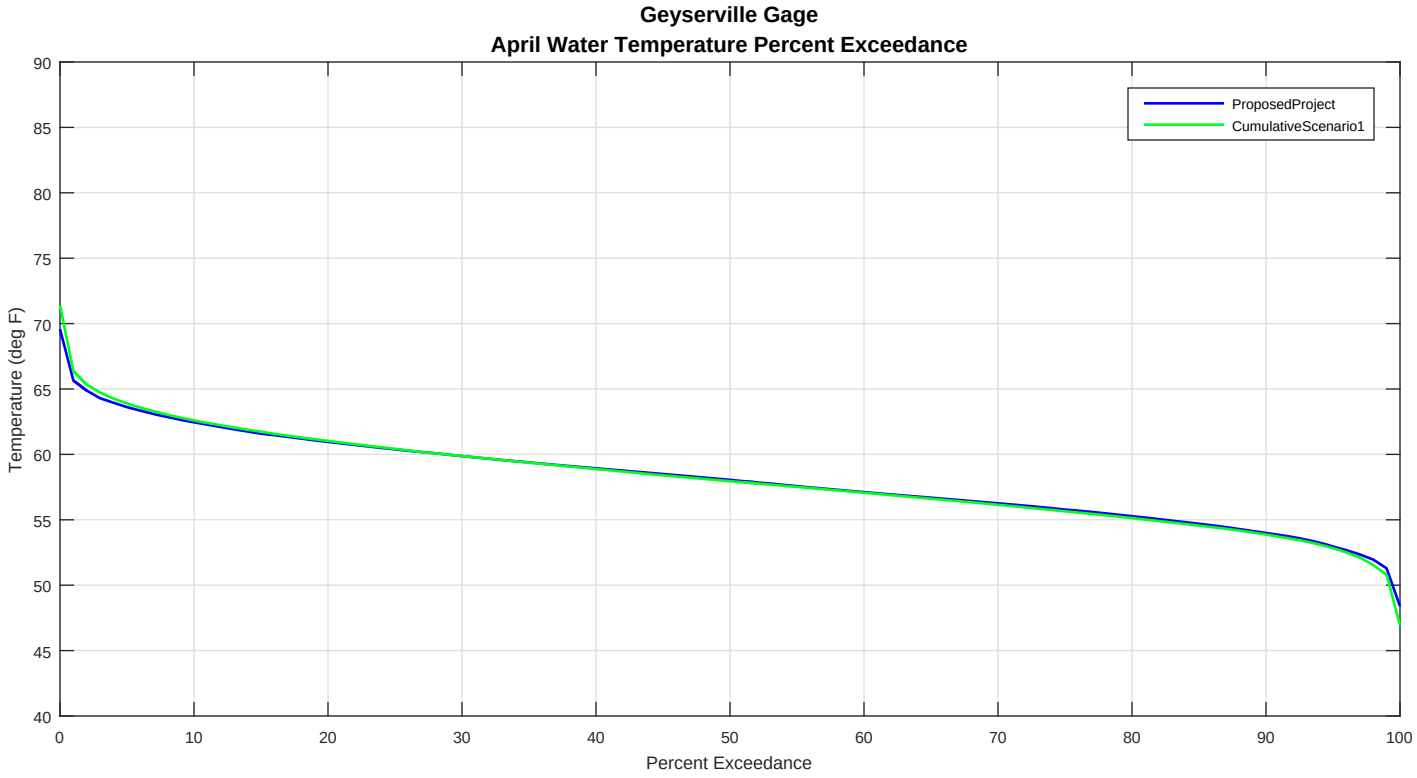
Geyserville Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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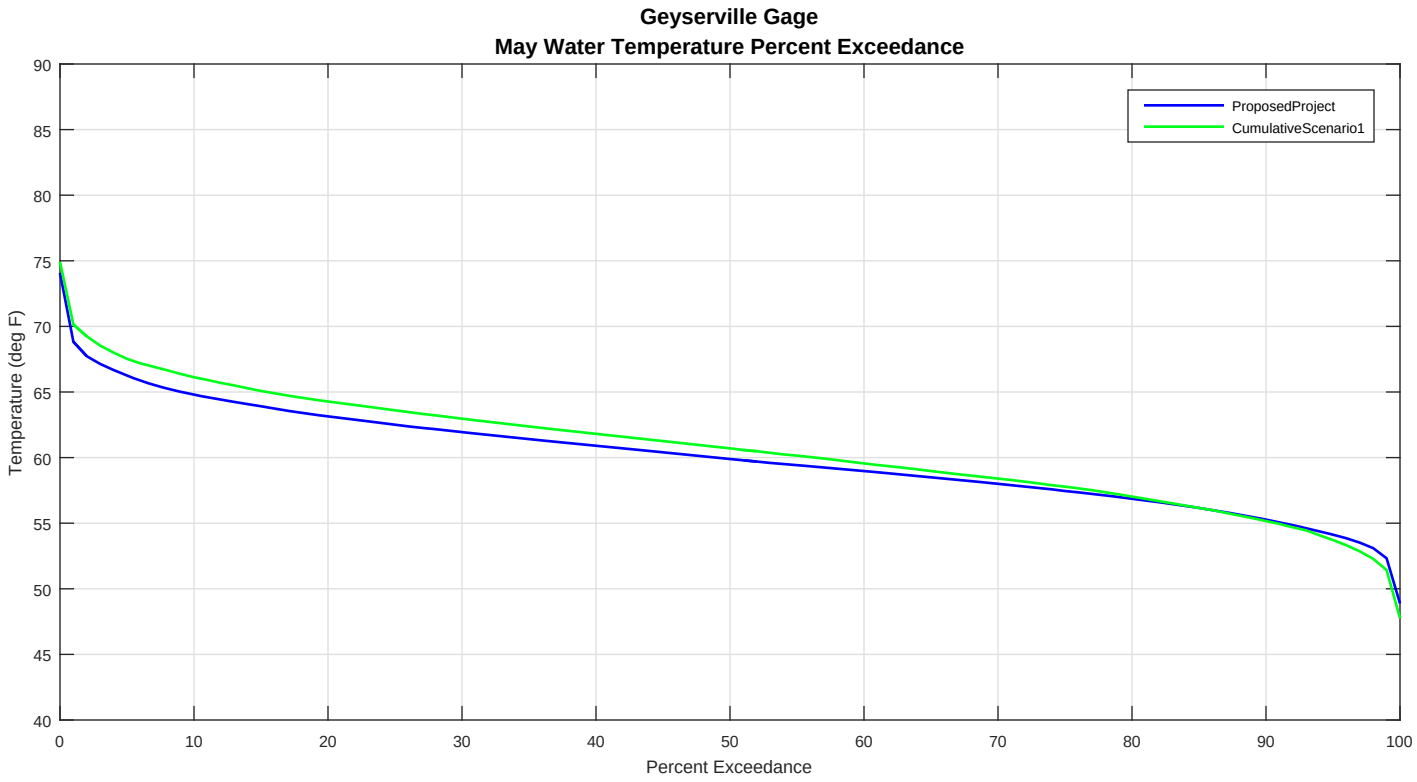
Geyserville Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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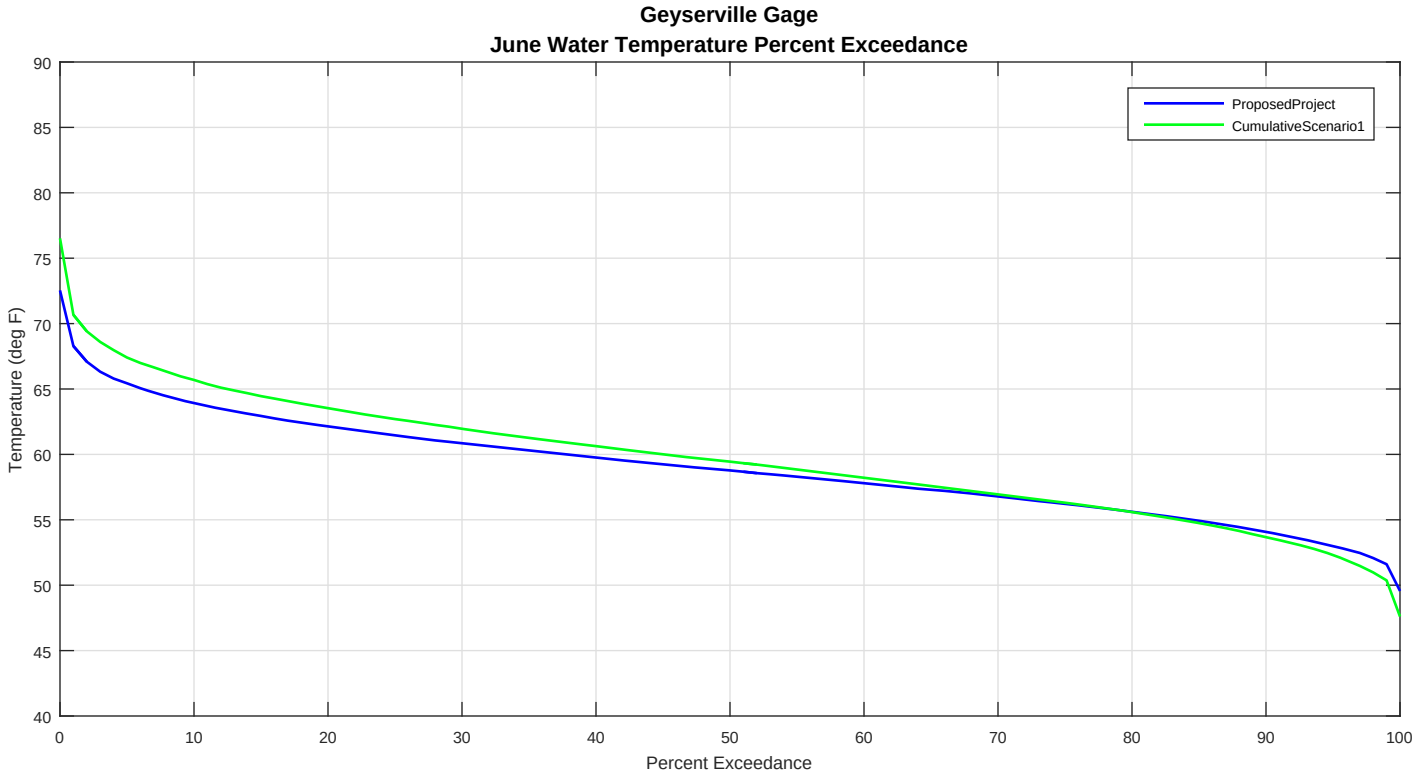
Geyserville Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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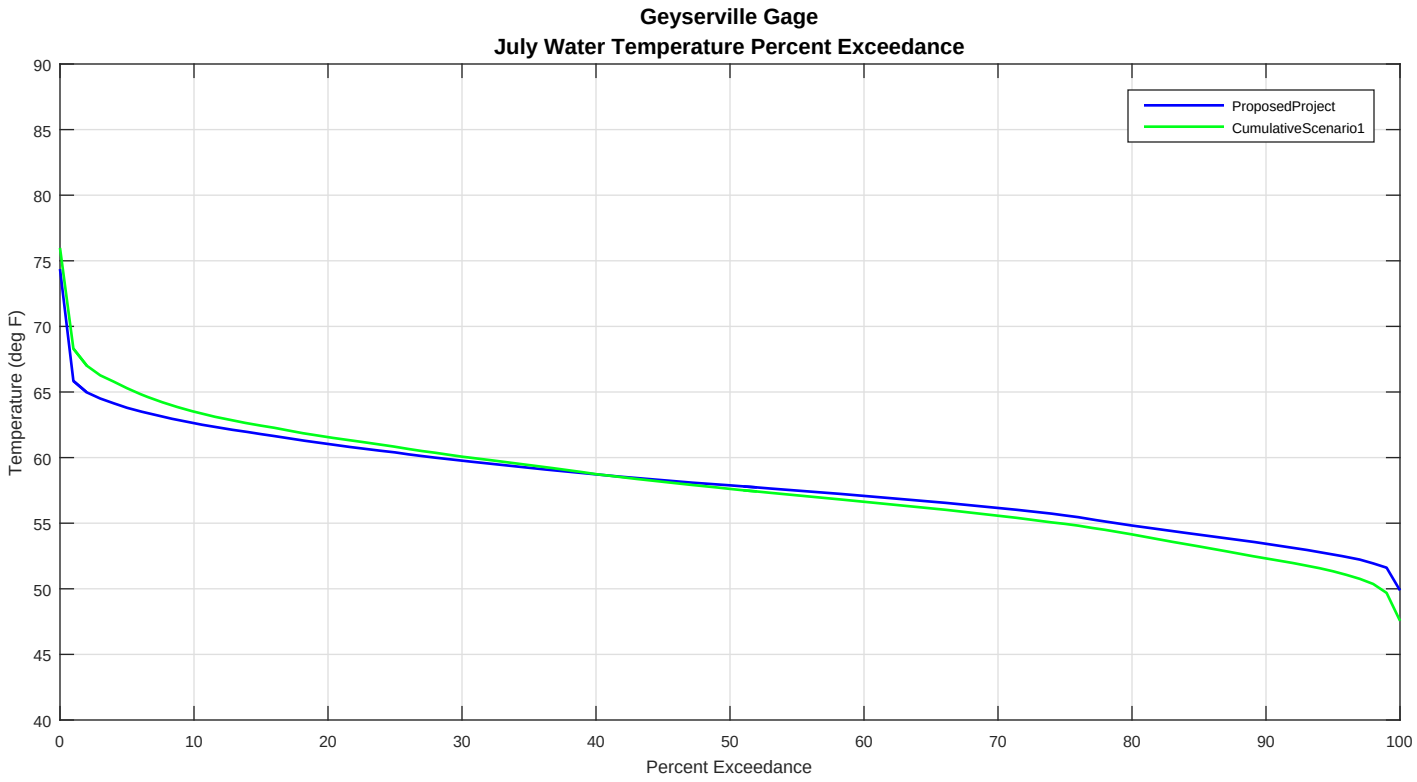
Geyserville Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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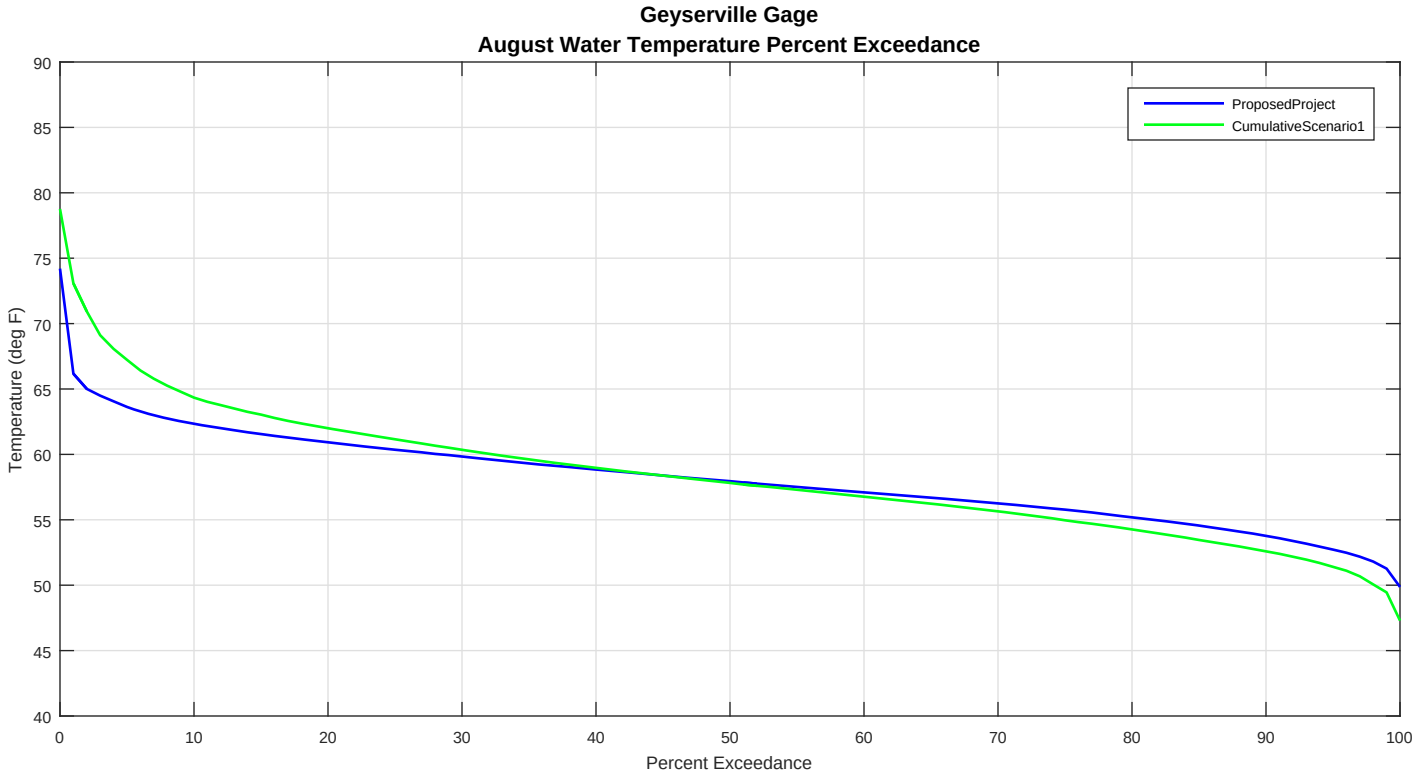
Geyserville Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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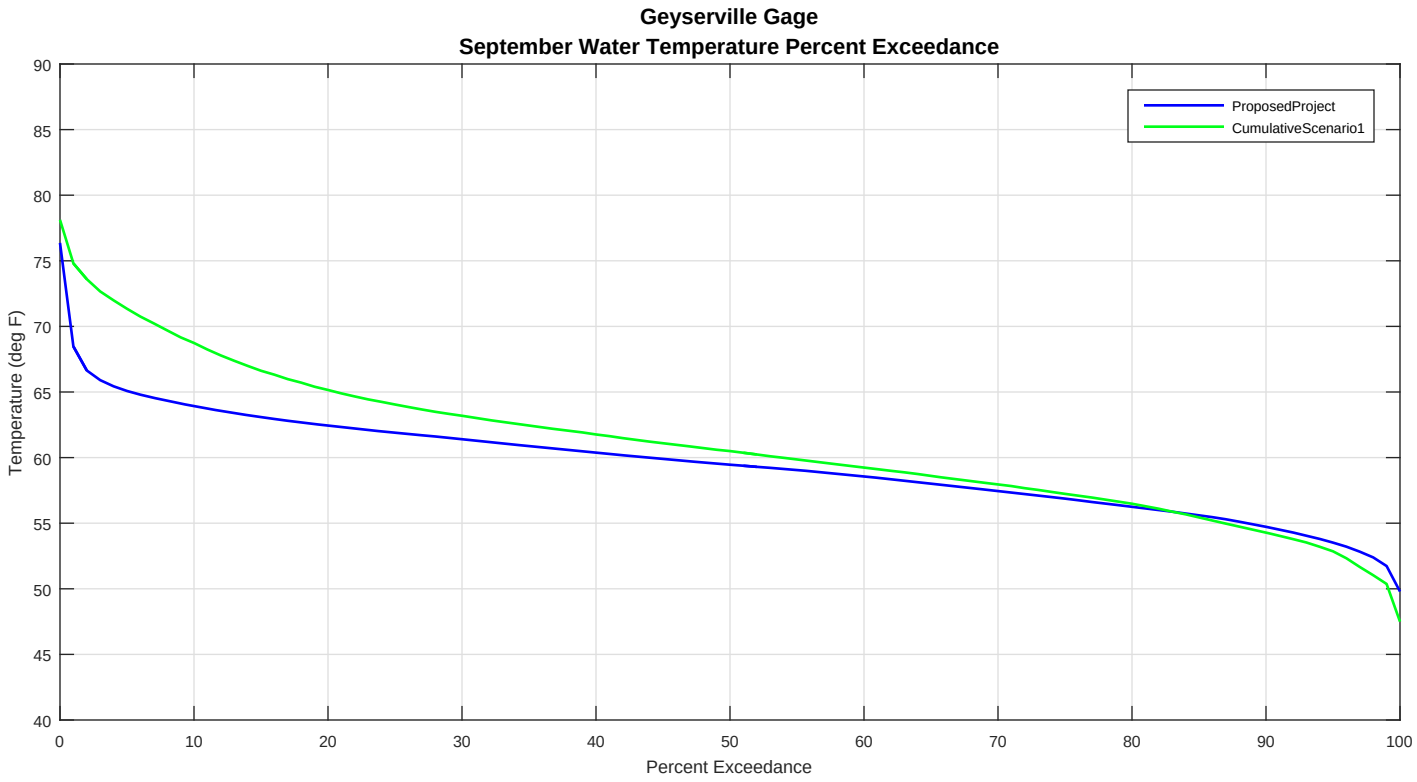
Geyserville Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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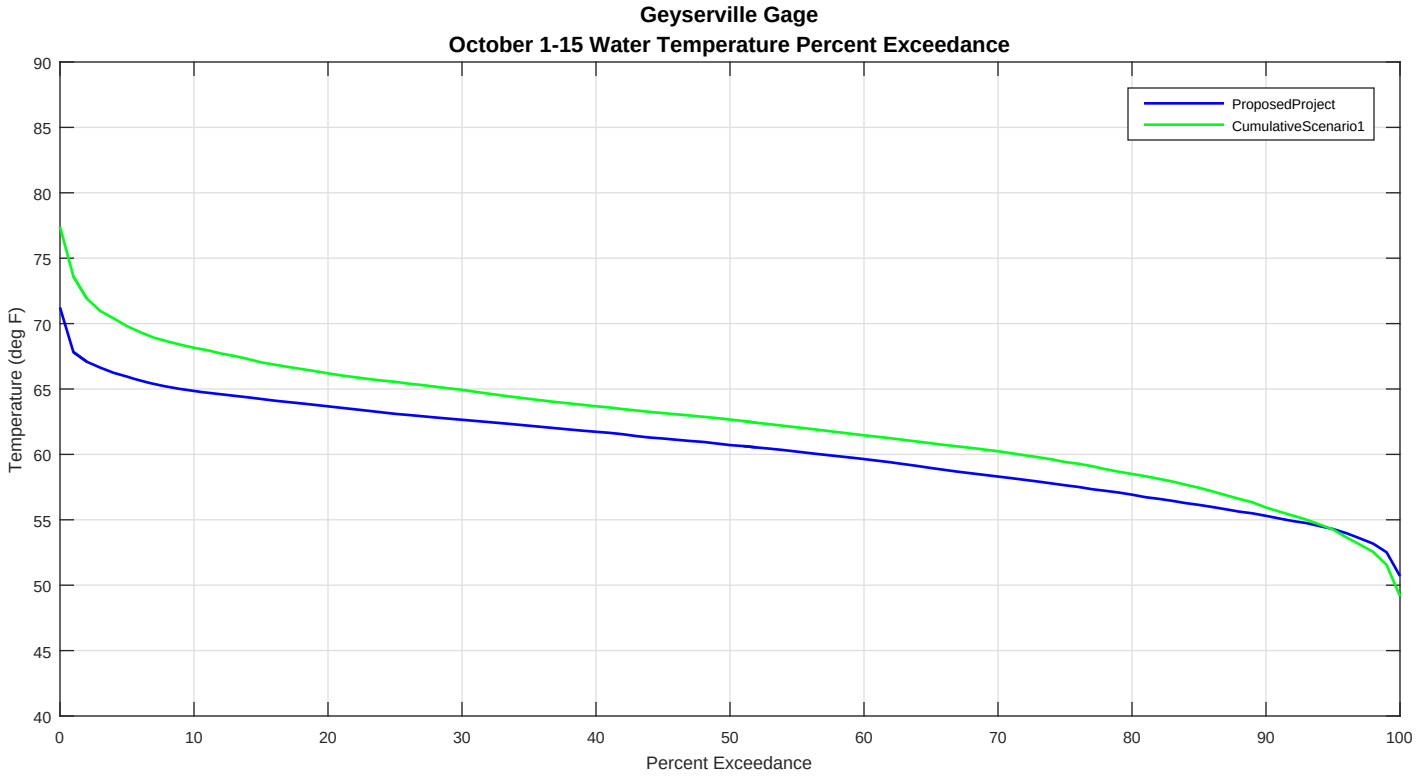
Geyserville Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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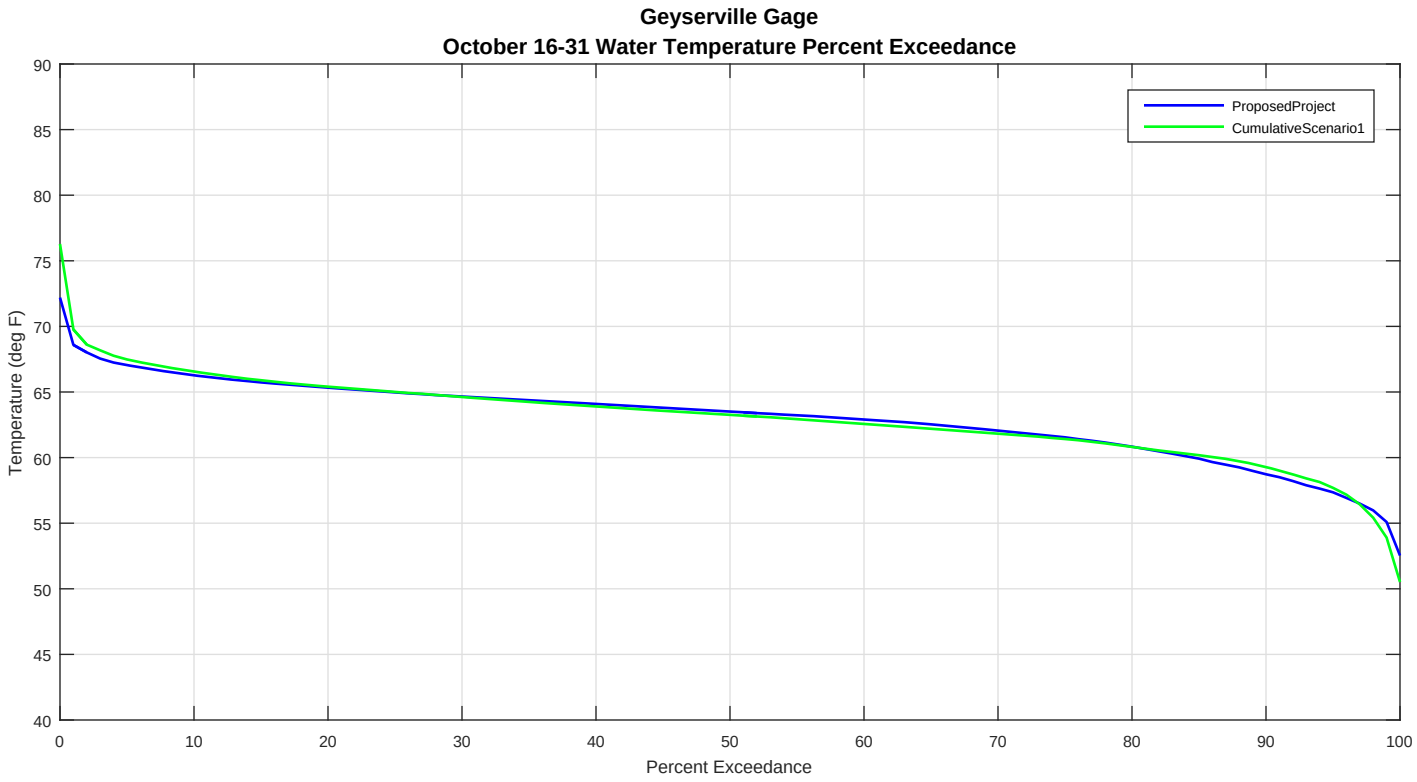
Geyserville Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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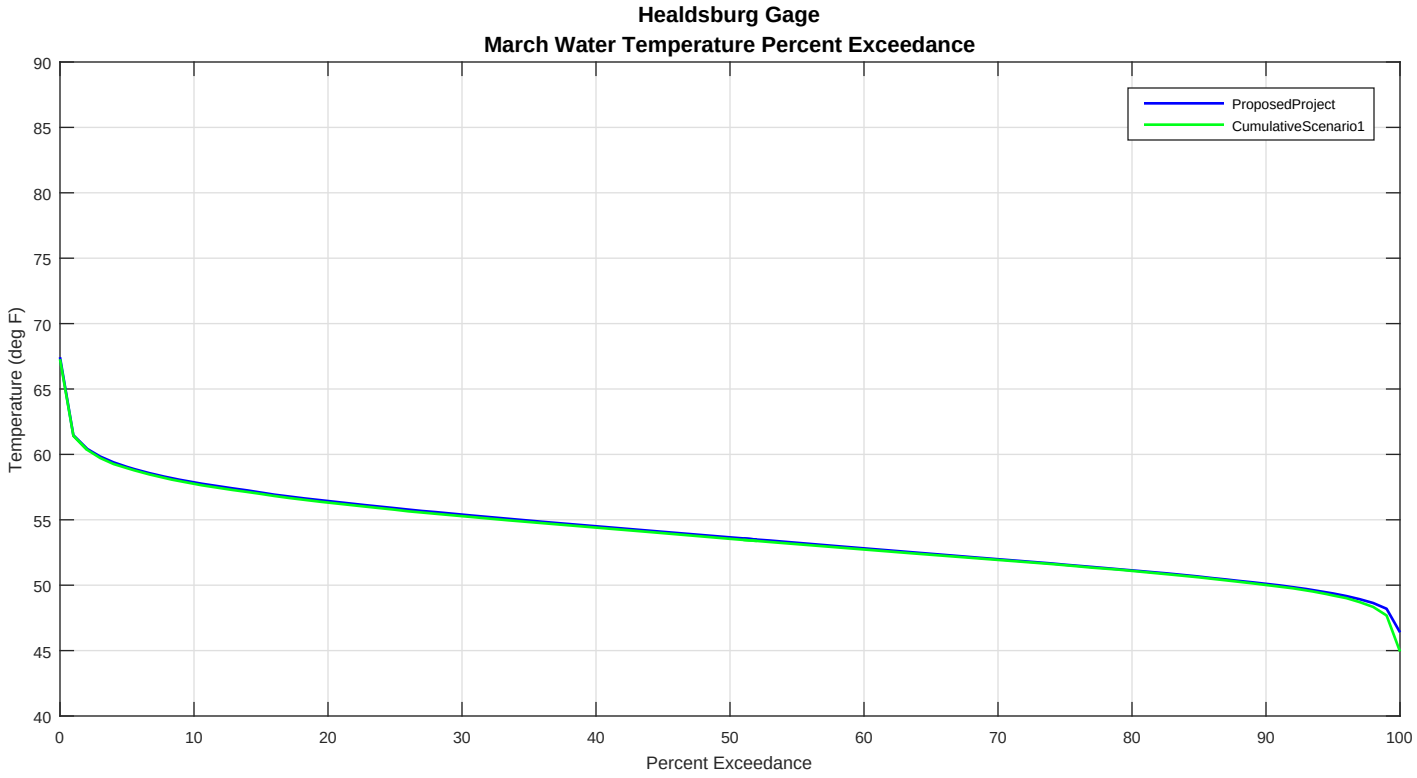
Healdsburg Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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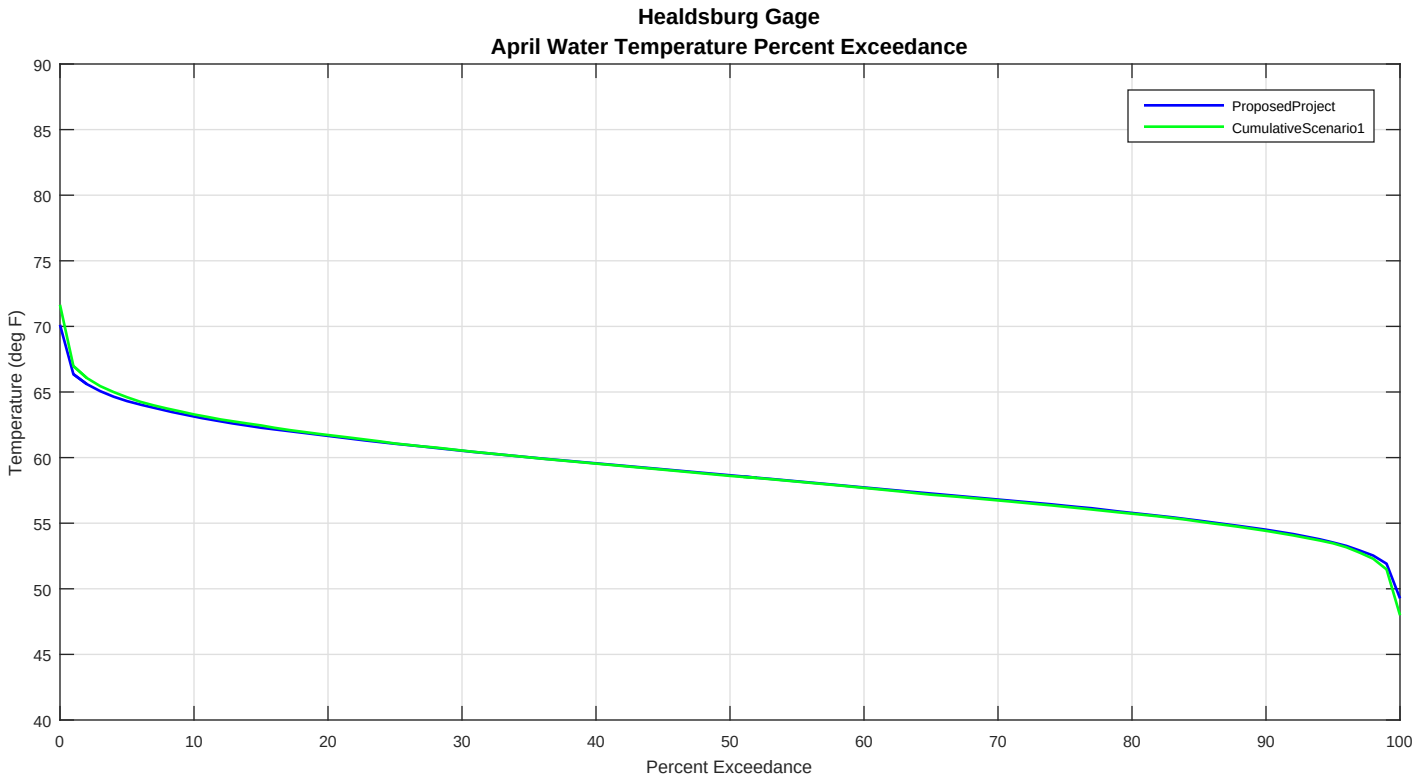
Healdsburg Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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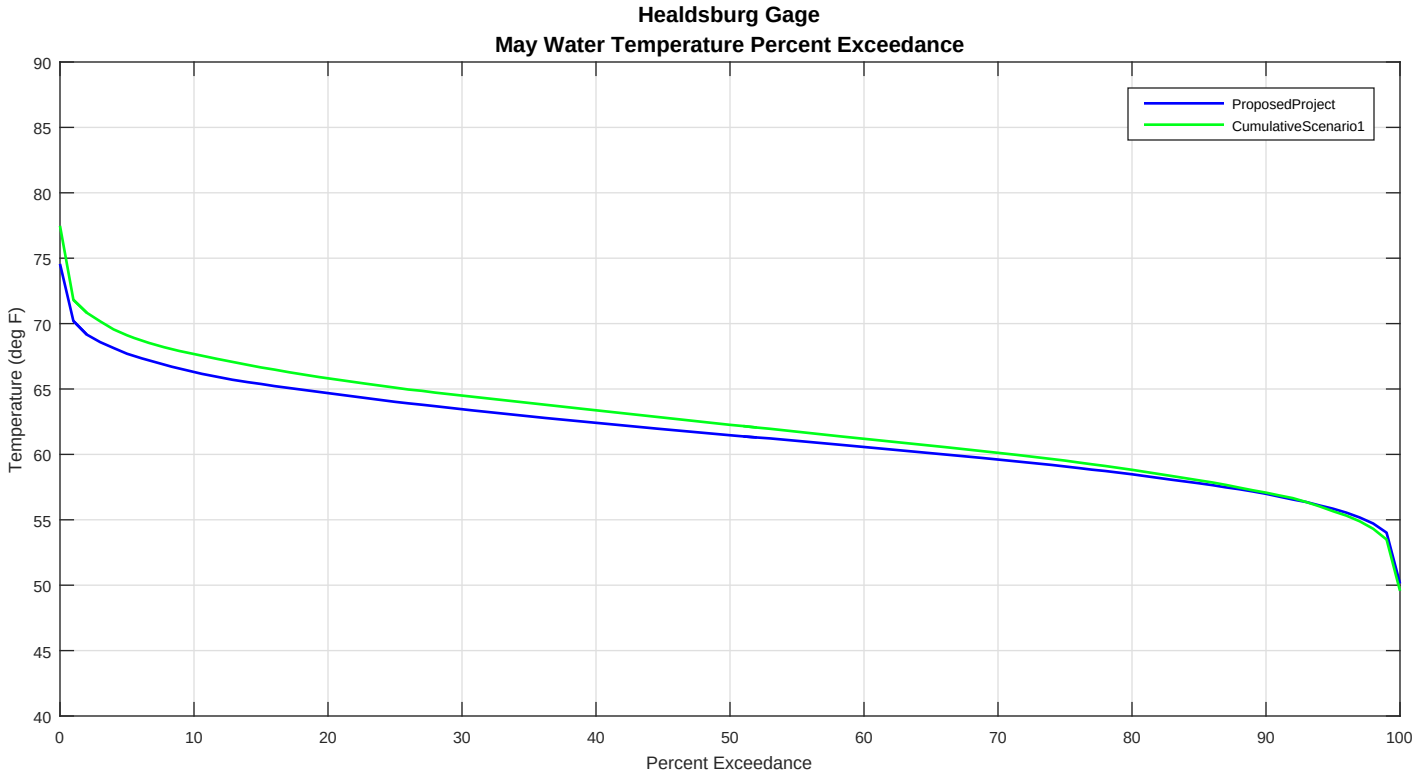
Healdsburg Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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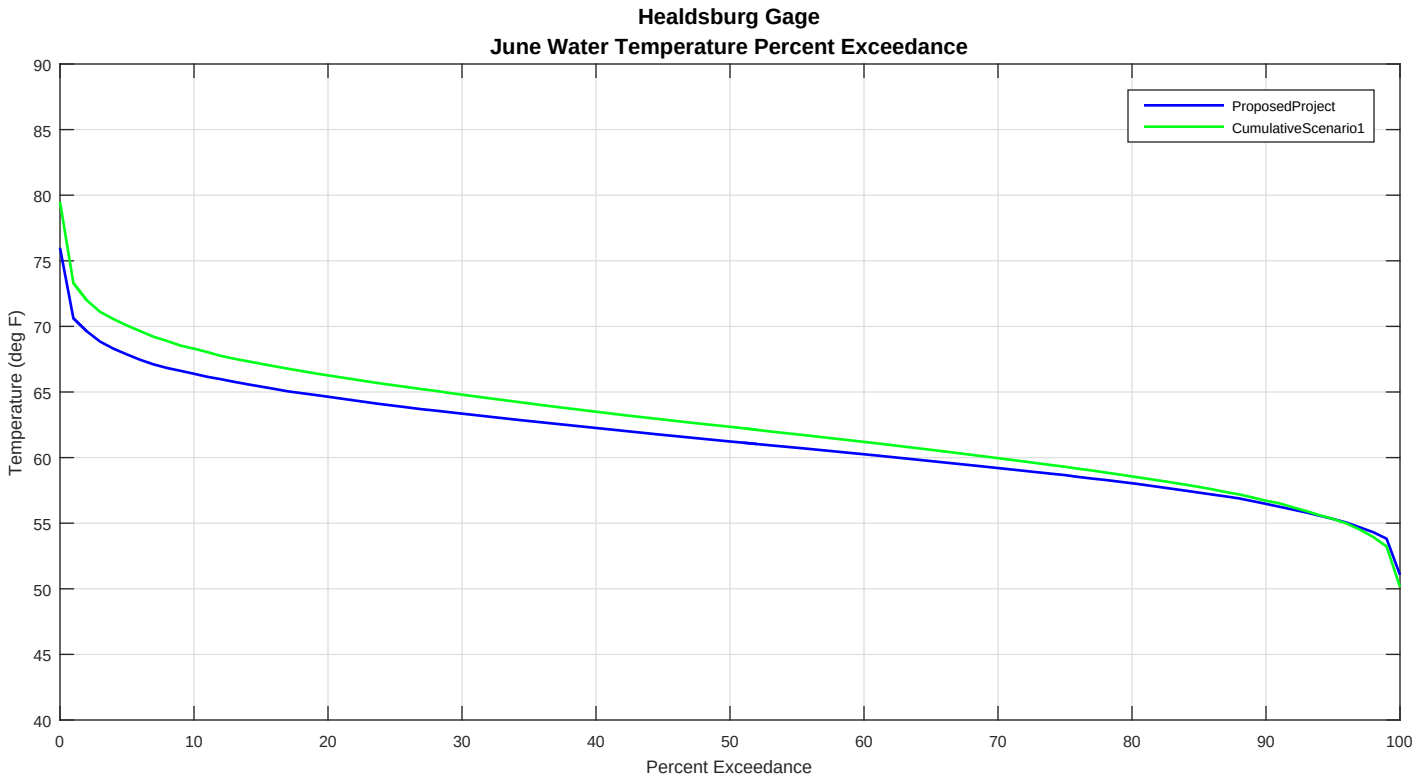
Healdsburg Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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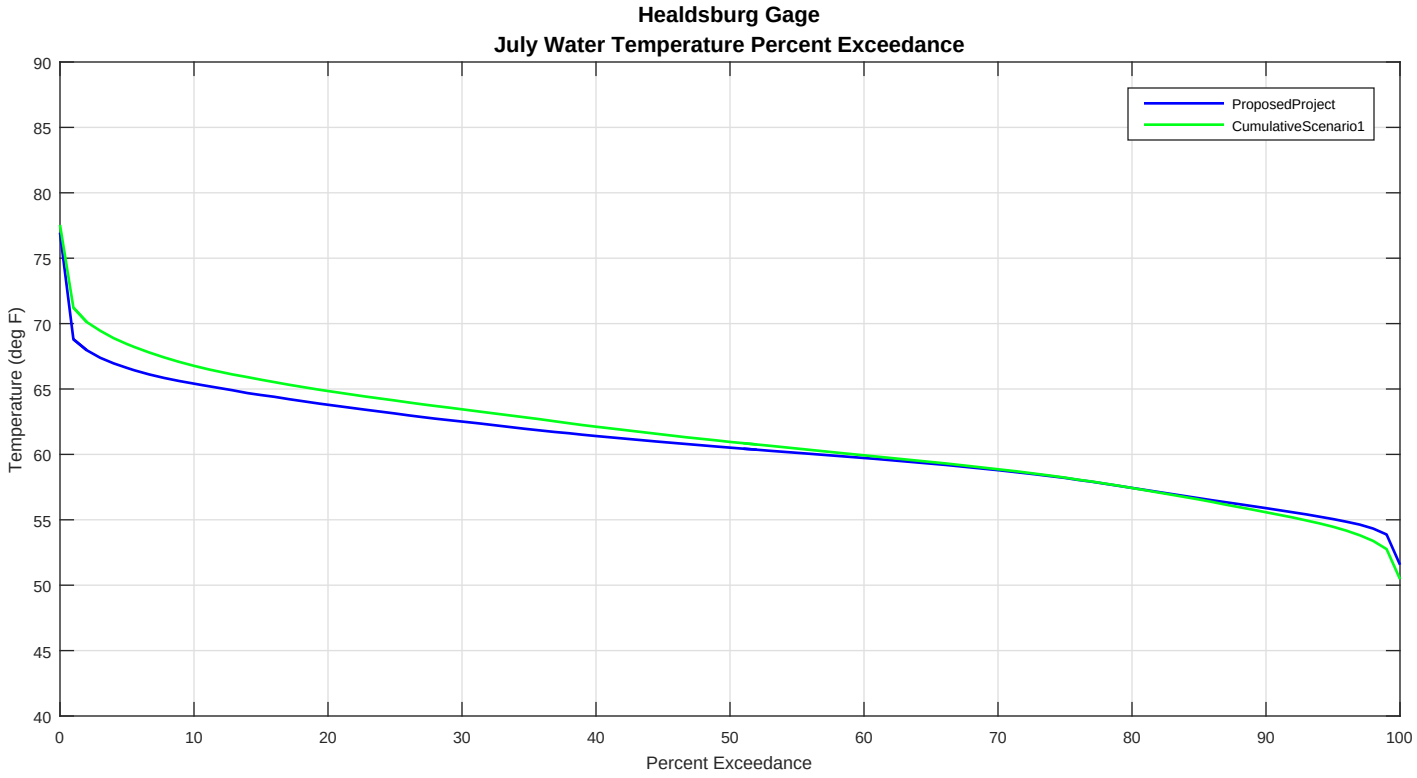
Healdsburg Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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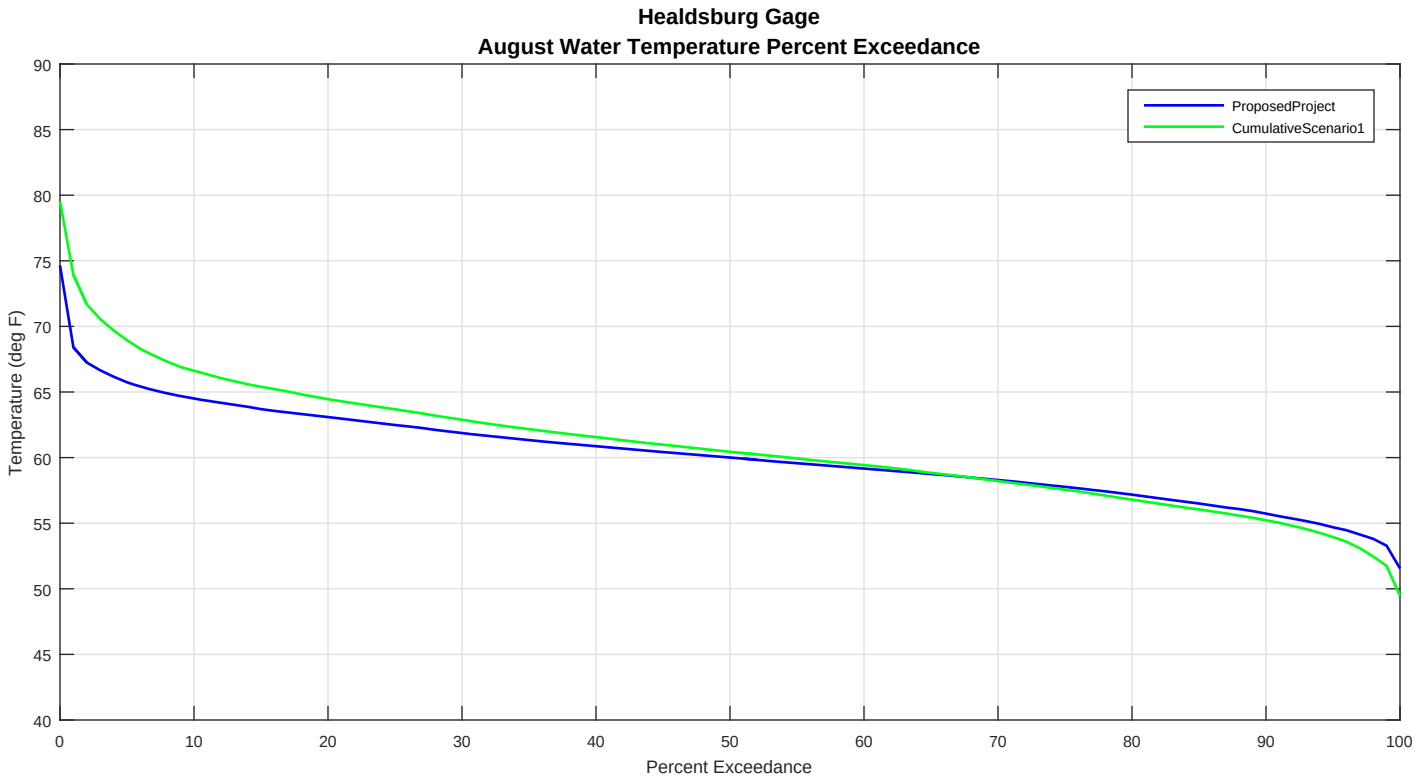
Healdsburg Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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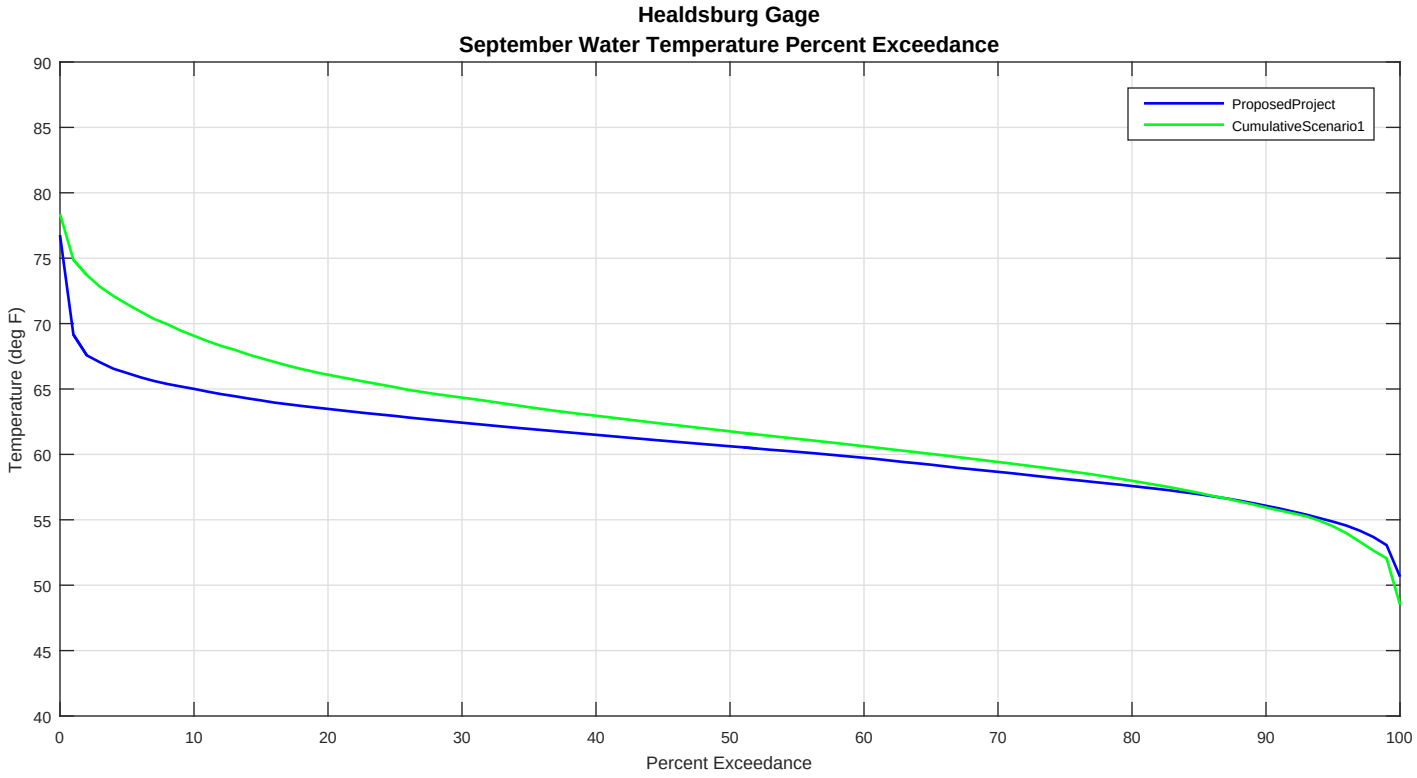
Healdsburg Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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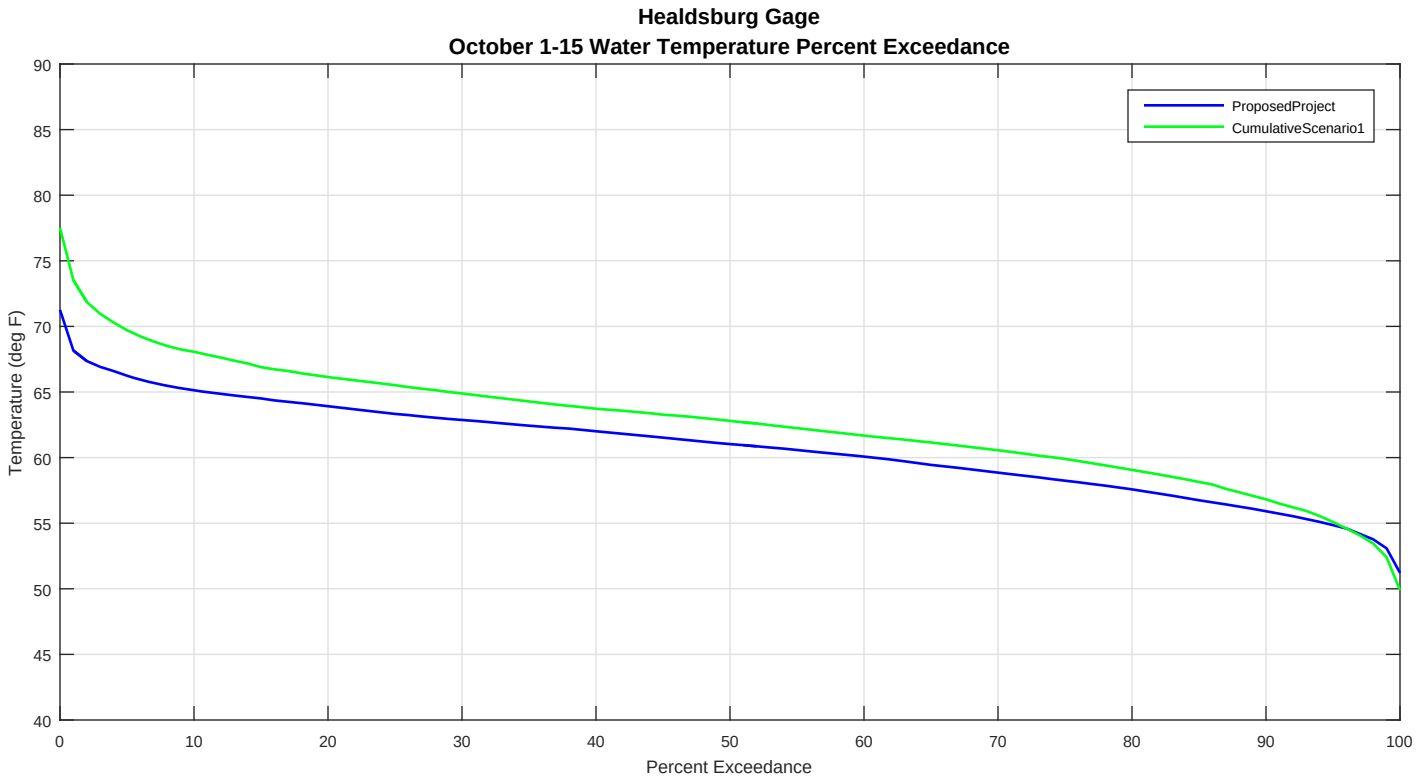
Healdsburg Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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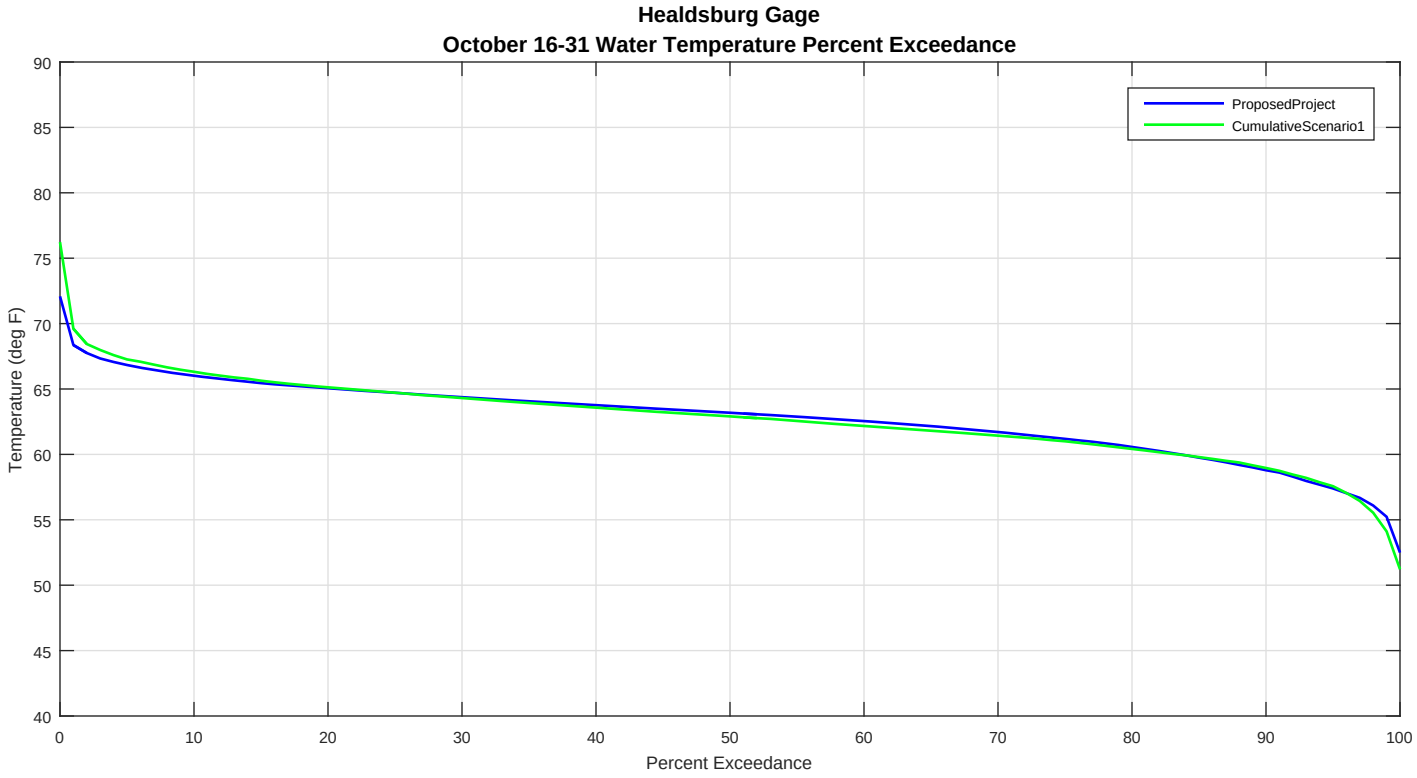
Healdsburg Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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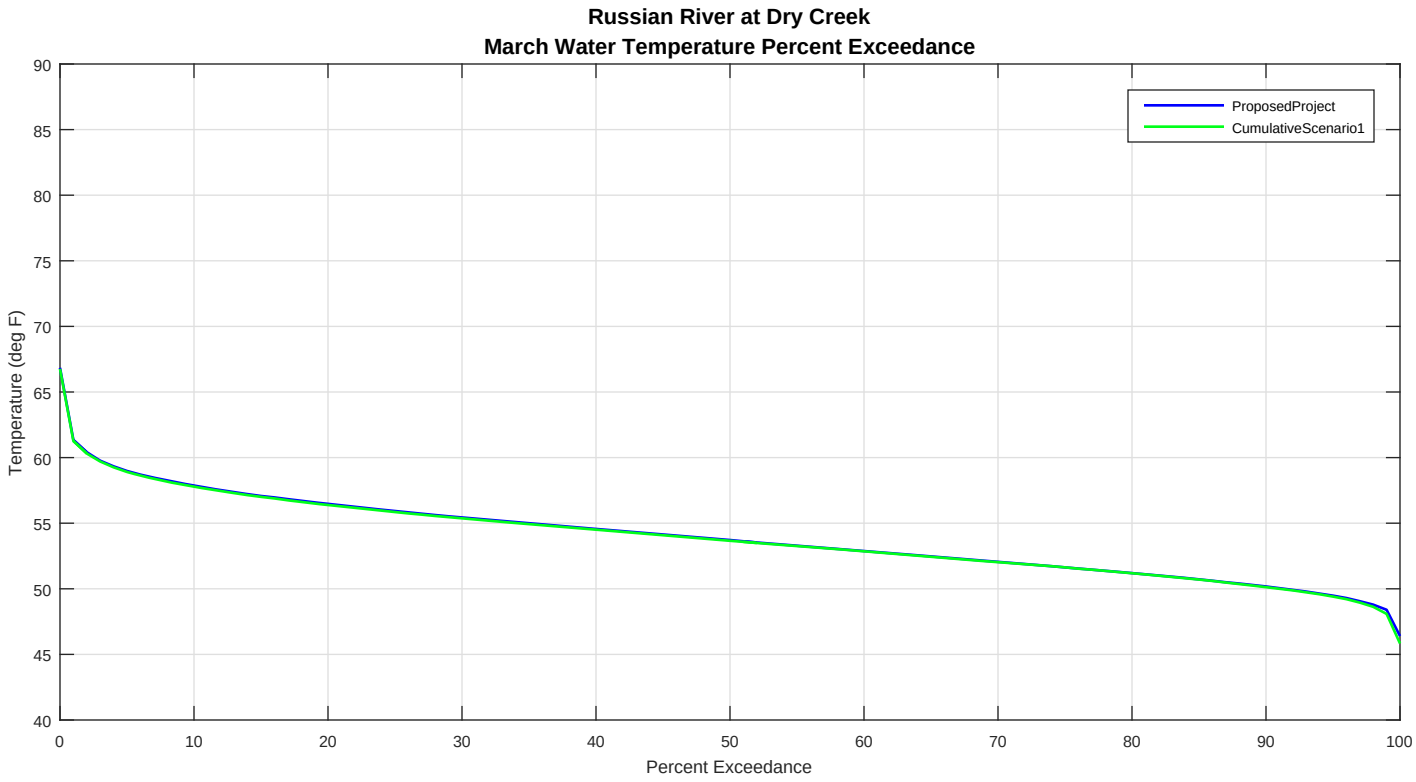
Russian River at Dry Creek
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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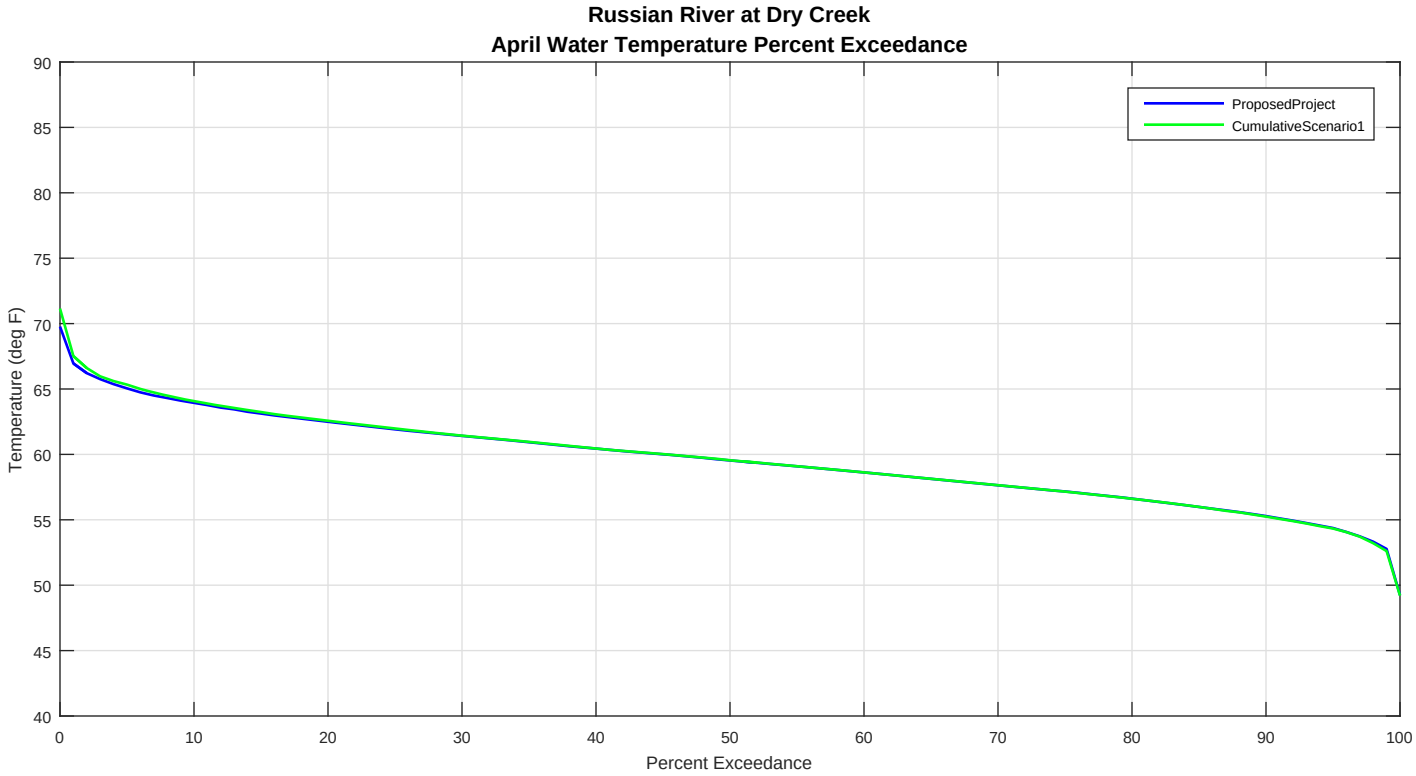
Russian River at Dry Creek
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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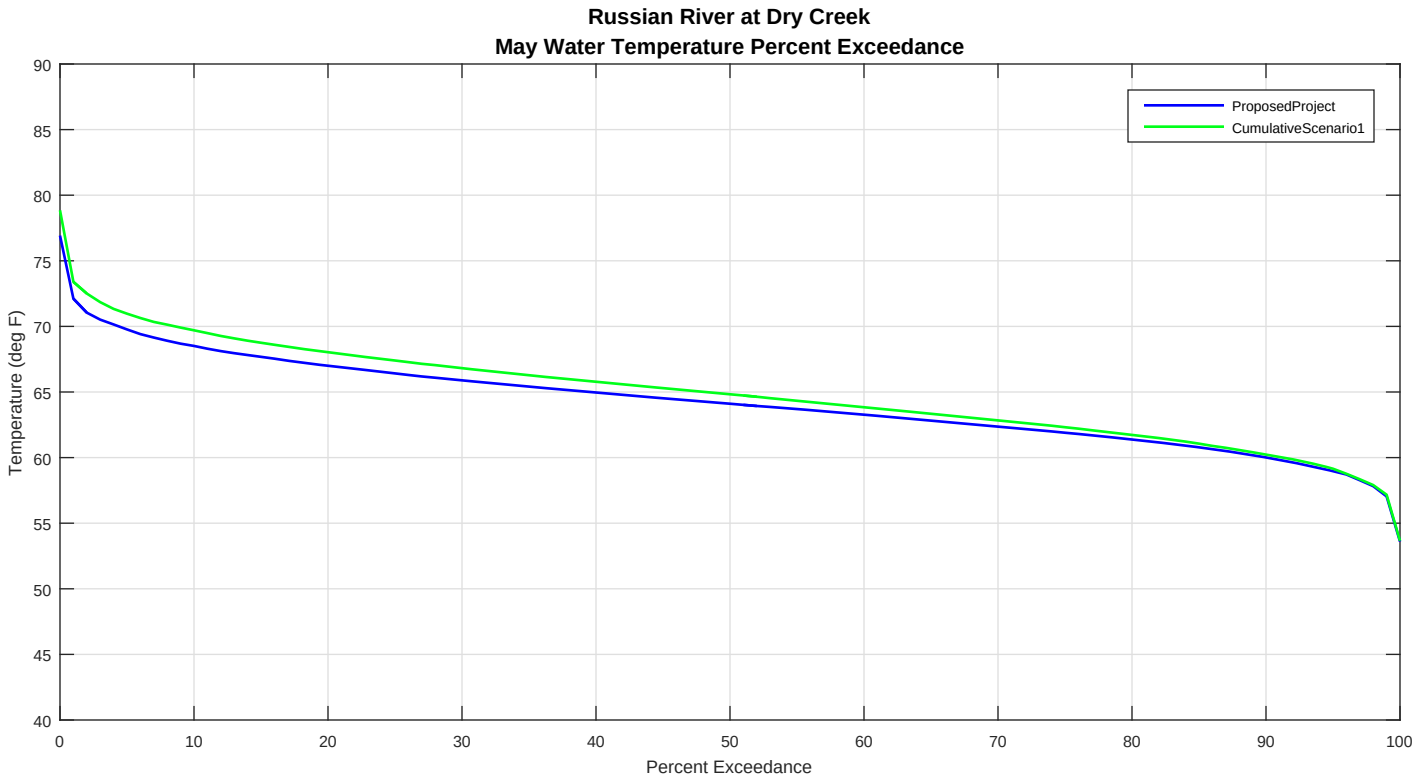
Russian River at Dry Creek
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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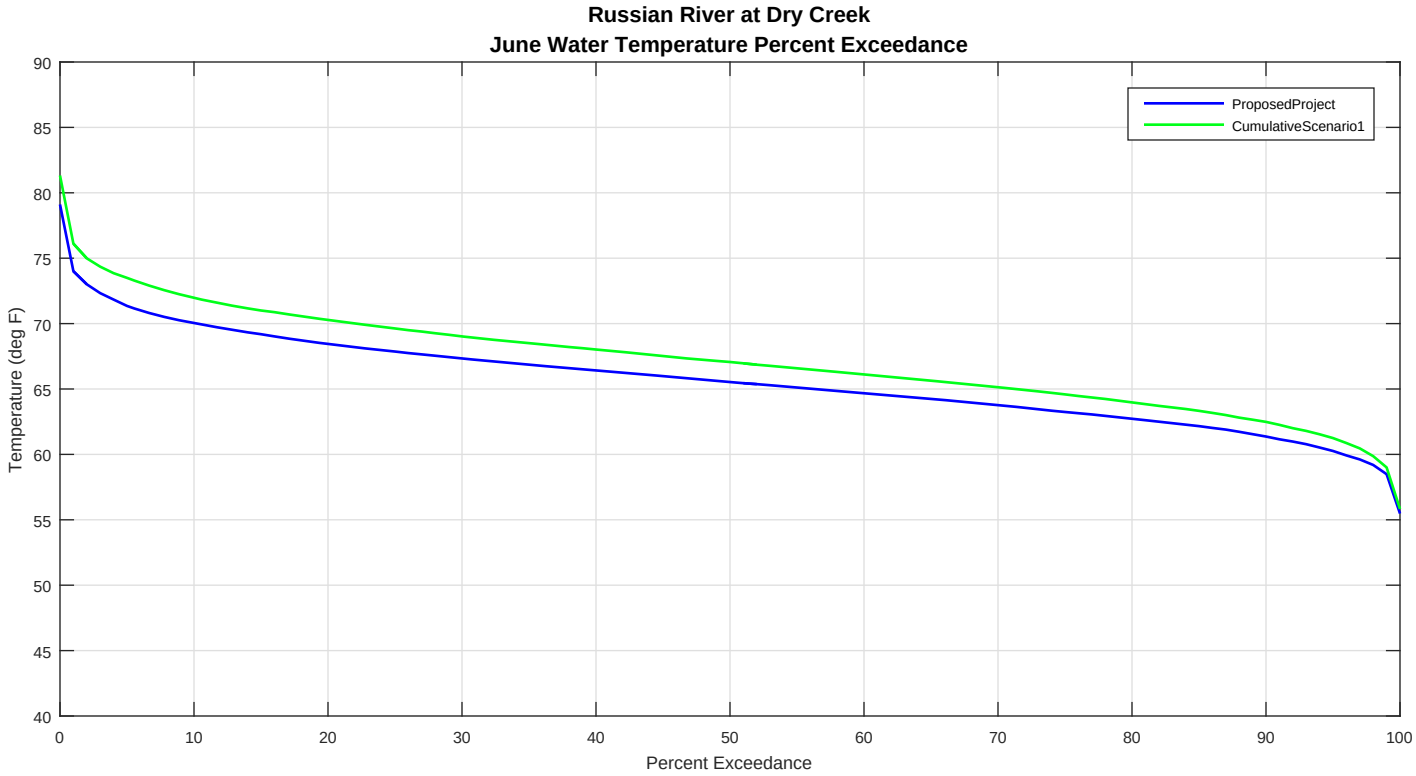
Russian River at Dry Creek
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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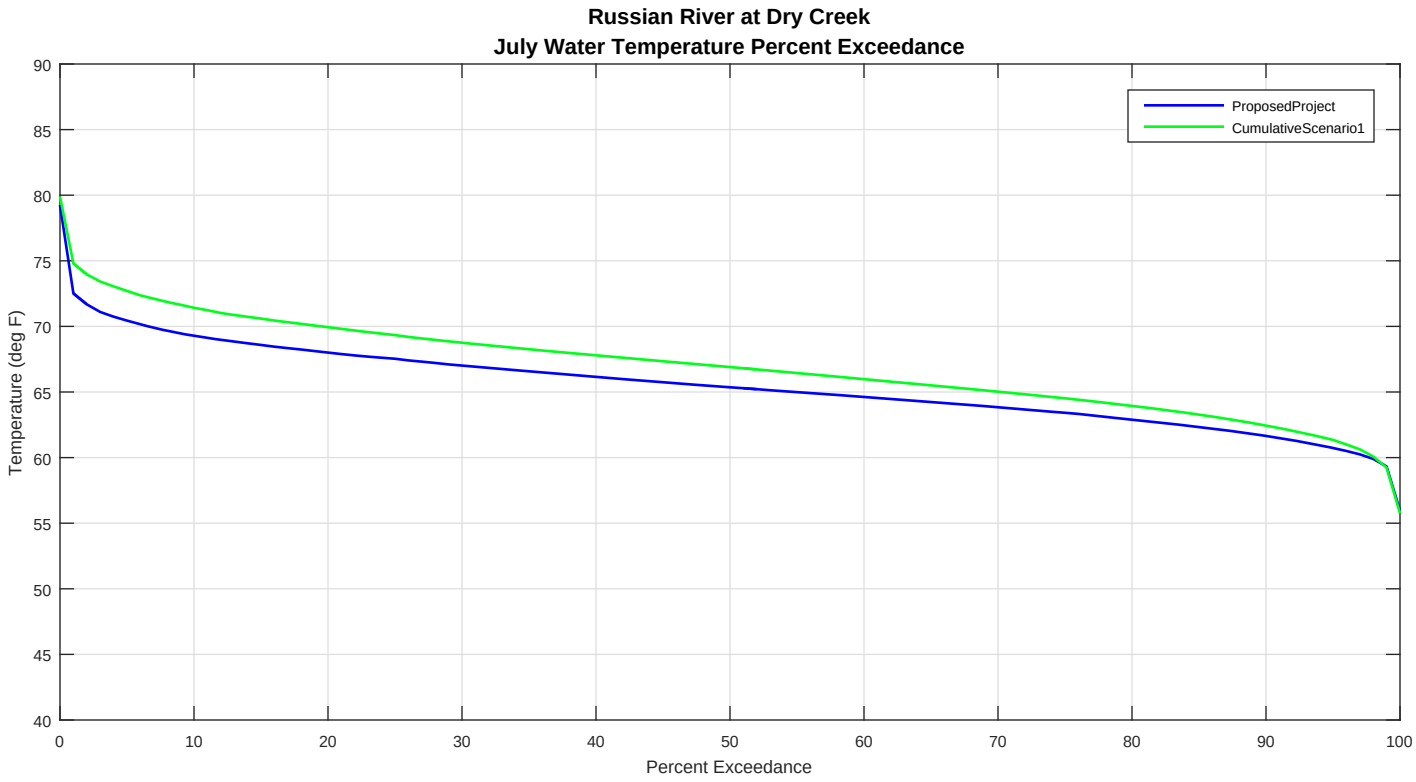
Russian River at Dry Creek
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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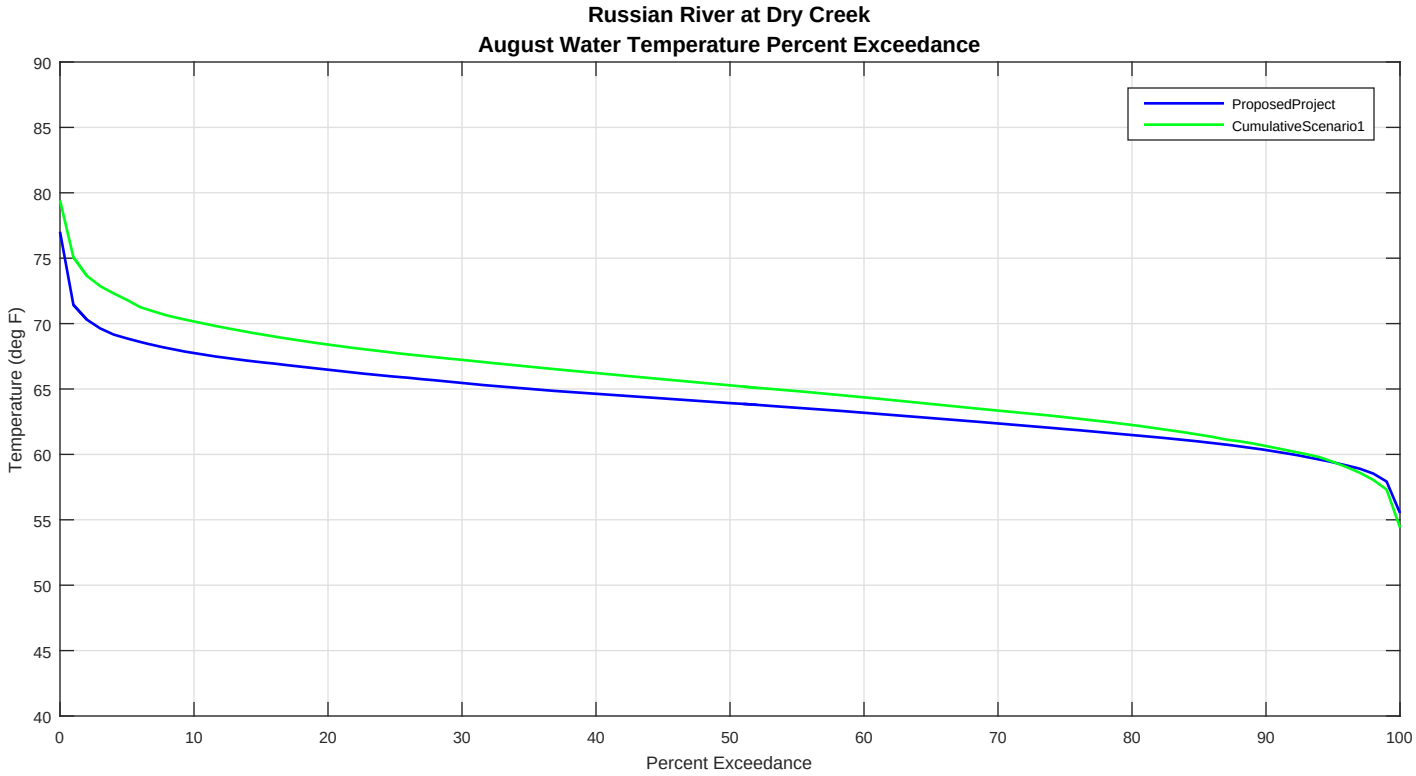
Russian River at Dry Creek
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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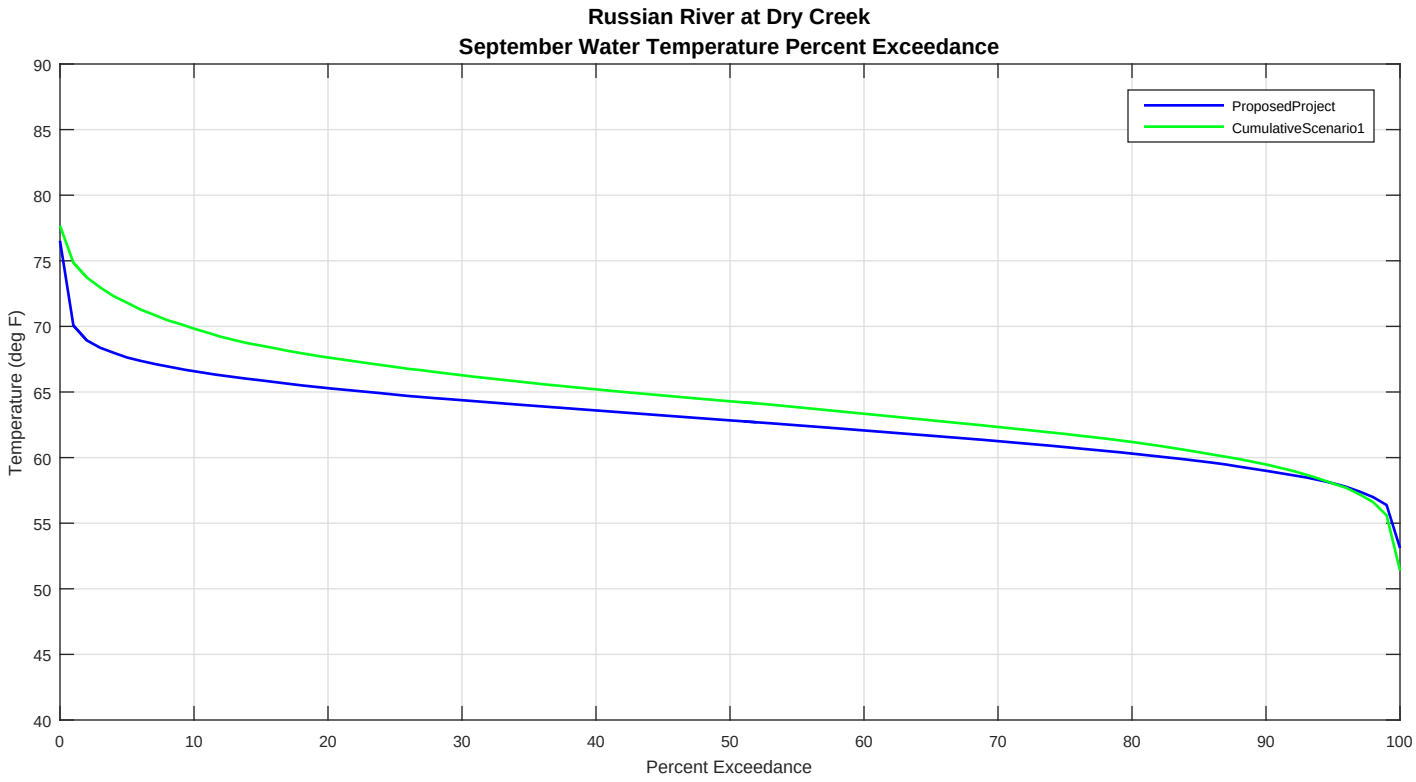
Russian River at Dry Creek
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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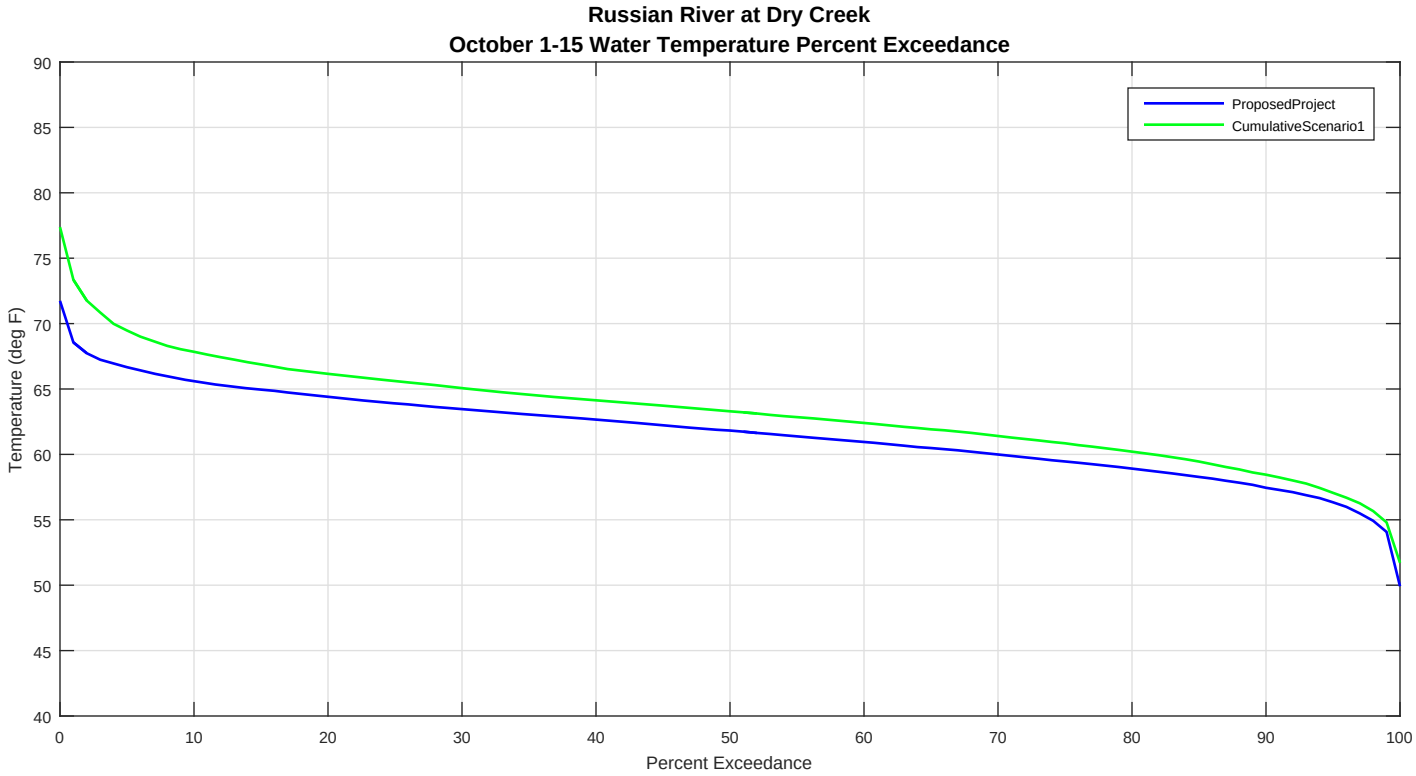
Russian River at Dry Creek
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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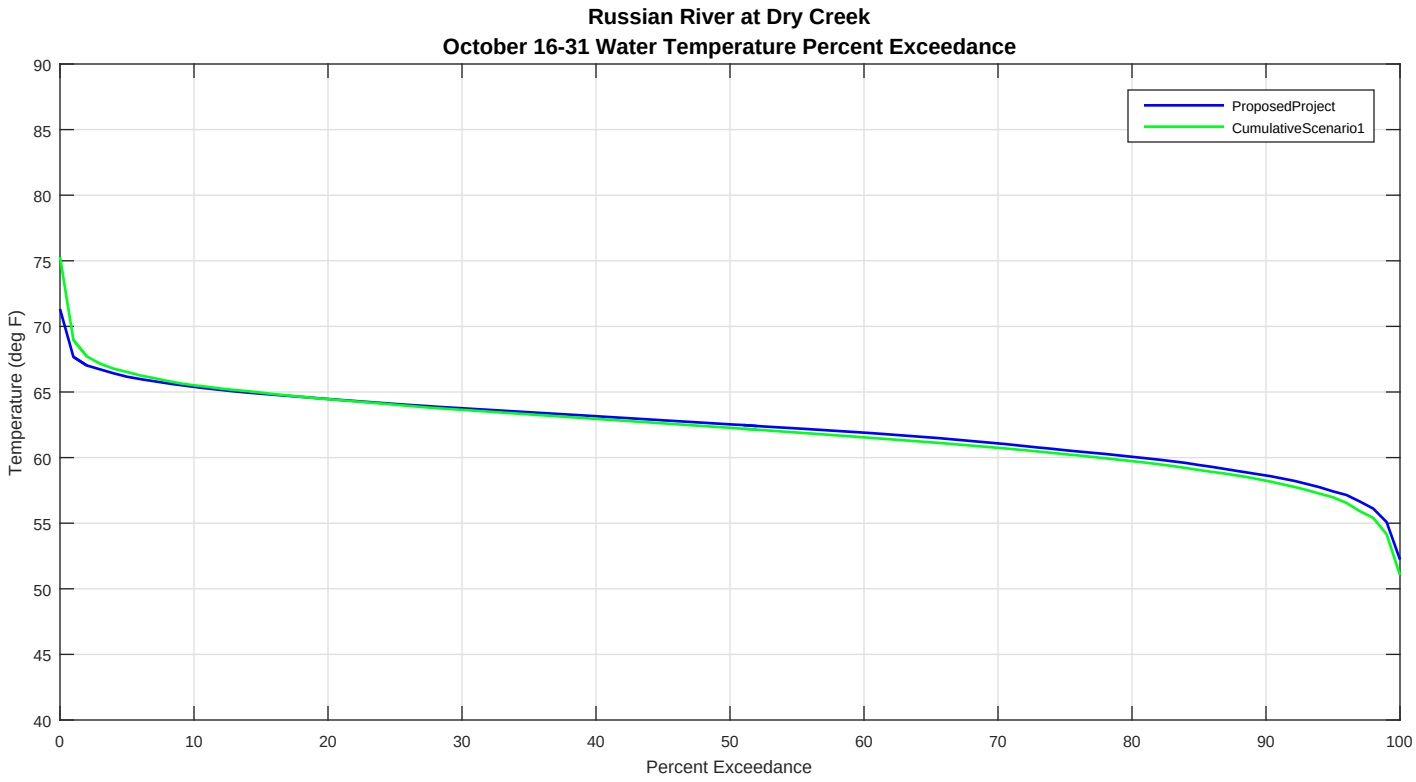
Russian River at Dry Creek
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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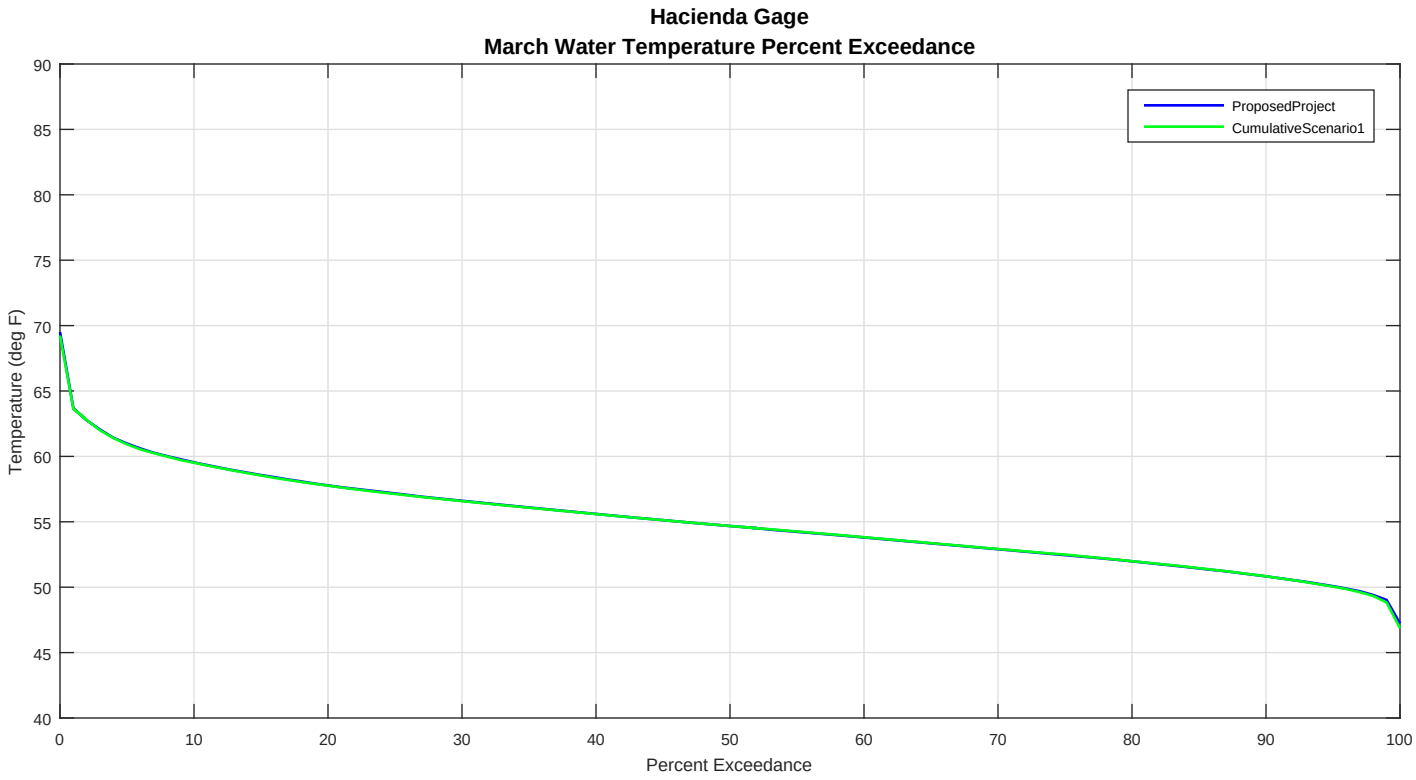
Hacienda Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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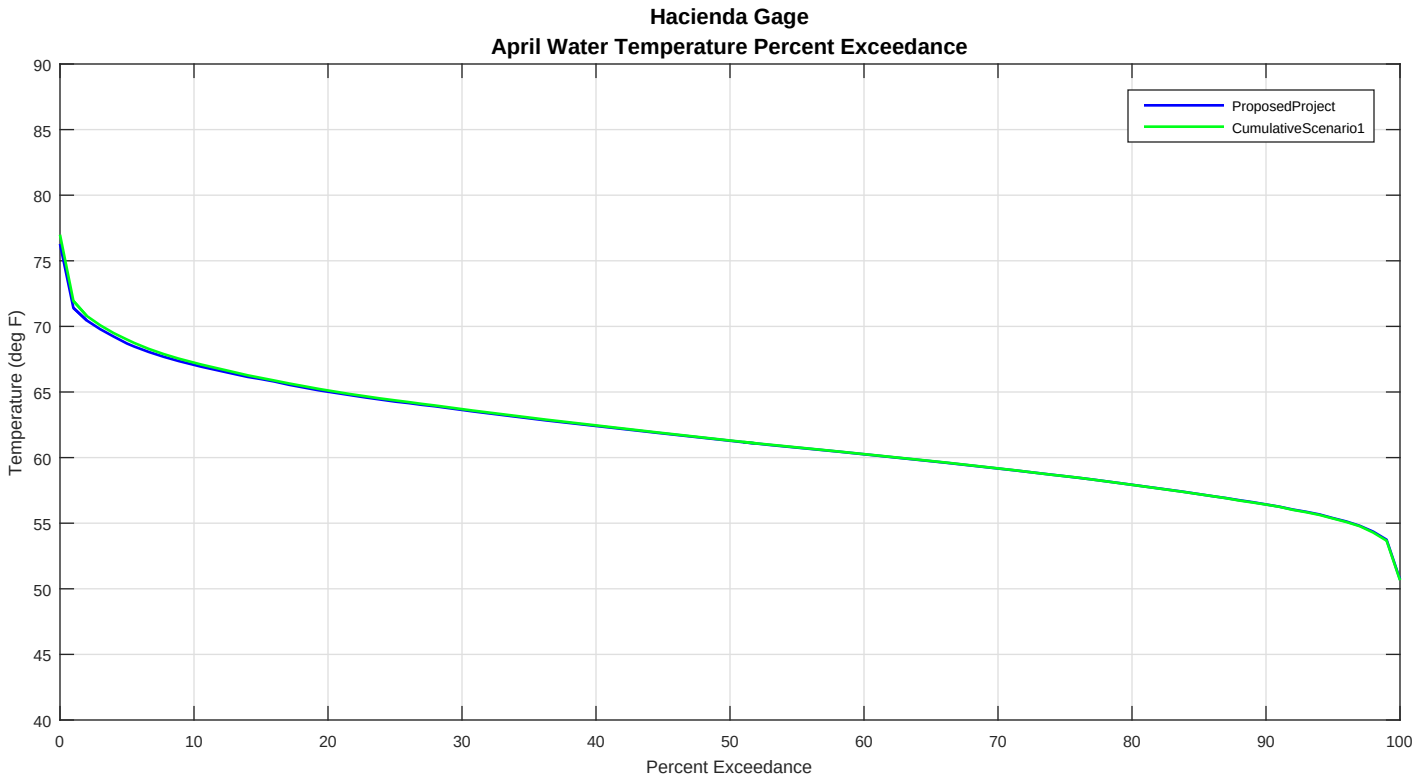
Hacienda Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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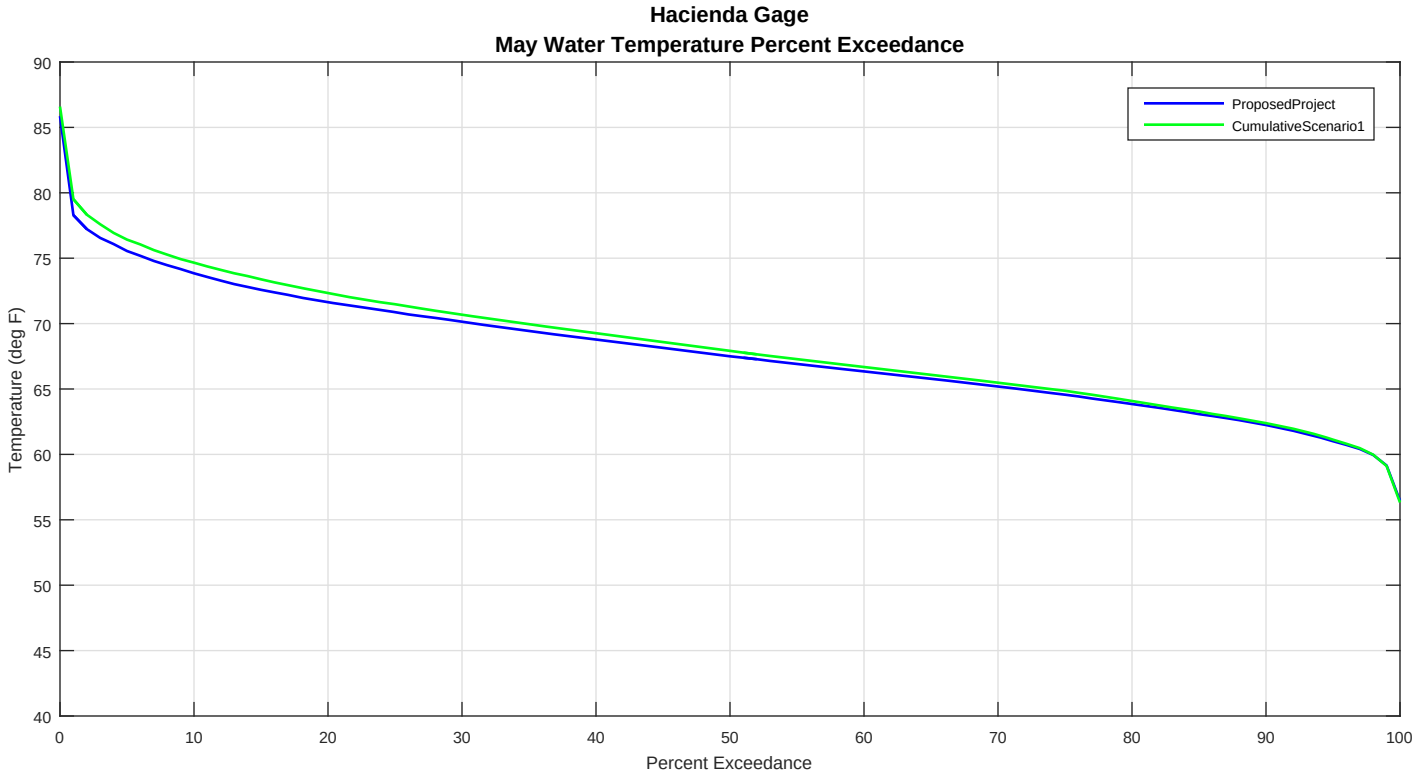
Hacienda Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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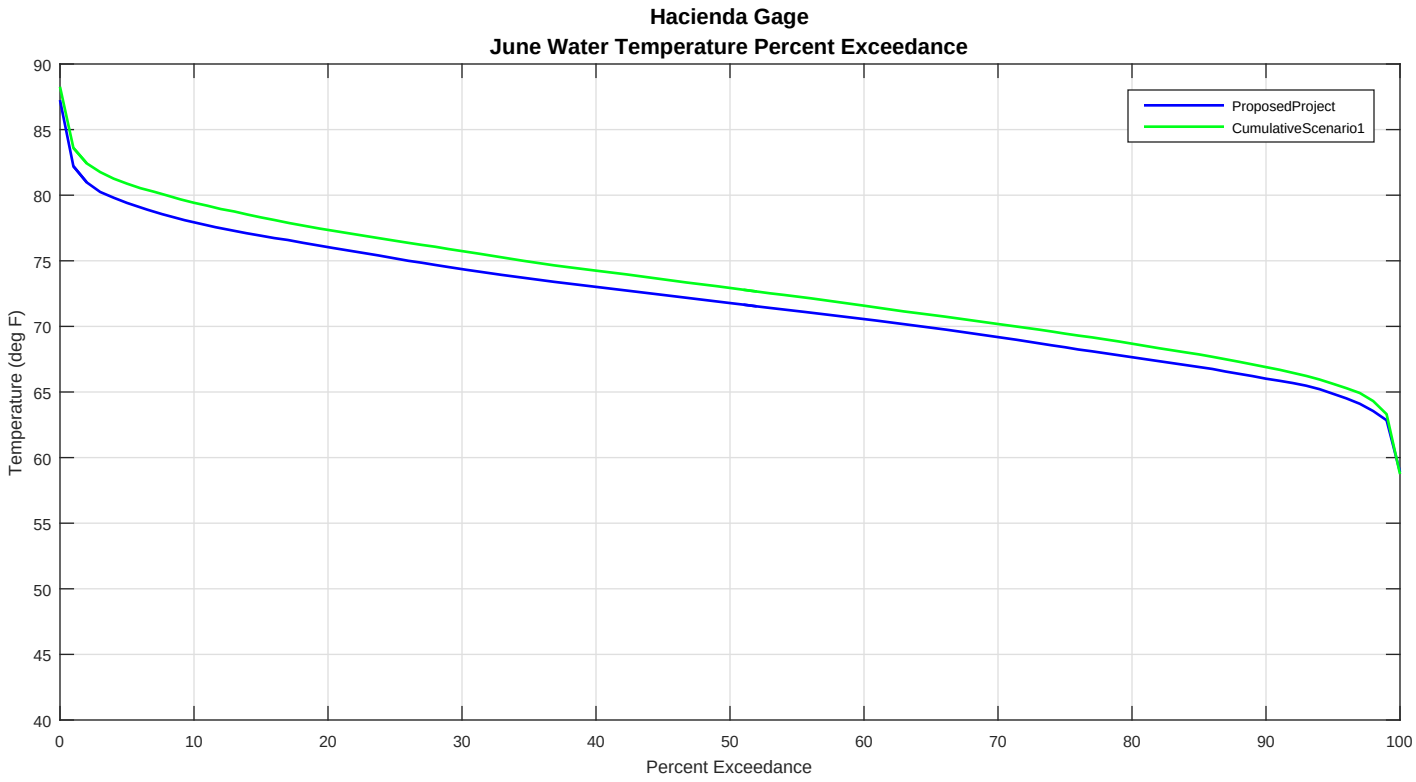
Hacienda Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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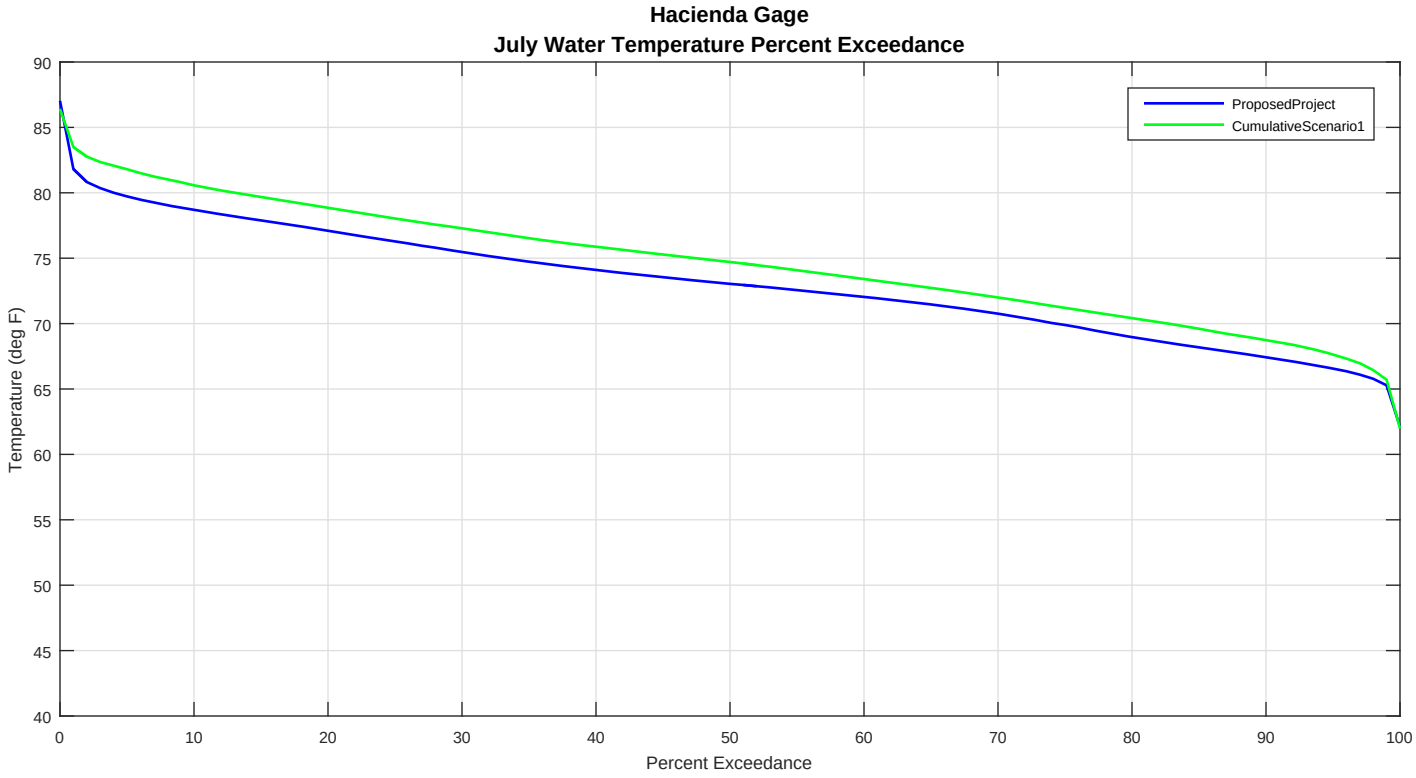
Hacienda Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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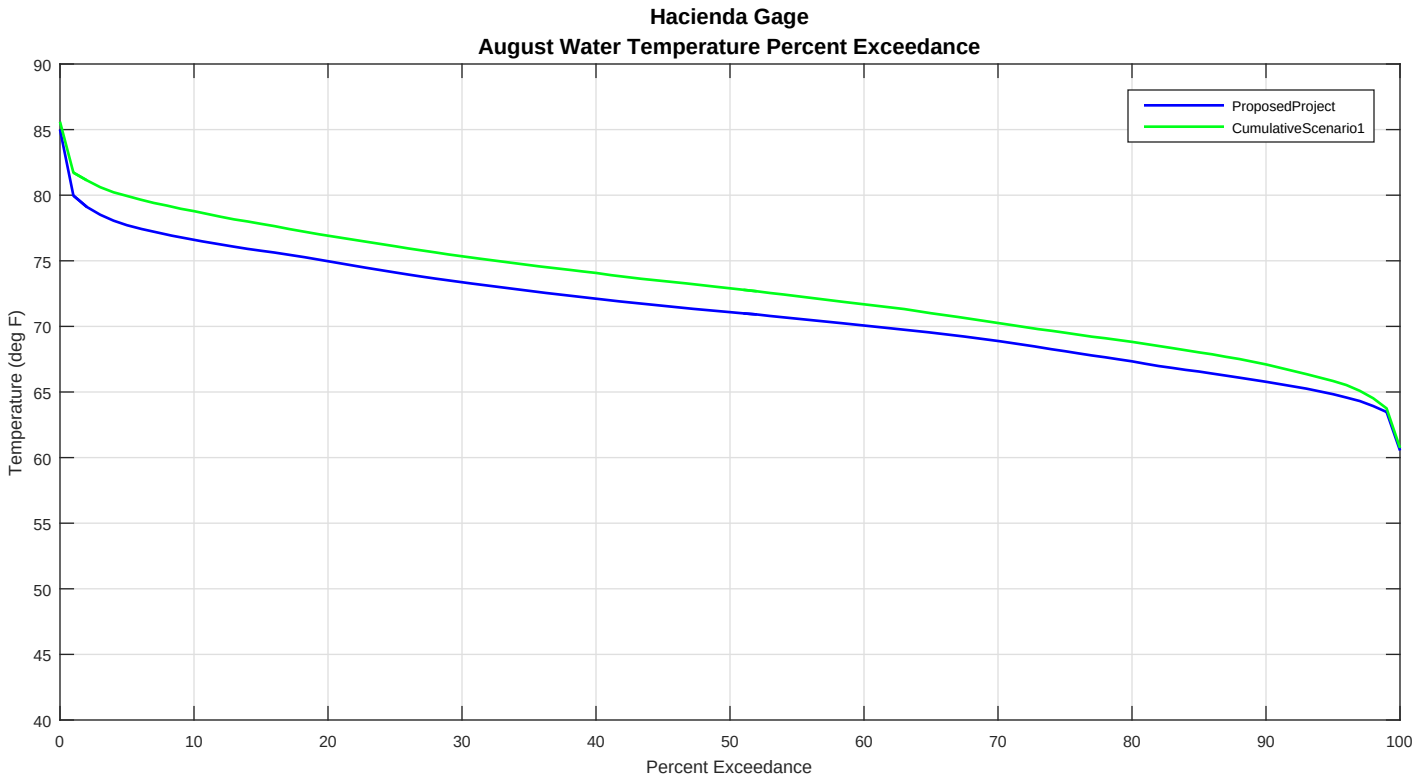
Hacienda Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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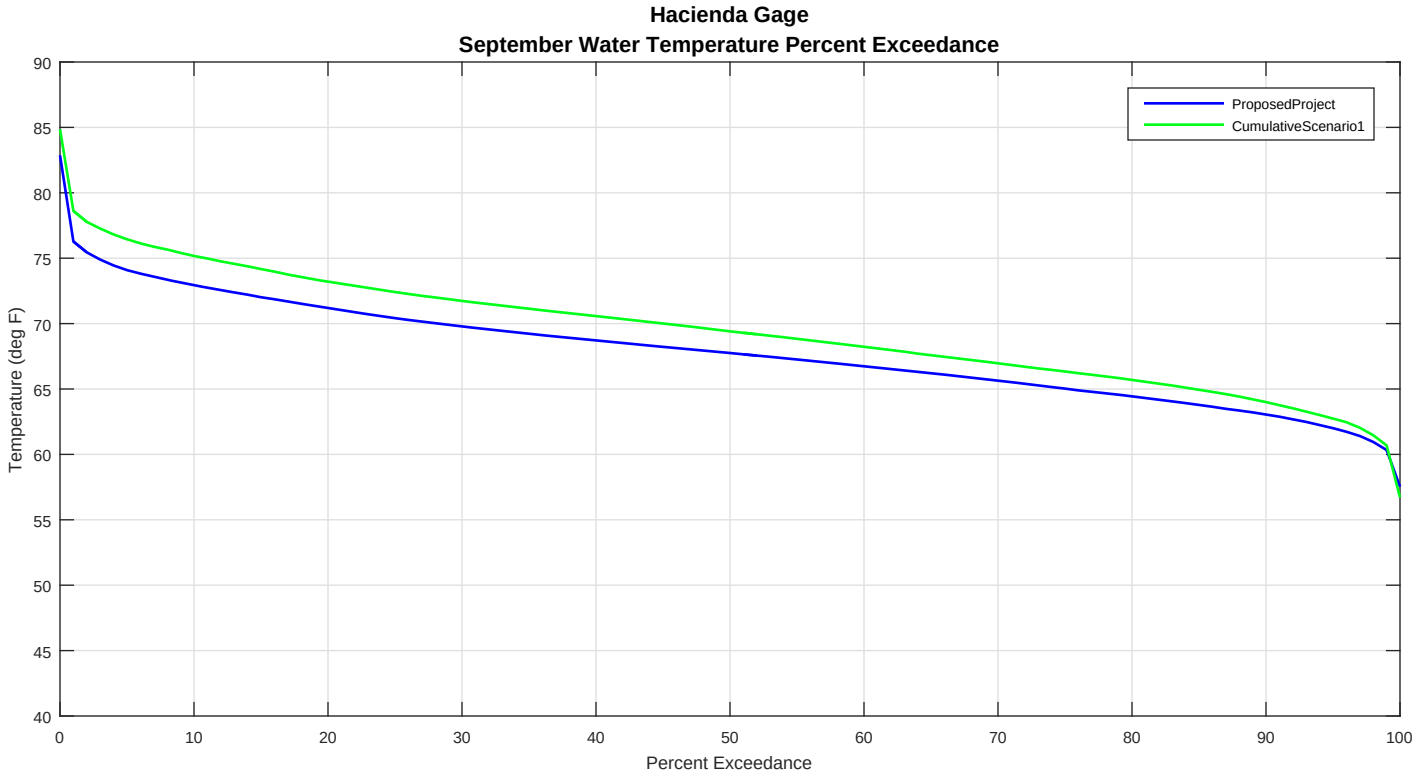
Hacienda Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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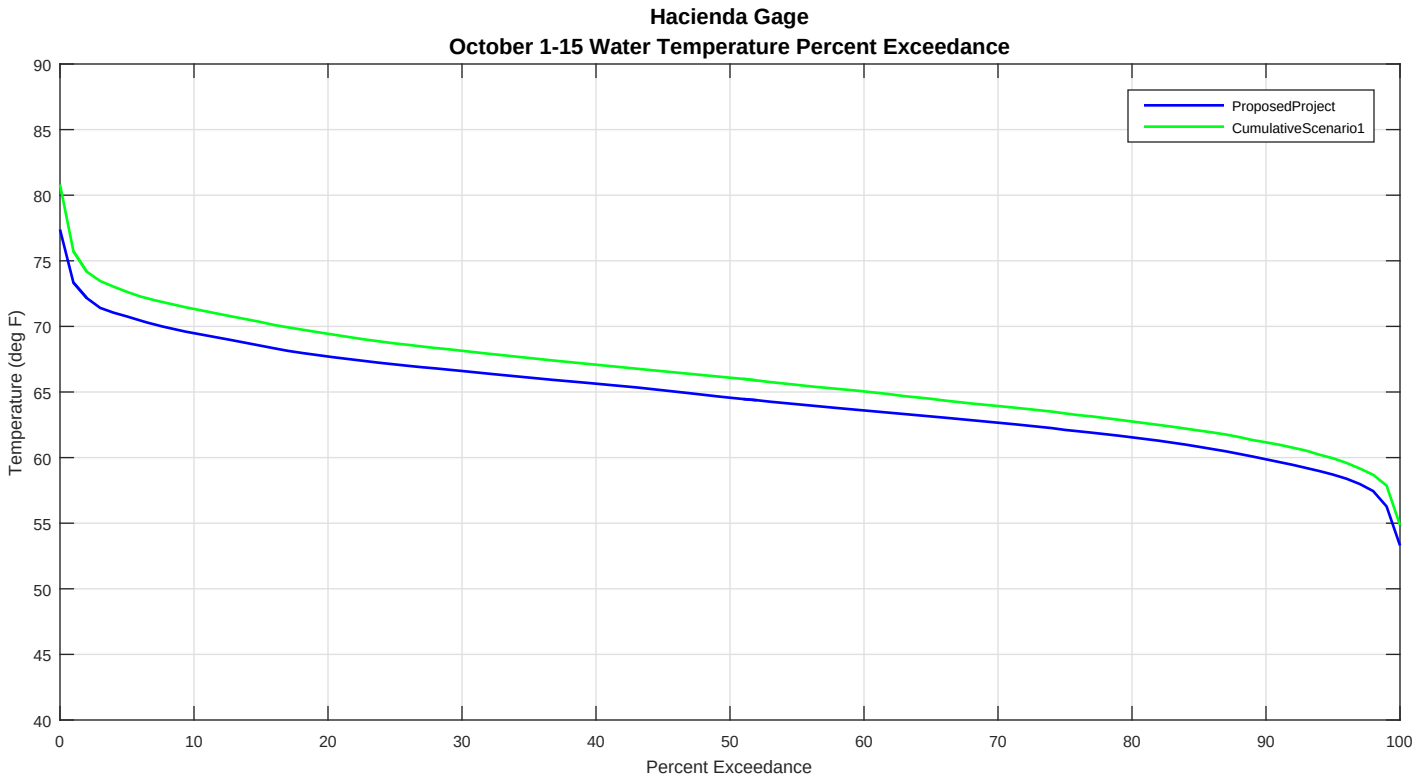
Hacienda Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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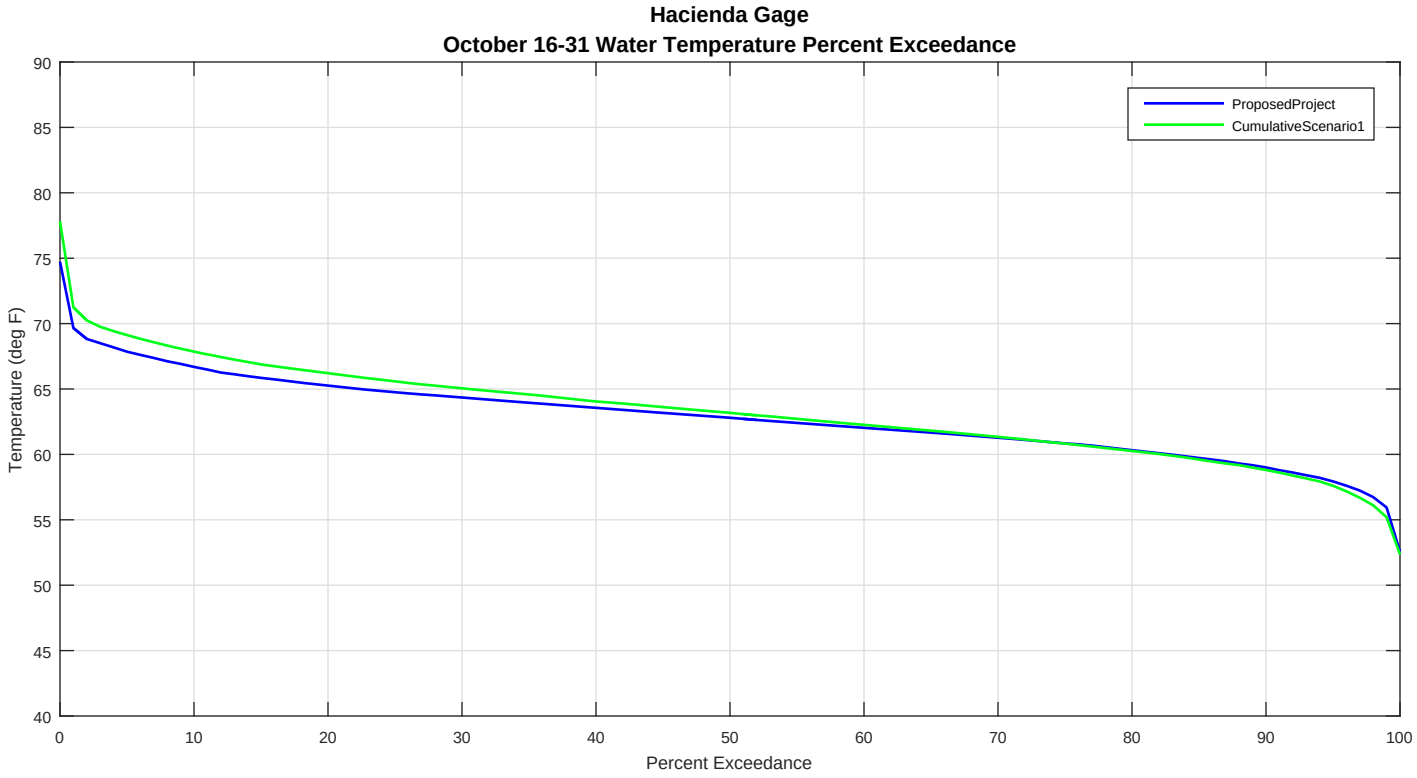
Hacienda Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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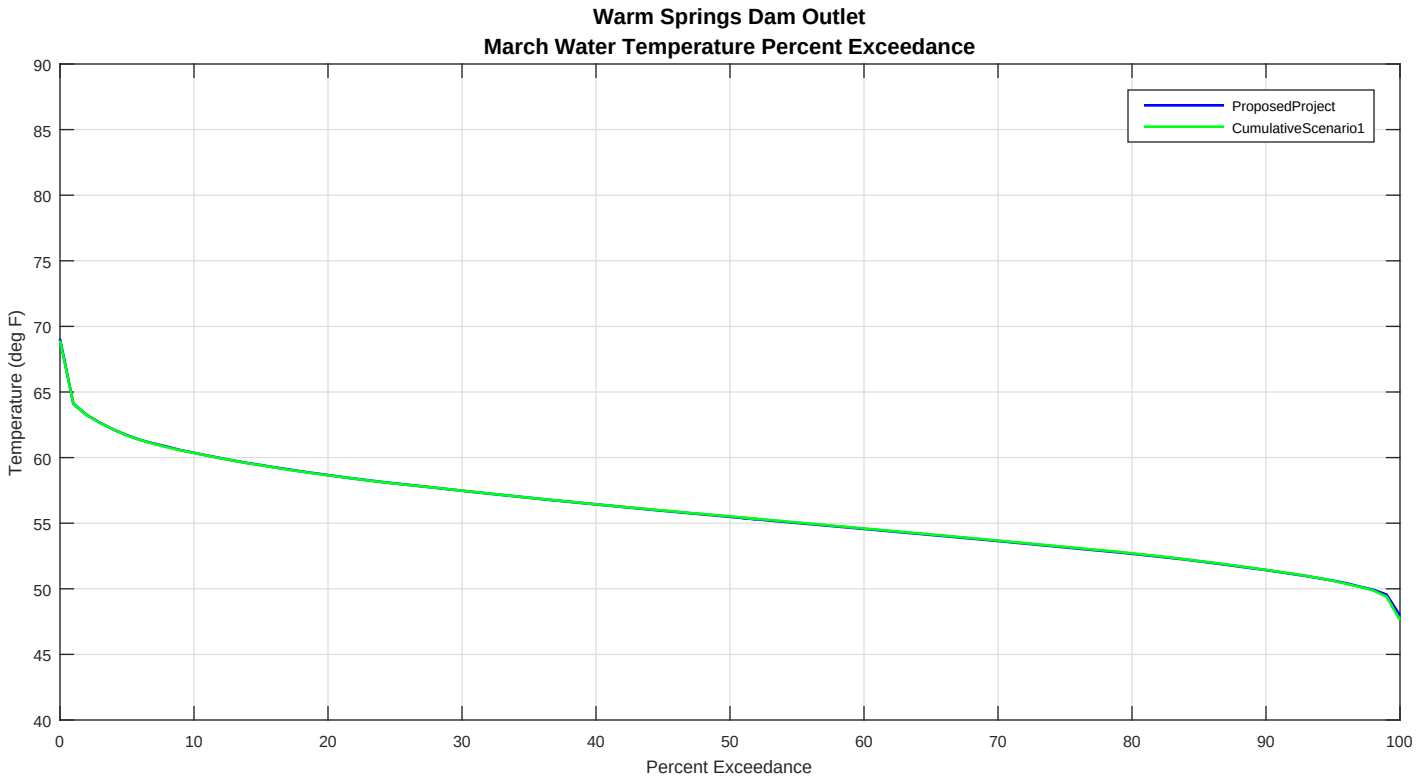
Warm Springs Dam Outlet
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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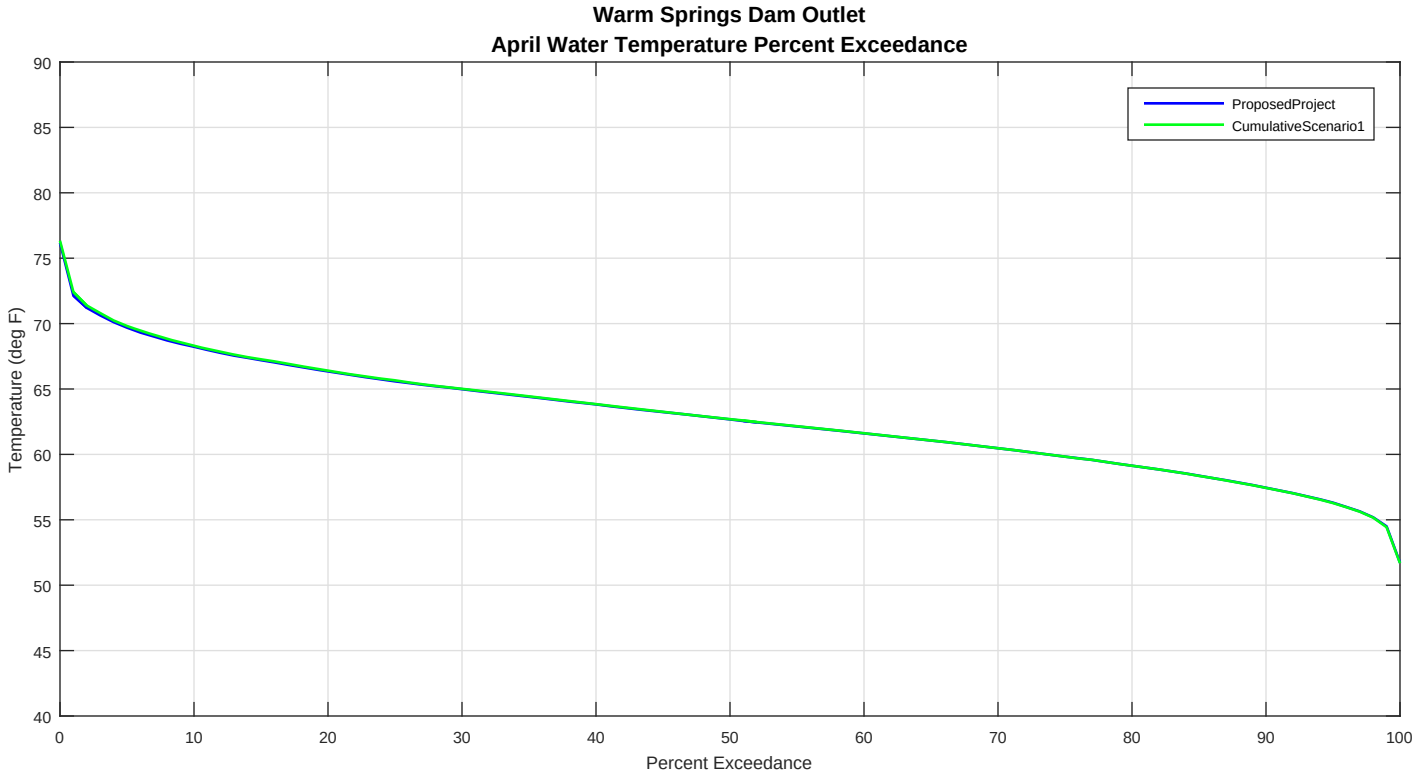
Warm Springs Dam Outlet
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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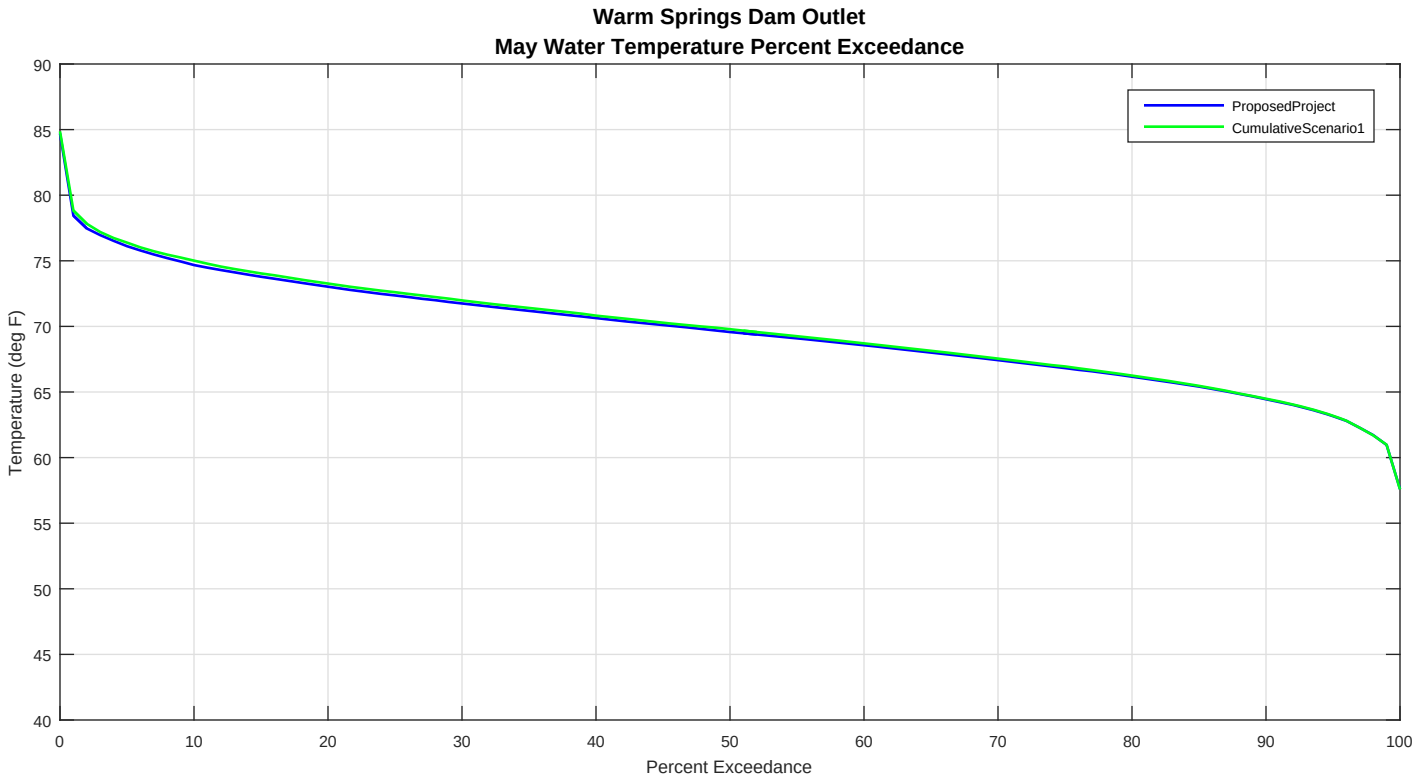
Warm Springs Dam Outlet
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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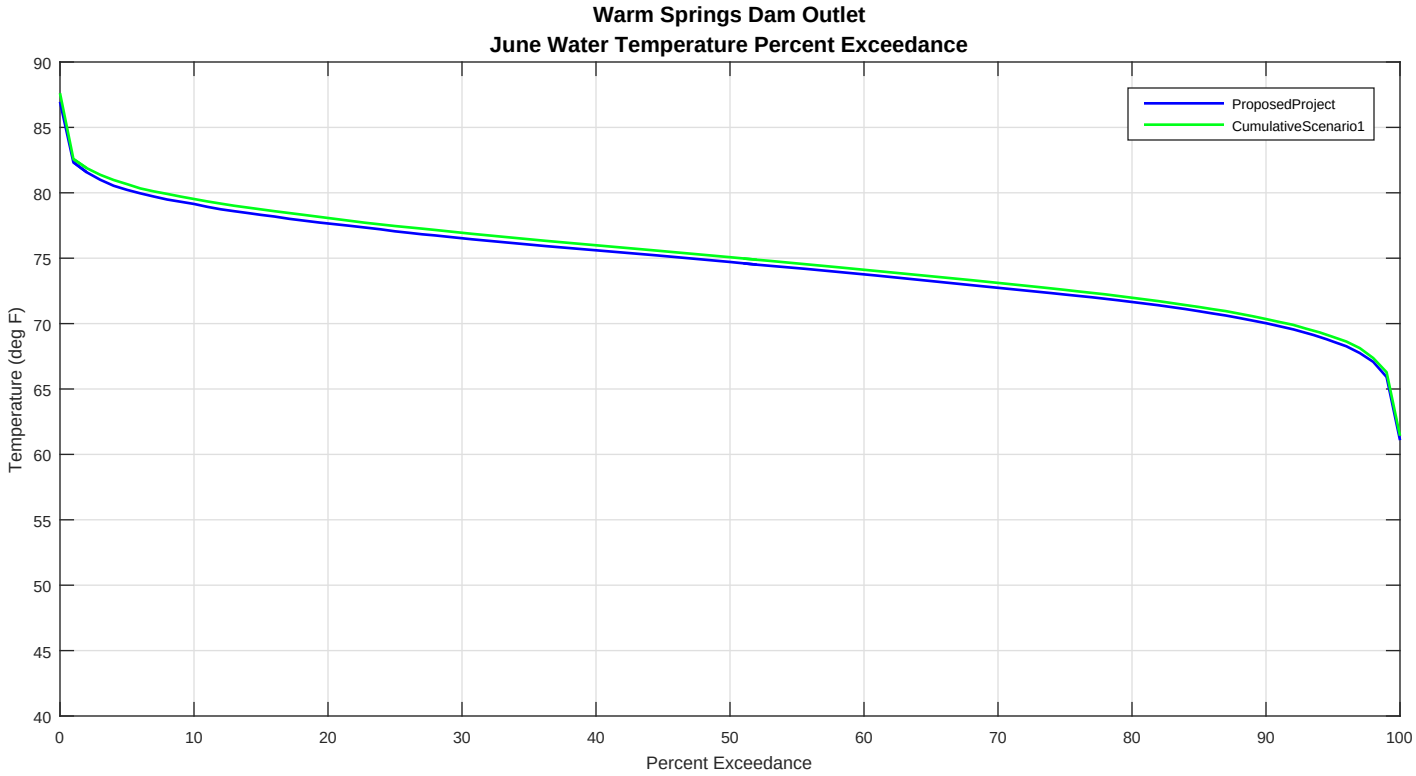
Warm Springs Dam Outlet
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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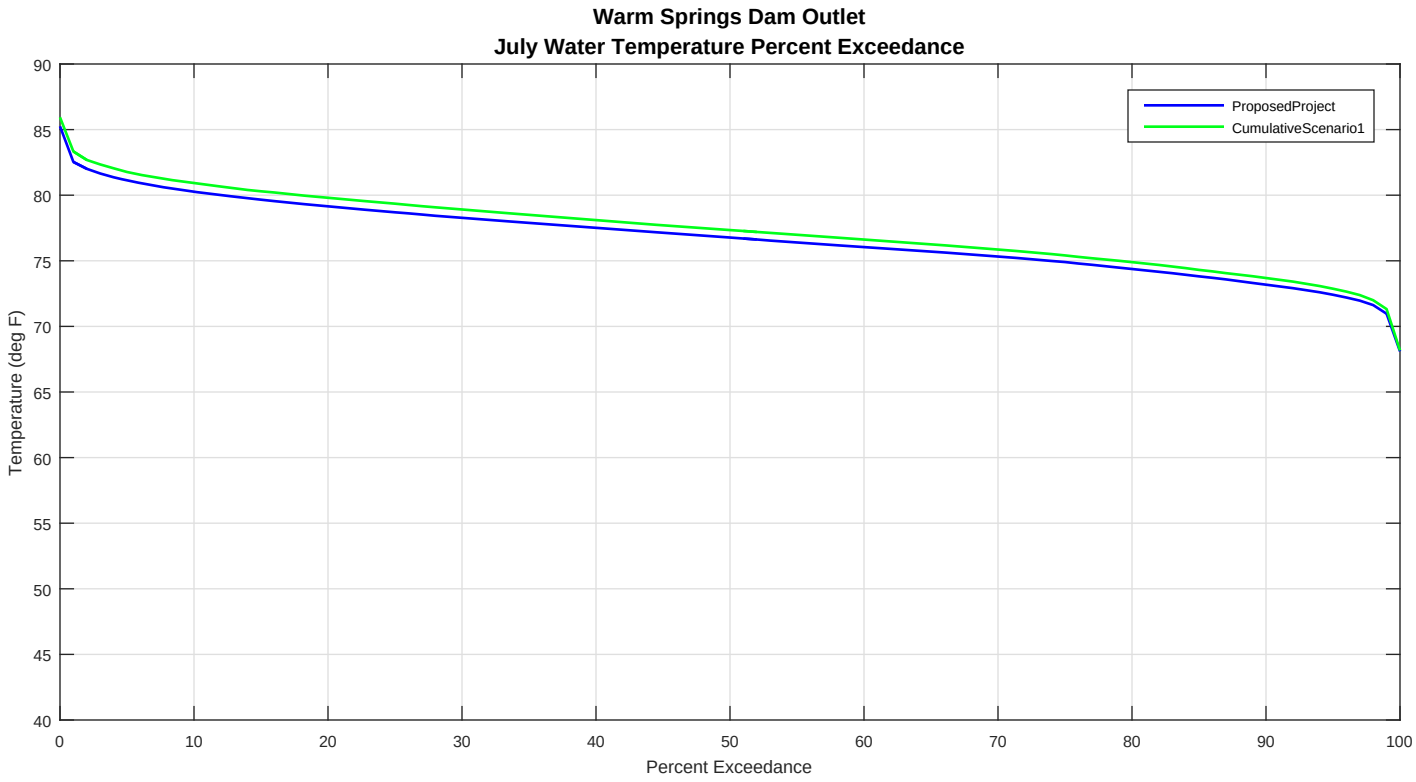
Warm Springs Dam Outlet
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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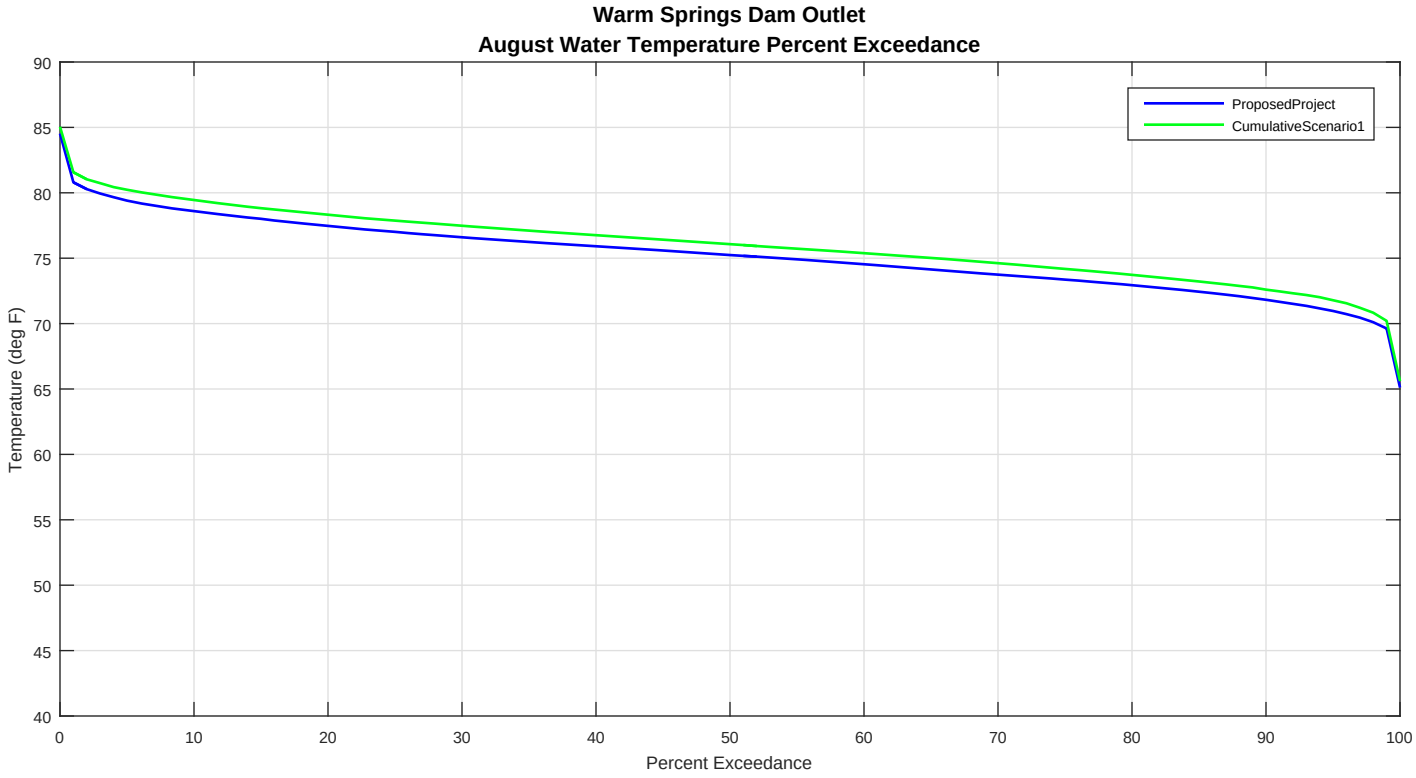
Warm Springs Dam Outlet
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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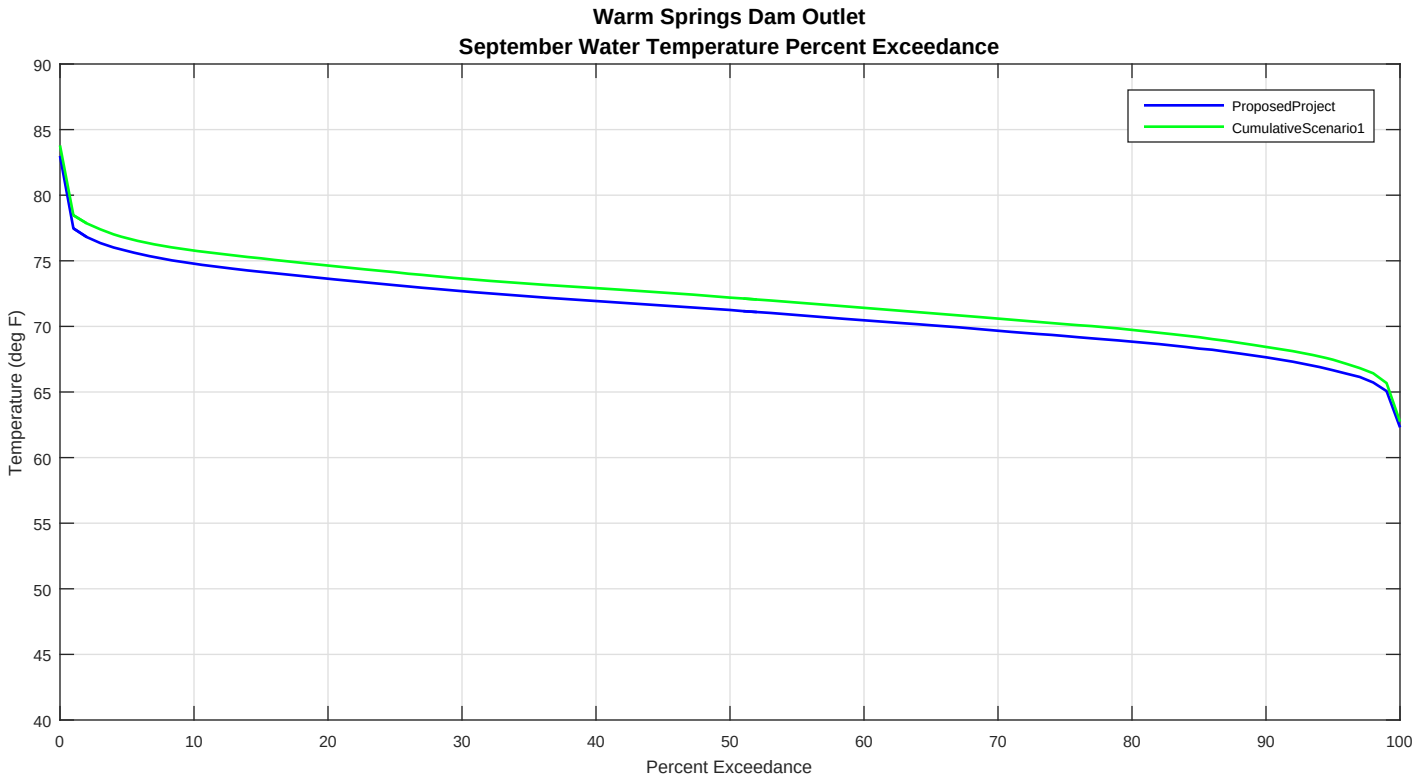
Warm Springs Dam Outlet
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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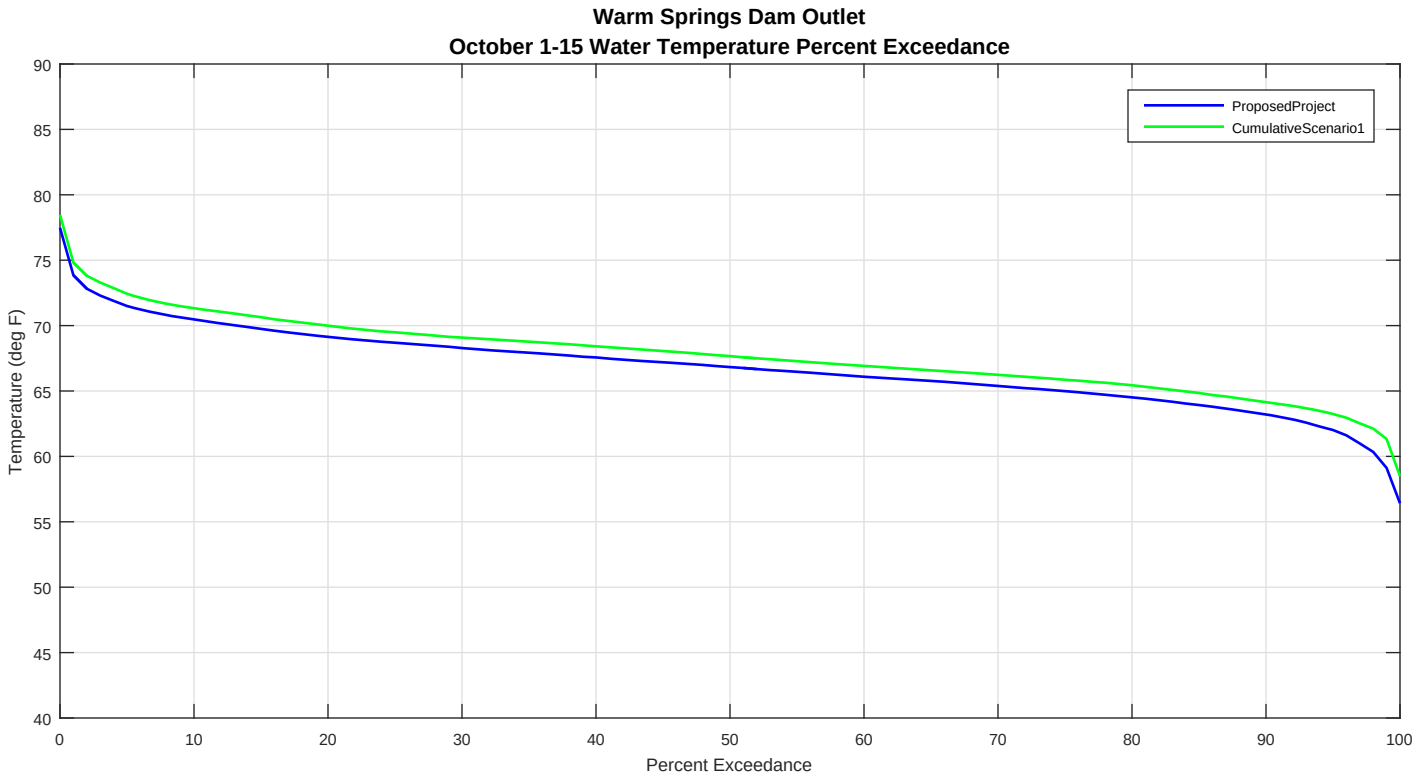
Warm Springs Dam Outlet
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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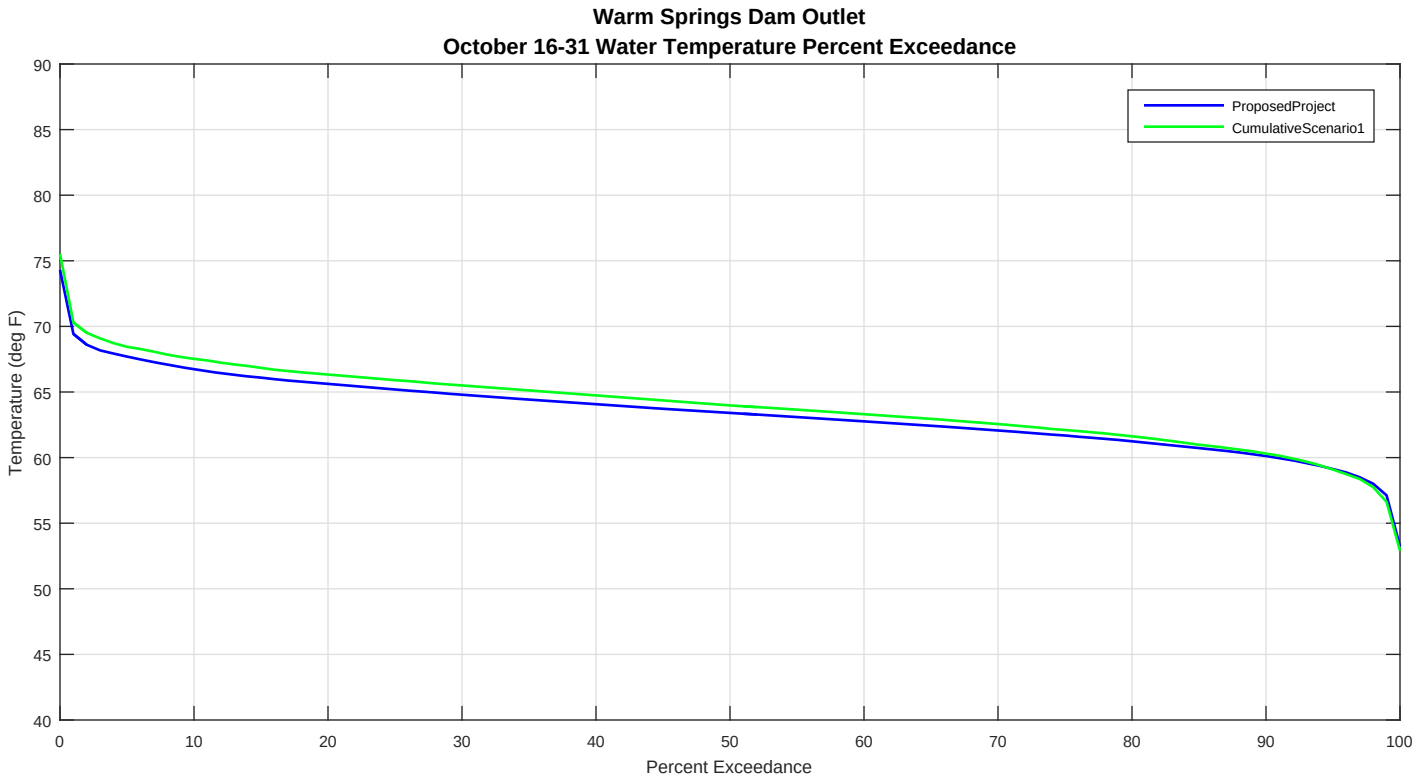
Warm Springs Dam Outlet
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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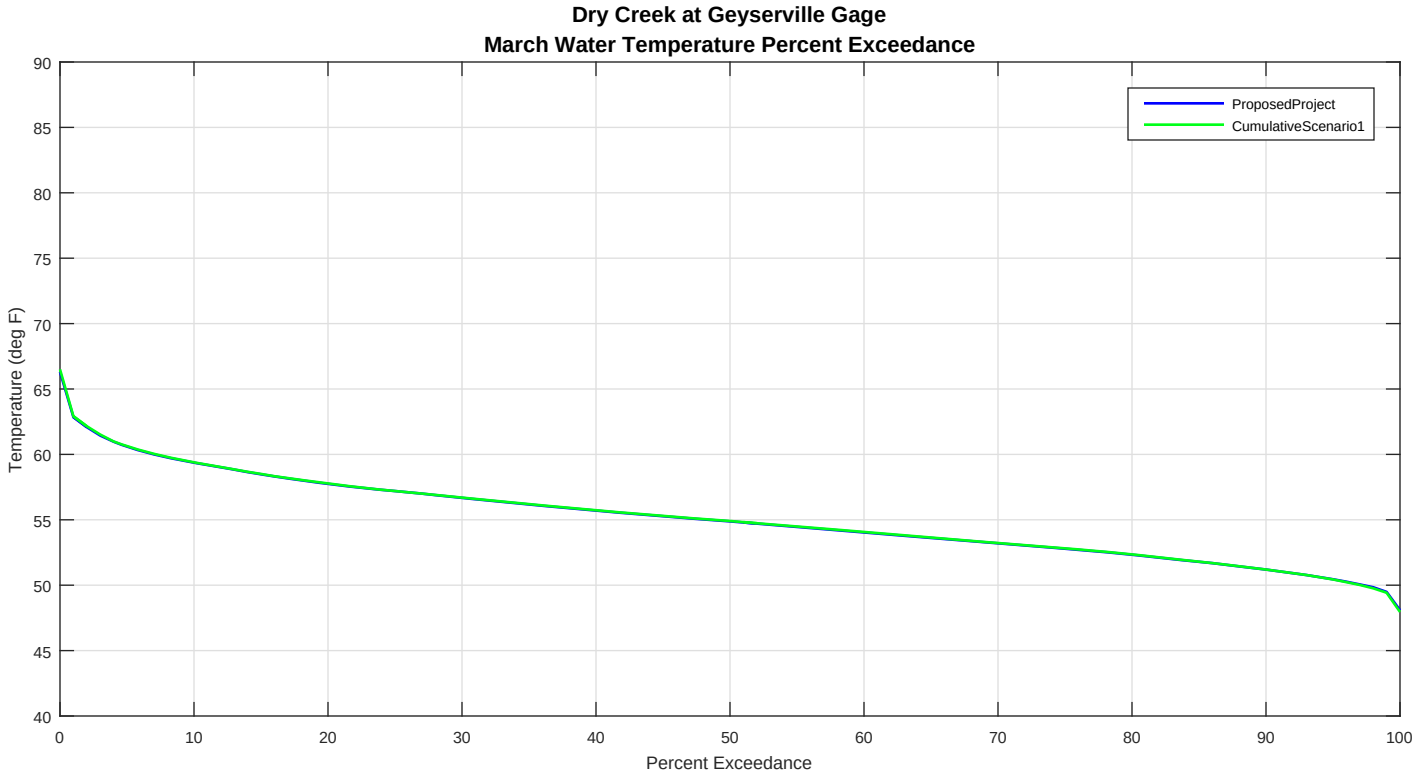
Dry Creek at Geyserville Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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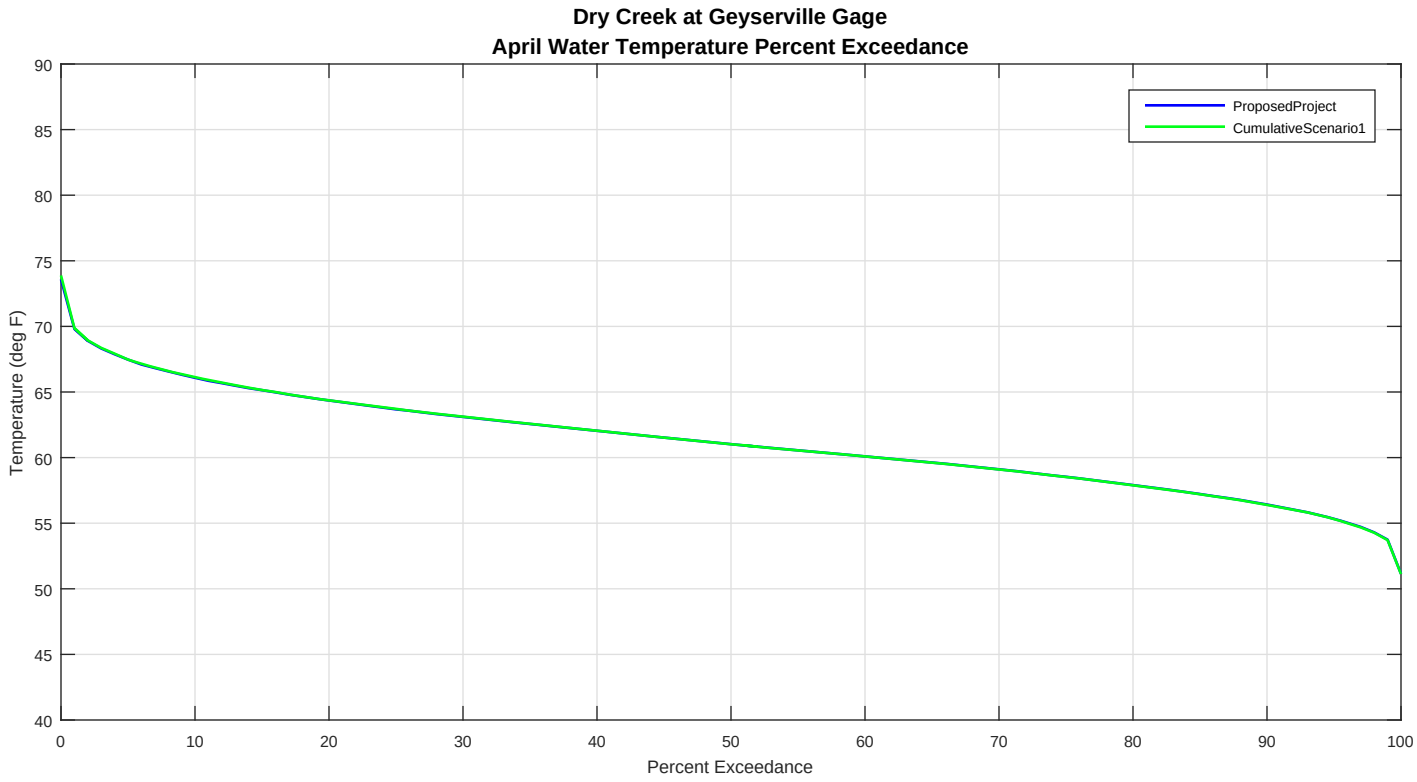
Dry Creek at Geyserville Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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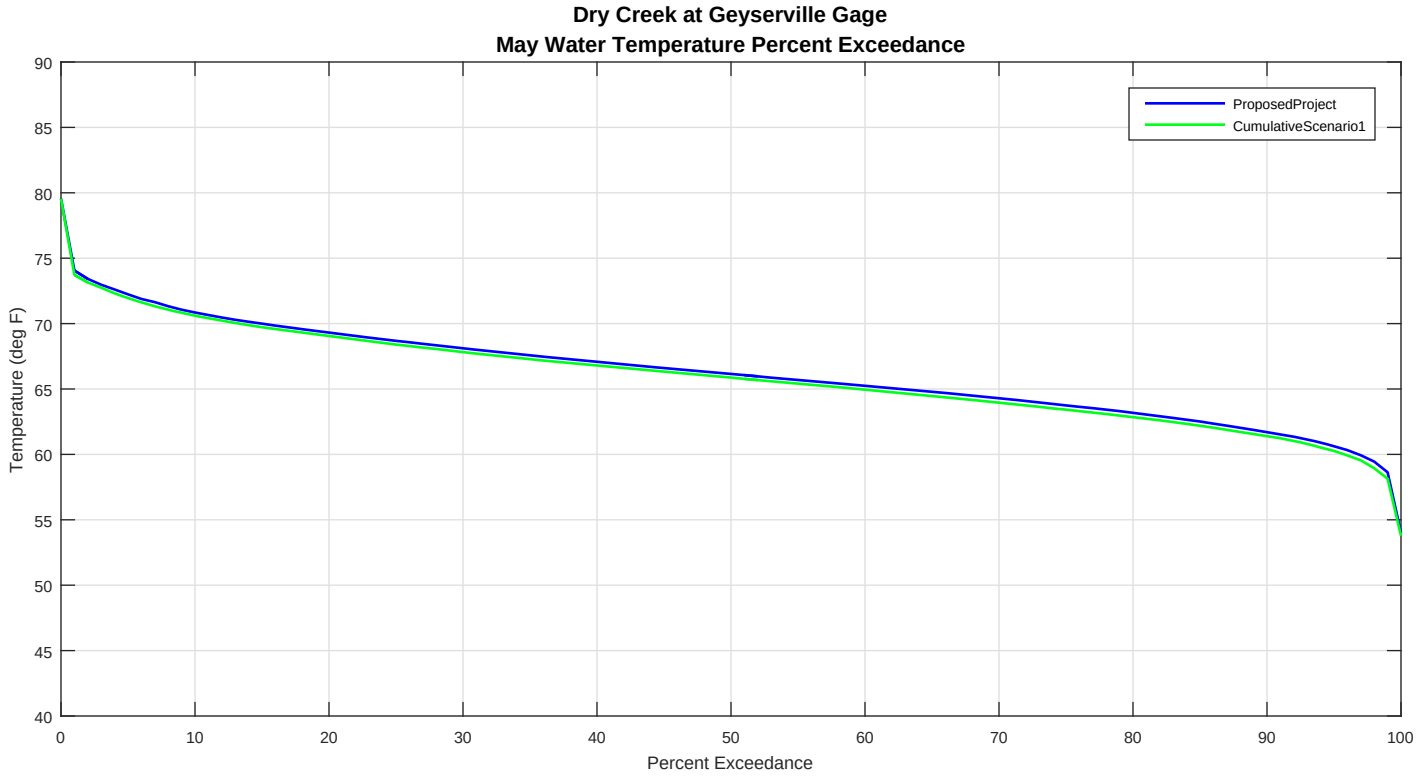
Dry Creek at Geyserville Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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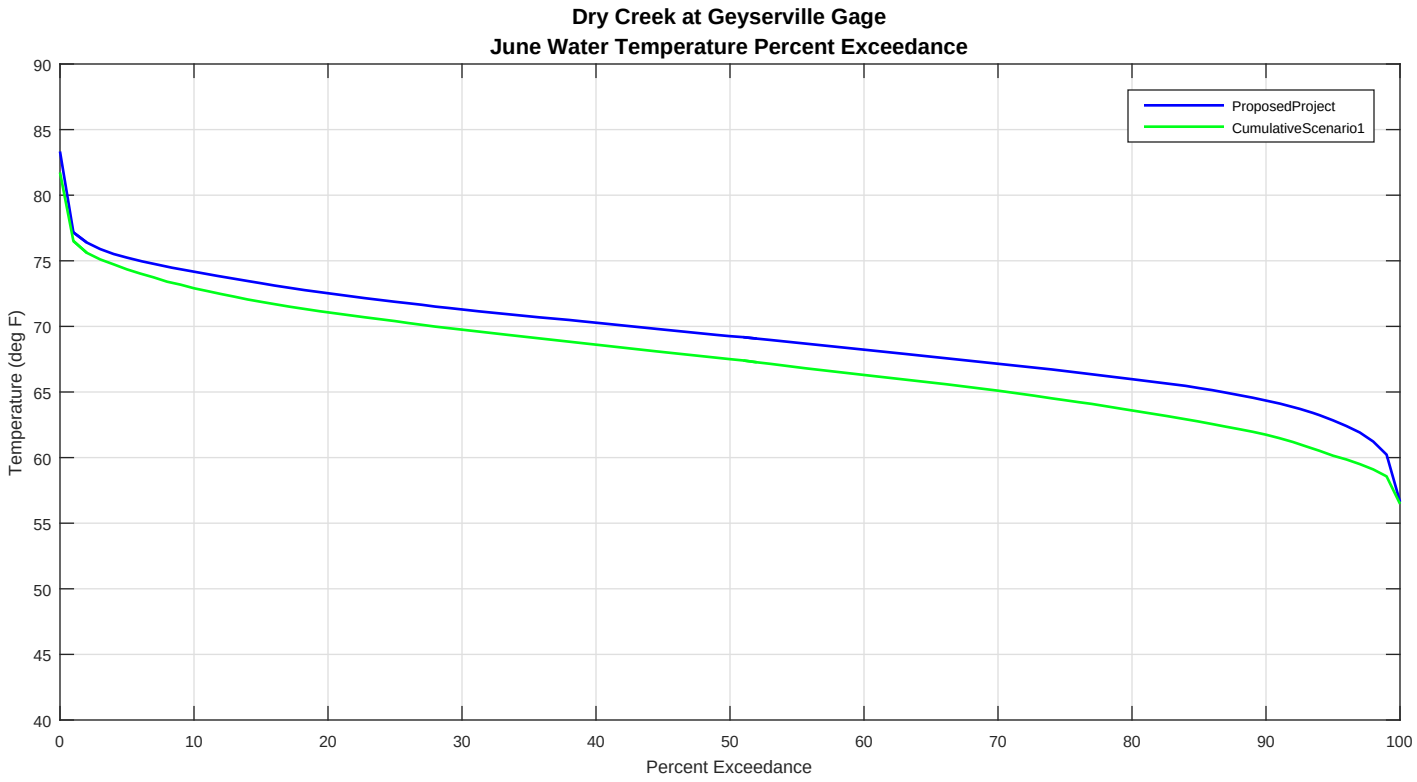
Dry Creek at Geyserville Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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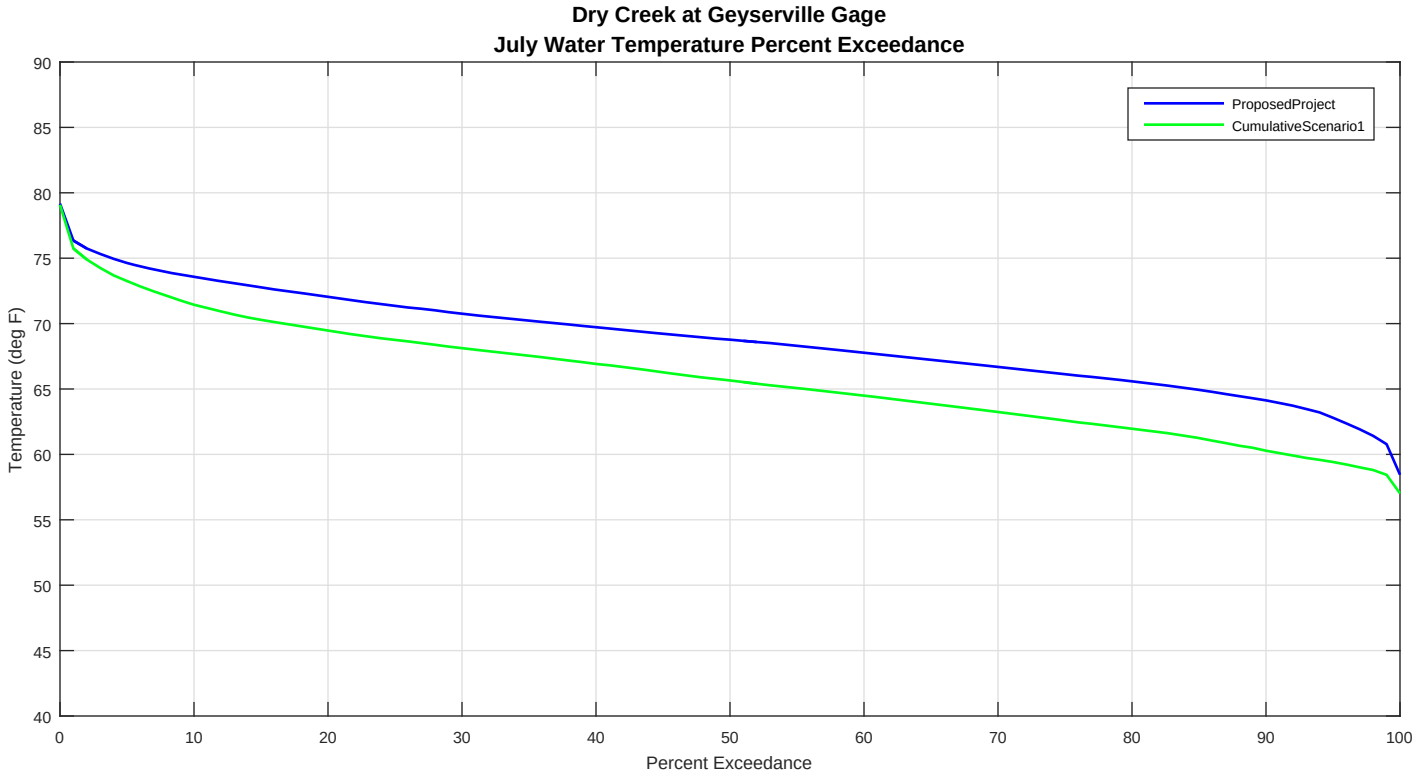
Dry Creek at Geyserville Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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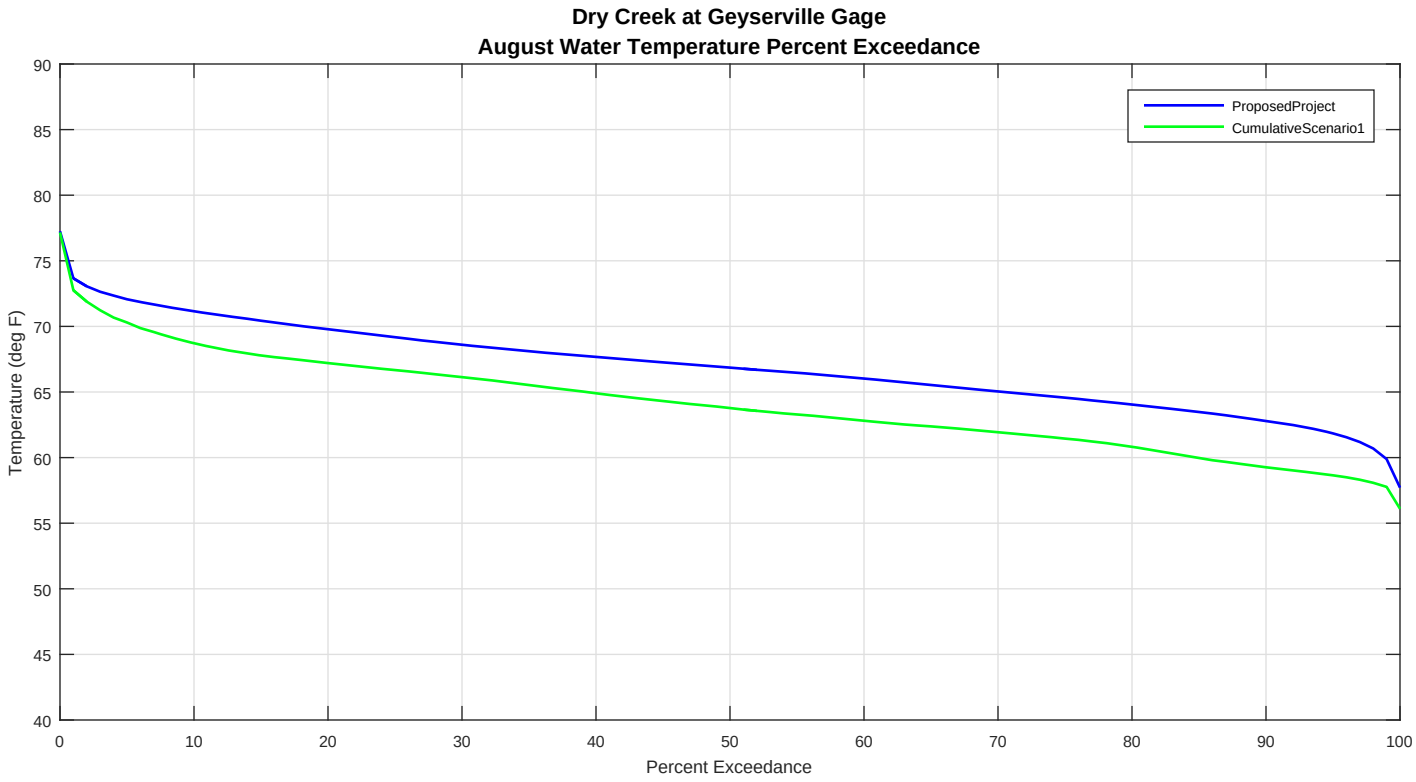
Dry Creek at Geyserville Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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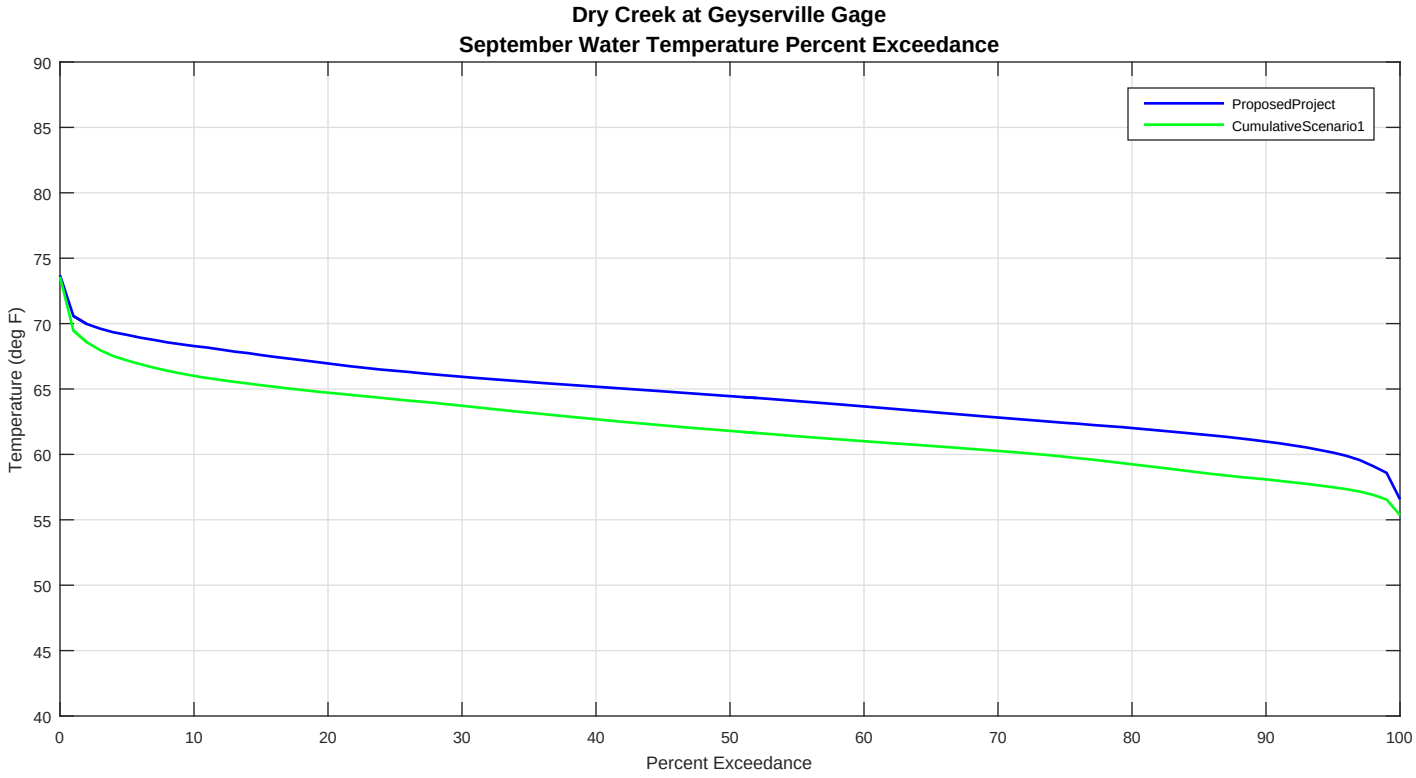
Dry Creek at Geyserville Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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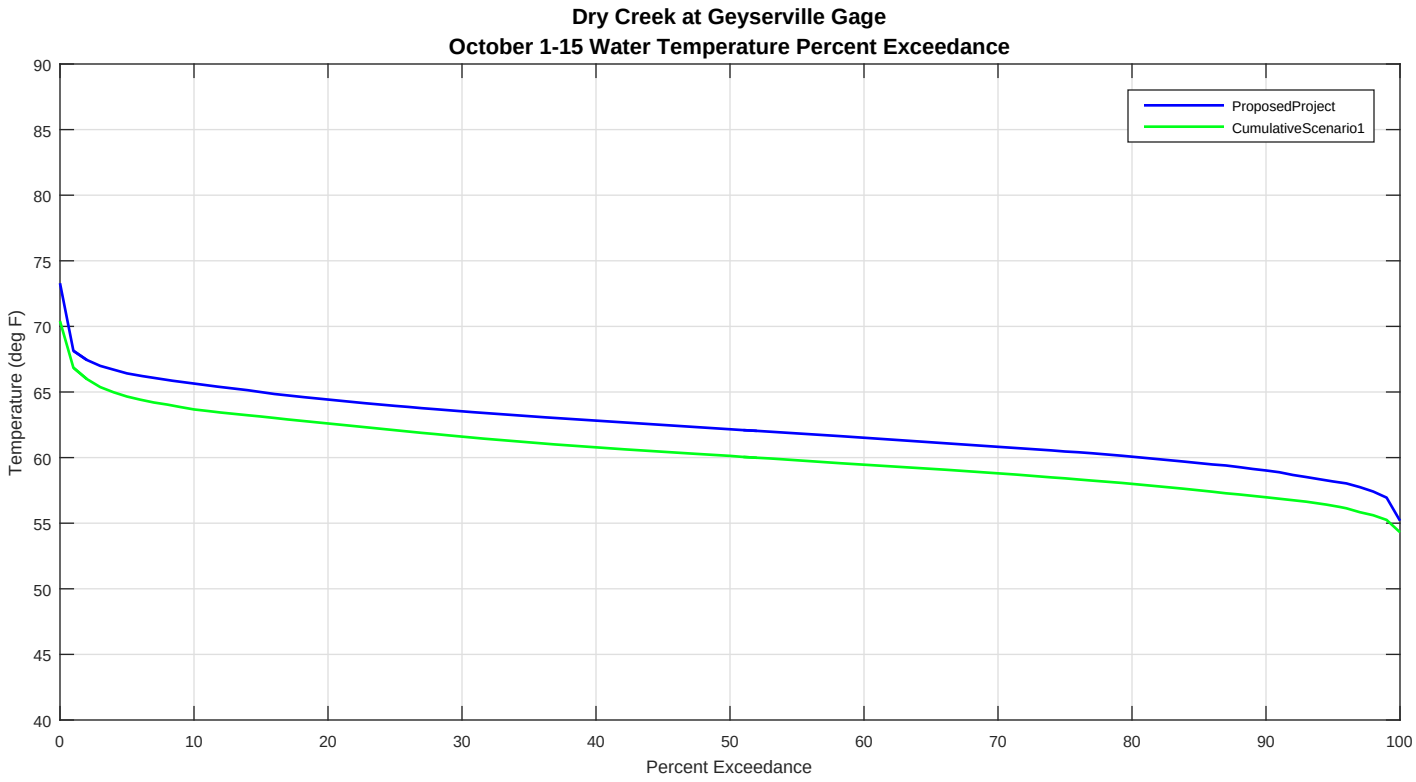
Dry Creek at Geyserville Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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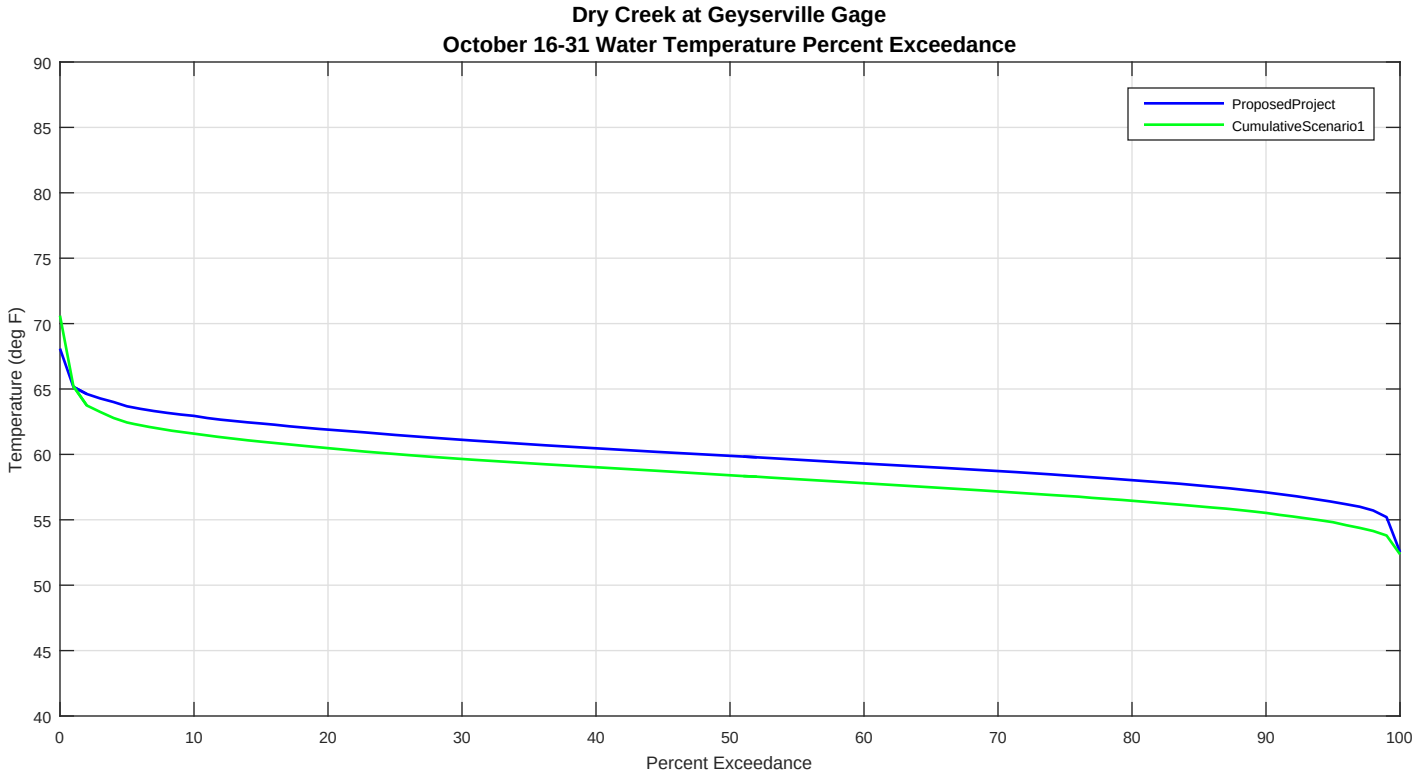
Dry Creek at Geyserville Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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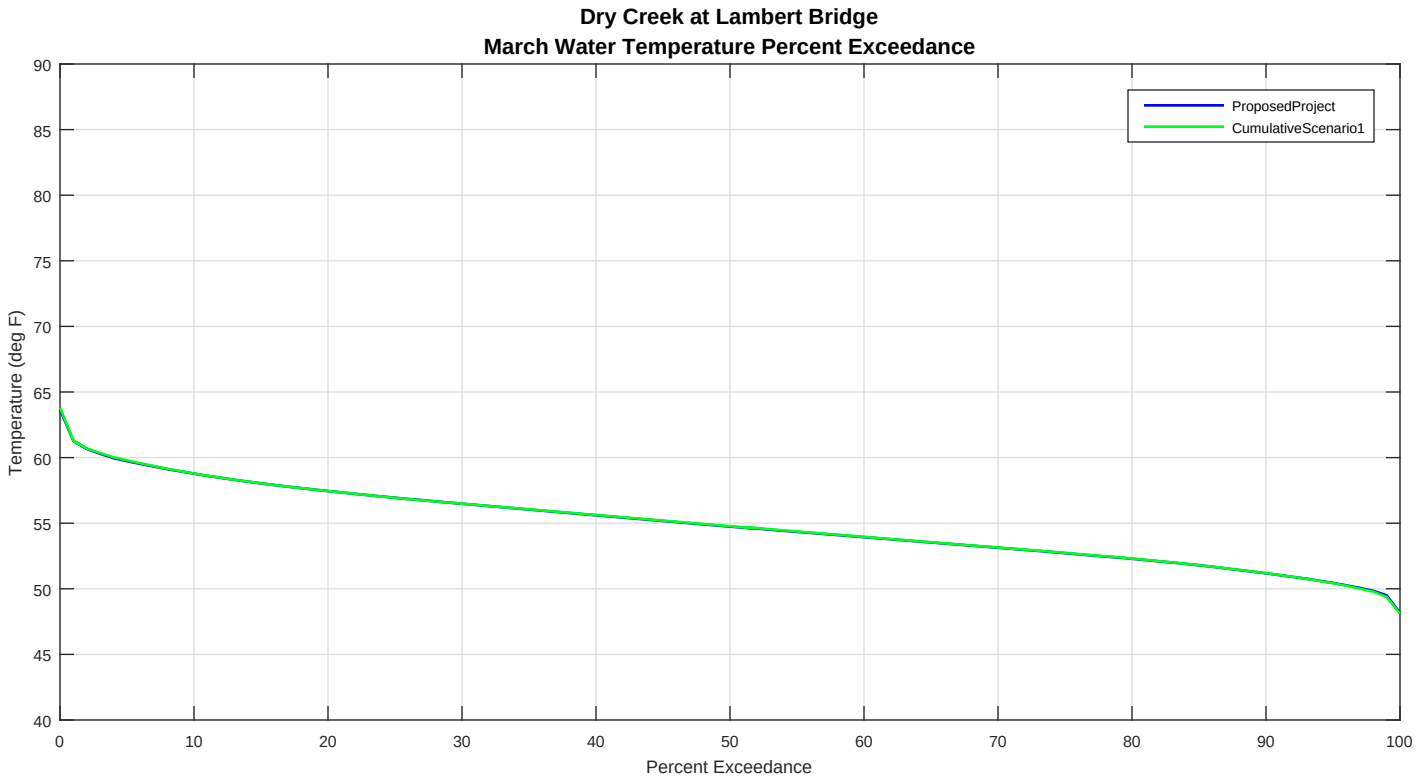
Dry Creek at Lambert Bridge
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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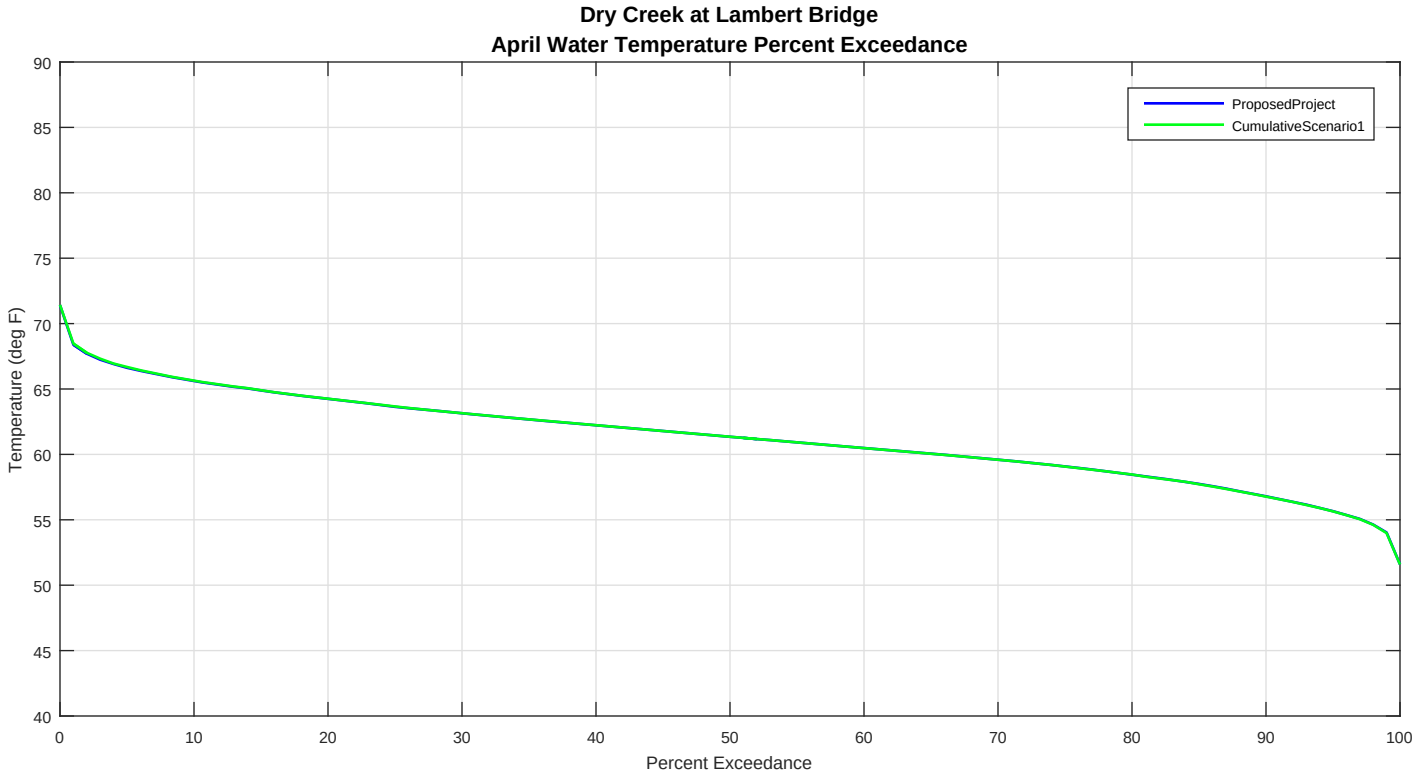
Dry Creek at Lambert Bridge
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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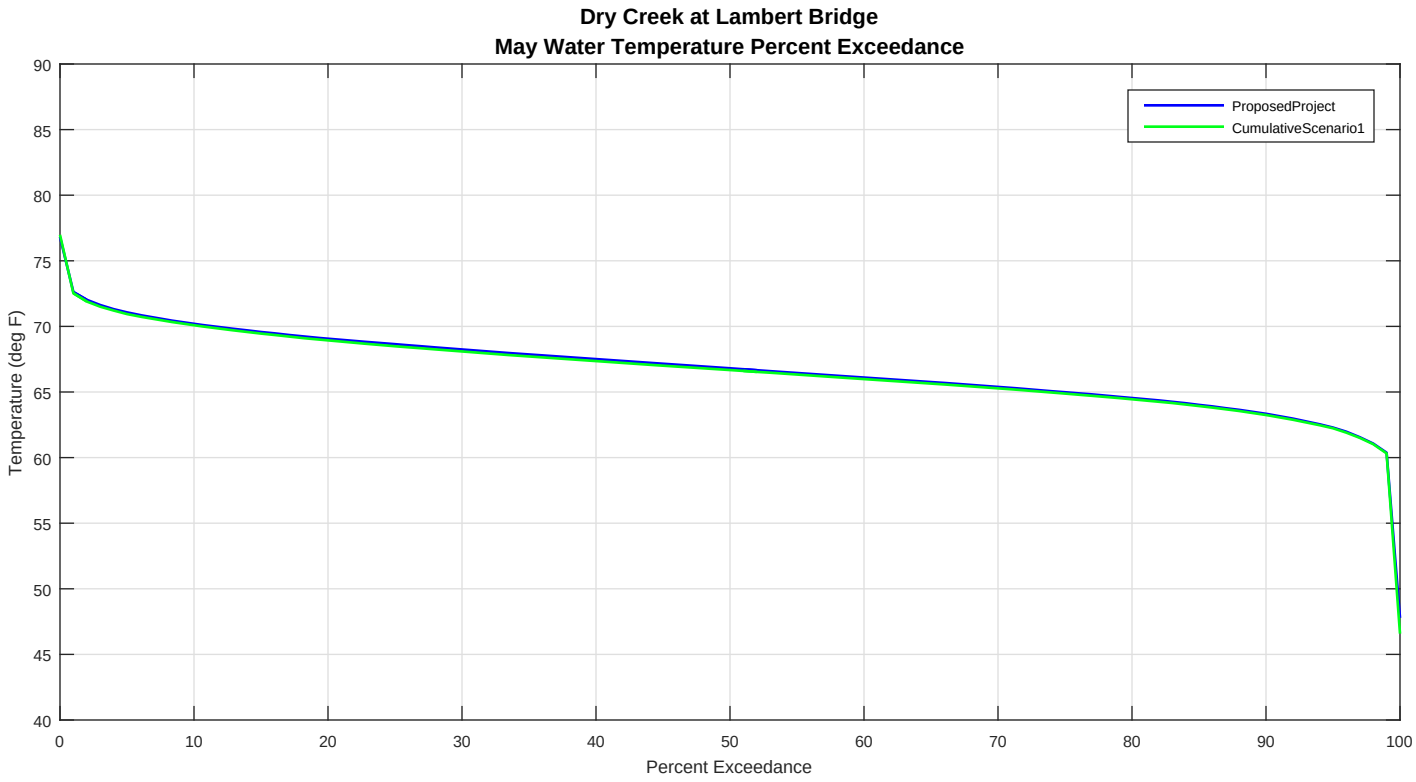
Dry Creek at Lambert Bridge
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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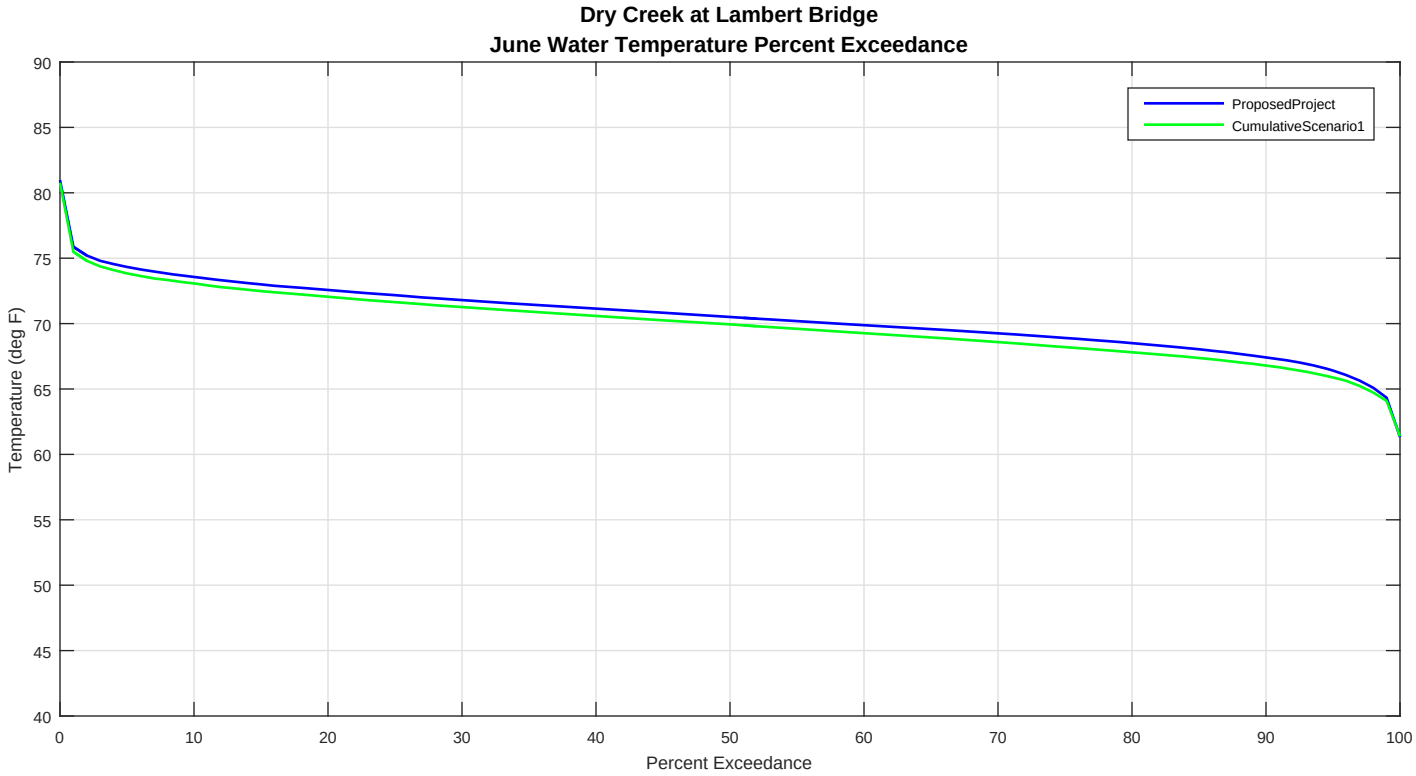
Dry Creek at Lambert Bridge
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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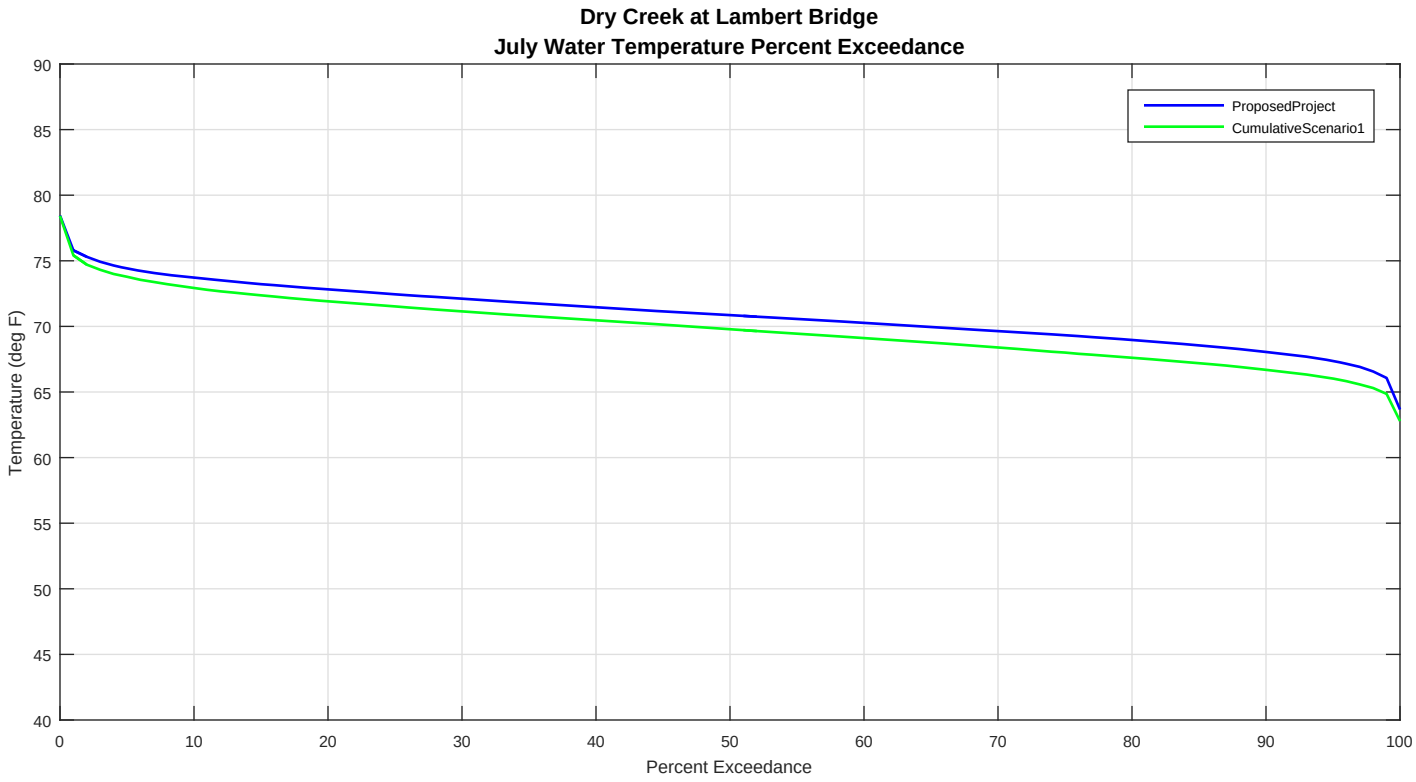
Dry Creek at Lambert Bridge
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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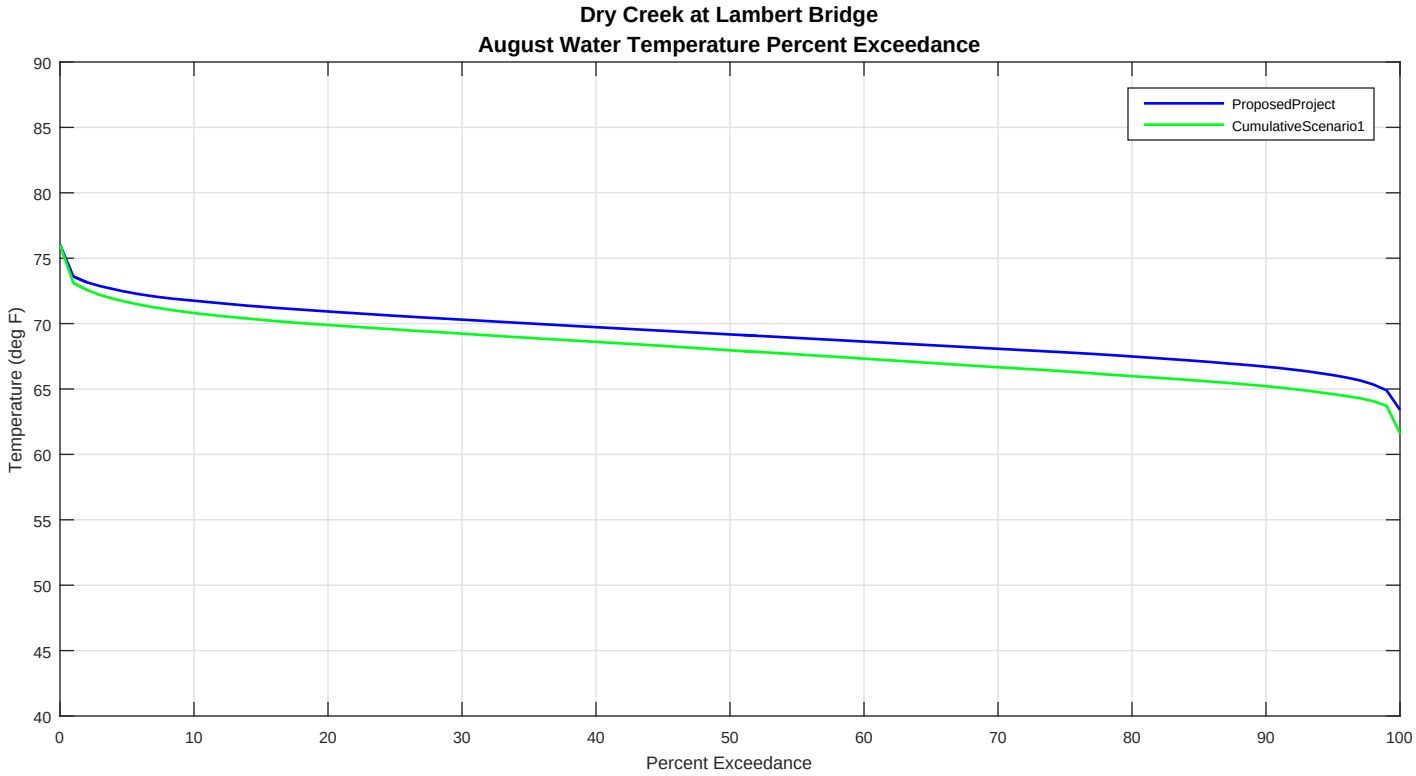
Dry Creek at Lambert Bridge
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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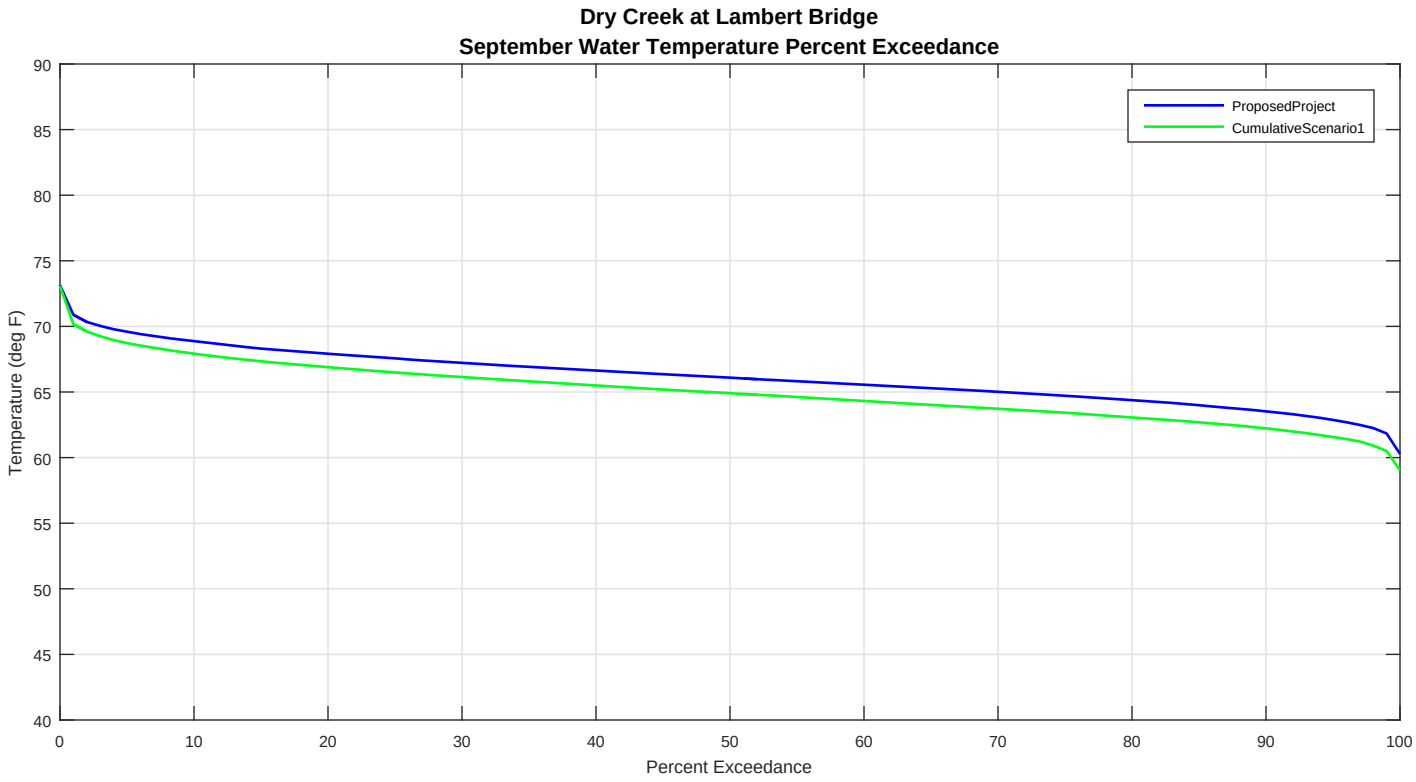
Dry Creek at Lambert Bridge
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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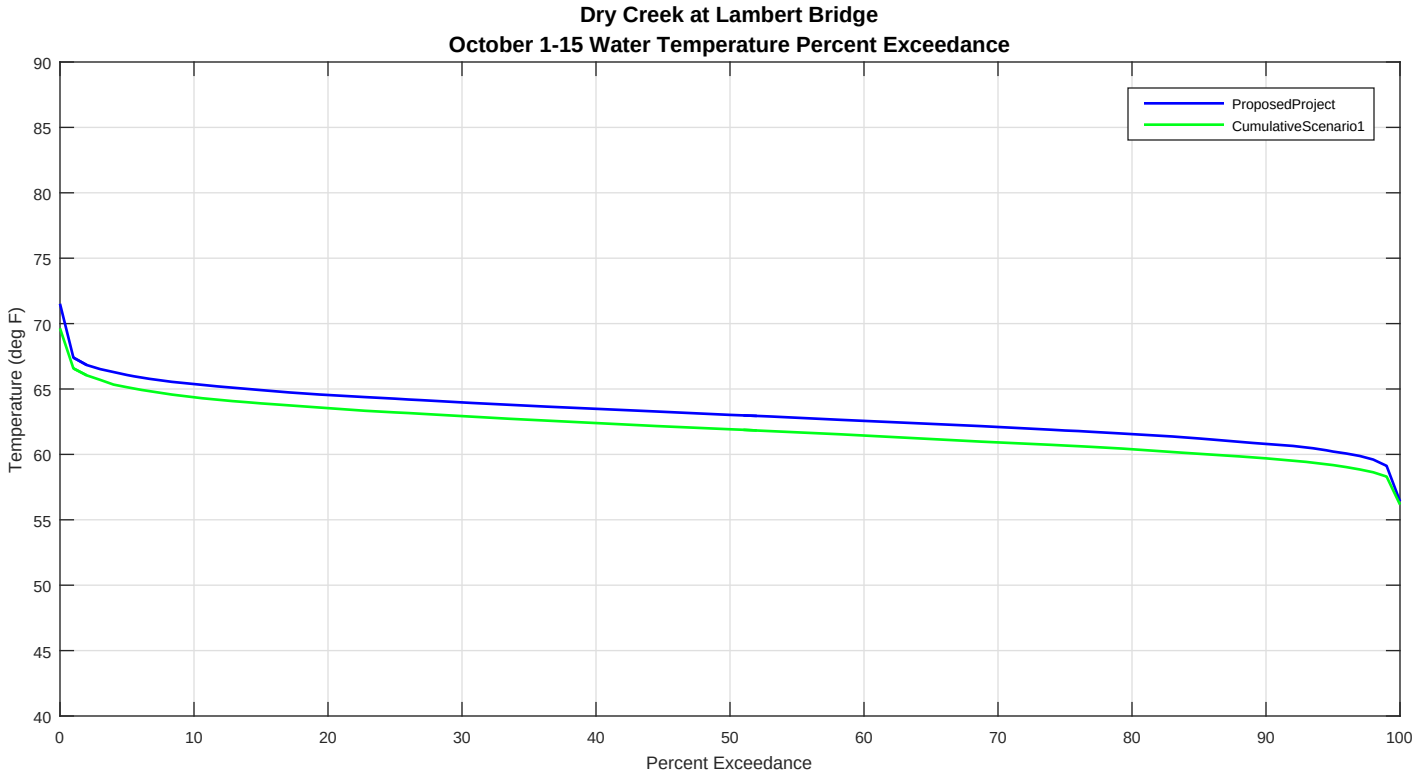
Dry Creek at Lambert Bridge
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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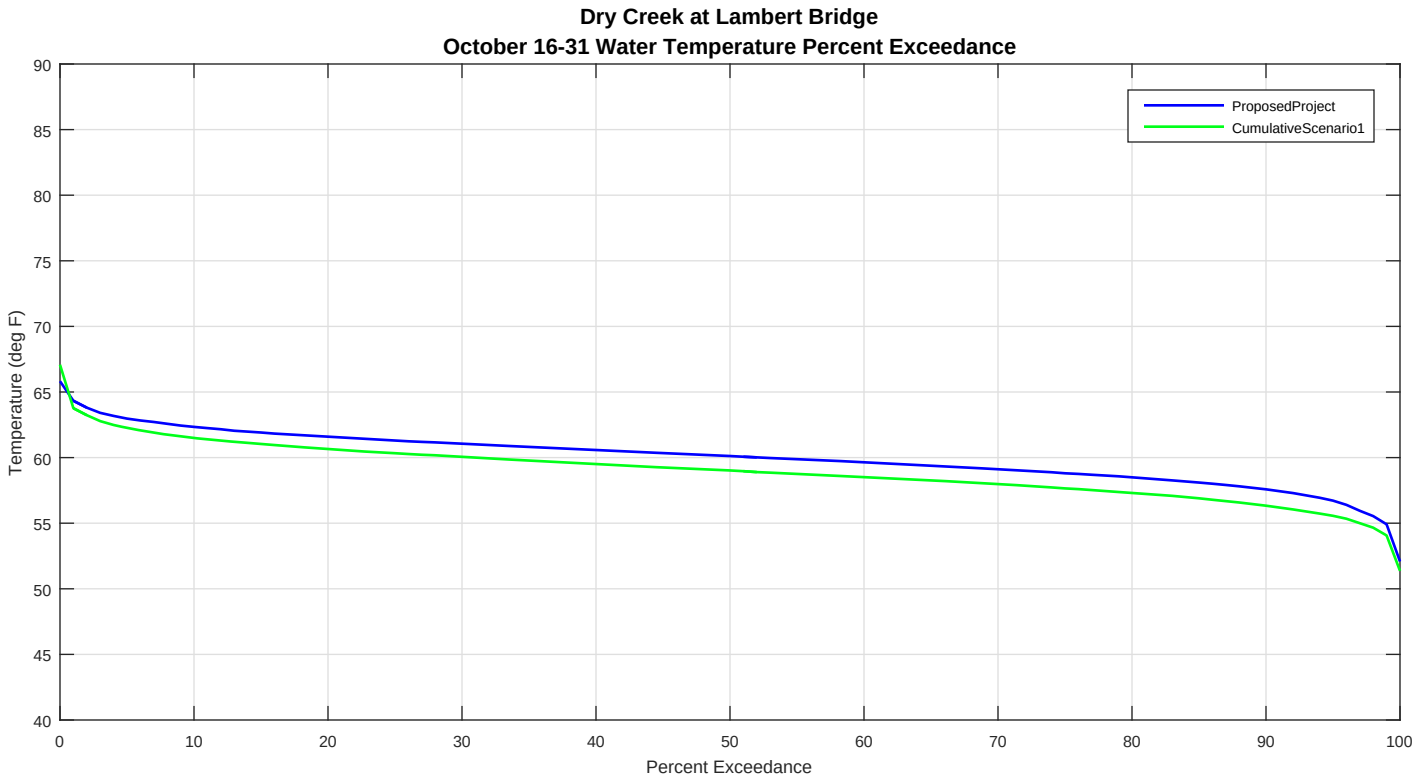
Dry Creek at Lambert Bridge
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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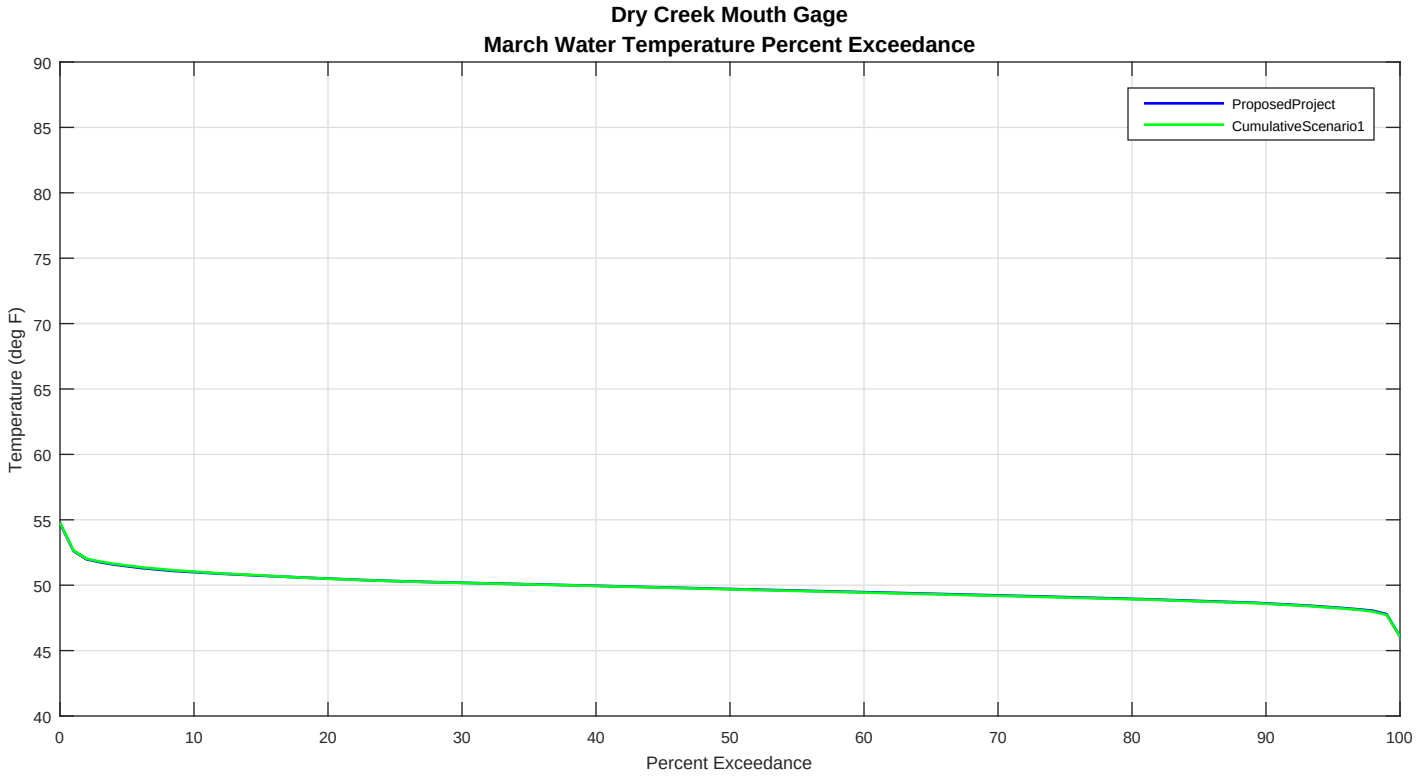
Dry Creek Mouth Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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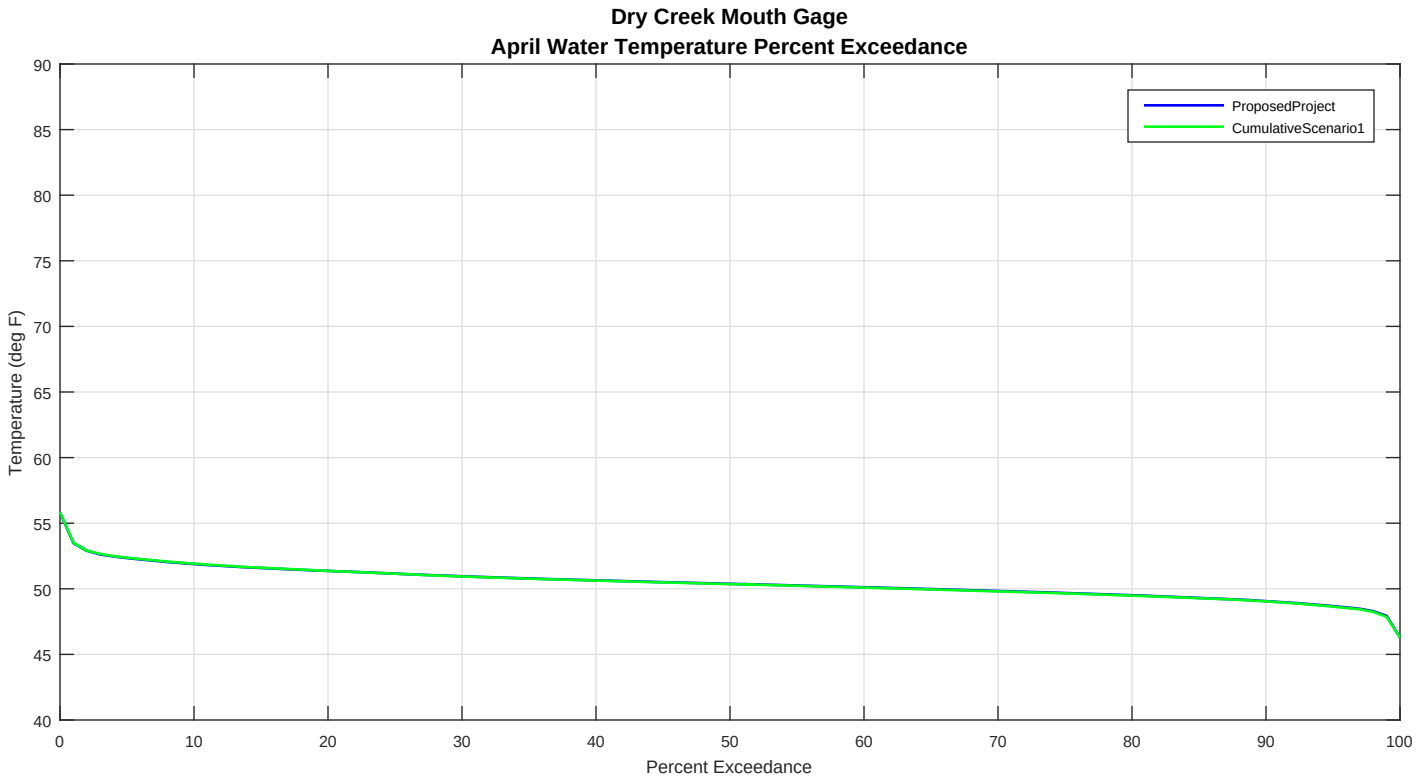
Dry Creek Mouth Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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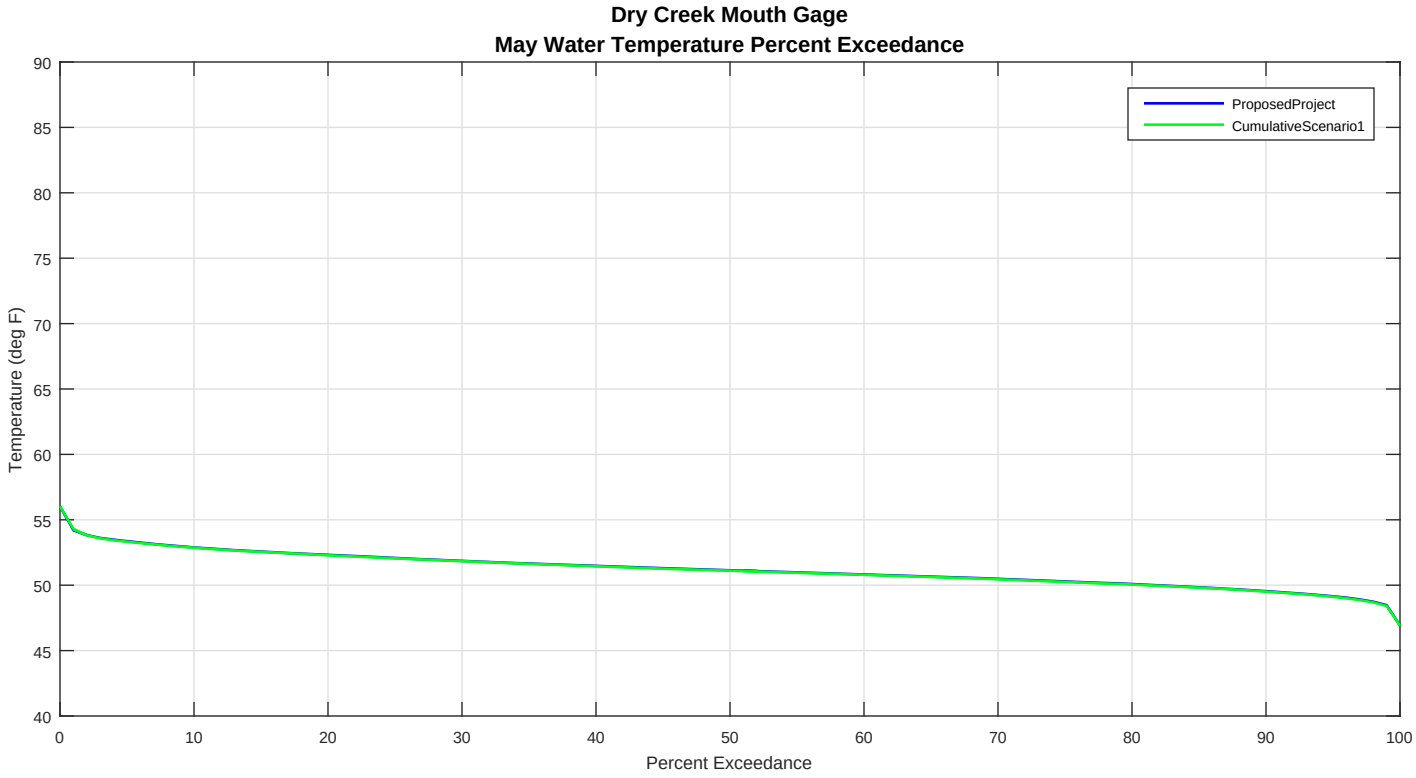
Dry Creek Mouth Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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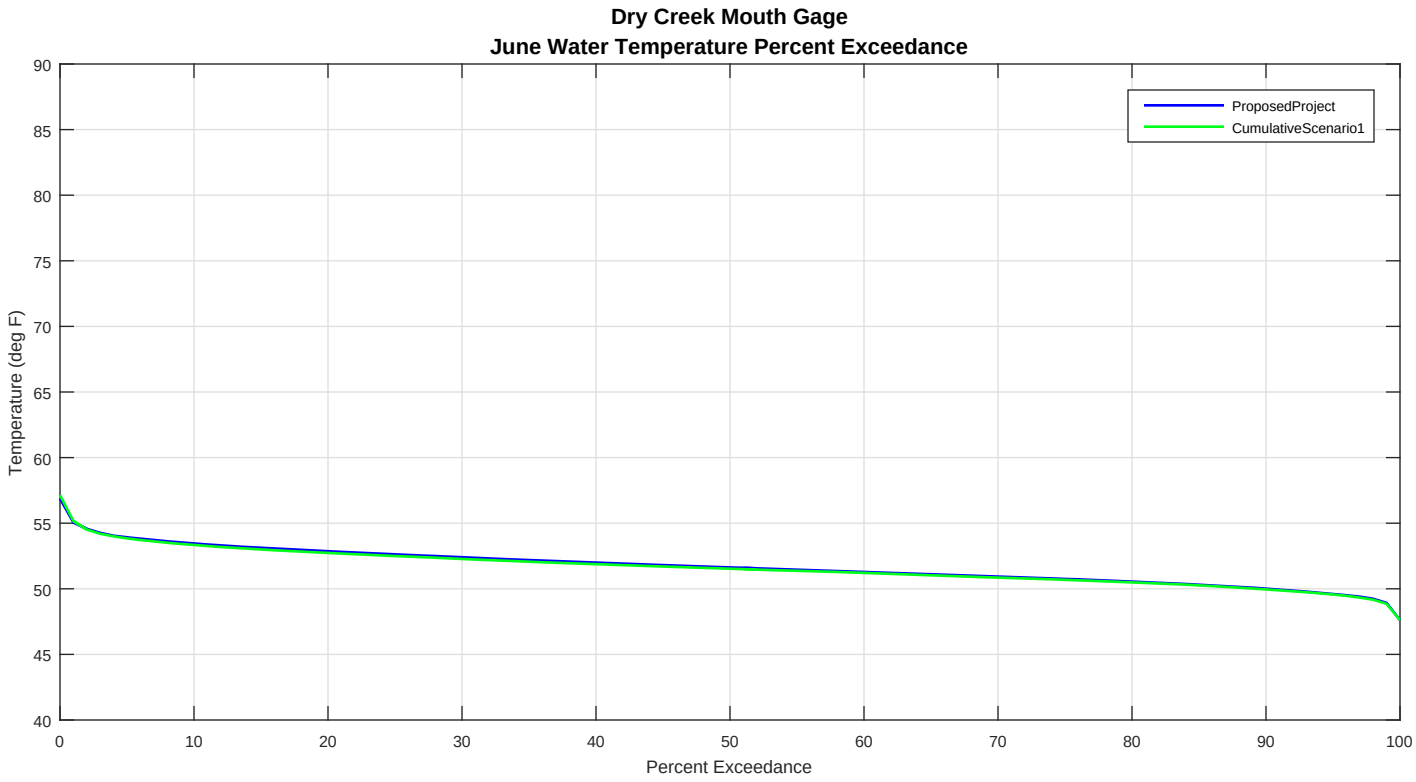
Dry Creek Mouth Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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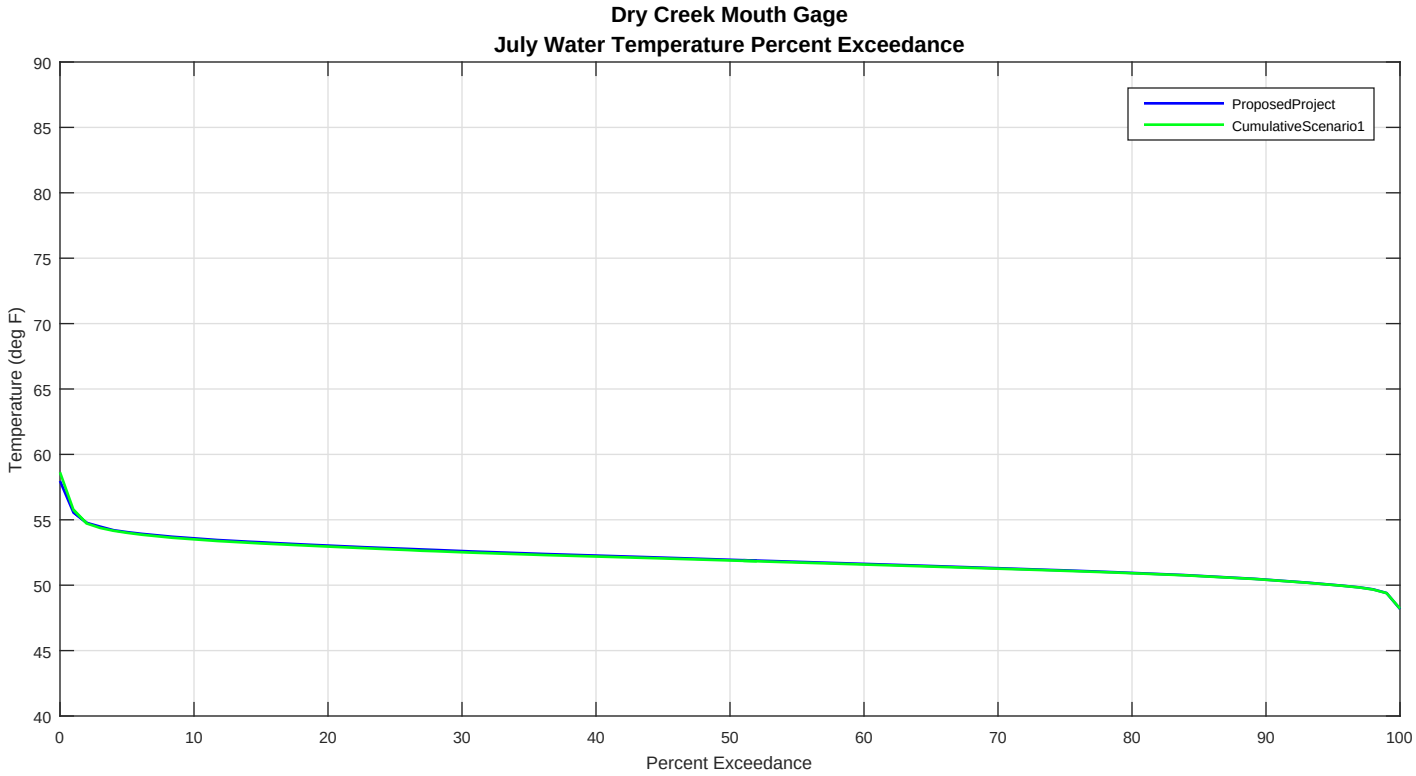
Dry Creek Mouth Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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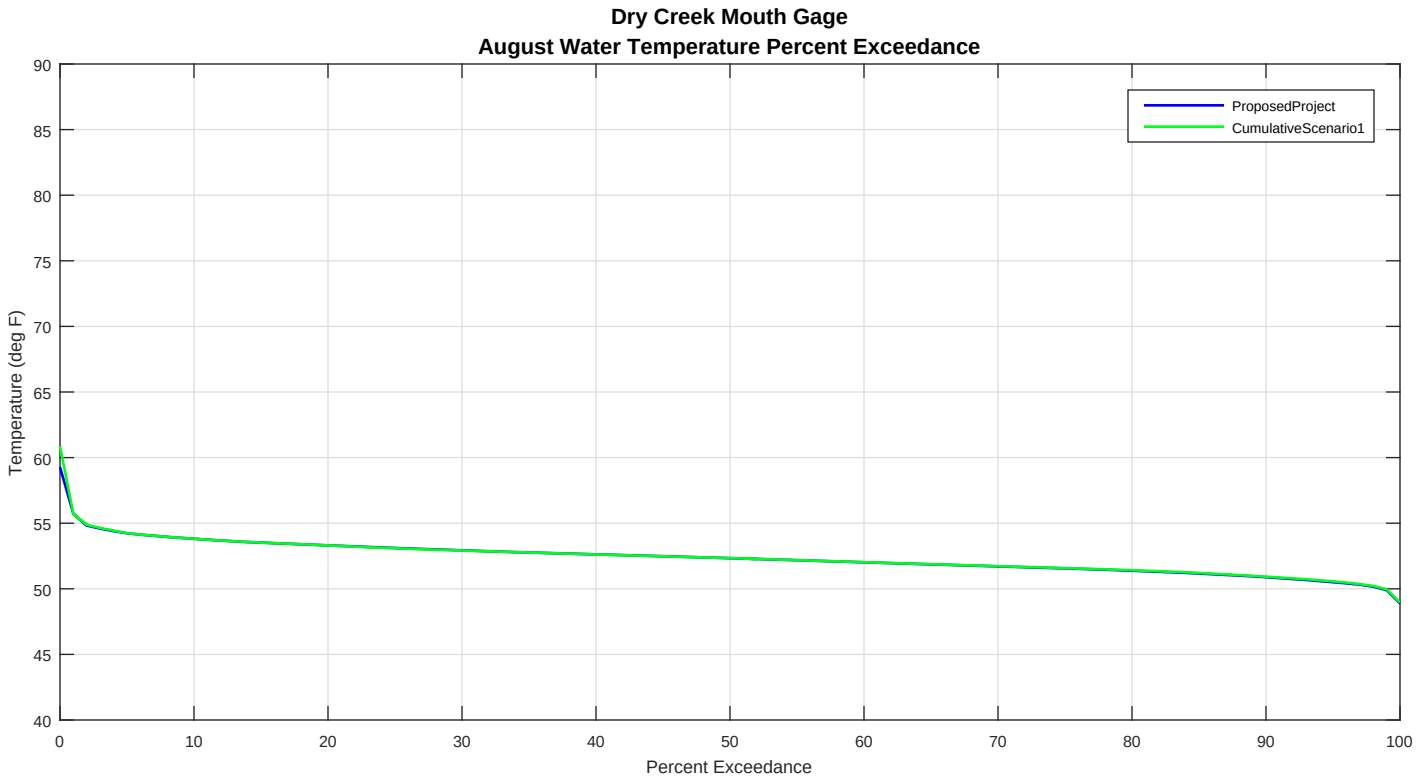
Dry Creek Mouth Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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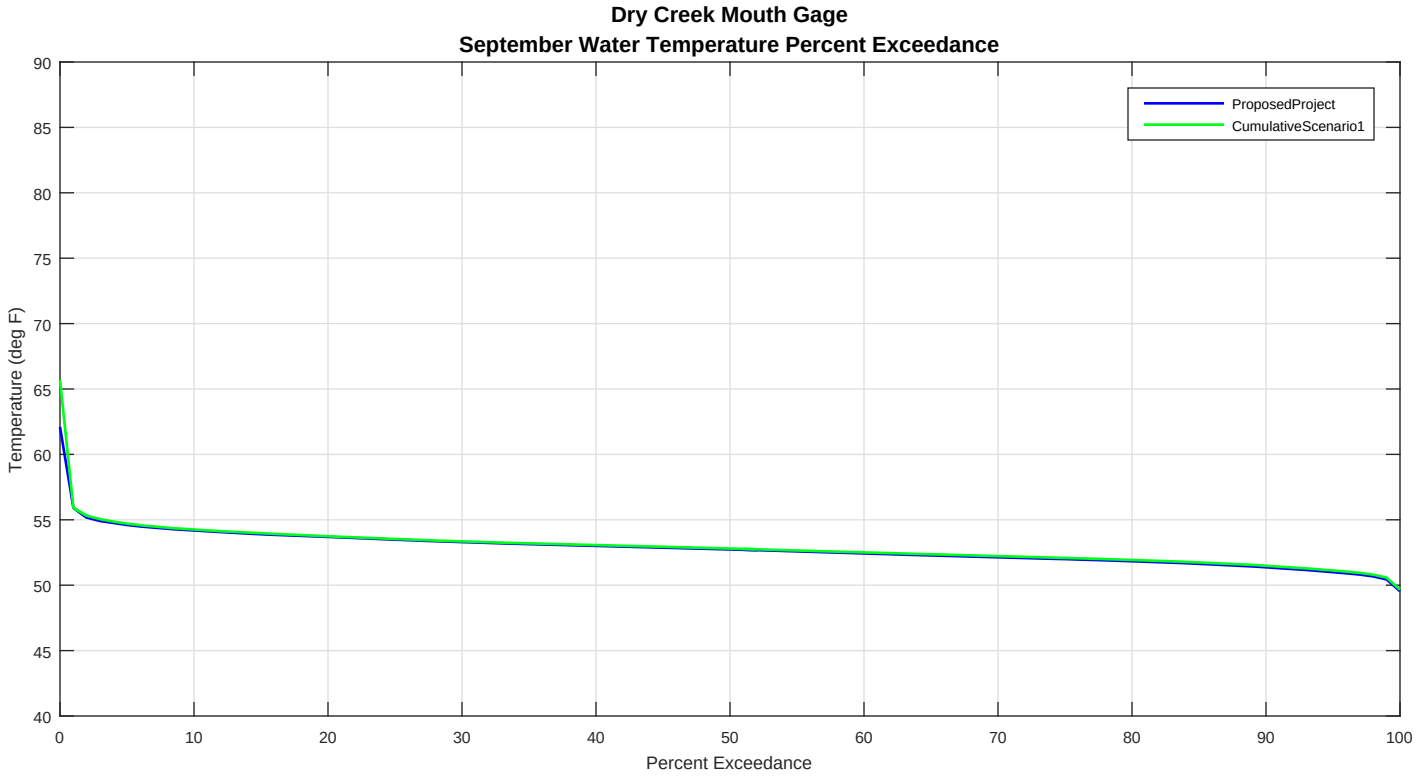
Dry Creek Mouth Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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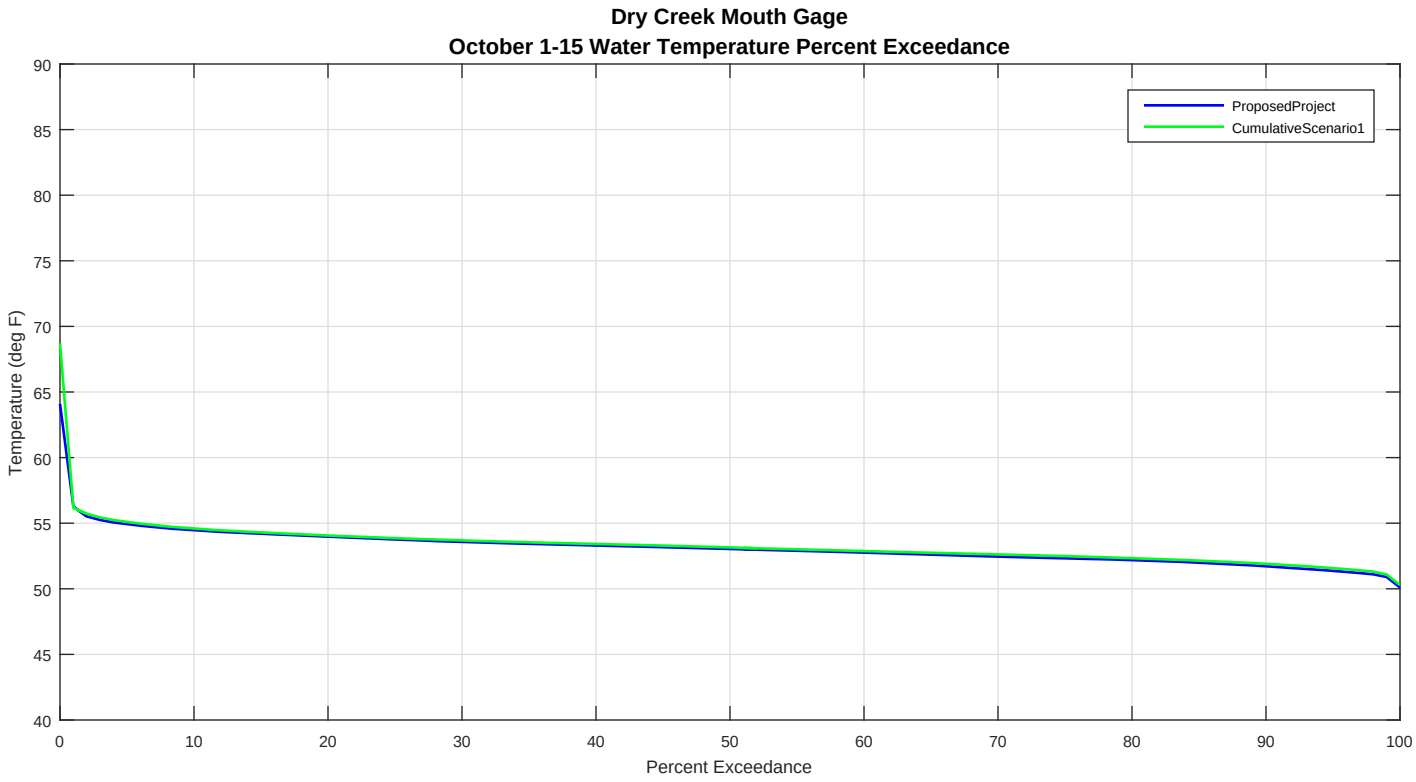
Dry Creek Mouth Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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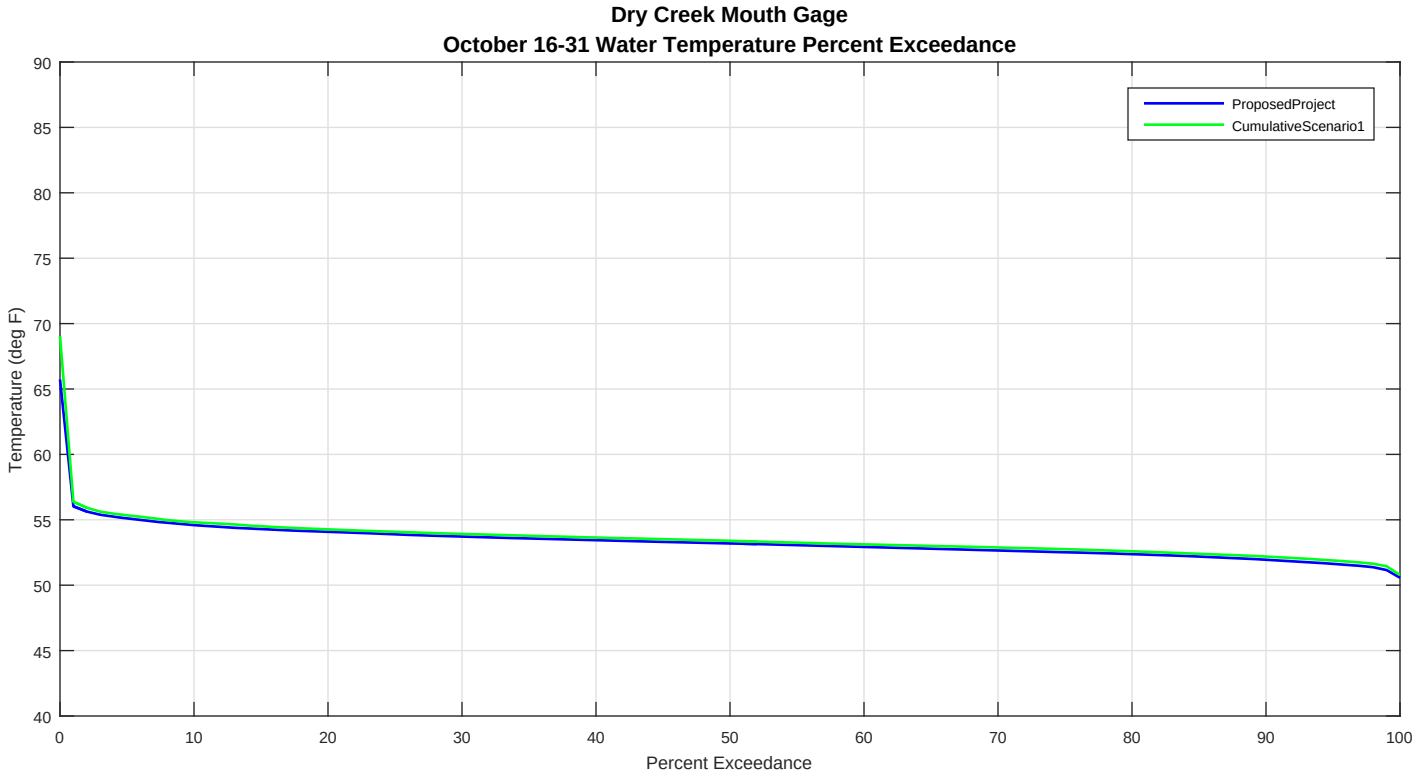
Dry Creek Mouth Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario1
Temperature (deg F)
Percent Exceedance
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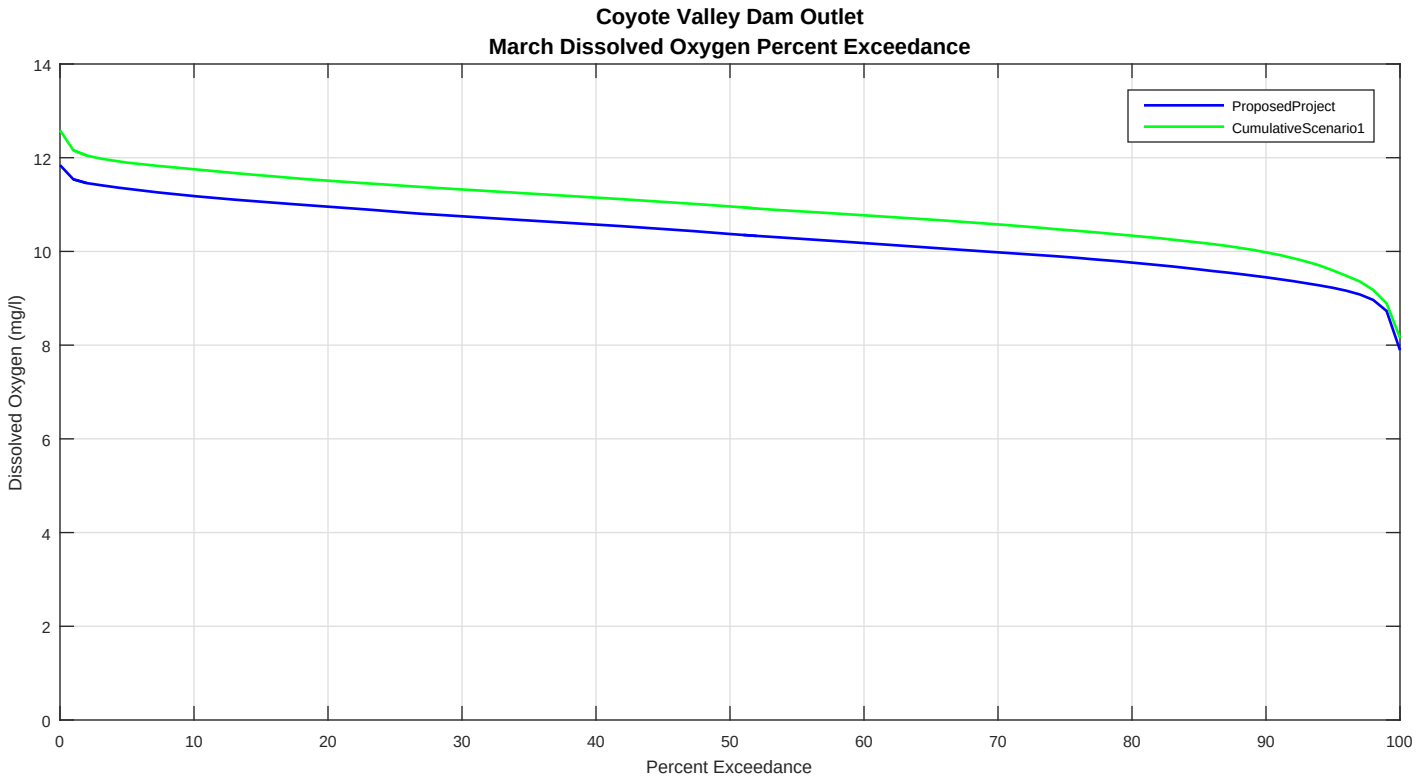
Coyote Valley Dam Outlet
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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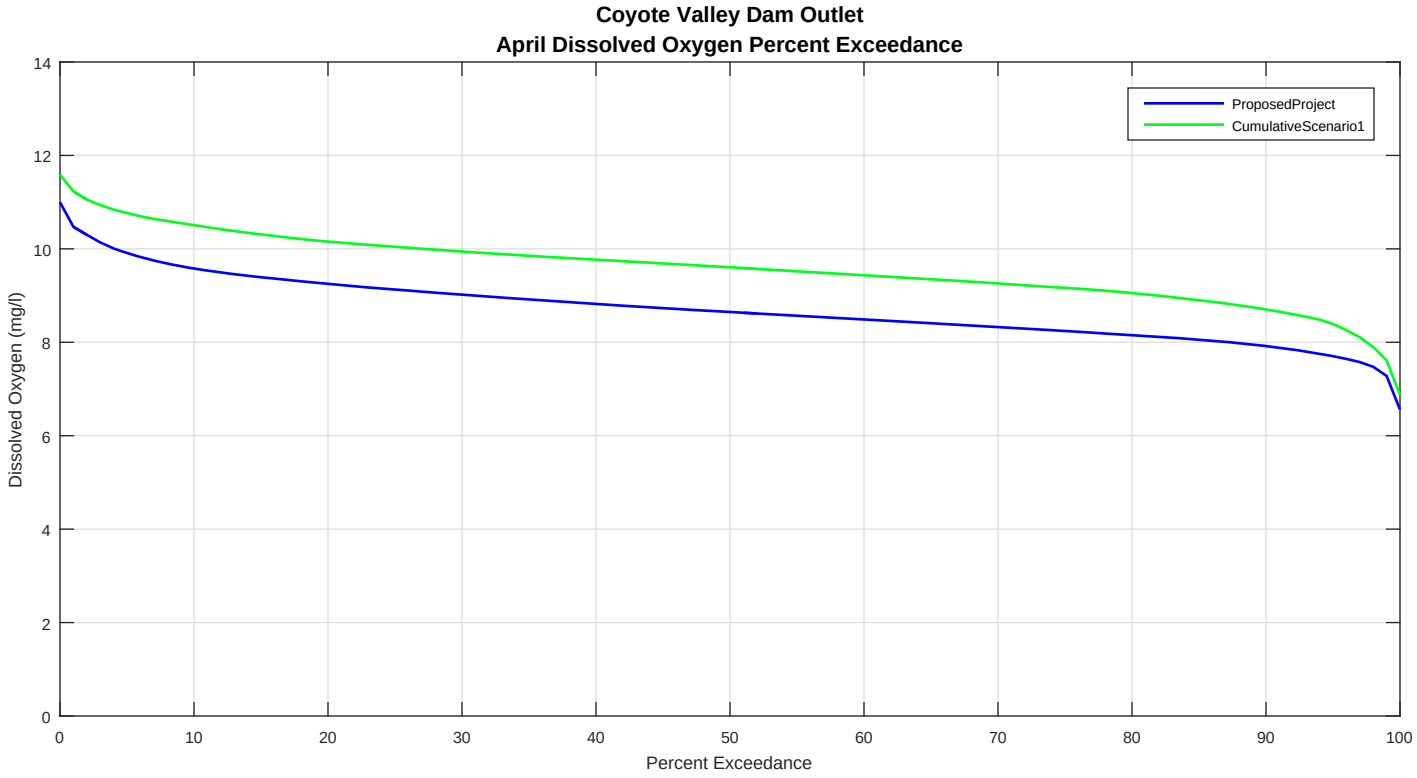
Coyote Valley Dam Outlet
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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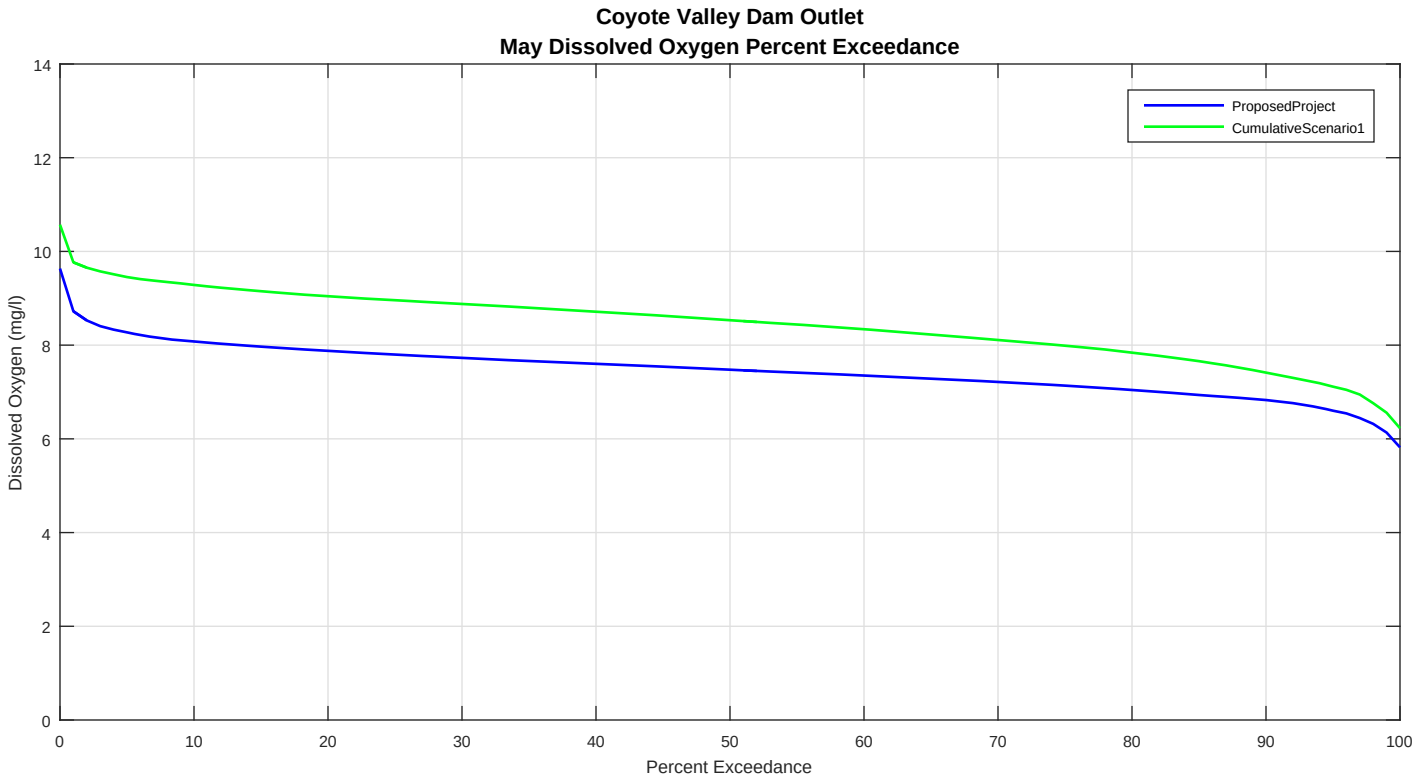
Coyote Valley Dam Outlet
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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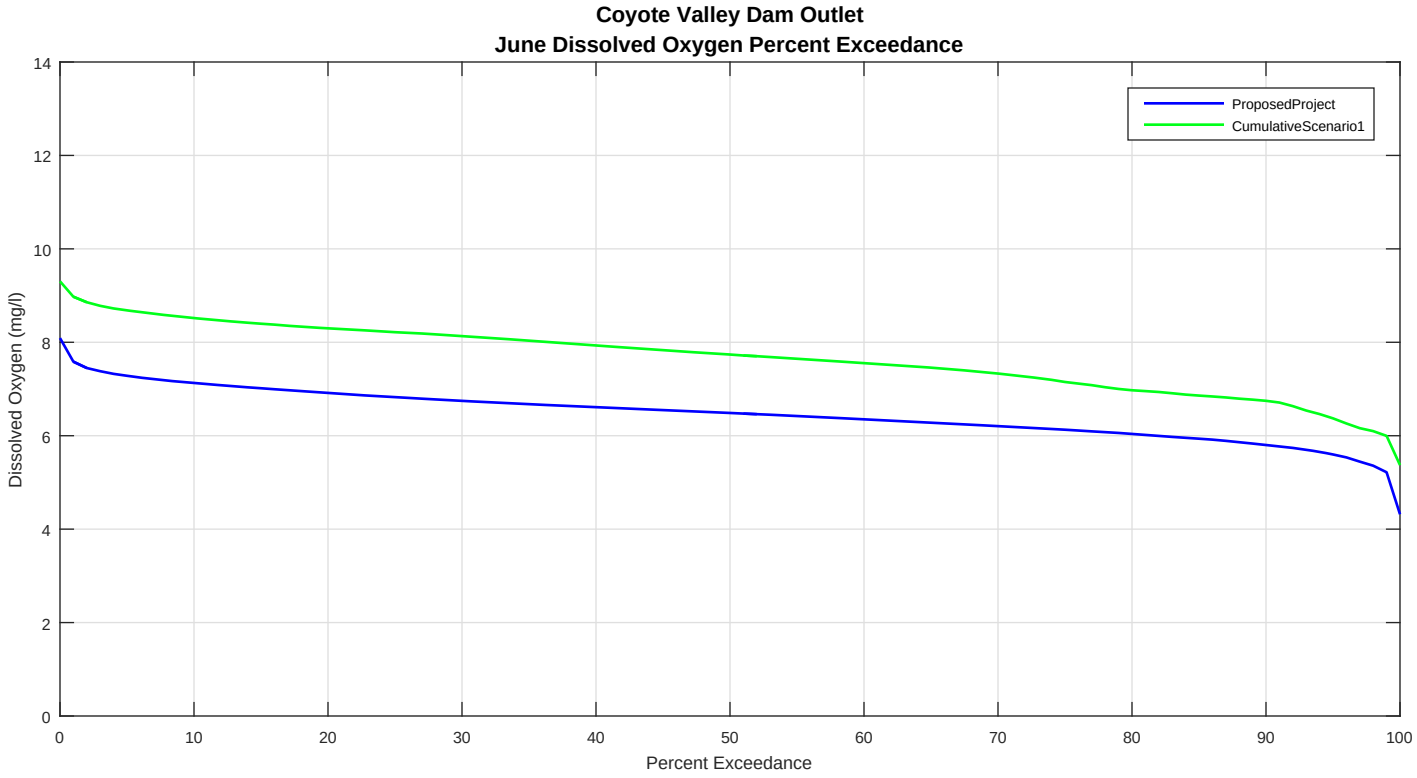
Coyote Valley Dam Outlet
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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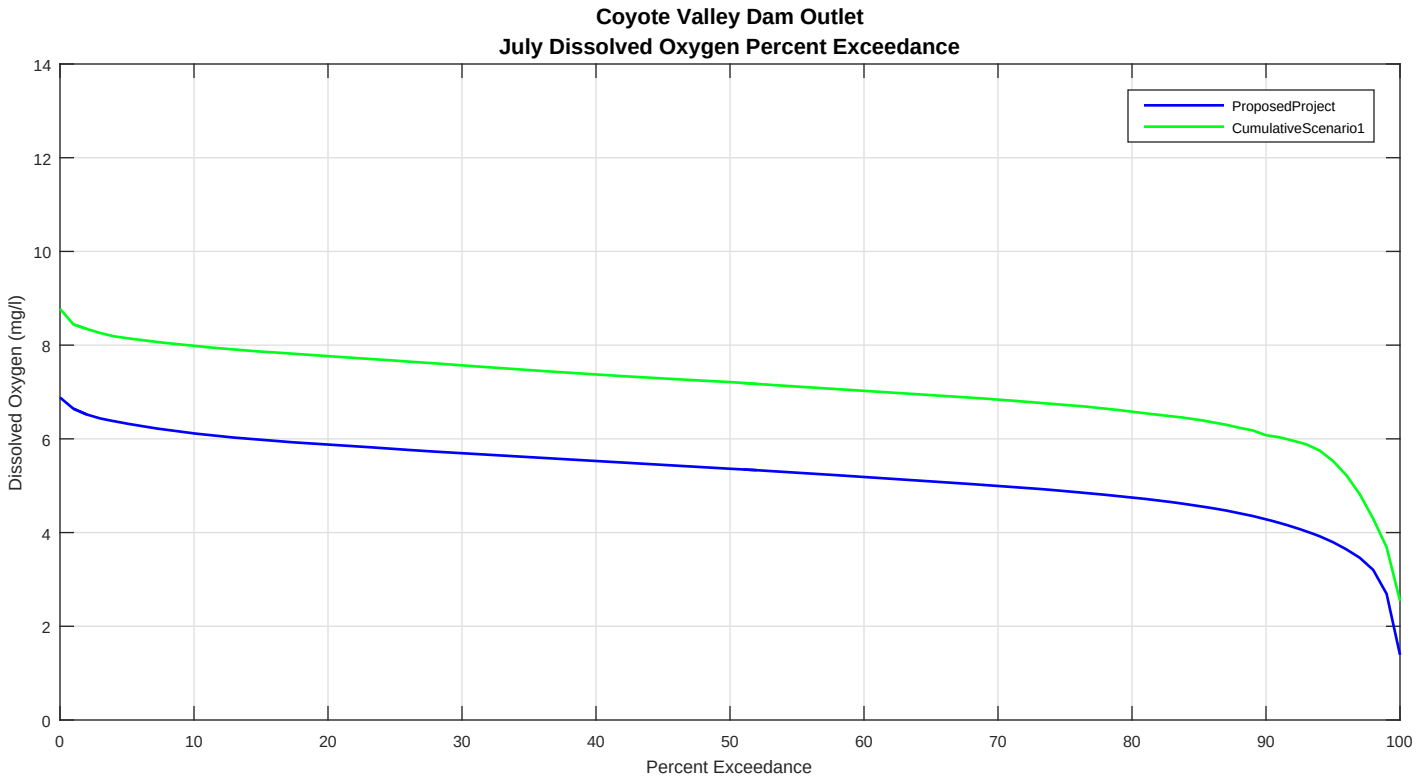
Coyote Valley Dam Outlet
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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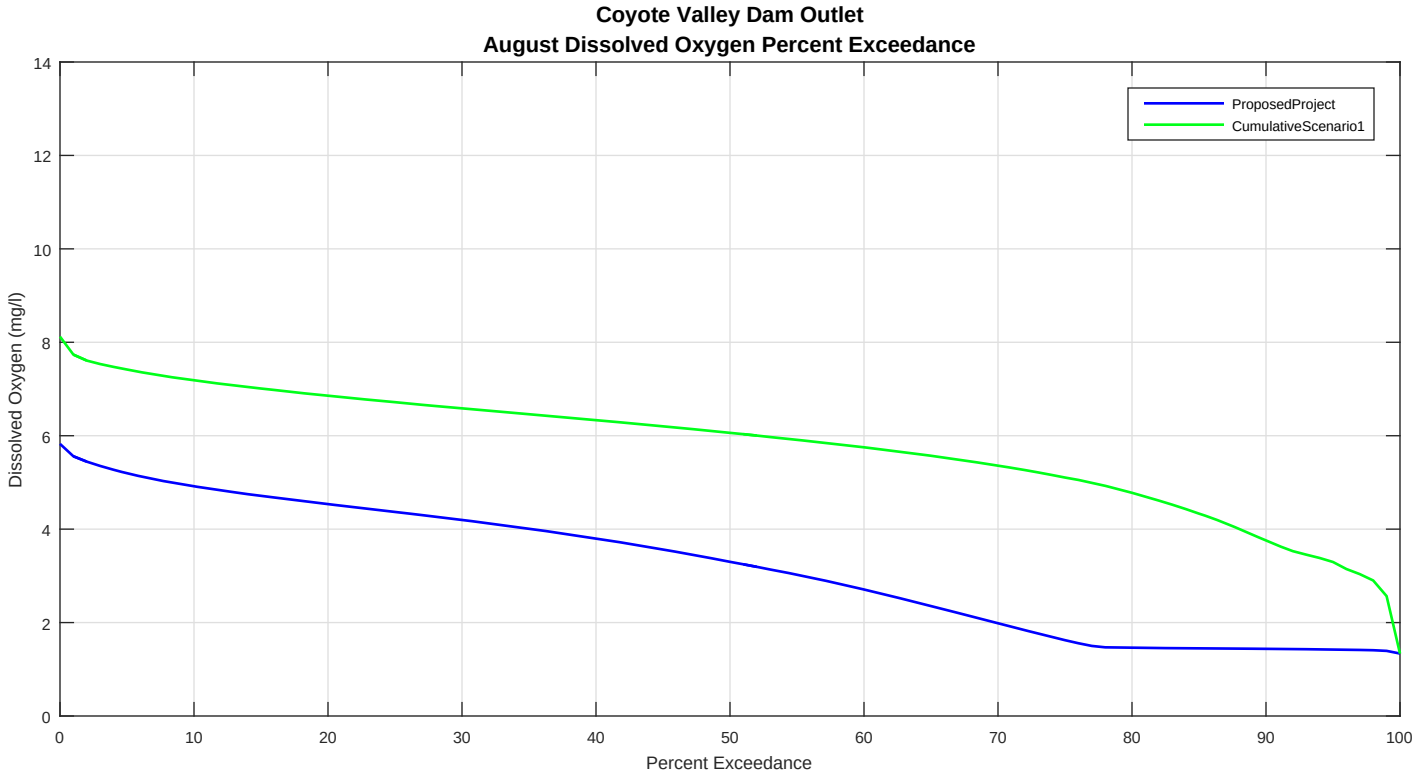
Coyote Valley Dam Outlet
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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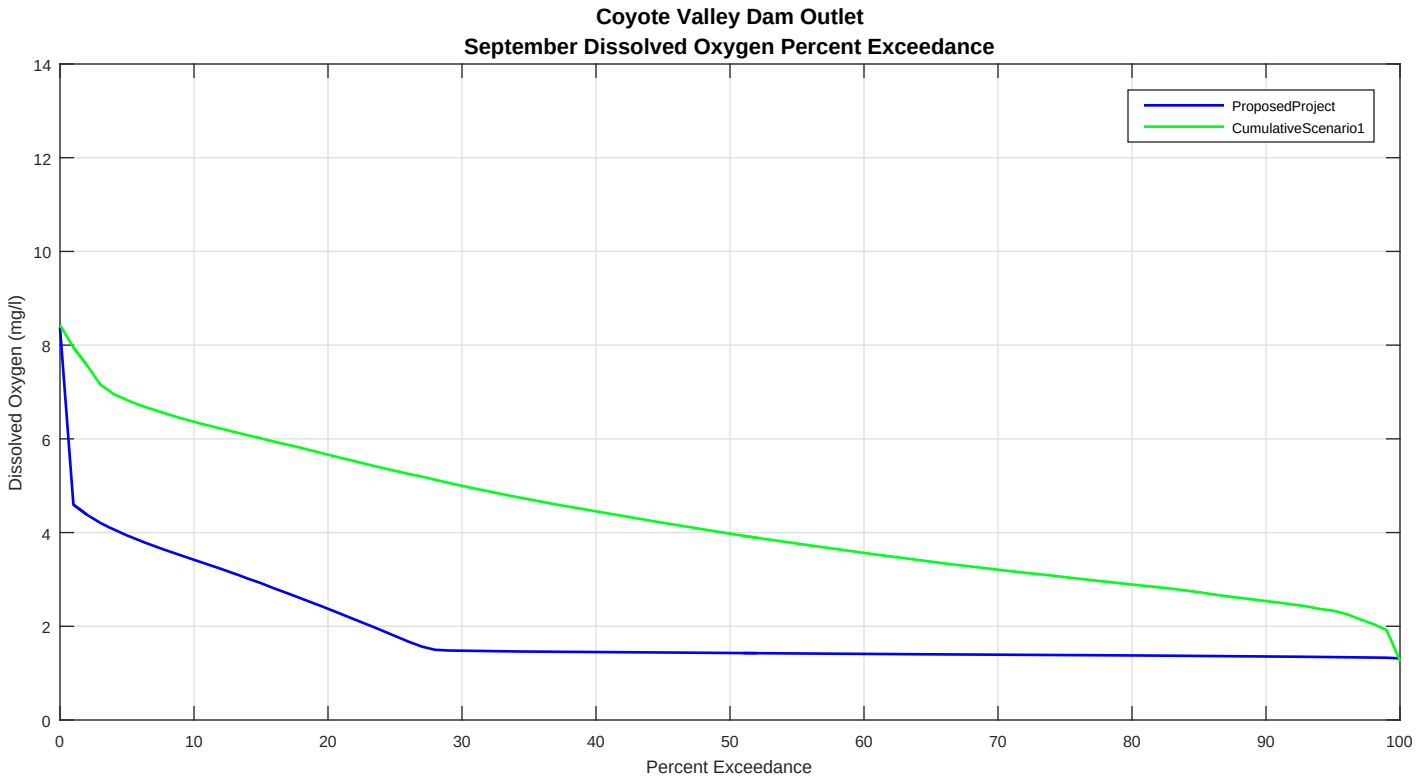
Coyote Valley Dam Outlet
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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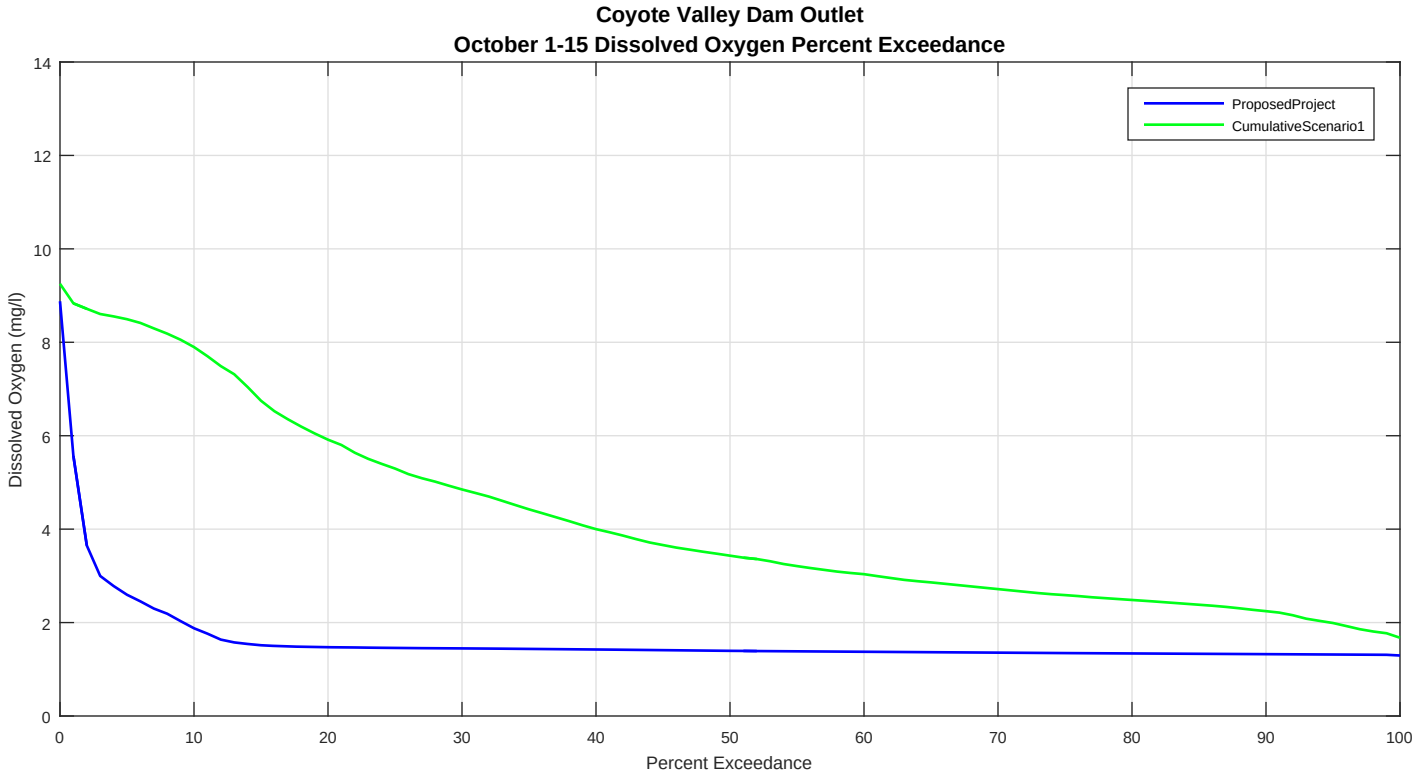
Coyote Valley Dam Outlet
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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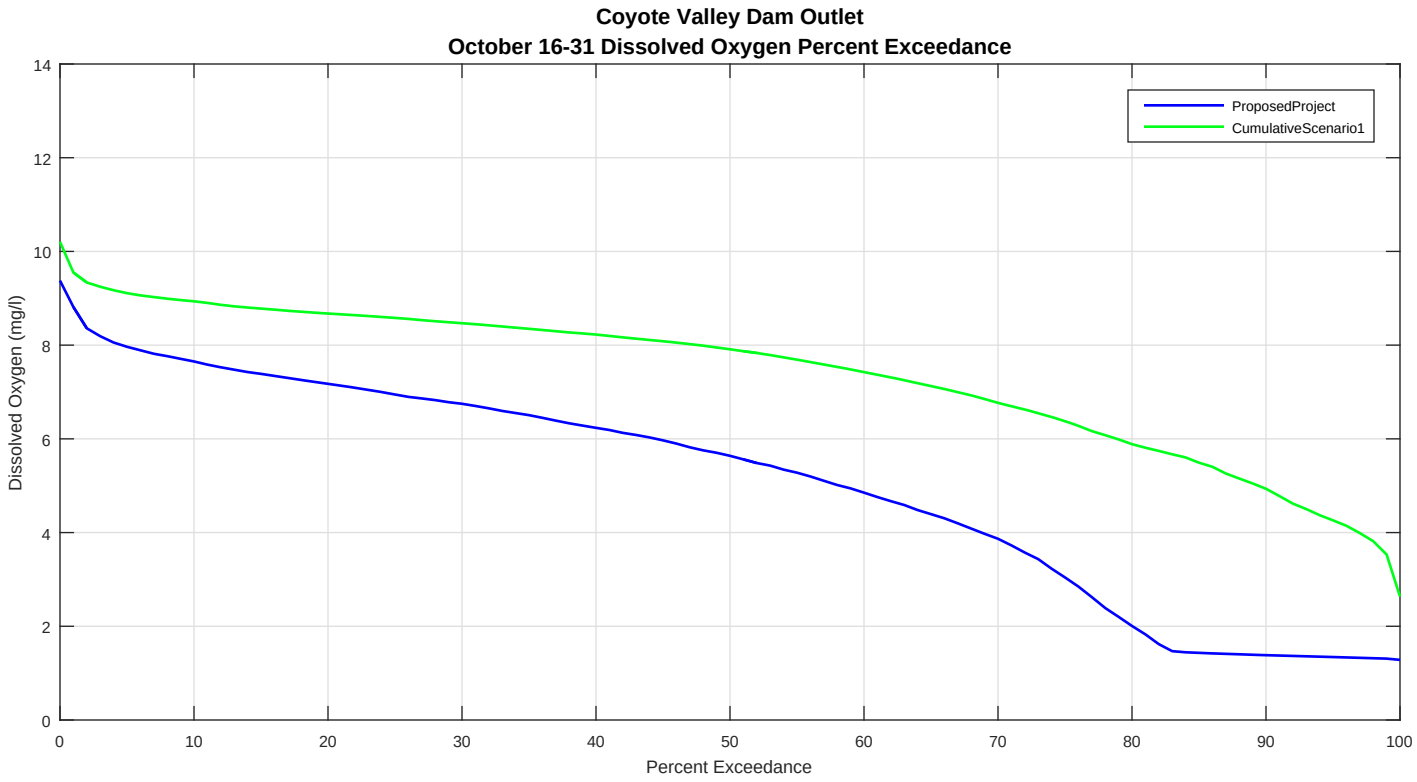
Coyote Valley Dam Outlet
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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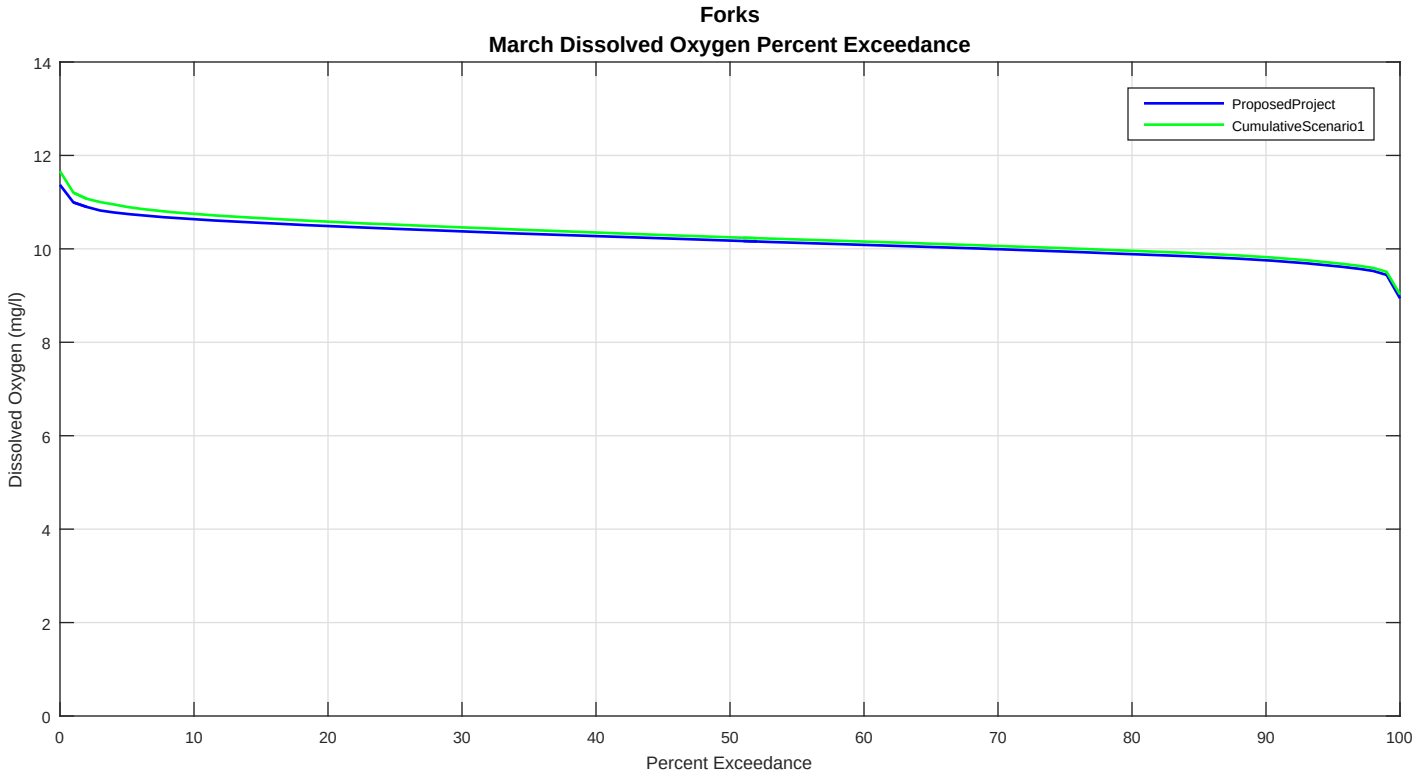
Forks
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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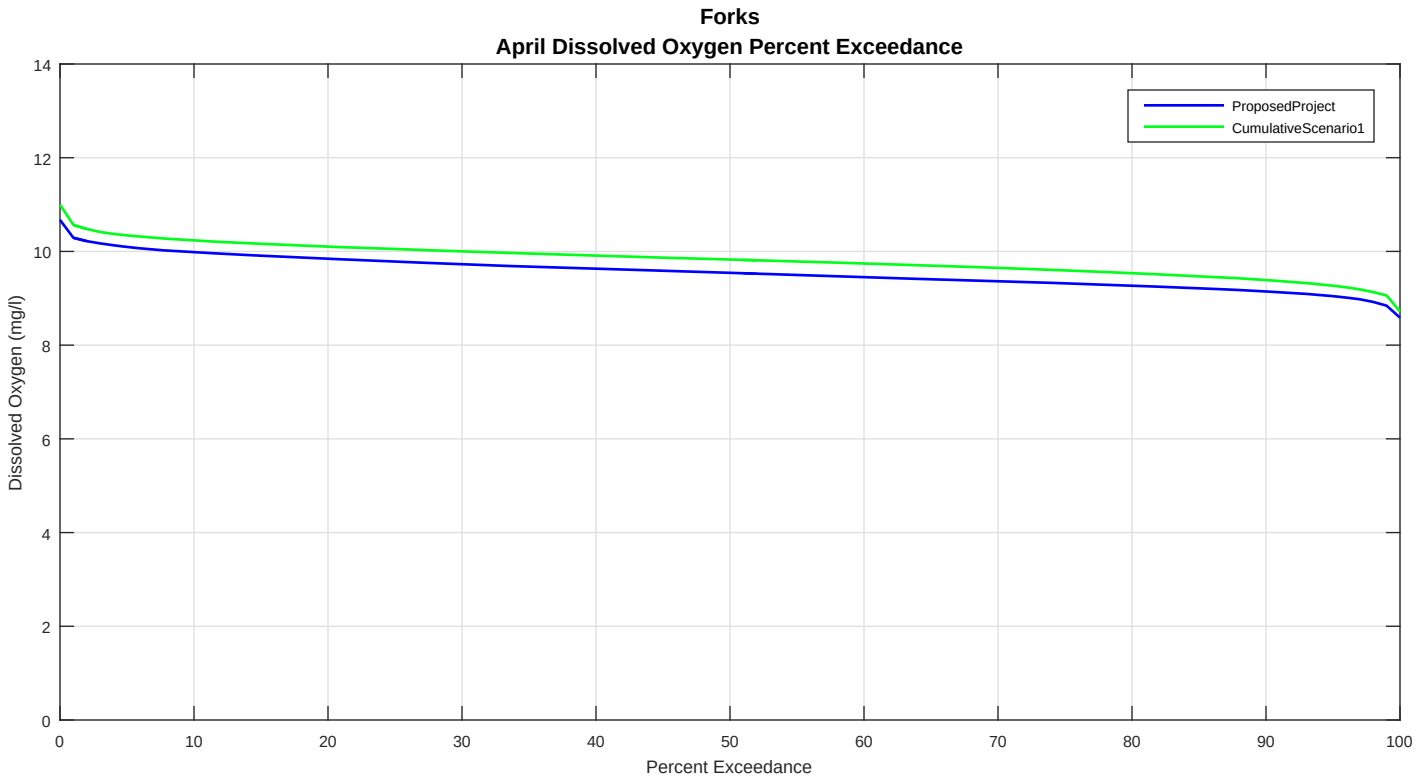
Forks
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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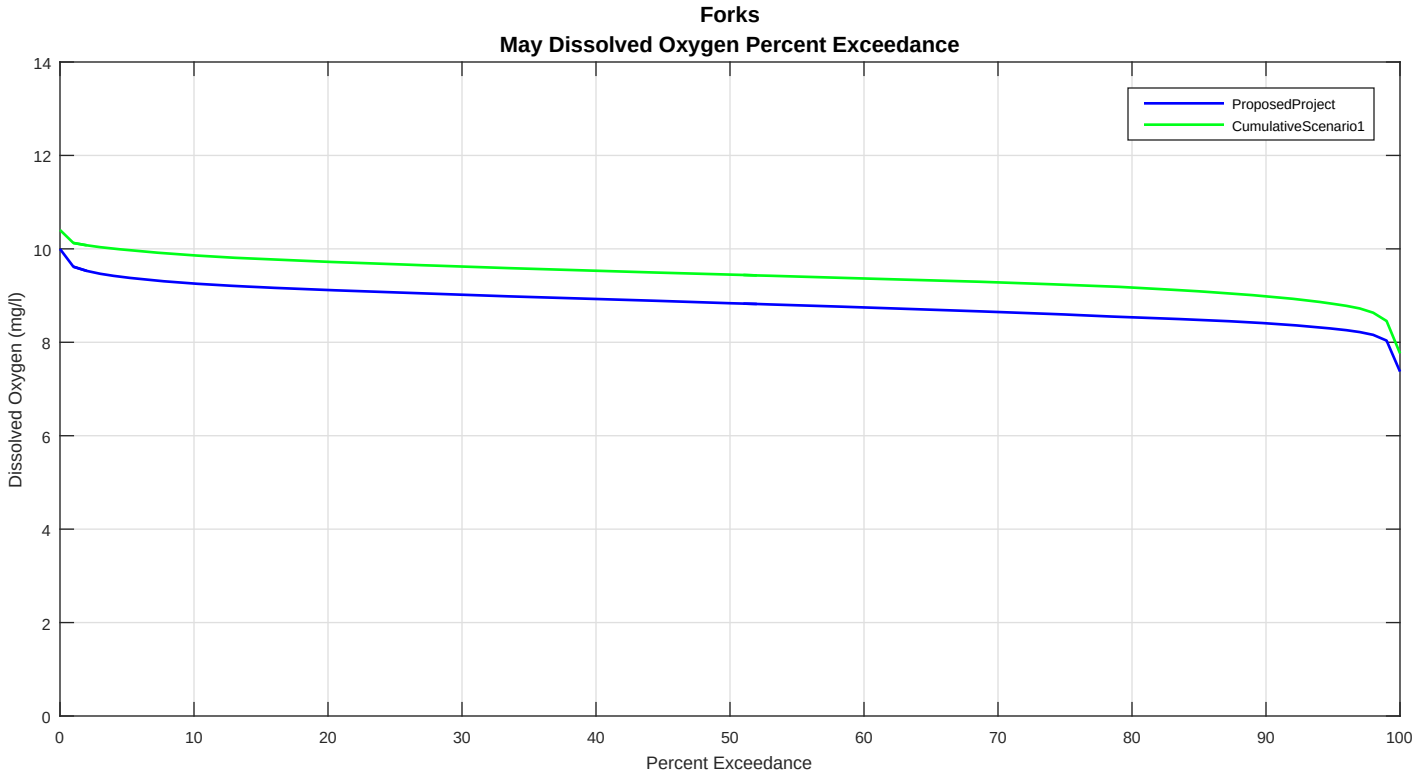
Forks
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
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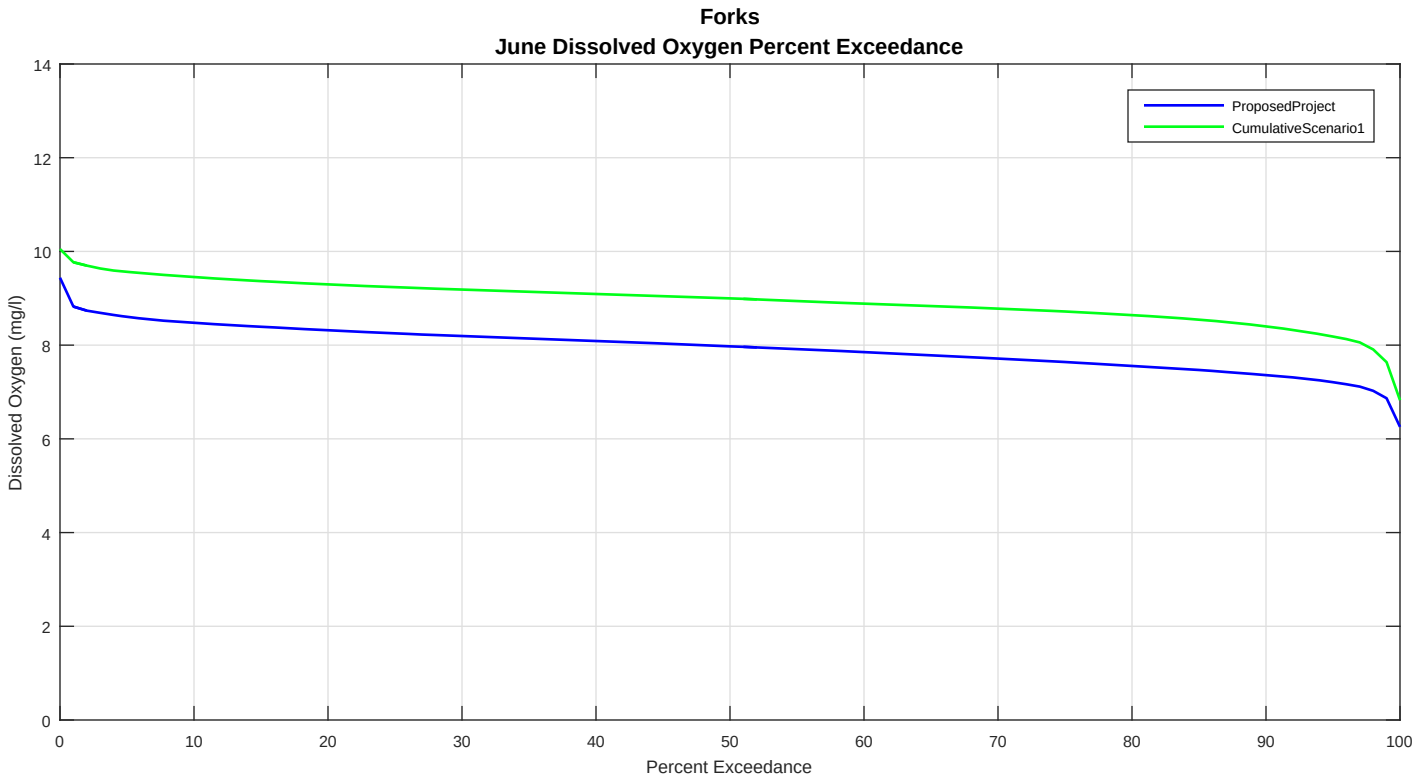
Forks
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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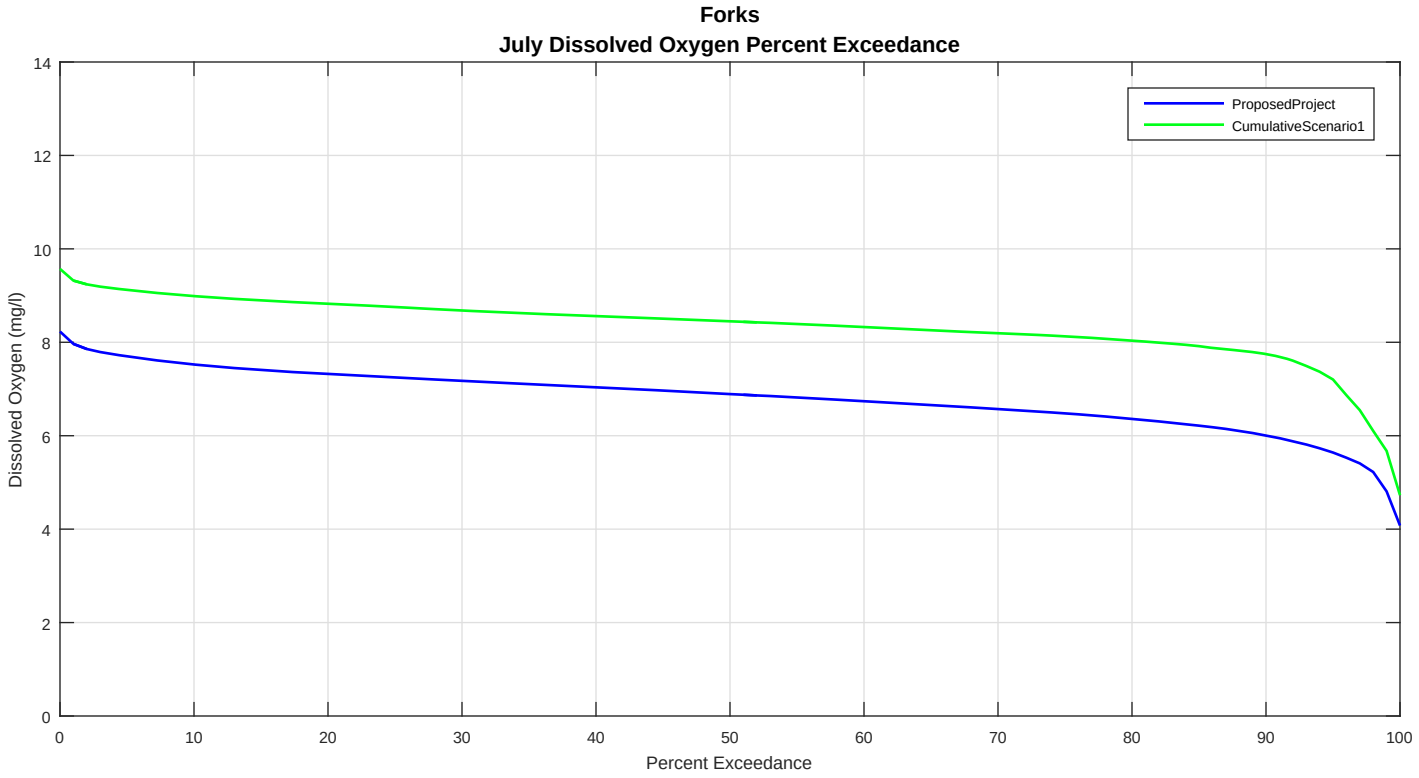
Forks
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
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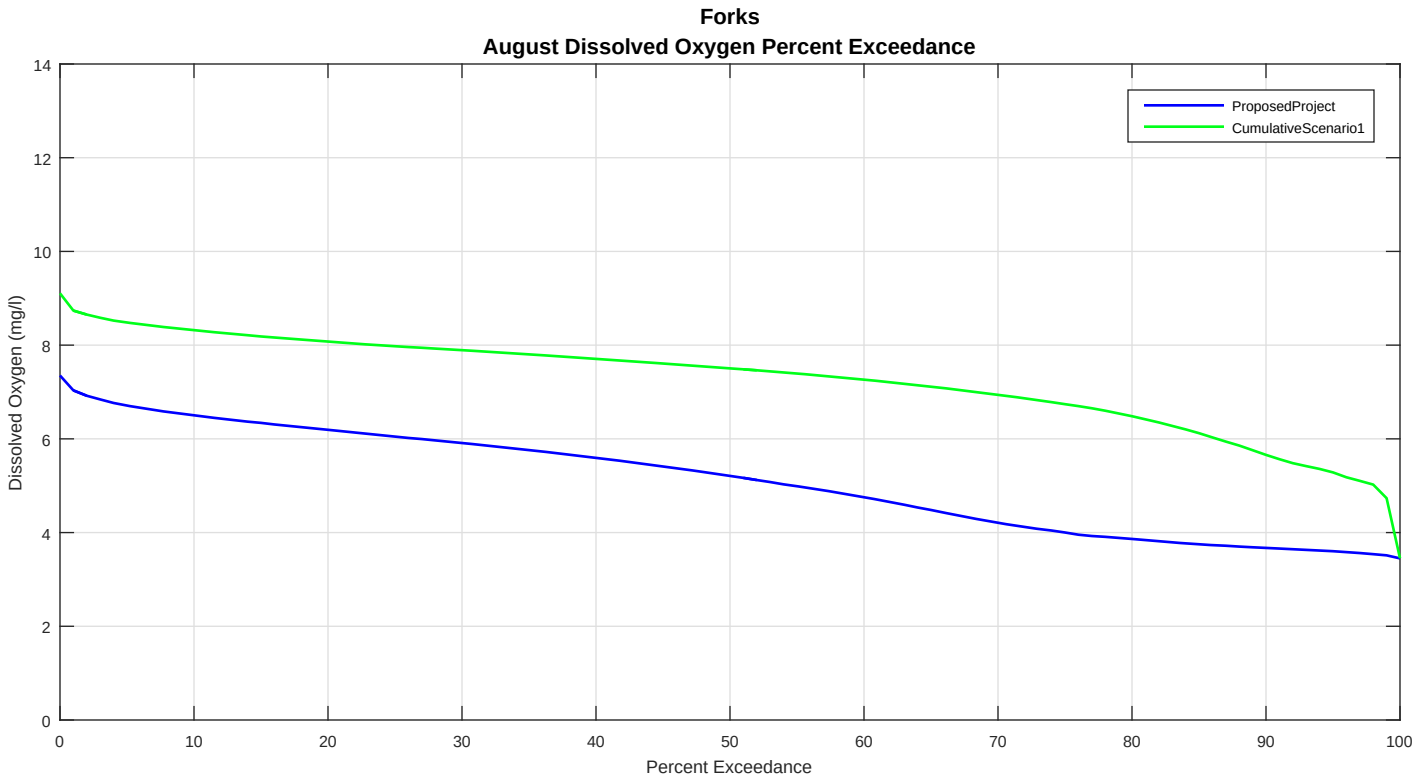
Forks
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
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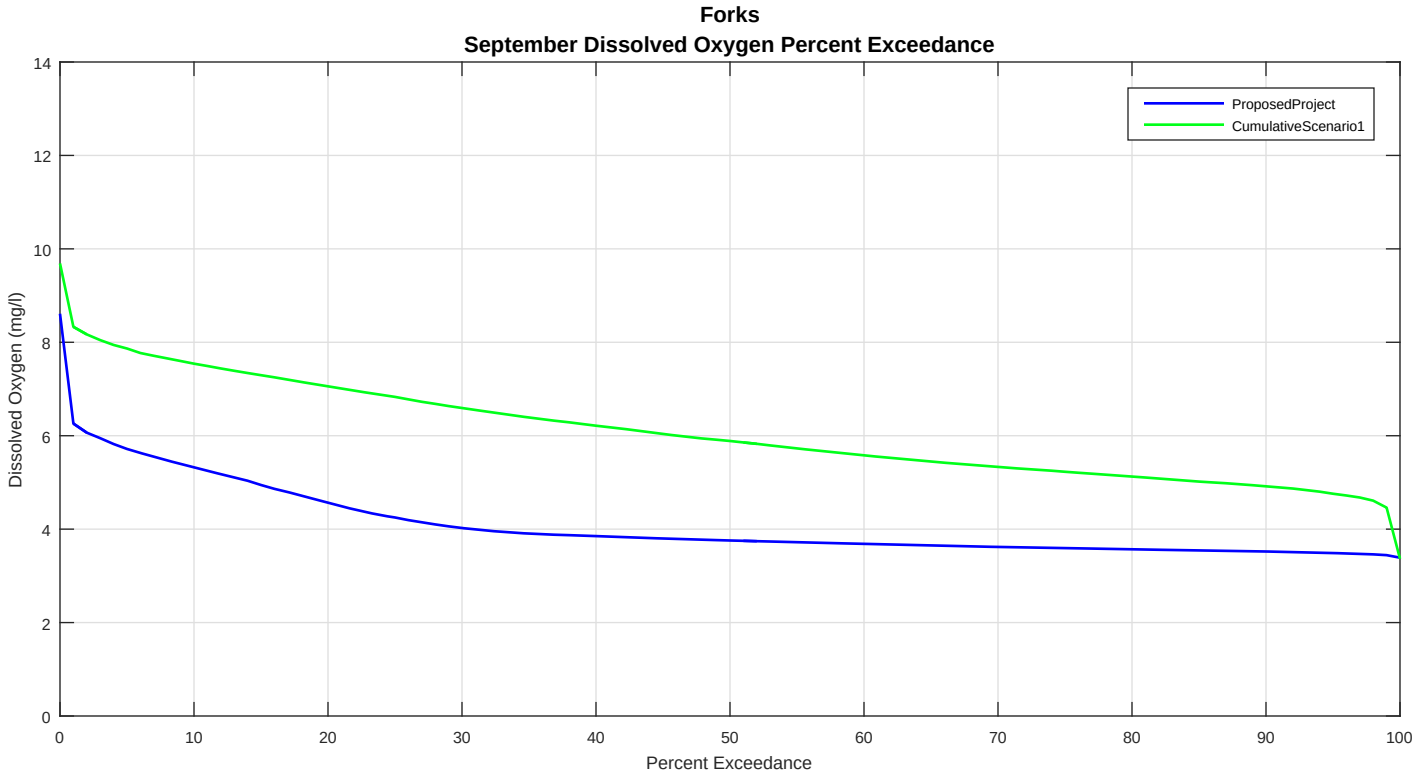
Forks
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
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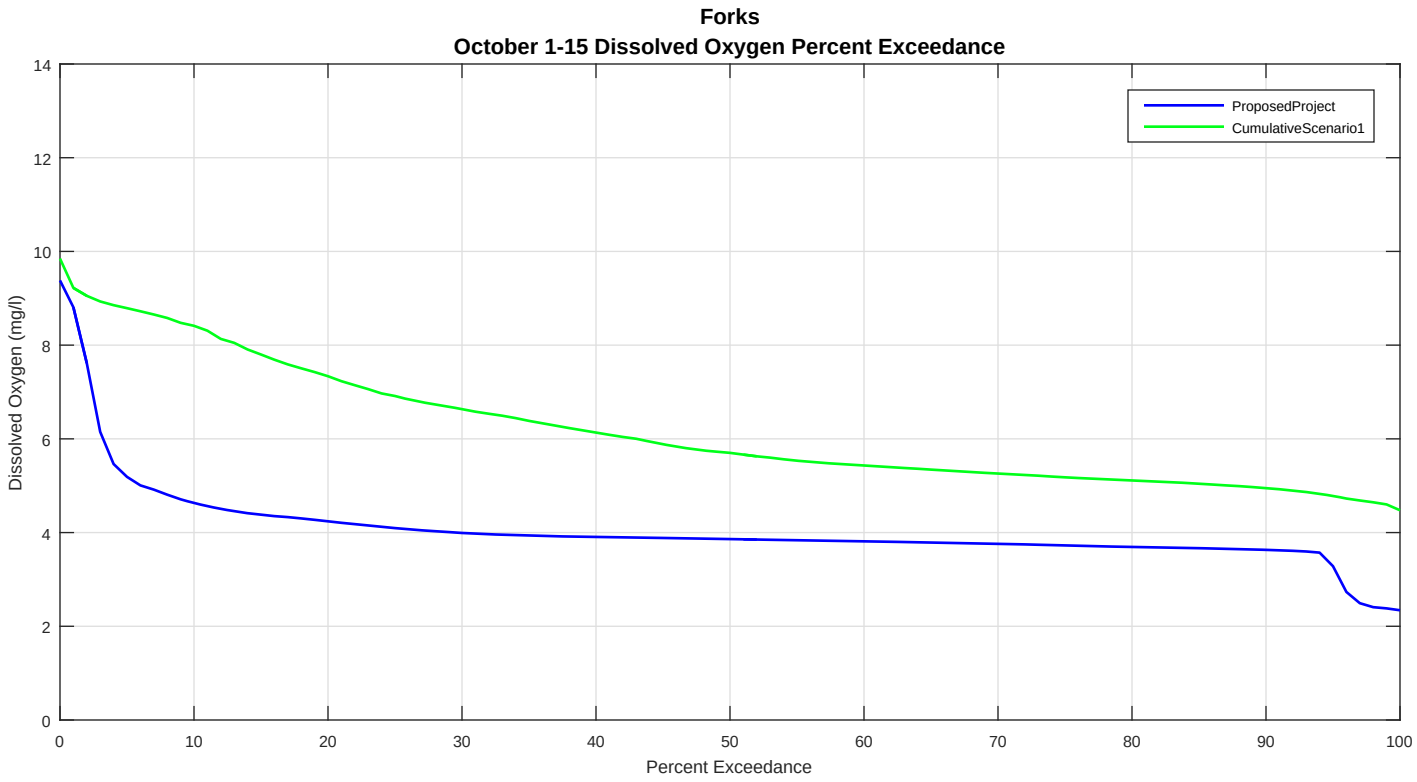
Forks
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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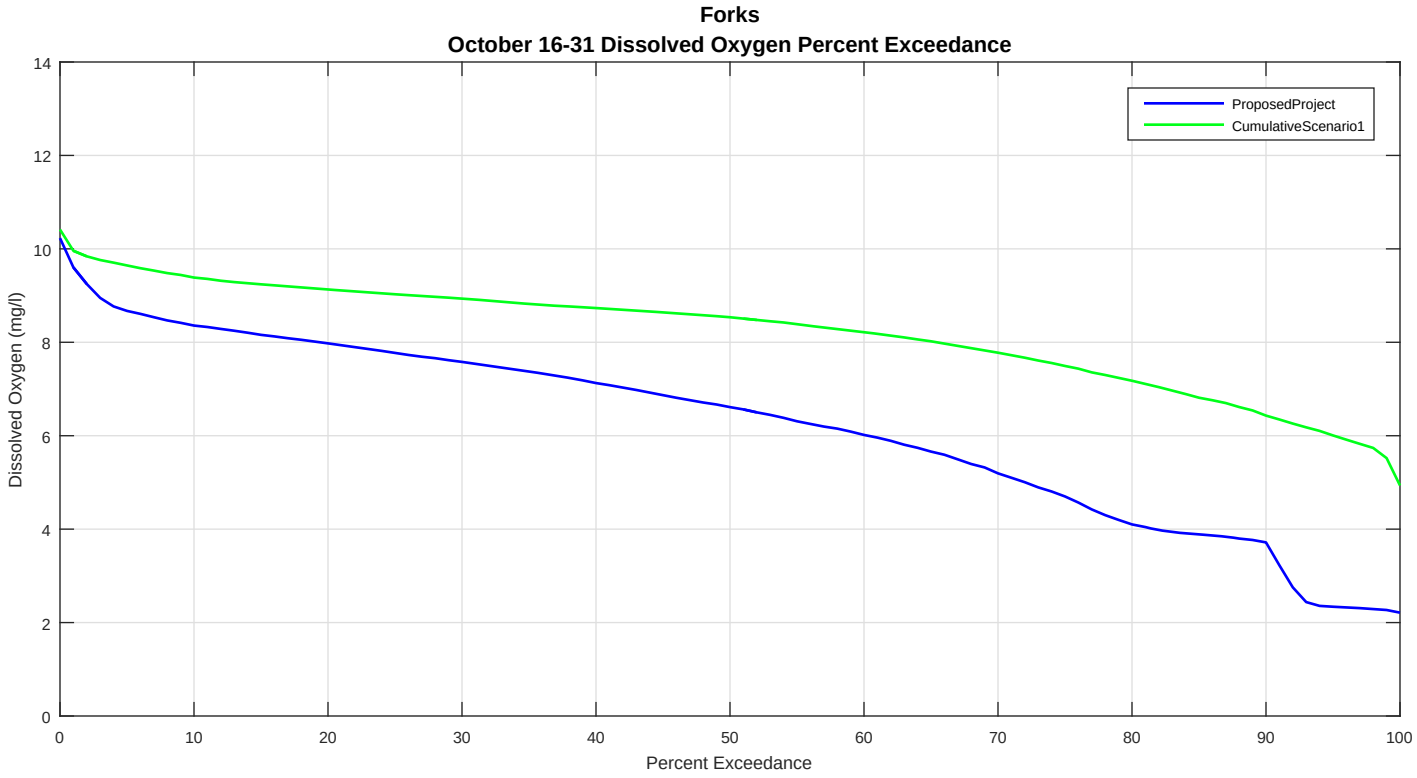
Forks
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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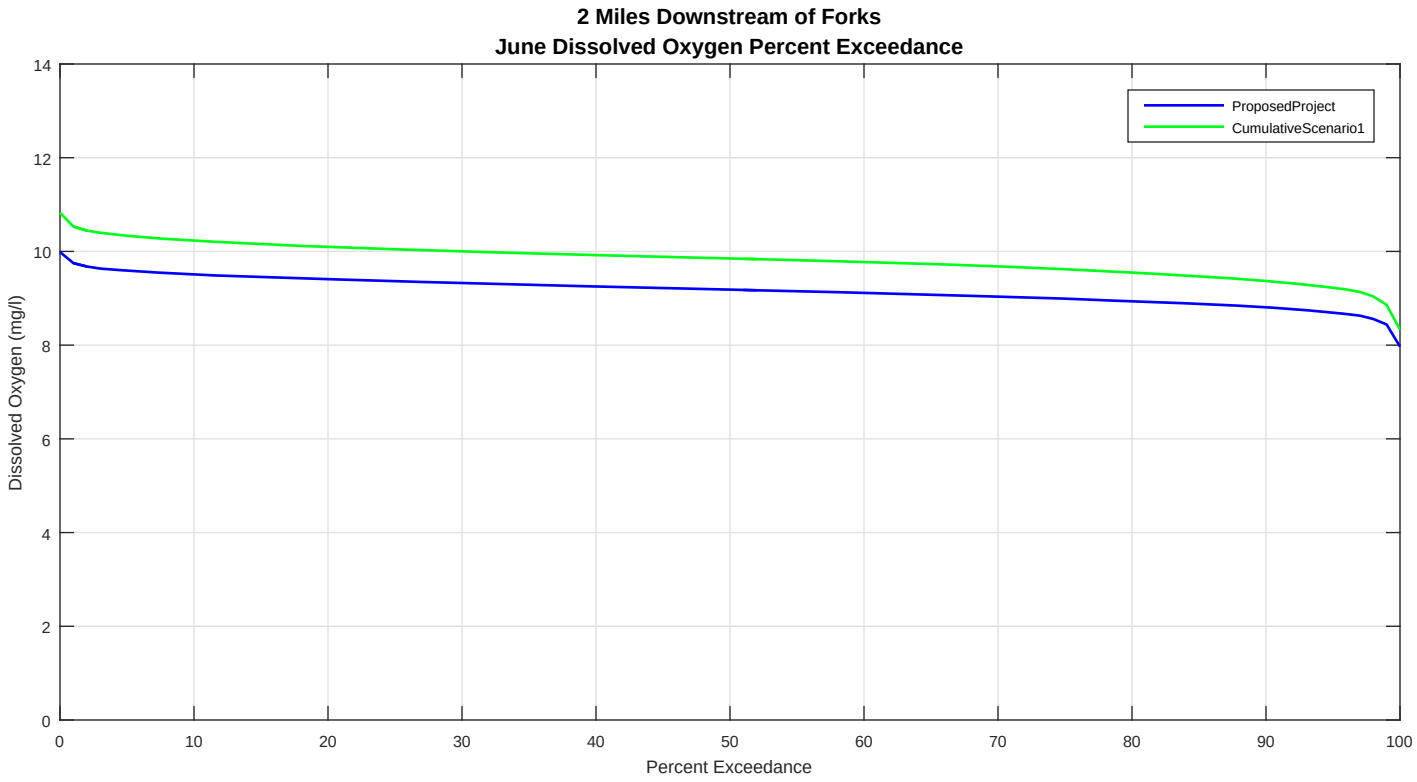
2 Miles Downstream of Forks
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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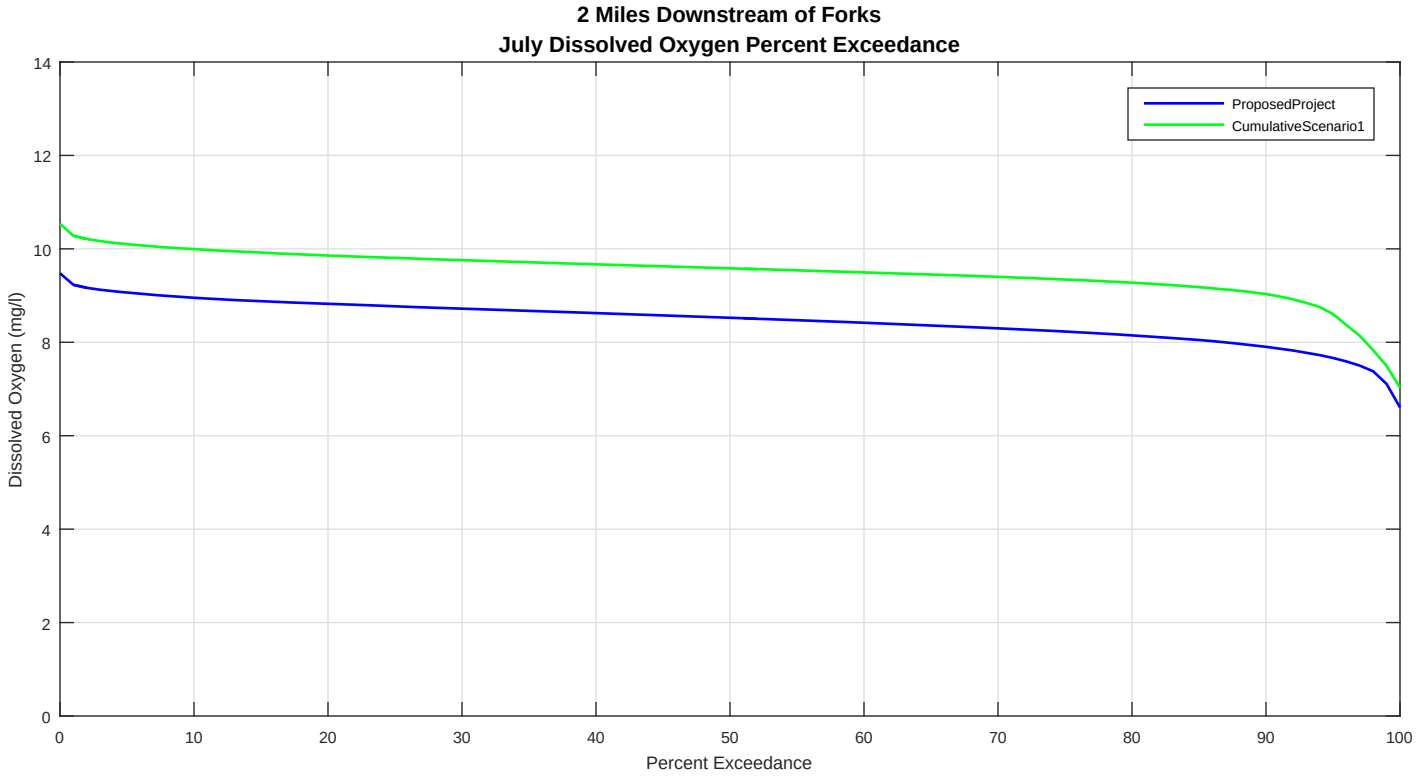
2 Miles Downstream of Forks
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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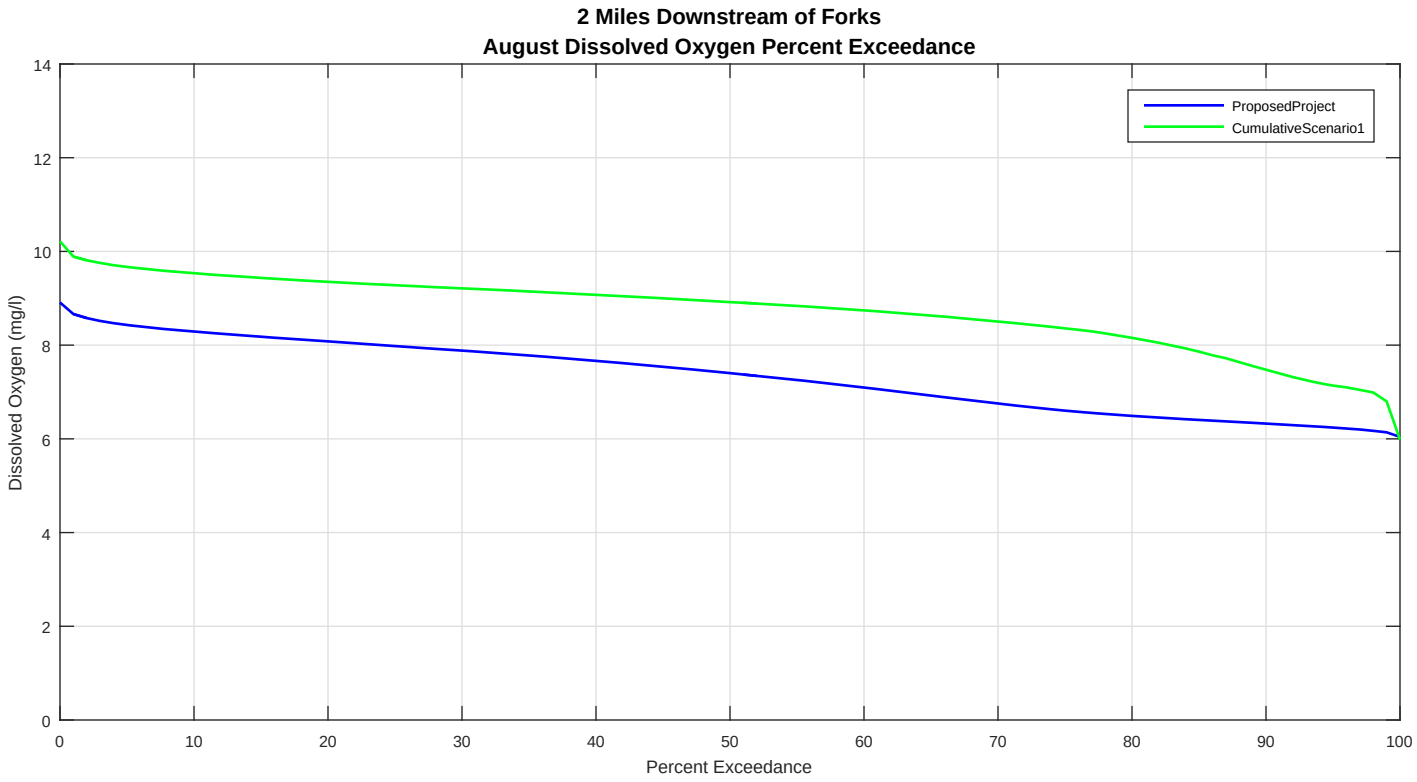
2 Miles Downstream of Forks
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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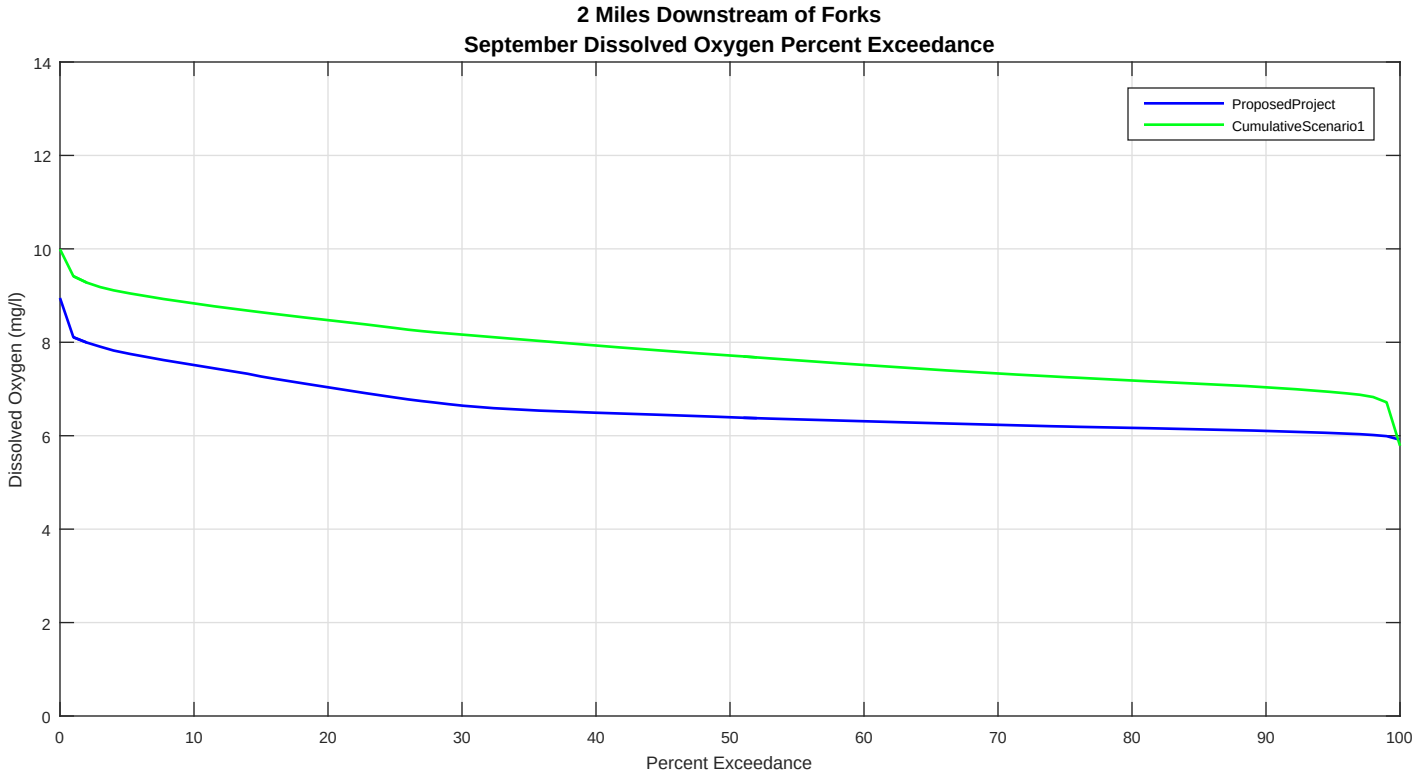
2 Miles Downstream of Forks
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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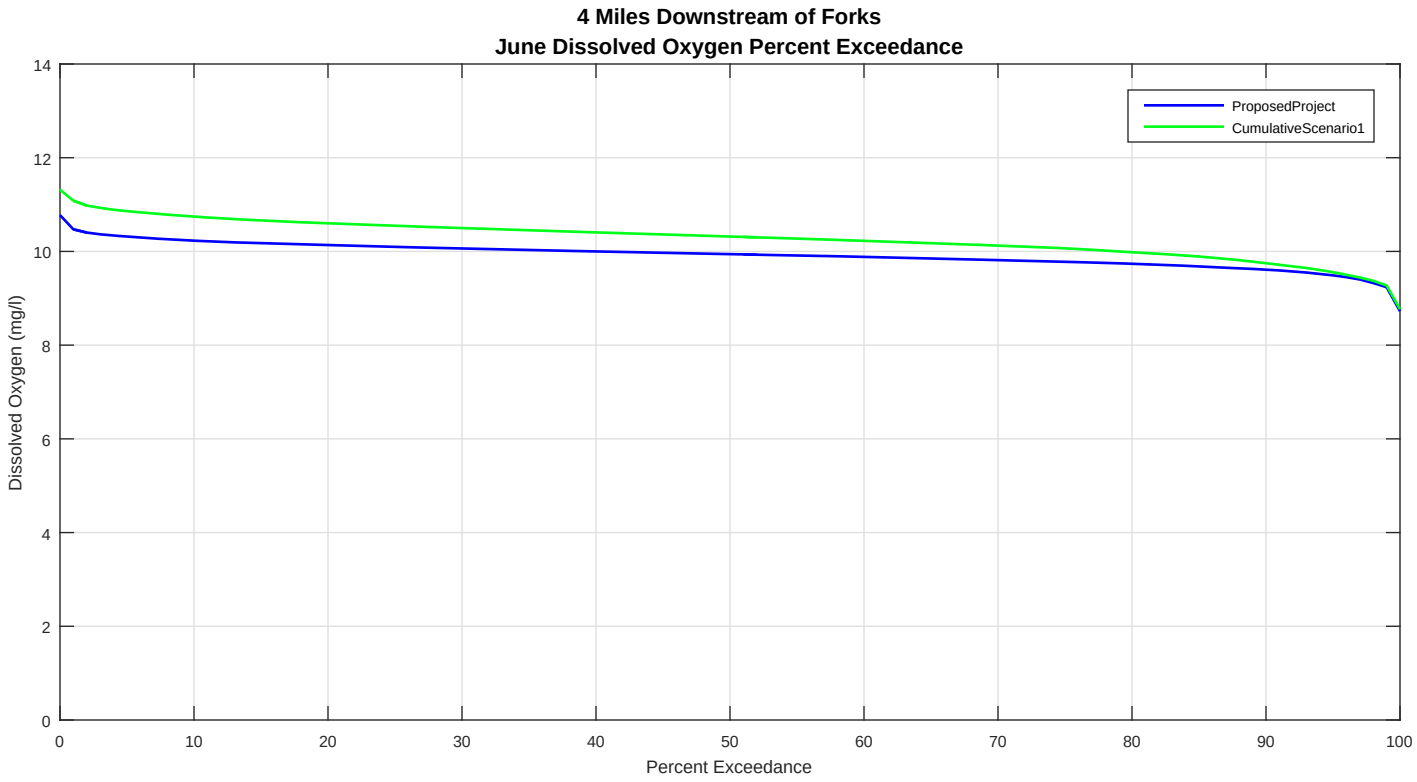
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June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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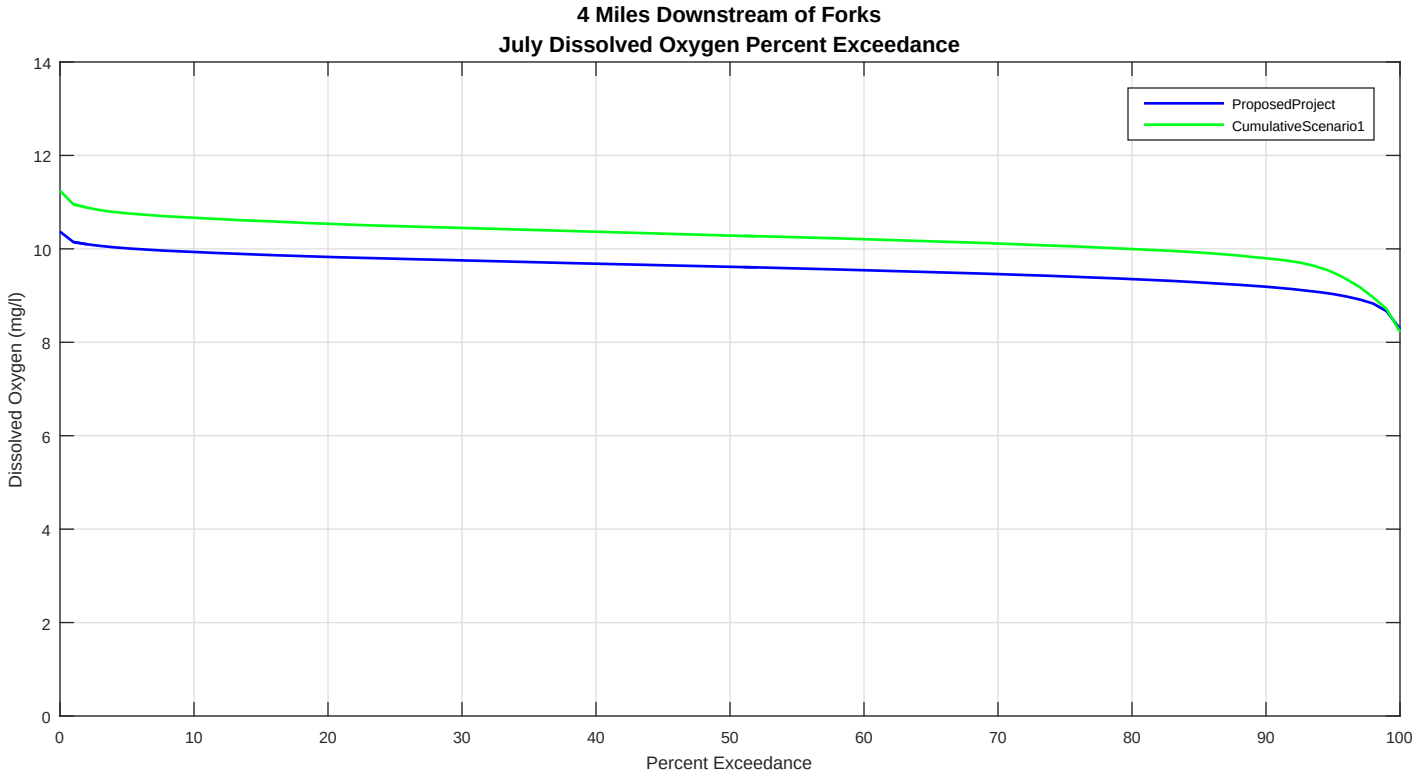
4 Miles Downstream of Forks
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
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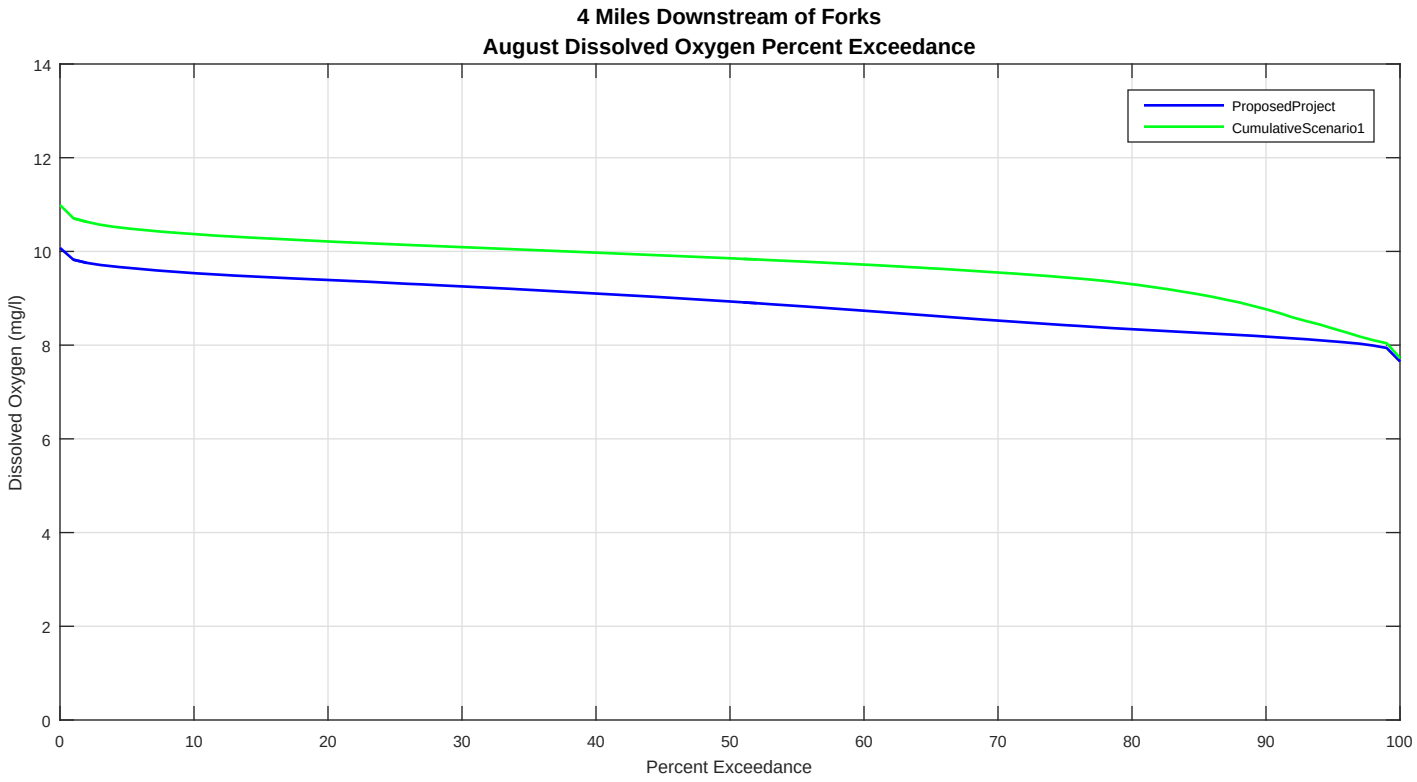
4 Miles Downstream of Forks
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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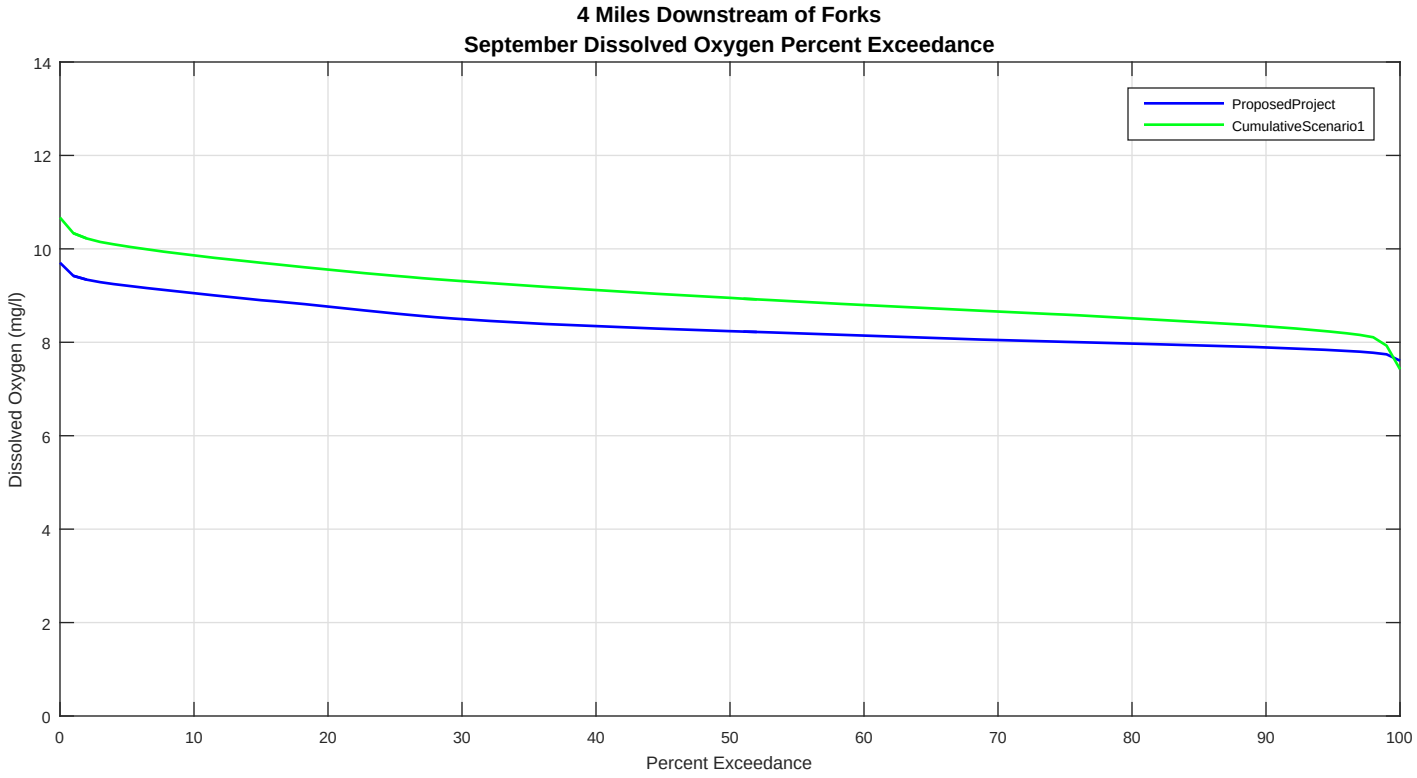
4 Miles Downstream of Forks
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
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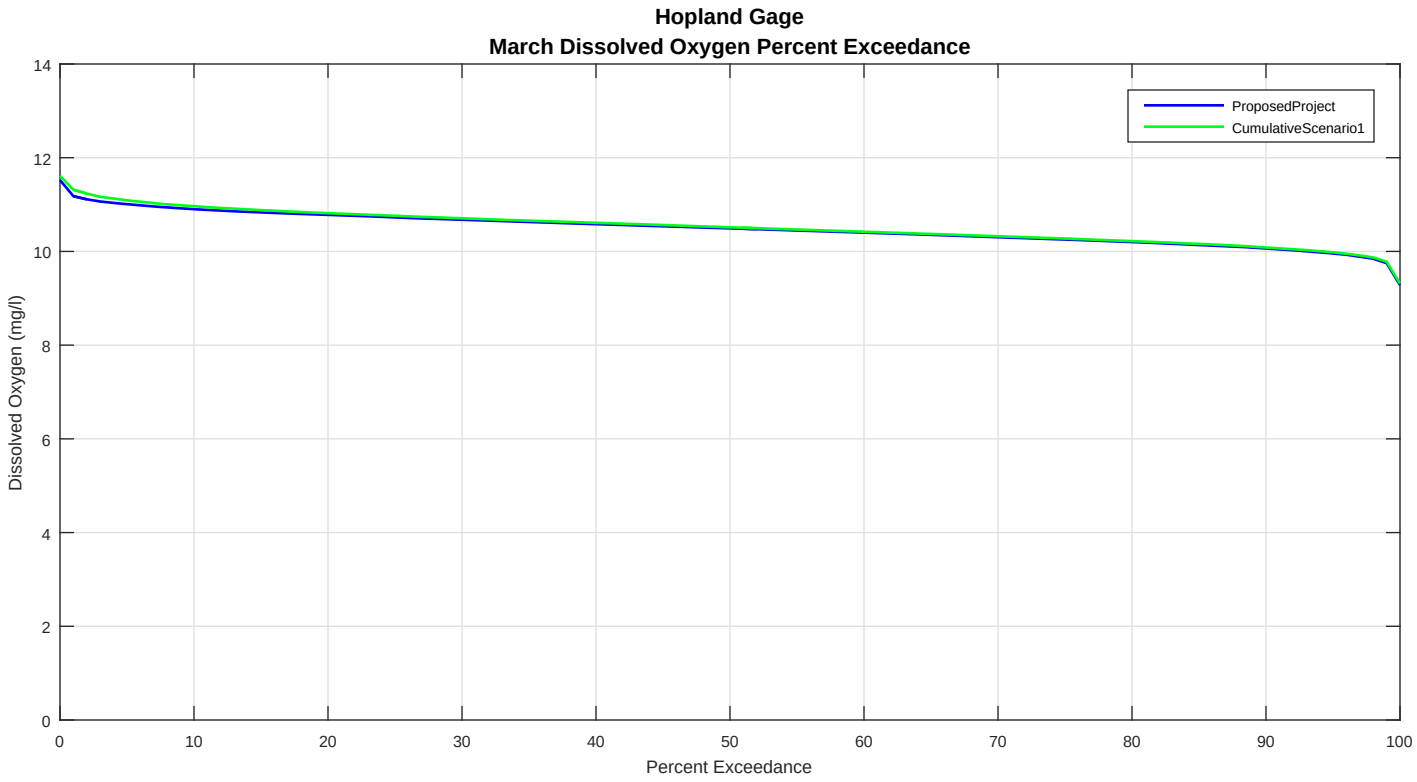
Hopland Gage
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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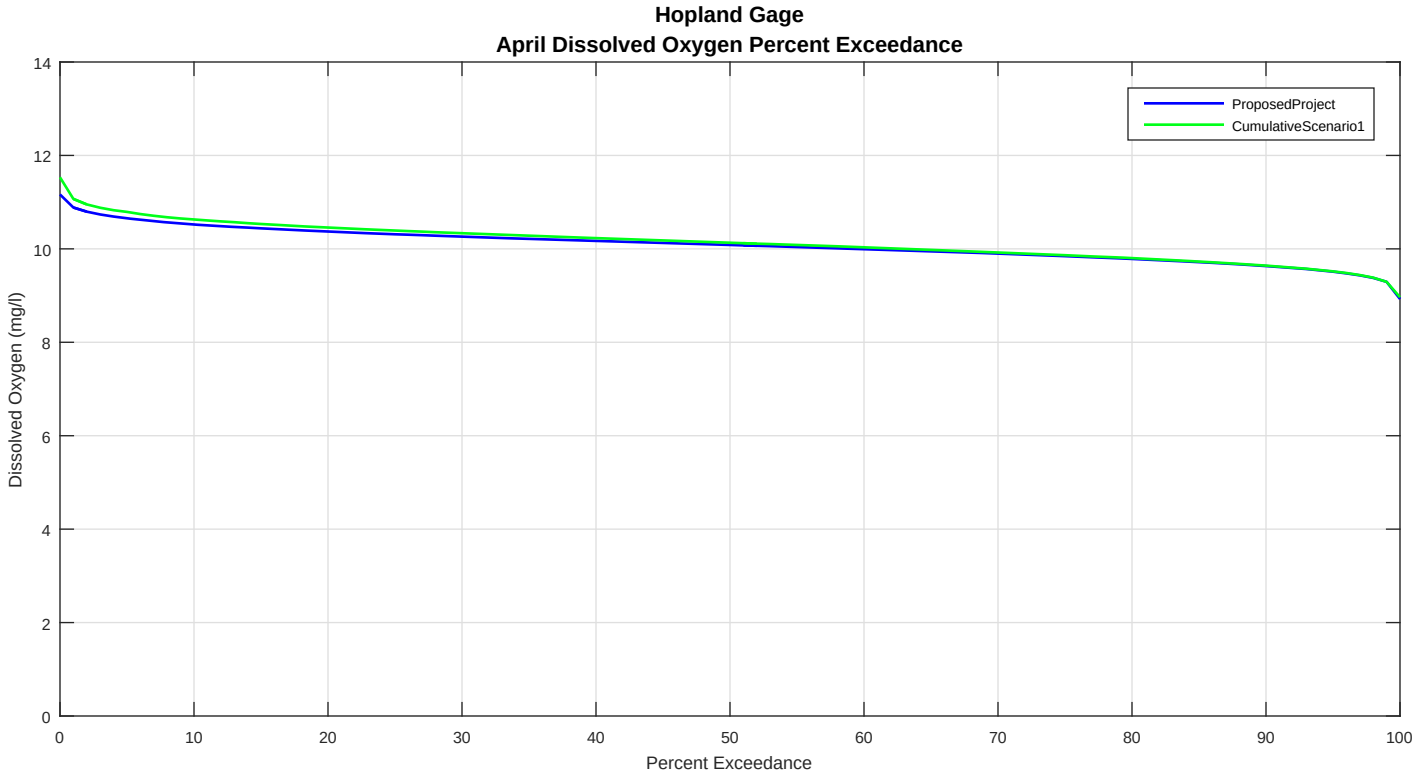
Hopland Gage
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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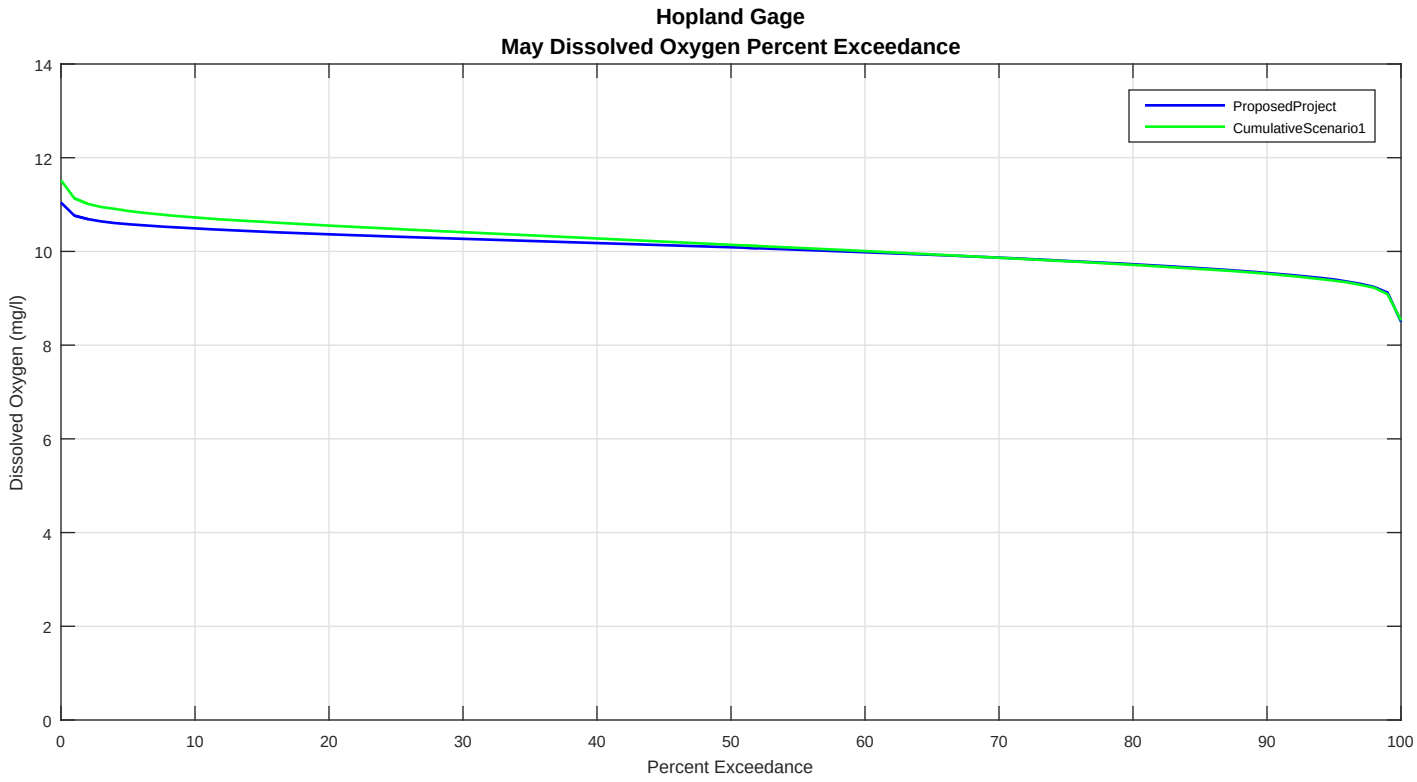
Hopland Gage
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
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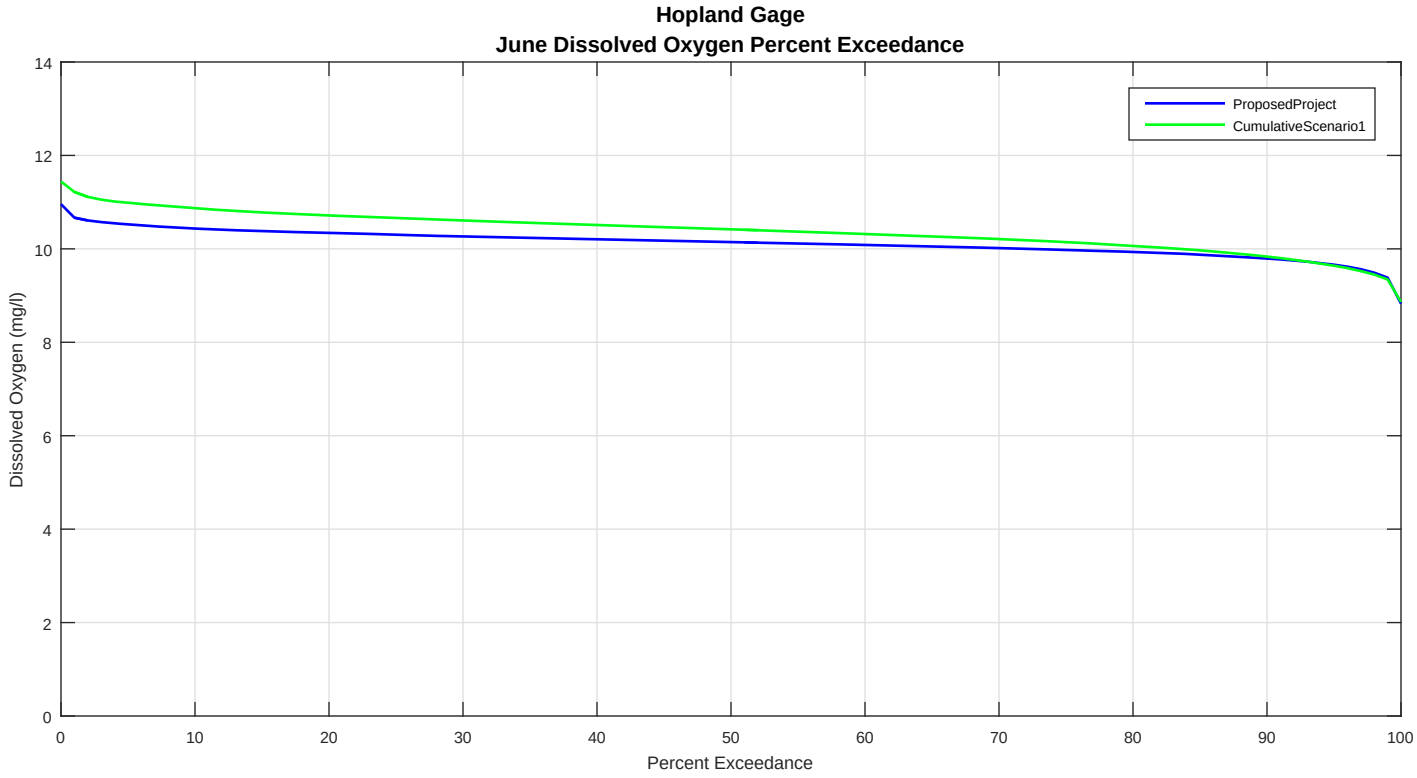
Hopland Gage
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
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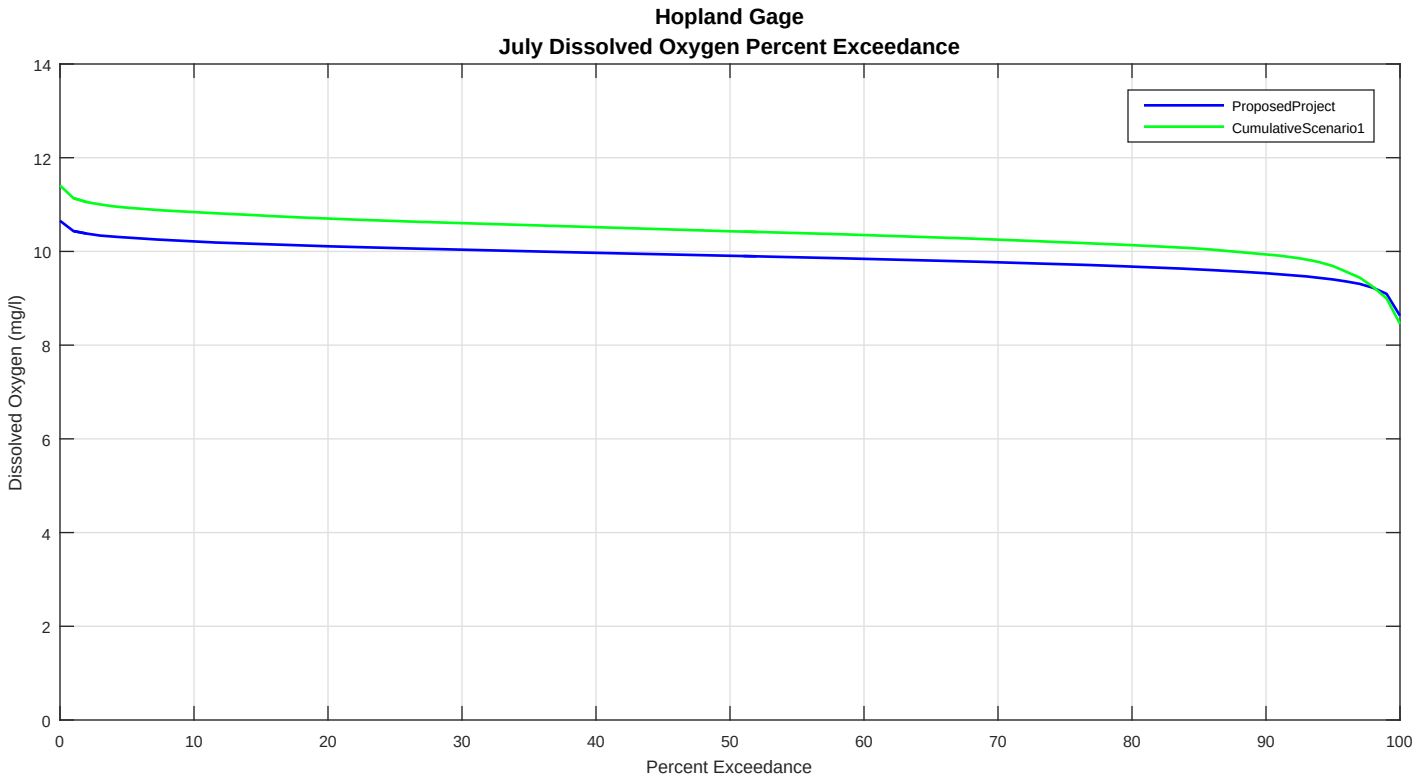
Hopland Gage
July Dissolved Oxygen Percent Exceedance
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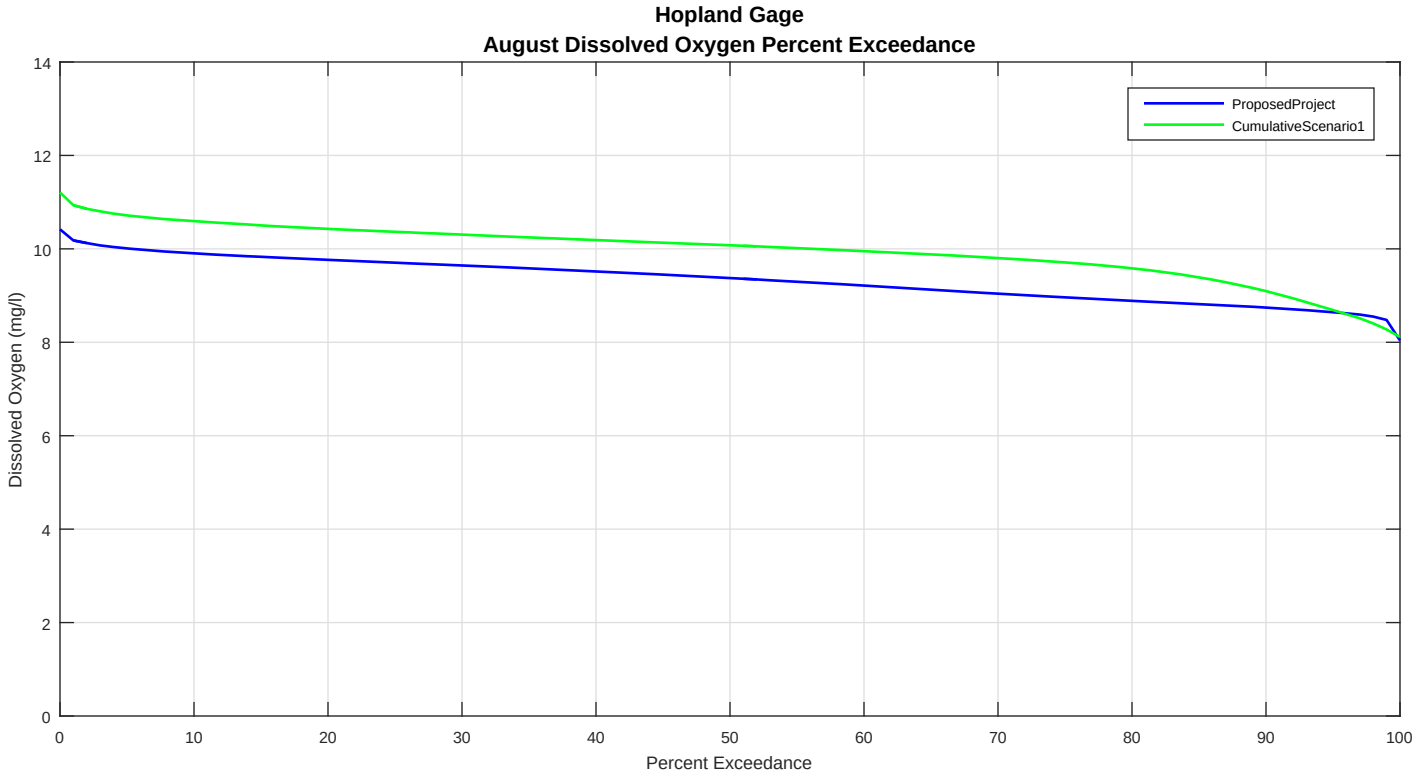
Hopland Gage
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
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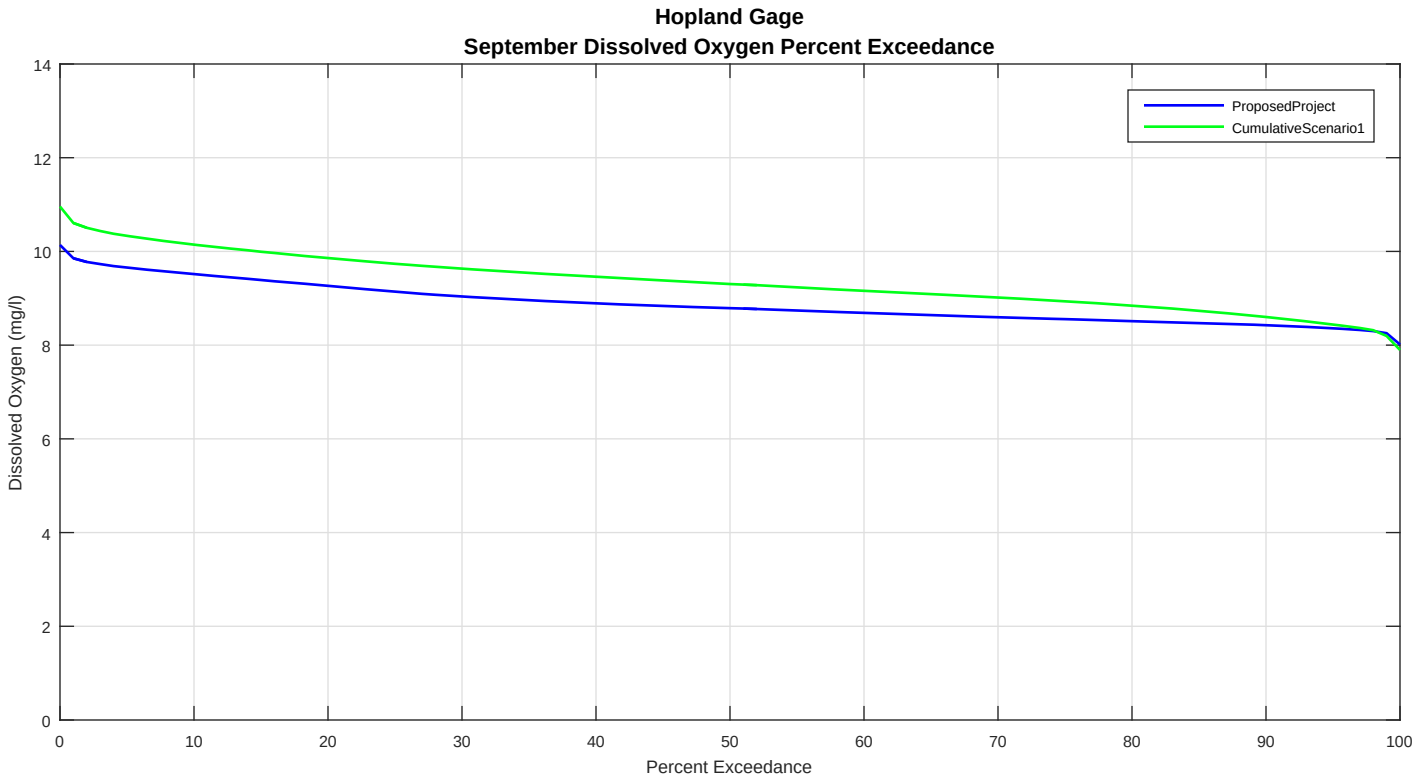
Hopland Gage
September Dissolved Oxygen Percent Exceedance
ProposedProject
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Dissolved Oxygen (mg/l)
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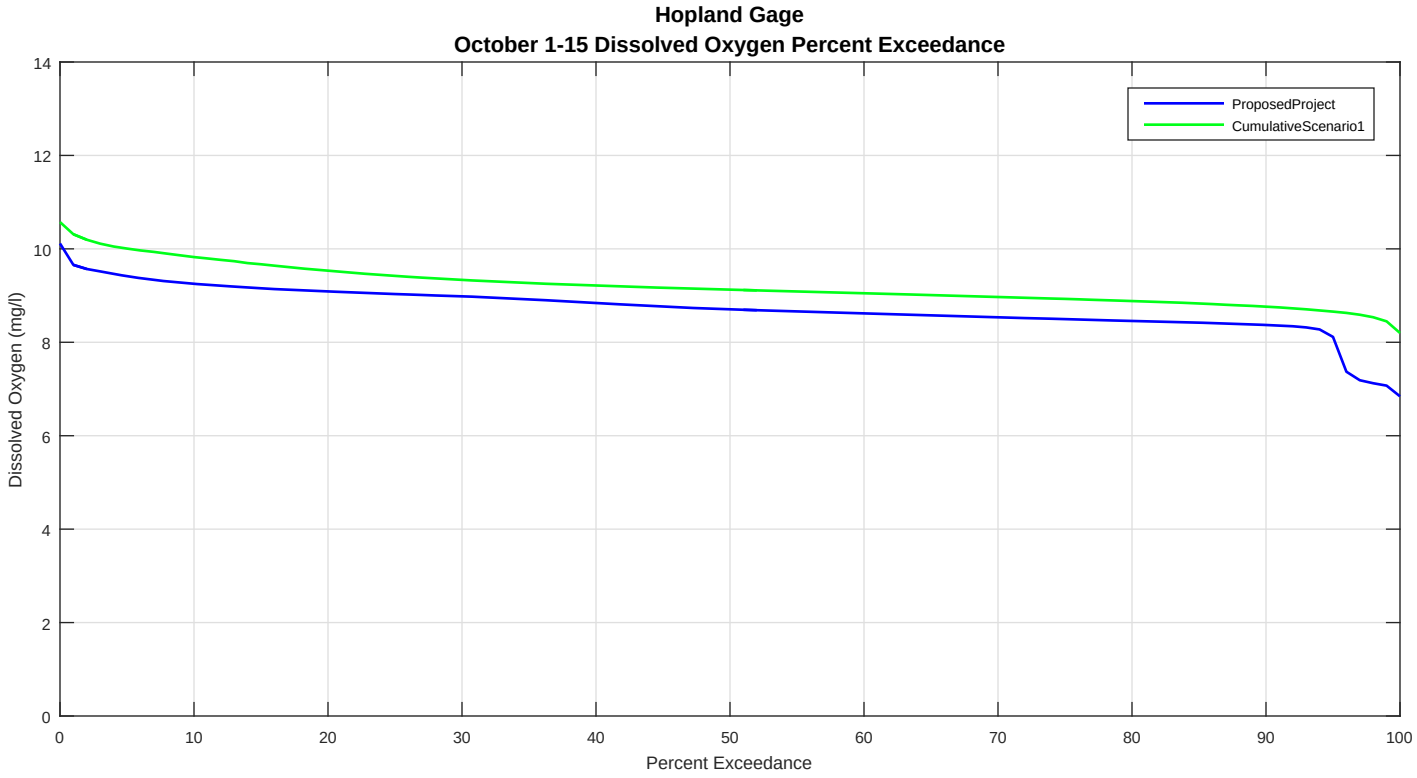
Hopland Gage
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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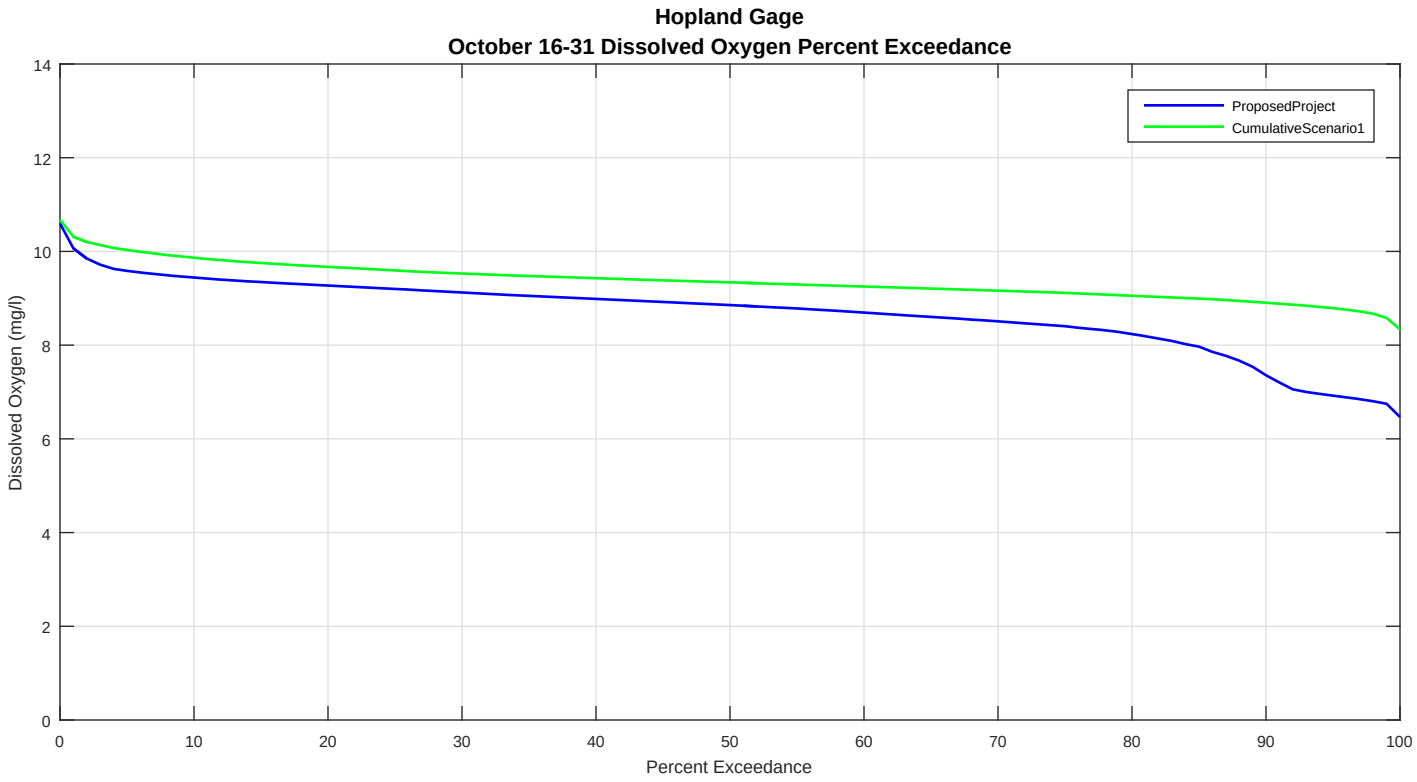
Hopland Gage
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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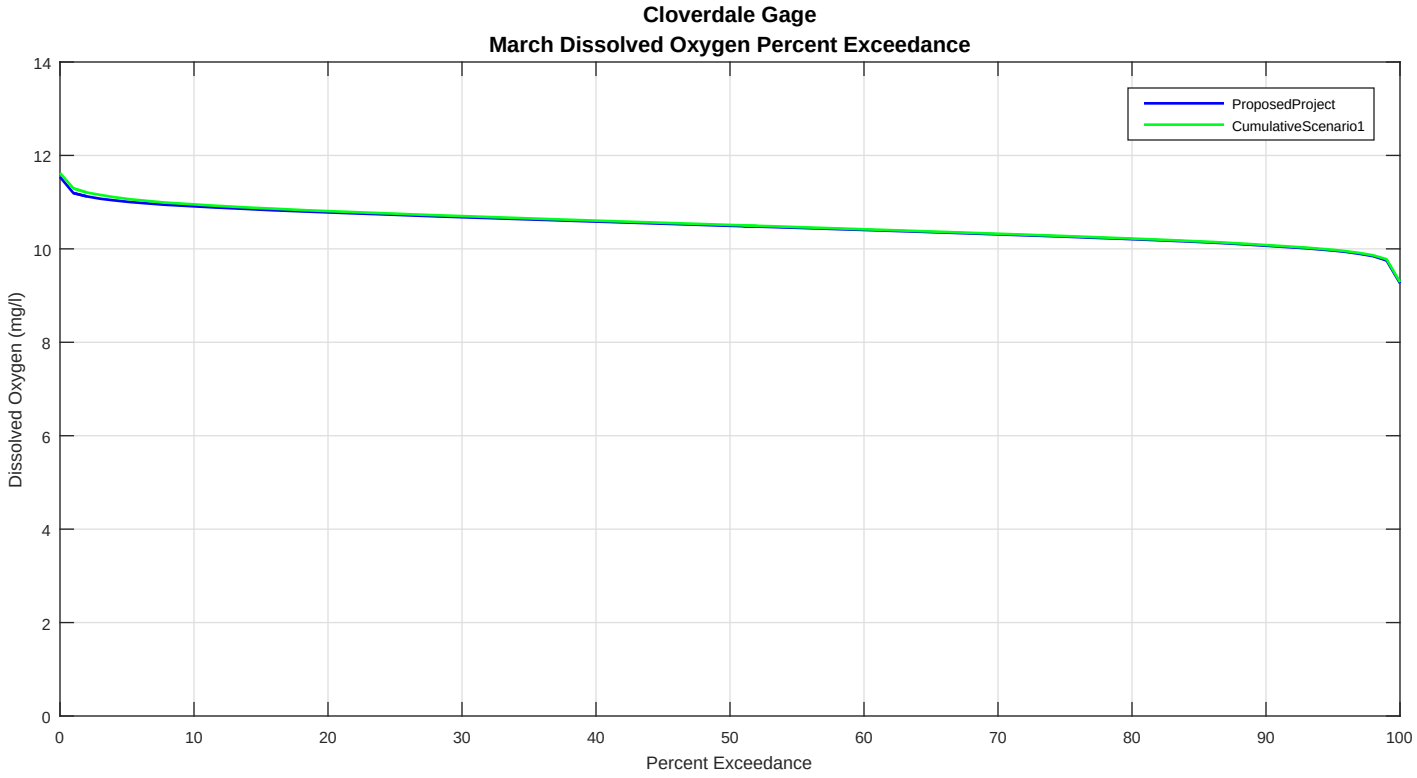
Cloverdale Gage
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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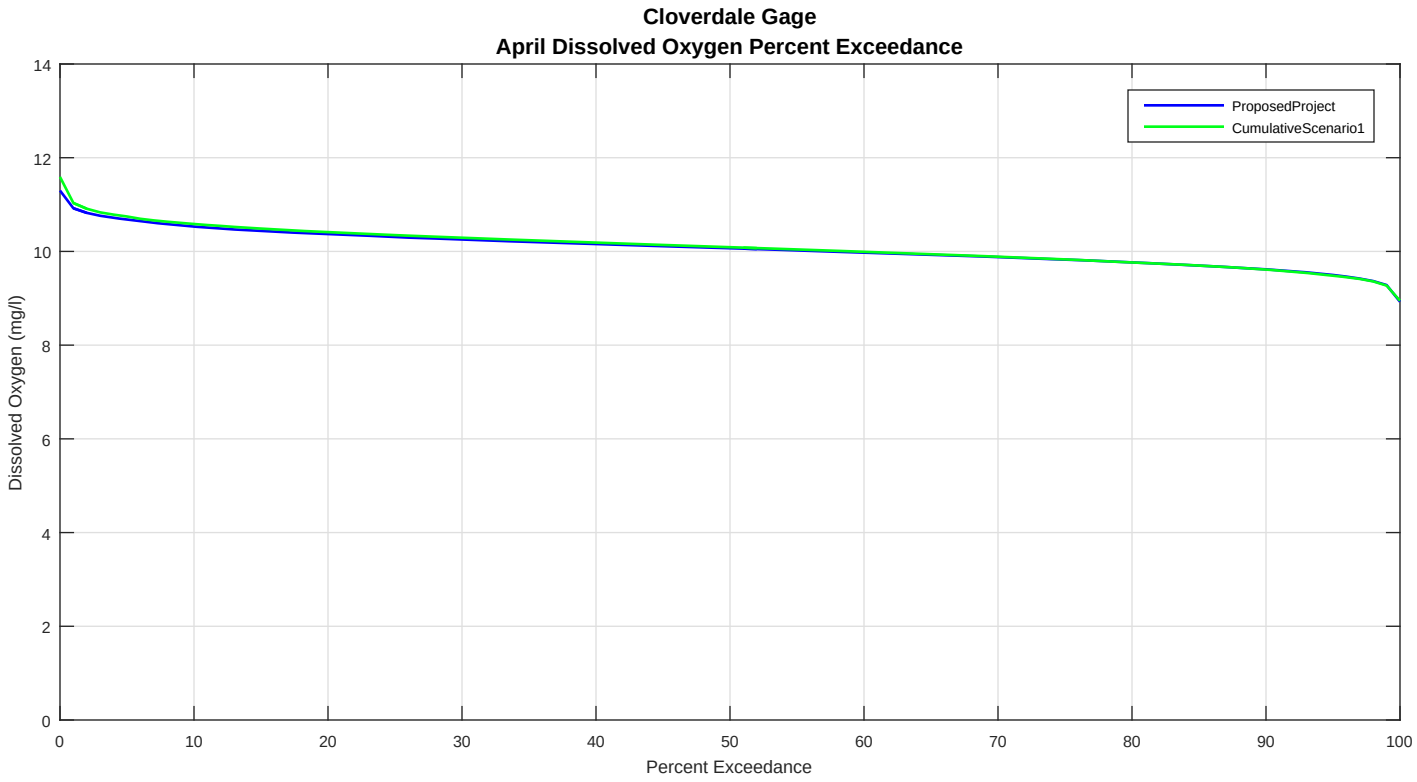
Cloverdale Gage
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
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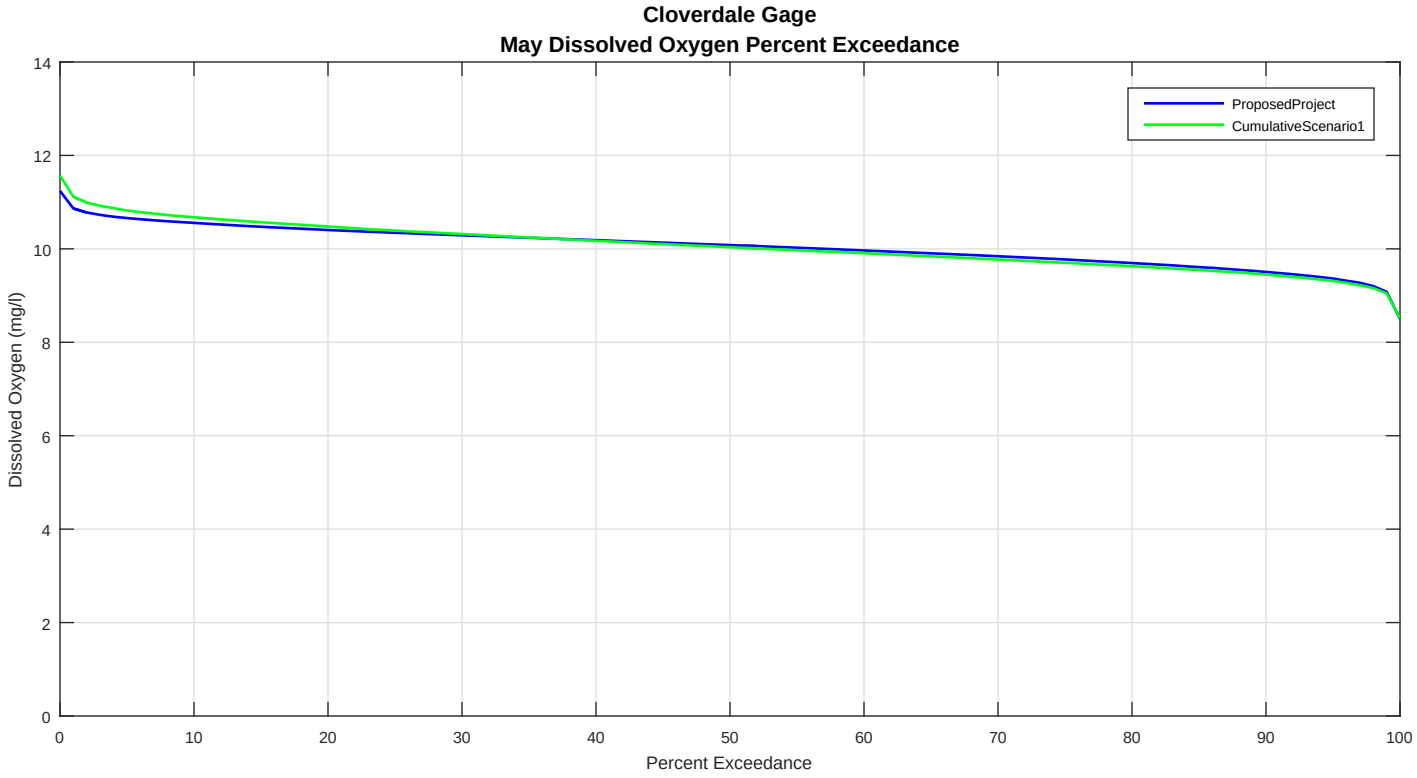
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May Dissolved Oxygen Percent Exceedance
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Dissolved Oxygen (mg/l)
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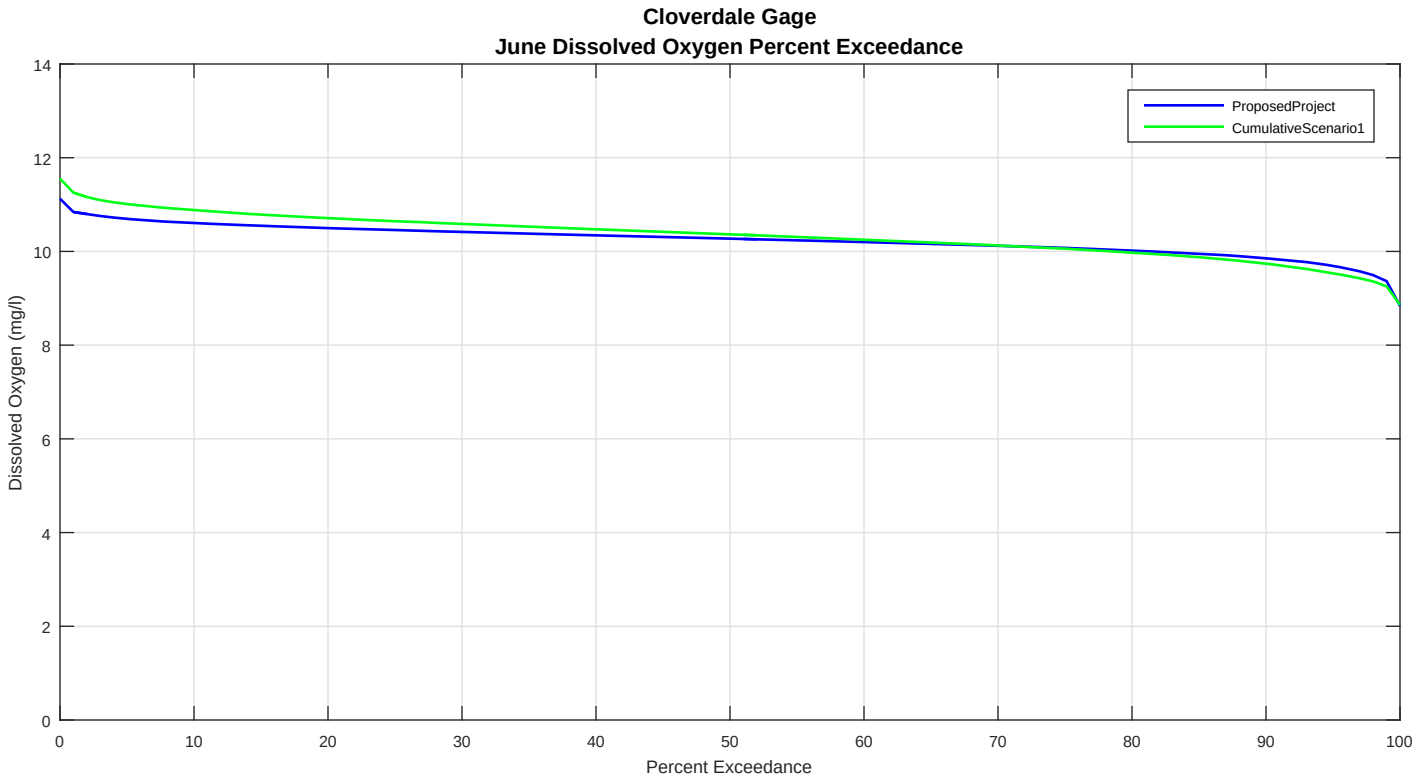
Cloverdale Gage
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
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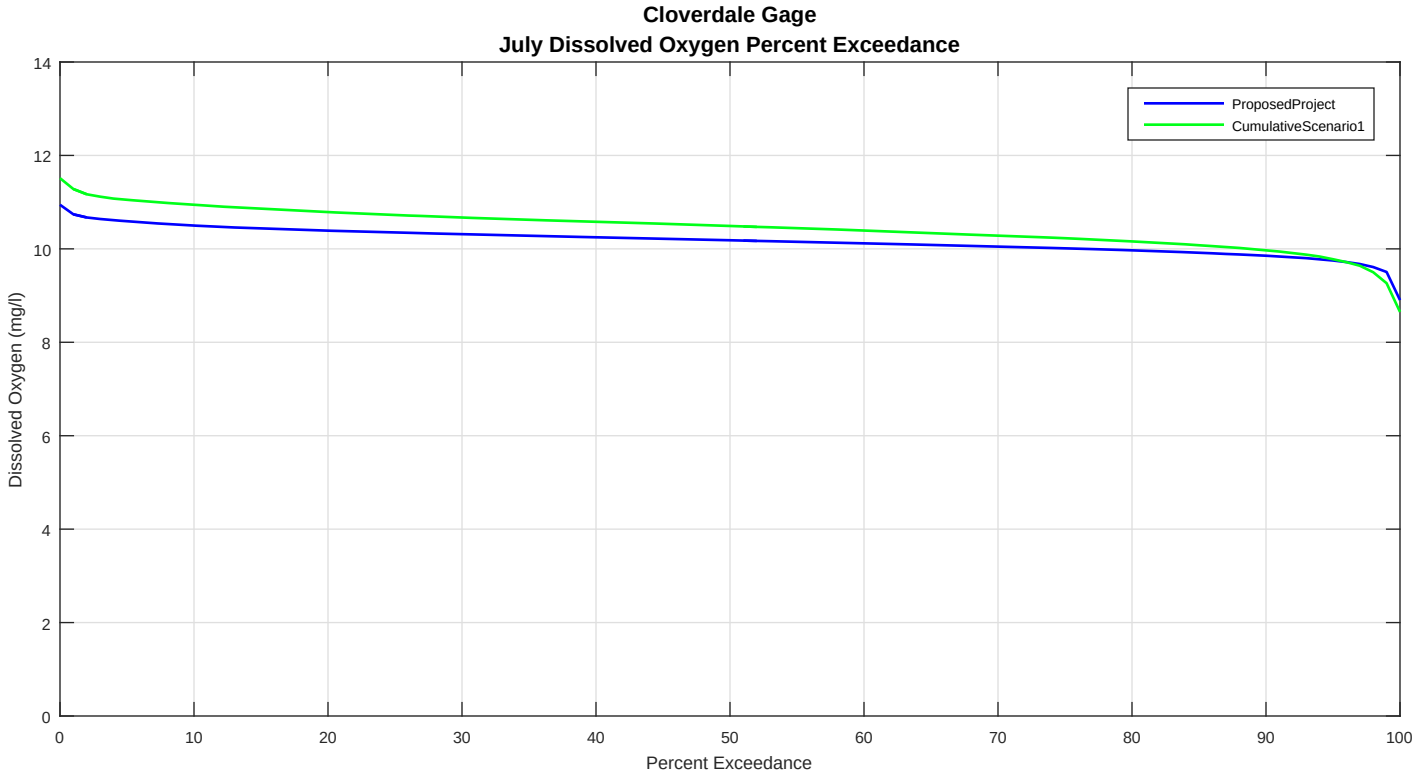
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ProposedProject
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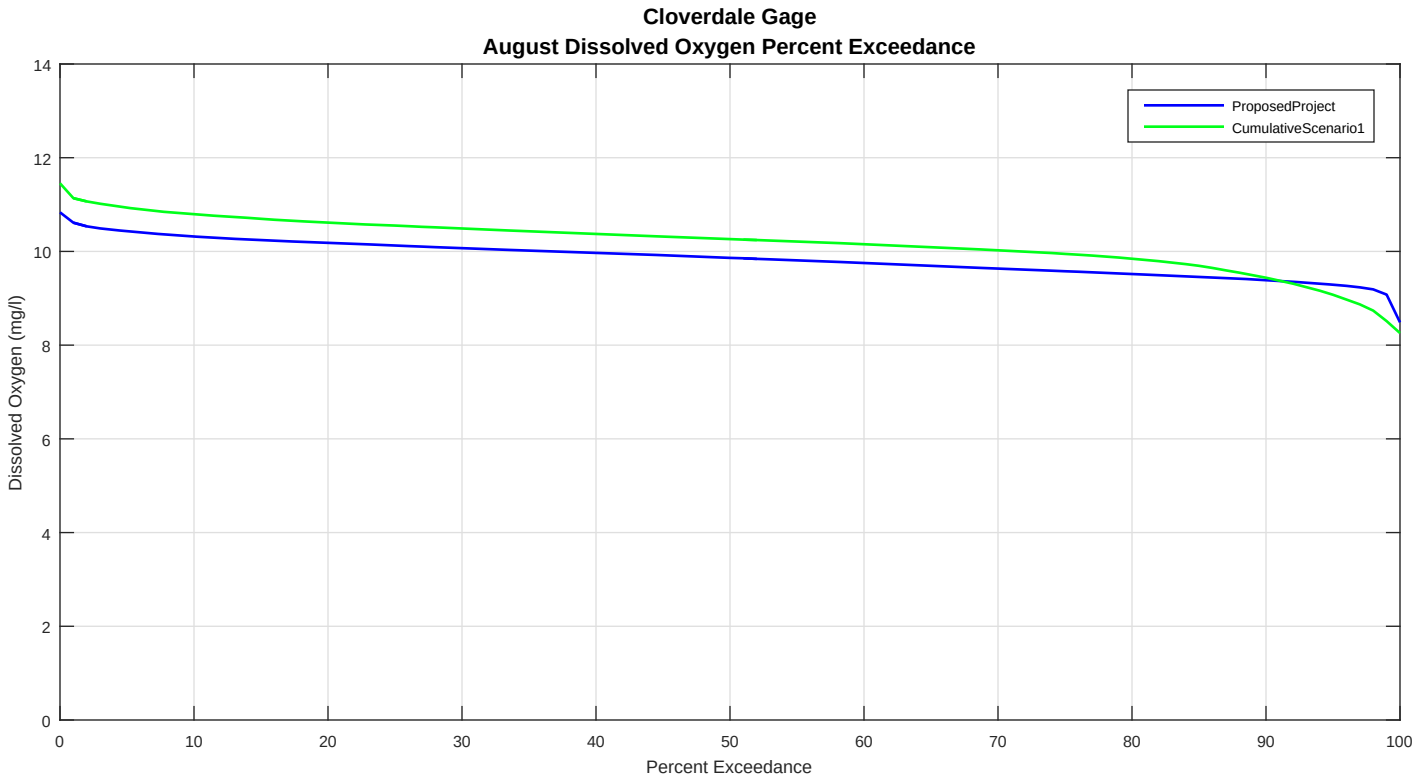
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ProposedProject
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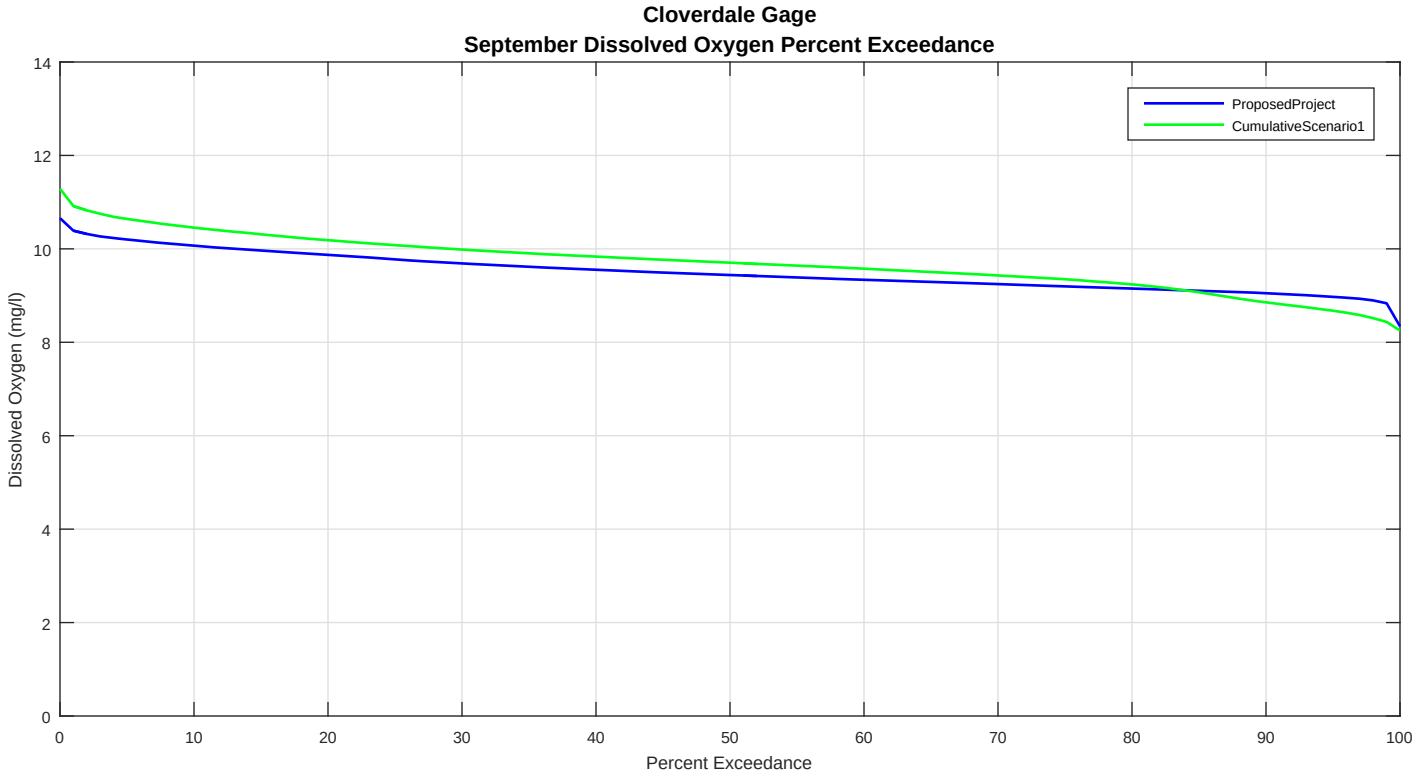
Cloverdale Gage
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ProposedProject
CumulativeScenario1
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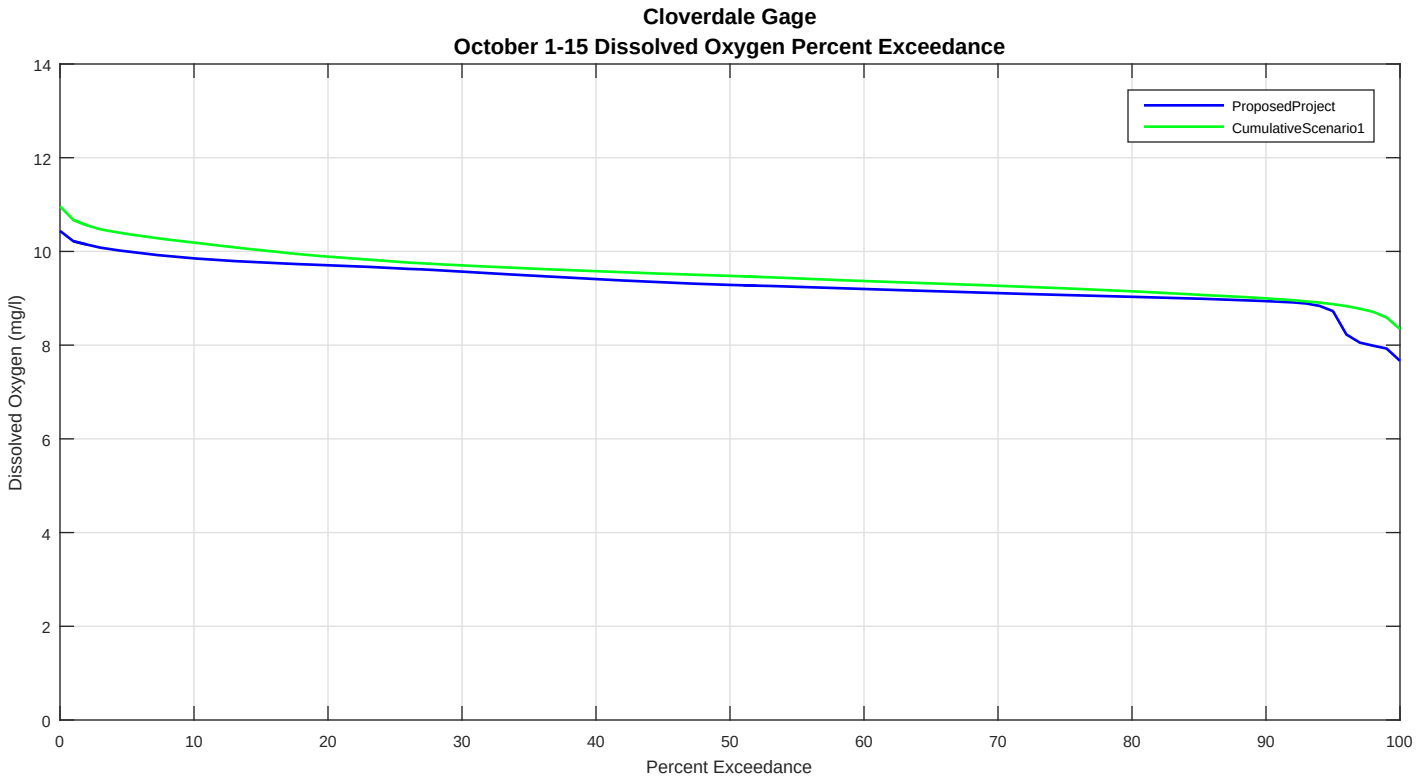
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October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
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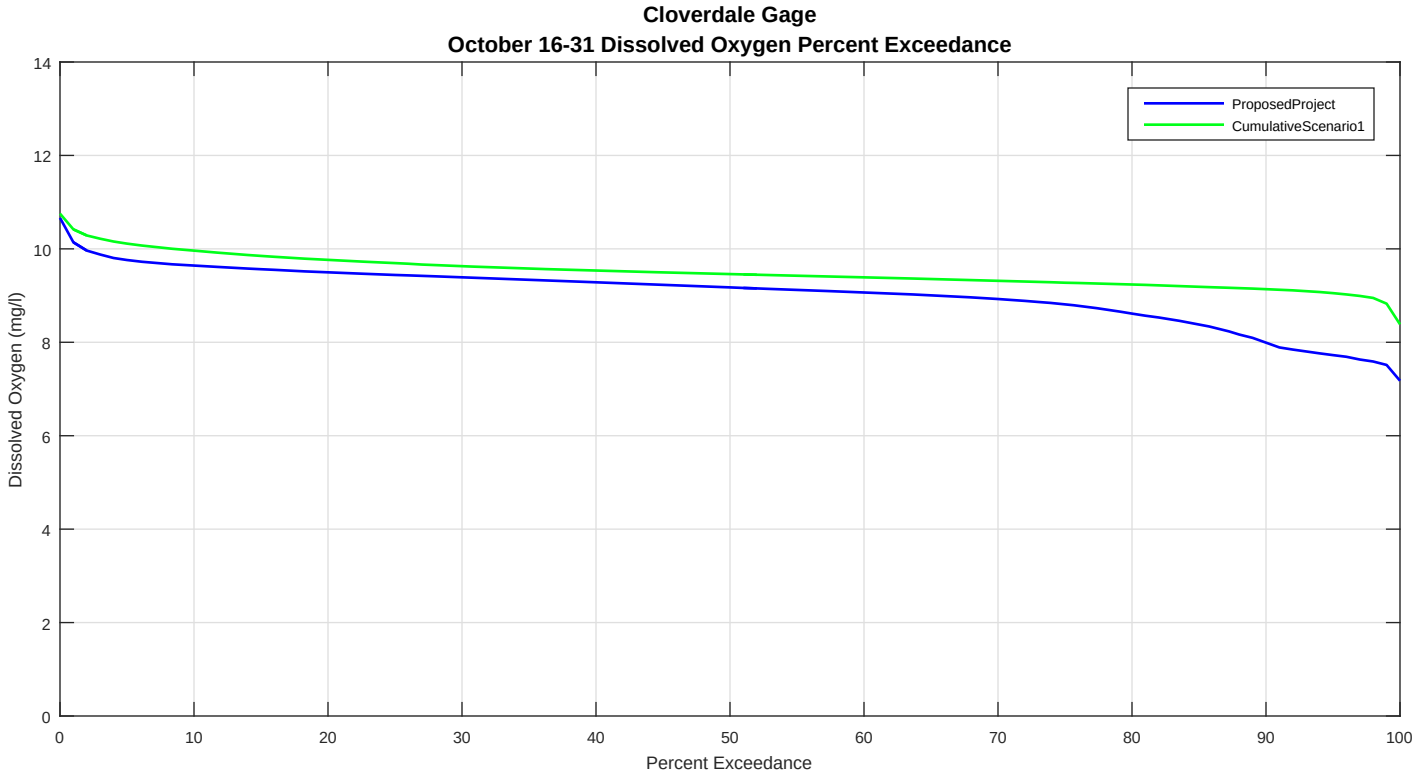
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October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
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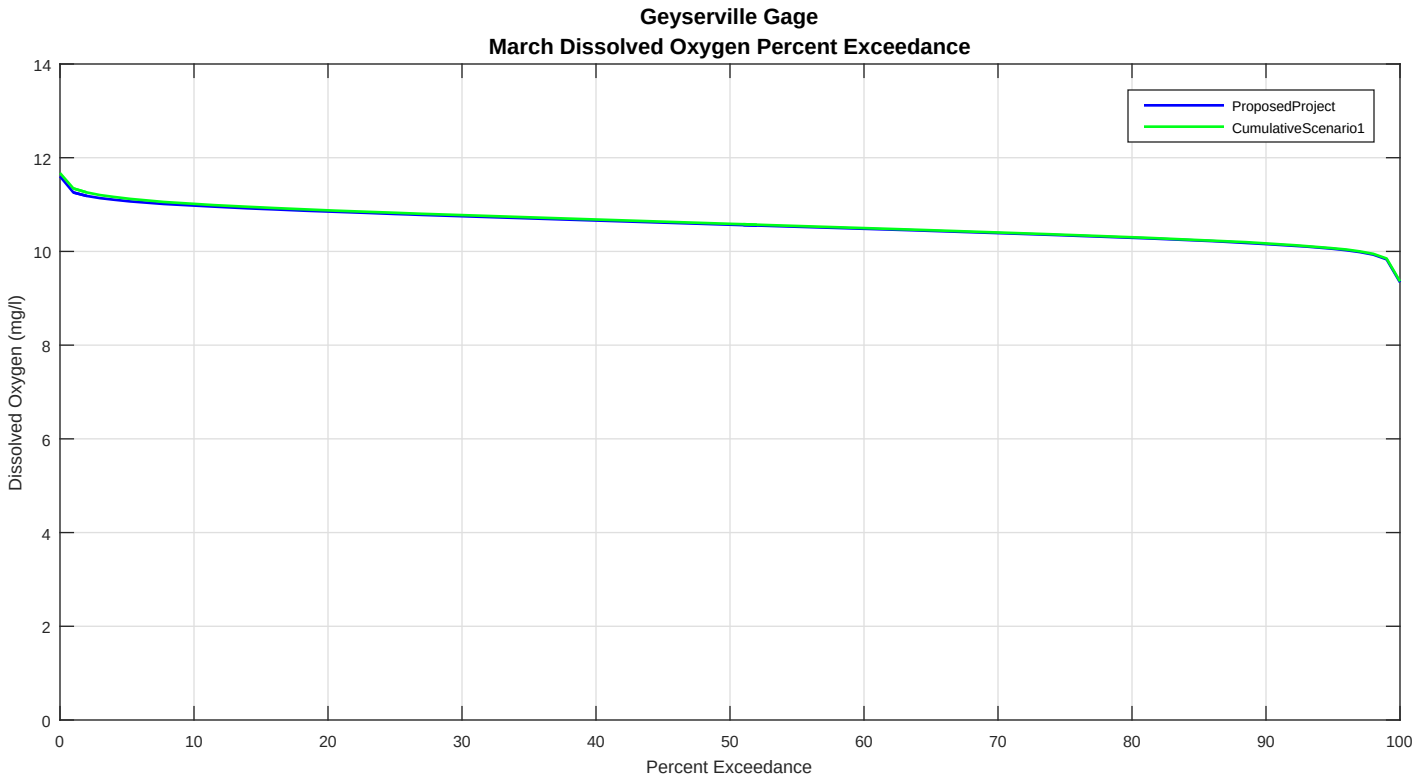
Geyserville Gage
March Dissolved Oxygen Percent Exceedance
ProposedProject
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Dissolved Oxygen (mg/l)
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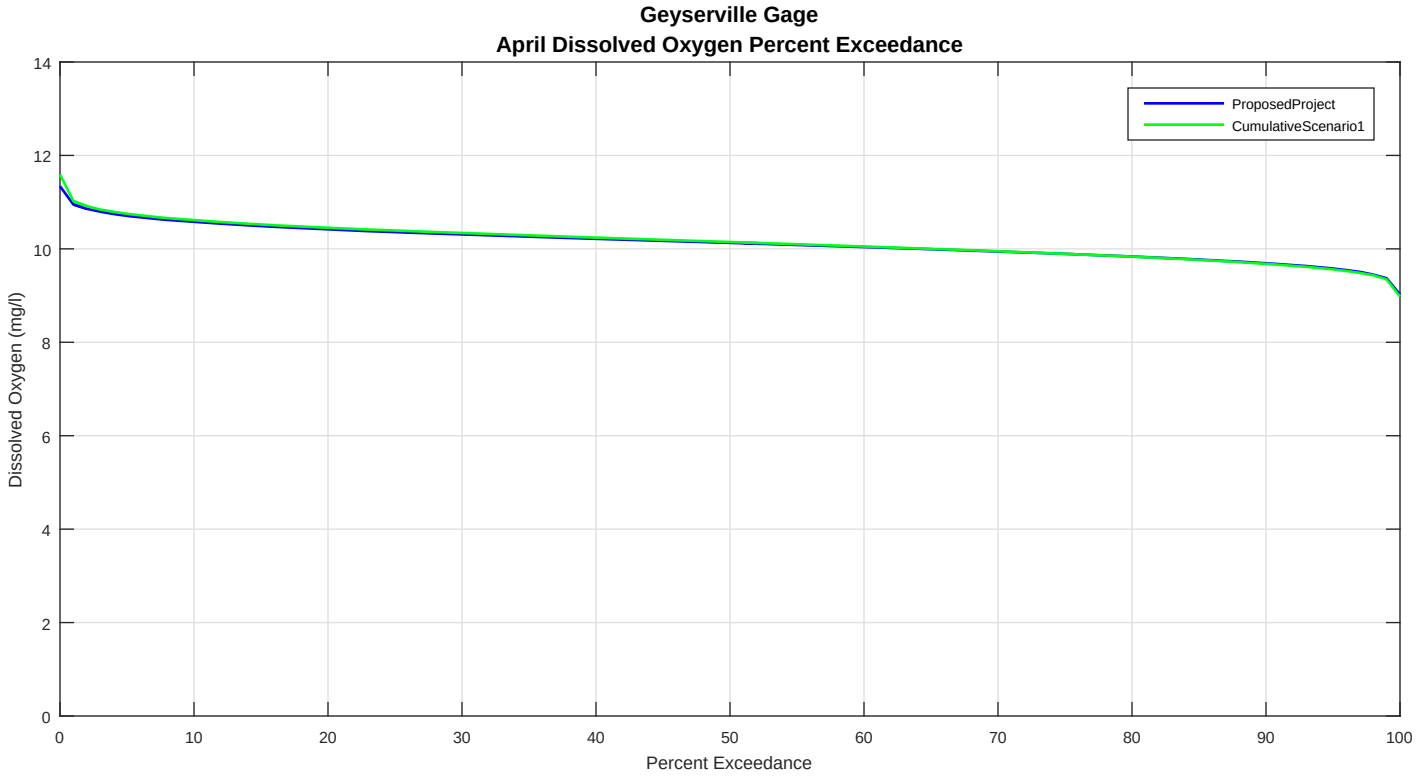
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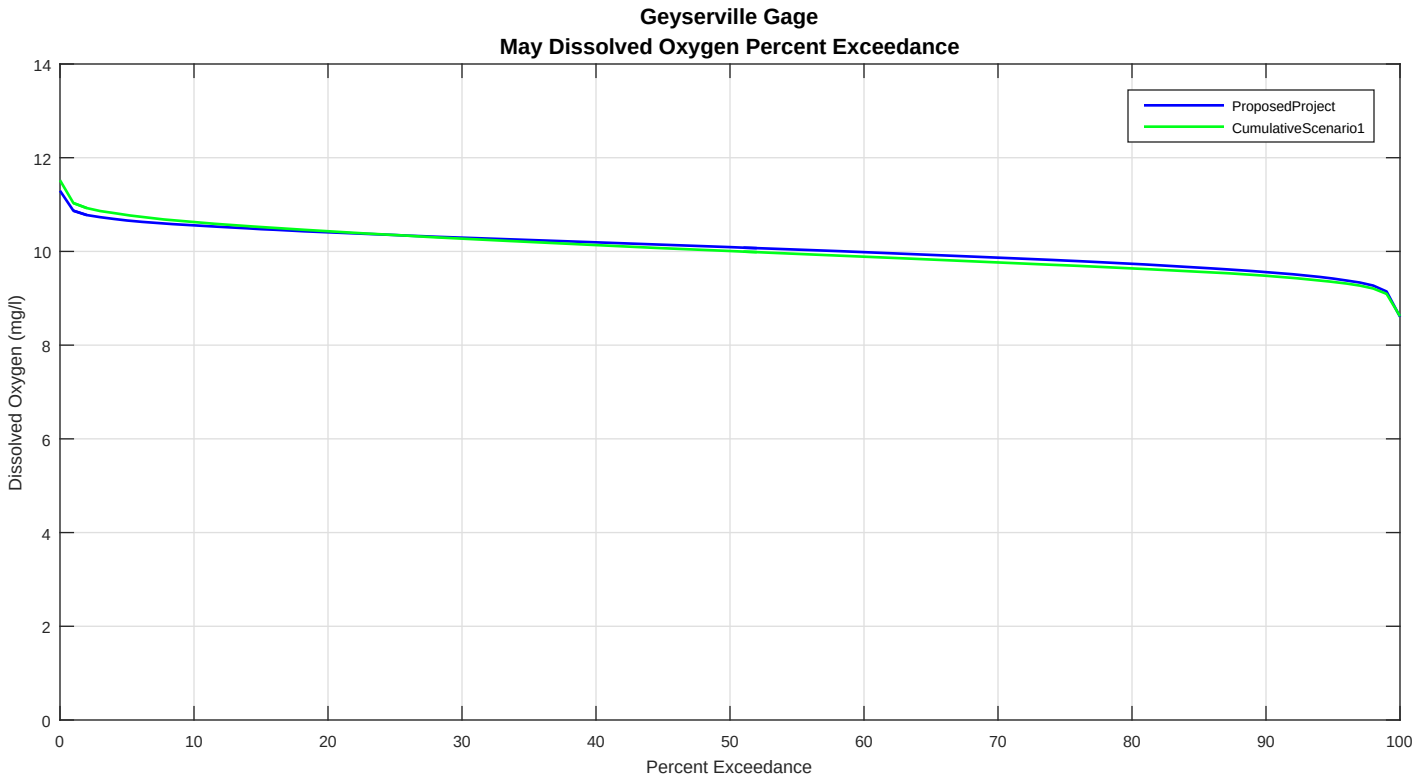
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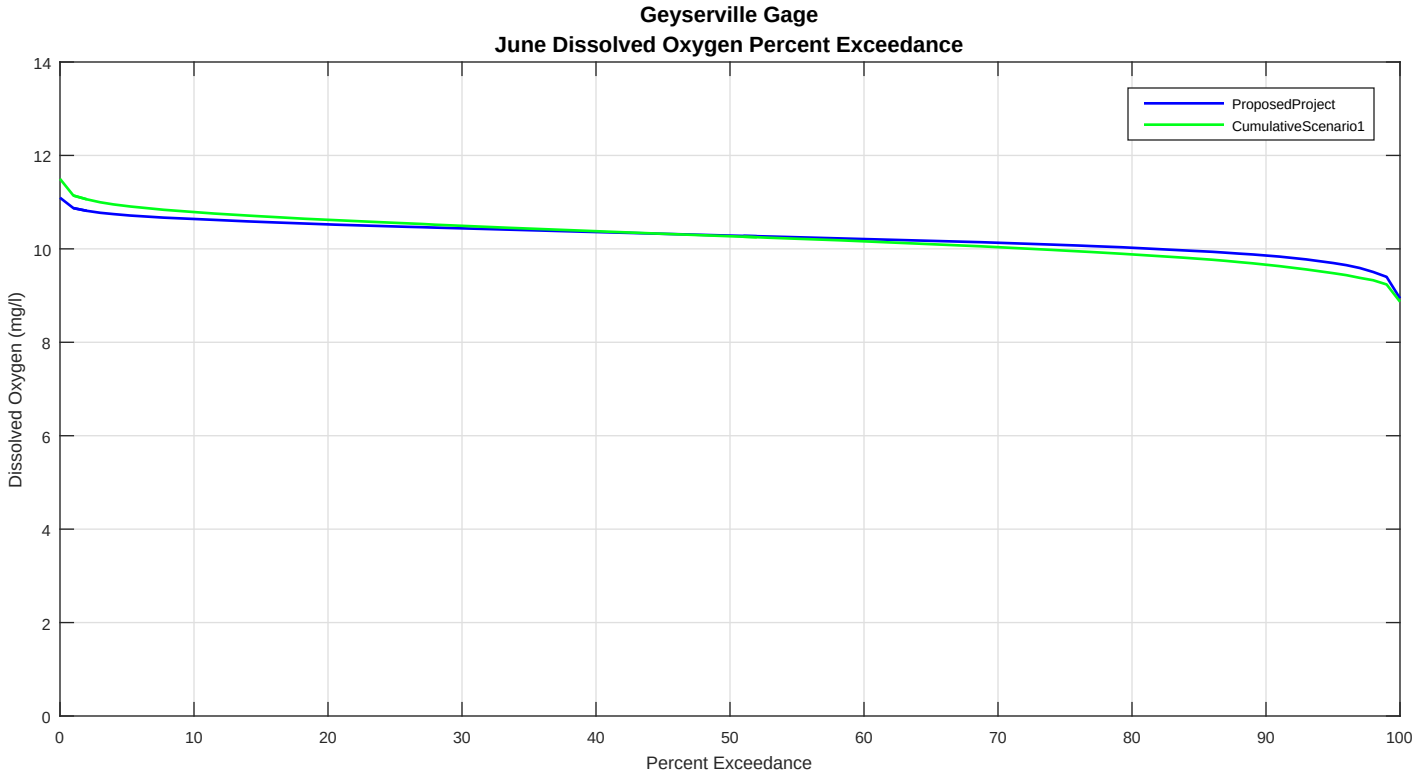
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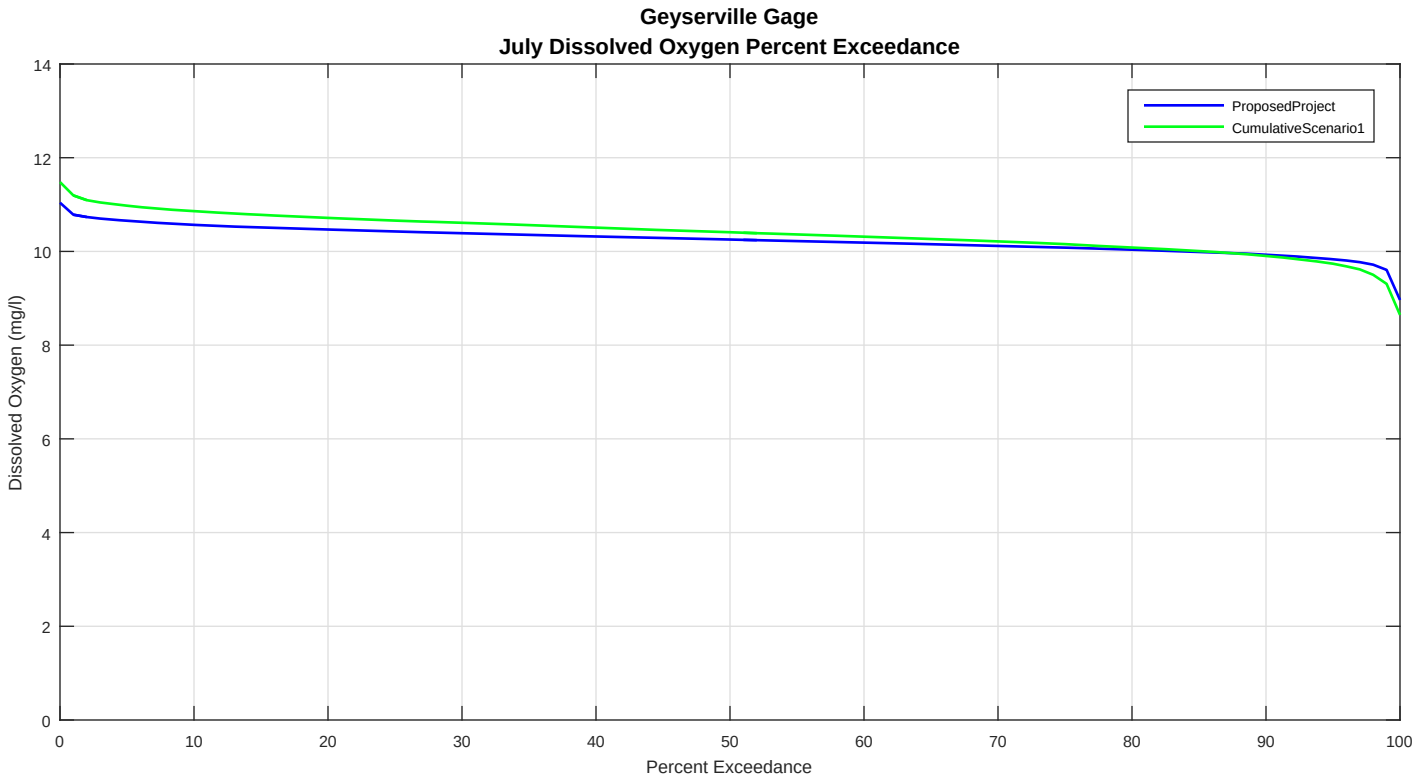
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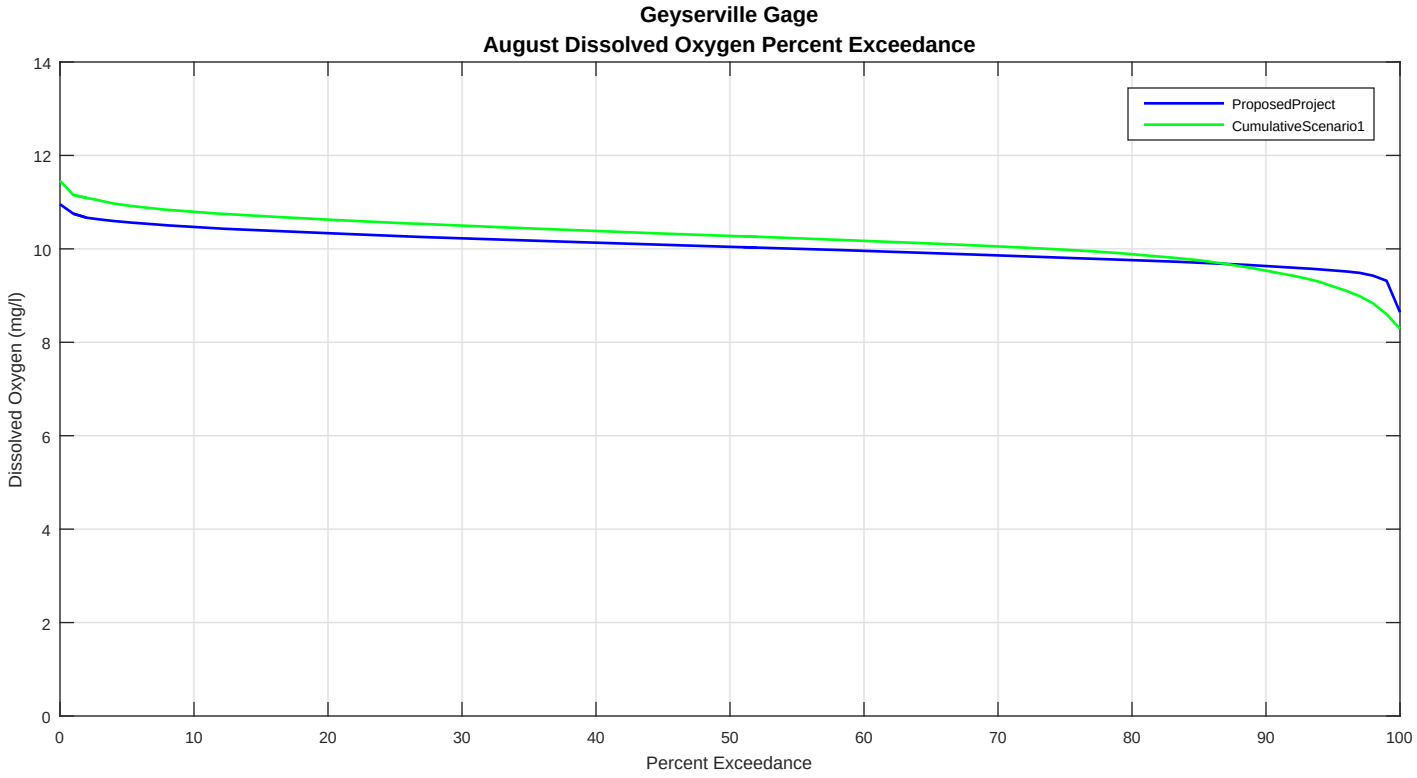
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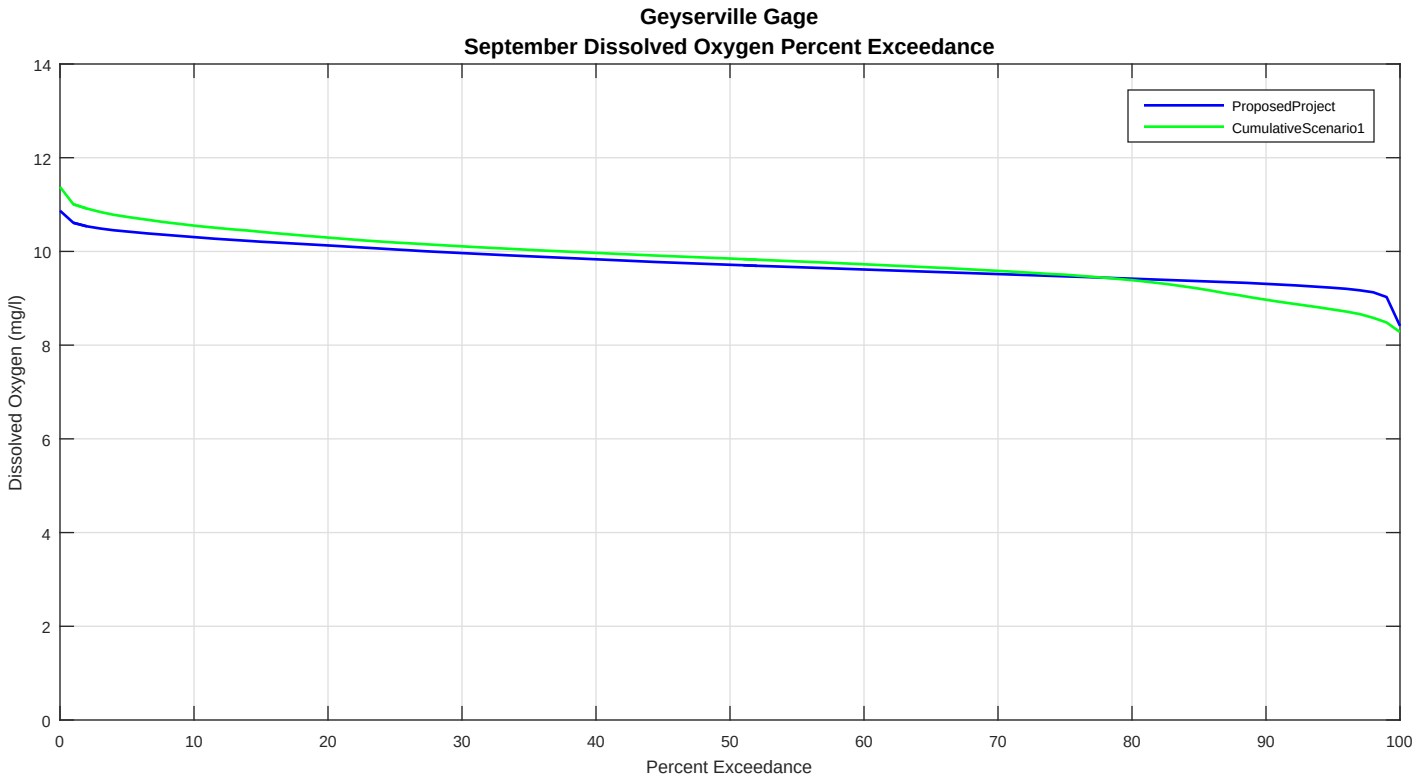
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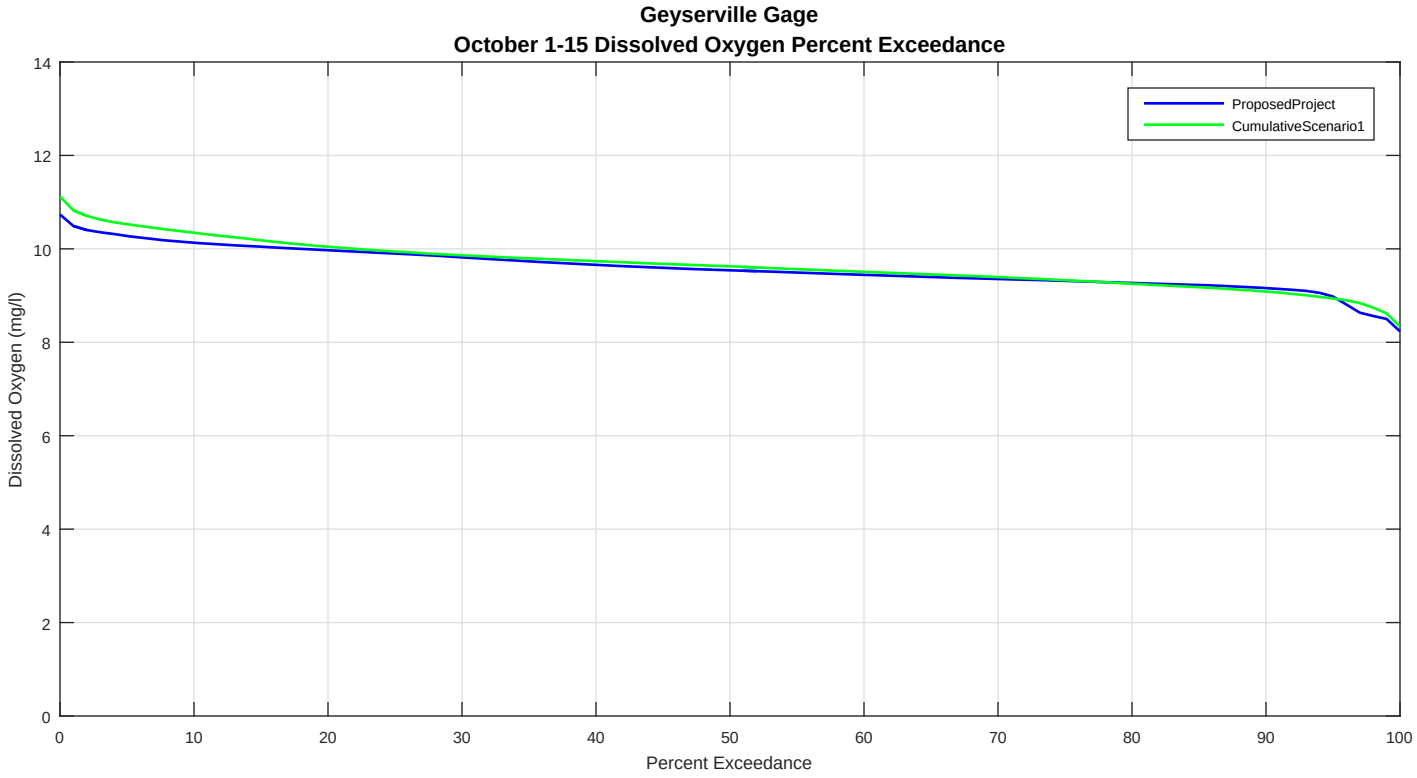
Geyserville Gage
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
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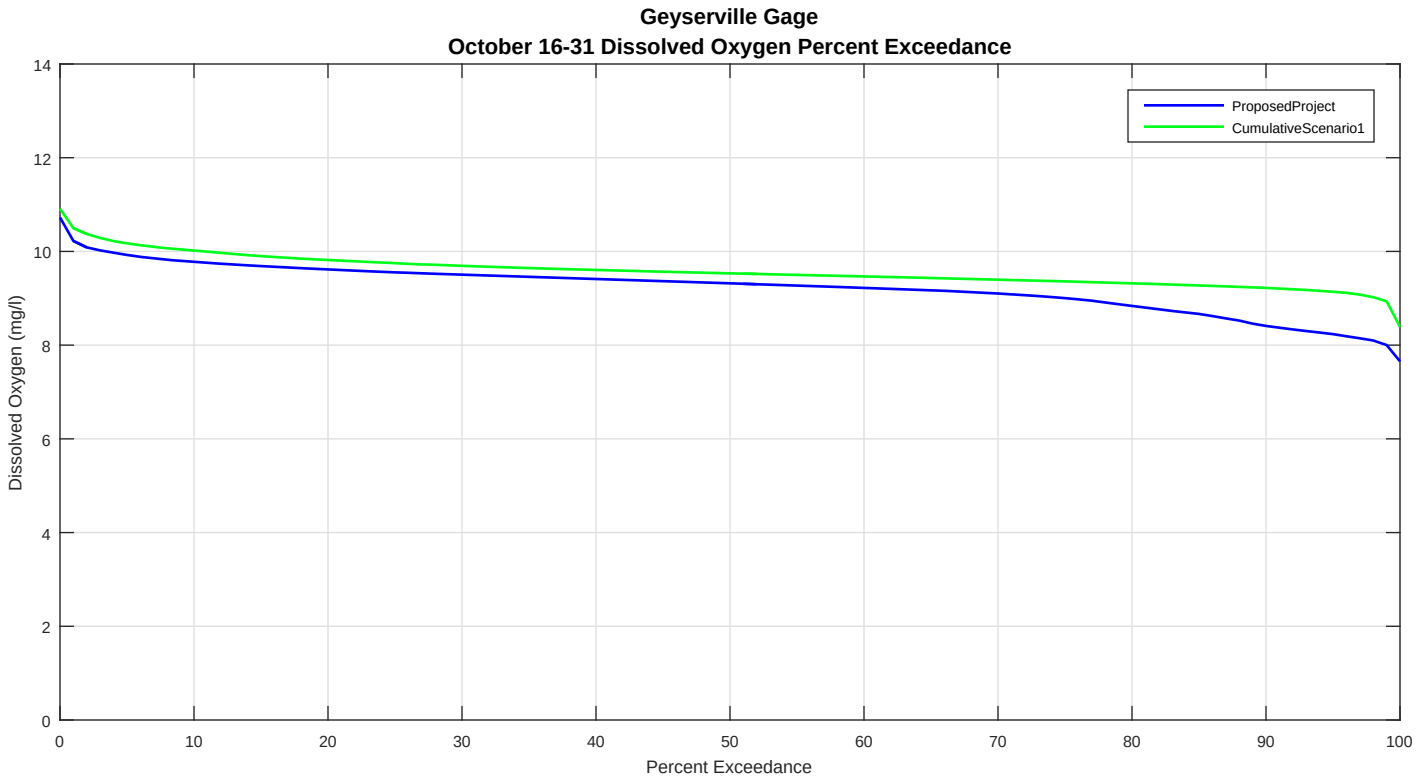
Geyserville Gage
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
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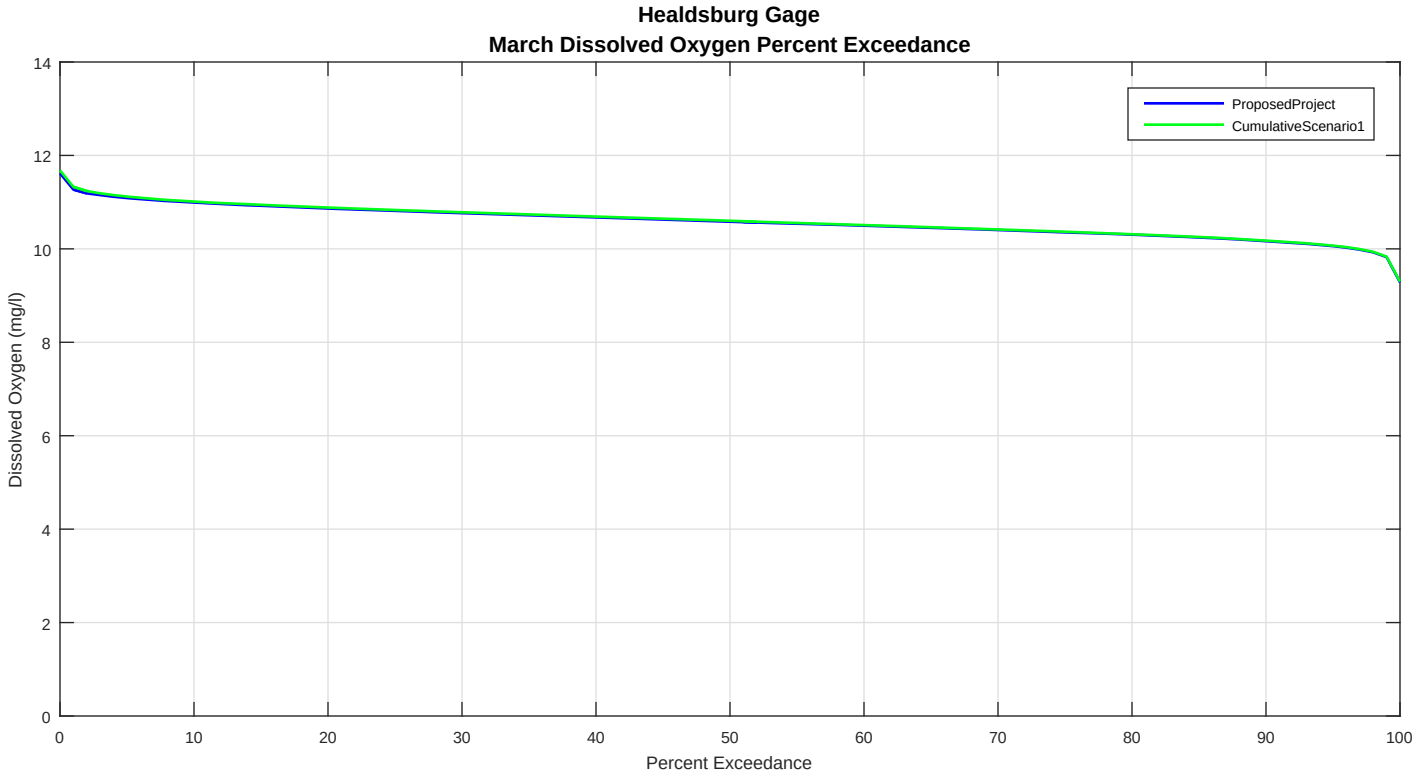
Healdsburg Gage
March Dissolved Oxygen Percent Exceedance
ProposedProject
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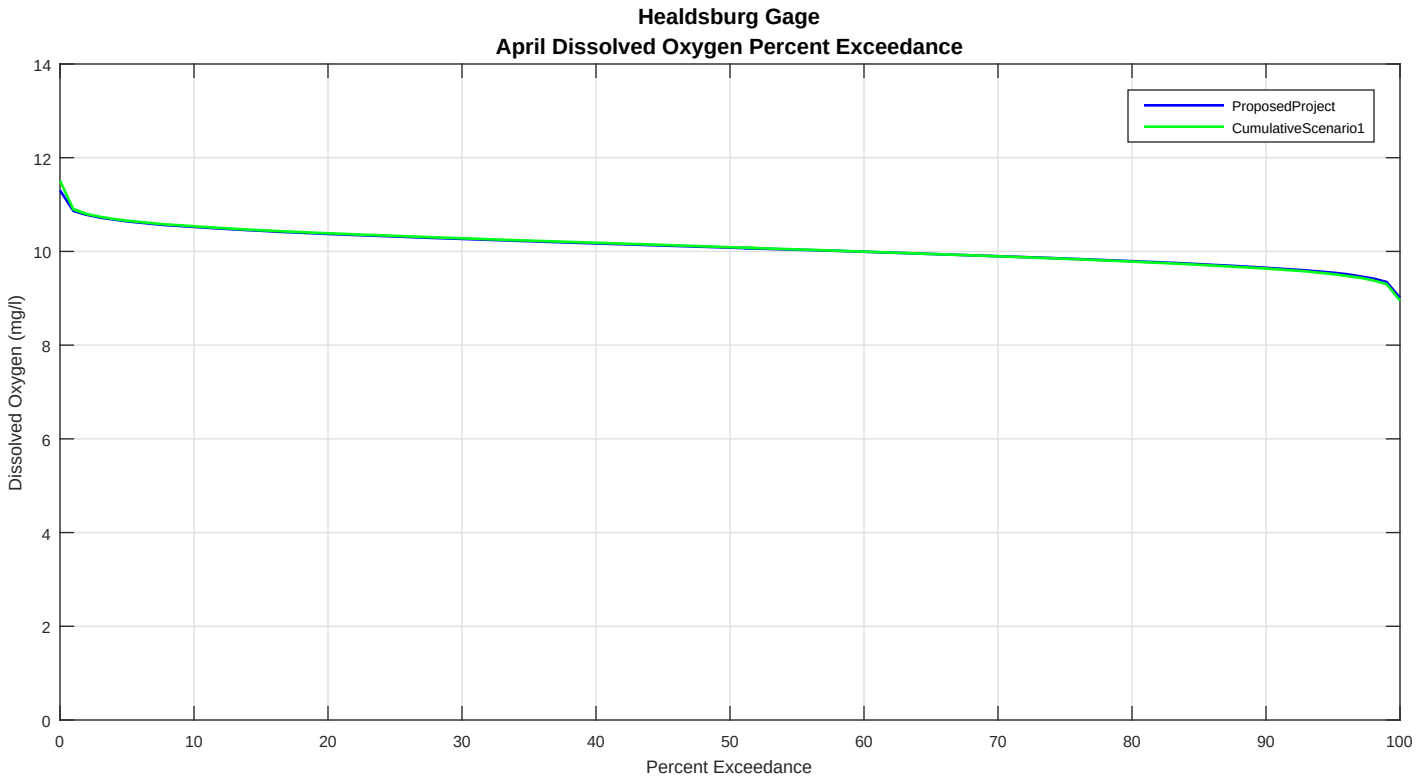
Healdsburg Gage
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
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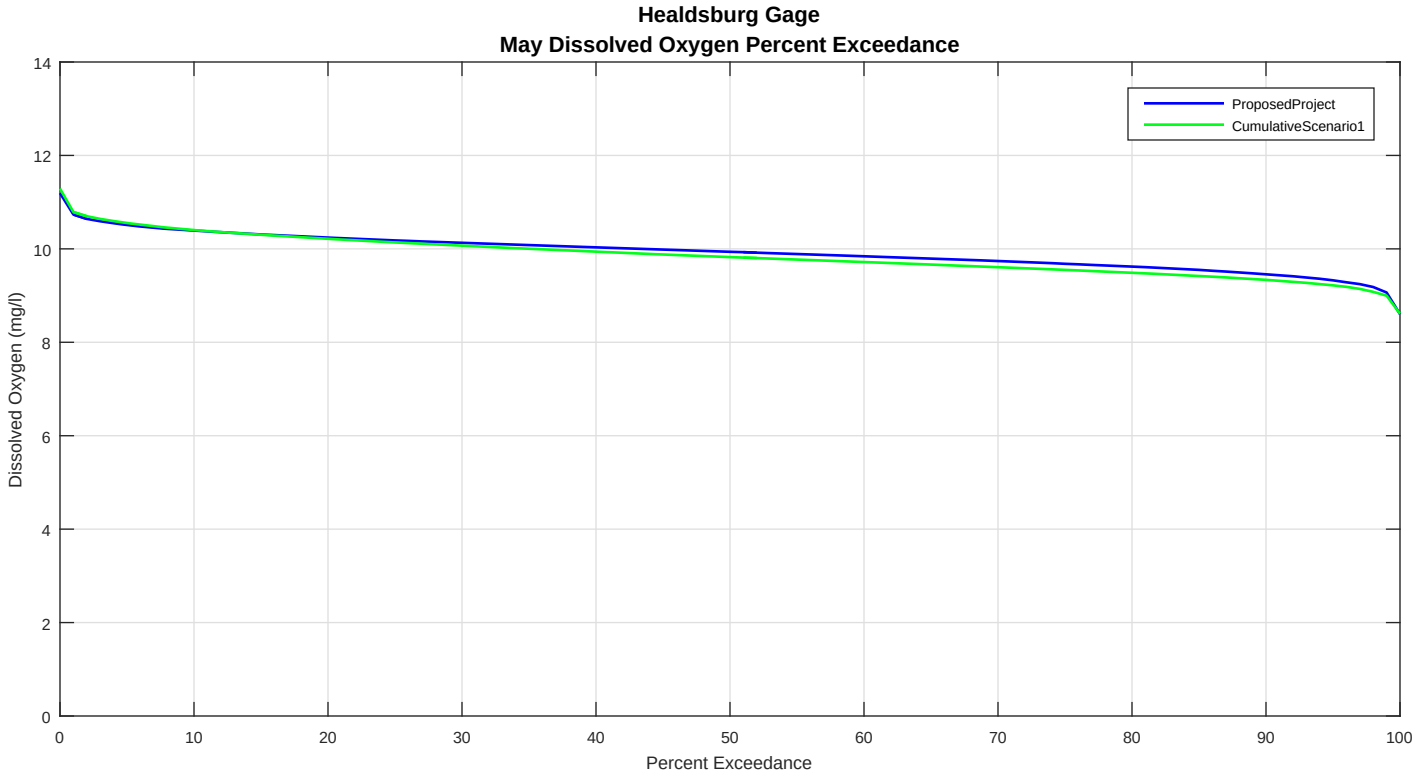
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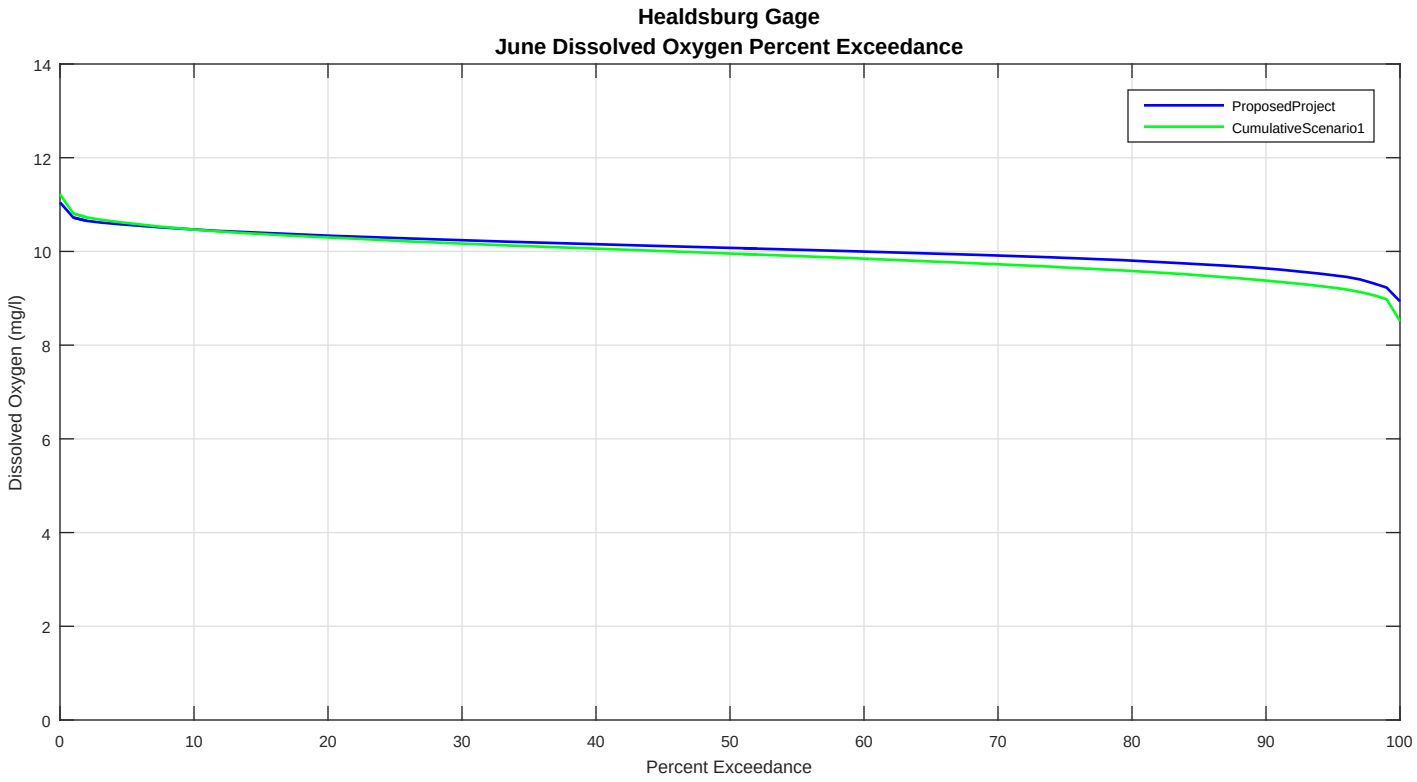
Healdsburg Gage
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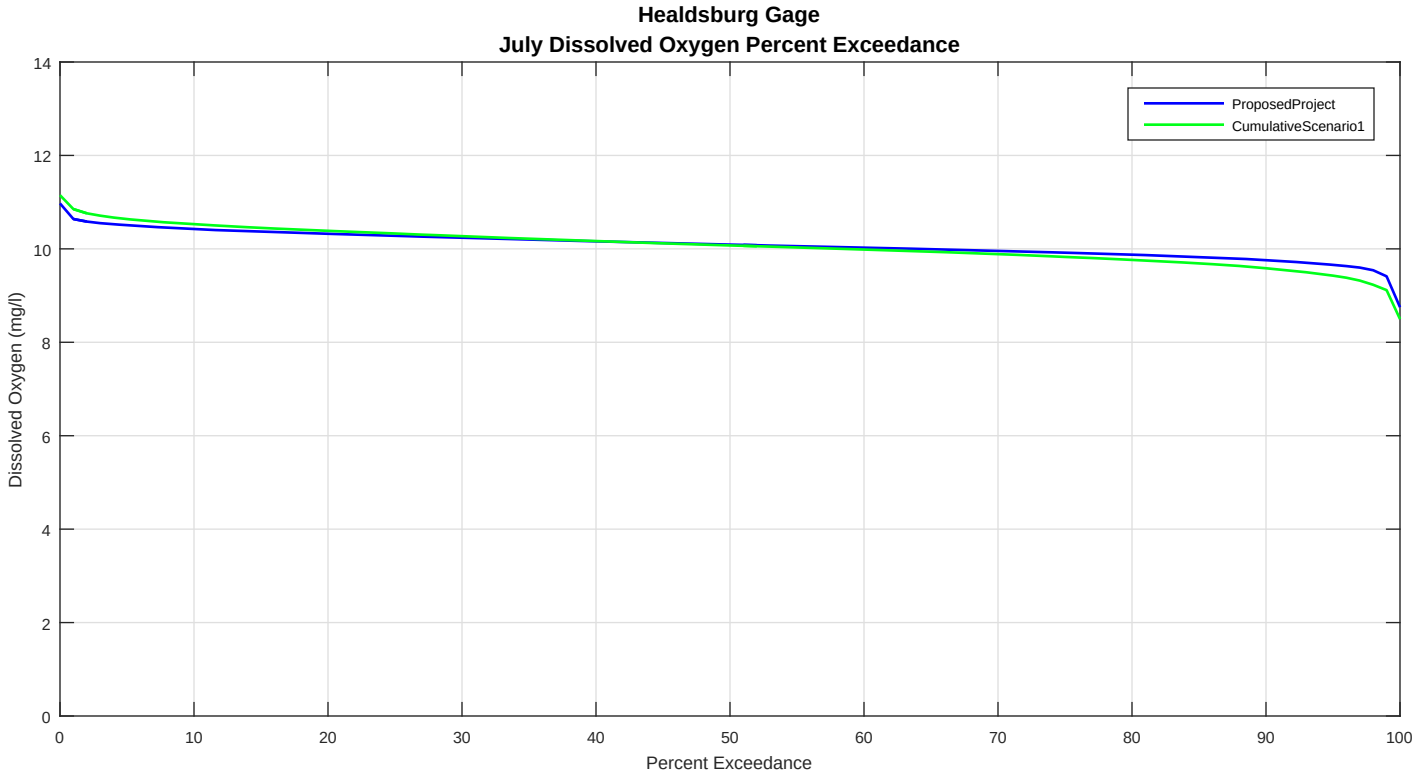
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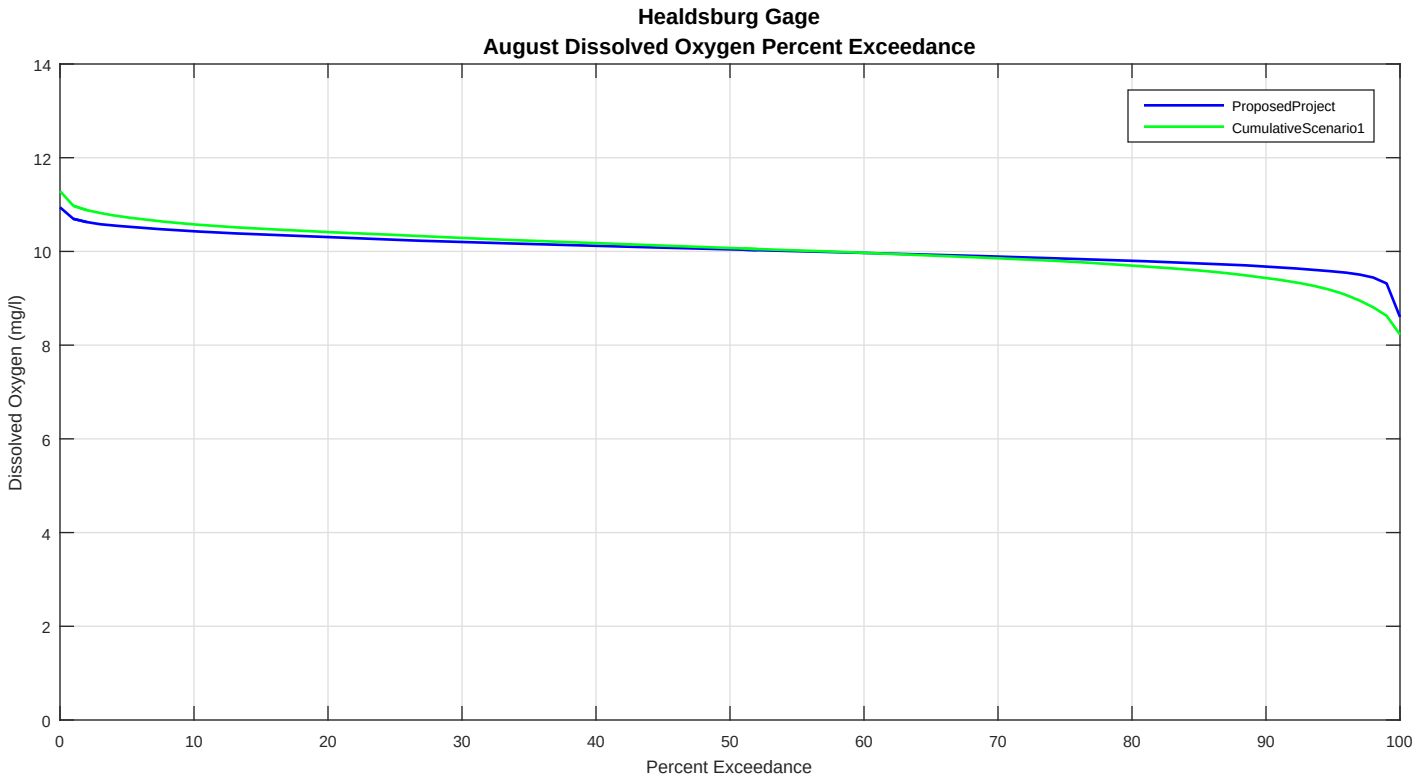
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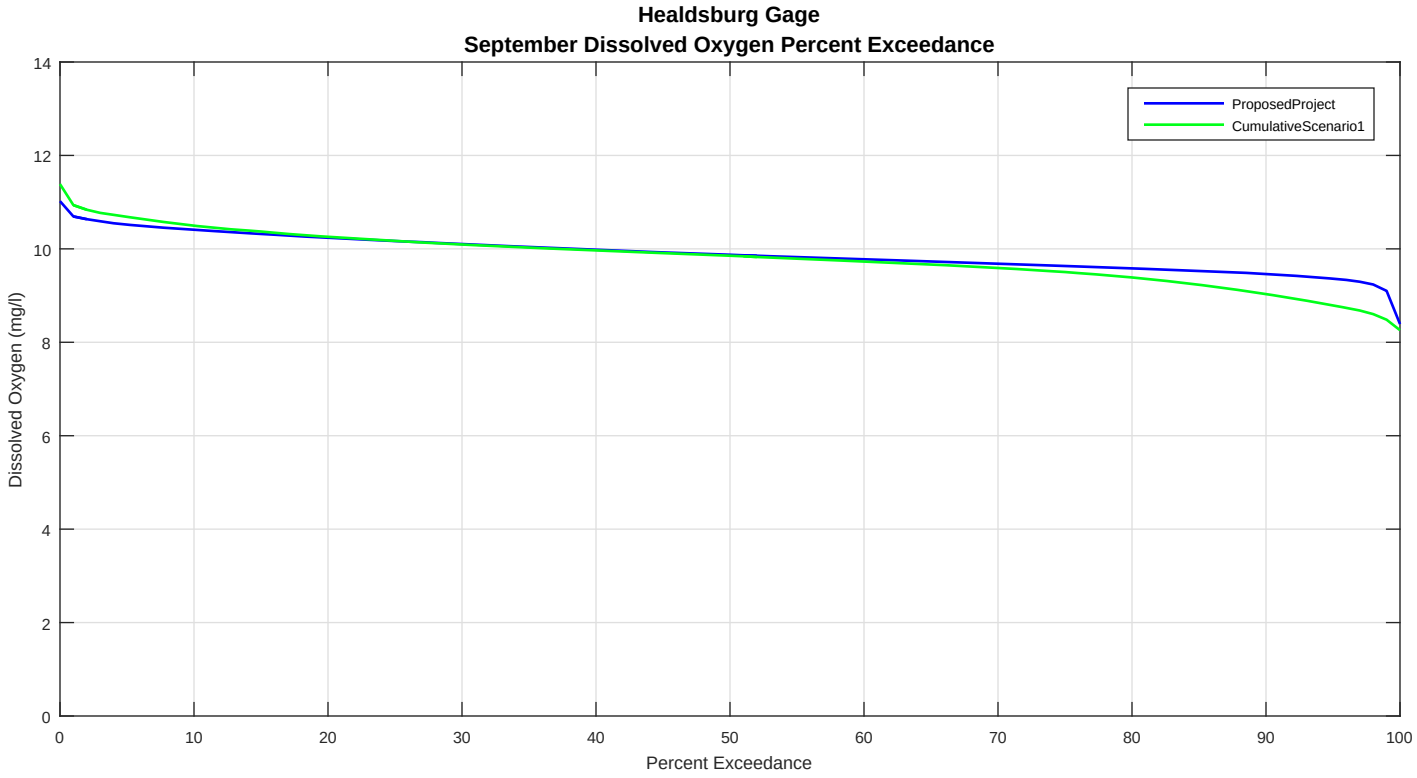
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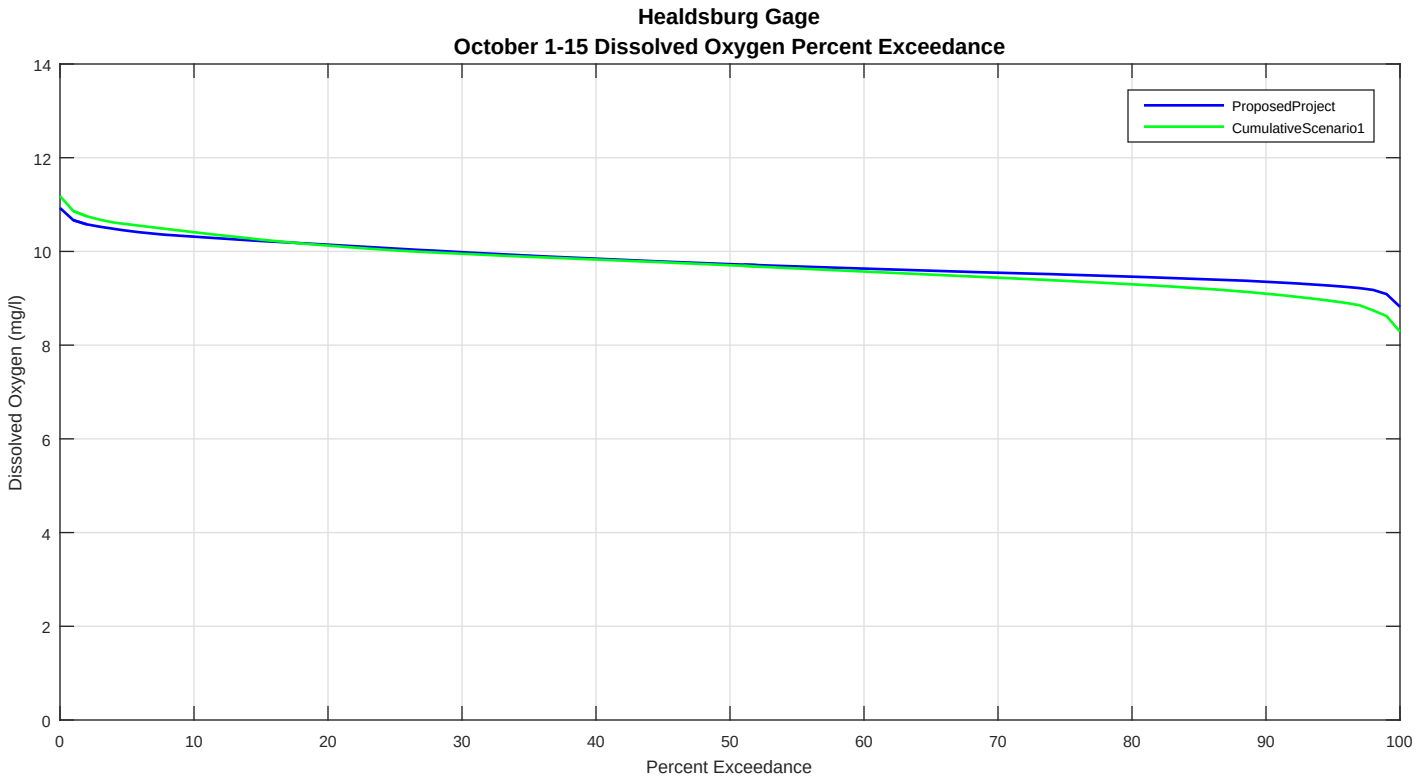
Healdsburg Gage
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
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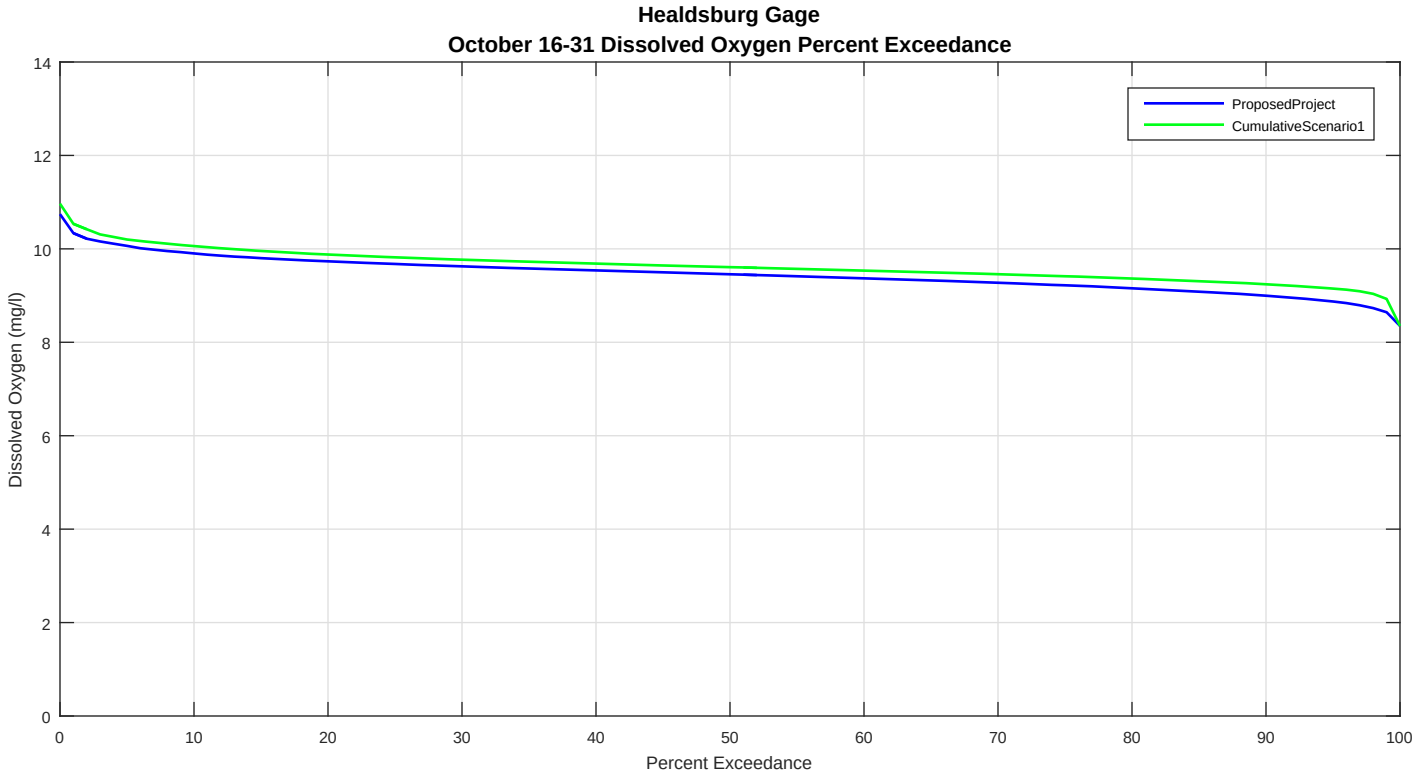
Healdsburg Gage
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ProposedProject
CumulativeScenario1
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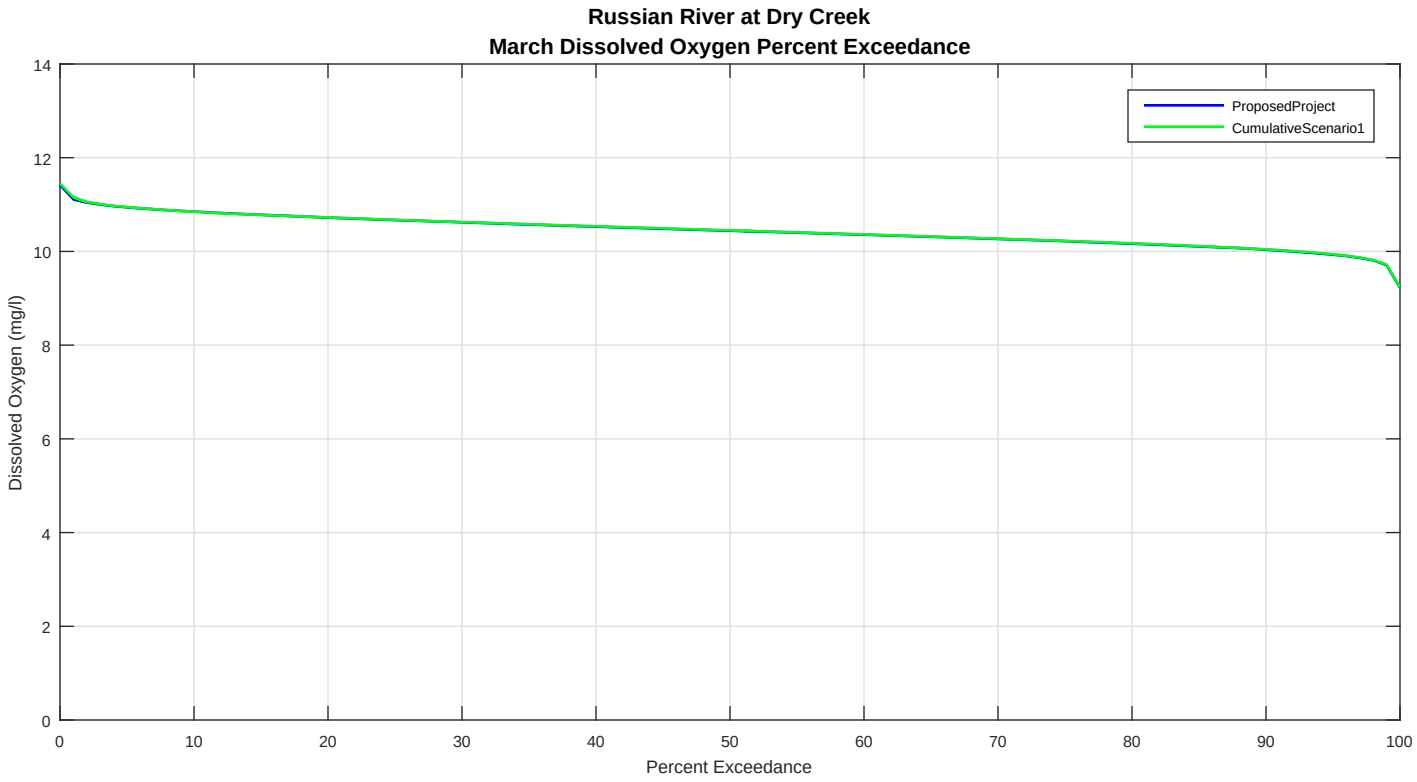
Russian River at Dry Creek
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
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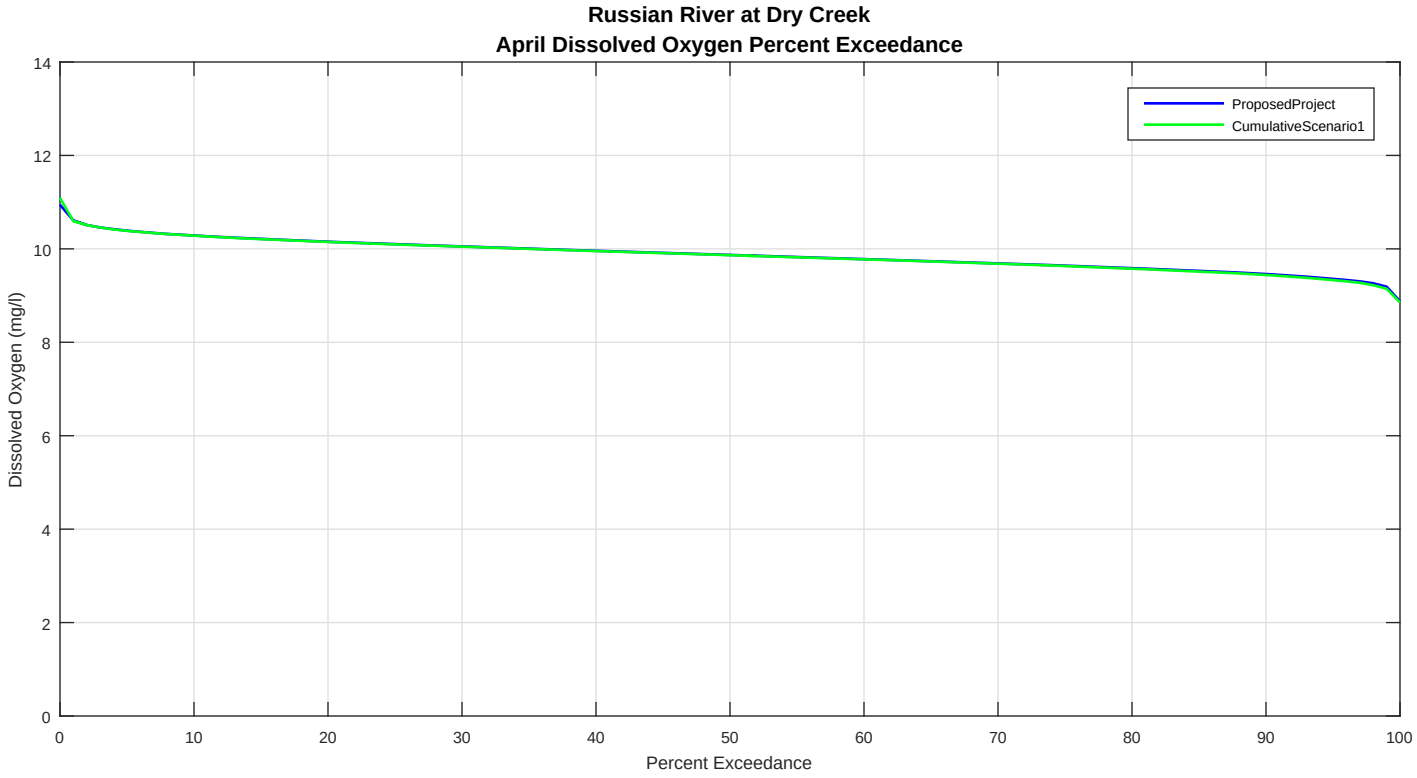
Russian River at Dry Creek
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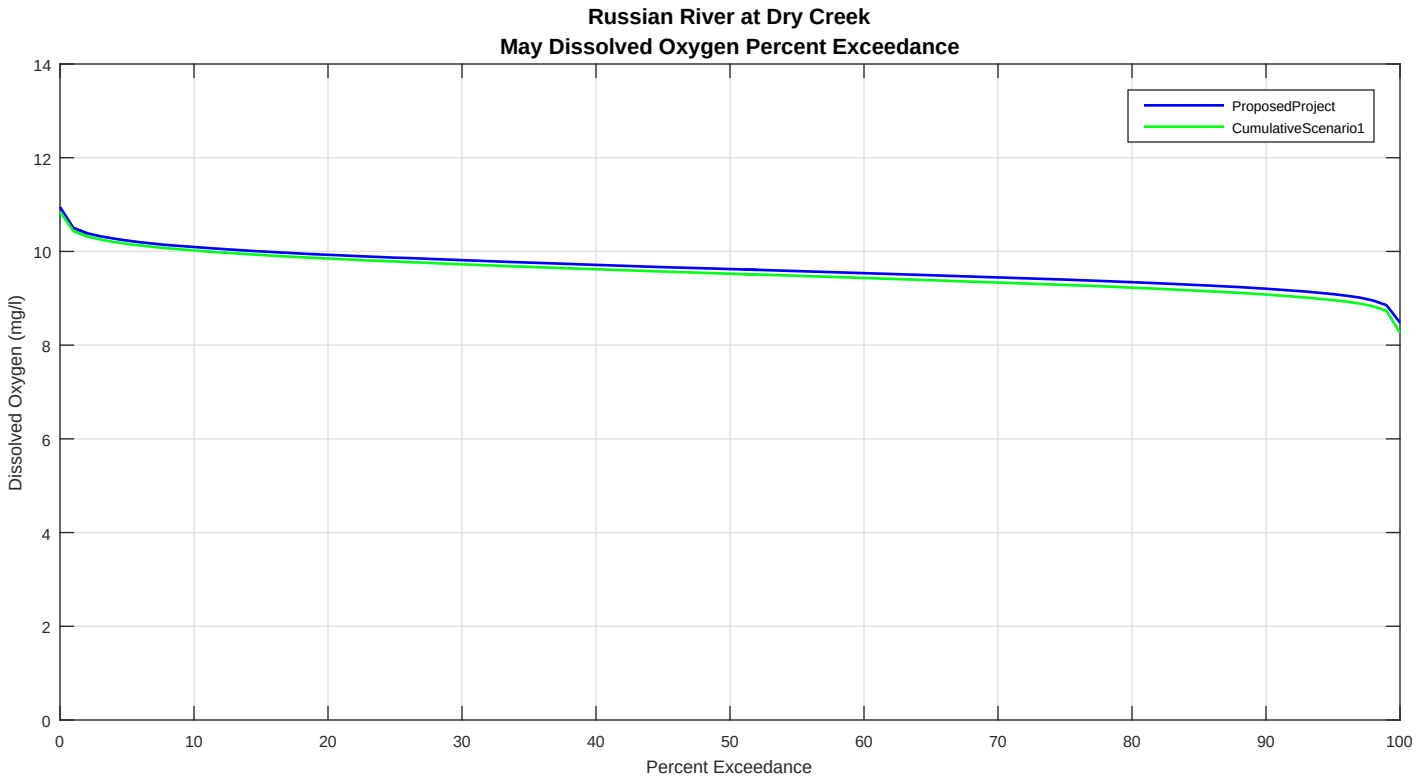
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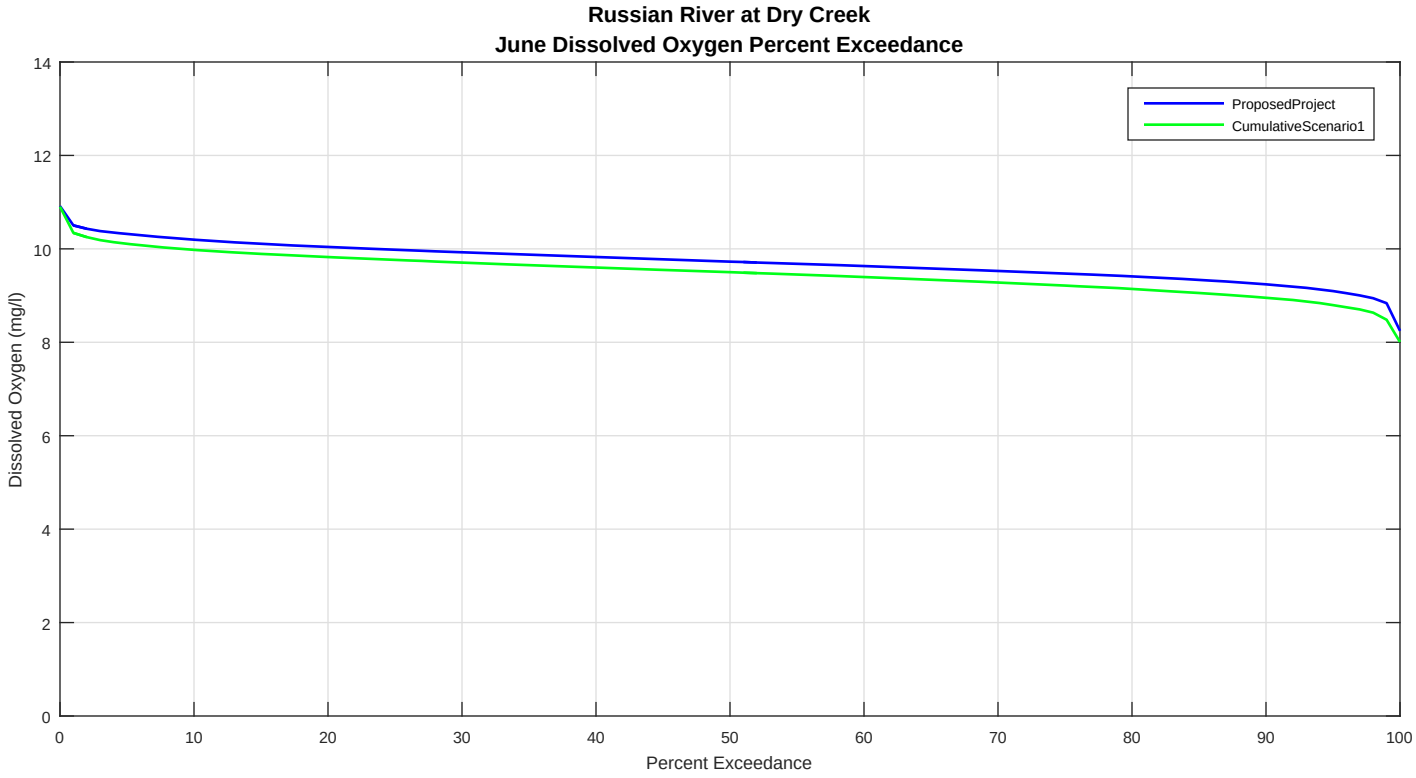
Russian River at Dry Creek
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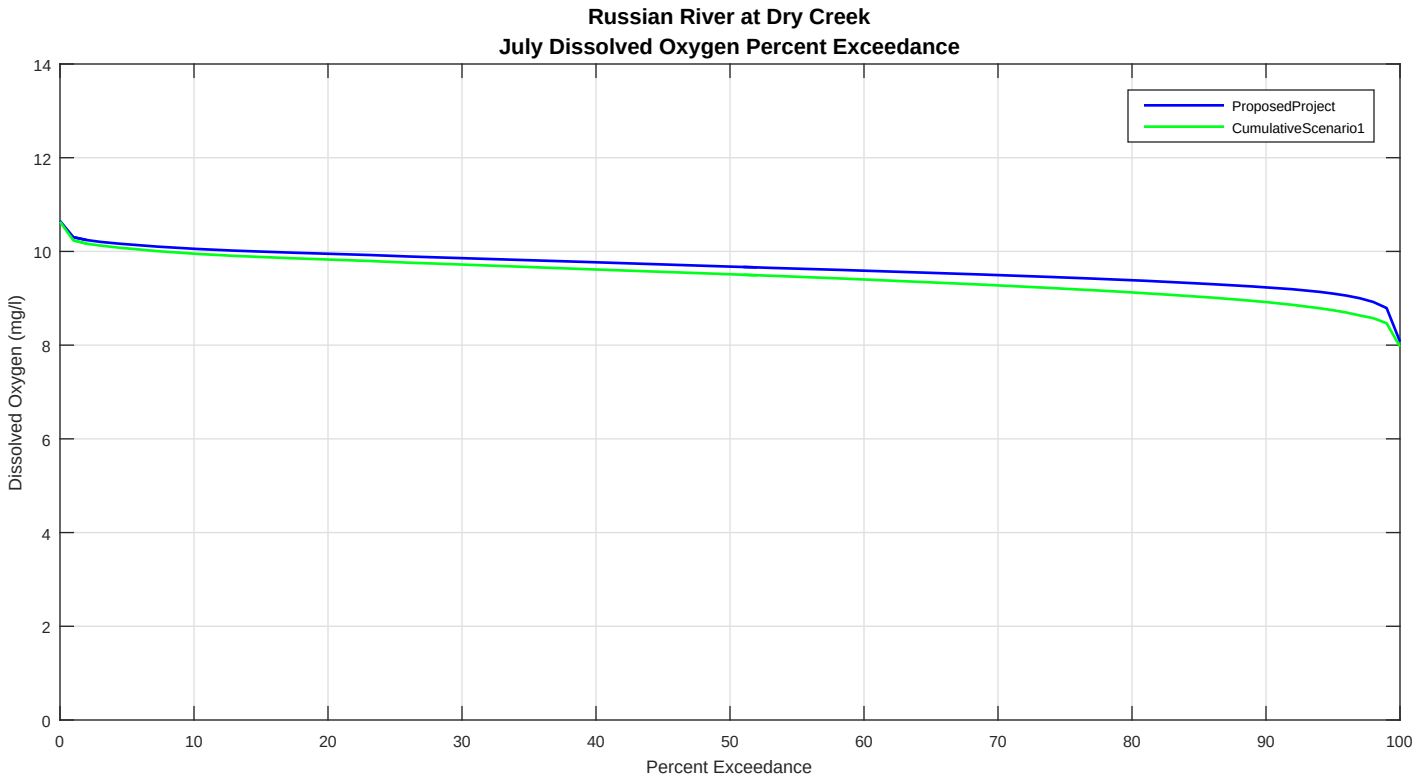
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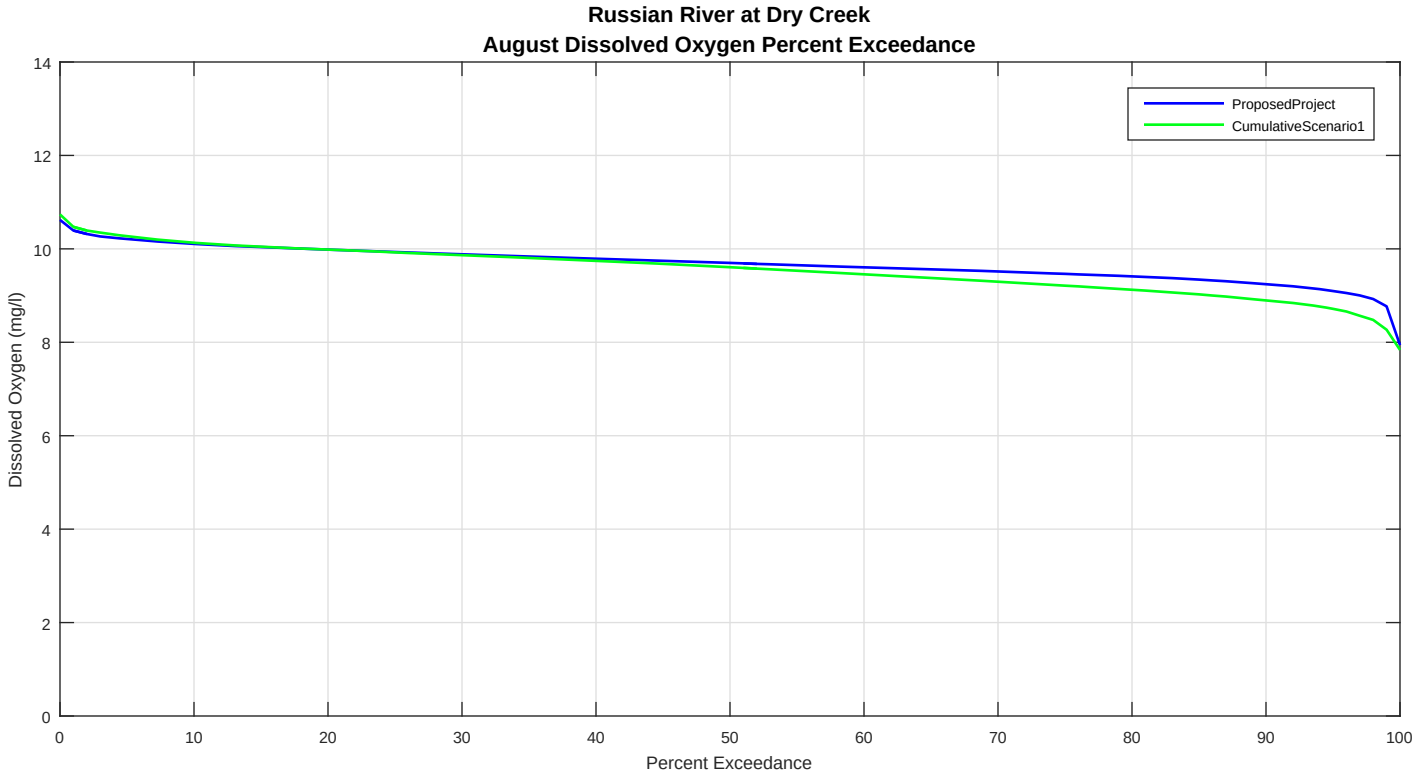
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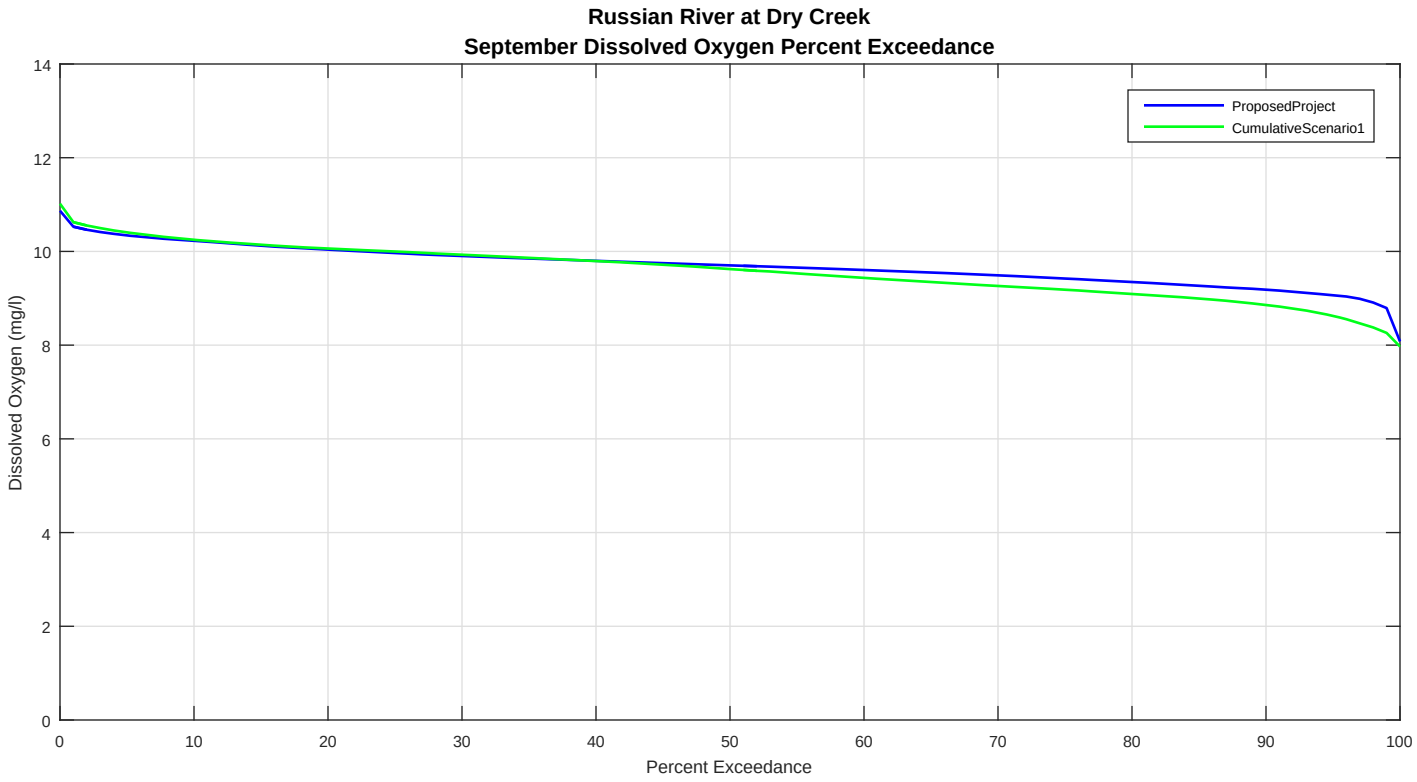
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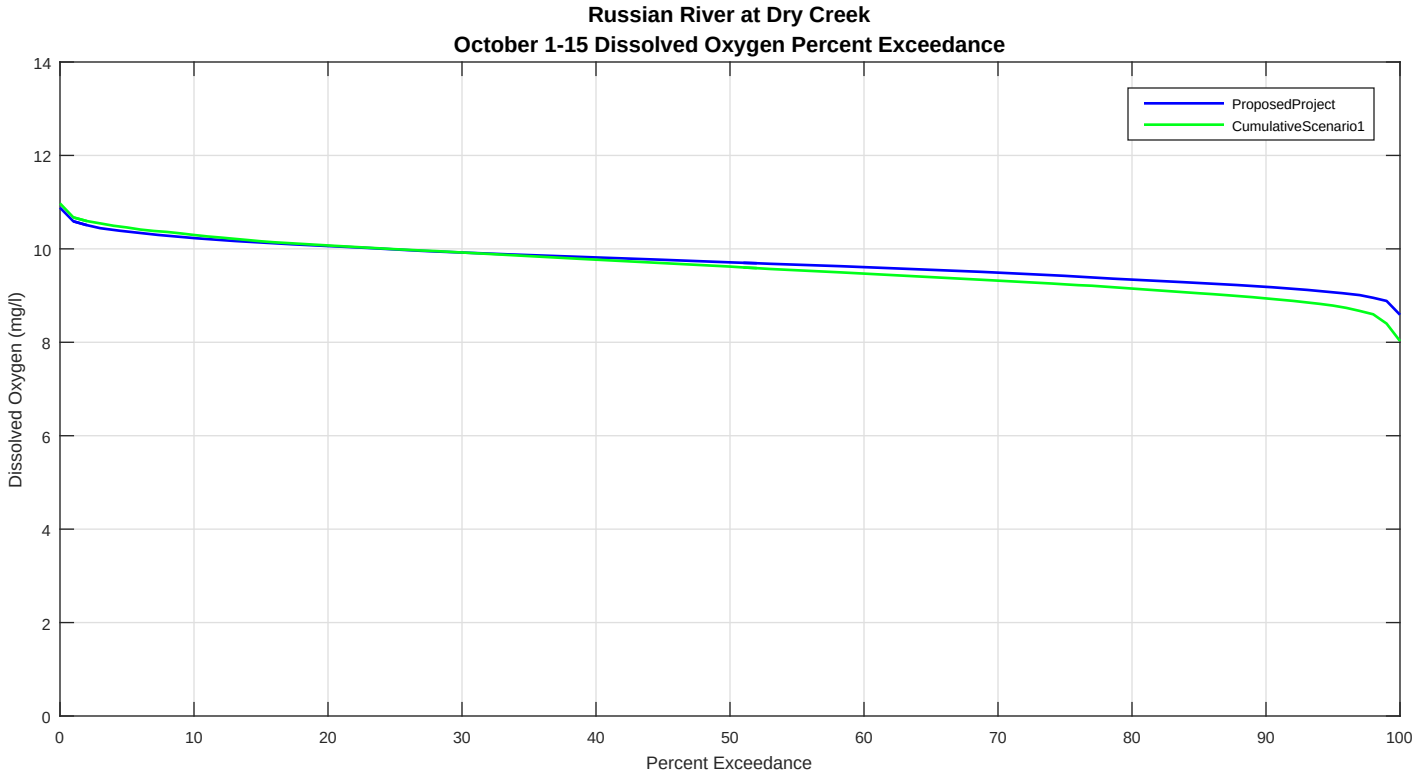
Russian River at Dry Creek
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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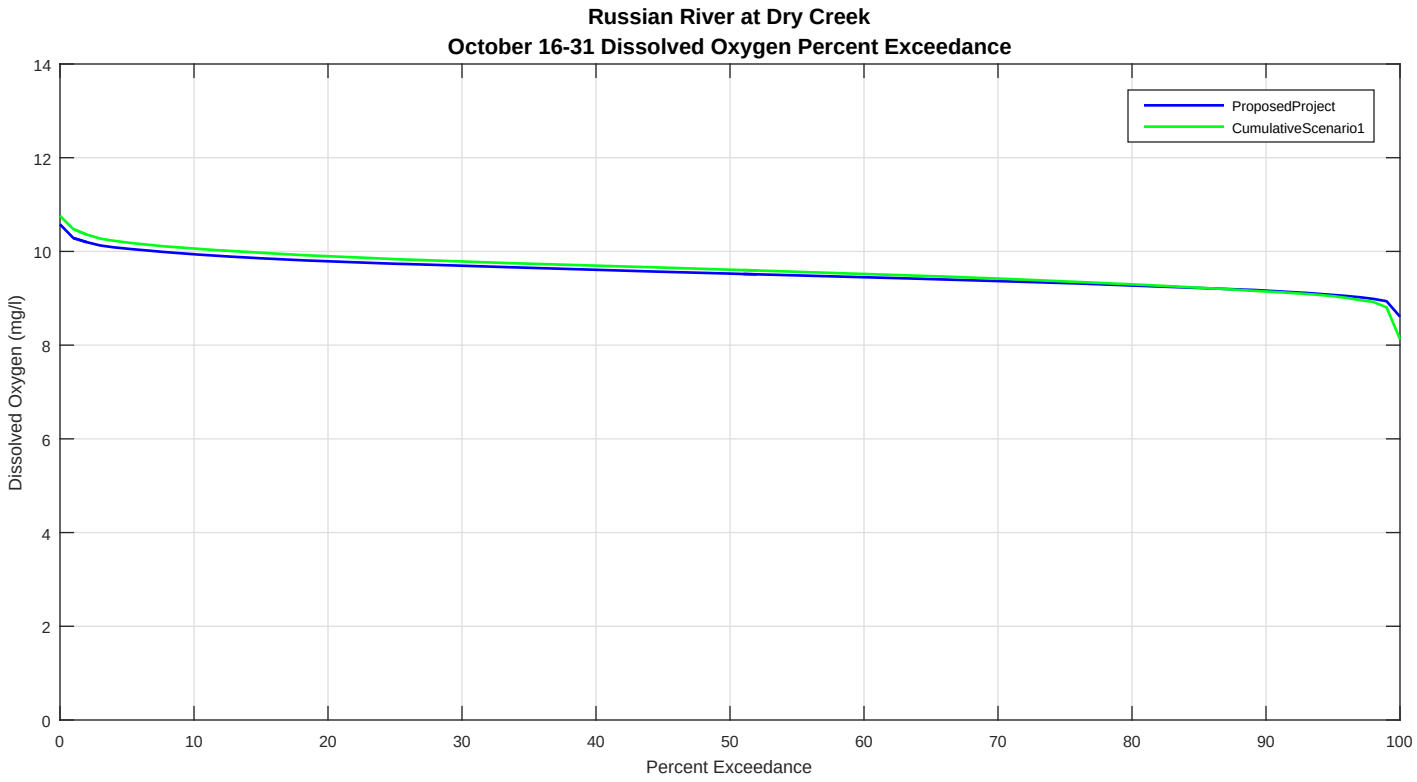
Russian River at Dry Creek
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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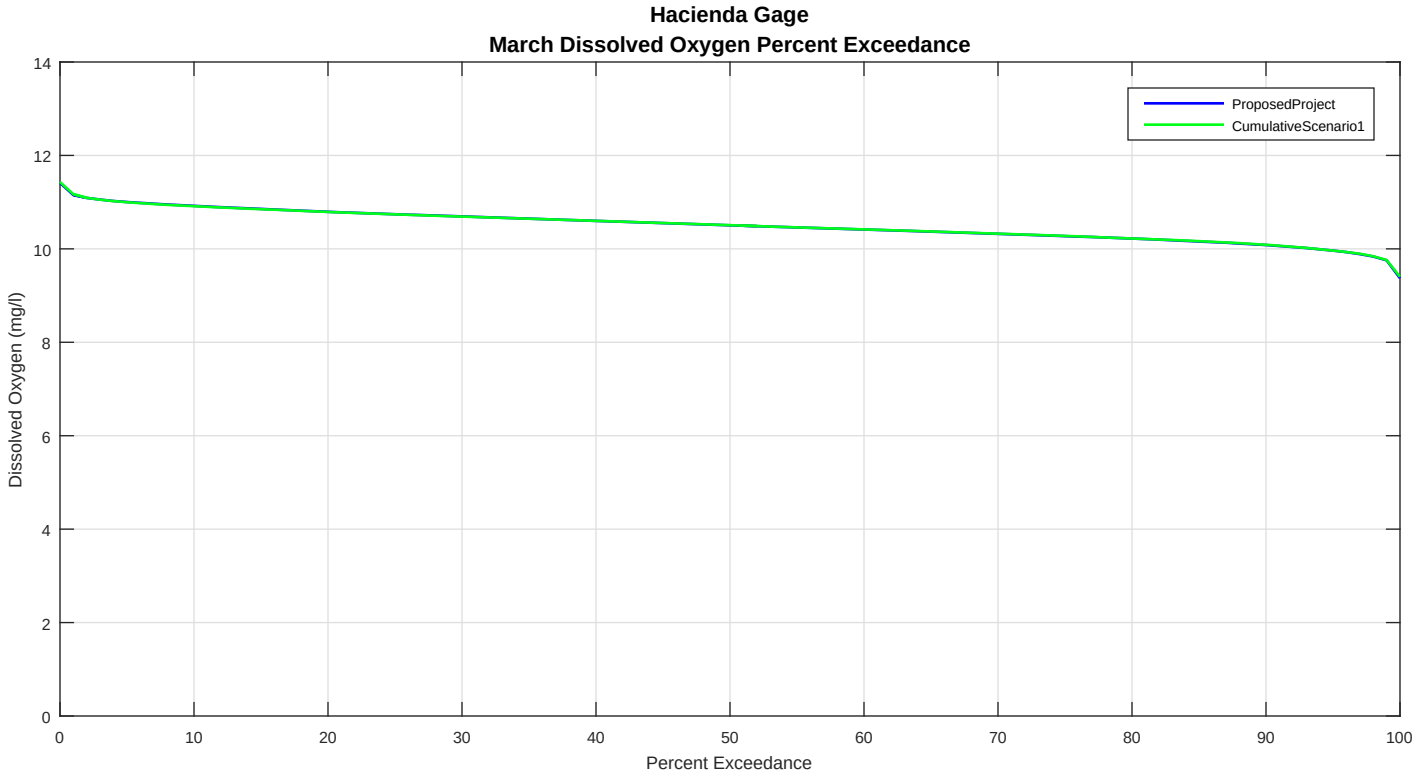
Hacienda Gage
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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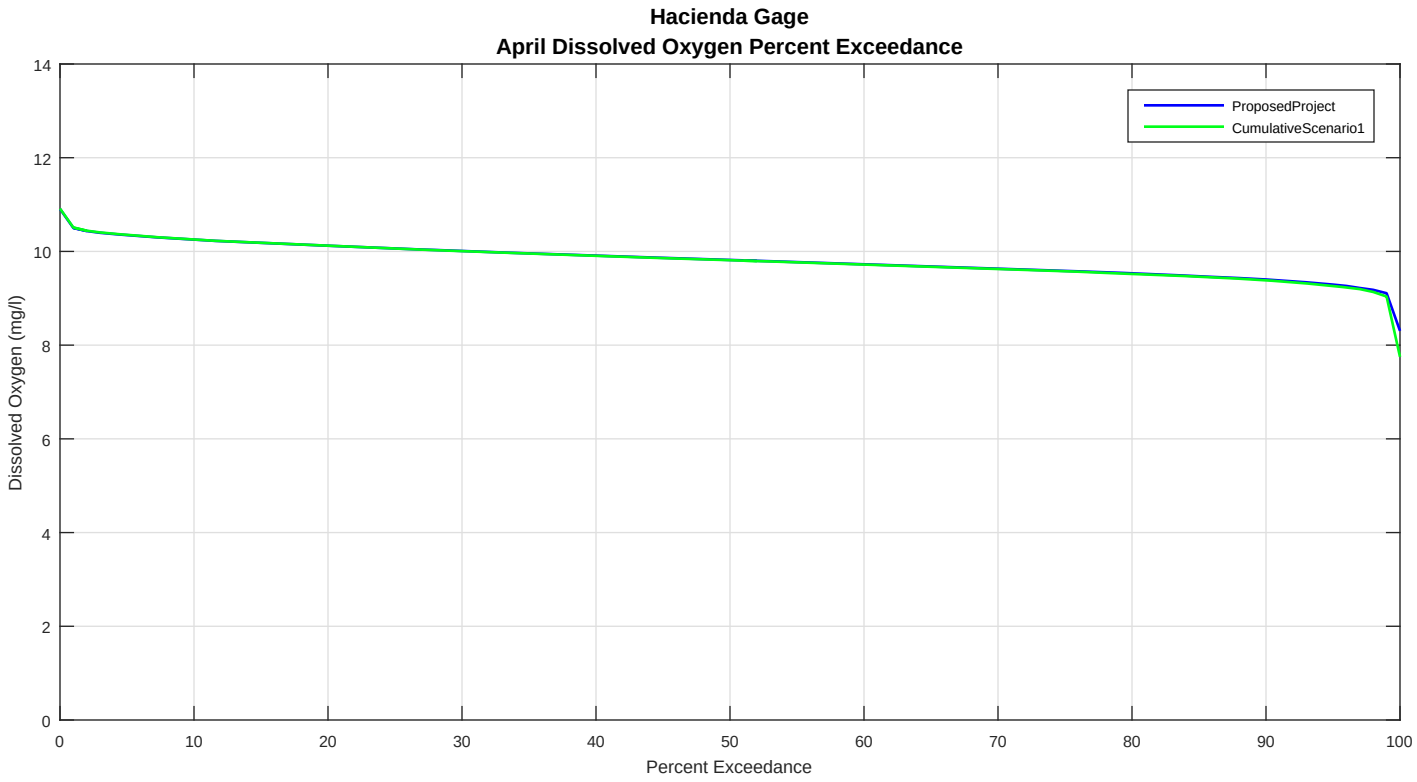
Hacienda Gage
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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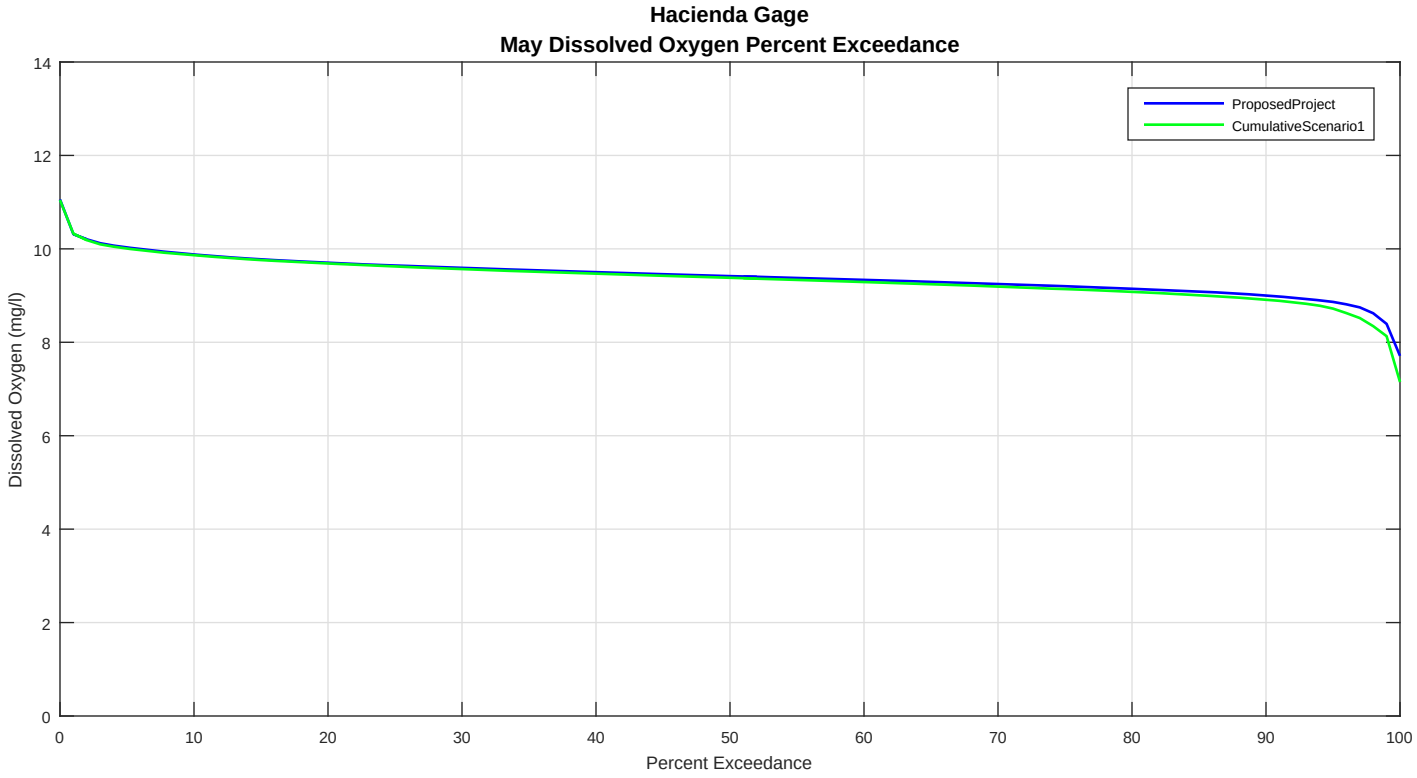
Hacienda Gage
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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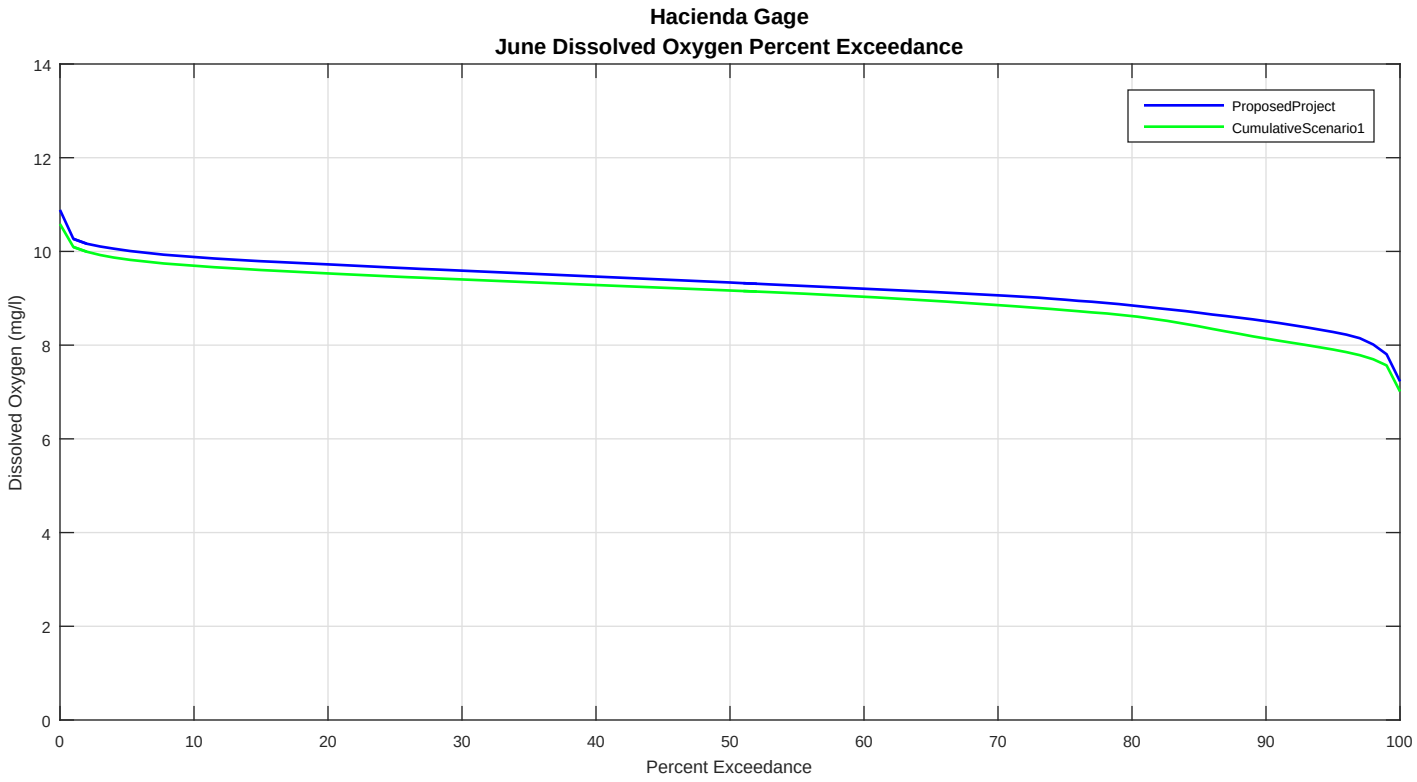
Hacienda Gage
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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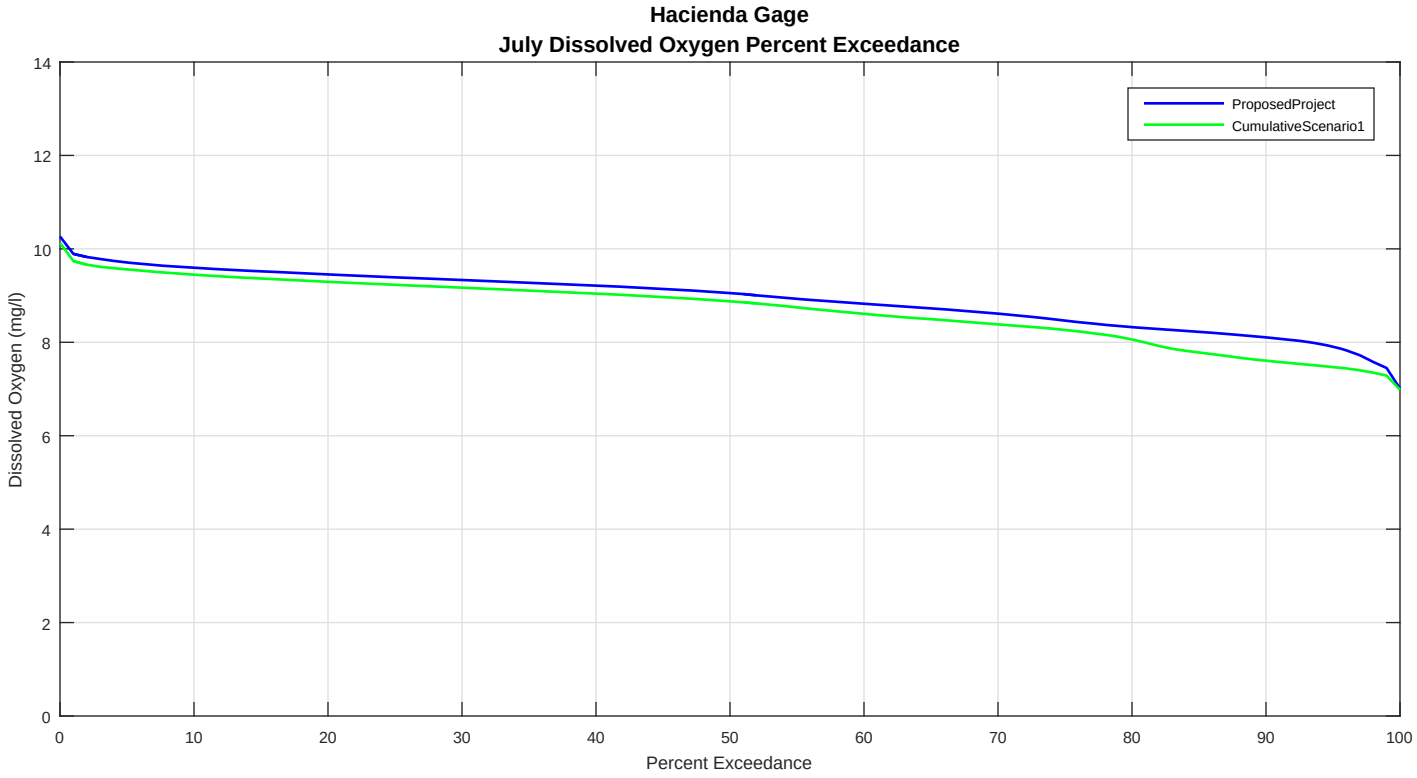
Hacienda Gage
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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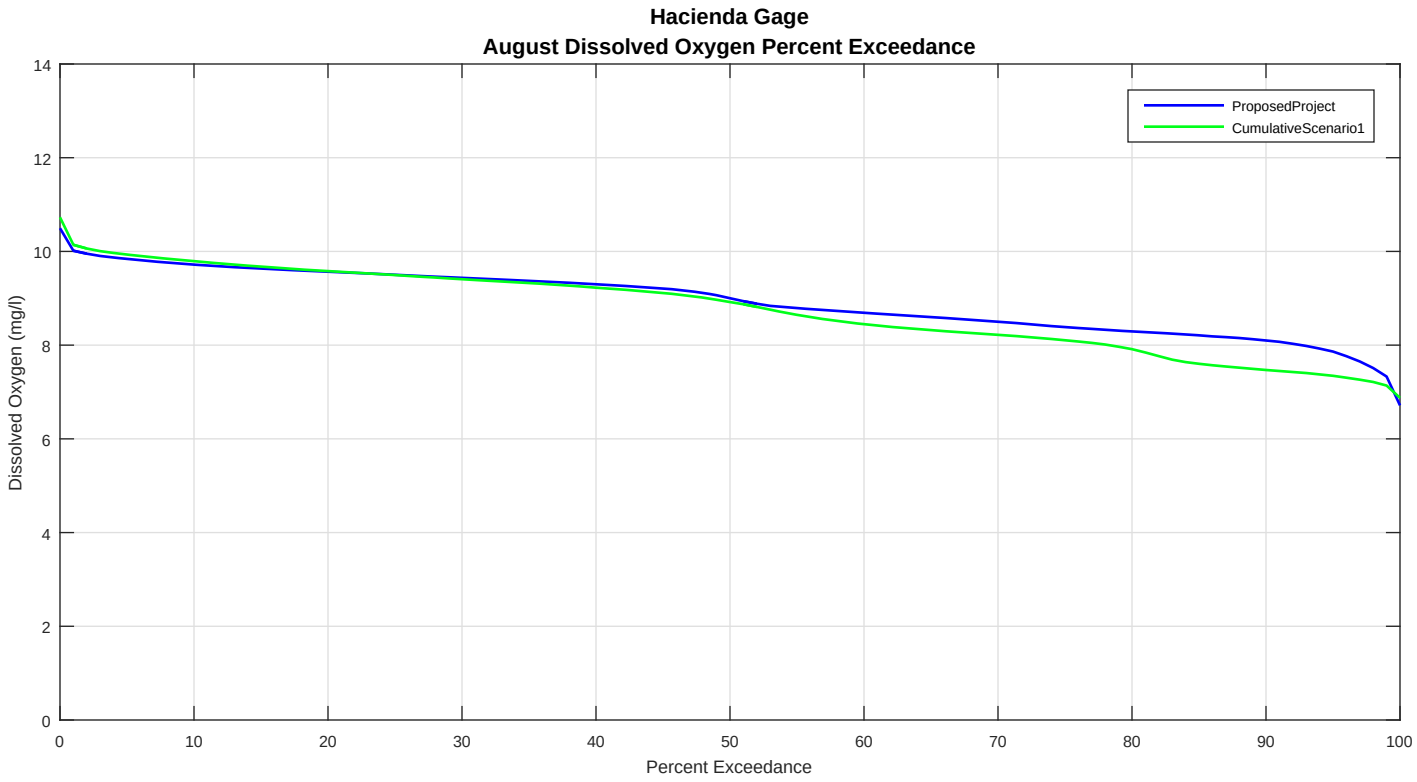
Hacienda Gage
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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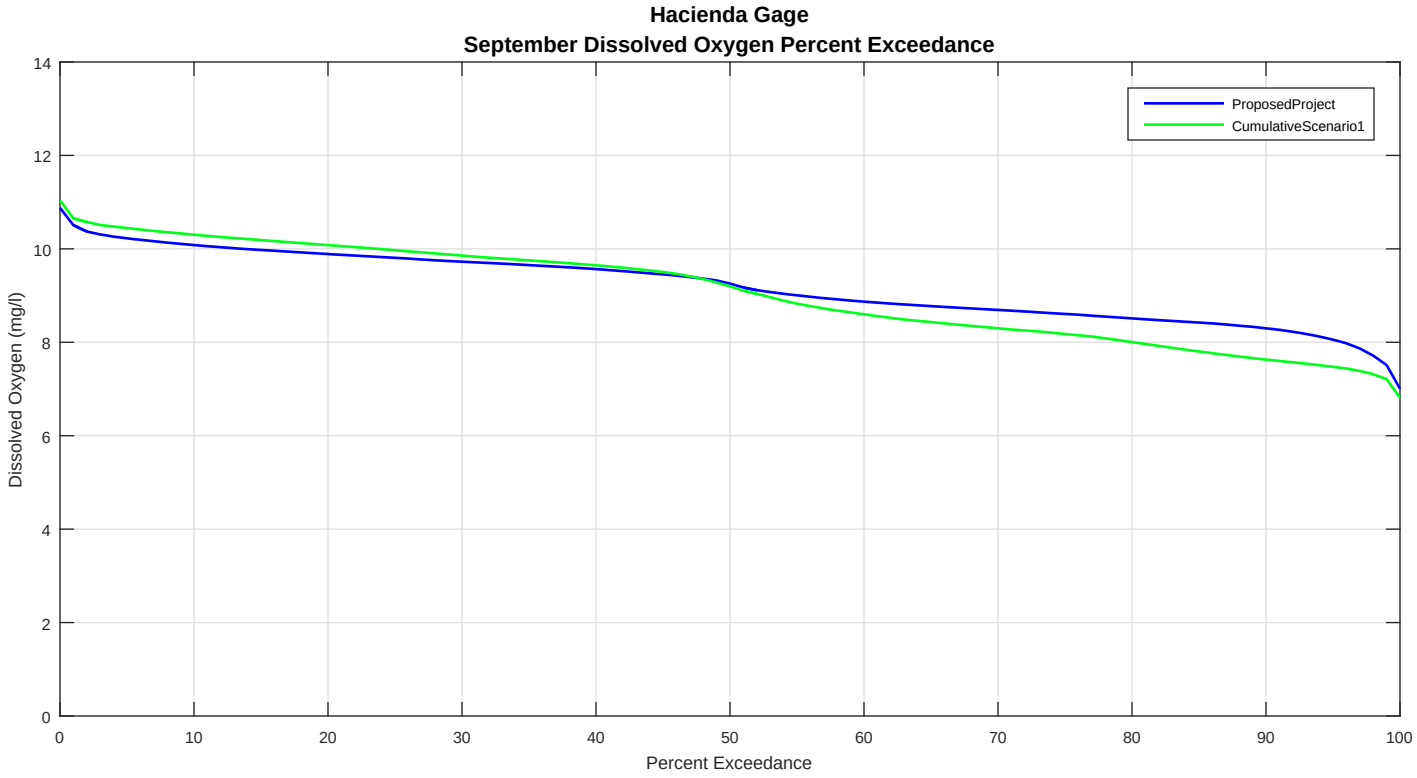
Hacienda Gage
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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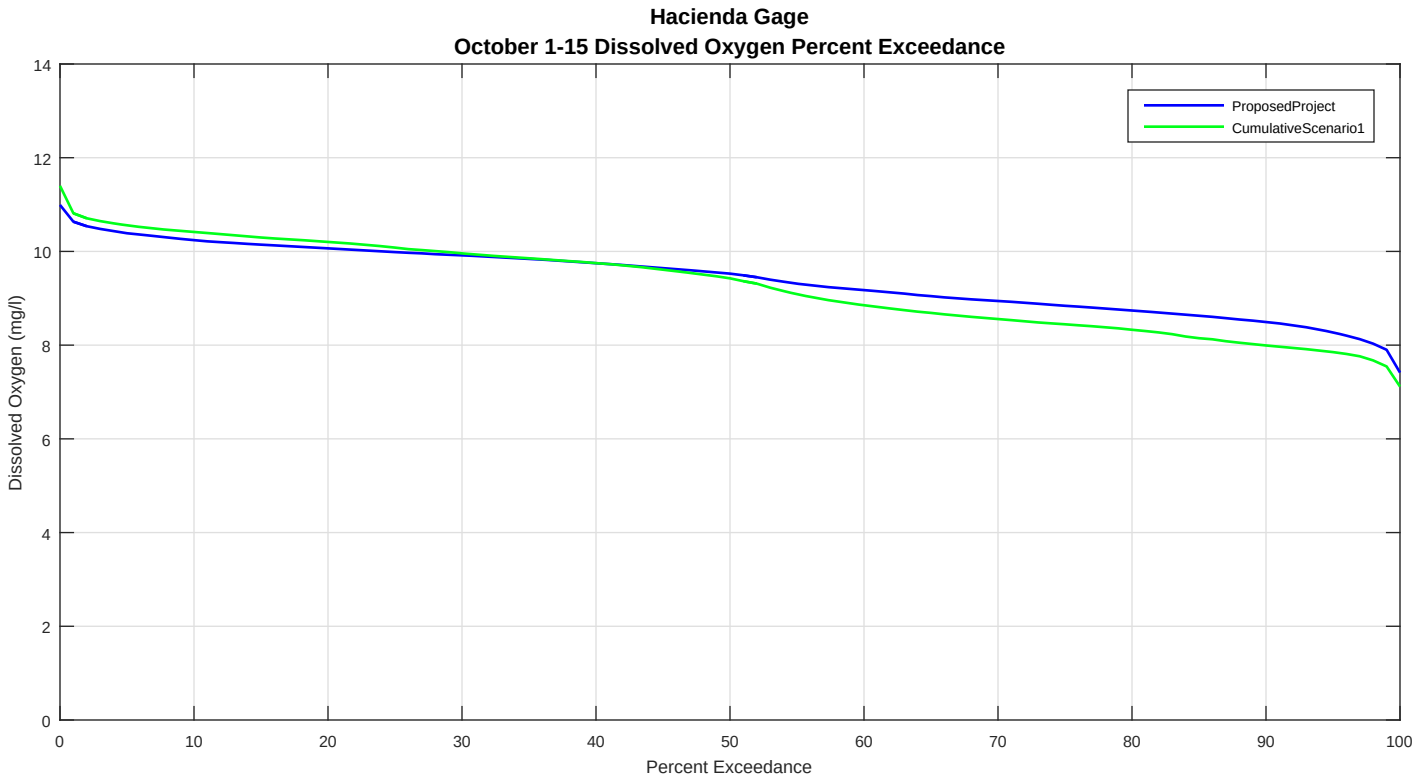
Hacienda Gage
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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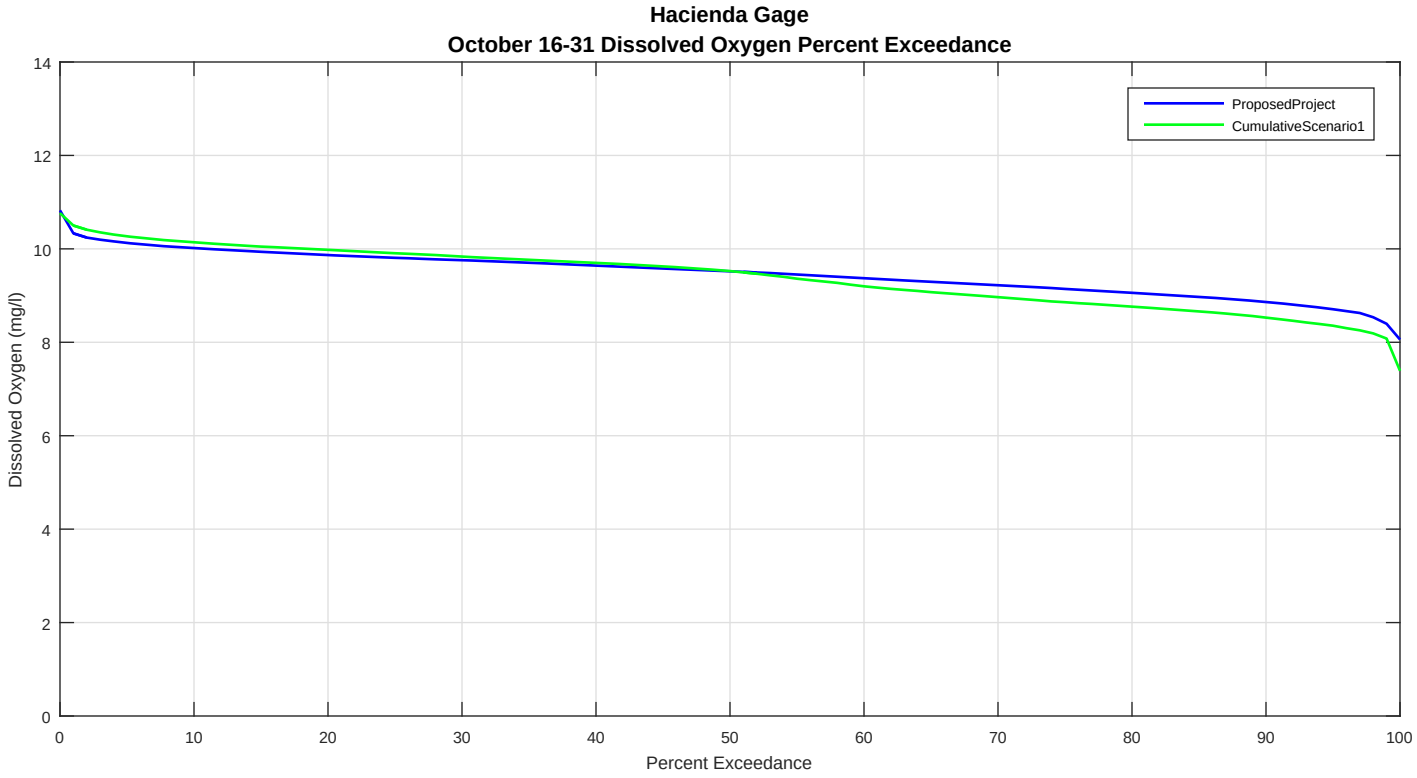
Hacienda Gage
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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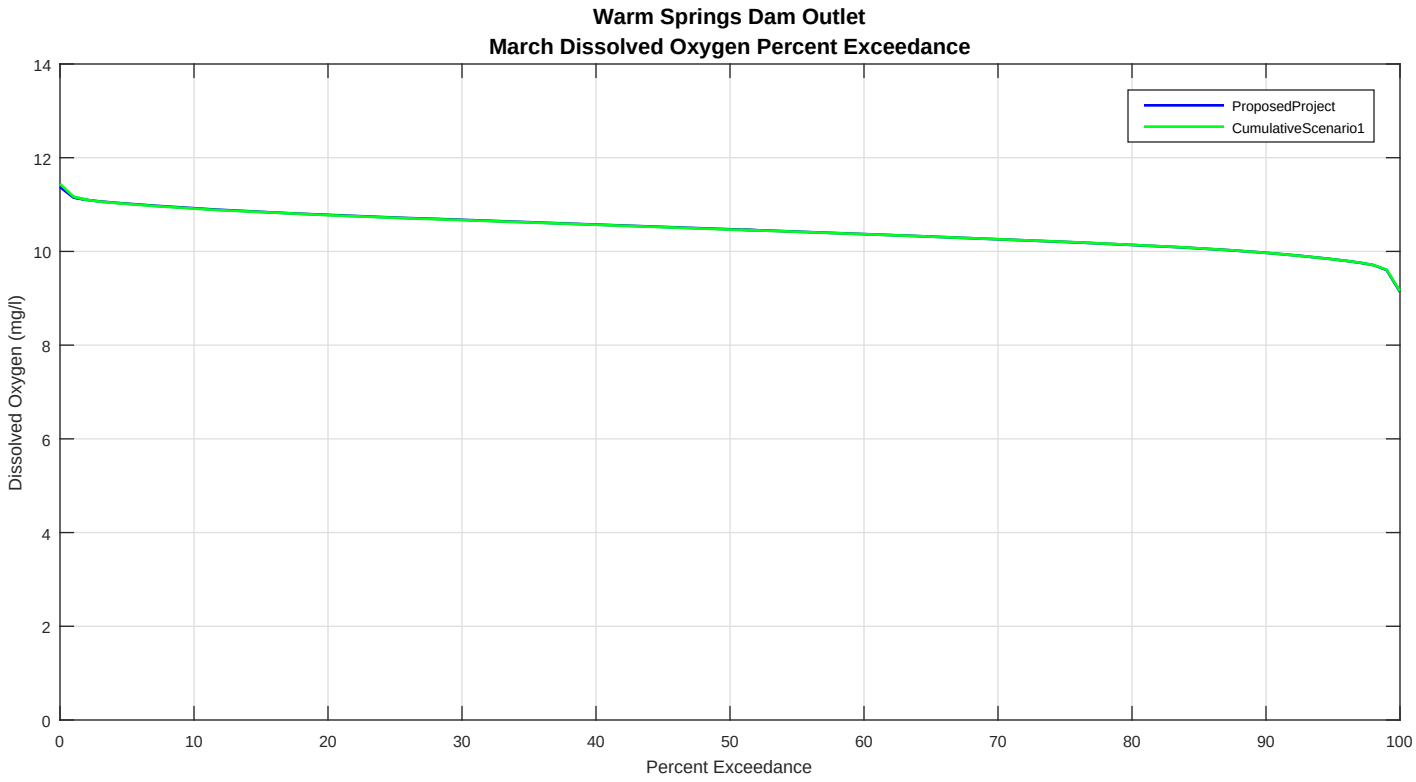
Warm Springs Dam Outlet
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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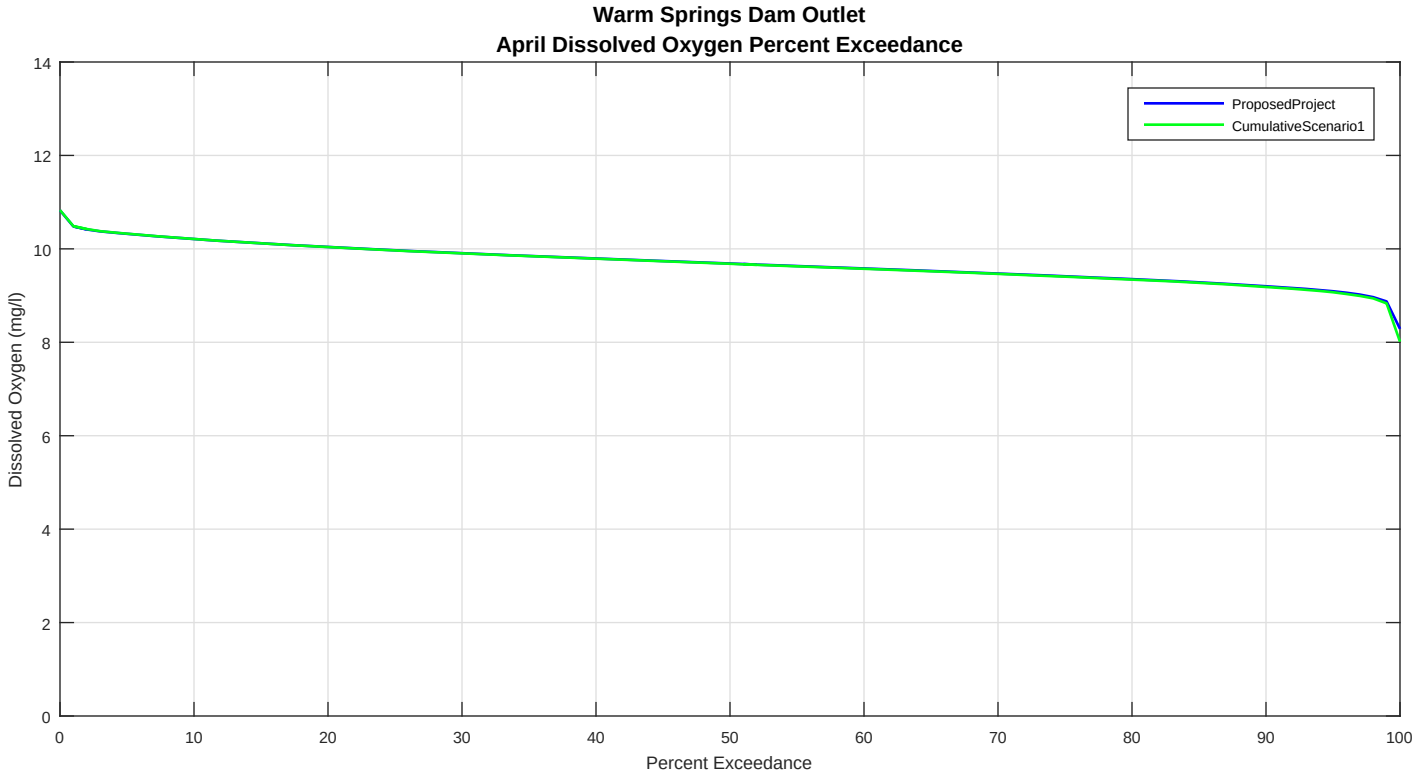
Warm Springs Dam Outlet
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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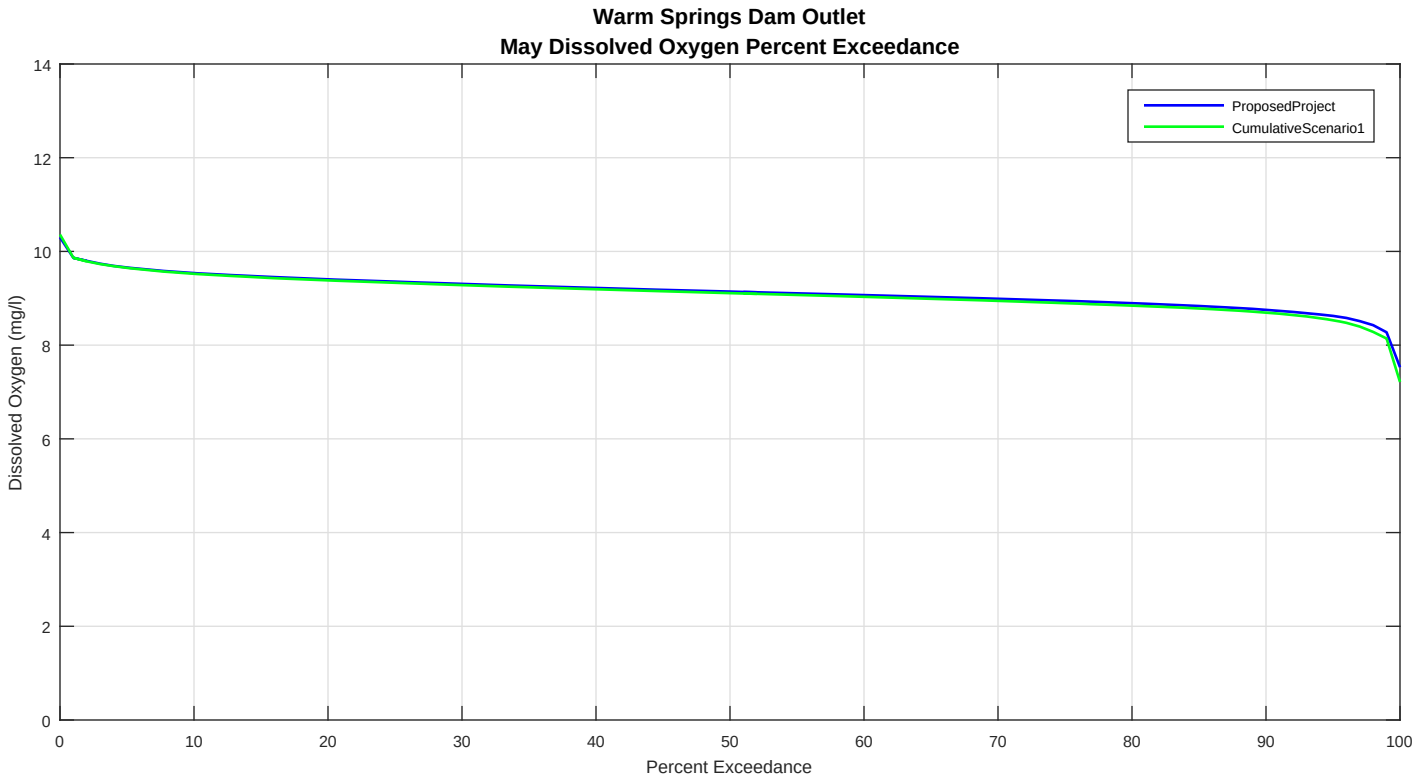
Warm Springs Dam Outlet
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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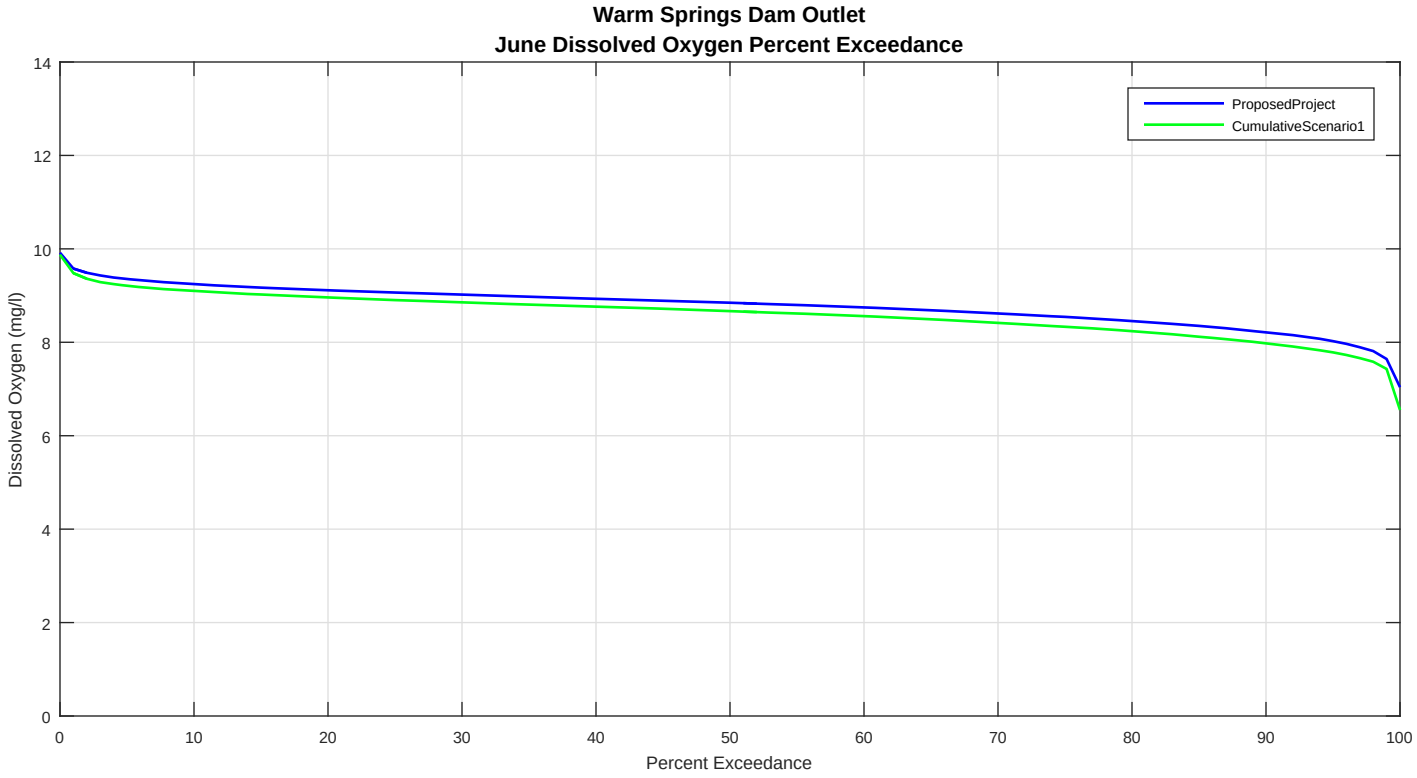
Warm Springs Dam Outlet
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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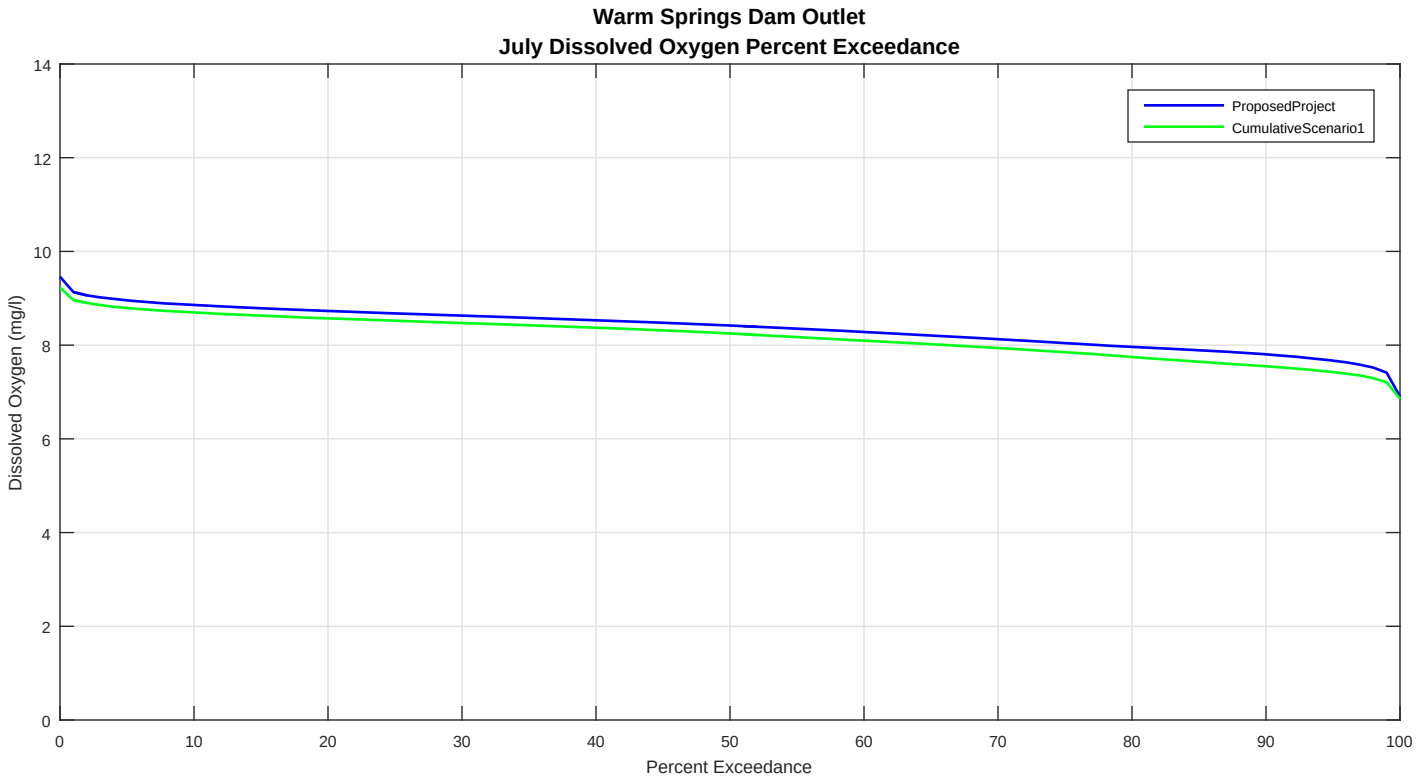
Warm Springs Dam Outlet
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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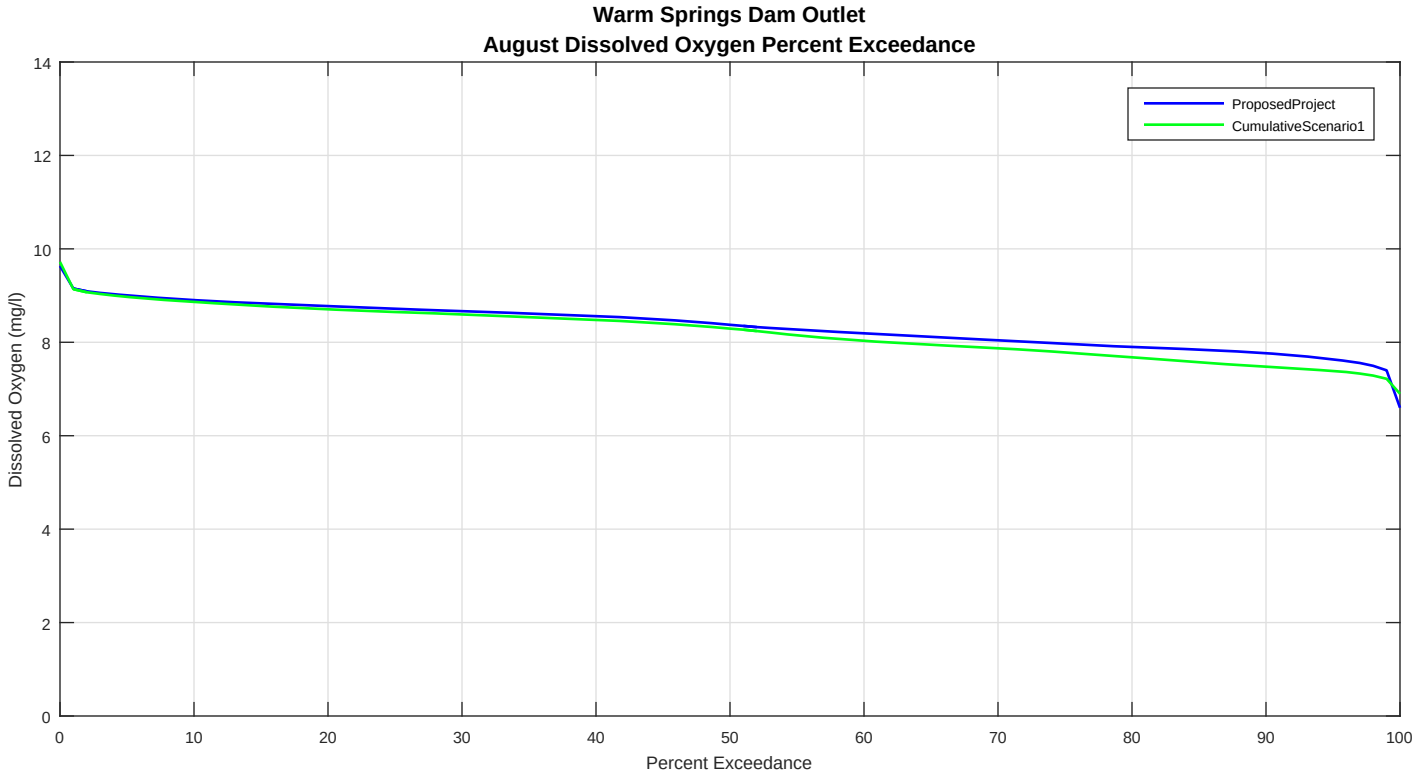
Warm Springs Dam Outlet
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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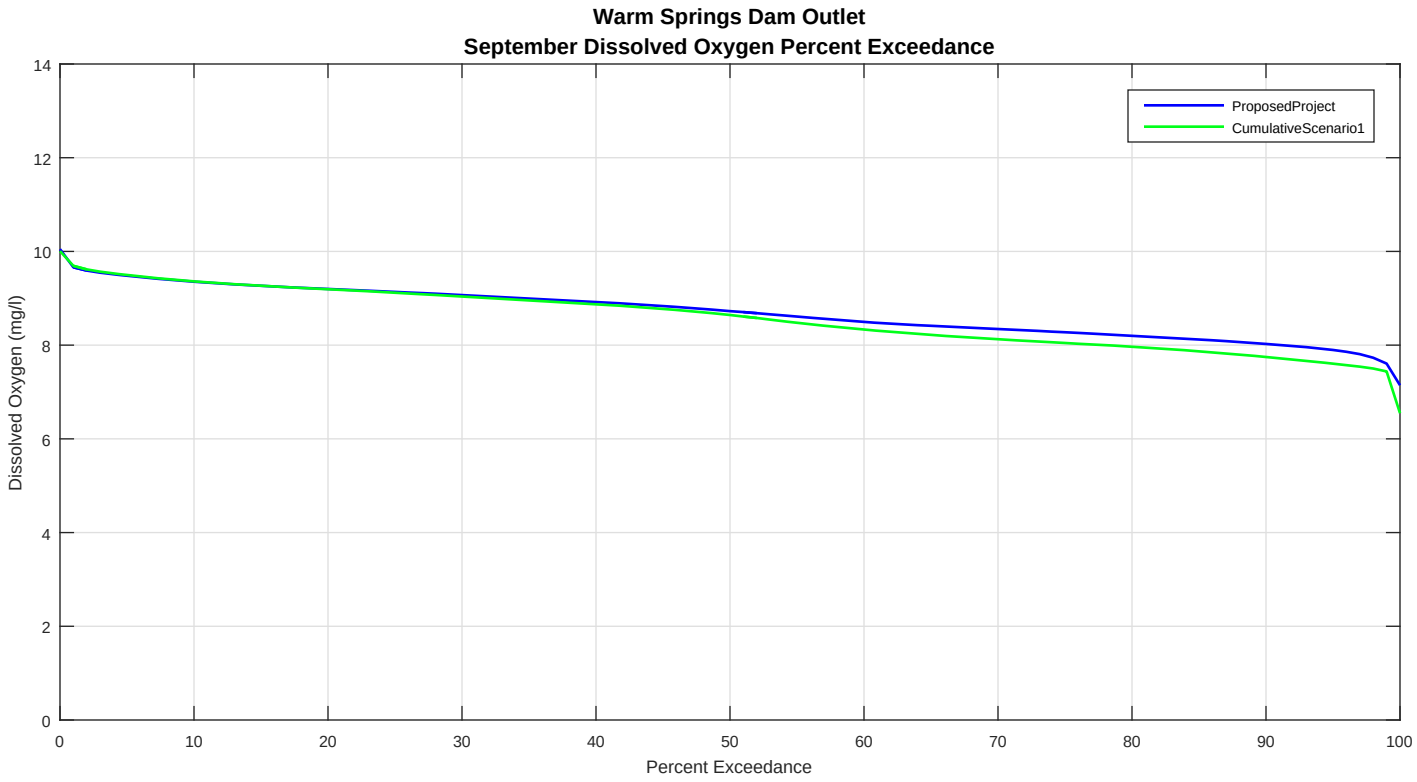
Warm Springs Dam Outlet
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
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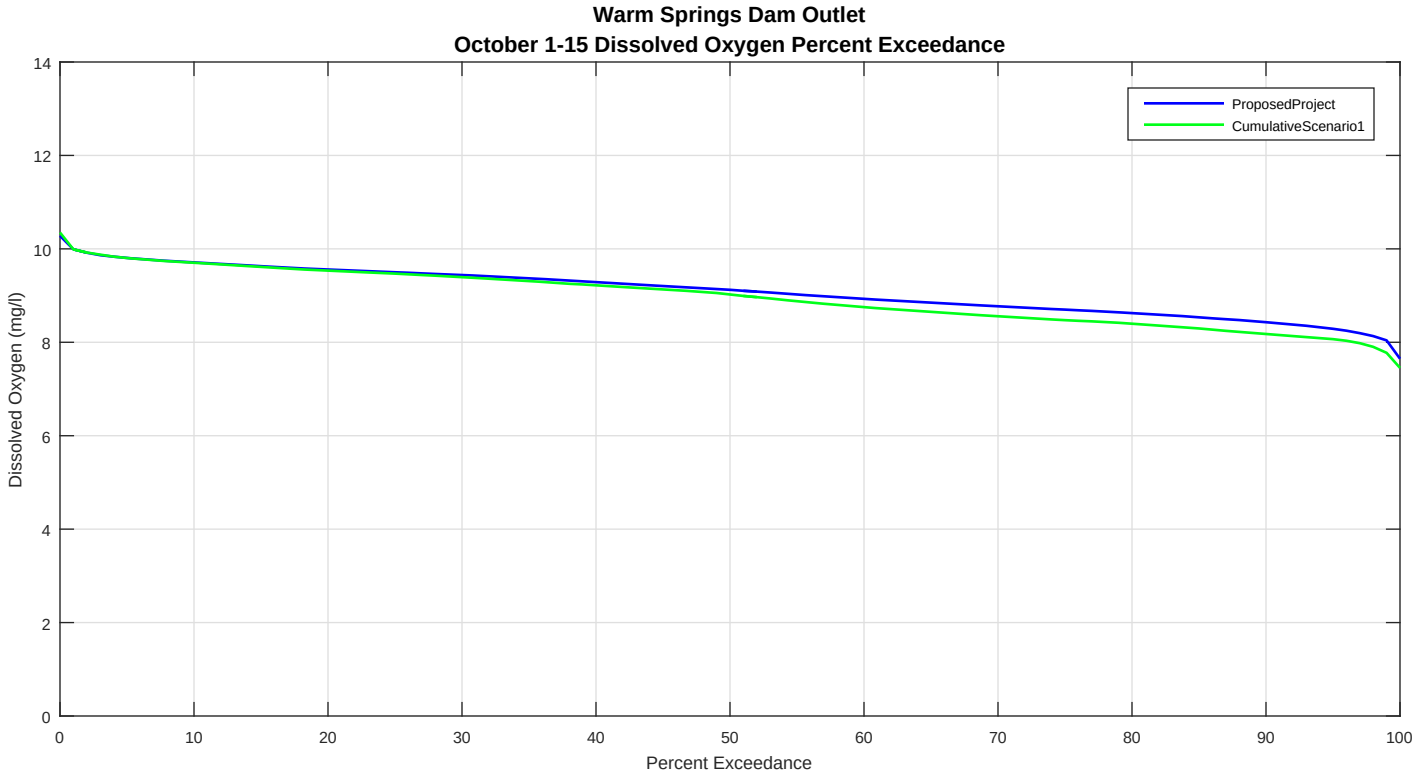
Warm Springs Dam Outlet
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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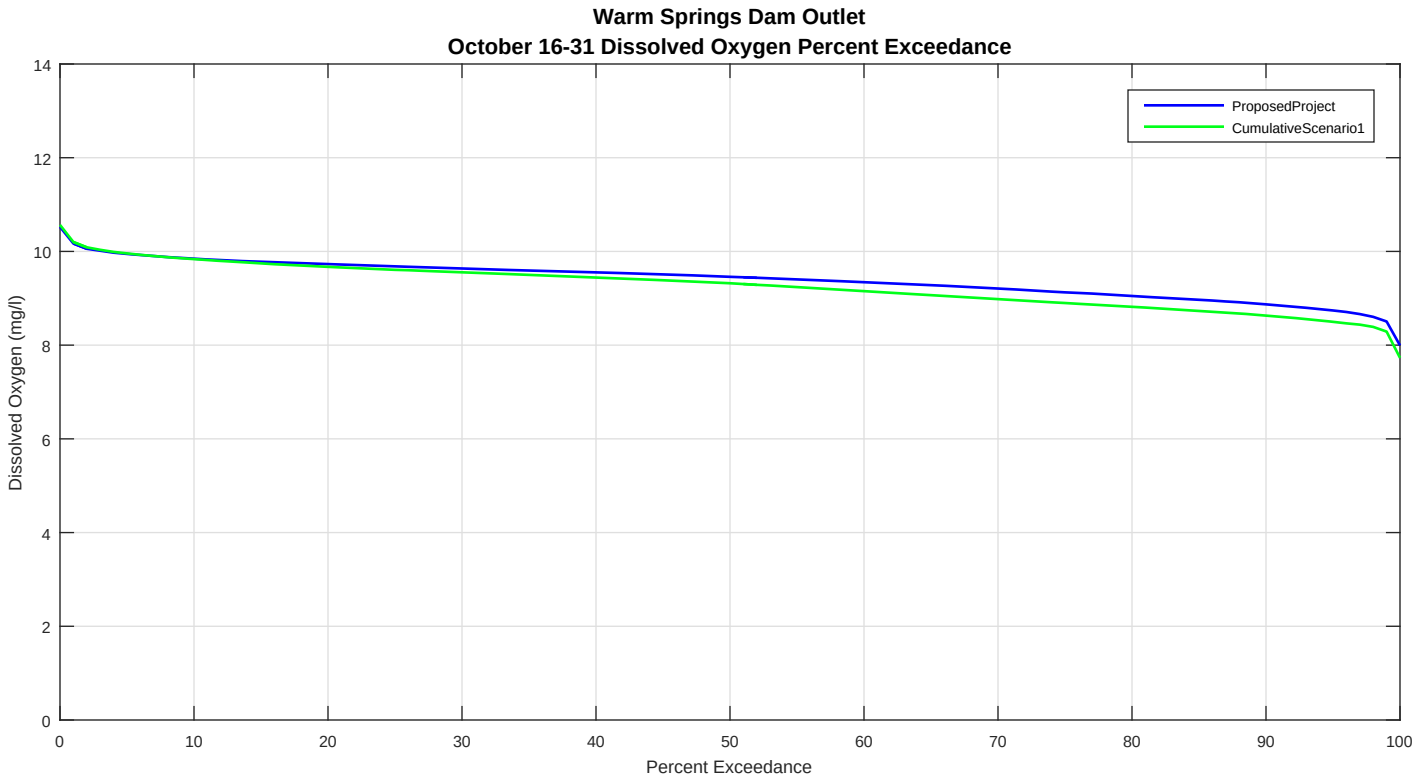
Warm Springs Dam Outlet
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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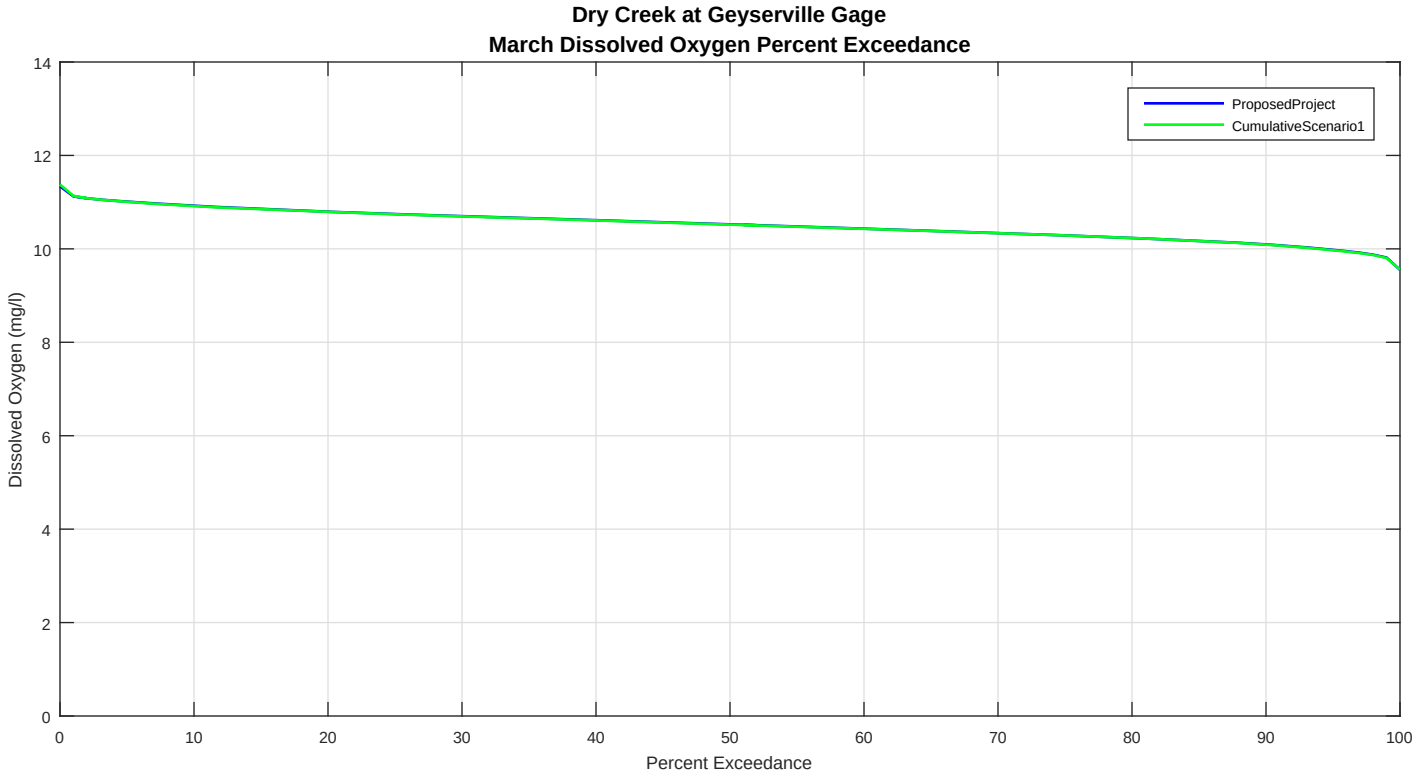
Dry Creek at Geyserville Gage
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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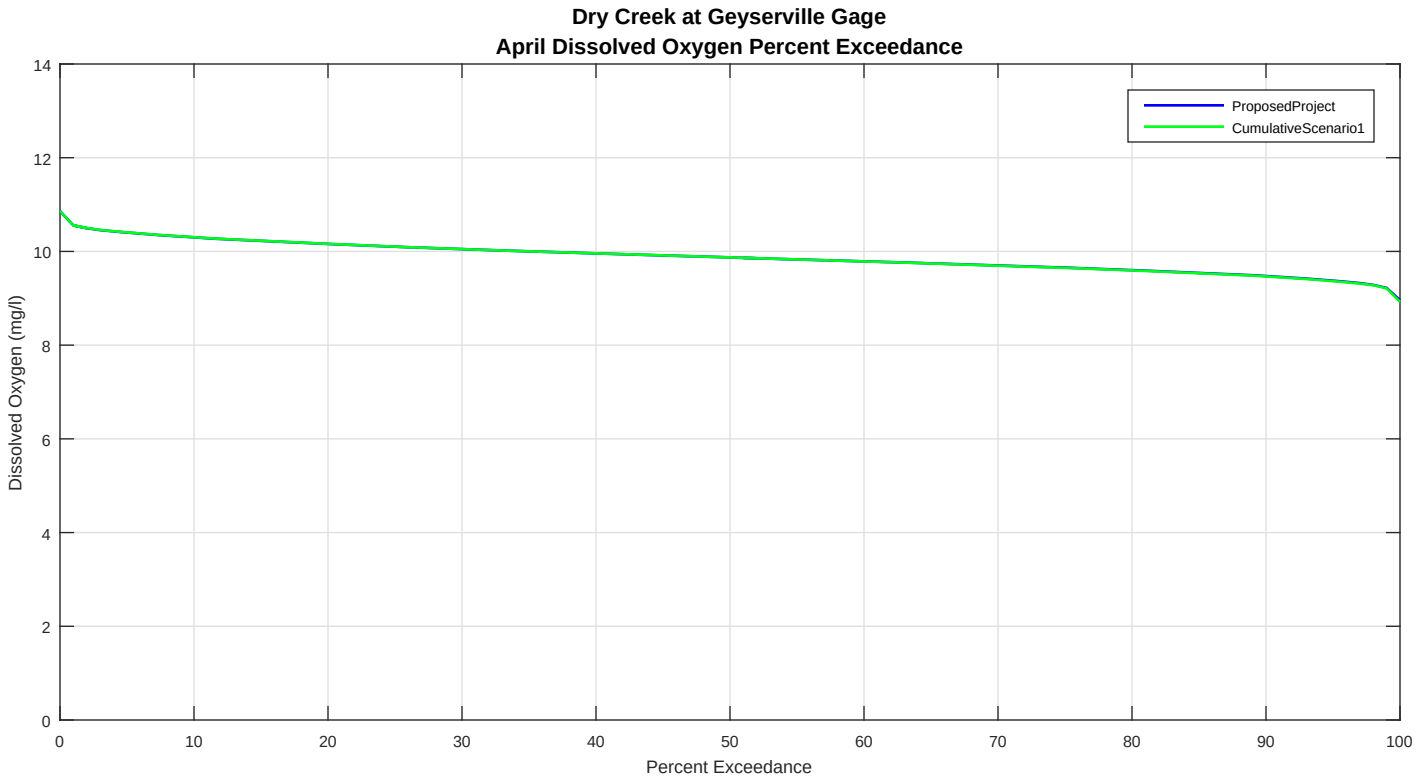
Dry Creek at Geyserville Gage
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
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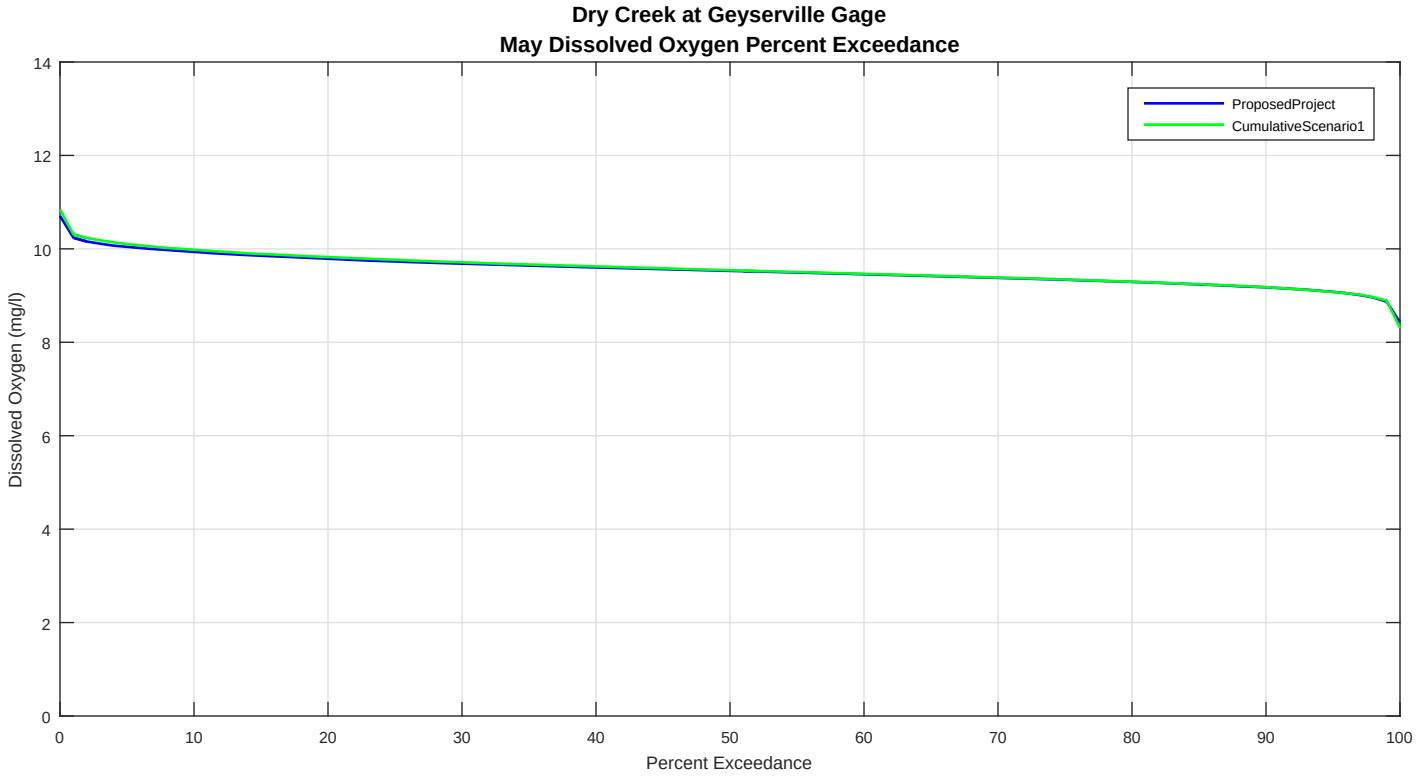
Dry Creek at Geyserville Gage
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
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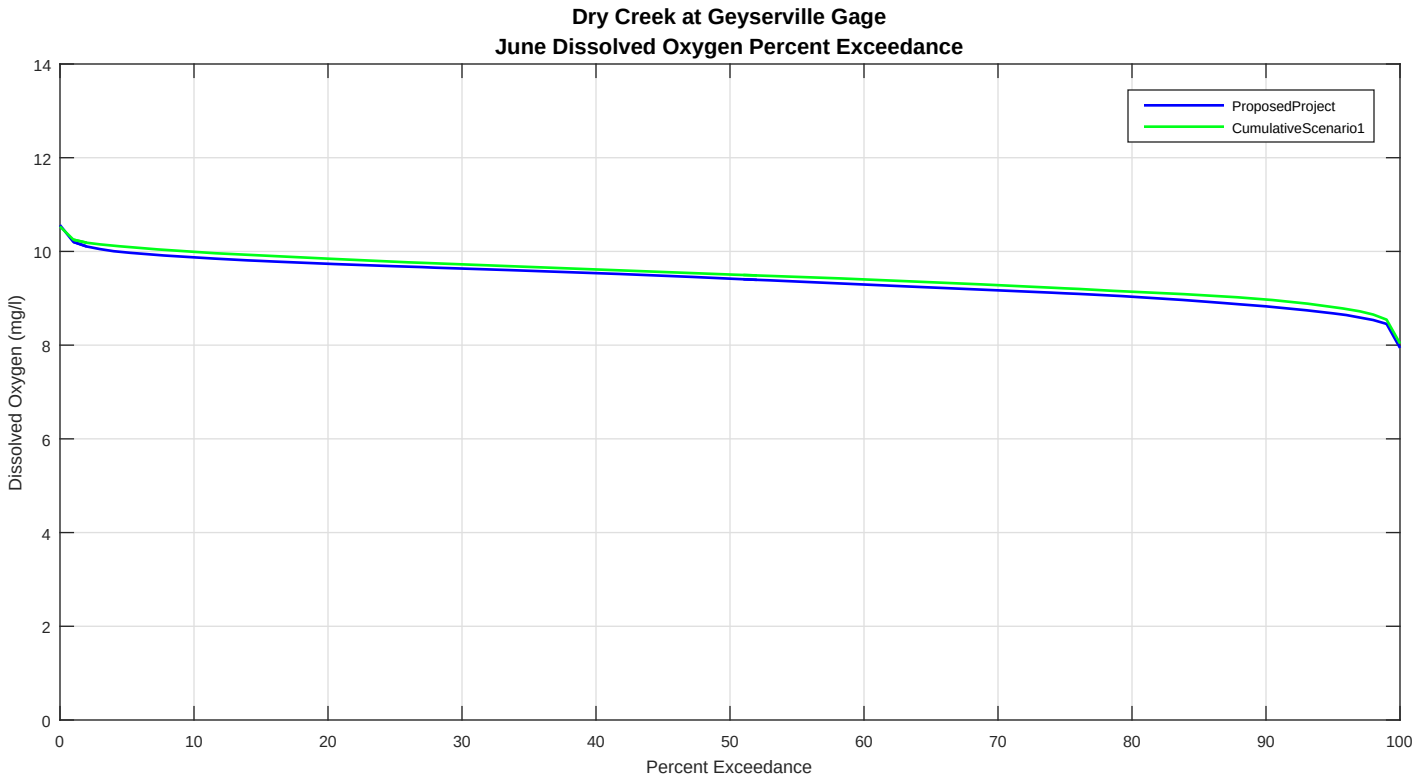
Dry Creek at Geyserville Gage
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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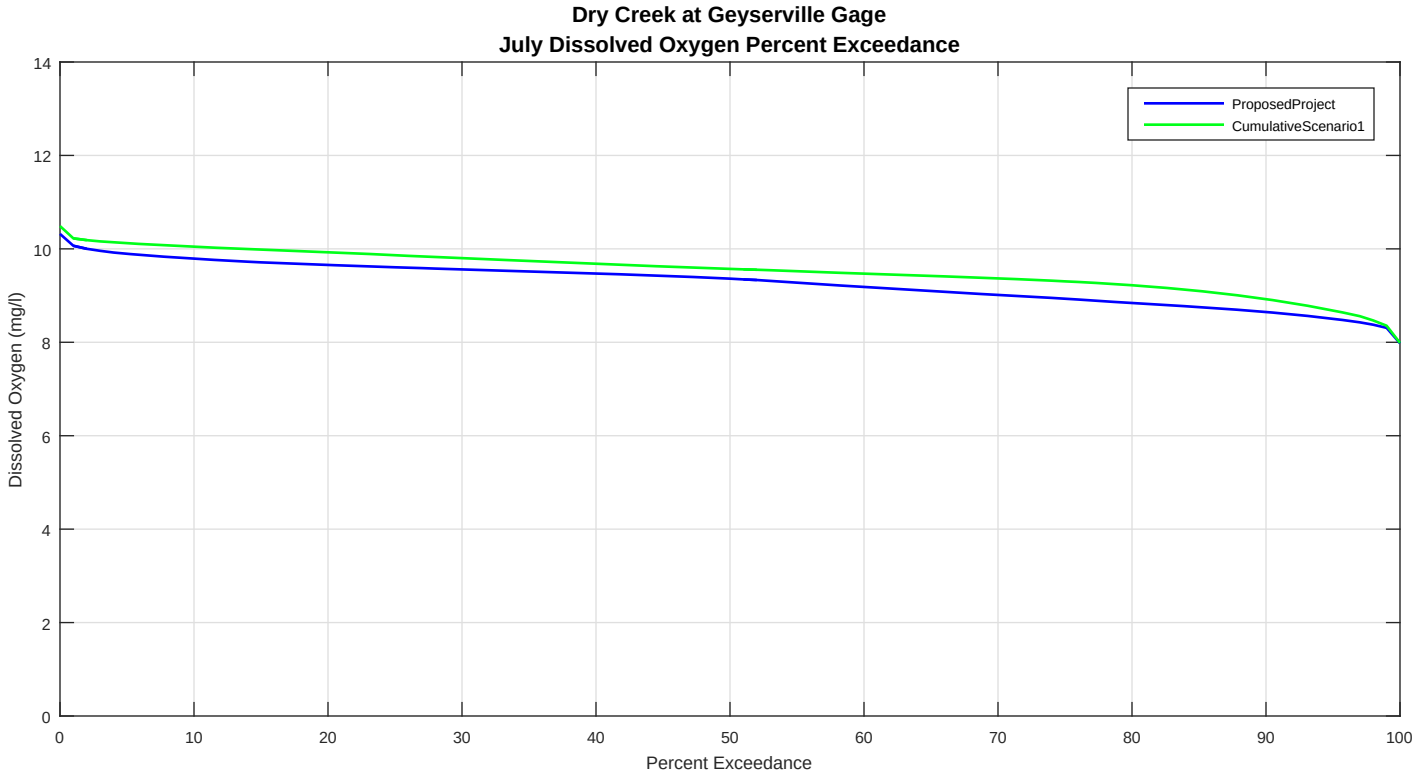
Dry Creek at Geyserville Gage
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
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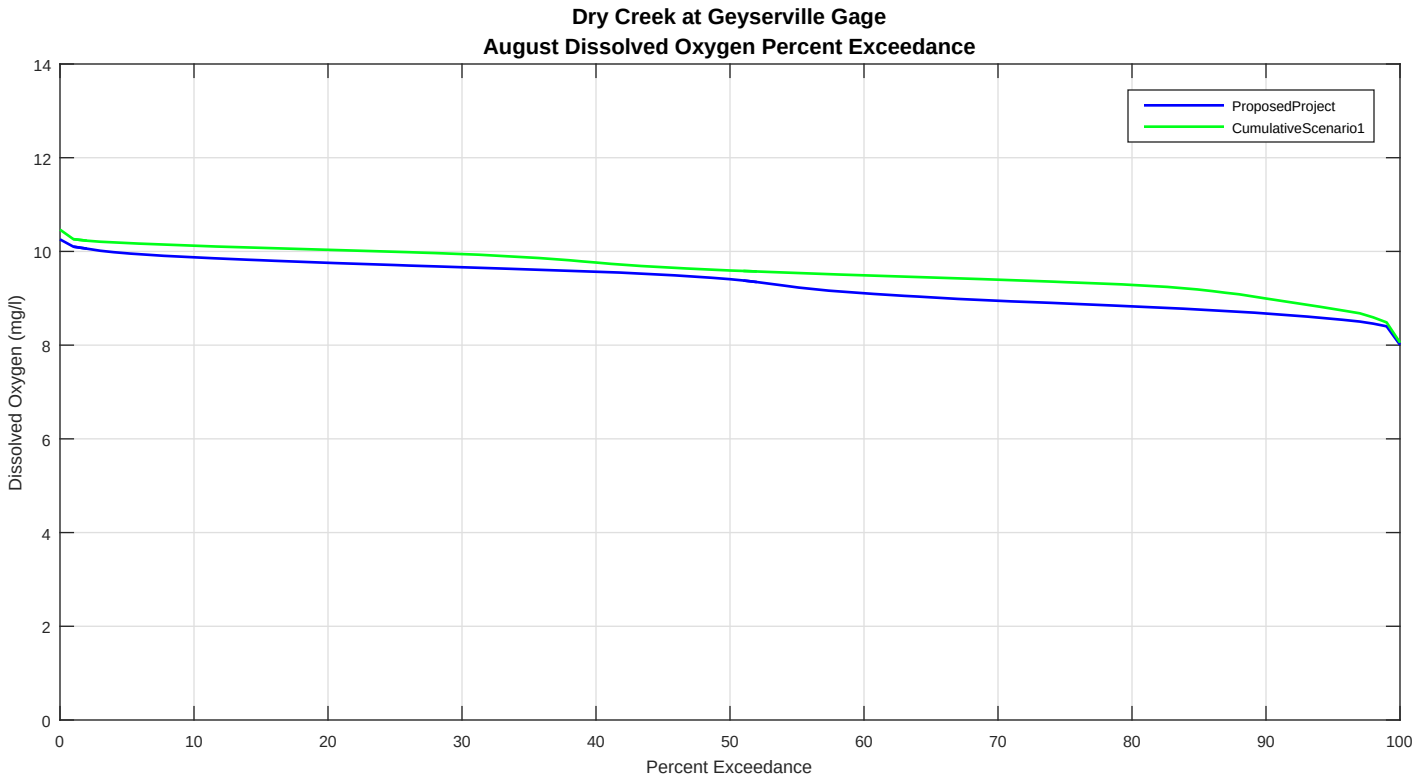
Dry Creek at Geyserville Gage
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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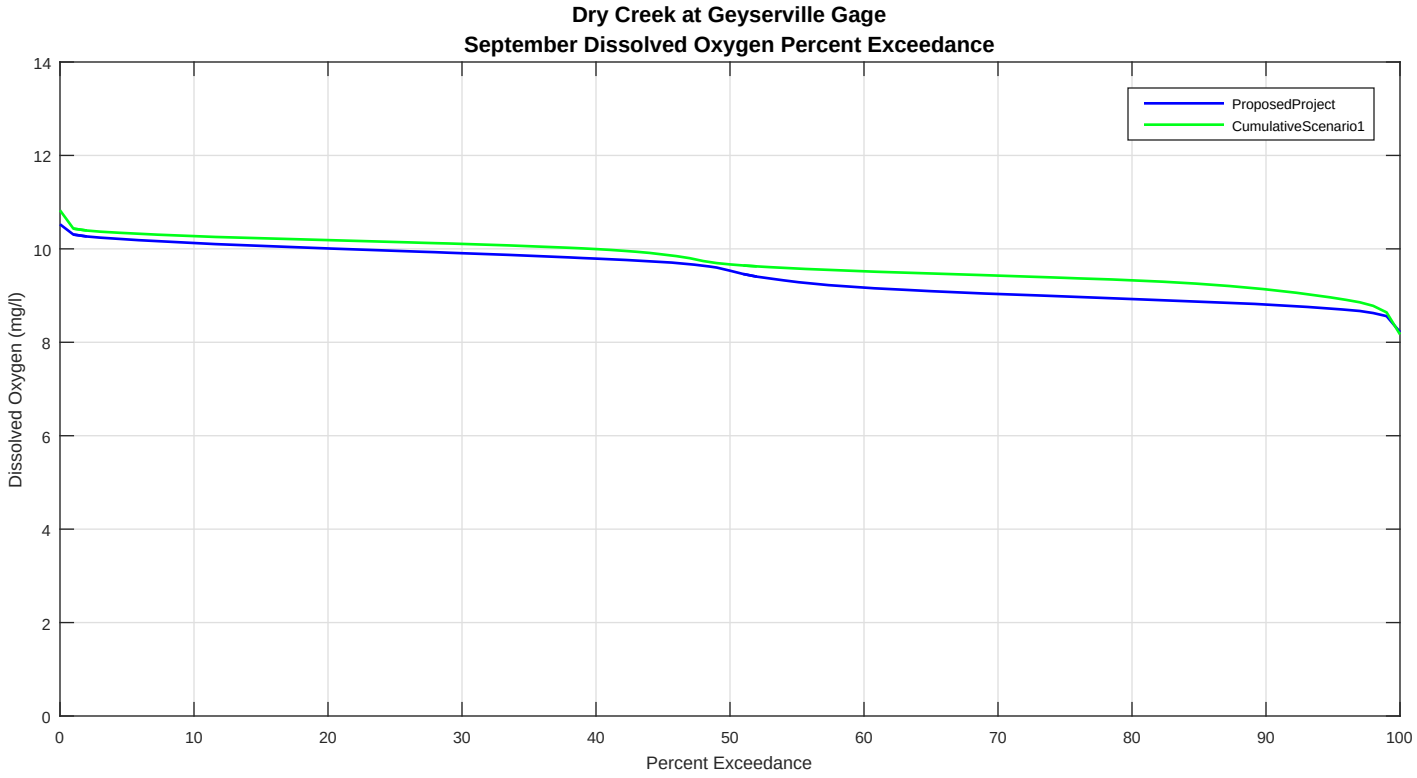
Dry Creek at Geyserville Gage
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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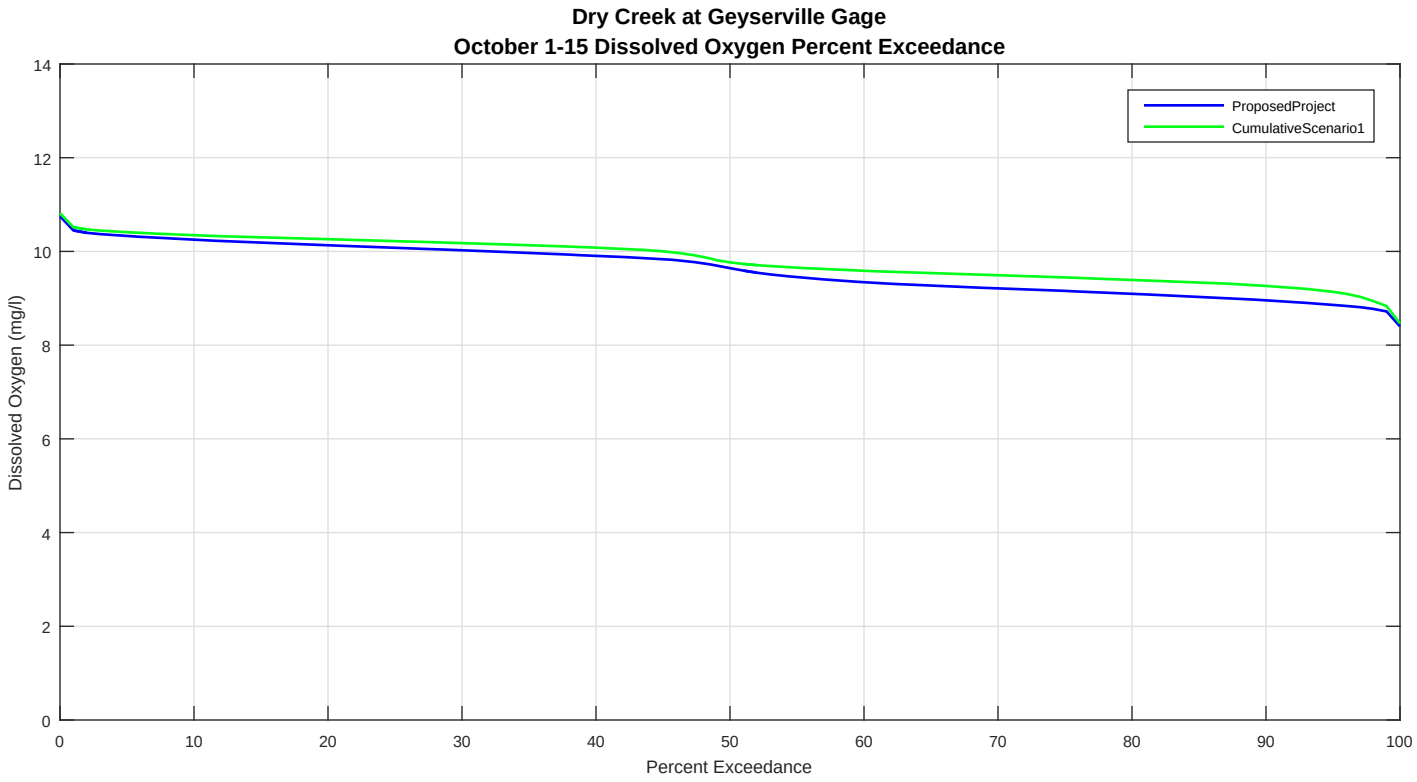
Dry Creek at Geyserville Gage
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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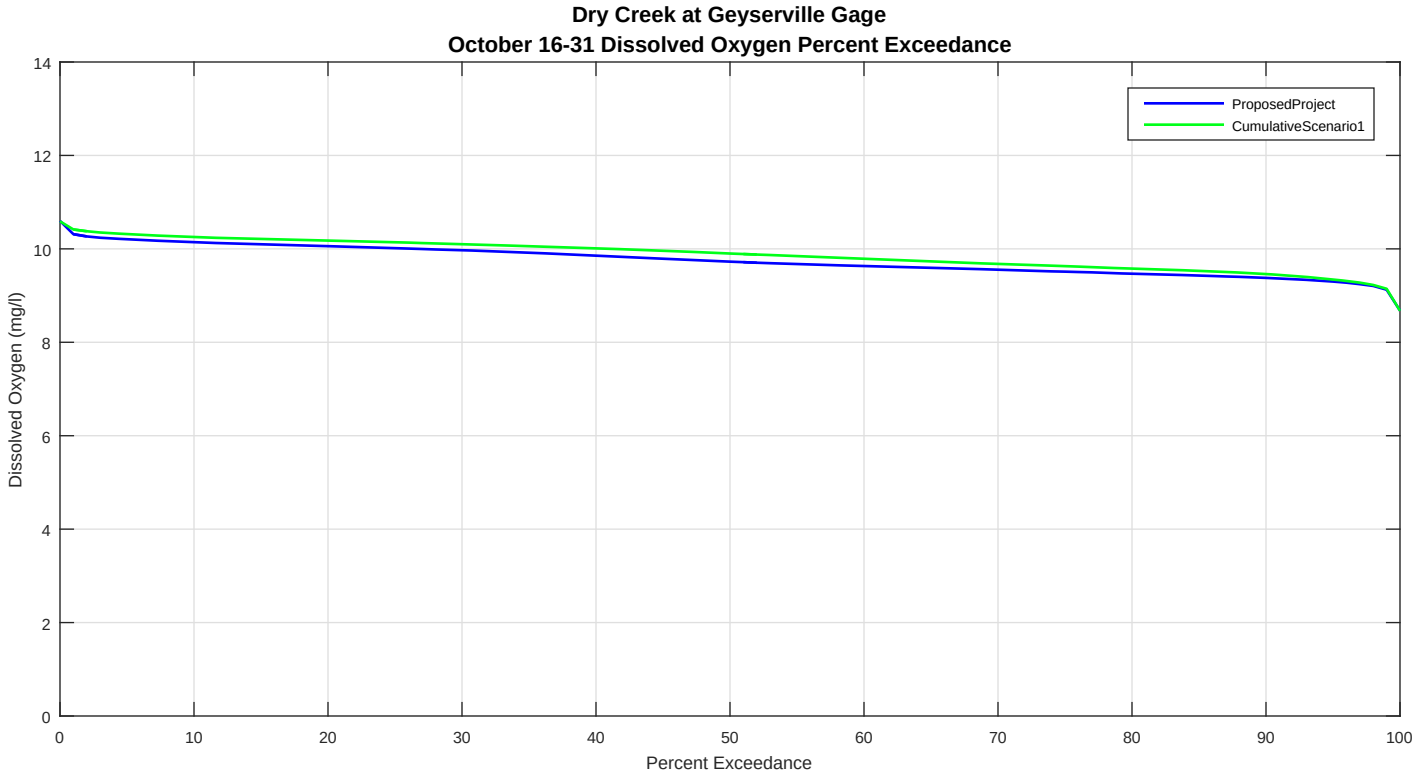
Dry Creek at Geyserville Gage
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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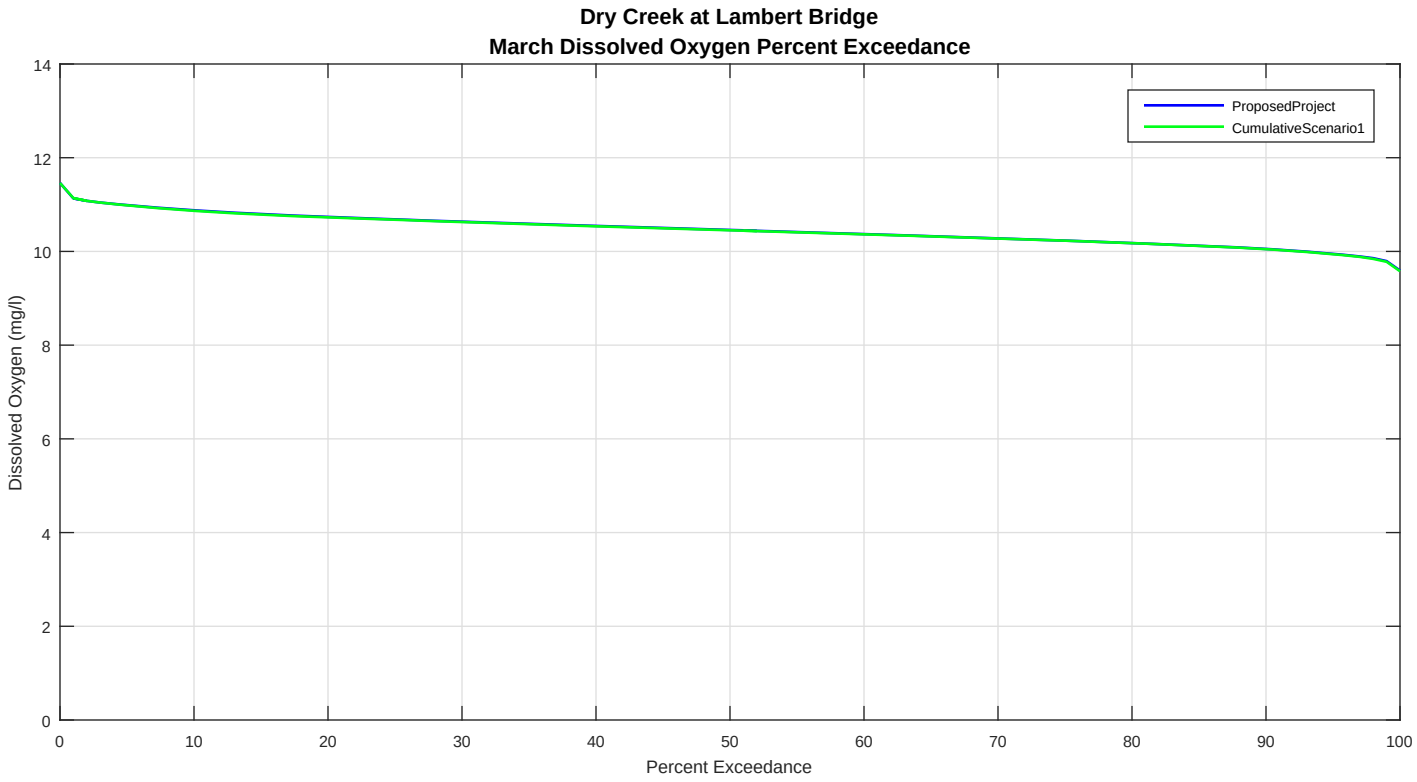
Dry Creek at Lambert Bridge
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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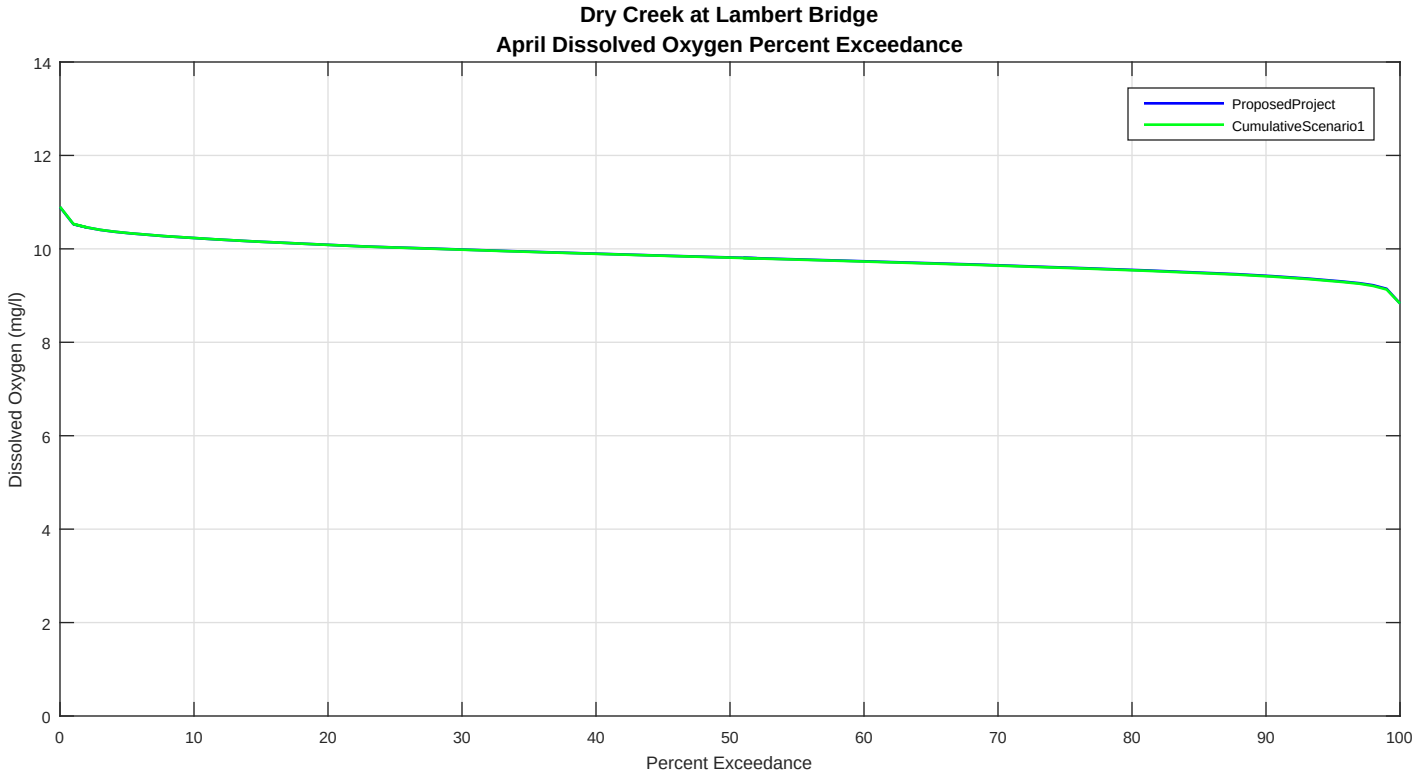
Dry Creek at Lambert Bridge
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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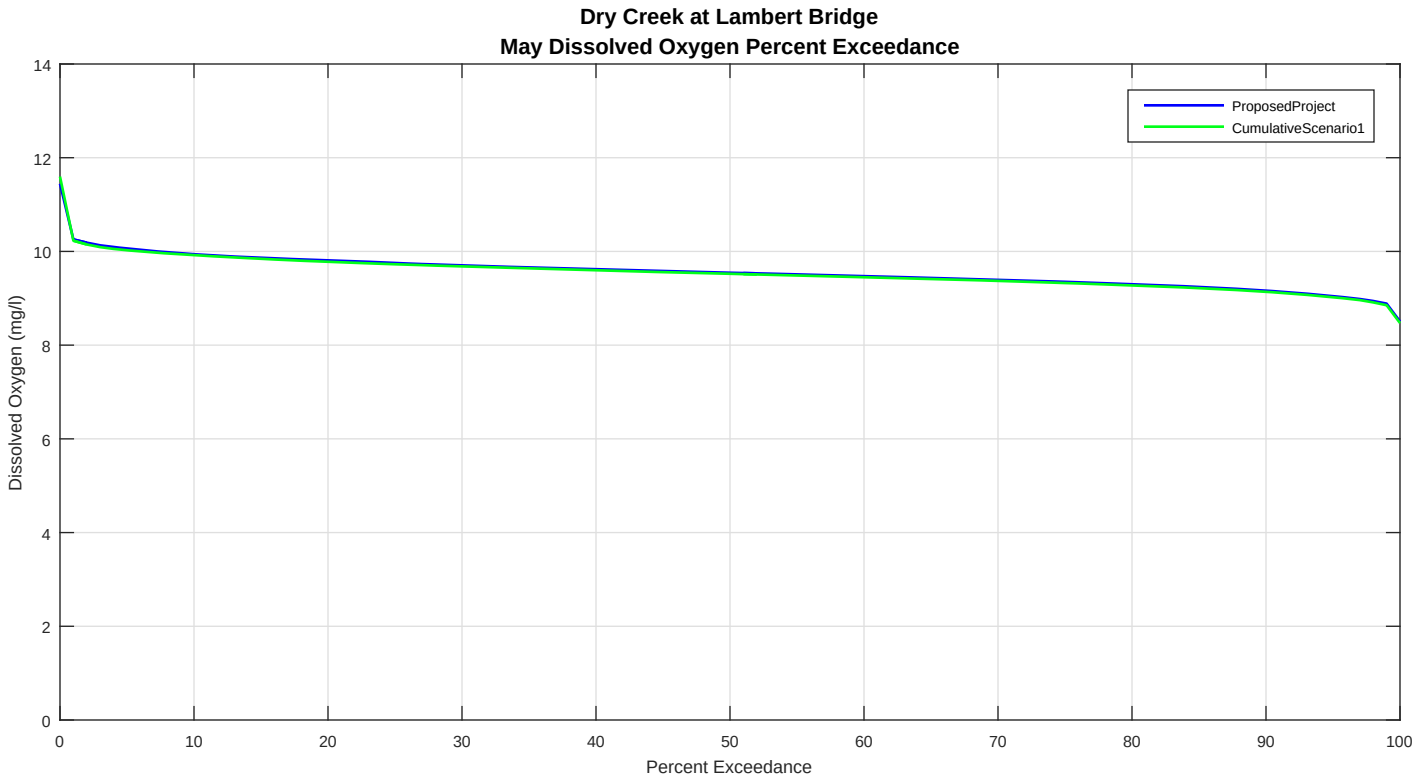
Dry Creek at Lambert Bridge
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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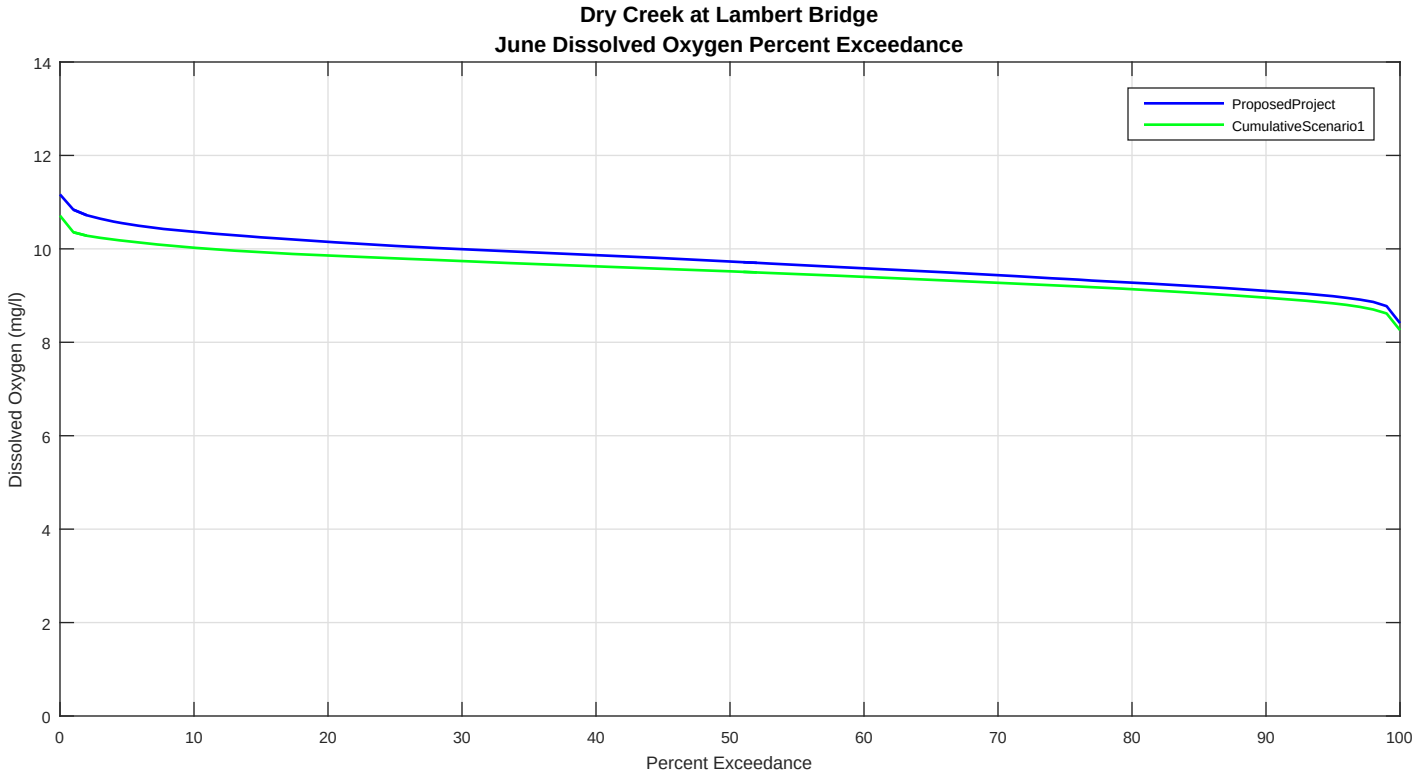
Dry Creek at Lambert Bridge
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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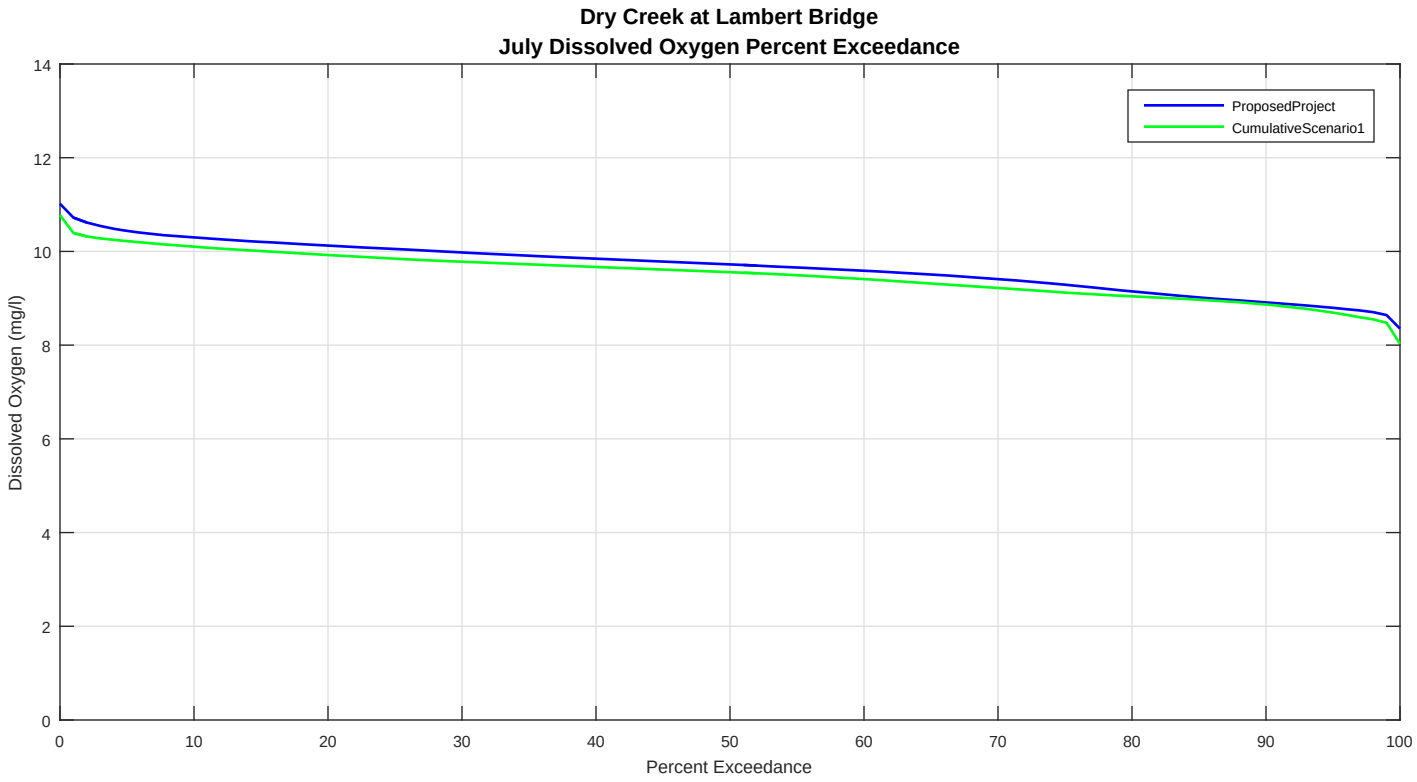
Dry Creek at Lambert Bridge
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
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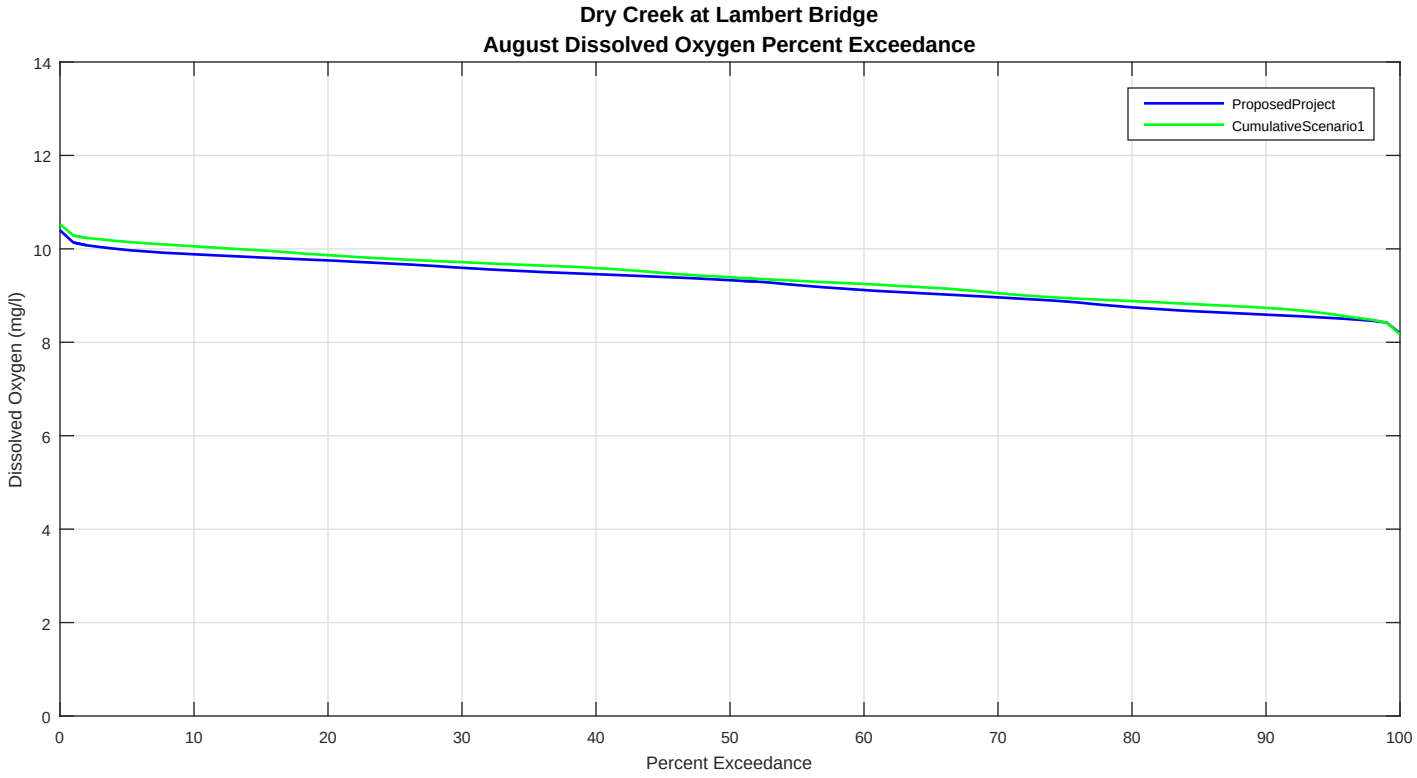
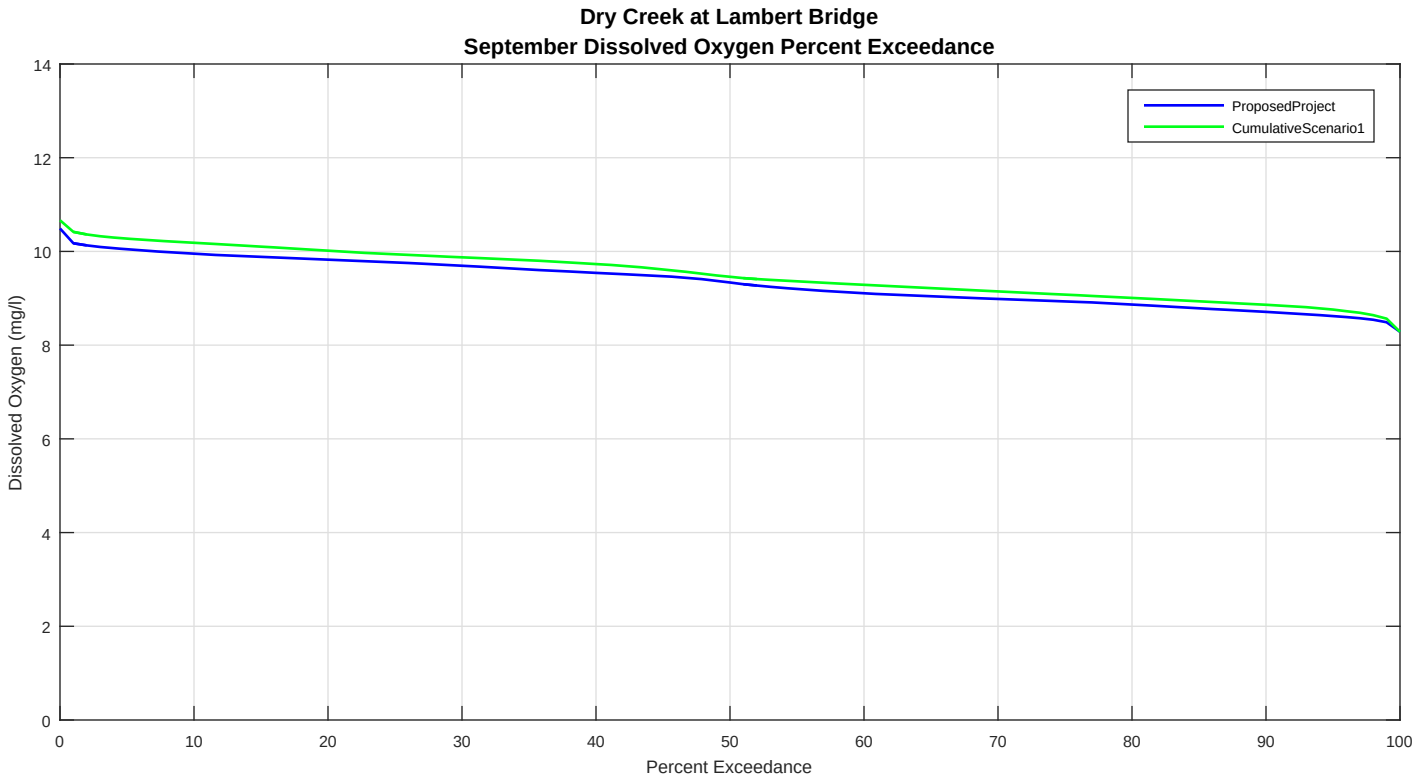
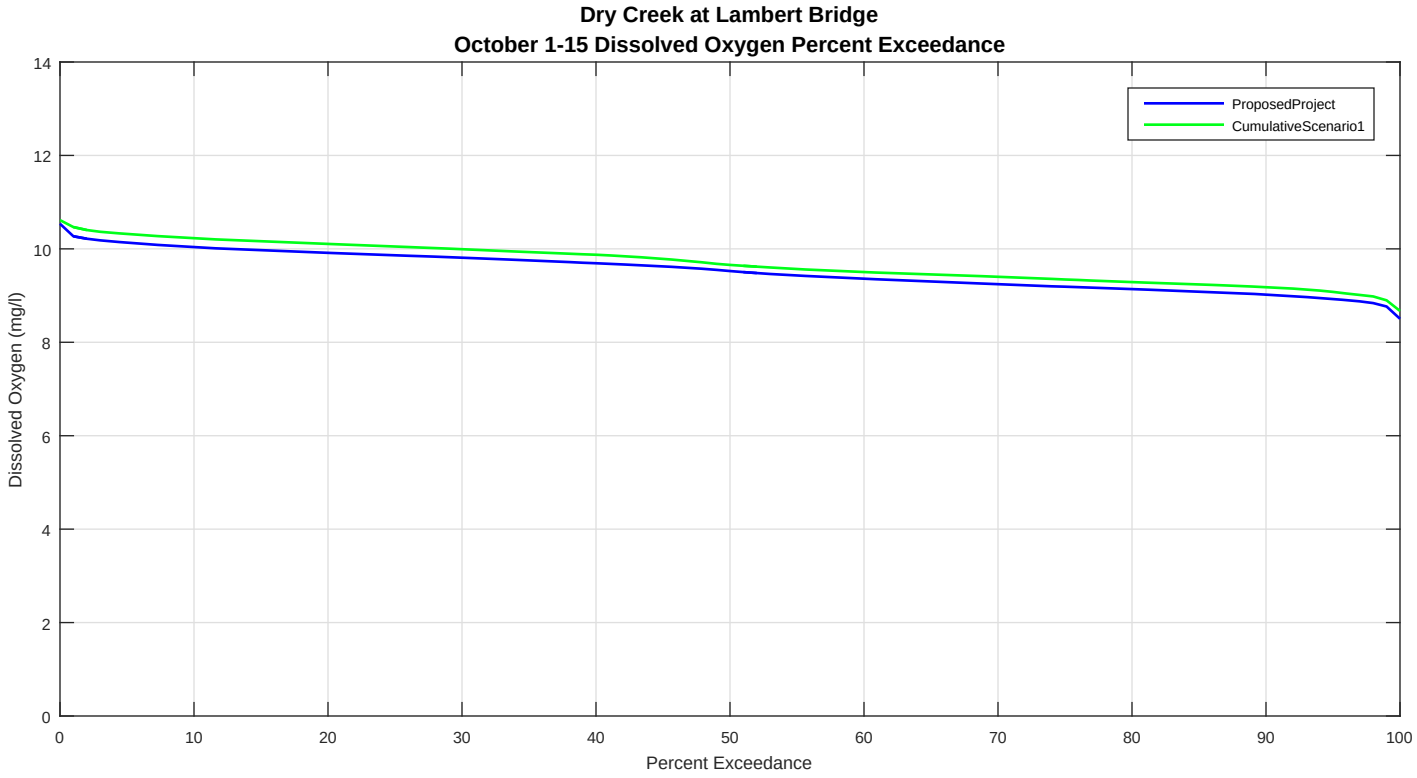
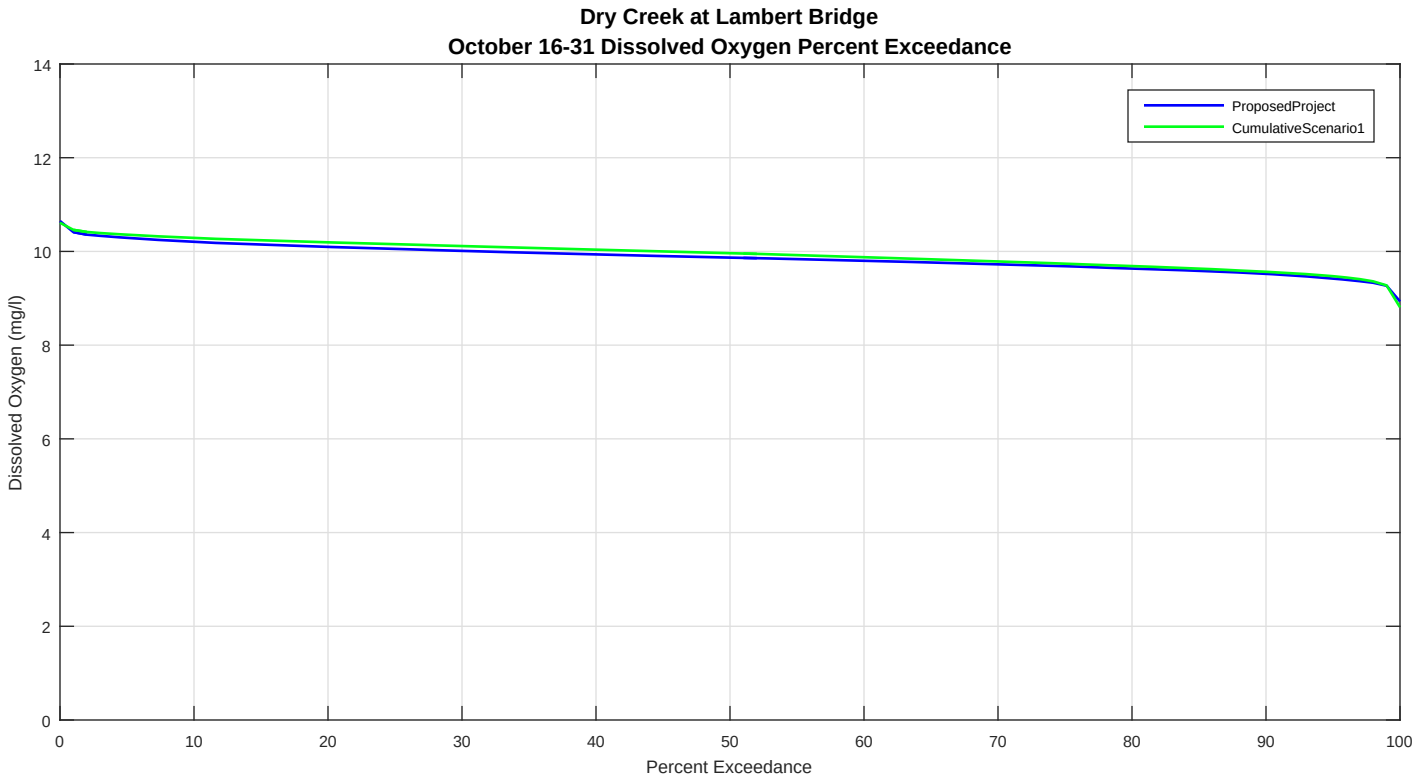
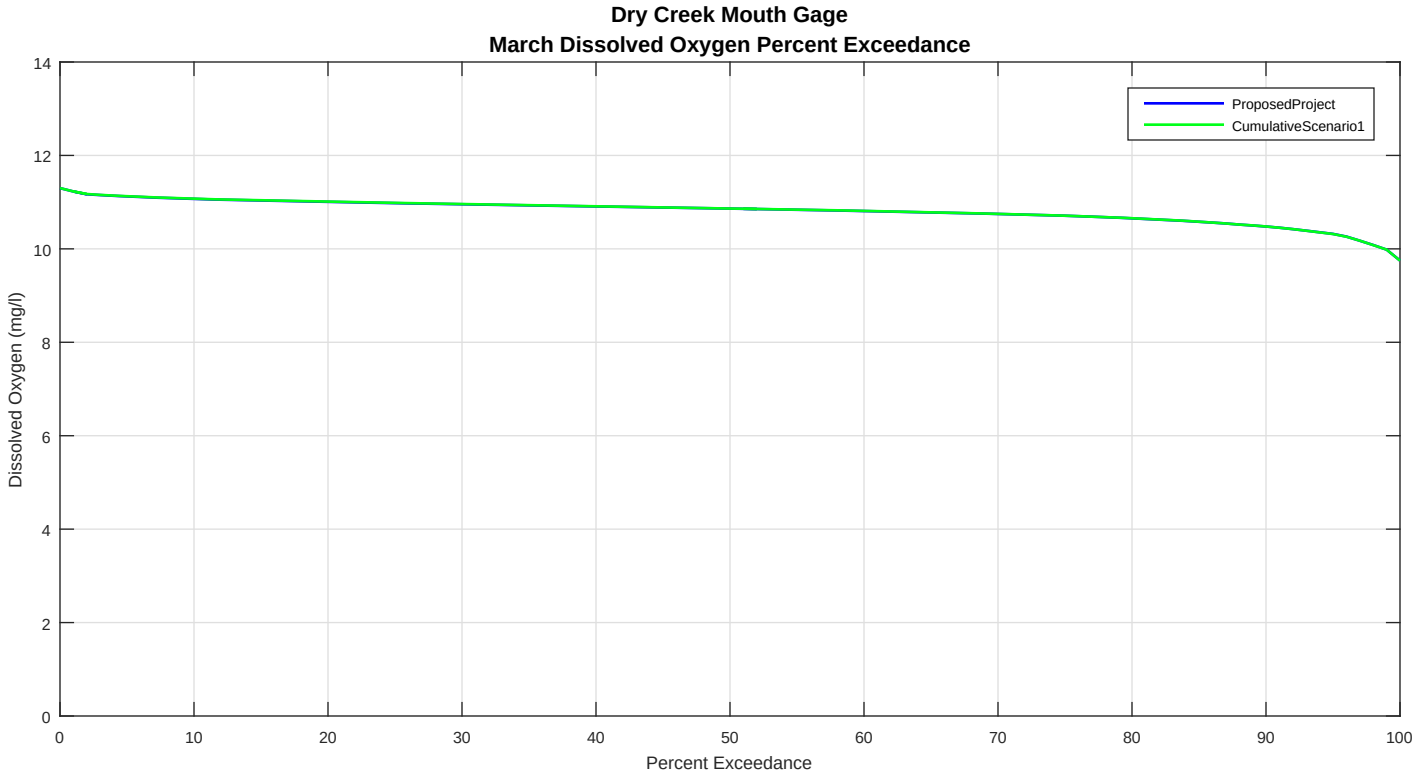
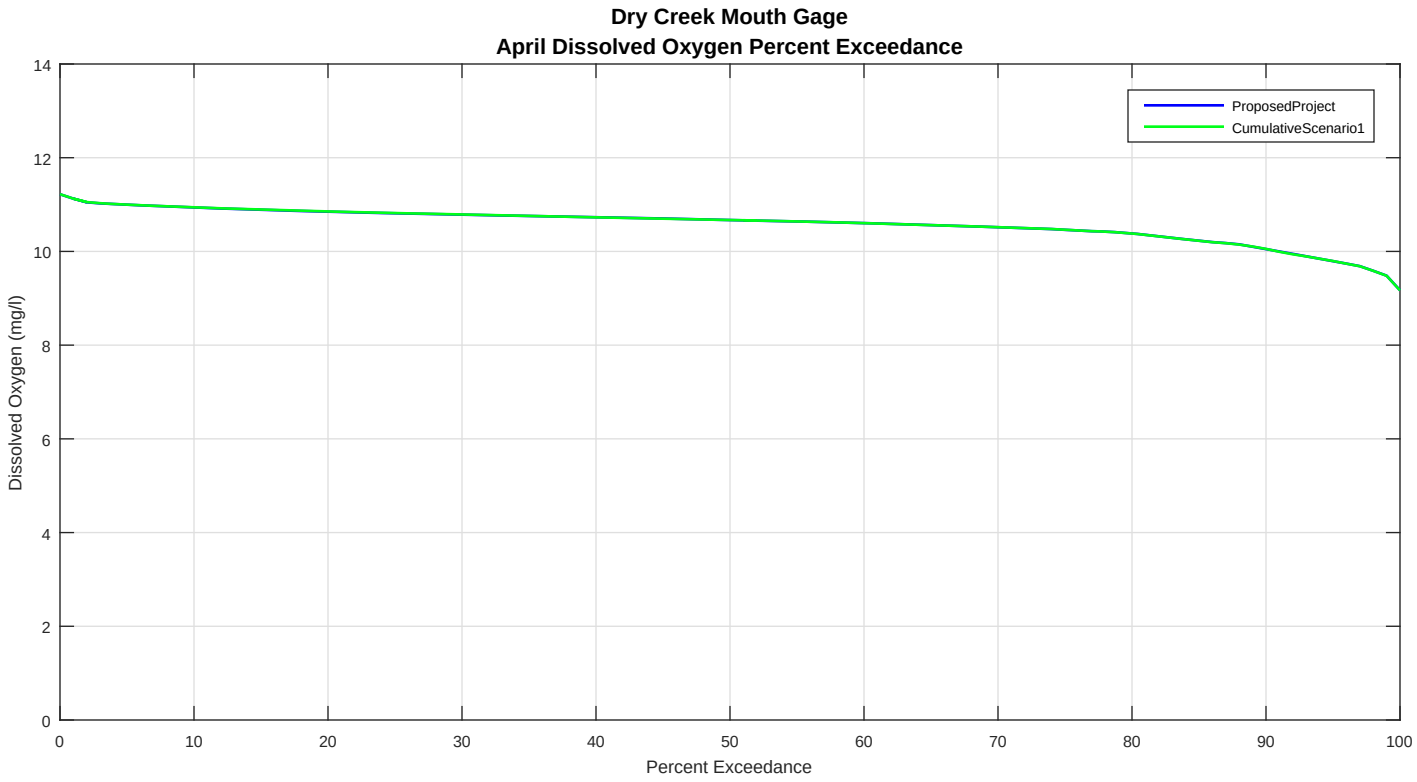

Dry Creek at Lambert Bridge
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

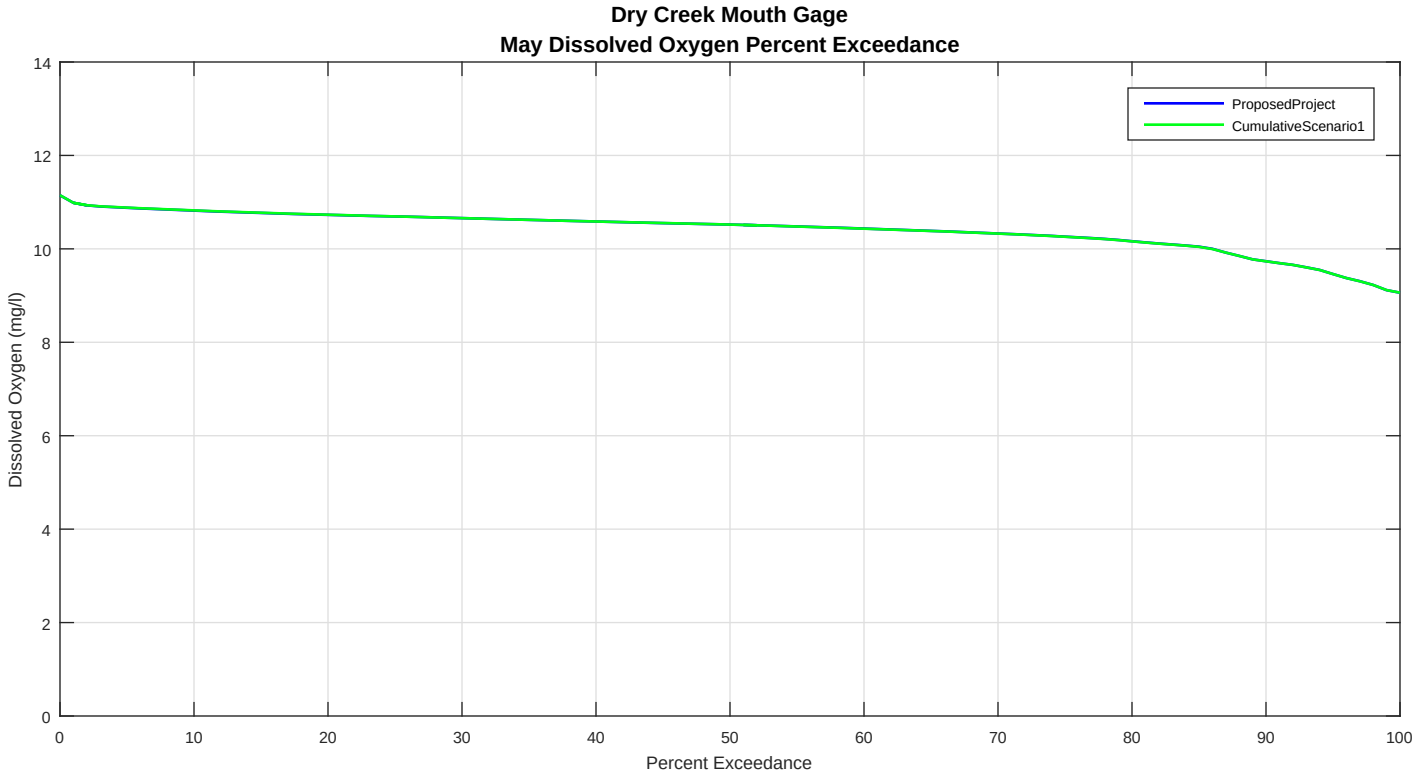

Dry Creek at Lambert Bridge
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

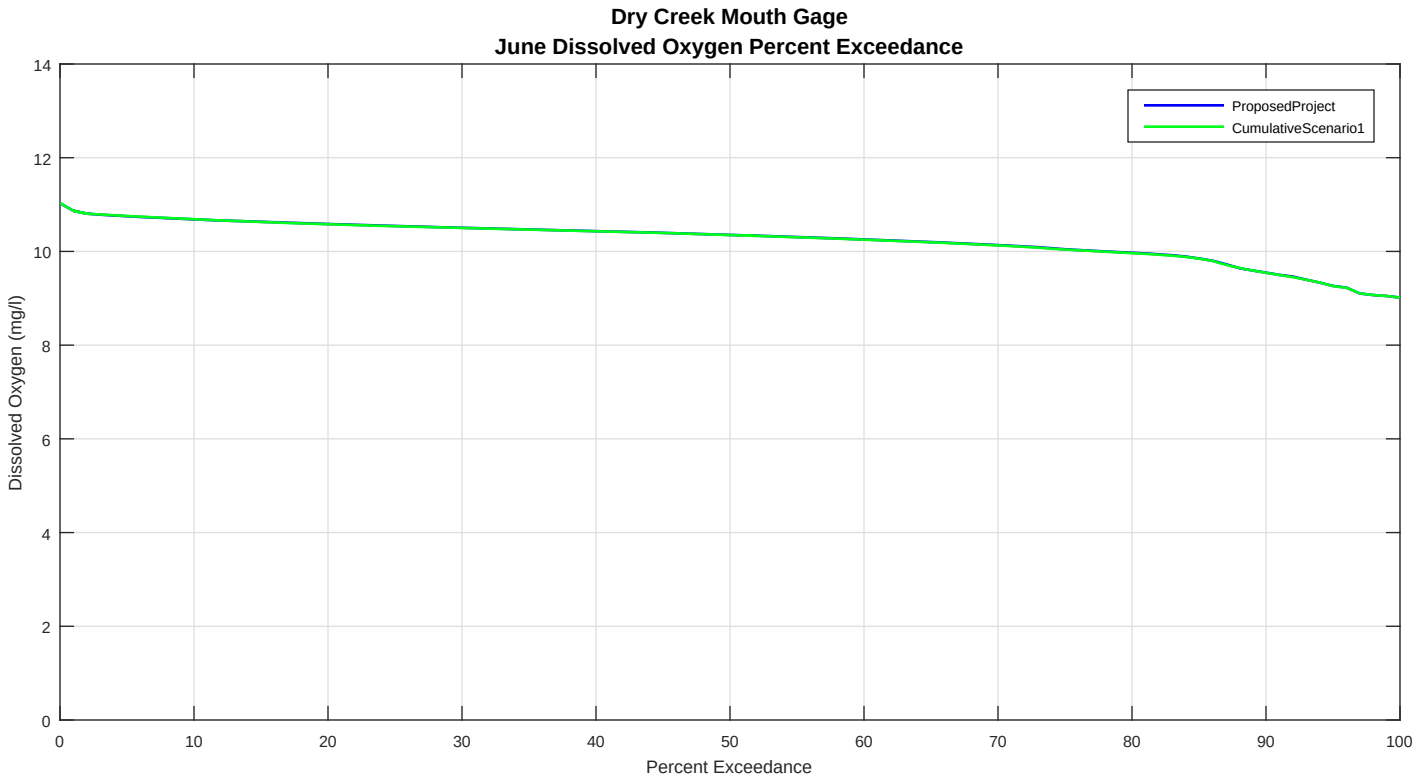

Dry Creek at Lambert Bridge
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

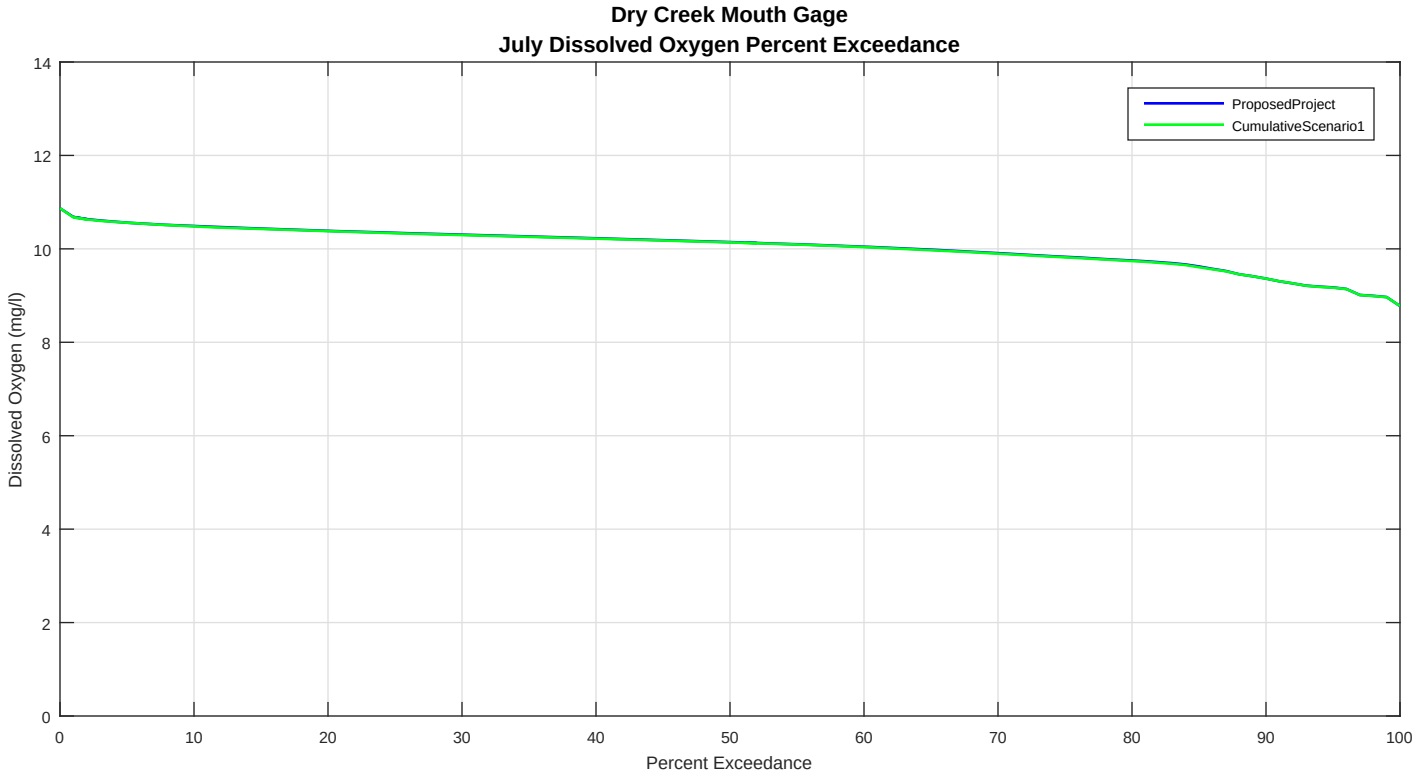

Dry Creek at Lambert Bridge
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

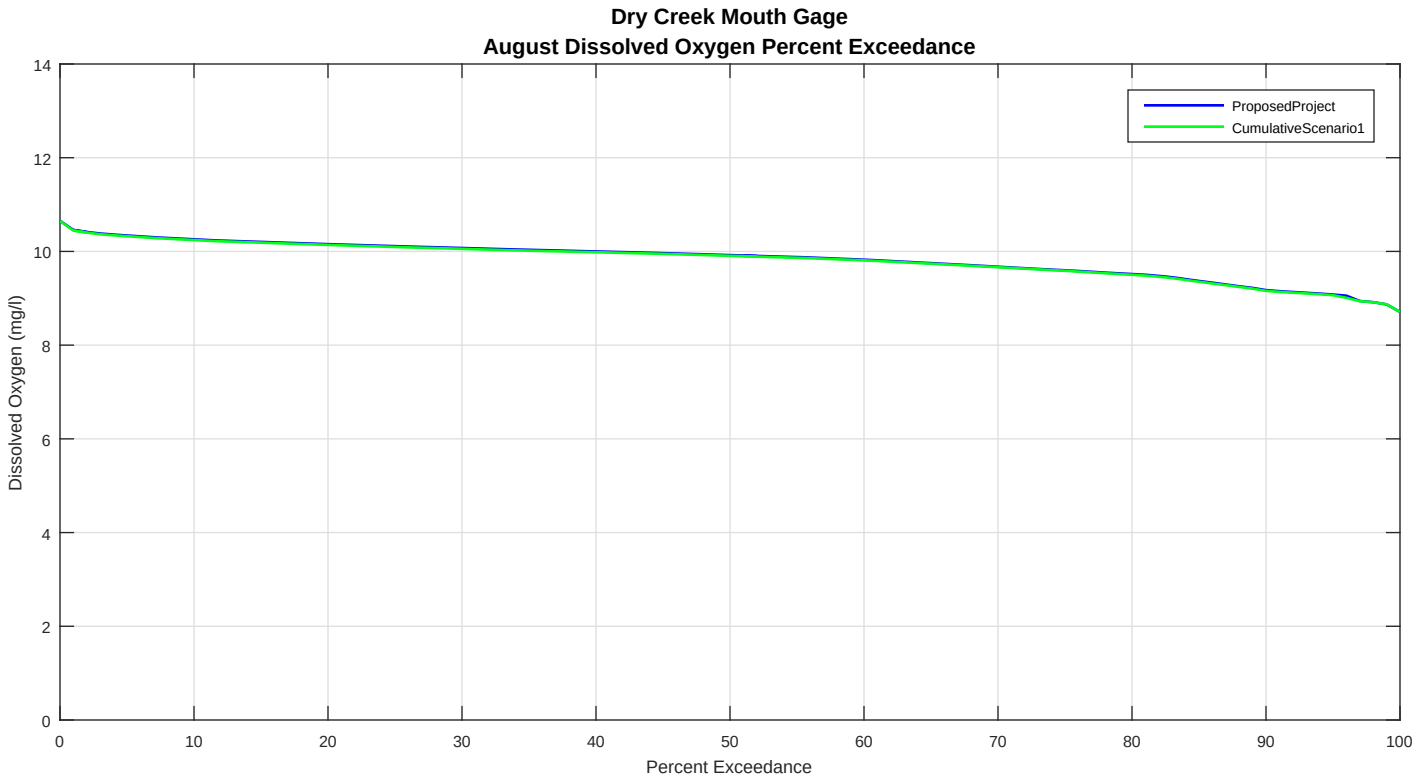

Dry Creek Mouth Gage
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

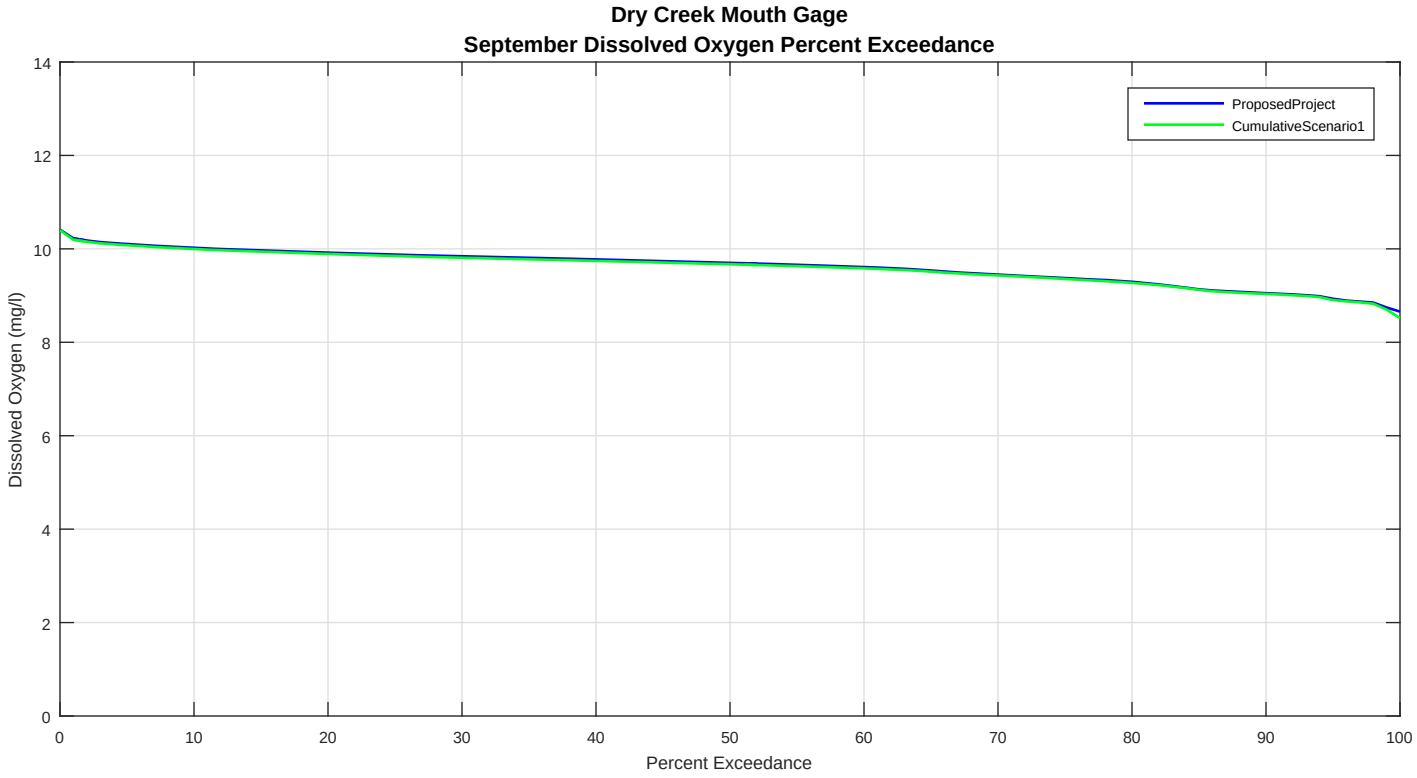

Dry Creek Mouth Gage
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

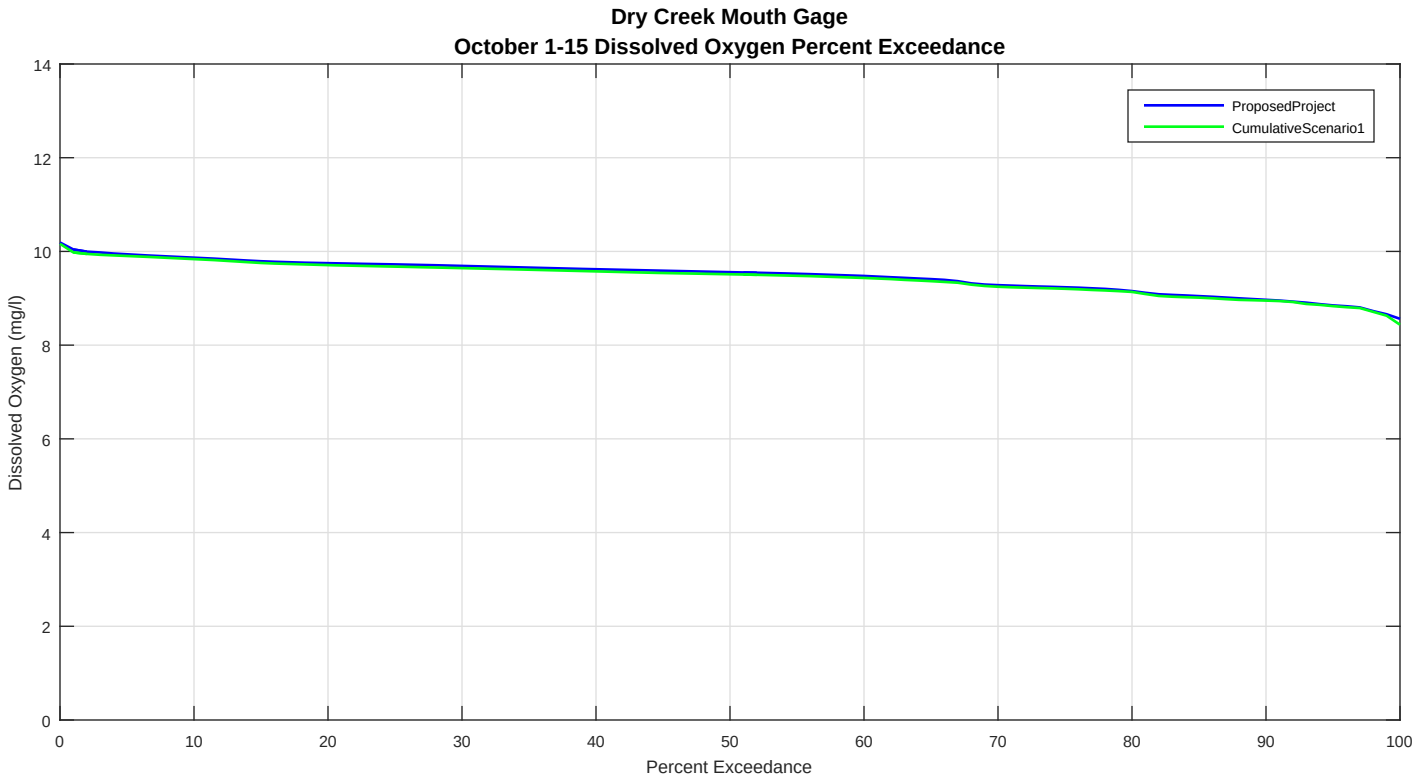

Dry Creek Mouth Gage
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

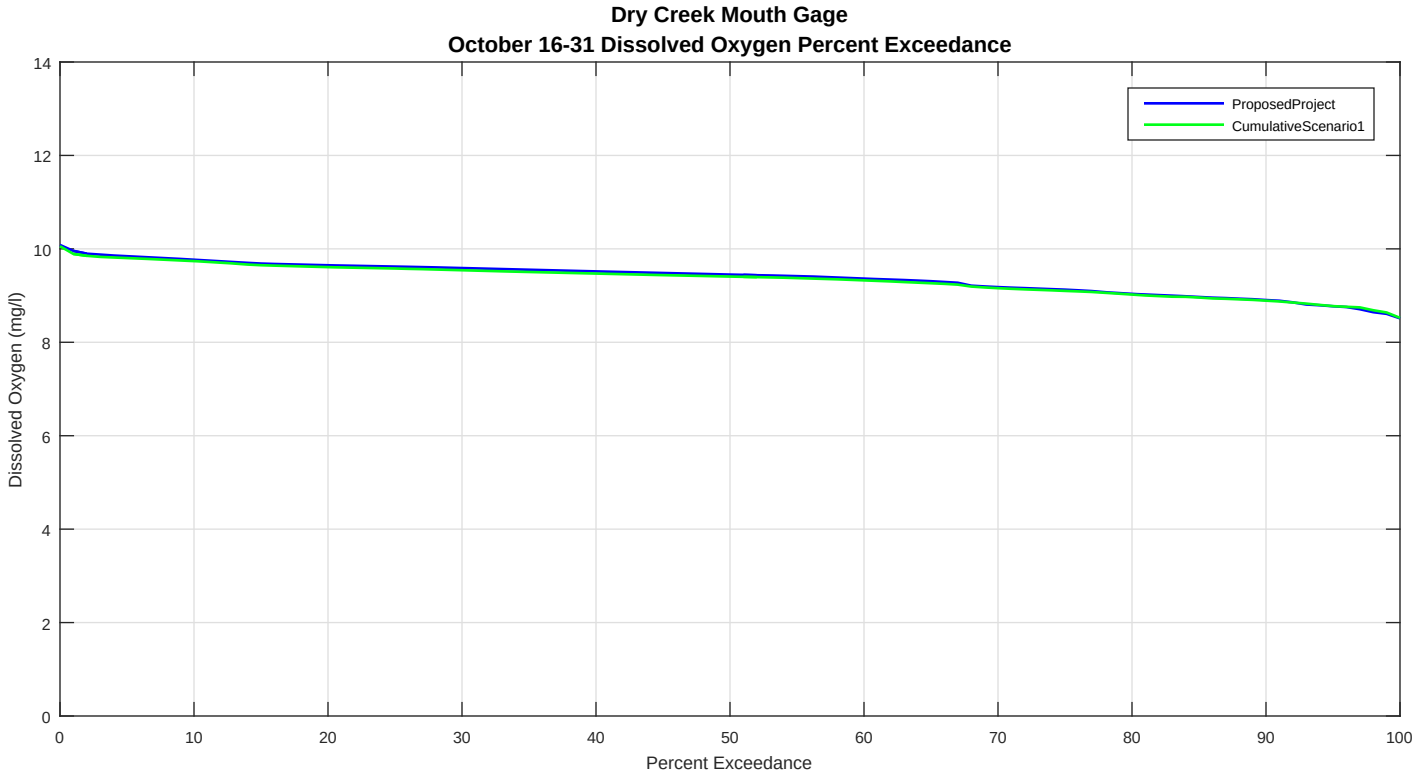

Dry Creek Mouth Gage
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario1
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

Attachment 5: Model Results, Cumulative 2 Scenario

FISH FLOWS EIR
RR ResSim Modeling Results Summary Report

Cumulative Analysis City of Ukiah EIR
Proposed Hydrologic Index
5-Sched Flow18 Min Flows
Max Water Right Demand: 75K AF

PLOT LEGEND	ProposedProject	CumulativeScenario2
Alt Name	2275i61860	2275i61860
Sim Begin Date	2/1/1910	2/1/1910
Sim End Date	12/31/2013	12/31/2013
ResSim Network	Base v2.2	Base v2.2
LM Storage Curve	2001	2040
LS Storage Curve	1984	2040
WSD Hatchery Flow (cfs)	70	70
Local Flow	USGS6.0	USGS6.0
Distributed Loss	RR System Losses POR 10011909 to 12312013 v06302015.dss	RR System Losses POR 10011909 to 12312013 v06302015.dss; HoplandLosses_UkiahEIR_POR_160602.dss
RRC Demand	RR System Losses POR 10011909 to 12312013 v06302015.dss, SCWA Windsor 75K POR 10011909 to 12312013 v06302015.dss	RR System Losses POR 10011909 to 12312013 v06302015.dss, SCWA Windsor 75K POR 10011909 to 12312013 v06302015.dss
RRC Vol (Ac-ft/yr)	5,639	5,639
Demand Year	2035	2035
Demand Desc	Max Water Right Demand	Max Water Right Demand
SCWA Demand	SCWA Windsor 75K POR 10011909 to 12312013 v06302015.dss	SCWA Windsor 75K POR 10011909 to 12312013 v06302015.dss
SCWA Vol (Ac-ft/yr)	69,361	69,361
Demand Year	2035	2035
Demand Desc	Max Water Right Demand	Max Water Right Demand
PVP Simulation	150217_V25_E5_Sed2006_RPA-TS_150max	160316_1910-2014_V25_E5_Sed2006-2045_RPA-TS_150max: 2040
LP Storage Curve	2006	2040
PVP Max Diversion	150	150
PVP Simulation Desc	Average operating conditions 10/1/2006 to 12/31/2014; Incorporated observed diversions and LP storage post 10/1/2006	Average operating conditions 10/1/2006 to 12/31/2014; Projected PVP diversions
Hydrologic Index	HI6	HI6
Index Desc	Cum LM Inflow Jan-Sep + LM Stor Cond Jun-De	Cum LM Inflow Jan-Sep + LM Stor Cond Jun-De
Min Flows UR	SCWA6	SCWA6
Min Flow Desc	Flows derived from sensitivity analysis	Flows derived from sensitivity analysis
Min Flows LR	LR6	LR6
Min Flow Desc	Flows derived from sensitivity analysis	Flows derived from sensitivity analysis

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Daily Average Temperature… 13

Daily Average Dissolved Oxygen… 20

Coyote Valley Dam Outlet

Monthly Flow Exceedance Frequency… 29

Monthly Temperature Exceedance Frequency… 106

Monthly D.O. Exceedance Frequency… 164

Forks

Monthly Flow Exceedance Frequency… 33

Monthly Temperature Exceedance Frequency… 110

Monthly D.O. Exceedance Frequency… 168

2 Miles Downstream of Forks

Monthly Temperature Exceedance Frequency… 115

Monthly D.O. Exceedance Frequency… 173

4 Miles Downstream of Forks

Monthly Temperature Exceedance Frequency… 117

Monthly D.O. Exceedance Frequency… 175

Hopland

Monthly Flow Exceedance Frequency… 38

Monthly Stage Exceedance Frequency… 74

Monthly Temperature Exceedance Frequency… 119

Monthly D.O. Exceedance Frequency… 177

Cloverdale

Monthly Flow Exceedance Frequency… 42

Monthly Stage Exceedance Frequency… 78

Monthly Temperature Exceedance Frequency… 123

Monthly D.O. Exceedance Frequency… 181

Geyserville

Monthly Temperature Exceedance Frequency… 128

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Russian River at Dry Creek

Monthly Flow Exceedance Frequency… 51

Monthly Temperature Exceedance Frequency… 137

Monthly D.O. Exceedance Frequency… 195

Hacienda

Monthly Flow Exceedance Frequency… 56

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Monthly Temperature Exceedance Frequency… 141

Monthly D.O. Exceedance Frequency… 199

Warm Springs Dam Outlet

Monthly Flow Exceedance Frequency… 60

Monthly Temperature Exceedance Frequency… 146

Monthly D.O. Exceedance Frequency… 204

Dry Creek at Geyserville Gage

Monthly Flow Exceedance Frequency… 65

Monthly Stage Exceedance Frequency… 92

Monthly Temperature Exceedance Frequency… 150

Monthly D.O. Exceedance Frequency… 208

Dry Creek at Lambert Bridge

Monthly Temperature Exceedance Frequency… 155

Monthly D.O. Exceedance Frequency… 213

Dry Creek Mouth

Monthly Flow Exceedance Frequency… 69

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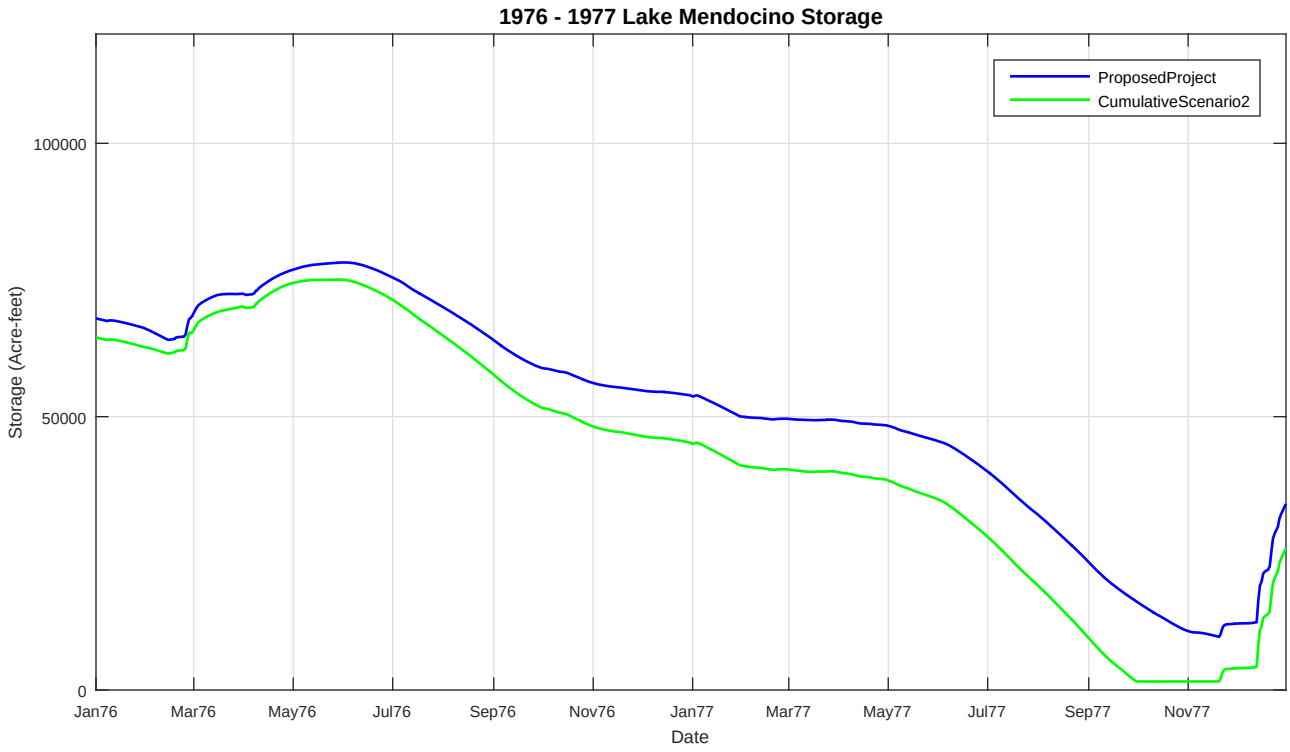
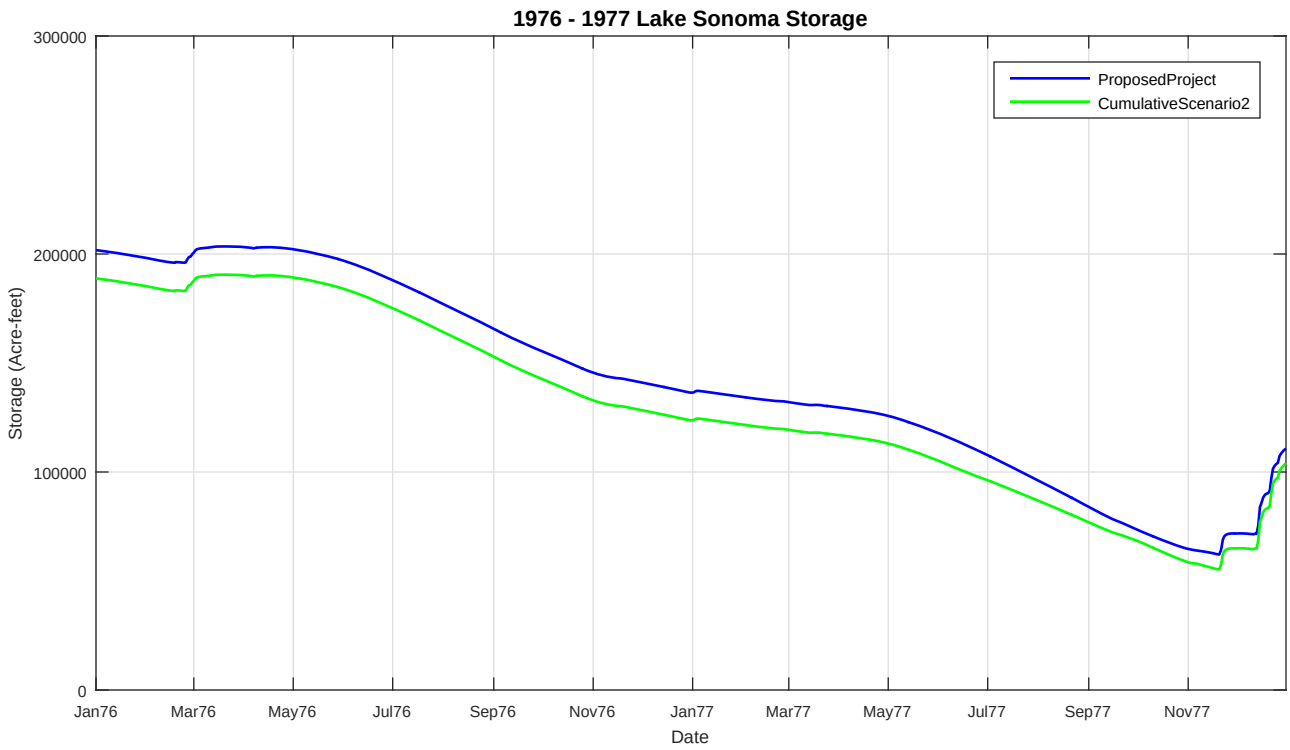
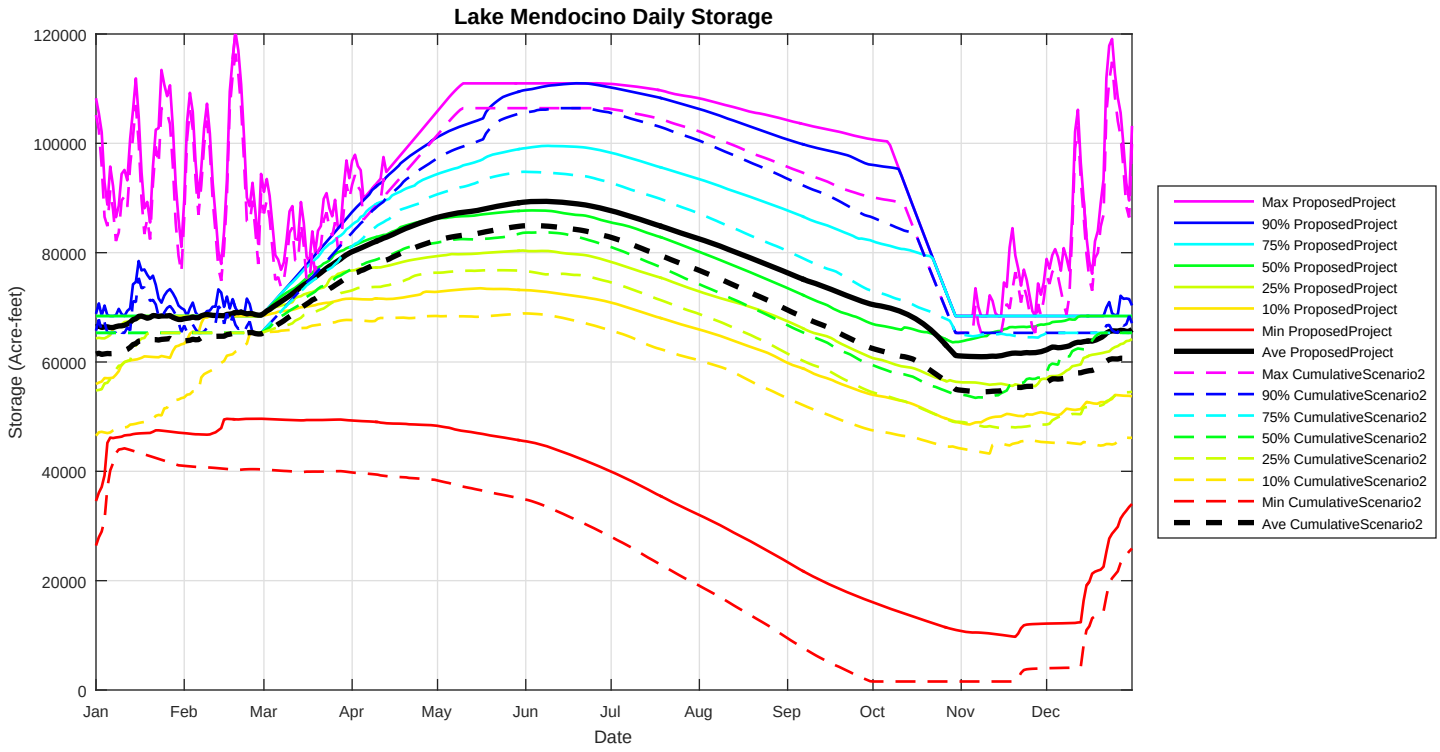
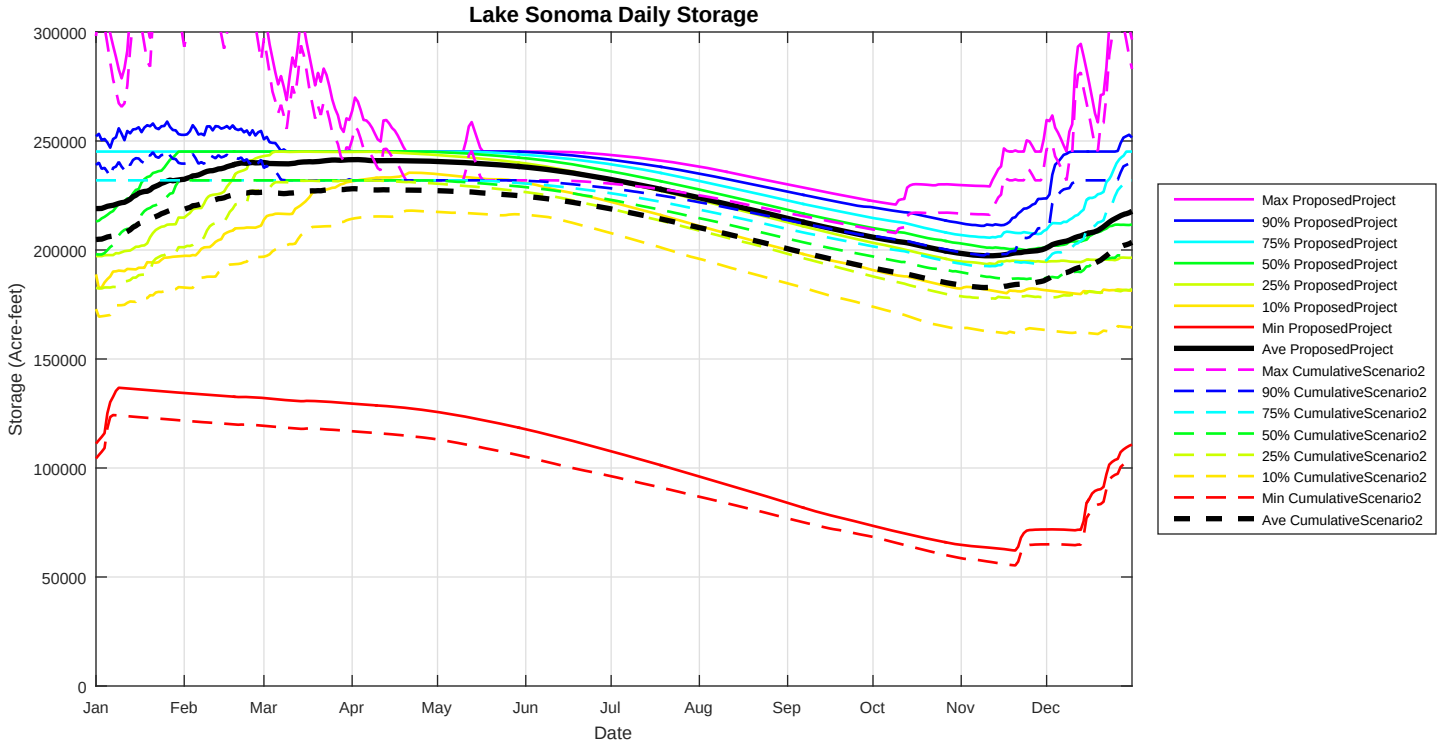
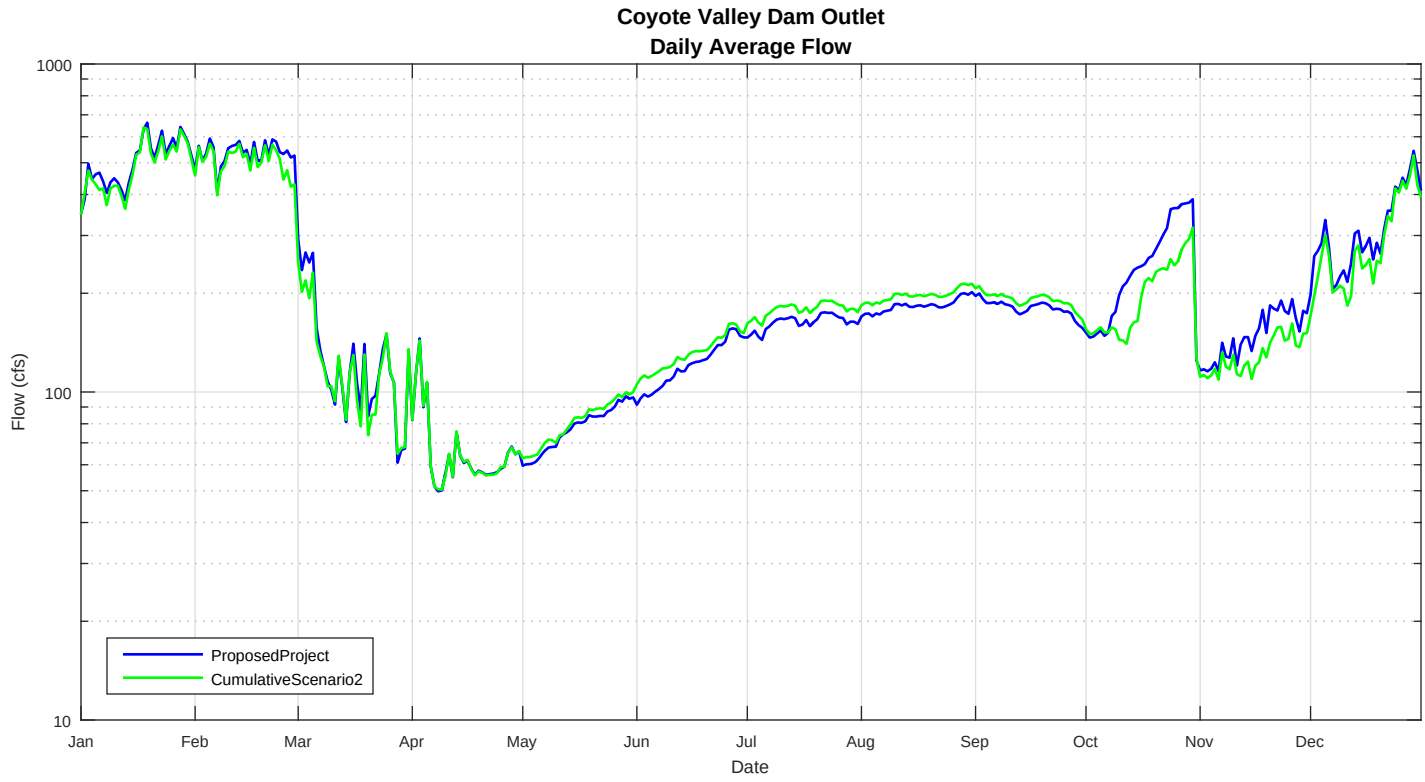
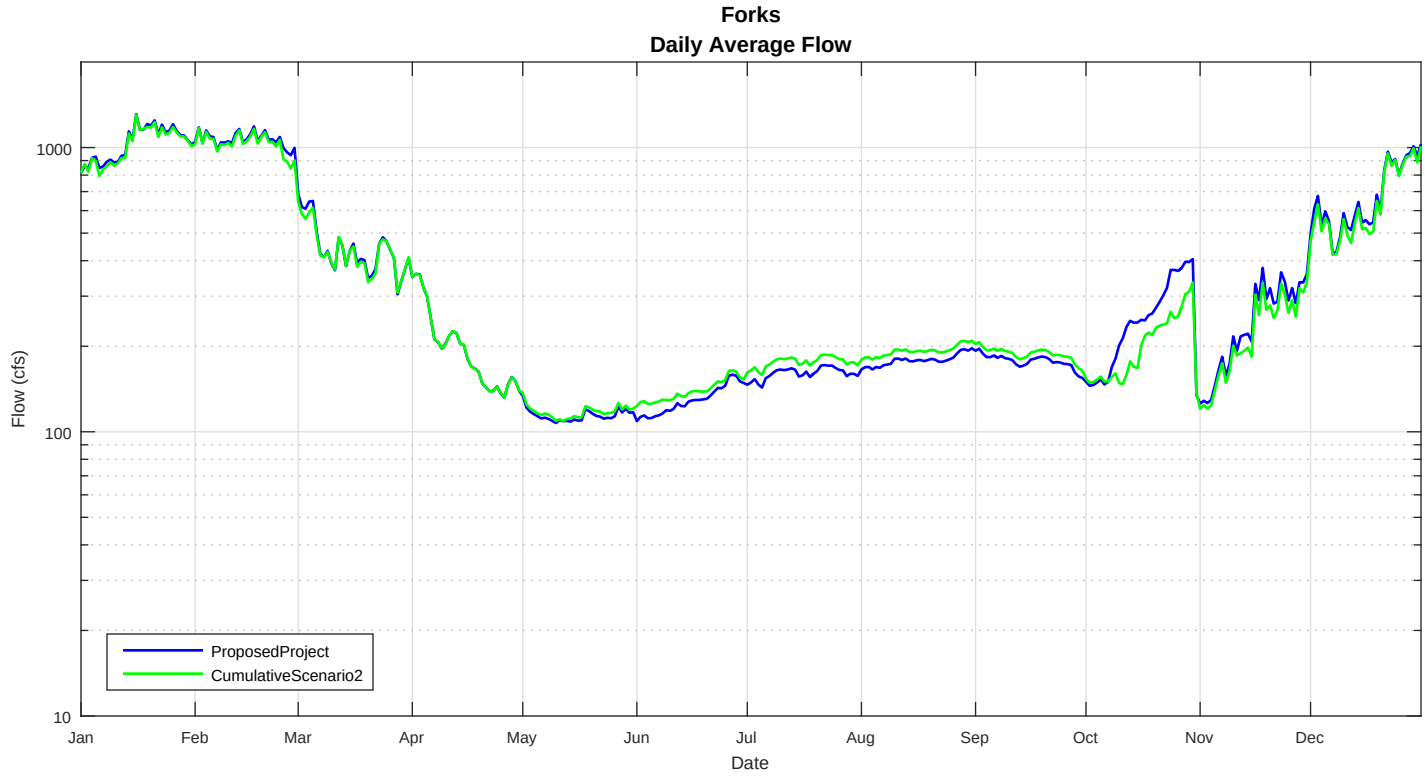

1976 - 1977 Lake Mendocino Storage
ProposedProject
CumulativeScenario2
Storage (Acre-feet)
100000
50000
0
Jan76
Mar76
May76
Jul76
Sep76
Nov76
Jan77
Mar77
May77
Jul77
Sep77
Nov77
Date

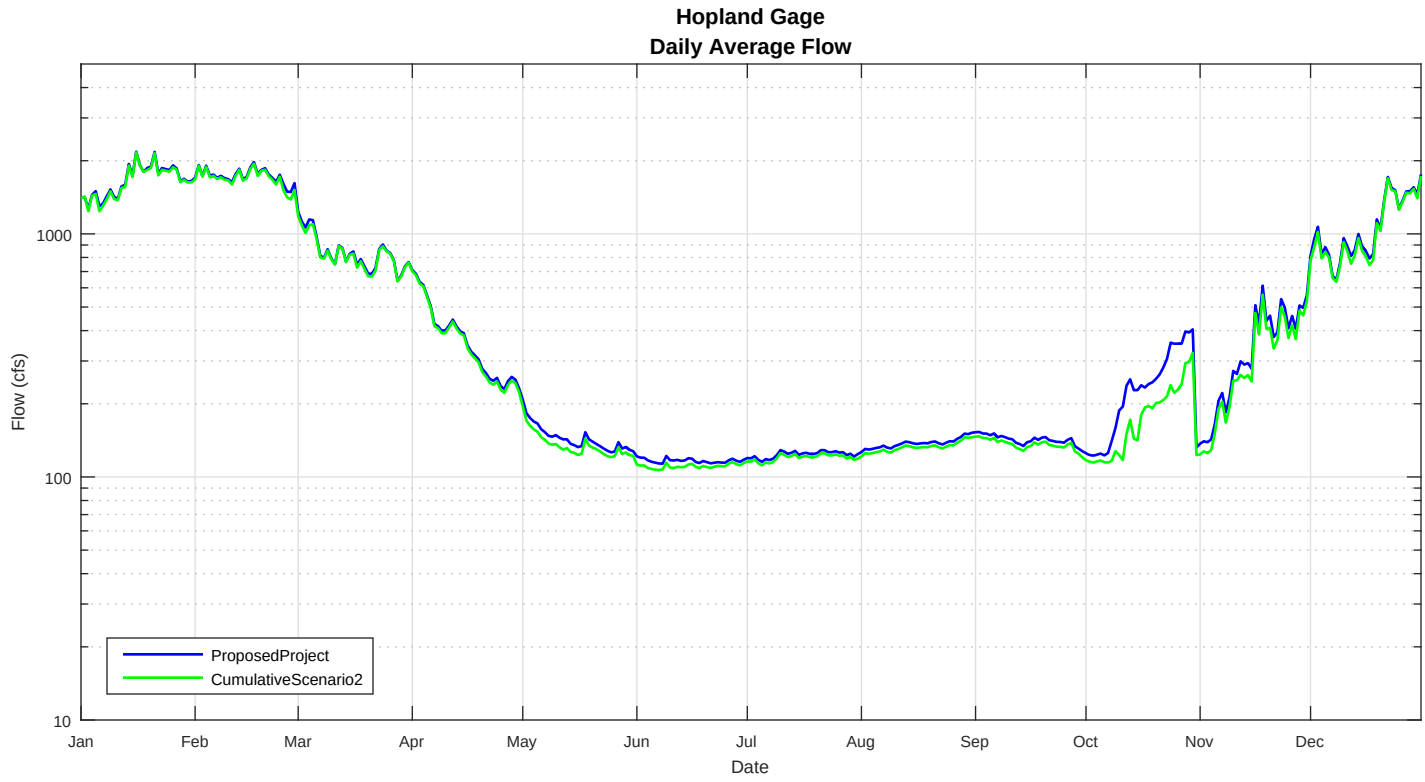

1976 - 1977 Lake Sonoma Storage
ProposedProject
CumulativeScenario2
Storage (Acre-feet)
300000
200000
100000
0
Jan76
Mar76
May76
Jul76
Sep76
Nov76
Jan77
Mar77
May77
Jul77
Sep77
Nov77
Date

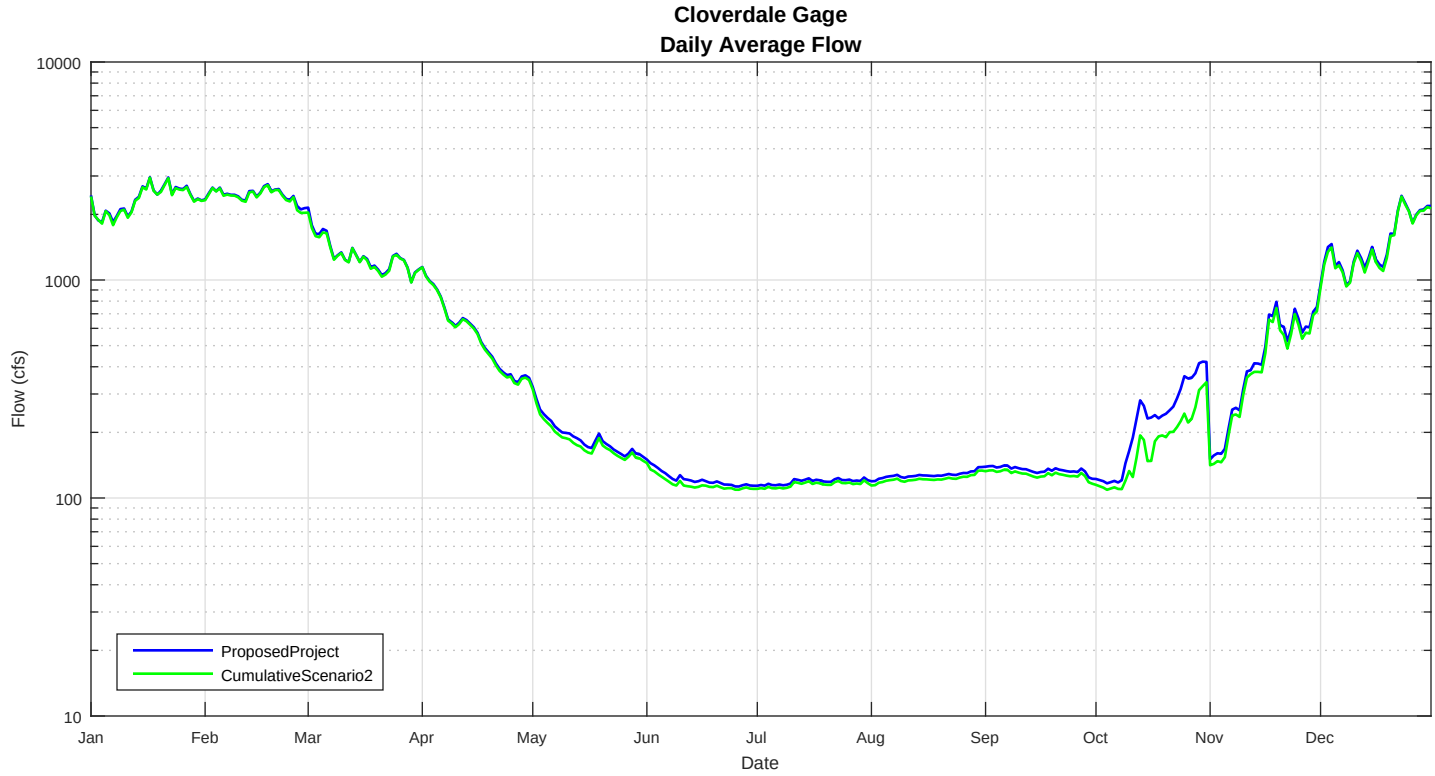

Lake Mendocino Daily Storage
Storage (Acre-feet)
120000
100000
80000
60000
40000
20000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Max ProposedProject
90% ProposedProject
75% ProposedProject
50% ProposedProject
25% ProposedProject
10% ProposedProject
Min ProposedProject
Ave ProposedProject
Max CumulativeScenario2
90% CumulativeScenario2
75% CumulativeScenario2
50% CumulativeScenario2
25% CumulativeScenario2
10% CumulativeScenario2
Min CumulativeScenario2
Ave CumulativeScenario2

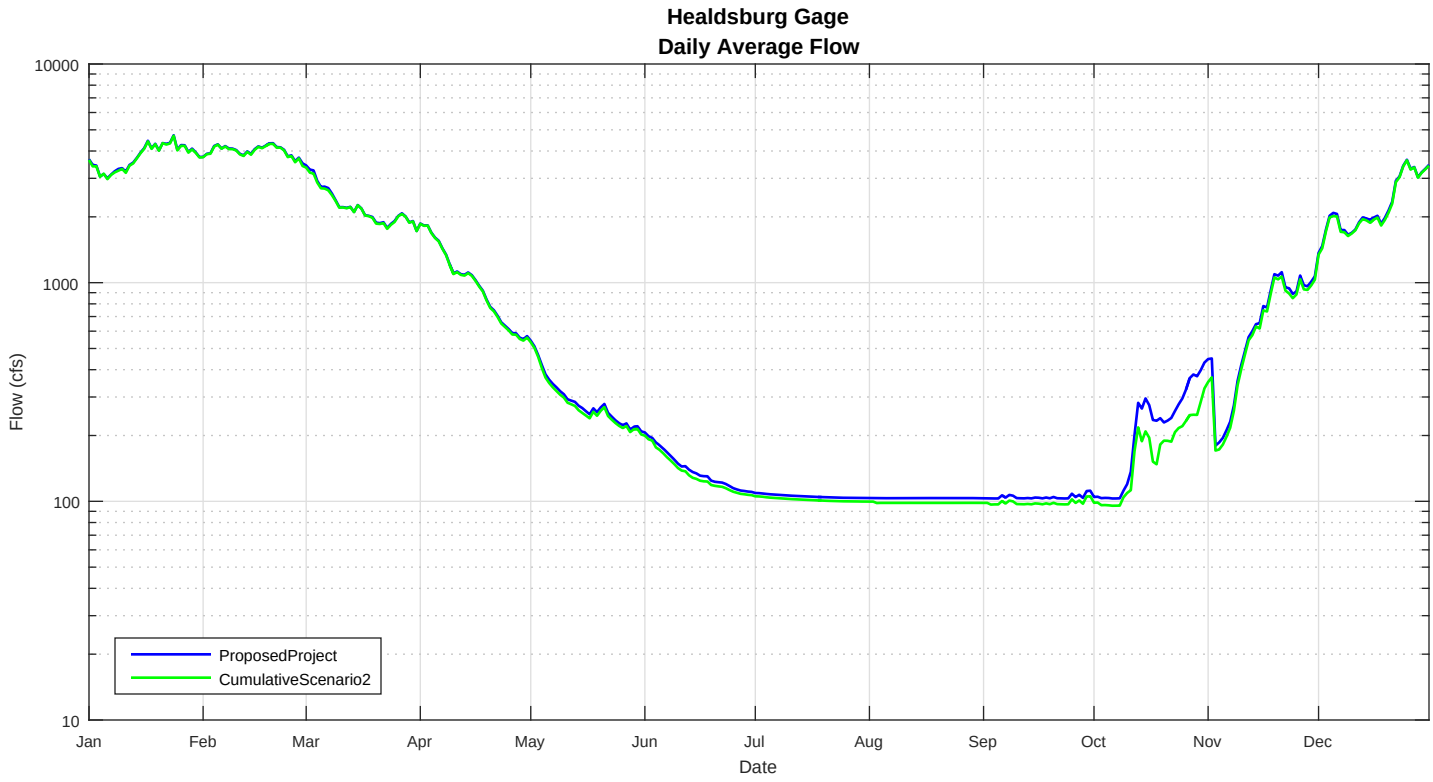

Lake Sonoma Daily Storage
Storage (Acre-feet)
300000
250000
200000
150000
100000
50000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Max ProposedProject
90% ProposedProject
75% ProposedProject
50% ProposedProject
25% ProposedProject
10% ProposedProject
Min ProposedProject
Ave ProposedProject
Max CumulativeScenario2
90% CumulativeScenario2
75% CumulativeScenario2
50% CumulativeScenario2
25% CumulativeScenario2
10% CumulativeScenario2
Min CumulativeScenario2
Ave CumulativeScenario2

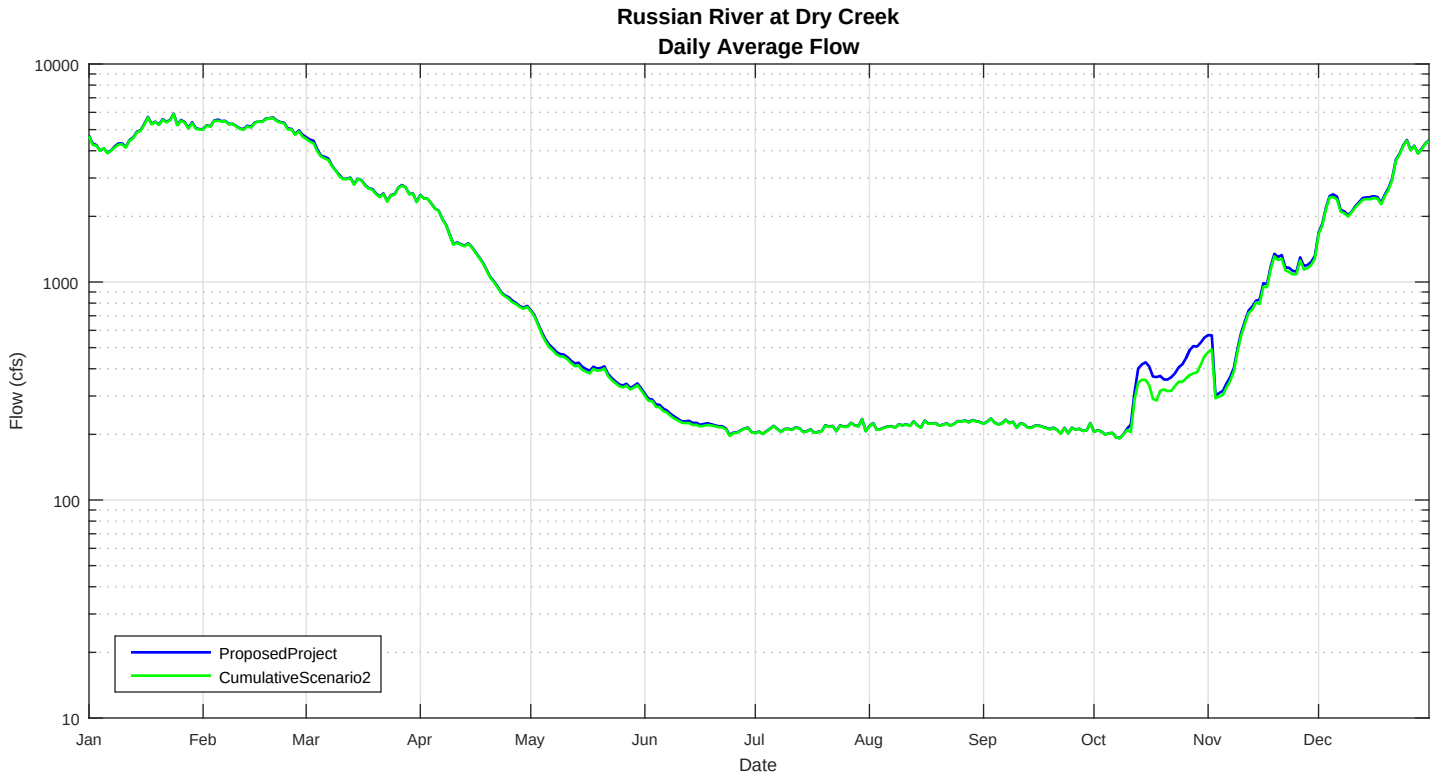

Coyote Valley Dam Outlet
Daily Average Flow
1000
100
10
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario2

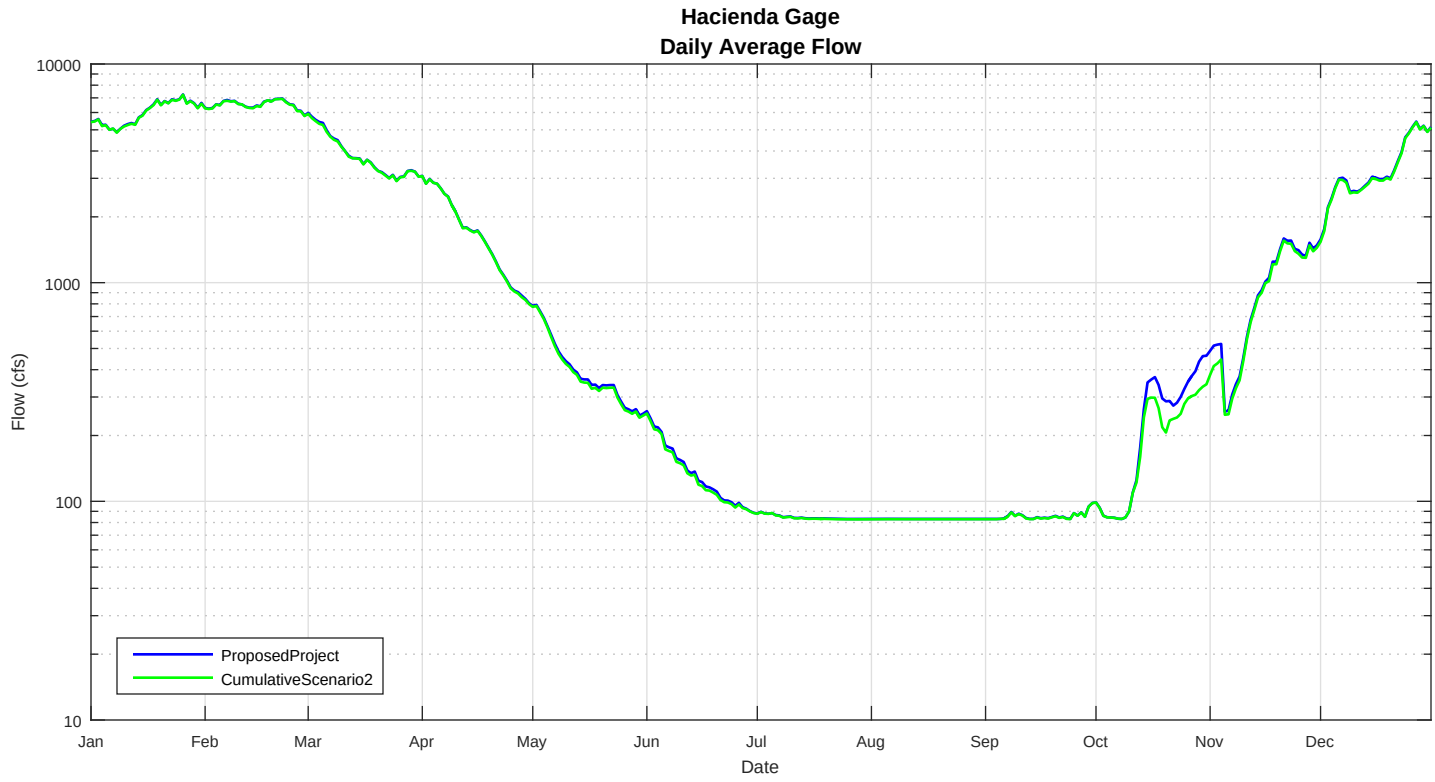

Forks
Daily Average Flow
1000
100
10
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario2

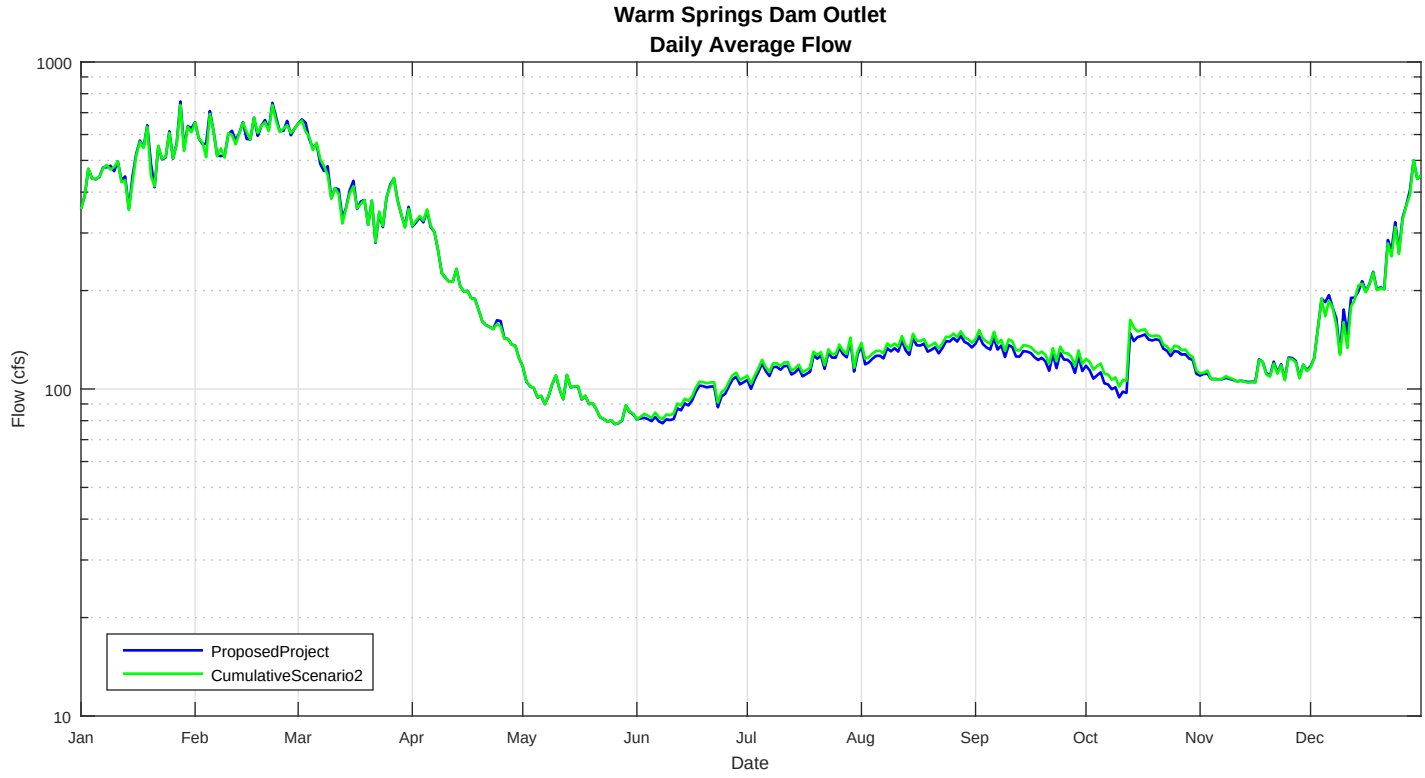

Hopland Gage
Daily Average Flow
Flow (cfs)
1000
100
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario2

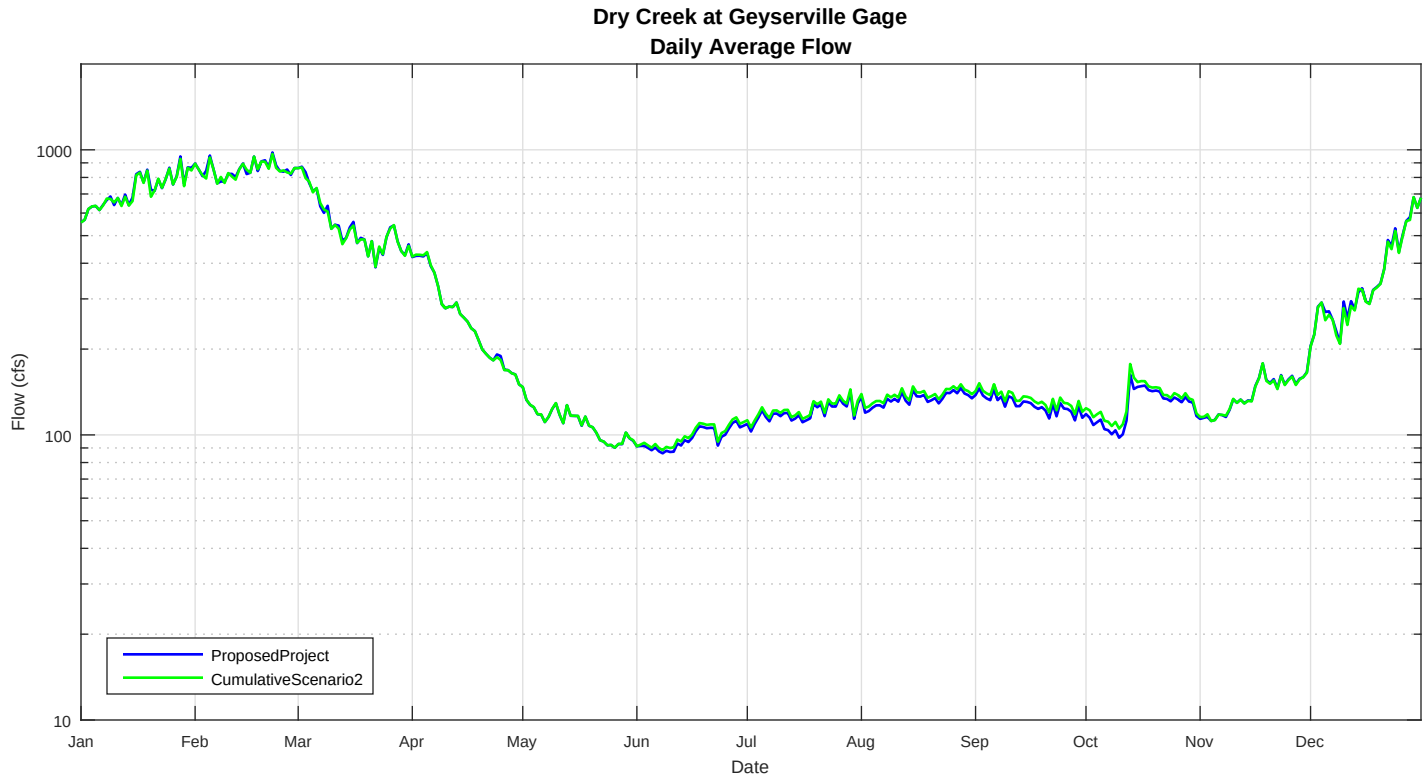

Cloverdale Gage
Daily Average Flow
Flow (cfs)
10000
1000
100
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario2

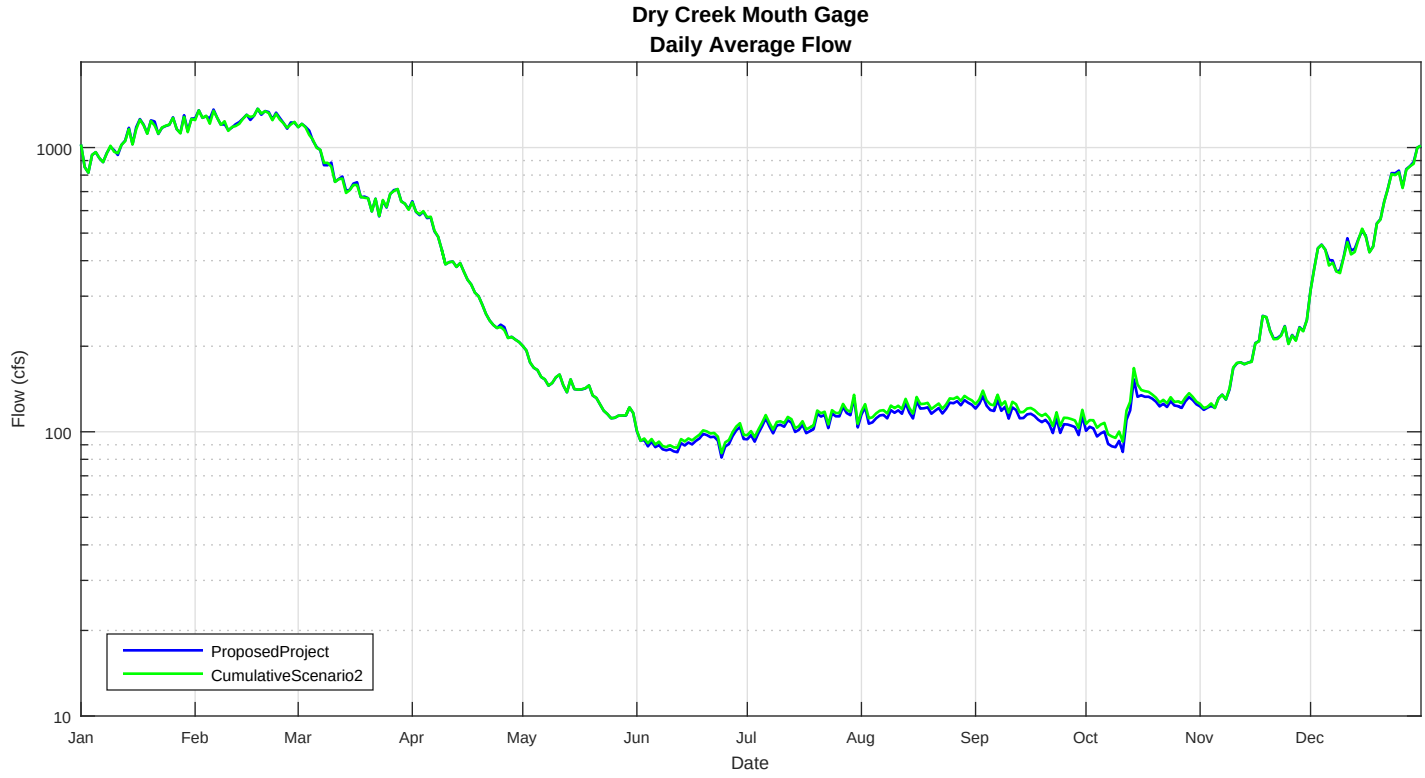

Healdsburg Gage
Daily Average Flow
10000
1000
100
10
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario2

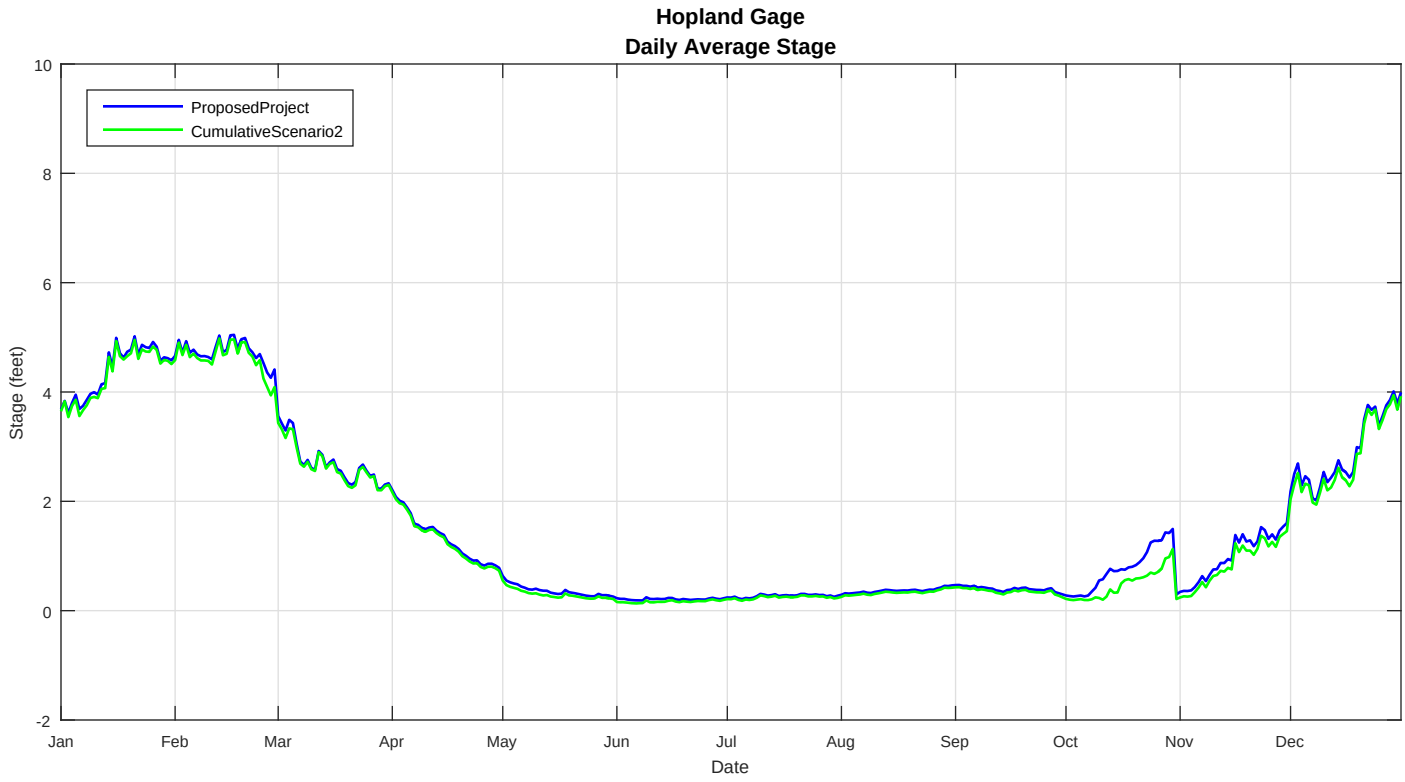

Russian River at Dry Creek
Daily Average Flow
10000
1000
100
10
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario2

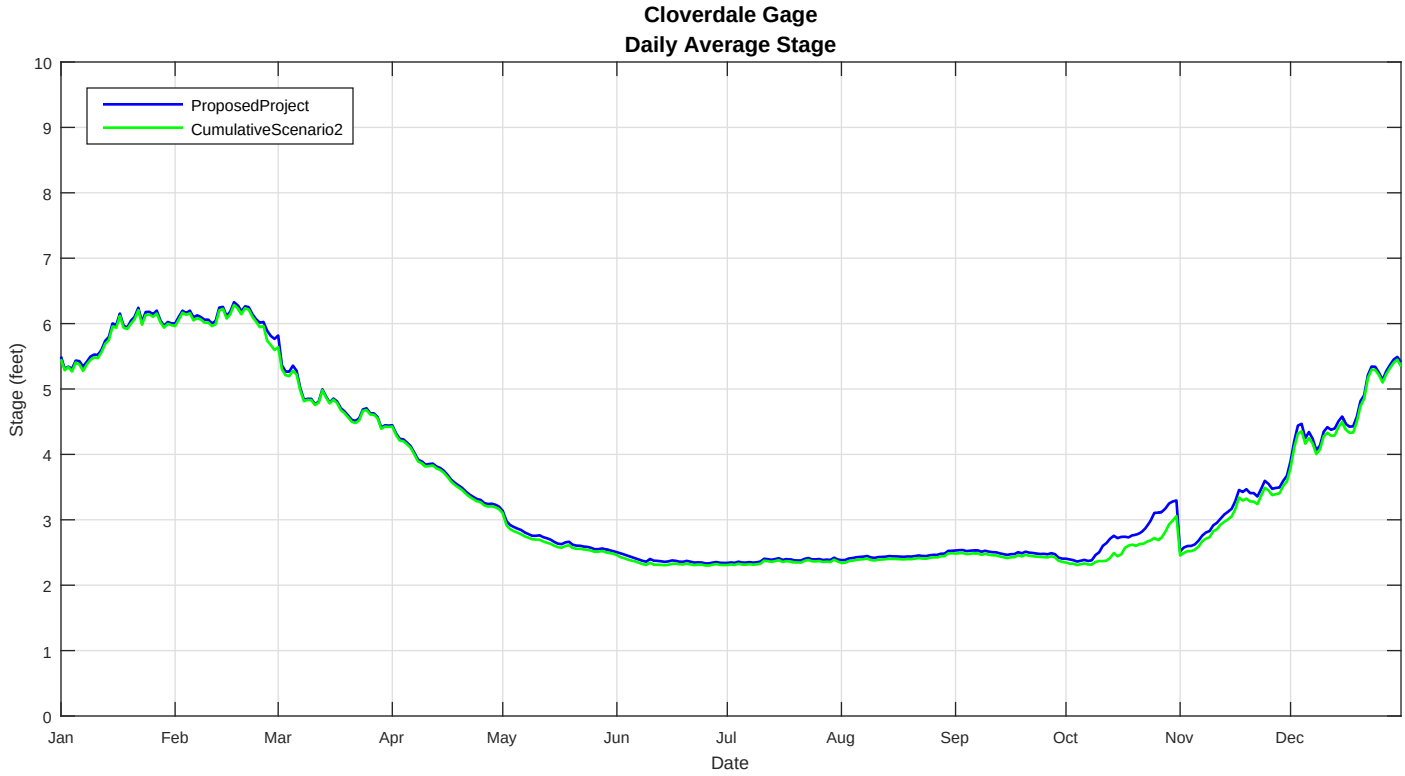

Hacienda Gage
Daily Average Flow
10000
1000
100
10
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario2

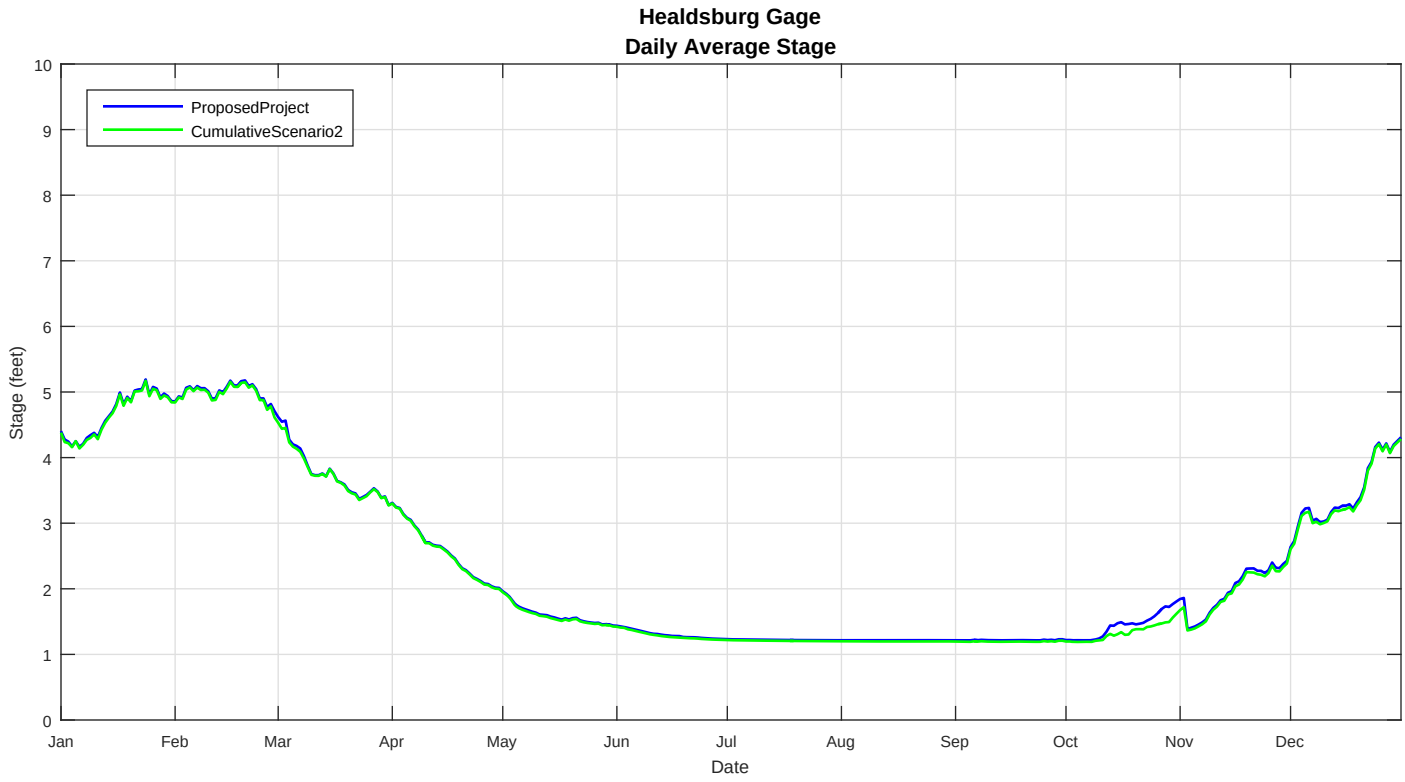

Warm Springs Dam Outlet
Daily Average Flow
1000
100
10
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario2

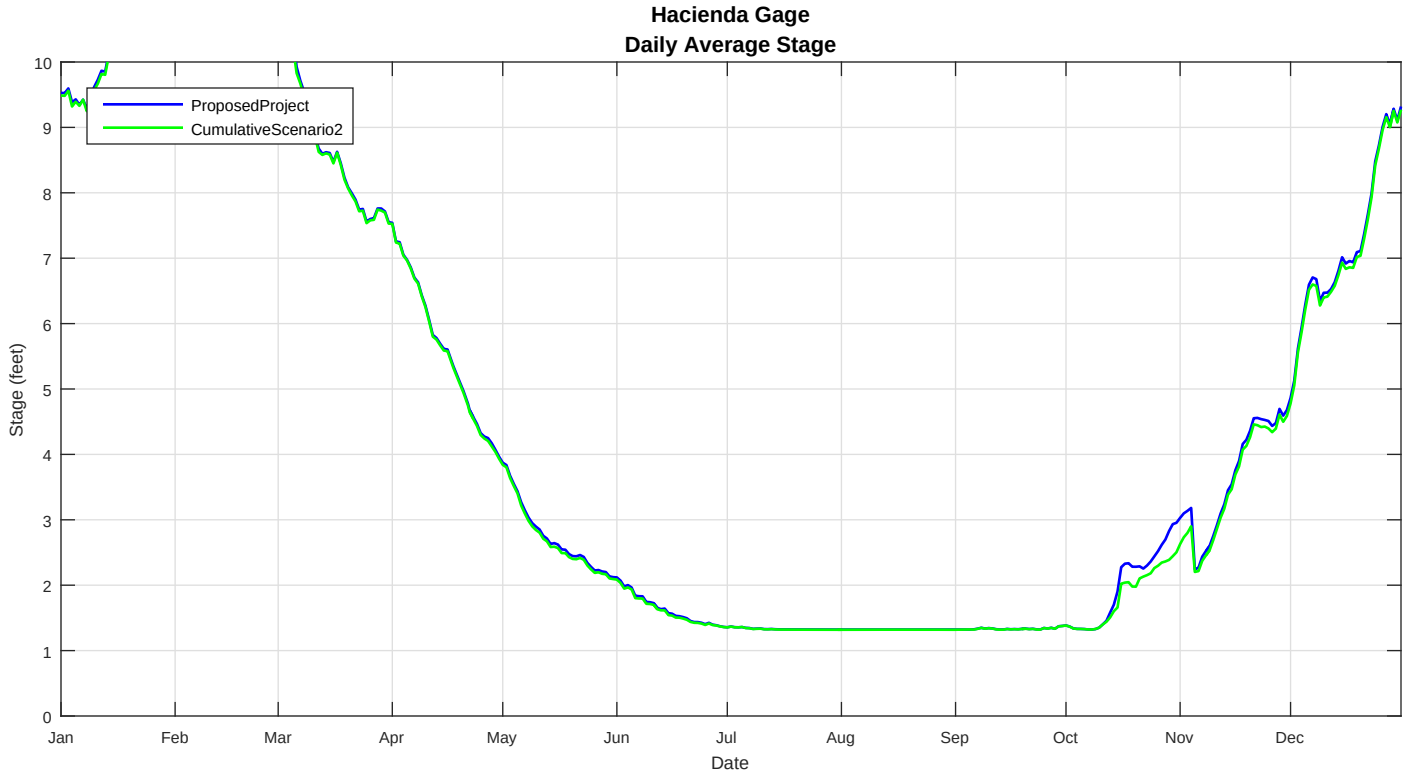

Dry Creek at Geyserville Gage
Daily Average Flow
1000
100
10
Flow (cfs)
ProposedProject
CumulativeScenario2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

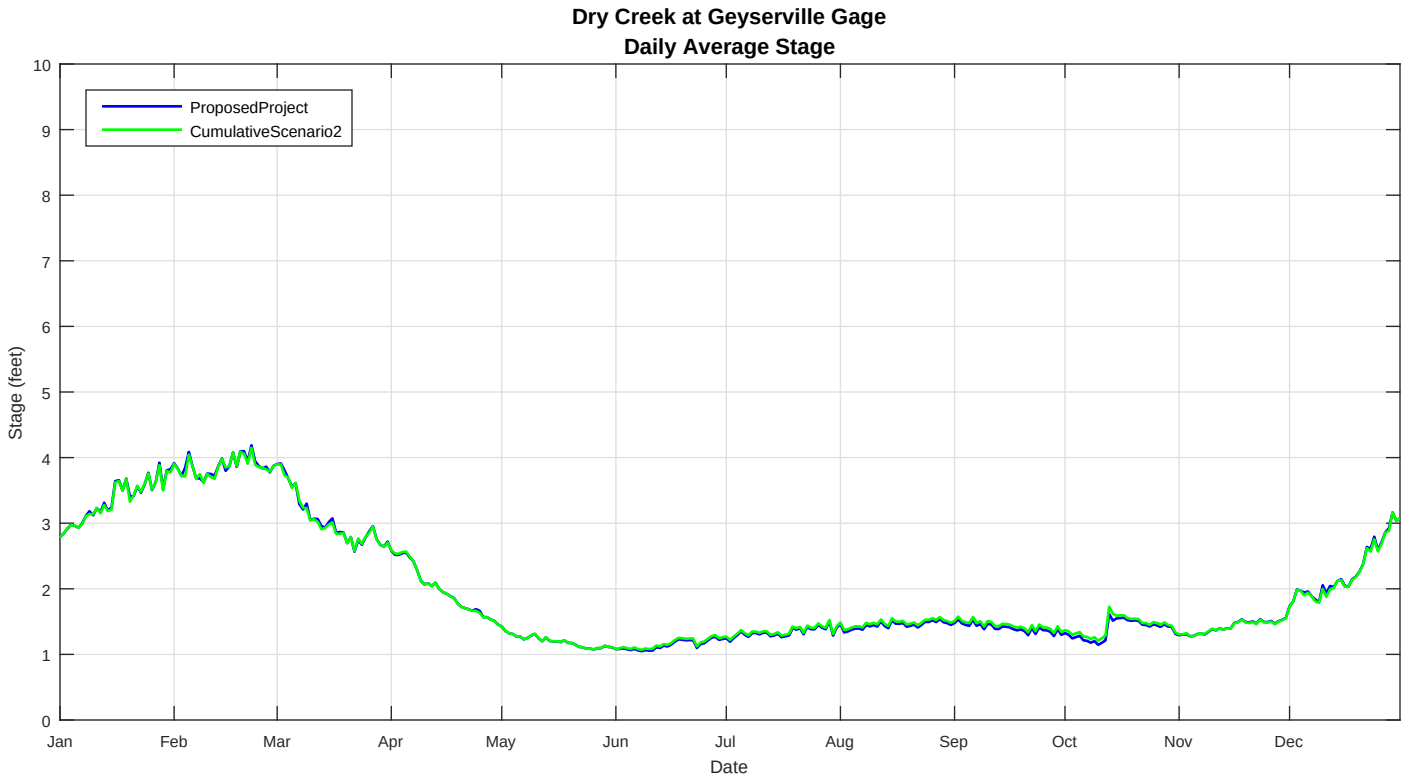

Dry Creek Mouth Gage
Daily Average Flow
1000
100
10
Flow (cfs)
ProposedProject
CumulativeScenario2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

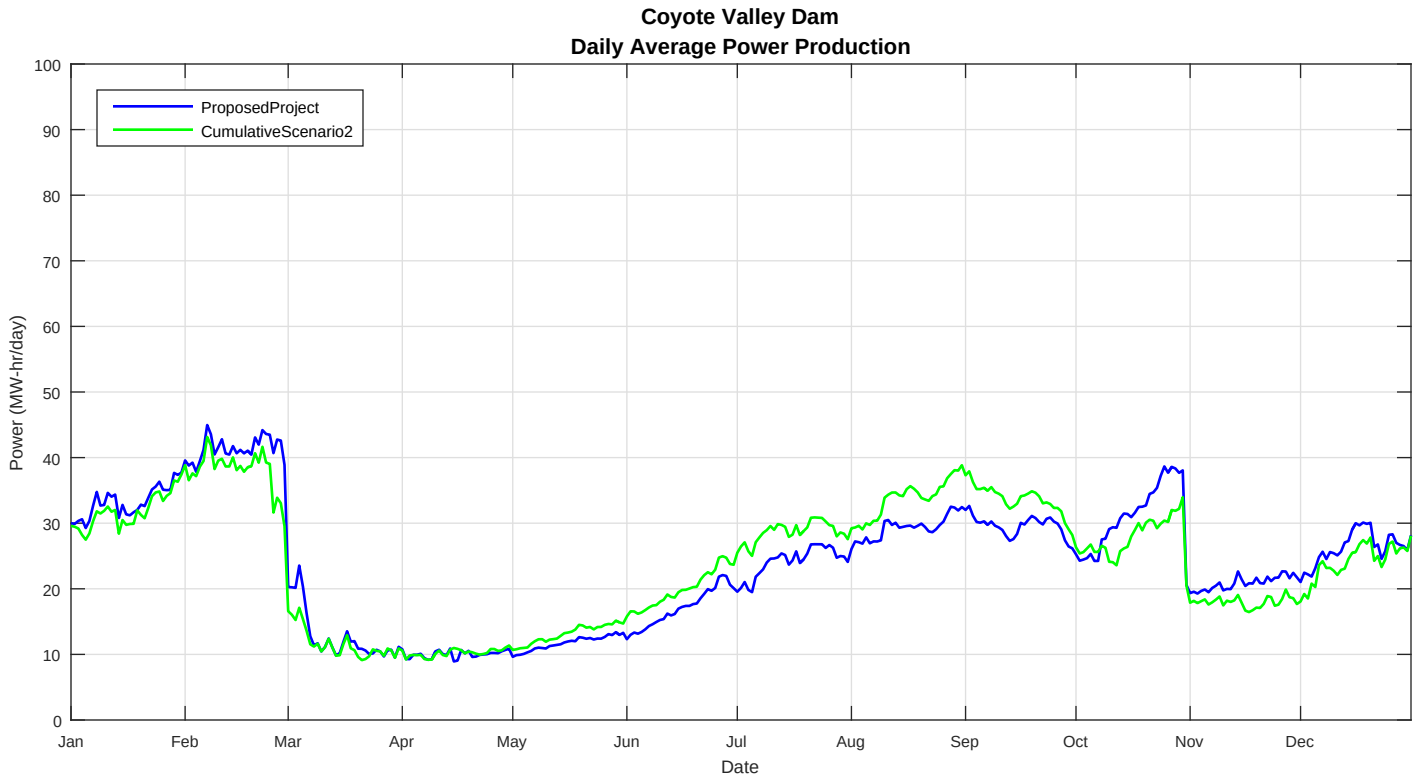

Hopland Gage
Daily Average Stage
ProposedProject
CumulativeScenario2
Stage (feet)
10
8
6
4
2
0
-2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

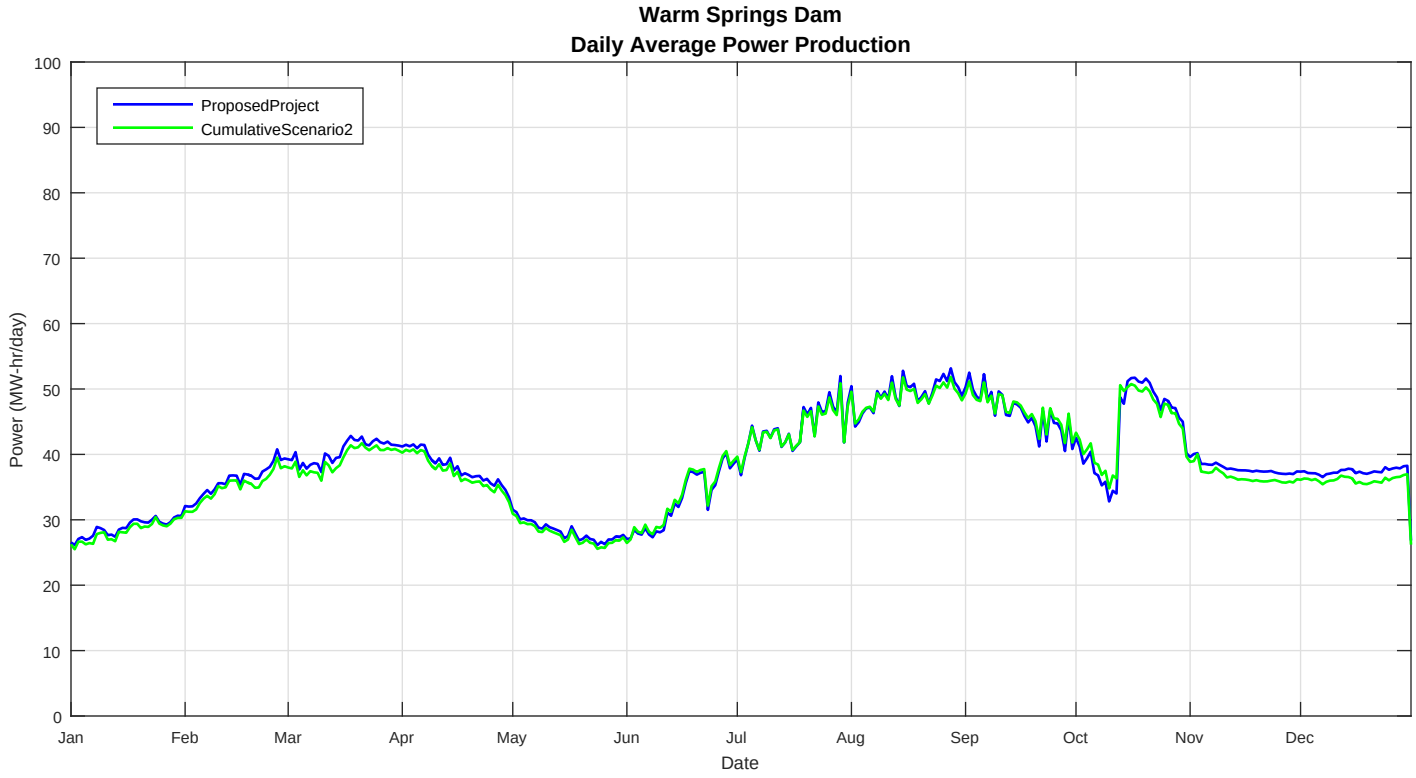

Cloverdale Gage
Daily Average Stage
ProposedProject
CumulativeScenario2
Stage (feet)
10
9
8
7
6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

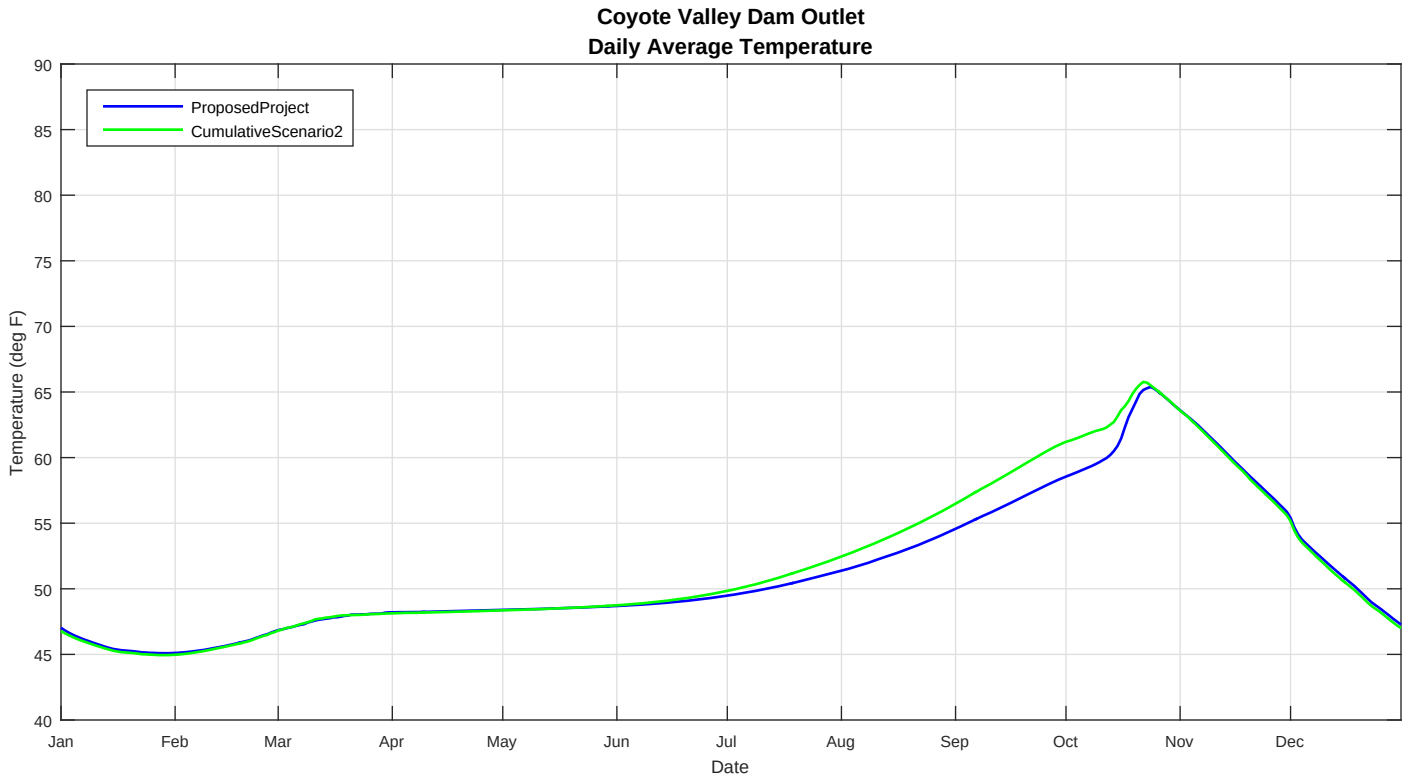

Healdsburg Gage
Daily Average Stage
ProposedProject
CumulativeScenario2
Stage (feet)
0
1
2
3
4
5
6
7
8
9
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

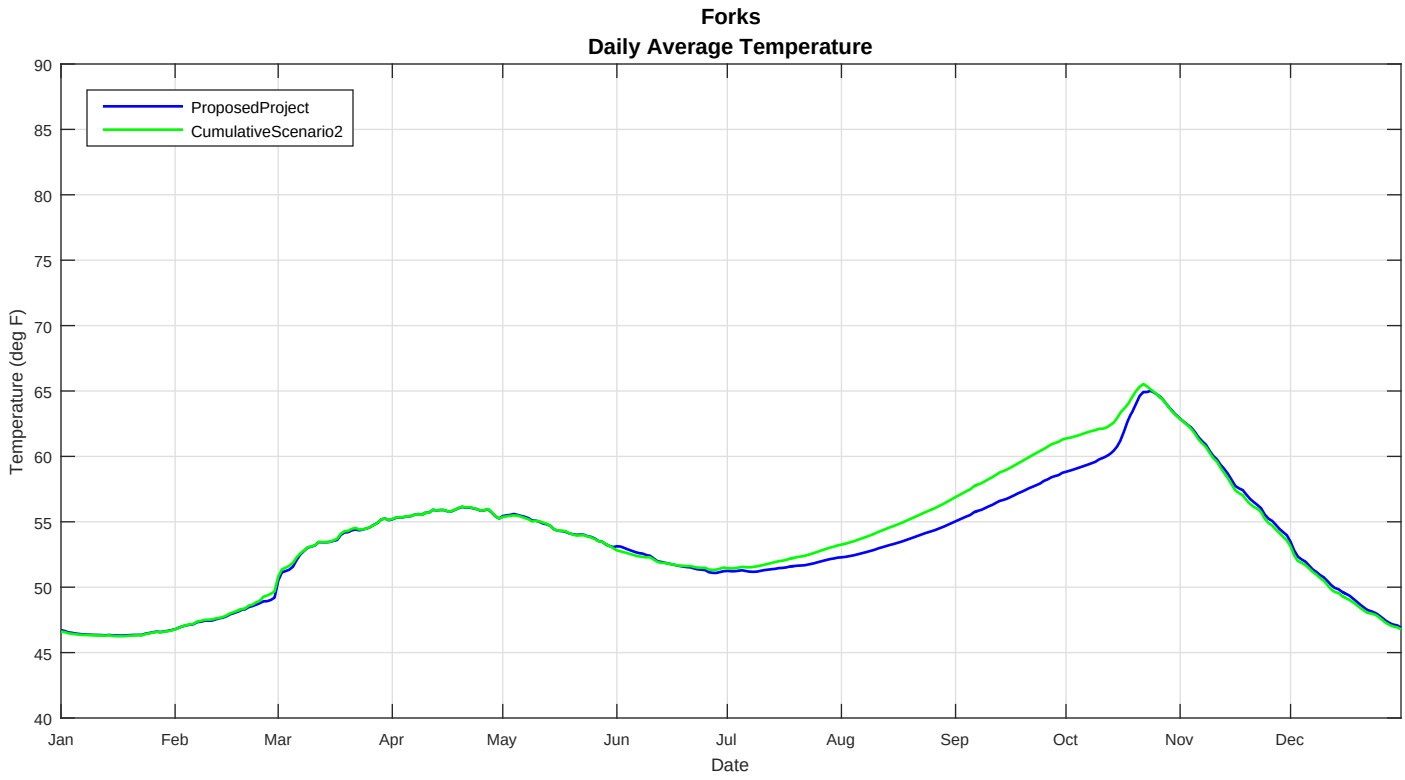

Hacienda Gage
Daily Average Stage
ProposedProject
CumulativeScenario2
Stage (feet)
0
1
2
3
4
5
6
7
8
9
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

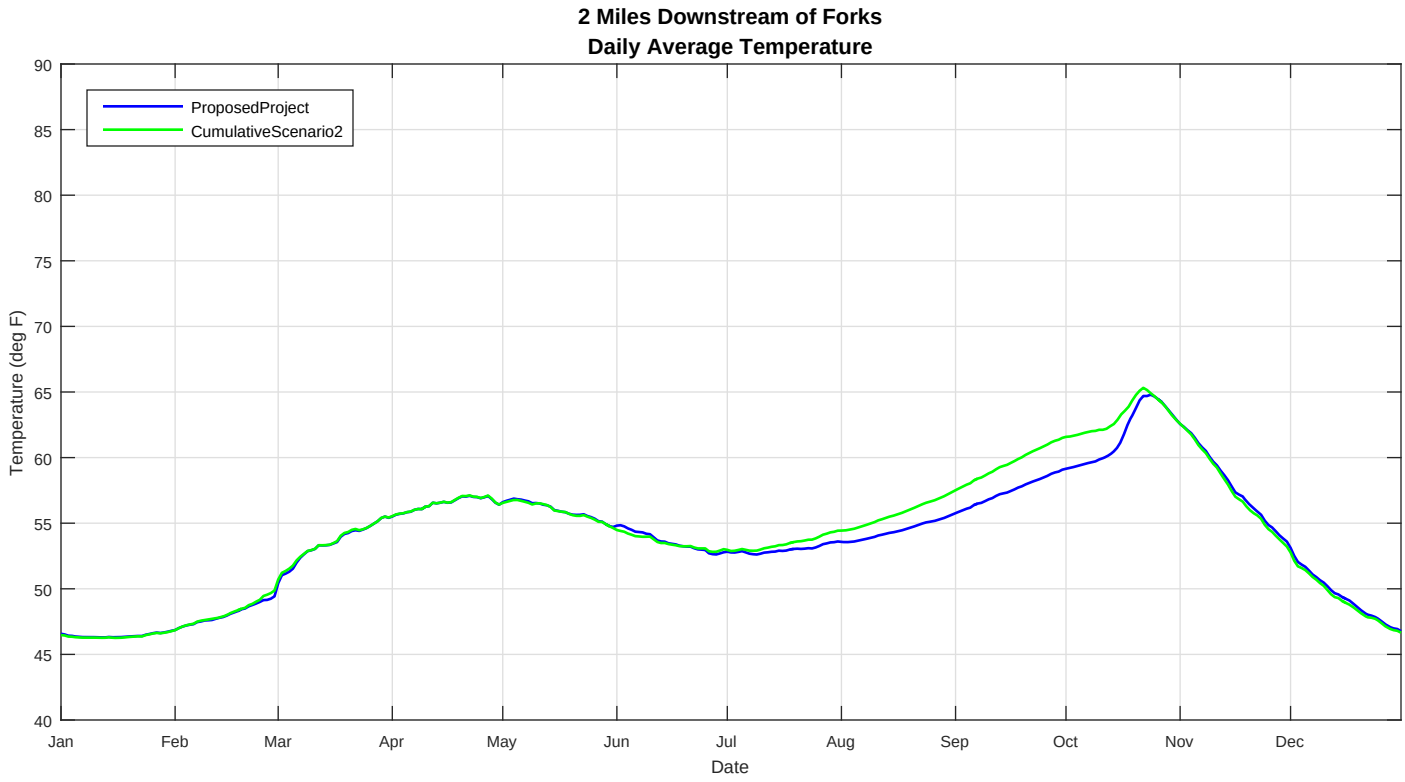

Dry Creek at Geyserville Gage
Daily Average Stage
ProposedProject
CumulativeScenario2
Stage (feet)
0
1
2
3
4
5
6
7
8
9
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

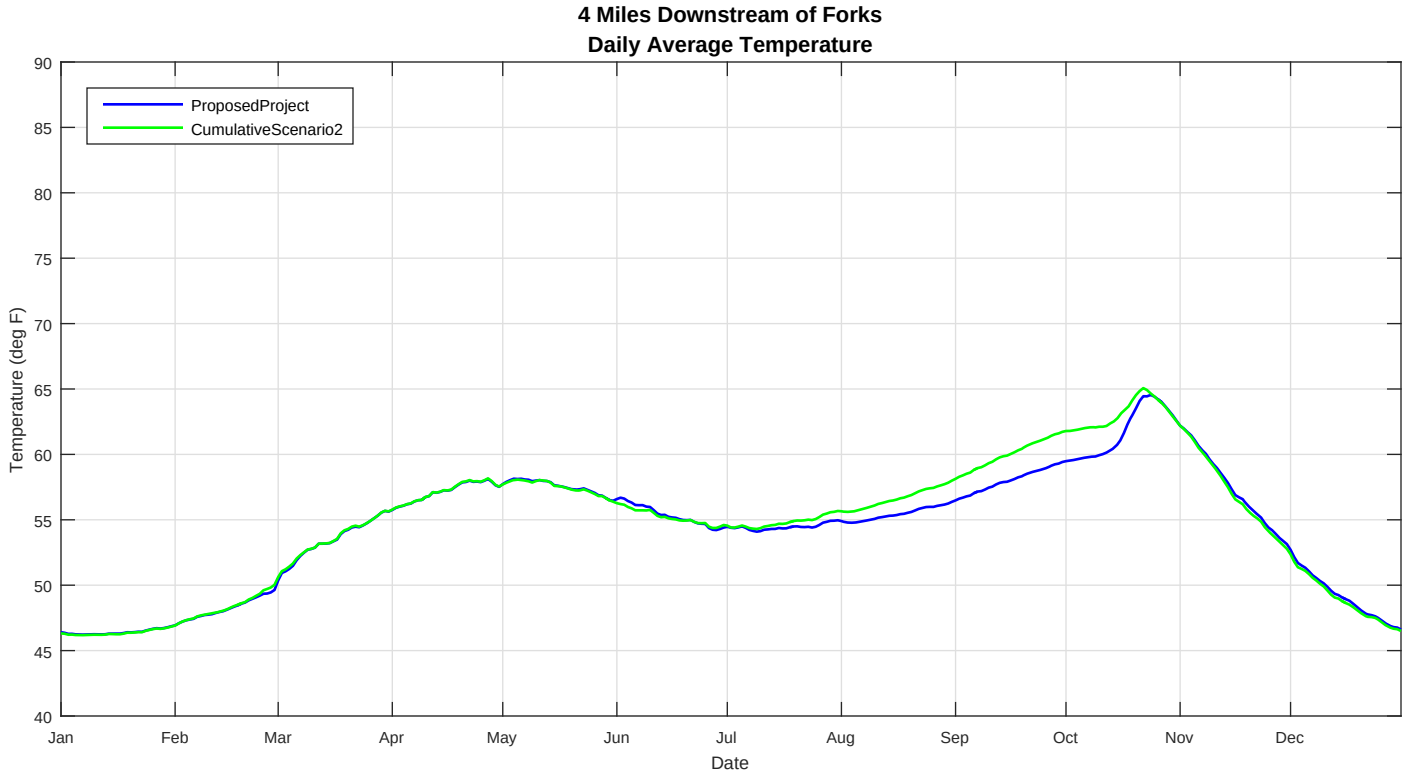

Coyote Valley Dam
Daily Average Power Production
ProposedProject
CumulativeScenario2
Power (MW-hr/day)
0
10
20
30
40
50
60
70
80
90
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

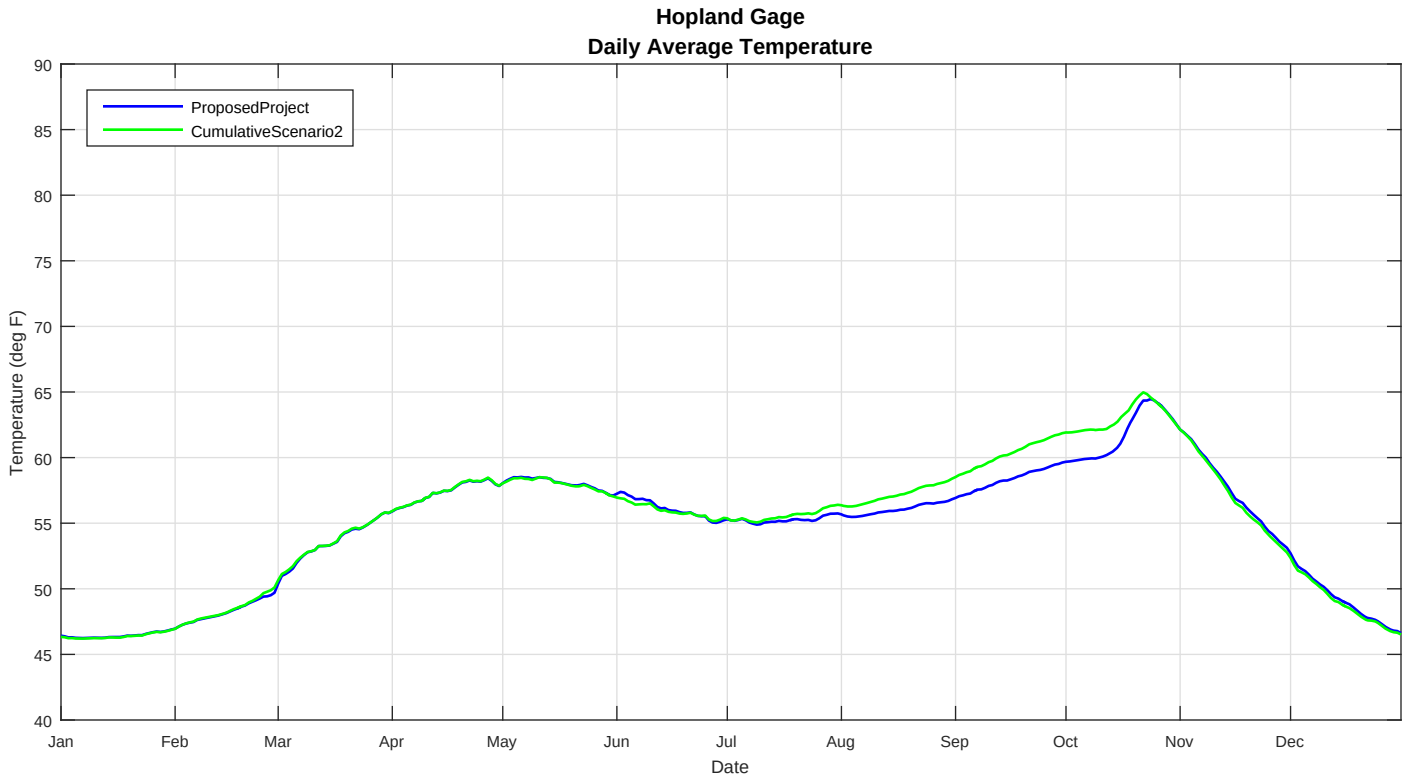

Warm Springs Dam
Daily Average Power Production
ProposedProject
CumulativeScenario2
Power (MW-hr/day)
0
10
20
30
40
50
60
70
80
90
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

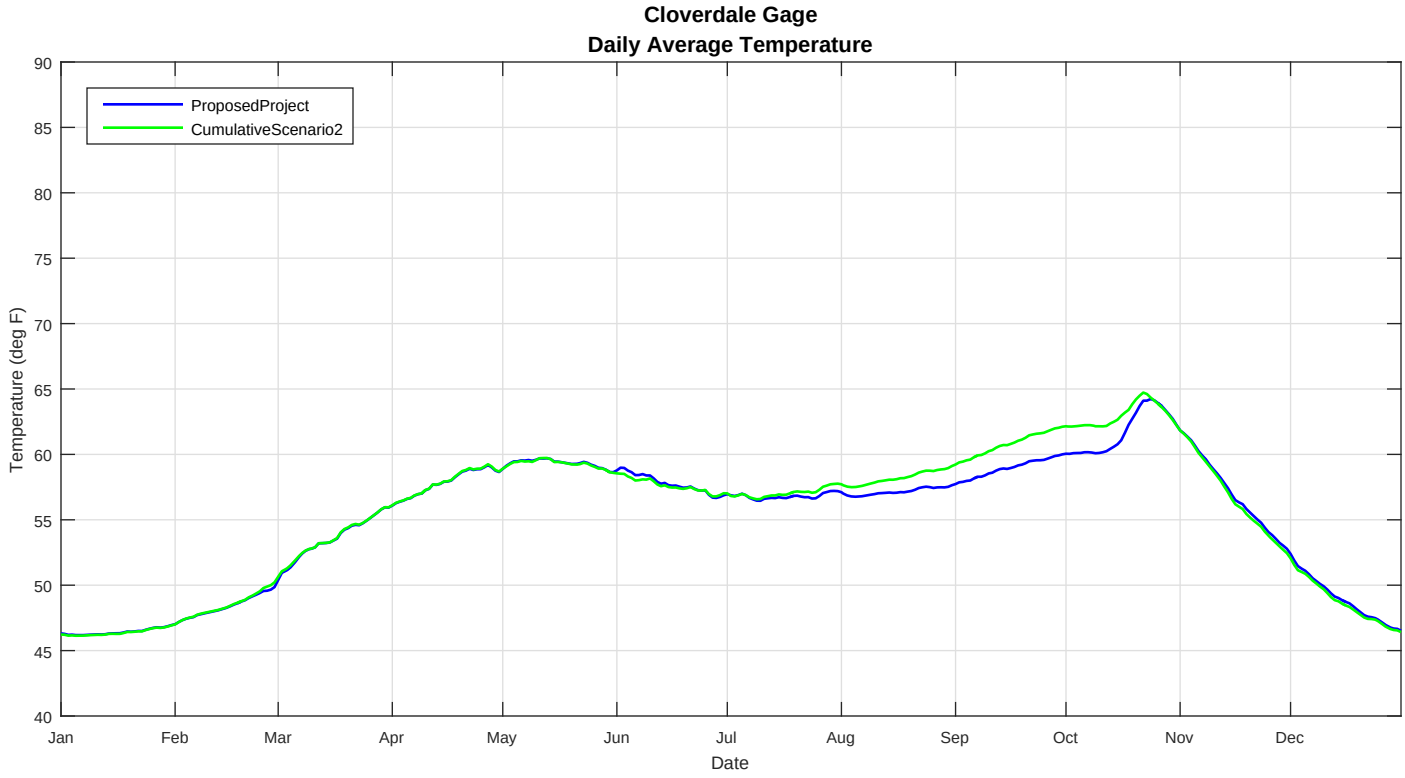

Coyote Valley Dam Outlet
Daily Average Temperature
ProposedProject
CumulativeScenario2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

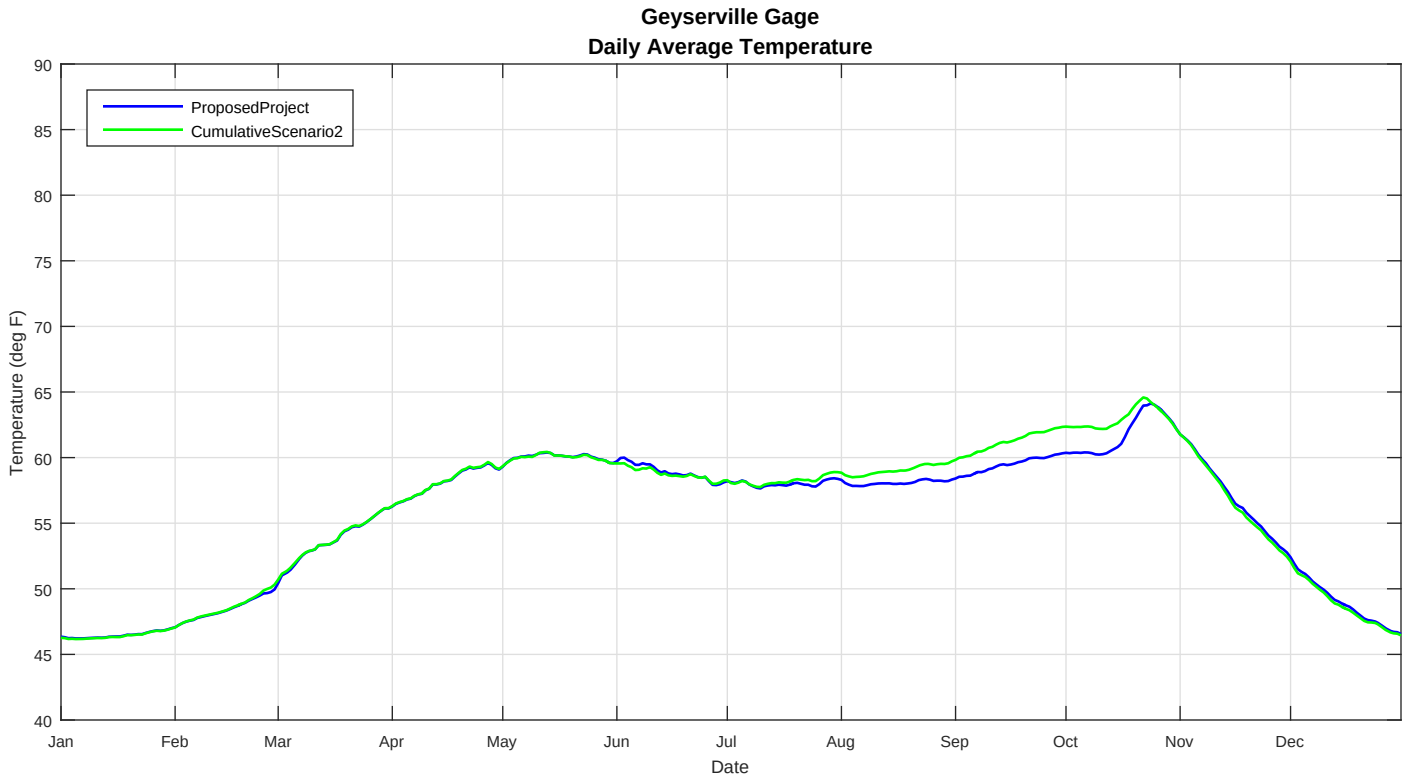

Forks
Daily Average Temperature
ProposedProject
CumulativeScenario2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

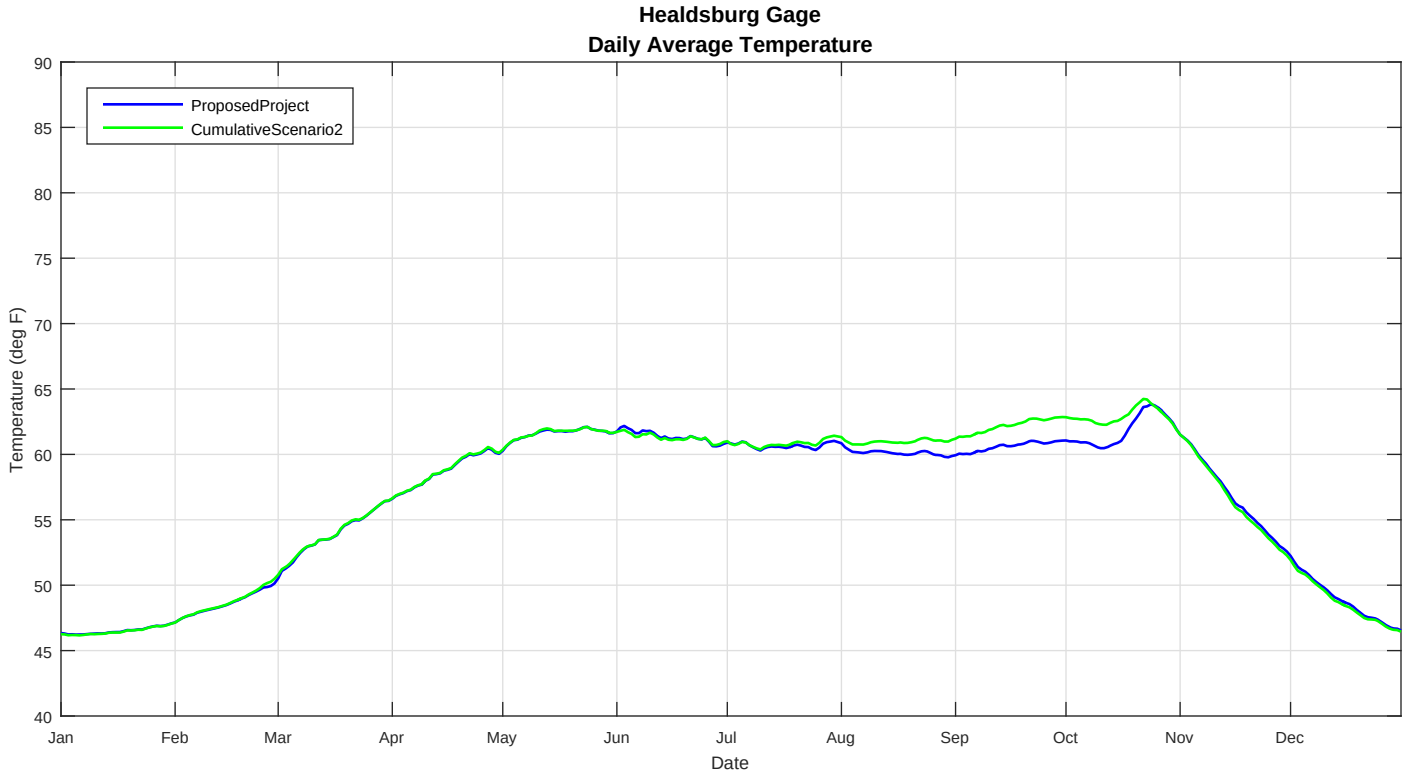

2 Miles Downstream of Forks
Daily Average Temperature
ProposedProject
CumulativeScenario2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

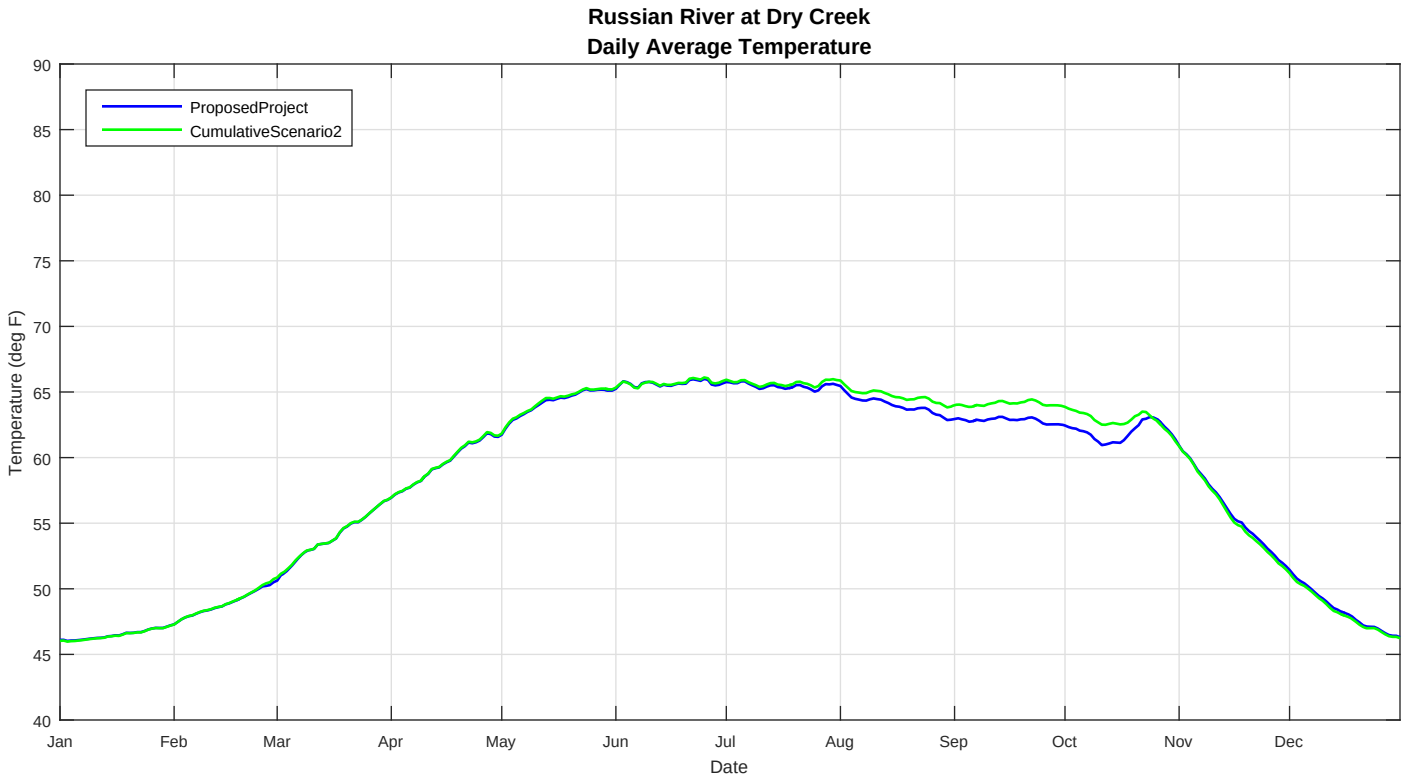

4 Miles Downstream of Forks
Daily Average Temperature
ProposedProject
CumulativeScenario2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

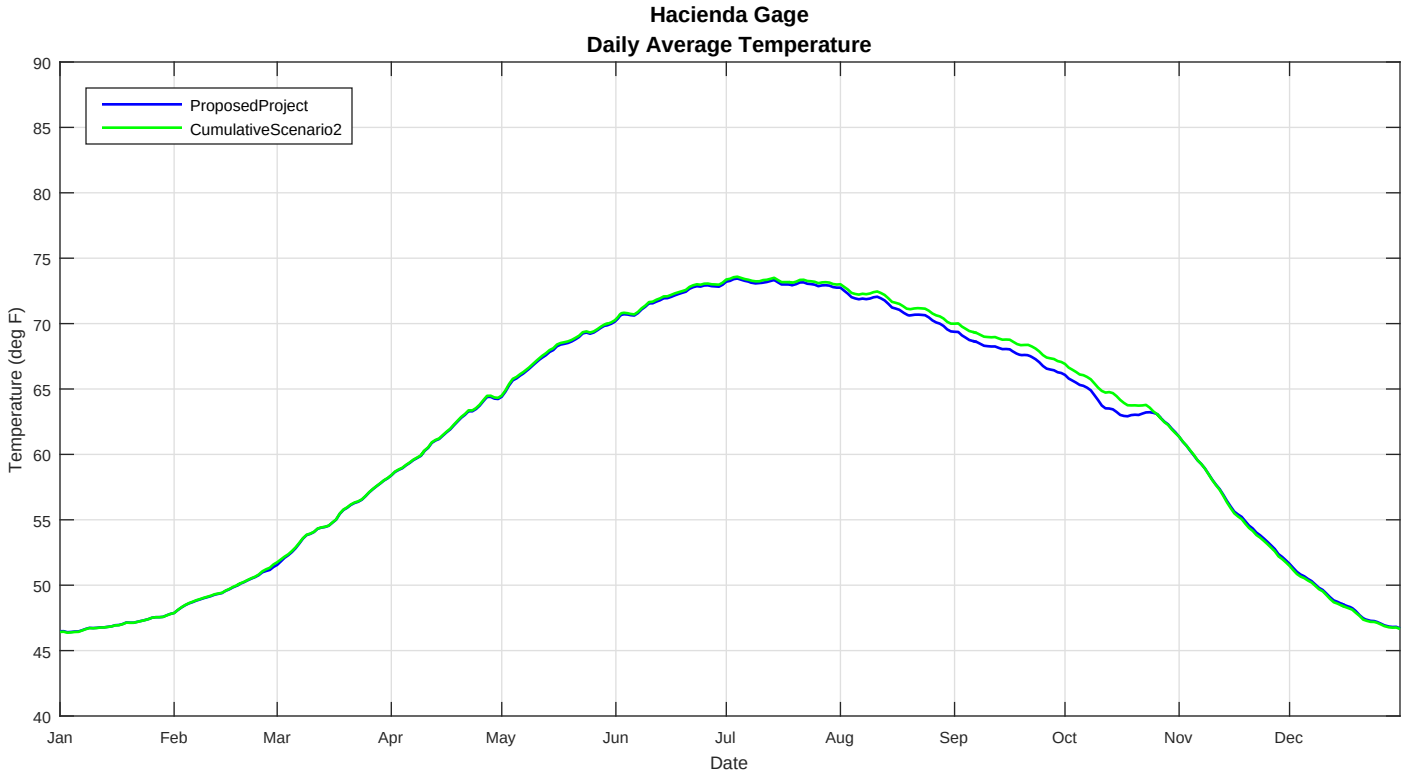

Hopland Gage
Daily Average Temperature
ProposedProject
CumulativeScenario2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

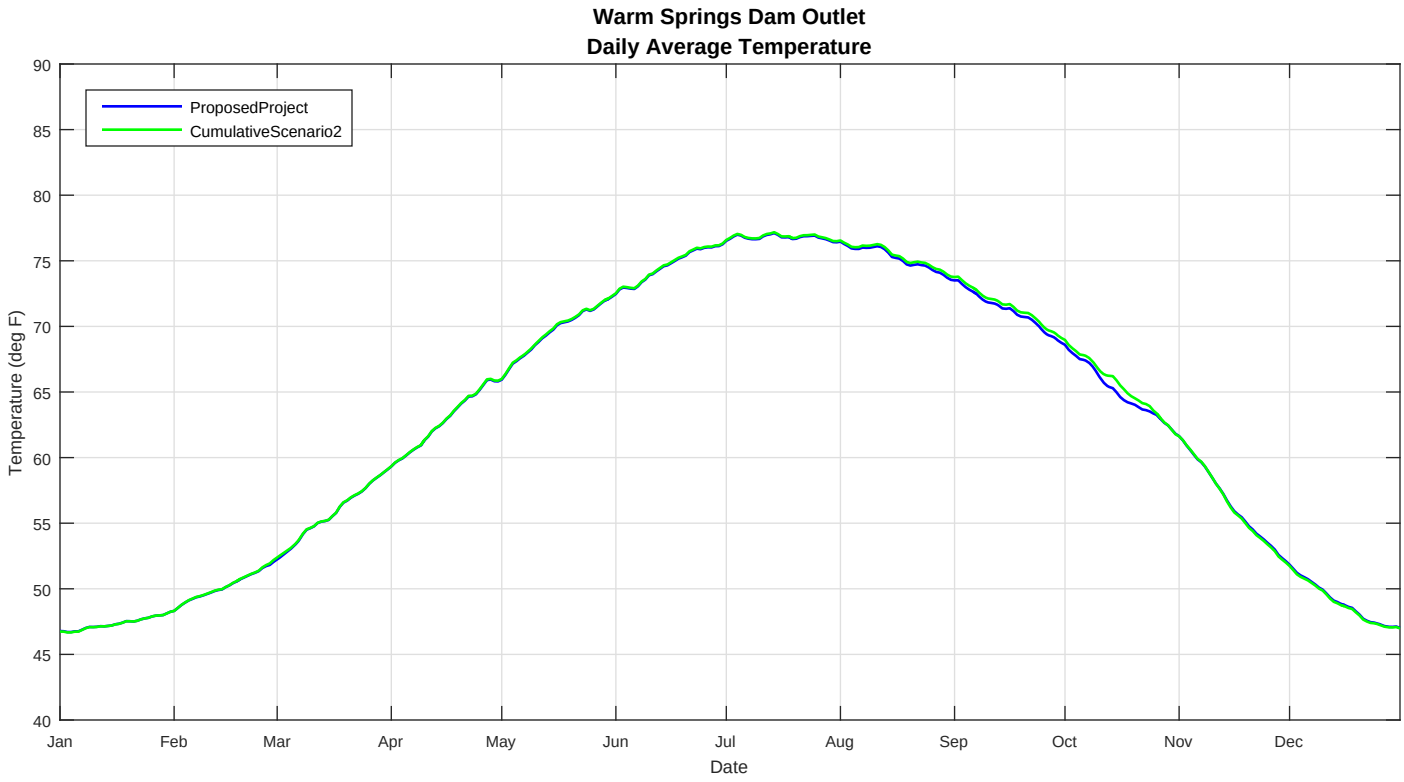

Cloverdale Gage
Daily Average Temperature
ProposedProject
CumulativeScenario2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

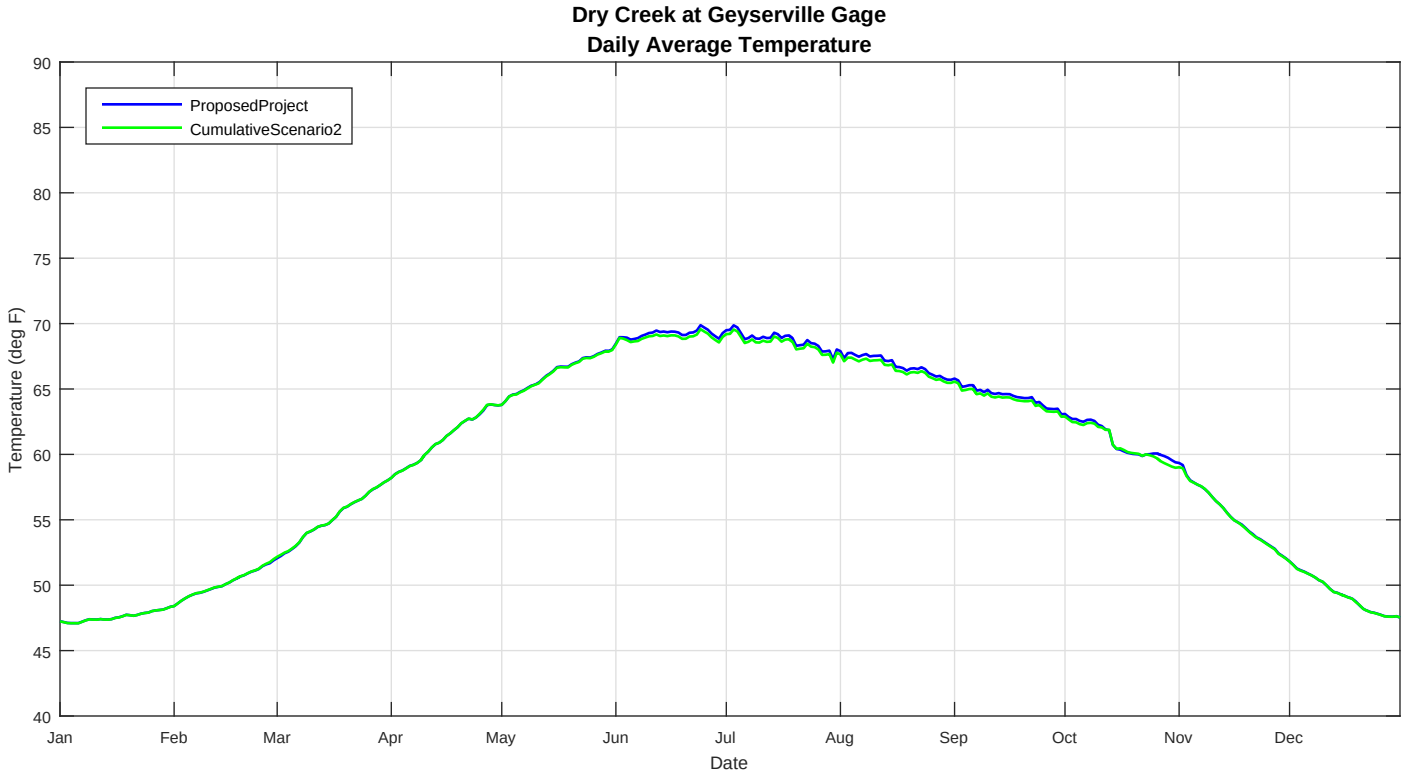

Geyserville Gage
Daily Average Temperature
ProposedProject
CumulativeScenario2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

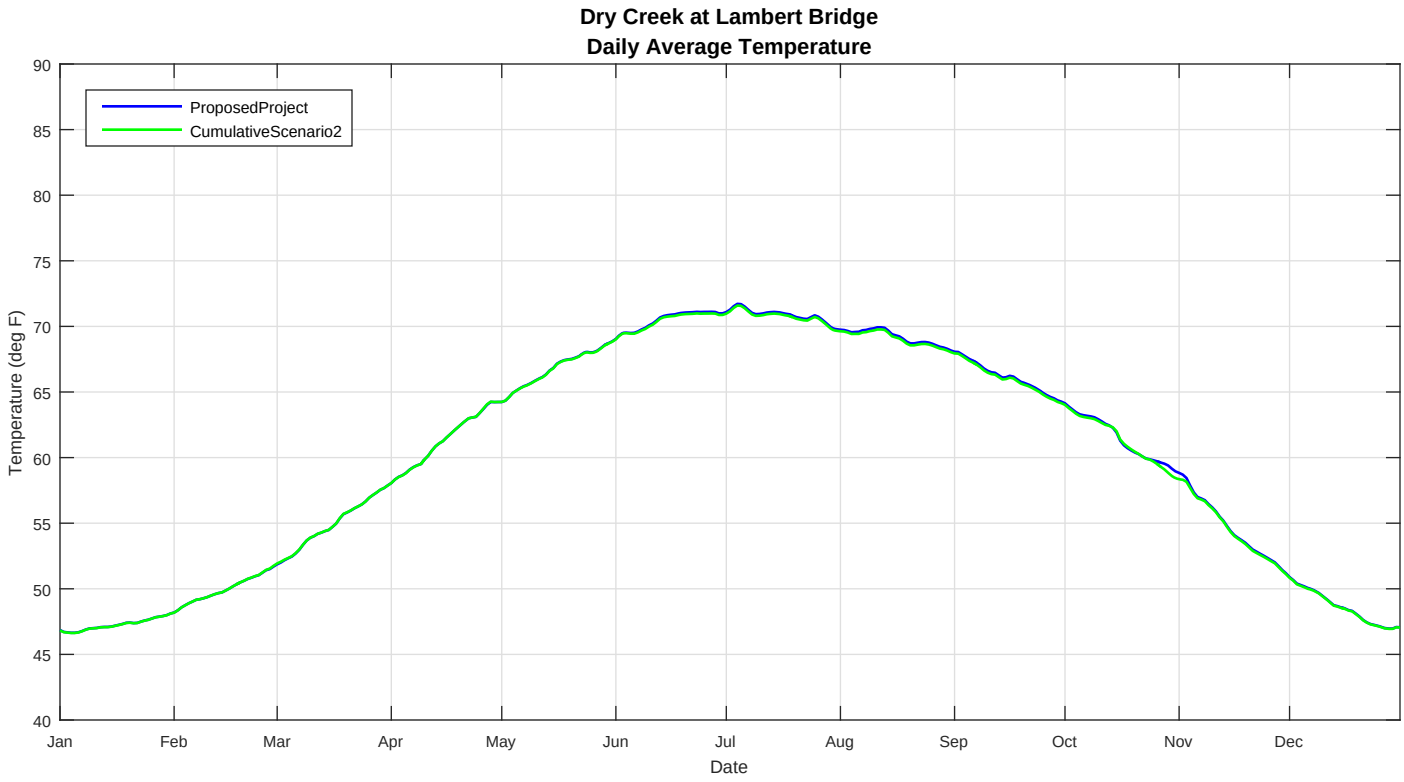

Healdsburg Gage
Daily Average Temperature
ProposedProject
CumulativeScenario2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

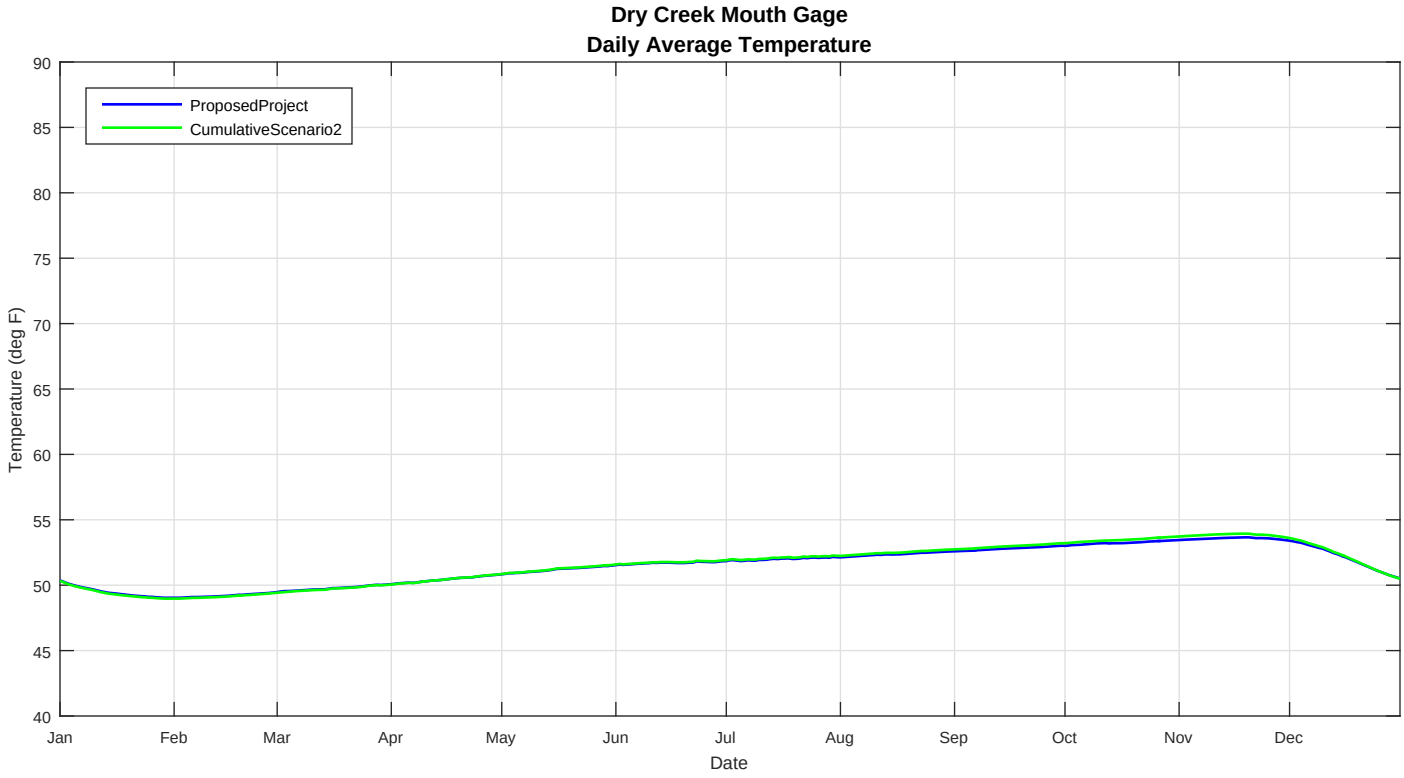

Russian River at Dry Creek
Daily Average Temperature
ProposedProject
CumulativeScenario2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

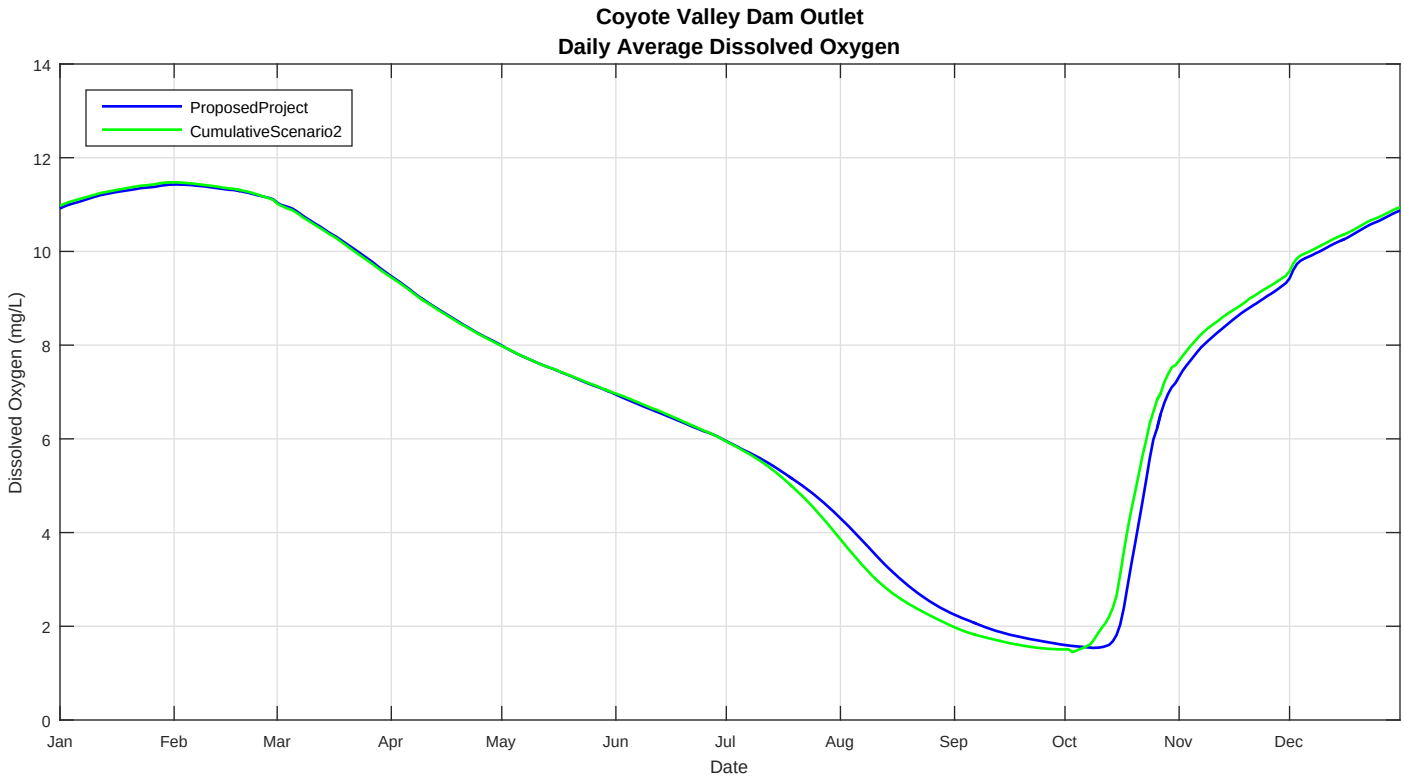

Hacienda Gage
Daily Average Temperature
ProposedProject
CumulativeScenario2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

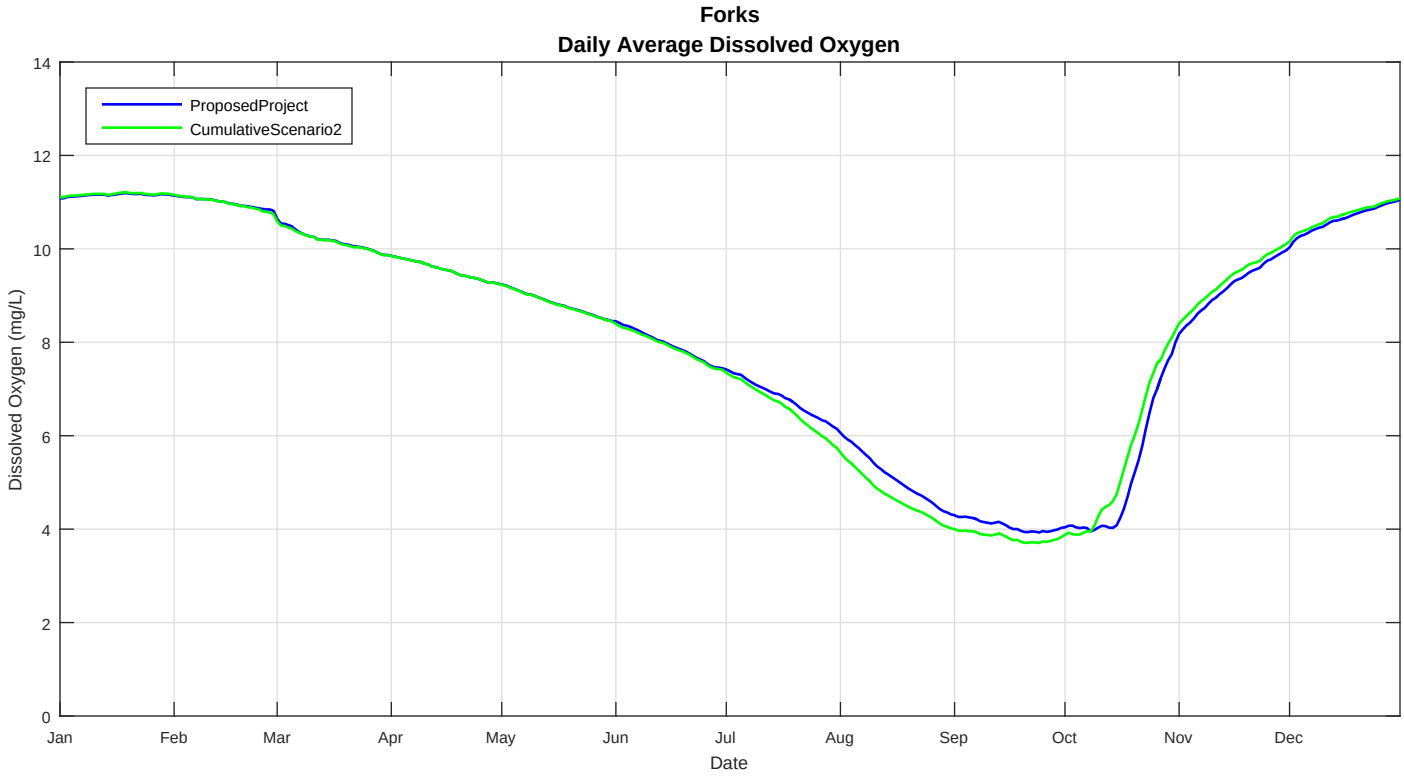

Warm Springs Dam Outlet
Daily Average Temperature
ProposedProject
CumulativeScenario2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

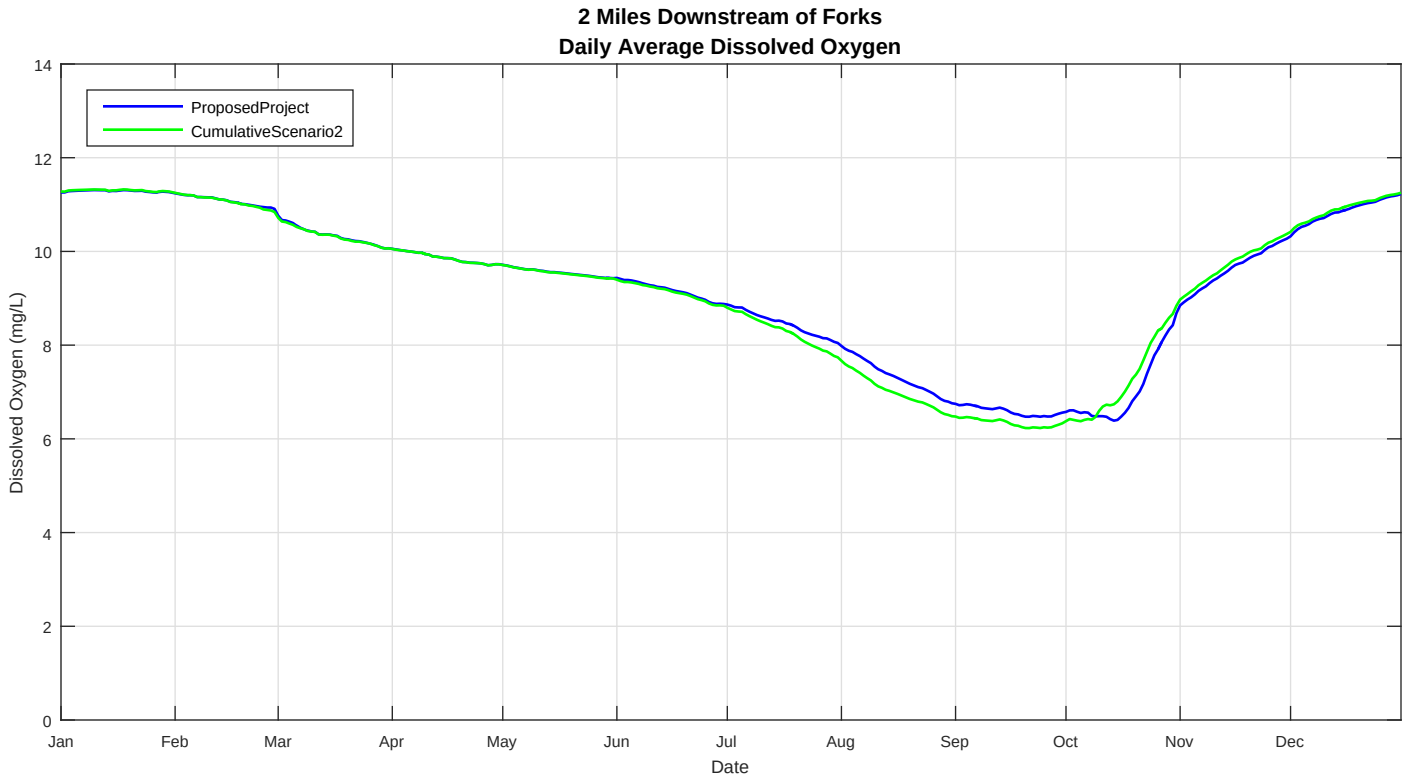

Dry Creek at Geyserville Gage
Daily Average Temperature
ProposedProject
CumulativeScenario2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

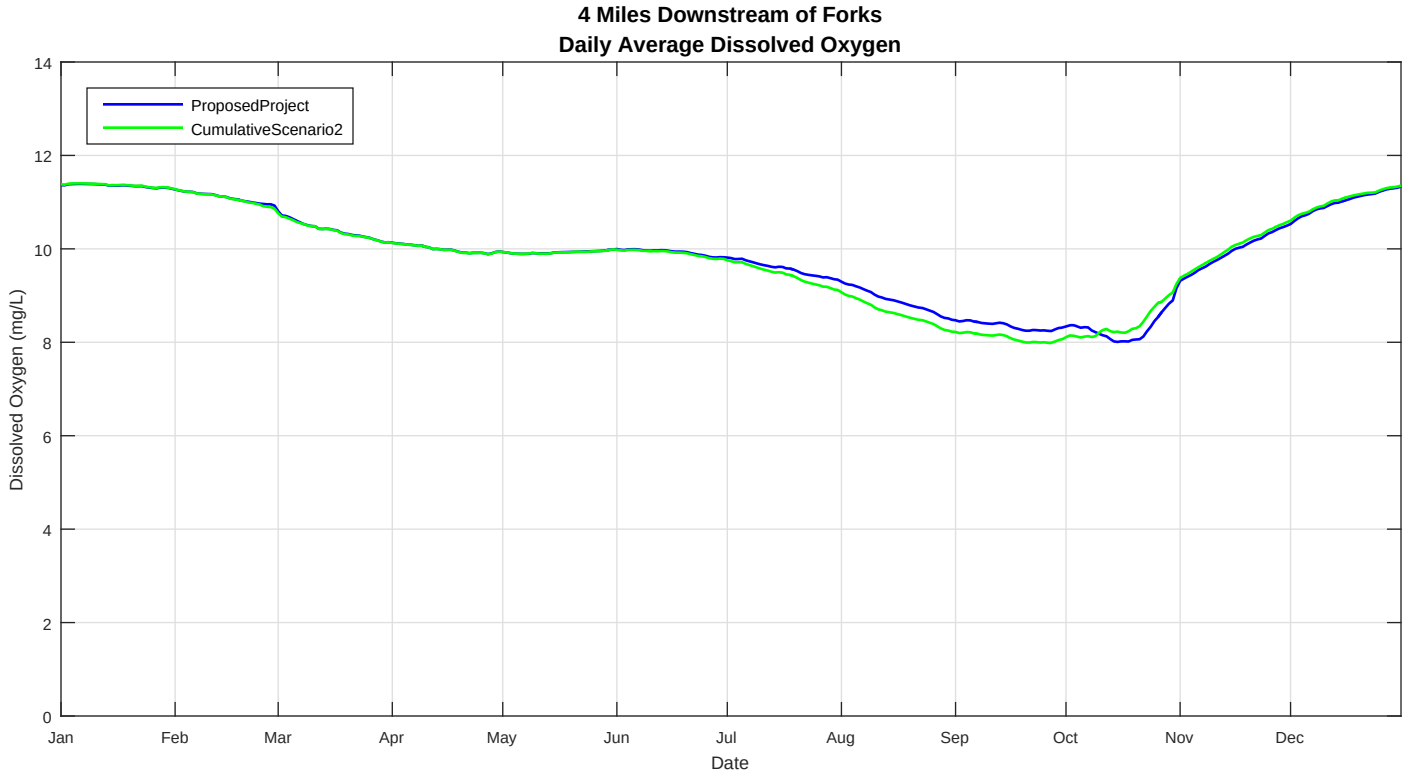

Dry Creek at Lambert Bridge
Daily Average Temperature
ProposedProject
CumulativeScenario2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

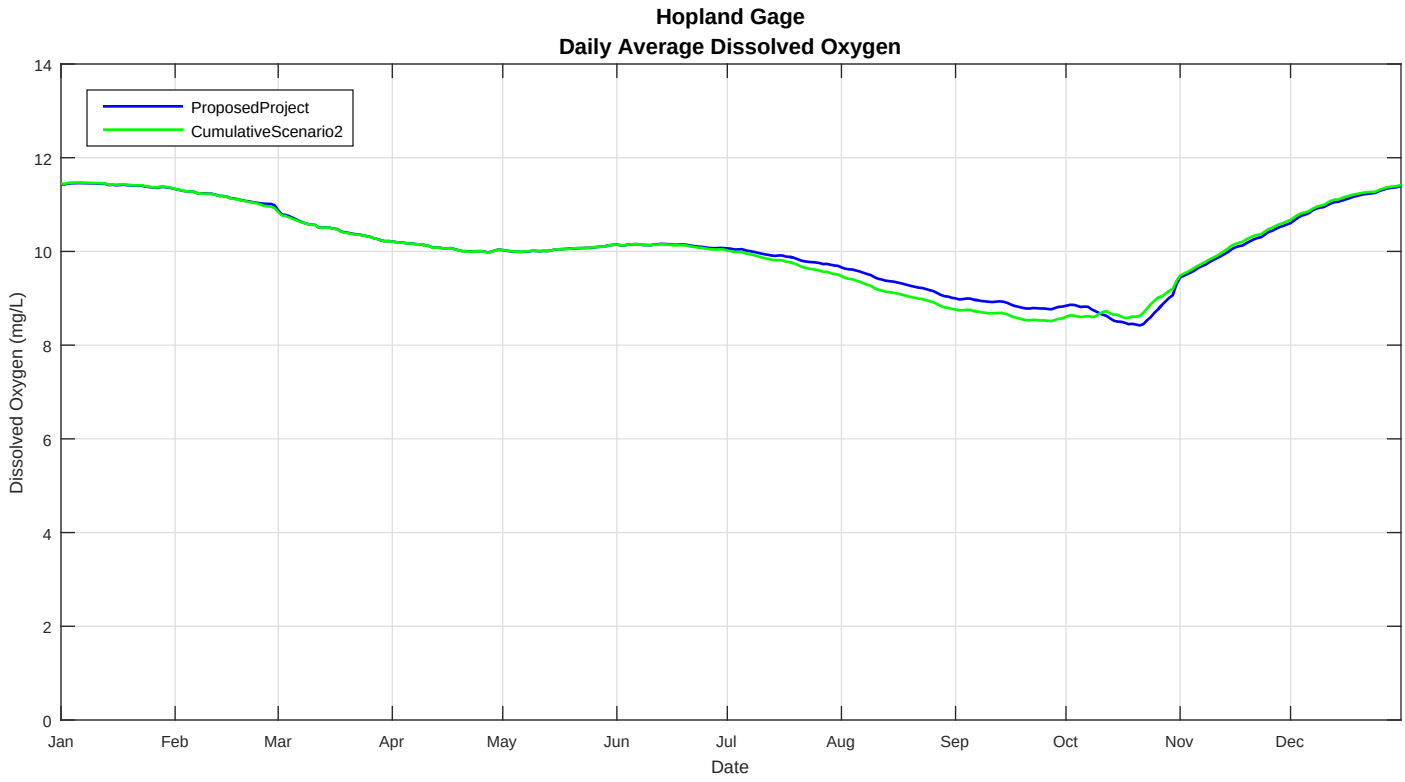

Dry Creek Mouth Gage
Daily Average Temperature
ProposedProject
CumulativeScenario2
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

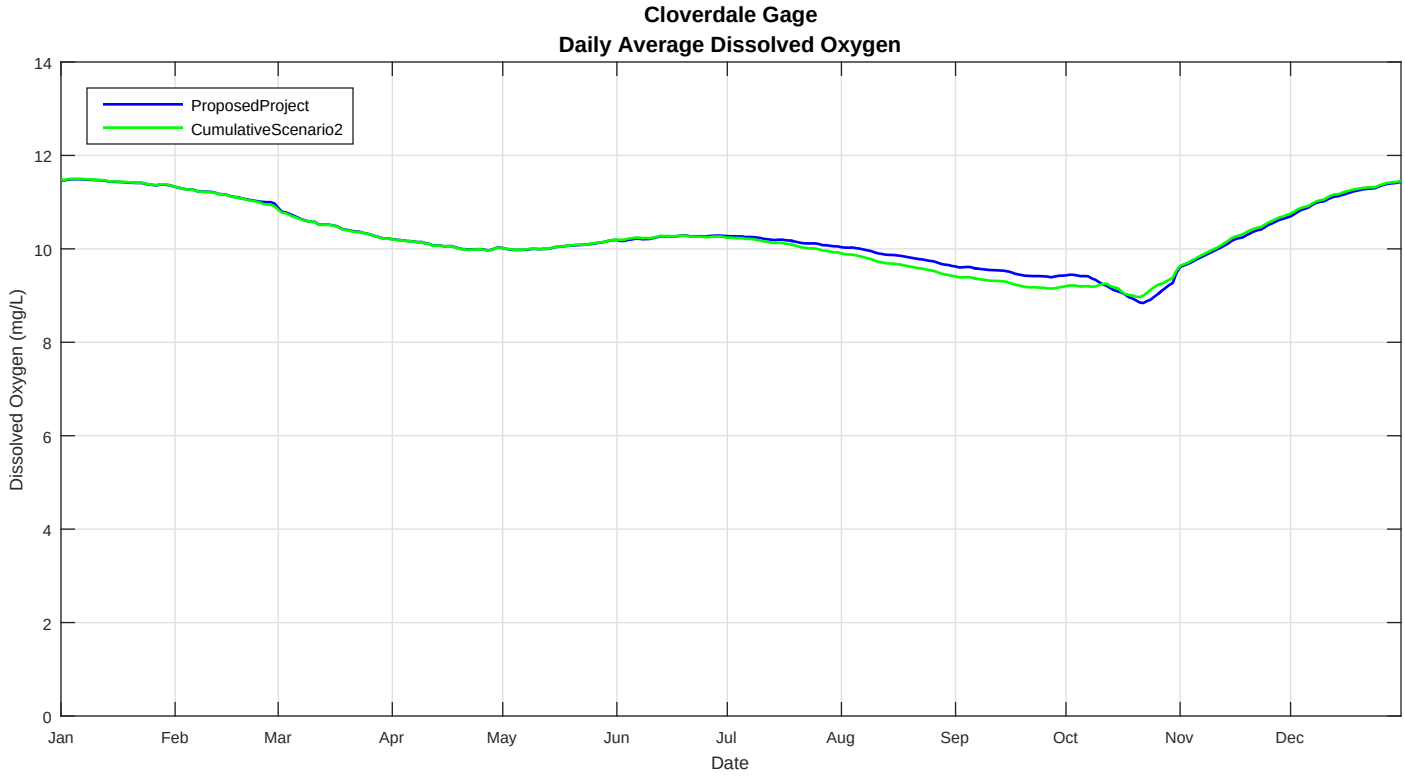

Coyote Valley Dam Outlet
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

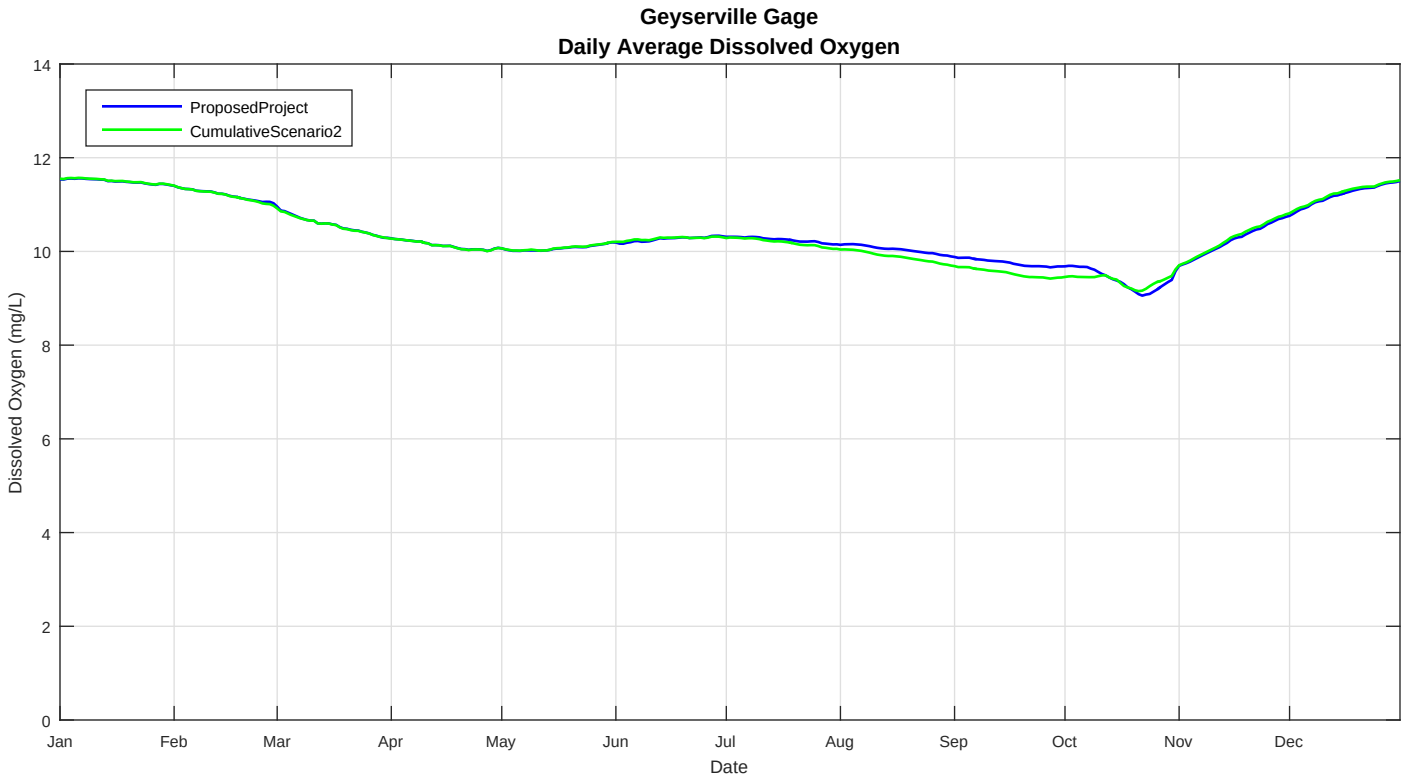

Forks
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

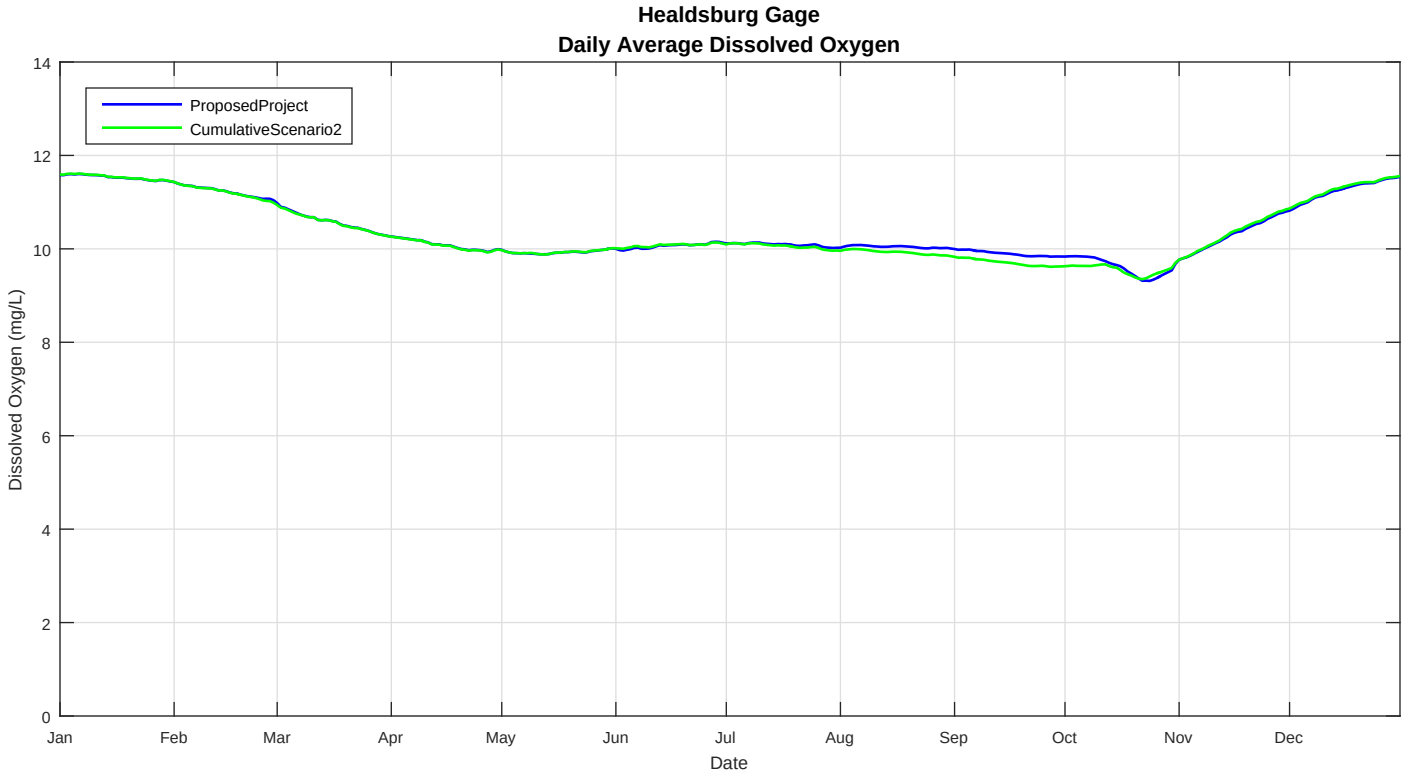

2 Miles Downstream of Forks
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

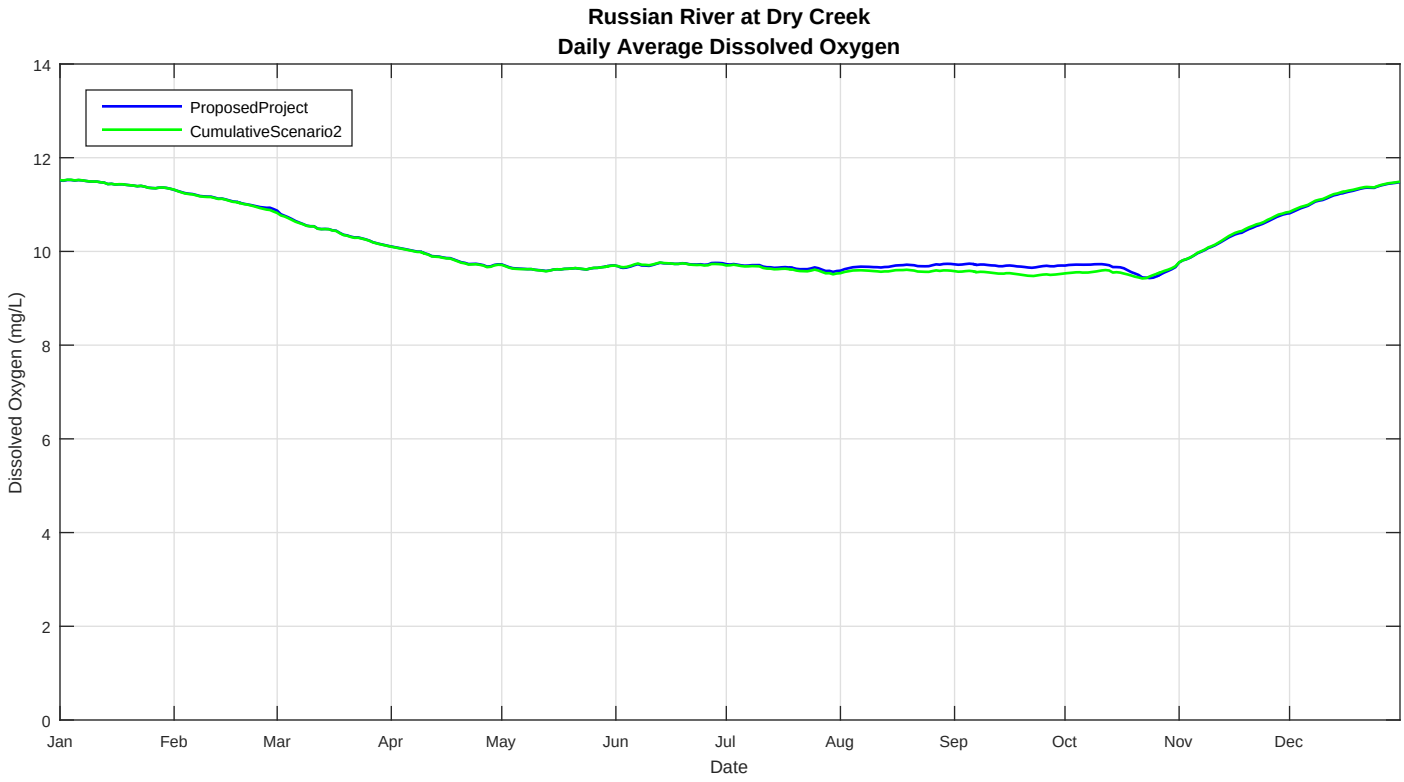

4 Miles Downstream of Forks
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

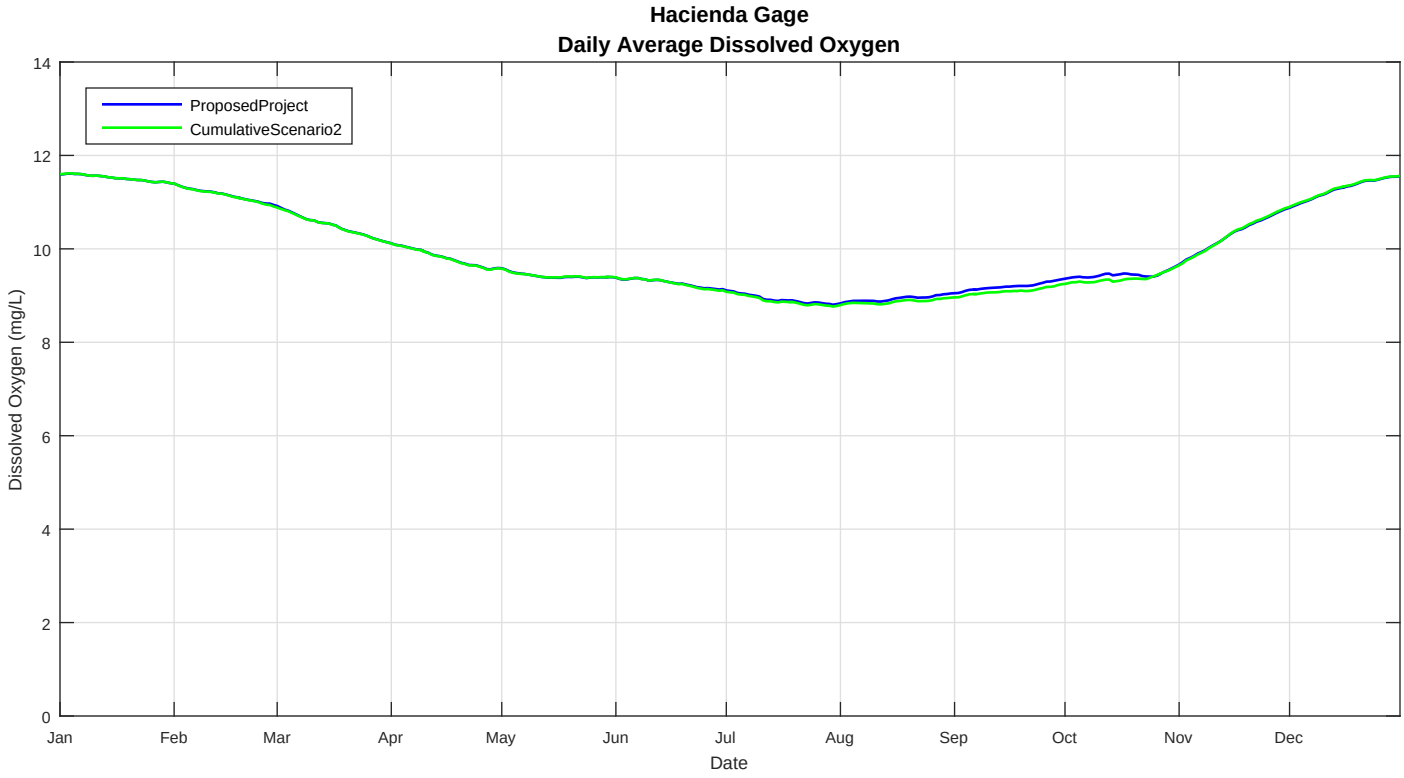

Hopland Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

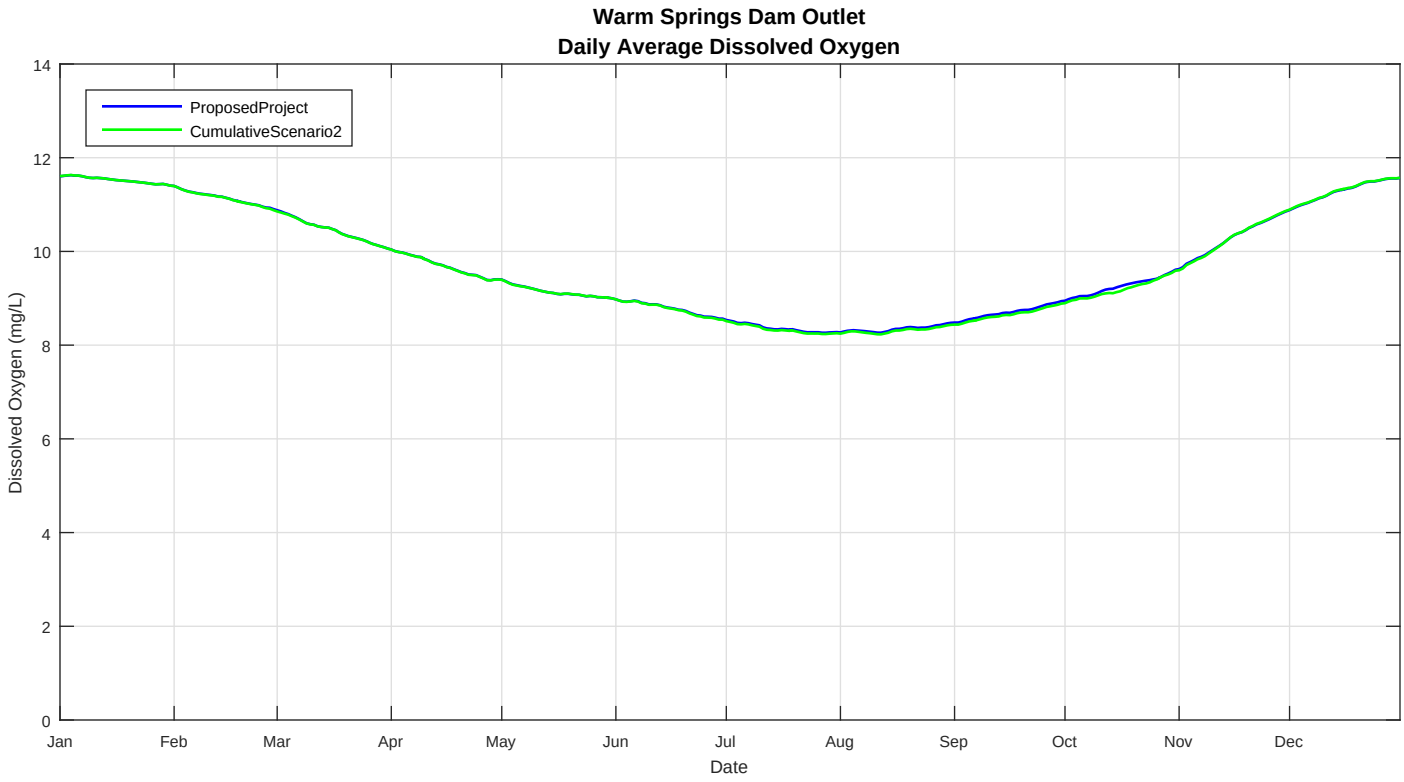

Cloverdale Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

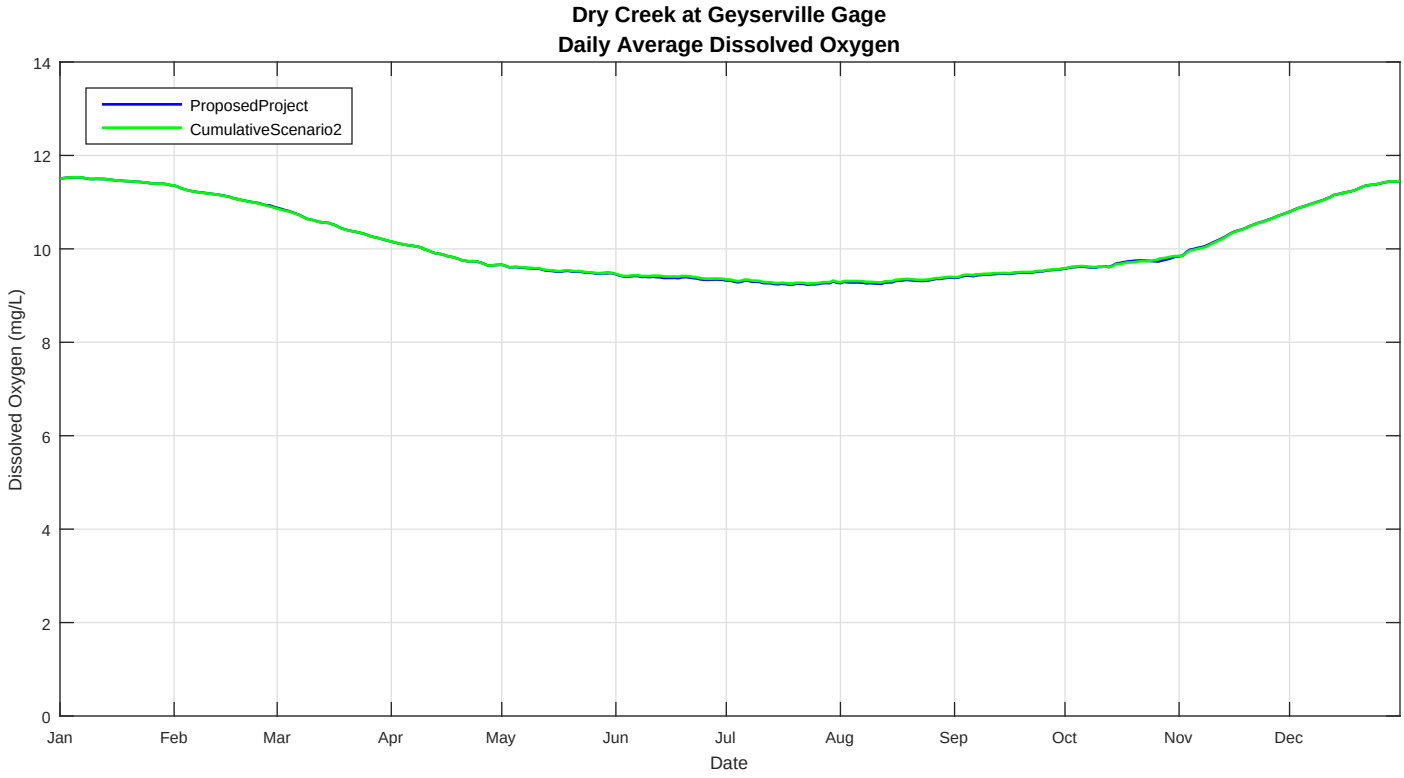

Geyserville Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

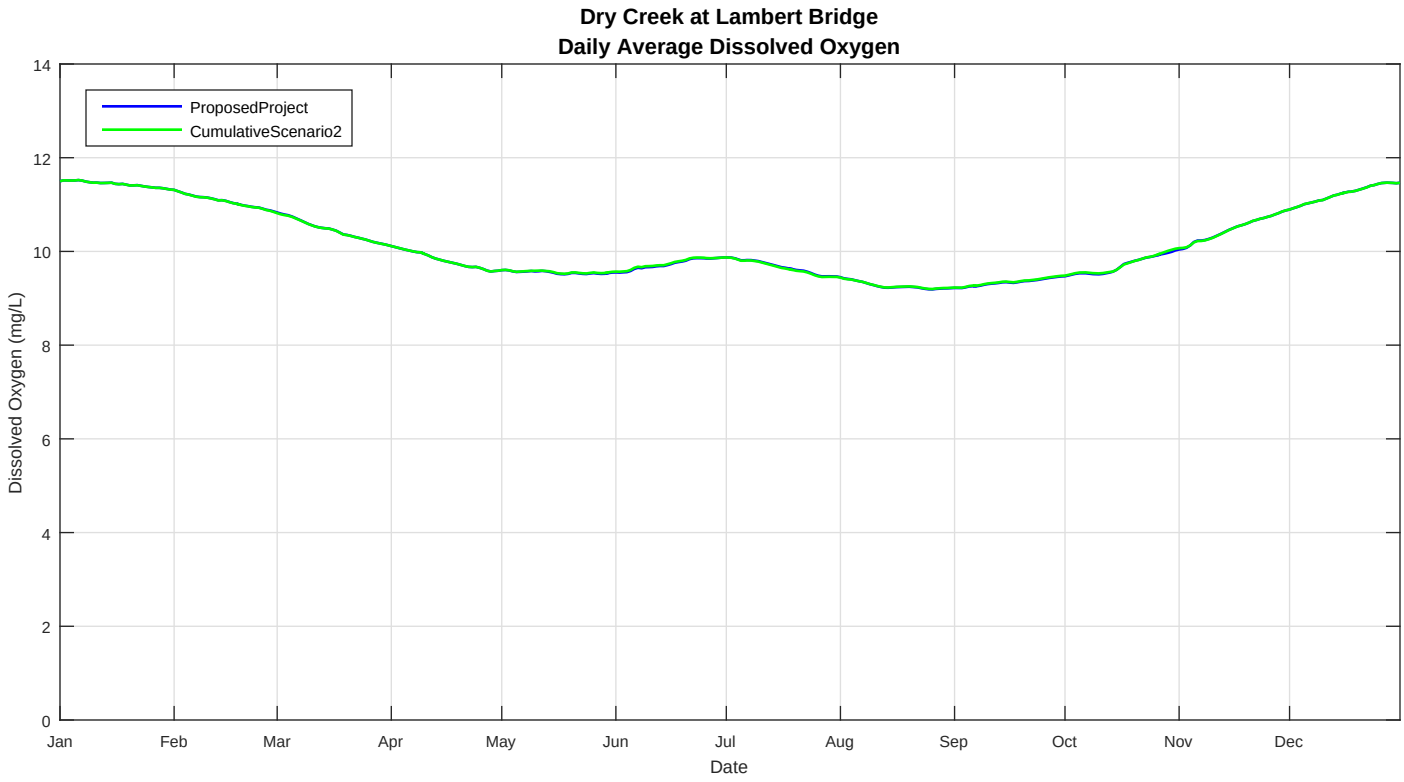

Healdsburg Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

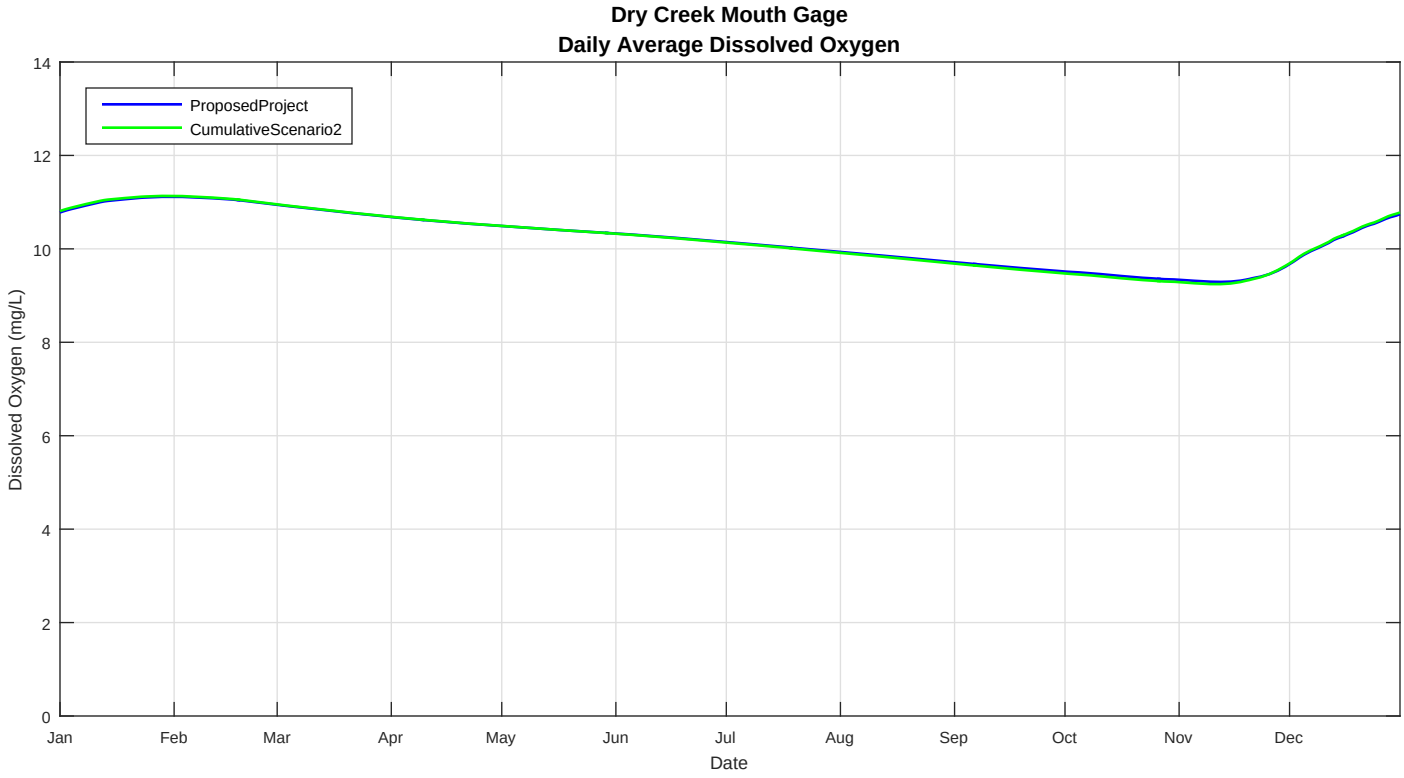

Russian River at Dry Creek
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

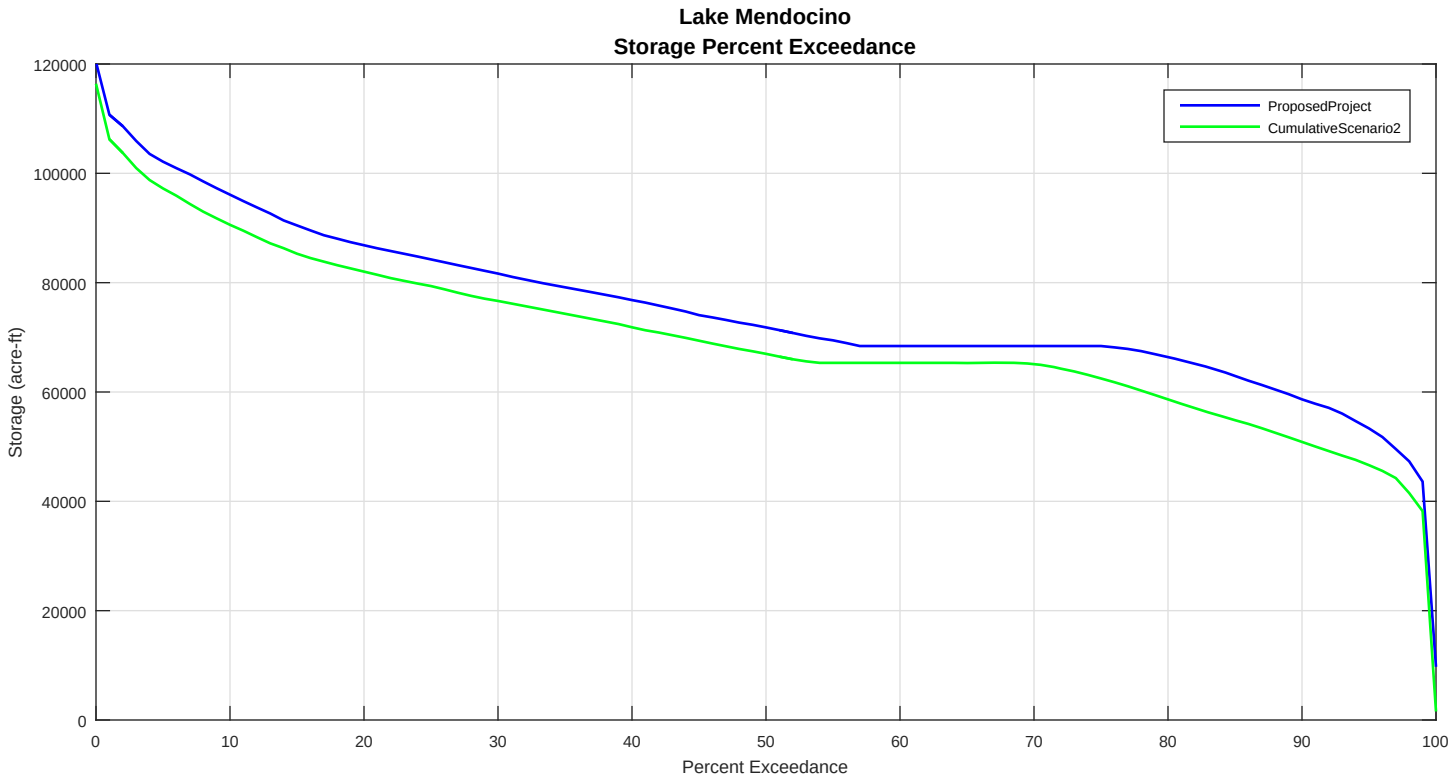

Hacienda Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

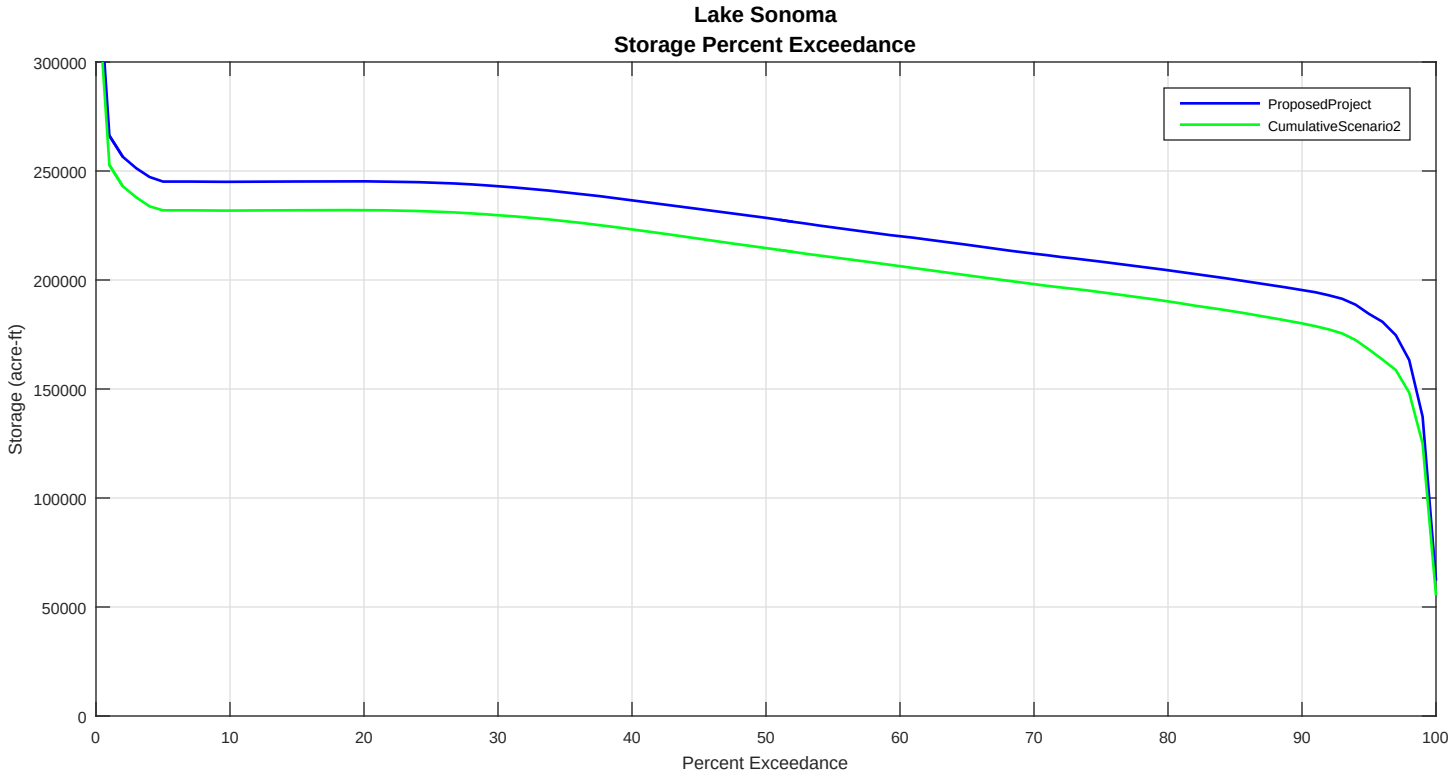

Warm Springs Dam Outlet
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date


Dry Creek at Geyserville Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date


Dry Creek at Lambert Bridge
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date


Dry Creek Mouth Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date


Lake Mendocino
Storage Percent Exceedance
ProposedProject
CumulativeScenario2
Storage (acre-ft)
Percent Exceedance
0
20000
40000
60000
80000
100000
120000
0
10
20
30
40
50
60
70
80
90
100


Lake Sonoma
Storage Percent Exceedance
ProposedProject
CumulativeScenario2
Storage (acre-ft)
Percent Exceedance
0
50000
100000
150000
200000
250000
300000
0
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30
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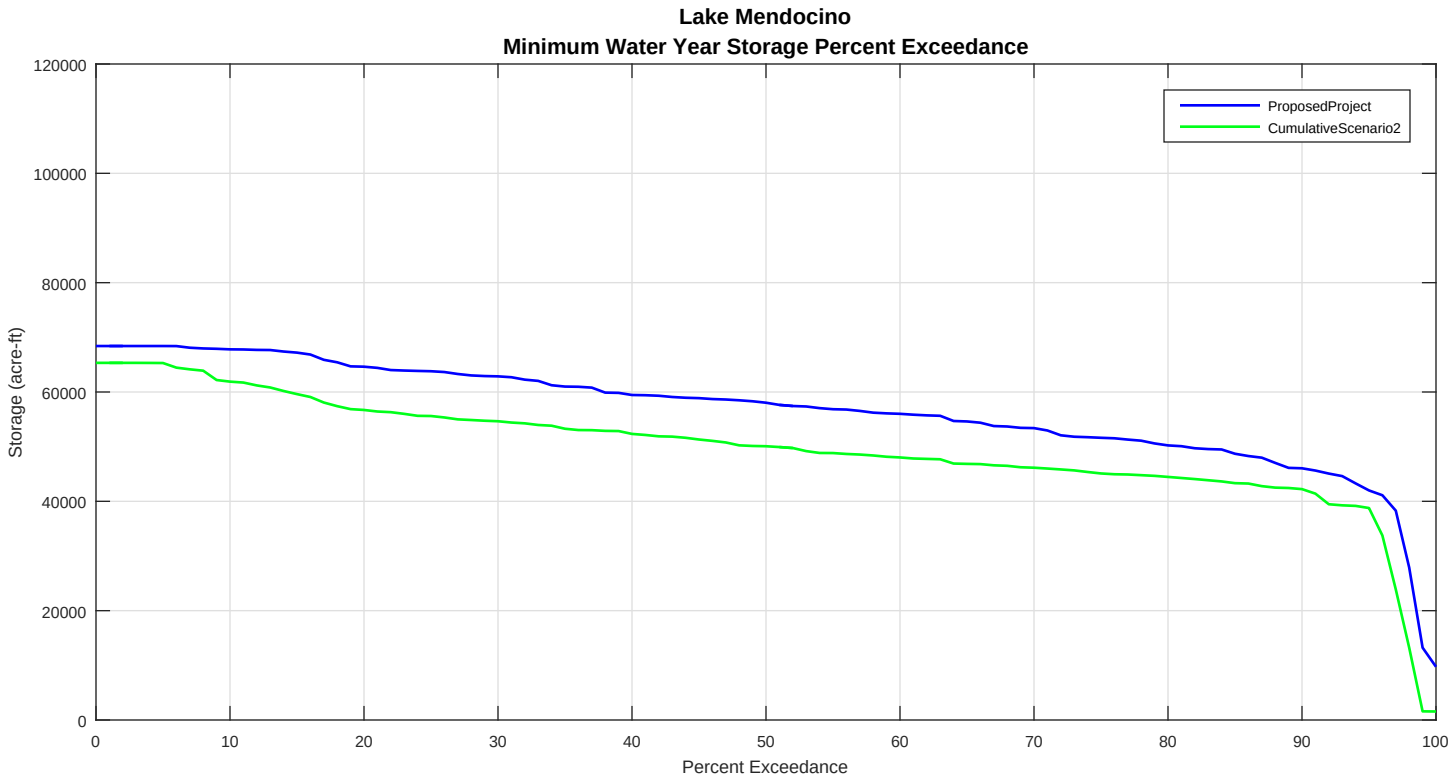
90
100


Lake Mendocino
Minimum Water Year Storage Percent Exceedance
ProposedProject
CumulativeScenario2
Storage (acre-ft)
Percent Exceedance
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20000
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60000
80000
100000
120000
0
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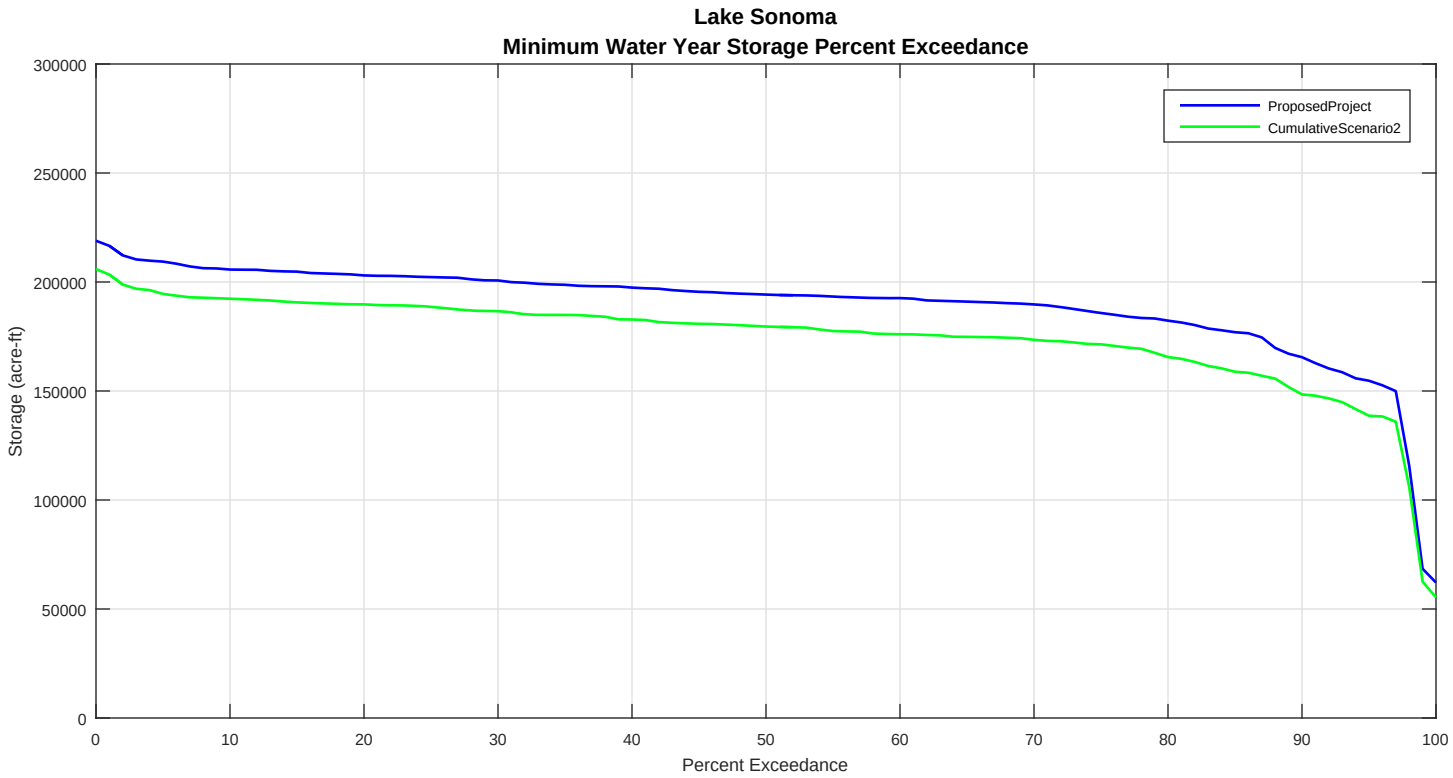
Lake Sonoma
Minimum Water Year Storage Percent Exceedance
ProposedProject
CumulativeScenario2
Storage (acre-ft)
Percent Exceedance
0
50000
100000
150000
200000
250000
300000
0
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30
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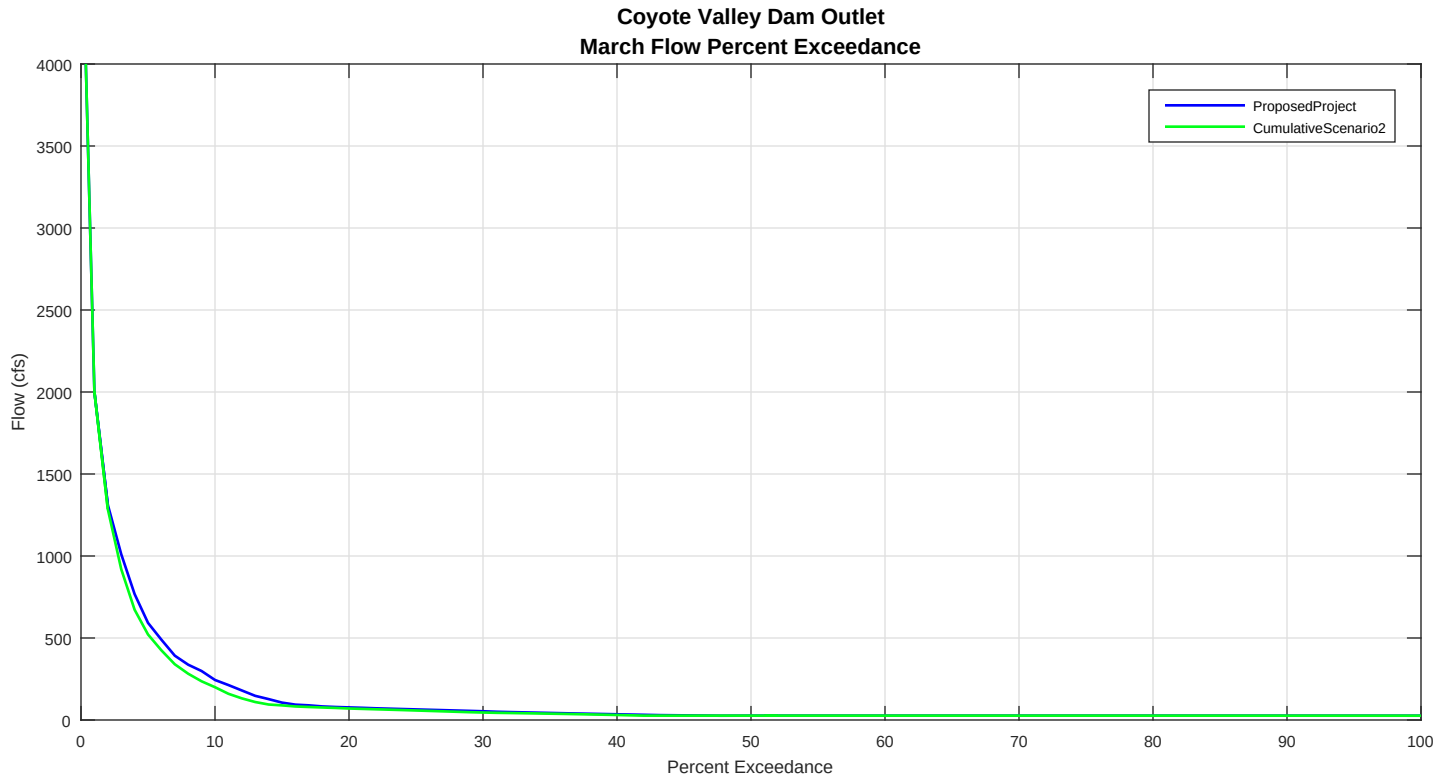
Coyote Valley Dam Outlet
March Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
500
1000
1500
2000
2500
3000
3500
4000
0
10
20
30
40
50
60
70
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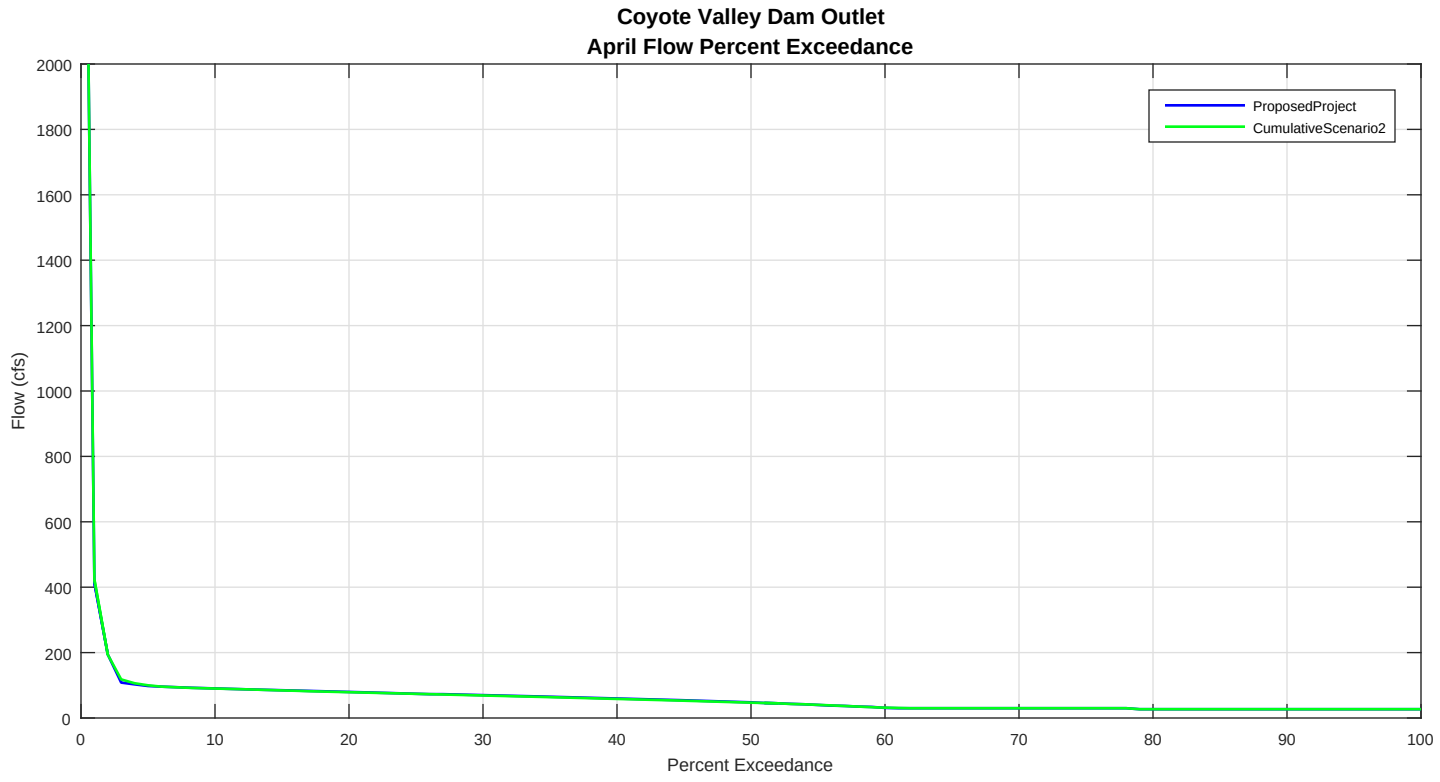
90
100


Coyote Valley Dam Outlet
April Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
200
400
600
800
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1200
1400
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1800
2000
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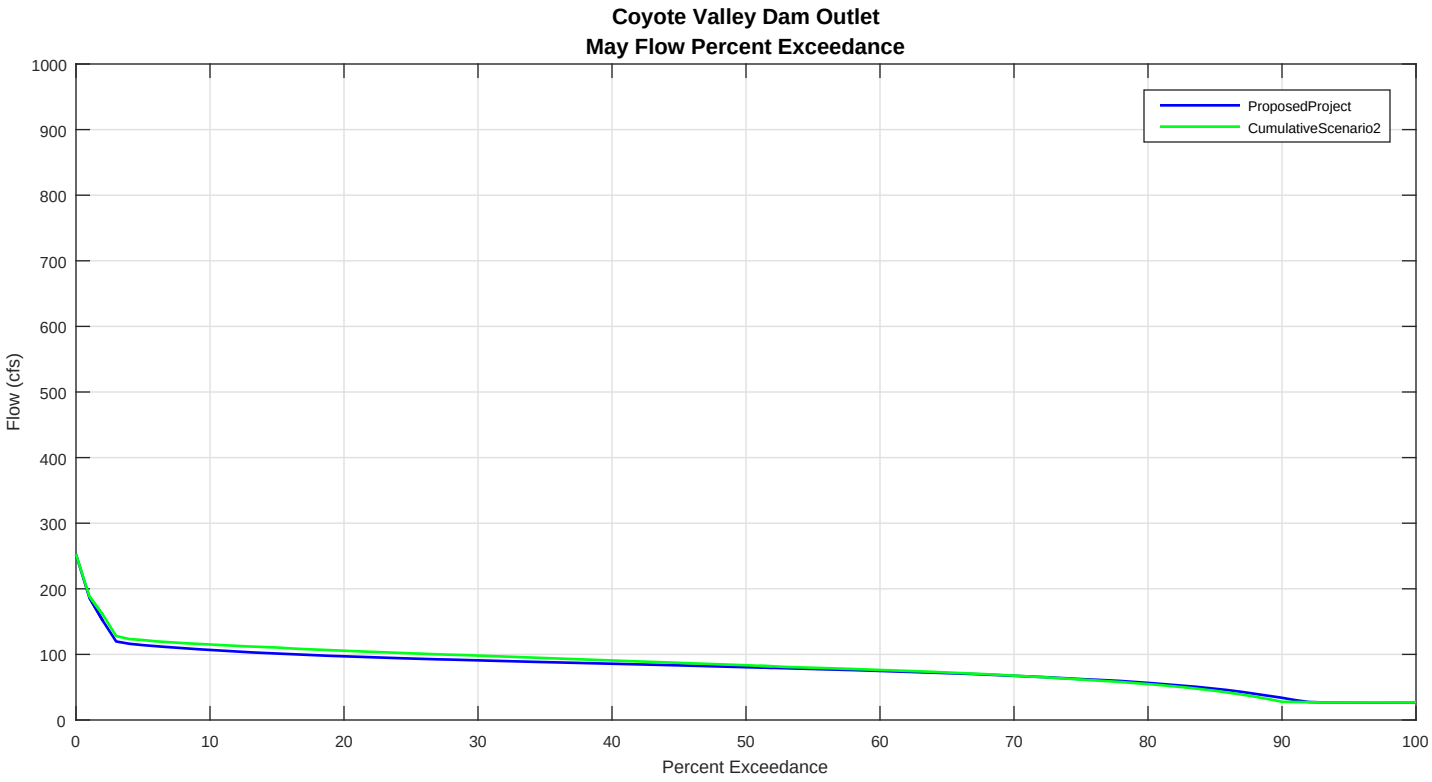
Coyote Valley Dam Outlet
May Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
100
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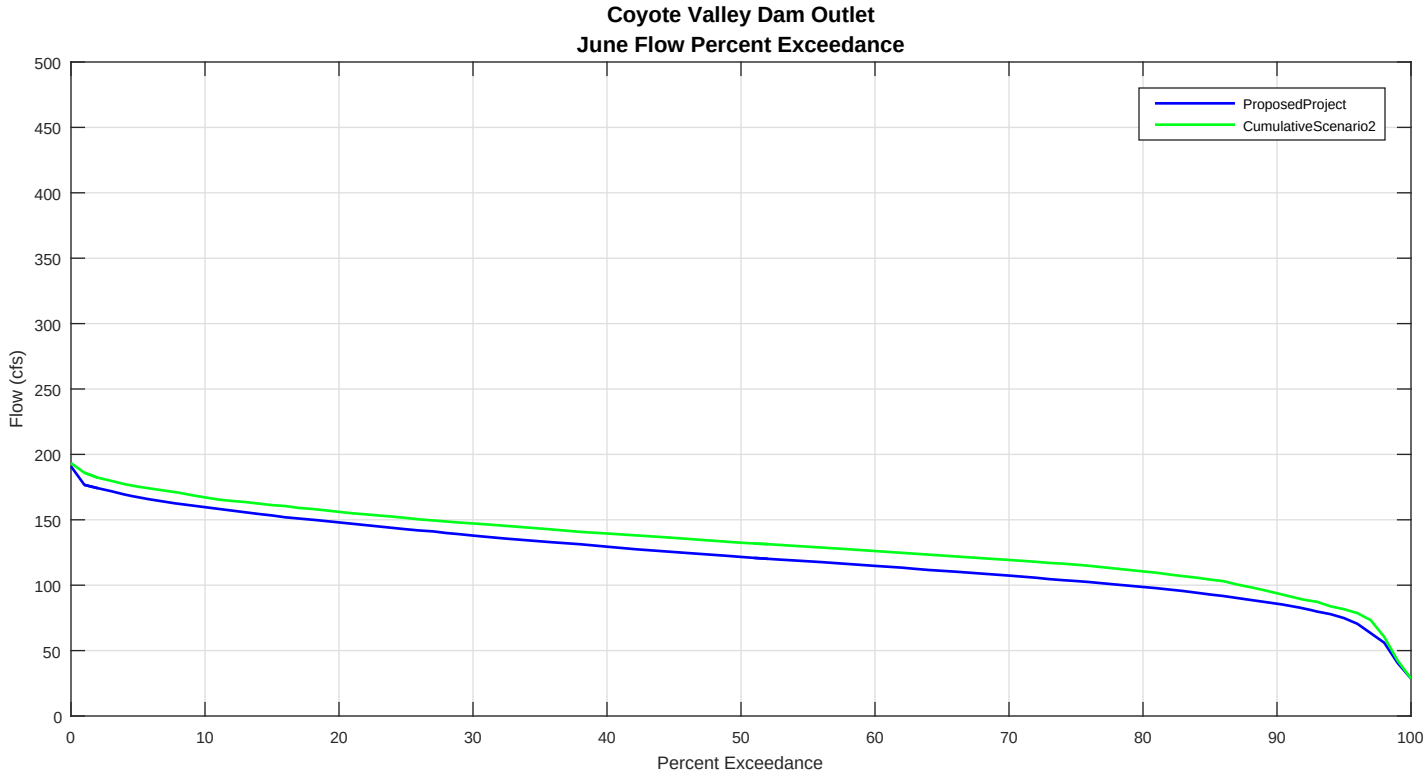
Coyote Valley Dam Outlet
June Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
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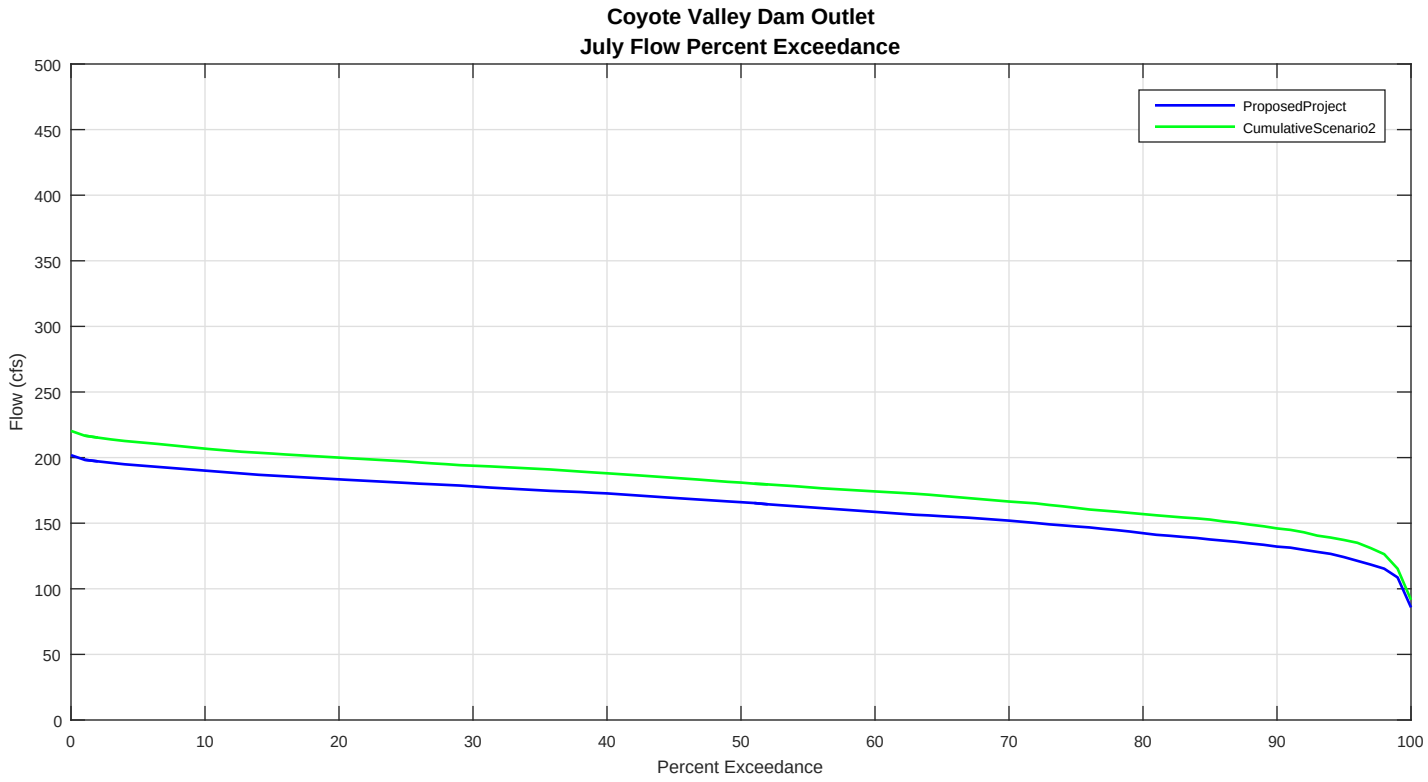
Coyote Valley Dam Outlet
July Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
50
100
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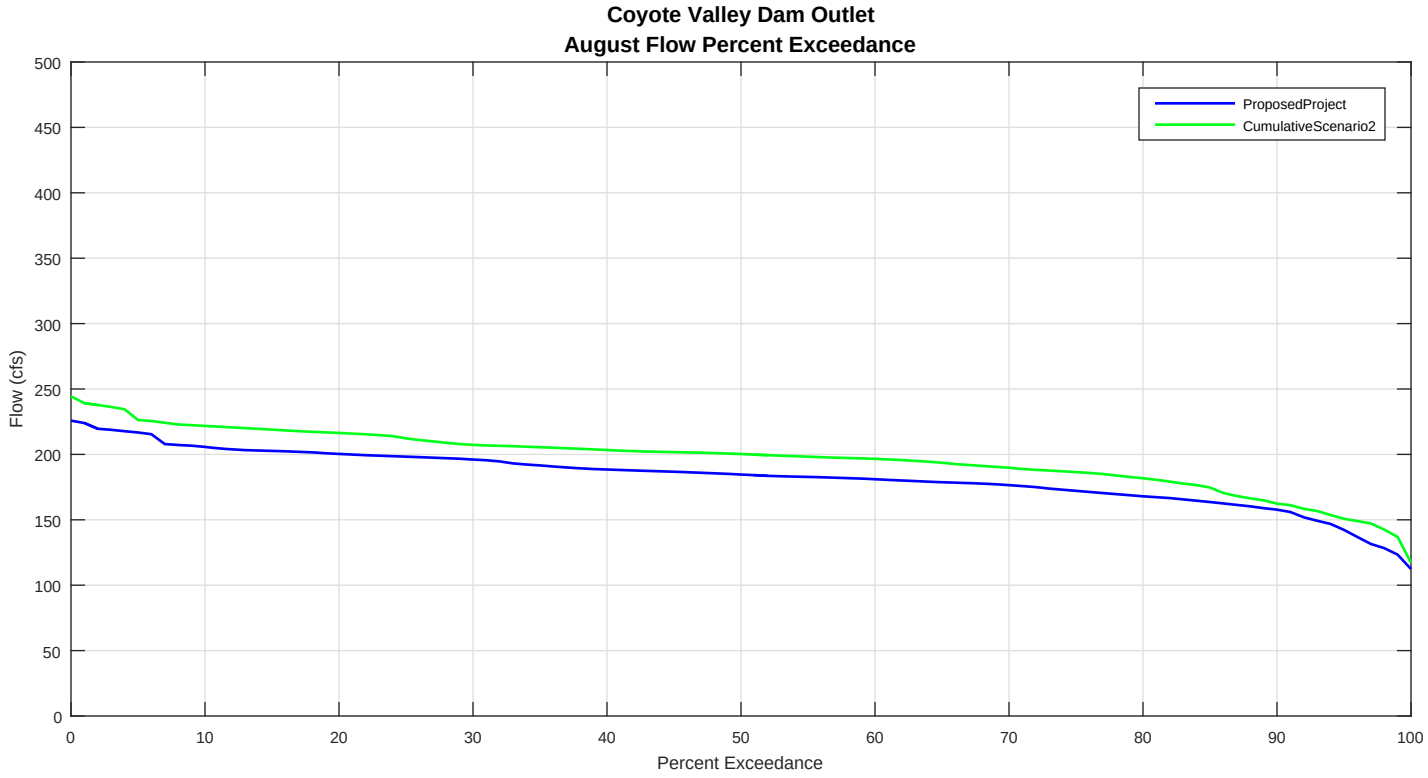
Coyote Valley Dam Outlet
August Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
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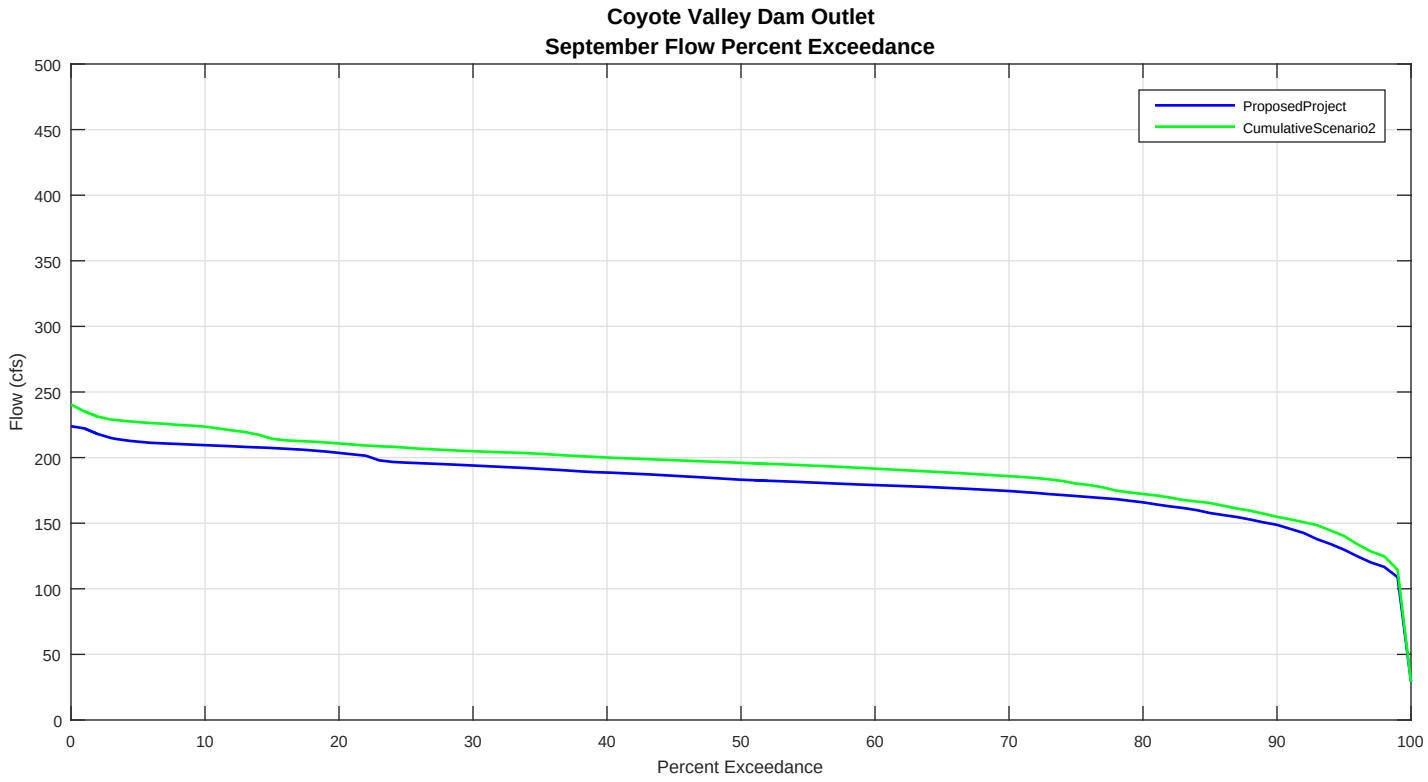
Coyote Valley Dam Outlet
September Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
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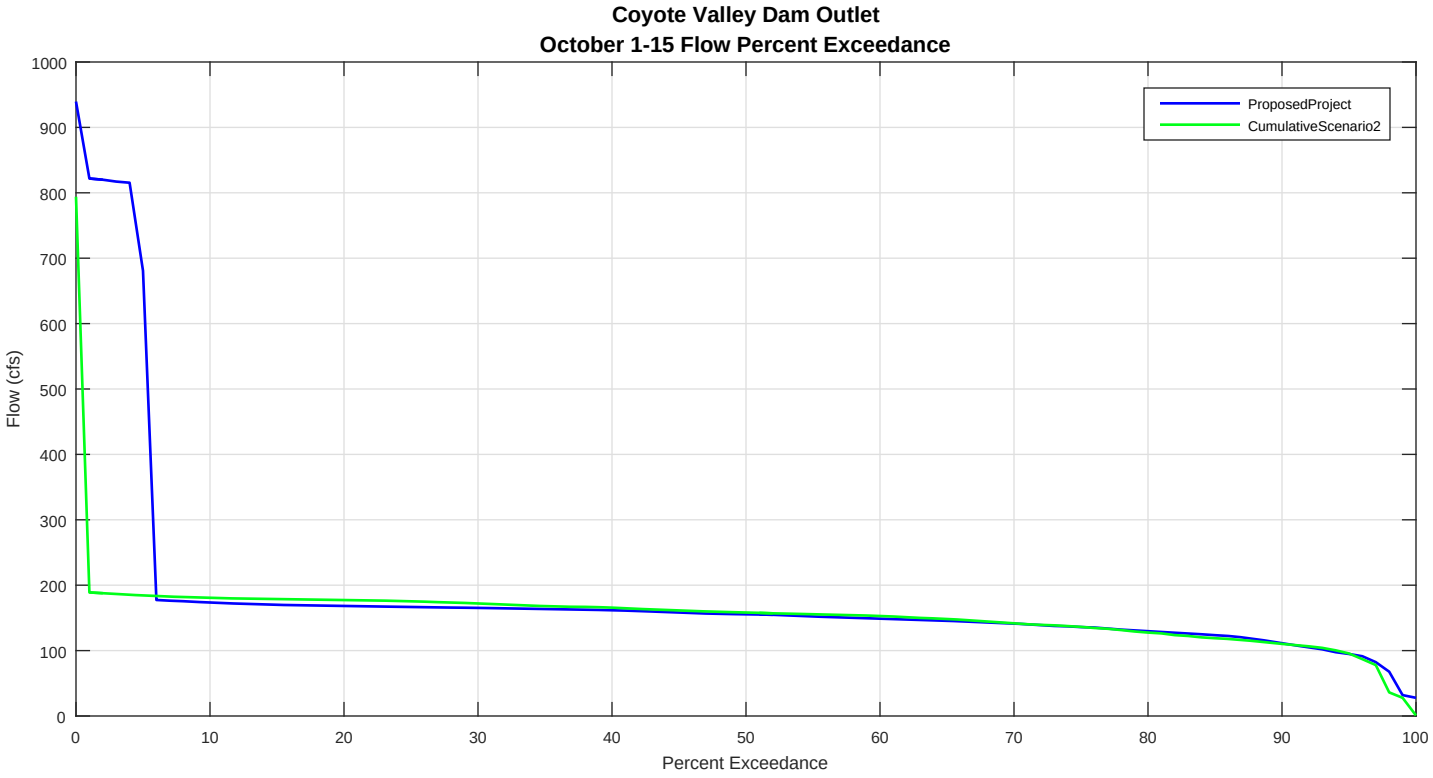
Coyote Valley Dam Outlet
October 1-15 Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
100
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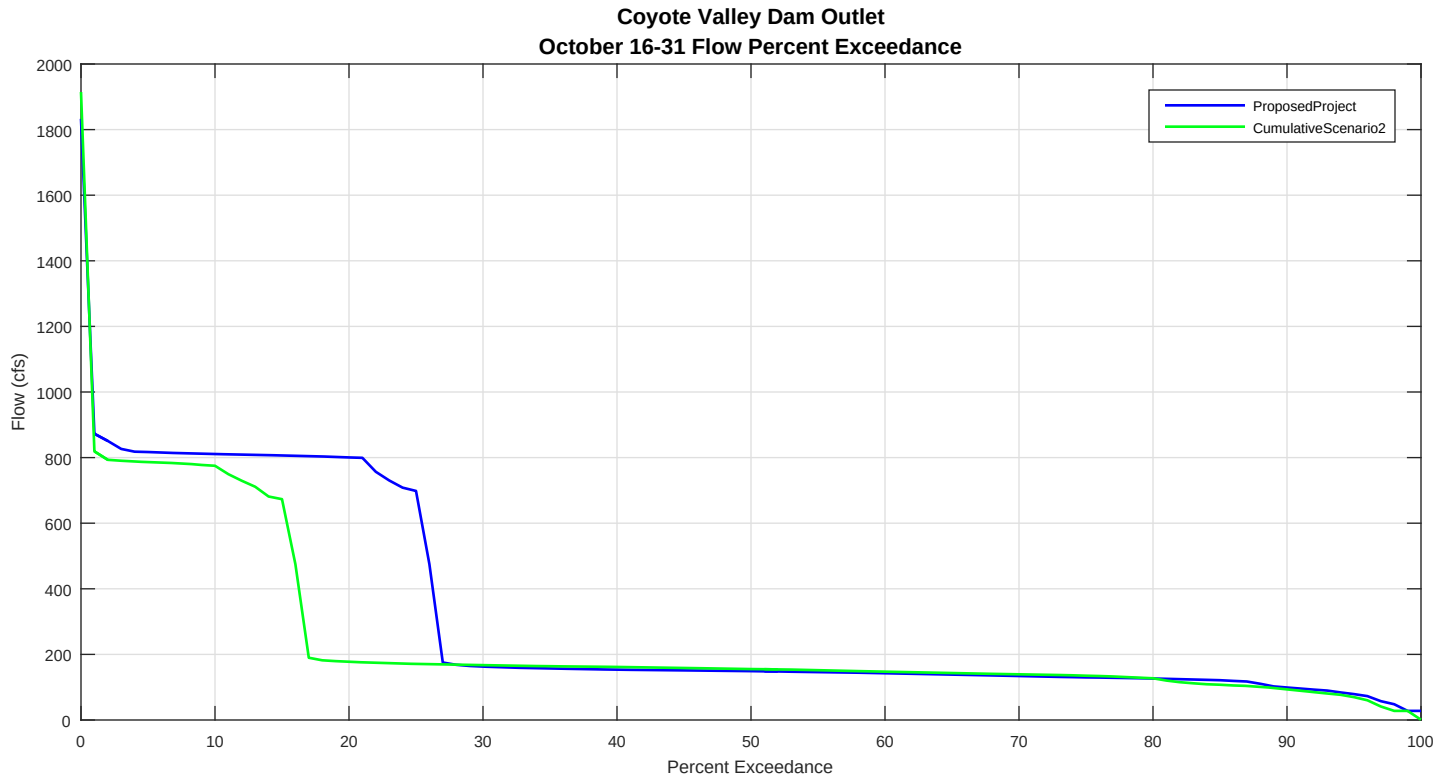
Coyote Valley Dam Outlet
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
200
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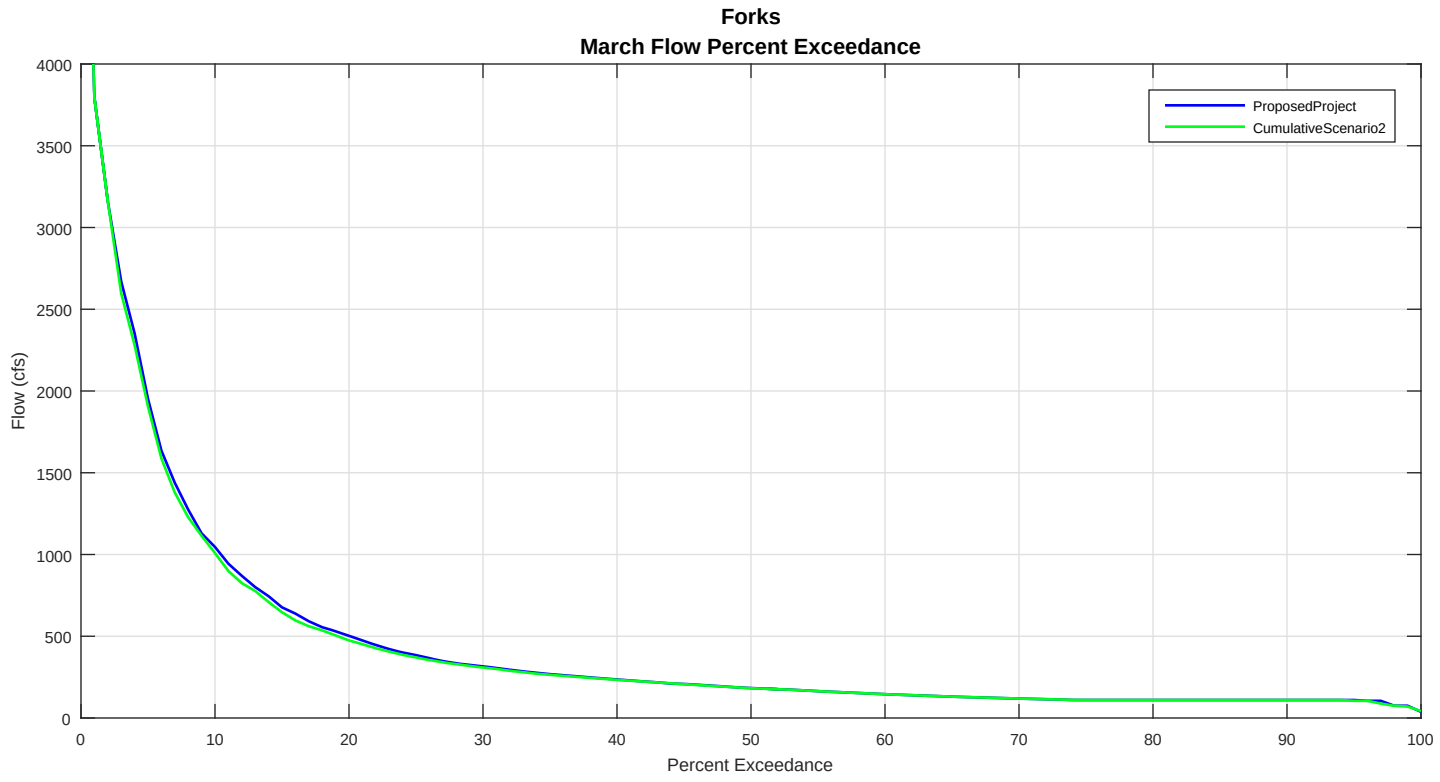
Forks
March Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
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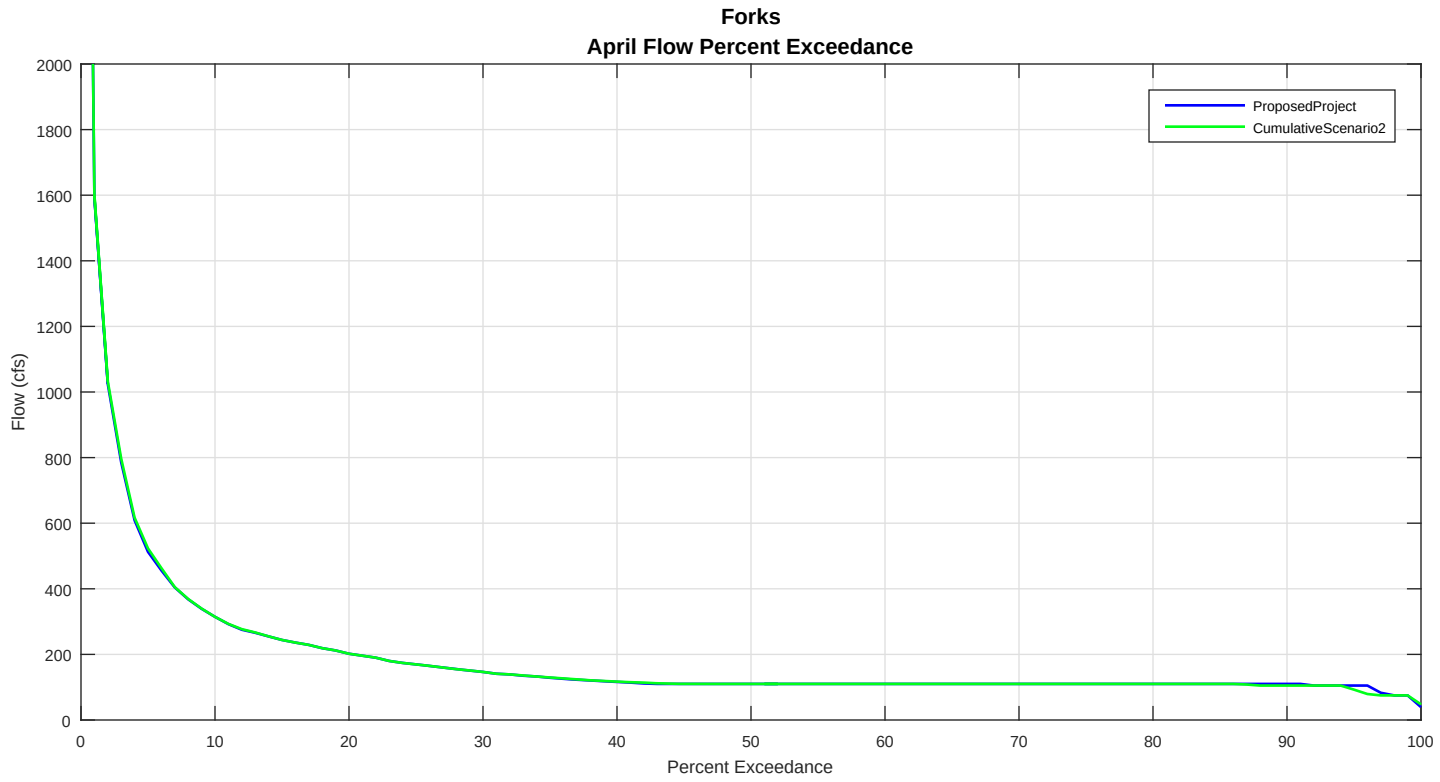
Forks
April Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
200
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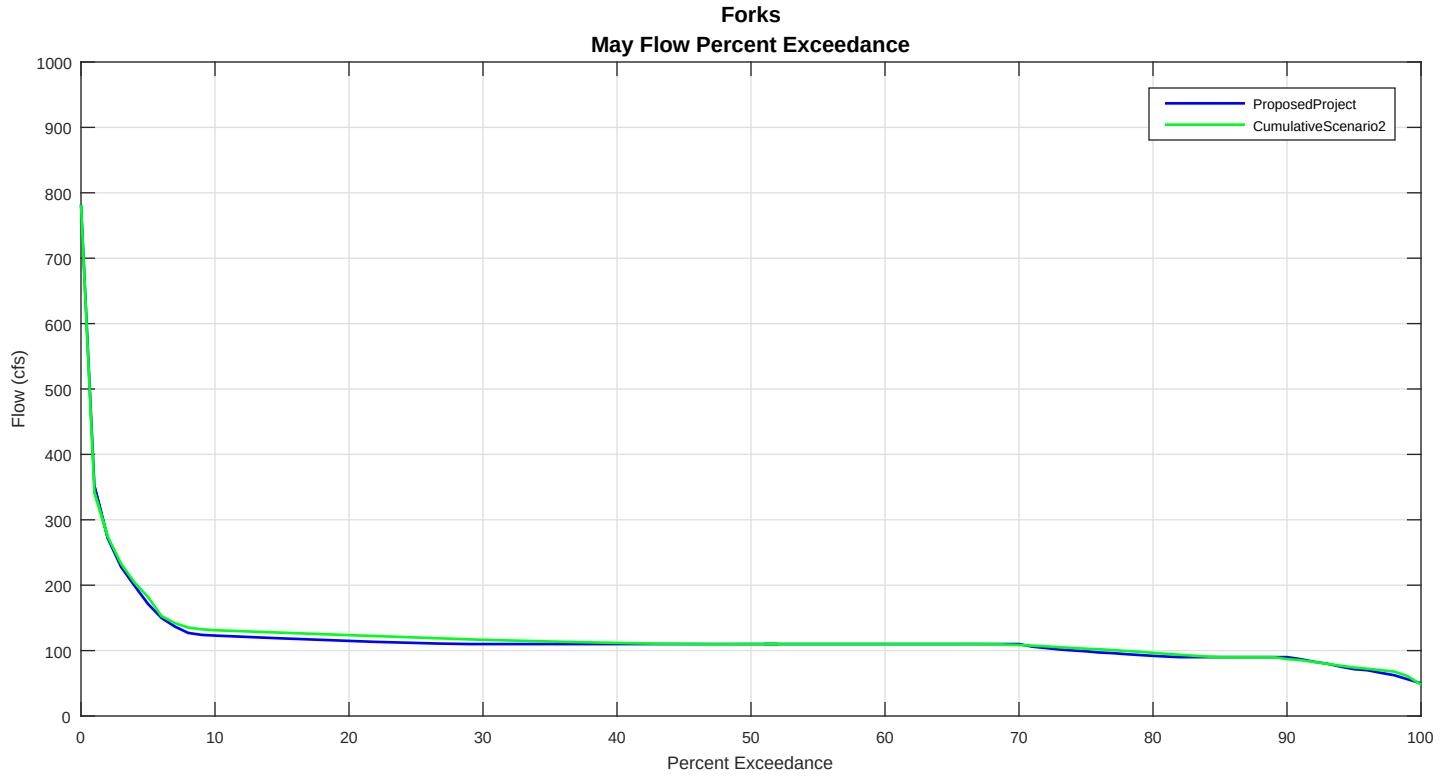
Forks
May Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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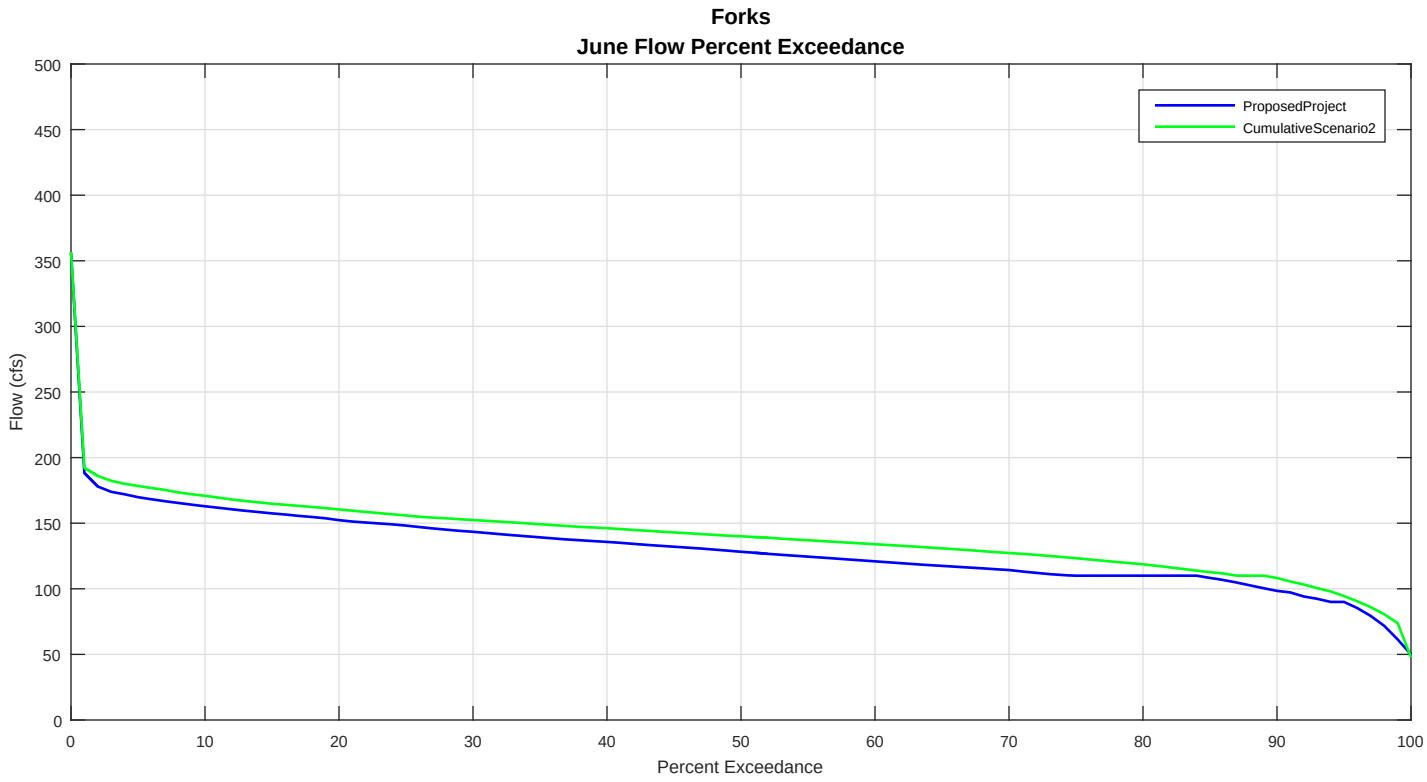
Forks
June Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
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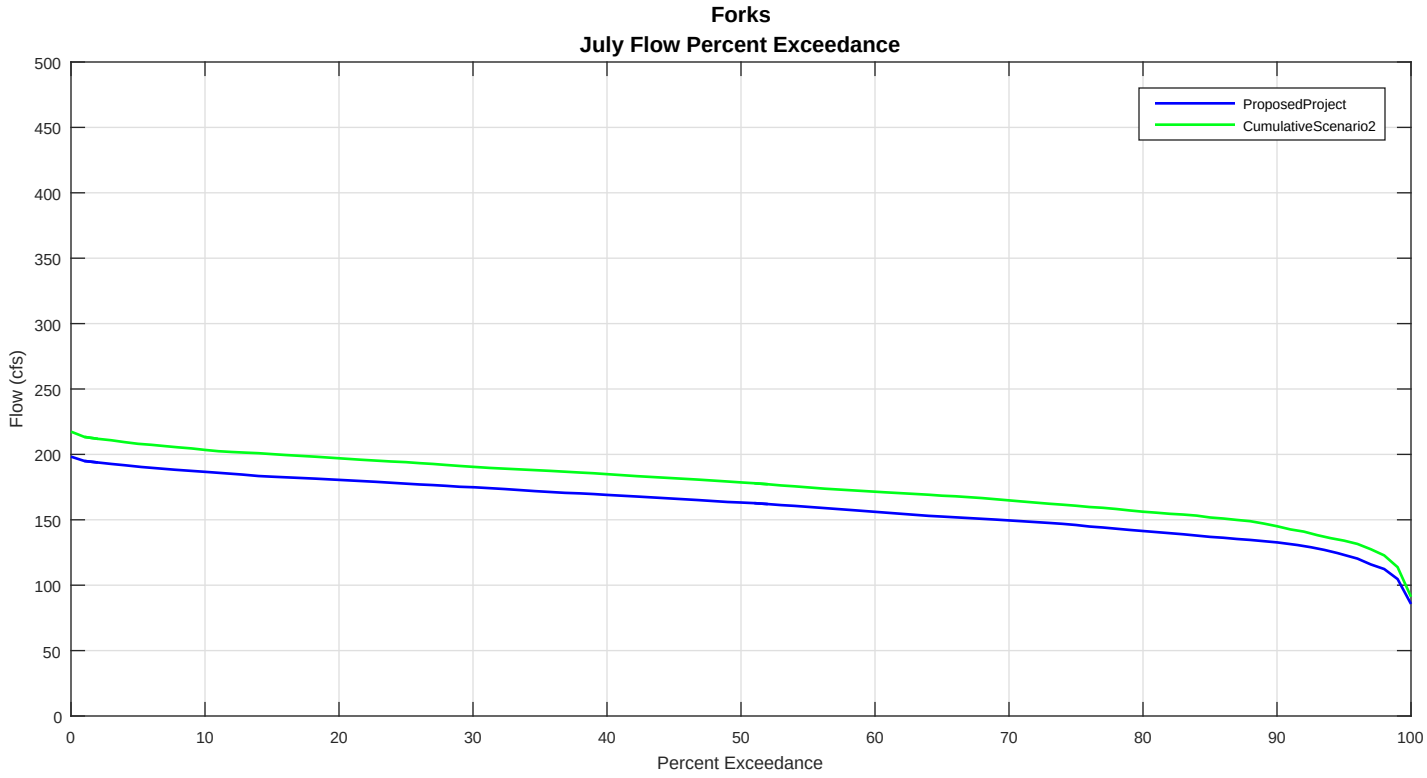
Forks
July Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
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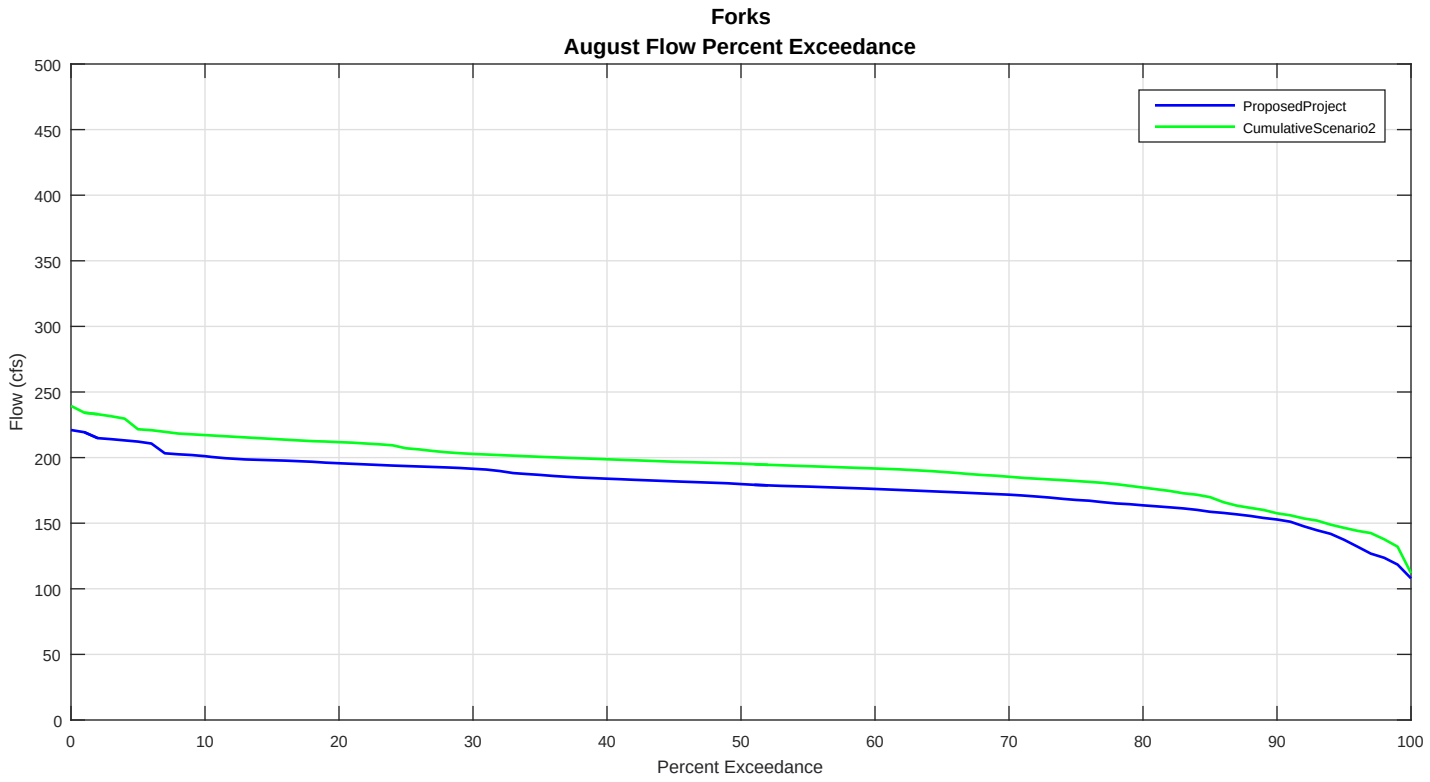
Forks
August Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
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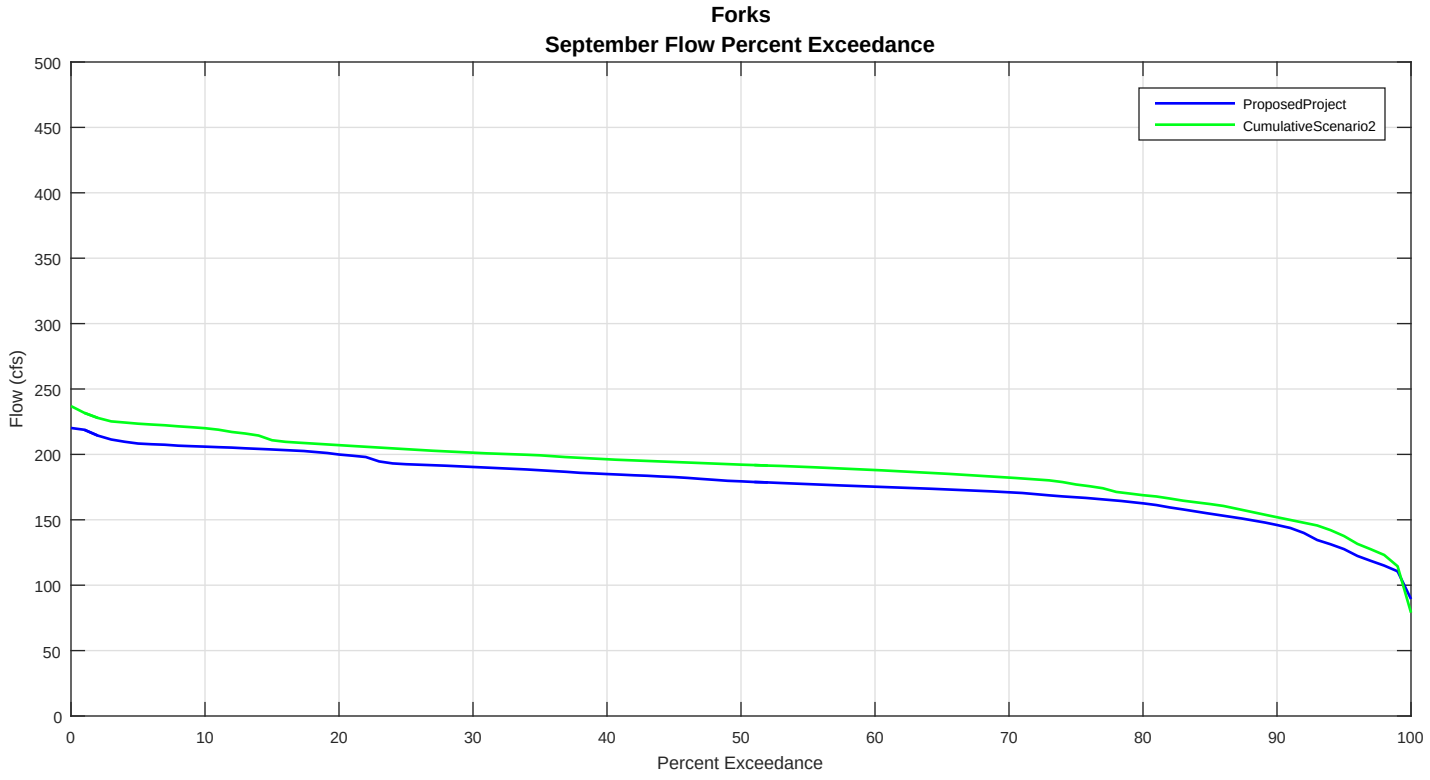
Forks
September Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
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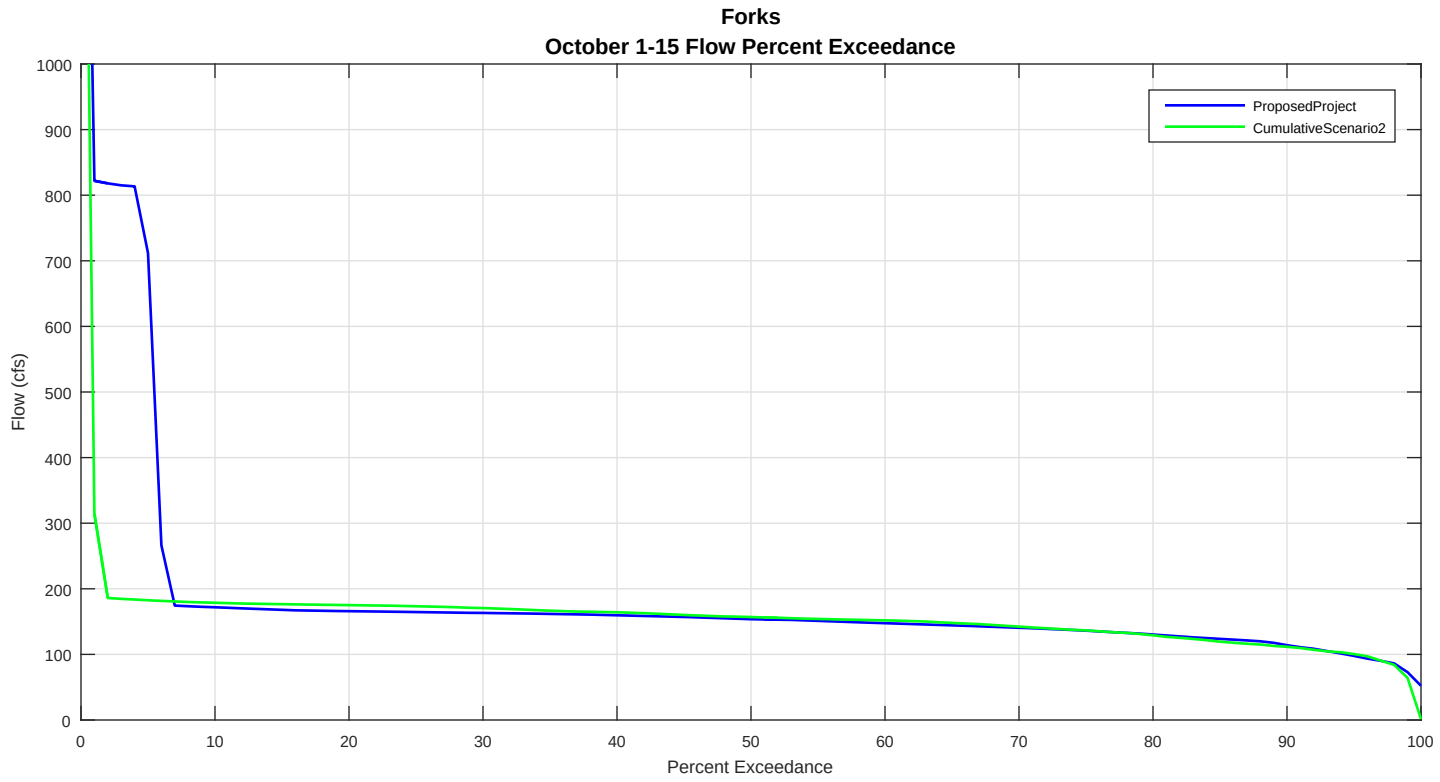
Forks
October 1-15 Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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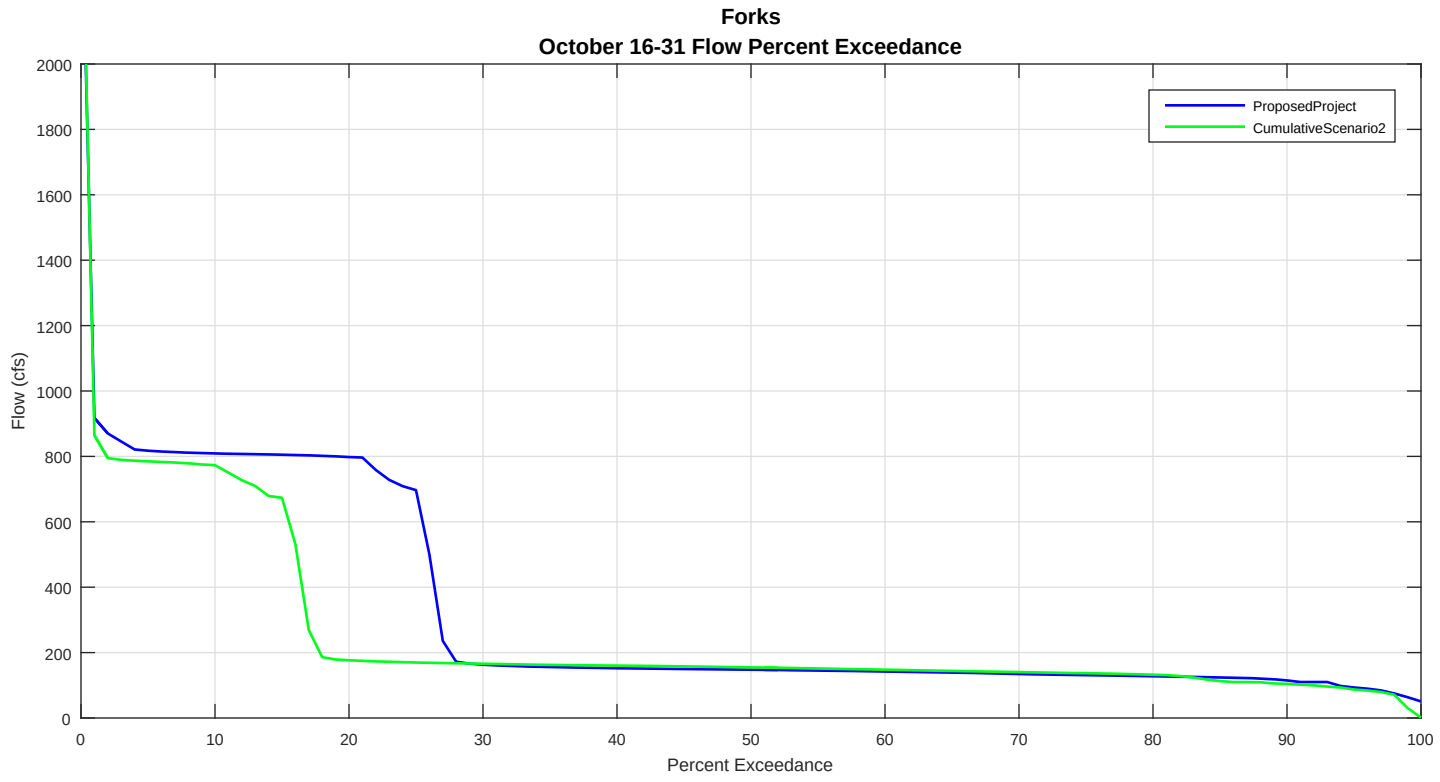
Forks
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
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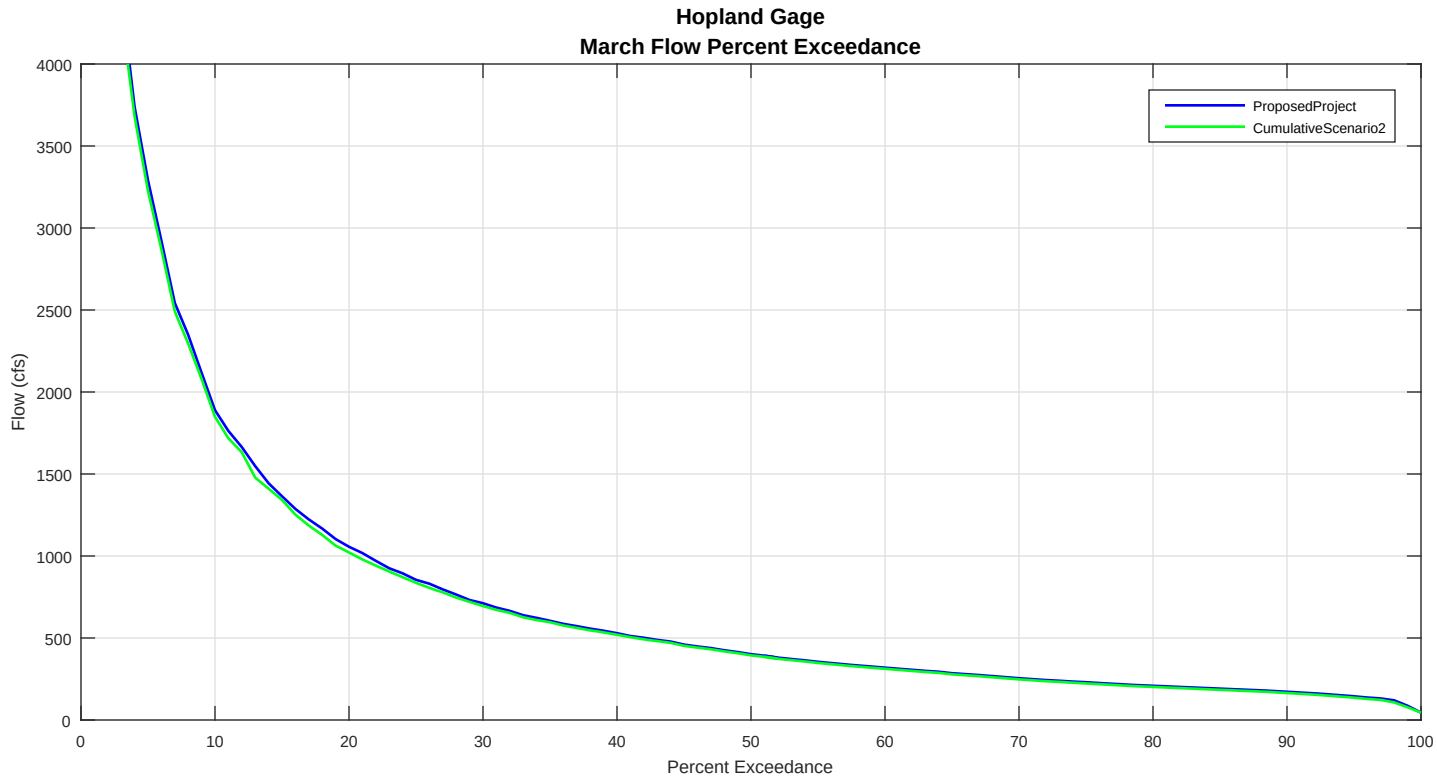
Hopland Gage
March Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
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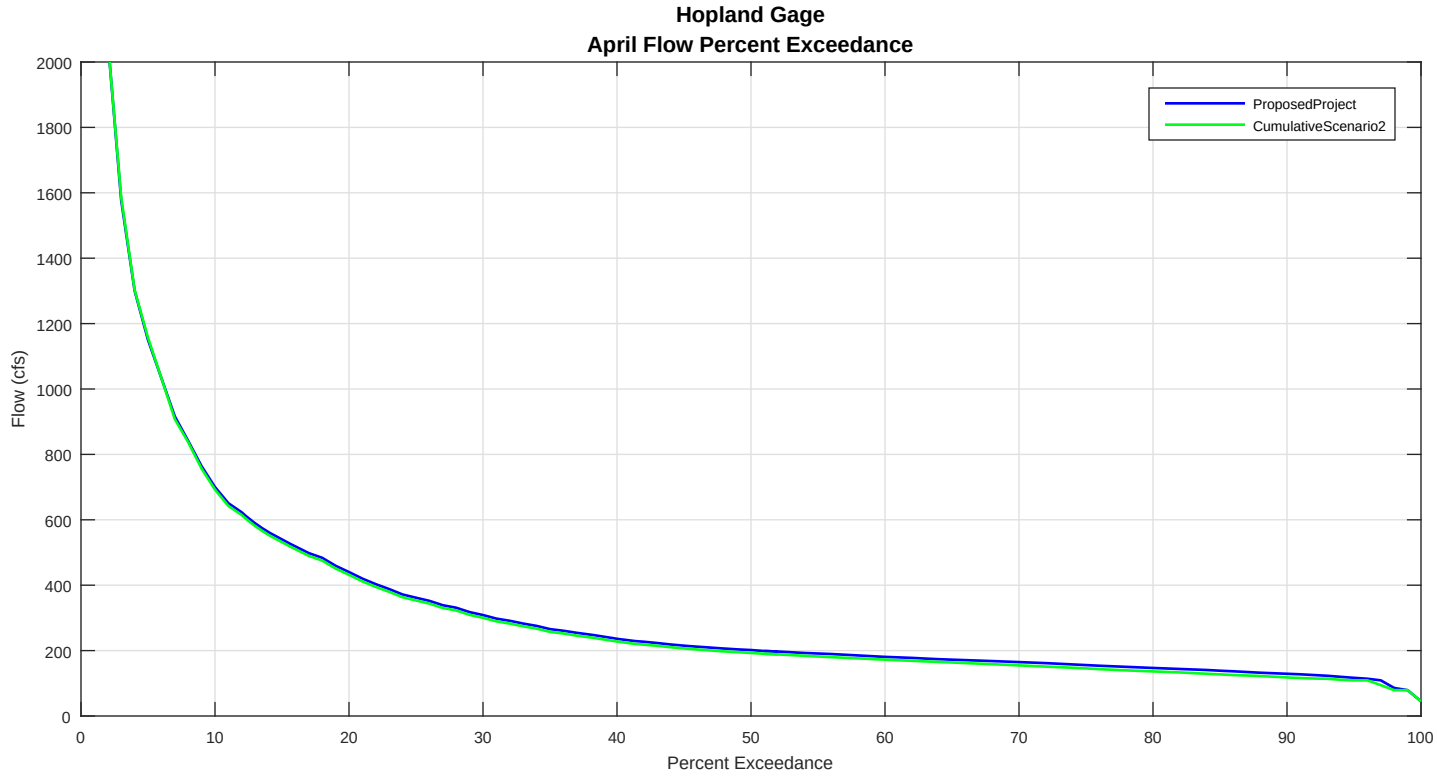
Hopland Gage
April Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
200
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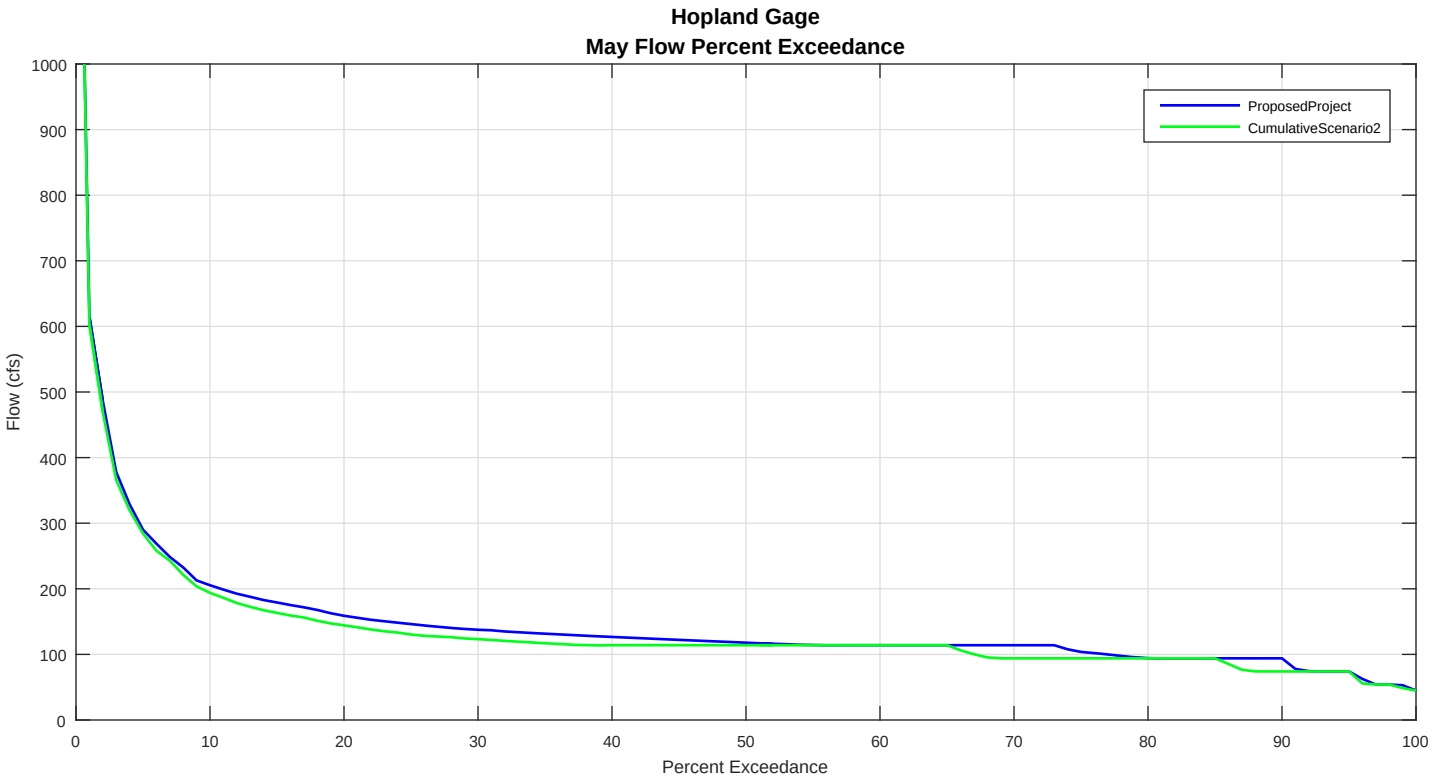
Hopland Gage
May Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario2
0
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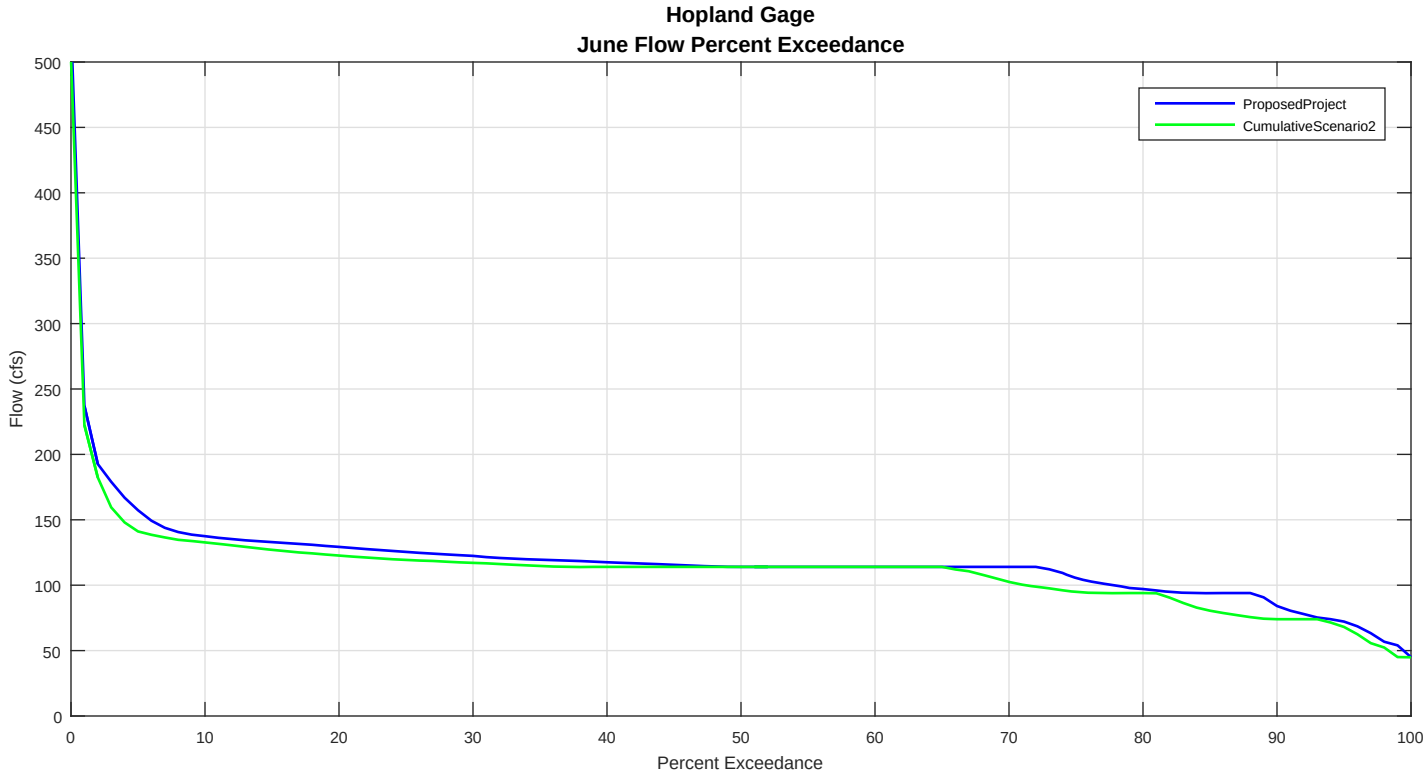
Hopland Gage
June Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario2
0
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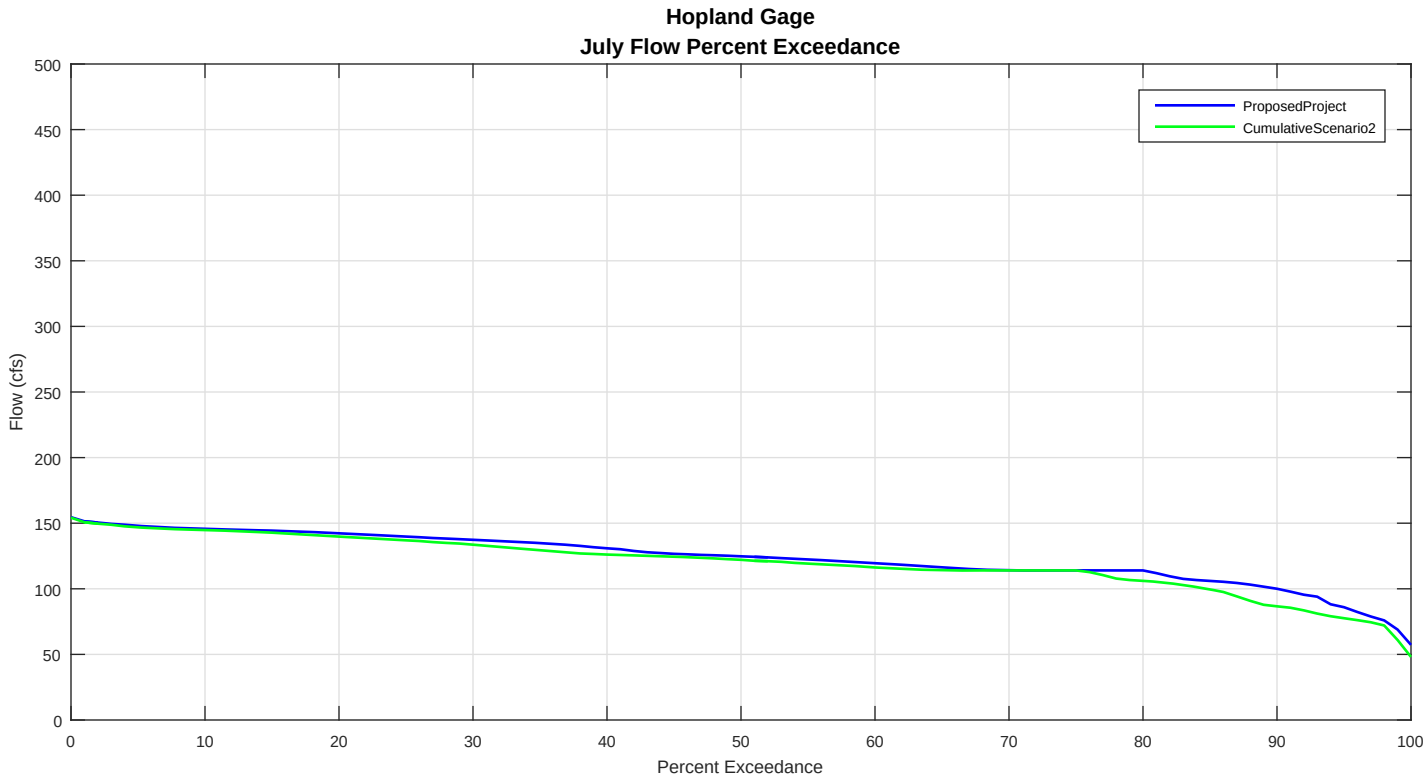
Hopland Gage
July Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
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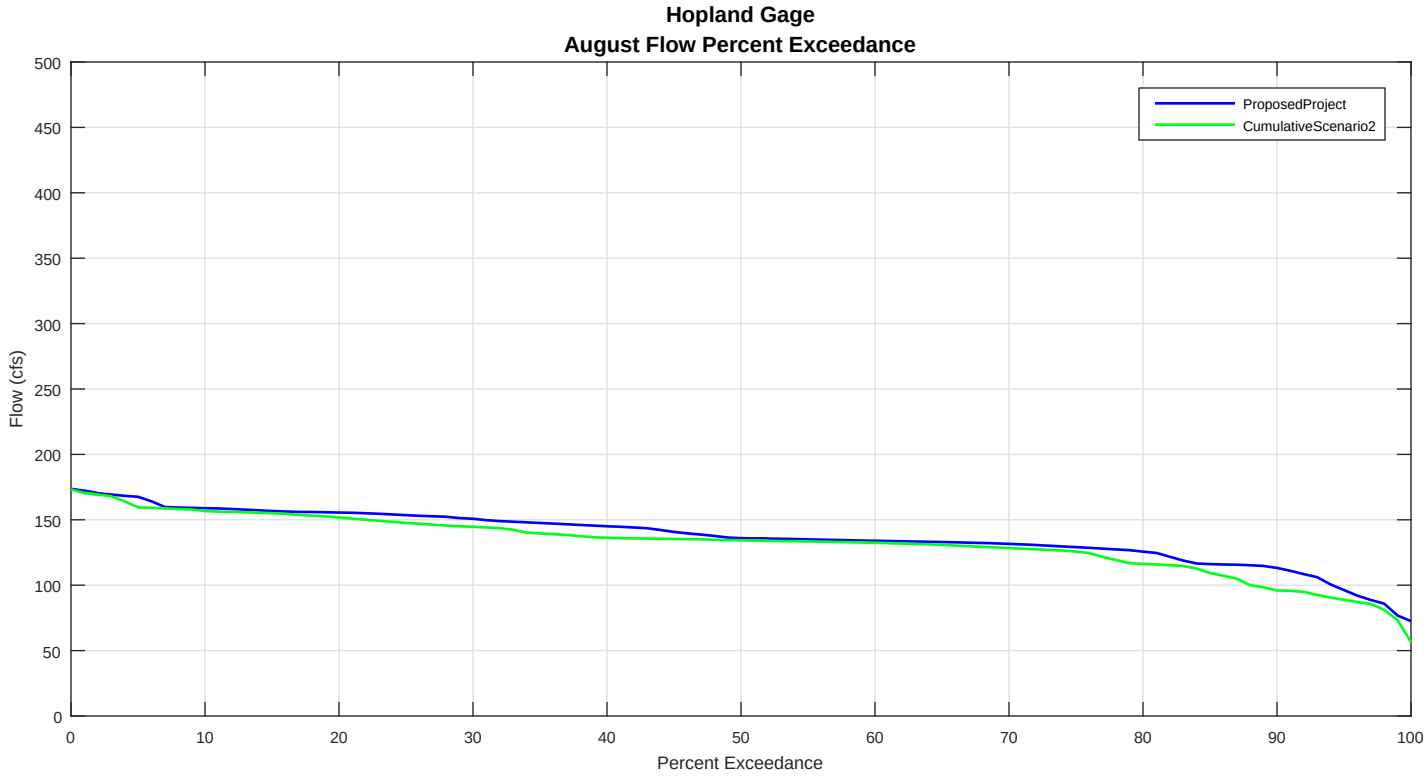
Hopland Gage
August Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
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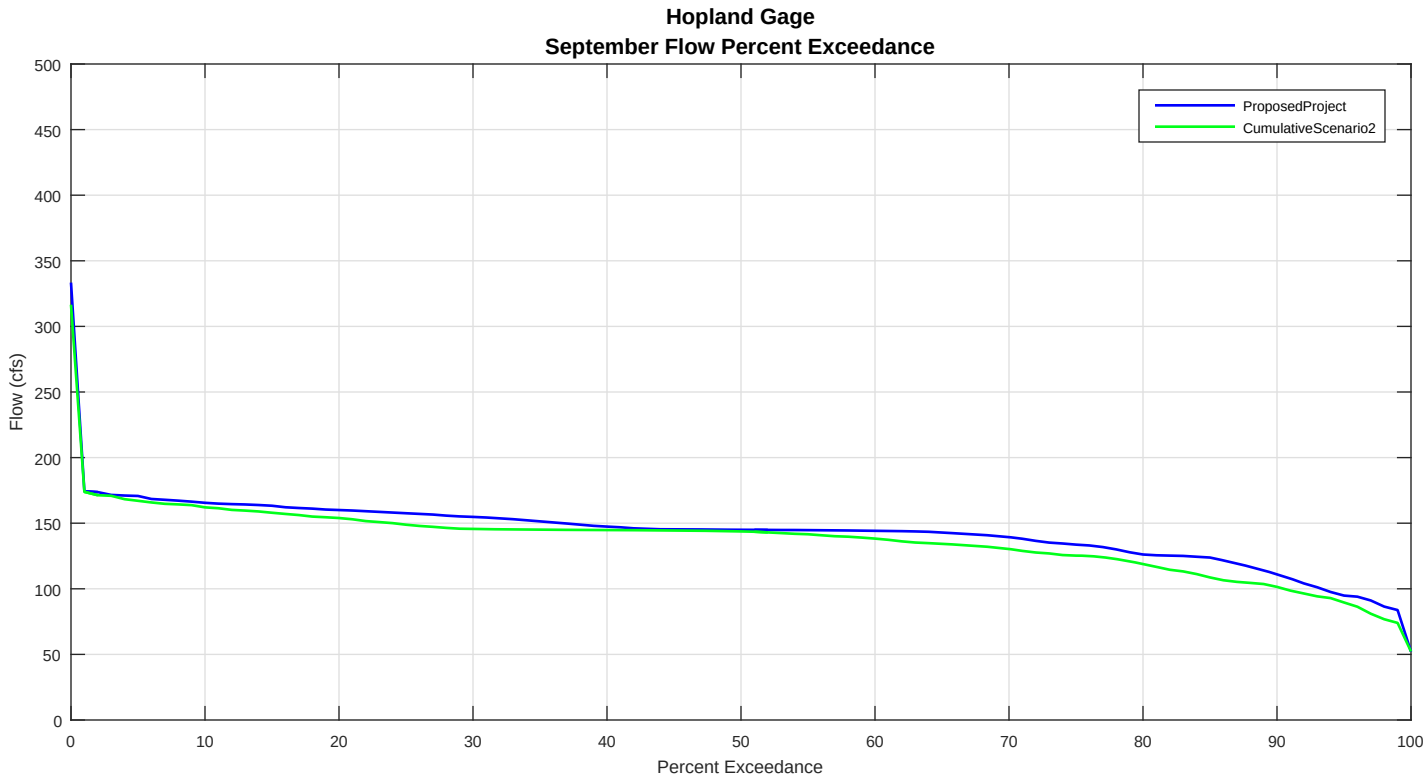
Hopland Gage
September Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
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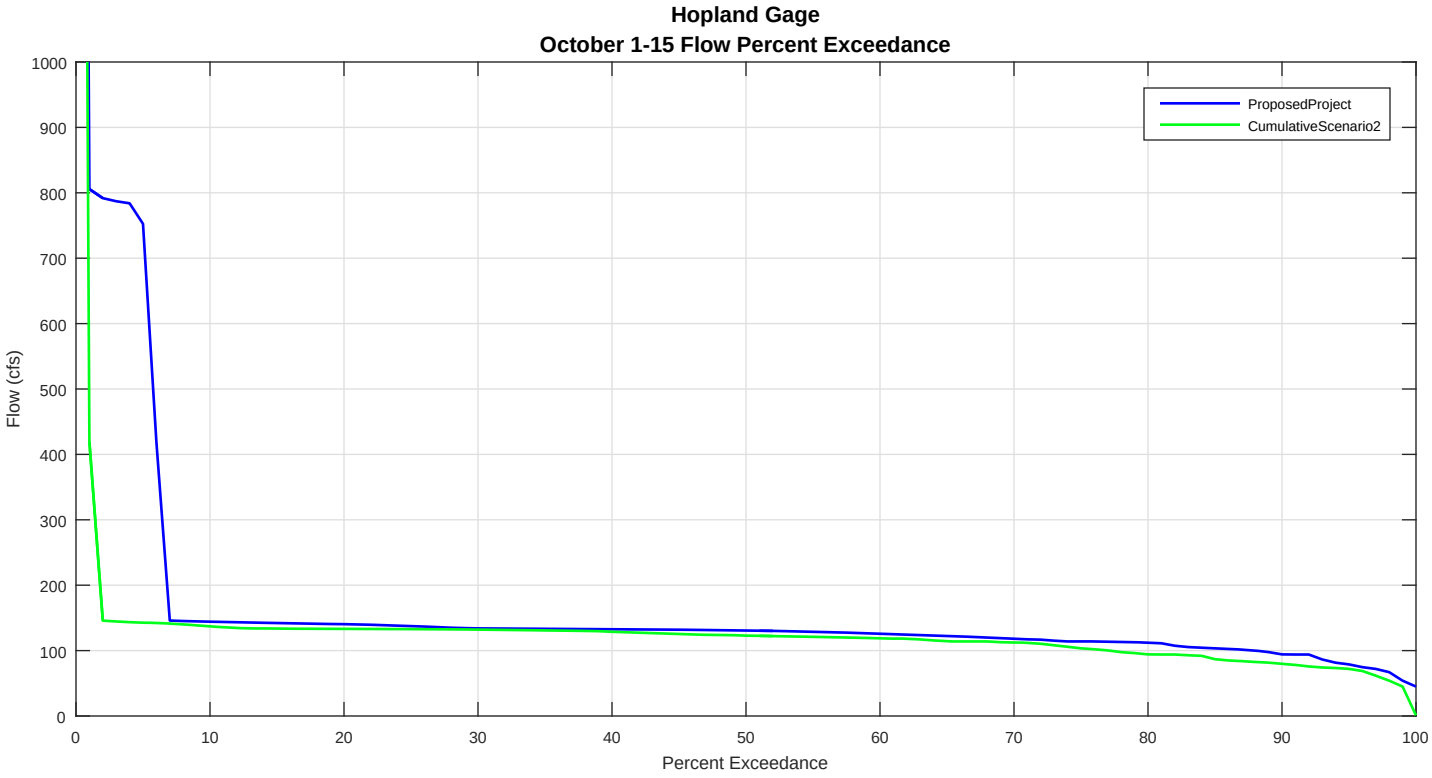
Hopland Gage
October 1-15 Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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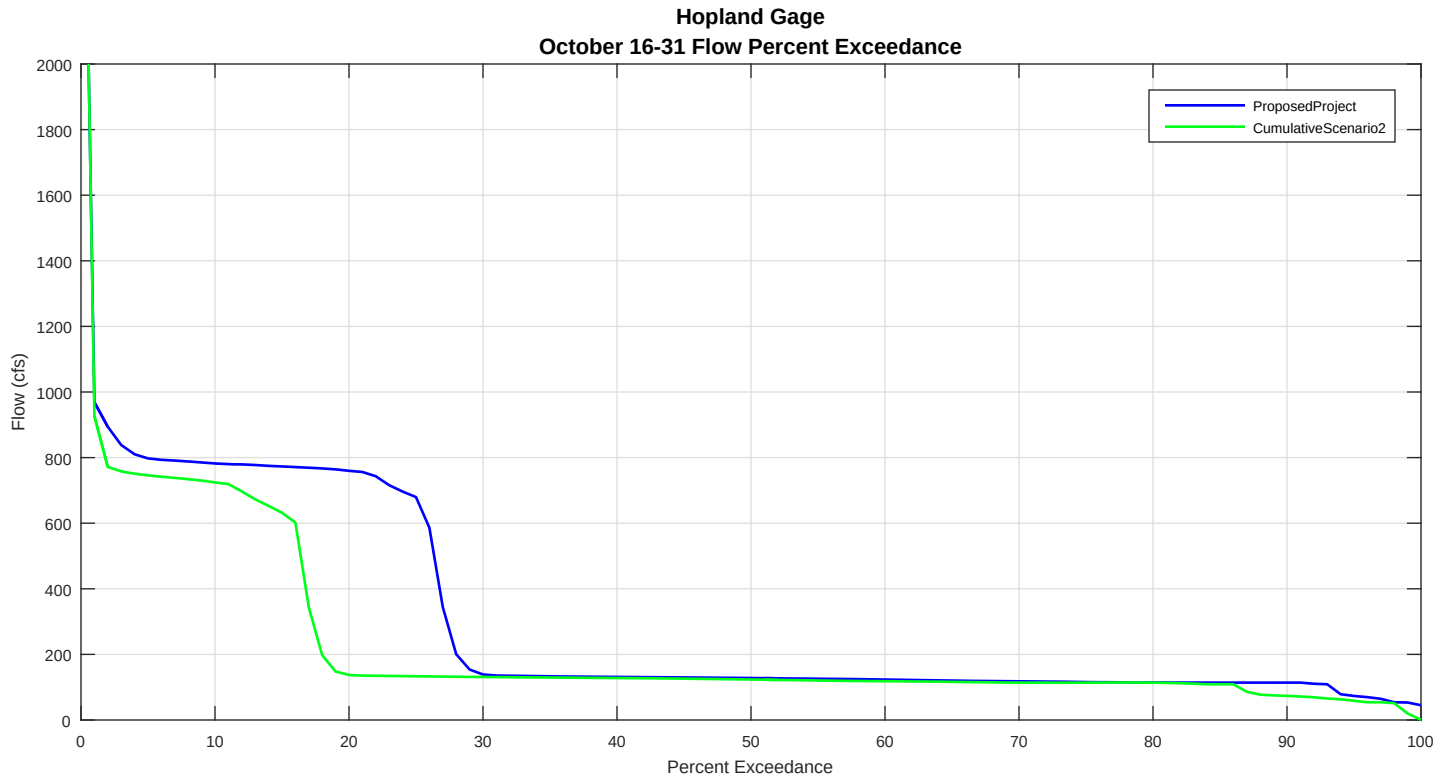
Hopland Gage
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
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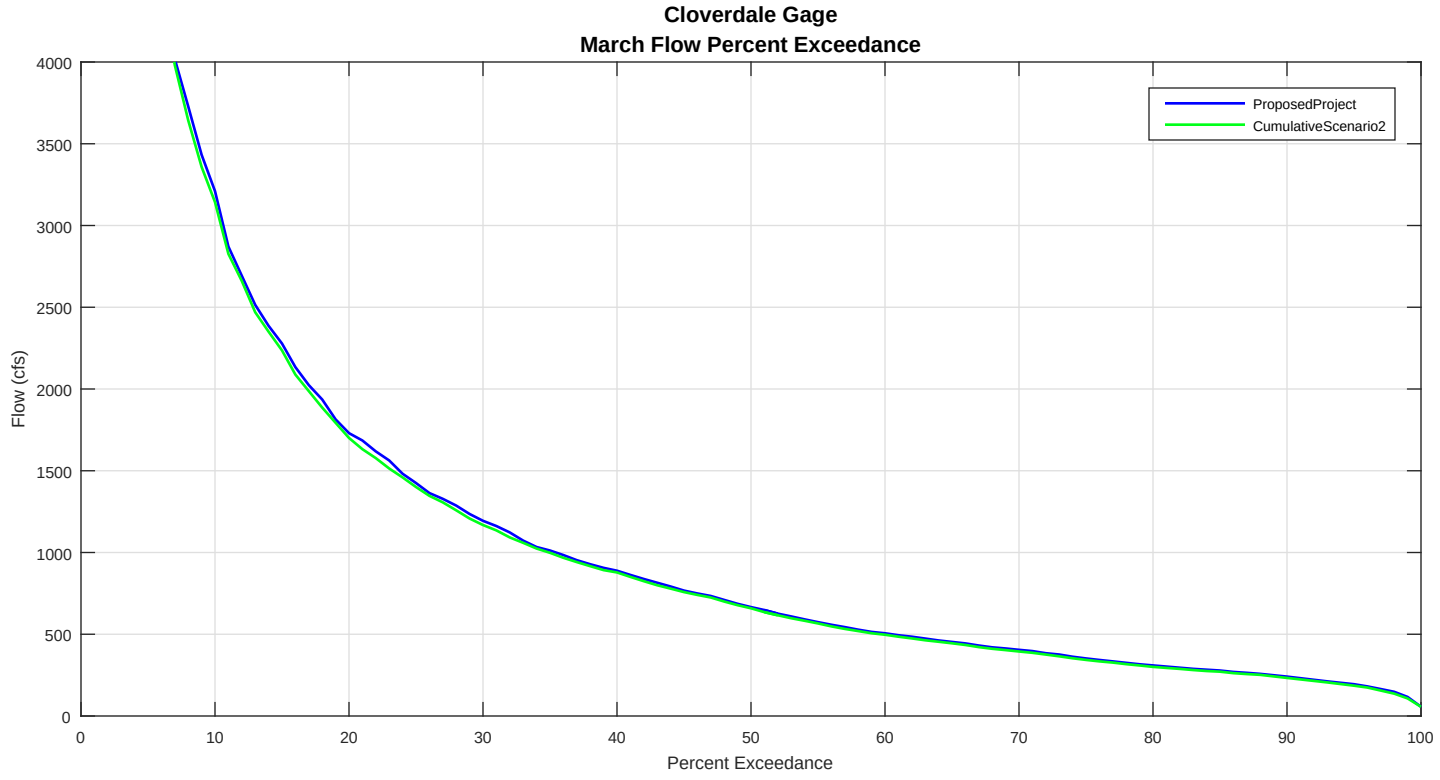
Cloverdale Gage
March Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
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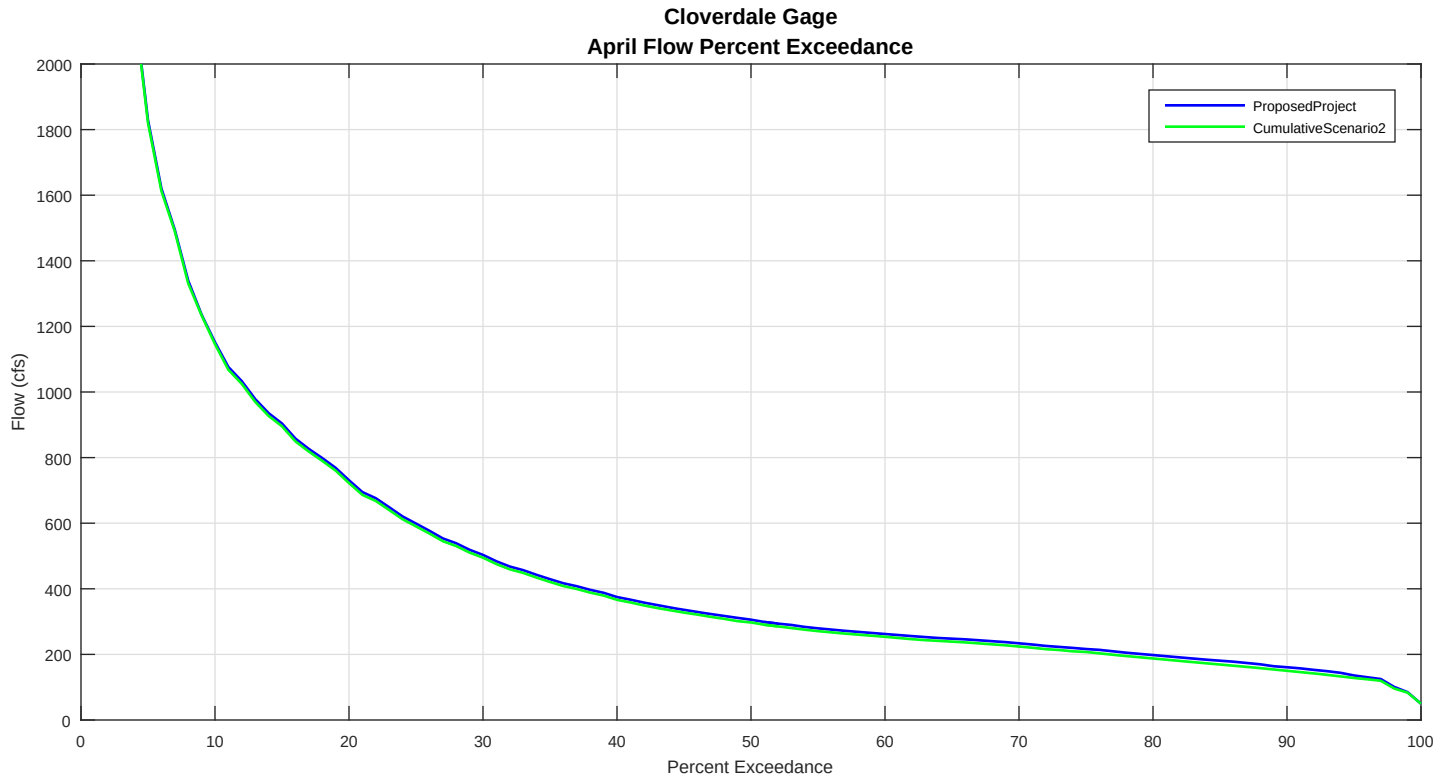
Cloverdale Gage
April Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
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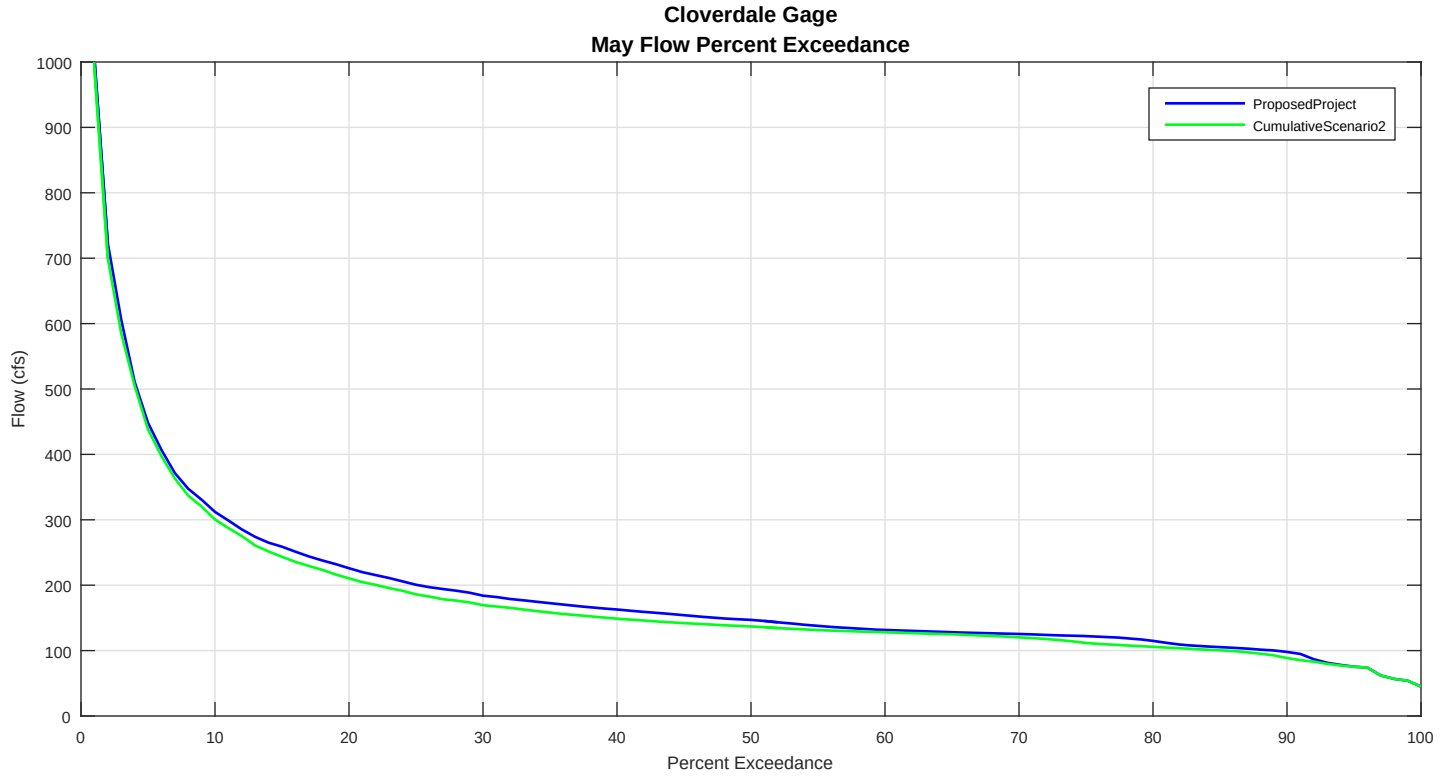
Cloverdale Gage
May Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
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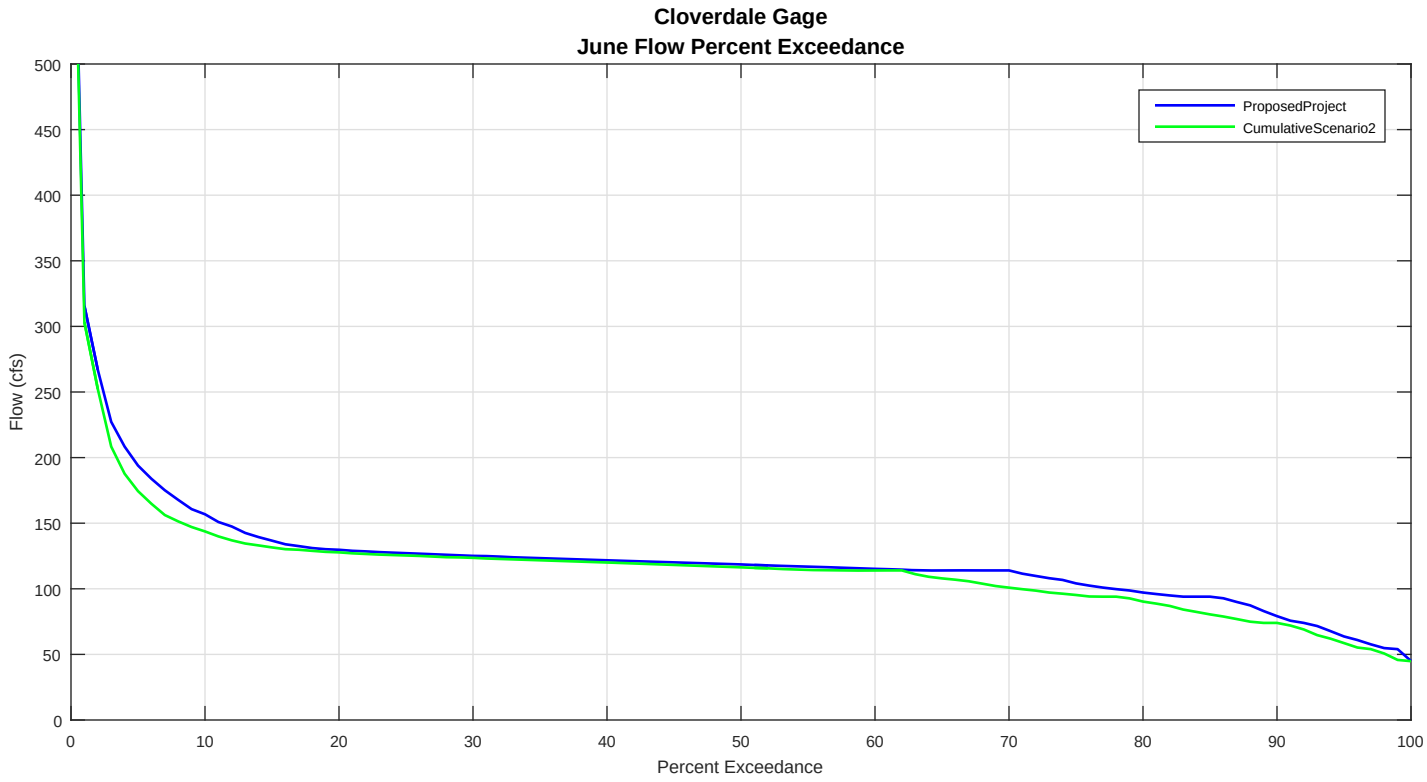
Cloverdale Gage
June Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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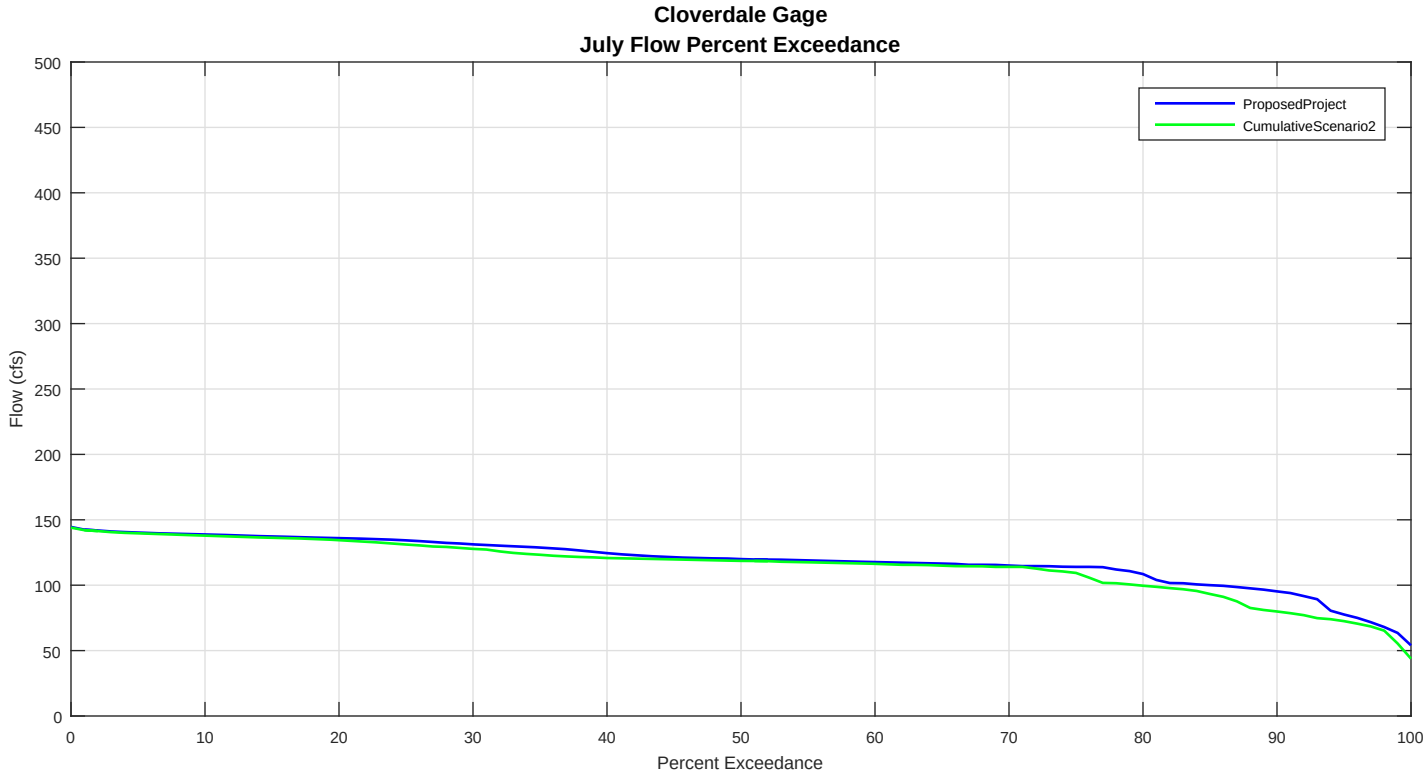
Cloverdale Gage
July Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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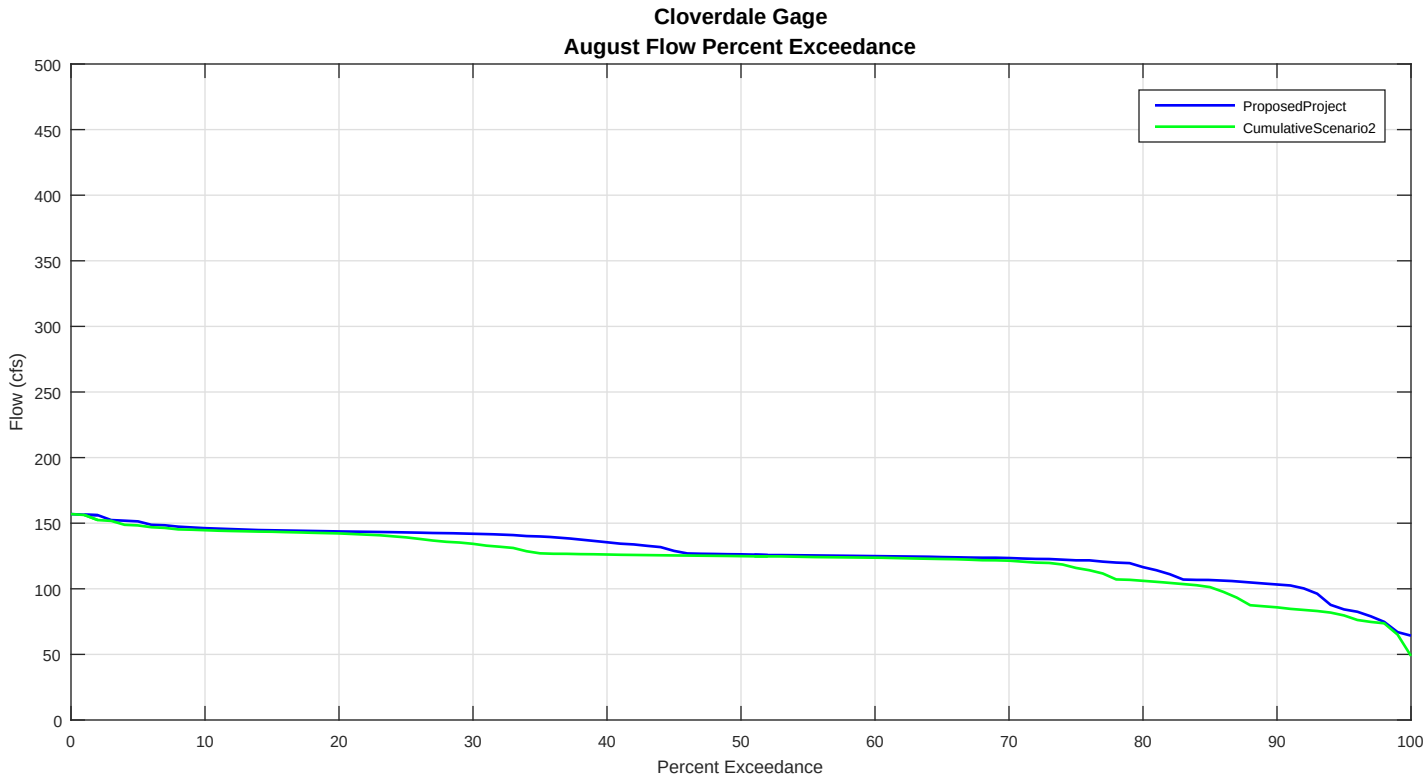
Cloverdale Gage
August Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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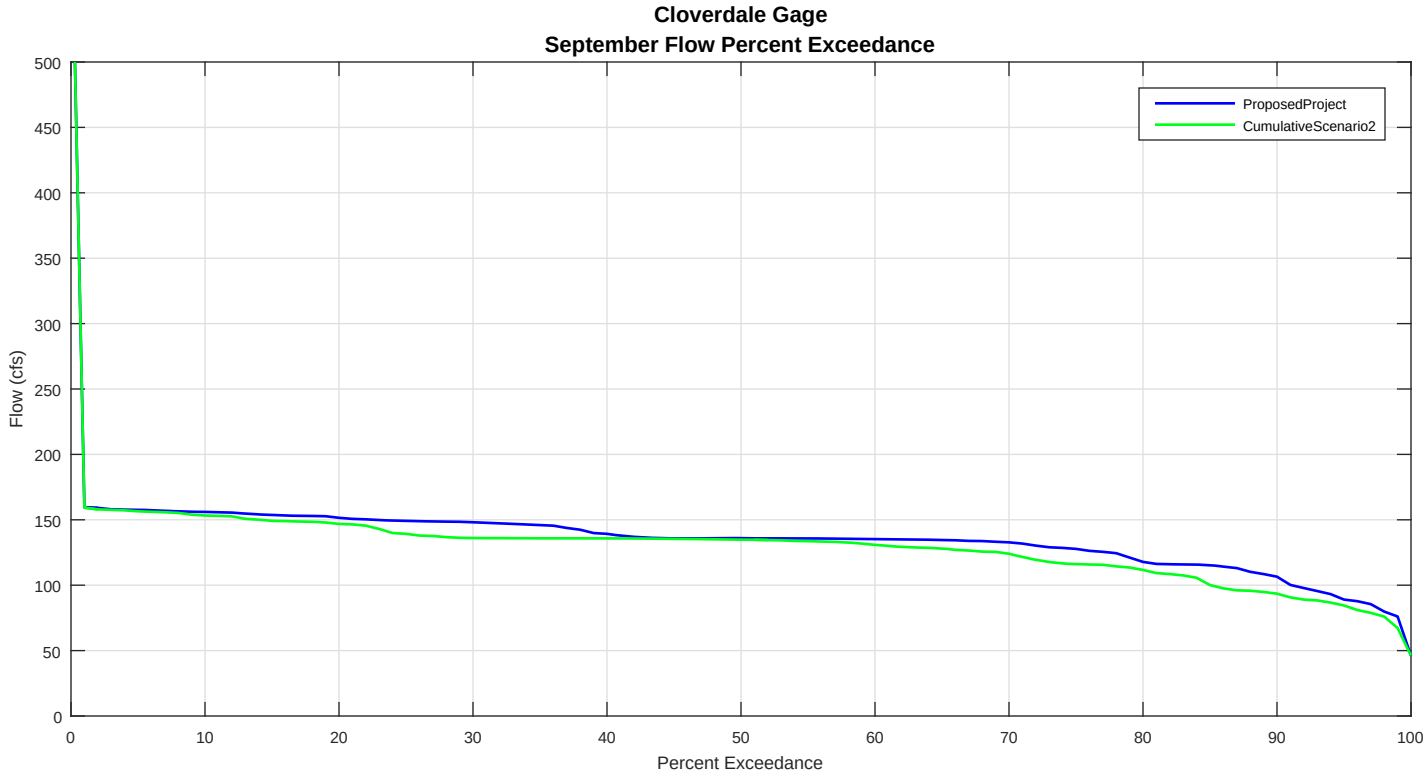
Cloverdale Gage
September Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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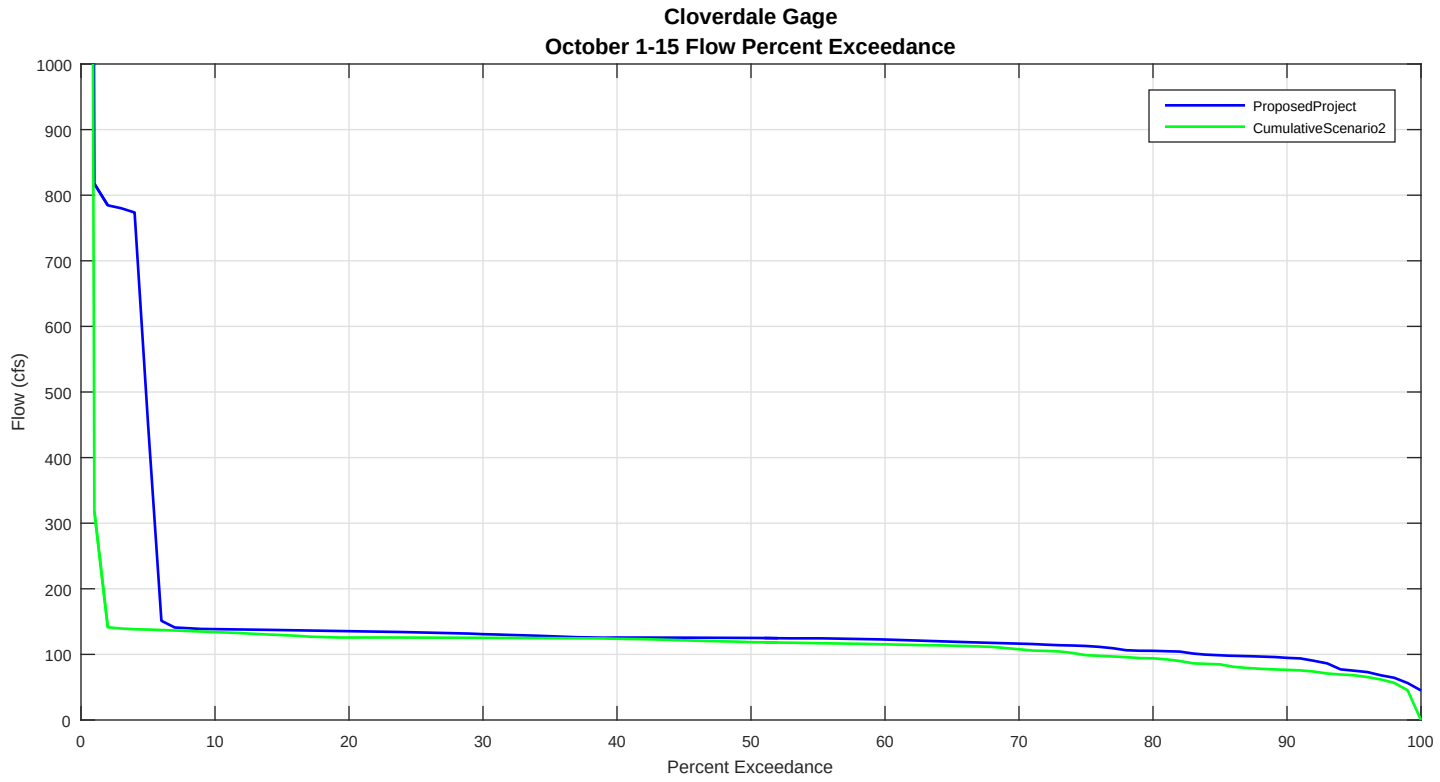
Cloverdale Gage
October 1-15 Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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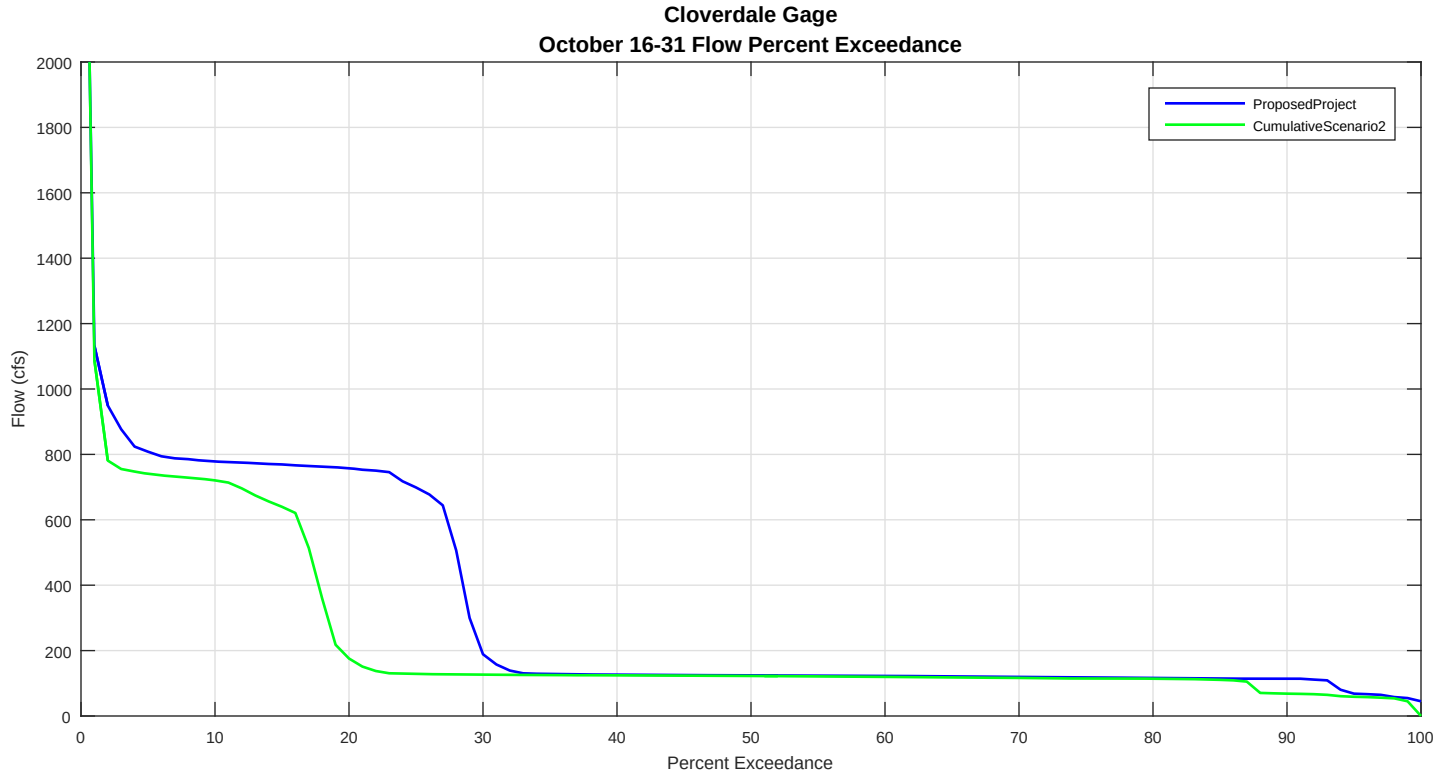
Cloverdale Gage
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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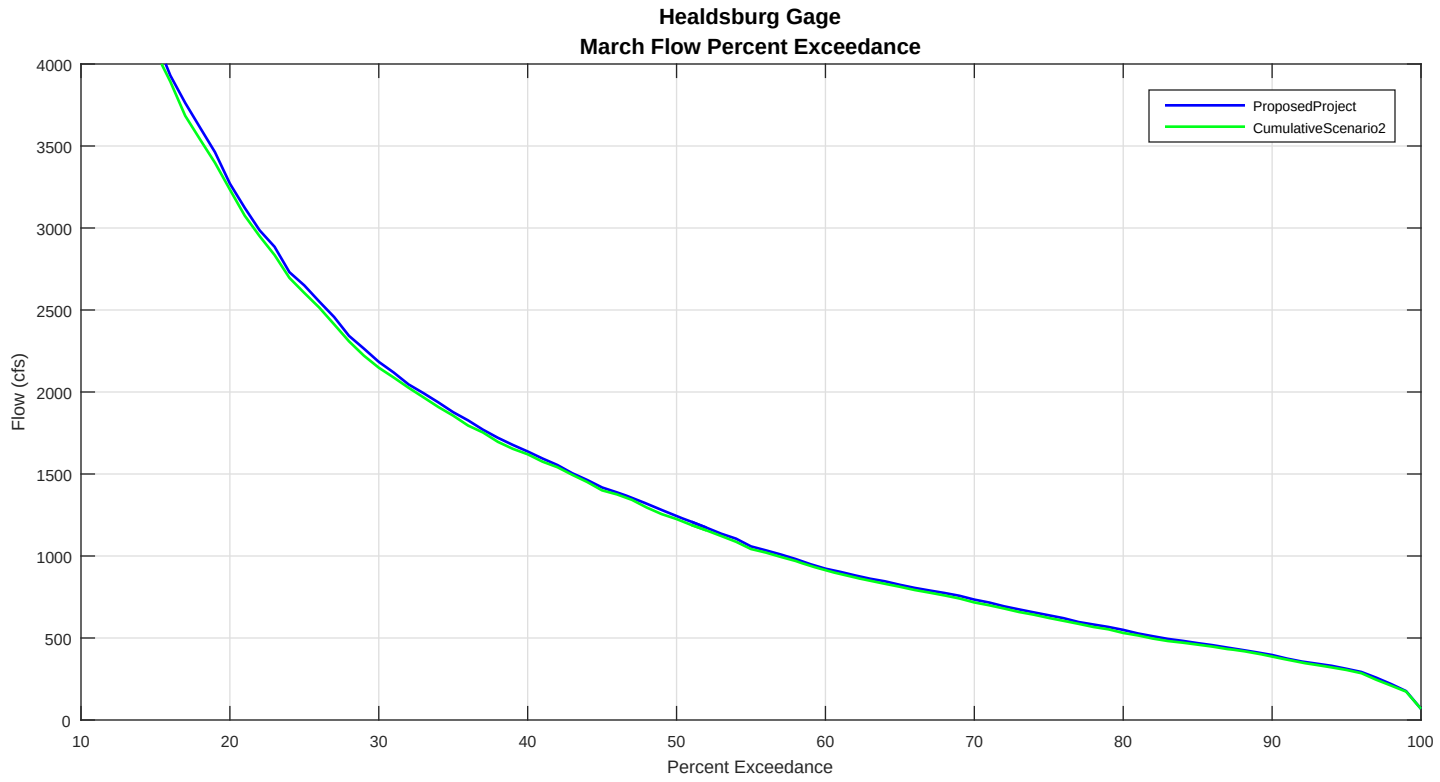
Healdsburg Gage
March Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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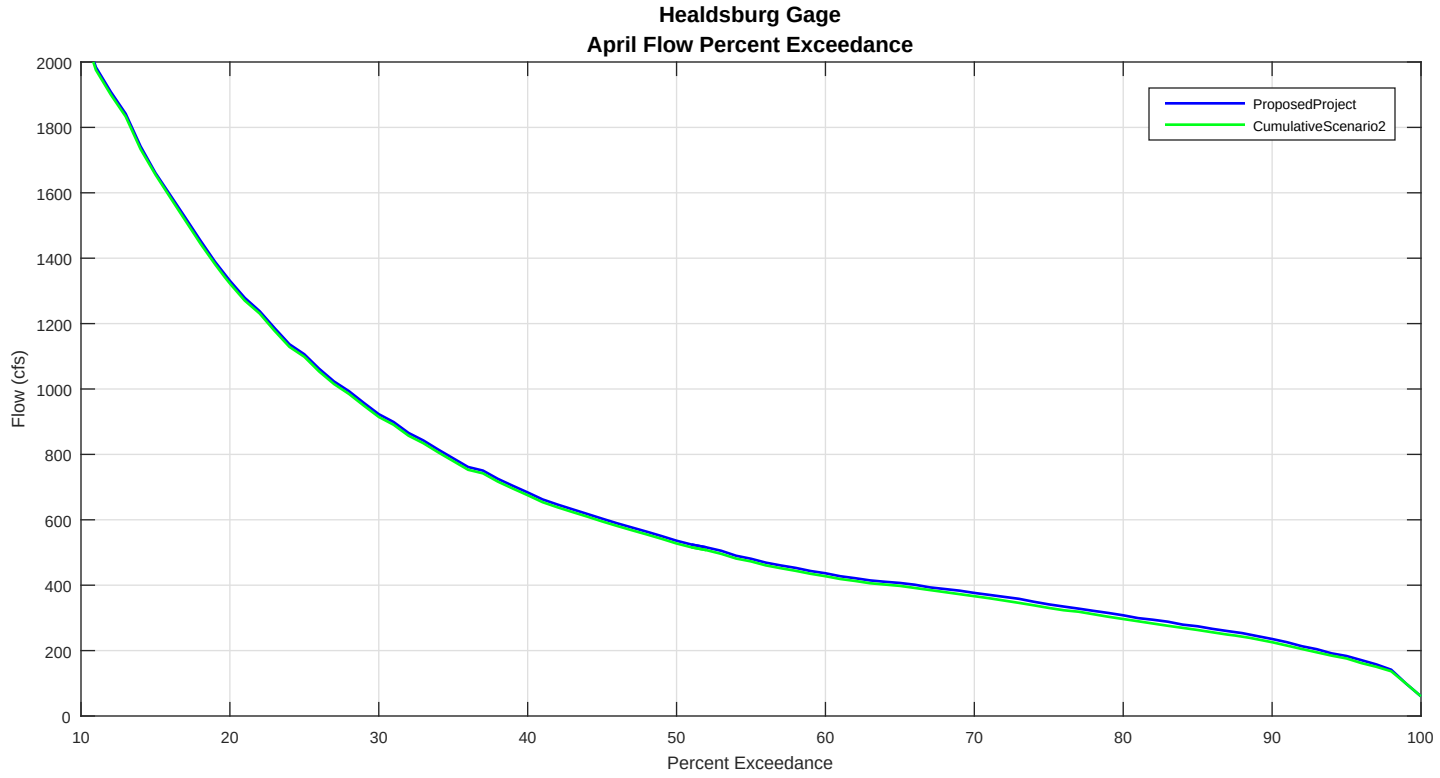
Healdsburg Gage
April Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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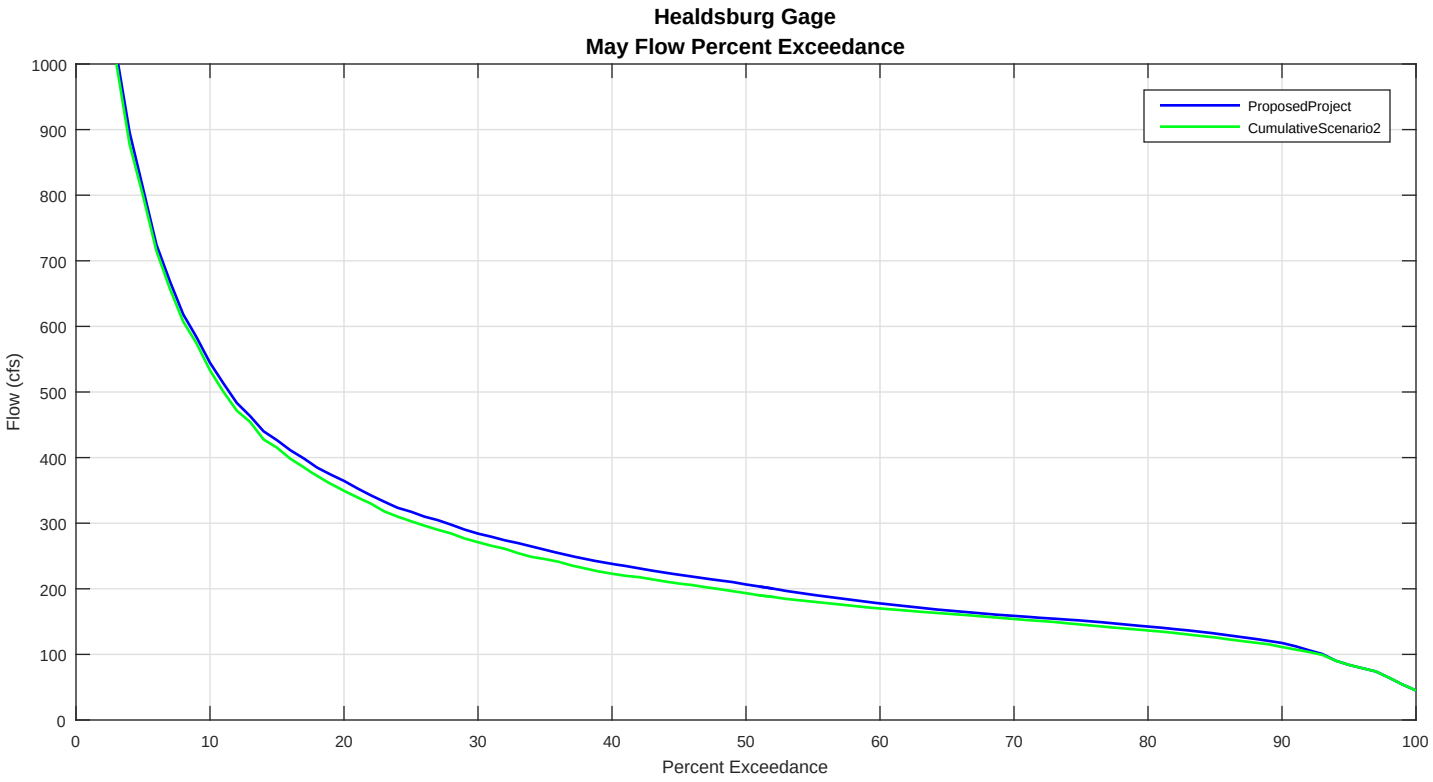
Healdsburg Gage
May Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario2
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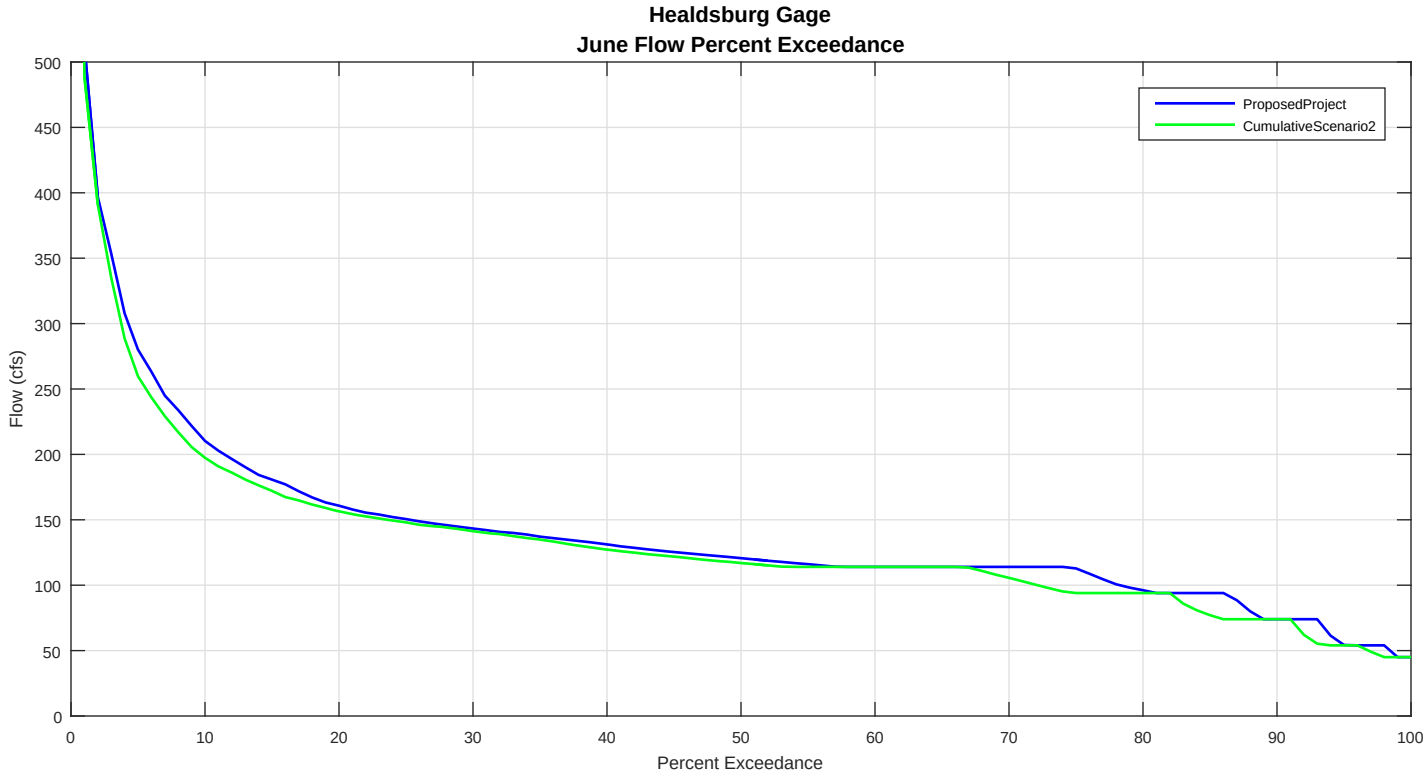
Healdsburg Gage
June Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario2
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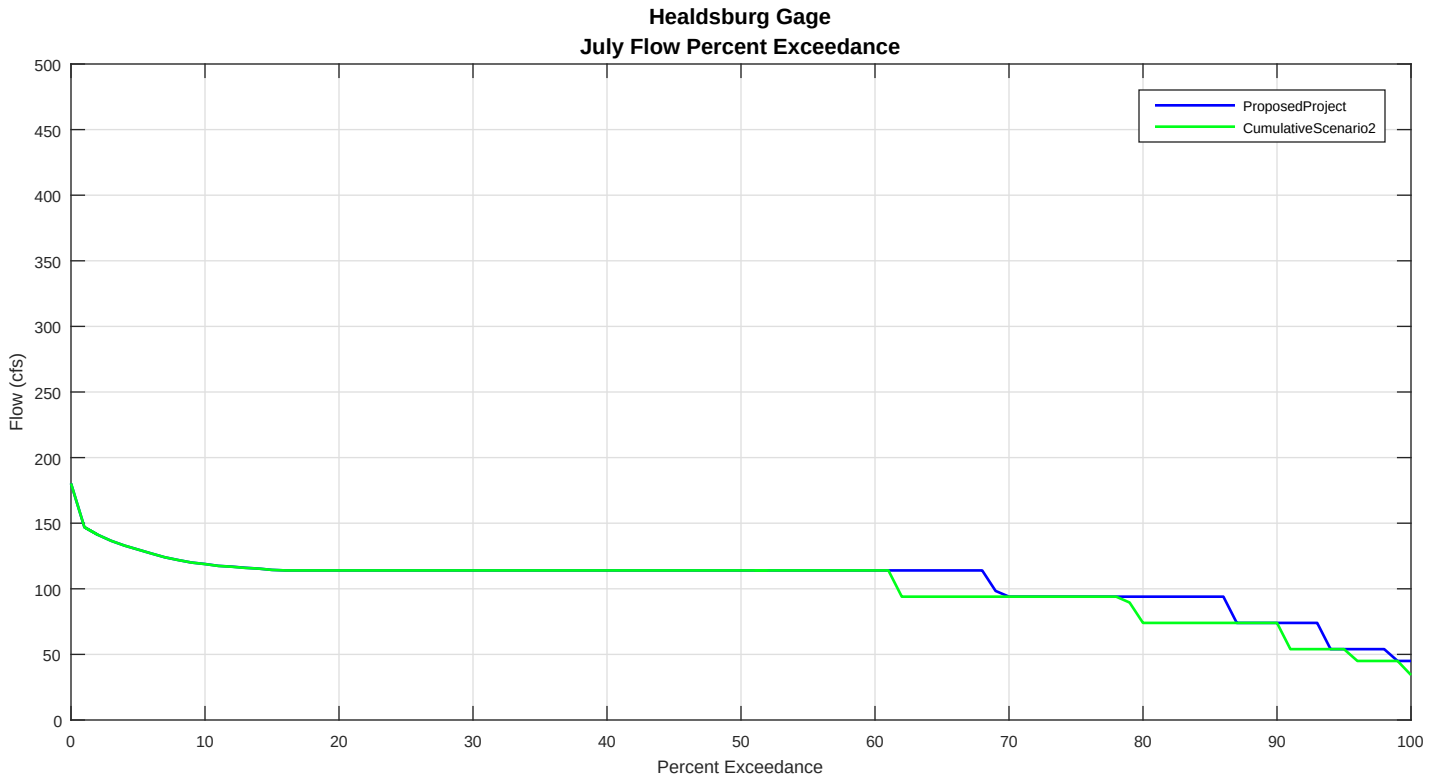
Healdsburg Gage
July Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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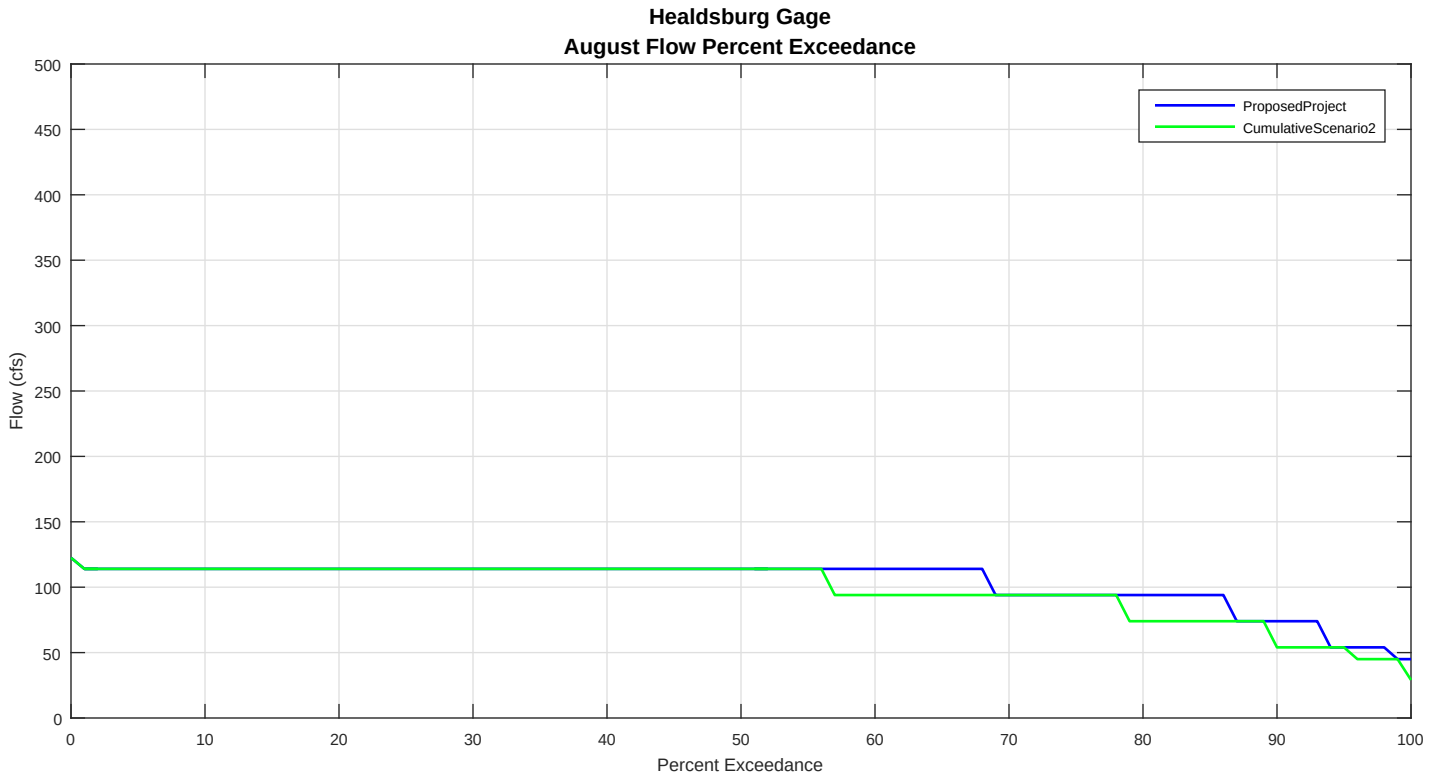
Healdsburg Gage
August Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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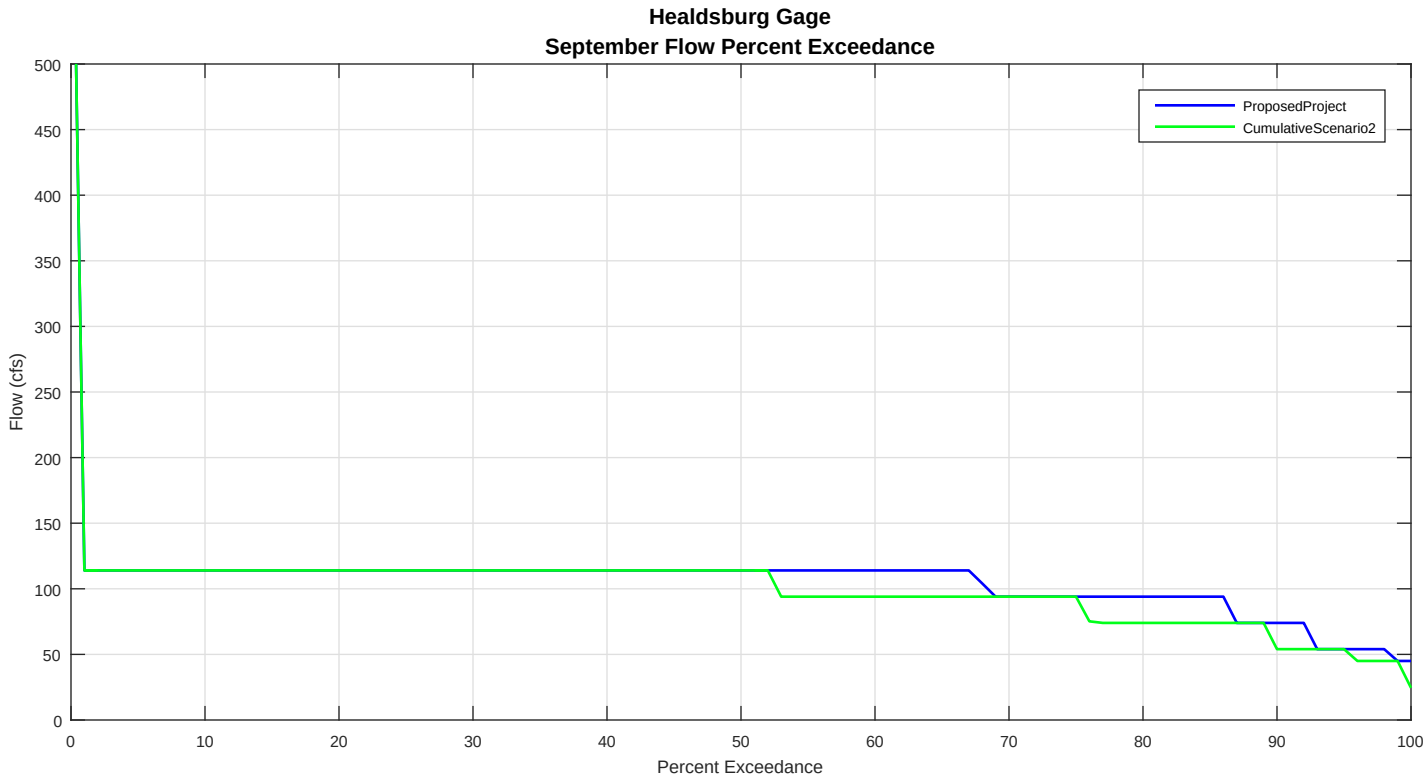
Healdsburg Gage
September Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario2
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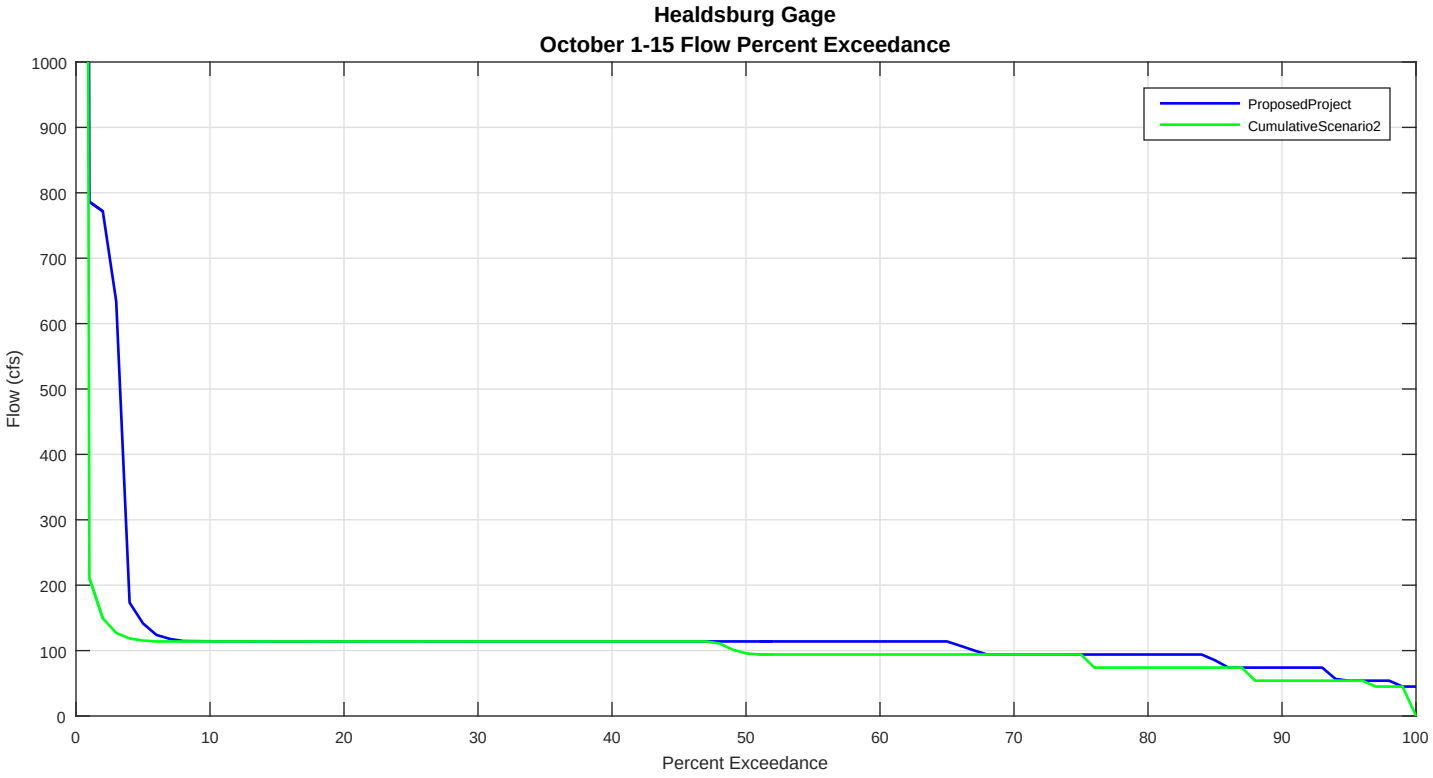
Healdsburg Gage
October 1-15 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario2
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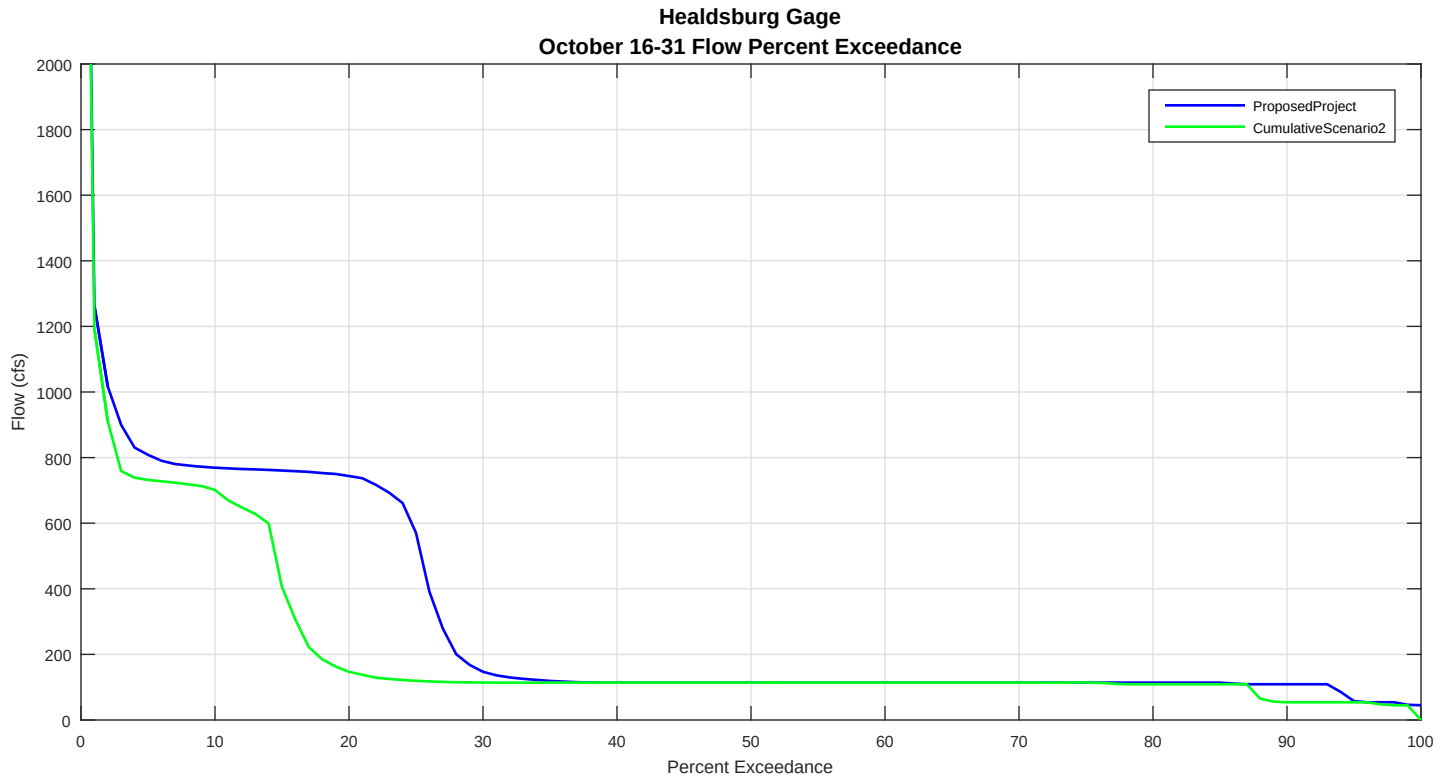
Healdsburg Gage
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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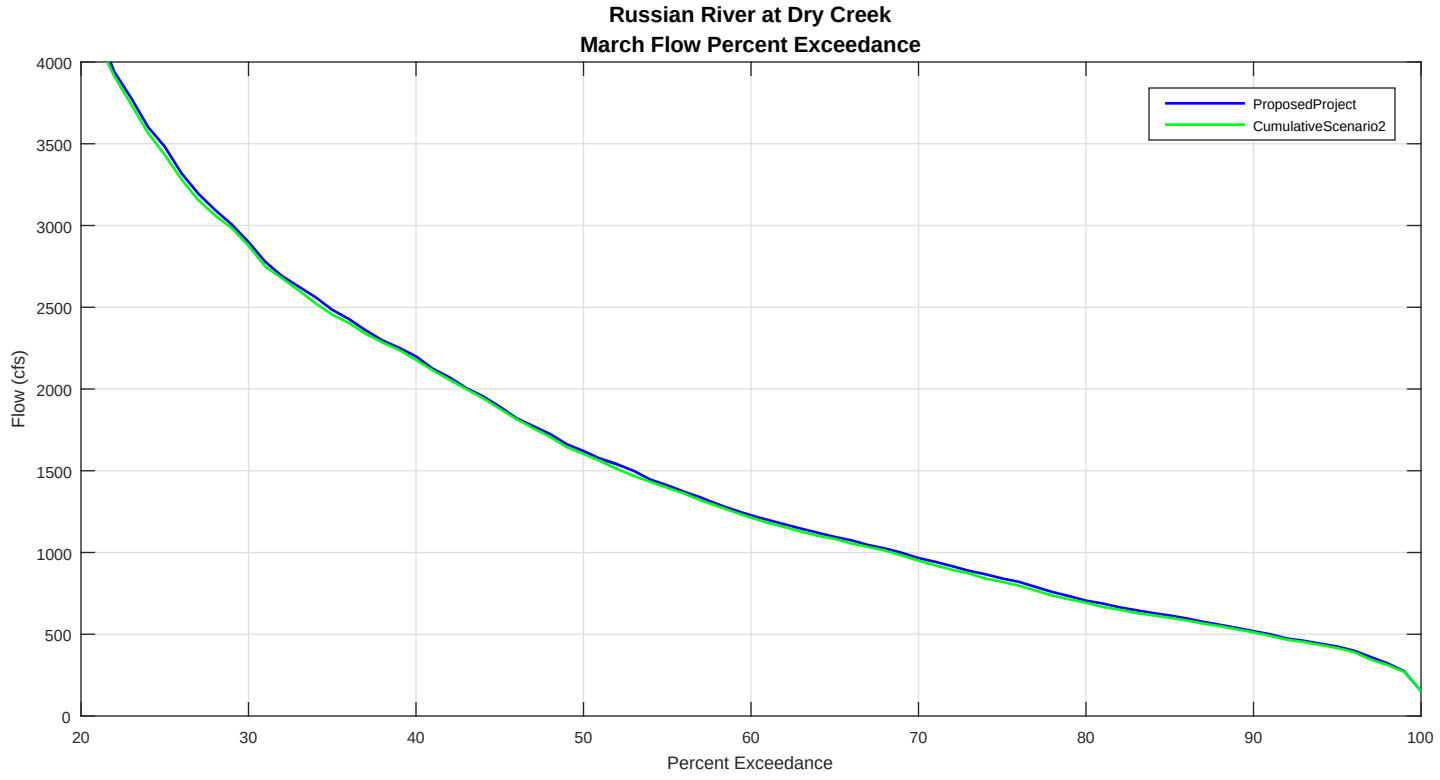
Russian River at Dry Creek
March Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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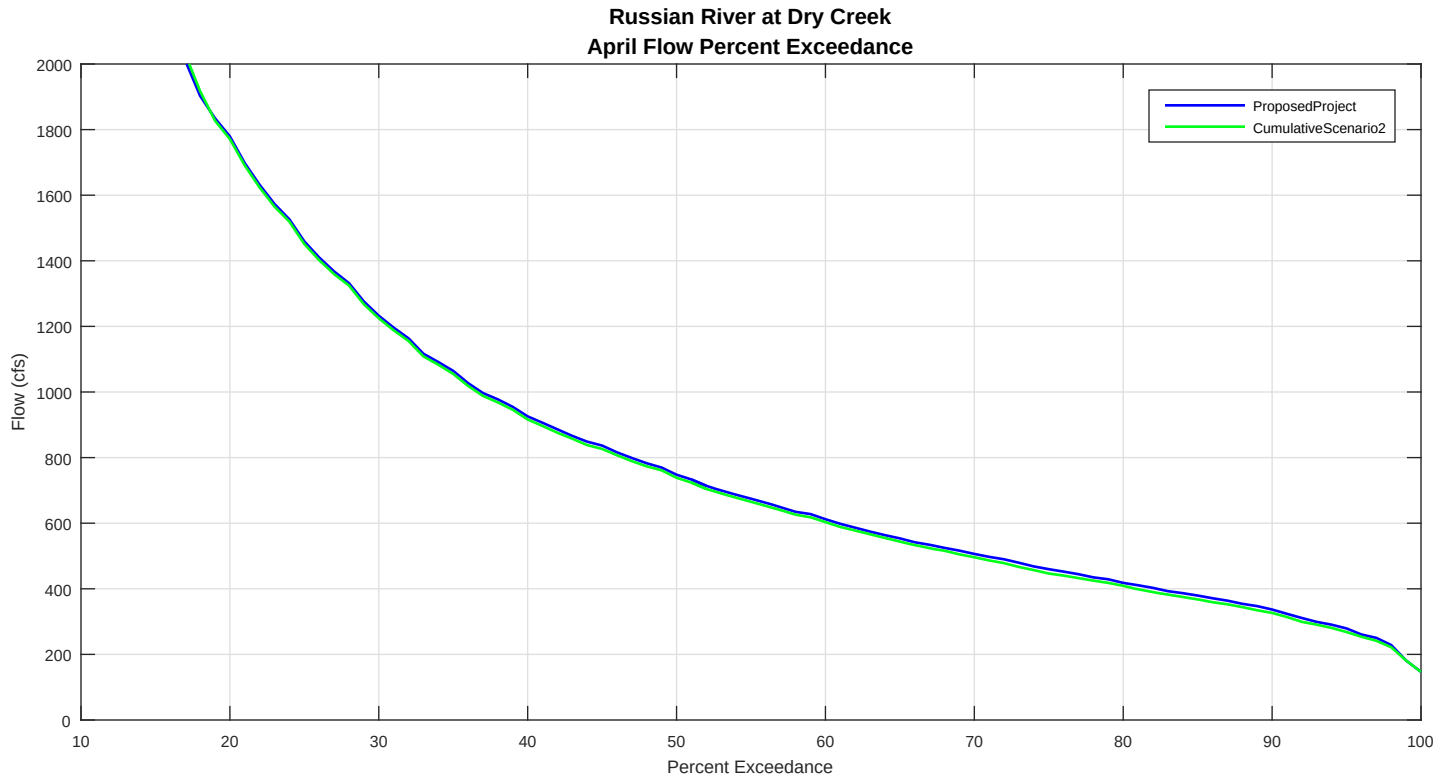
Russian River at Dry Creek
April Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario2
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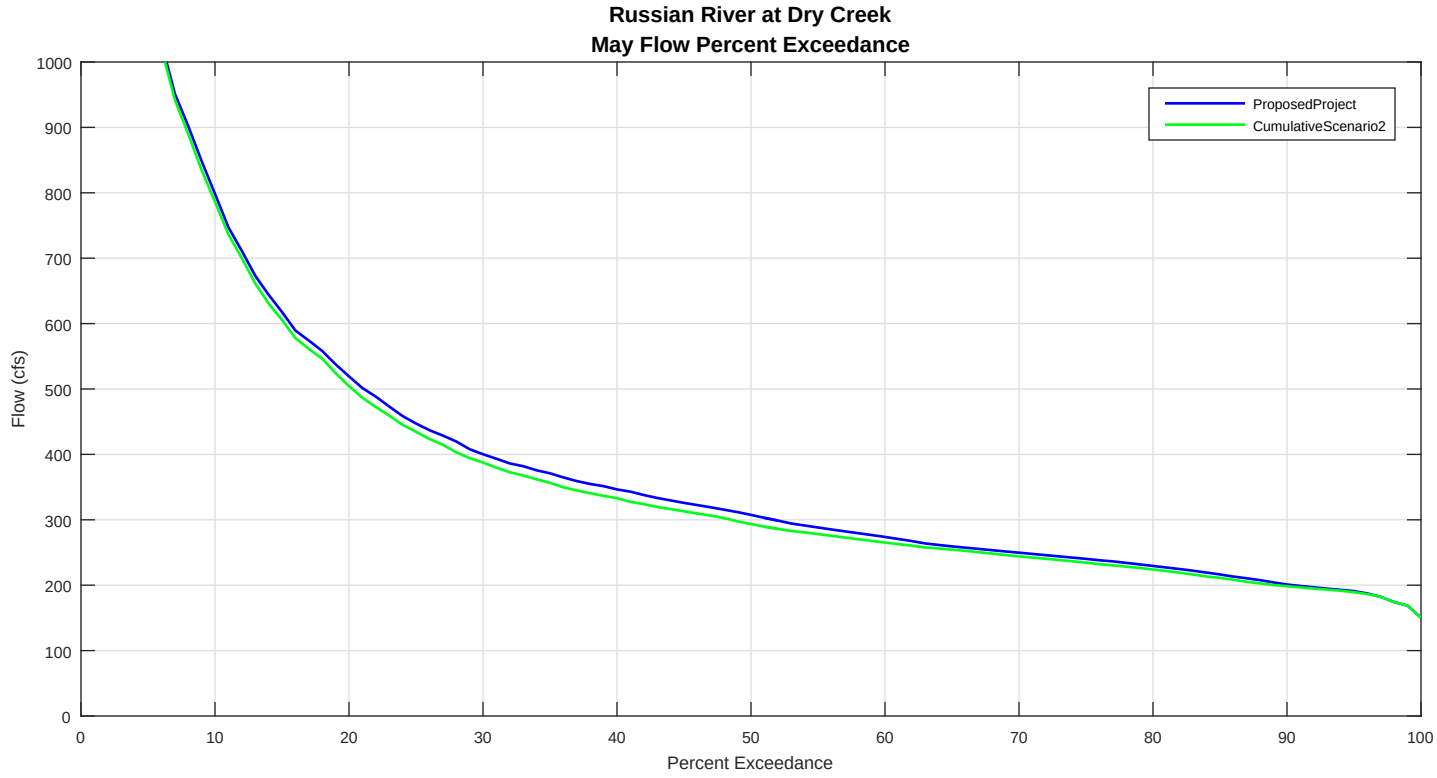
Russian River at Dry Creek
May Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario2
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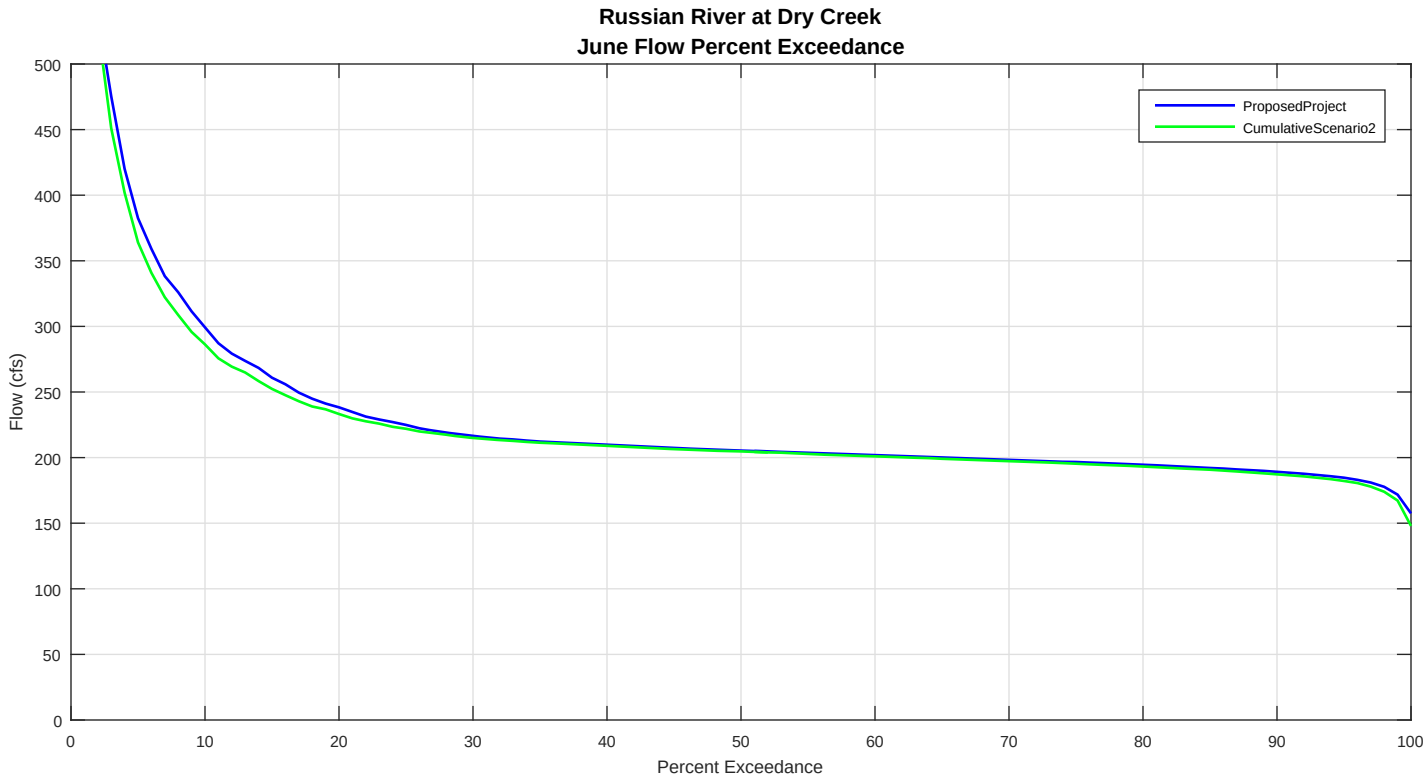
Russian River at Dry Creek
June Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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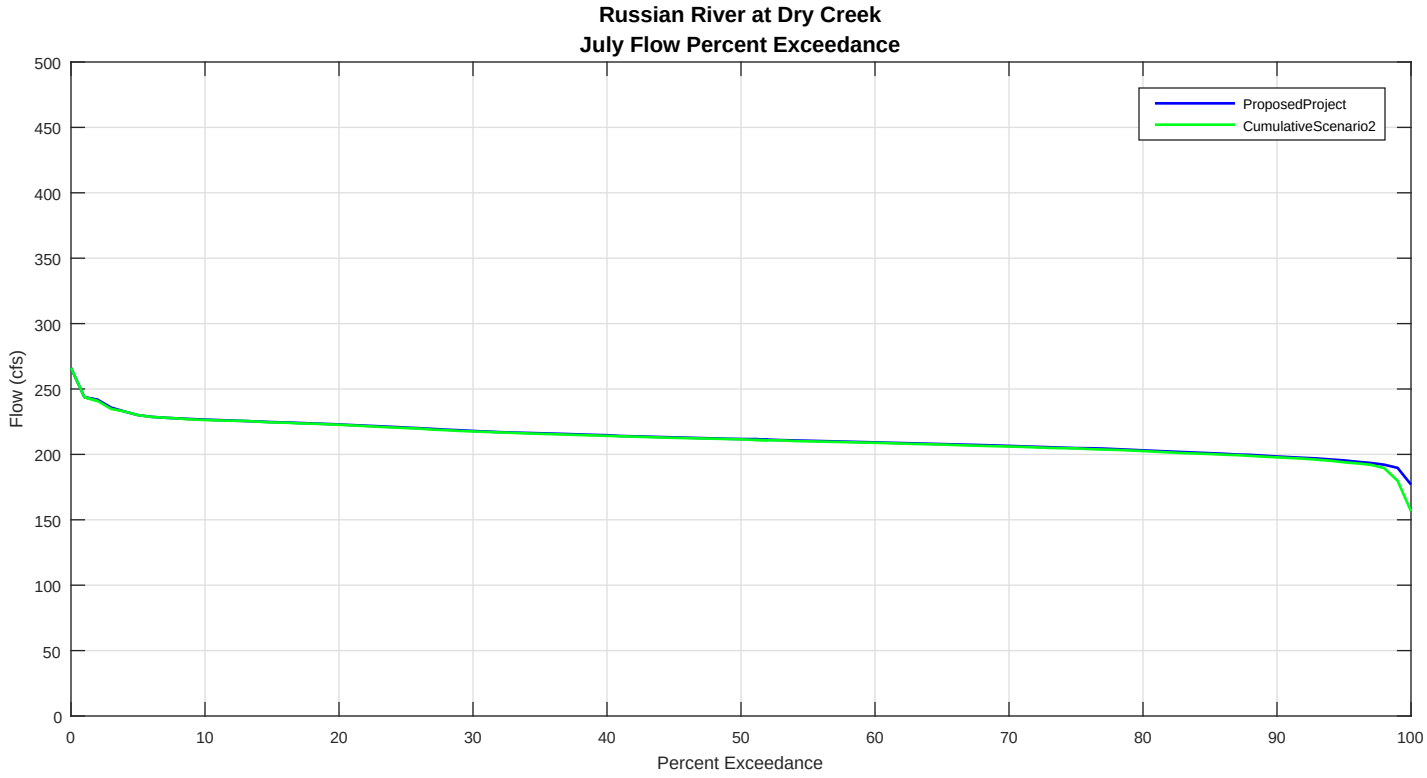
Russian River at Dry Creek
July Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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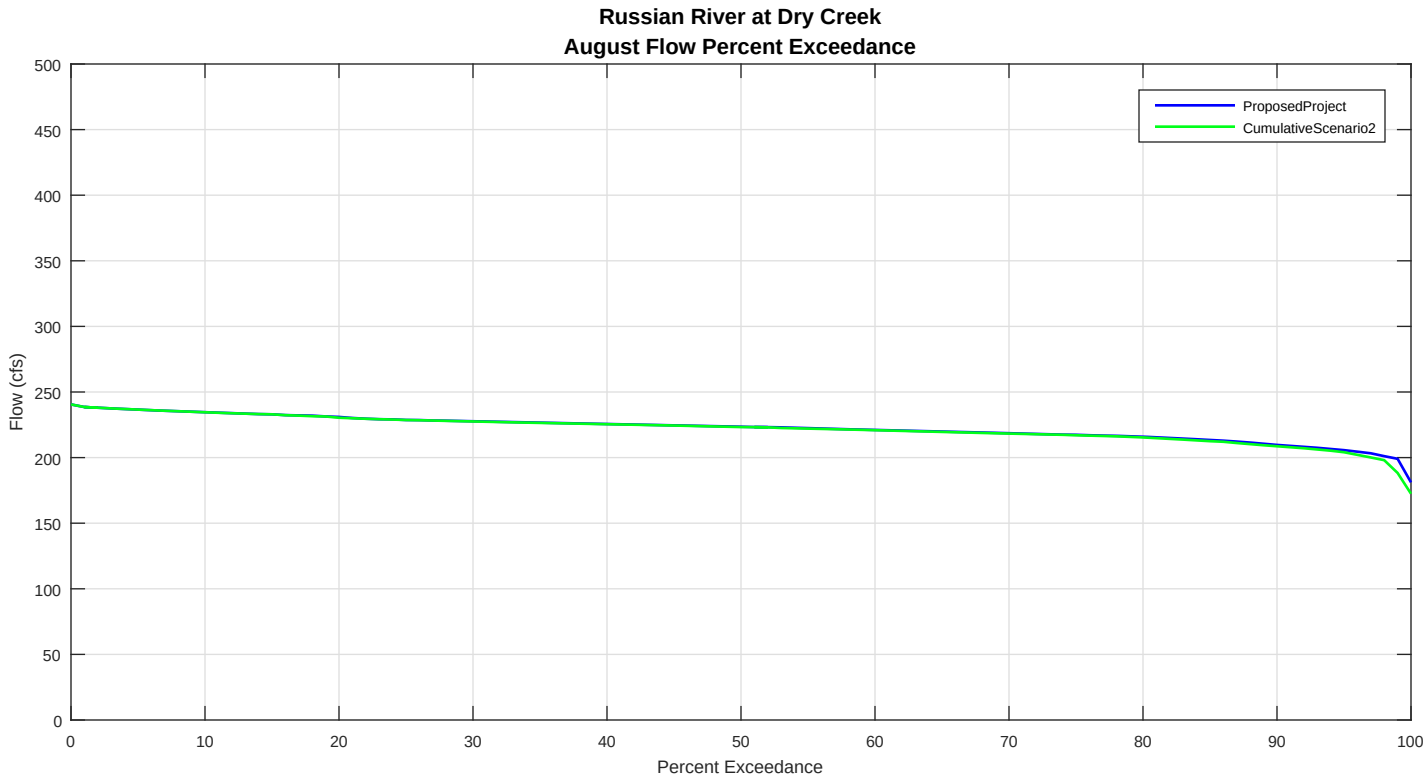
Russian River at Dry Creek
August Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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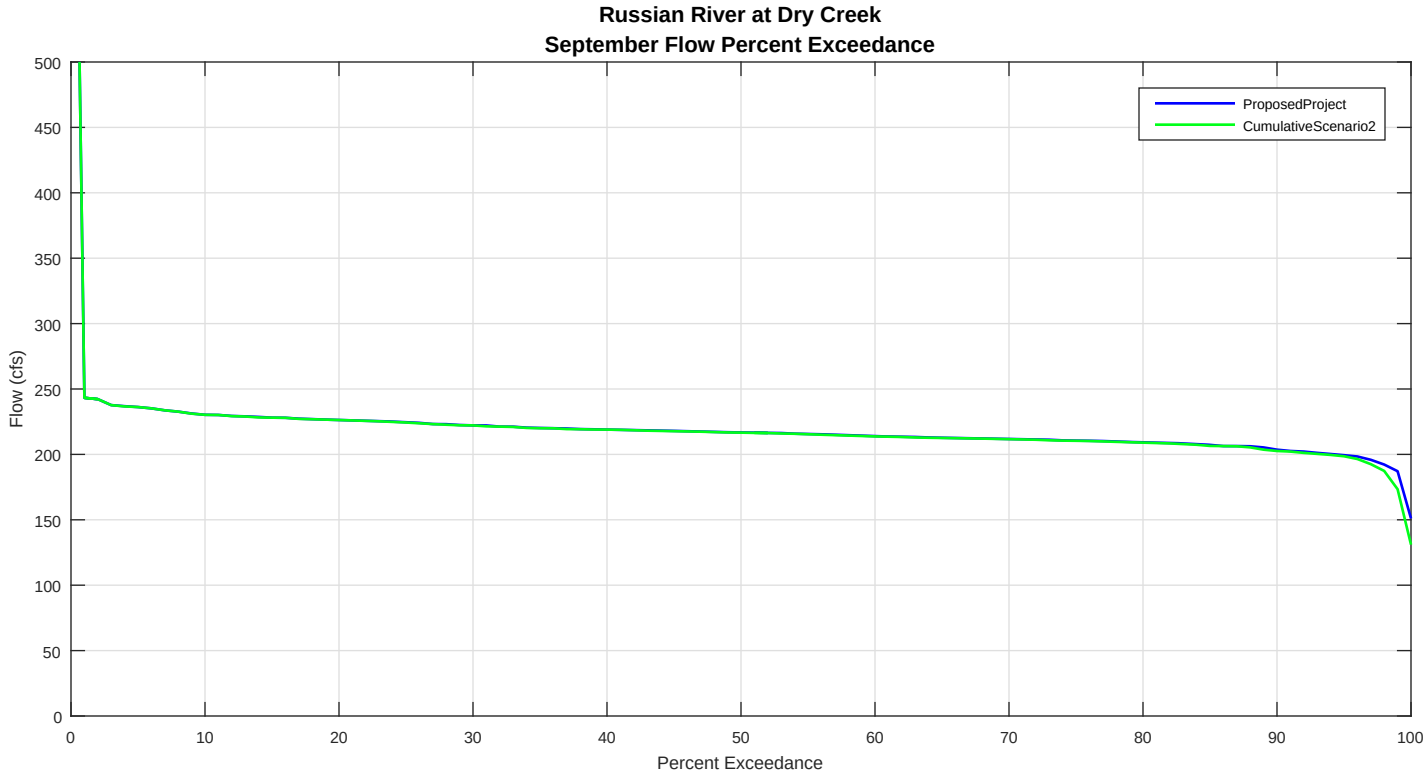
Russian River at Dry Creek
September Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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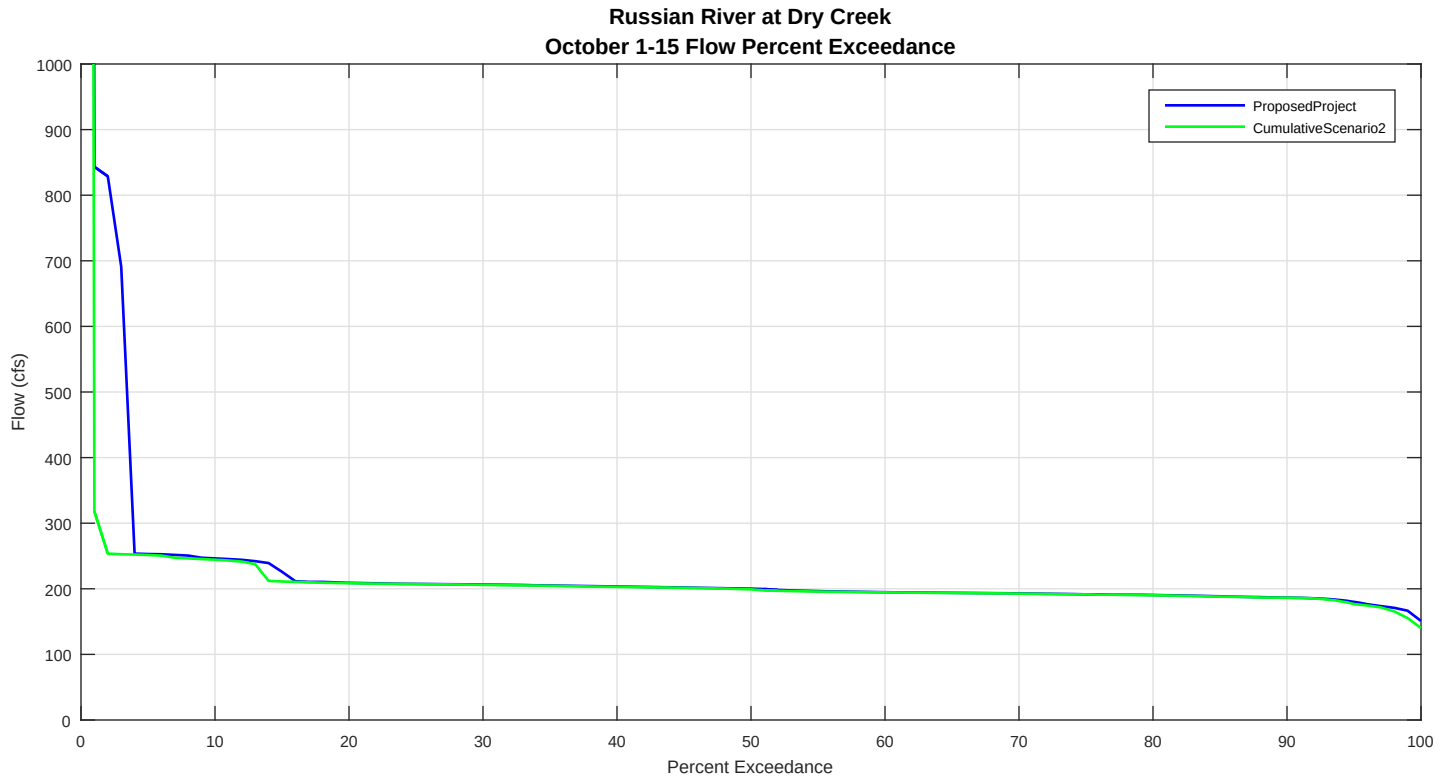
Russian River at Dry Creek
October 1-15 Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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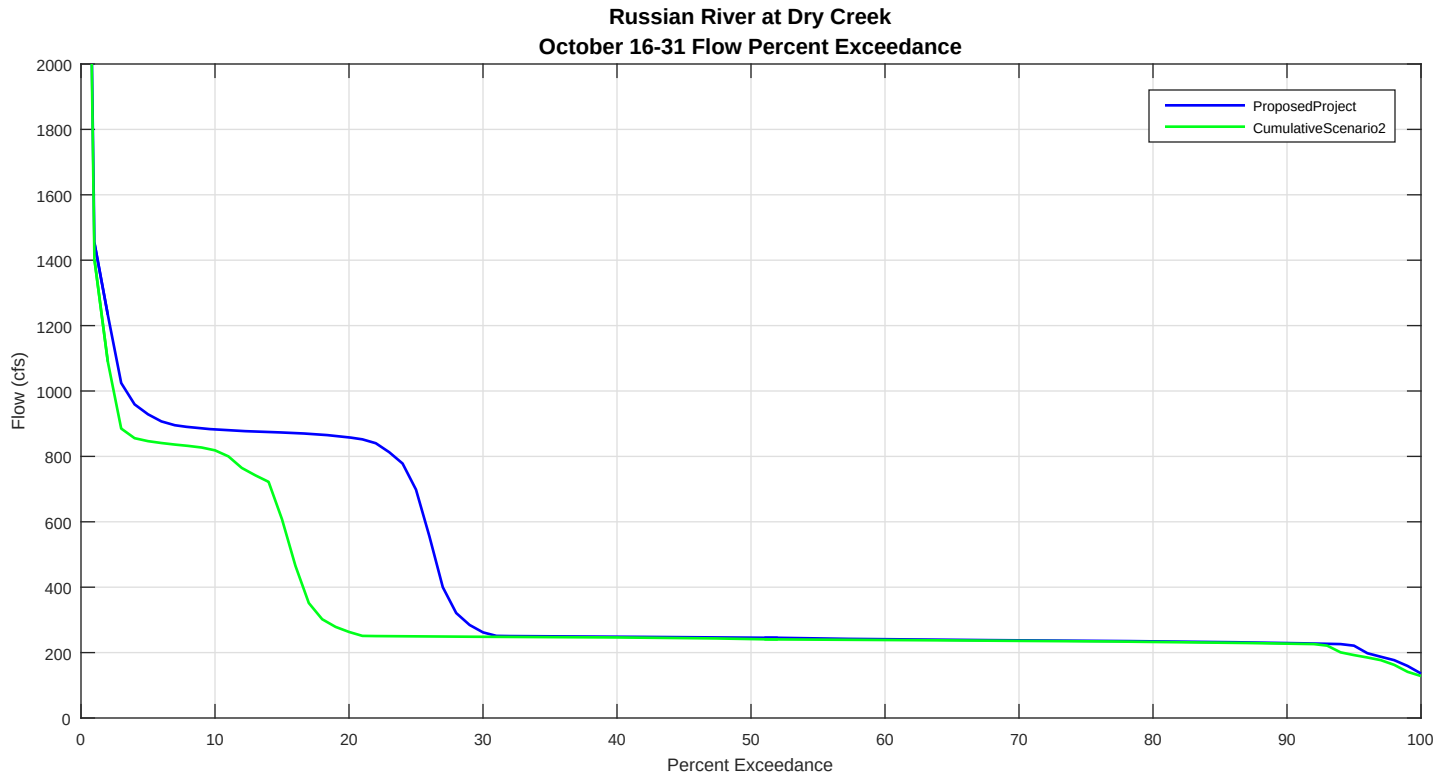
Russian River at Dry Creek
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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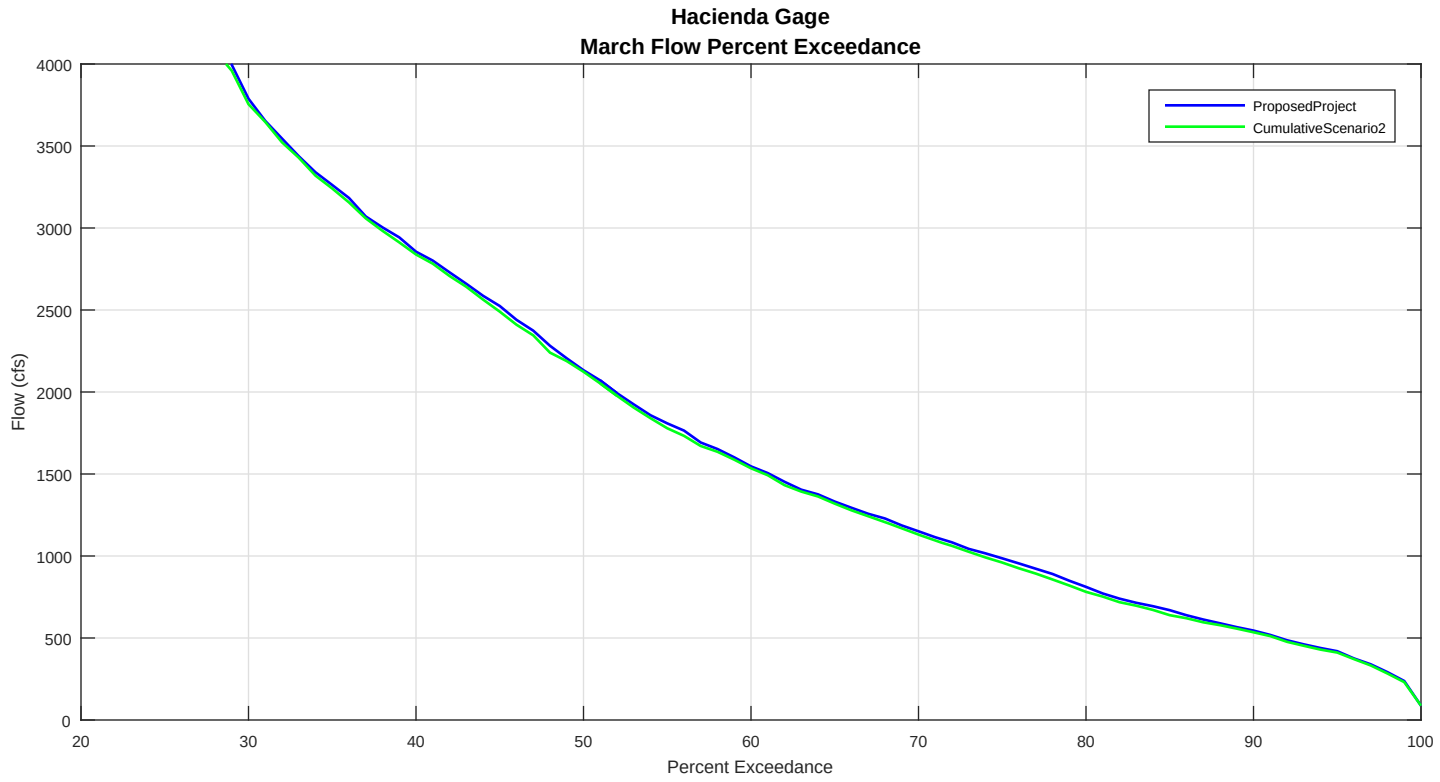
Hacienda Gage
March Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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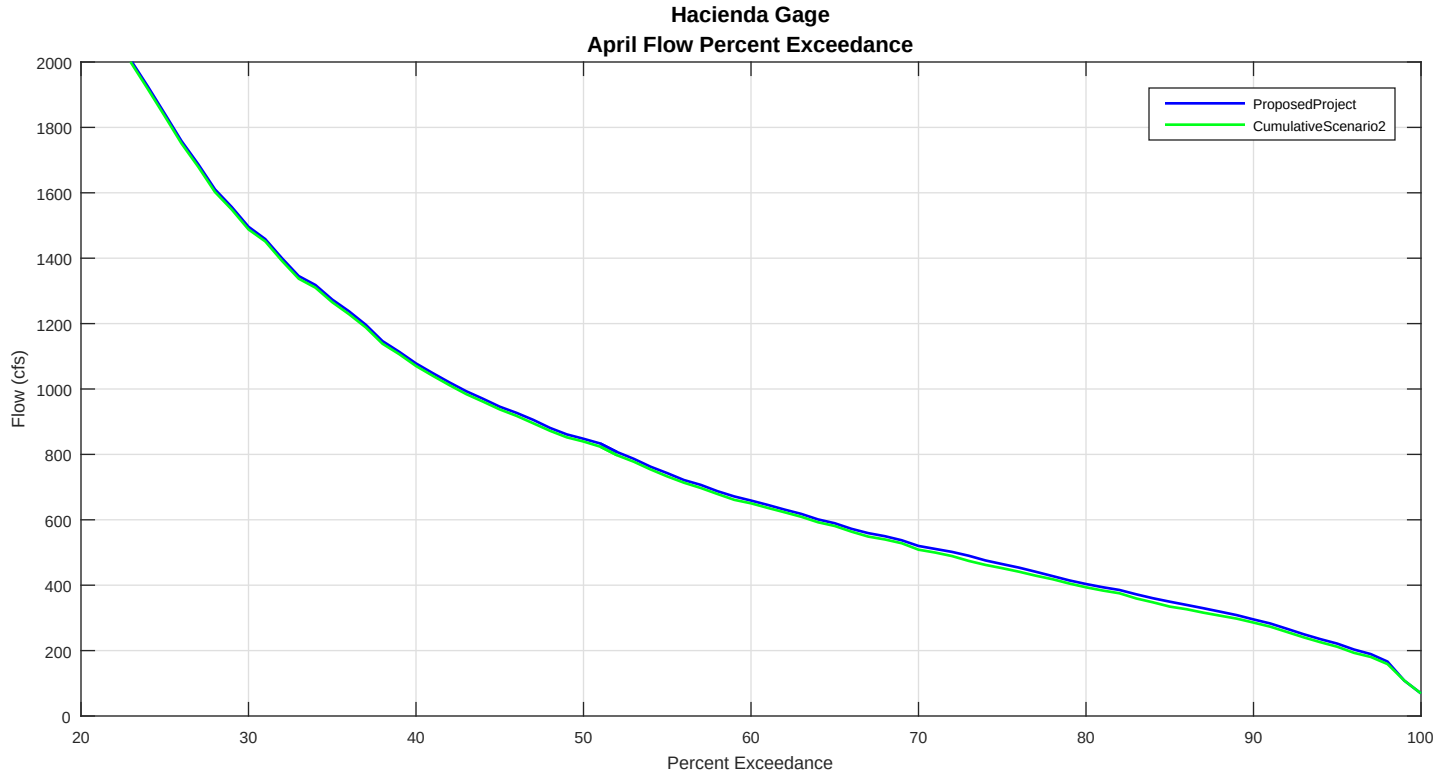
Hacienda Gage
April Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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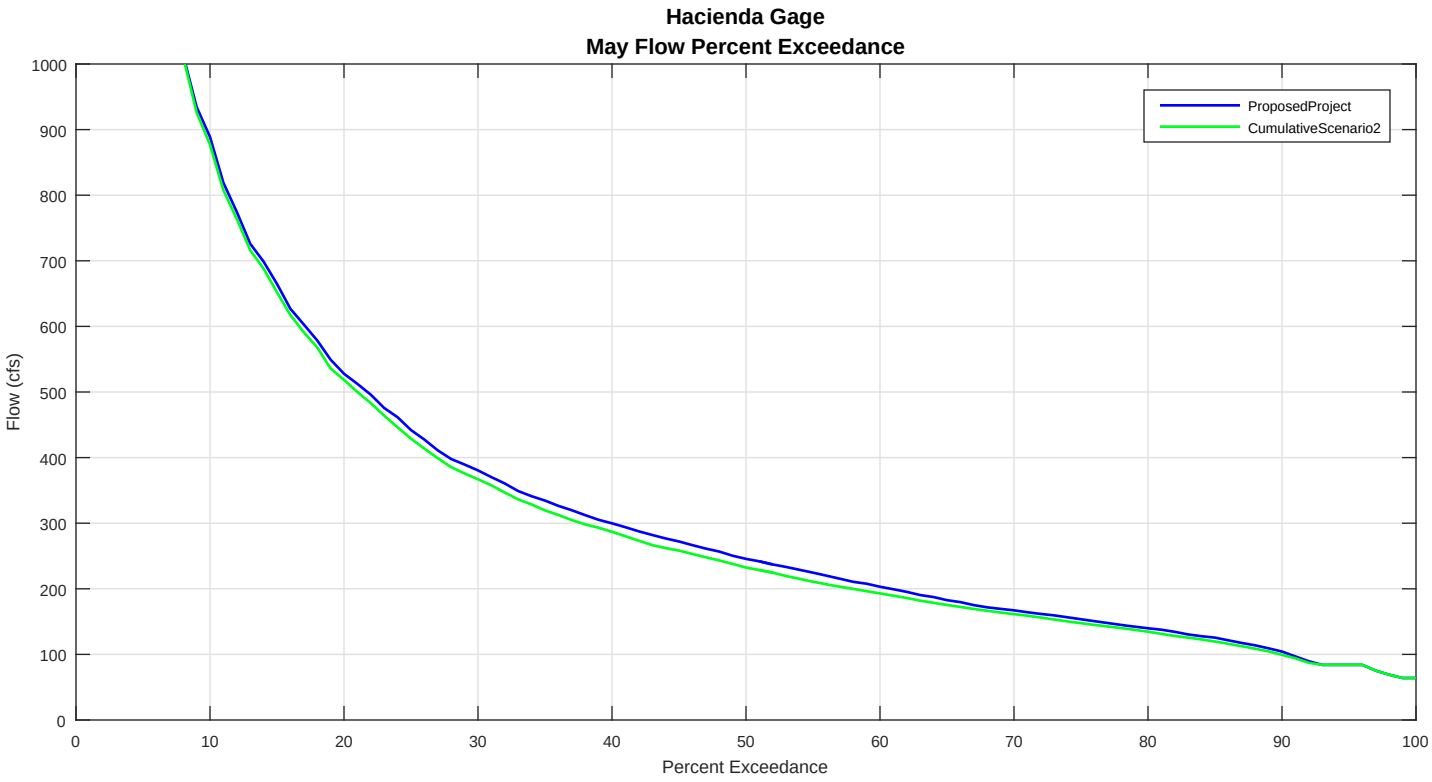
Hacienda Gage
May Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario2
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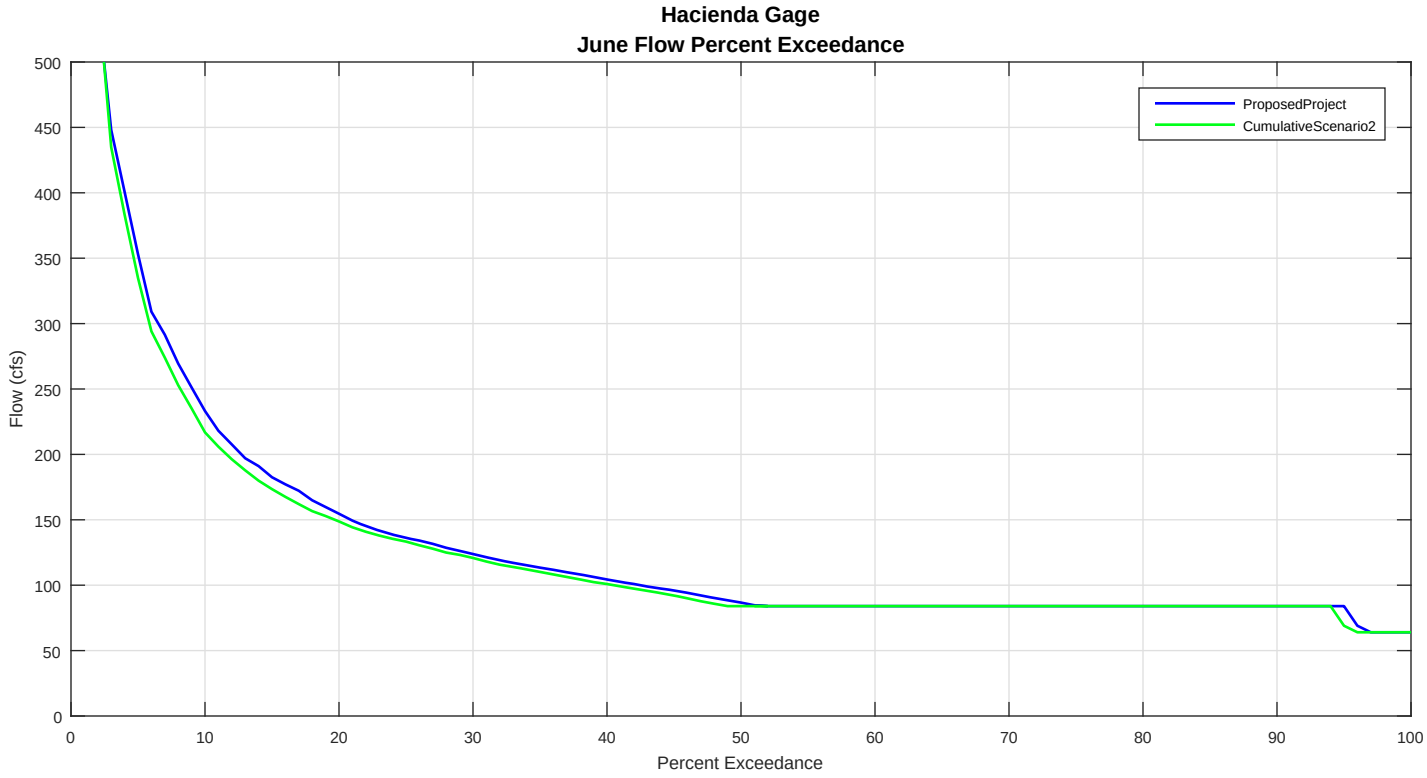
Hacienda Gage
June Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario2
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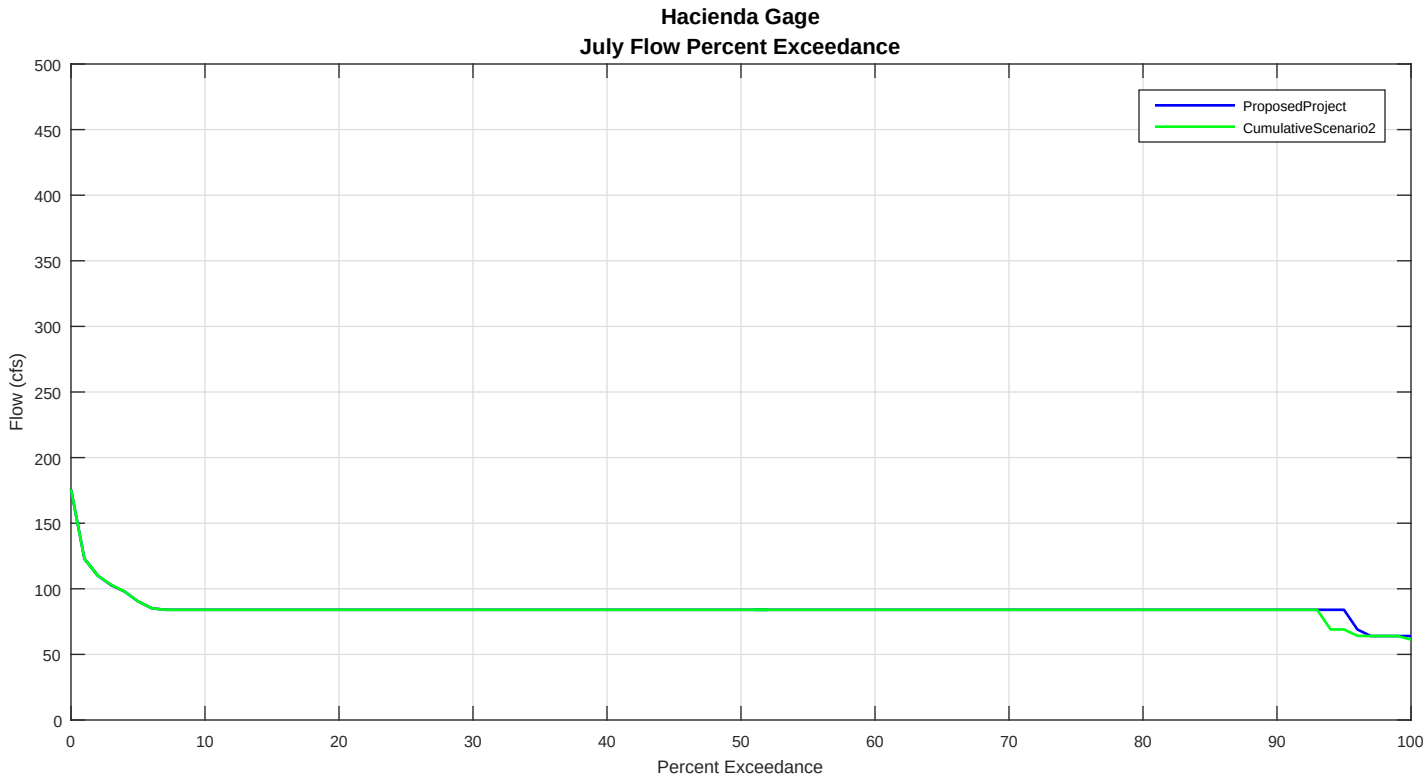
Hacienda Gage
July Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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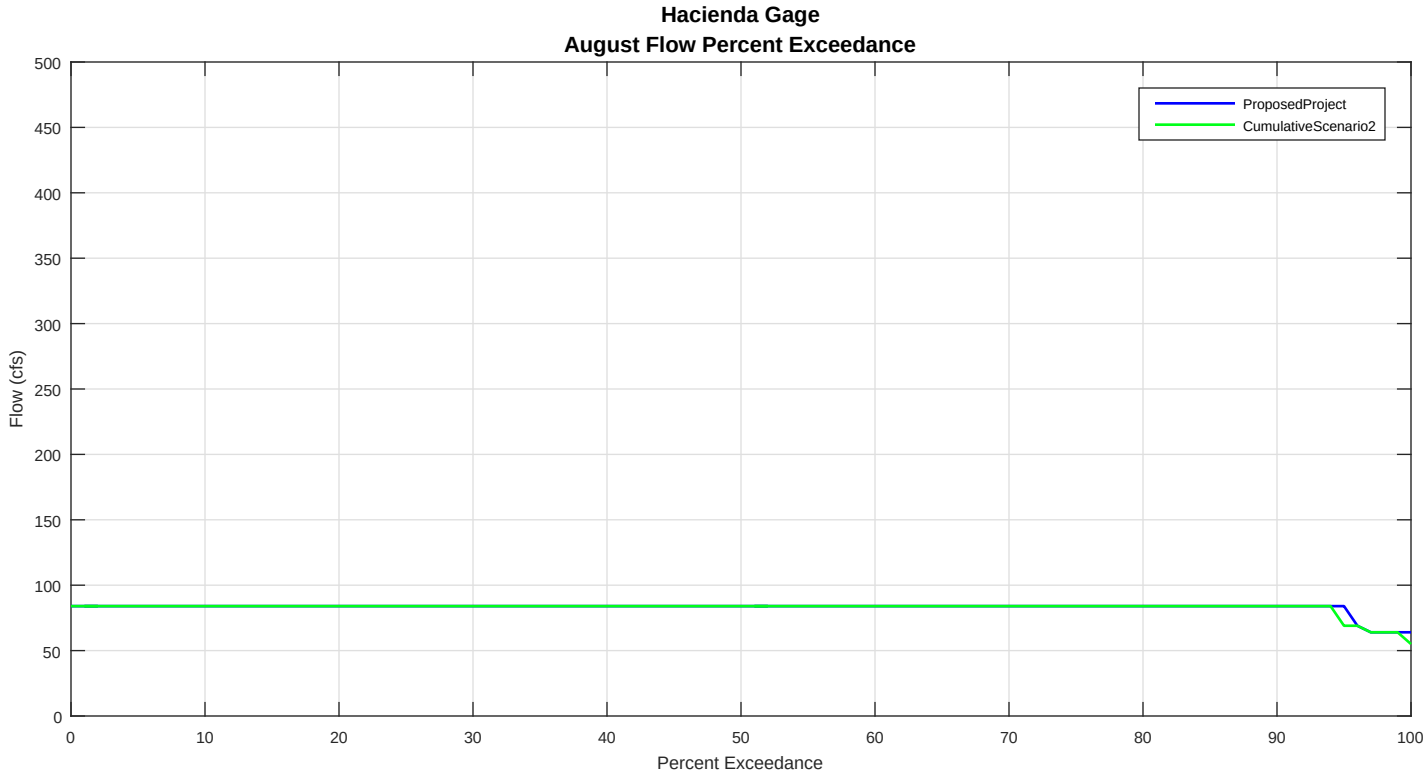
Hacienda Gage
August Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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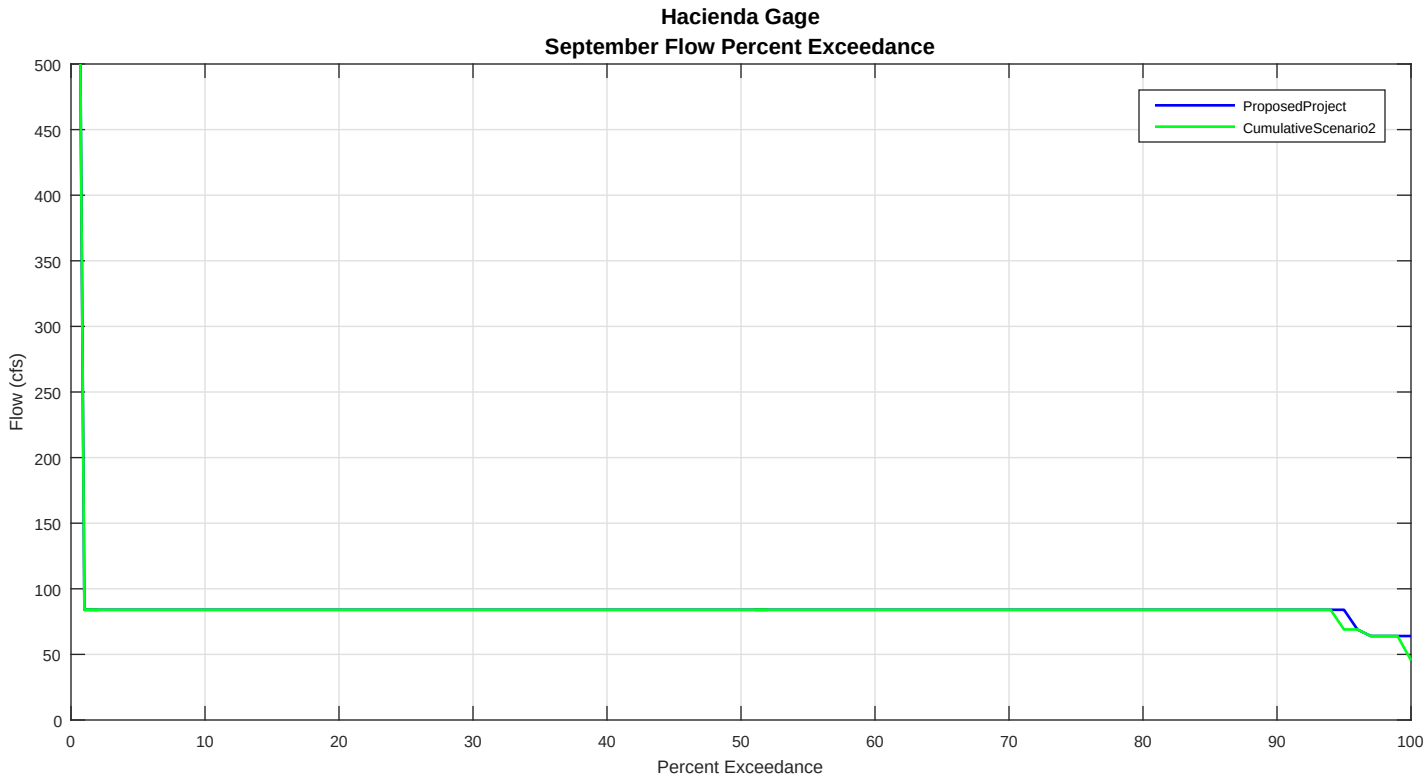
Hacienda Gage
September Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario2
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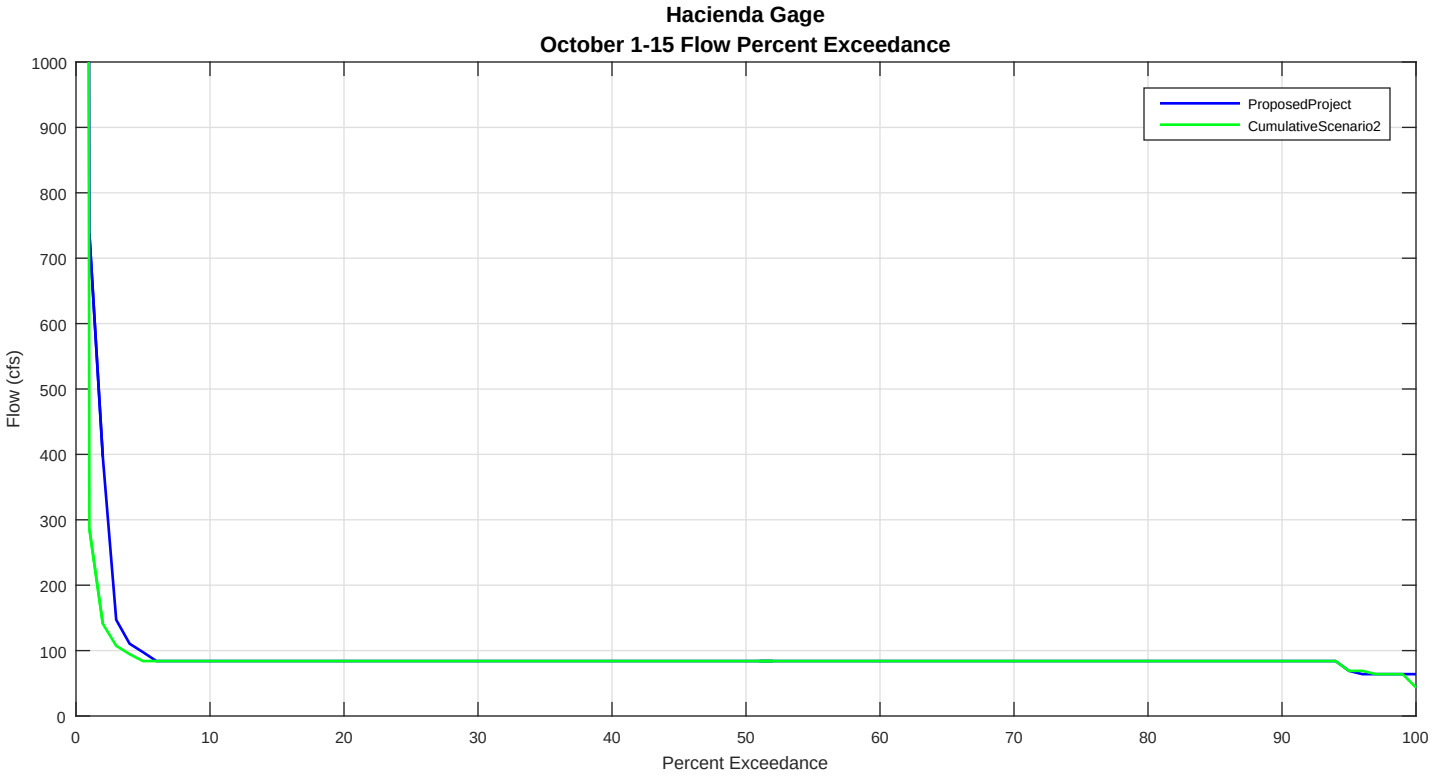
Hacienda Gage
October 1-15 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario2
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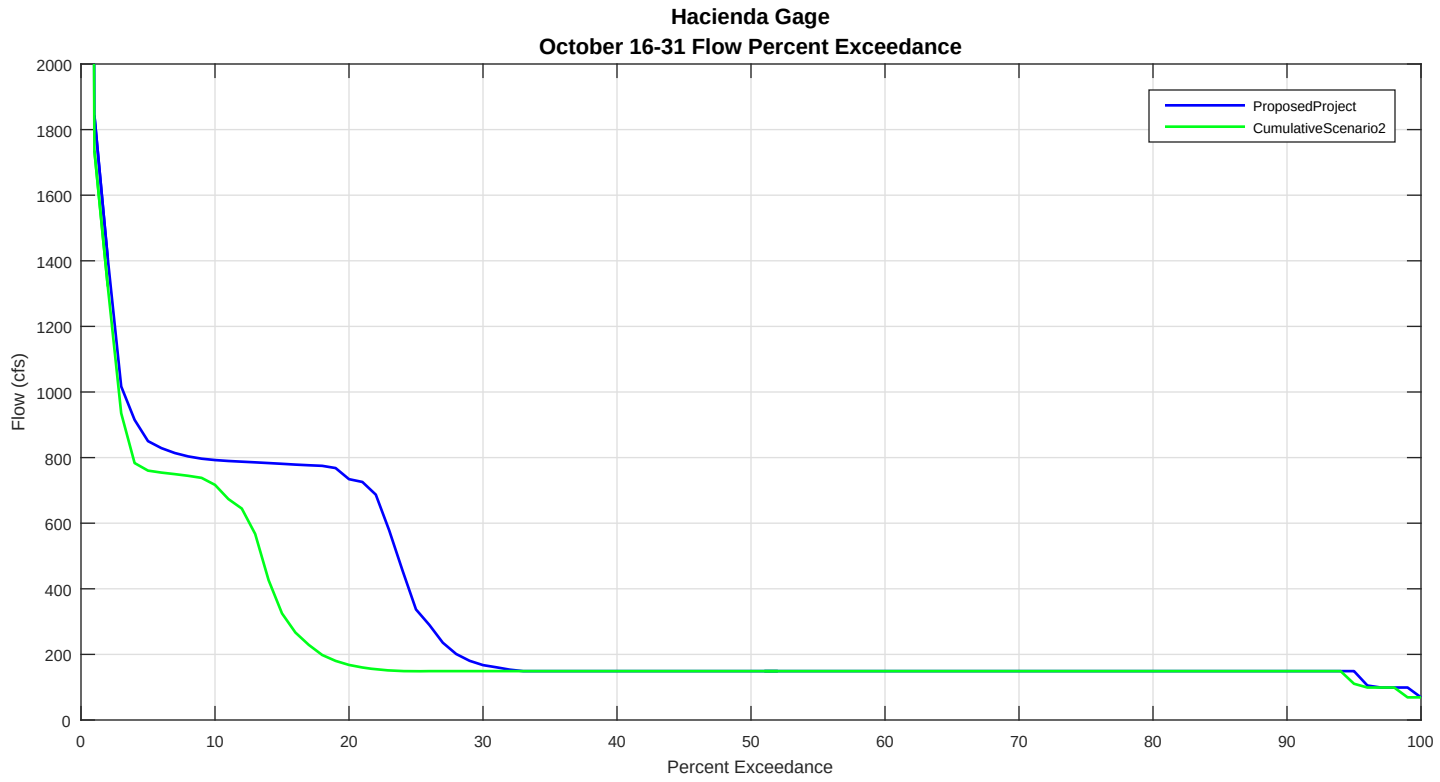
Hacienda Gage
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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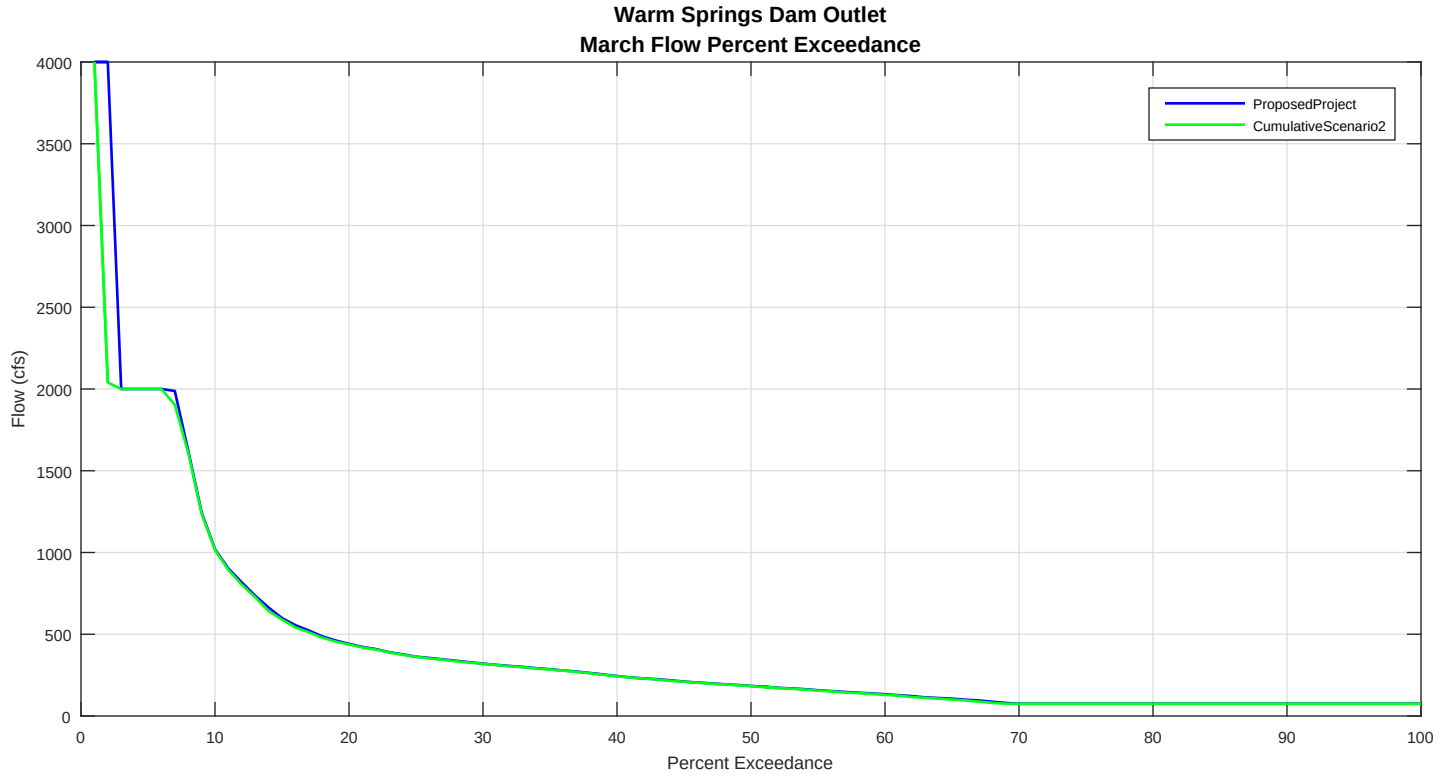
Warm Springs Dam Outlet
March Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
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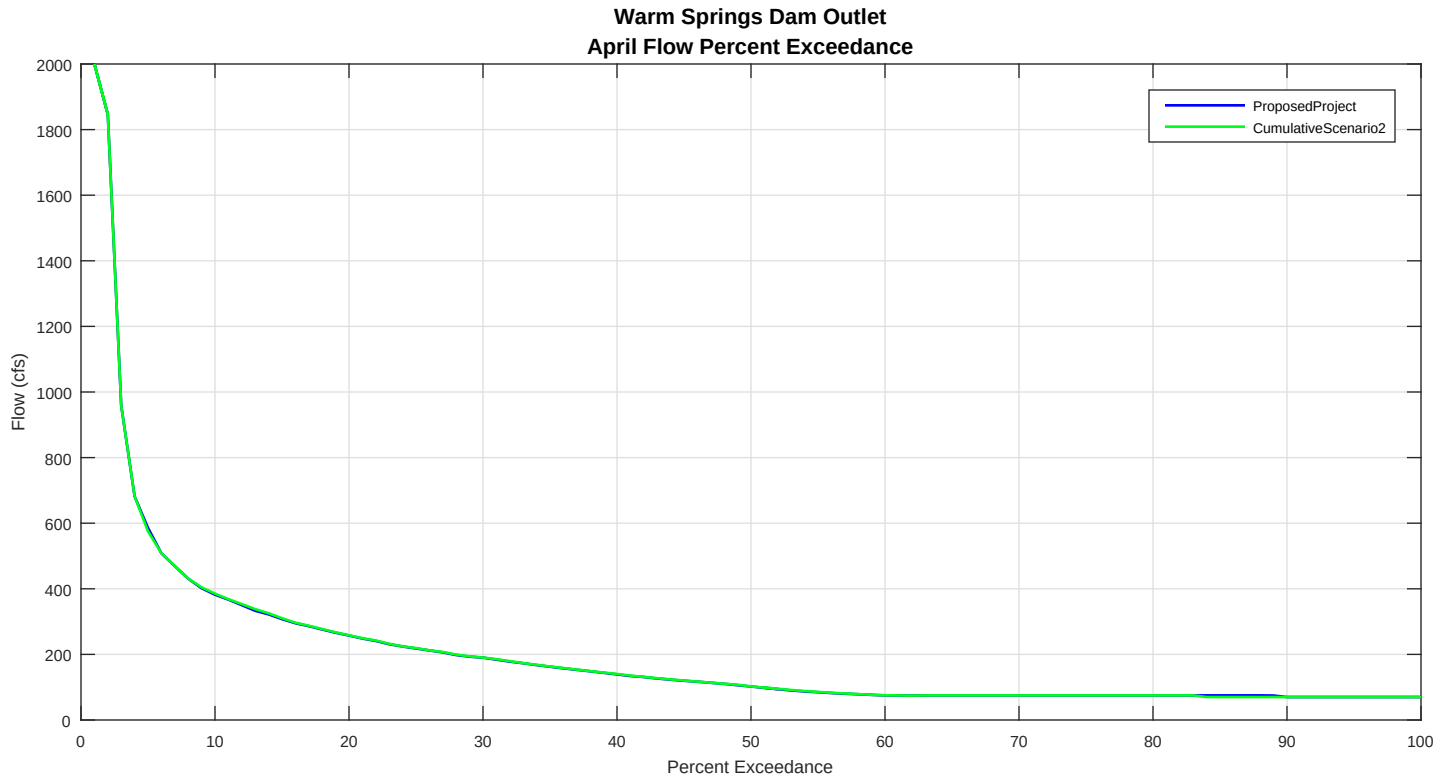
Warm Springs Dam Outlet
April Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario2
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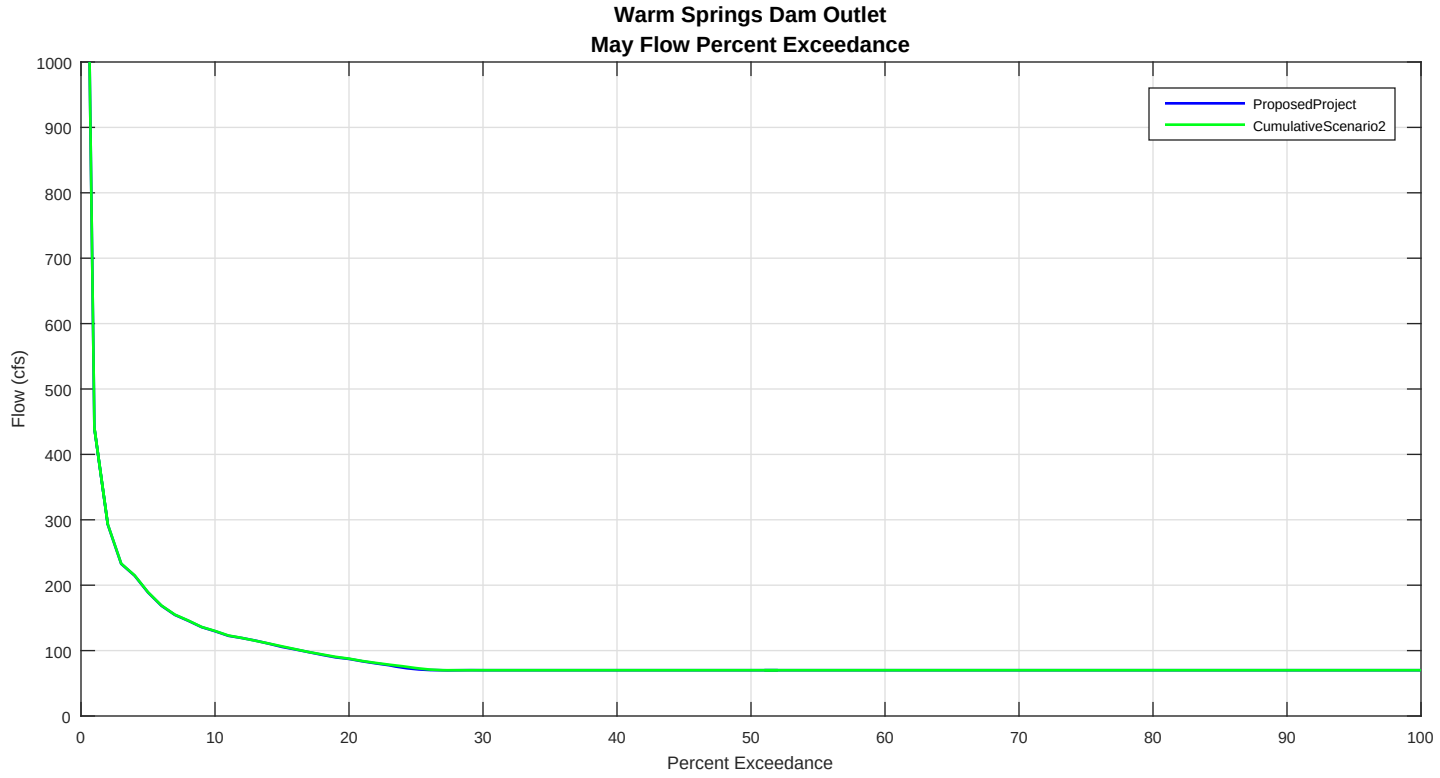
Warm Springs Dam Outlet
May Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario2
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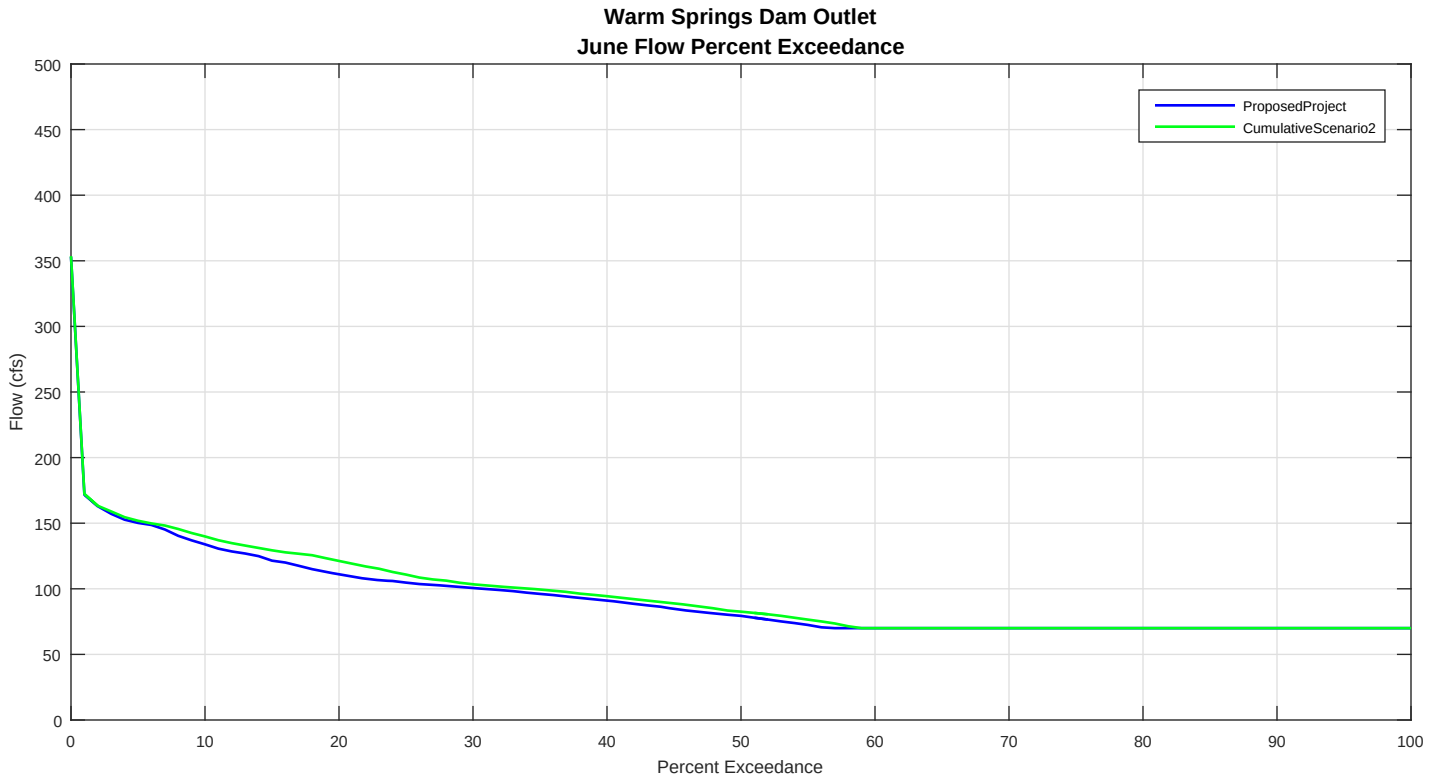
Warm Springs Dam Outlet
June Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
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60
70
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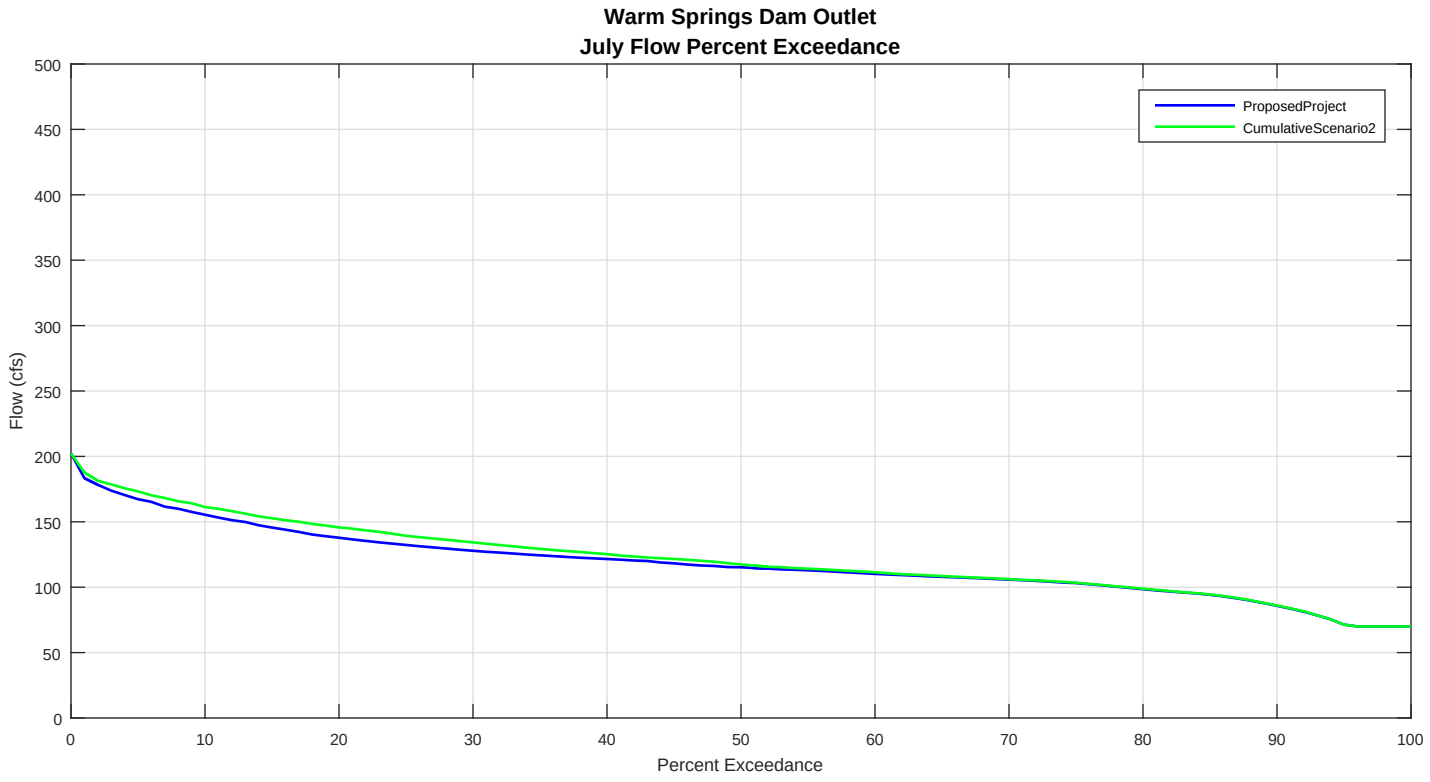
90
100


Warm Springs Dam Outlet
July Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
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30
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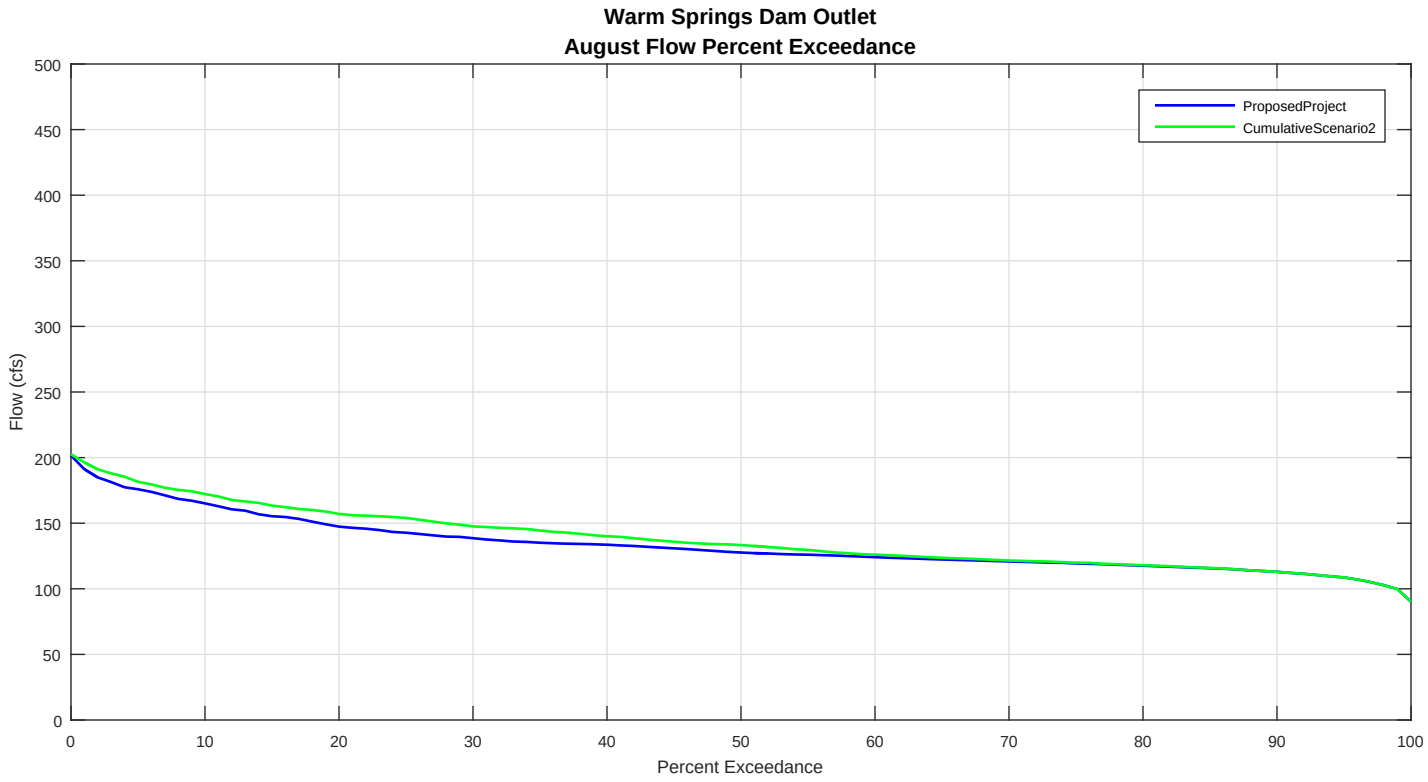
Warm Springs Dam Outlet
August Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
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30
40
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60
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90
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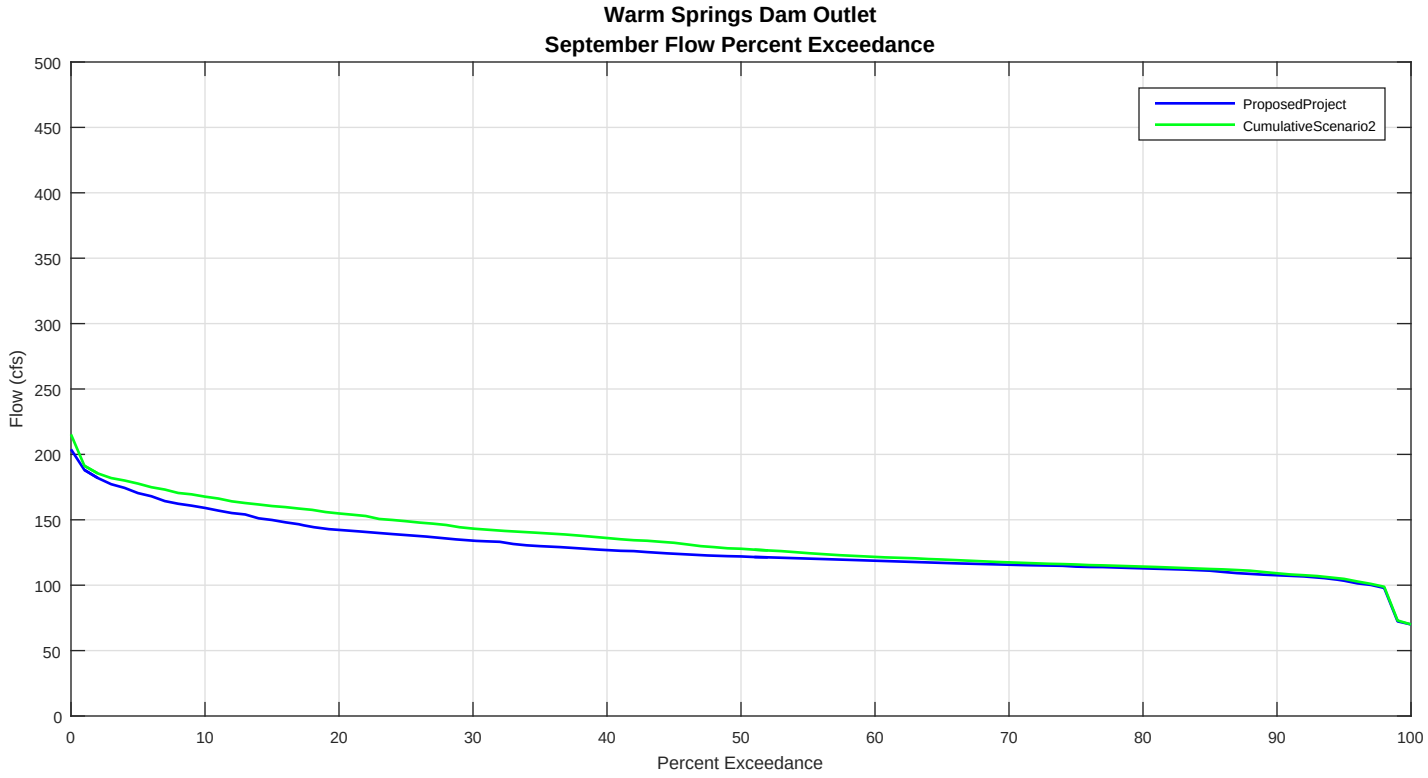
Warm Springs Dam Outlet
September Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
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100
150
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300
350
400
450
500
0
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30
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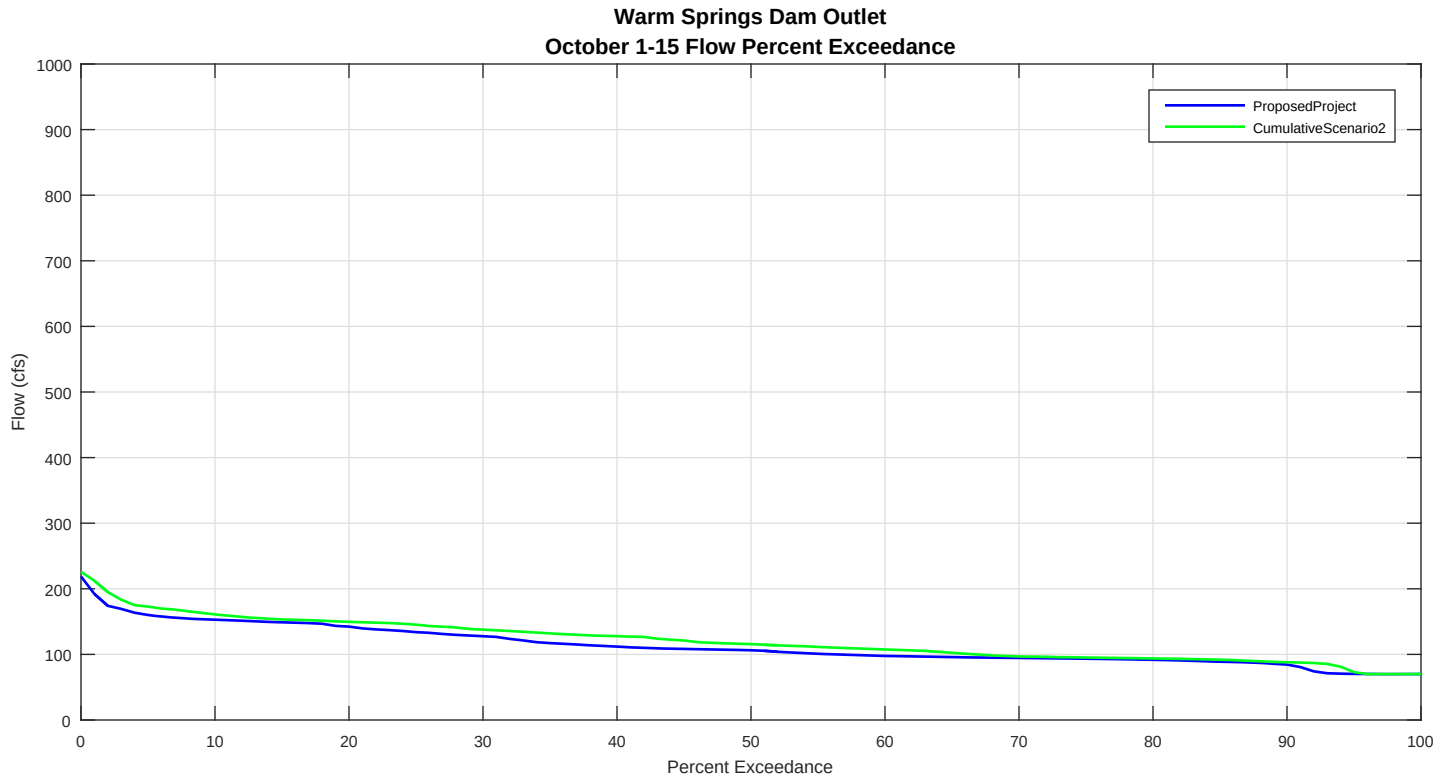
Warm Springs Dam Outlet
October 1-15 Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
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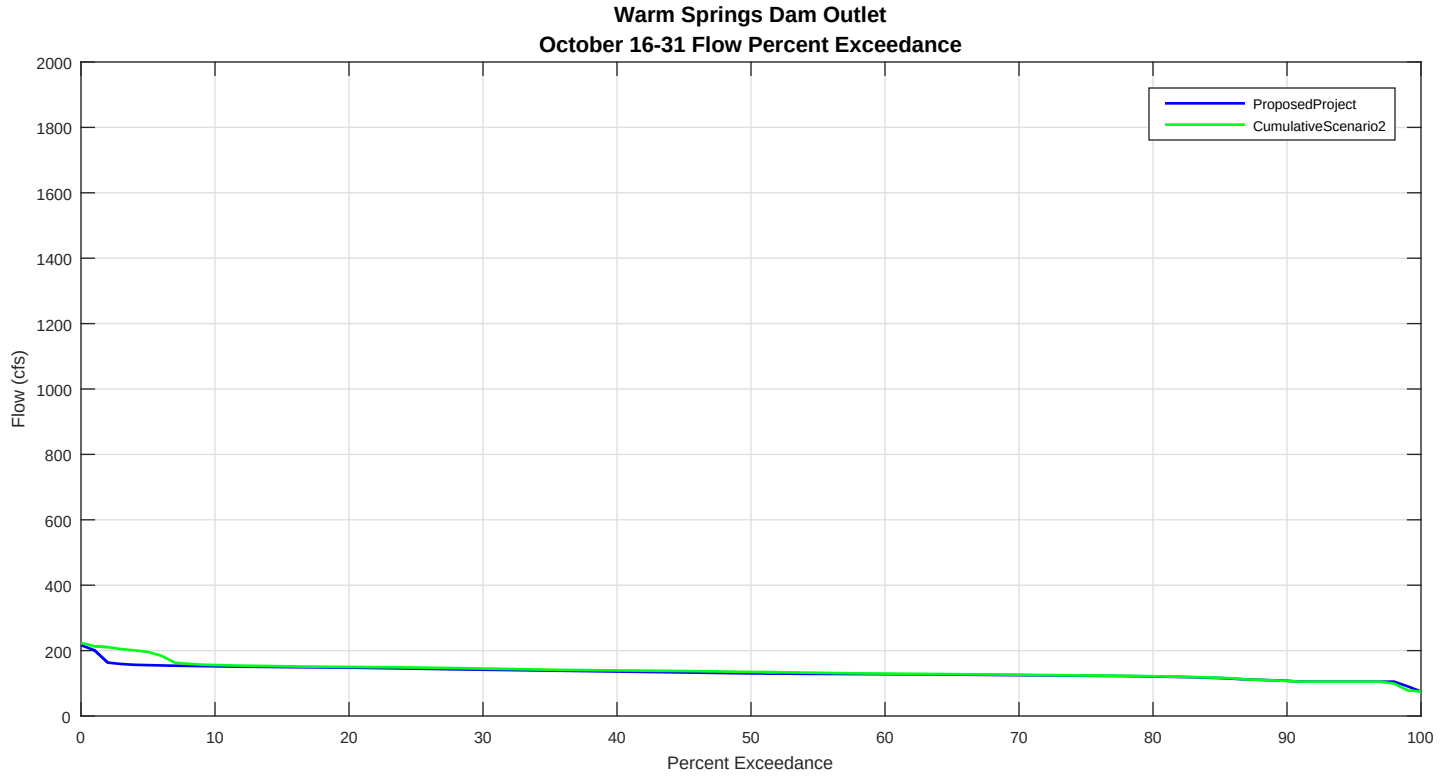
90
100


Warm Springs Dam Outlet
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
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60
70
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90
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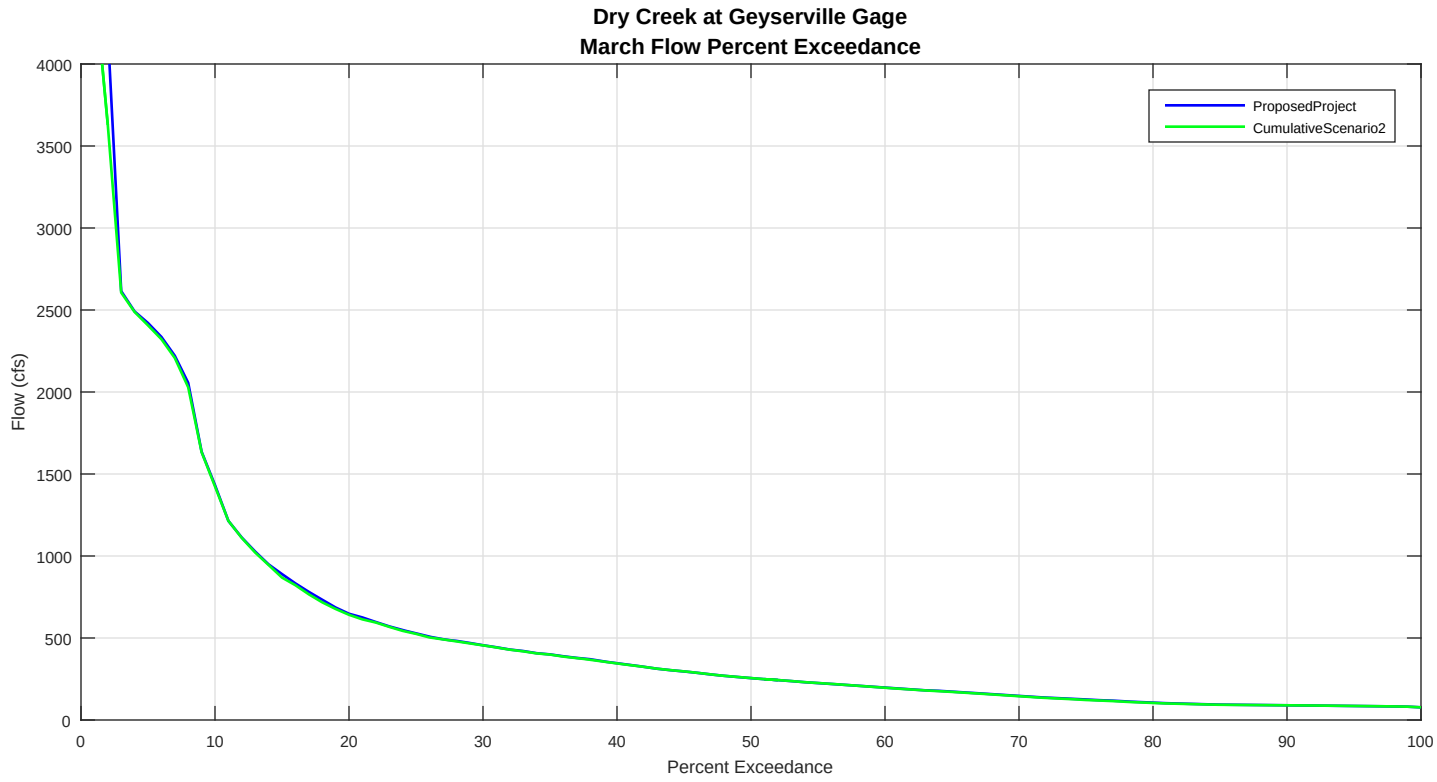
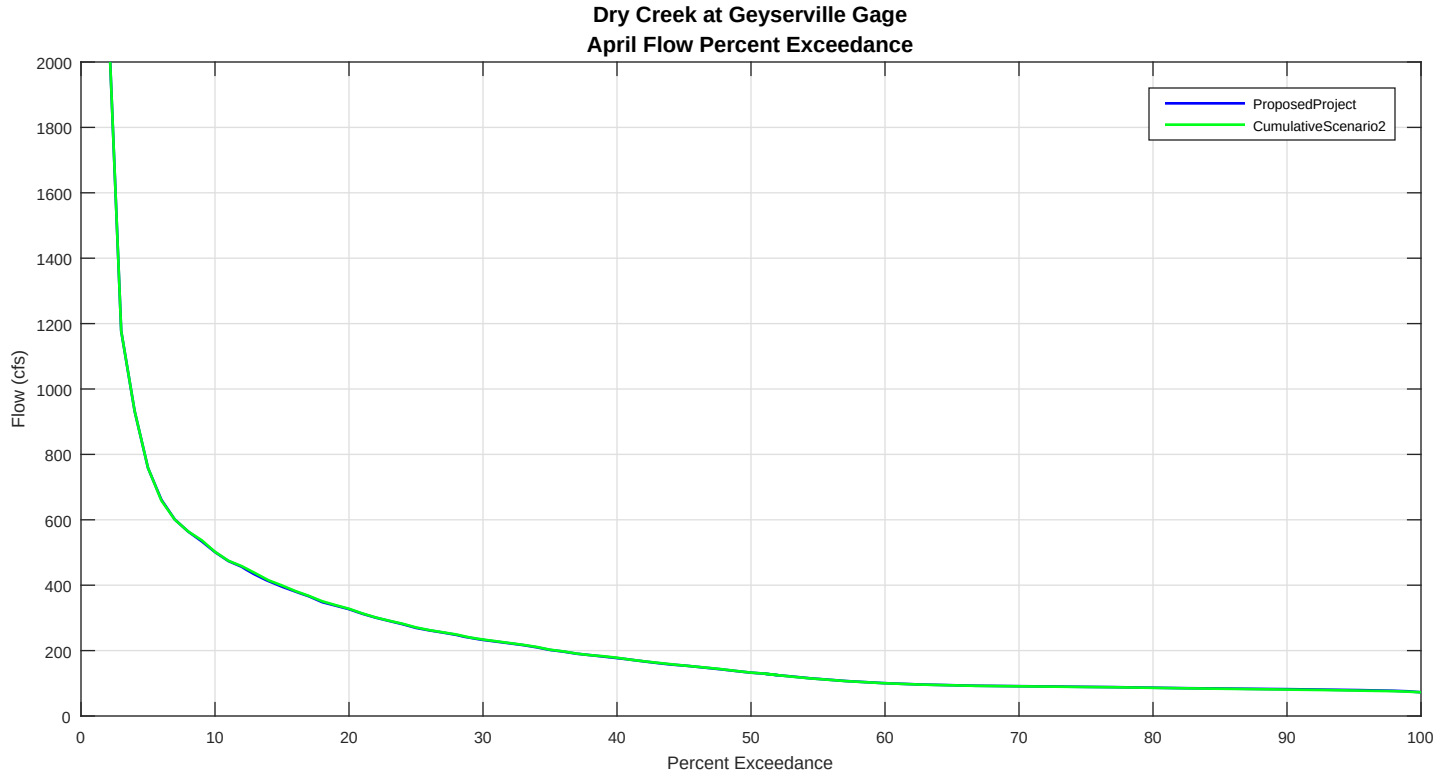

Dry Creek at Geyserville Gage
March Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
500
1000
1500
2000
2500
3000
3500
4000
0
10
20
30
40
50
60
70
80
90
100


Dry Creek at Geyserville Gage
April Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
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70
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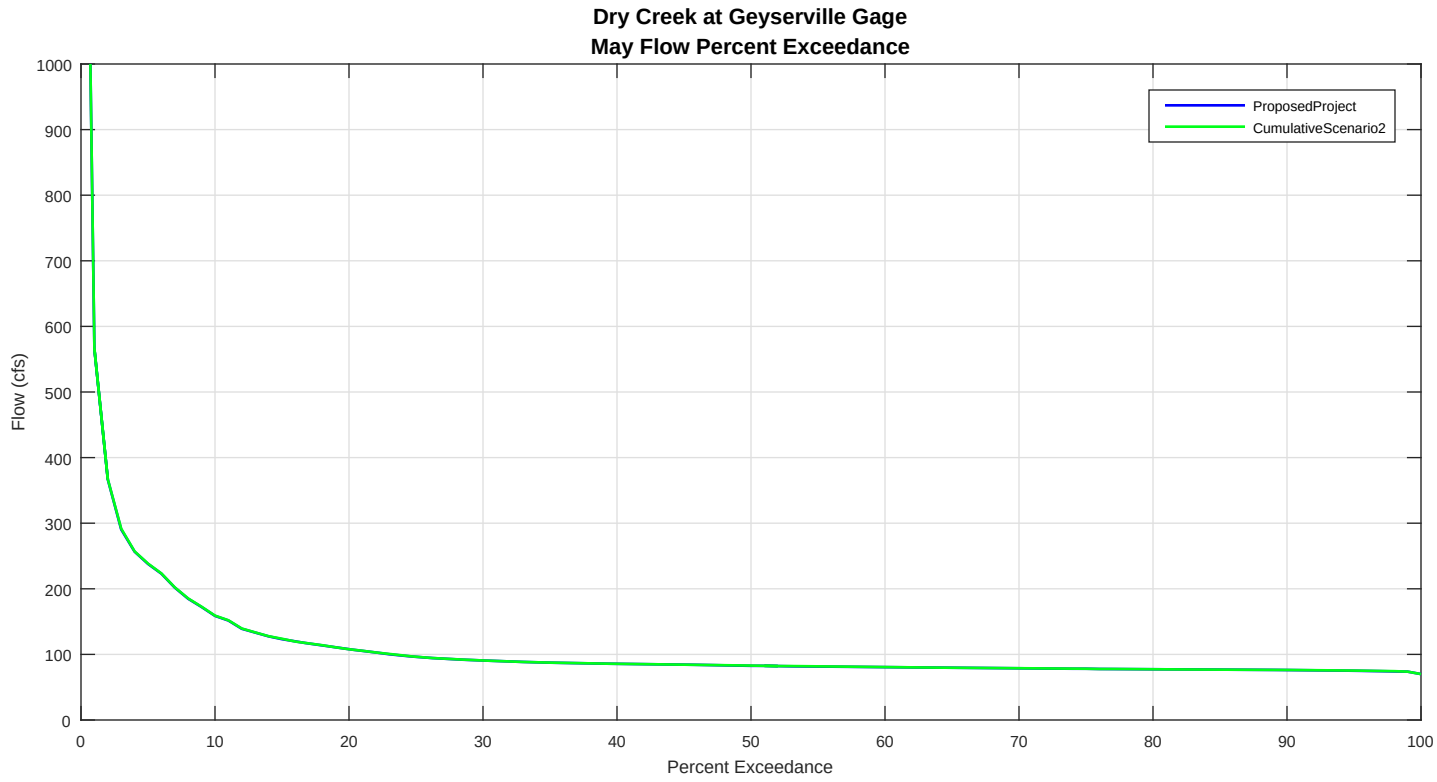
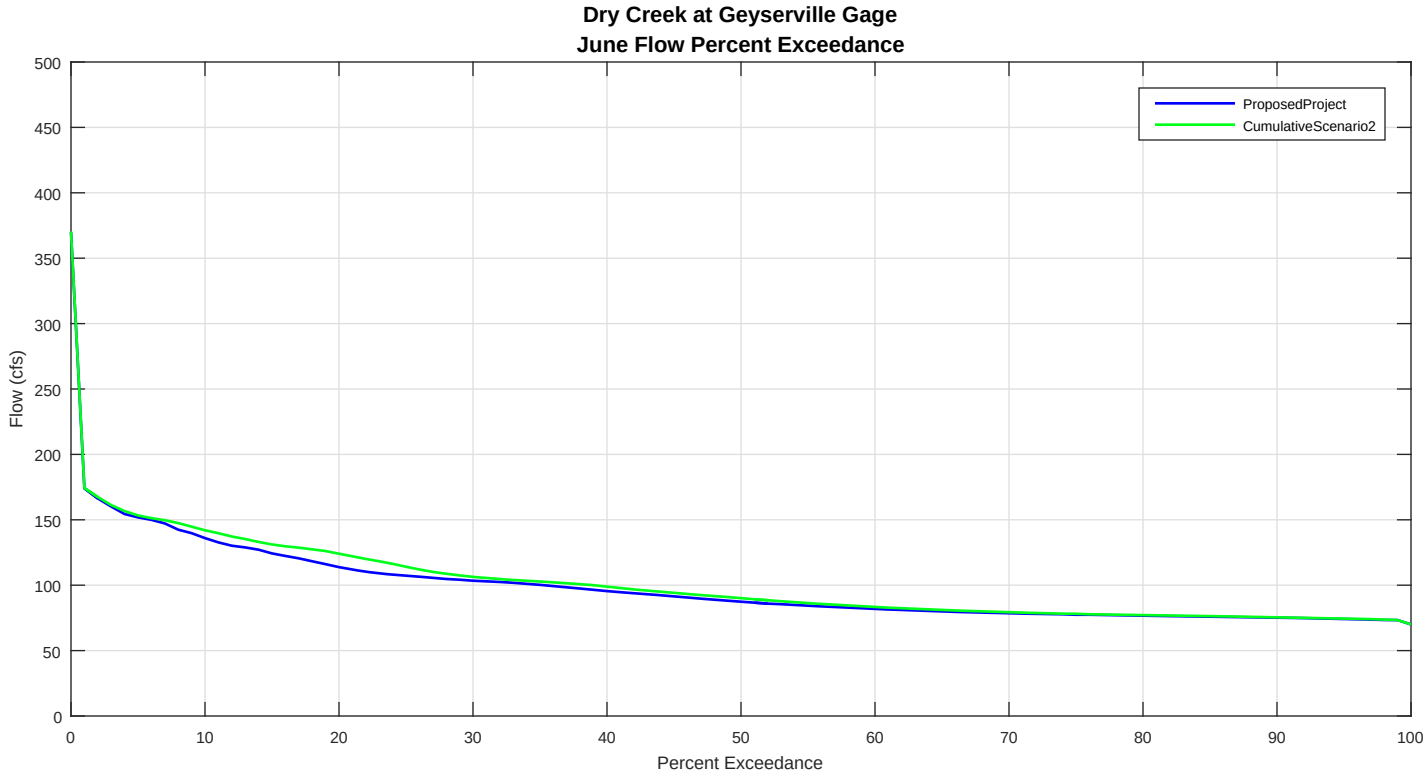
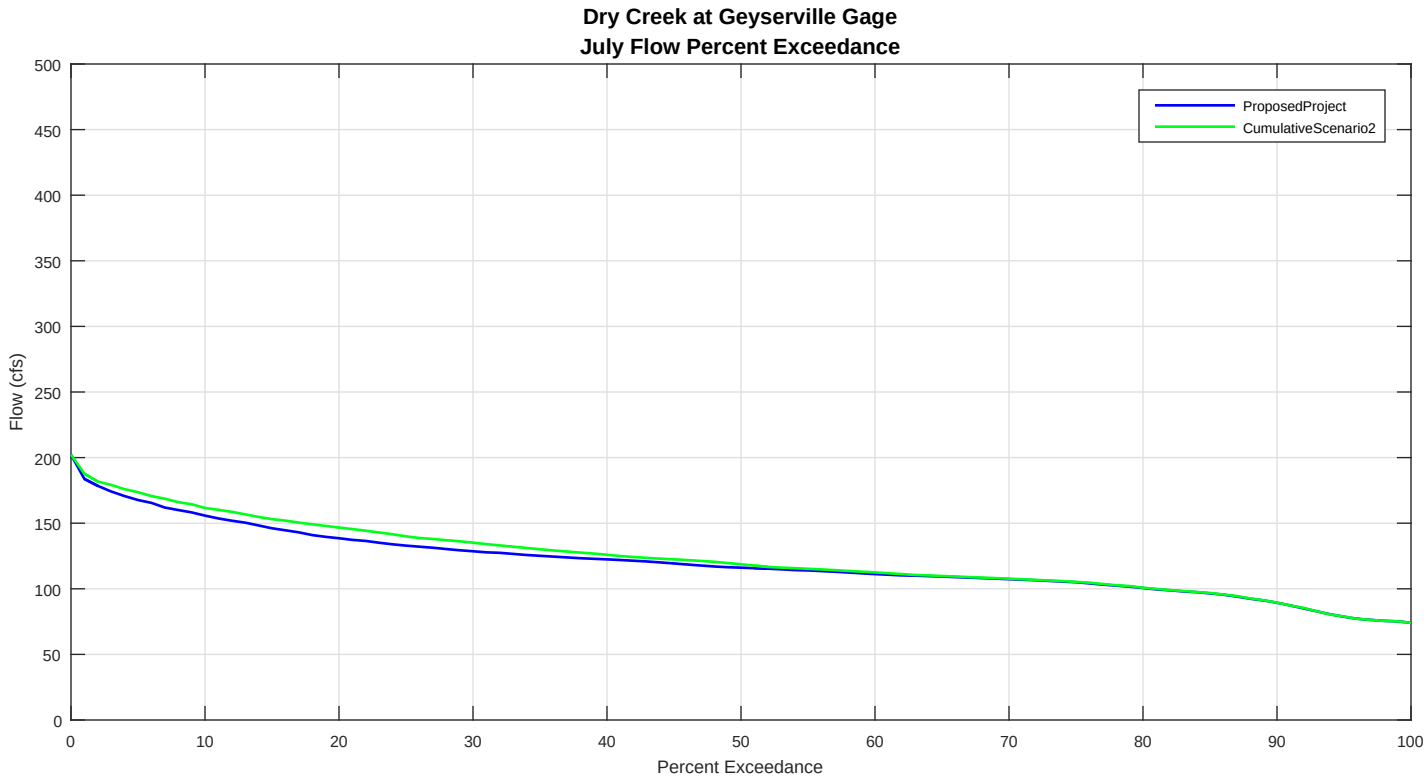
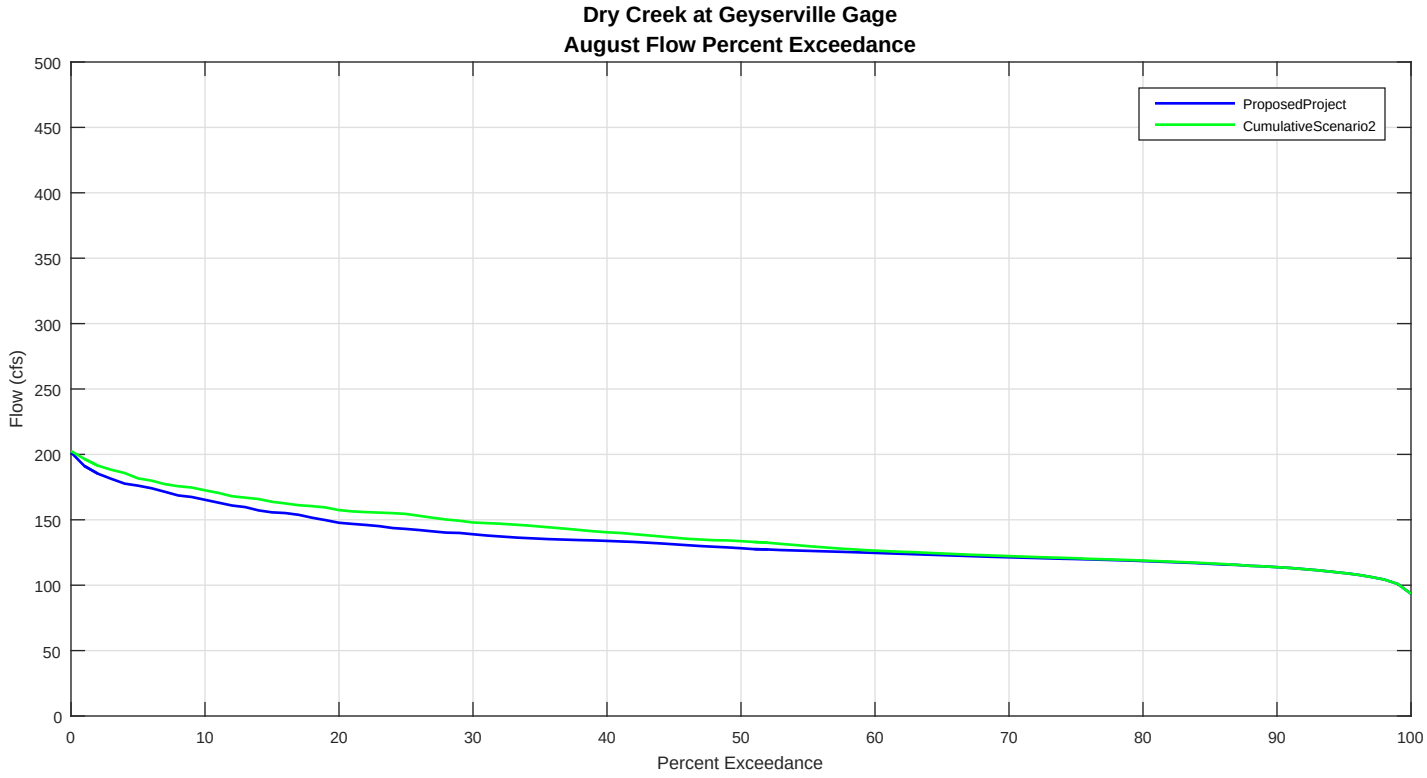
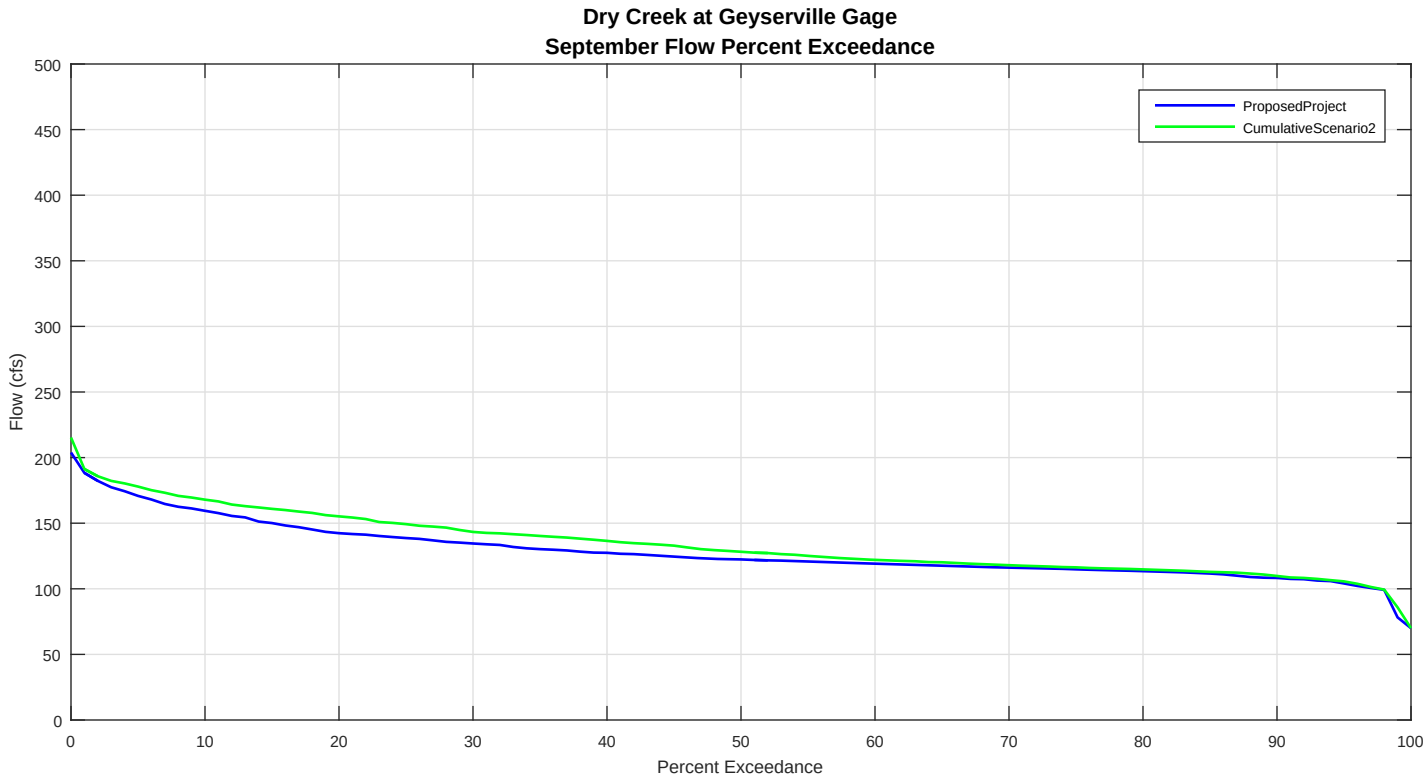
90
100

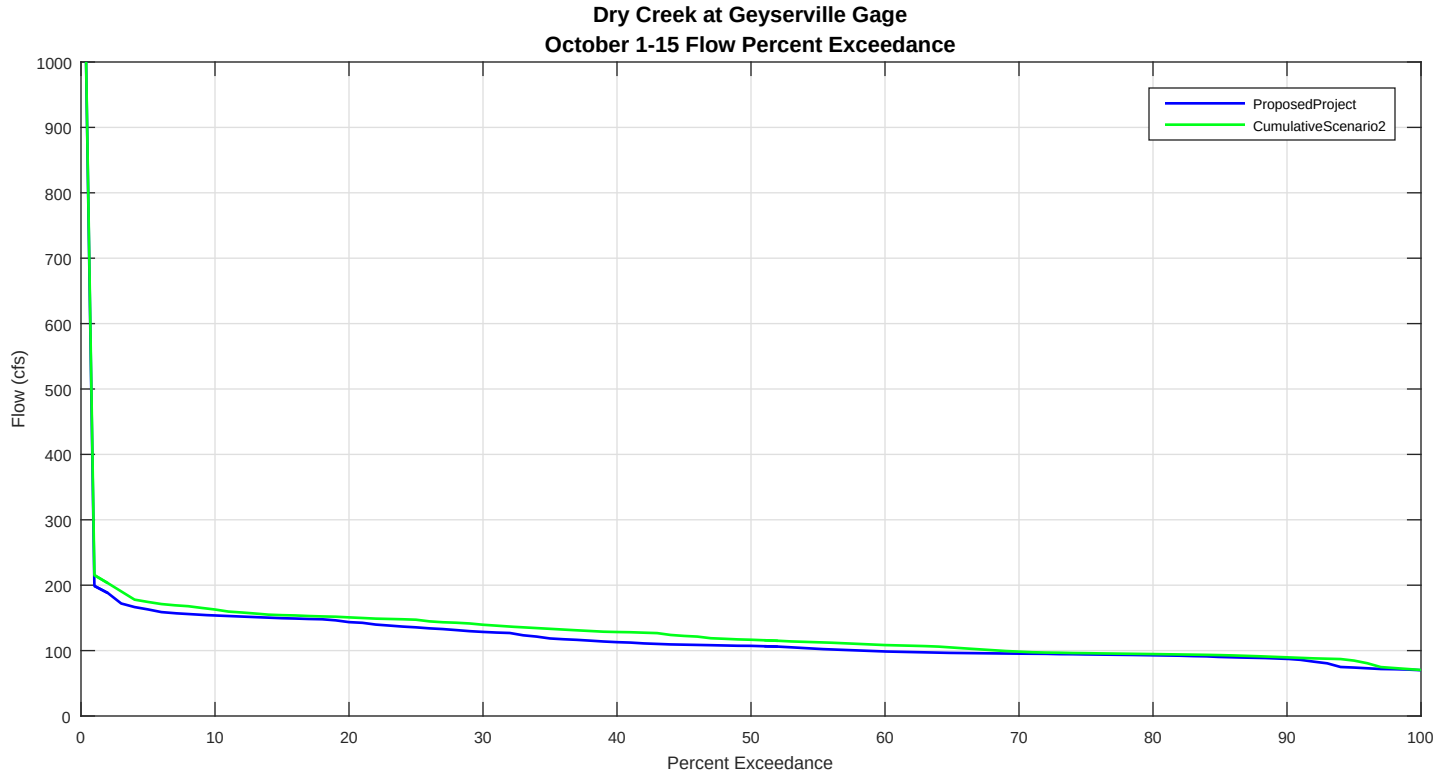

Dry Creek at Geyserville Gage
May Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100

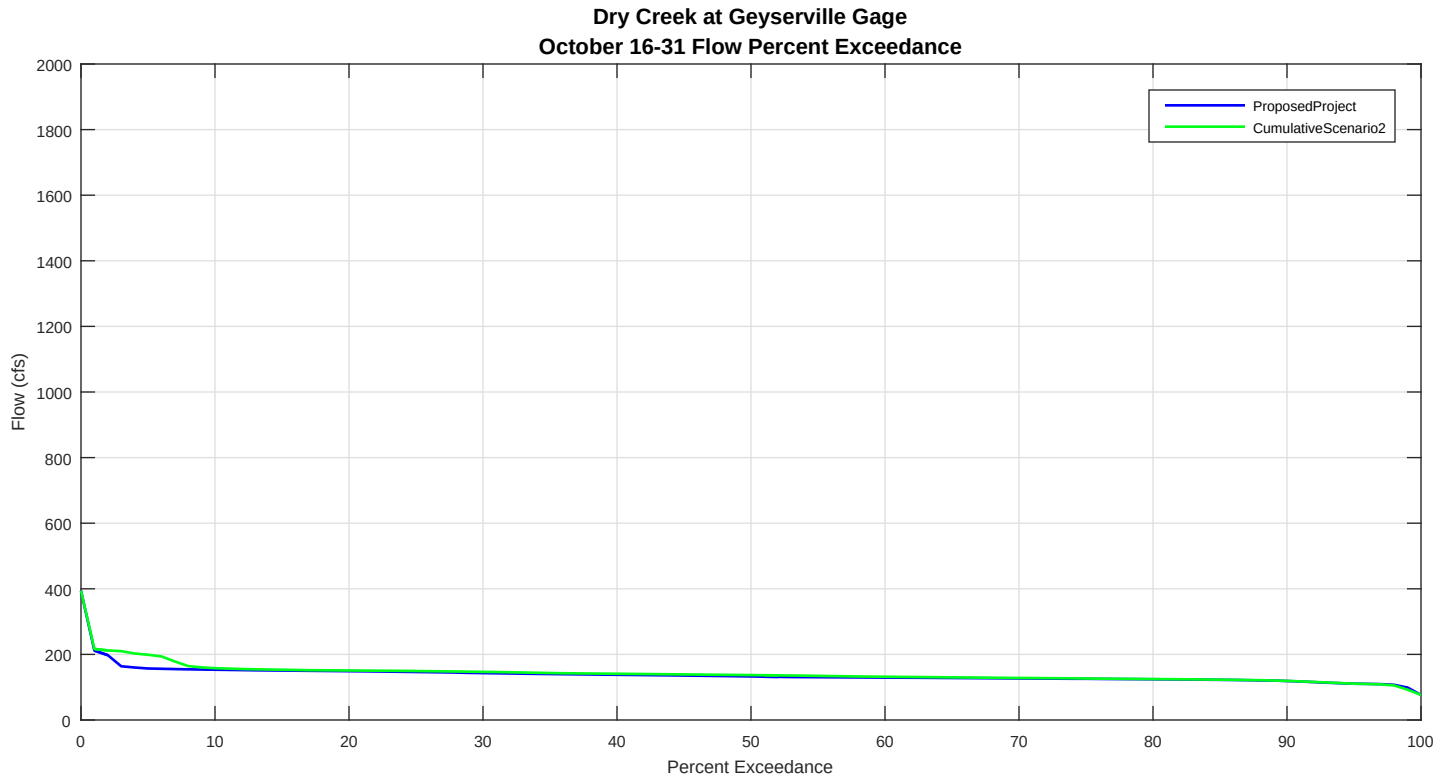

Dry Creek at Geyserville Gage
June Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

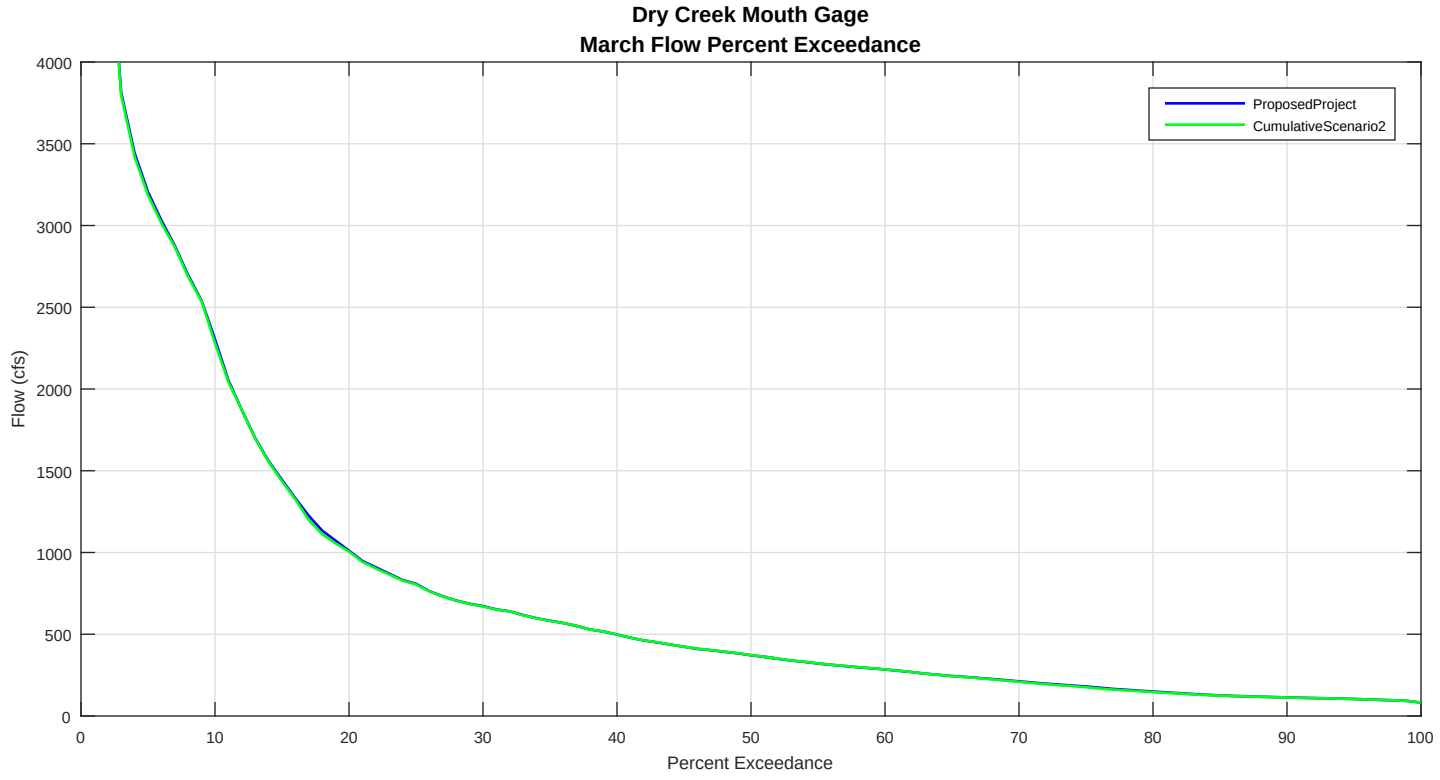

Dry Creek at Geyserville Gage
July Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

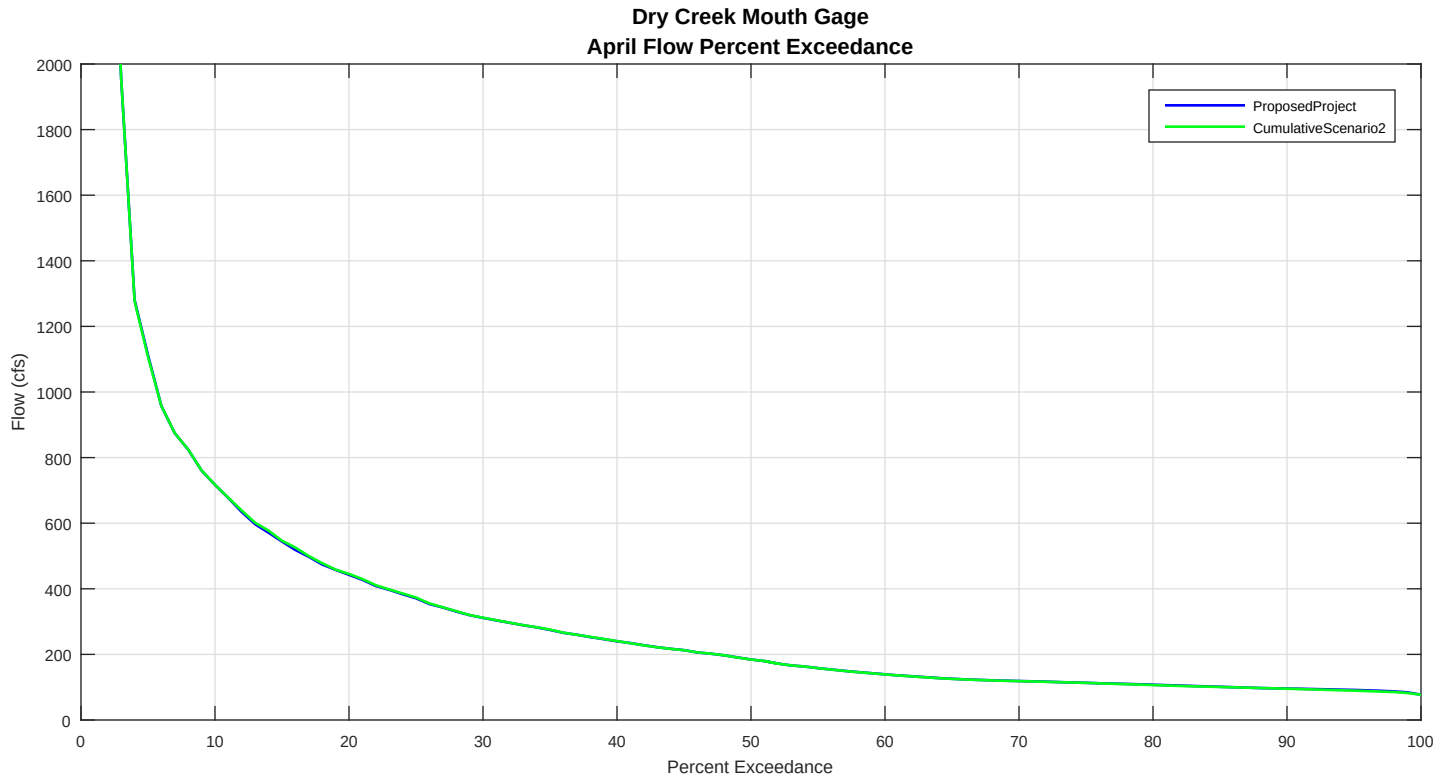

Dry Creek at Geyserville Gage
August Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100


Dry Creek at Geyserville Gage
September Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100


Dry Creek at Geyserville Gage
October 1-15 Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100


Dry Creek at Geyserville Gage
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
March Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
500
1000
1500
2000
2500
3000
3500
4000
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
April Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario2
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
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70
80
90
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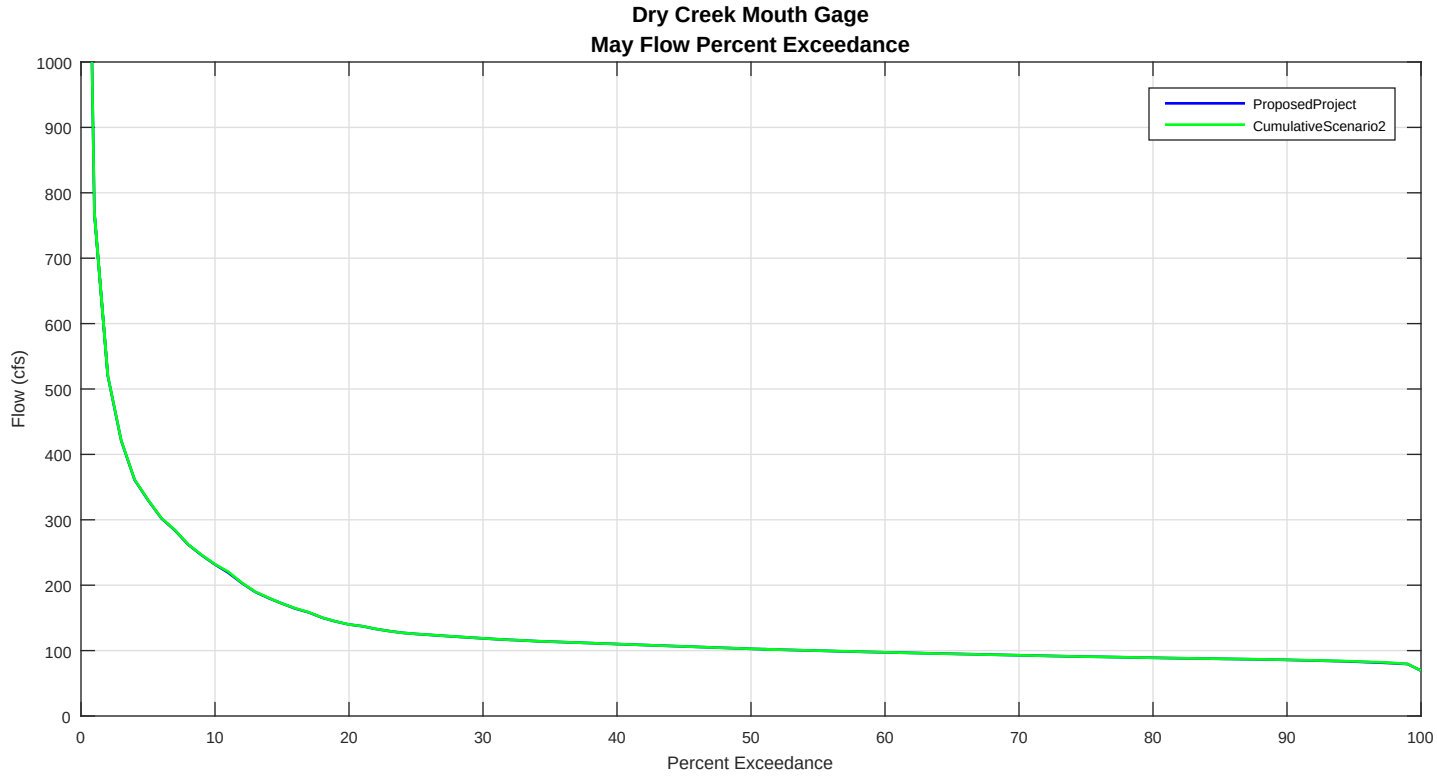
Dry Creek Mouth Gage
May Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario2
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
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70
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90
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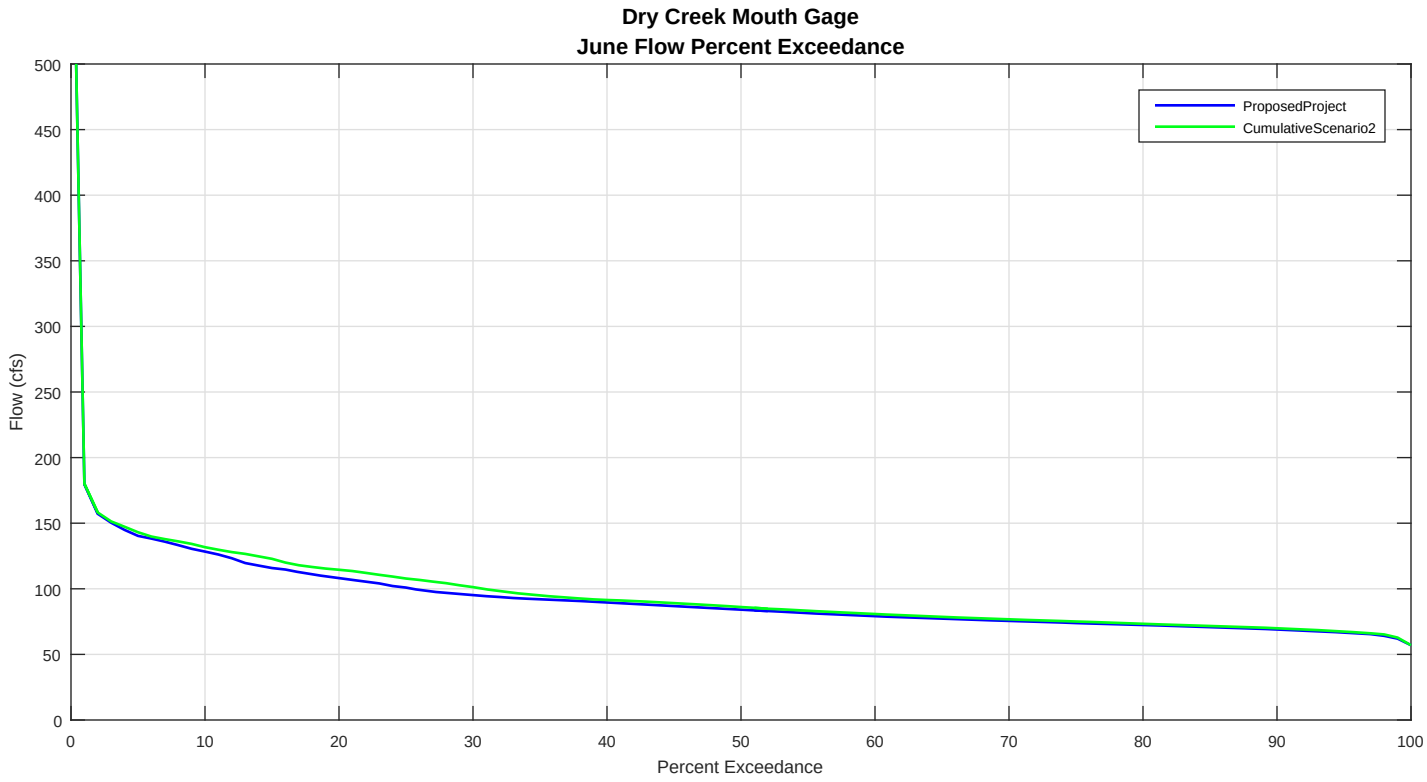
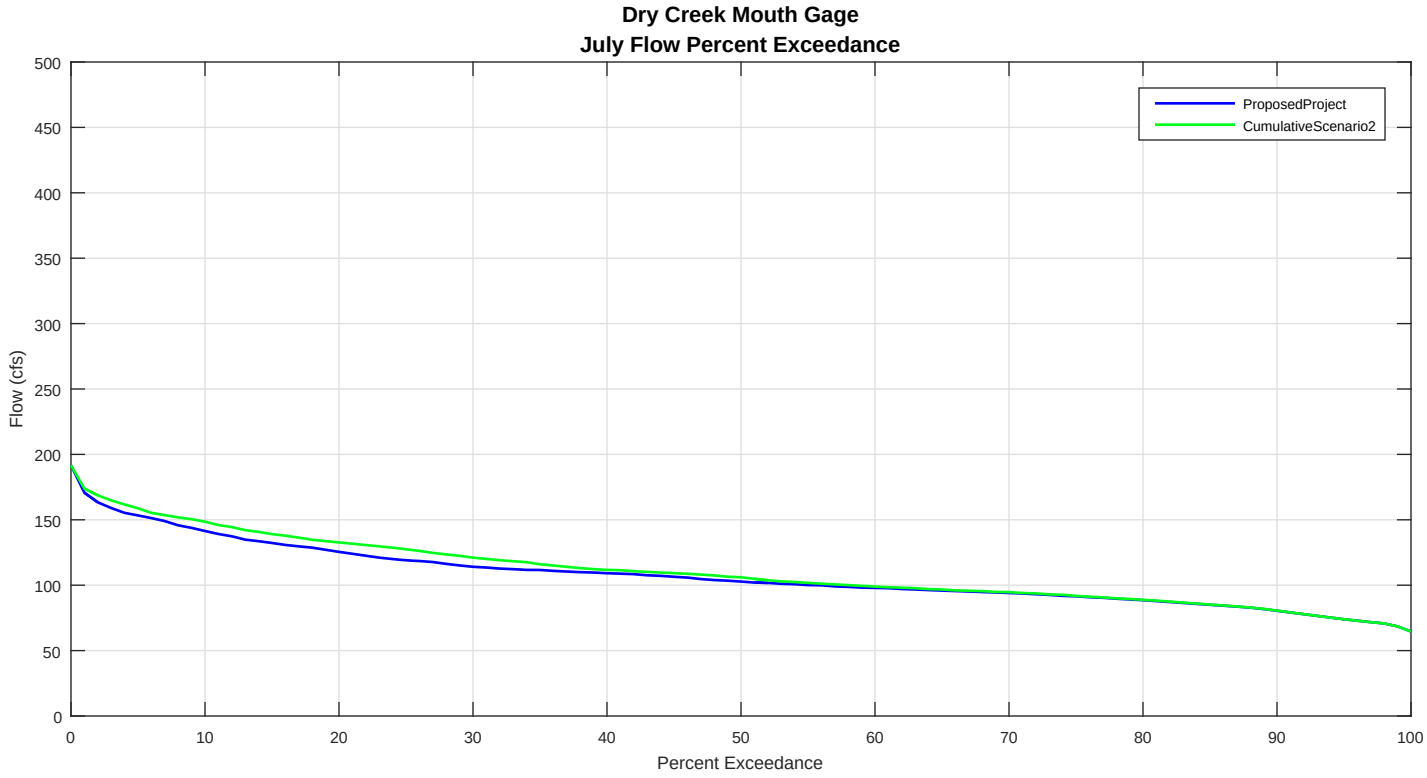
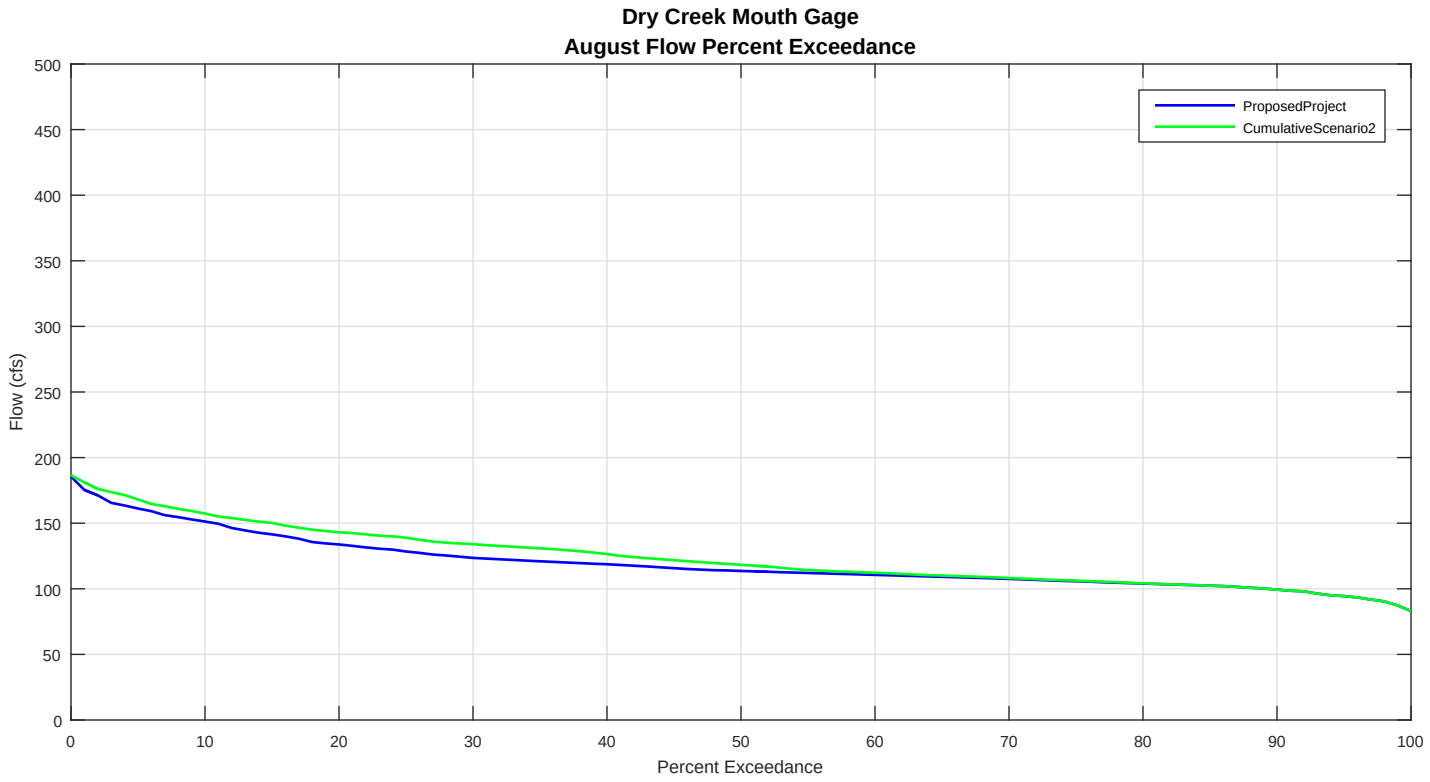
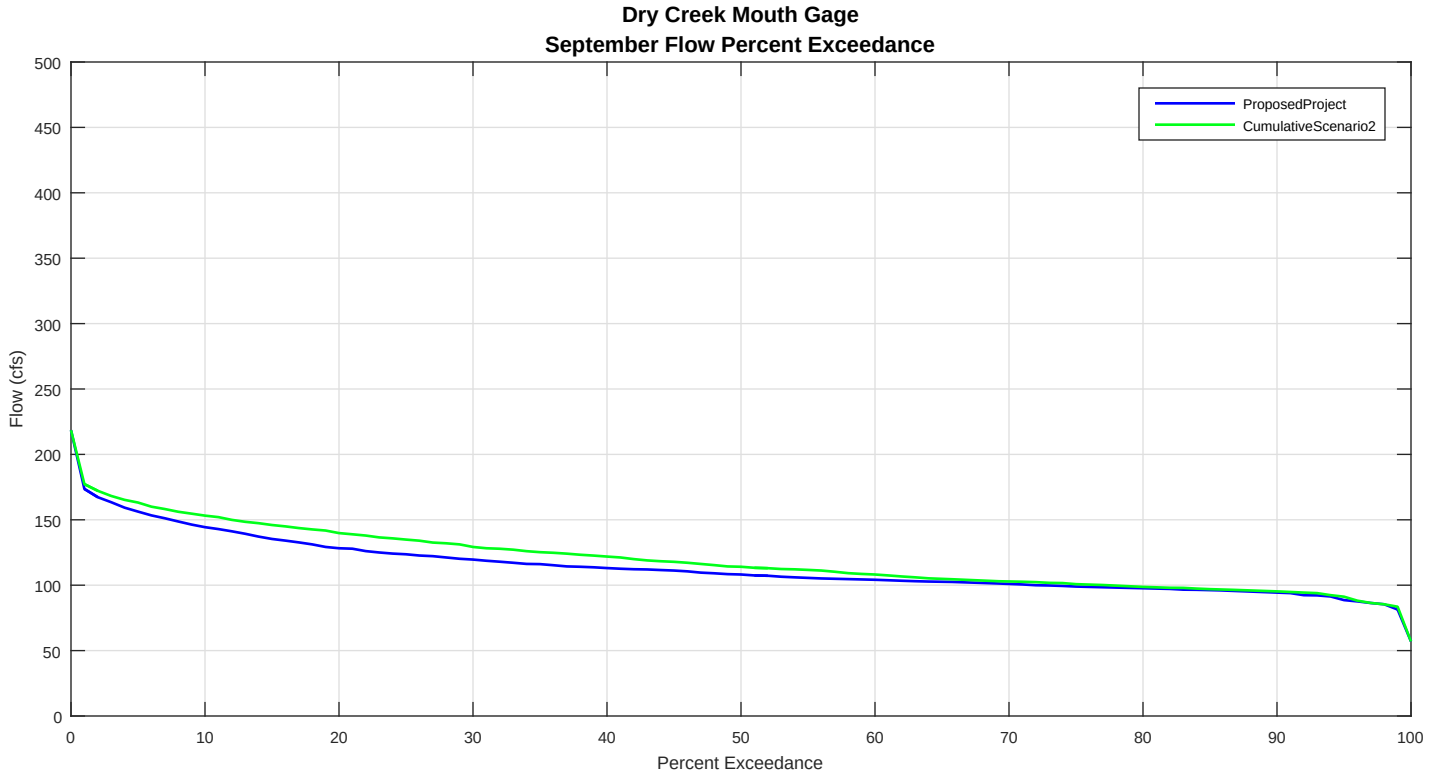
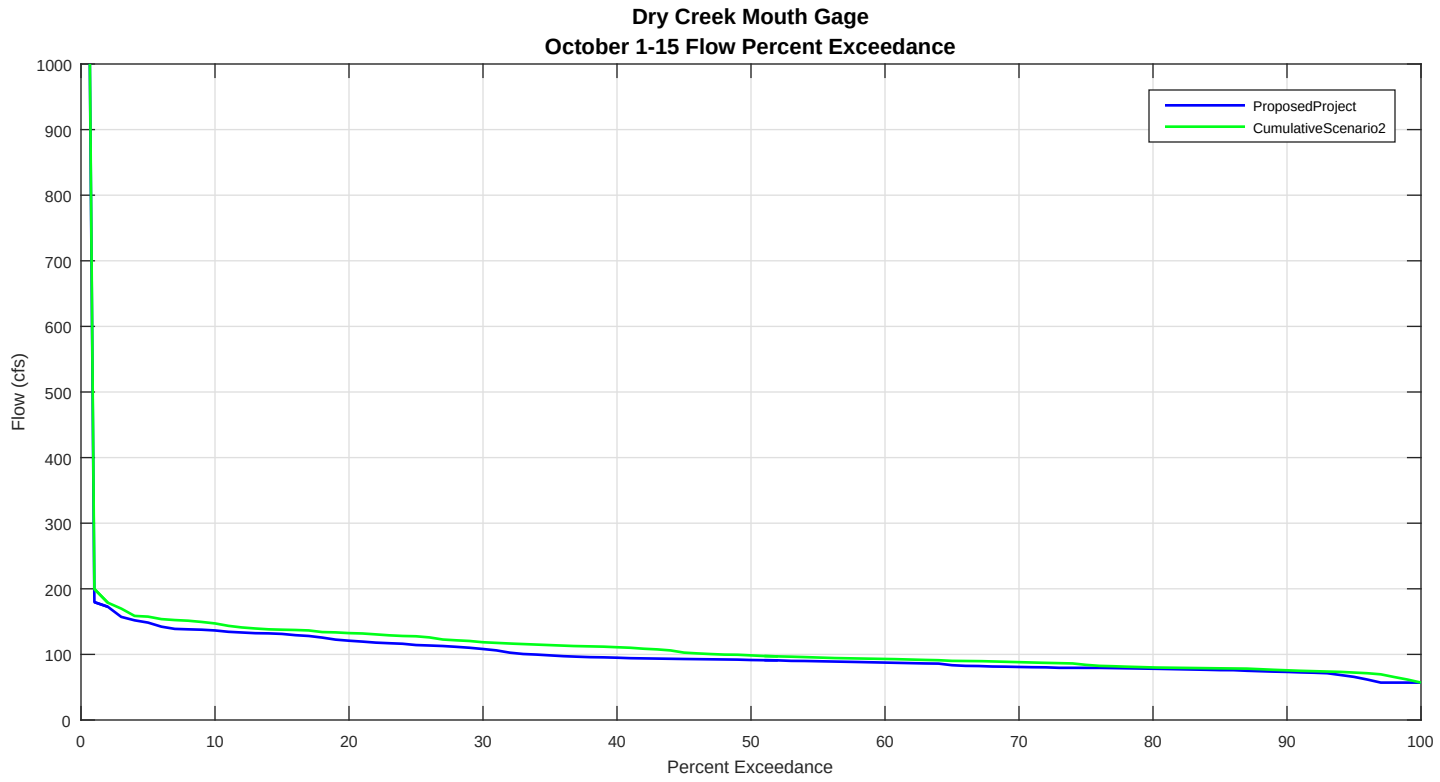
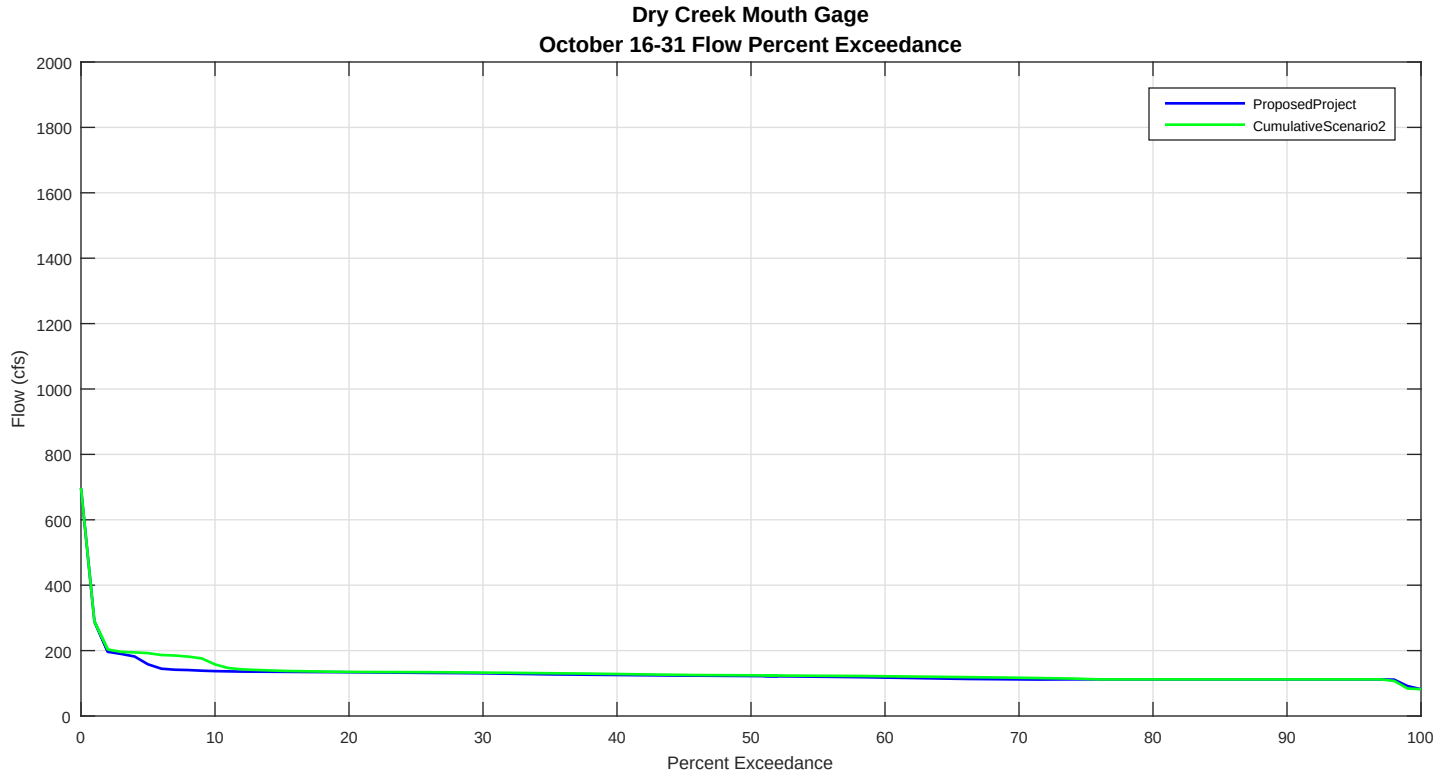

Dry Creek Mouth Gage
June Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario2
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

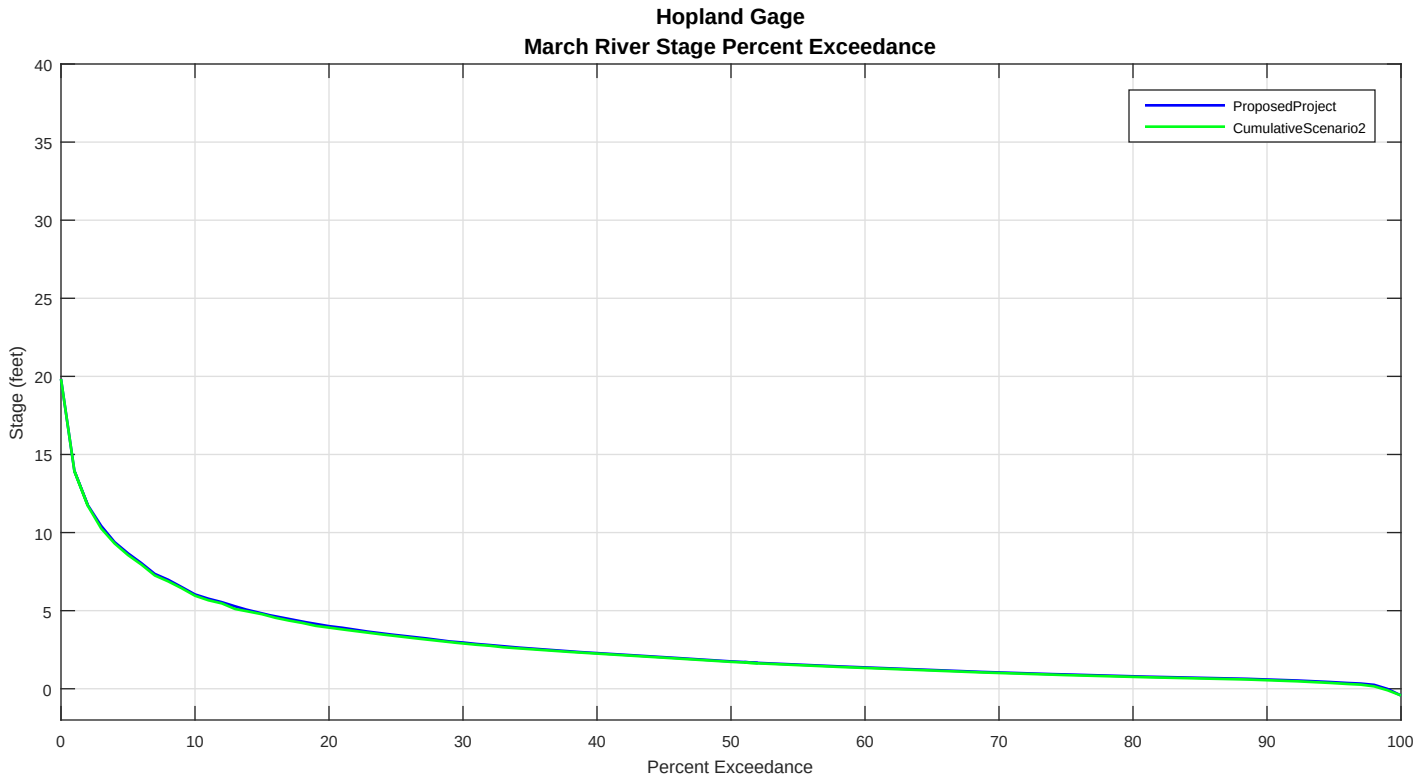

Dry Creek Mouth Gage
July Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario2
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

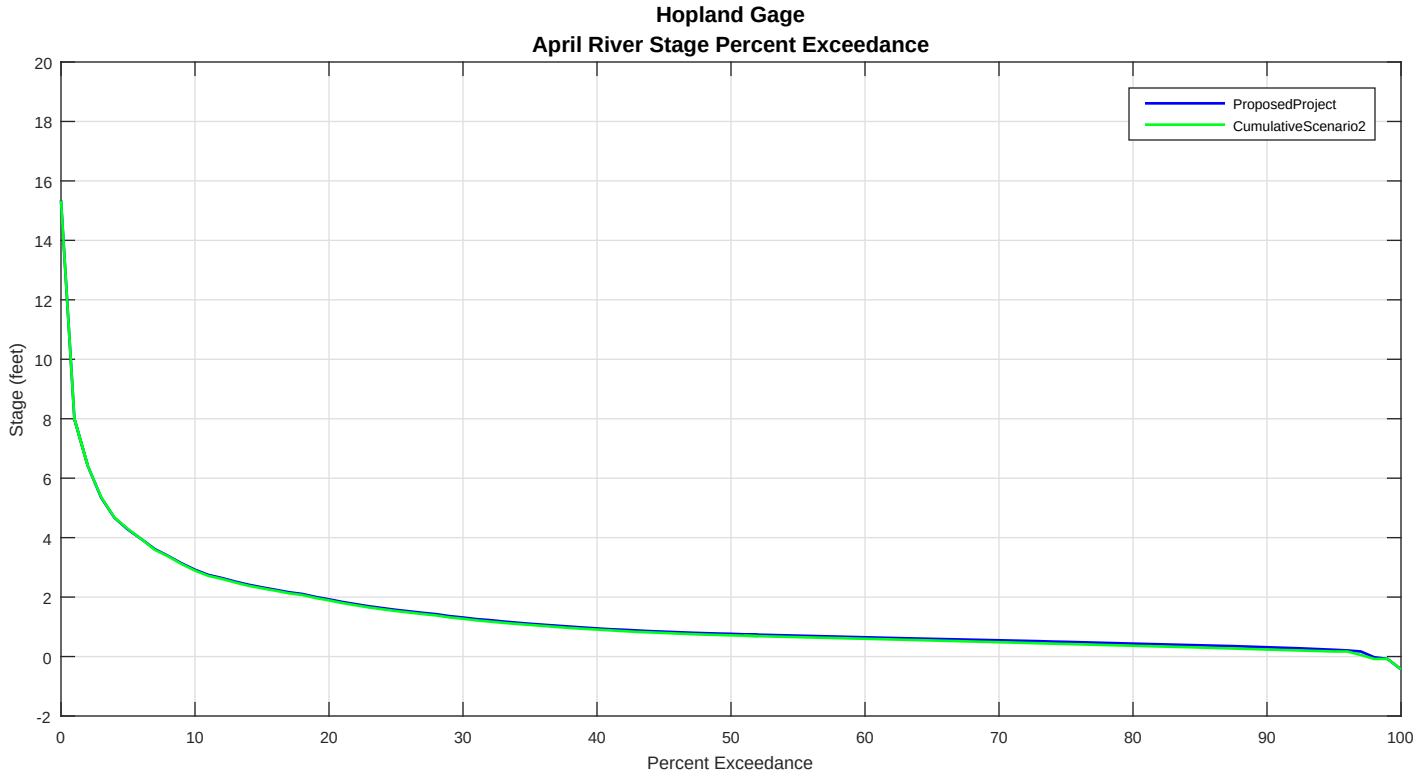

Dry Creek Mouth Gage
August Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

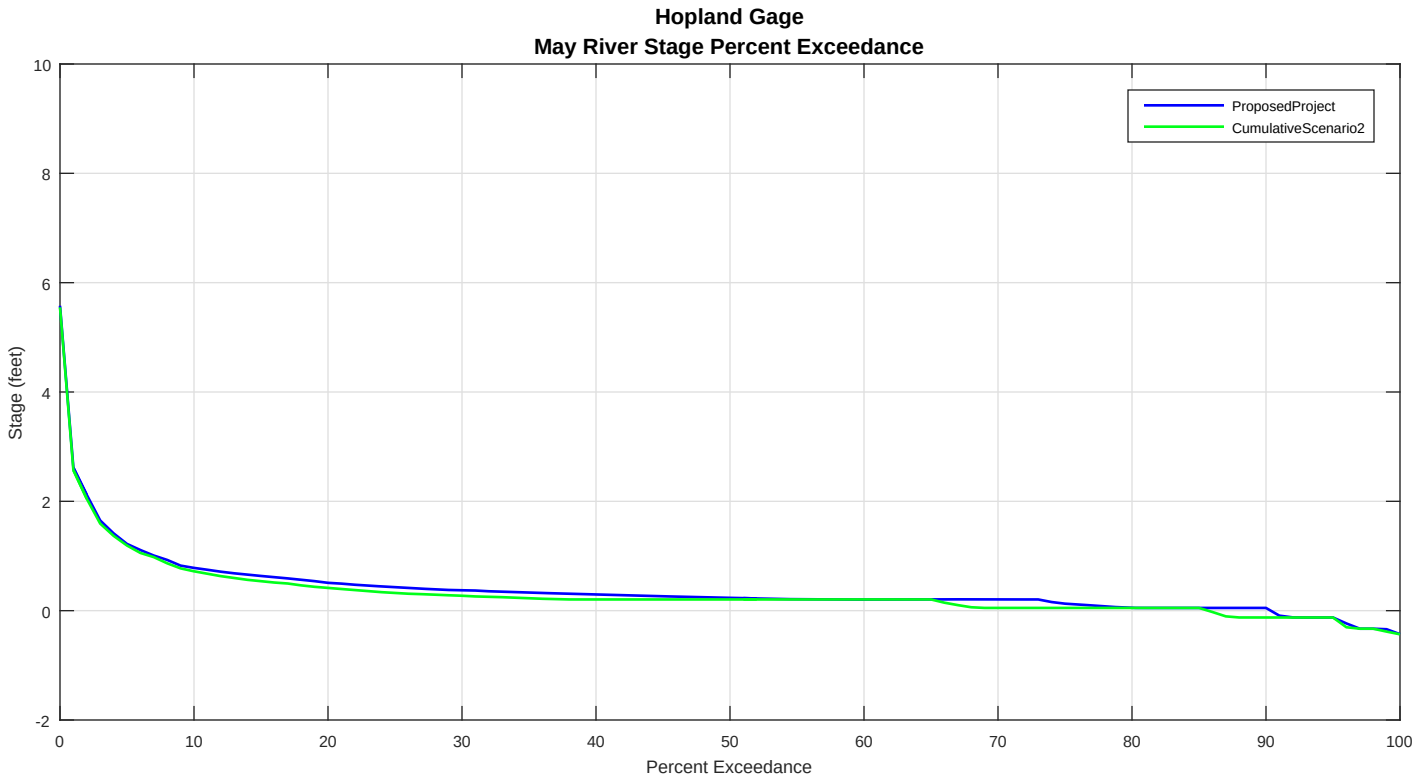

Dry Creek Mouth Gage
September Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

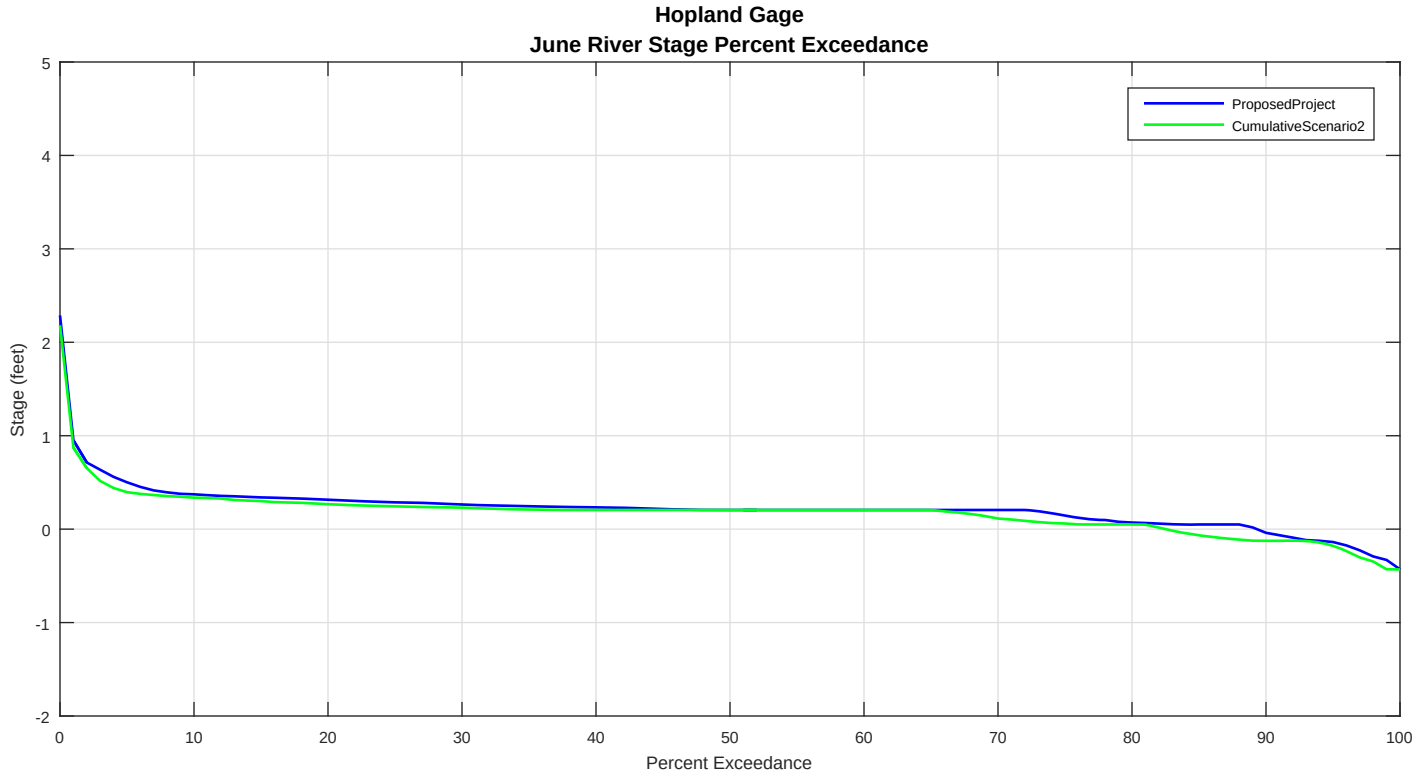

Dry Creek Mouth Gage
October 1-15 Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100

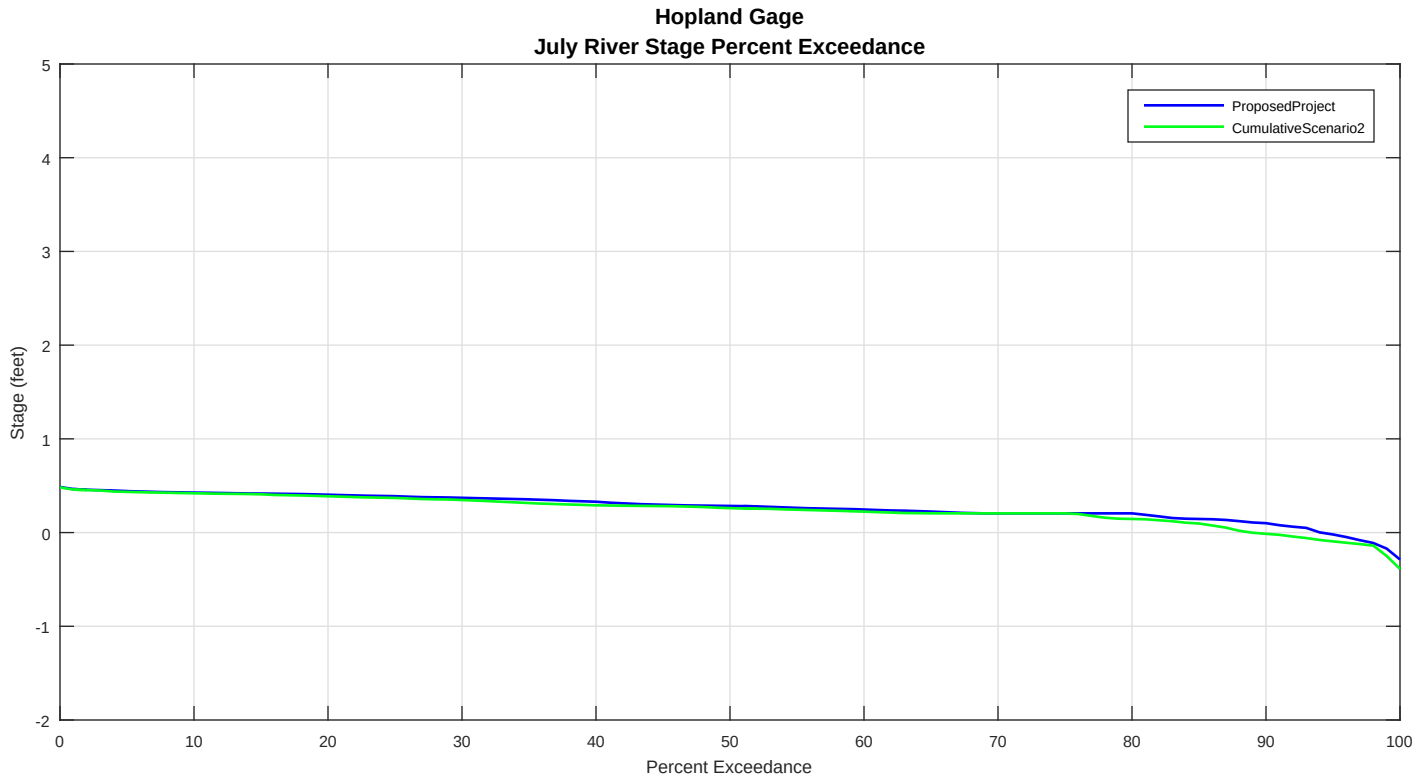

Dry Creek Mouth Gage
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario2
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100

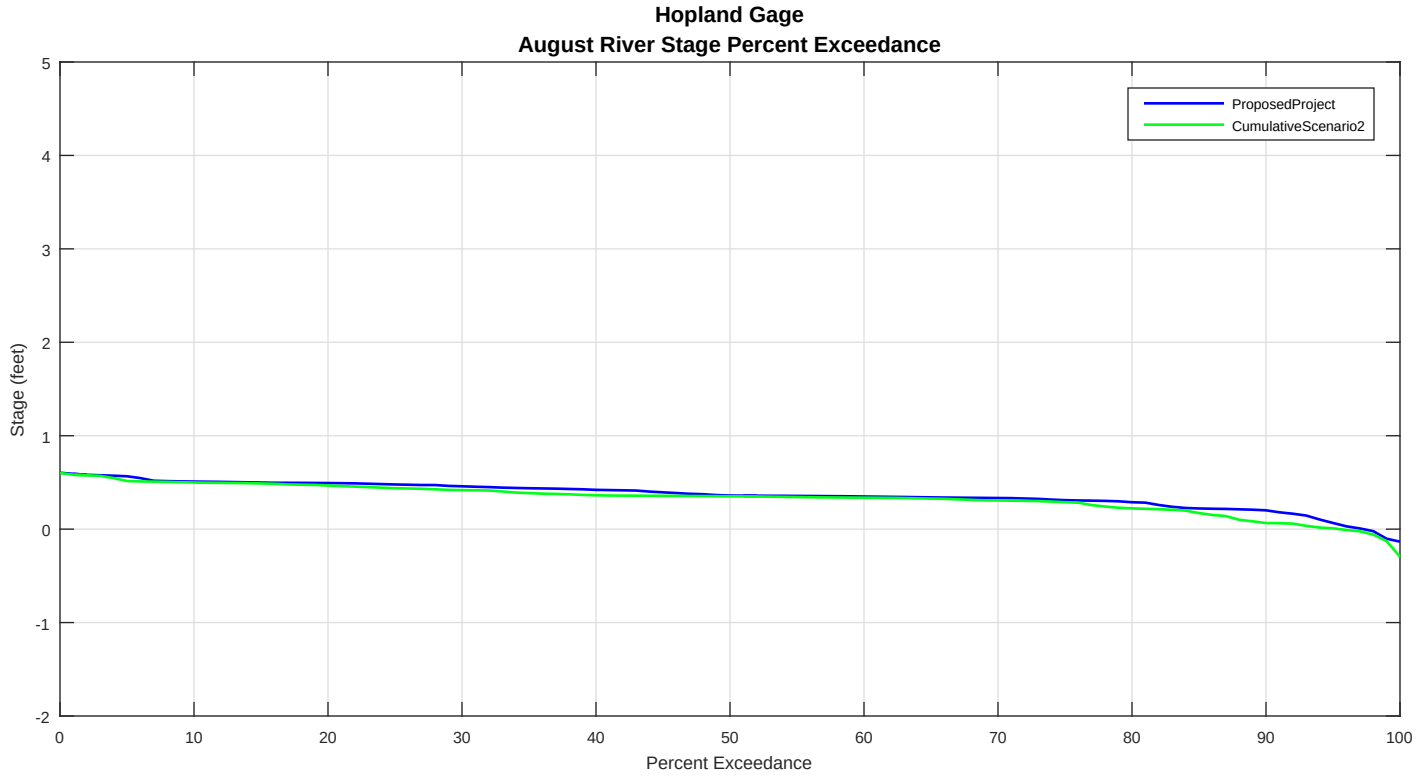

Hopland Gage
March River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100

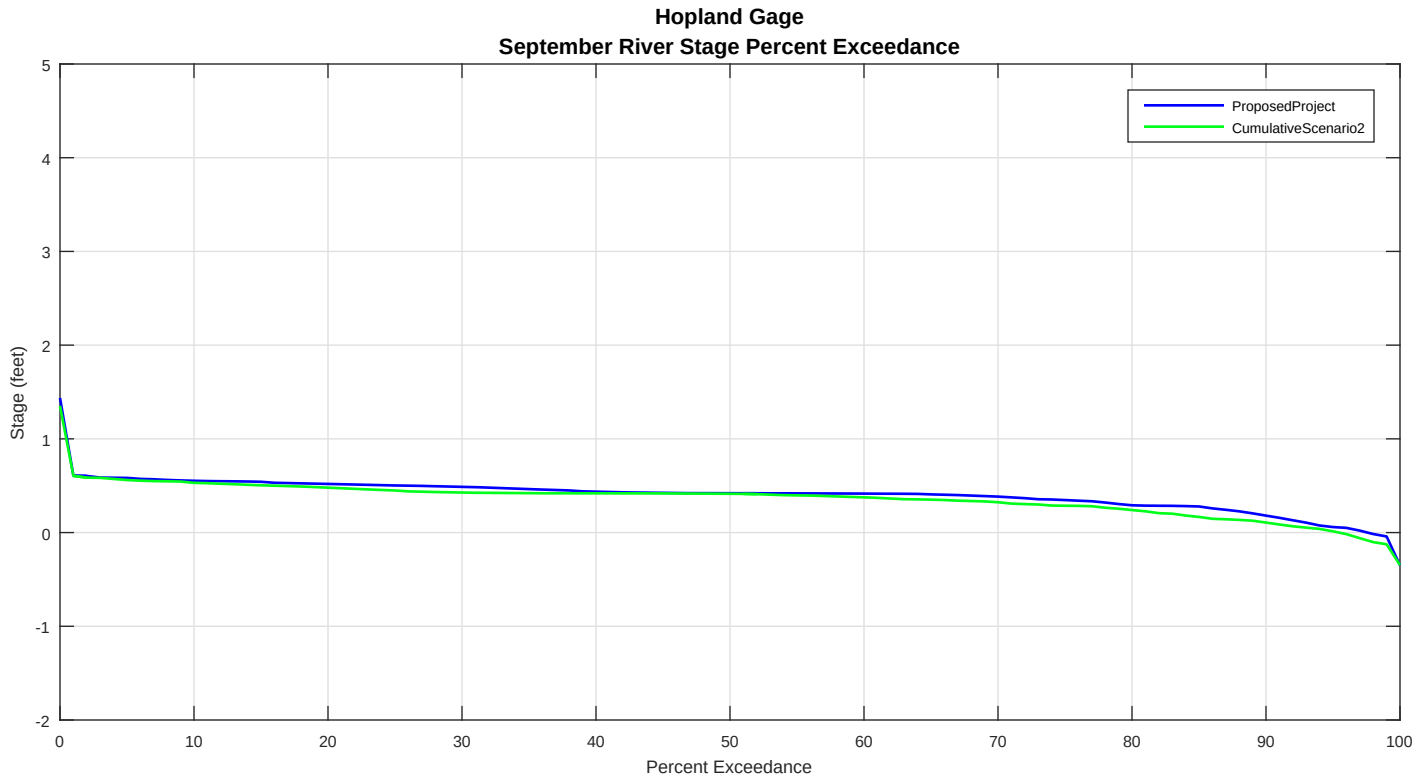

Hopland Gage
April River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
20
18
16
14
12
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

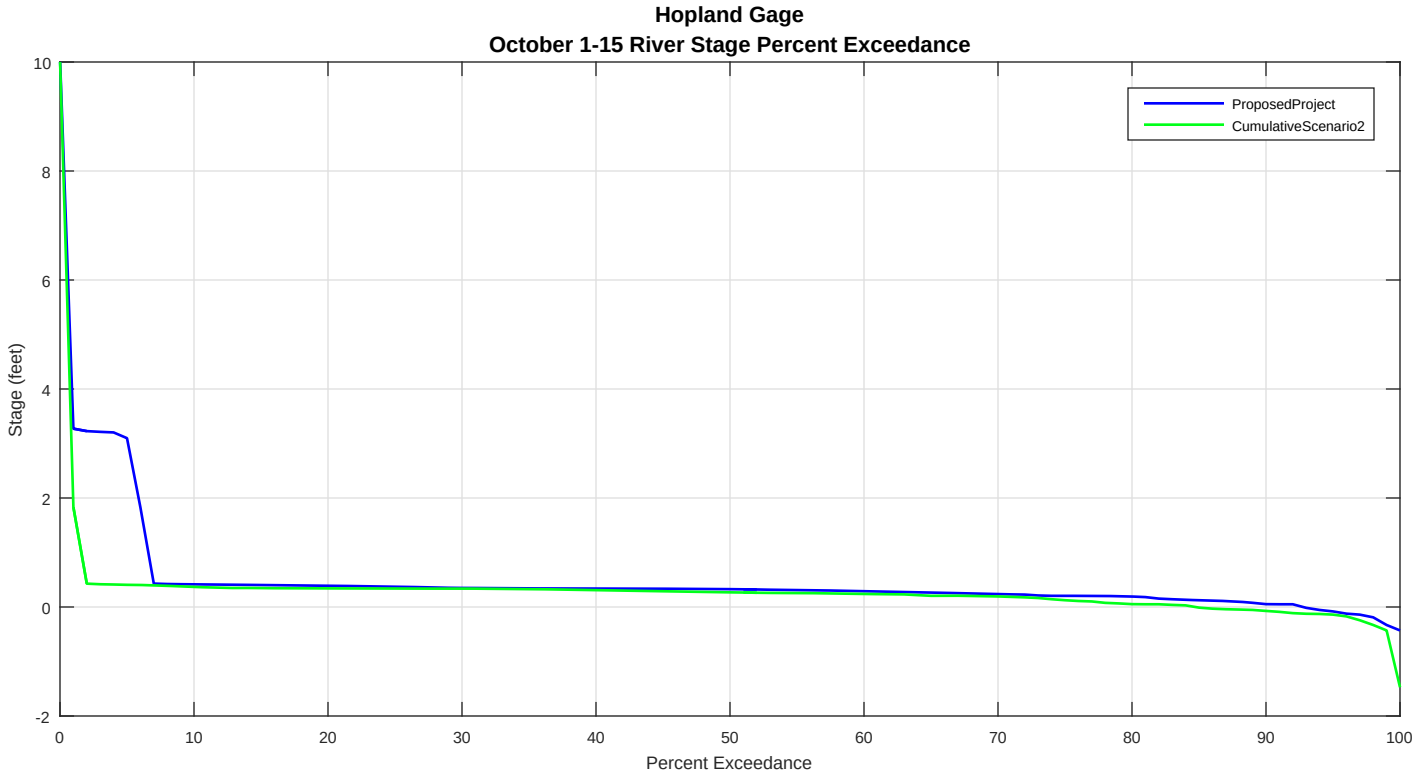

Hopland Gage
May River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

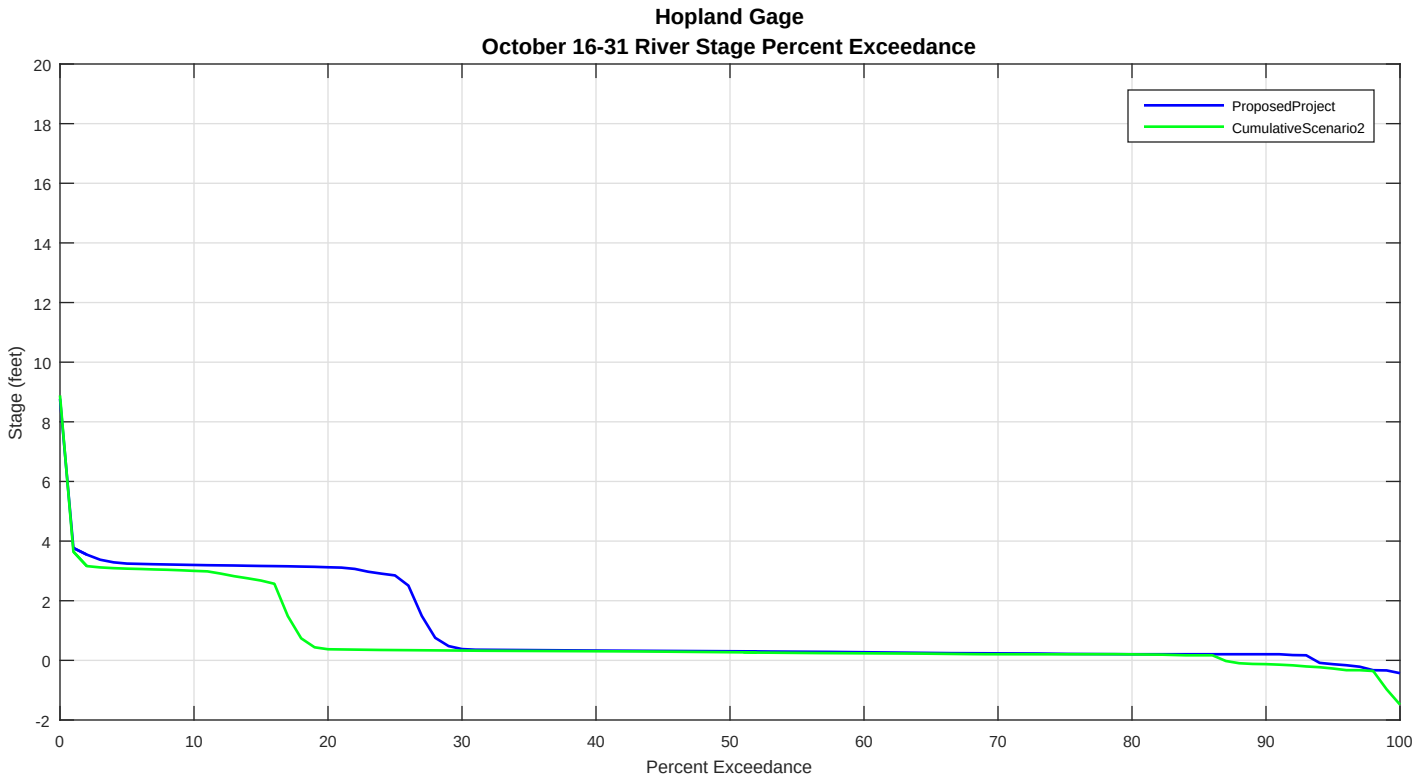

Hopland Gage
June River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

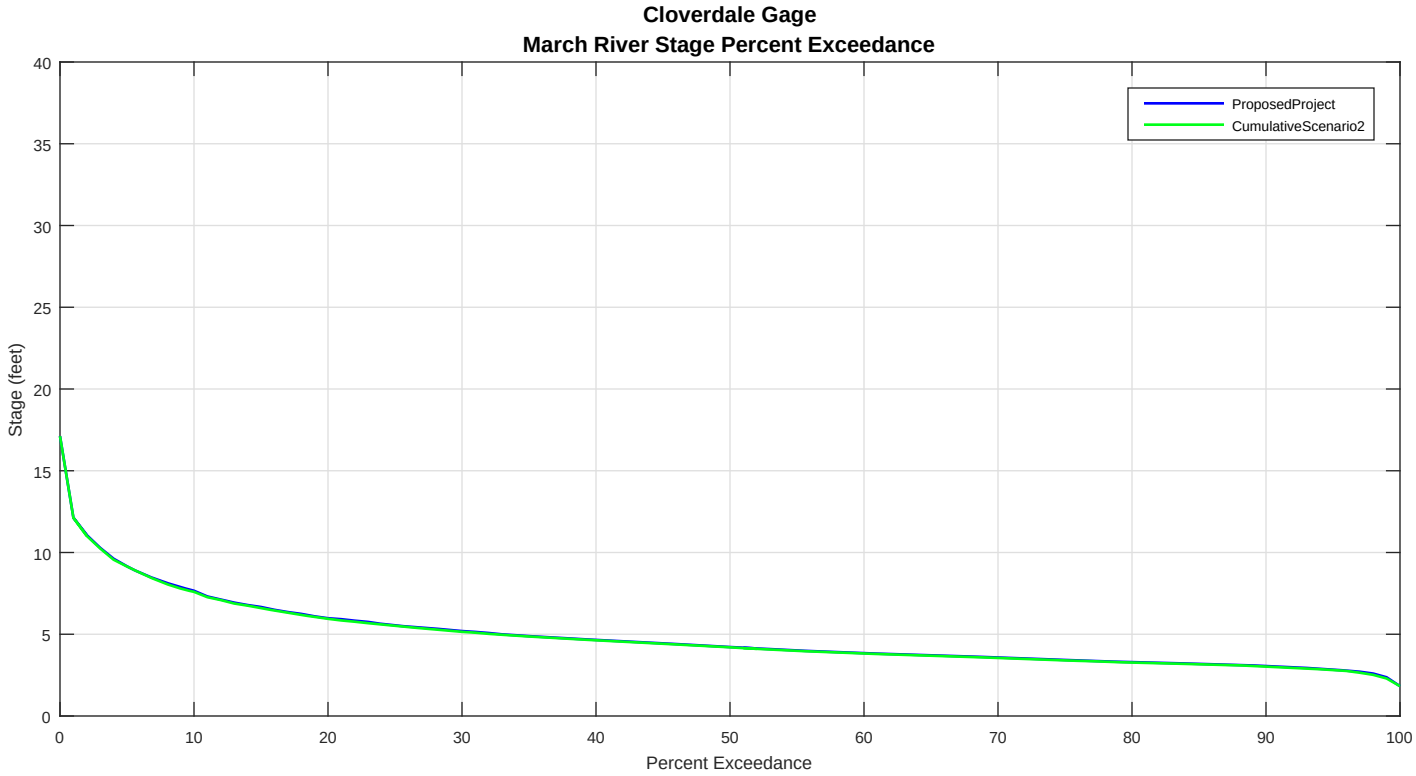

Hopland Gage
July River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

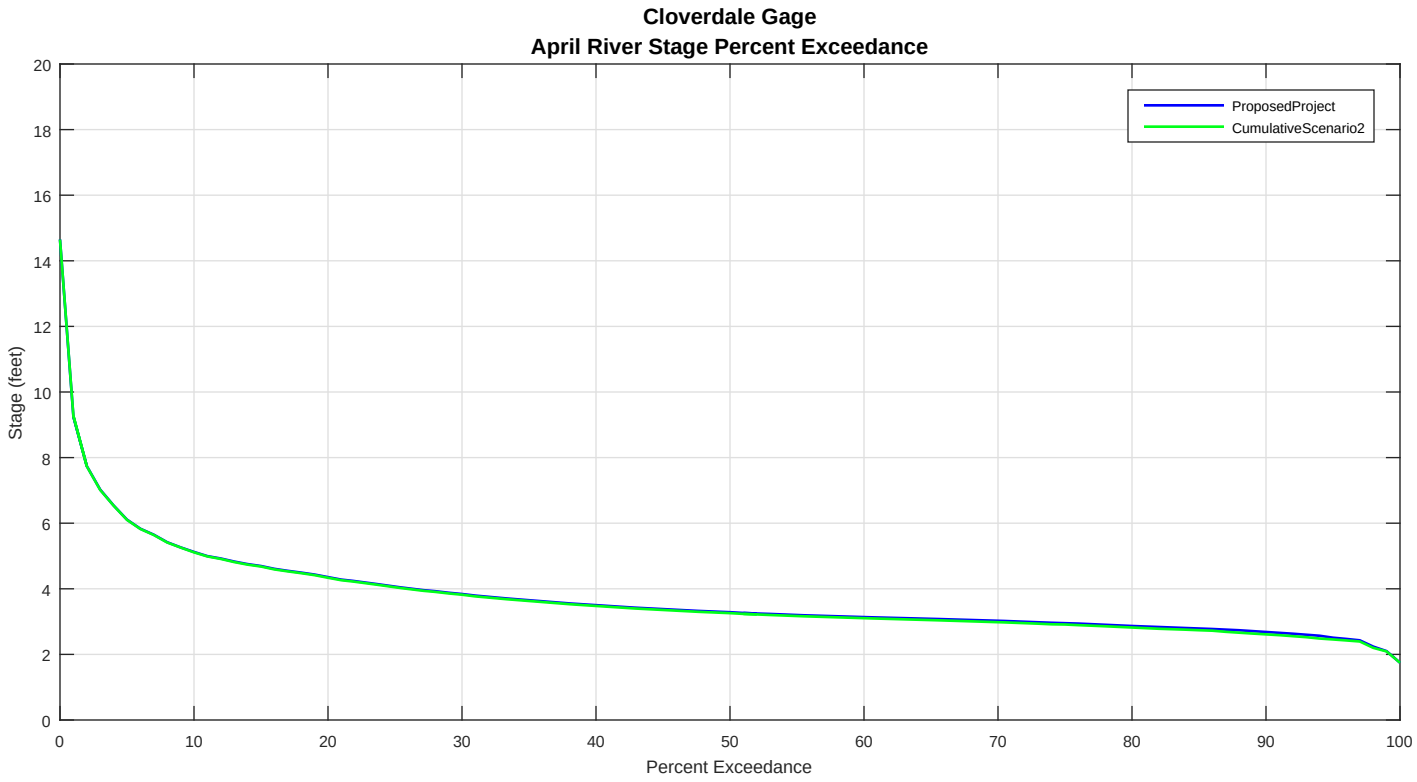

Hopland Gage
August River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

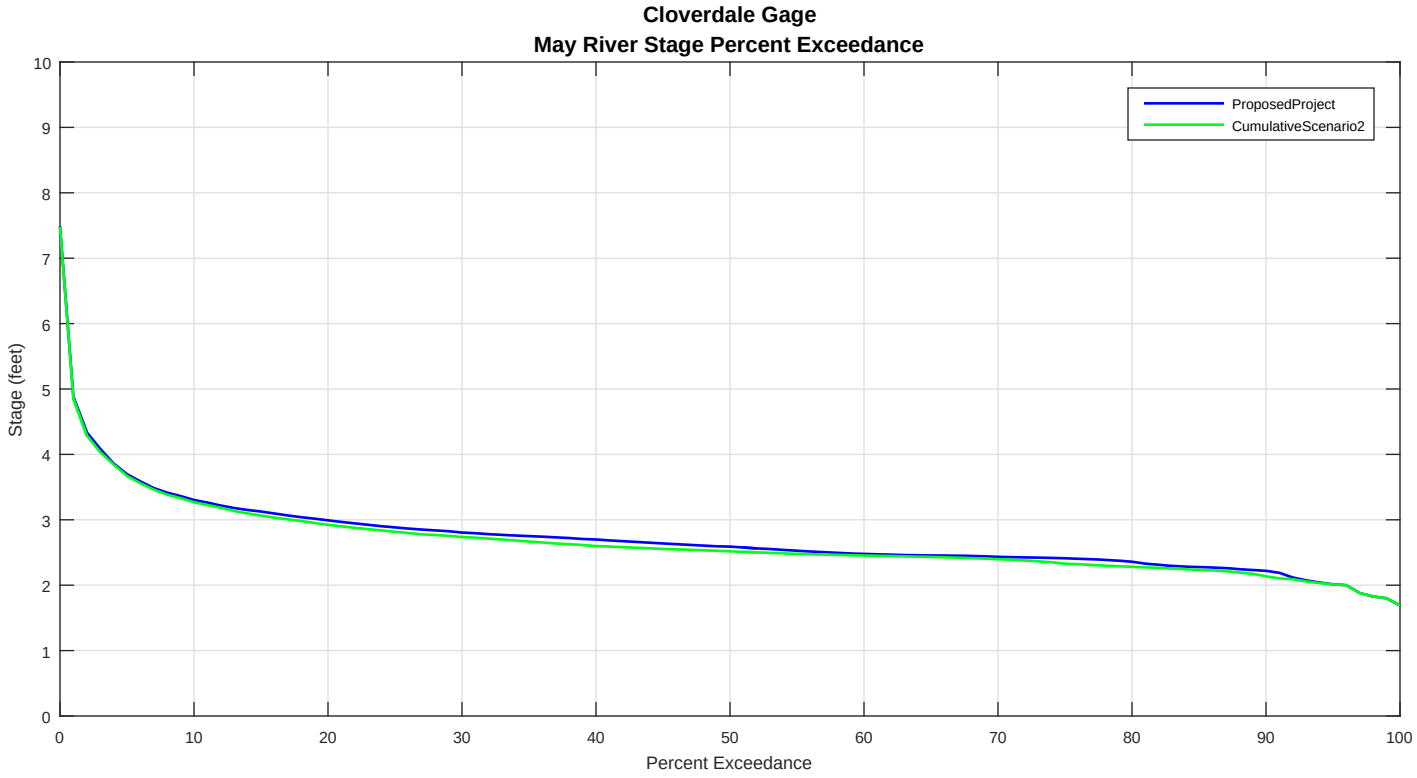

Hopland Gage
September River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

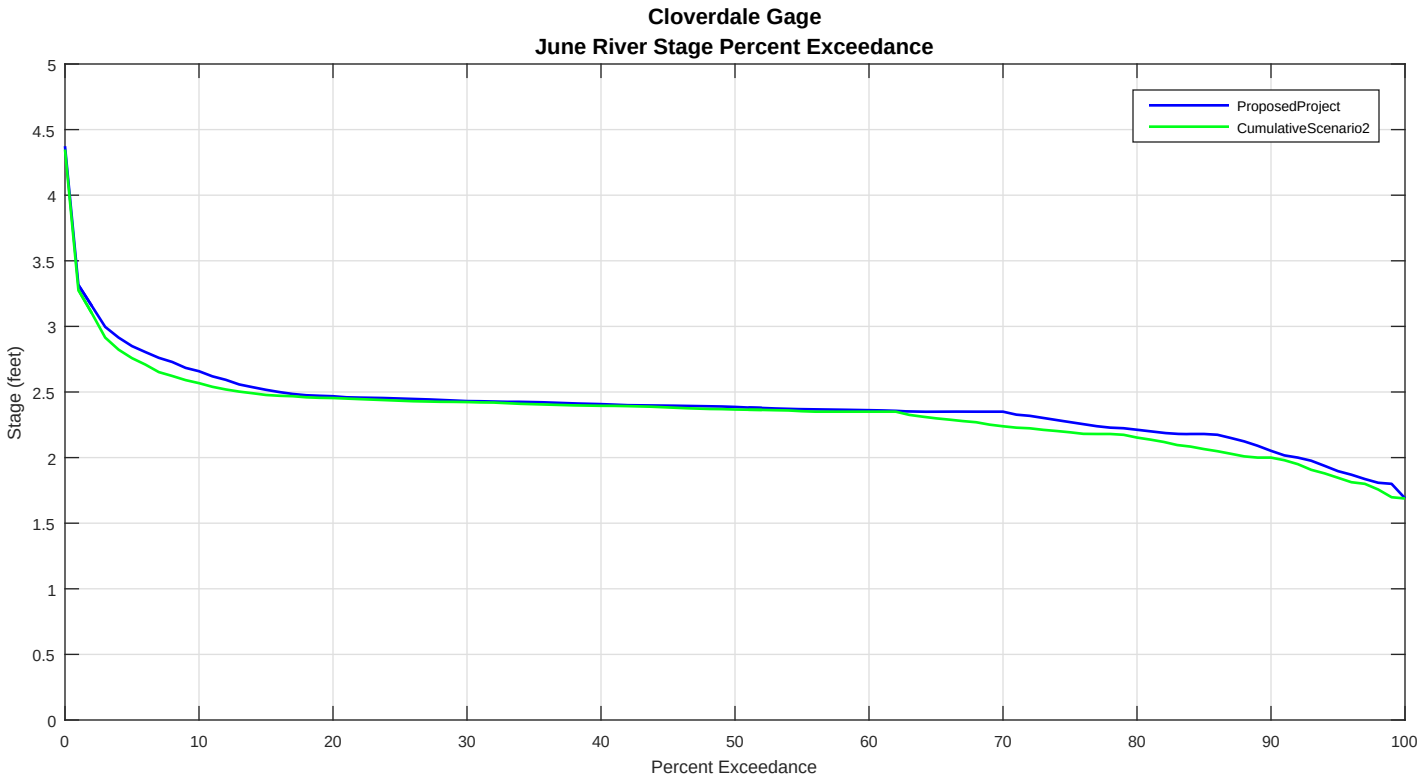

Hopland Gage
October 1-15 River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

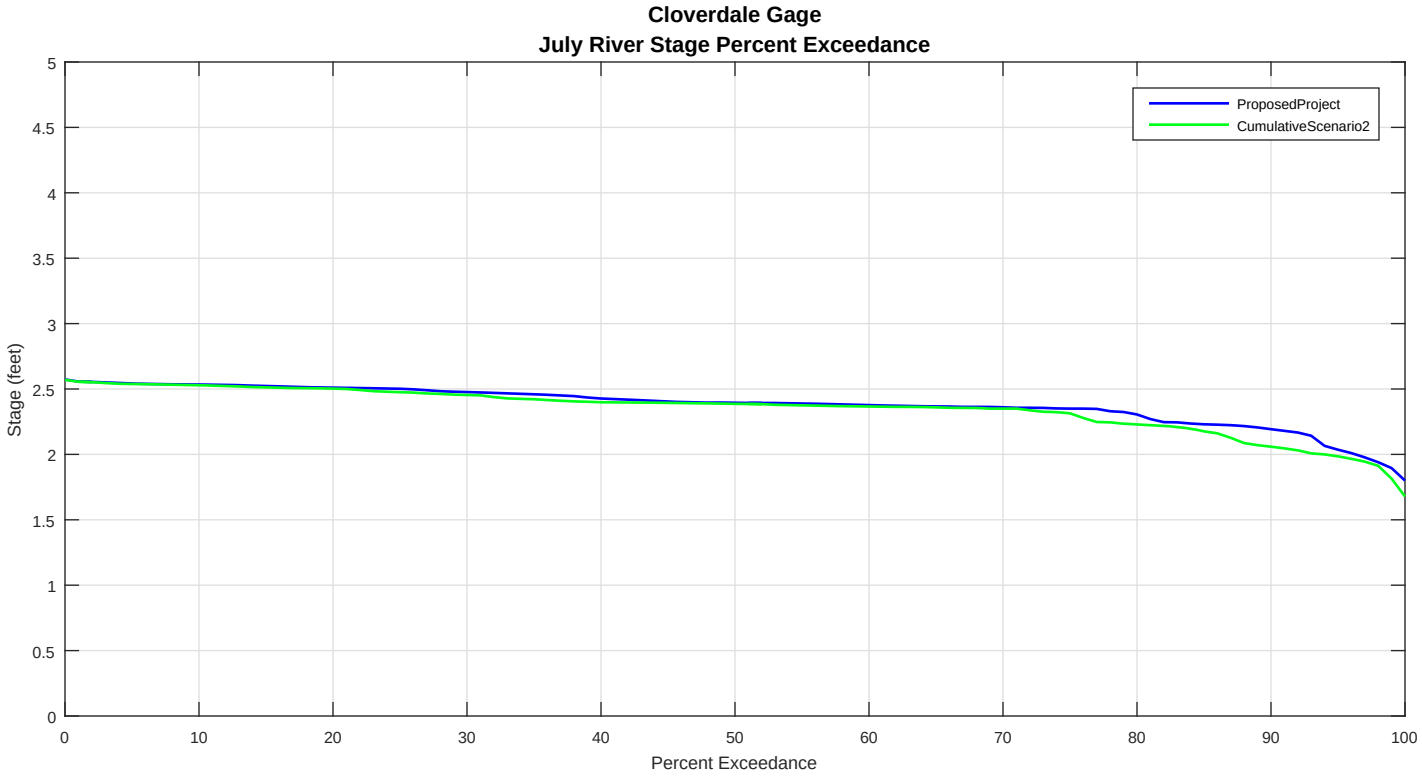

Hopland Gage
October 16-31 River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
20
18
16
14
12
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

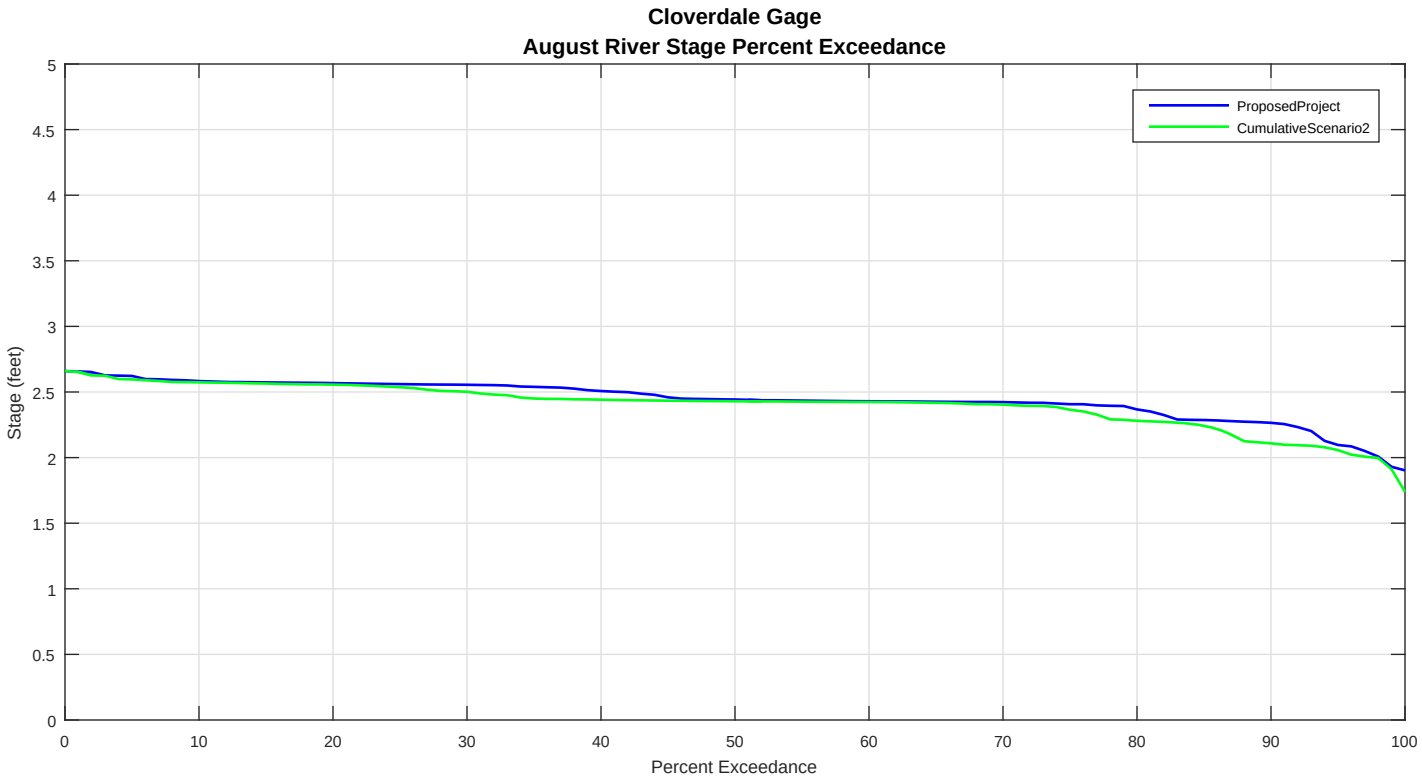

Cloverdale Gage
March River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100

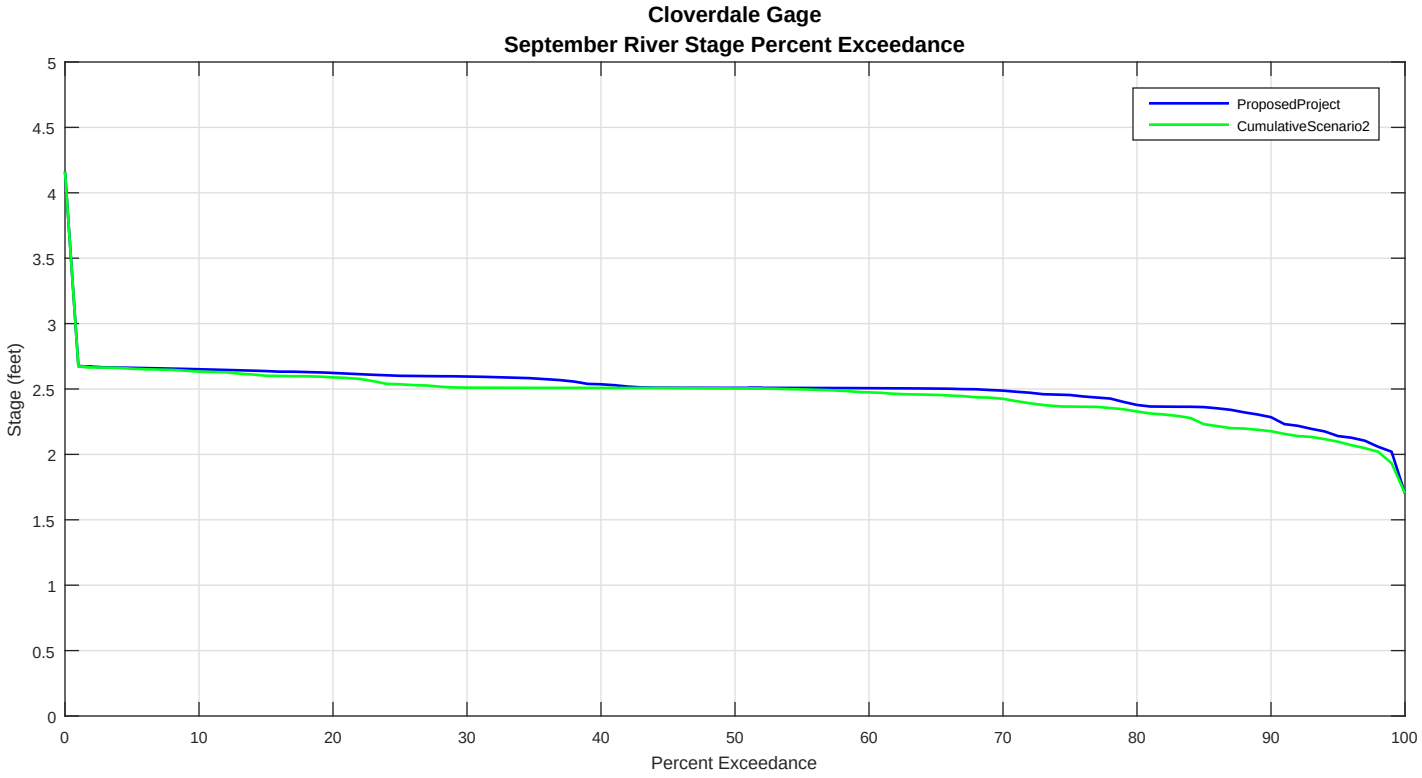

Cloverdale Gage
April River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

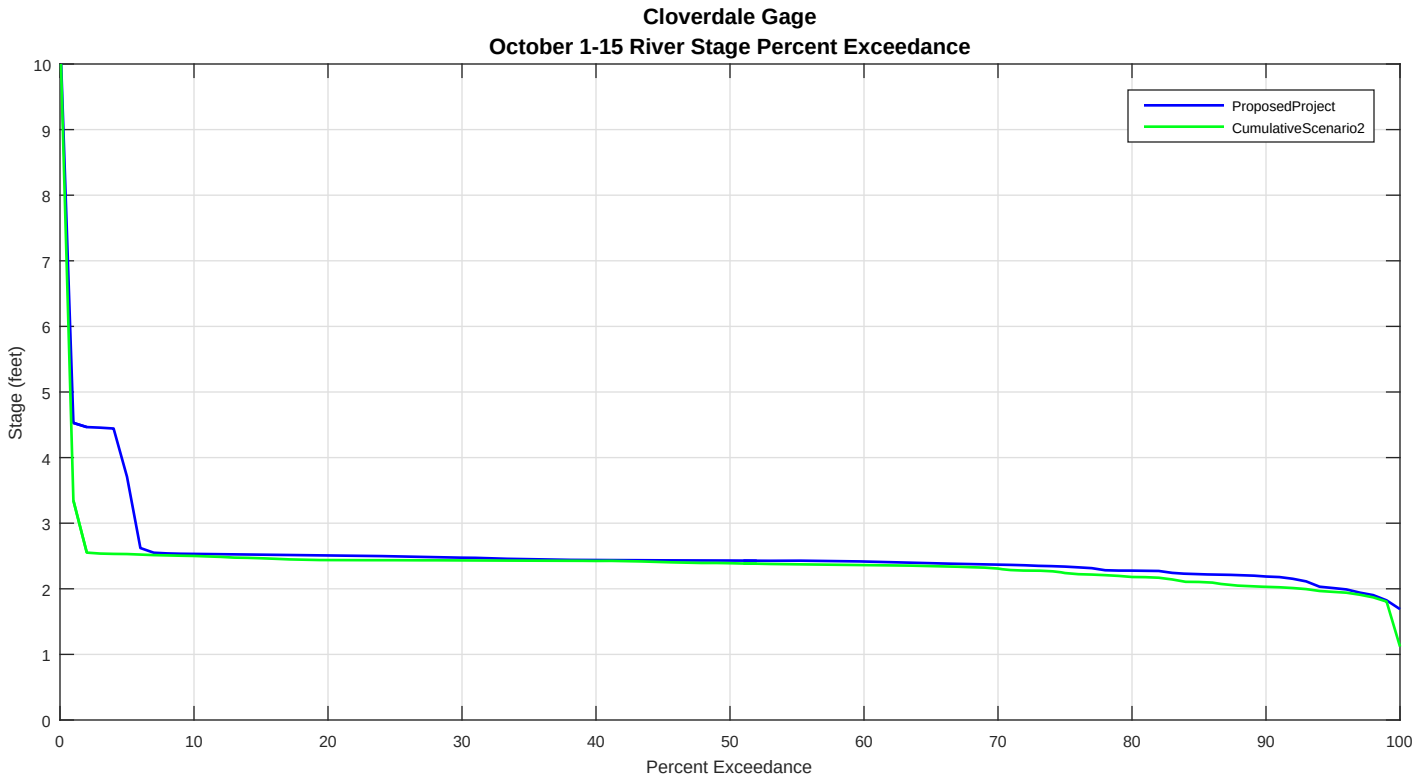

Cloverdale Gage
May River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

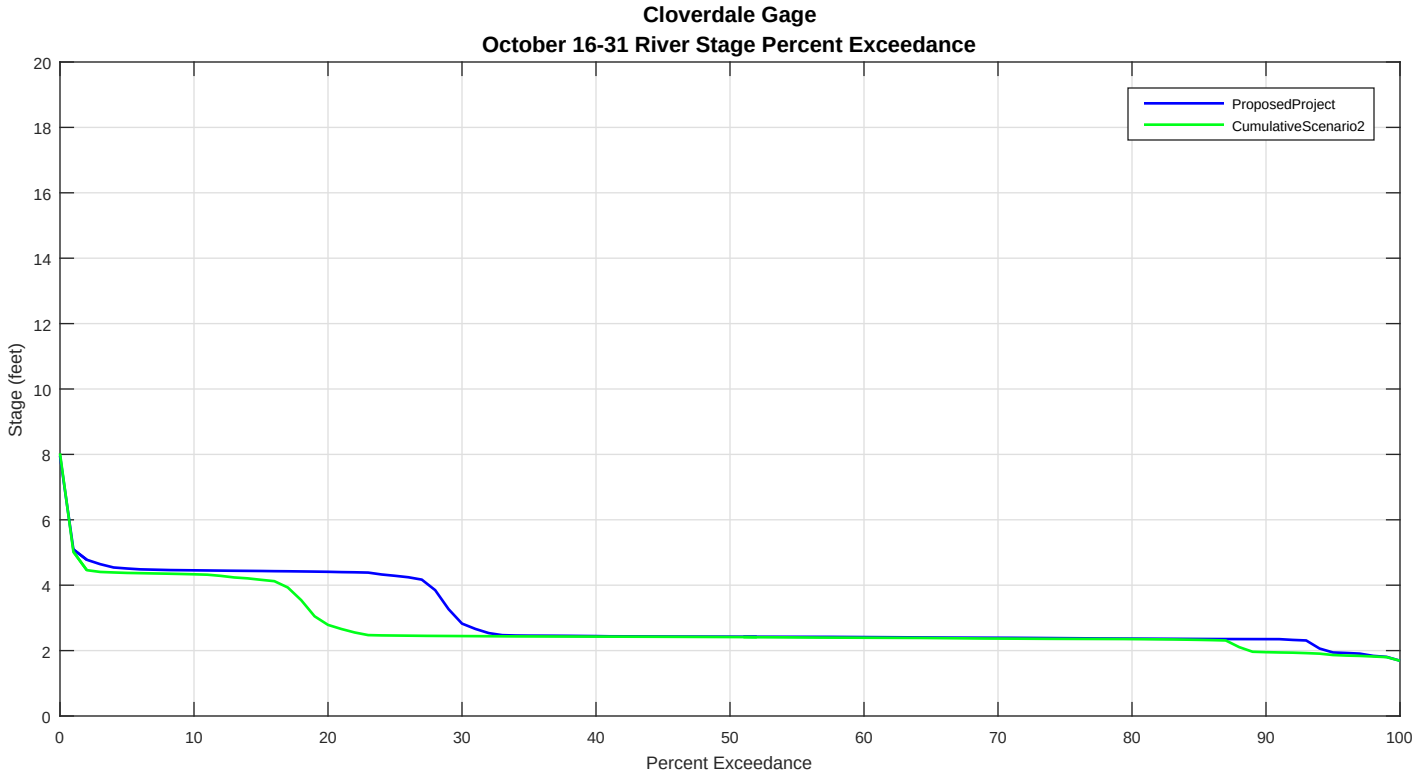

Cloverdale Gage
June River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

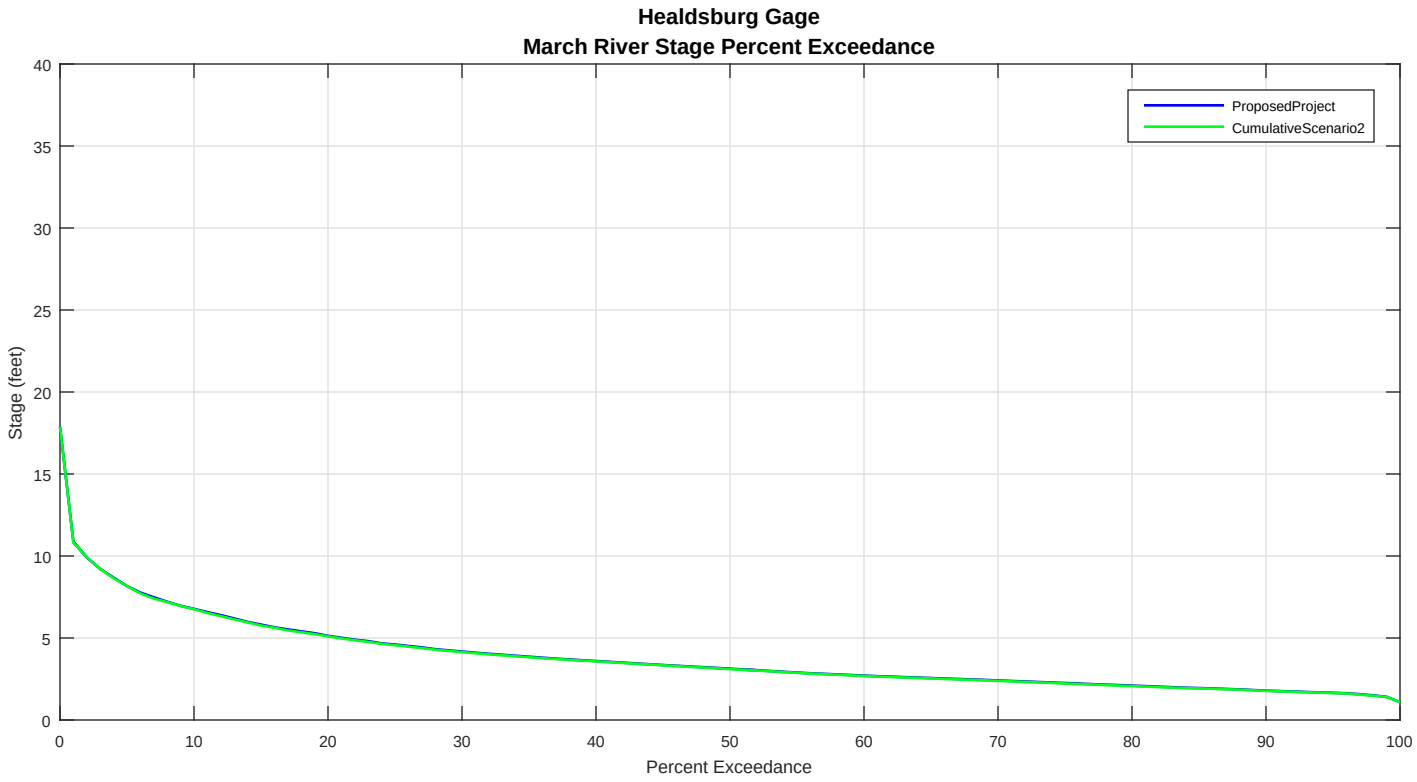

Cloverdale Gage
July River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

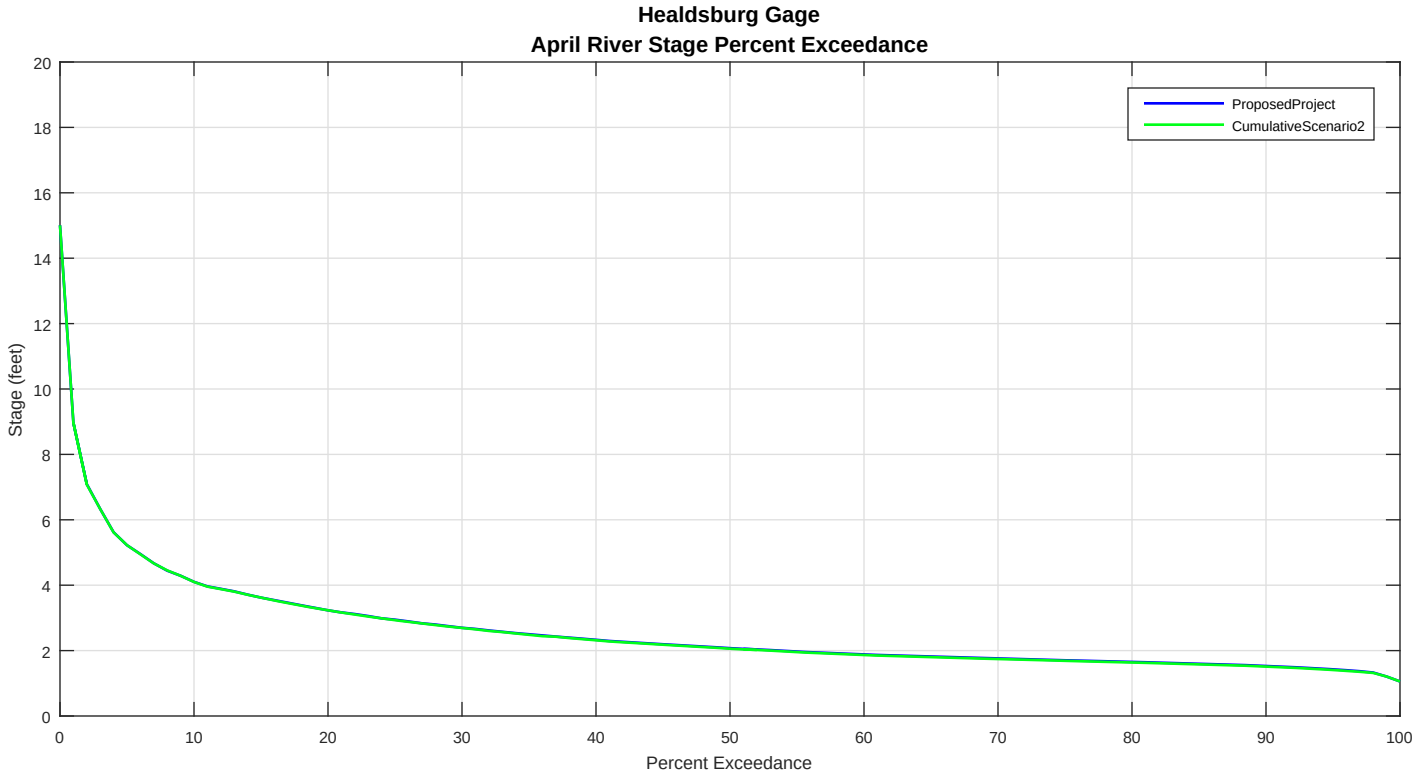

Cloverdale Gage
August River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

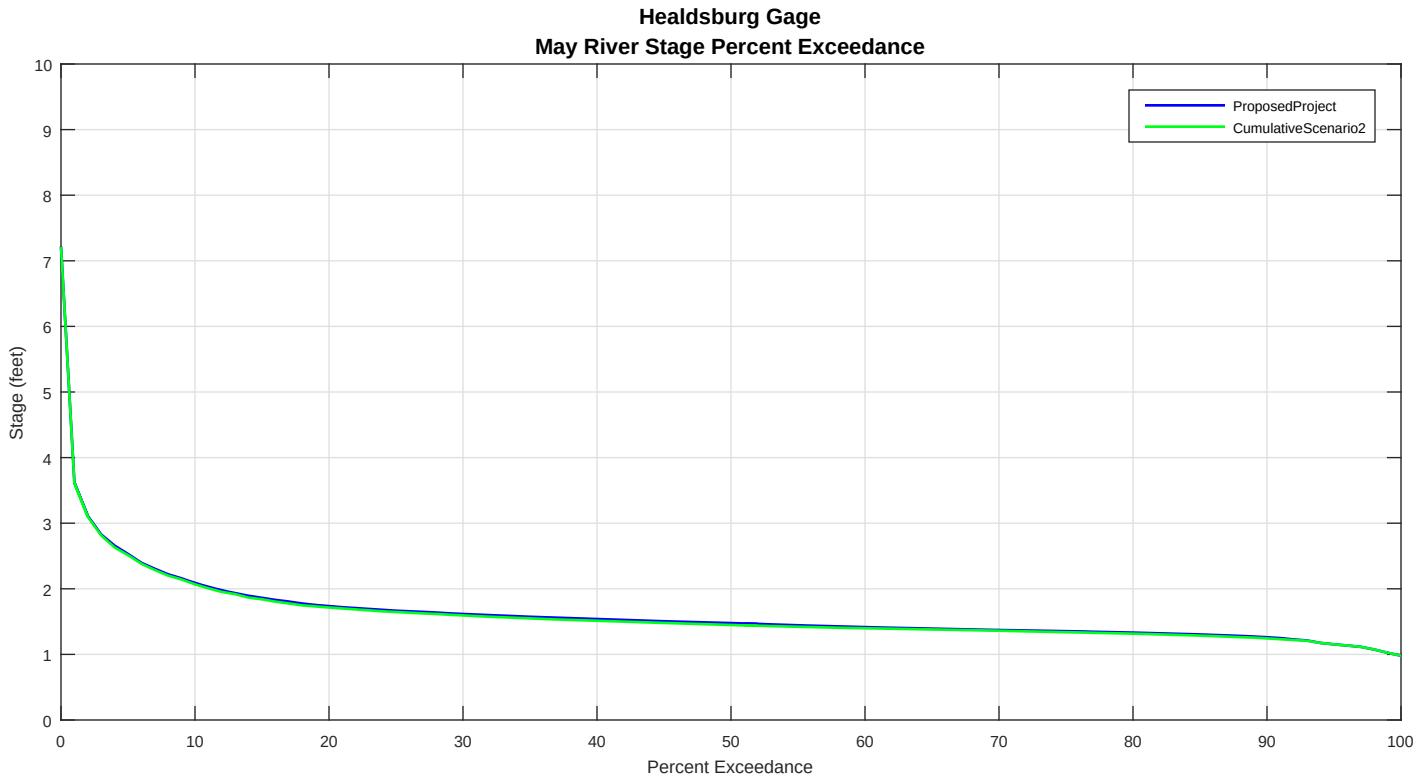

Cloverdale Gage
September River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

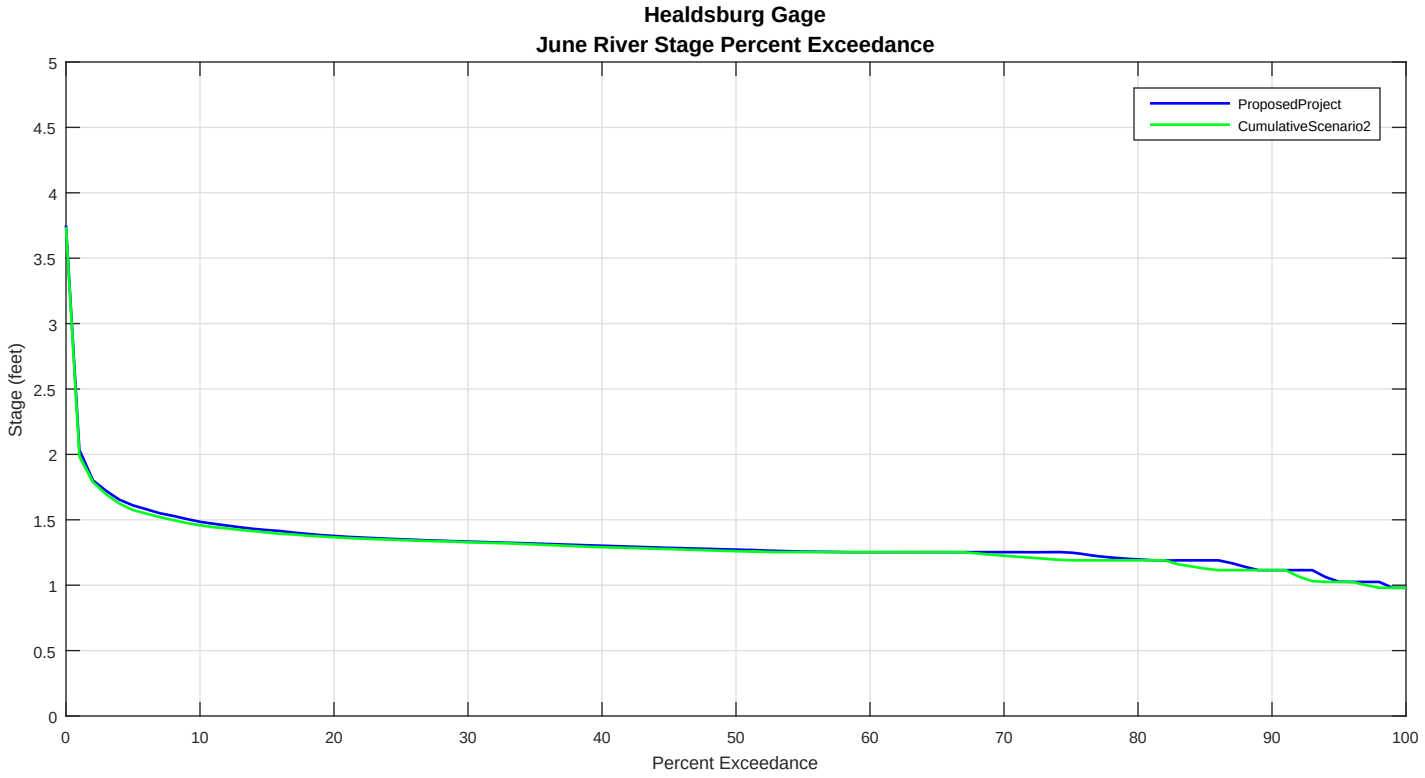

Cloverdale Gage
October 1-15 River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

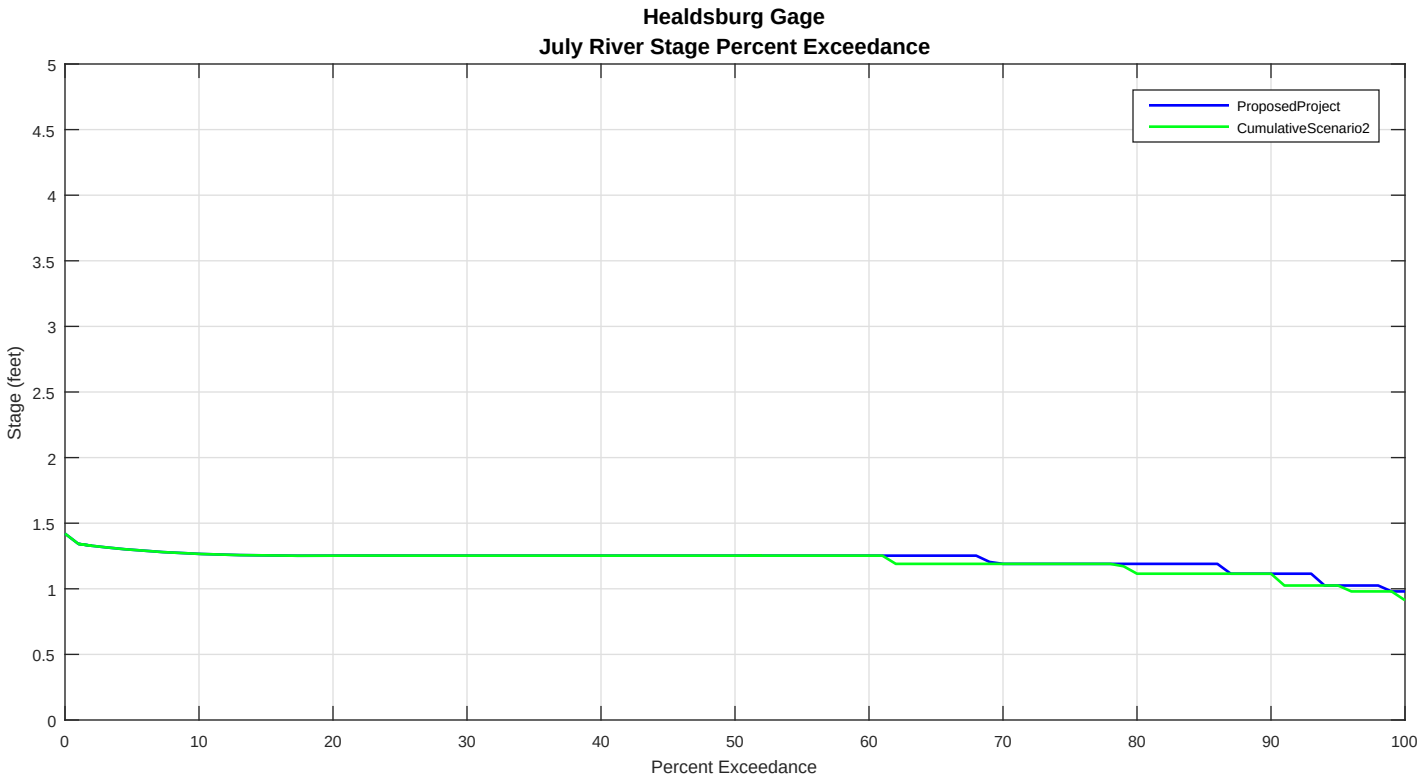

Cloverdale Gage
October 16-31 River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

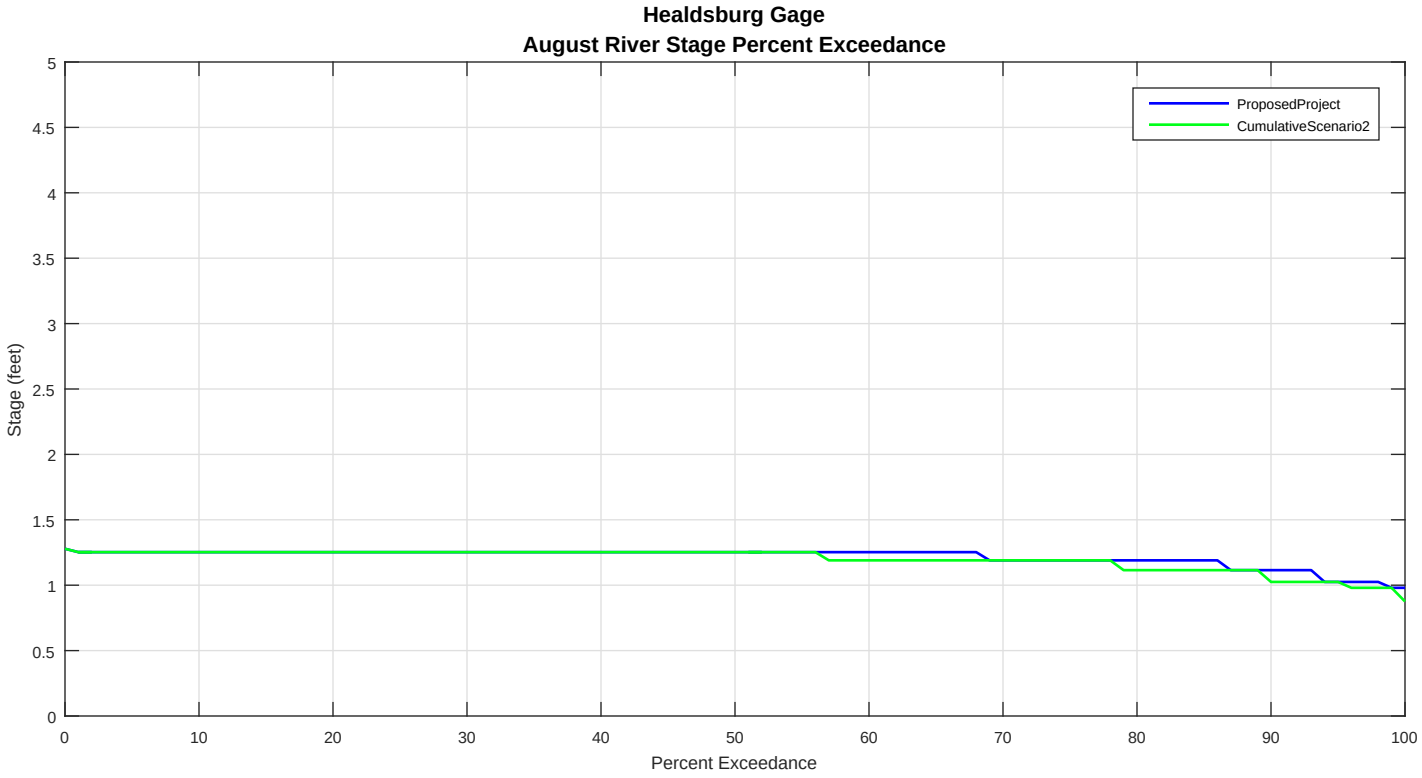

Healdsburg Gage
March River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80
90
100

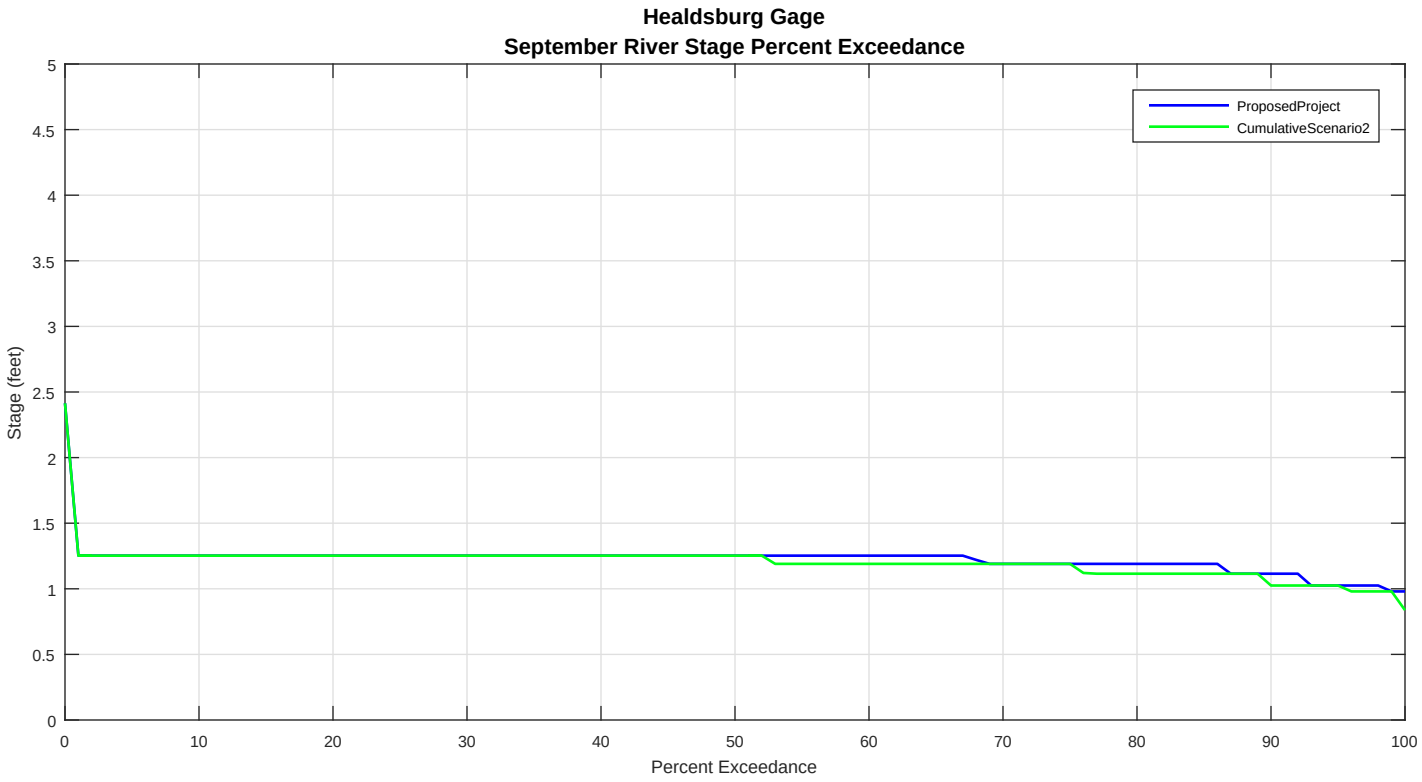

Healdsburg Gage
April River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

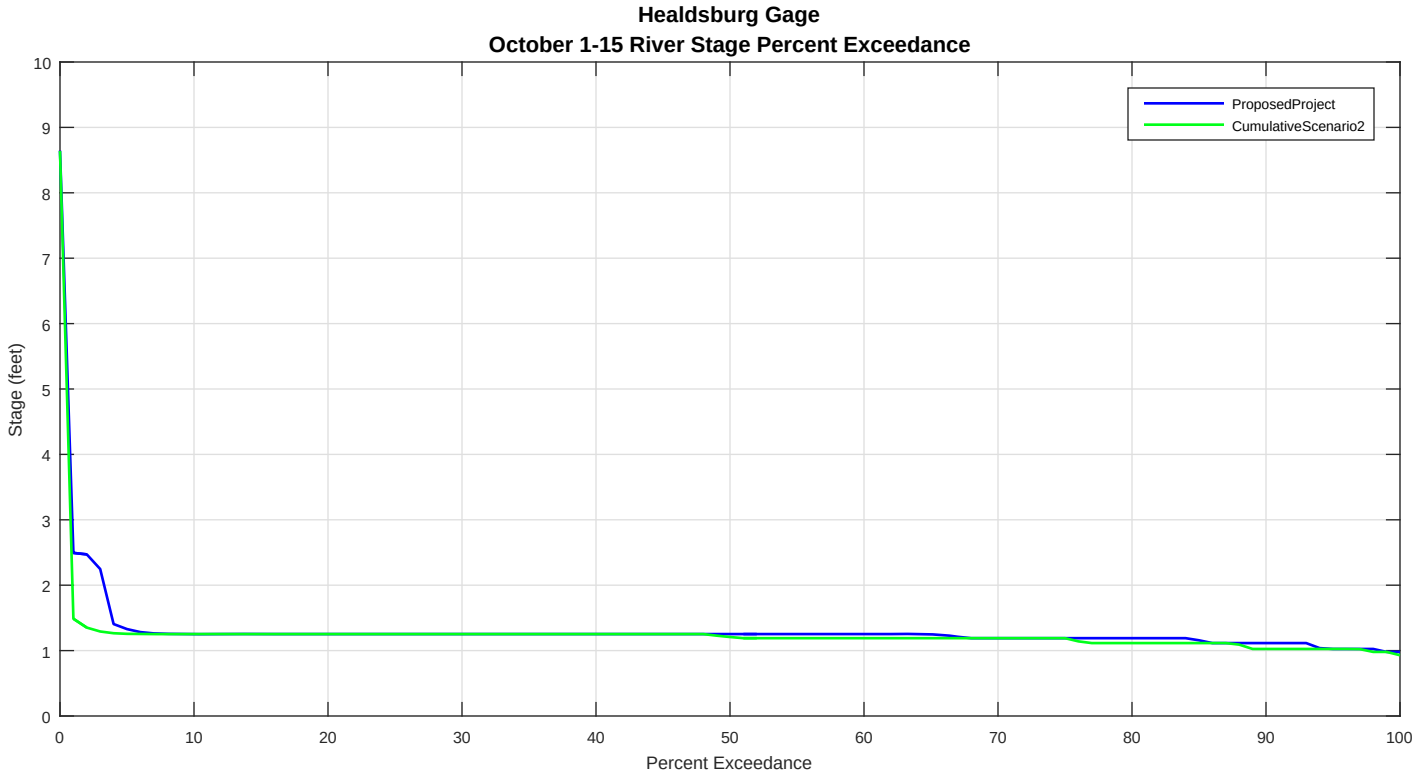

Healdsburg Gage
May River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

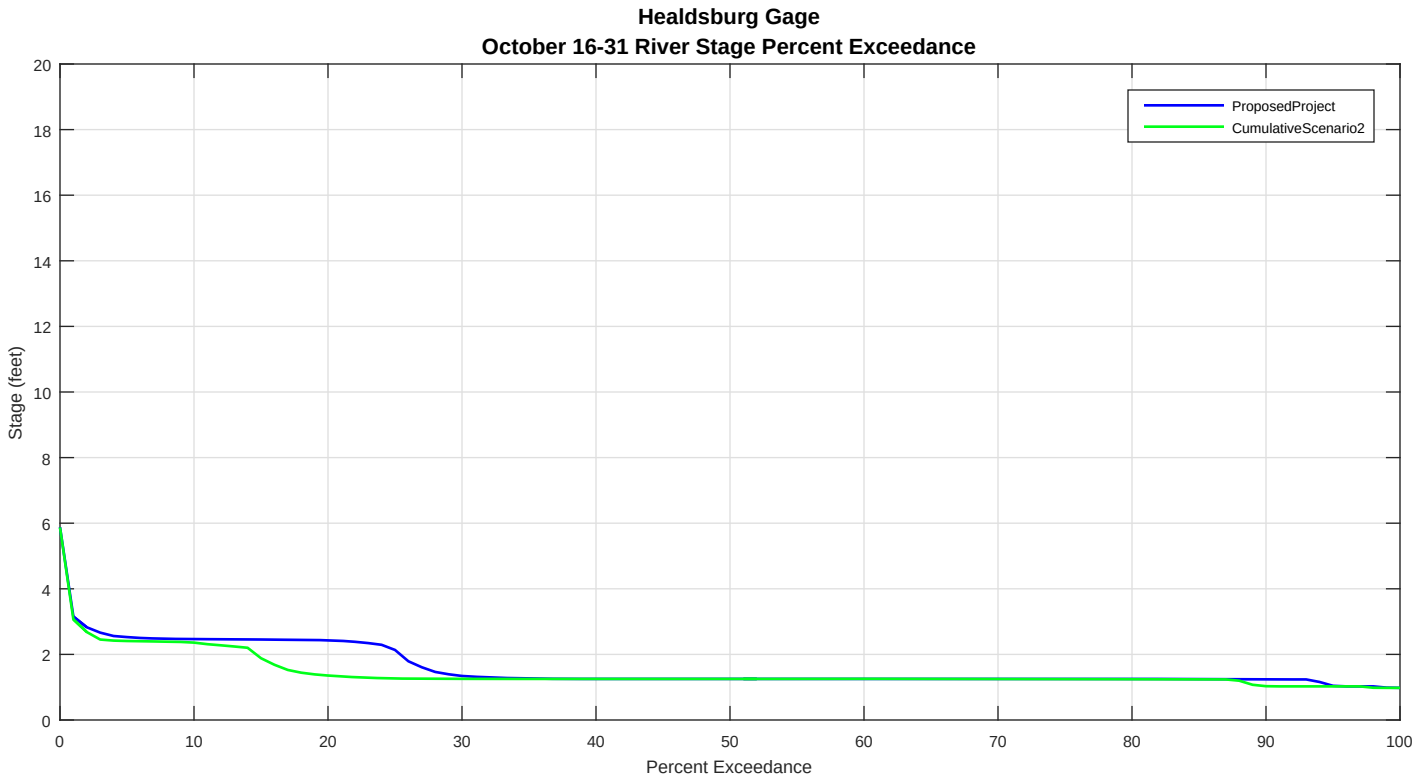

Healdsburg Gage
June River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

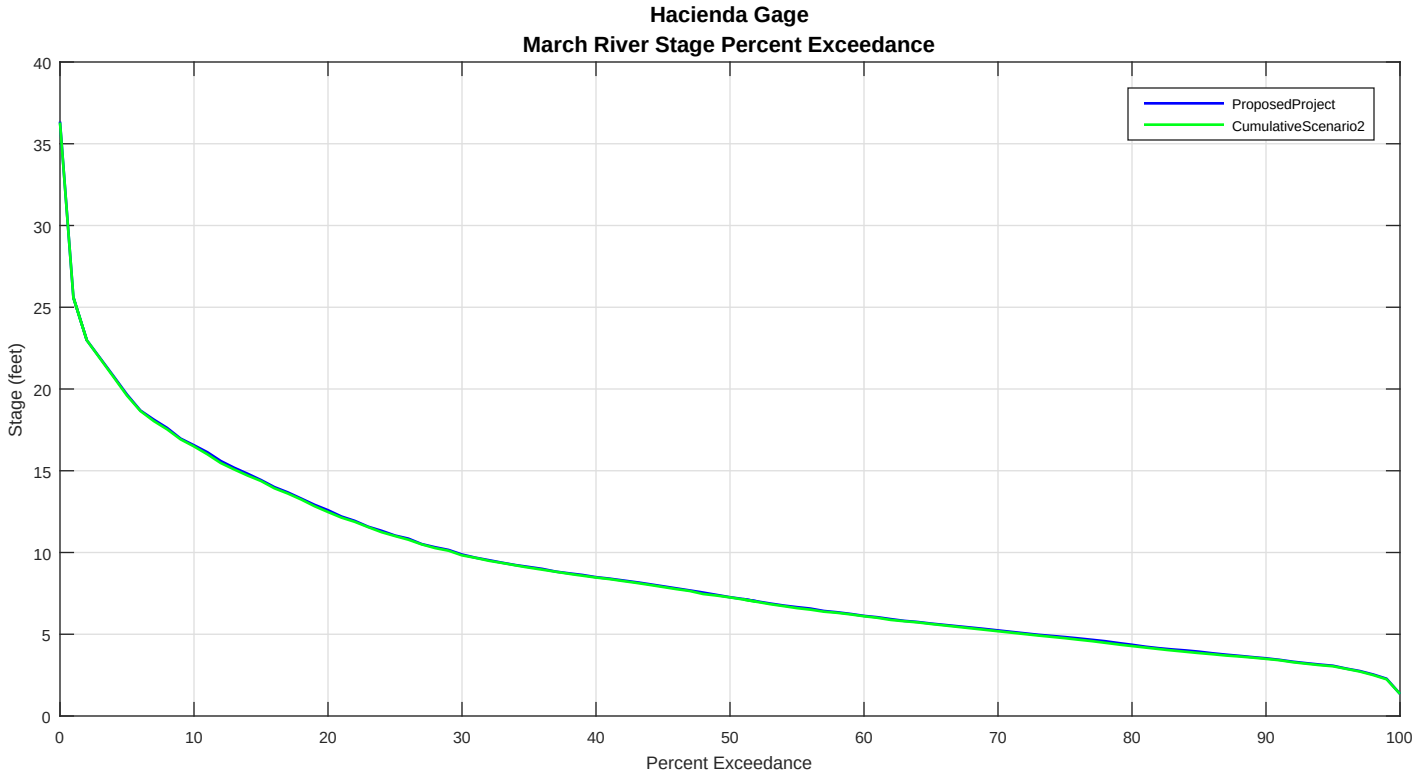

Healdsburg Gage
July River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

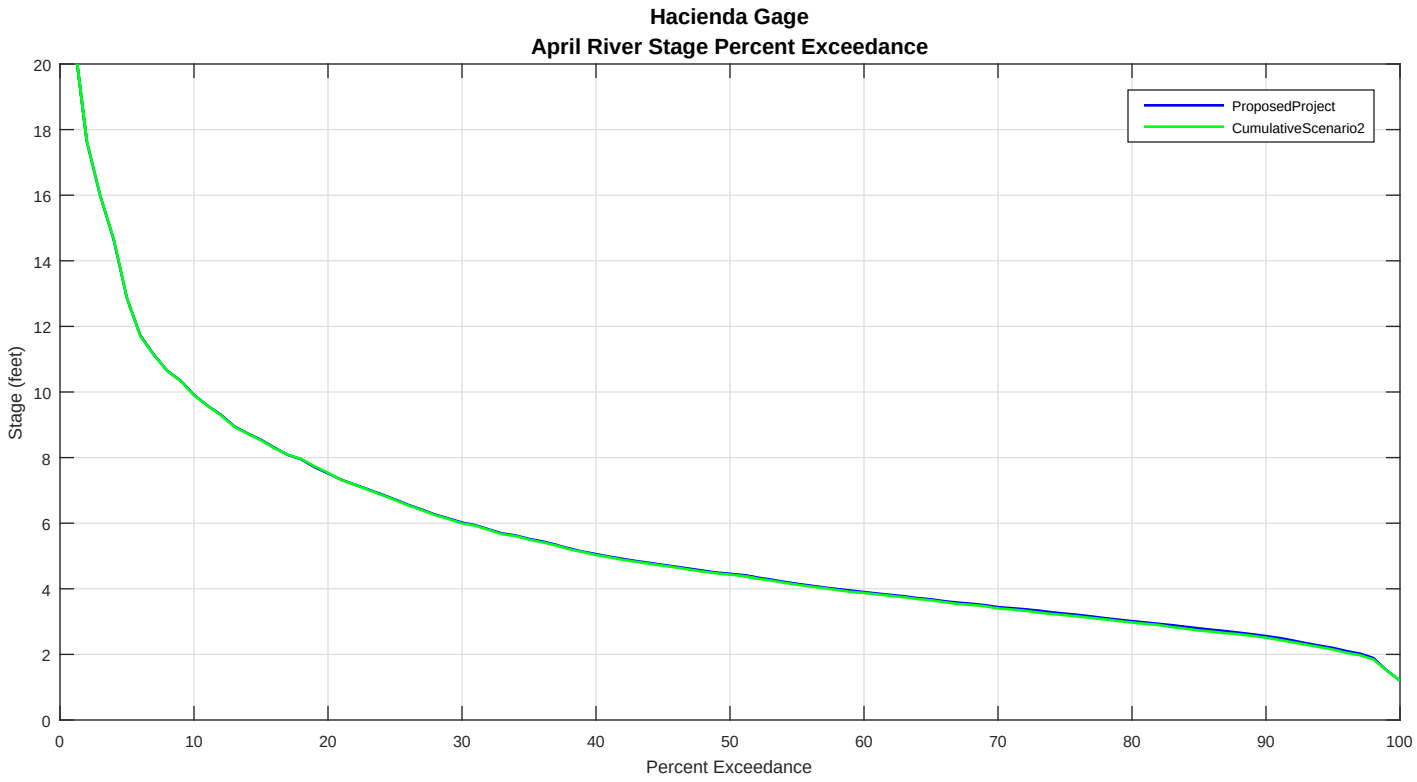

Healdsburg Gage
August River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

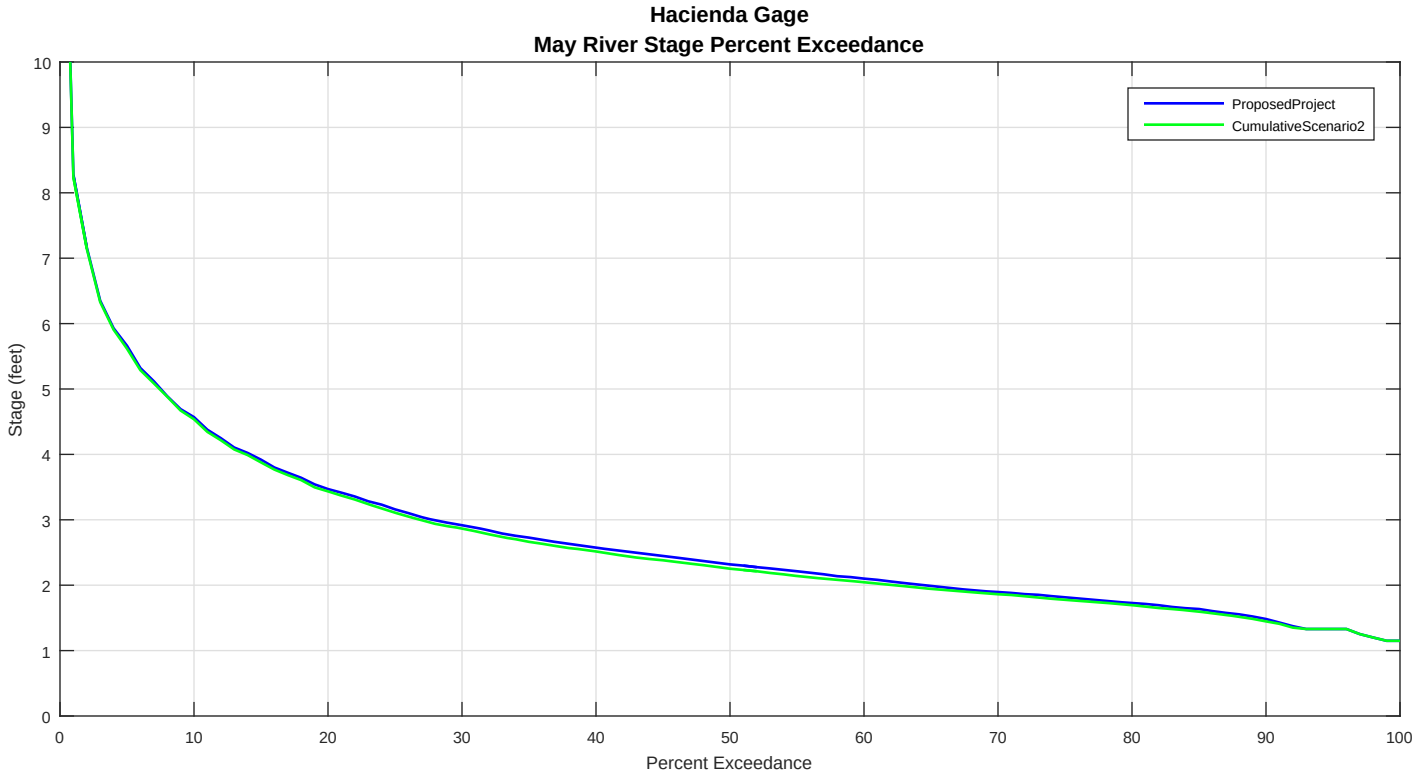

Healdsburg Gage
September River Stage Percent Exceedance
Stage (feet)
Percent Exceedance
ProposedProject
CumulativeScenario2
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

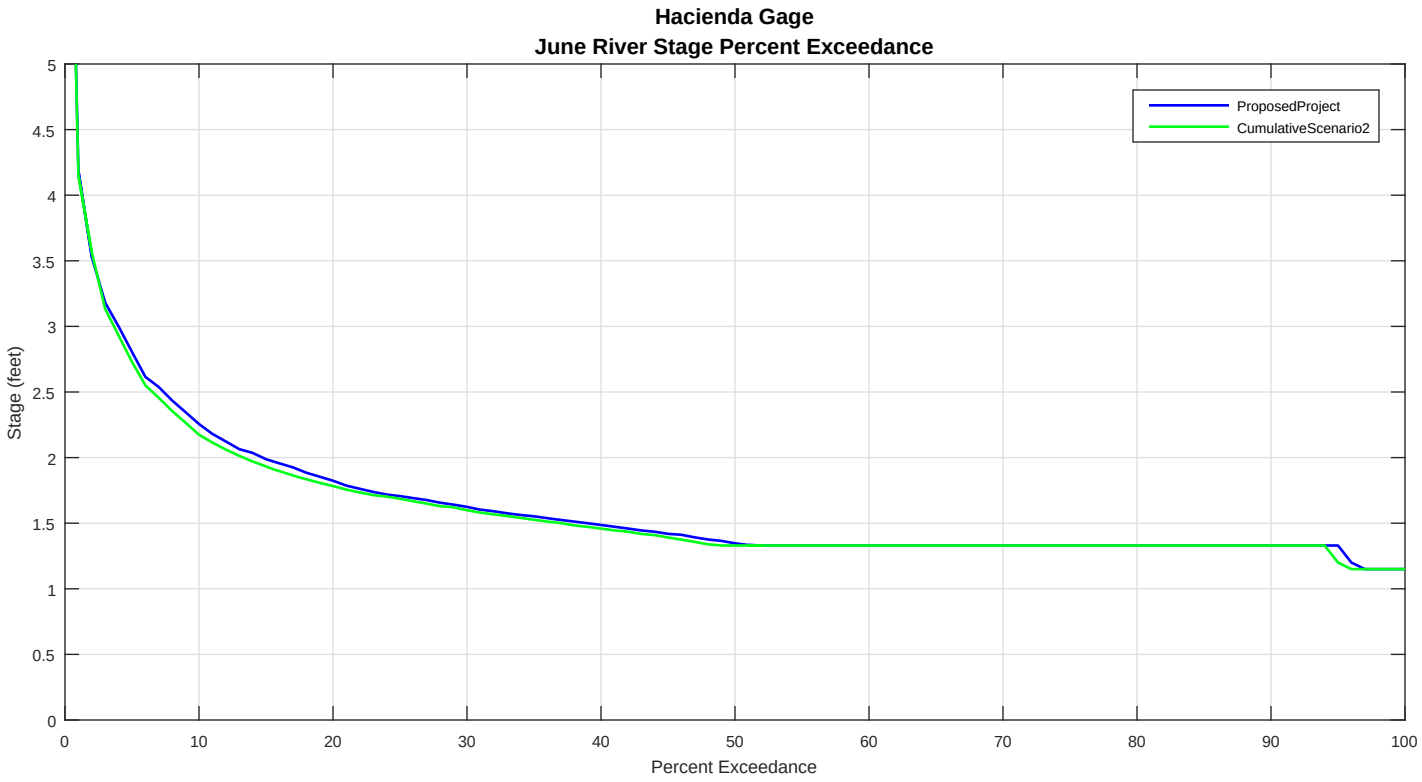

Healdsburg Gage
October 1-15 River Stage Percent Exceedance
Stage (feet)
Percent Exceedance
ProposedProject
CumulativeScenario2
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

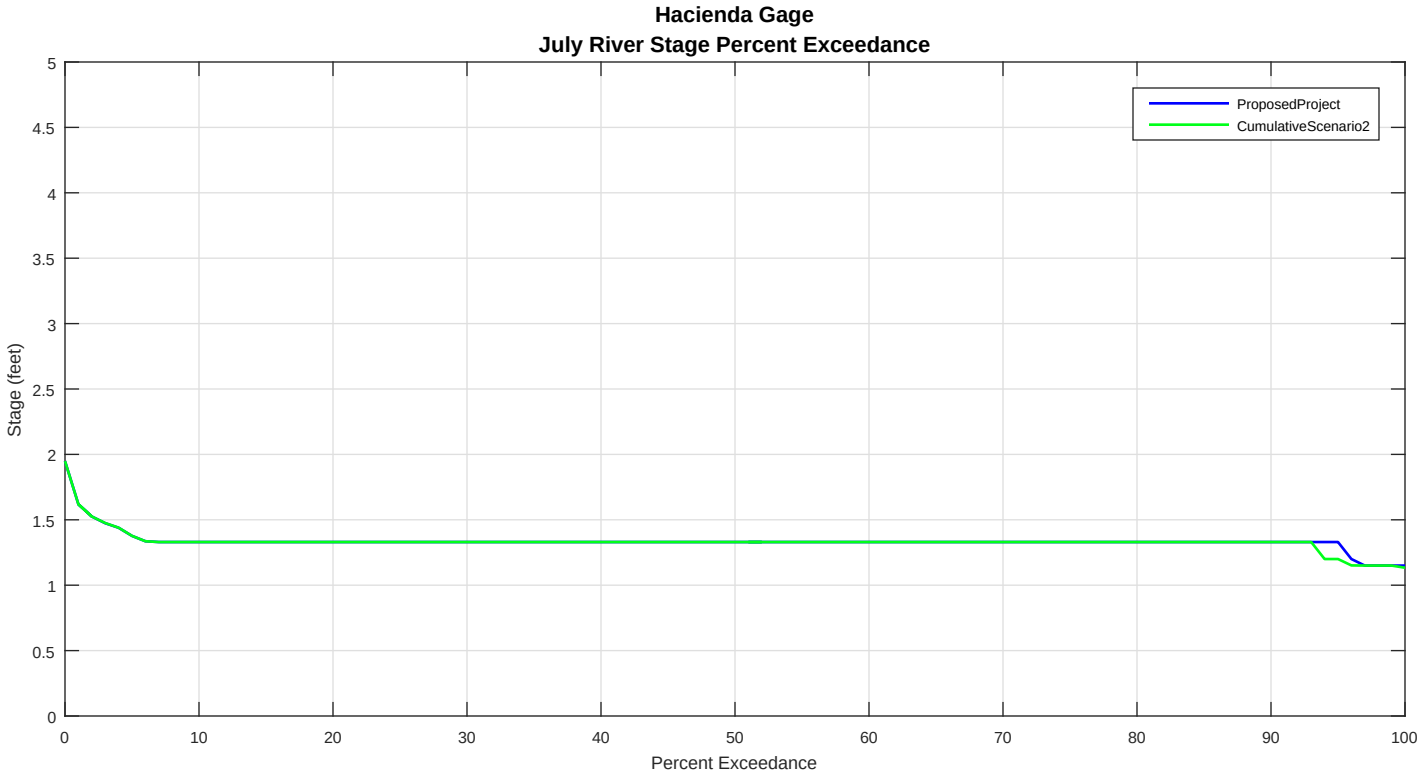

Healdsburg Gage
October 16-31 River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

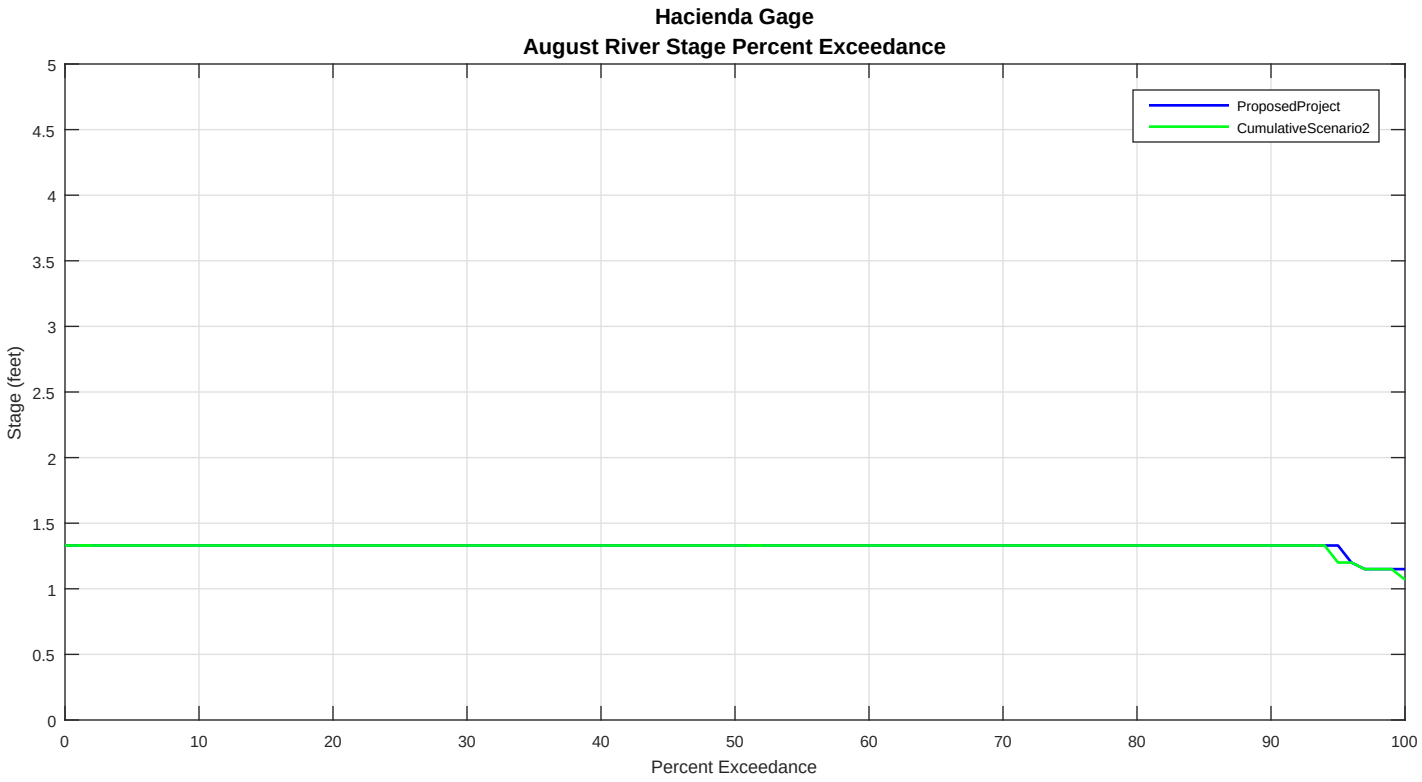

Hacienda Gage
March River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80
90
100

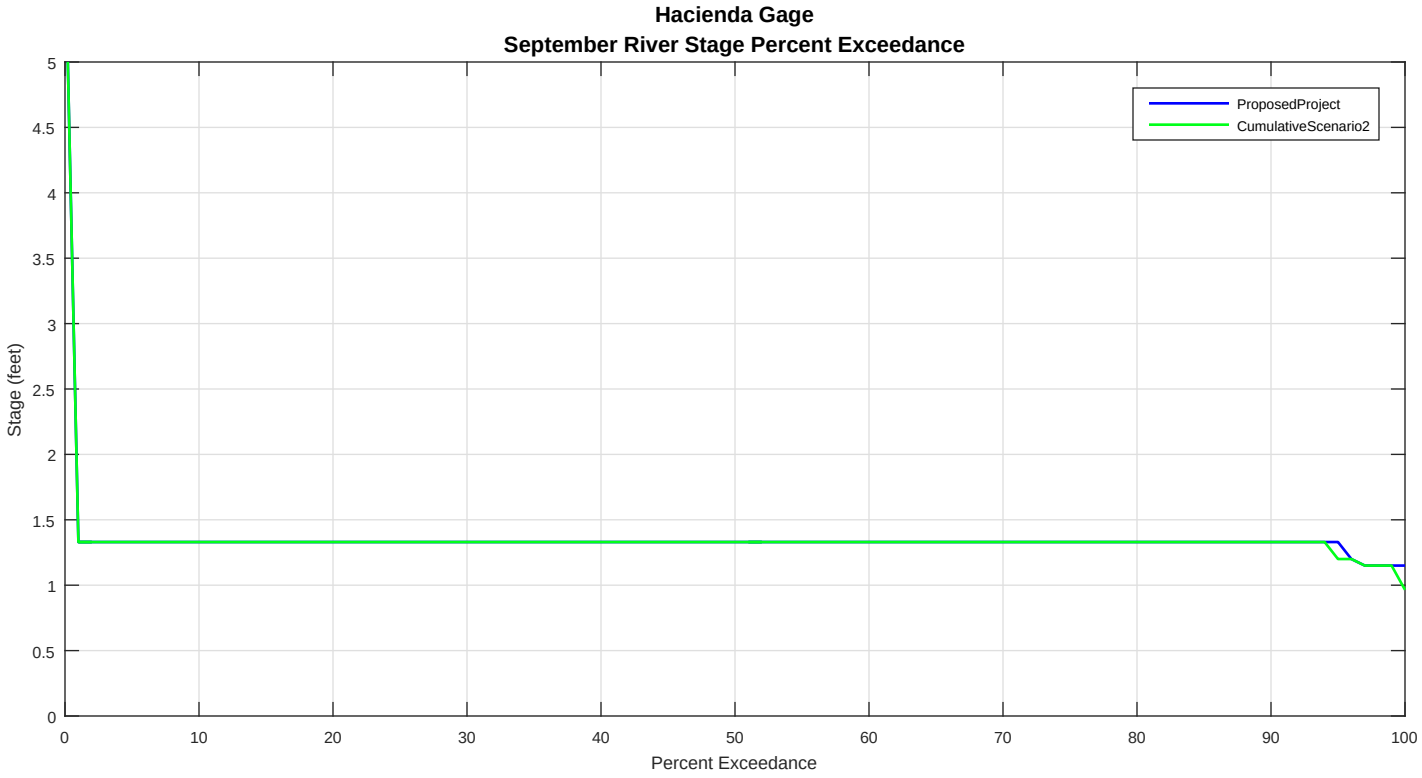

Hacienda Gage
April River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

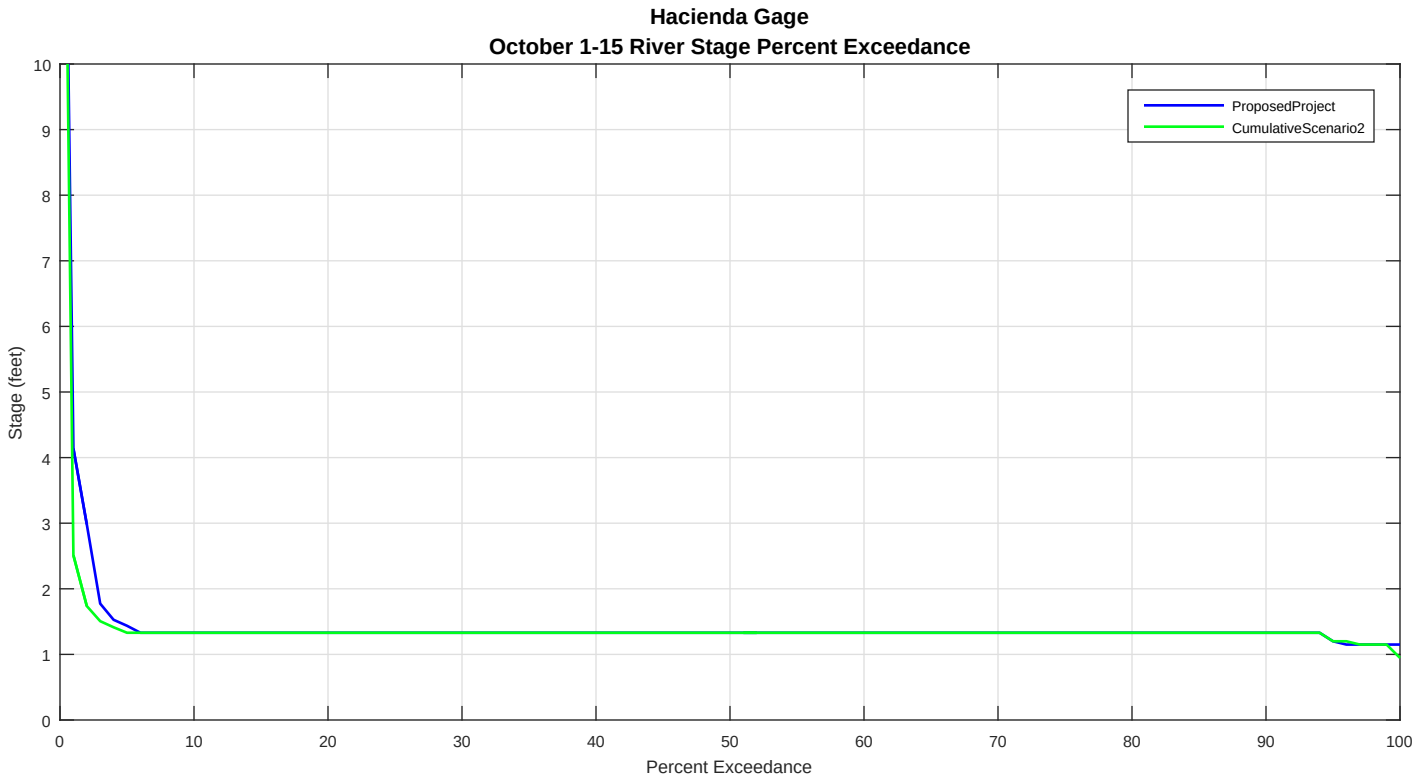

Hacienda Gage
May River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

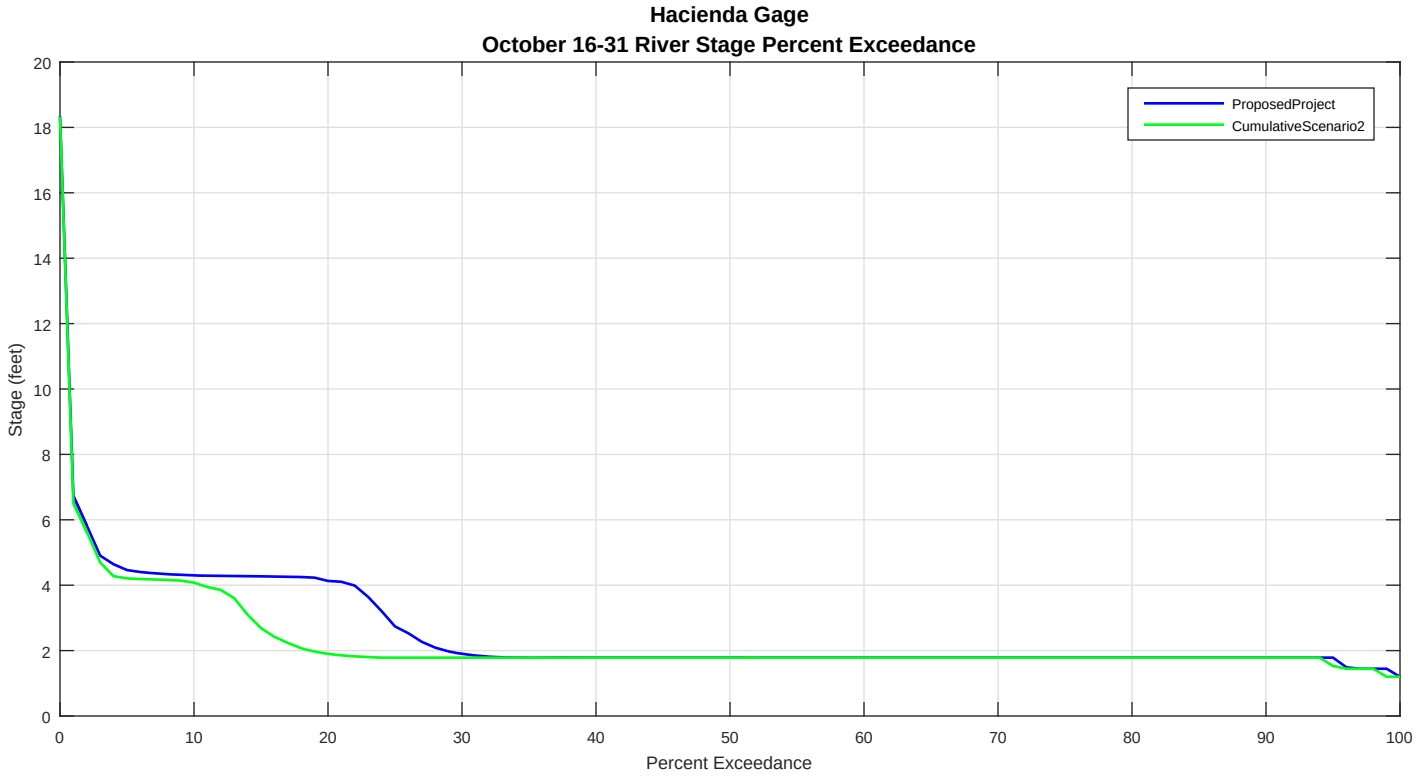

Hacienda Gage
June River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

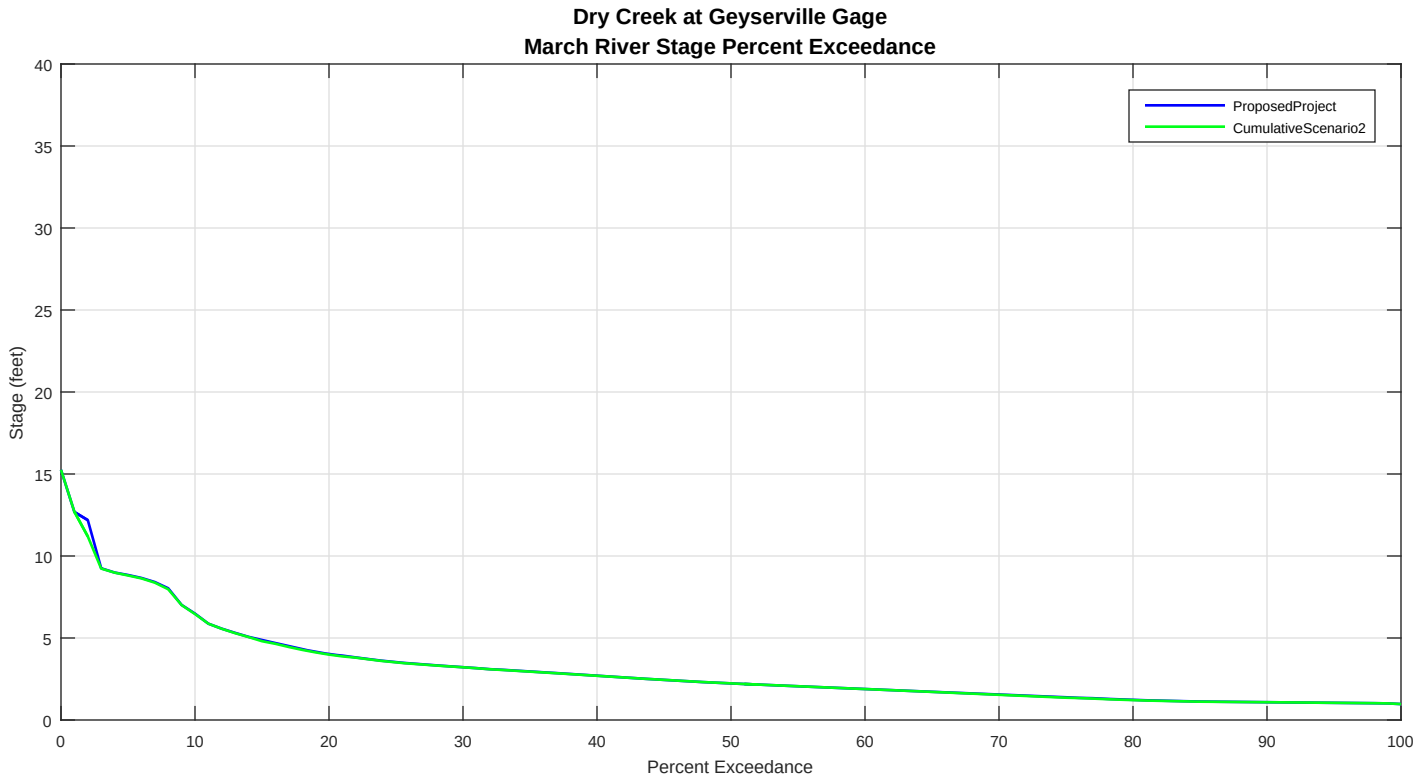

Hacienda Gage
July River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

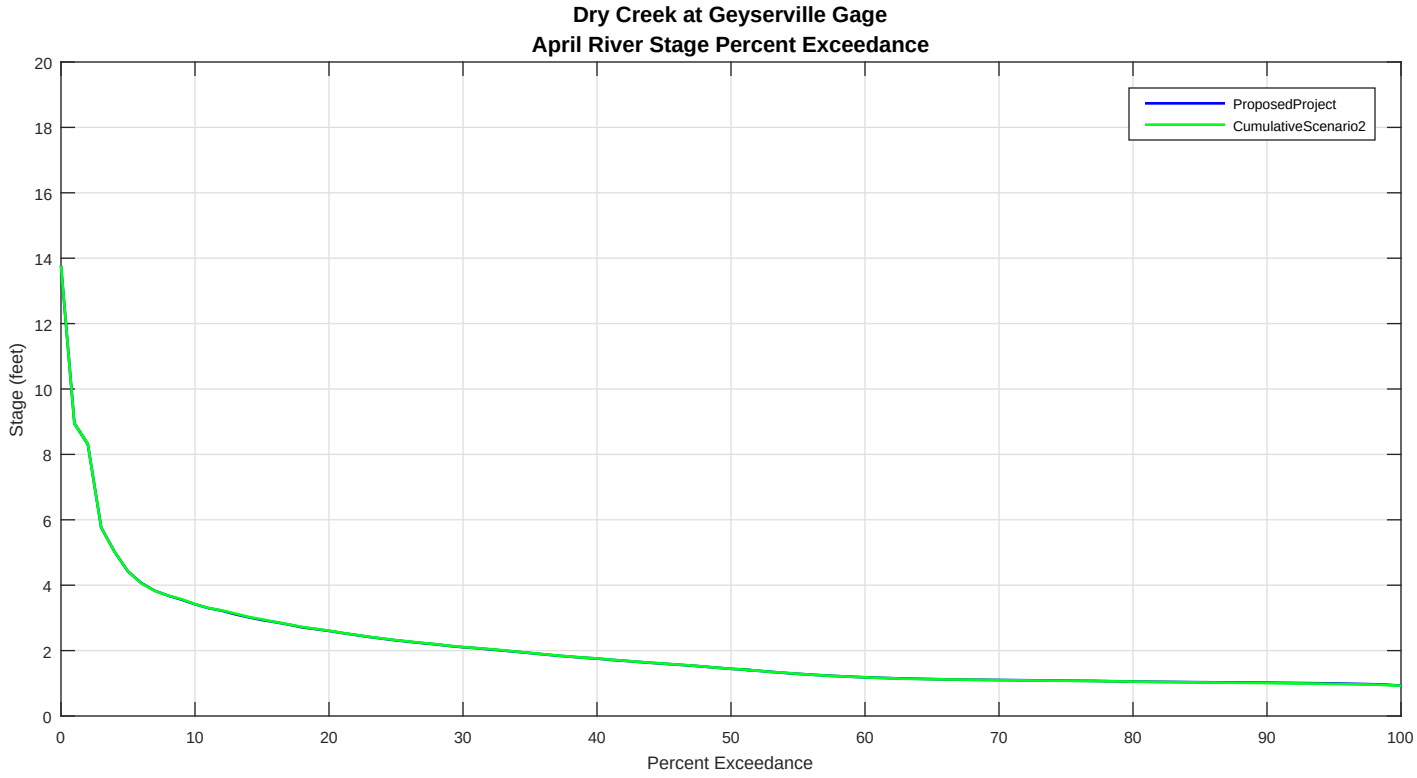

Hacienda Gage
August River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

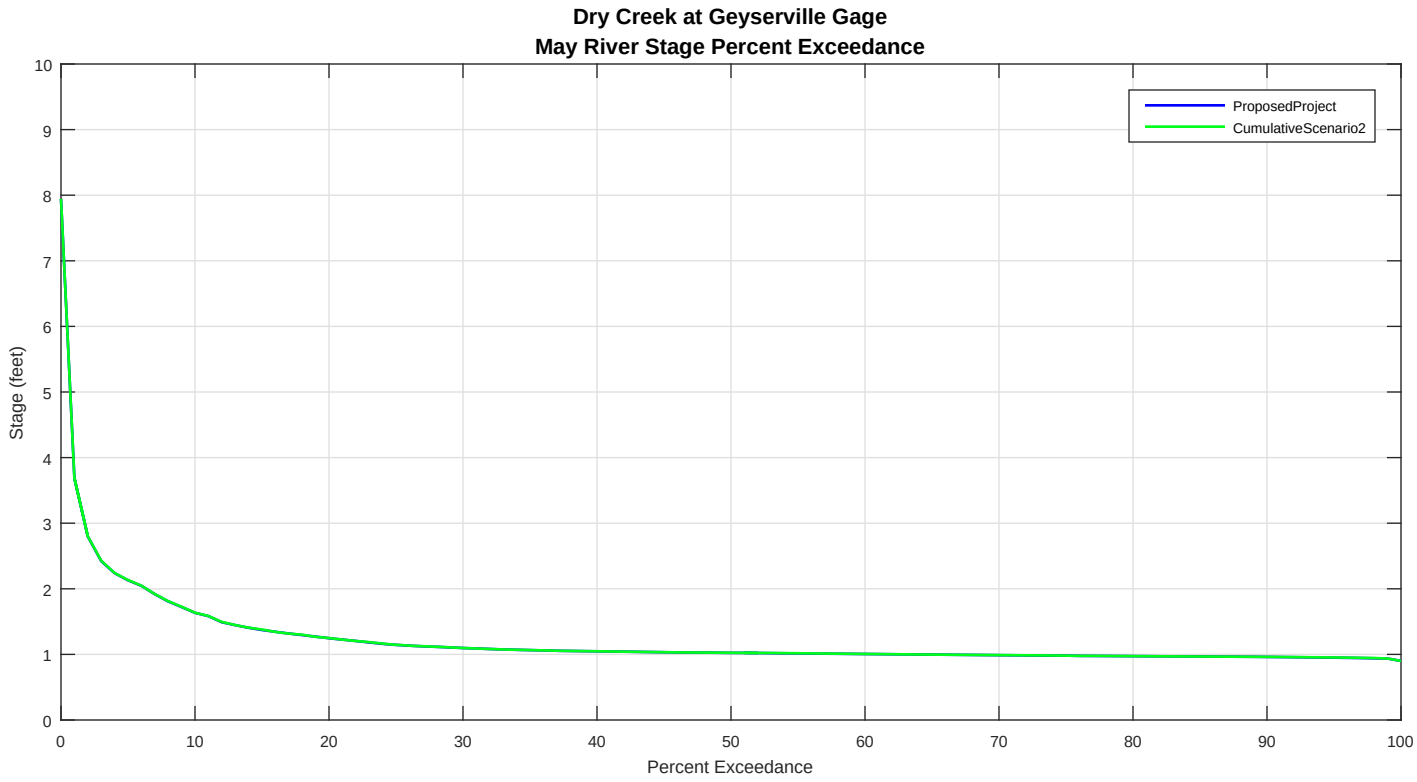

Hacienda Gage
September River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

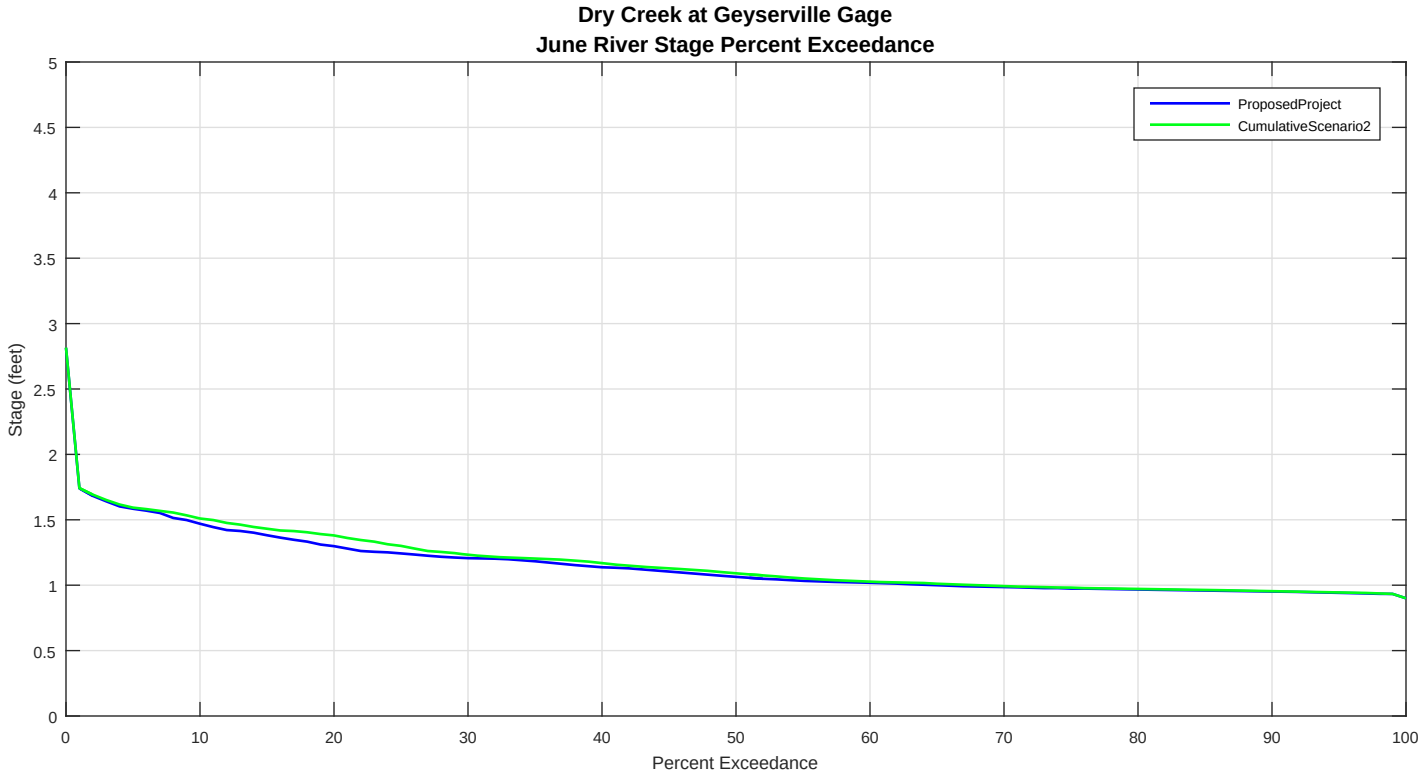

Hacienda Gage
October 1-15 River Stage Percent Exceedance
Stage (feet)
Percent Exceedance
ProposedProject
CumulativeScenario2
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

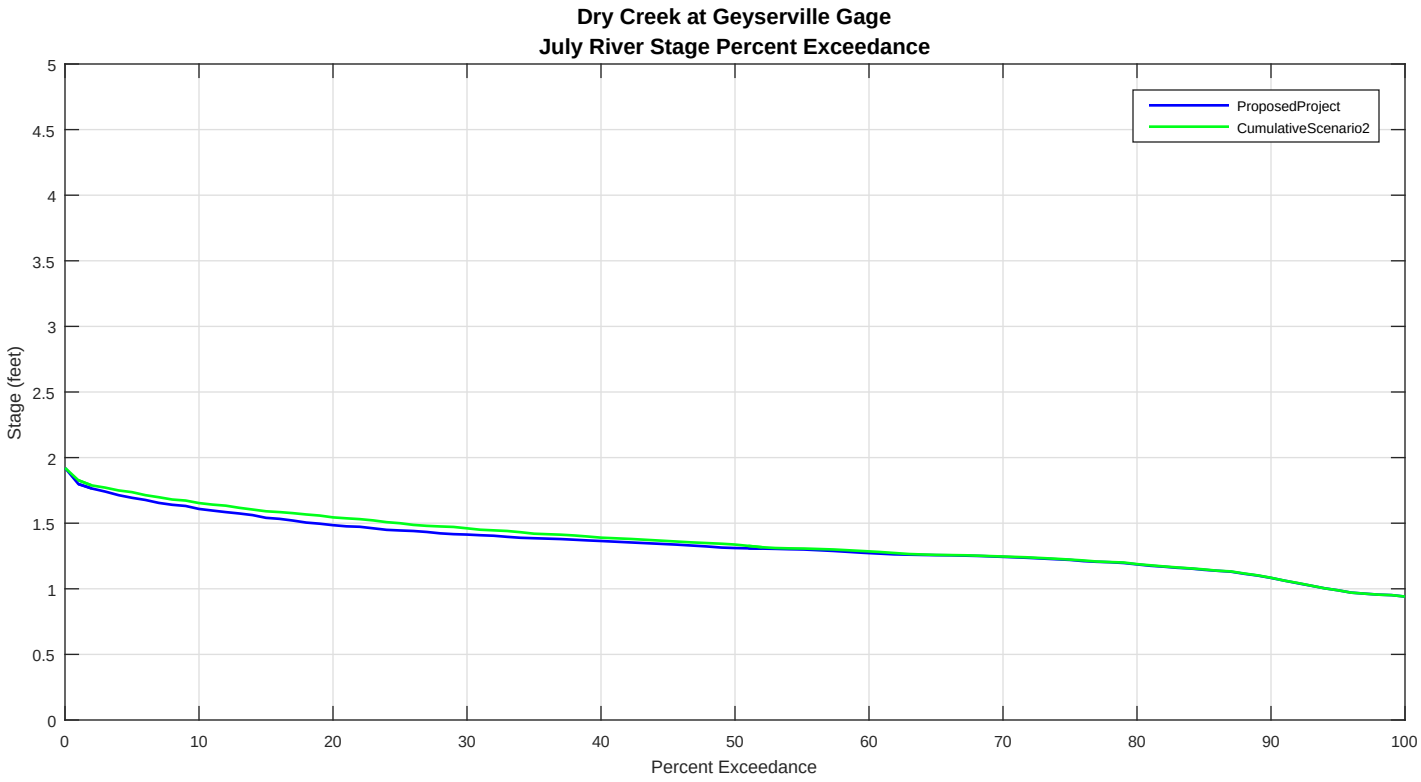

Hacienda Gage
October 16-31 River Stage Percent Exceedance
Stage (feet)
Percent Exceedance
ProposedProject
CumulativeScenario2
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

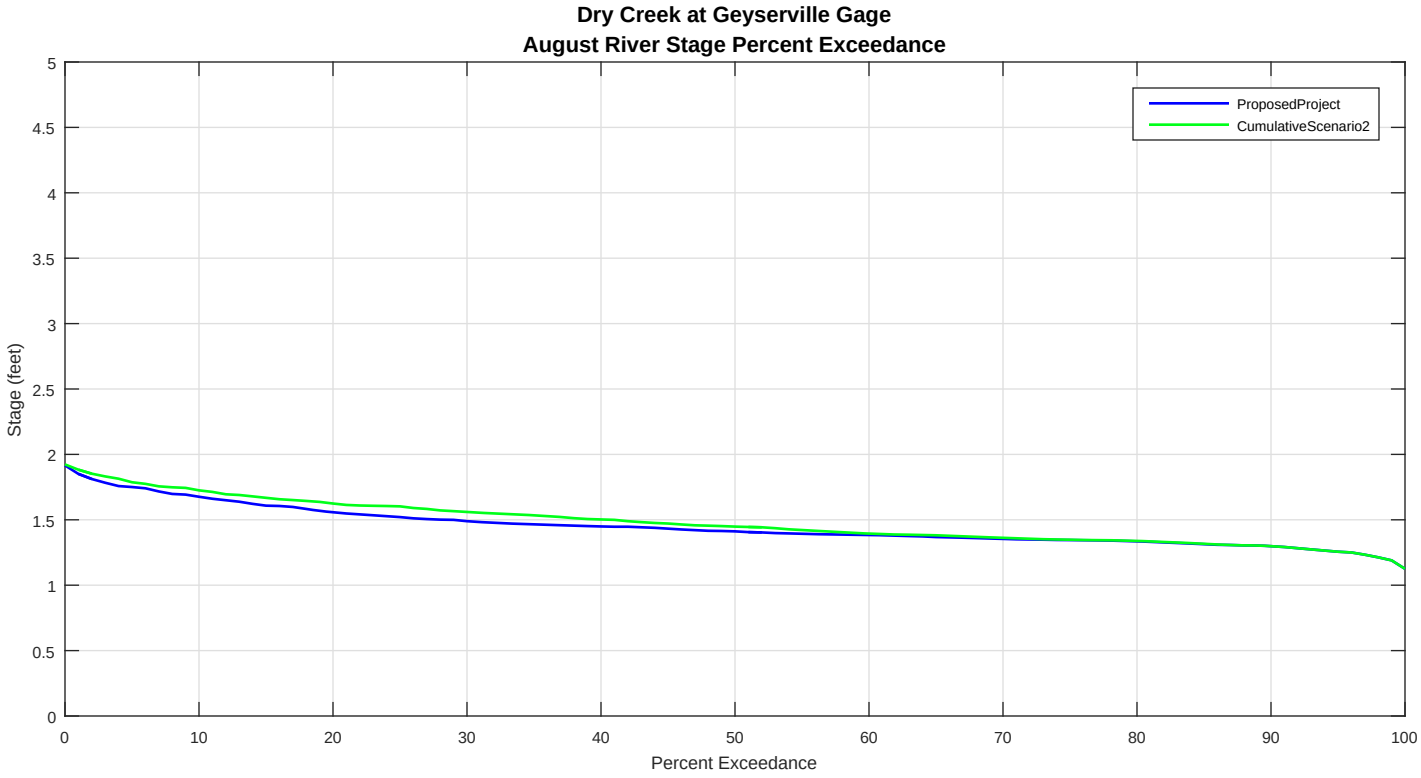

Dry Creek at Geyserville Gage
March River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80
90
100

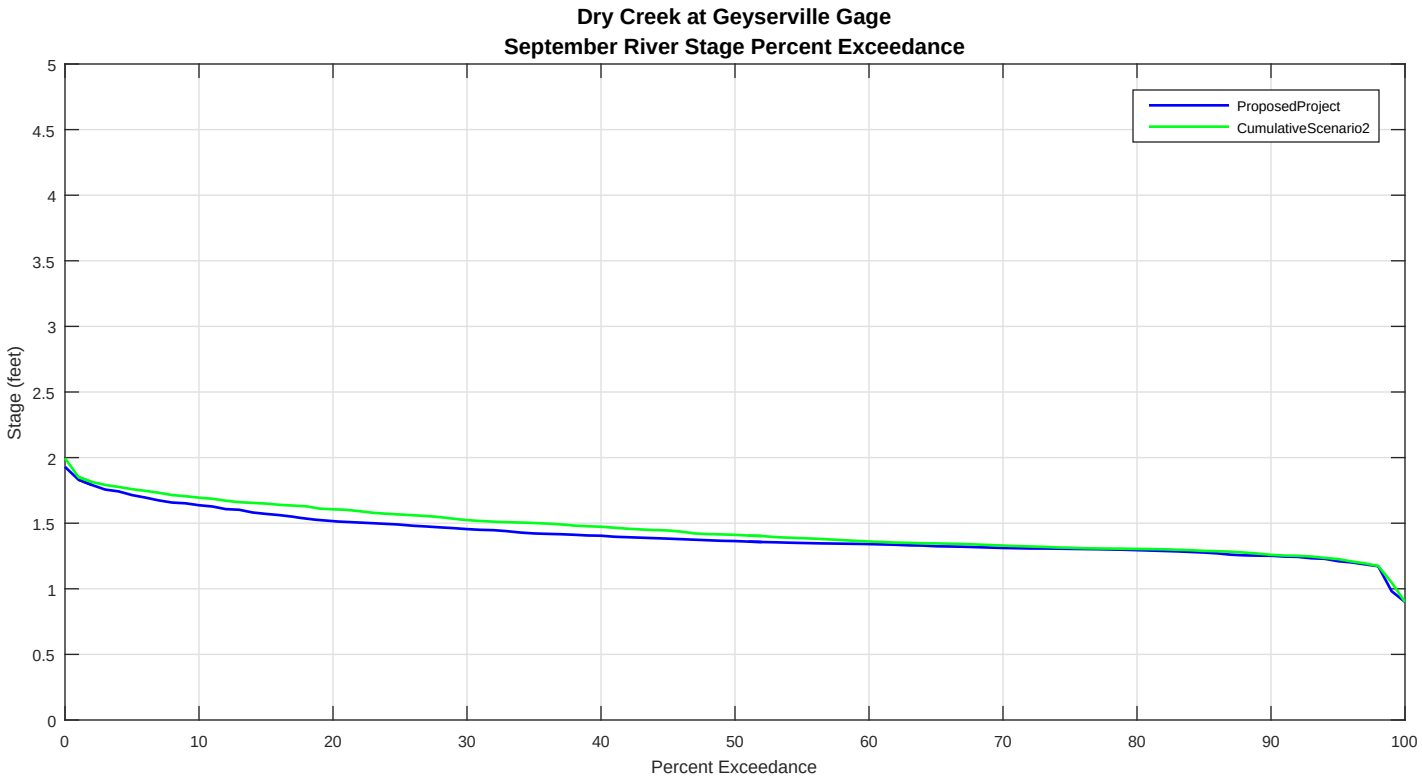

Dry Creek at Geyserville Gage
April River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

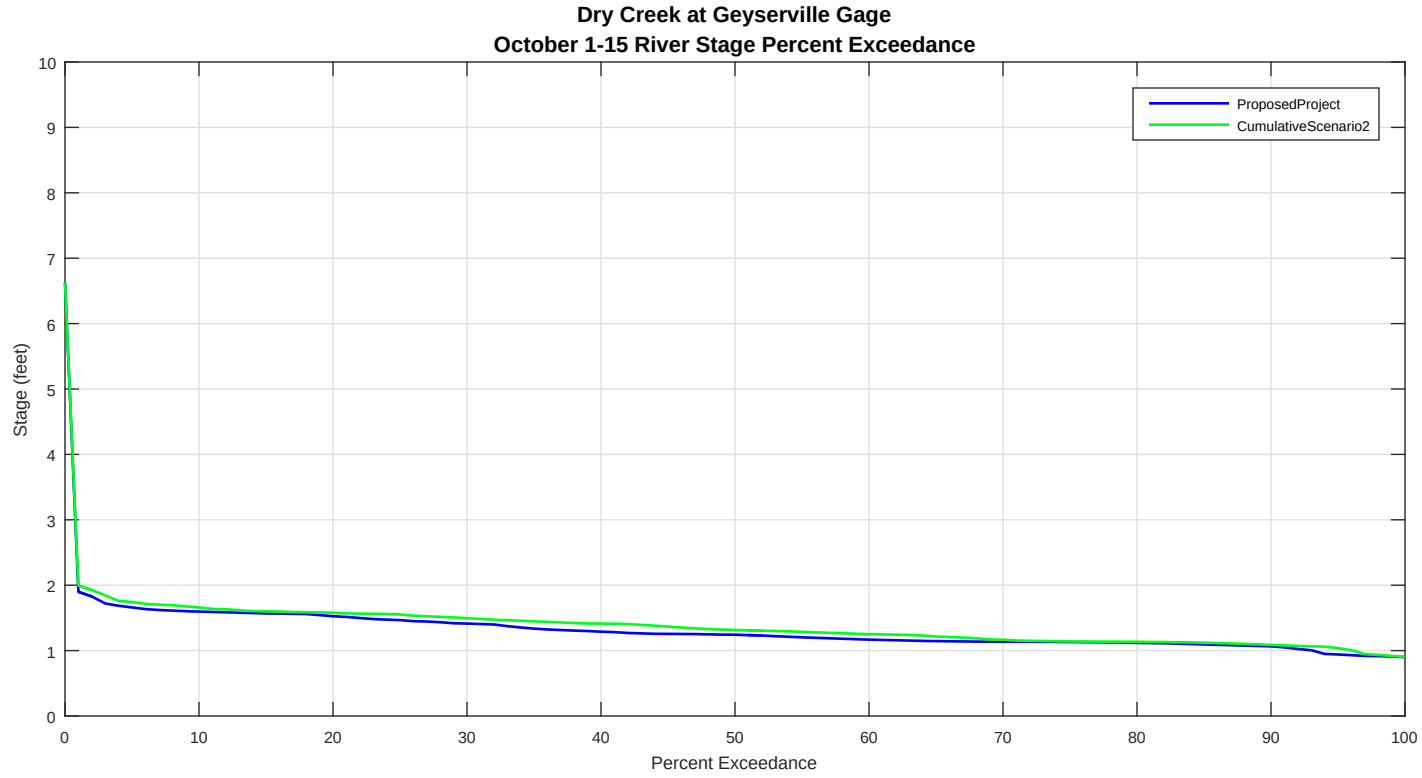

Dry Creek at Geyserville Gage
May River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

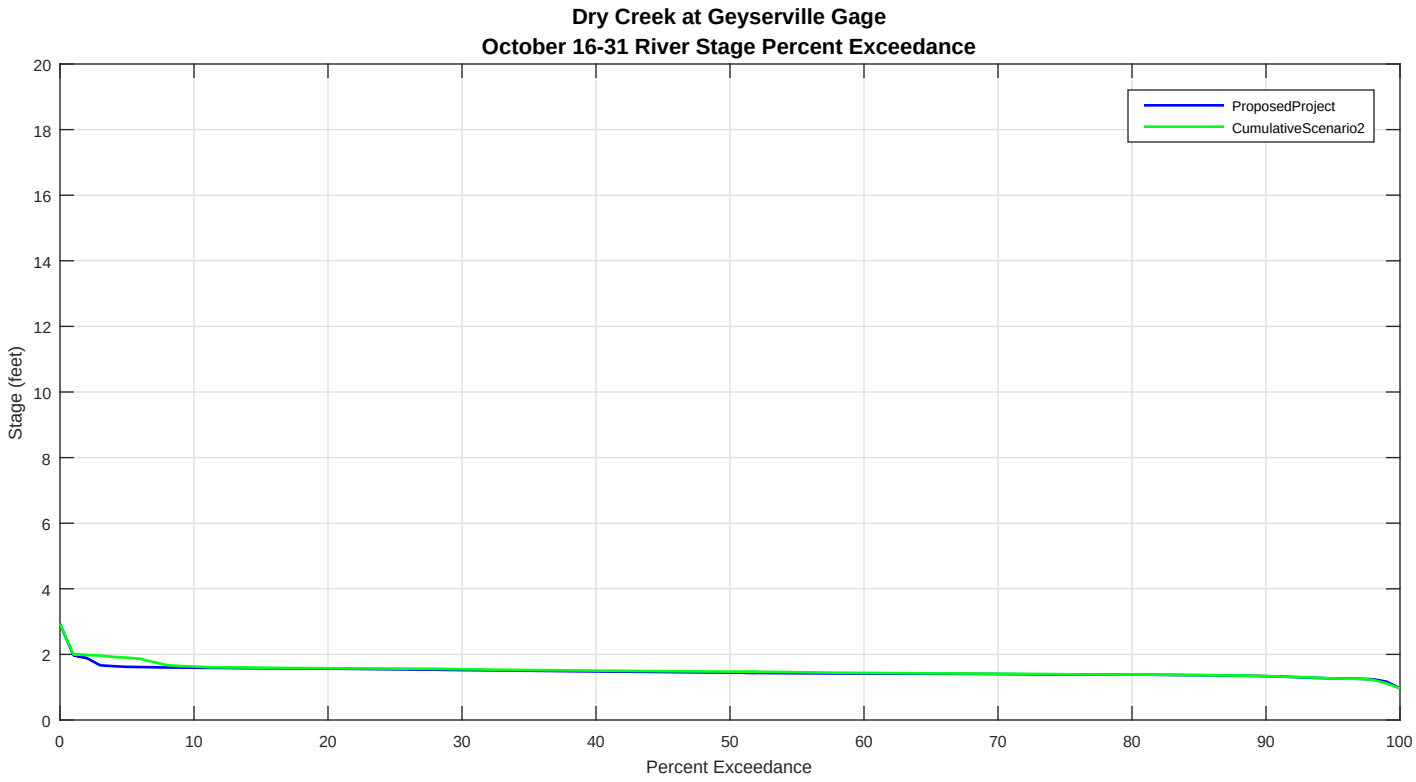

Dry Creek at Geyserville Gage
June River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100


Dry Creek at Geyserville Gage
July River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100


Dry Creek at Geyserville Gage
August River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100


Dry Creek at Geyserville Gage
September River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100


Dry Creek at Geyserville Gage
October 1-15 River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100


Dry Creek at Geyserville Gage
October 16-31 River Stage Percent Exceedance
ProposedProject
CumulativeScenario2
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
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90
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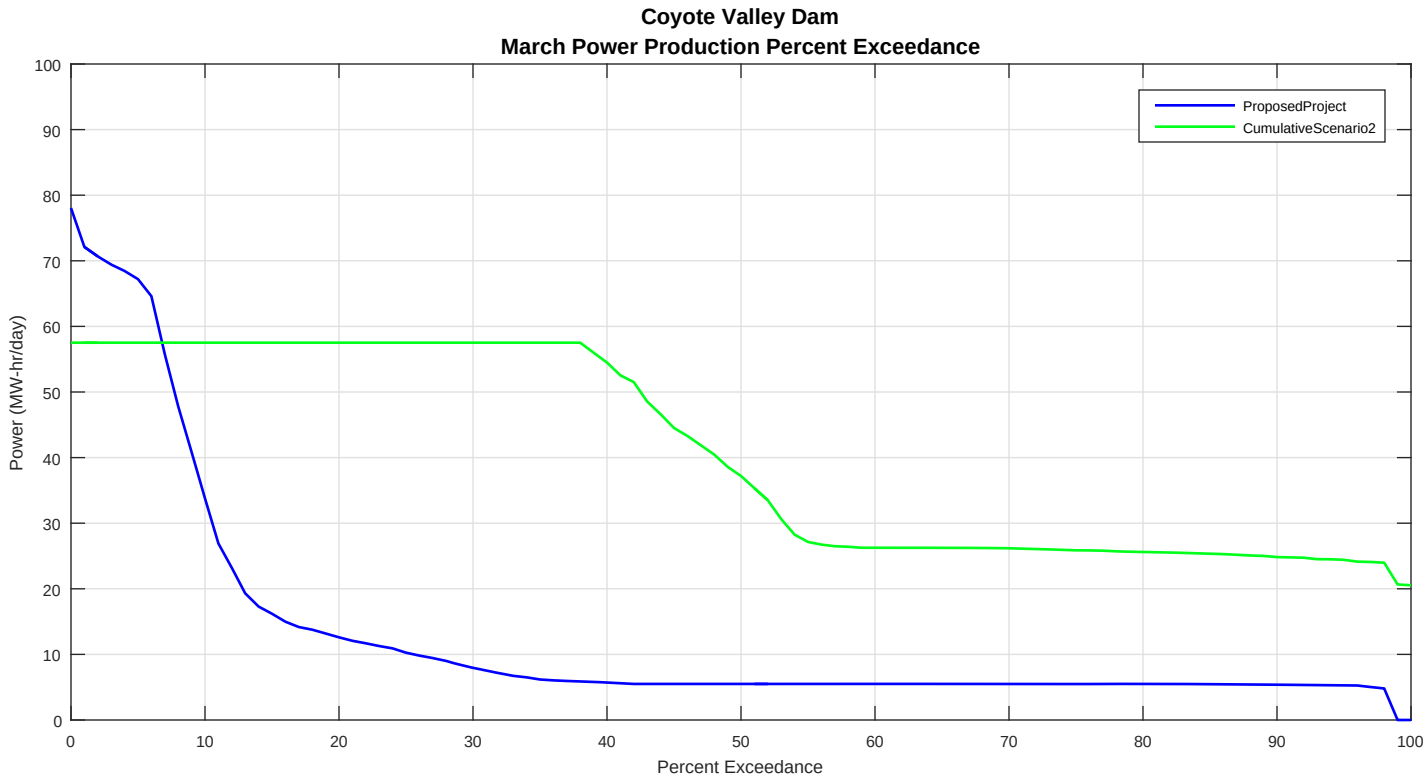
Coyote Valley Dam
March Power Production Percent Exceedance
ProposedProject
CumulativeScenario2
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
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80
90
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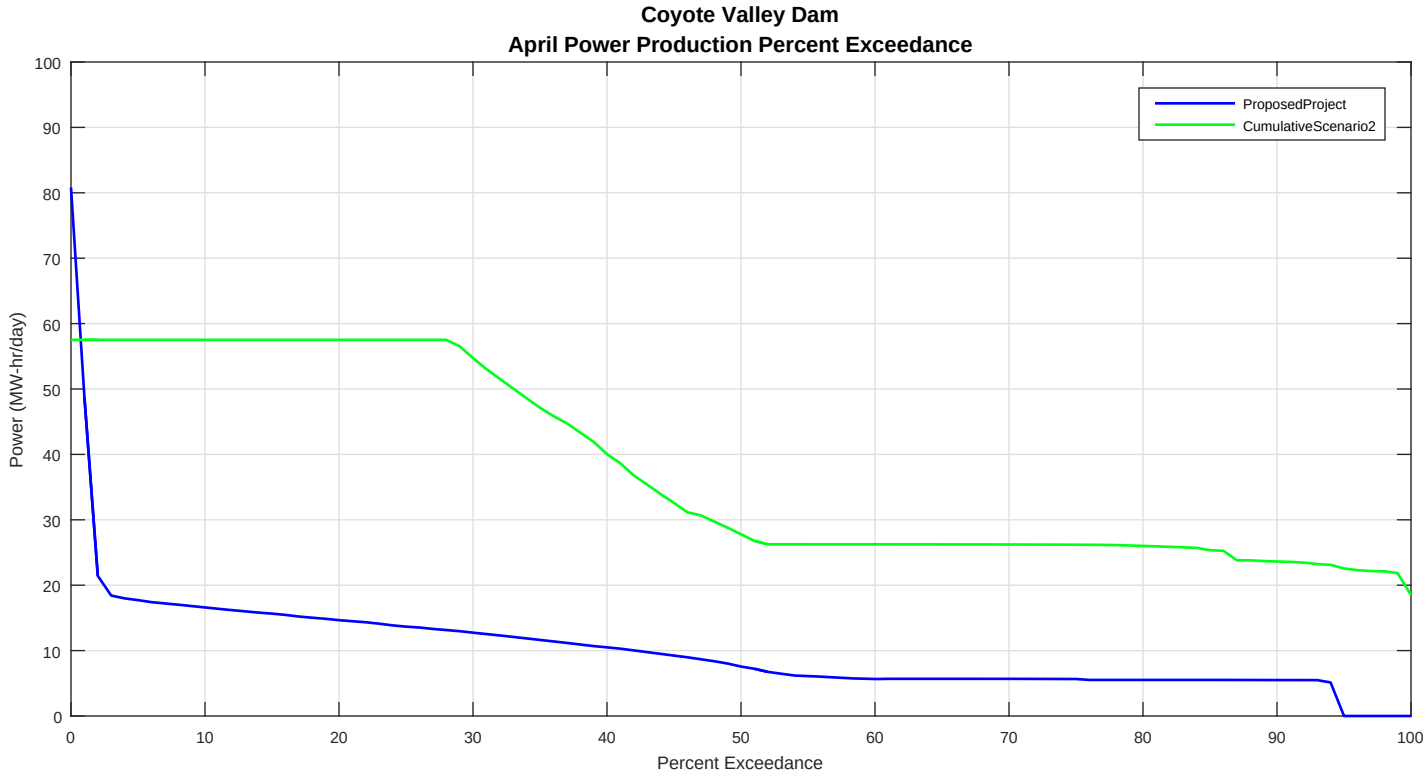
Coyote Valley Dam
April Power Production Percent Exceedance
ProposedProject
CumulativeScenario2
Power (MW-hr/day)
Percent Exceedance
0
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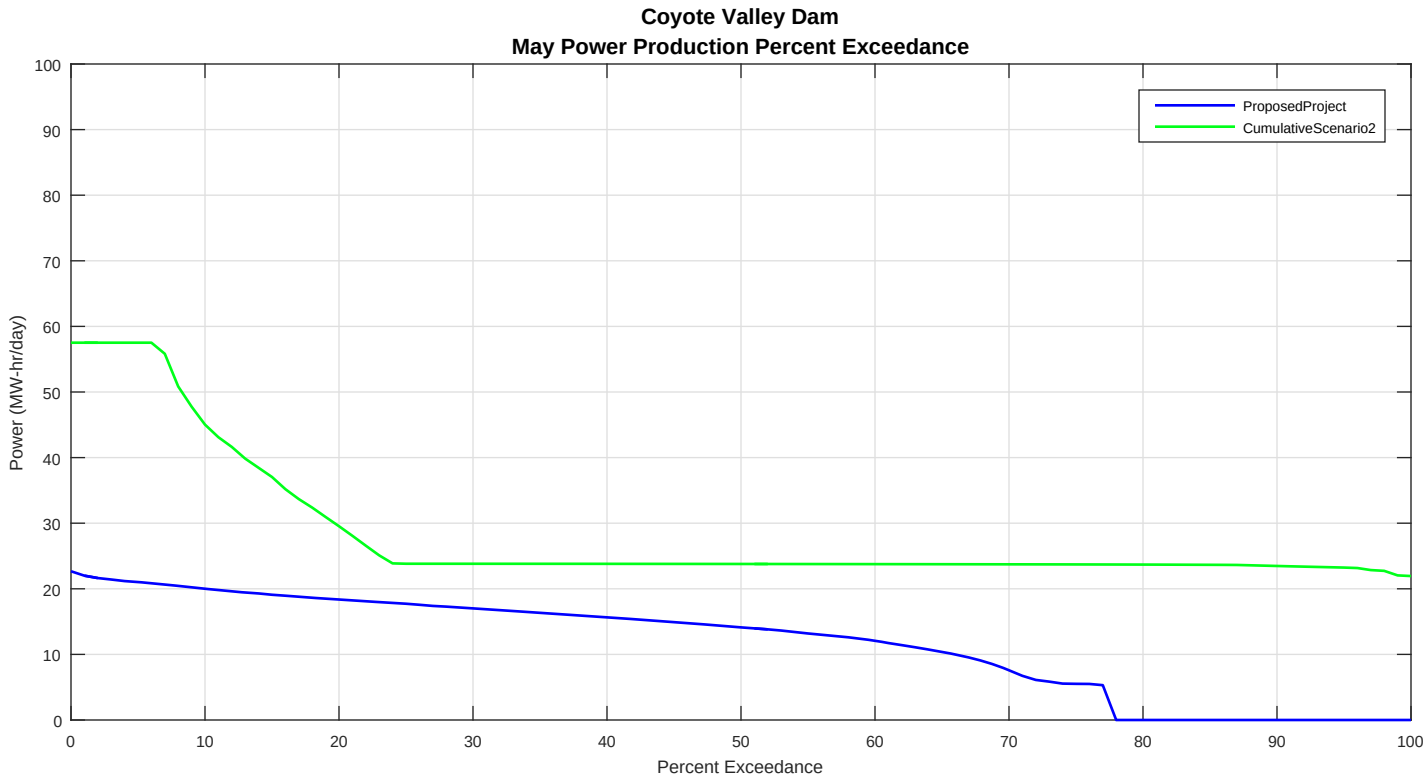
Coyote Valley Dam
May Power Production Percent Exceedance
ProposedProject
CumulativeScenario2
Power (MW-hr/day)
Percent Exceedance
0
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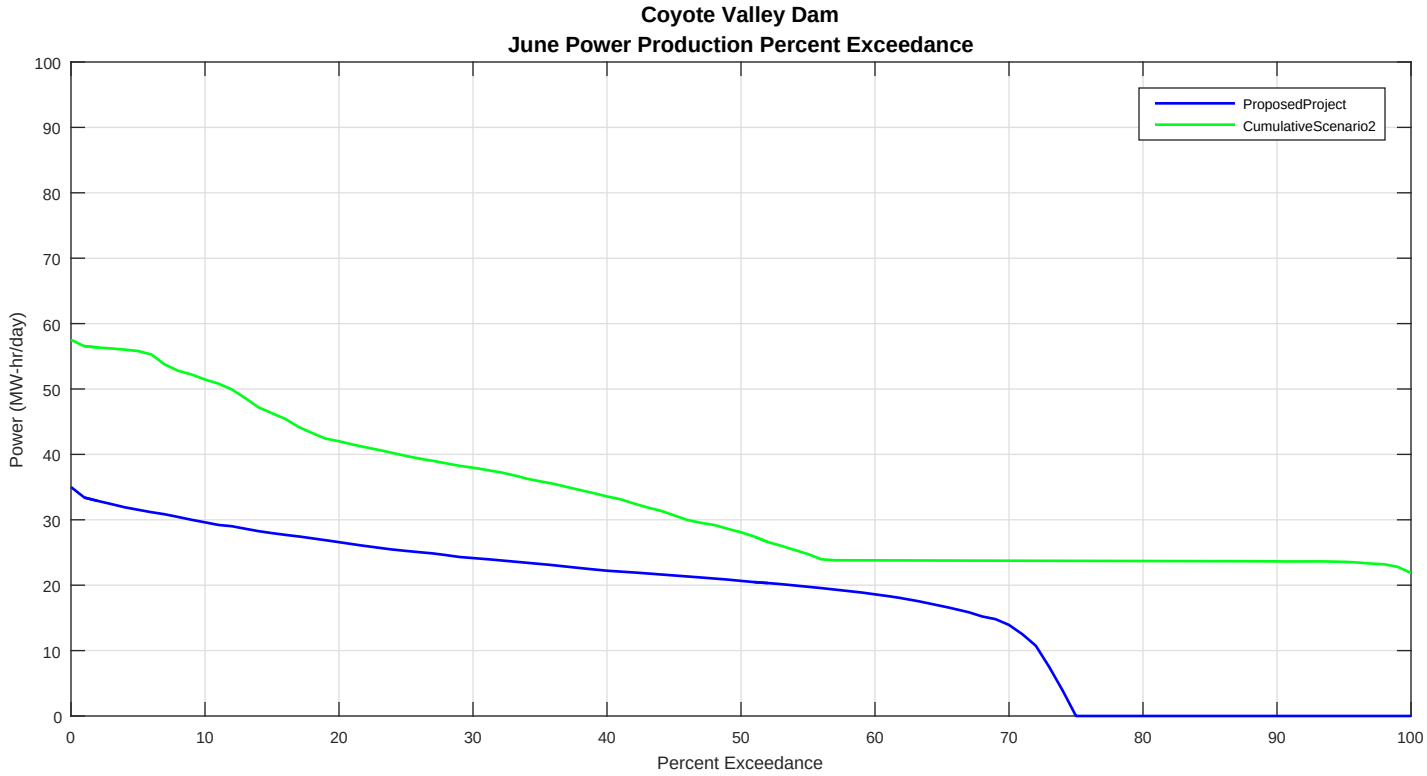
Coyote Valley Dam
June Power Production Percent Exceedance
ProposedProject
CumulativeScenario2
Power (MW-hr/day)
Percent Exceedance
0
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20
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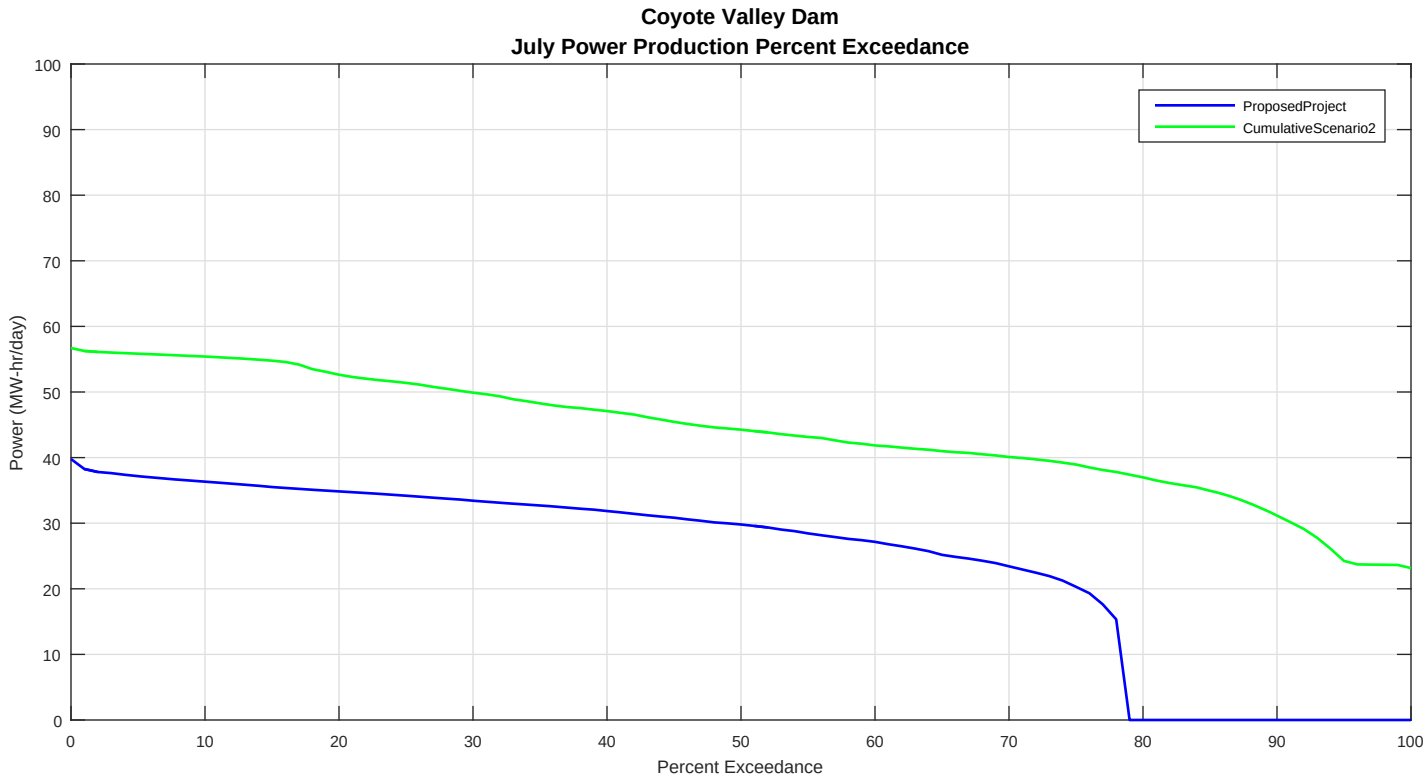
Coyote Valley Dam
July Power Production Percent Exceedance
ProposedProject
CumulativeScenario2
Power (MW-hr/day)
Percent Exceedance
0
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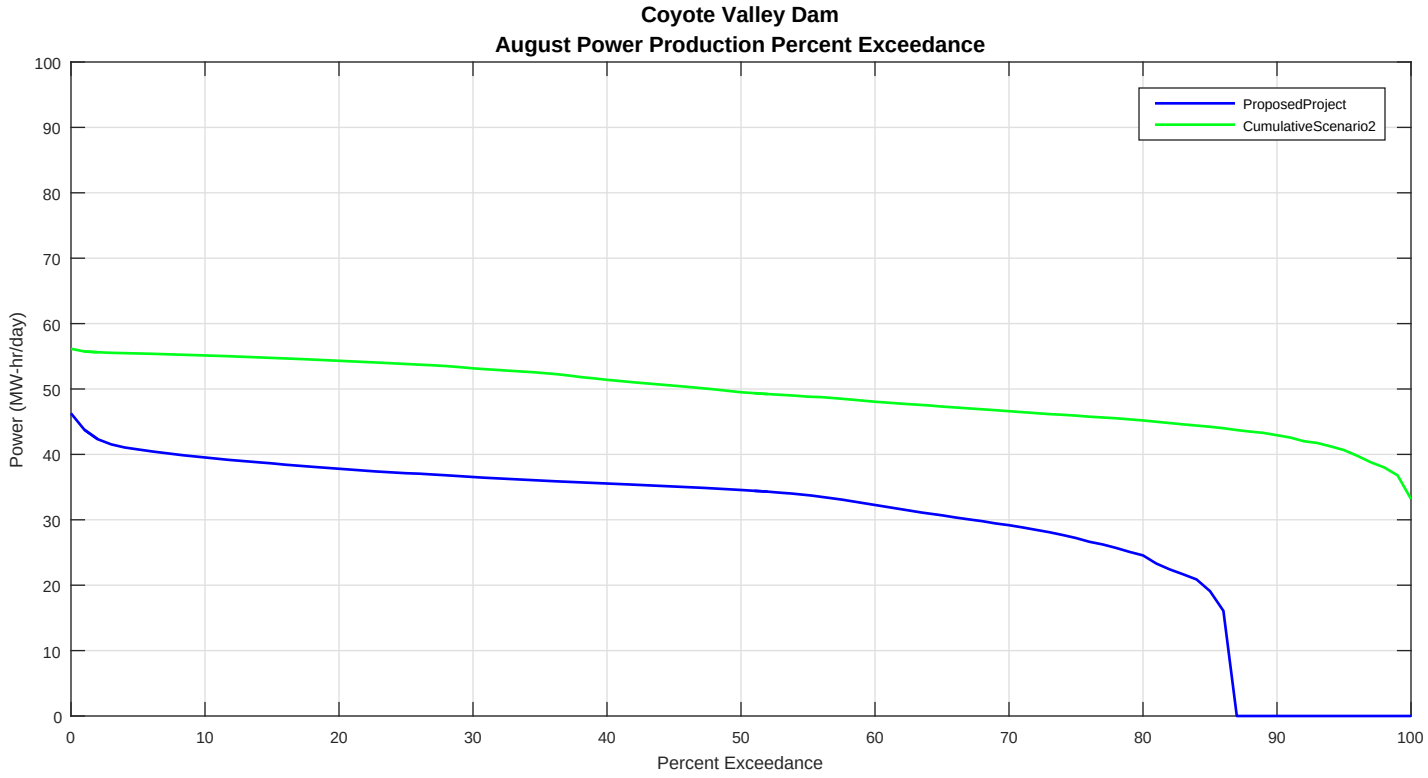
Coyote Valley Dam
August Power Production Percent Exceedance
ProposedProject
CumulativeScenario2
Power (MW-hr/day)
Percent Exceedance
0
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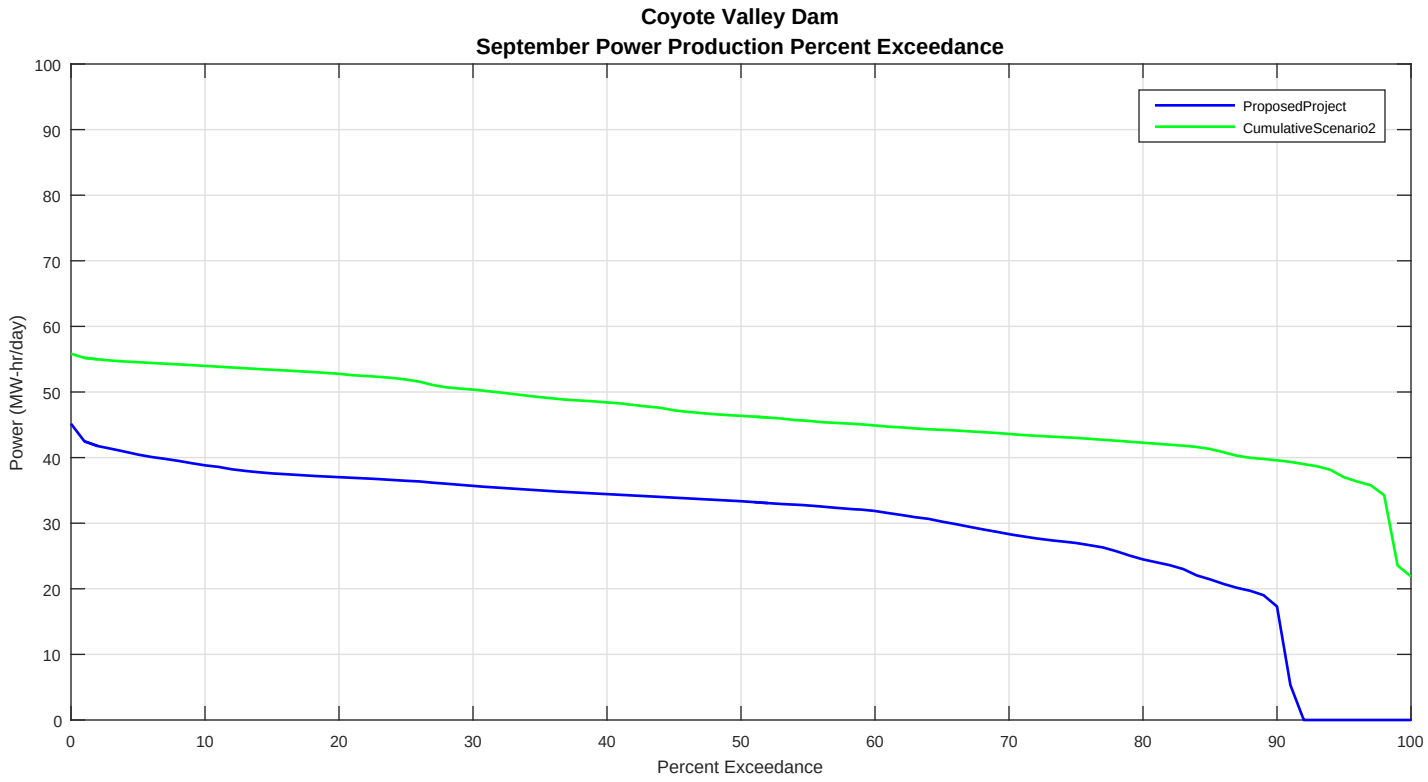
Coyote Valley Dam
September Power Production Percent Exceedance
ProposedProject
CumulativeScenario2
Power (MW-hr/day)
Percent Exceedance
0
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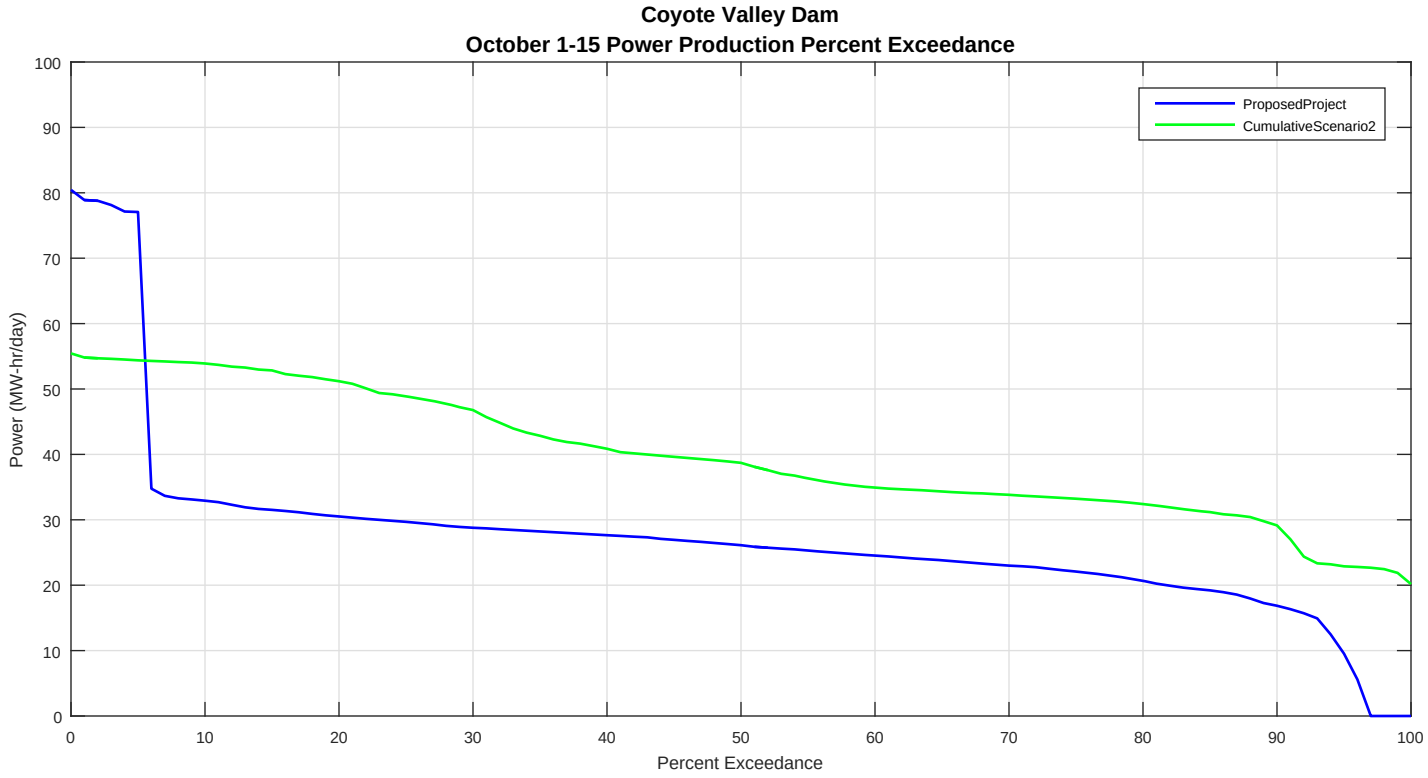
Coyote Valley Dam
October 1-15 Power Production Percent Exceedance
ProposedProject
CumulativeScenario2
Power (MW-hr/day)
Percent Exceedance
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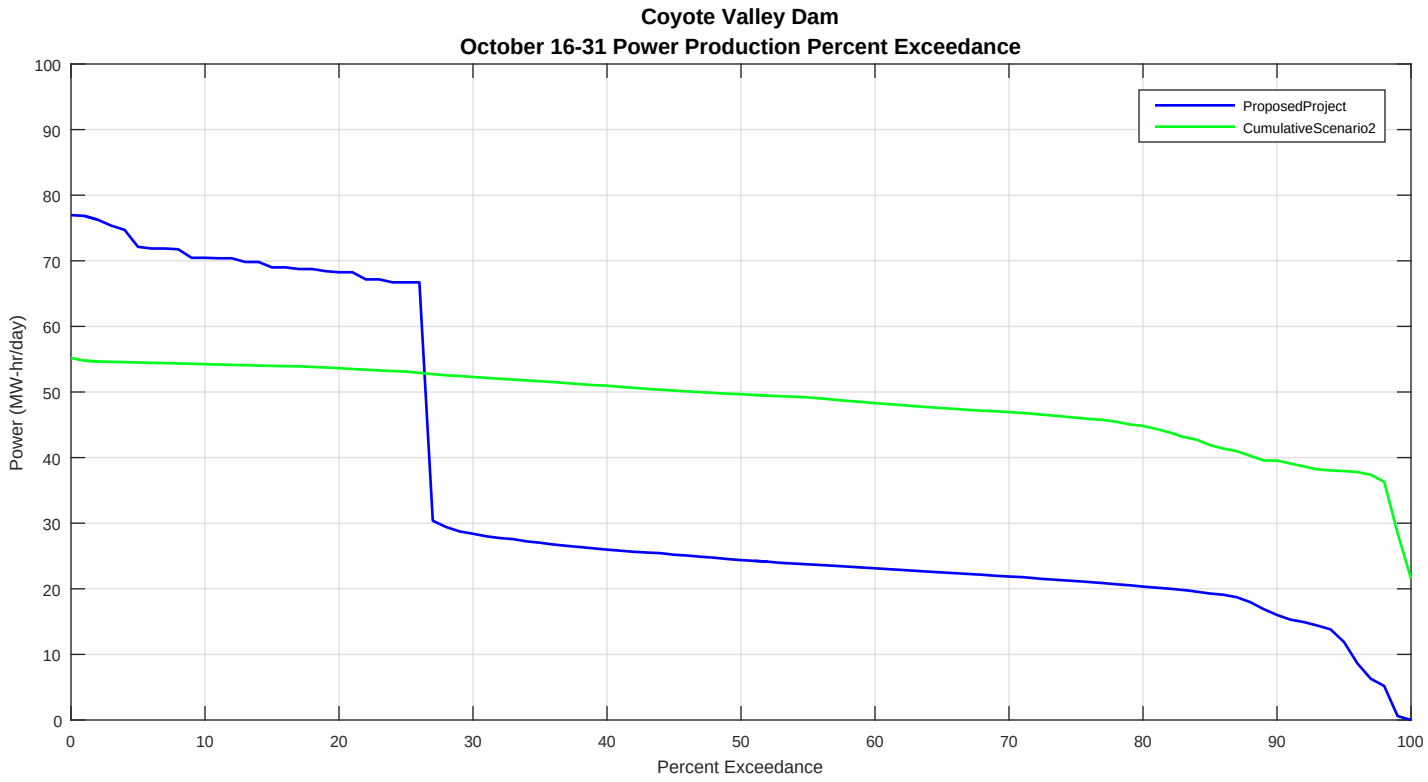
Coyote Valley Dam
October 16-31 Power Production Percent Exceedance
ProposedProject
CumulativeScenario2
Power (MW-hr/day)
Percent Exceedance
0
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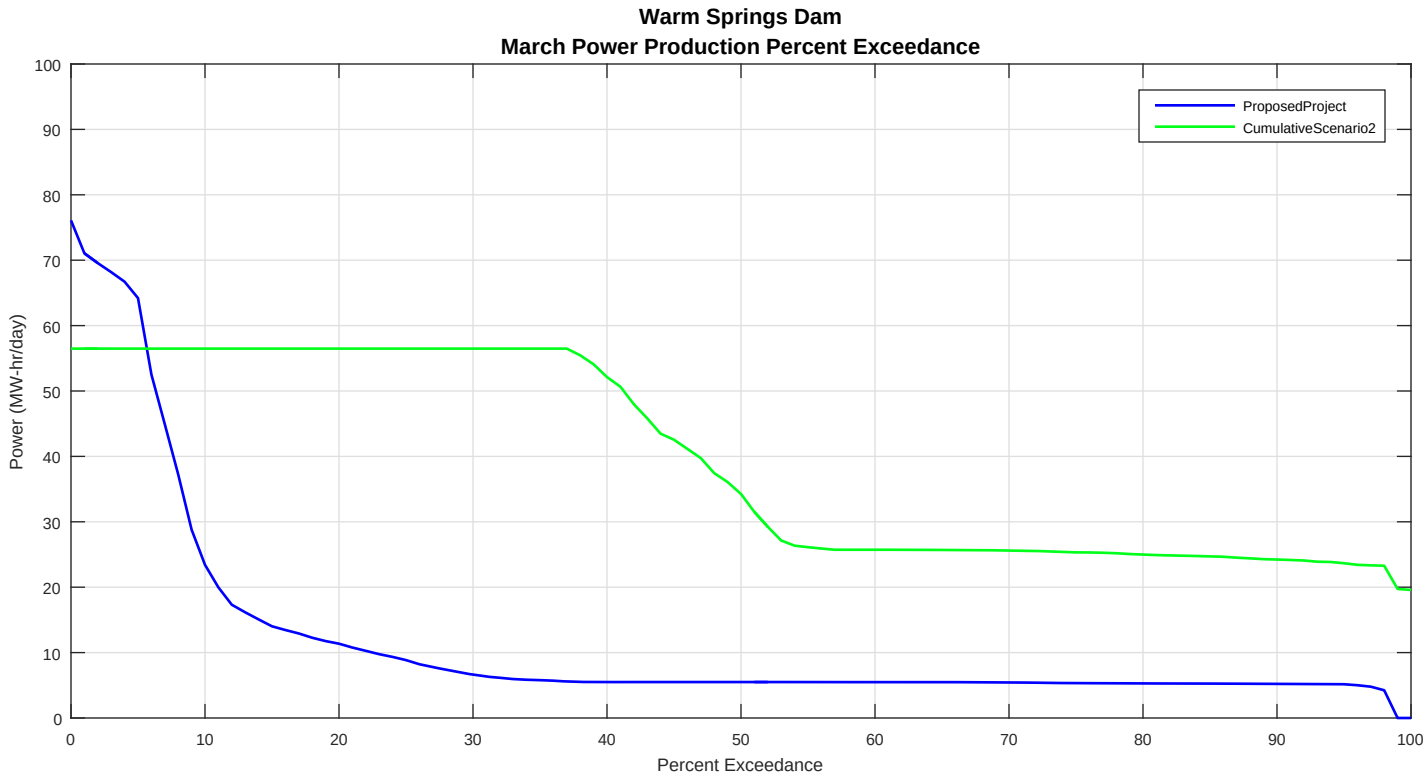
Warm Springs Dam
March Power Production Percent Exceedance
ProposedProject
CumulativeScenario2
Power (MW-hr/day)
Percent Exceedance
0
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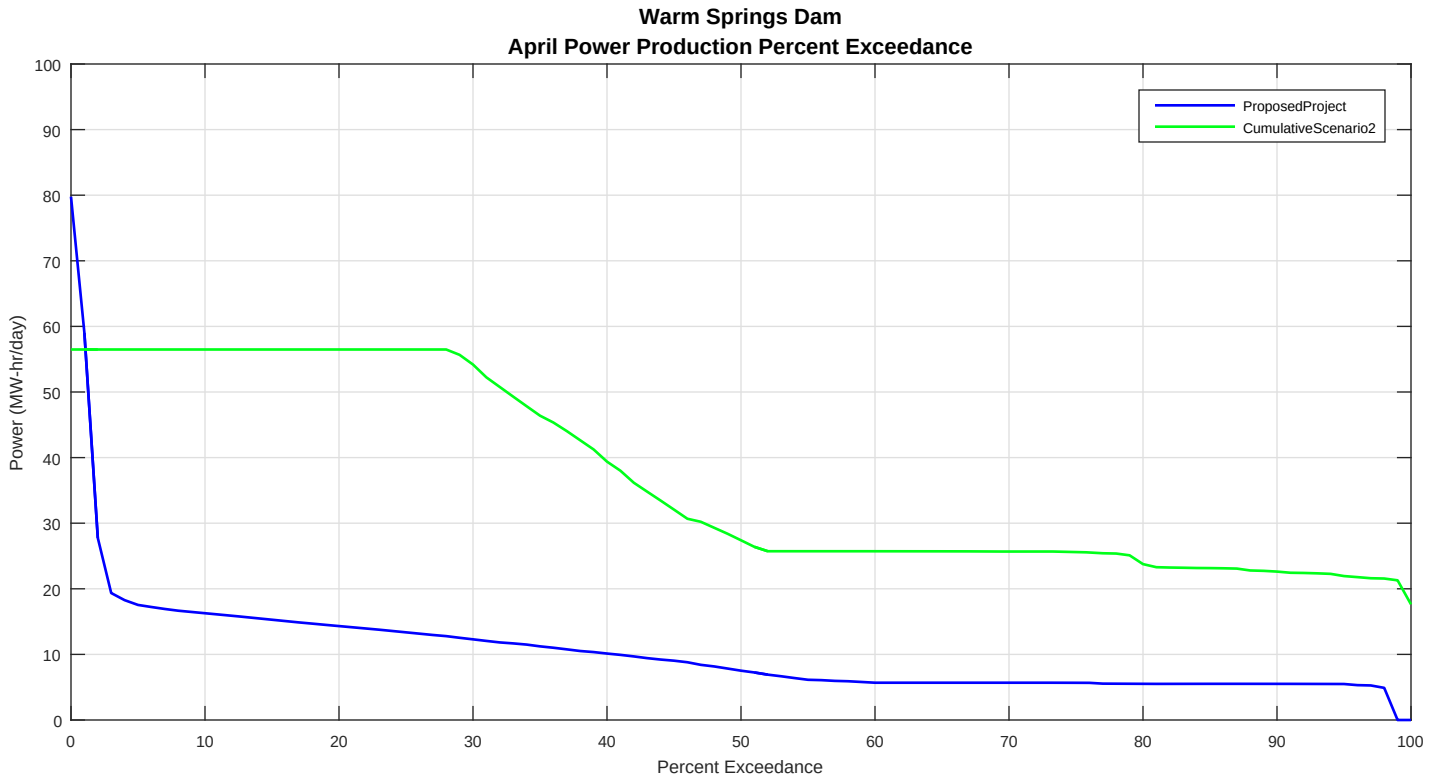
Warm Springs Dam
April Power Production Percent Exceedance
ProposedProject
CumulativeScenario2
Power (MW-hr/day)
Percent Exceedance
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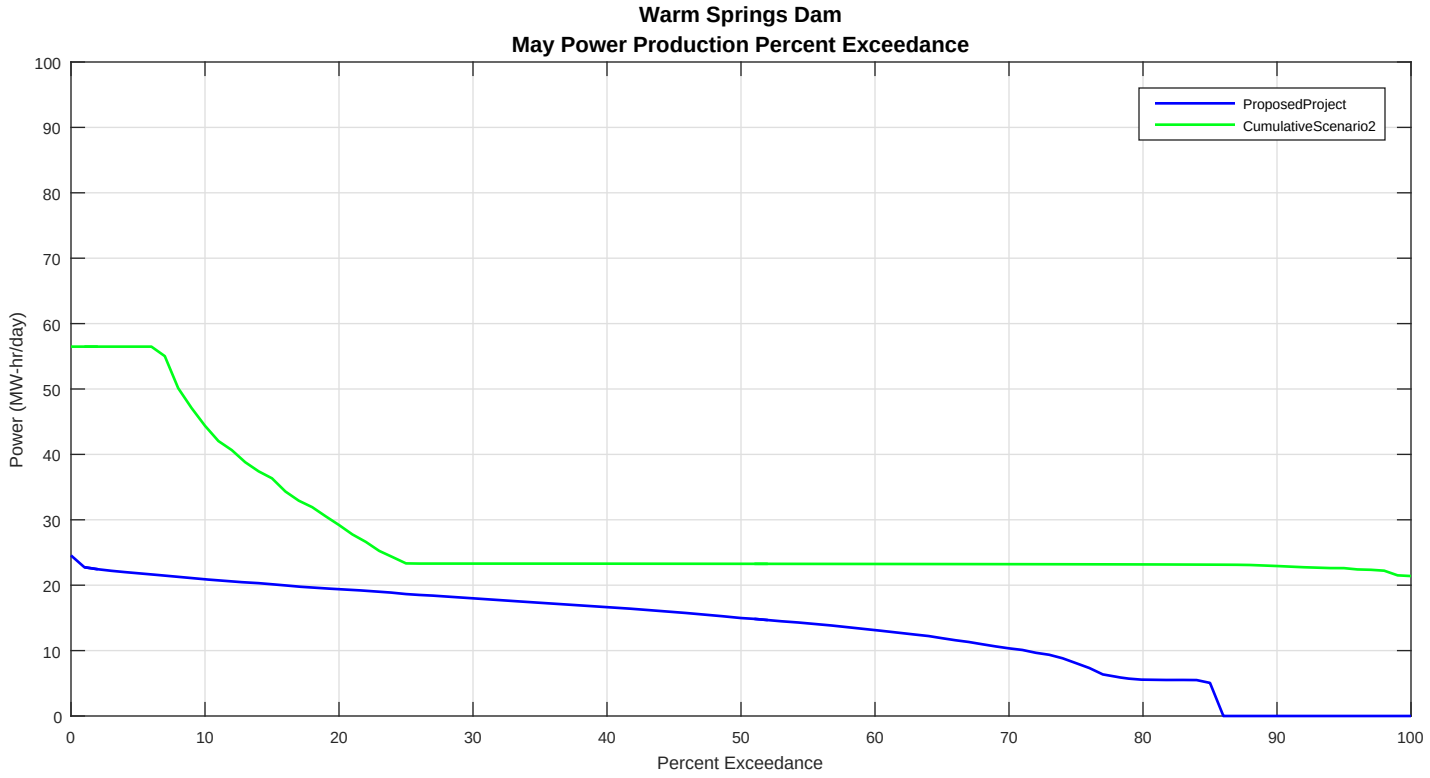
Warm Springs Dam
May Power Production Percent Exceedance
ProposedProject
CumulativeScenario2
Power (MW-hr/day)
Percent Exceedance
0
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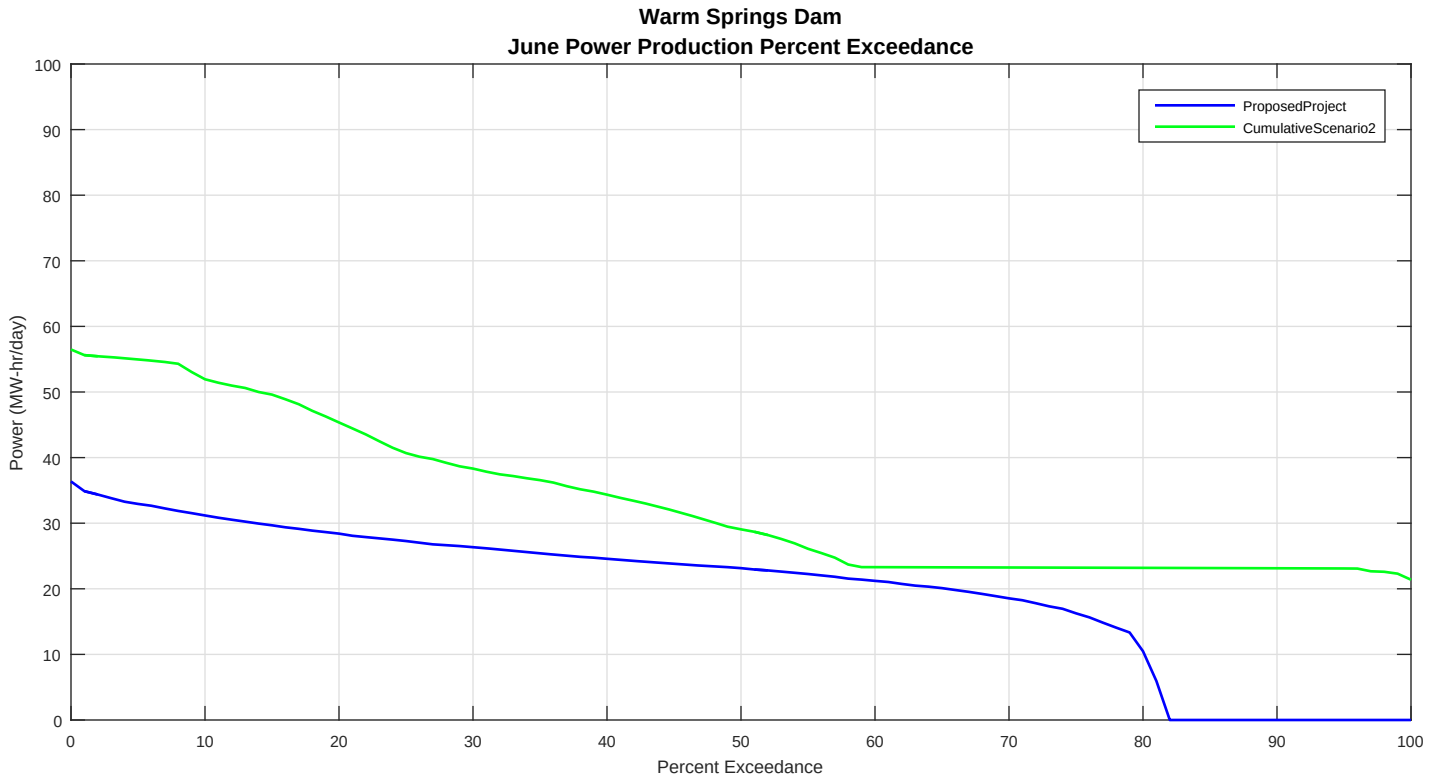
Warm Springs Dam
June Power Production Percent Exceedance
ProposedProject
CumulativeScenario2
Power (MW-hr/day)
Percent Exceedance
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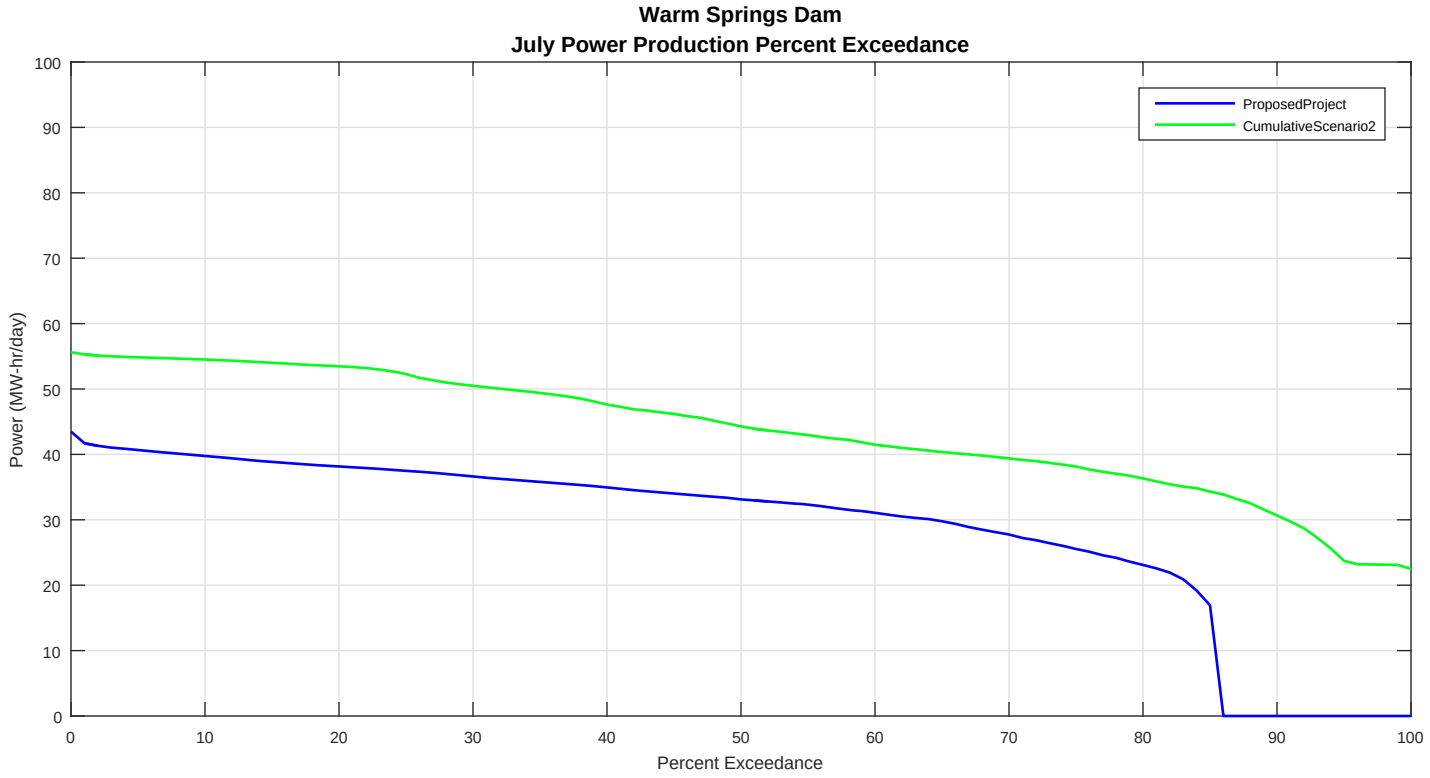
Warm Springs Dam
July Power Production Percent Exceedance
ProposedProject
CumulativeScenario2
Power (MW-hr/day)
Percent Exceedance
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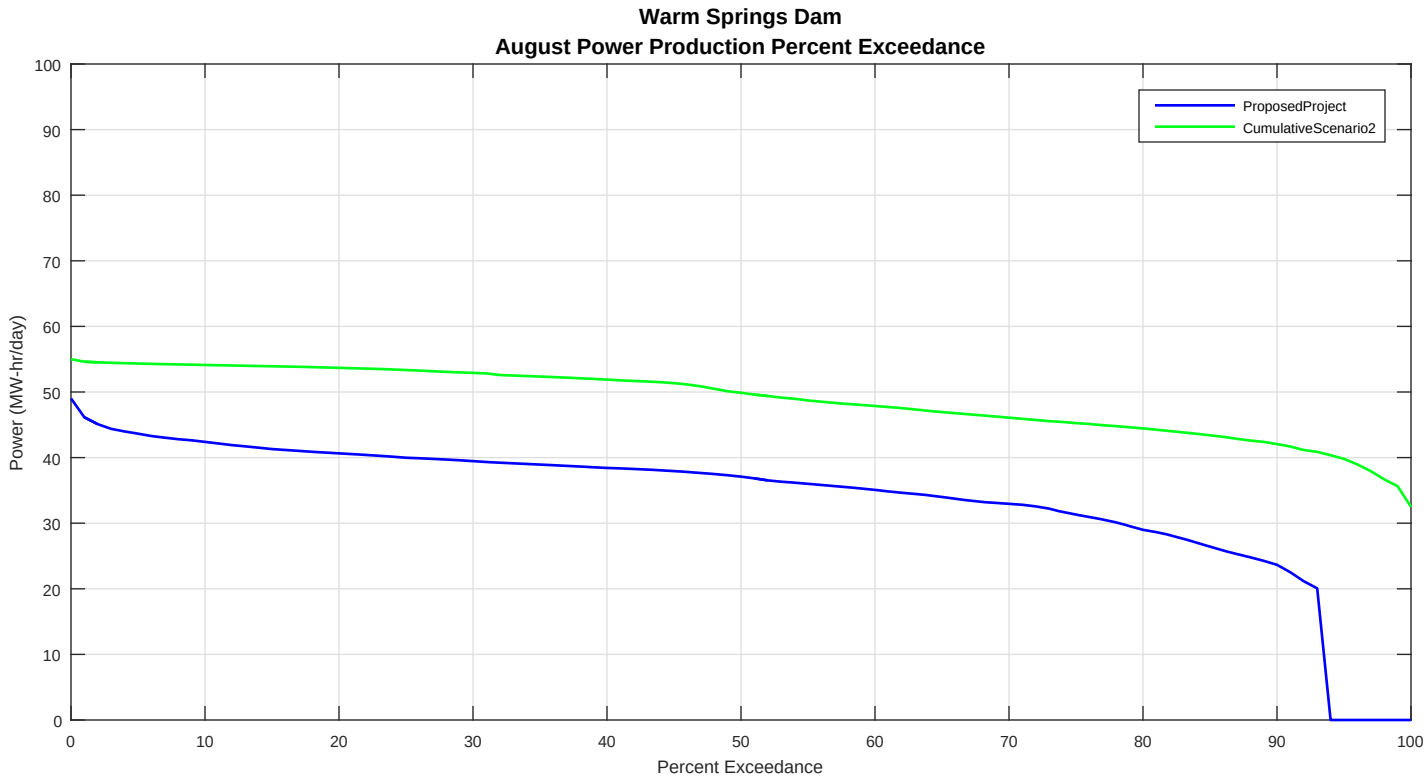
Warm Springs Dam
August Power Production Percent Exceedance
ProposedProject
CumulativeScenario2
Power (MW-hr/day)
Percent Exceedance
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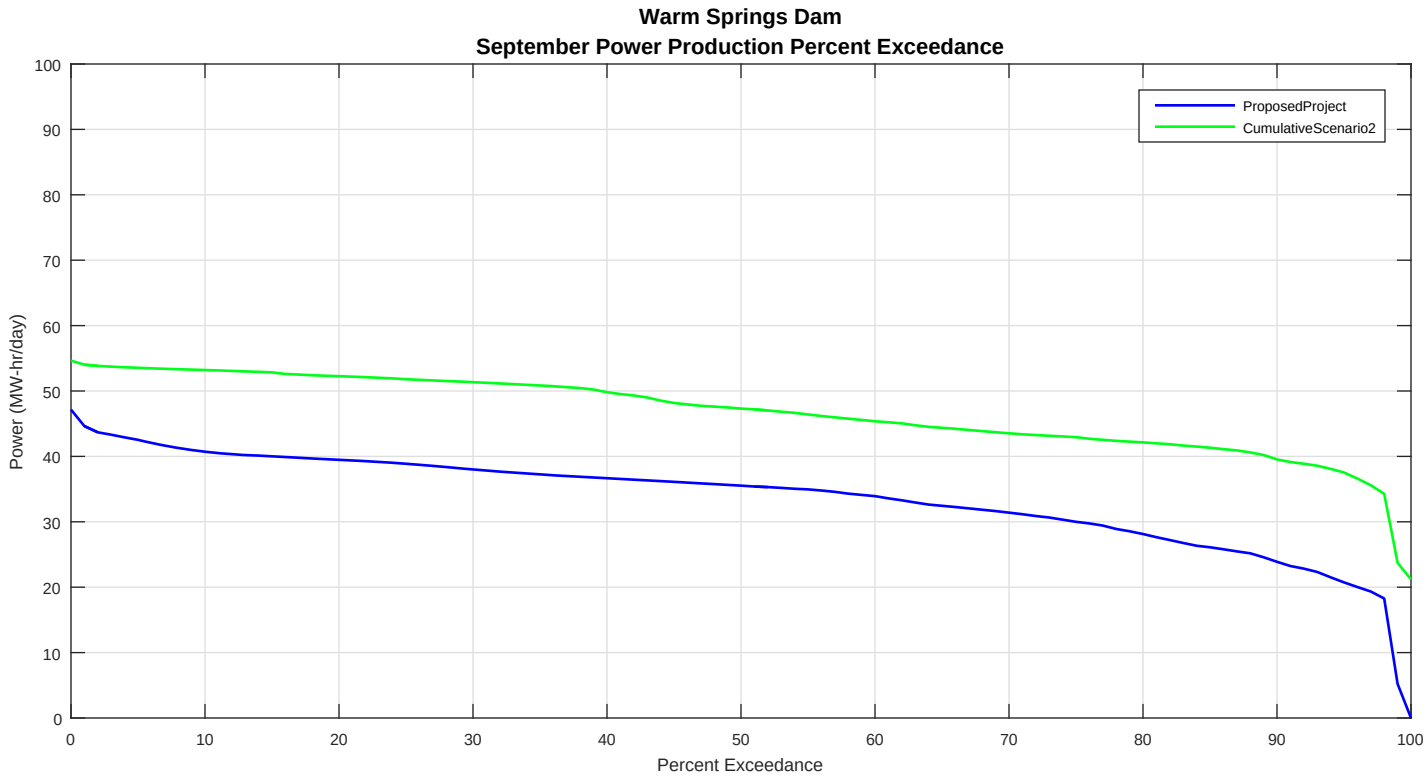
Warm Springs Dam
September Power Production Percent Exceedance
ProposedProject
CumulativeScenario2
Power (MW-hr/day)
Percent Exceedance
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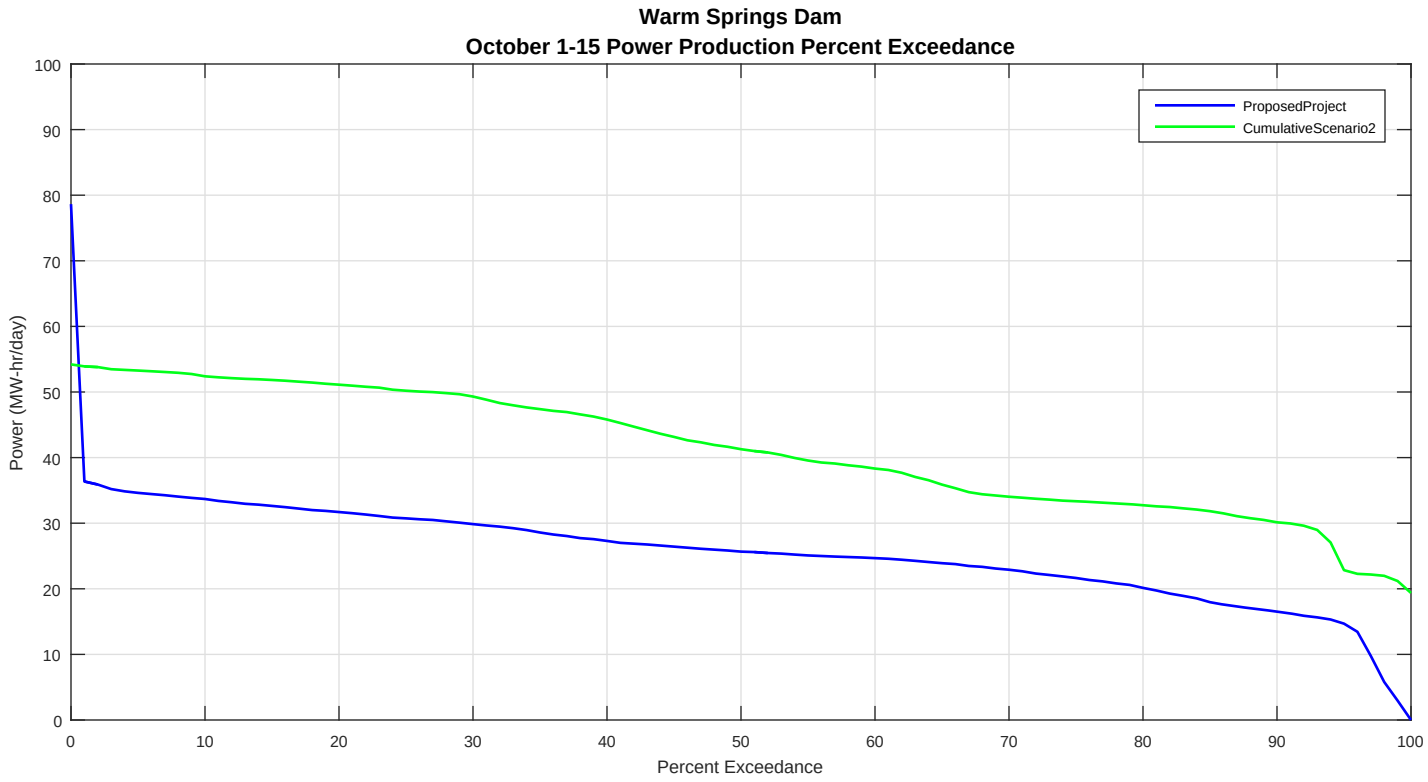
Warm Springs Dam
October 1-15 Power Production Percent Exceedance
ProposedProject
CumulativeScenario2
Power (MW-hr/day)
Percent Exceedance
0
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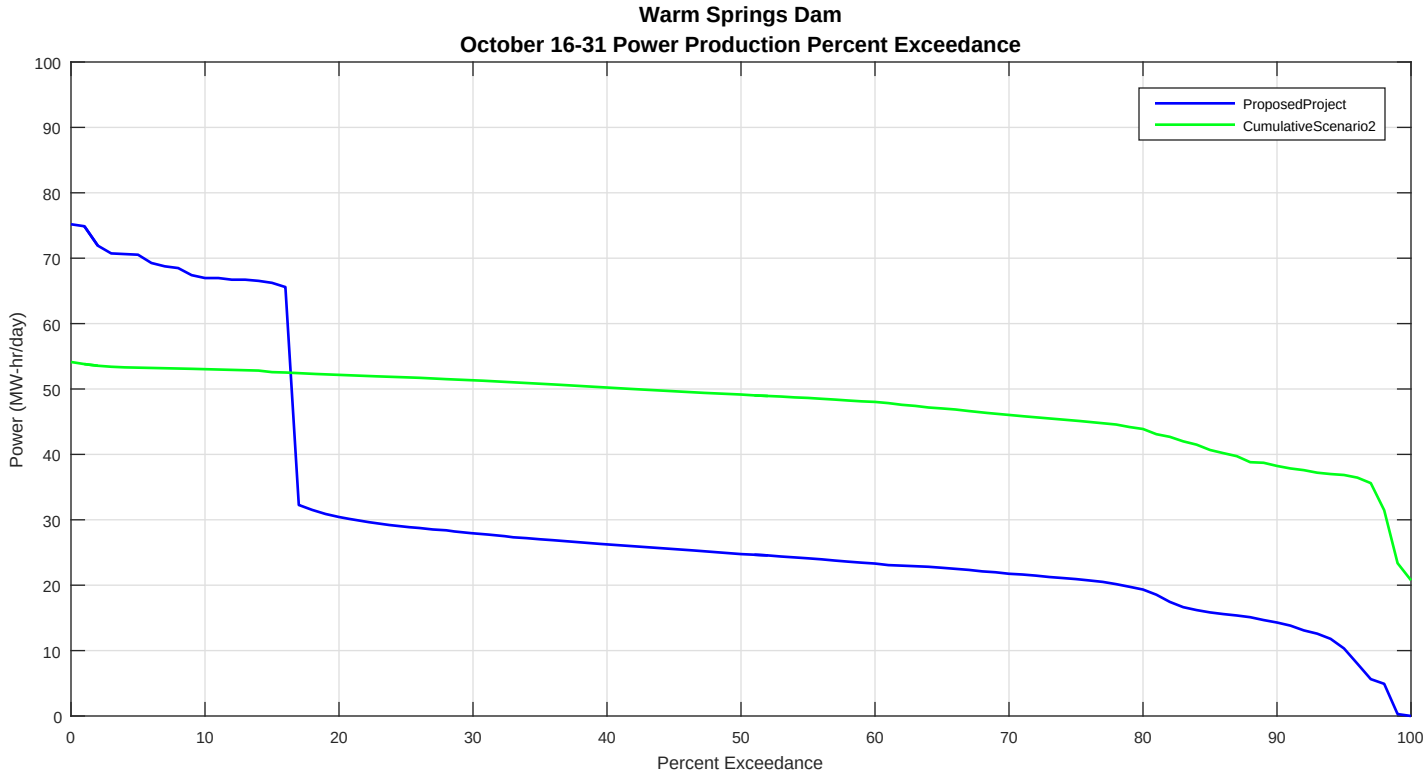
Warm Springs Dam
October 16-31 Power Production Percent Exceedance
ProposedProject
CumulativeScenario2
Power (MW-hr/day)
Percent Exceedance
0
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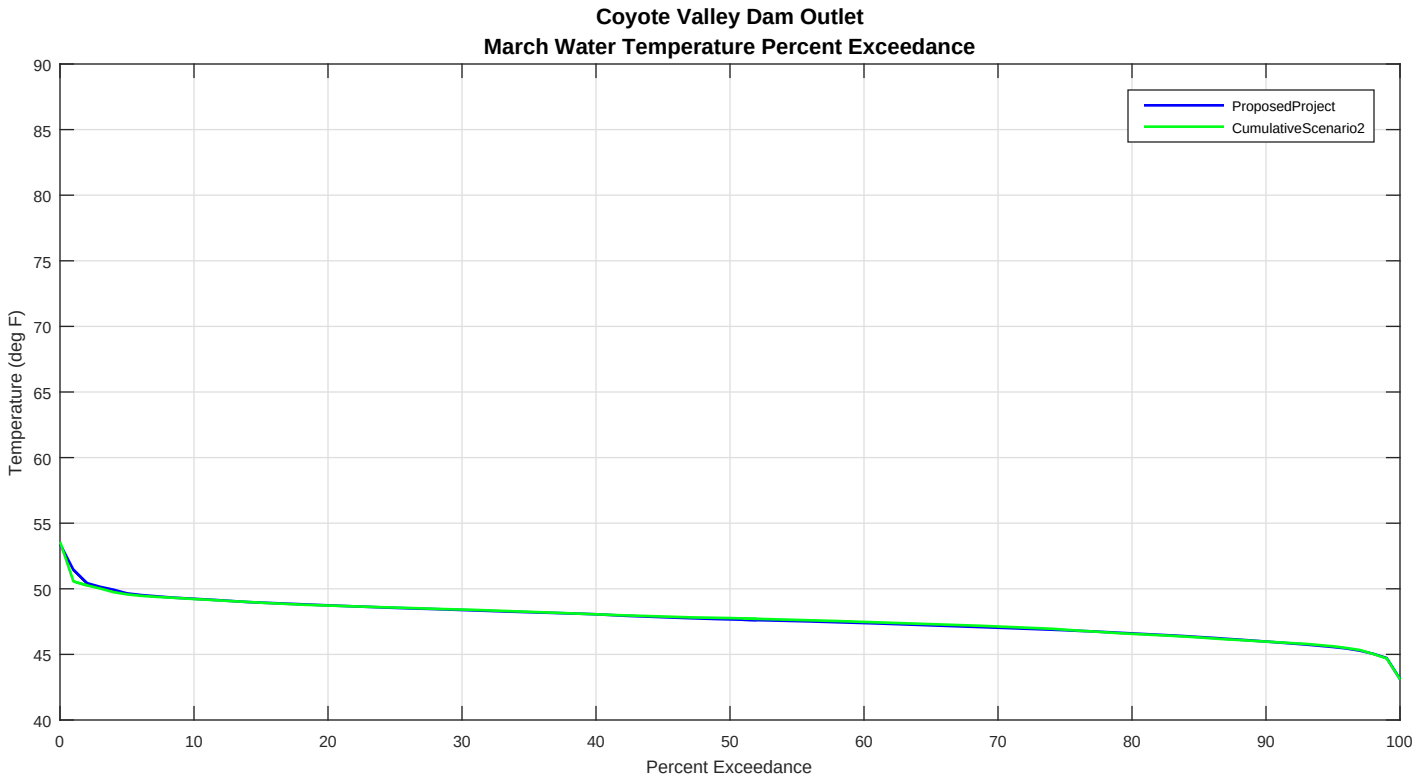
Coyote Valley Dam Outlet
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
50
45
40
0
10
20
30
40
50
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70
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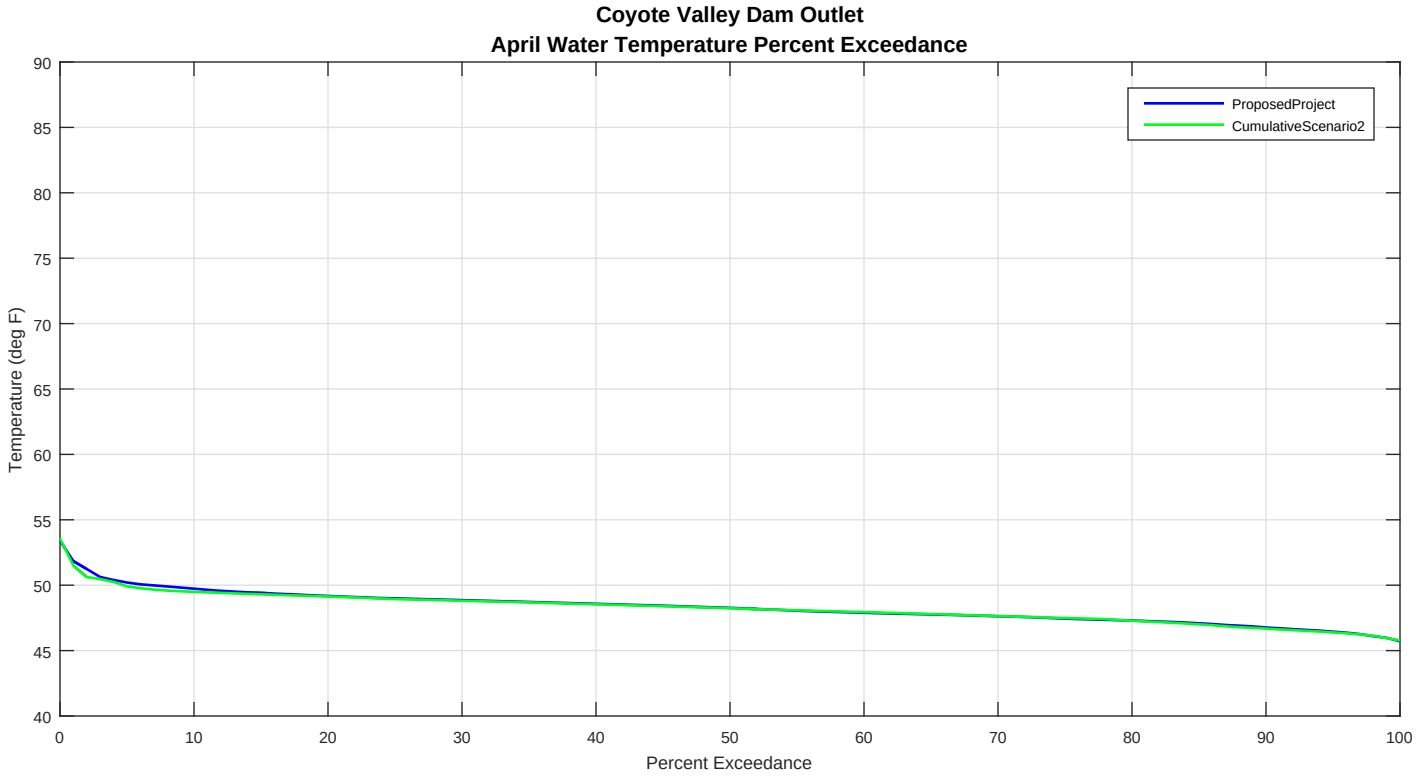
90
100


Coyote Valley Dam Outlet
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
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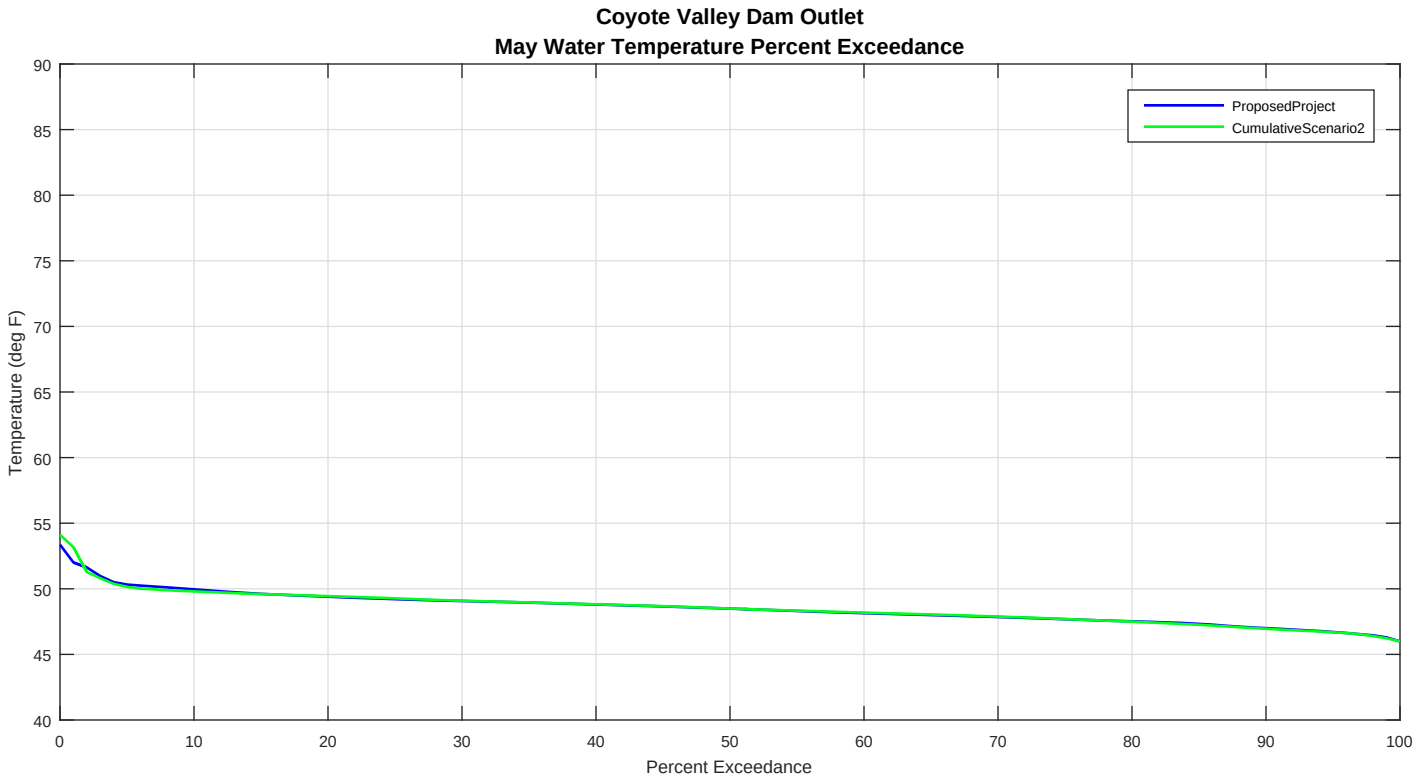
Coyote Valley Dam Outlet
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
90
85
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75
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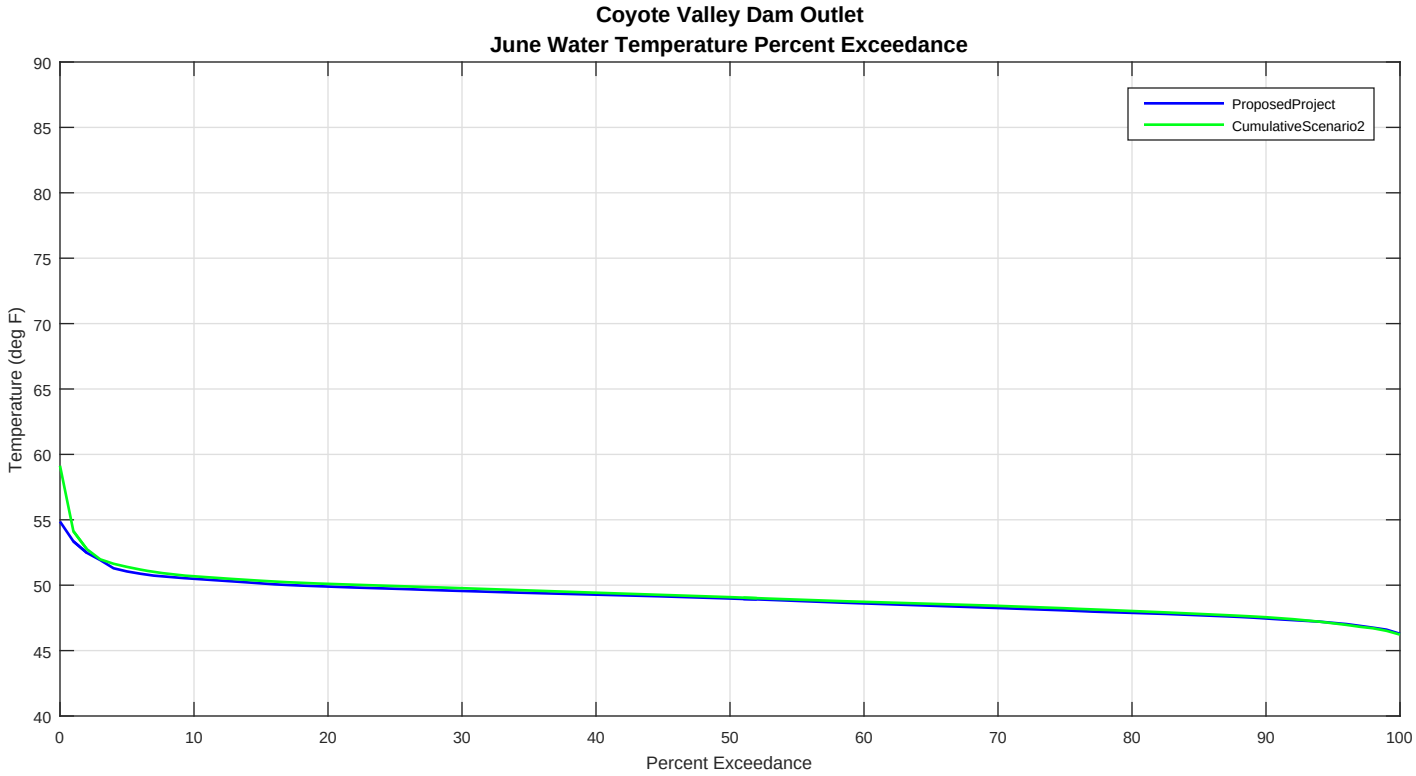
Coyote Valley Dam Outlet
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
90
85
80
75
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65
60
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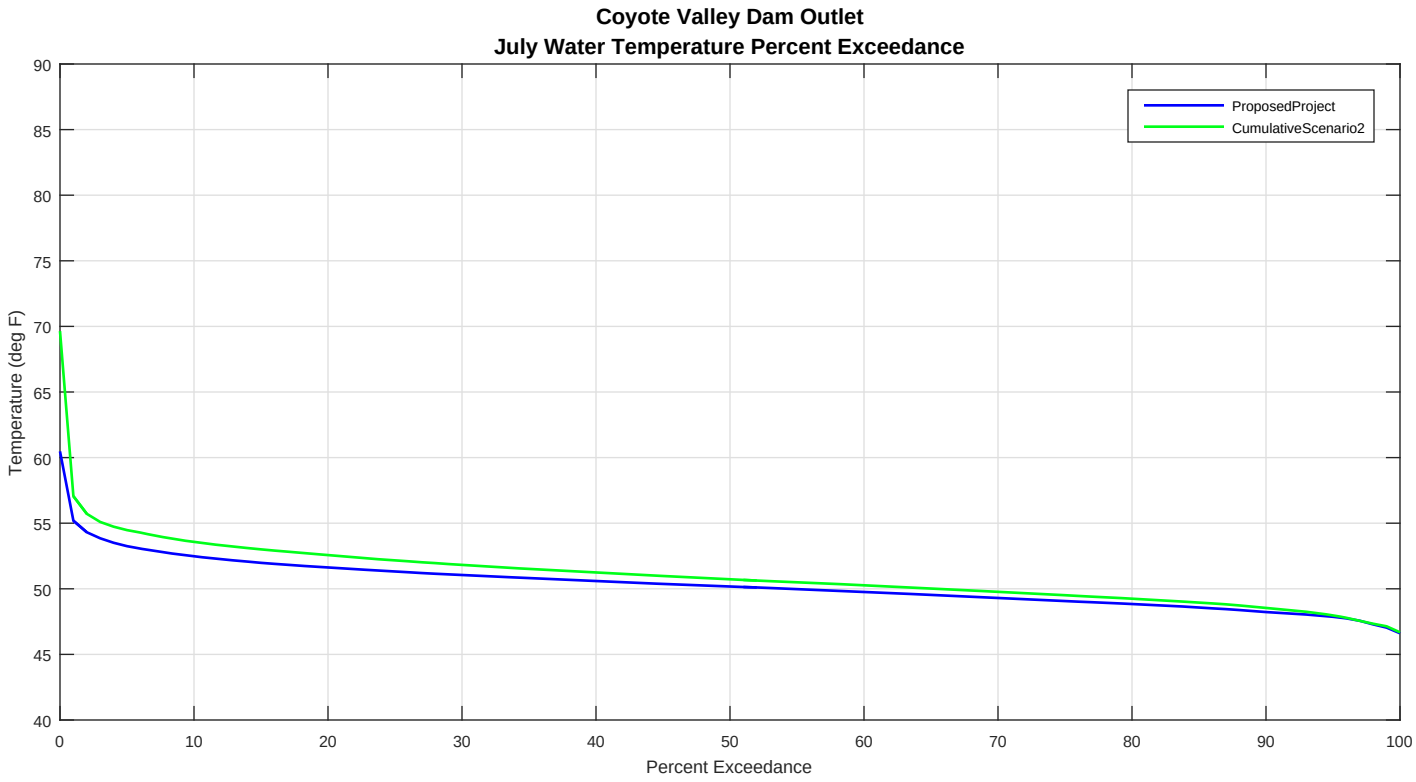
Coyote Valley Dam Outlet
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
90
85
80
75
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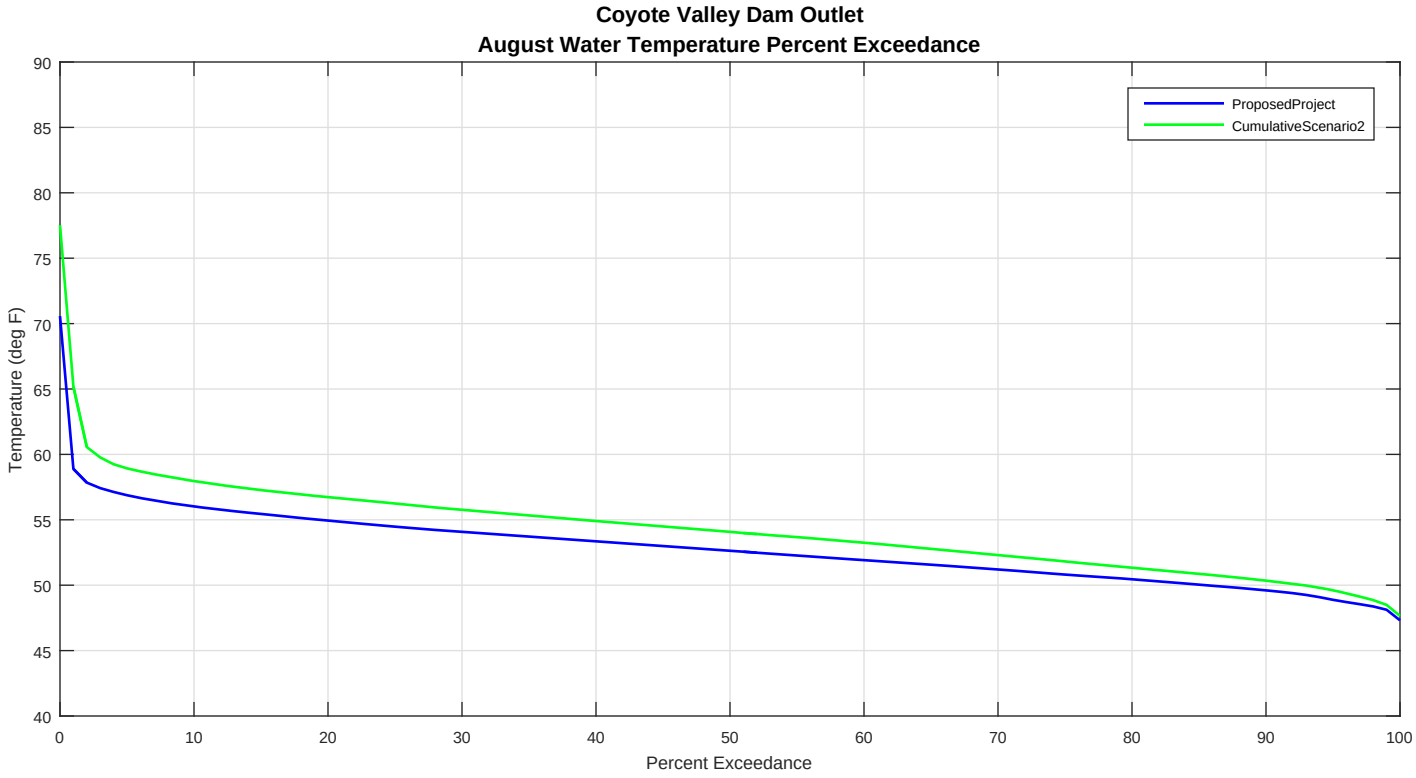
Coyote Valley Dam Outlet
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
90
85
80
75
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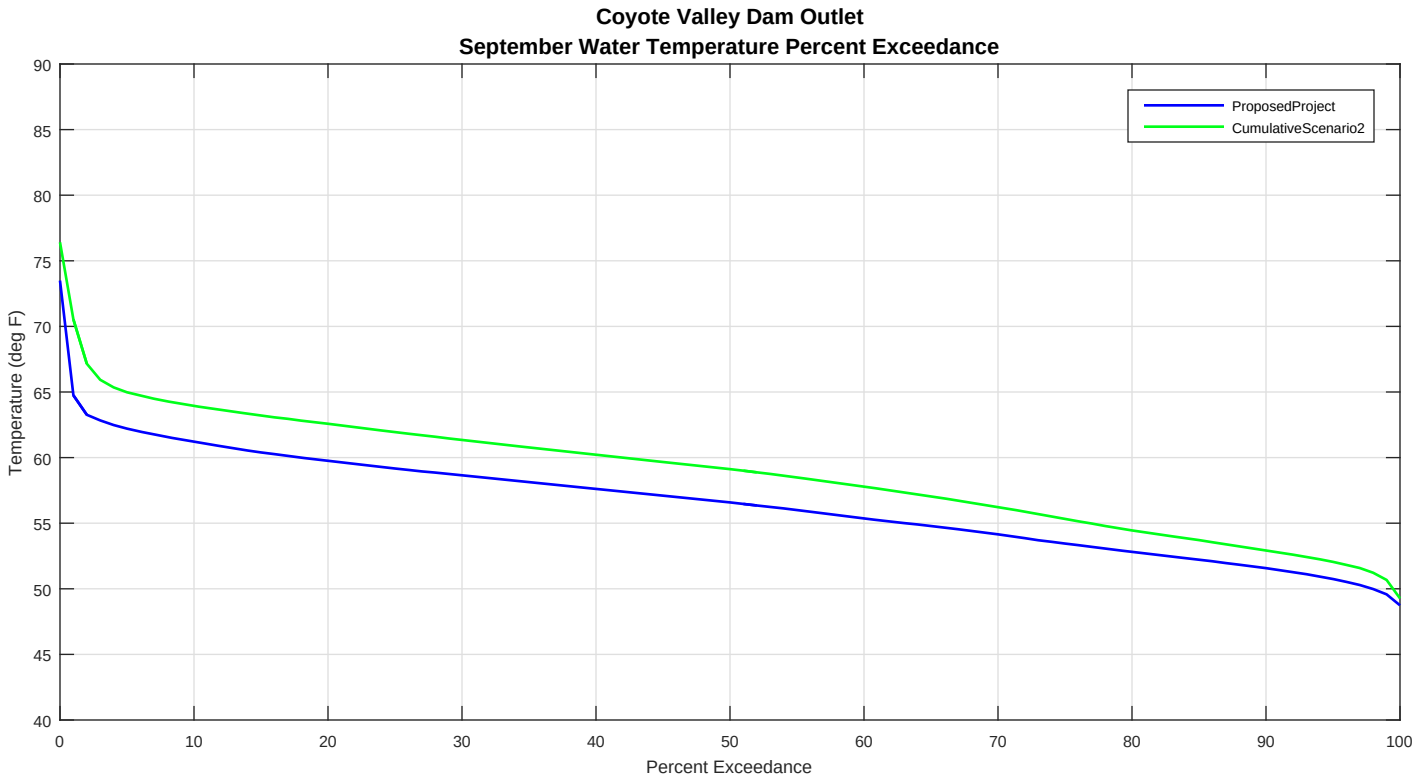
Coyote Valley Dam Outlet
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
90
85
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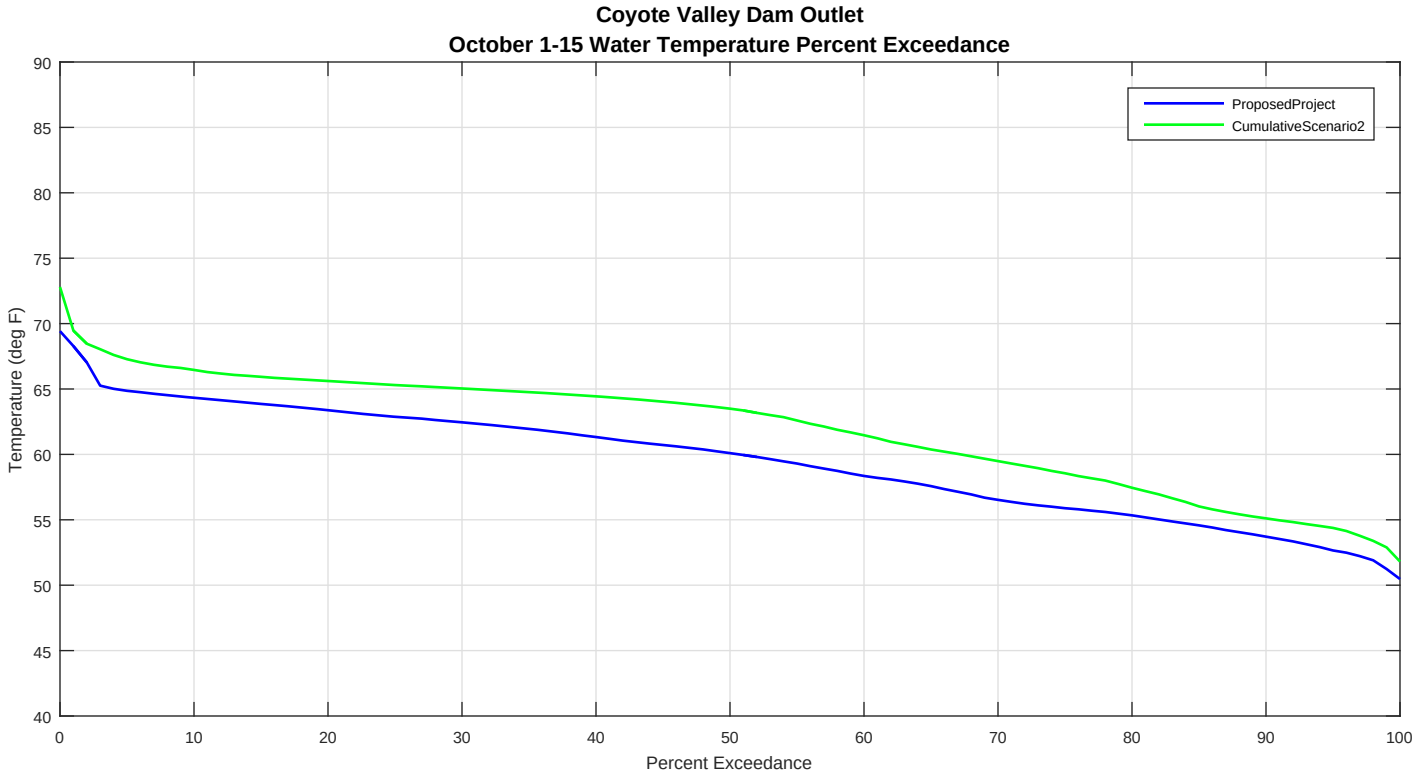
Coyote Valley Dam Outlet
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
90
85
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75
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60
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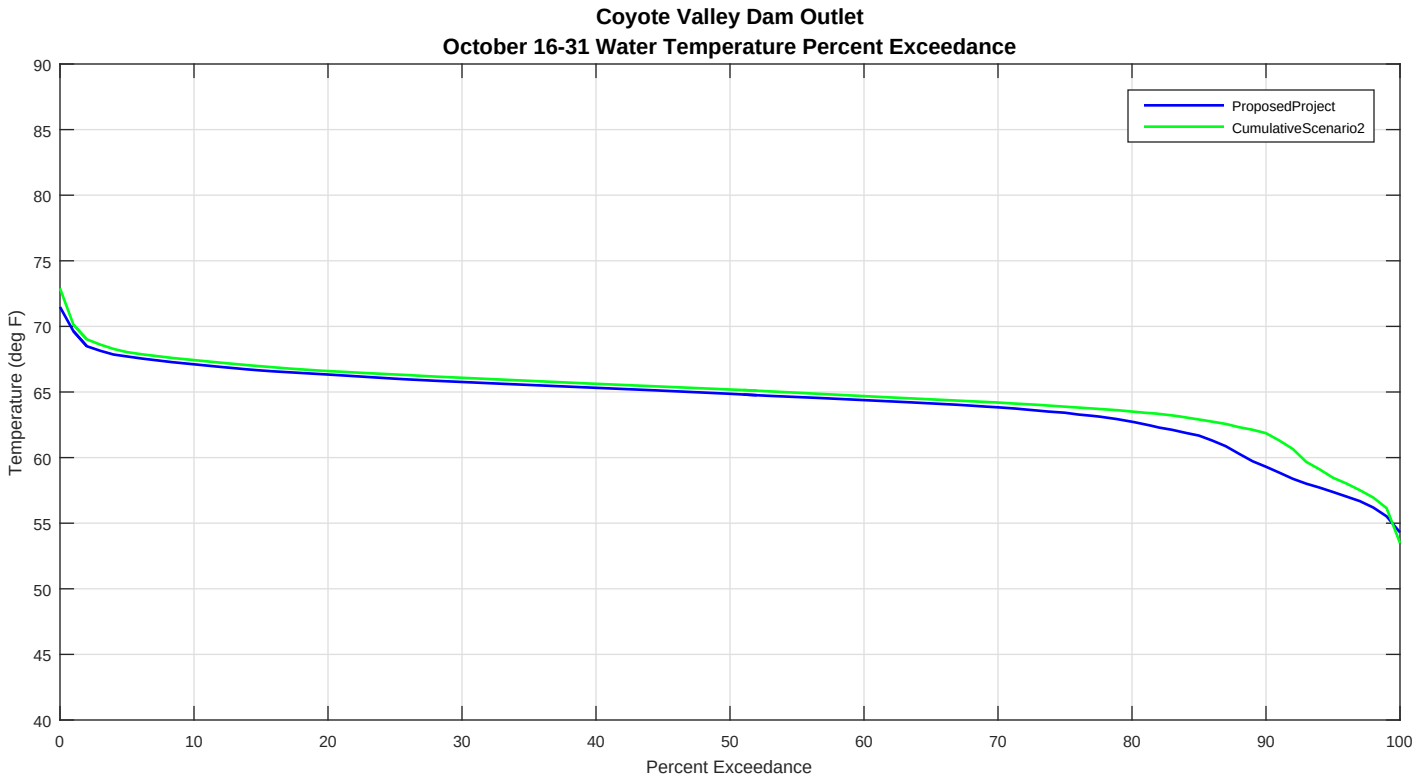
Coyote Valley Dam Outlet
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
90
85
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75
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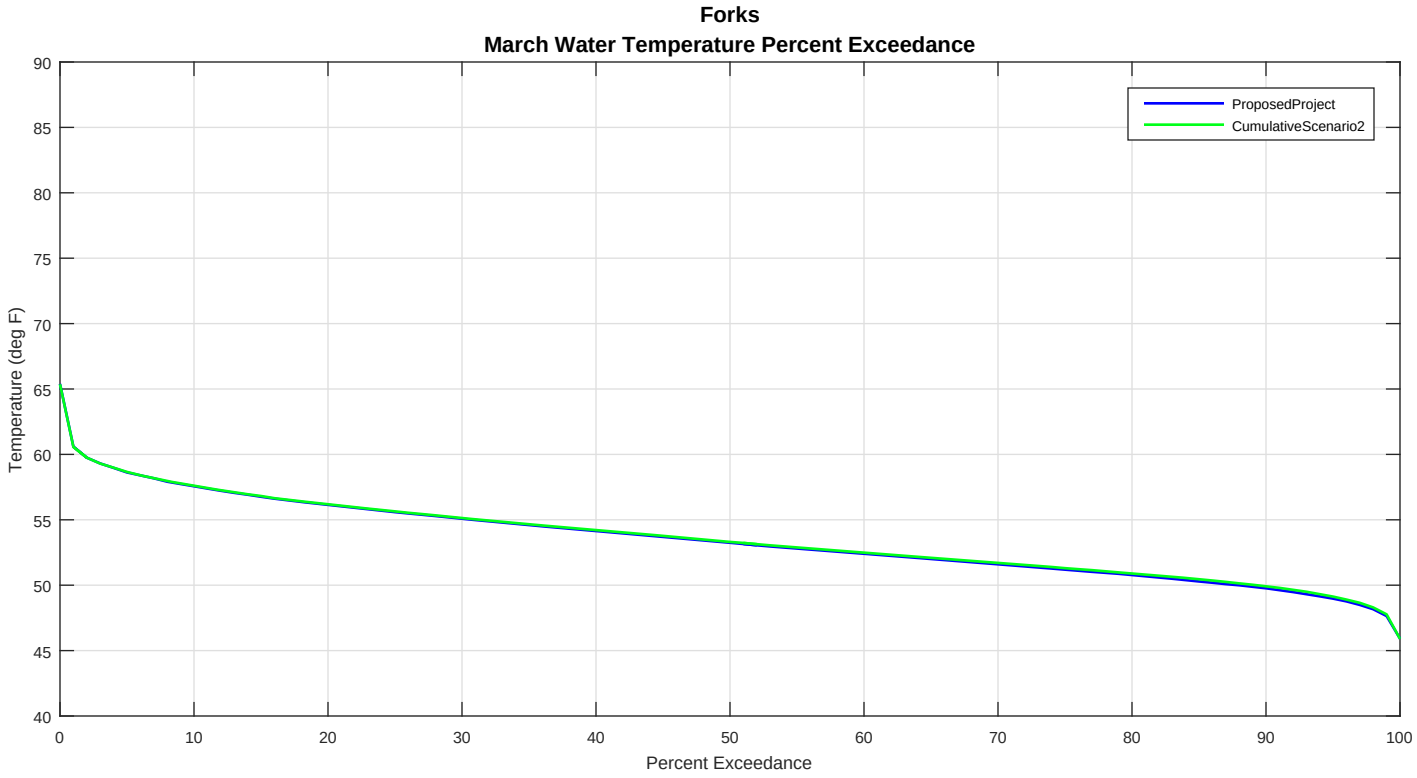
Forks
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
90
85
80
75
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60
55
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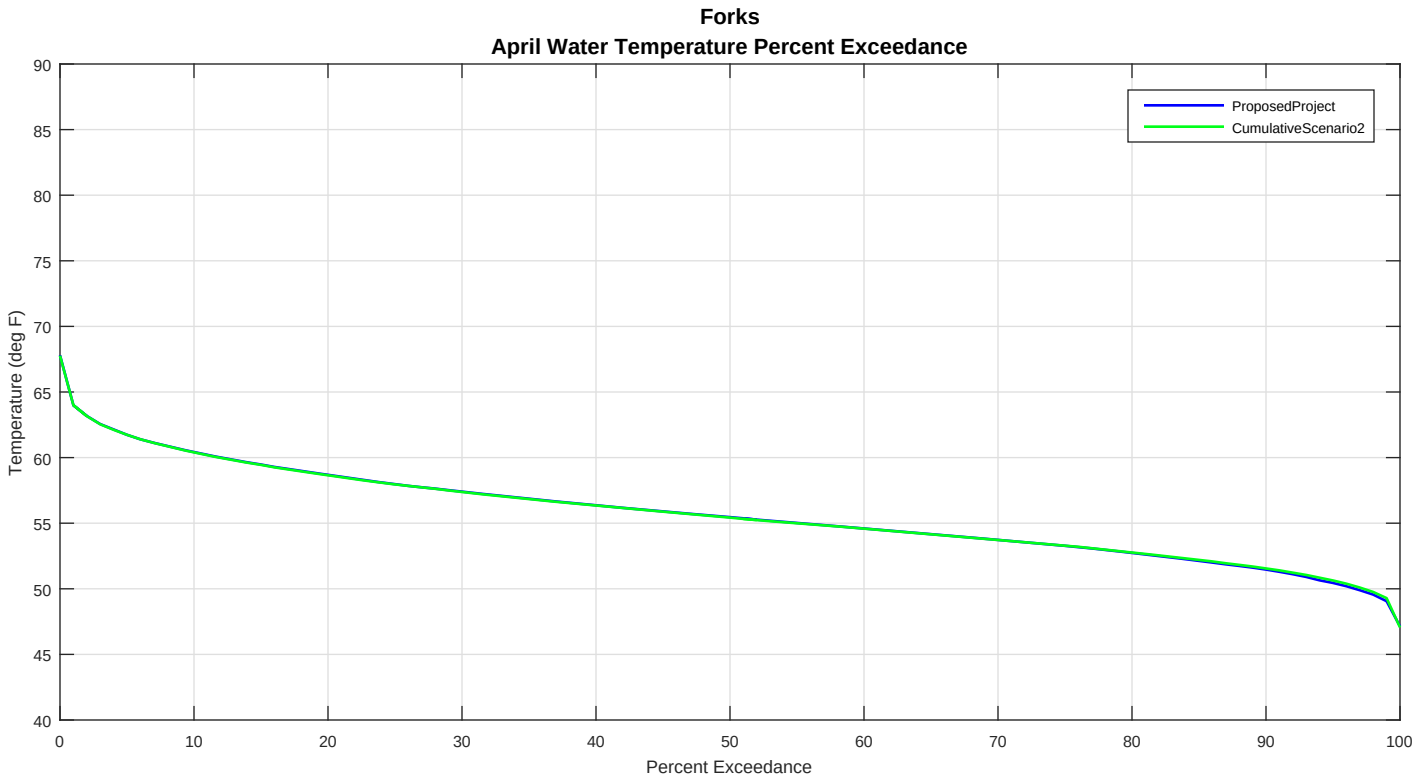
Forks
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
90
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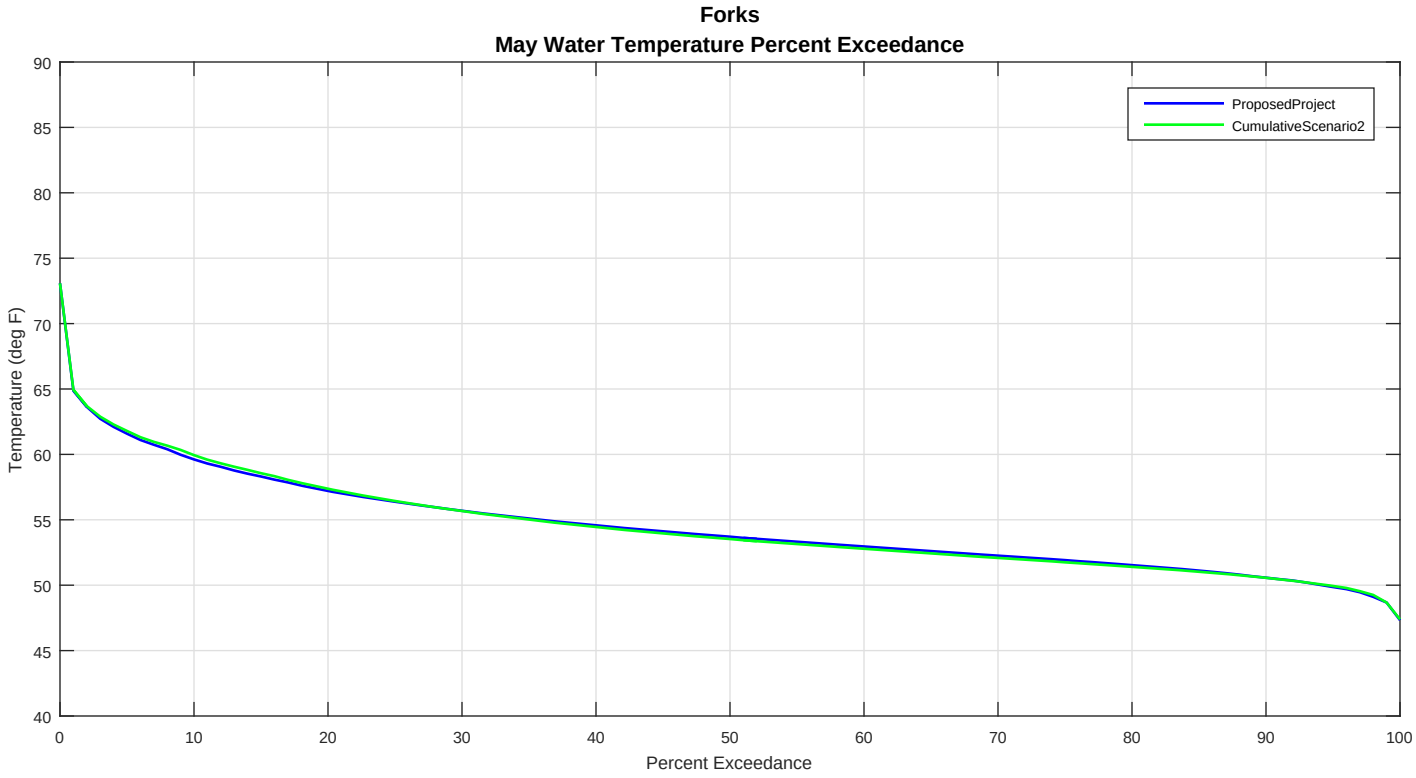
Forks
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
90
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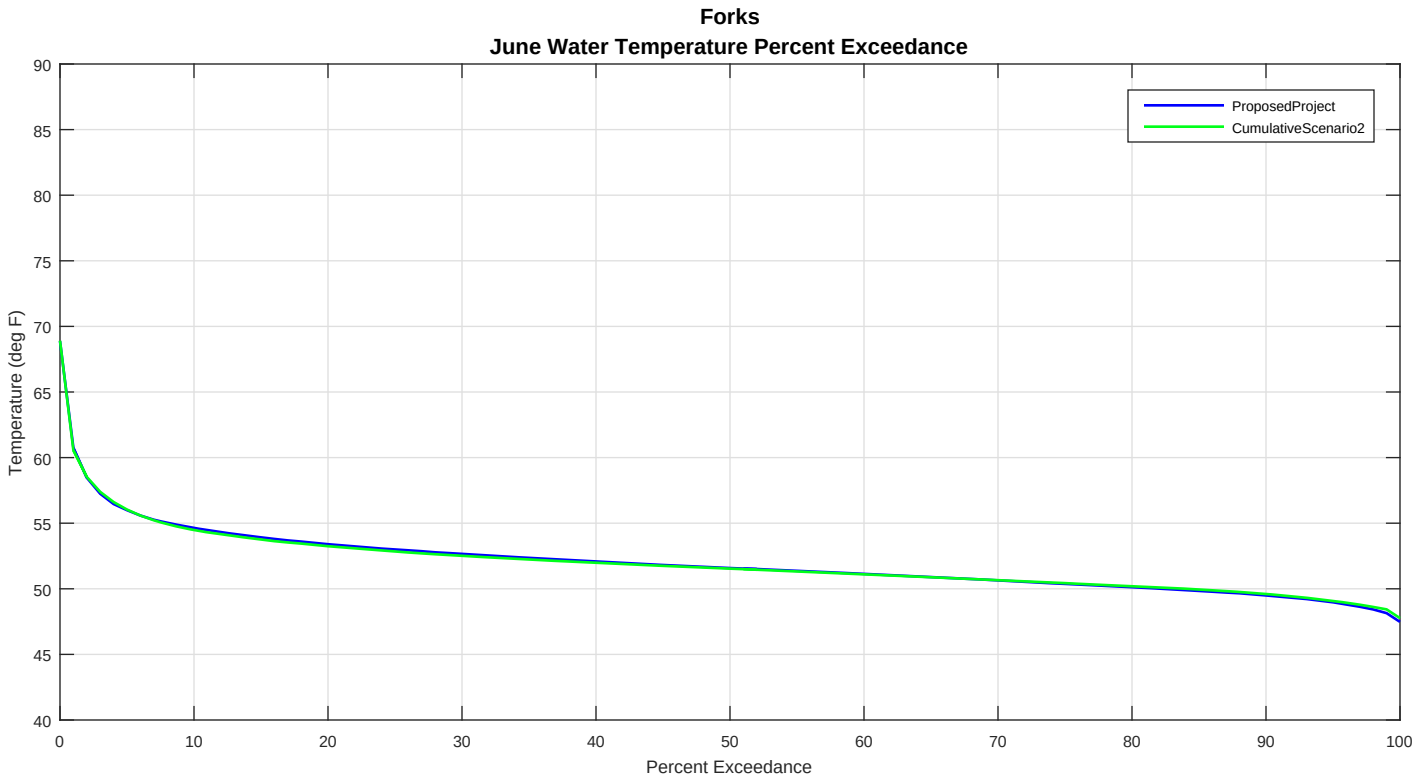
Forks
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
90
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75
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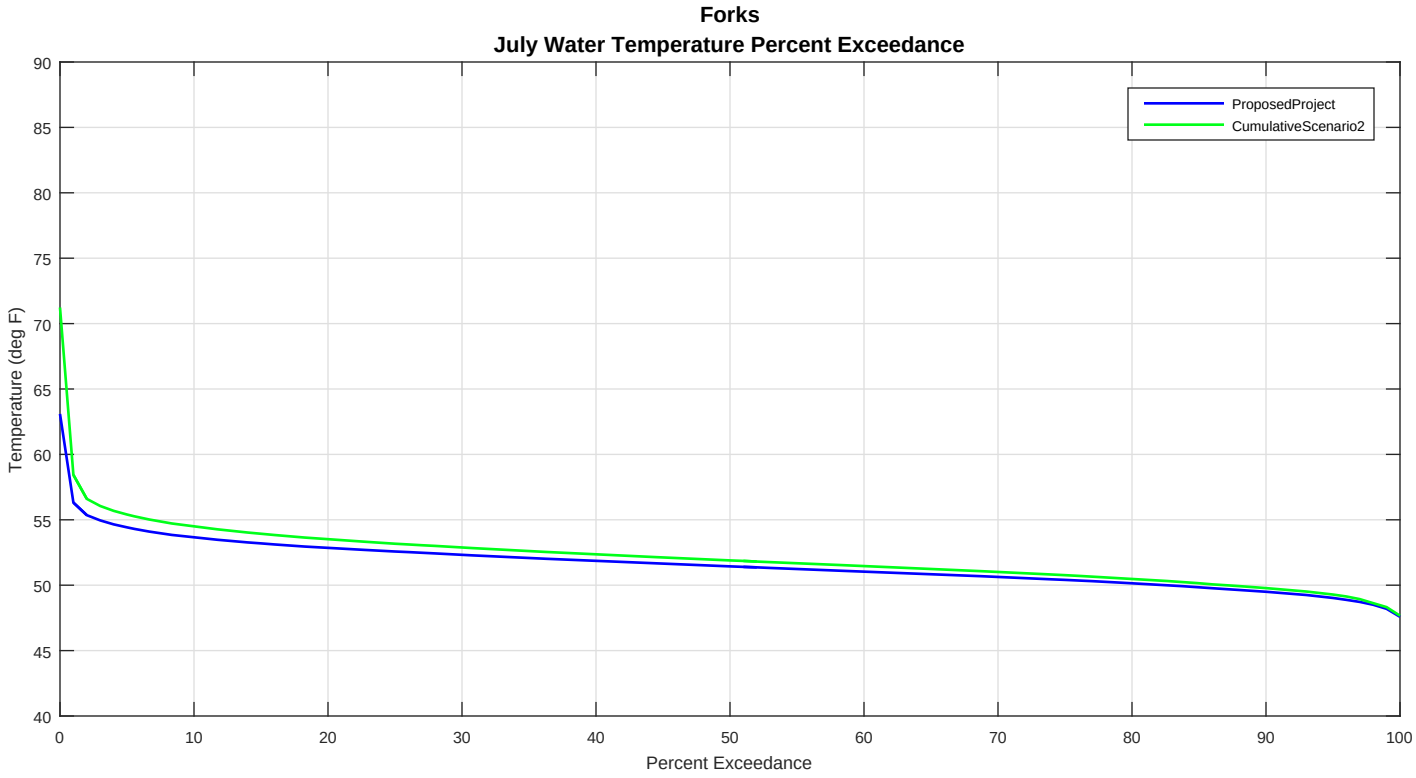
Forks
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
90
85
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75
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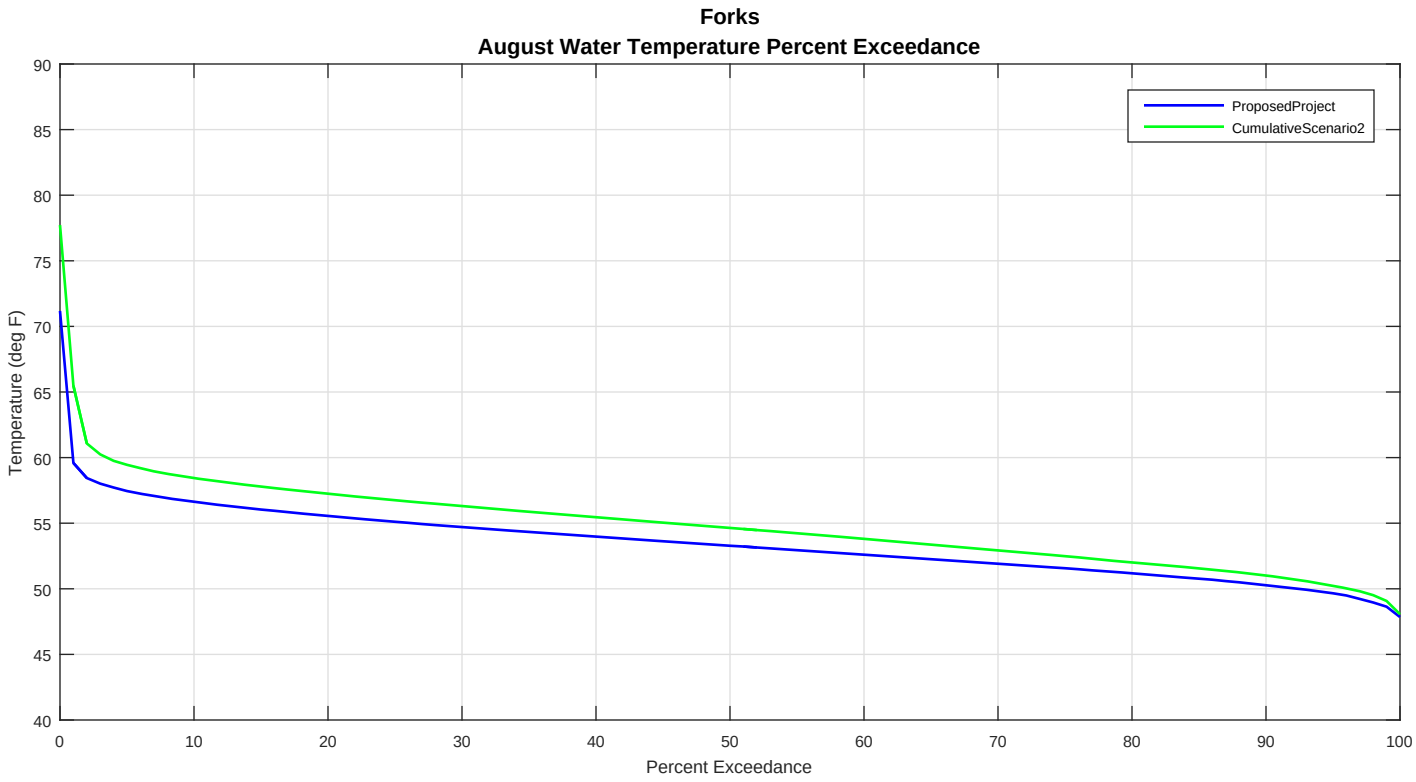
Forks
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
90
85
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75
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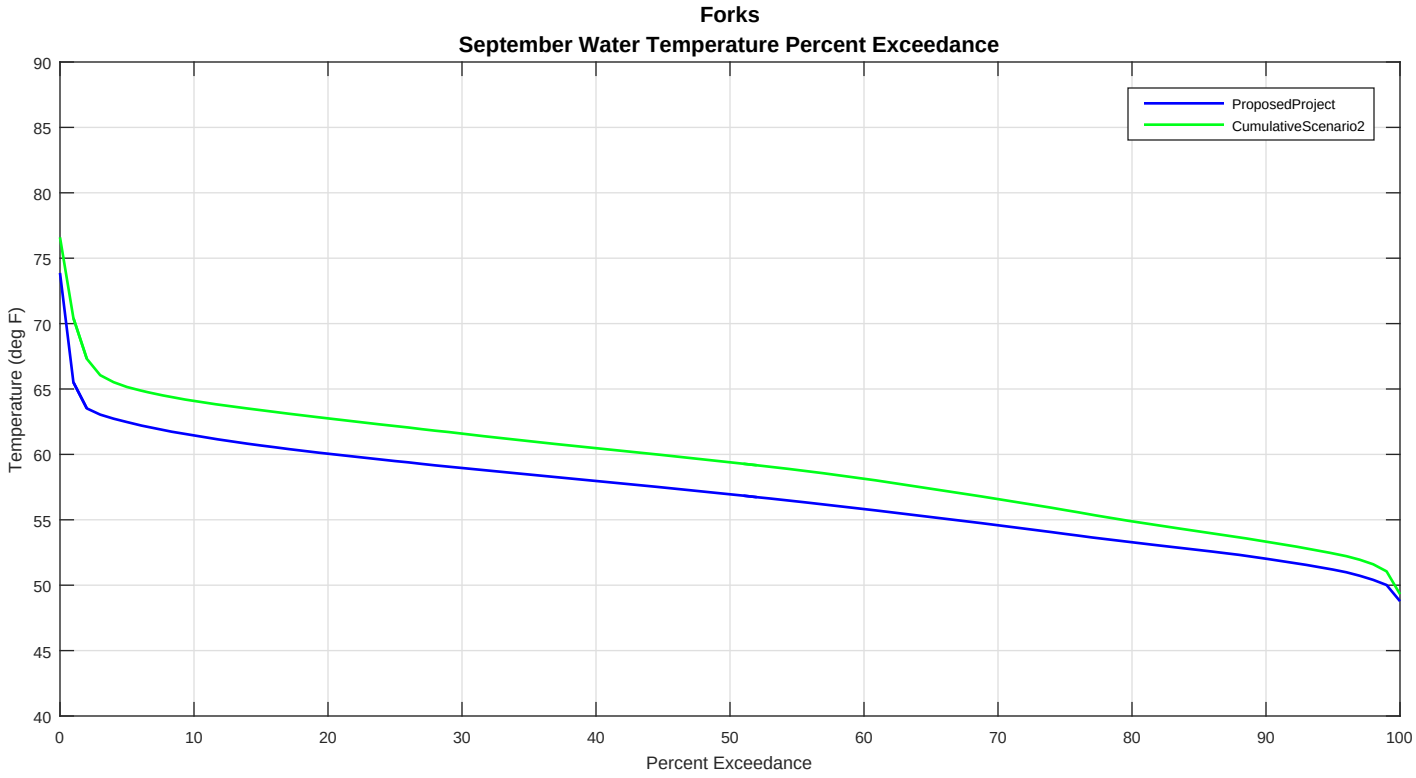
Forks
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
90
85
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75
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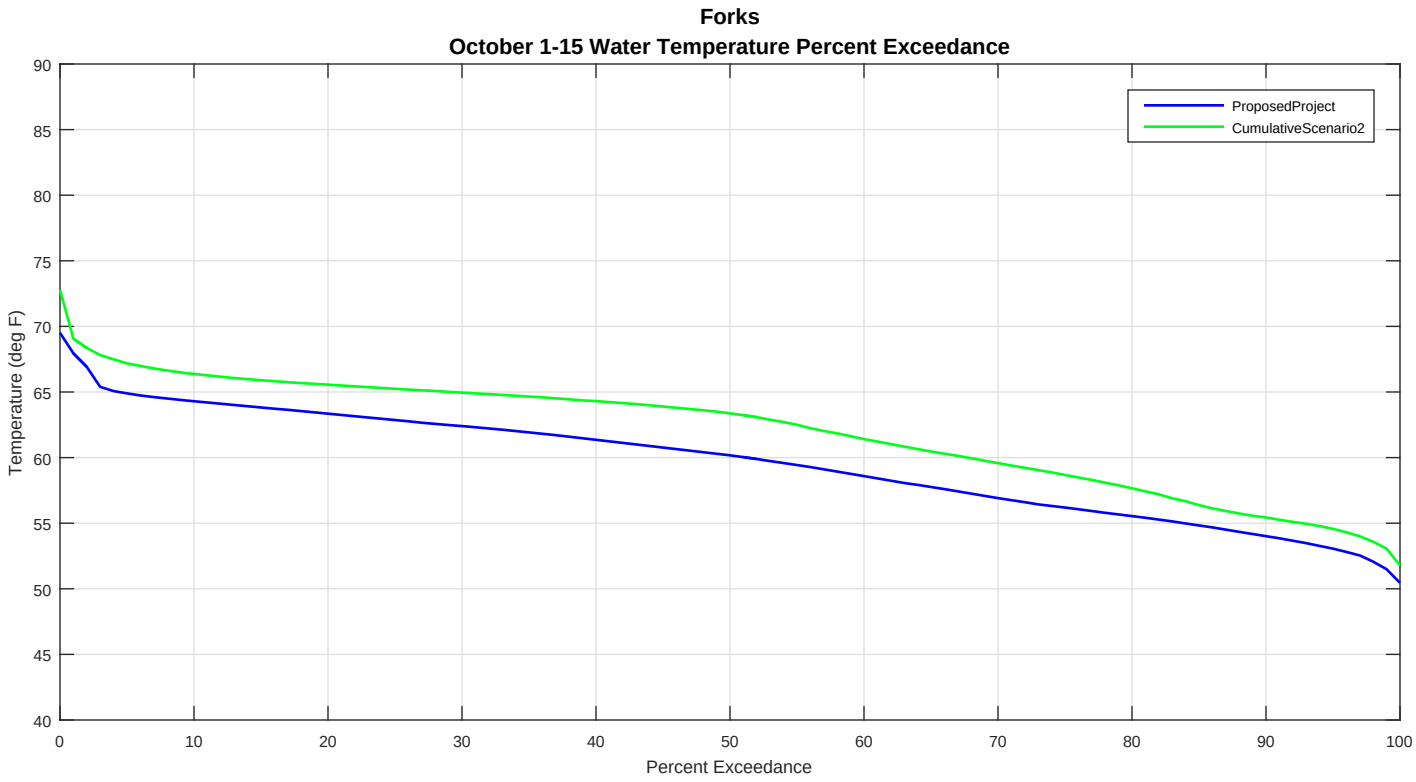
Forks
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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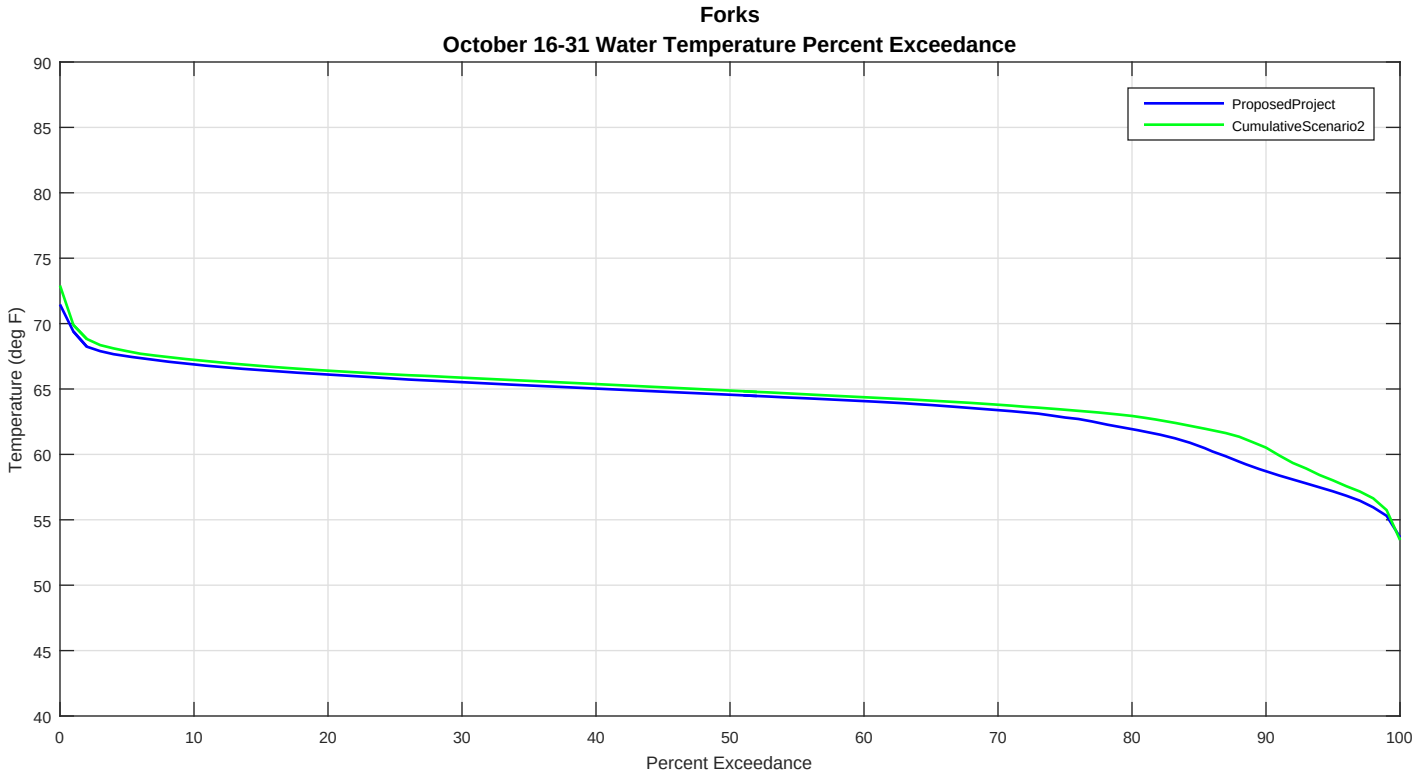
Forks
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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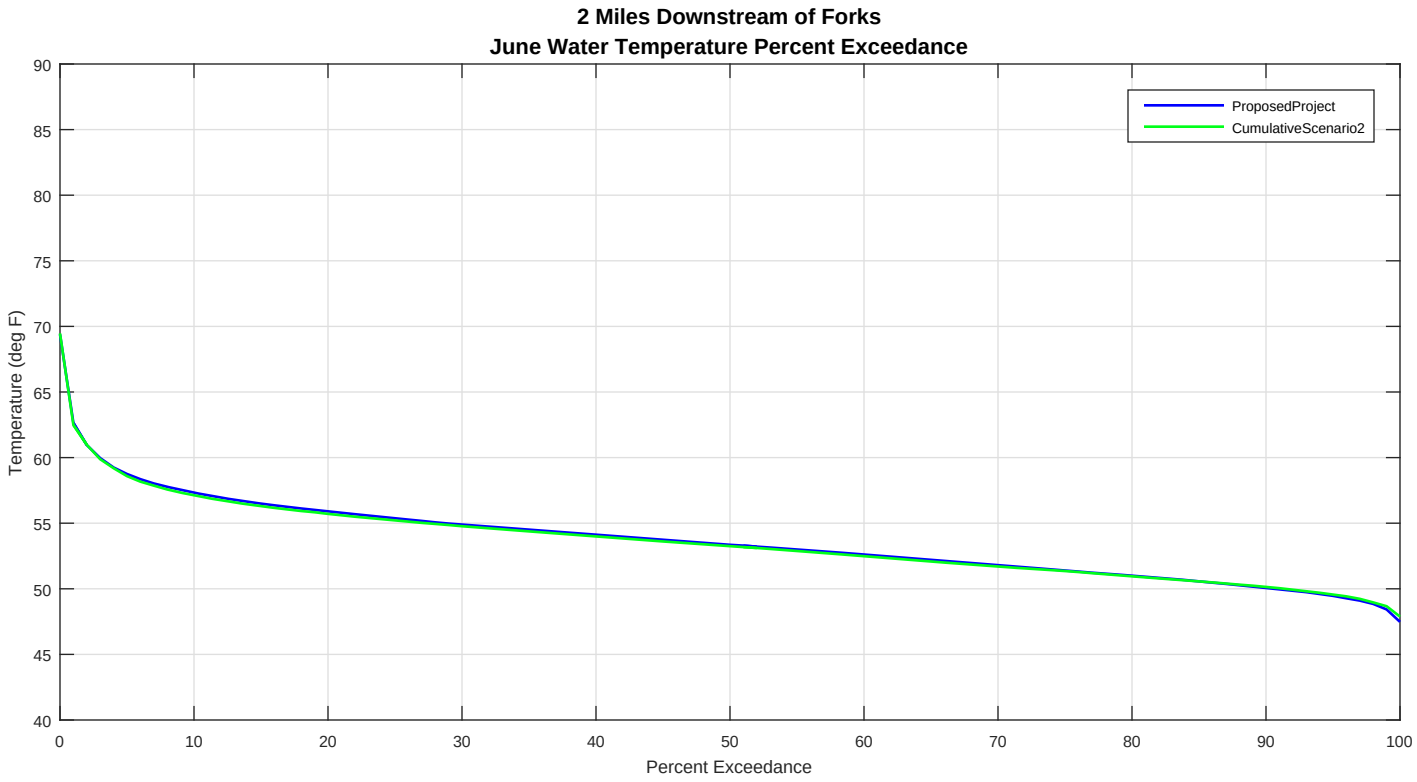
2 Miles Downstream of Forks
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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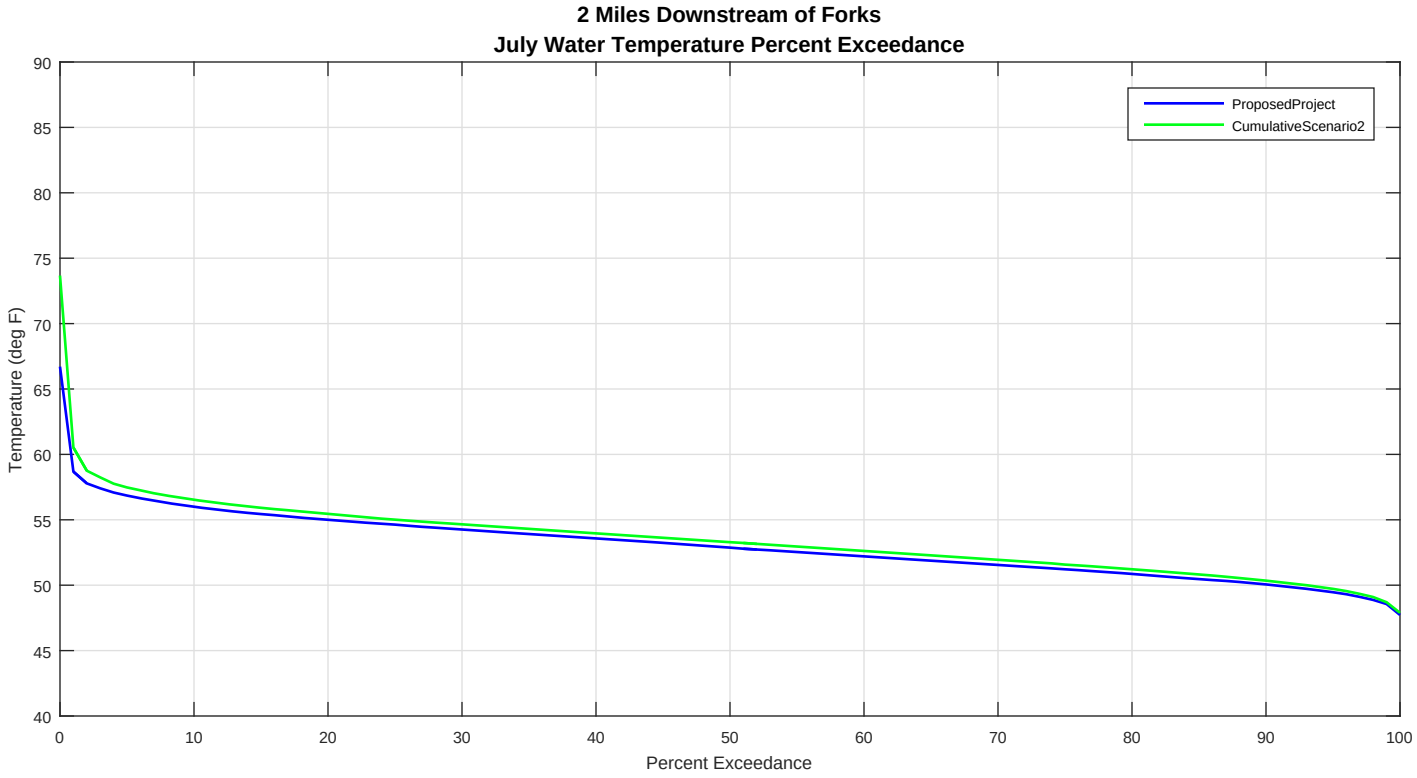
2 Miles Downstream of Forks
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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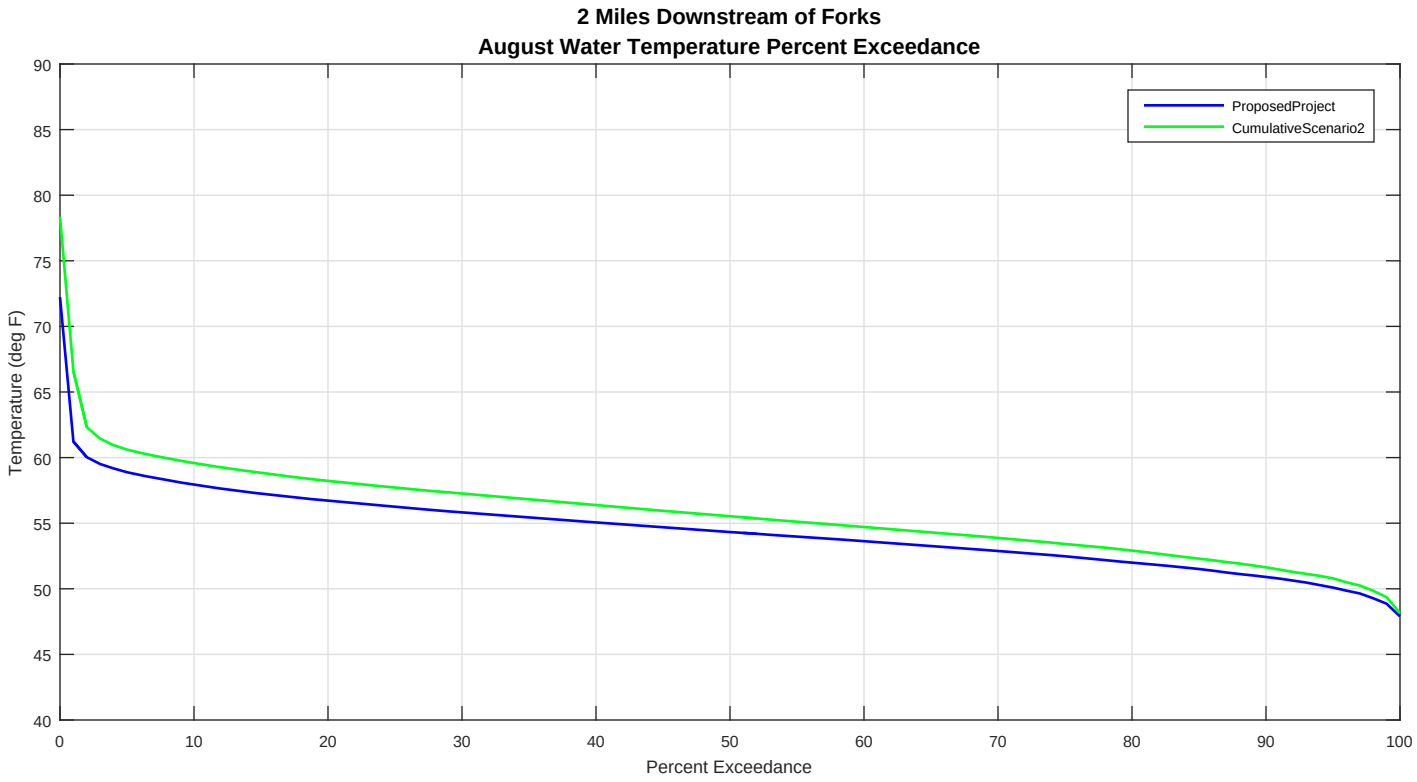
2 Miles Downstream of Forks
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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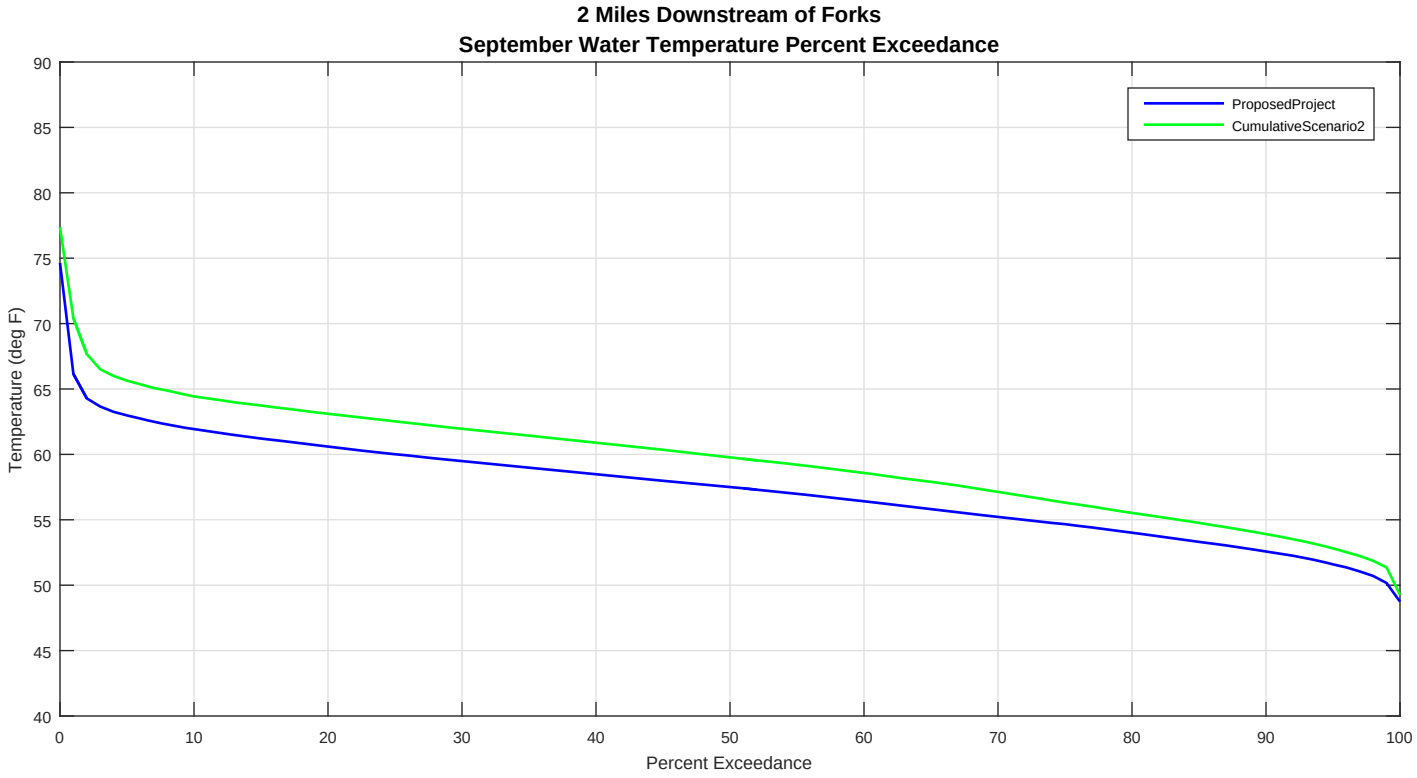
2 Miles Downstream of Forks
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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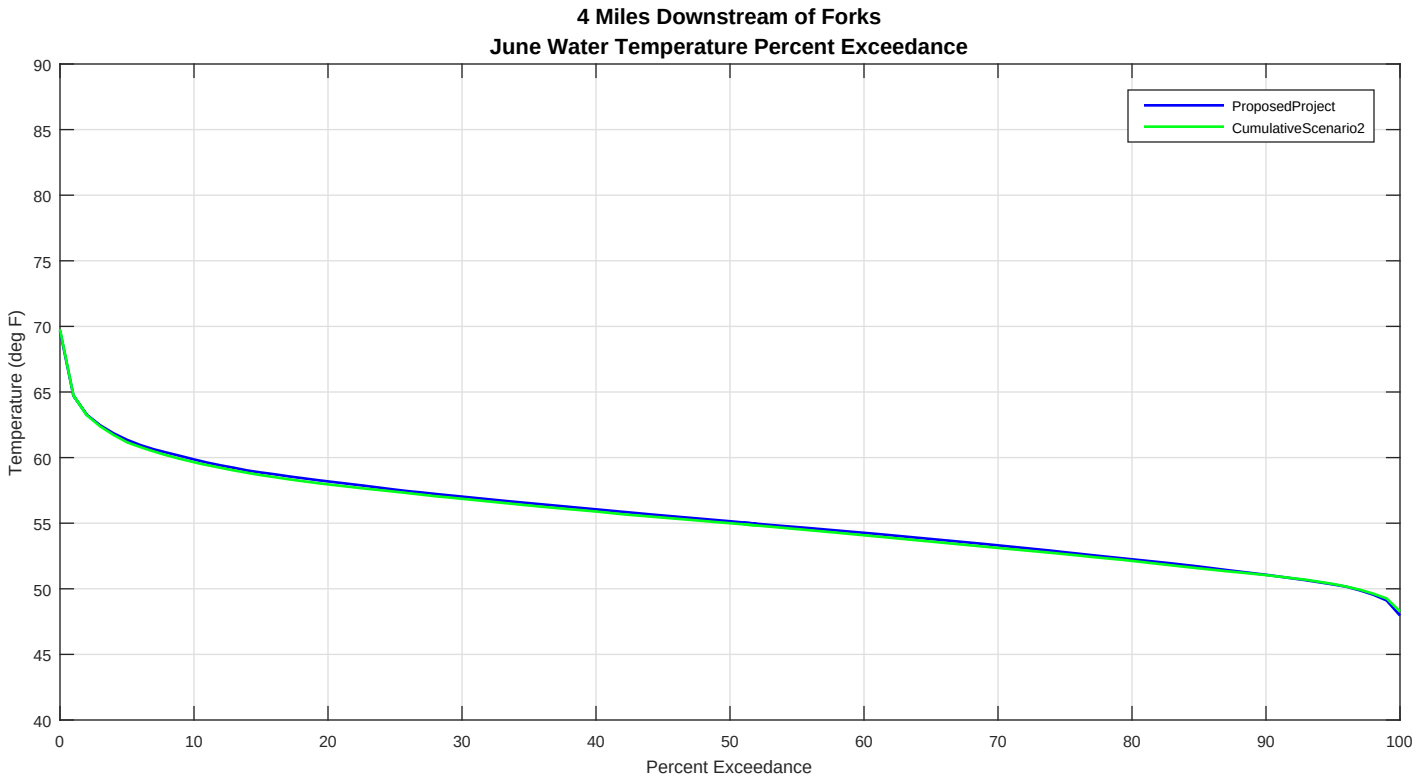
4 Miles Downstream of Forks
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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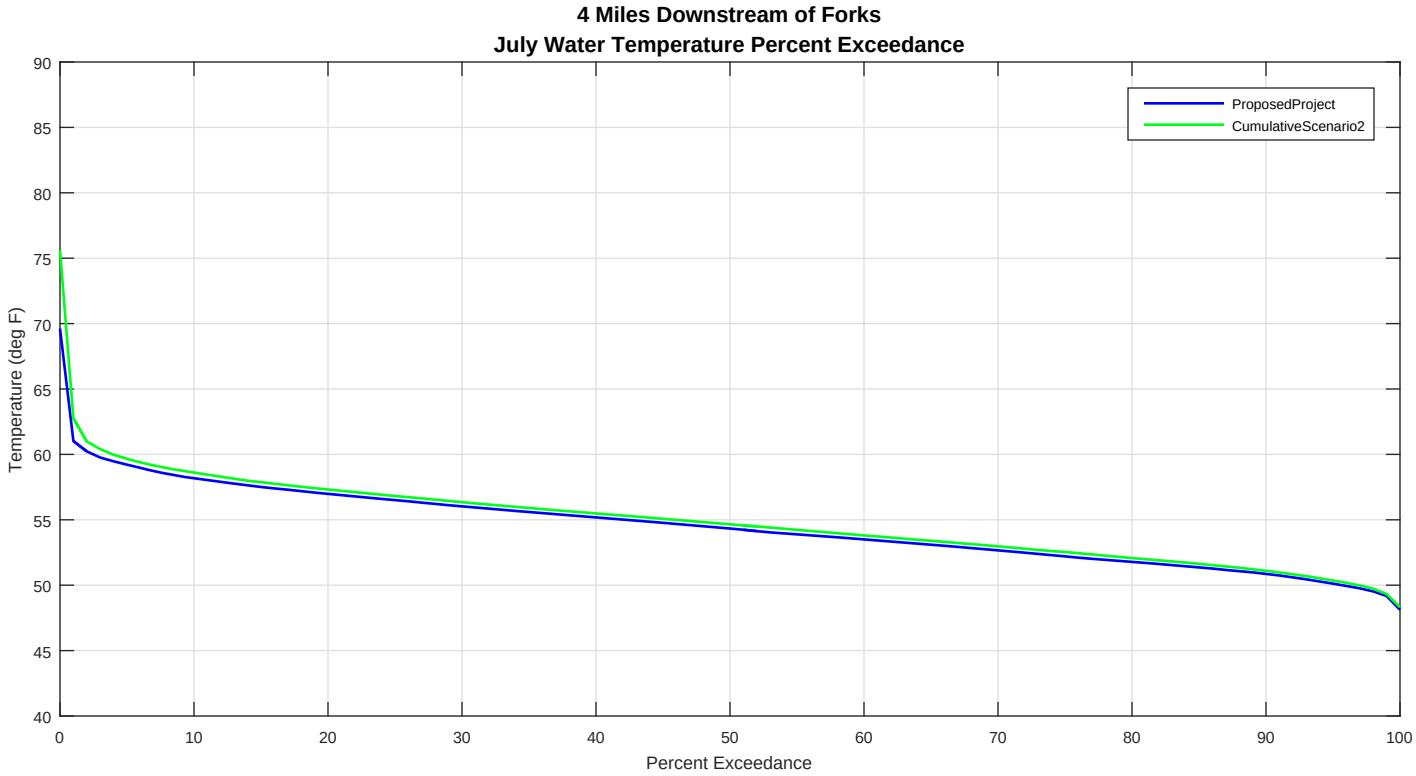
4 Miles Downstream of Forks
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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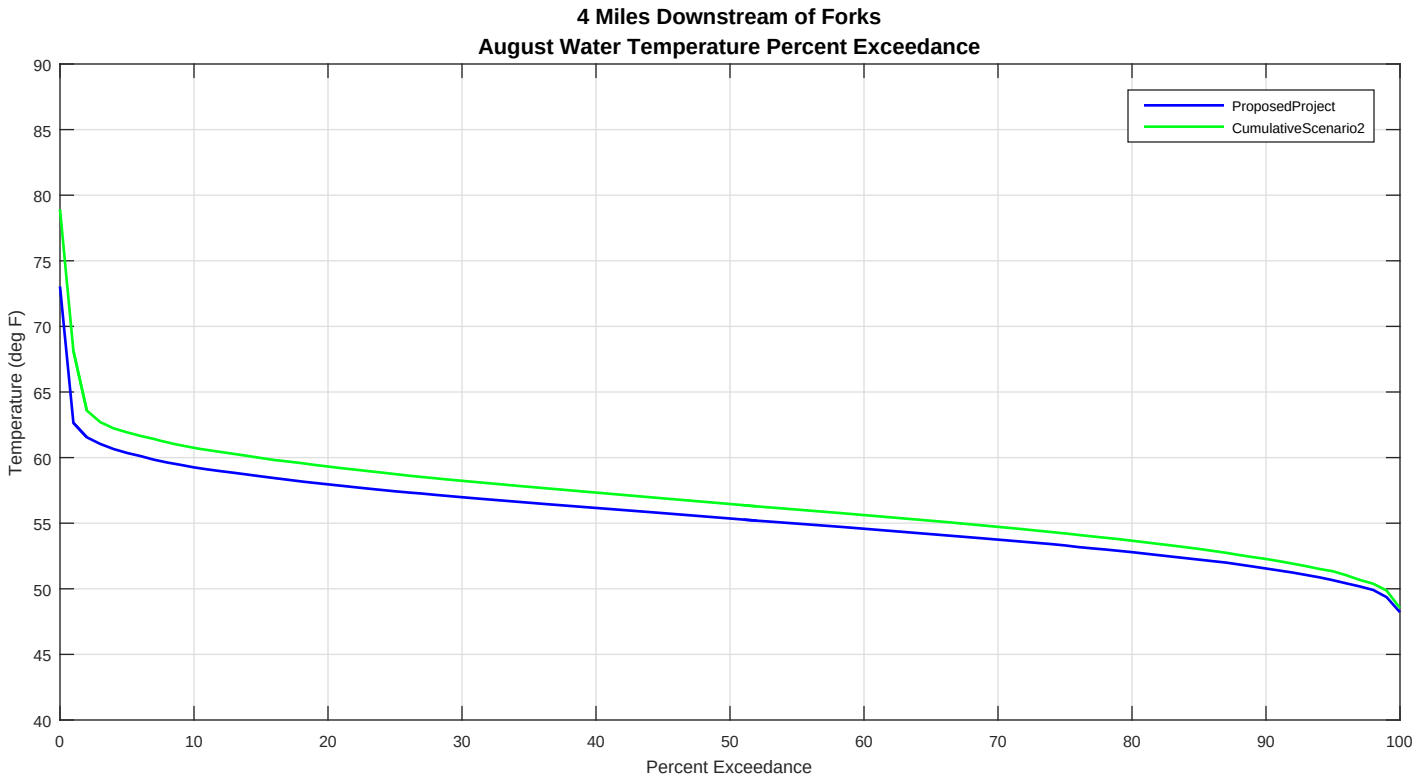
4 Miles Downstream of Forks
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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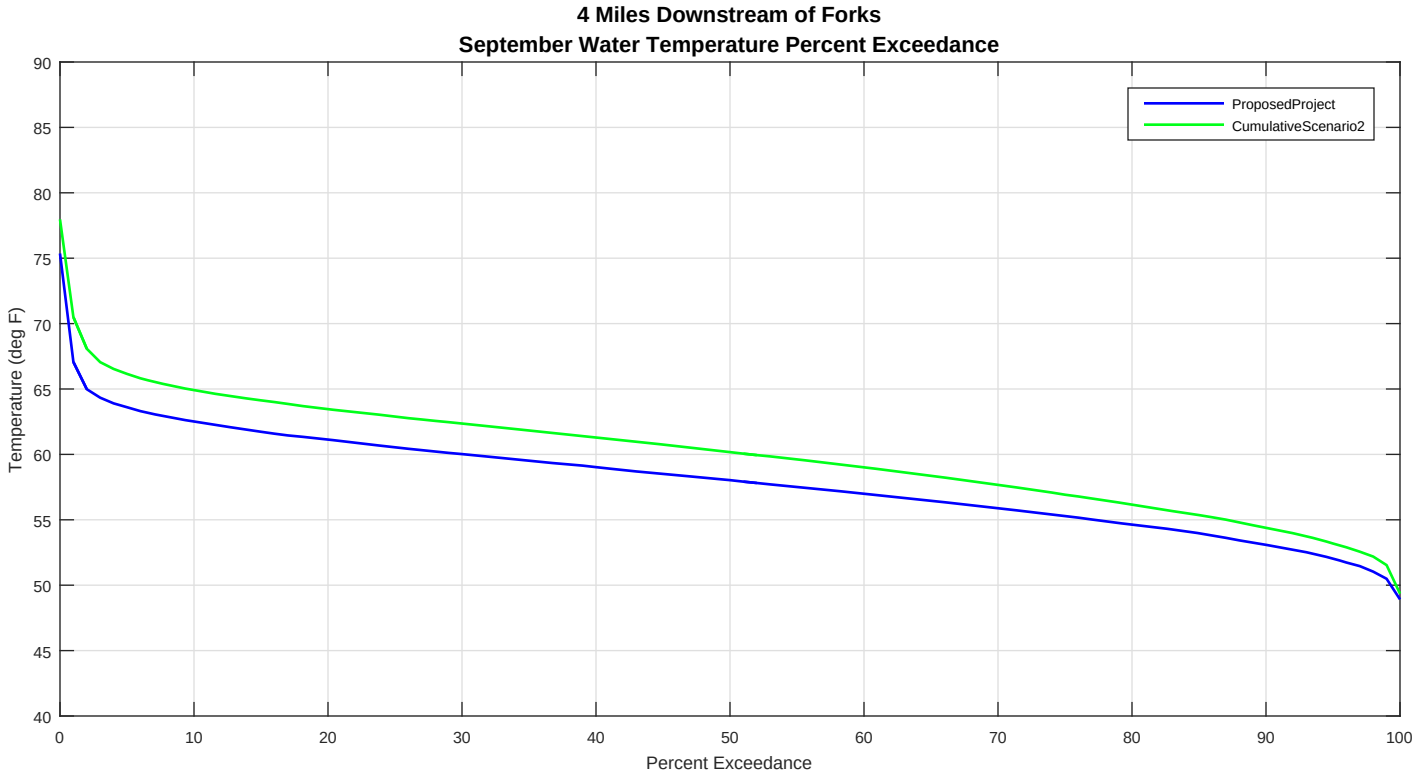
4 Miles Downstream of Forks
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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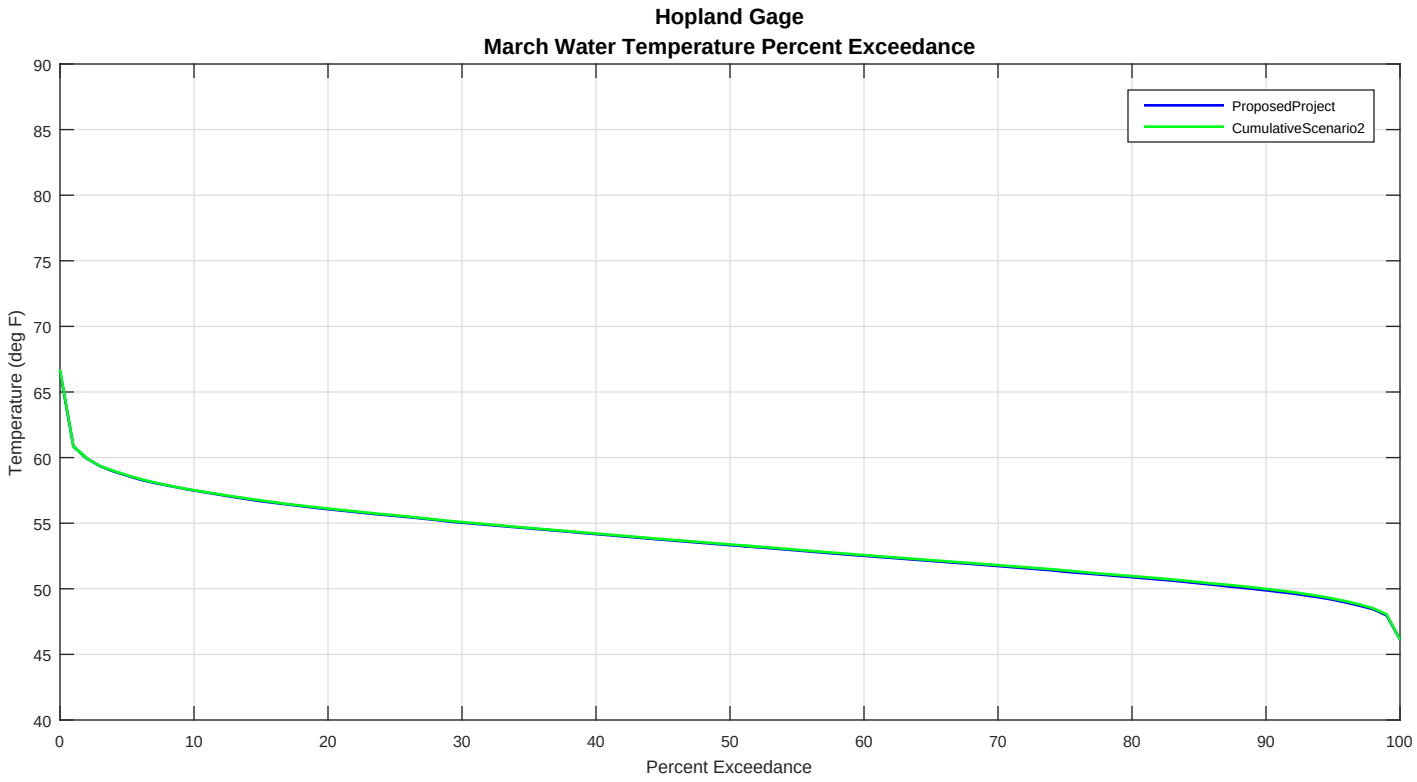
Hopland Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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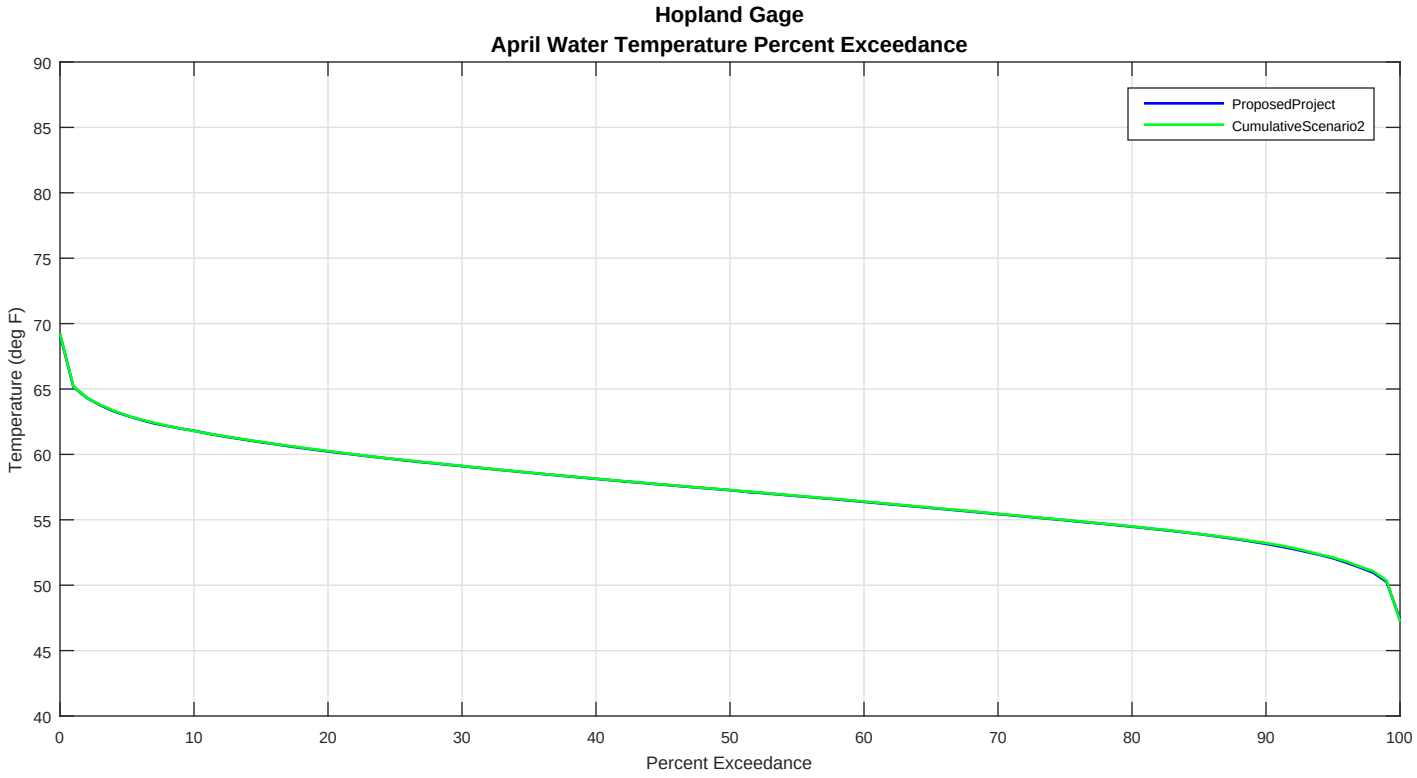
Hopland Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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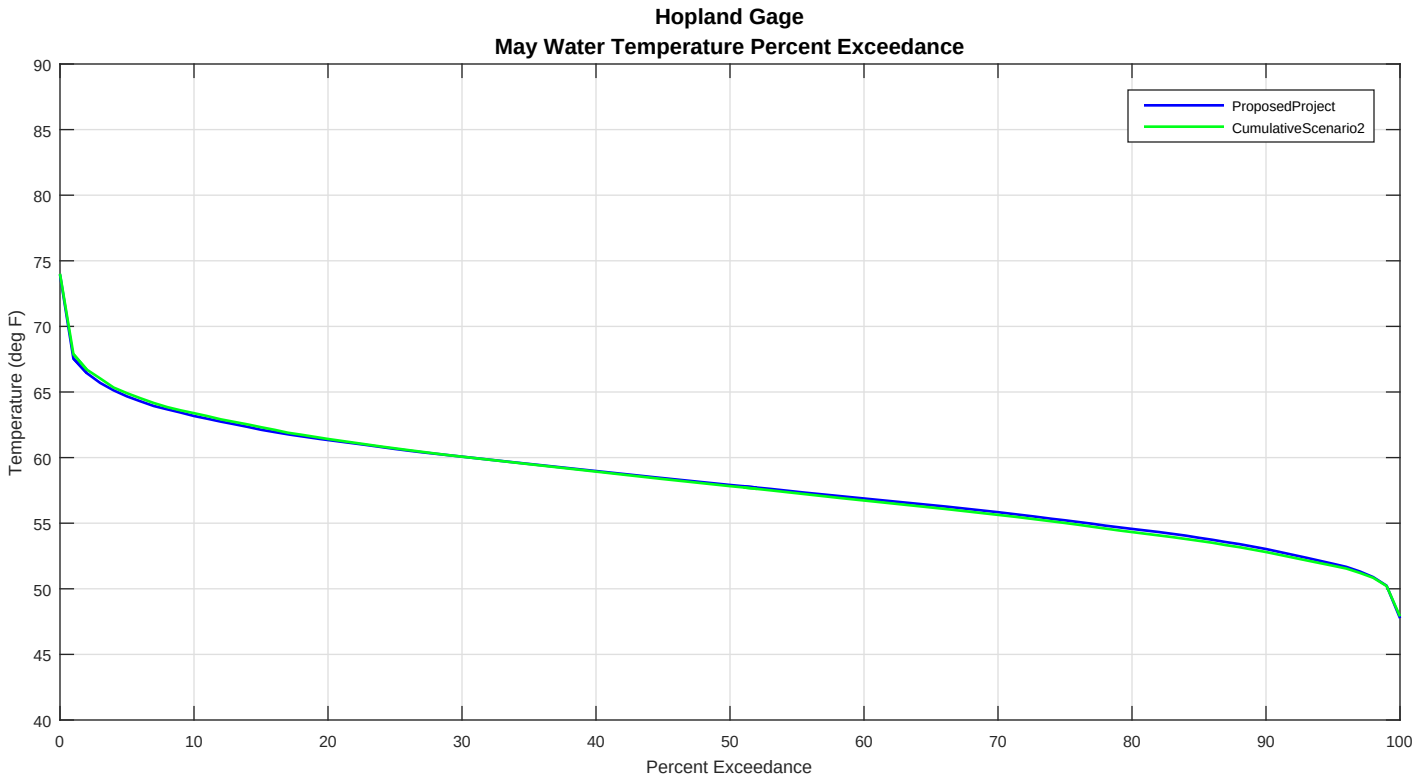
Hopland Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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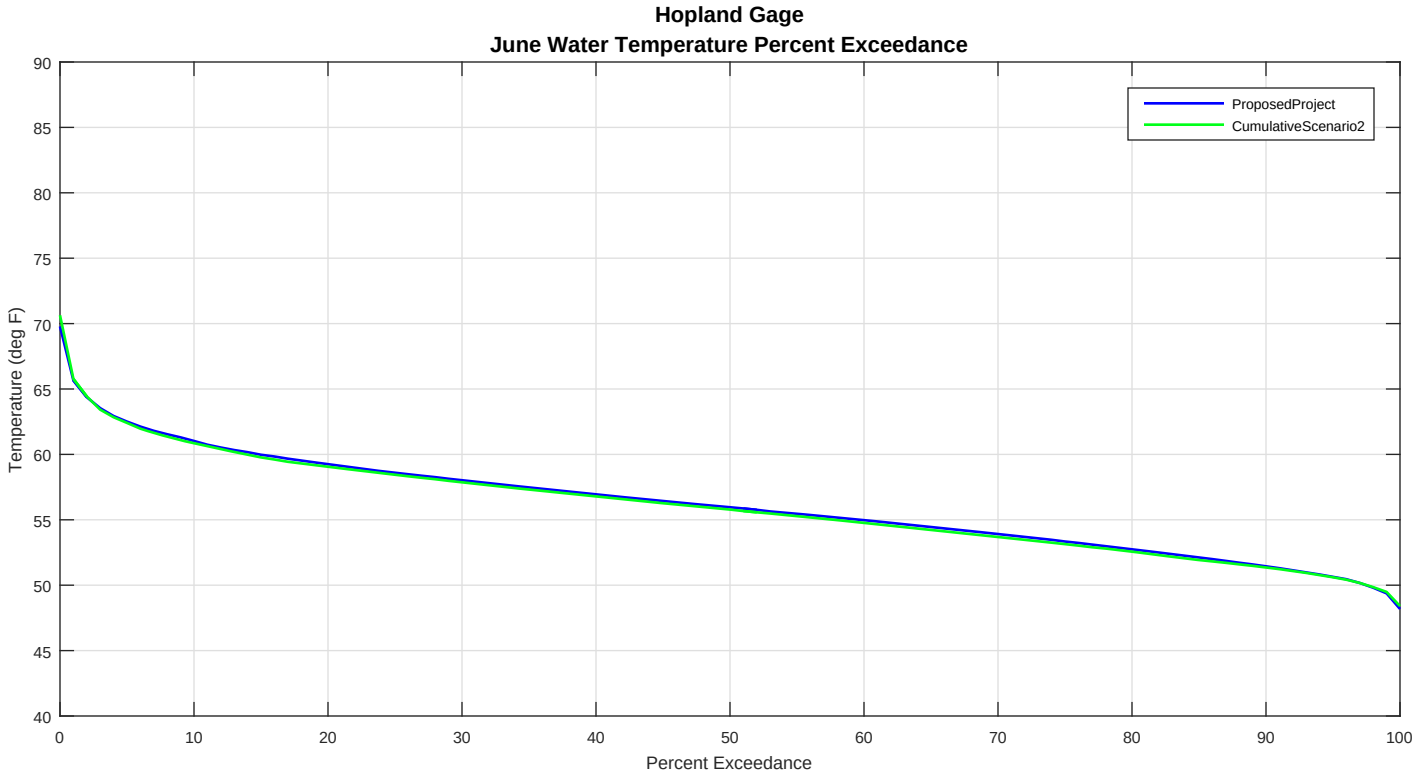
Hopland Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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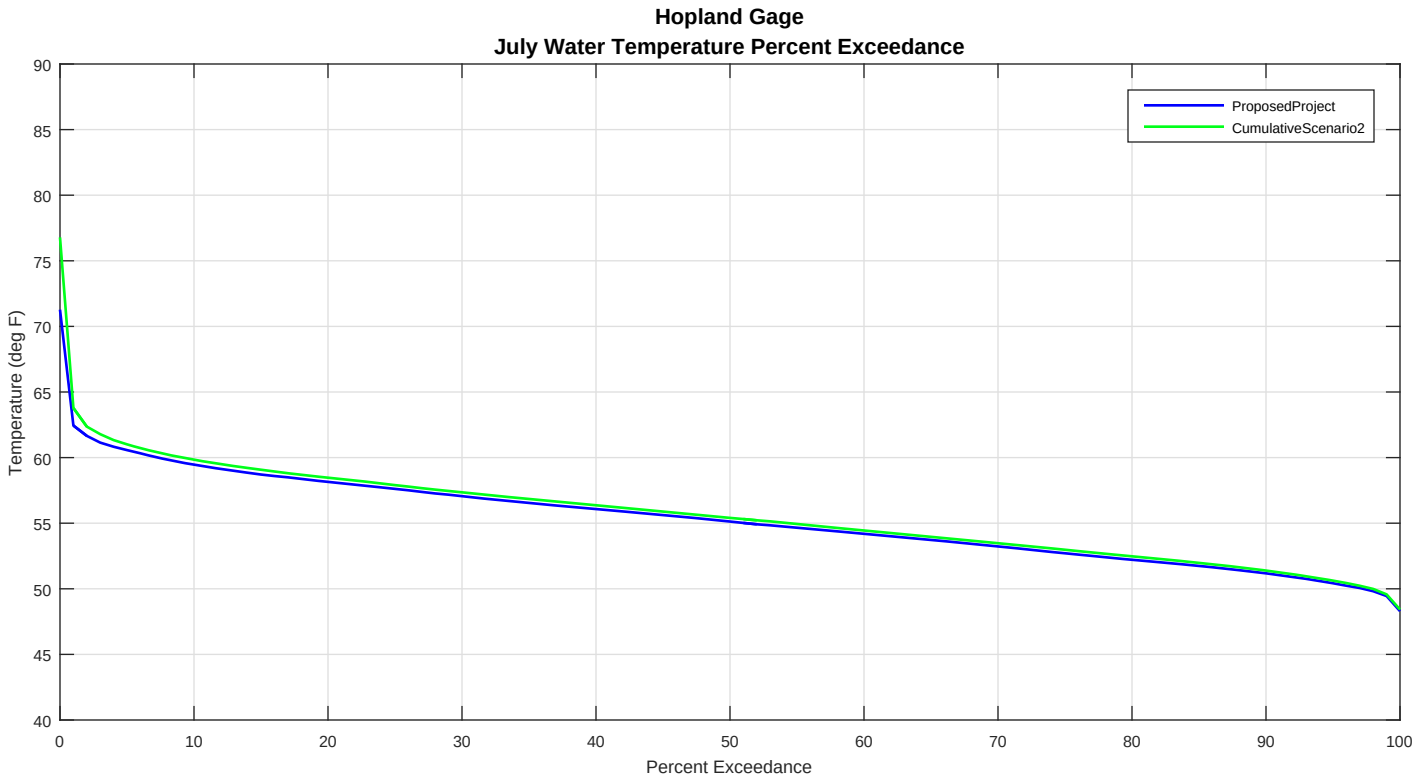
Hopland Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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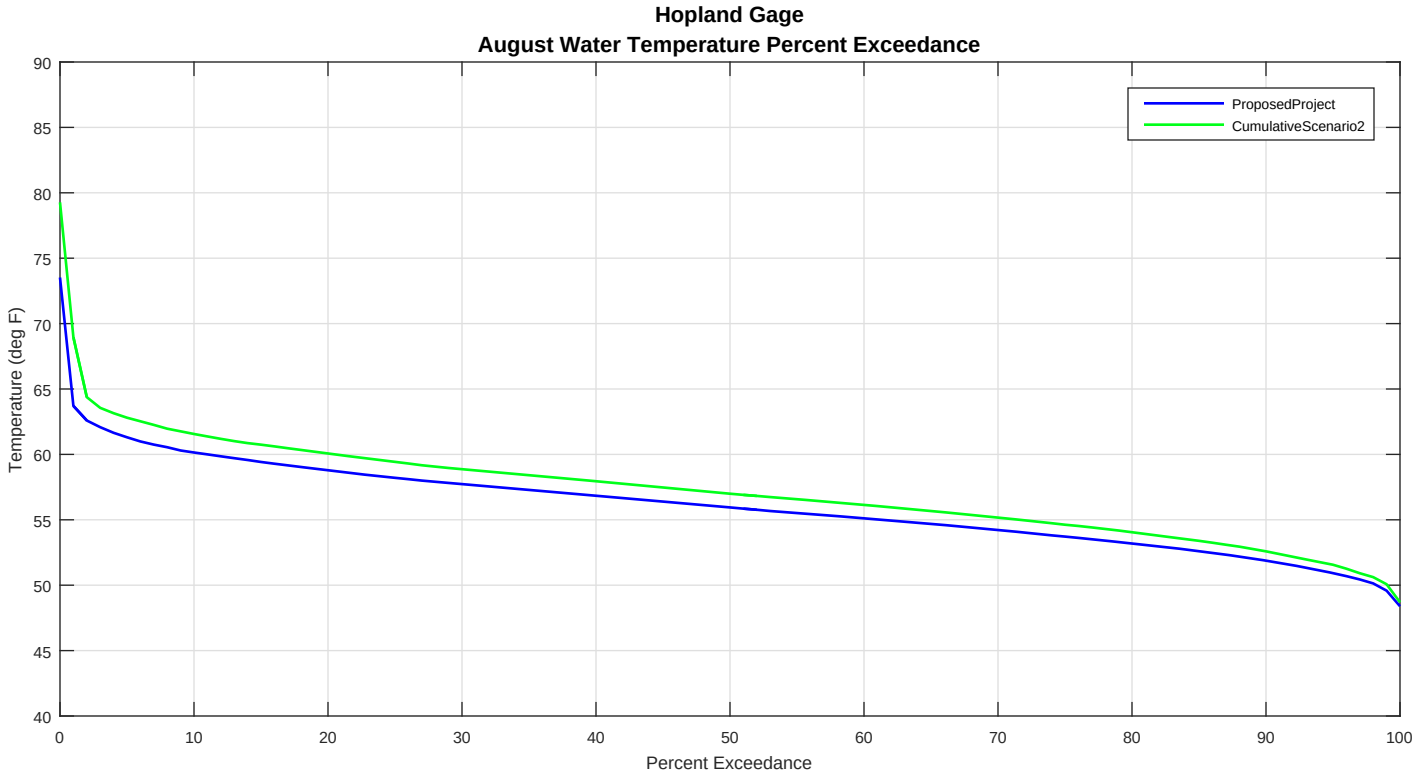
Hopland Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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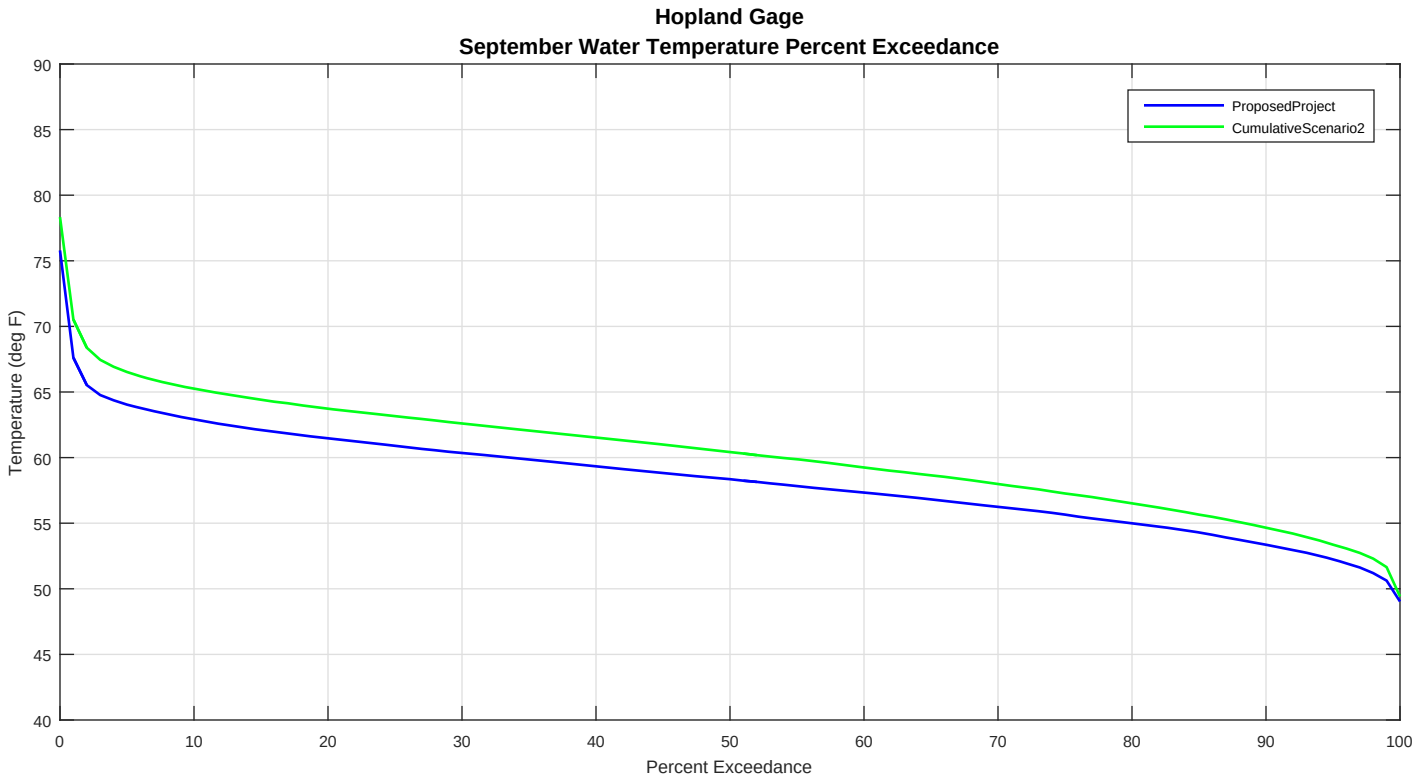
Hopland Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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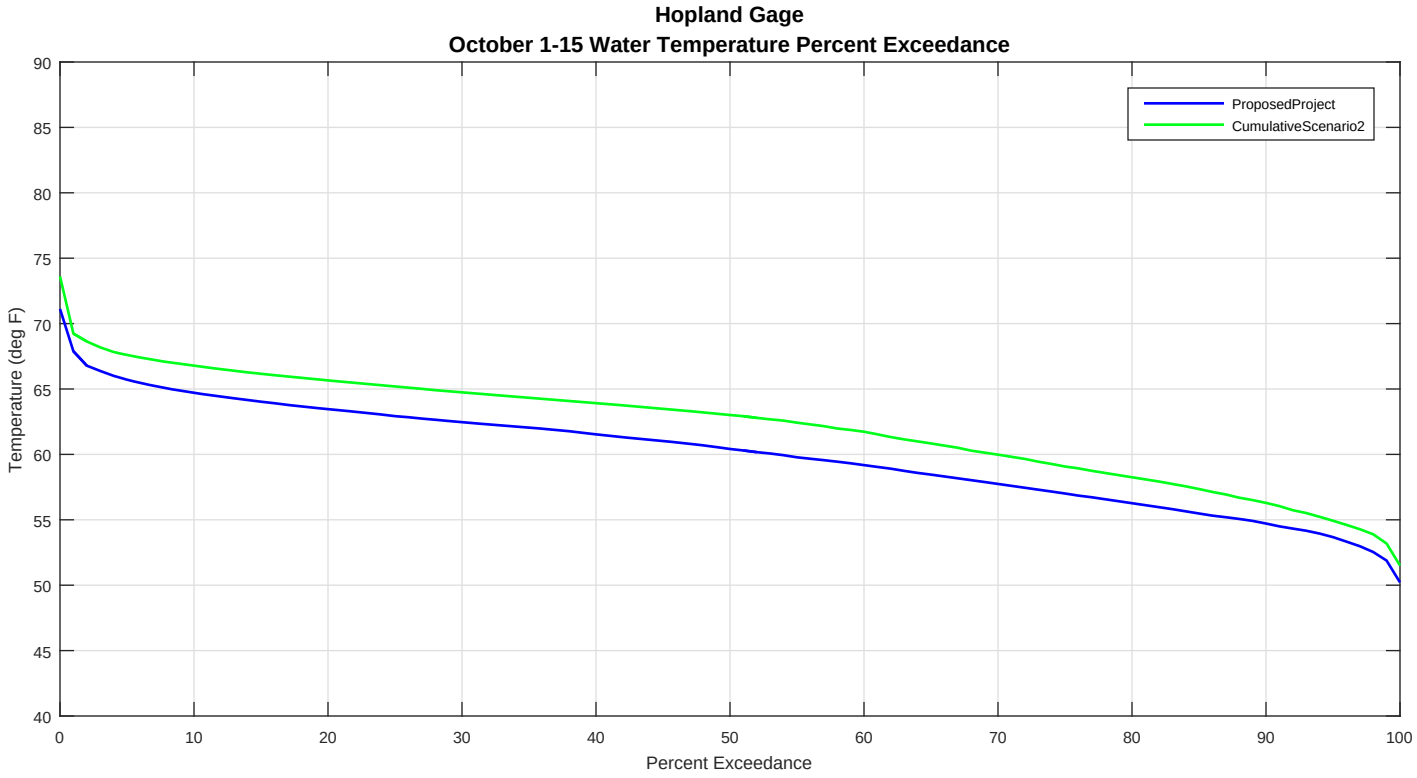
Hopland Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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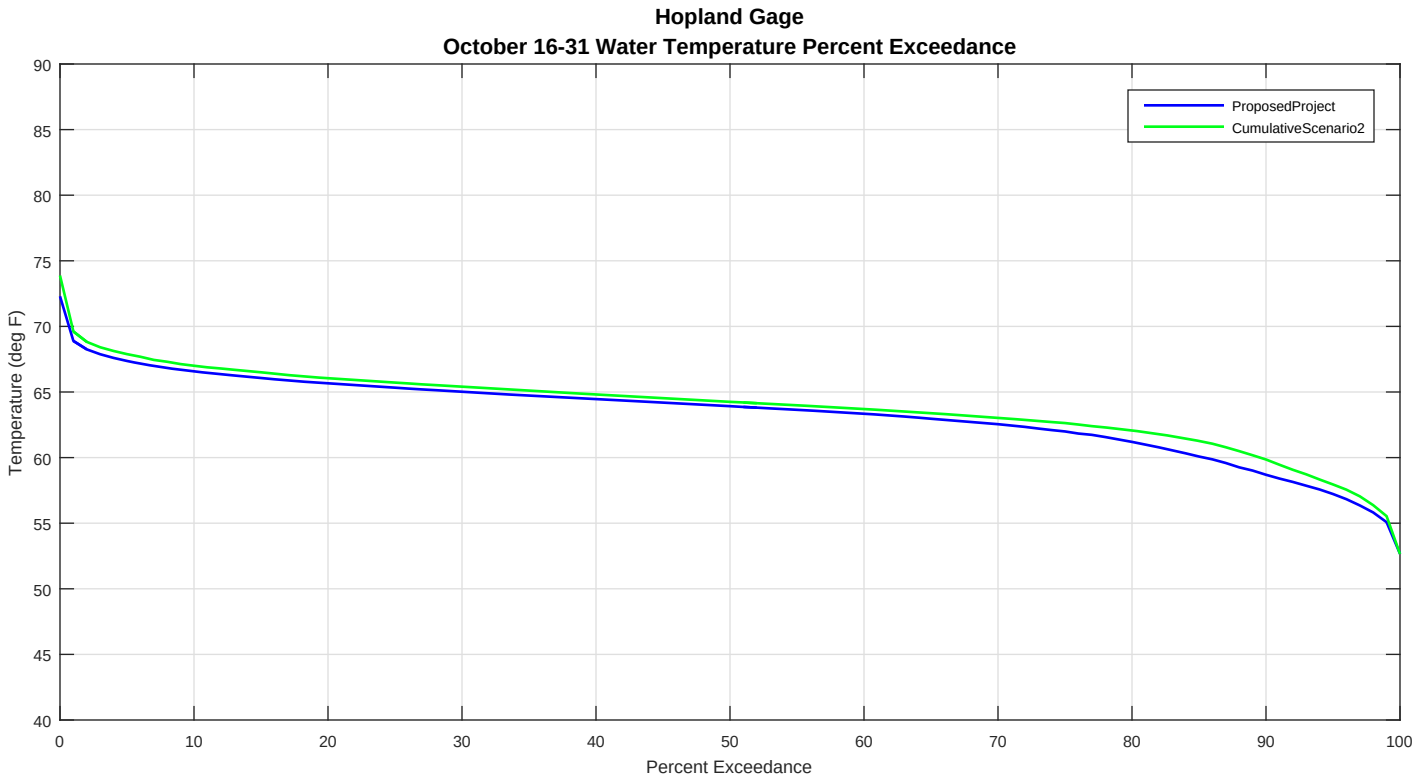
Hopland Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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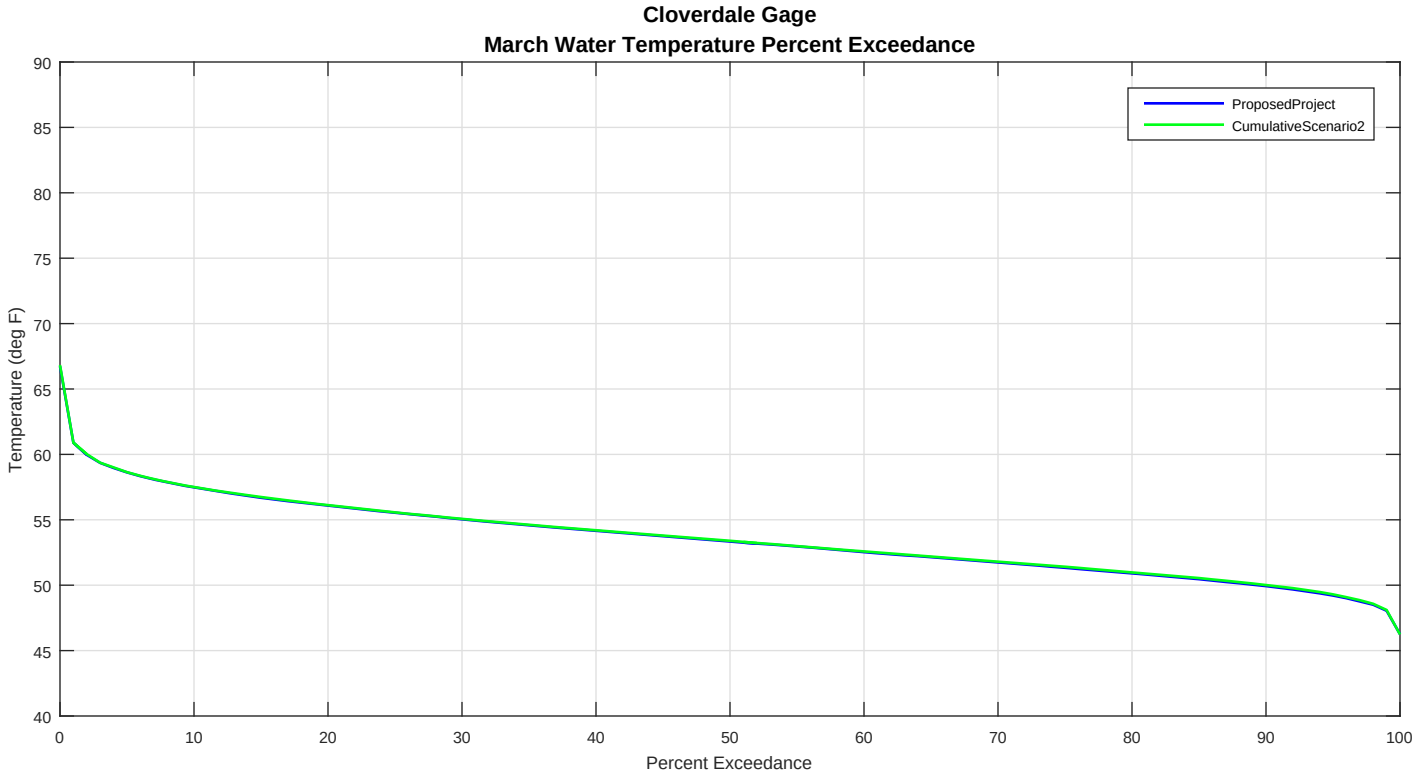
Cloverdale Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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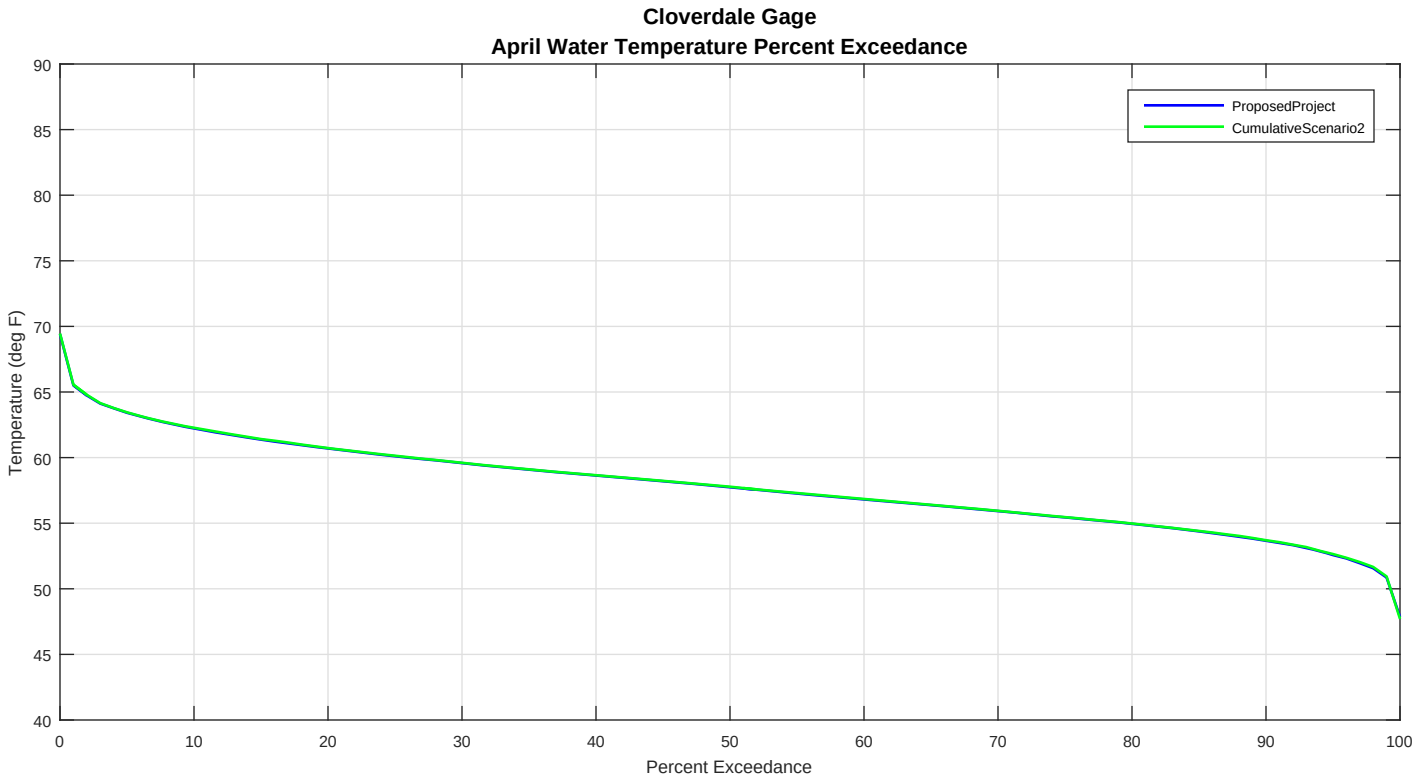
Cloverdale Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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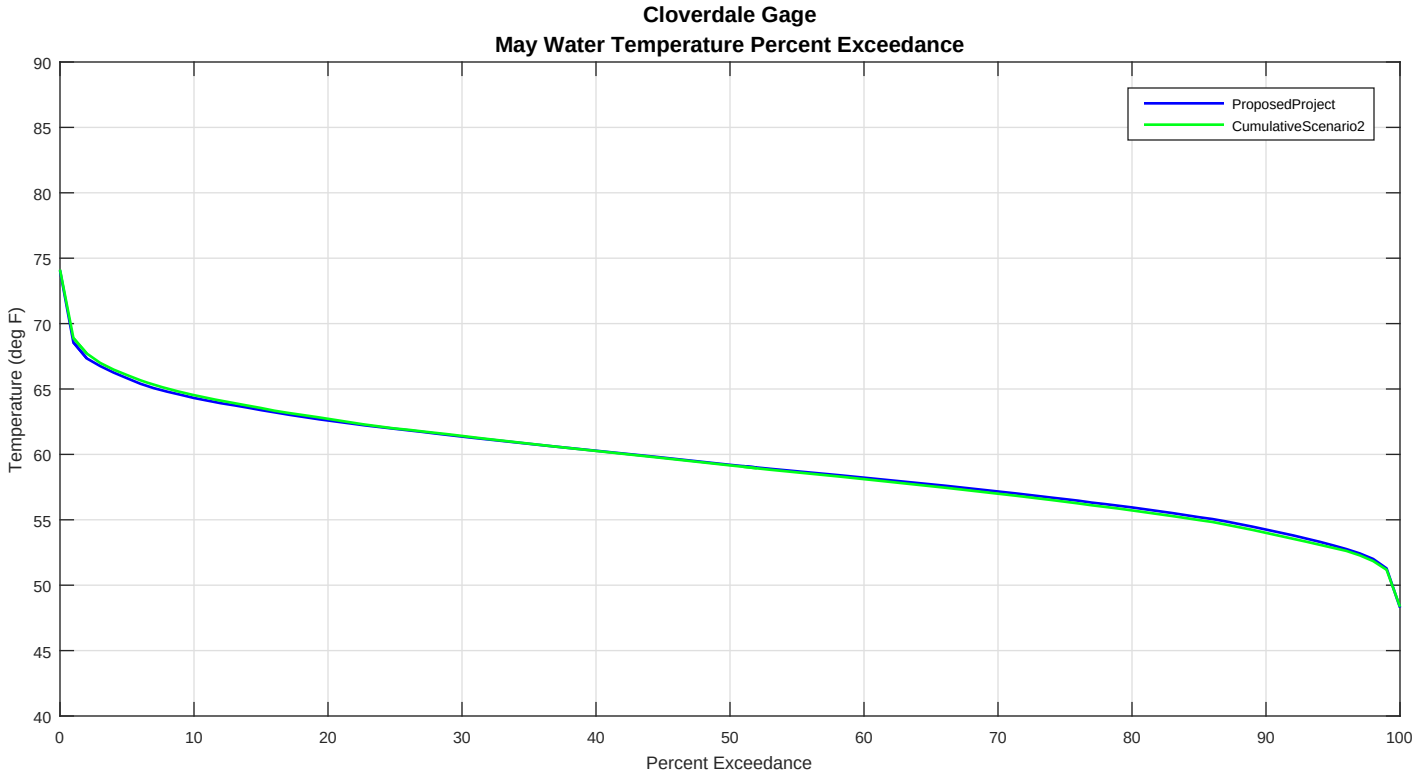
Cloverdale Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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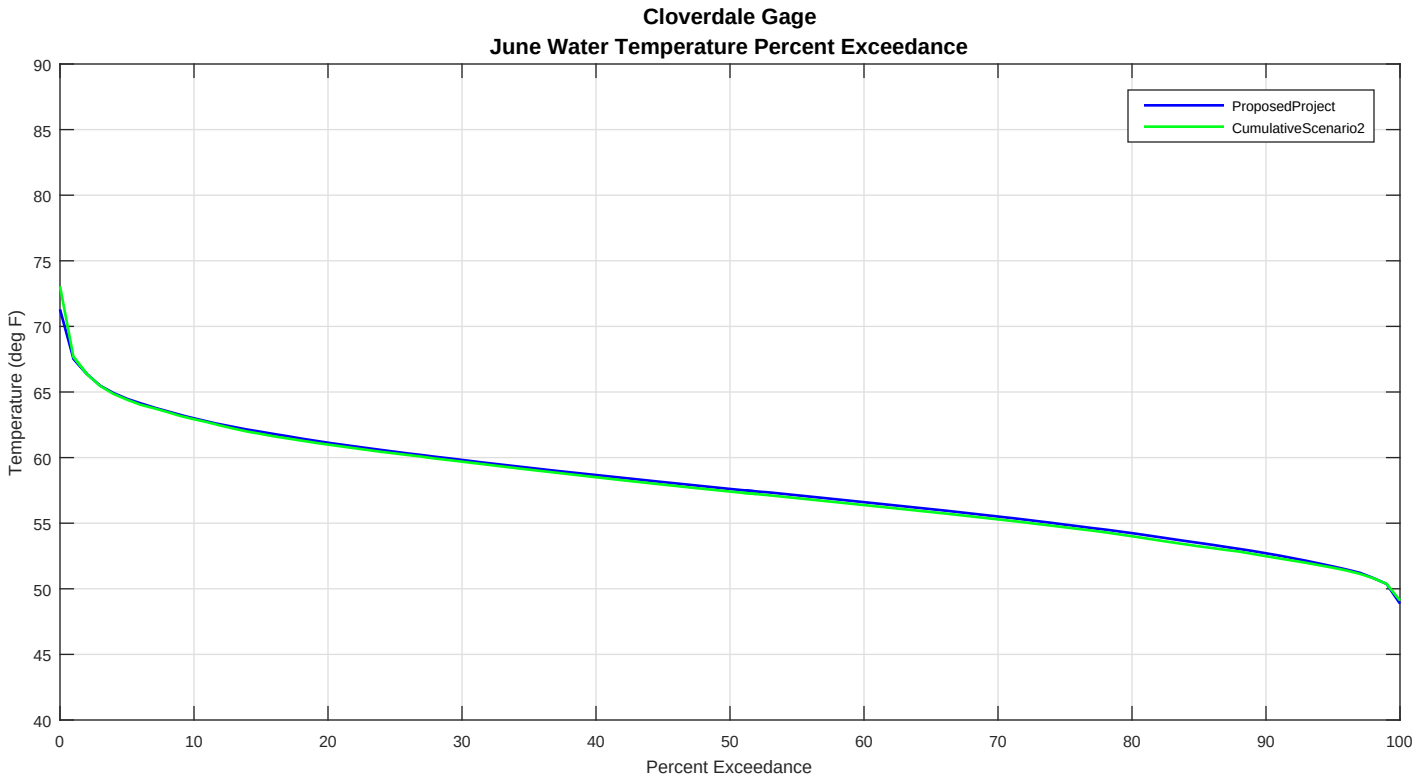
Cloverdale Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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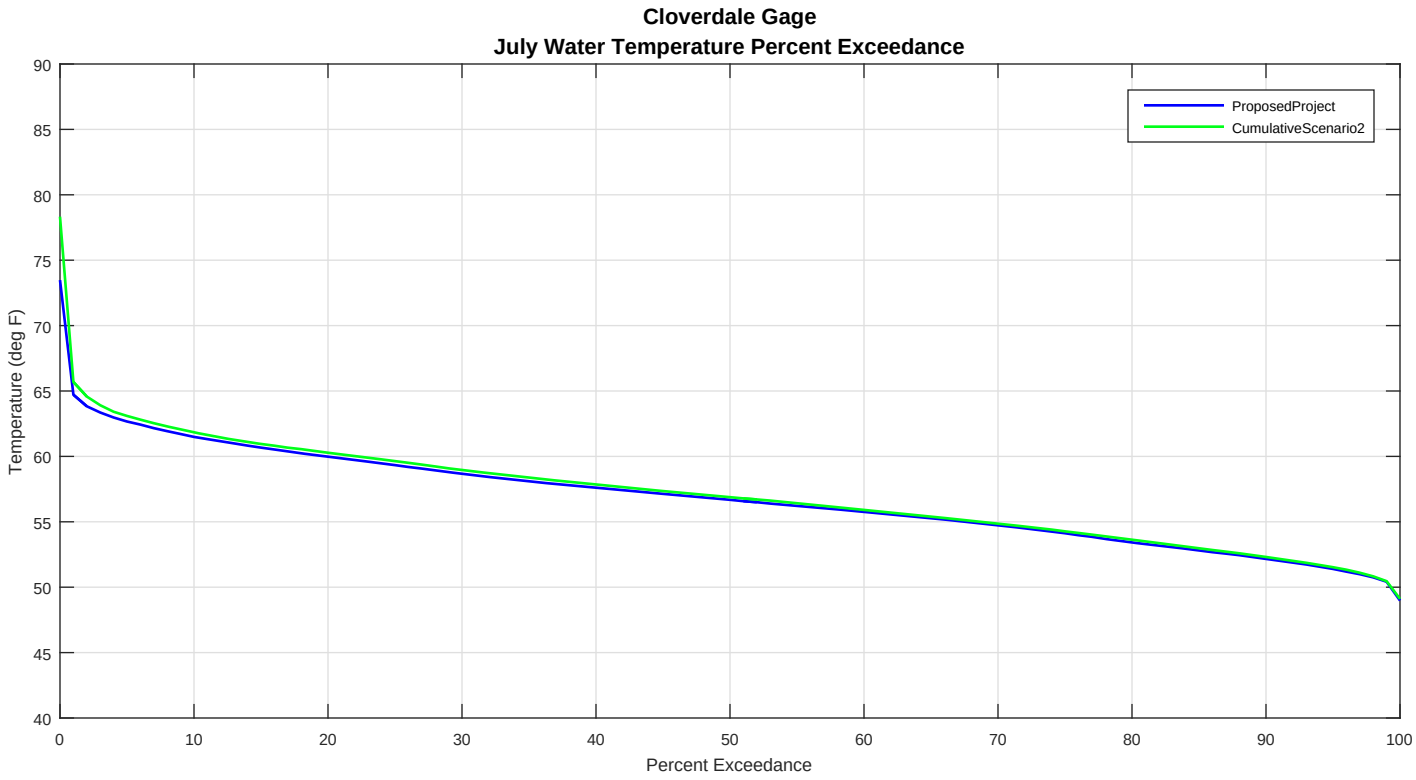
Cloverdale Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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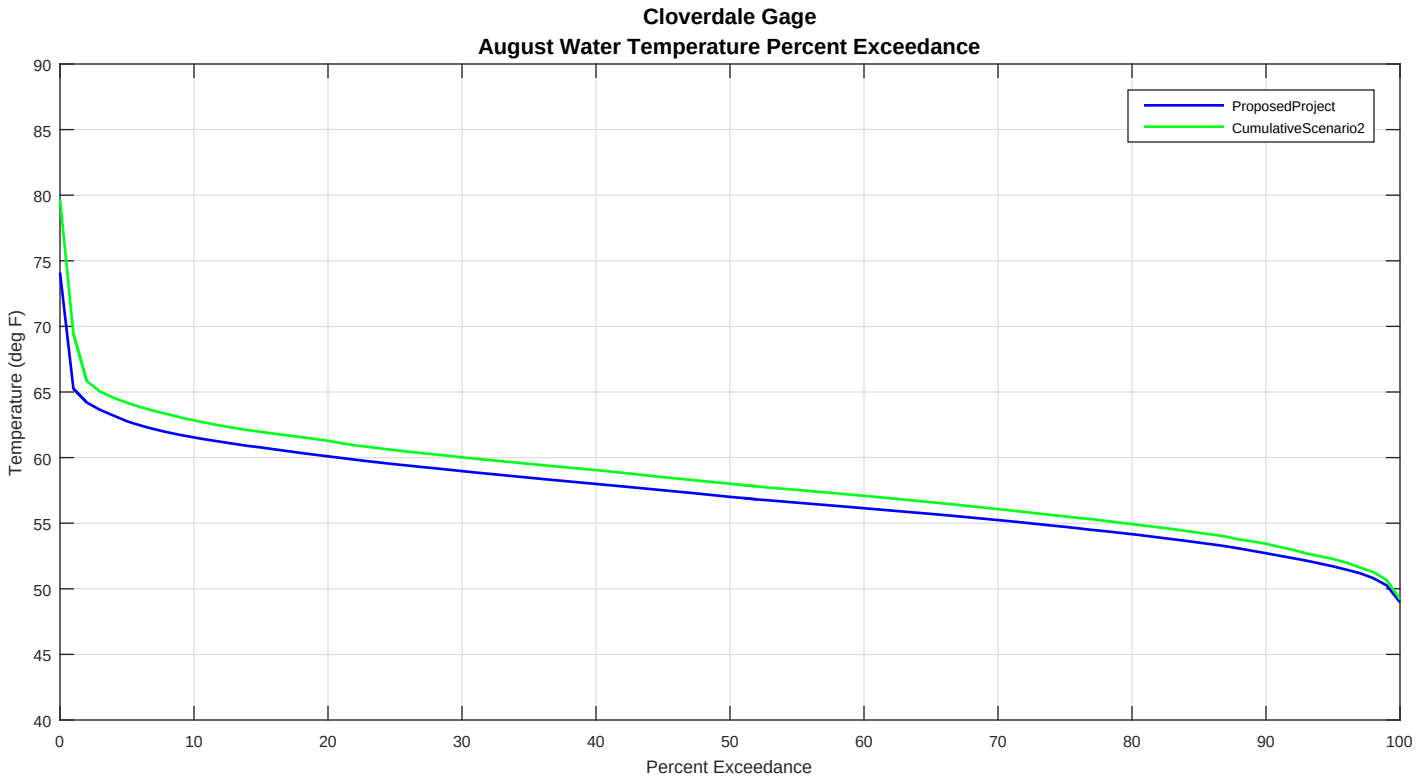
Cloverdale Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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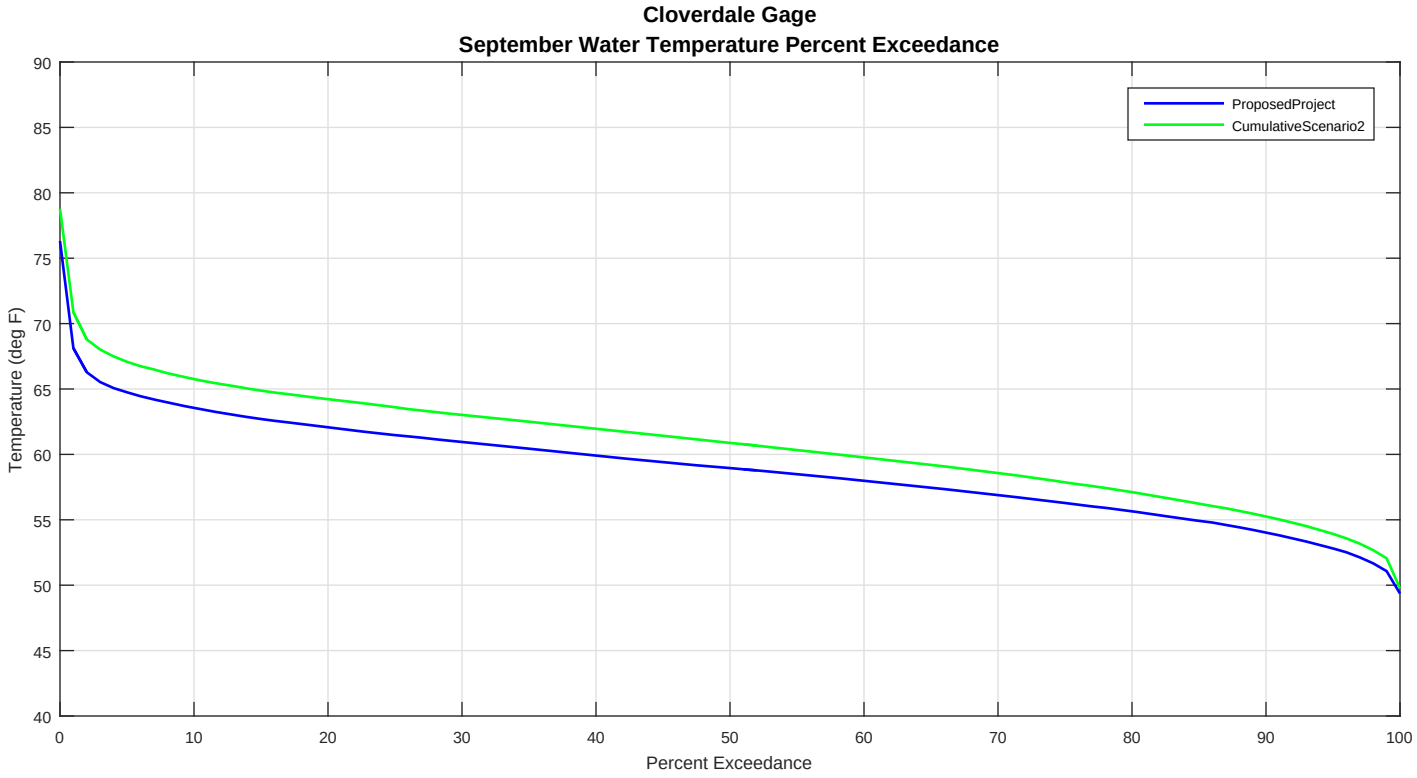
Cloverdale Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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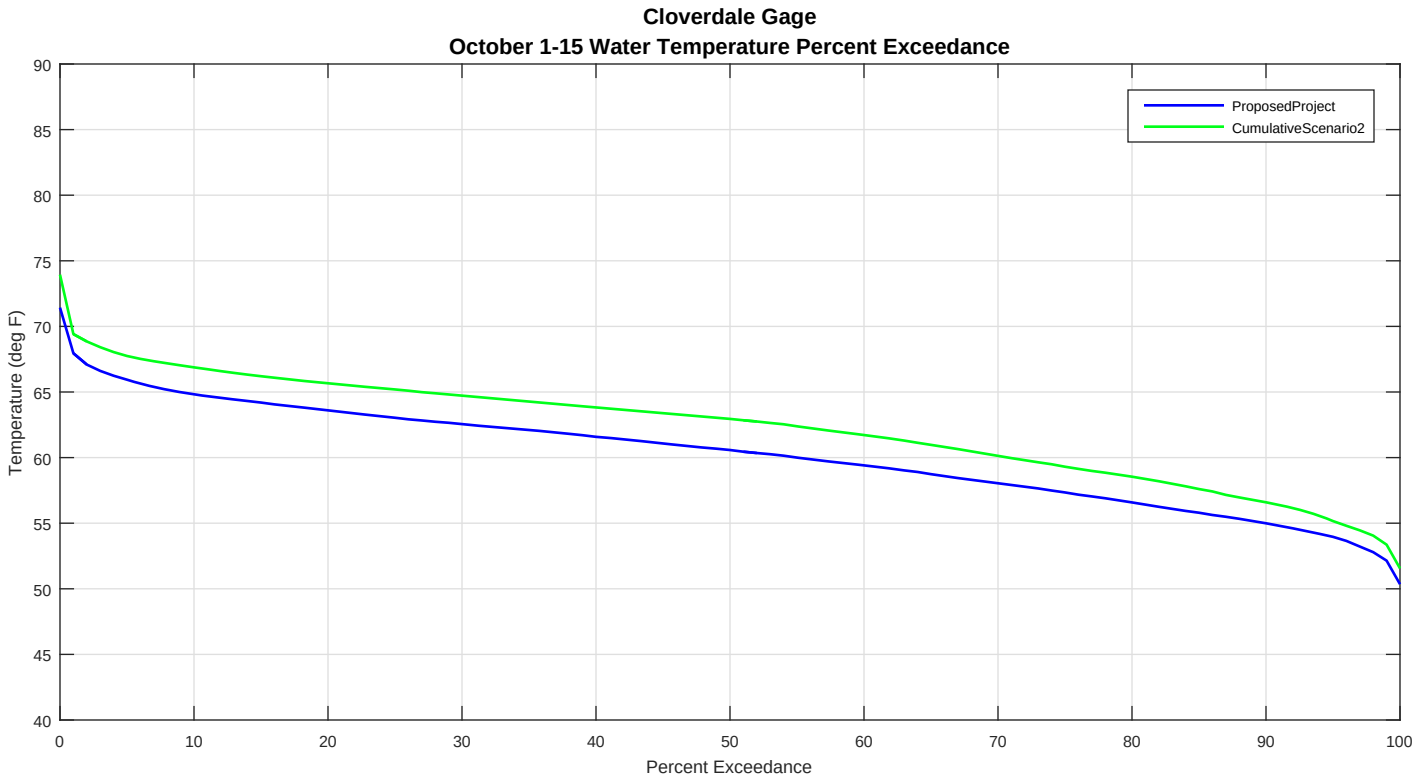
Cloverdale Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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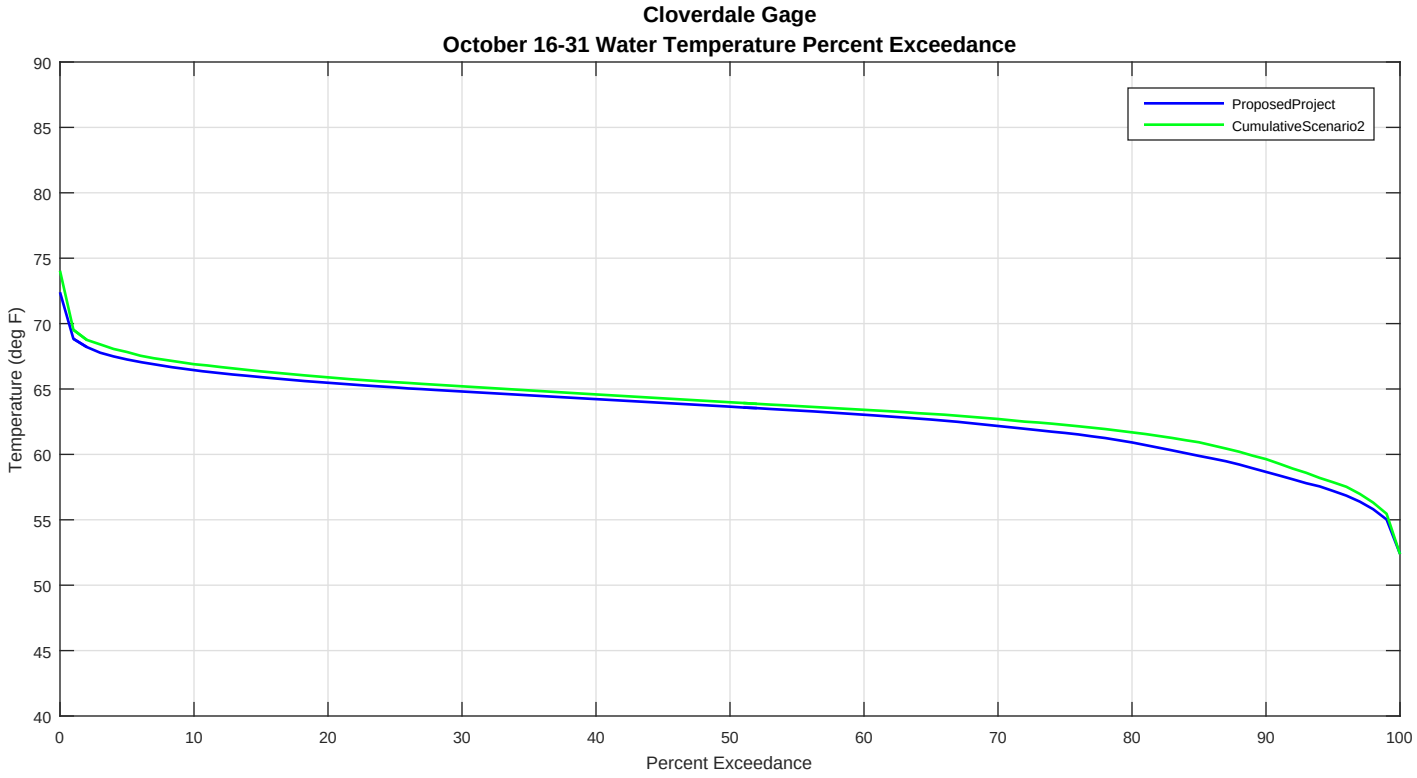
Cloverdale Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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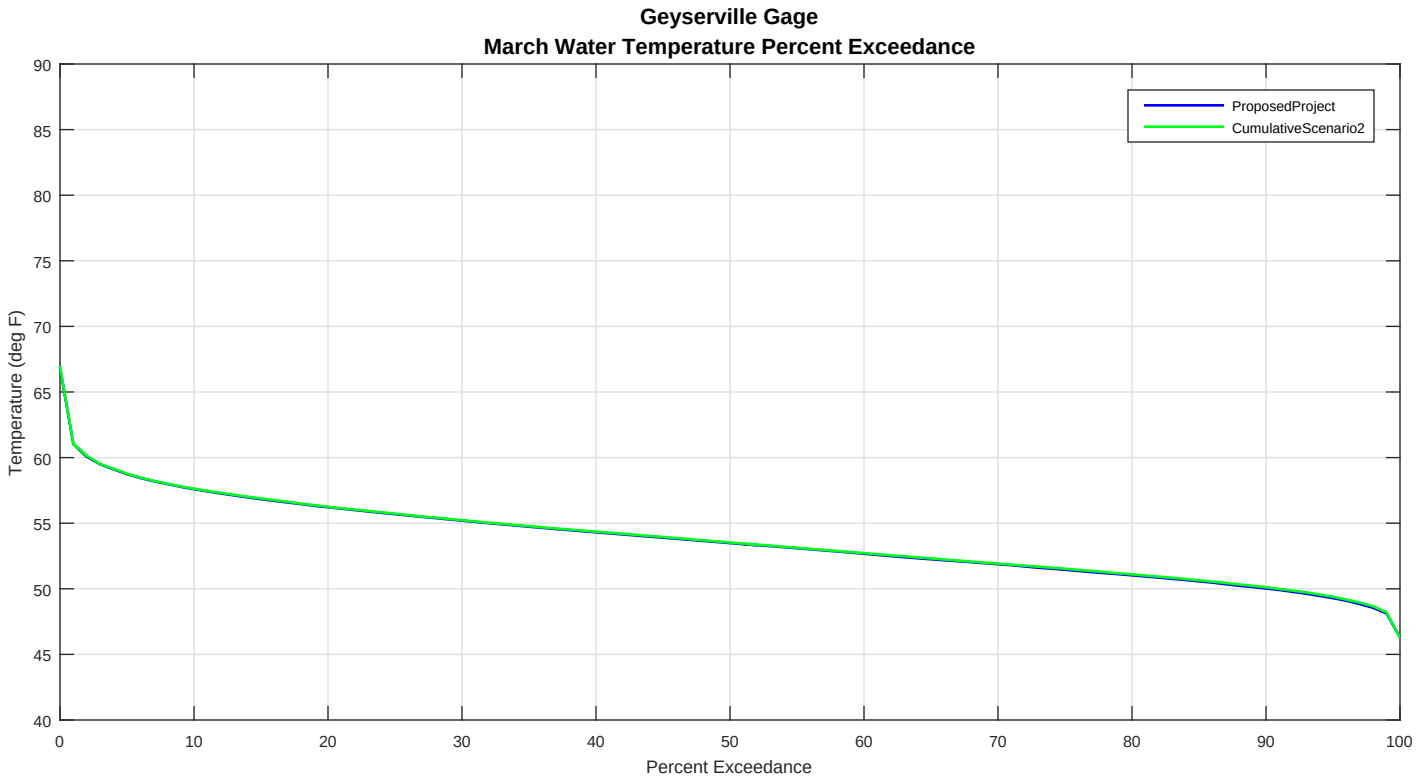
Geyserville Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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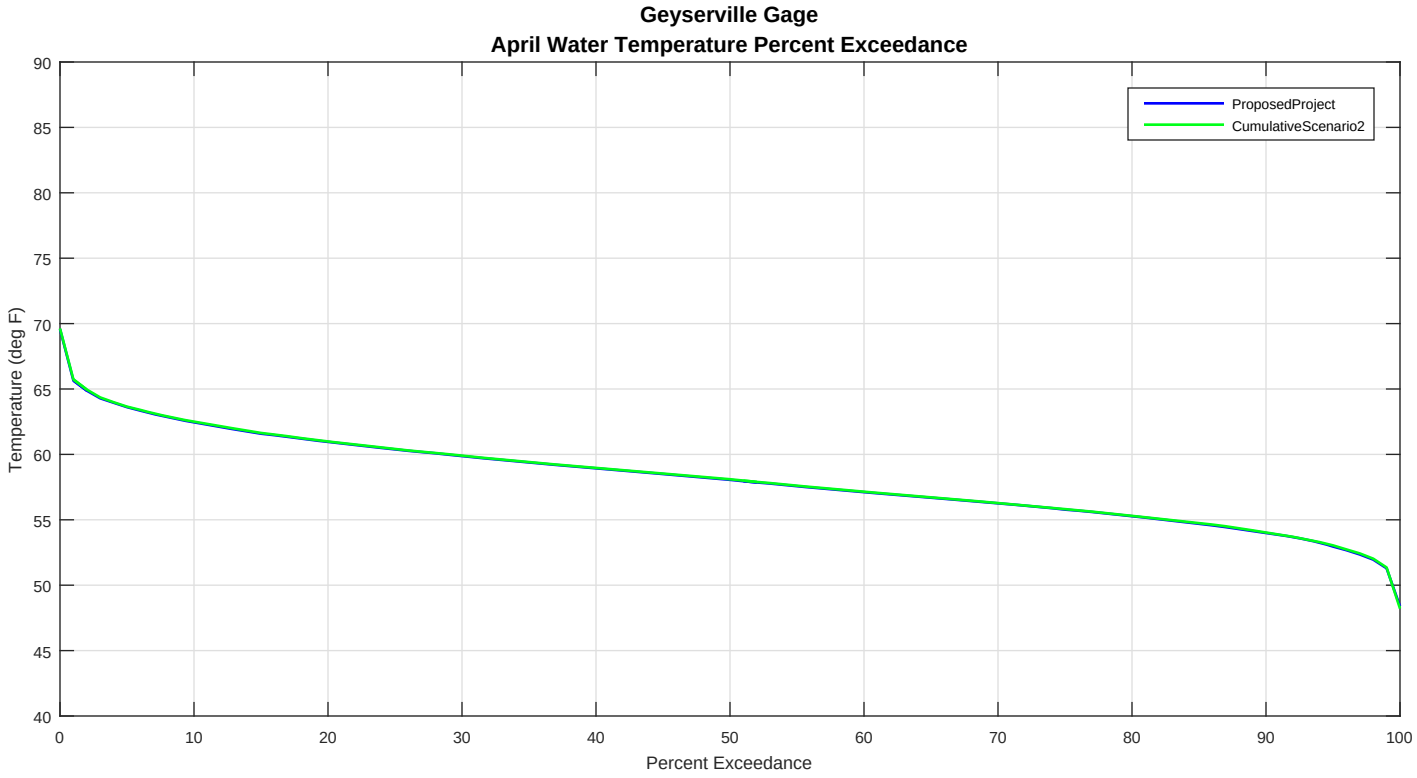
Geyserville Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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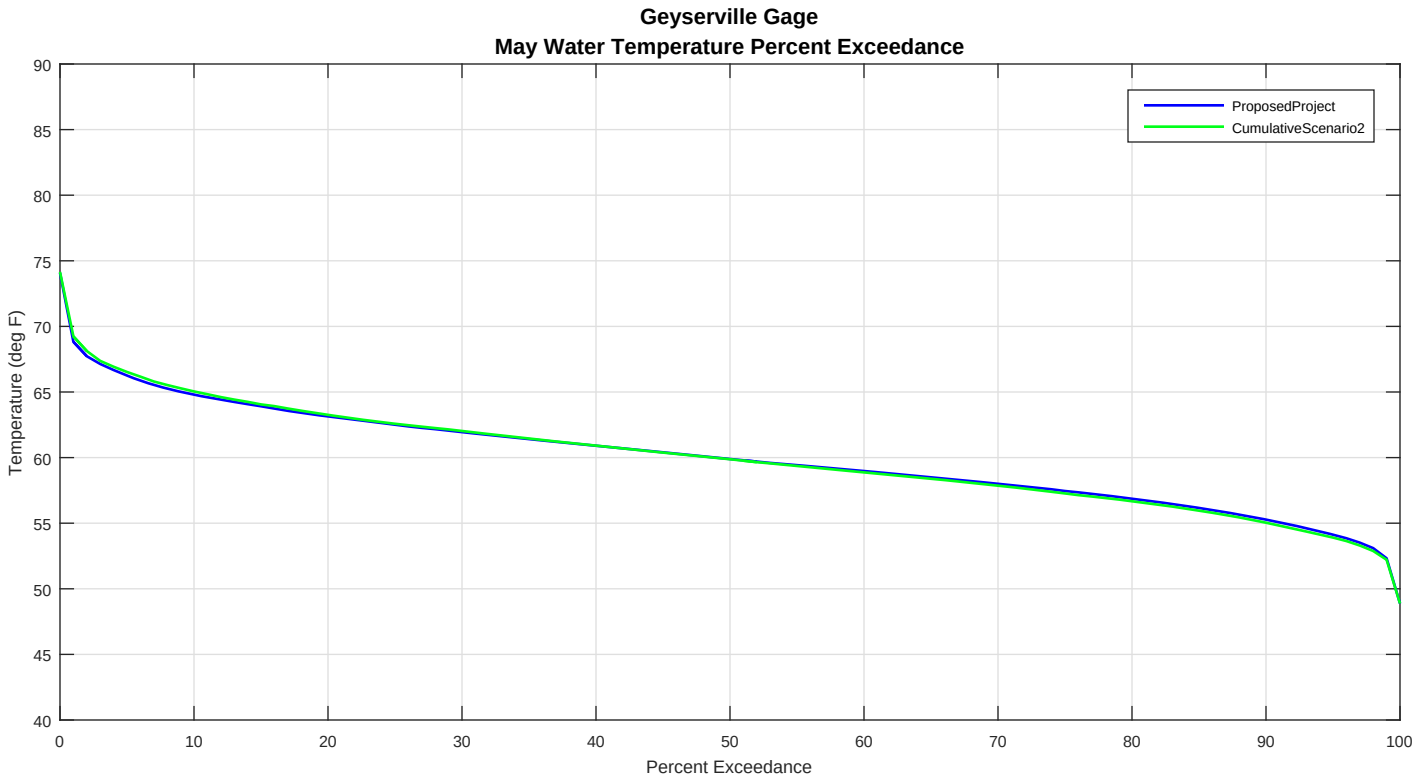
Geyserville Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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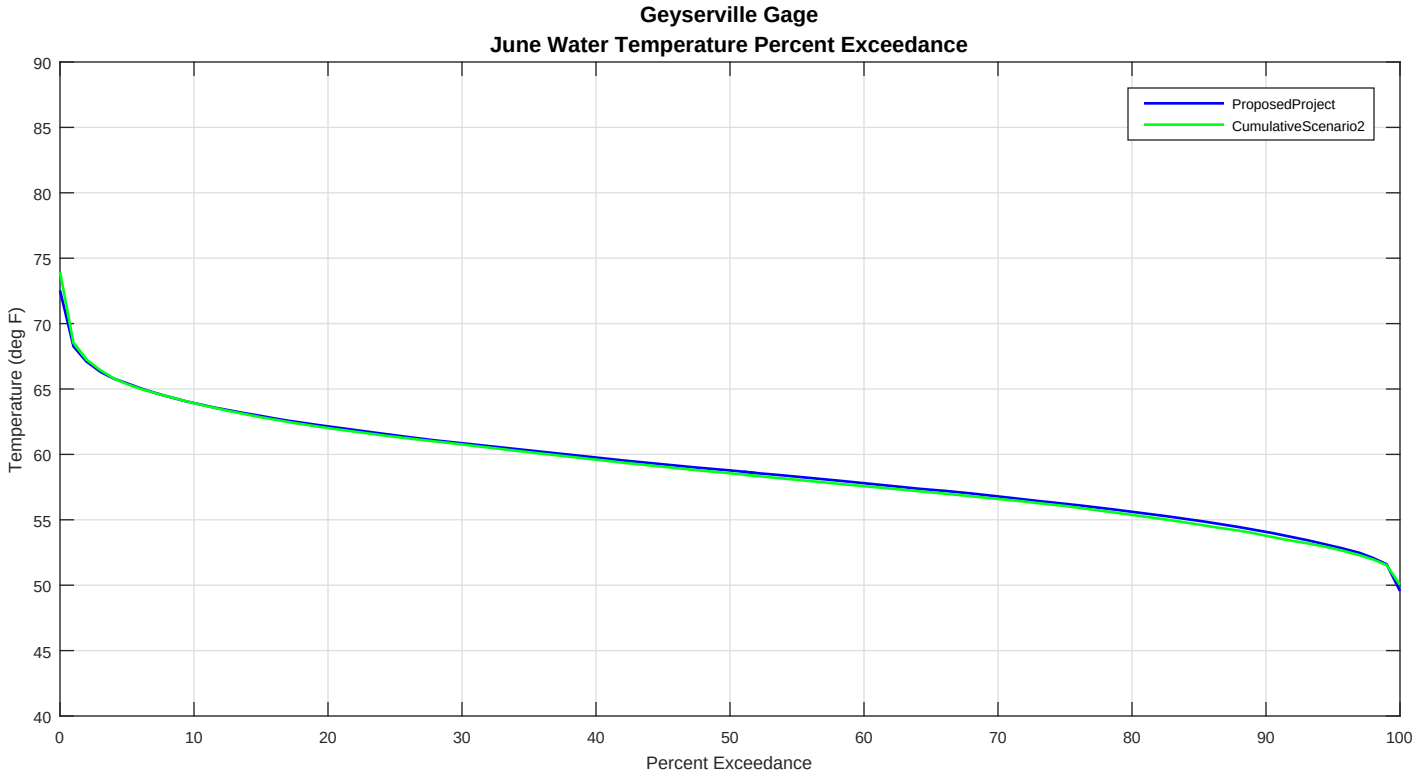
Geyserville Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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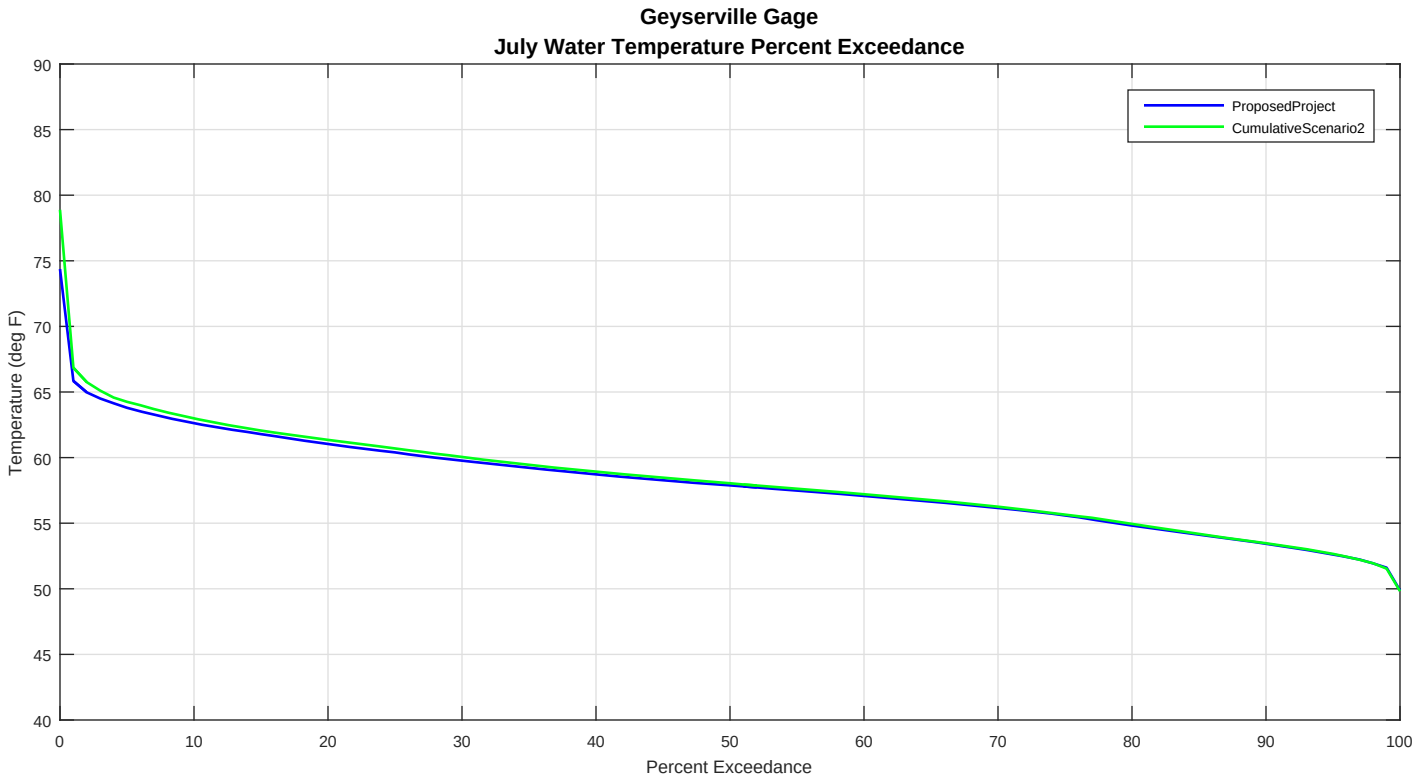
Geyserville Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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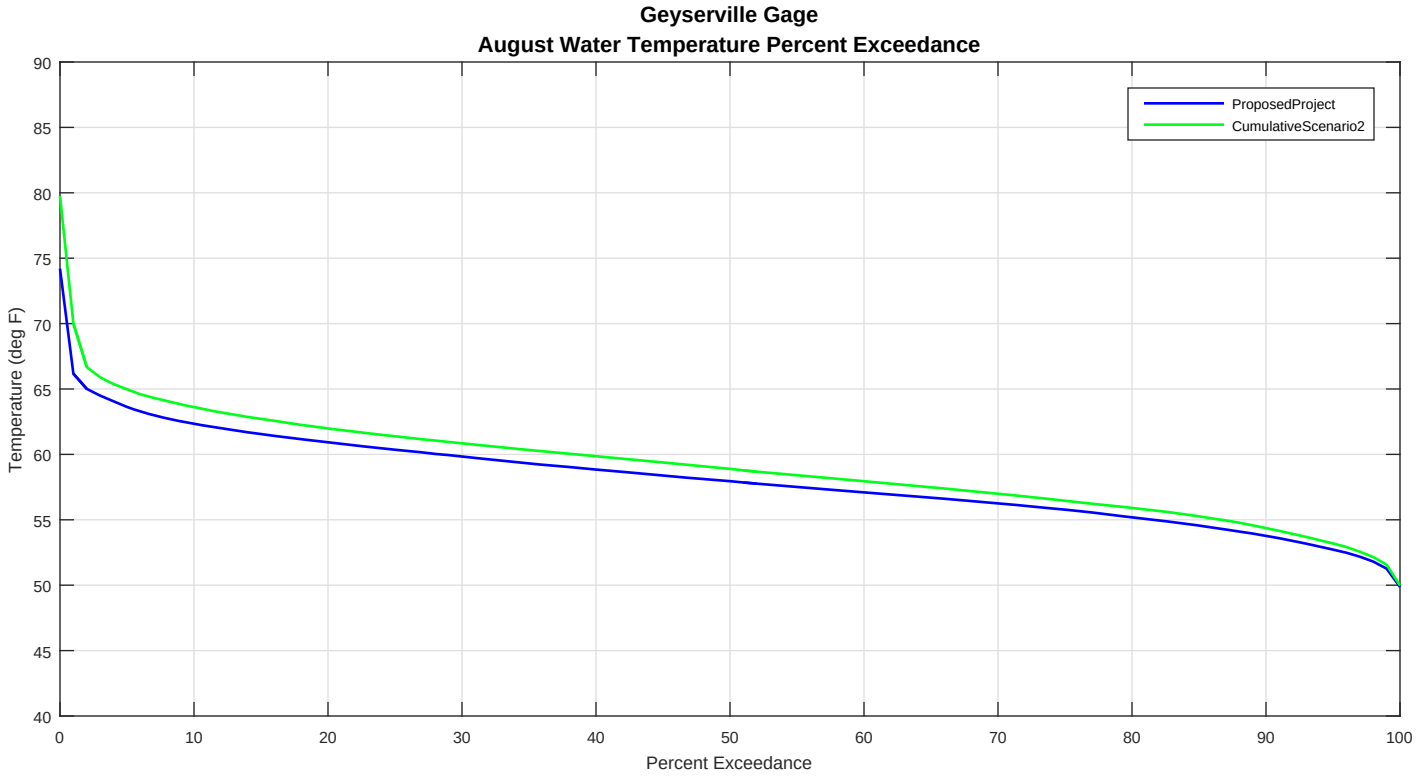
Geyserville Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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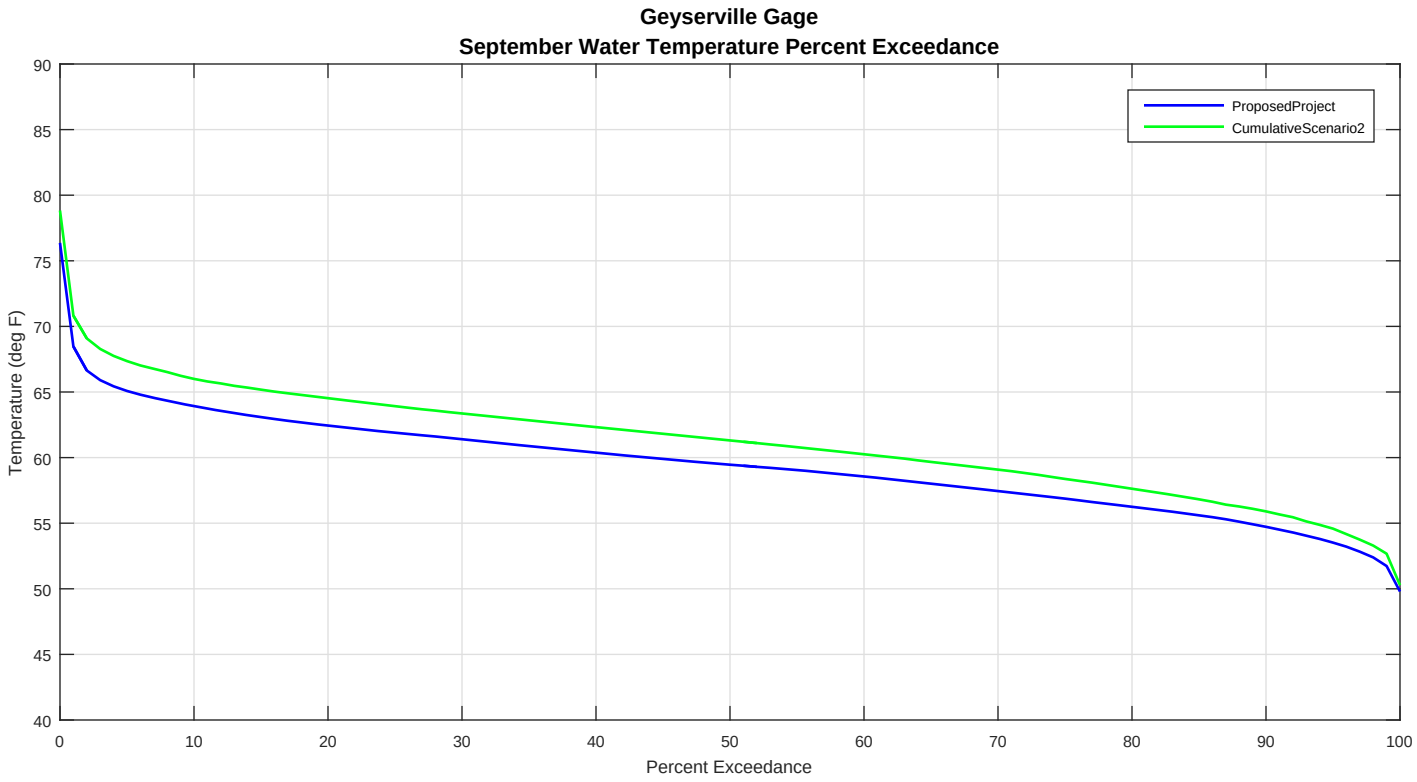
Geyserville Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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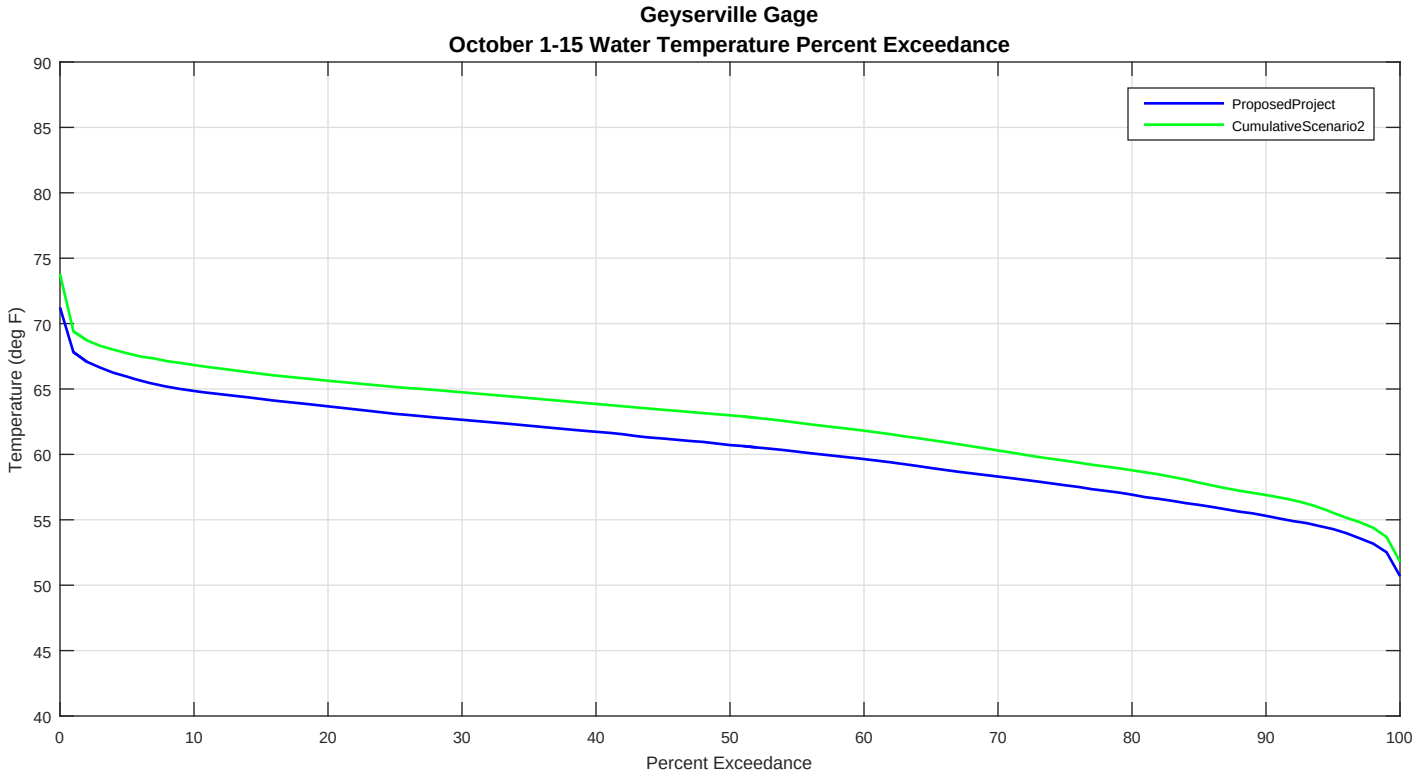
Geyserville Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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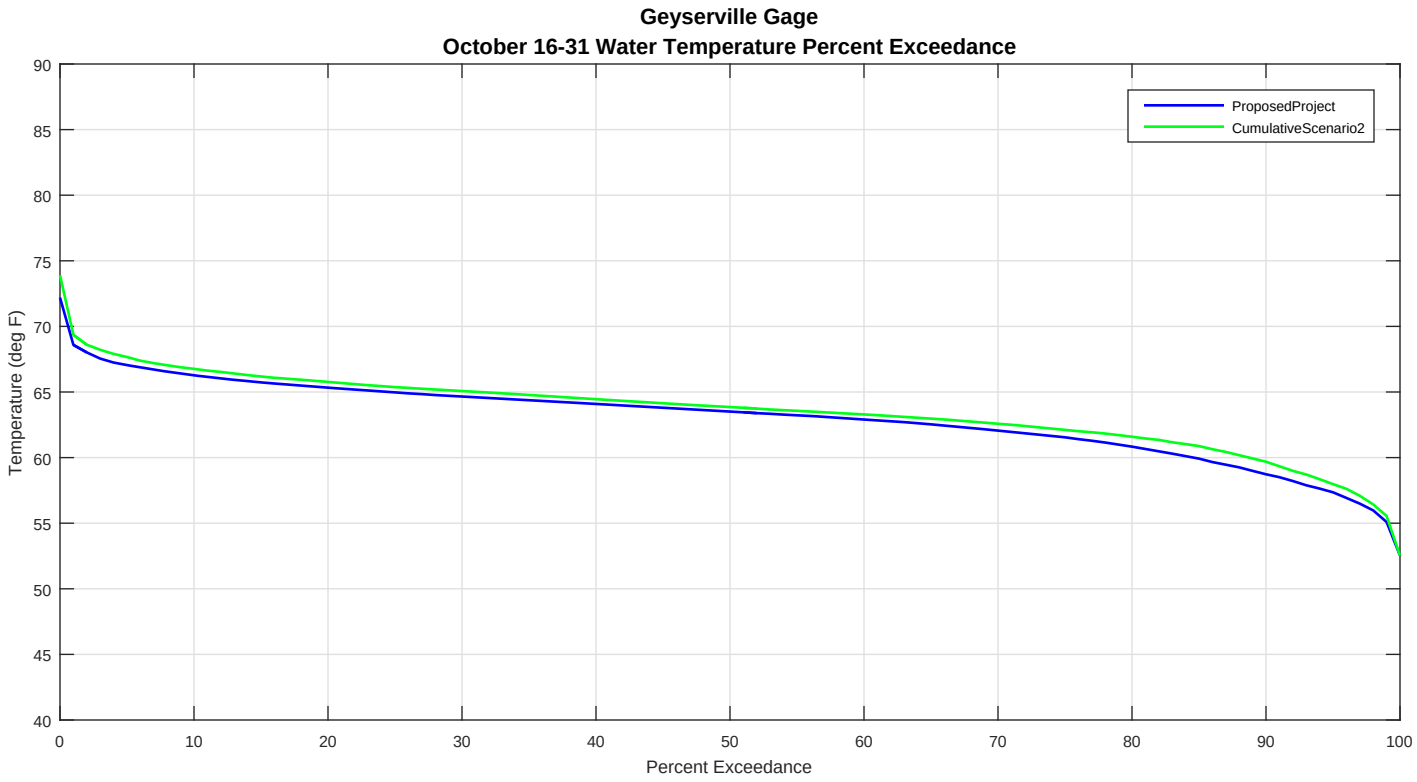
Geyserville Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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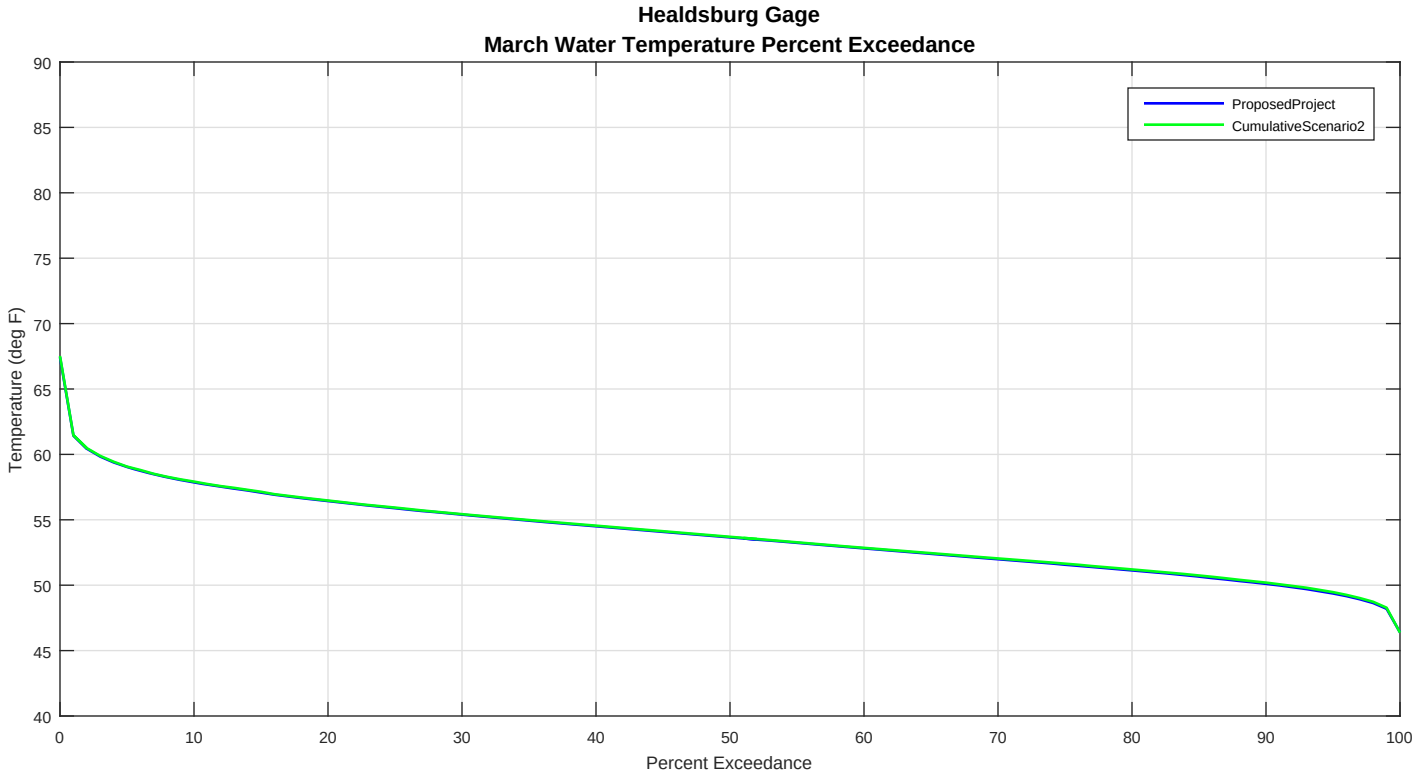
Healdsburg Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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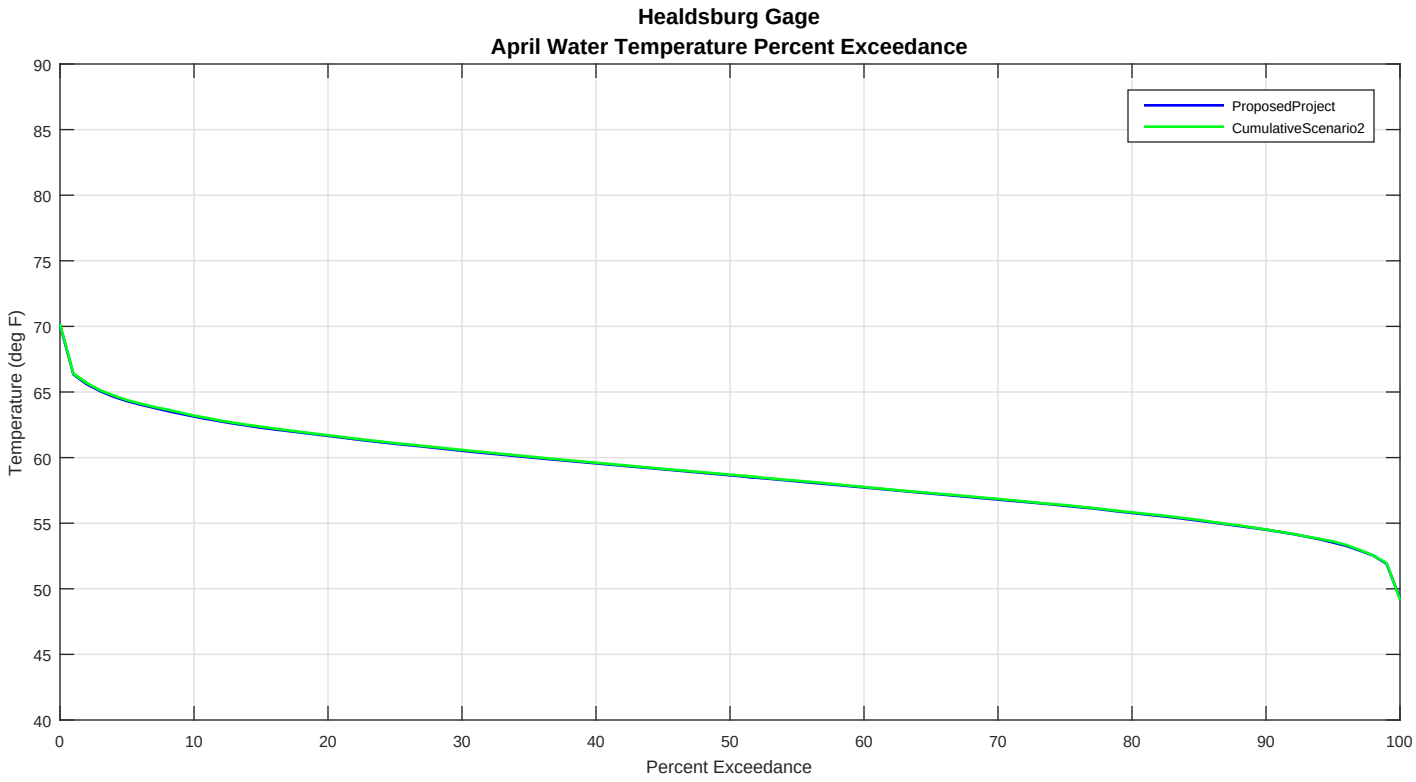
Healdsburg Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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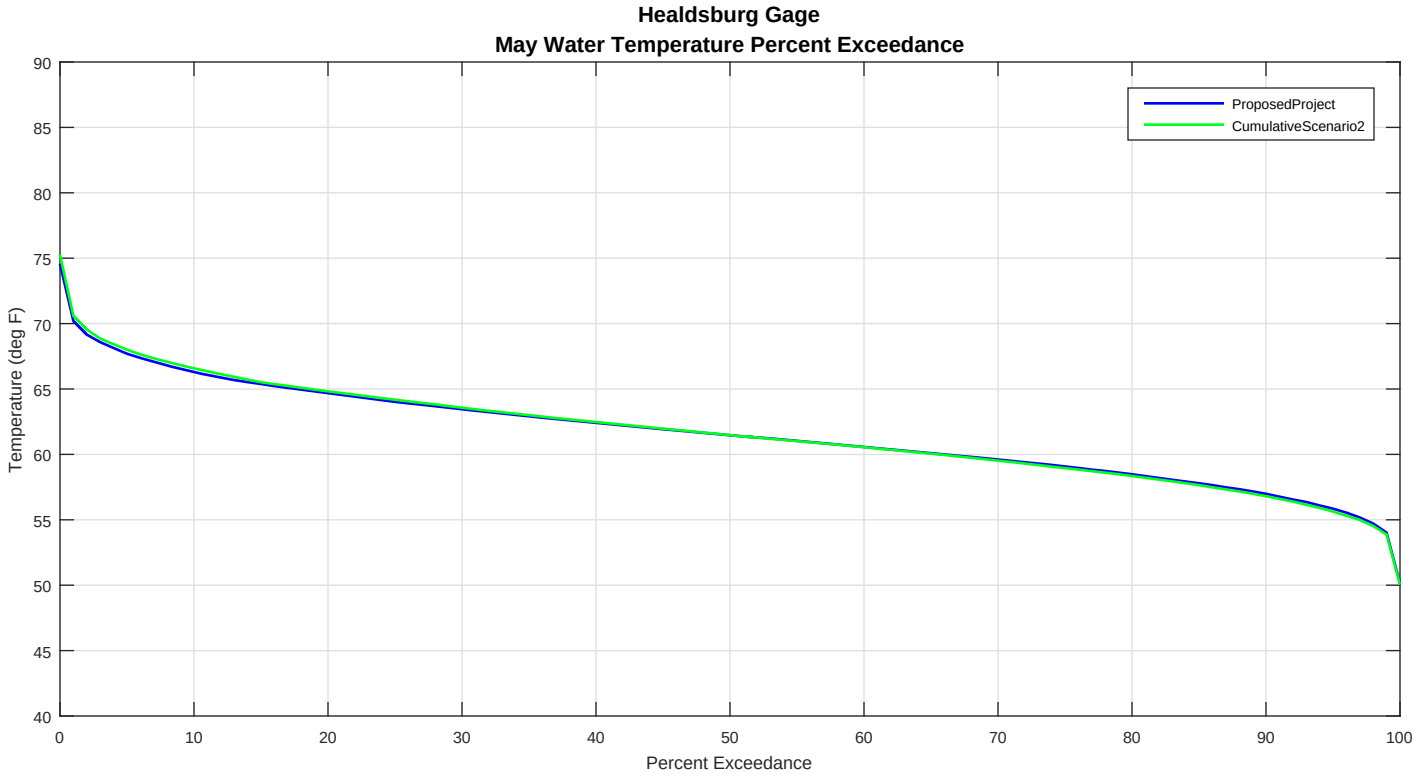
Healdsburg Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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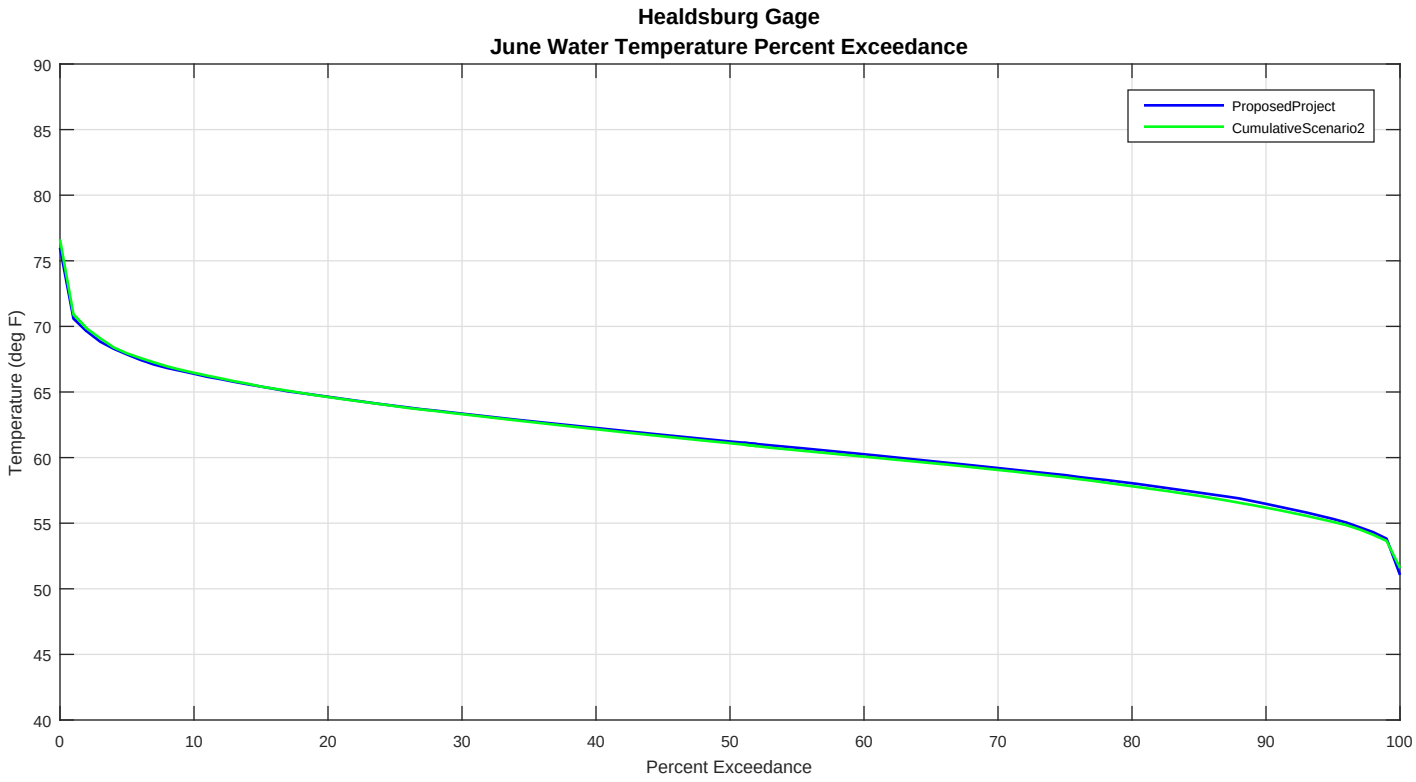
Healdsburg Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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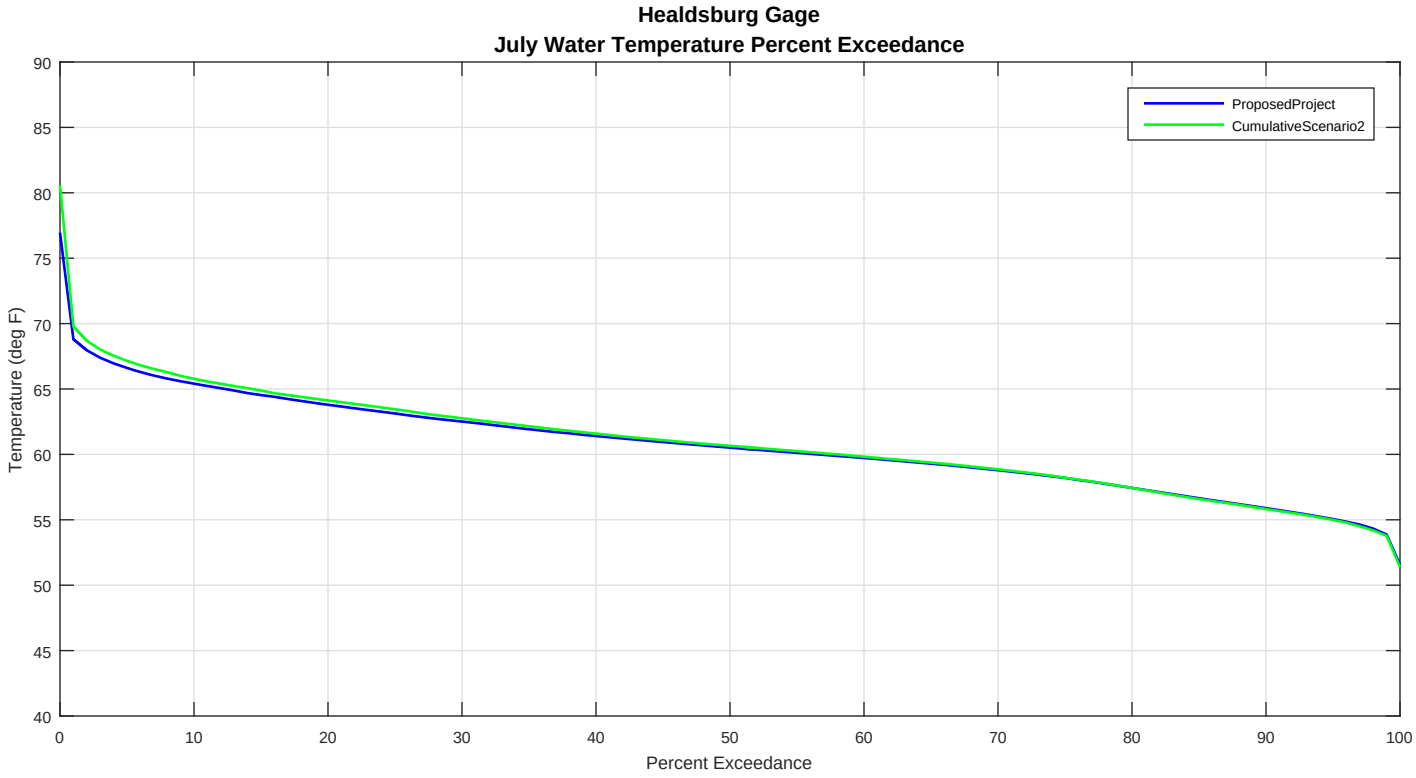
Healdsburg Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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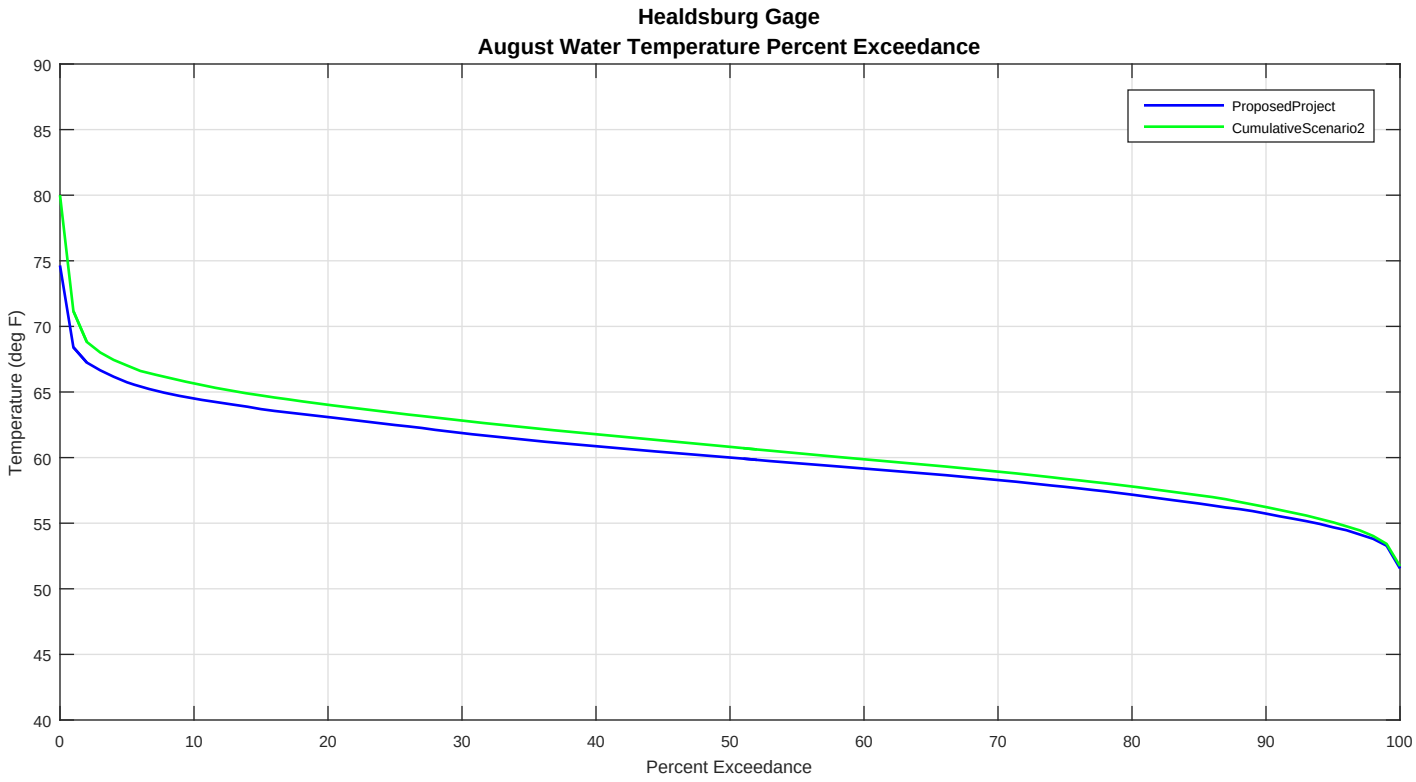
Healdsburg Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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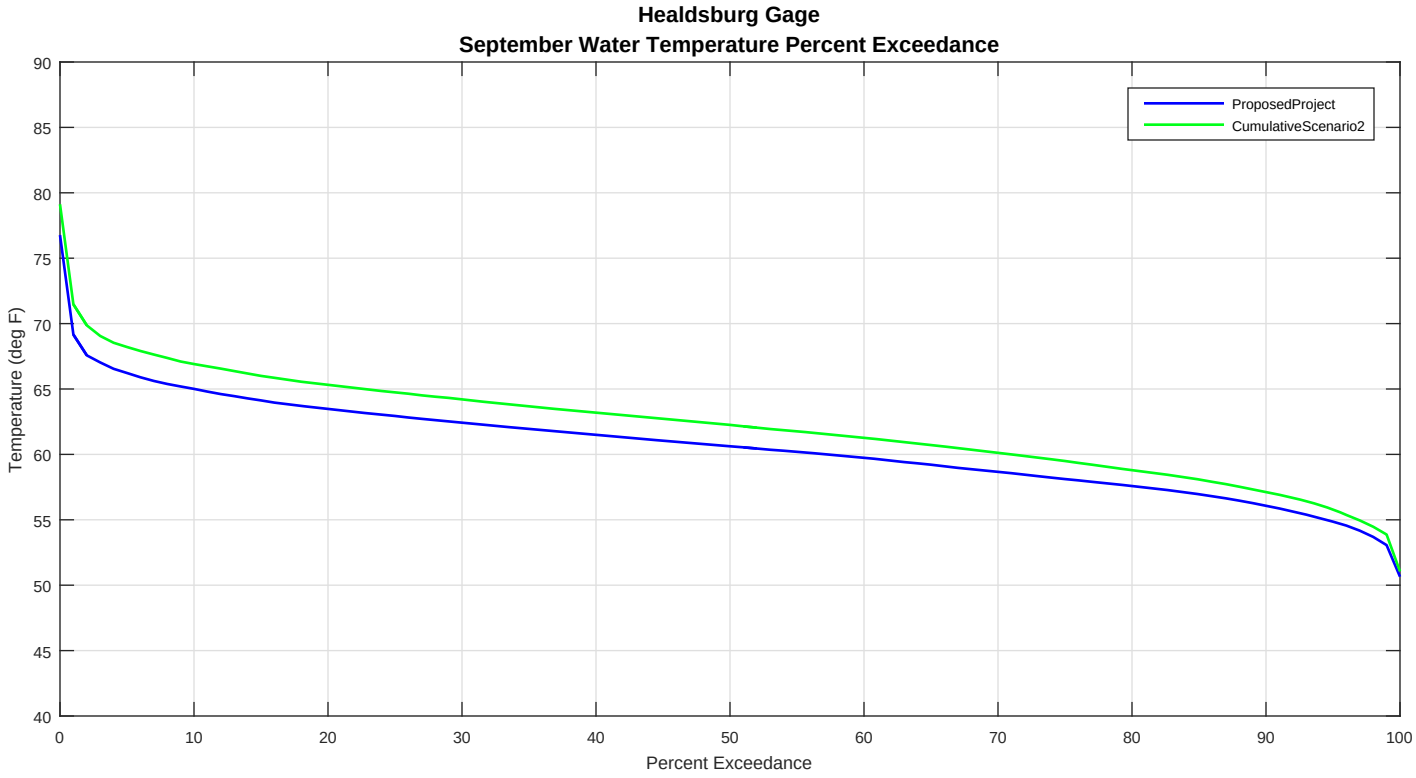
Healdsburg Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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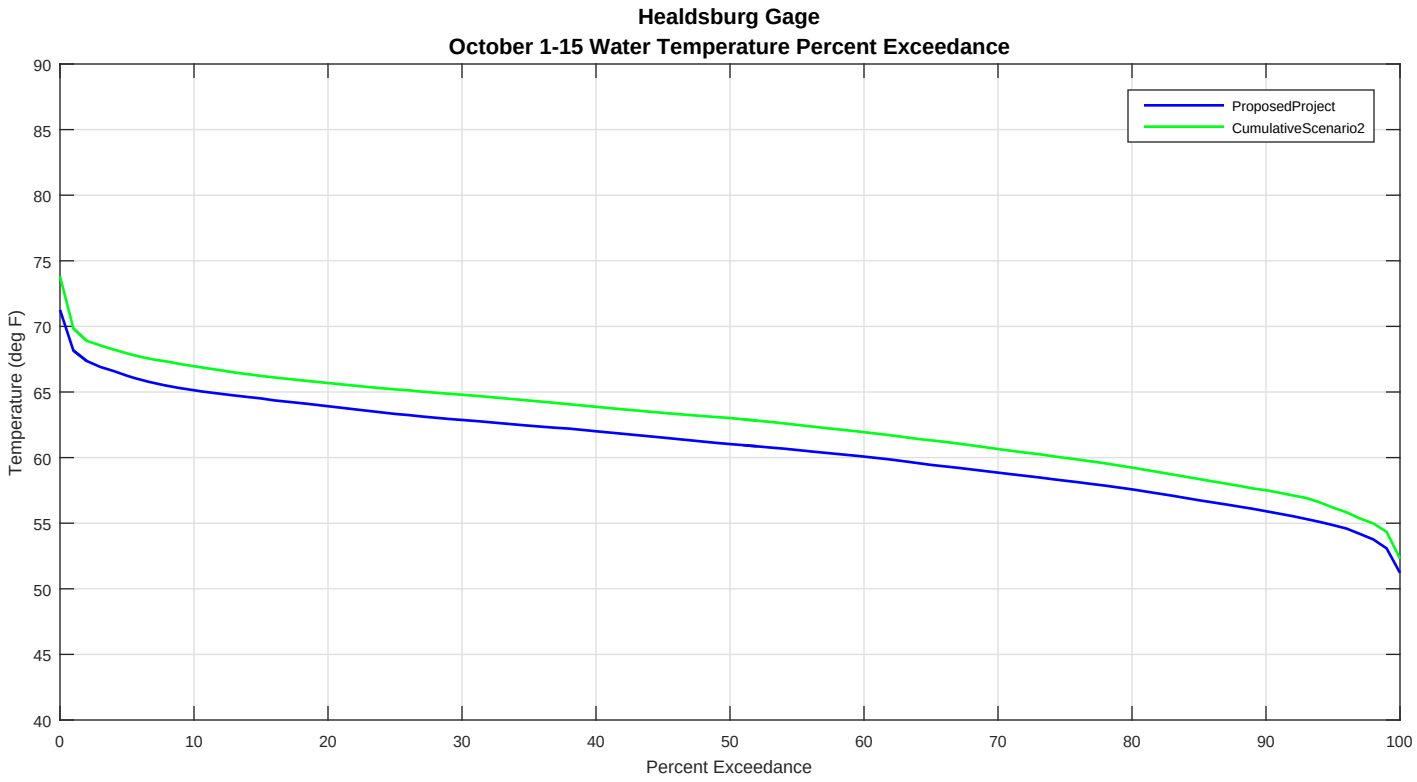
Healdsburg Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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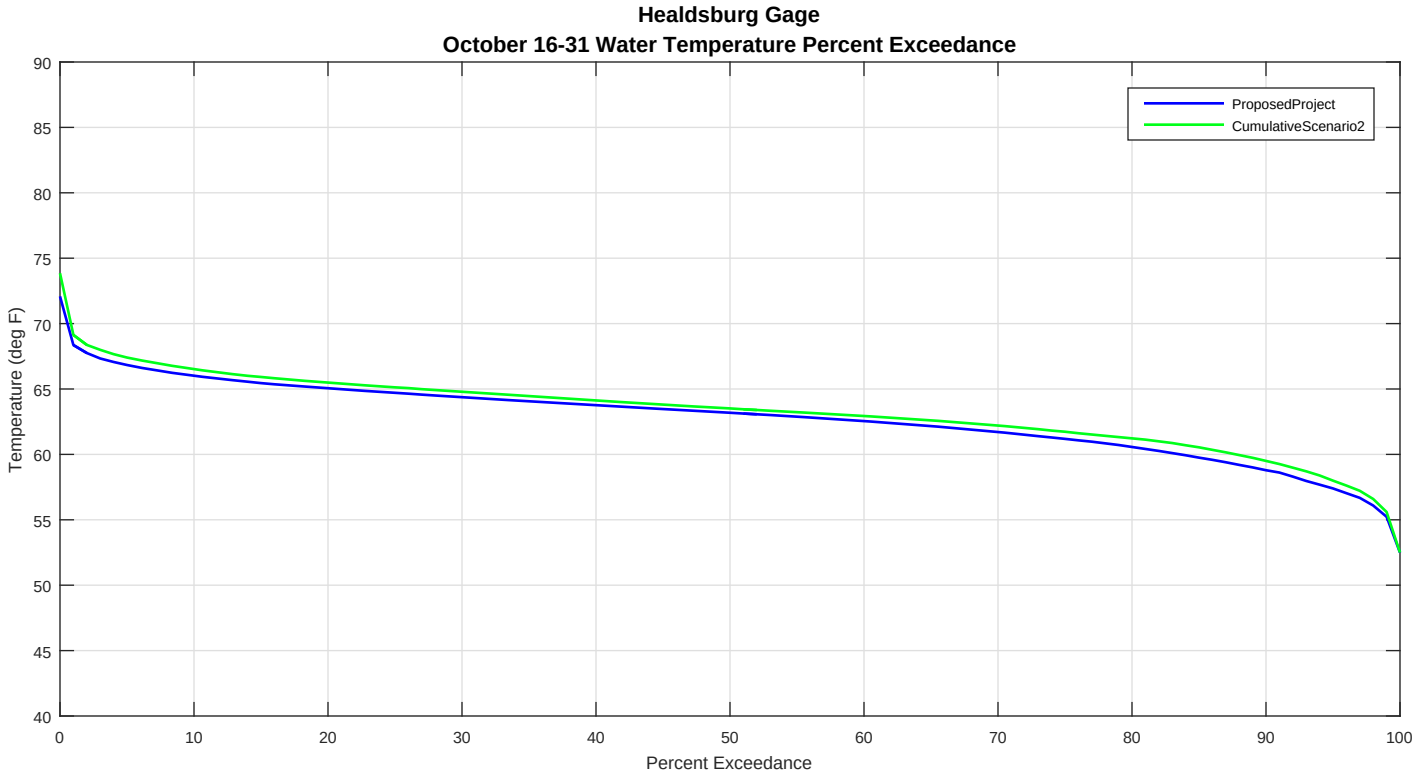
Healdsburg Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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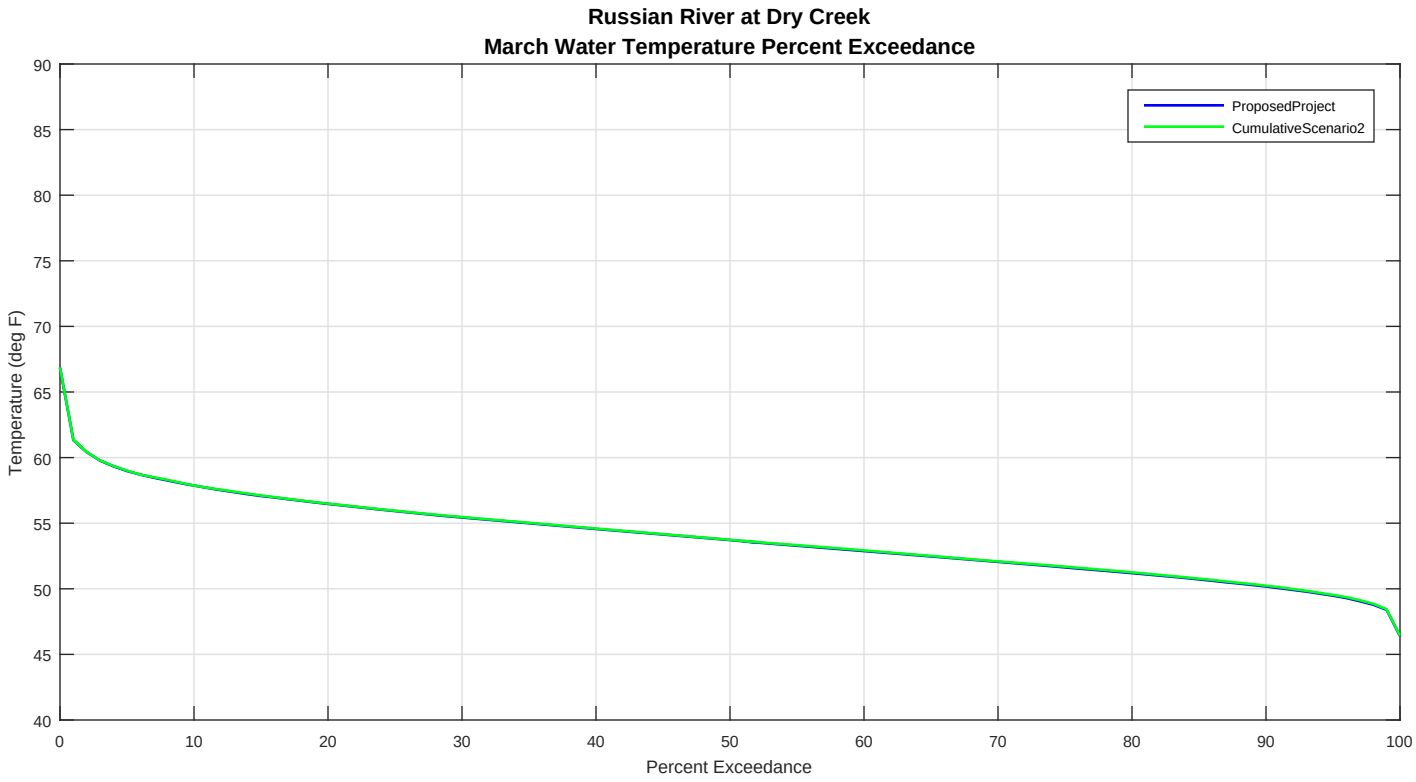
Russian River at Dry Creek
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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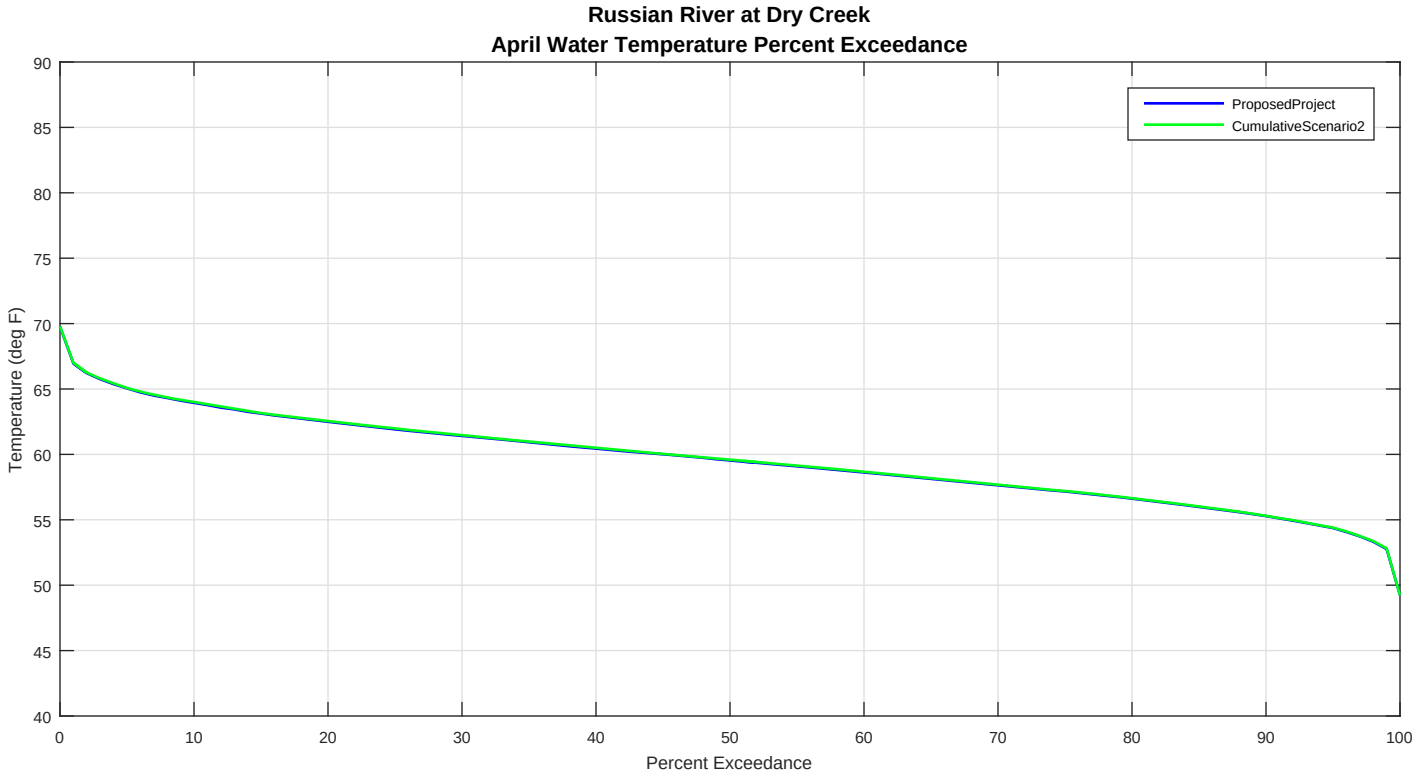
Russian River at Dry Creek
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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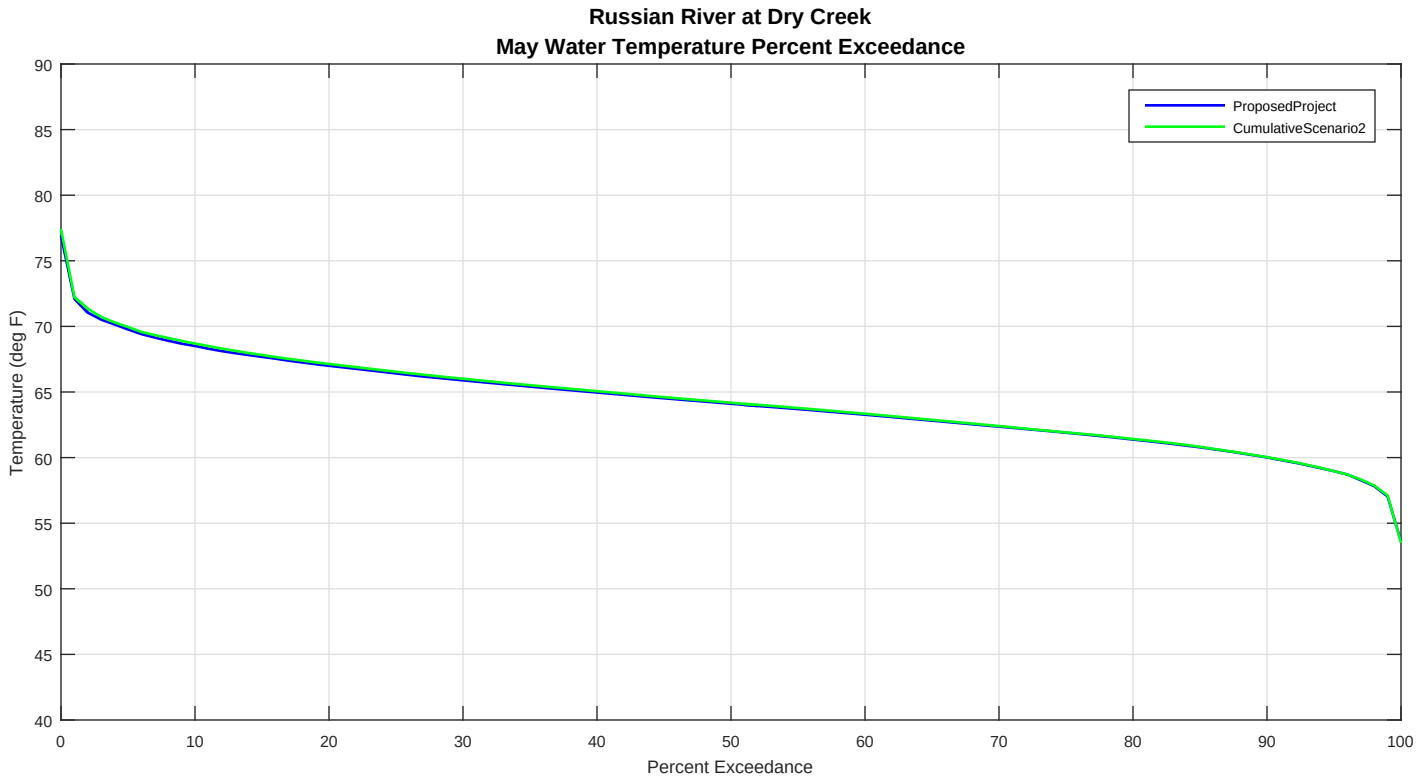
Russian River at Dry Creek
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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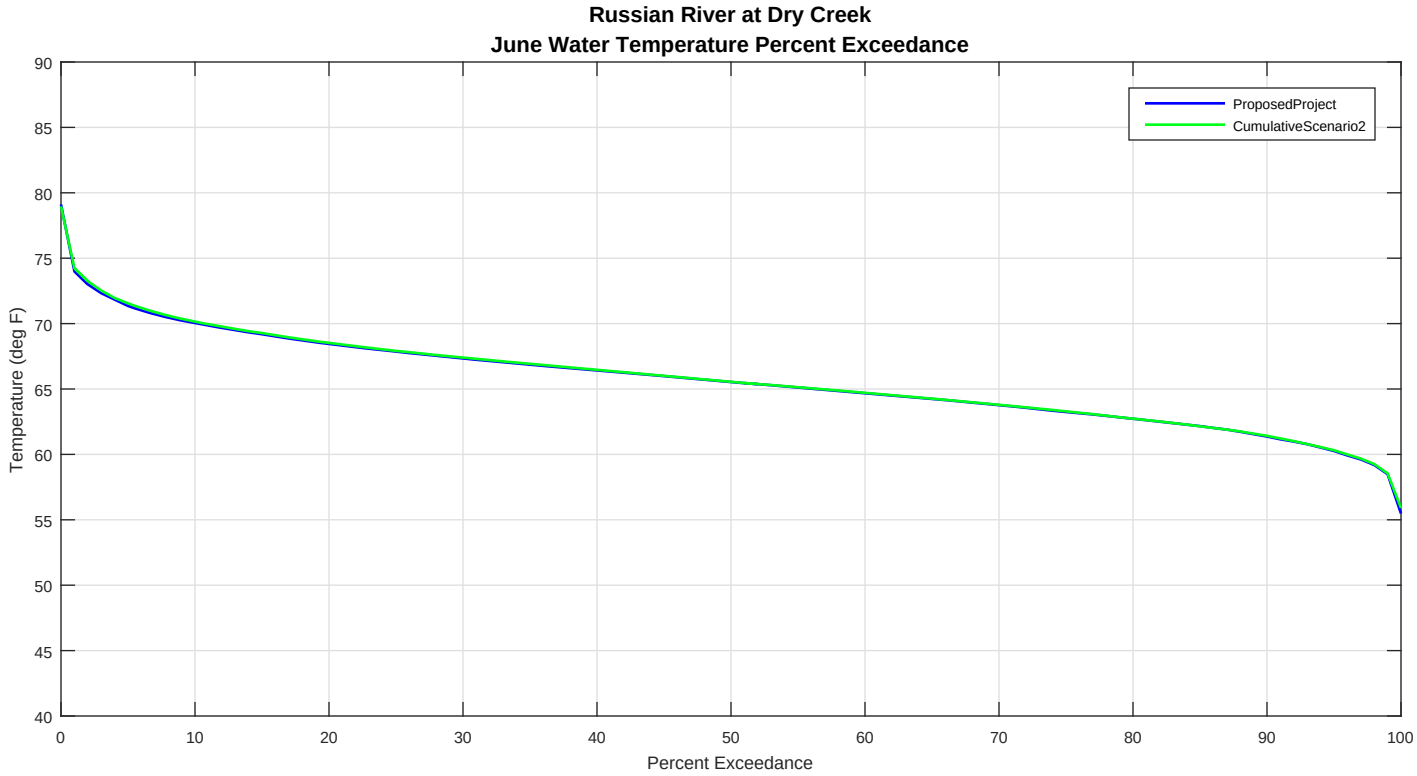
Russian River at Dry Creek
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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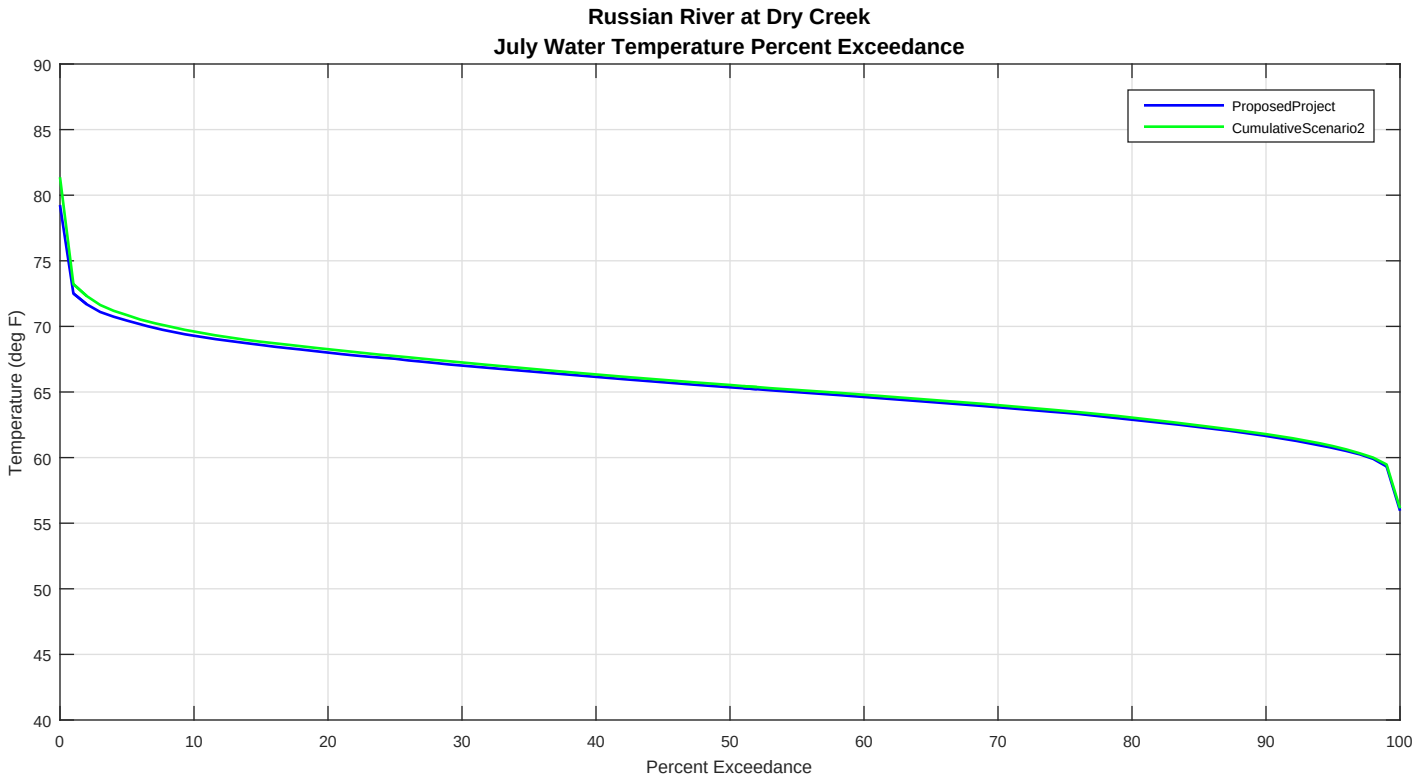
Russian River at Dry Creek
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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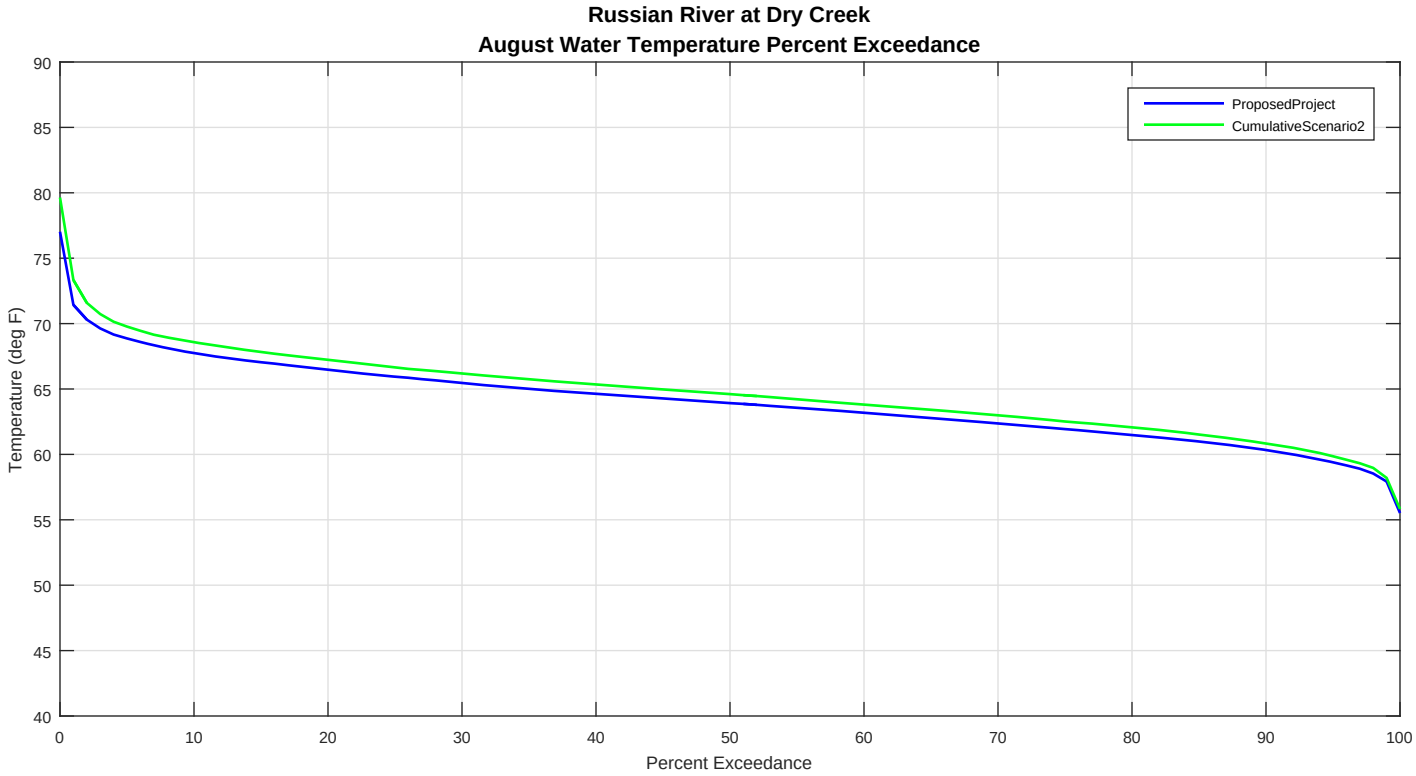
Russian River at Dry Creek
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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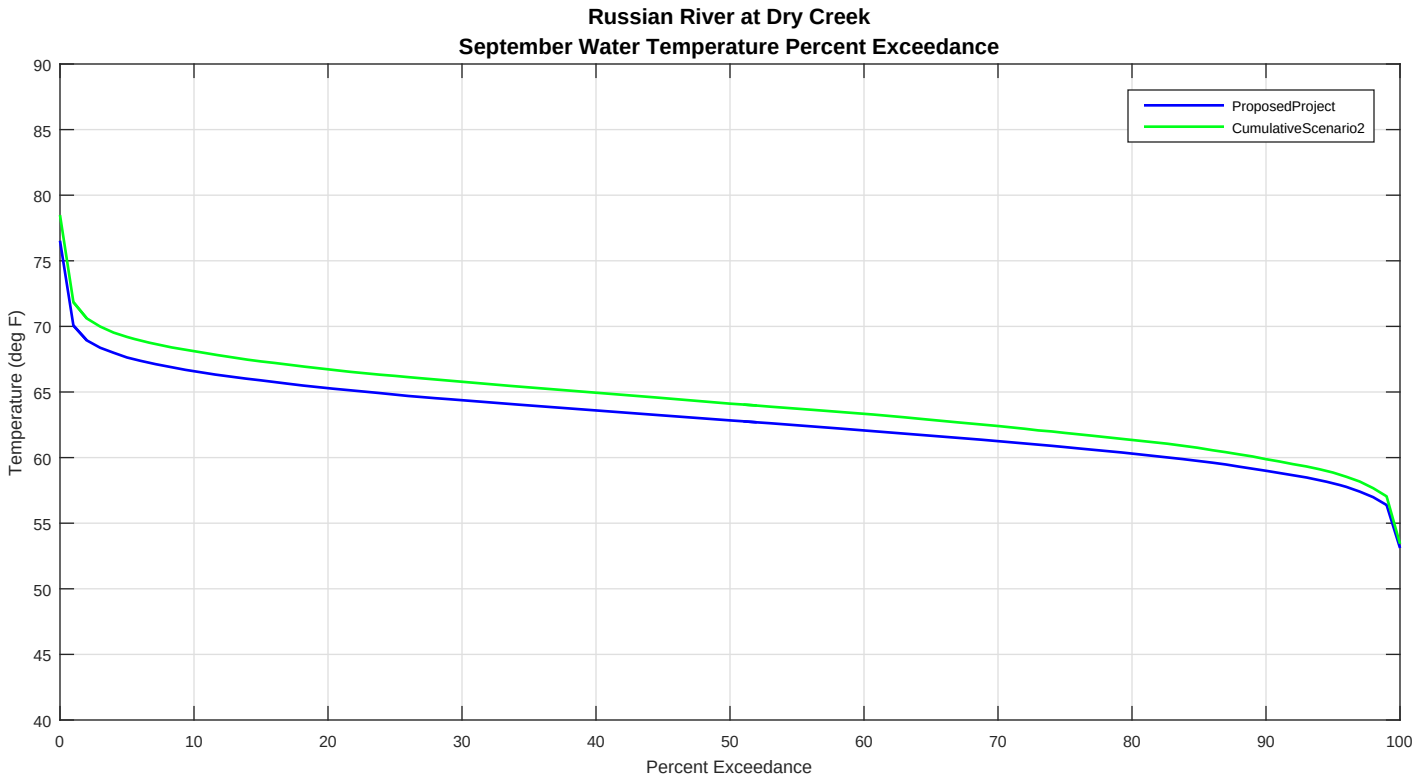
Russian River at Dry Creek
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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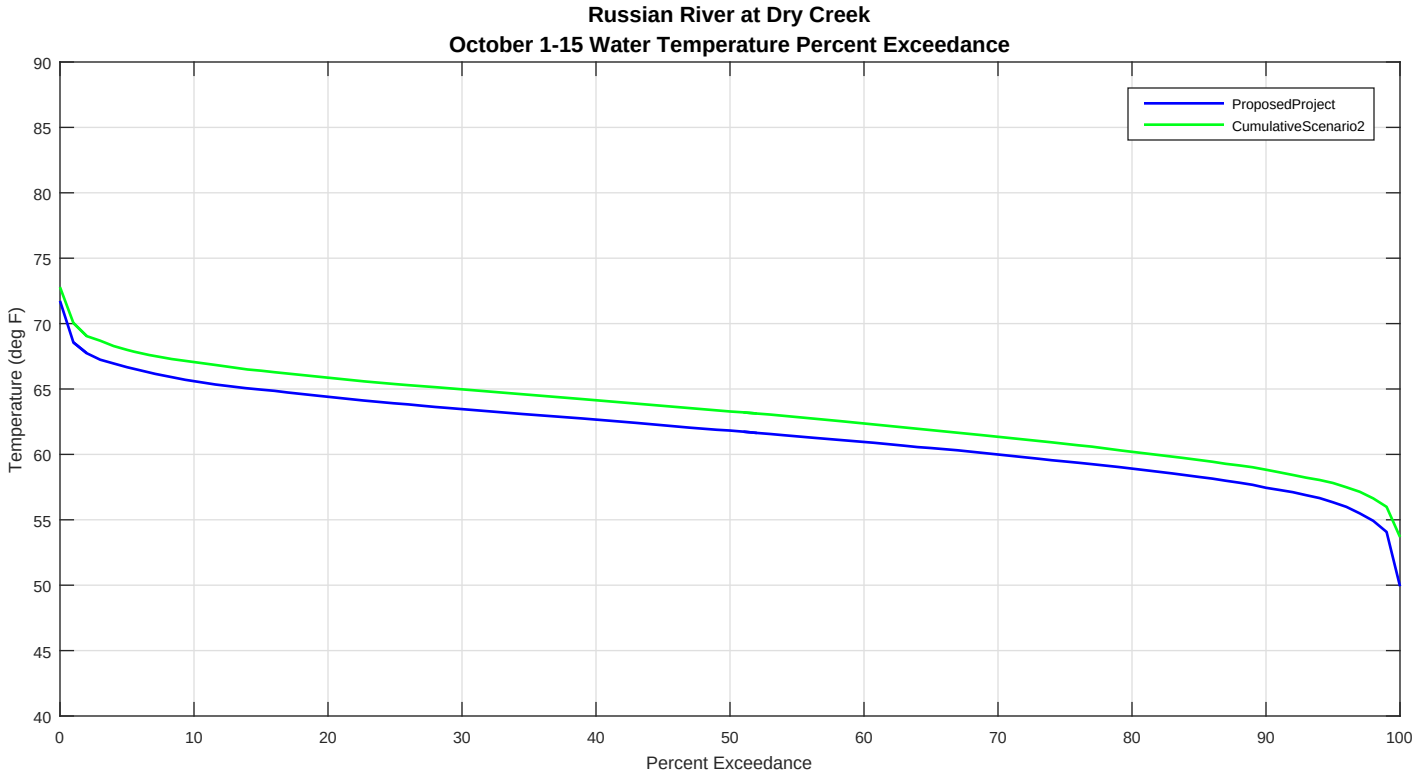
Russian River at Dry Creek
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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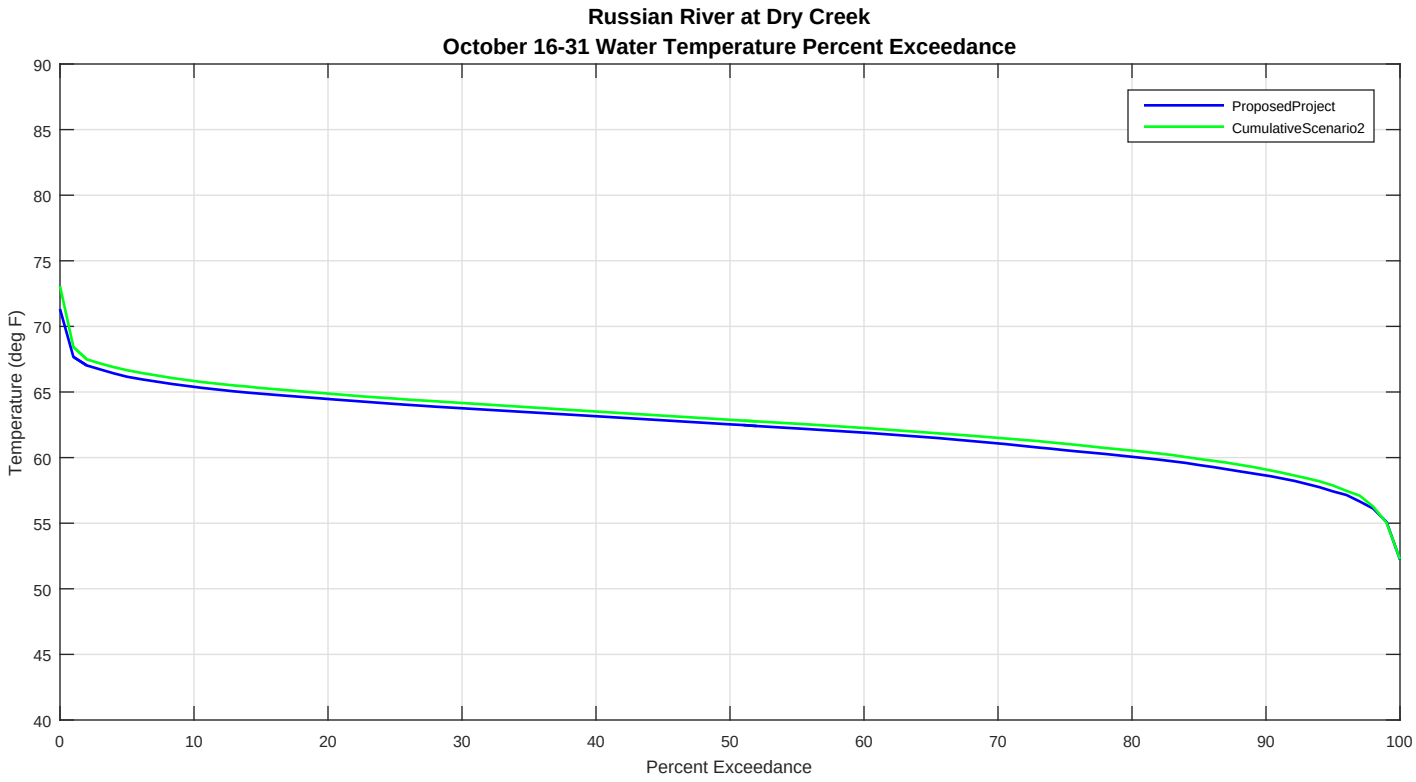
Russian River at Dry Creek
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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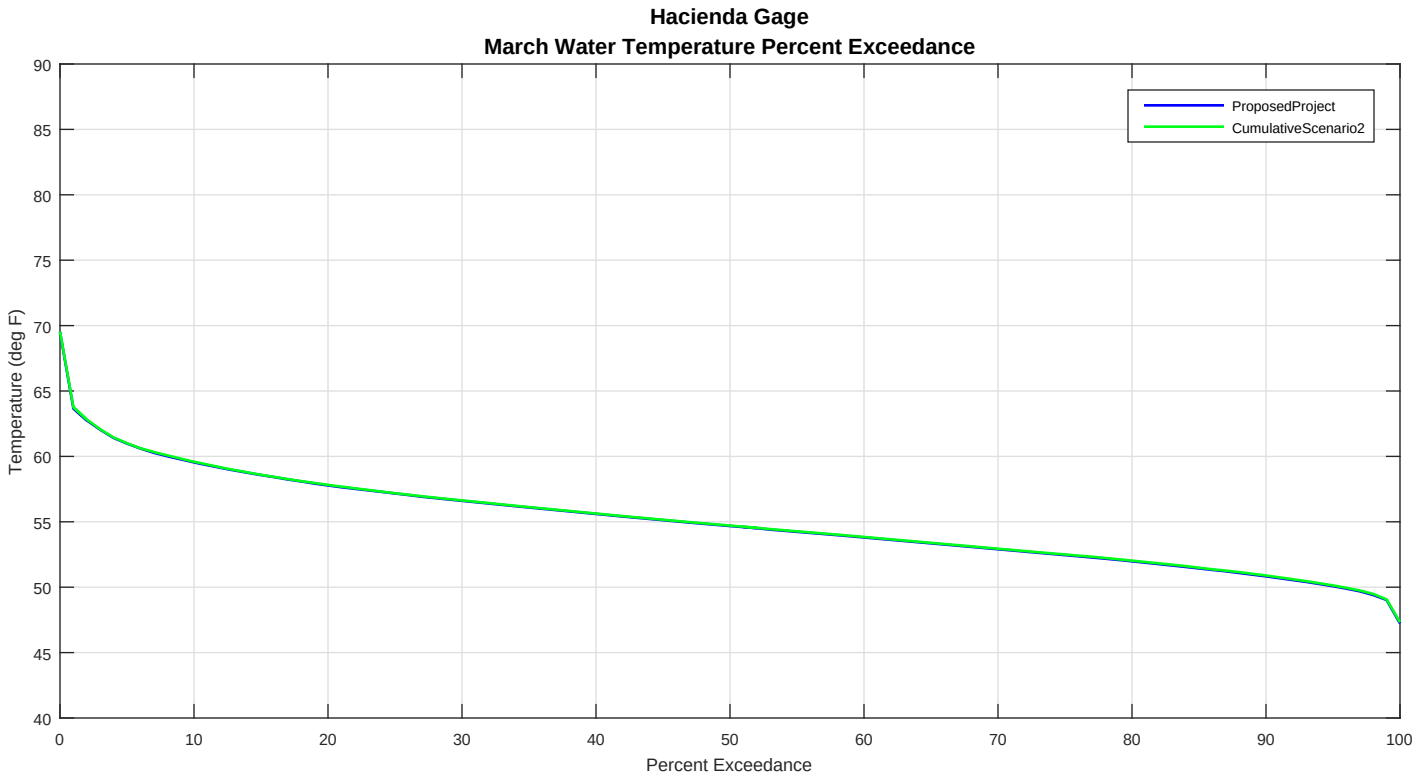
Hacienda Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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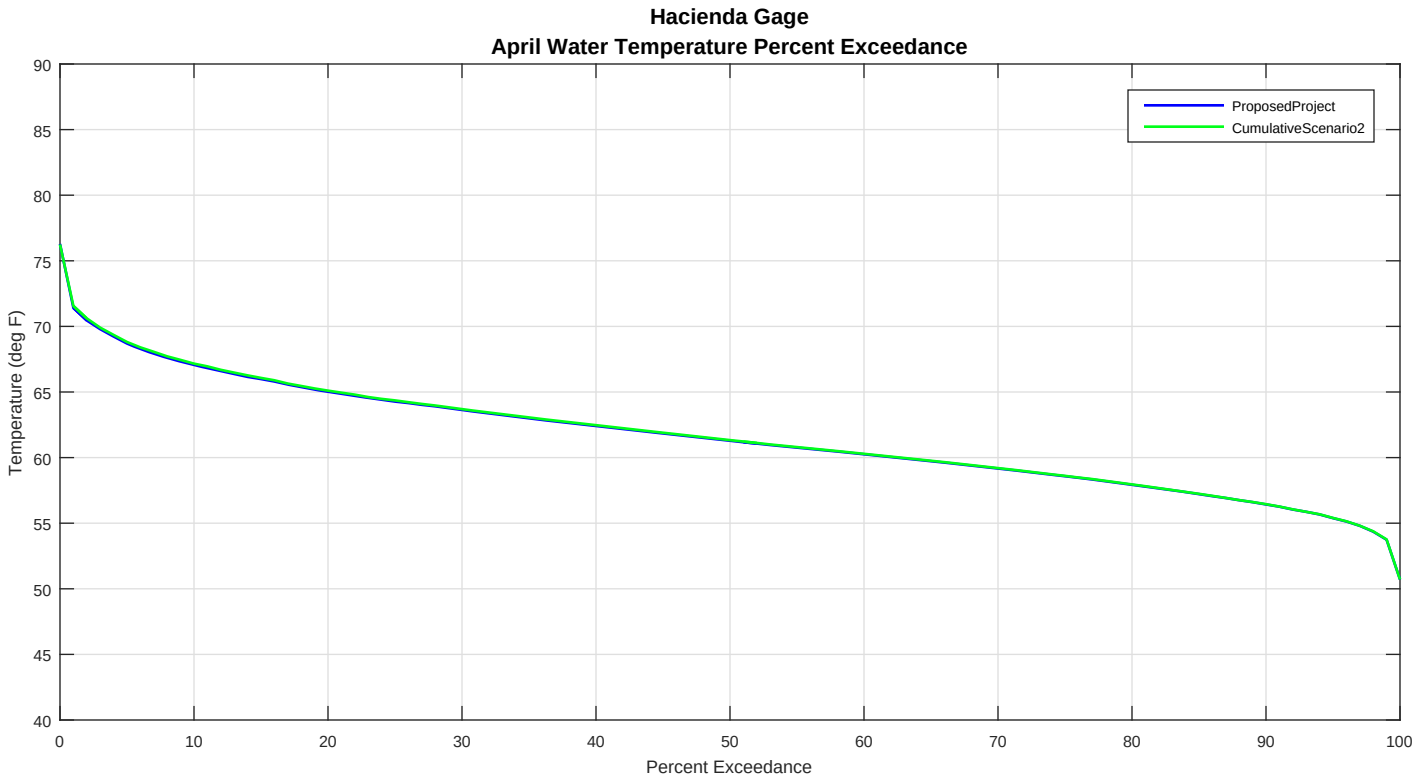
Hacienda Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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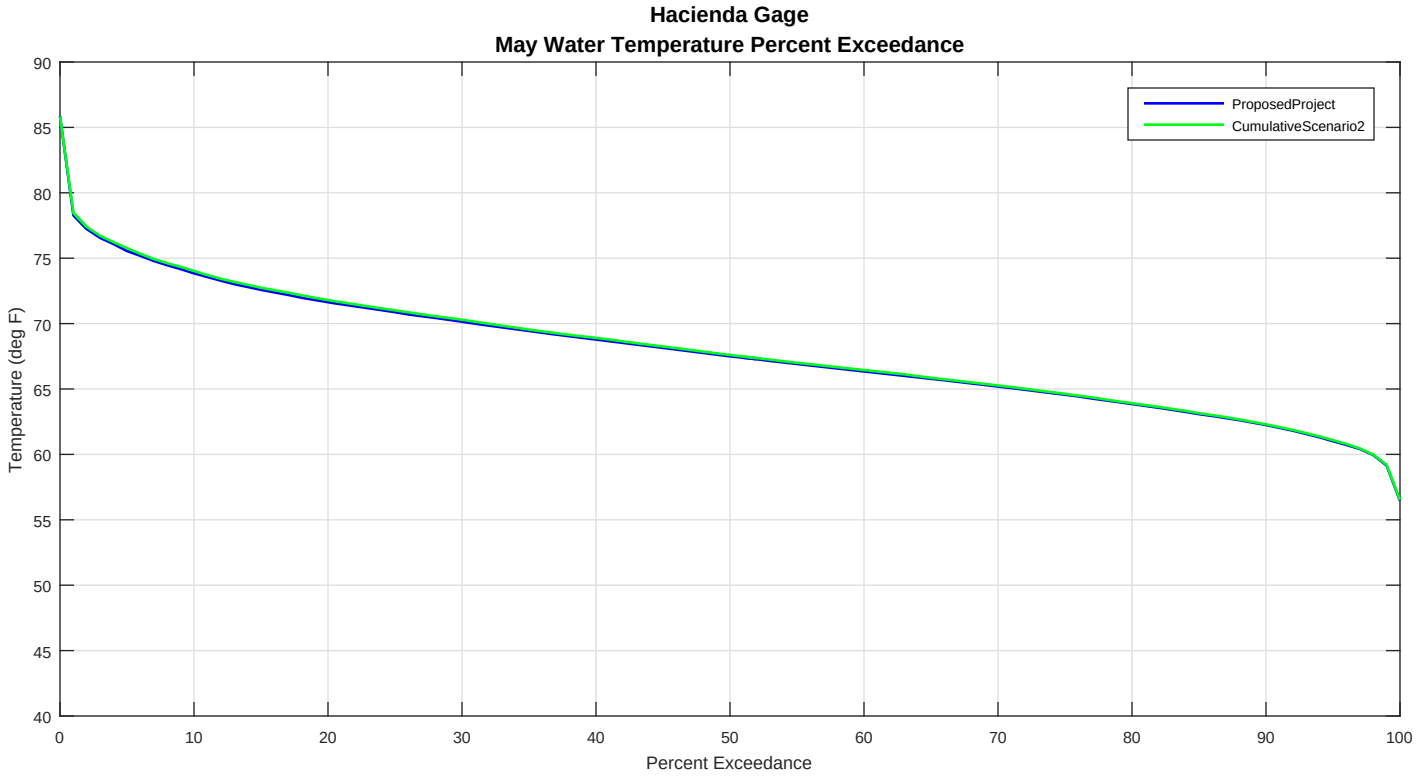
Hacienda Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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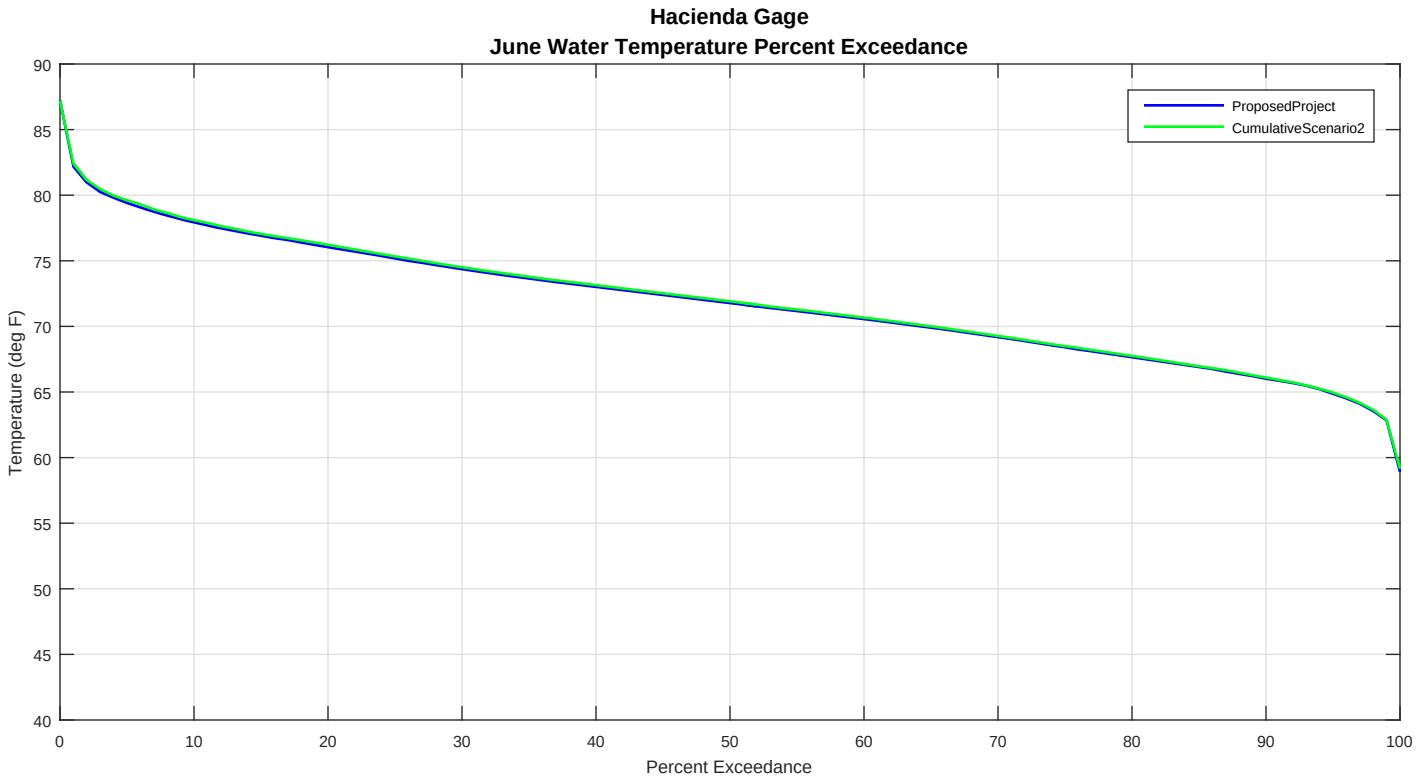
Hacienda Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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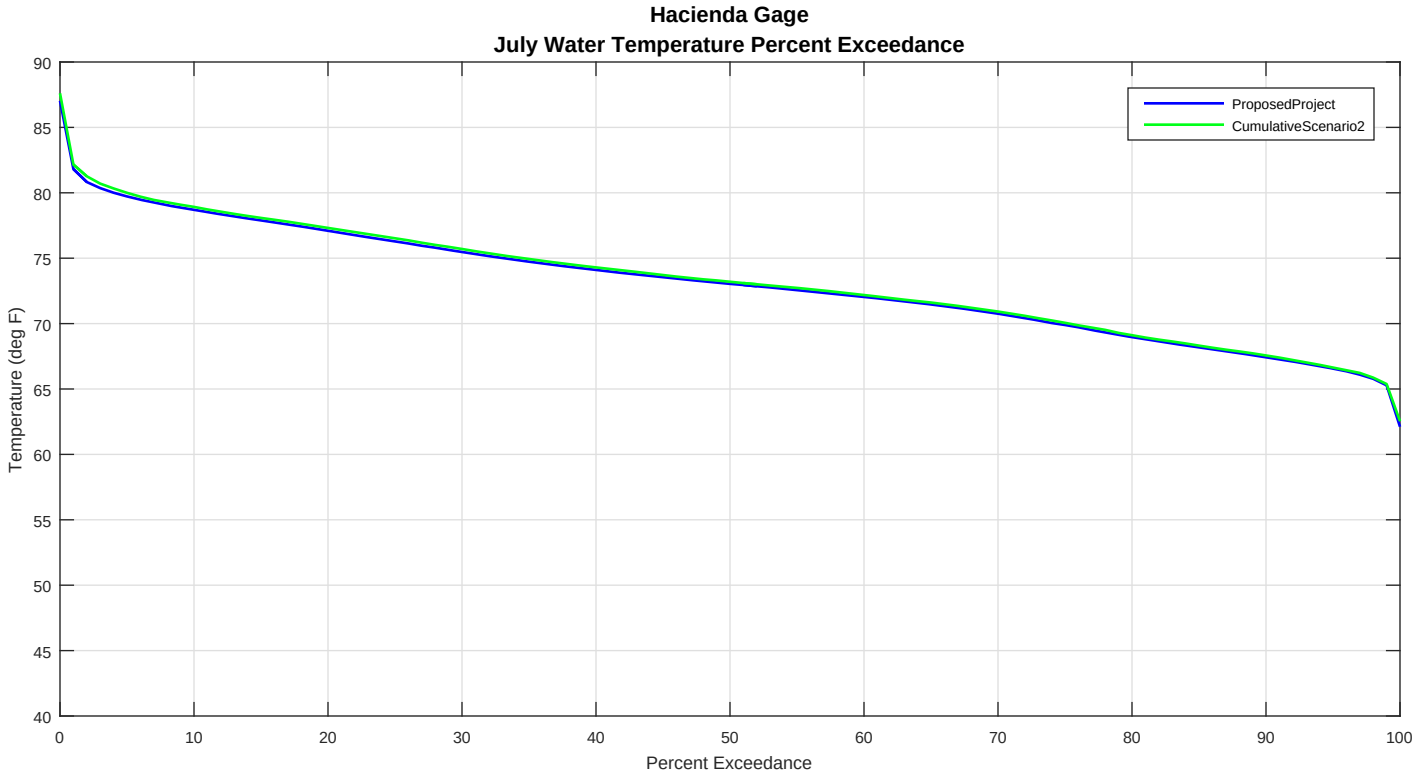
Hacienda Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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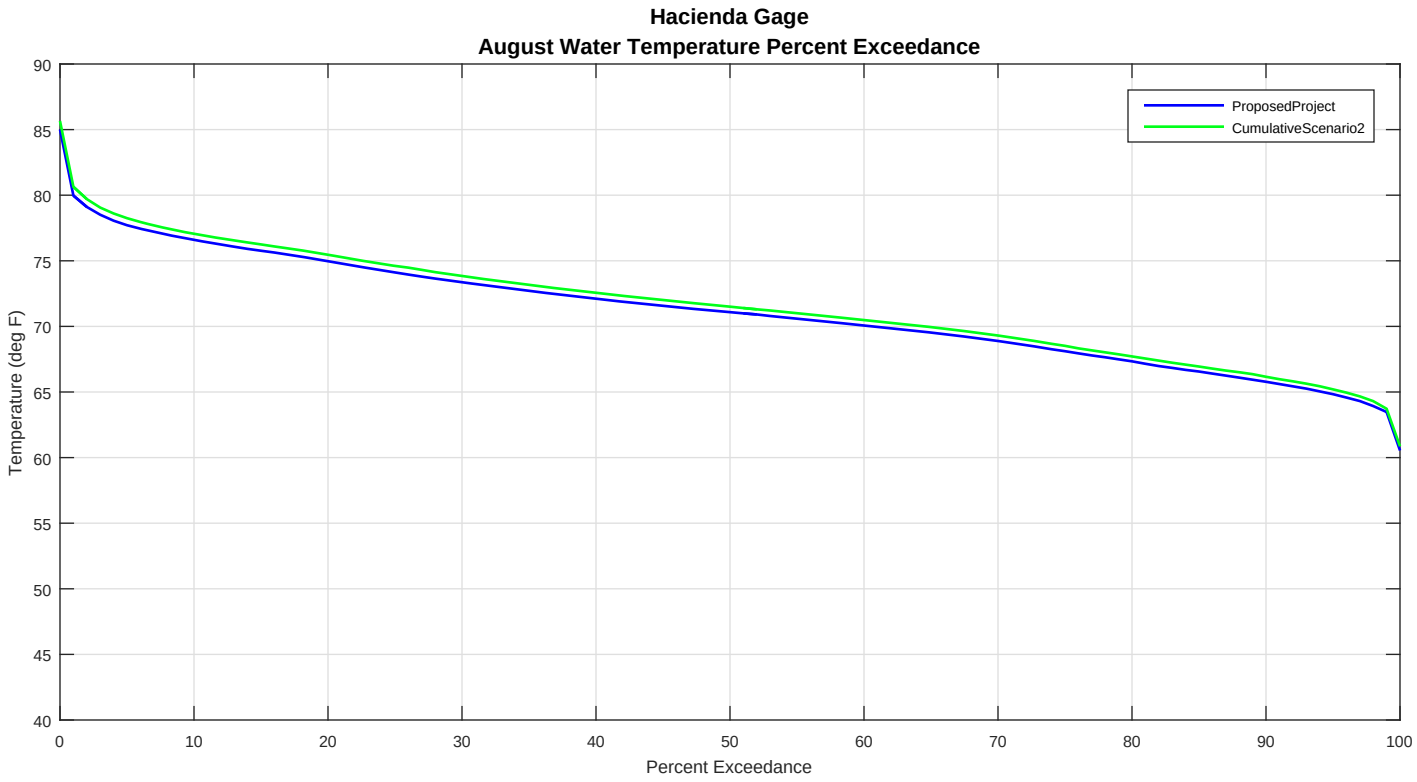
Hacienda Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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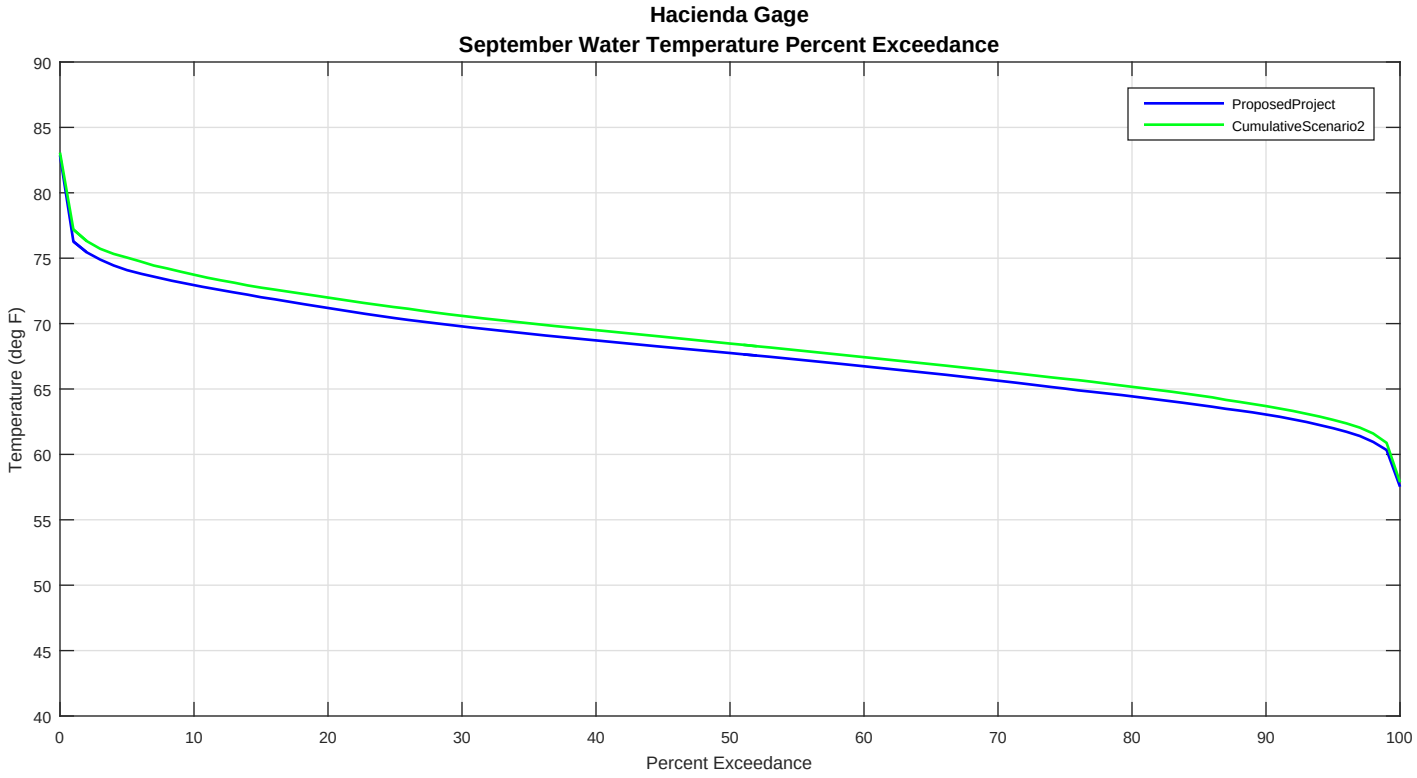
Hacienda Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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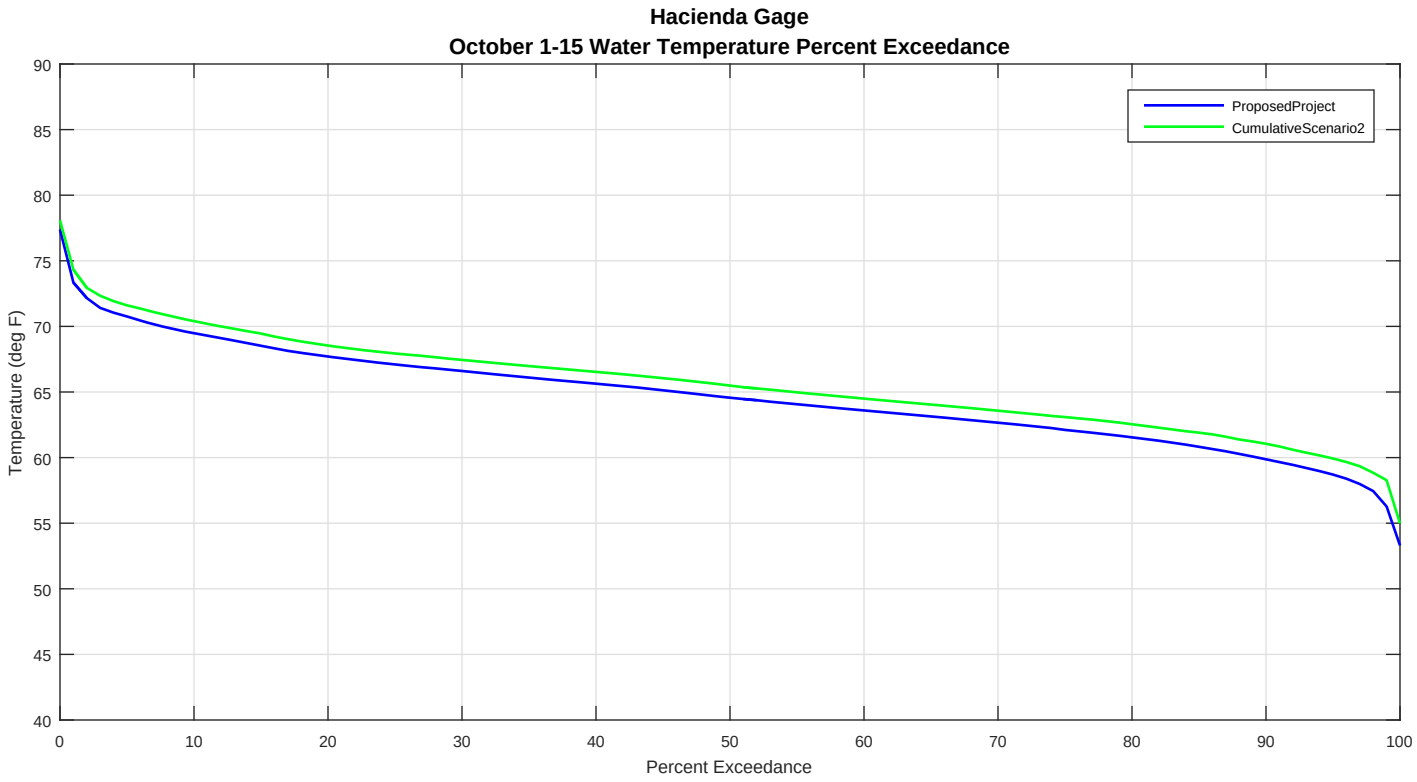
Hacienda Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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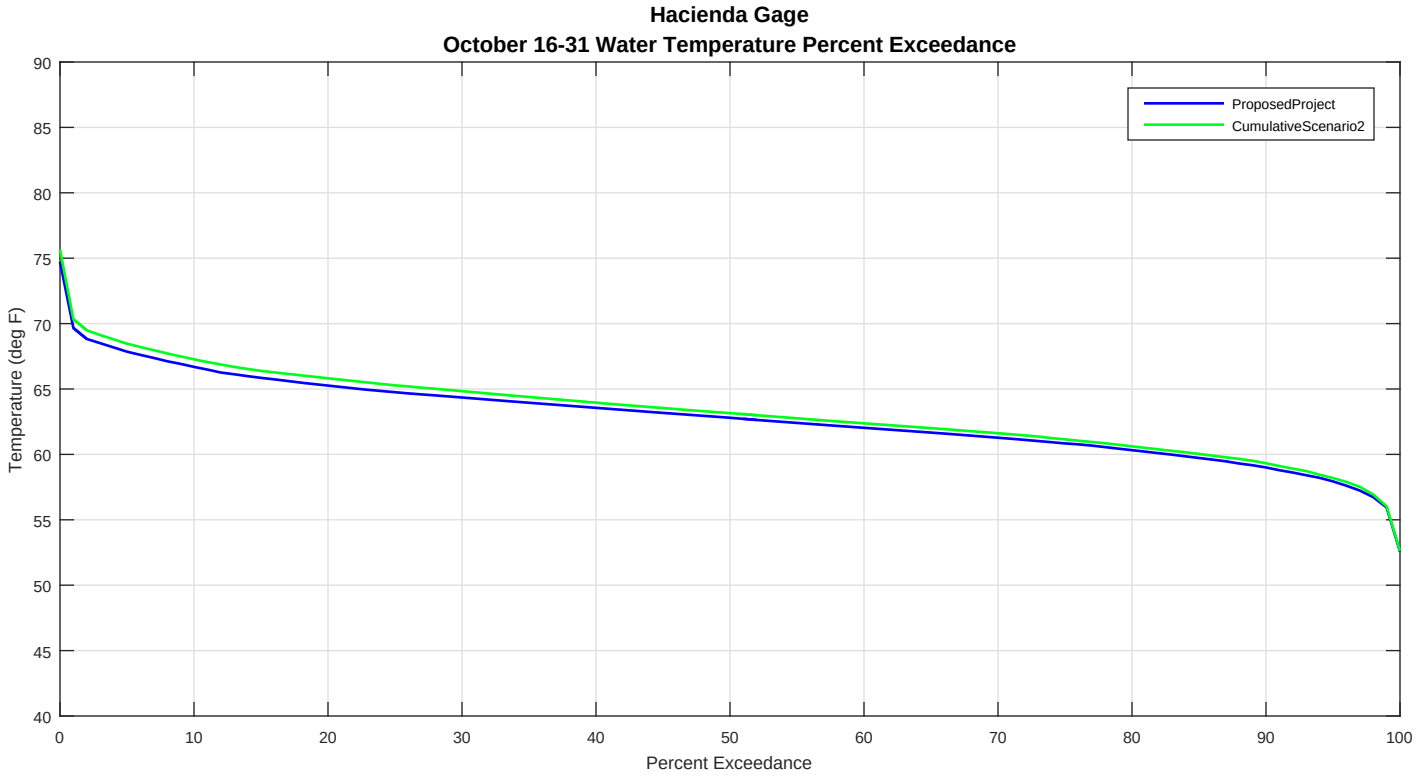
Hacienda Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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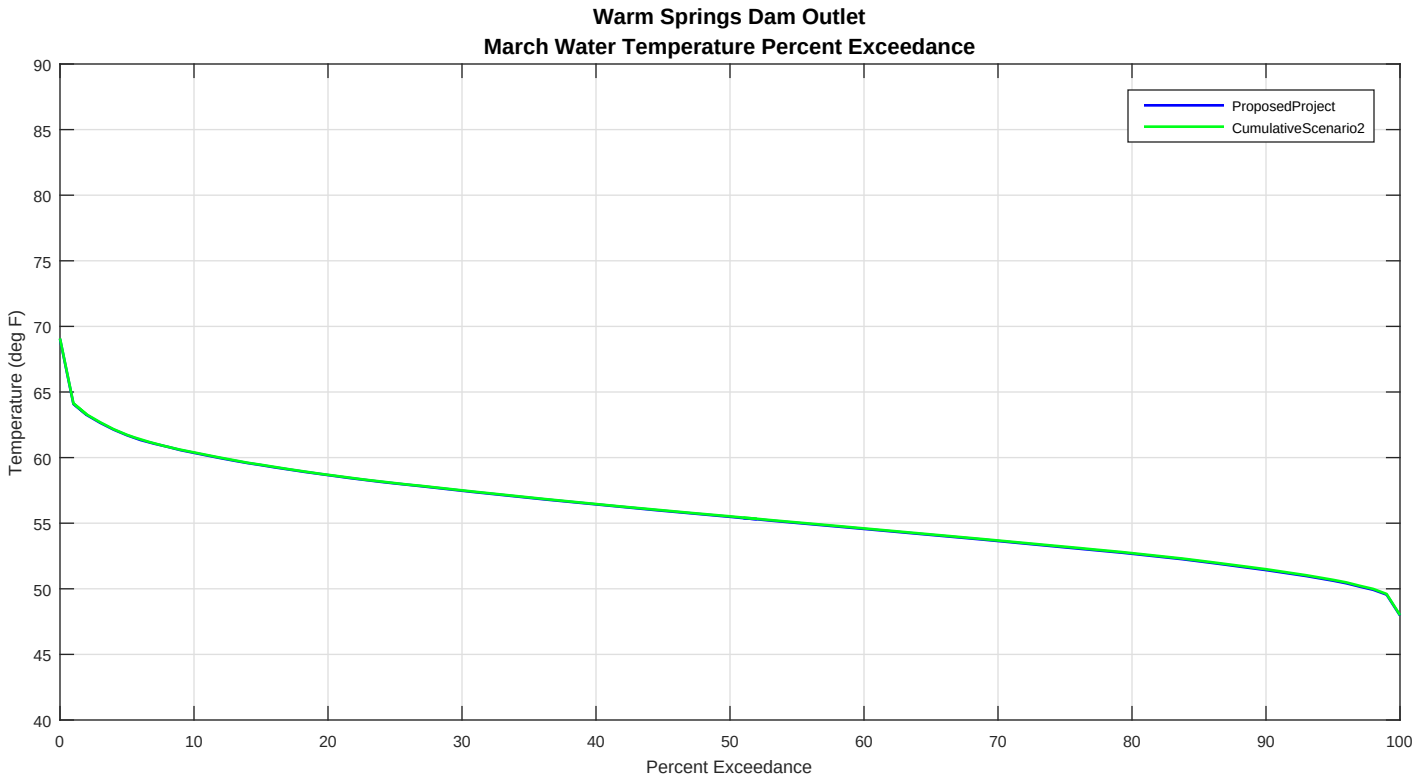
Warm Springs Dam Outlet
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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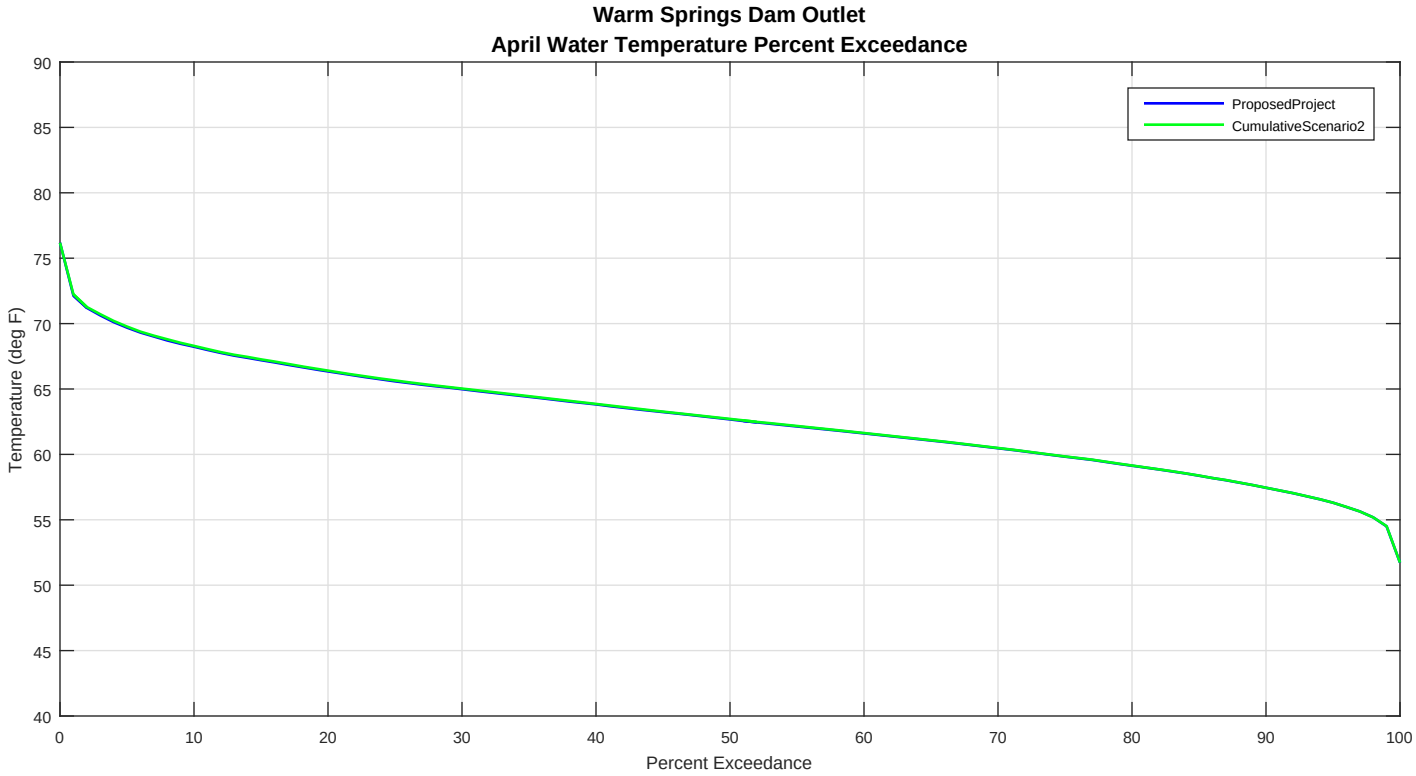
Warm Springs Dam Outlet
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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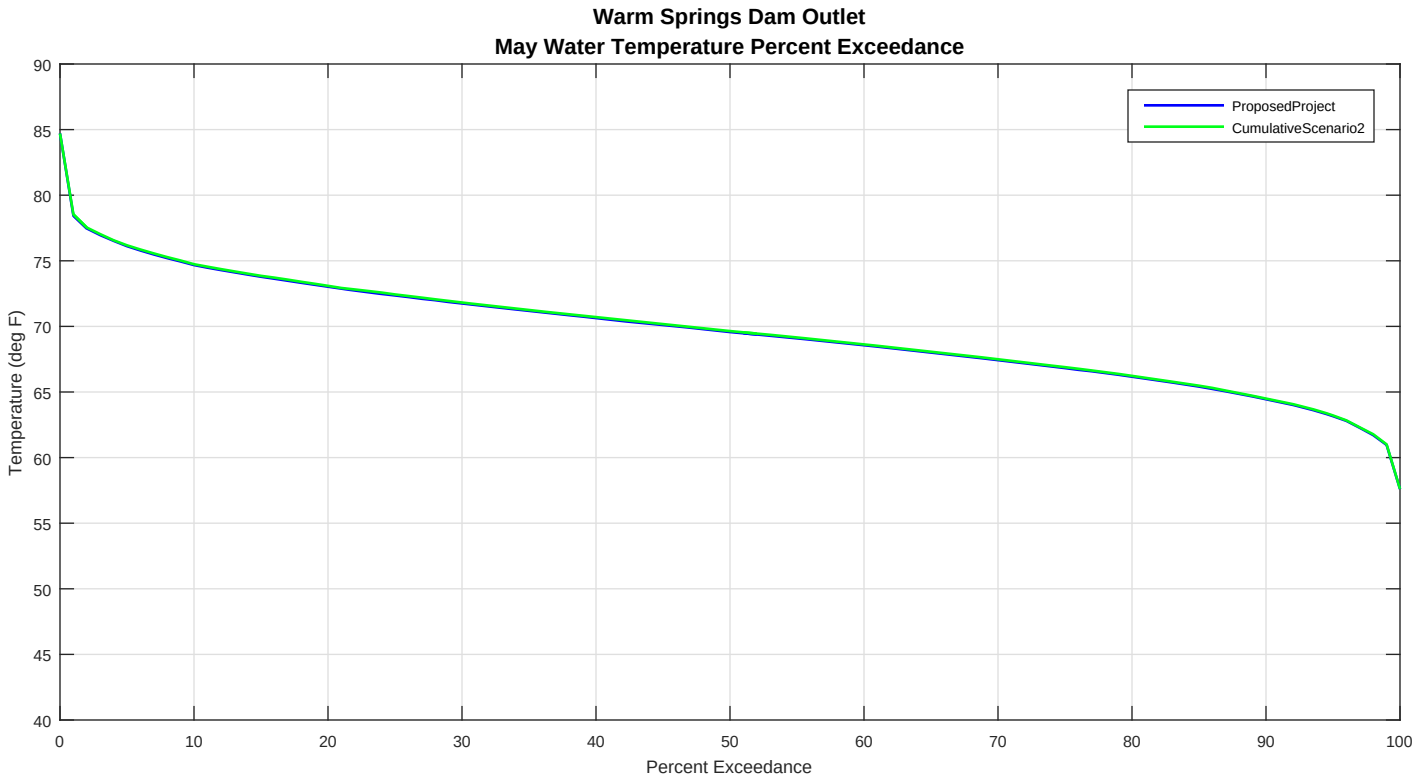
Warm Springs Dam Outlet
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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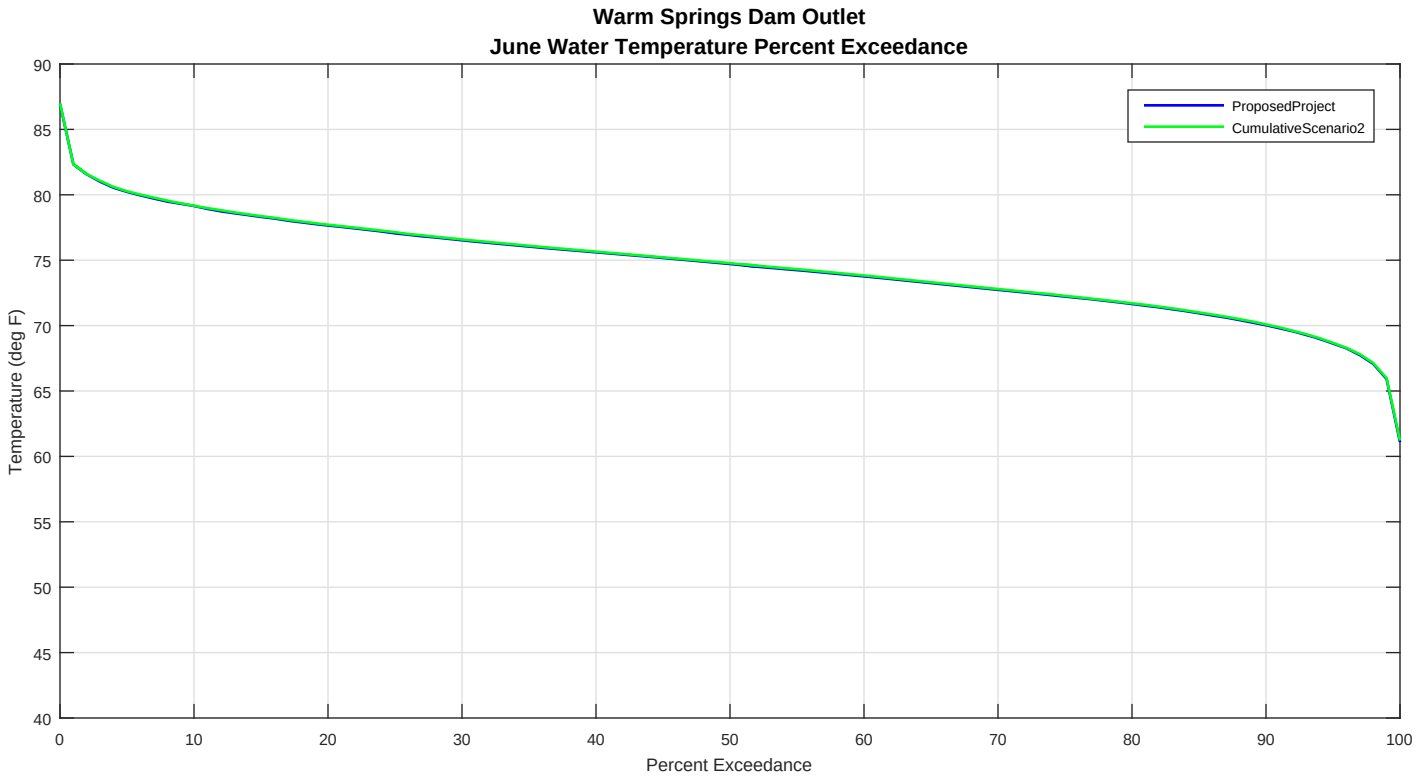
Warm Springs Dam Outlet
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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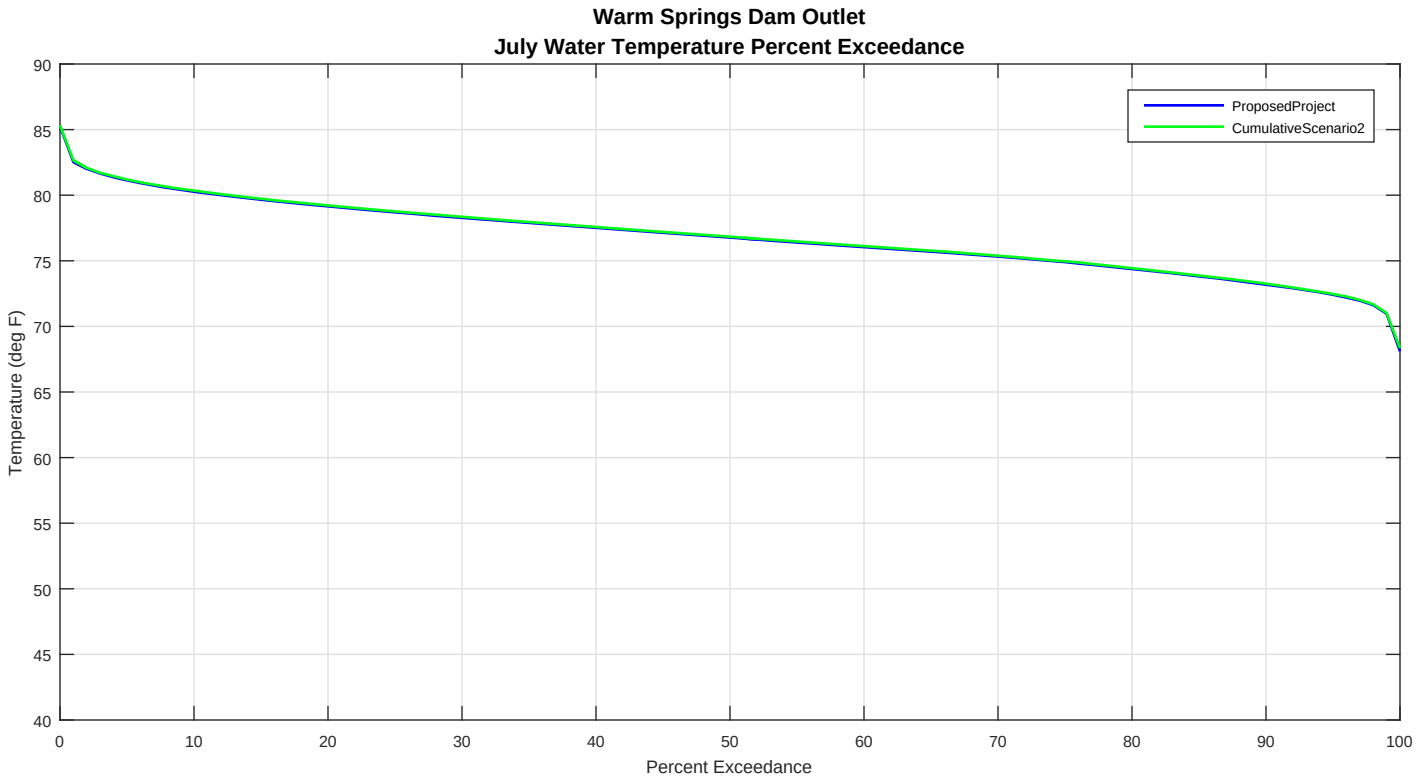
Warm Springs Dam Outlet
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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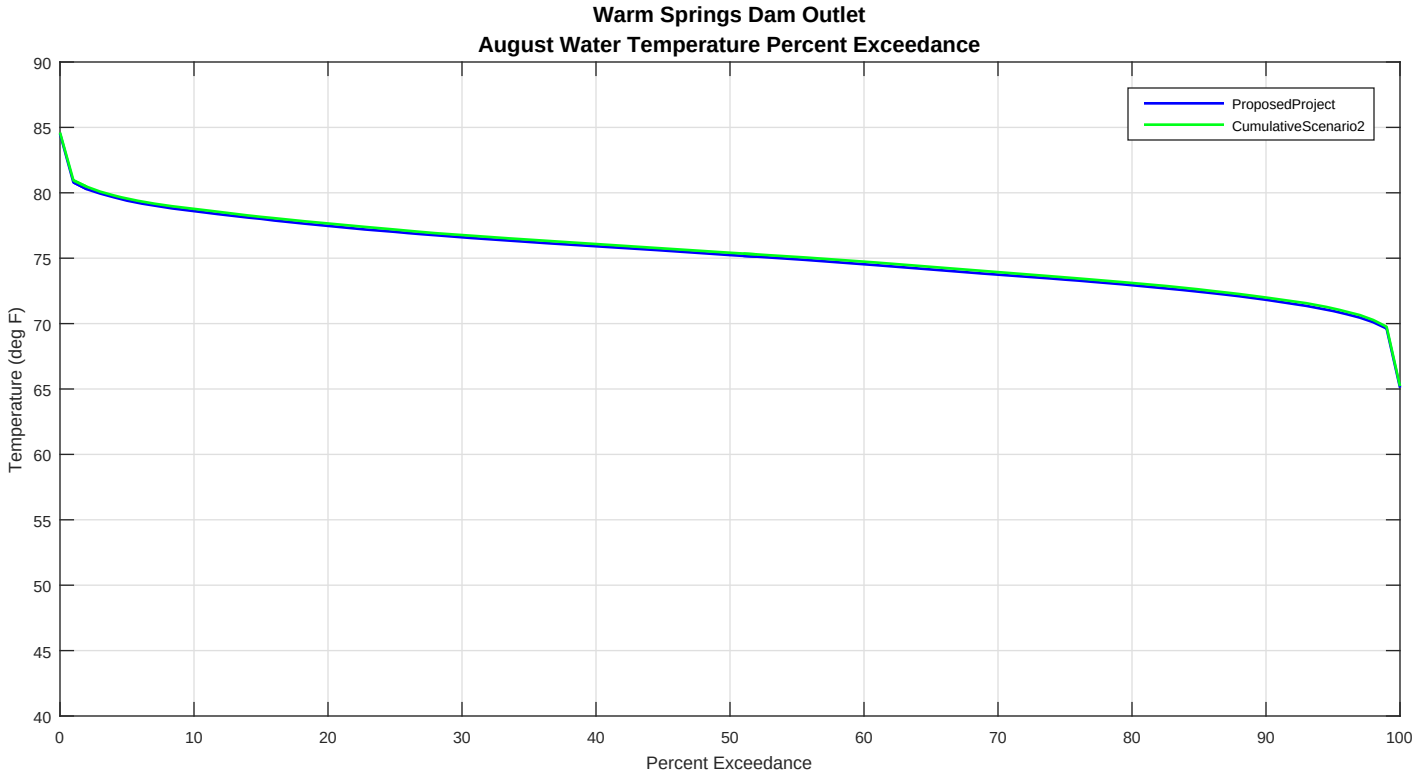
Warm Springs Dam Outlet
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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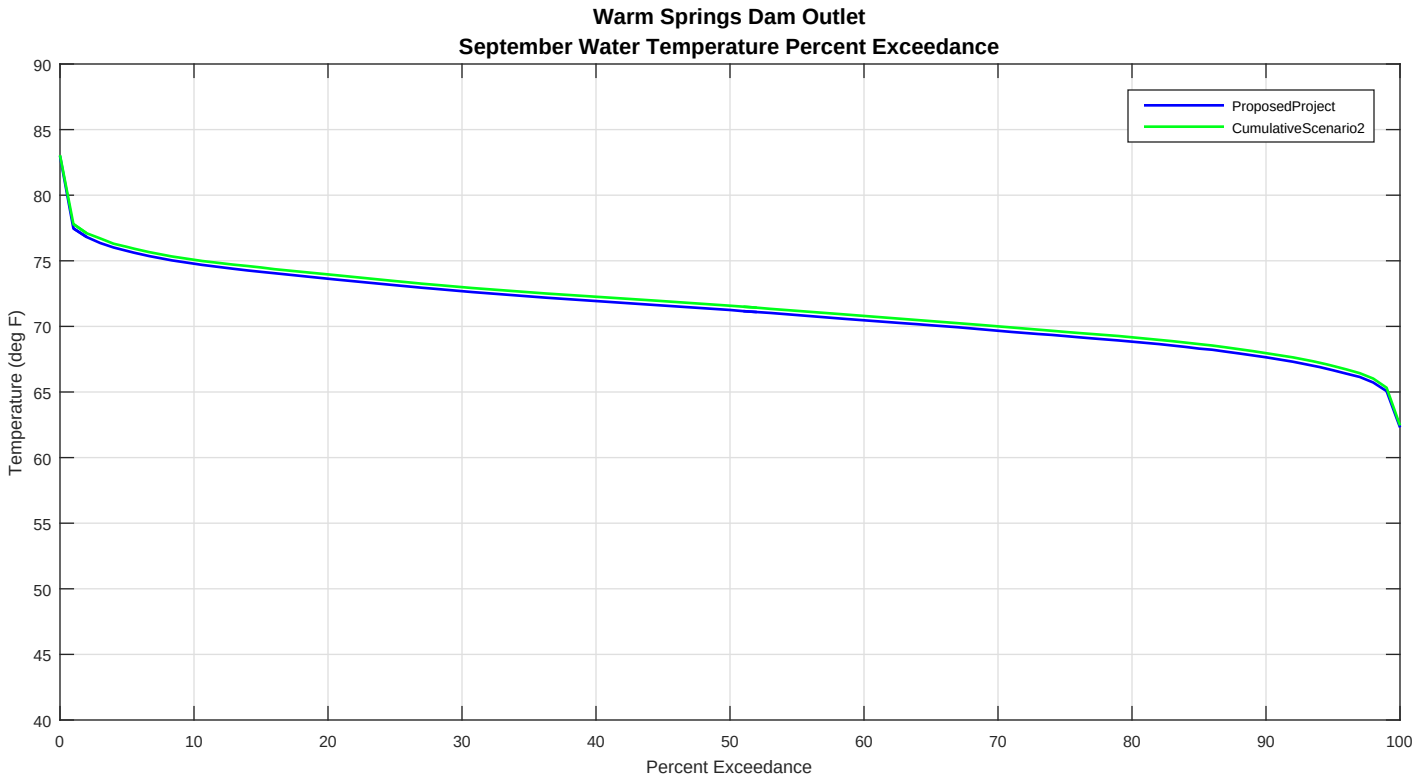
Warm Springs Dam Outlet
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
90
85
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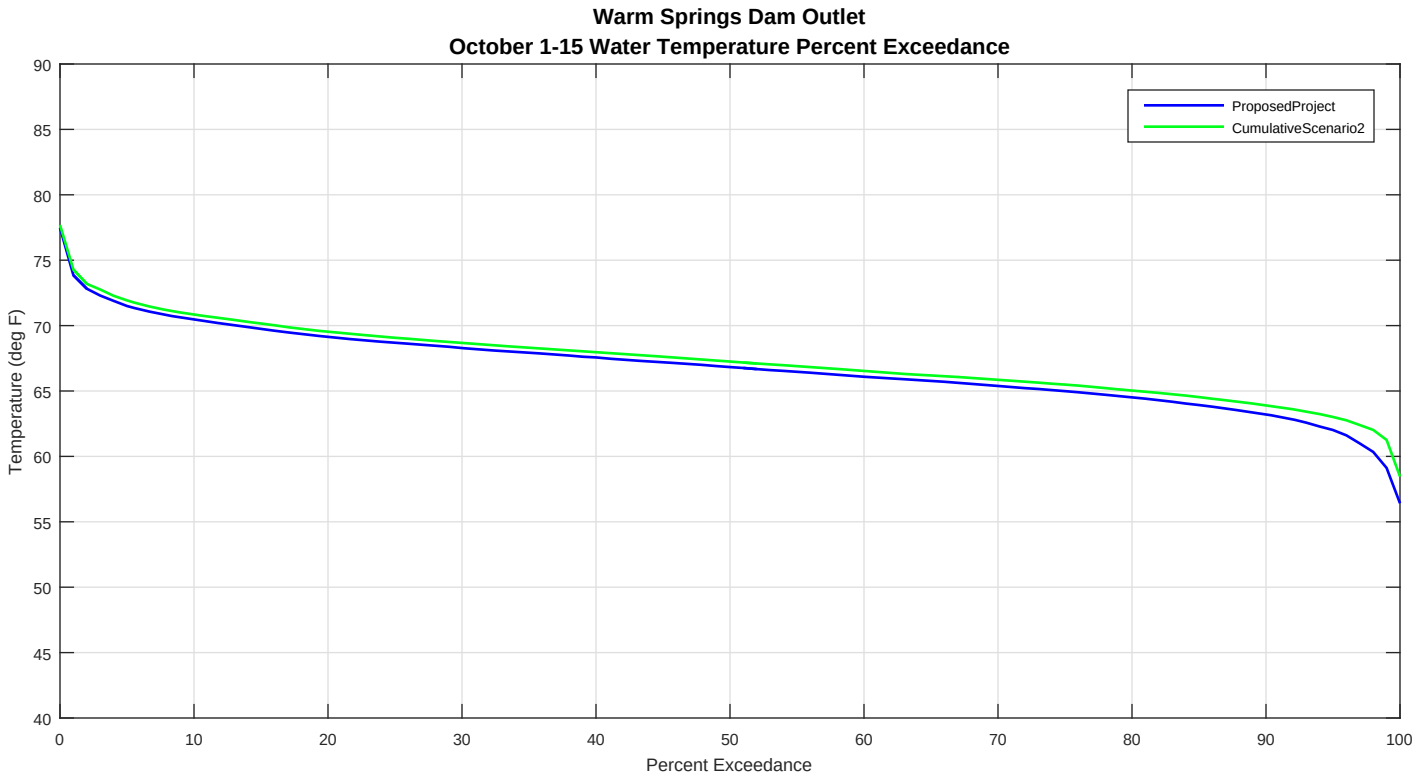
Warm Springs Dam Outlet
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
90
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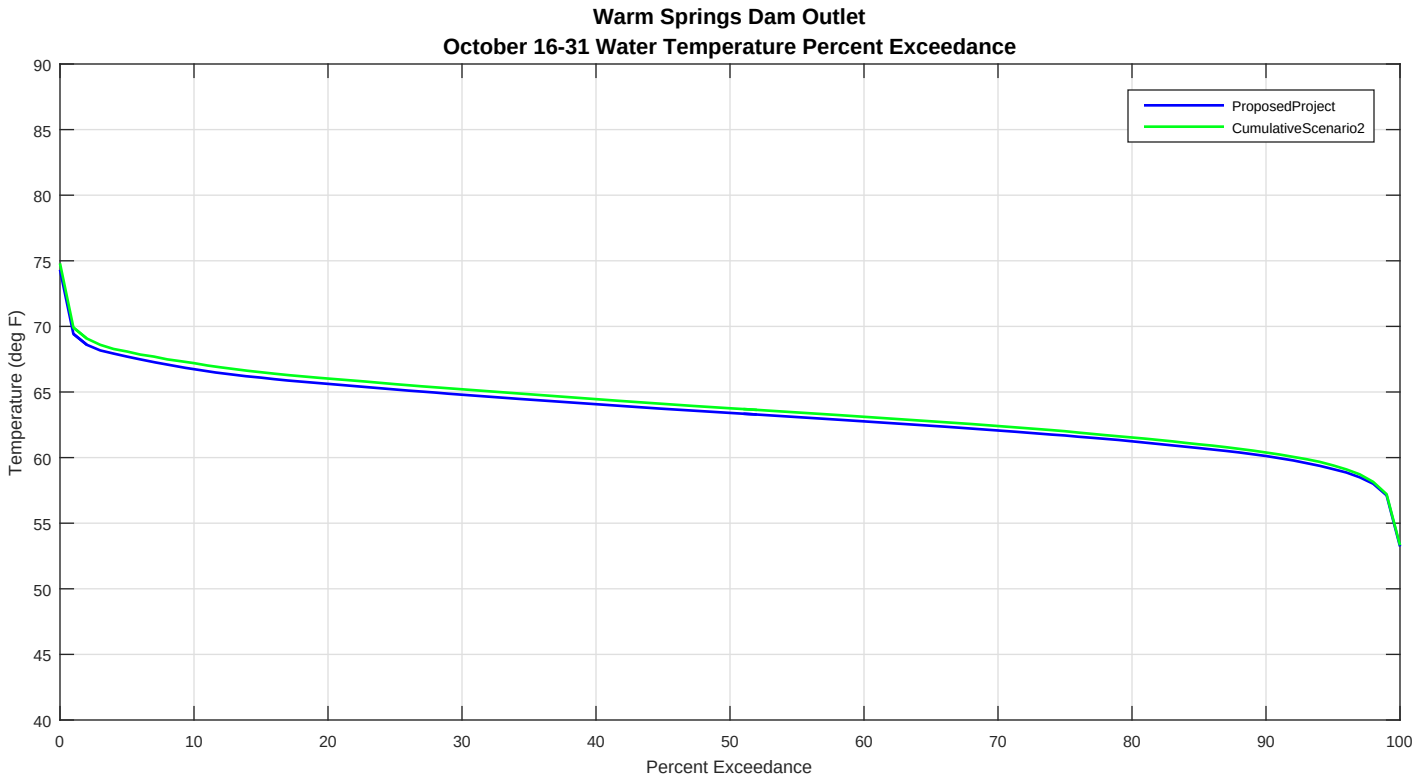
Warm Springs Dam Outlet
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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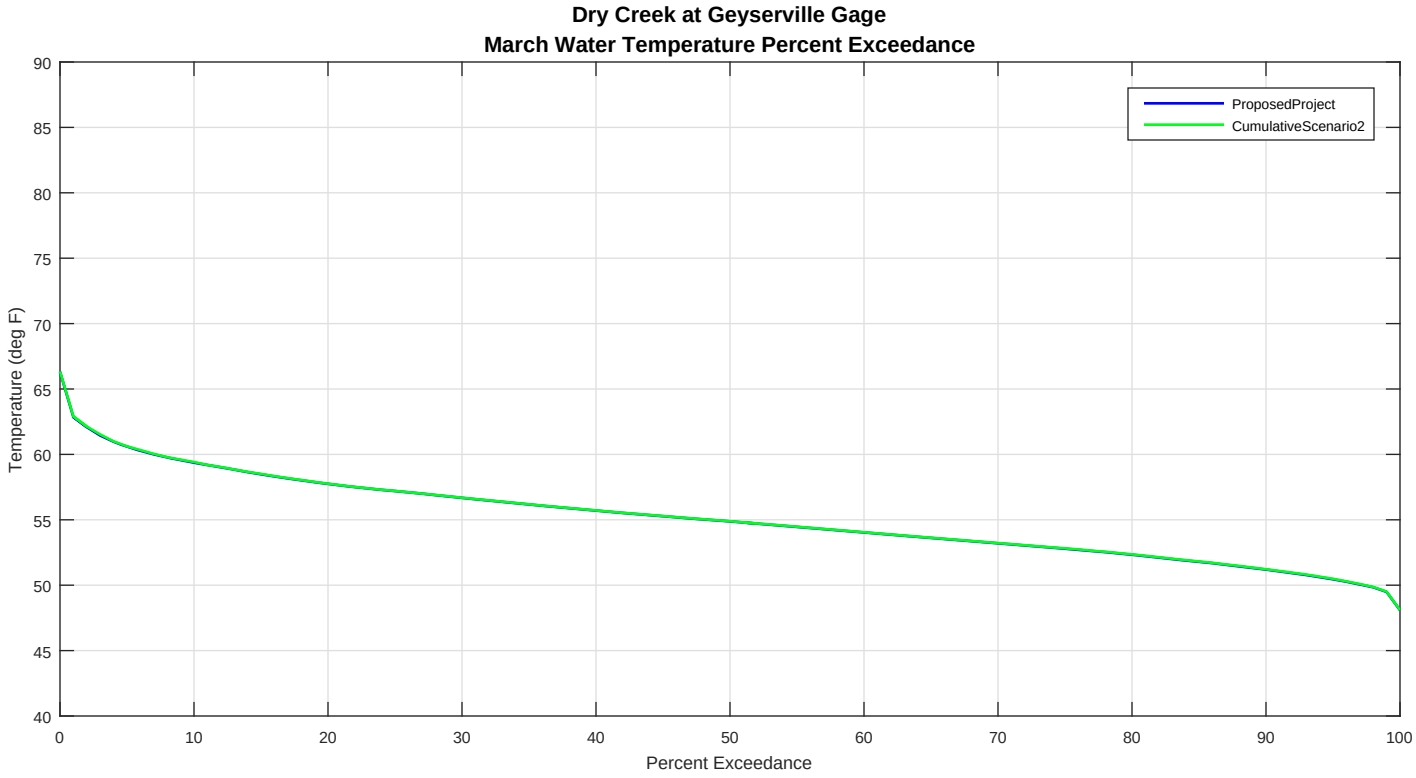
Dry Creek at Geyserville Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
90
85
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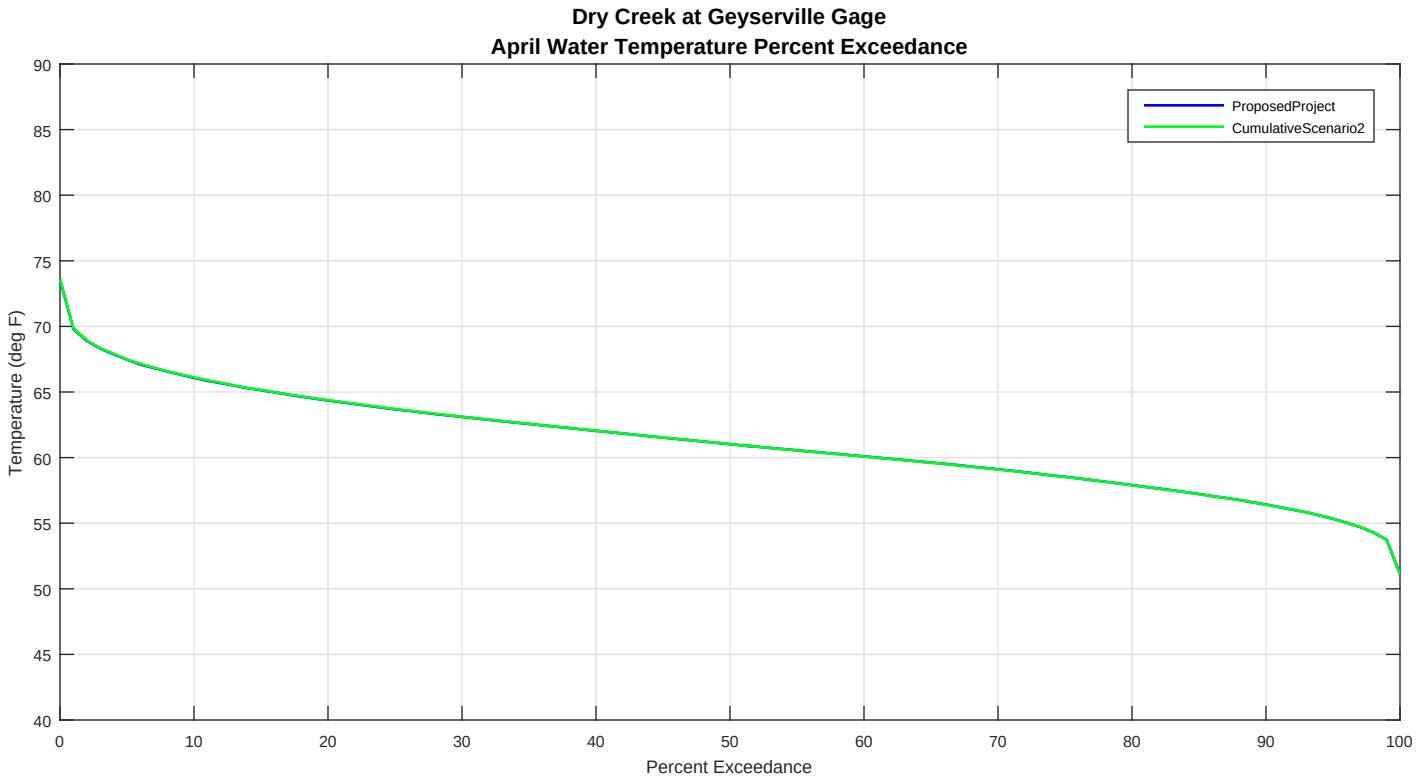
Dry Creek at Geyserville Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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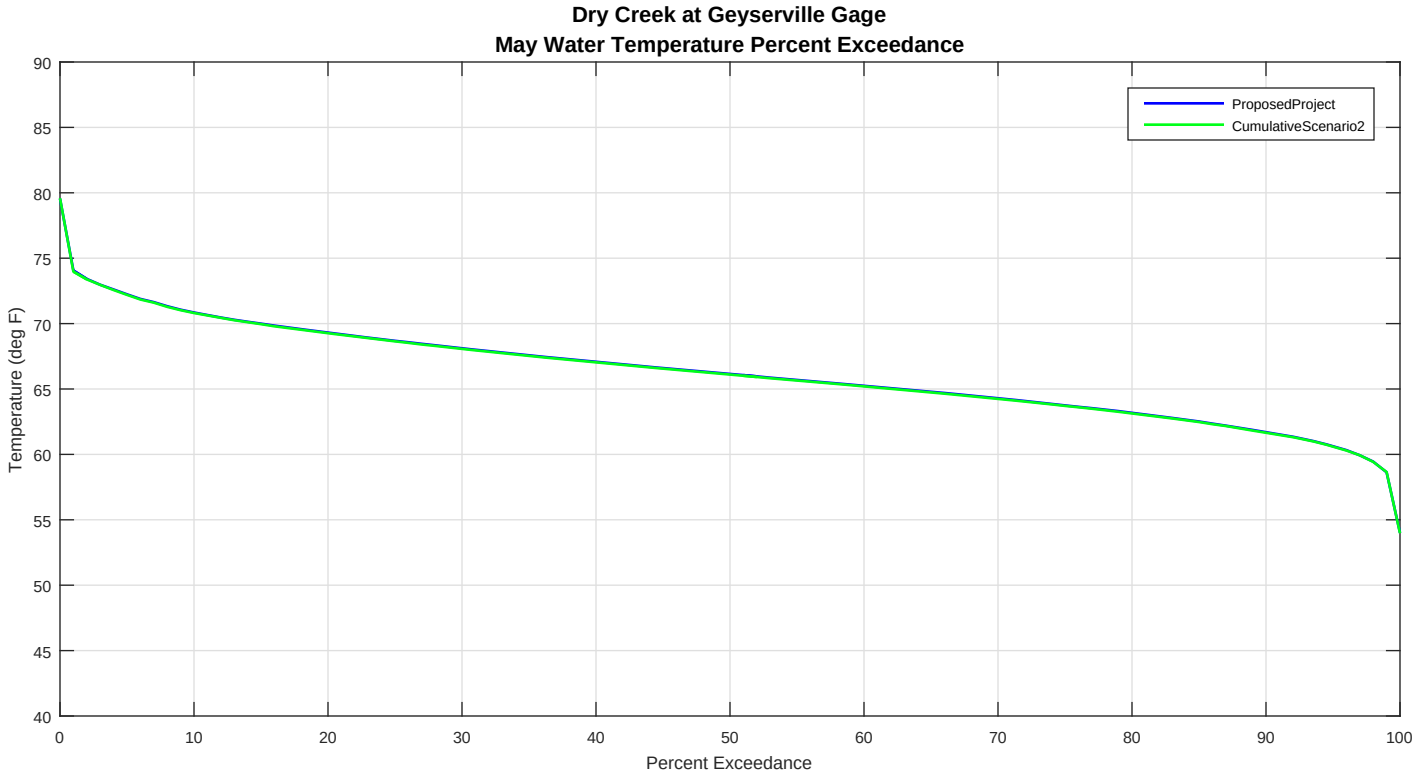
Dry Creek at Geyserville Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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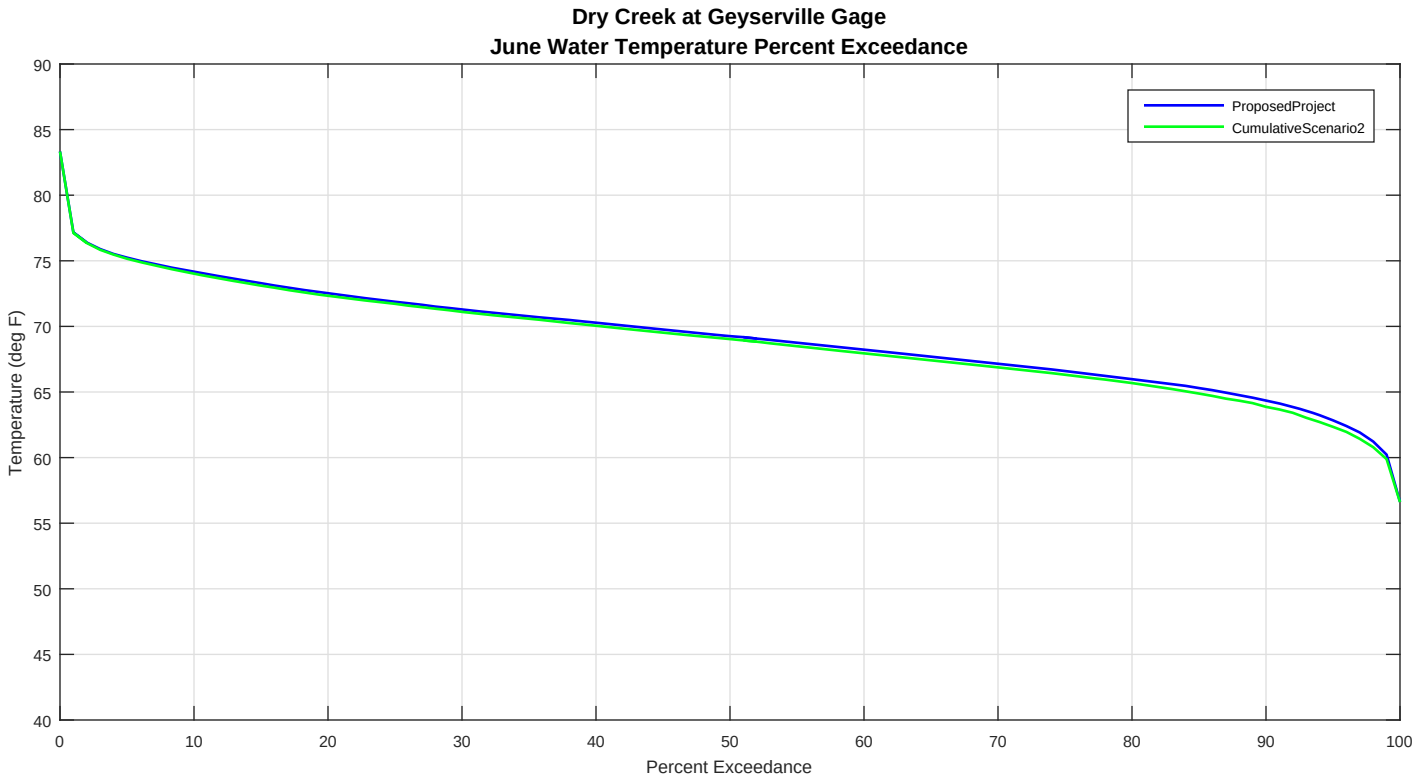
Dry Creek at Geyserville Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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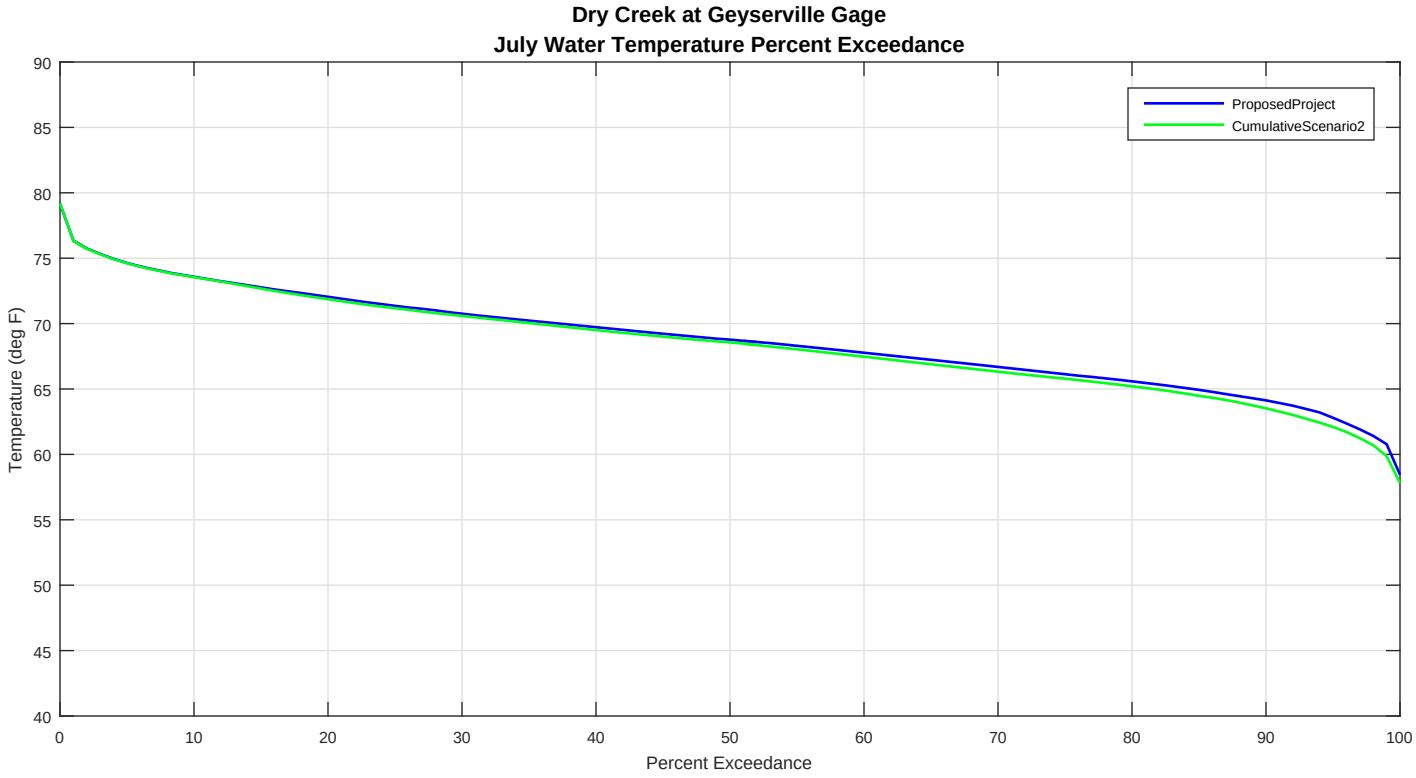
Dry Creek at Geyserville Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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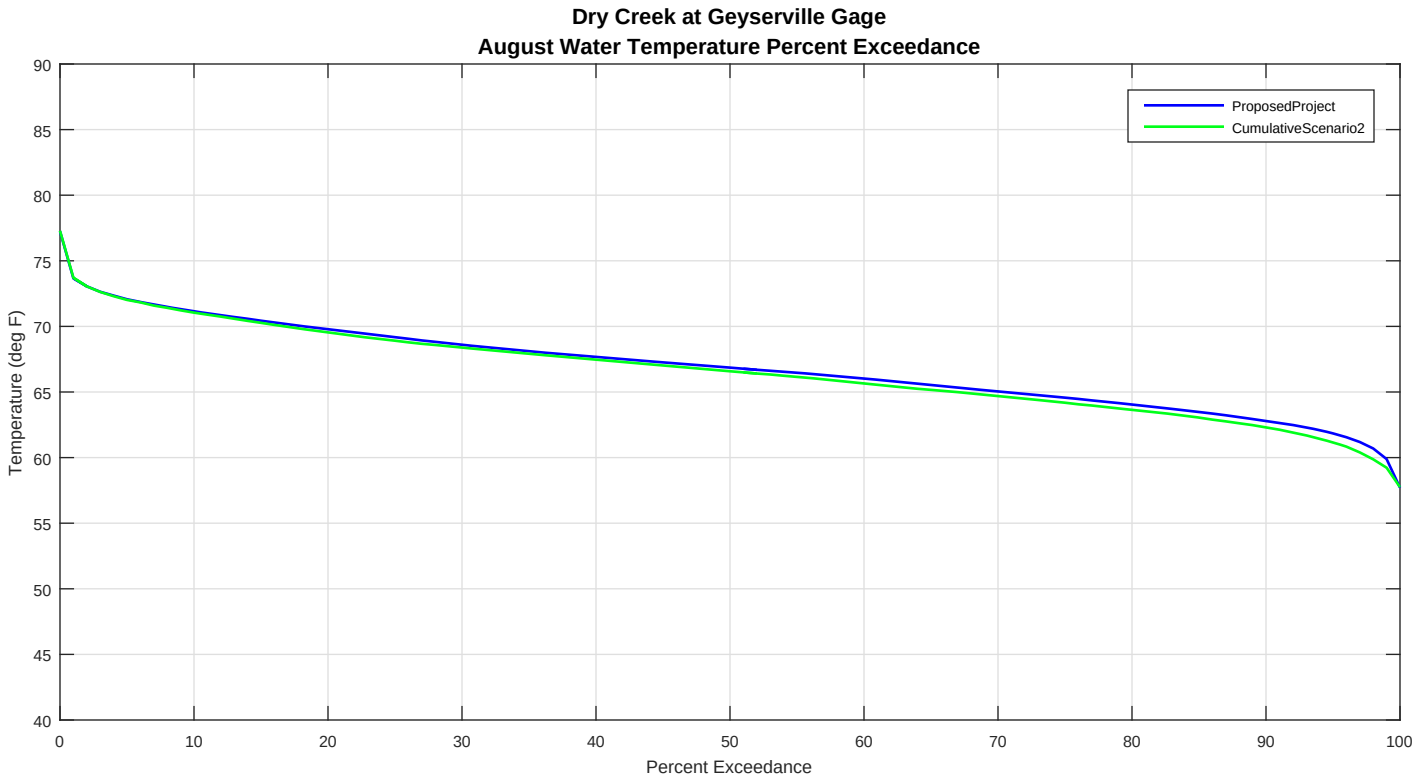
Dry Creek at Geyserville Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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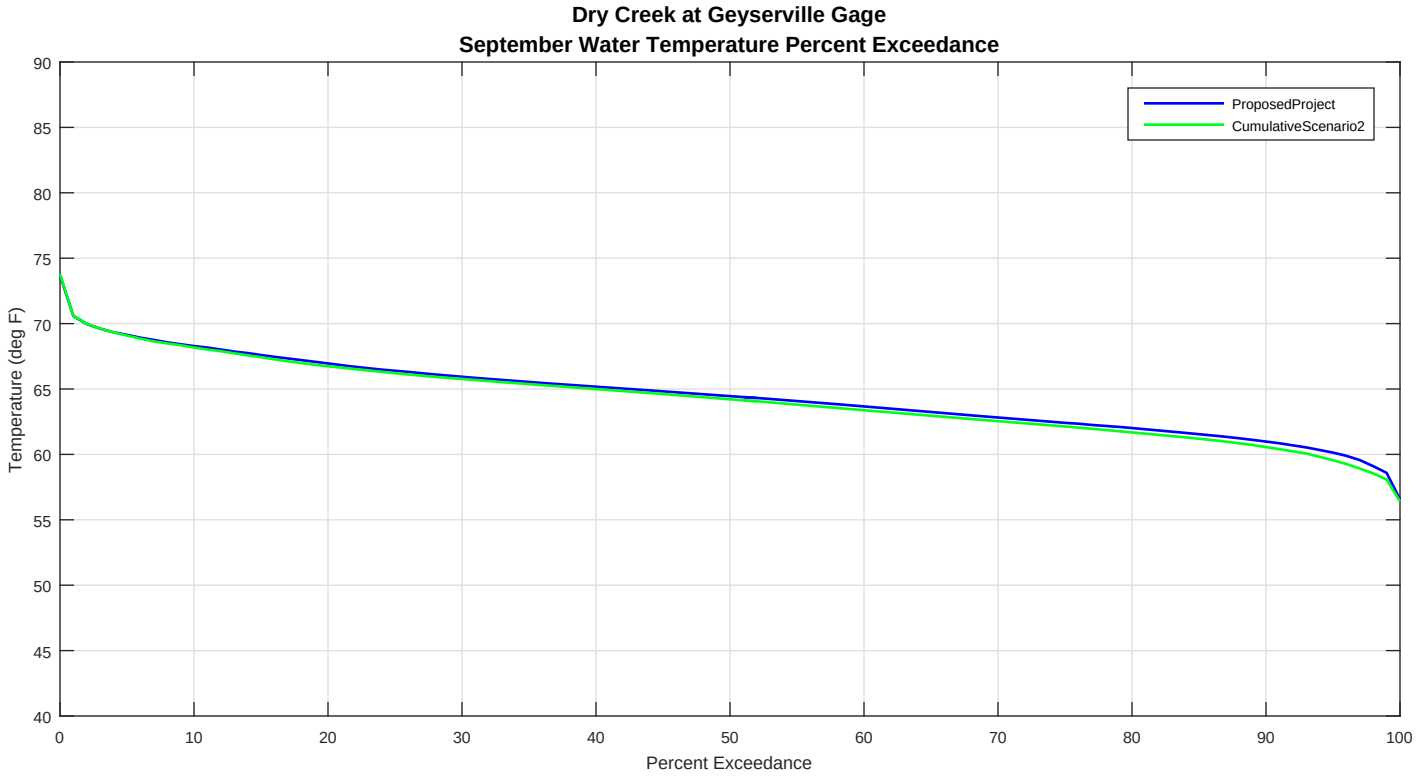
Dry Creek at Geyserville Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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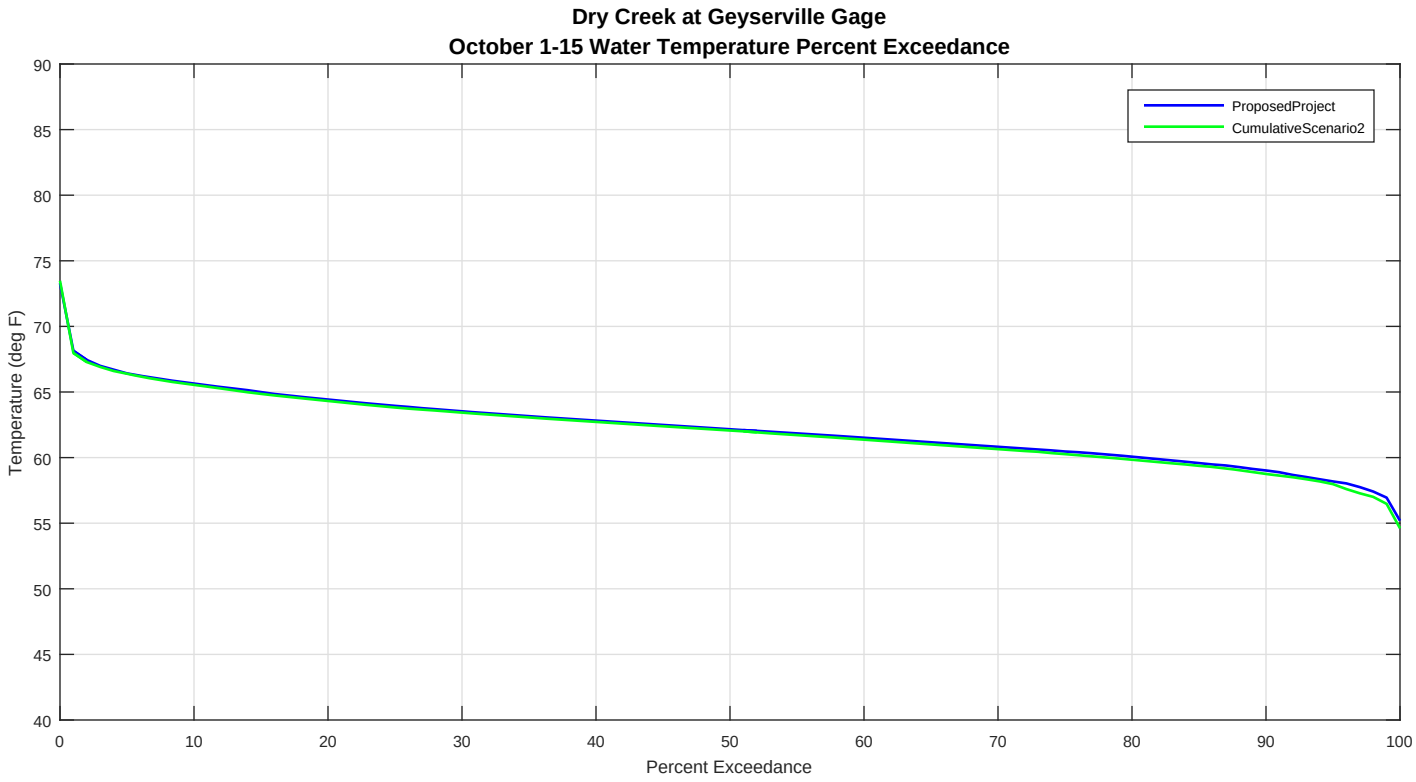
Dry Creek at Geyserville Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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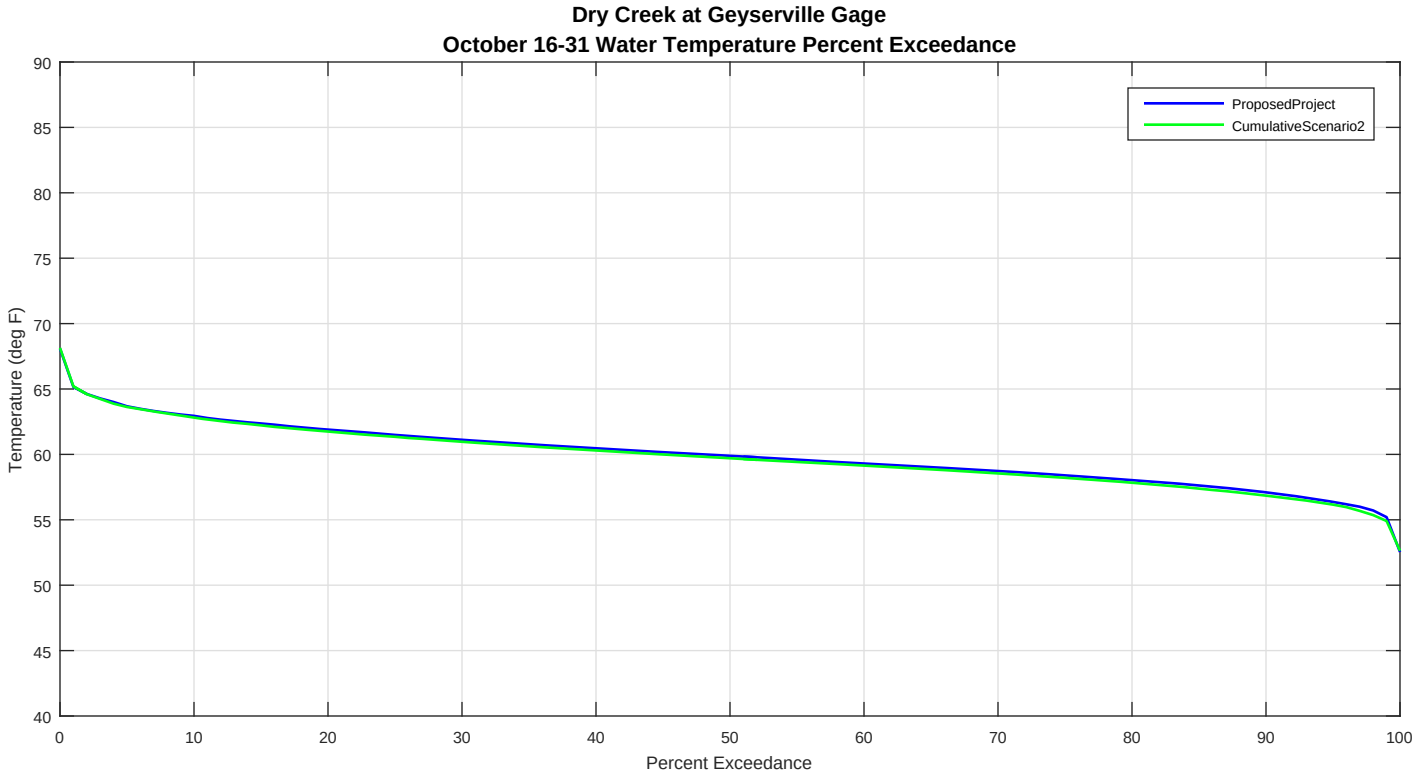
Dry Creek at Geyserville Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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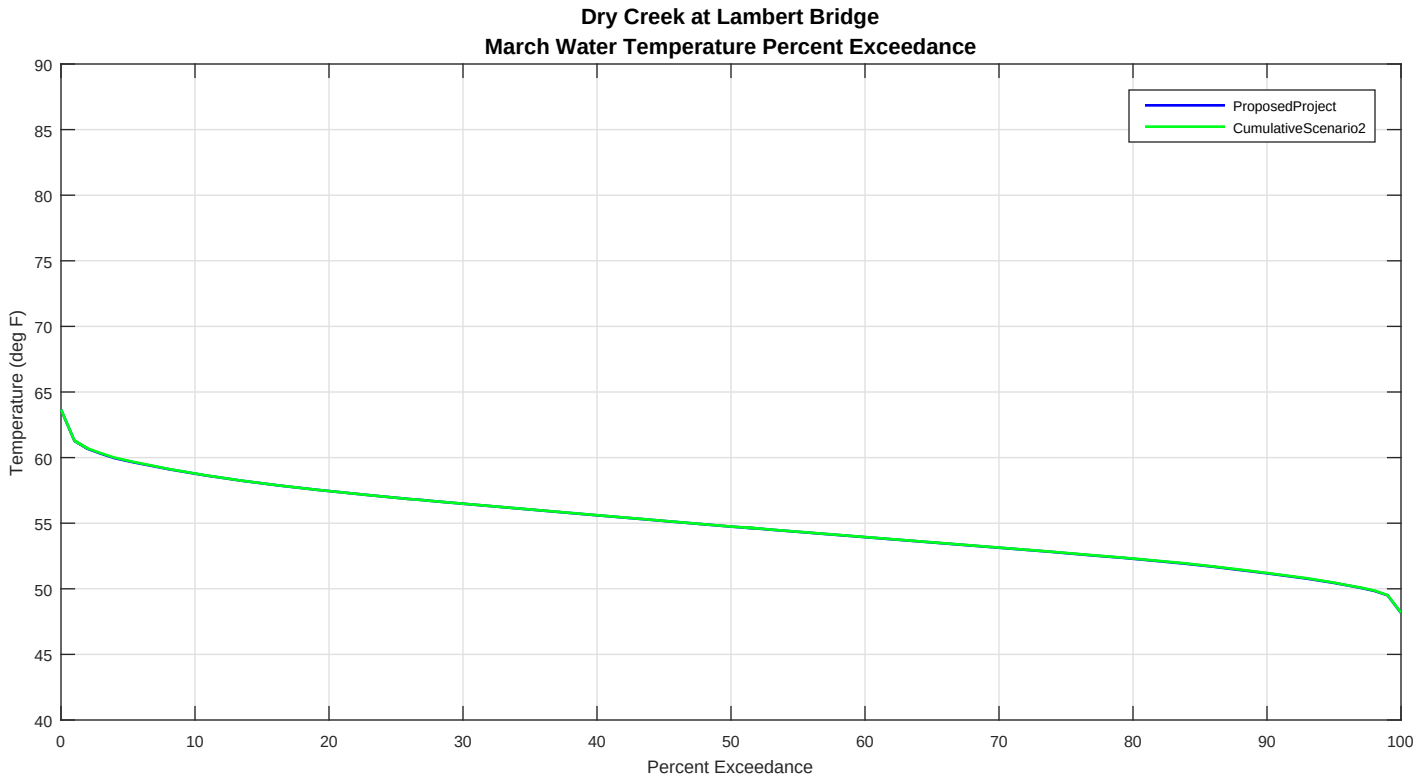
Dry Creek at Lambert Bridge
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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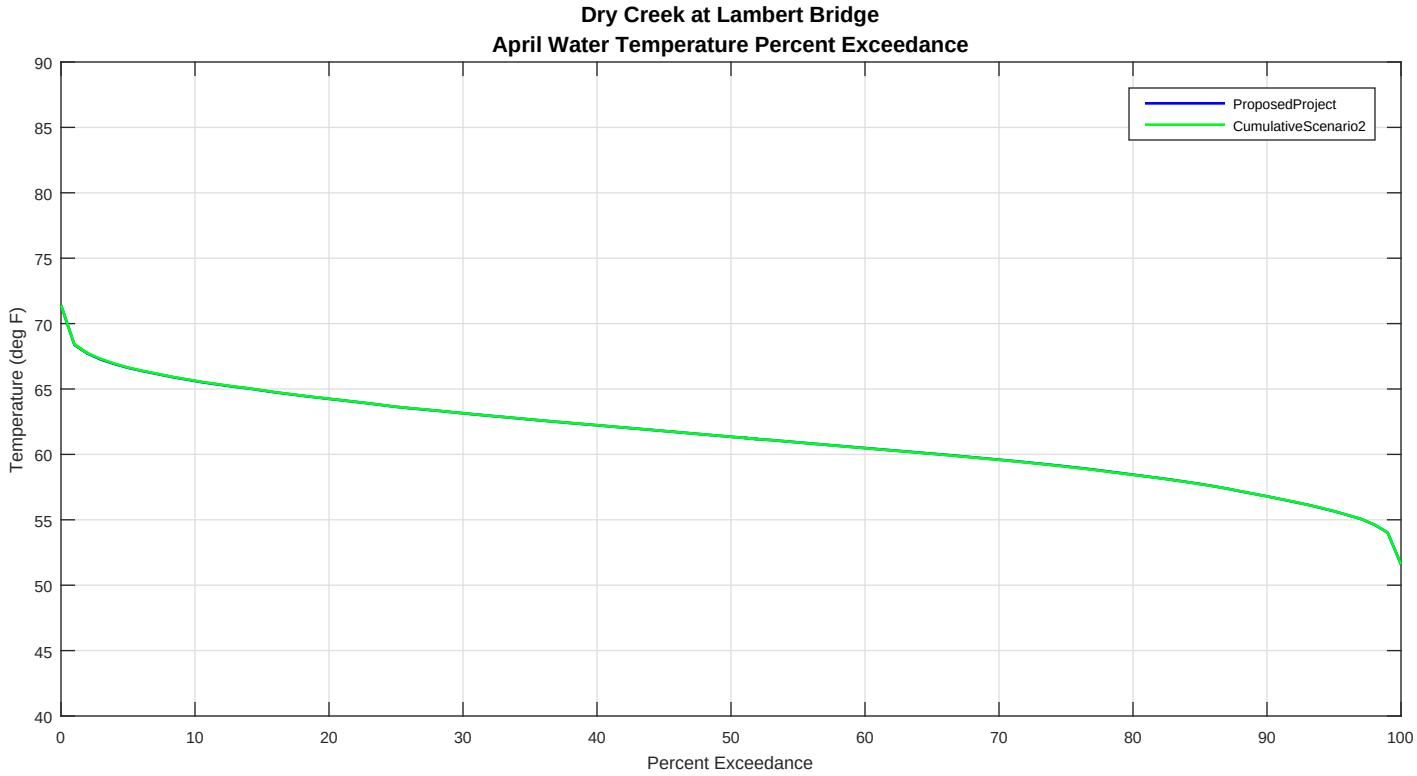
Dry Creek at Lambert Bridge
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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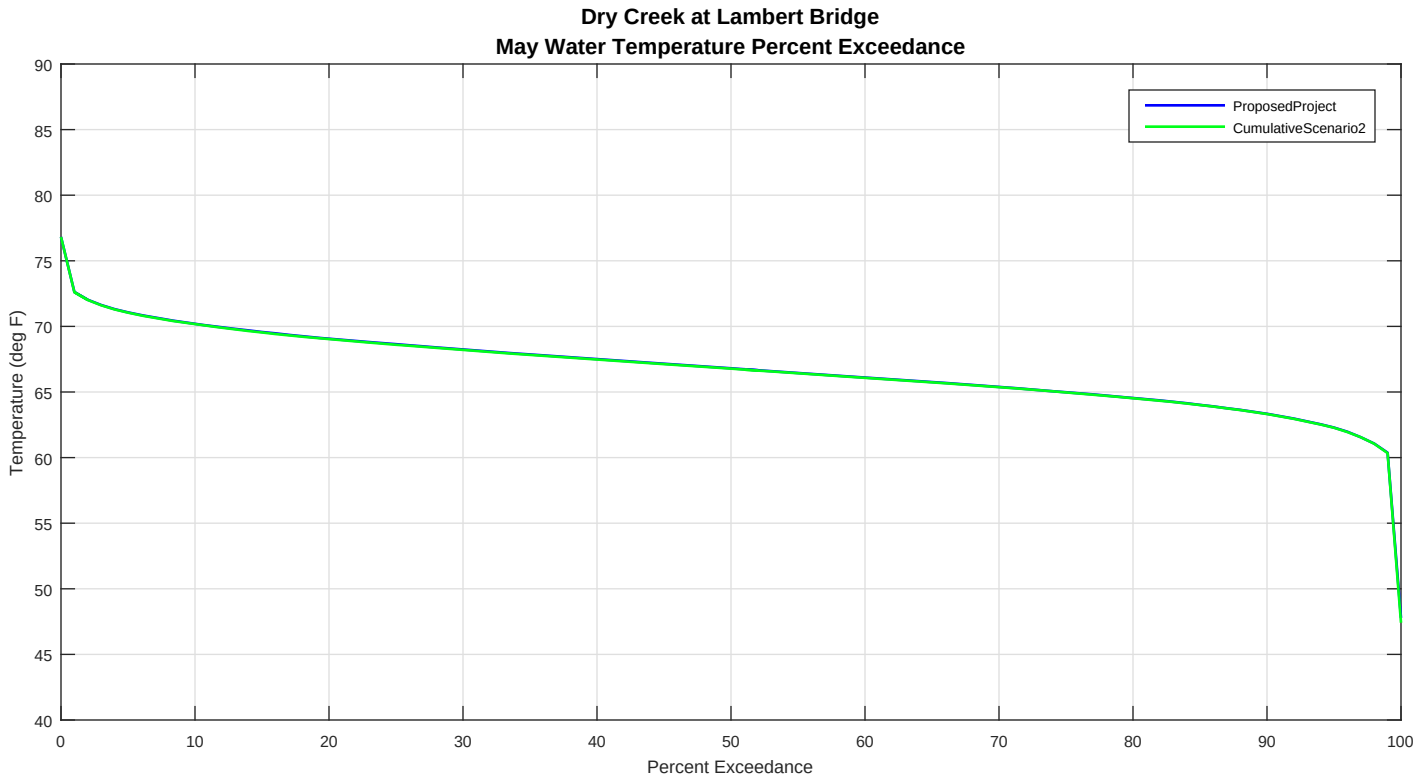
Dry Creek at Lambert Bridge
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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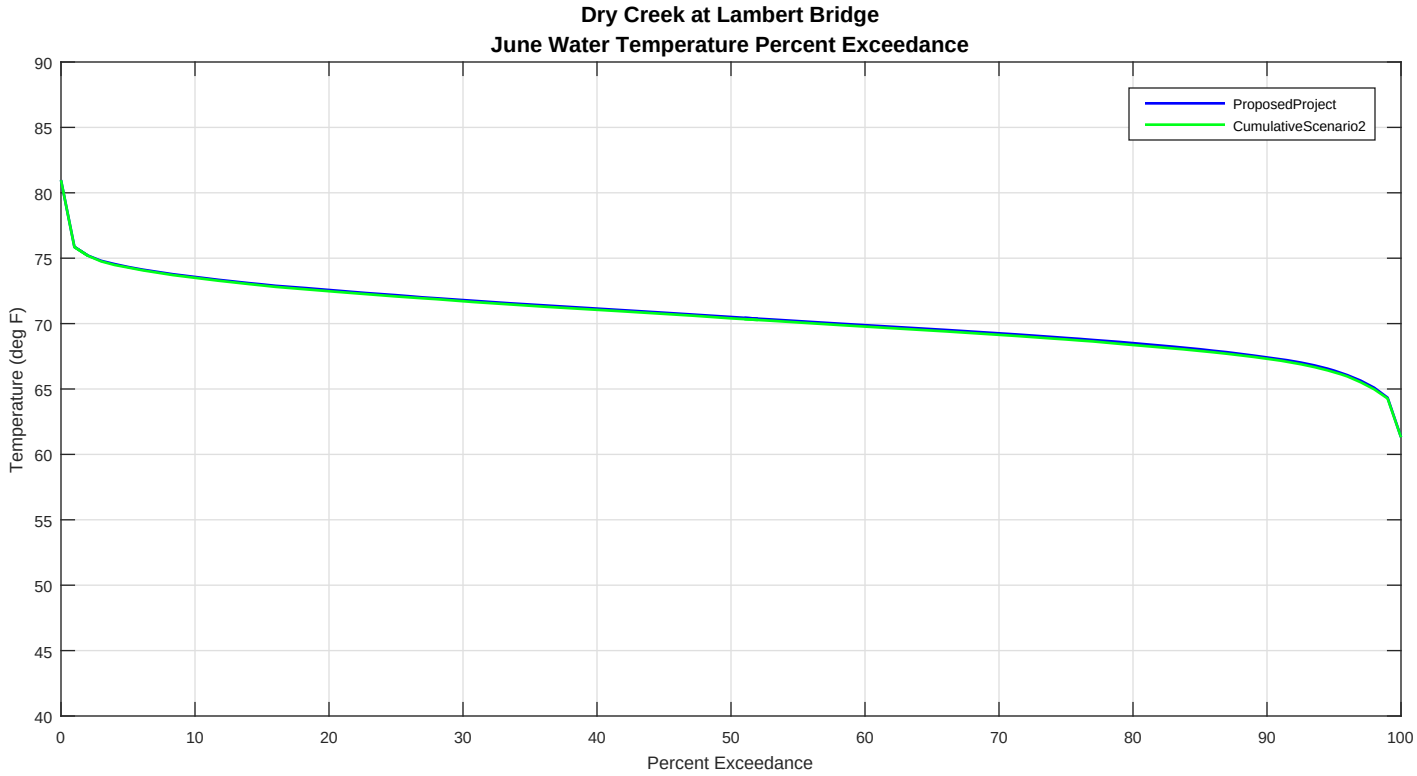
Dry Creek at Lambert Bridge
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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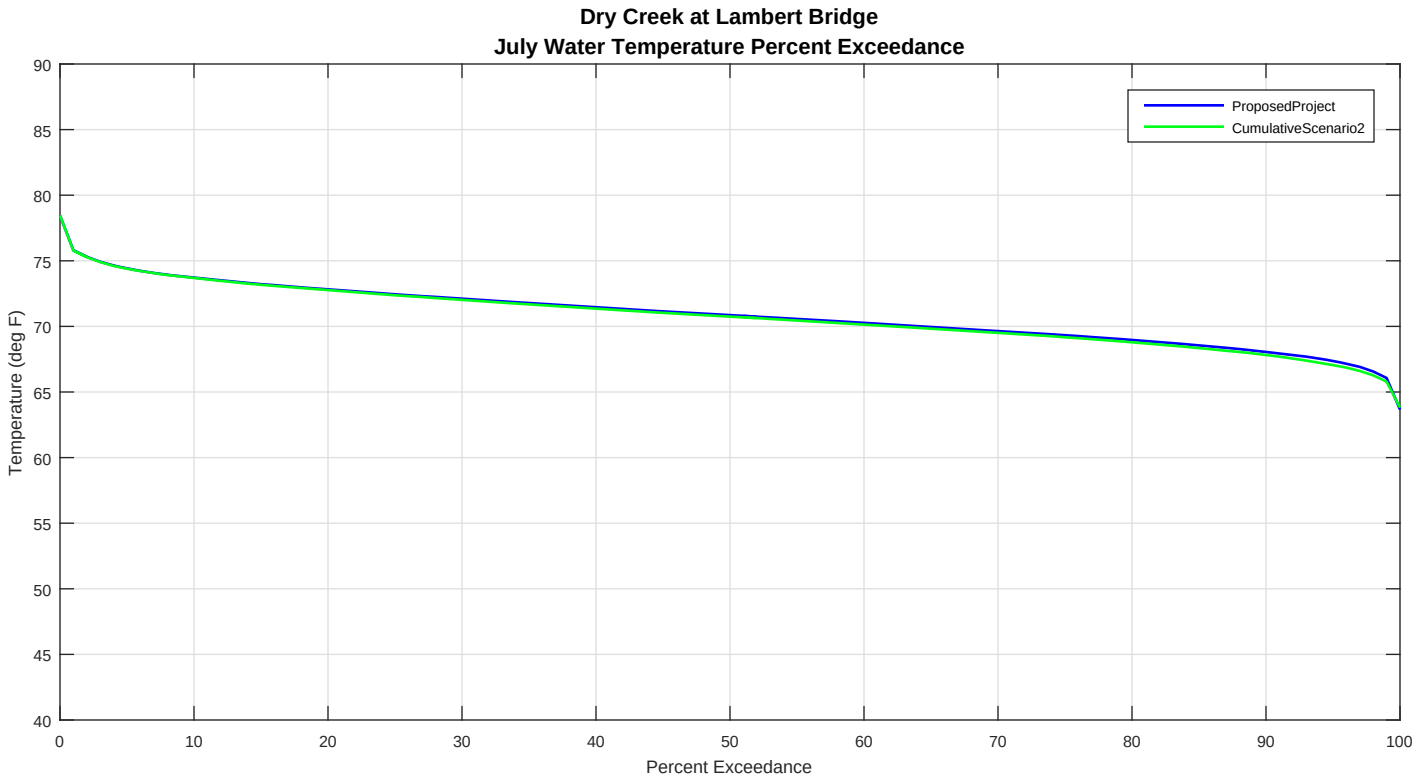
Dry Creek at Lambert Bridge
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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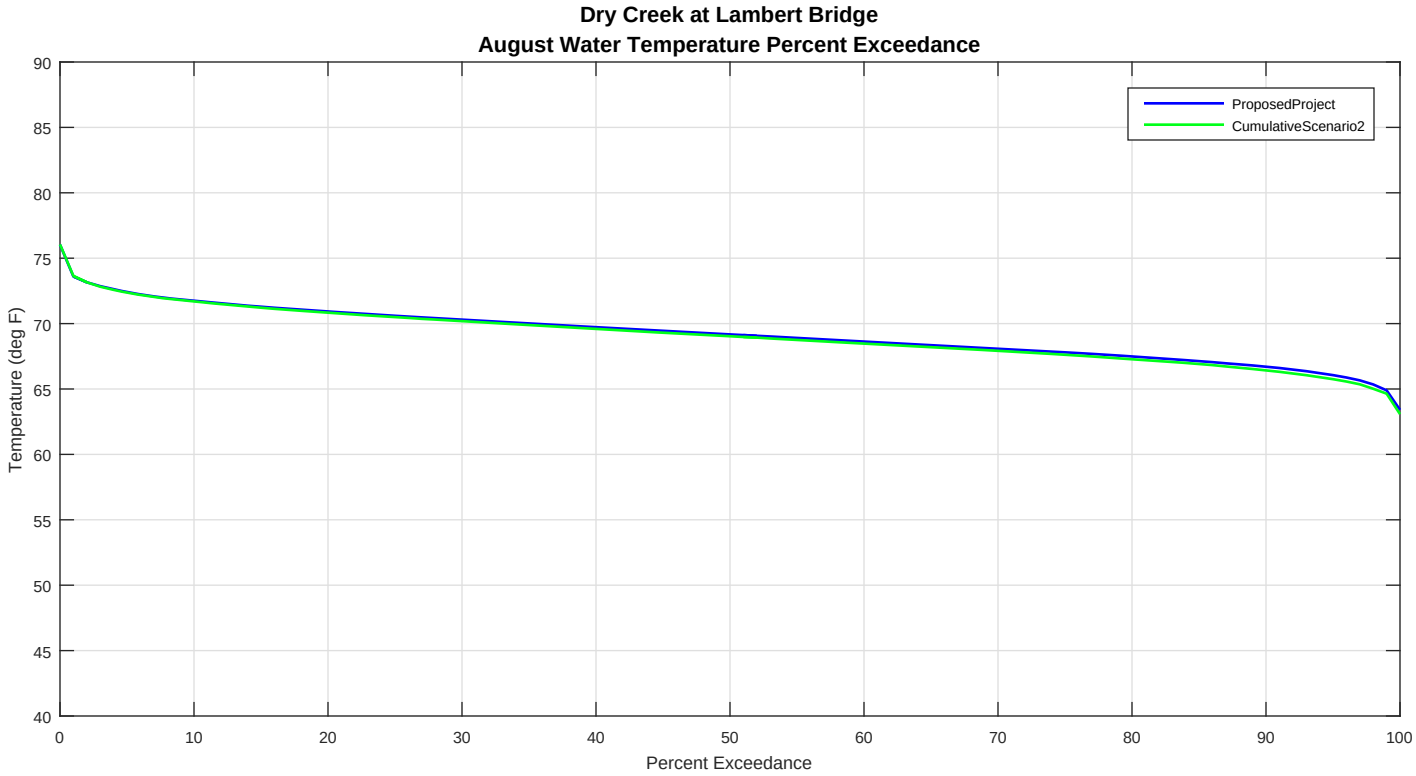
Dry Creek at Lambert Bridge
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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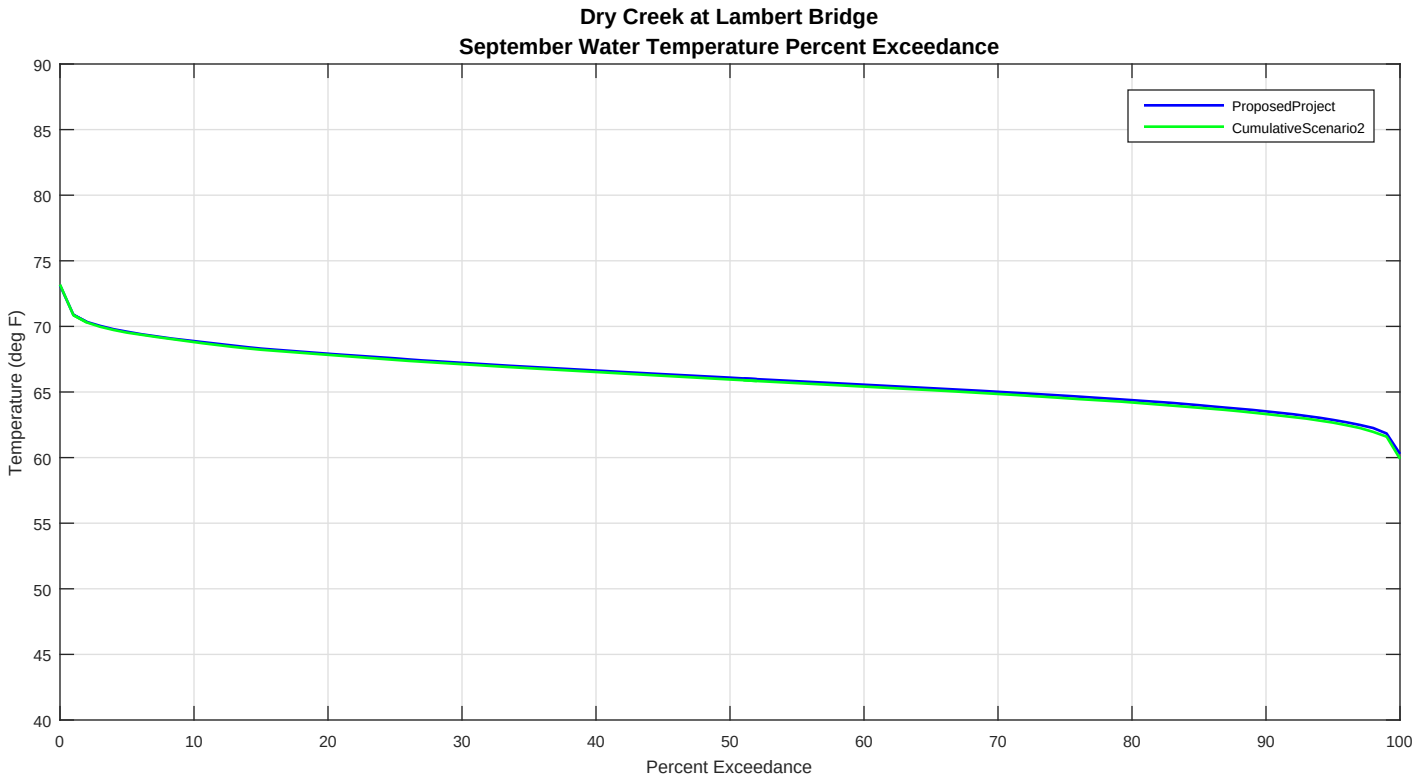
Dry Creek at Lambert Bridge
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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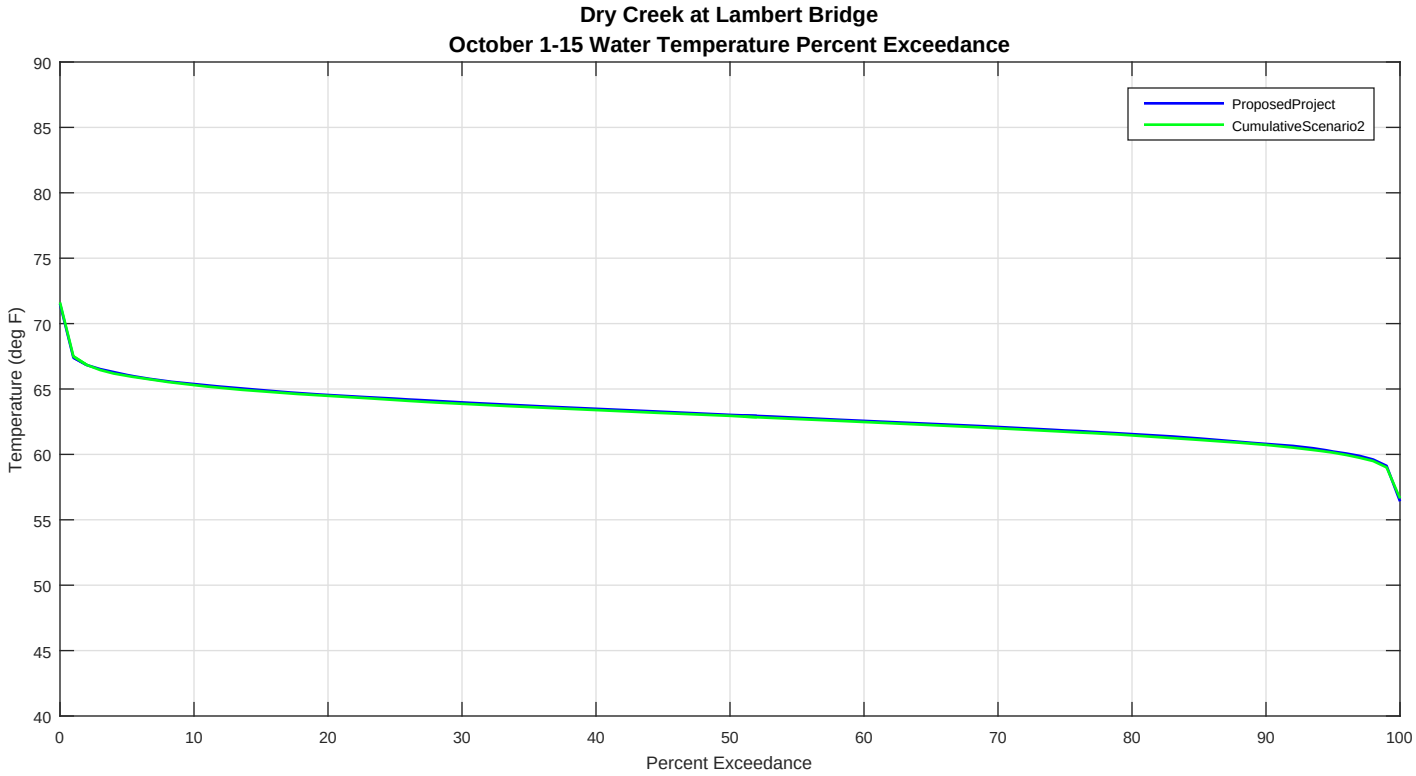
Dry Creek at Lambert Bridge
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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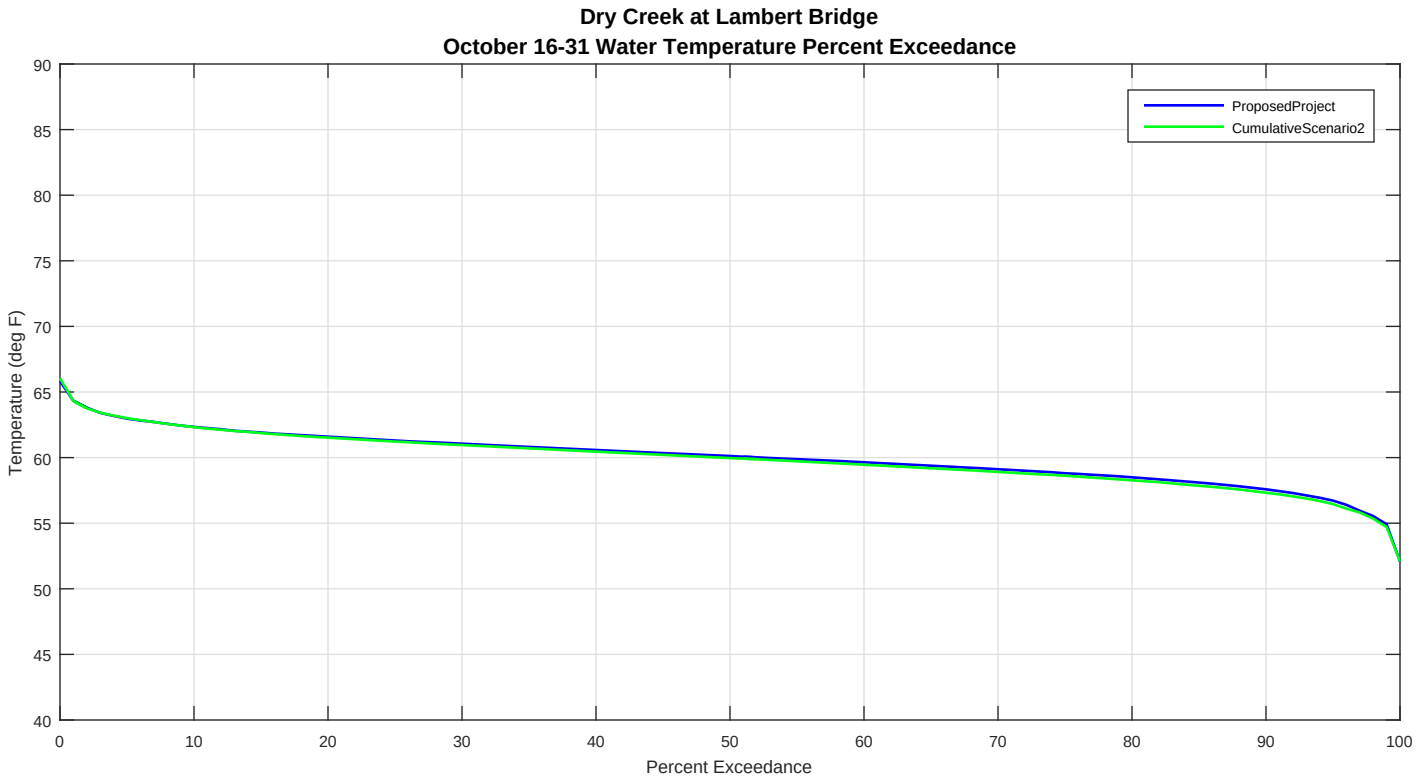
Dry Creek at Lambert Bridge
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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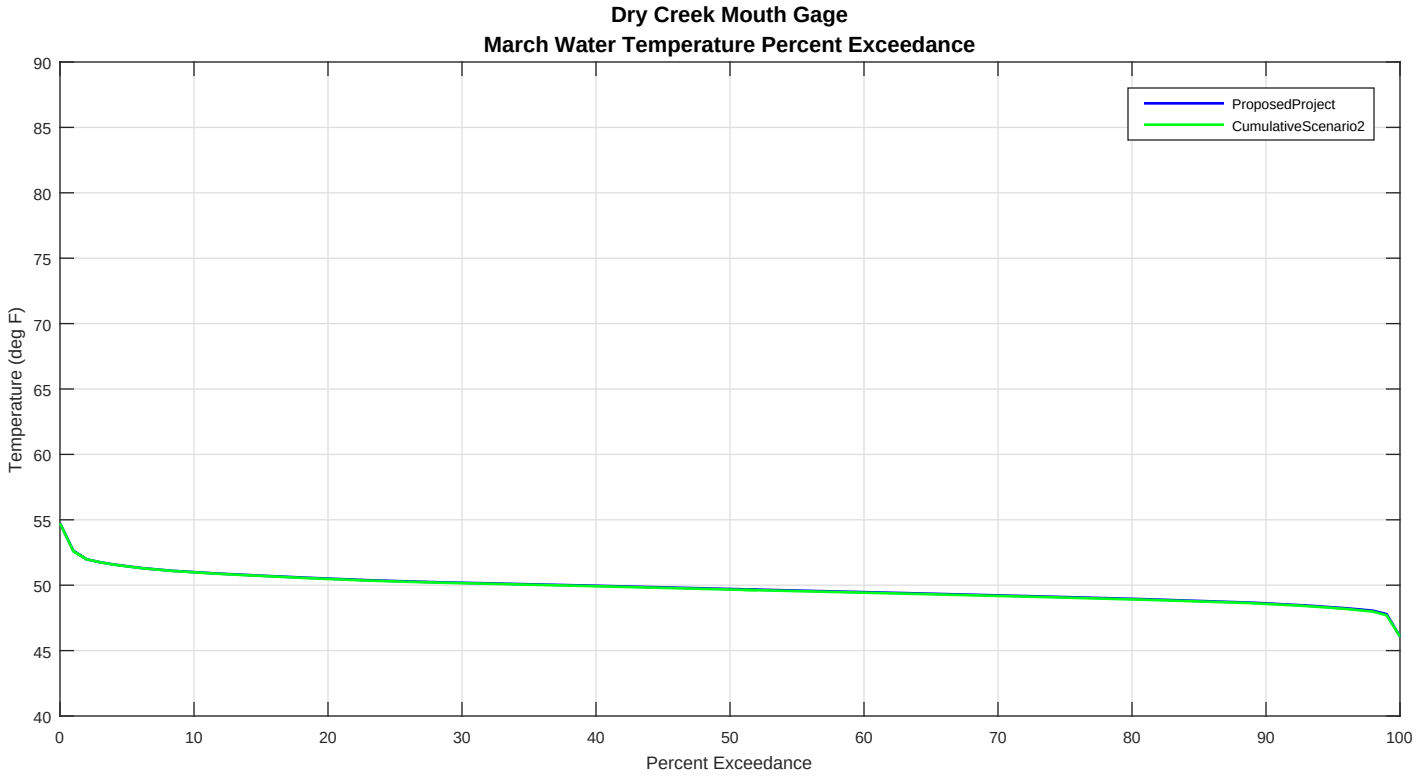
Dry Creek Mouth Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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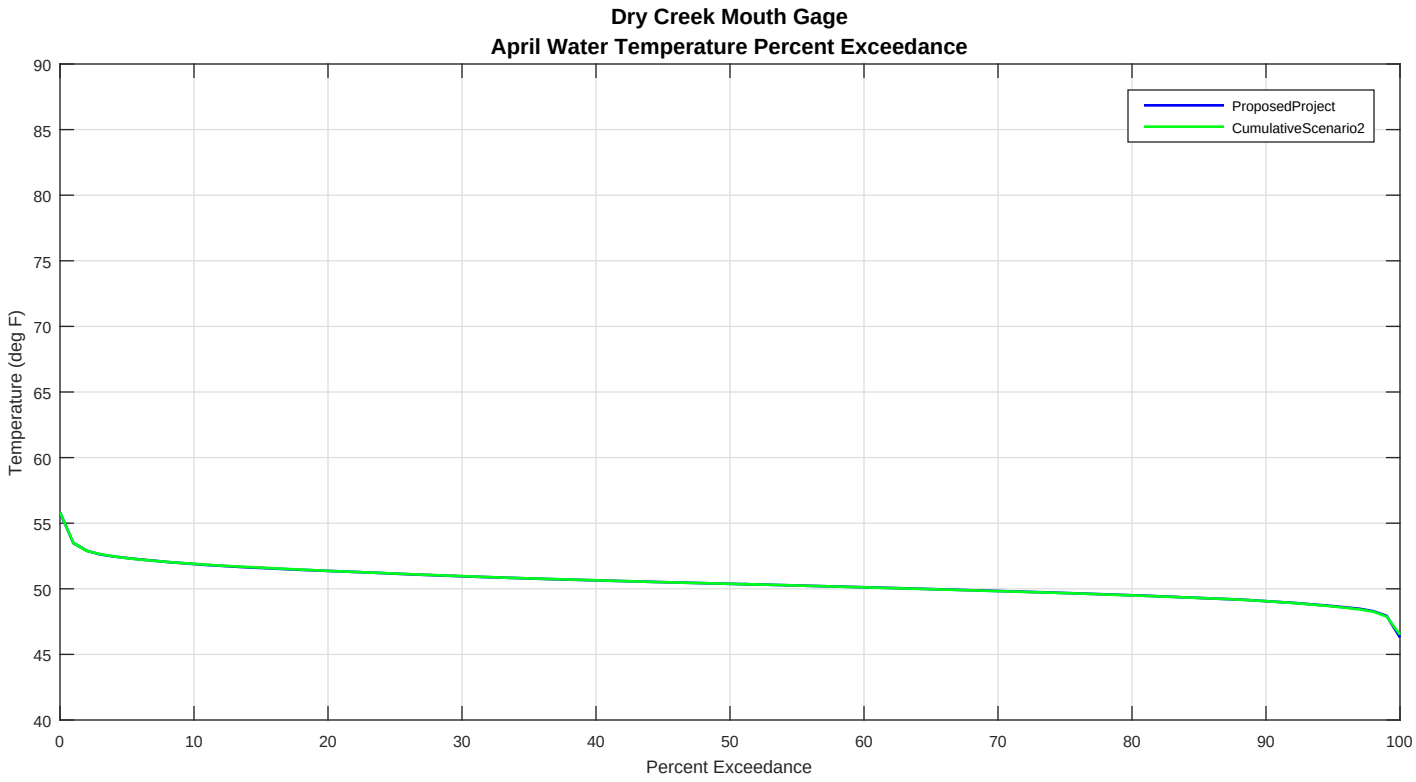
Dry Creek Mouth Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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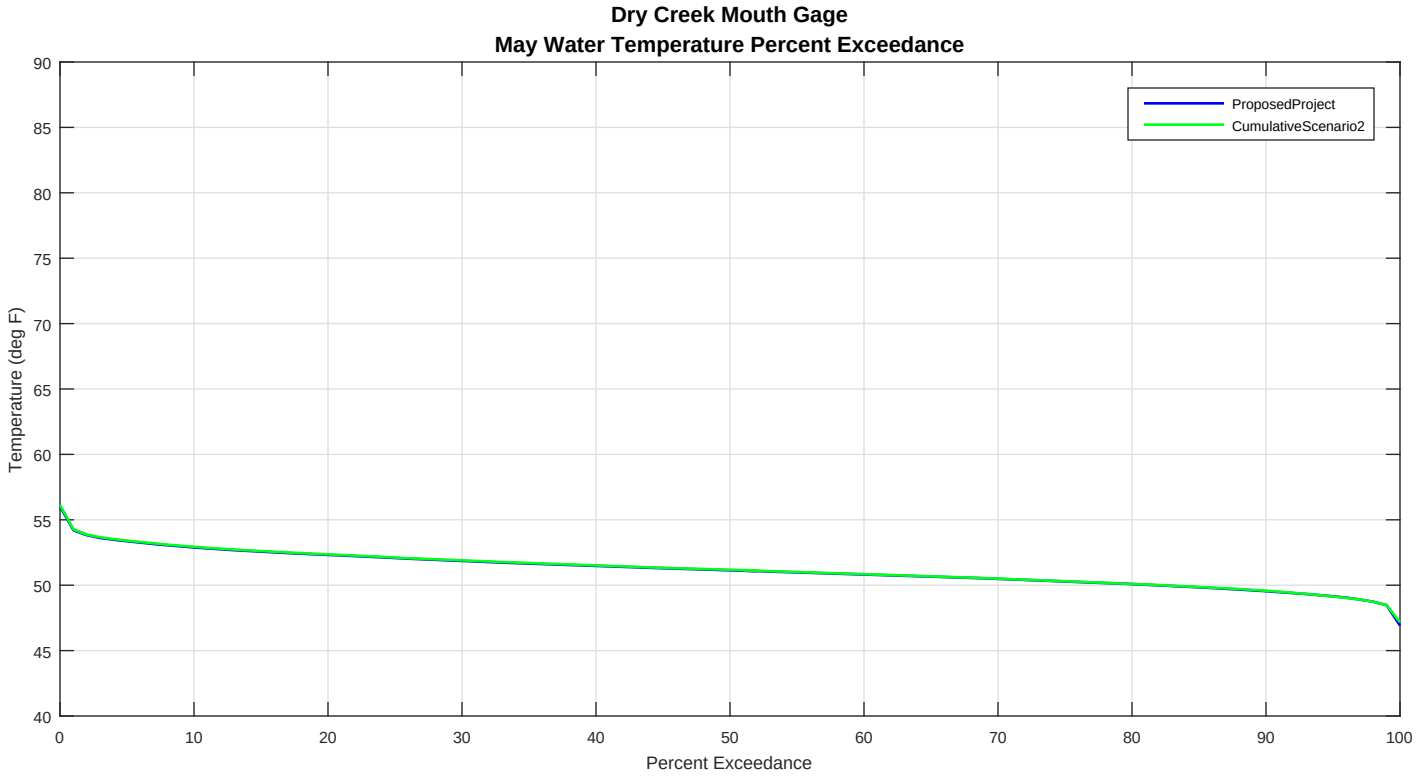
Dry Creek Mouth Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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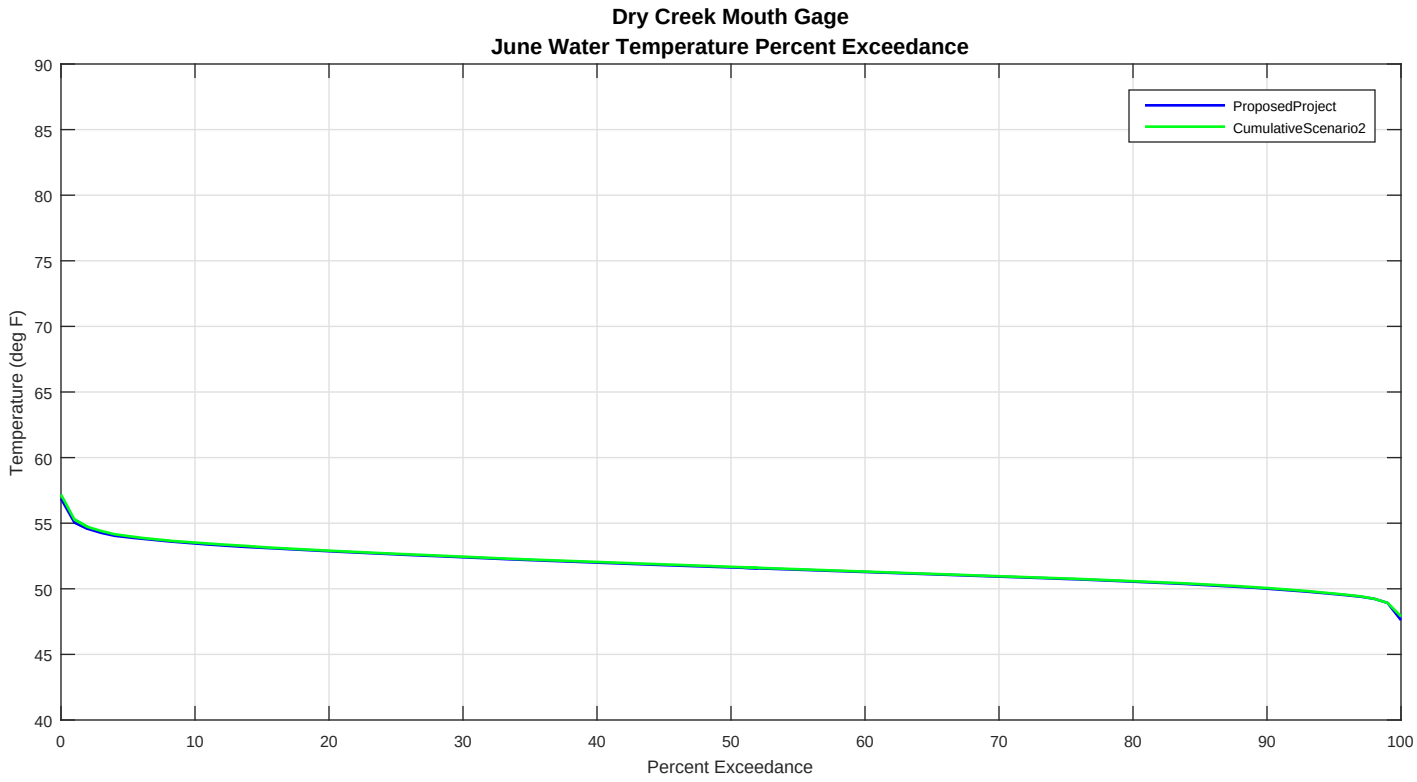
Dry Creek Mouth Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
90
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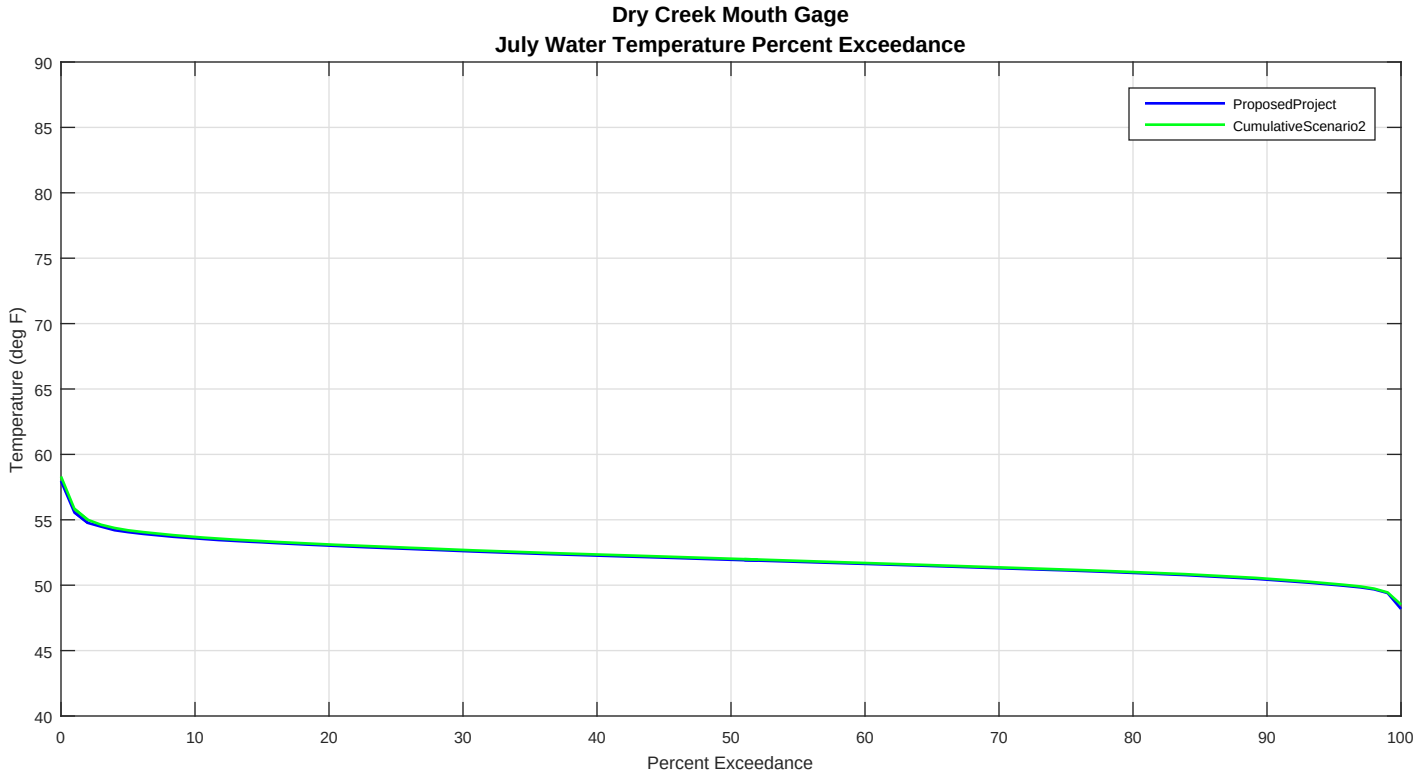
Dry Creek Mouth Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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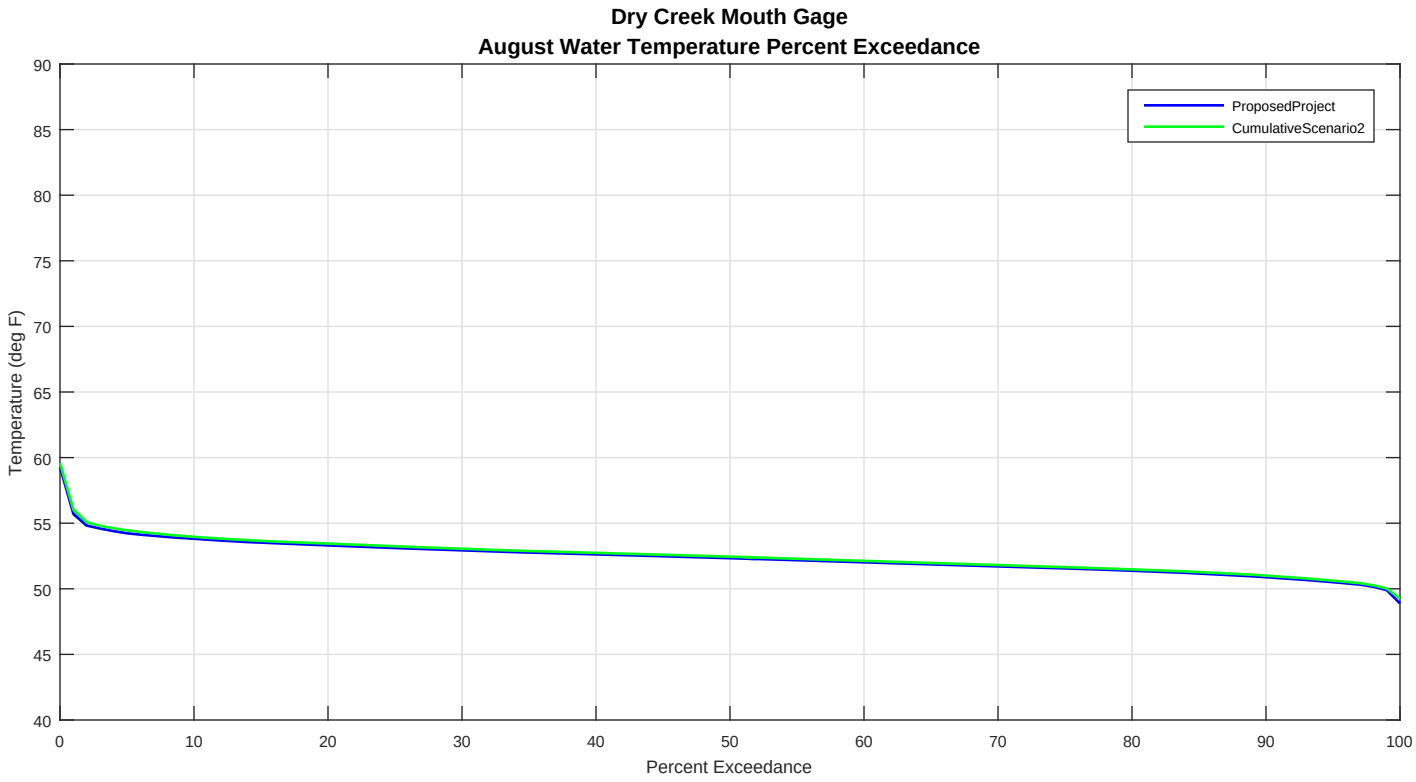
Dry Creek Mouth Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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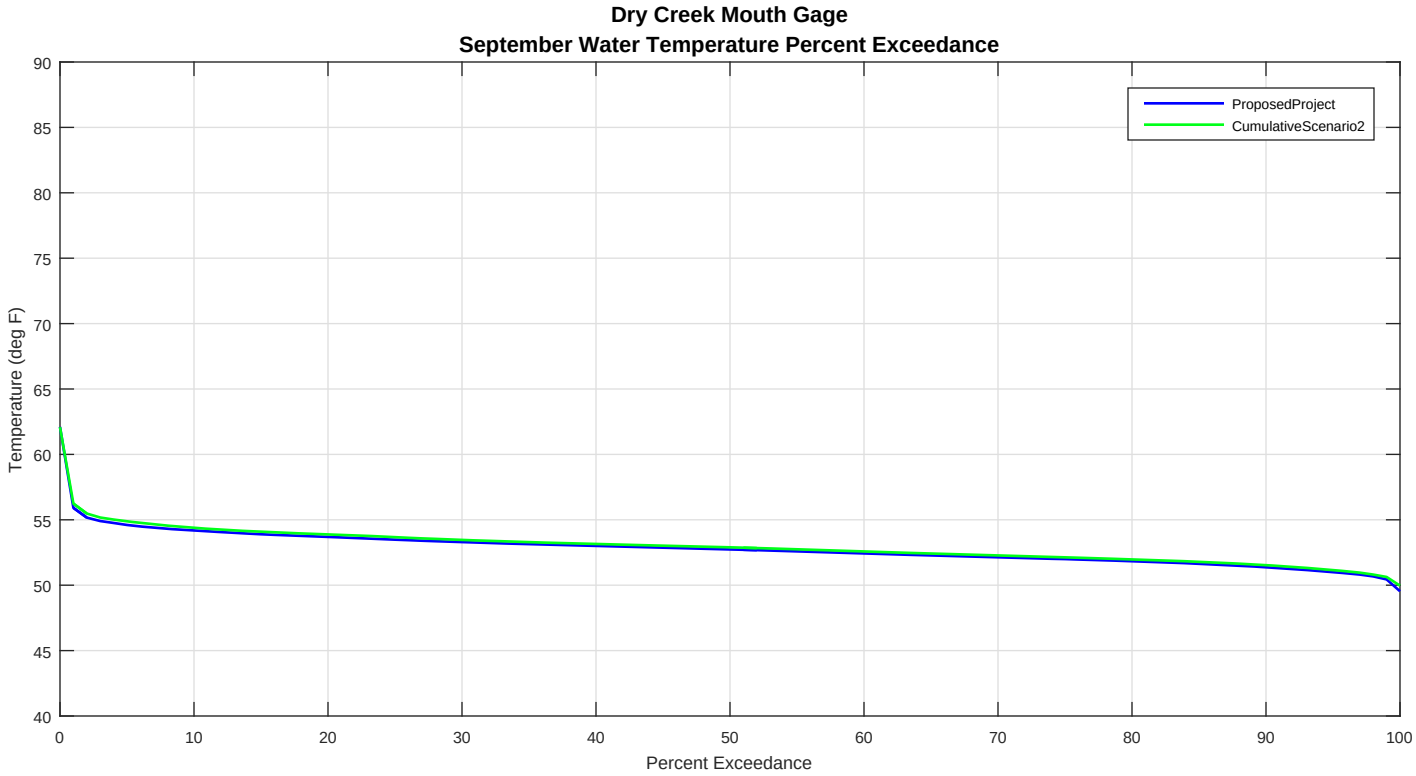
Dry Creek Mouth Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
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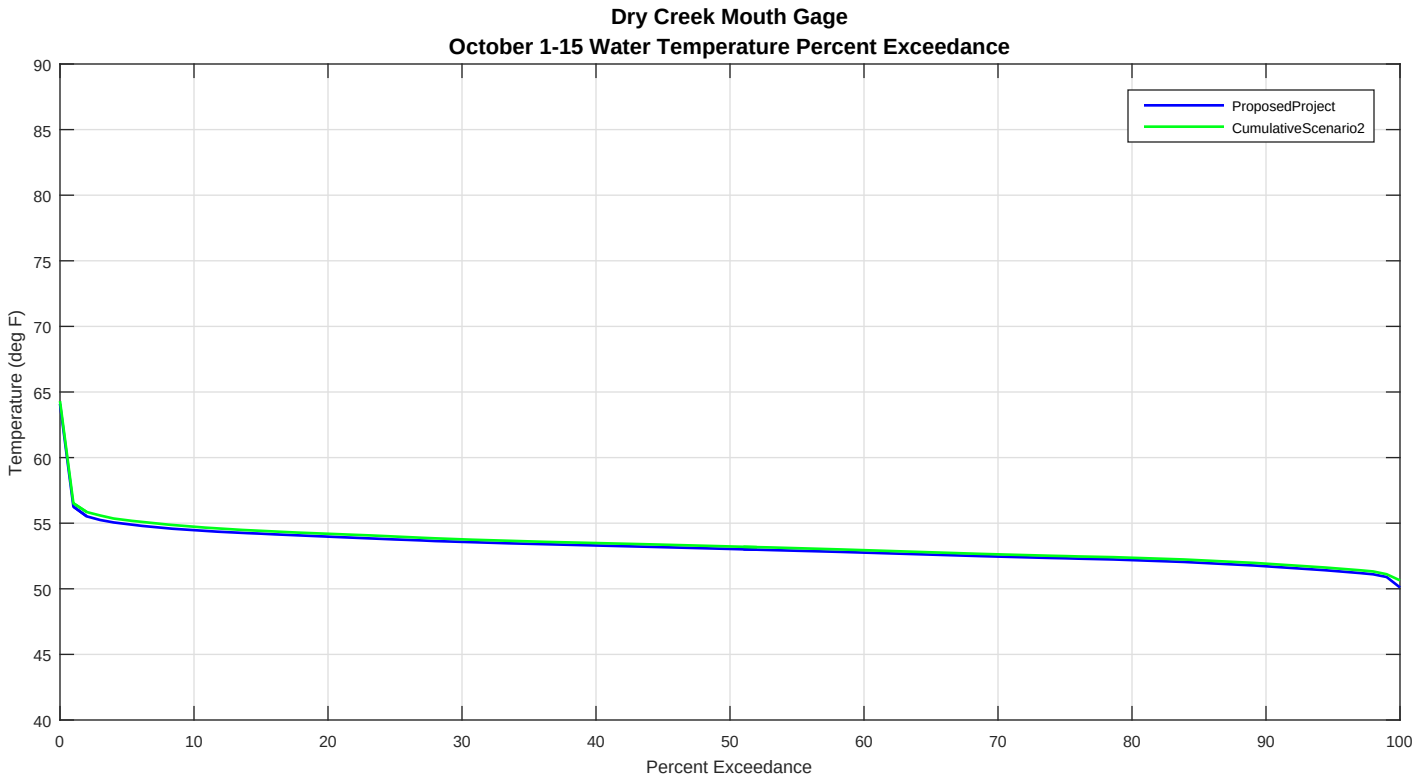
Dry Creek Mouth Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
90
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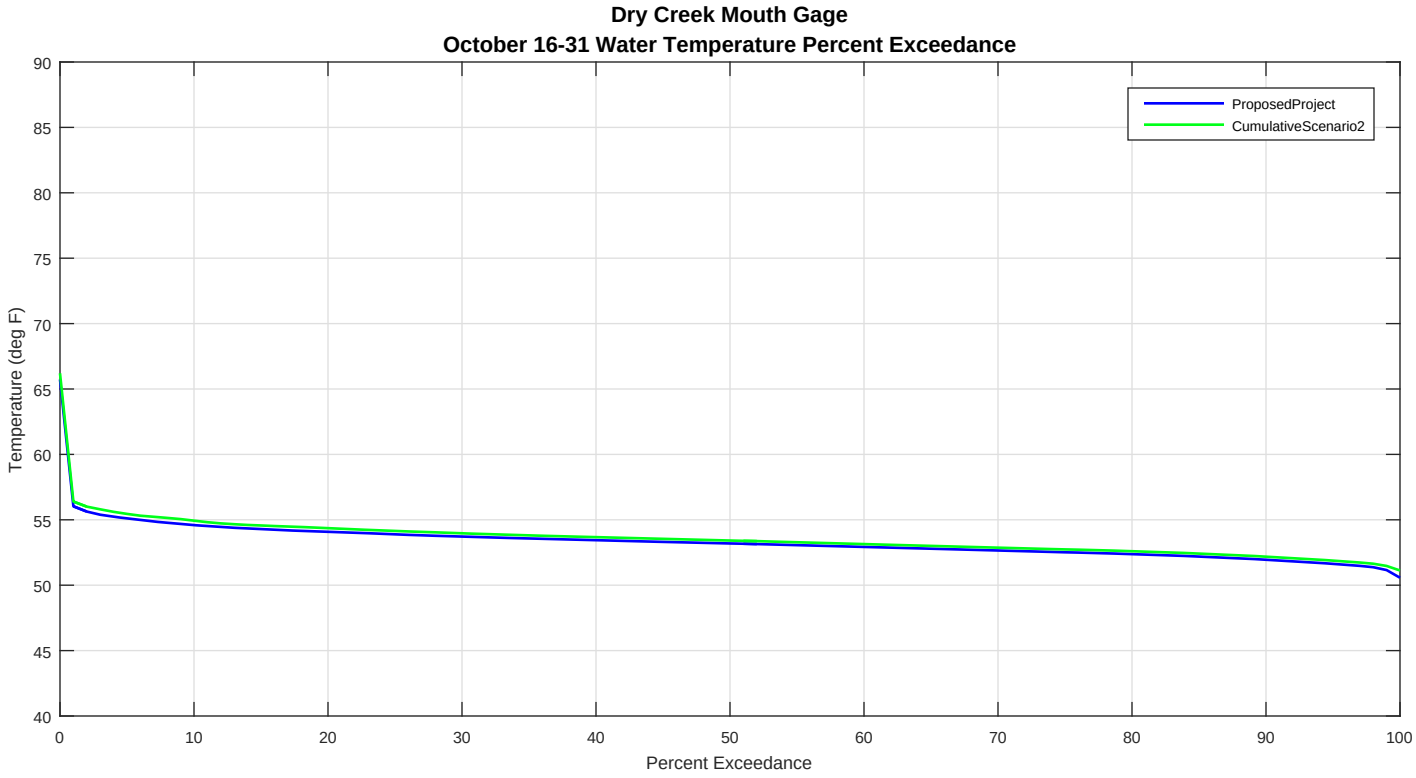
Dry Creek Mouth Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario2
Temperature (deg F)
Percent Exceedance
90
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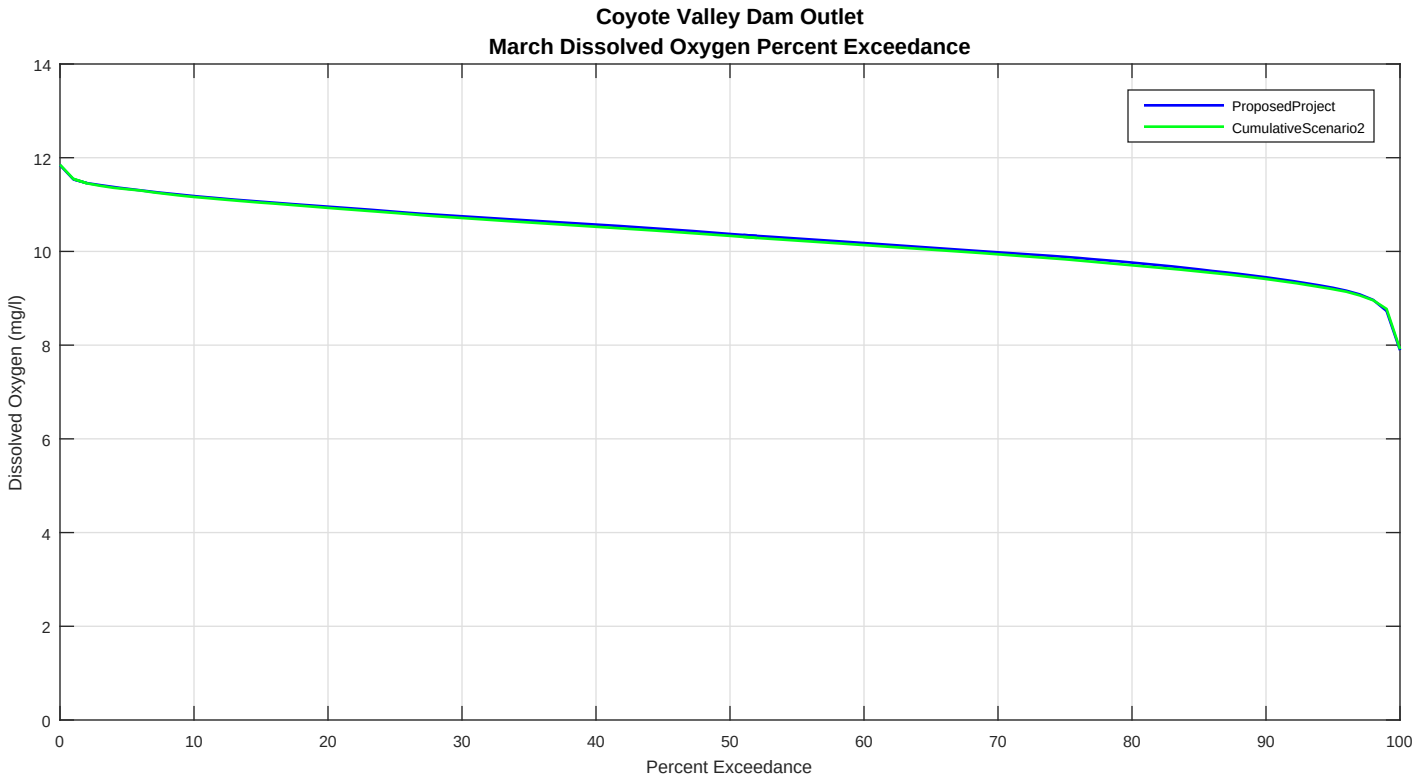
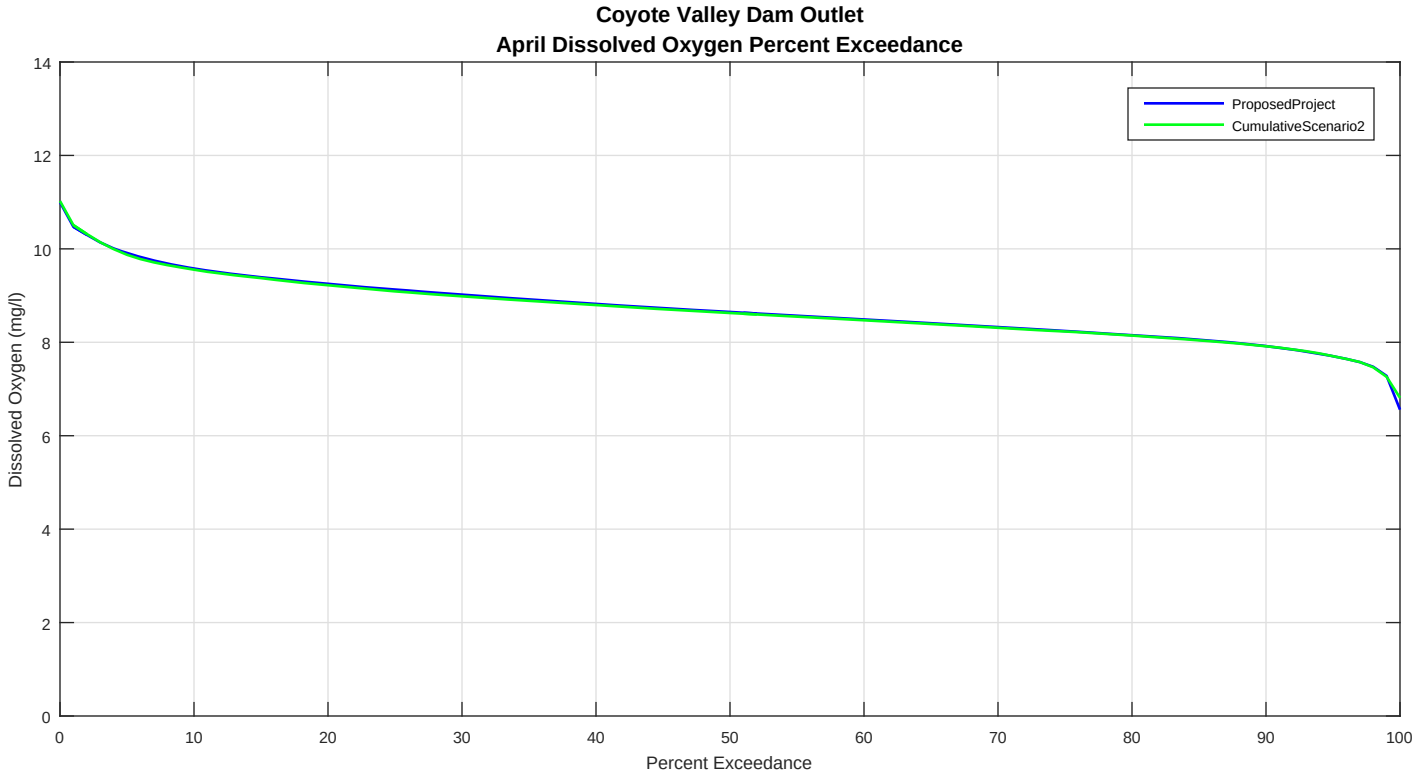

Coyote Valley Dam Outlet
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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4
6
8
10
12
14
0
10
20
30
40
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60
70
80
90
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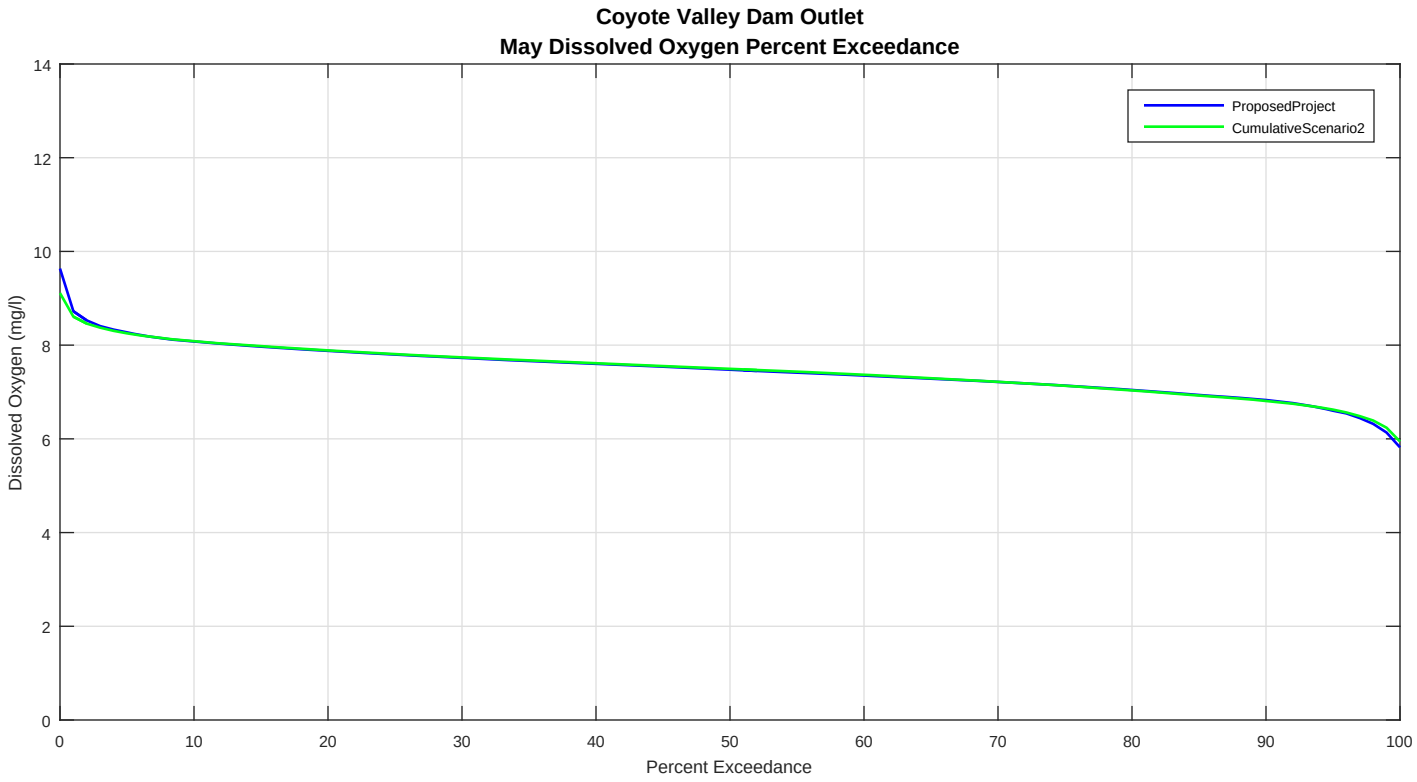
Coyote Valley Dam Outlet
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
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4
6
8
10
12
14
0
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30
40
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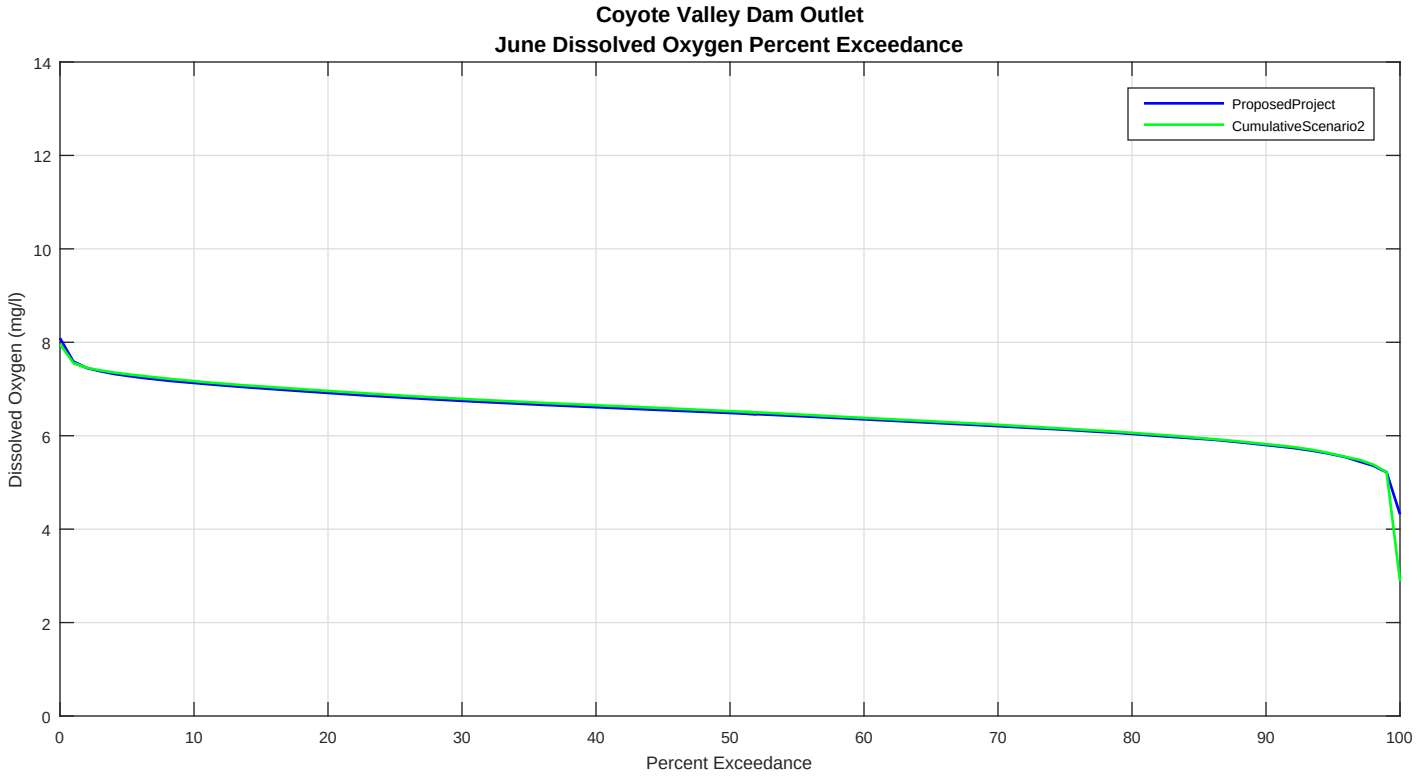
90
100


Coyote Valley Dam Outlet
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
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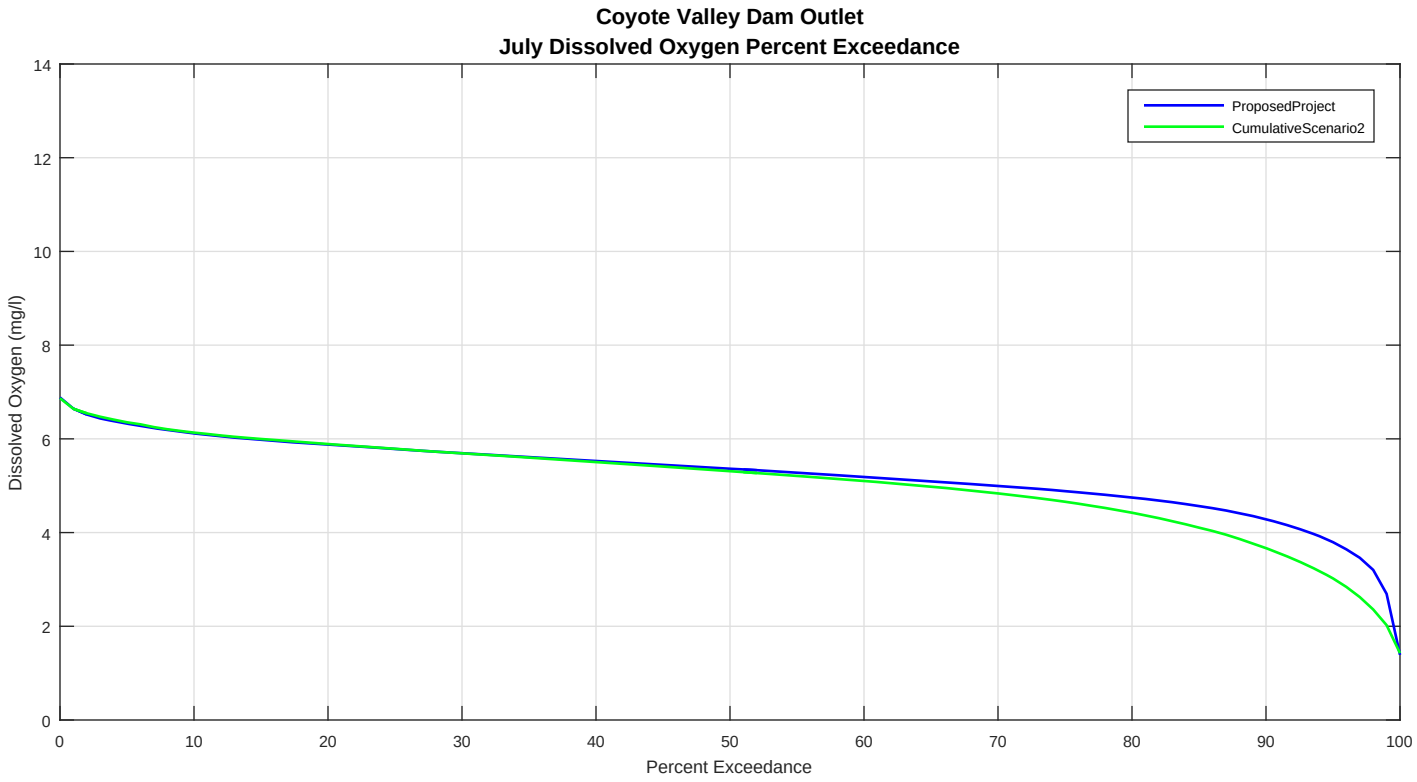
Coyote Valley Dam Outlet
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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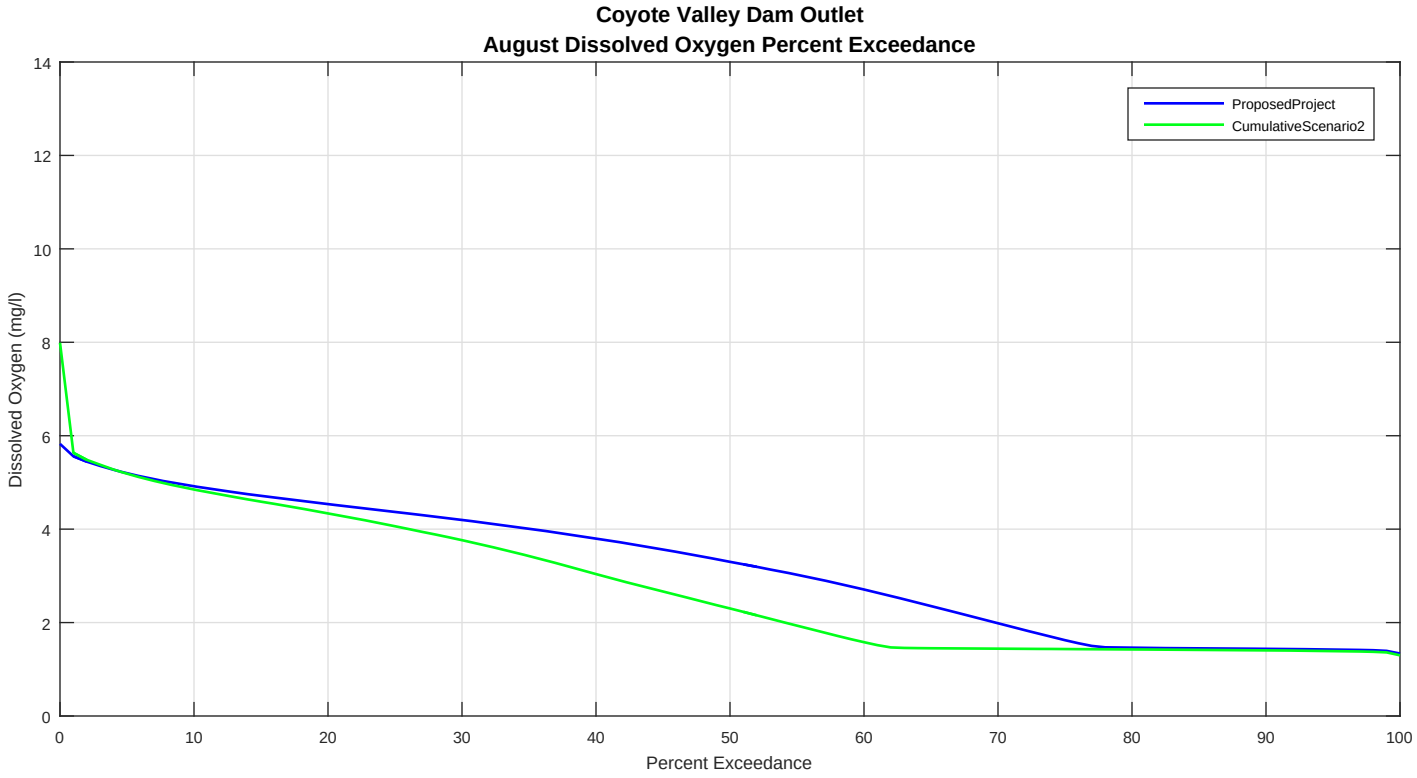
Coyote Valley Dam Outlet
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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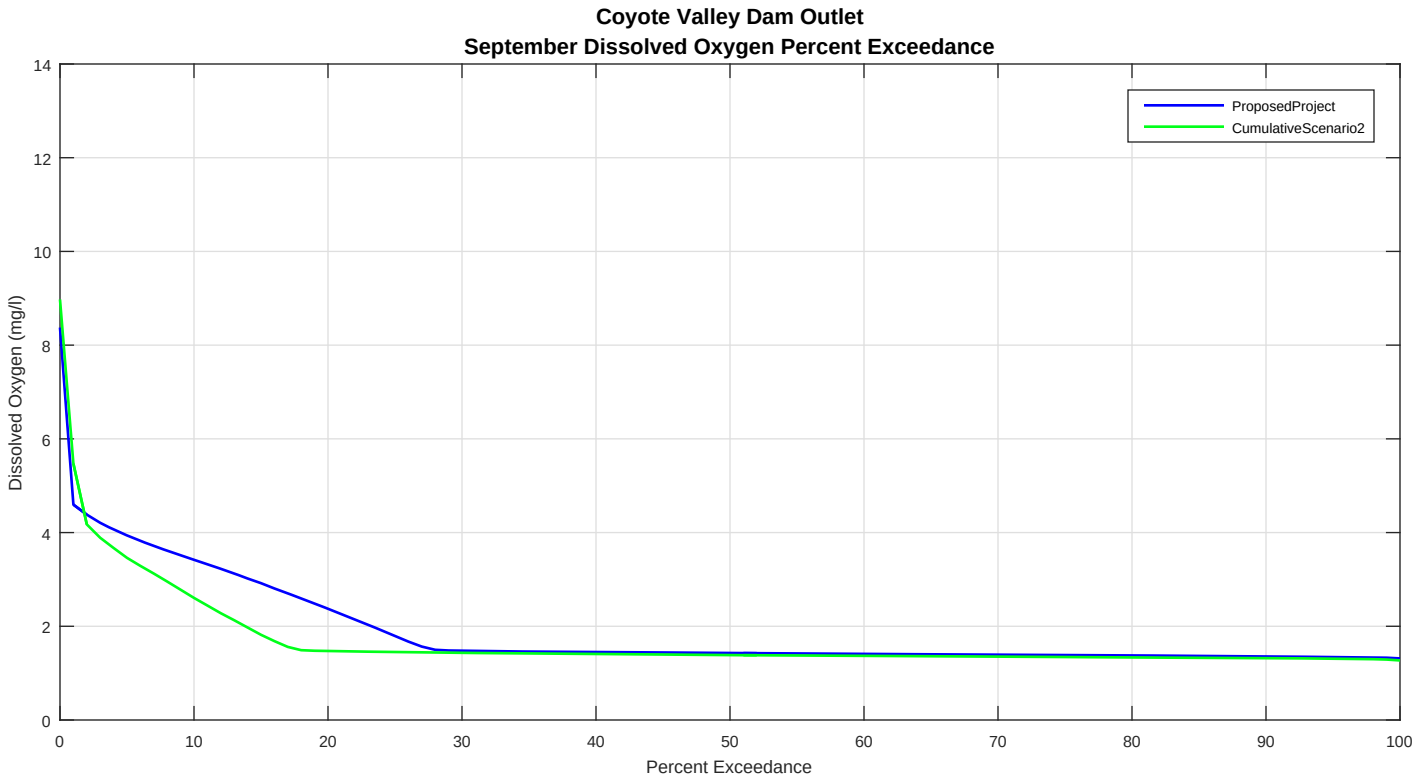
Coyote Valley Dam Outlet
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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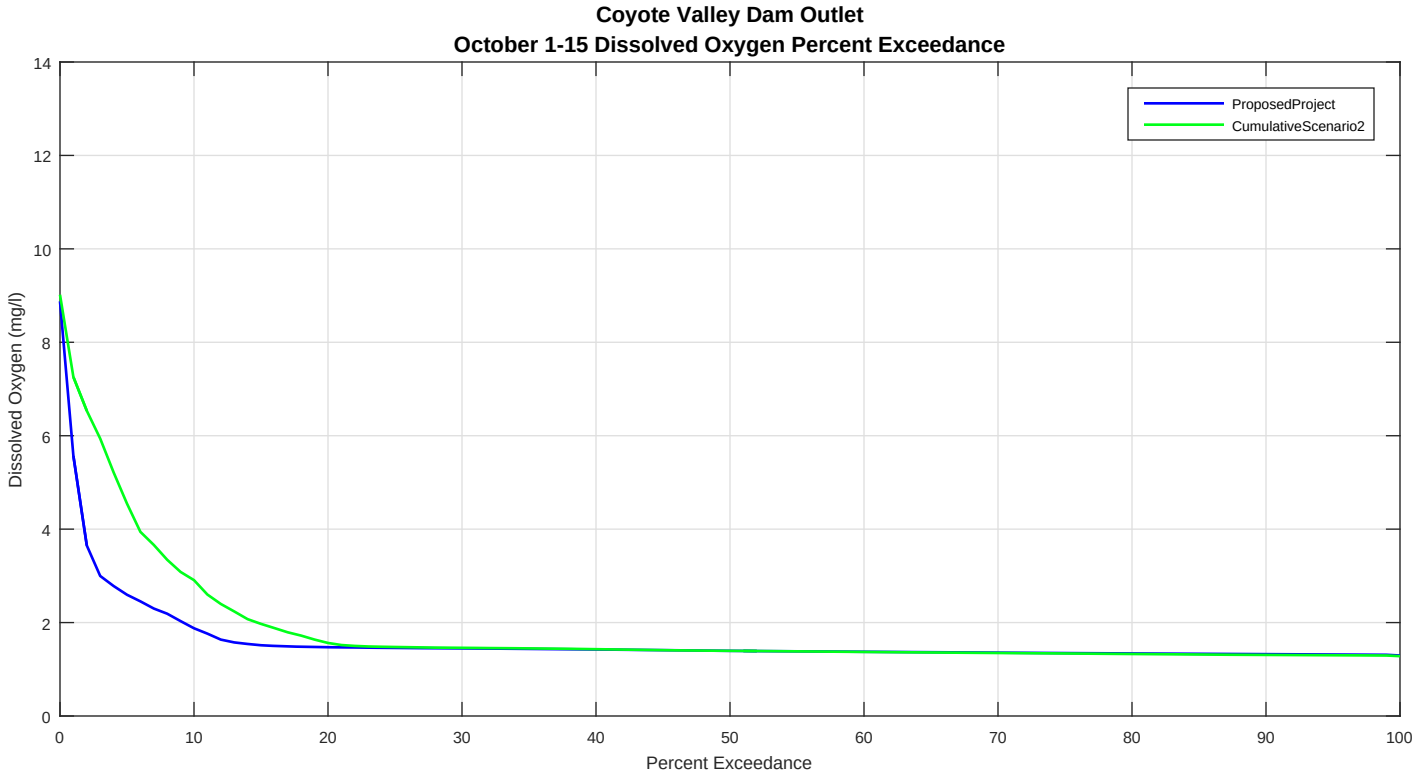
Coyote Valley Dam Outlet
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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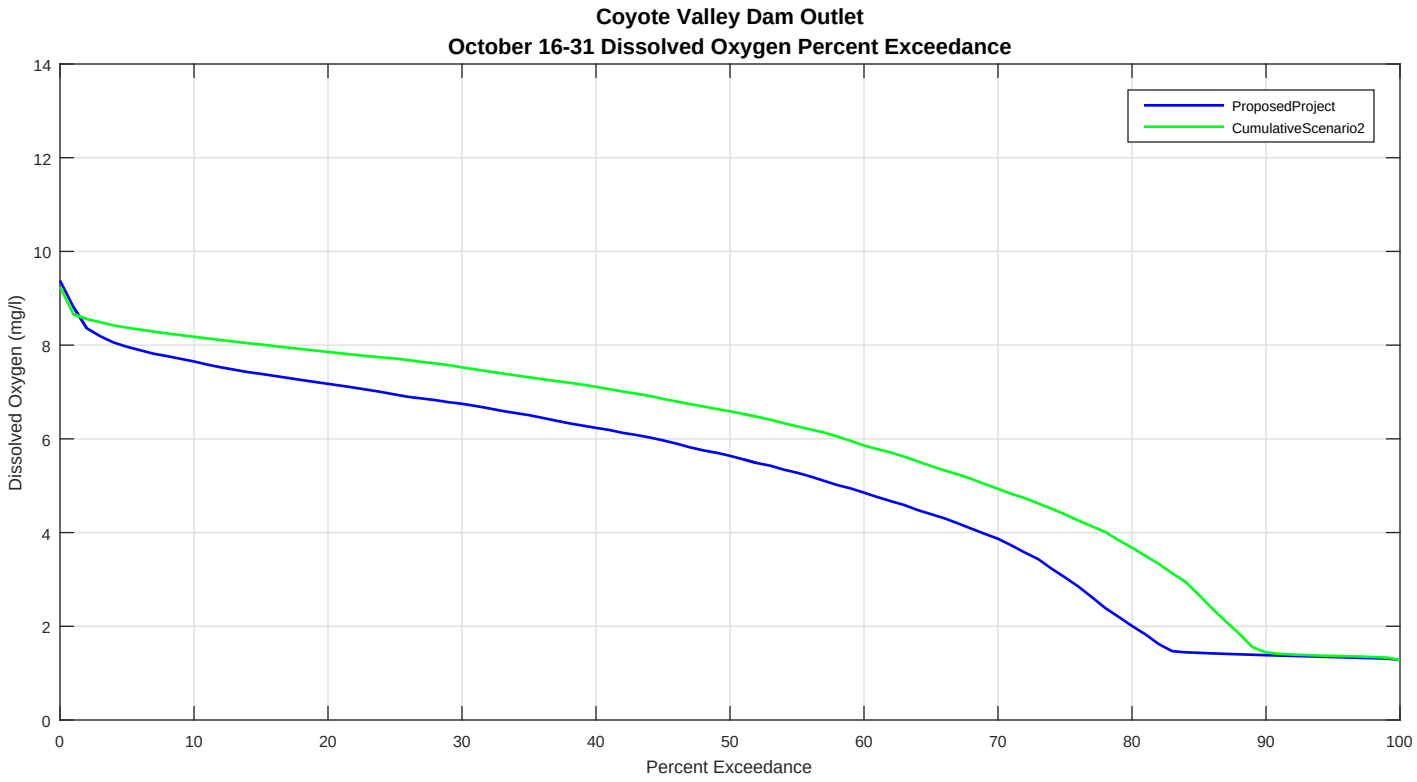
Coyote Valley Dam Outlet
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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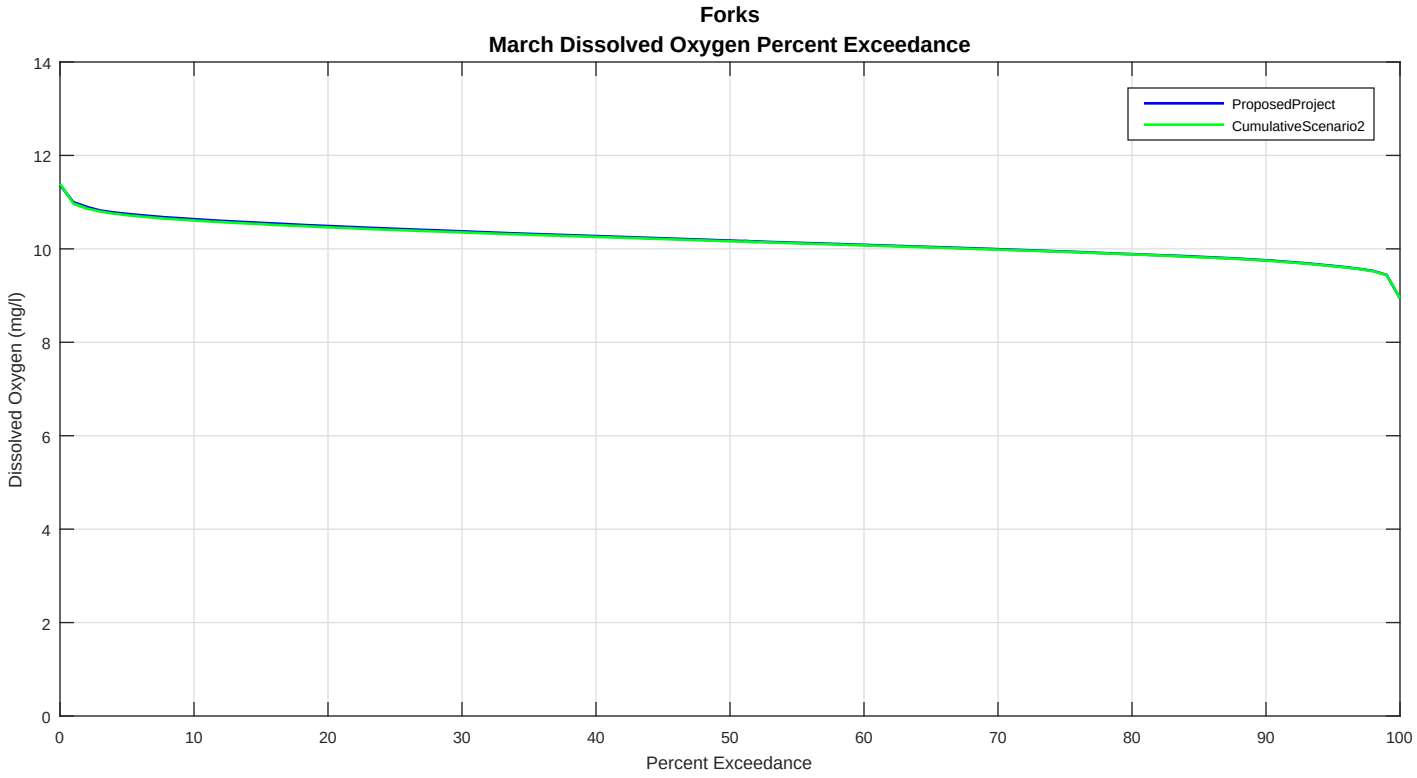
Forks
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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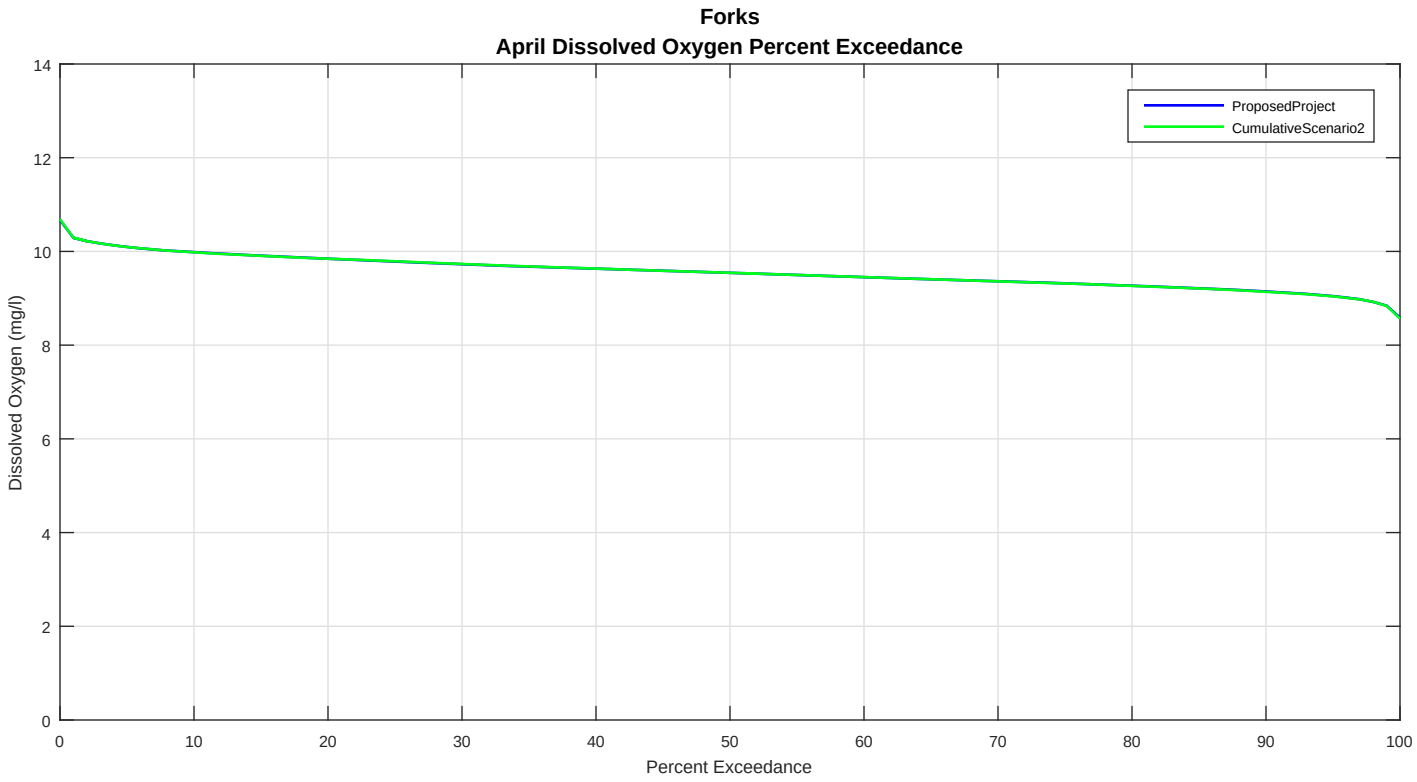
Forks
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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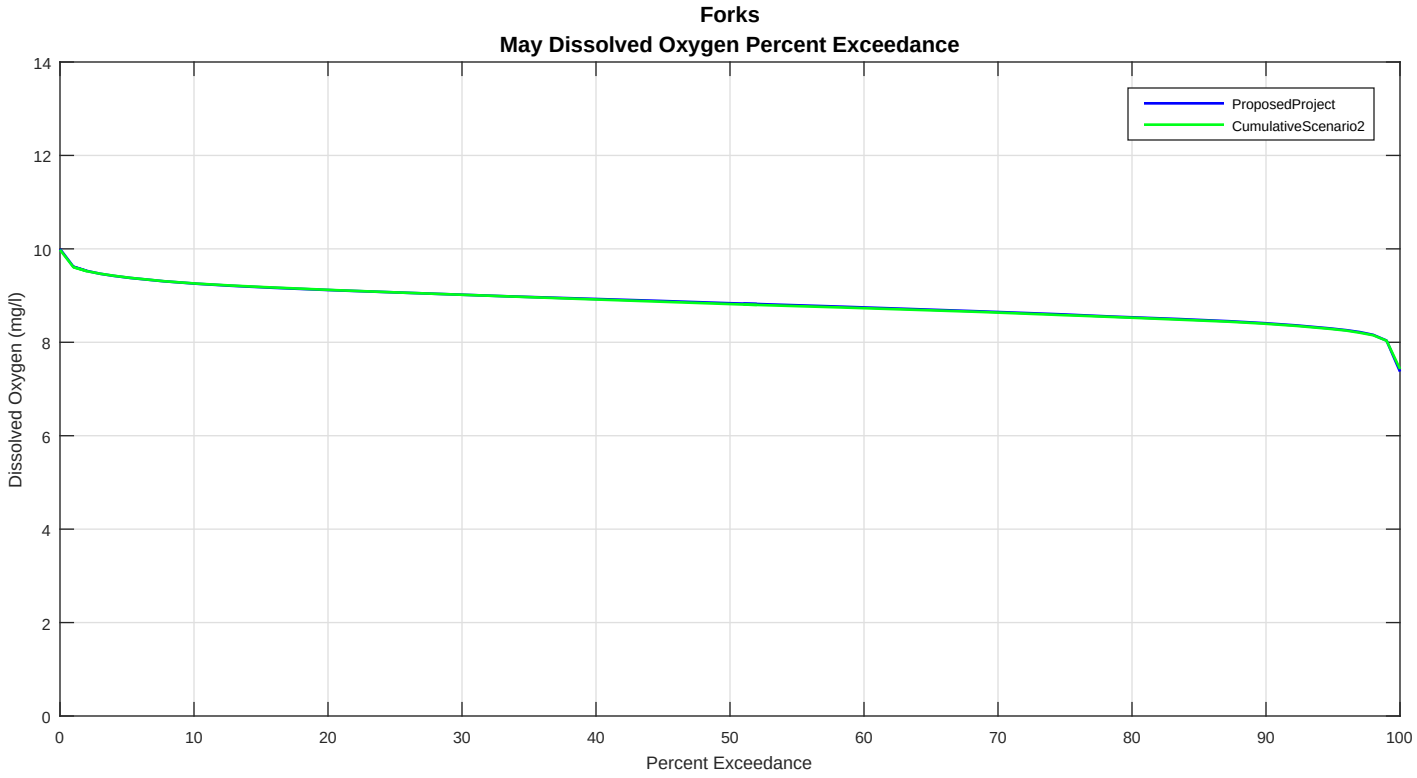
Forks
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ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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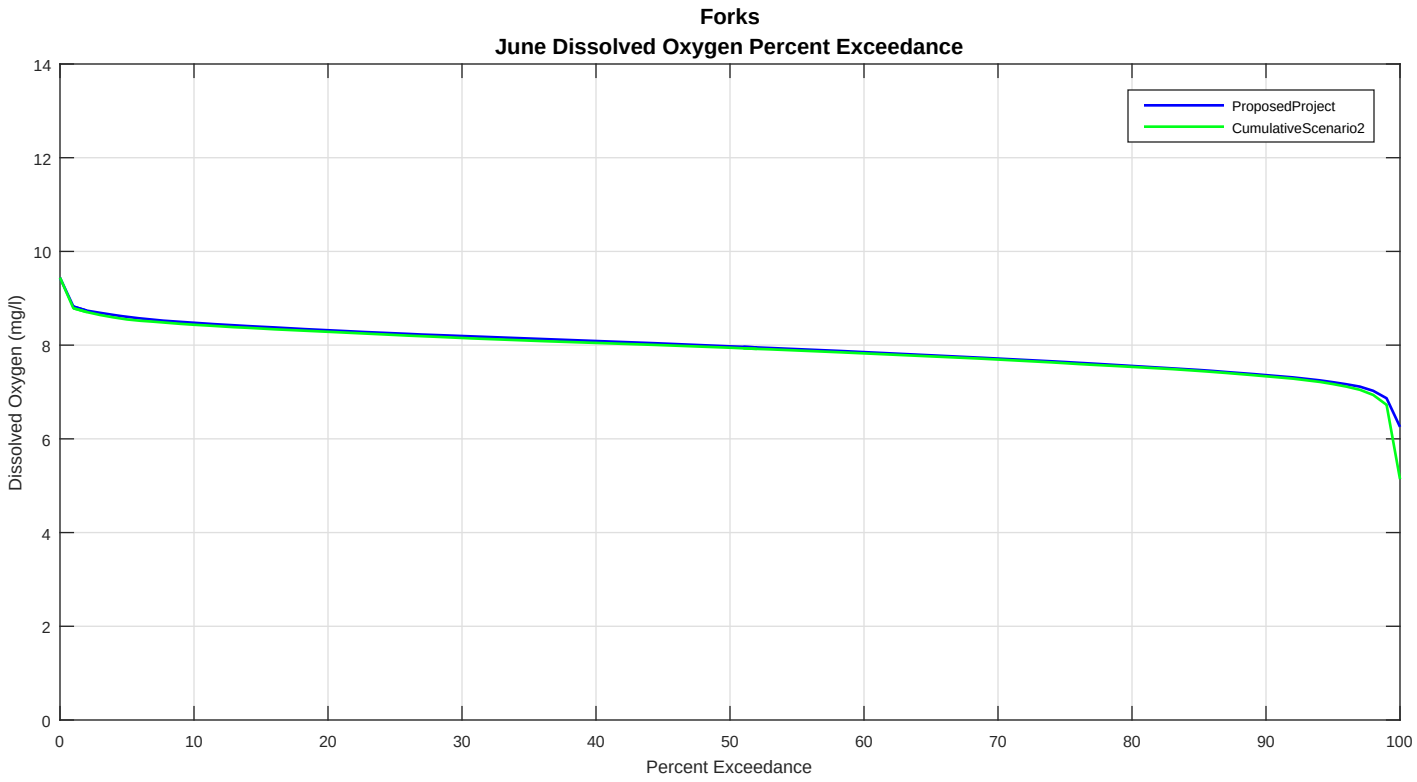
Forks
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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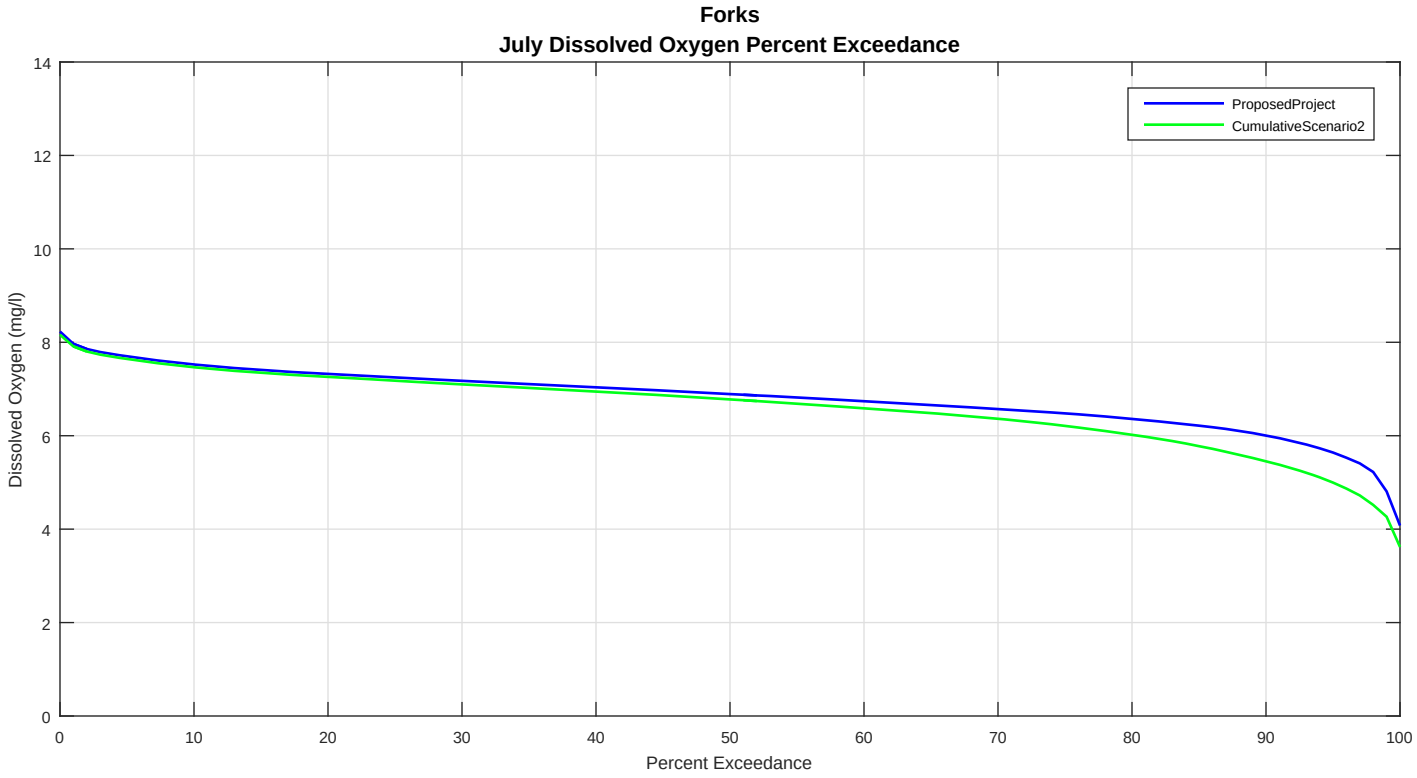
Forks
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
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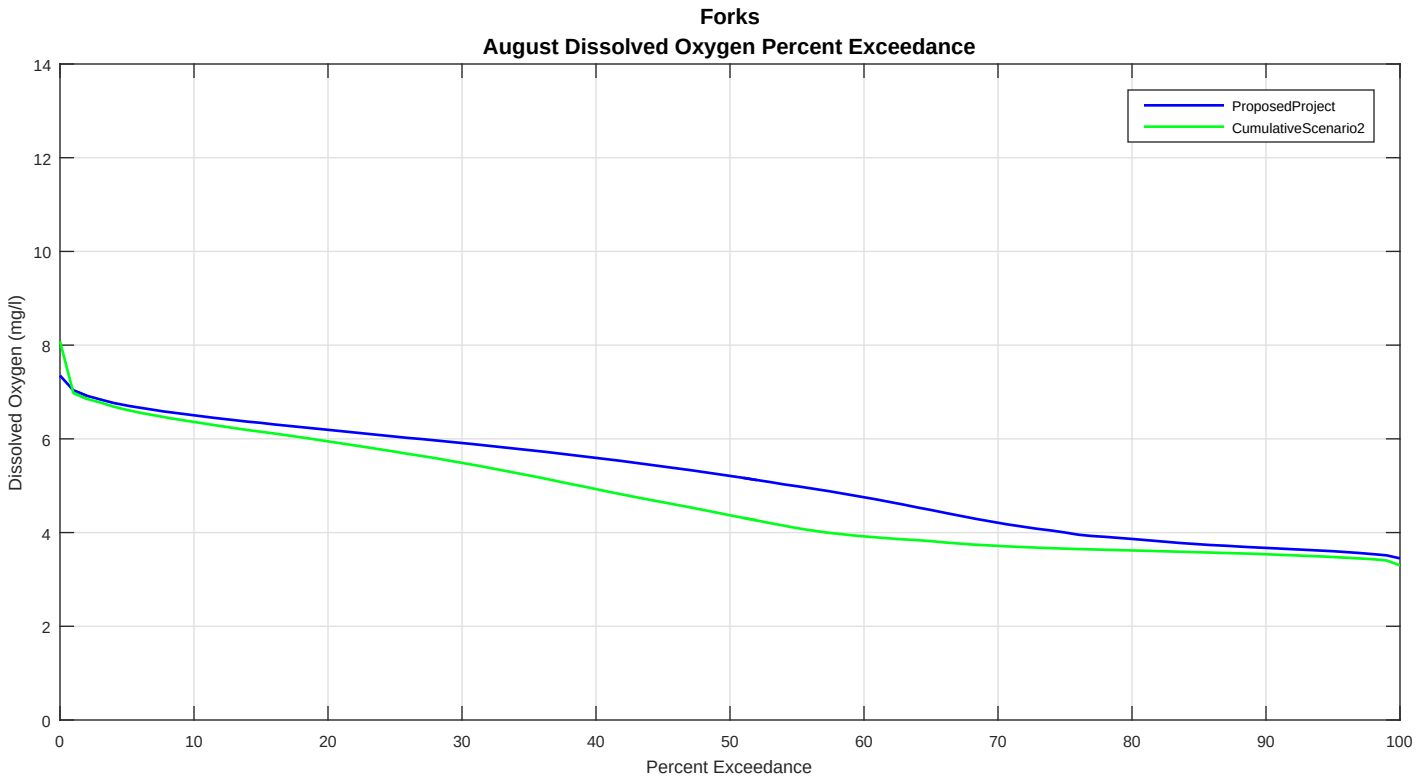
Forks
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
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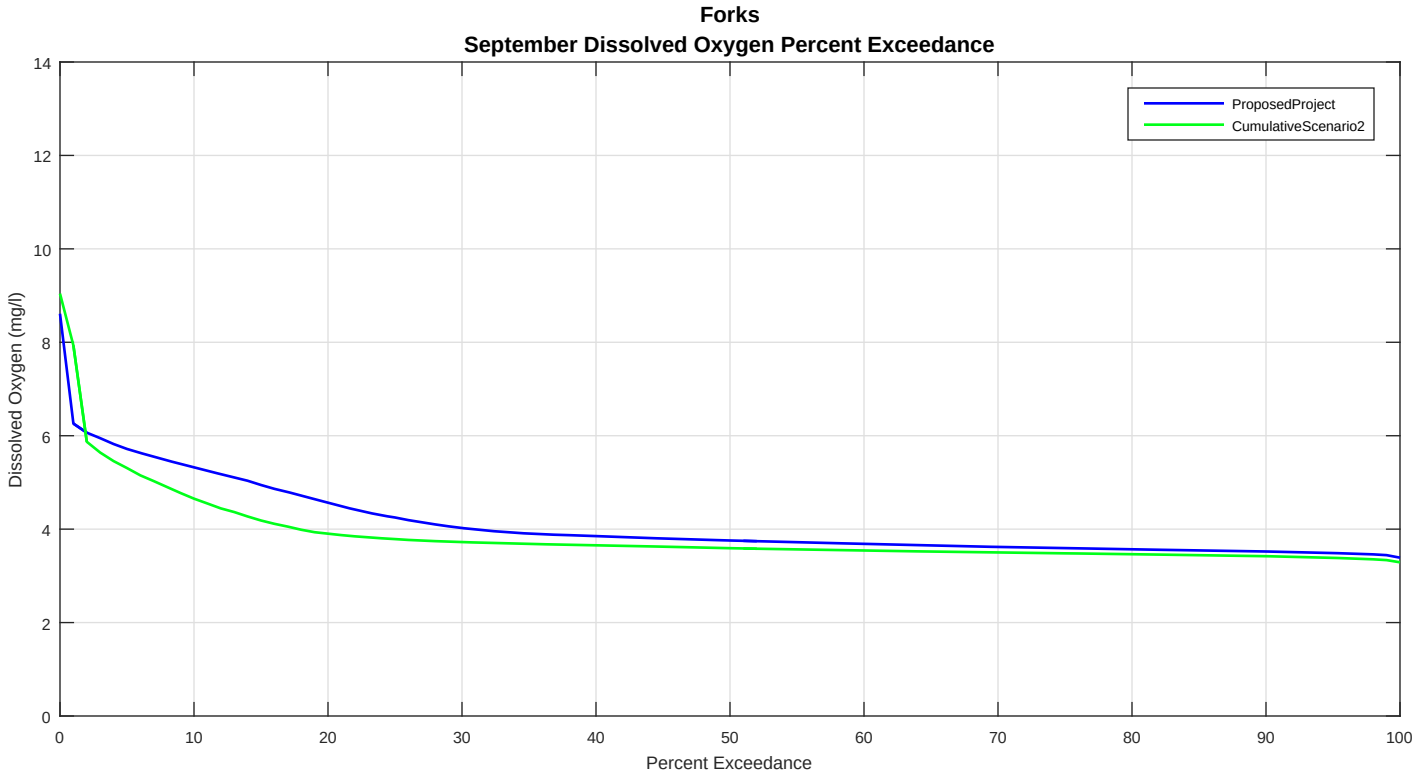
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September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
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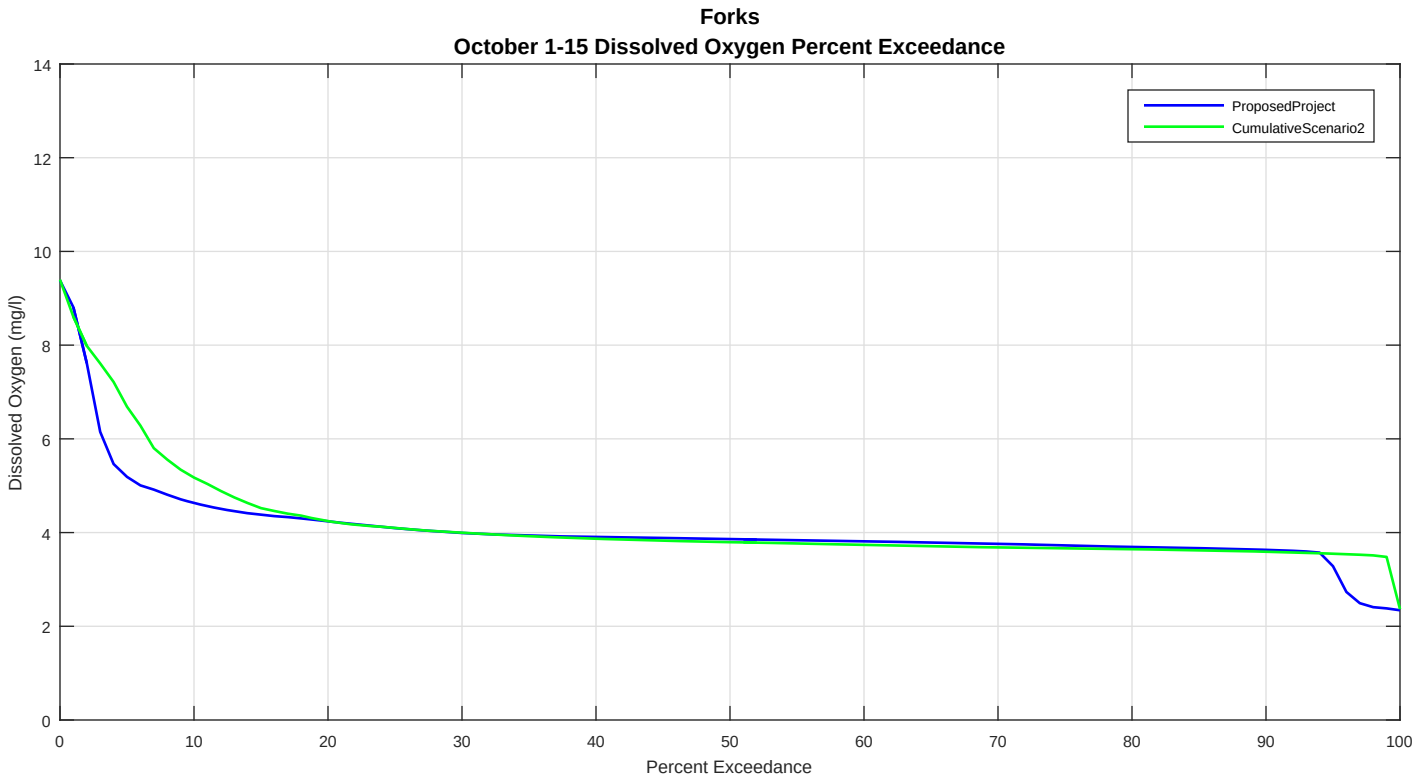
Forks
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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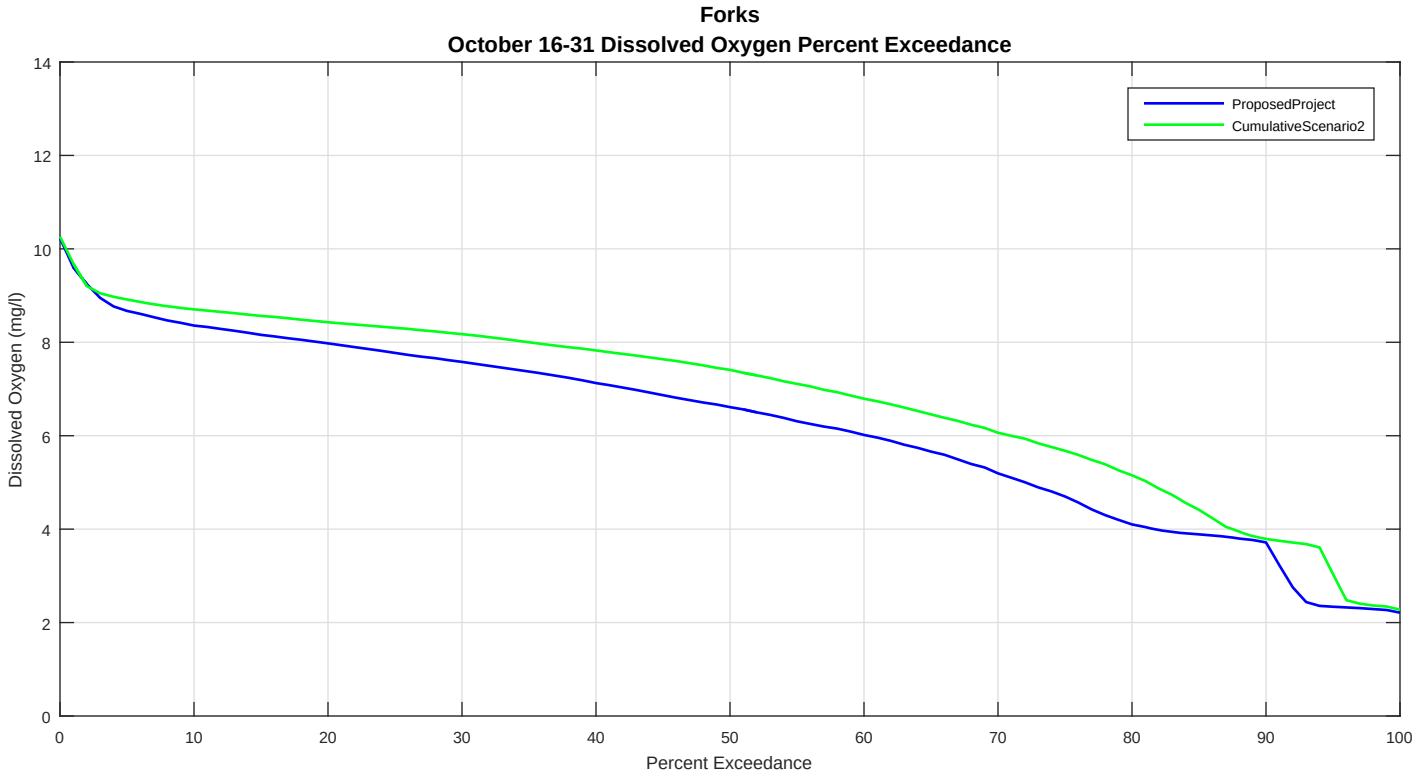
Forks
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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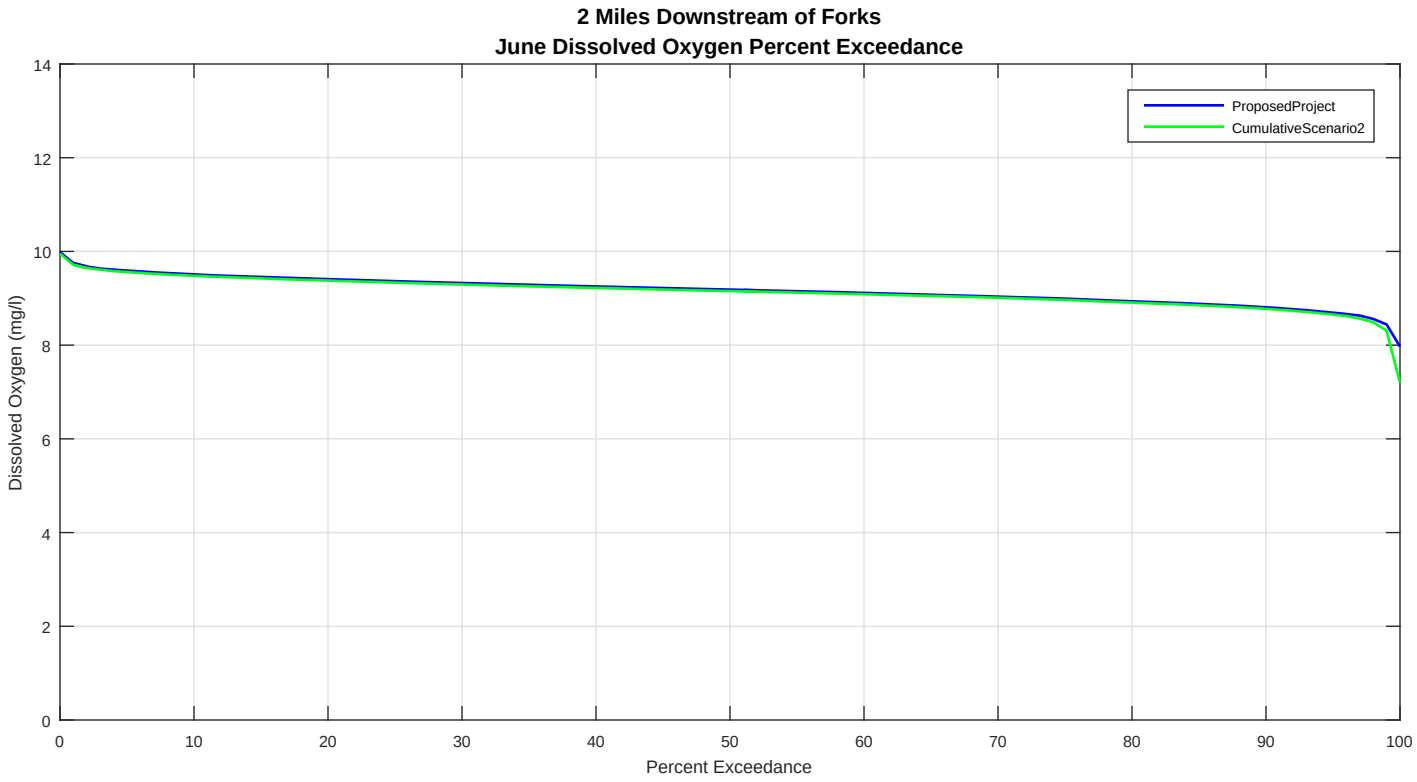
2 Miles Downstream of Forks
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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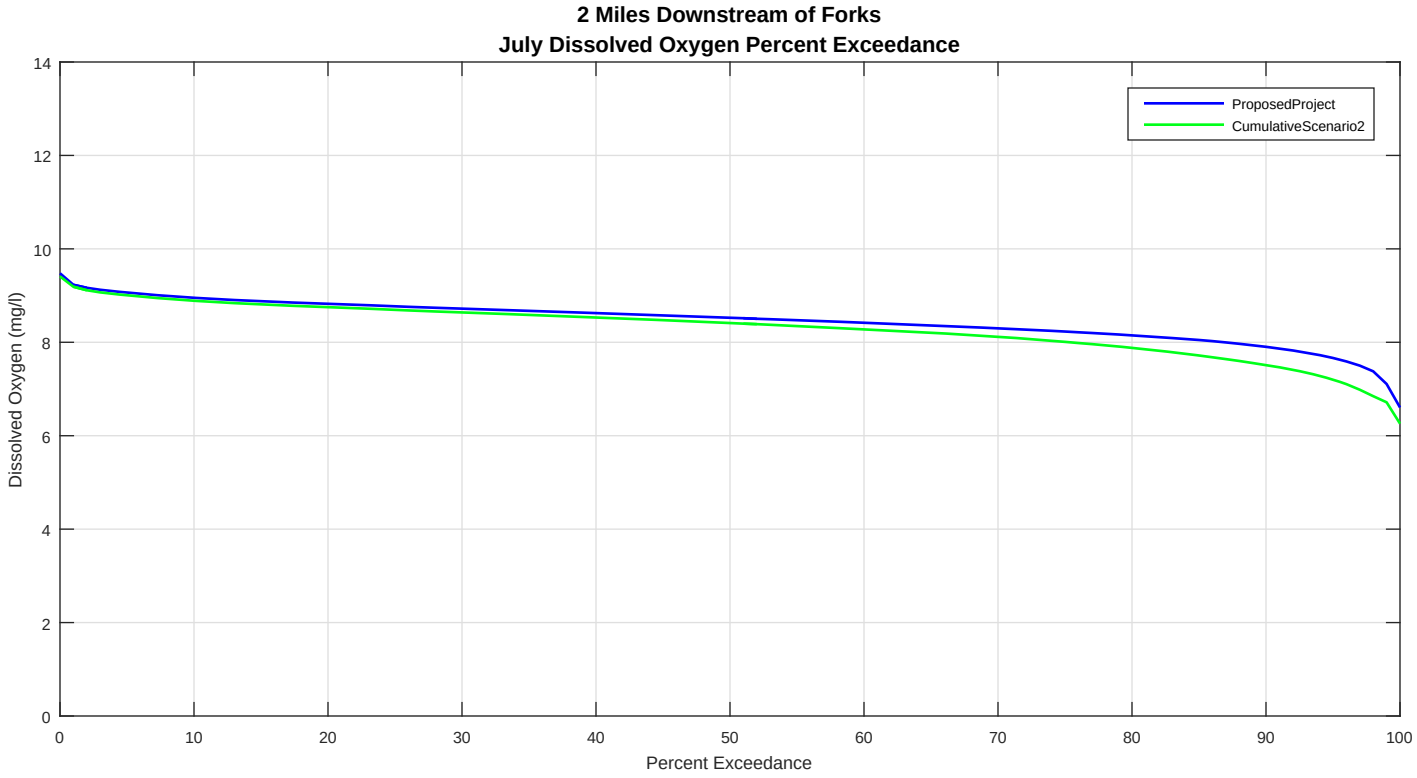
2 Miles Downstream of Forks
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
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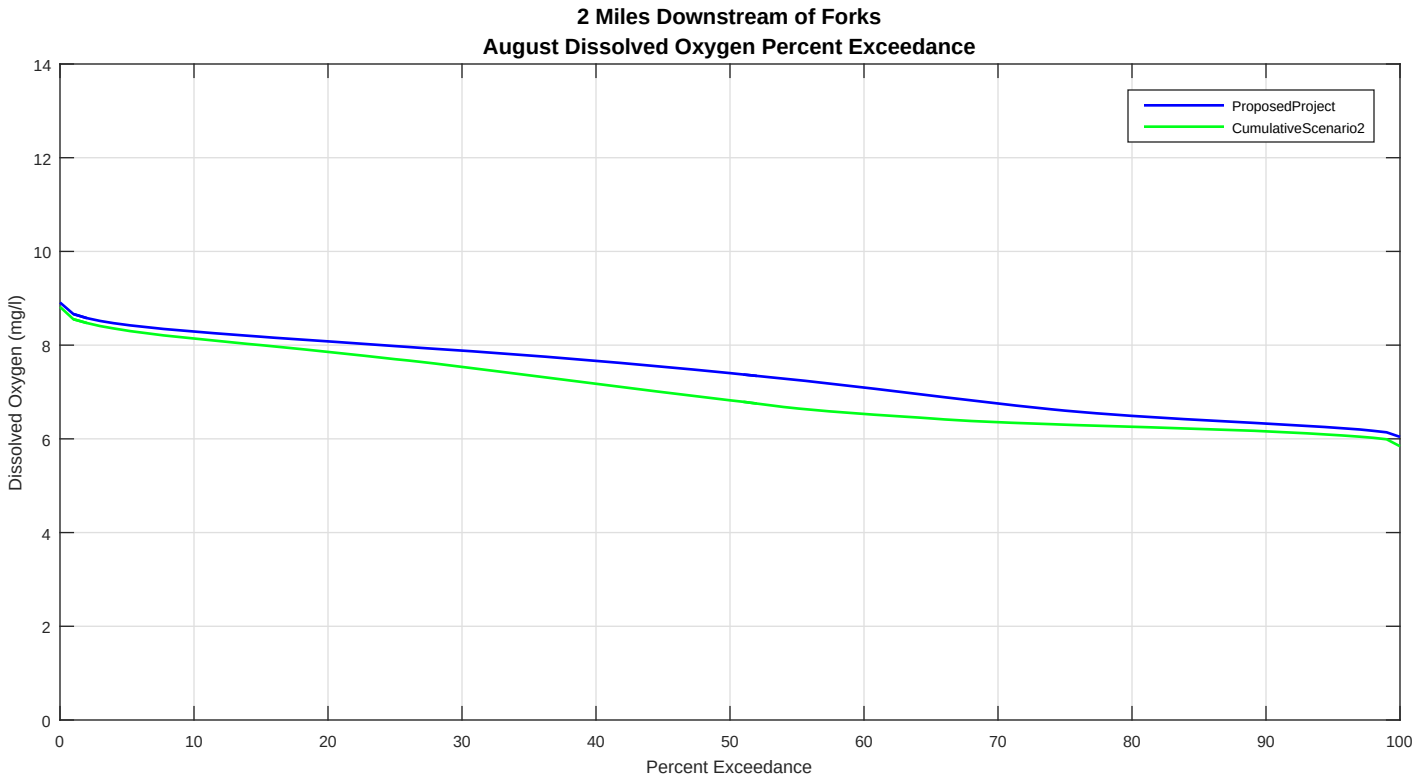
2 Miles Downstream of Forks
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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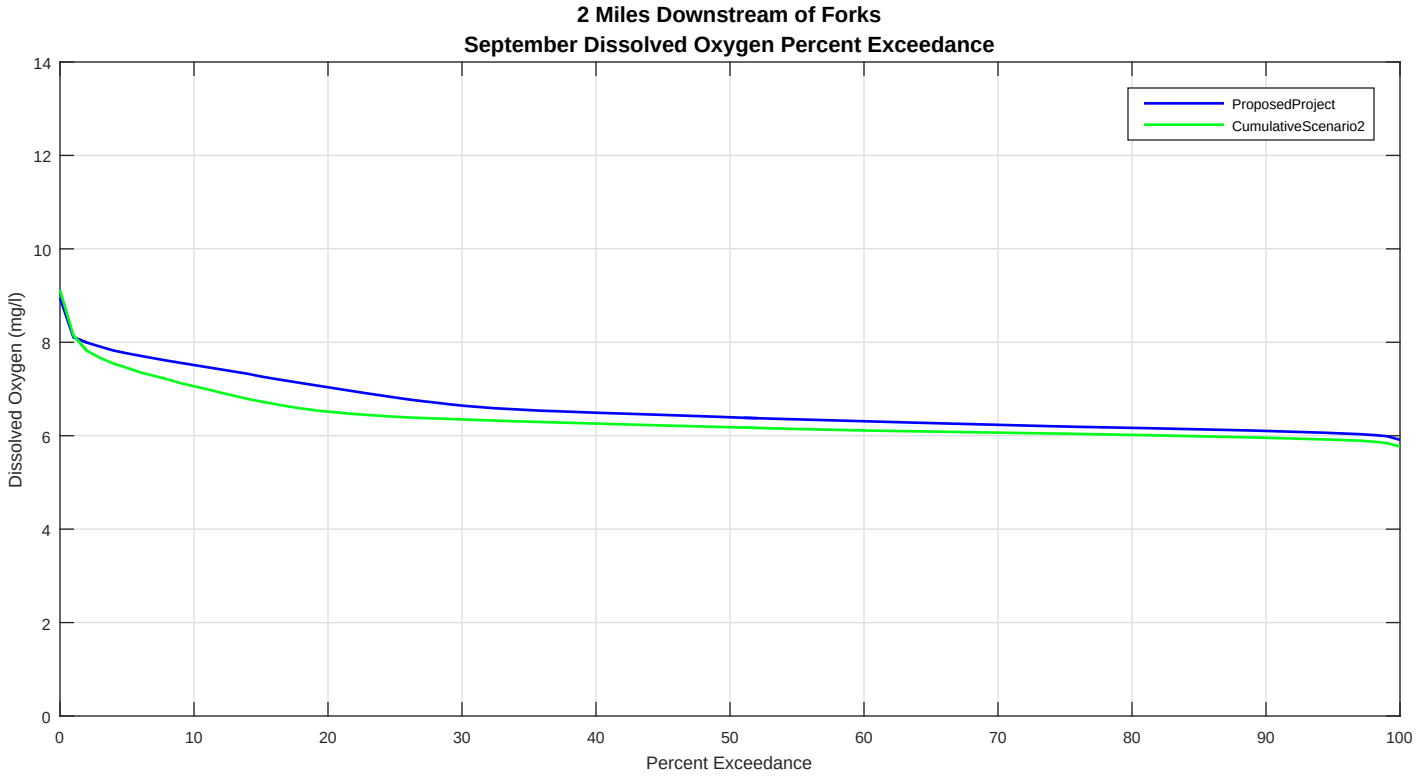
2 Miles Downstream of Forks
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
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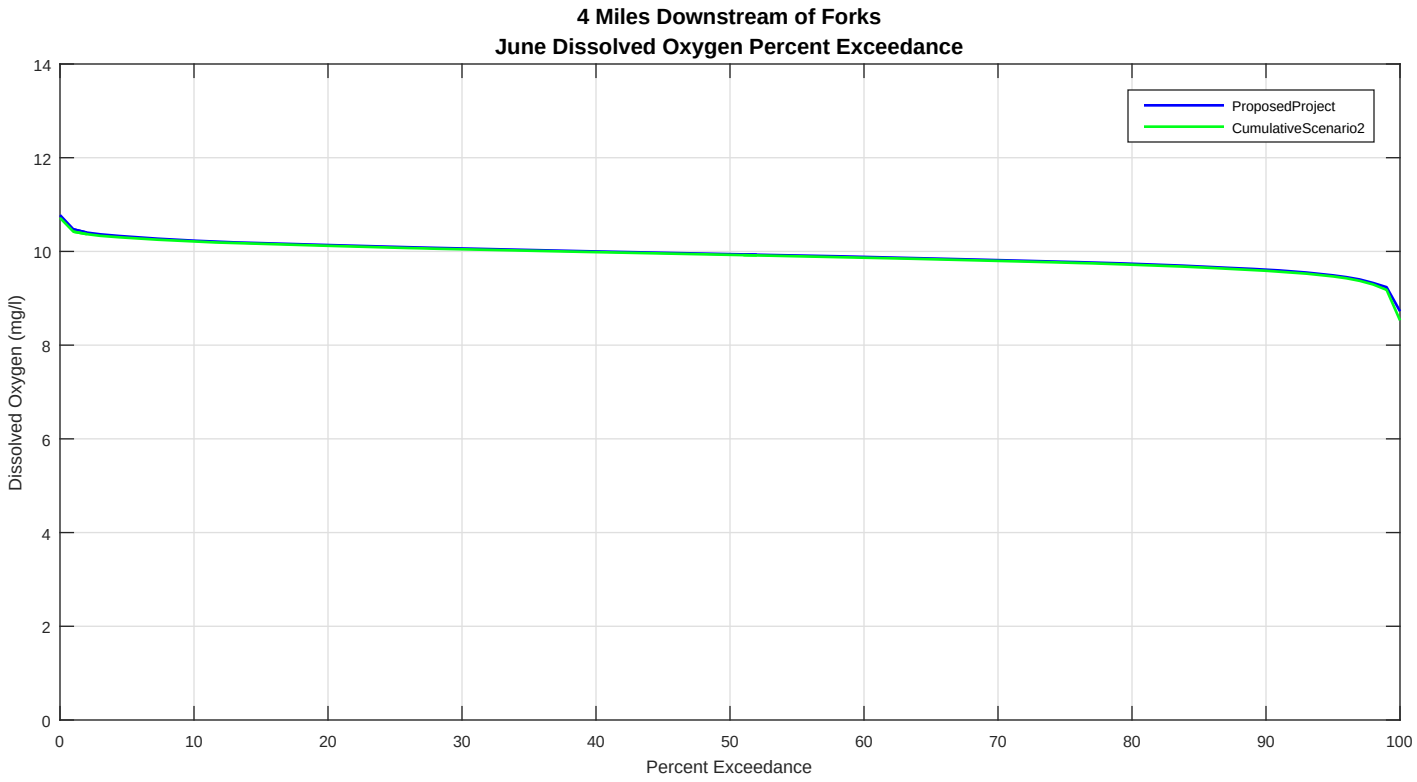
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June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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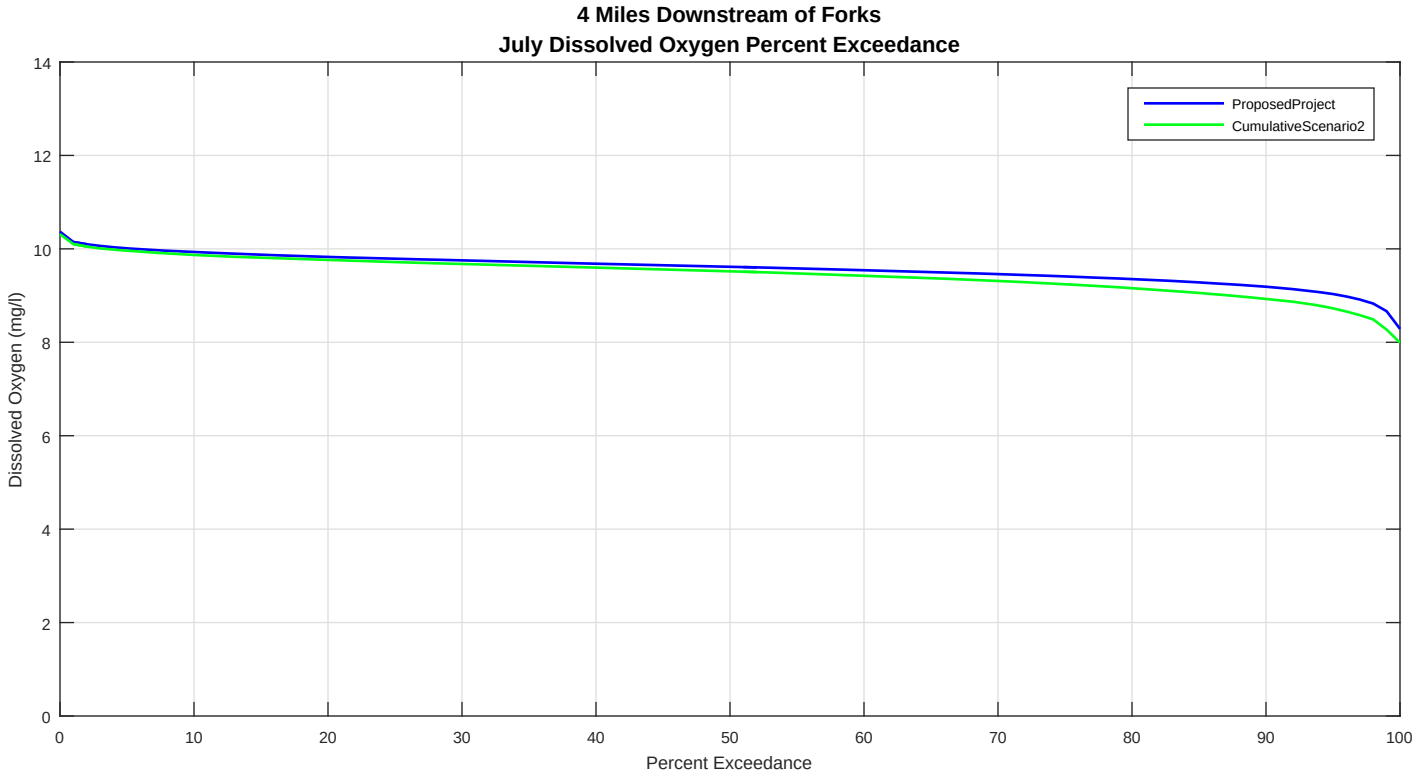
4 Miles Downstream of Forks
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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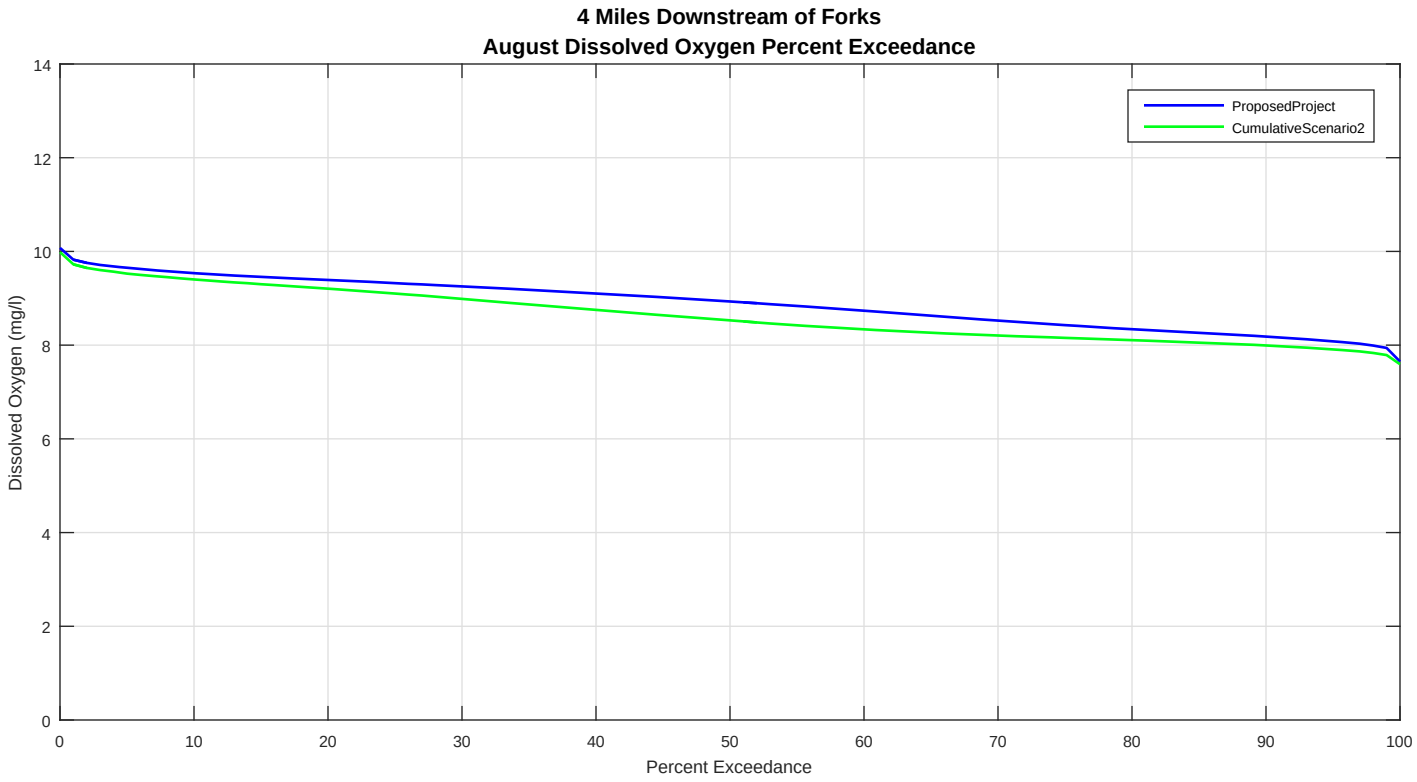
4 Miles Downstream of Forks
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
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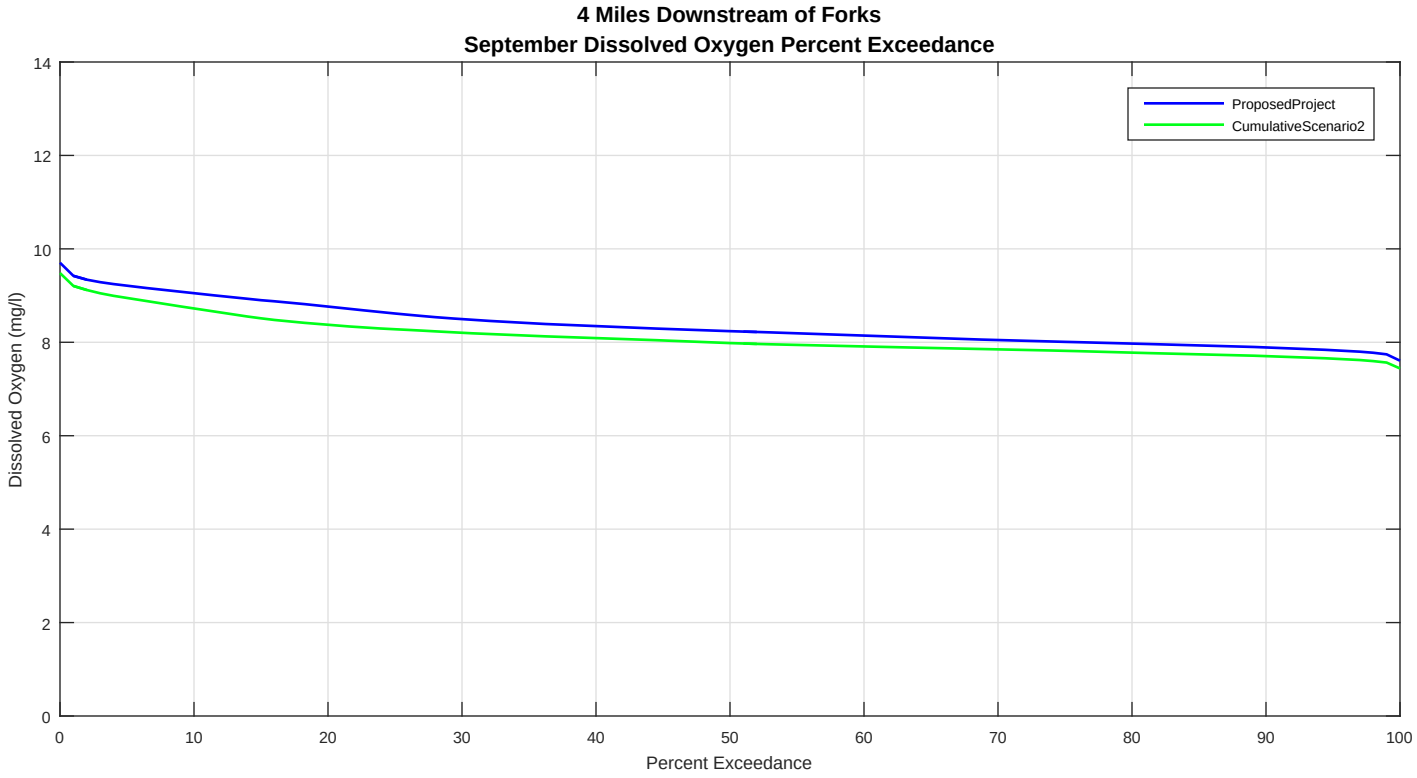
4 Miles Downstream of Forks
September Dissolved Oxygen Percent Exceedance
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CumulativeScenario2
Dissolved Oxygen (mg/l)
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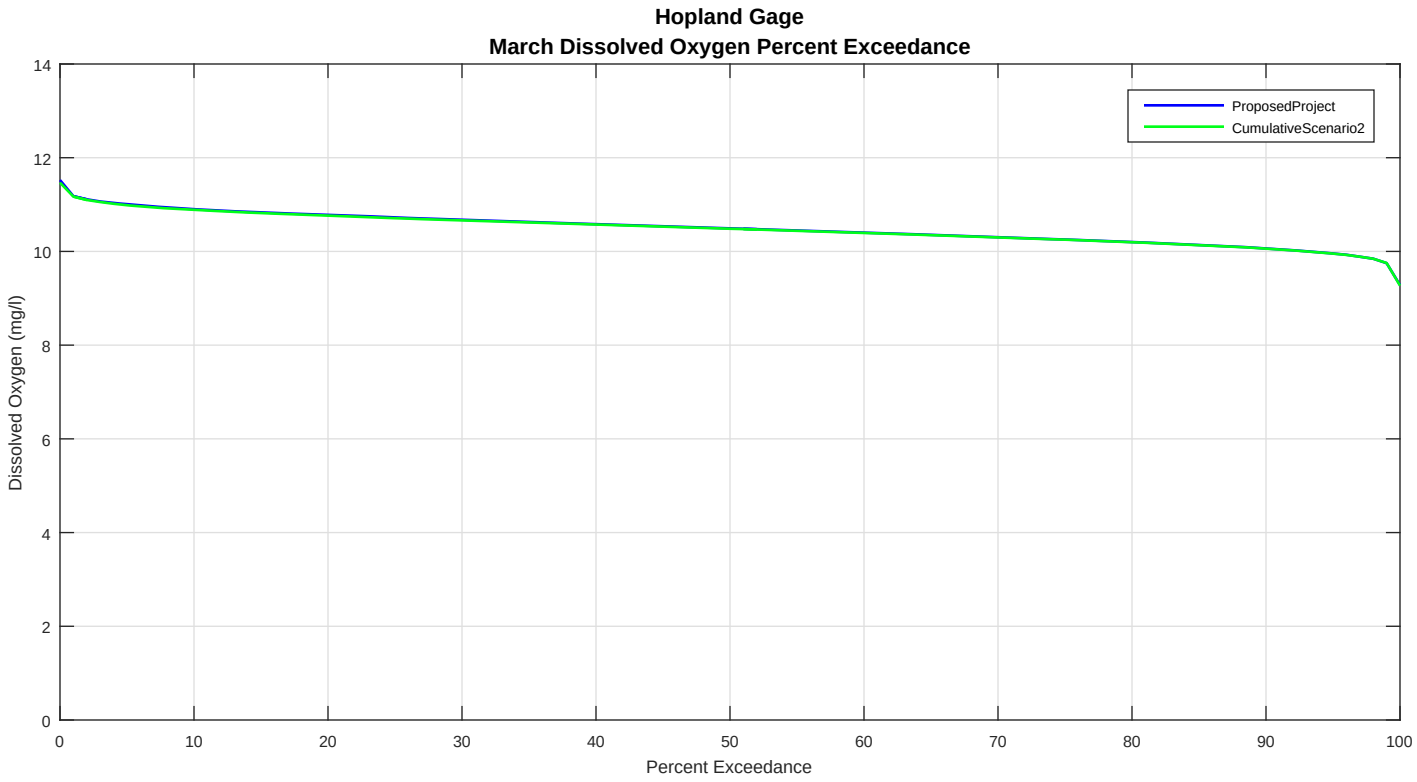
Hopland Gage
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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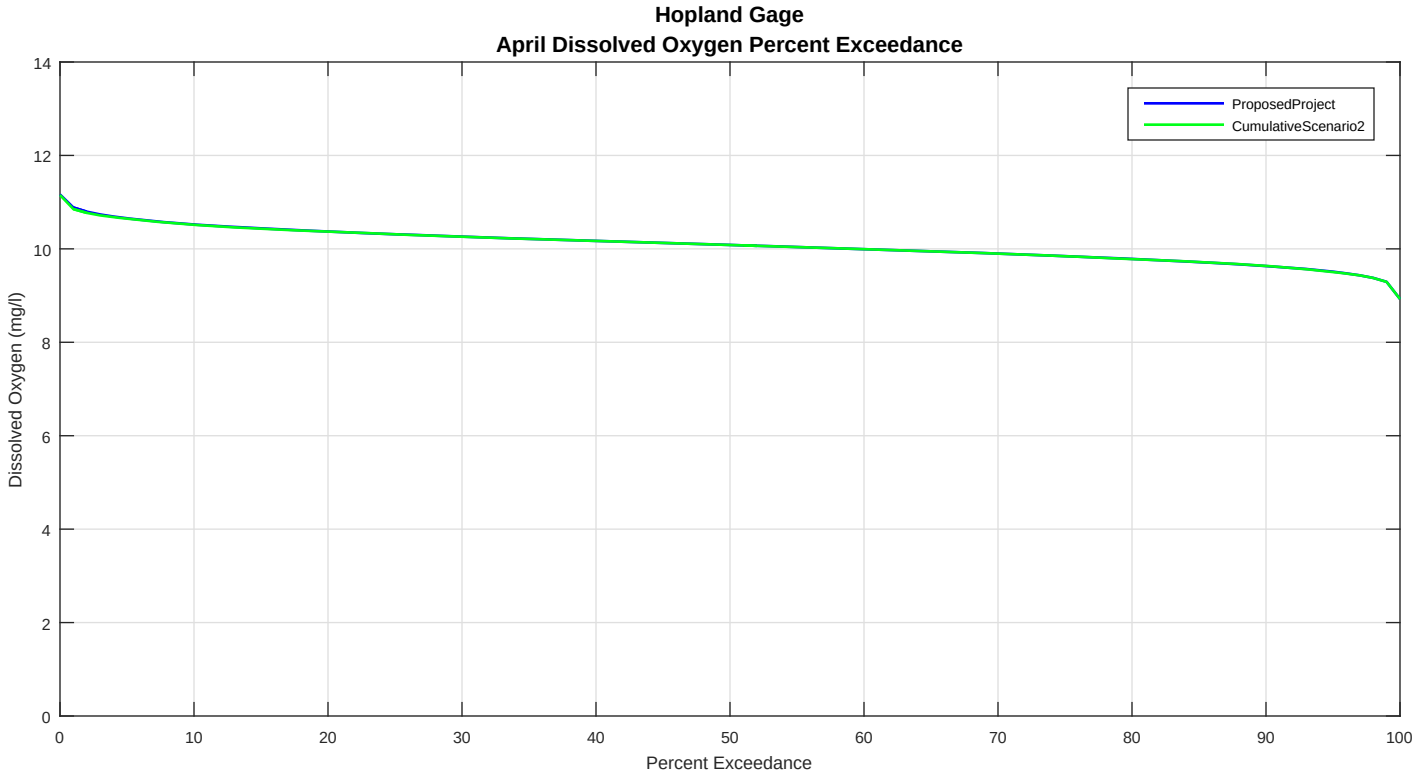
Hopland Gage
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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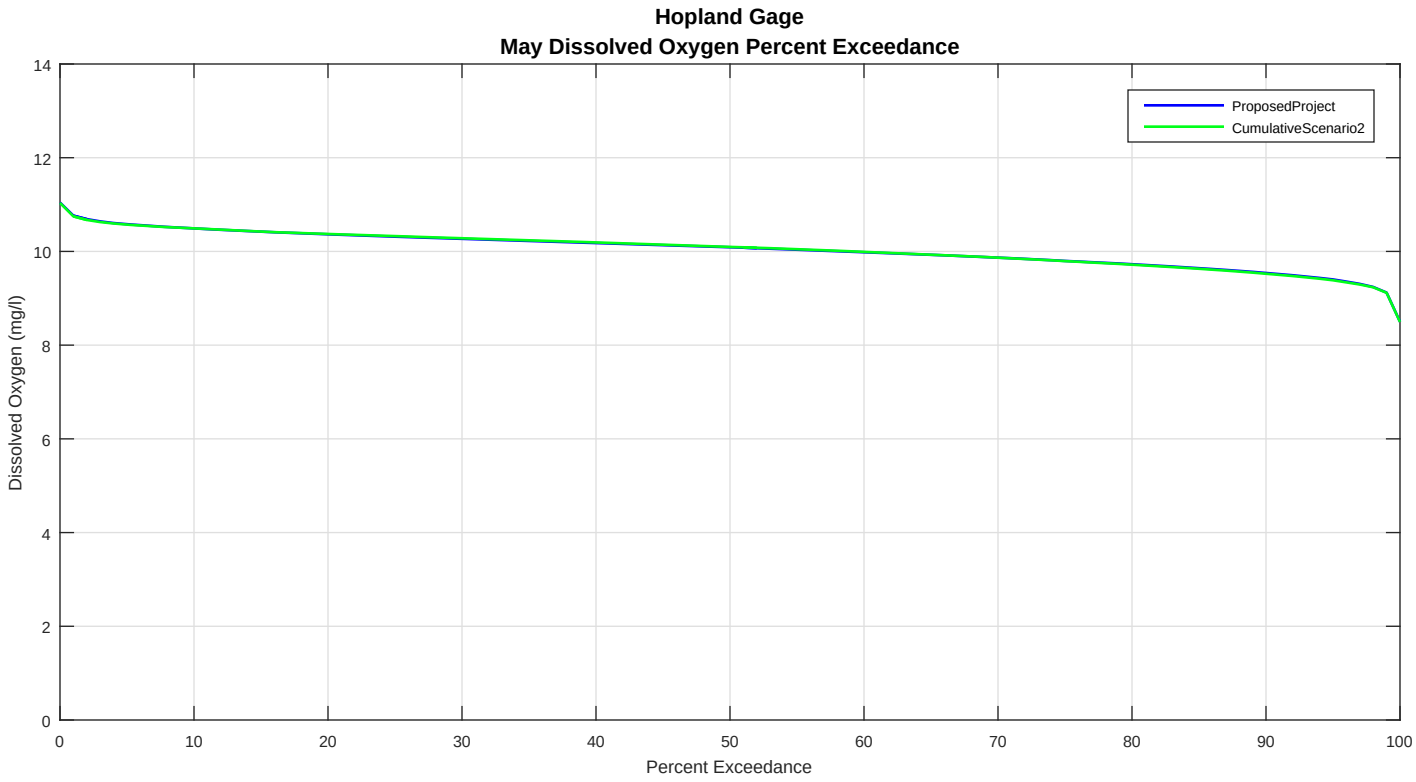
Hopland Gage
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
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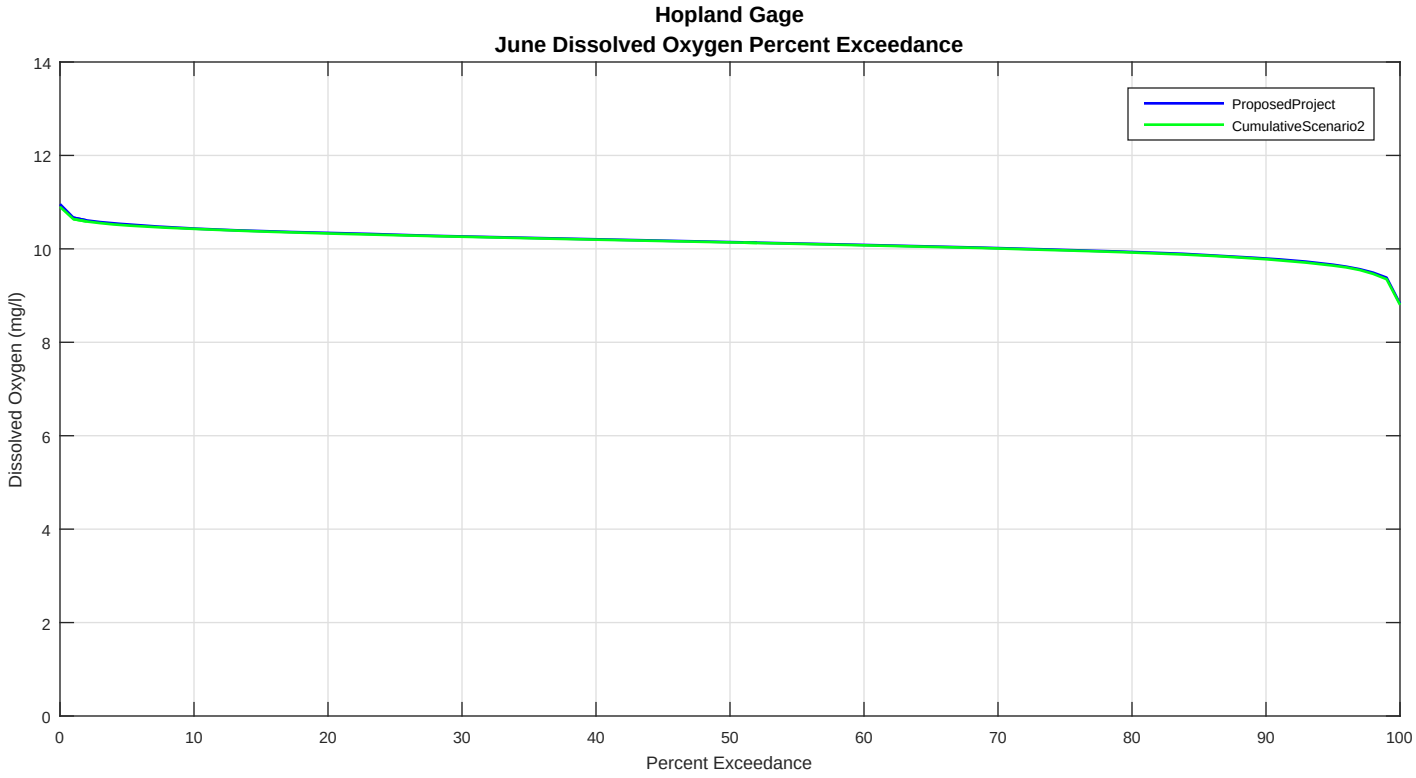
Hopland Gage
June Dissolved Oxygen Percent Exceedance
ProposedProject
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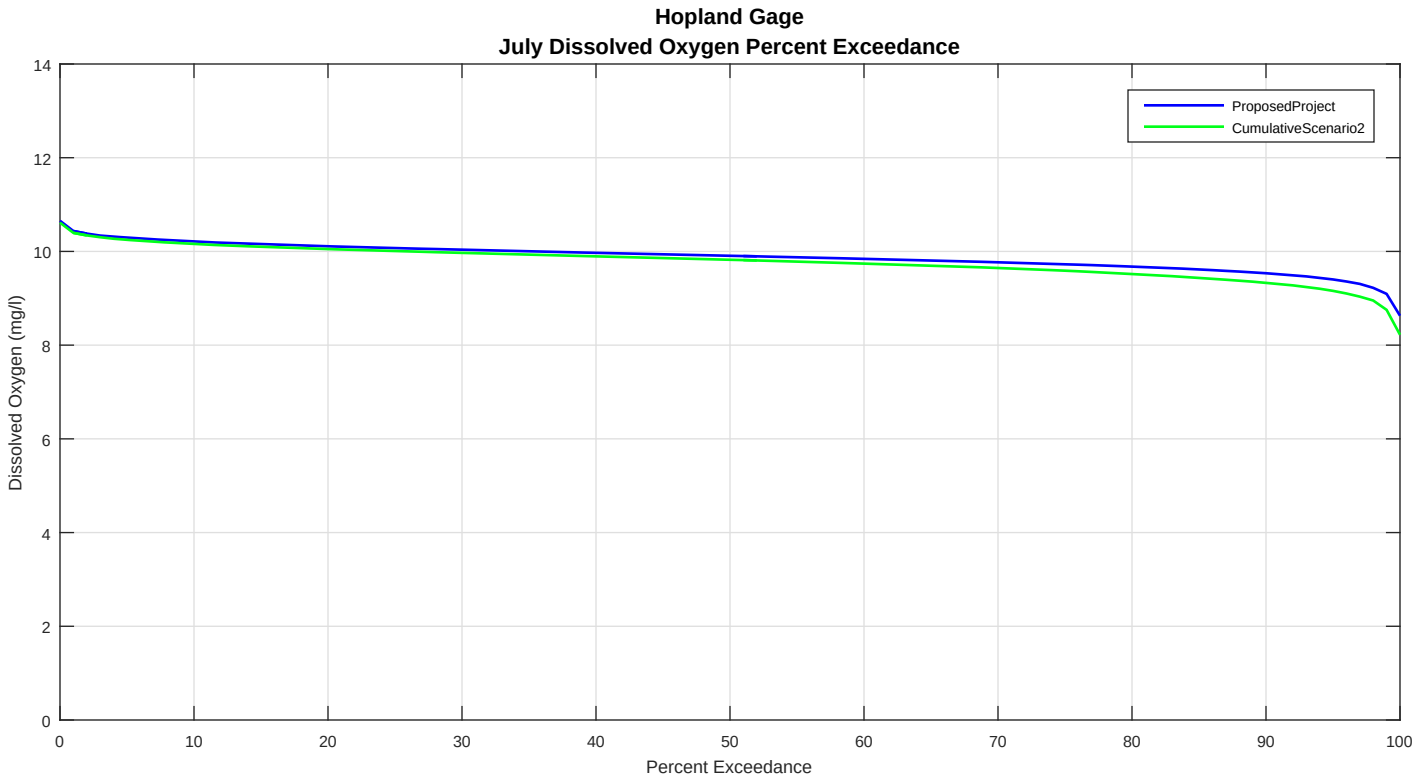
Hopland Gage
July Dissolved Oxygen Percent Exceedance
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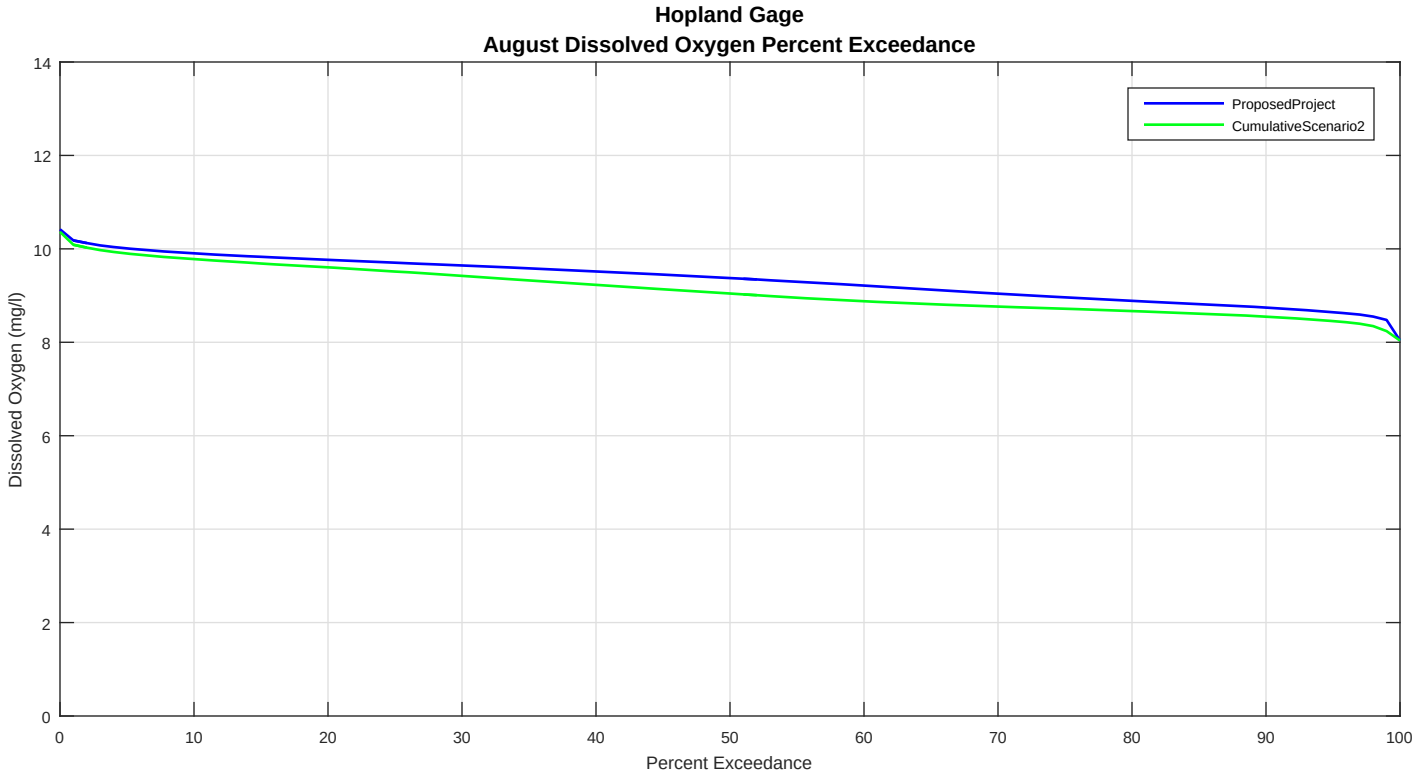
Hopland Gage
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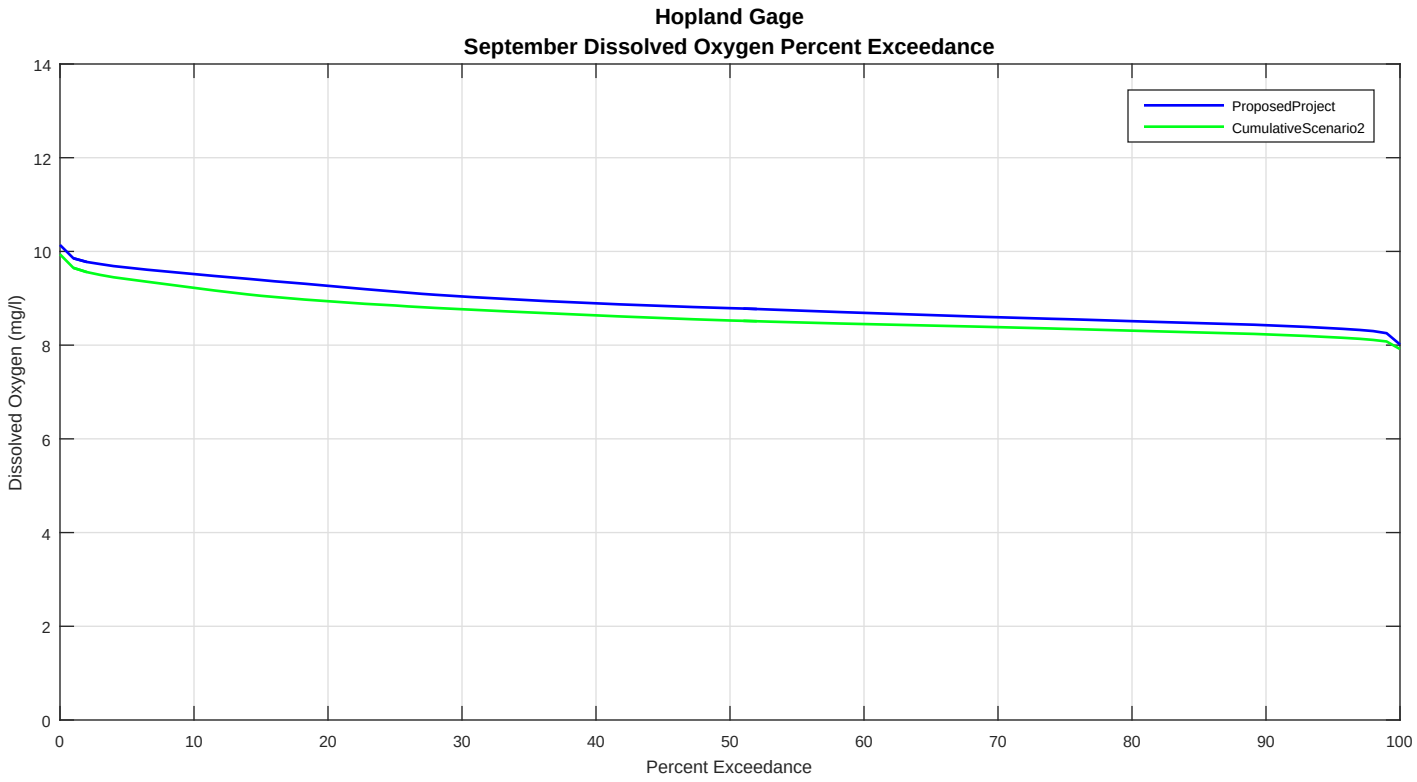
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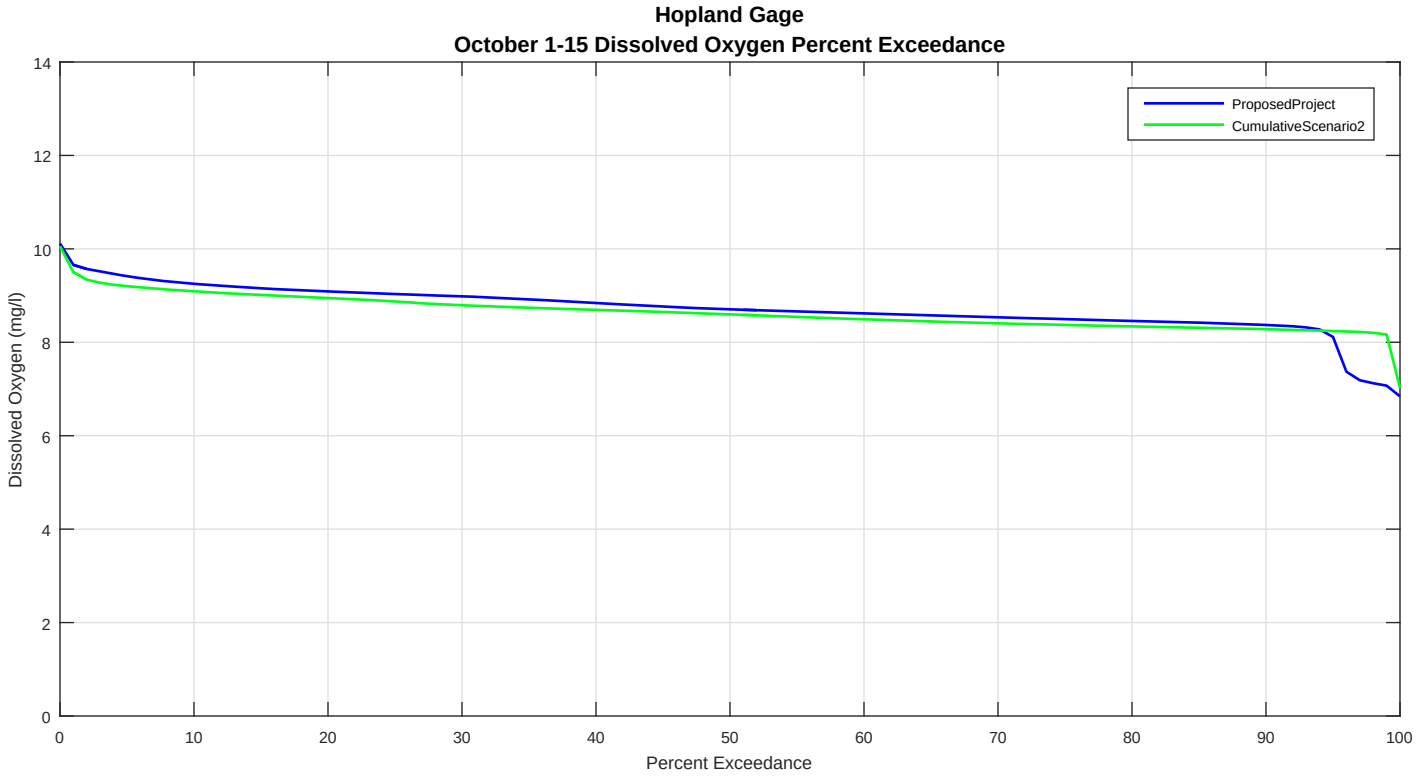
Hopland Gage
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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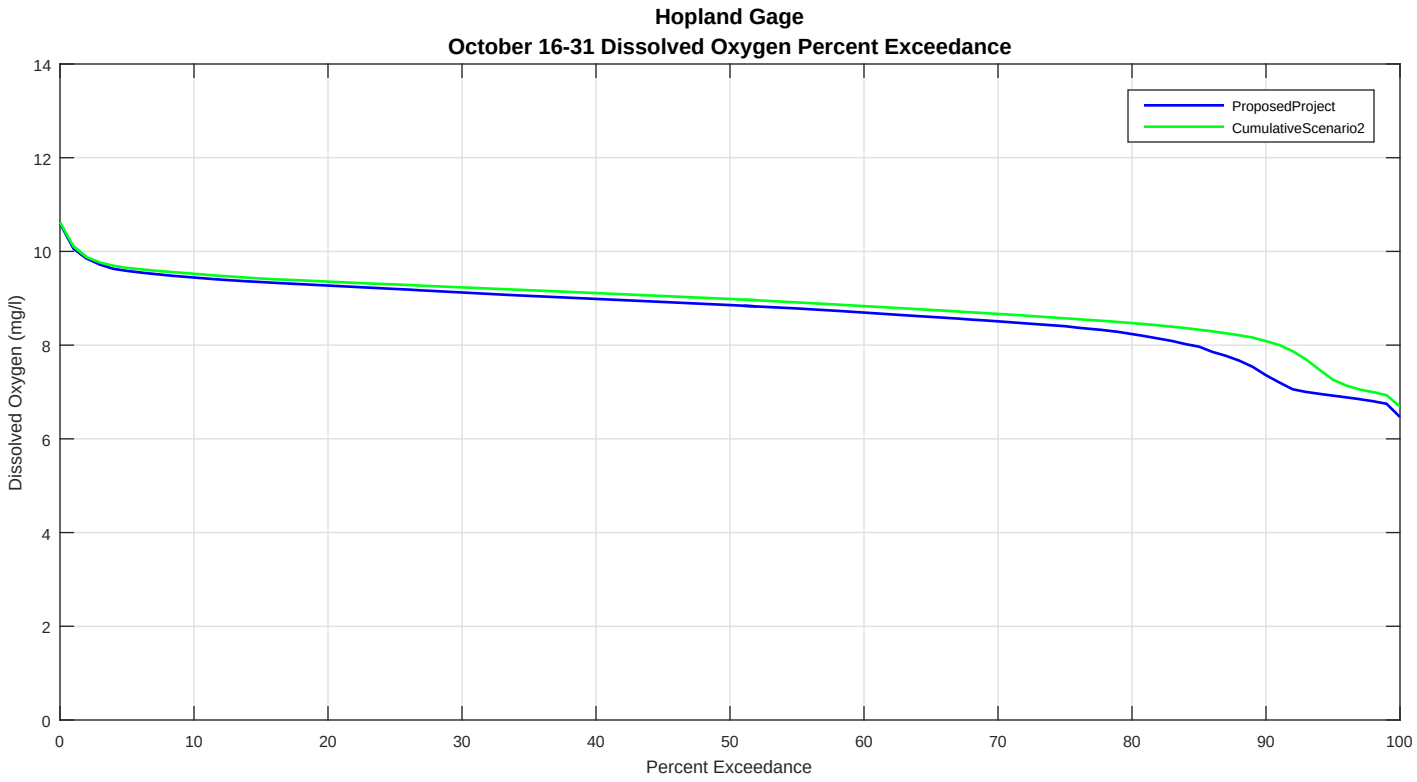
Hopland Gage
October 16-31 Dissolved Oxygen Percent Exceedance
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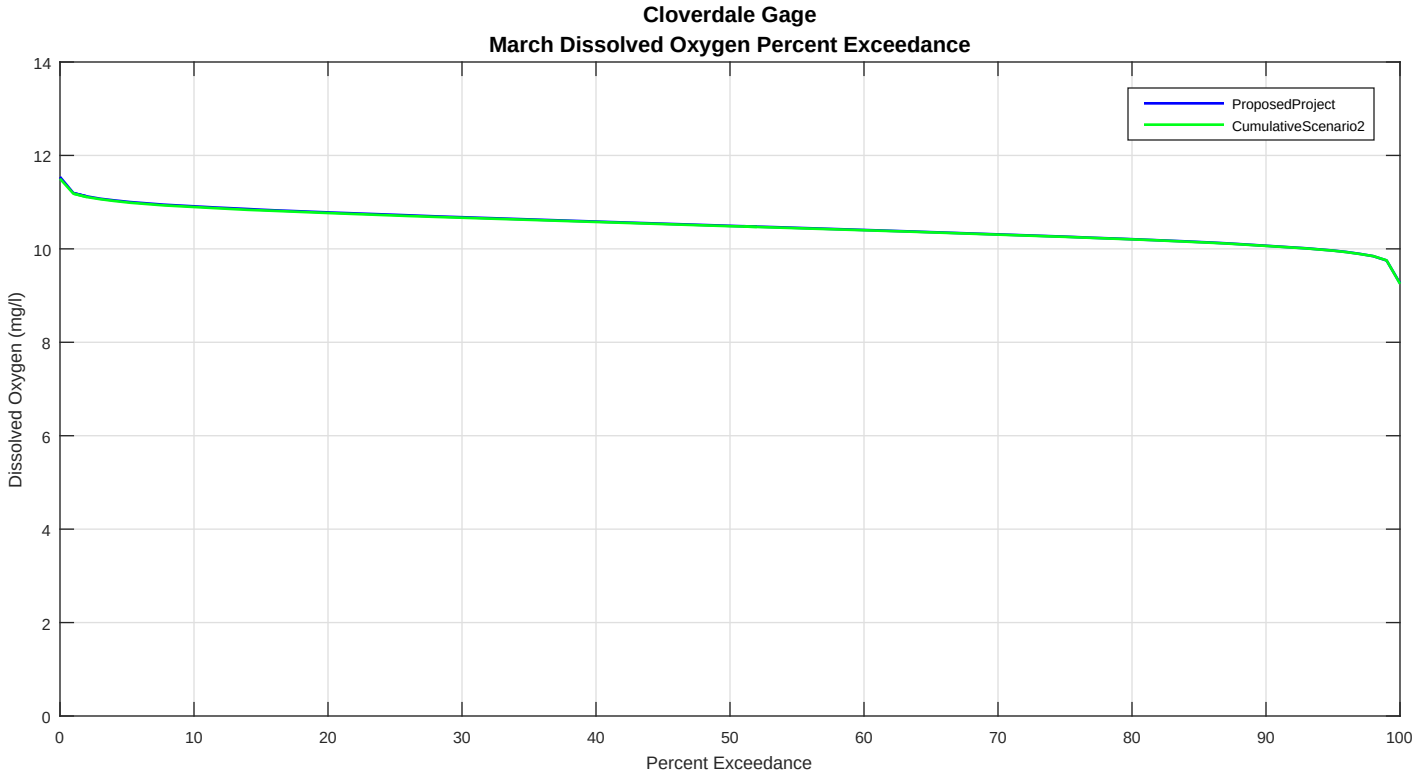
Cloverdale Gage
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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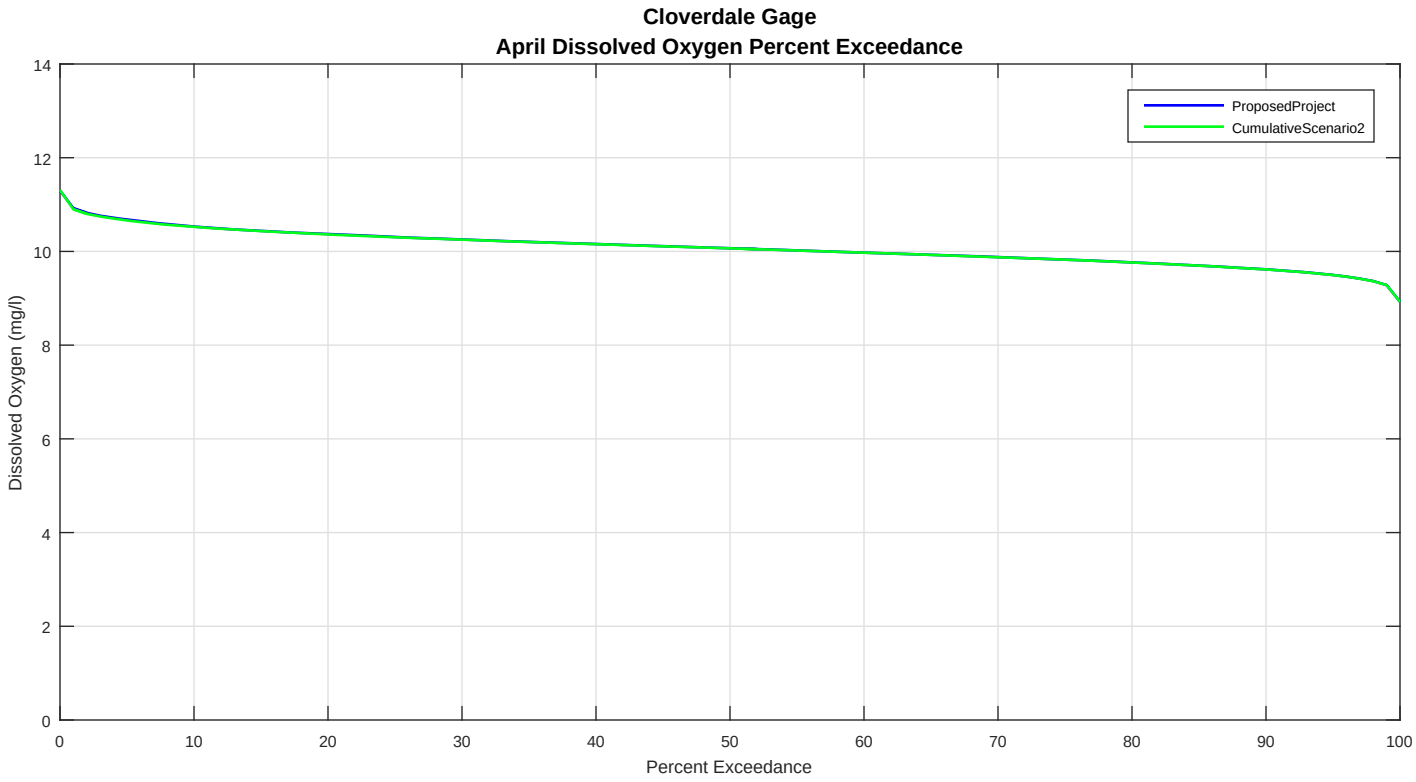
Cloverdale Gage
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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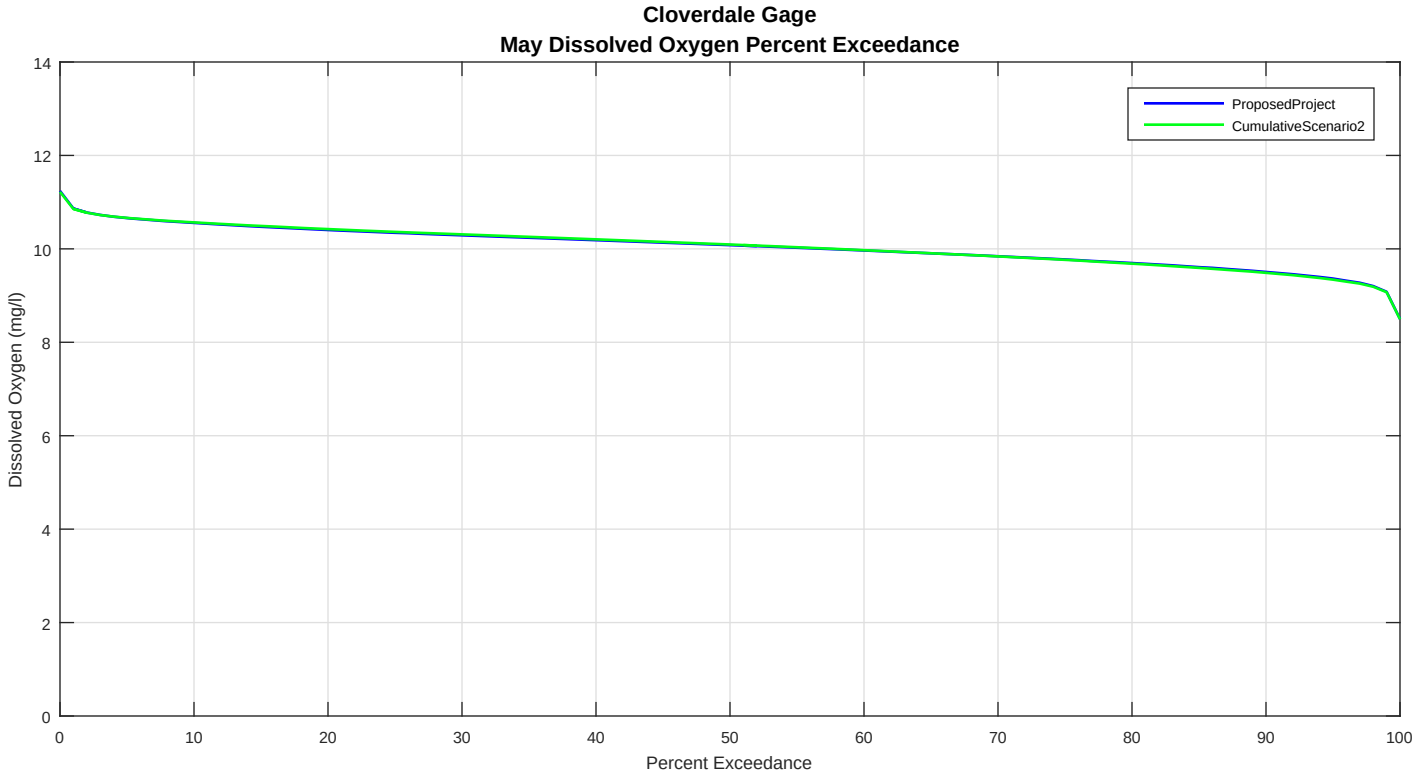
Cloverdale Gage
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
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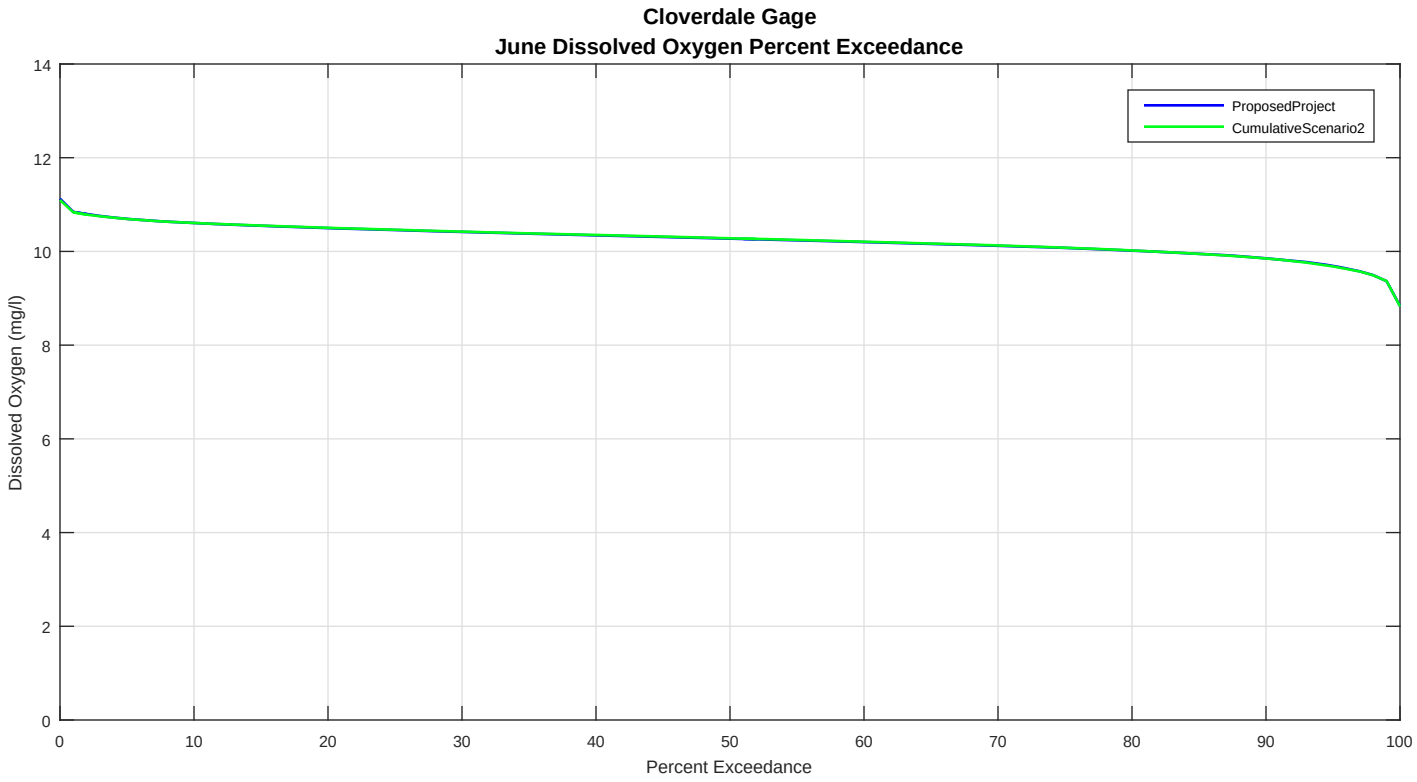
Cloverdale Gage
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
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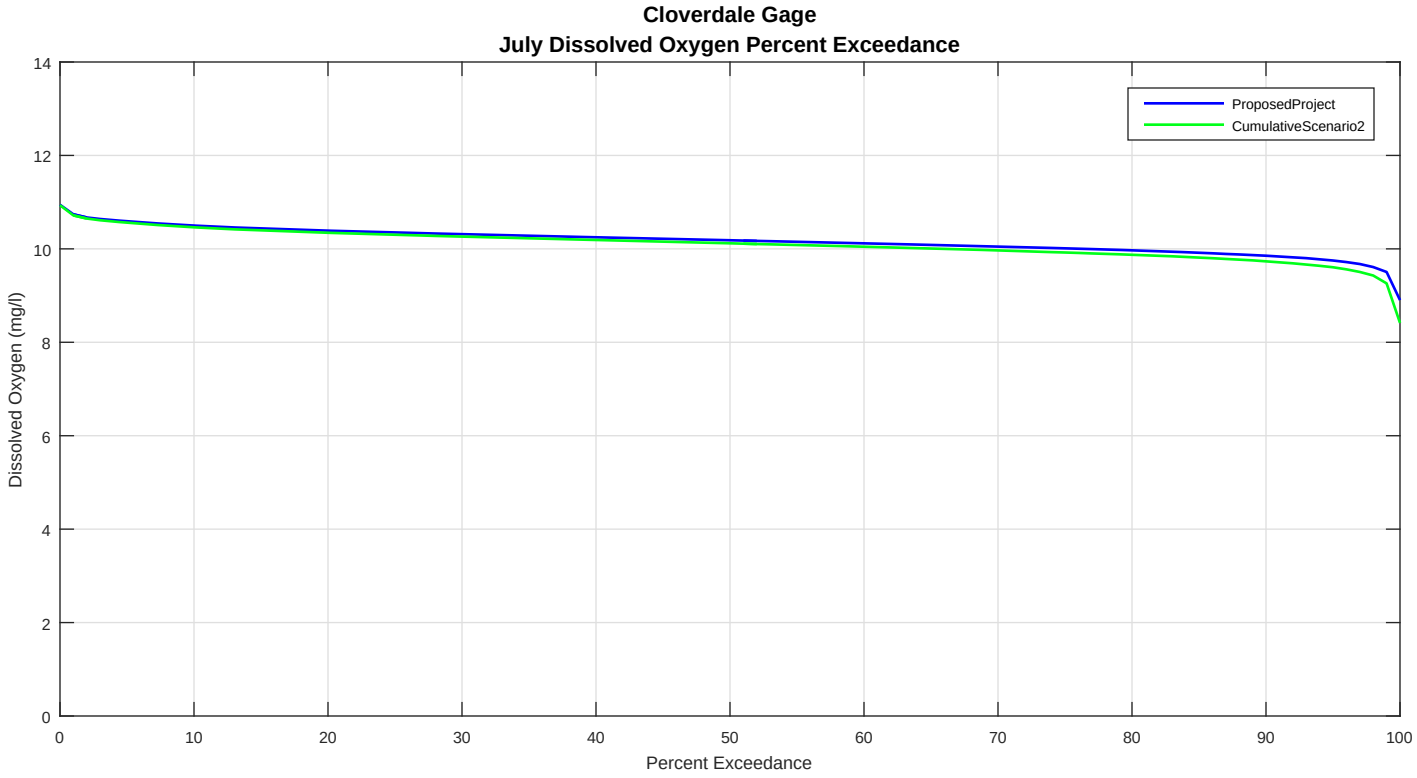
Cloverdale Gage
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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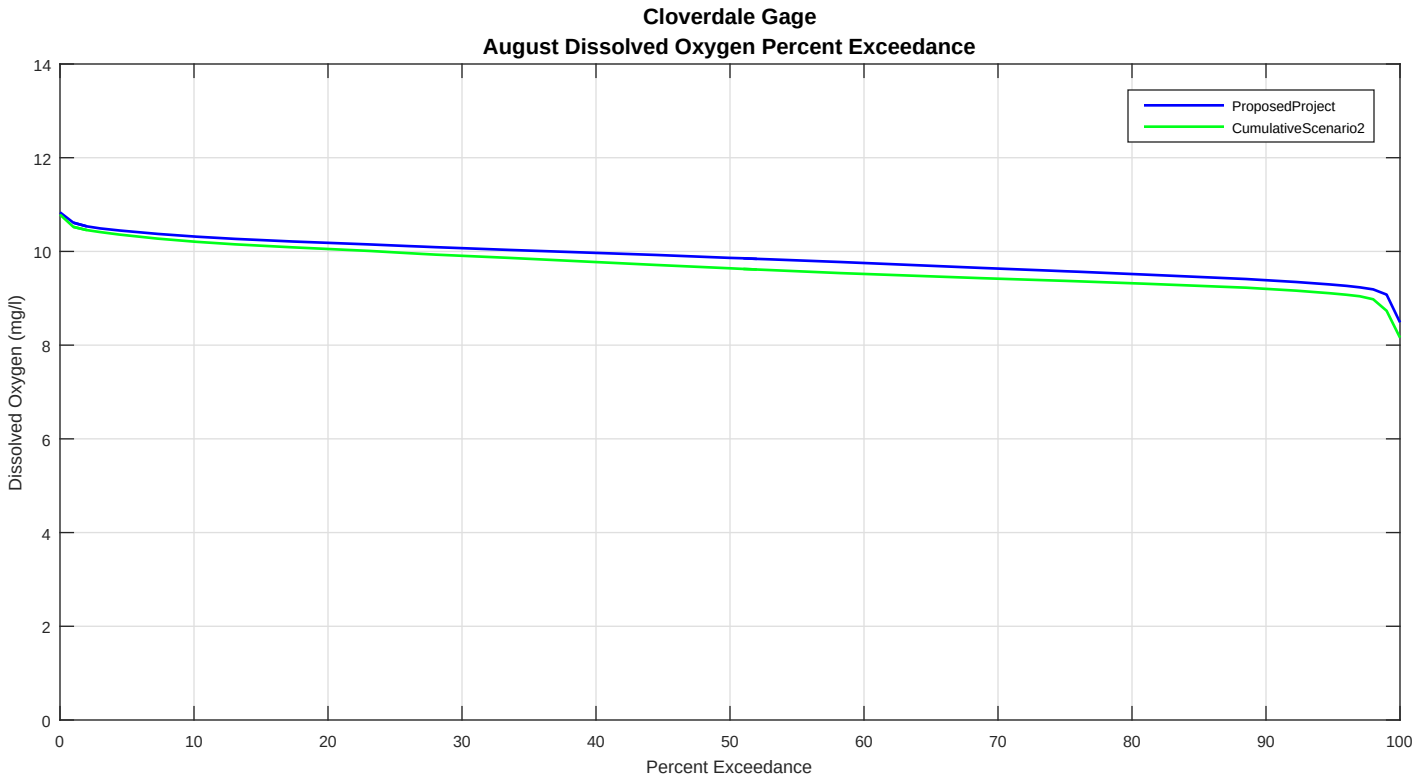
Cloverdale Gage
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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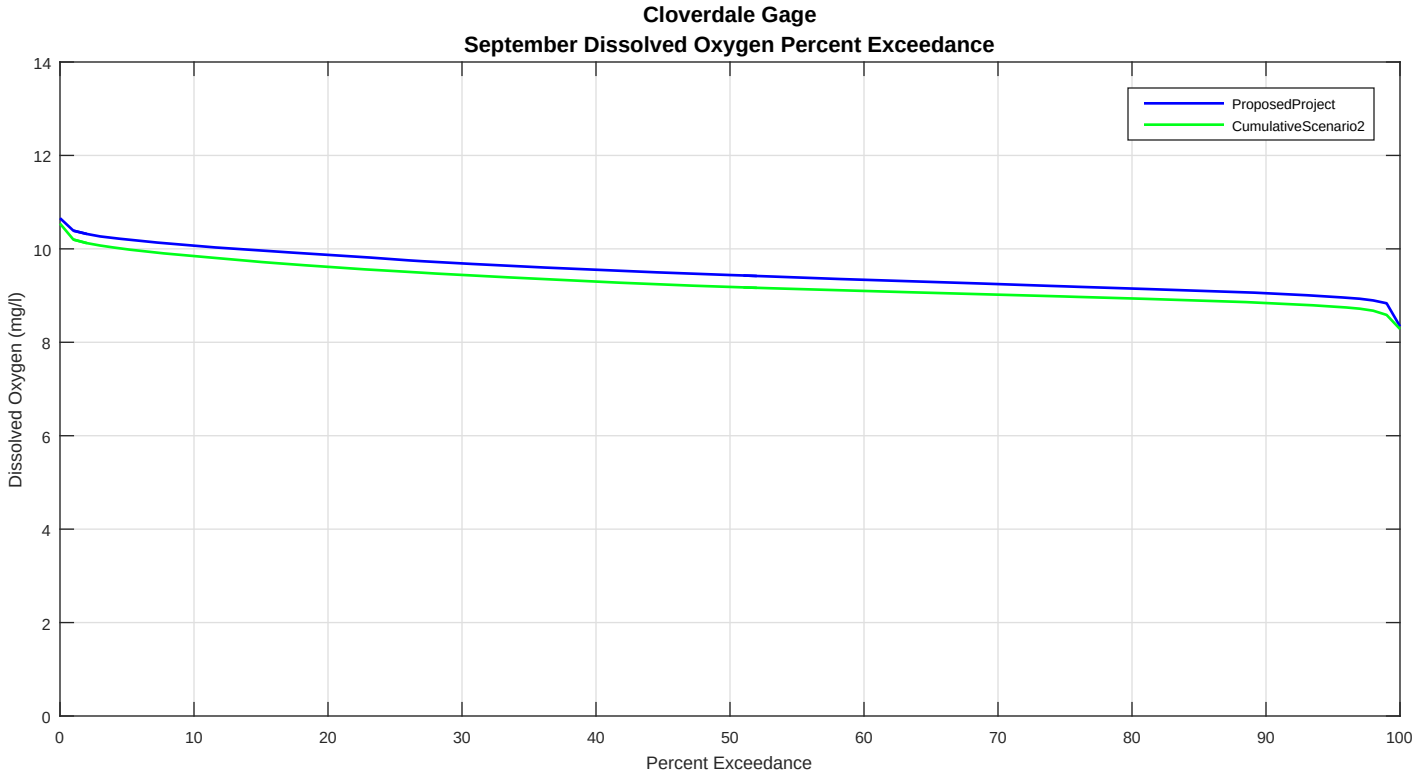
Cloverdale Gage
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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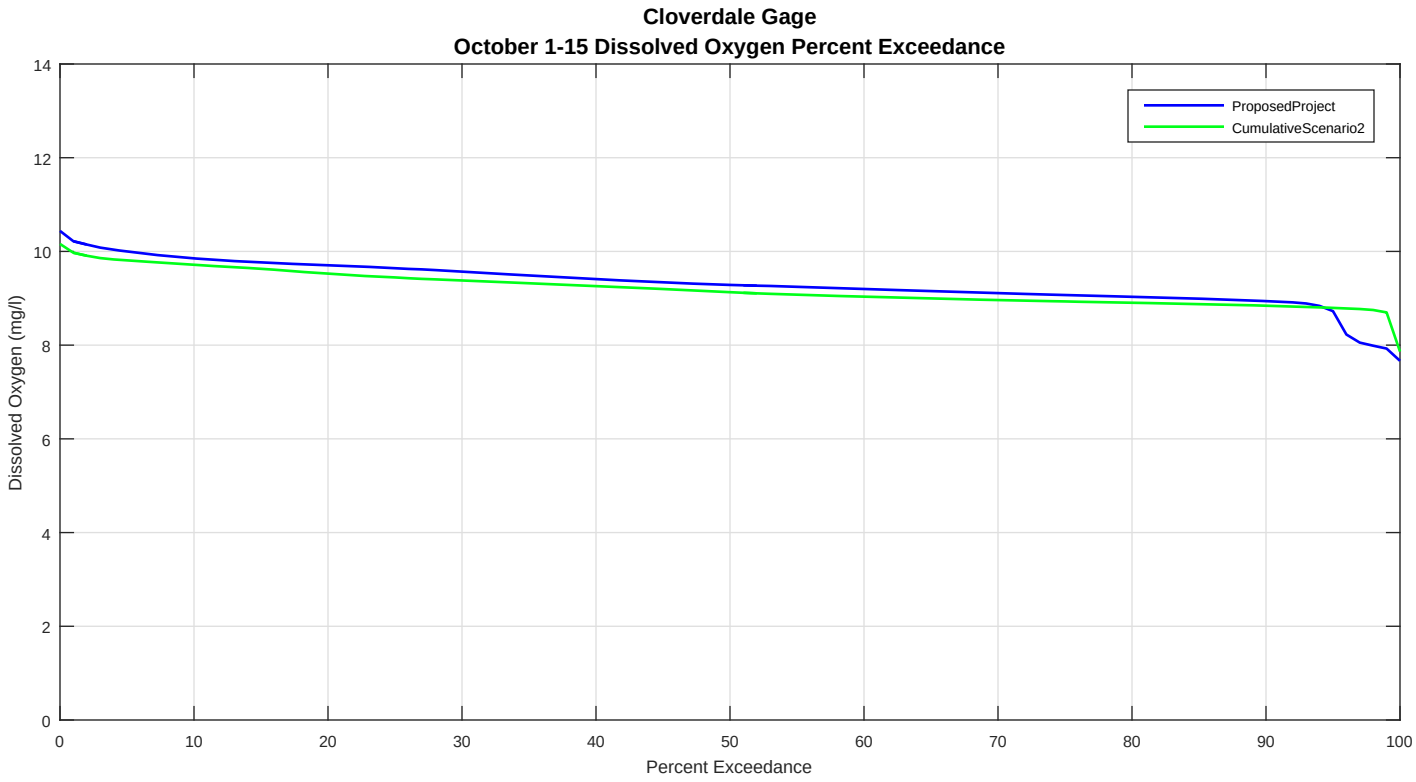
Cloverdale Gage
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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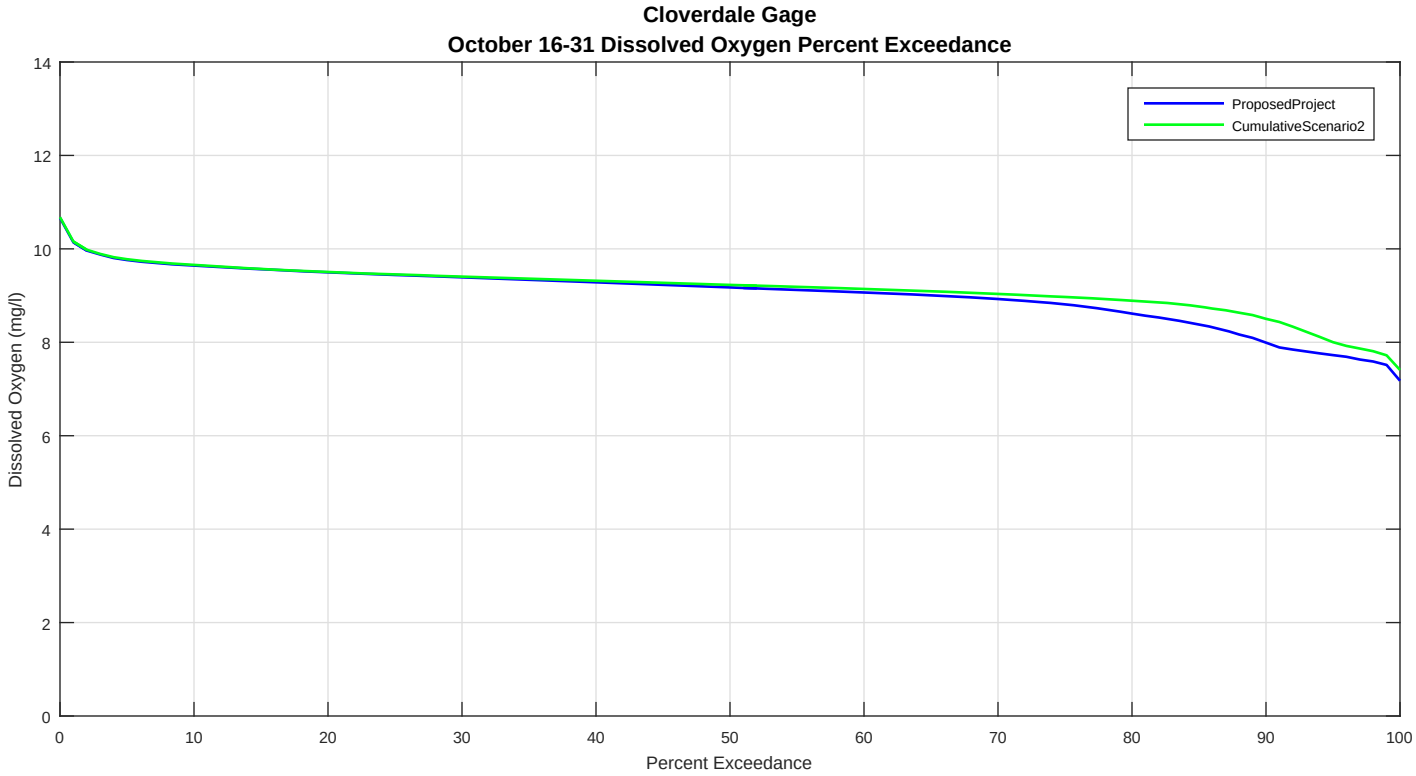
Cloverdale Gage
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
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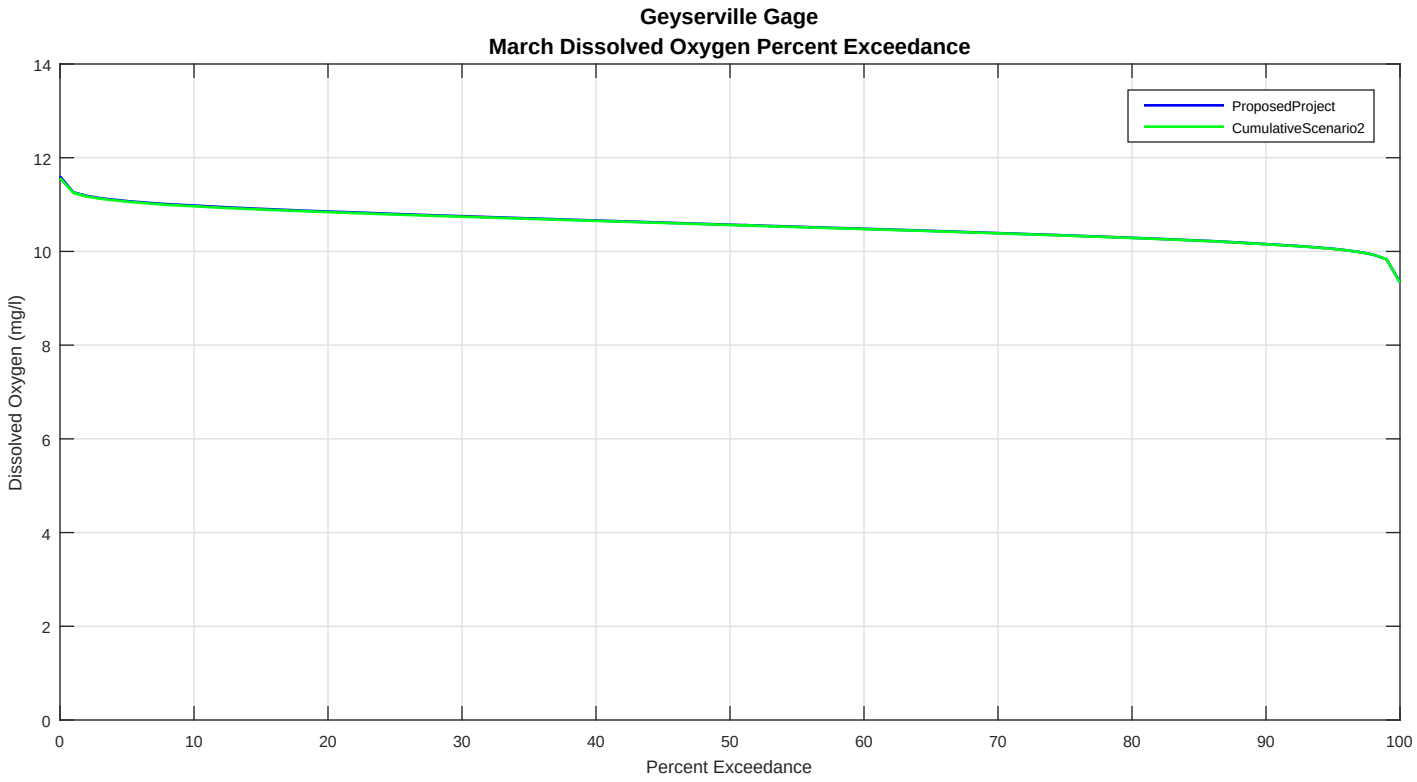
Geyserville Gage
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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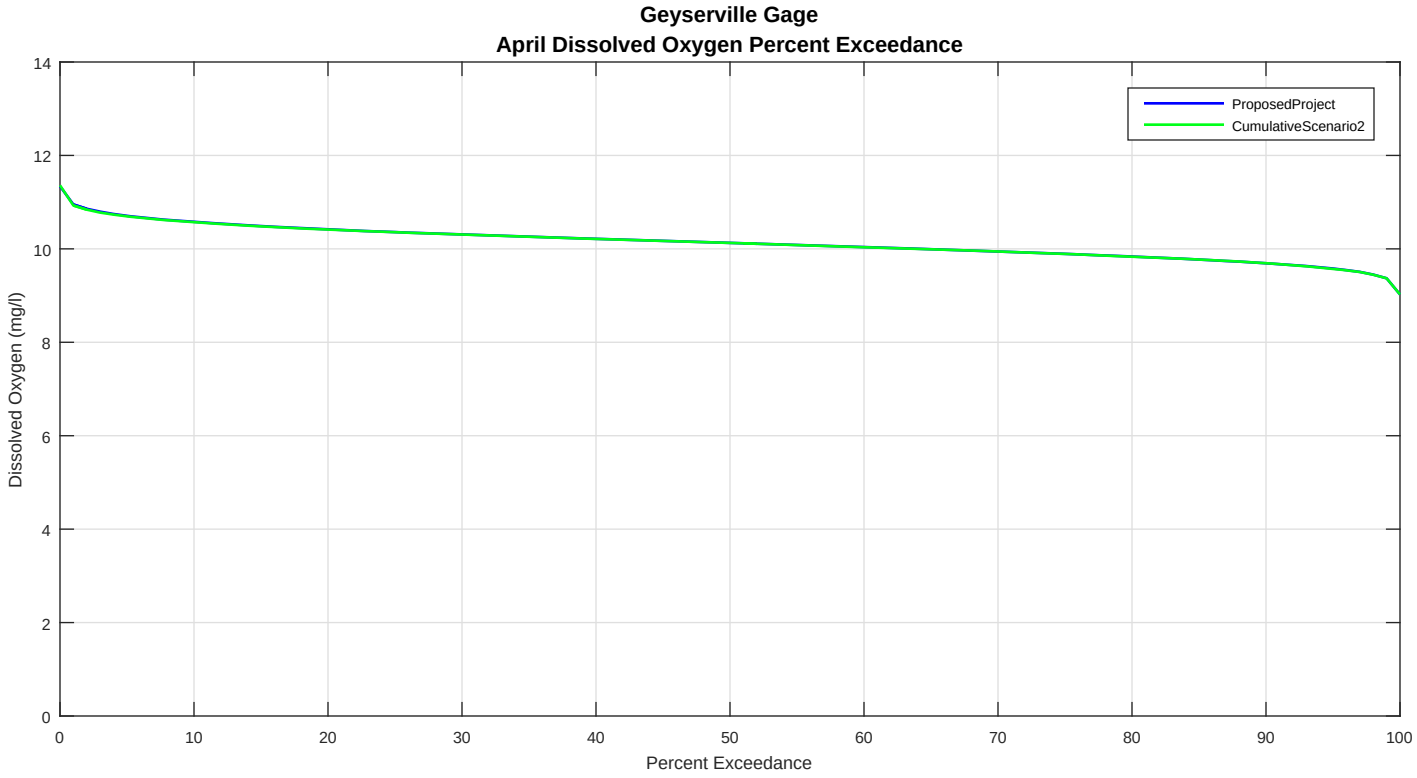
Geyserville Gage
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
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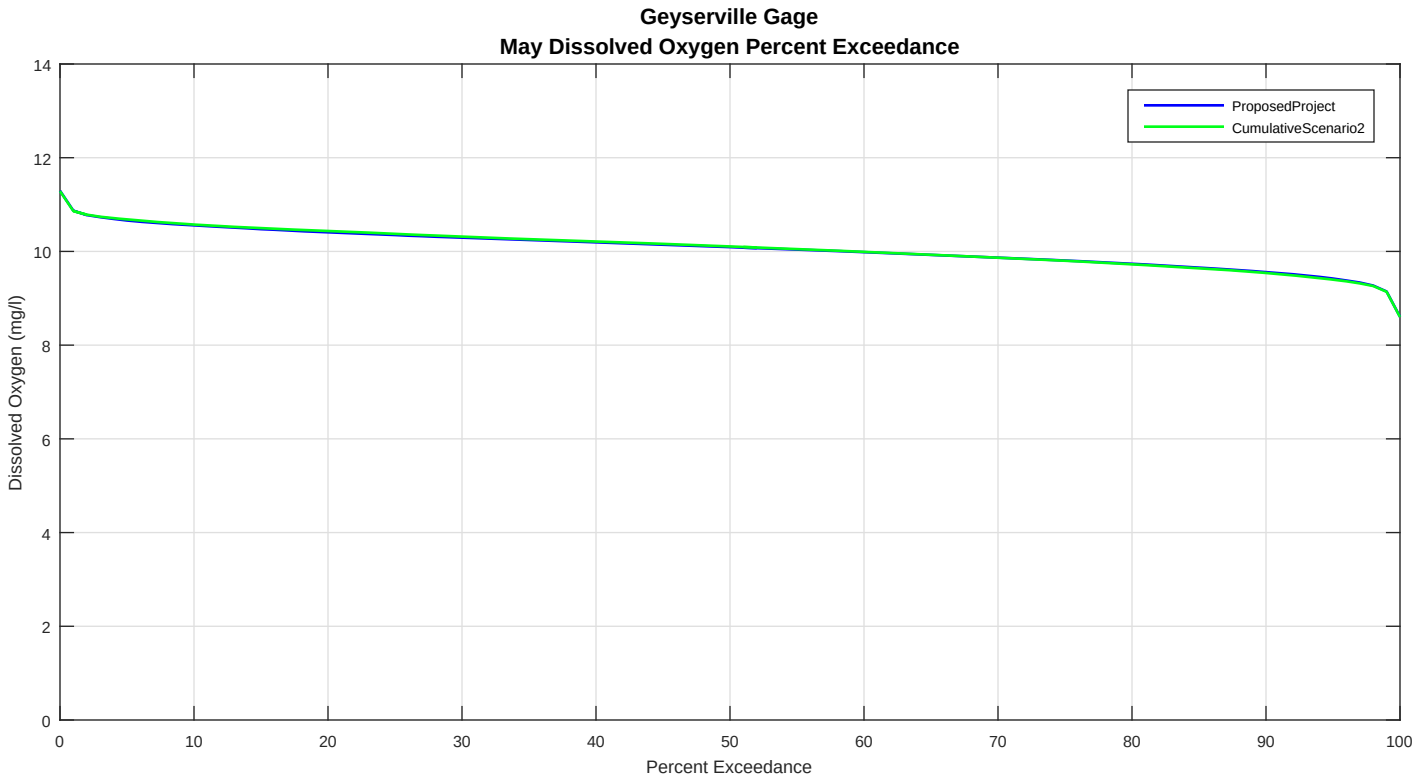
Geyserville Gage
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
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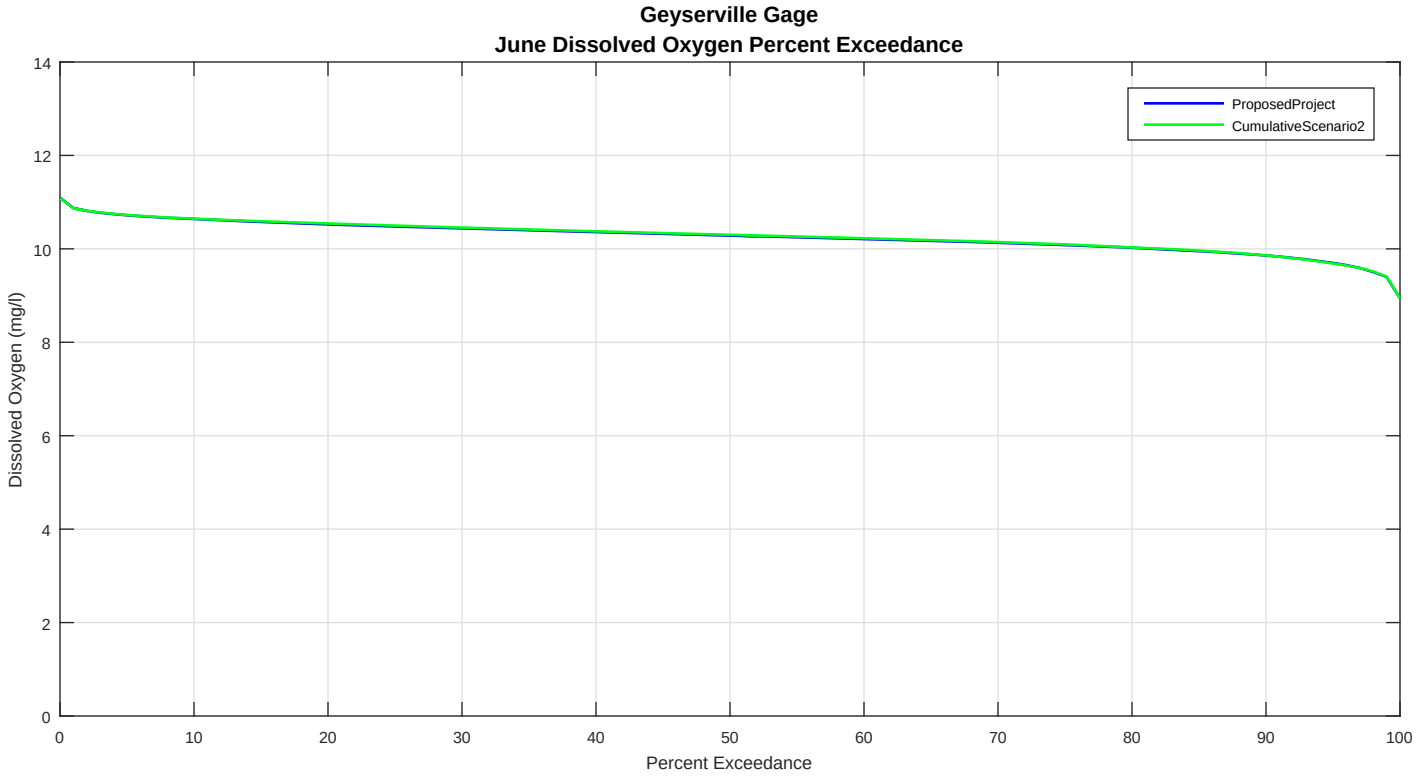
Geyserville Gage
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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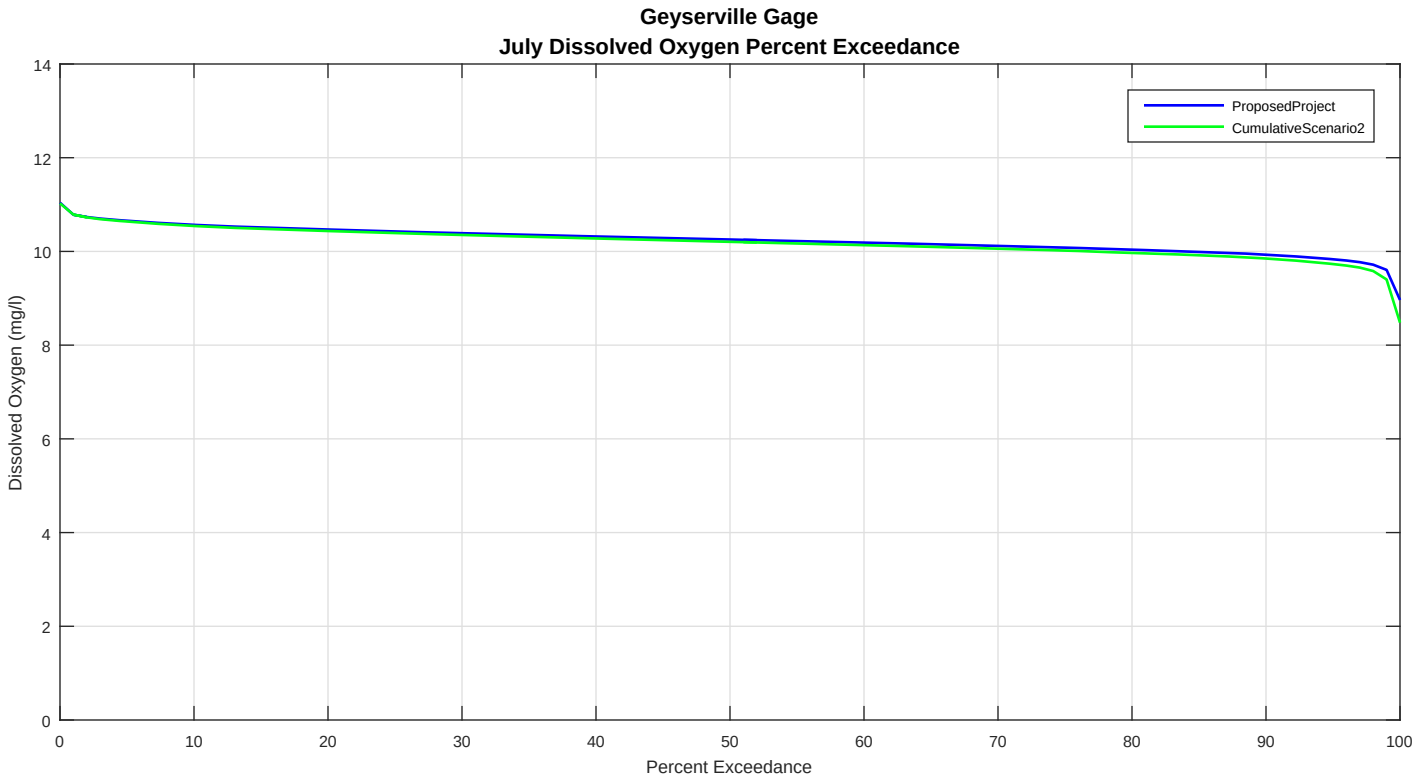
Geyserville Gage
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
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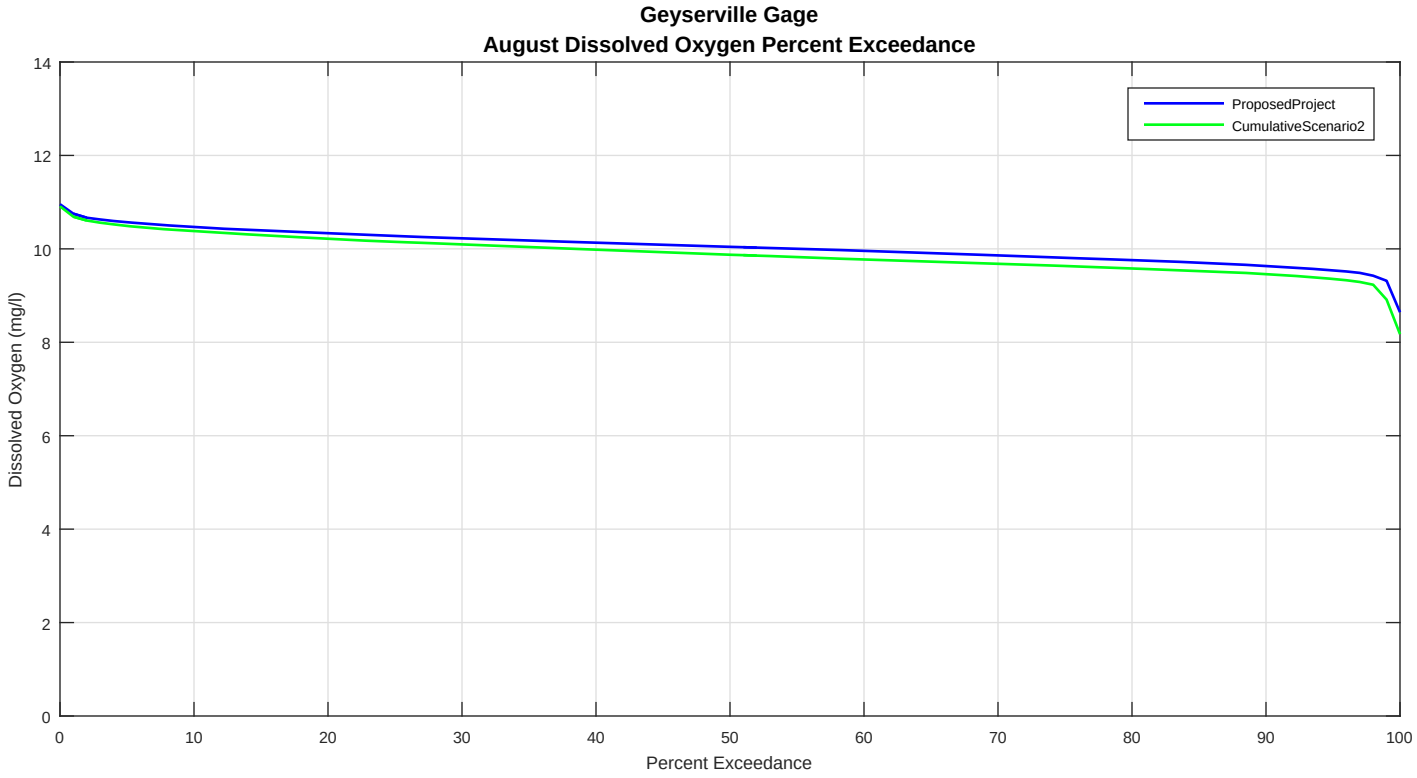
Geyserville Gage
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
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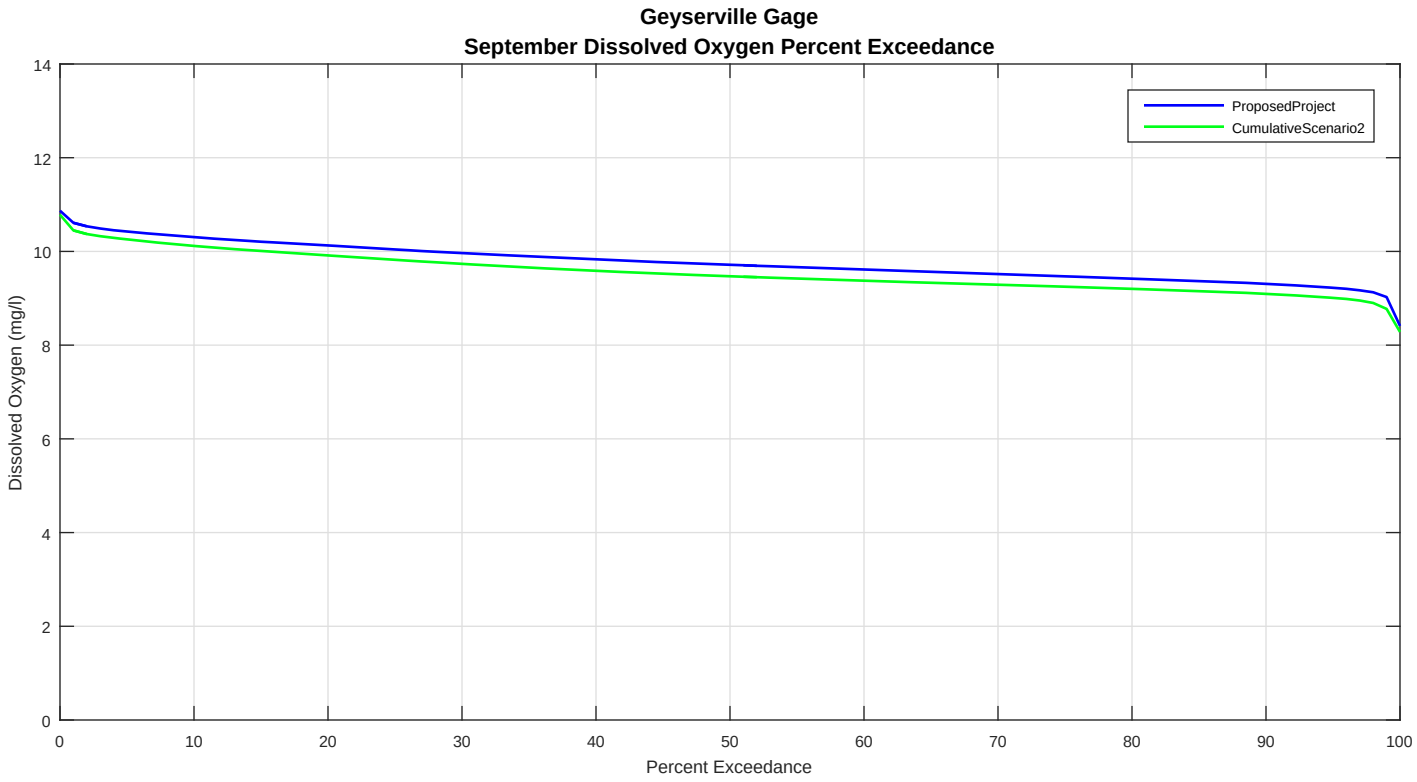
Geyserville Gage
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
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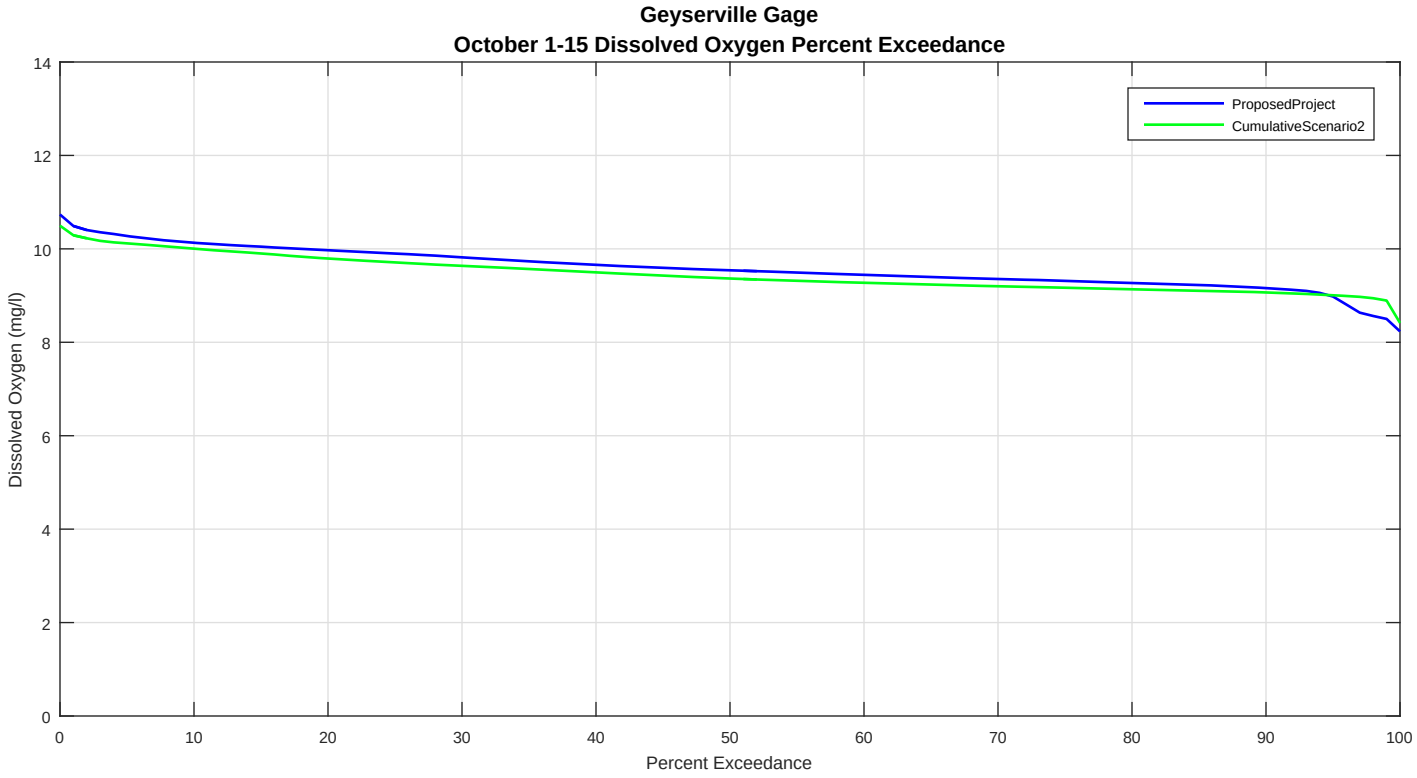
Geyserville Gage
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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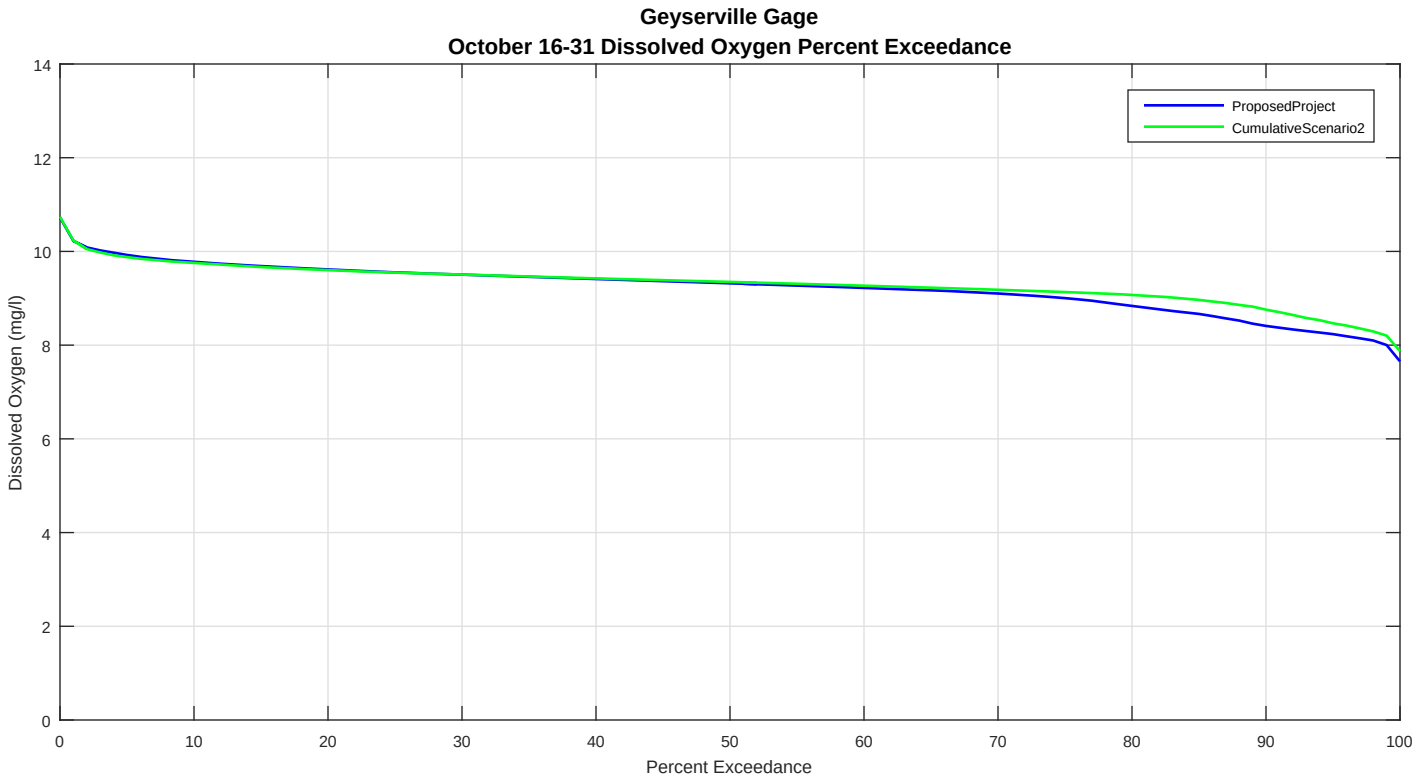
Geyserville Gage
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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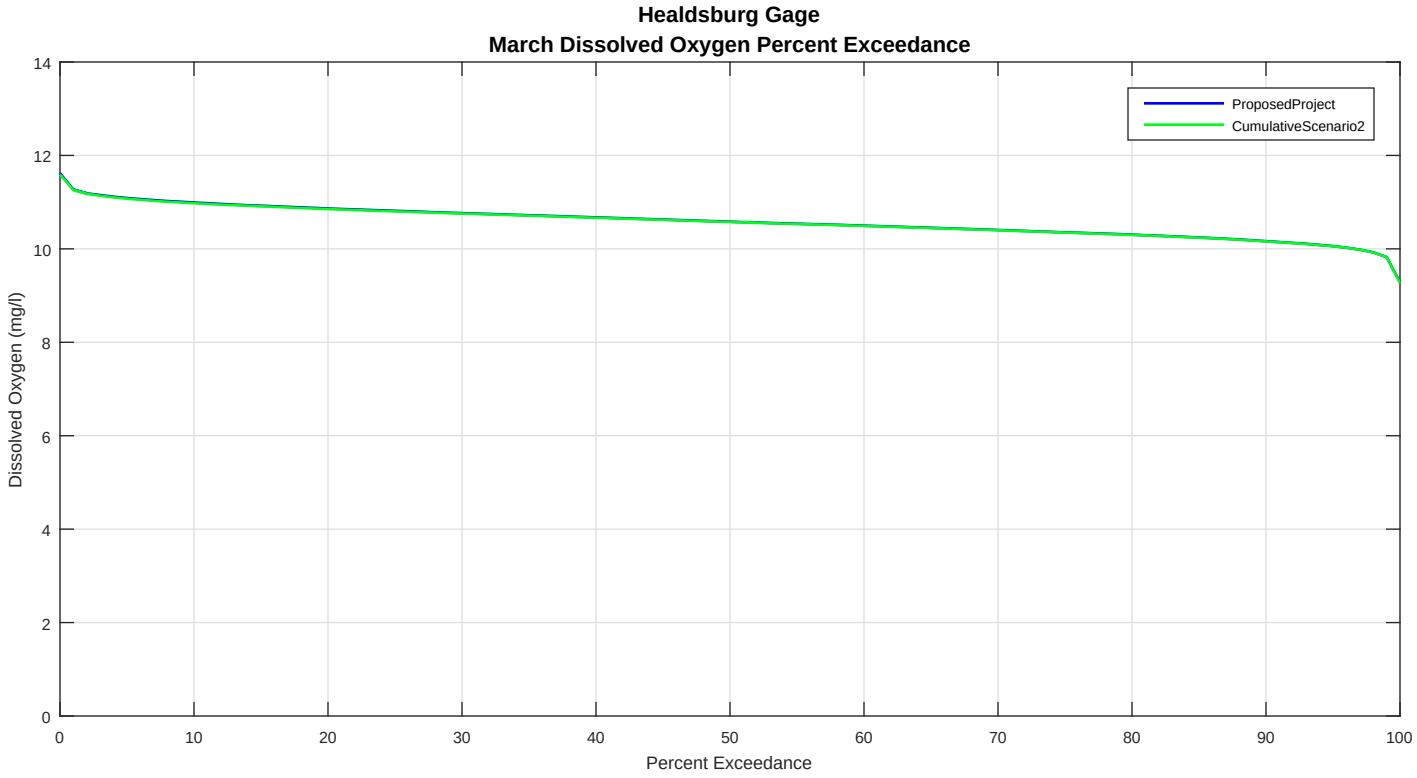
Healdsburg Gage
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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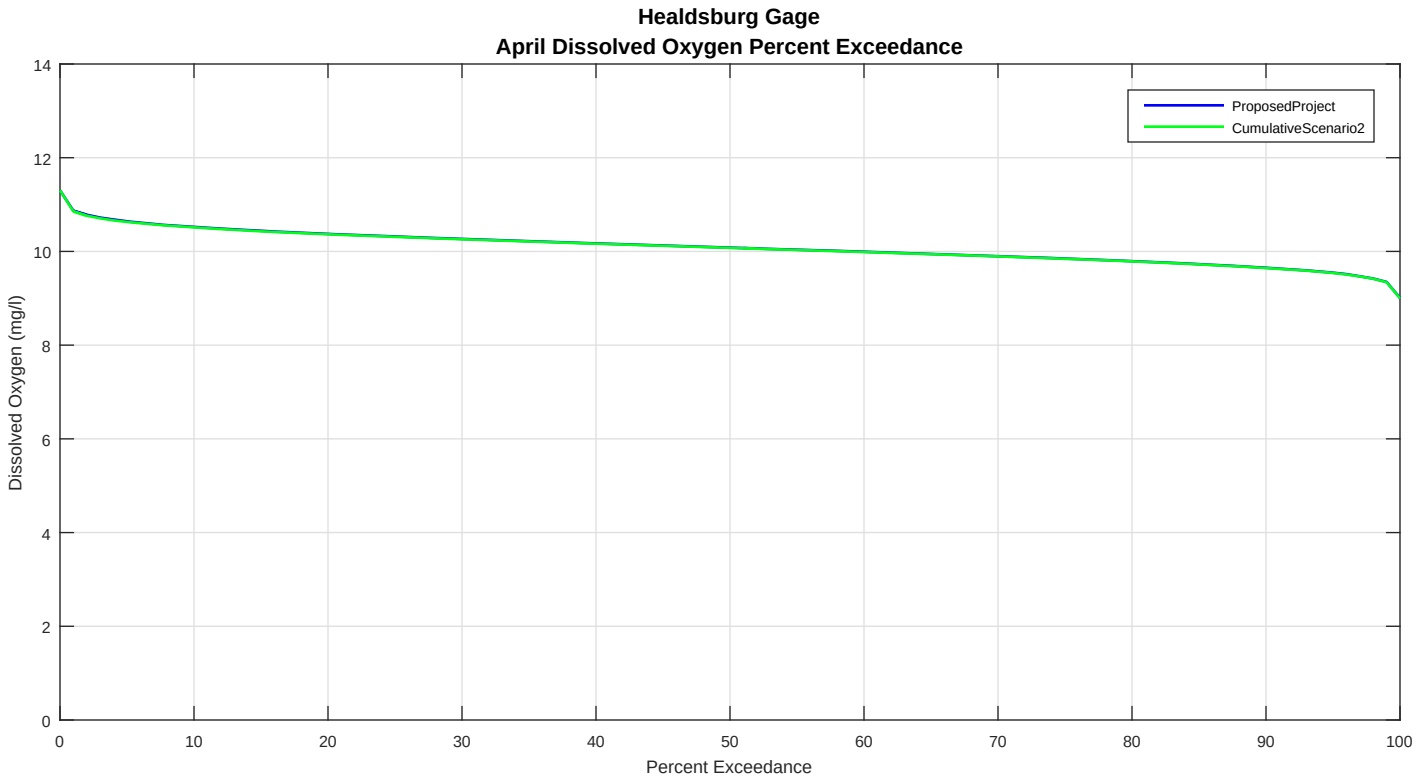
Healdsburg Gage
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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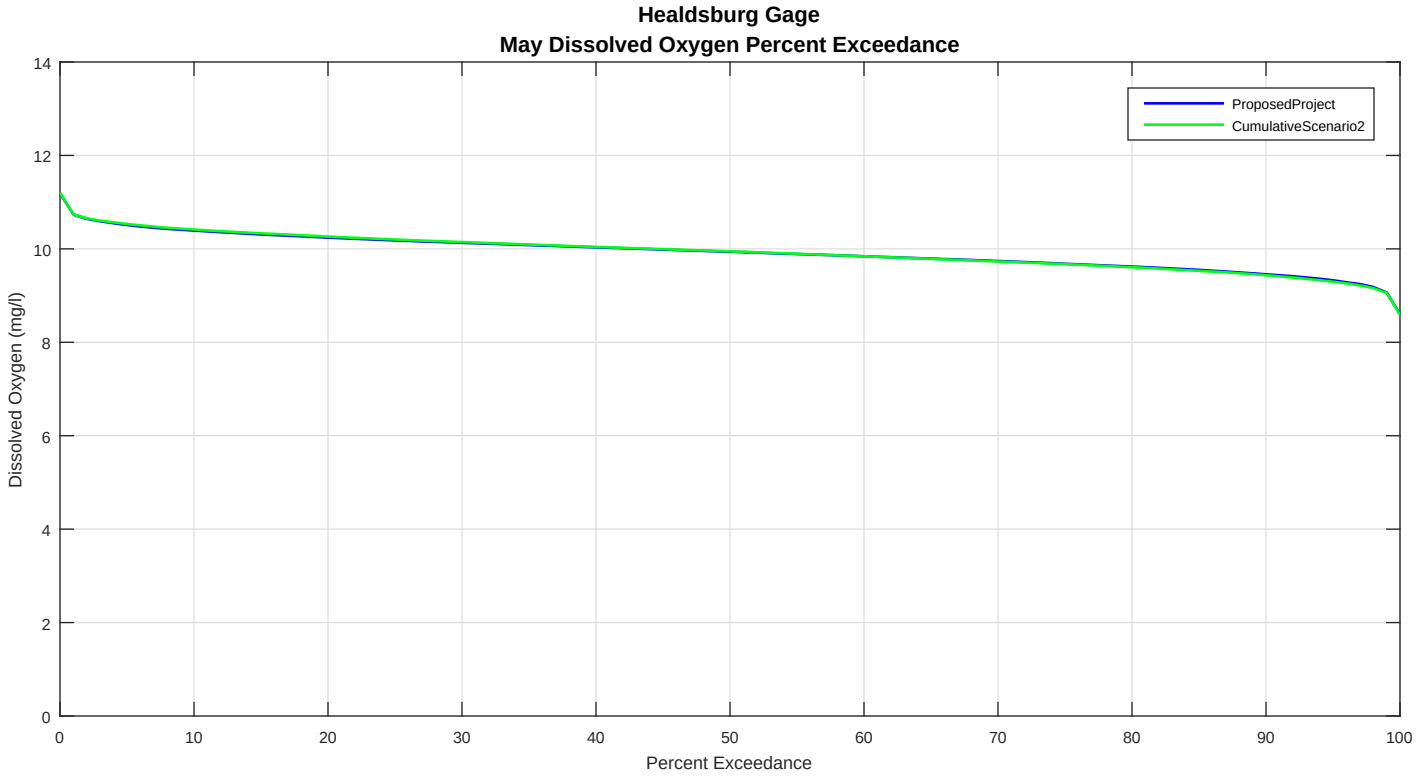
Healdsburg Gage
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
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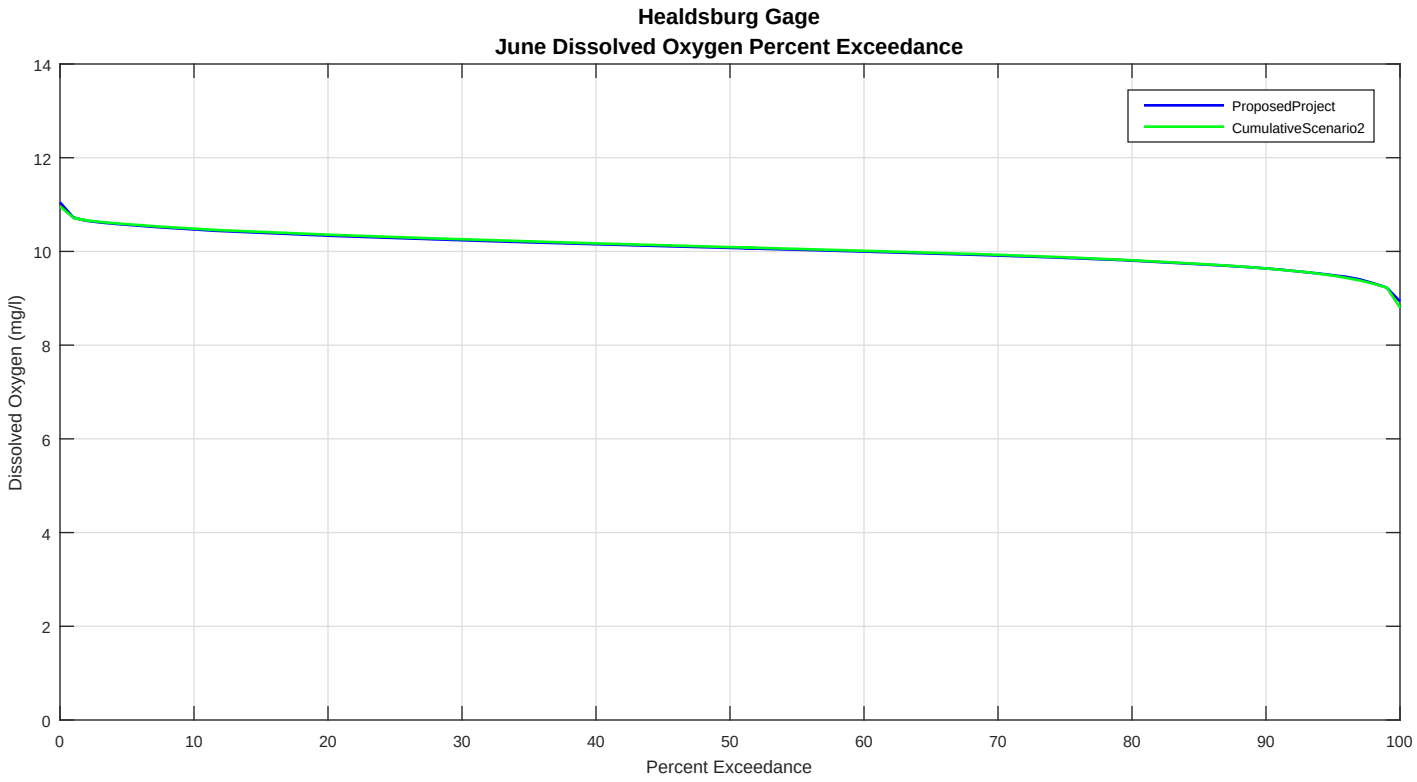
Healdsburg Gage
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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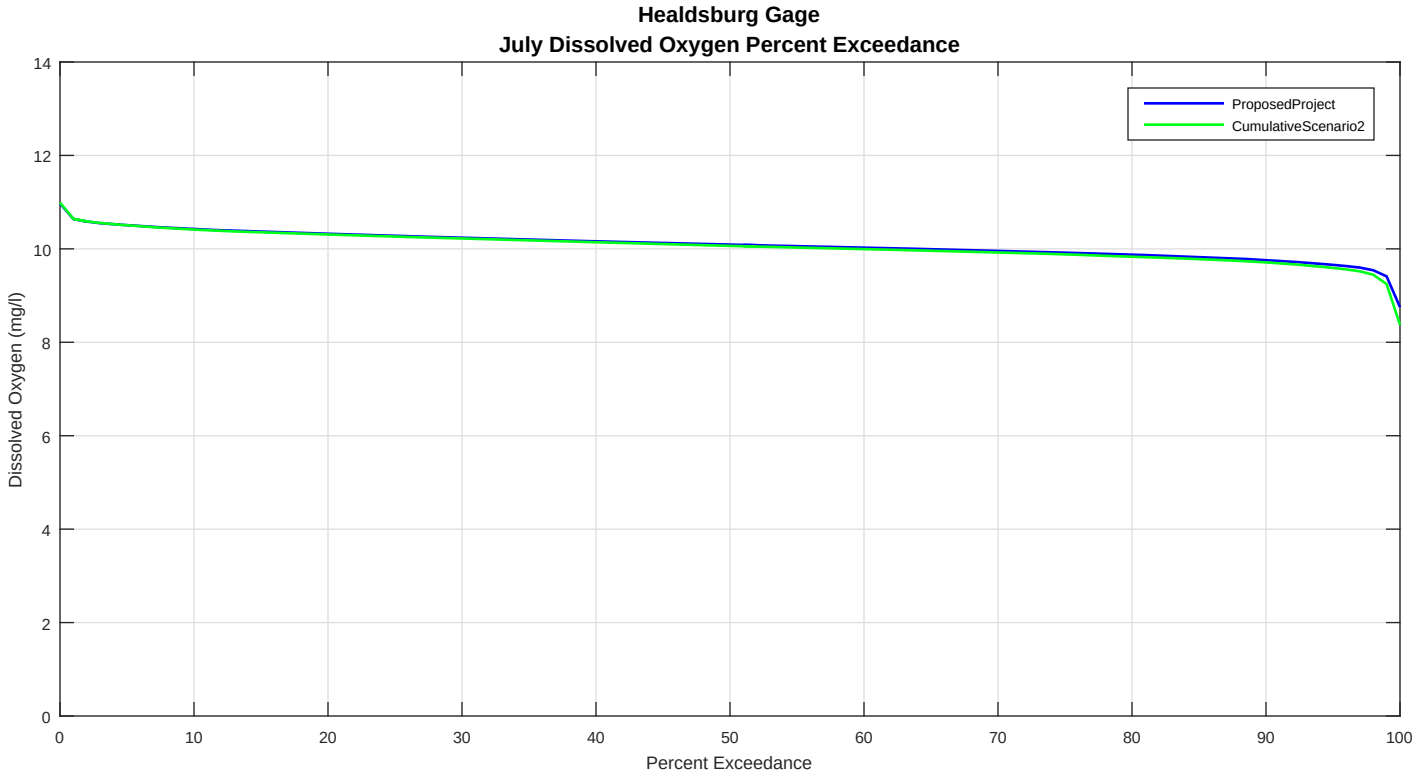
Healdsburg Gage
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
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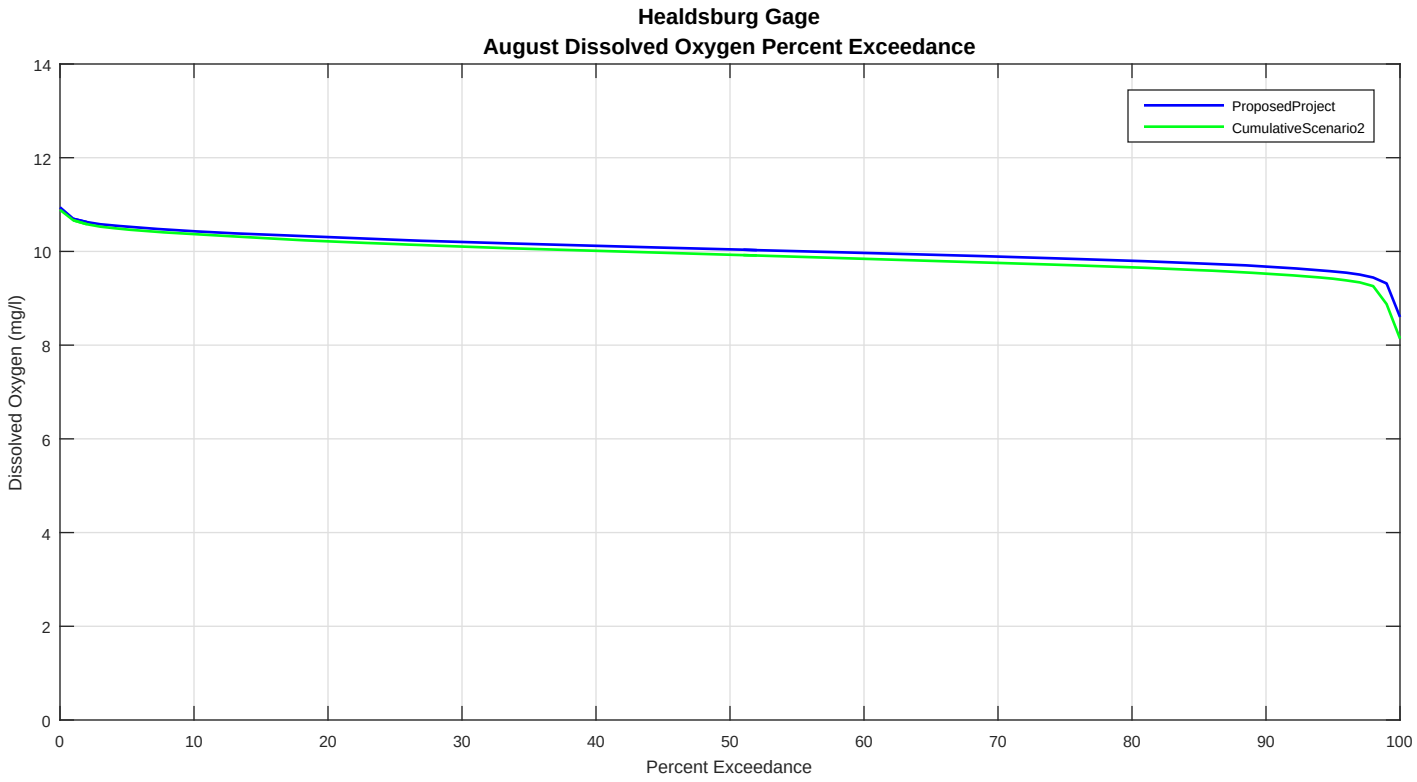
Healdsburg Gage
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
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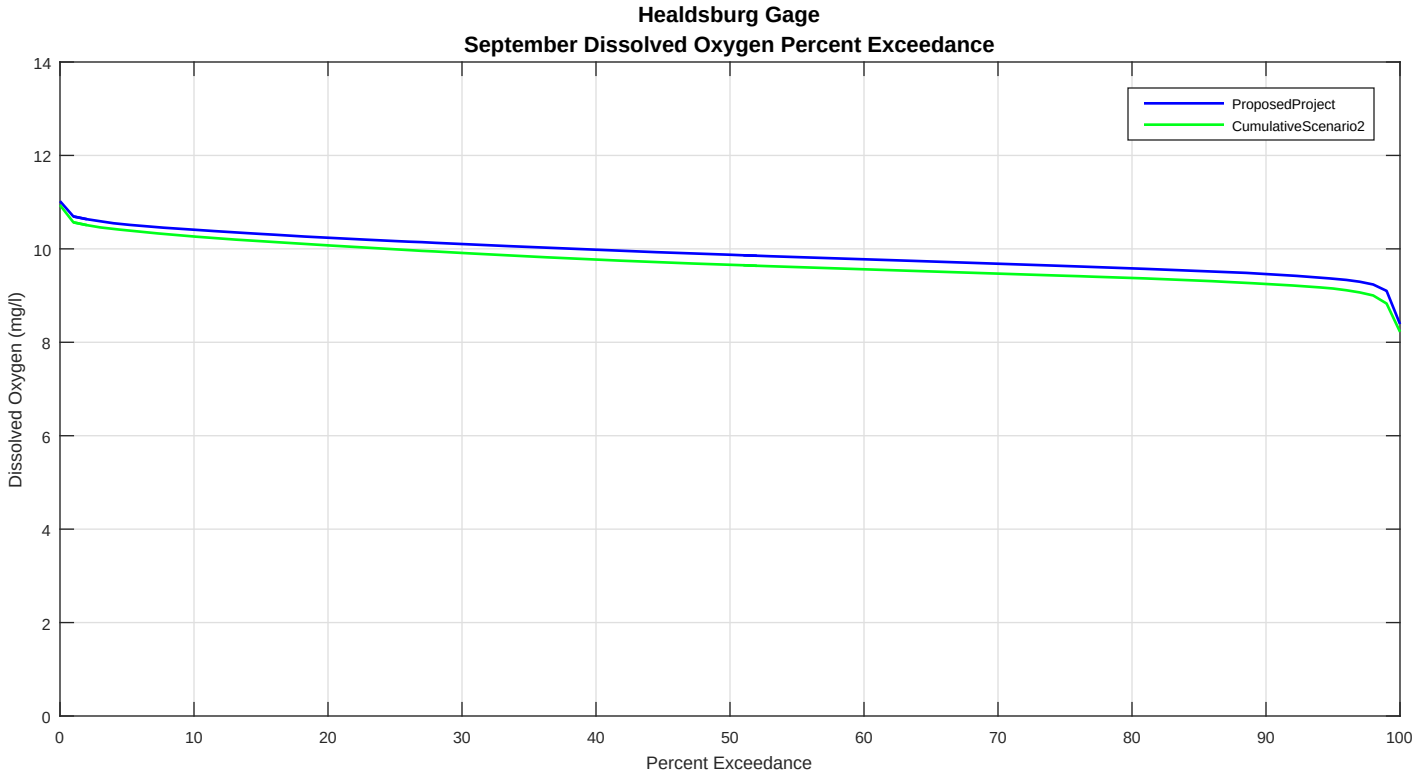
Healdsburg Gage
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
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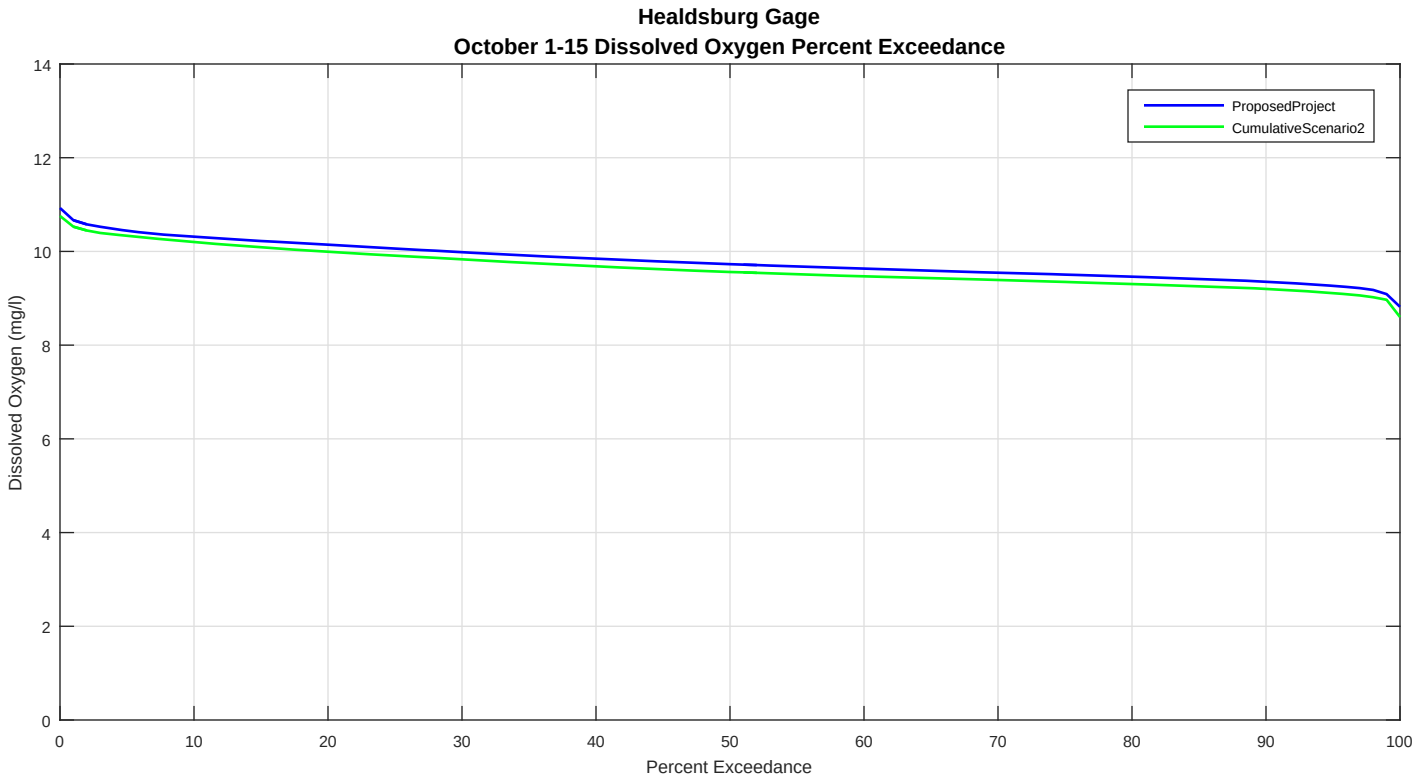
Healdsburg Gage
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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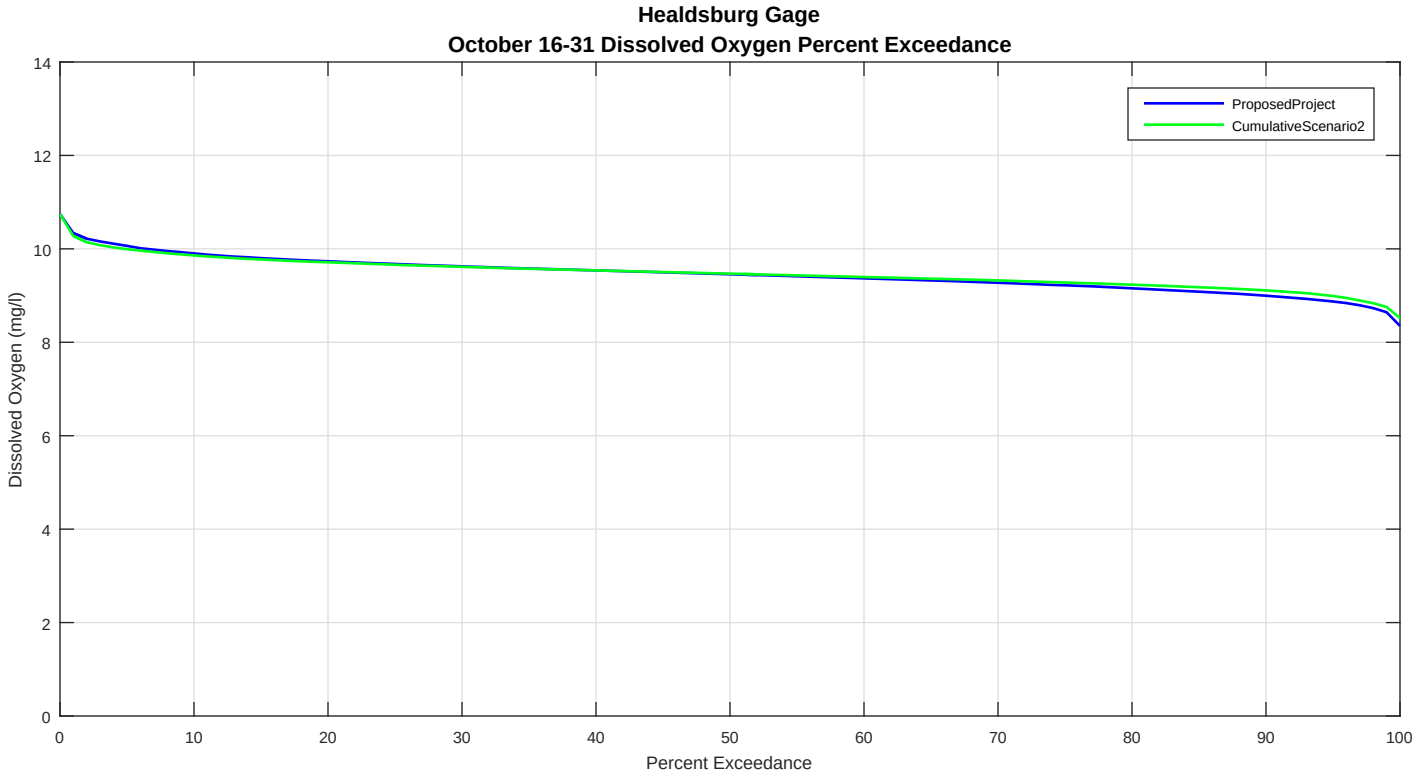
Healdsburg Gage
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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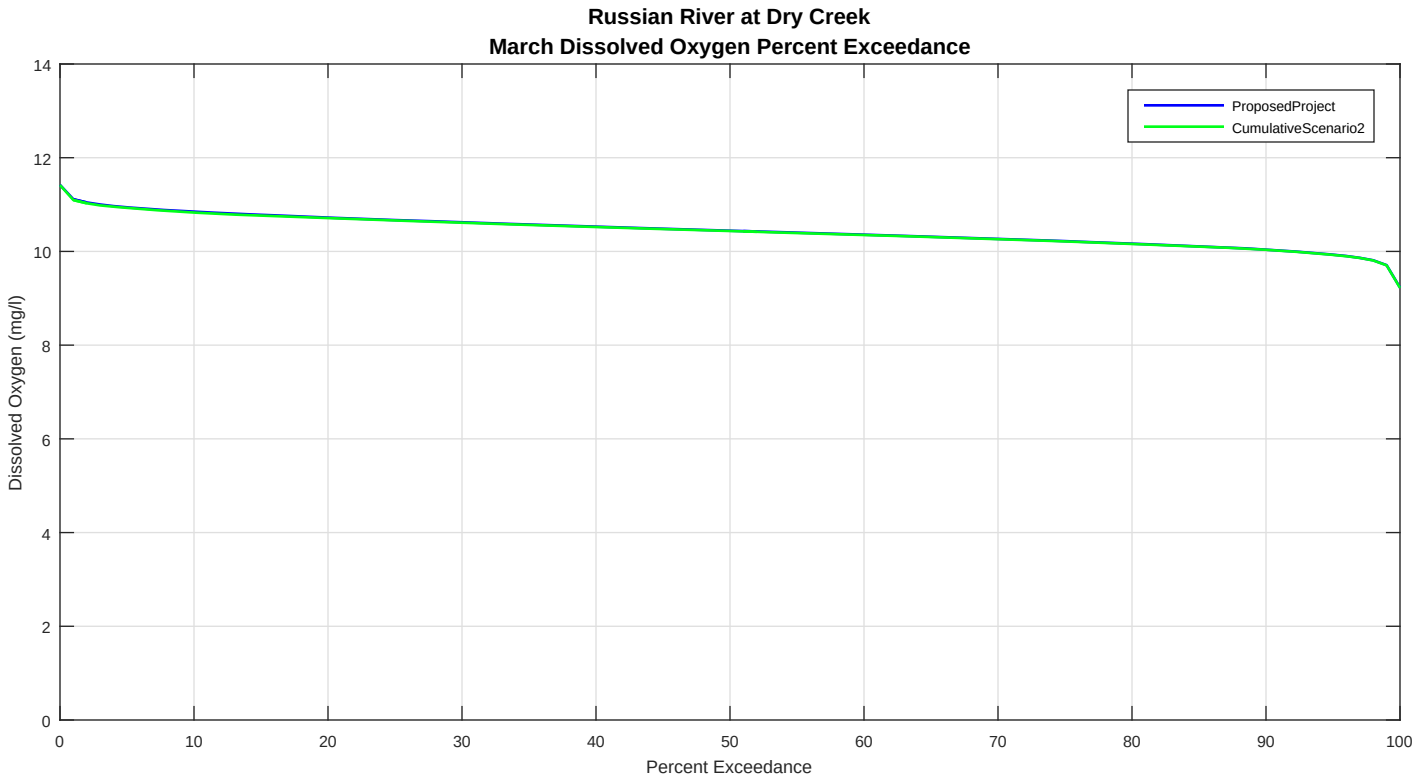
Russian River at Dry Creek
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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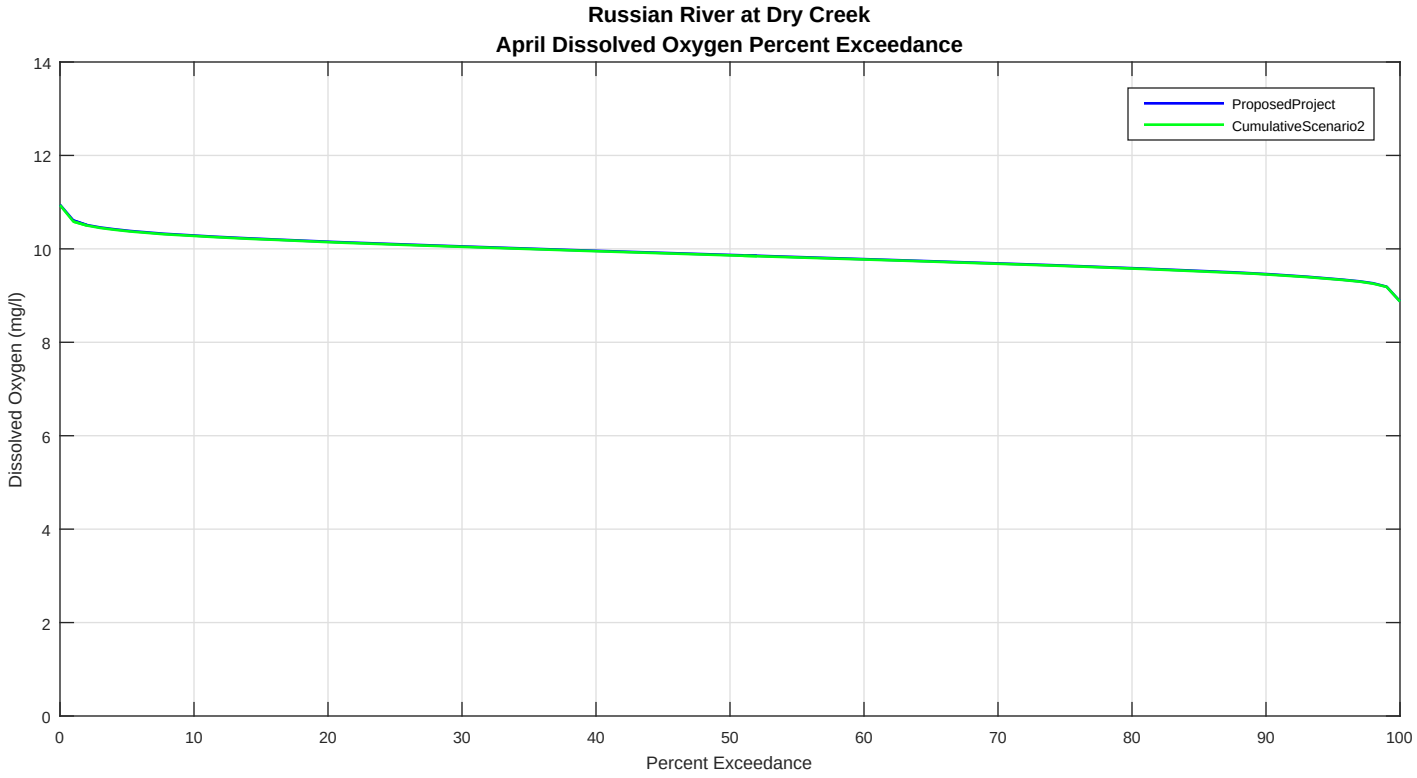
Russian River at Dry Creek
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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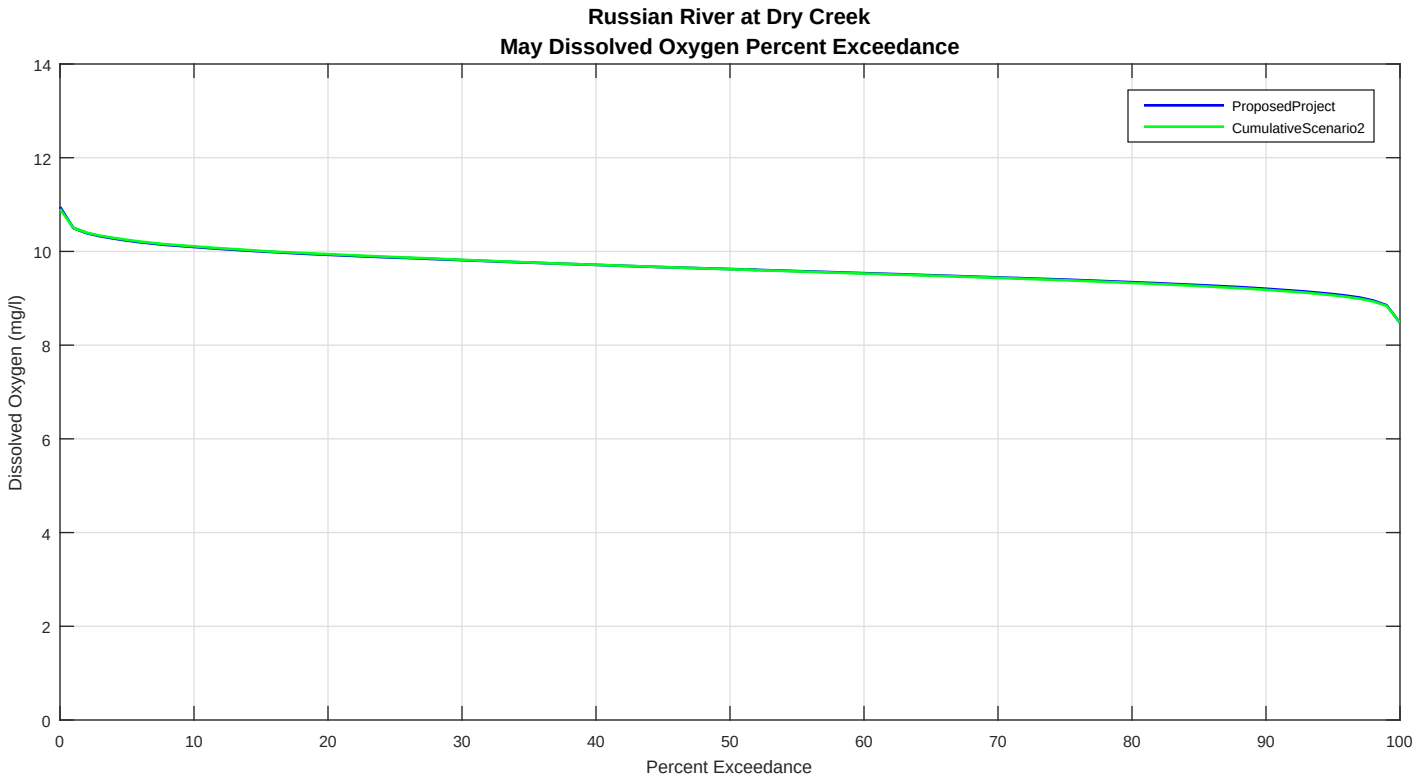
Russian River at Dry Creek
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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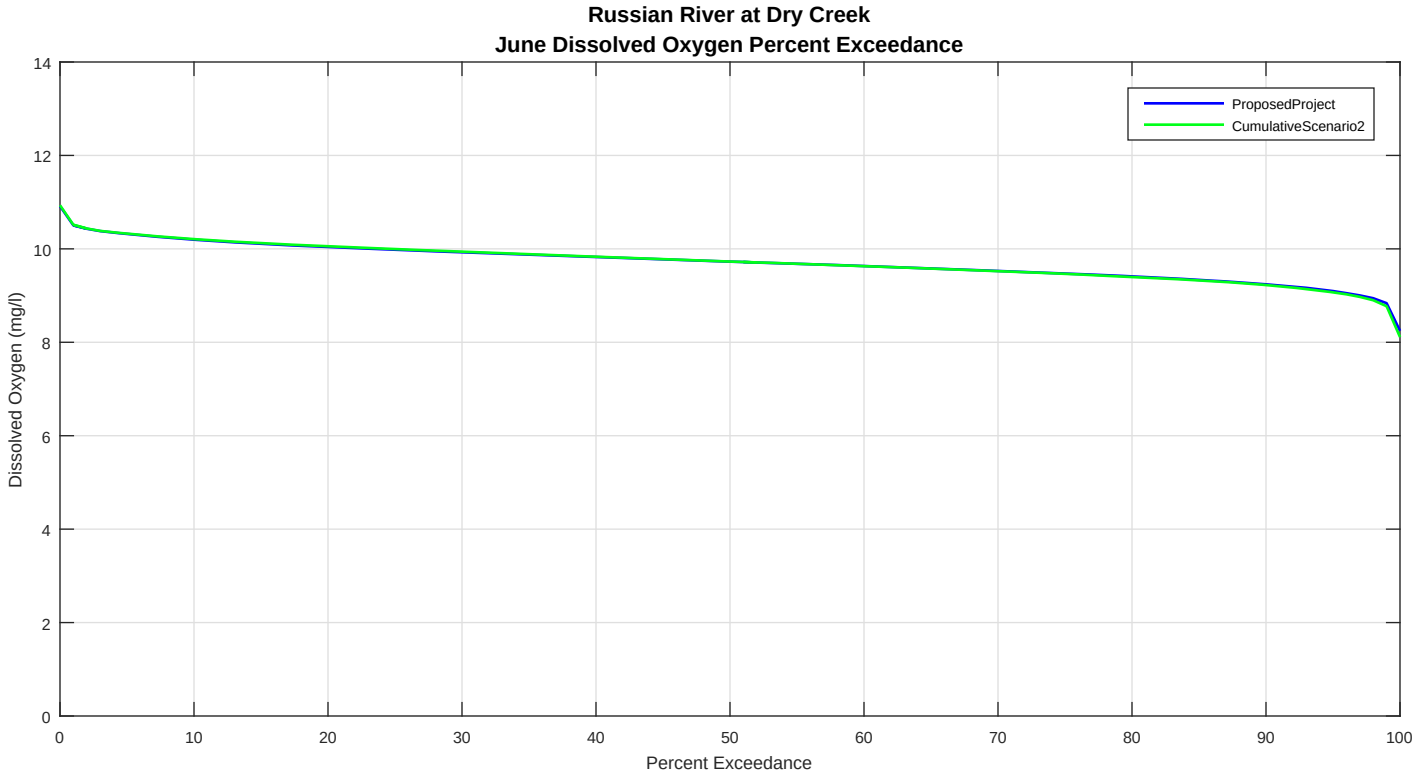
Russian River at Dry Creek
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
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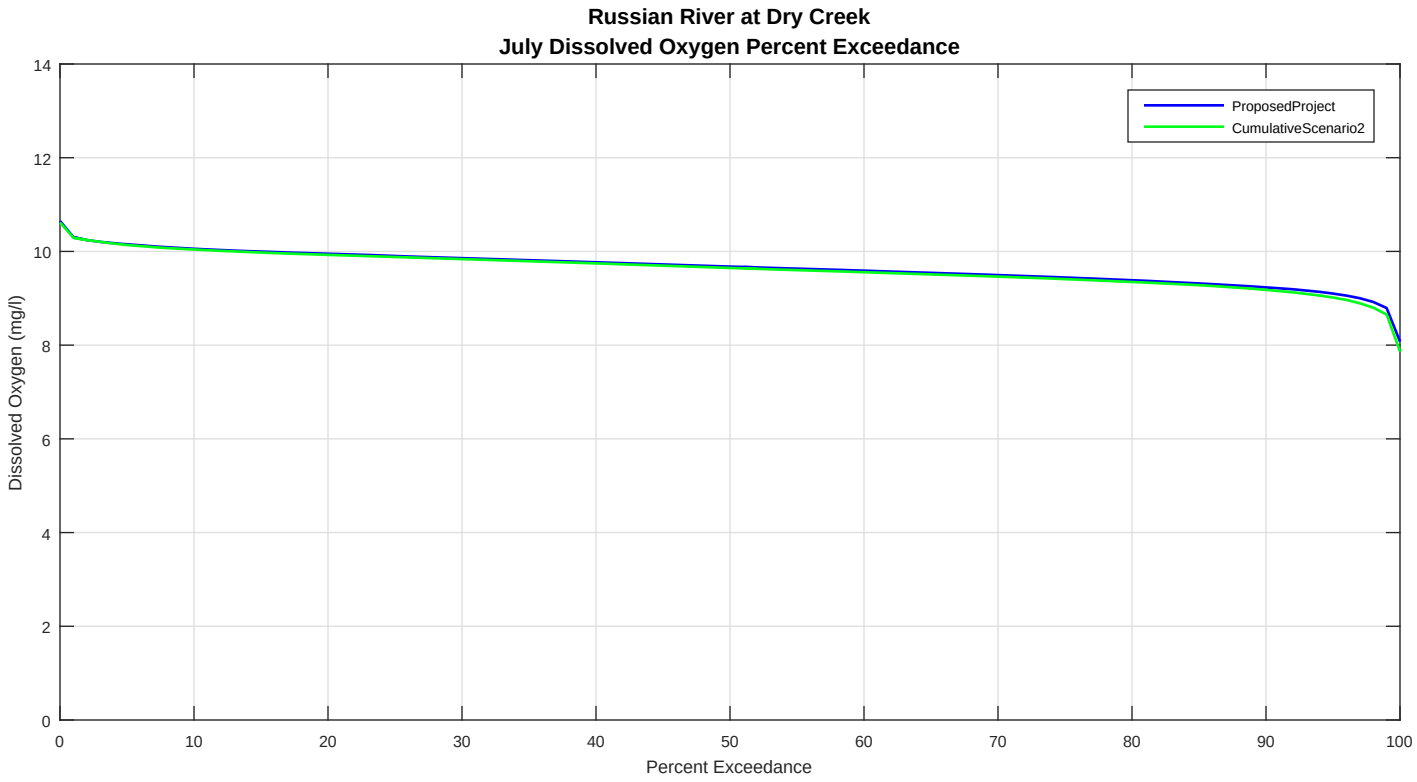
Russian River at Dry Creek
July Dissolved Oxygen Percent Exceedance
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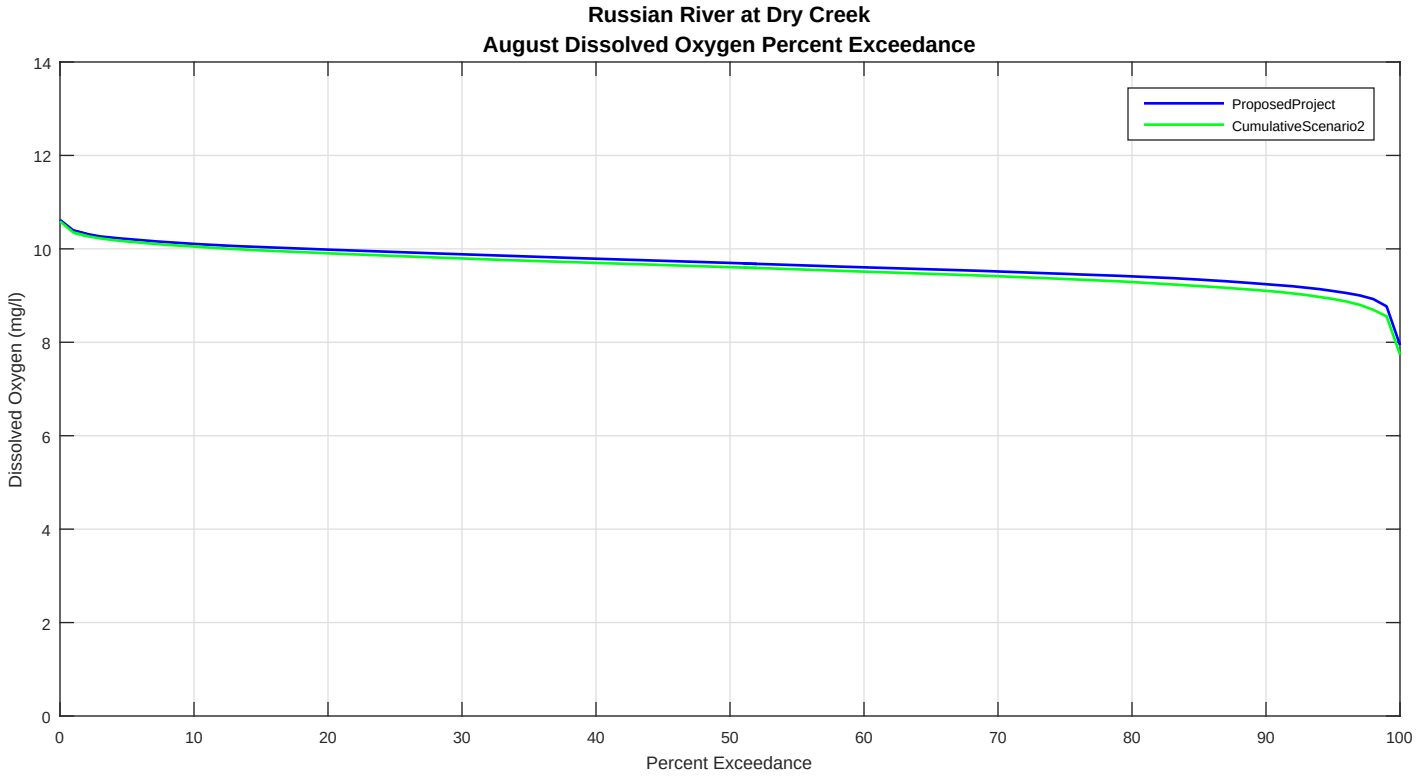
Russian River at Dry Creek
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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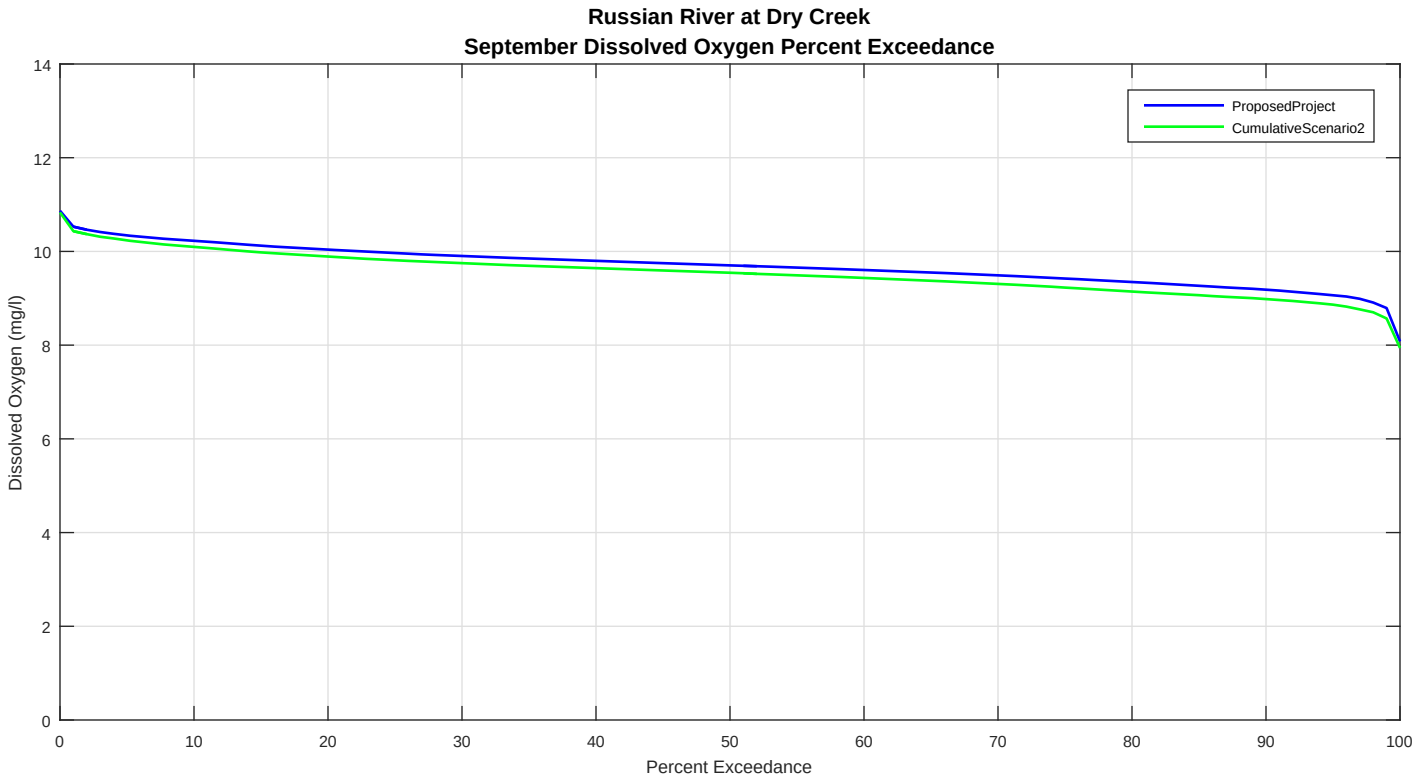
Russian River at Dry Creek
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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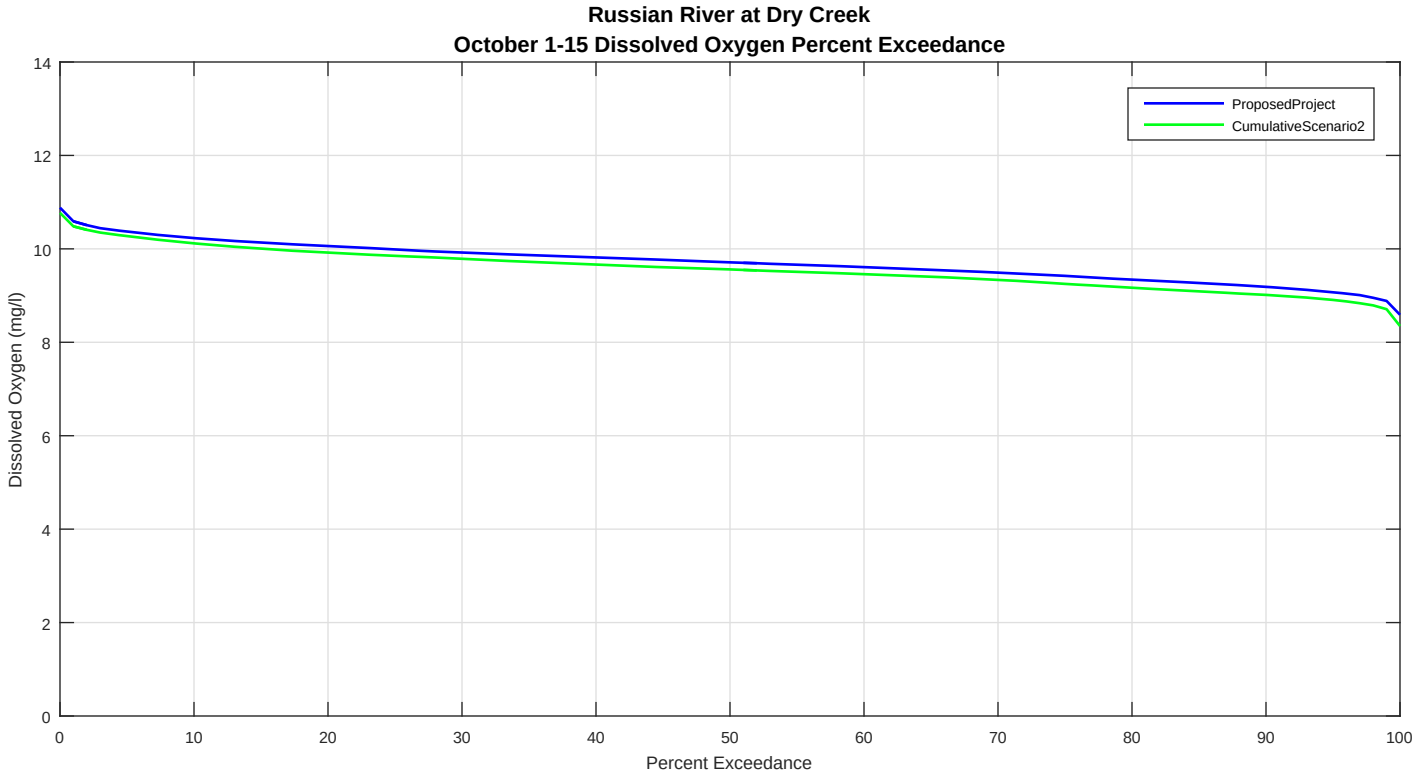
Russian River at Dry Creek
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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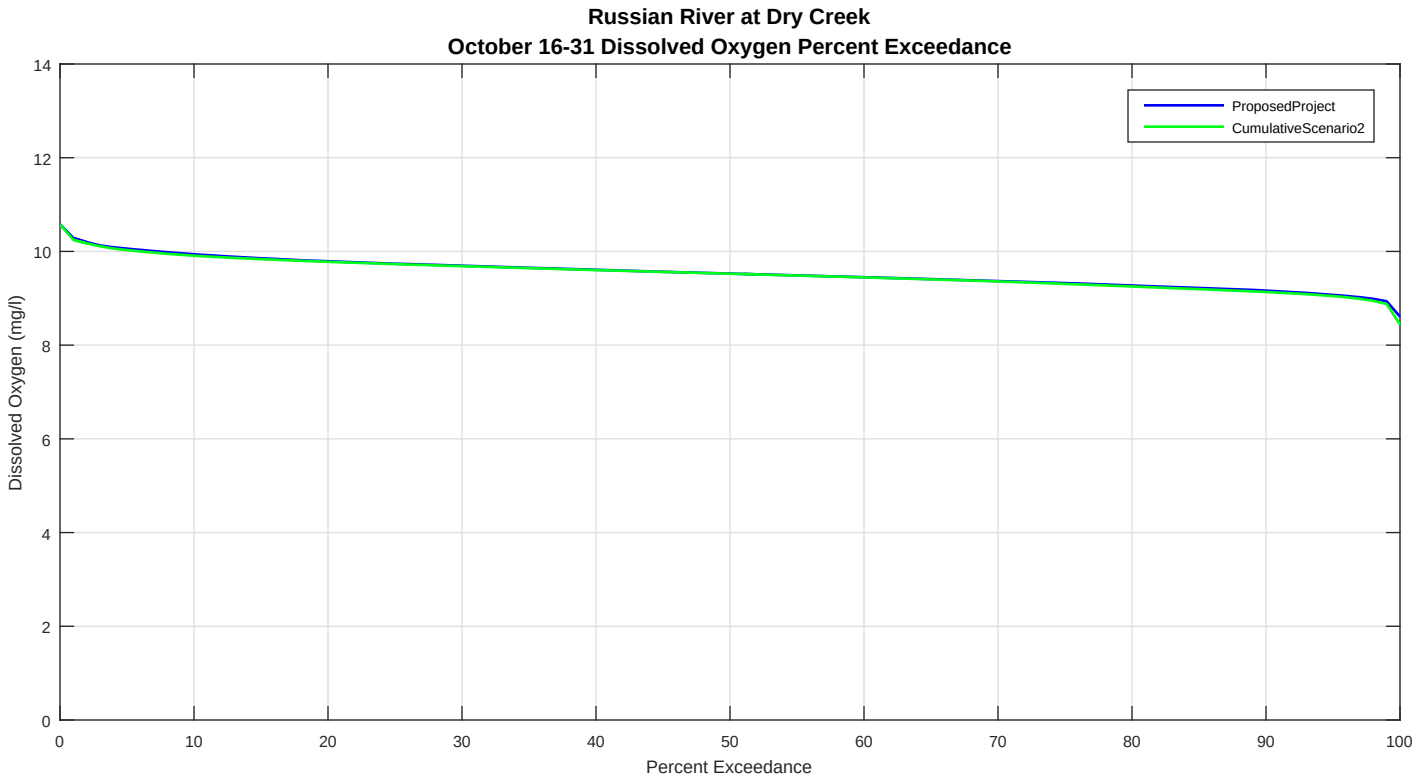
Russian River at Dry Creek
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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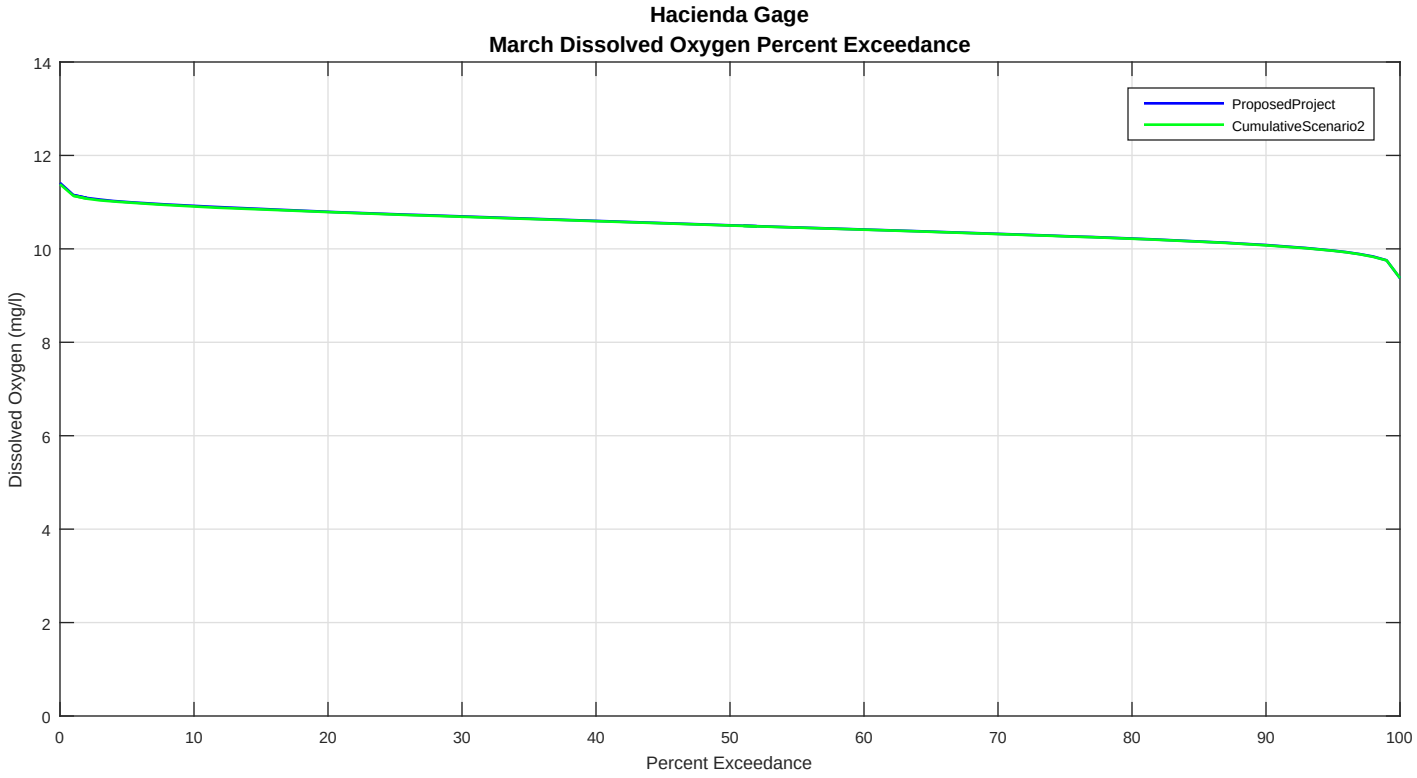
Hacienda Gage
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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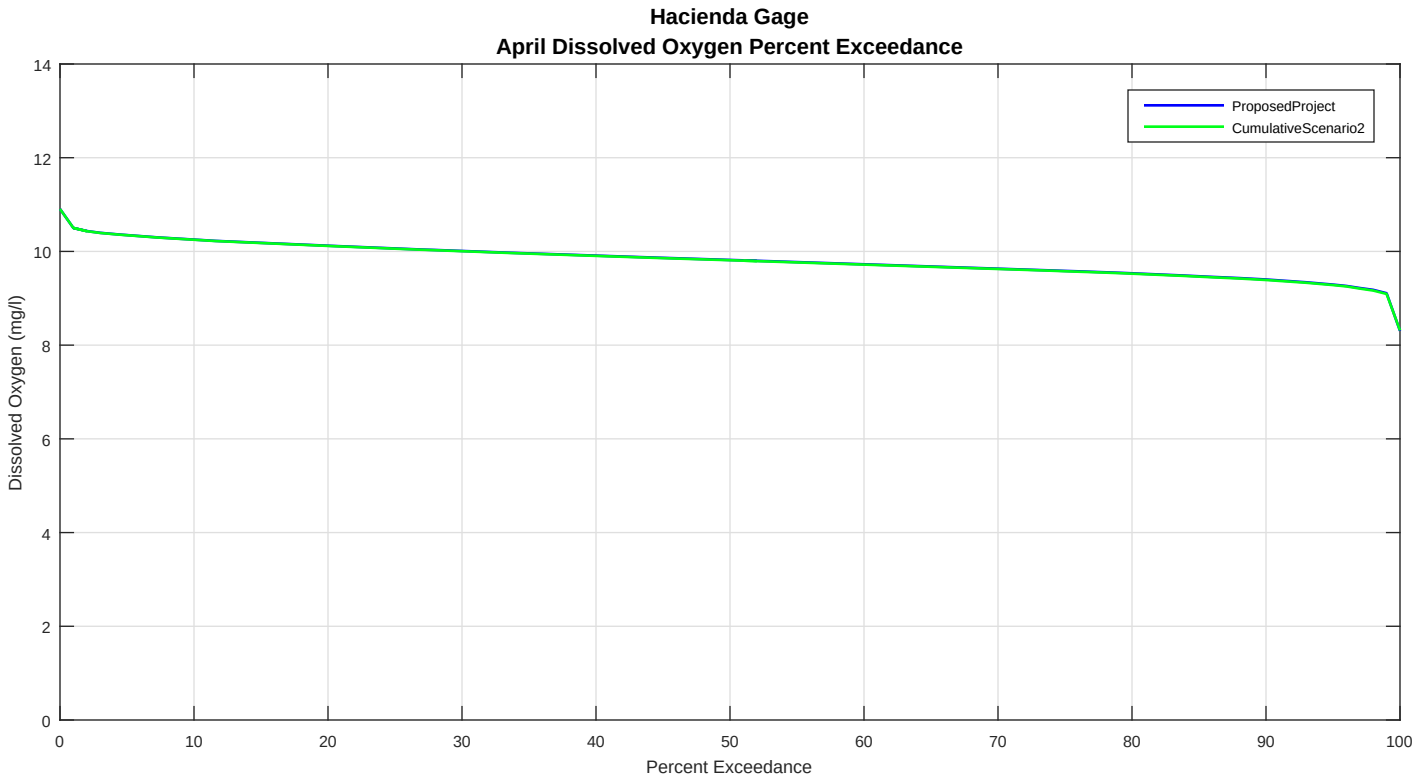
Hacienda Gage
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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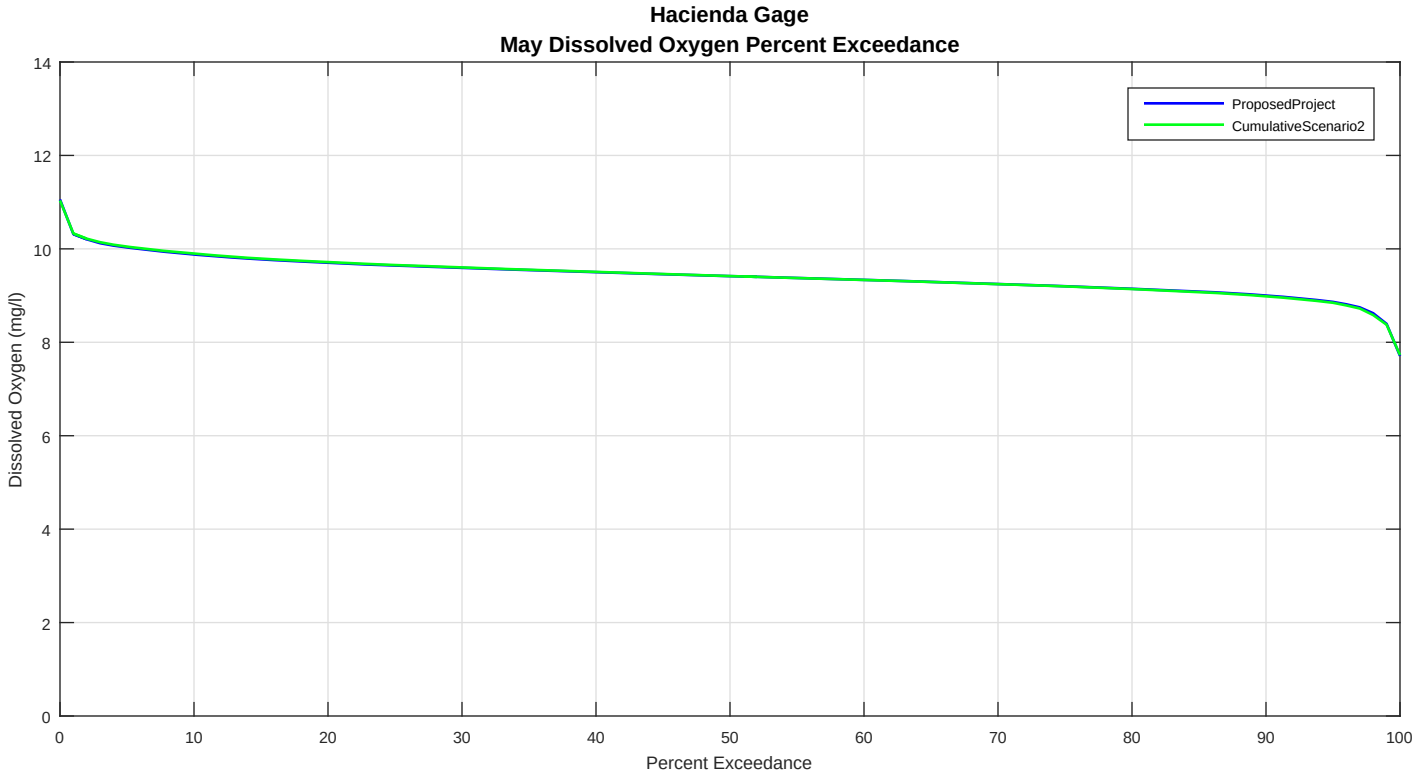
Hacienda Gage
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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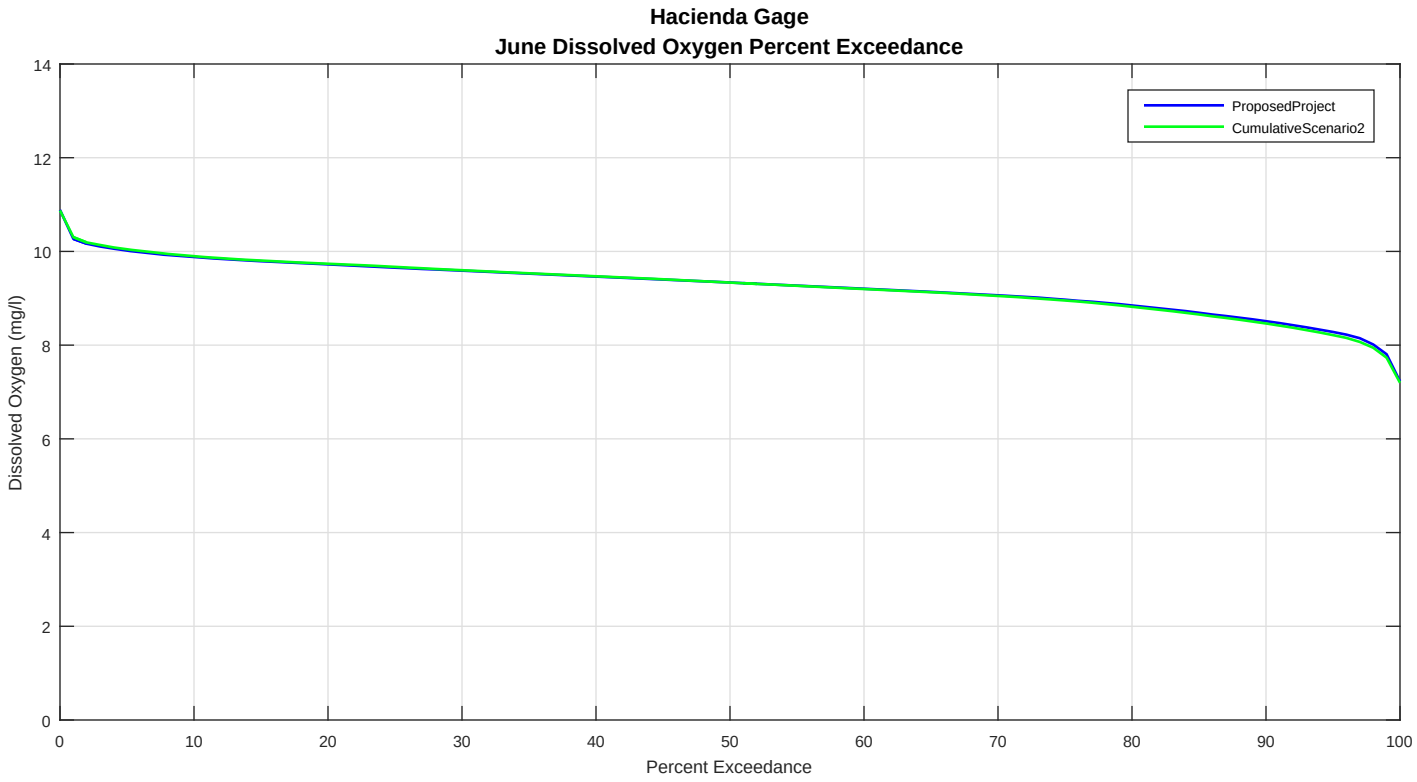
Hacienda Gage
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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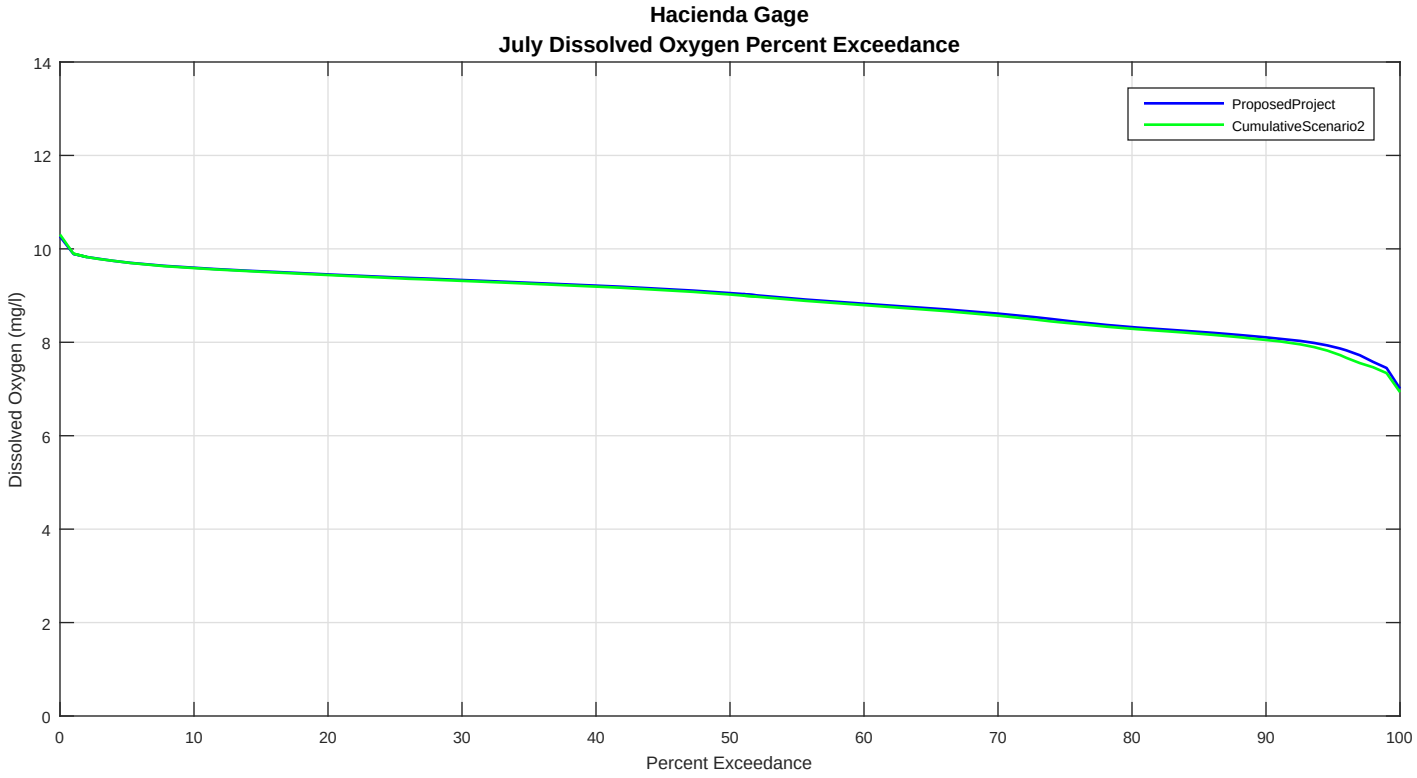
Hacienda Gage
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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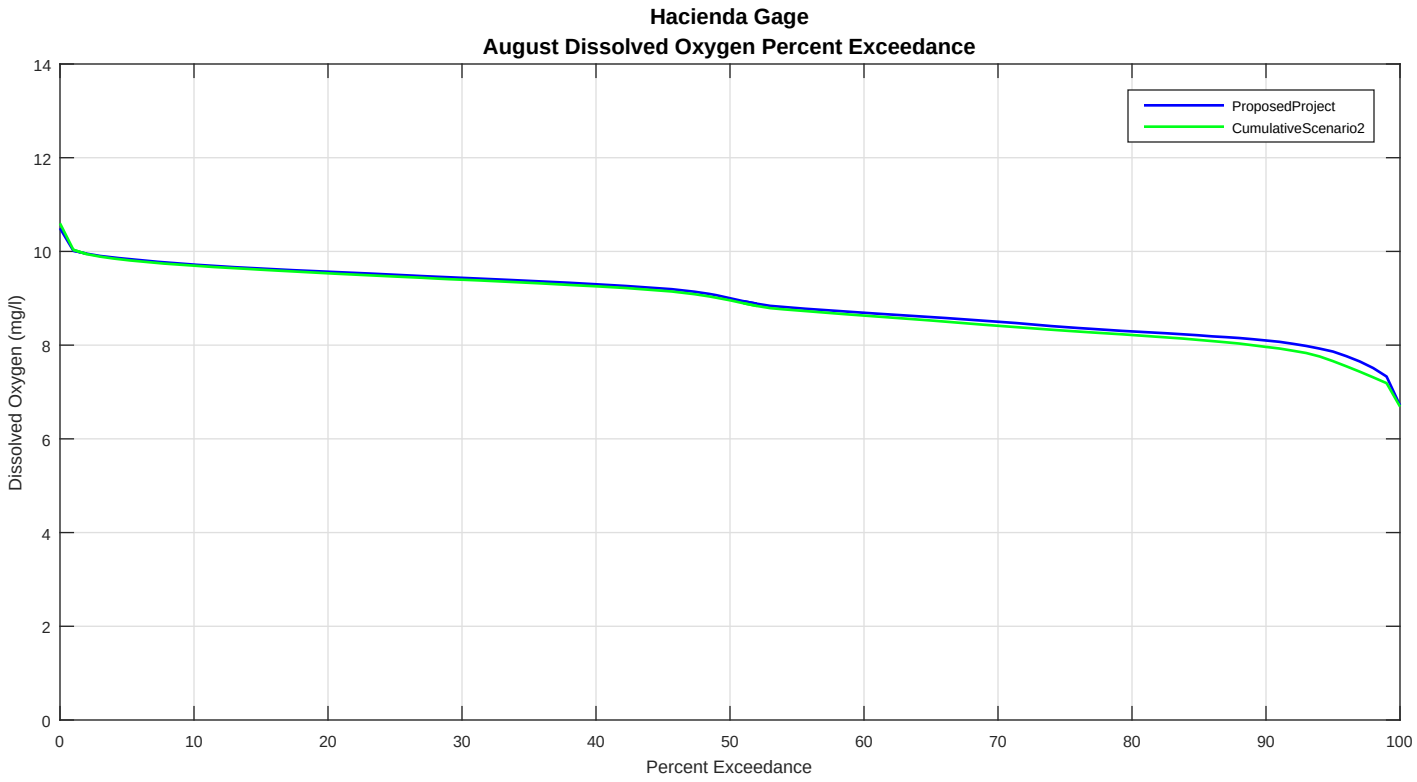
Hacienda Gage
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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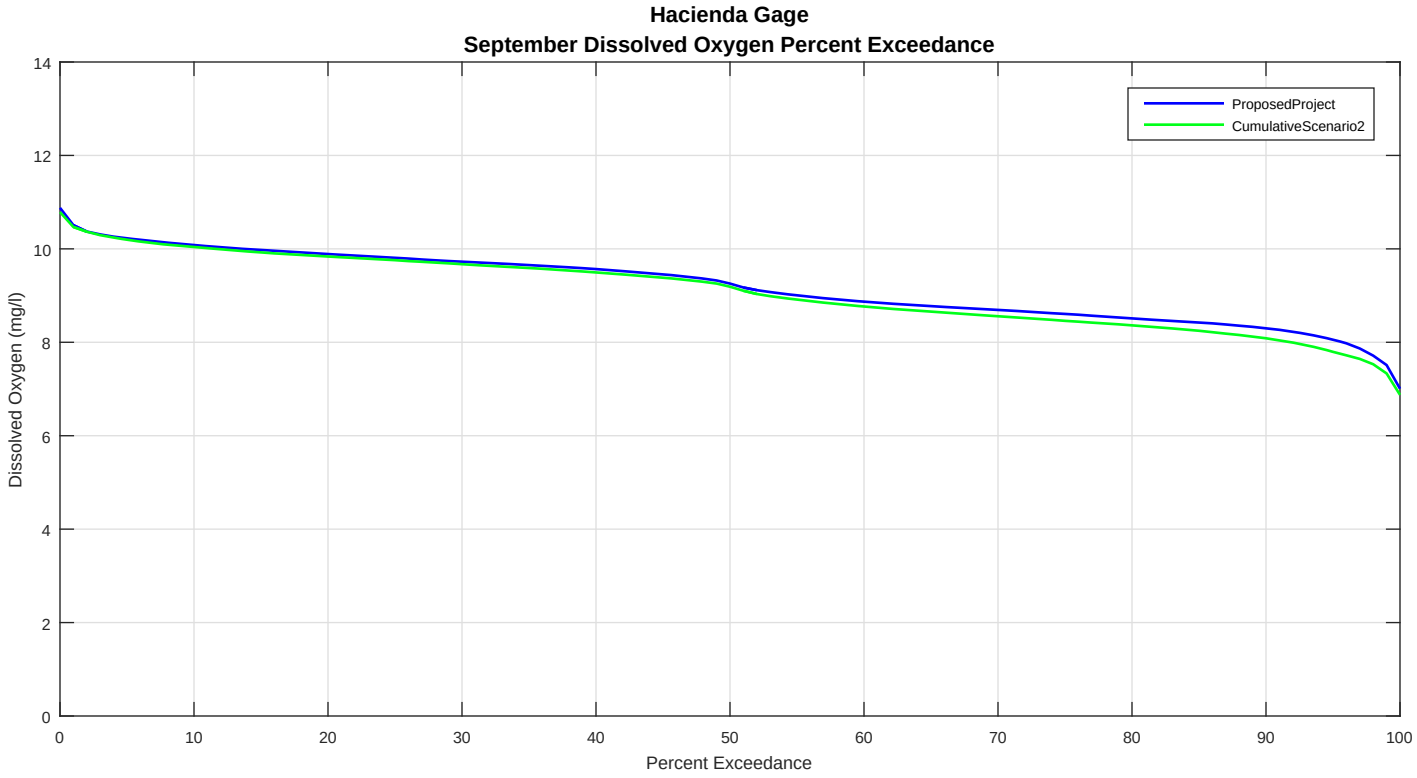
Hacienda Gage
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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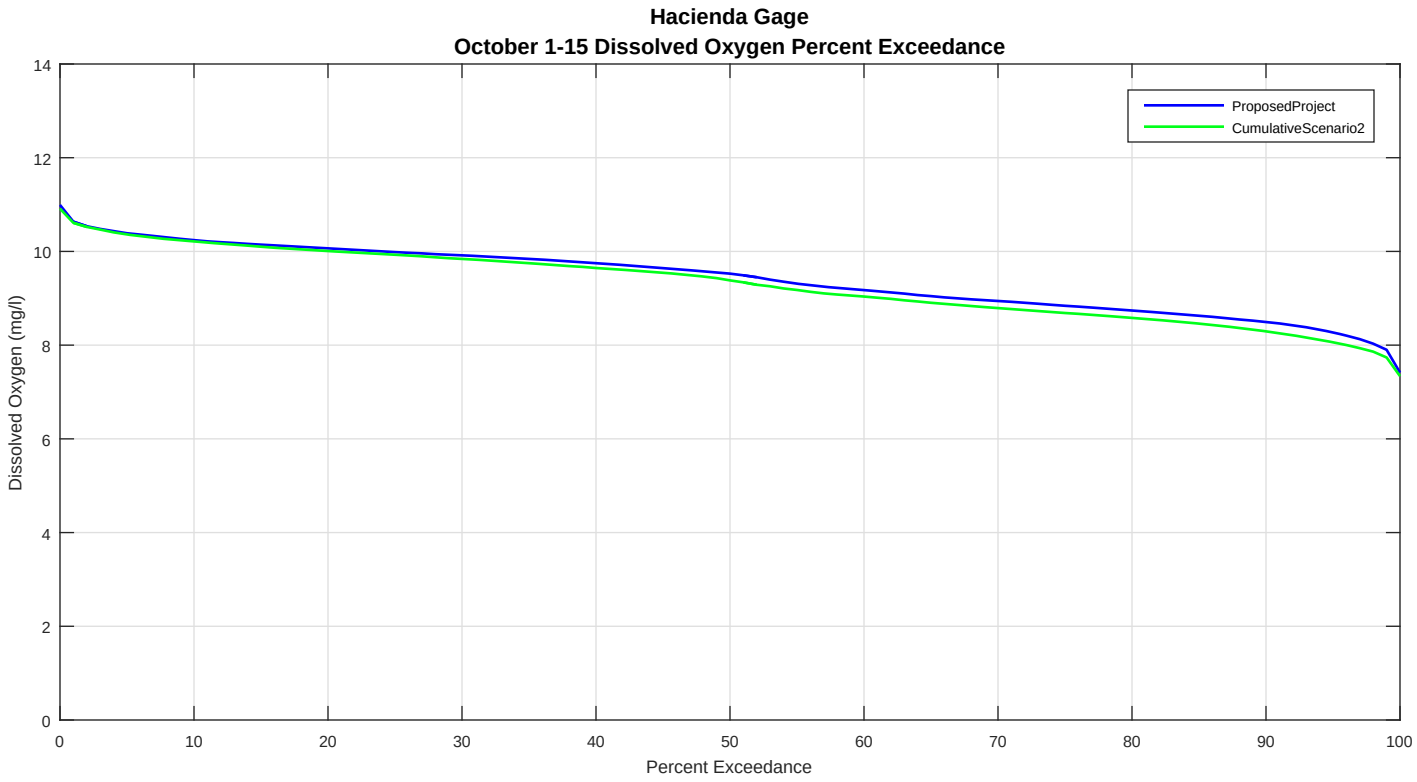
Hacienda Gage
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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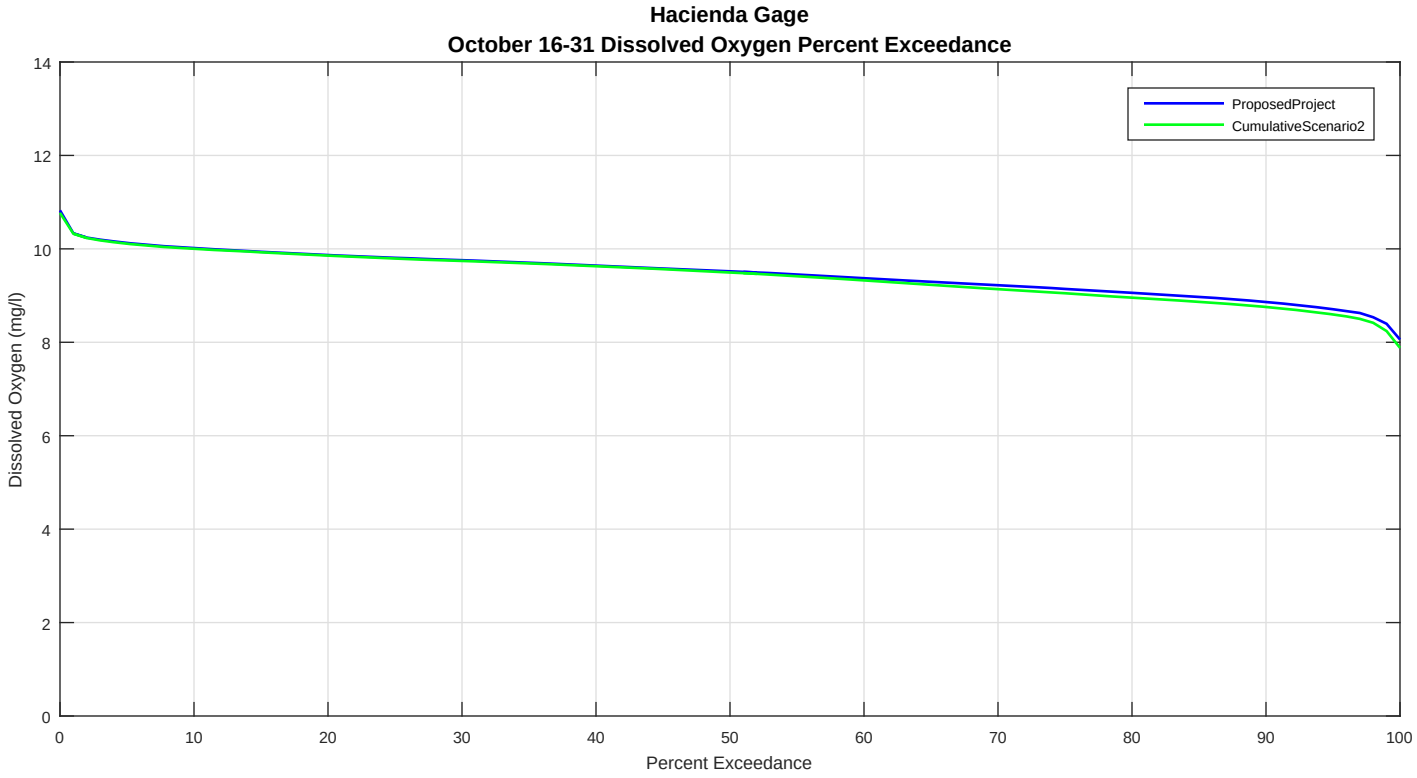
Hacienda Gage
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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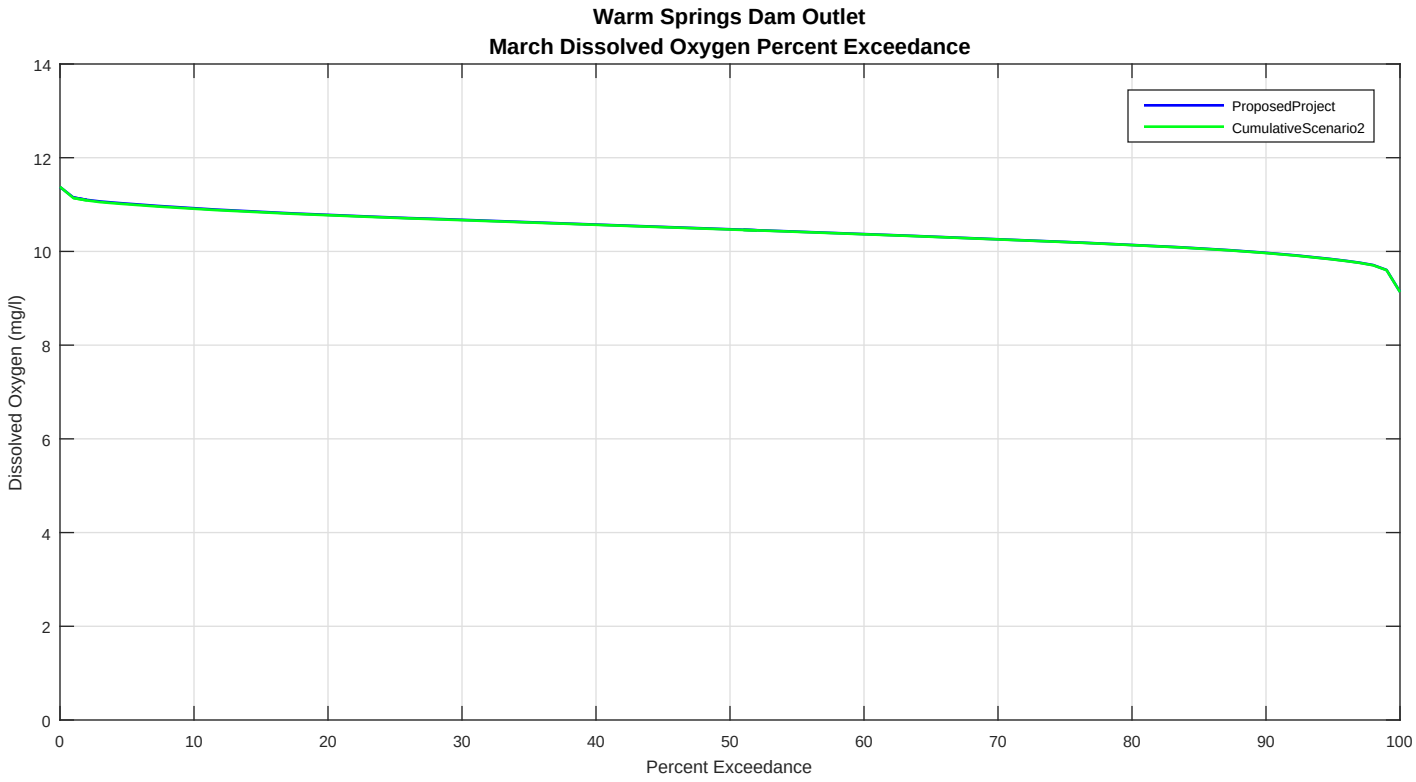
Warm Springs Dam Outlet
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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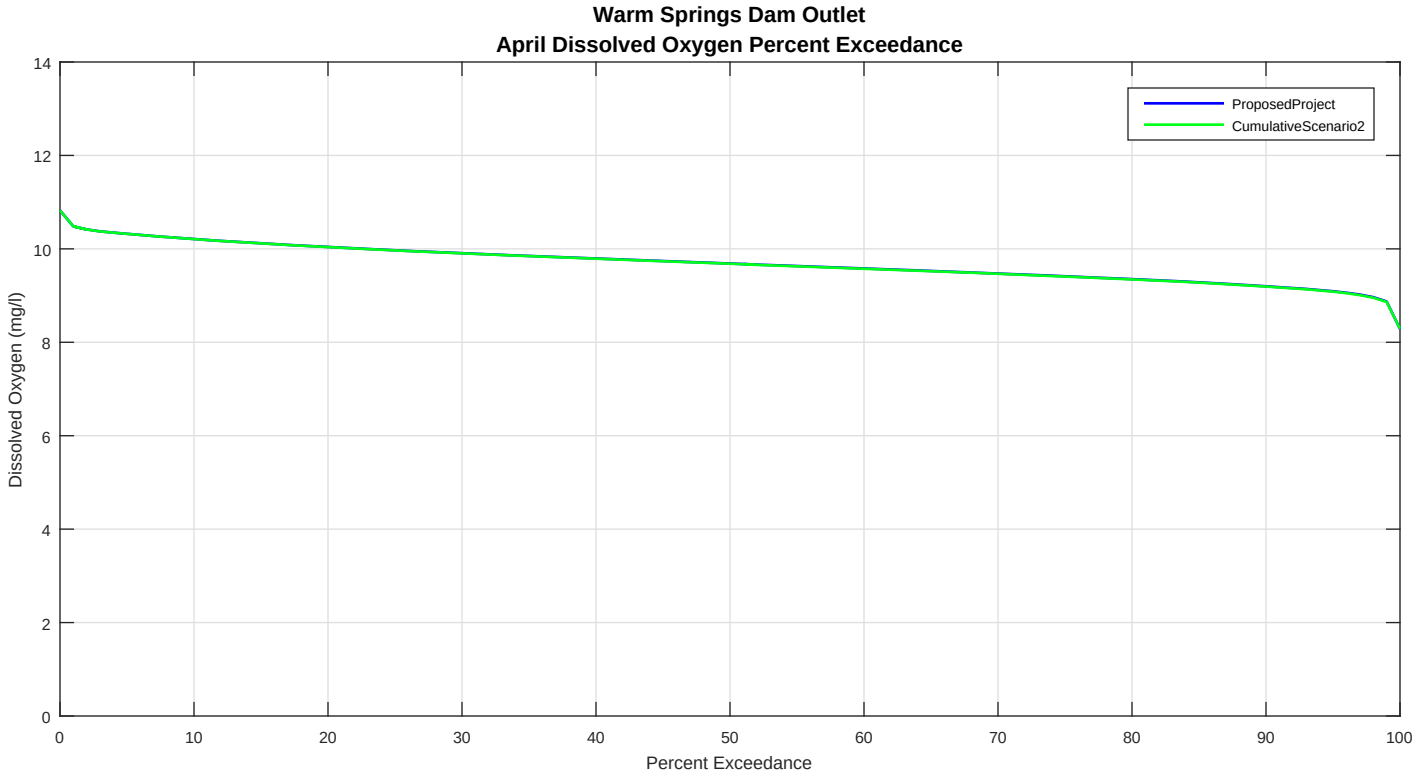
Warm Springs Dam Outlet
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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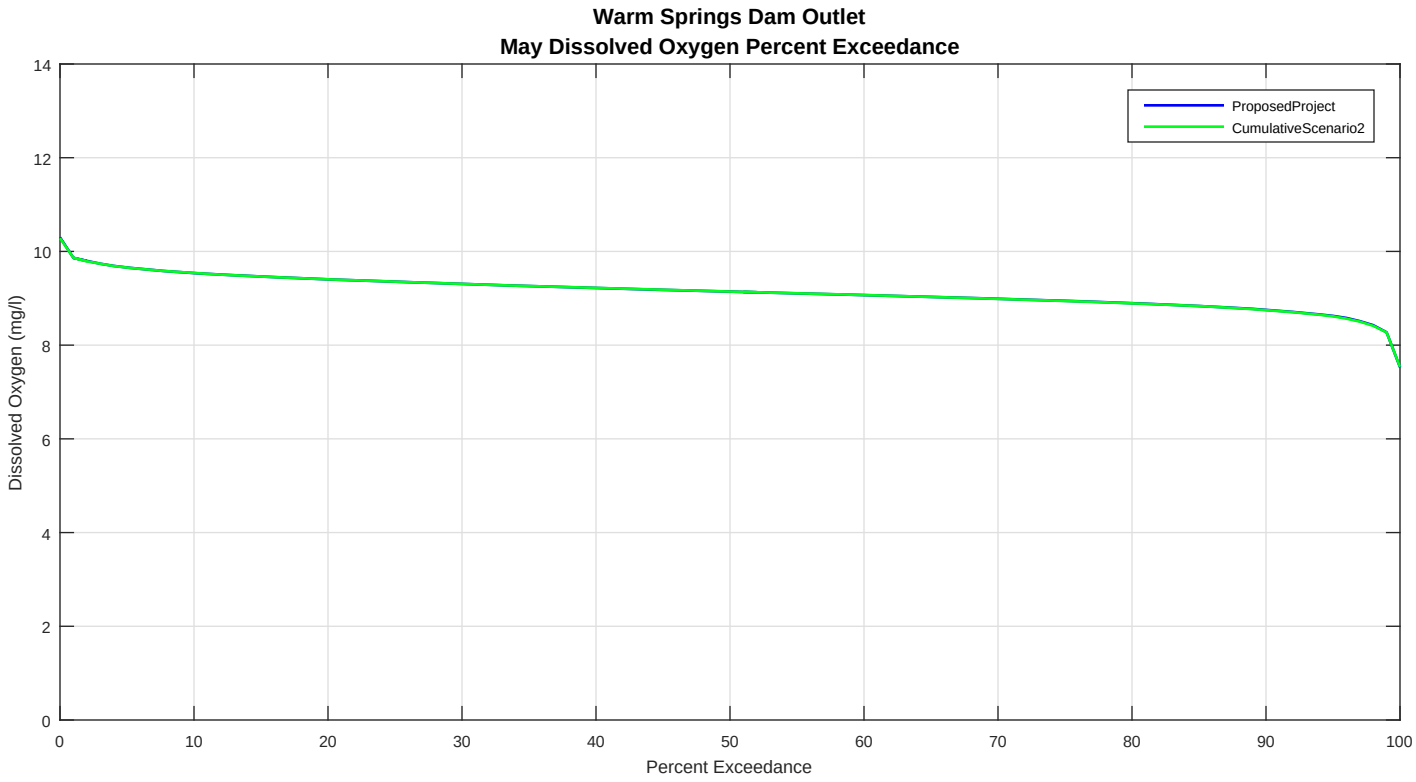
Warm Springs Dam Outlet
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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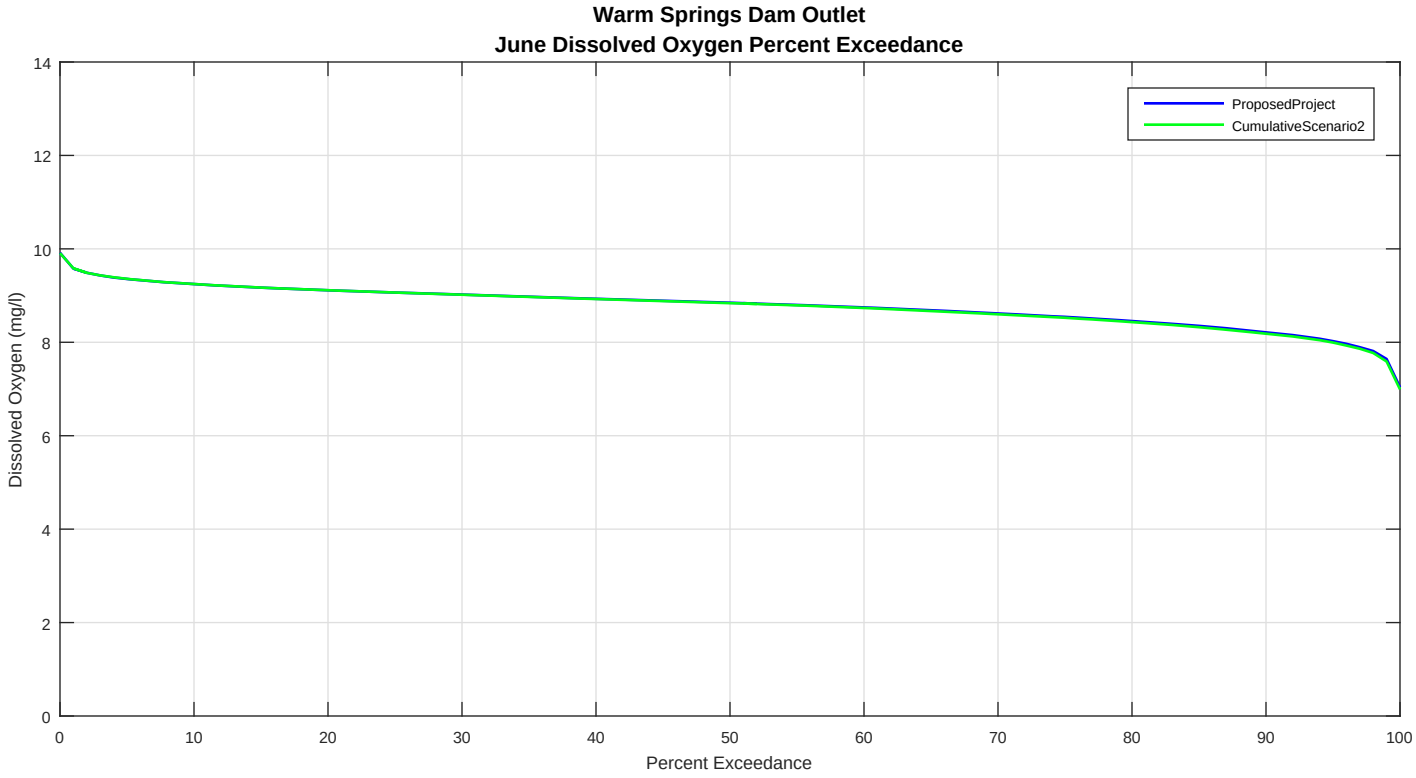
Warm Springs Dam Outlet
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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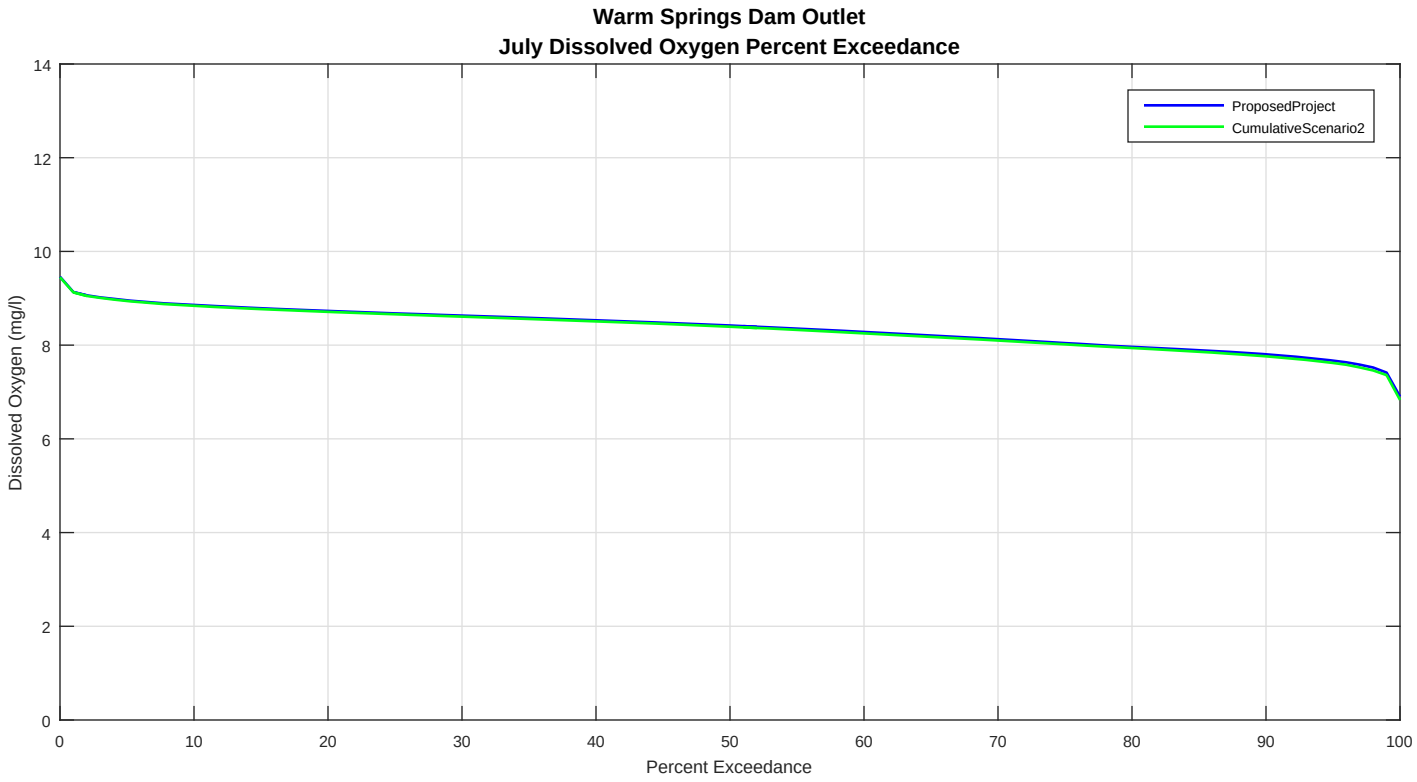
Warm Springs Dam Outlet
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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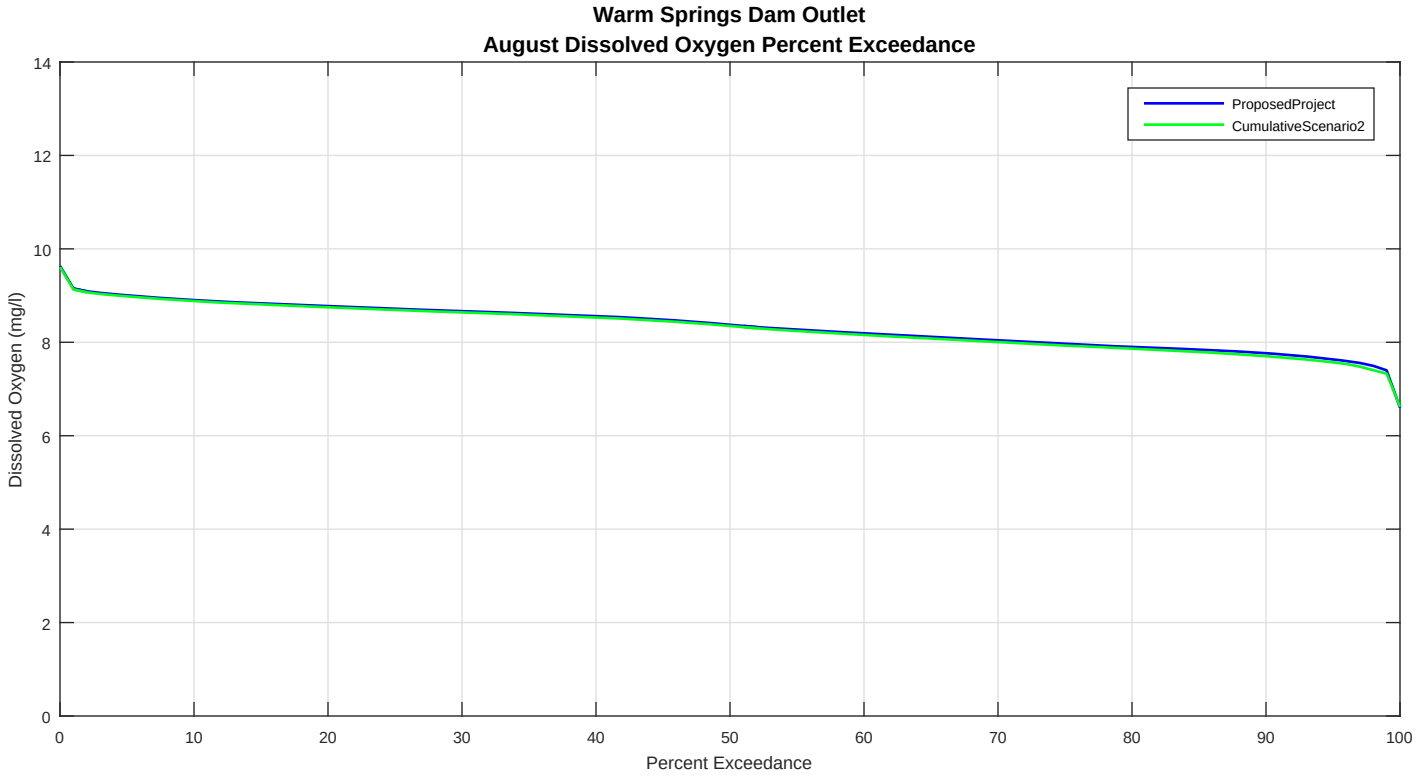
Warm Springs Dam Outlet
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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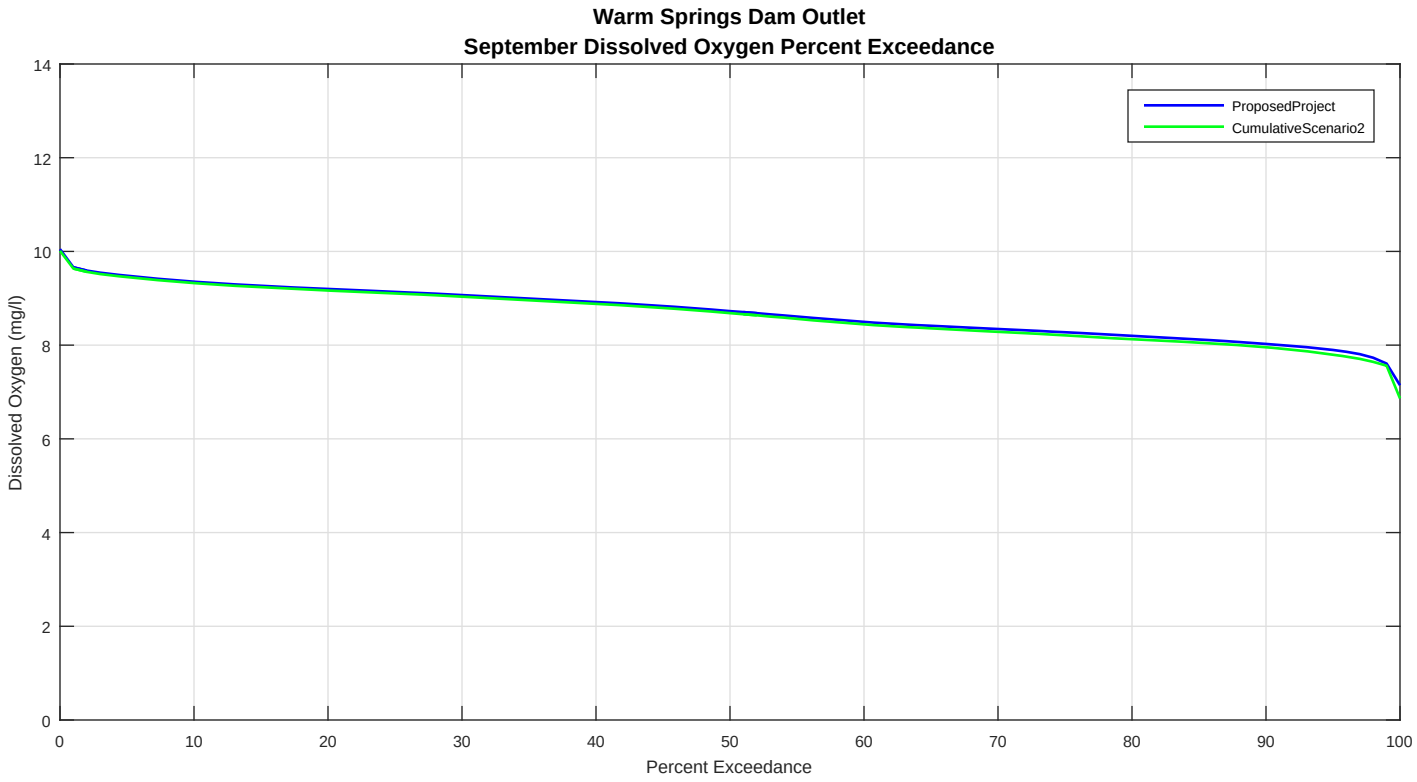
Warm Springs Dam Outlet
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
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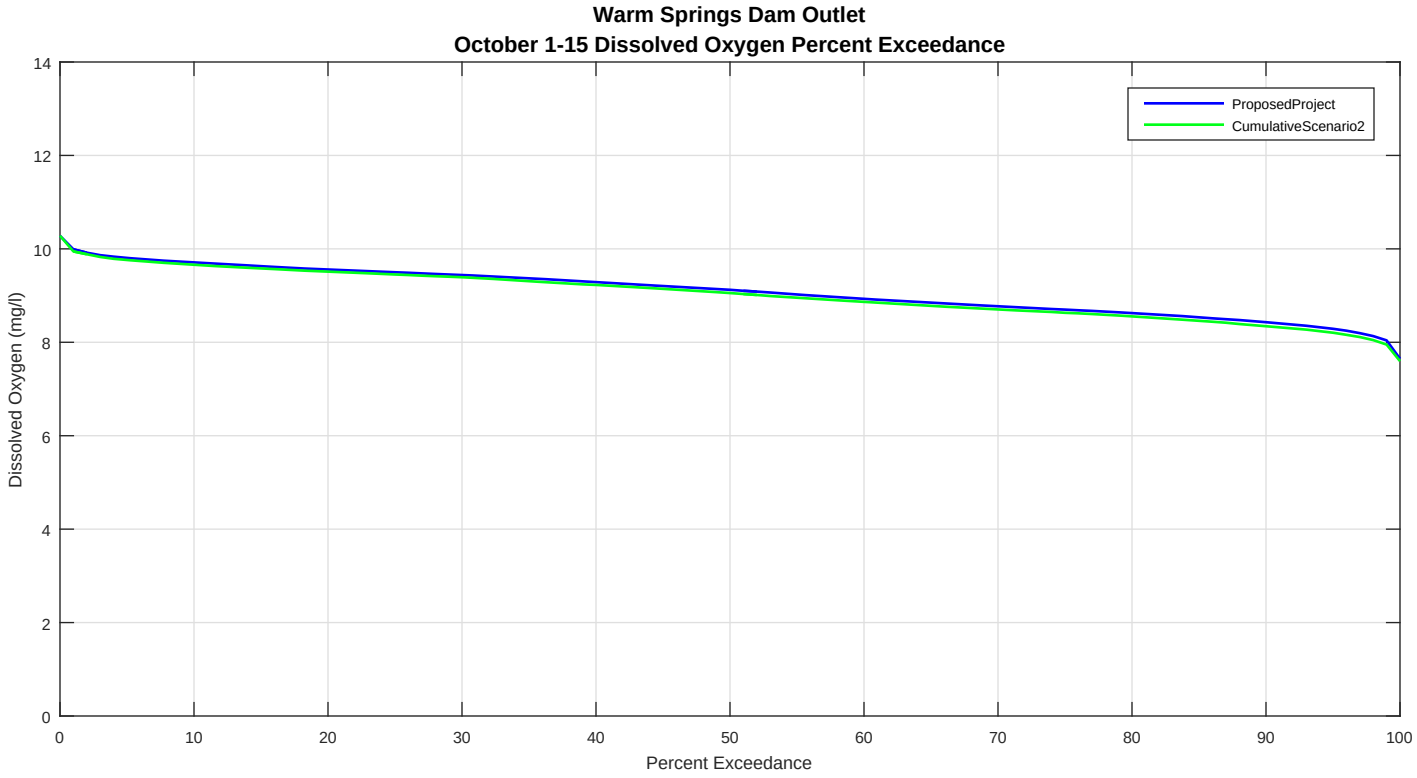
Warm Springs Dam Outlet
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
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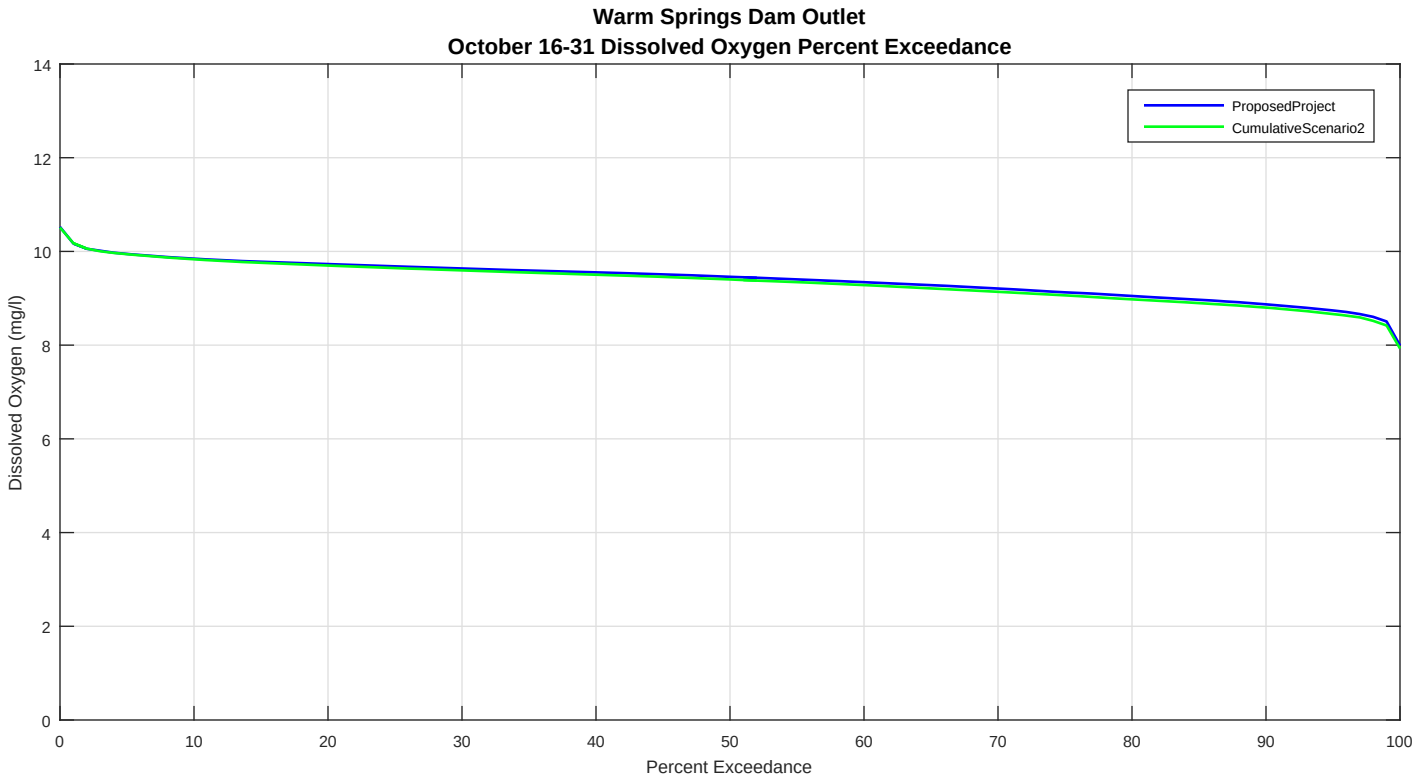
Warm Springs Dam Outlet
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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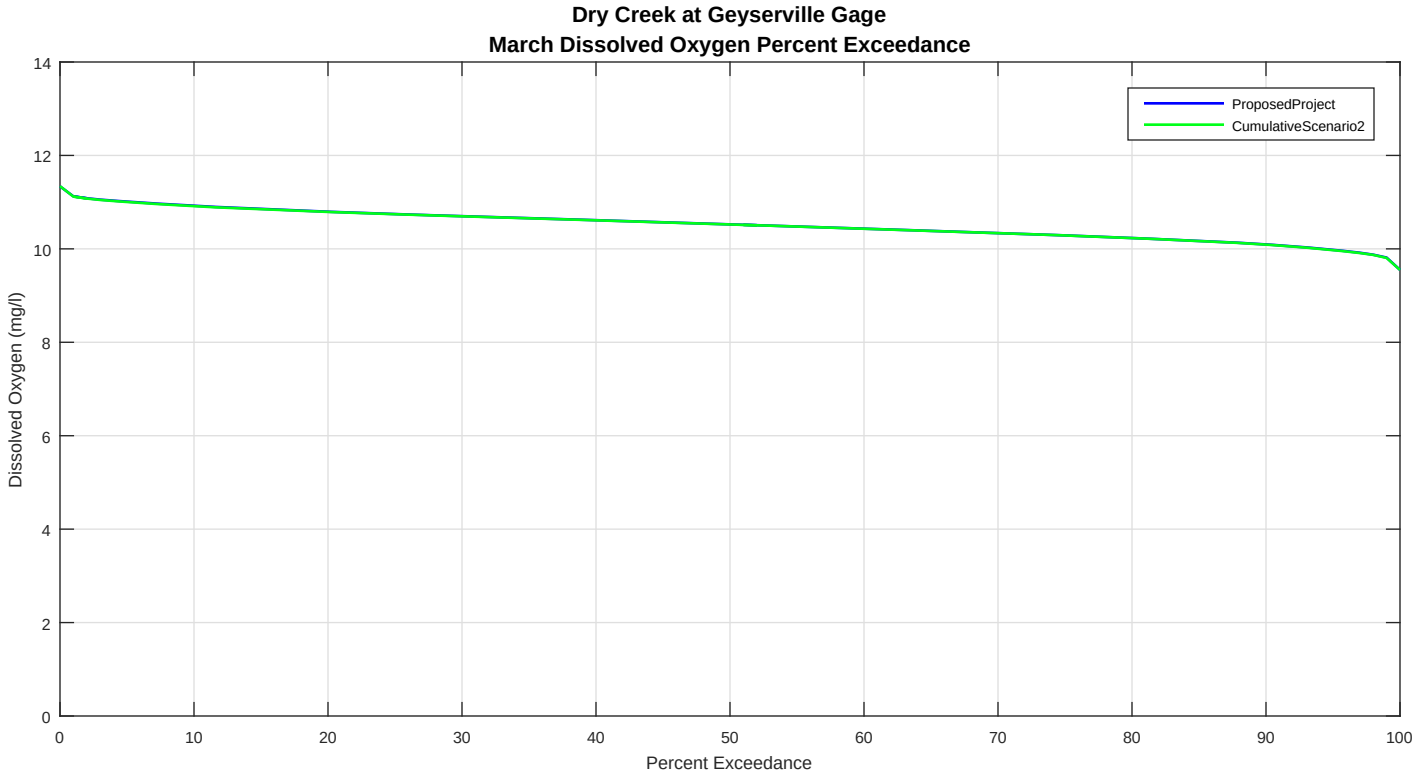
Dry Creek at Geyserville Gage
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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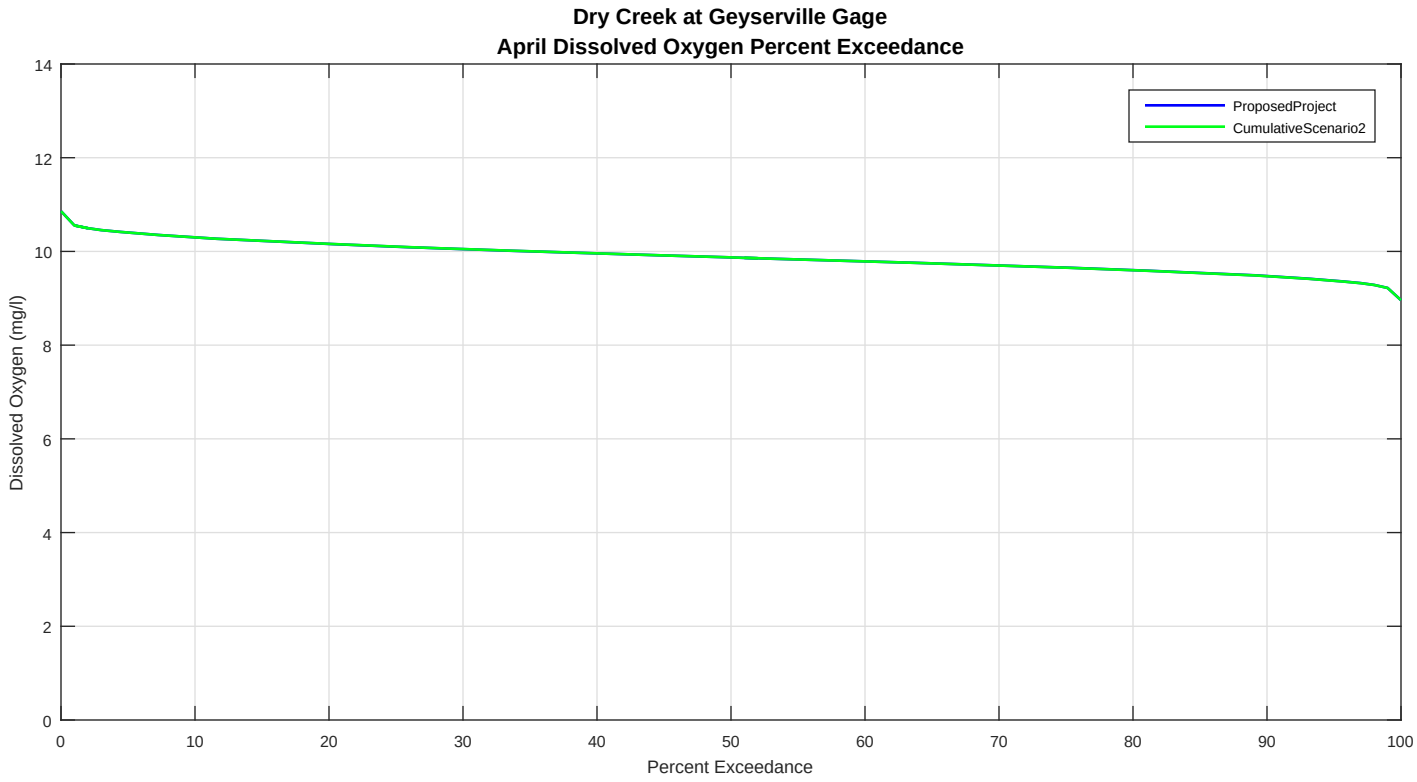
Dry Creek at Geyserville Gage
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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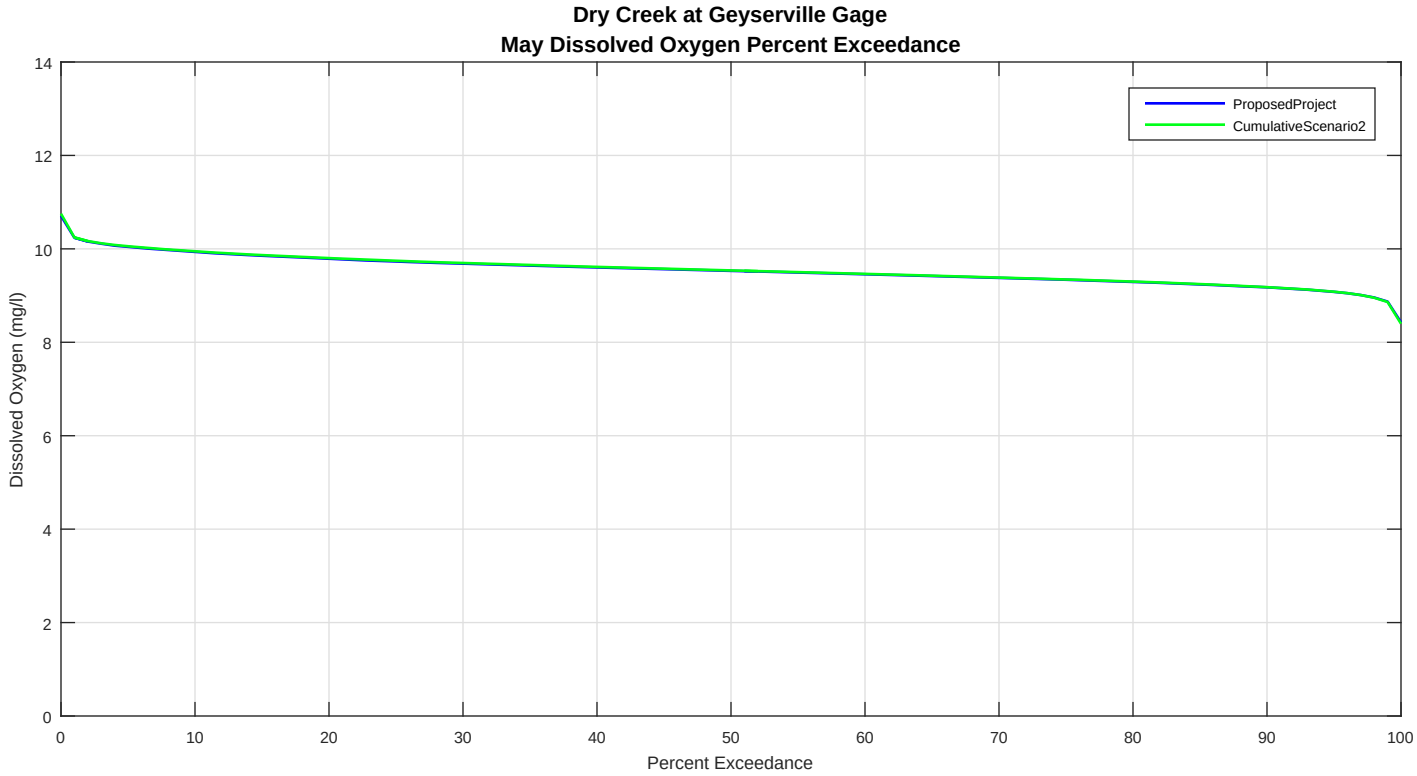
Dry Creek at Geyserville Gage
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
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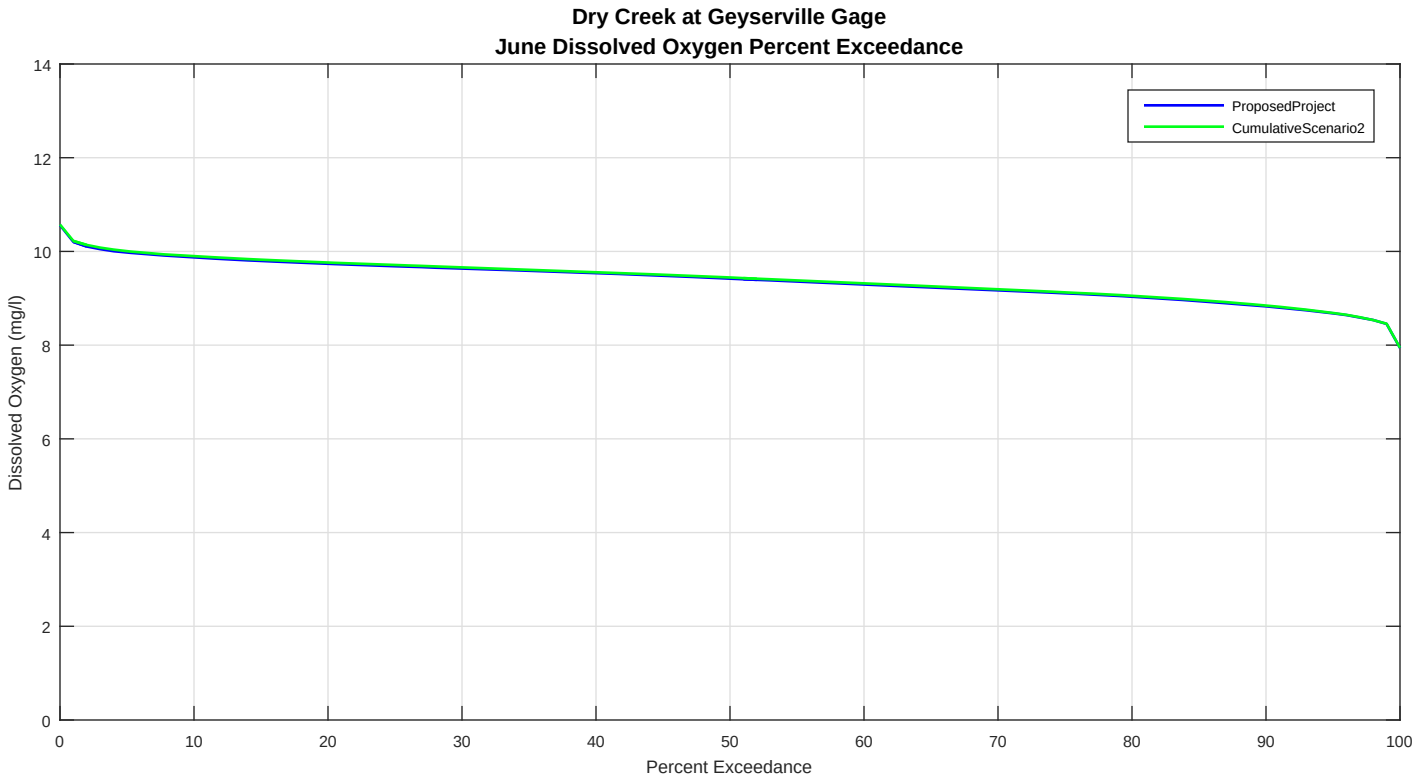
Dry Creek at Geyserville Gage
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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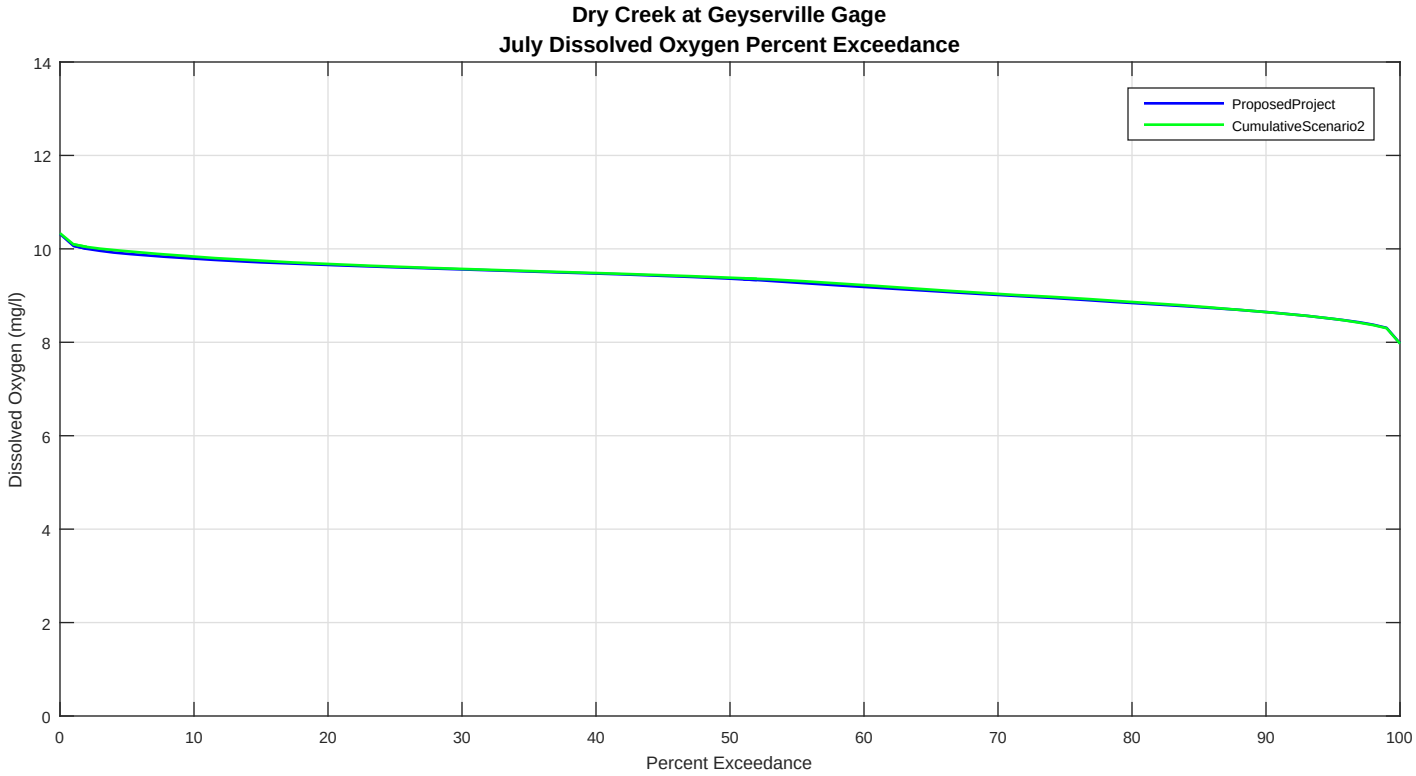
Dry Creek at Geyserville Gage
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
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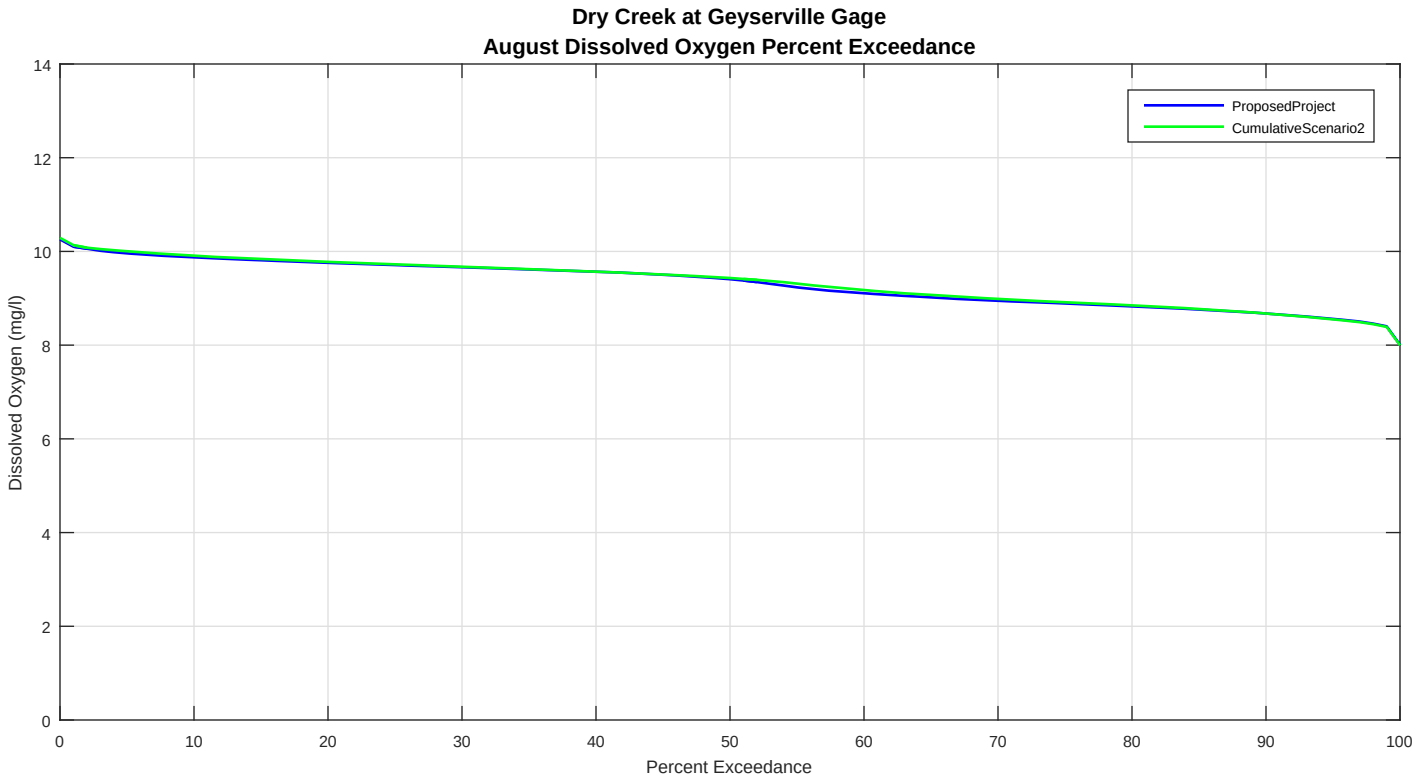
Dry Creek at Geyserville Gage
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
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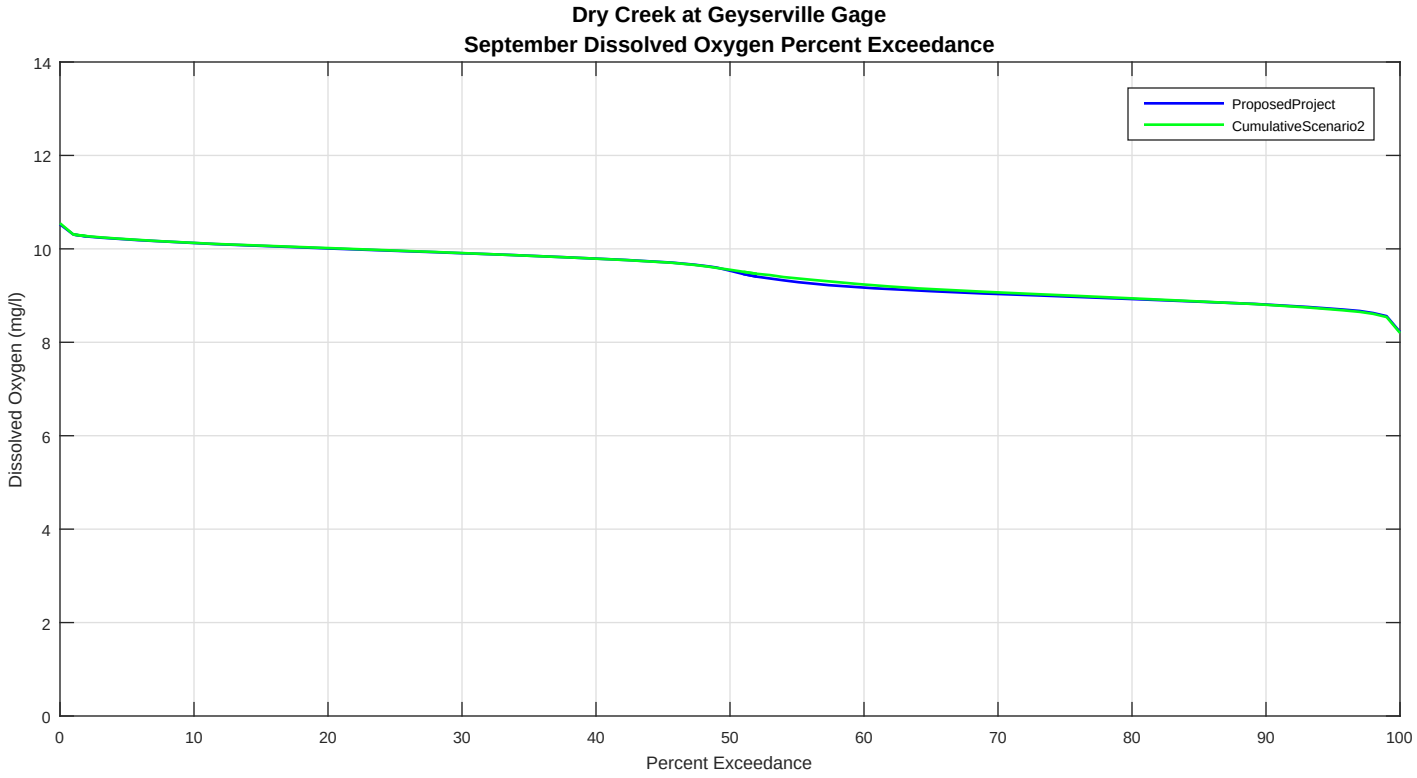
Dry Creek at Geyserville Gage
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
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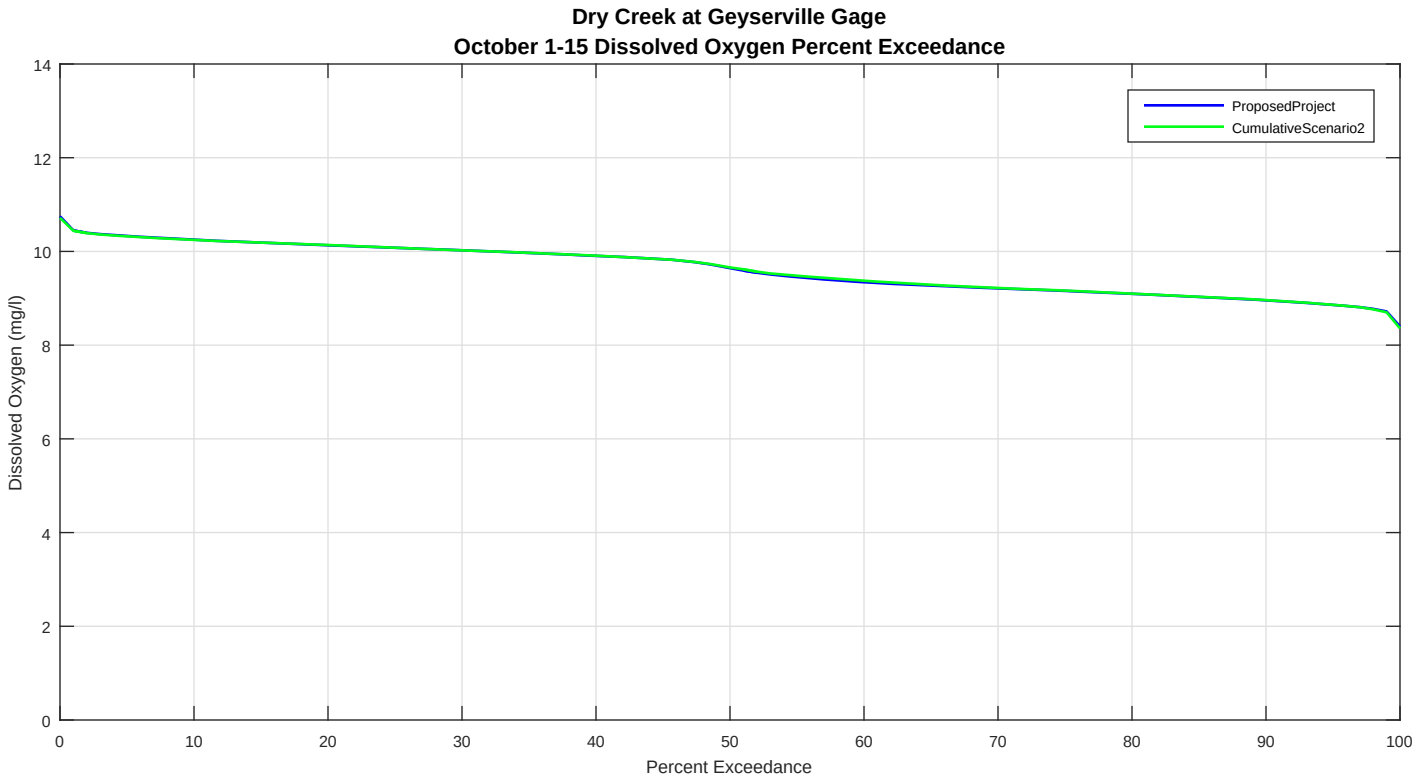
Dry Creek at Geyserville Gage
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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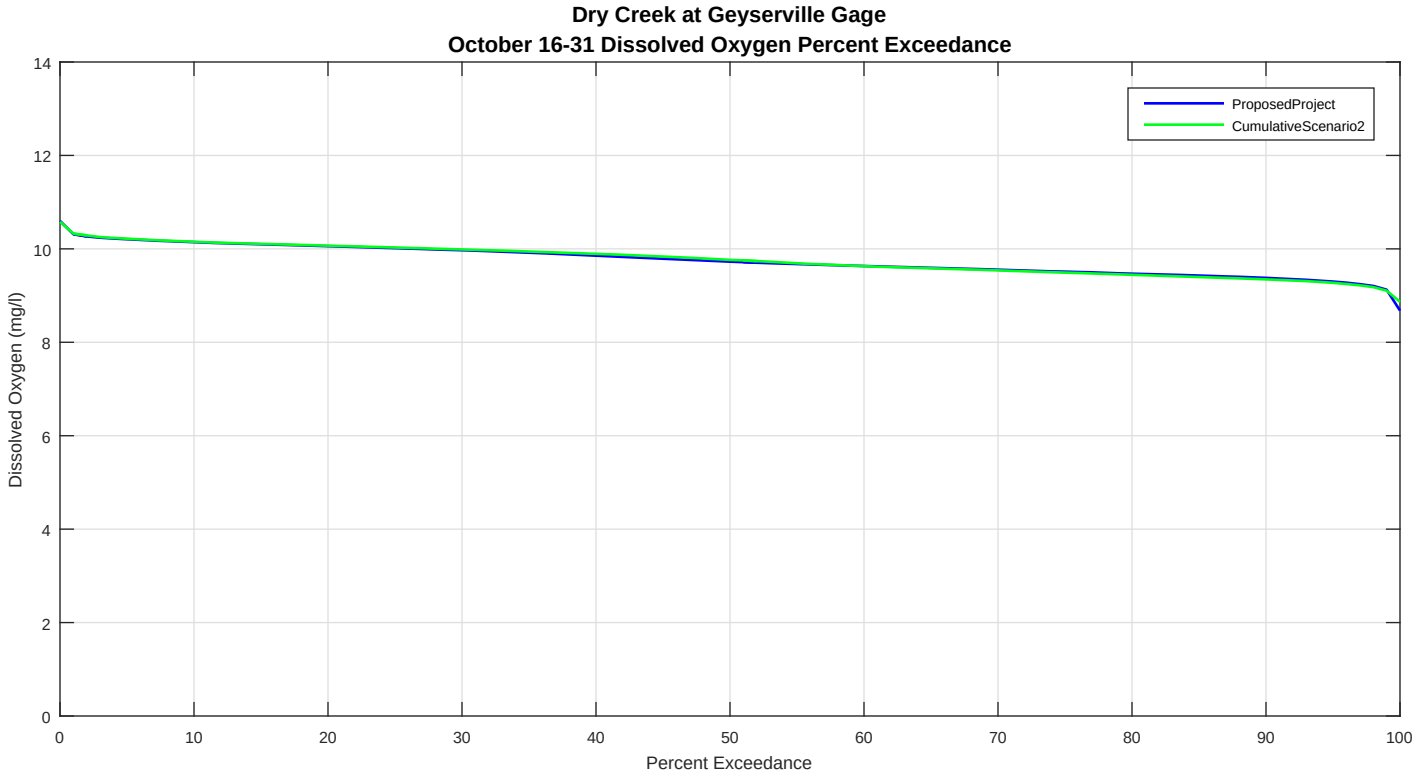
Dry Creek at Geyserville Gage
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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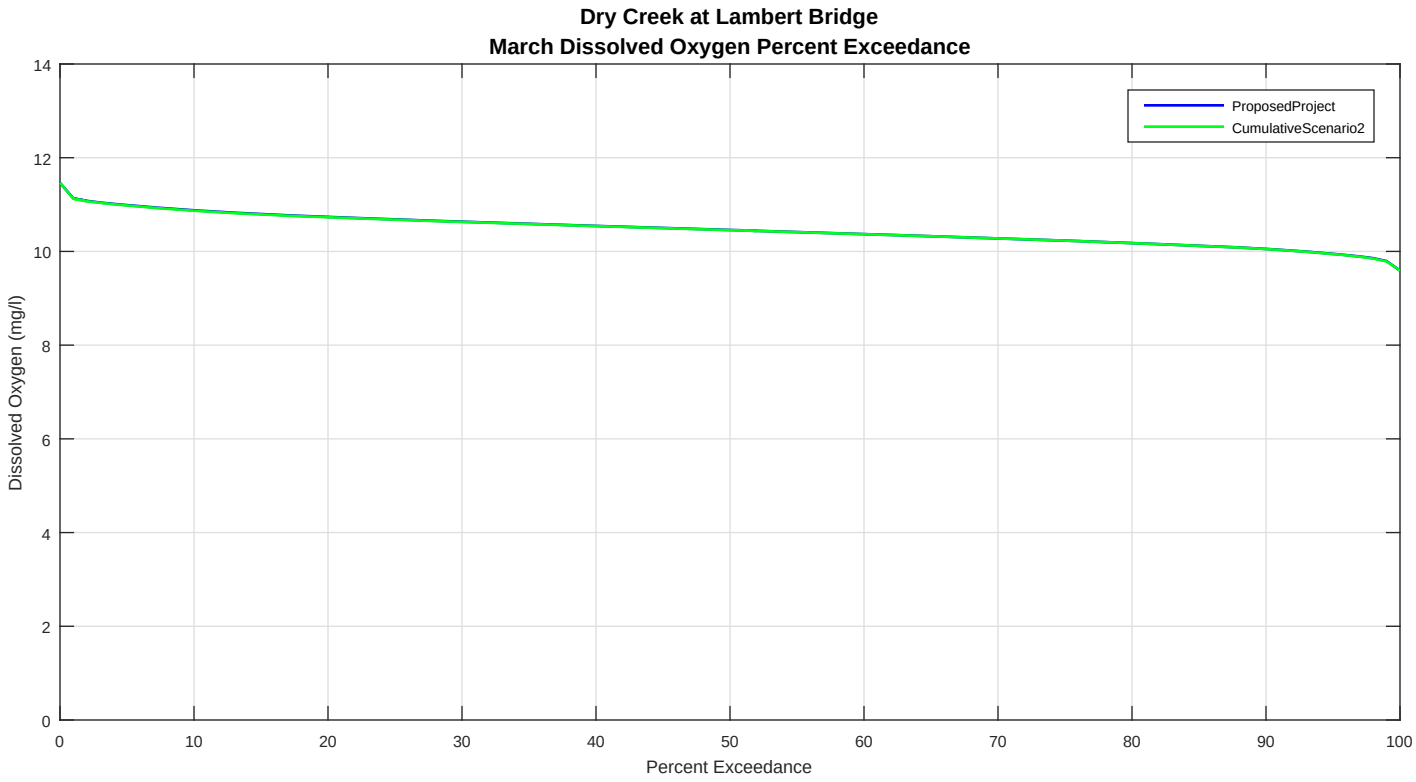
Dry Creek at Lambert Bridge
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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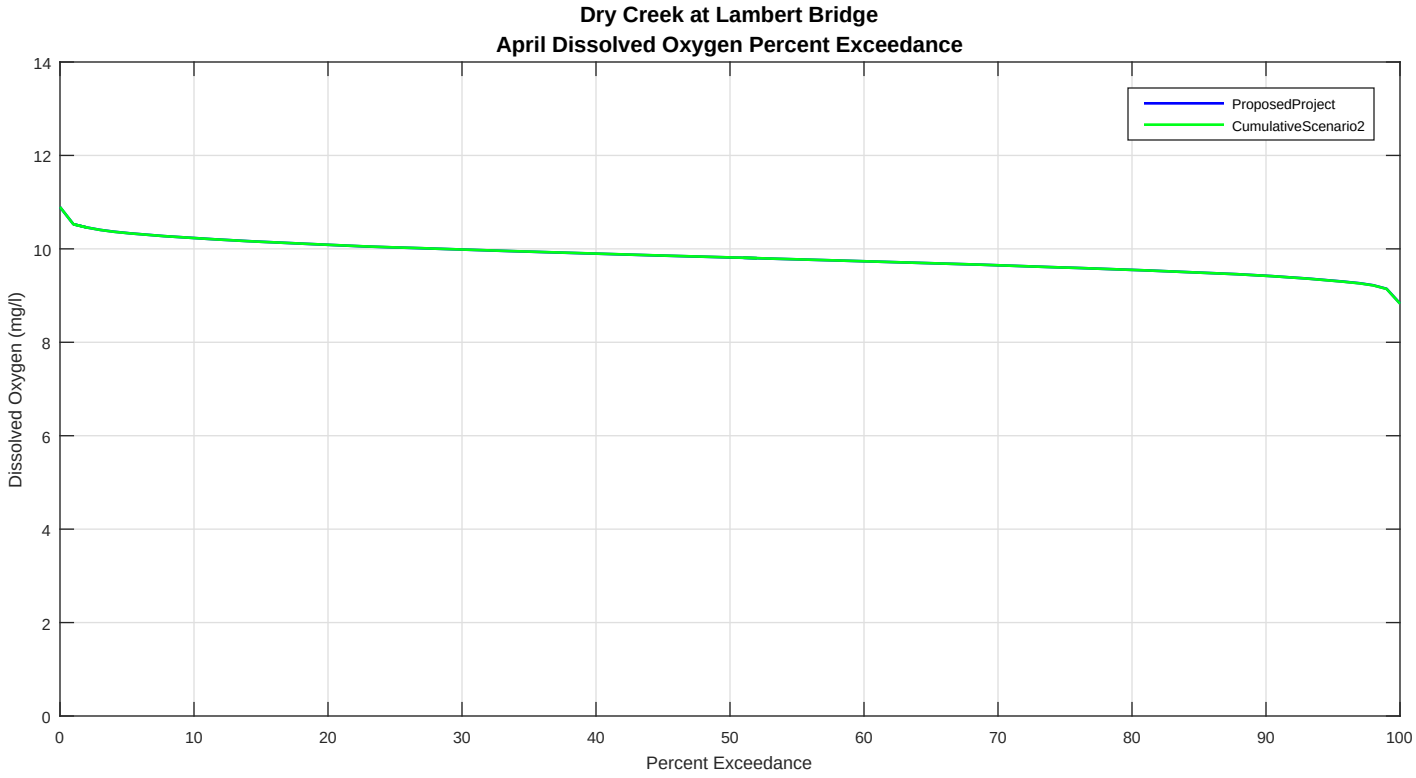
Dry Creek at Lambert Bridge
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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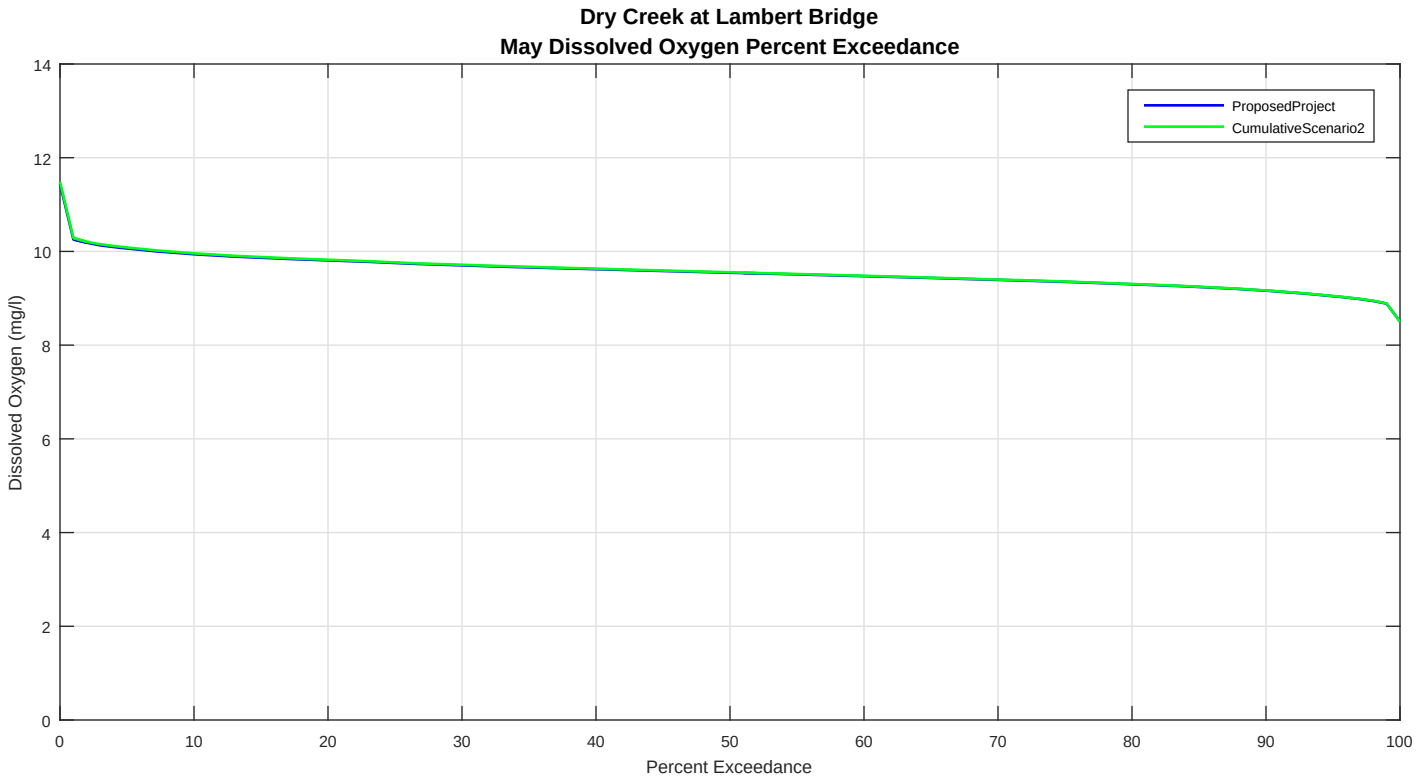
Dry Creek at Lambert Bridge
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
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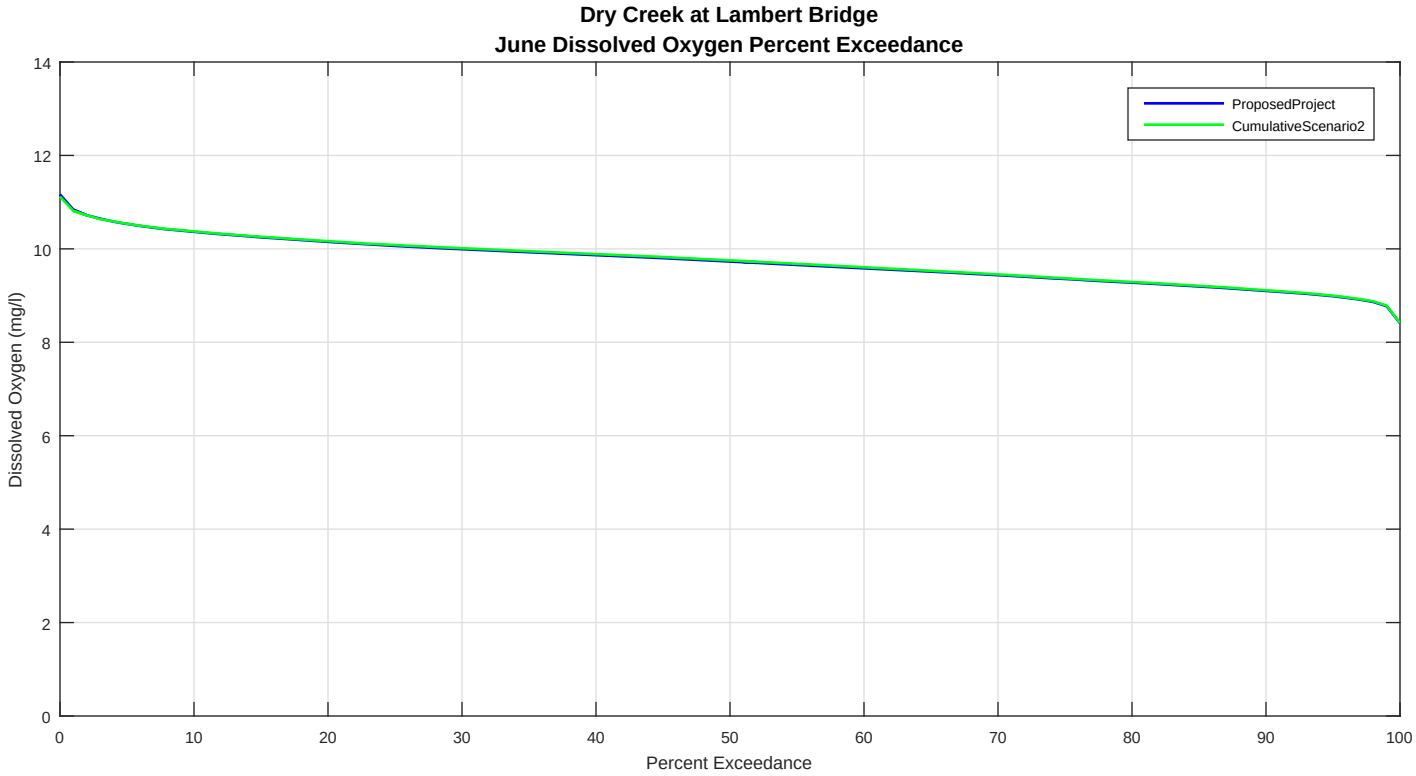
Dry Creek at Lambert Bridge
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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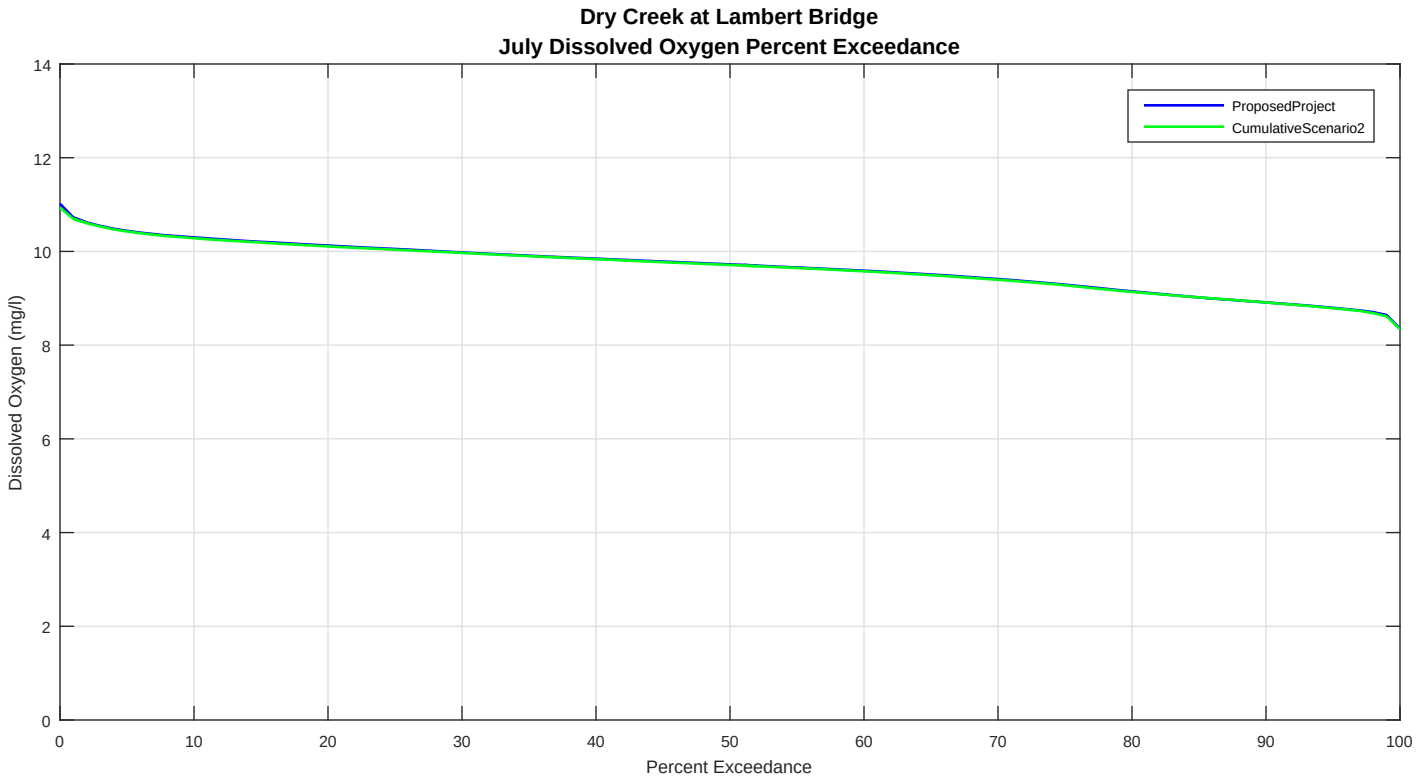
Dry Creek at Lambert Bridge
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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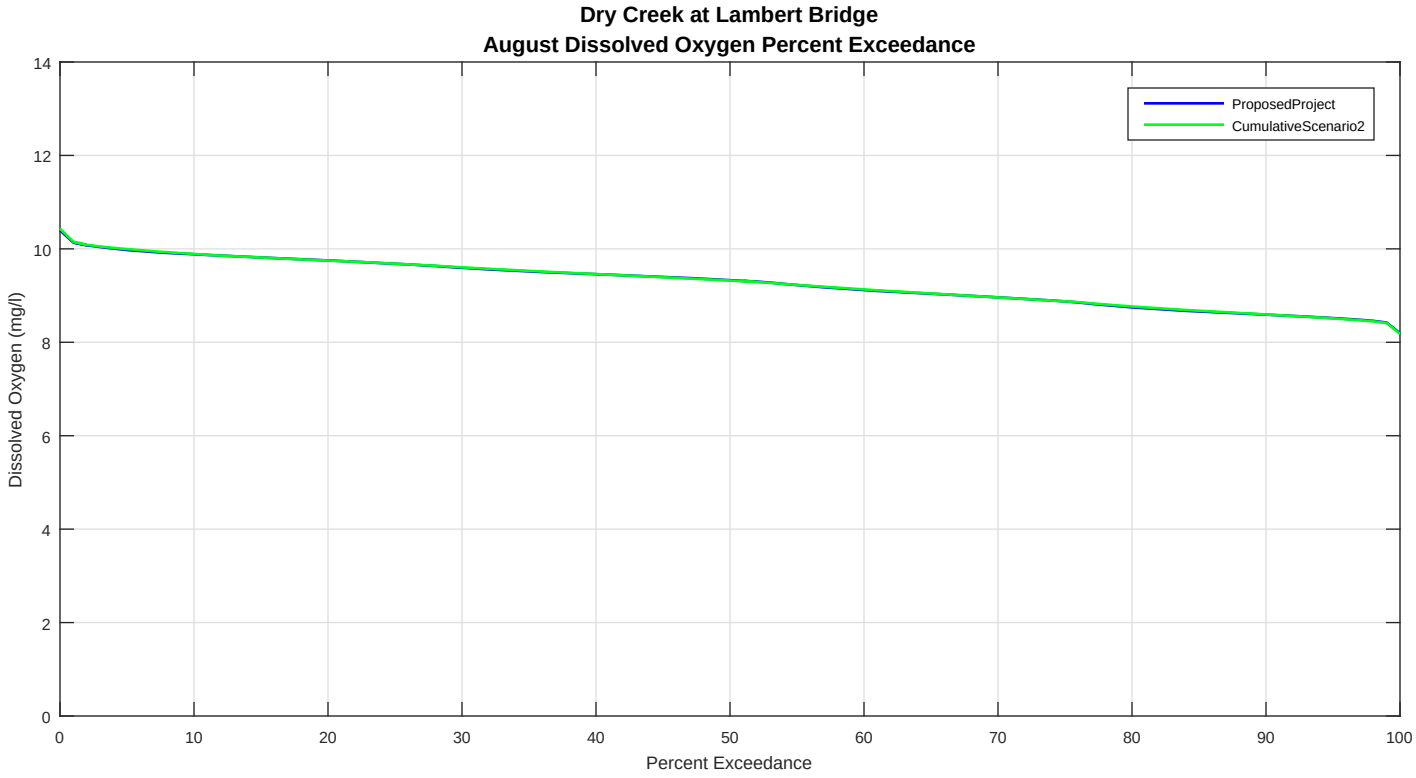
Dry Creek at Lambert Bridge
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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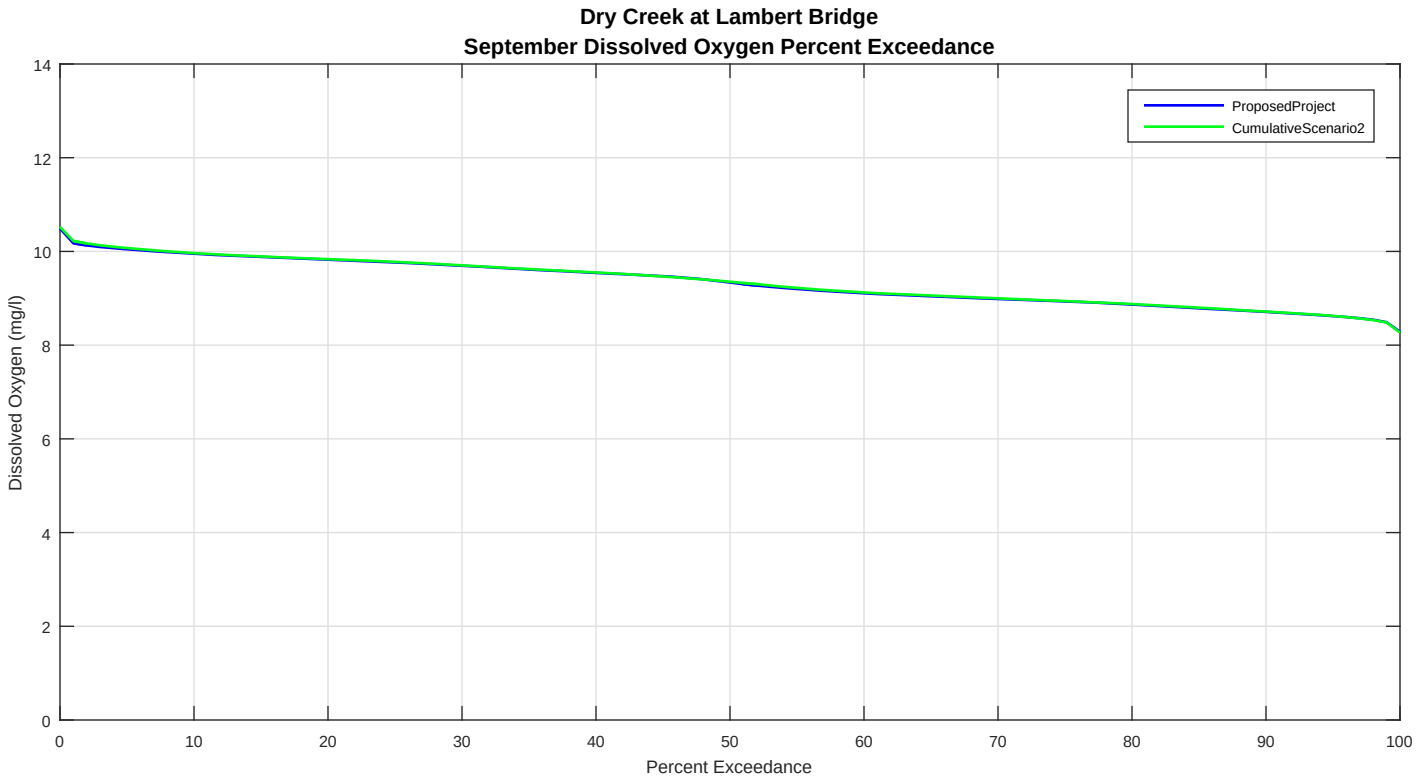
Dry Creek at Lambert Bridge
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
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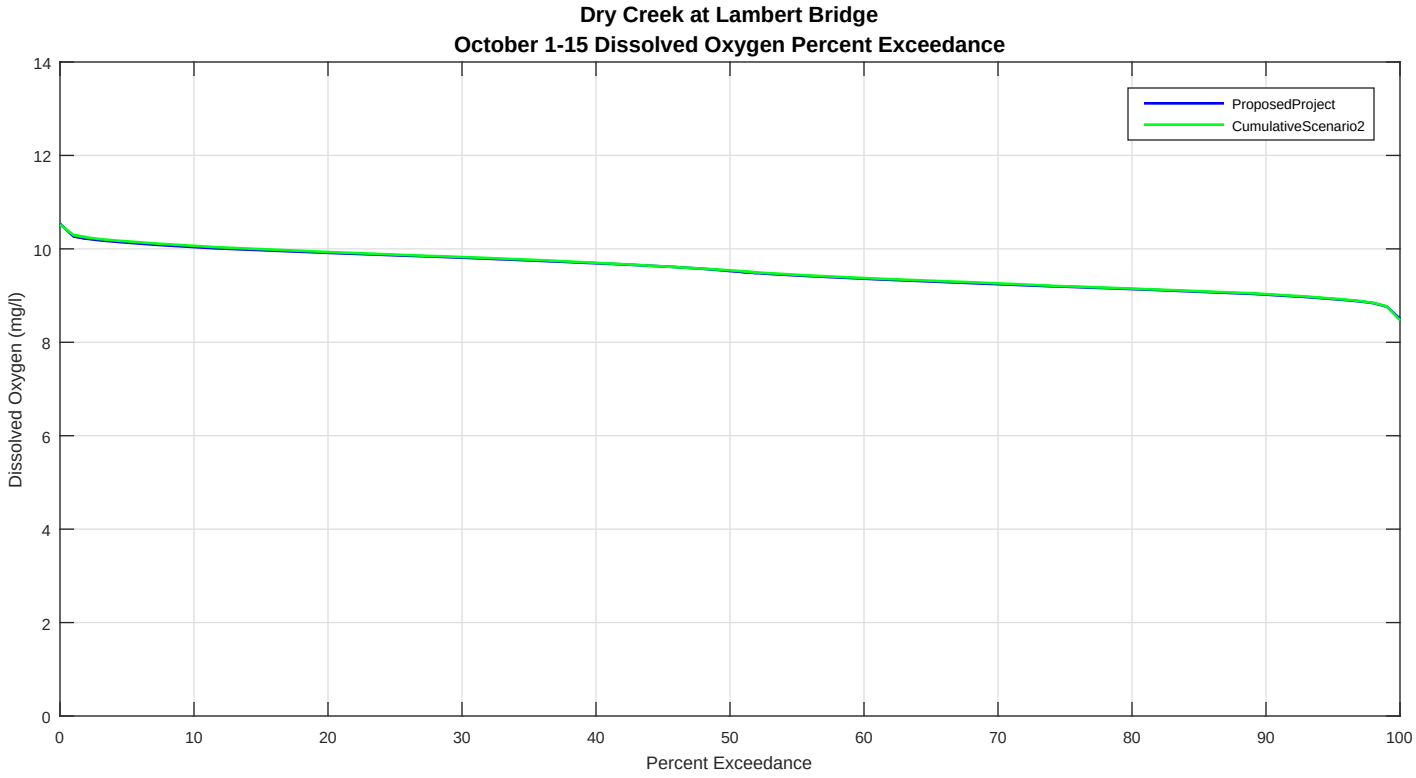
Dry Creek at Lambert Bridge
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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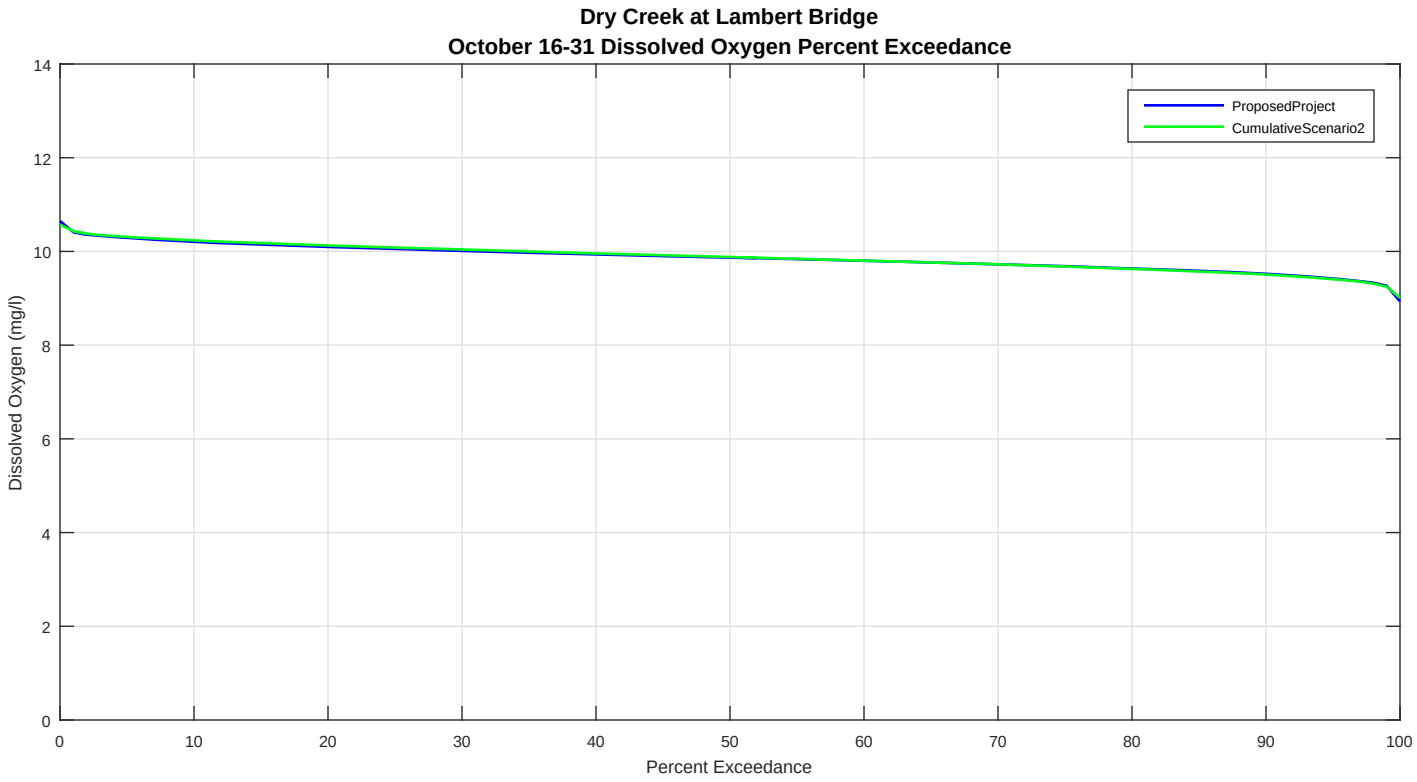
Dry Creek at Lambert Bridge
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
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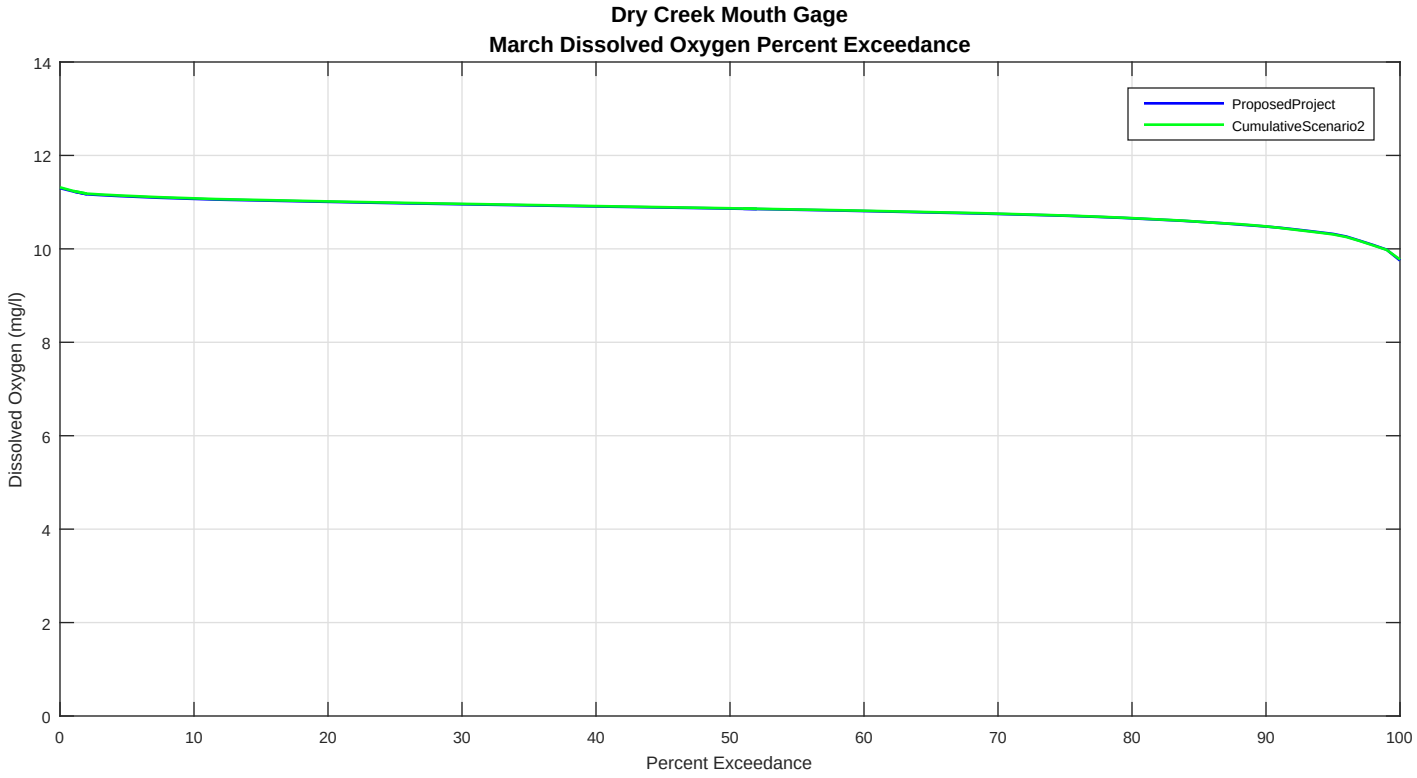
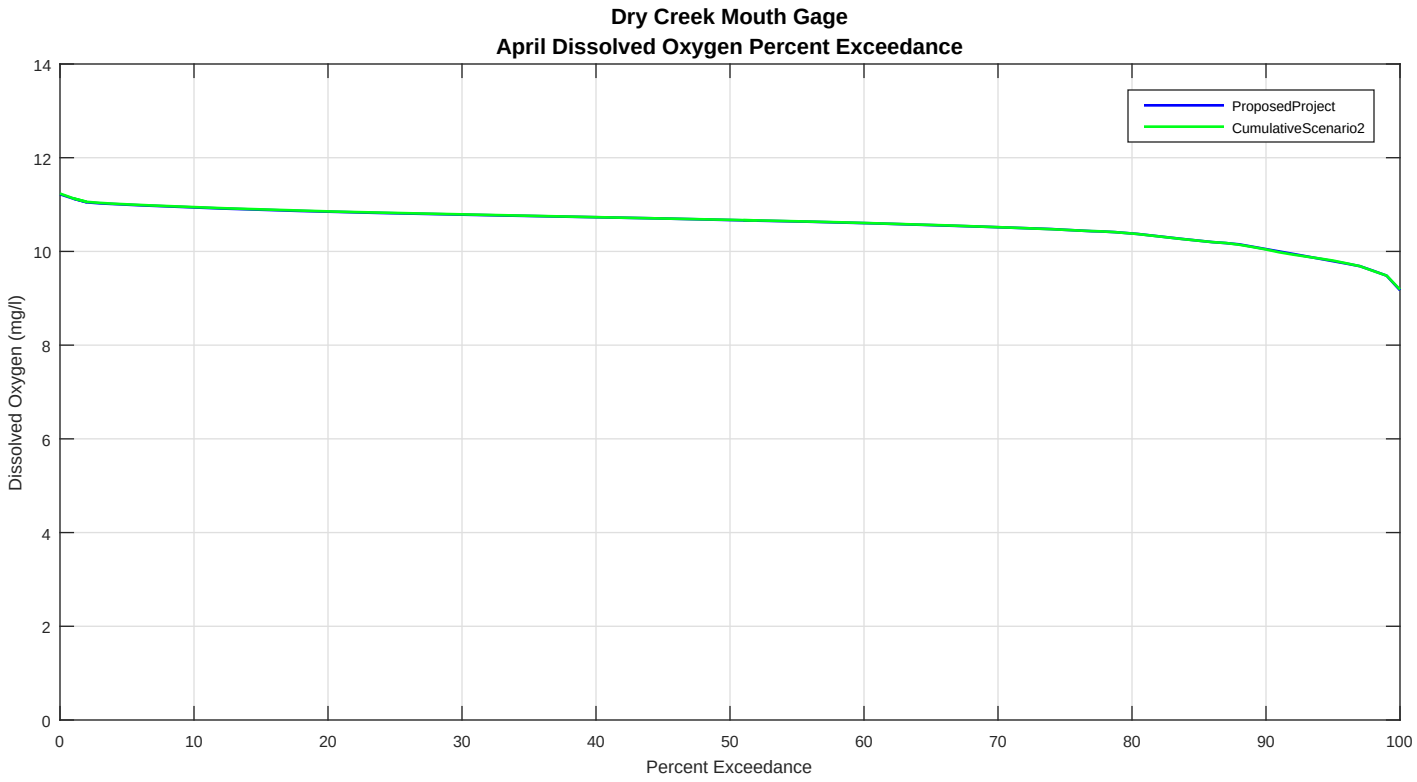
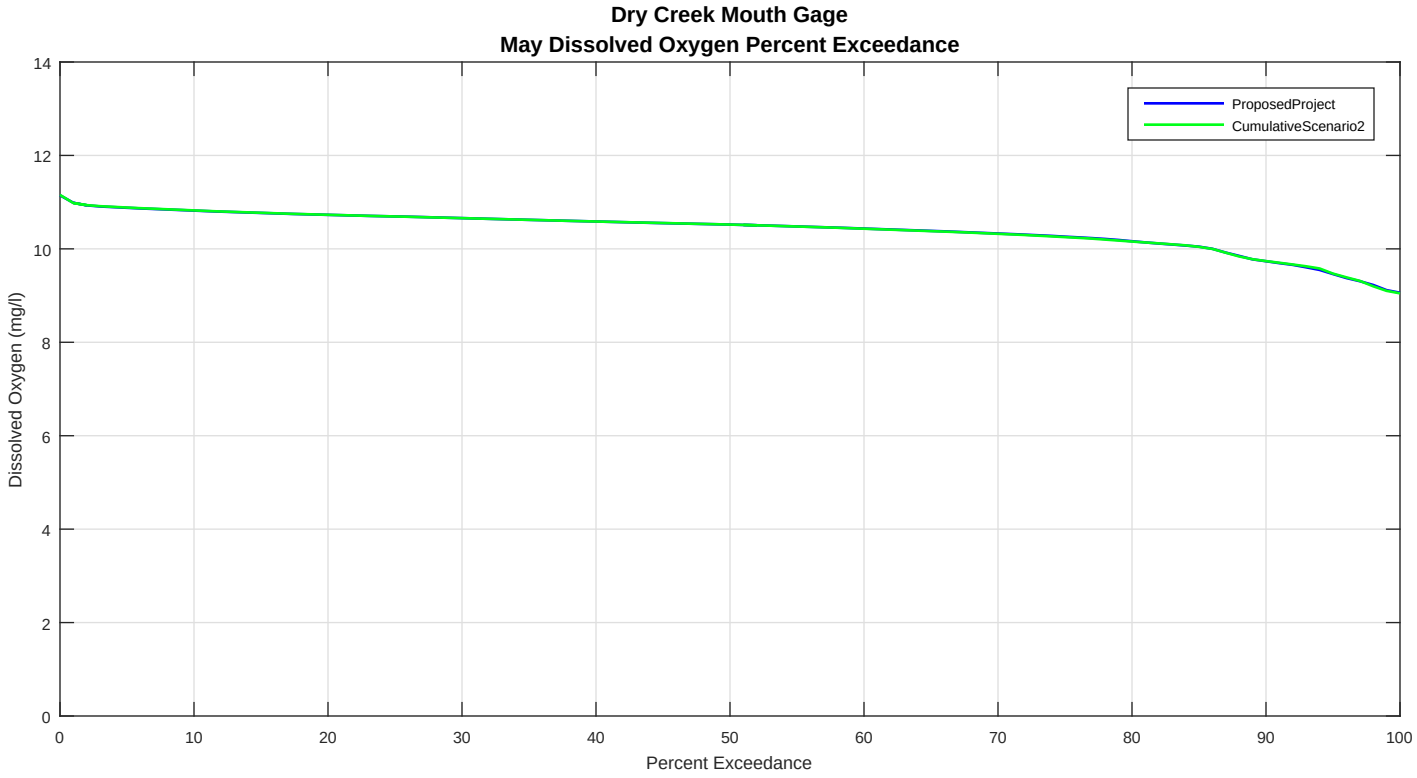
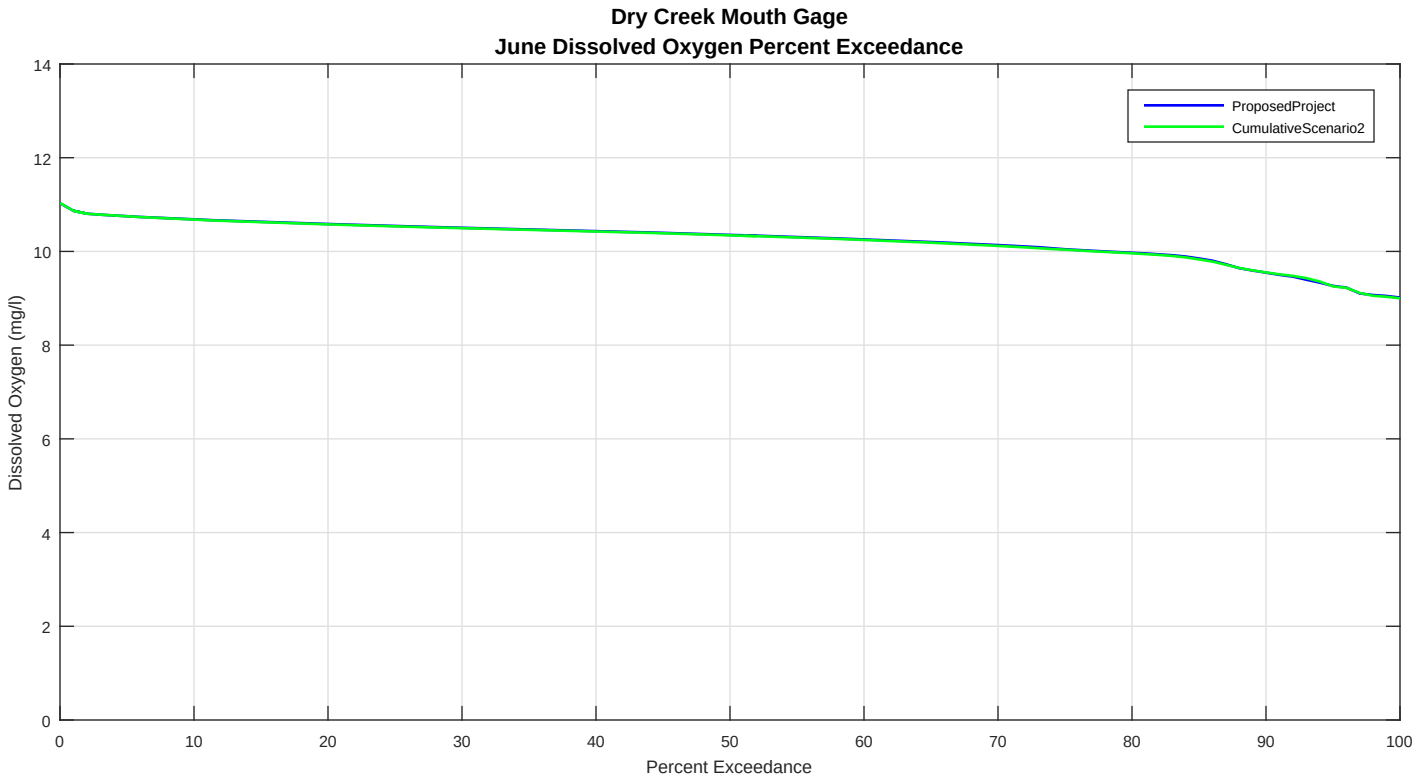
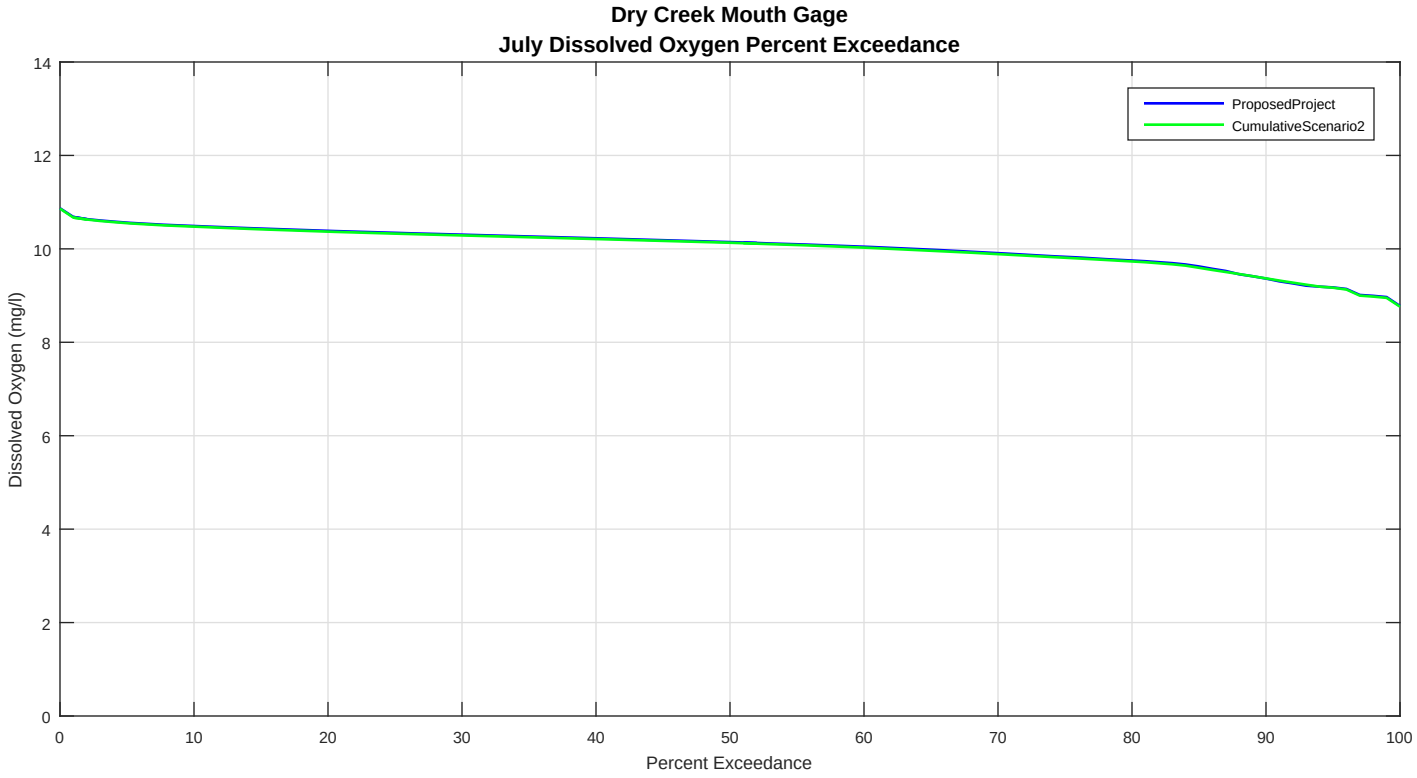
90
100

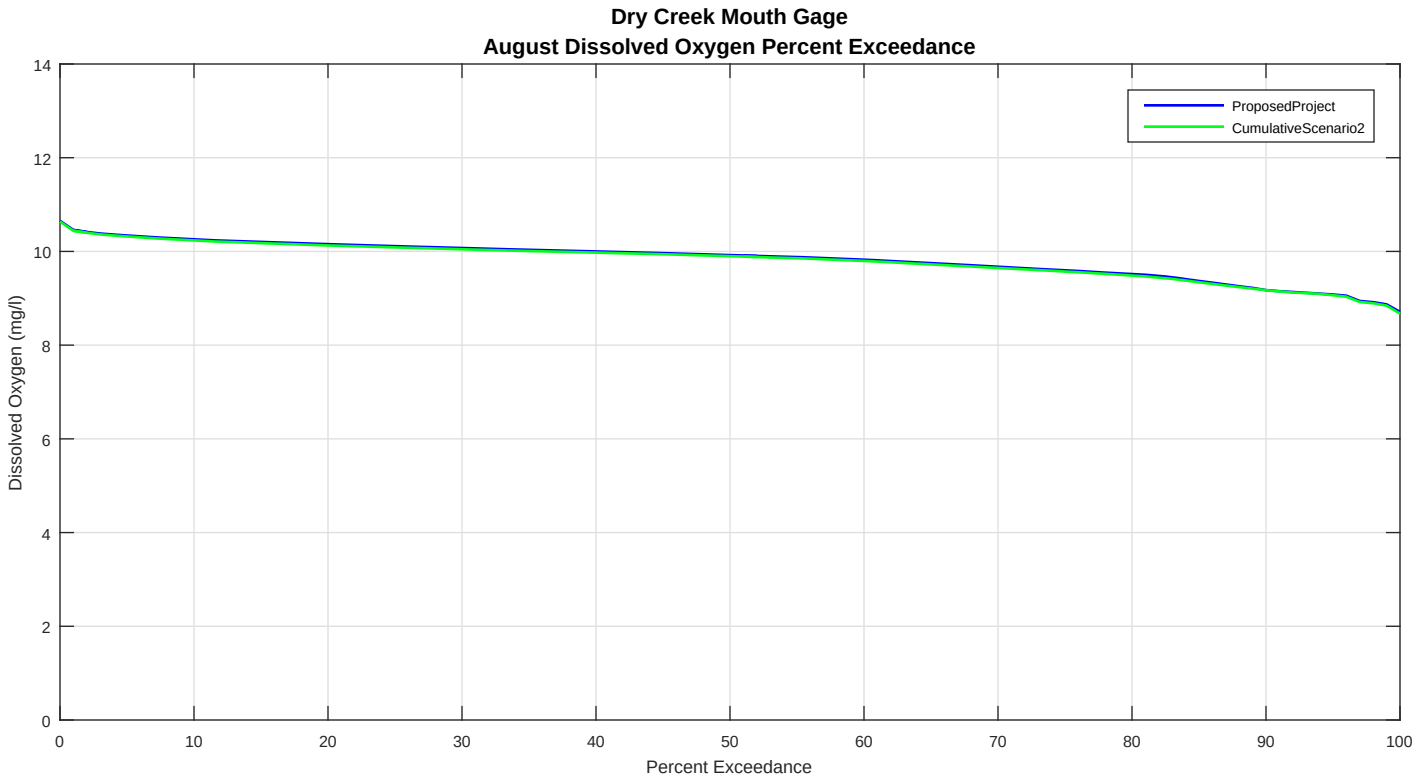

Dry Creek Mouth Gage
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

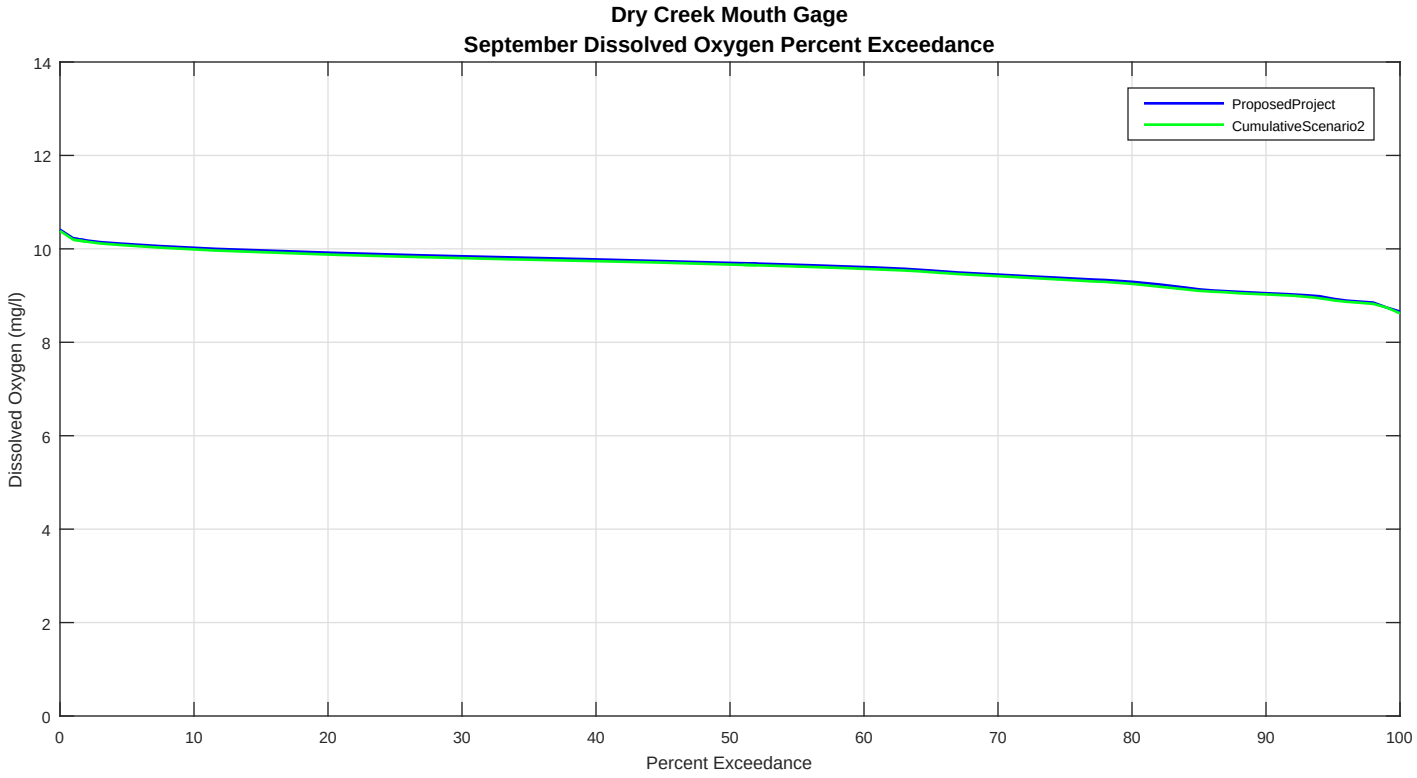

Dry Creek Mouth Gage
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

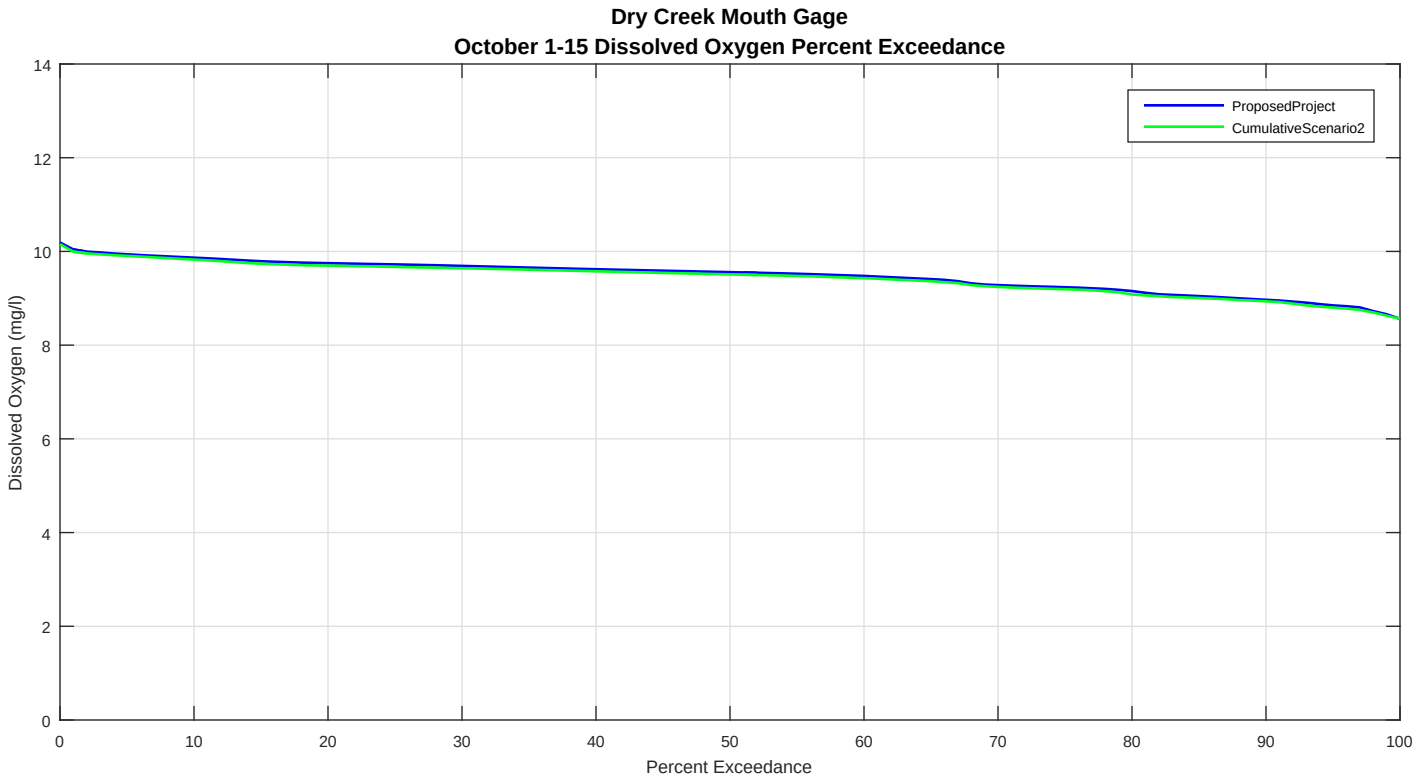

Dry Creek Mouth Gage
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

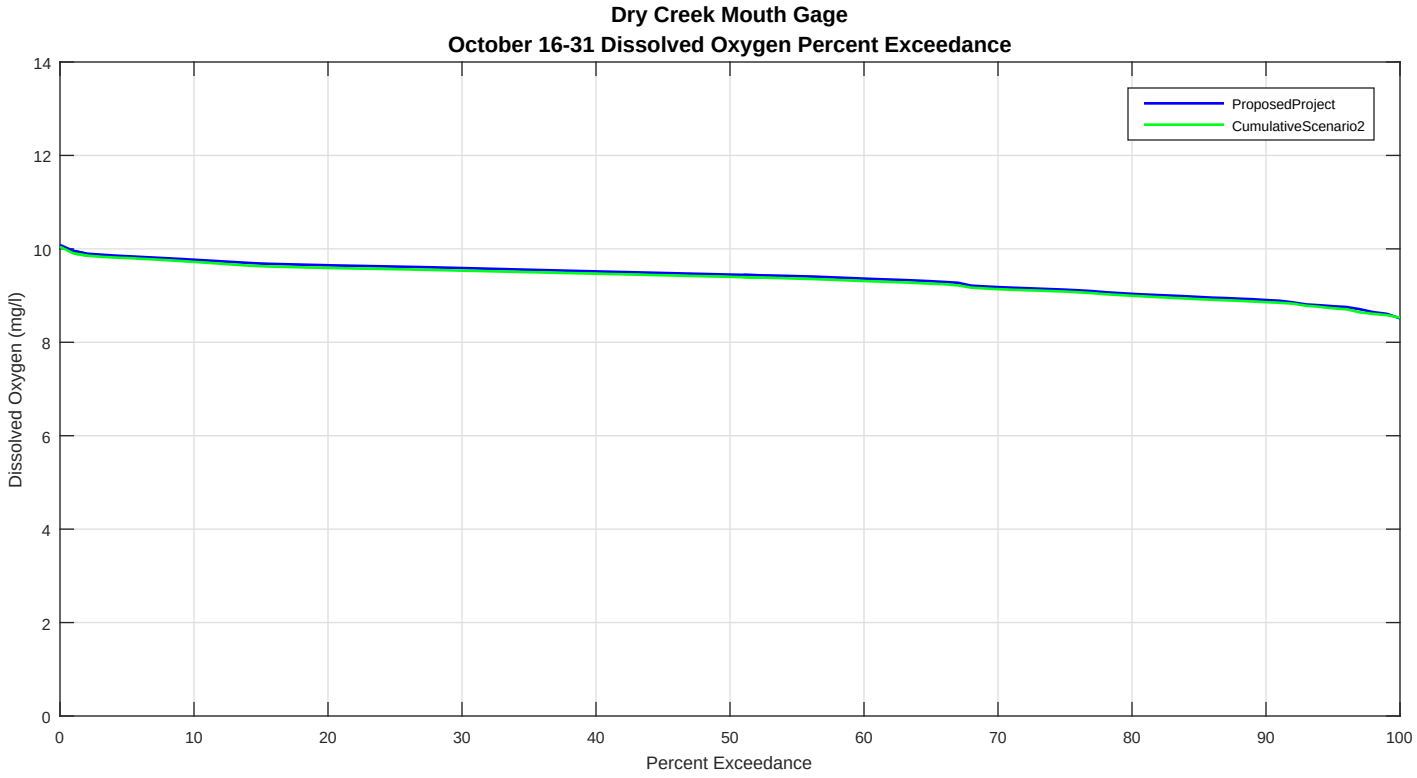

Dry Creek Mouth Gage
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario2
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

Attachment 6: Model Results, Cumulative 3 Scenario

FISH FLOWS EIR
RR ResSim Modeling Results Summary Report

Cumulative Analysis 2015 UWMP
Proposed Hydrologic Index
5-Sched Flow18 Min Flows
Max Water Right Demand: 75K AF

PLOT LEGEND	ProposedProject	CumulativeScenario3
Alt Name	2275i61860	2275i61860
Sim Begin Date	2/1/1910	2/1/1910
Sim End Date	12/31/2013	12/31/2013
ResSim Network	Base v2.2	Base v2.2
LM Storage Curve	2001	2040
LS Storage Curve	1984	2040
WSD Hatchery Flow (cfs)	70	70
Local Flow	USGS6.0	USGS6.0
Distributed Loss	RR System Losses POR 10011909 to 12312013 v06302015.dss	RR System Losses POR 10011909 to 12312013 v06302015.dss
RRC Demand	RR System Losses POR 10011909 to 12312013 v06302015.dss, SCWA Windsor 75K POR 10011909 to 12312013 v06302015.dss	UWMP_2016_Datasets.dss
RRC Vol (Ac-ft/yr)	5,639	3,935
Demand Year	2035	2040
Demand Desc	Max Water Right Demand	UWMP 2040 Demand
SCWA Demand	SCWA Windsor 75K POR 10011909 to 12312013 v06302015.dss	UWMP_2016_Datasets.dss
SCWA Vol (Ac-ft/yr)	69,361	71,871
Demand Year	2035	2040
Demand Desc	Max Water Right Demand	UWMP 2040 Demand
PVP Simulation	150217_V25_E5_Sed2006_RPA-TS_150max	160316_1910-2014_V25_E5_Sed2006-2045_RPA-TS_150max: 2040
LP Storage Curve	2006	2040
PVP Max Diversion	150	150
PVP Simulation Desc	Average operating conditions 10/1/2006 to 12/31/2014; Incorporated observed diversions and LP storage post 10/1/2006	Average operating conditions 10/1/2006 to 12/31/2014; Projected PVP diversions
Hydrologic Index	HI6	HI6
Index Desc	Cum LM Inflow Jan-Sep + LM Stor Cond Jun-De	Cum LM Inflow Jan-Sep + LM Stor Cond Jun-De
Min Flows UR	SCWA6	SCWA6
Min Flow Desc	Flows derived from sensitivity analysis	Flows derived from sensitivity analysis
Min Flows LR	LR6	LR6
Min Flow Desc	Flows derived from sensitivity analysis	Flows derived from sensitivity analysis

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Minimum Water Year Storage Exceedances… 28

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Daily Average Temperature… 13

Daily Average Dissolved Oxygen… 20

Coyote Valley Dam Outlet

Monthly Flow Exceedance Frequency… 29

Monthly Temperature Exceedance Frequency… 106

Monthly D.O. Exceedance Frequency… 164

Forks

Monthly Flow Exceedance Frequency… 33

Monthly Temperature Exceedance Frequency… 110

Monthly D.O. Exceedance Frequency… 168

2 Miles Downstream of Forks

Monthly Temperature Exceedance Frequency… 115

Monthly D.O. Exceedance Frequency… 173

4 Miles Downstream of Forks

Monthly Temperature Exceedance Frequency… 117

Monthly D.O. Exceedance Frequency… 175

Hopland

Monthly Flow Exceedance Frequency… 38

Monthly Stage Exceedance Frequency… 74

Monthly Temperature Exceedance Frequency… 119

Monthly D.O. Exceedance Frequency… 177

Cloverdale

Monthly Flow Exceedance Frequency… 42

Monthly Stage Exceedance Frequency… 78

Monthly Temperature Exceedance Frequency… 123

Monthly D.O. Exceedance Frequency… 181

Geyserville

Monthly Temperature Exceedance Frequency… 128

Monthly D.O. Exceedance Frequency… 186

Healdsburg

Monthly Flow Exceedance Frequency… 47

Monthly Stage Exceedance Frequency… 83

Monthly Temperature Exceedance Frequency… 132

Monthly D.O. Exceedance Frequency… 190

Russian River at Dry Creek

Monthly Flow Exceedance Frequency… 51

Monthly Temperature Exceedance Frequency… 137

Monthly D.O. Exceedance Frequency… 195

Hacienda

Monthly Flow Exceedance Frequency… 56

Monthly Stage Exceedance Frequency… 87

Monthly Temperature Exceedance Frequency… 141

Monthly D.O. Exceedance Frequency… 199

Warm Springs Dam Outlet

Monthly Flow Exceedance Frequency… 60

Monthly Temperature Exceedance Frequency… 146

Monthly D.O. Exceedance Frequency… 204

Dry Creek at Geyserville Gage

Monthly Flow Exceedance Frequency… 65

Monthly Stage Exceedance Frequency… 92

Monthly Temperature Exceedance Frequency… 150

Monthly D.O. Exceedance Frequency… 208

Dry Creek at Lambert Bridge

Monthly Temperature Exceedance Frequency… 155

Monthly D.O. Exceedance Frequency… 213

Dry Creek Mouth

Monthly Flow Exceedance Frequency… 69

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Monthly Power Production Exceedance Frequencies

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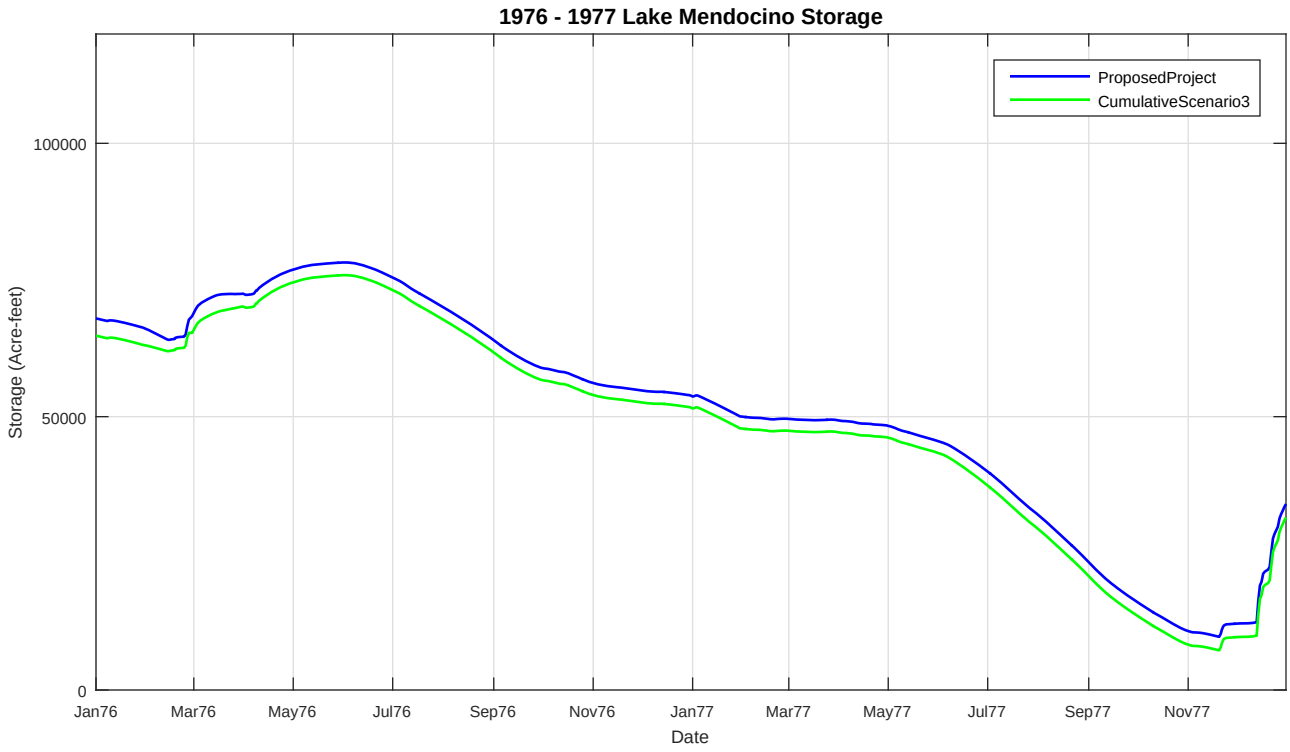
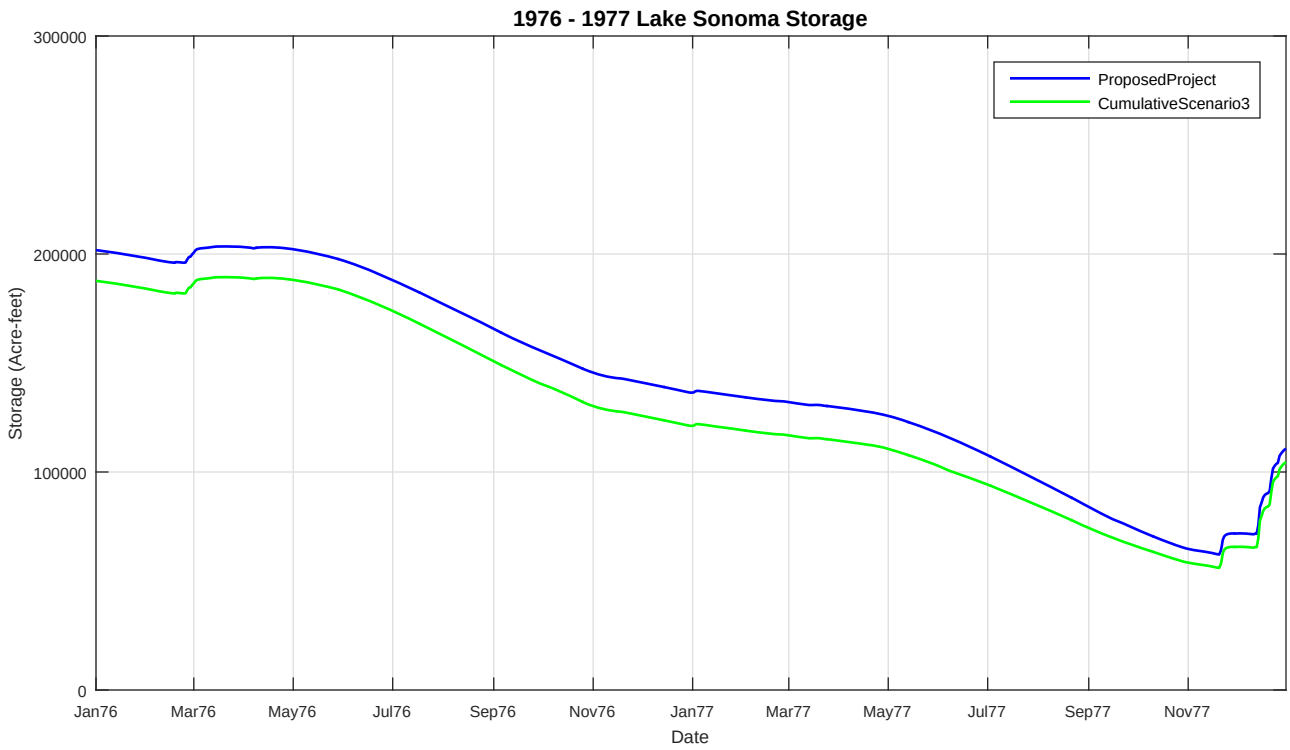
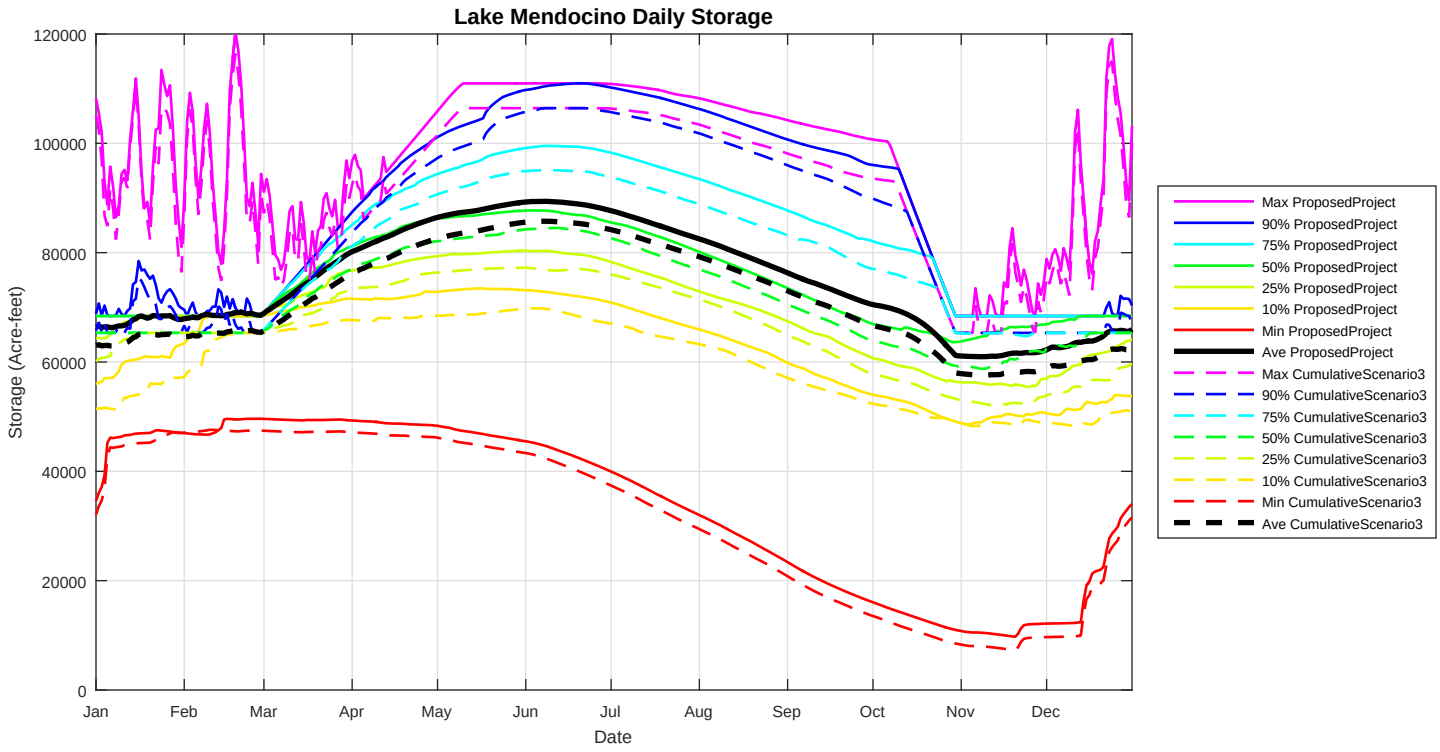
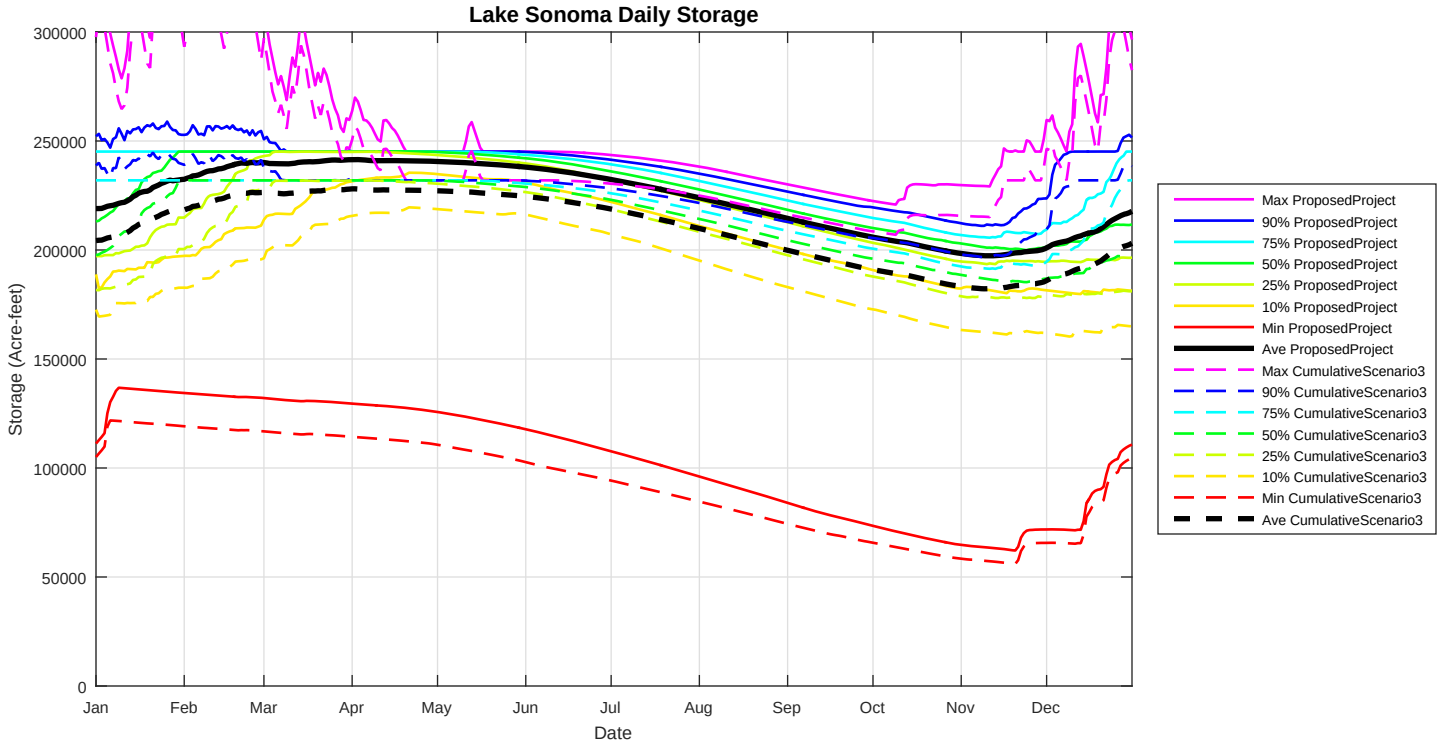
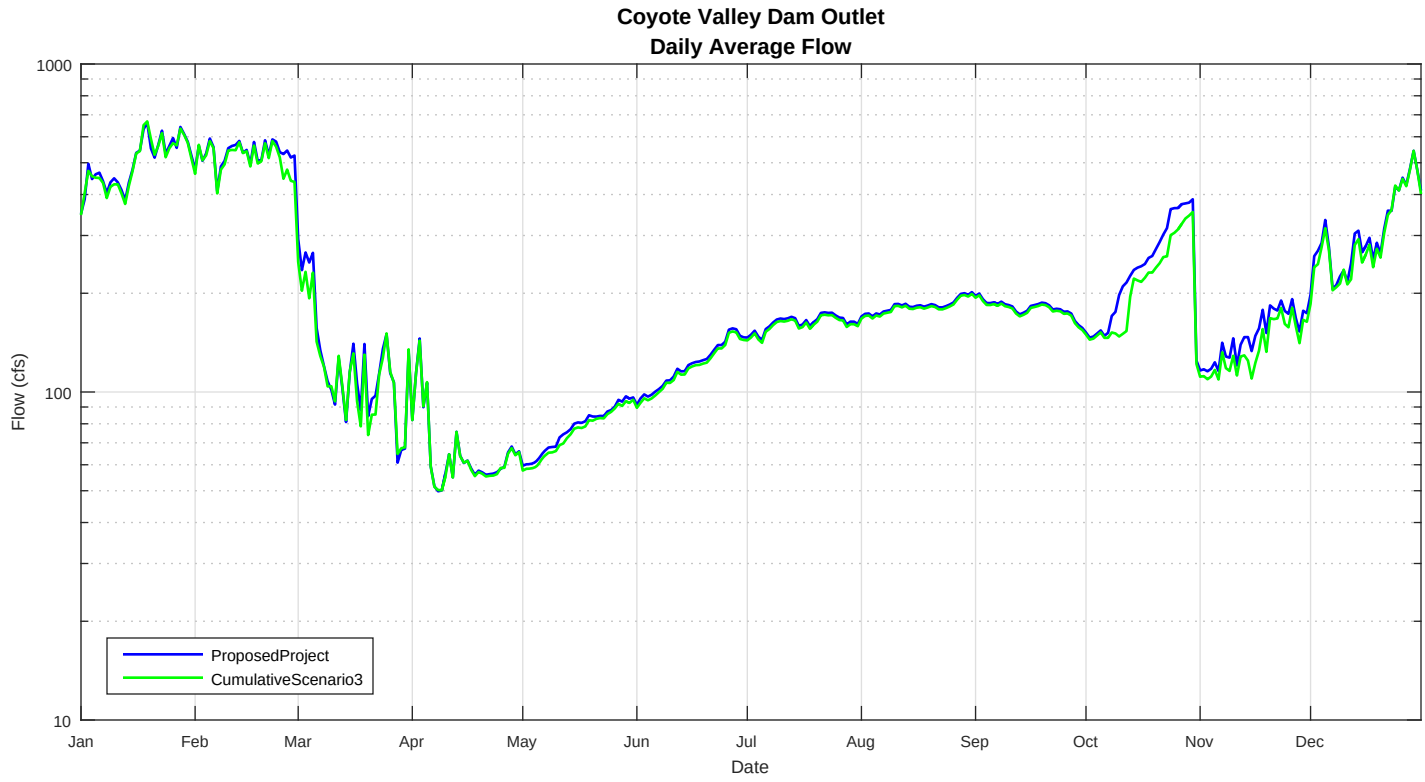
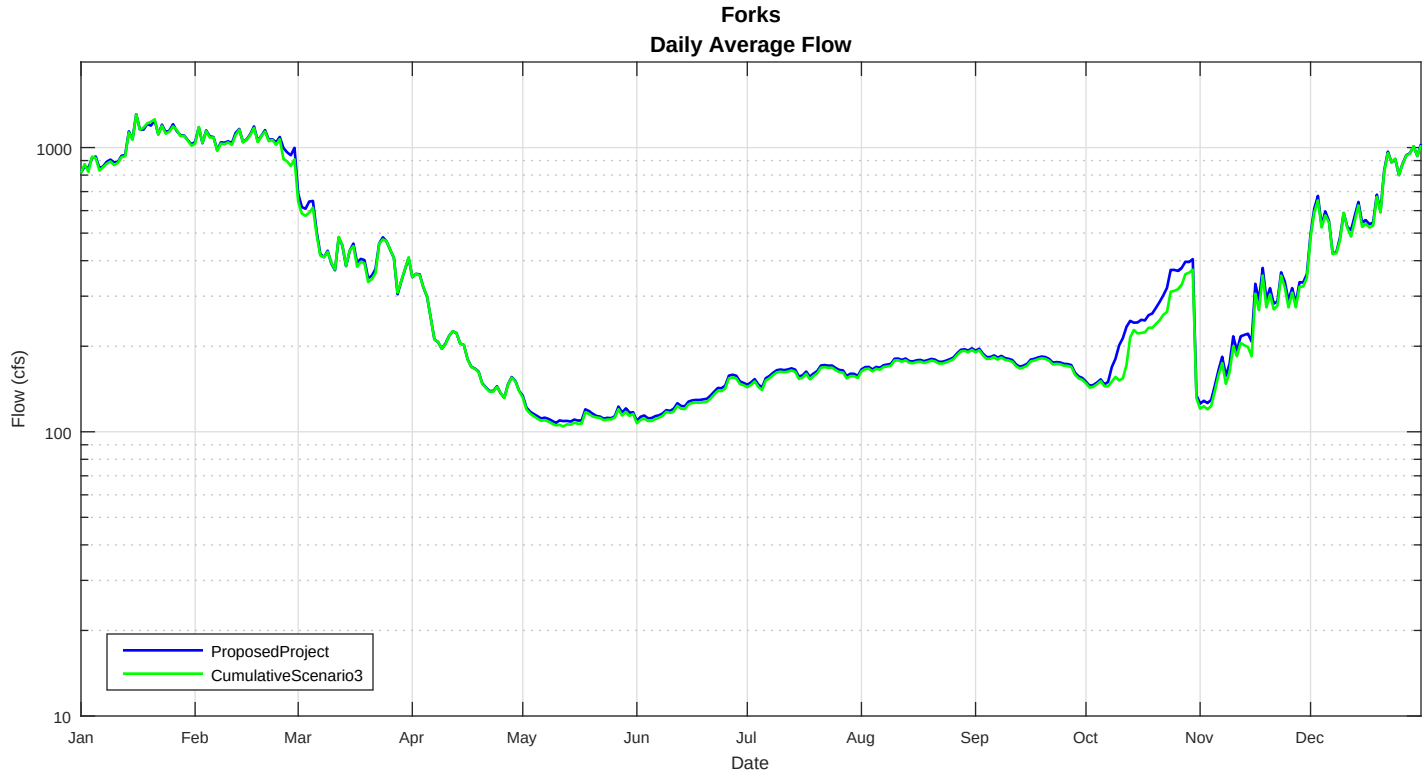

1976 - 1977 Lake Mendocino Storage
ProposedProject
CumulativeScenario3
Storage (Acre-feet)
100000
50000
0
Jan76
Mar76
May76
Jul76
Sep76
Nov76
Jan77
Mar77
May77
Jul77
Sep77
Nov77
Date

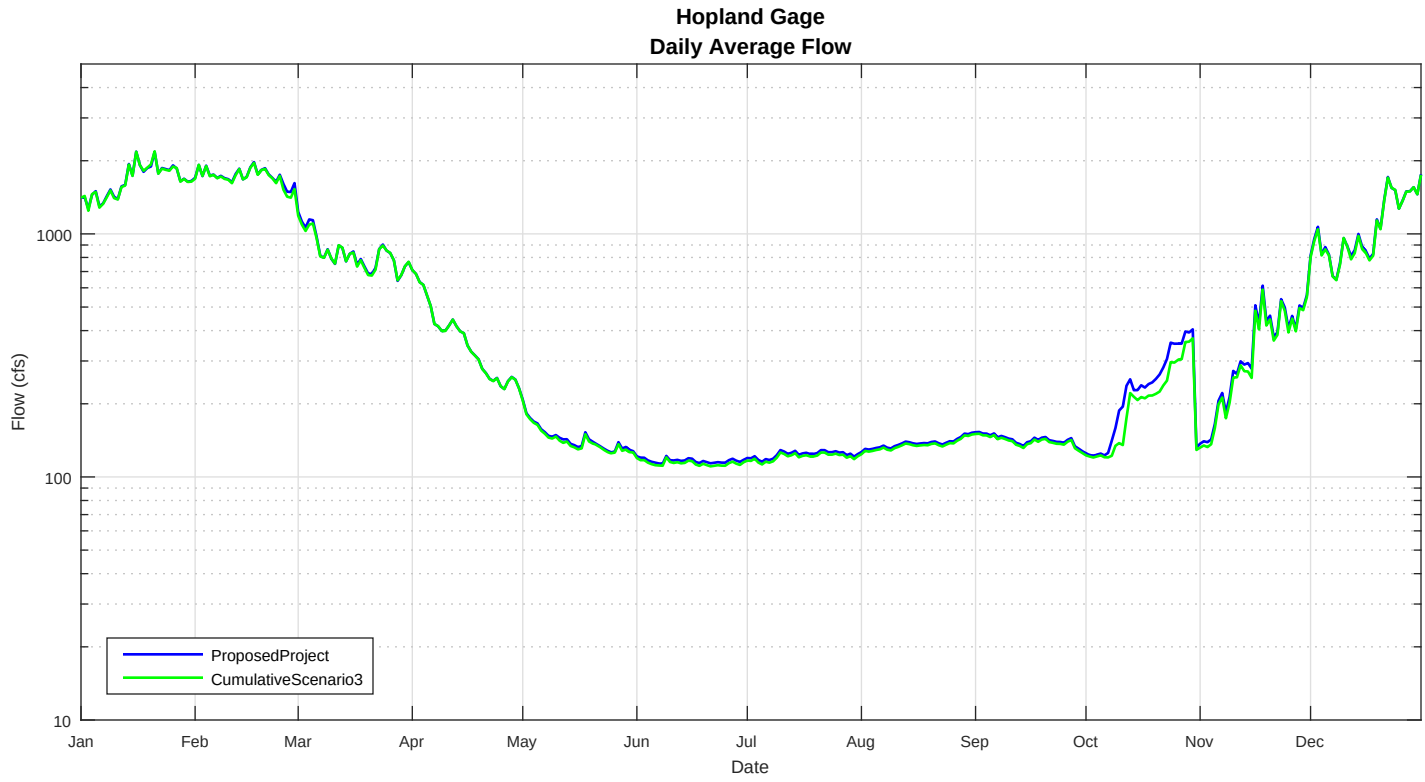

1976 - 1977 Lake Sonoma Storage
ProposedProject
CumulativeScenario3
Storage (Acre-feet)
300000
200000
100000
0
Jan76
Mar76
May76
Jul76
Sep76
Nov76
Jan77
Mar77
May77
Jul77
Sep77
Nov77
Date

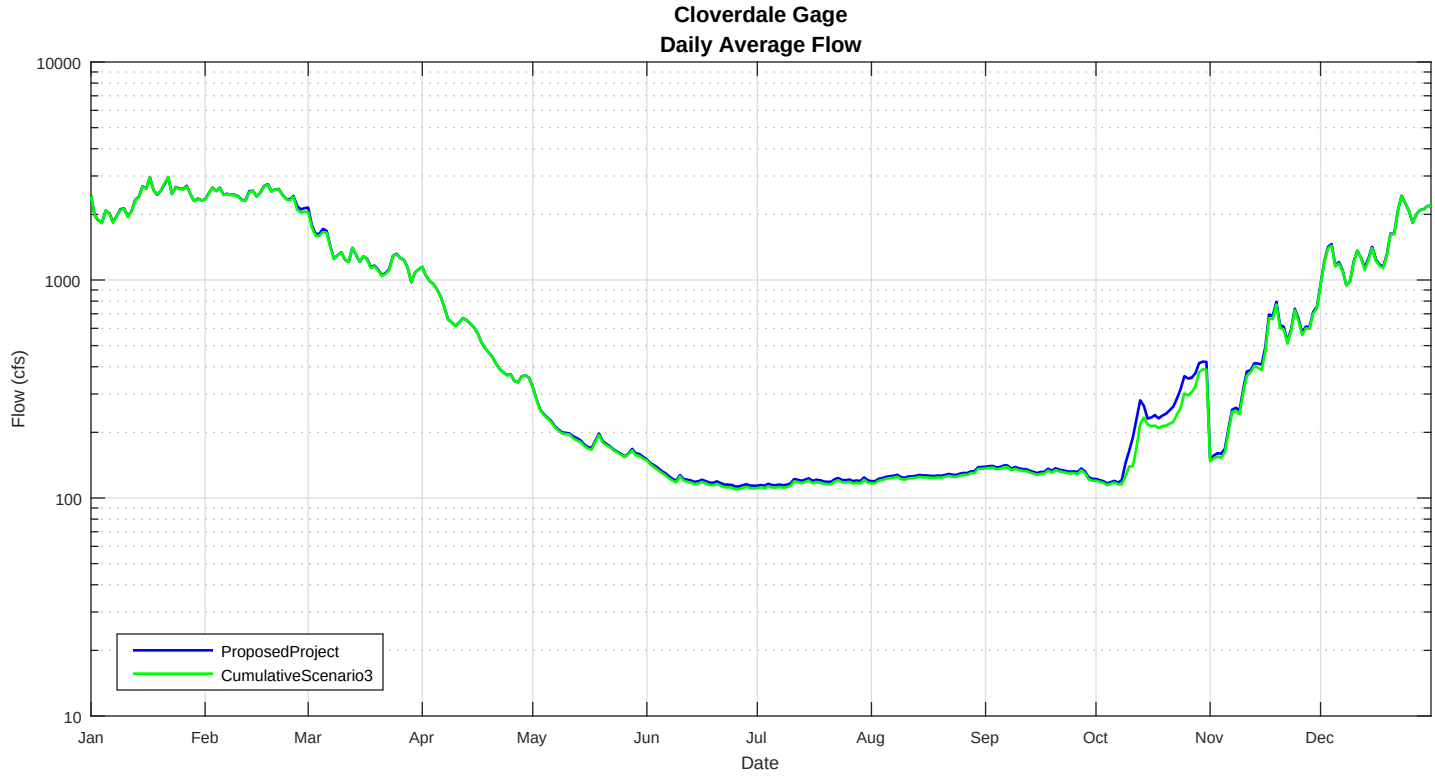

Lake Mendocino Daily Storage
Storage (Acre-feet)
120000
100000
80000
60000
40000
20000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Max ProposedProject
90% ProposedProject
75% ProposedProject
50% ProposedProject
25% ProposedProject
10% ProposedProject
Min ProposedProject
Ave ProposedProject
Max CumulativeScenario3
90% CumulativeScenario3
75% CumulativeScenario3
50% CumulativeScenario3
25% CumulativeScenario3
10% CumulativeScenario3
Min CumulativeScenario3
Ave CumulativeScenario3

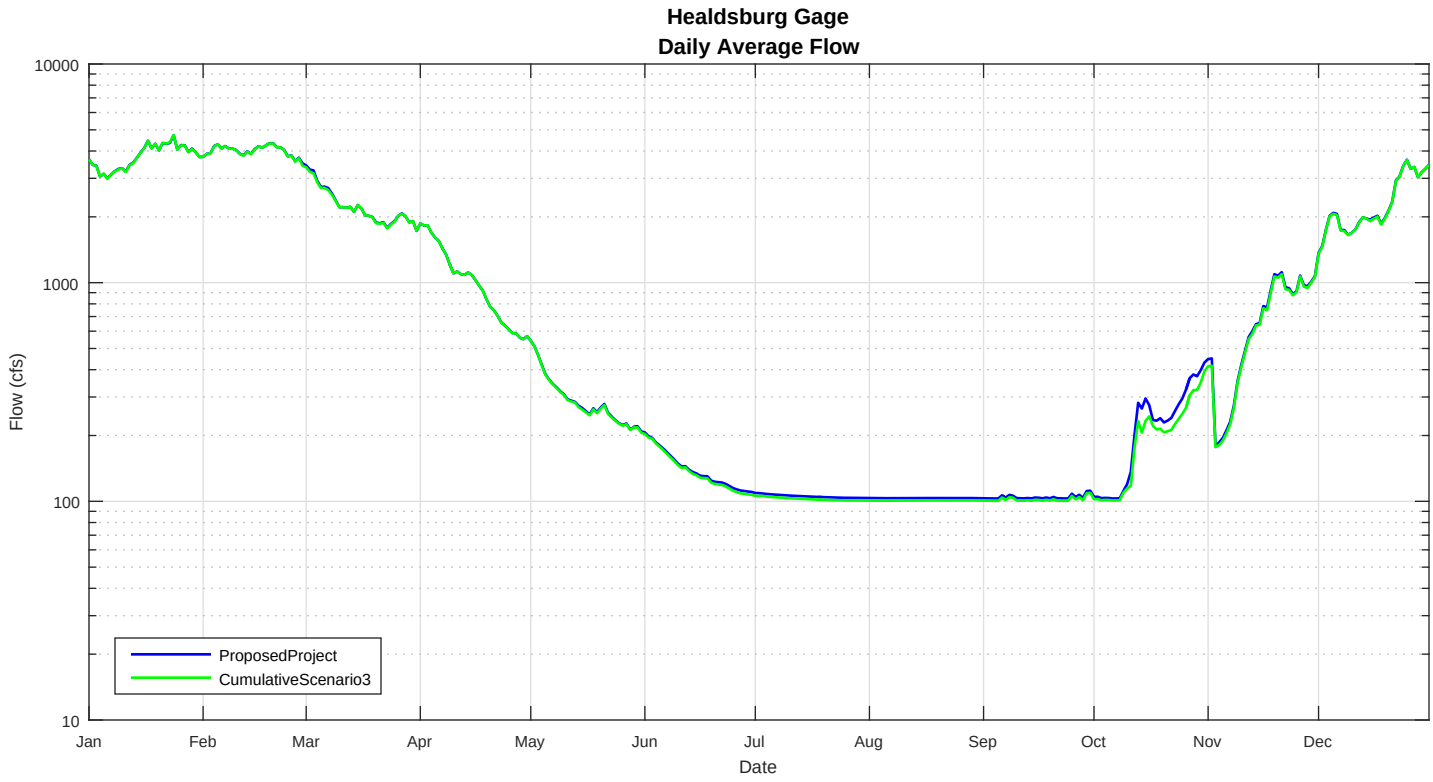

Lake Sonoma Daily Storage
Storage (Acre-feet)
300000
250000
200000
150000
100000
50000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Max ProposedProject
90% ProposedProject
75% ProposedProject
50% ProposedProject
25% ProposedProject
10% ProposedProject
Min ProposedProject
Ave ProposedProject
Max CumulativeScenario3
90% CumulativeScenario3
75% CumulativeScenario3
50% CumulativeScenario3
25% CumulativeScenario3
10% CumulativeScenario3
Min CumulativeScenario3
Ave CumulativeScenario3

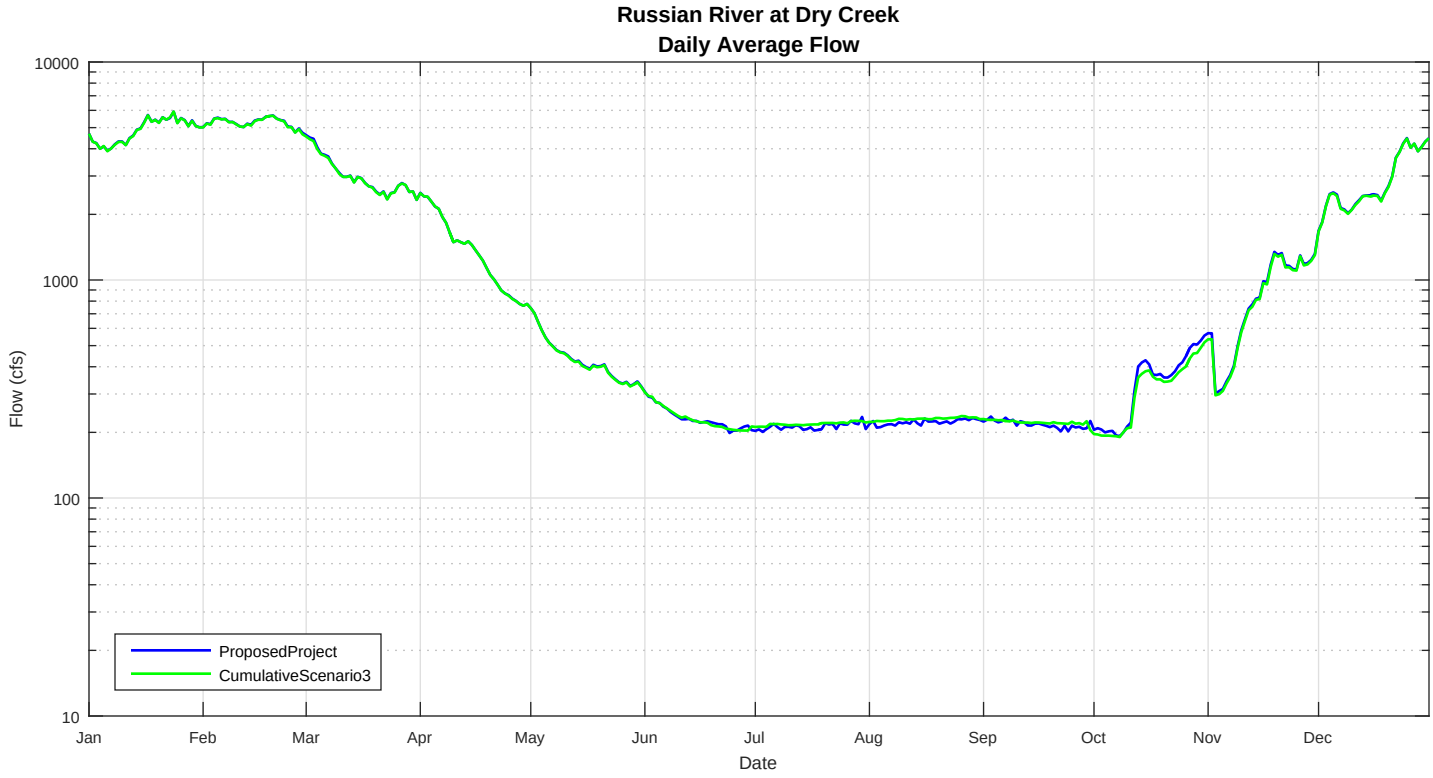

Coyote Valley Dam Outlet
Daily Average Flow
1000
100
10
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario3

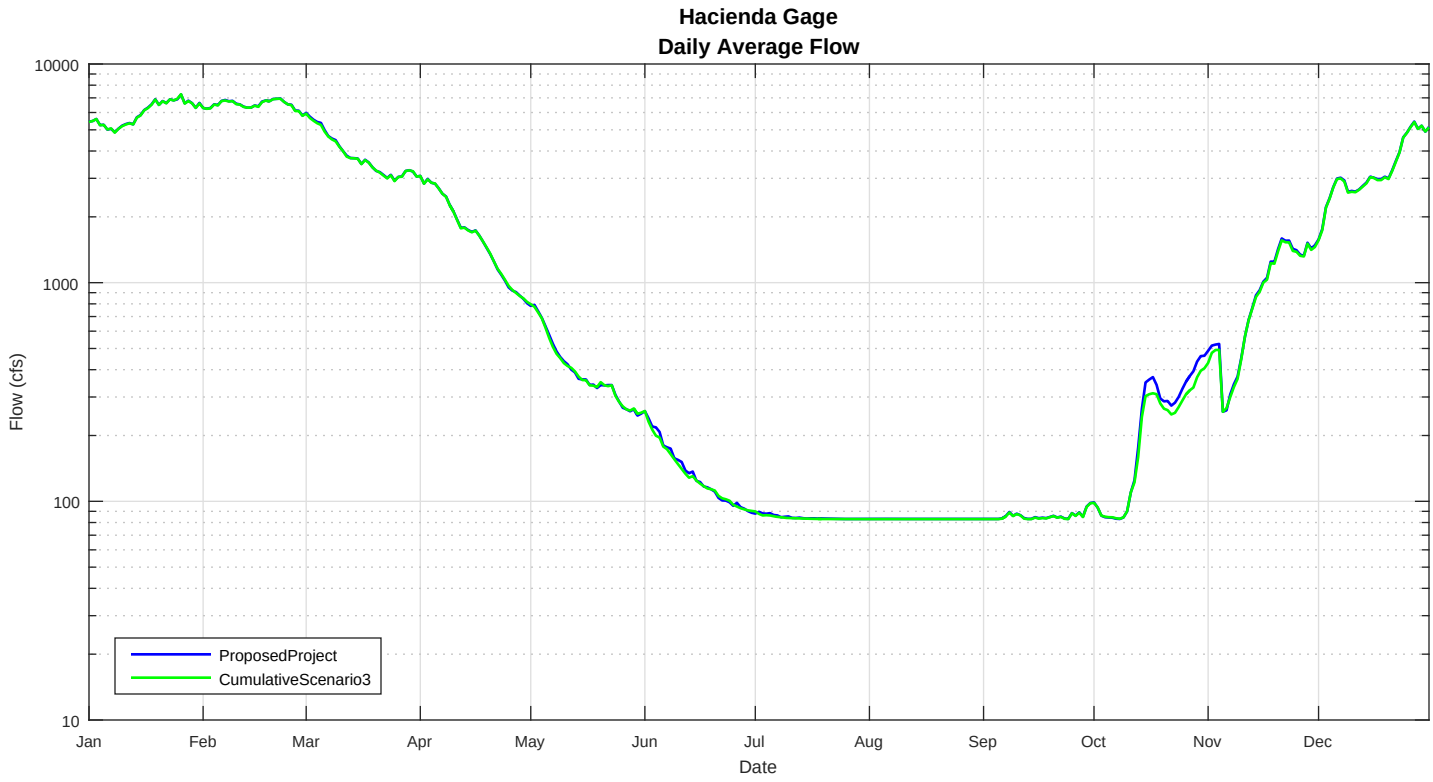

Forks
Daily Average Flow
1000
100
10
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario3

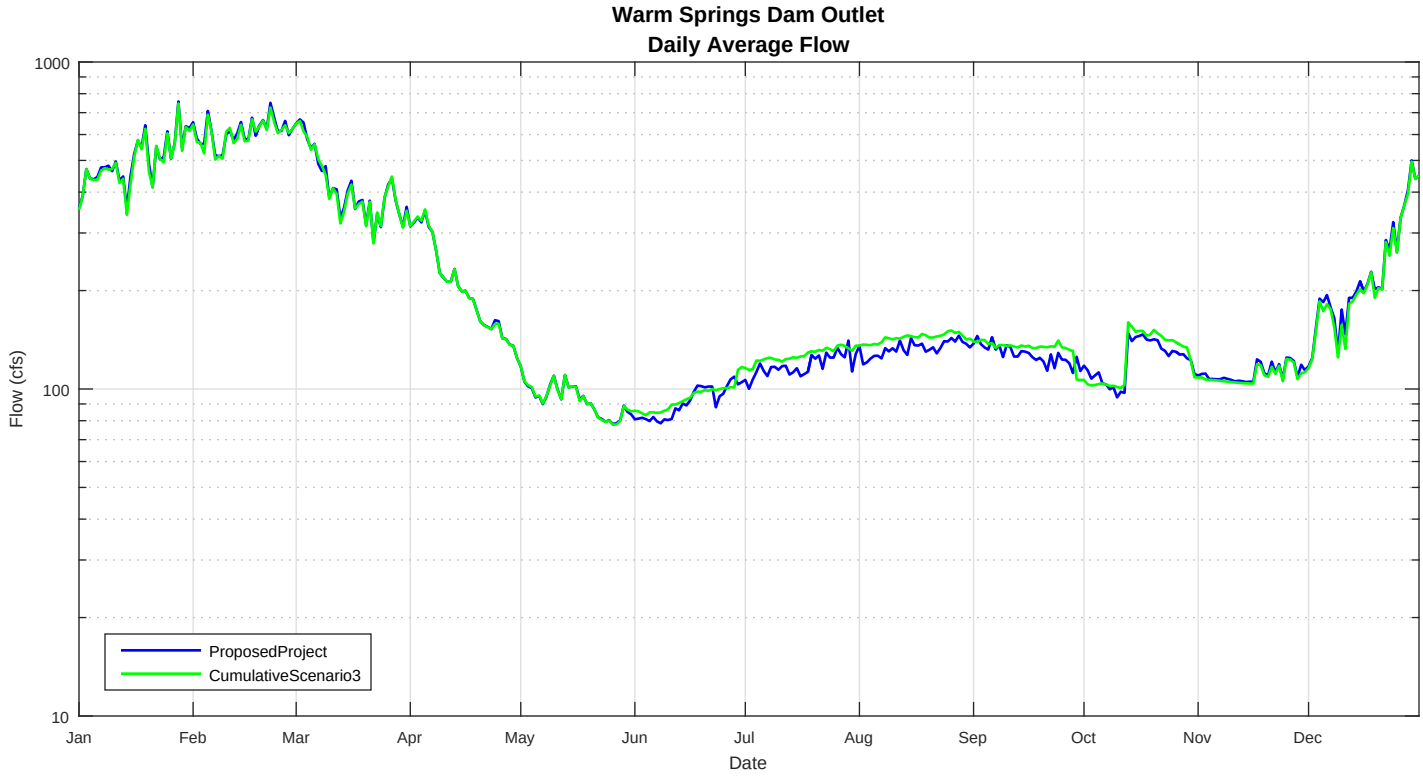

Hopland Gage
Daily Average Flow
Flow (cfs)
1000
100
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario3

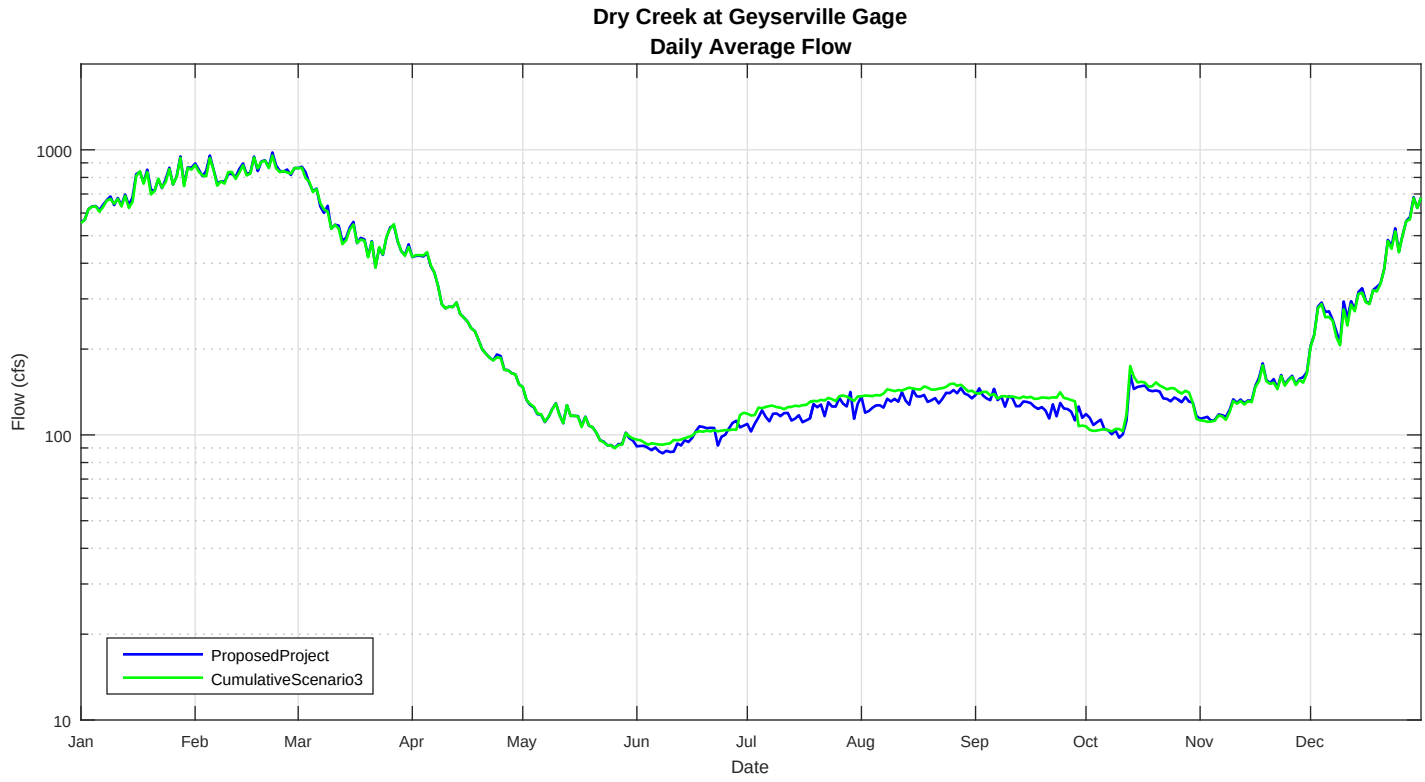

Cloverdale Gage
Daily Average Flow
Flow (cfs)
10000
1000
100
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario3

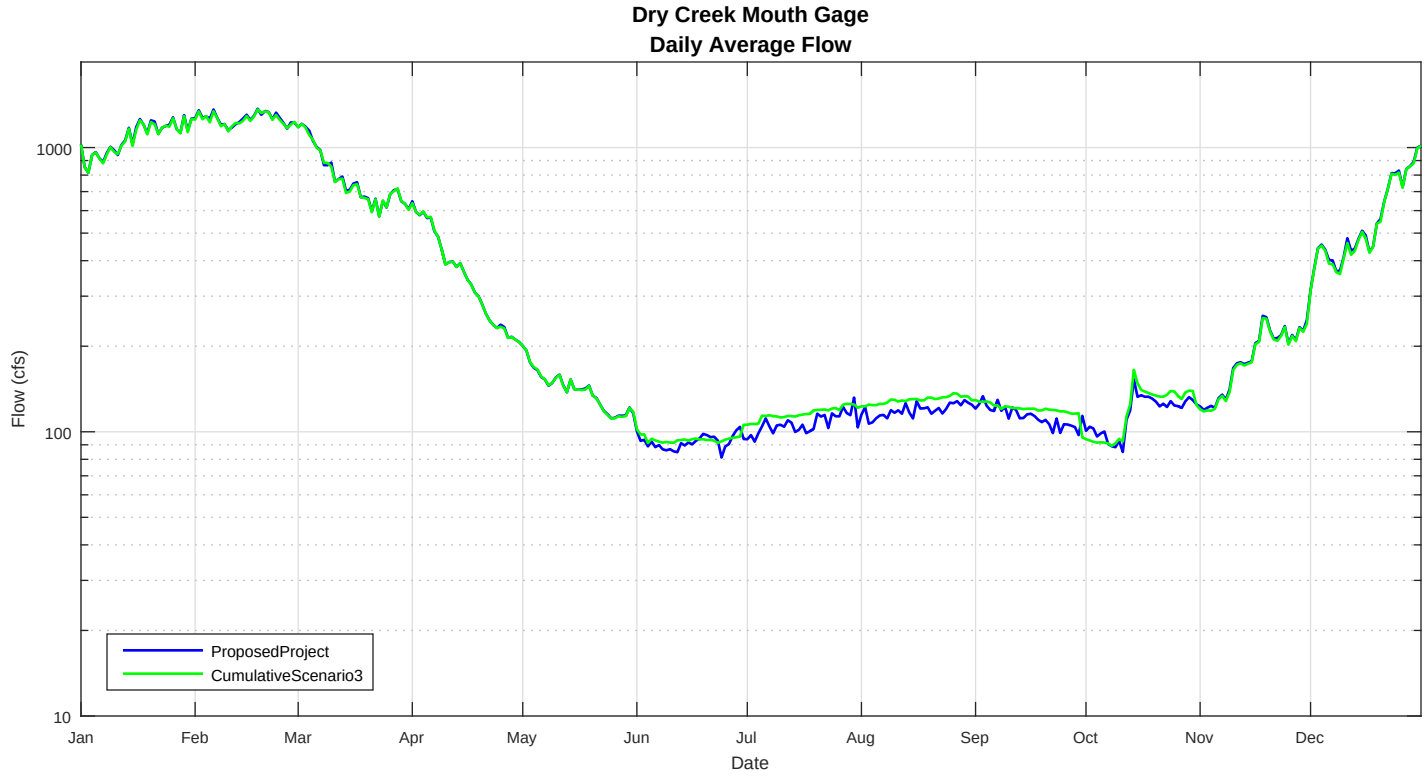

Healdsburg Gage
Daily Average Flow
10000
1000
100
10
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario3

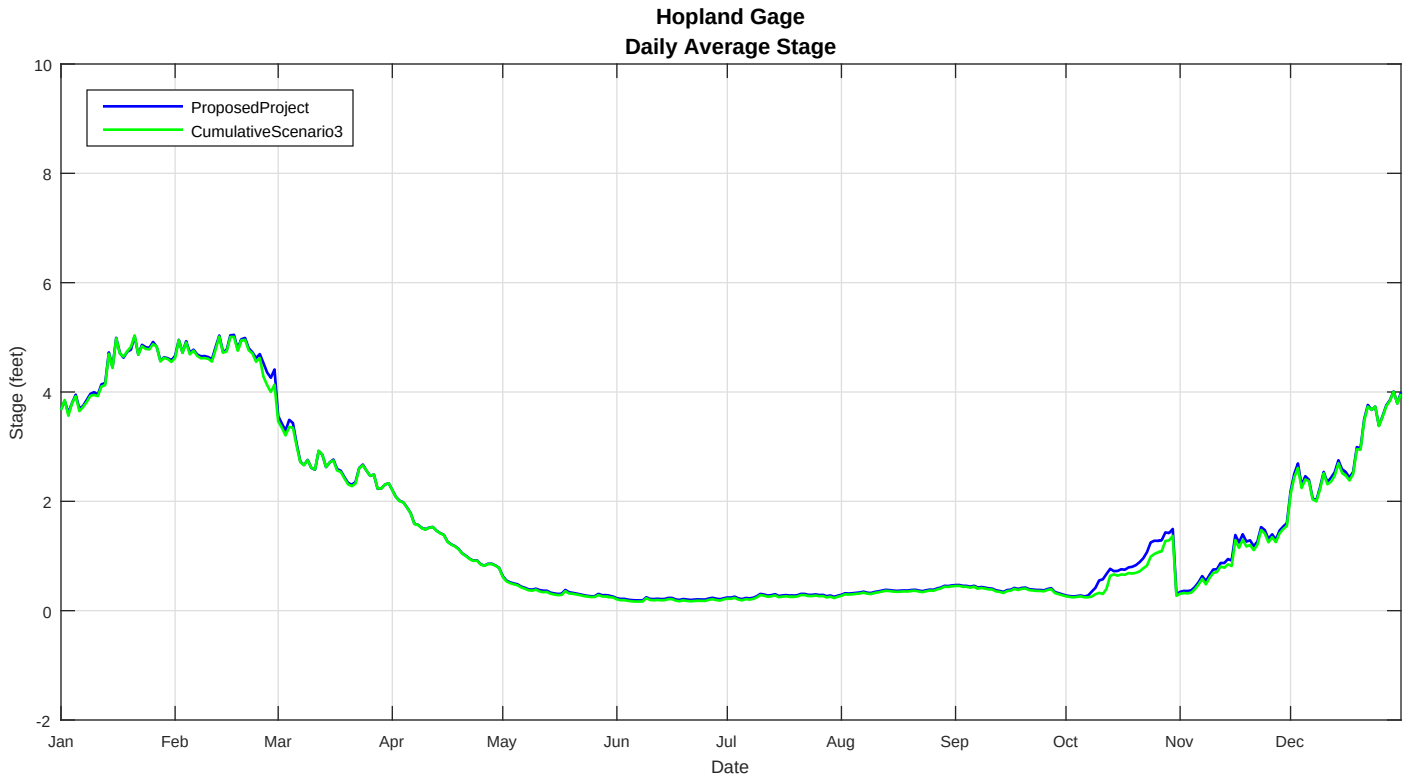

Russian River at Dry Creek
Daily Average Flow
10000
1000
100
10
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario3

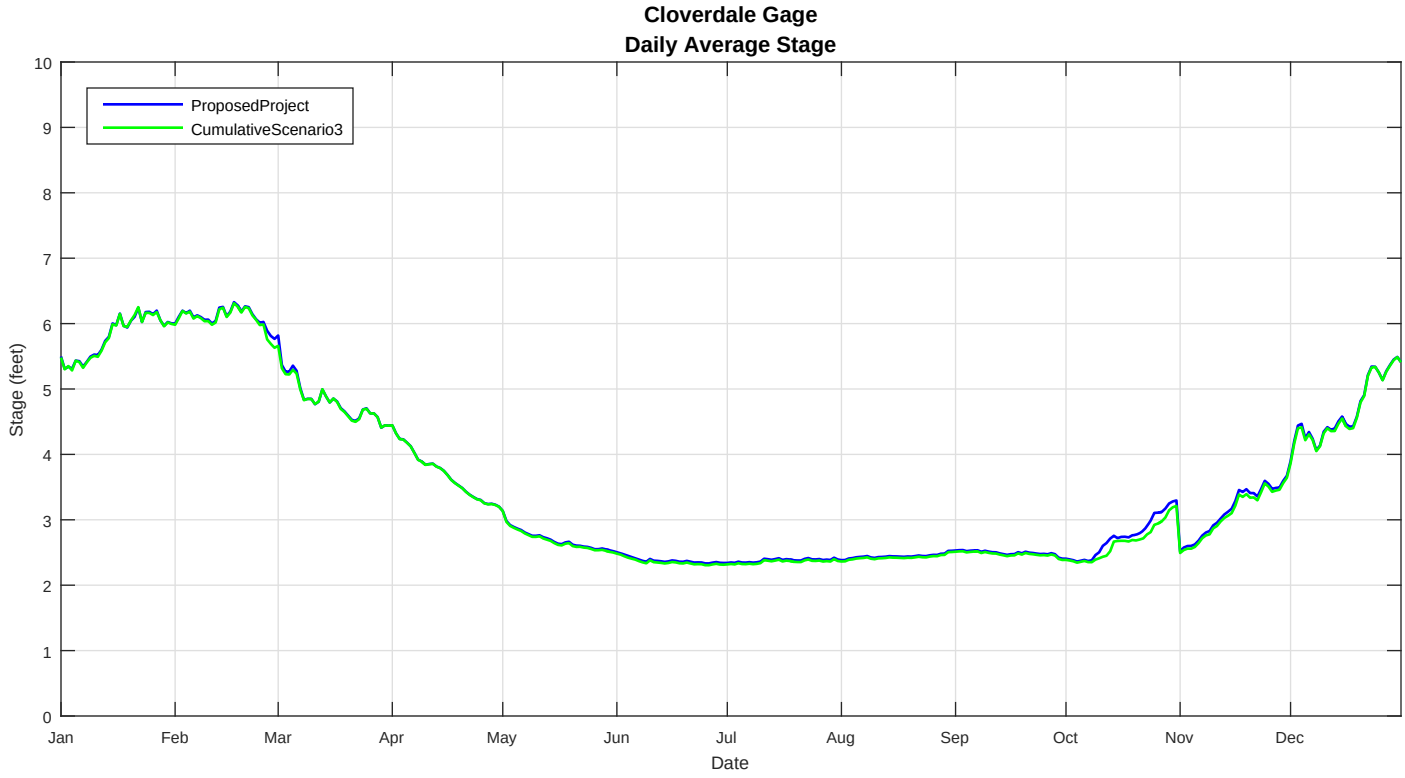

Hacienda Gage
Daily Average Flow
10000
1000
100
10
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario3

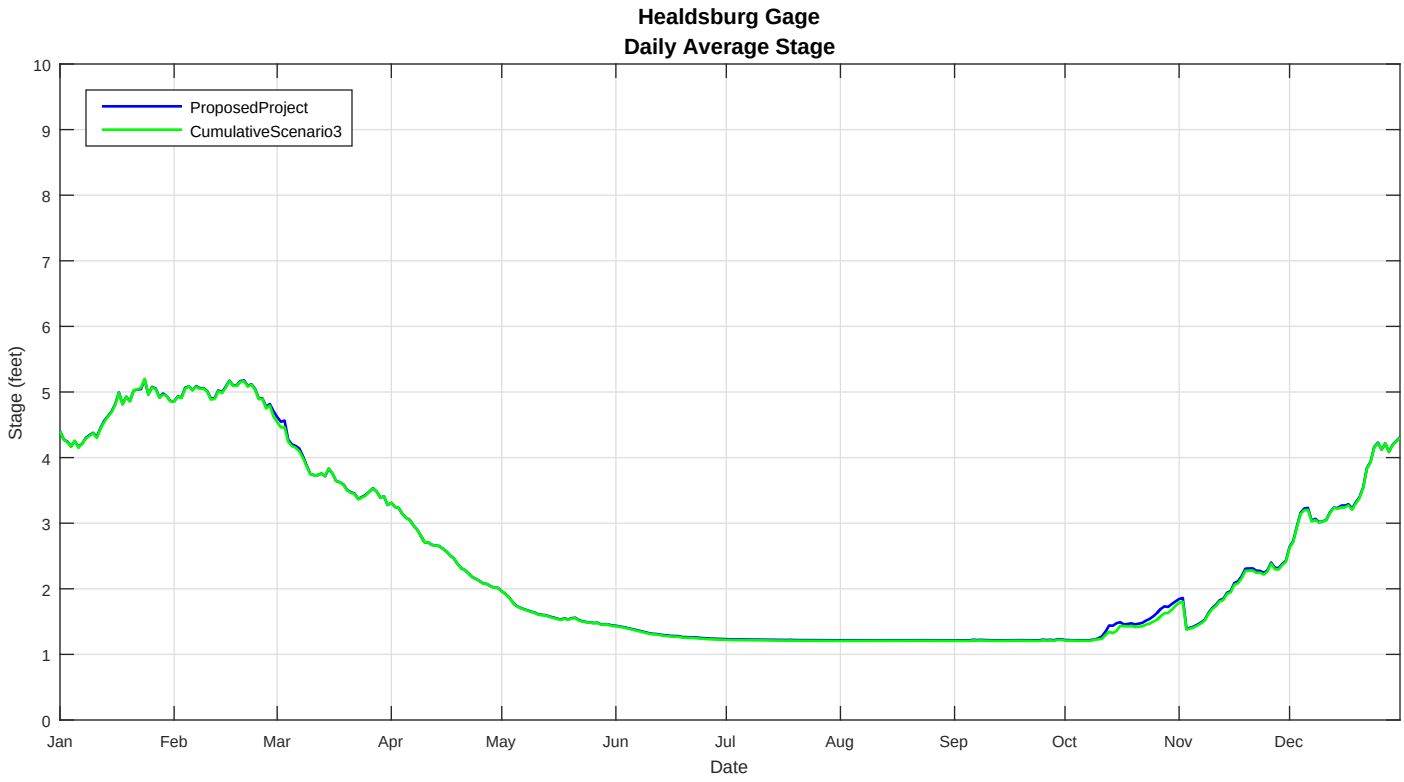

Warm Springs Dam Outlet
Daily Average Flow
1000
100
10
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario3

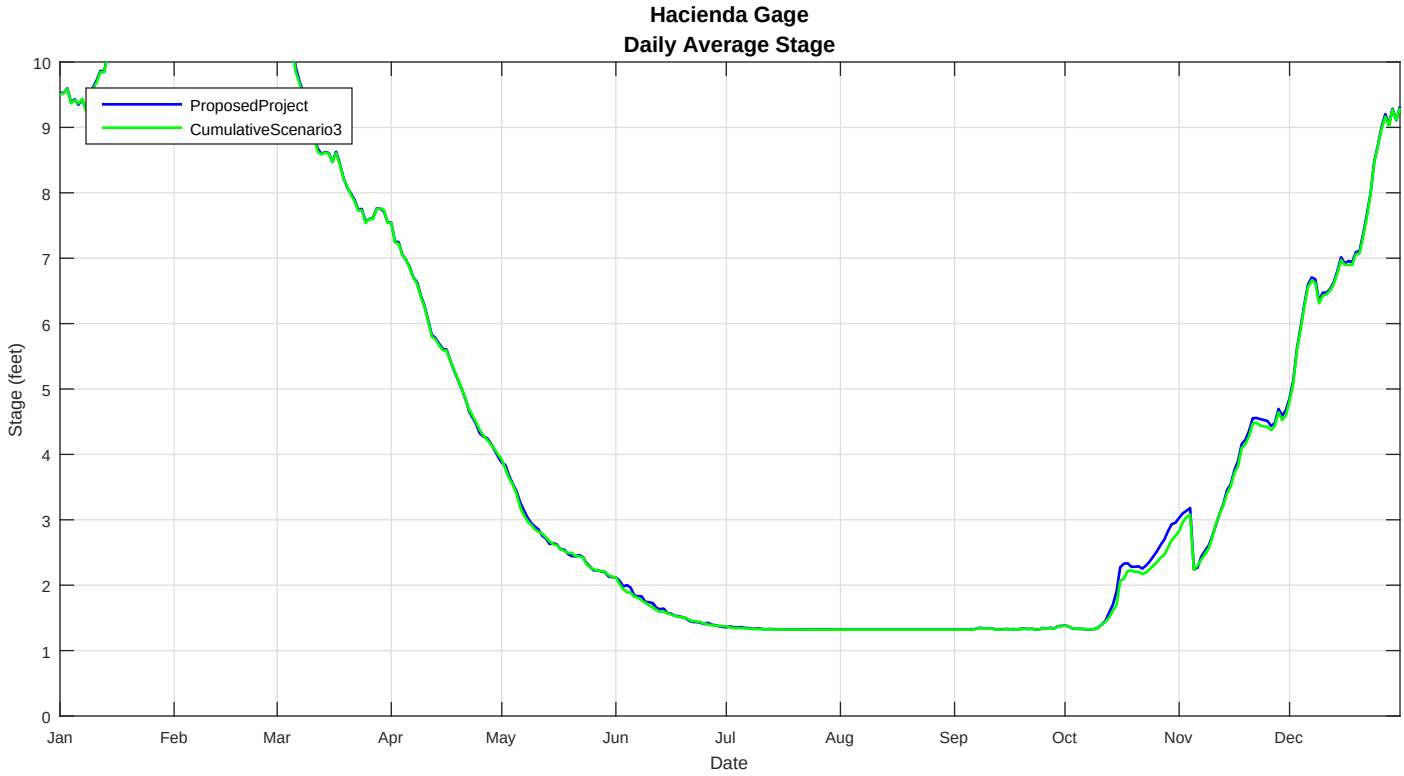

Dry Creek at Geyserville Gage
Daily Average Flow
Flow (cfs)
1000
100
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario3

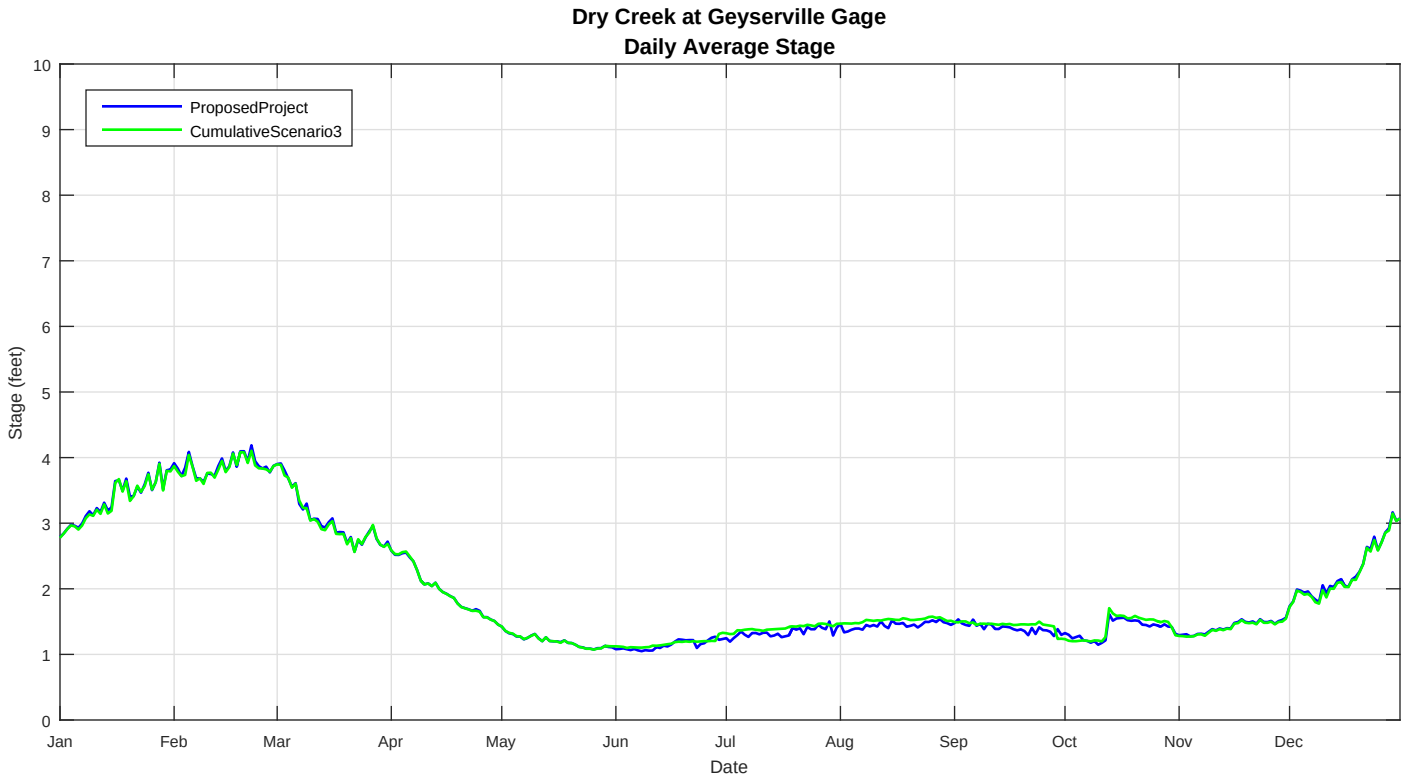

Dry Creek Mouth Gage
Daily Average Flow
Flow (cfs)
1000
100
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario3

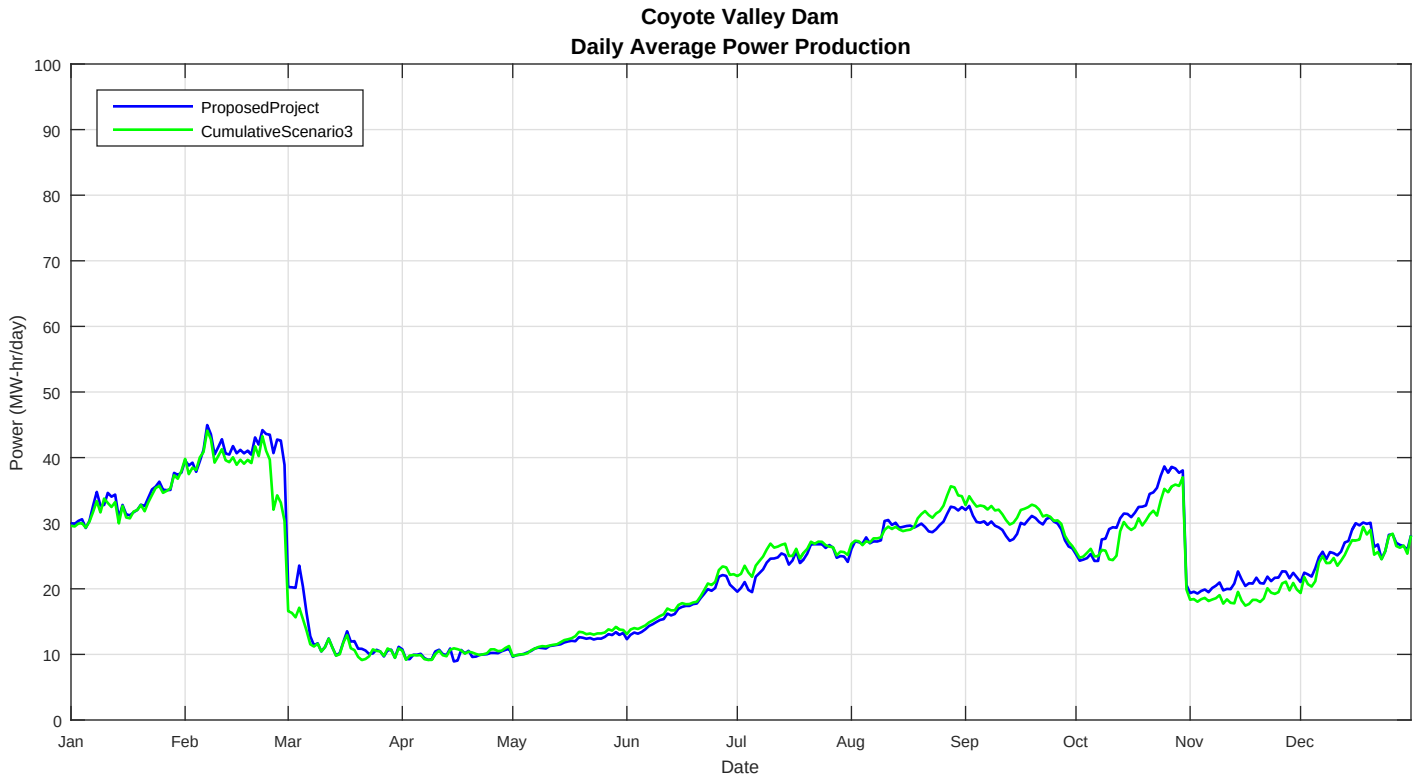

Hopland Gage
Daily Average Stage
ProposedProject
CumulativeScenario3
Stage (feet)
10
8
6
4
2
0
-2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

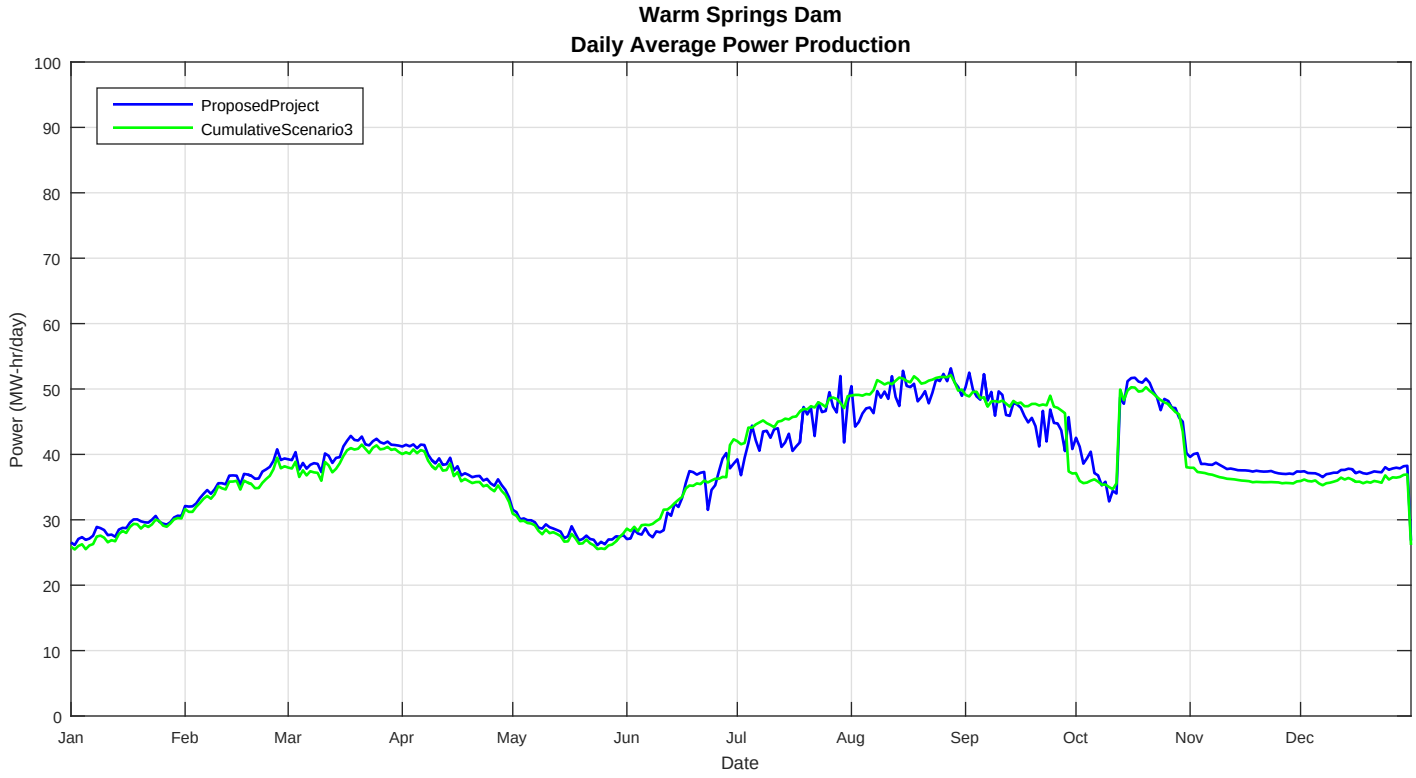

Cloverdale Gage
Daily Average Stage
ProposedProject
CumulativeScenario3
Stage (feet)
10
9
8
7
6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

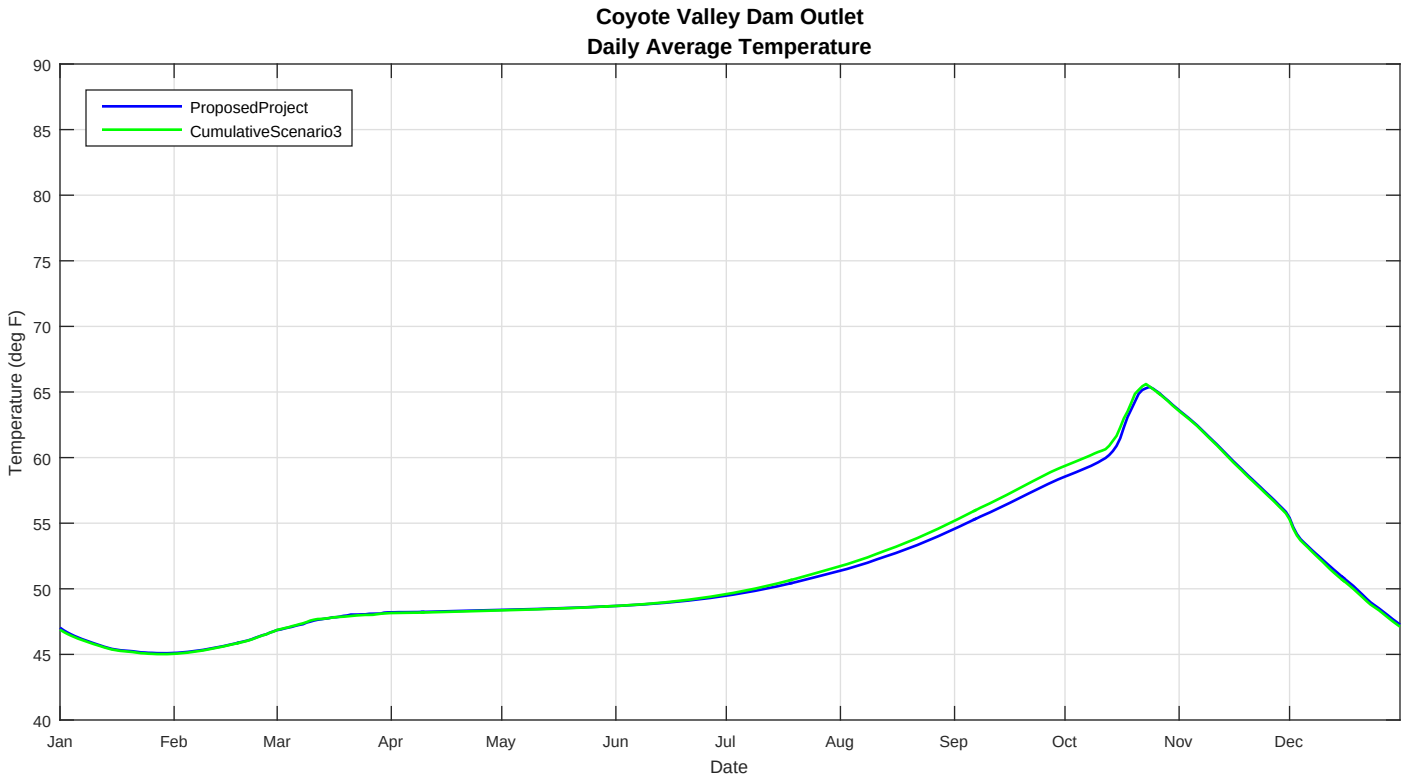

Healdsburg Gage
Daily Average Stage
ProposedProject
CumulativeScenario3
Stage (feet)
0
1
2
3
4
5
6
7
8
9
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

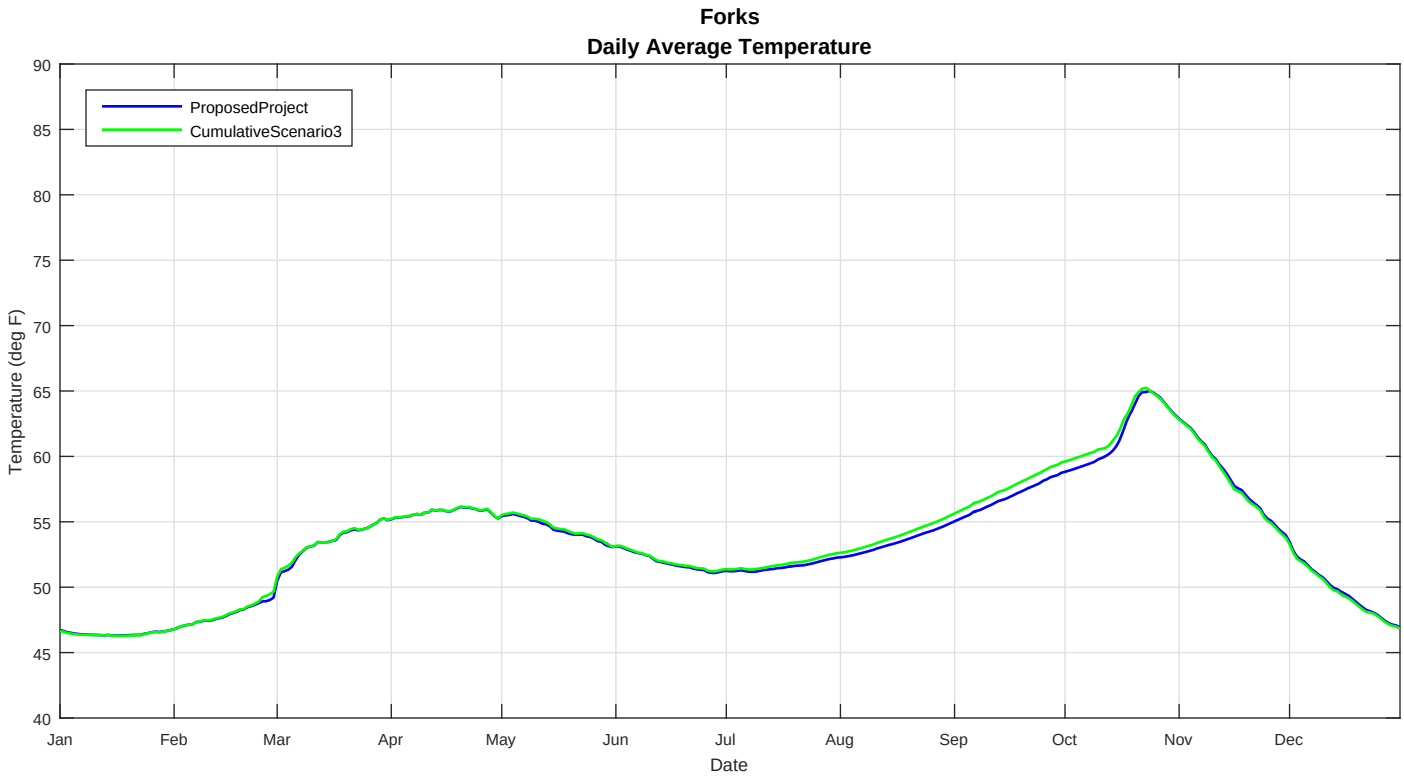

Hacienda Gage
Daily Average Stage
ProposedProject
CumulativeScenario3
Stage (feet)
0
1
2
3
4
5
6
7
8
9
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

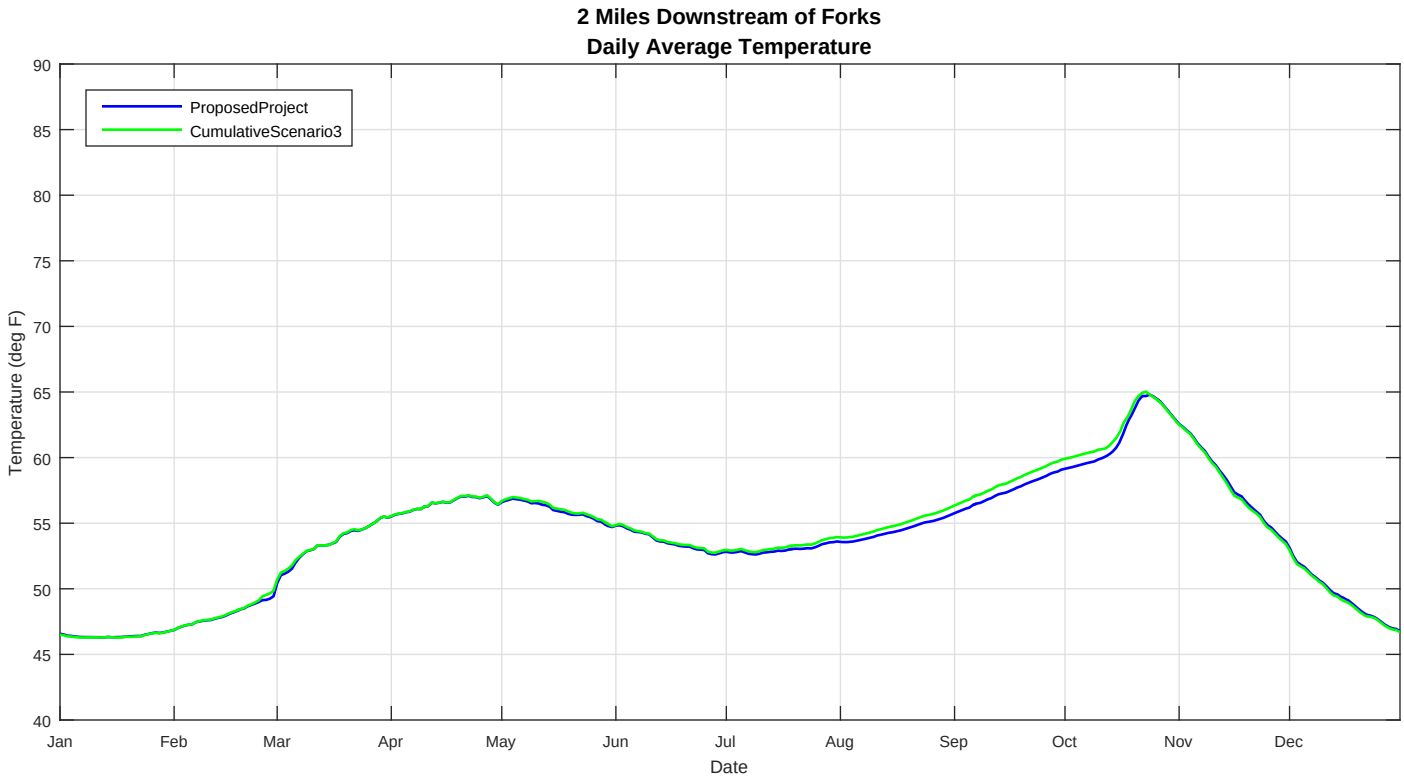

Dry Creek at Geyserville Gage
Daily Average Stage
ProposedProject
CumulativeScenario3
Stage (feet)
0
1
2
3
4
5
6
7
8
9
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

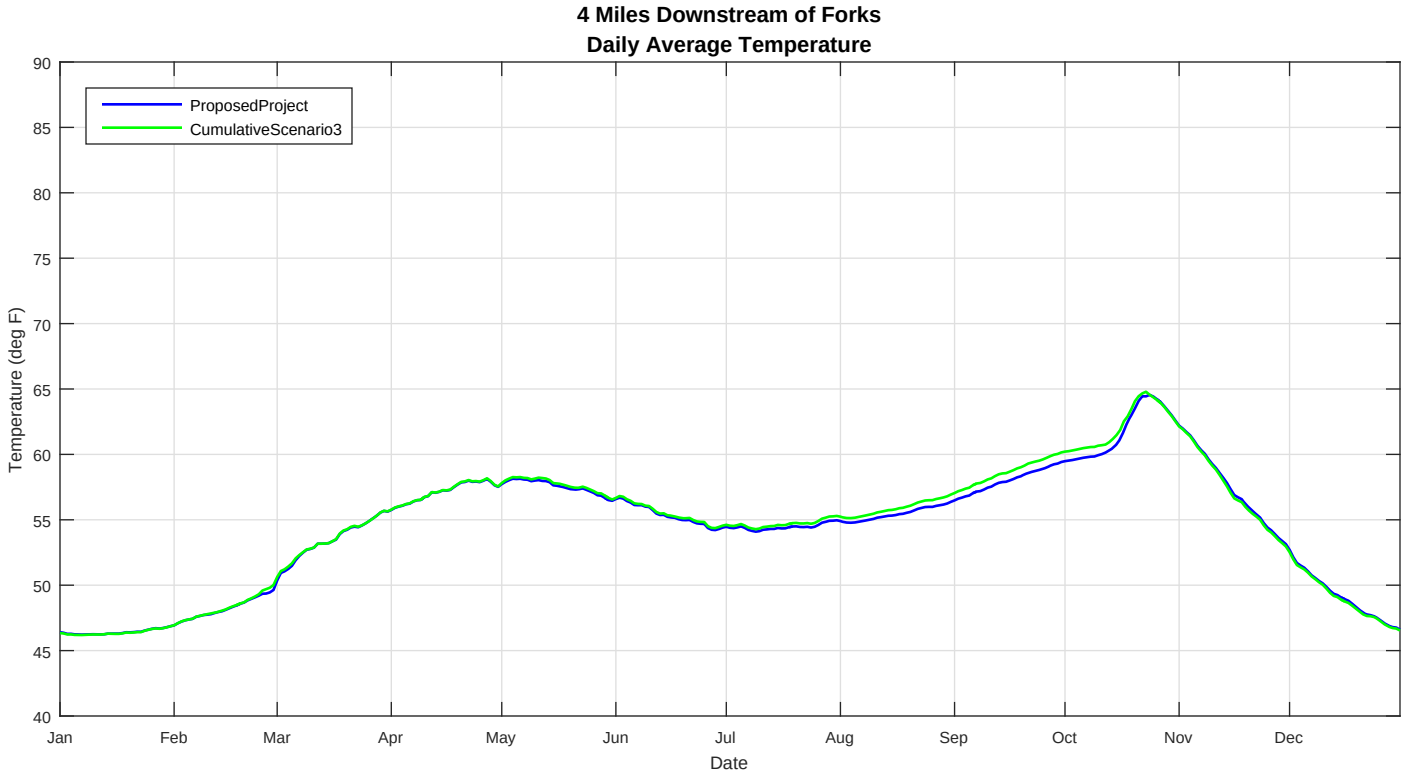

Coyote Valley Dam
Daily Average Power Production
ProposedProject
CumulativeScenario3
Power (MW-hr/day)
0
10
20
30
40
50
60
70
80
90
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

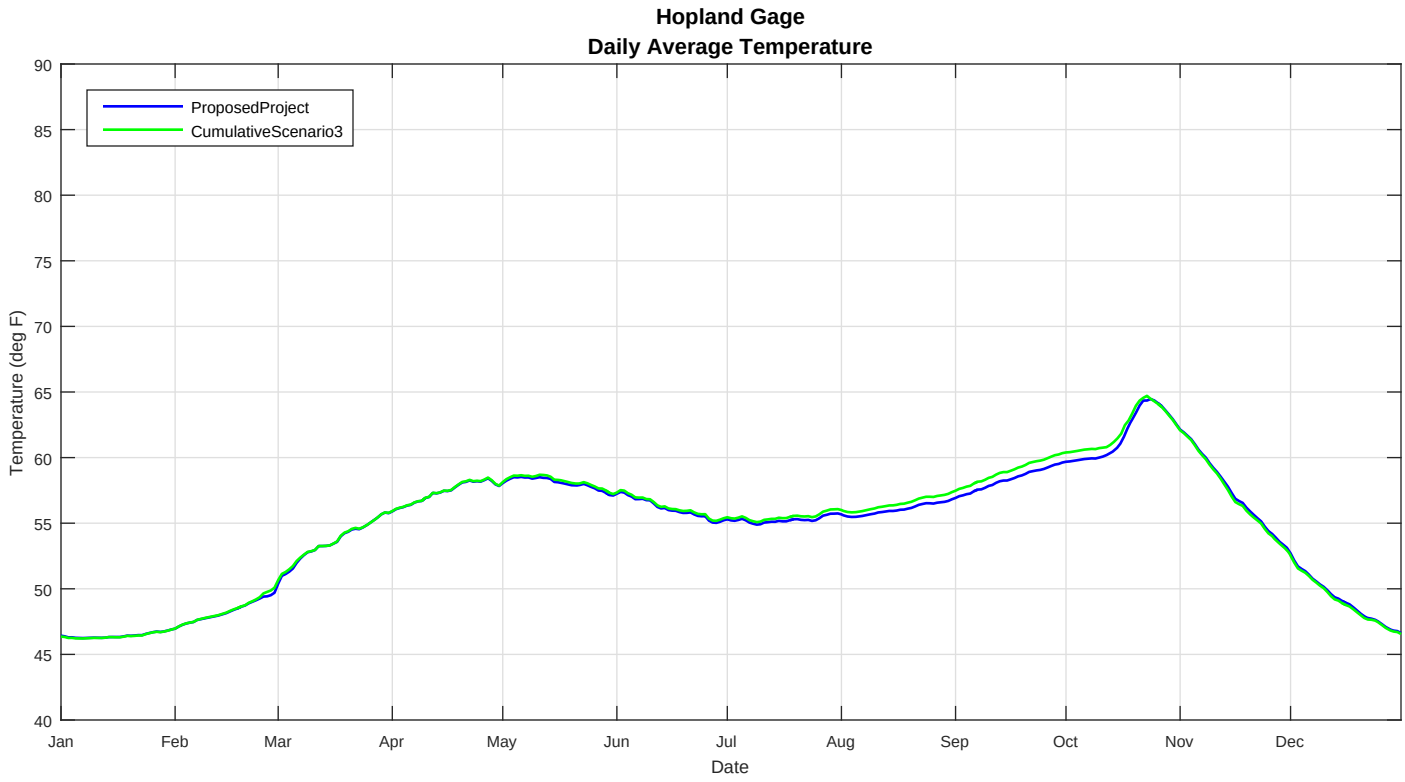

Warm Springs Dam
Daily Average Power Production
ProposedProject
CumulativeScenario3
Power (MW-hr/day)
0
10
20
30
40
50
60
70
80
90
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

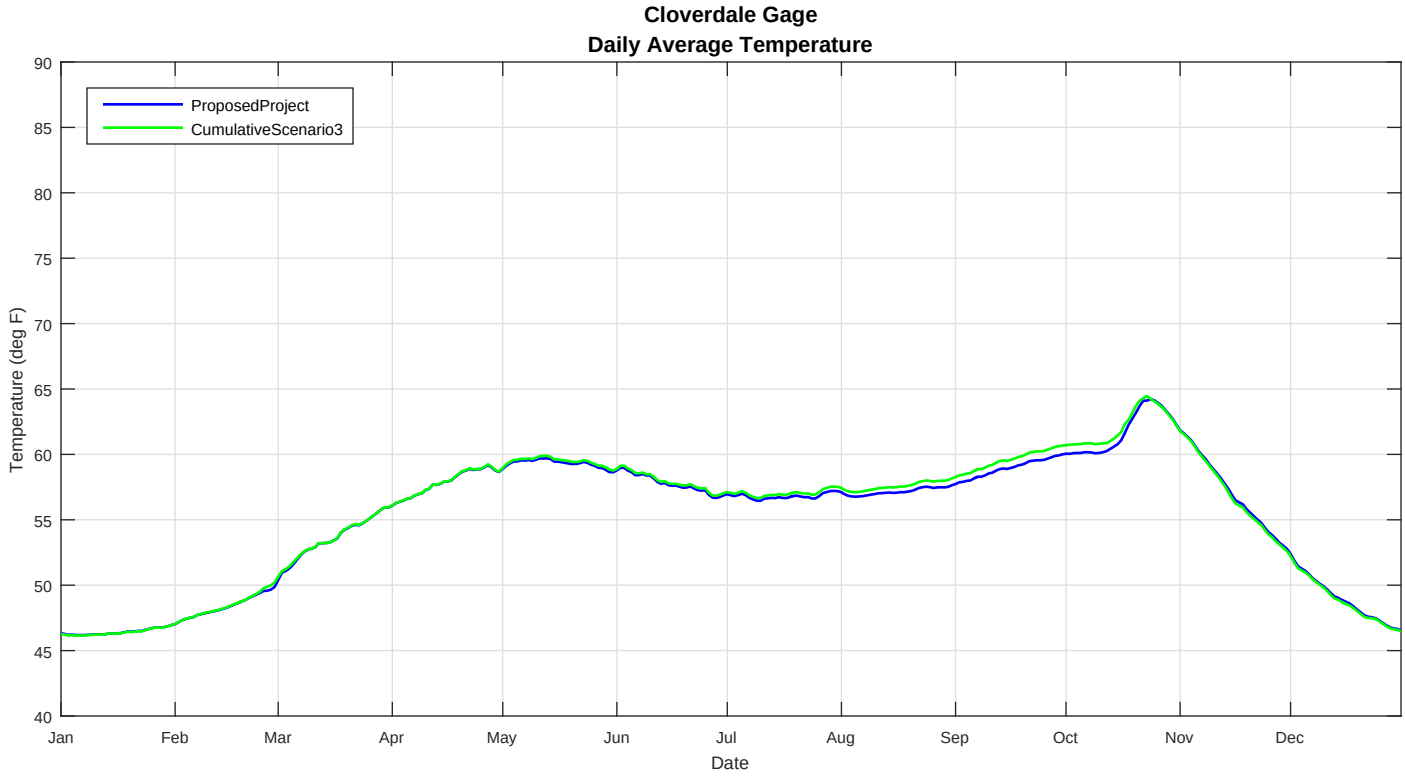

Coyote Valley Dam Outlet
Daily Average Temperature
ProposedProject
CumulativeScenario3
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

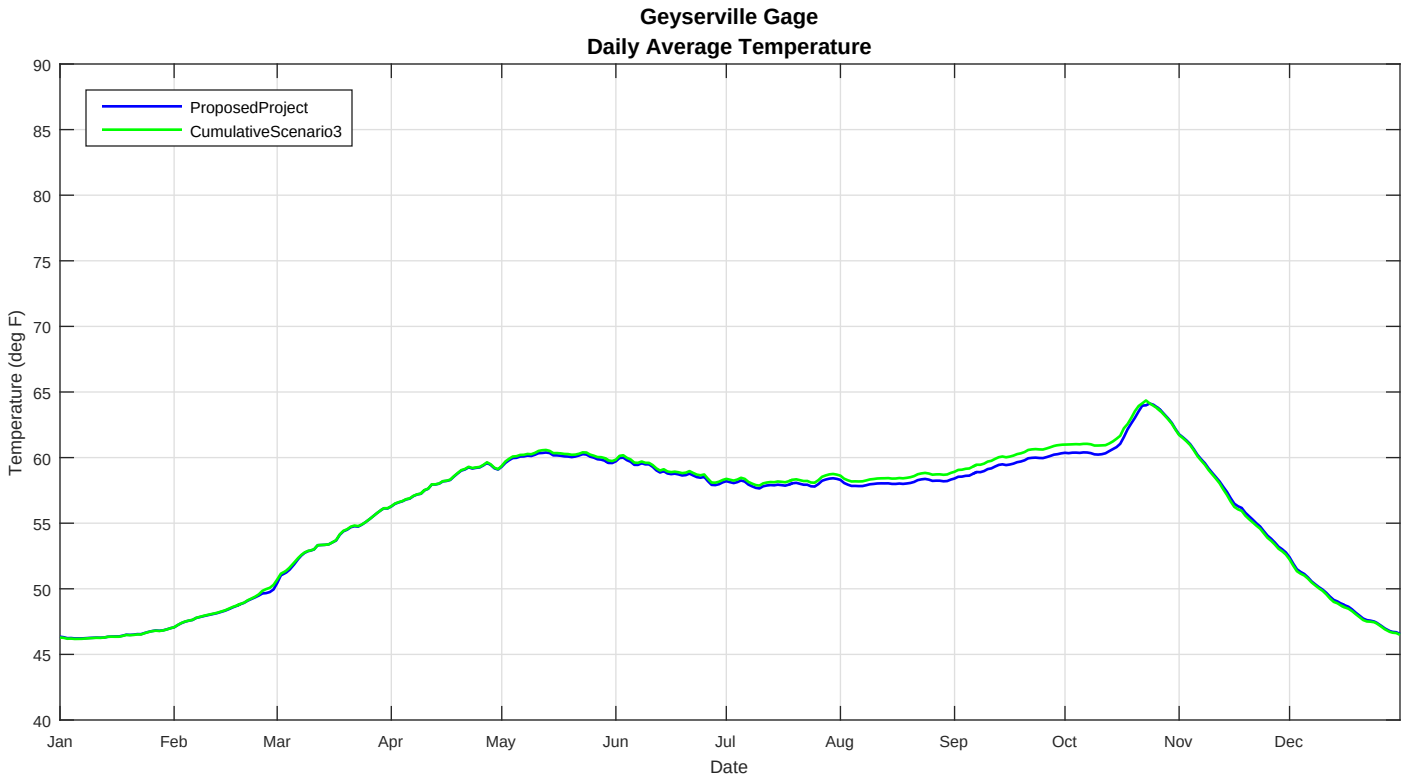

Forks
Daily Average Temperature
ProposedProject
CumulativeScenario3
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

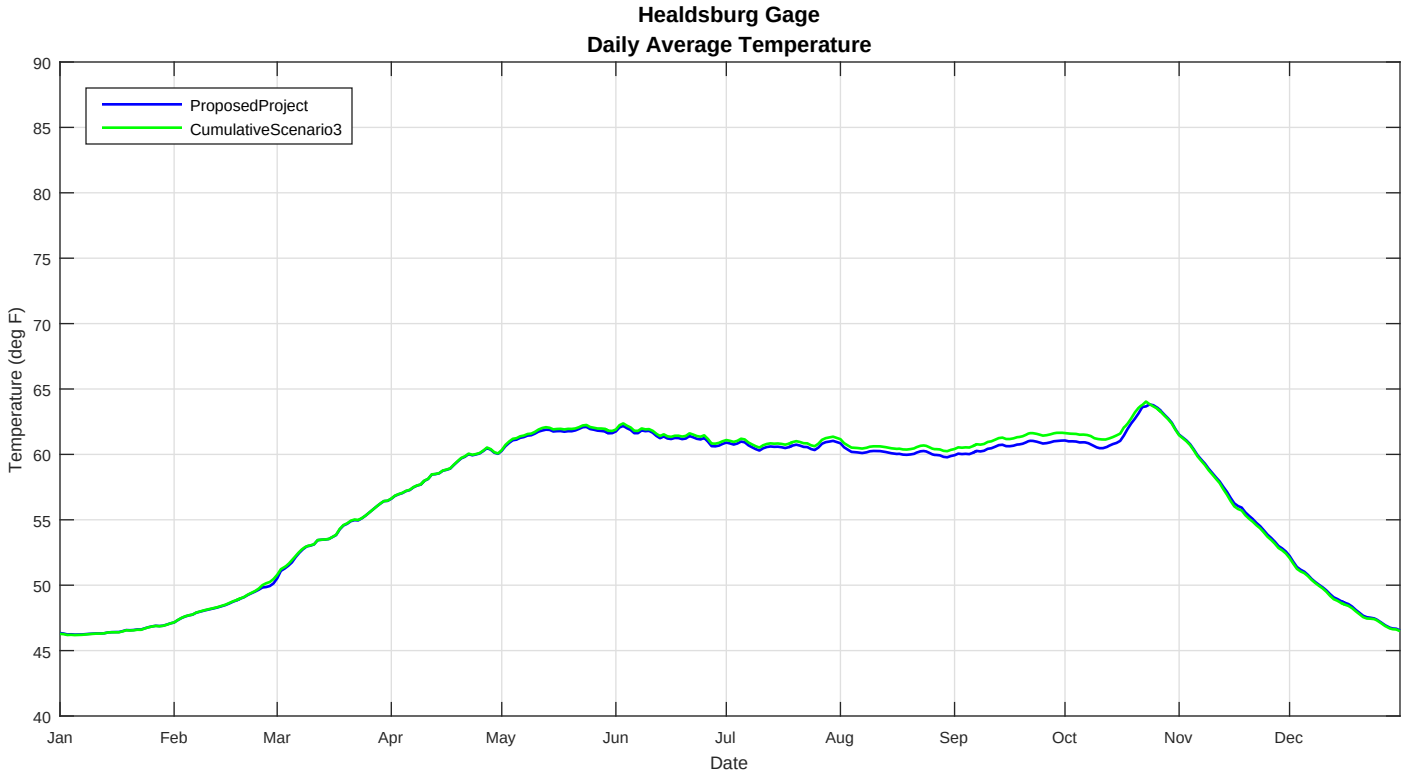

2 Miles Downstream of Forks
Daily Average Temperature
ProposedProject
CumulativeScenario3
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

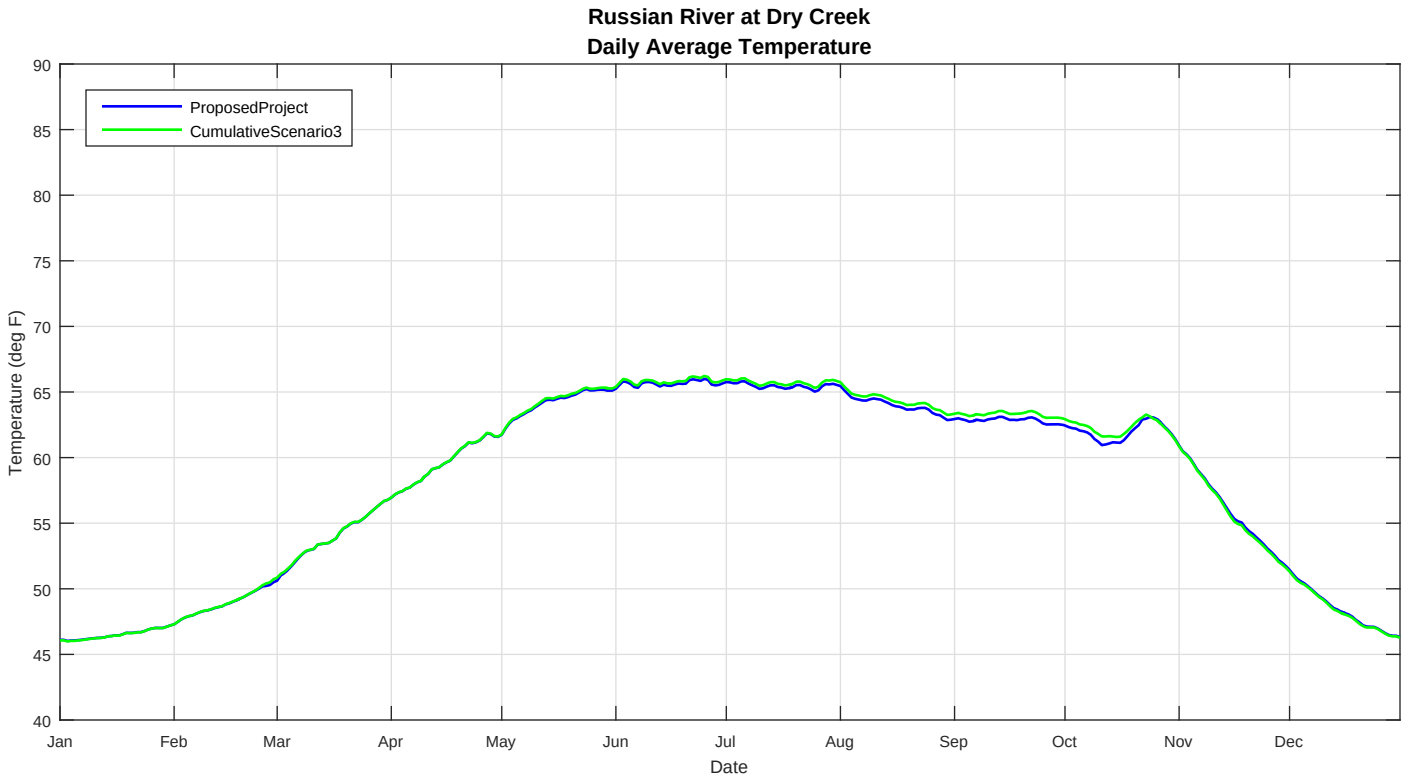

4 Miles Downstream of Forks
Daily Average Temperature
ProposedProject
CumulativeScenario3
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

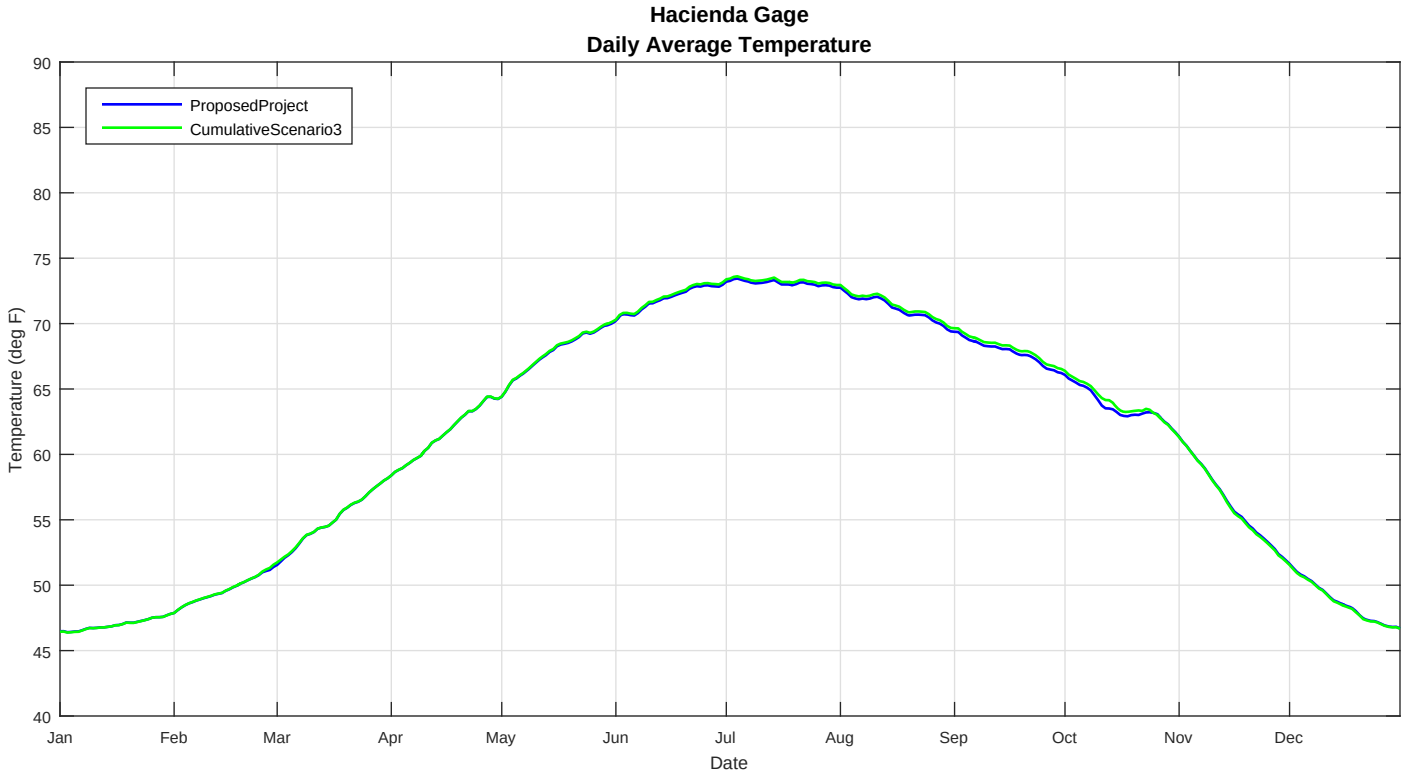

Hopland Gage
Daily Average Temperature
ProposedProject
CumulativeScenario3
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

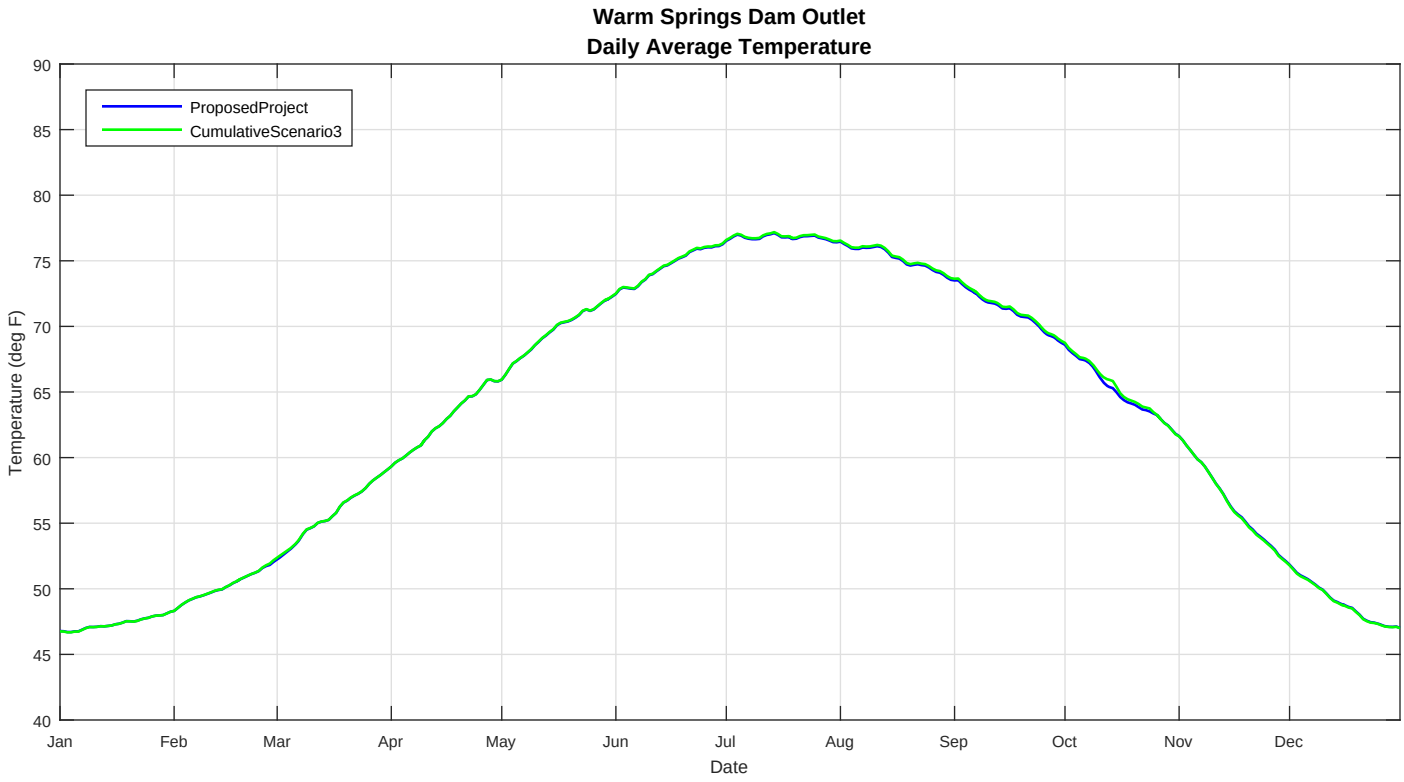

Cloverdale Gage
Daily Average Temperature
ProposedProject
CumulativeScenario3
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

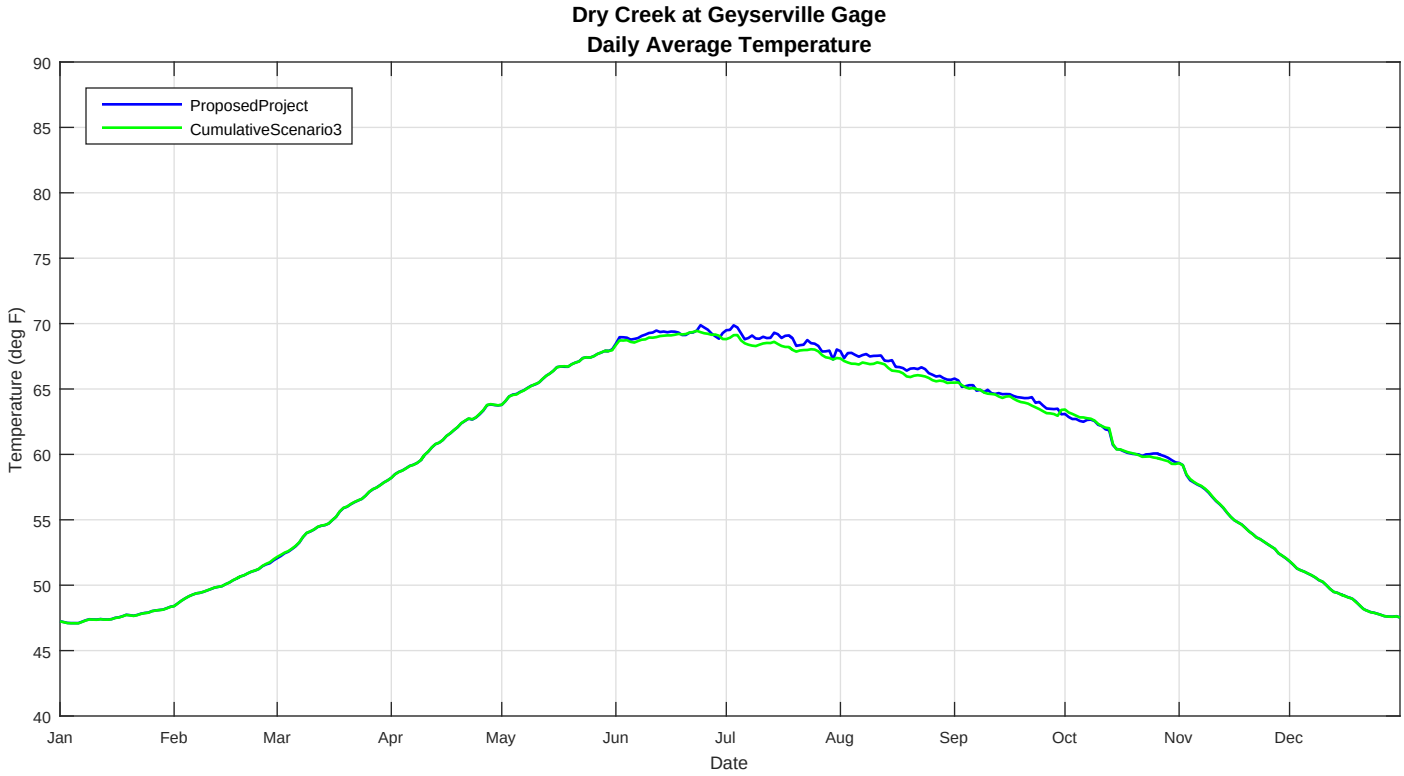

Geyserville Gage
Daily Average Temperature
ProposedProject
CumulativeScenario3
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

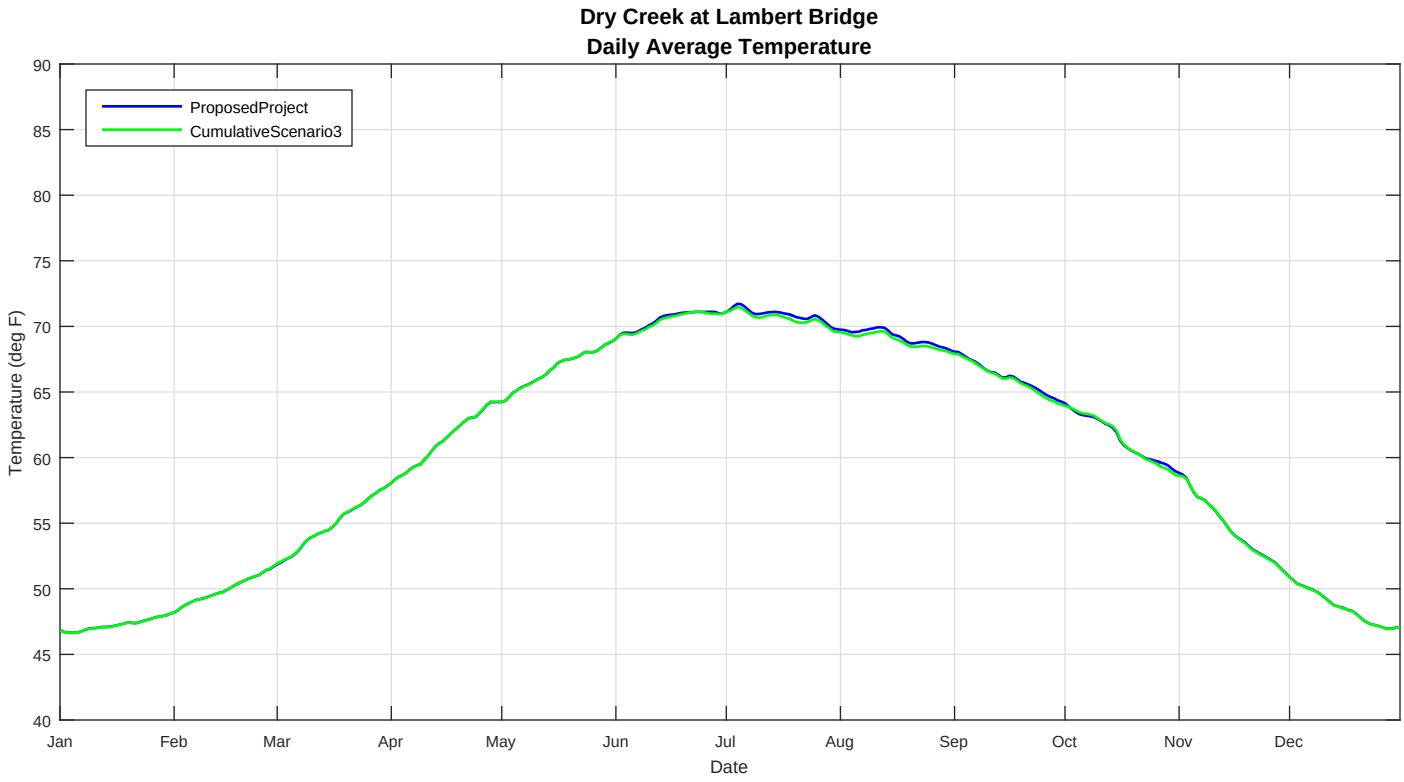

Healdsburg Gage
Daily Average Temperature
ProposedProject
CumulativeScenario3
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

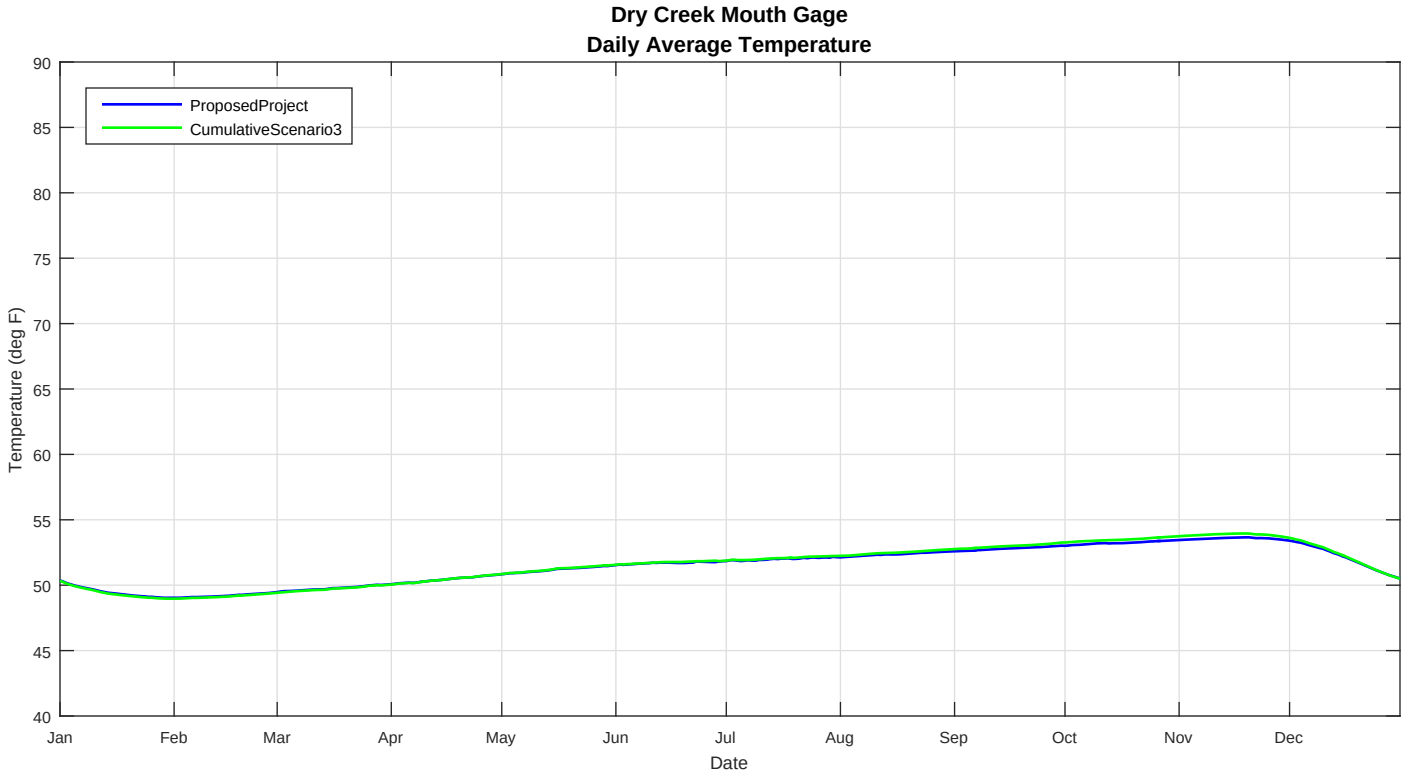

Russian River at Dry Creek
Daily Average Temperature
ProposedProject
CumulativeScenario3
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

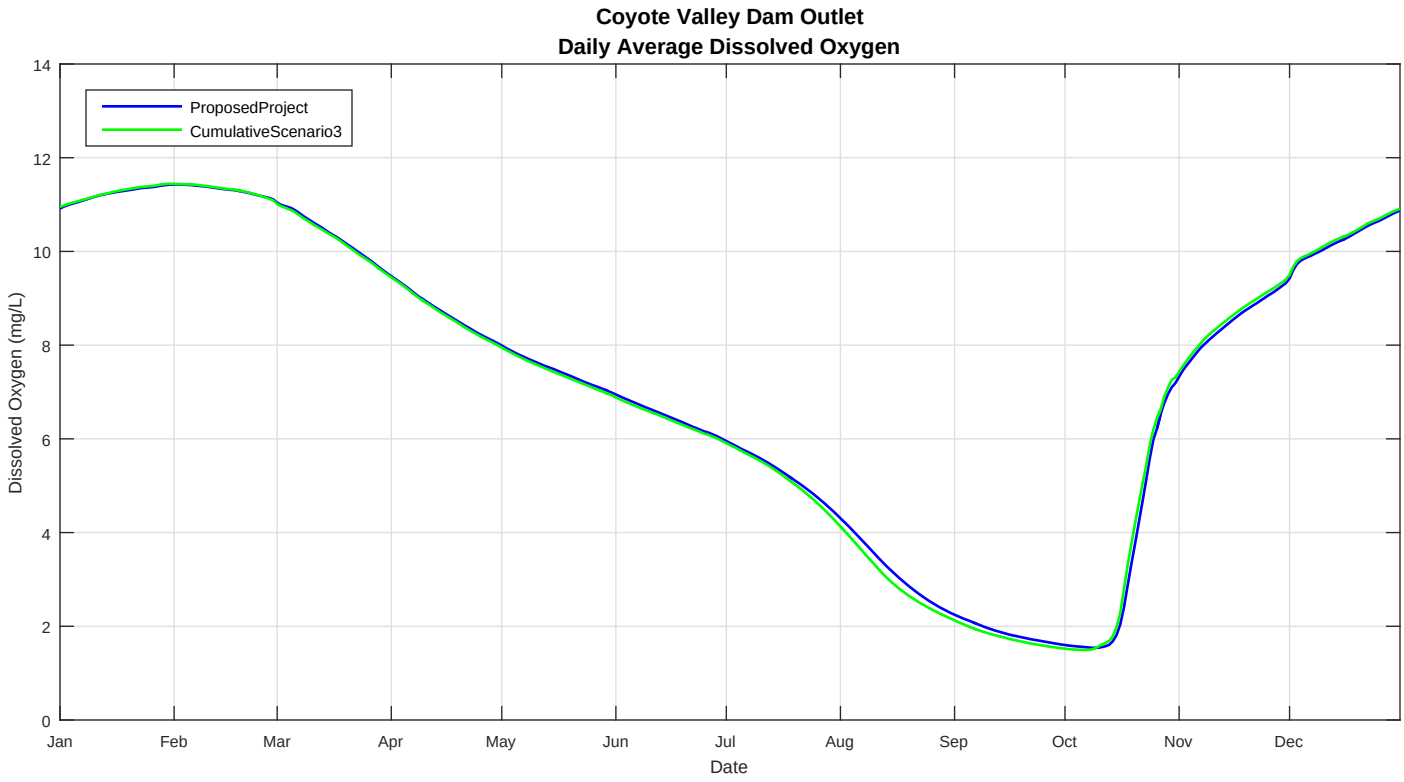

Hacienda Gage
Daily Average Temperature
ProposedProject
CumulativeScenario3
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

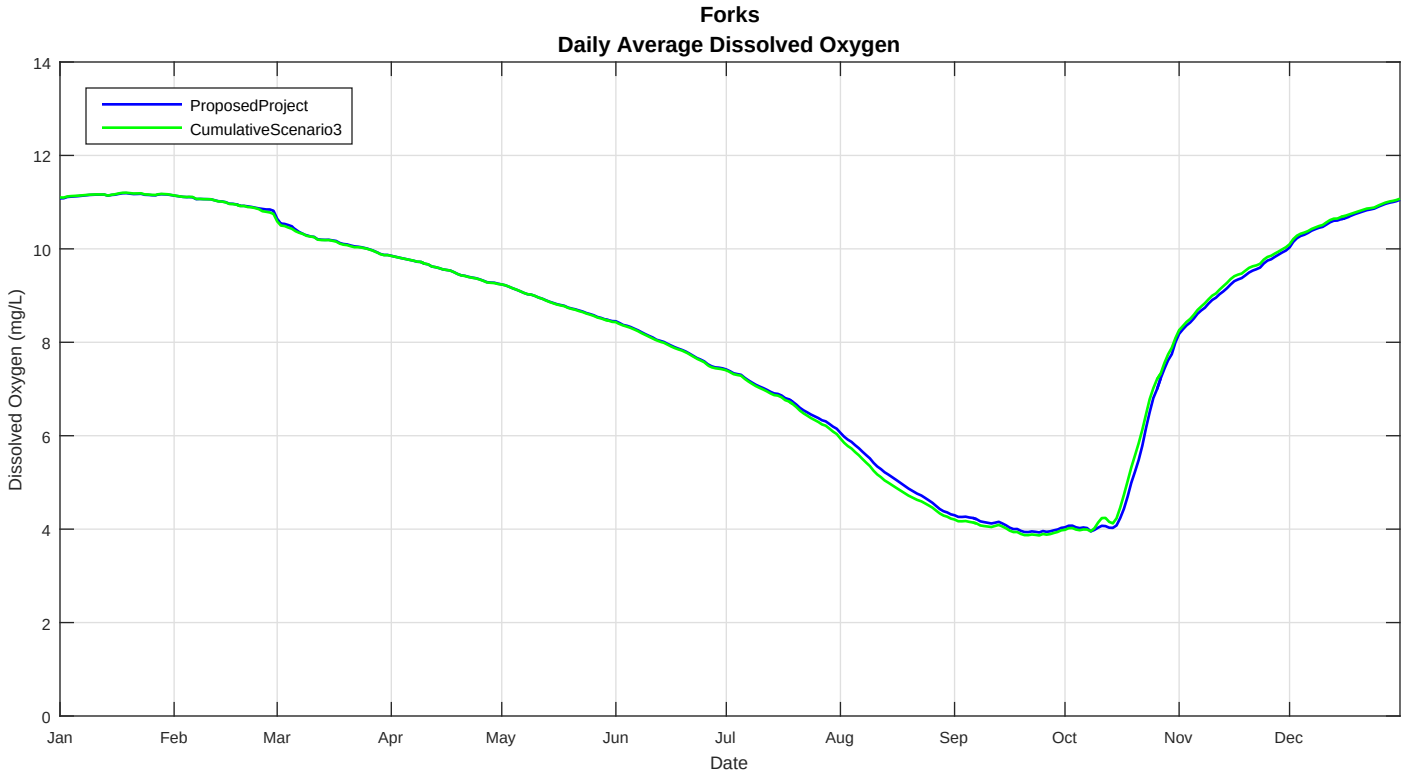

Warm Springs Dam Outlet
Daily Average Temperature
ProposedProject
CumulativeScenario3
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

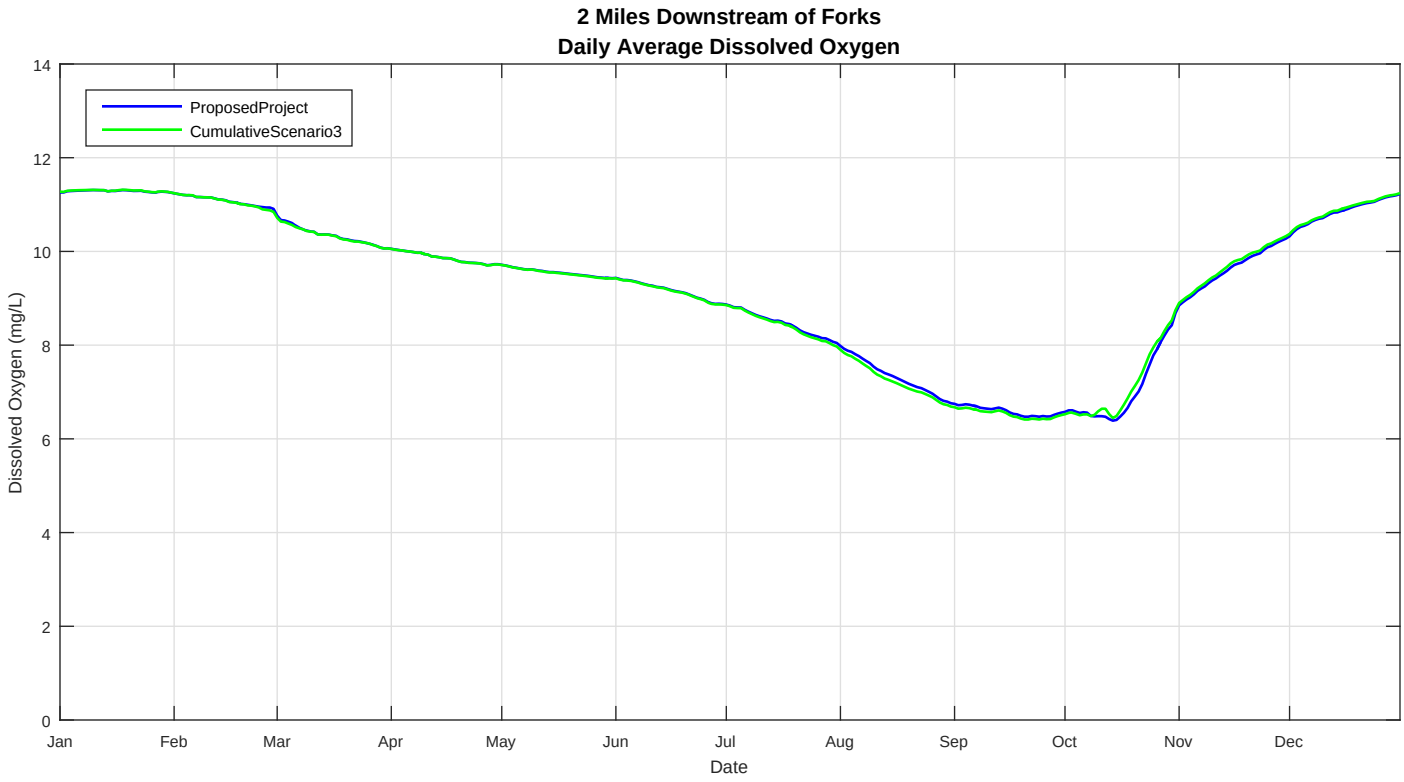

Dry Creek at Geyserville Gage
Daily Average Temperature
ProposedProject
CumulativeScenario3
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

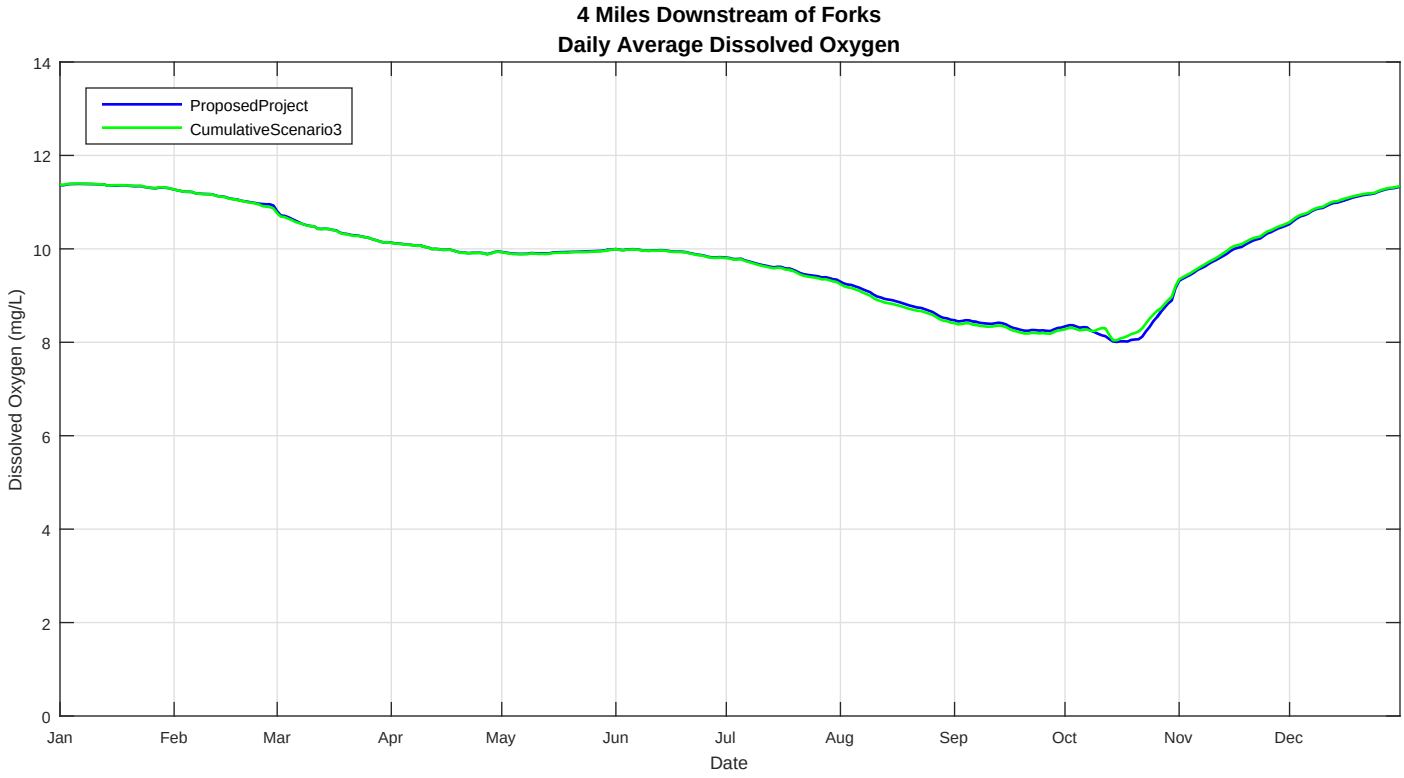

Dry Creek at Lambert Bridge
Daily Average Temperature
ProposedProject
CumulativeScenario3
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

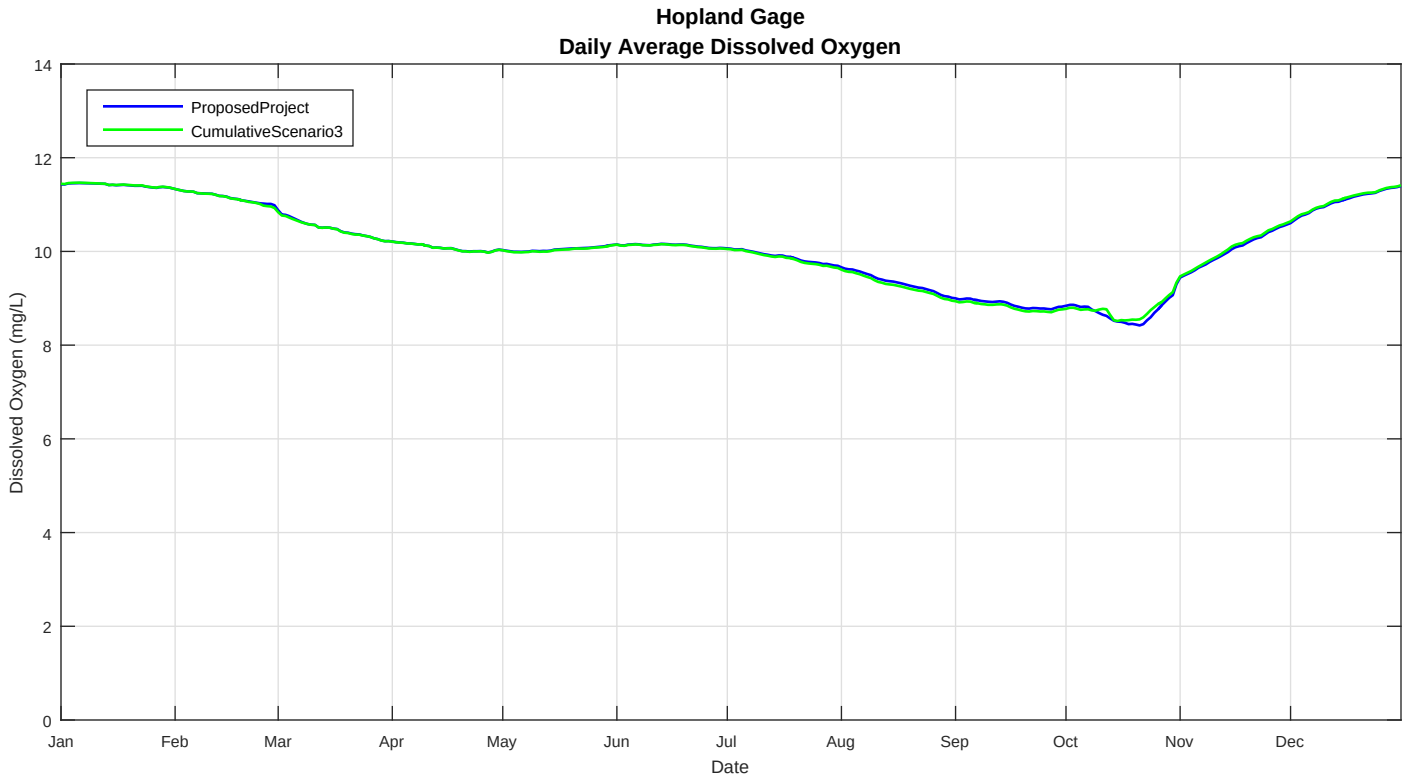

Dry Creek Mouth Gage
Daily Average Temperature
ProposedProject
CumulativeScenario3
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

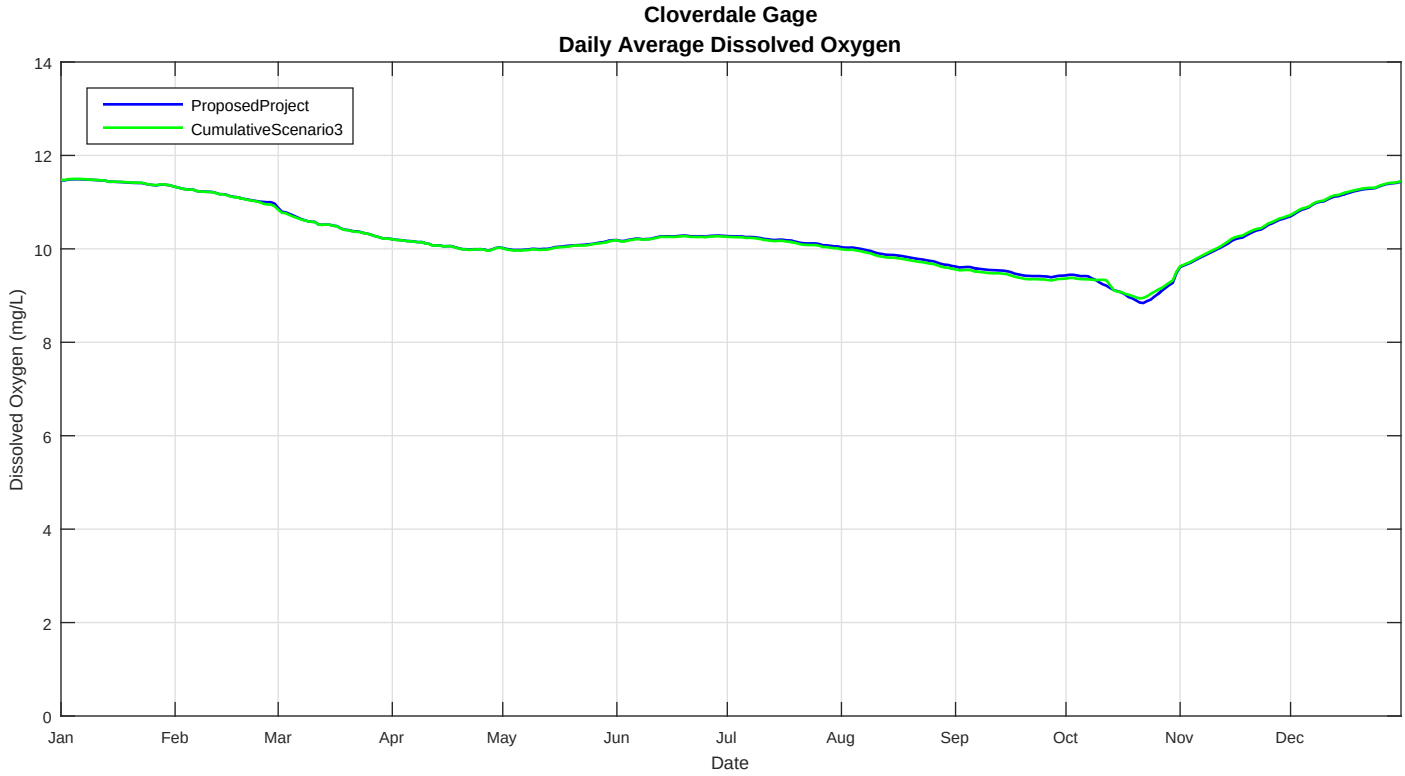

Coyote Valley Dam Outlet
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

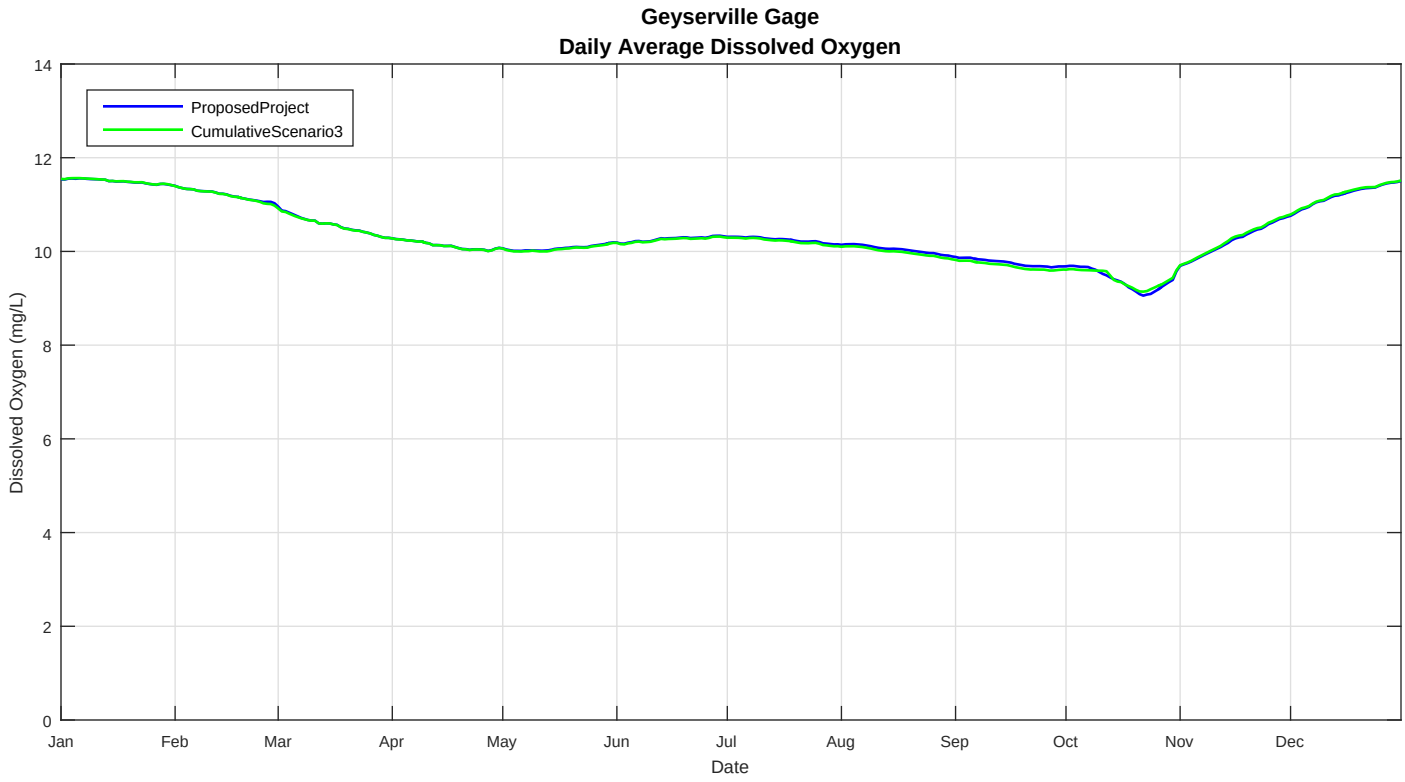

Forks
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

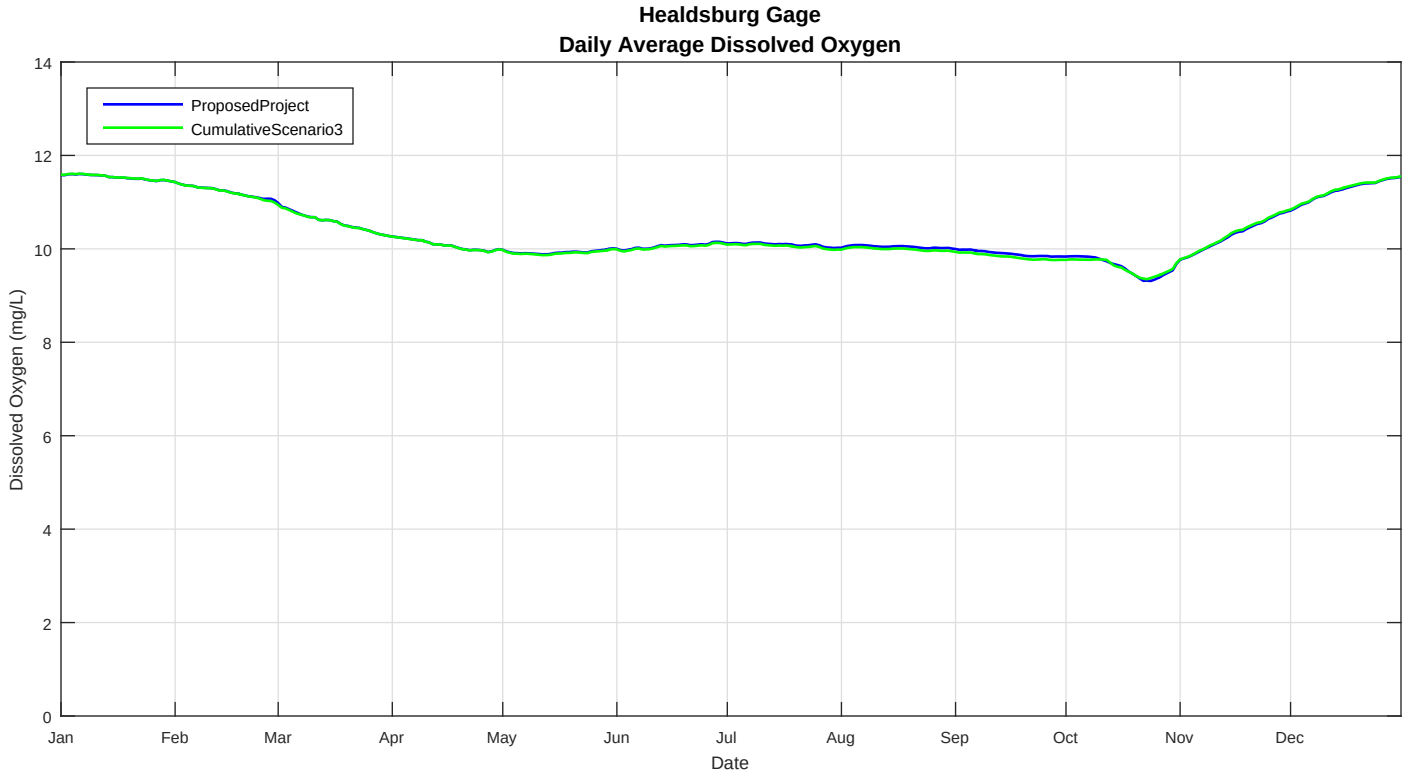

2 Miles Downstream of Forks
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

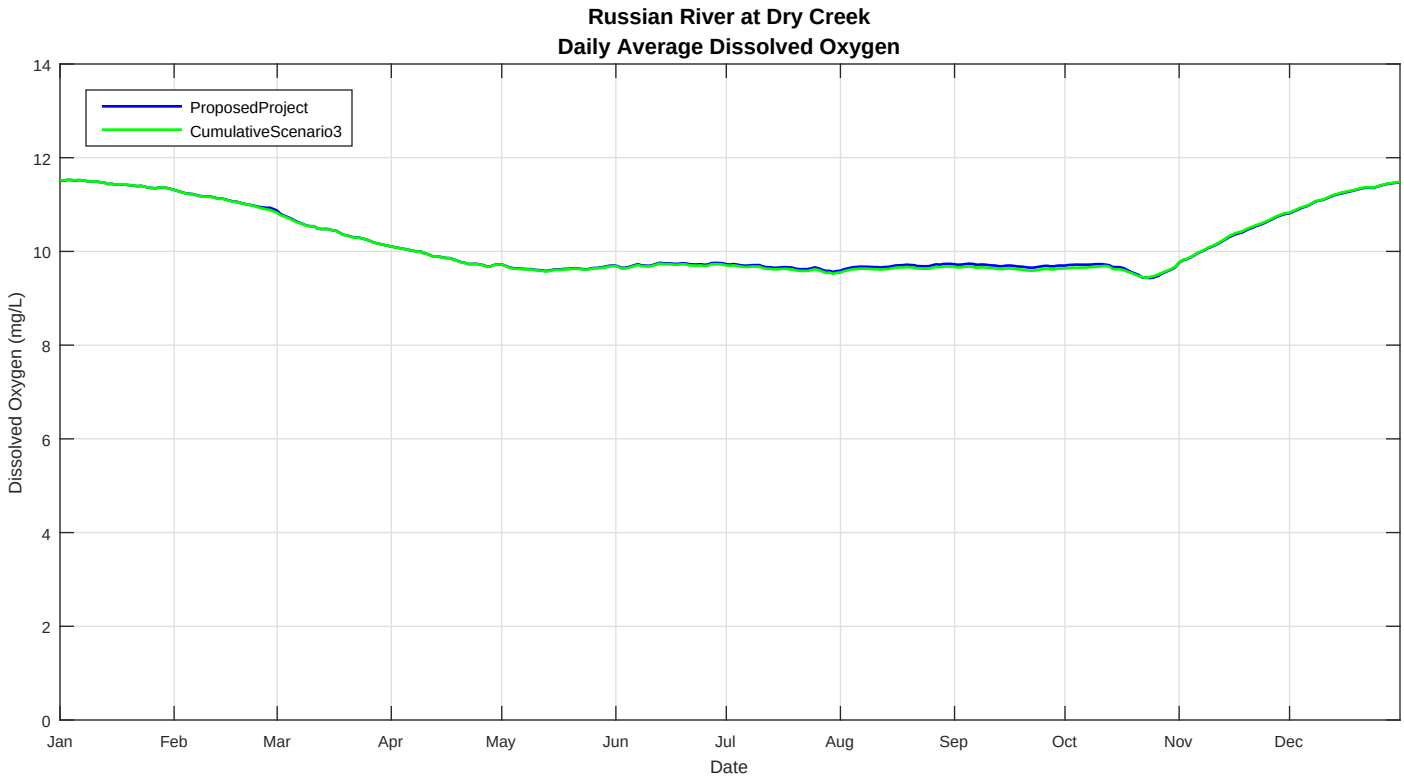

4 Miles Downstream of Forks
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

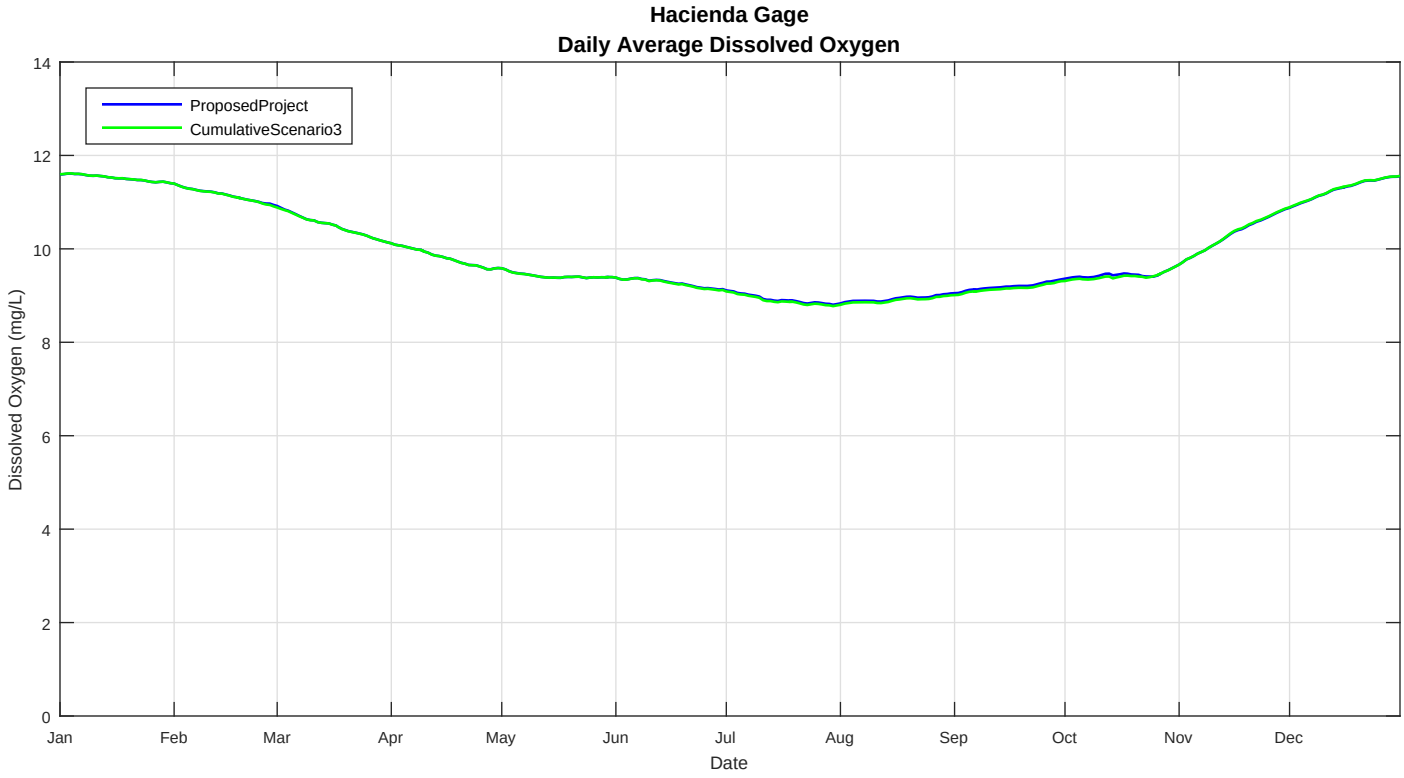

Hopland Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

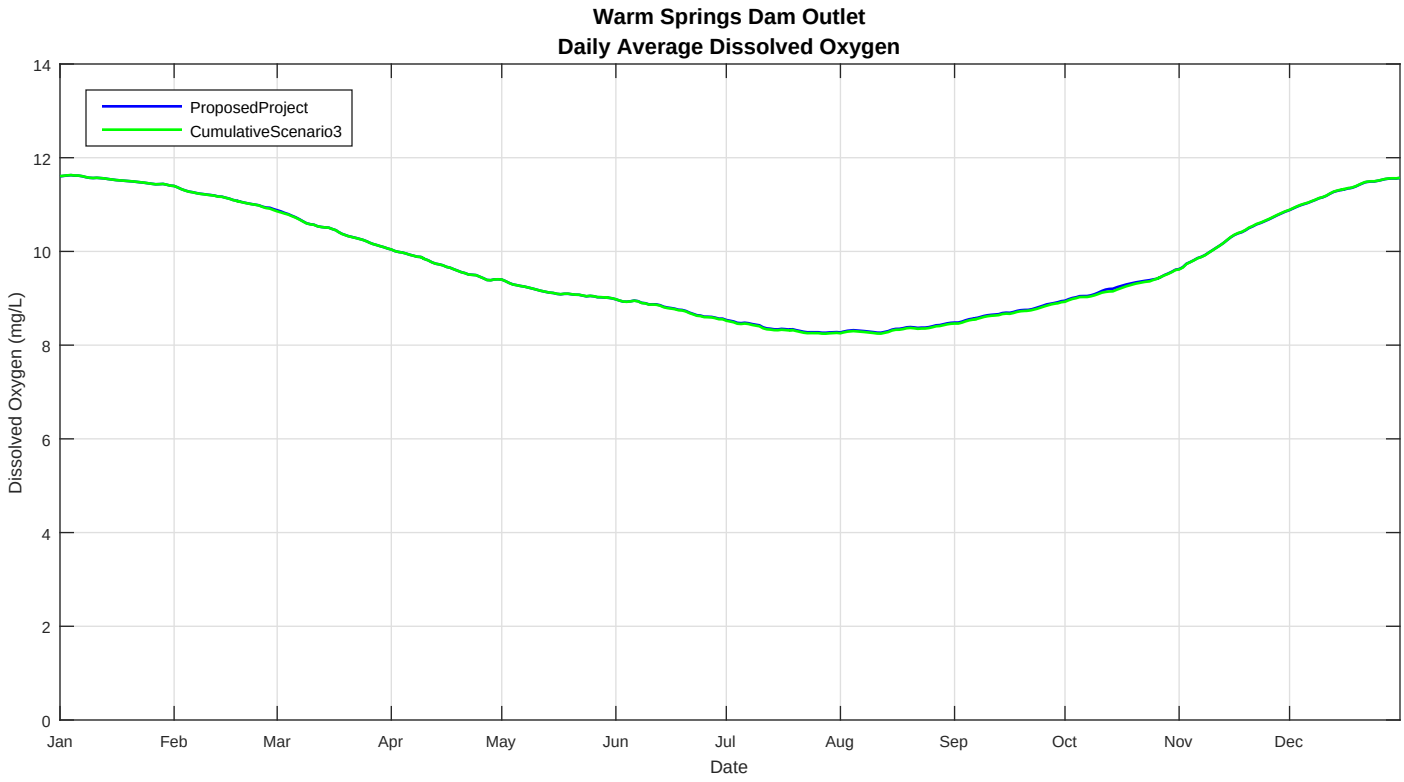

Cloverdale Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

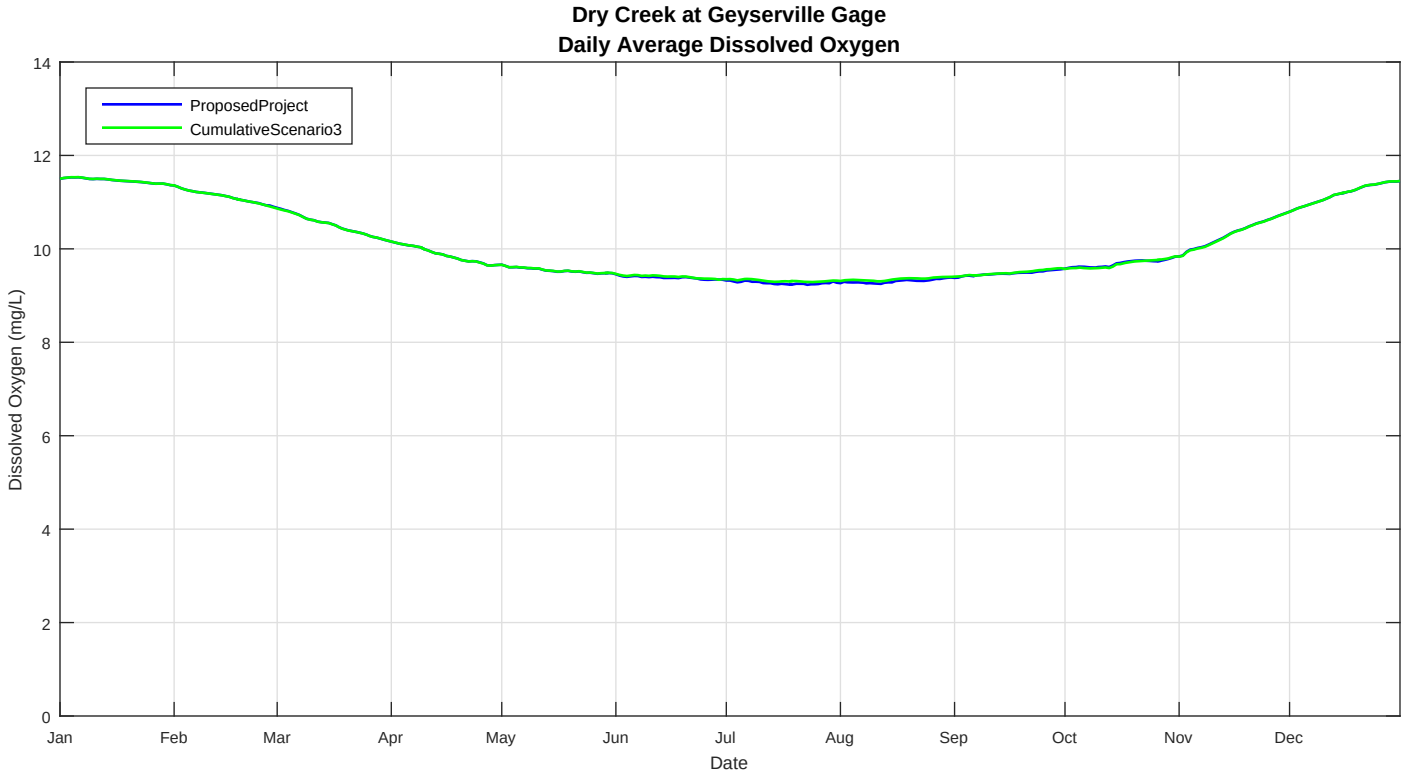

Geyserville Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

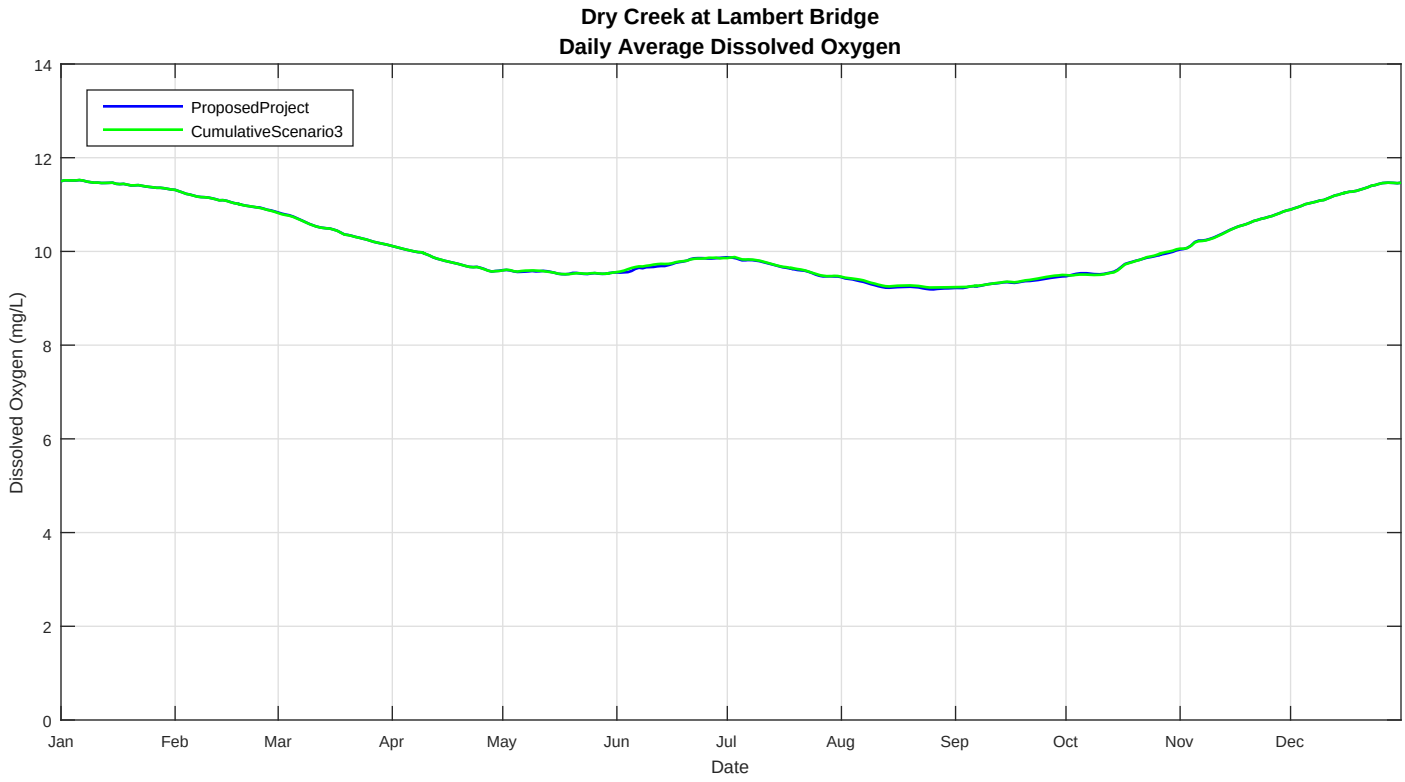

Healdsburg Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

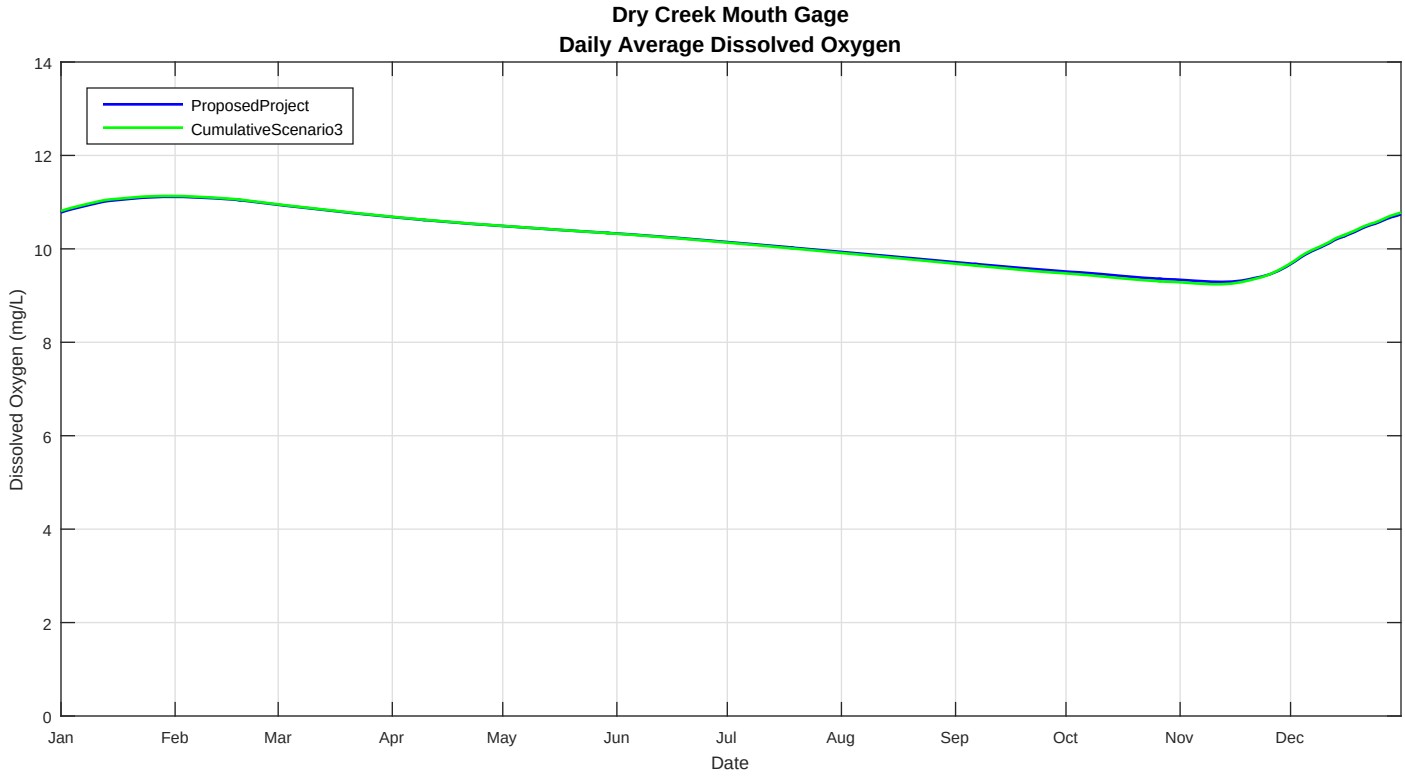

Russian River at Dry Creek
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

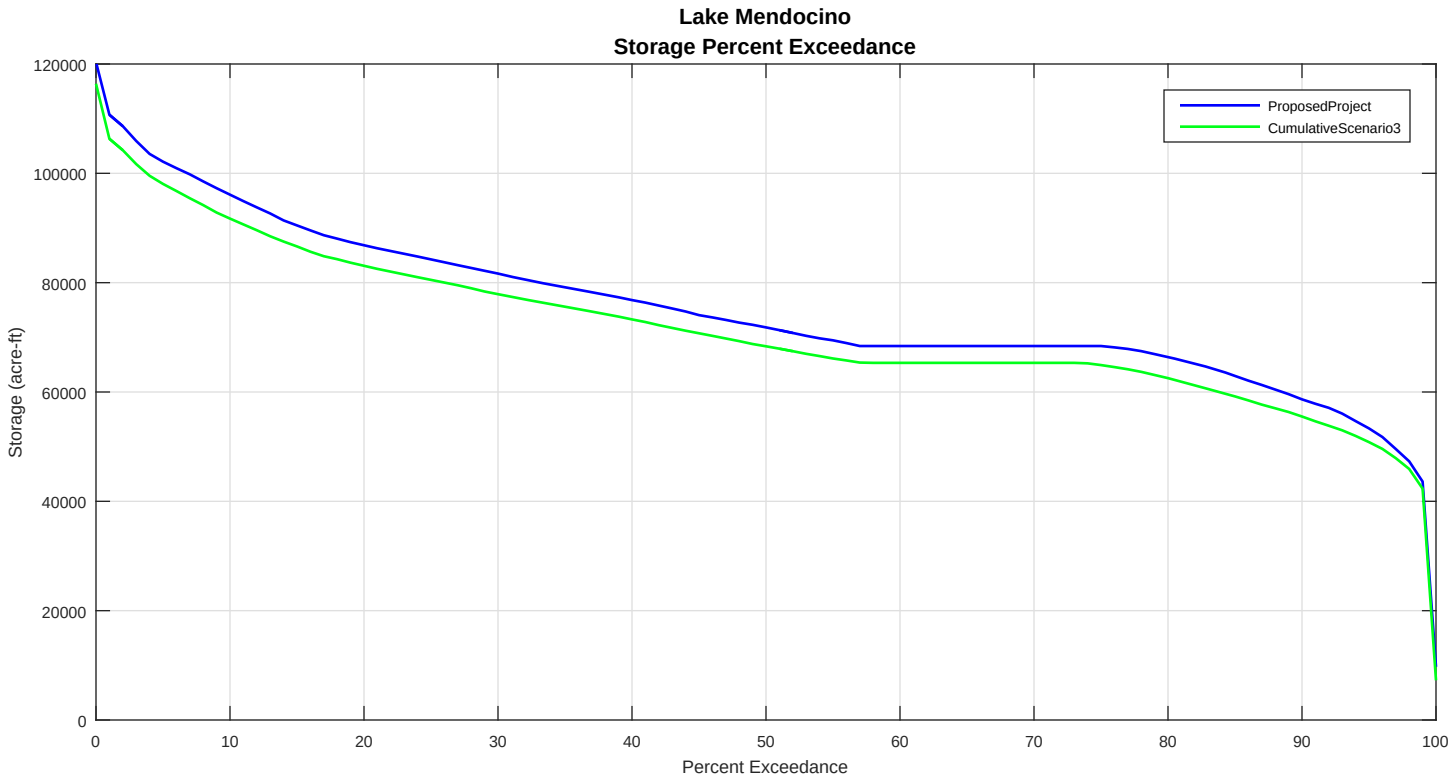

Hacienda Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

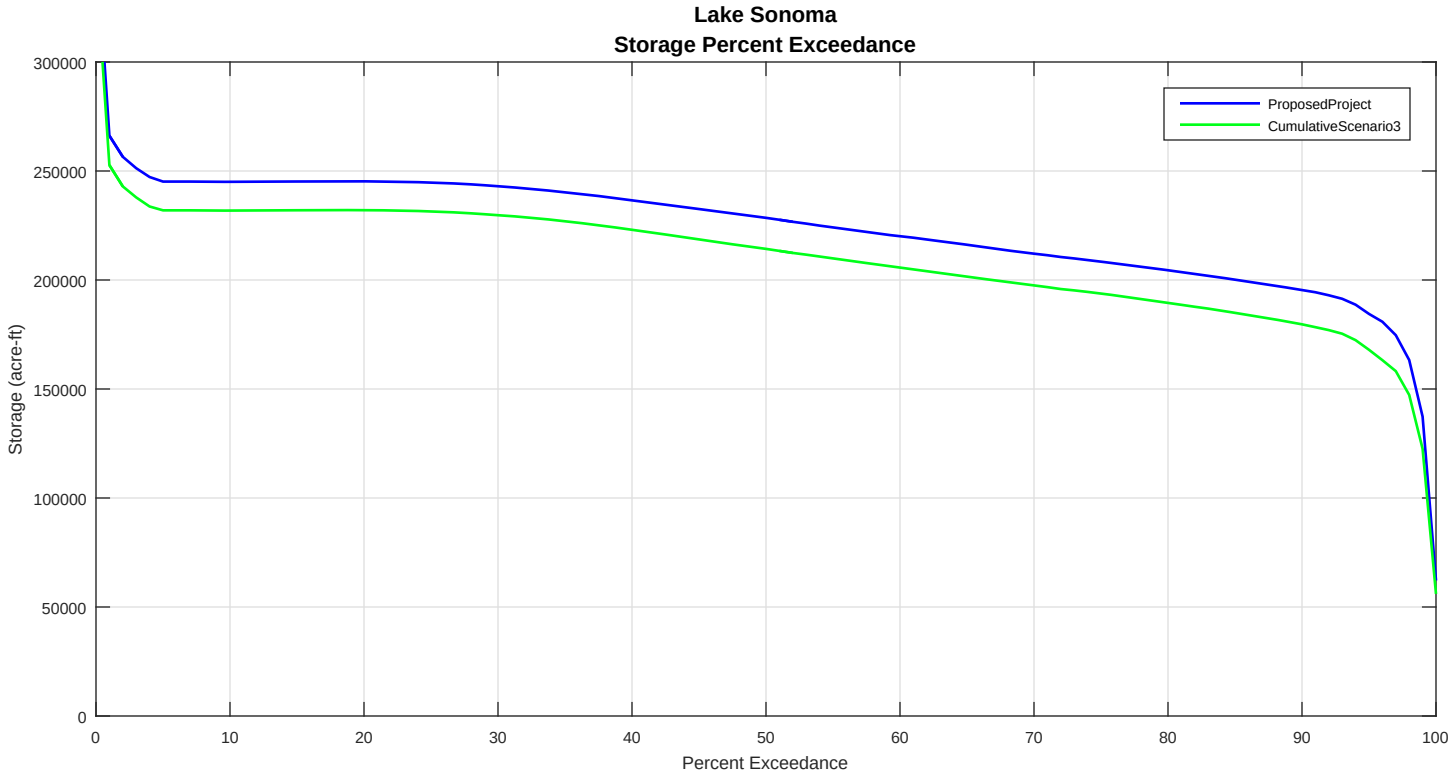

Warm Springs Dam Outlet
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

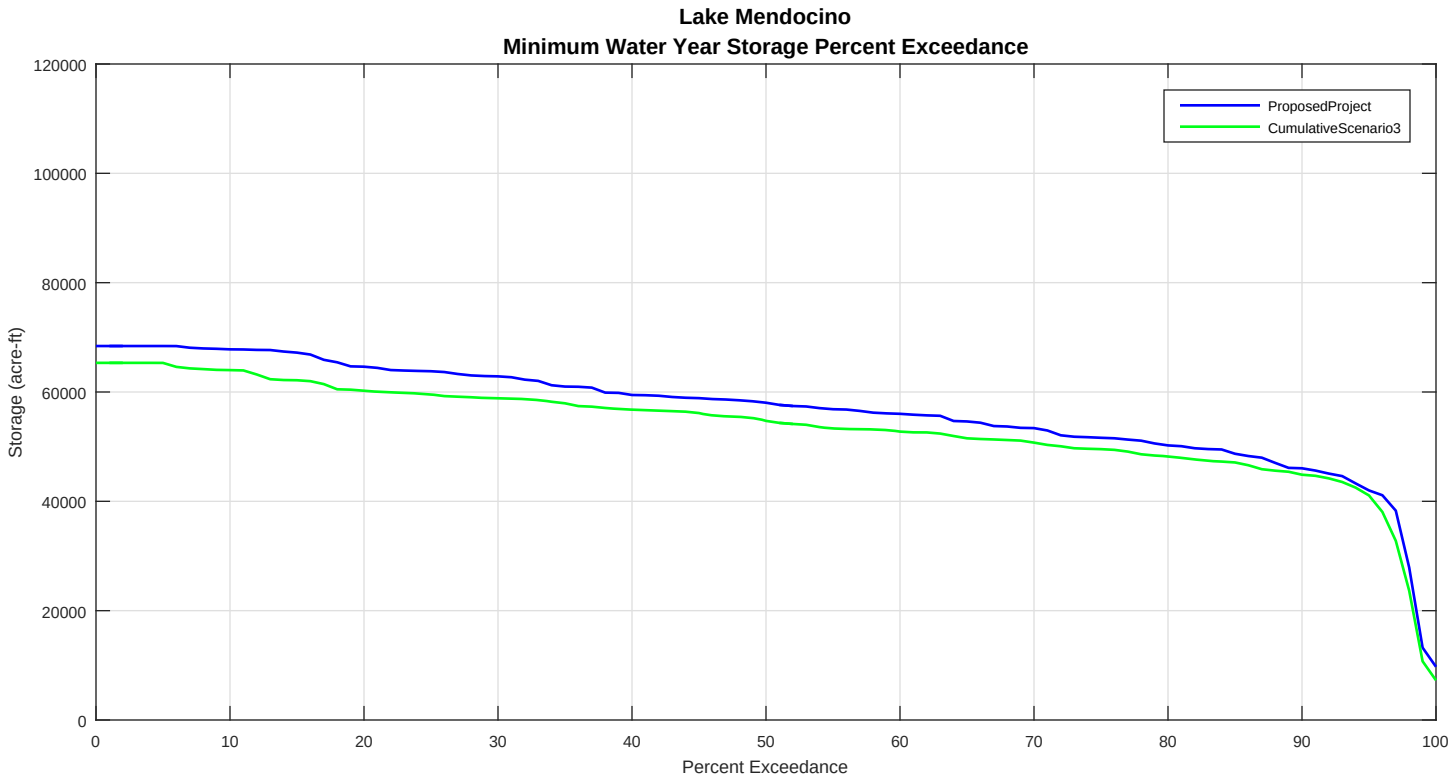

Dry Creek at Geyserville Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

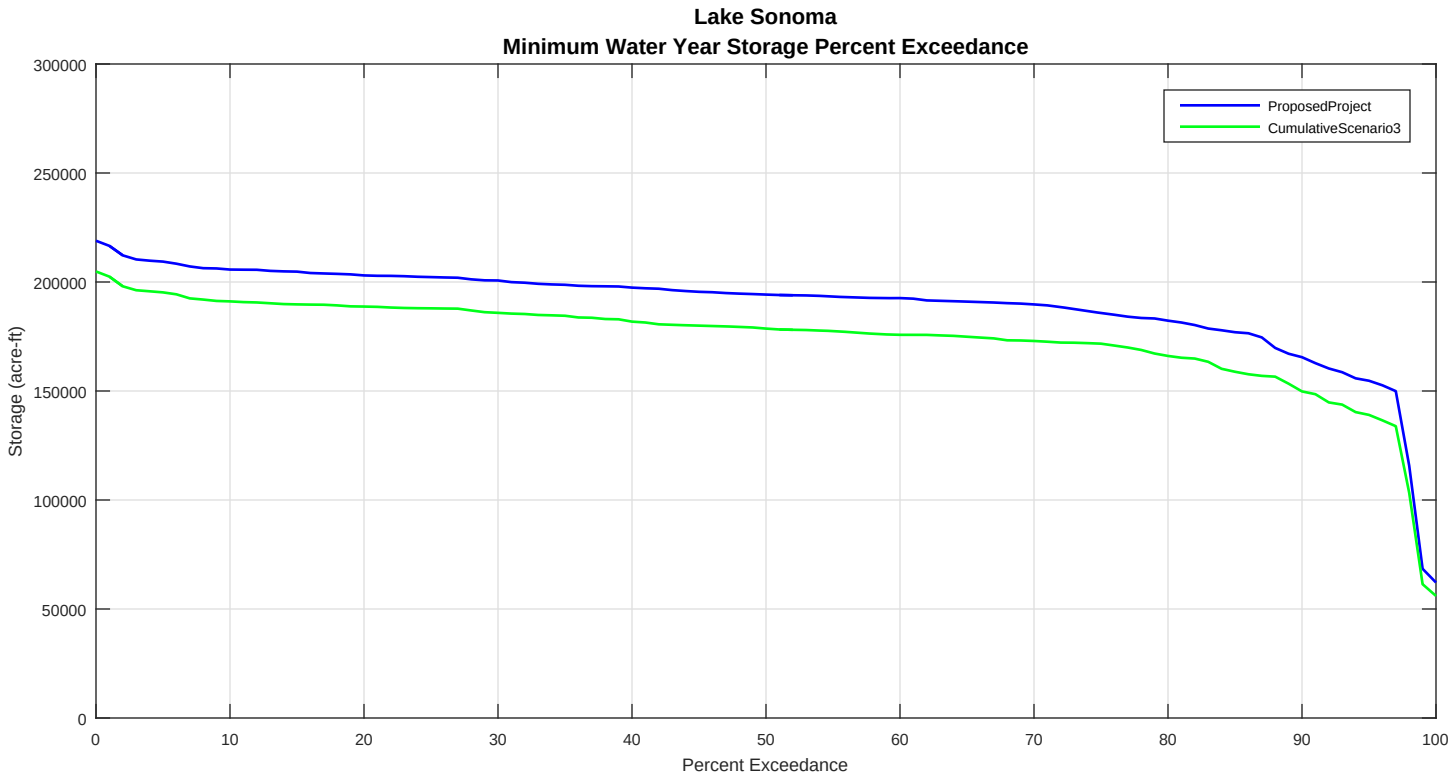

Dry Creek at Lambert Bridge
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

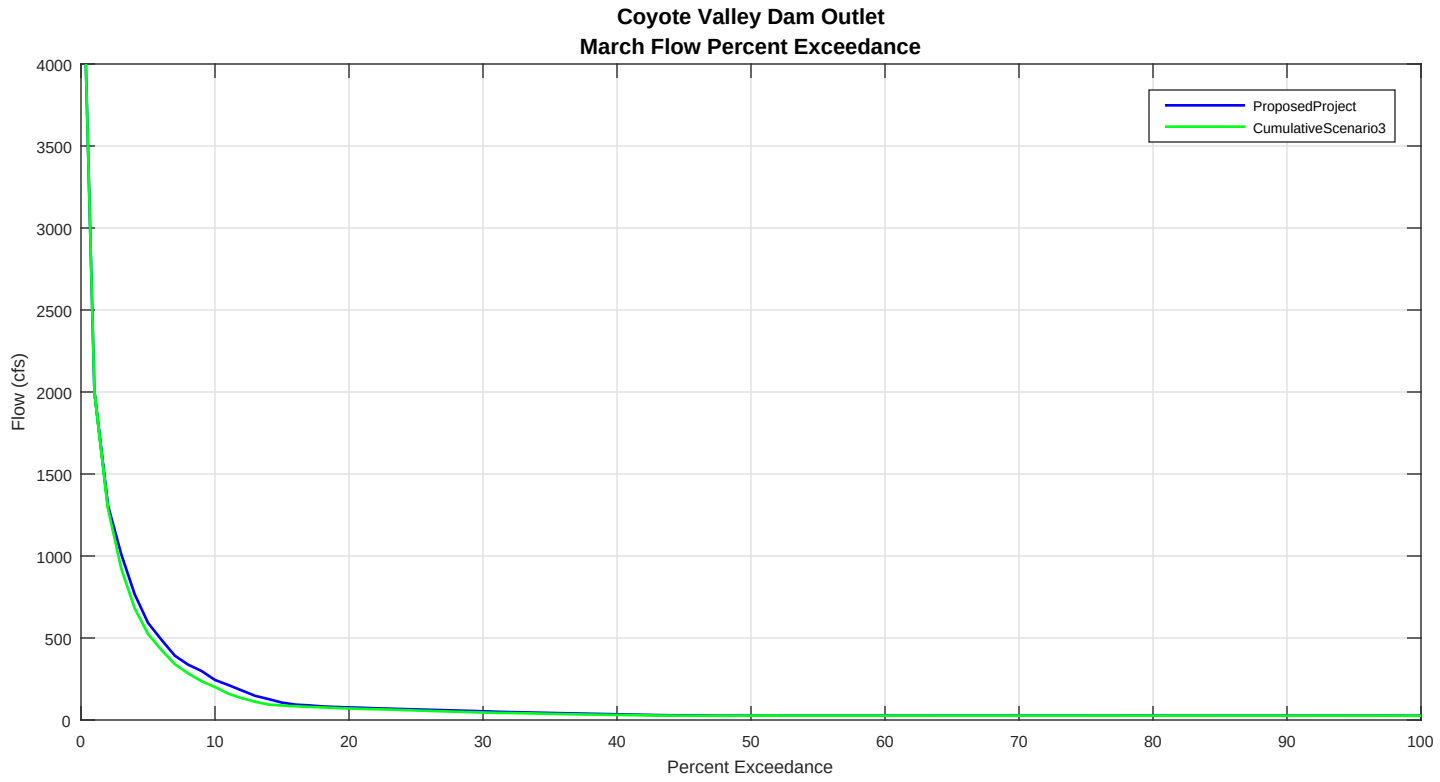

Dry Creek Mouth Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

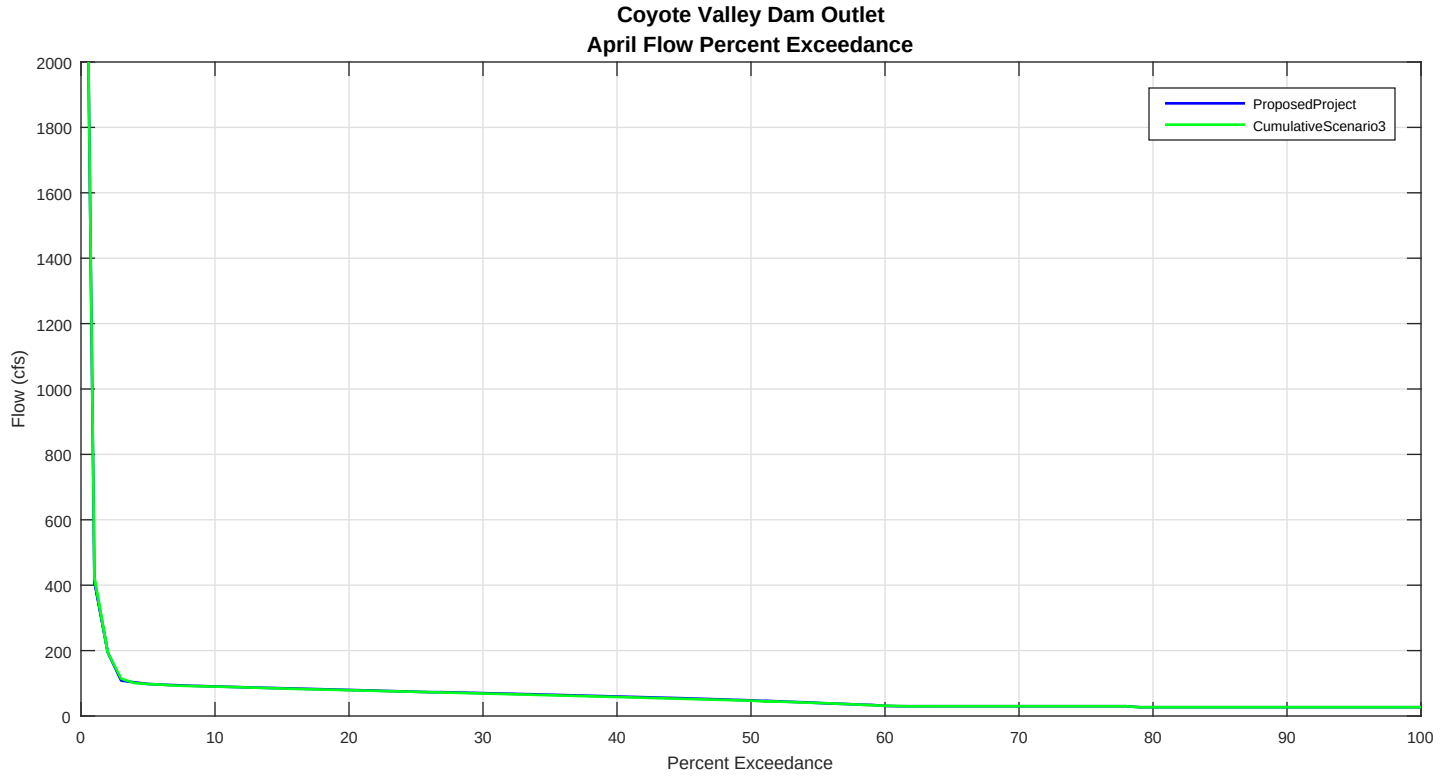

Lake Mendocino
Storage Percent Exceedance
ProposedProject
CumulativeScenario3
Storage (acre-ft)
Percent Exceedance
0
20000
40000
60000
80000
100000
120000
0
10
20
30
40
50
60
70
80
90
100


Lake Sonoma
Storage Percent Exceedance
ProposedProject
CumulativeScenario3
Storage (acre-ft)
Percent Exceedance
0
50000
100000
150000
200000
250000
300000
0
10
20
30
40
50
60
70
80
90
100


Lake Mendocino
Minimum Water Year Storage Percent Exceedance
ProposedProject
CumulativeScenario3
Storage (acre-ft)
Percent Exceedance
0
20000
40000
60000
80000
100000
120000
0
10
20
30
40
50
60
70
80
90
100


Lake Sonoma
Minimum Water Year Storage Percent Exceedance
ProposedProject
CumulativeScenario3
Storage (acre-ft)
Percent Exceedance
0
50000
100000
150000
200000
250000
300000
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
March Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
0
500
1000
1500
2000
2500
3000
3500
4000
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
April Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
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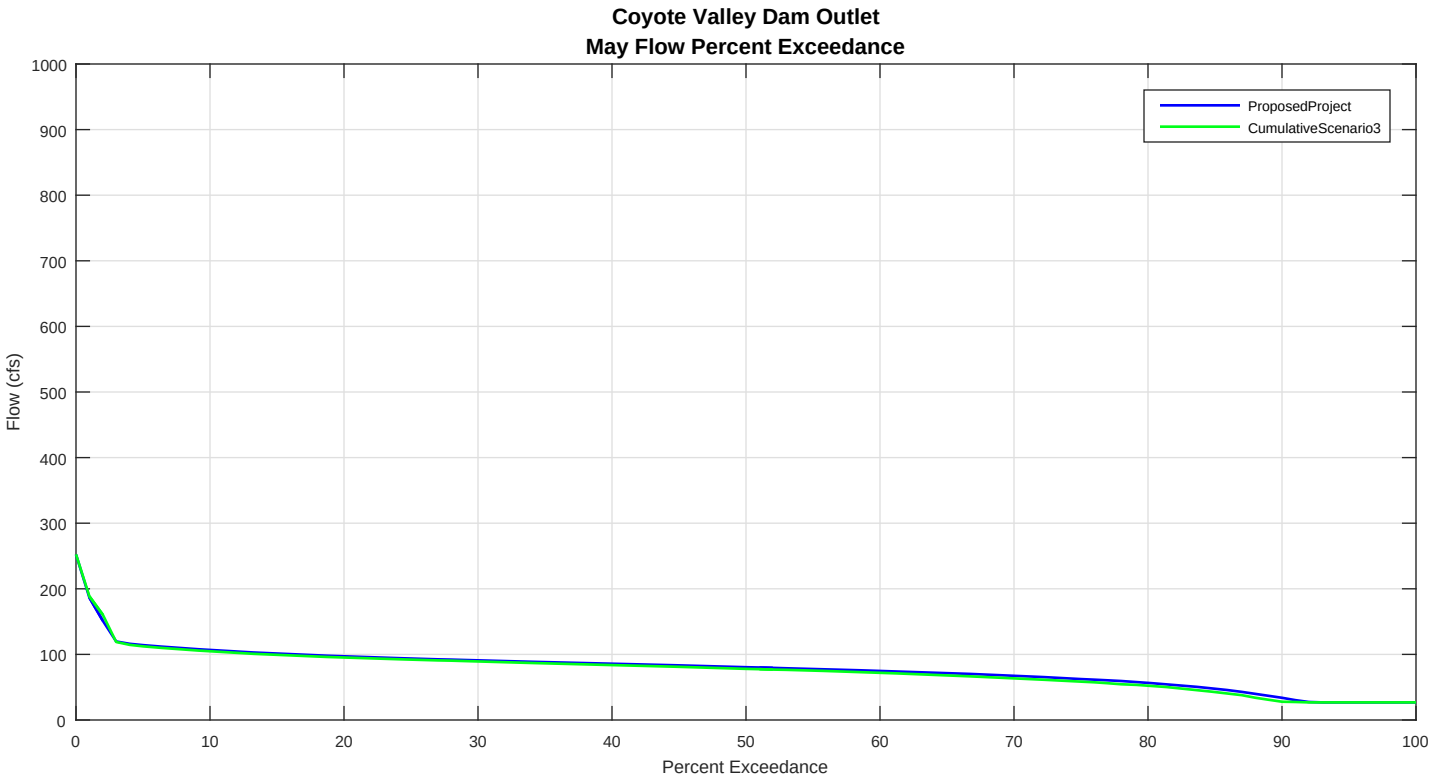
Coyote Valley Dam Outlet
May Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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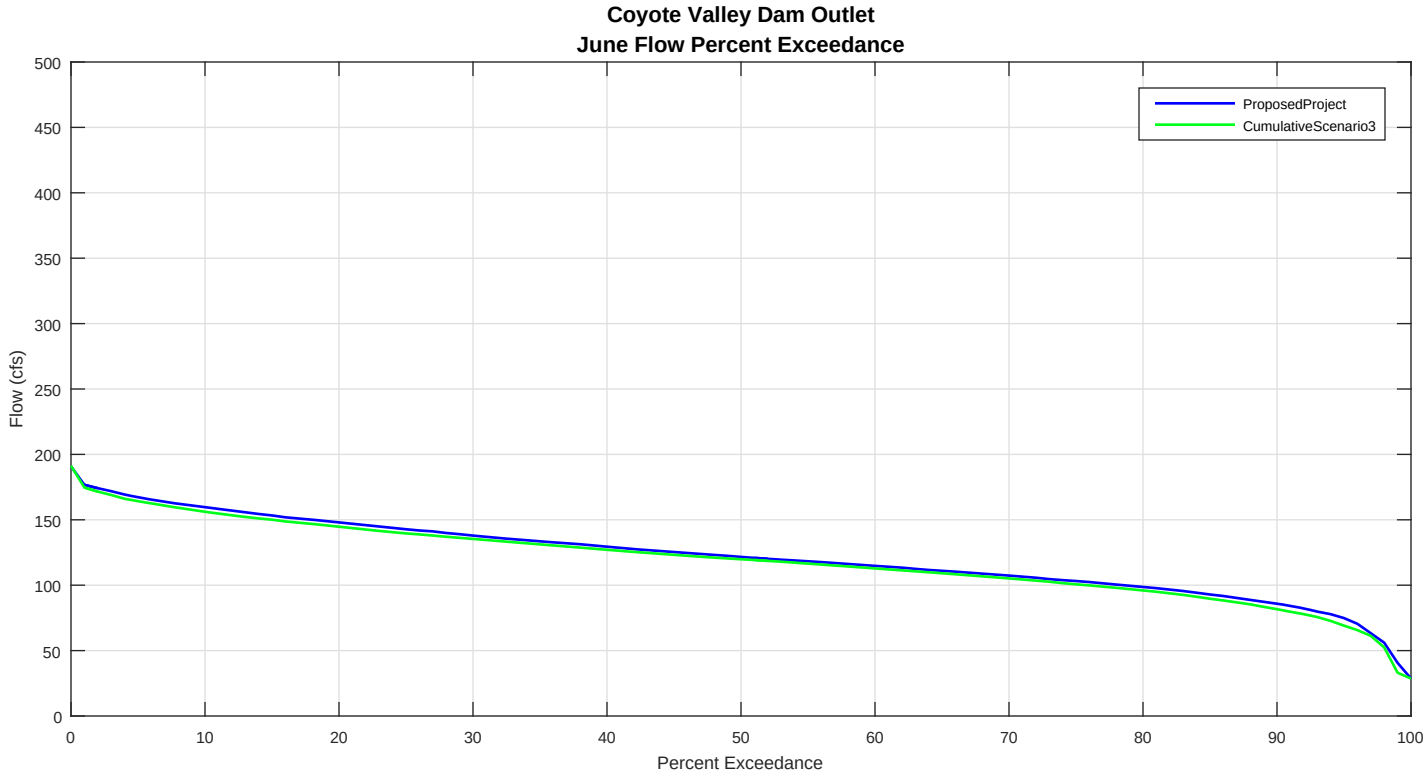
Coyote Valley Dam Outlet
June Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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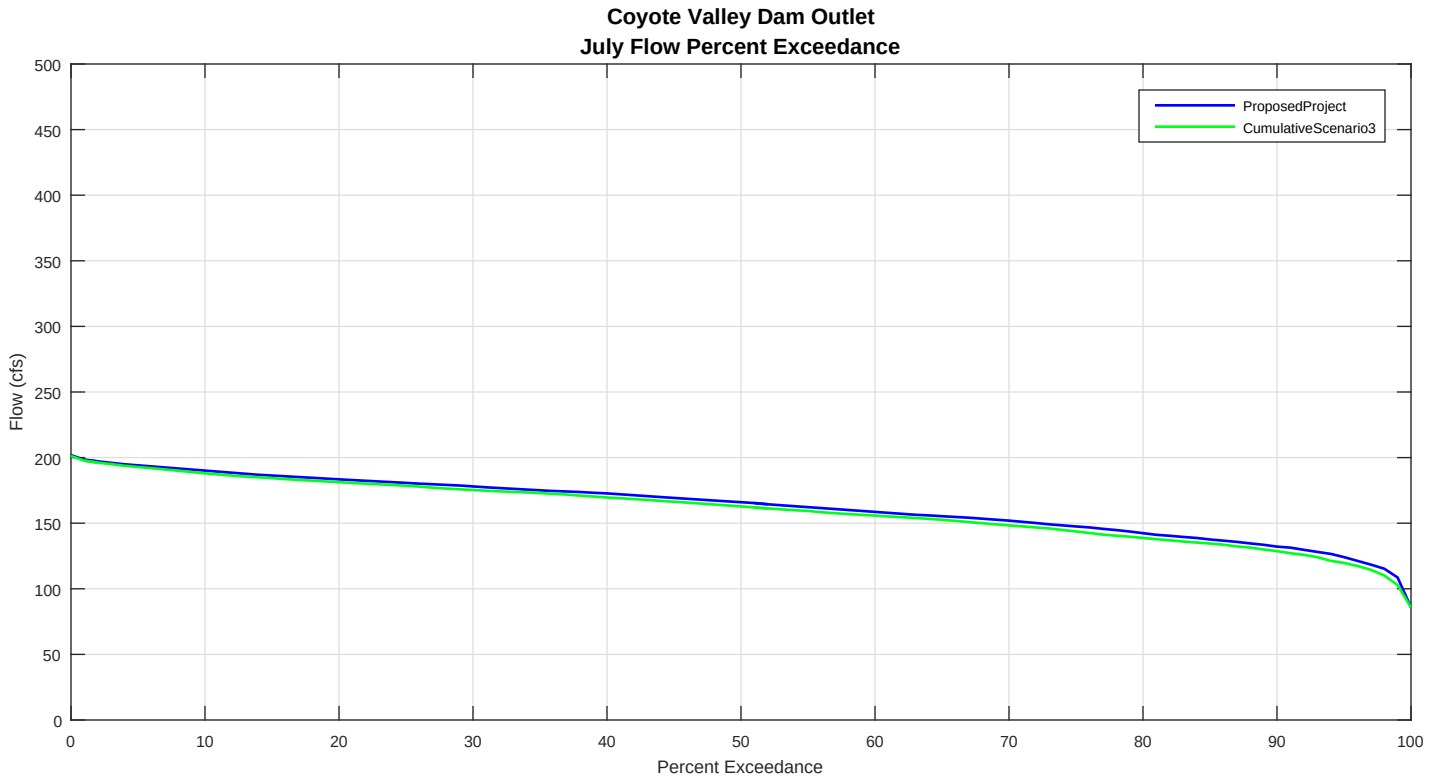
Coyote Valley Dam Outlet
July Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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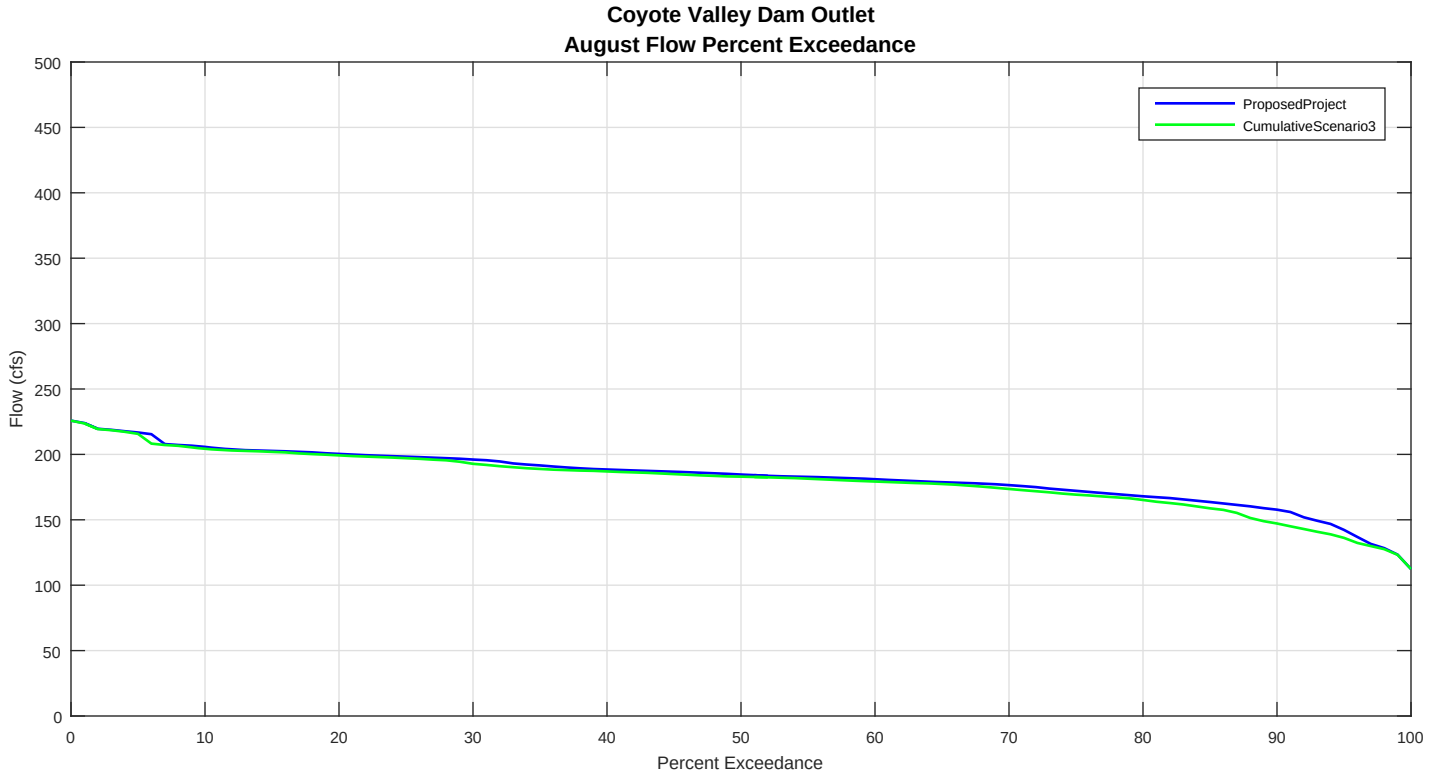
Coyote Valley Dam Outlet
August Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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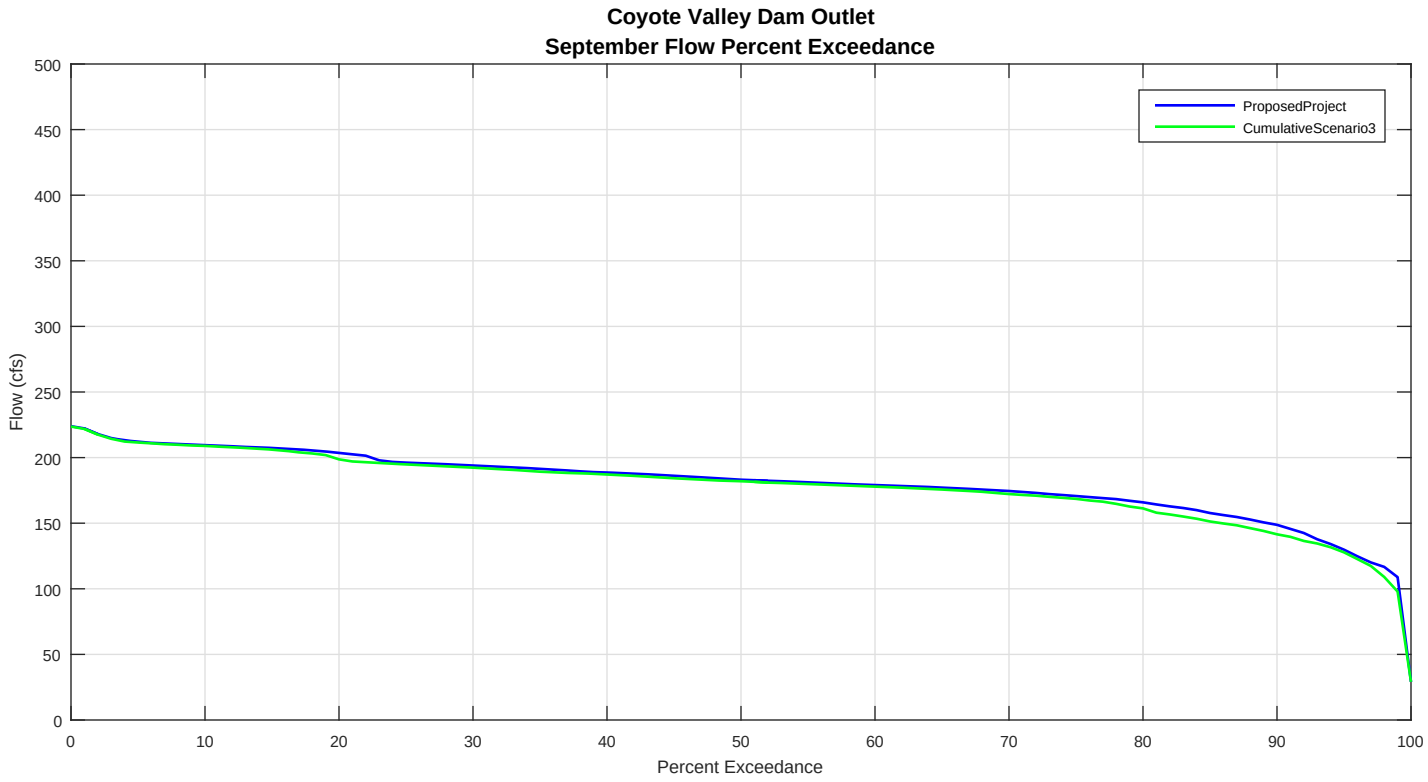
Coyote Valley Dam Outlet
September Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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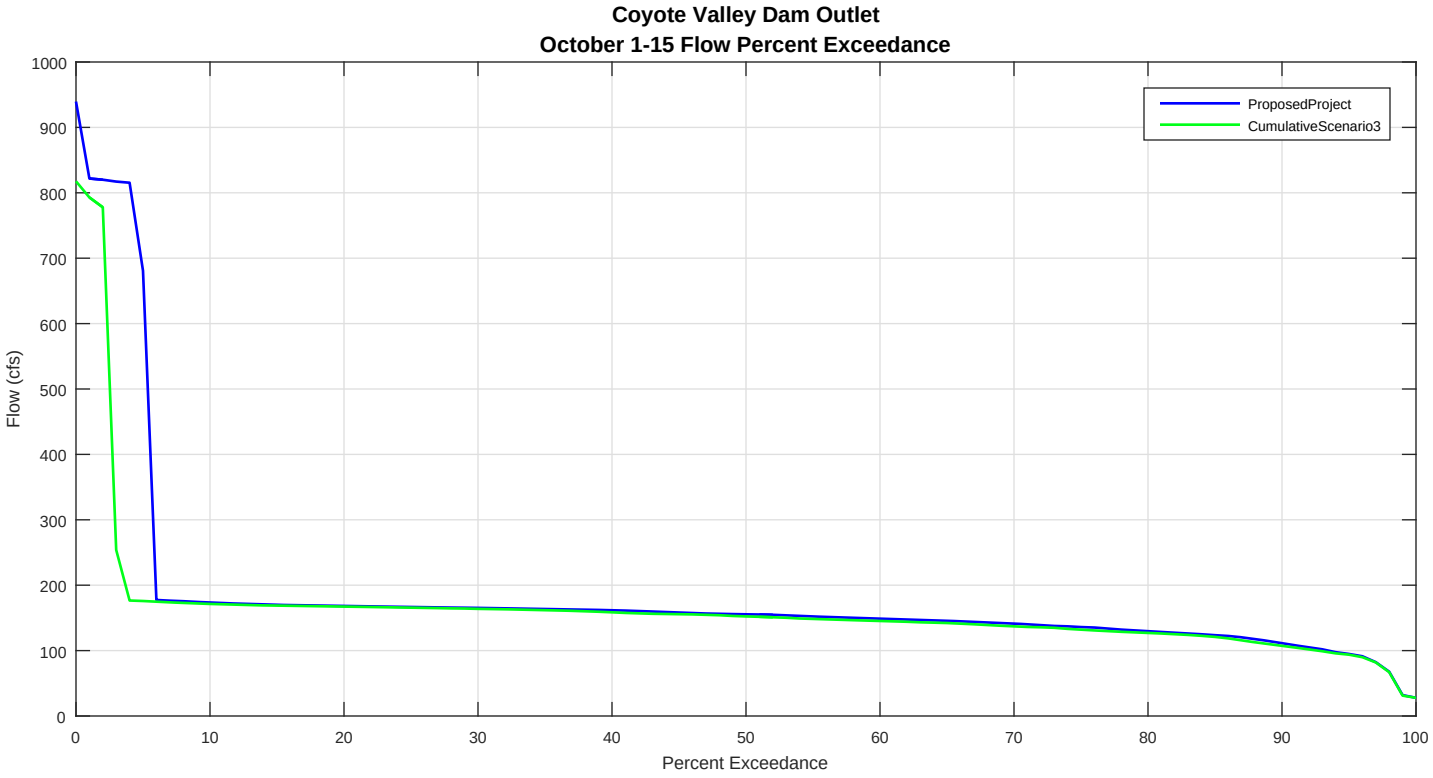
Coyote Valley Dam Outlet
October 1-15 Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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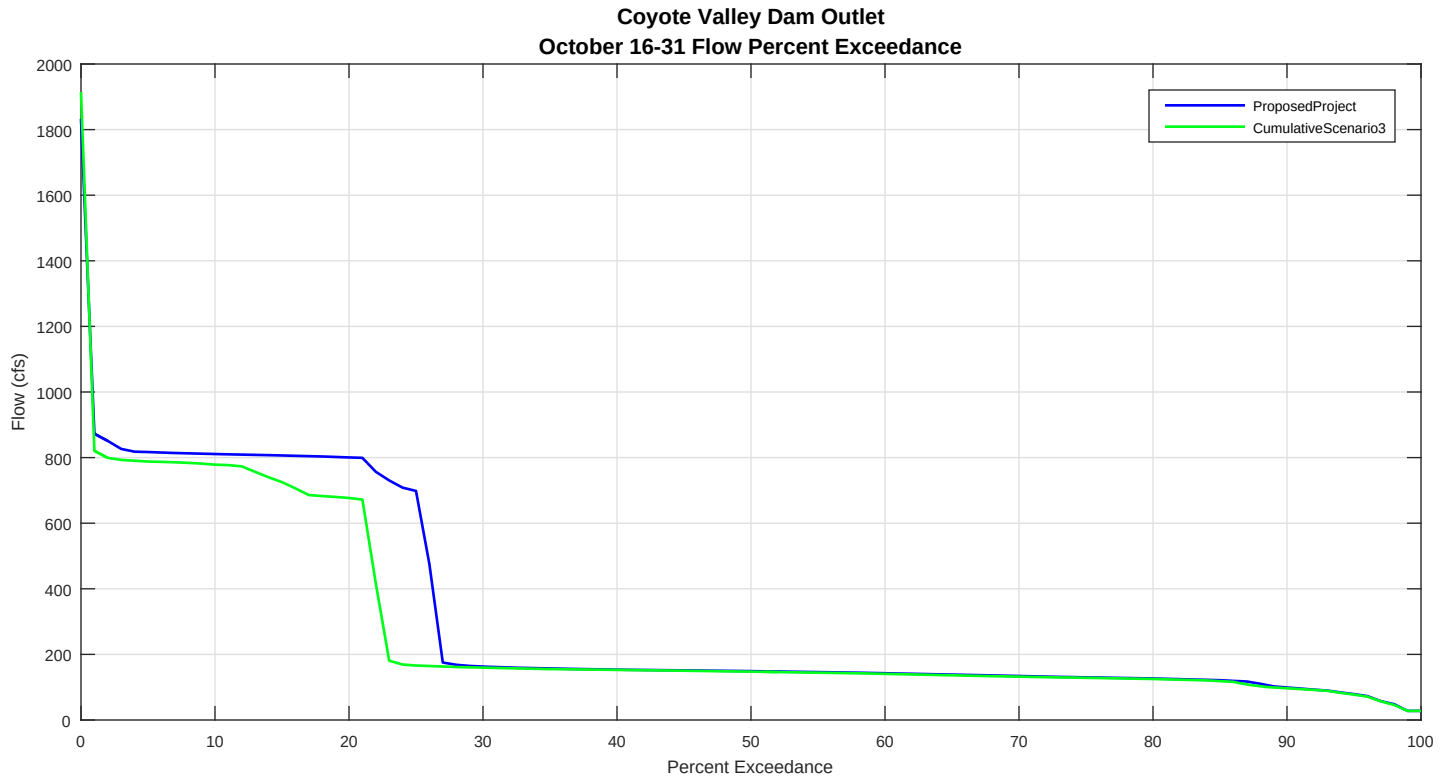
Coyote Valley Dam Outlet
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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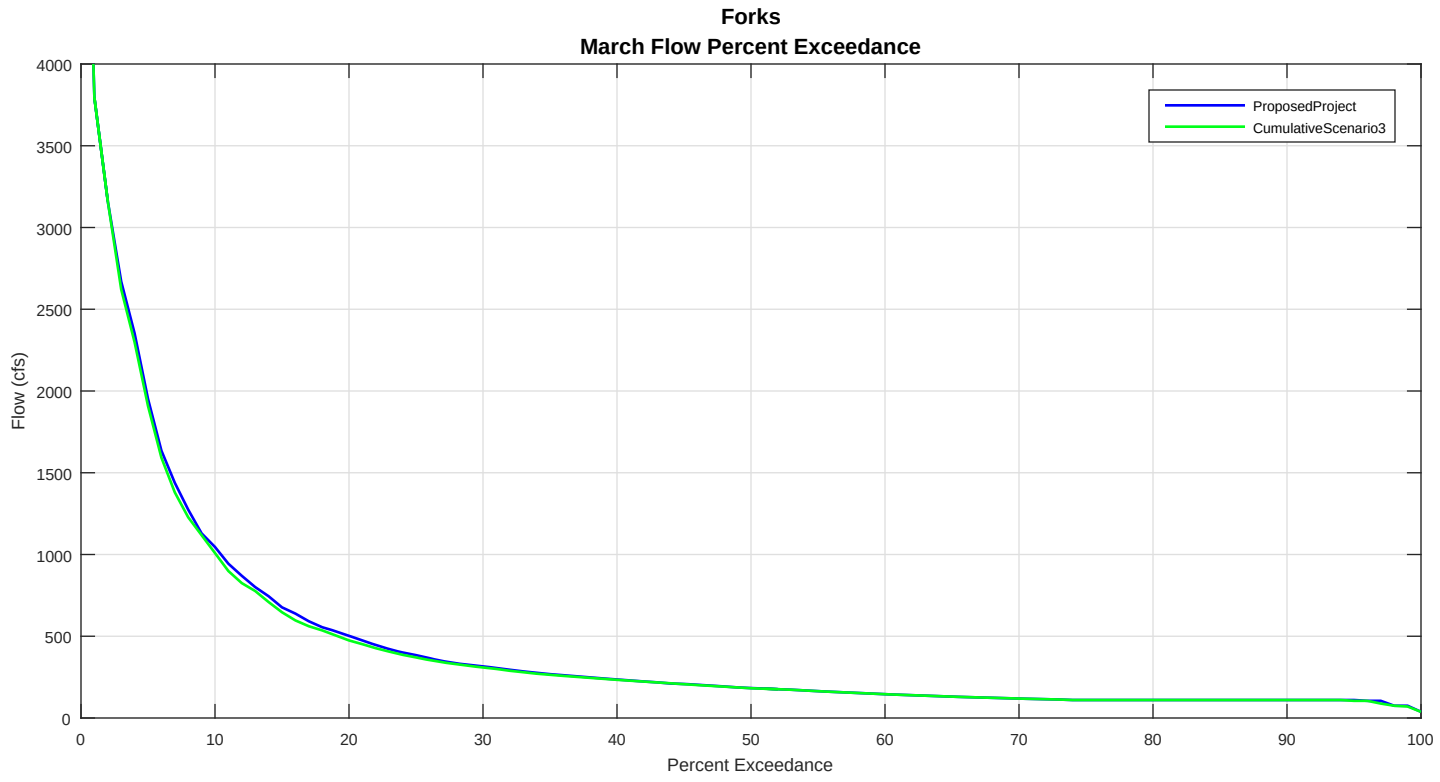
Forks
March Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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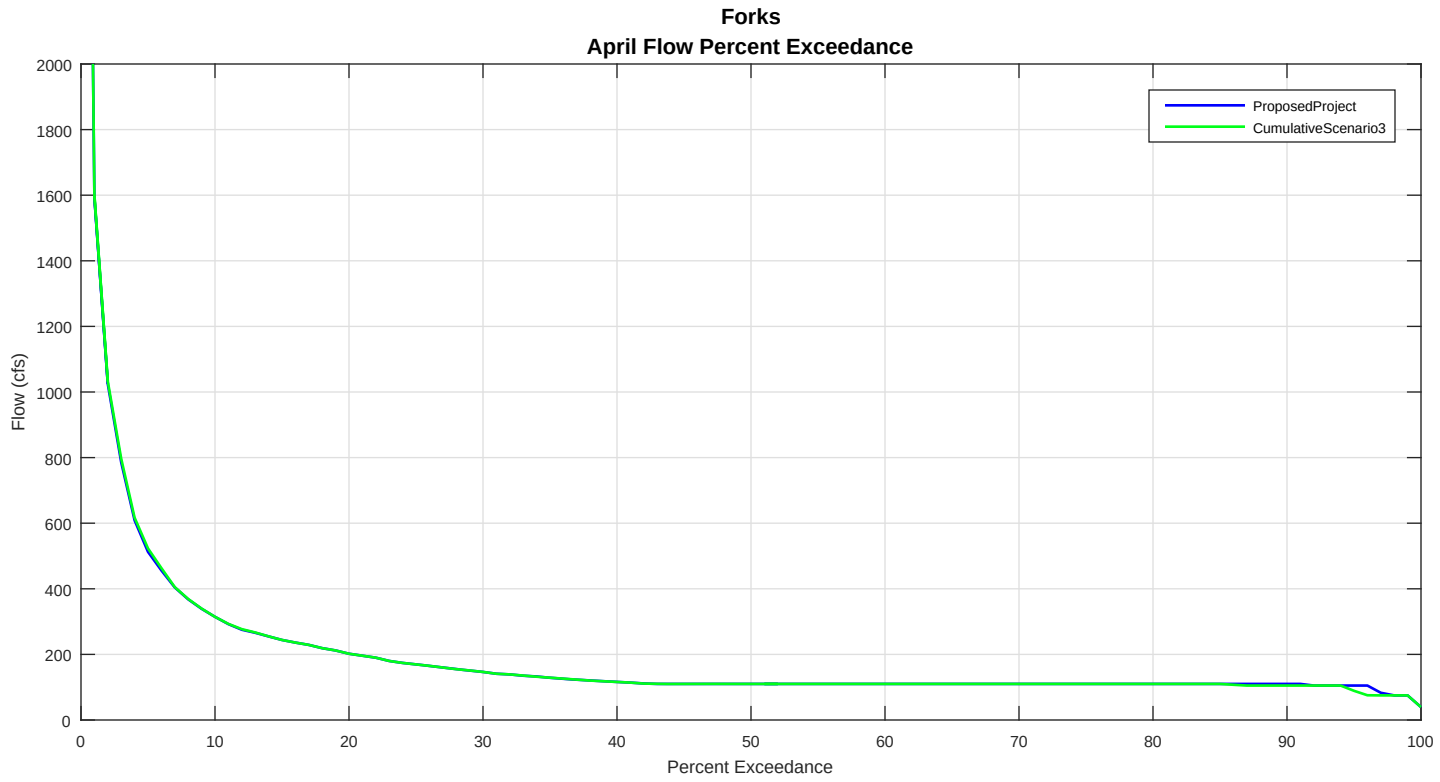
Forks
April Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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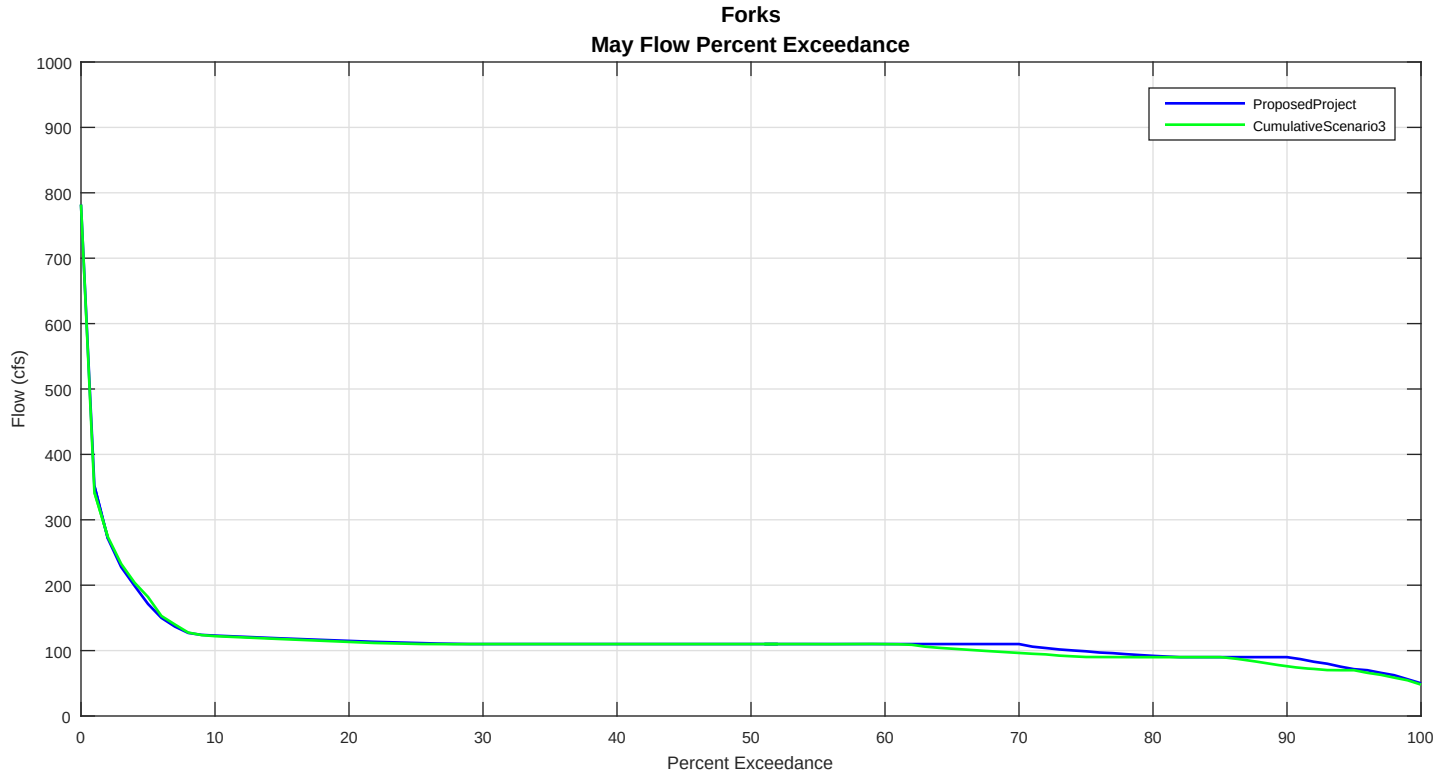
Forks
May Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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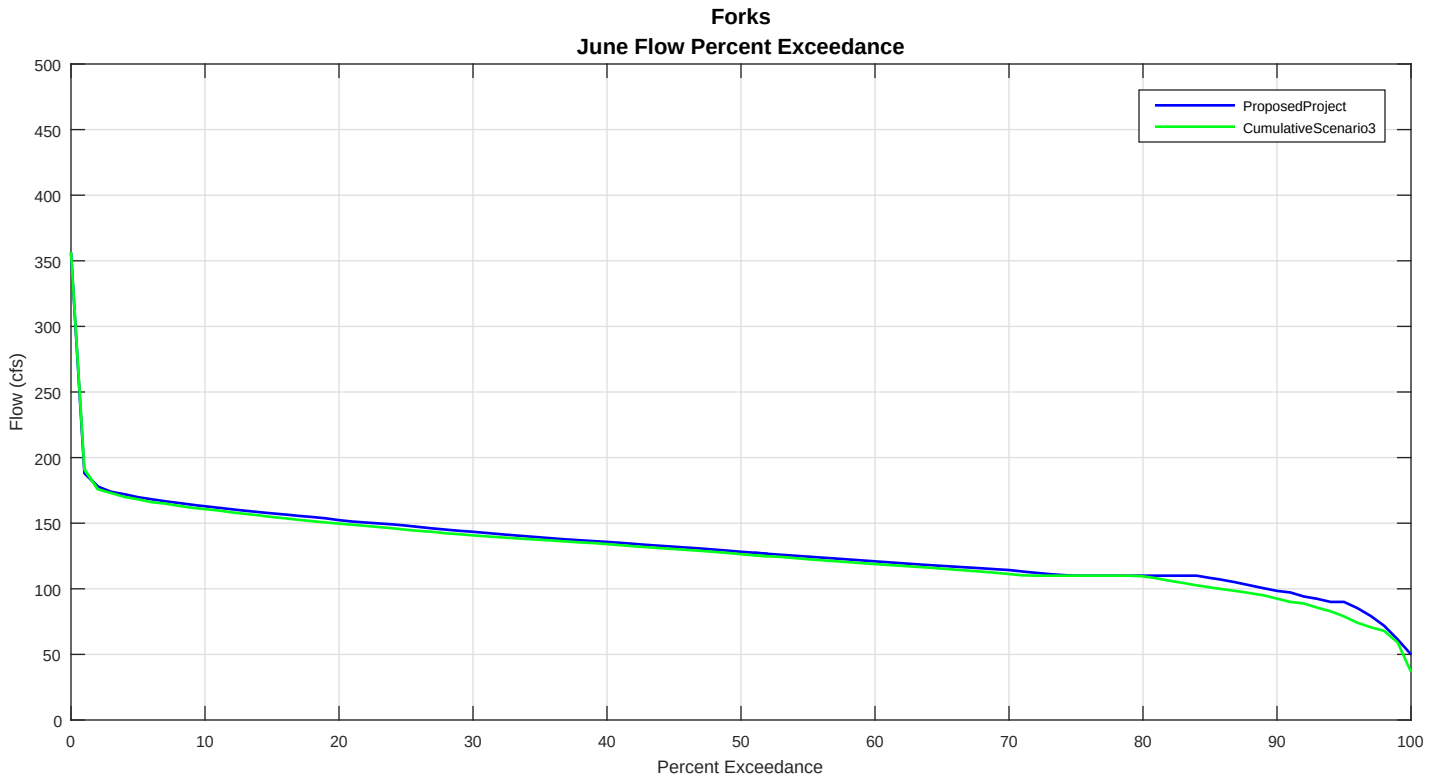
Forks
June Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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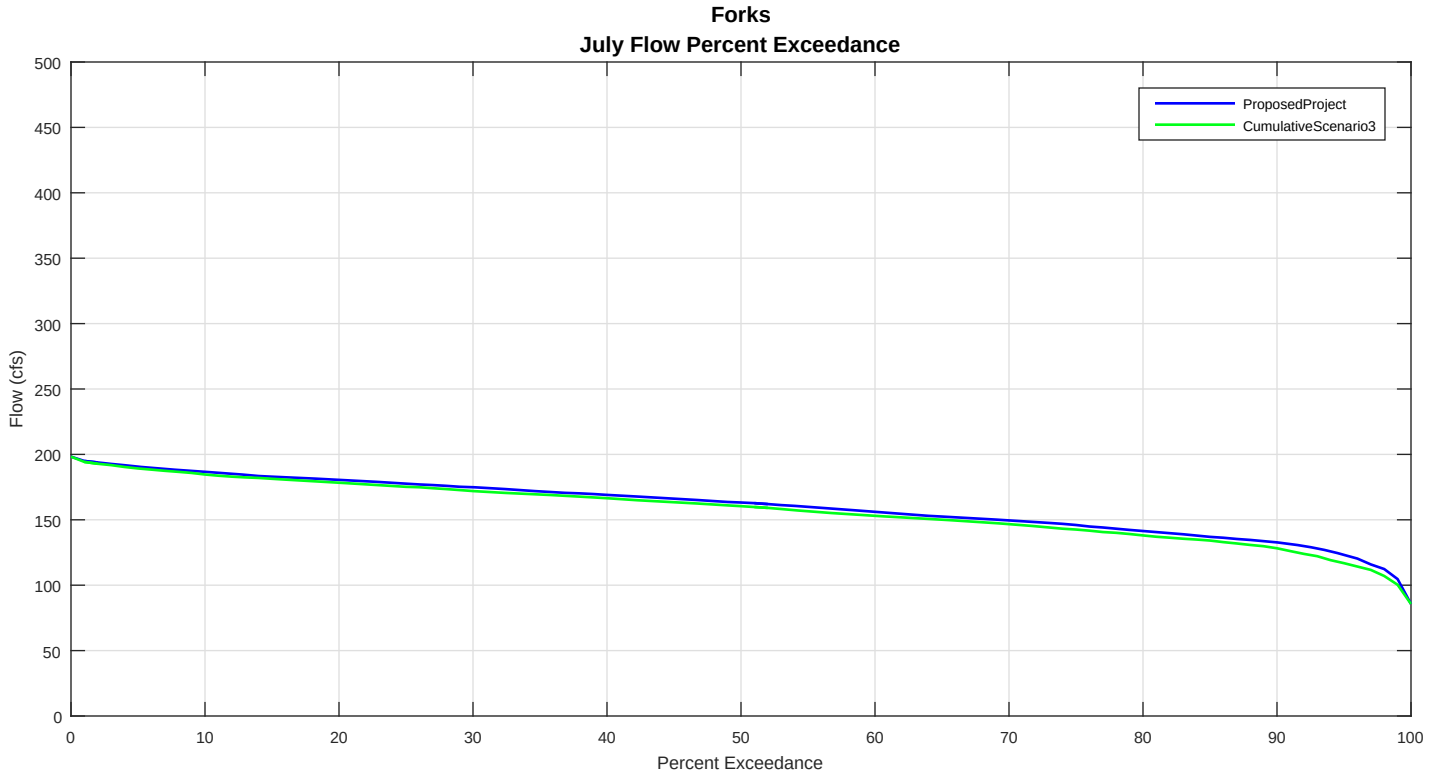
Forks
July Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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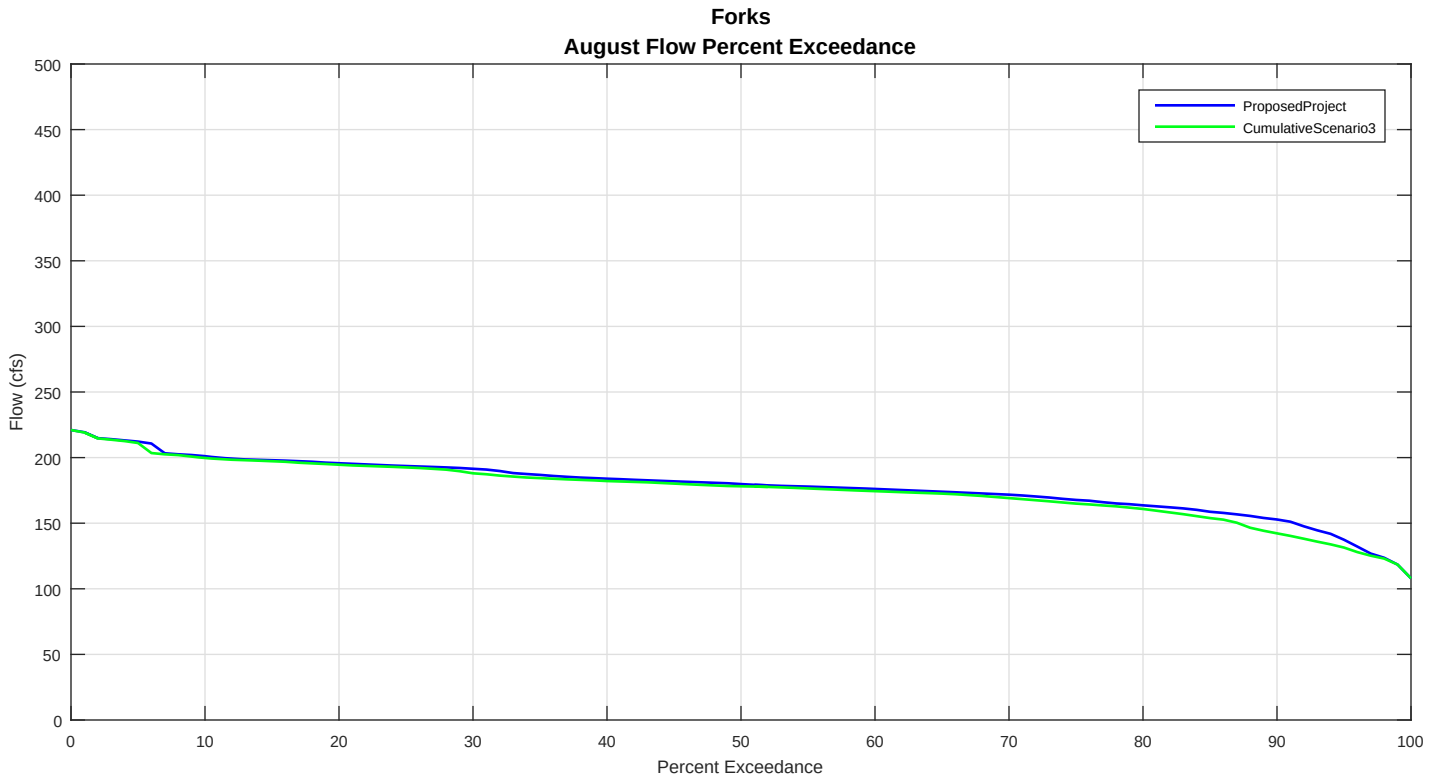
Forks
August Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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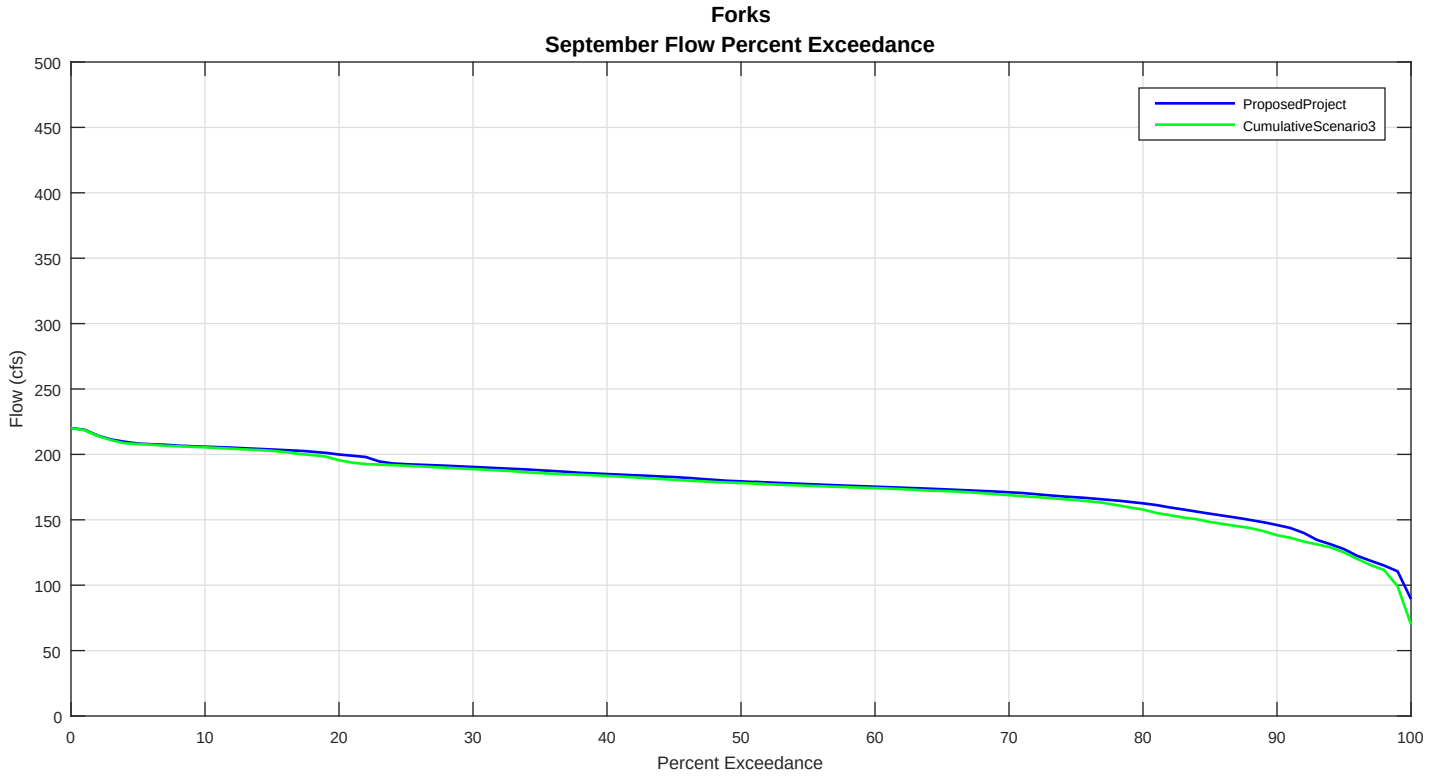
Forks
September Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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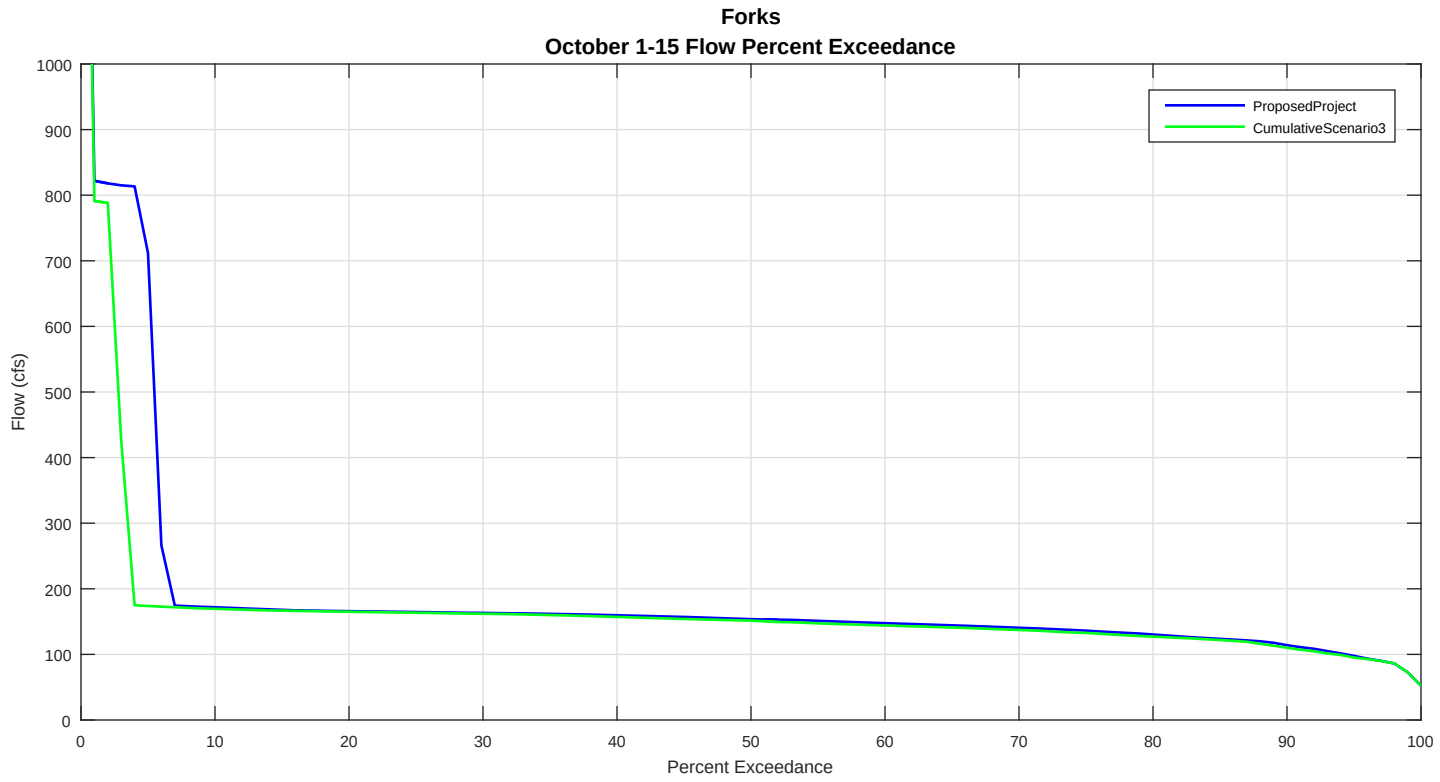
Forks
October 1-15 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario3
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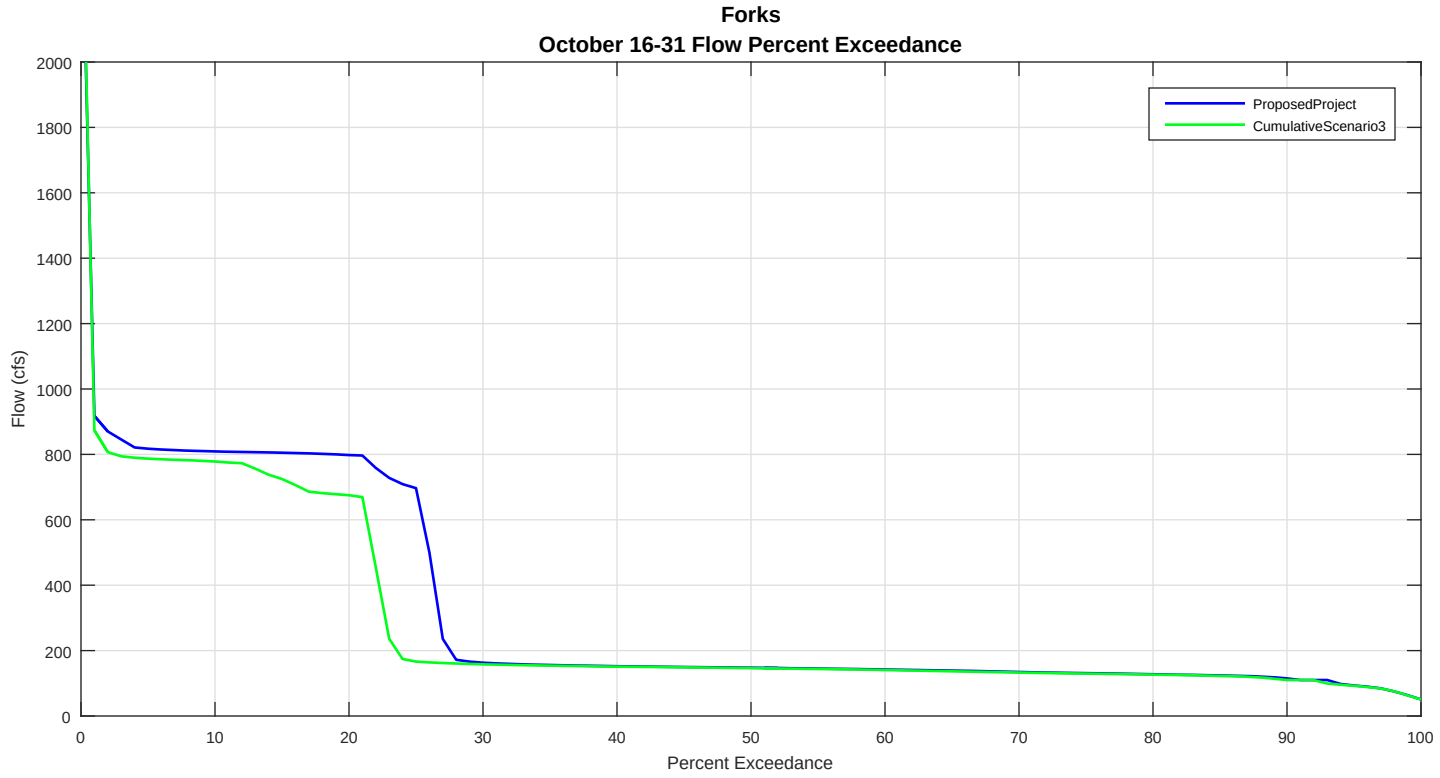
Forks
October 16-31 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario3
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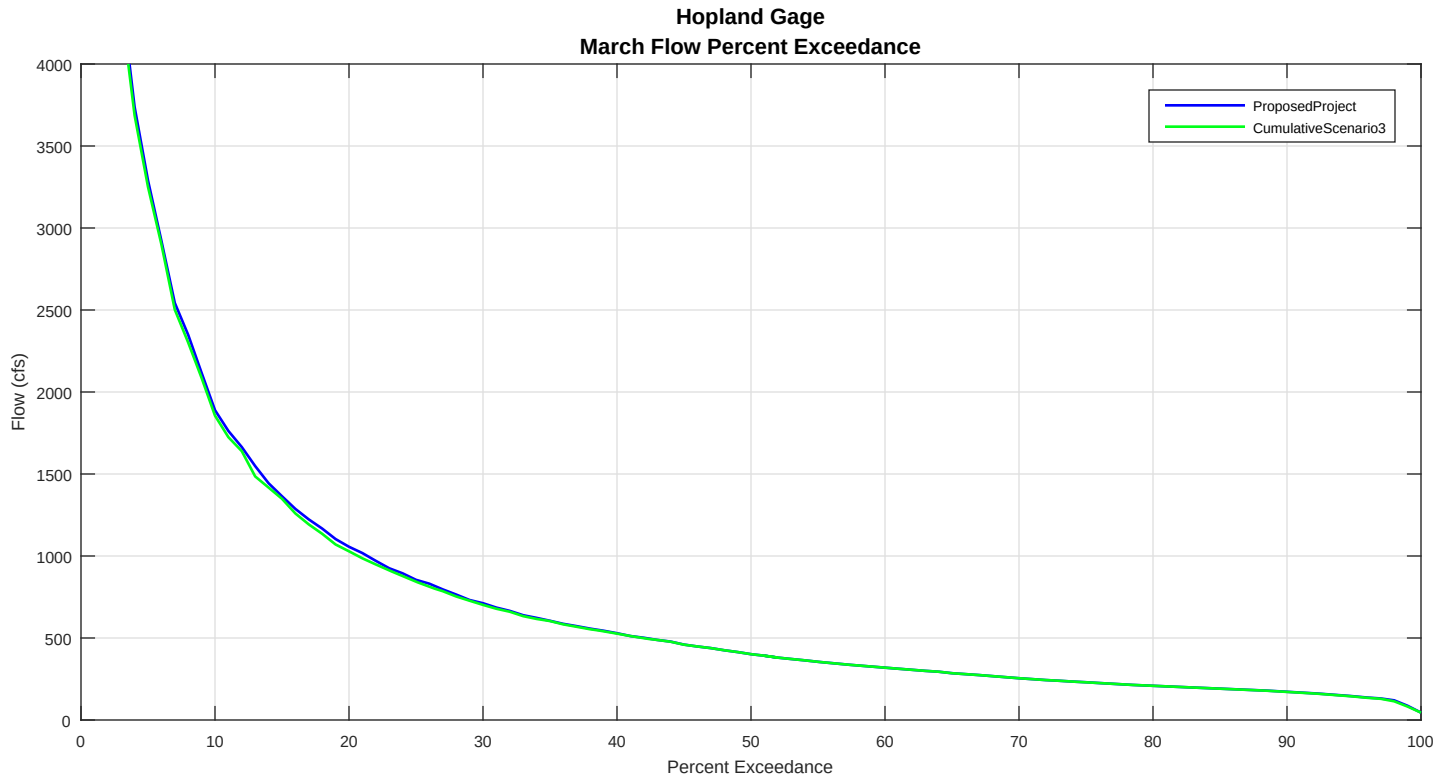
Hopland Gage
March Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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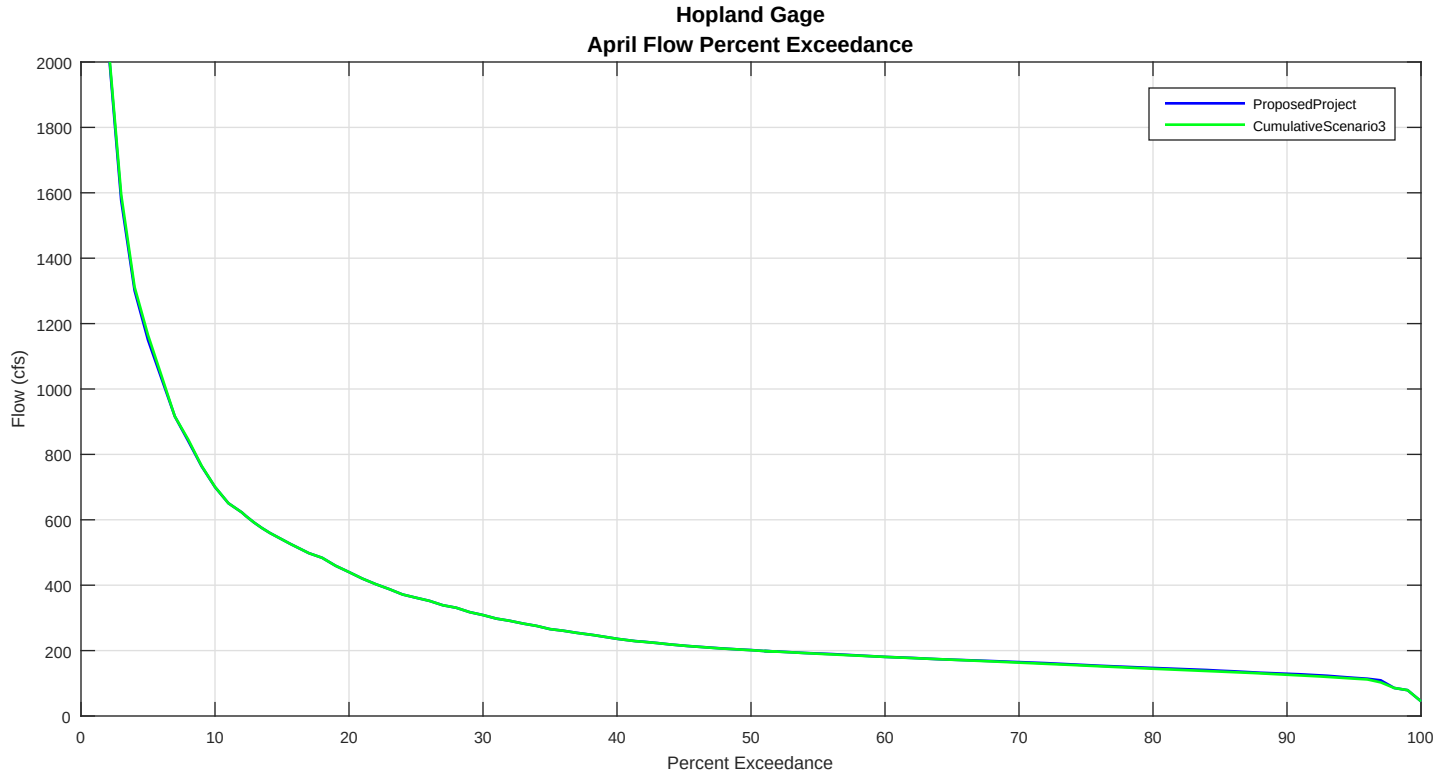
Hopland Gage
April Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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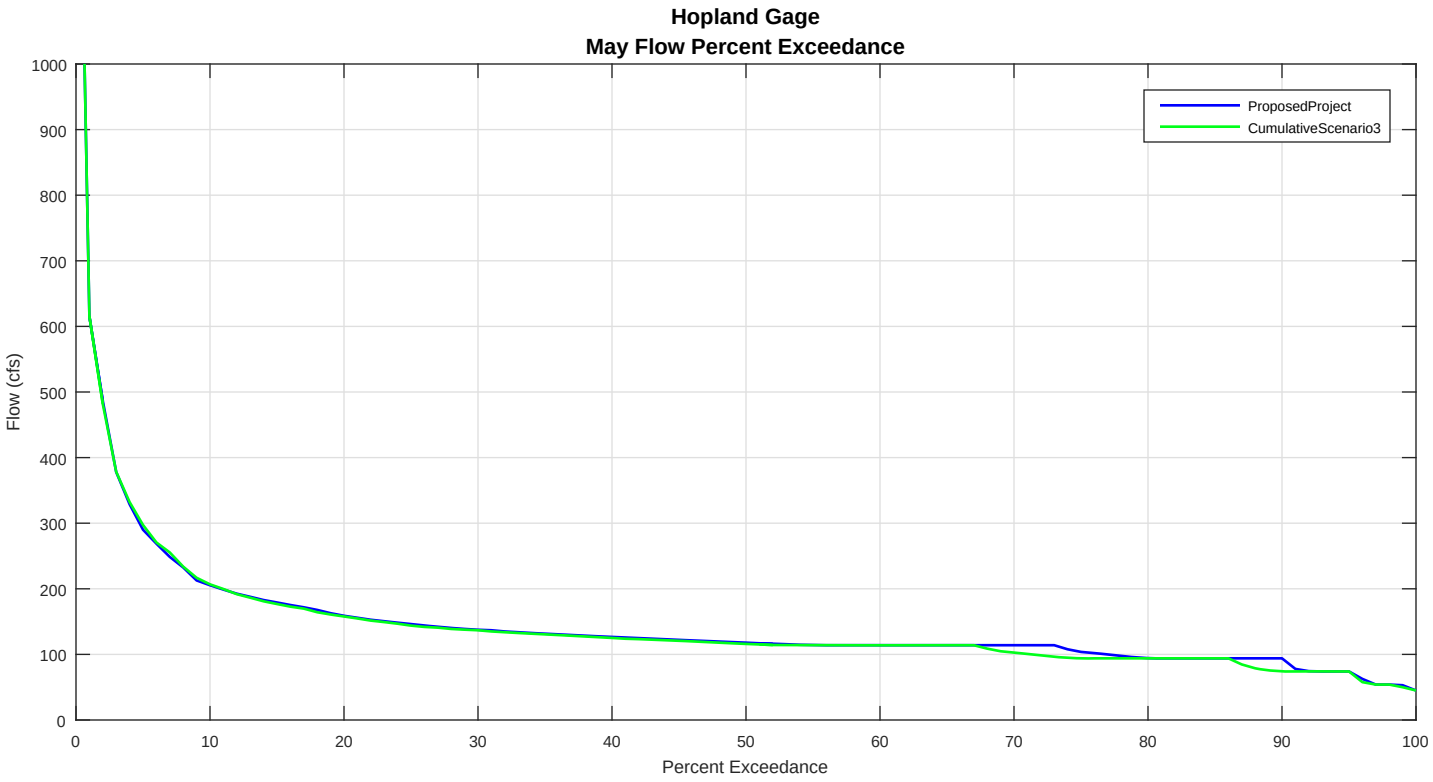
Hopland Gage
May Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
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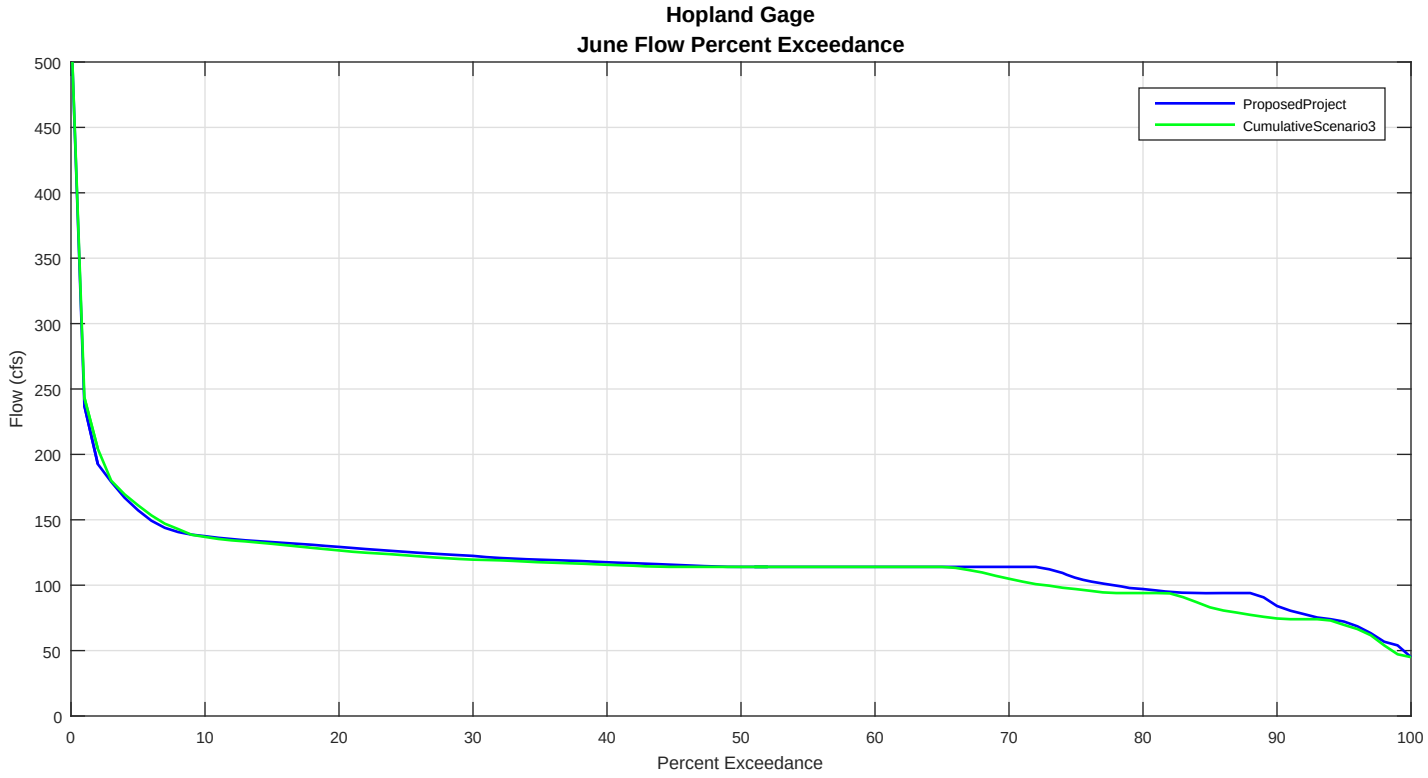
Hopland Gage
June Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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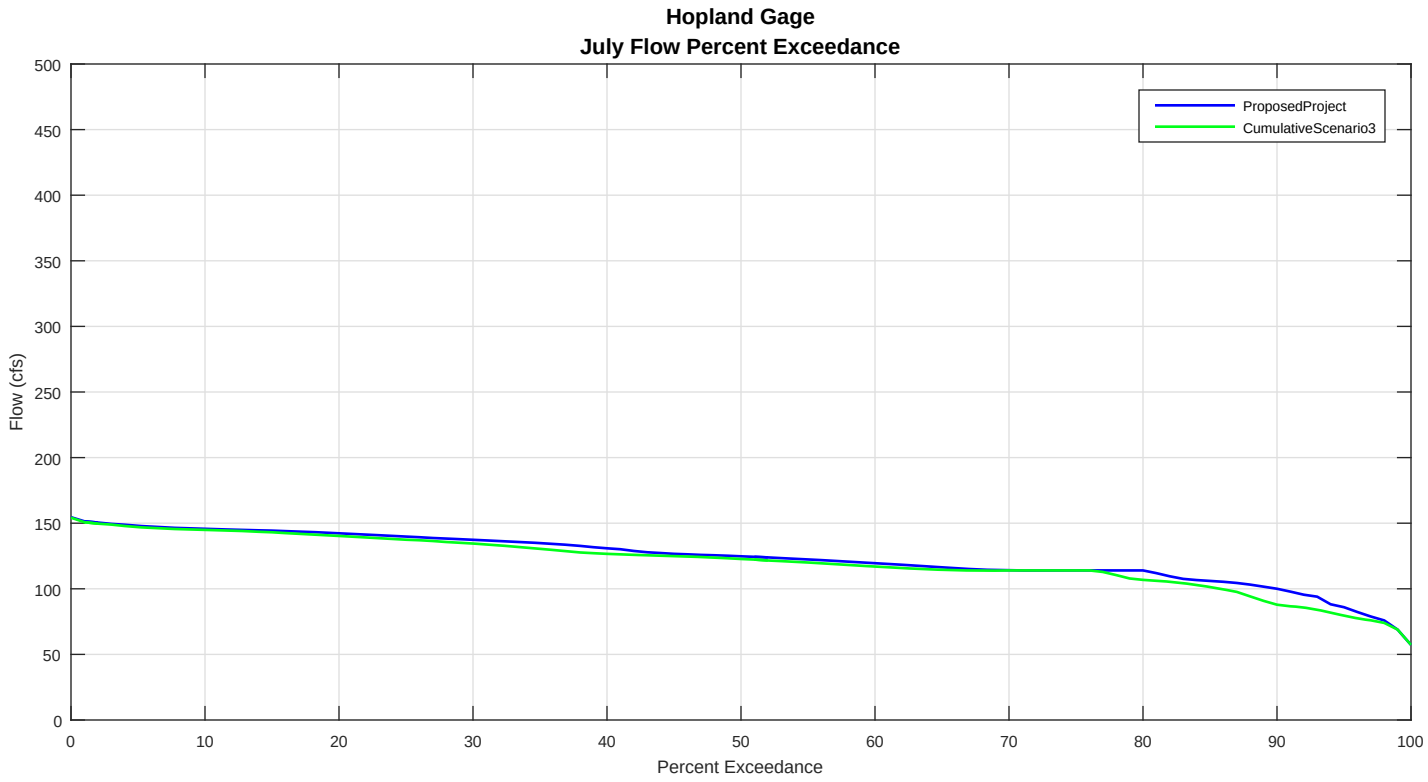
Hopland Gage
July Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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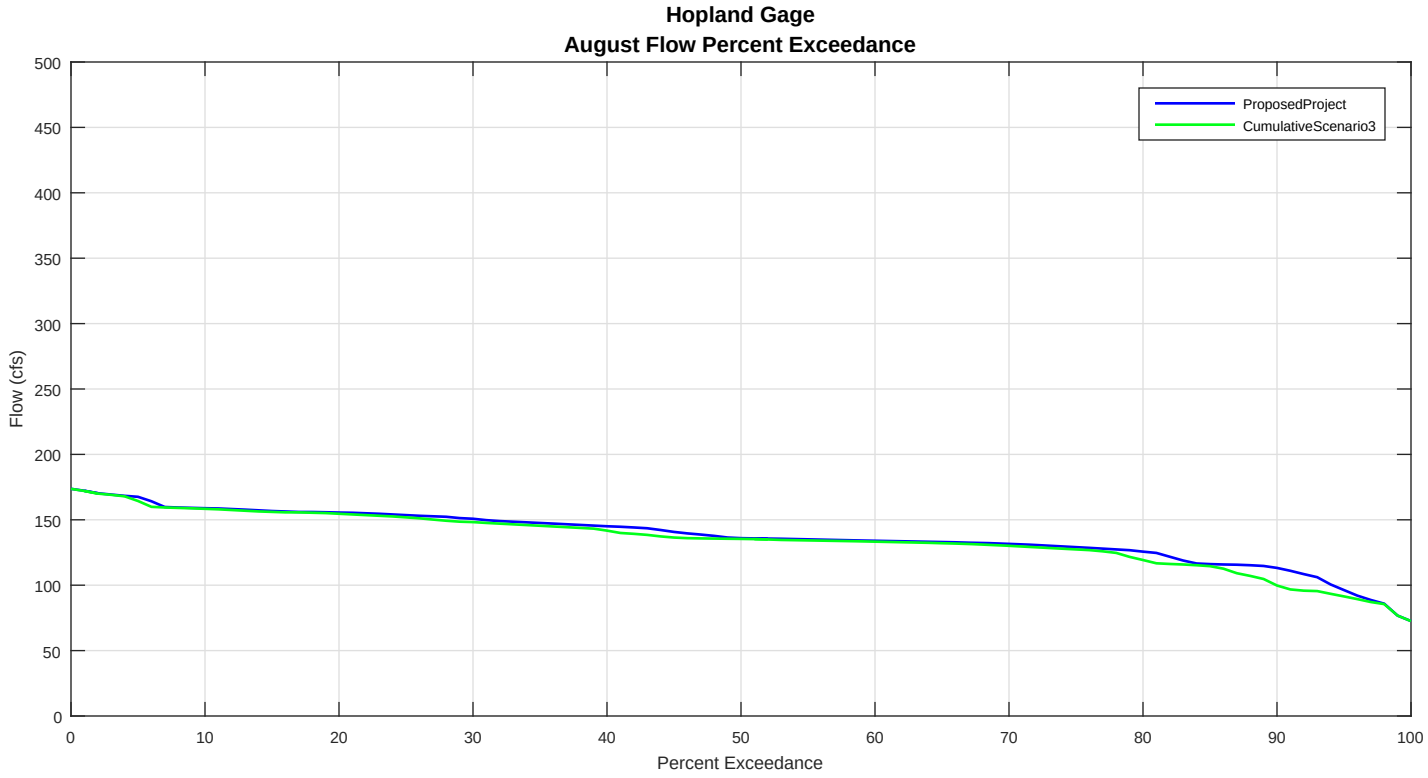
Hopland Gage
August Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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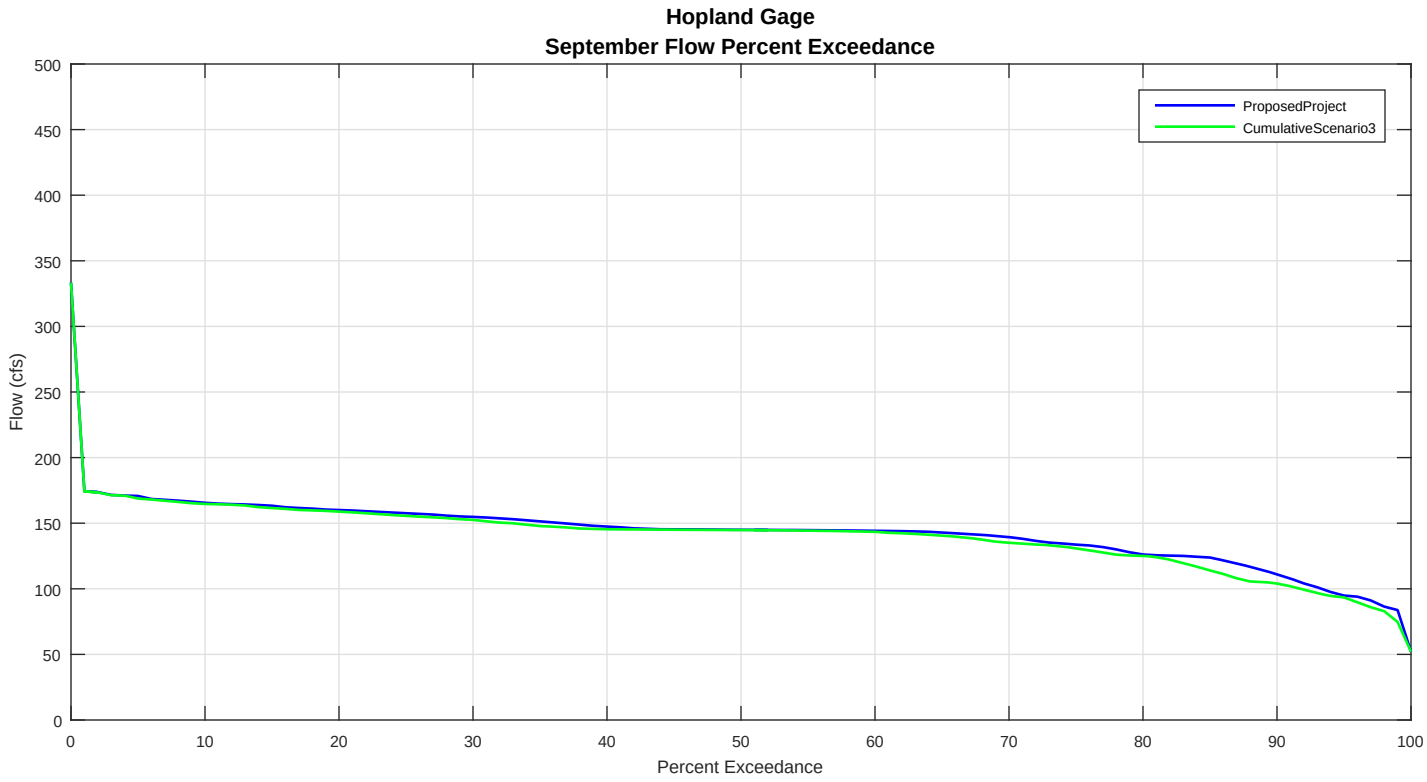
Hopland Gage
September Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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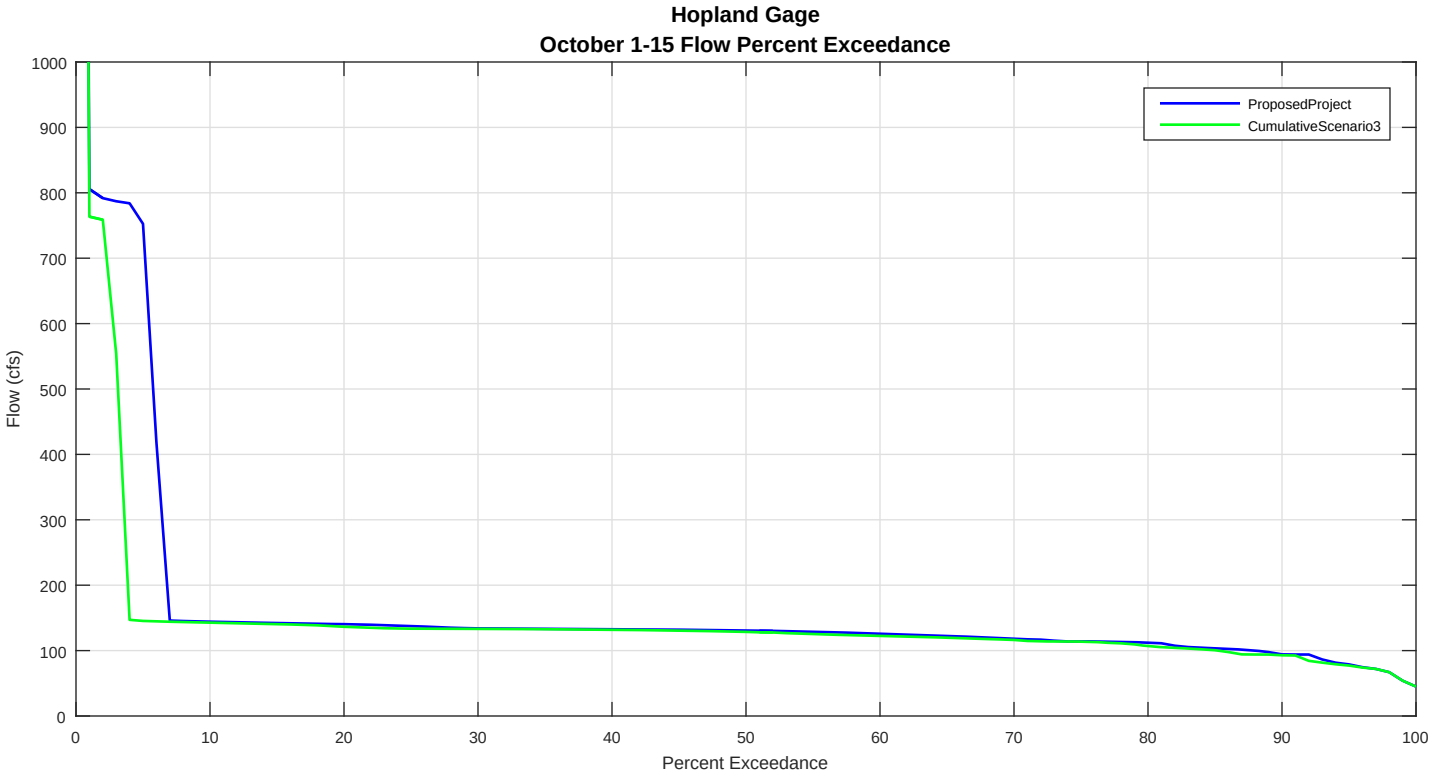
Hopland Gage
October 1-15 Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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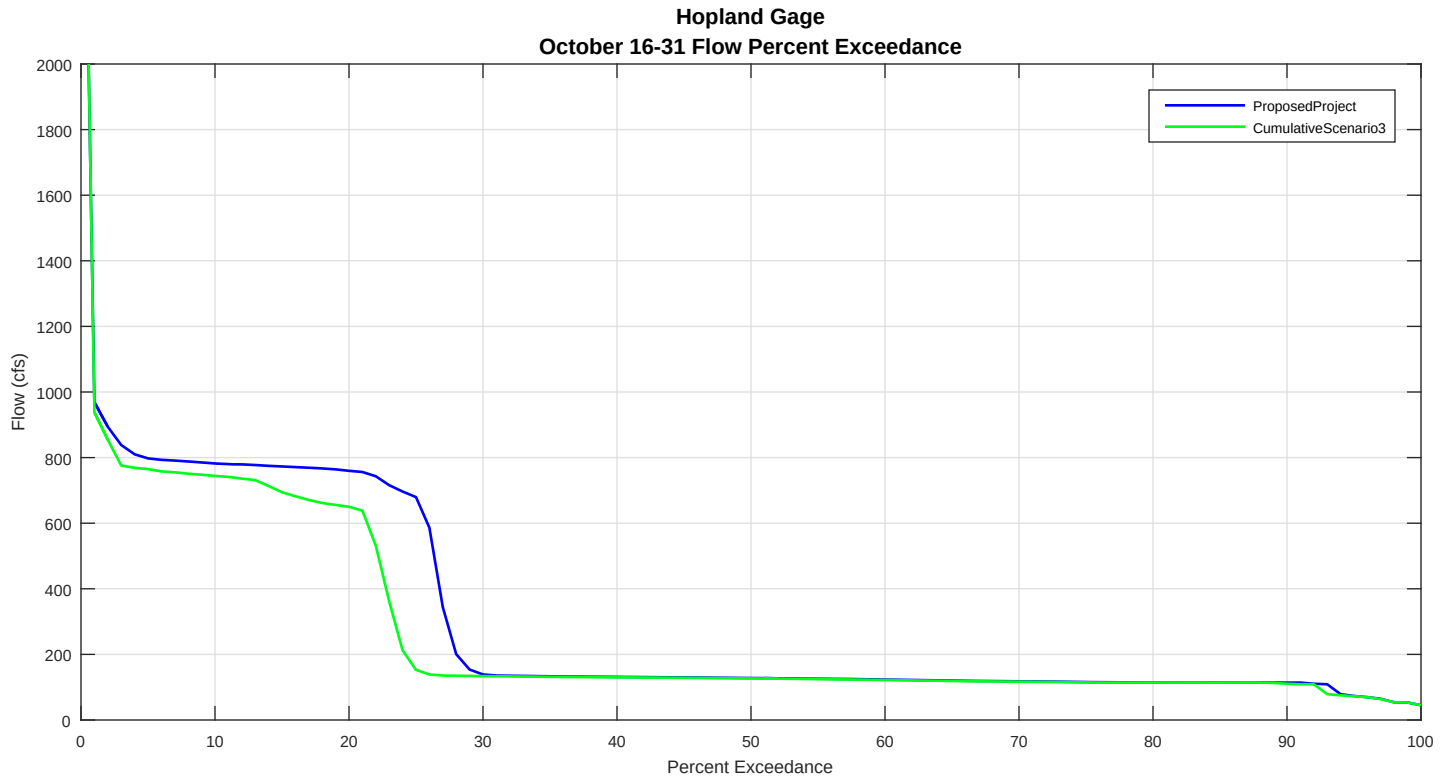
Hopland Gage
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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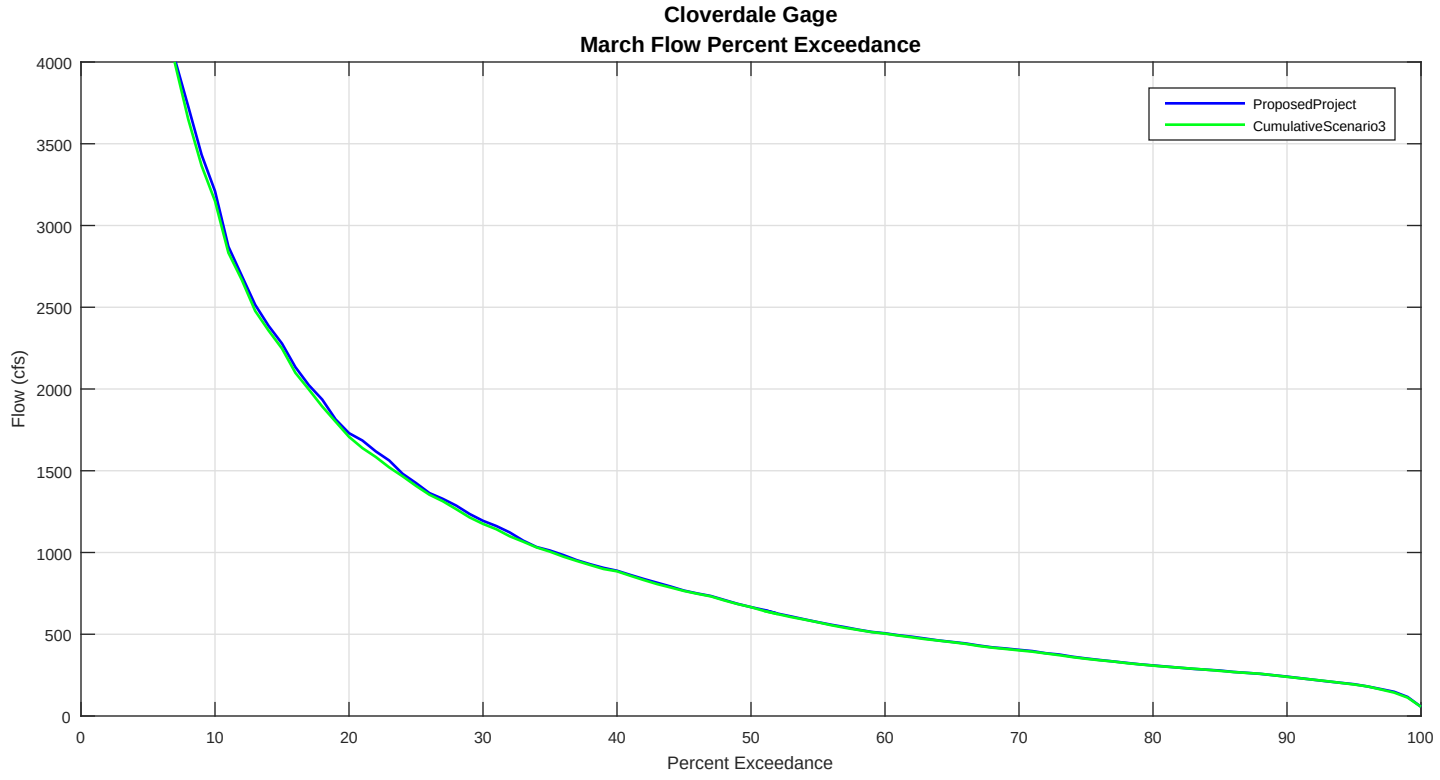
Cloverdale Gage
March Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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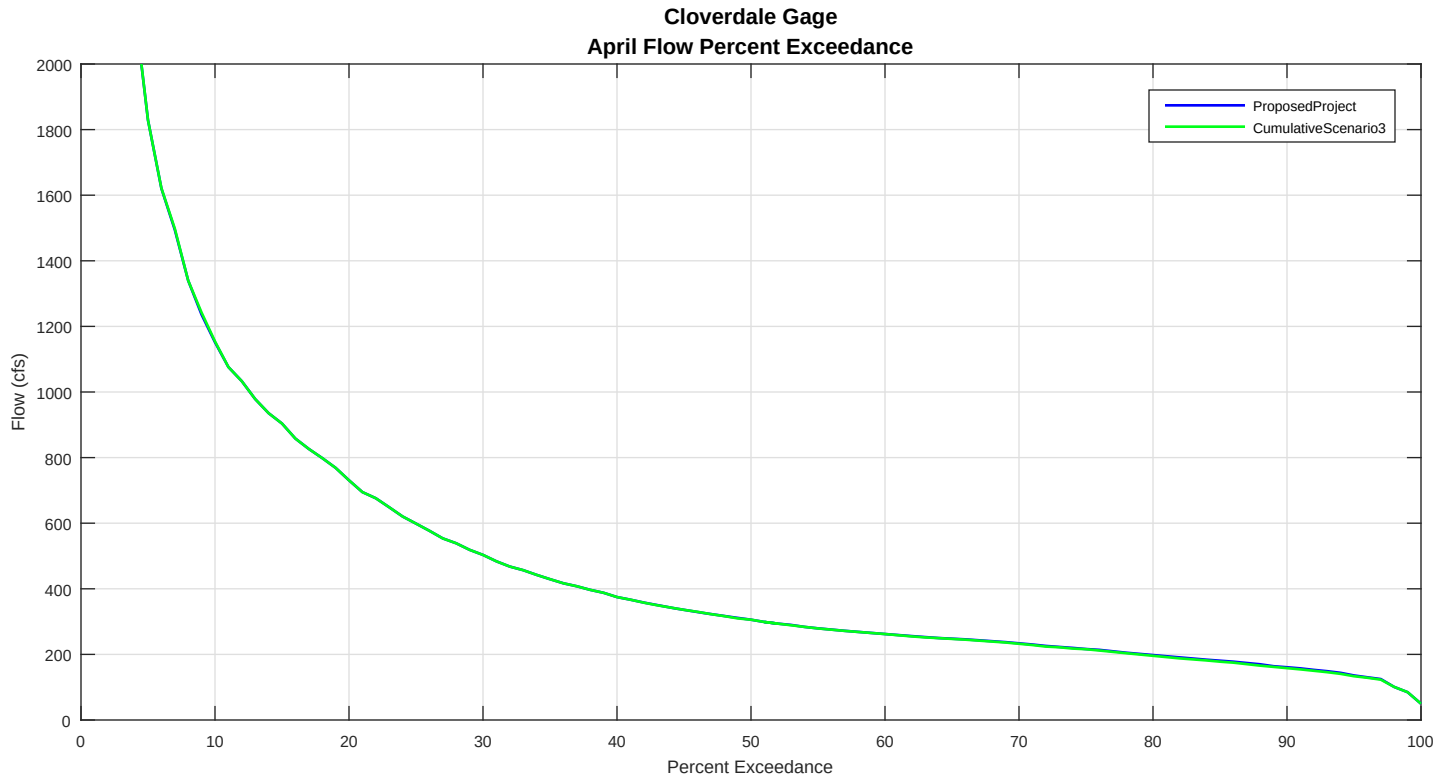
Cloverdale Gage
April Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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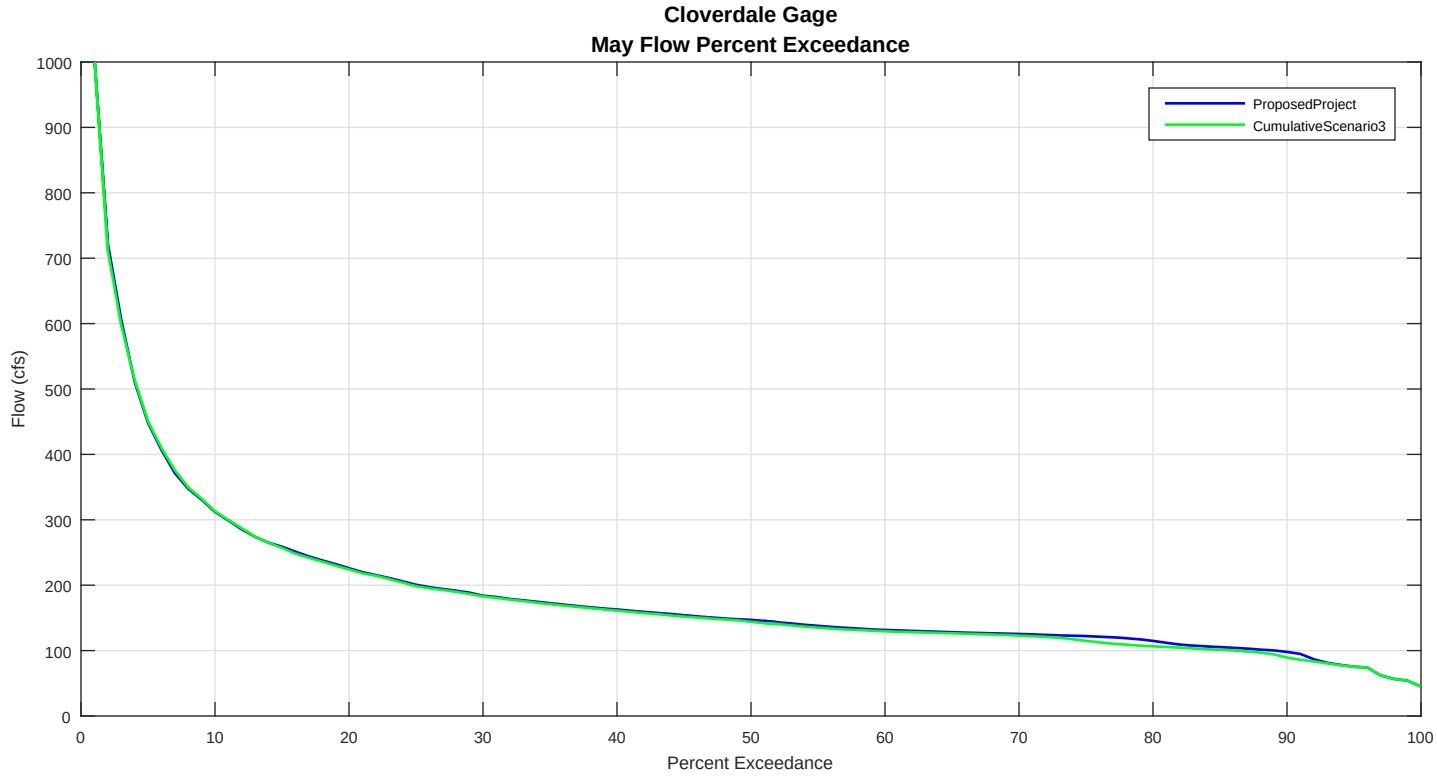
Cloverdale Gage
May Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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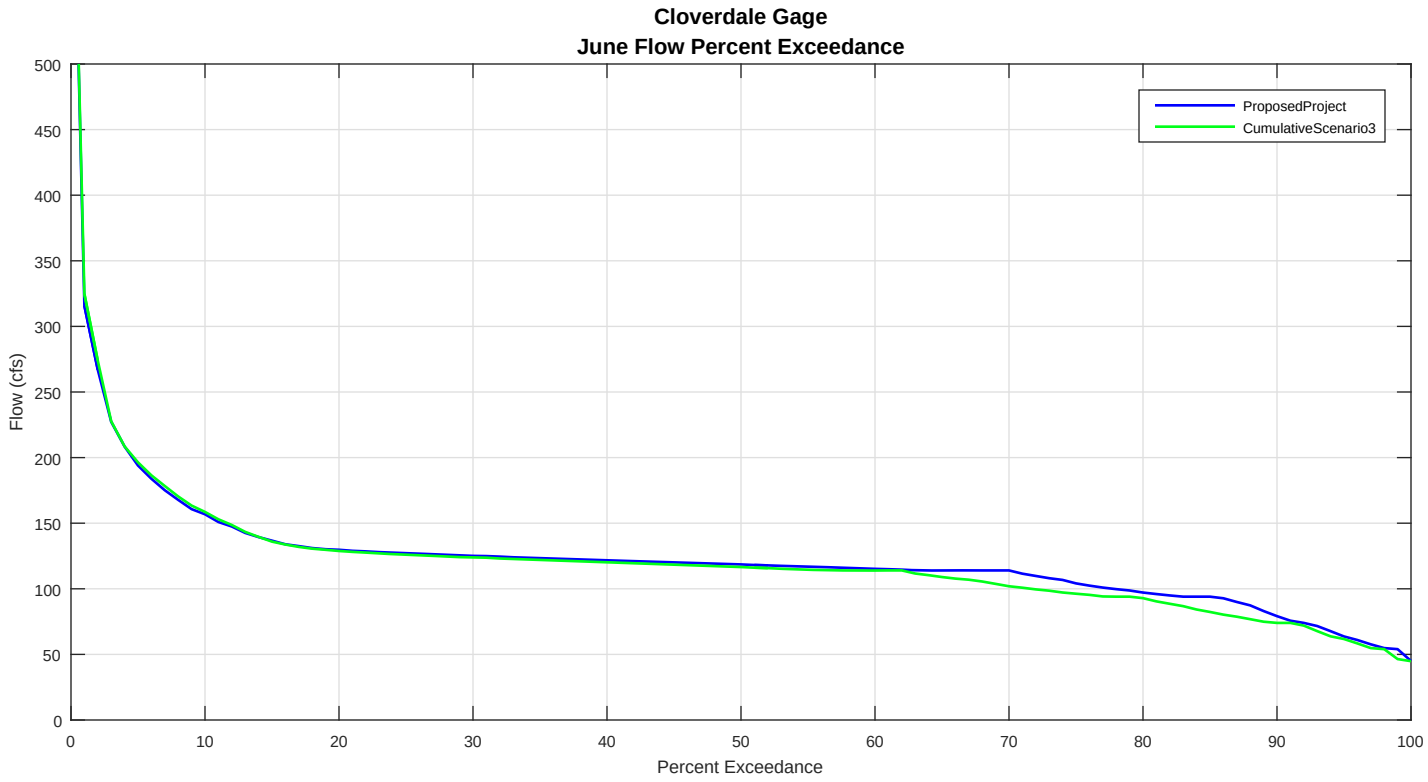
Cloverdale Gage
June Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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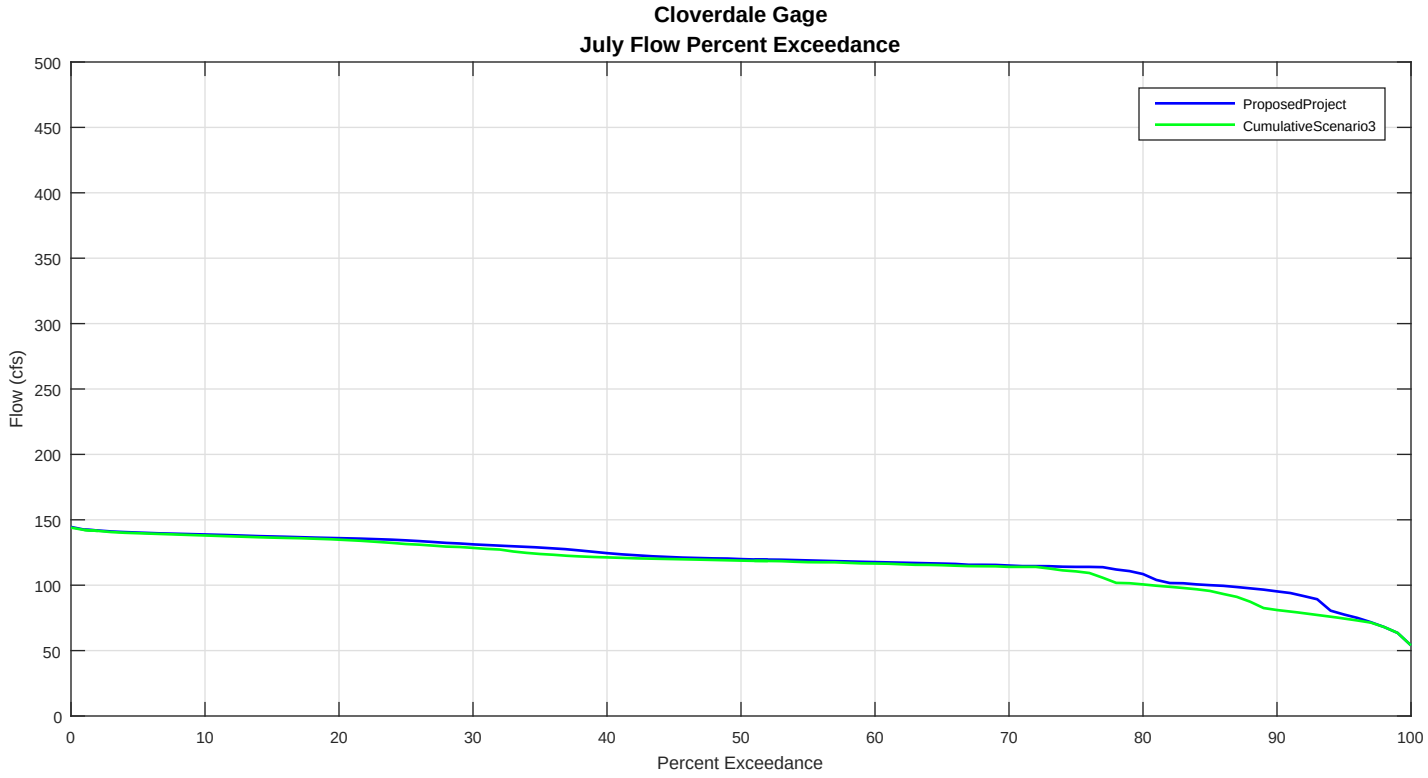
Cloverdale Gage
July Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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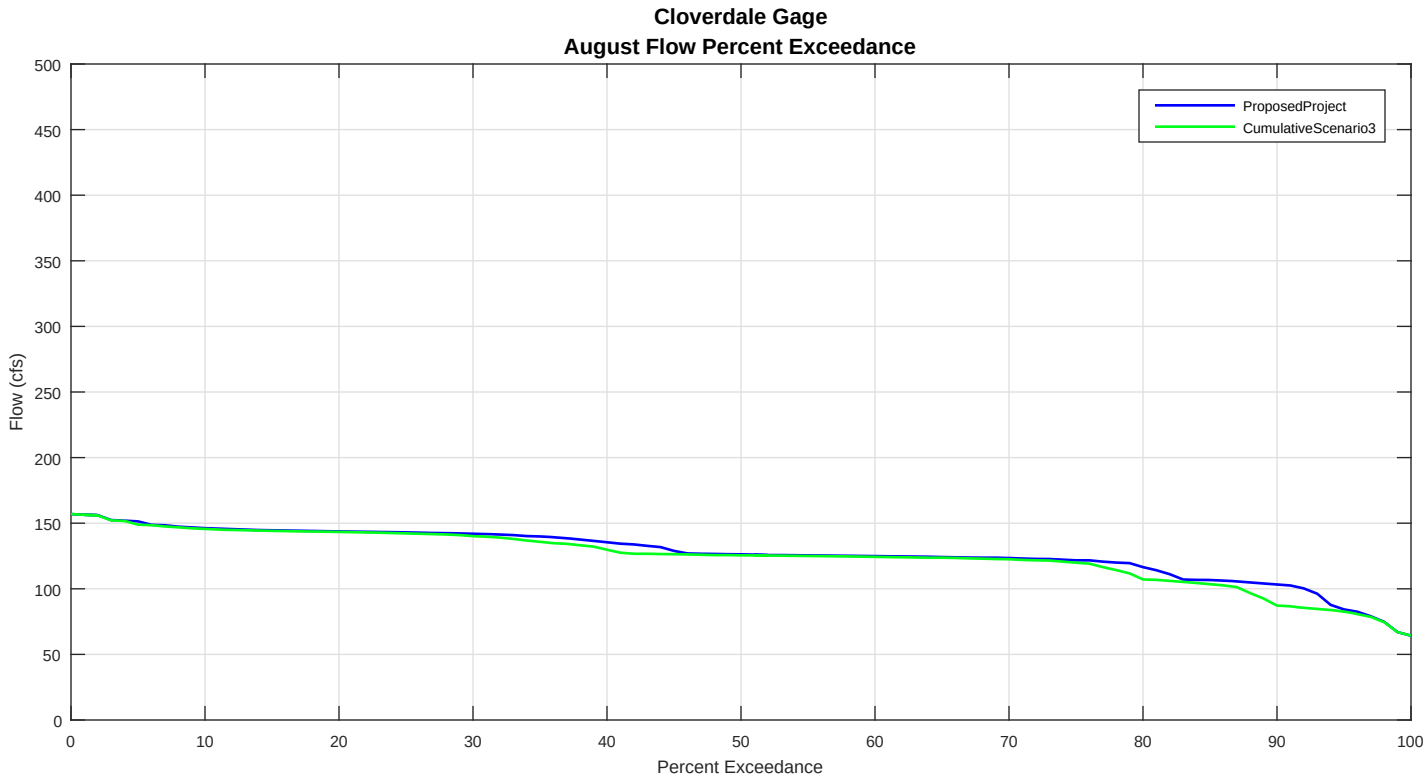
Cloverdale Gage
August Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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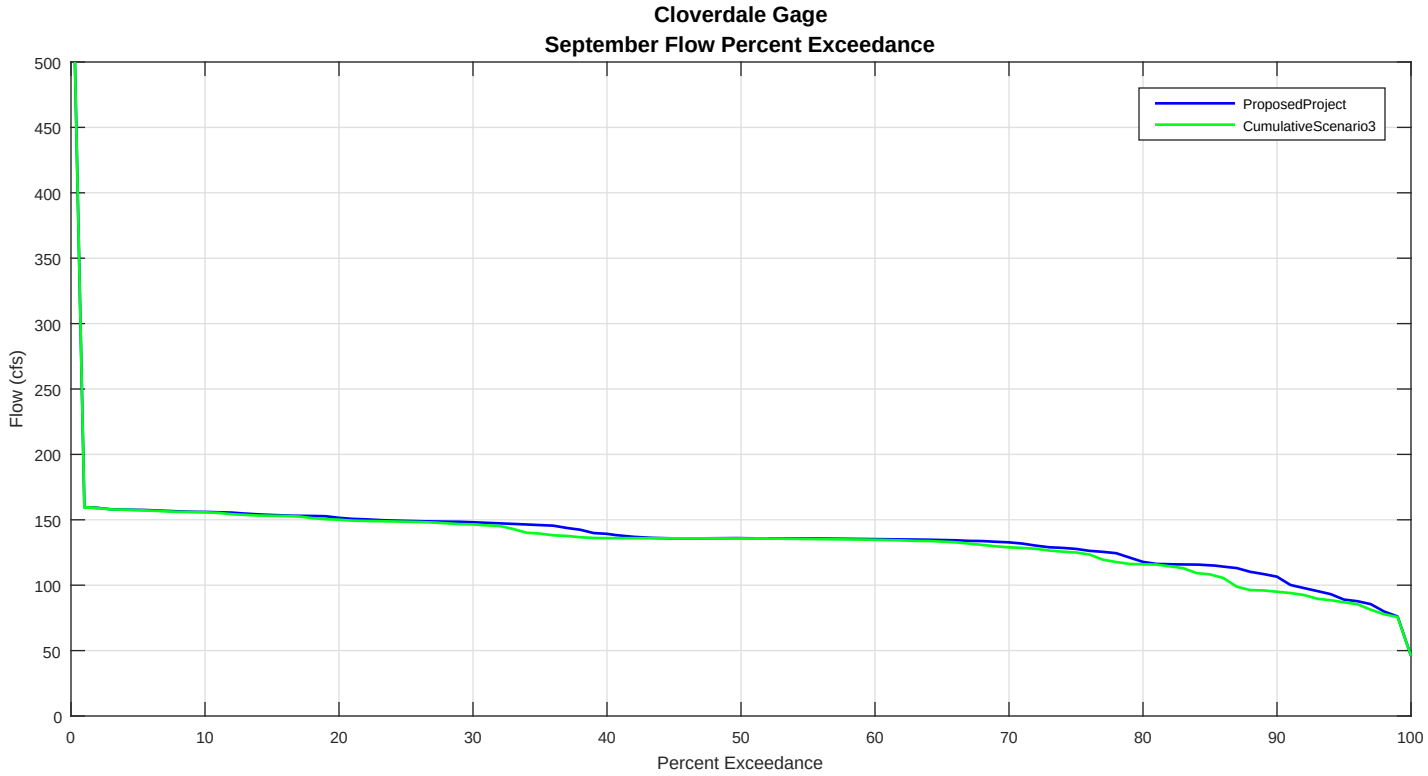
Cloverdale Gage
September Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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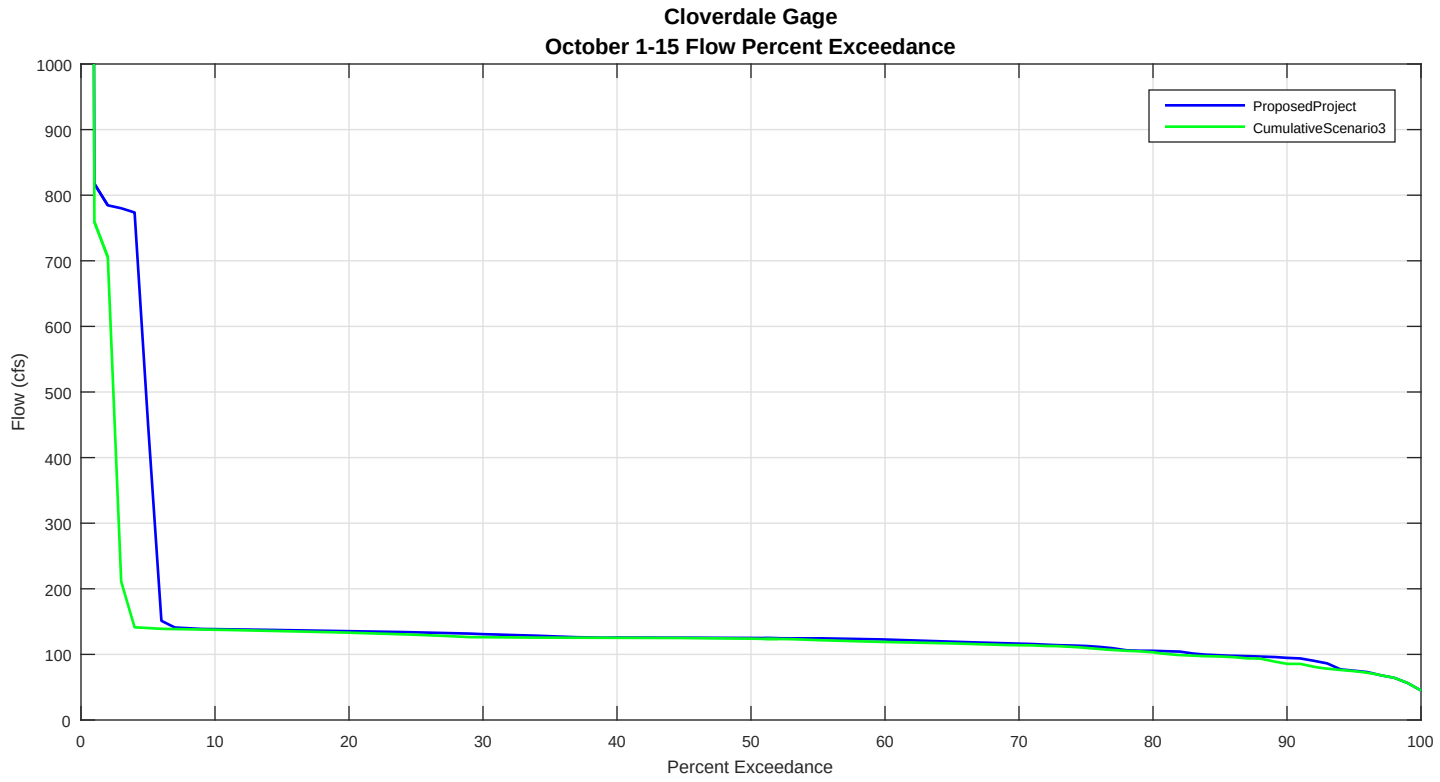
Cloverdale Gage
October 1-15 Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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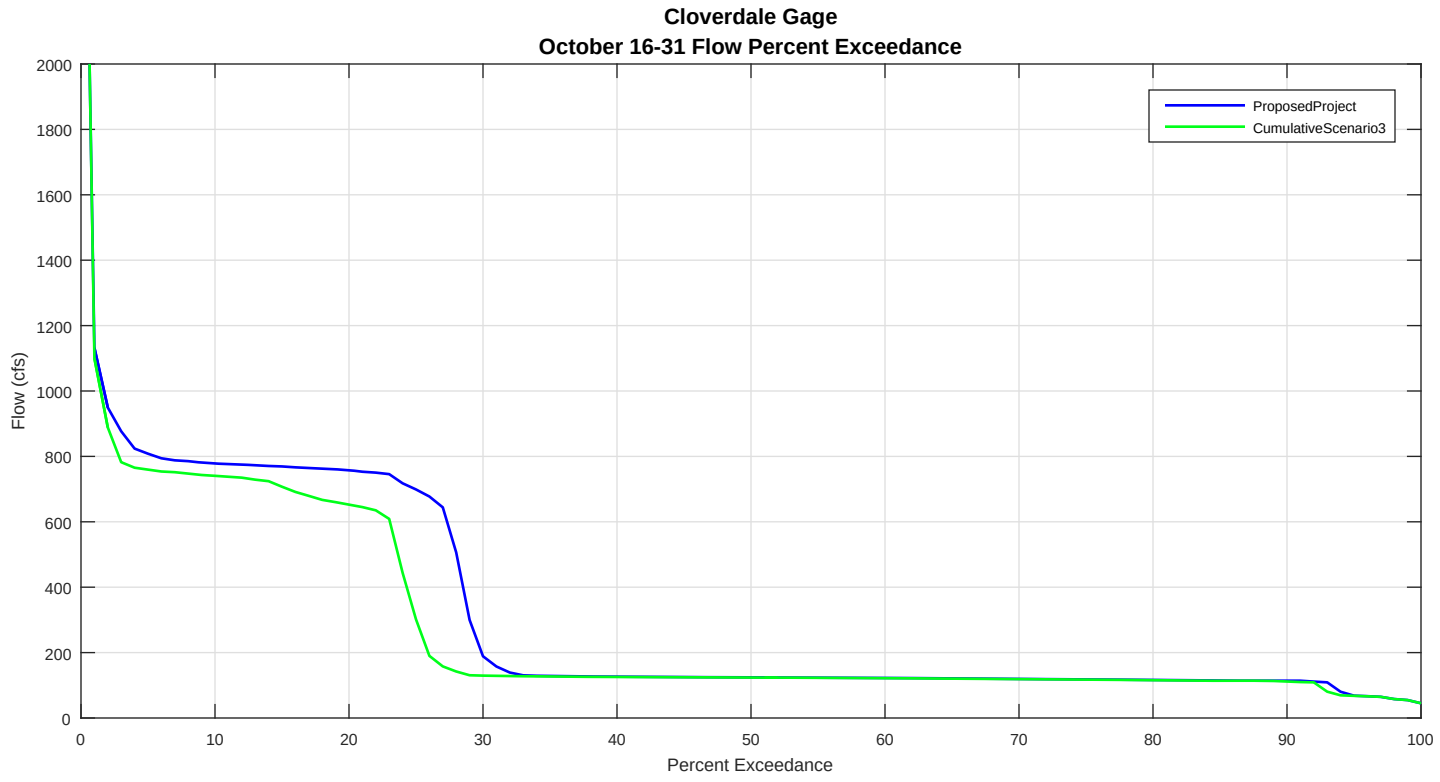
Cloverdale Gage
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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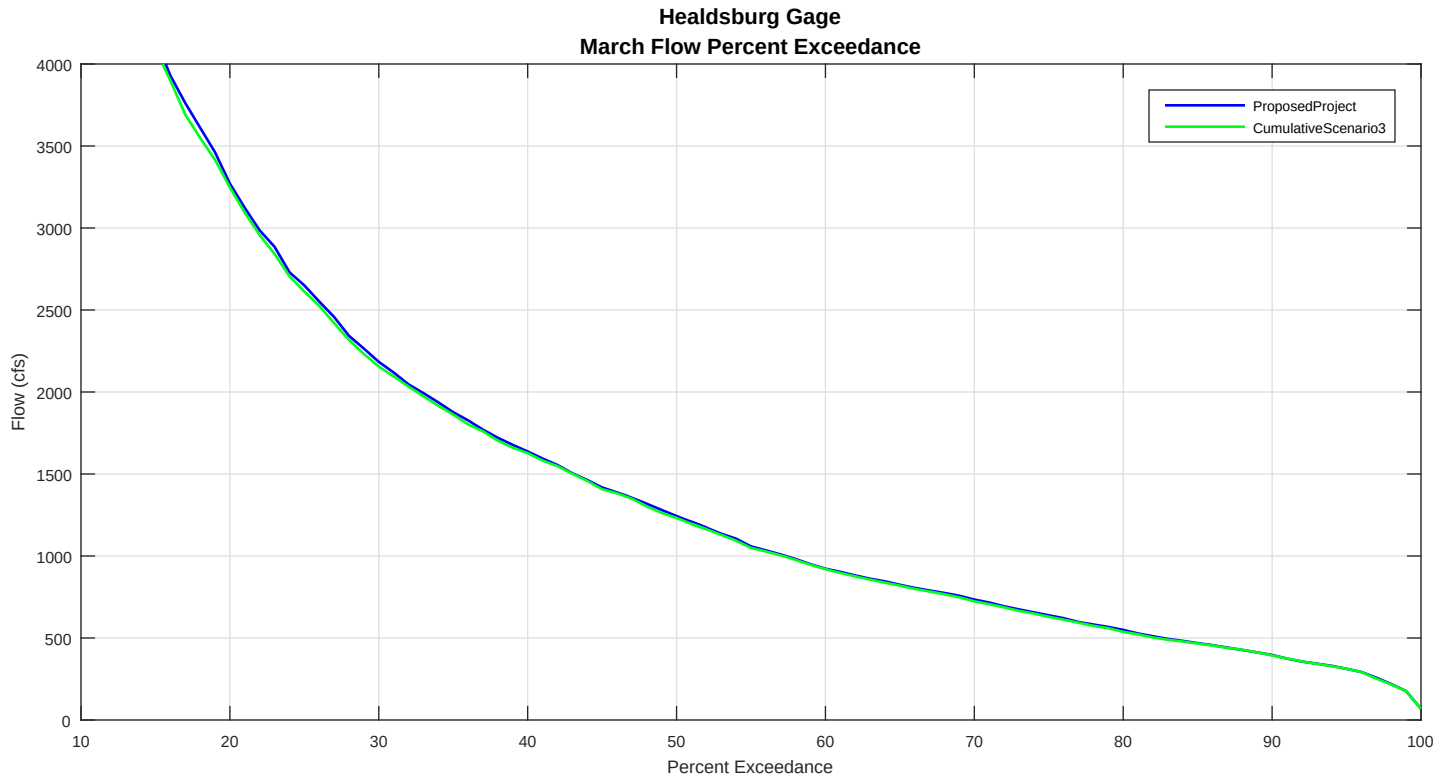
Healdsburg Gage
March Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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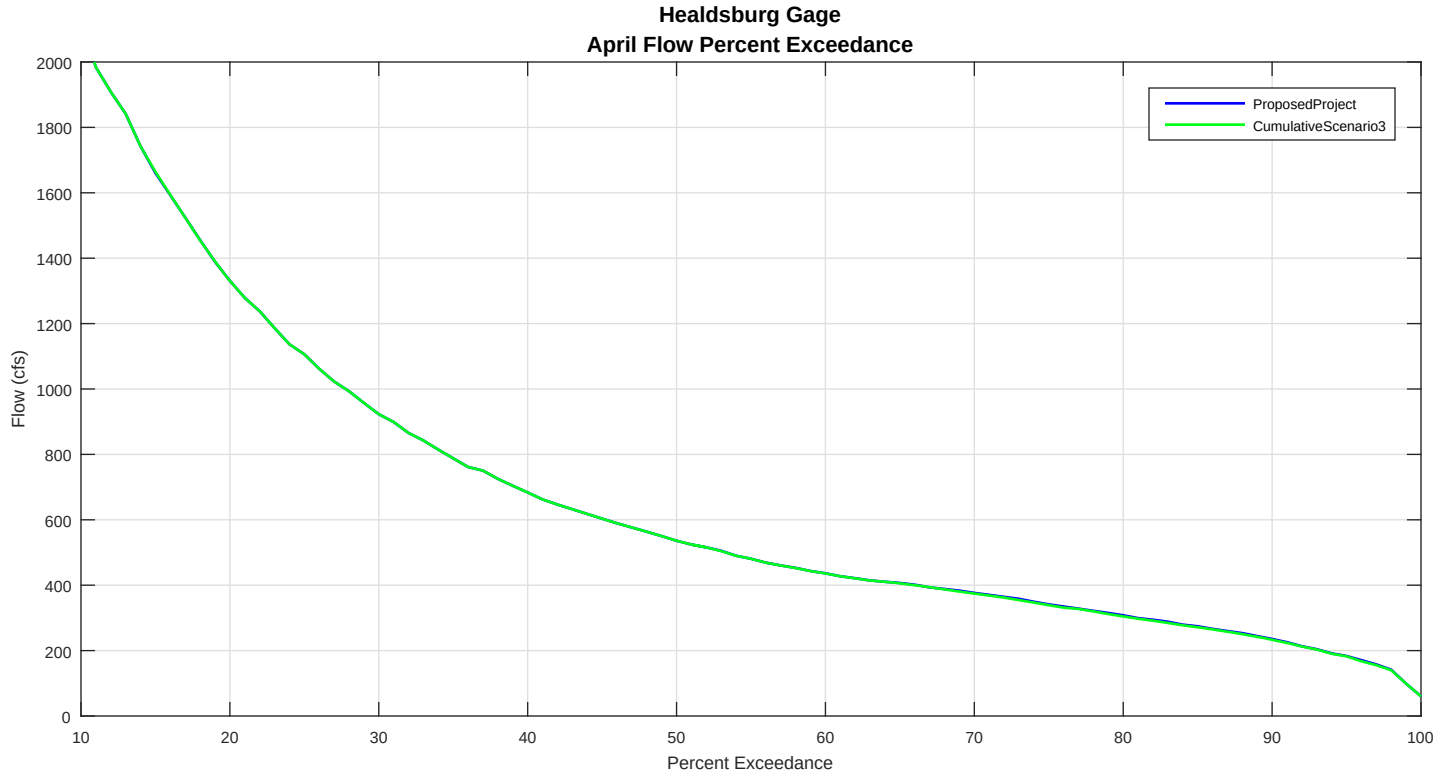
Healdsburg Gage
April Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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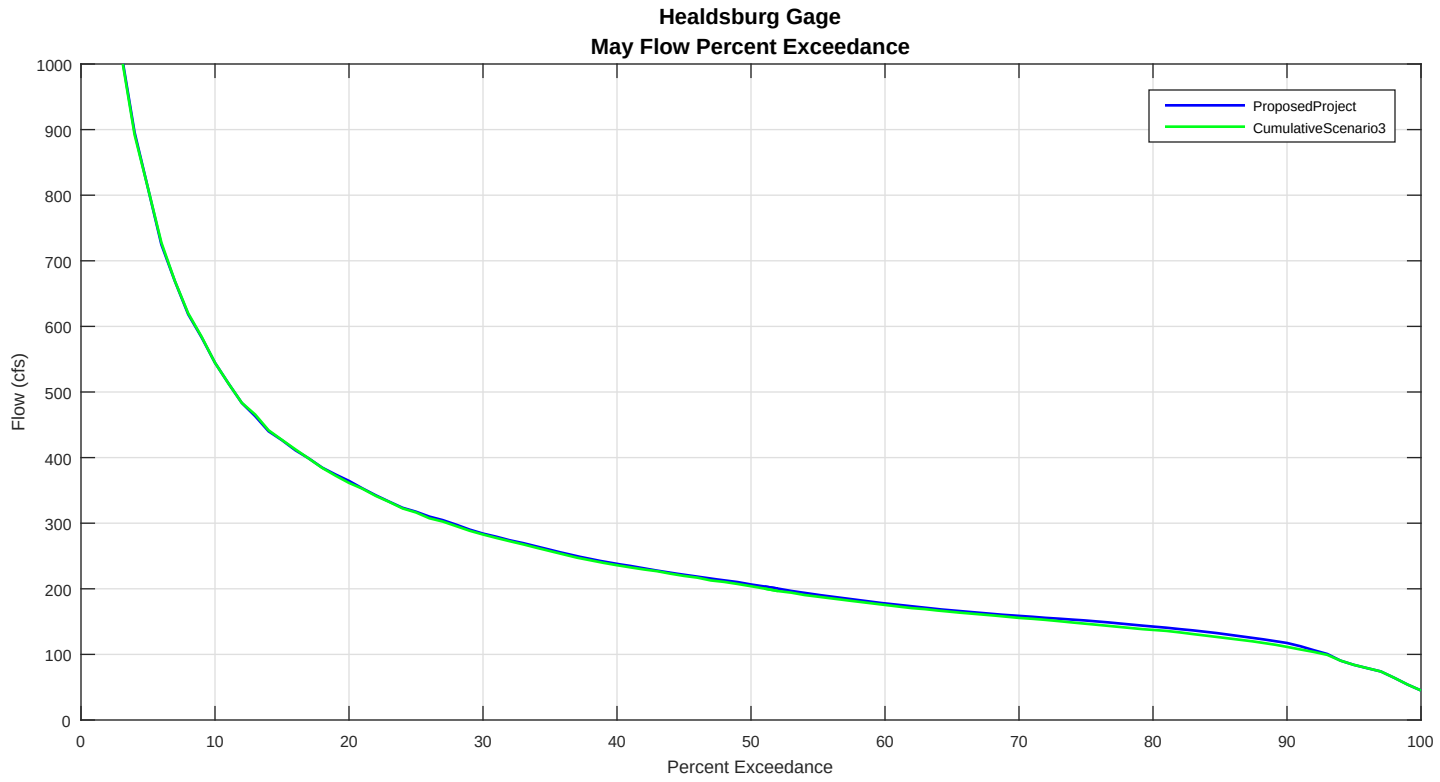
Healdsburg Gage
May Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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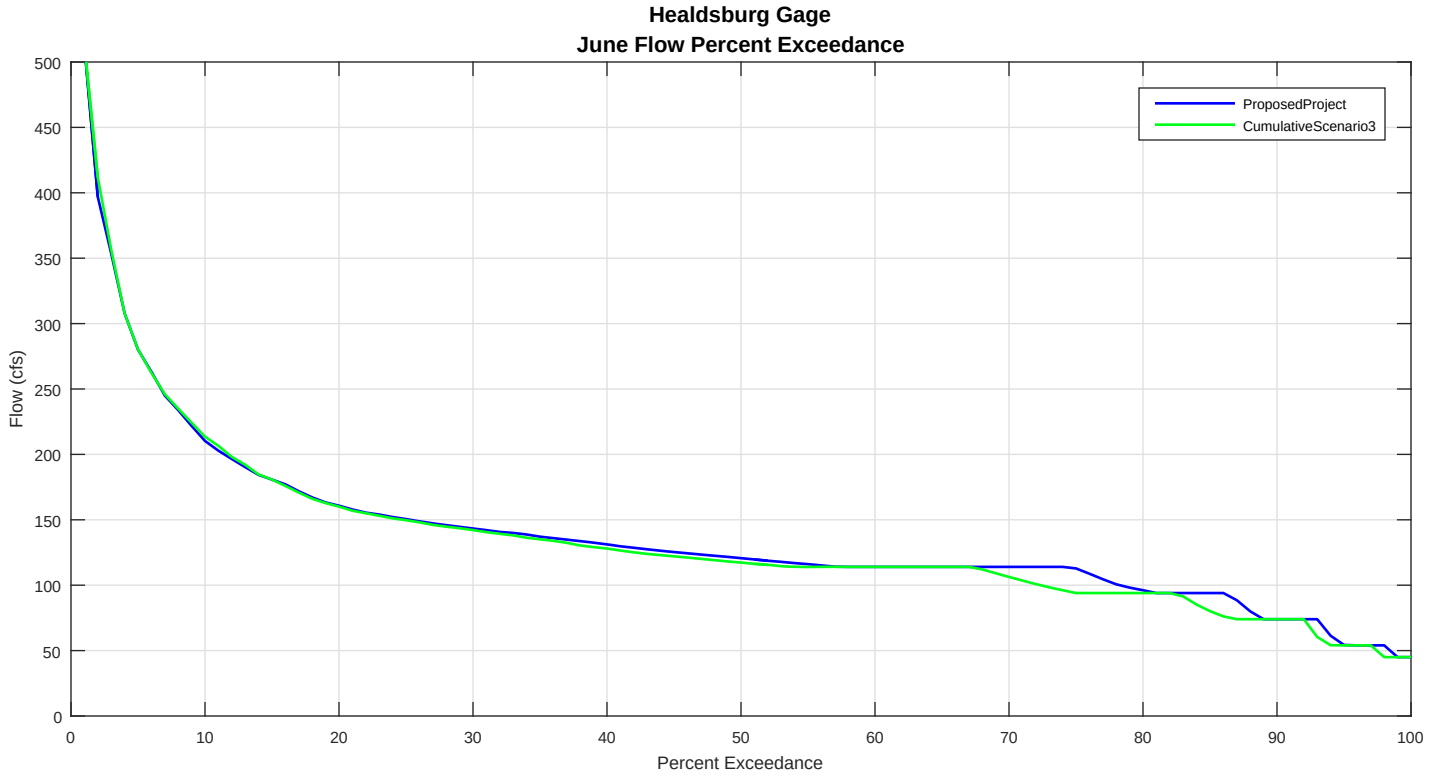
Healdsburg Gage
June Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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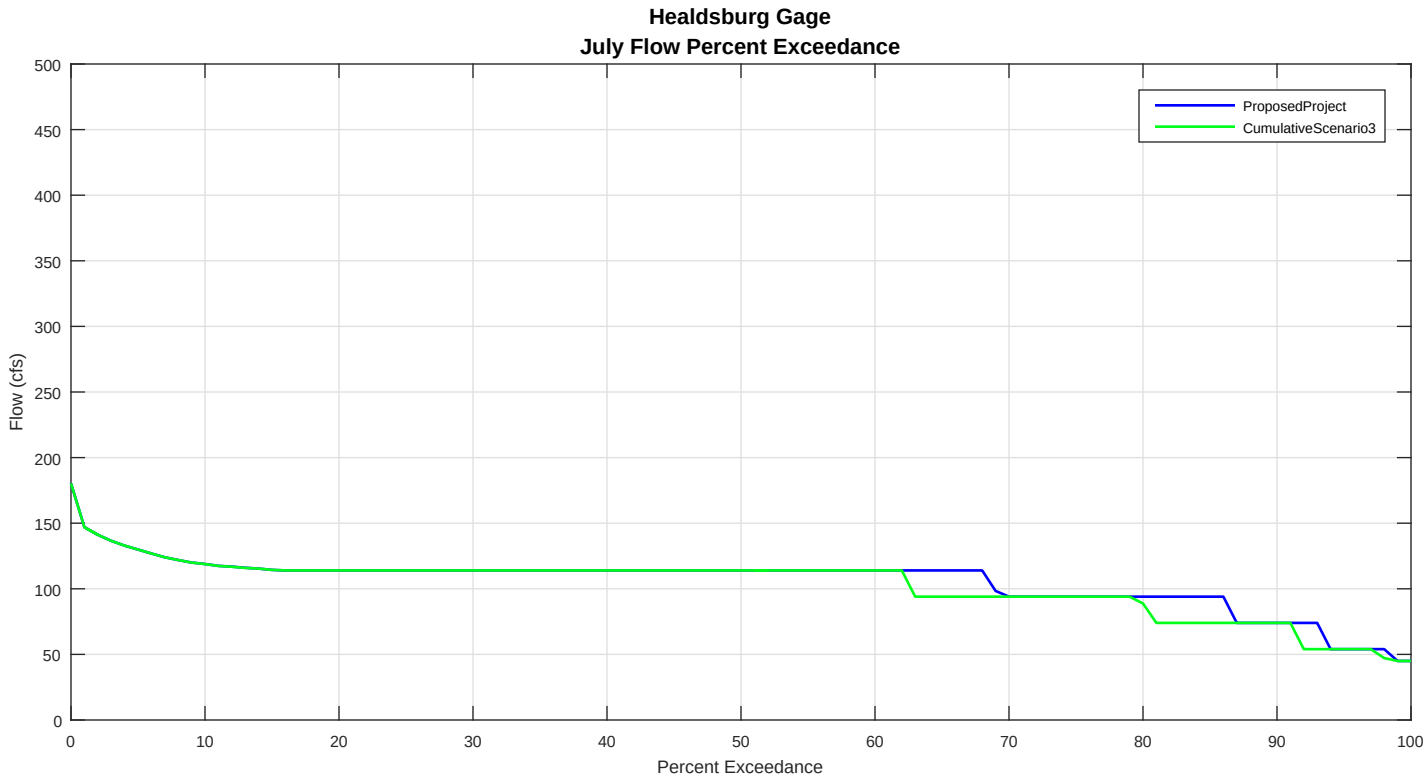
Healdsburg Gage
July Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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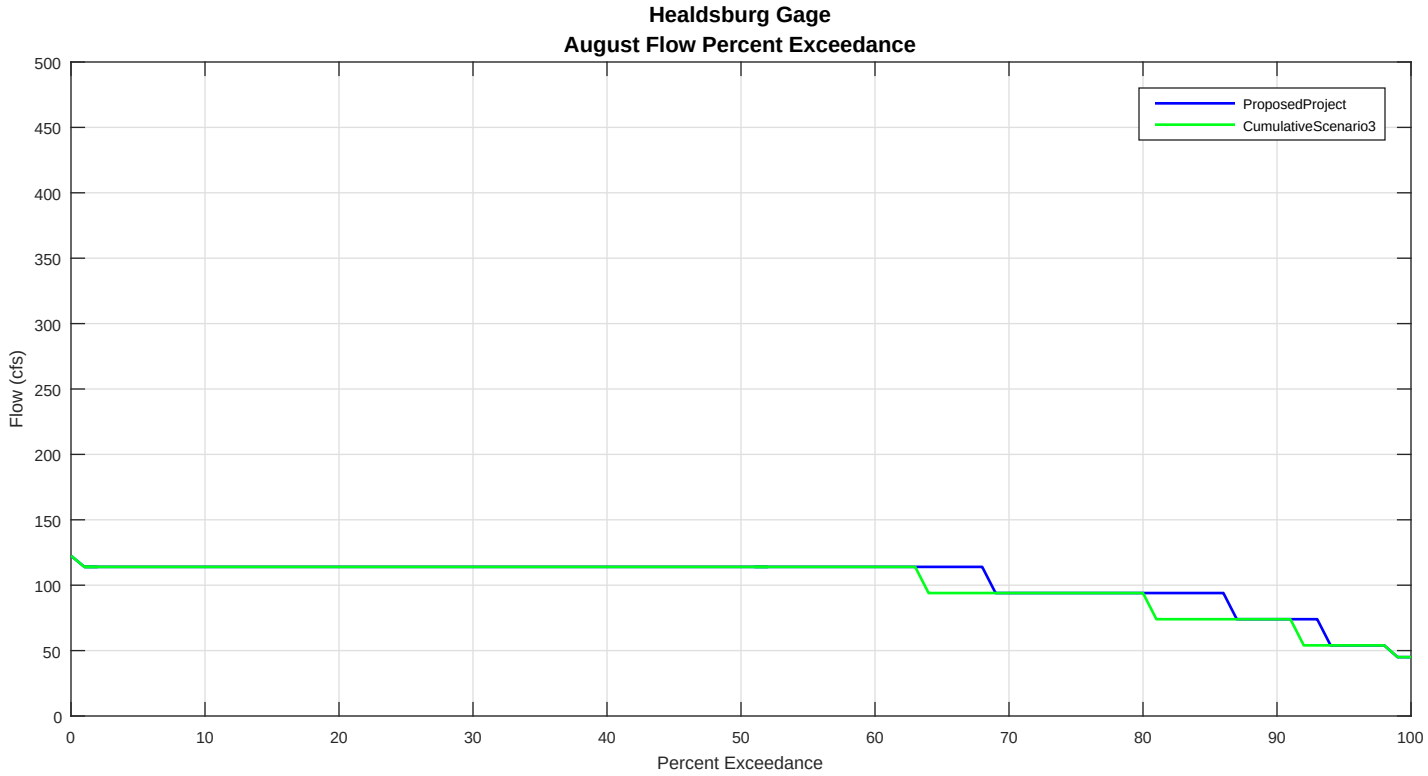
Healdsburg Gage
August Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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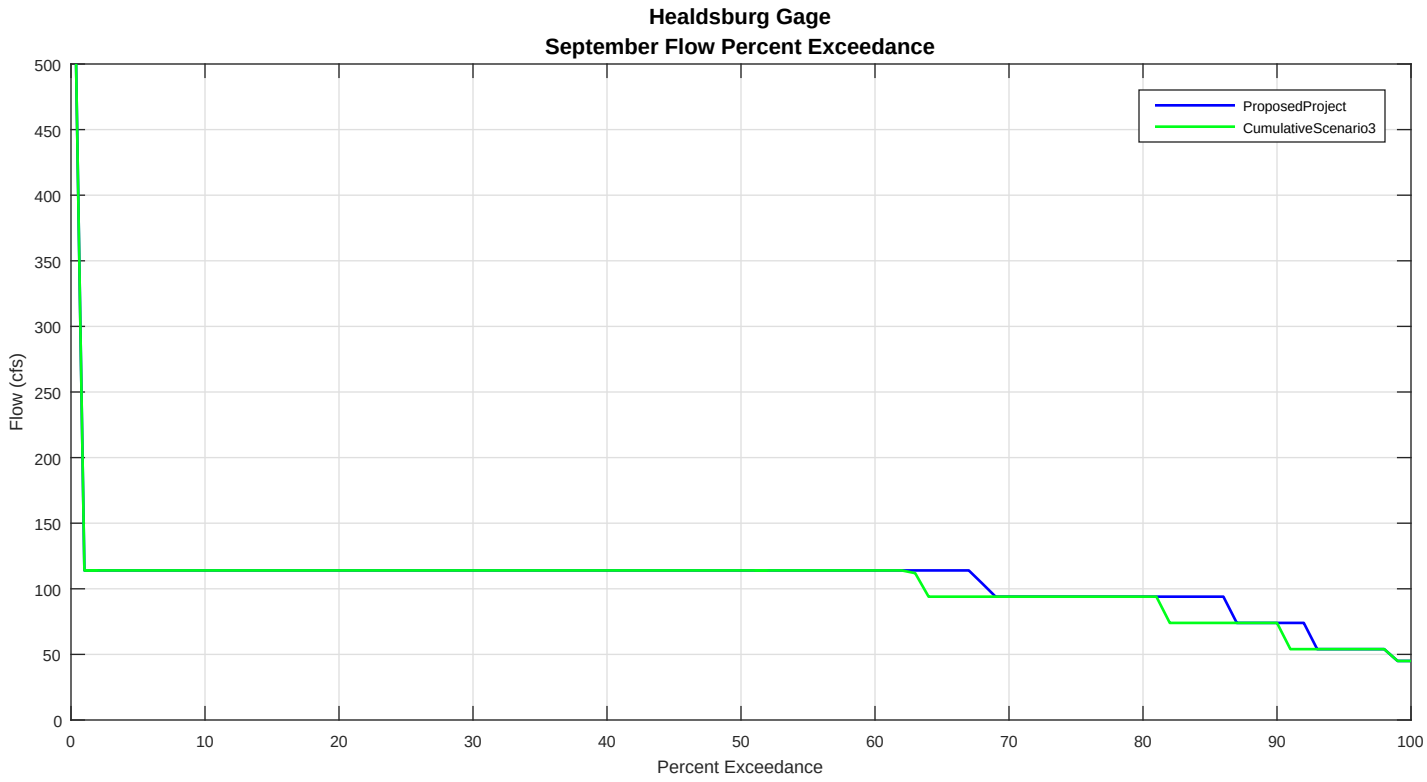
Healdsburg Gage
September Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario3
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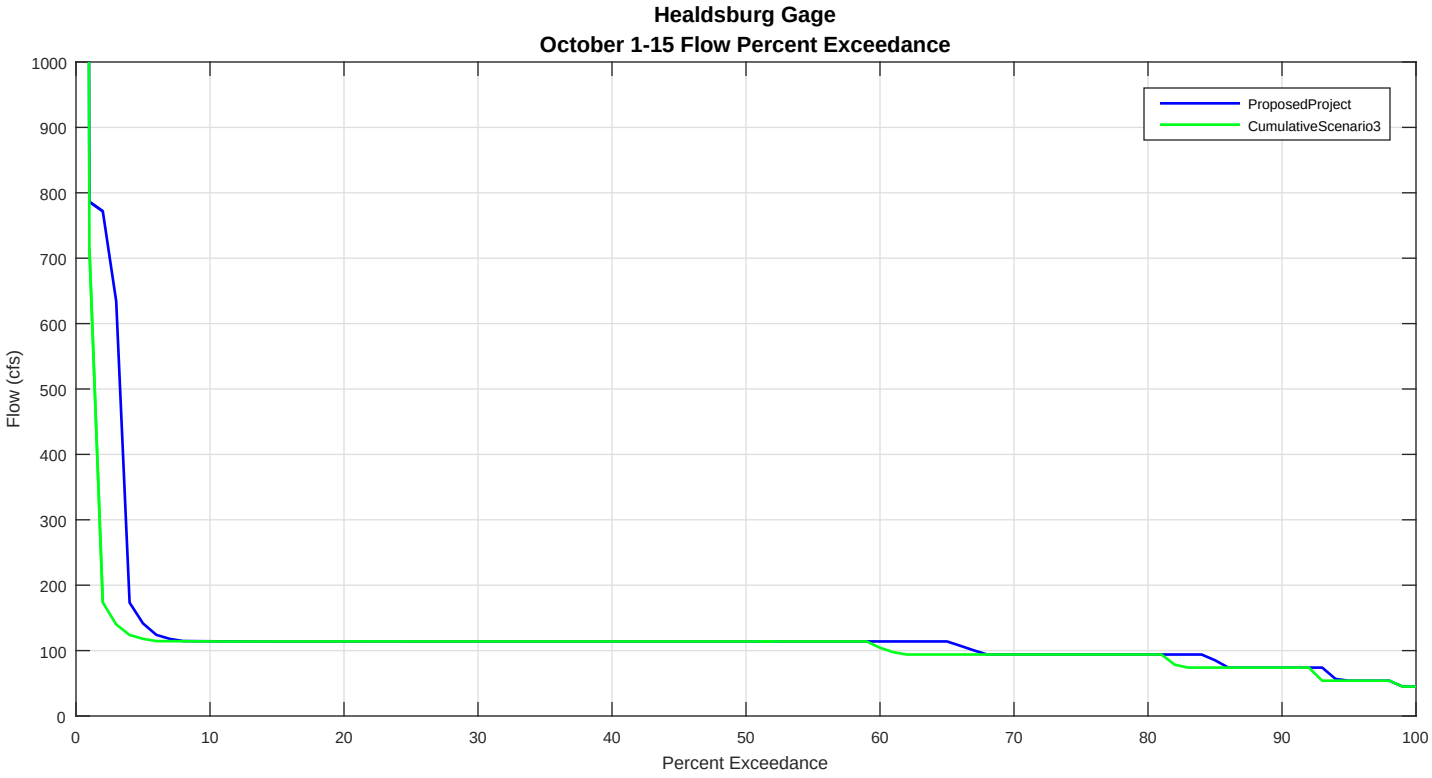
Healdsburg Gage
October 1-15 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario3
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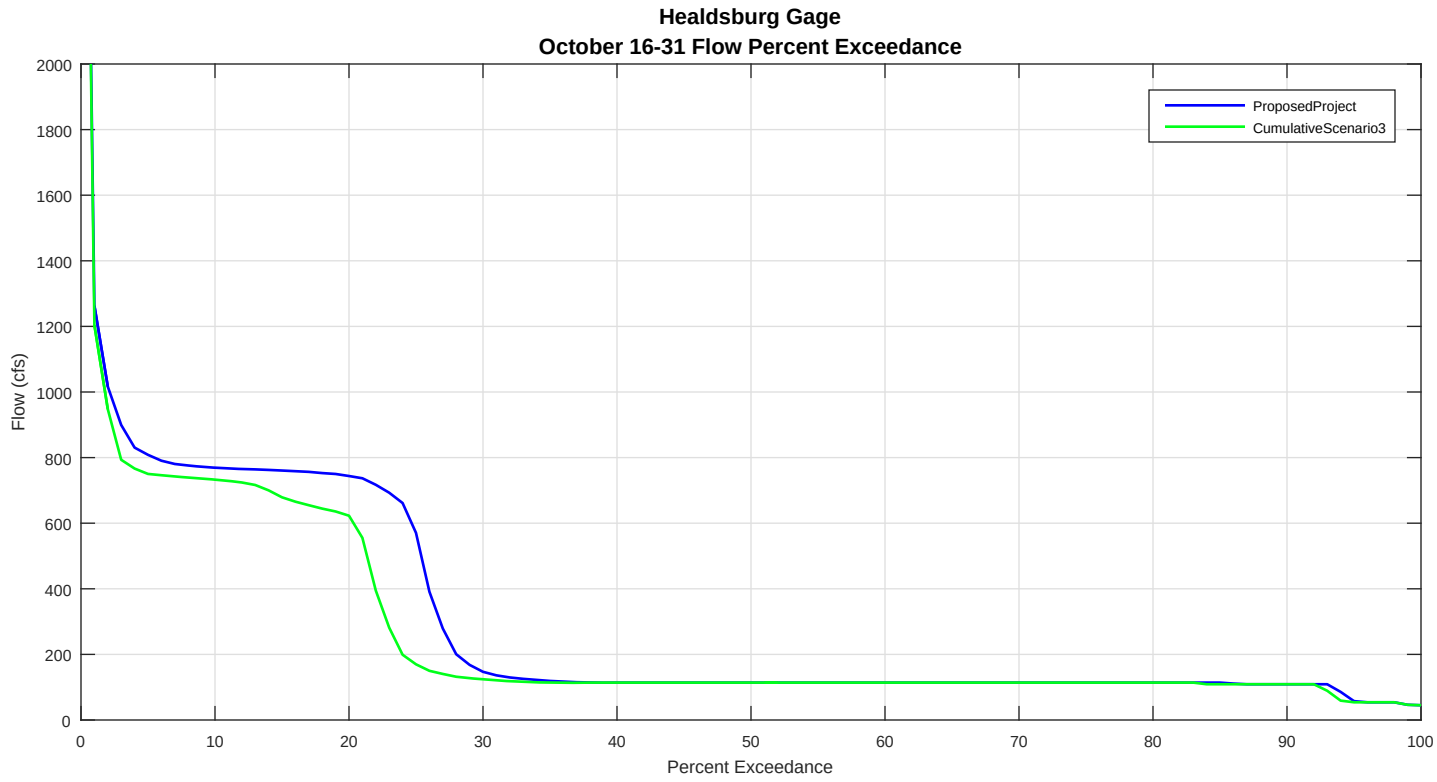
Healdsburg Gage
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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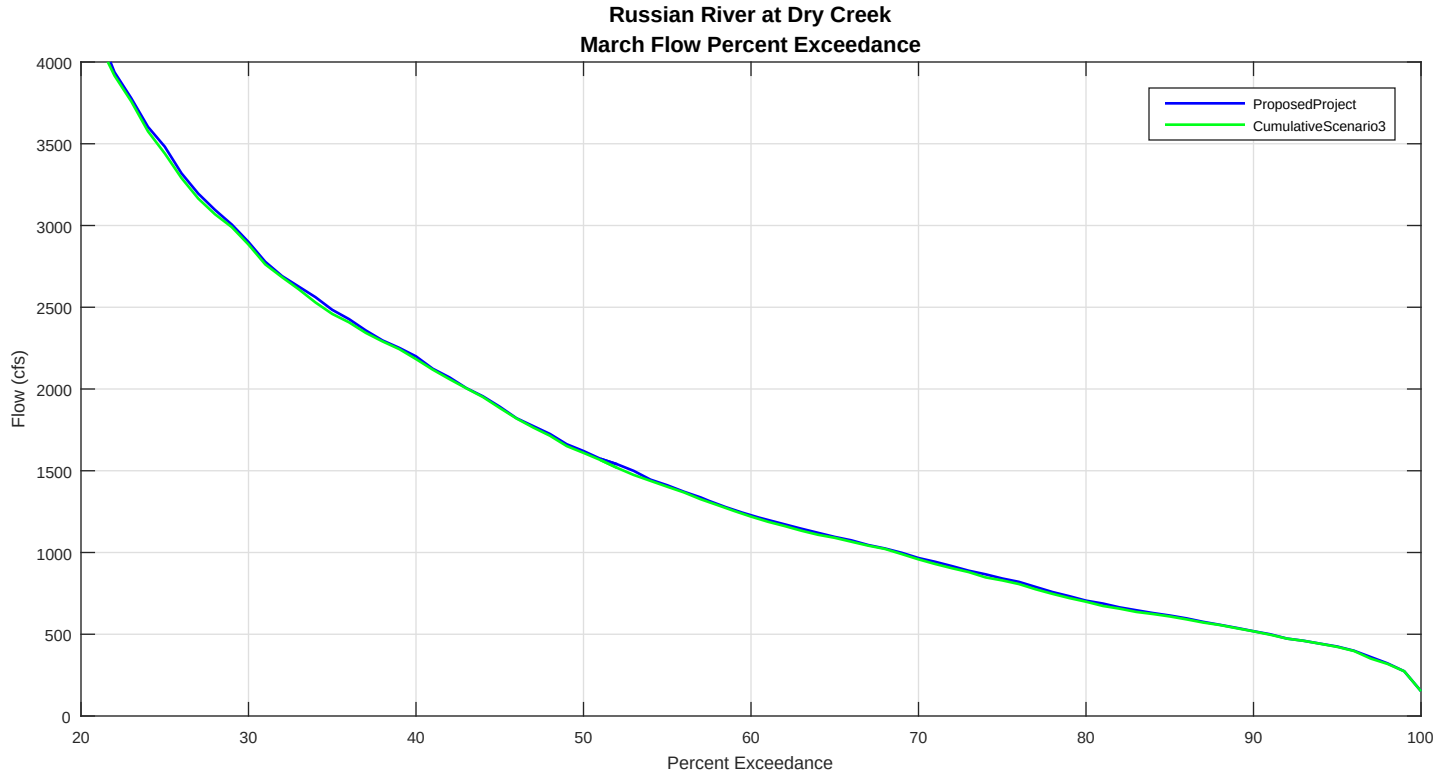
Russian River at Dry Creek
March Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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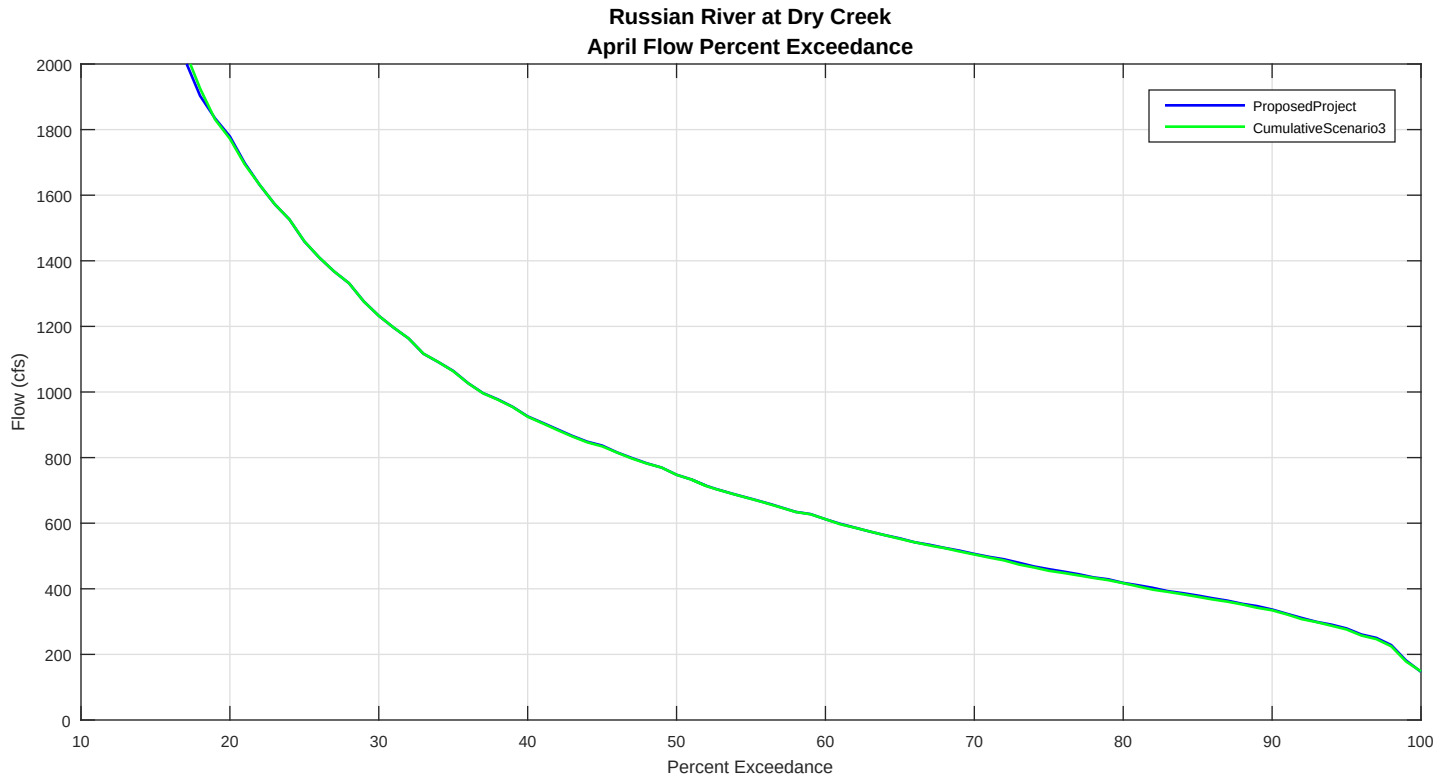
Russian River at Dry Creek
April Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario3
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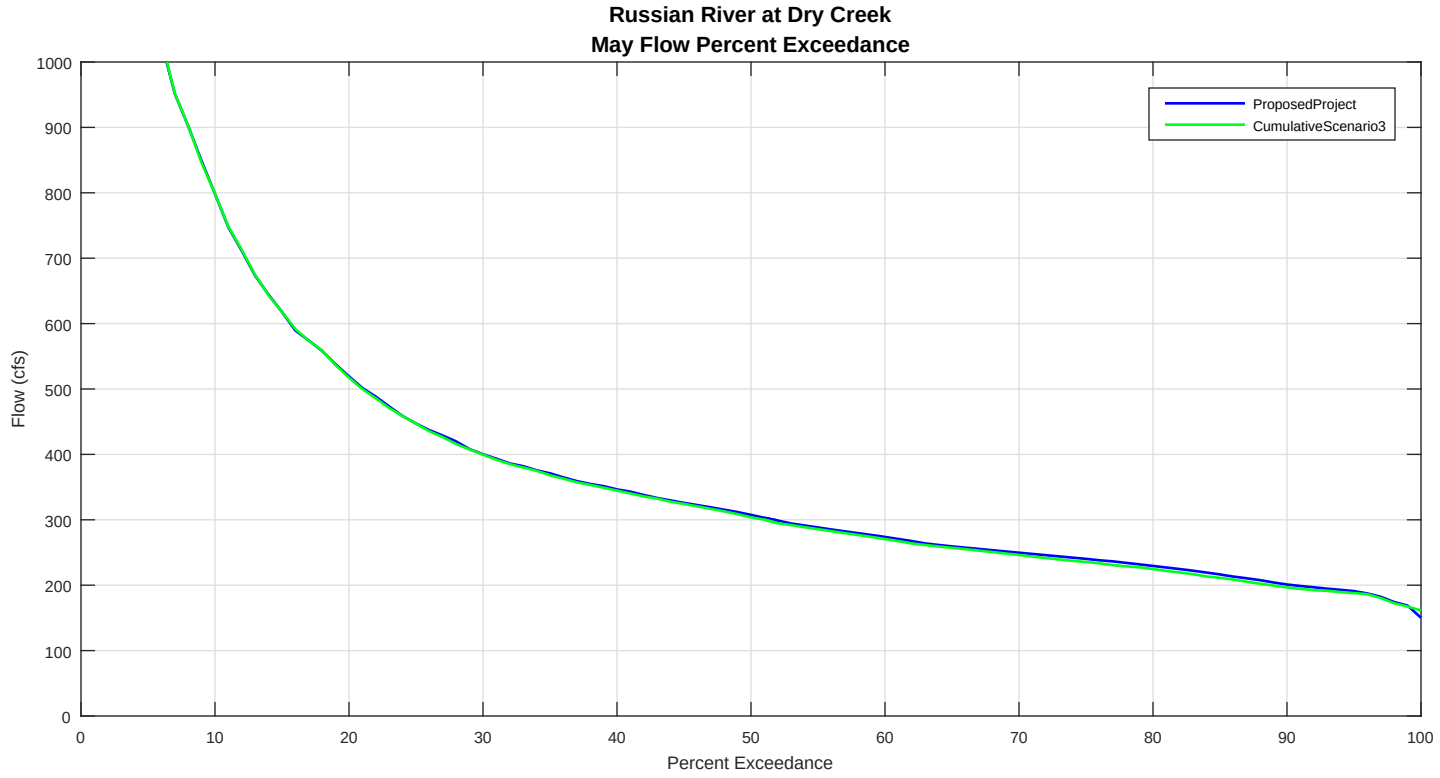
Russian River at Dry Creek
May Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario3
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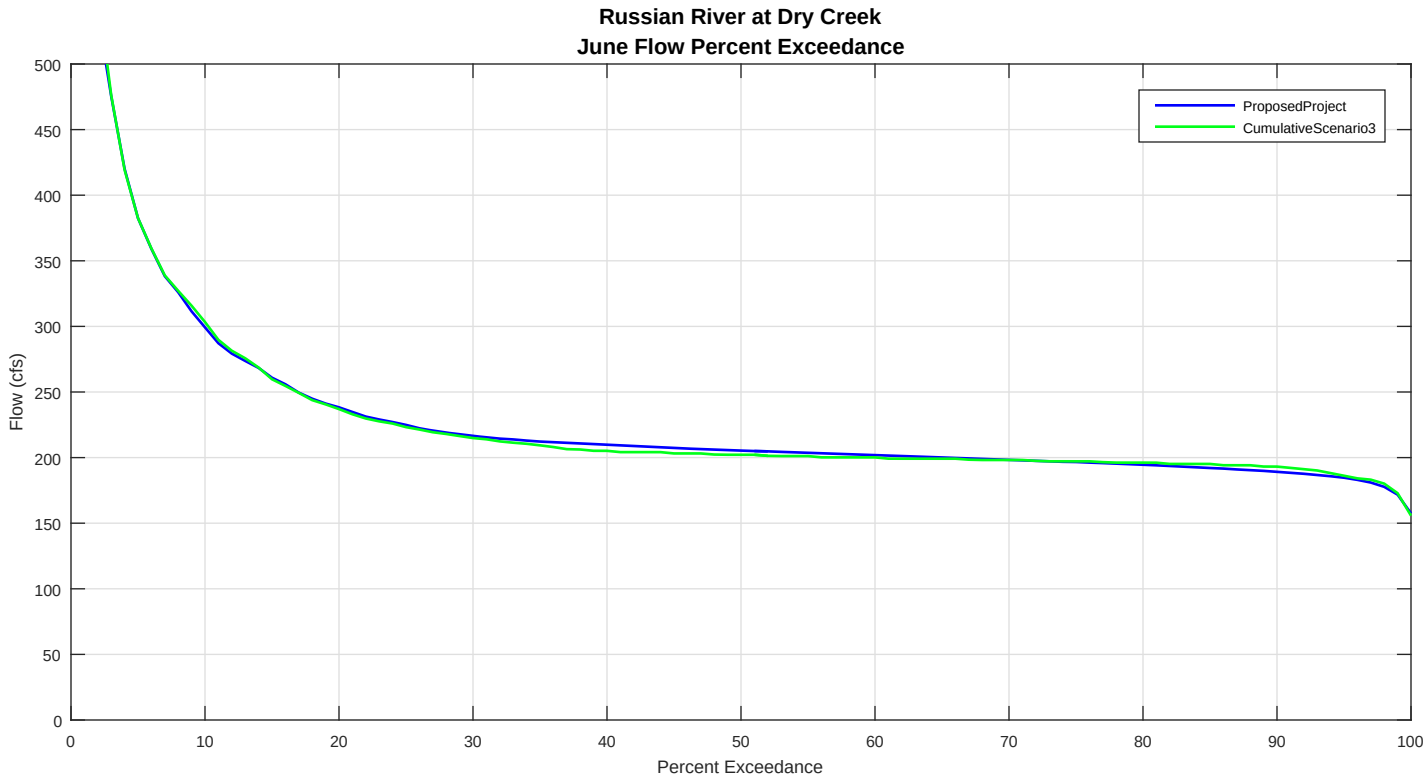
Russian River at Dry Creek
June Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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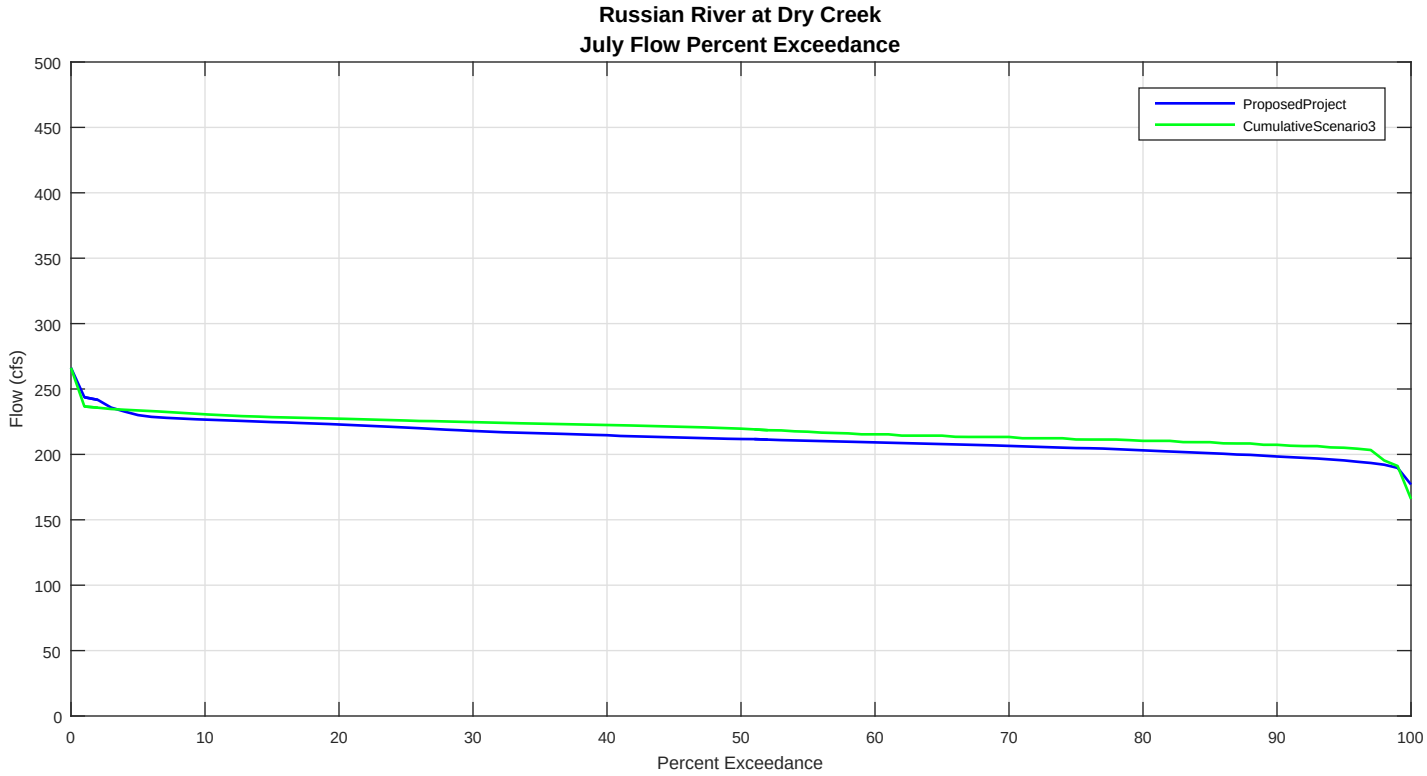
Russian River at Dry Creek
July Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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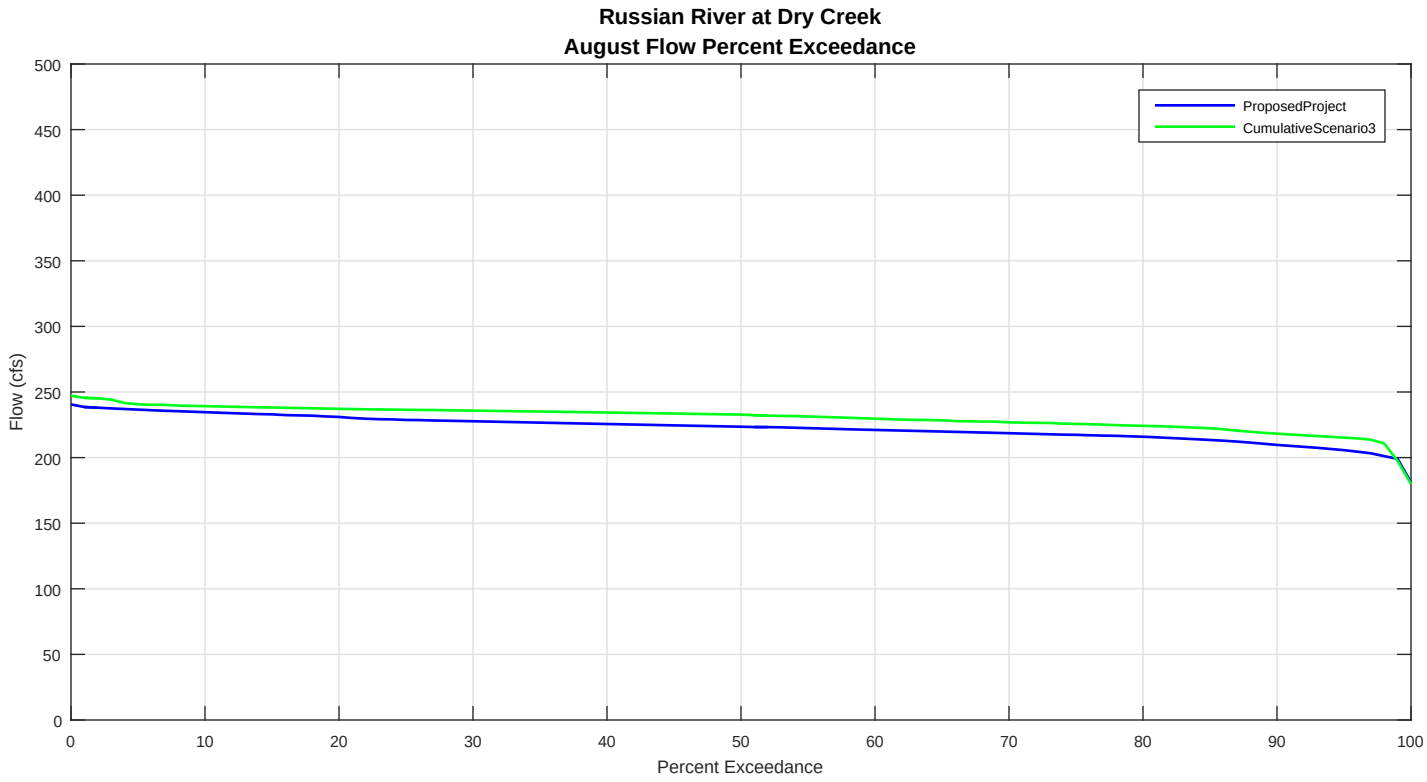
Russian River at Dry Creek
August Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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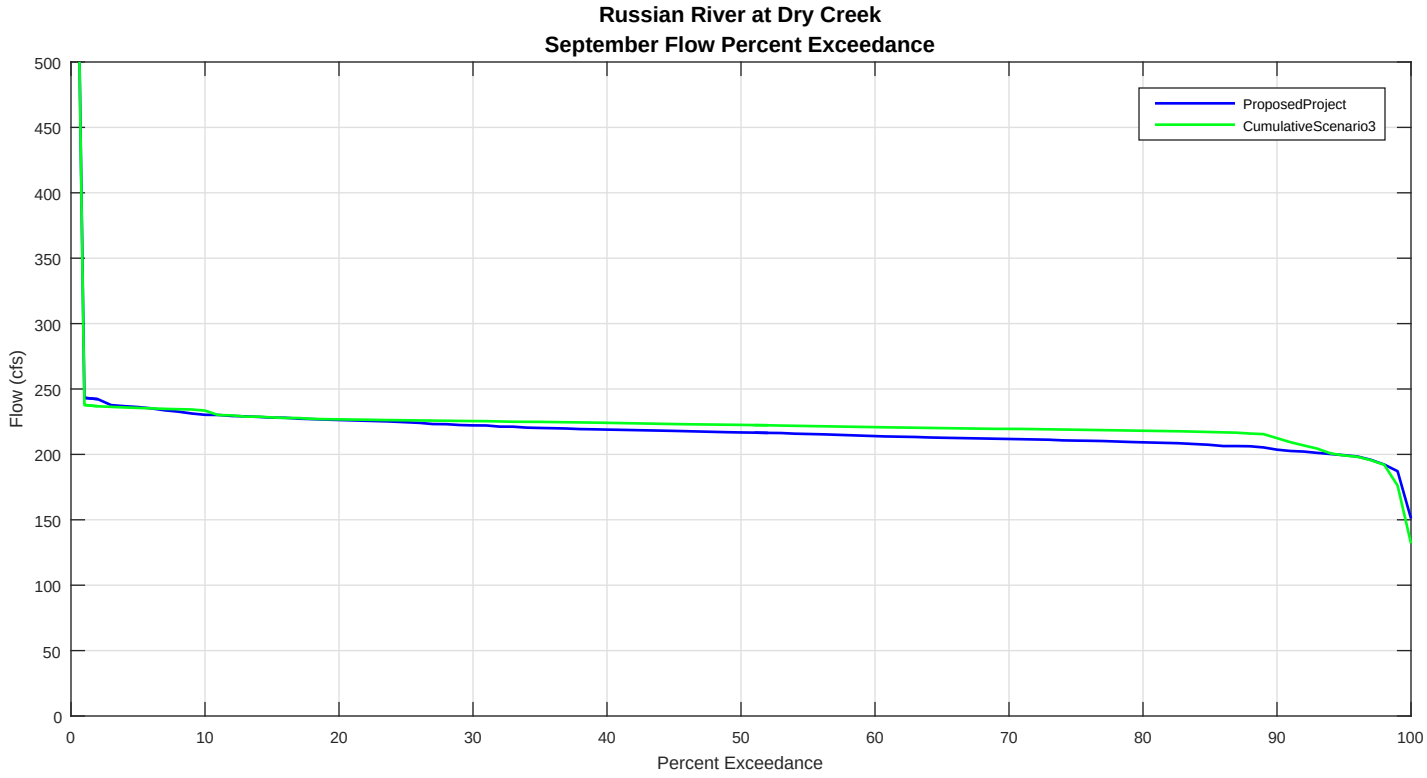
Russian River at Dry Creek
September Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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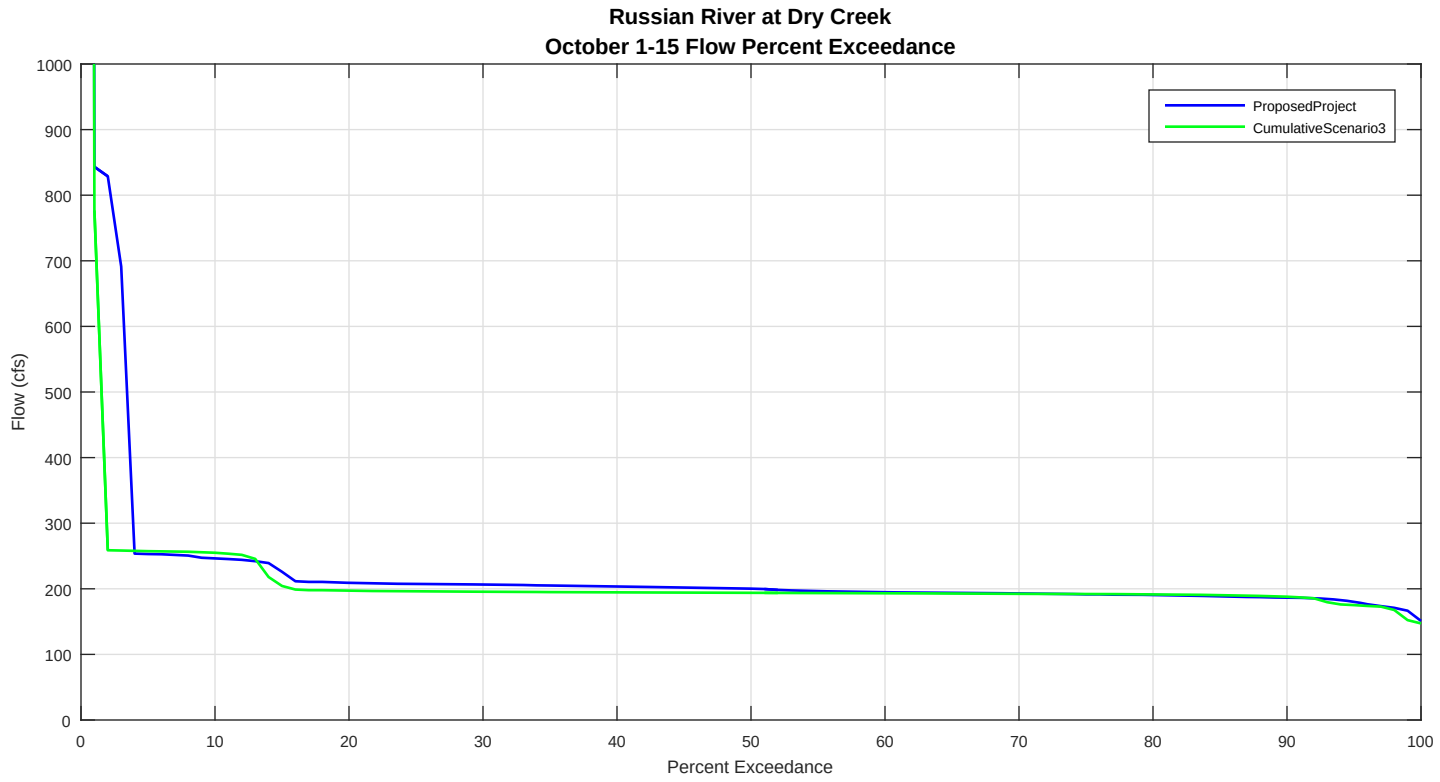
Russian River at Dry Creek
October 1-15 Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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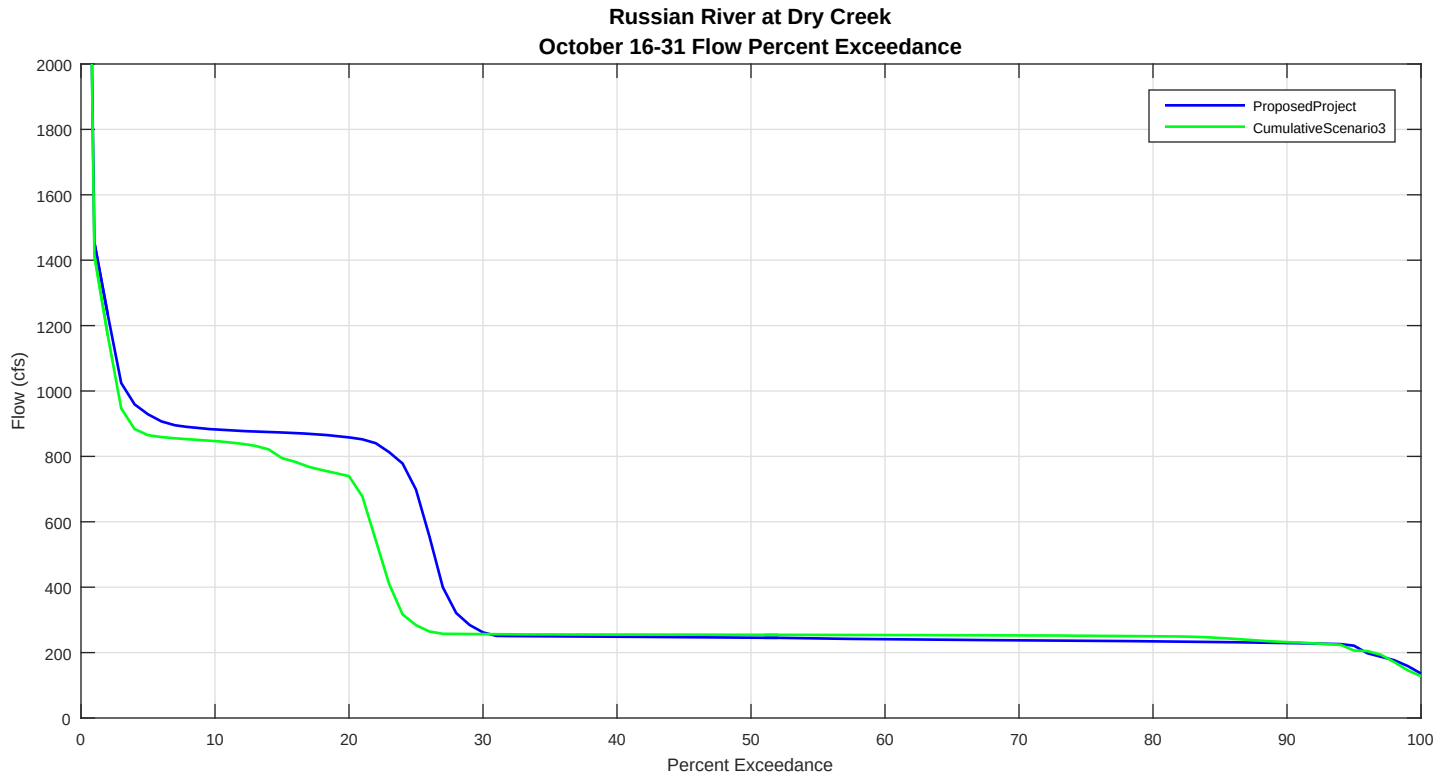
Russian River at Dry Creek
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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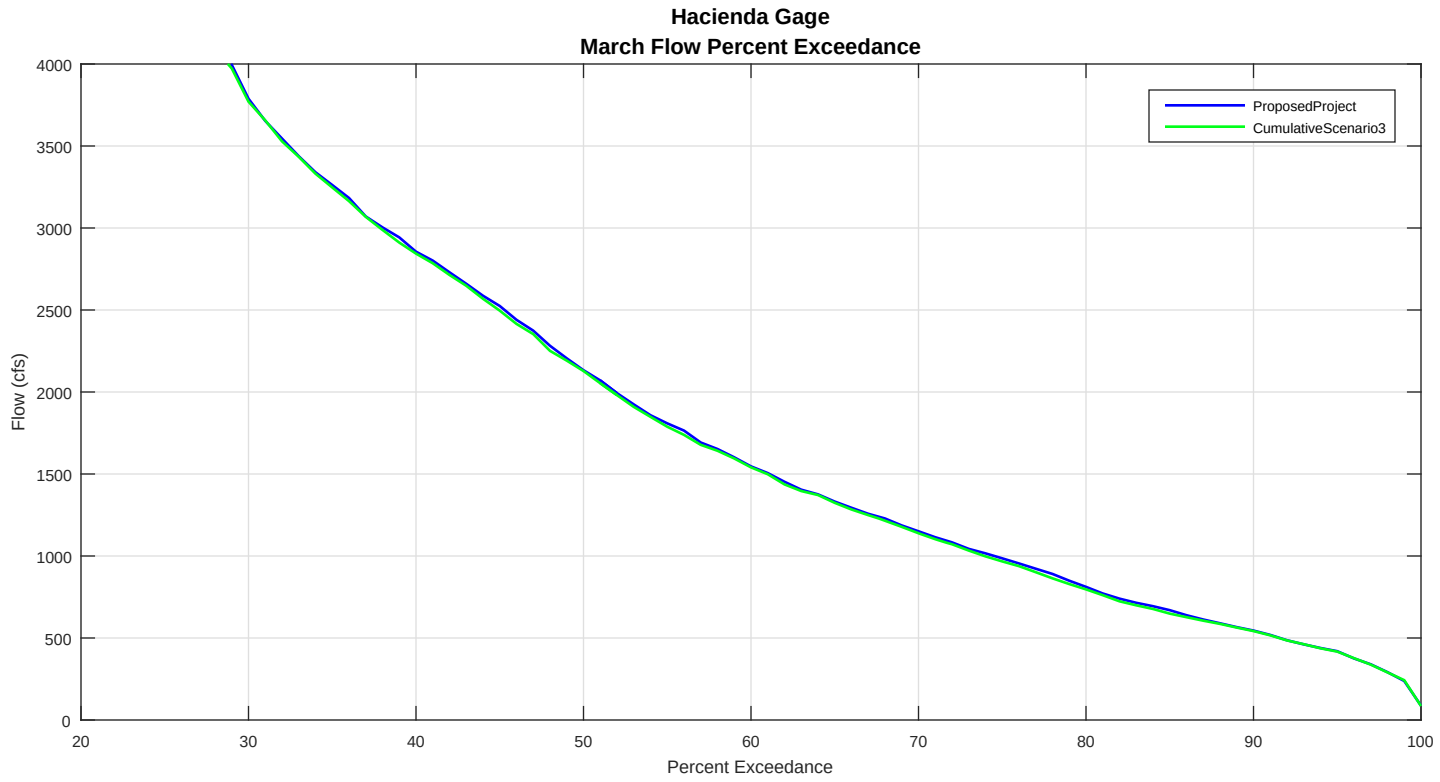
Hacienda Gage
March Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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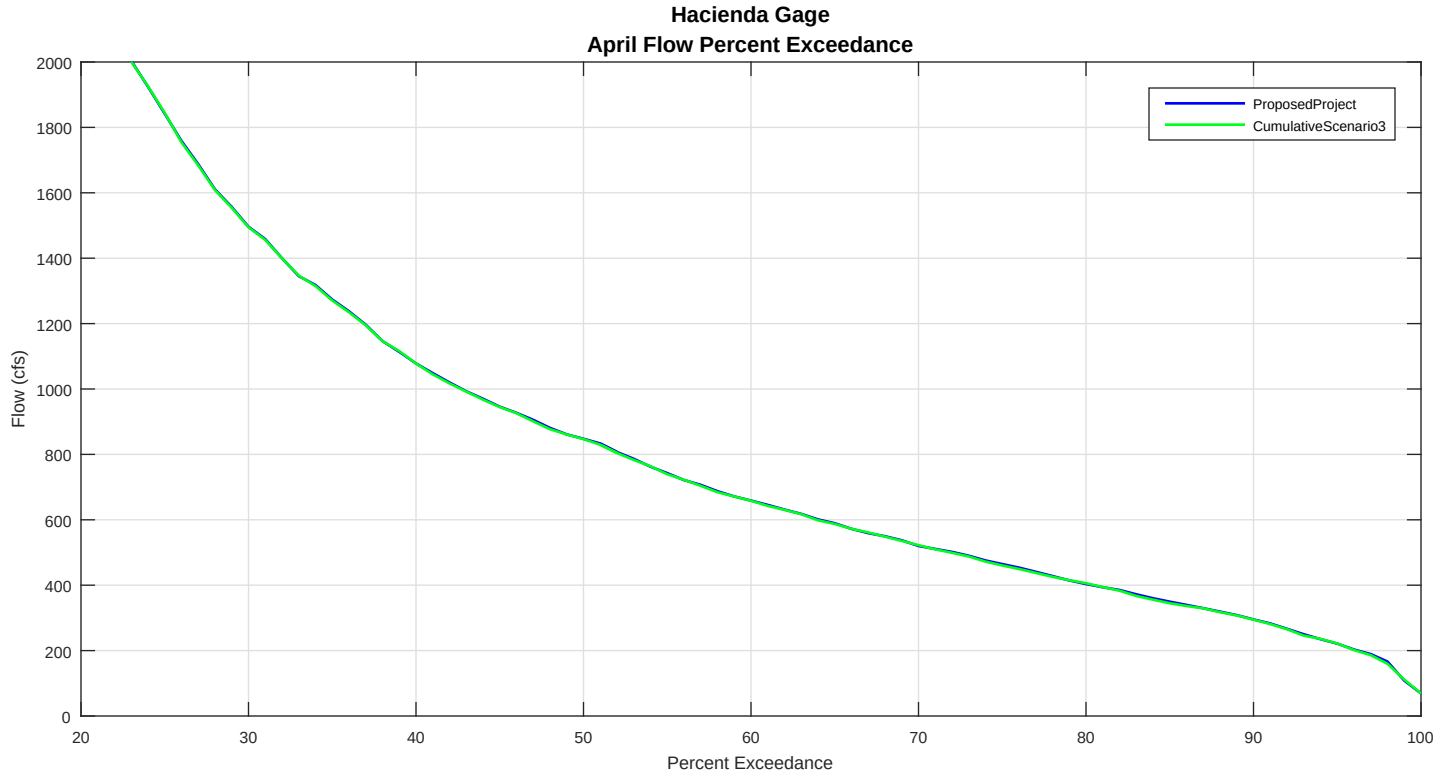
Hacienda Gage
April Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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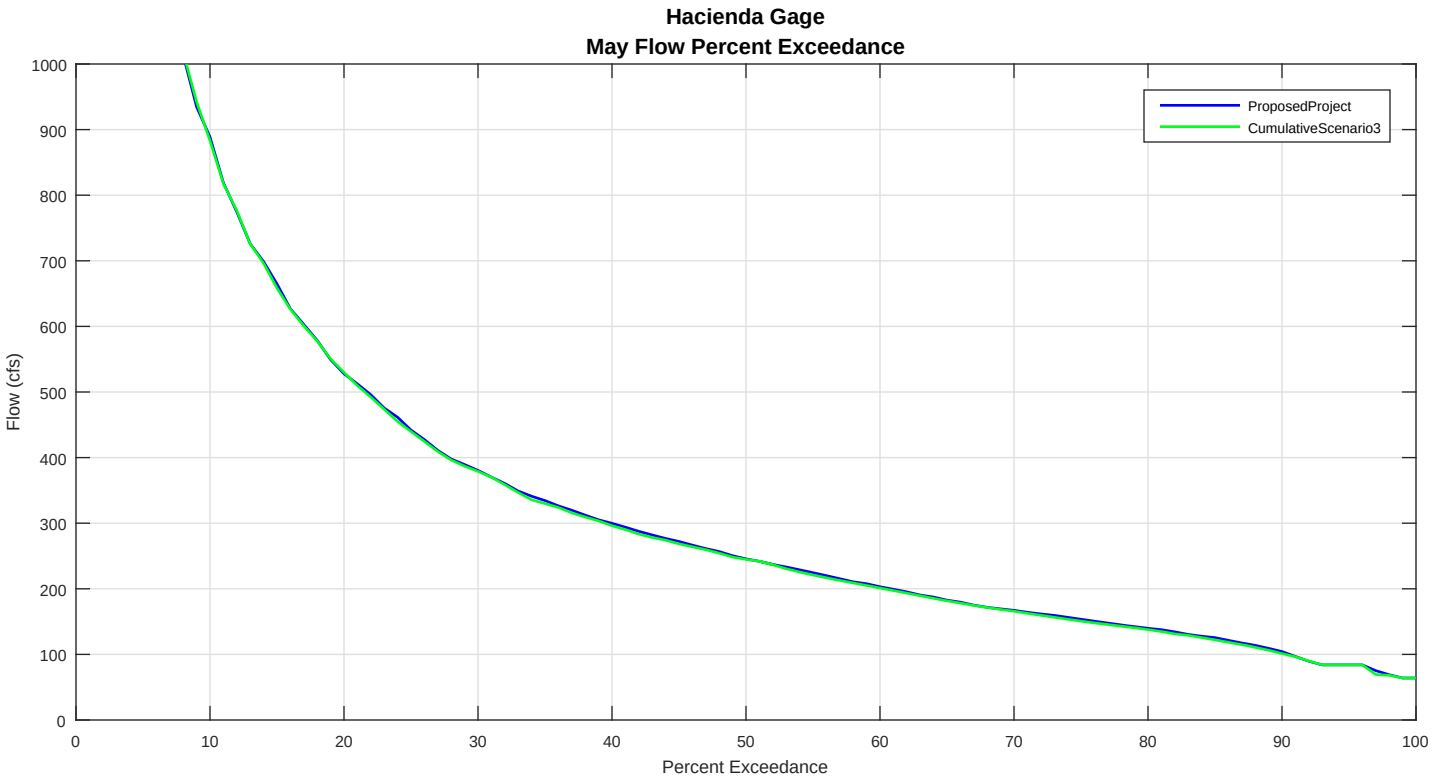
Hacienda Gage
May Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario3
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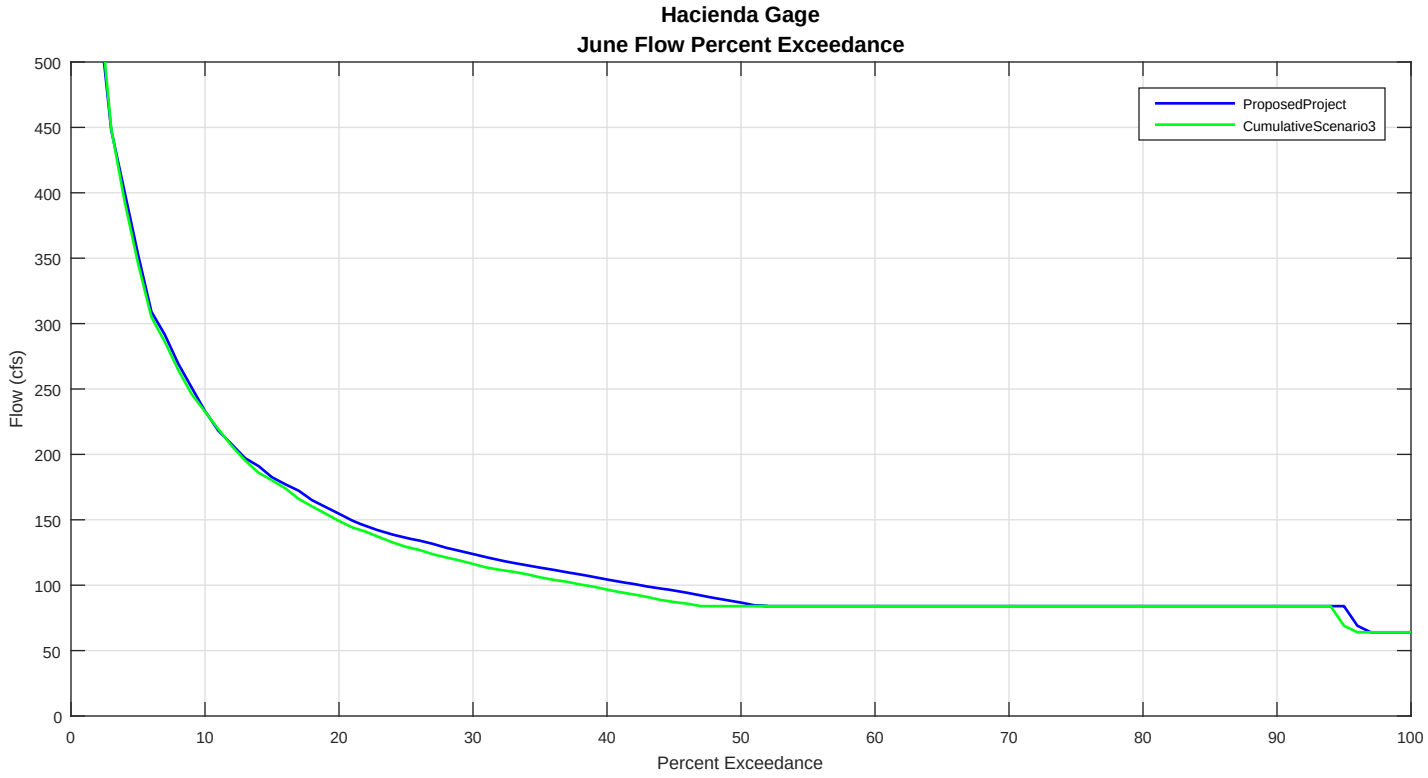
Hacienda Gage
June Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario3
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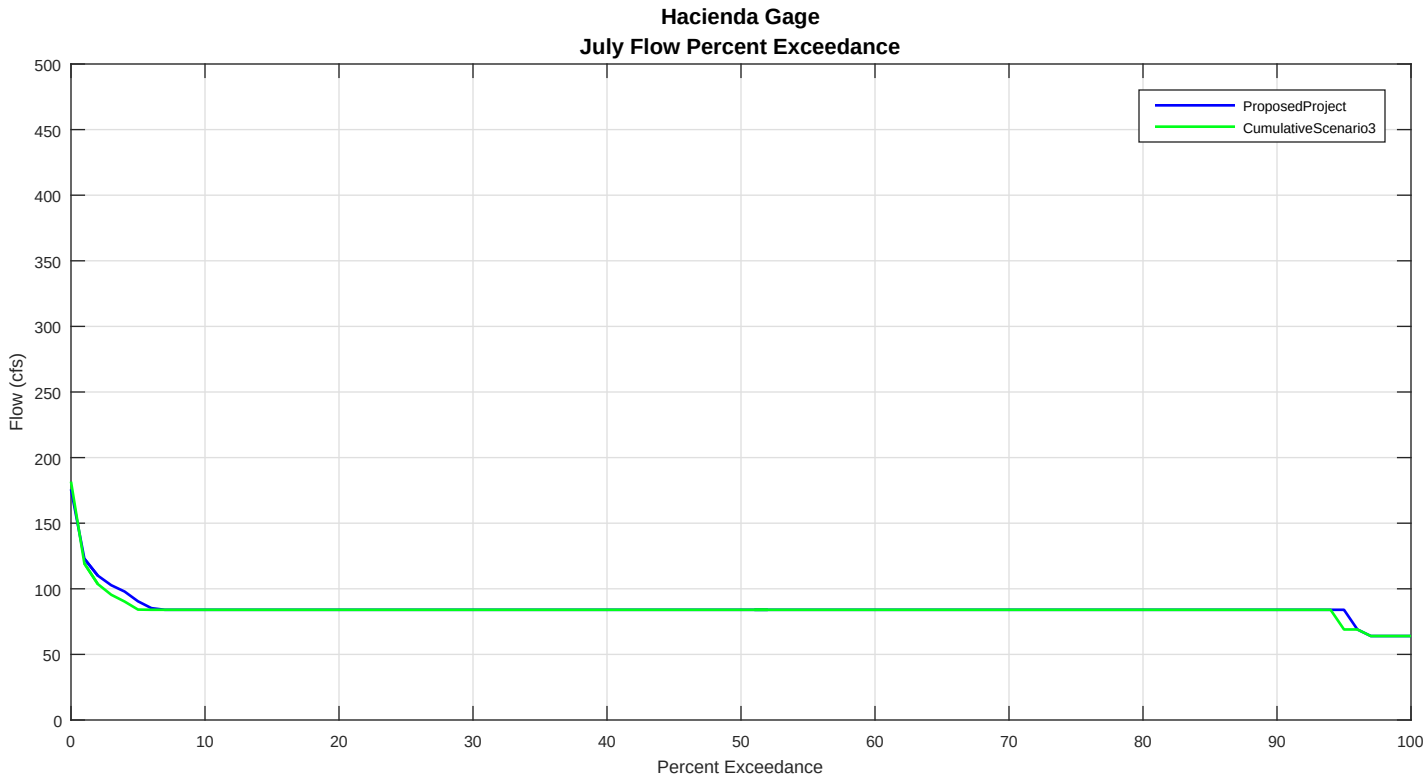
Hacienda Gage
July Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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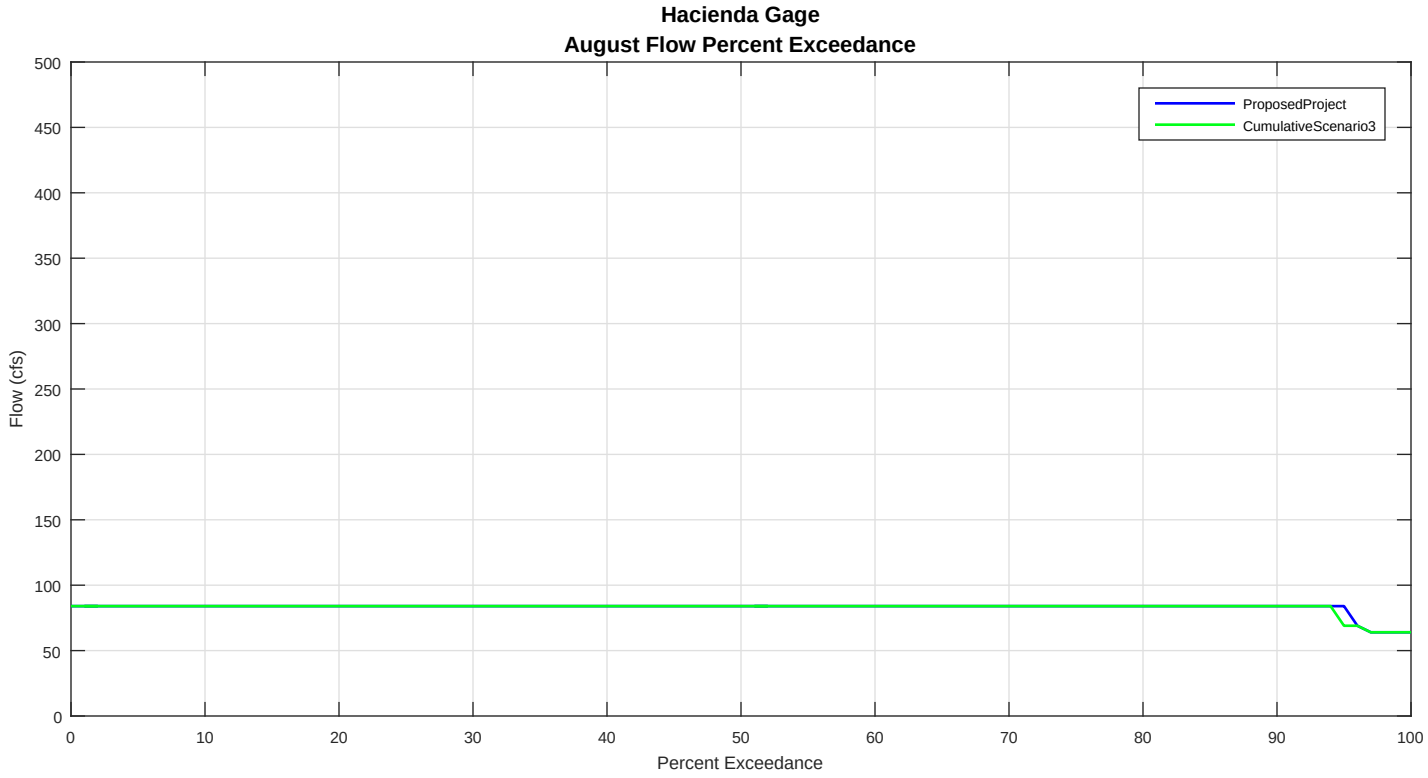
Hacienda Gage
August Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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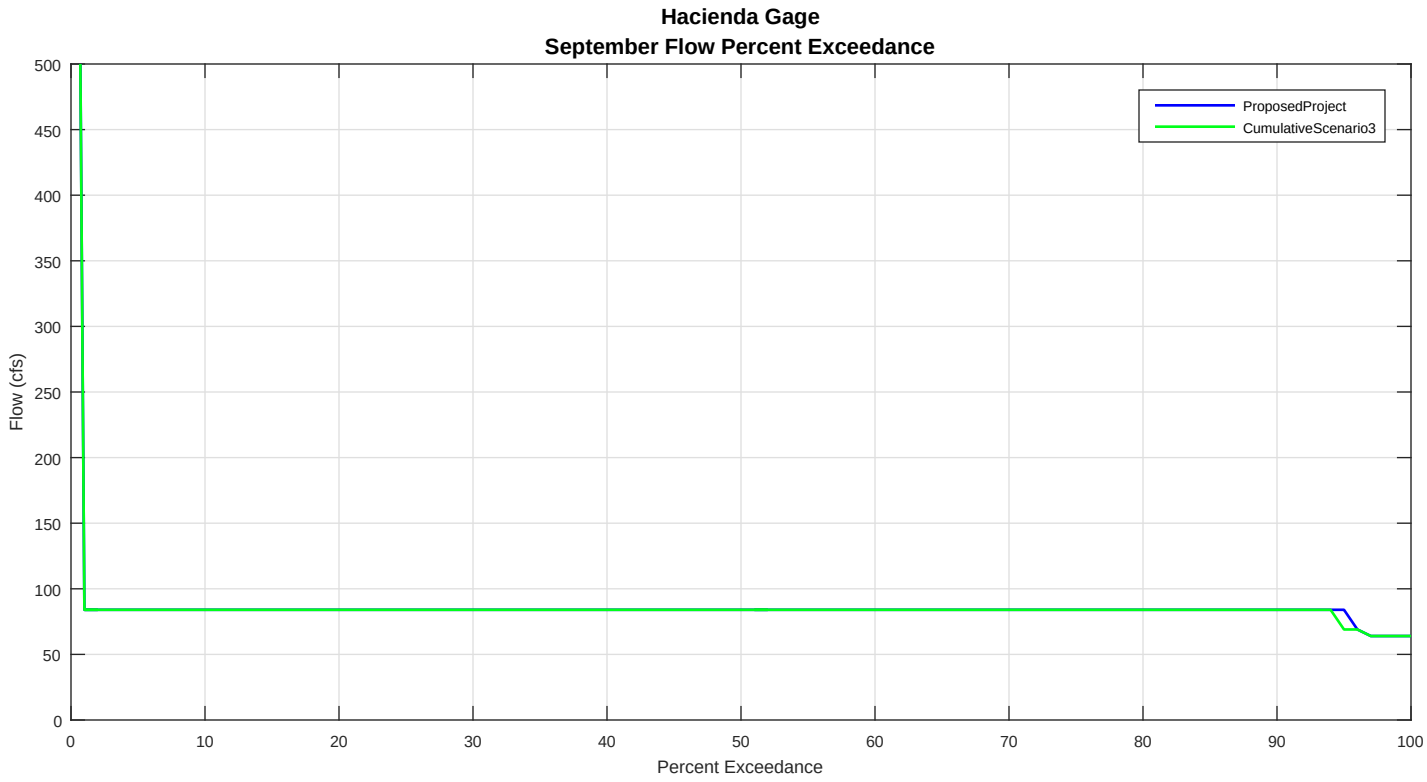
Hacienda Gage
September Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario3
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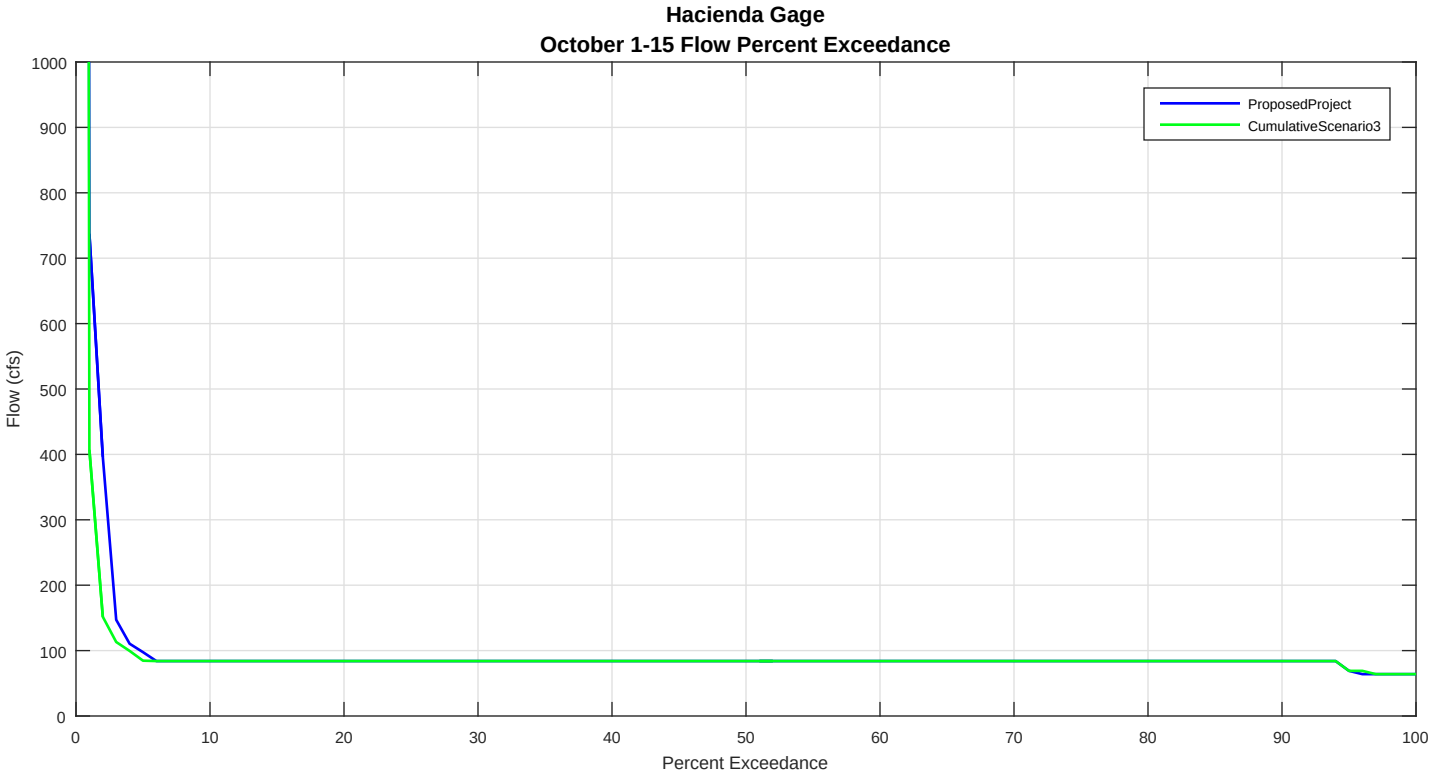
Hacienda Gage
October 1-15 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario3
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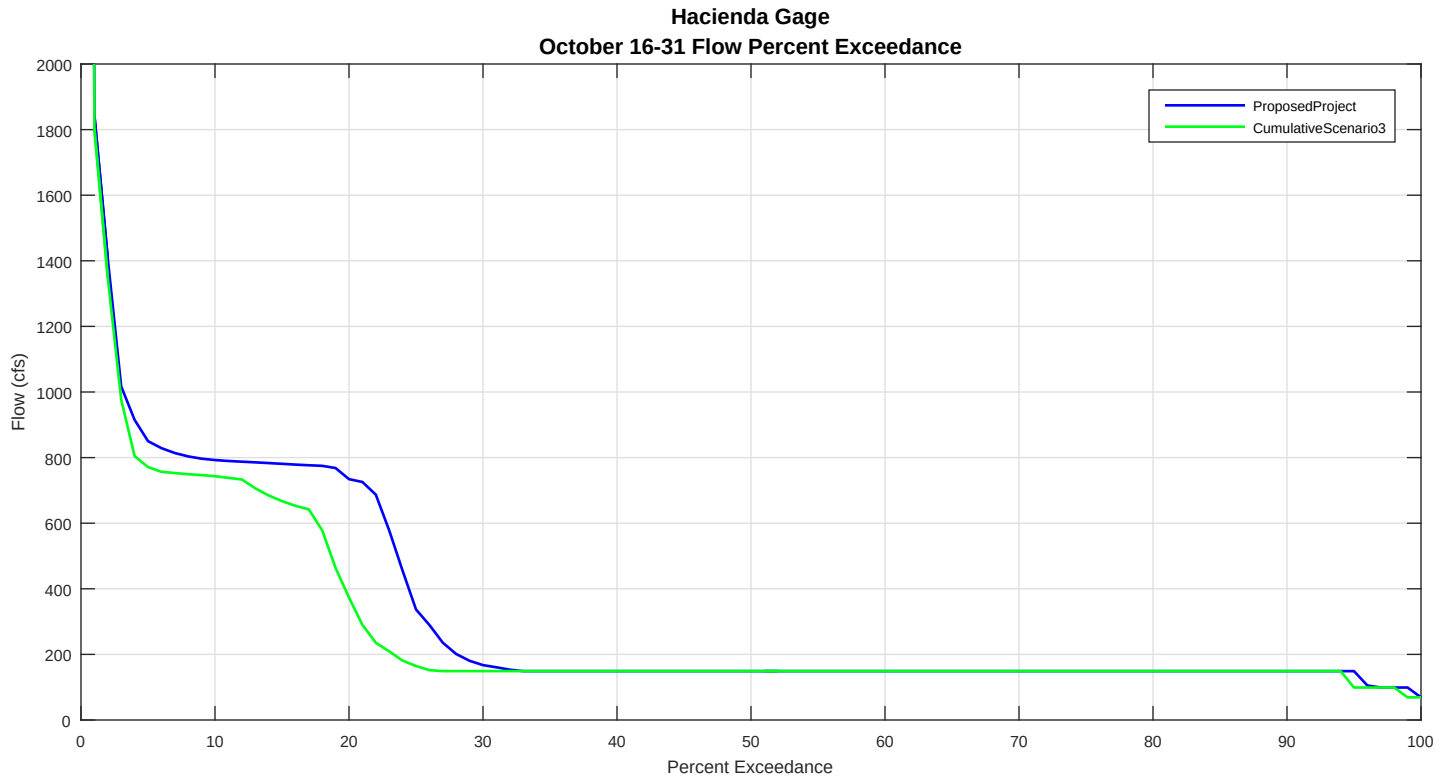
Hacienda Gage
October 16-31 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario3
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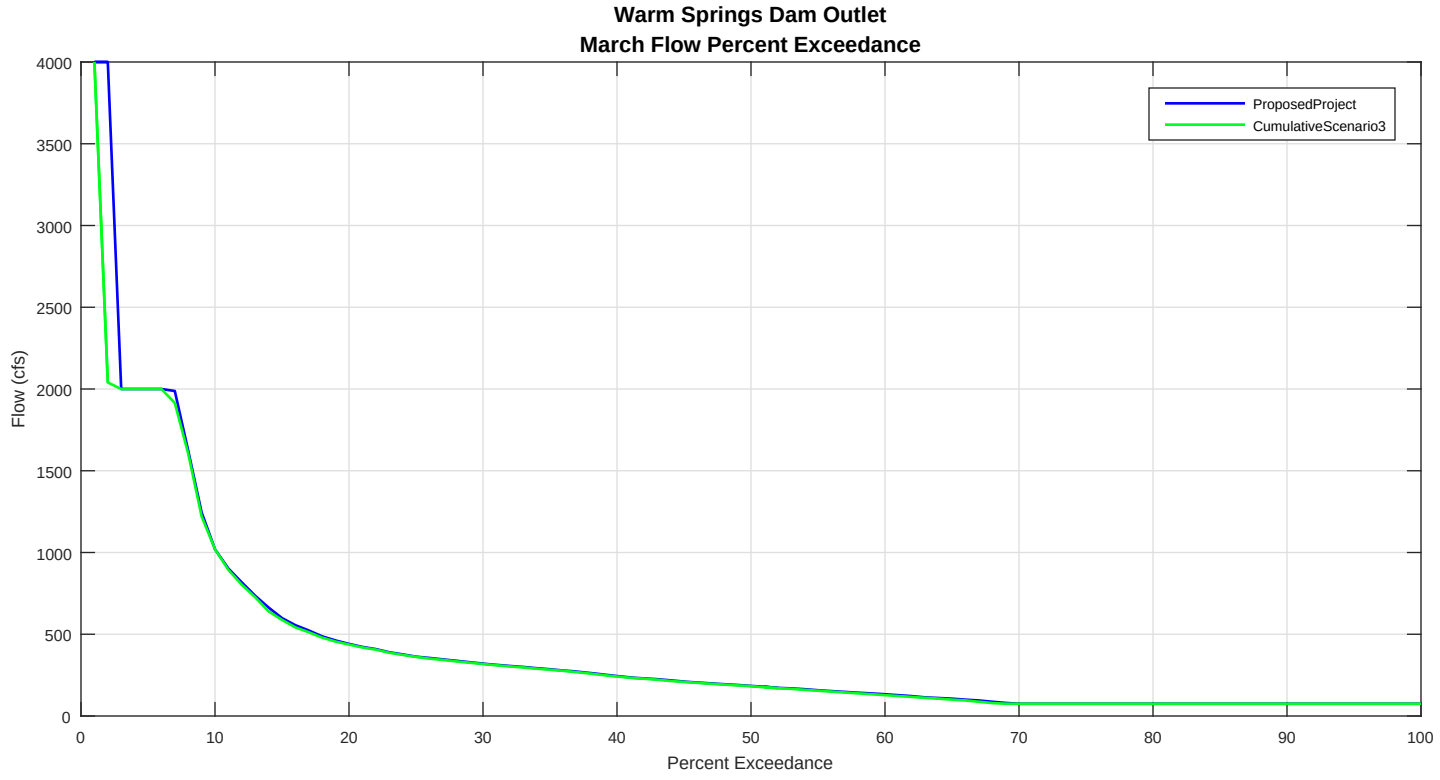
Warm Springs Dam Outlet
March Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario3
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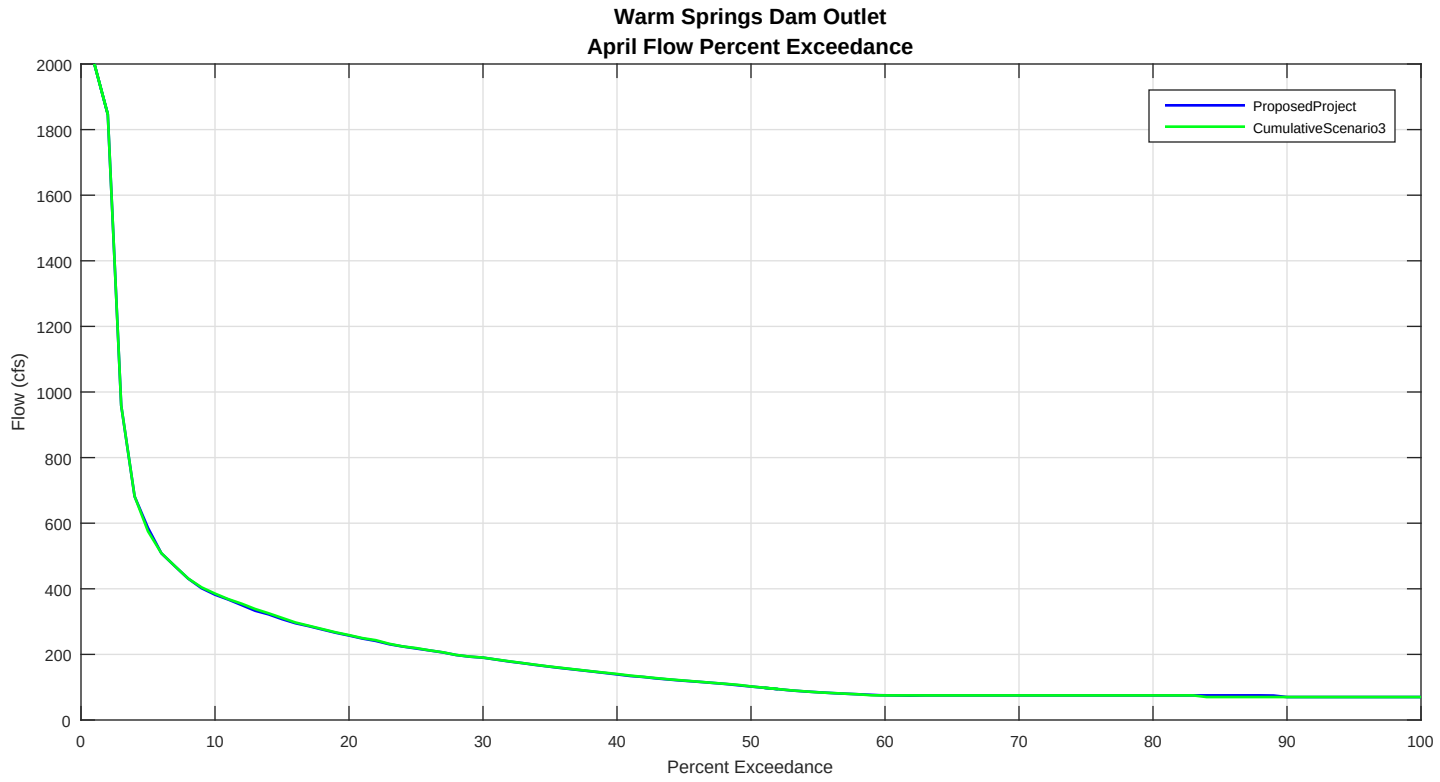
Warm Springs Dam Outlet
April Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario3
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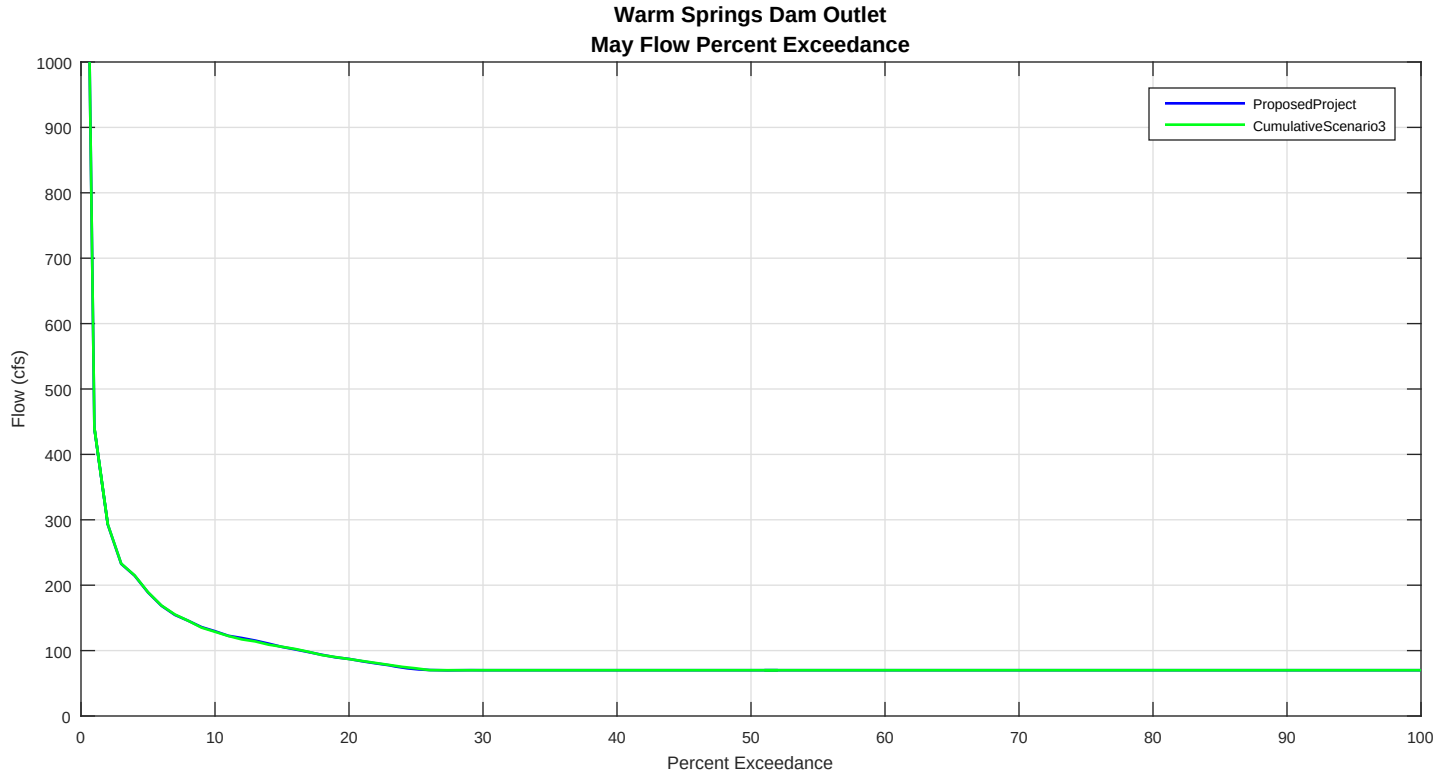
Warm Springs Dam Outlet
May Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario3
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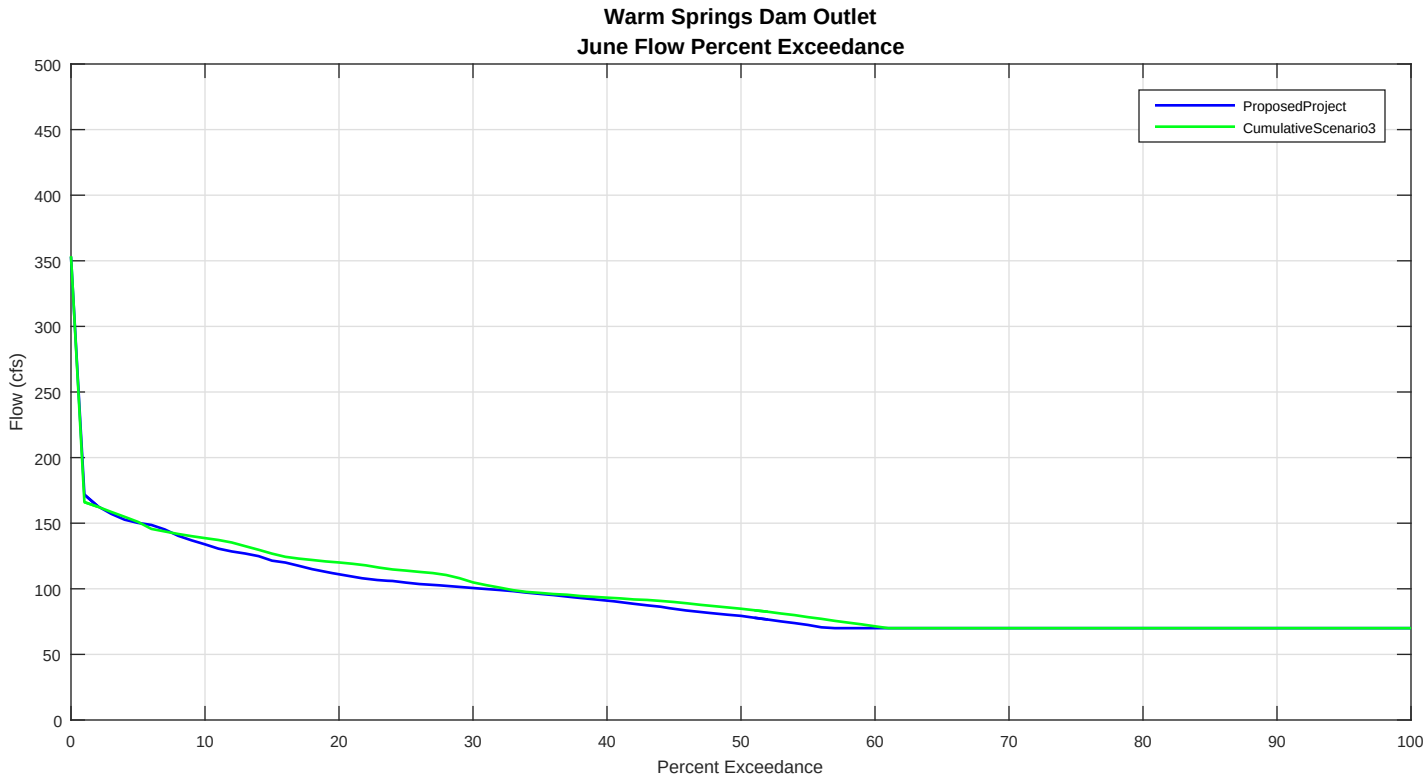
Warm Springs Dam Outlet
June Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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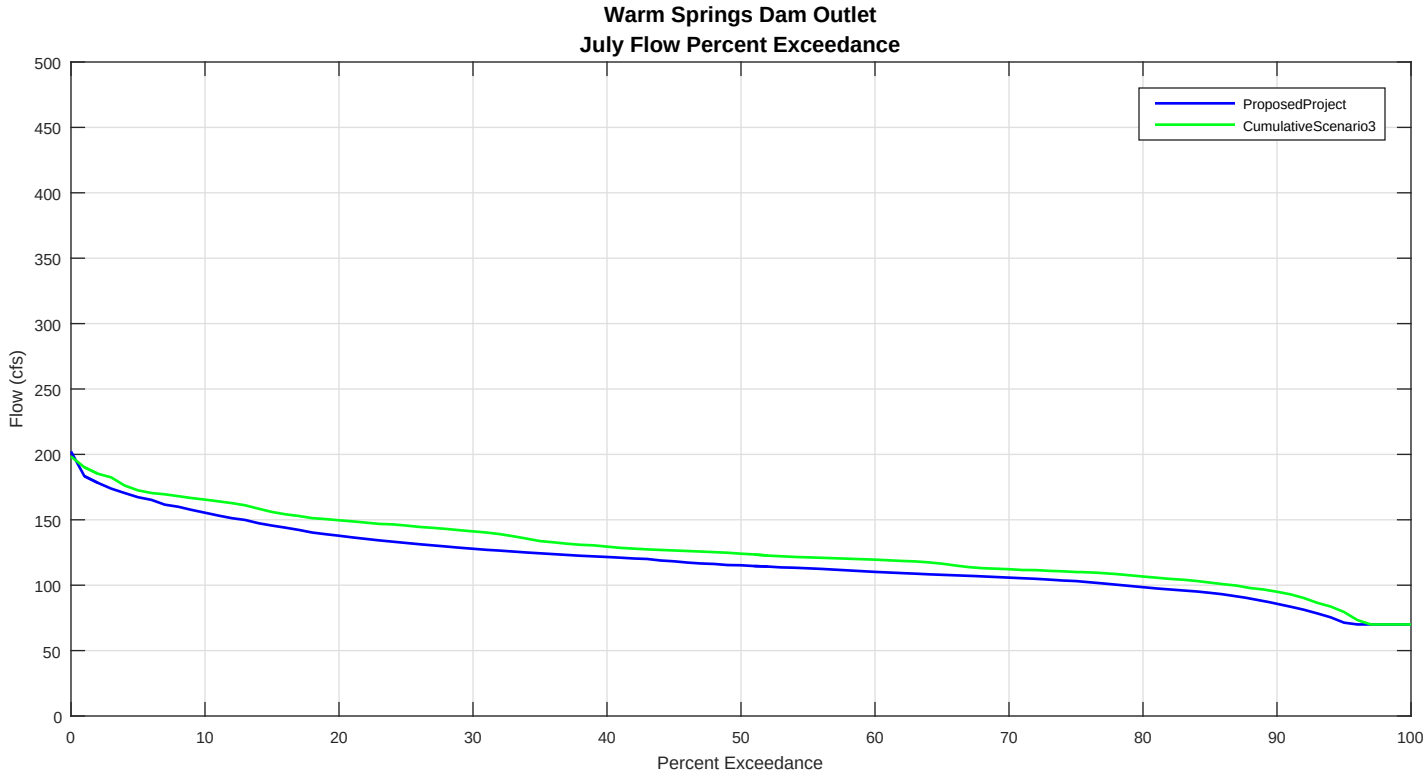
Warm Springs Dam Outlet
July Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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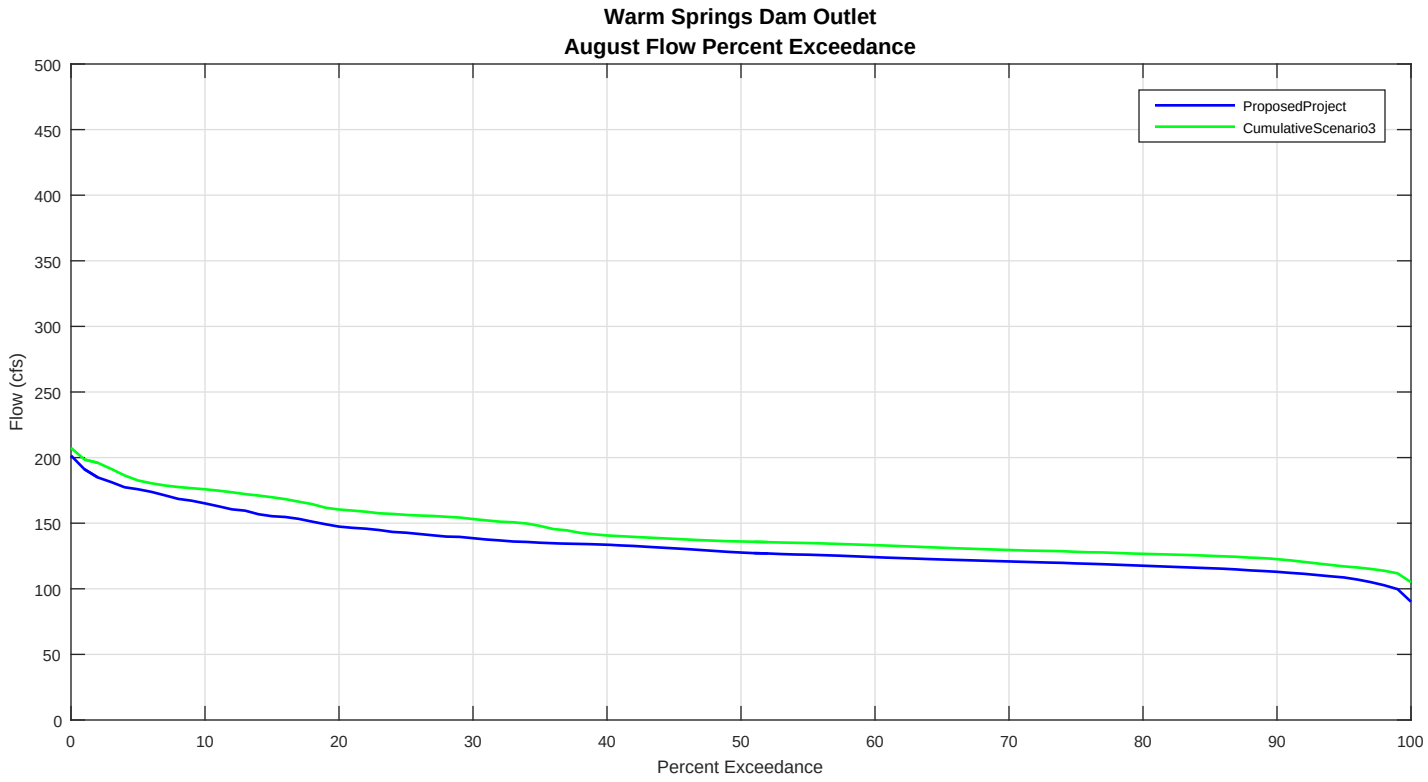
Warm Springs Dam Outlet
August Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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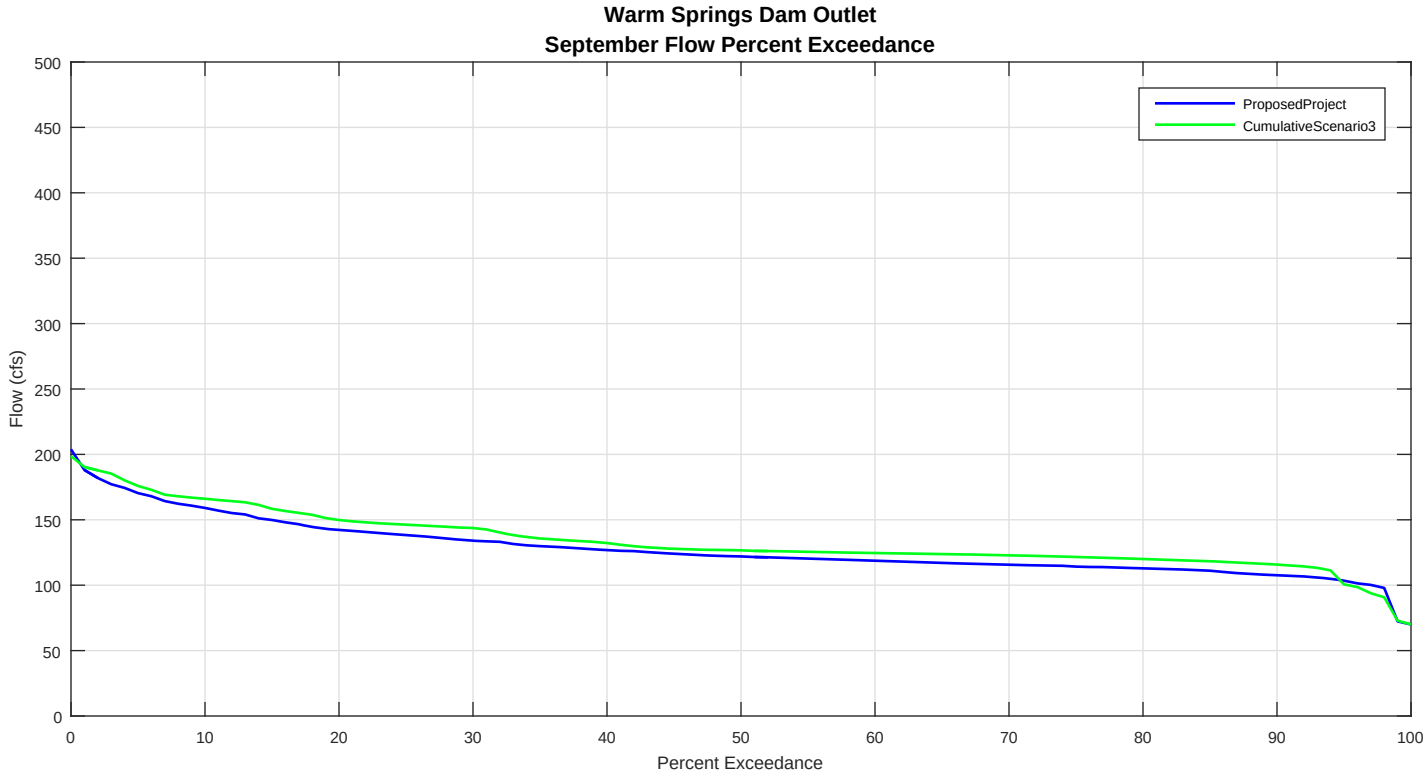
Warm Springs Dam Outlet
September Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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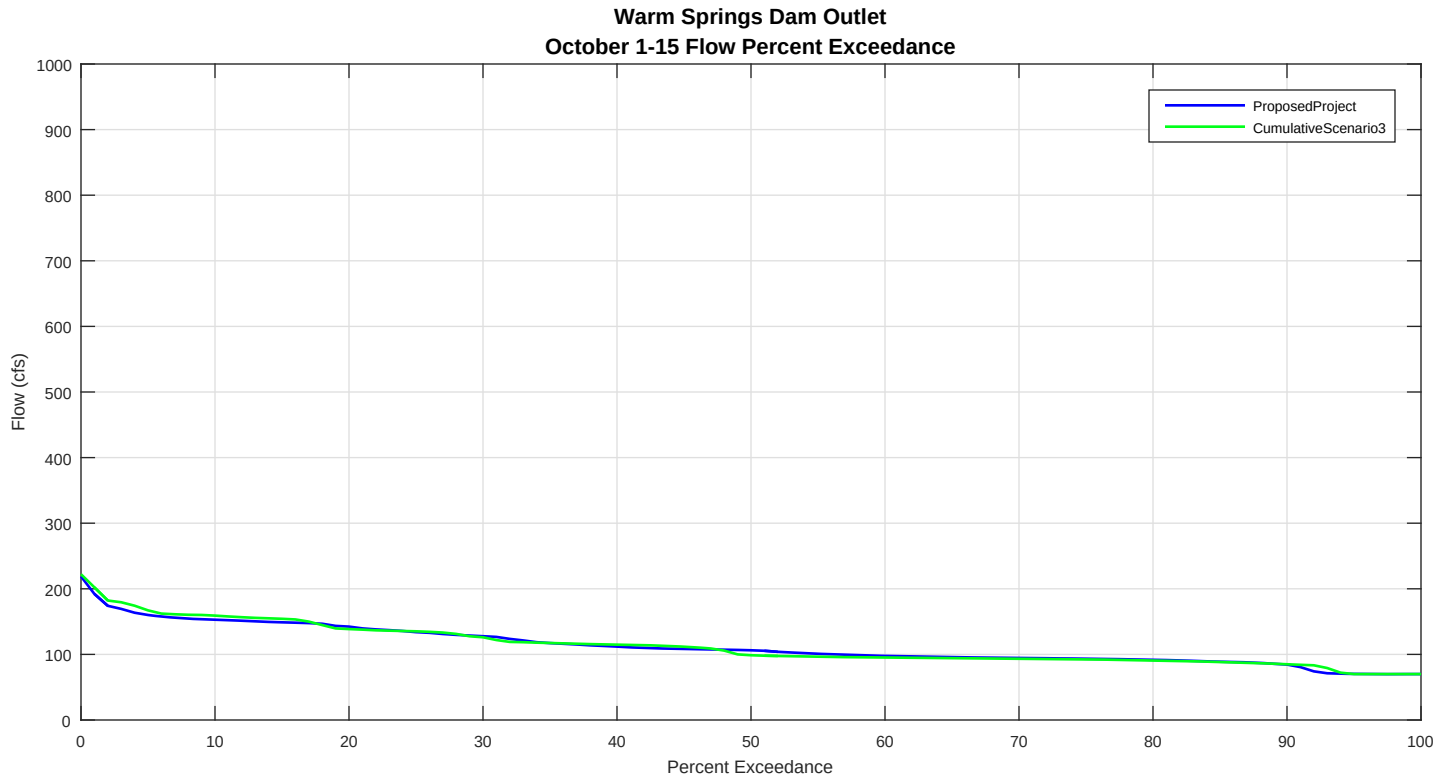
Warm Springs Dam Outlet
October 1-15 Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
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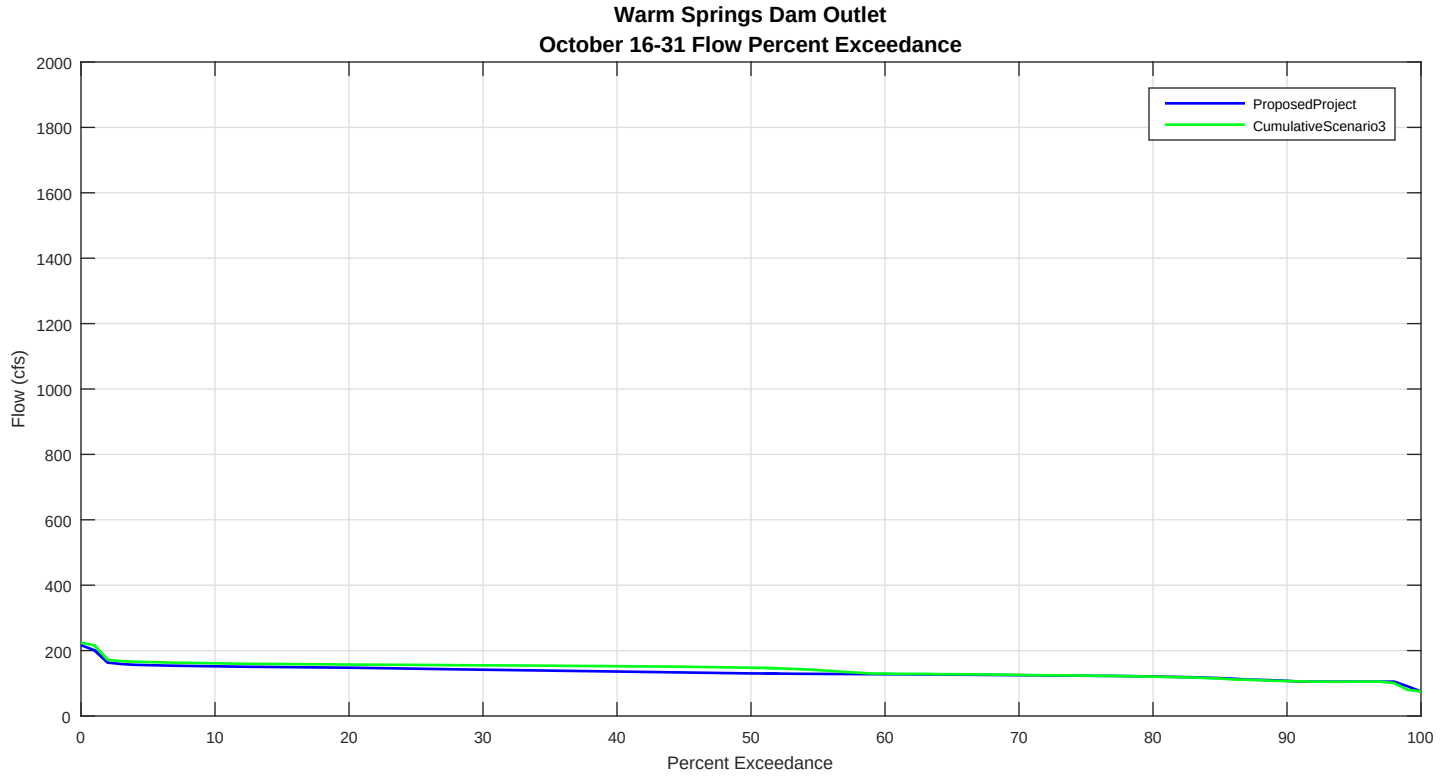
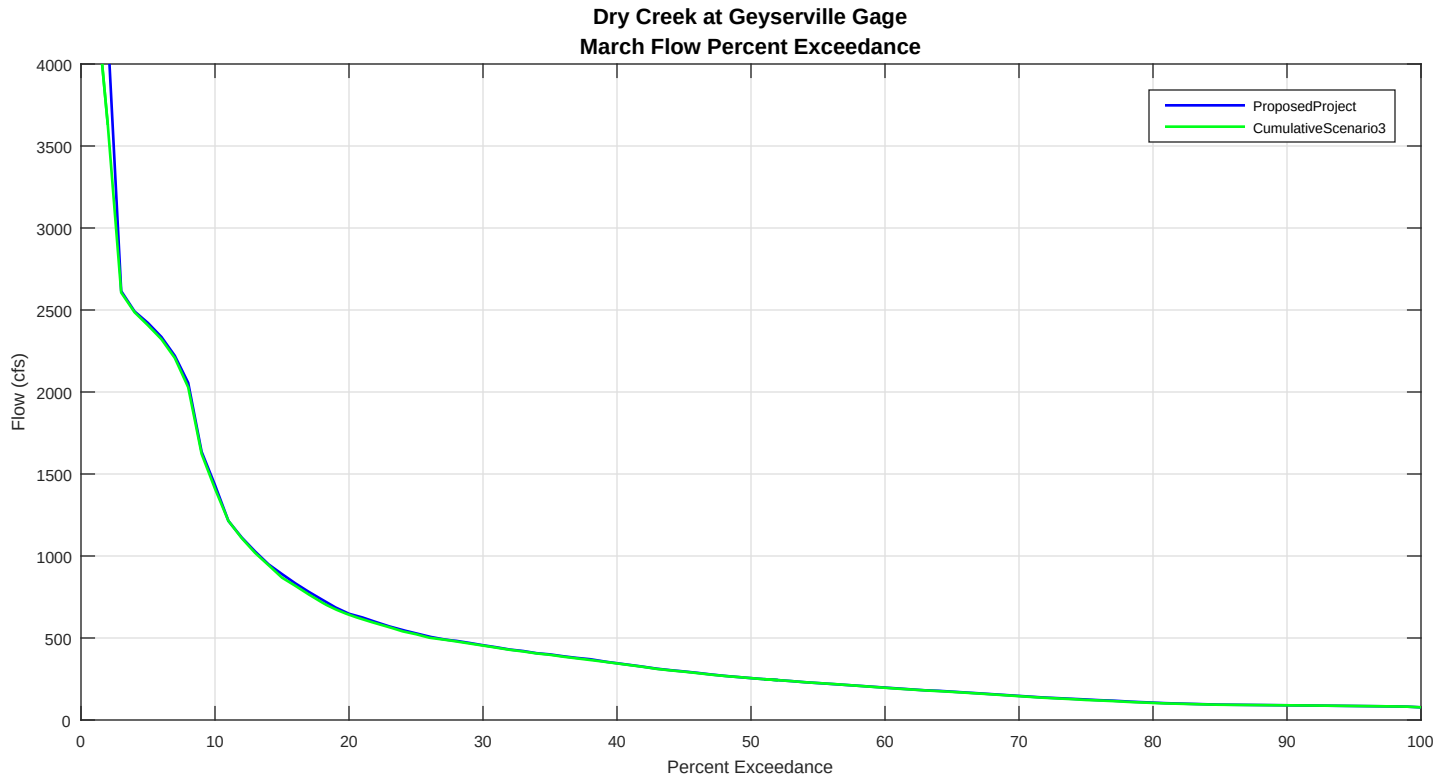
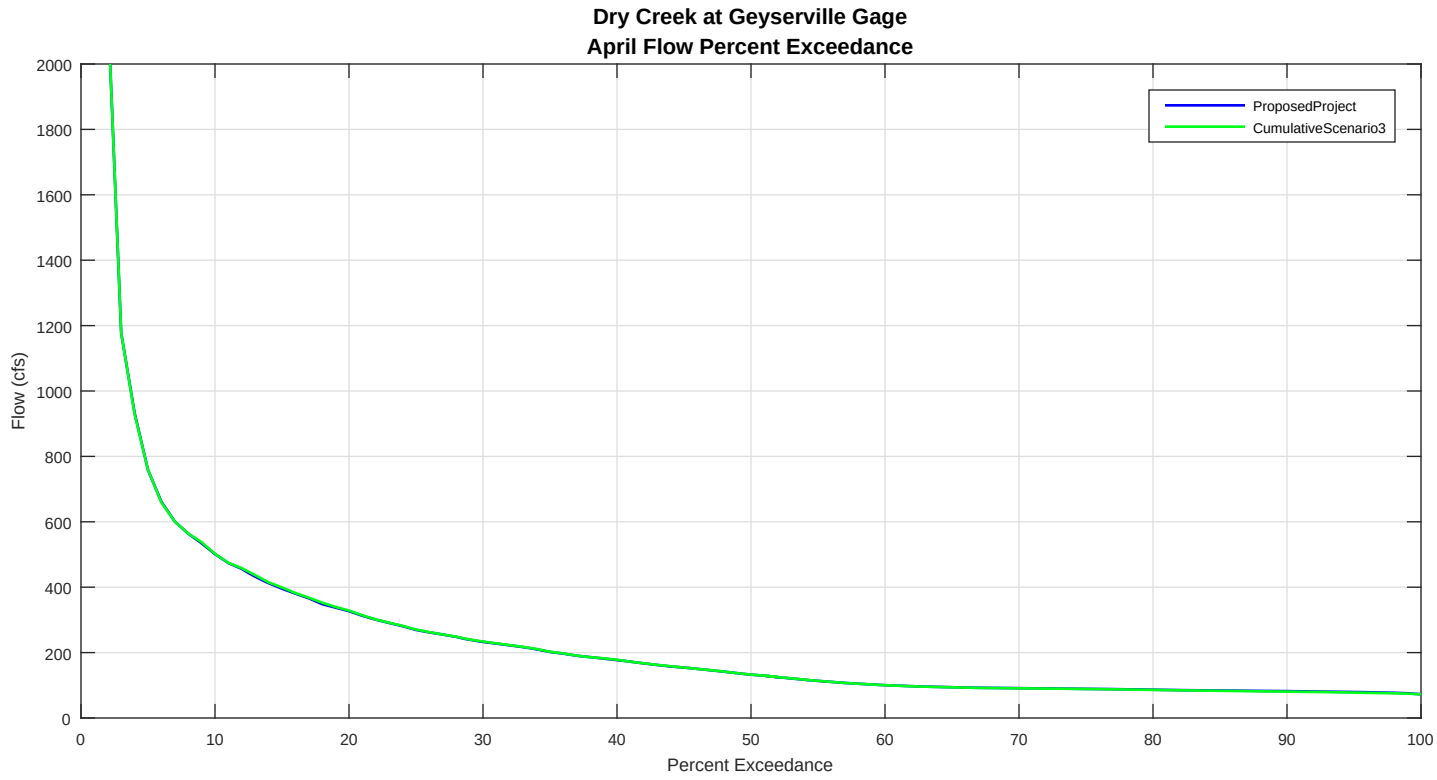
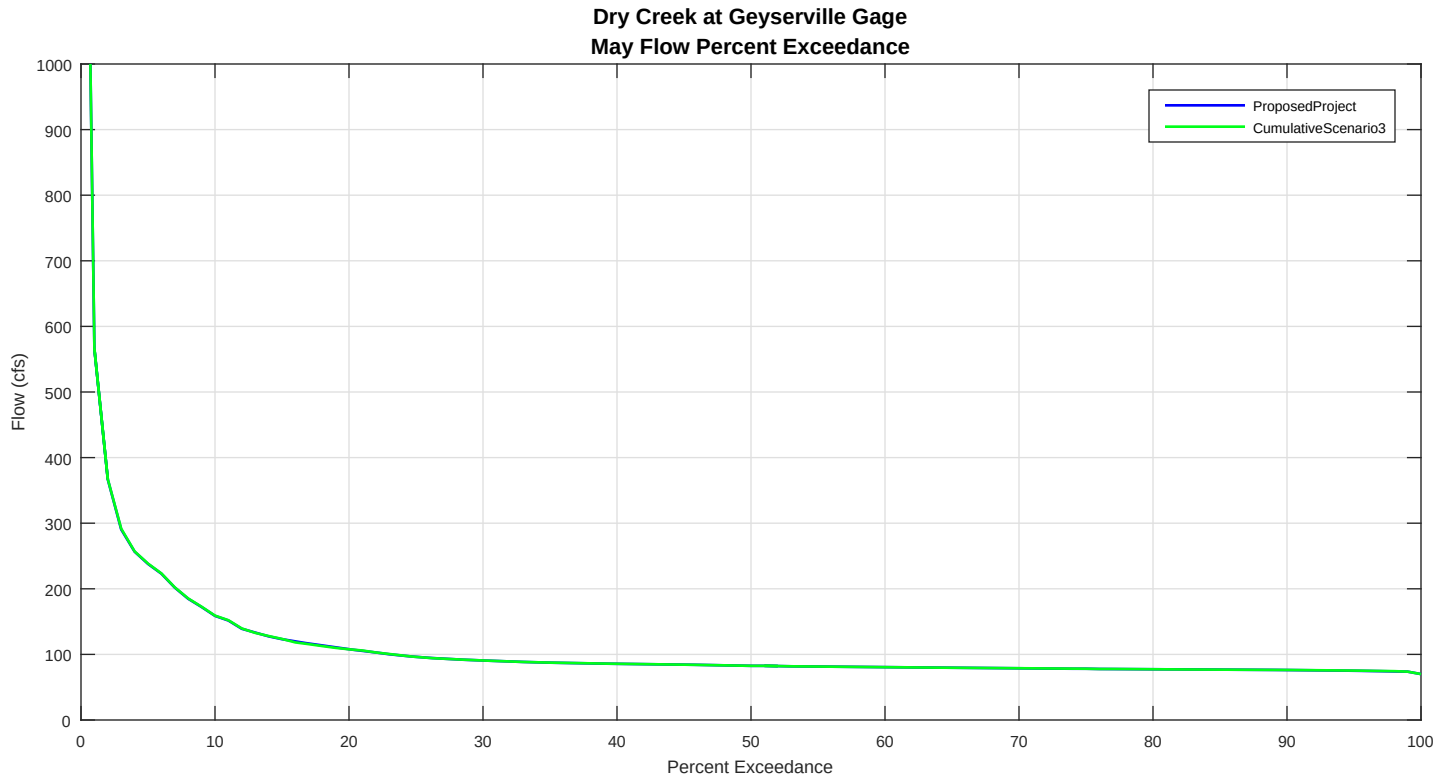

Warm Springs Dam Outlet
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100


Dry Creek at Geyserville Gage
March Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
0
500
1000
1500
2000
2500
3000
3500
4000
0
10
20
30
40
50
60
70
80
90
100


Dry Creek at Geyserville Gage
April Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100


Dry Creek at Geyserville Gage
May Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
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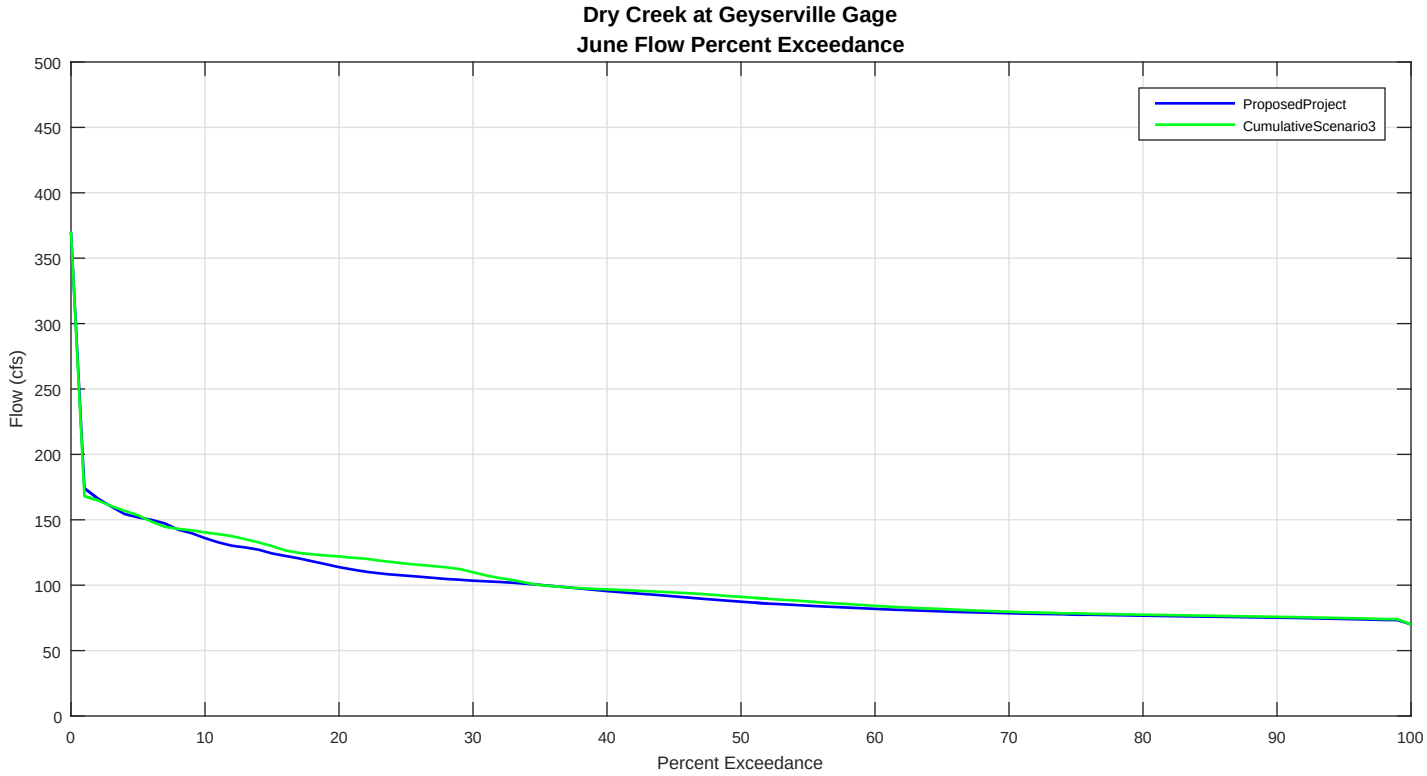
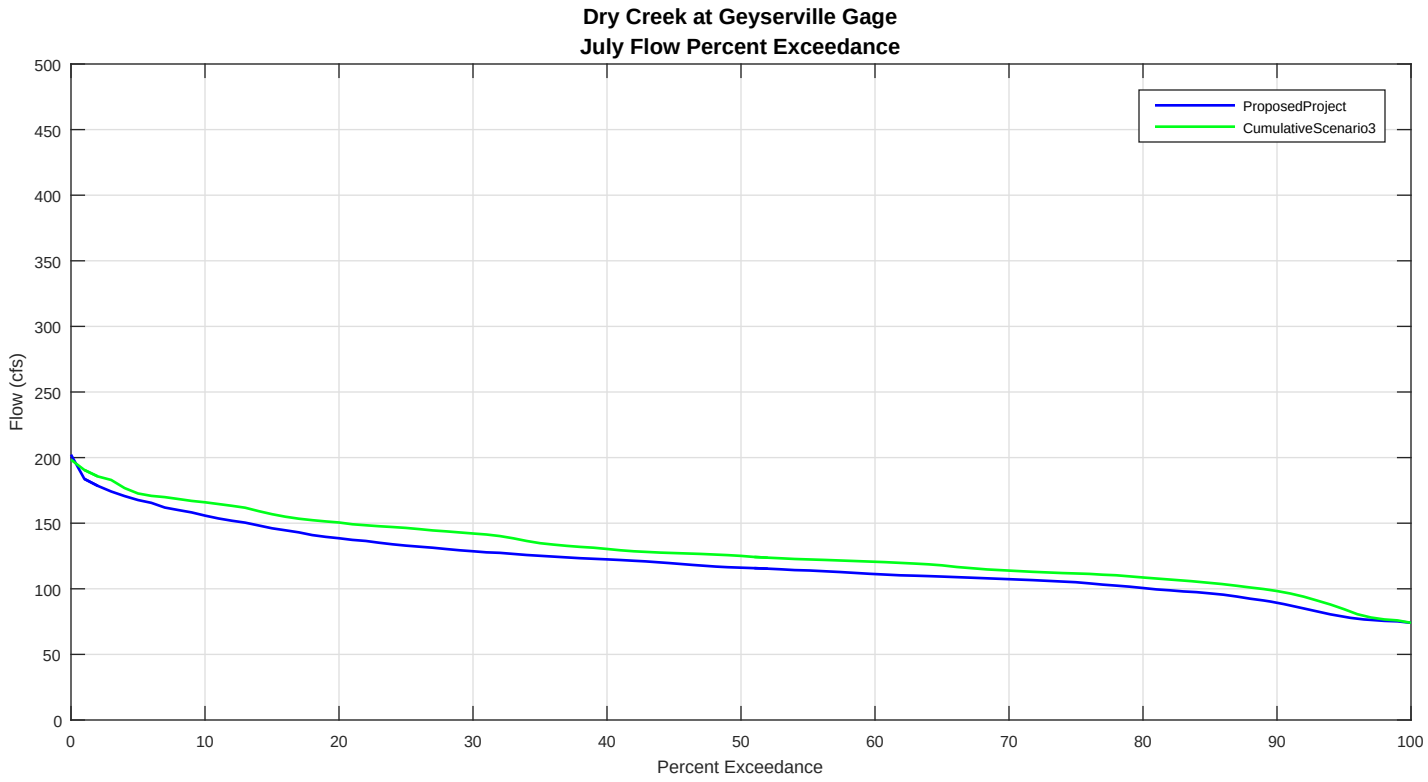
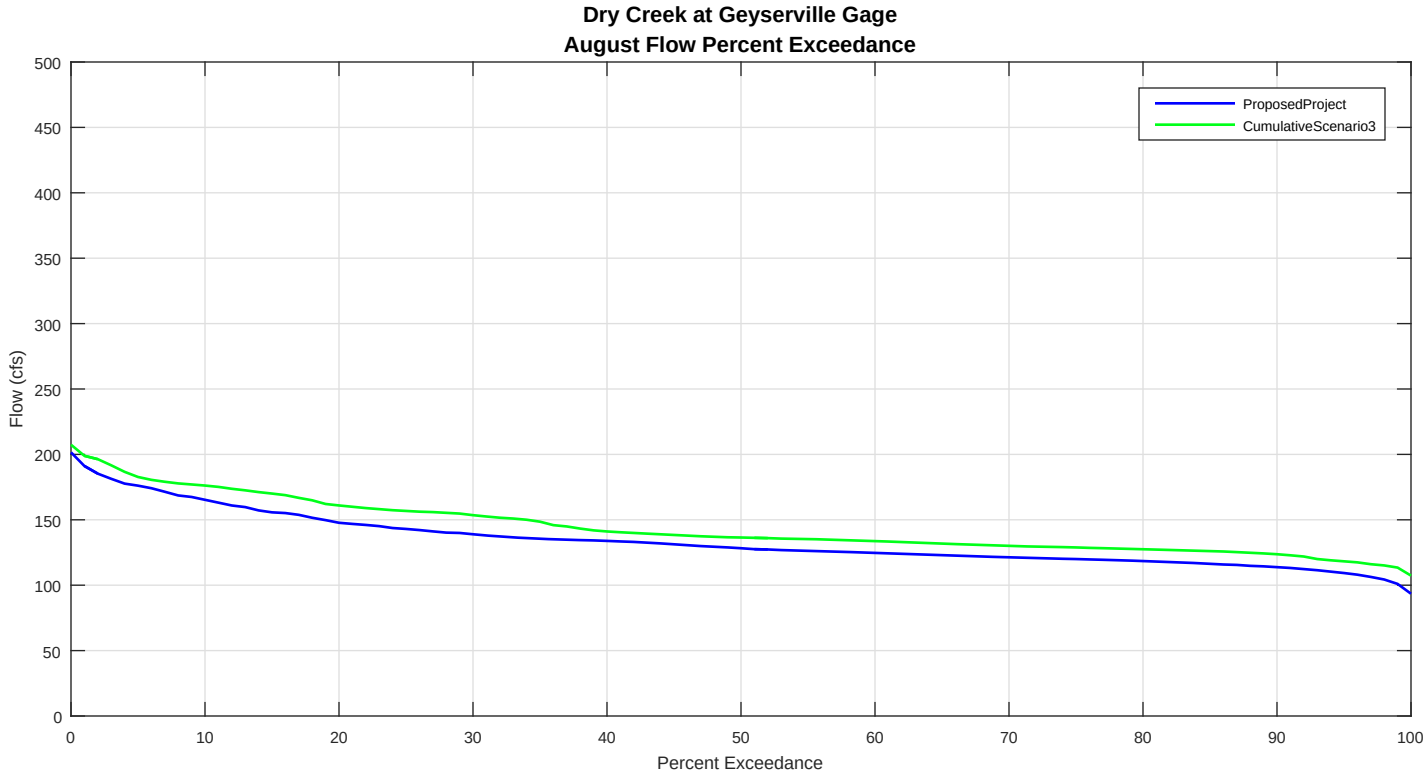
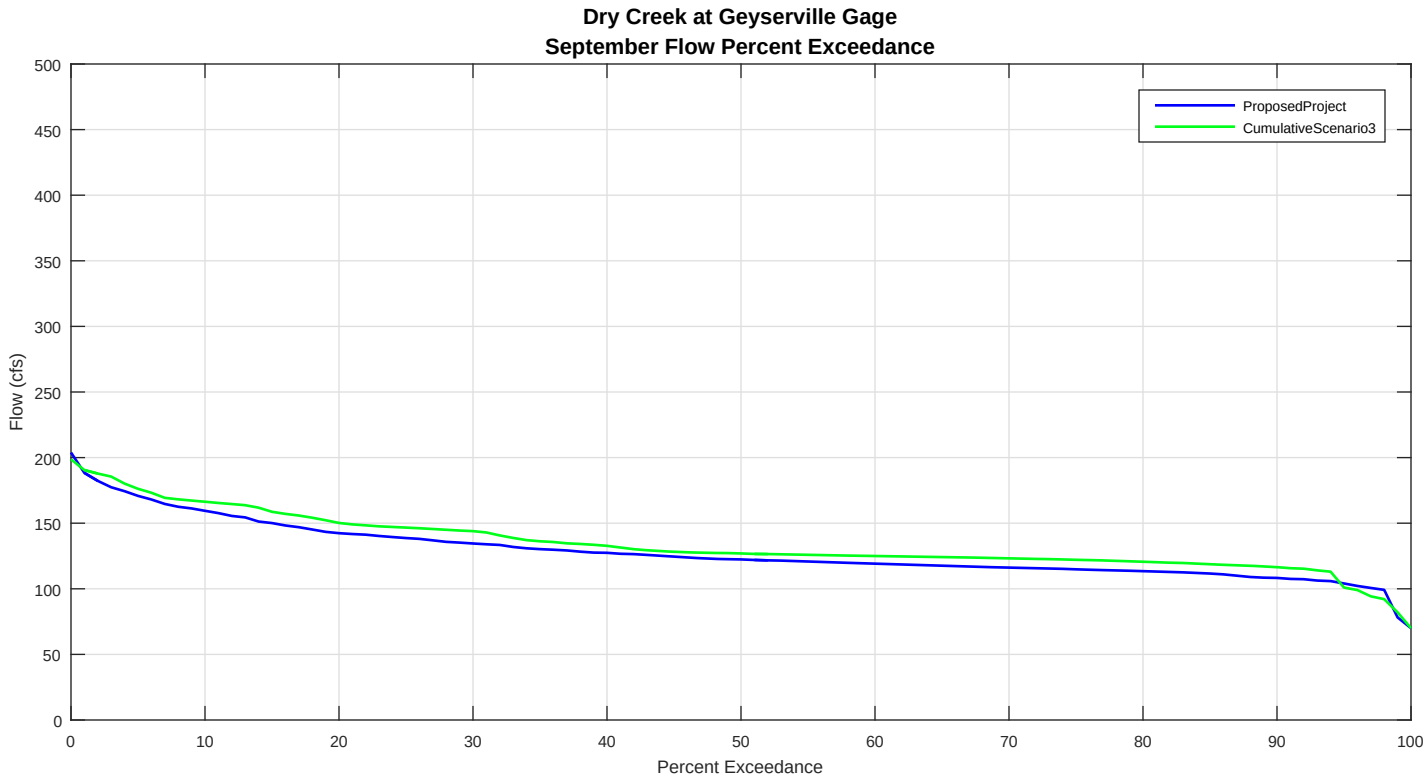
60
70
80
90
100


Dry Creek at Geyserville Gage
June Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100


Dry Creek at Geyserville Gage
July Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100


Dry Creek at Geyserville Gage
August Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100


Dry Creek at Geyserville Gage
September Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
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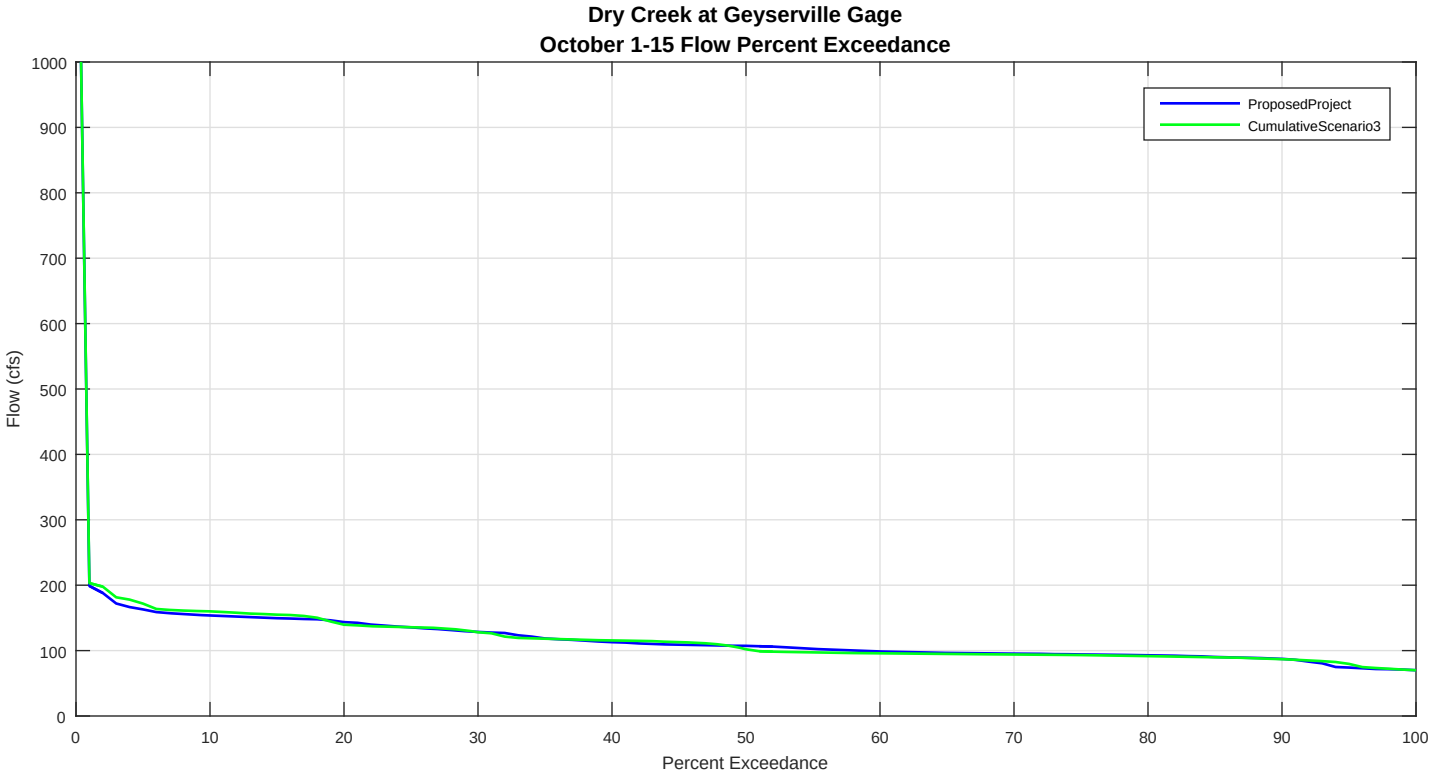
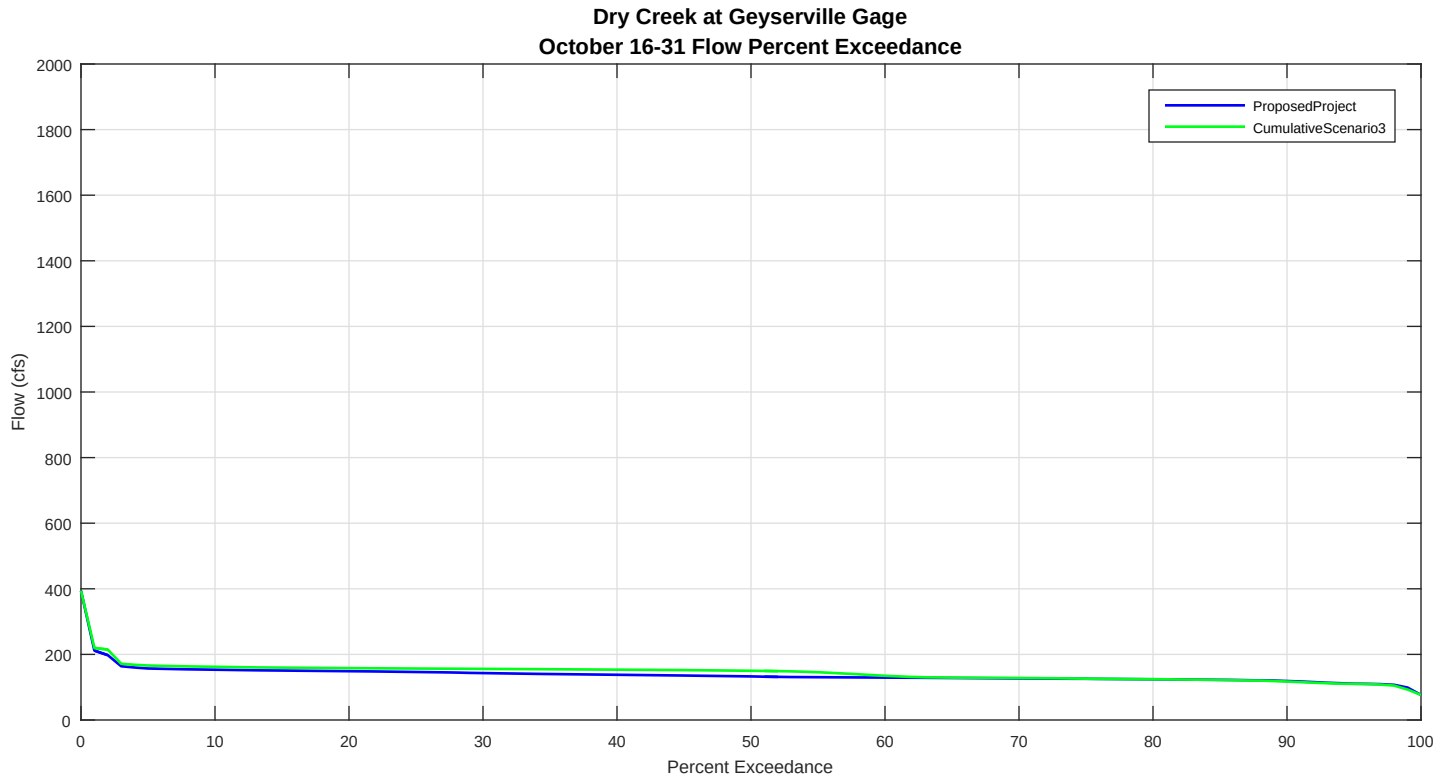
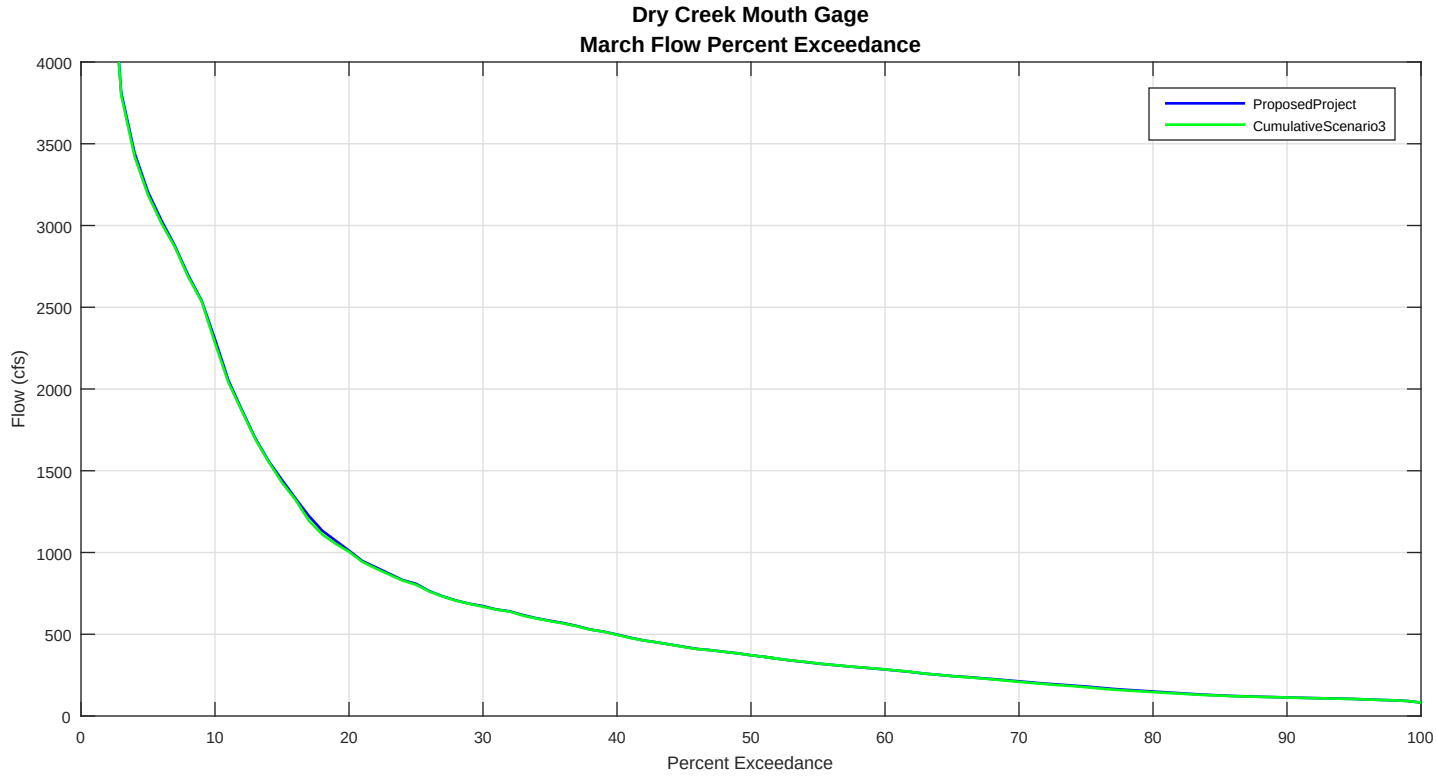
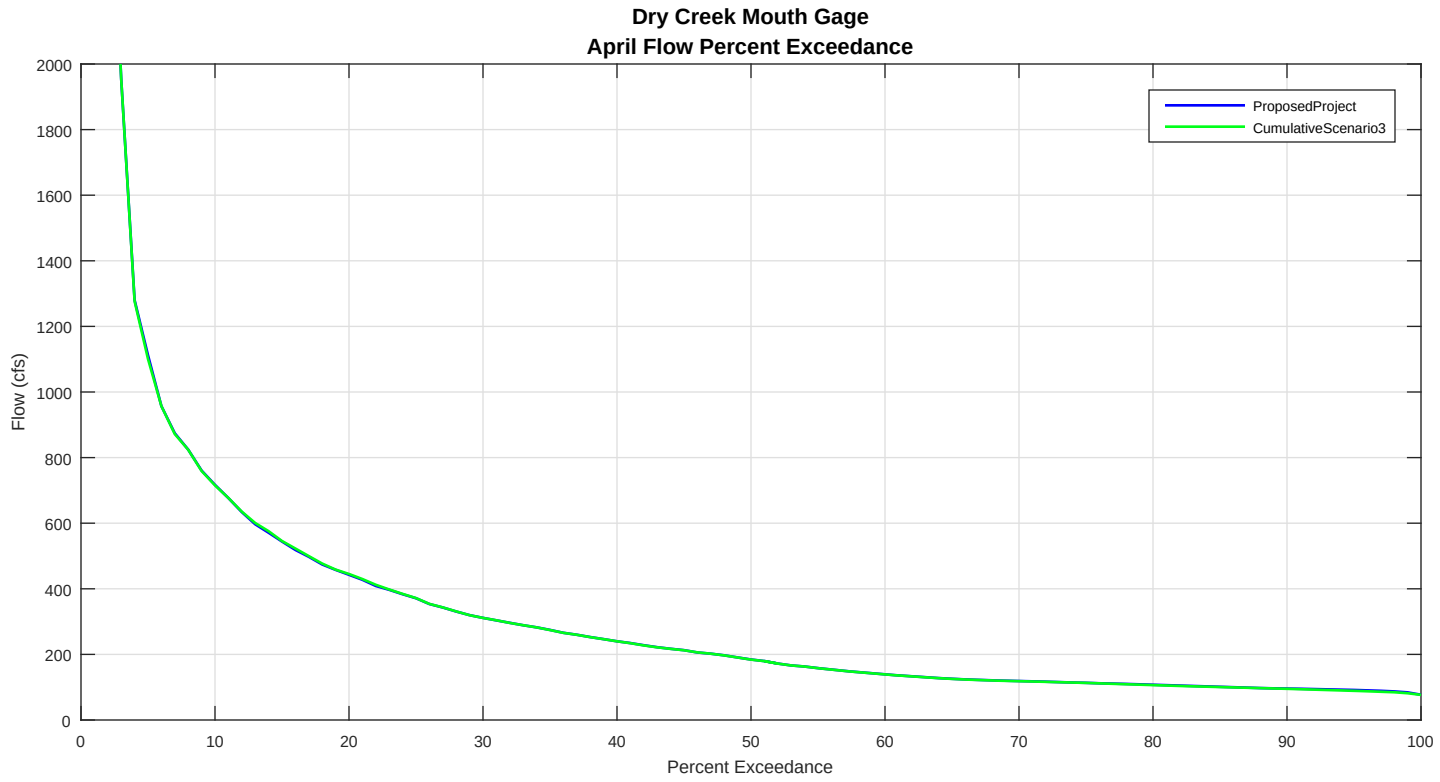
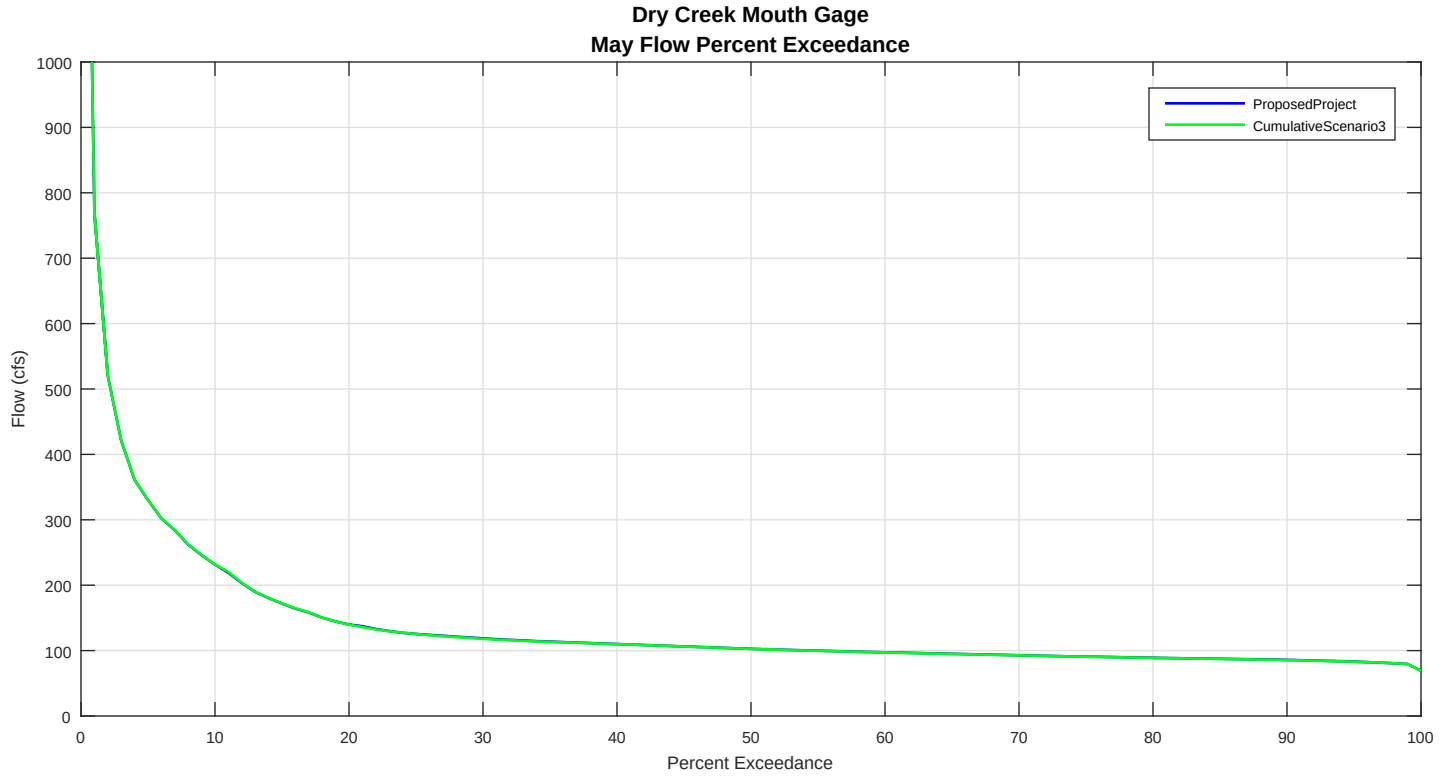
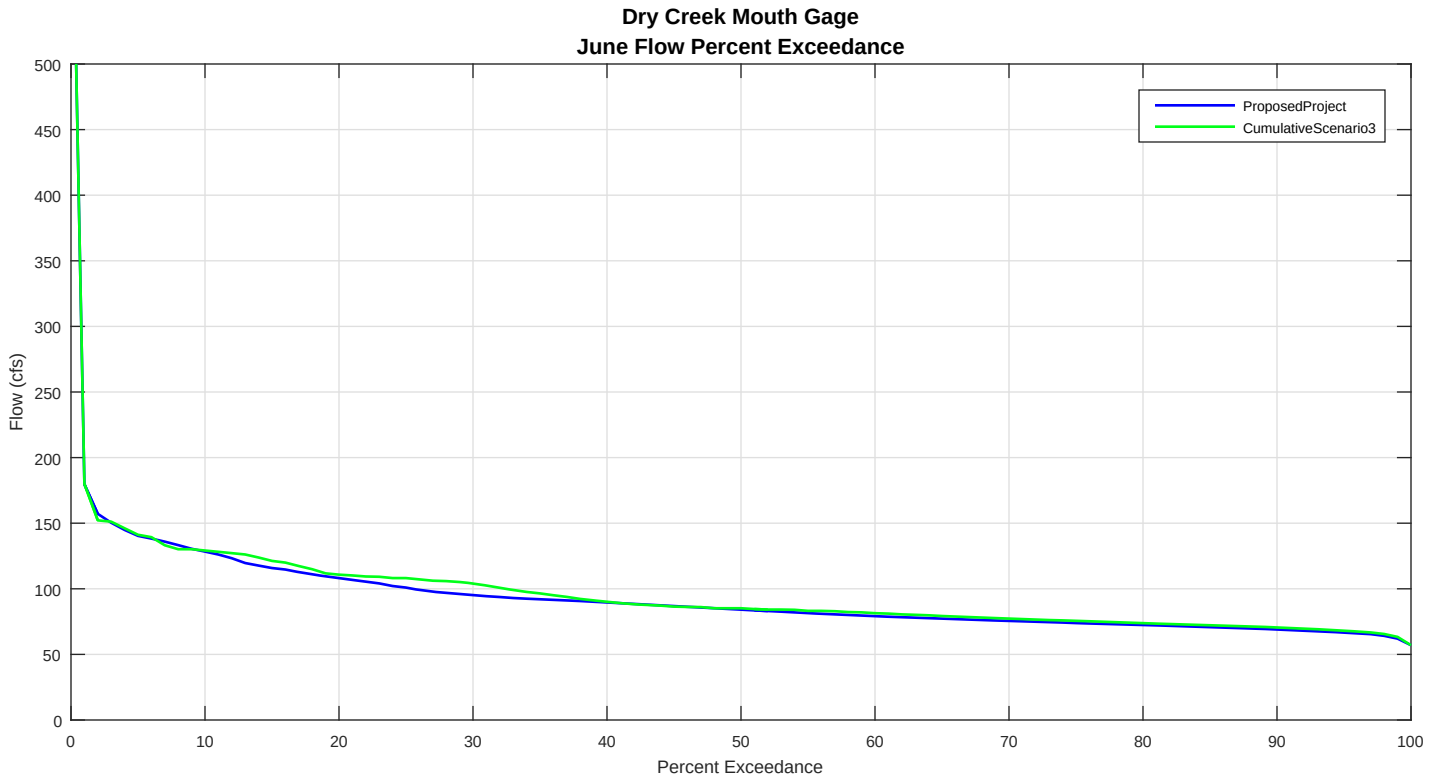

Dry Creek at Geyserville Gage
October 1-15 Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100

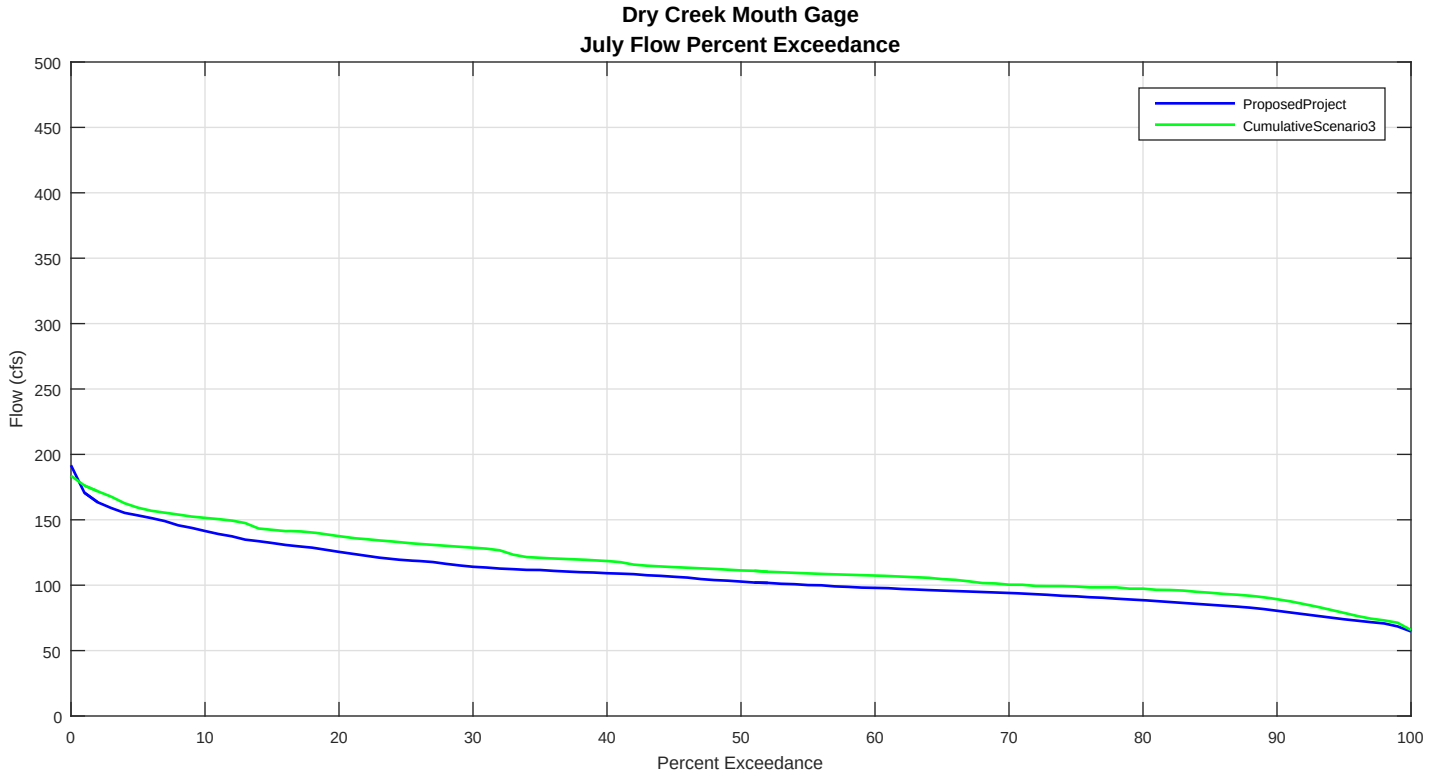

Dry Creek at Geyserville Gage
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100

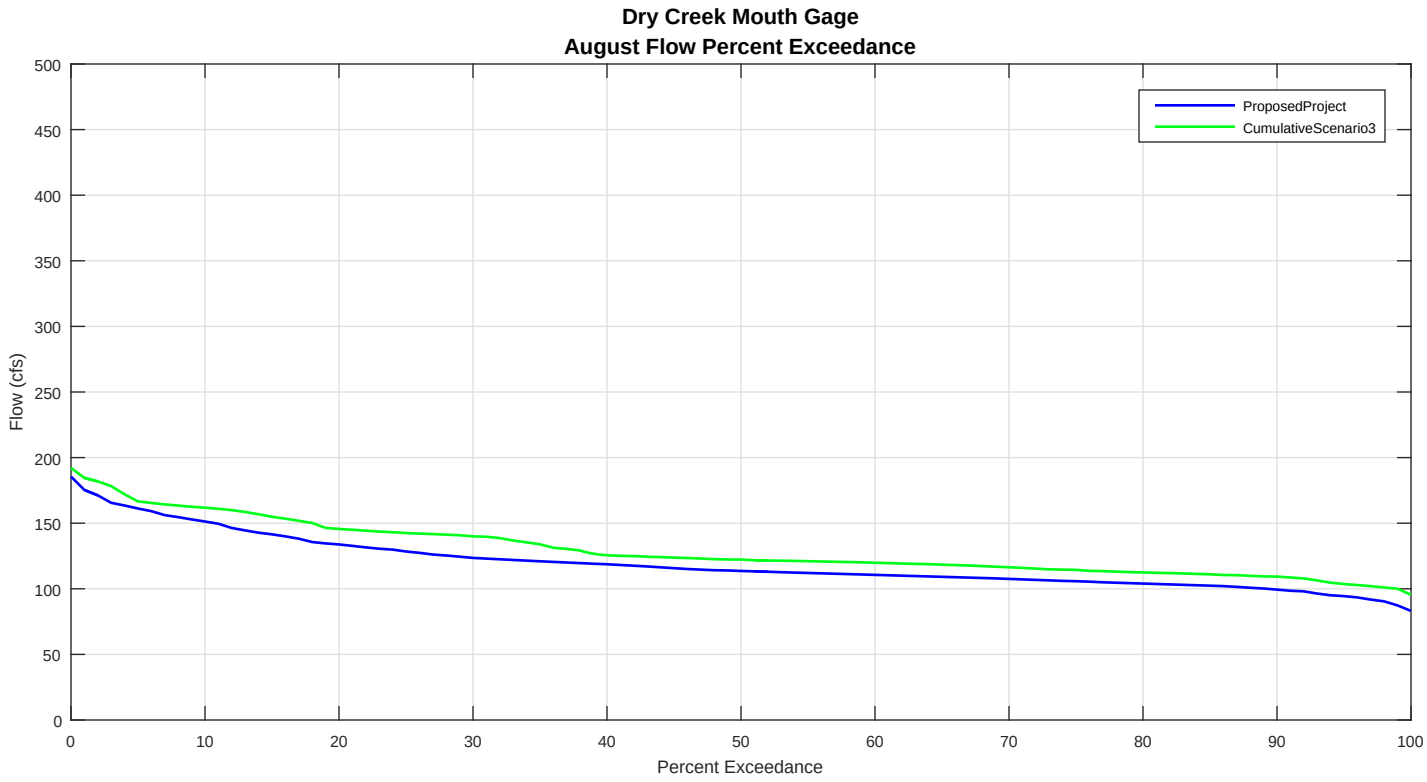

Dry Creek Mouth Gage
March Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
0
500
1000
1500
2000
2500
3000
3500
4000
0
10
20
30
40
50
60
70
80
90
100

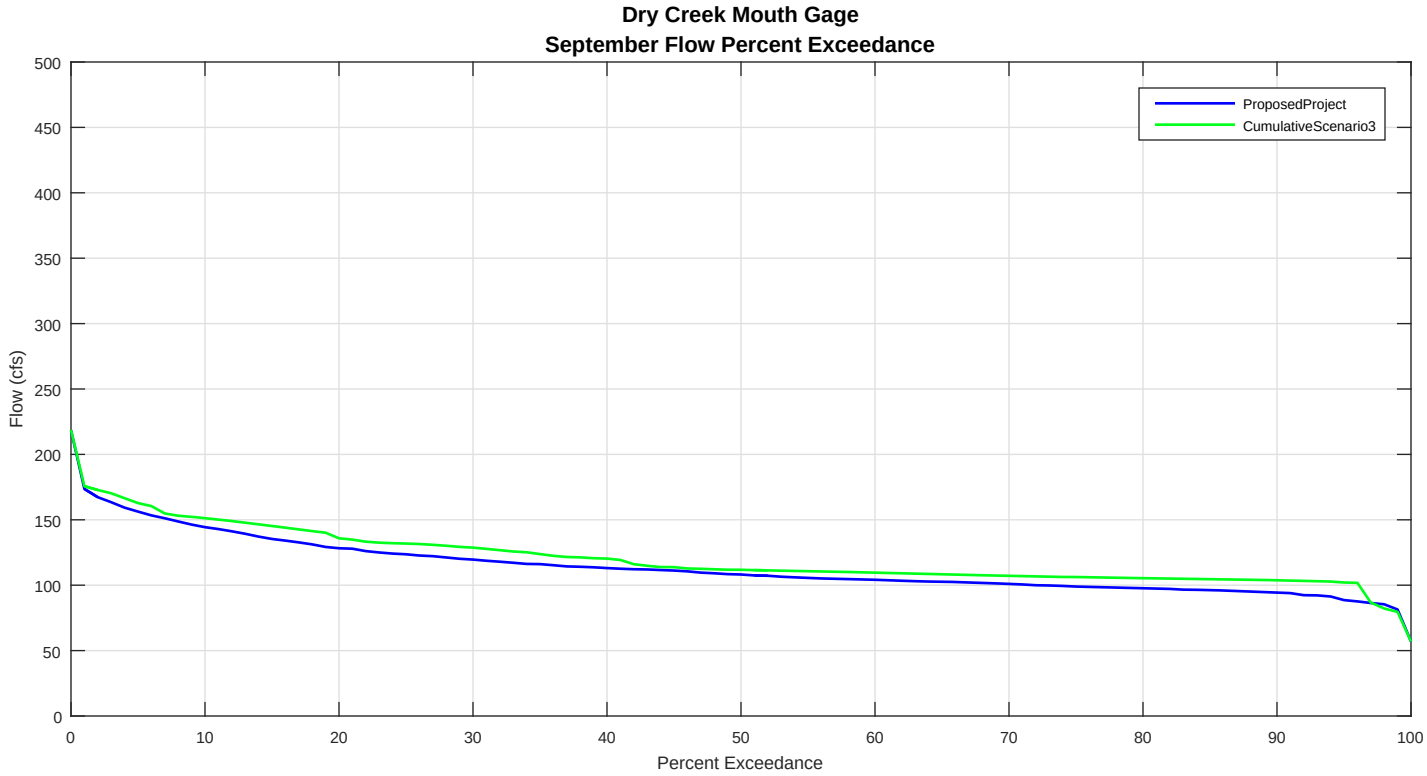

Dry Creek Mouth Gage
April Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario3
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100

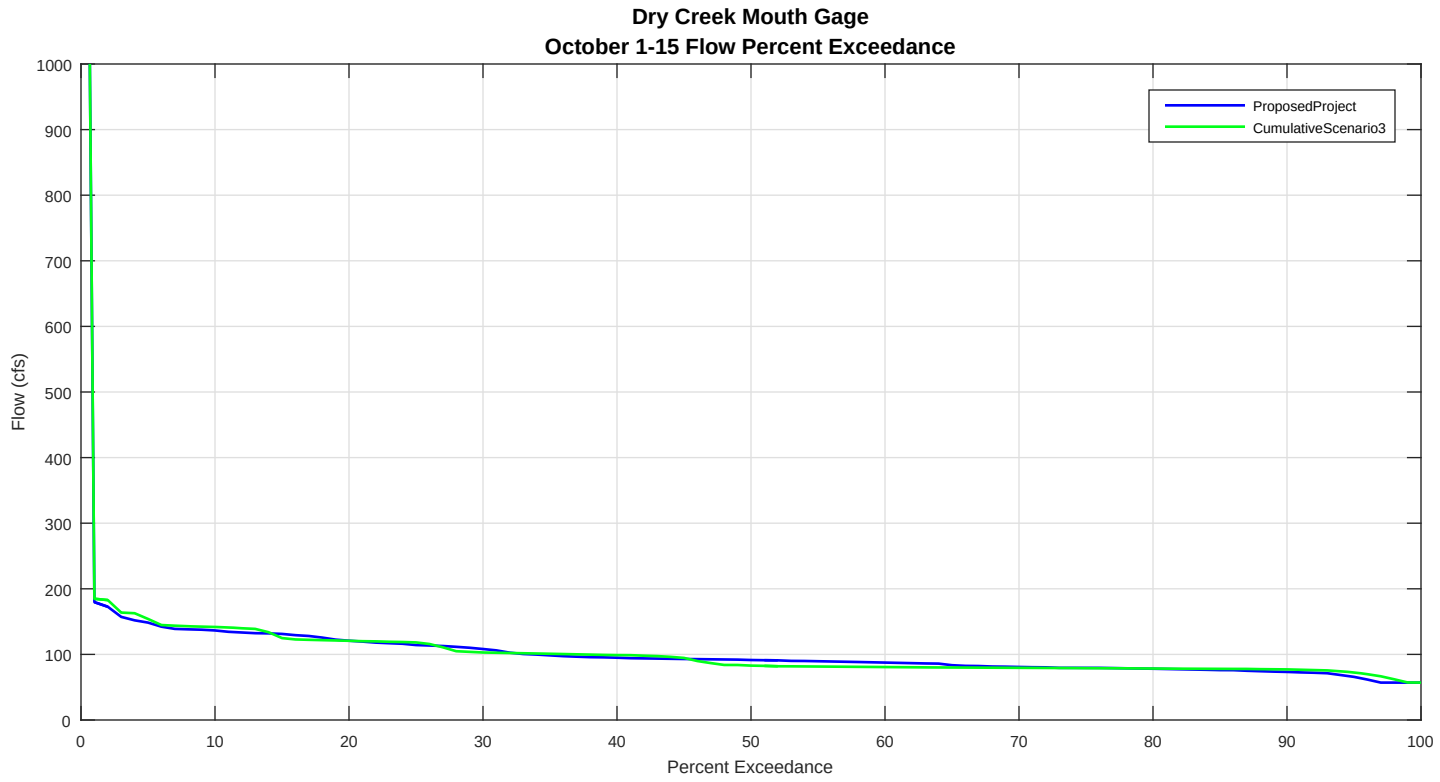

Dry Creek Mouth Gage
May Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario3
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100

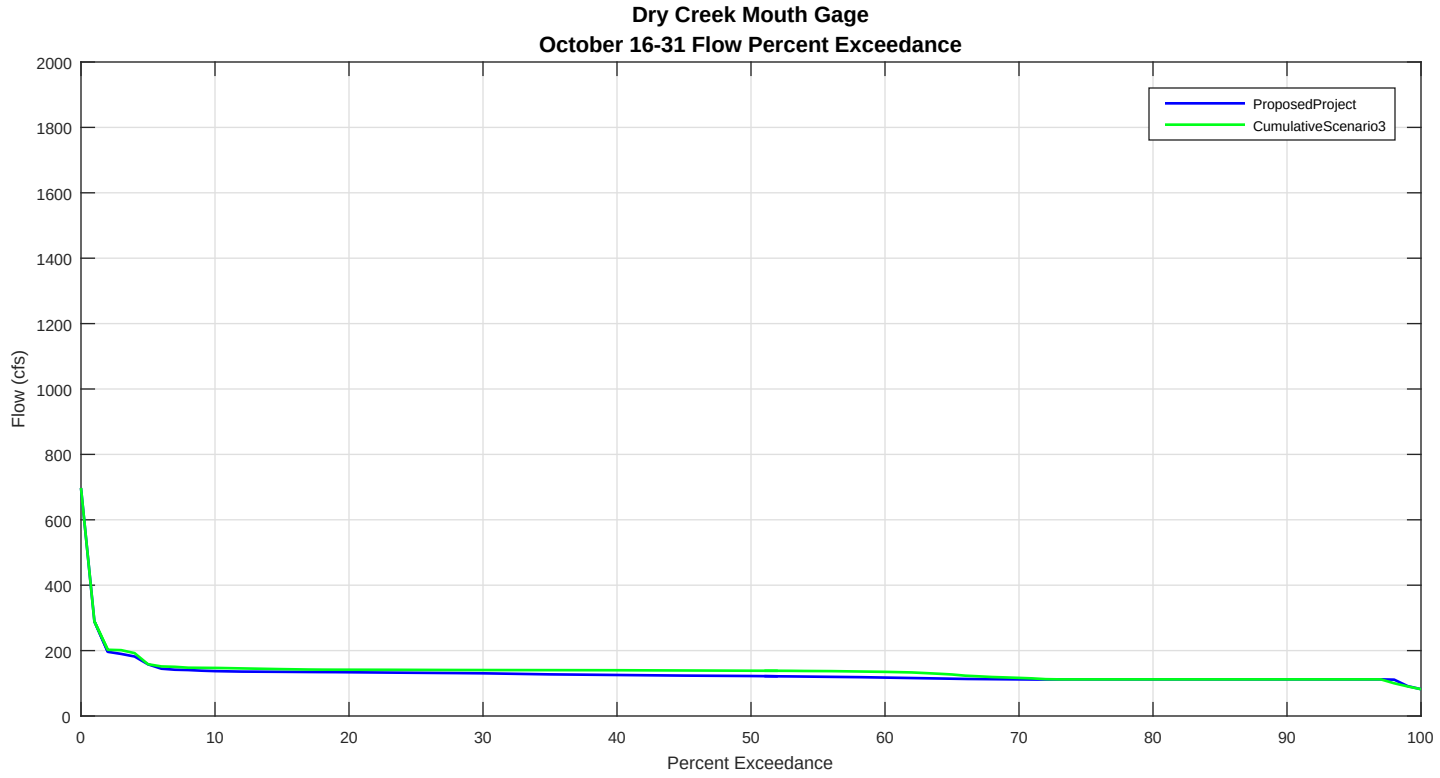

Dry Creek Mouth Gage
June Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

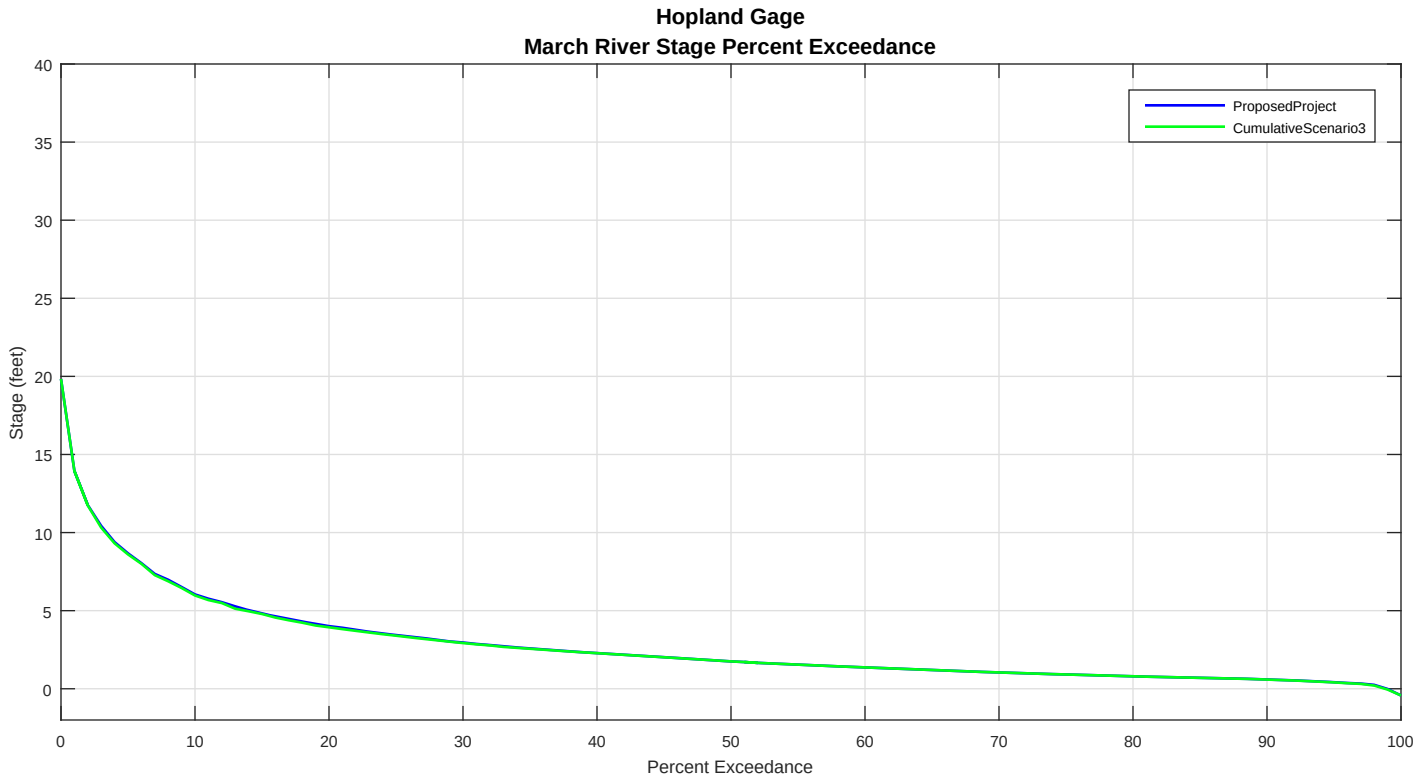

Dry Creek Mouth Gage
July Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

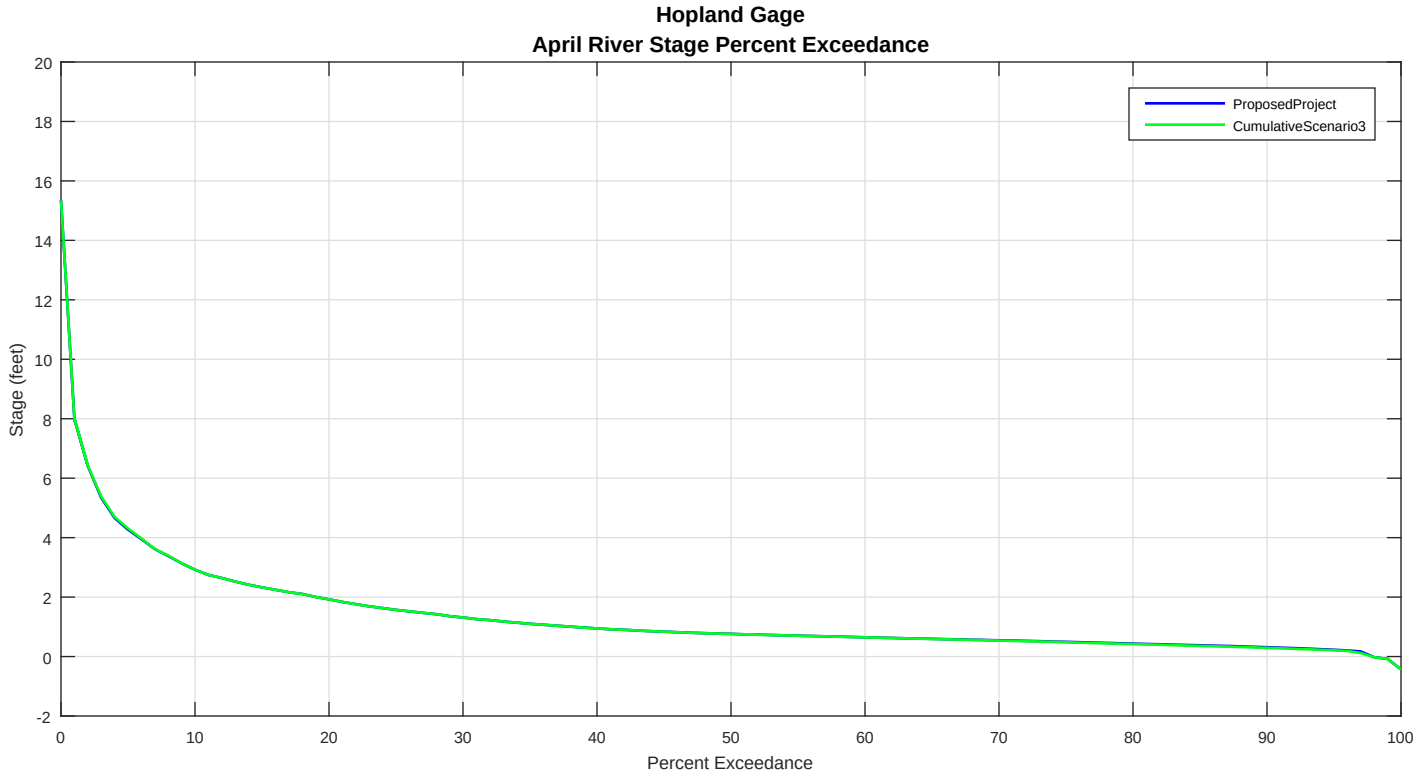

Dry Creek Mouth Gage
August Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

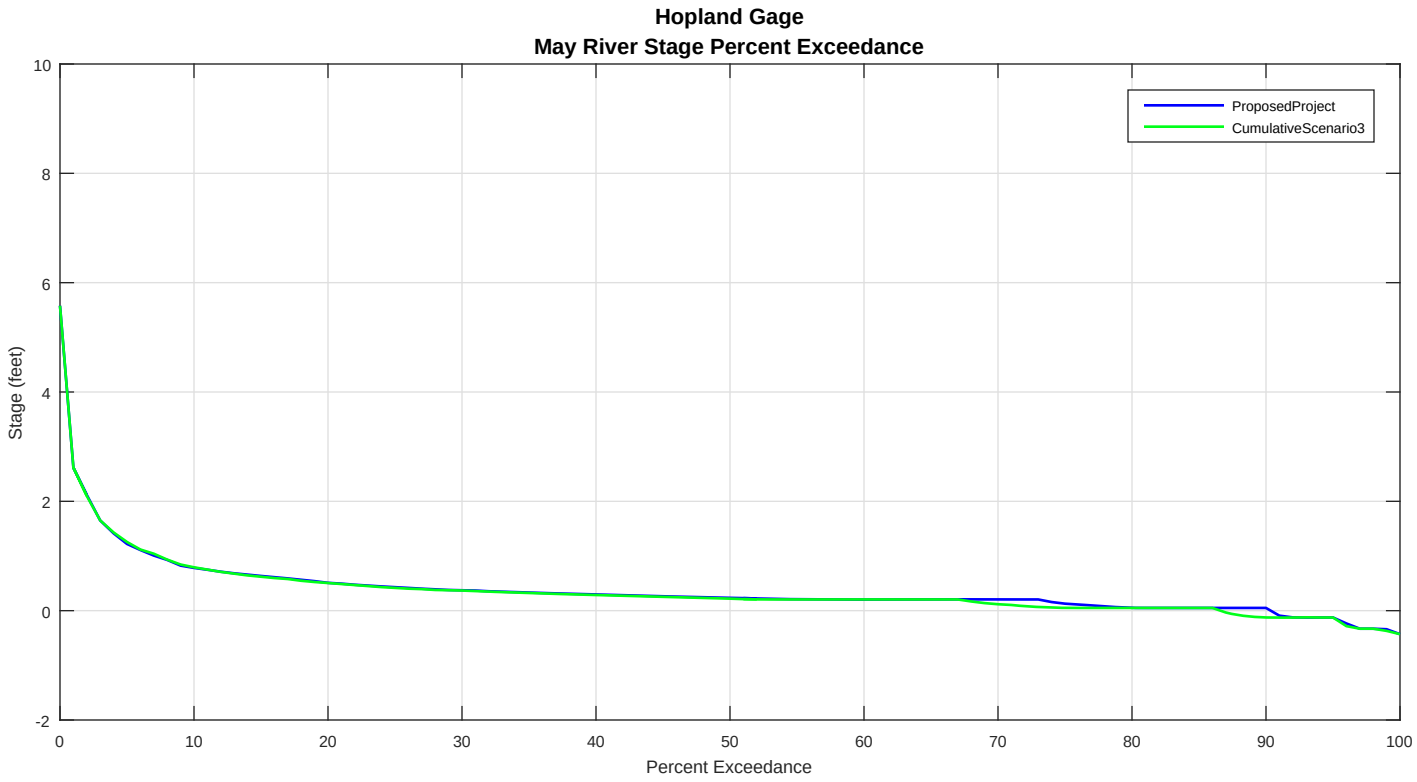

Dry Creek Mouth Gage
September Flow Percent Exceedance
ProposedProject
CumulativeScenario3
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

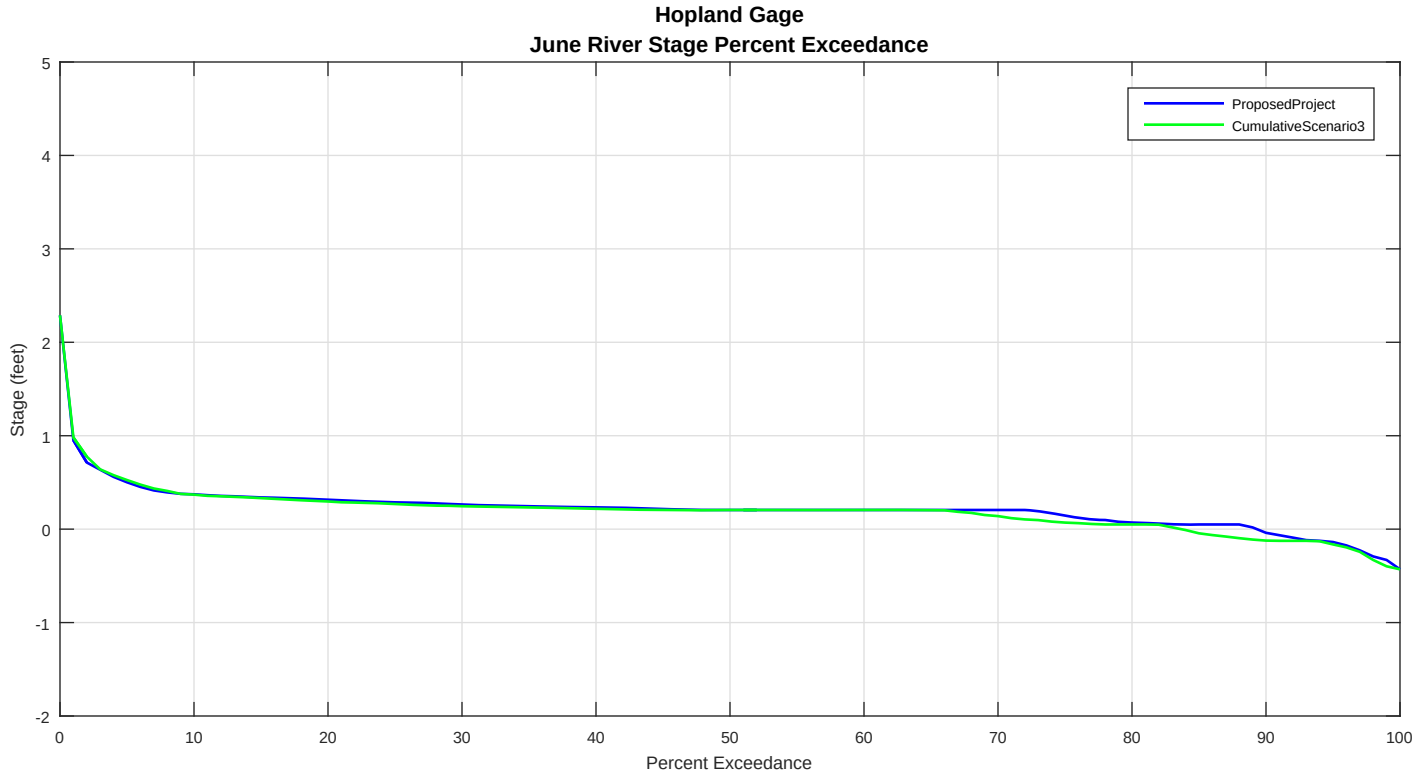

Dry Creek Mouth Gage
October 1-15 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario3
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100

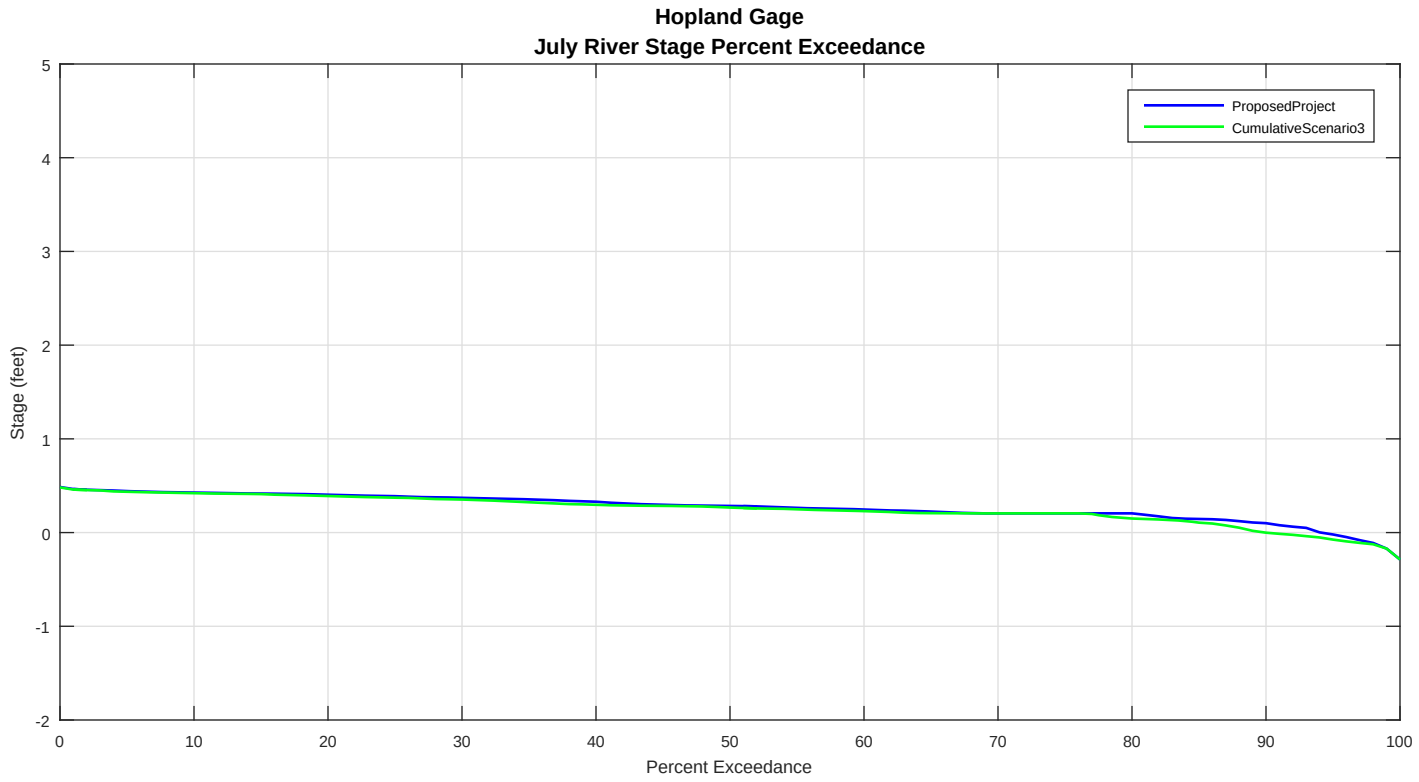

Dry Creek Mouth Gage
October 16-31 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario3
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100

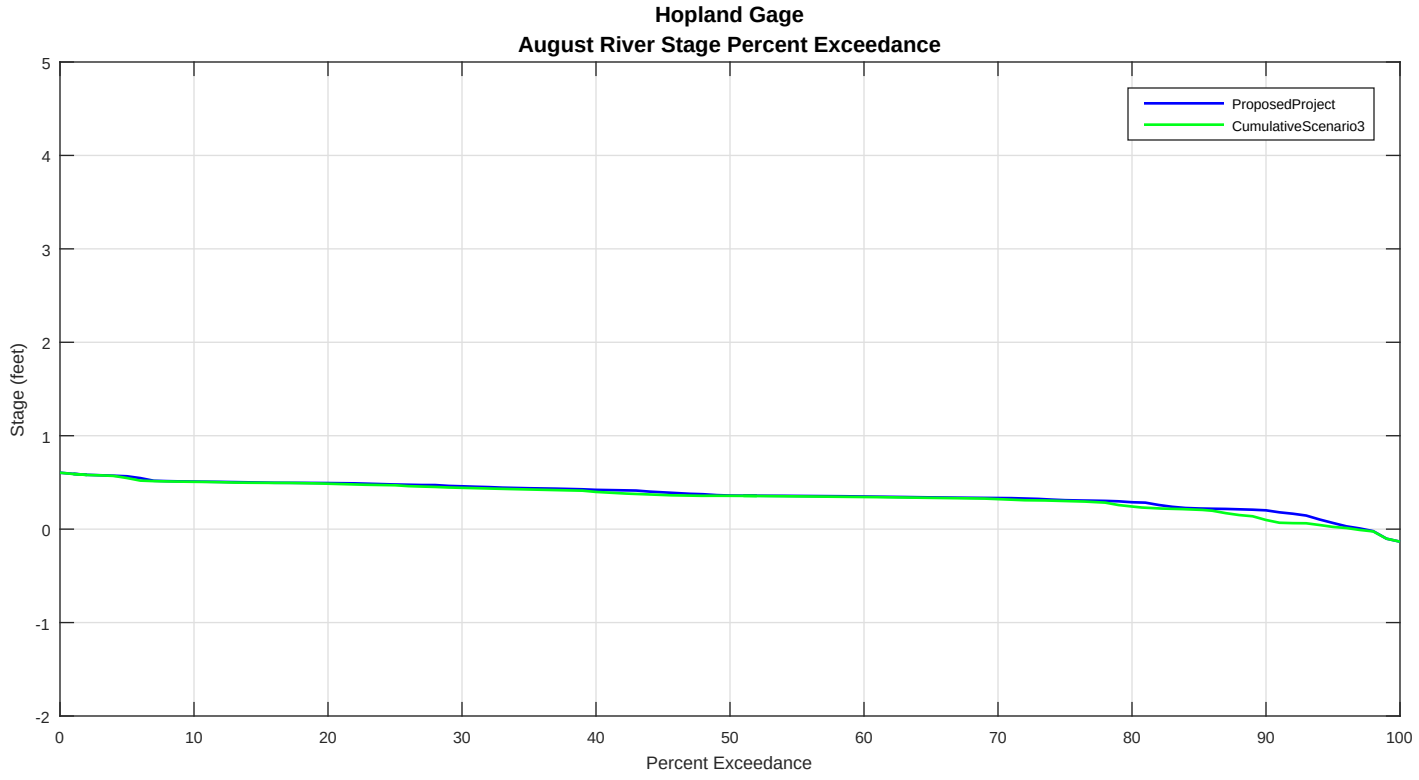

Hopland Gage
March River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100

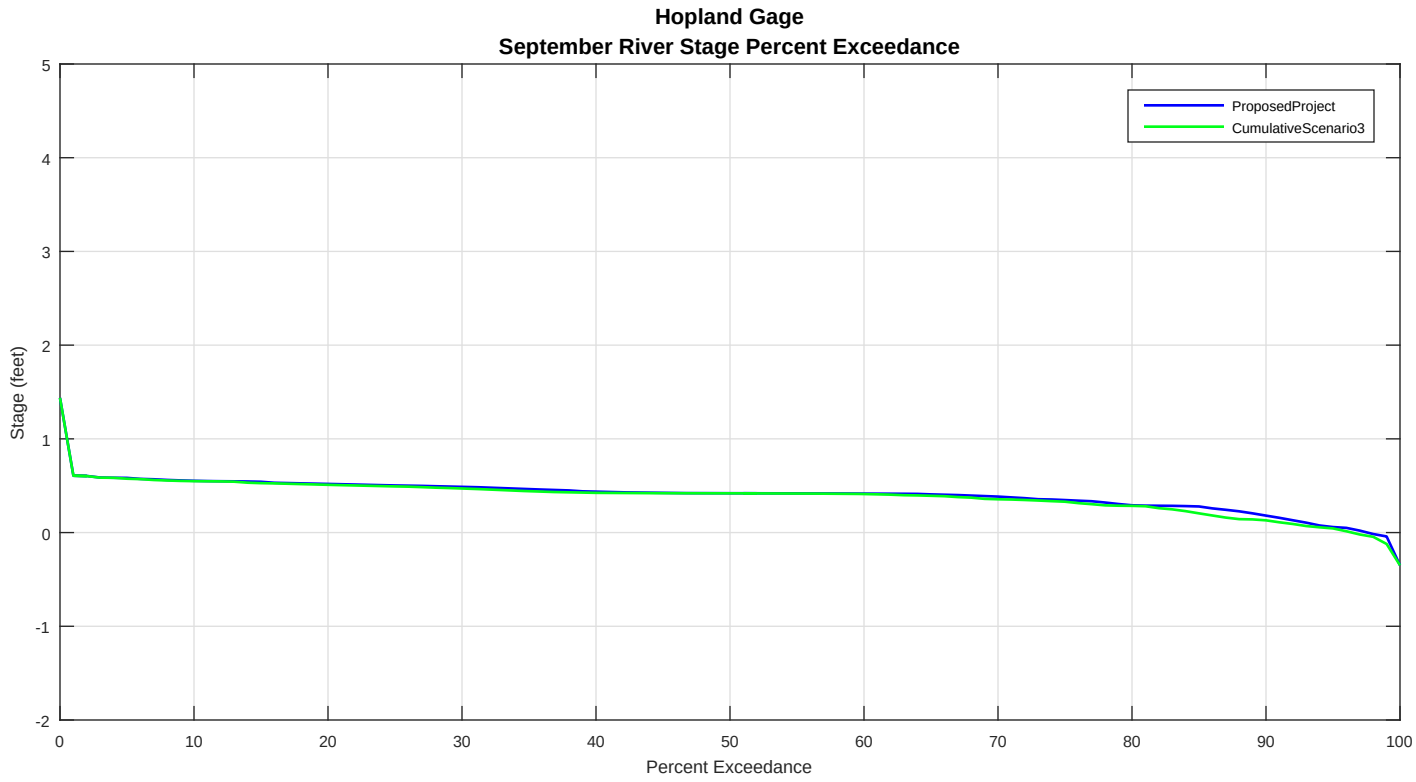

Hopland Gage
April River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
20
18
16
14
12
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

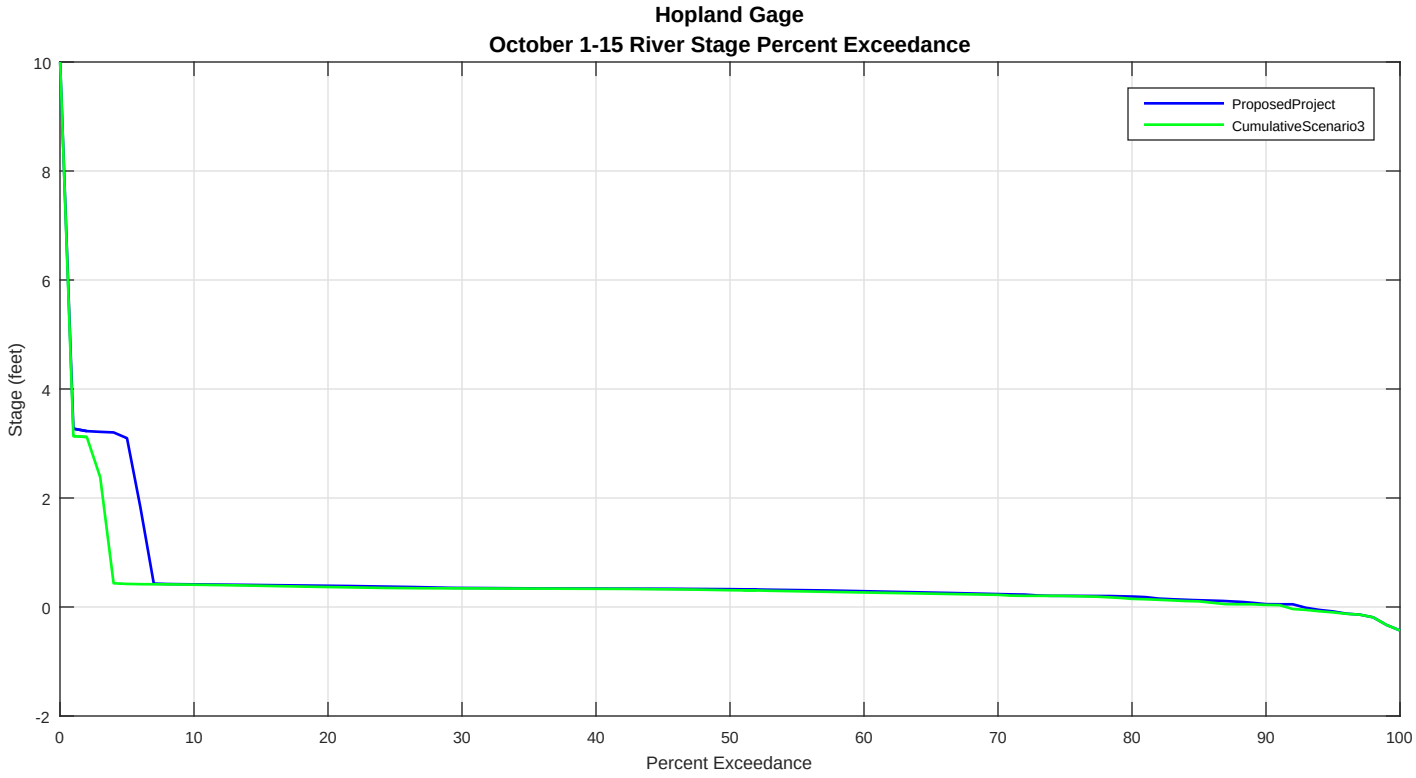

Hopland Gage
May River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

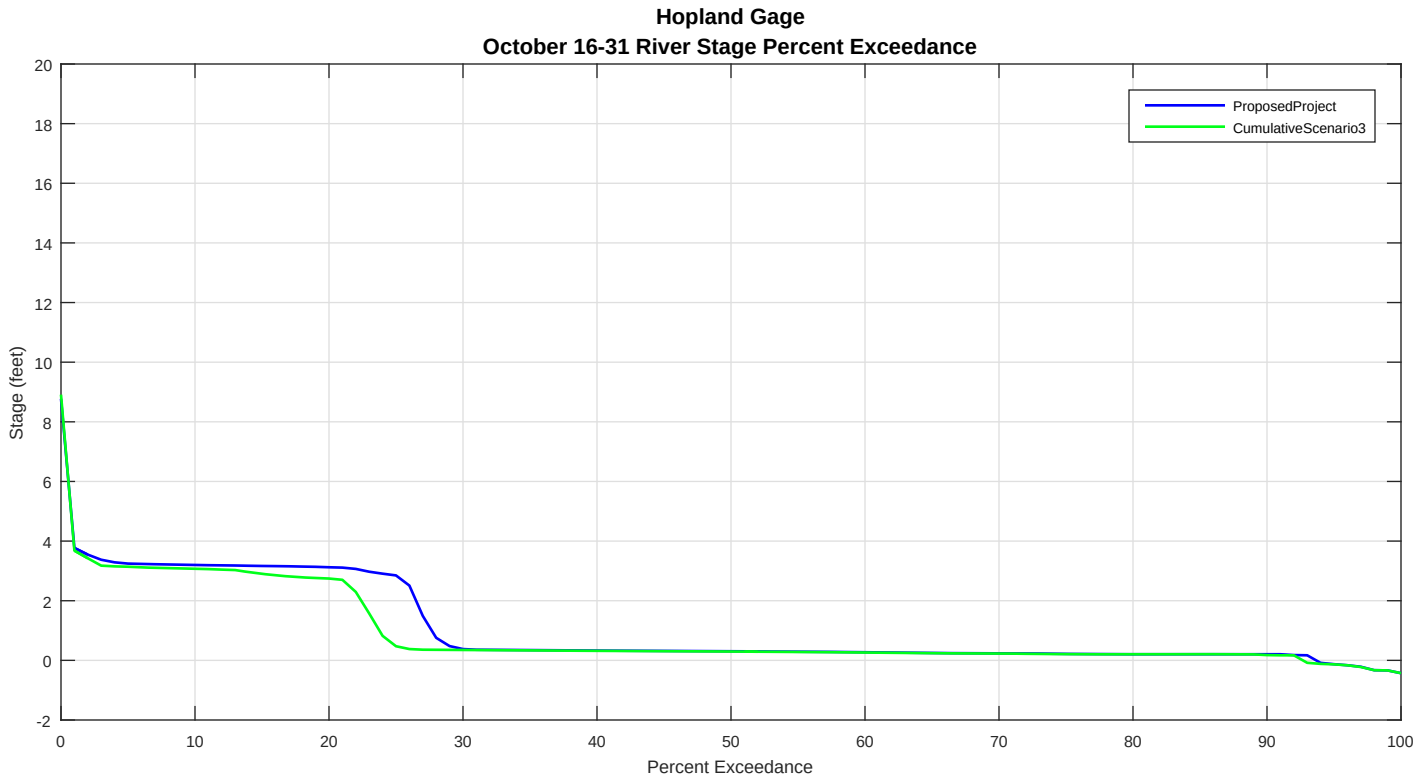

Hopland Gage
June River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

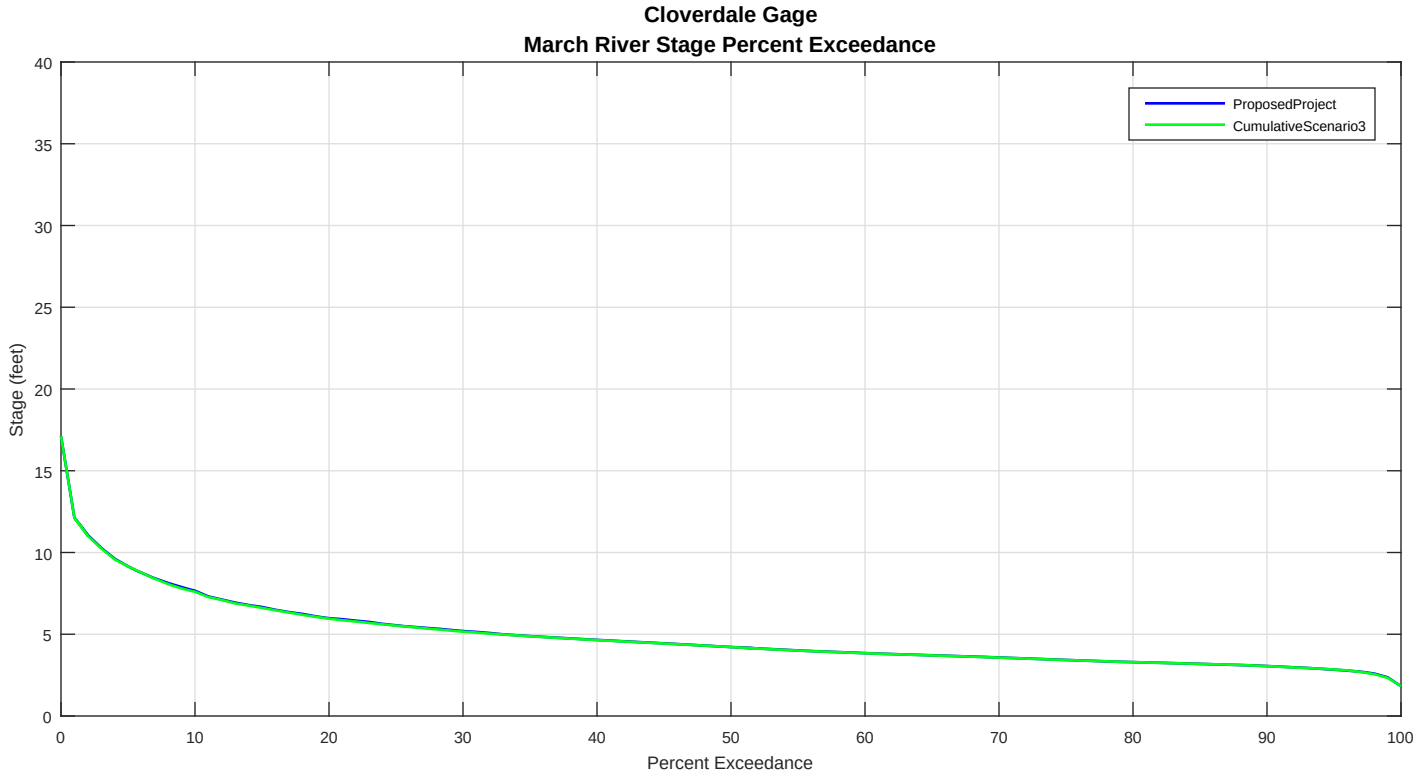

Hopland Gage
July River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

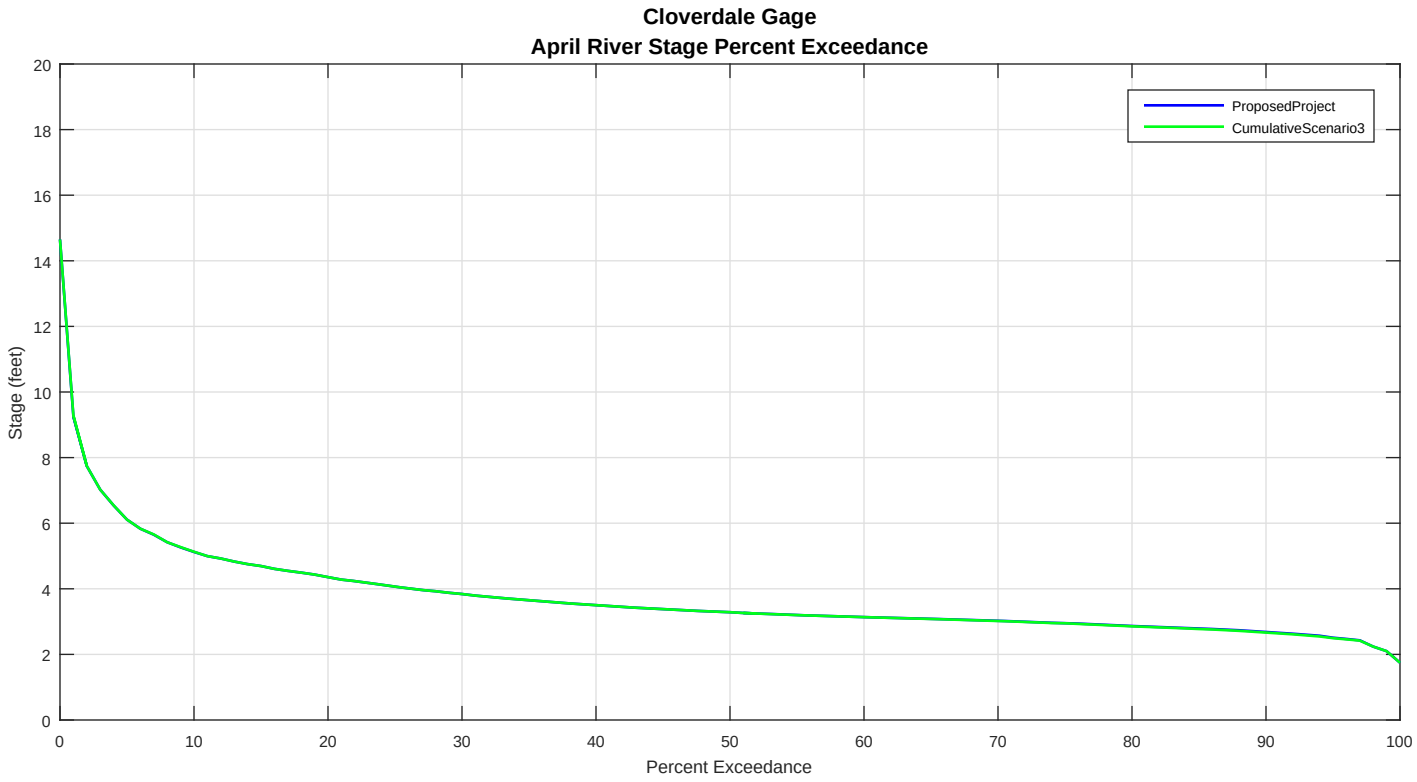

Hopland Gage
August River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

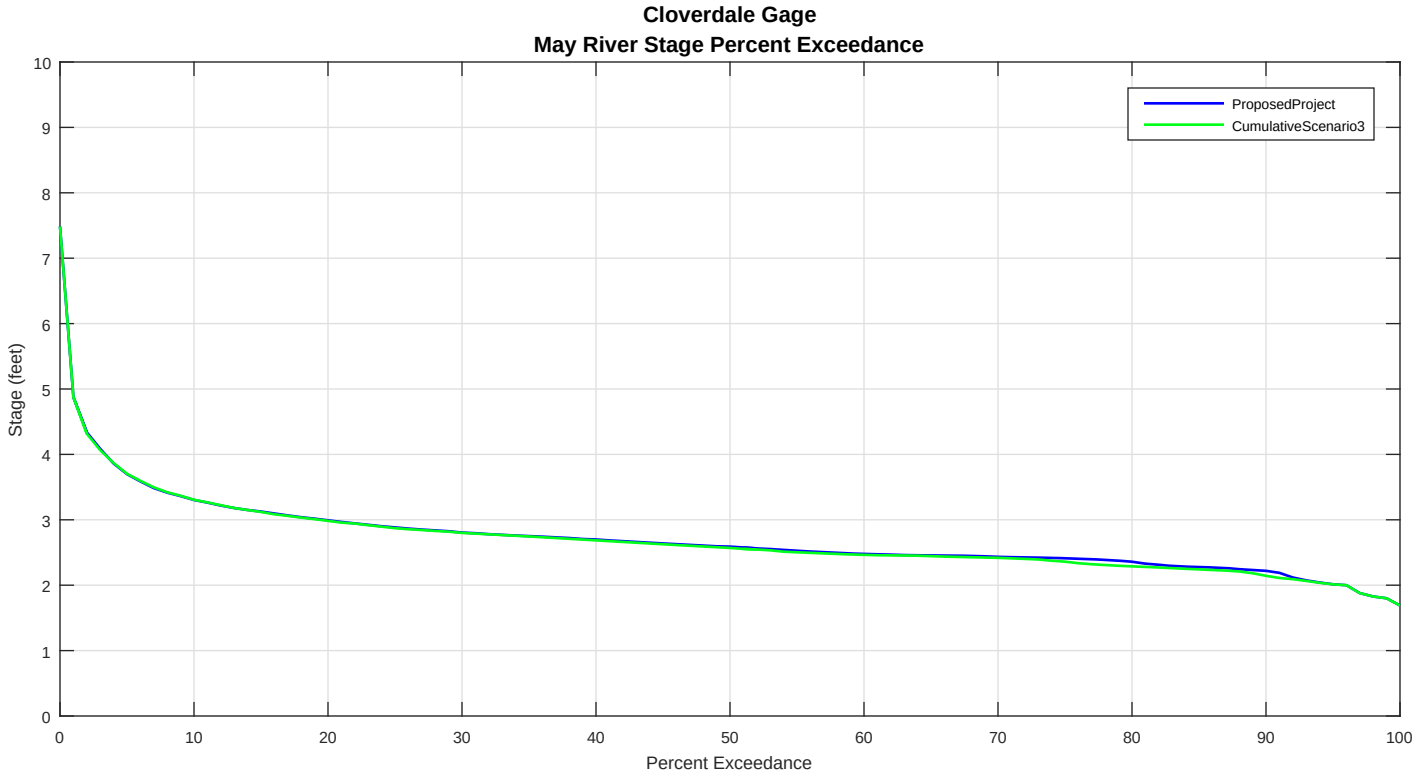

Hopland Gage
September River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

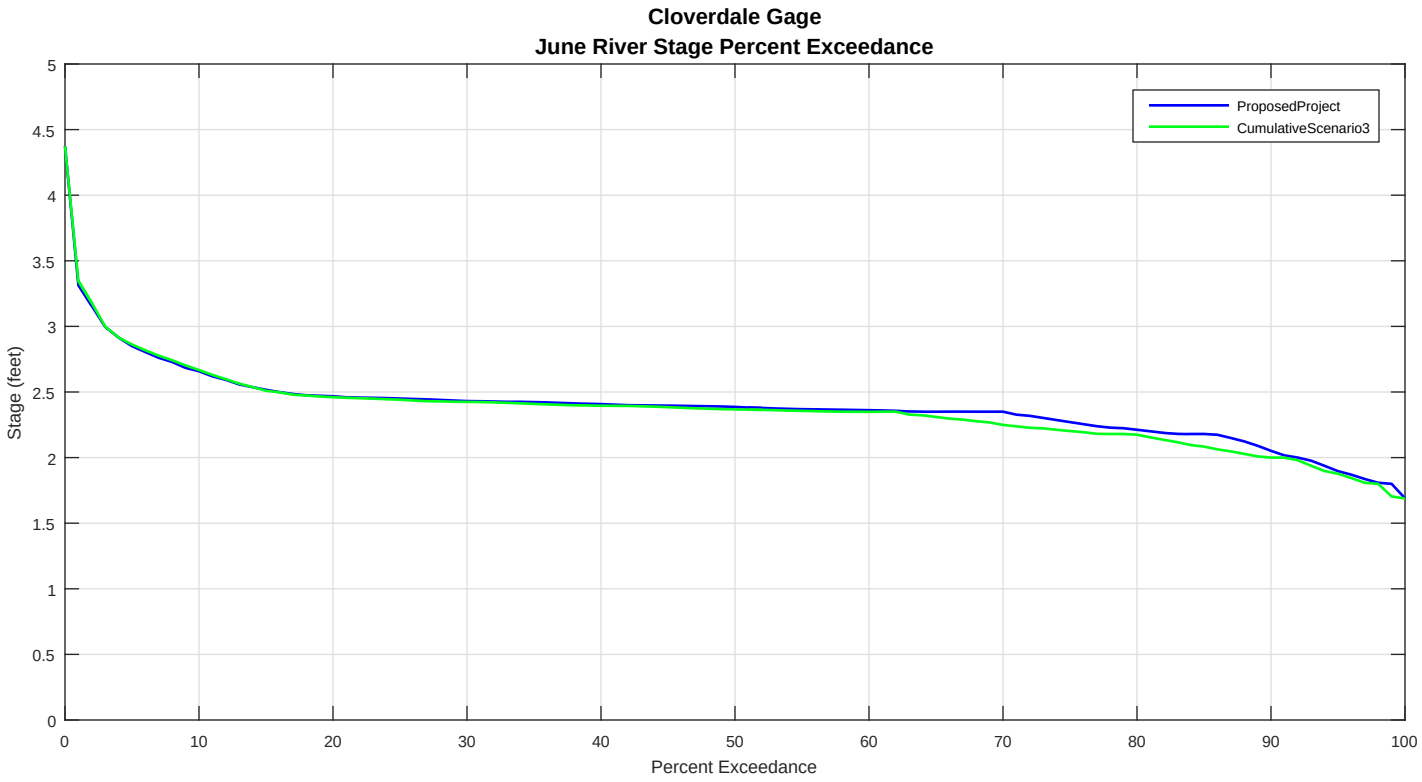

Hopland Gage
October 1-15 River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

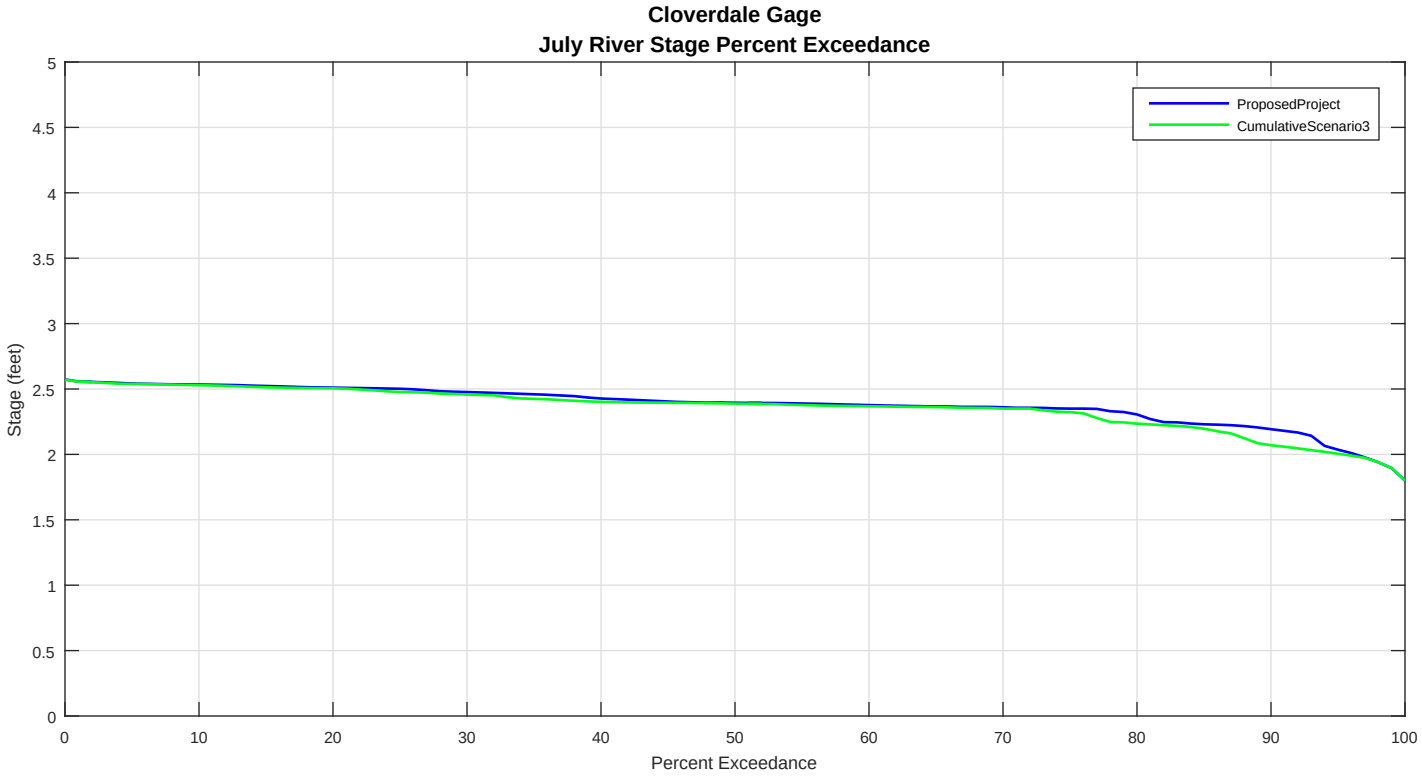

Hopland Gage
October 16-31 River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
20
18
16
14
12
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

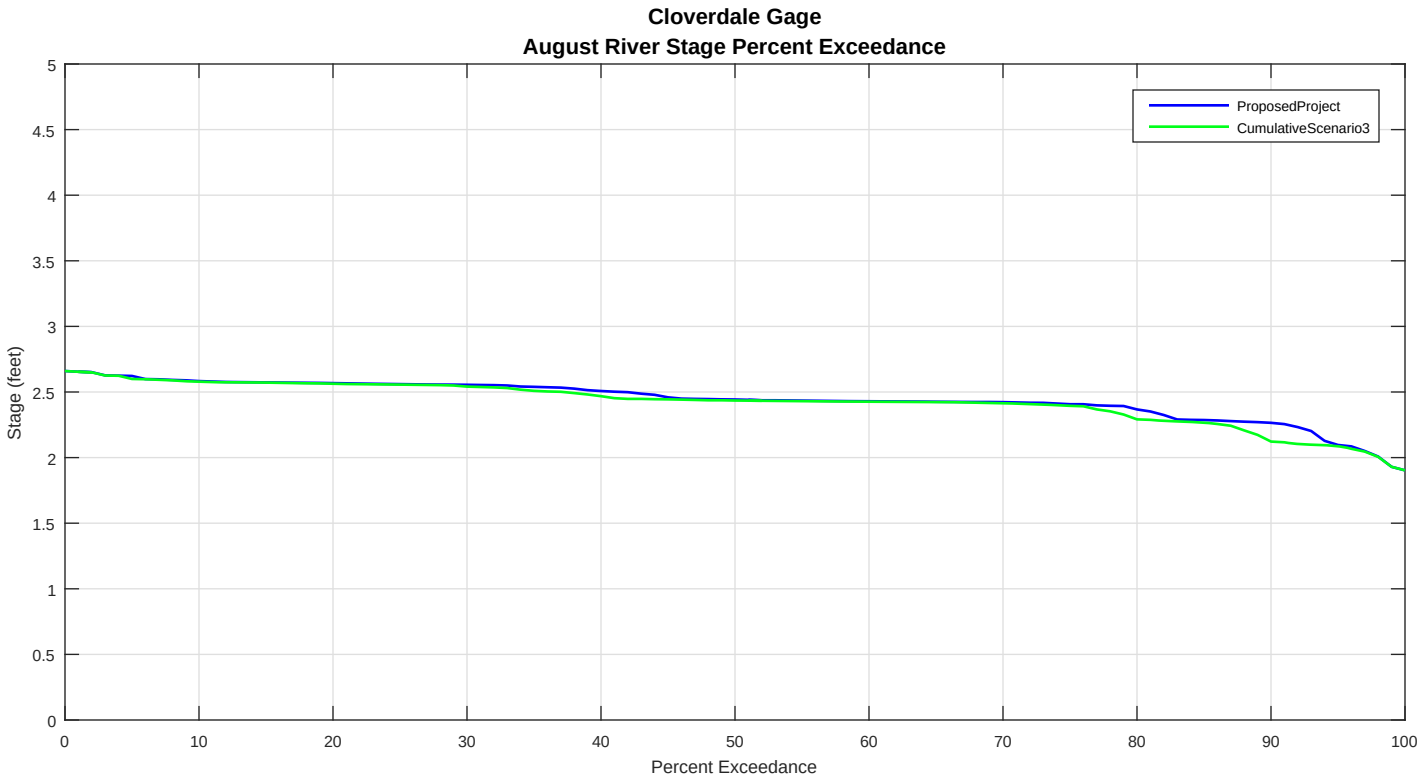

Cloverdale Gage
March River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100

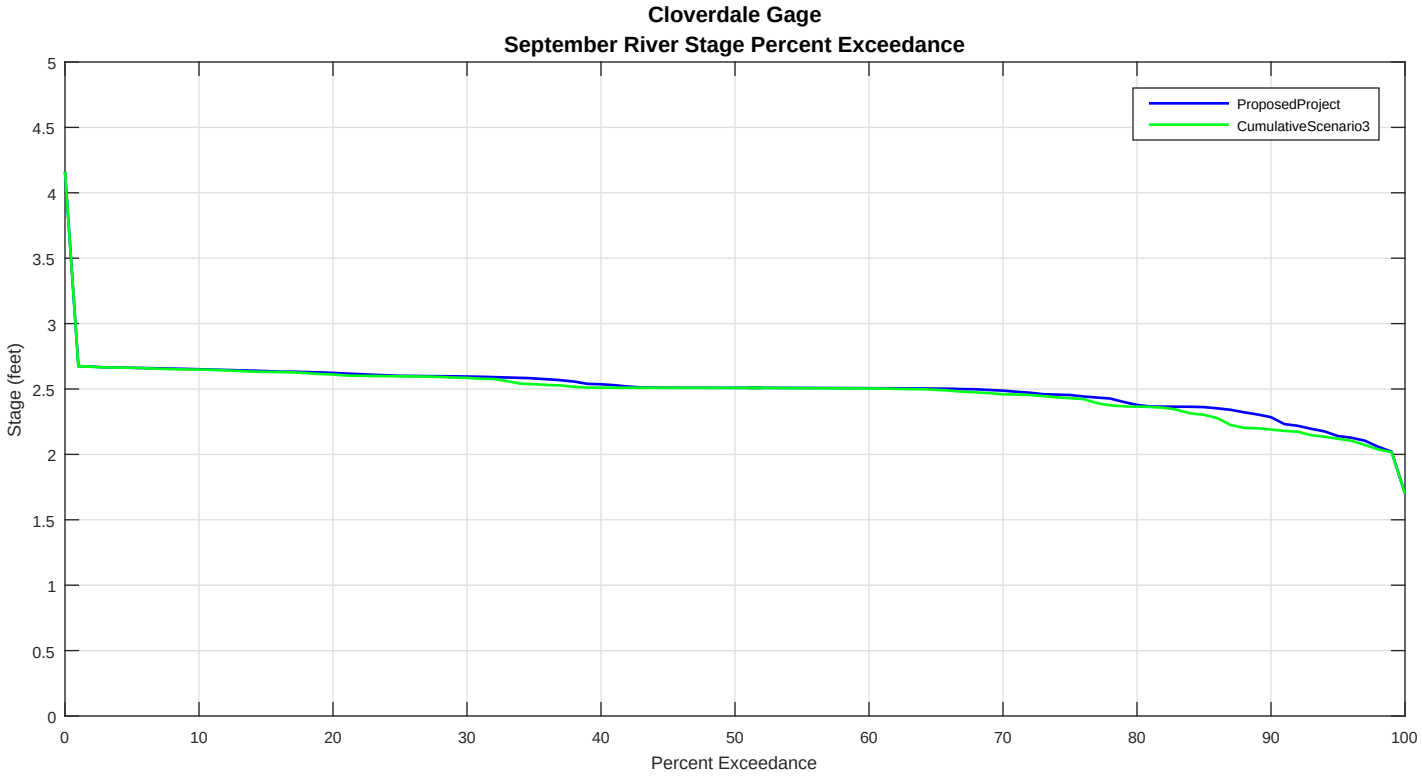

Cloverdale Gage
April River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

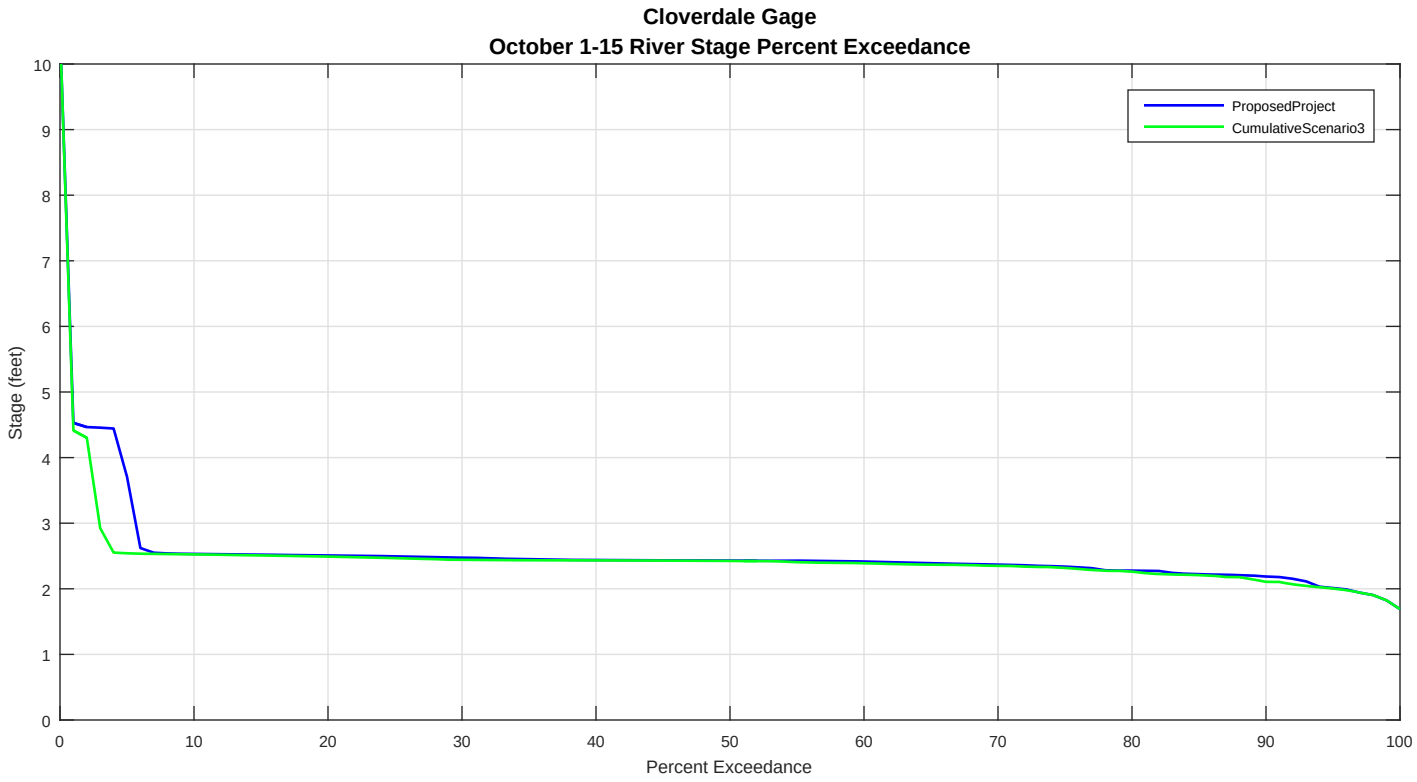

Cloverdale Gage
May River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

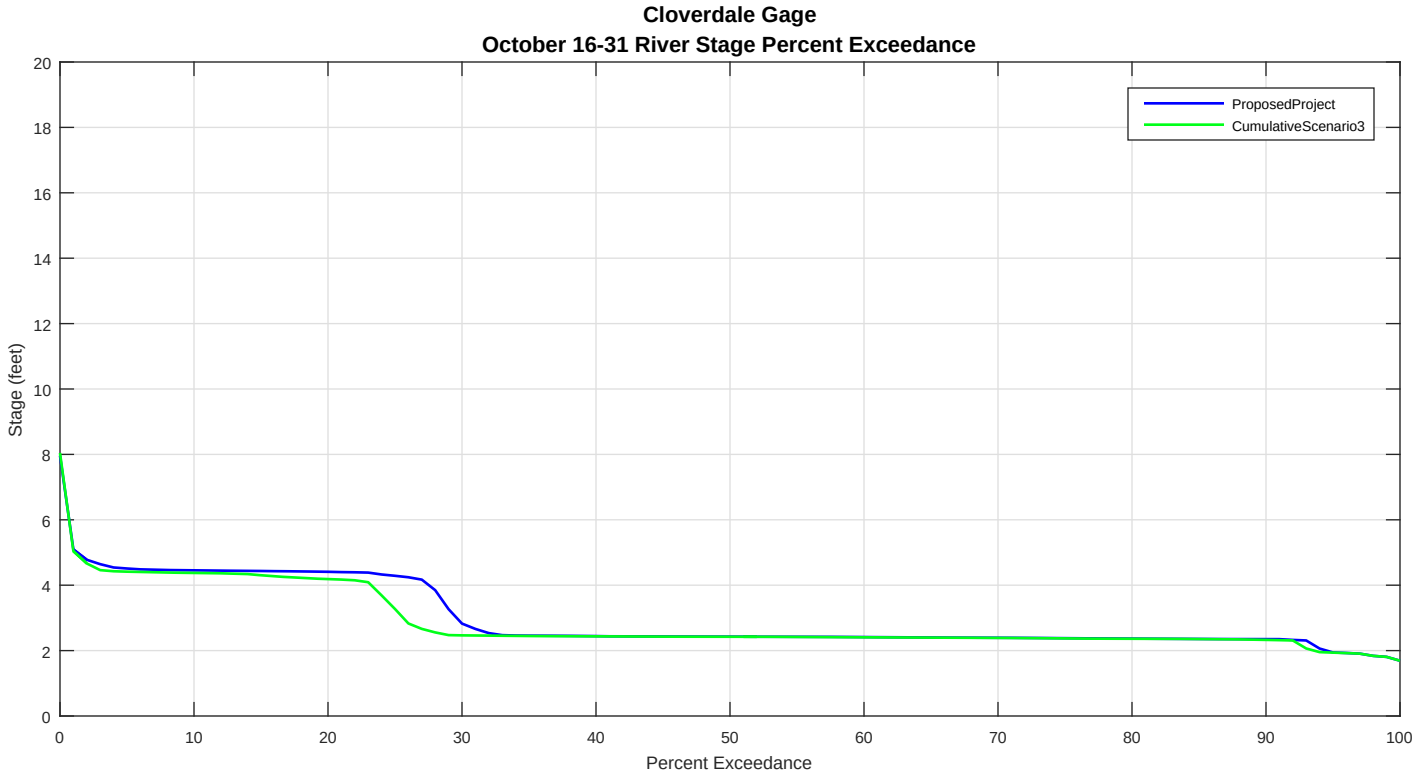

Cloverdale Gage
June River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

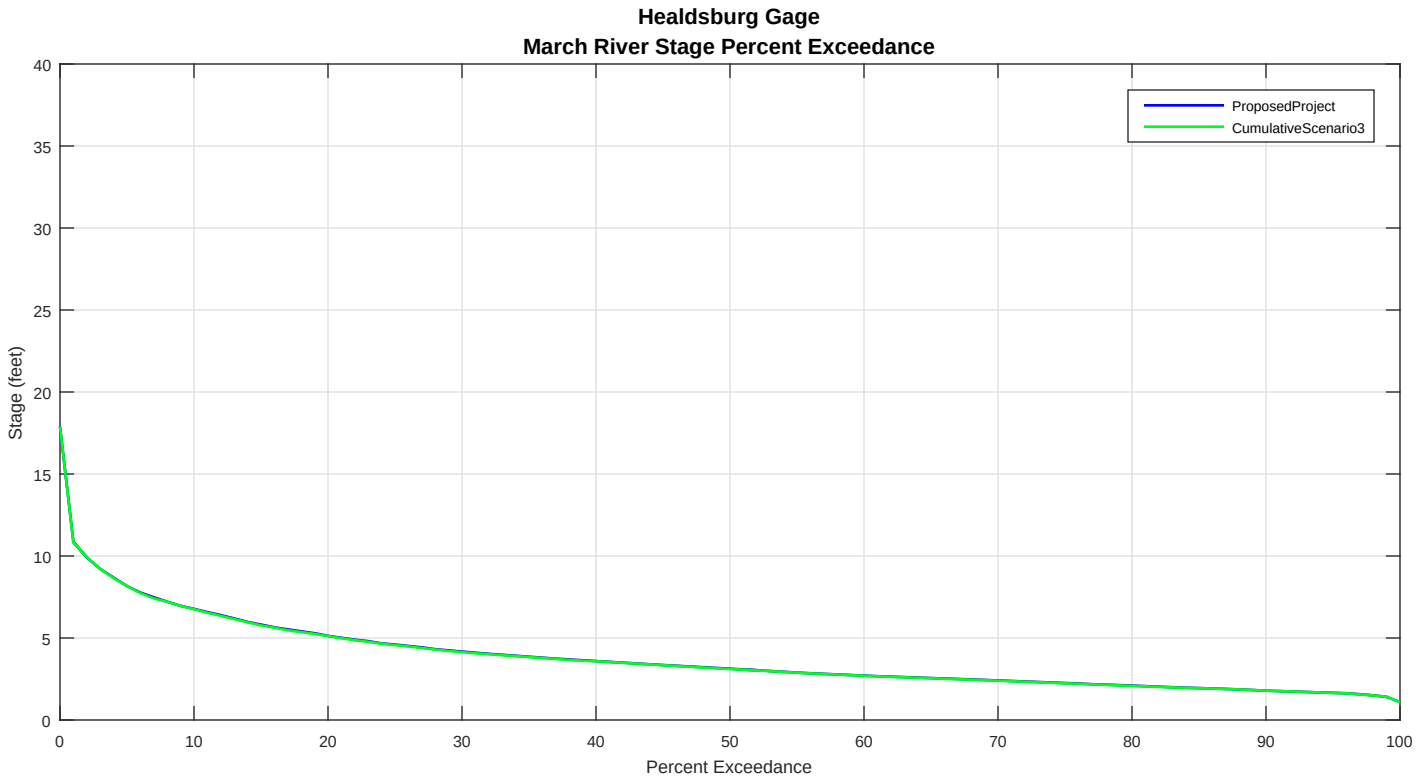

Cloverdale Gage
July River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

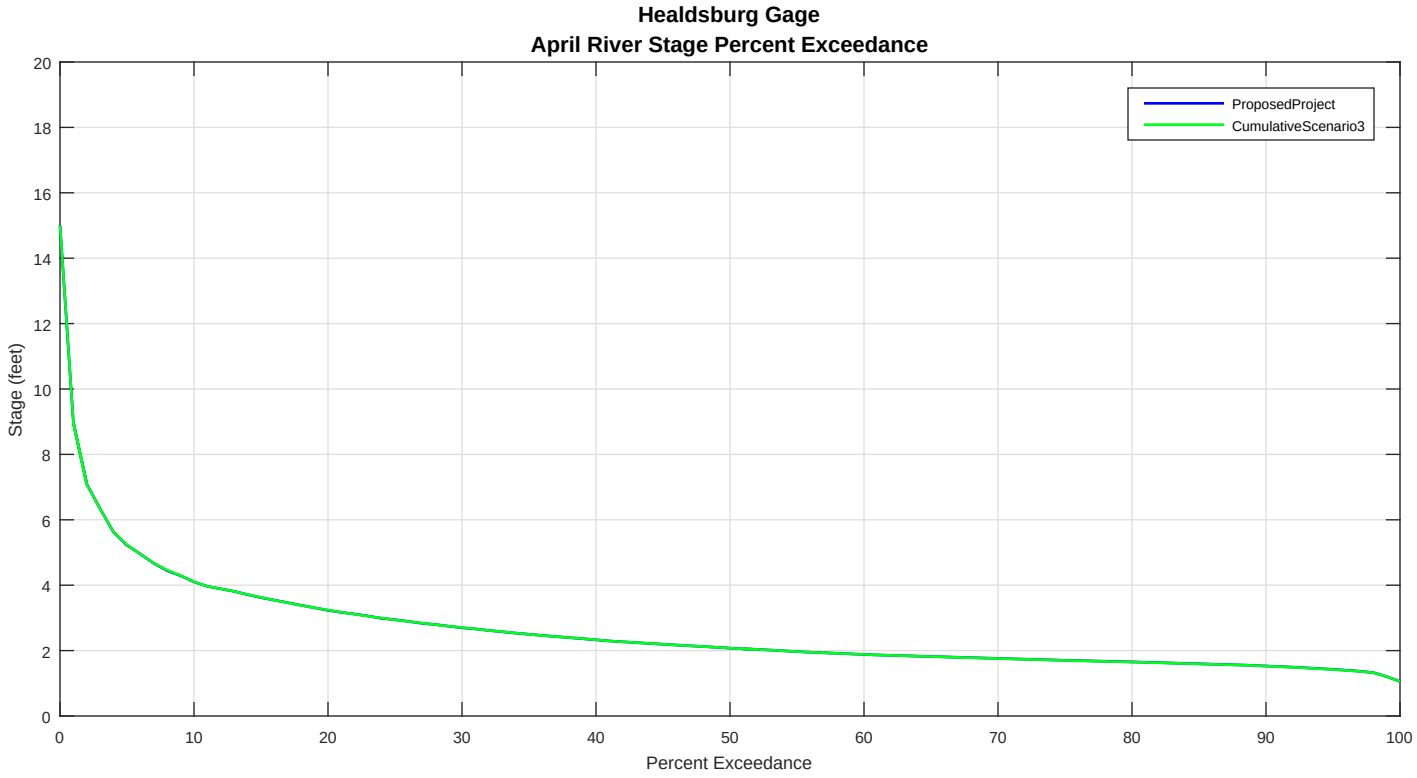

Cloverdale Gage
August River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

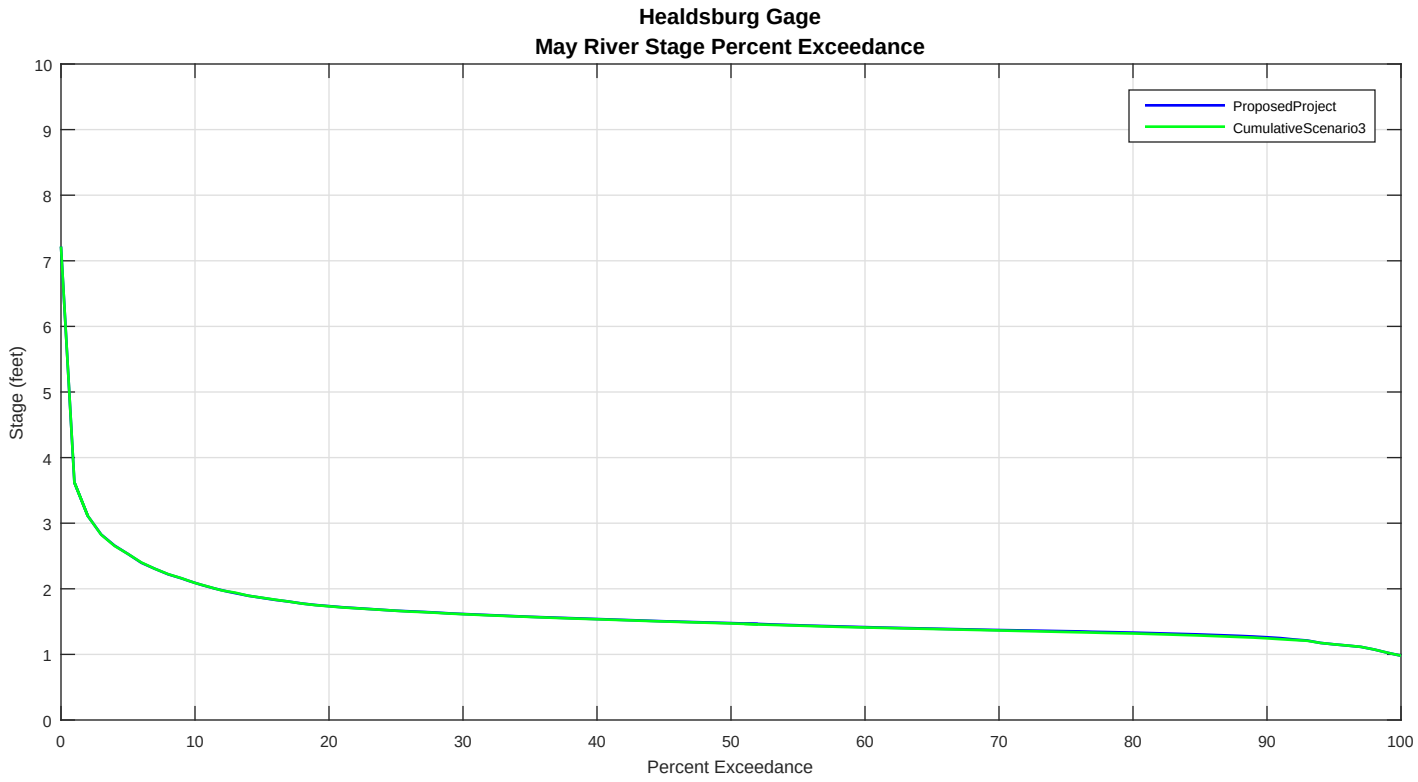

Cloverdale Gage
September River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

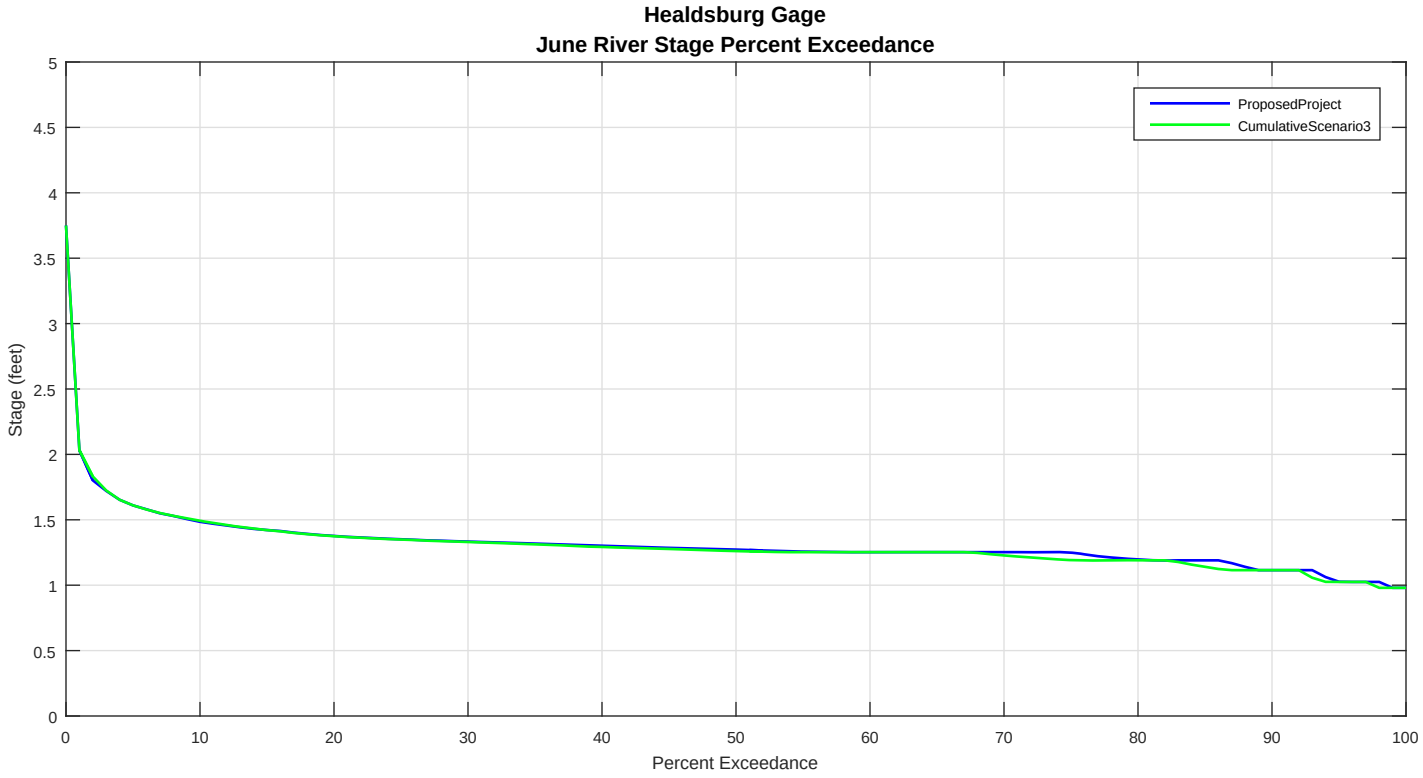

Cloverdale Gage
October 1-15 River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

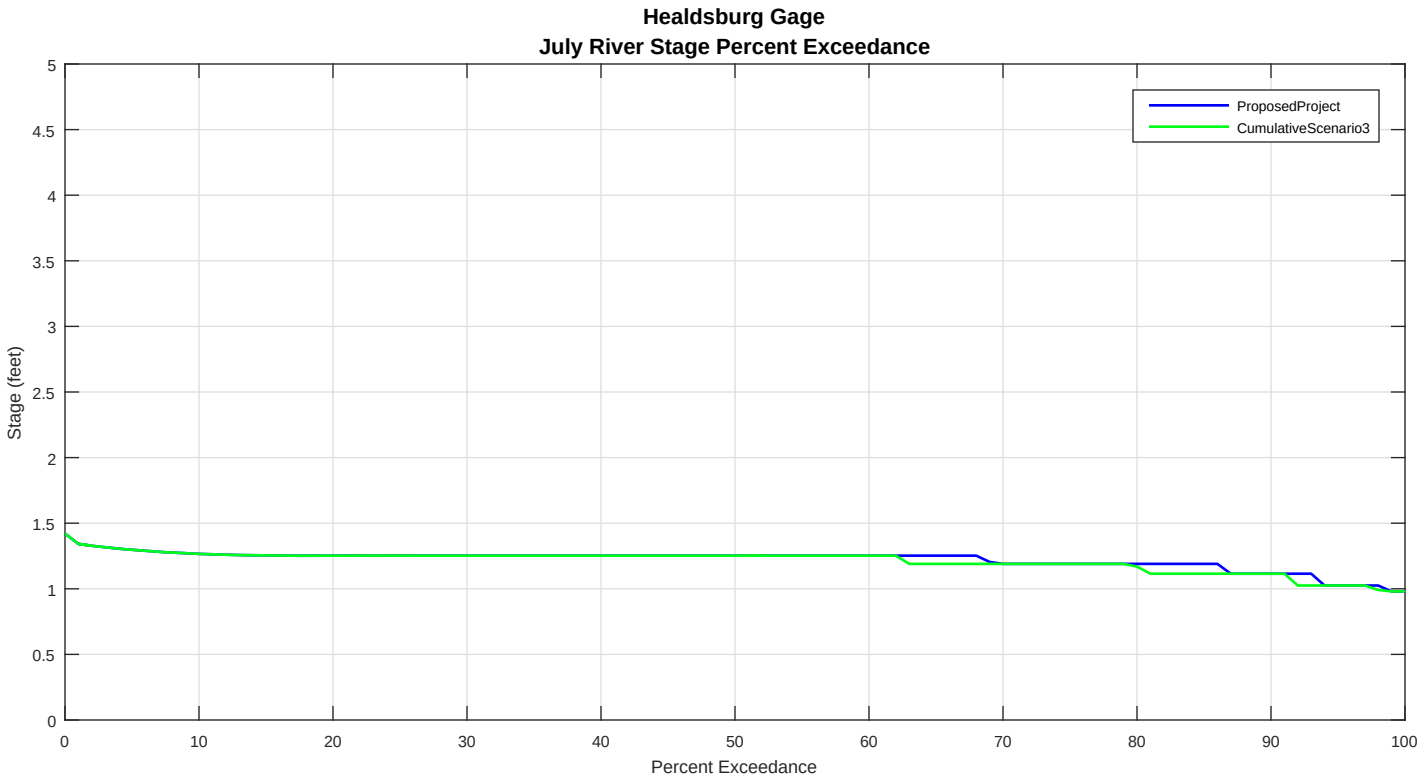

Cloverdale Gage
October 16-31 River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

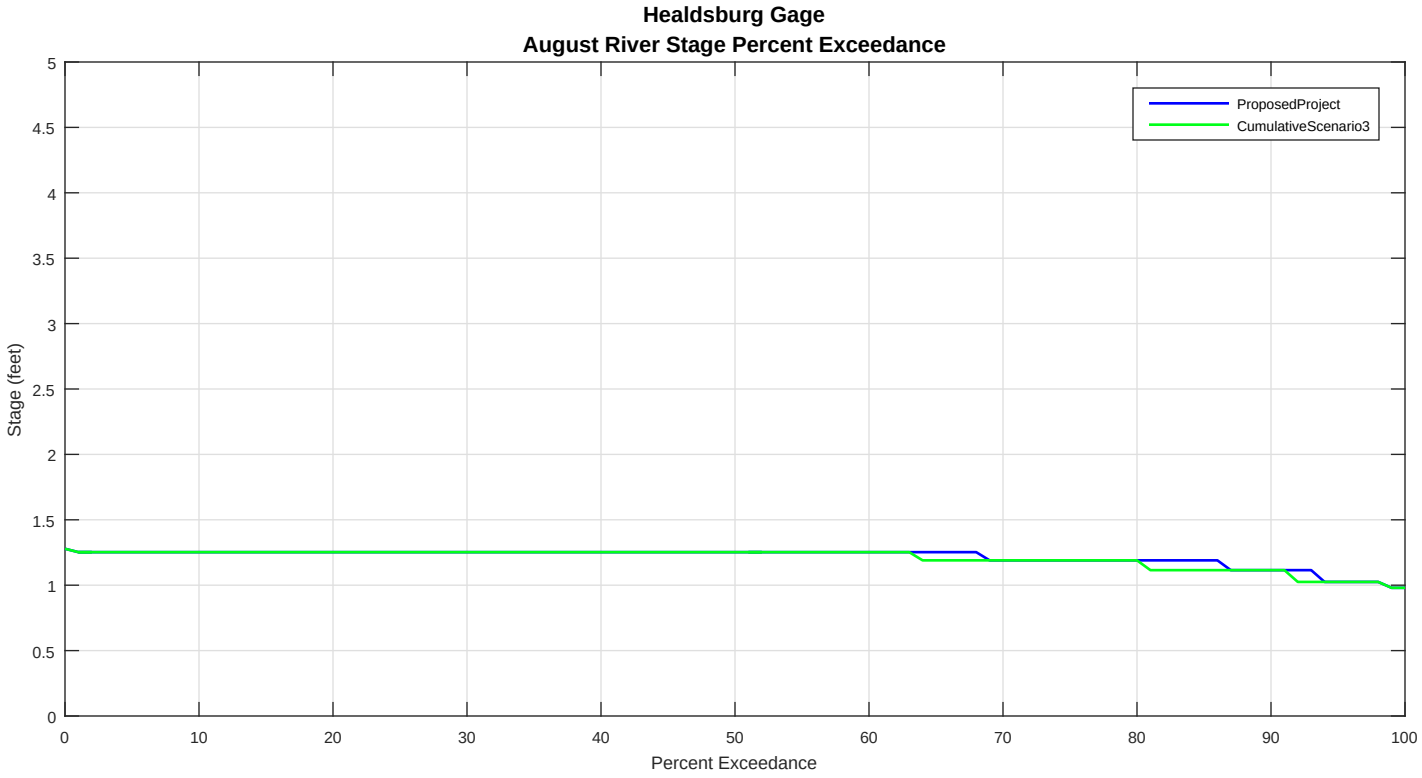

Healdsburg Gage
March River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80
90
100

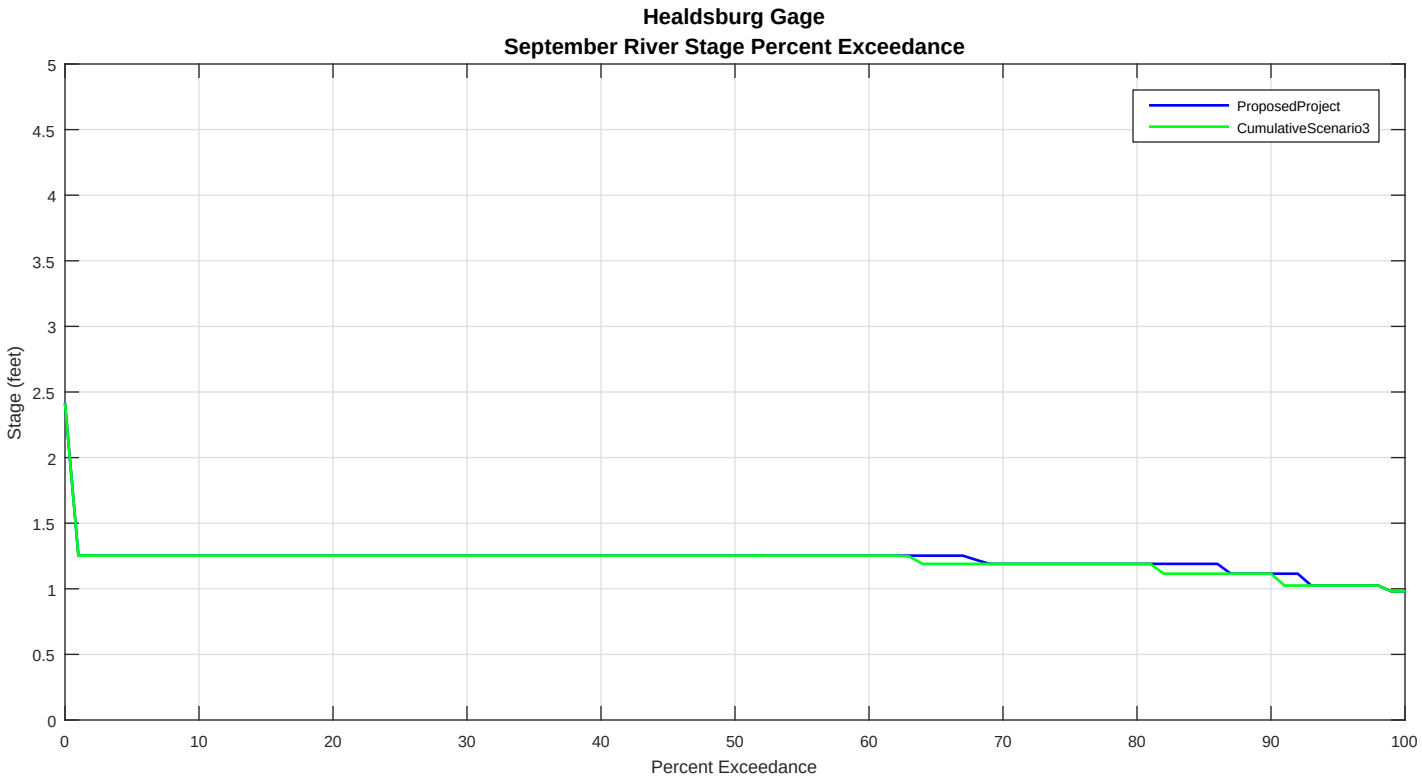

Healdsburg Gage
April River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

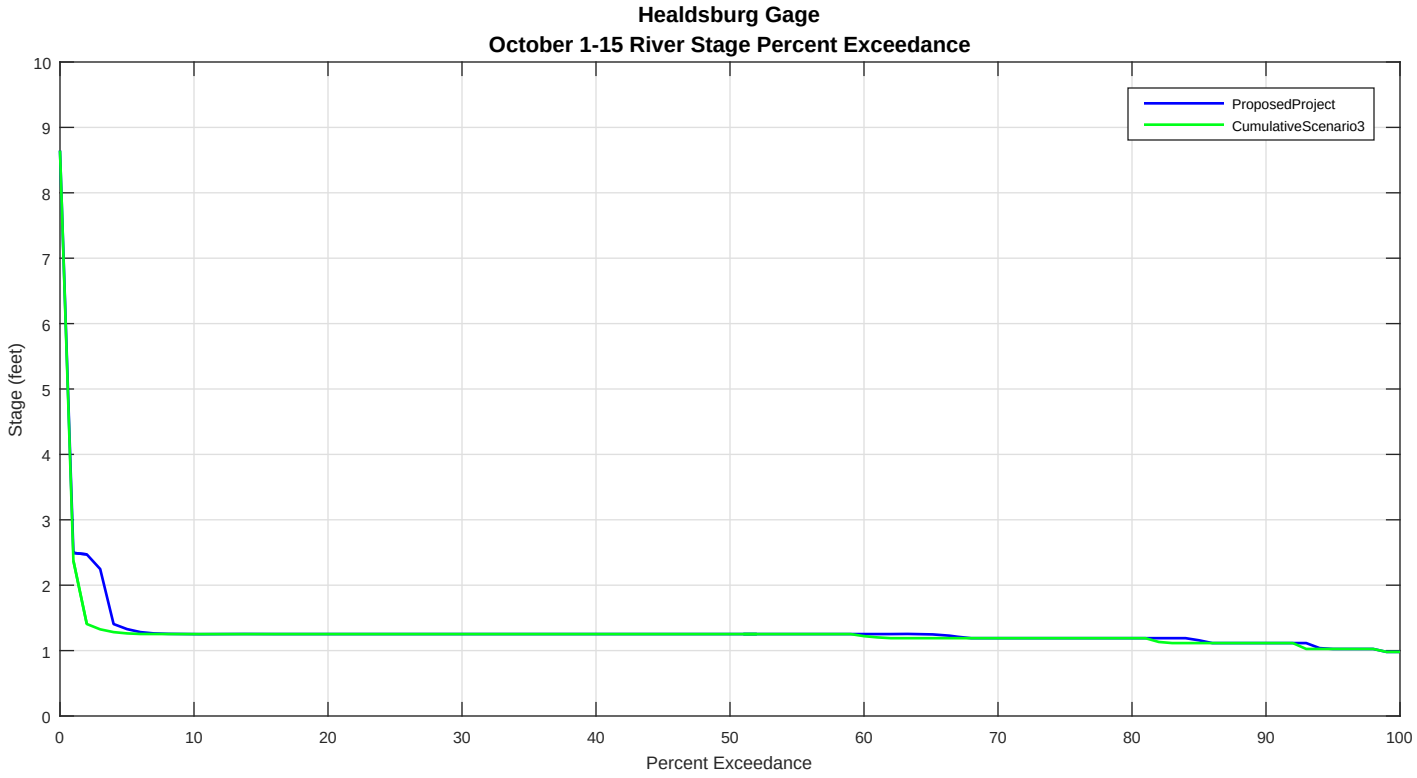

Healdsburg Gage
May River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

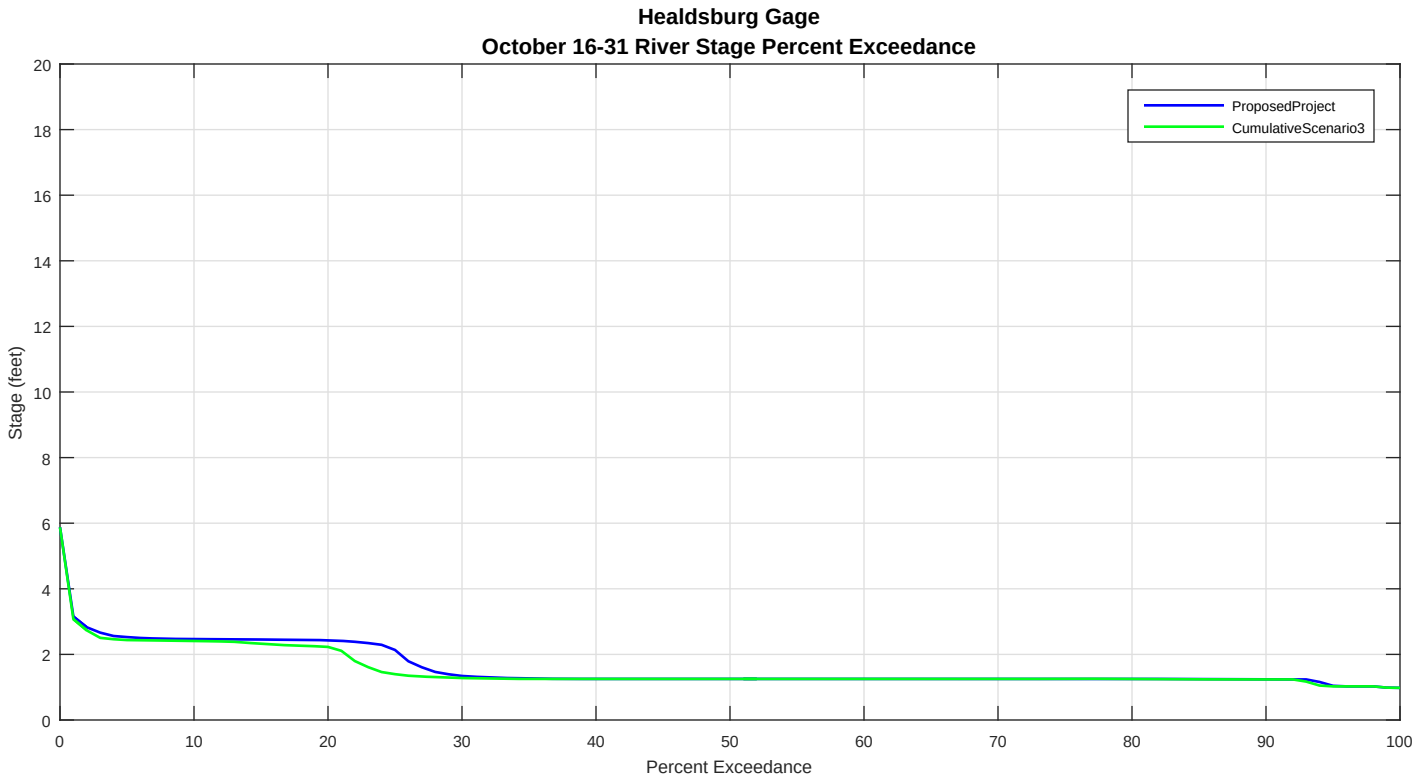

Healdsburg Gage
June River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

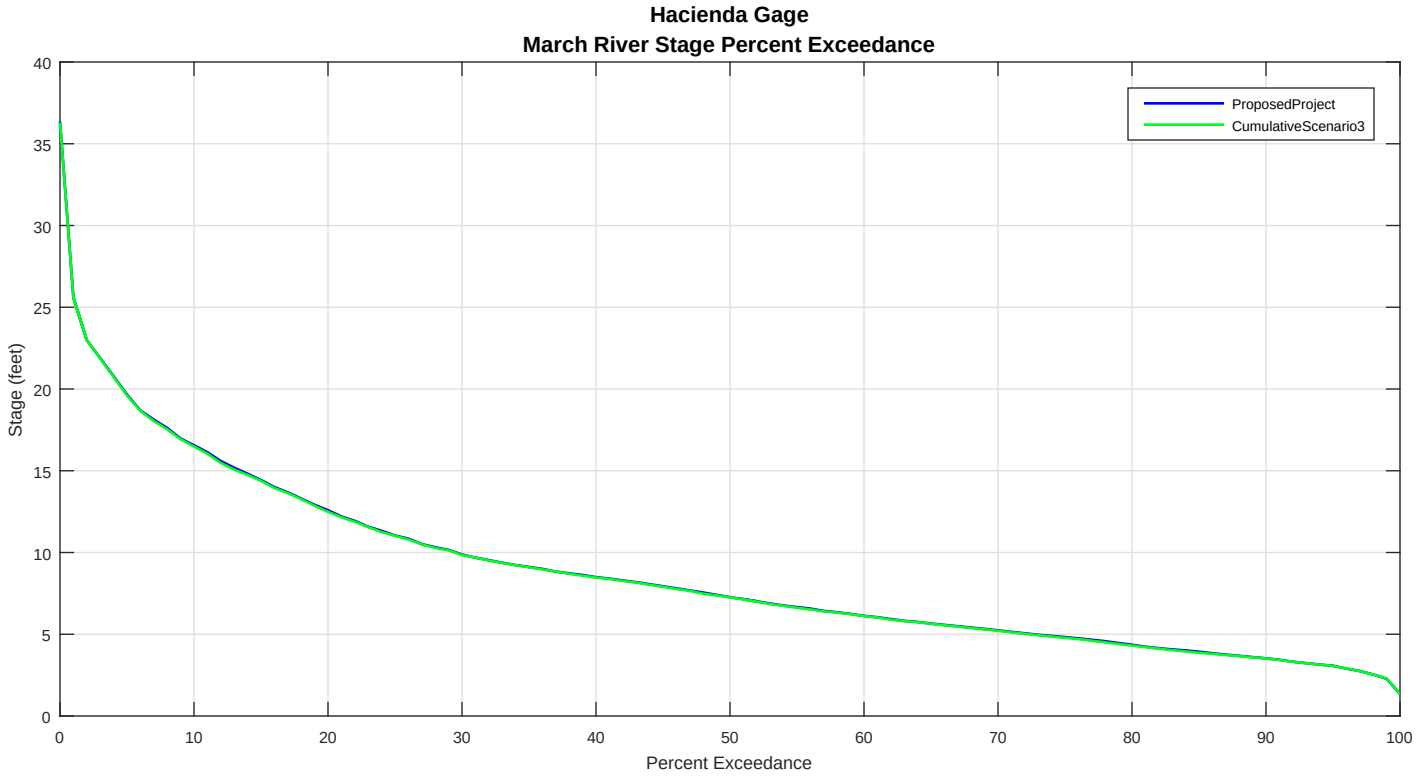

Healdsburg Gage
July River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

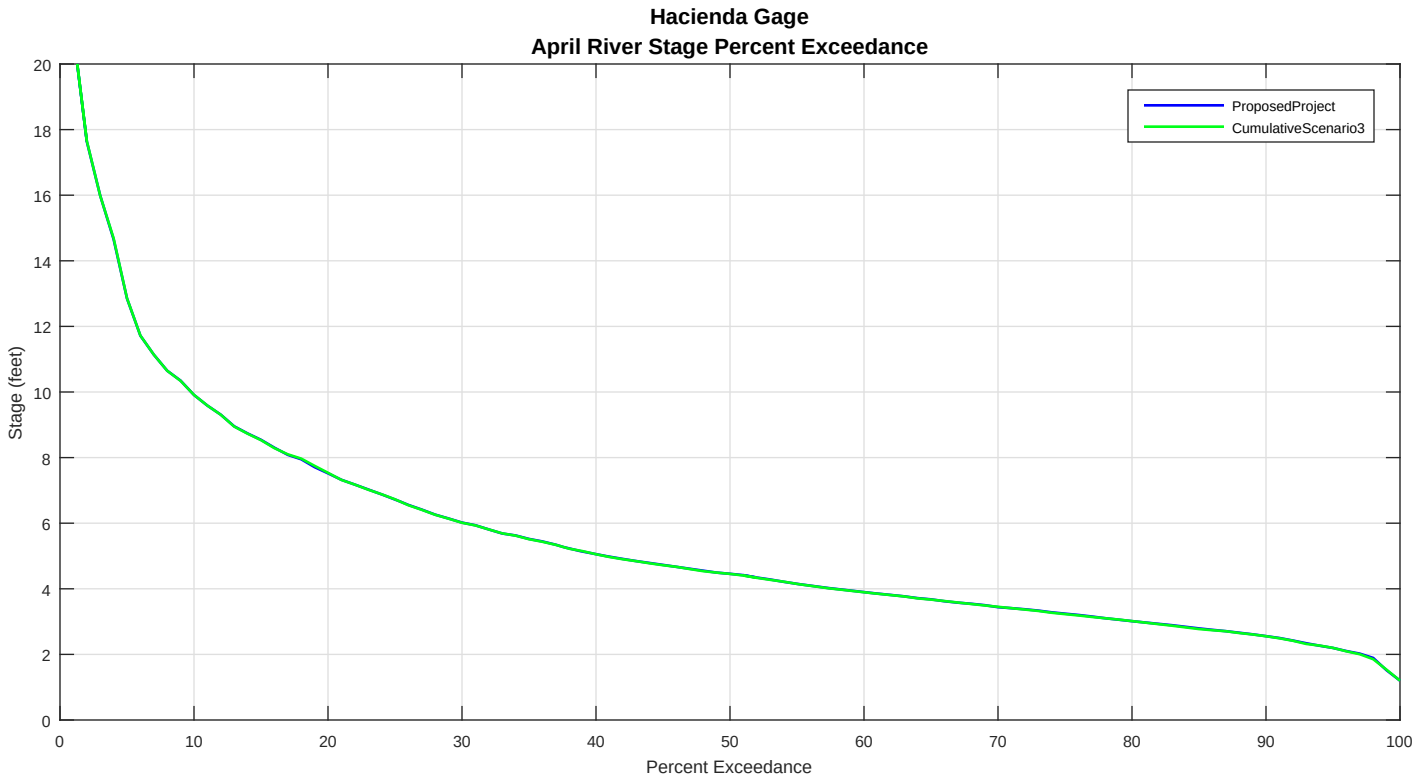

Healdsburg Gage
August River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

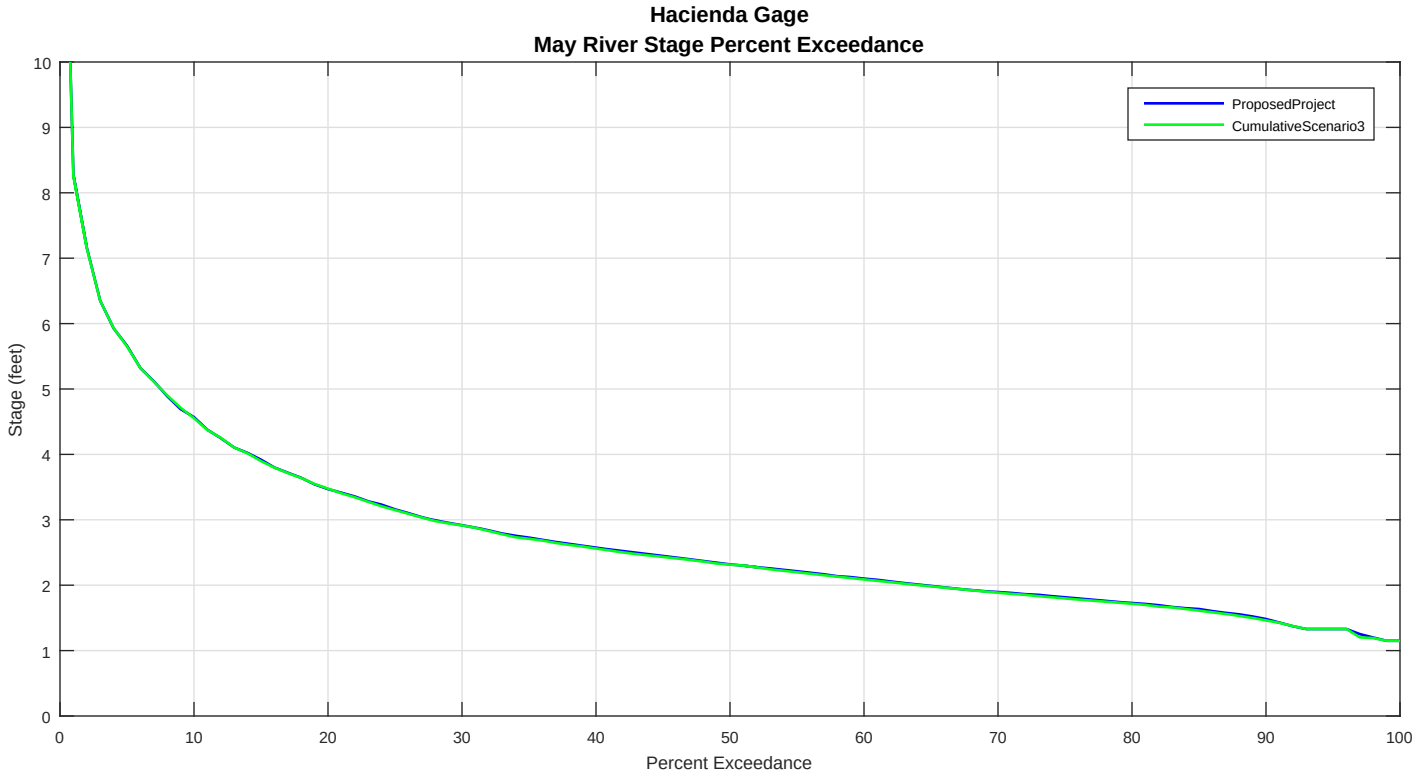

Healdsburg Gage
September River Stage Percent Exceedance
Stage (feet)
Percent Exceedance
ProposedProject
CumulativeScenario3
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

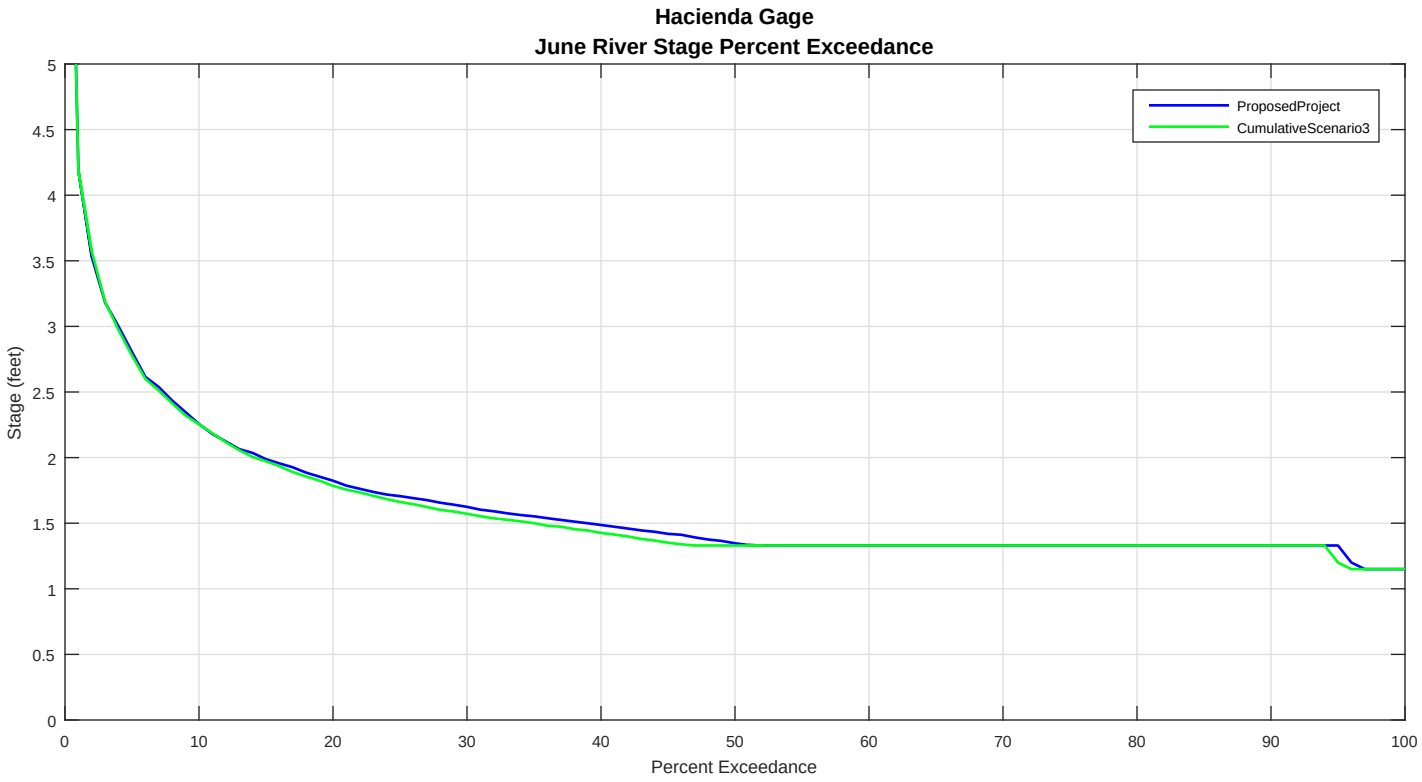

Healdsburg Gage
October 1-15 River Stage Percent Exceedance
Stage (feet)
Percent Exceedance
ProposedProject
CumulativeScenario3
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

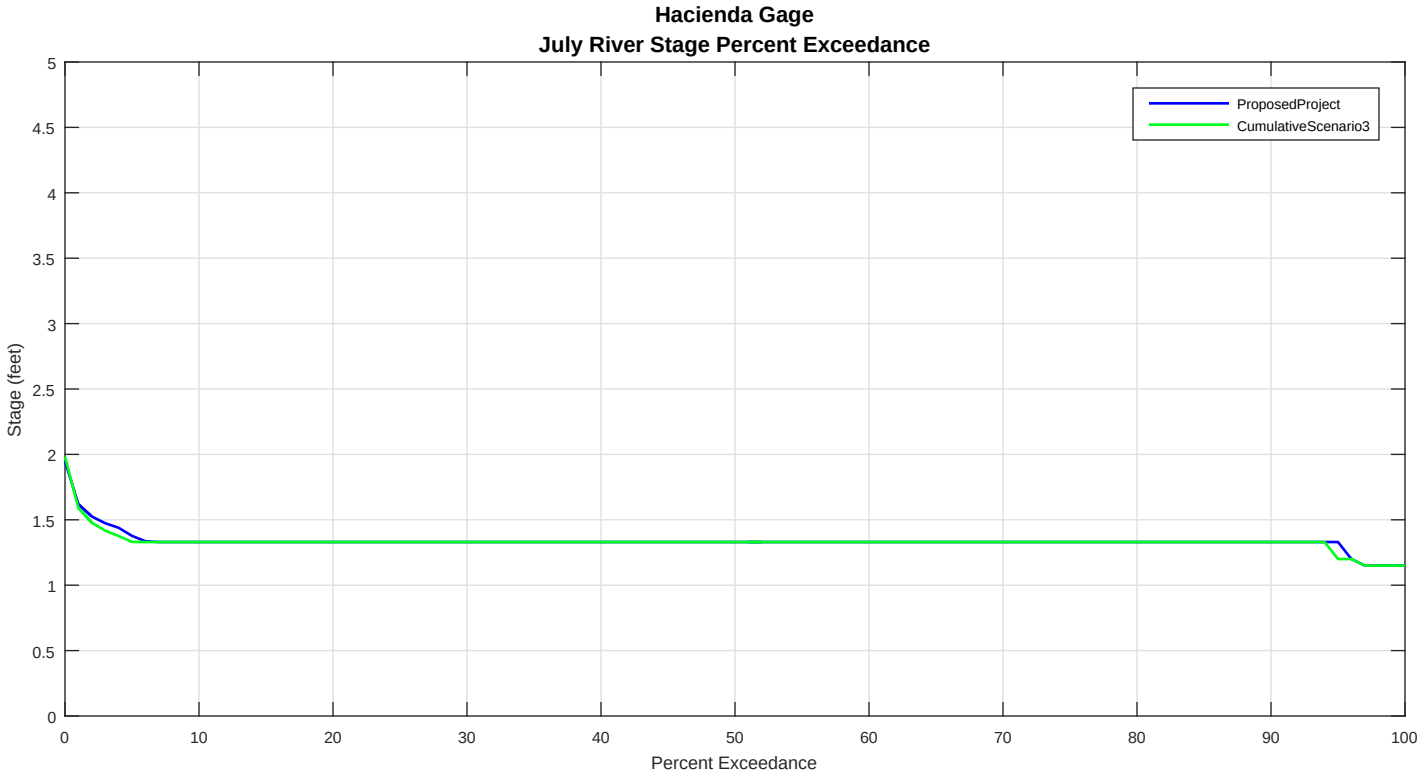

Healdsburg Gage
October 16-31 River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

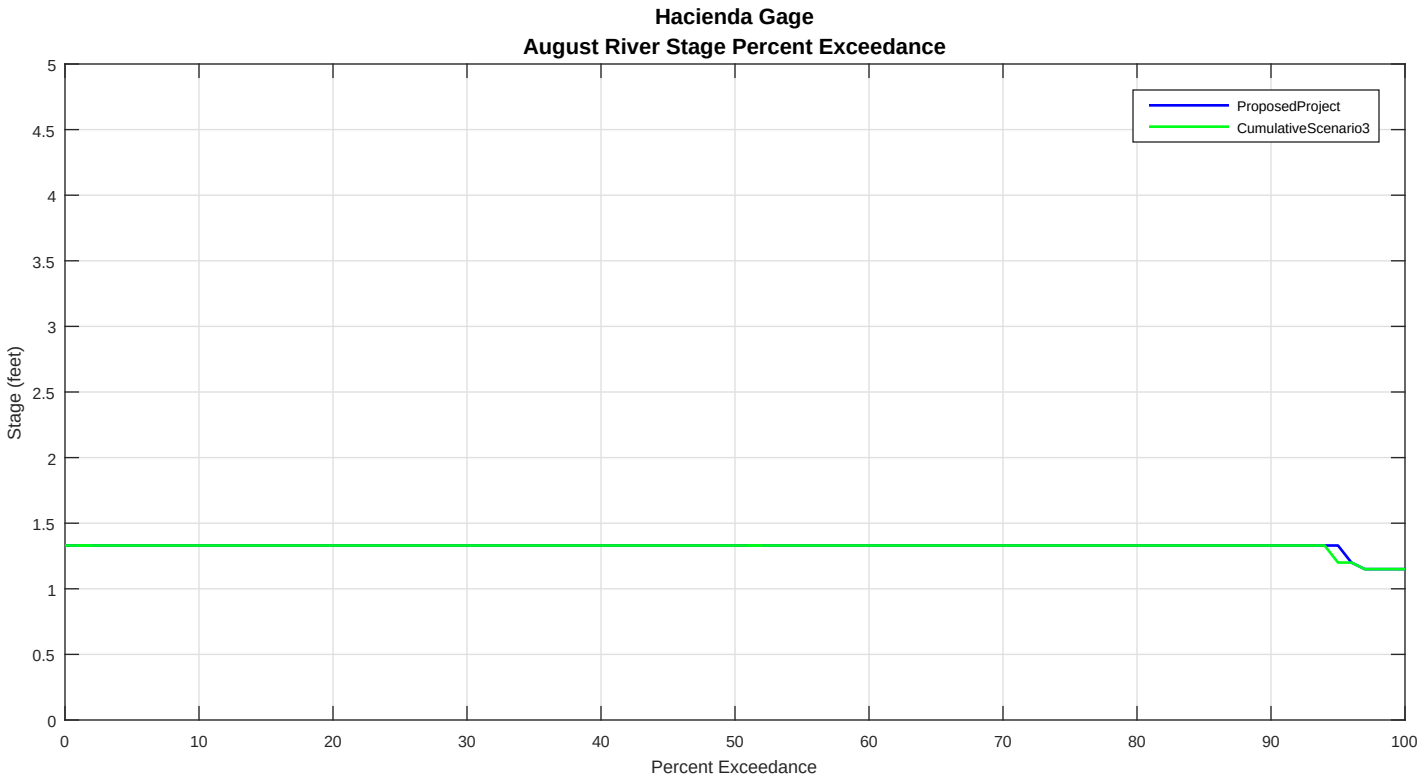

Hacienda Gage
March River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80
90
100

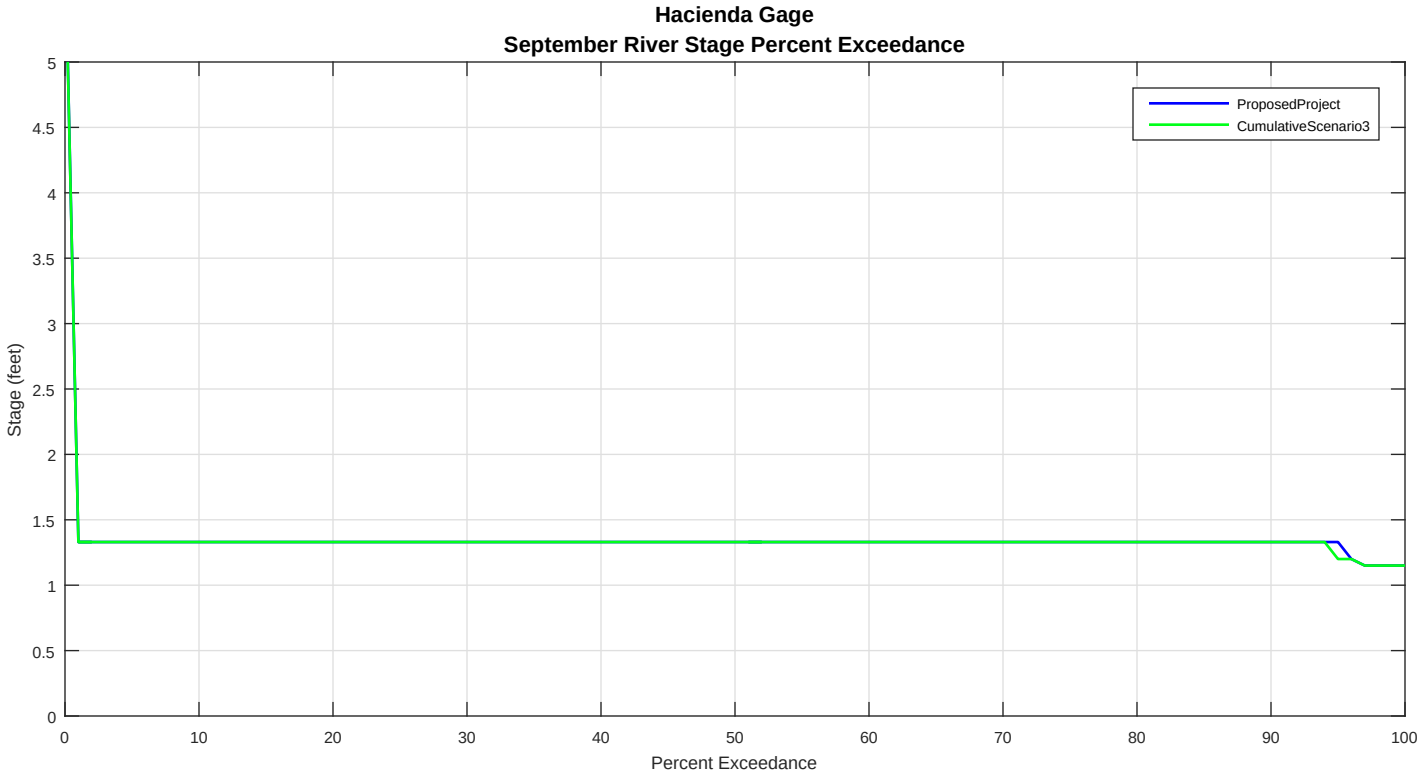

Hacienda Gage
April River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

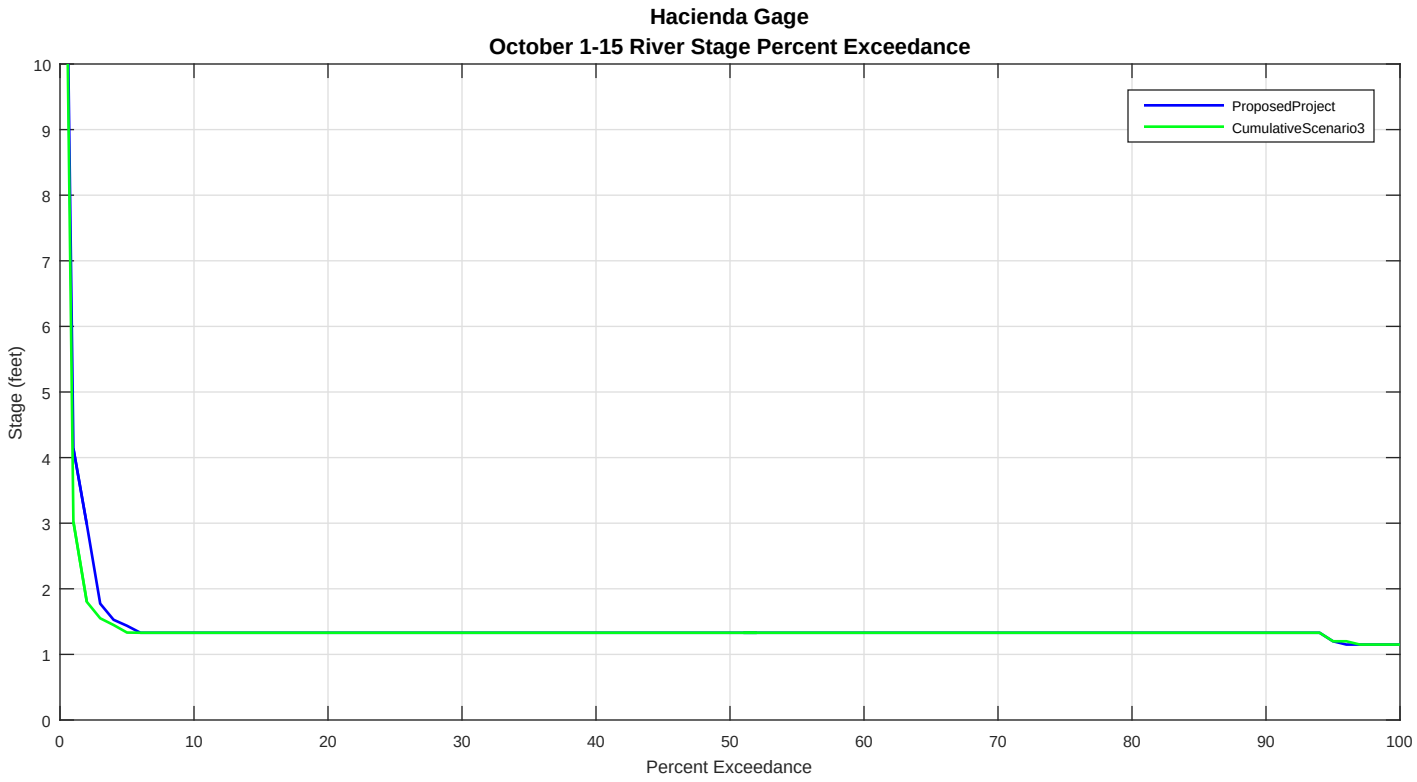

Hacienda Gage
May River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

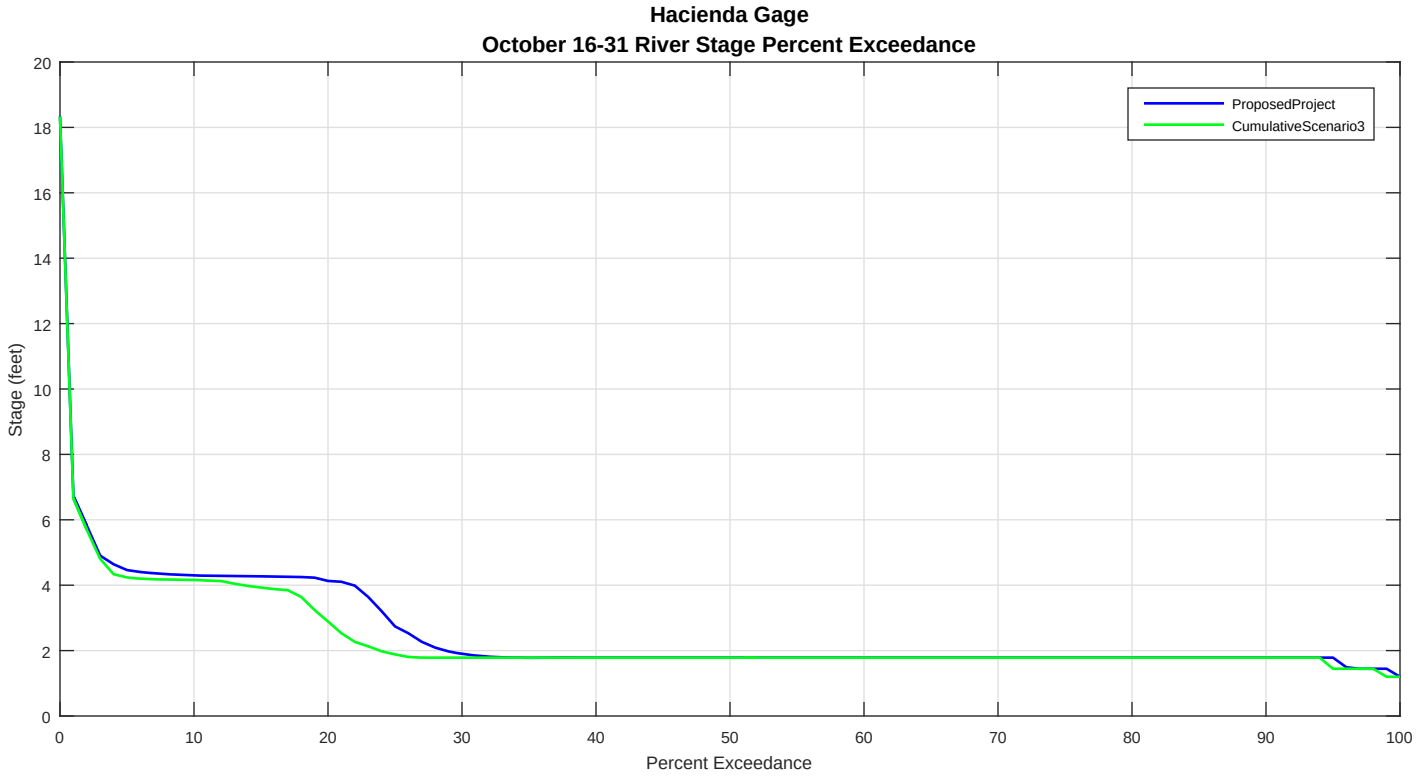

Hacienda Gage
June River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

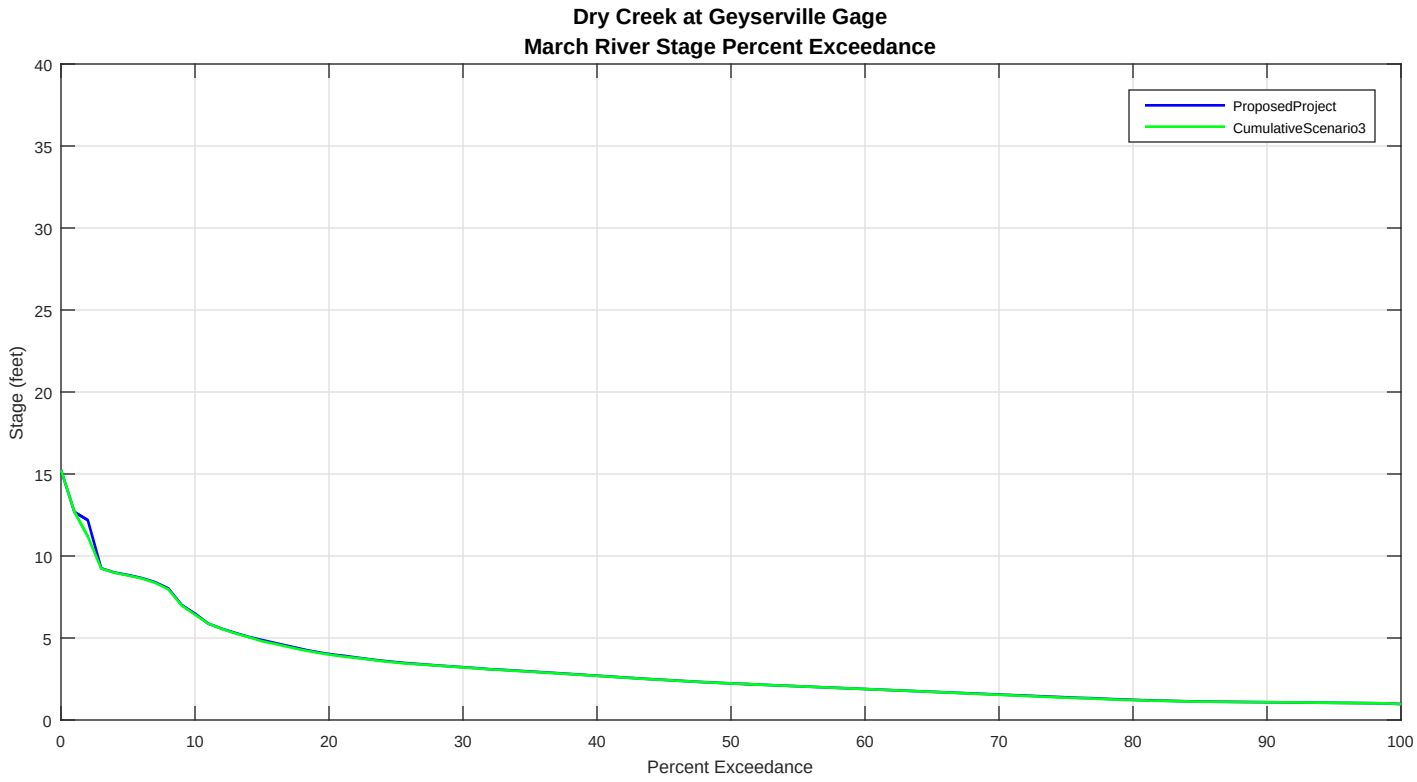

Hacienda Gage
July River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

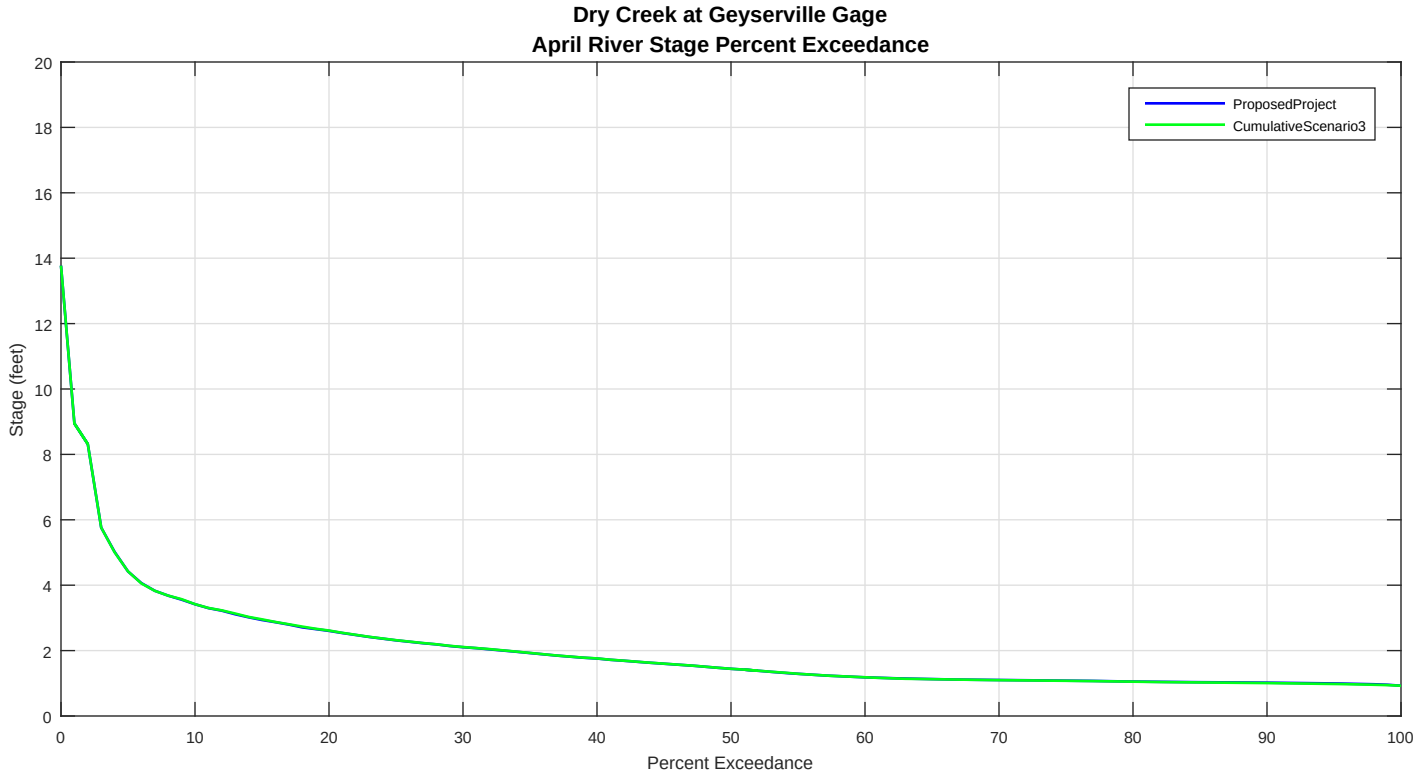

Hacienda Gage
August River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

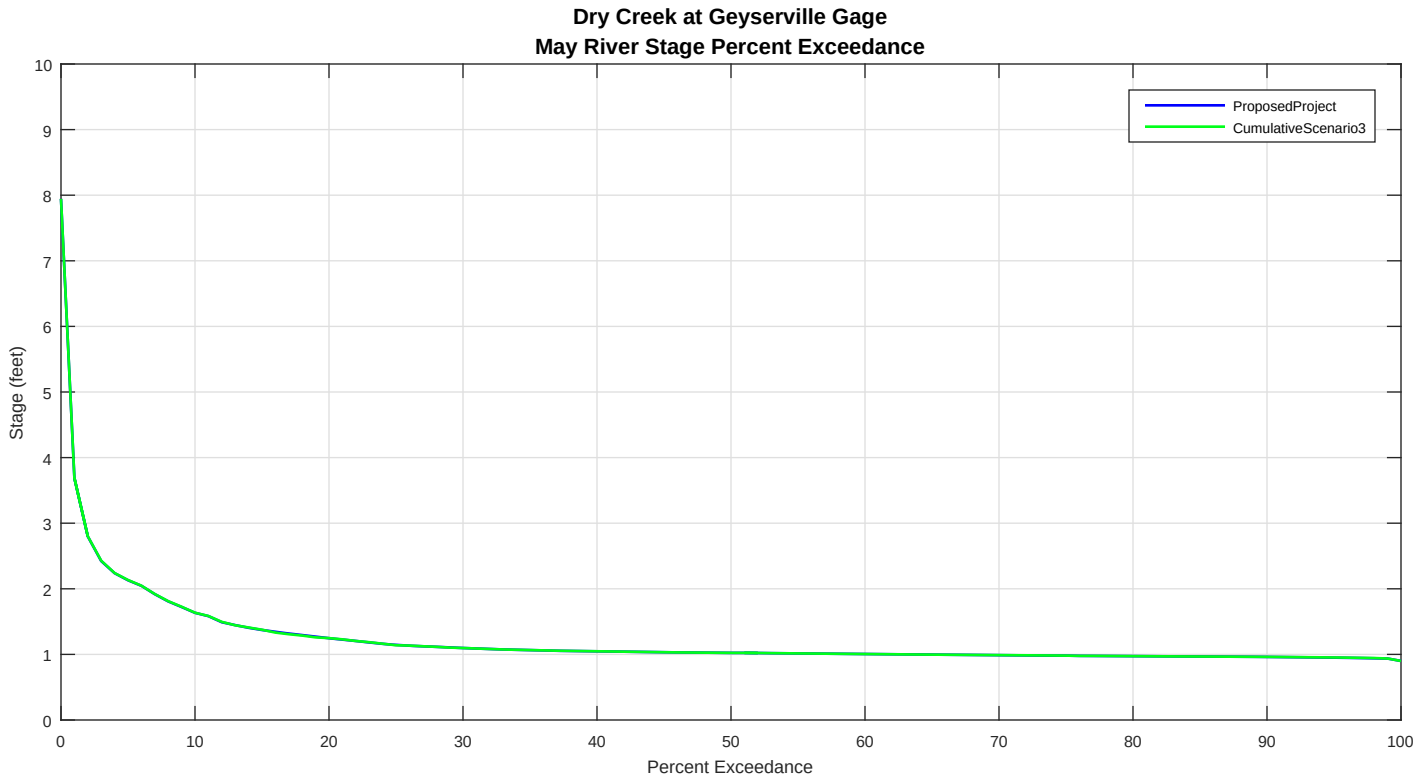

Hacienda Gage
September River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

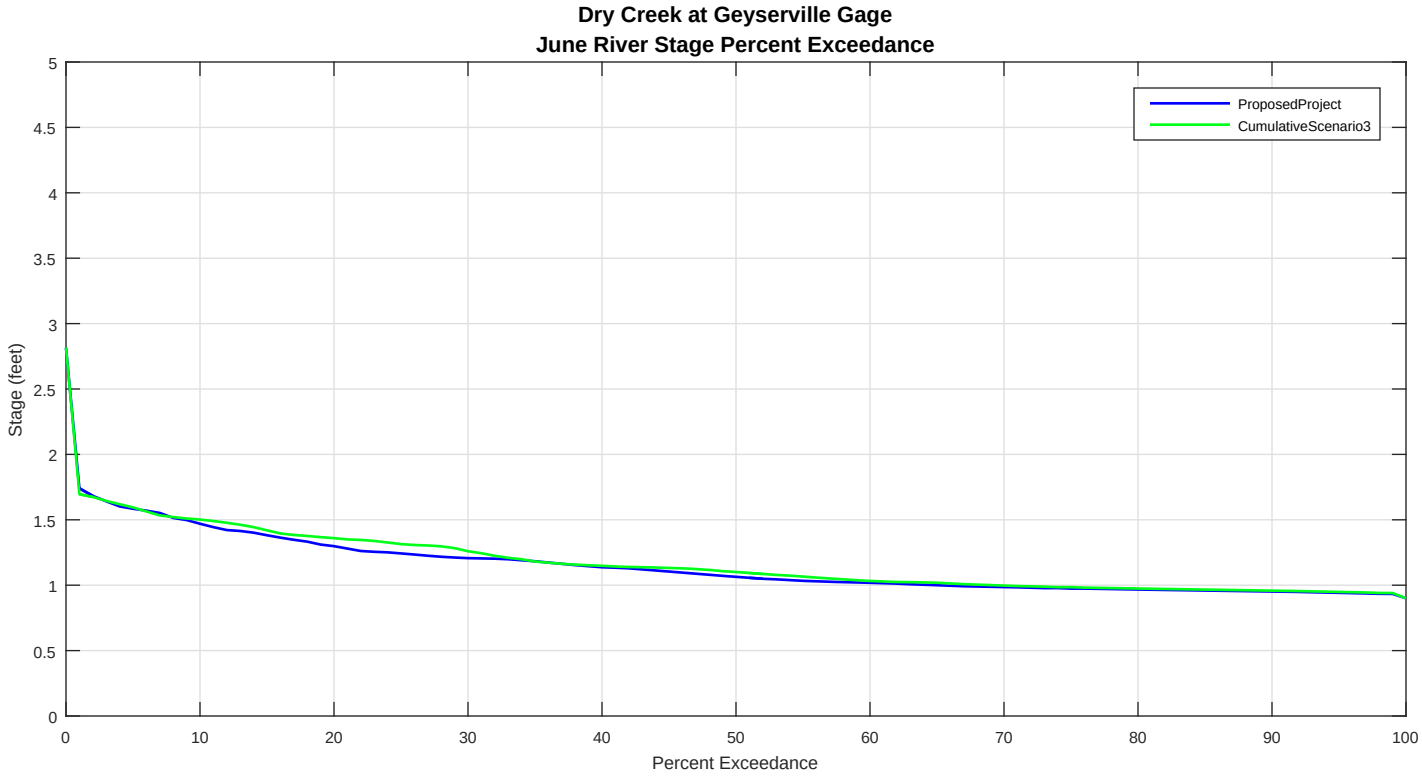

Hacienda Gage
October 1-15 River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

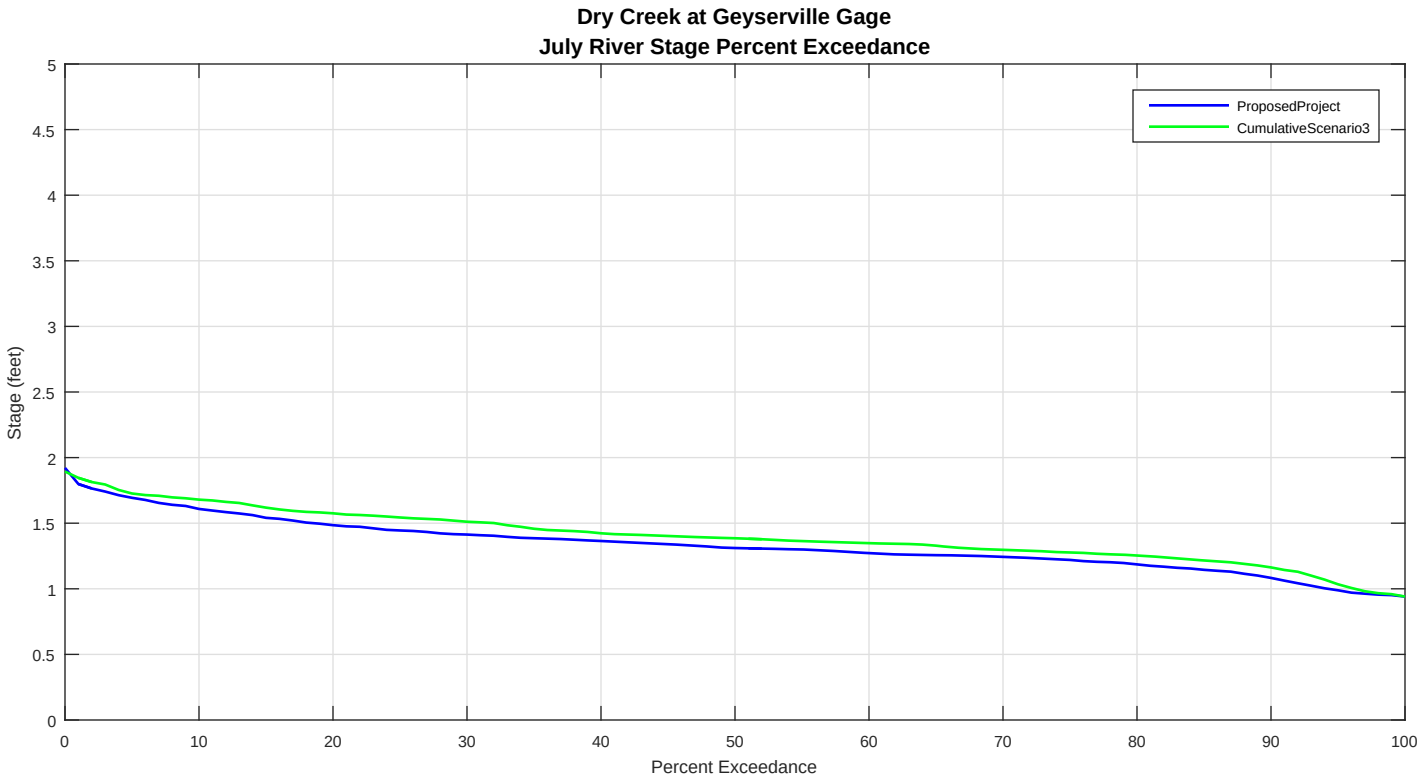

Hacienda Gage
October 16-31 River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

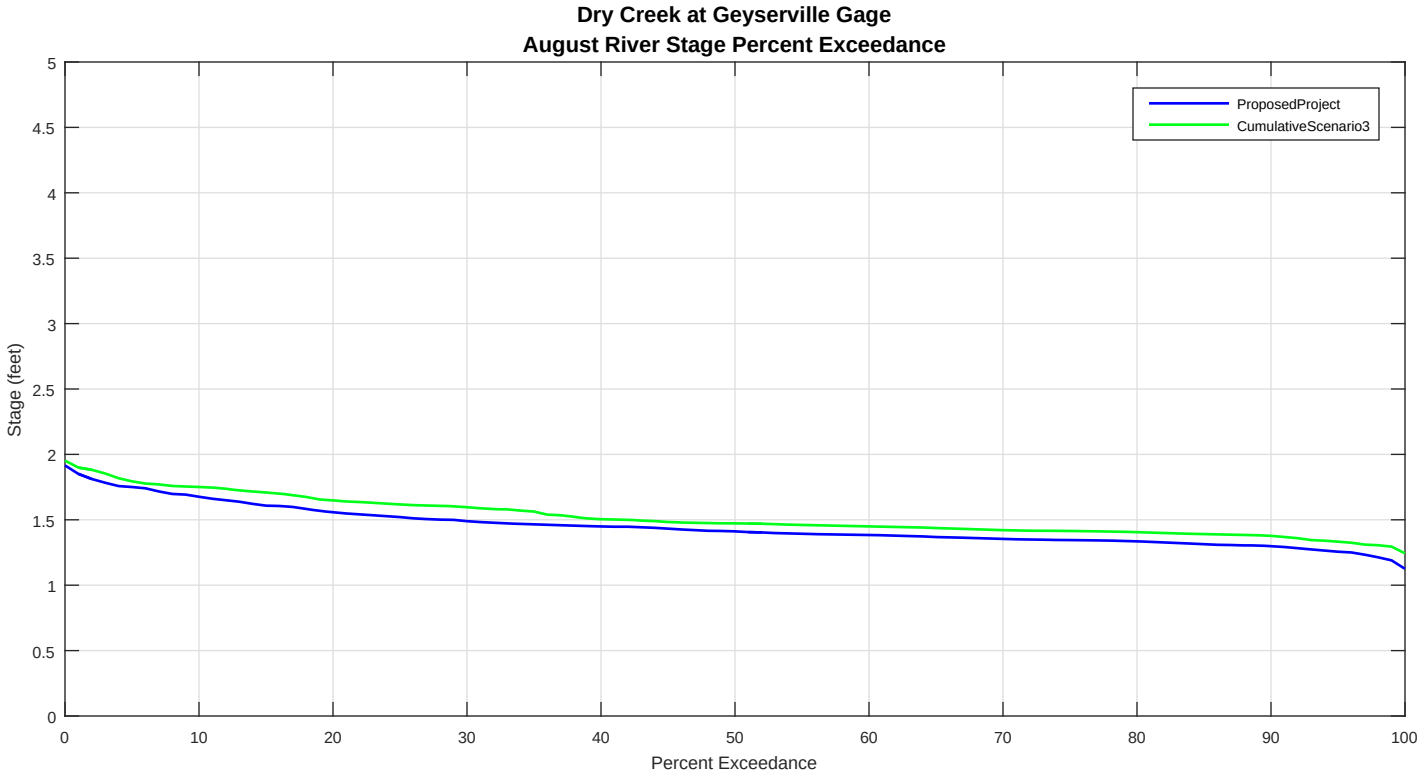

Dry Creek at Geyserville Gage
March River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80
90
100

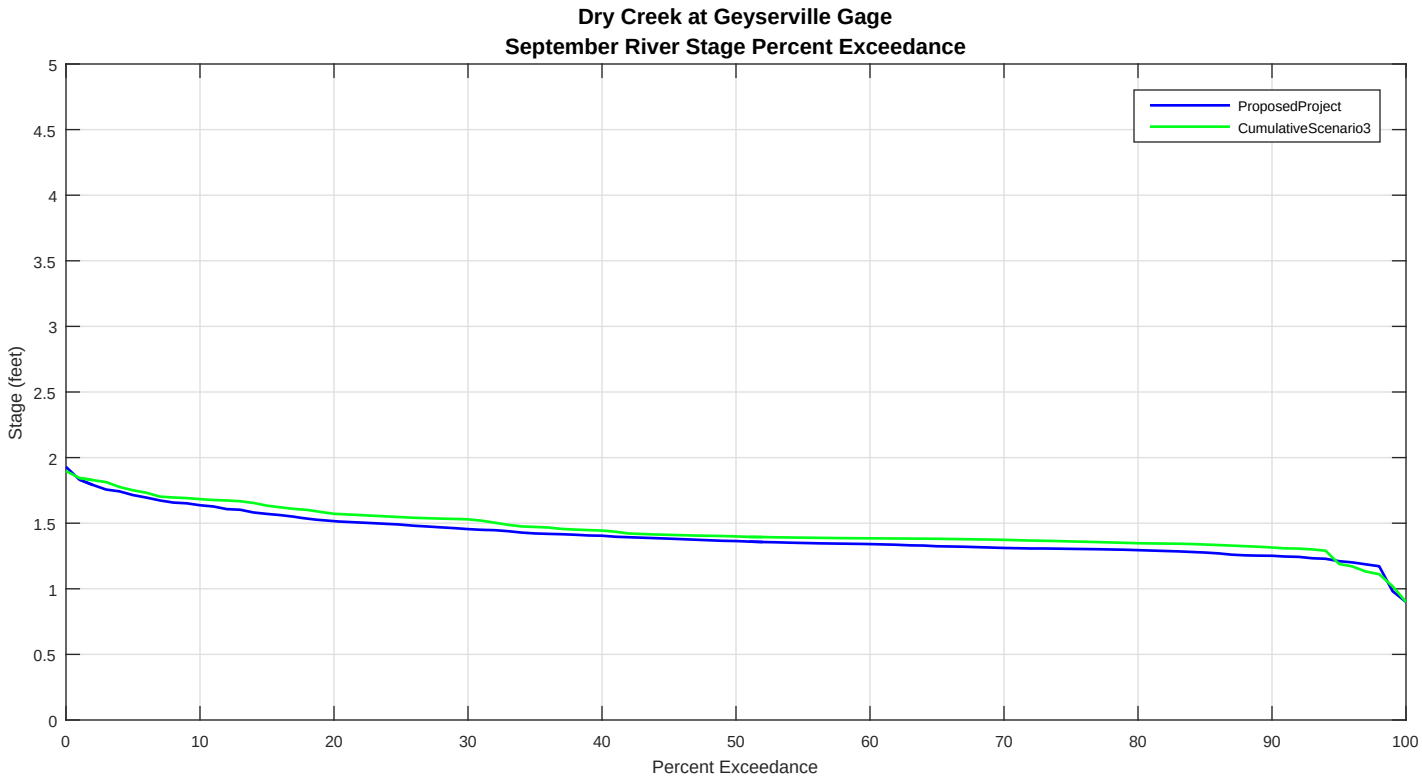

Dry Creek at Geyserville Gage
April River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

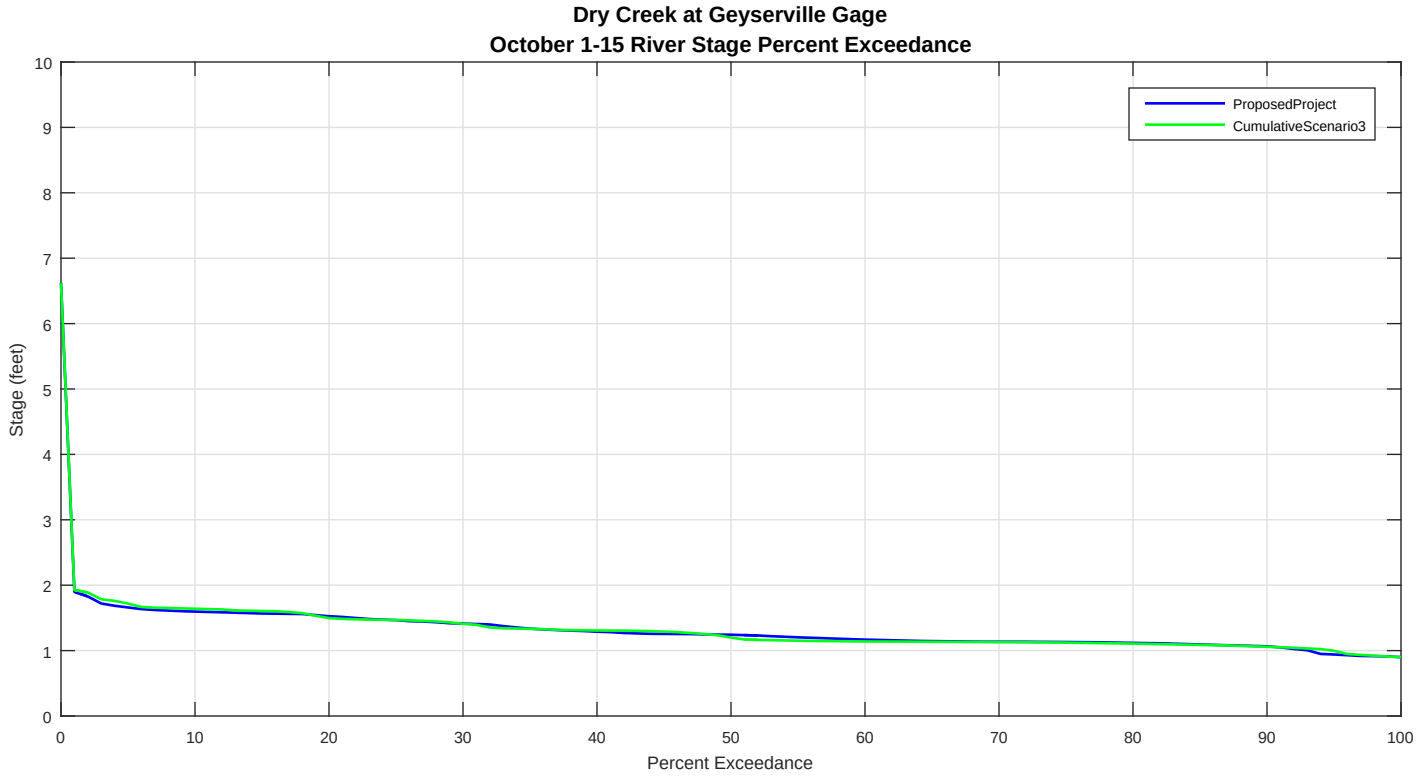

Dry Creek at Geyserville Gage
May River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

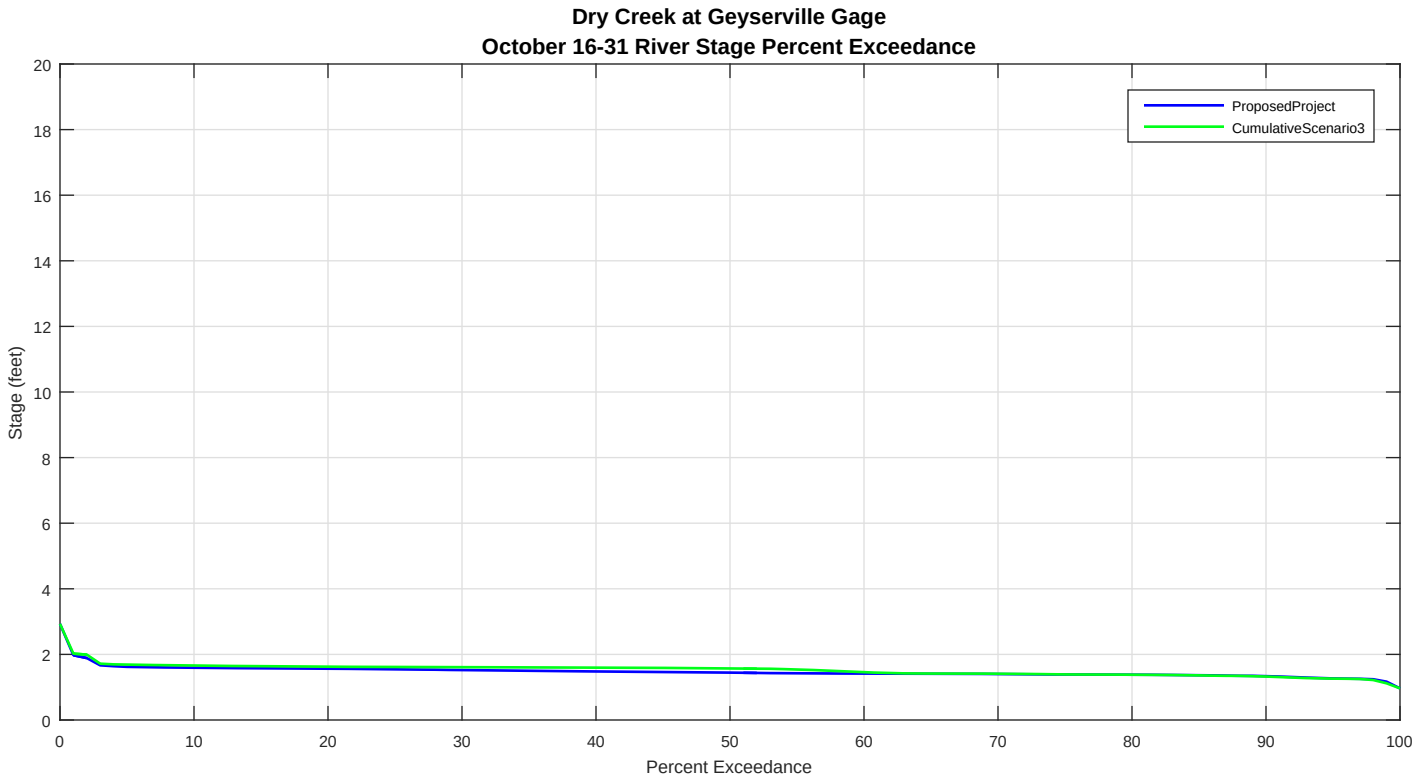

Dry Creek at Geyserville Gage
June River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

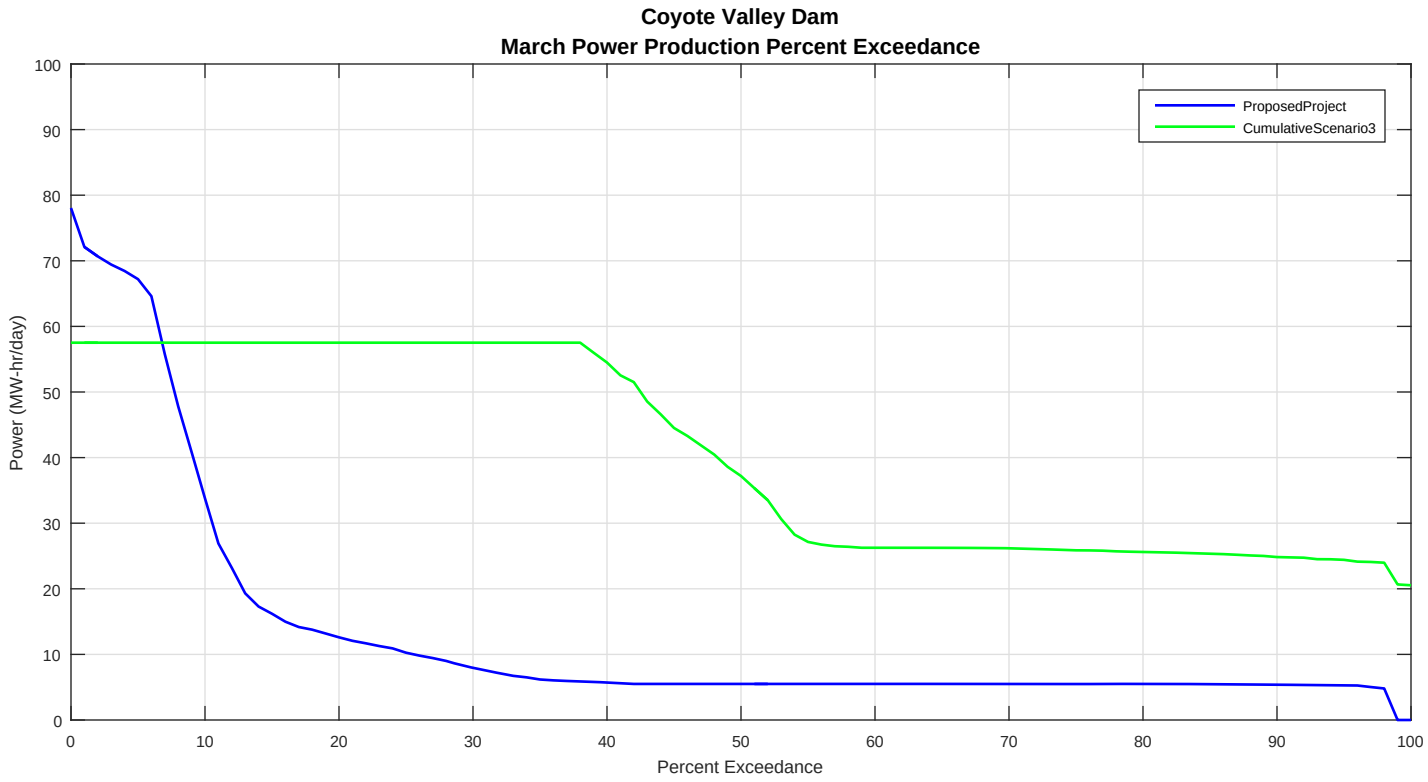

Dry Creek at Geyserville Gage
July River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

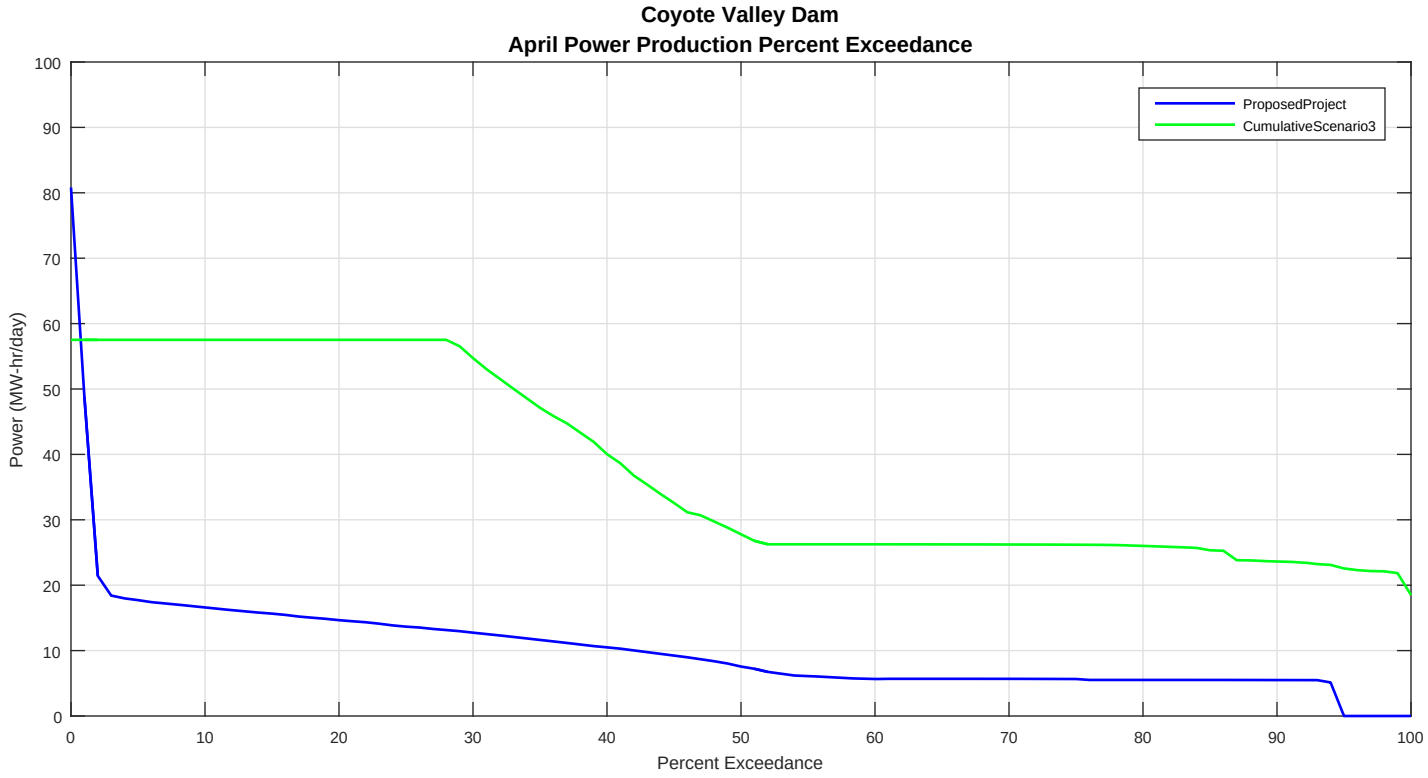

Dry Creek at Geyserville Gage
August River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

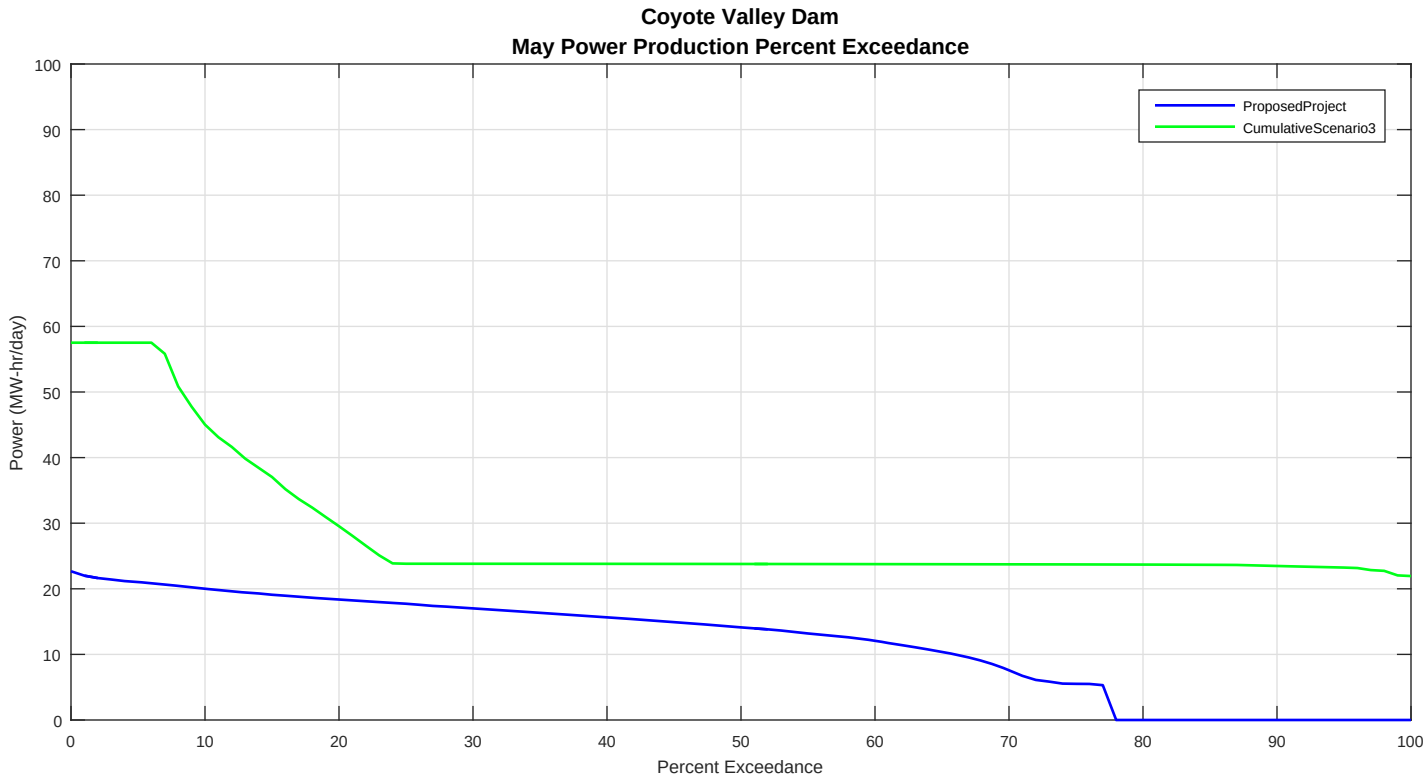

Dry Creek at Geyserville Gage
September River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

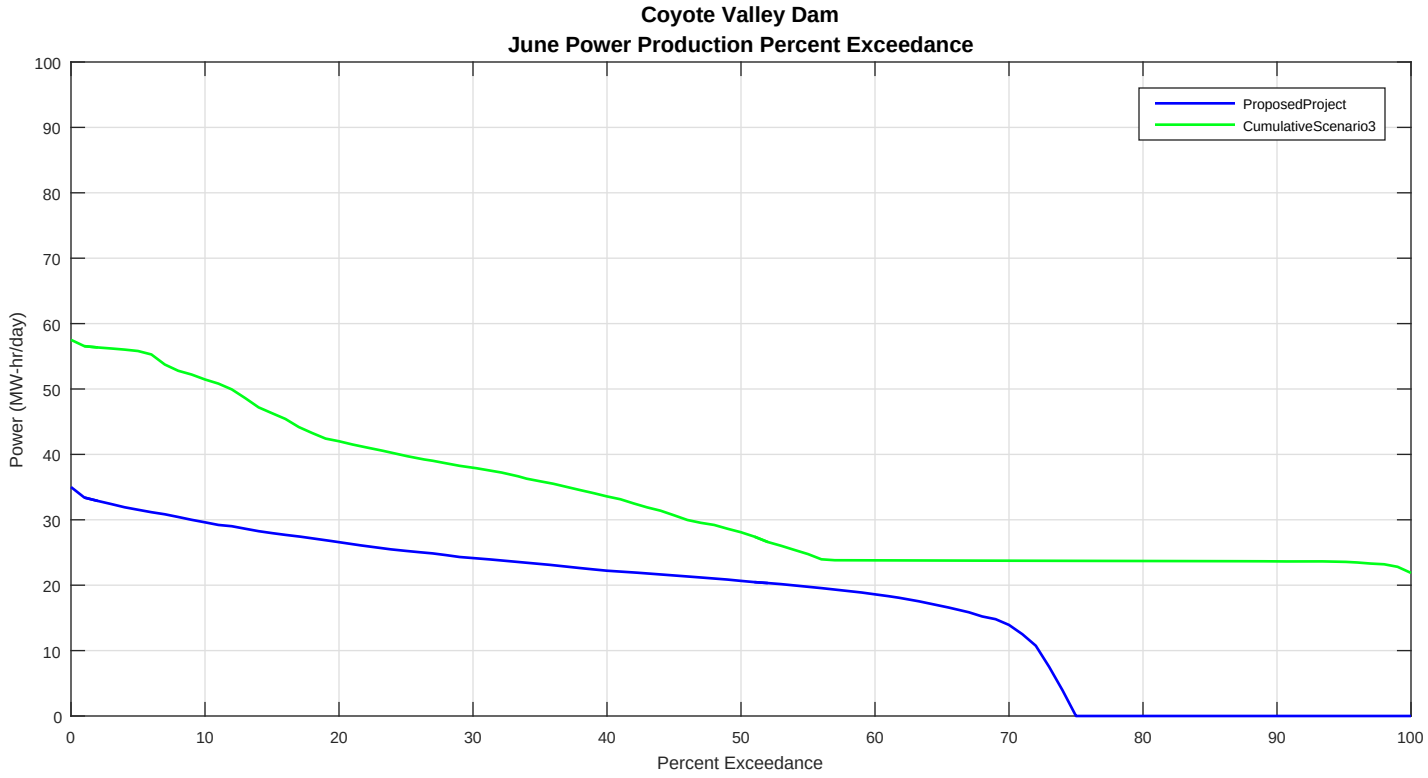

Dry Creek at Geyserville Gage
October 1-15 River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

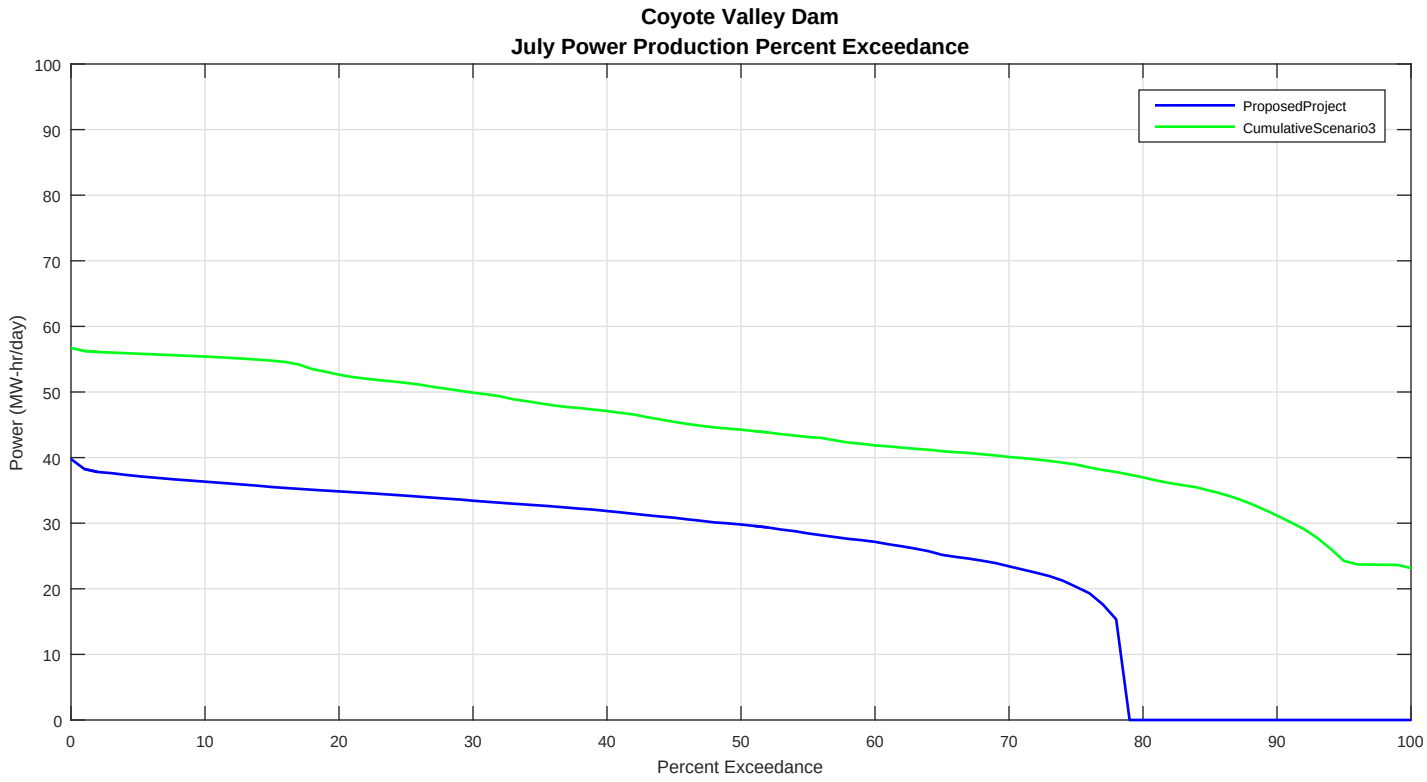

Dry Creek at Geyserville Gage
October 16-31 River Stage Percent Exceedance
ProposedProject
CumulativeScenario3
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam
March Power Production Percent Exceedance
ProposedProject
CumulativeScenario3
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam
April Power Production Percent Exceedance
ProposedProject
CumulativeScenario3
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam
May Power Production Percent Exceedance
ProposedProject
CumulativeScenario3
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam
June Power Production Percent Exceedance
ProposedProject
CumulativeScenario3
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam
July Power Production Percent Exceedance
ProposedProject
CumulativeScenario3
Power (MW-hr/day)
Percent Exceedance
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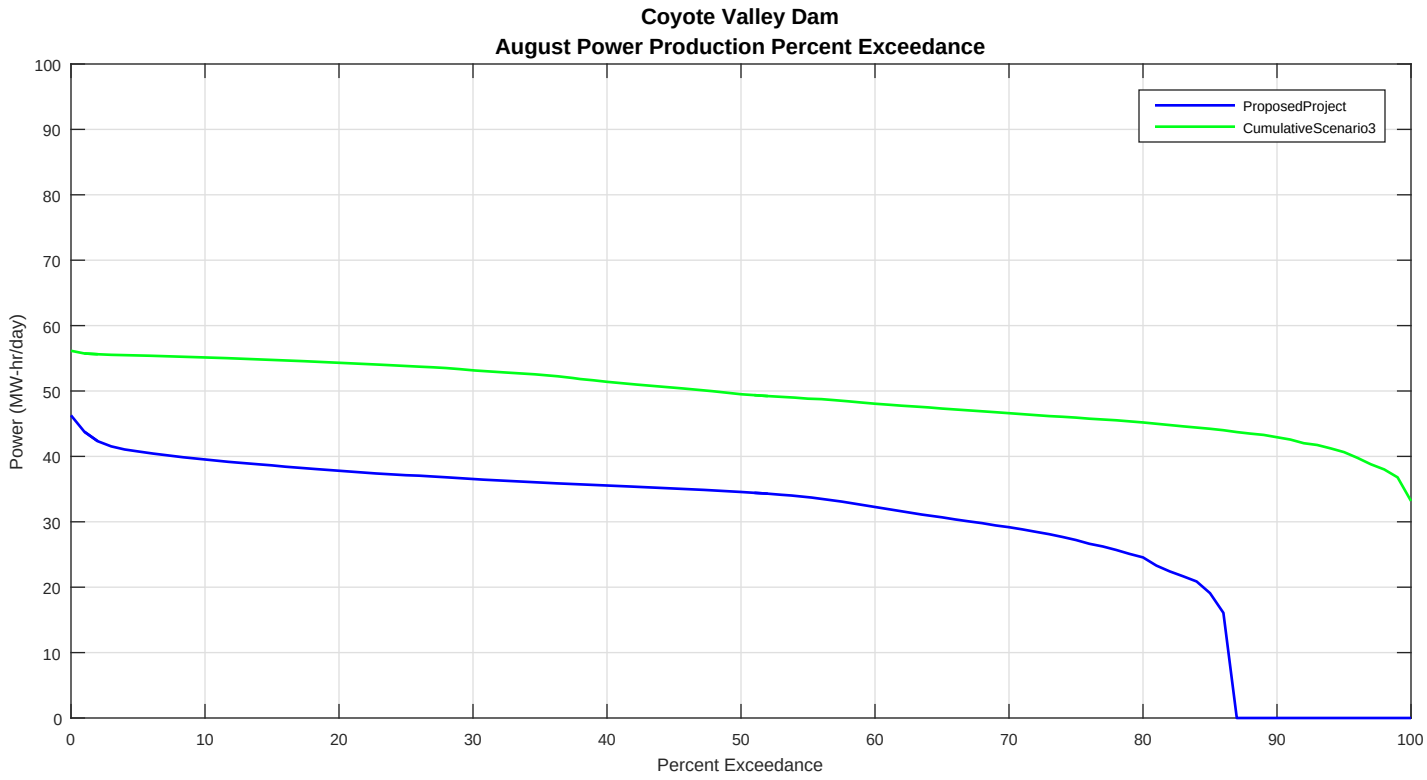
Coyote Valley Dam
August Power Production Percent Exceedance
ProposedProject
CumulativeScenario3
Power (MW-hr/day)
Percent Exceedance
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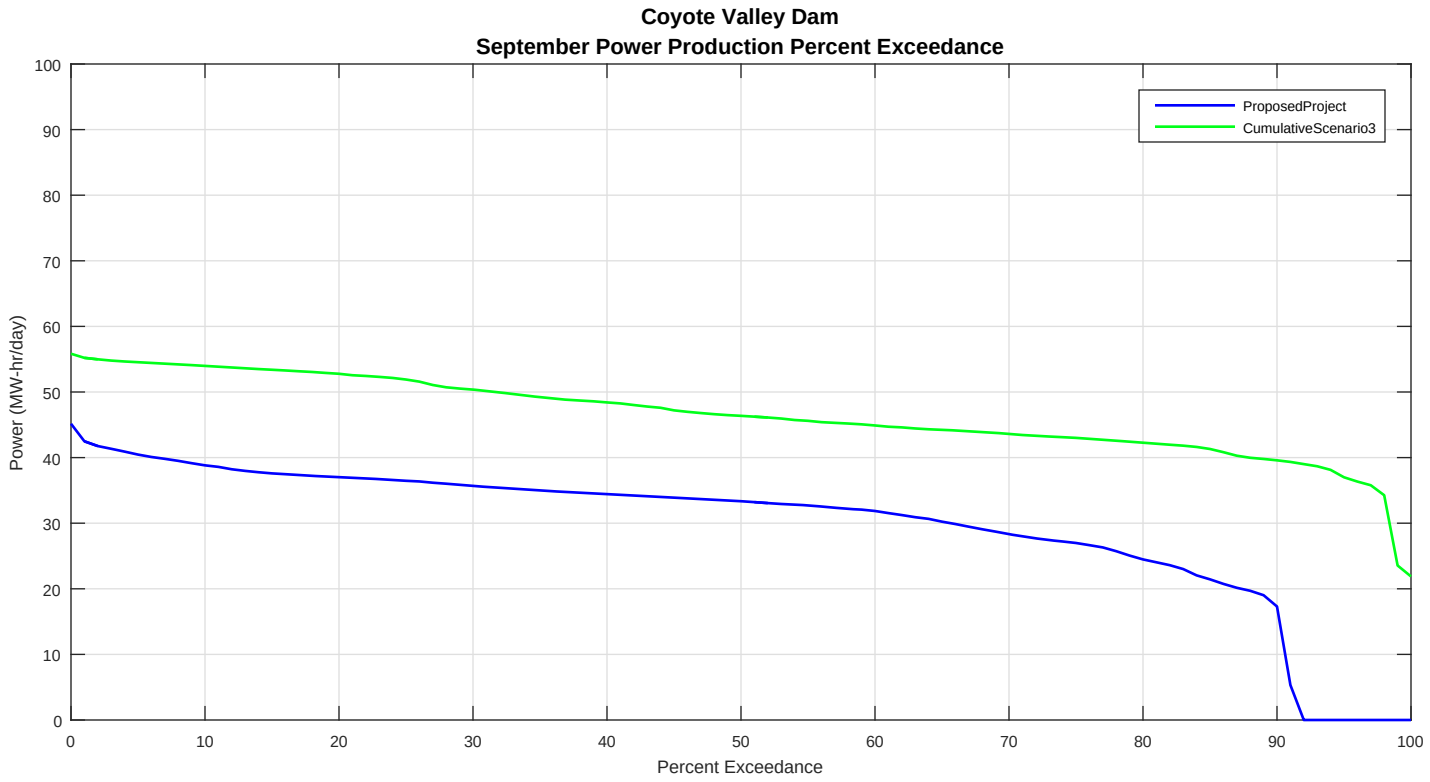
Coyote Valley Dam
September Power Production Percent Exceedance
ProposedProject
CumulativeScenario3
Power (MW-hr/day)
Percent Exceedance
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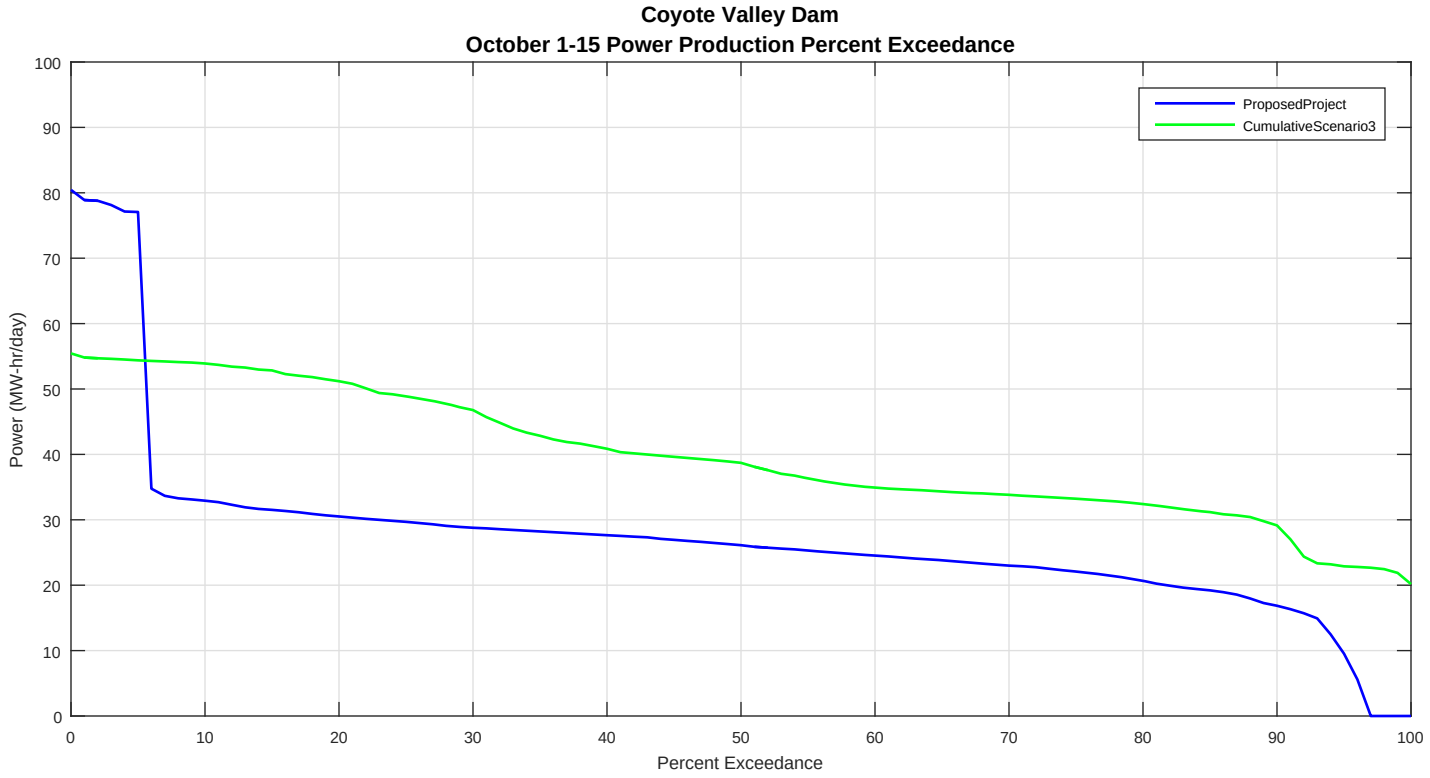
Coyote Valley Dam
October 1-15 Power Production Percent Exceedance
ProposedProject
CumulativeScenario3
Power (MW-hr/day)
Percent Exceedance
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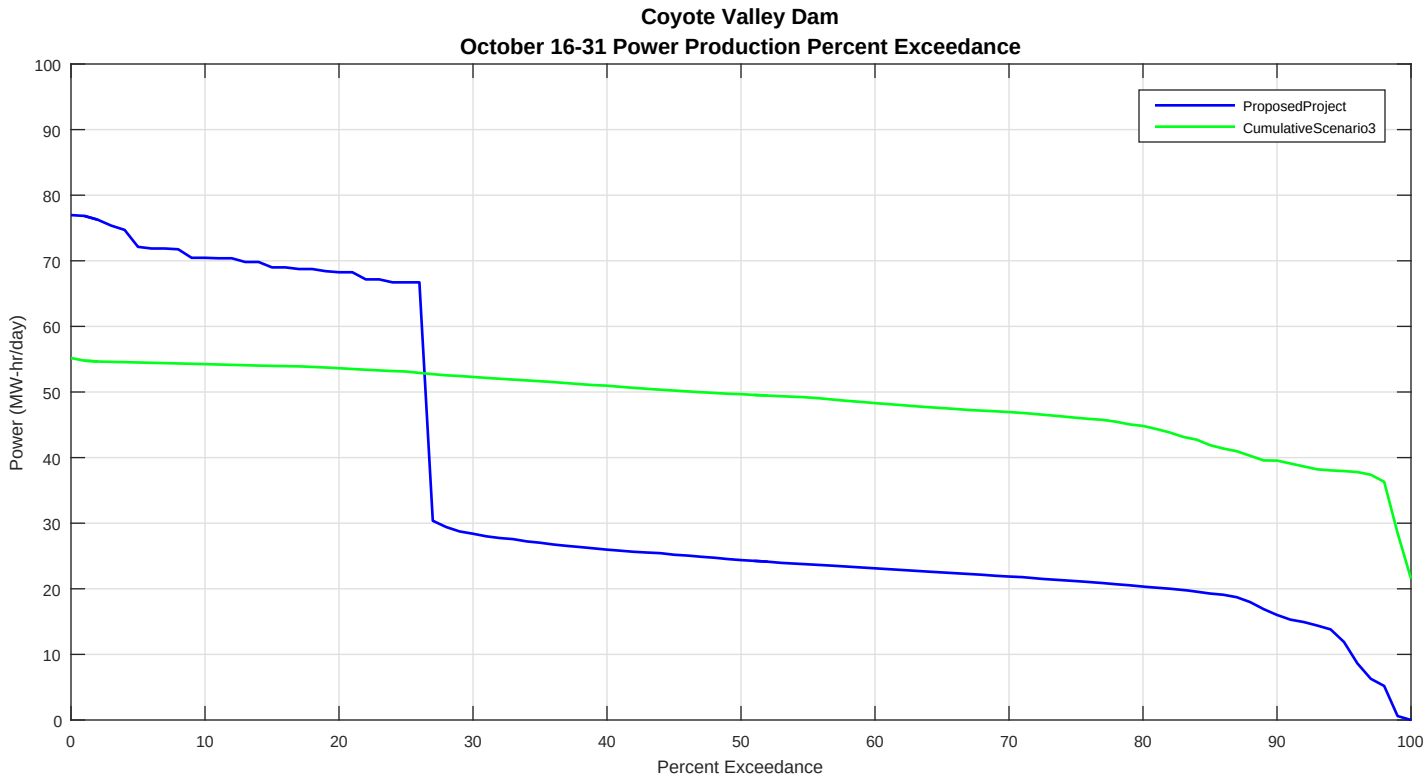
Coyote Valley Dam
October 16-31 Power Production Percent Exceedance
ProposedProject
CumulativeScenario3
Power (MW-hr/day)
Percent Exceedance
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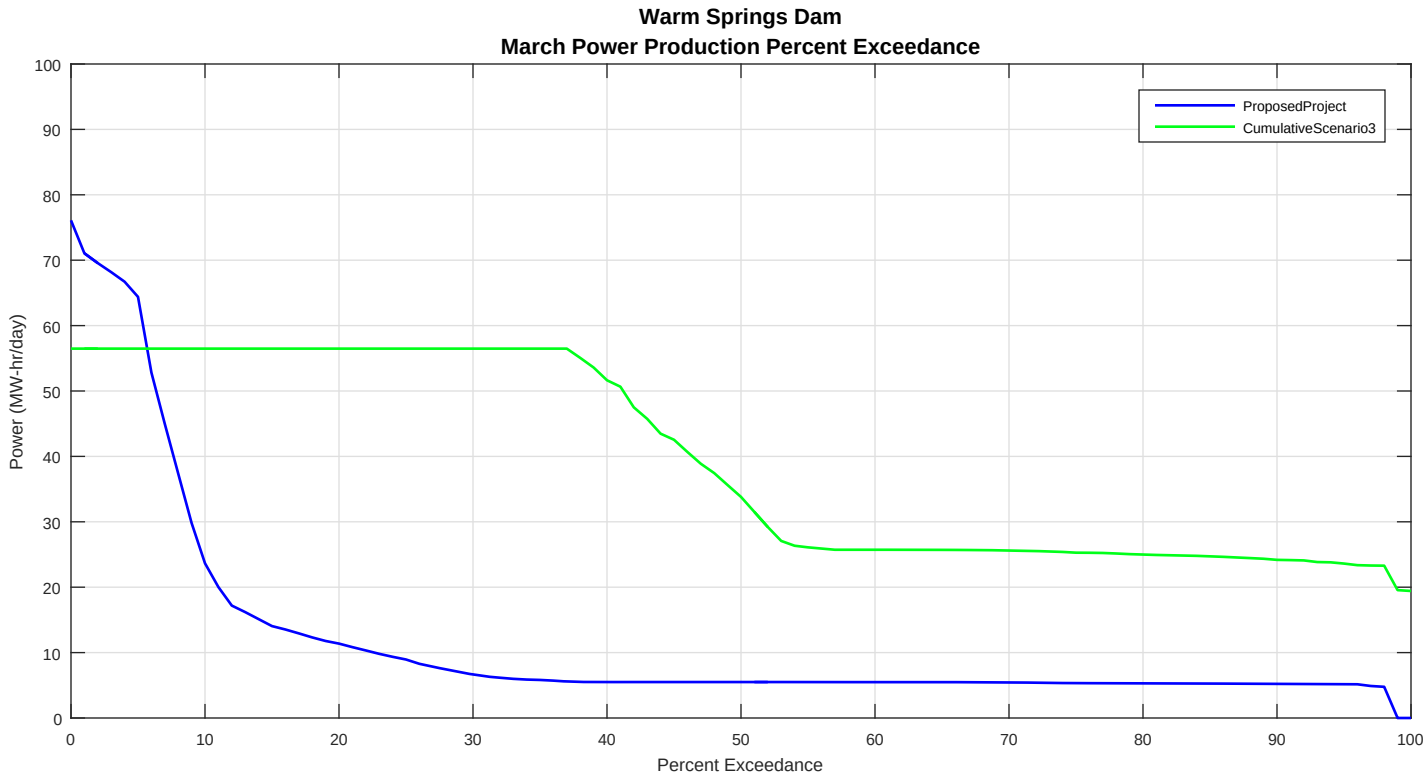
Warm Springs Dam
March Power Production Percent Exceedance
ProposedProject
CumulativeScenario3
Power (MW-hr/day)
Percent Exceedance
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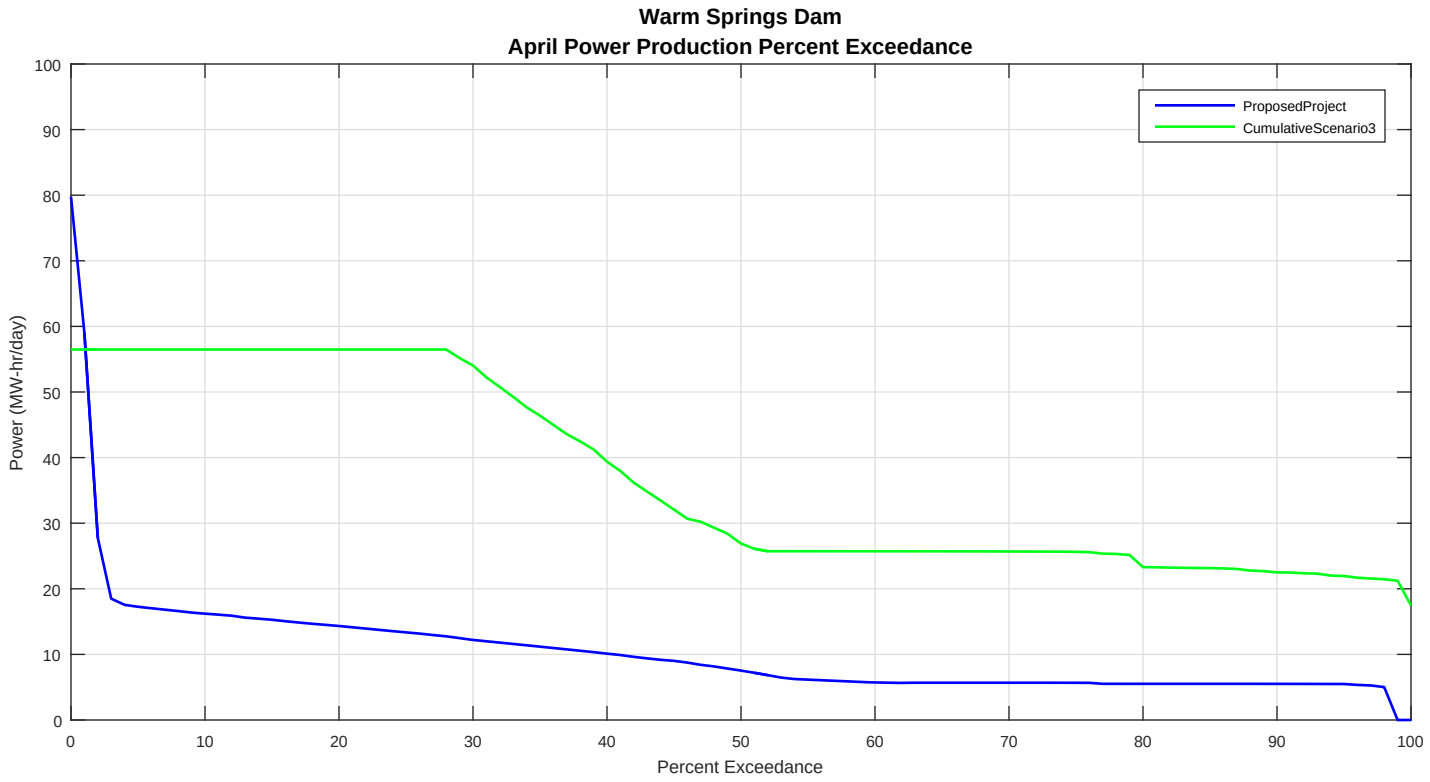
Warm Springs Dam
April Power Production Percent Exceedance
ProposedProject
CumulativeScenario3
Power (MW-hr/day)
Percent Exceedance
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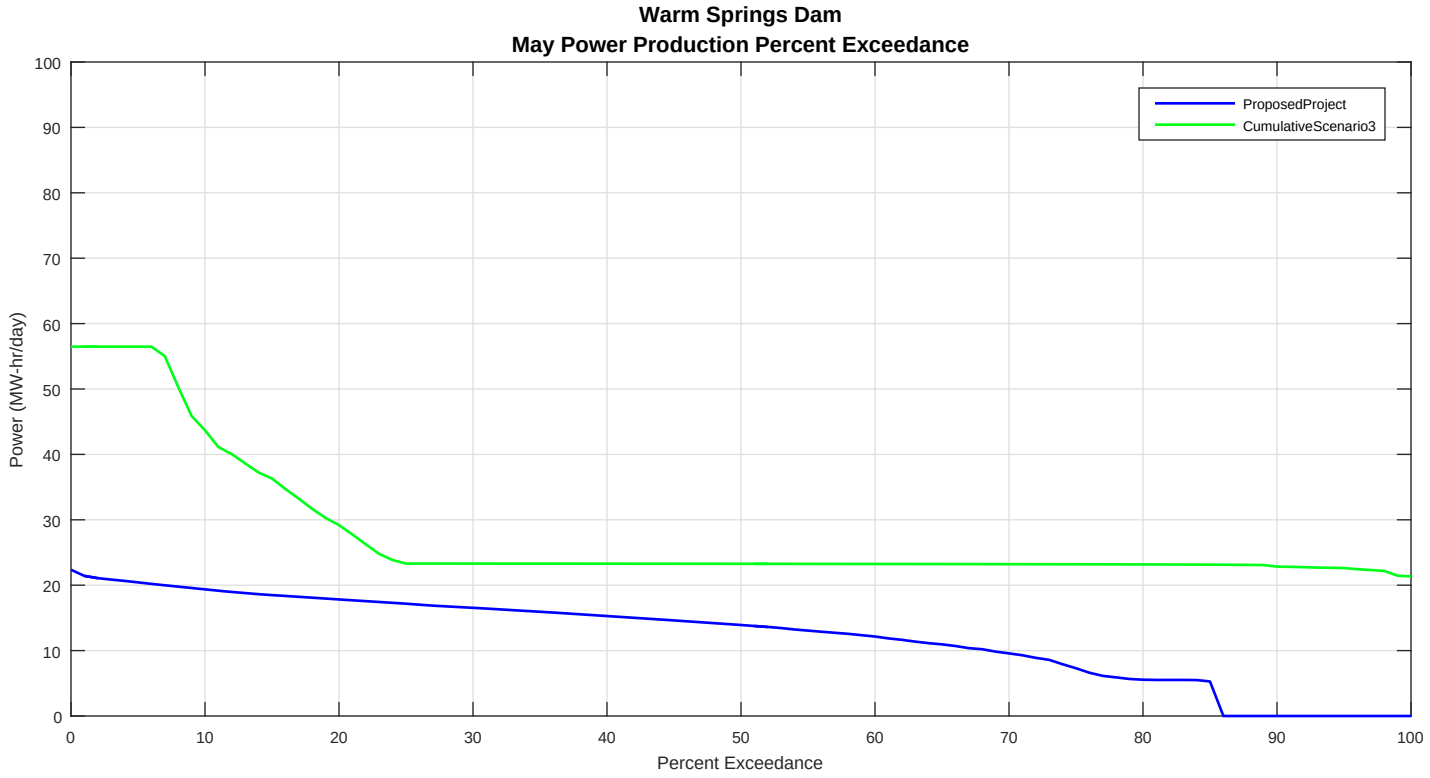
Warm Springs Dam
May Power Production Percent Exceedance
ProposedProject
CumulativeScenario3
Power (MW-hr/day)
Percent Exceedance
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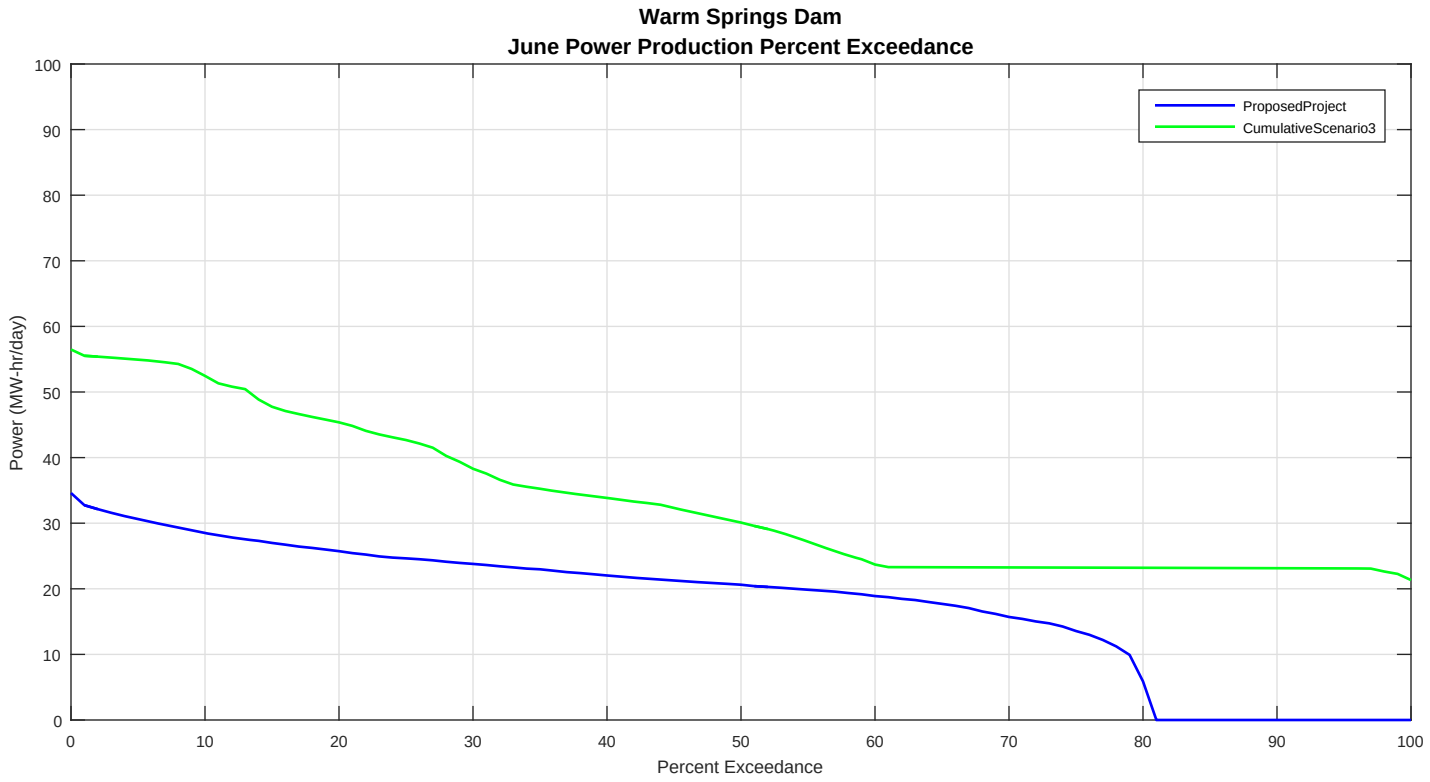
Warm Springs Dam
June Power Production Percent Exceedance
ProposedProject
CumulativeScenario3
Power (MW-hr/day)
Percent Exceedance
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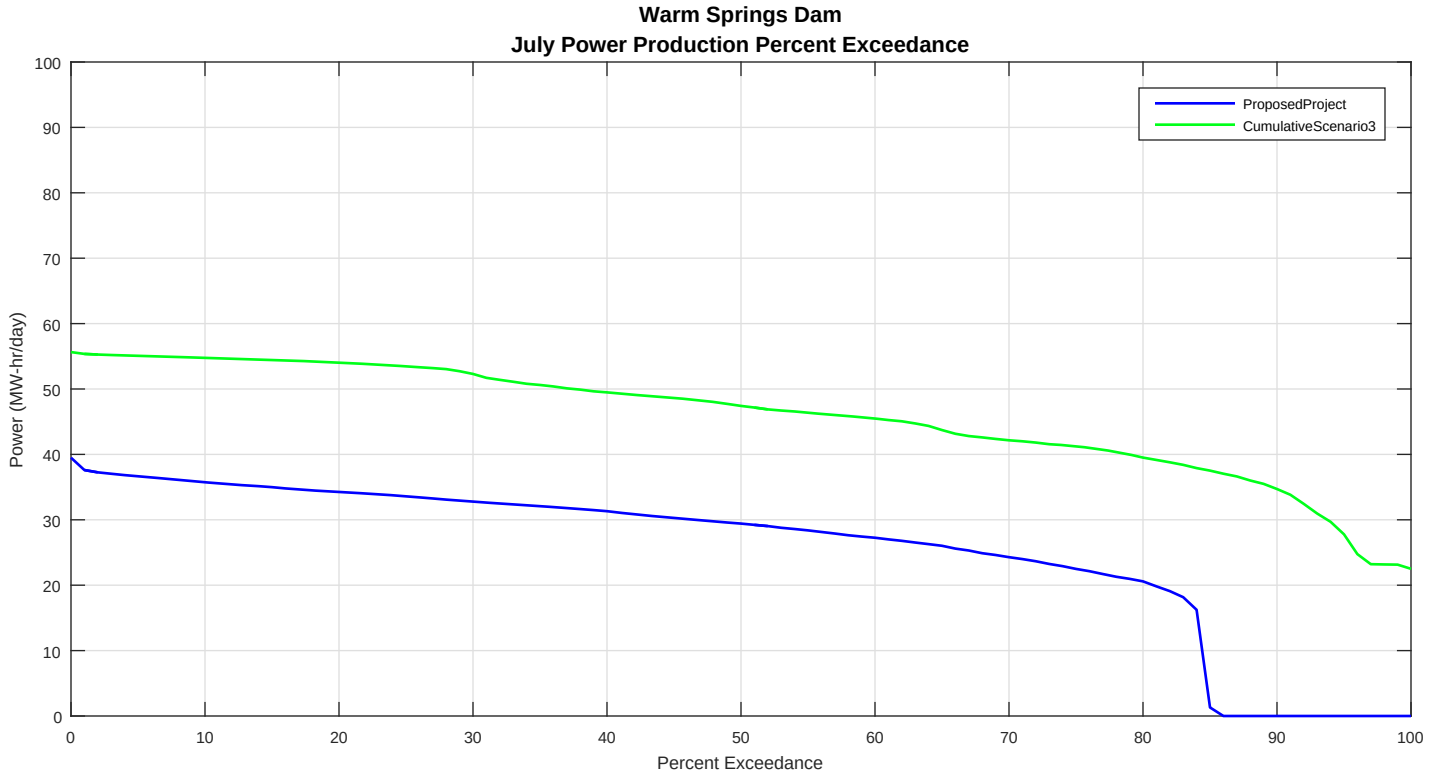
Warm Springs Dam
July Power Production Percent Exceedance
ProposedProject
CumulativeScenario3
Power (MW-hr/day)
Percent Exceedance
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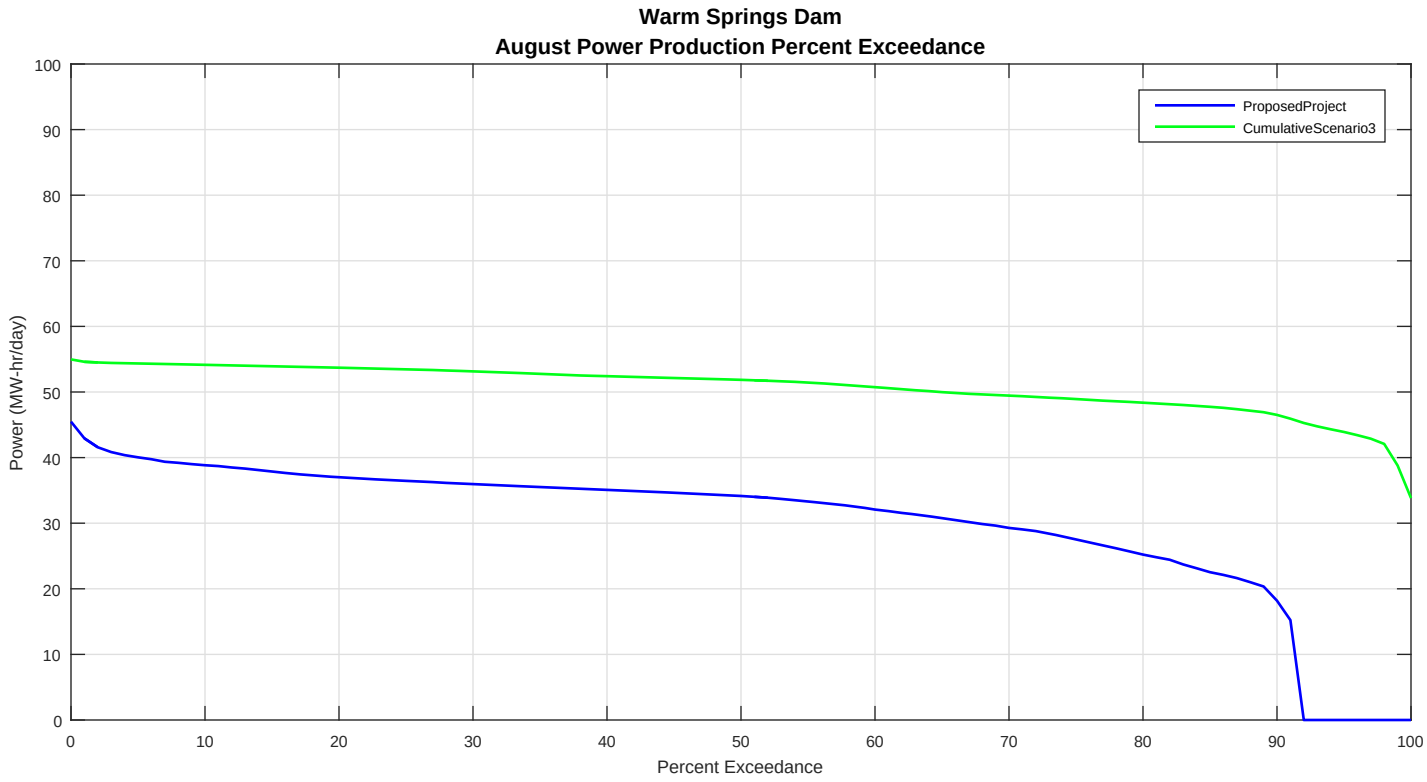
Warm Springs Dam
August Power Production Percent Exceedance
ProposedProject
CumulativeScenario3
Power (MW-hr/day)
Percent Exceedance
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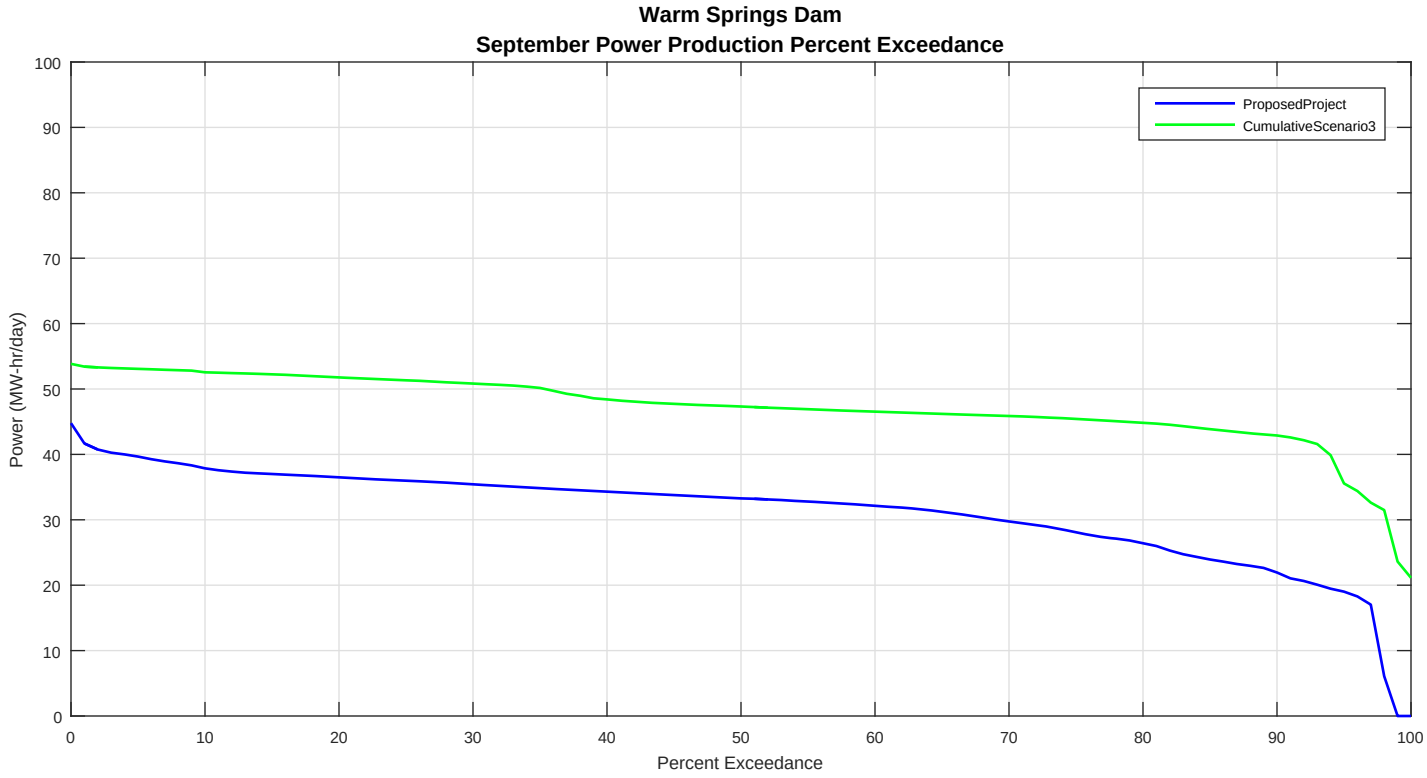
Warm Springs Dam
September Power Production Percent Exceedance
ProposedProject
CumulativeScenario3
Power (MW-hr/day)
Percent Exceedance
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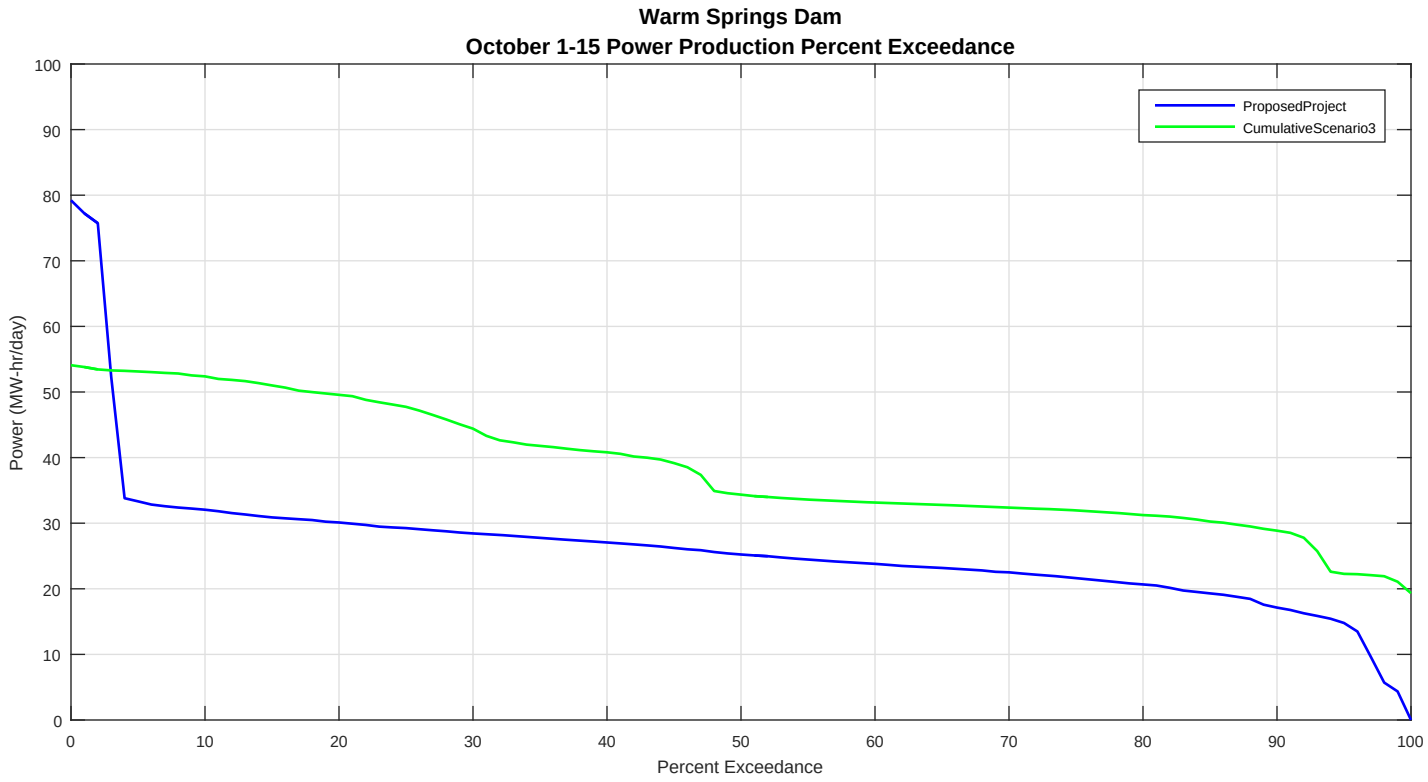
Warm Springs Dam
October 1-15 Power Production Percent Exceedance
ProposedProject
CumulativeScenario3
Power (MW-hr/day)
Percent Exceedance
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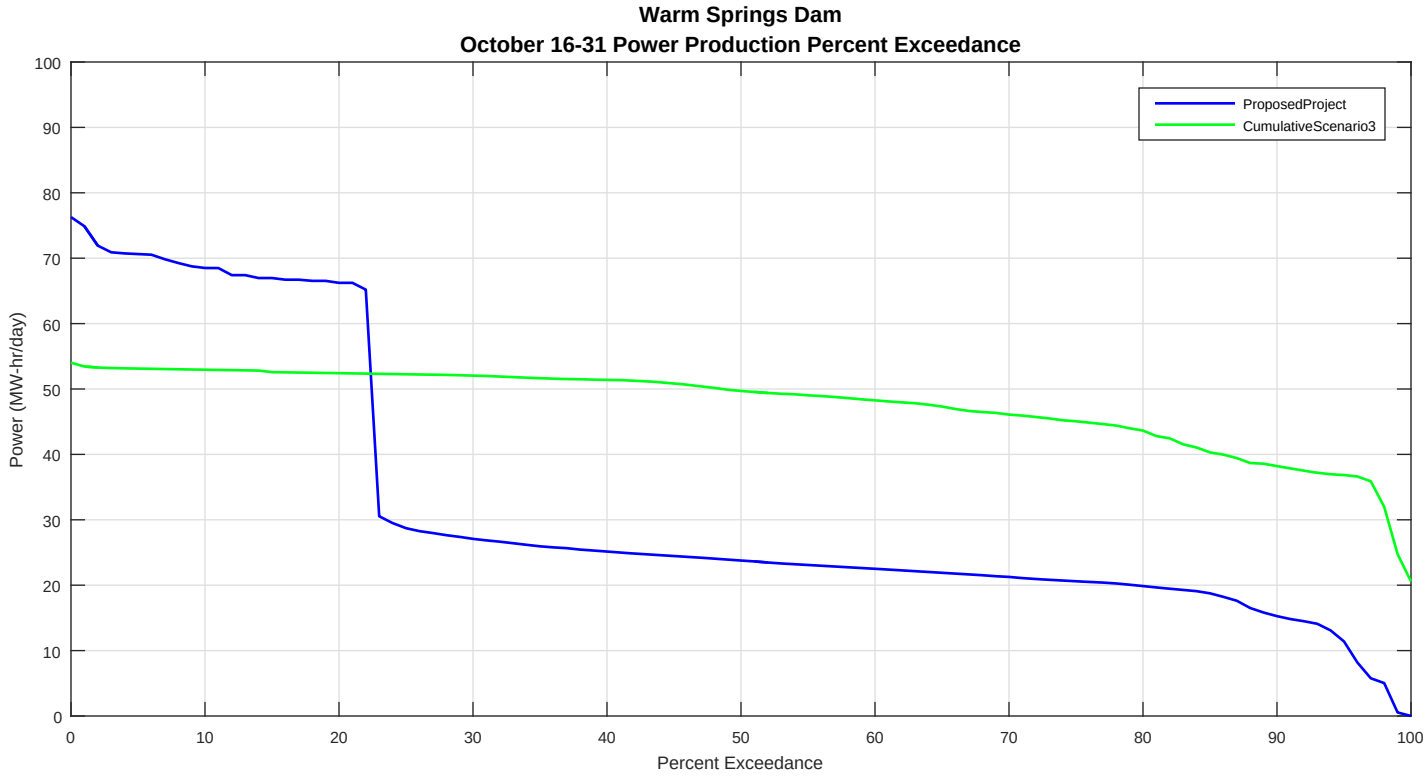
Warm Springs Dam
October 16-31 Power Production Percent Exceedance
ProposedProject
CumulativeScenario3
Power (MW-hr/day)
Percent Exceedance
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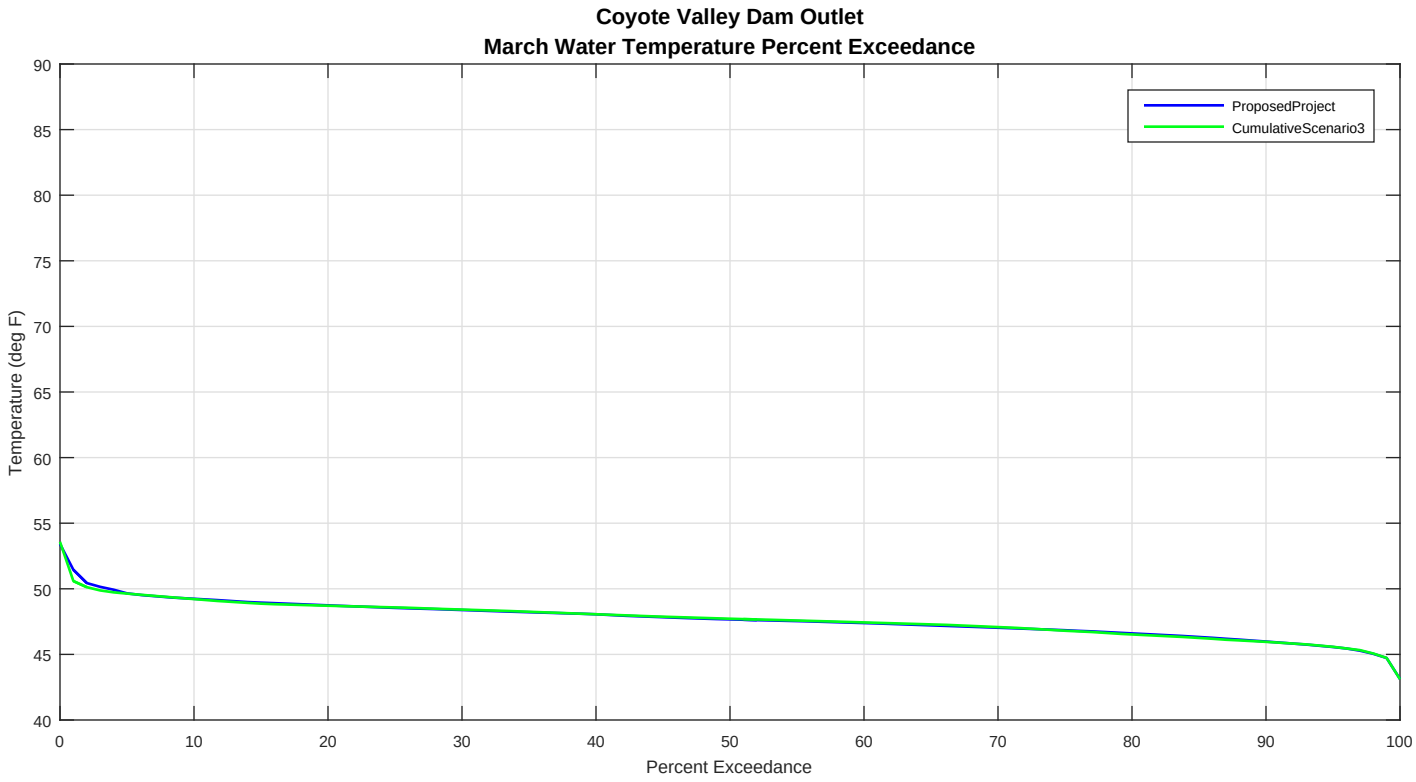
Coyote Valley Dam Outlet
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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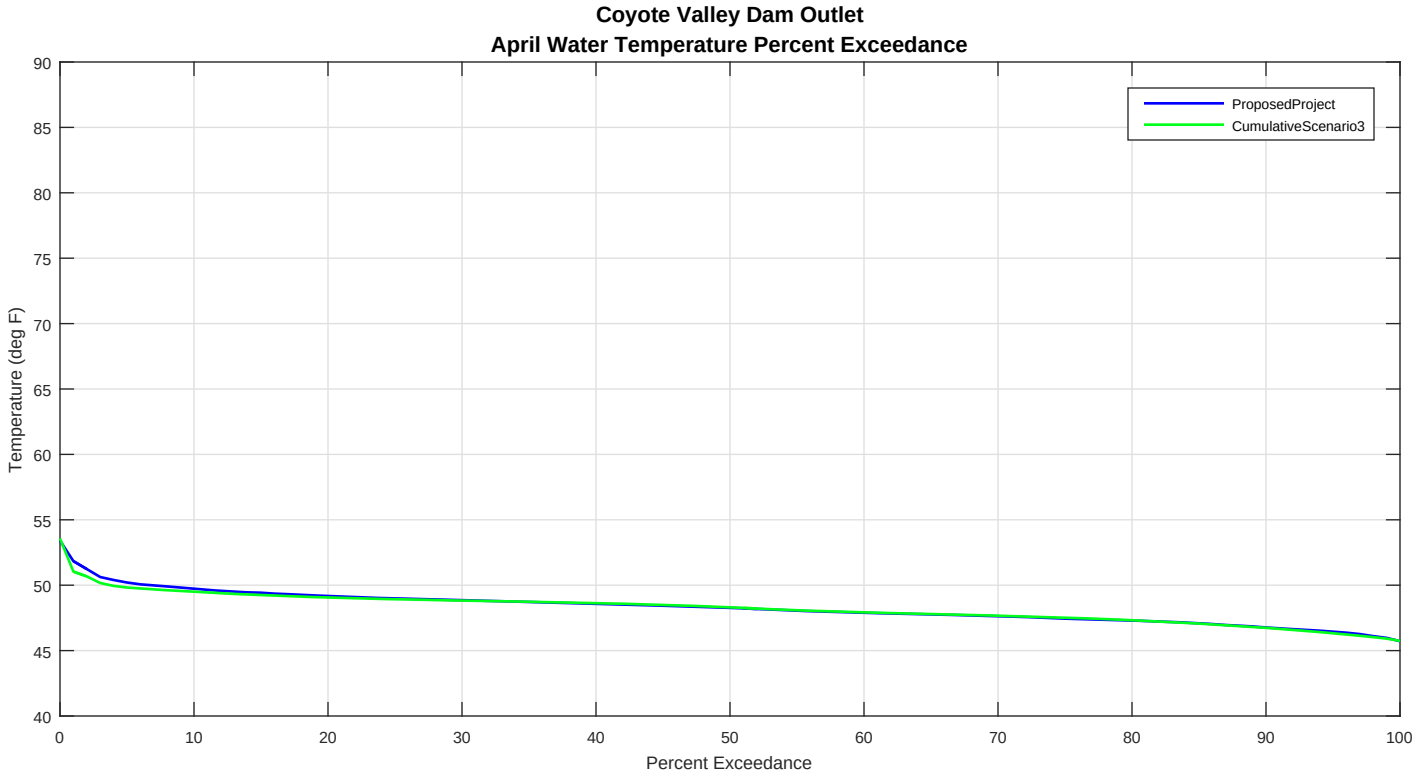
Coyote Valley Dam Outlet
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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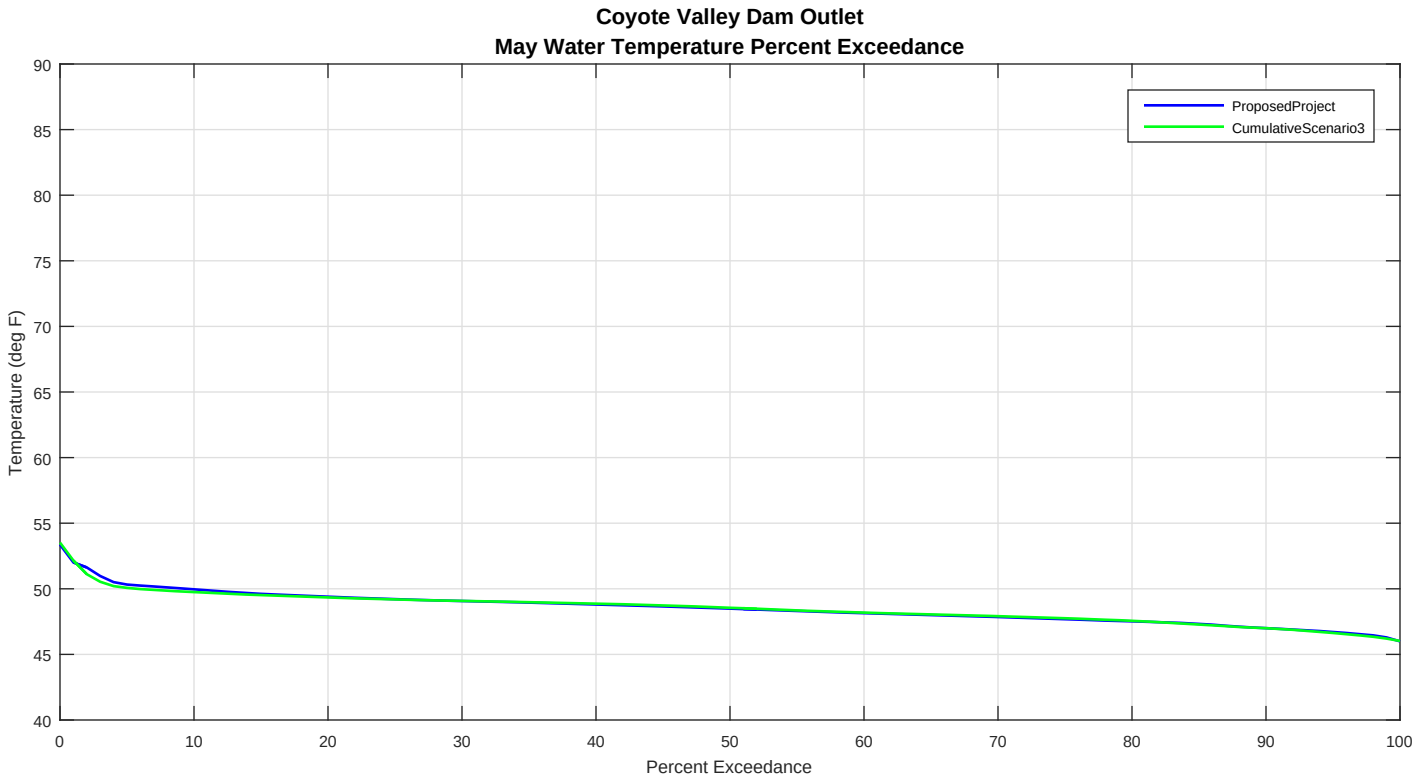
Coyote Valley Dam Outlet
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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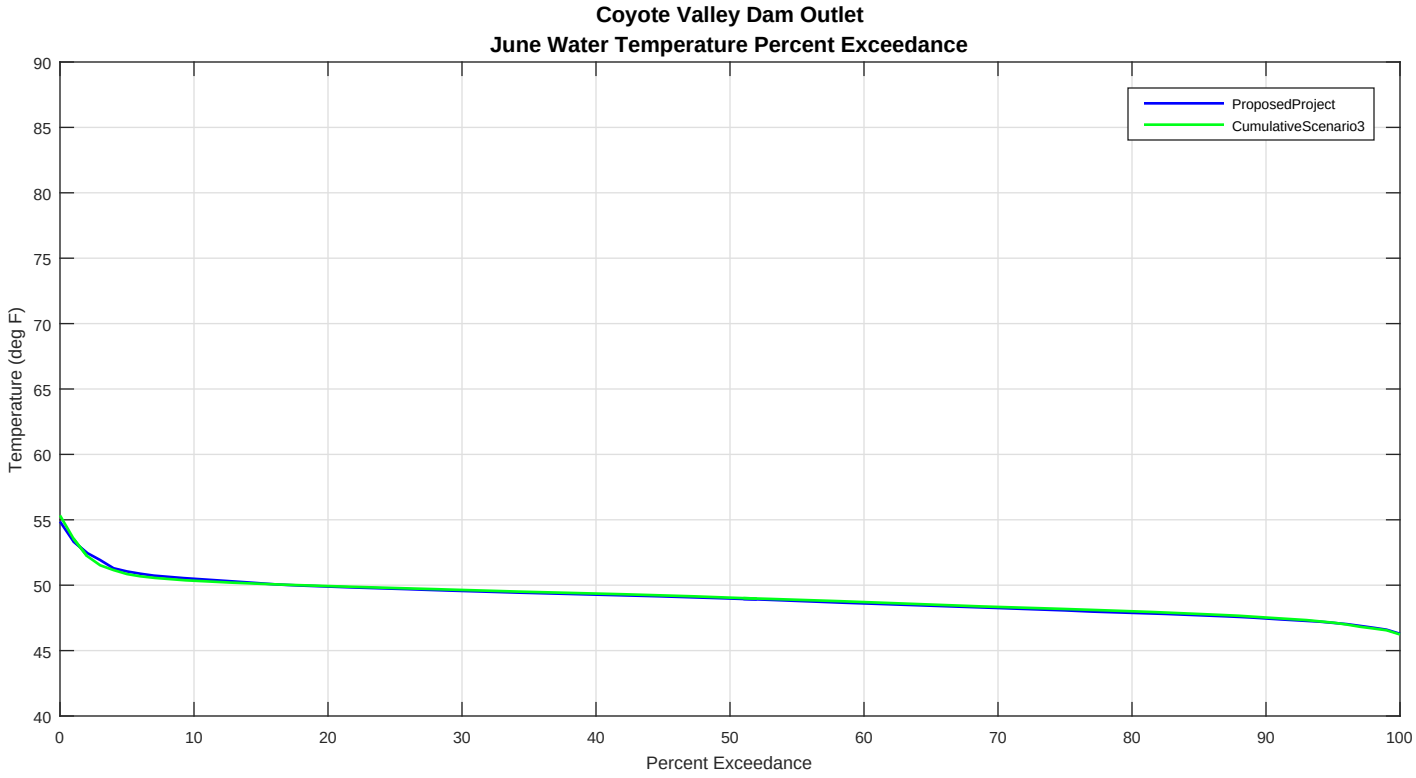
Coyote Valley Dam Outlet
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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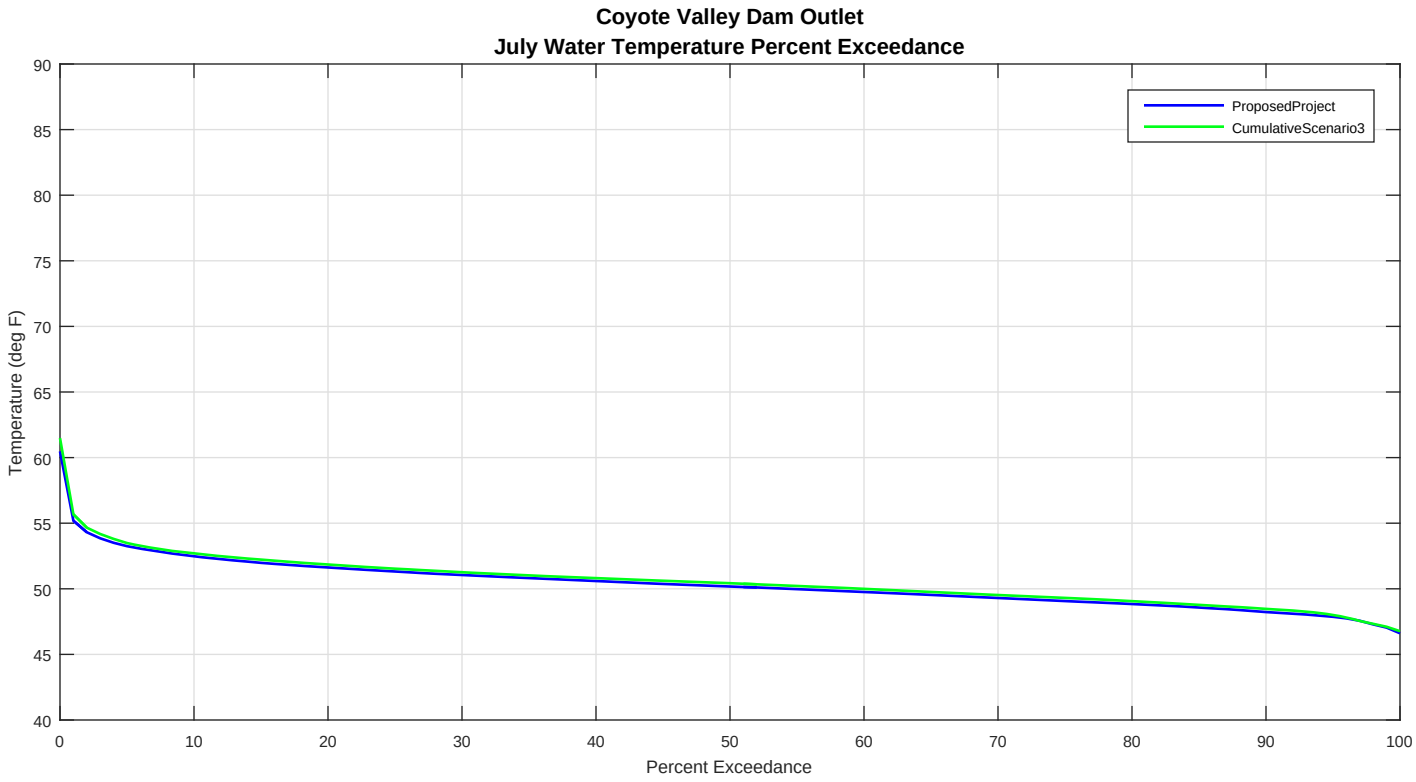
Coyote Valley Dam Outlet
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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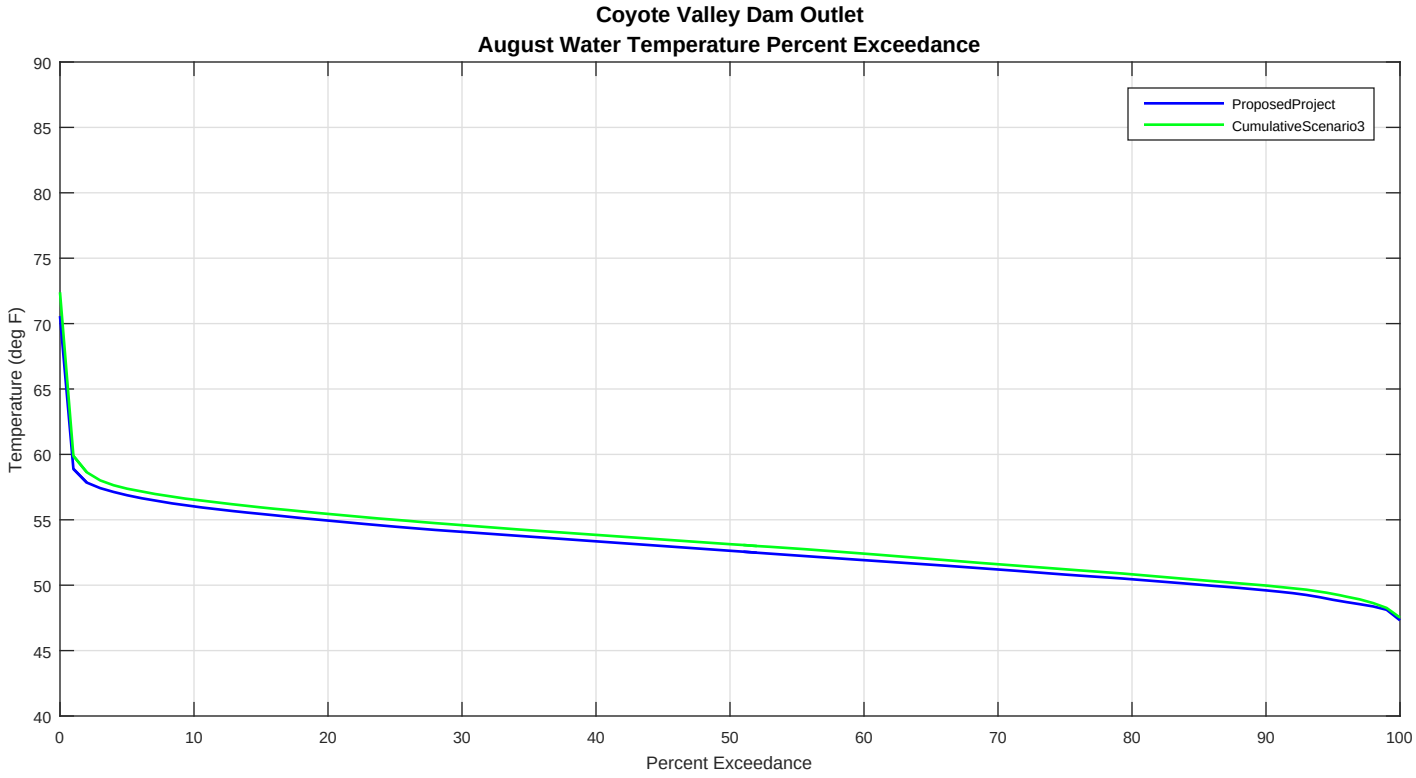
Coyote Valley Dam Outlet
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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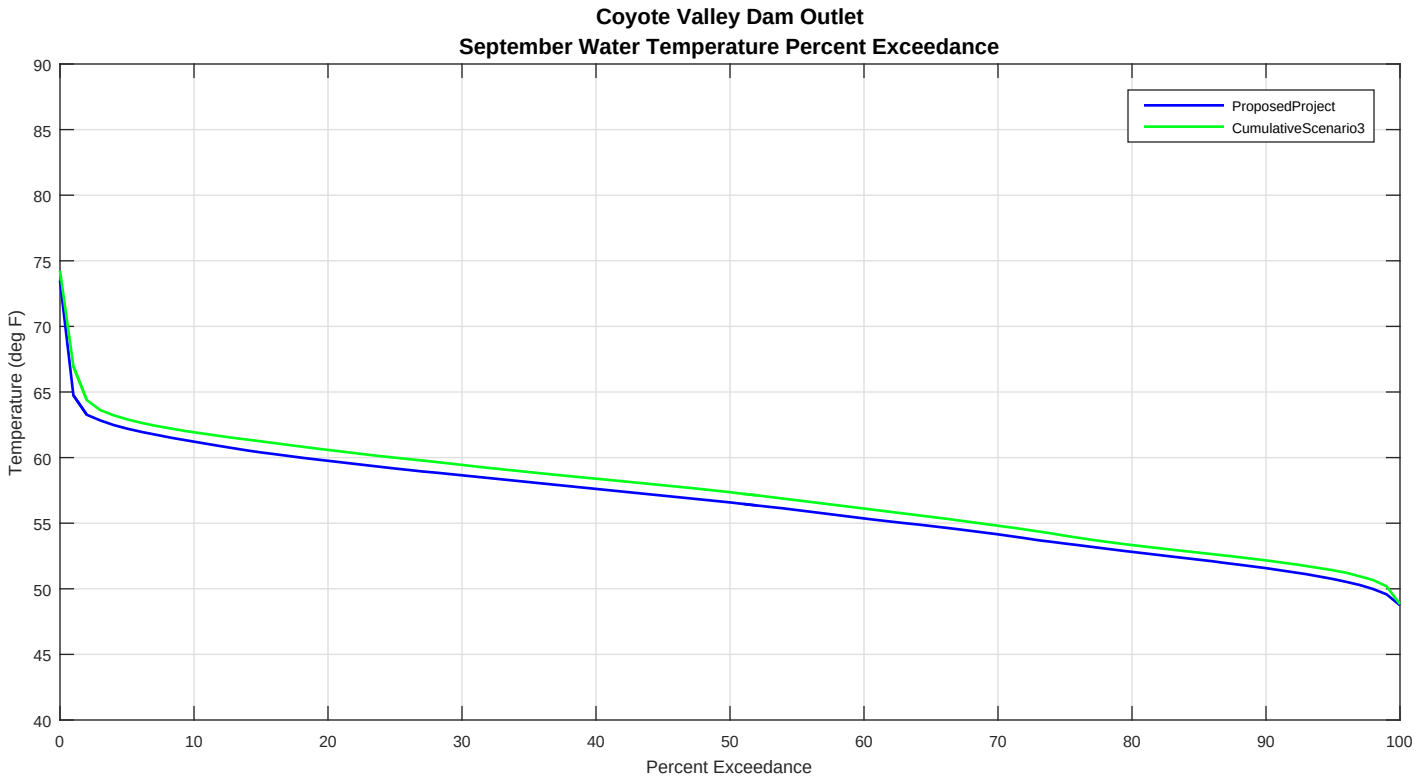
Coyote Valley Dam Outlet
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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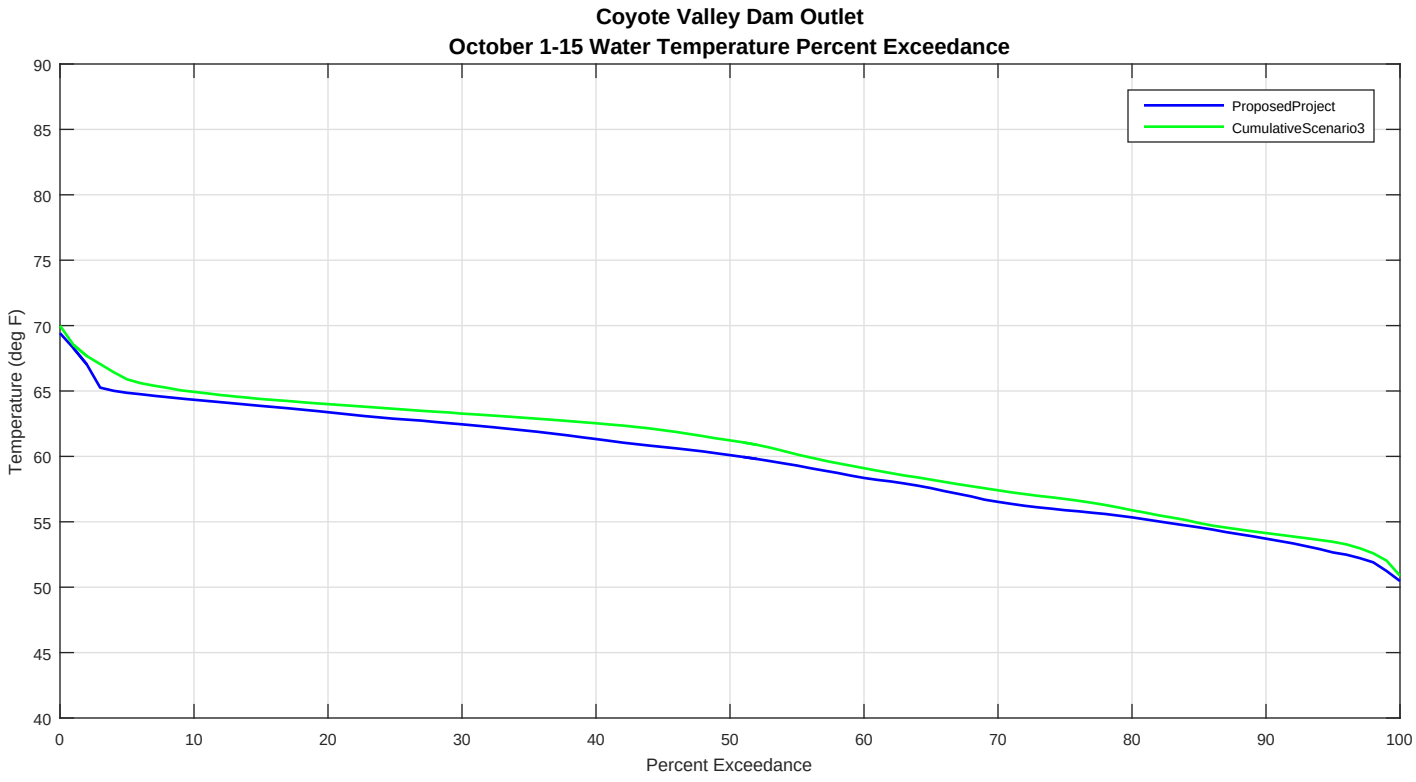
Coyote Valley Dam Outlet
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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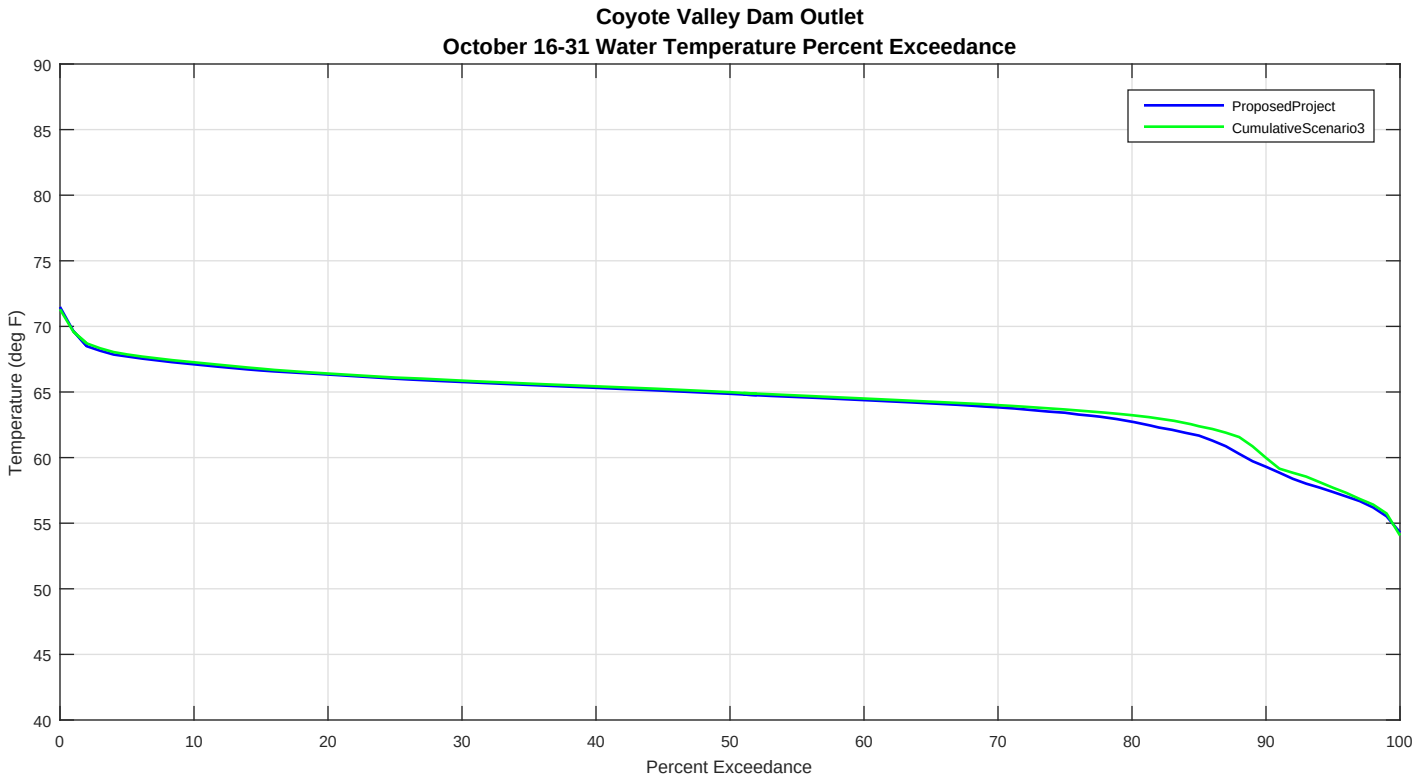
Coyote Valley Dam Outlet
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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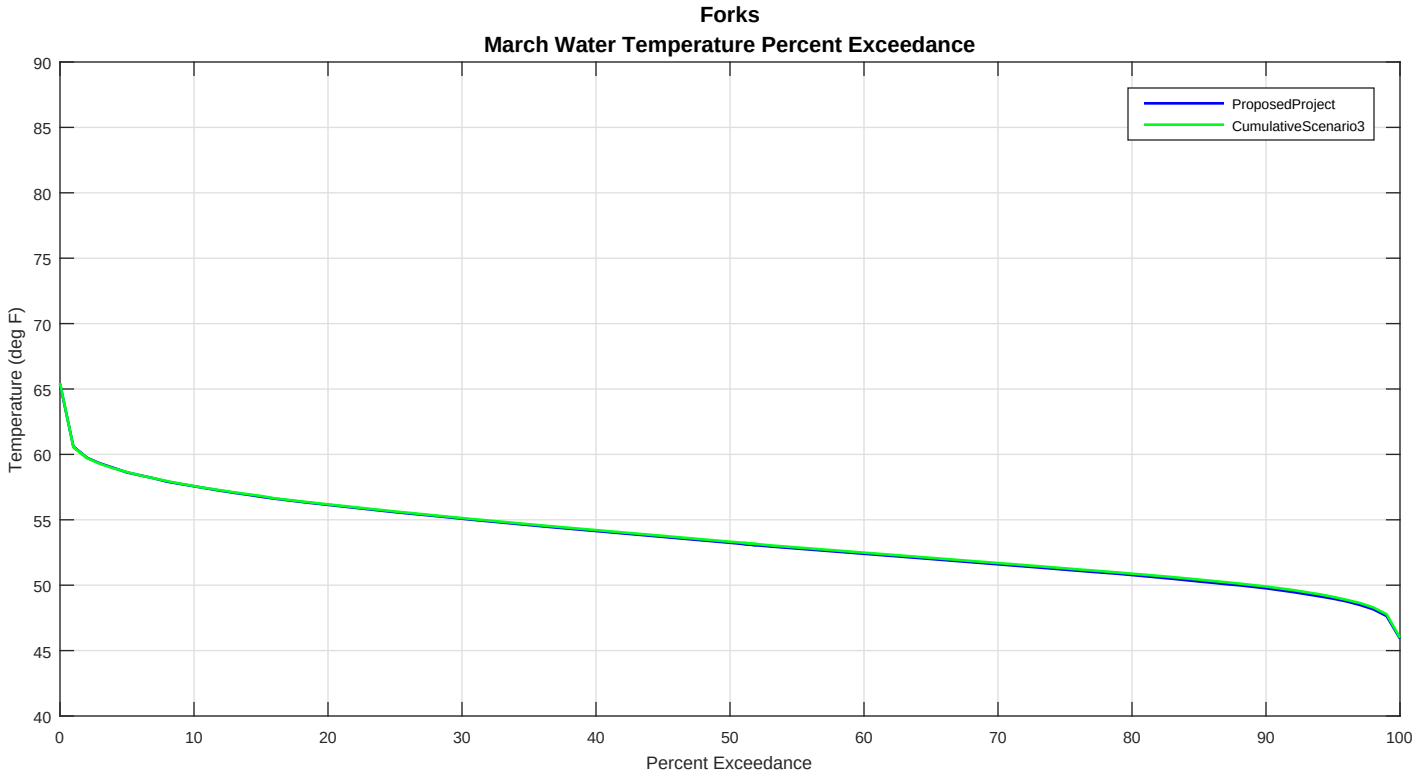
Forks
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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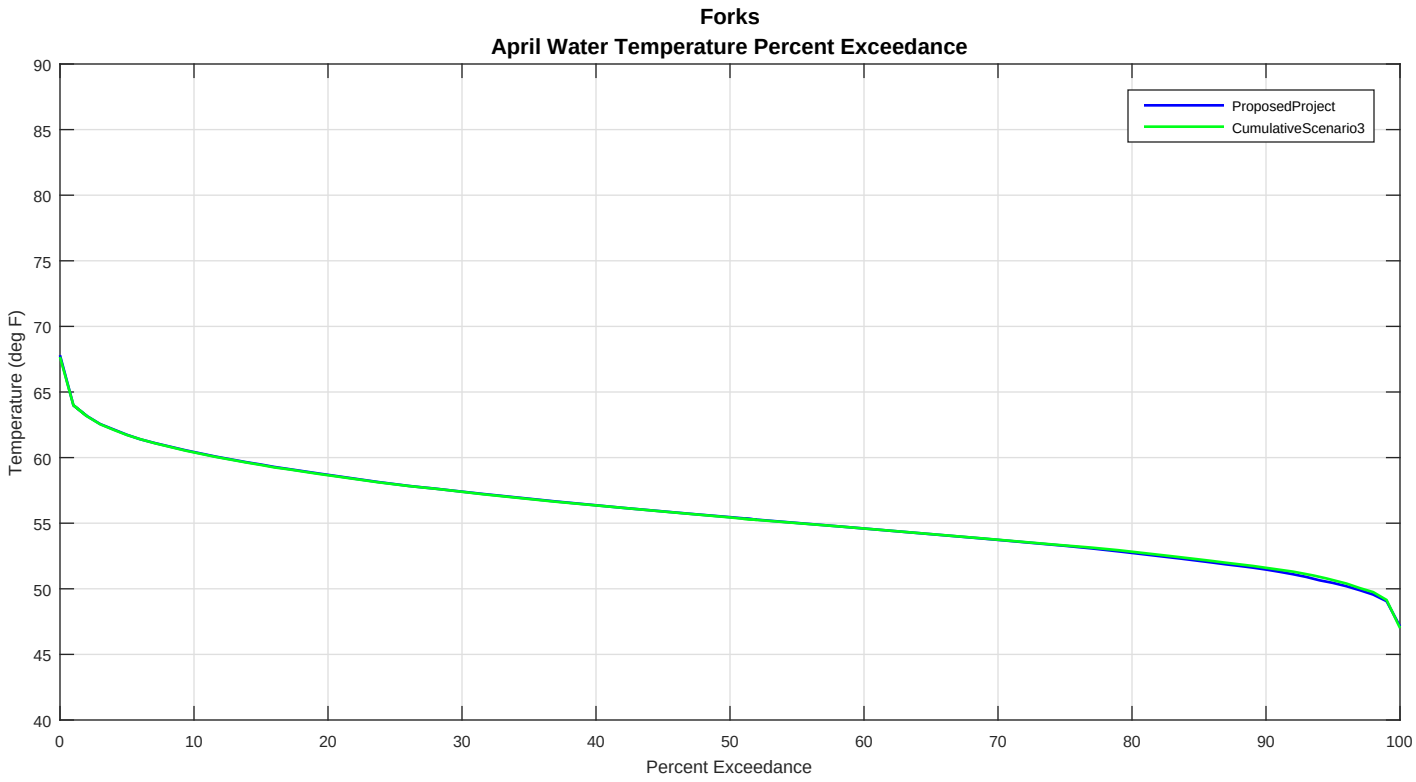
Forks
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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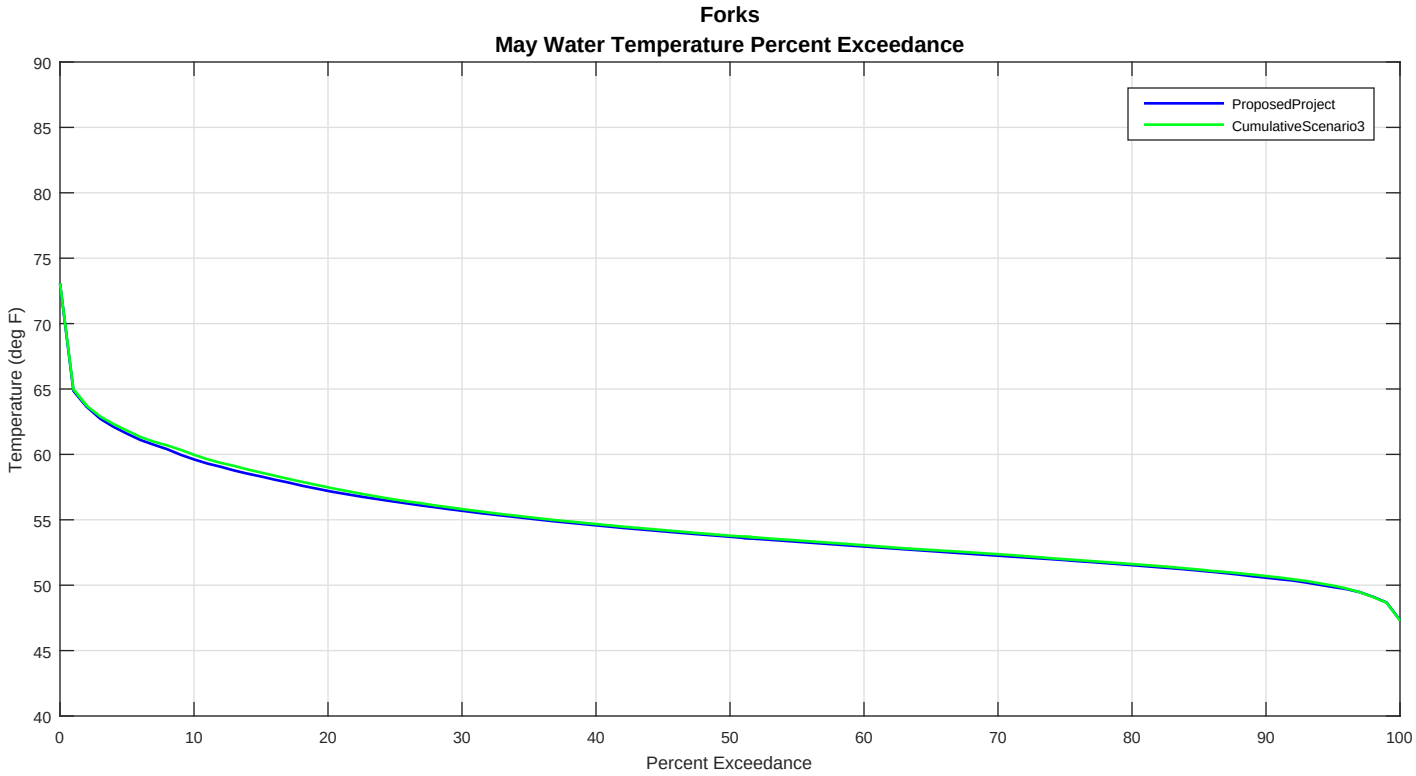
Forks
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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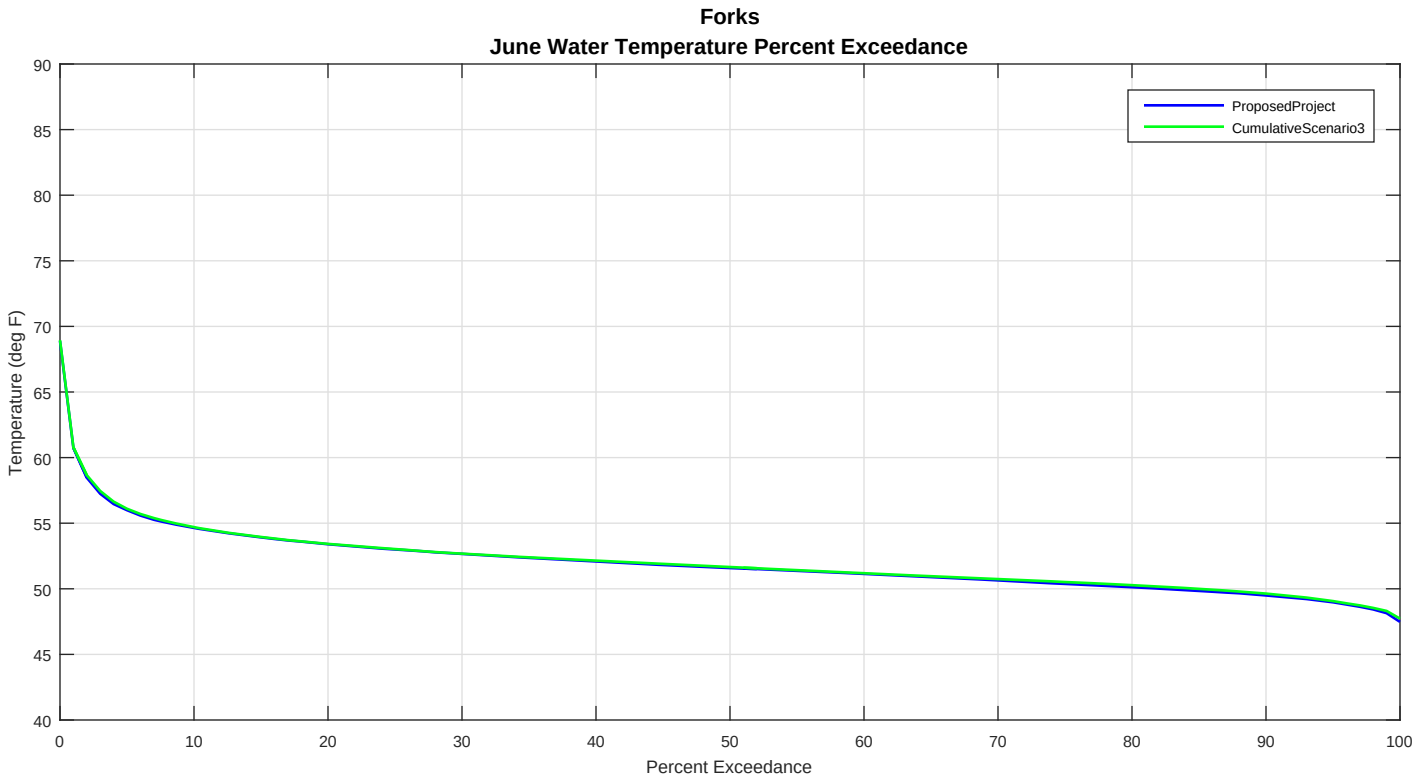
Forks
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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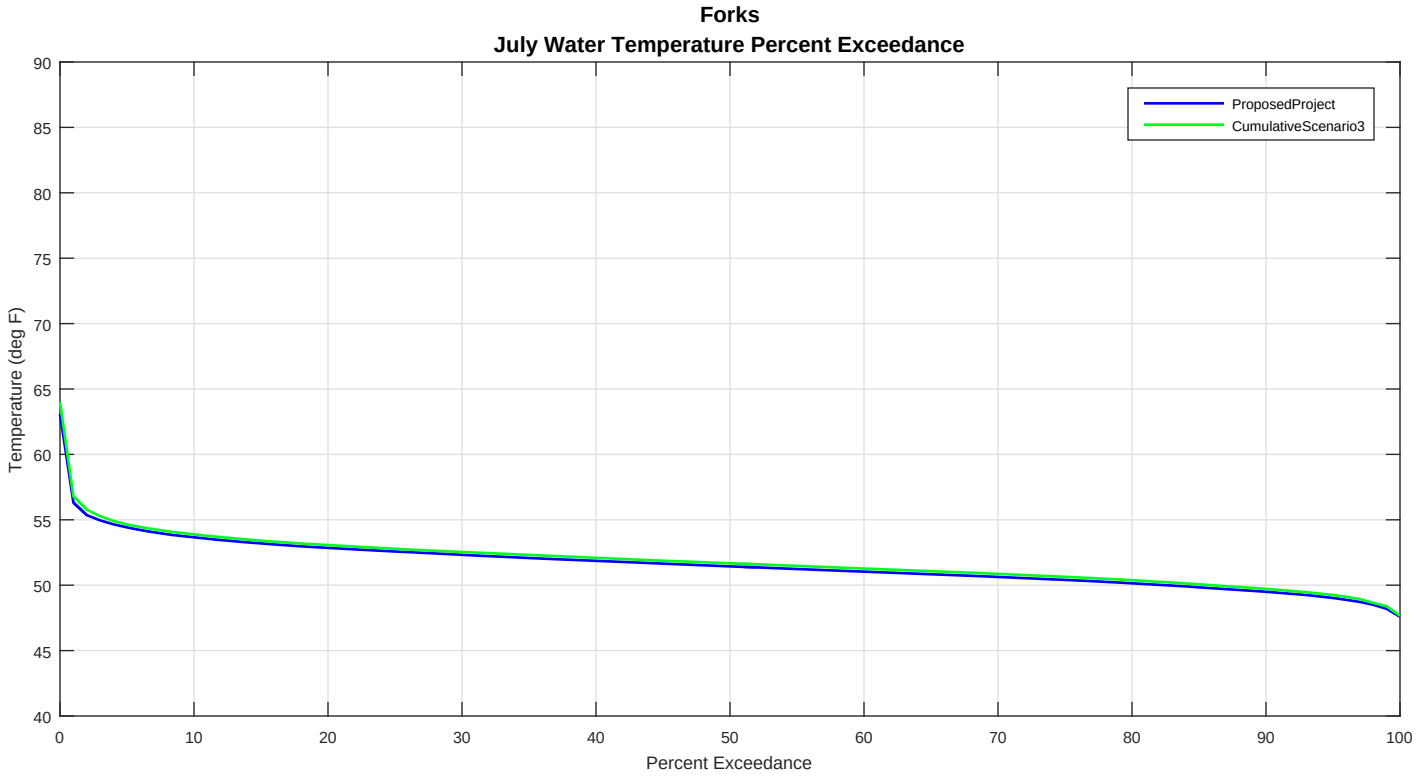
Forks
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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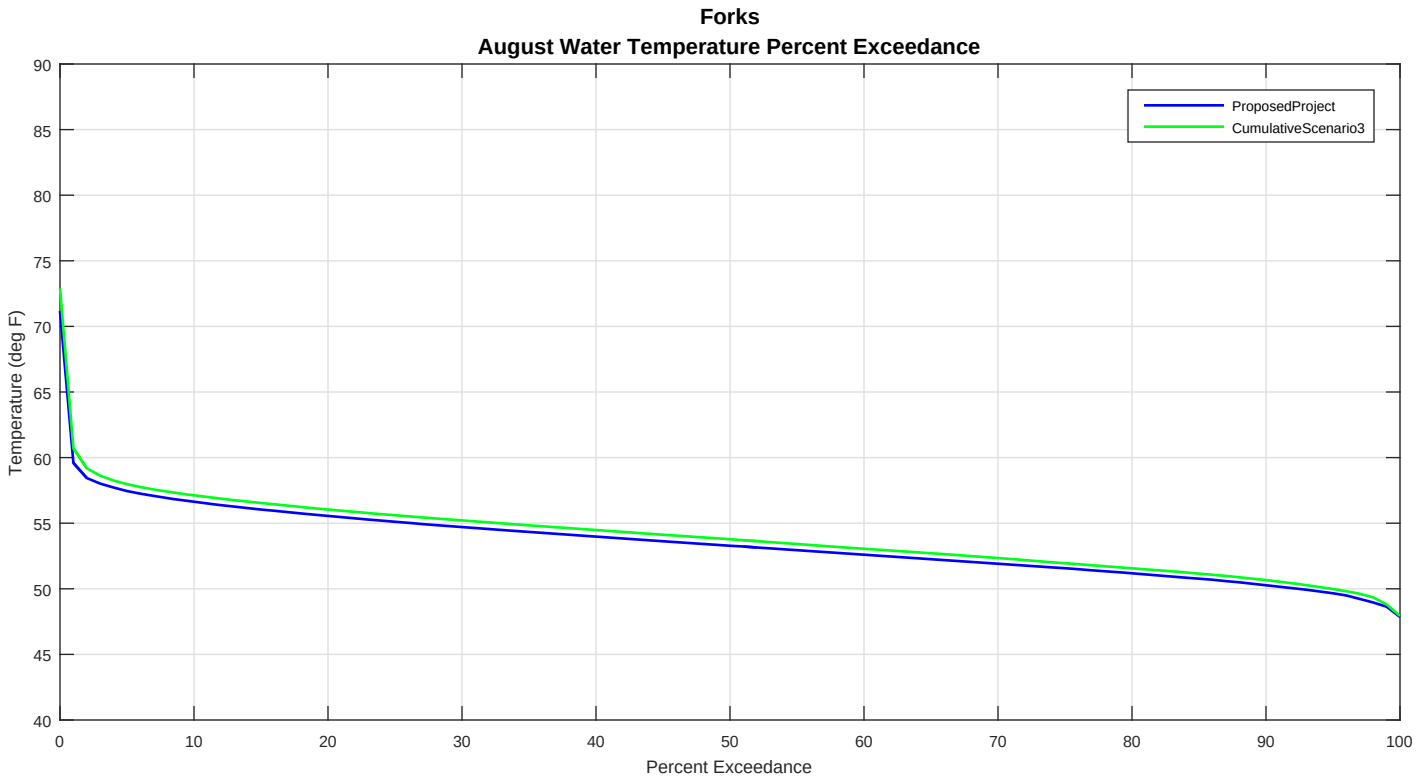
Forks
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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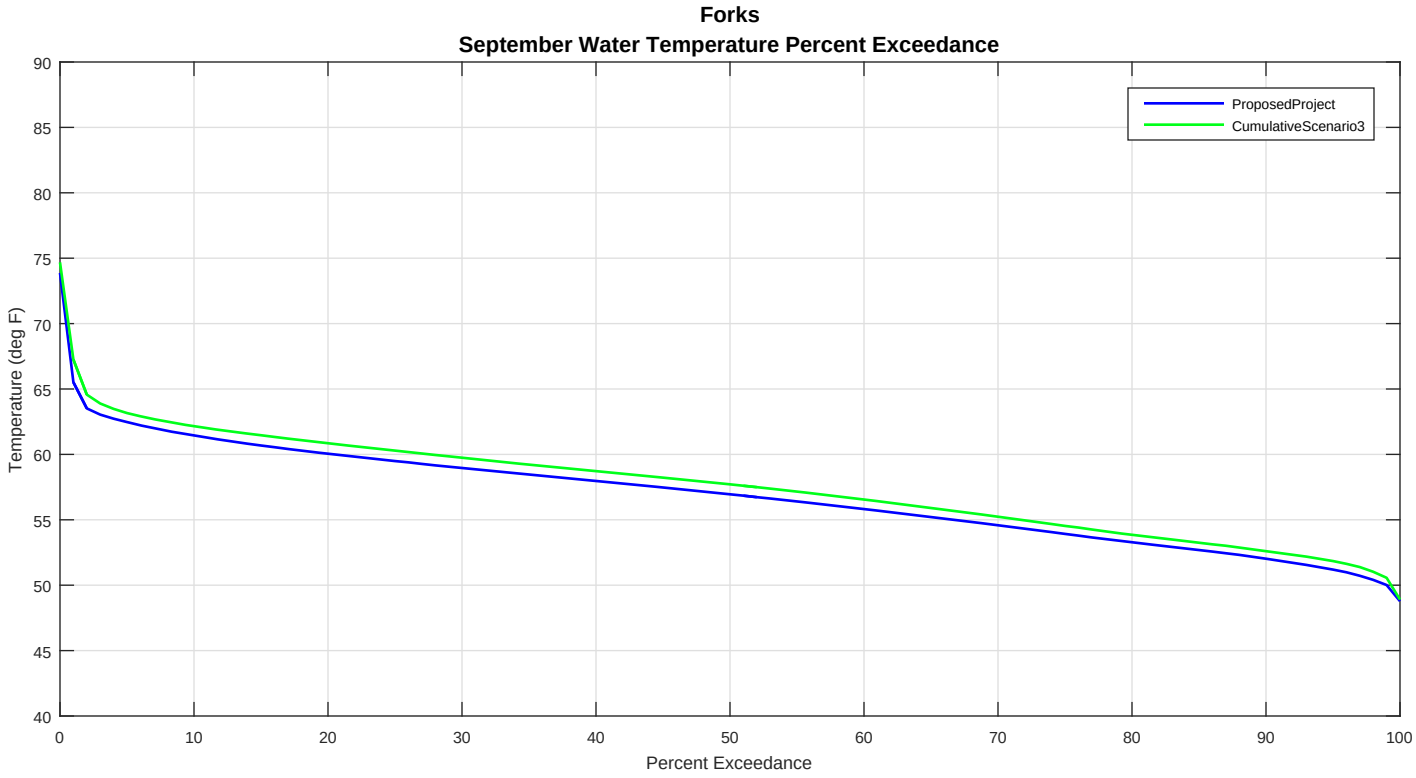
Forks
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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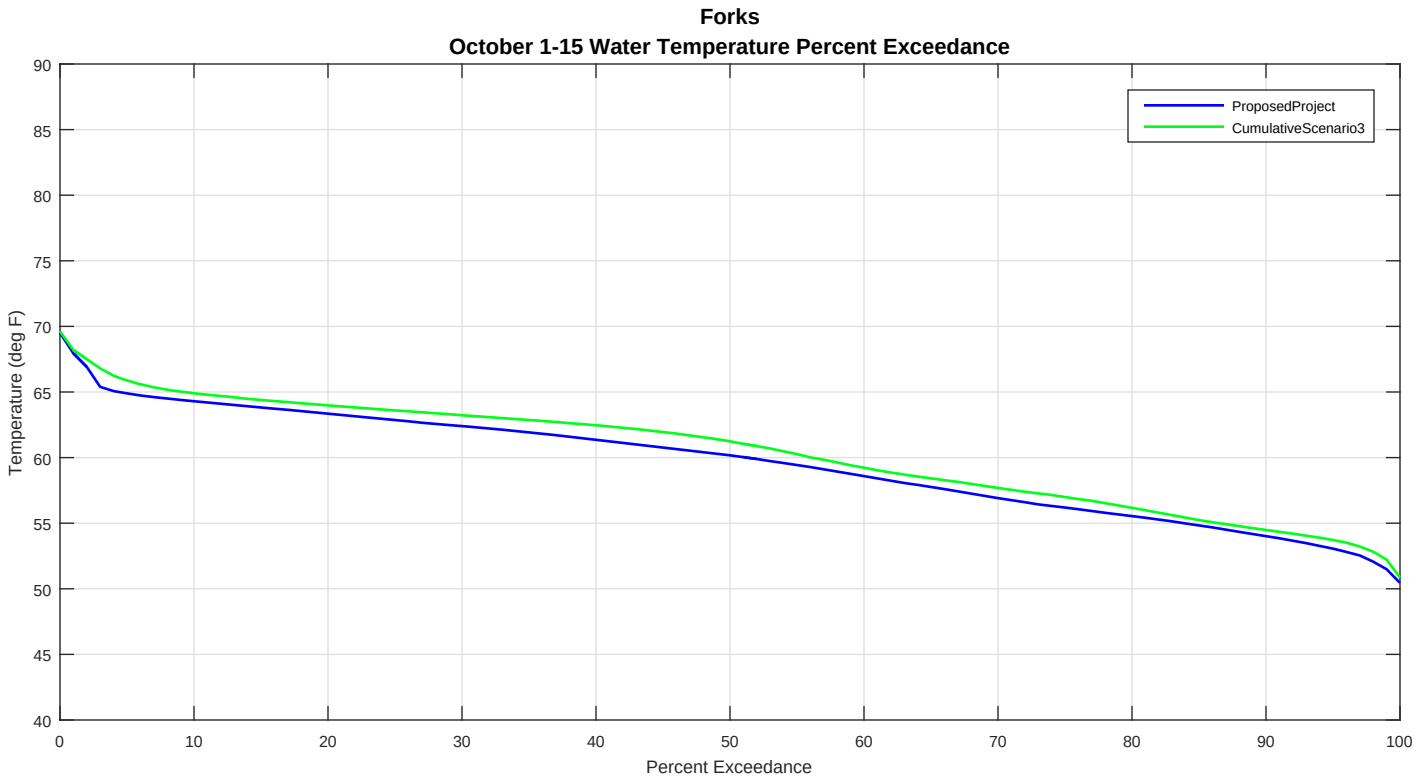
Forks
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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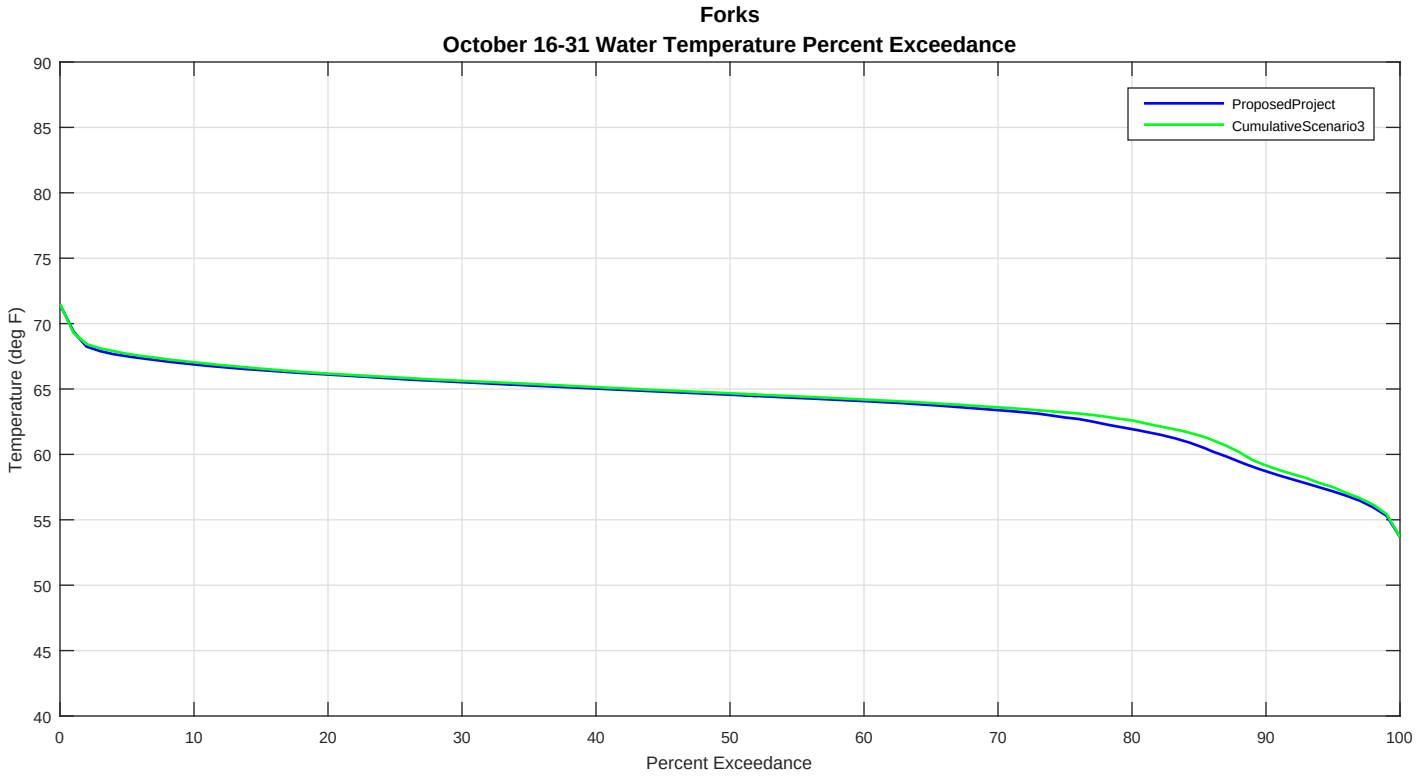
Forks
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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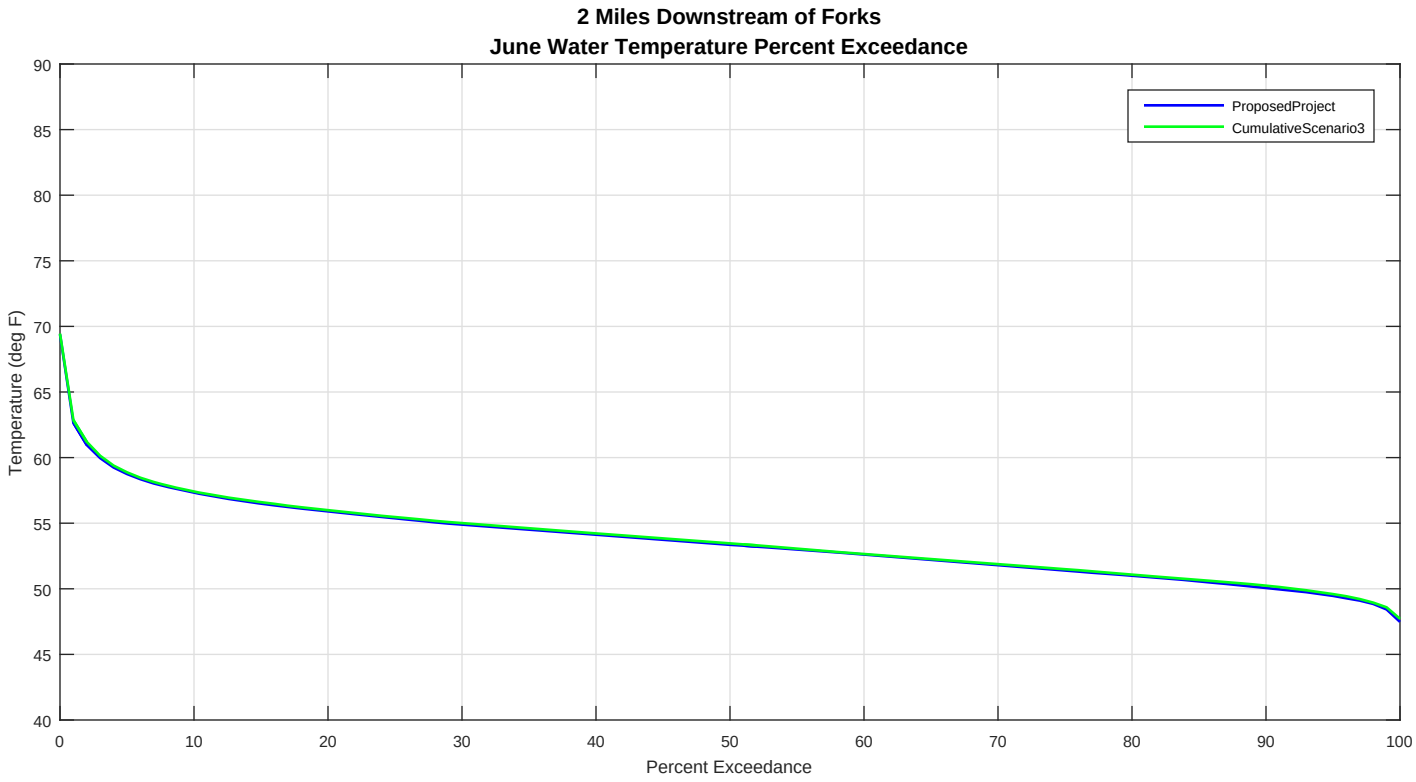
2 Miles Downstream of Forks
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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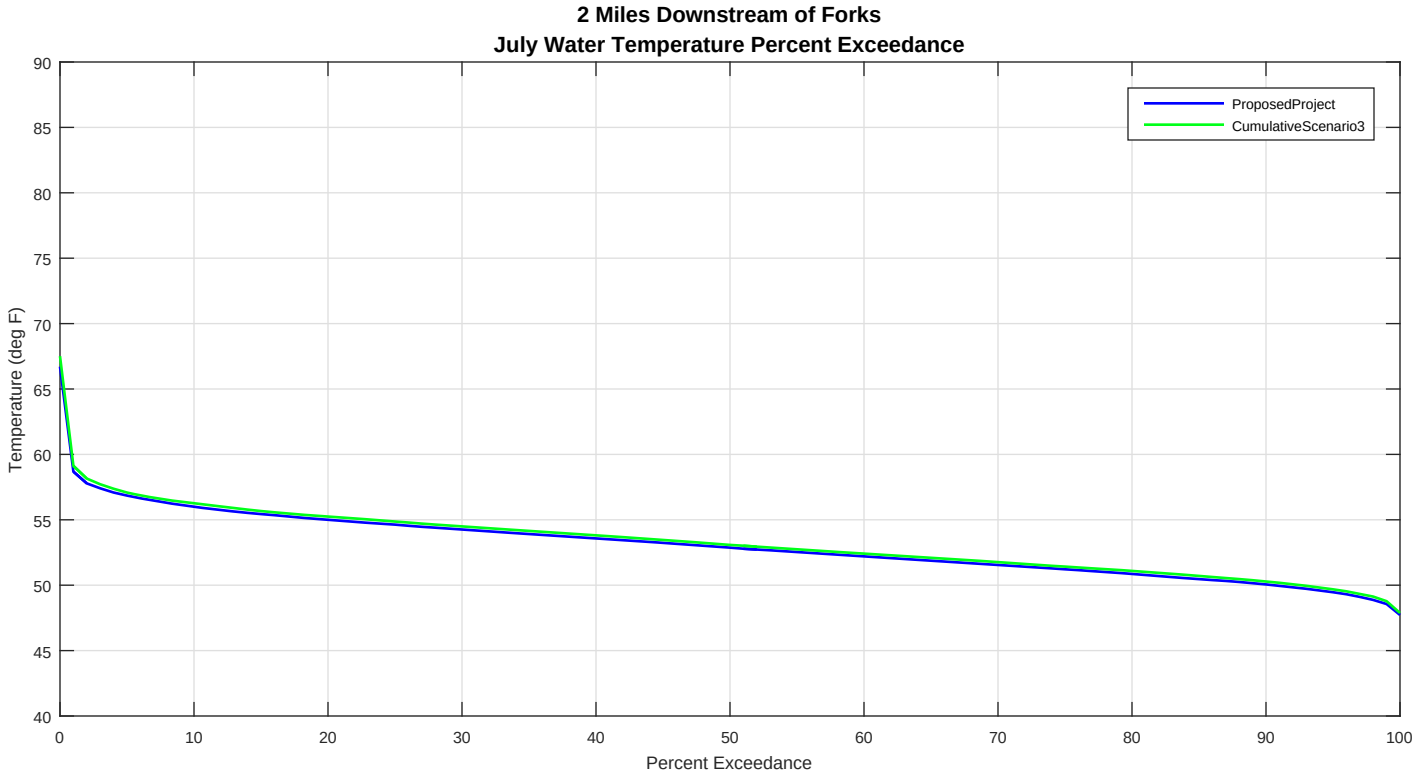
2 Miles Downstream of Forks
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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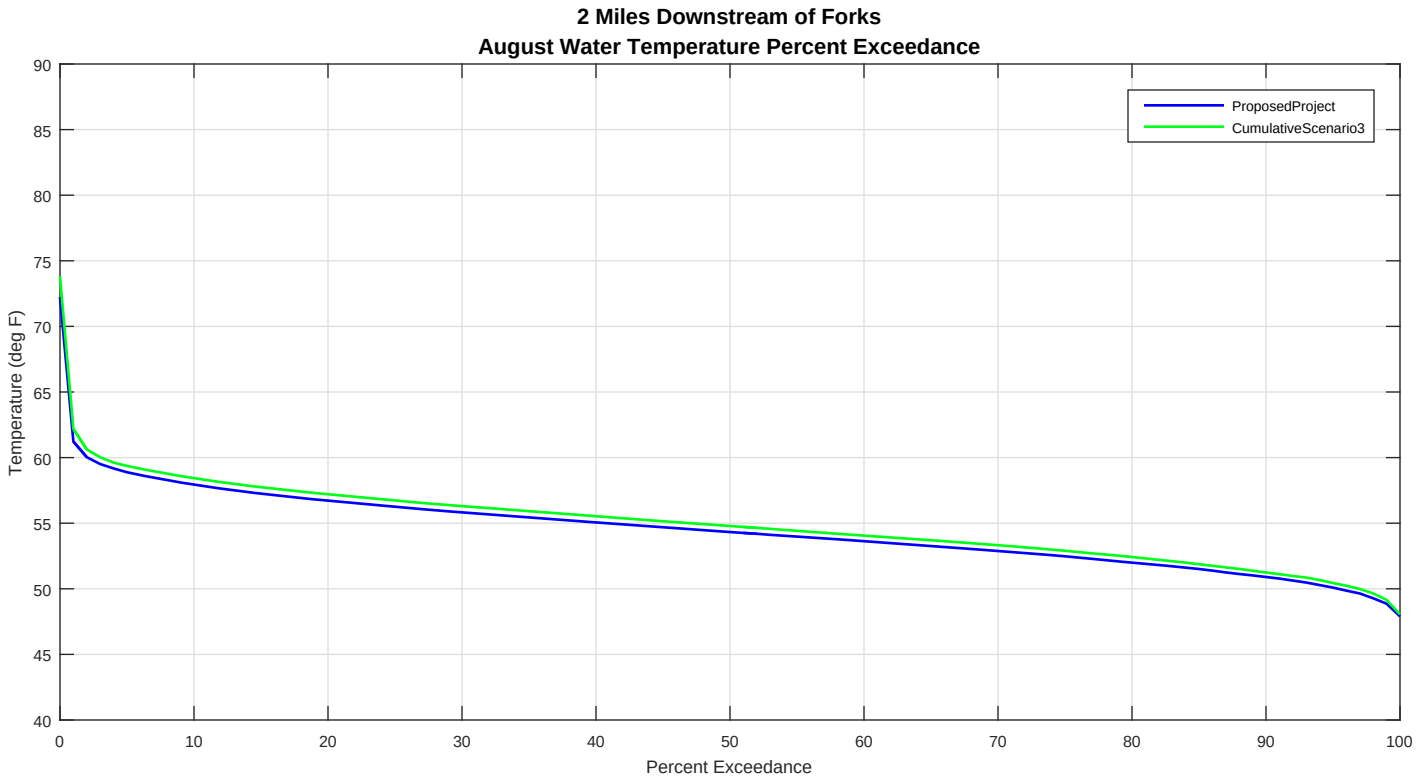
2 Miles Downstream of Forks
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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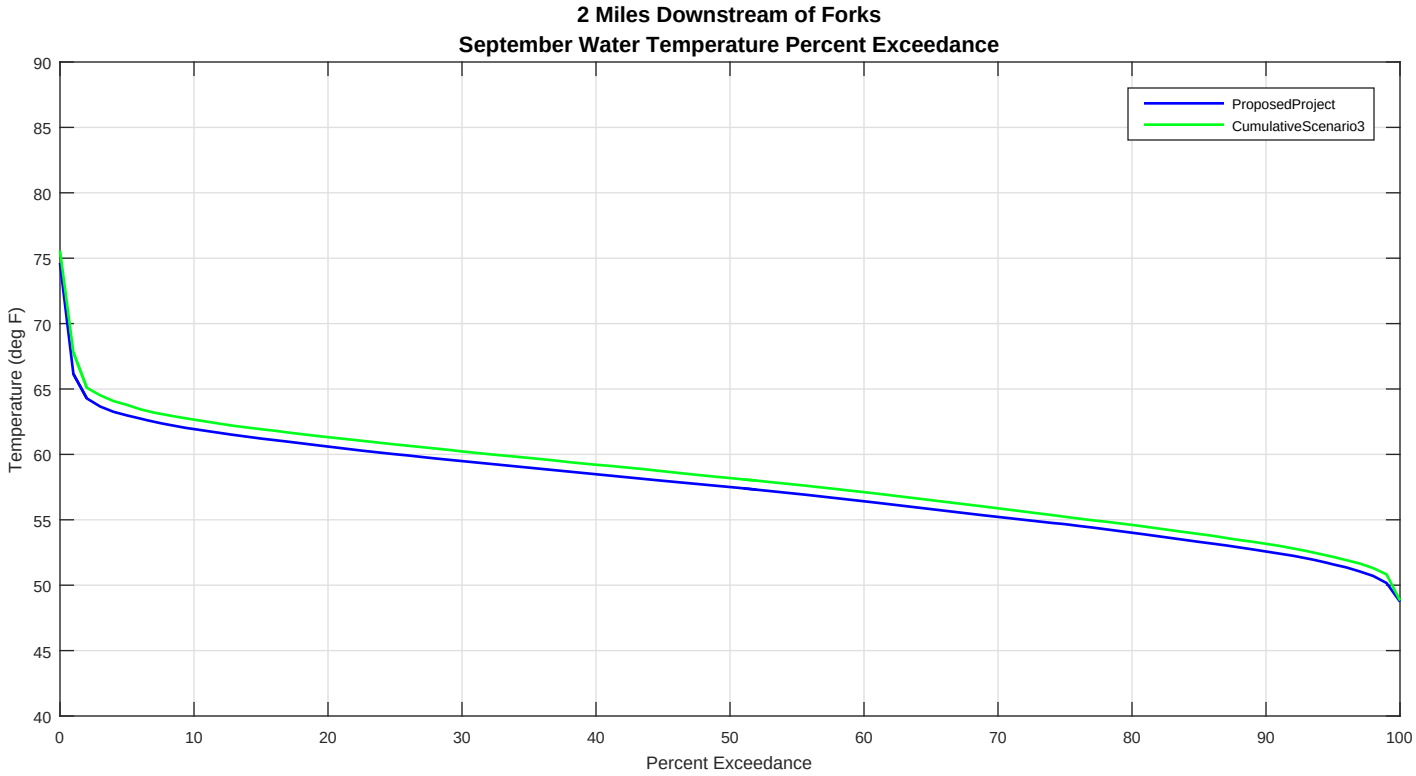
2 Miles Downstream of Forks
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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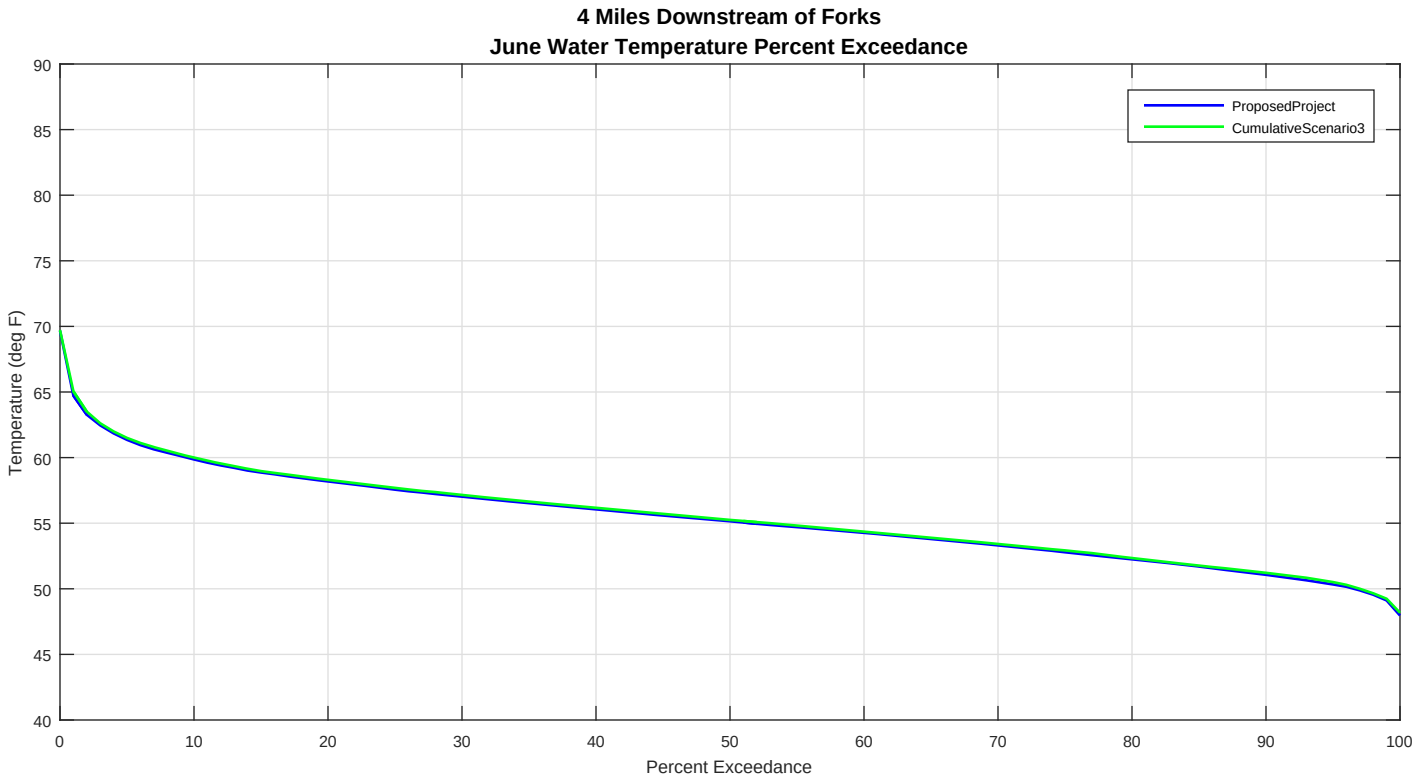
4 Miles Downstream of Forks
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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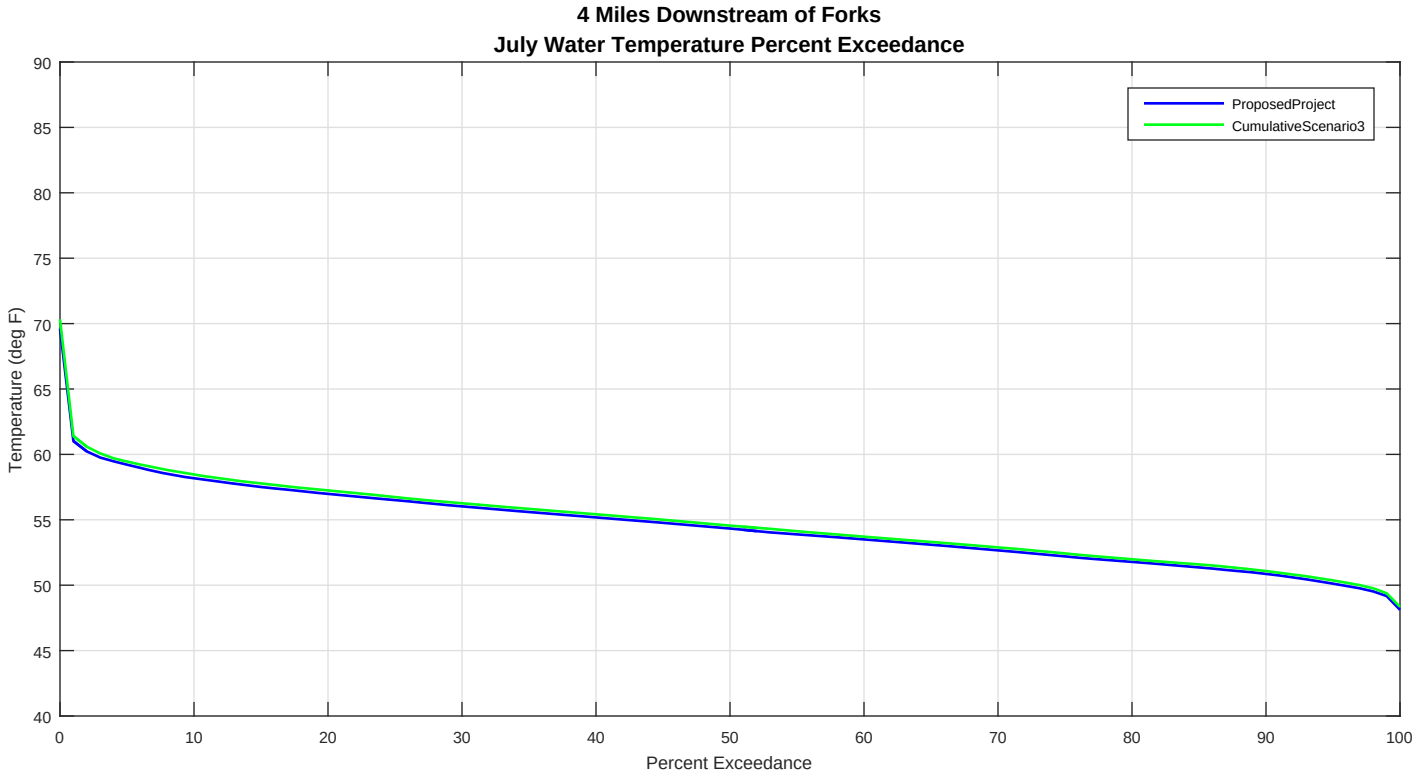
4 Miles Downstream of Forks
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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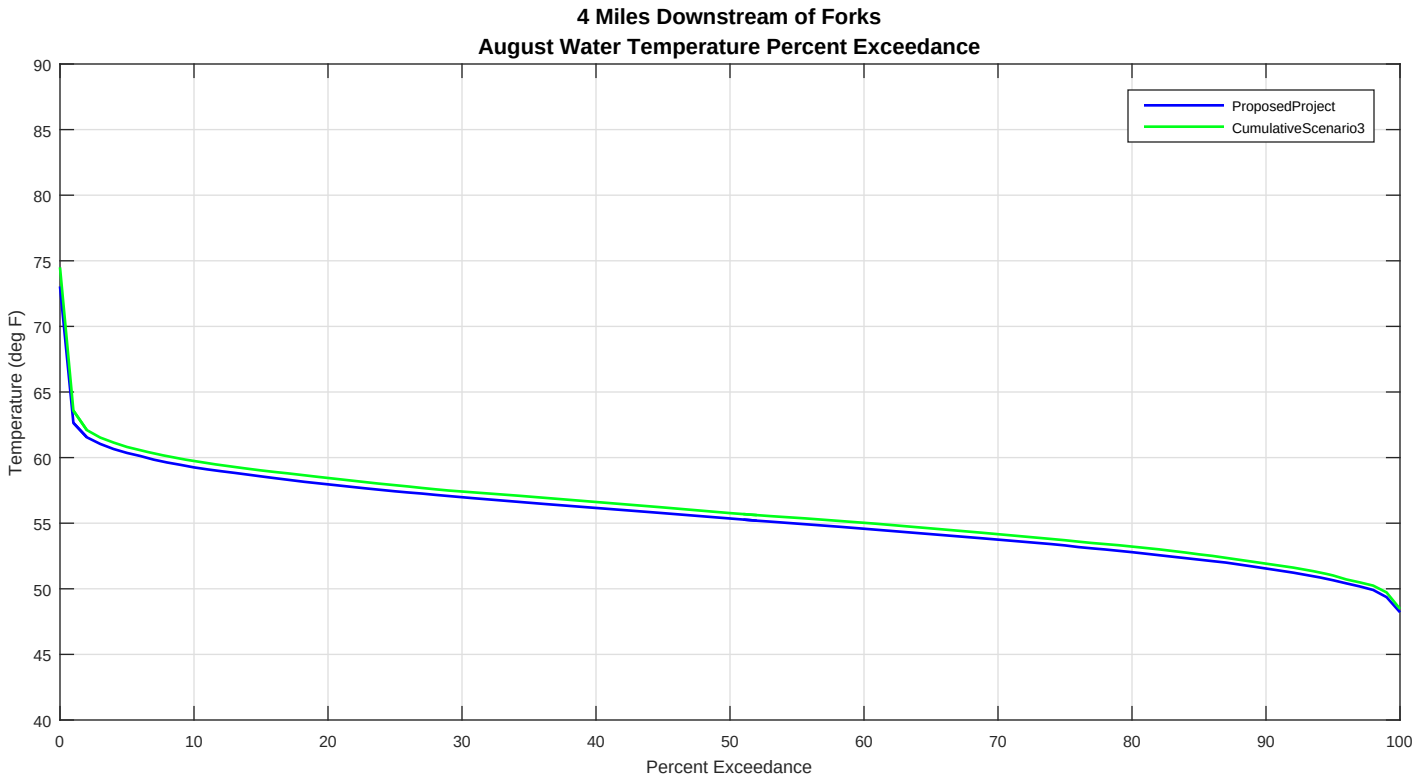
4 Miles Downstream of Forks
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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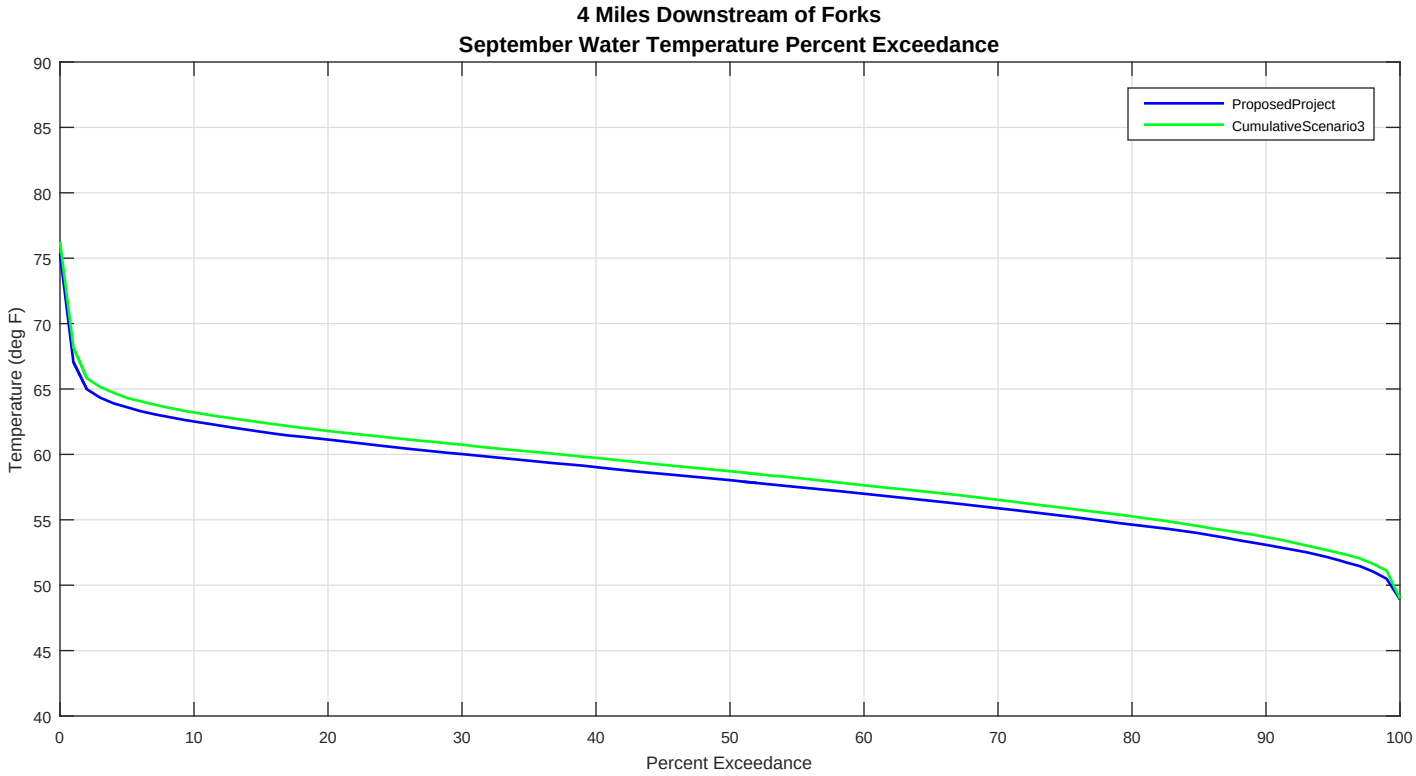
4 Miles Downstream of Forks
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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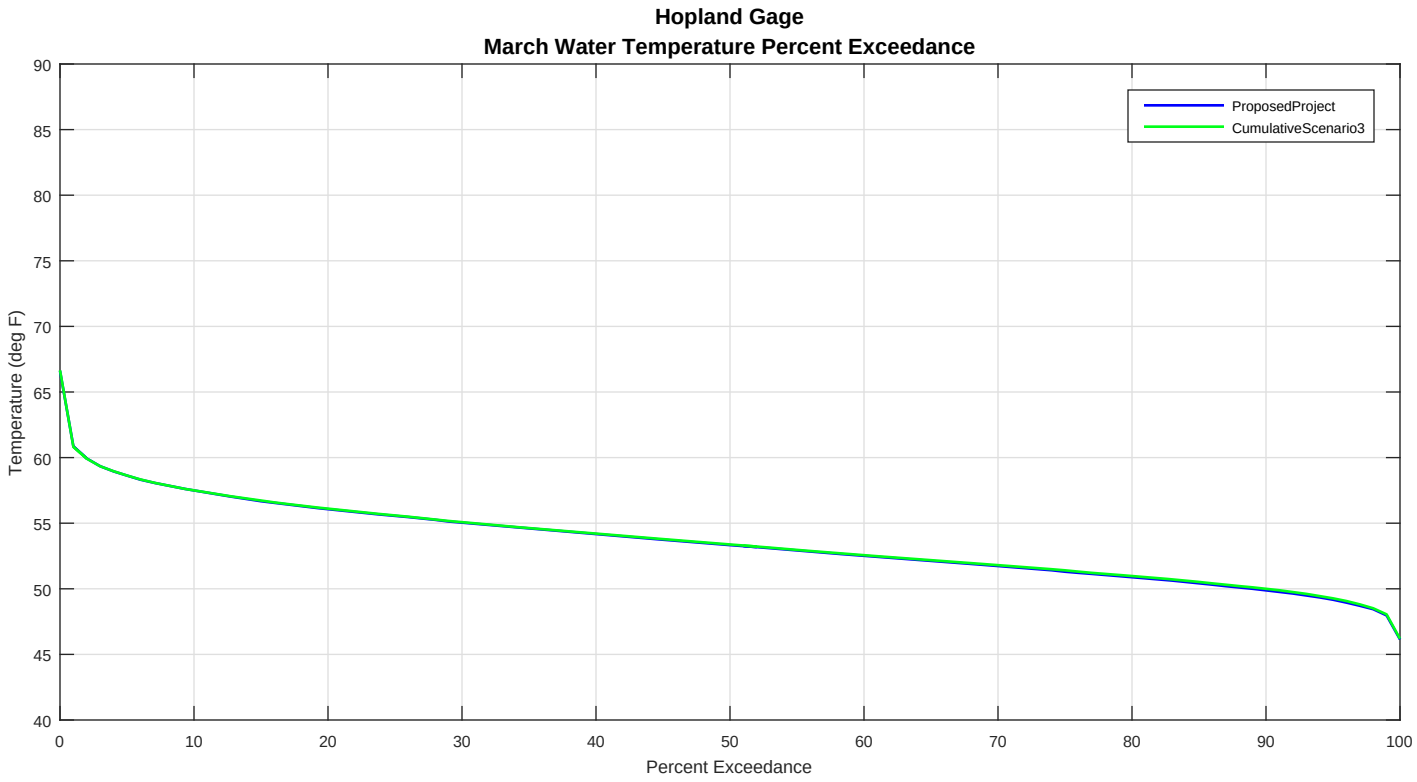
Hopland Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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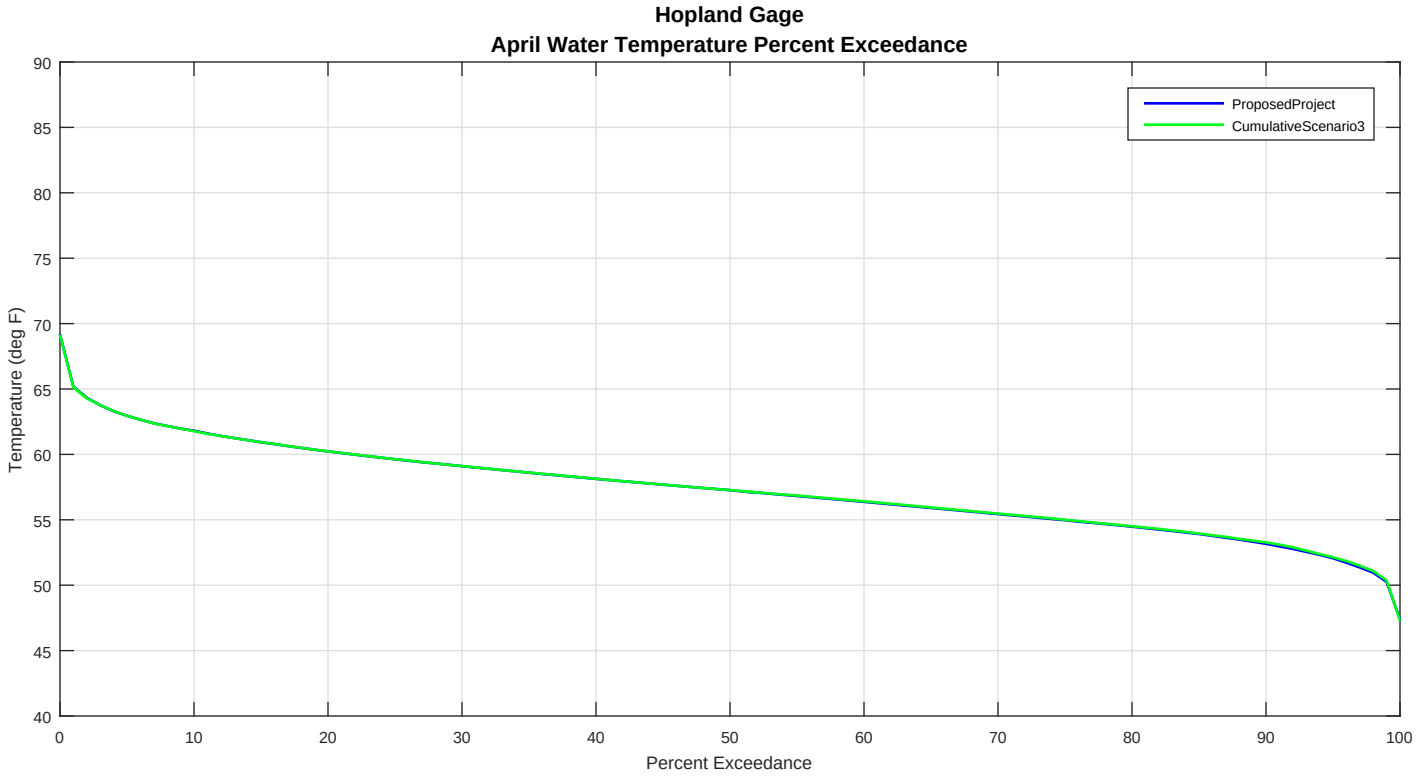
Hopland Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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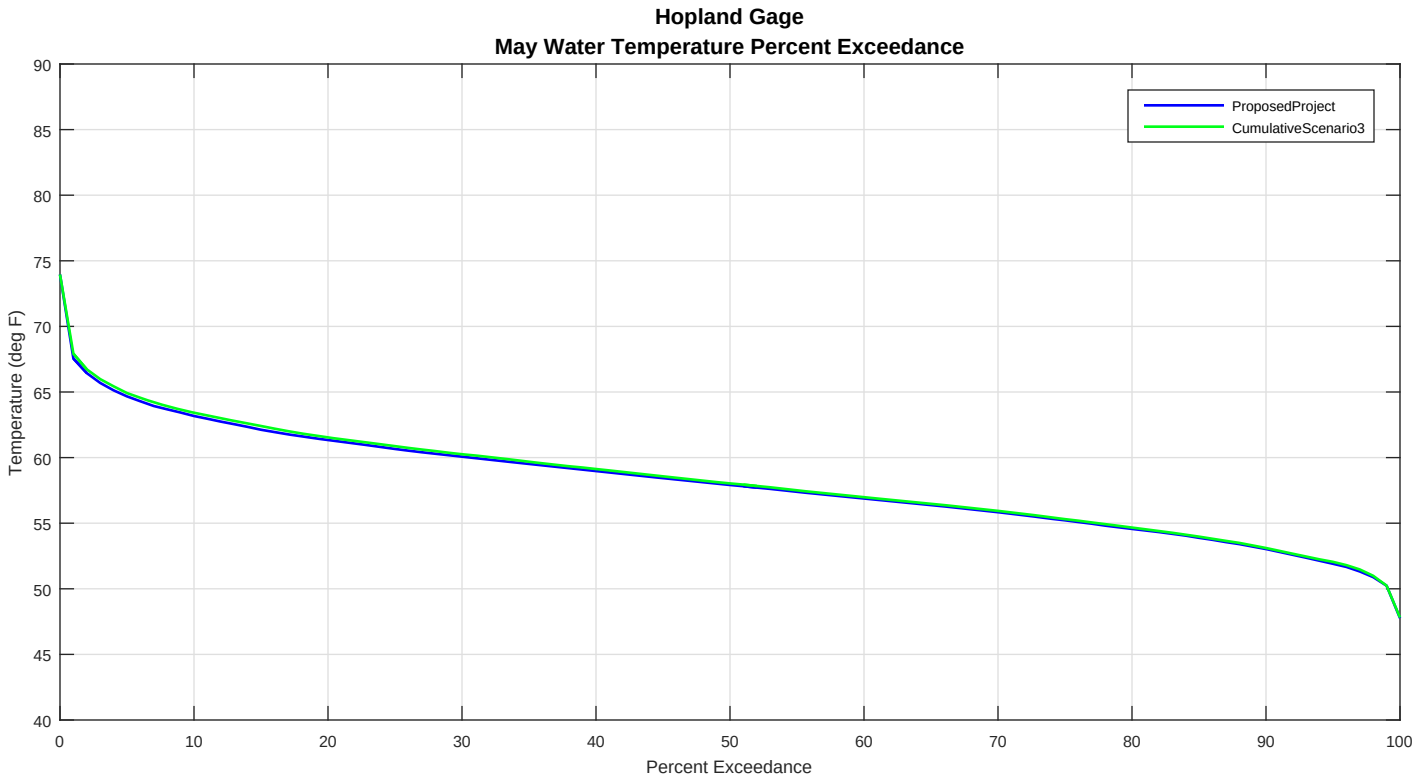
Hopland Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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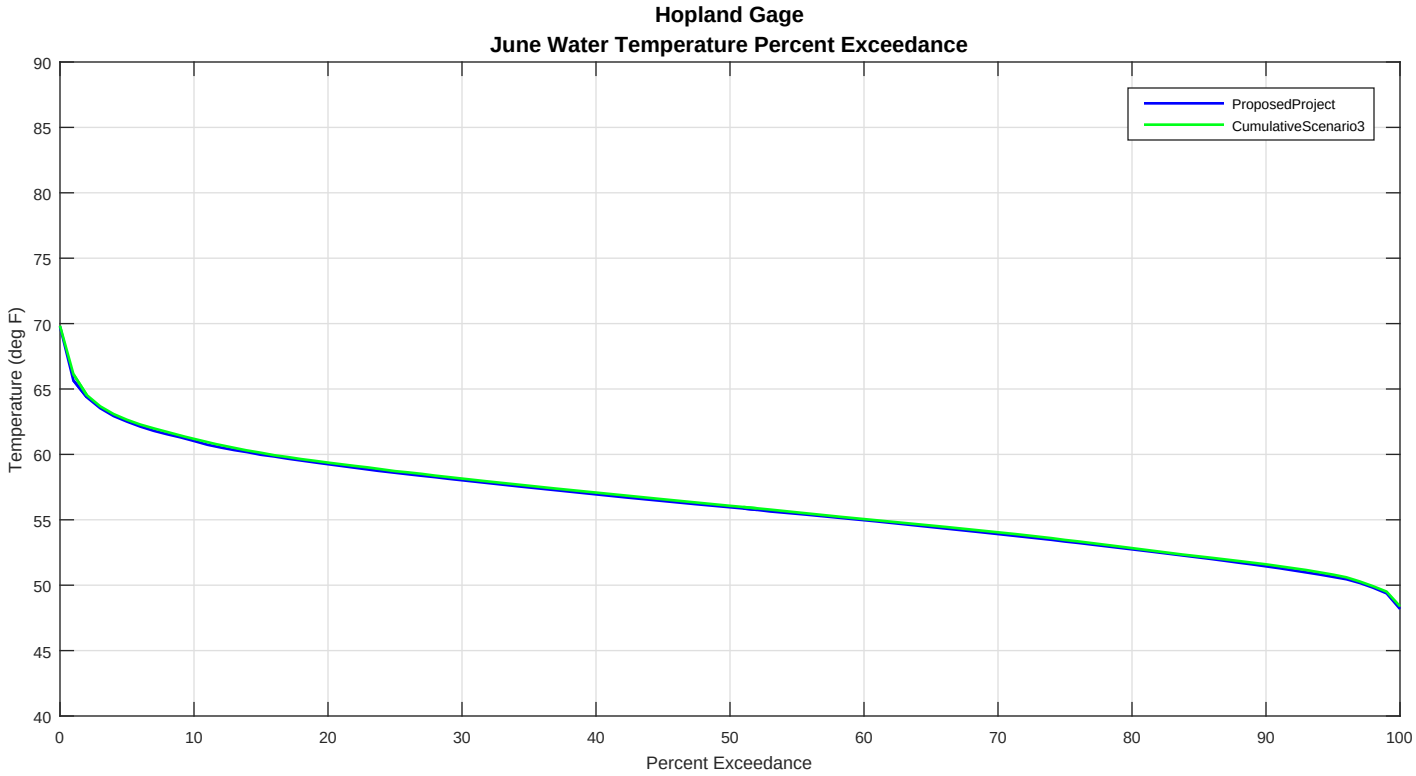
Hopland Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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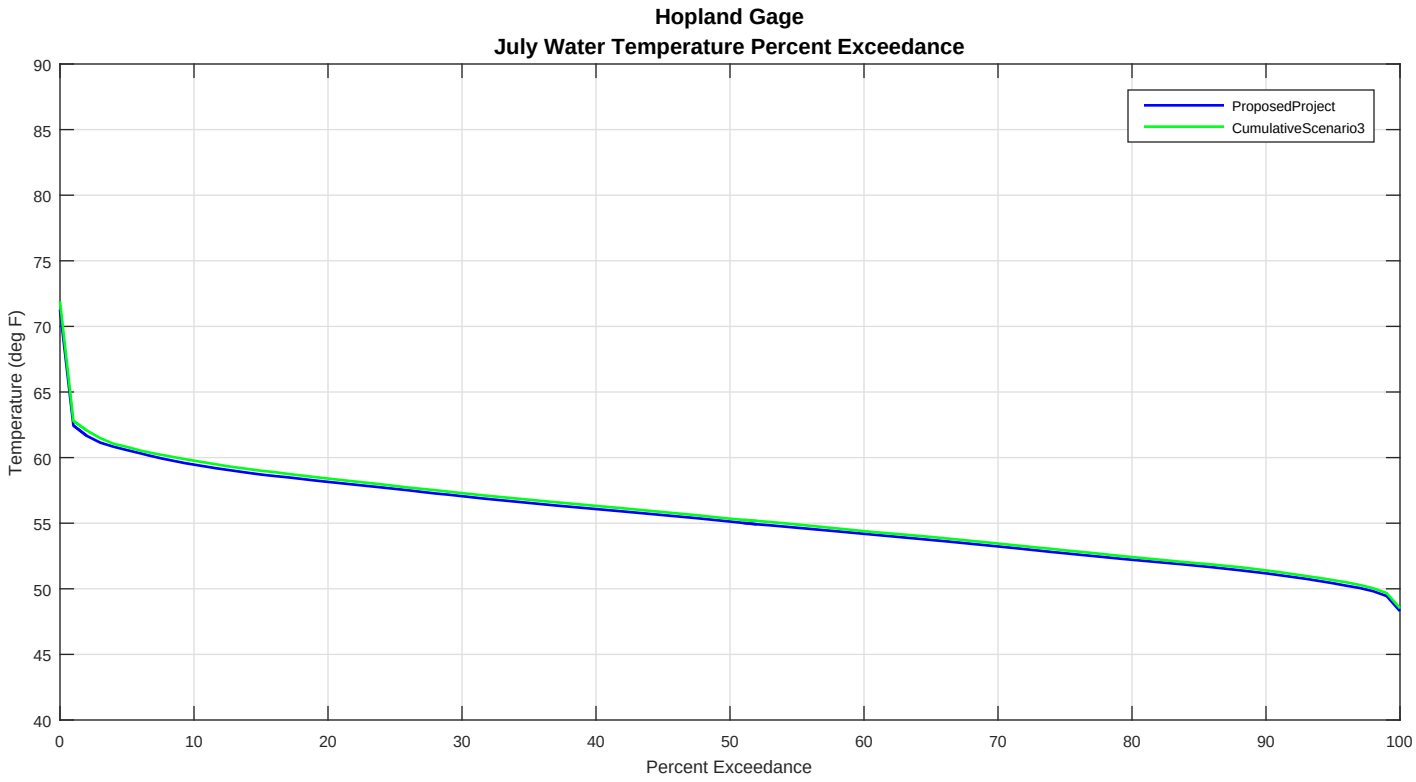
Hopland Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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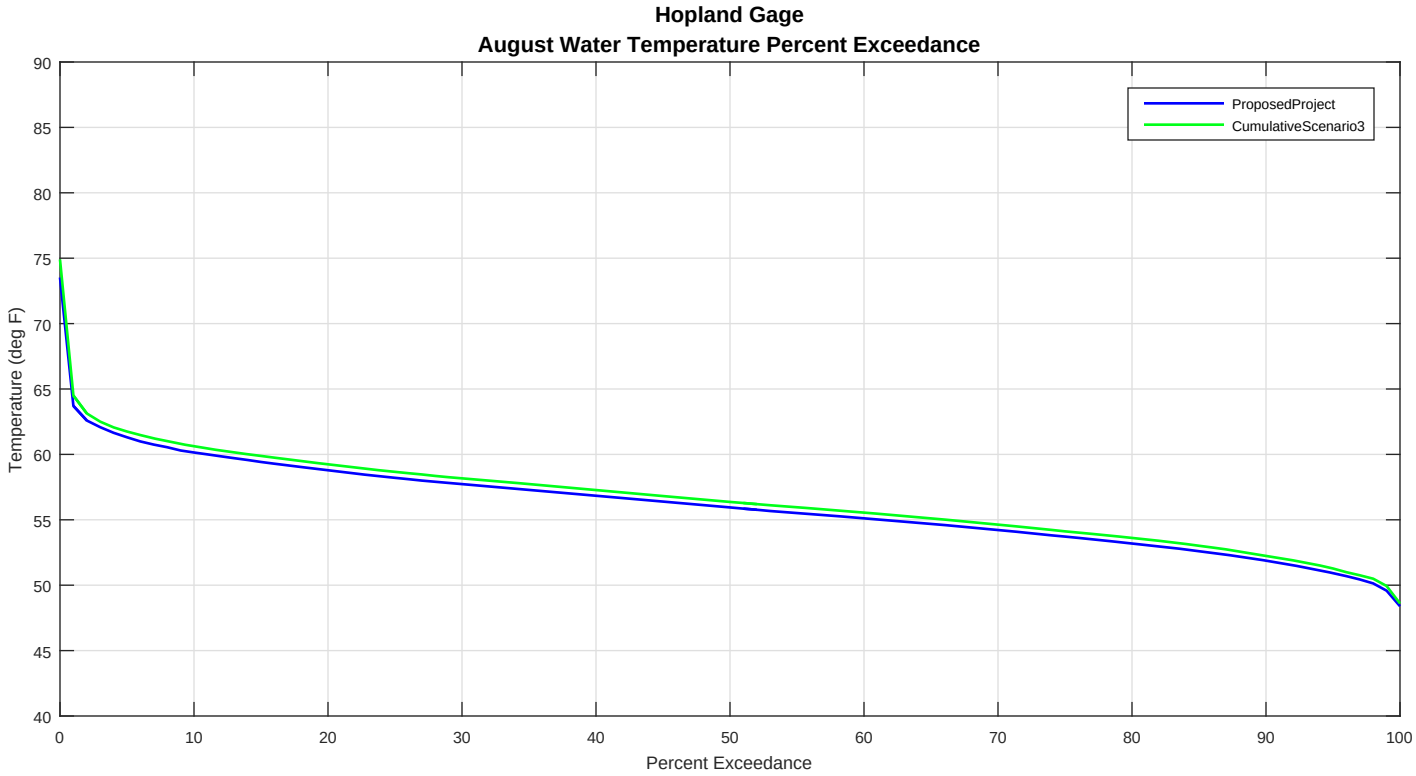
Hopland Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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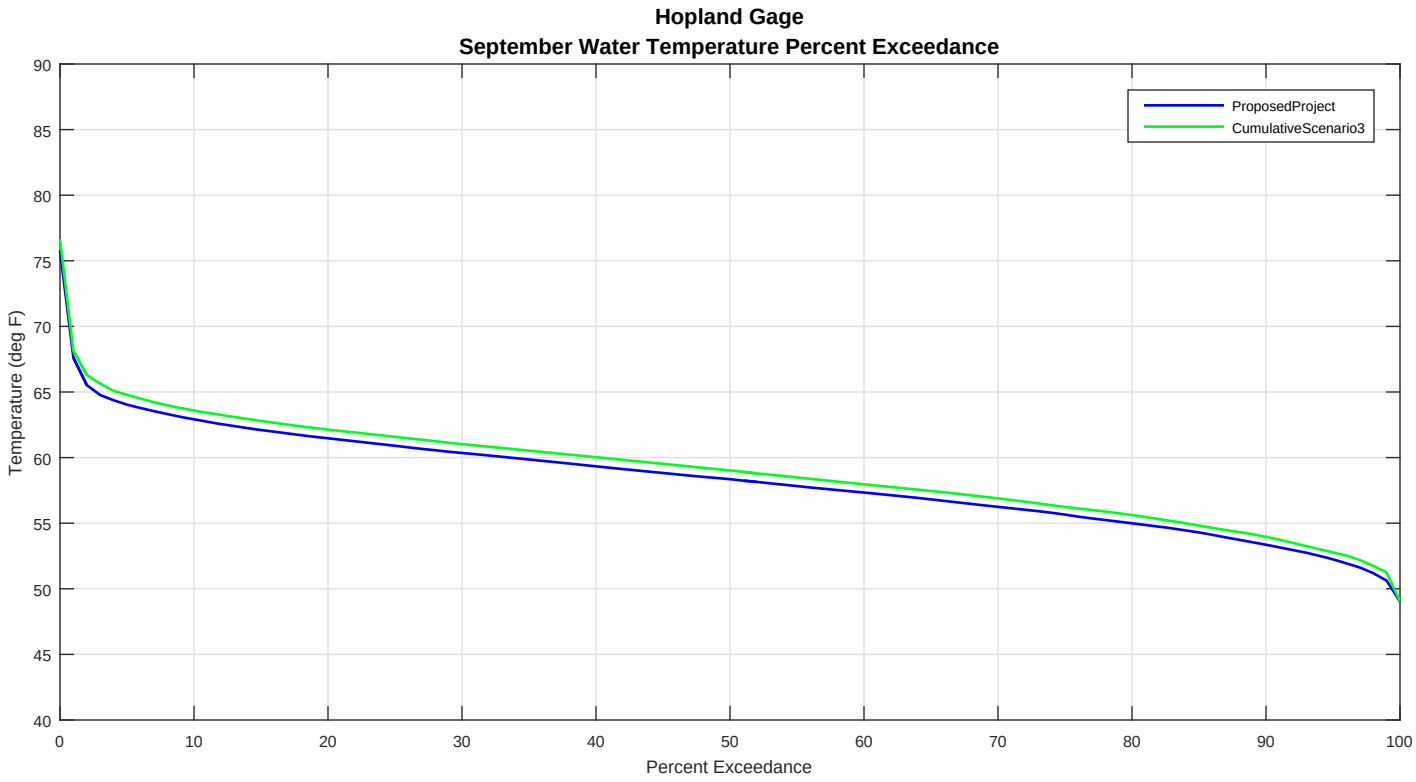
Hopland Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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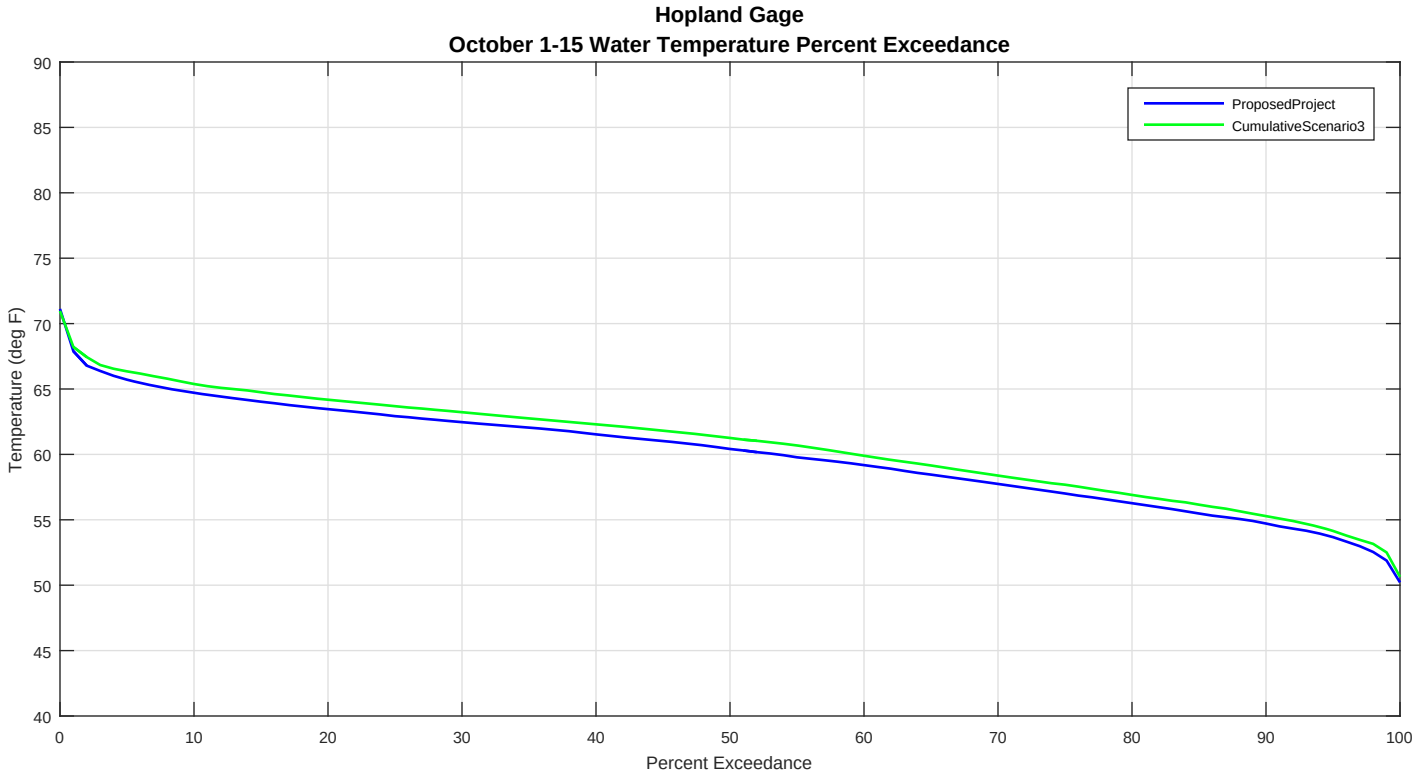
Hopland Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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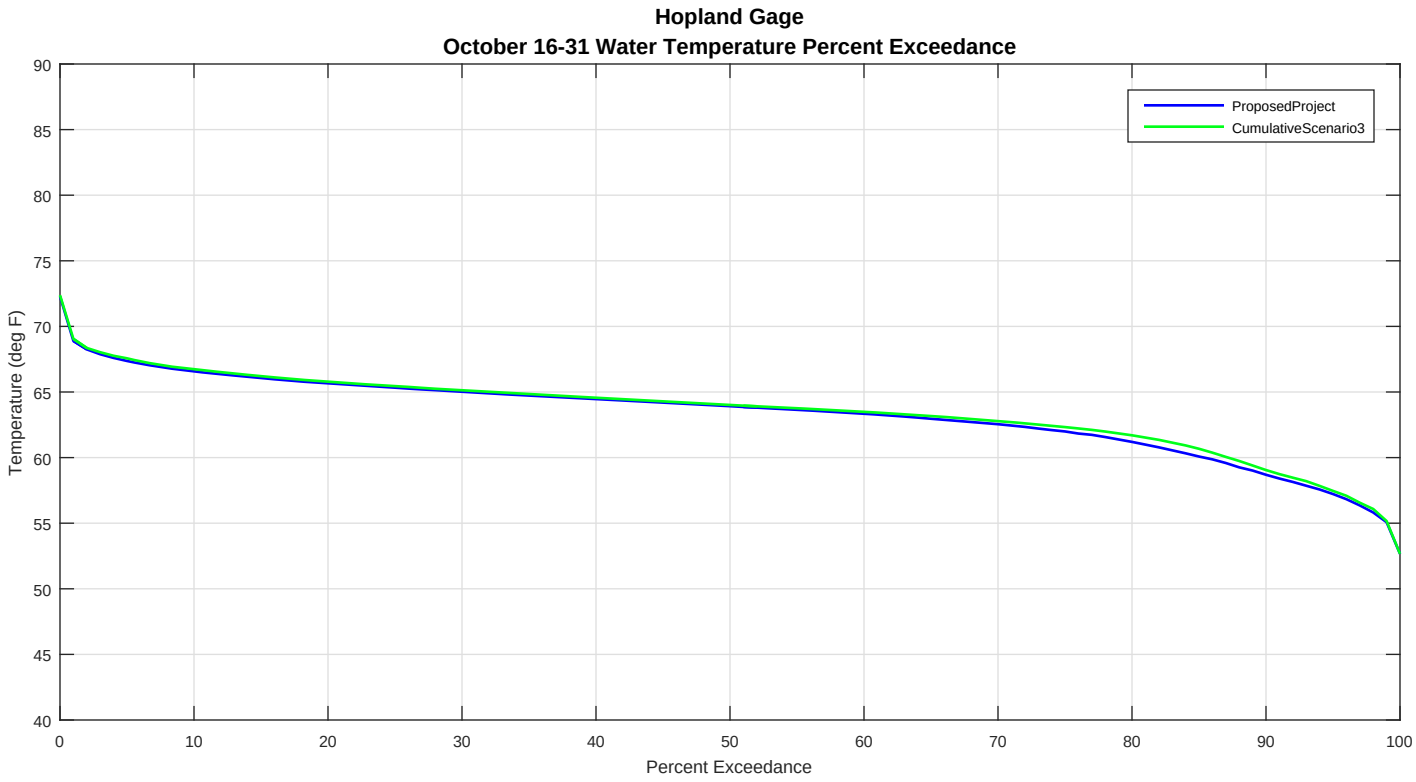
Hopland Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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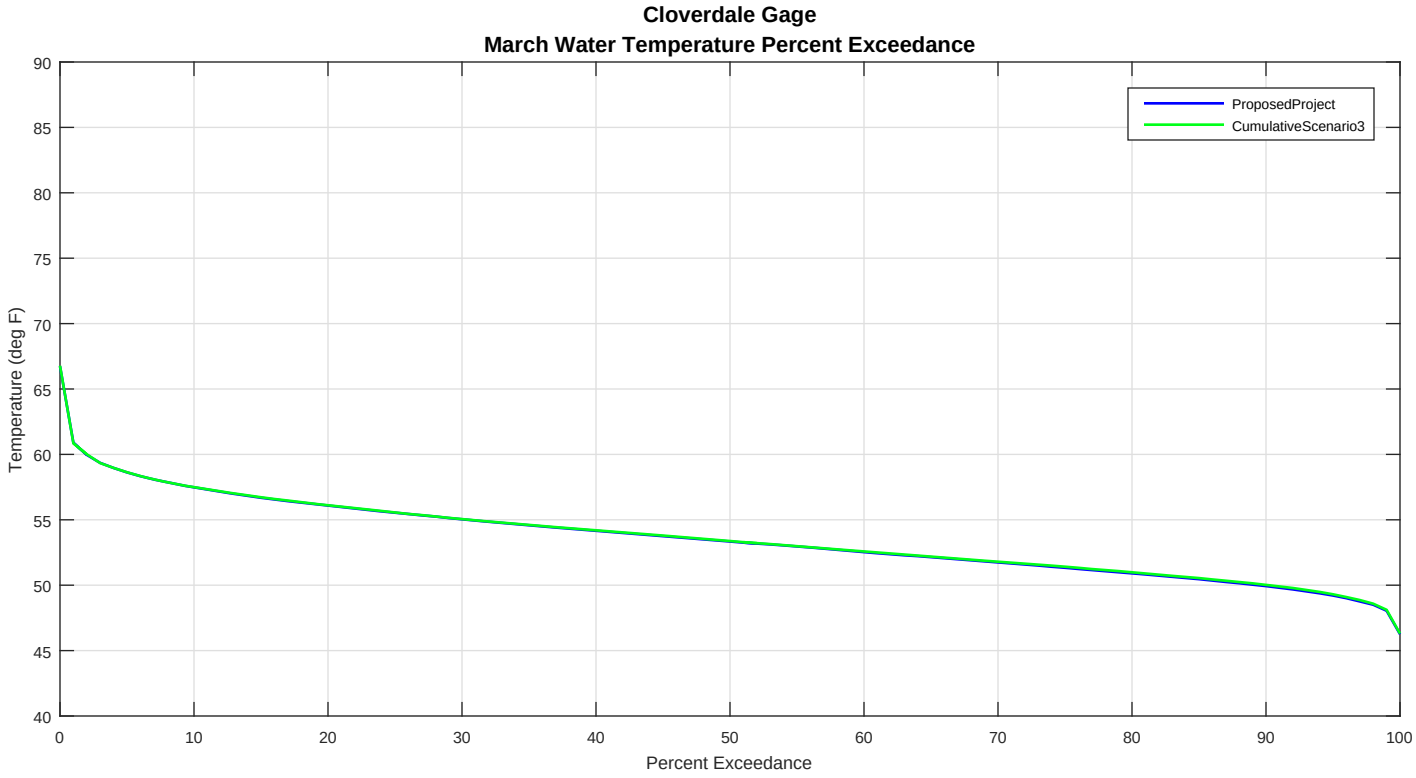
Cloverdale Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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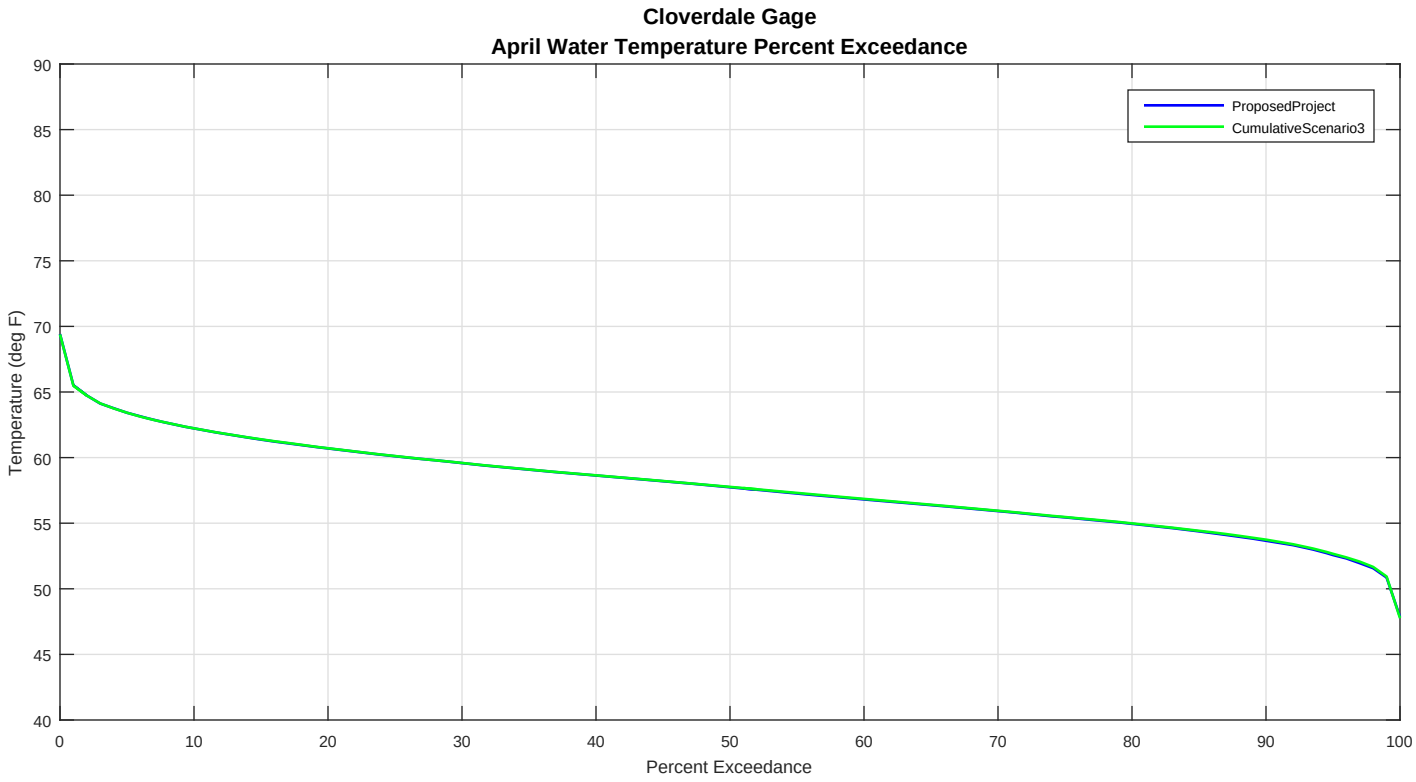
Cloverdale Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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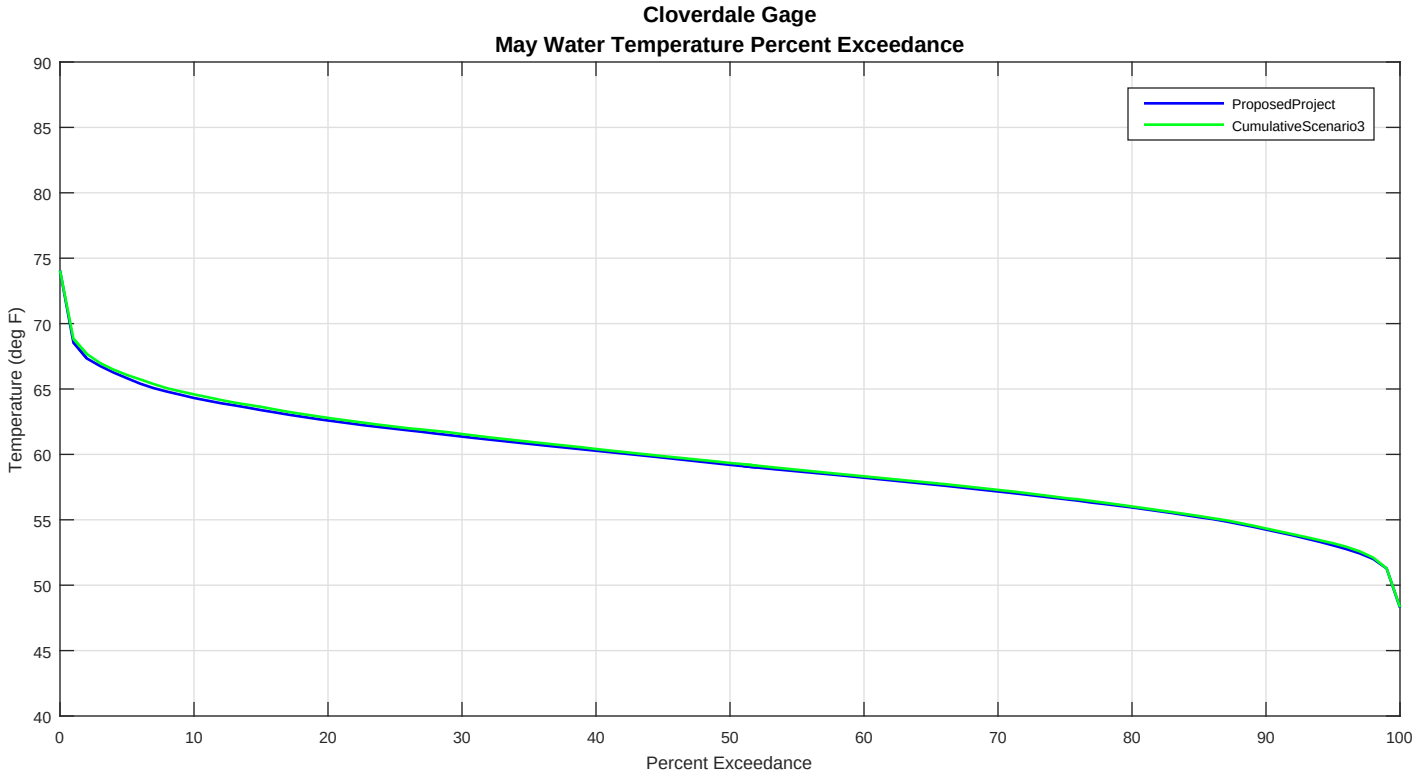
Cloverdale Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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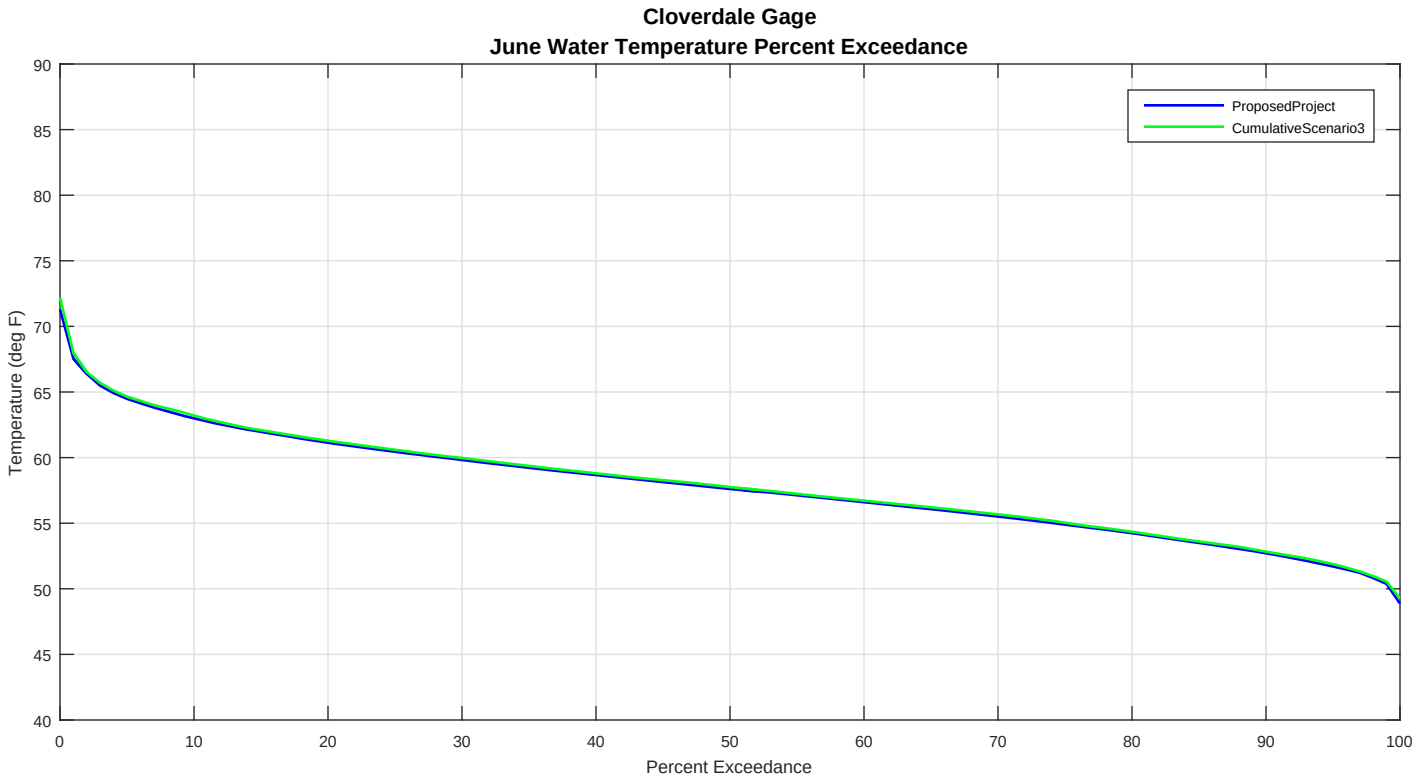
Cloverdale Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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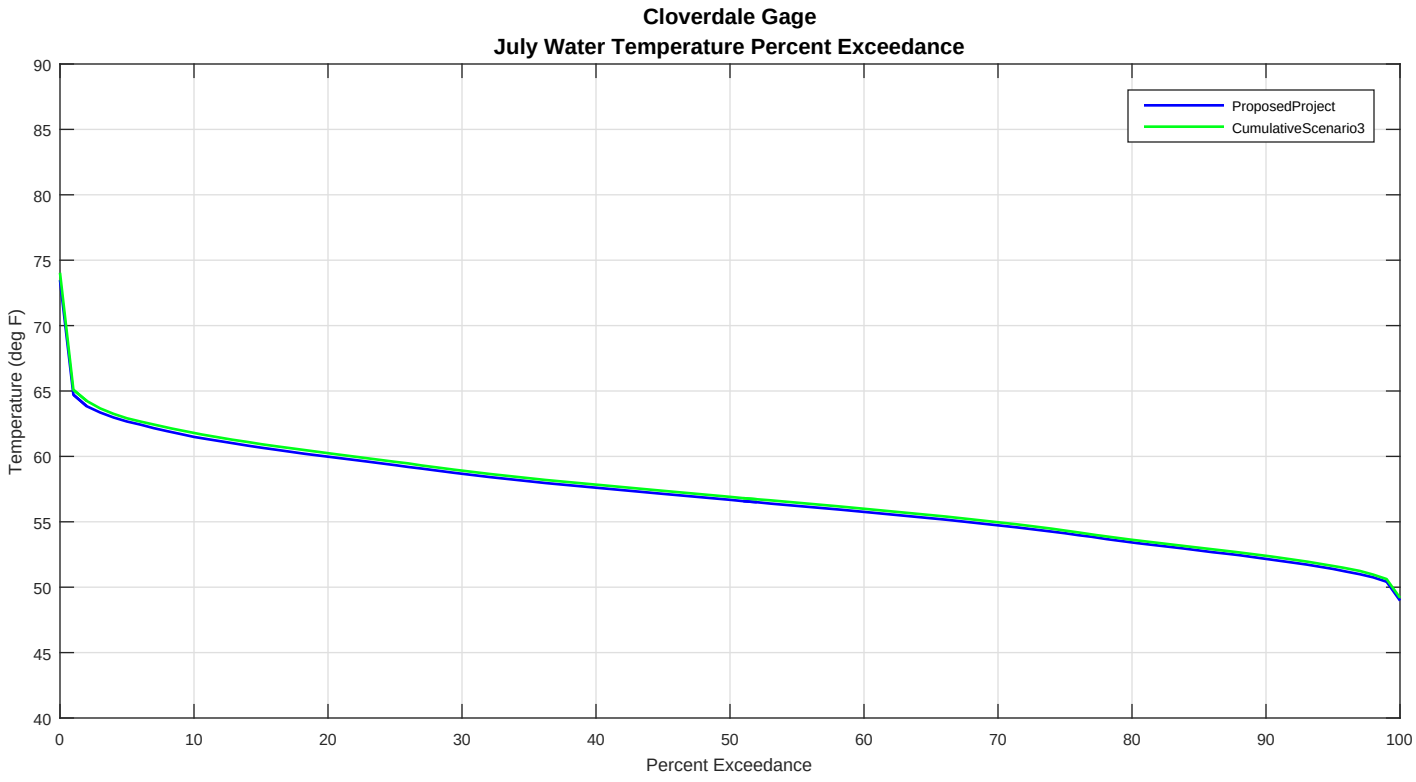
Cloverdale Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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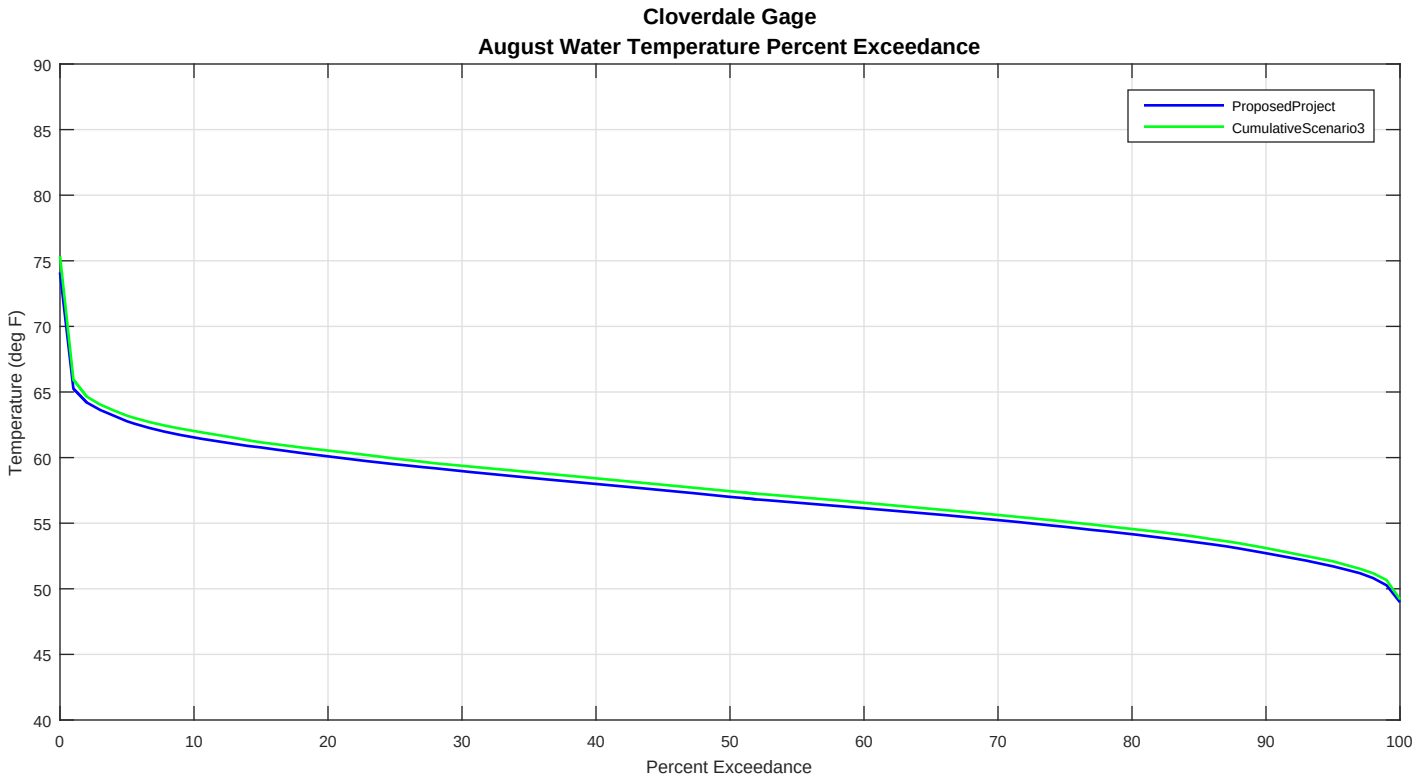
Cloverdale Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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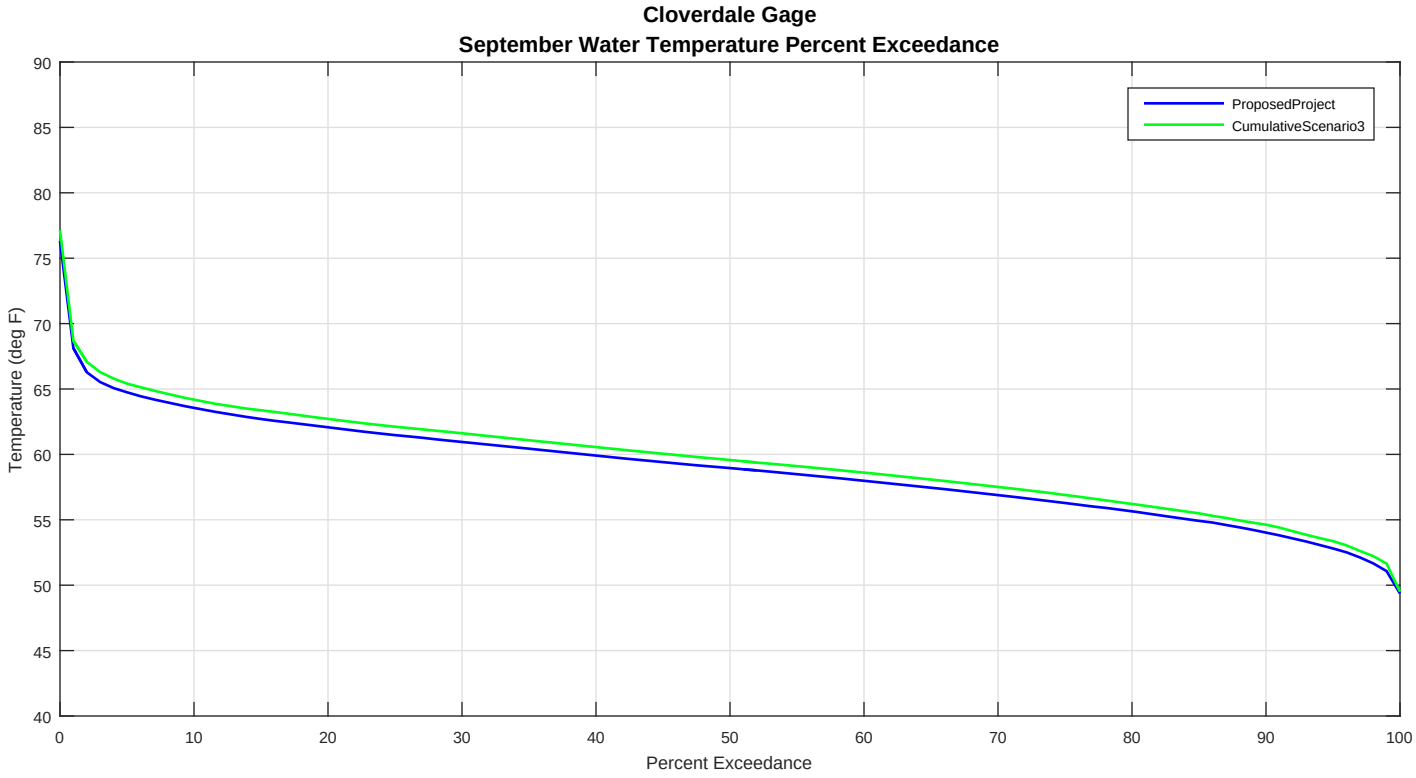
Cloverdale Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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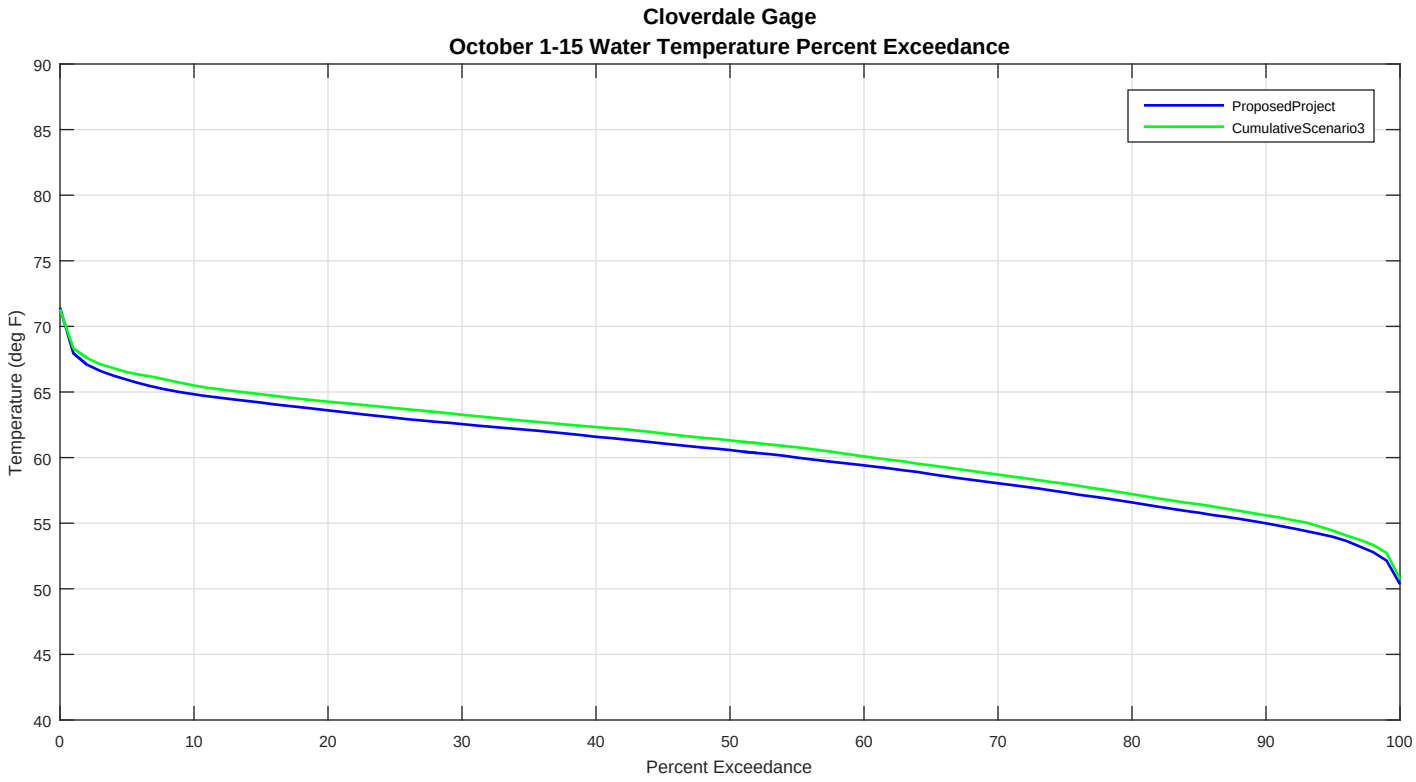
Cloverdale Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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Cloverdale Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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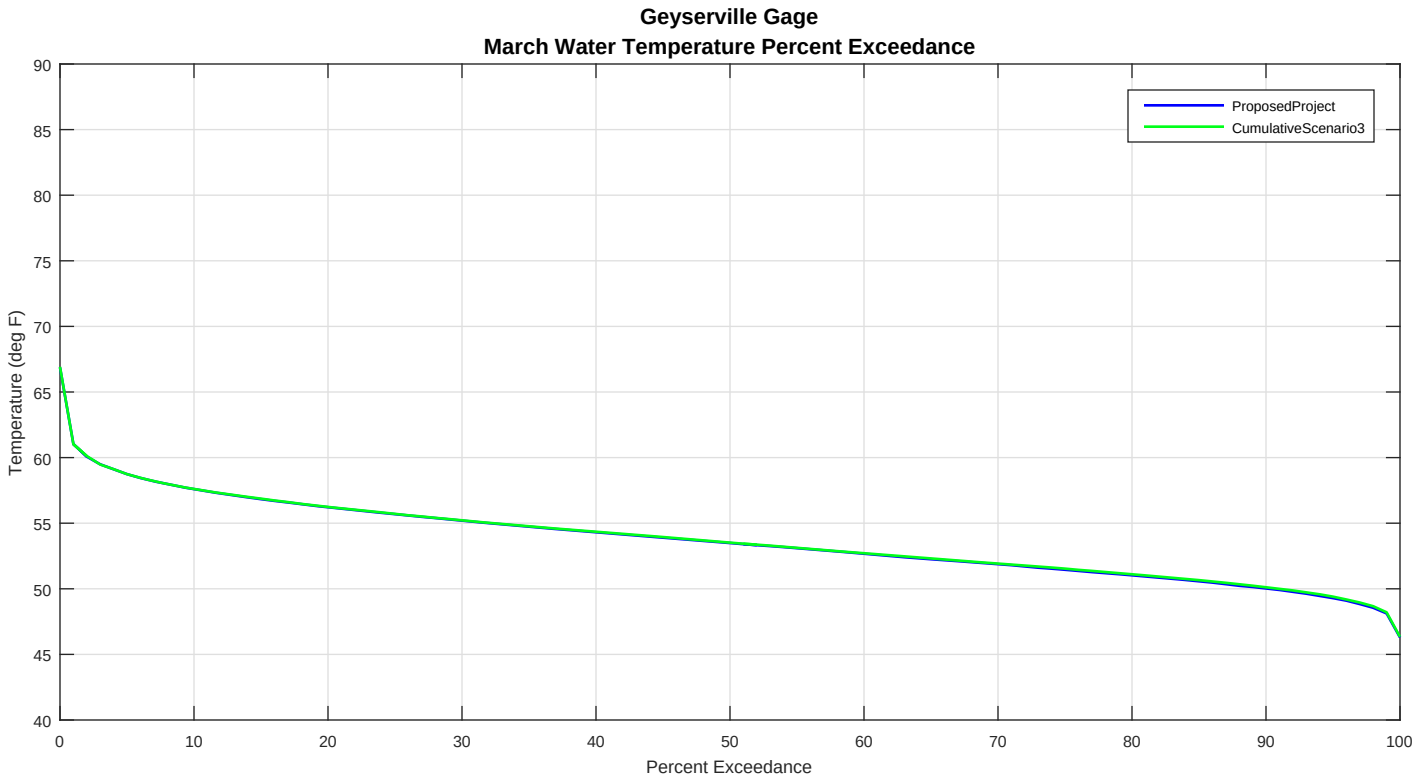
Geyserville Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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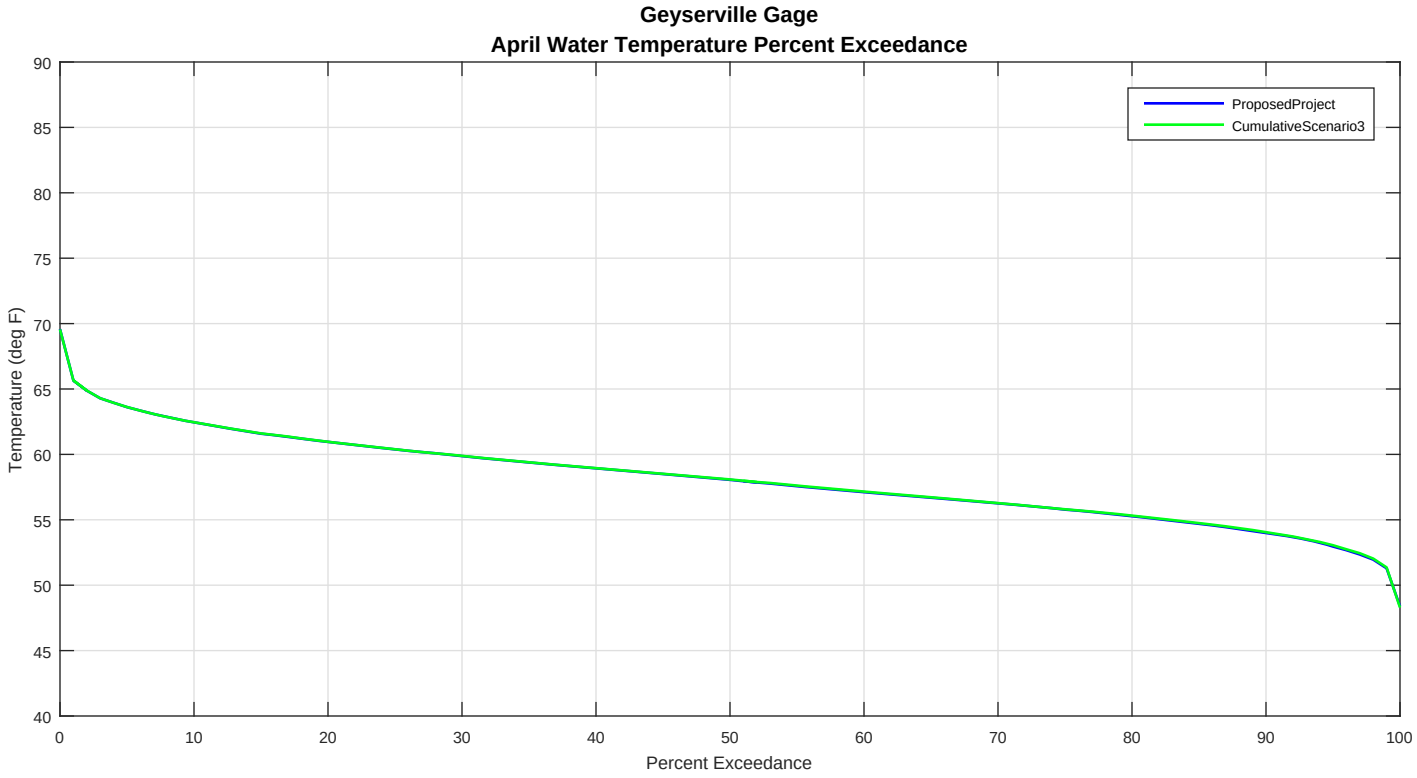
Geyserville Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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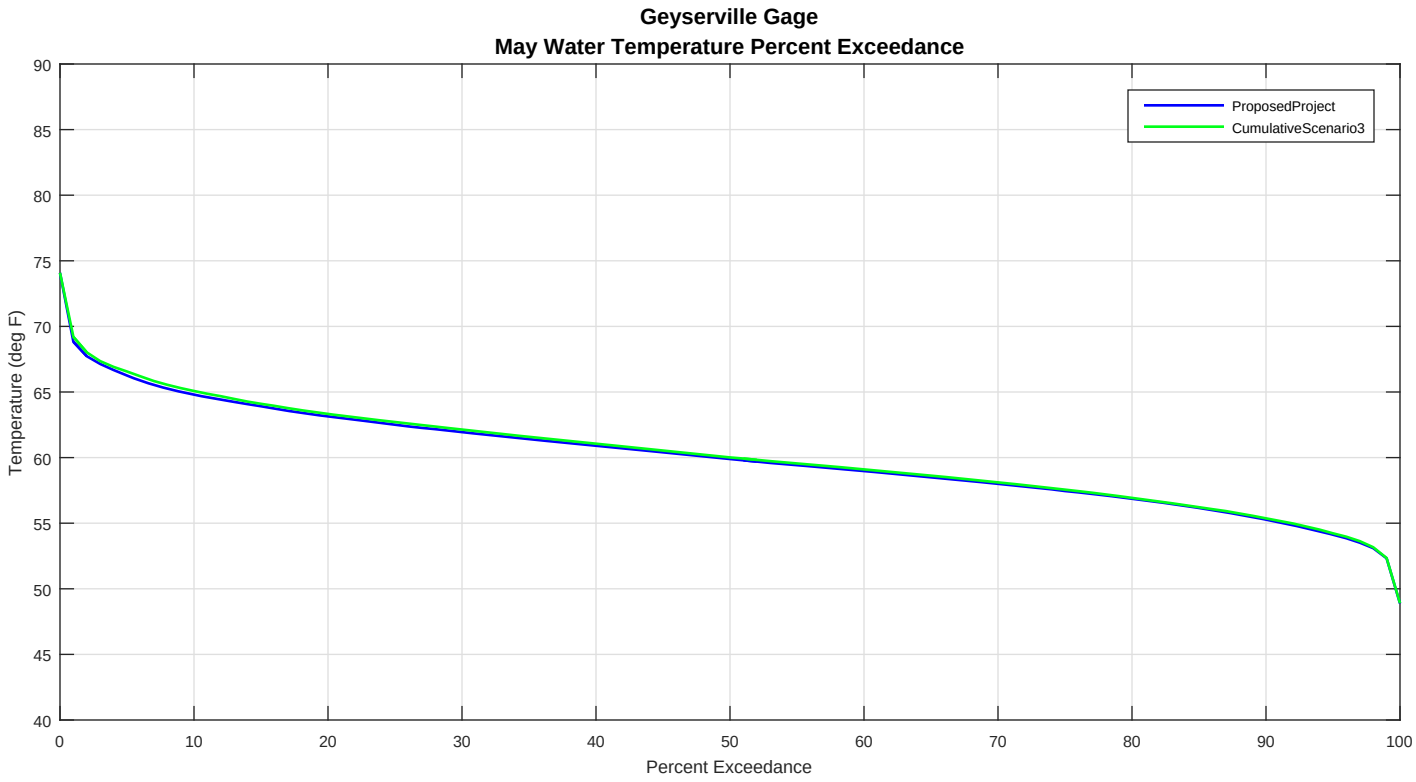
Geyserville Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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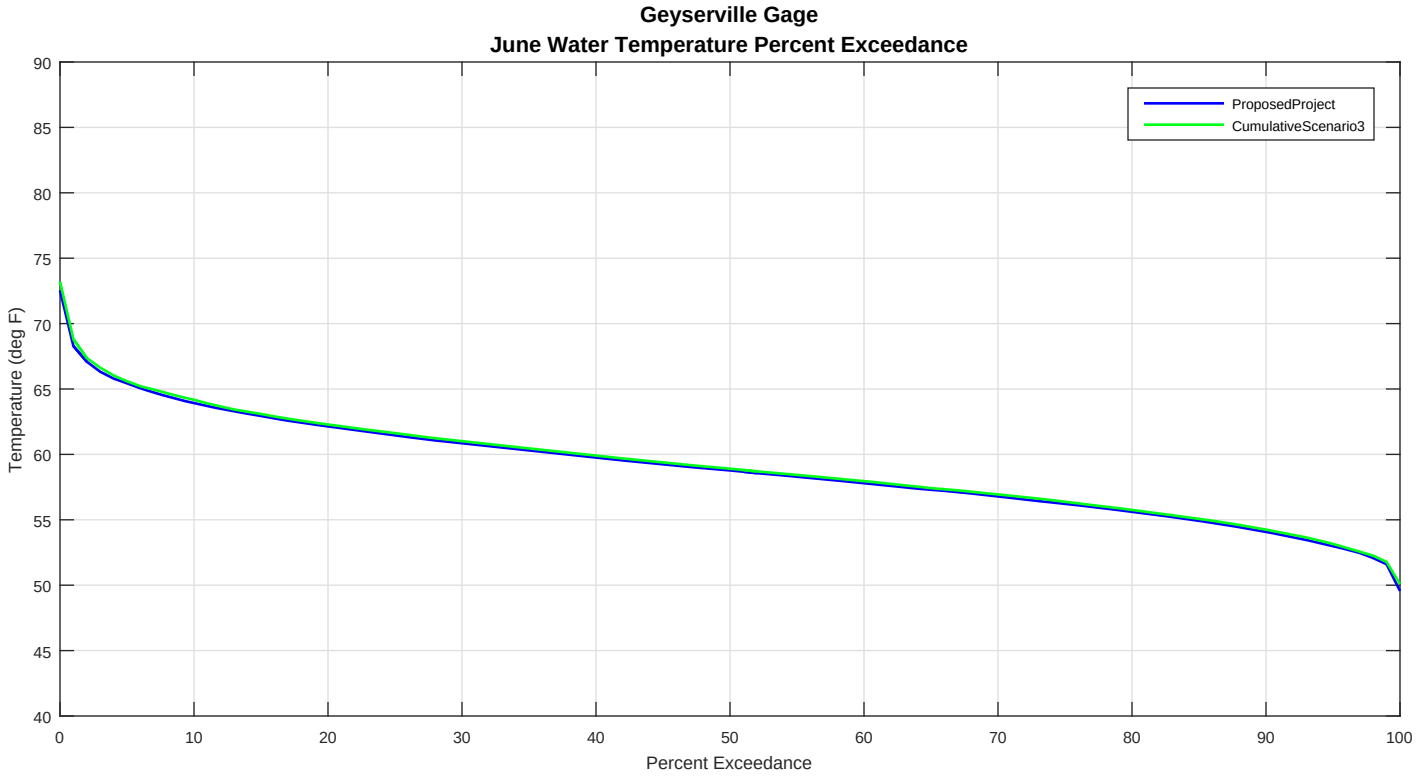
Geyserville Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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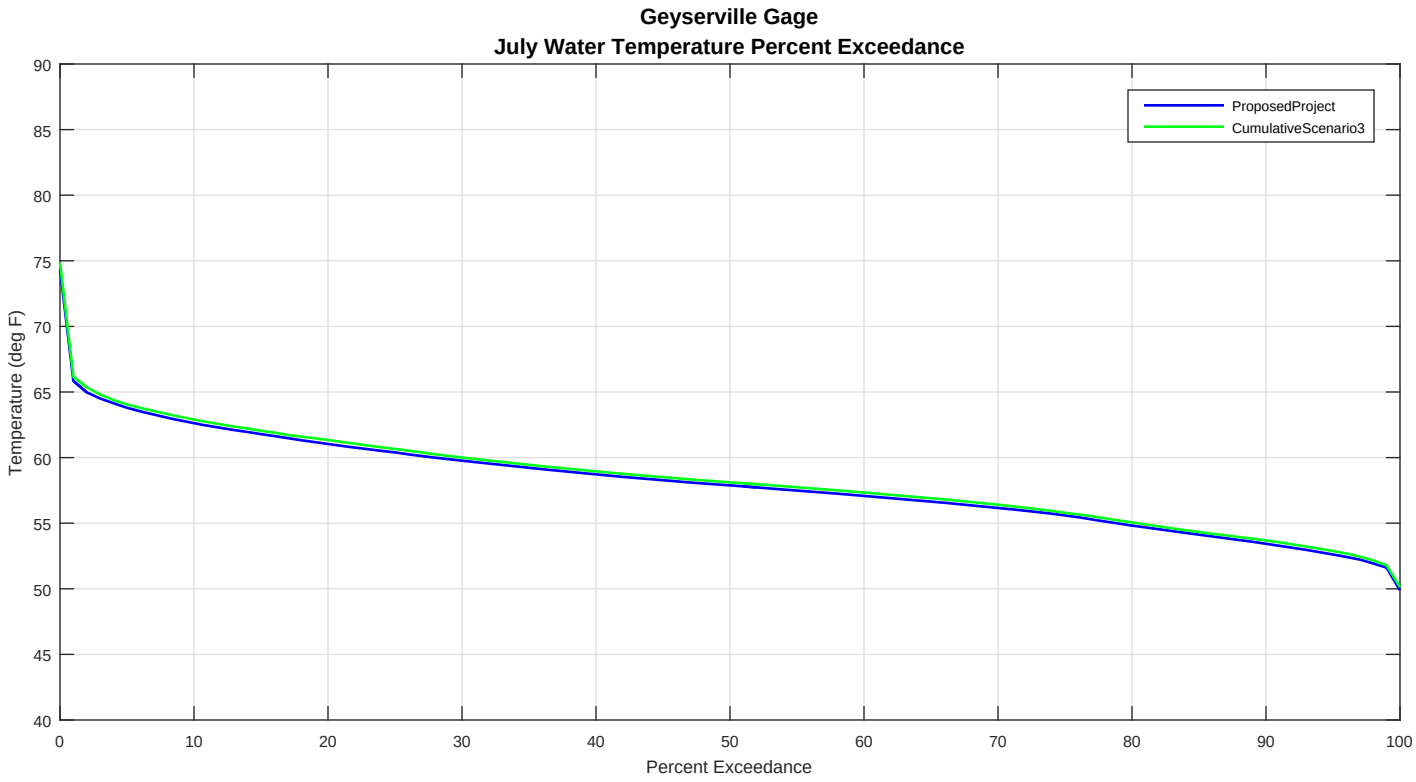
Geyserville Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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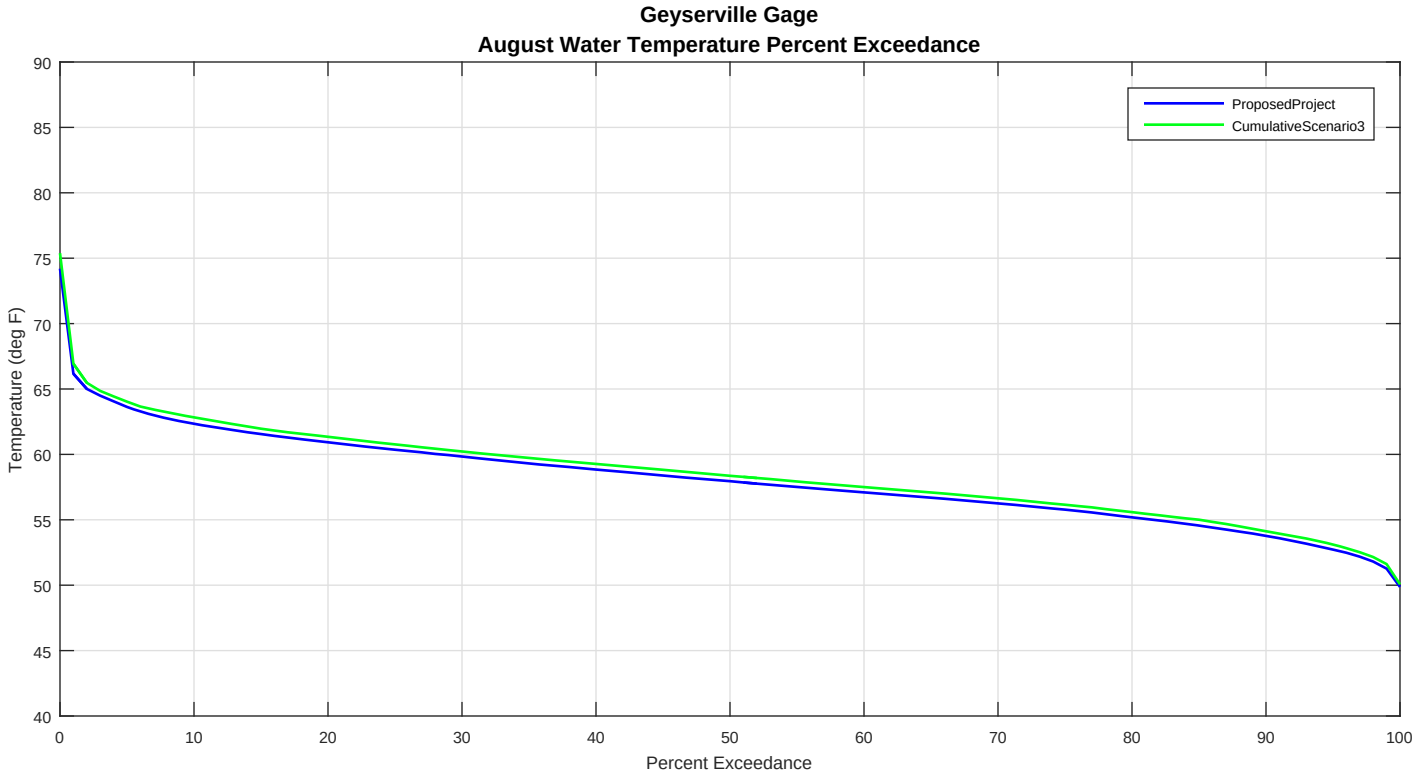
Geyserville Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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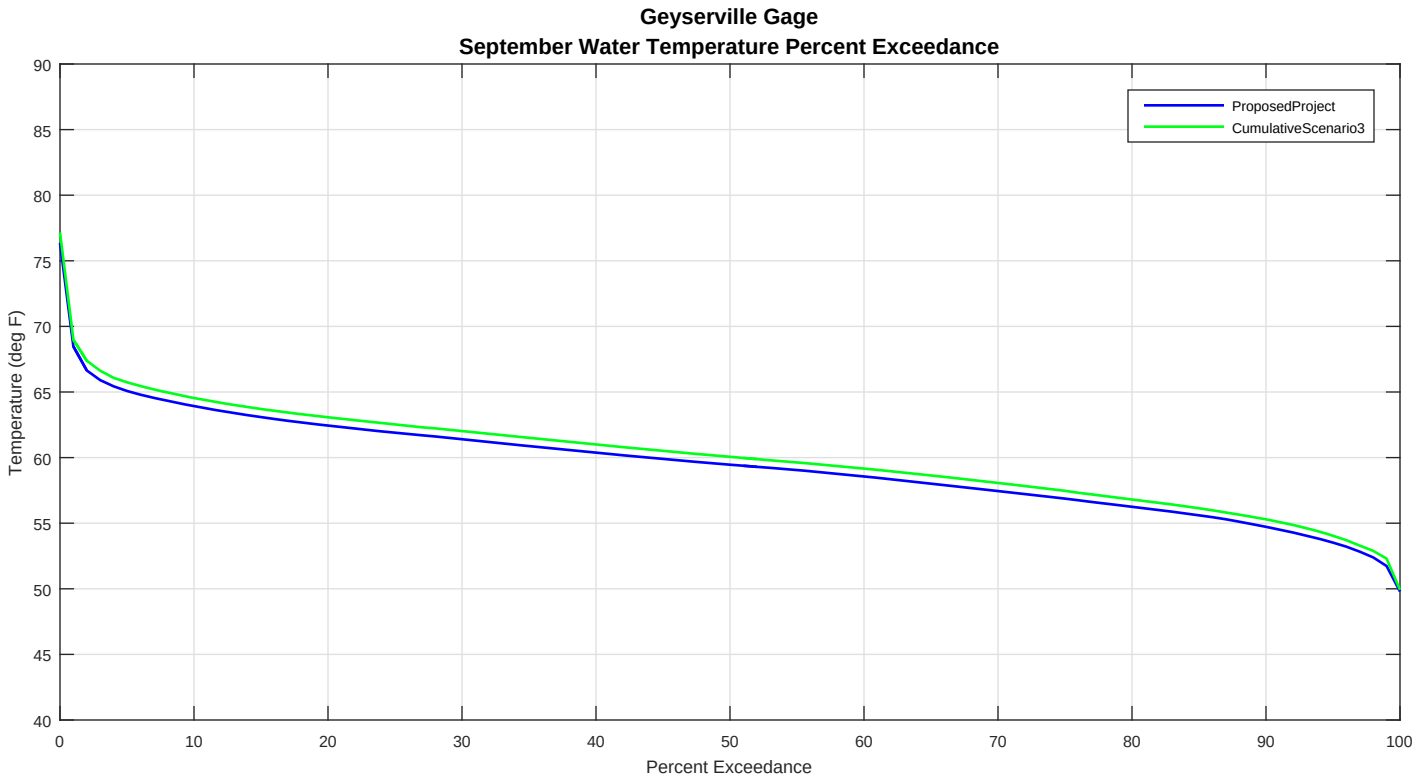
Geyserville Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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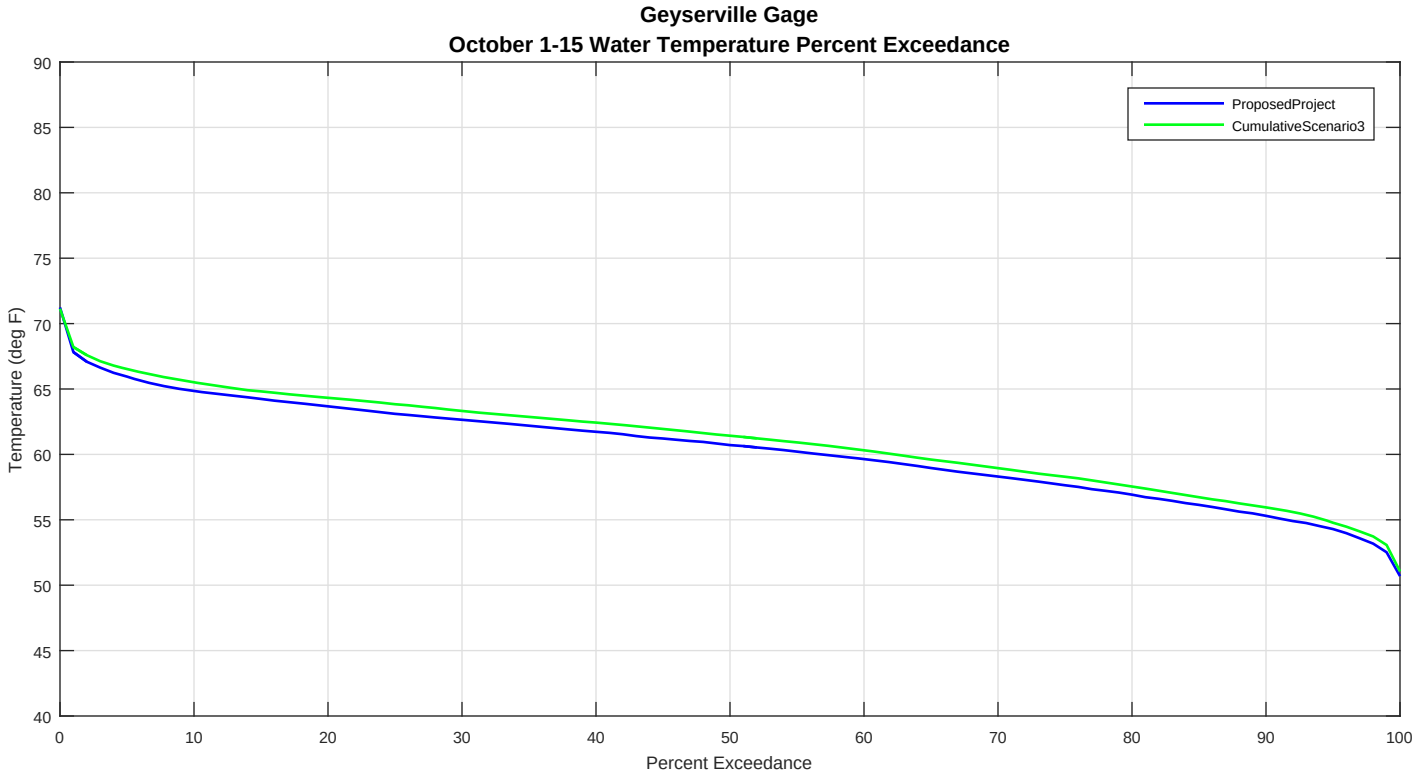
Geyserville Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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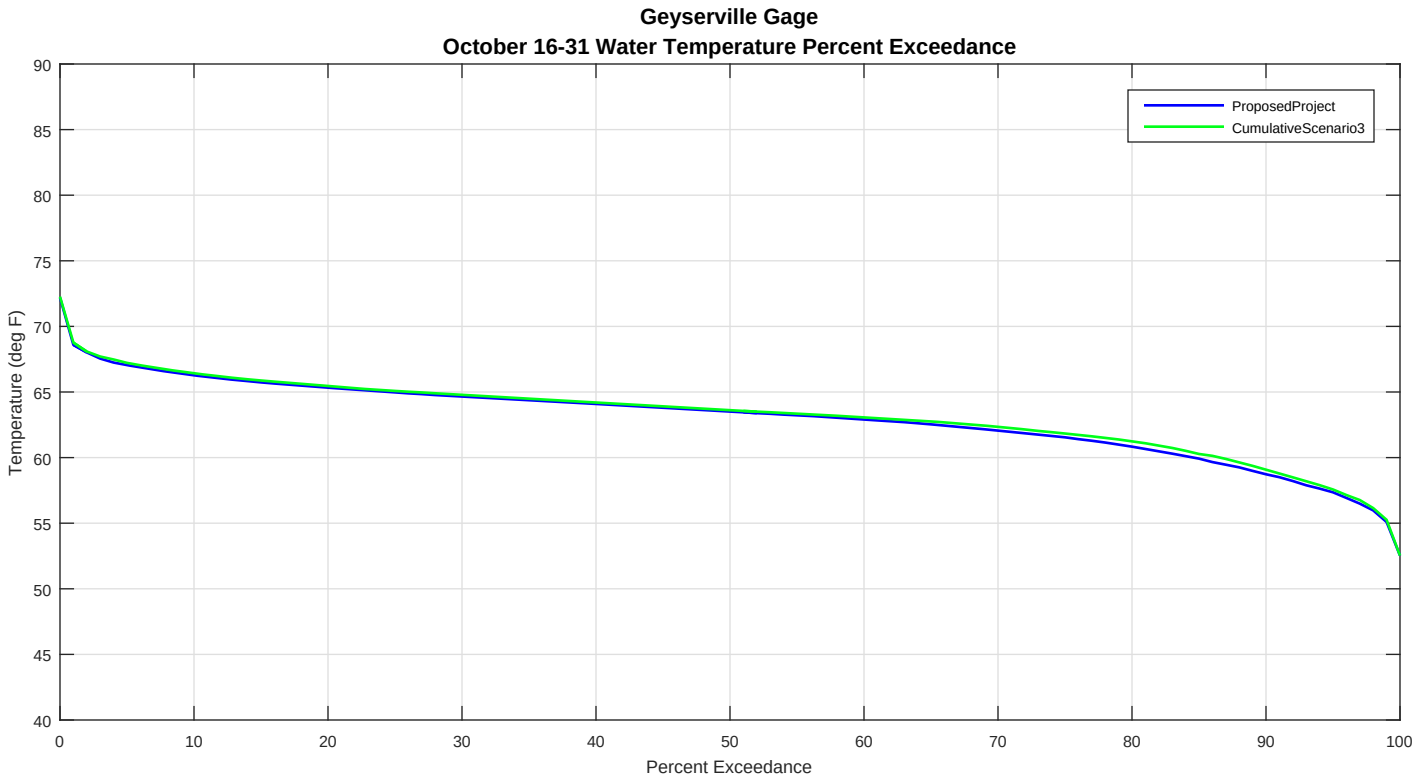
Geyserville Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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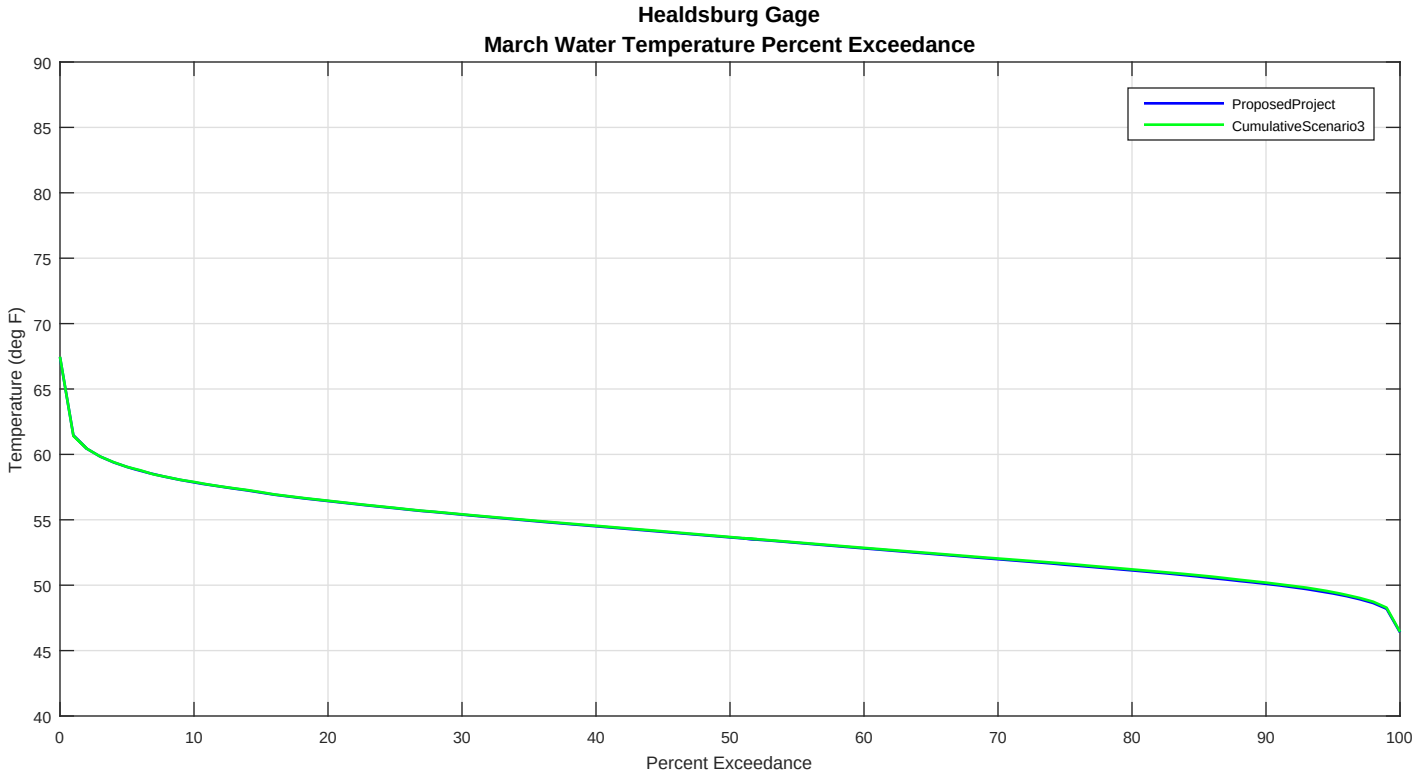
Healdsburg Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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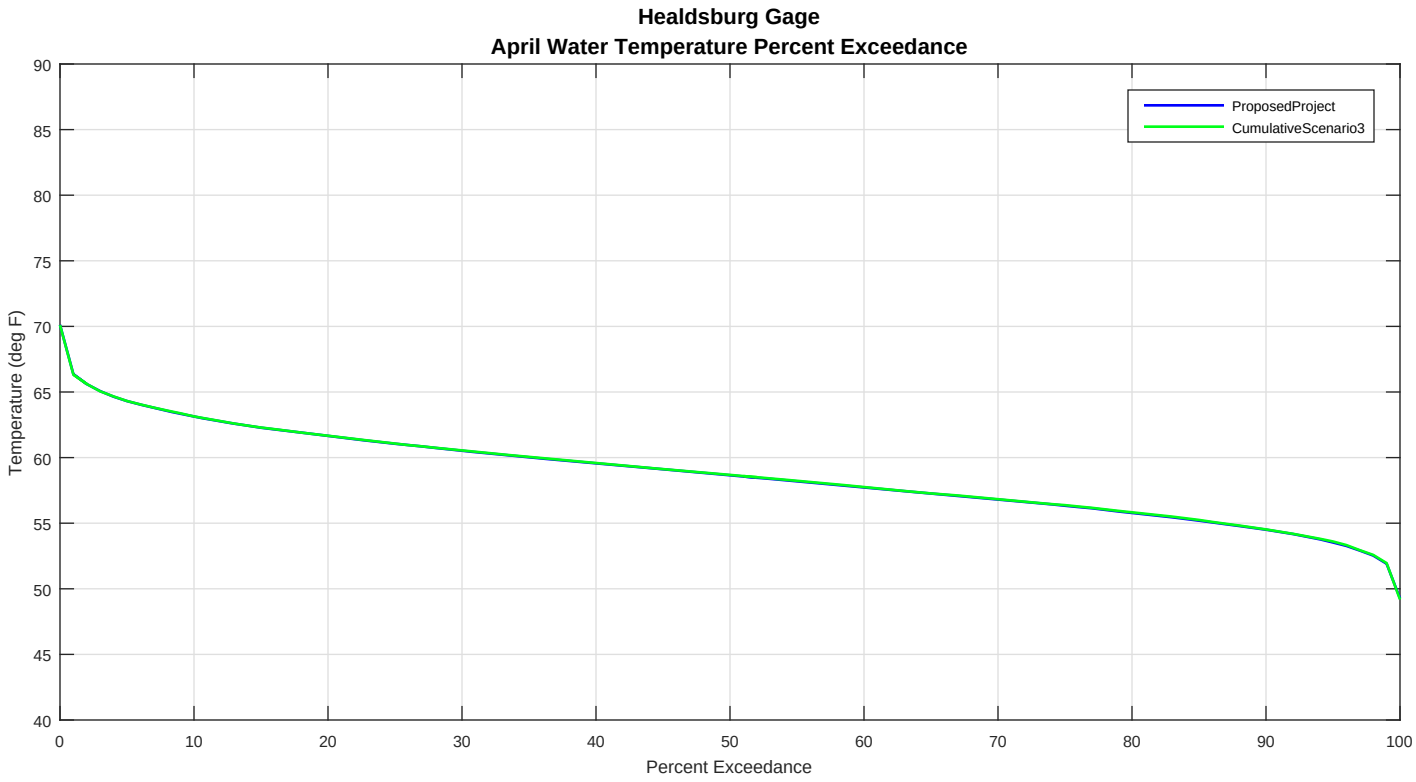
Healdsburg Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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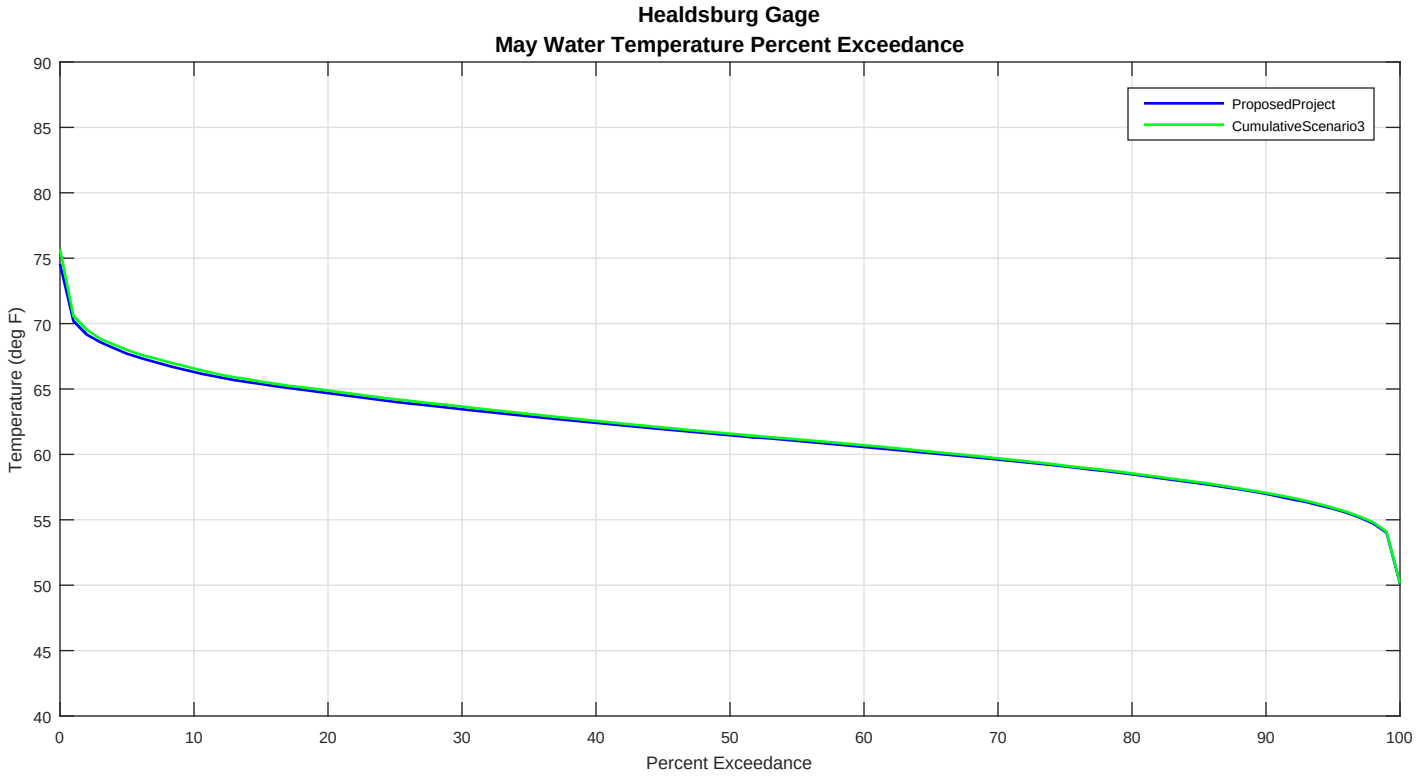
Healdsburg Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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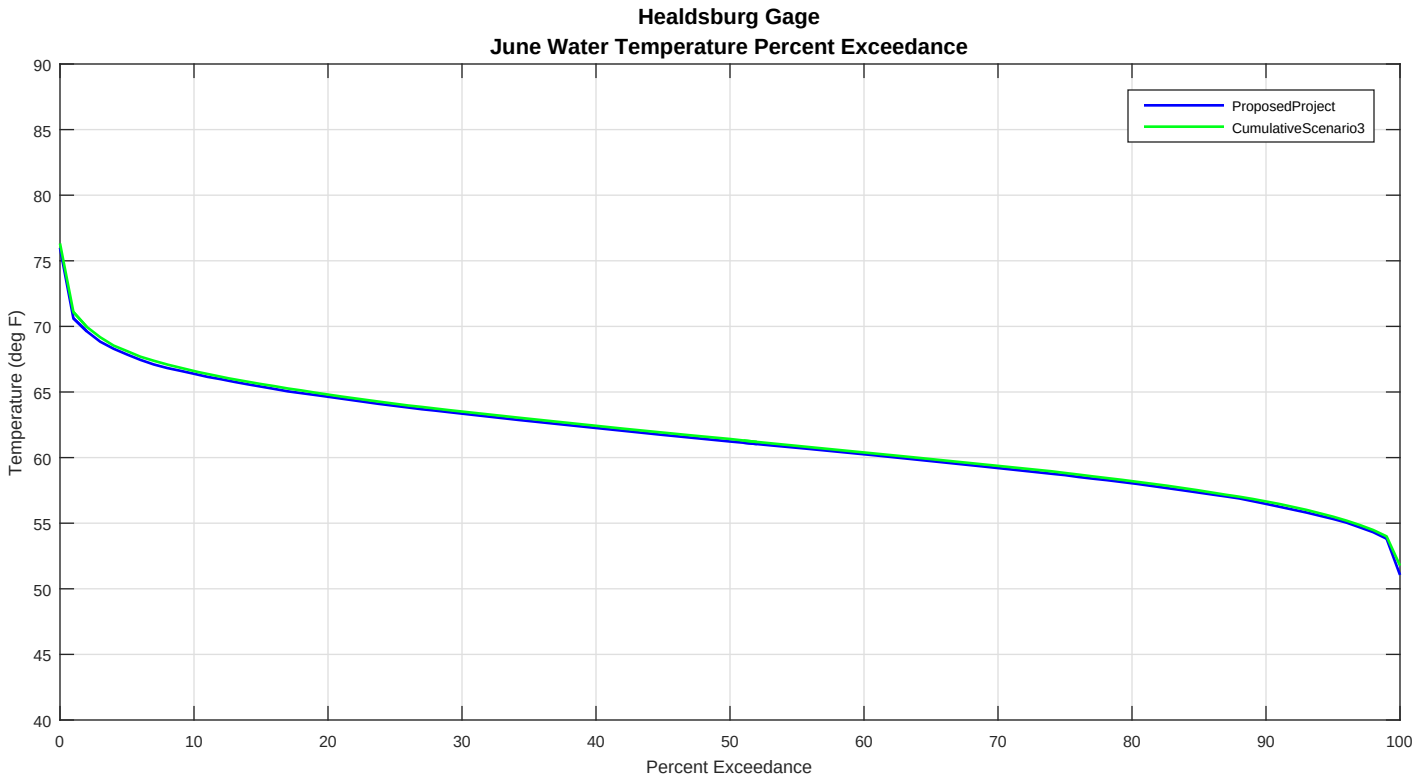
Healdsburg Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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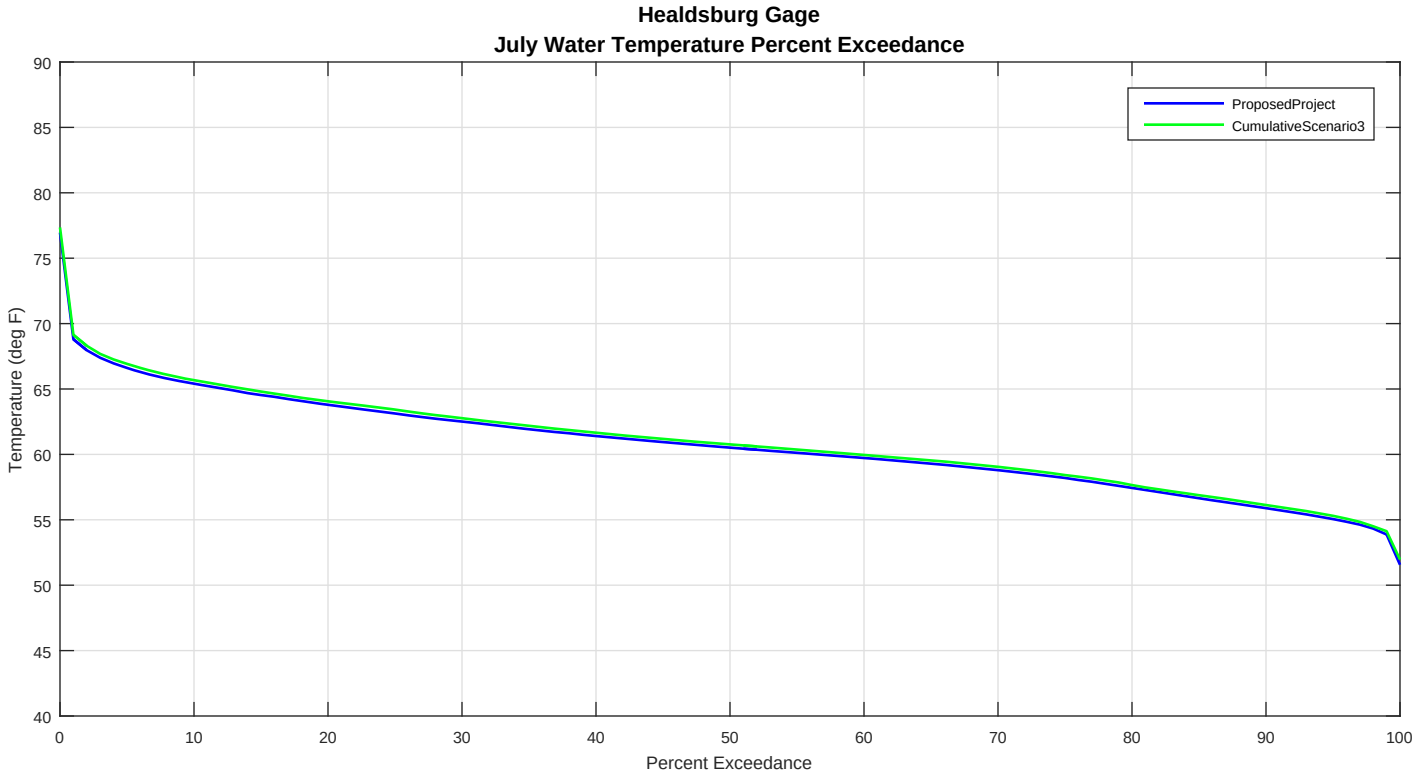
Healdsburg Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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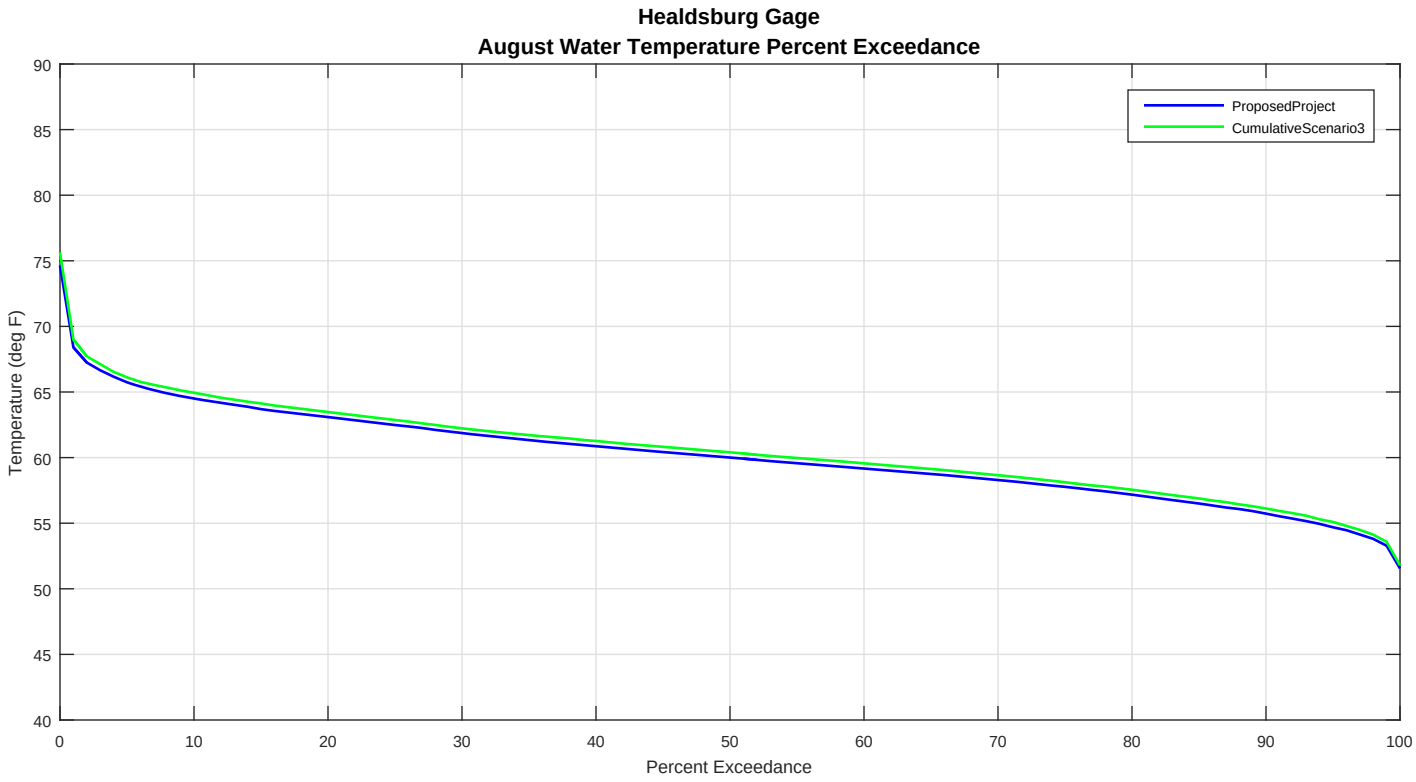
Healdsburg Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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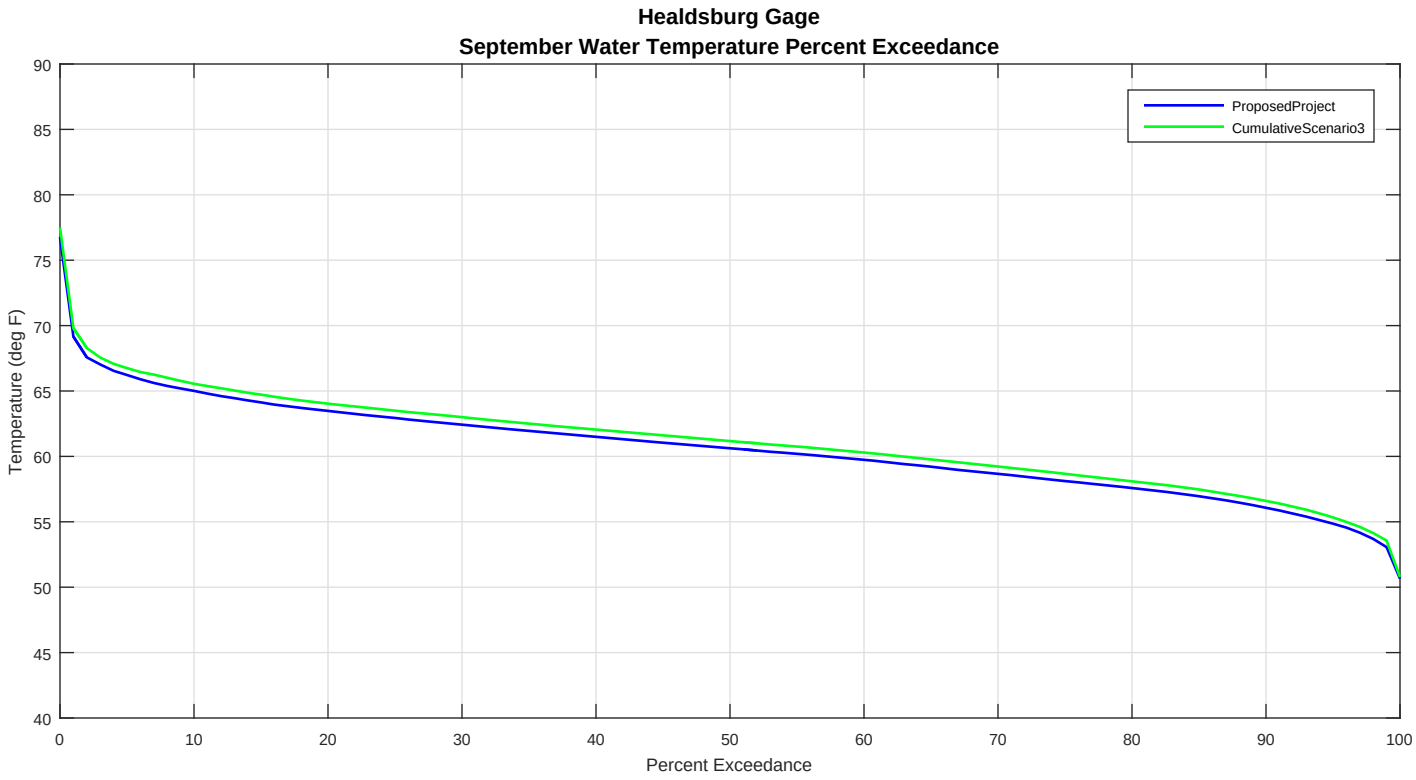
Healdsburg Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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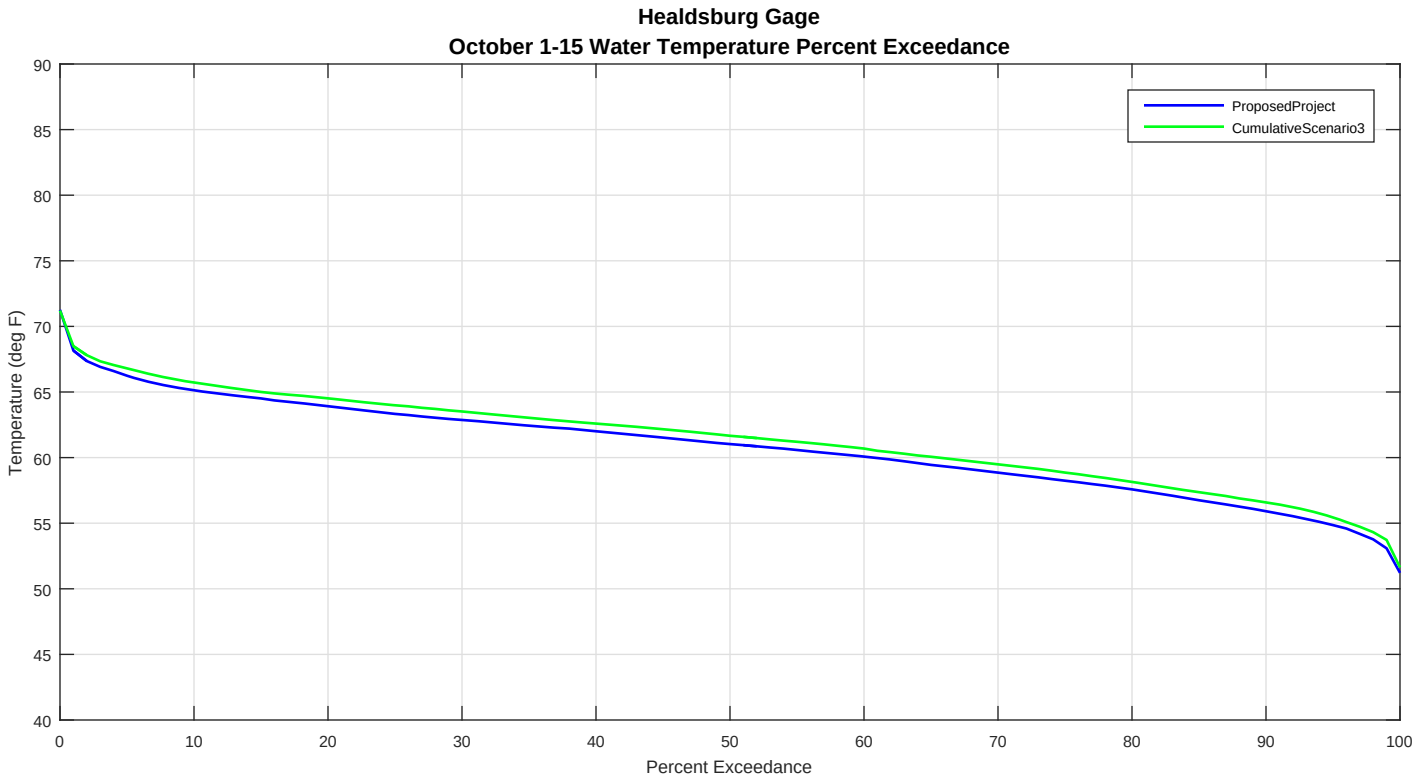
Healdsburg Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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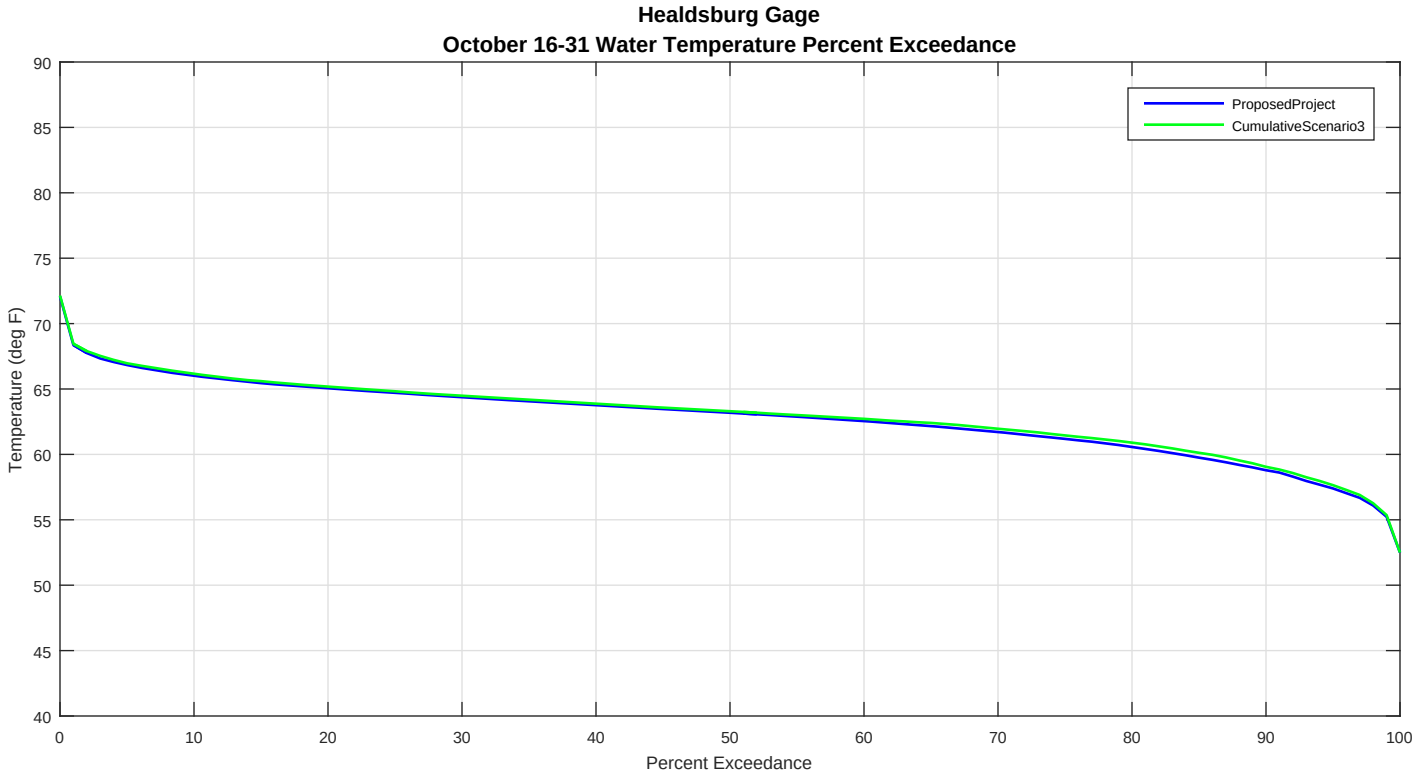
Healdsburg Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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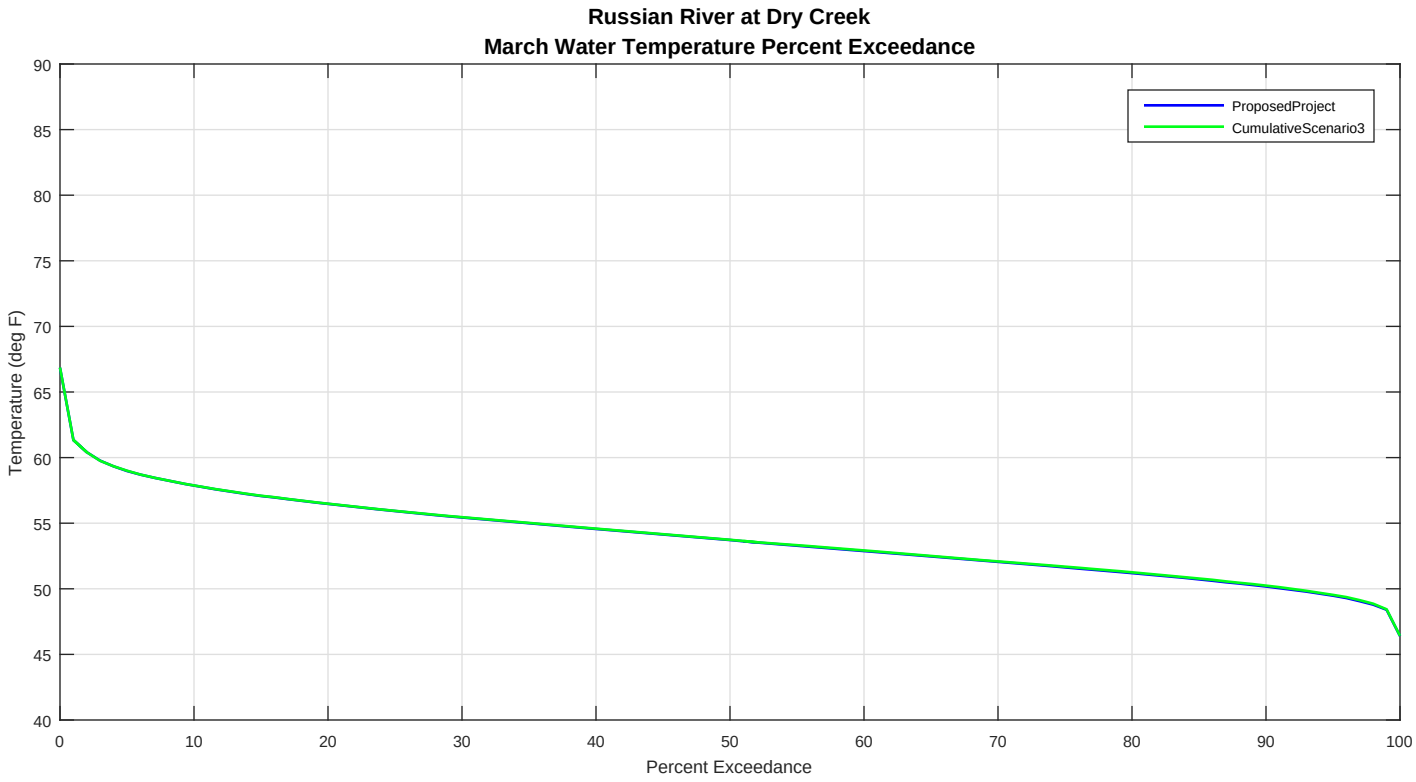
Russian River at Dry Creek
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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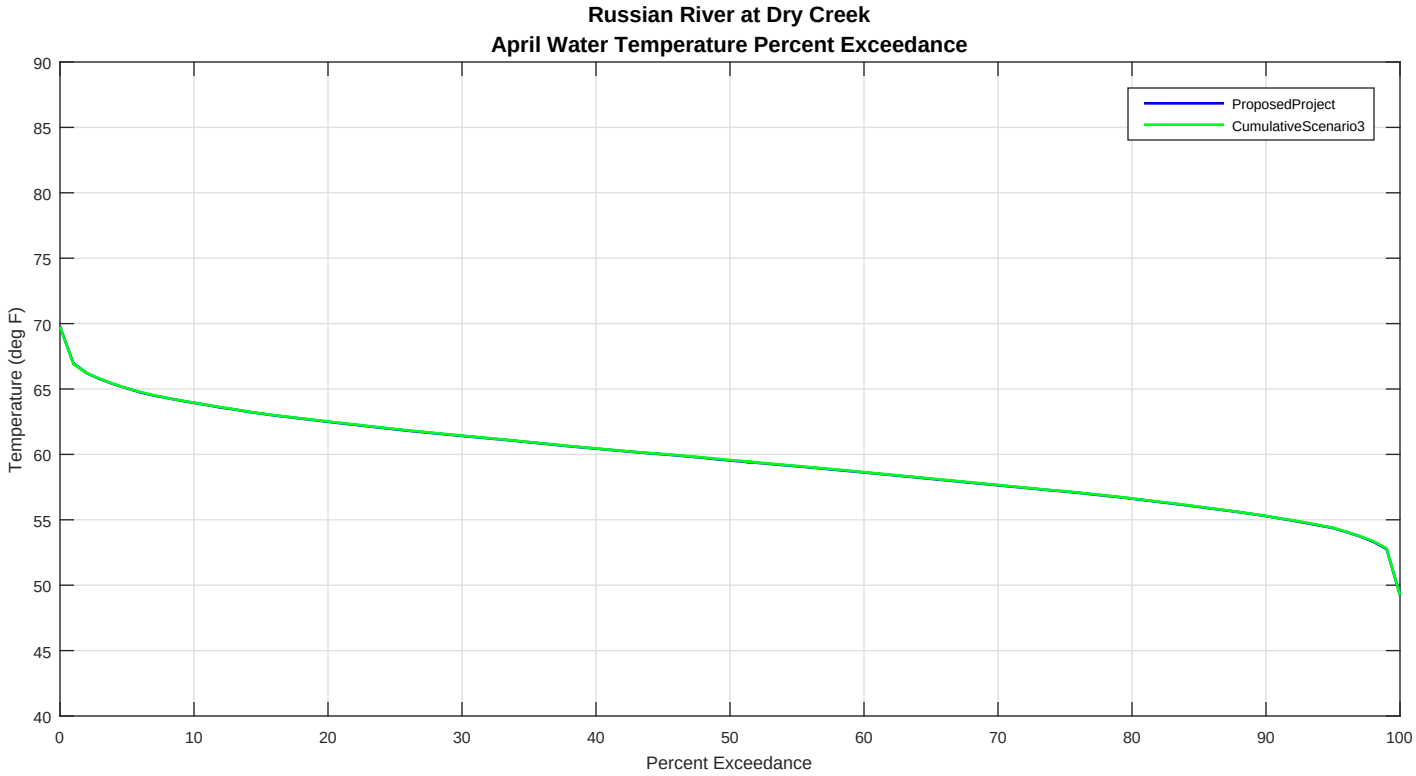
Russian River at Dry Creek
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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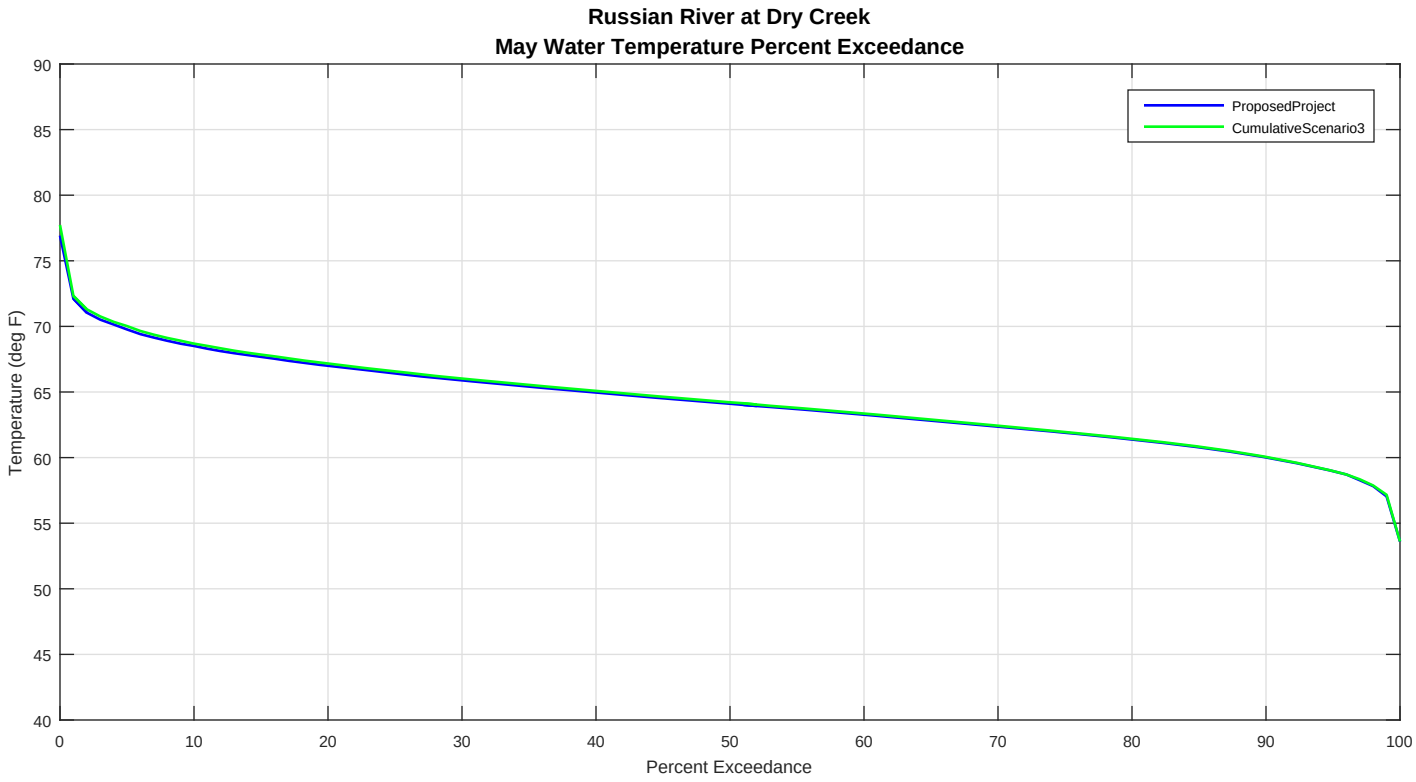
Russian River at Dry Creek
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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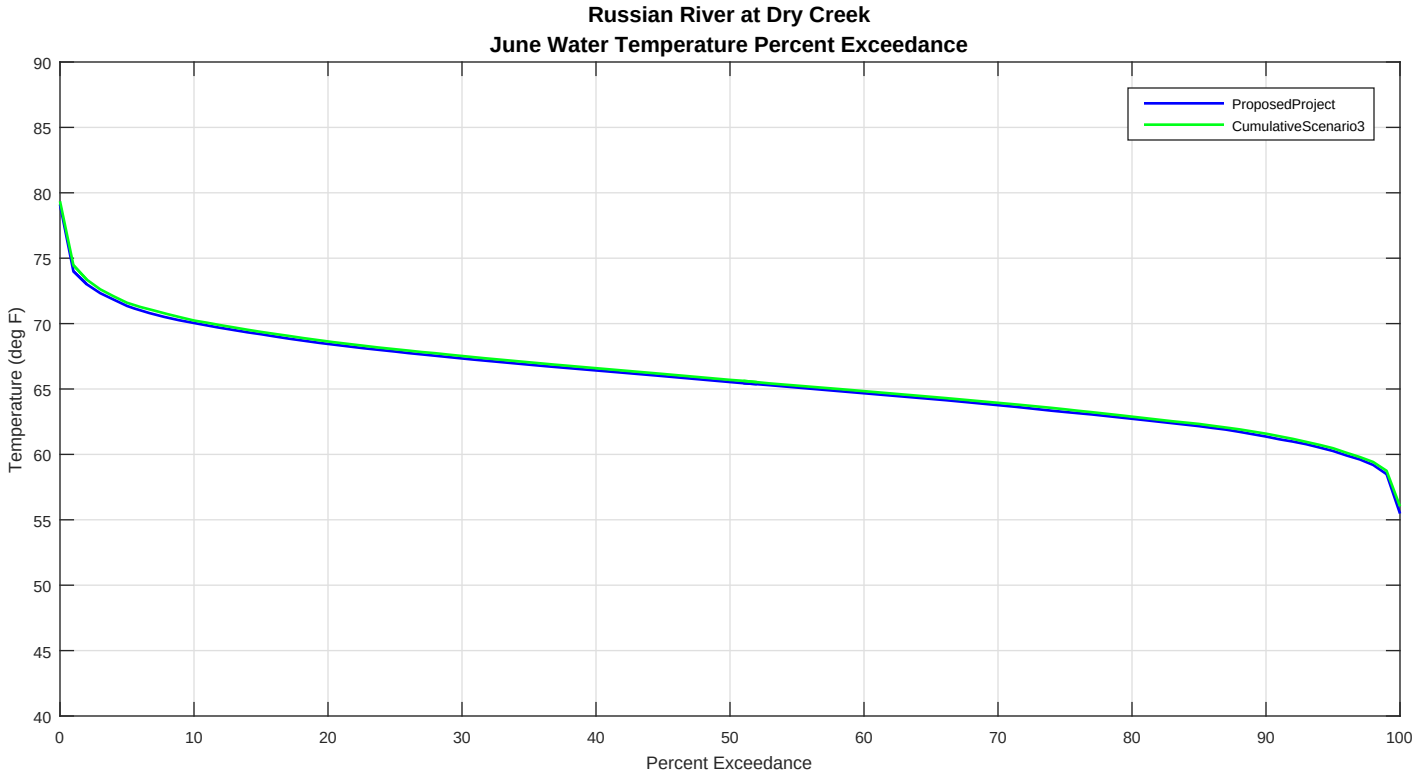
Russian River at Dry Creek
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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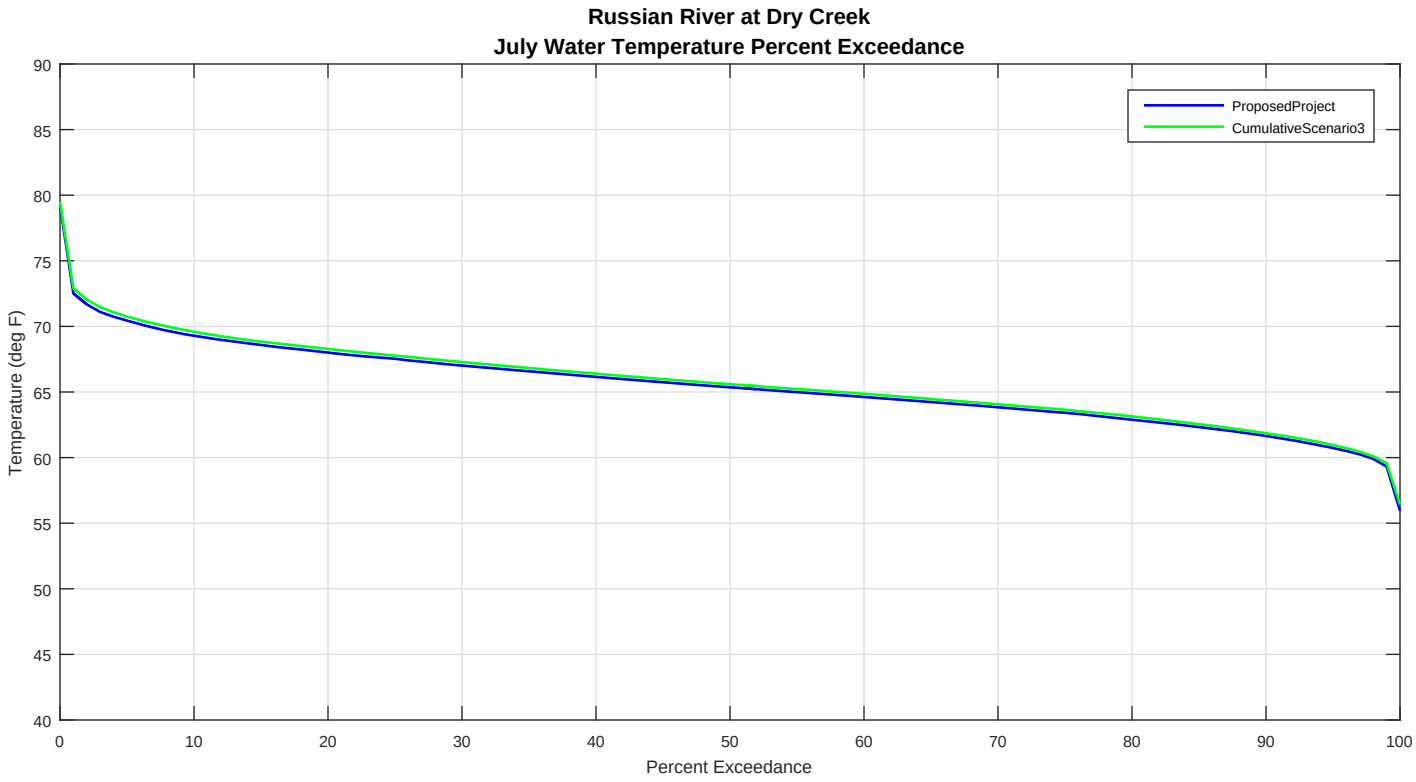
Russian River at Dry Creek
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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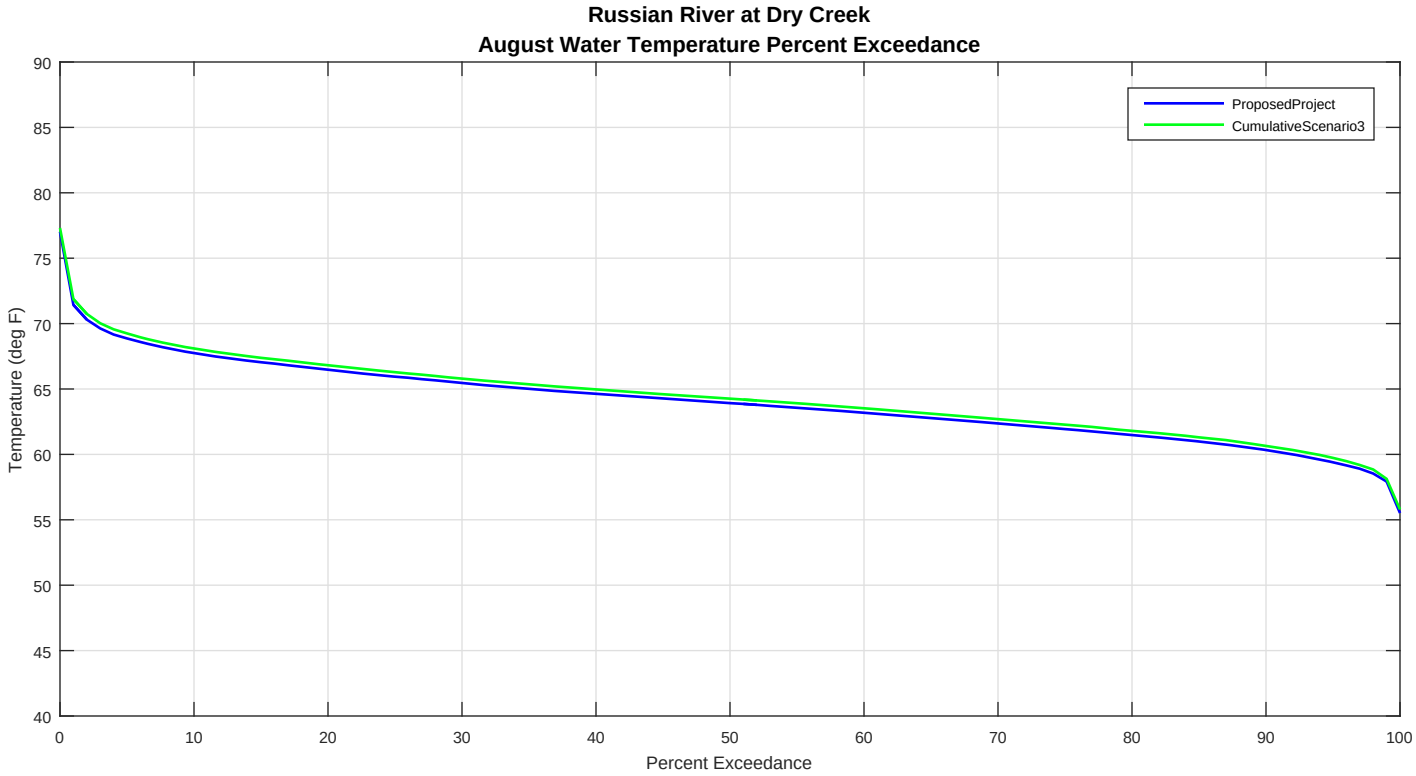
Russian River at Dry Creek
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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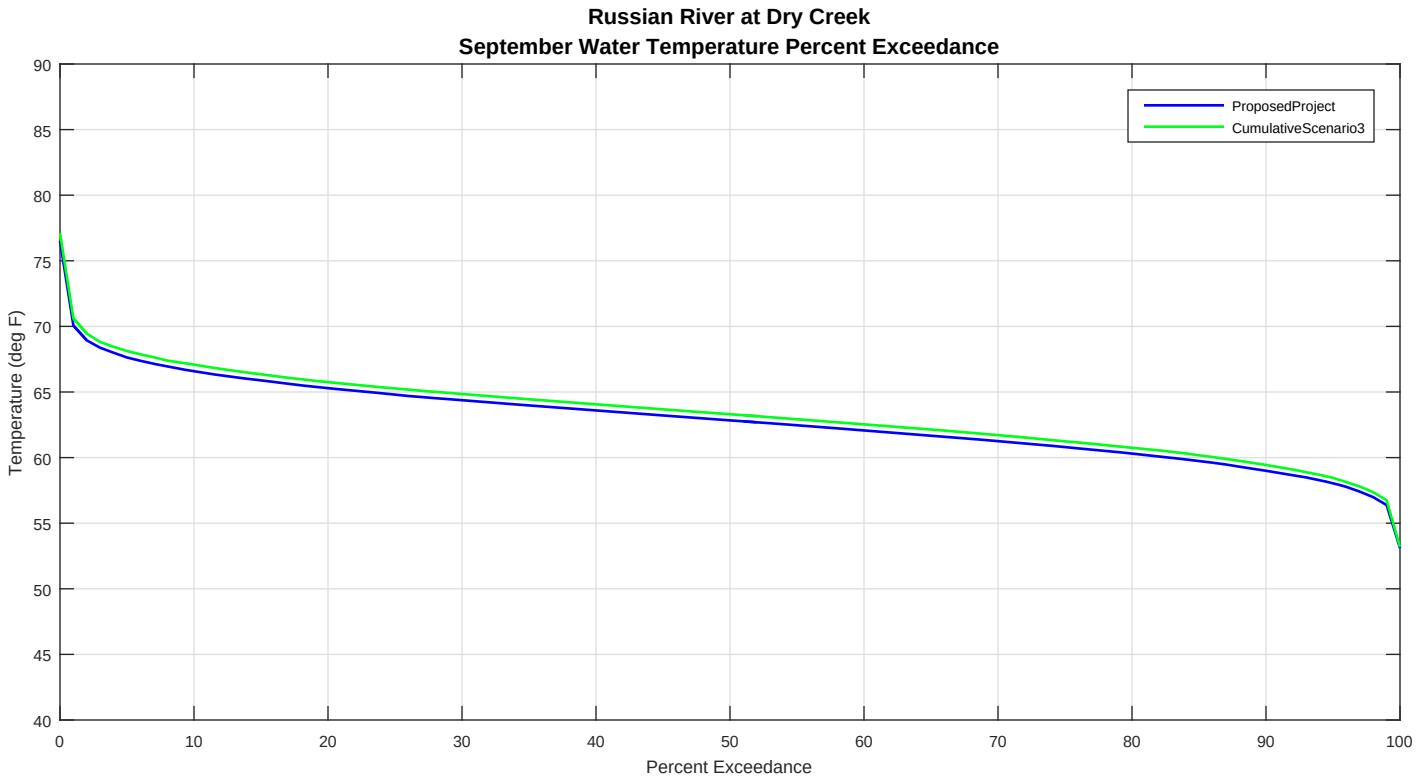
Russian River at Dry Creek
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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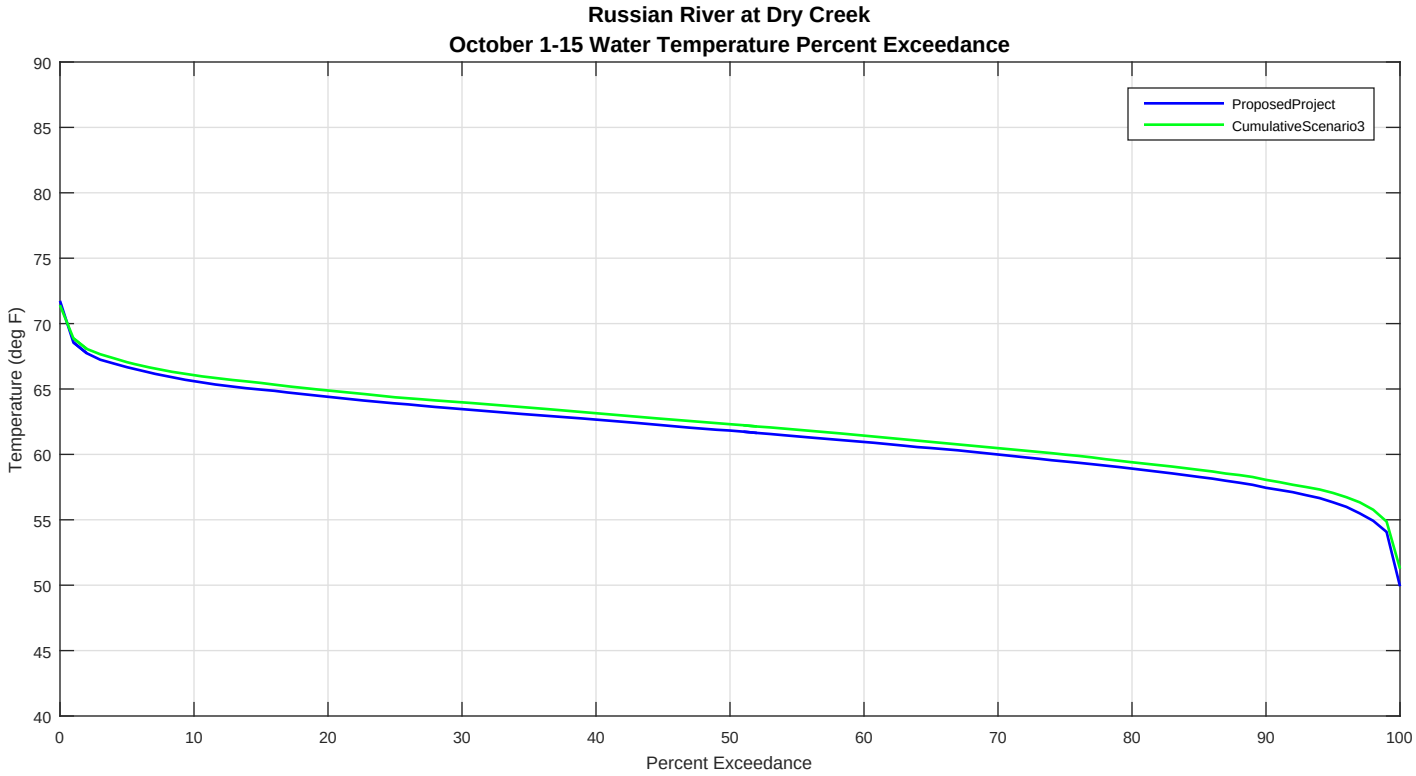
Russian River at Dry Creek
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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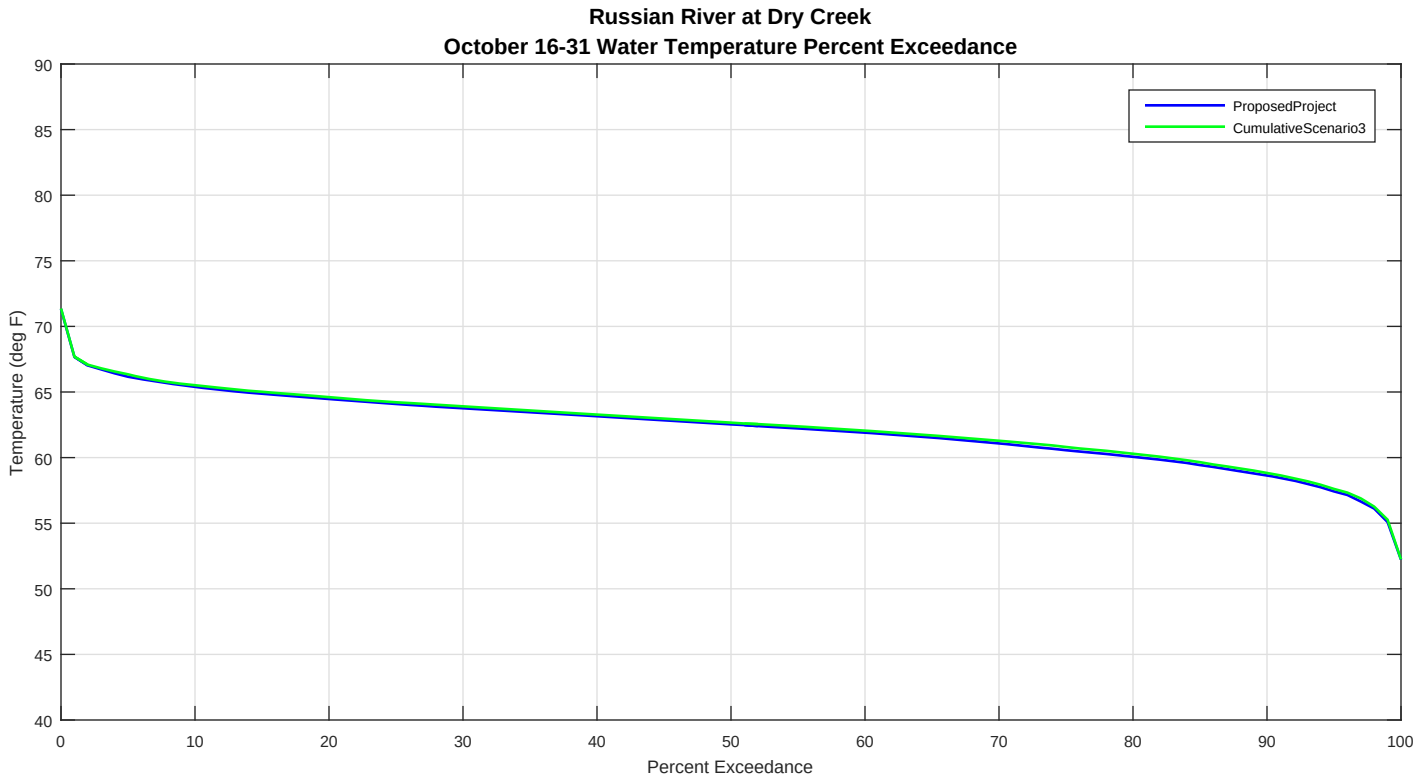
Russian River at Dry Creek
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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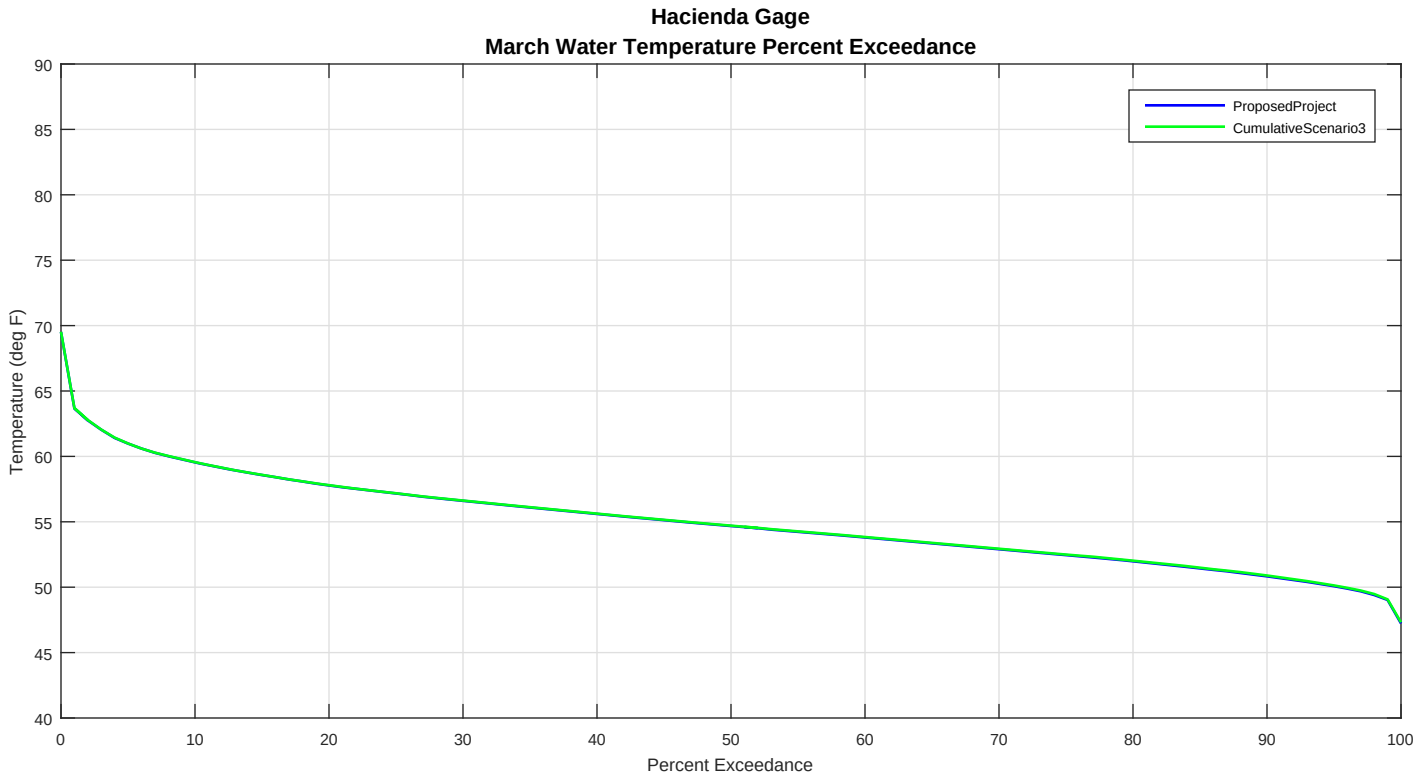
Hacienda Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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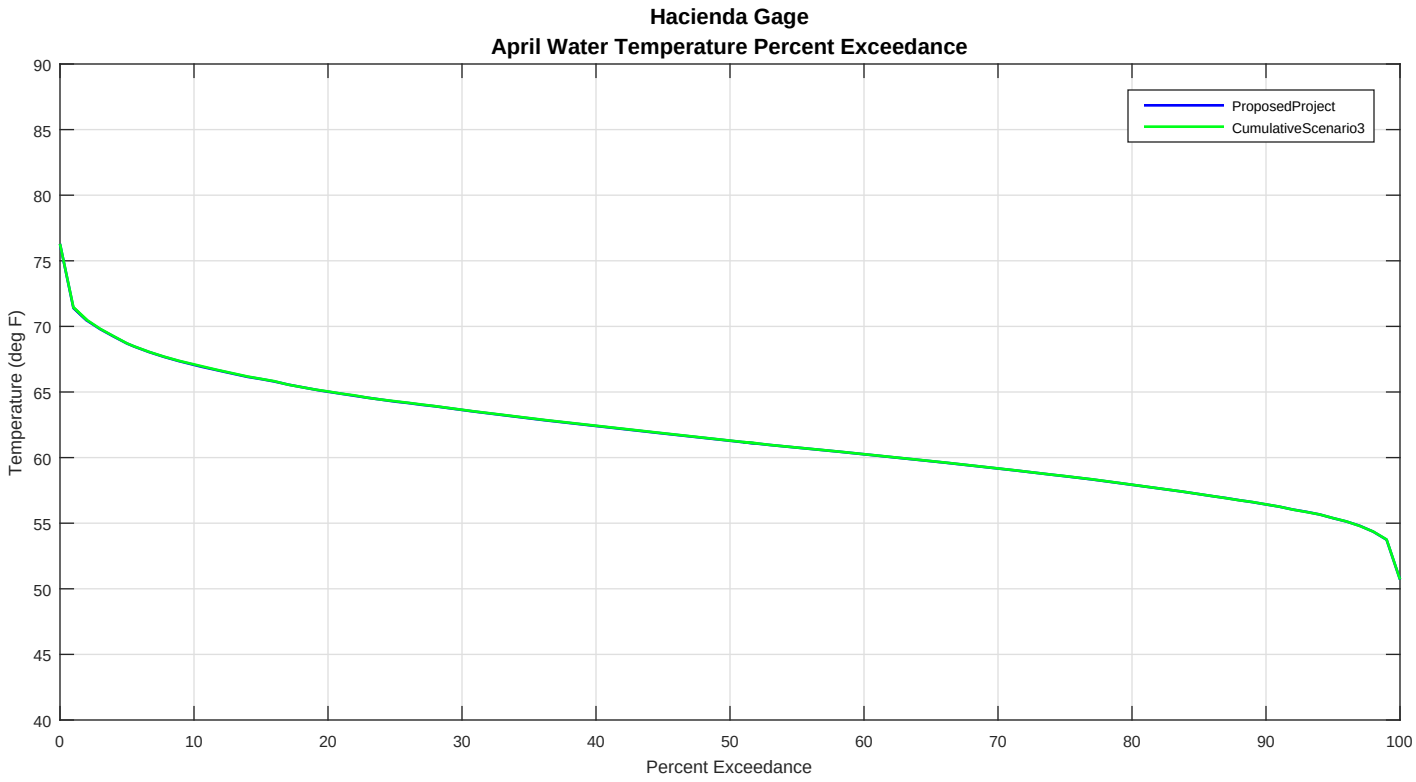
Hacienda Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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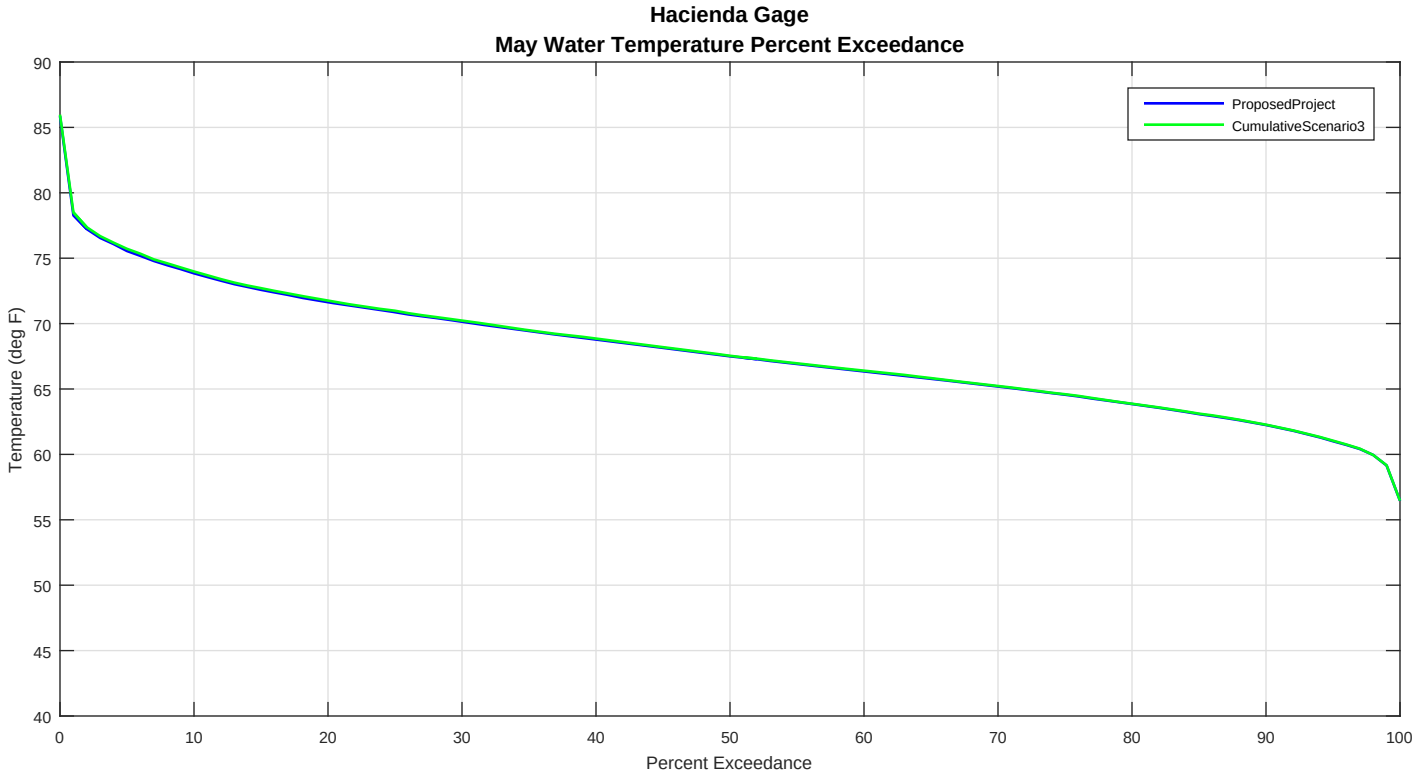
Hacienda Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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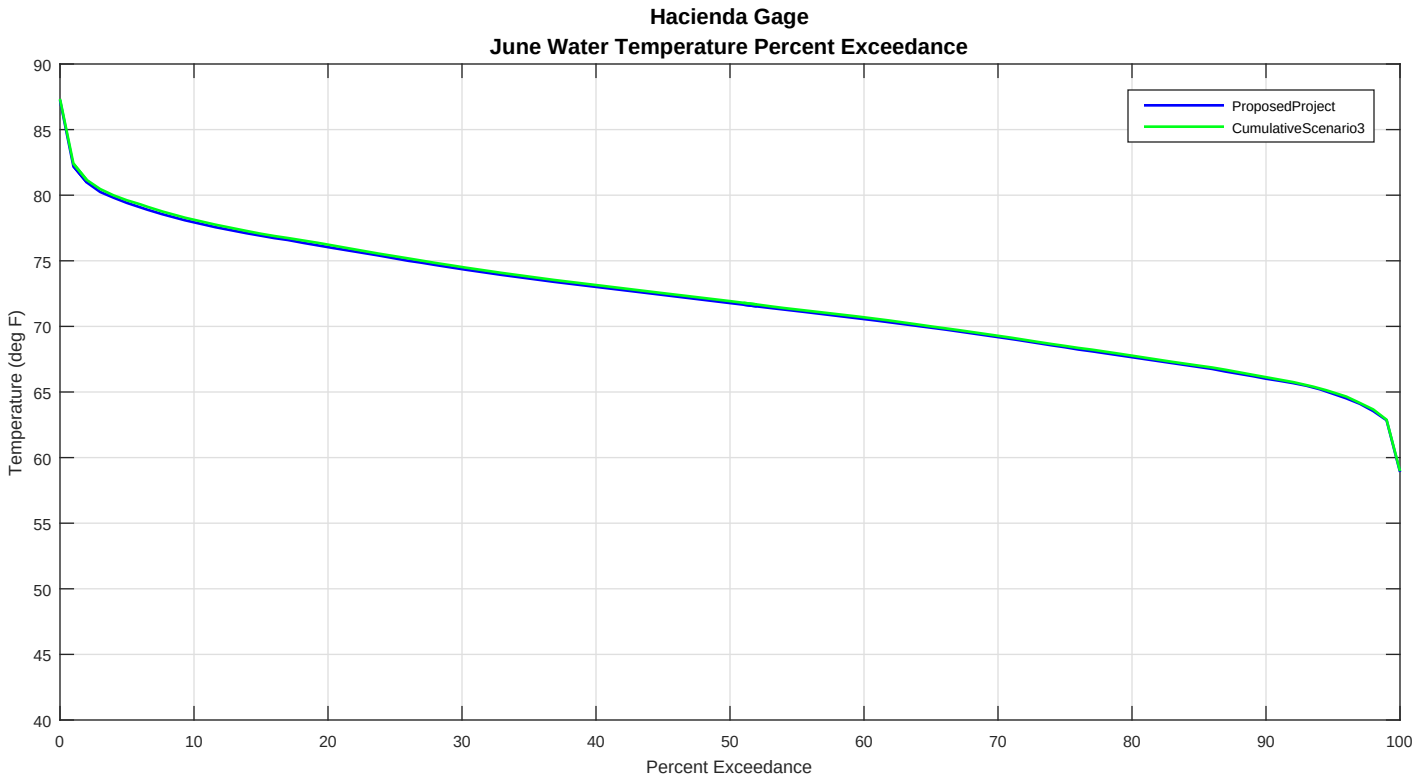
Hacienda Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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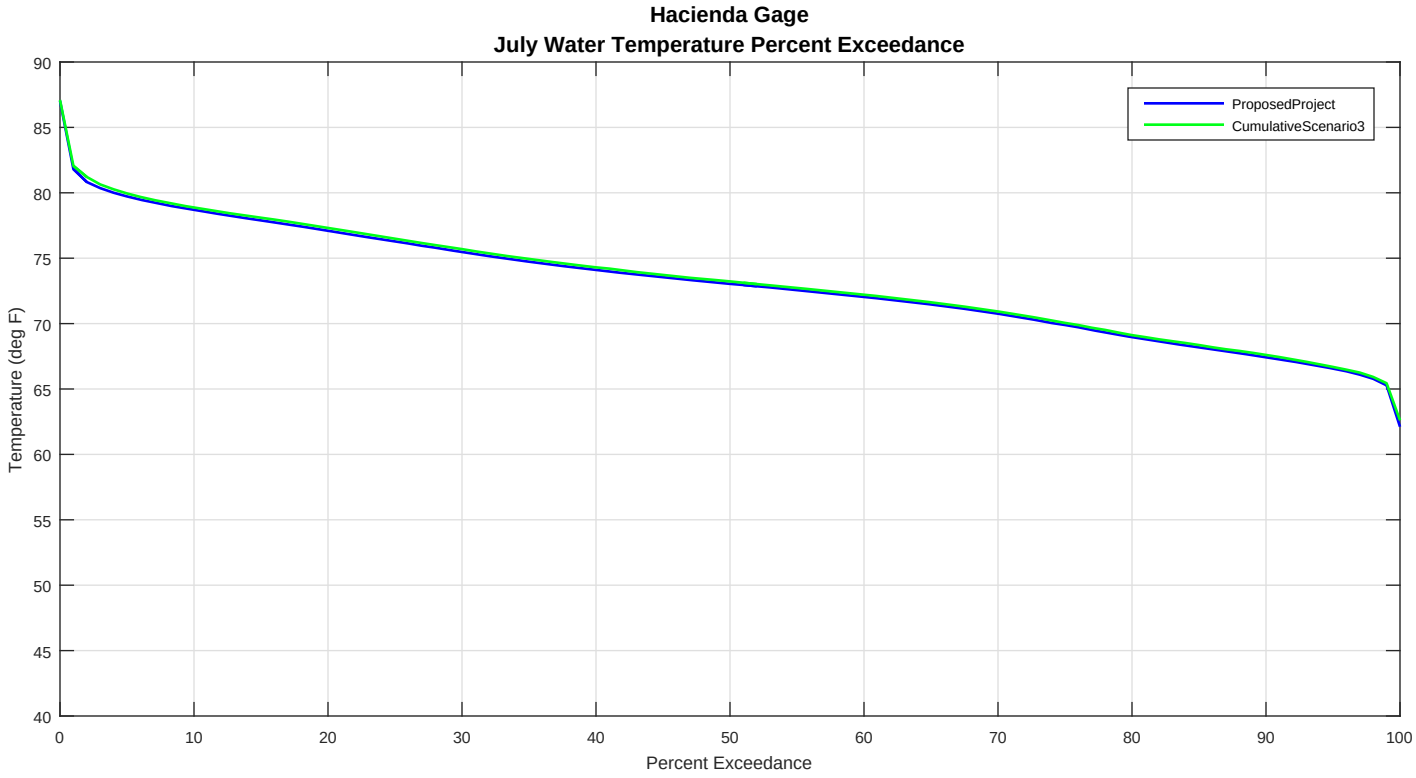
Hacienda Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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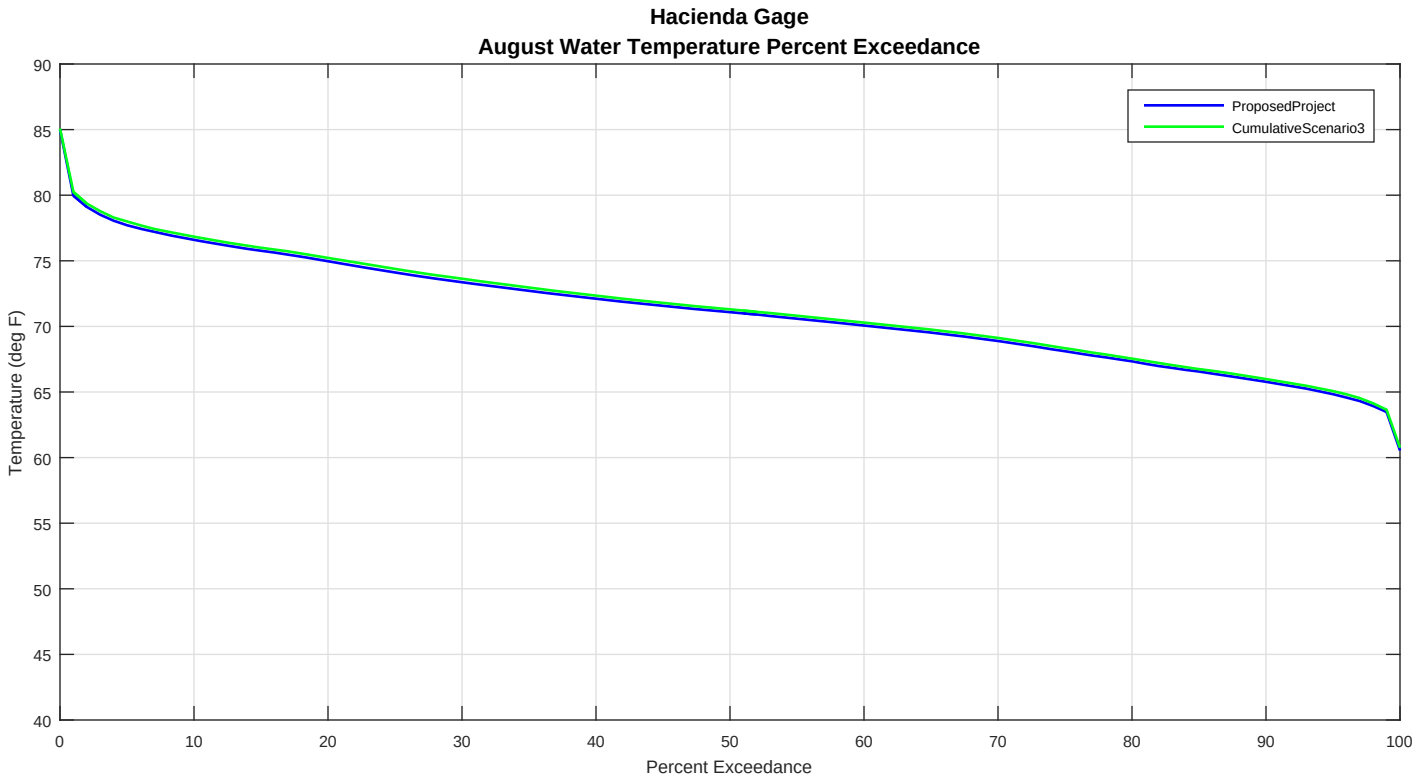
Hacienda Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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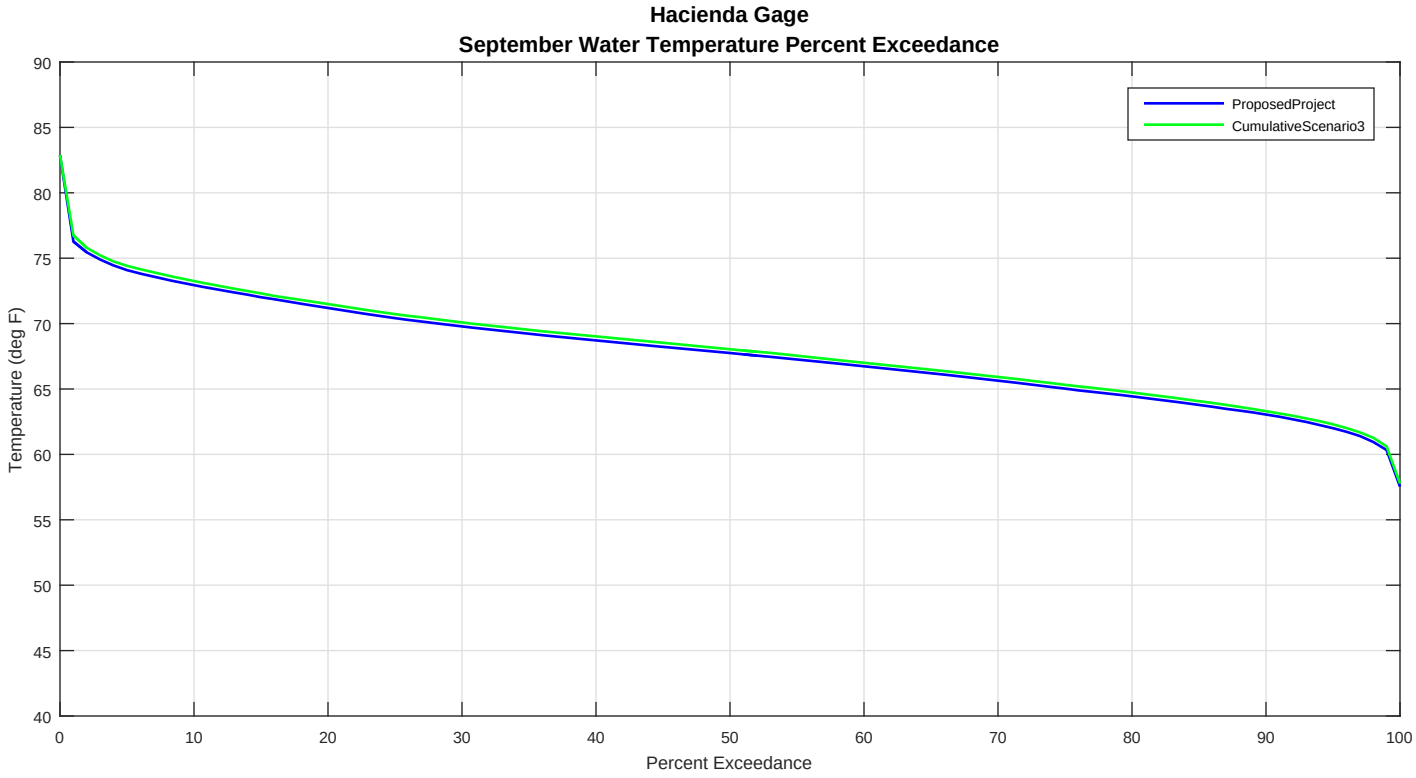
Hacienda Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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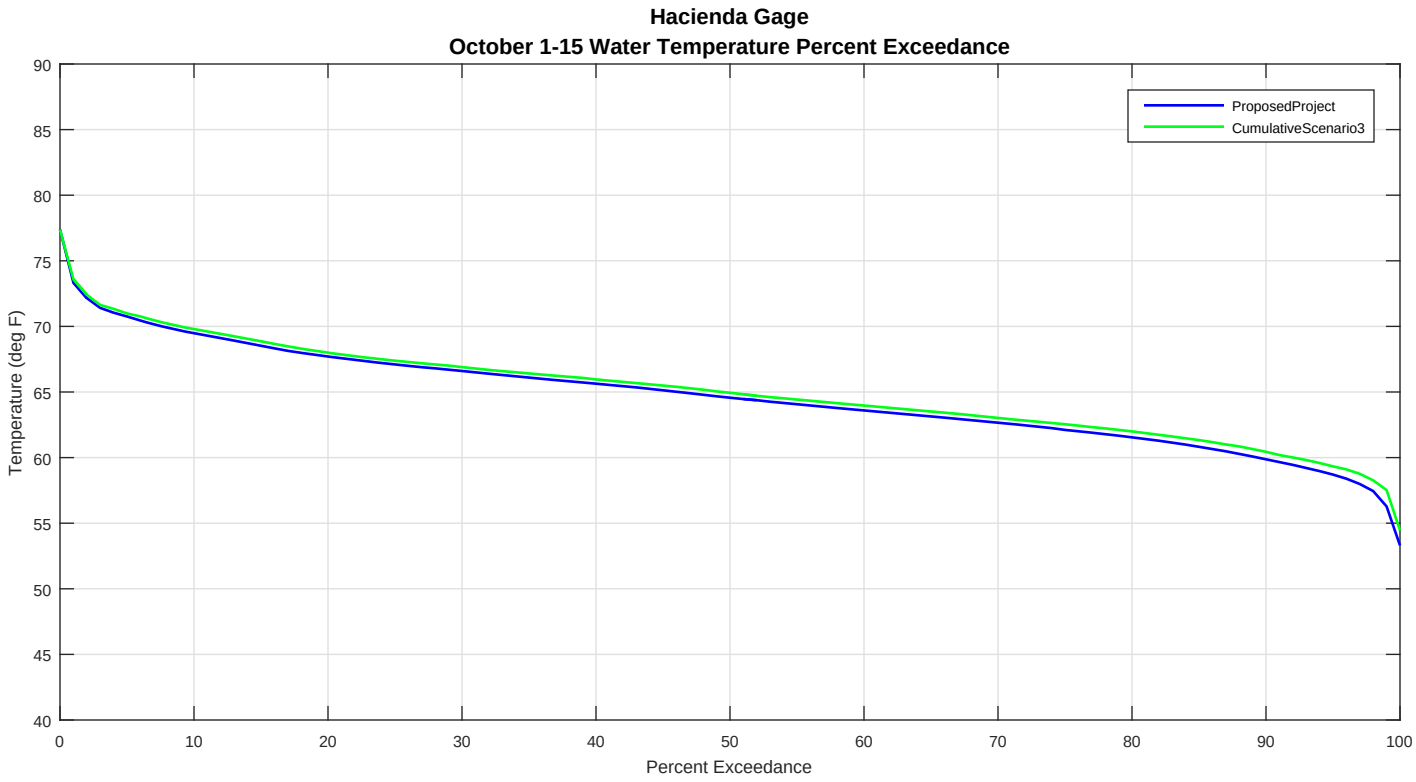
Hacienda Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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Hacienda Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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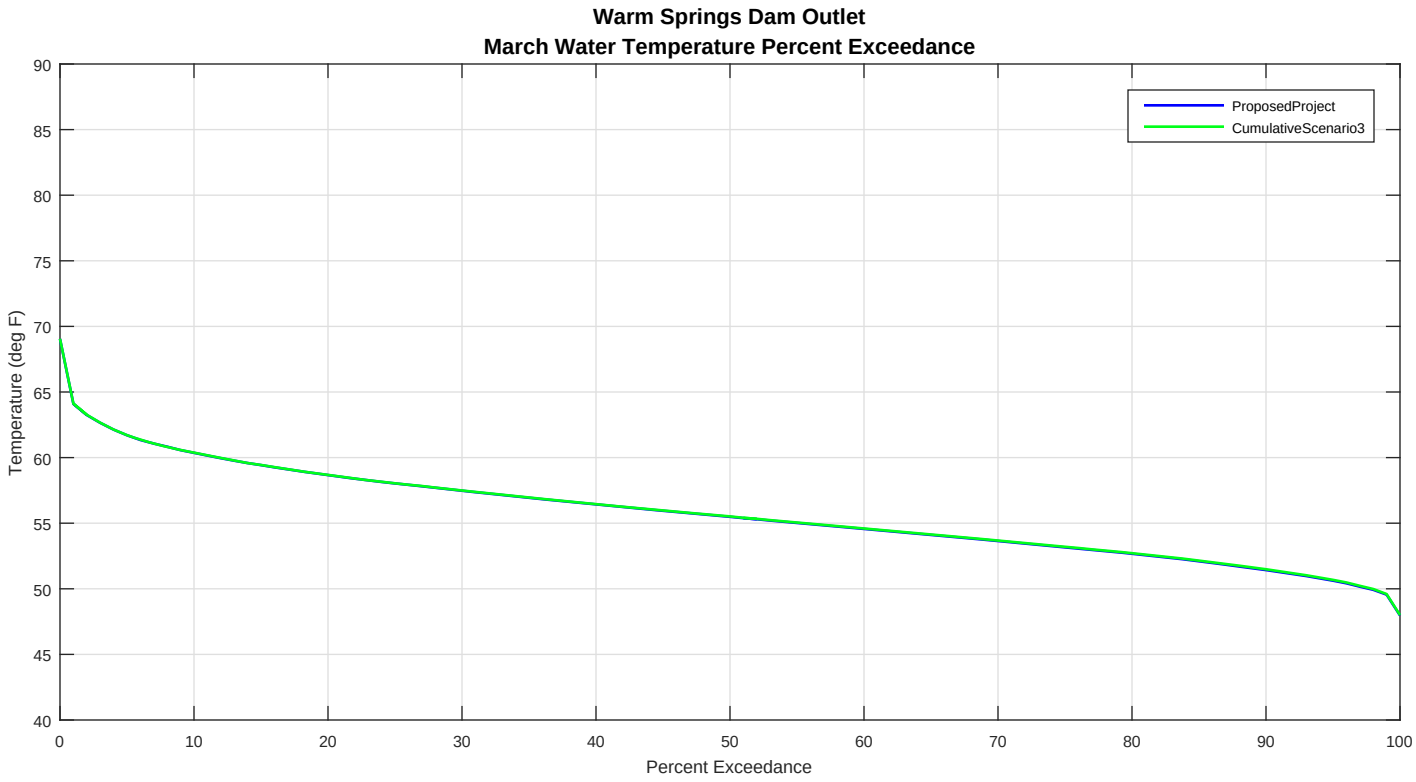
Warm Springs Dam Outlet
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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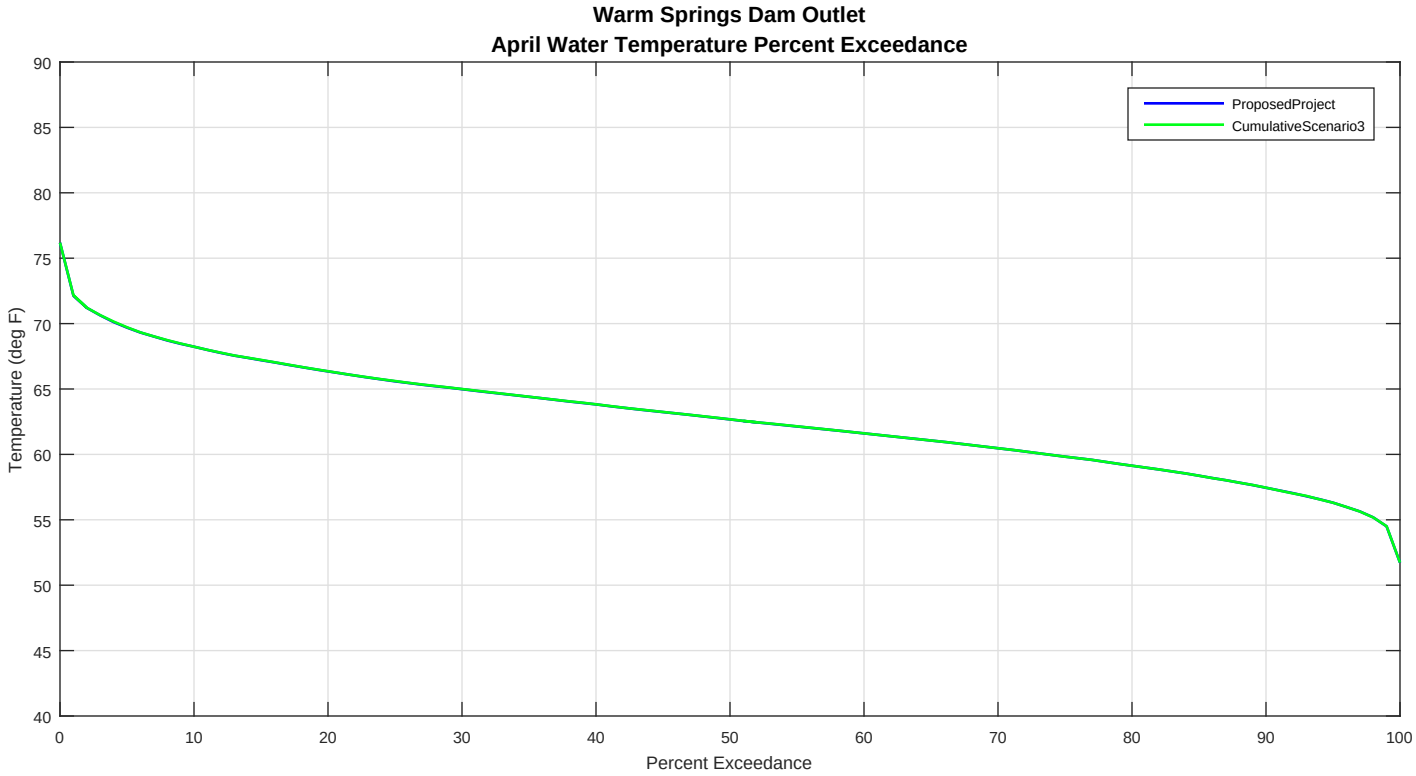
Warm Springs Dam Outlet
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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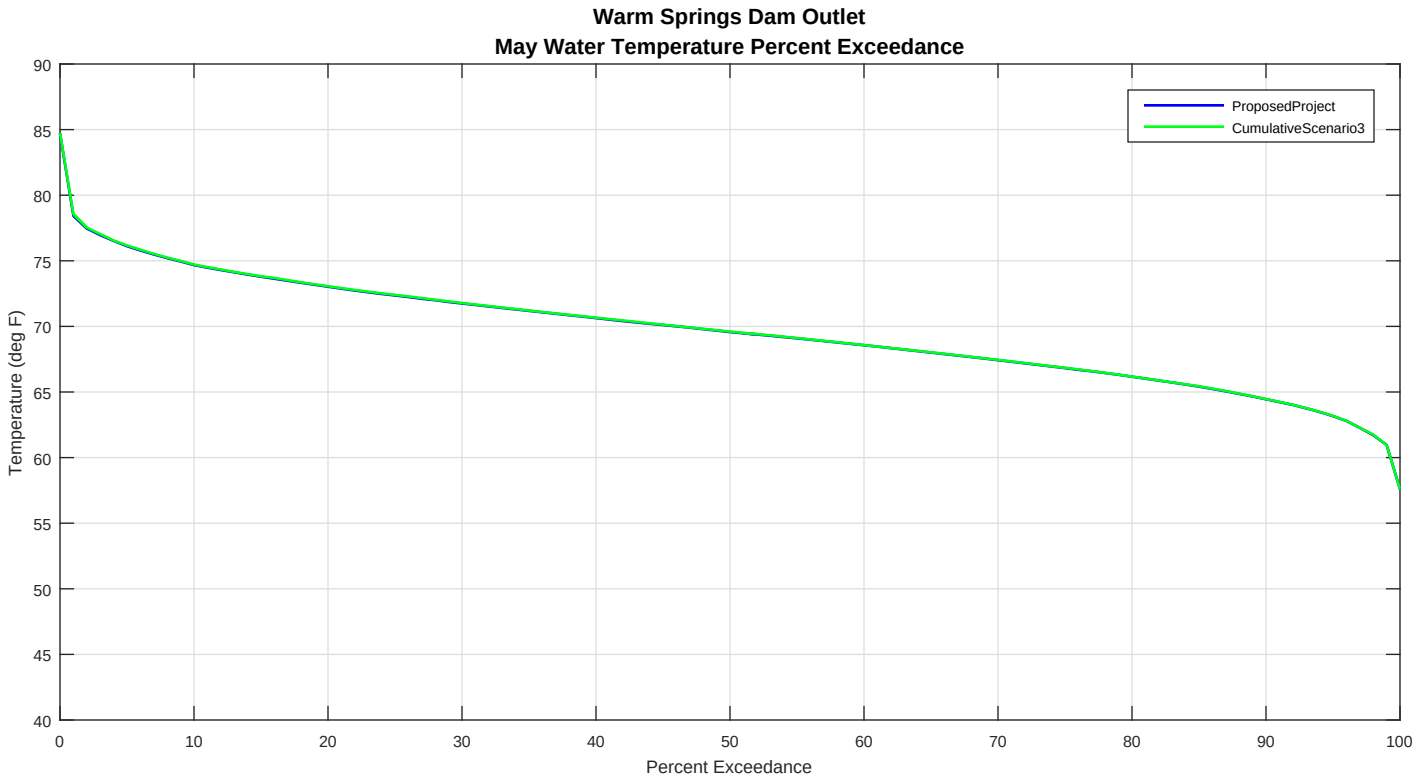
Warm Springs Dam Outlet
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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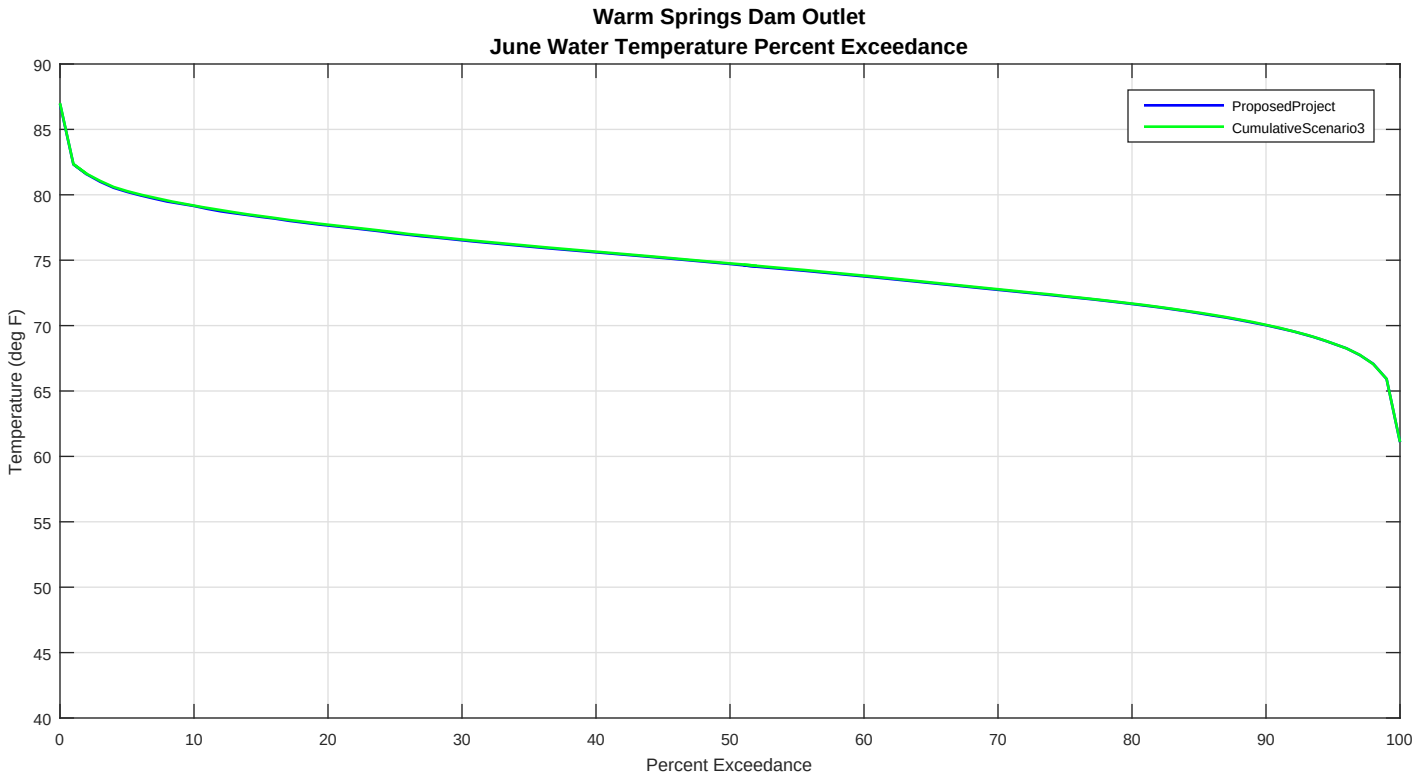
Warm Springs Dam Outlet
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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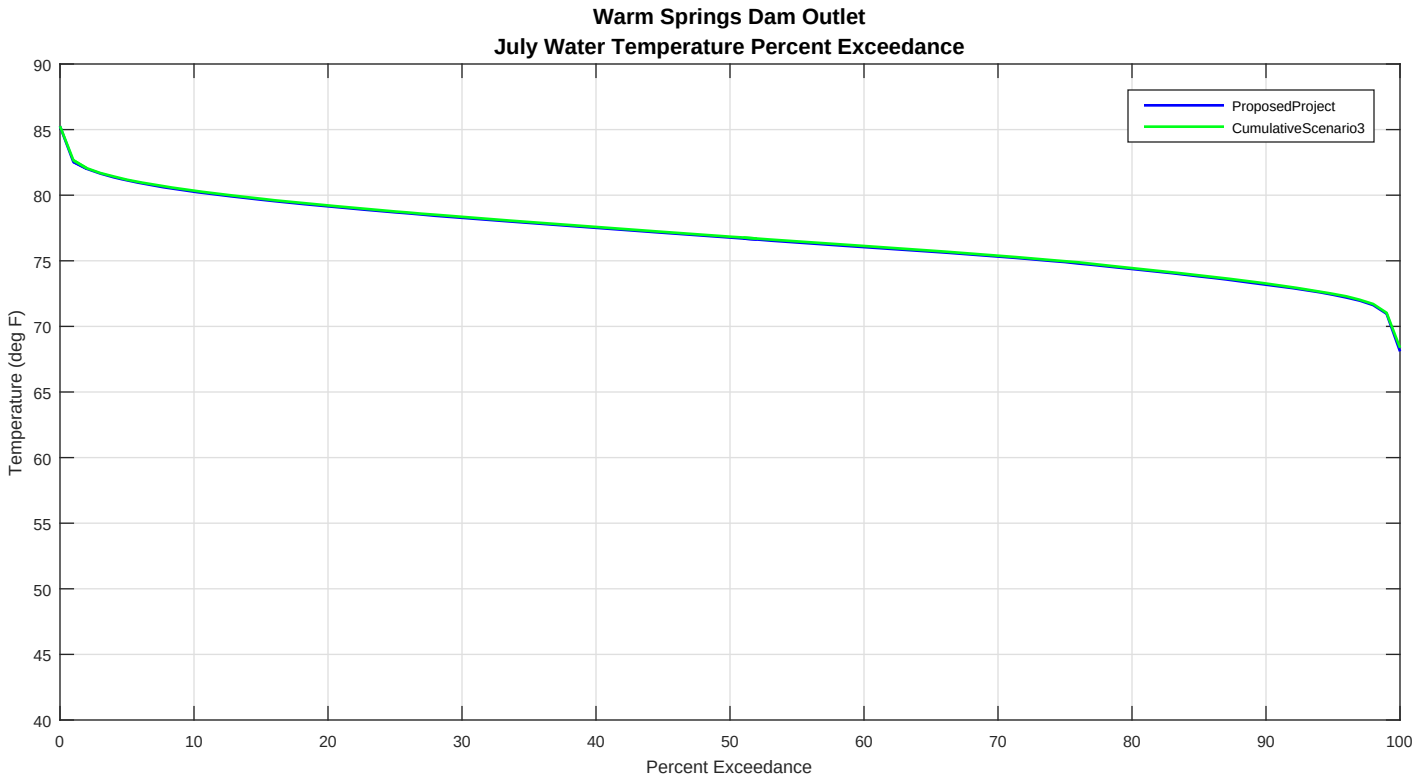
Warm Springs Dam Outlet
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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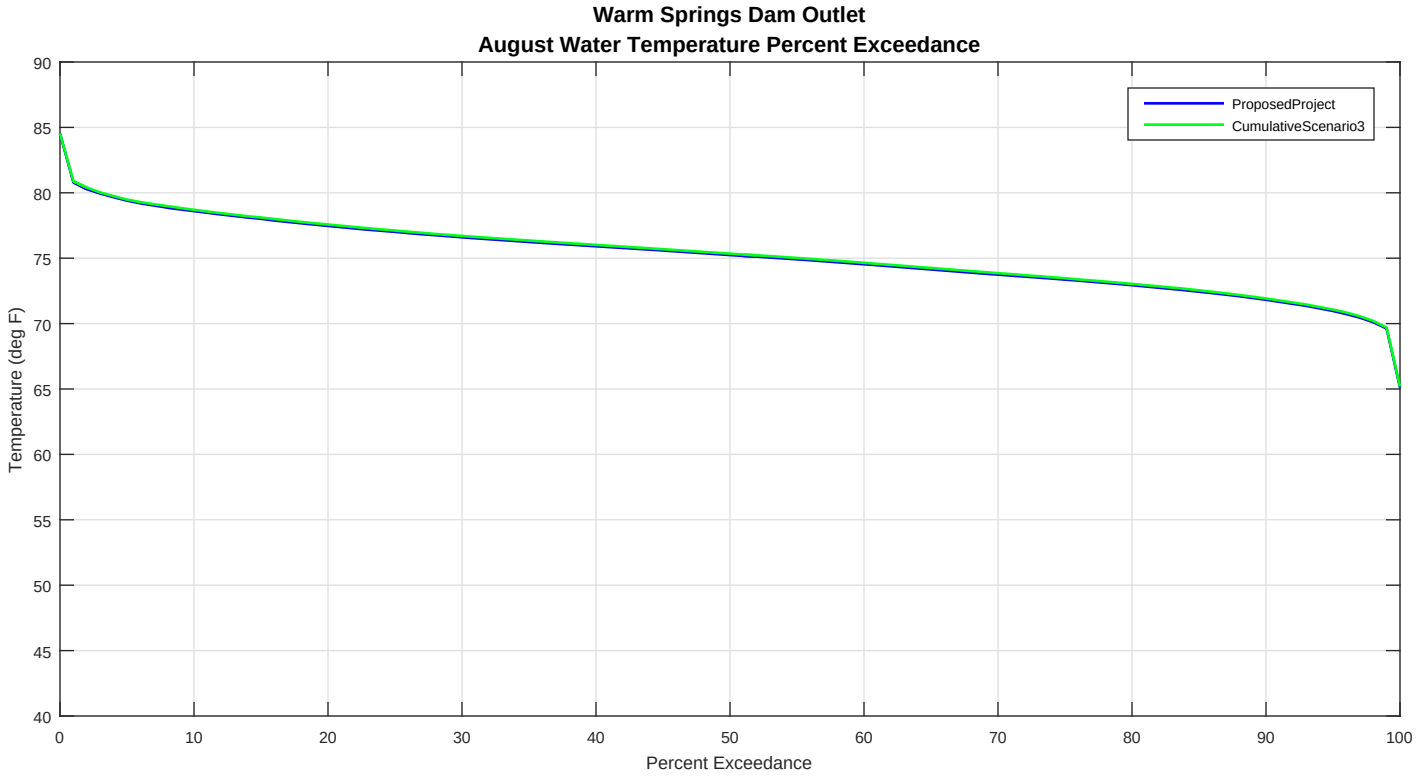
Warm Springs Dam Outlet
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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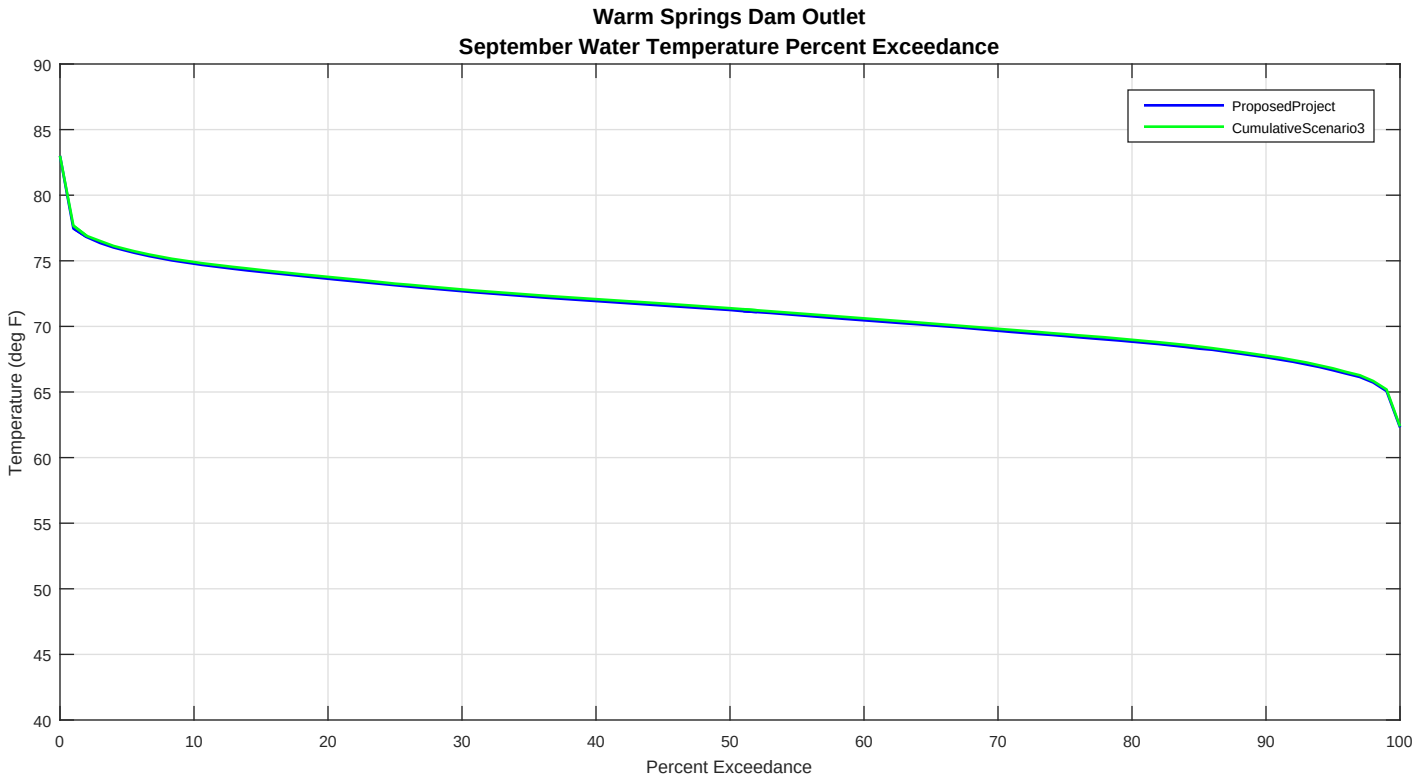
Warm Springs Dam Outlet
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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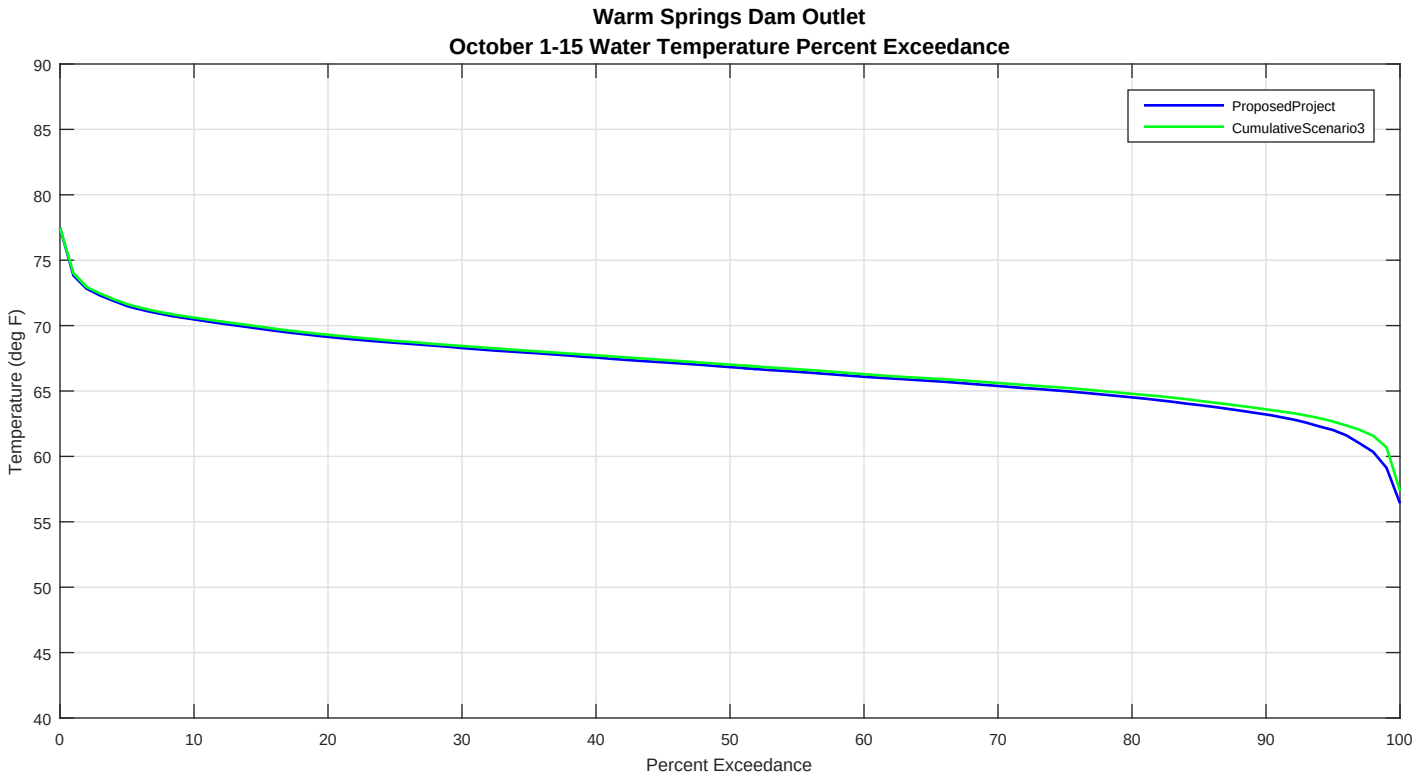
Warm Springs Dam Outlet
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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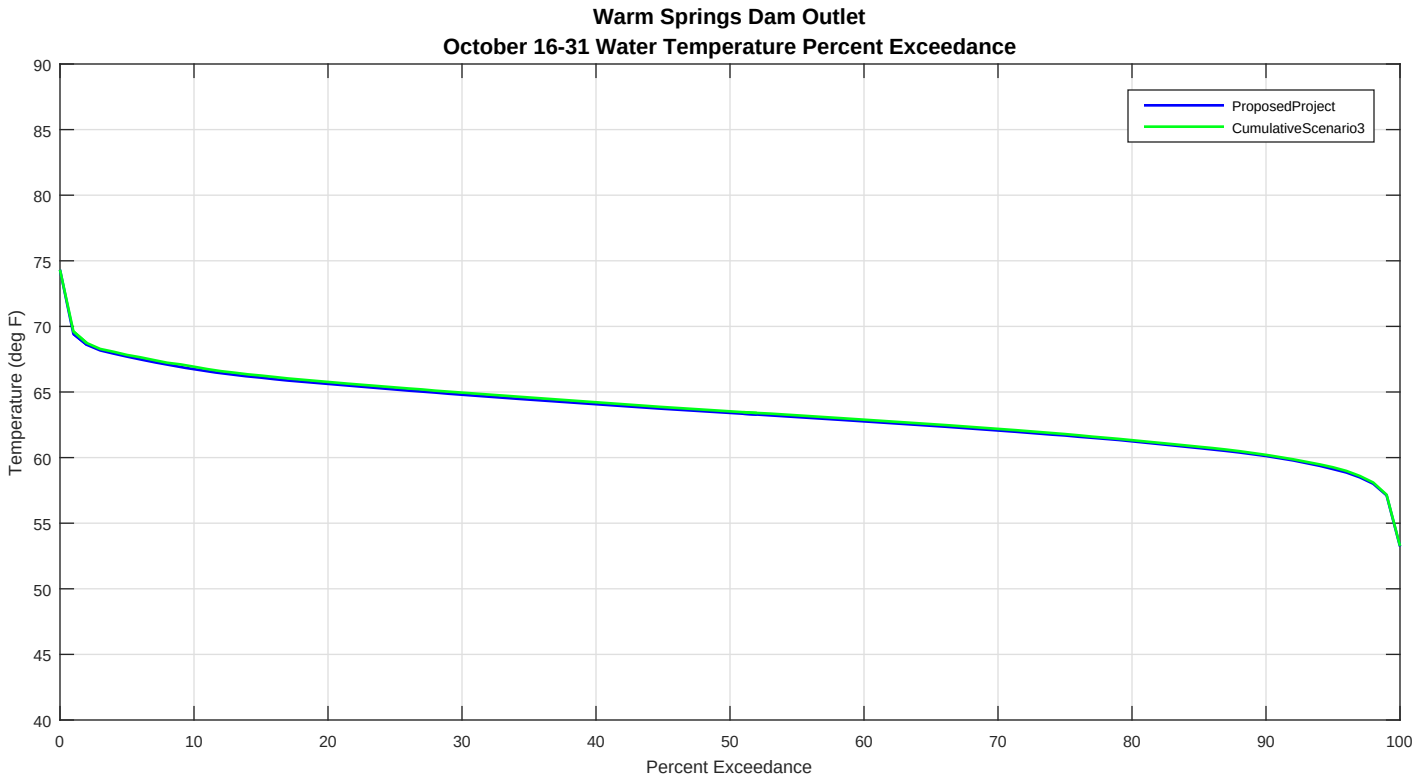
Warm Springs Dam Outlet
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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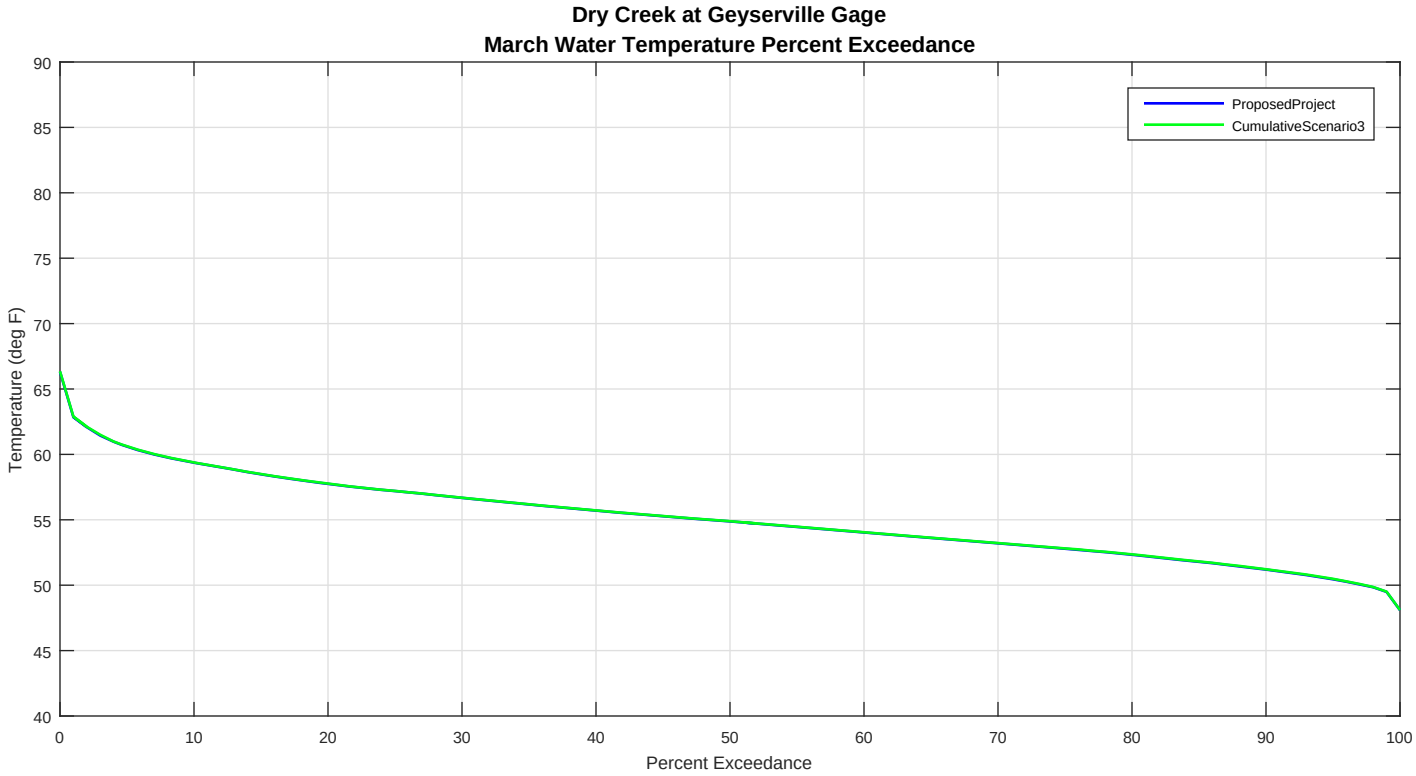
Dry Creek at Geyserville Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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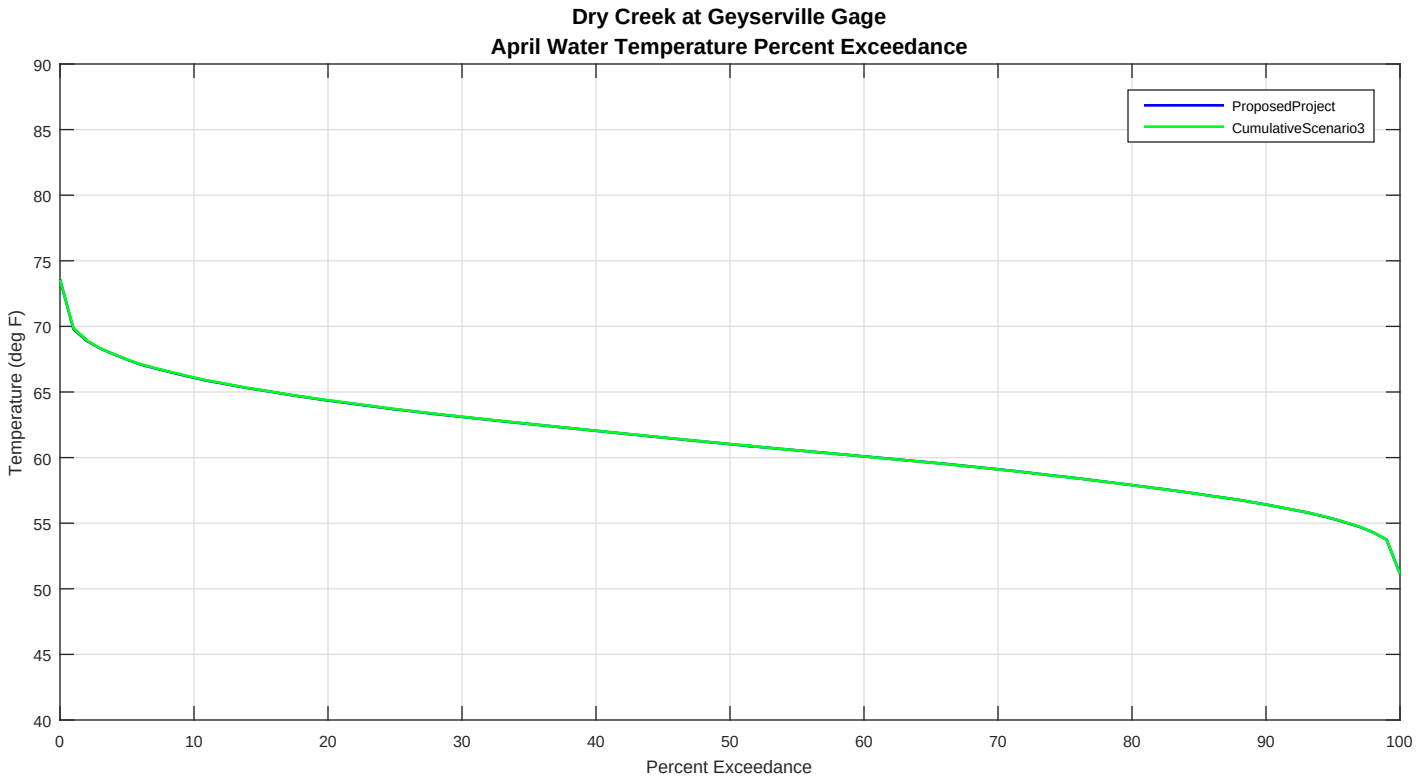
Dry Creek at Geyserville Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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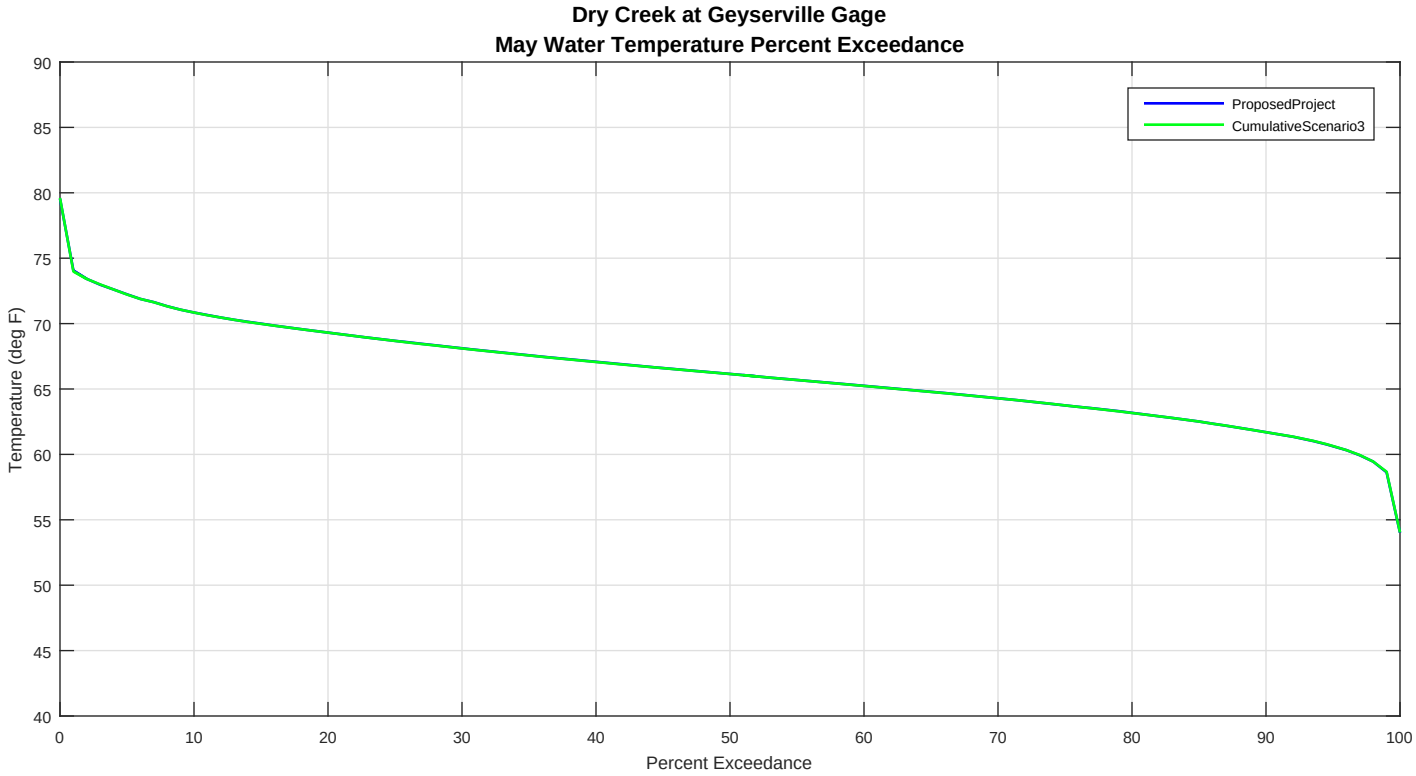
Dry Creek at Geyserville Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
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45
40
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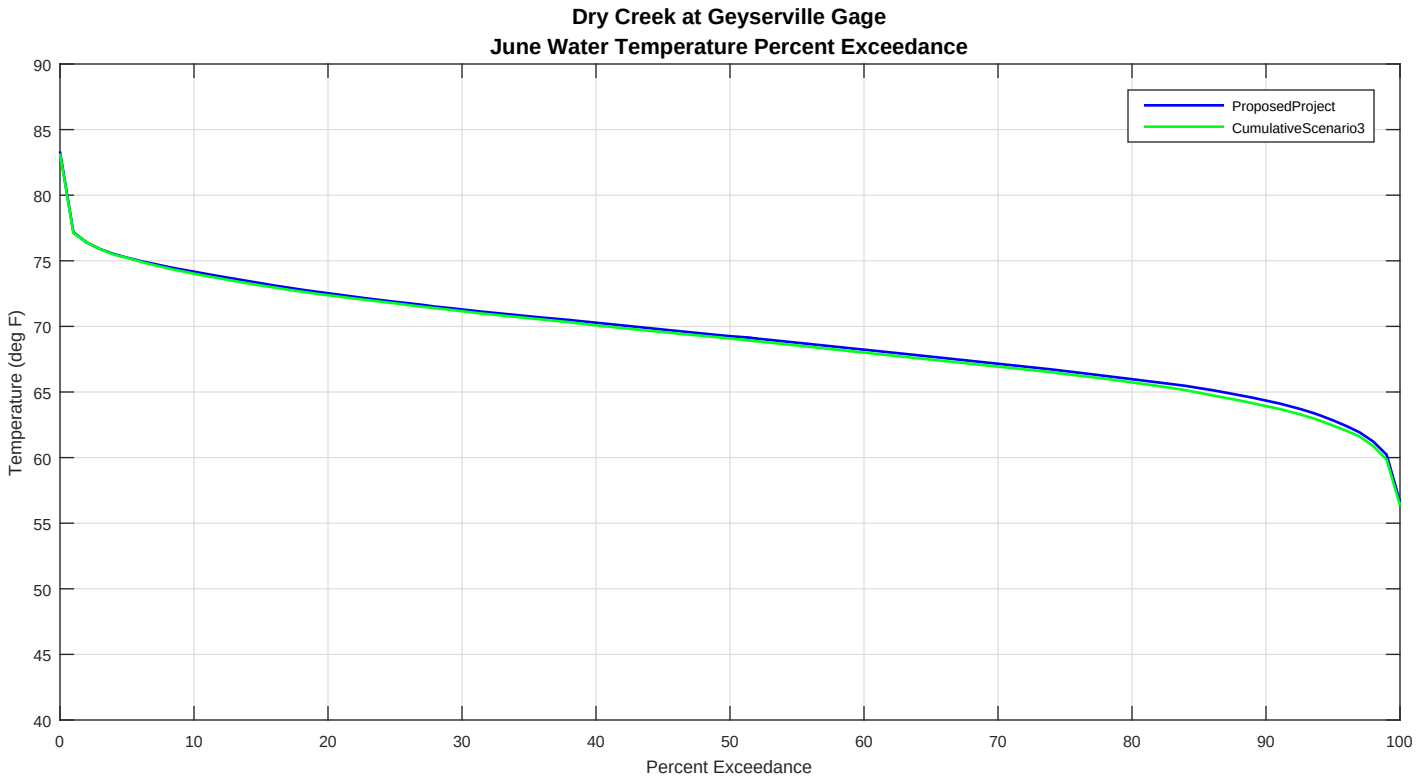
Dry Creek at Geyserville Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
90
85
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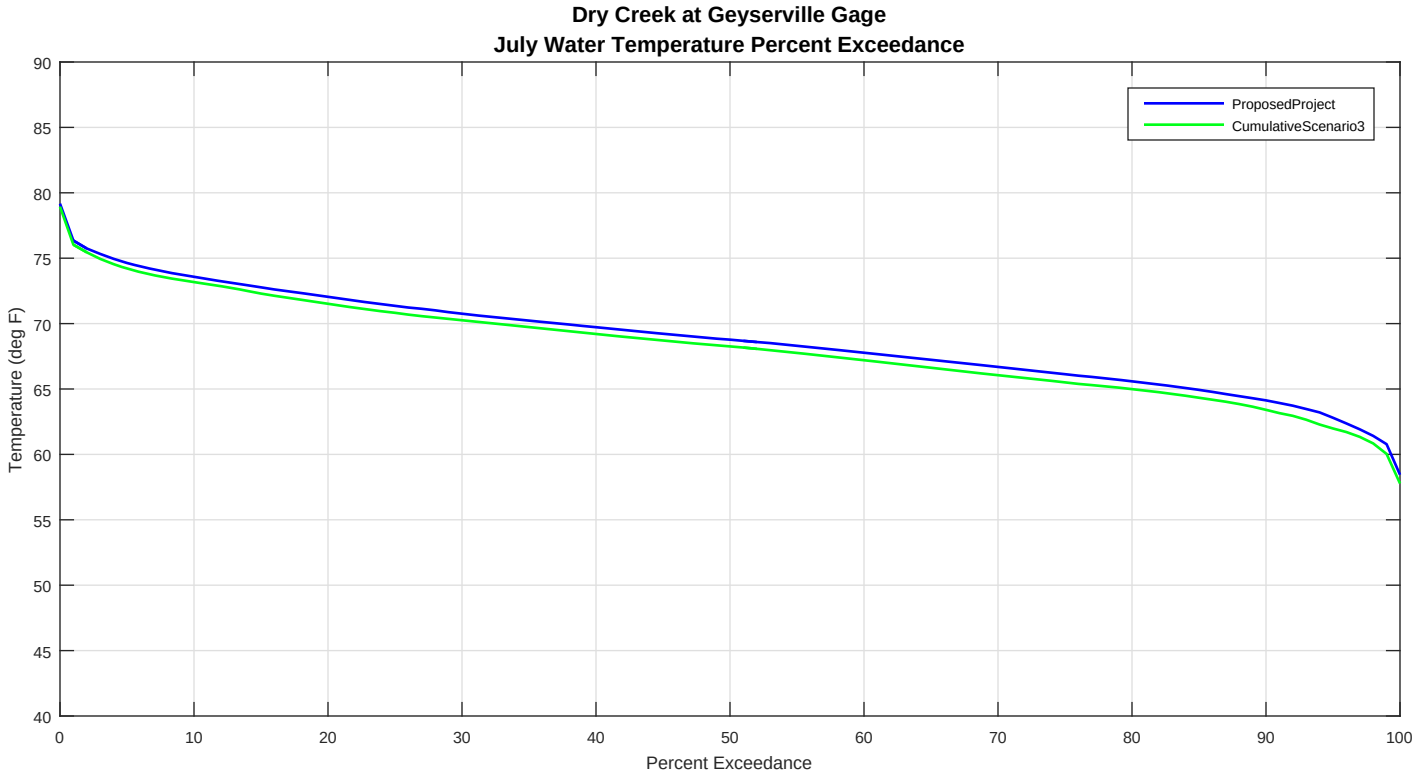
Dry Creek at Geyserville Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
90
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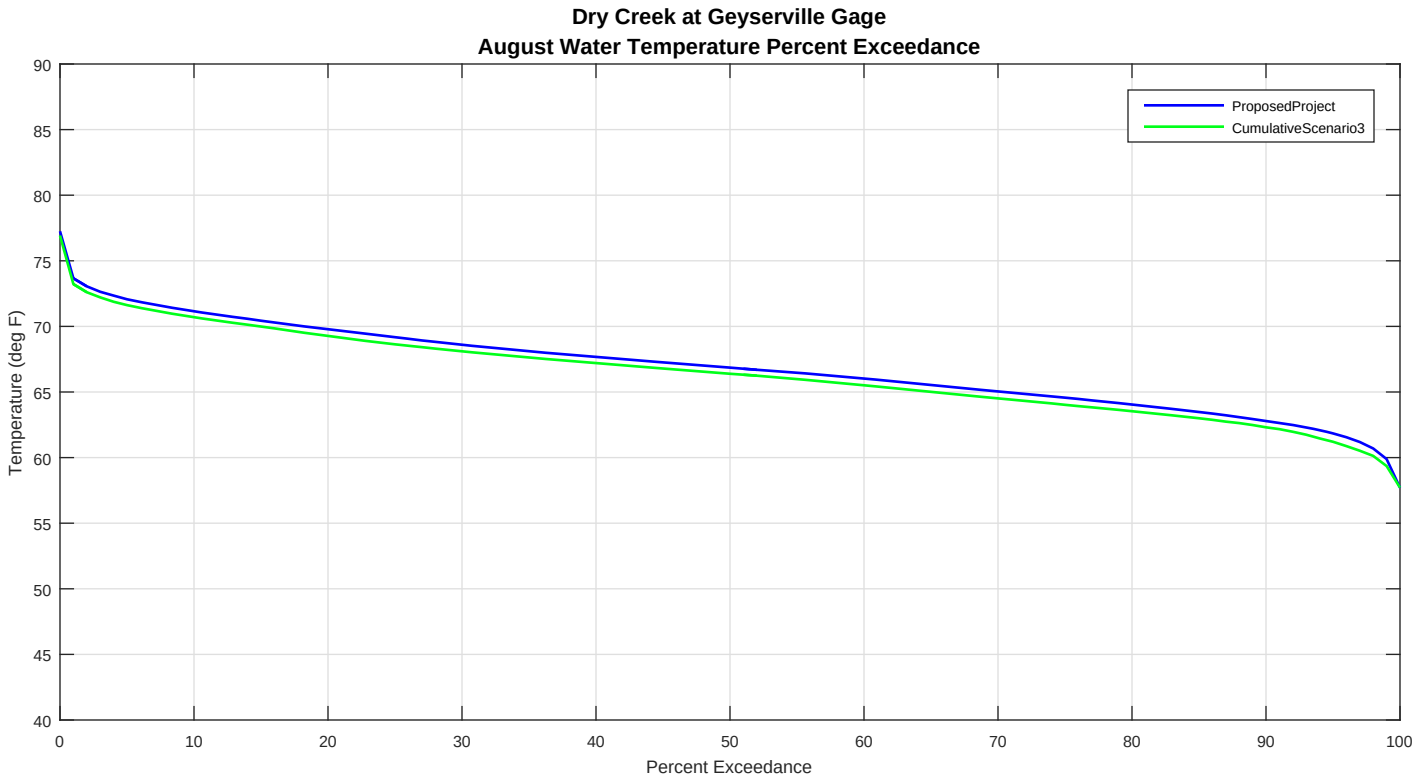
Dry Creek at Geyserville Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
90
85
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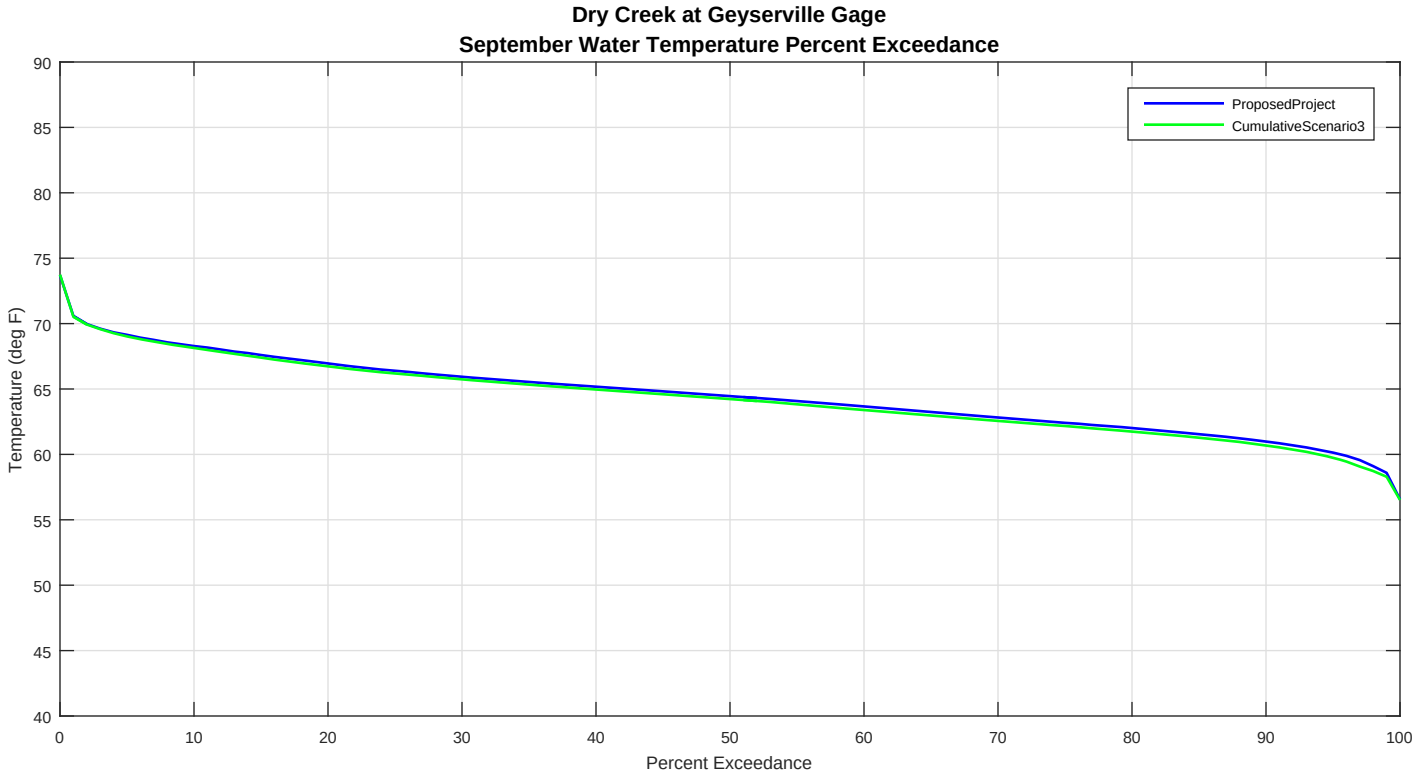
Dry Creek at Geyserville Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
90
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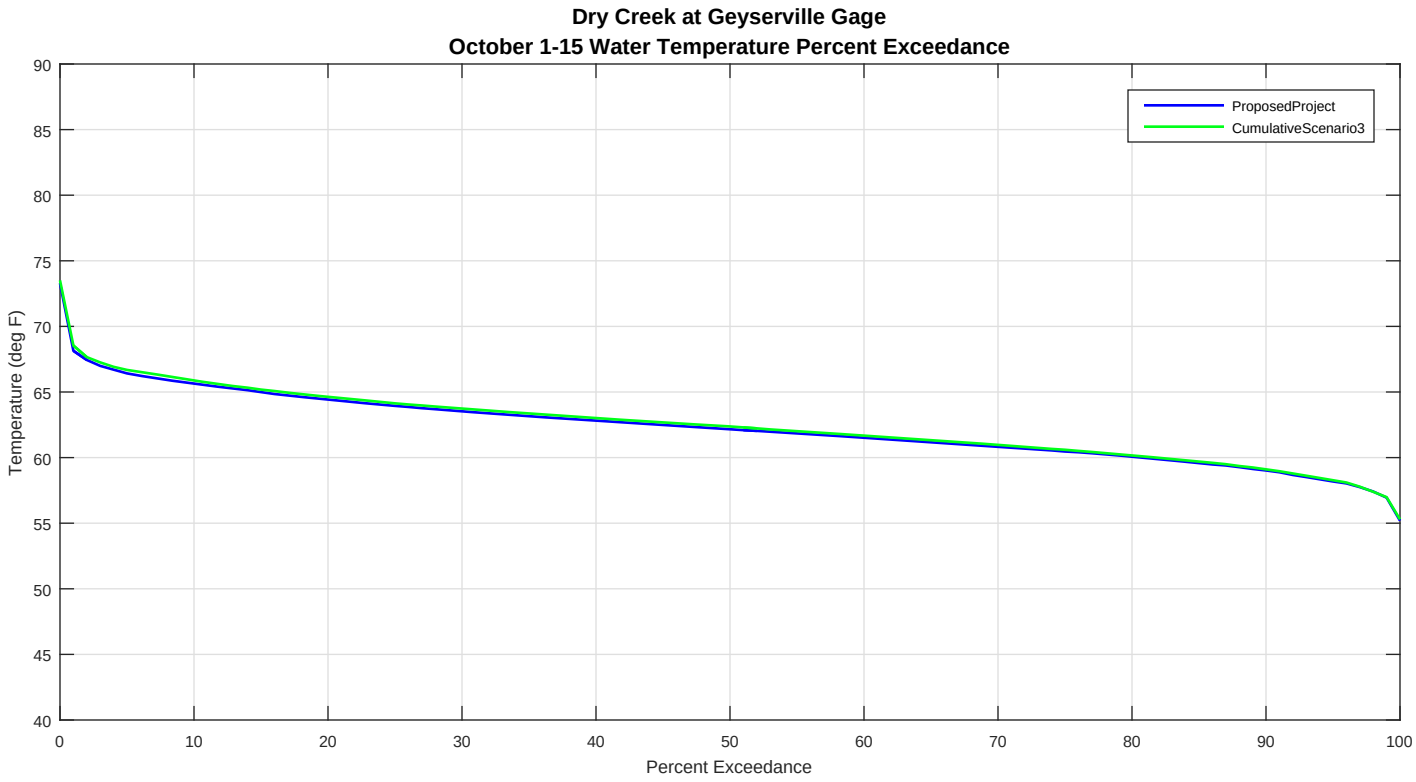
Dry Creek at Geyserville Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
90
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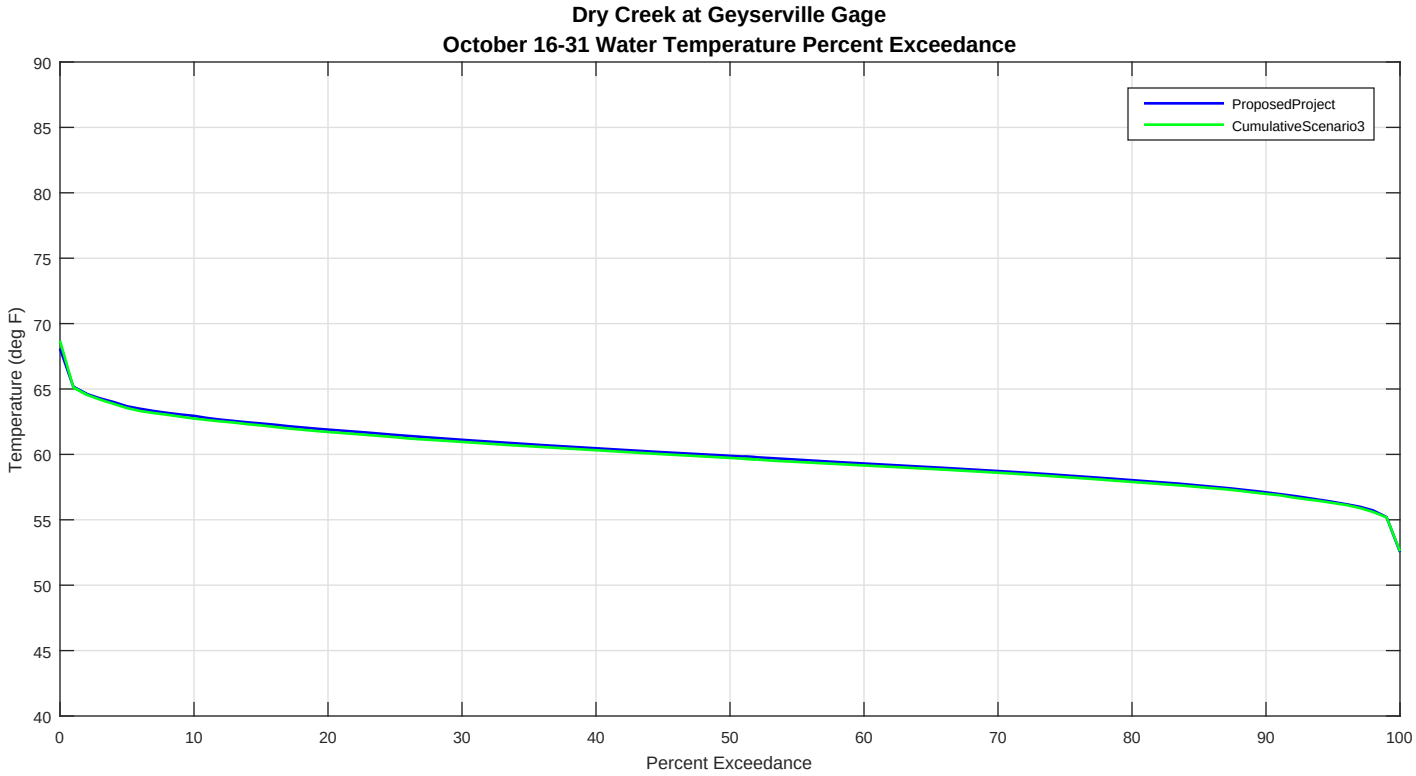
Dry Creek at Geyserville Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
90
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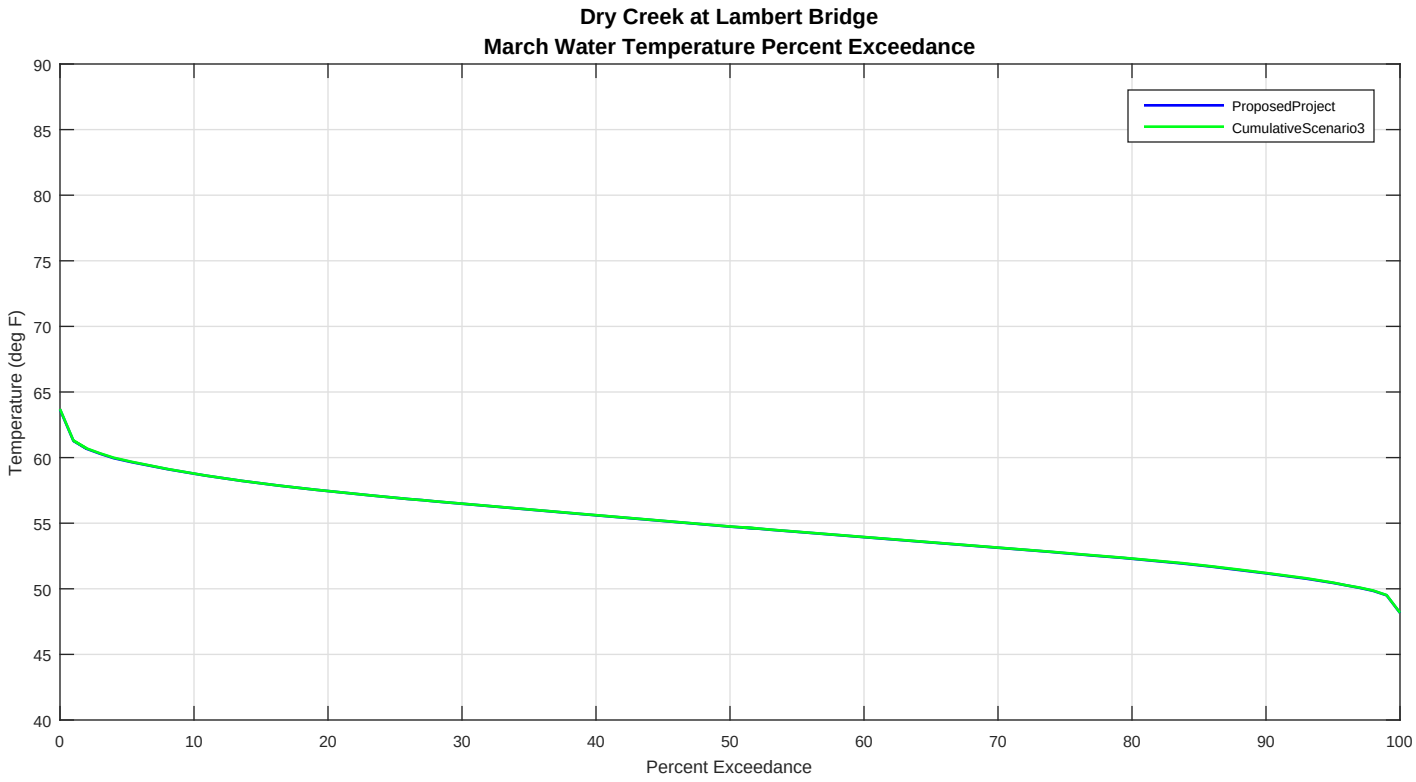
Dry Creek at Lambert Bridge
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
90
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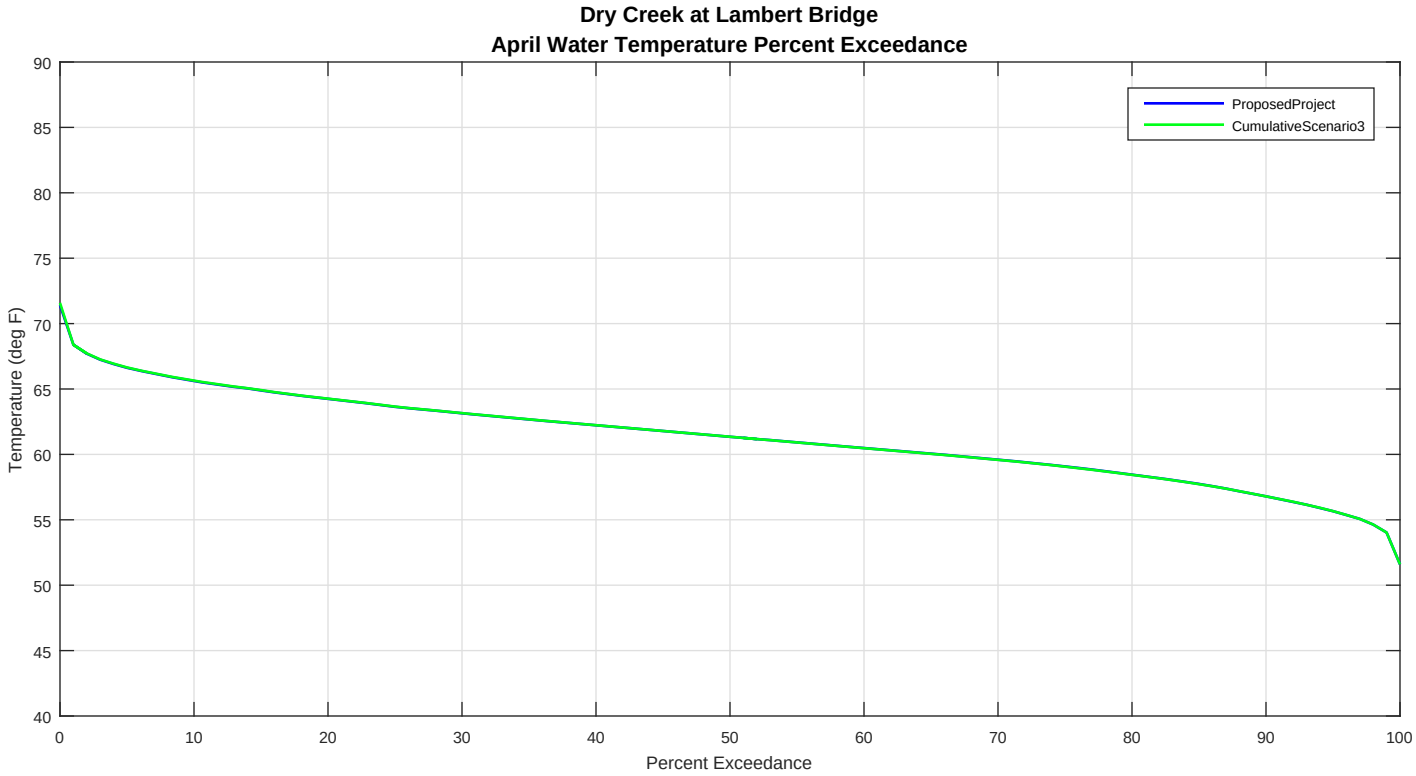
Dry Creek at Lambert Bridge
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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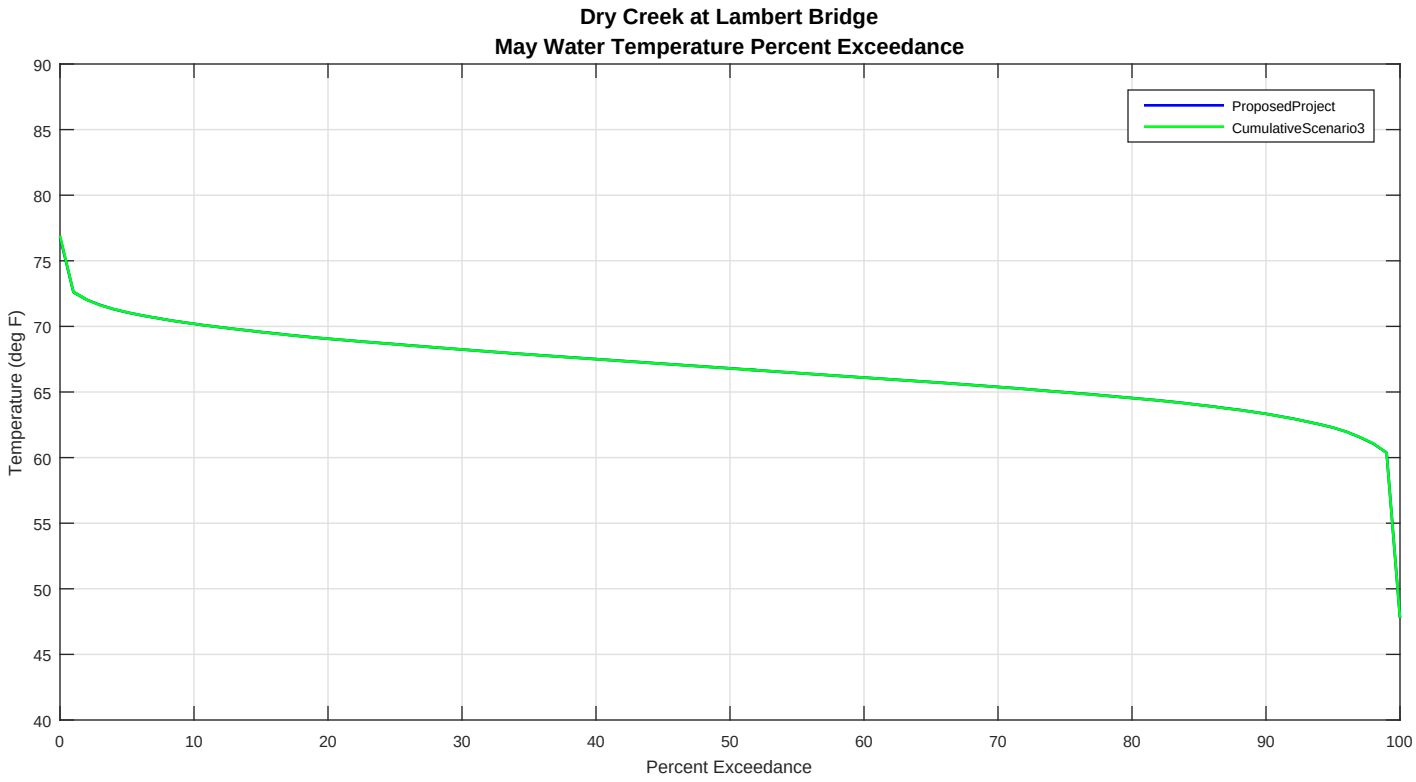
Dry Creek at Lambert Bridge
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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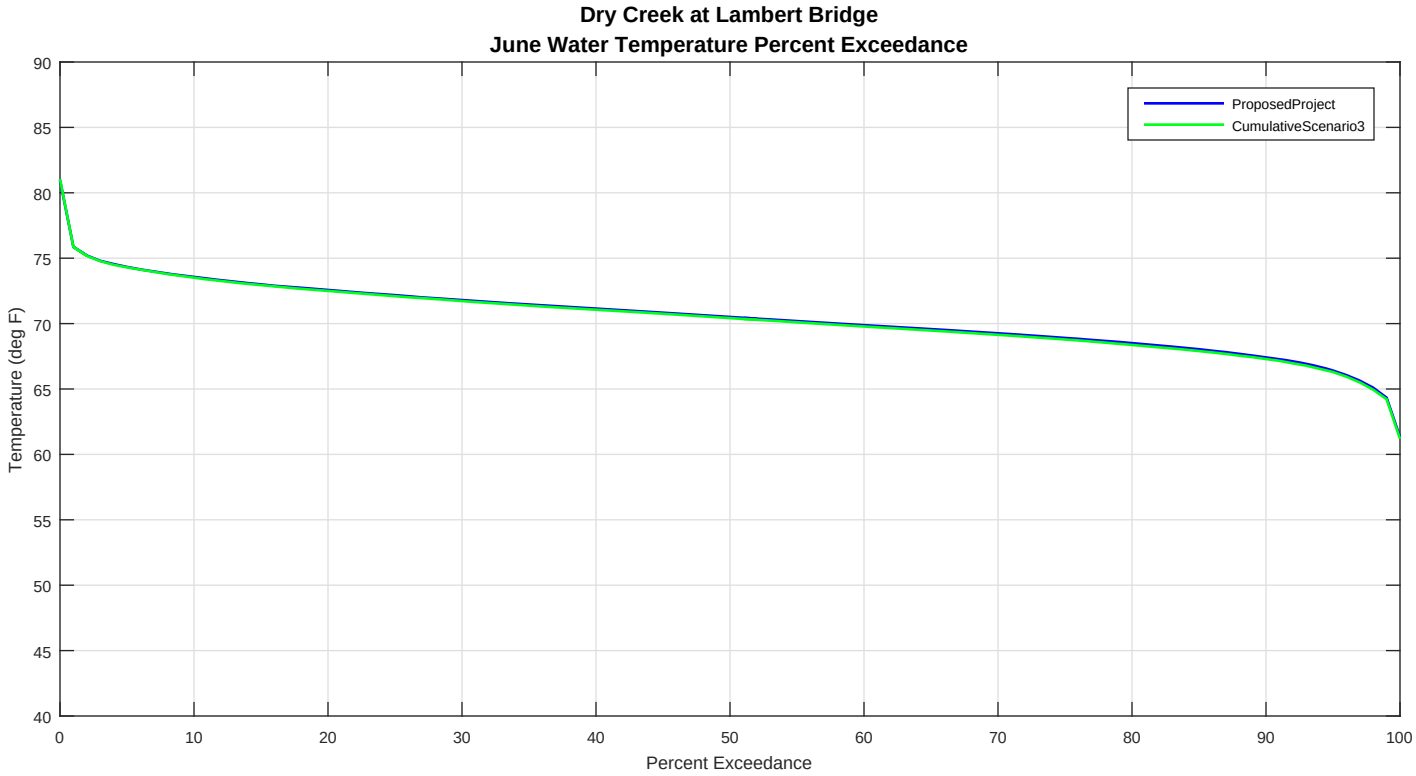
Dry Creek at Lambert Bridge
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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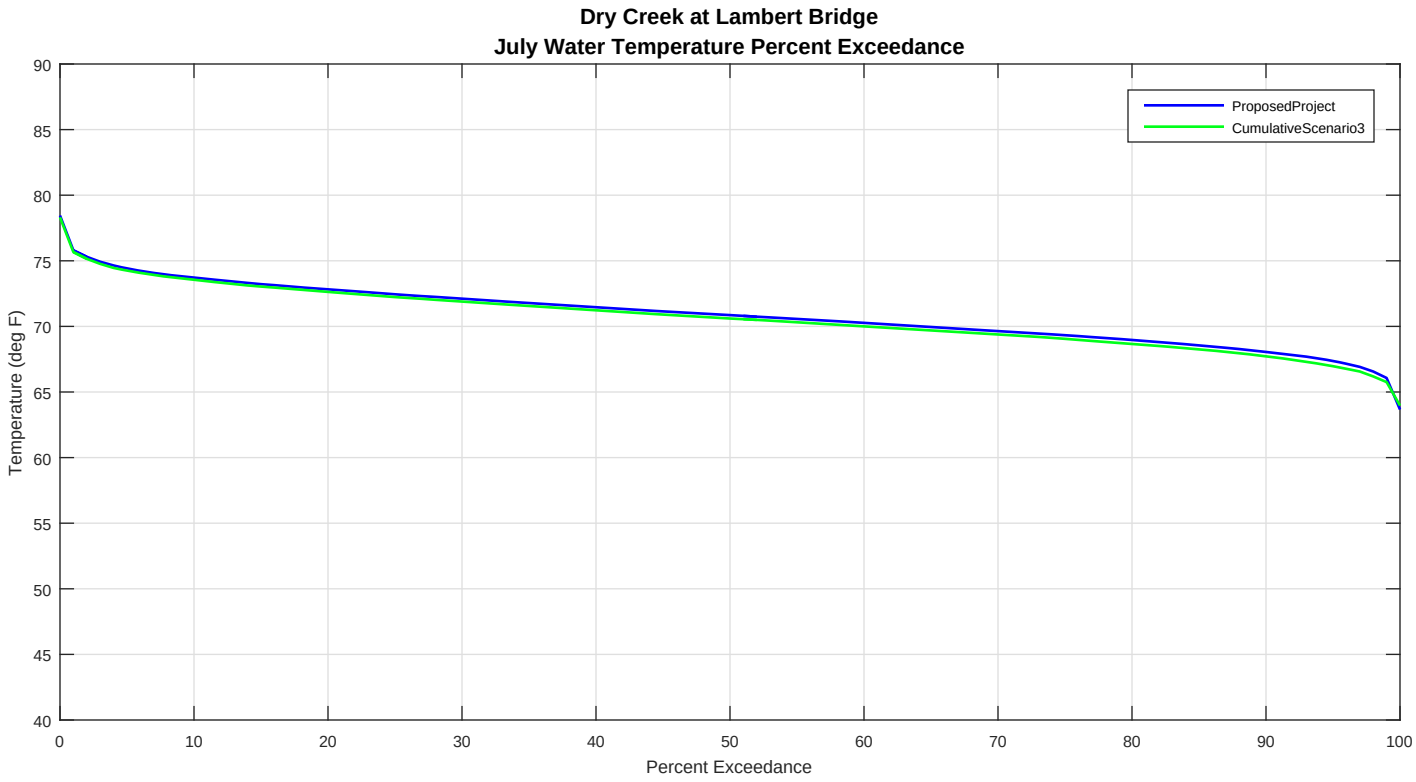
Dry Creek at Lambert Bridge
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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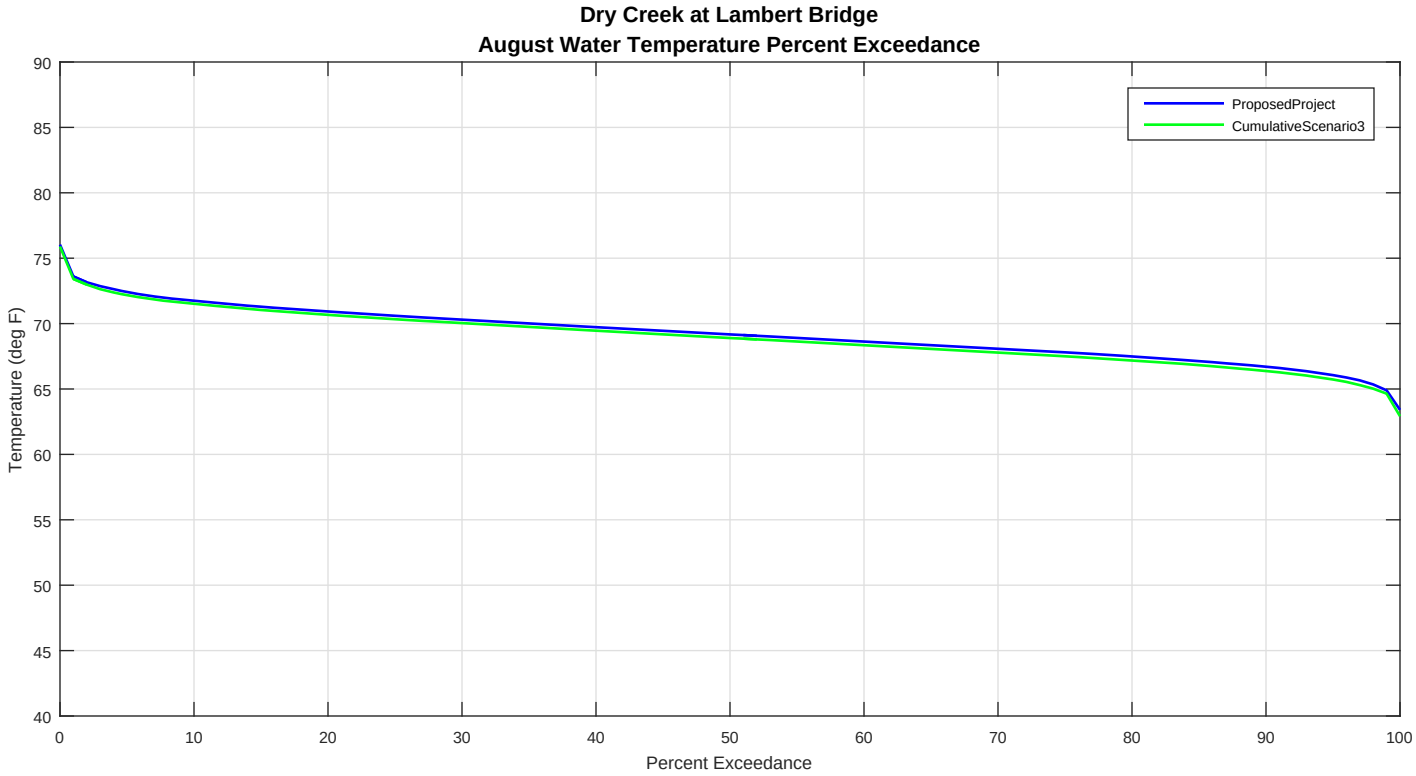
Dry Creek at Lambert Bridge
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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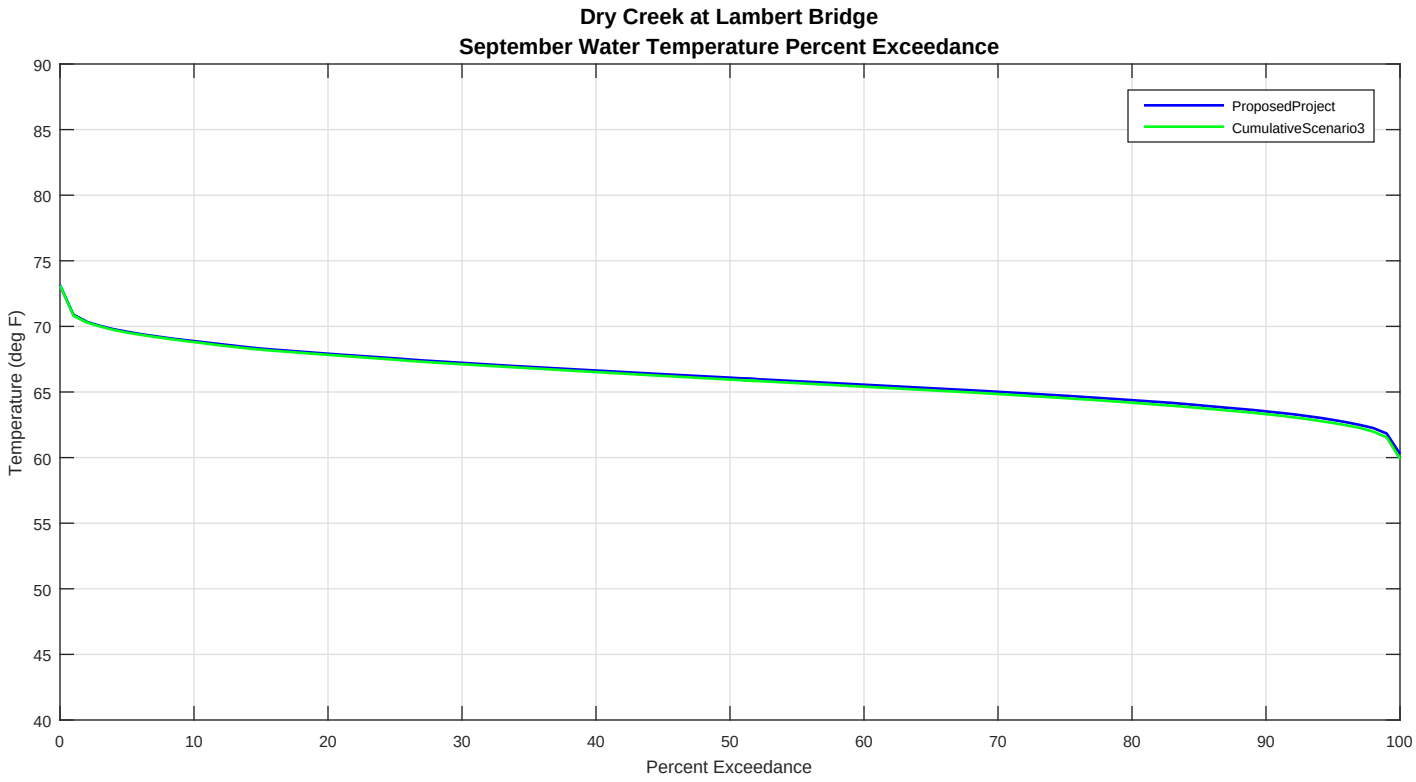
Dry Creek at Lambert Bridge
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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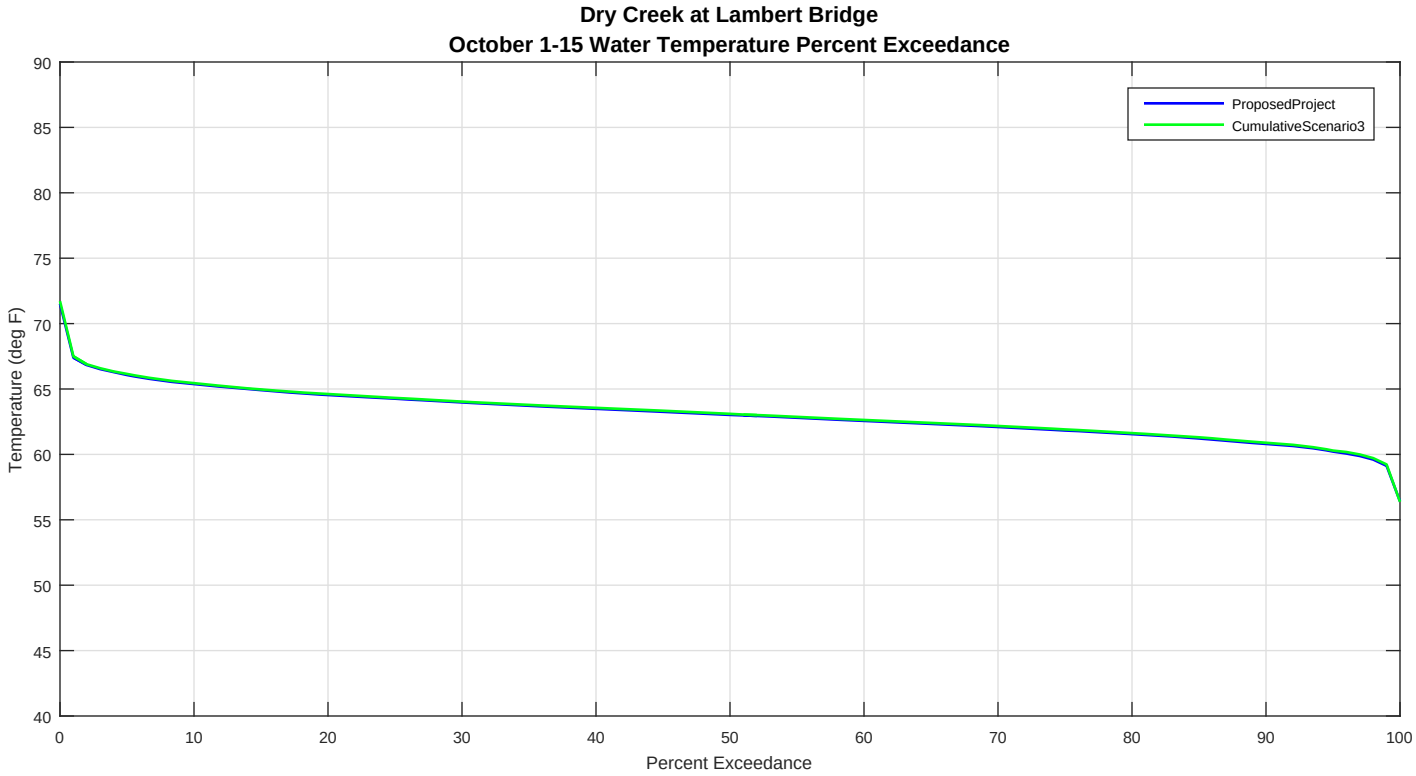
Dry Creek at Lambert Bridge
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
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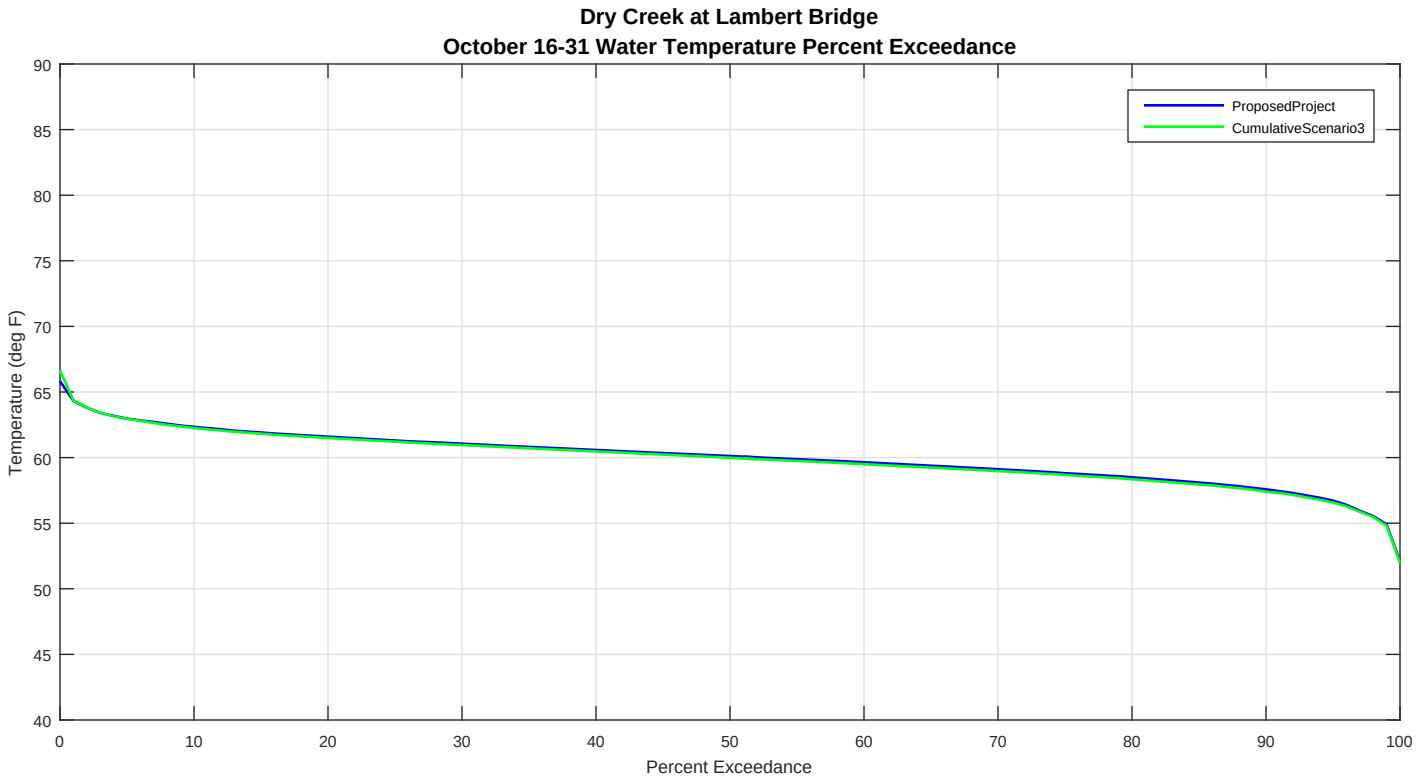
Dry Creek at Lambert Bridge
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
90
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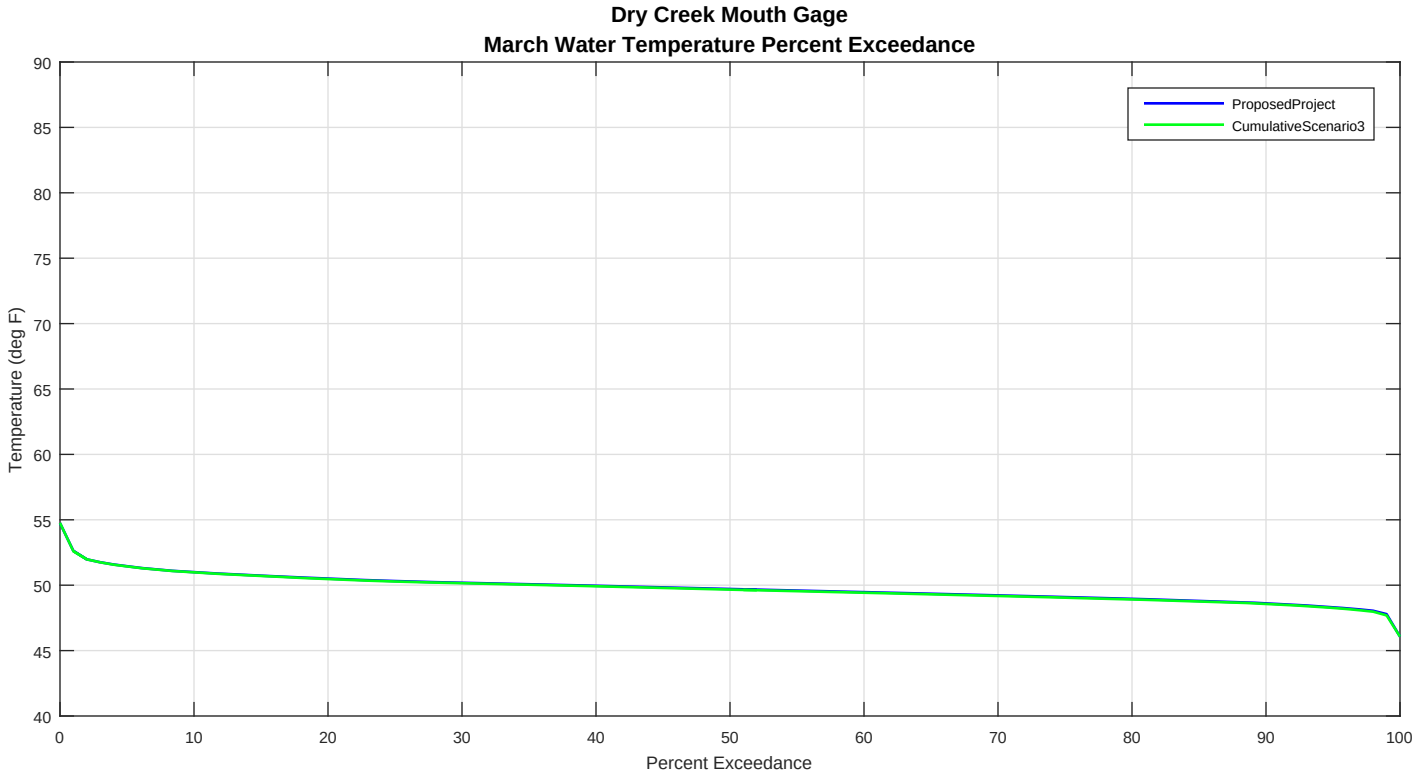
Dry Creek Mouth Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
90
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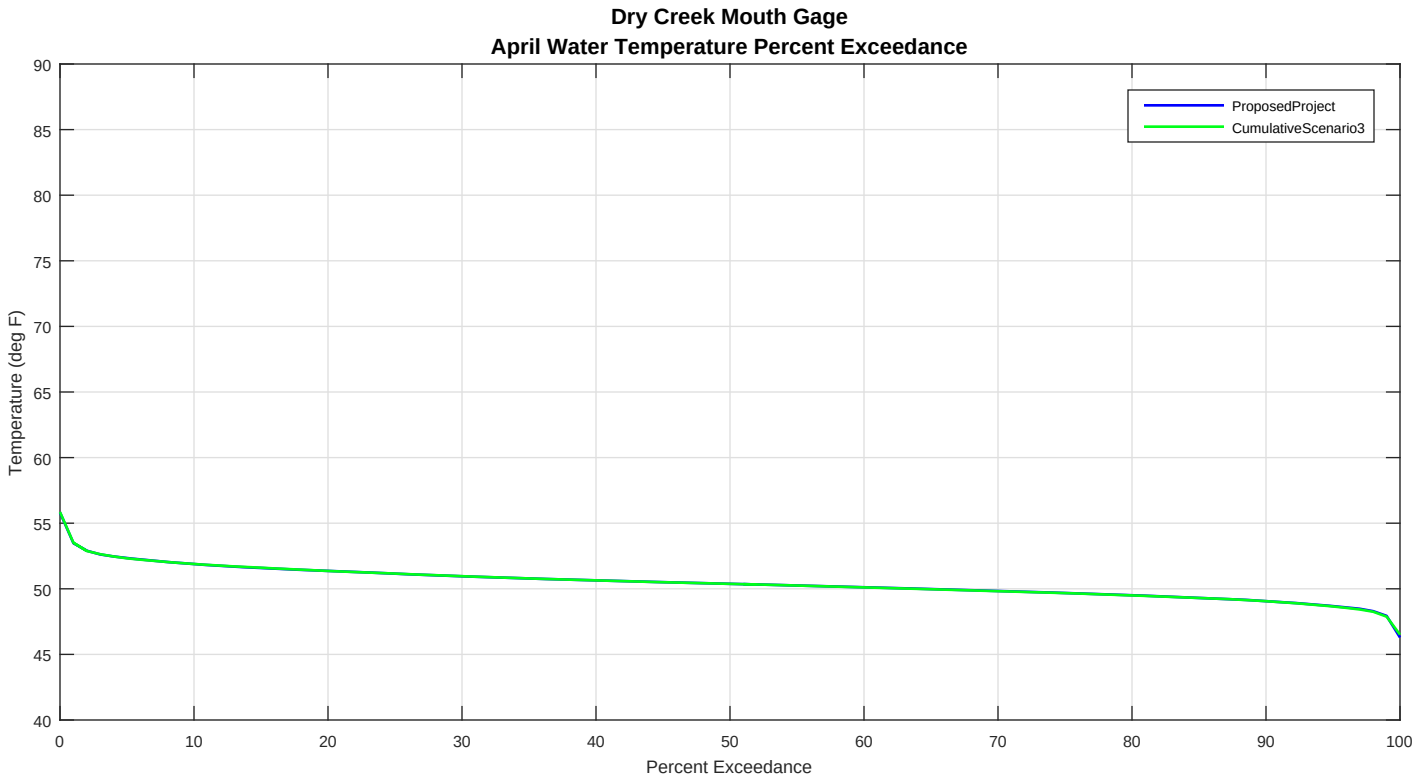
Dry Creek Mouth Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
90
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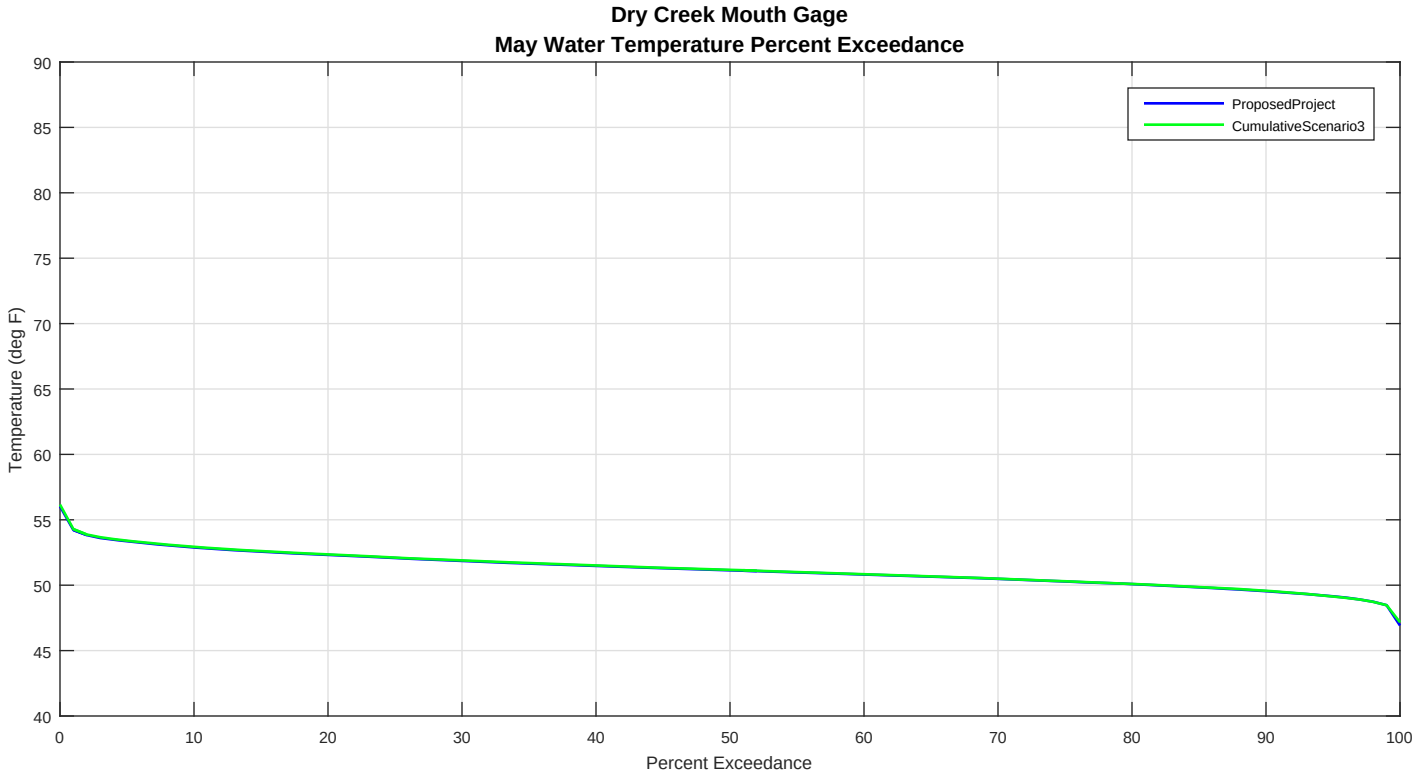
Dry Creek Mouth Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
90
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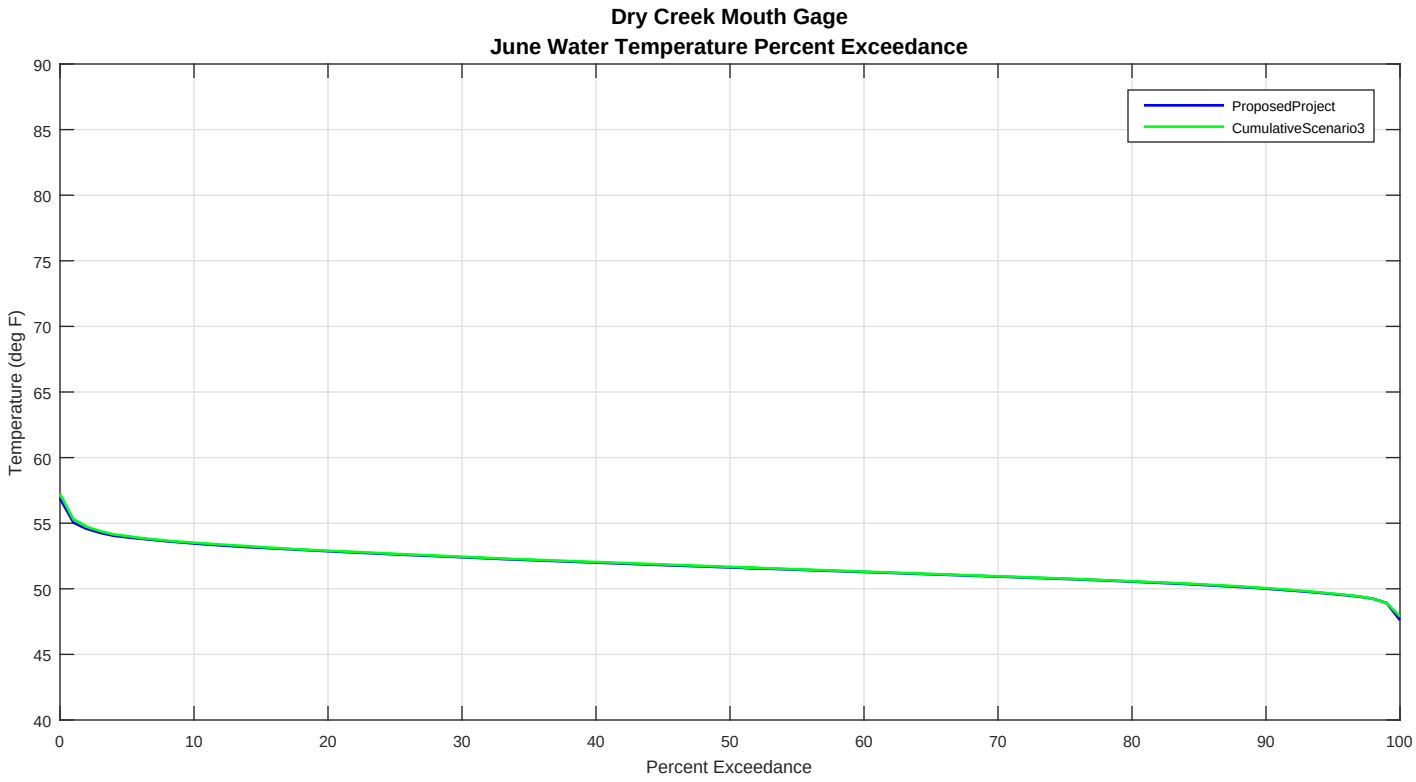
Dry Creek Mouth Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
90
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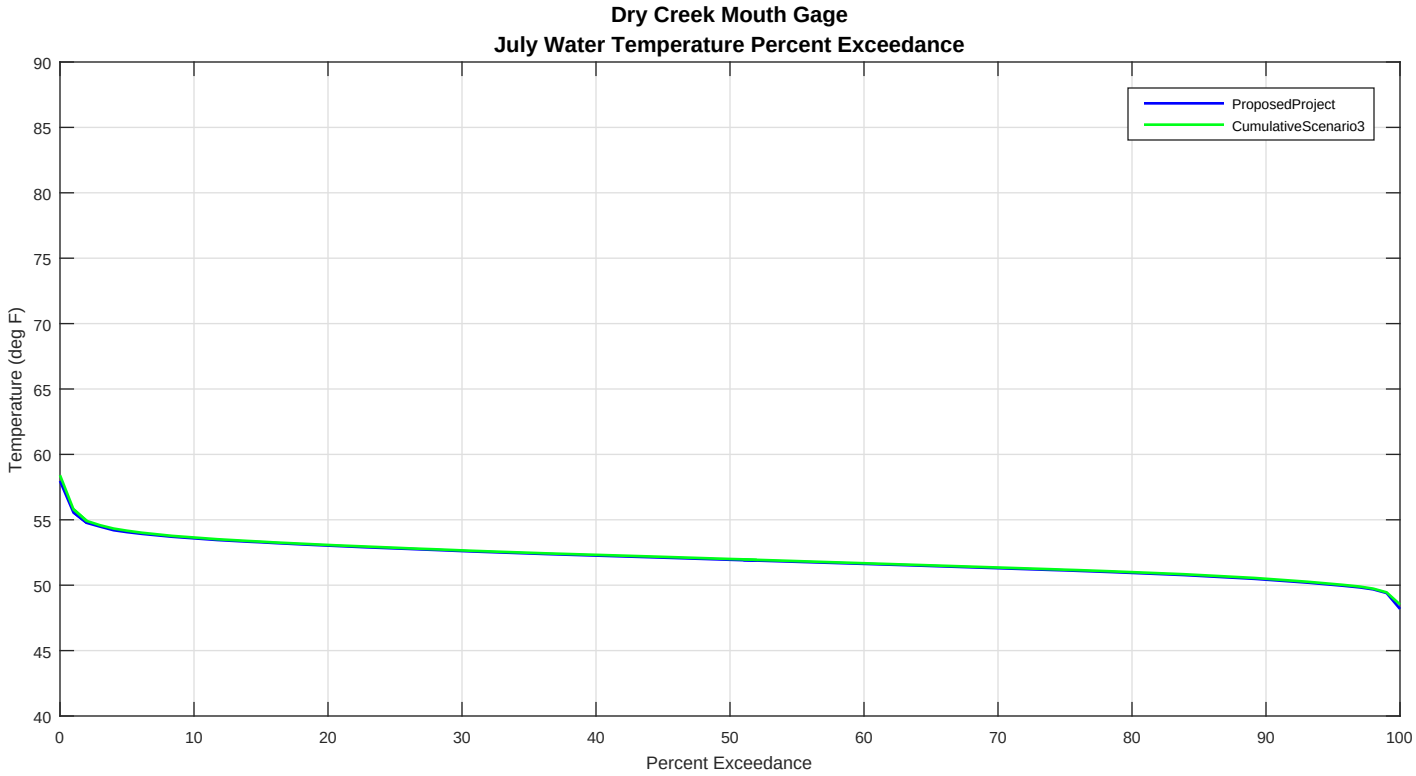
Dry Creek Mouth Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
90
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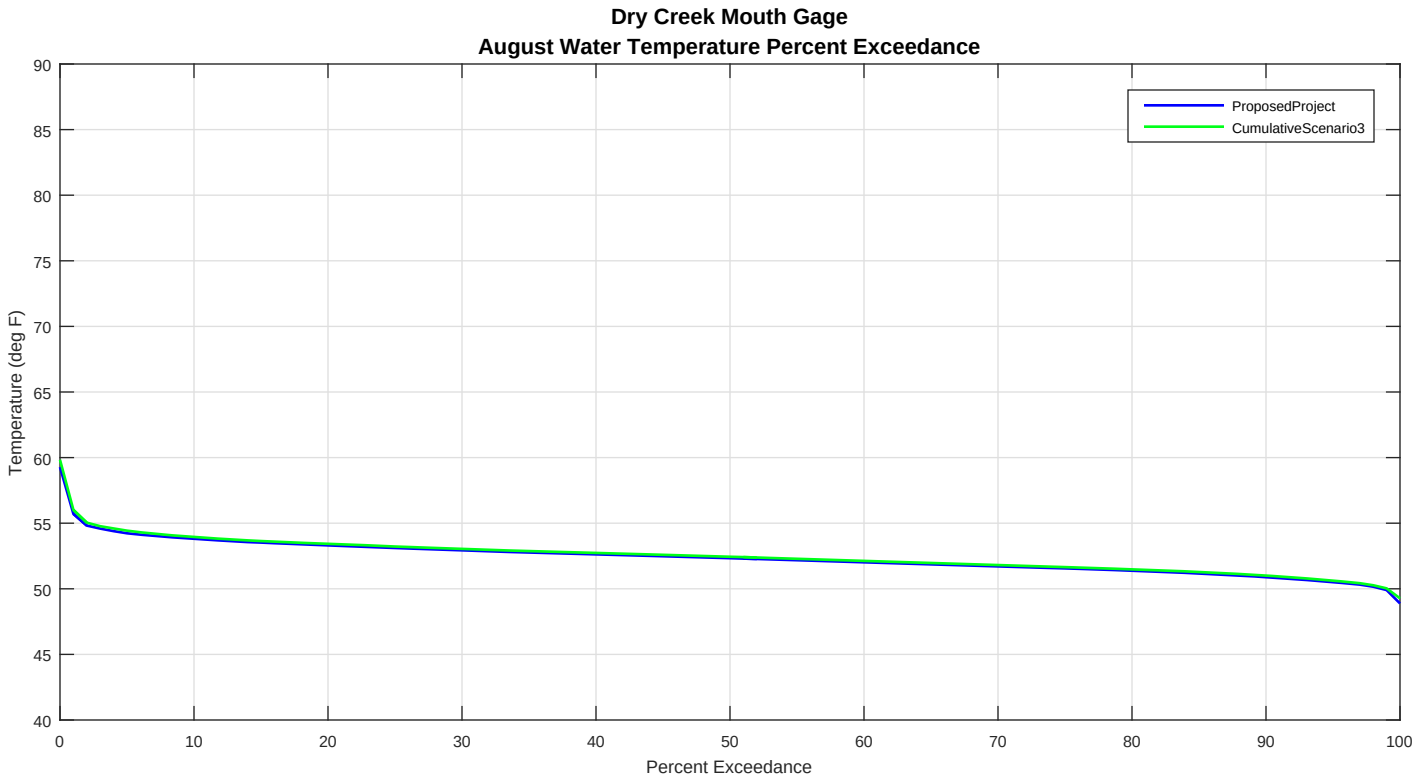
Dry Creek Mouth Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
90
85
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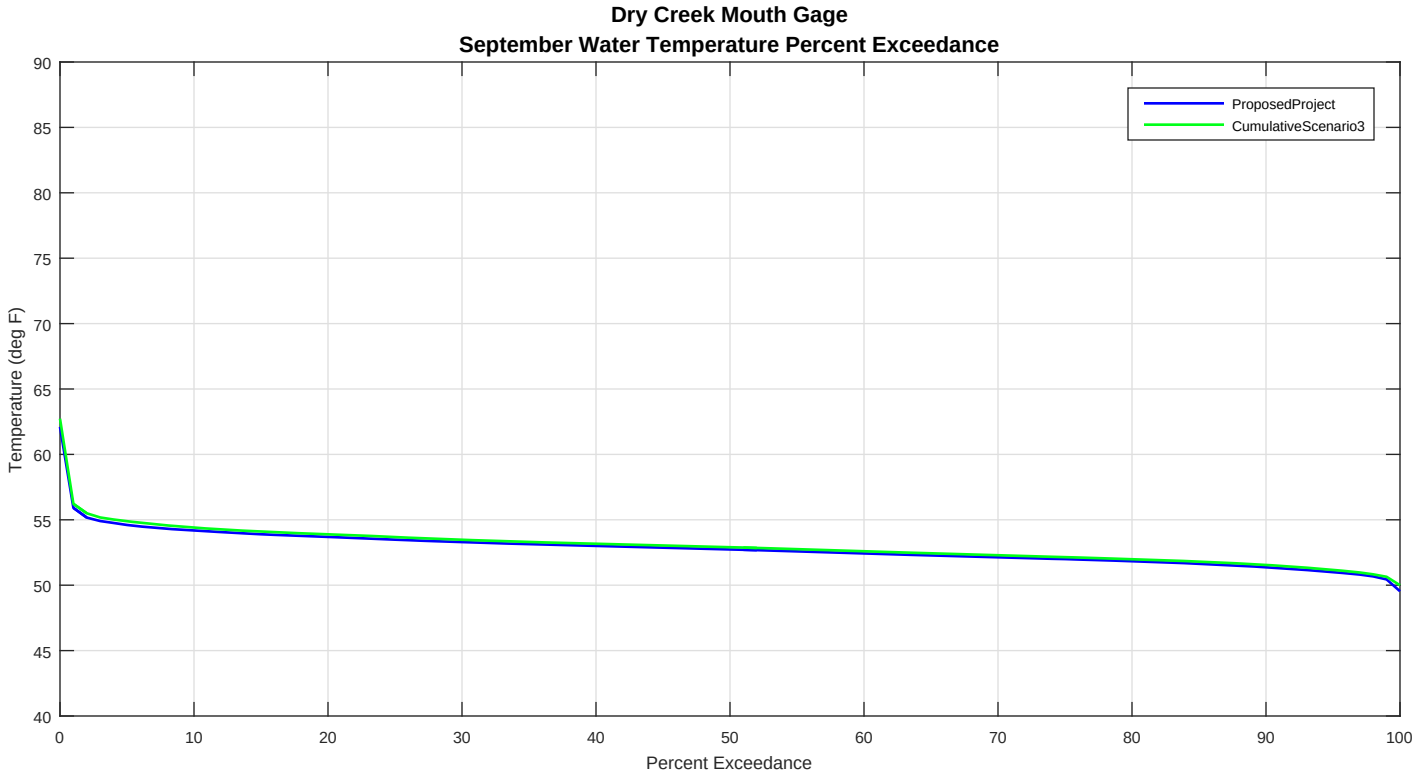
Dry Creek Mouth Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
90
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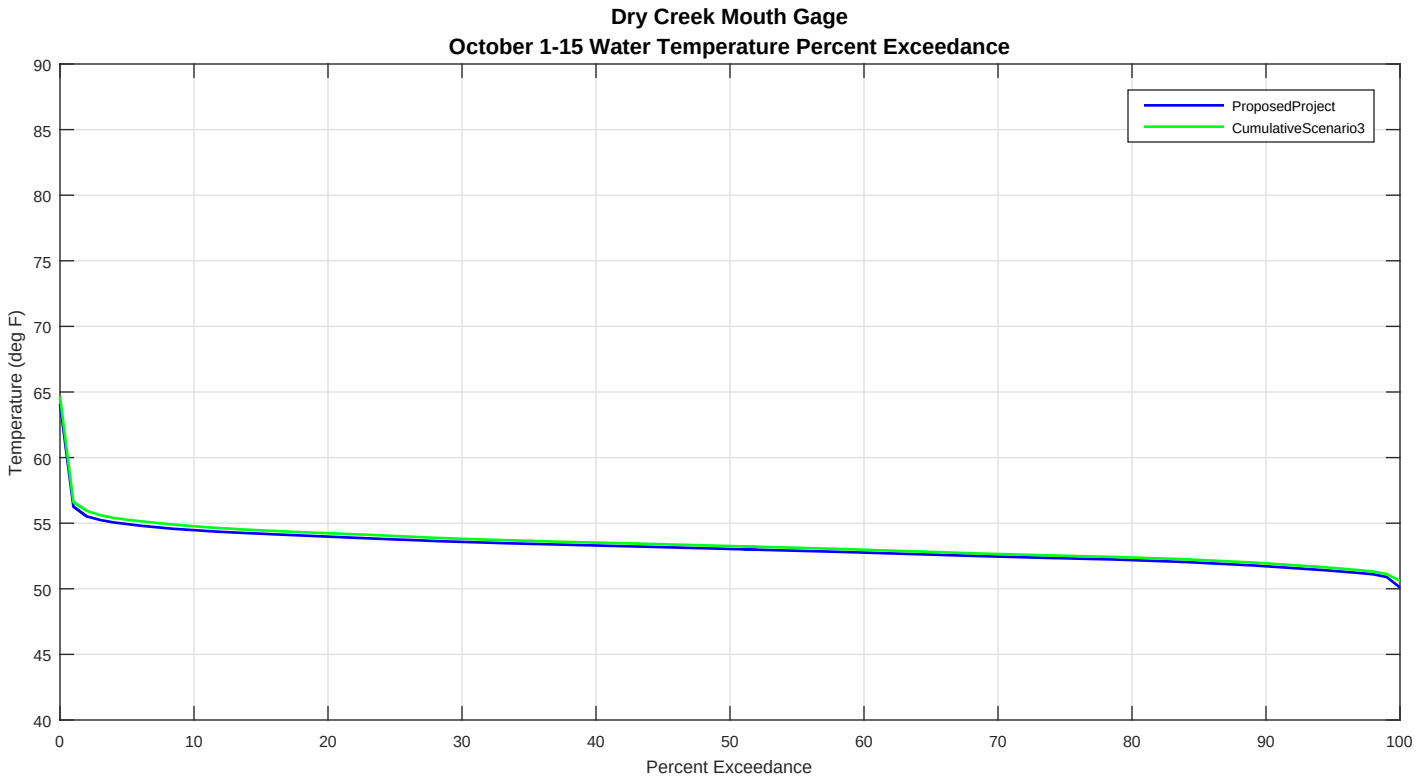
Dry Creek Mouth Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
90
85
80
75
70
65
60
55
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40
0
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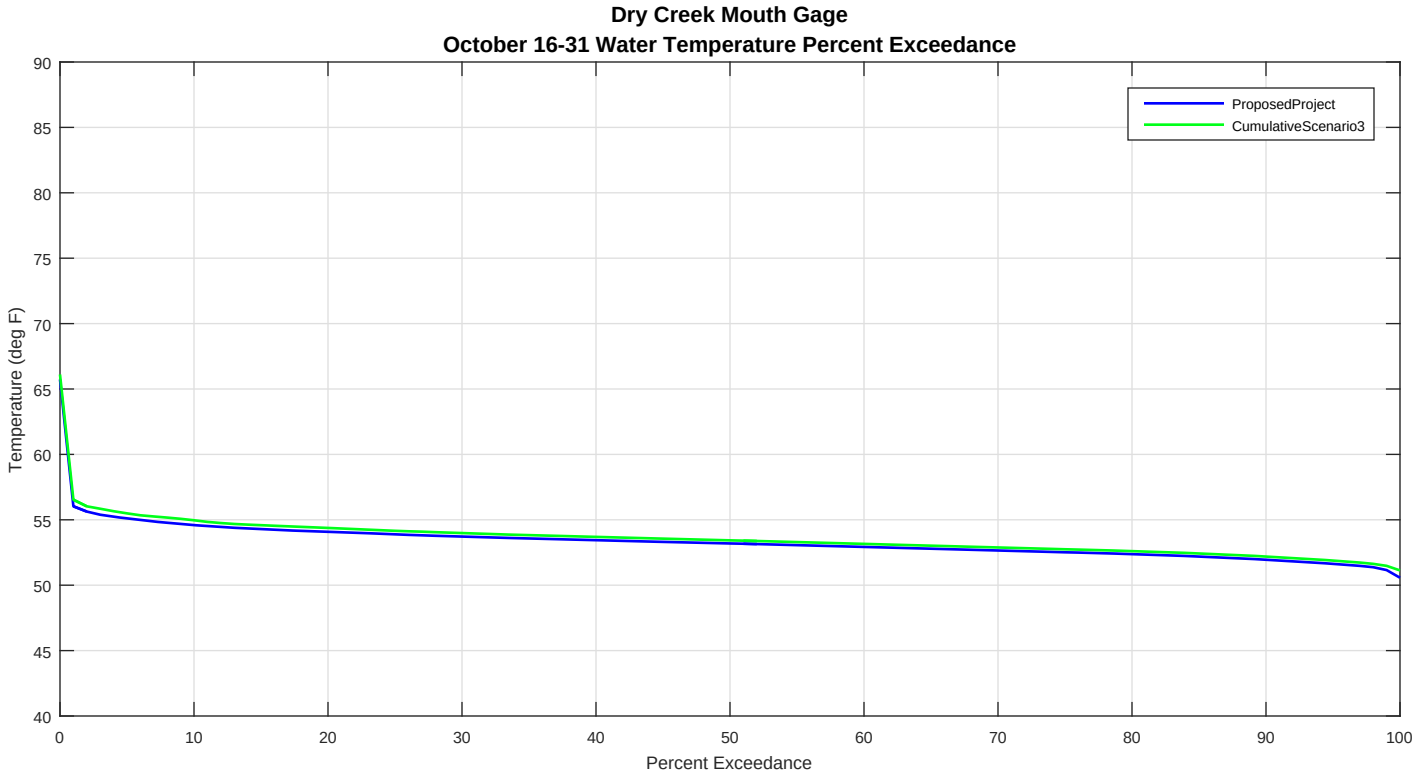
90
100


Dry Creek Mouth Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario3
Temperature (deg F)
Percent Exceedance
90
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75
70
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60
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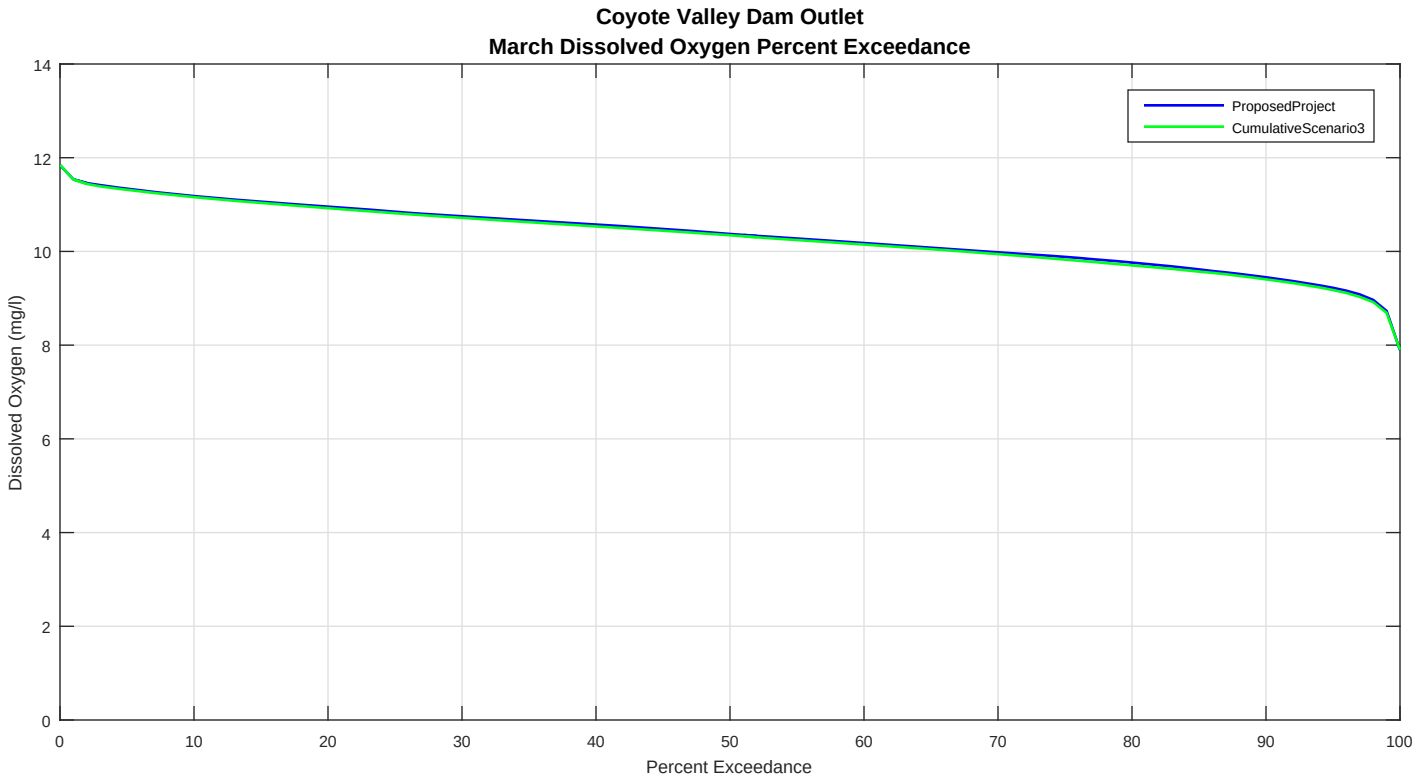
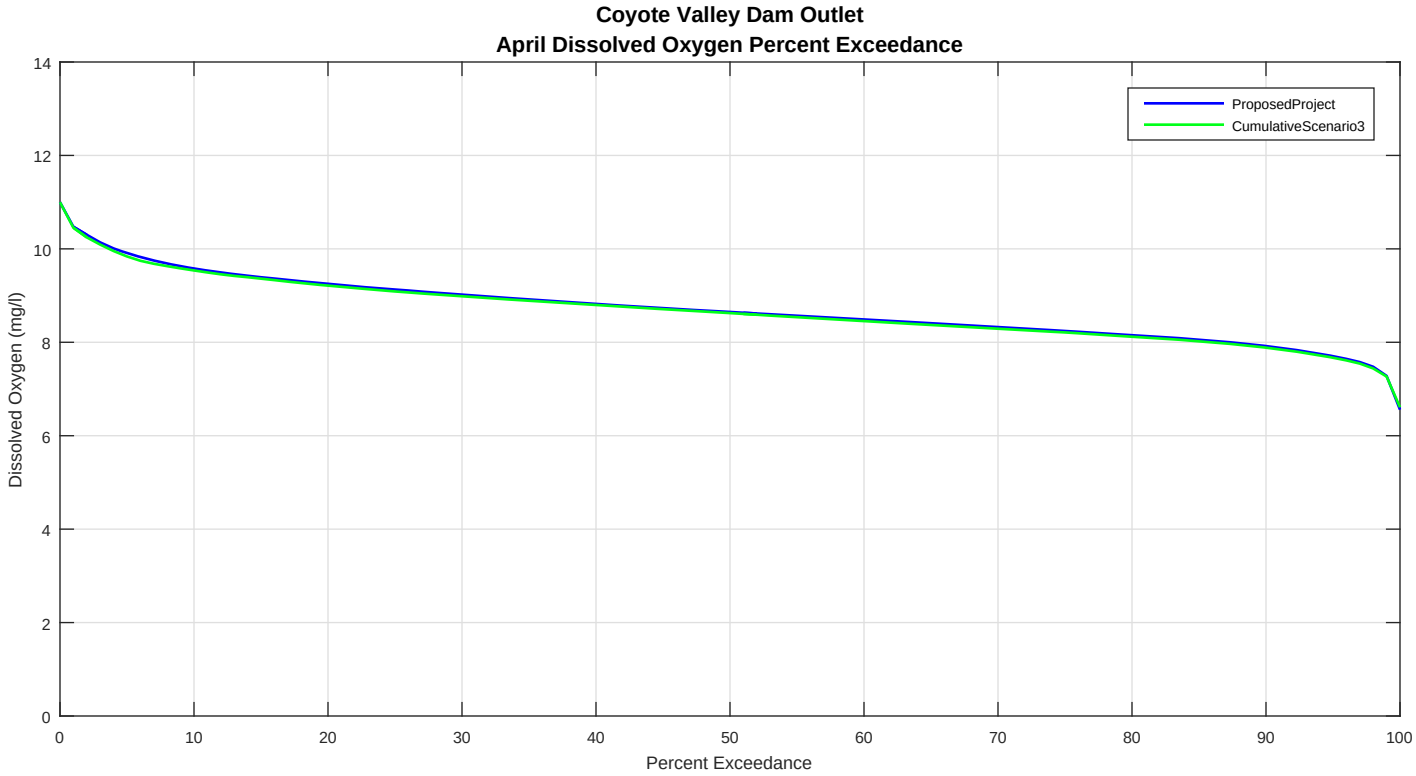
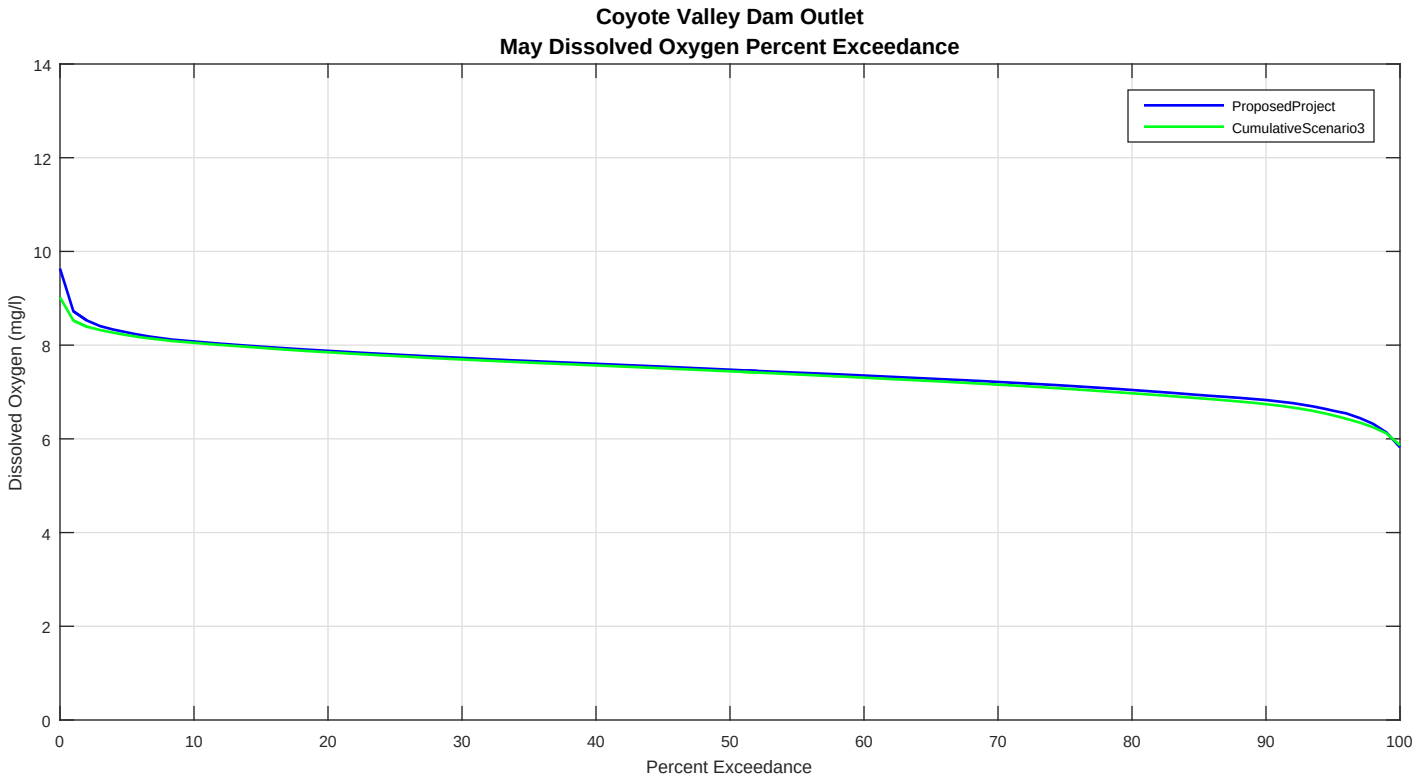
100


Coyote Valley Dam Outlet
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
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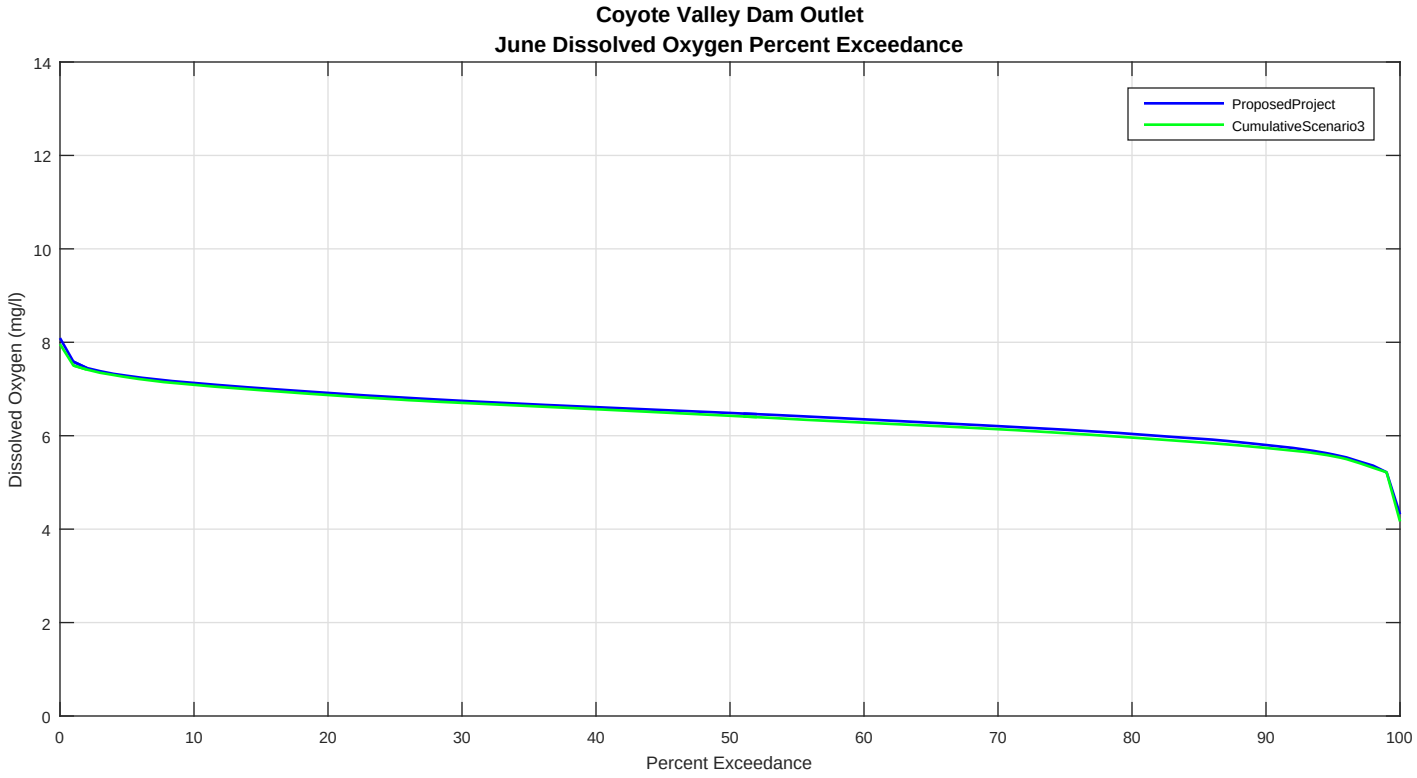
70
80
90
100


Coyote Valley Dam Outlet
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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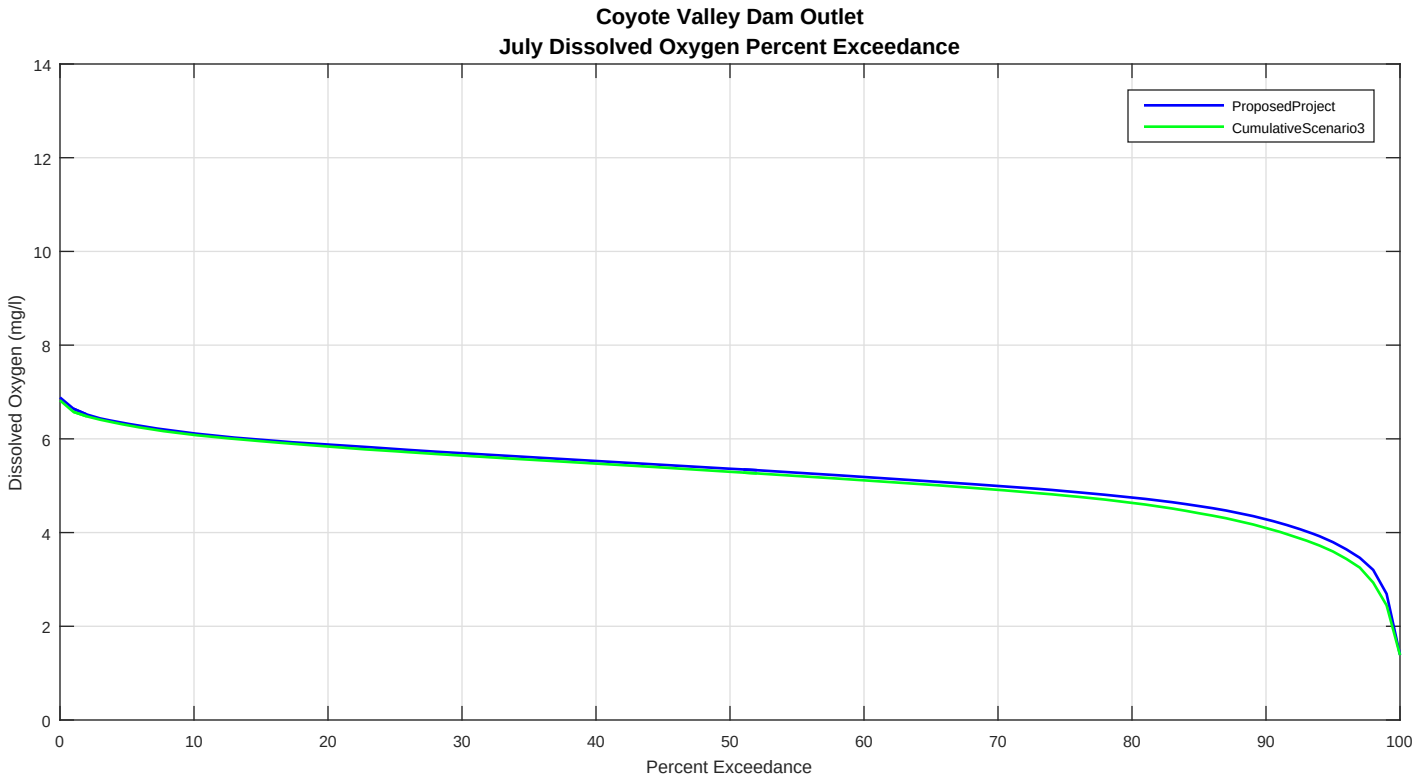
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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4
6
8
10
12
14
0
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20
30
40
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90
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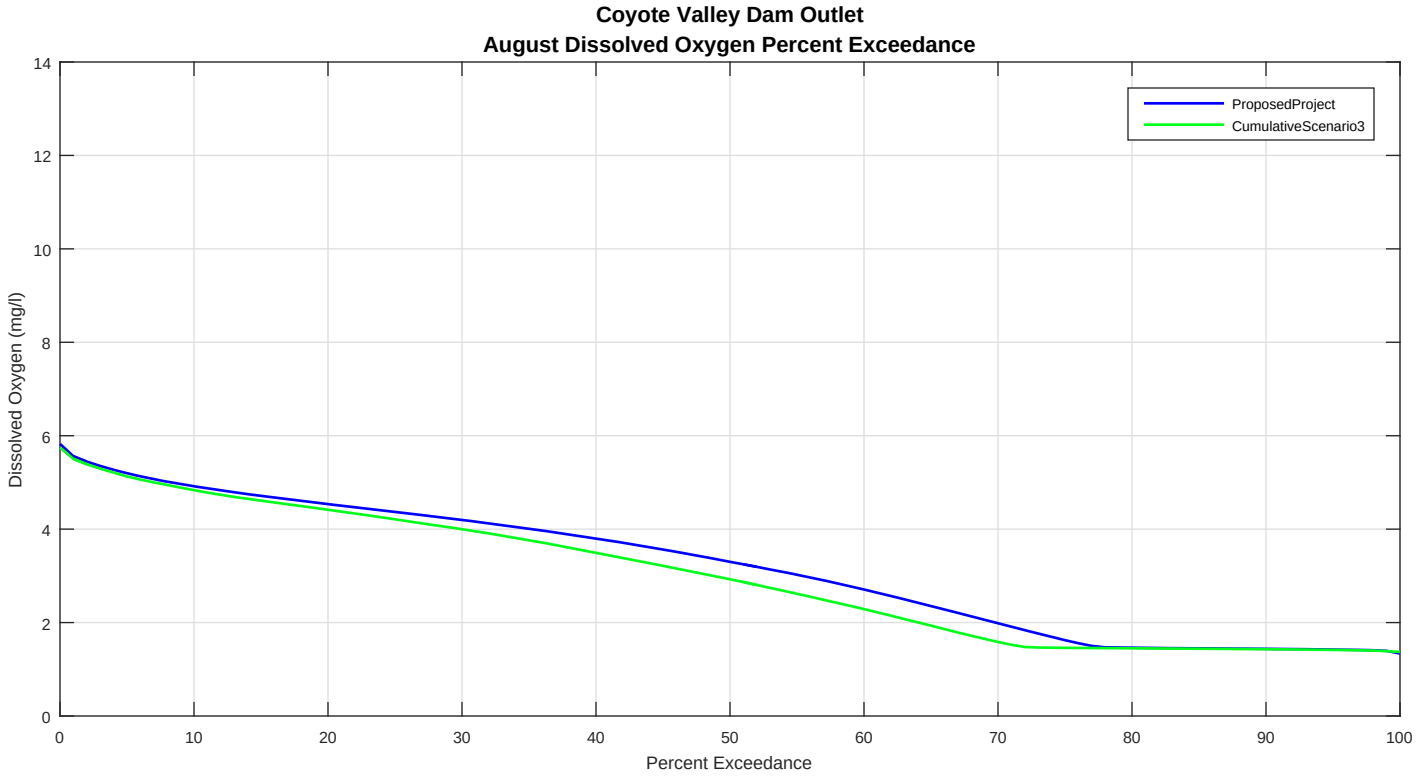
Coyote Valley Dam Outlet
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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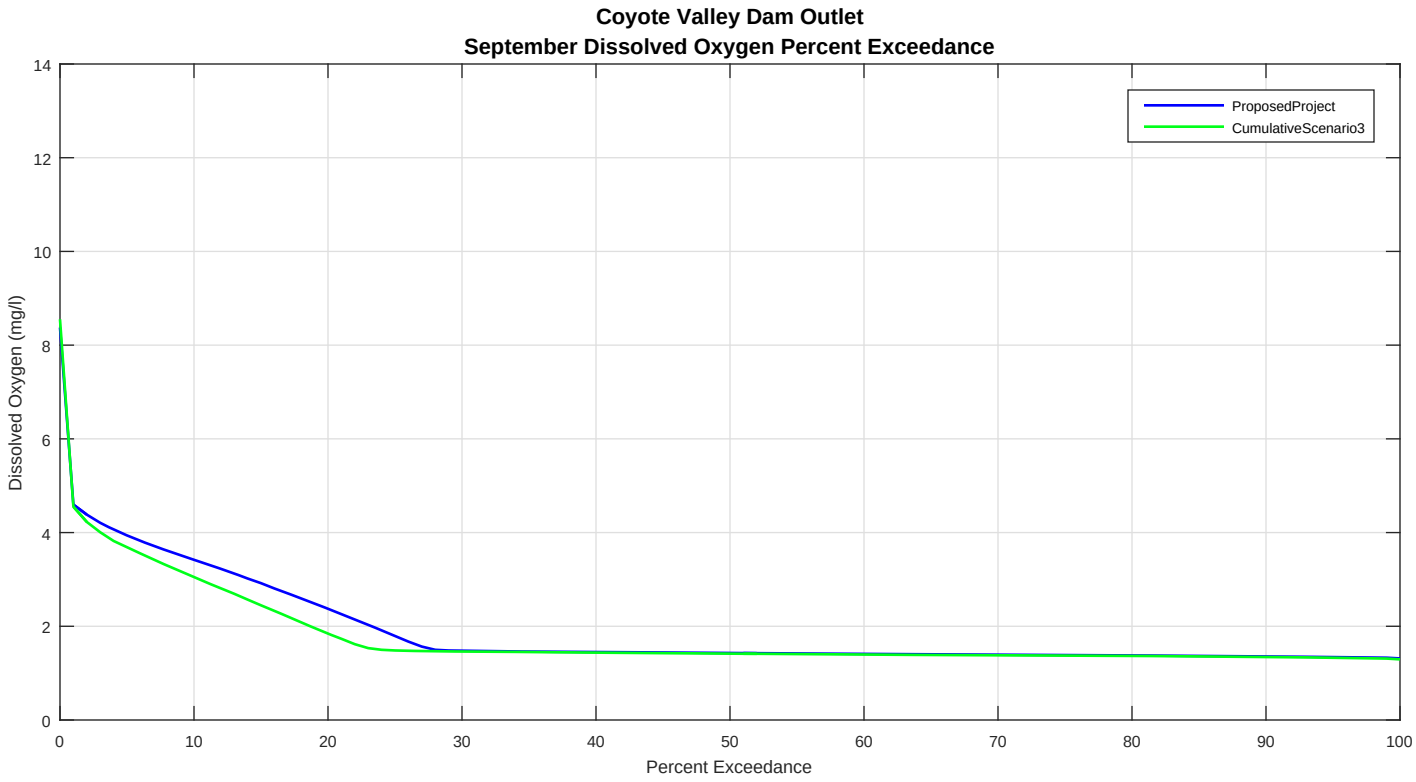
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
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40
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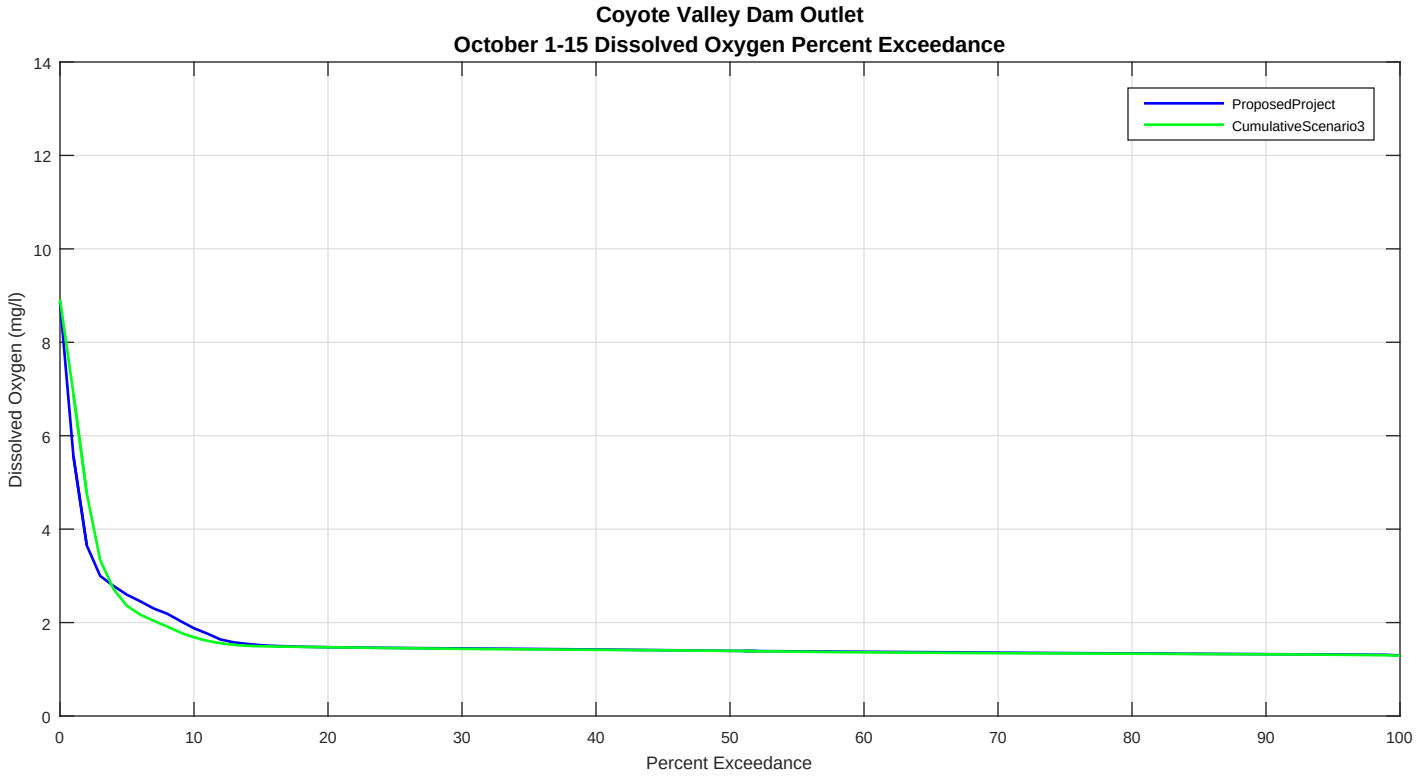
Coyote Valley Dam Outlet
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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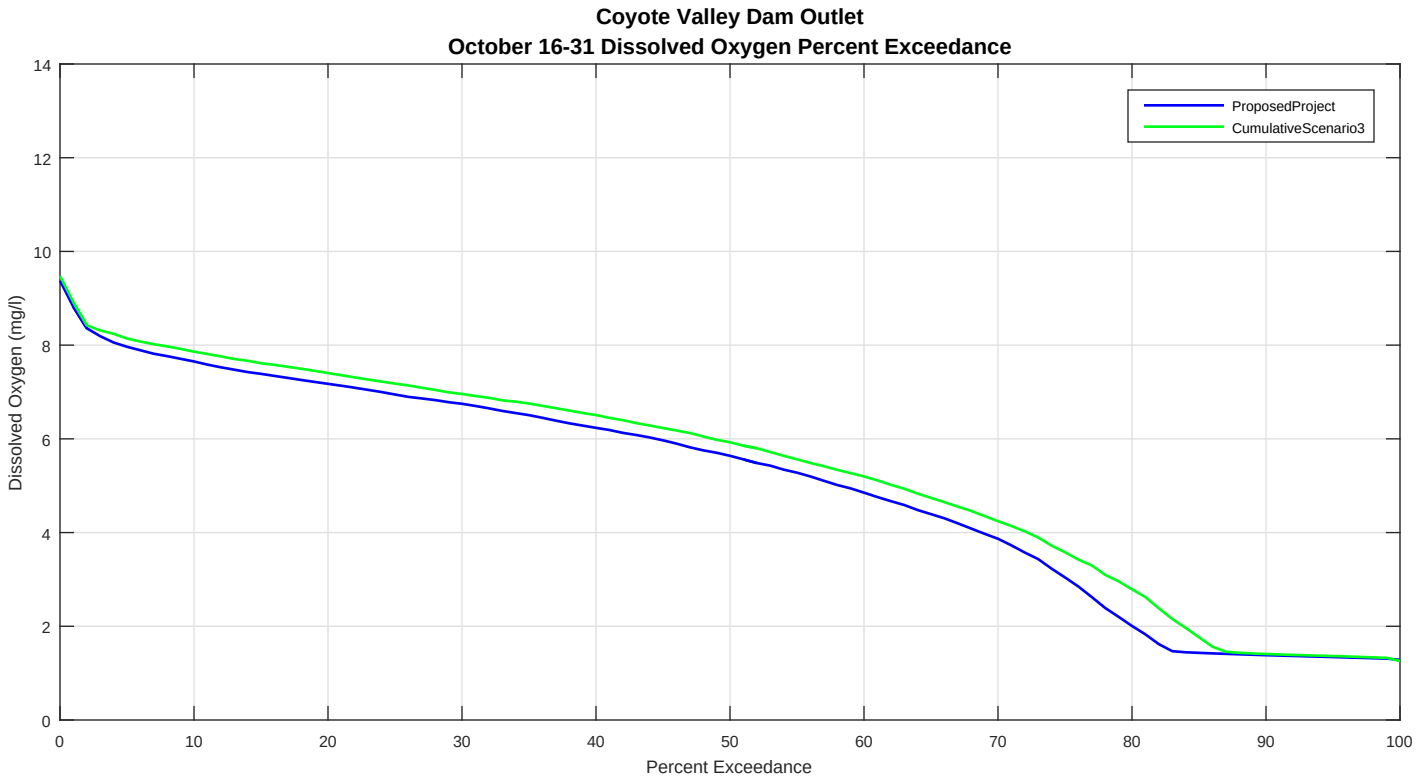
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
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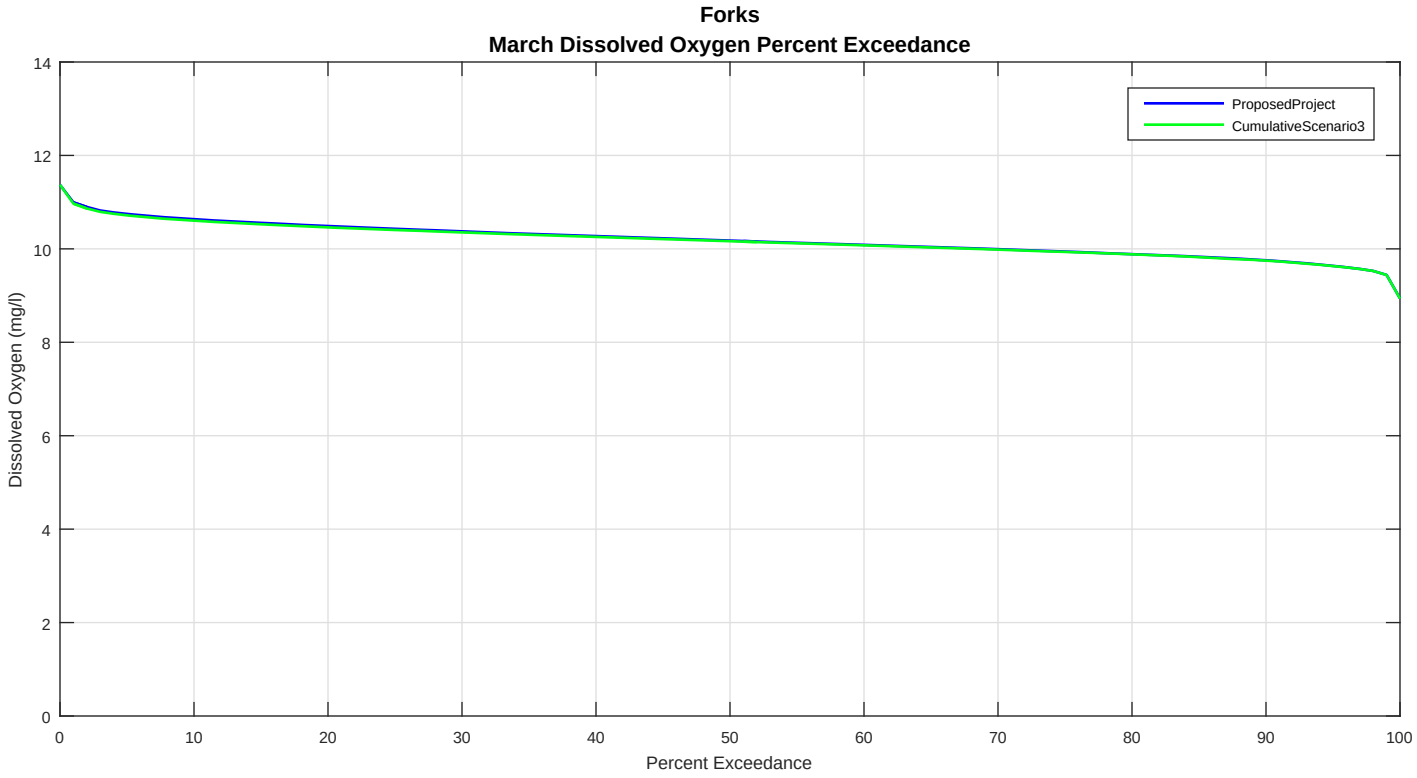
Forks
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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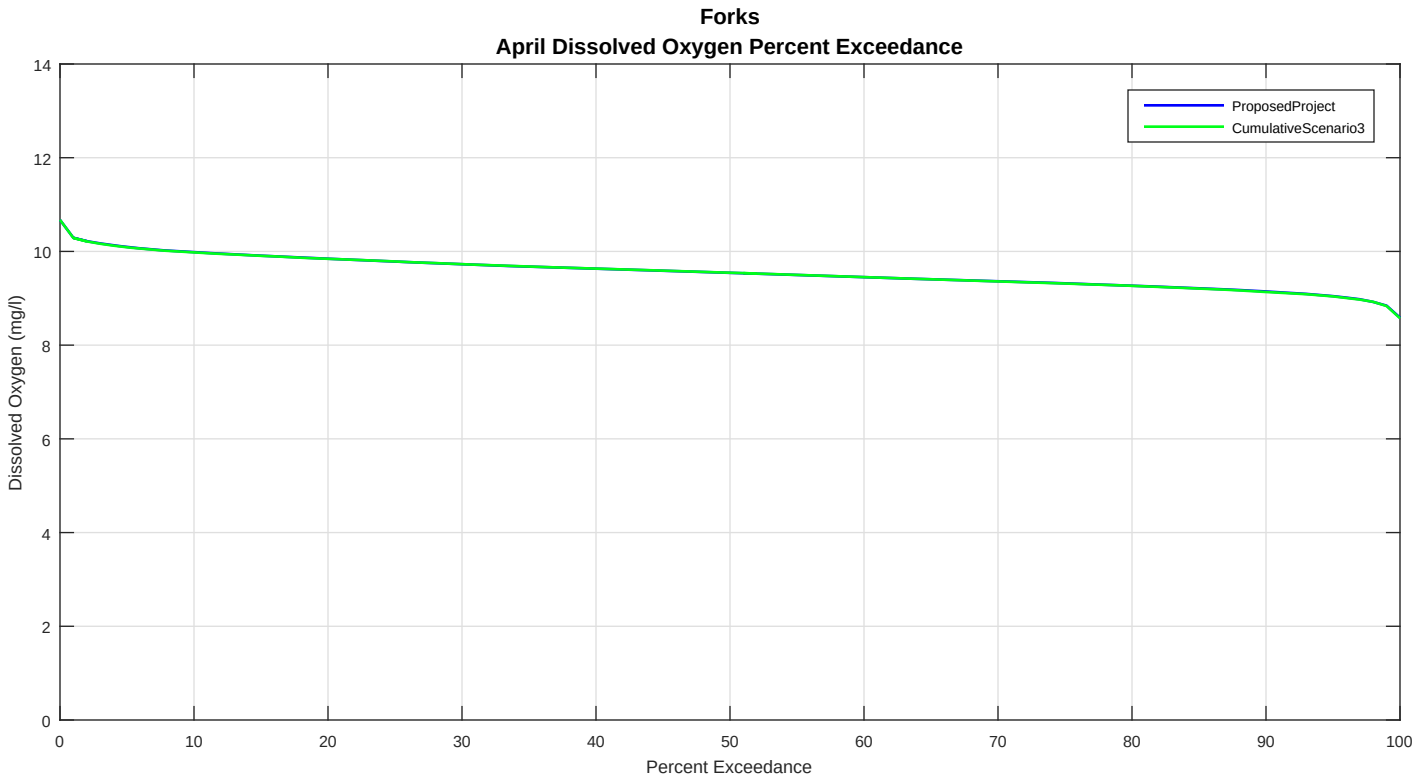
Forks
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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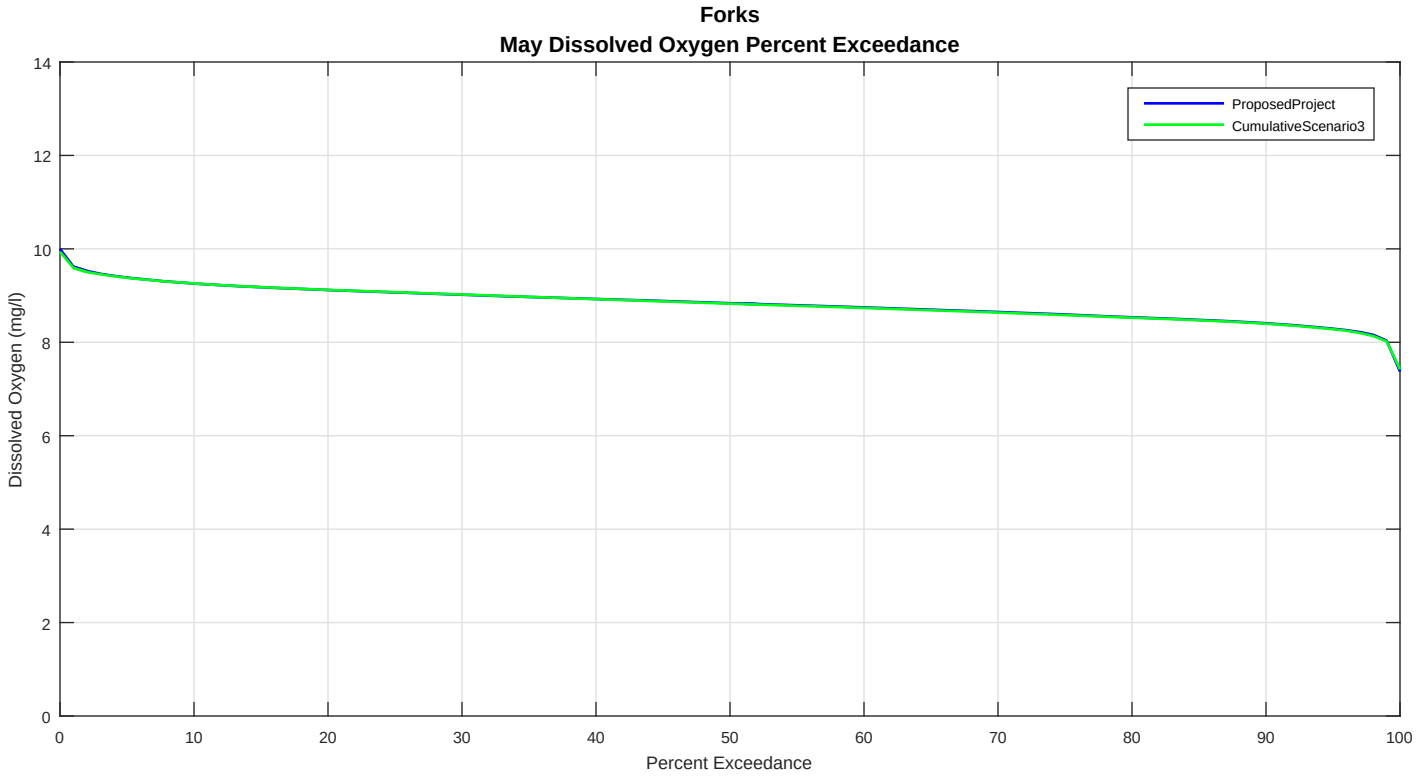
Forks
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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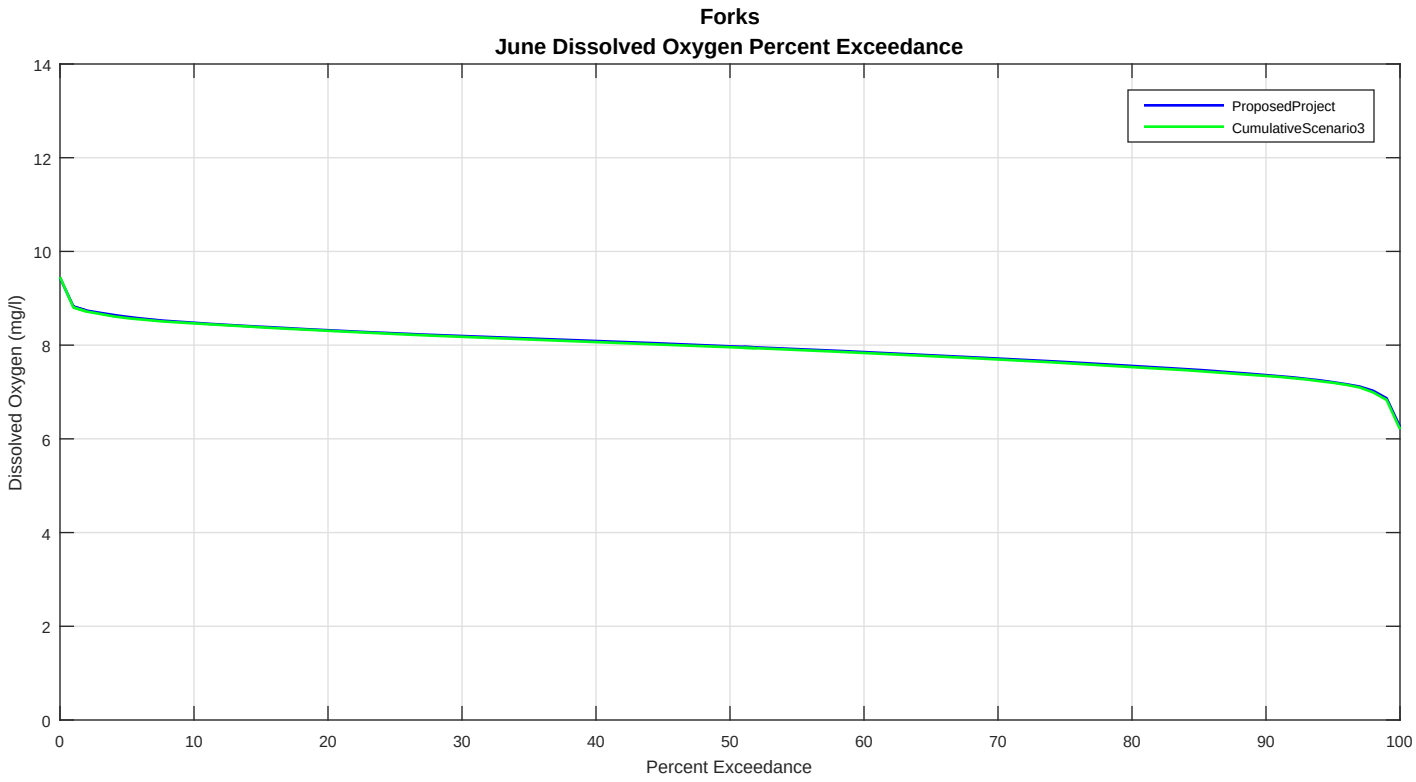
Forks
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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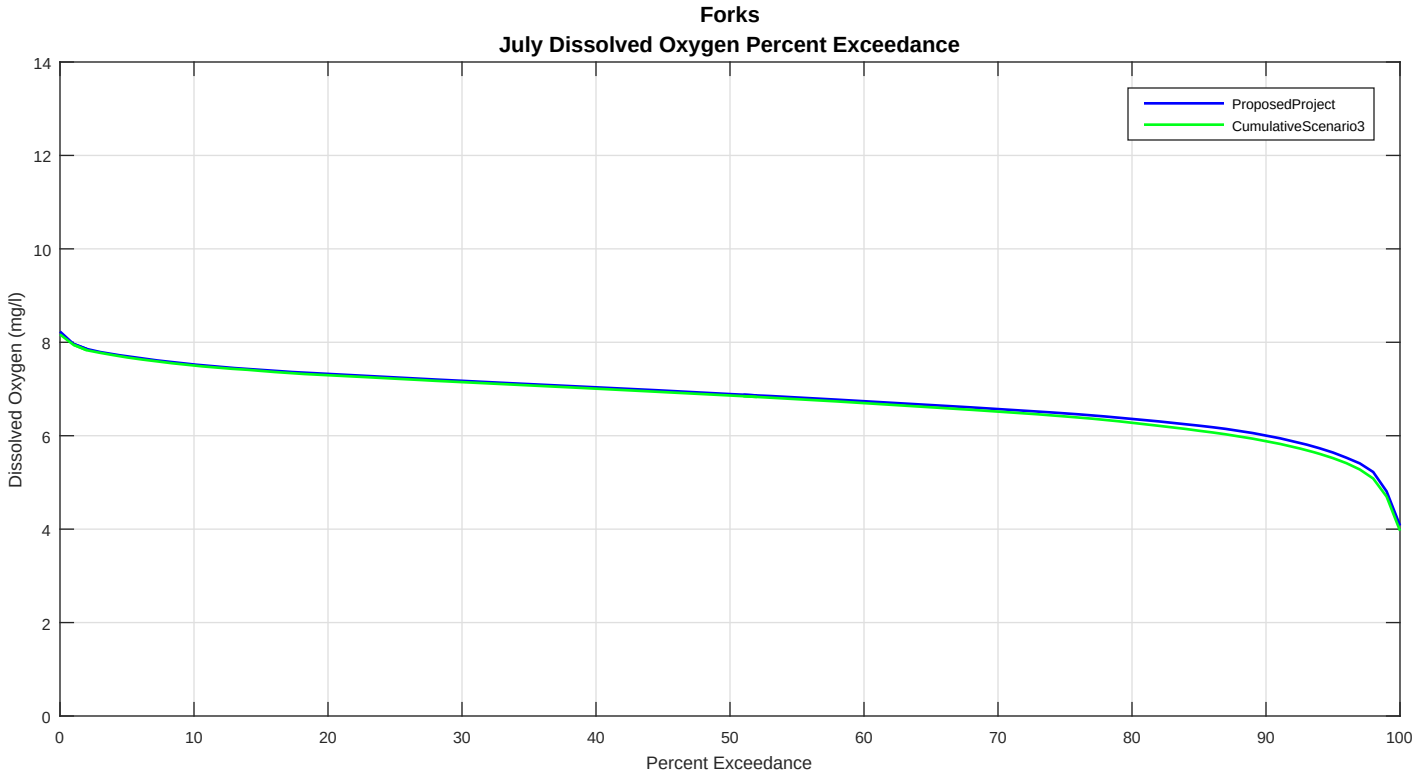
Forks
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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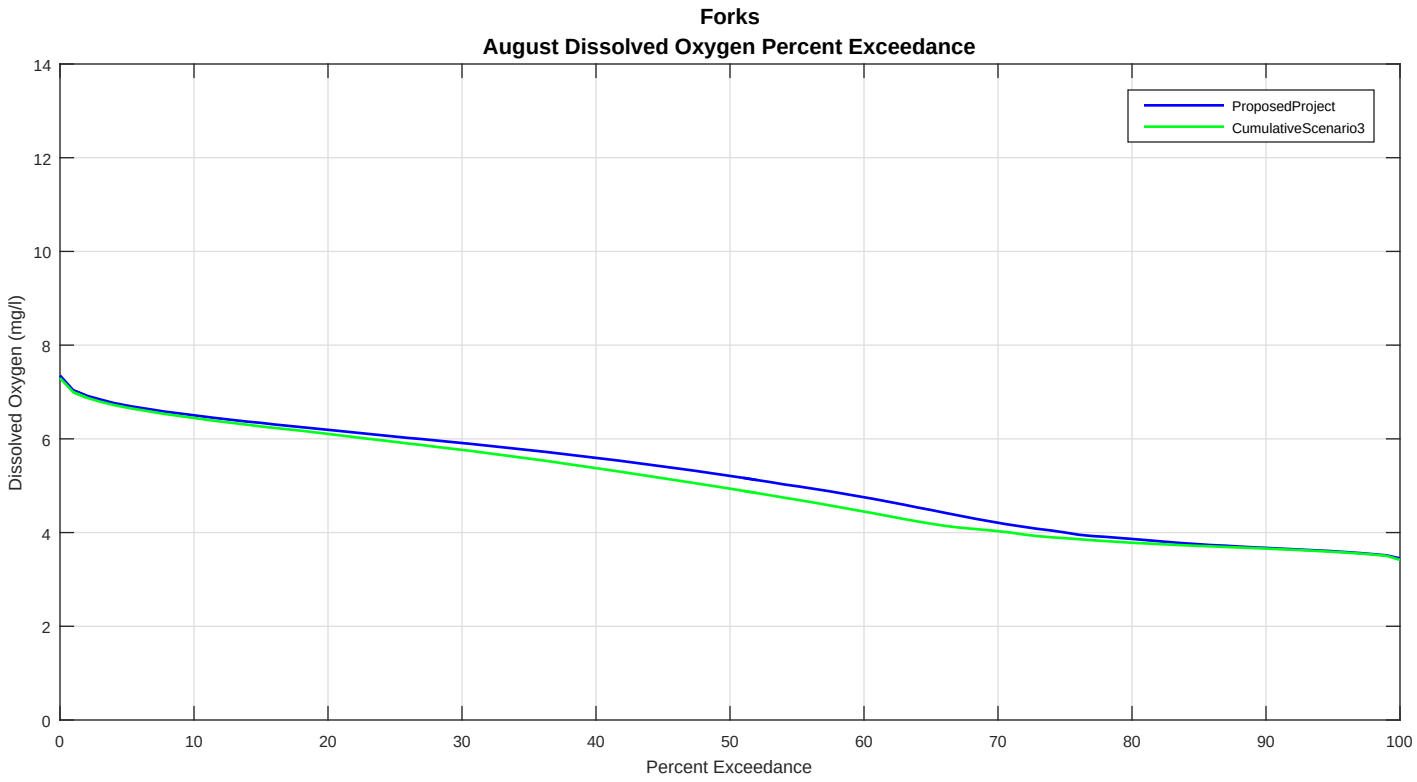
Forks
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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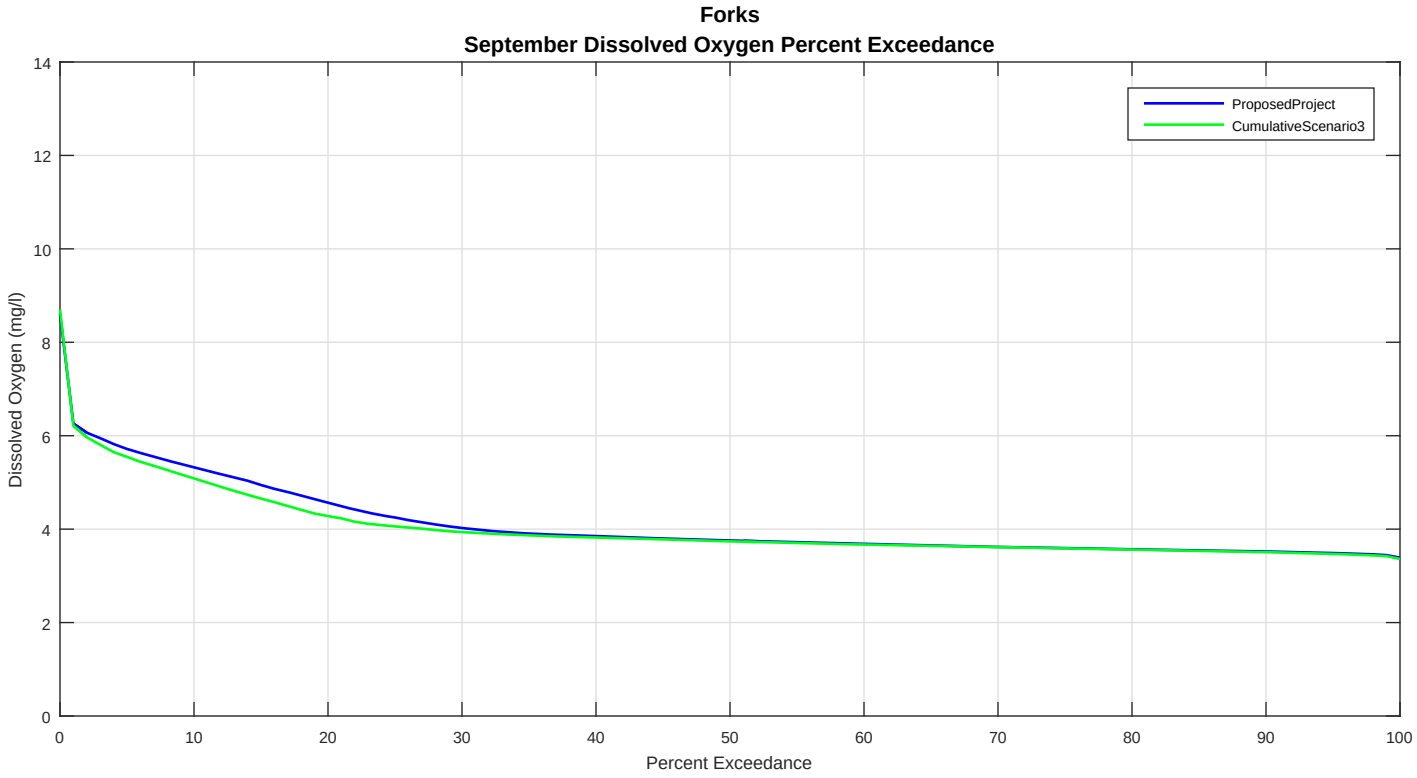
Forks
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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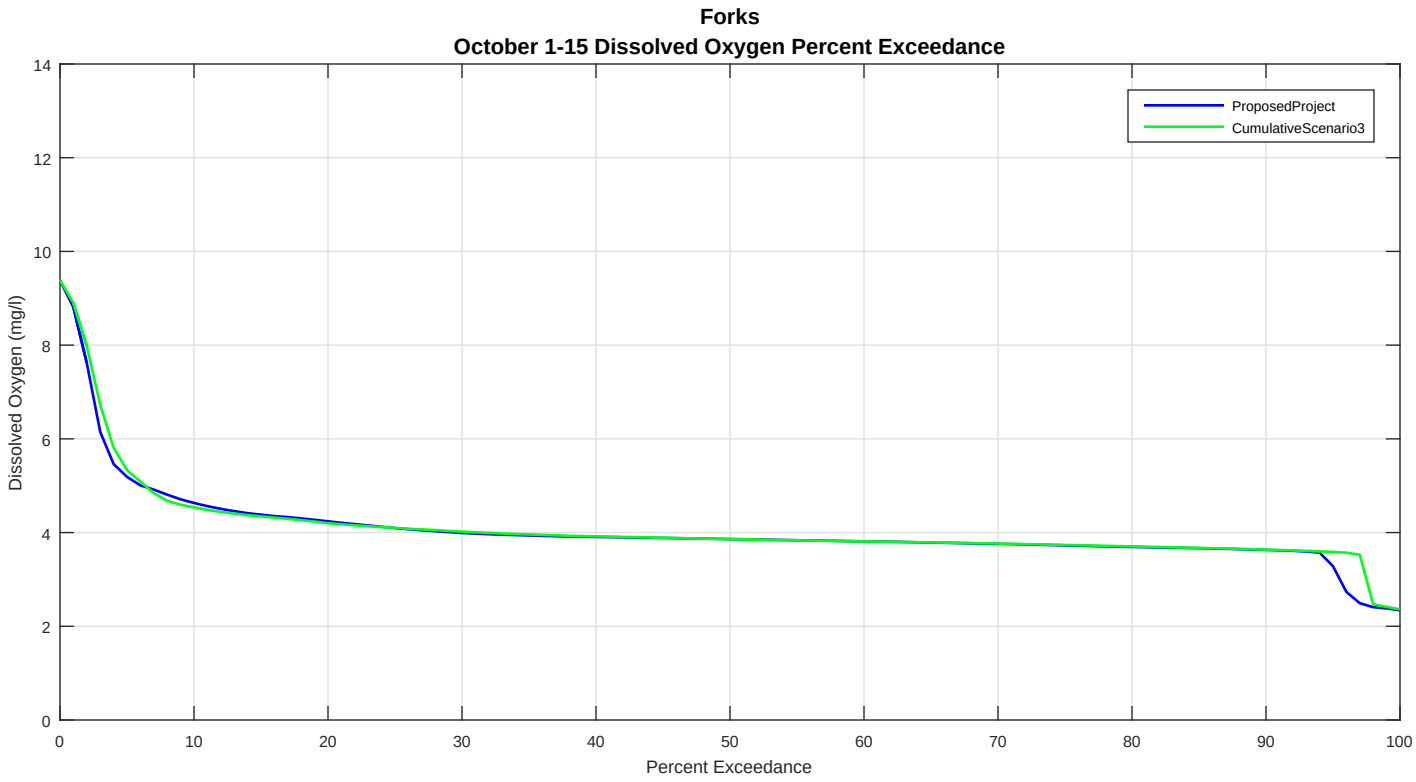
Forks
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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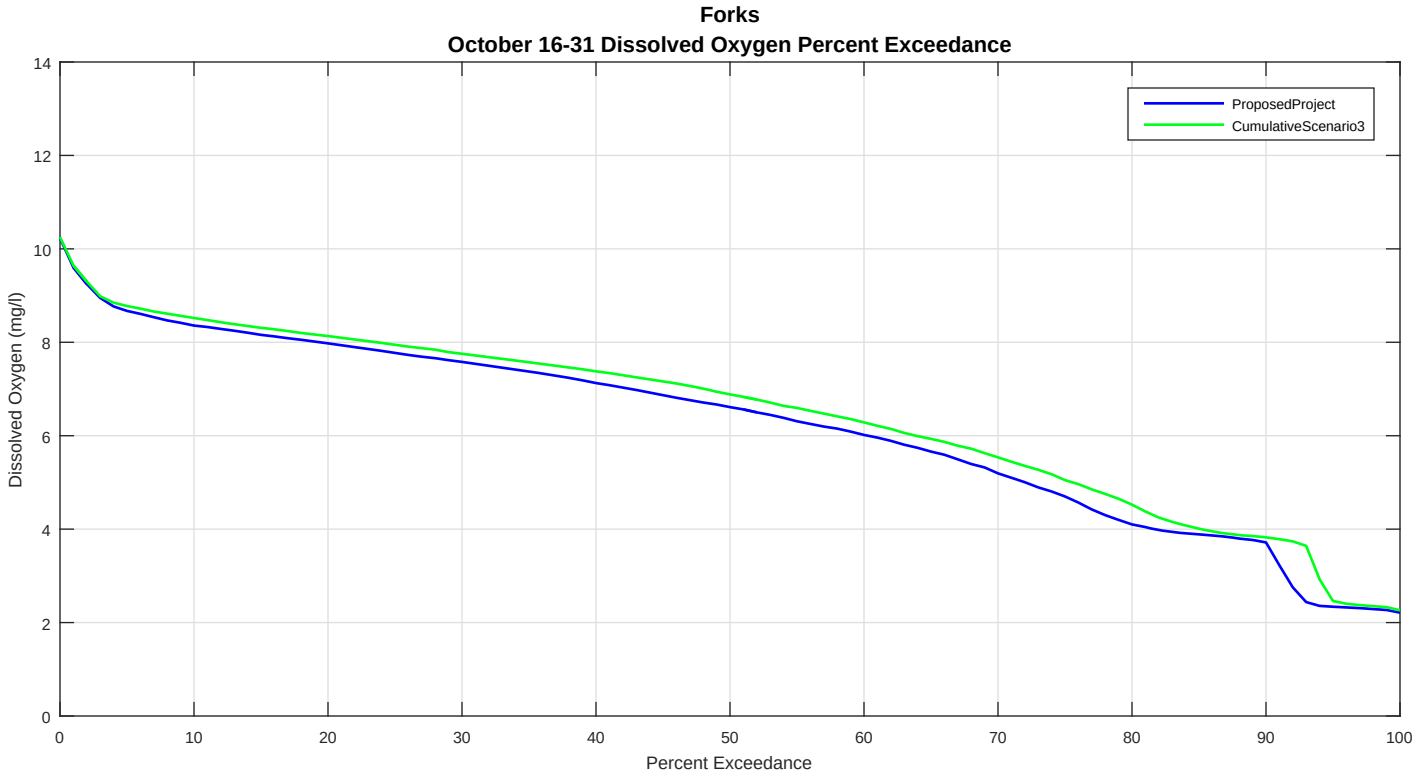
Forks
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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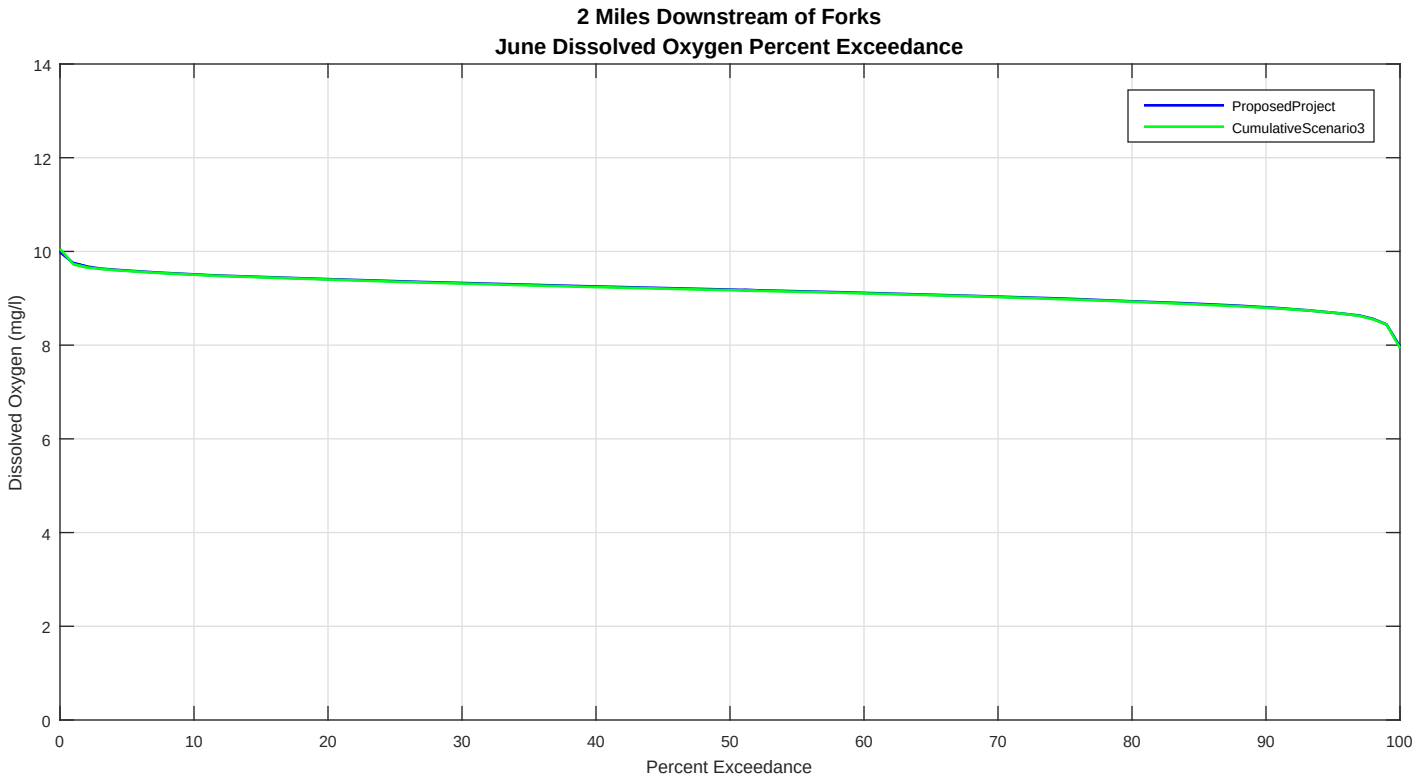
2 Miles Downstream of Forks
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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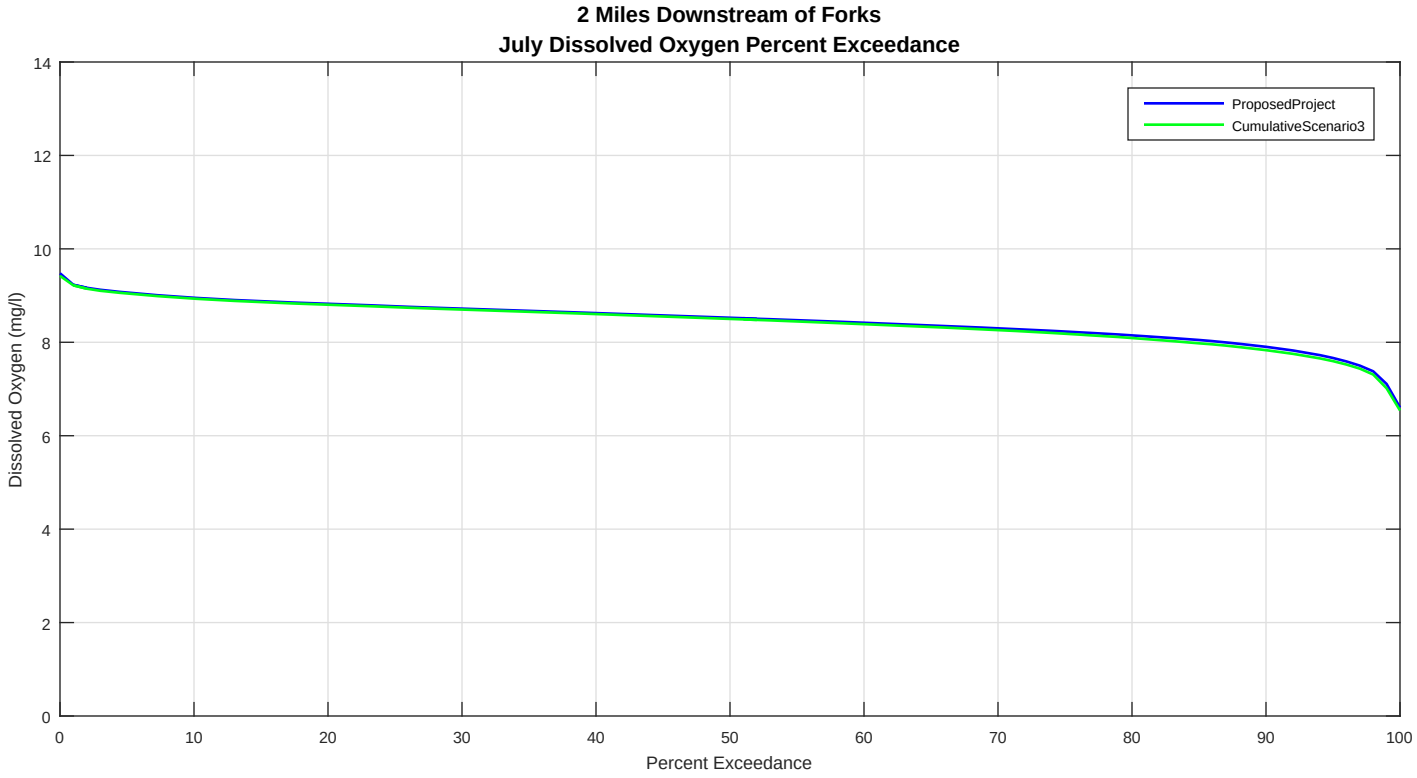
2 Miles Downstream of Forks
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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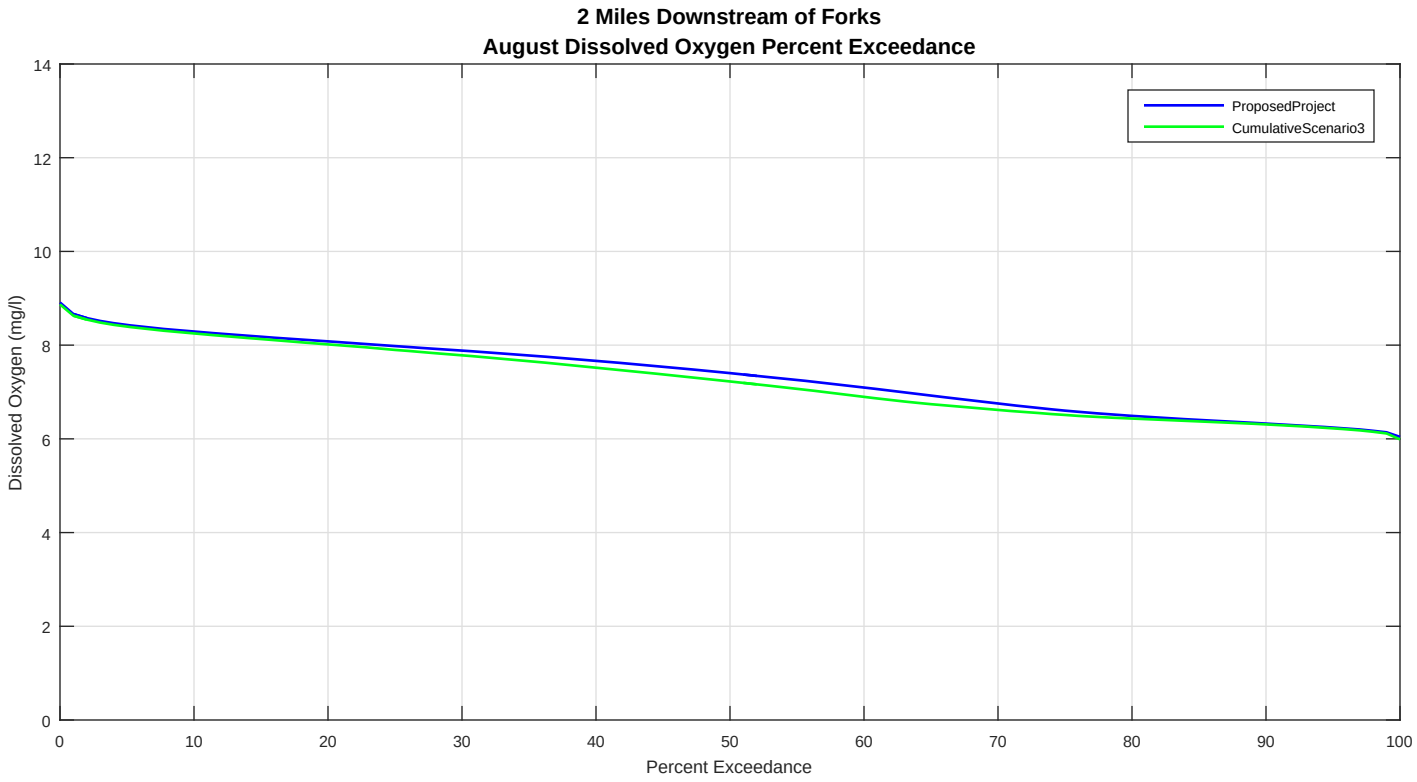
2 Miles Downstream of Forks
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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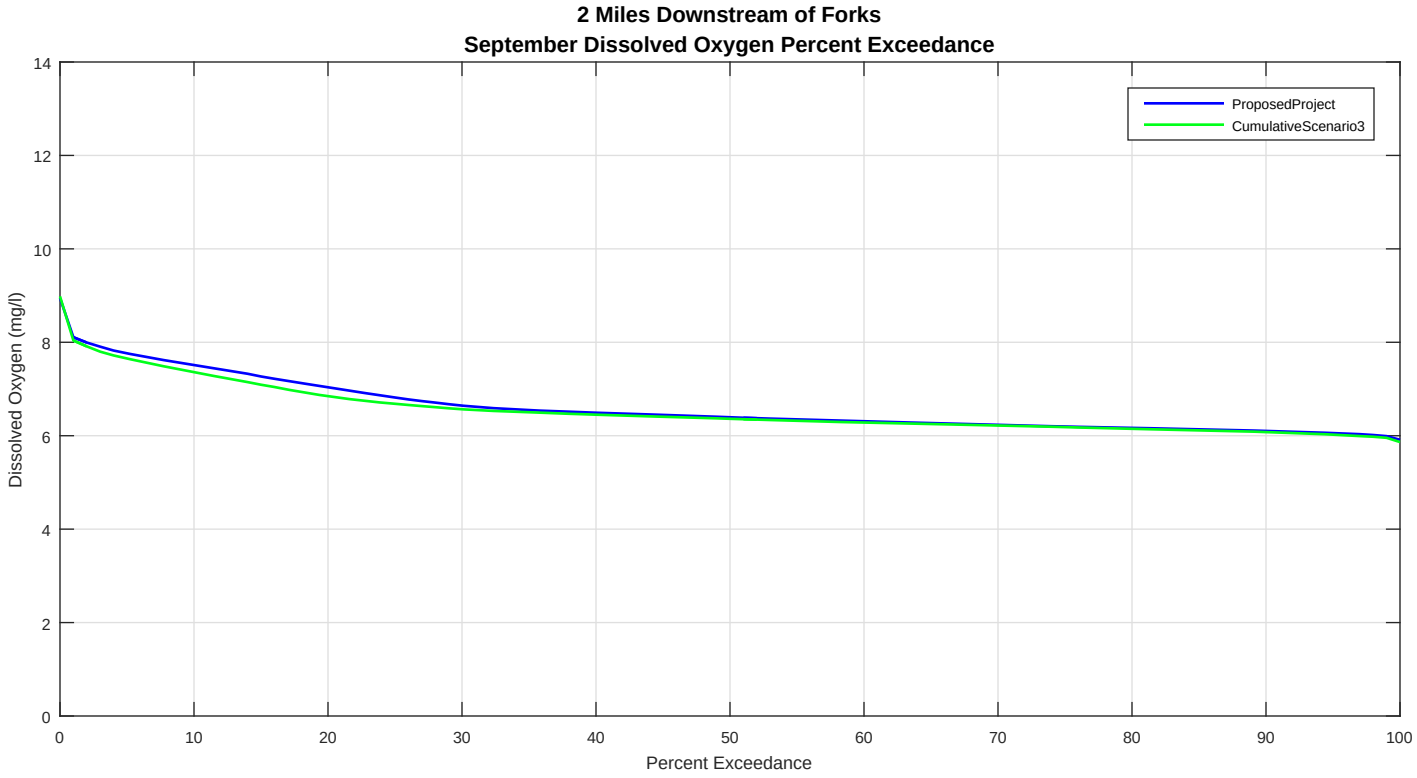
2 Miles Downstream of Forks
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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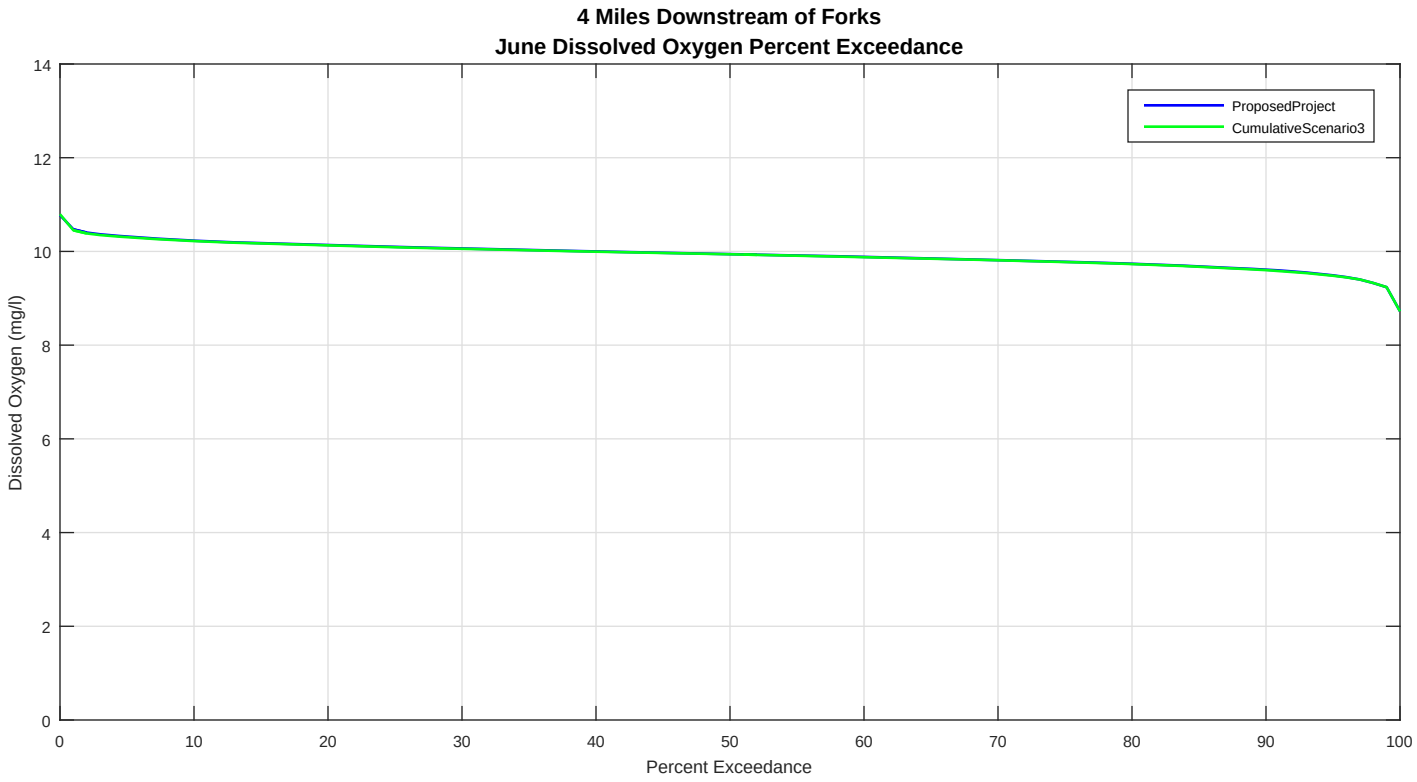
4 Miles Downstream of Forks
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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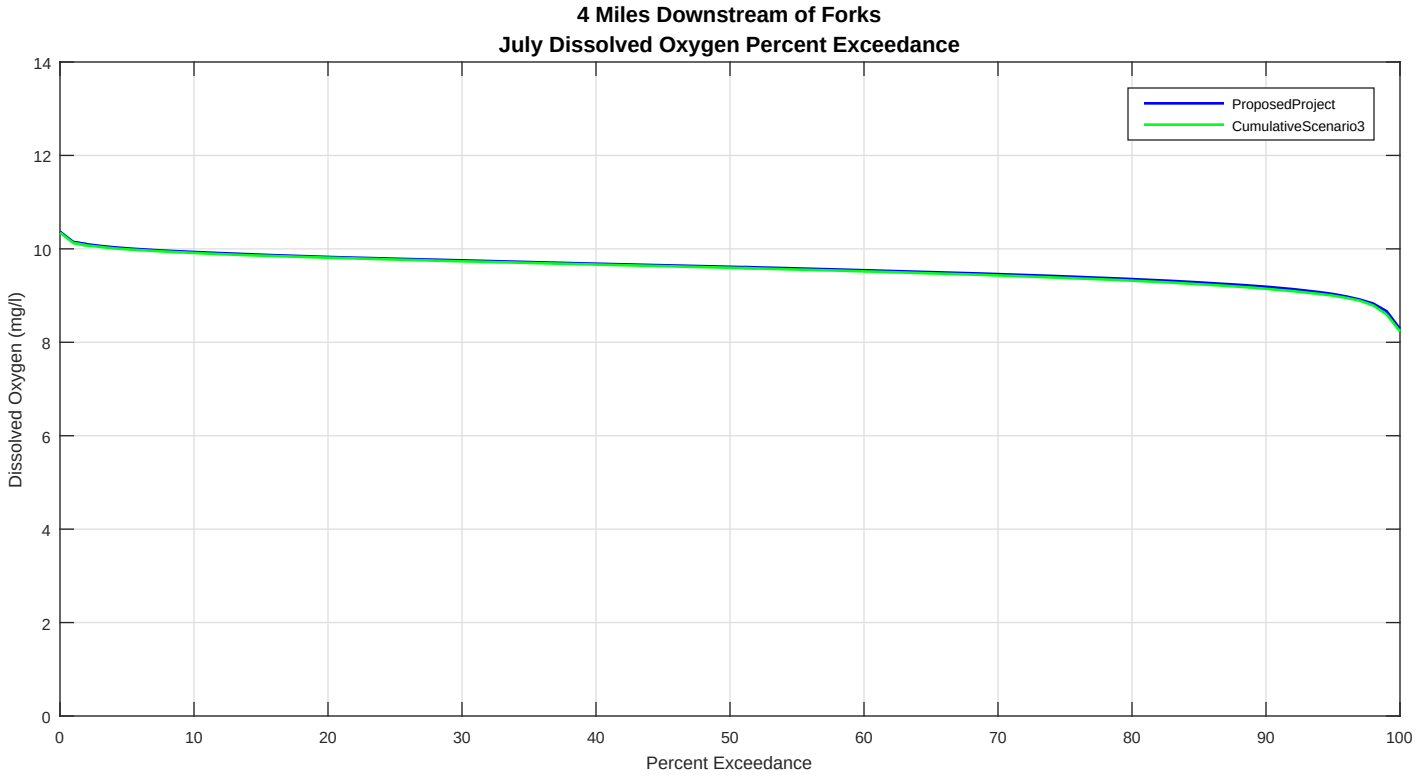
4 Miles Downstream of Forks
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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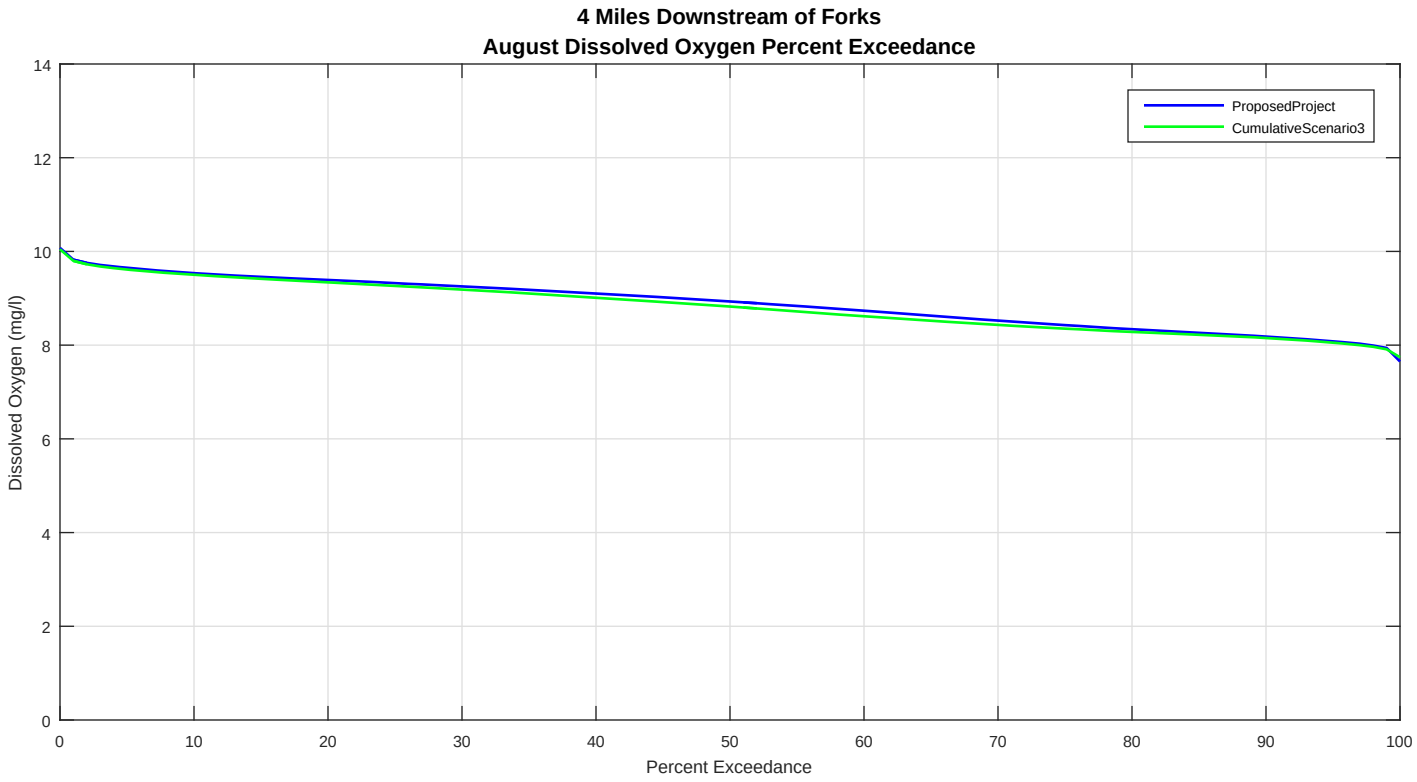
4 Miles Downstream of Forks
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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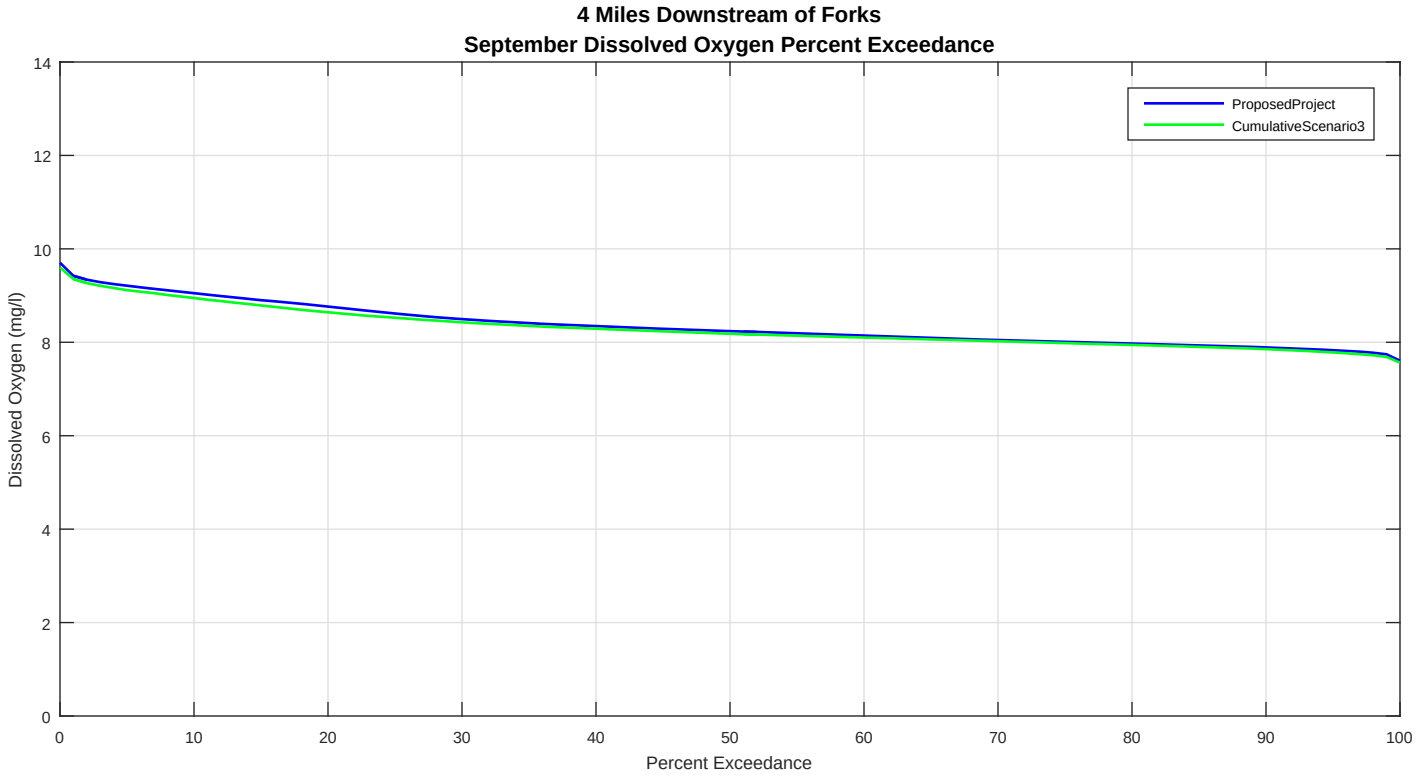
4 Miles Downstream of Forks
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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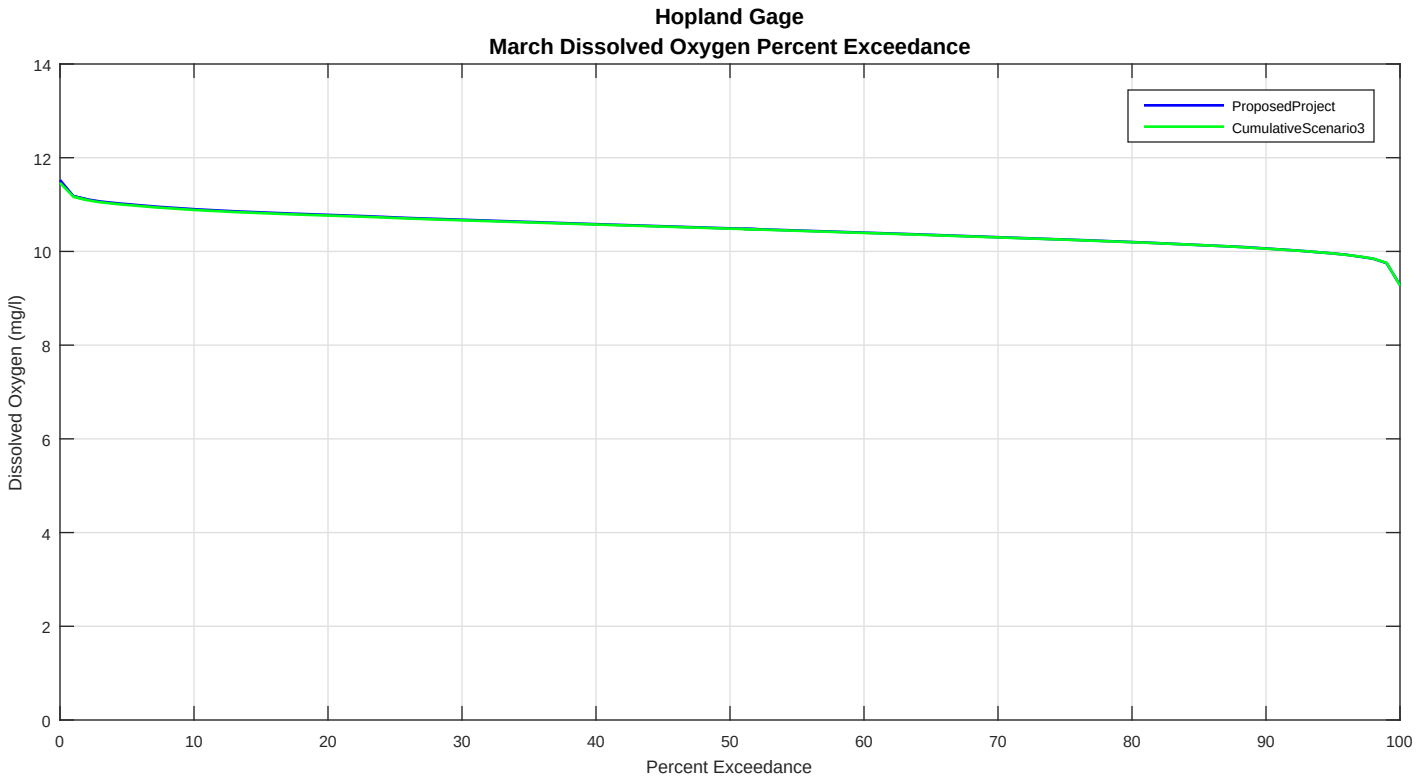
Hopland Gage
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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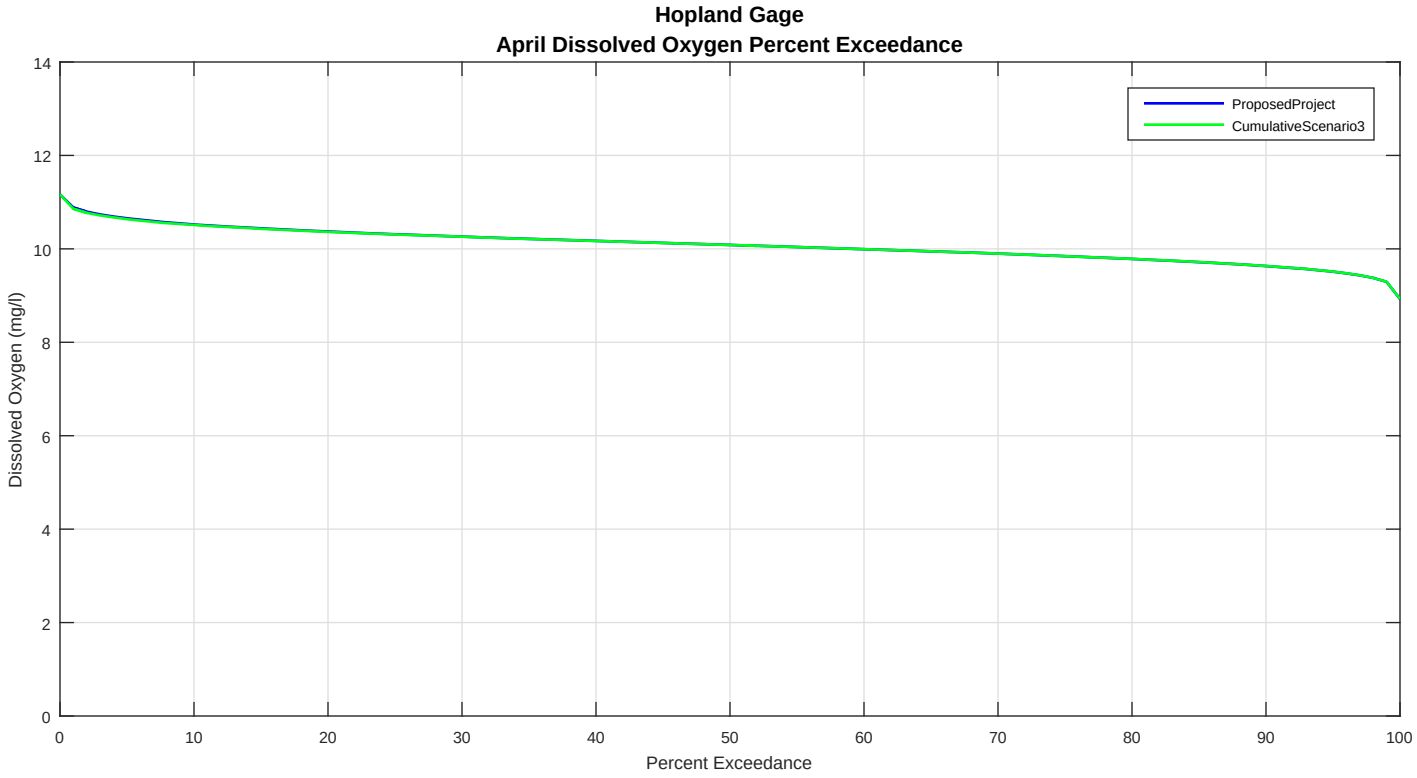
Hopland Gage
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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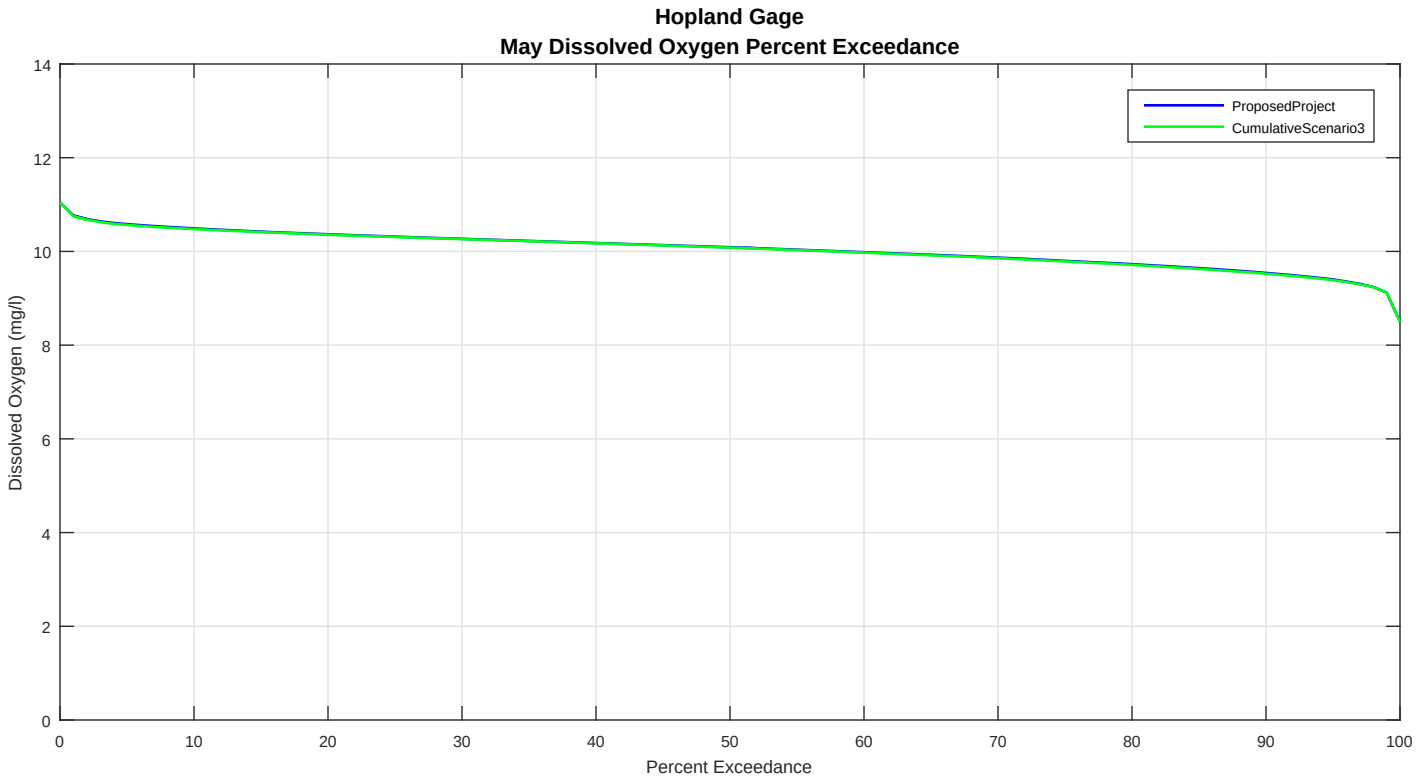
Hopland Gage
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ProposedProject
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Dissolved Oxygen (mg/l)
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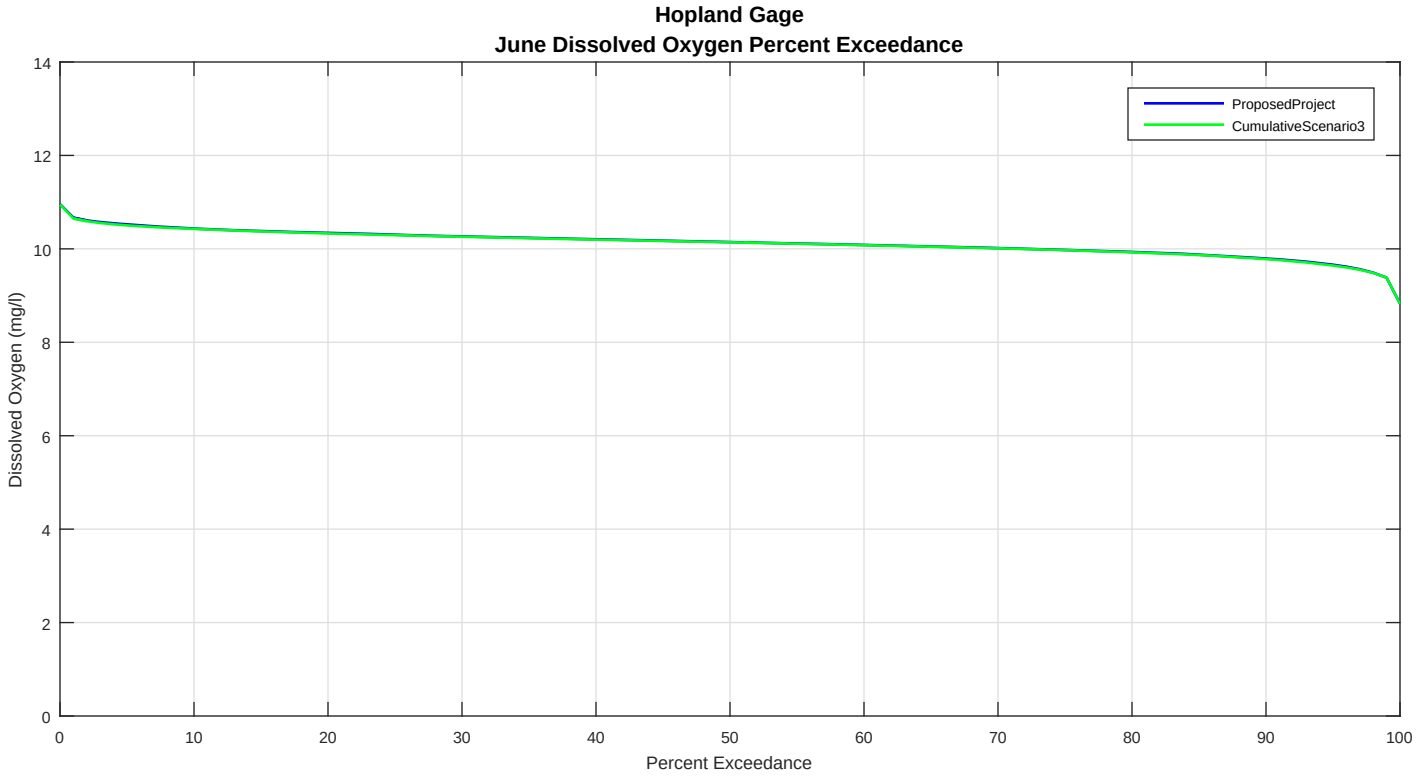
Hopland Gage
June Dissolved Oxygen Percent Exceedance
ProposedProject
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Dissolved Oxygen (mg/l)
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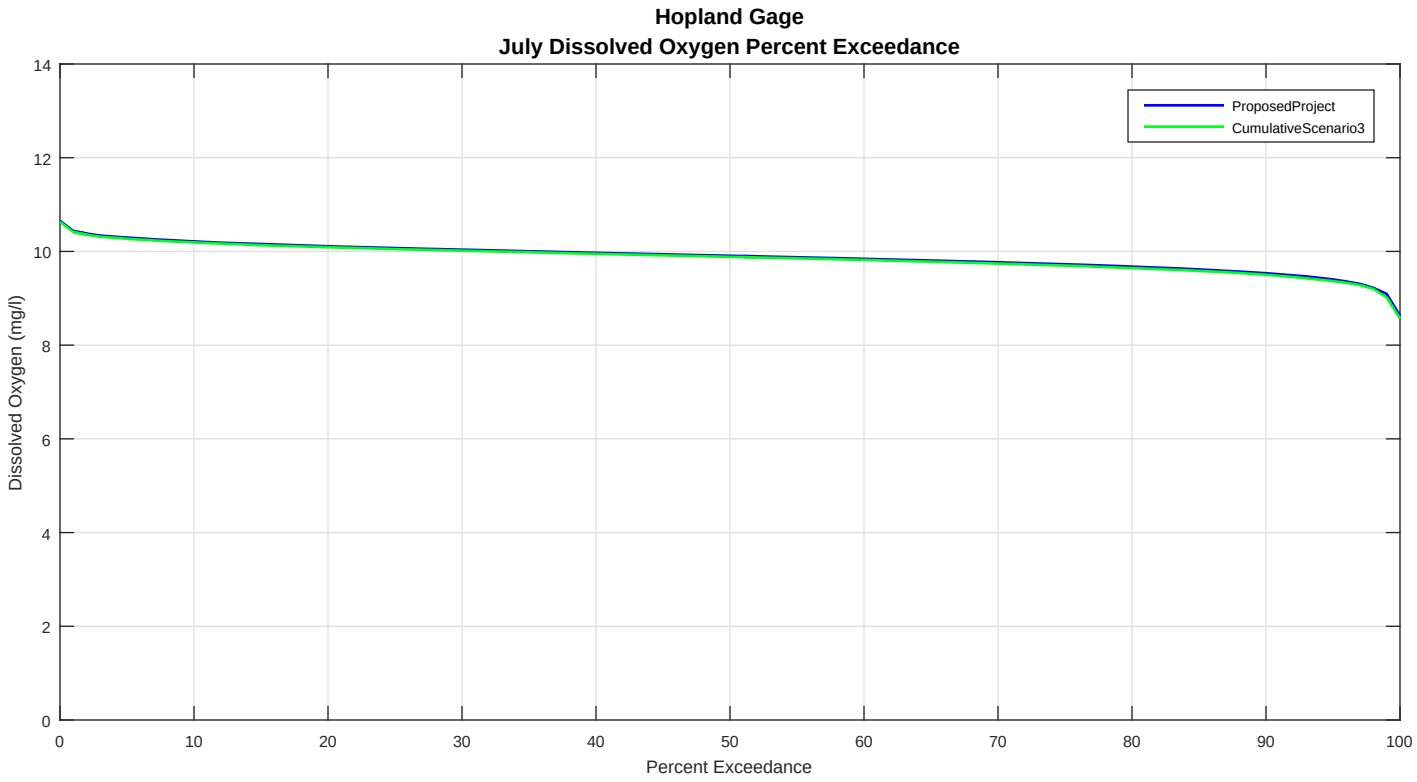
Hopland Gage
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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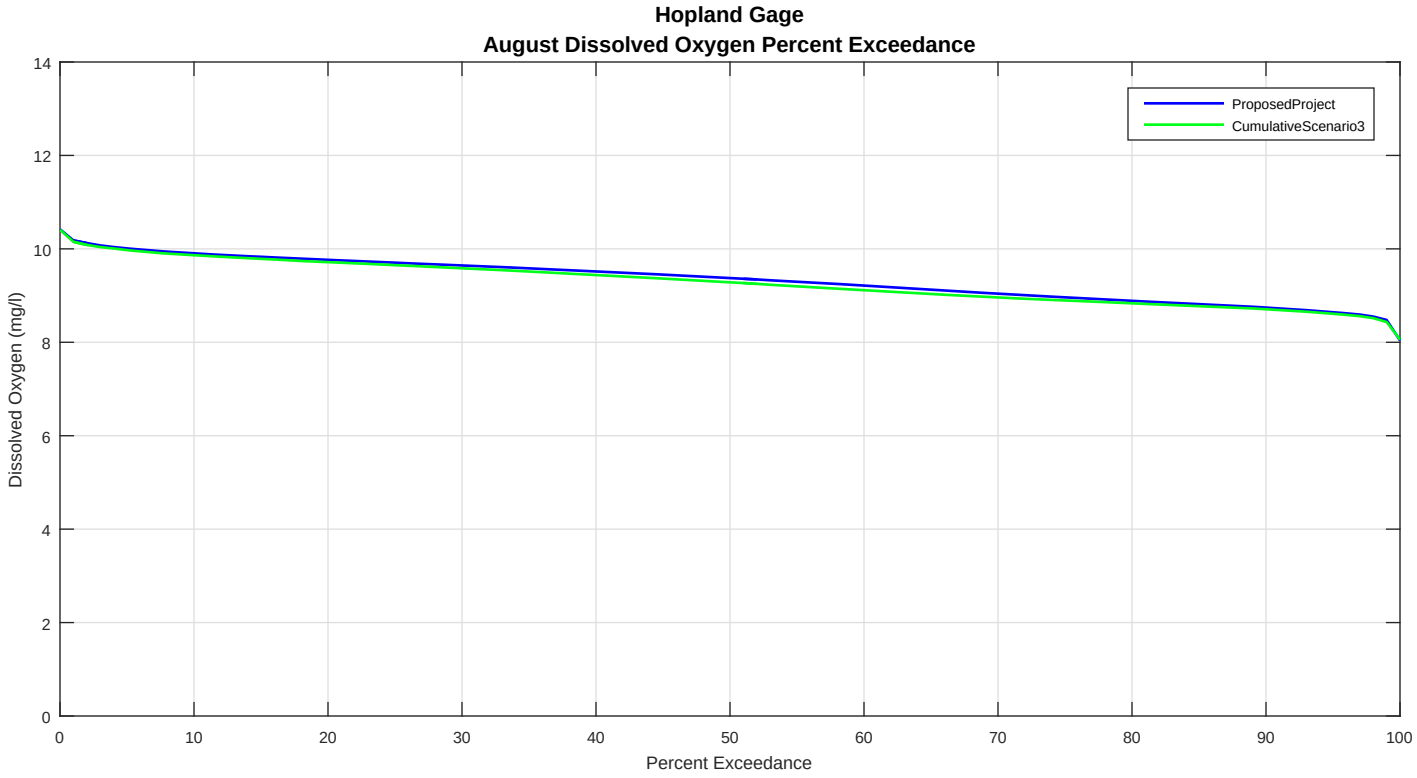
Hopland Gage
August Dissolved Oxygen Percent Exceedance
ProposedProject
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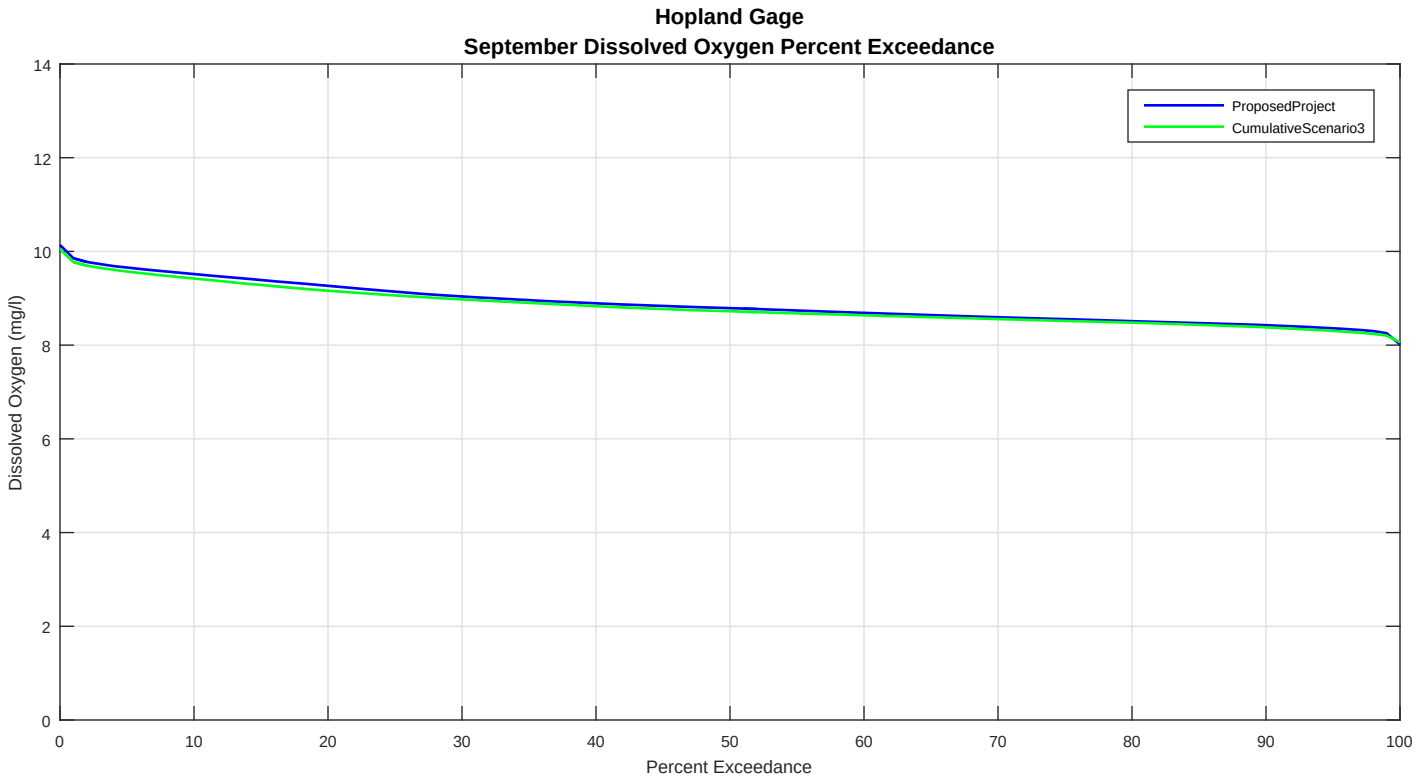
Hopland Gage
September Dissolved Oxygen Percent Exceedance
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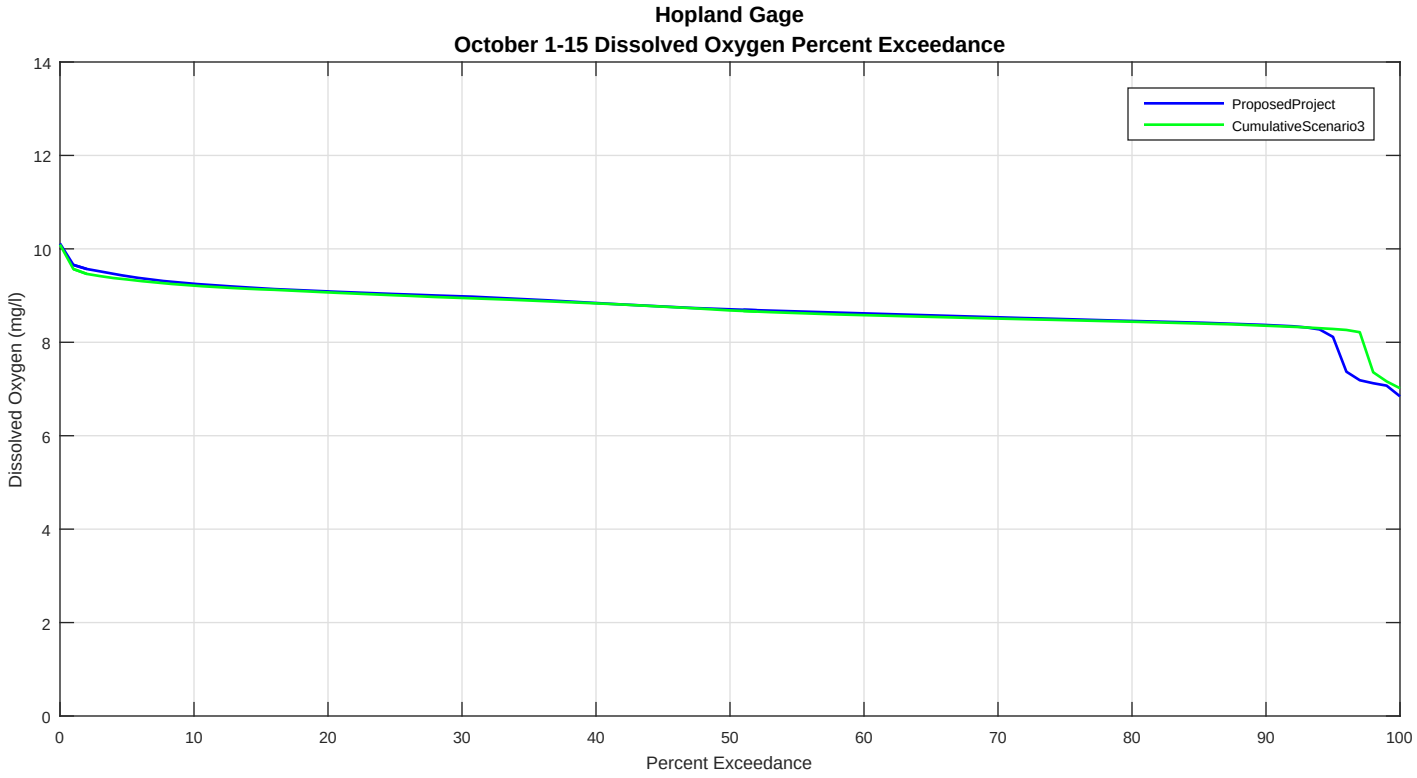
Hopland Gage
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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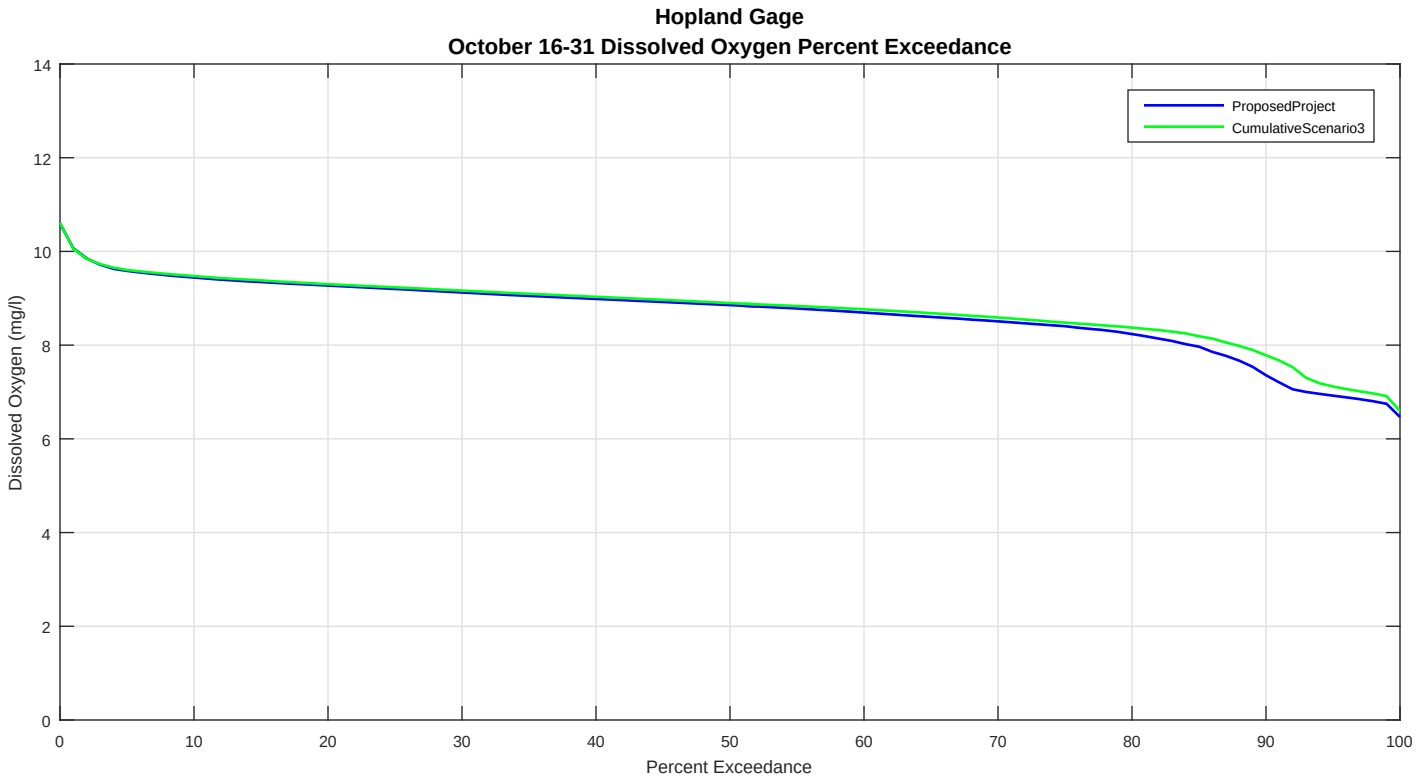
Hopland Gage
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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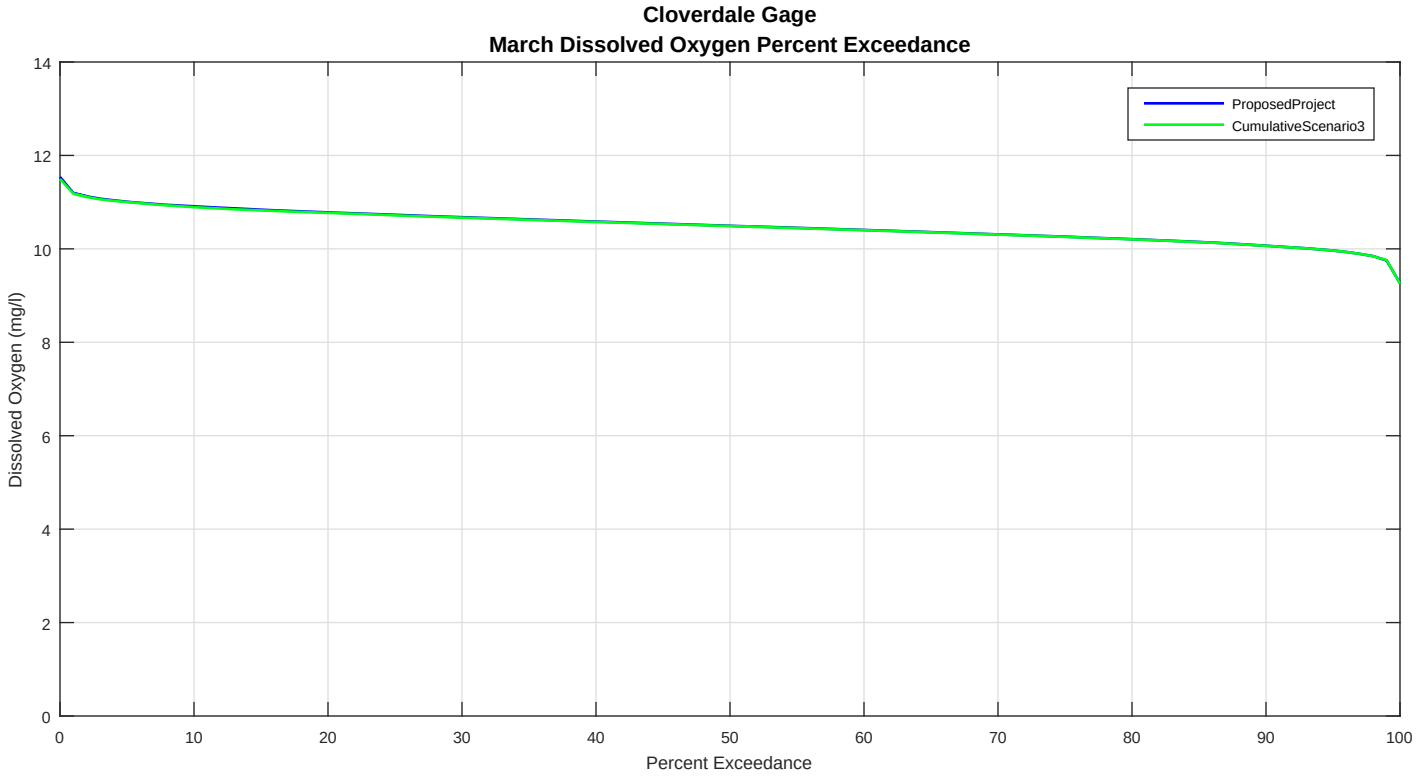
Cloverdale Gage
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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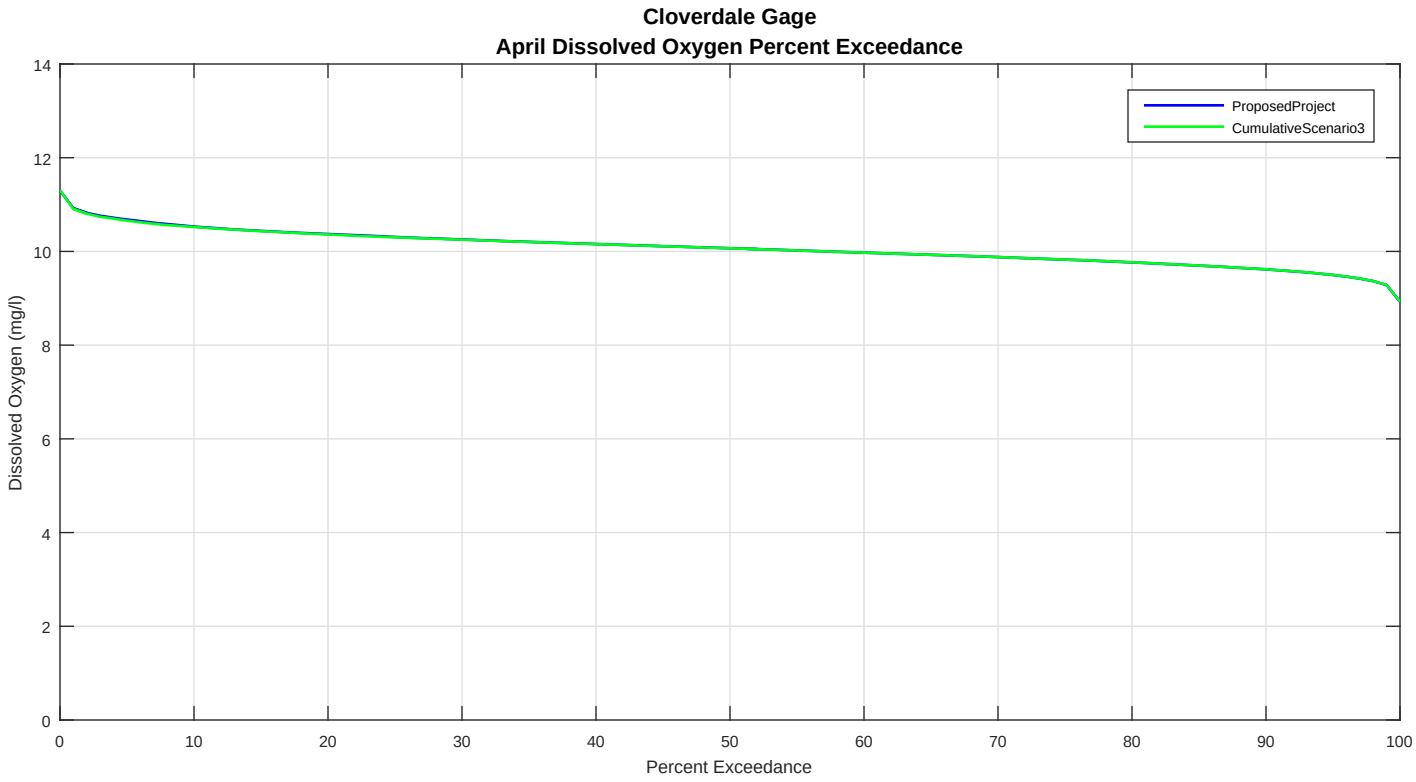
Cloverdale Gage
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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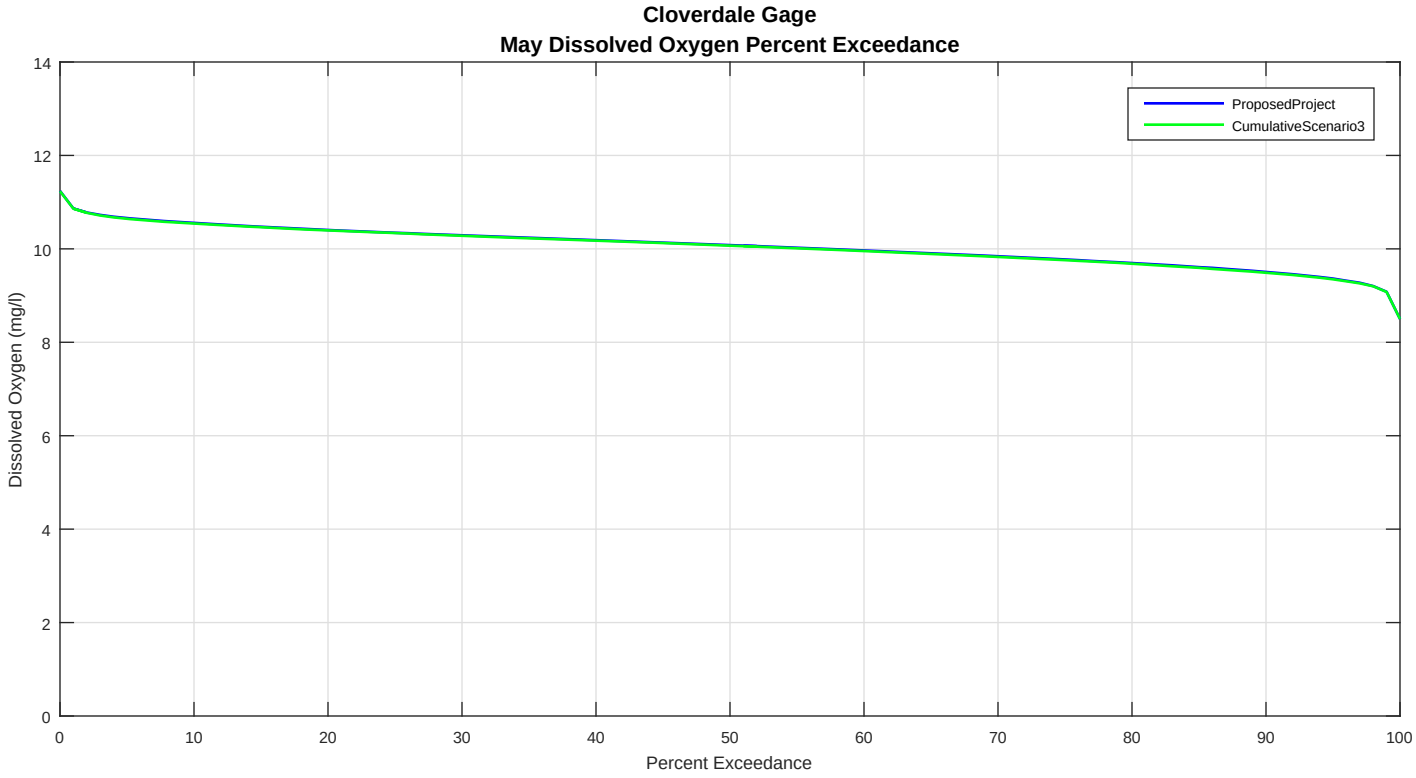
Cloverdale Gage
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ProposedProject
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Dissolved Oxygen (mg/l)
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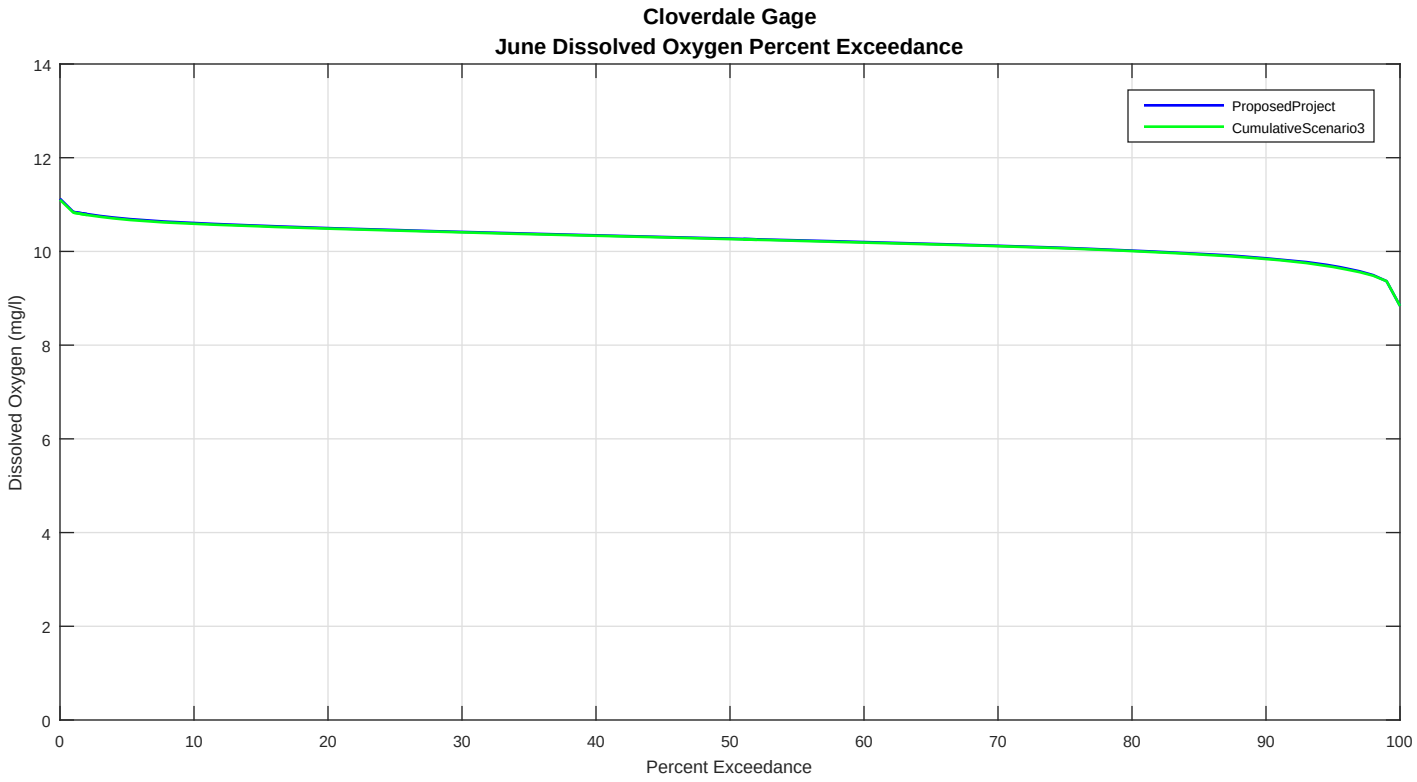
Cloverdale Gage
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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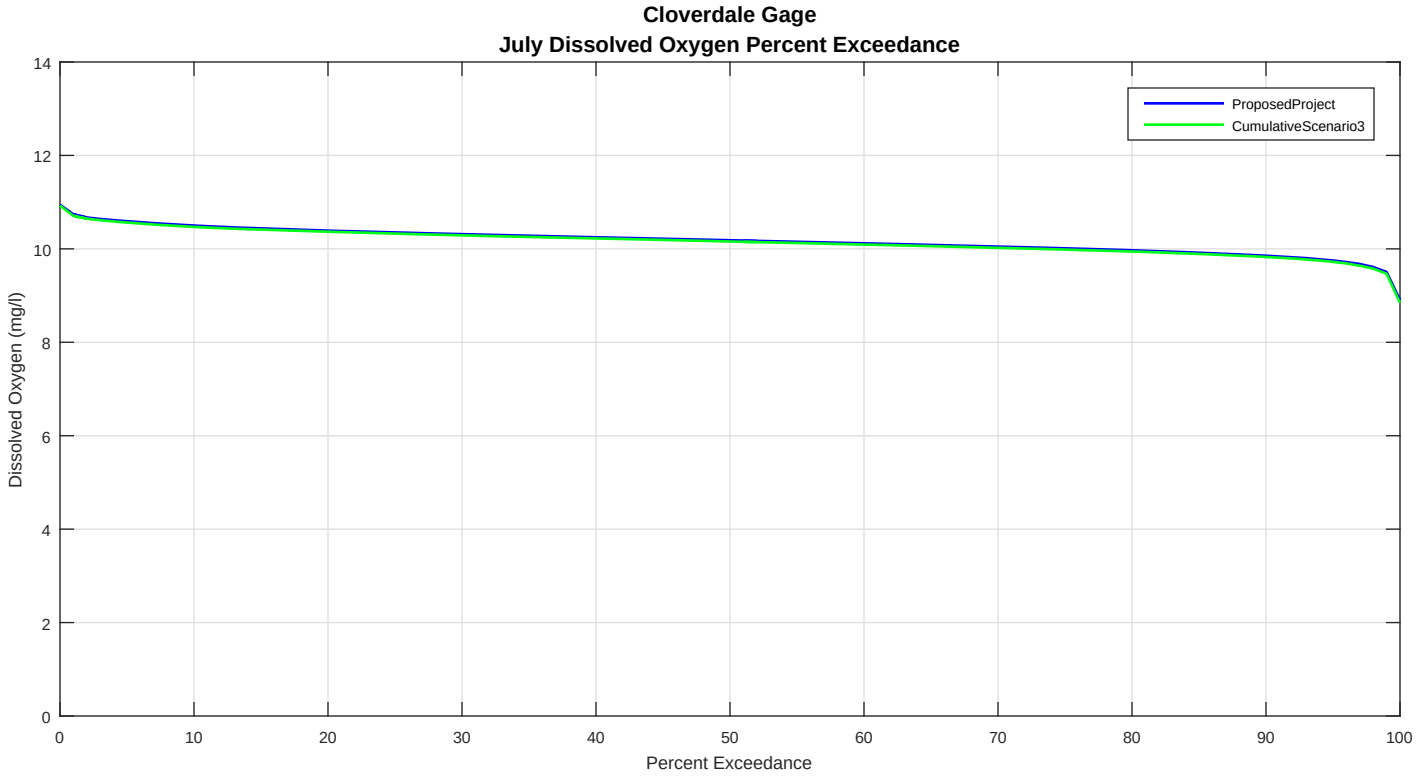
Cloverdale Gage
July Dissolved Oxygen Percent Exceedance
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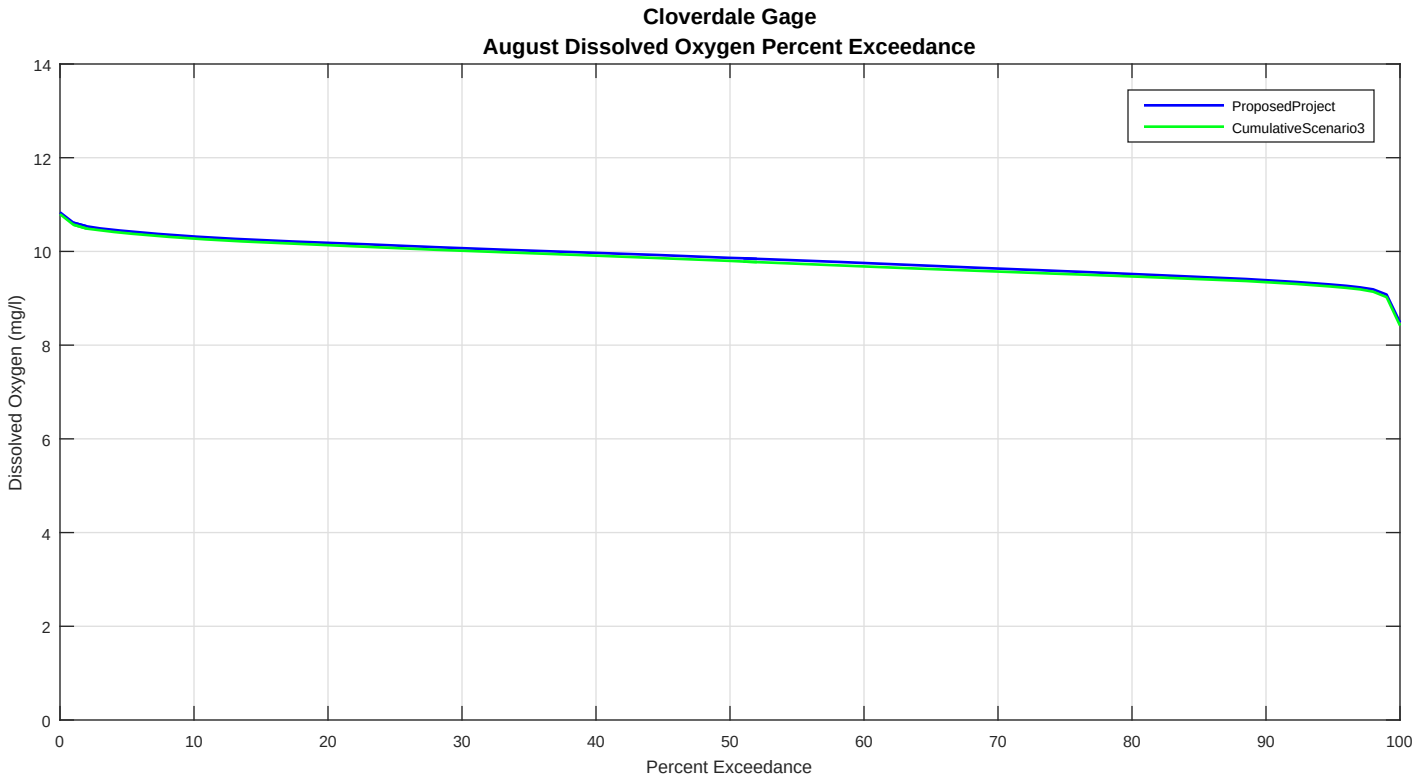
Cloverdale Gage
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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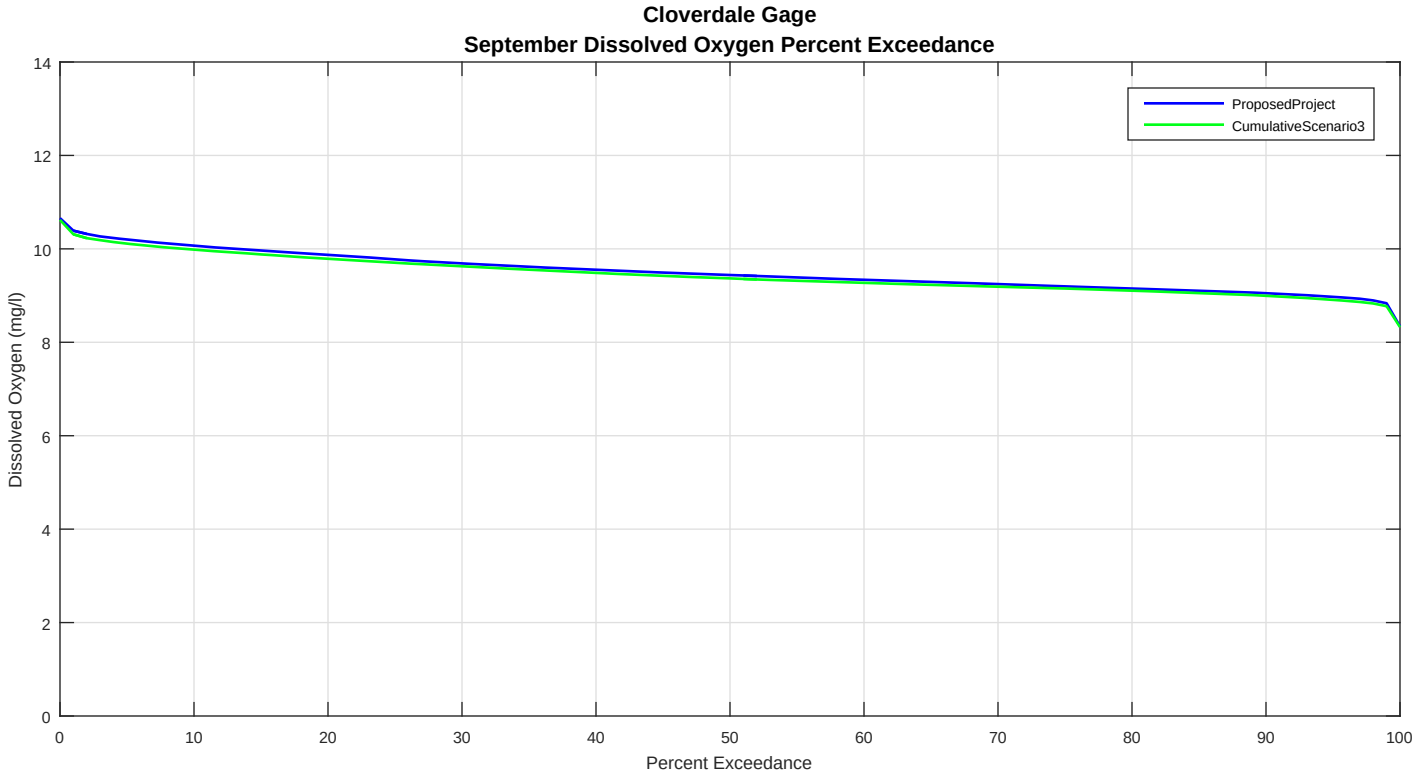
Cloverdale Gage
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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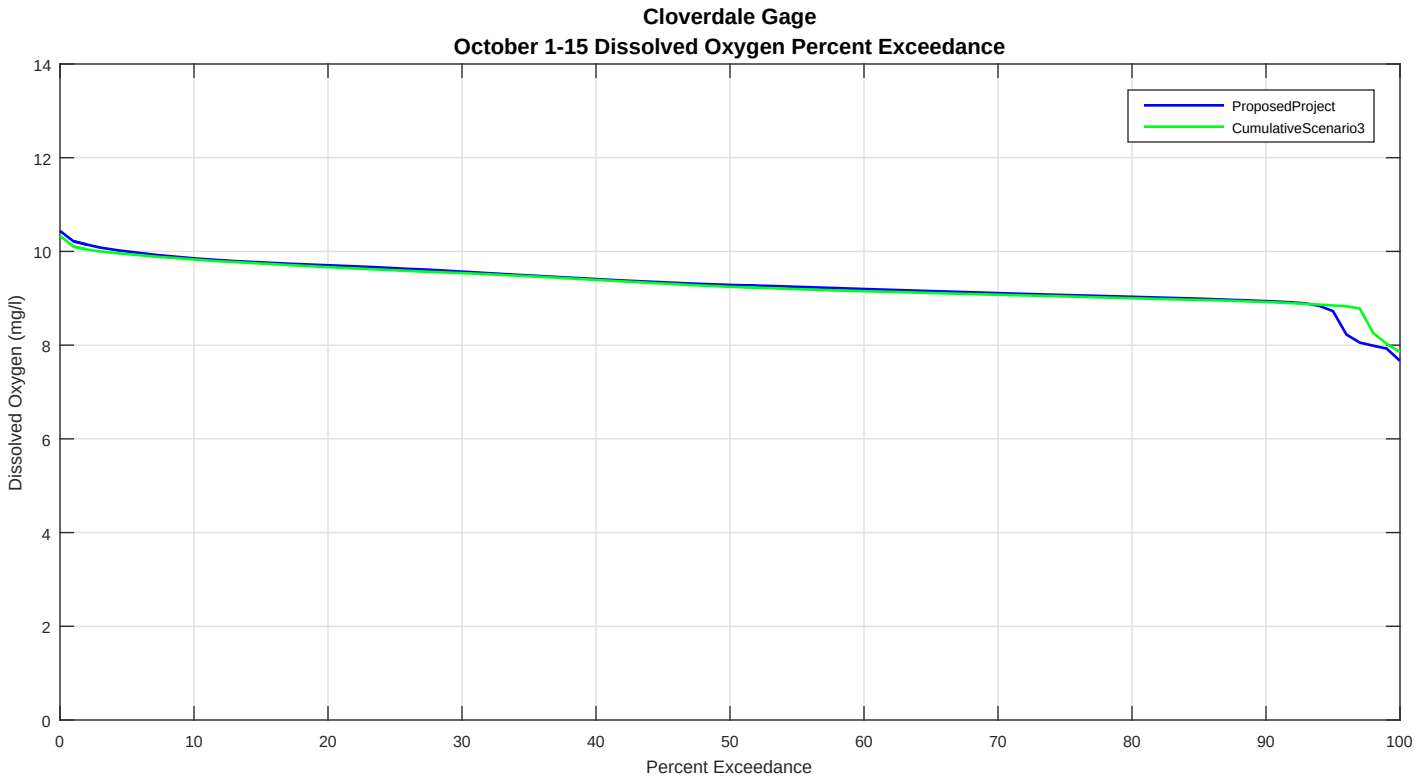
Cloverdale Gage
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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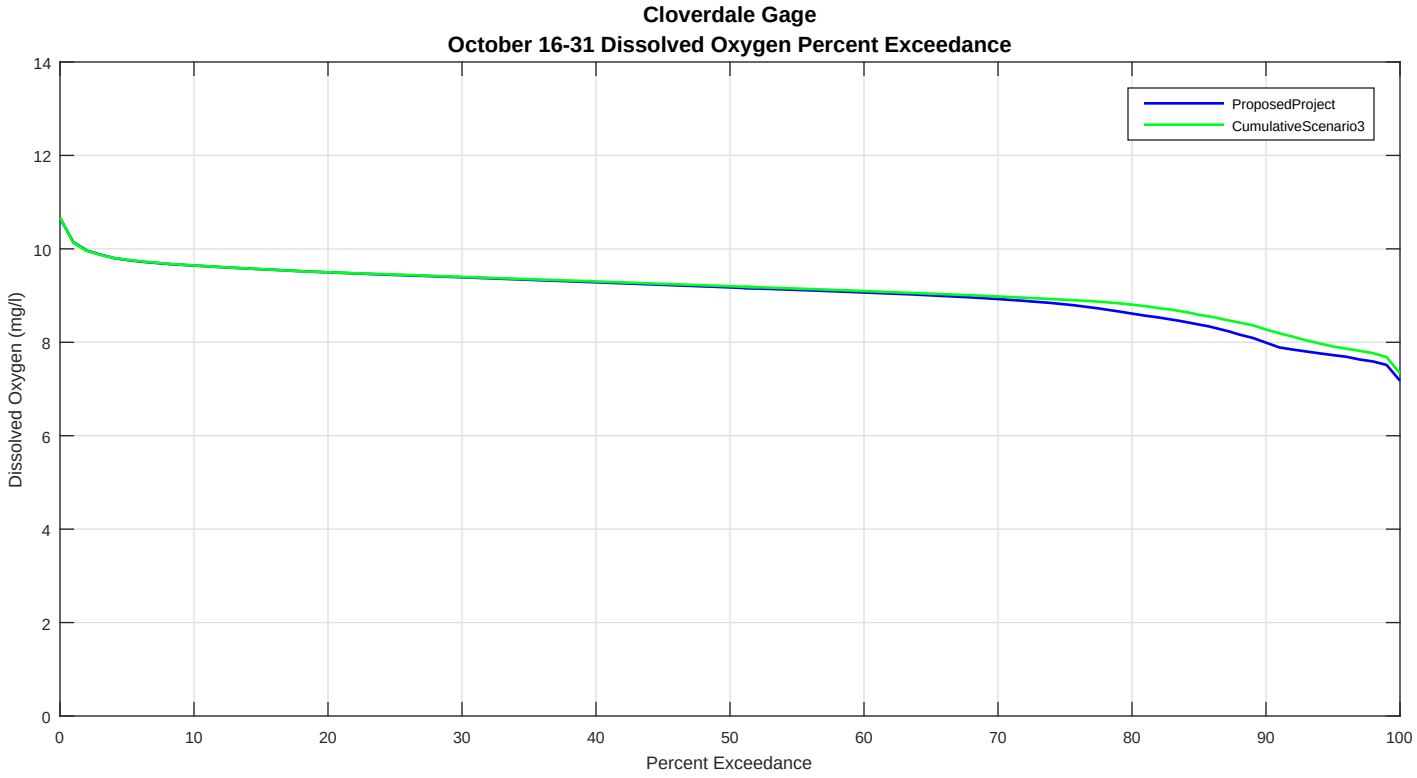
Cloverdale Gage
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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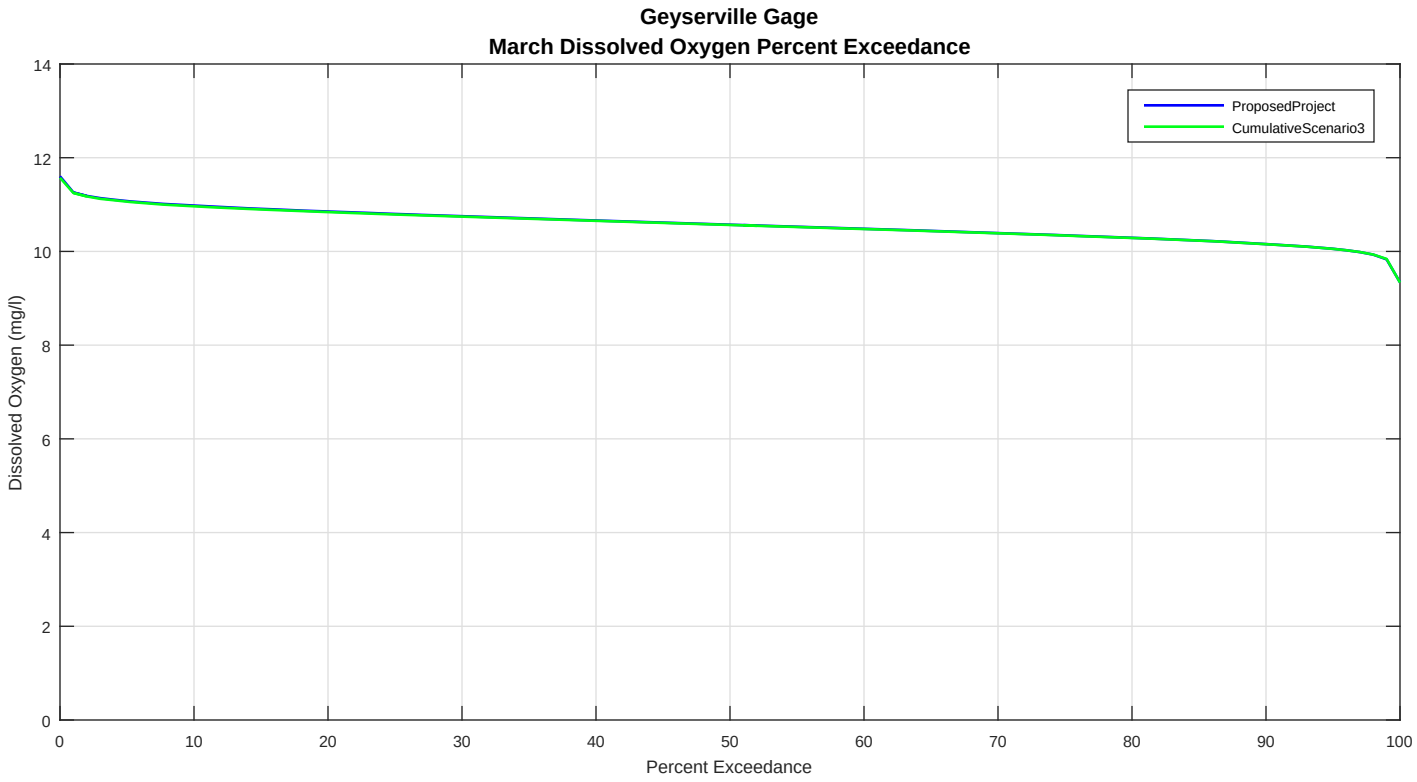
Geyserville Gage
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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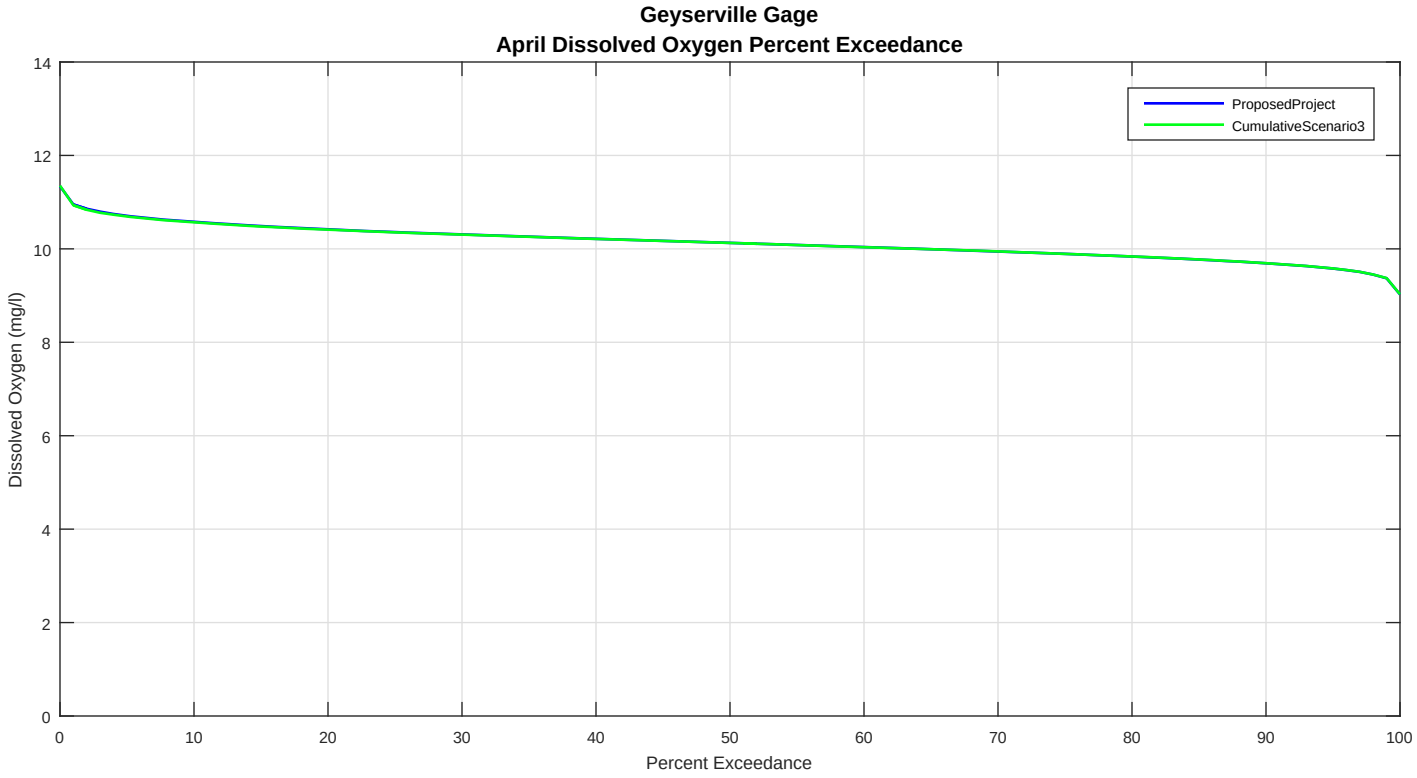
Geyserville Gage
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Dissolved Oxygen (mg/l)
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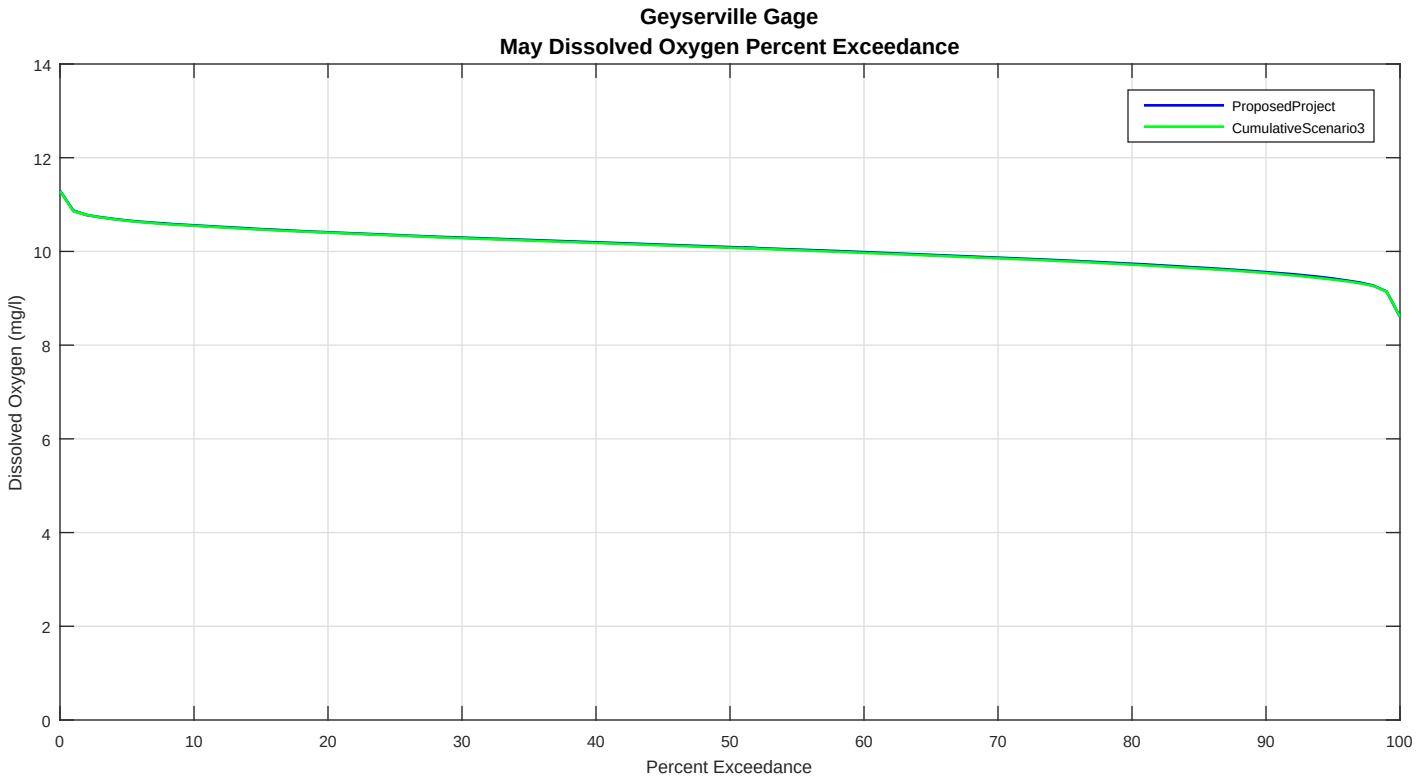
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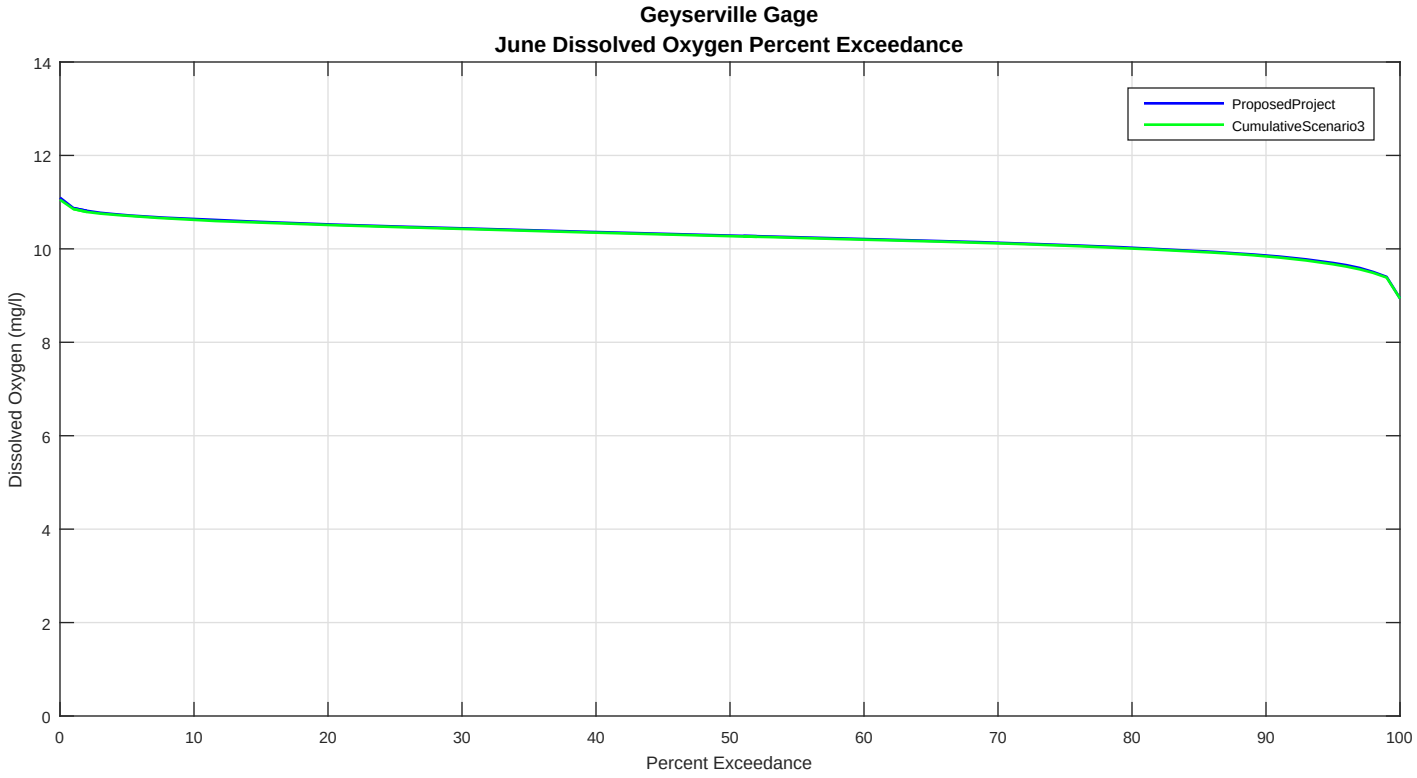
Geyserville Gage
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Dissolved Oxygen (mg/l)
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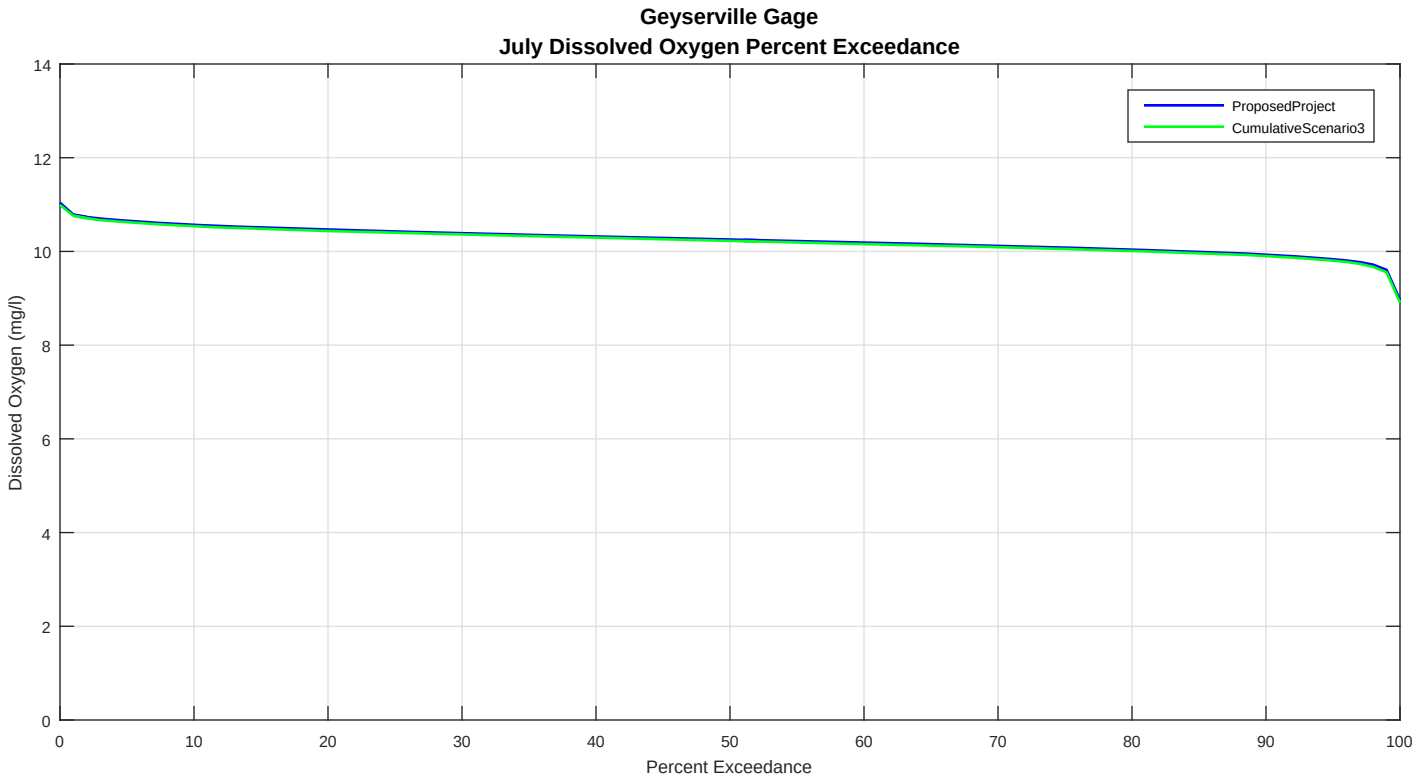
Geyserville Gage
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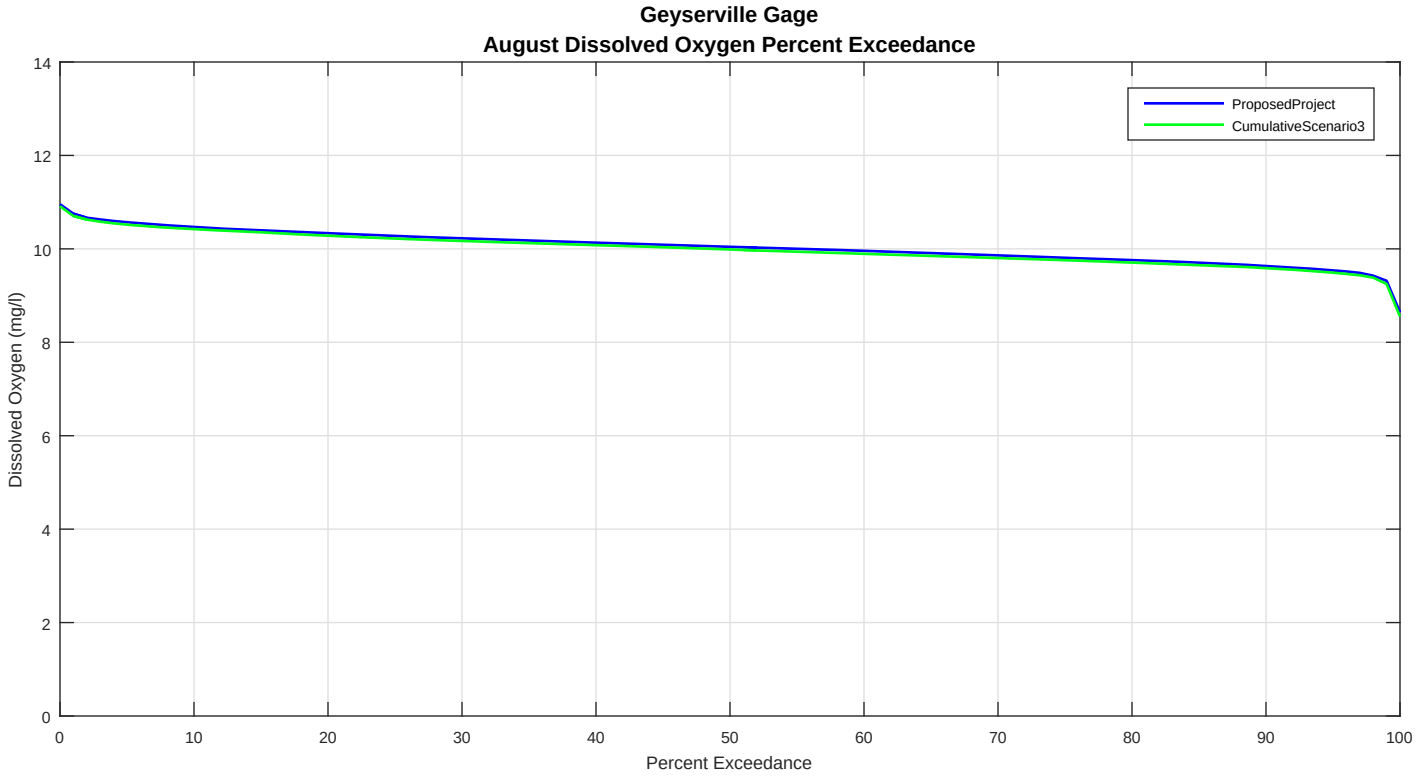
Geyserville Gage
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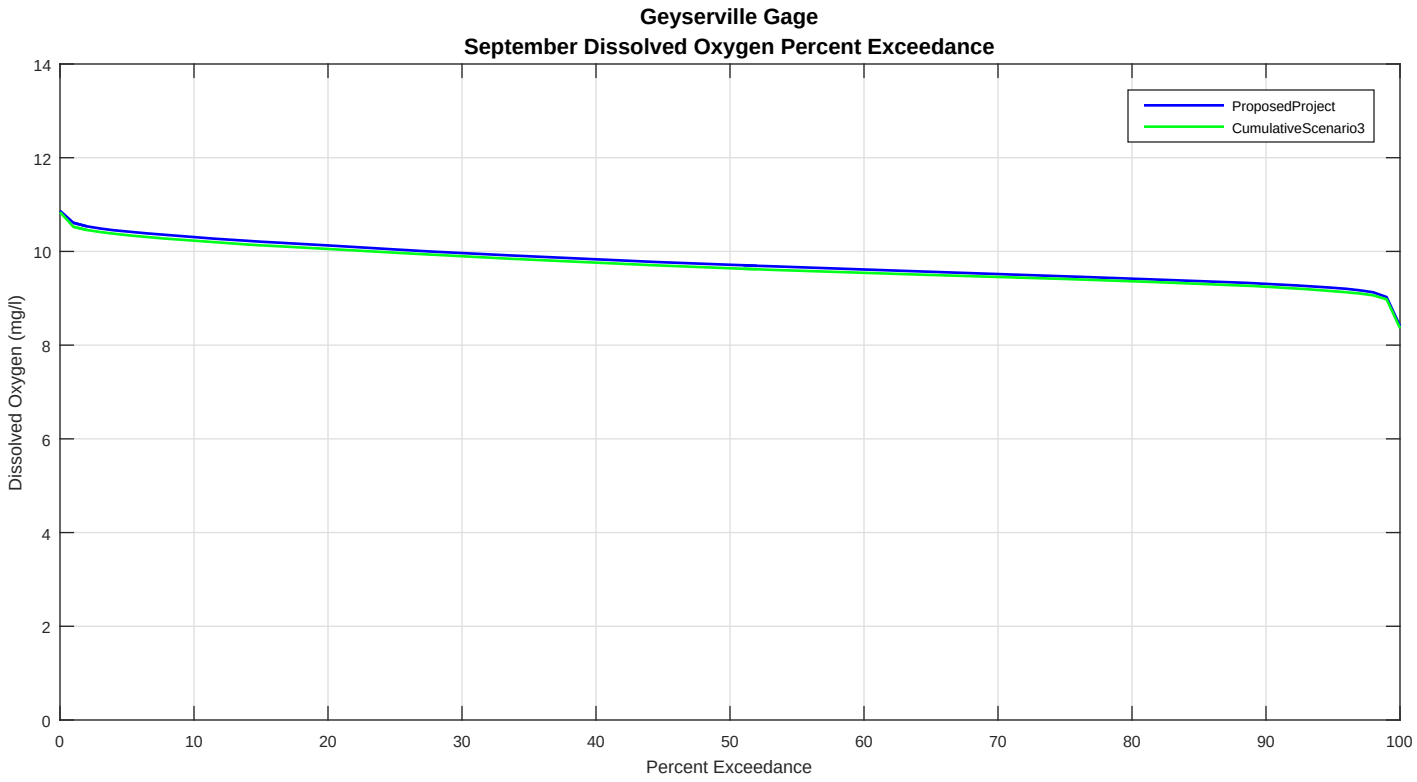
Geyserville Gage
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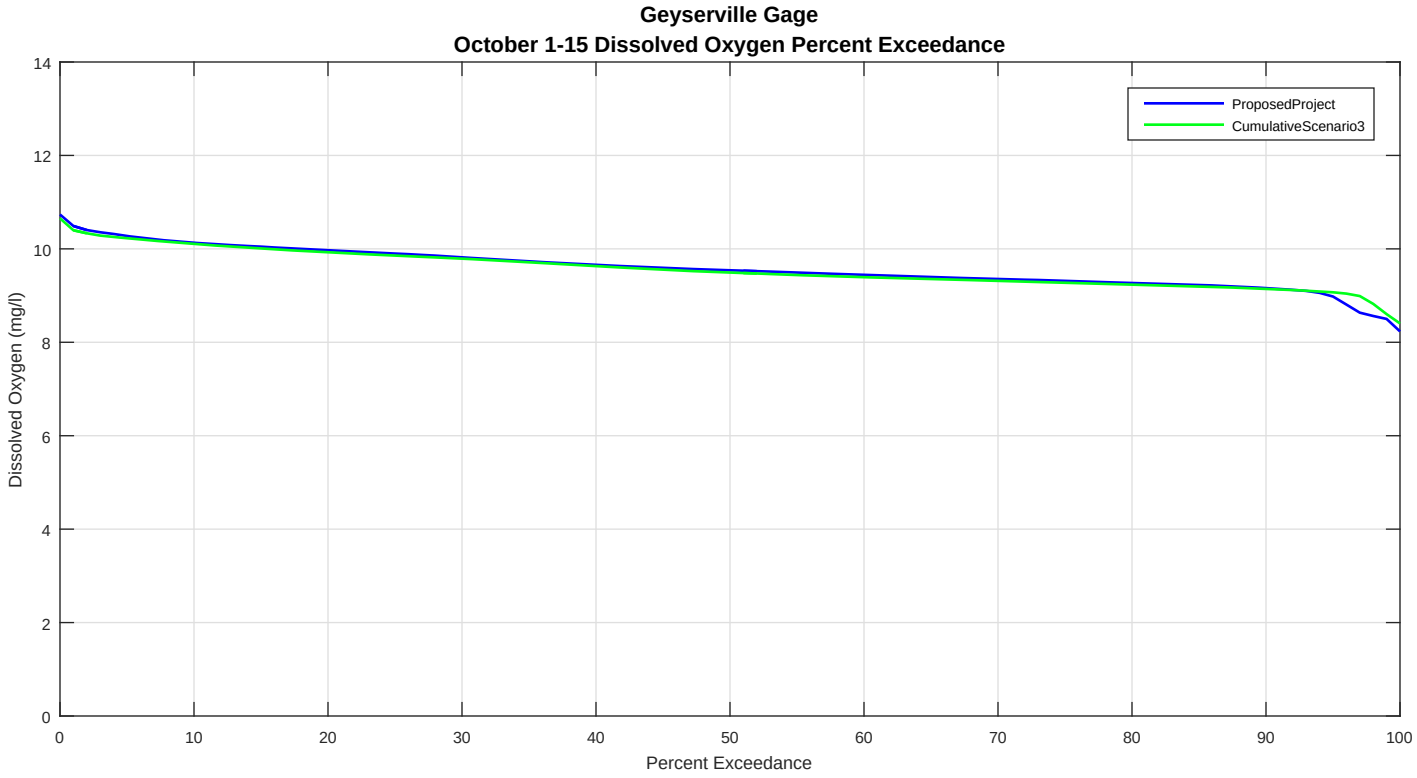
Geyserville Gage
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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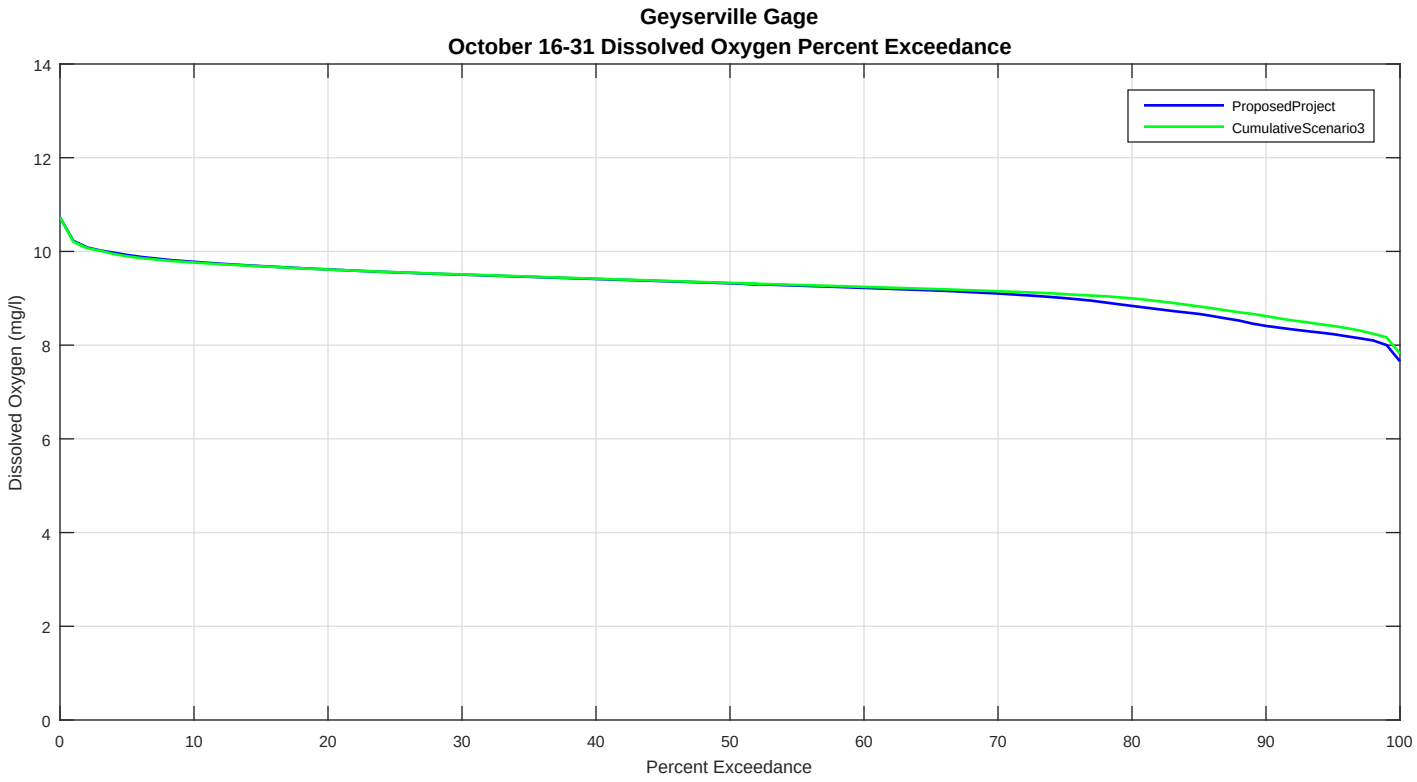
Geyserville Gage
October 16-31 Dissolved Oxygen Percent Exceedance
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CumulativeScenario3
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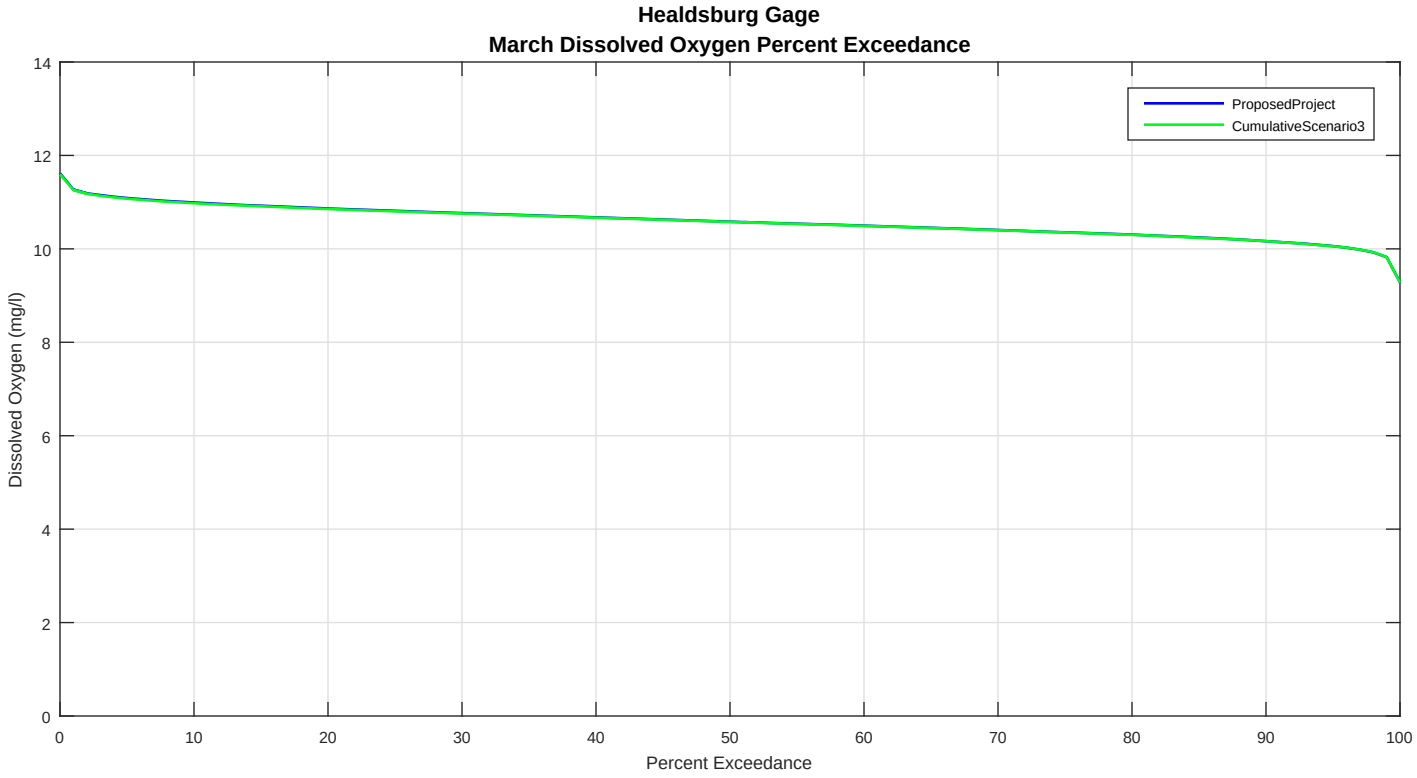
Healdsburg Gage
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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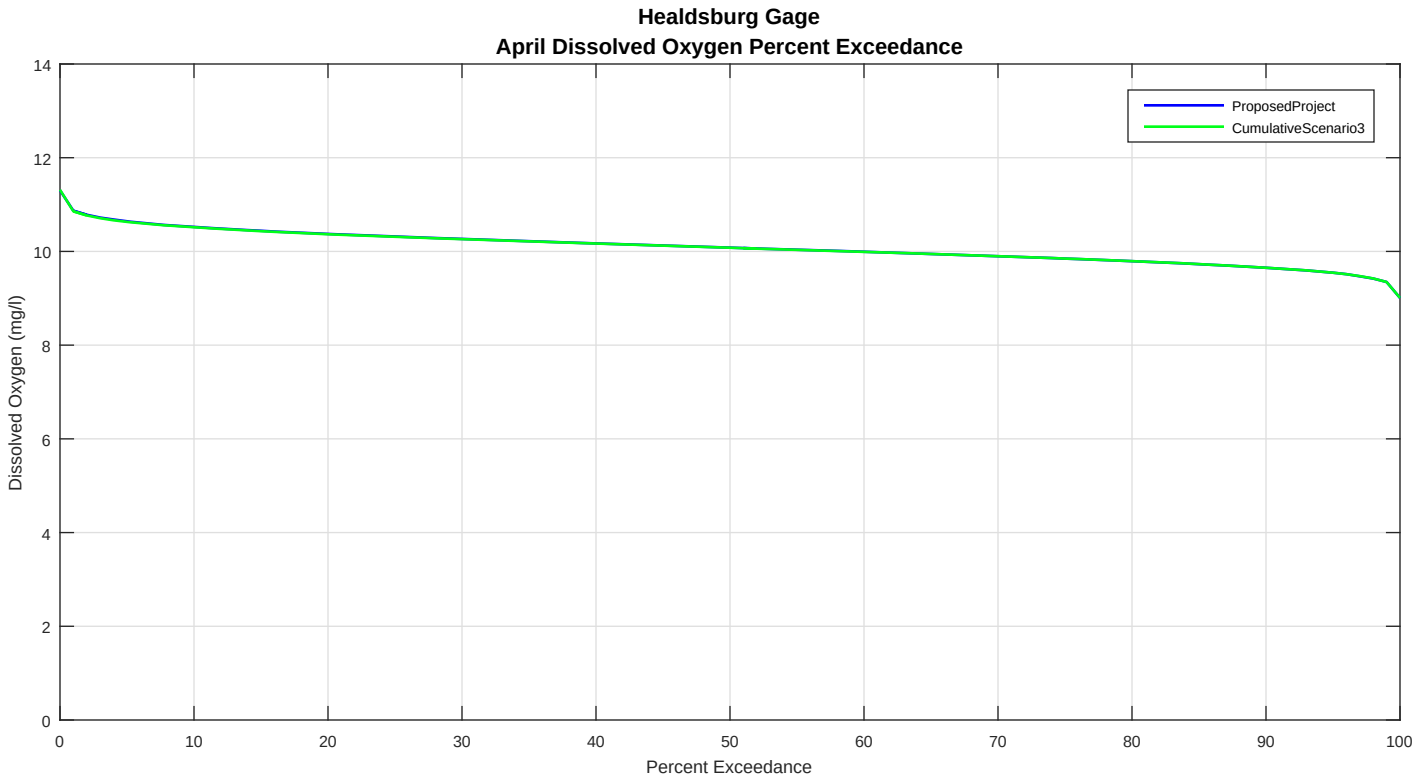
Healdsburg Gage
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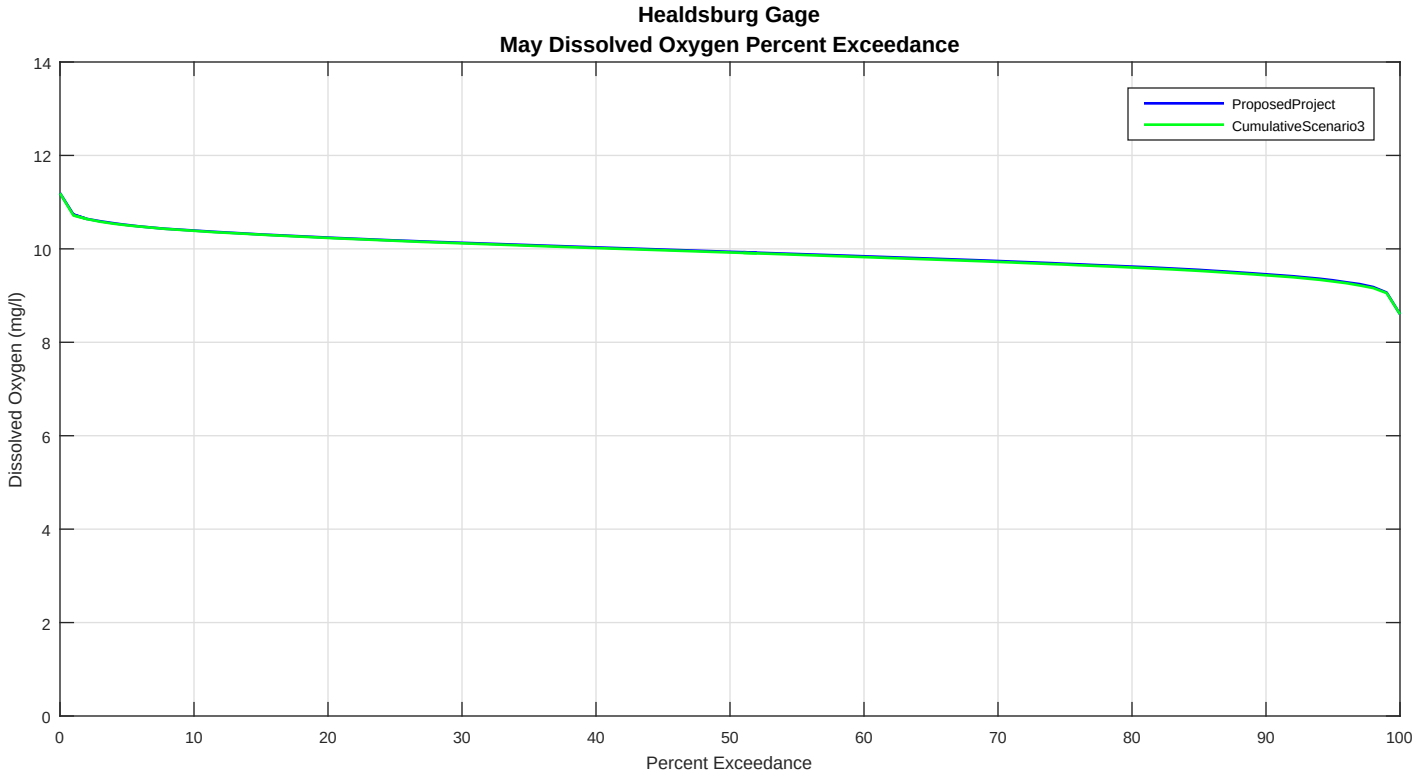
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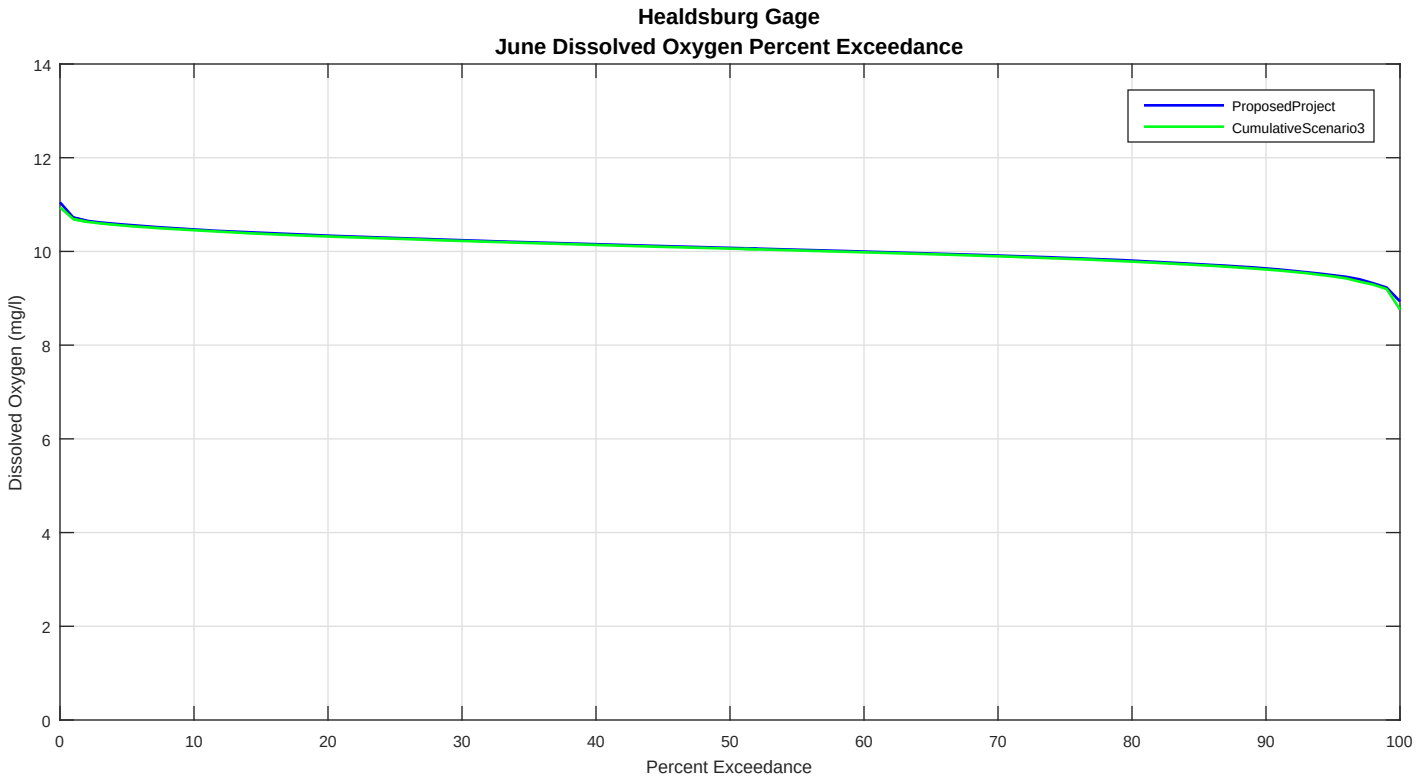
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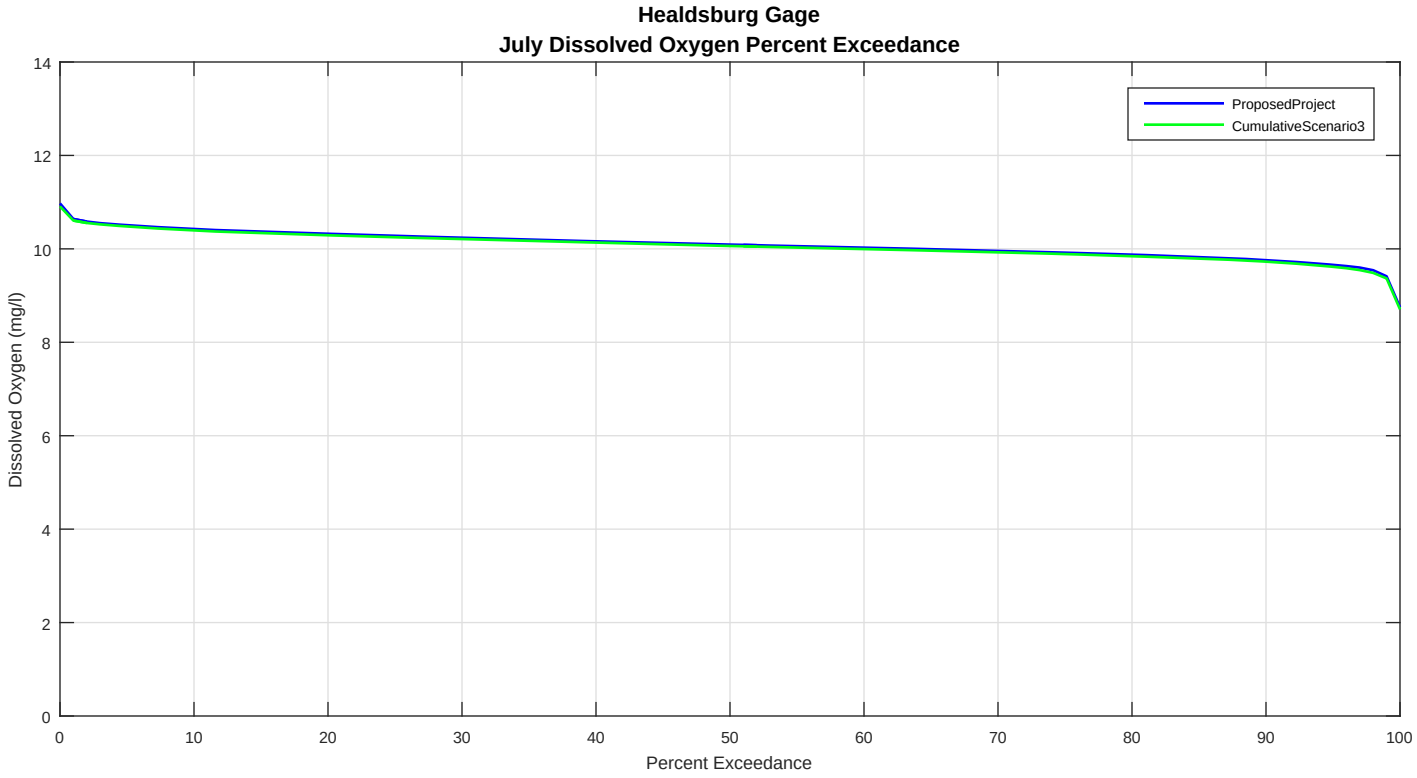
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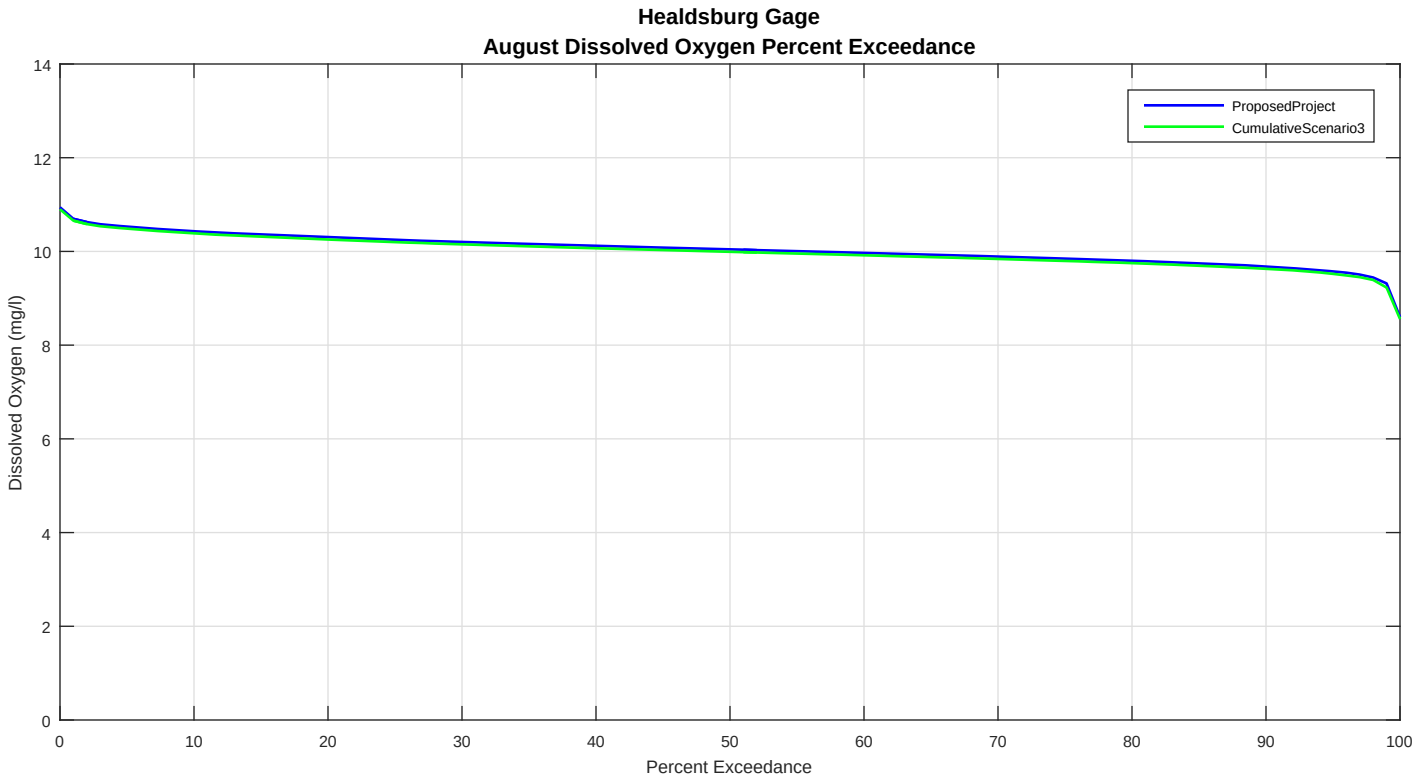
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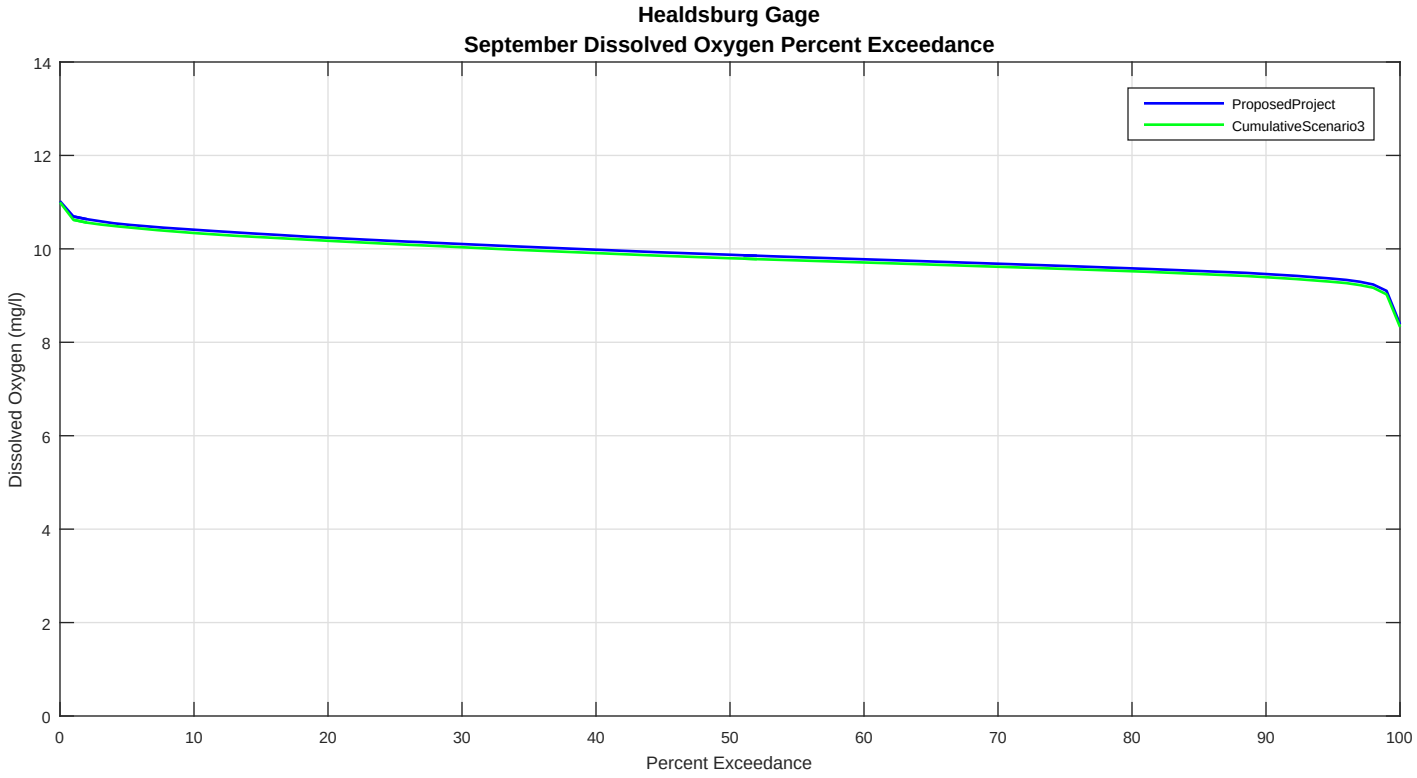
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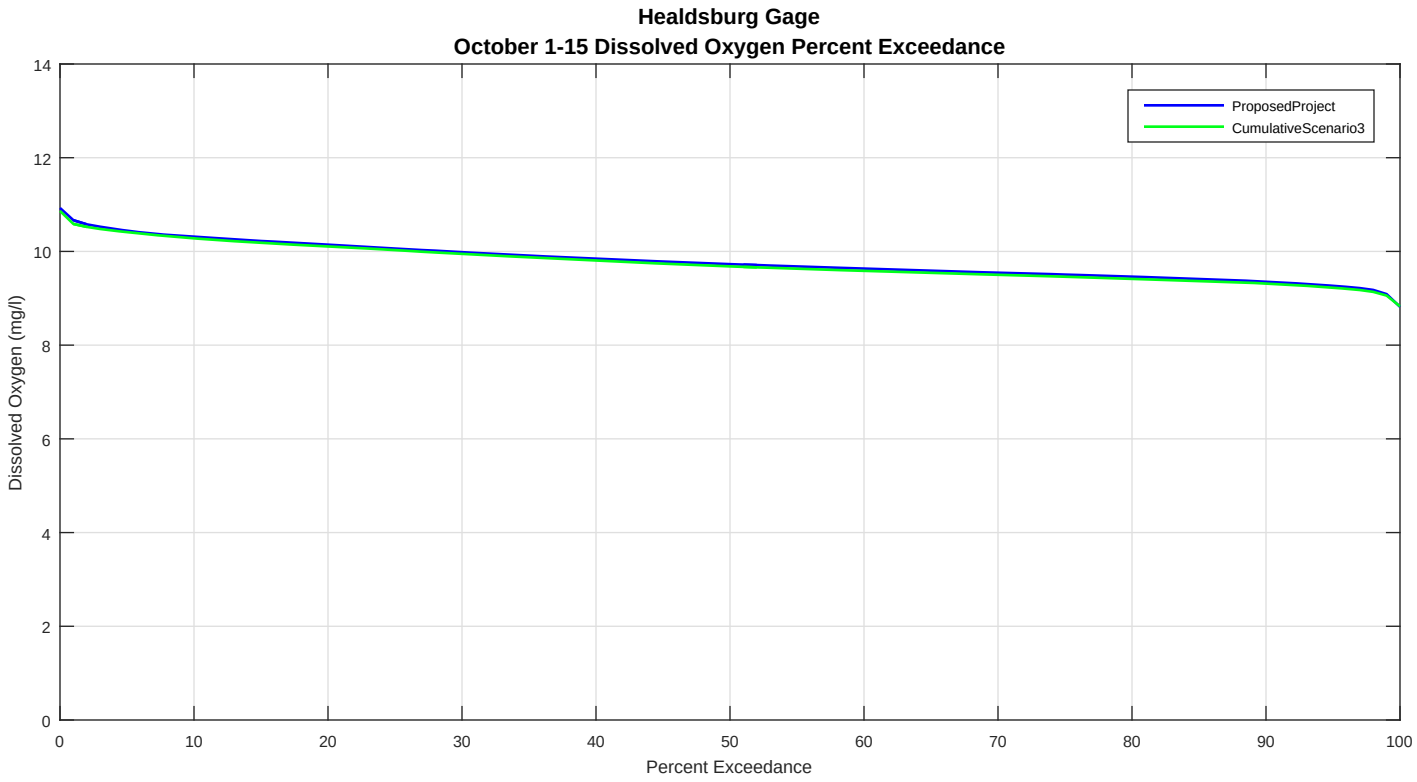
Healdsburg Gage
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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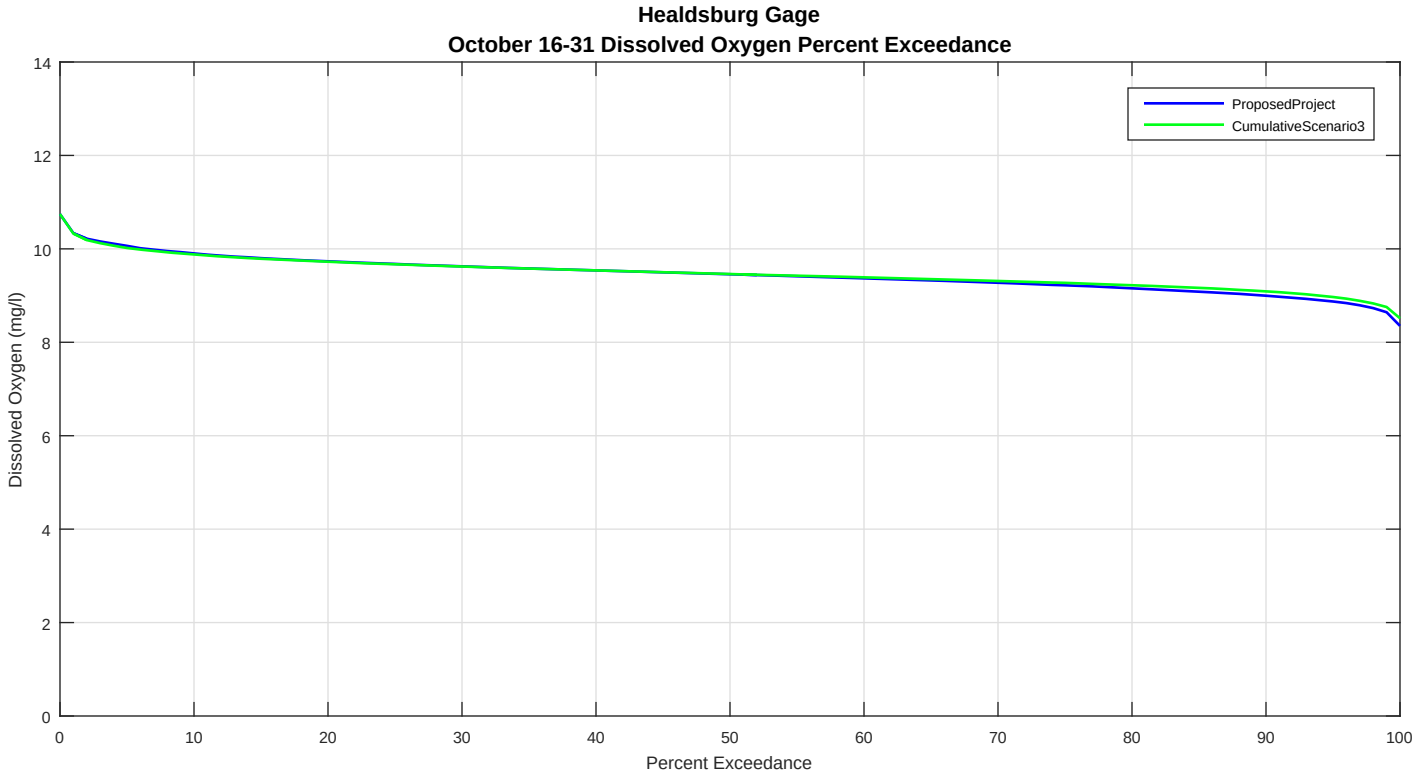
Healdsburg Gage
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
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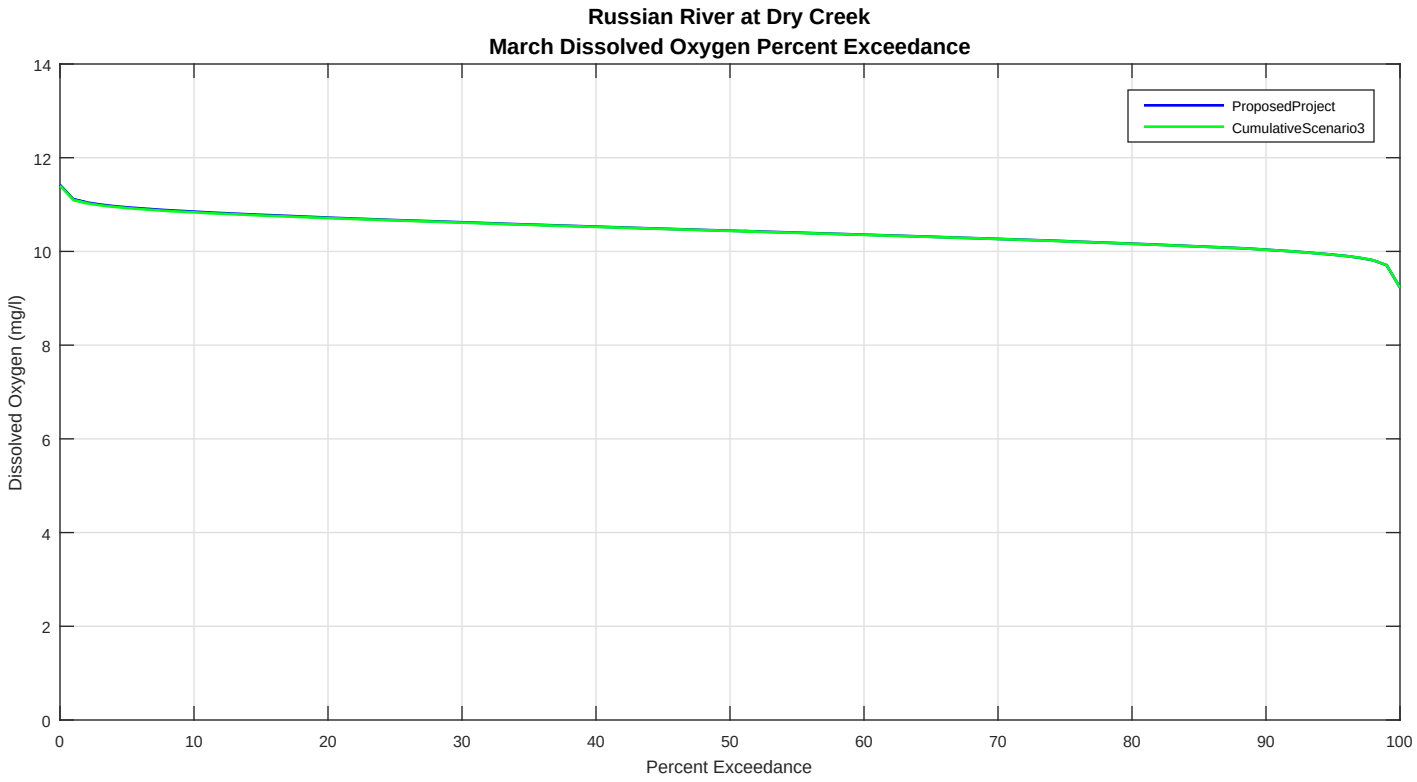
Russian River at Dry Creek
March Dissolved Oxygen Percent Exceedance
ProposedProject
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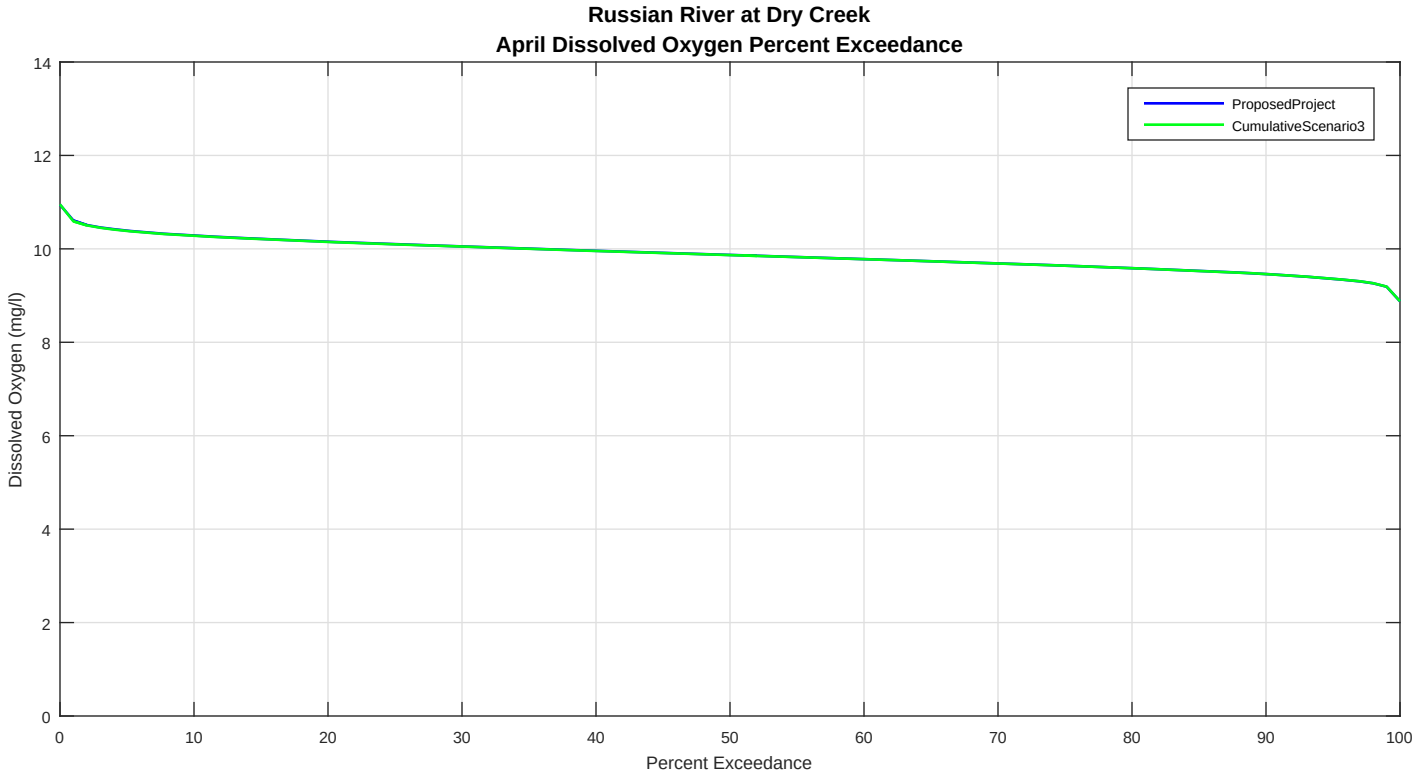
Russian River at Dry Creek
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ProposedProject
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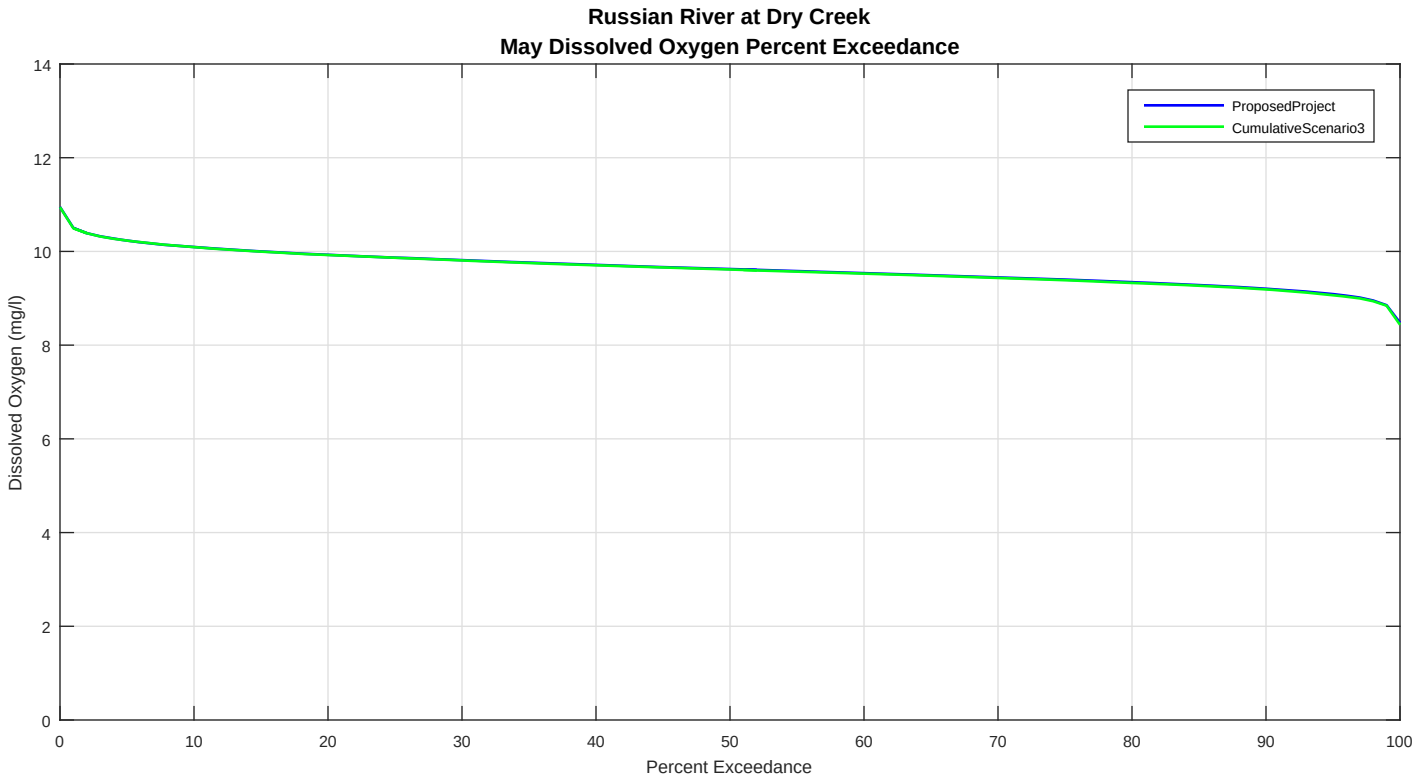
Russian River at Dry Creek
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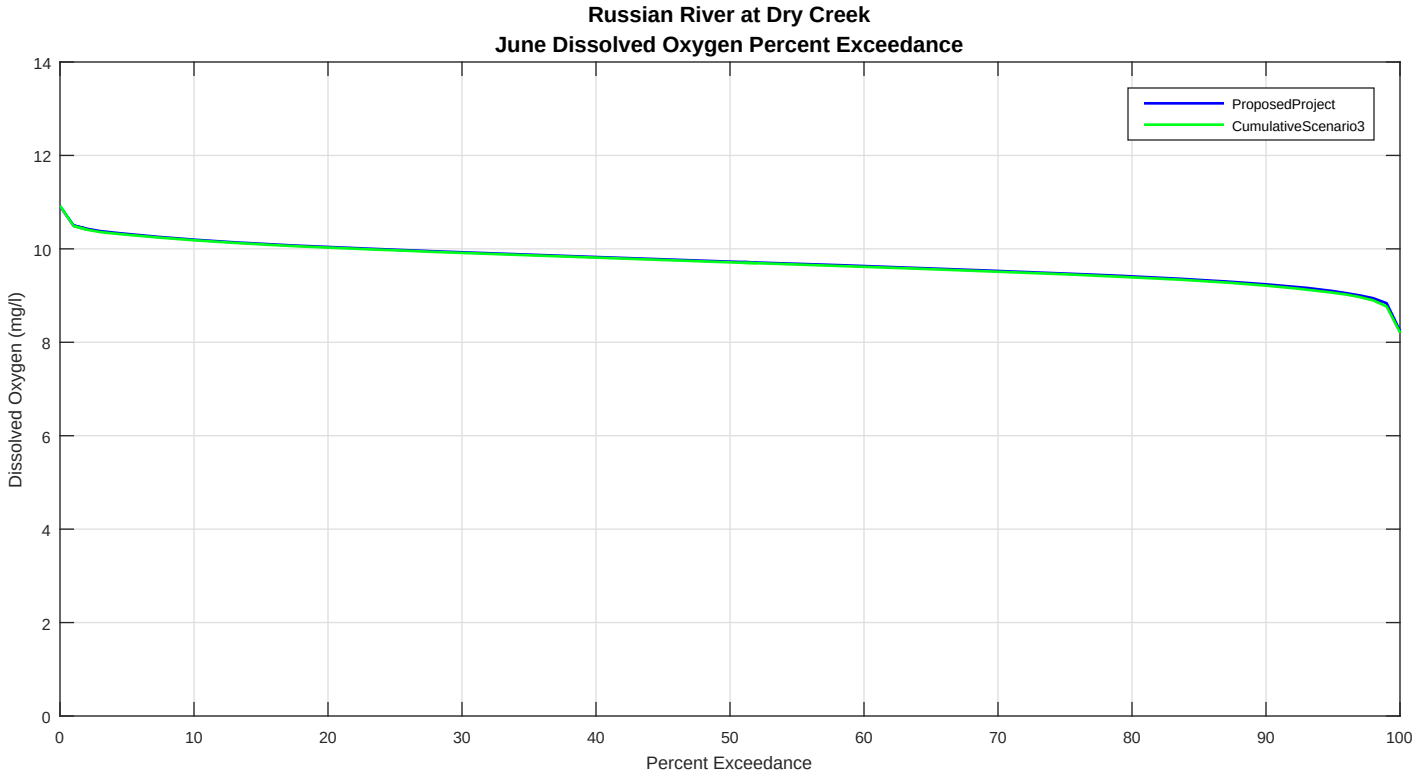
Russian River at Dry Creek
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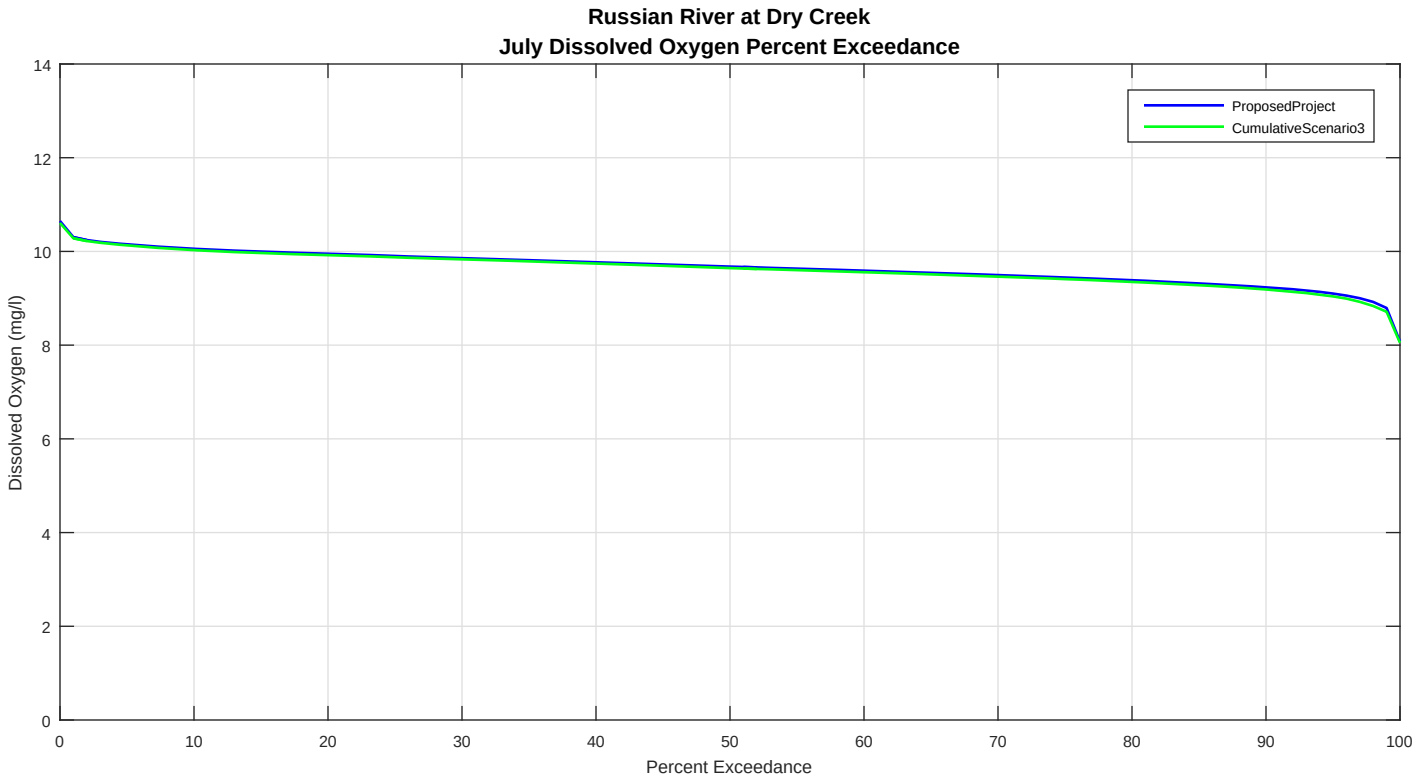
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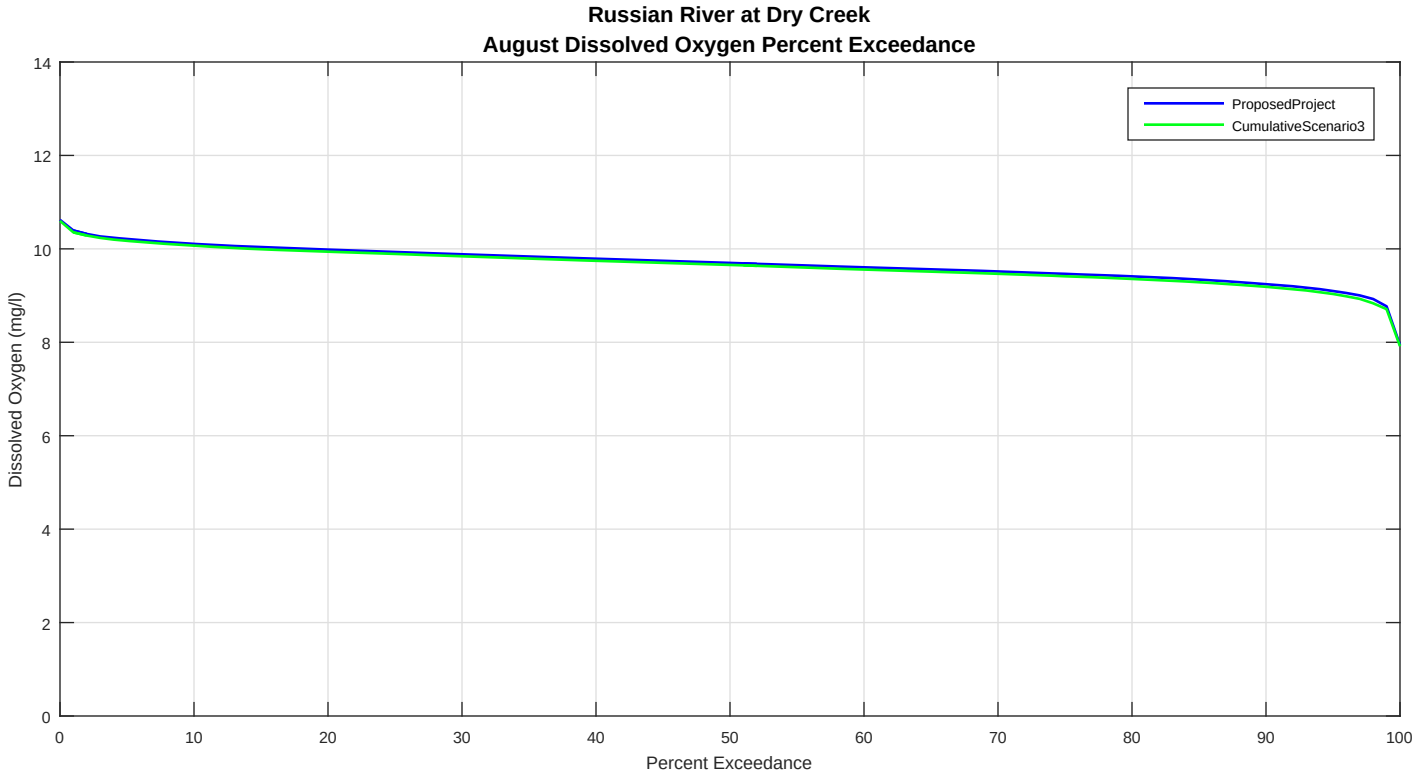
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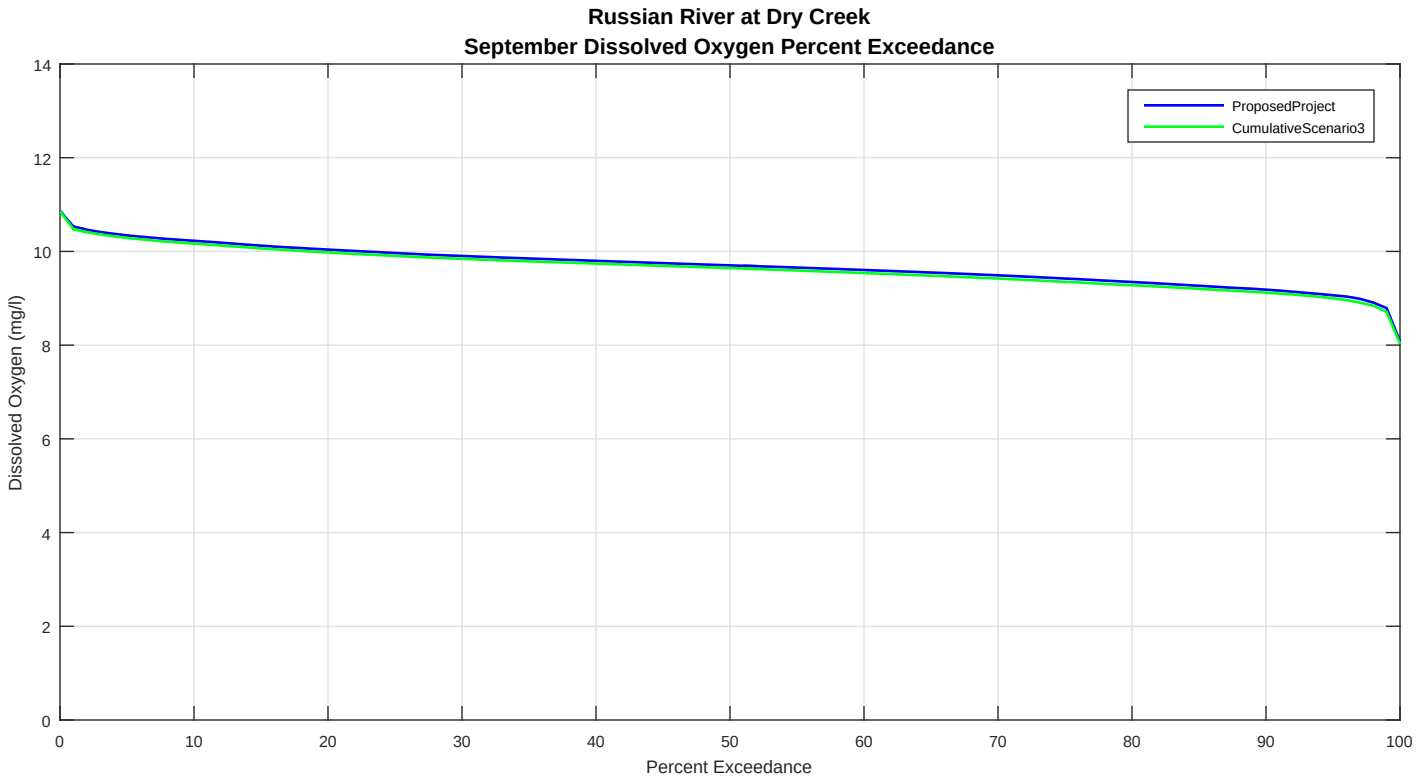
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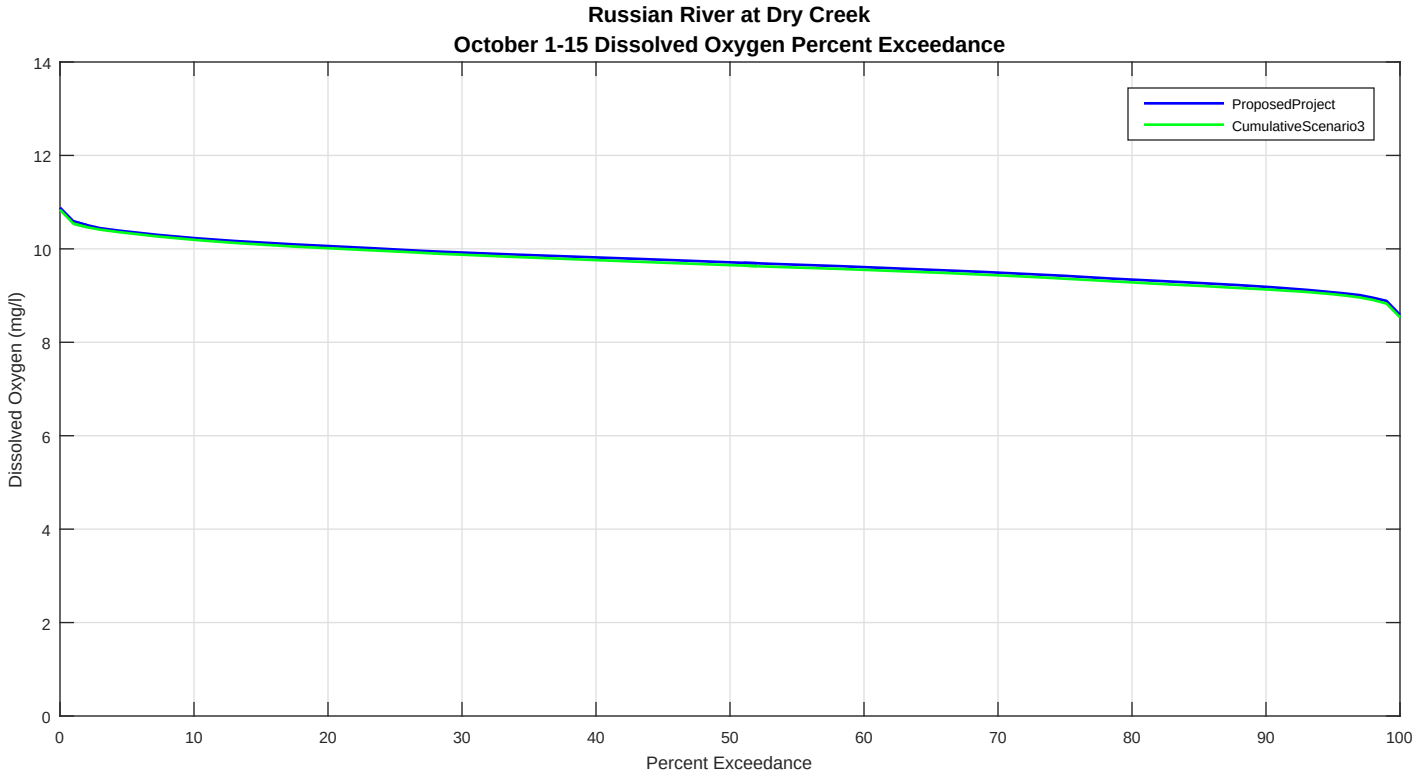
Russian River at Dry Creek
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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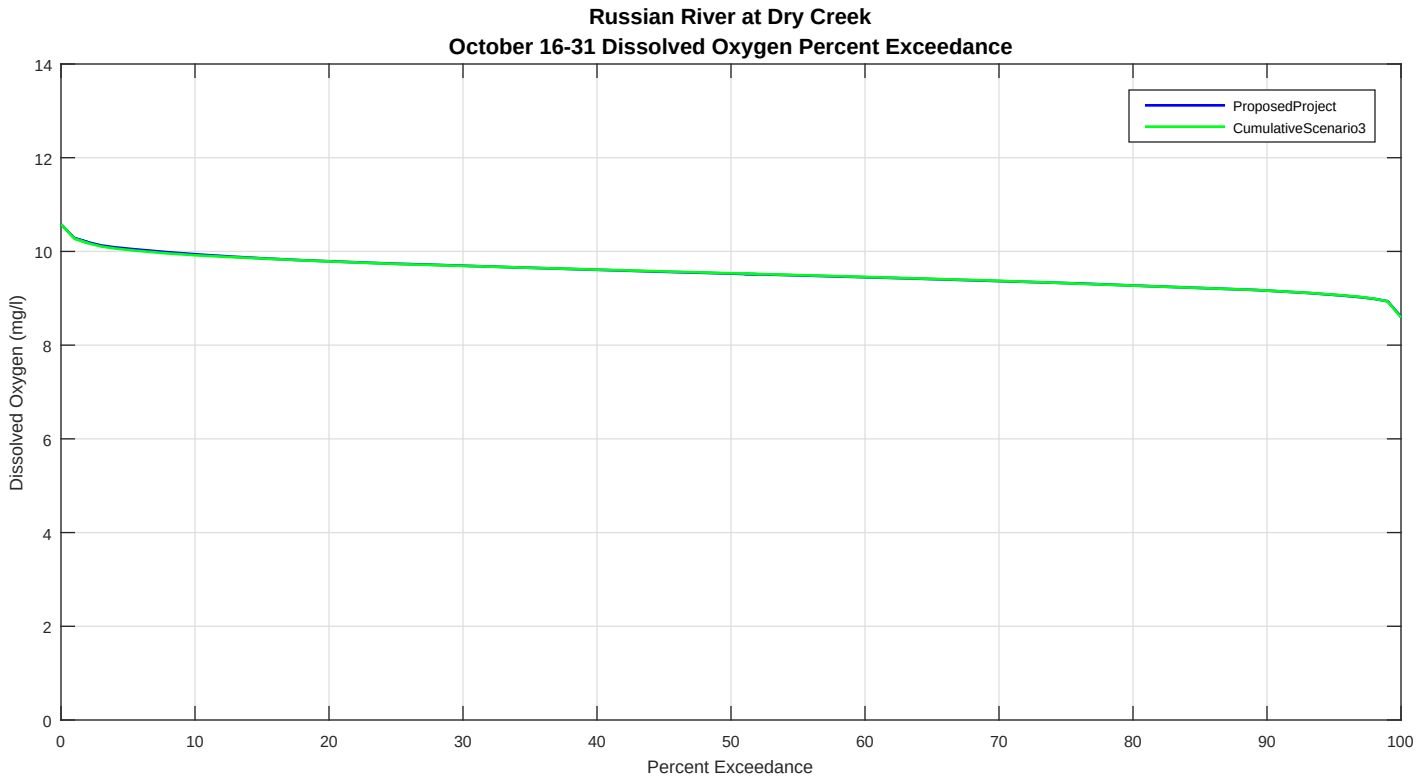
Russian River at Dry Creek
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
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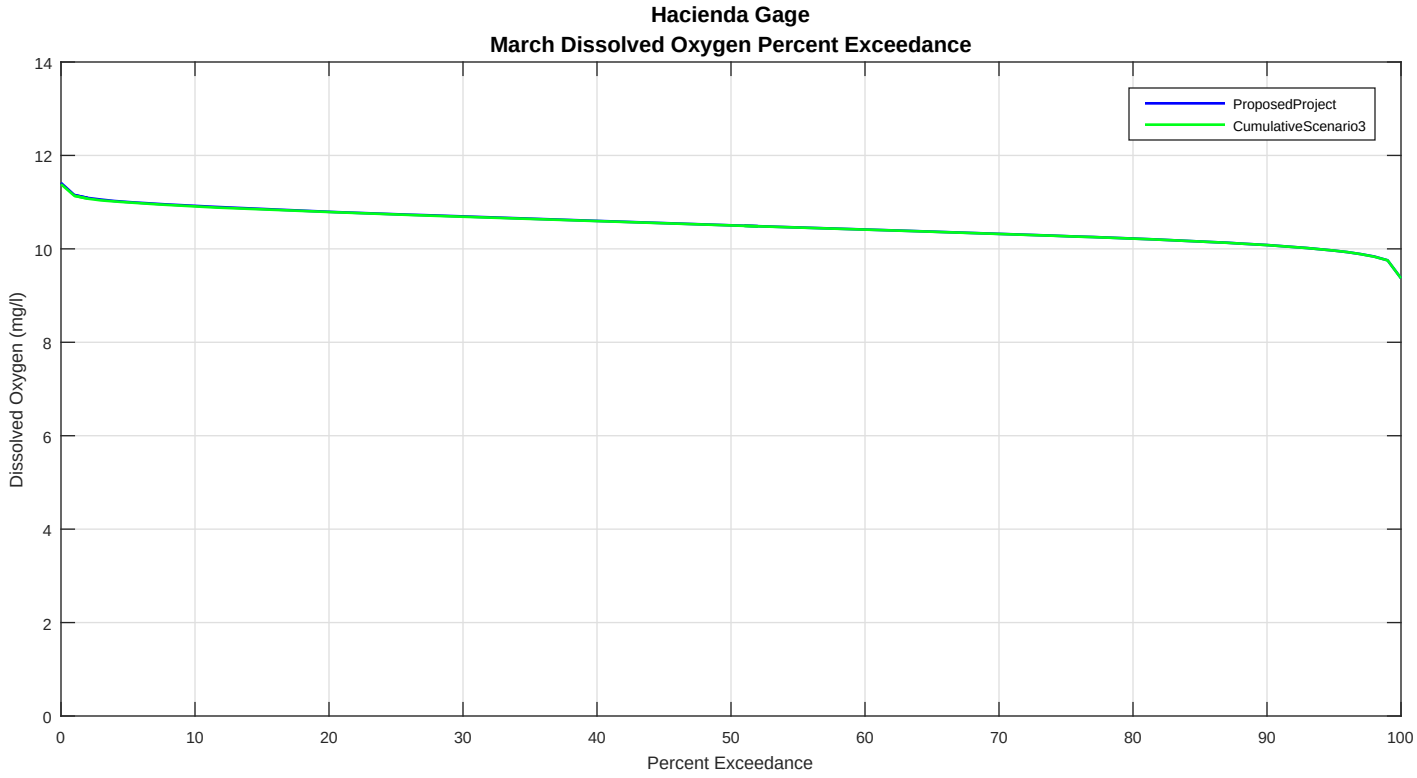
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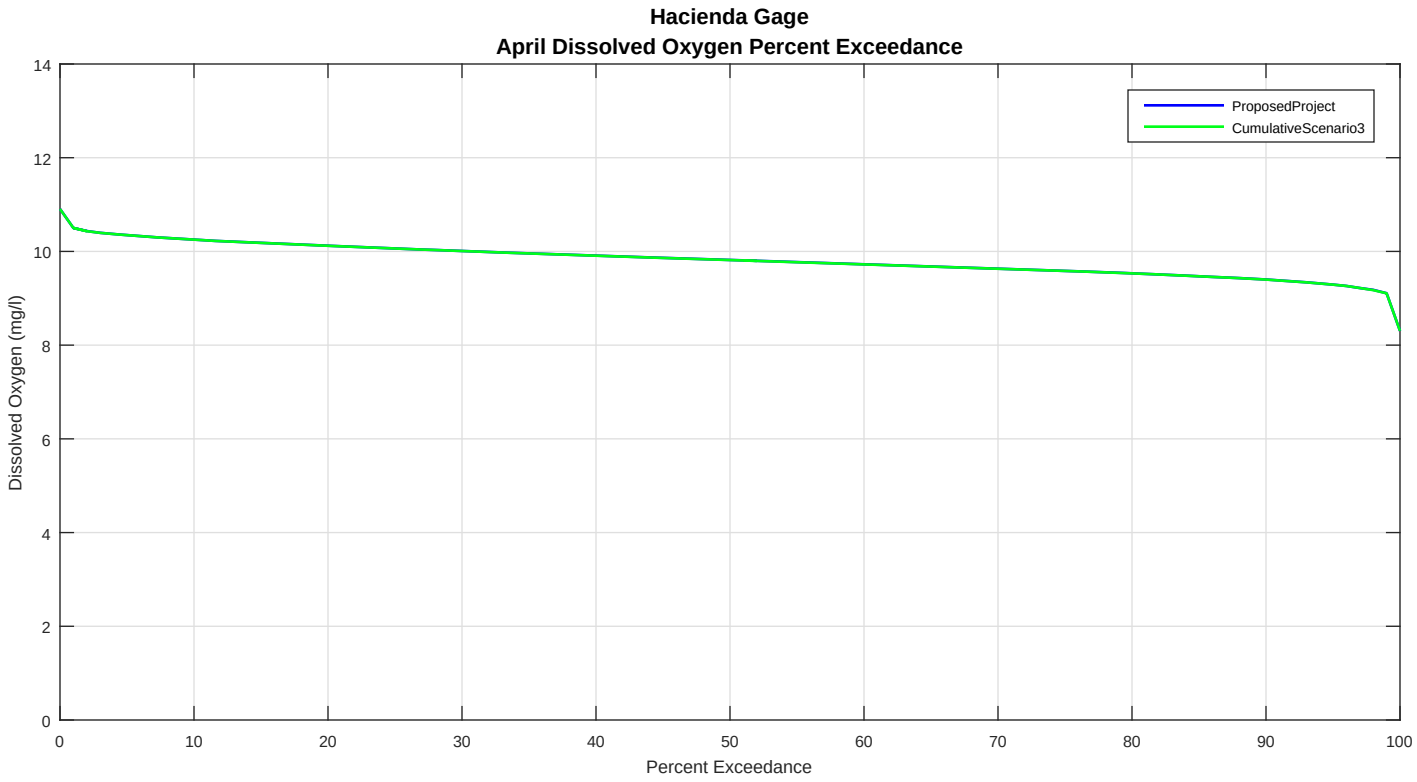
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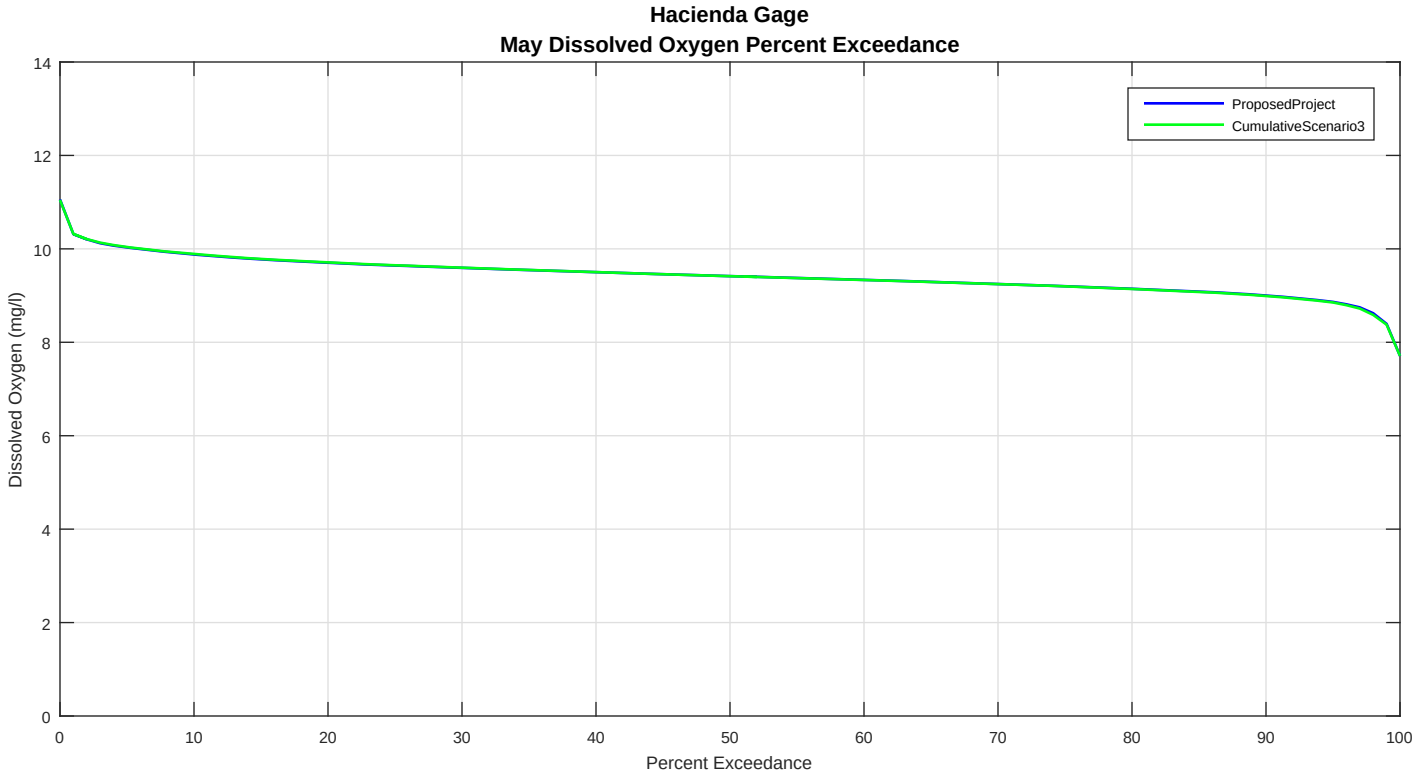
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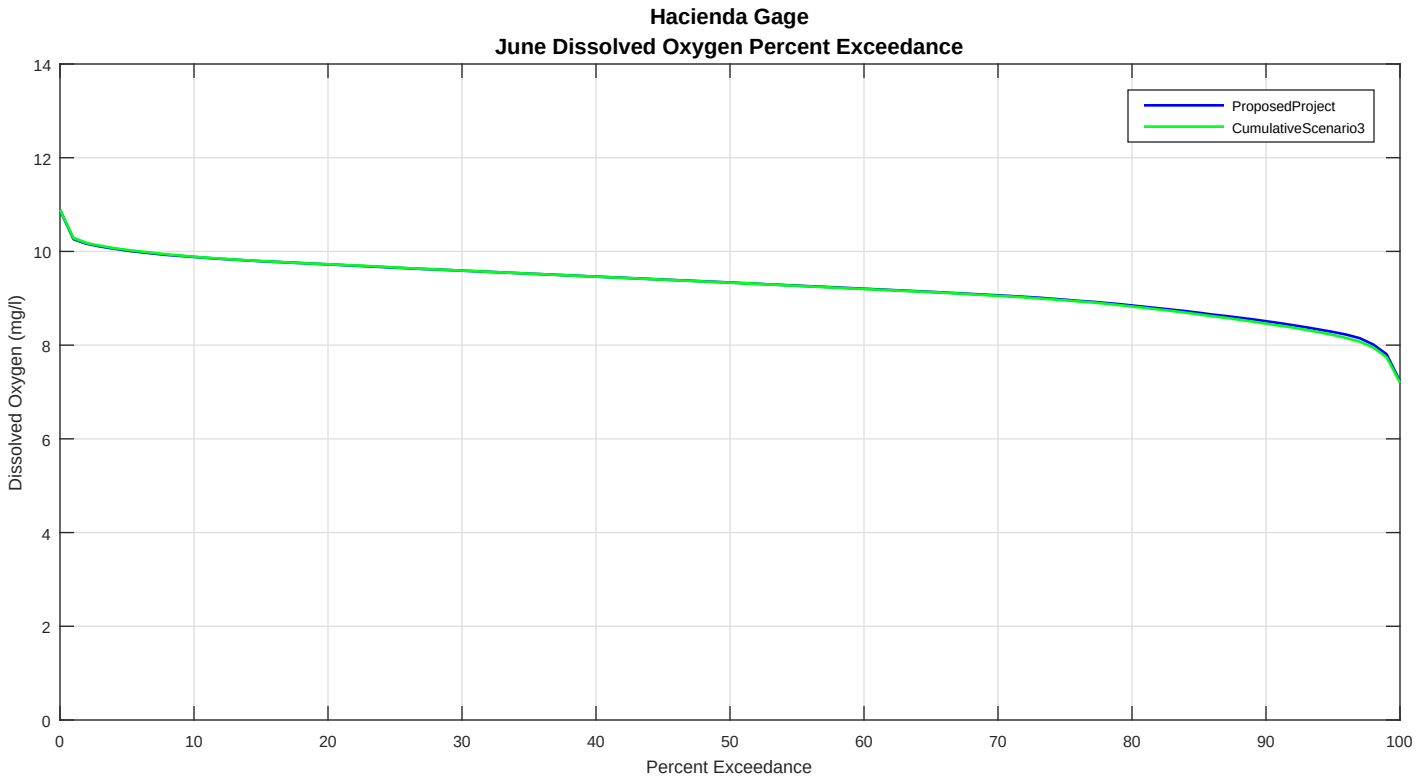
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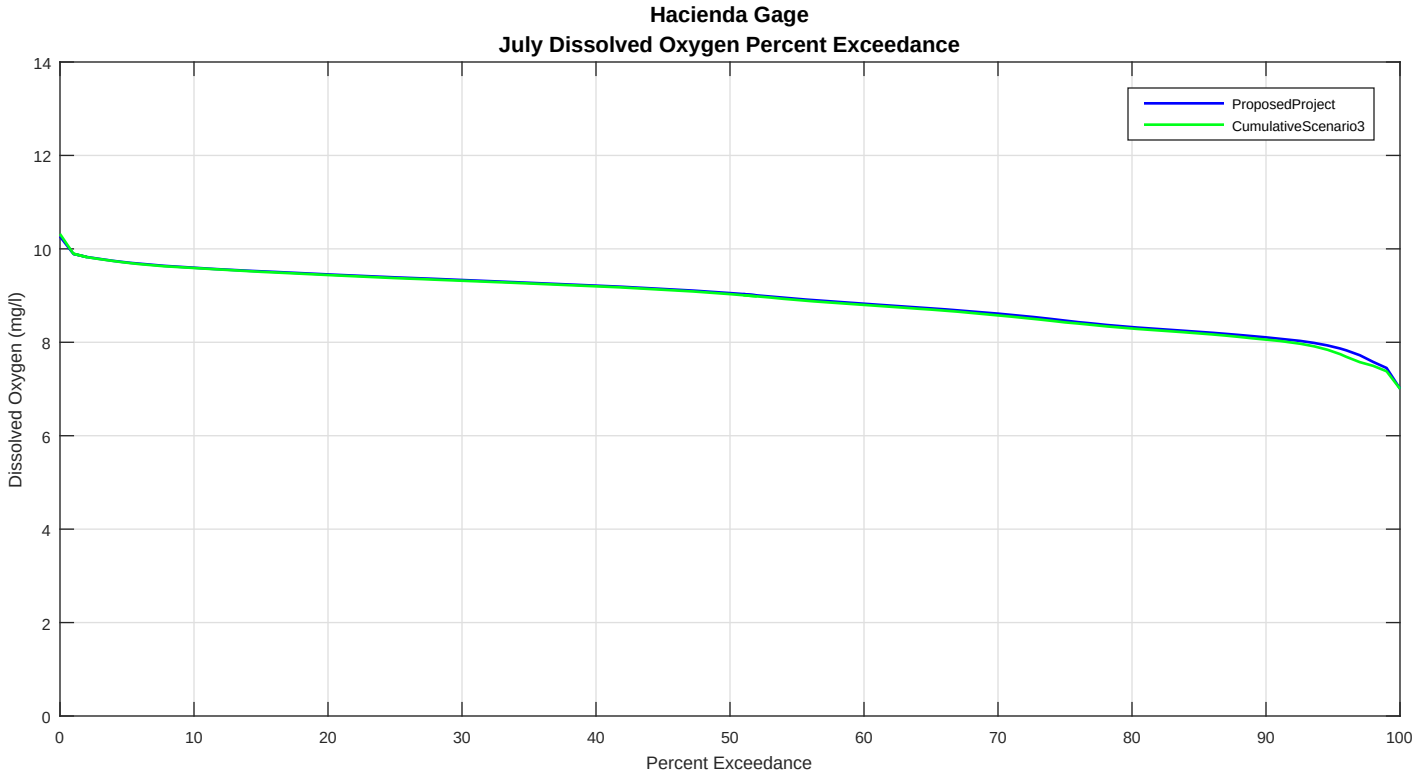
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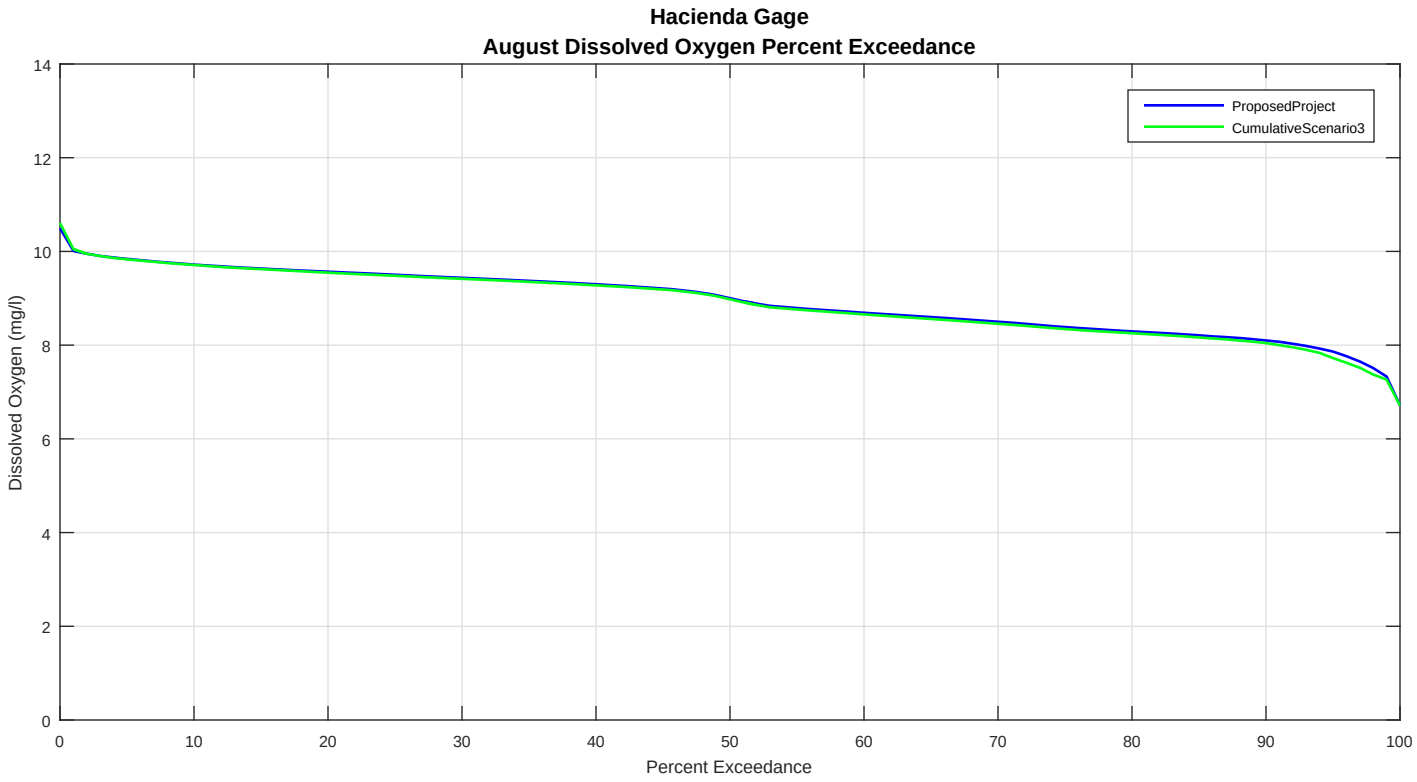
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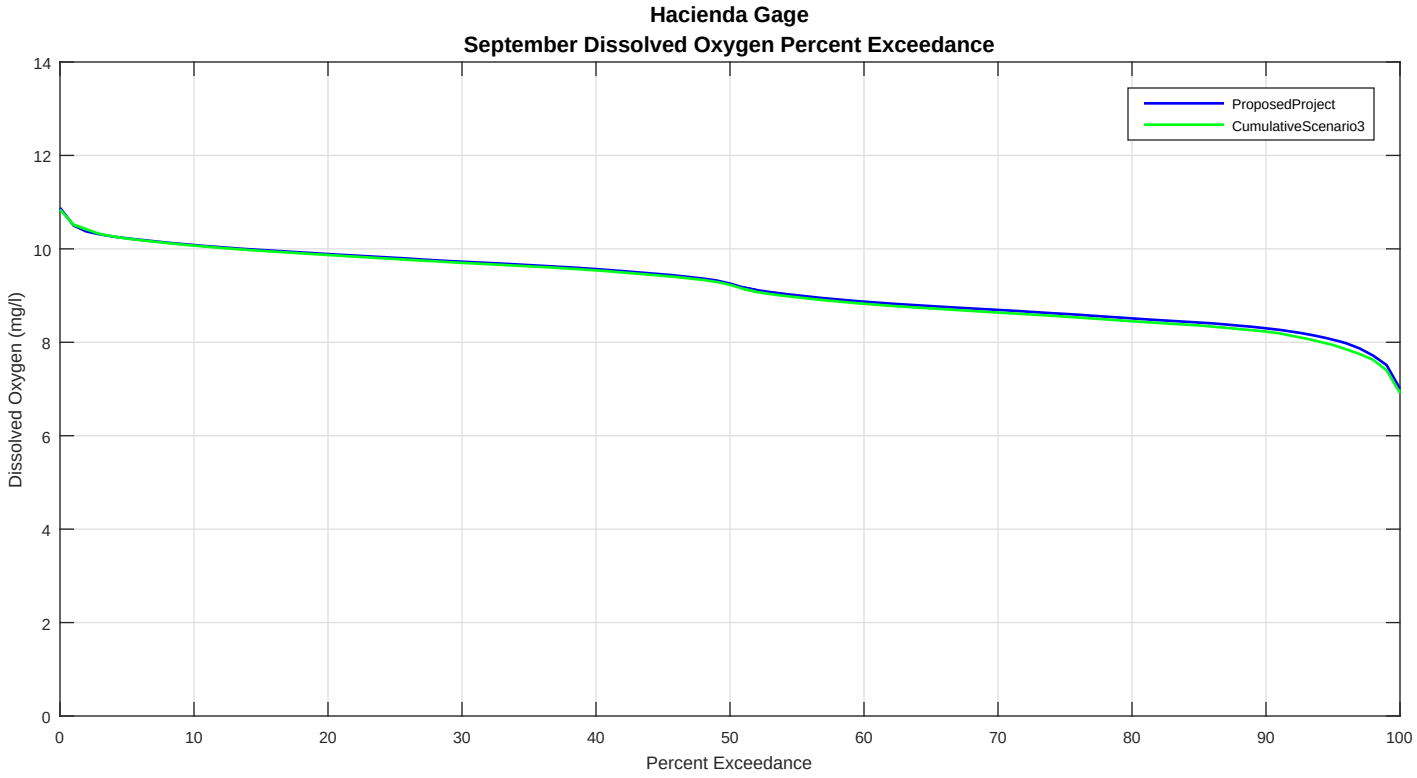
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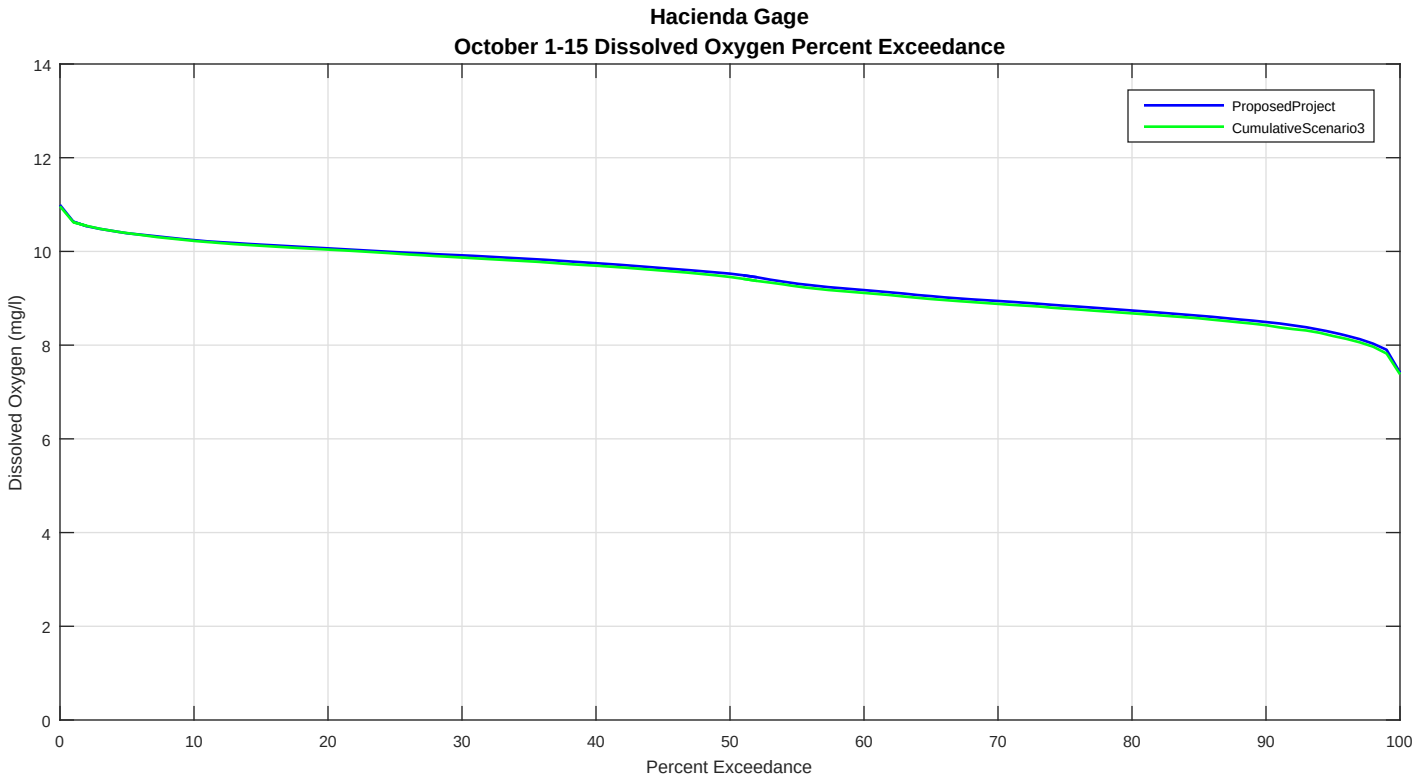
Hacienda Gage
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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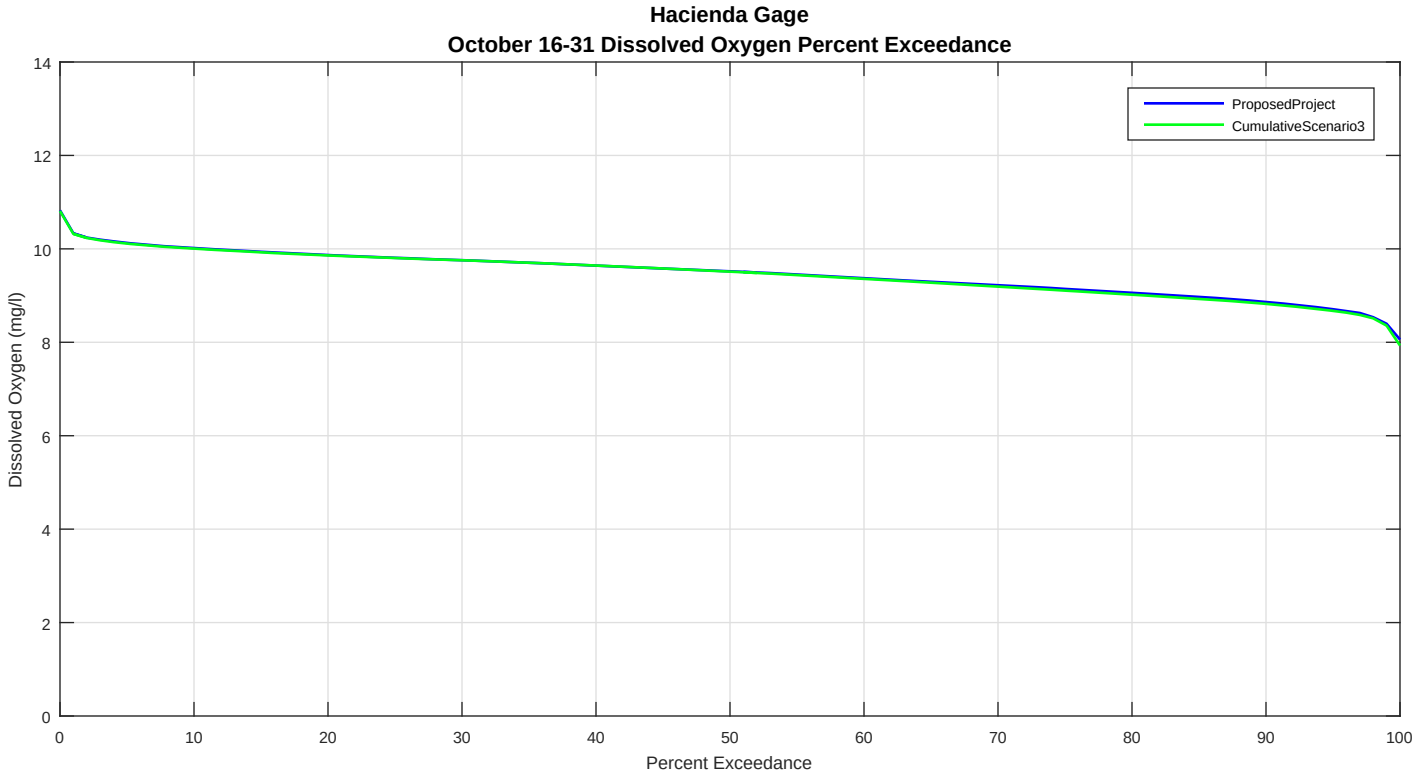
Hacienda Gage
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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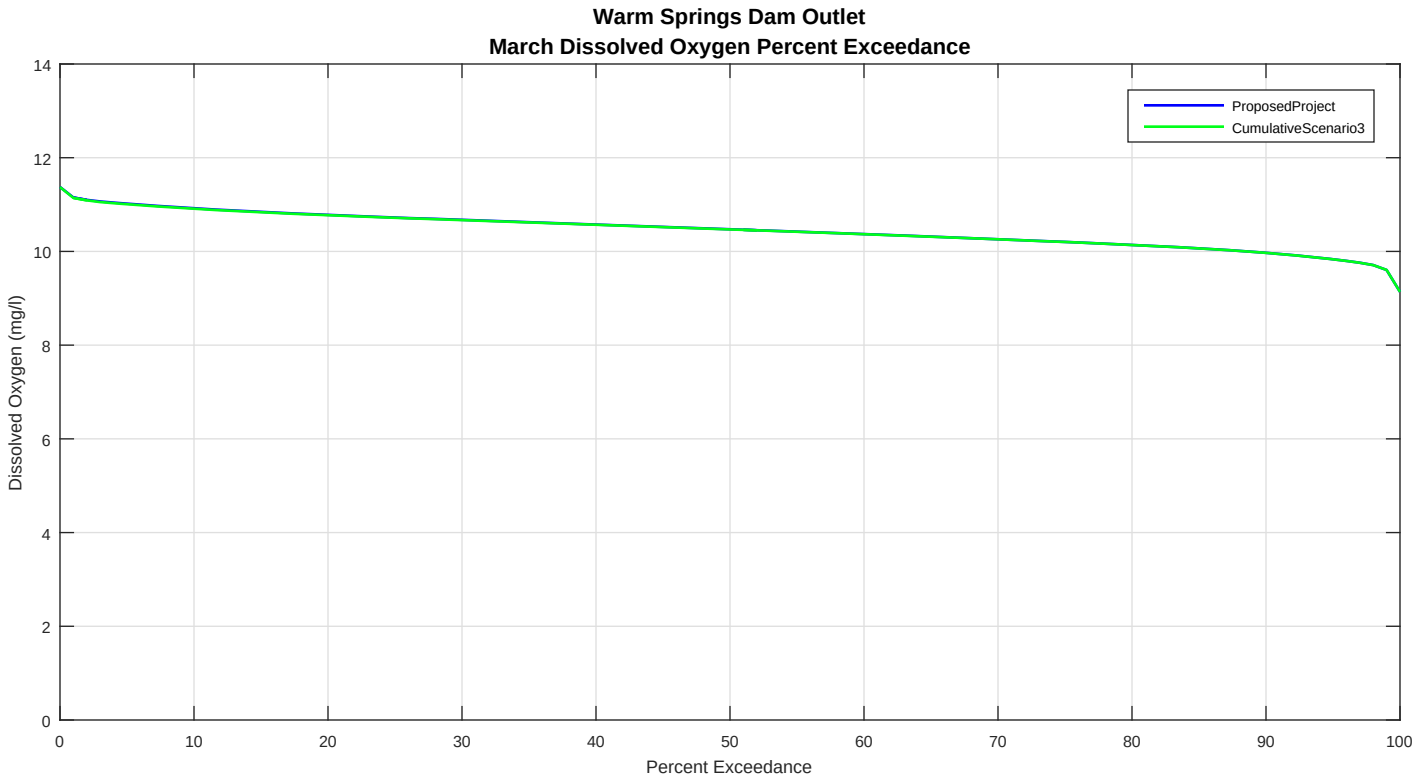
Warm Springs Dam Outlet
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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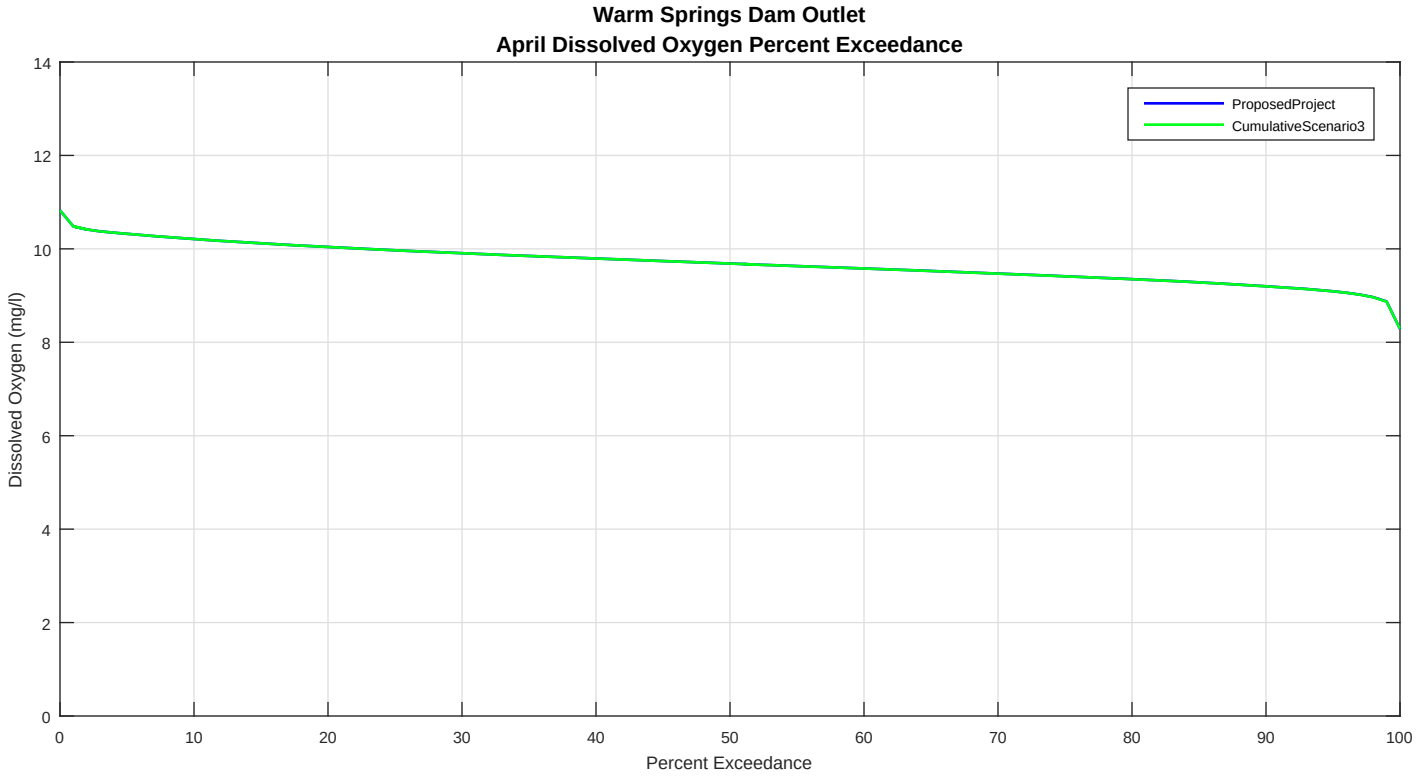
Warm Springs Dam Outlet
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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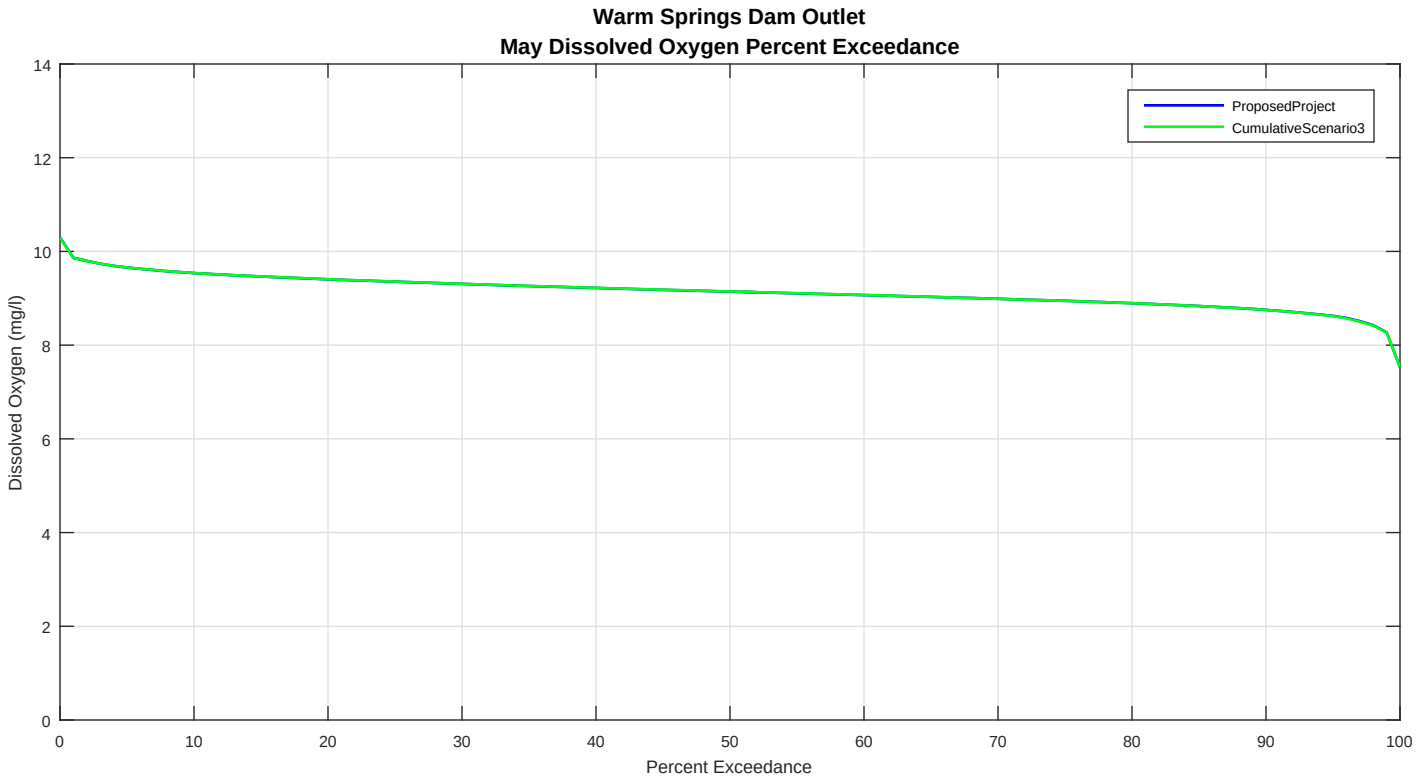
Warm Springs Dam Outlet
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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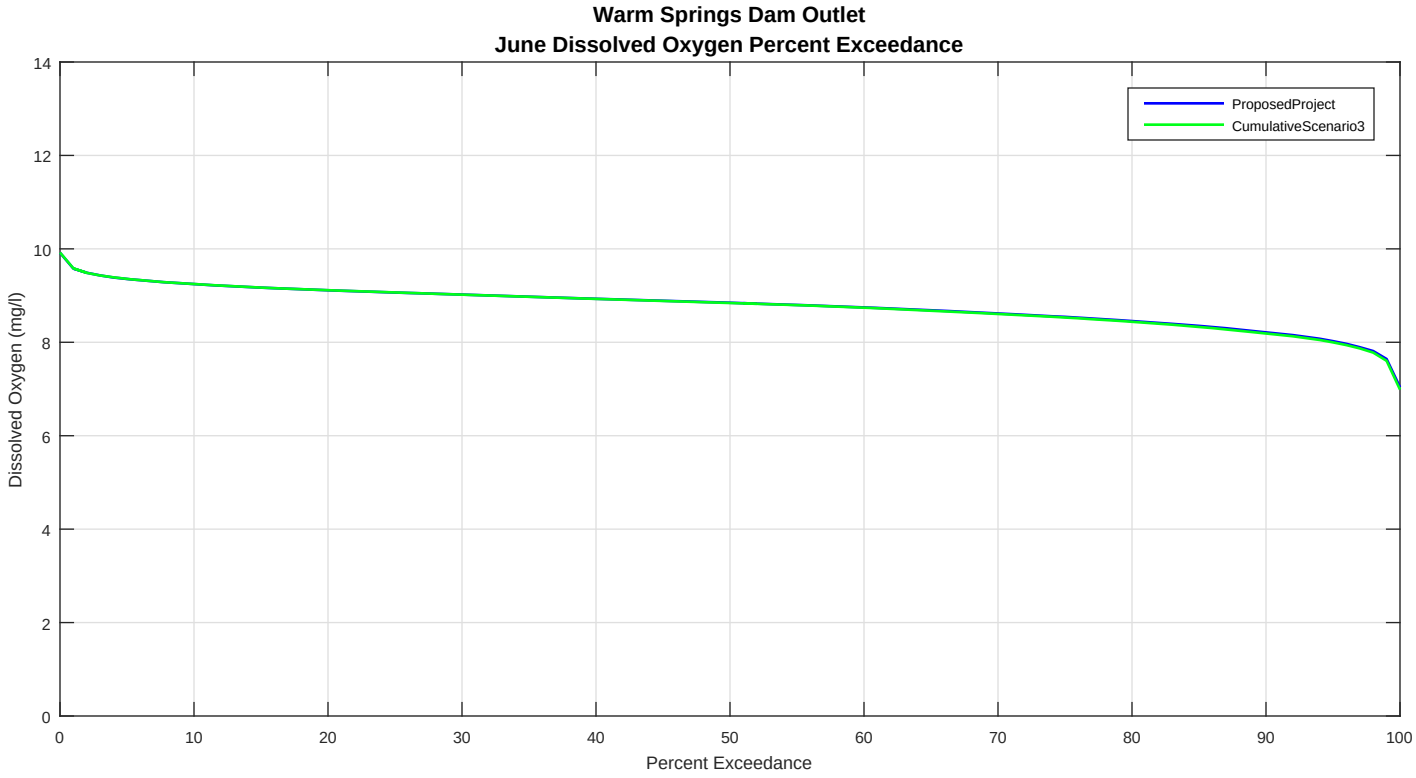
Warm Springs Dam Outlet
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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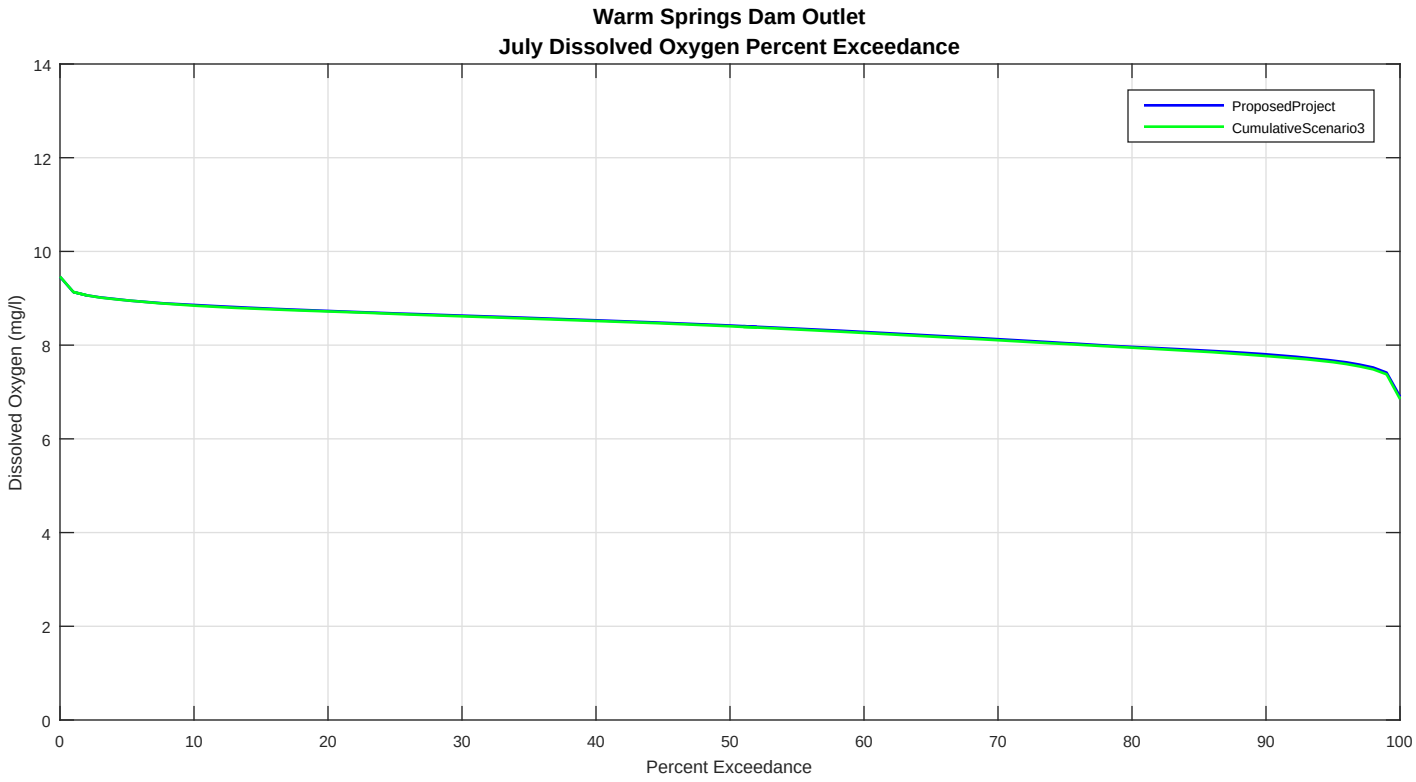
Warm Springs Dam Outlet
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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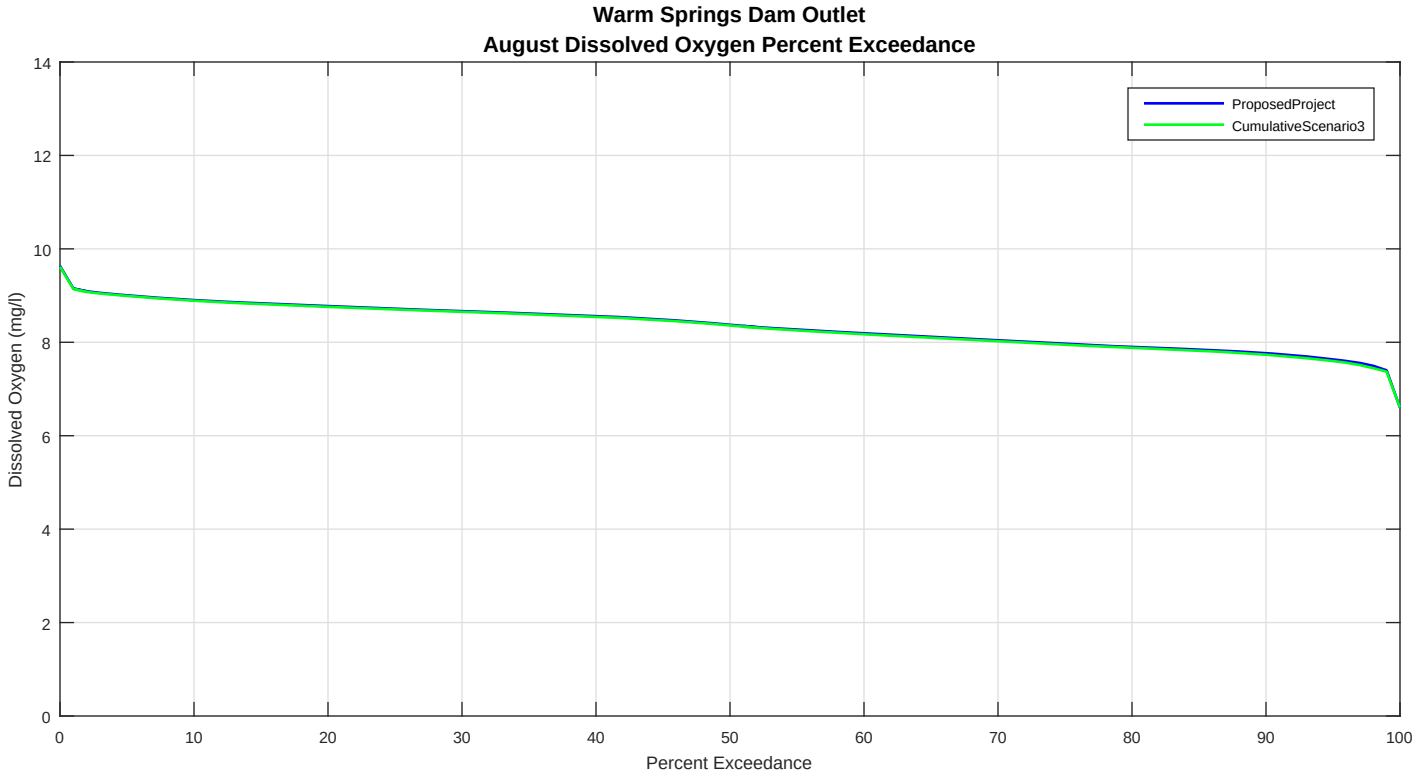
Warm Springs Dam Outlet
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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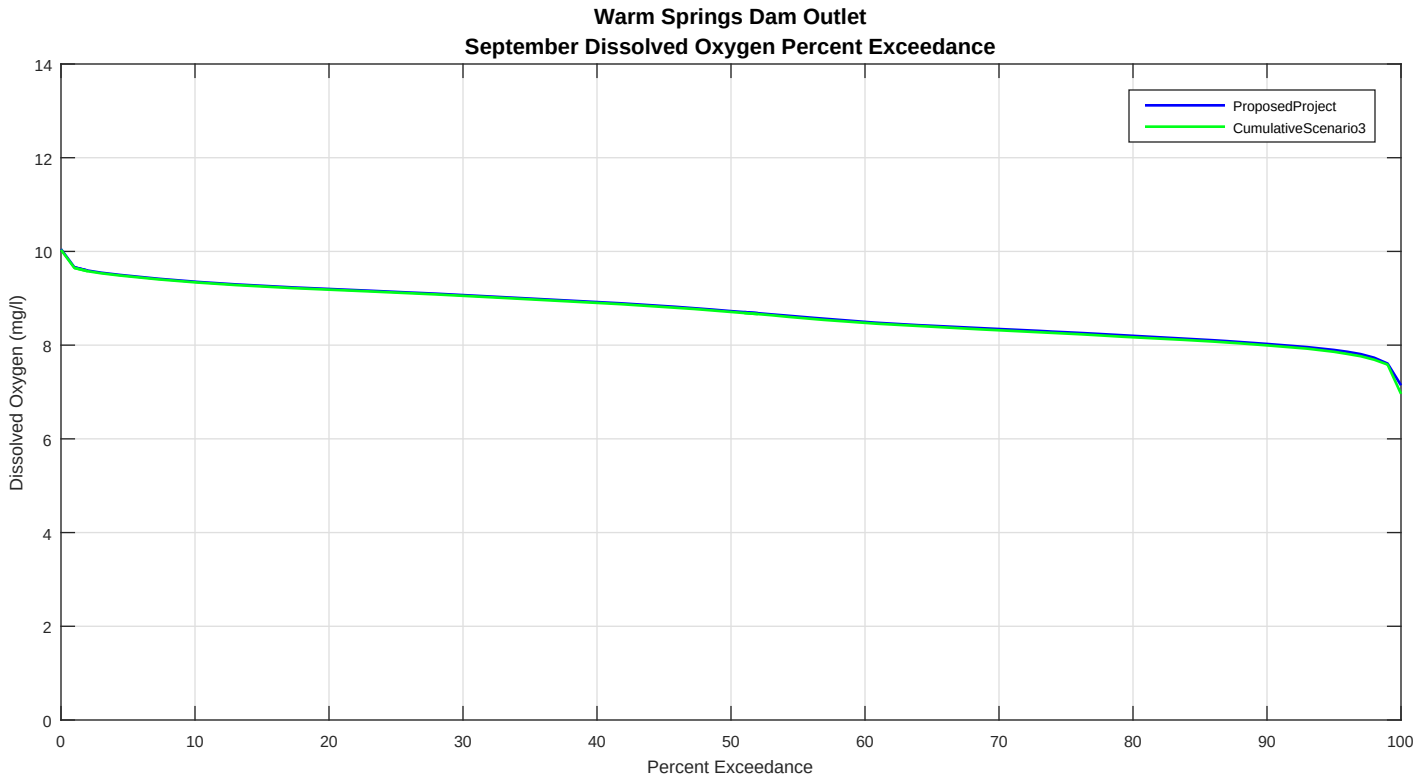
Warm Springs Dam Outlet
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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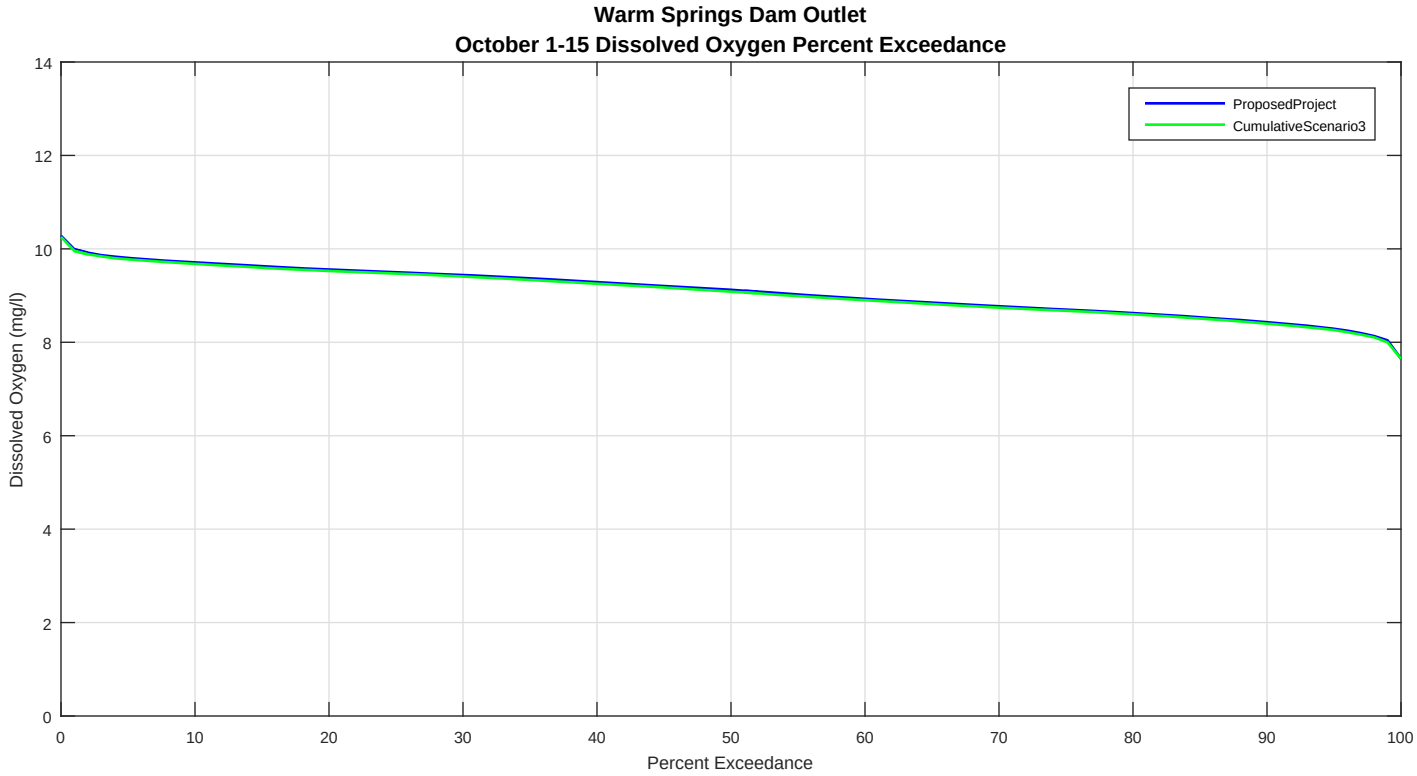
Warm Springs Dam Outlet
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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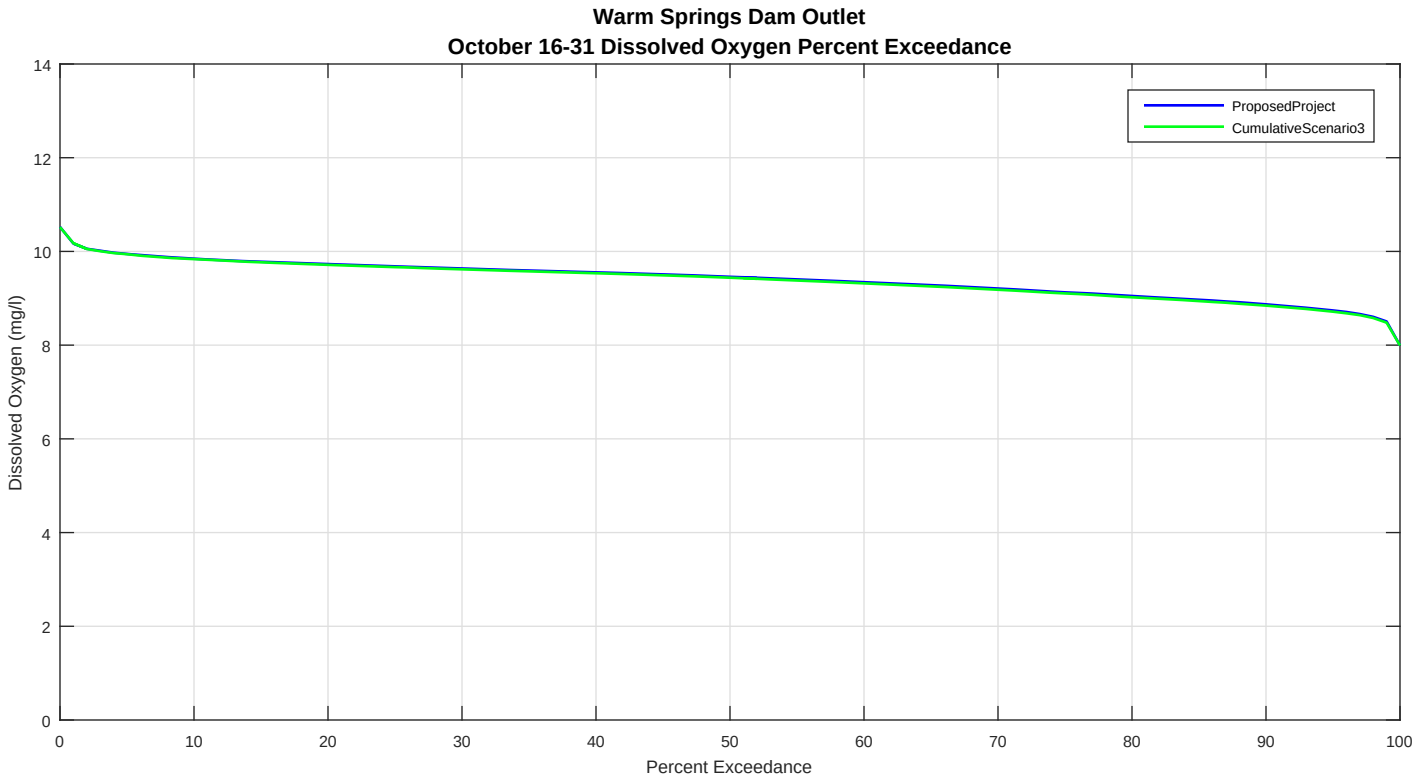
Warm Springs Dam Outlet
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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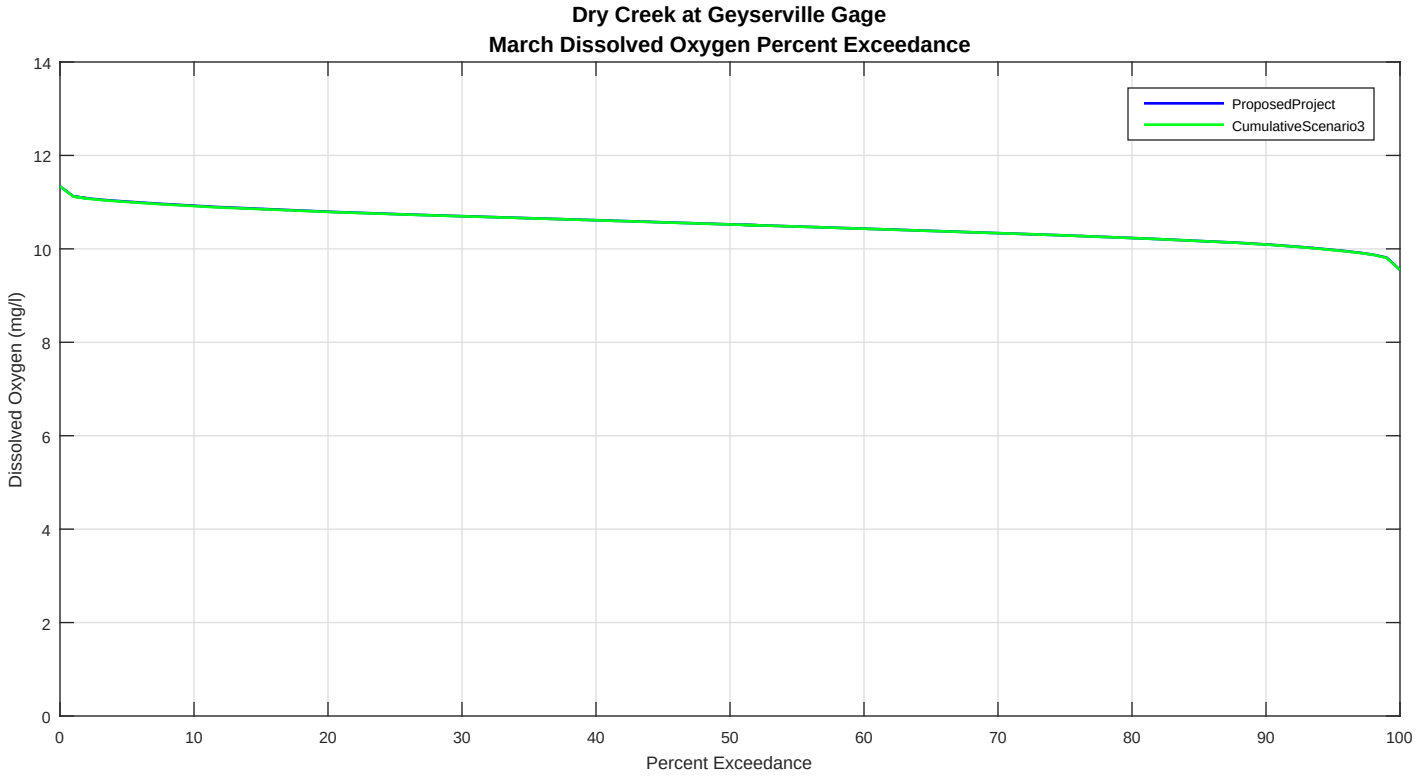
Dry Creek at Geyserville Gage
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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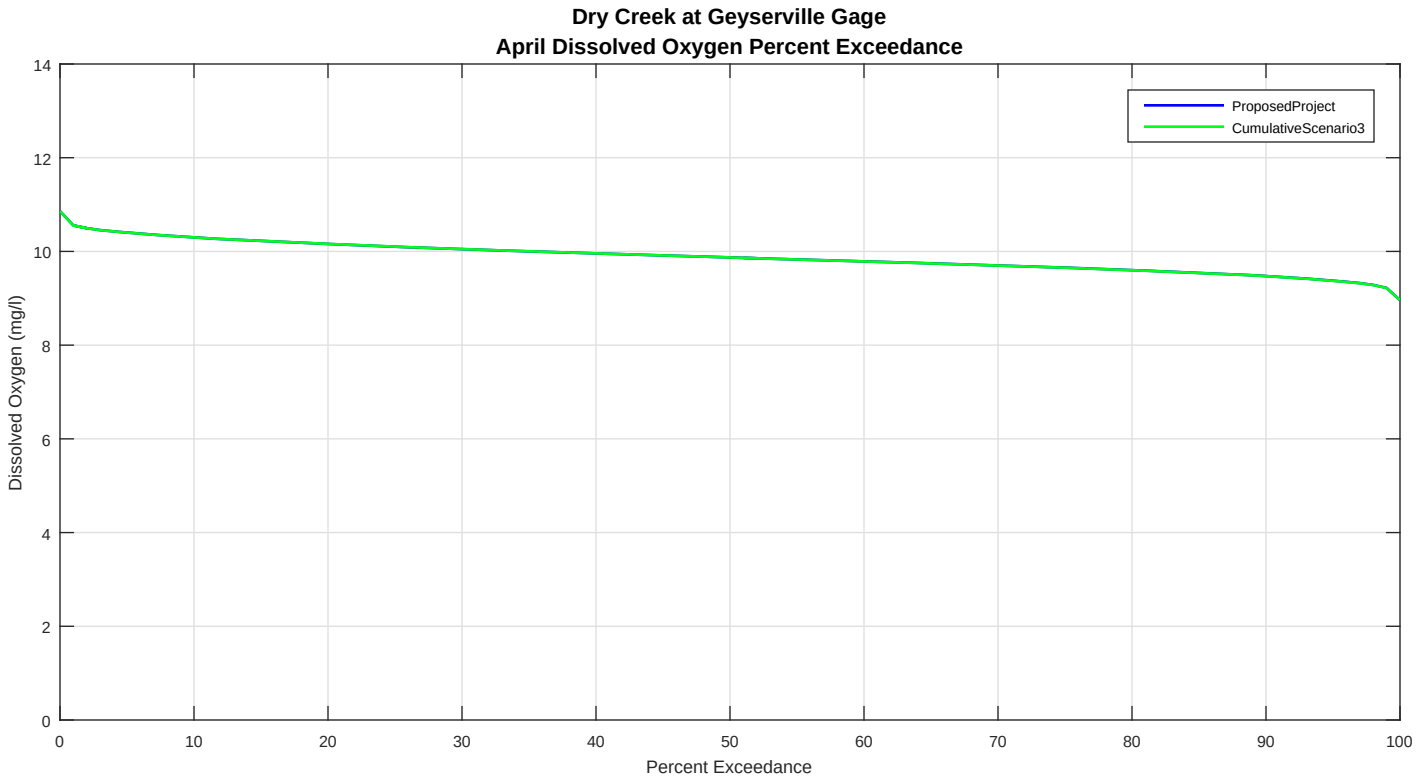
Dry Creek at Geyserville Gage
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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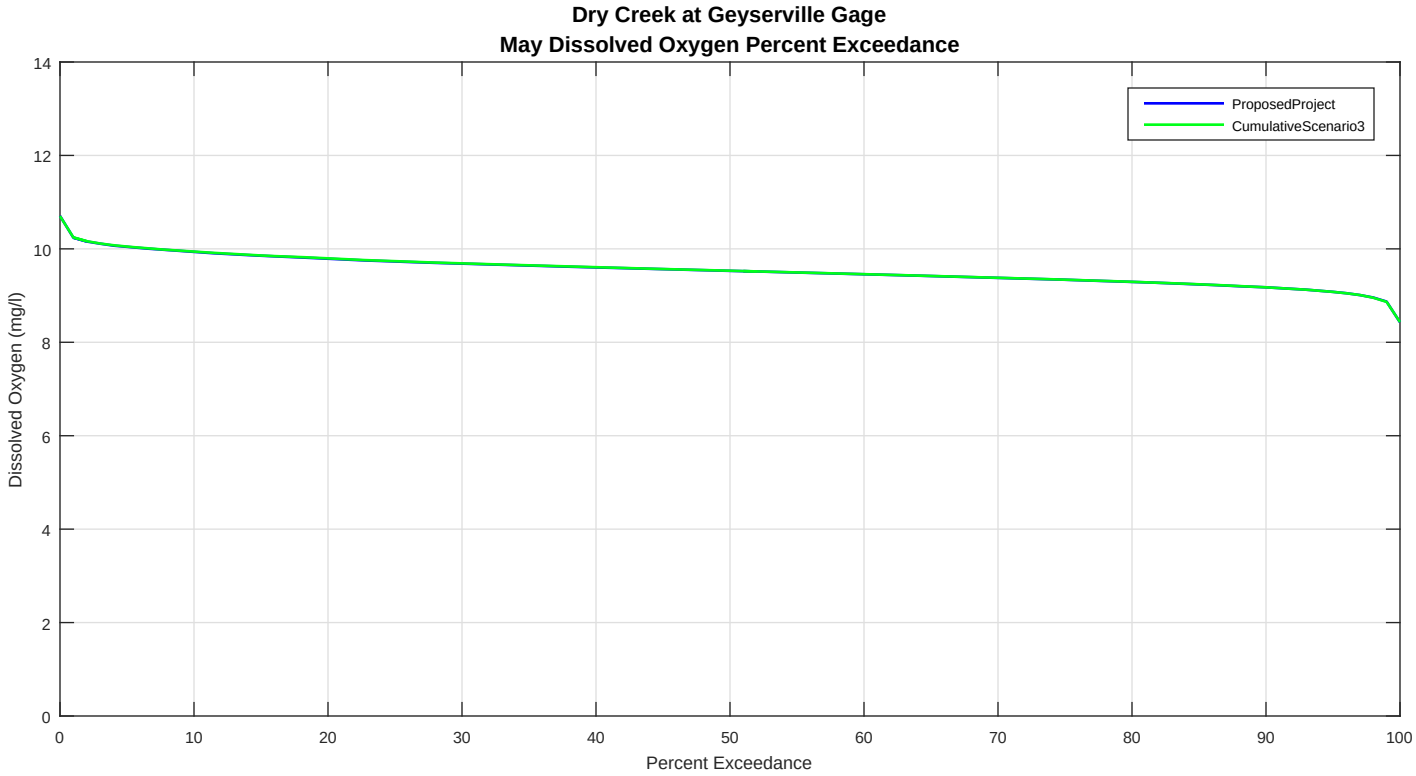
Dry Creek at Geyserville Gage
May Dissolved Oxygen Percent Exceedance
ProposedProject
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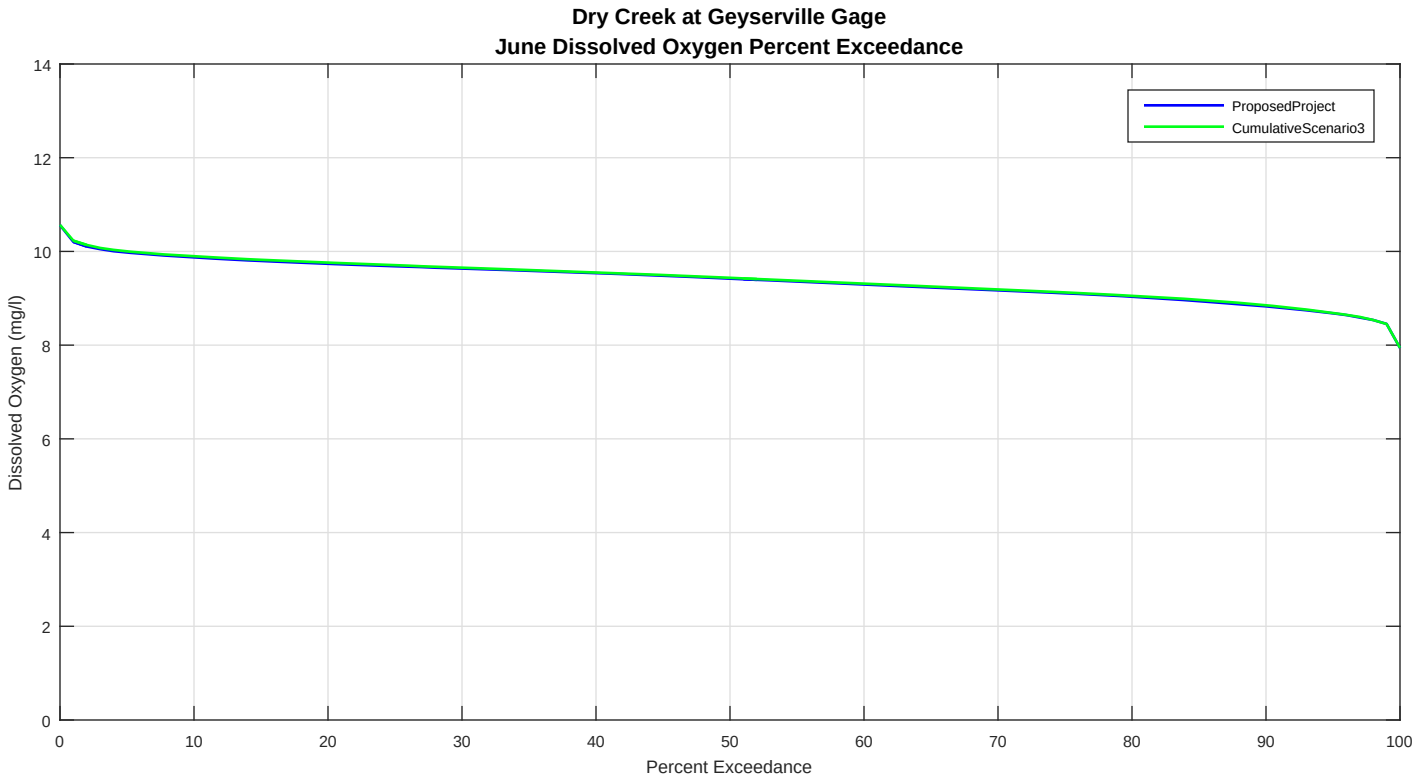
Dry Creek at Geyserville Gage
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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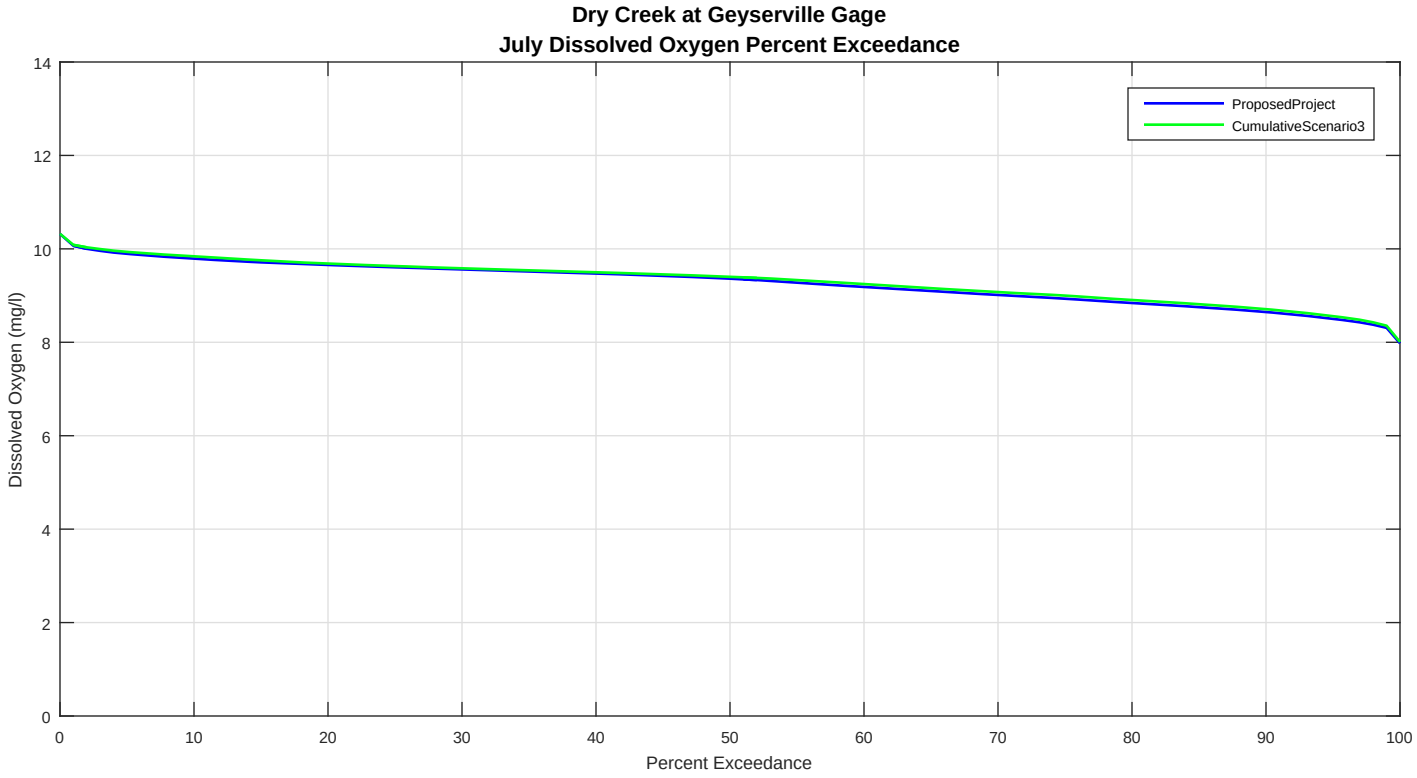
Dry Creek at Geyserville Gage
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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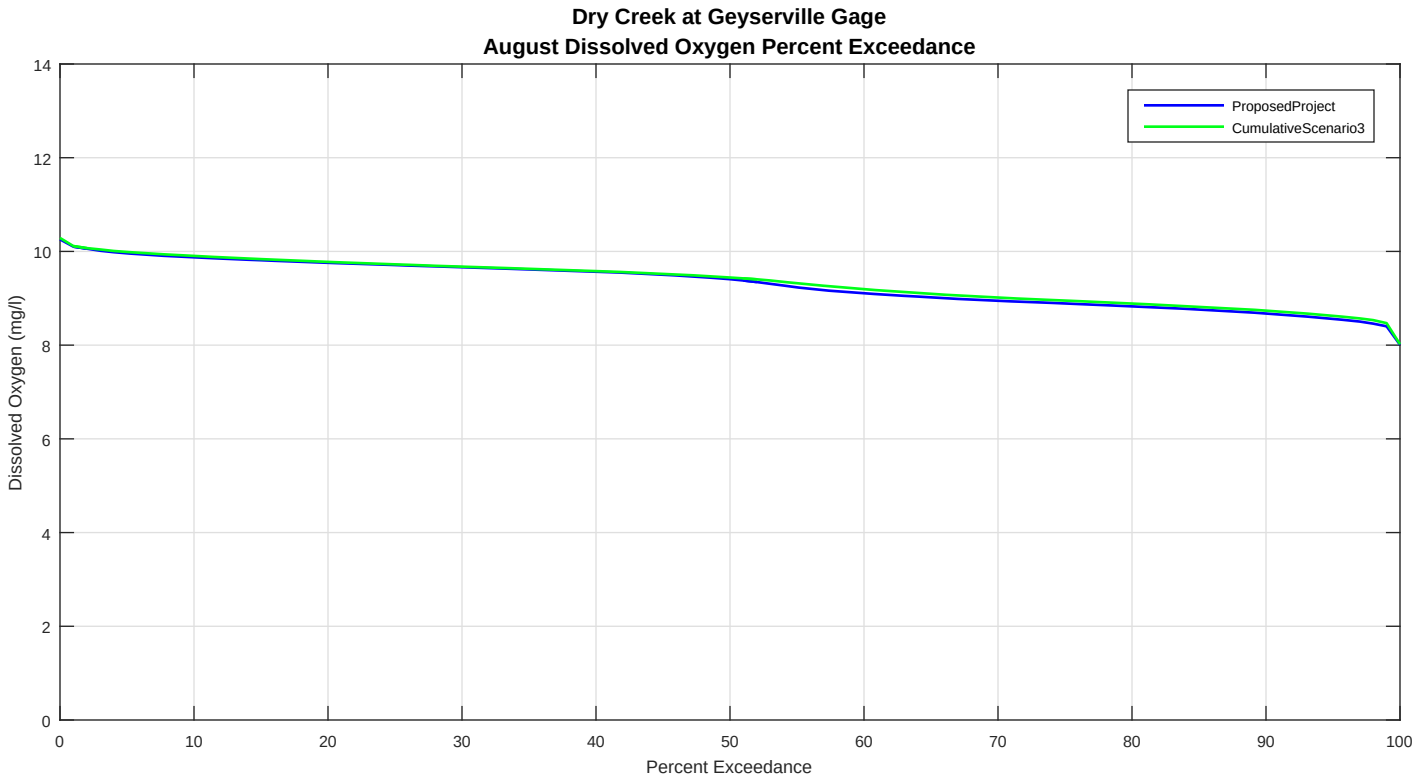
Dry Creek at Geyserville Gage
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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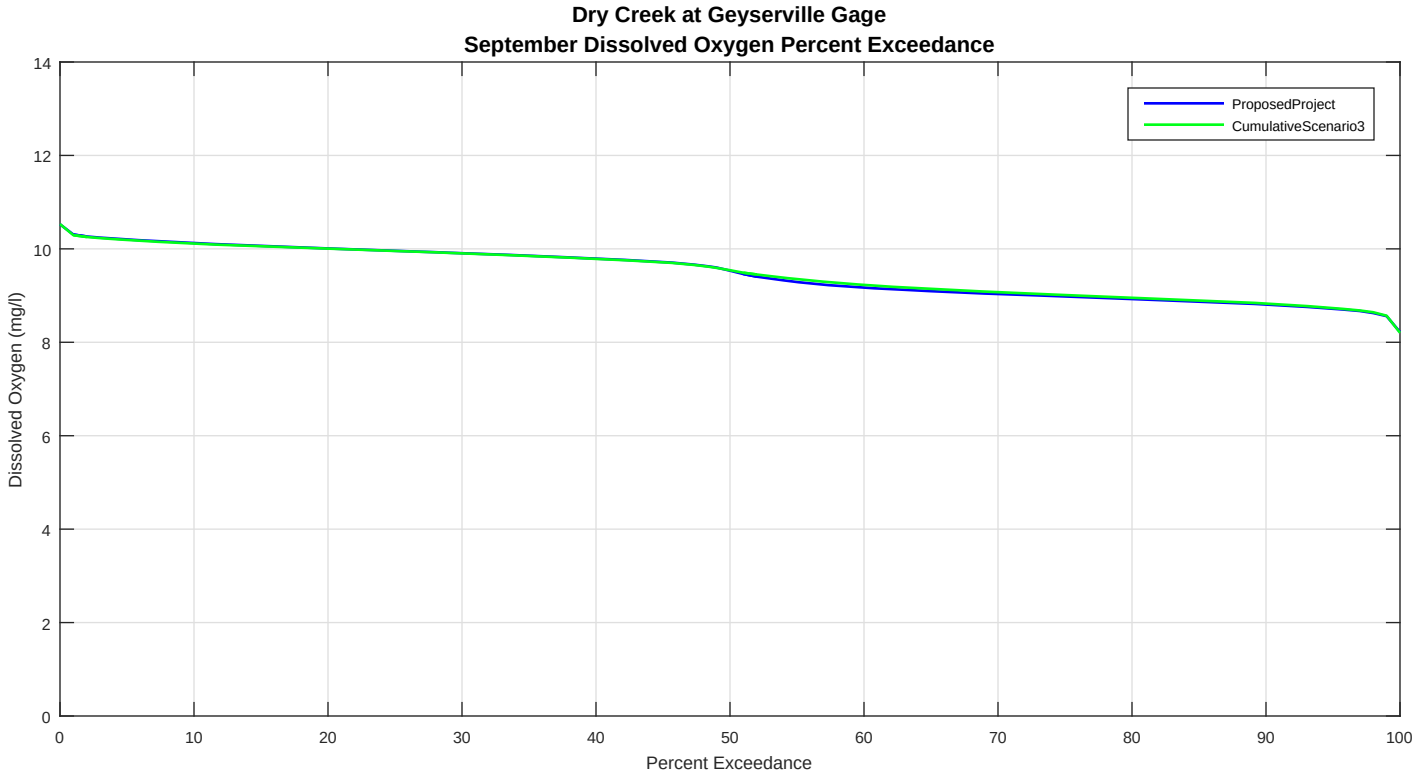
Dry Creek at Geyserville Gage
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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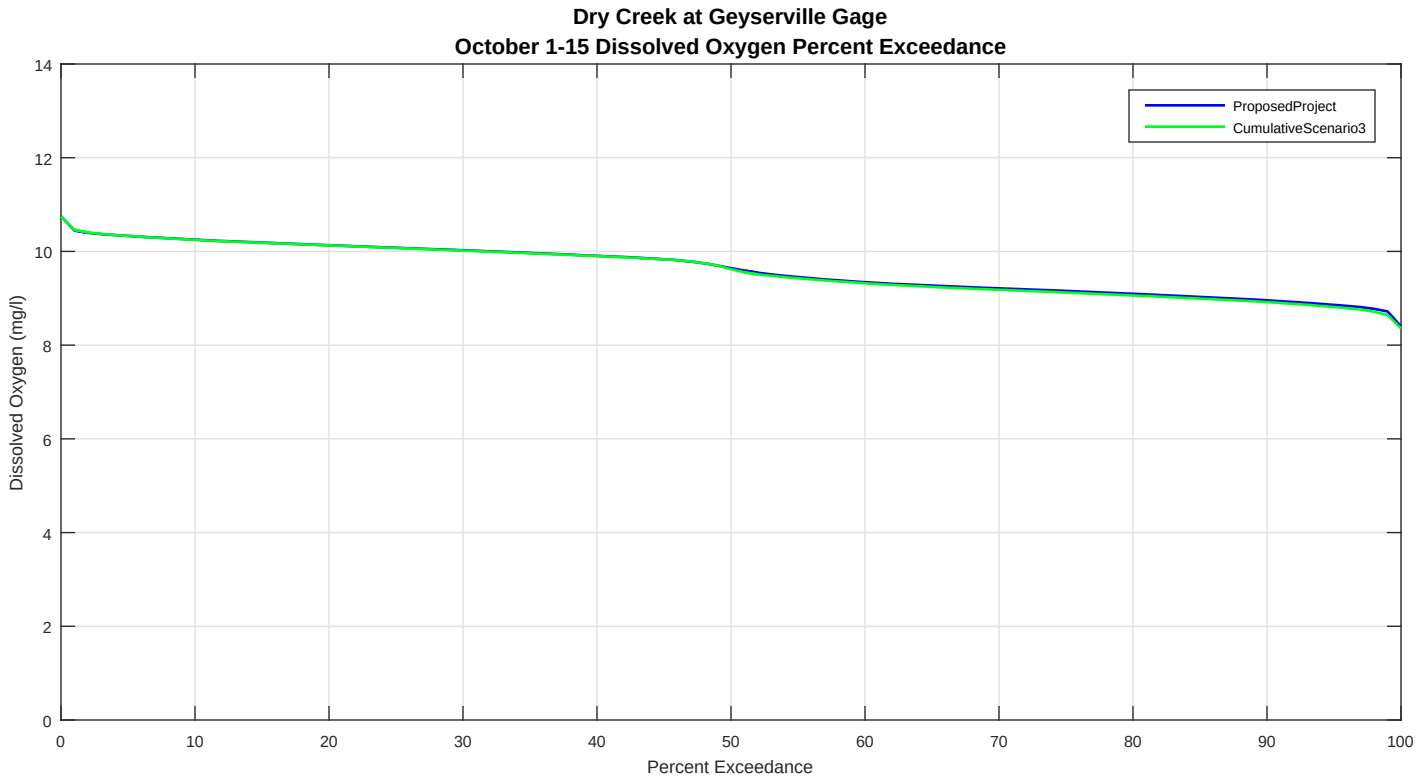
Dry Creek at Geyserville Gage
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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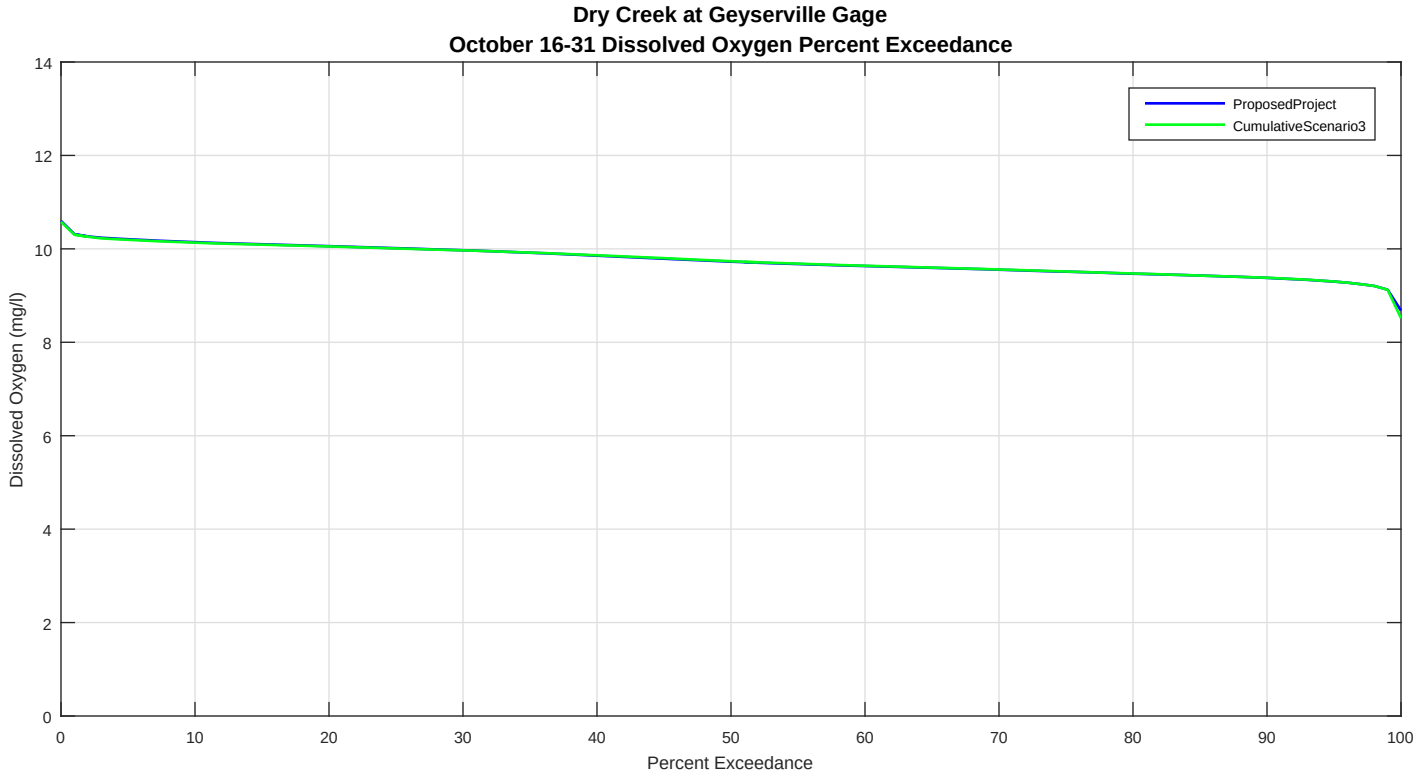
Dry Creek at Geyserville Gage
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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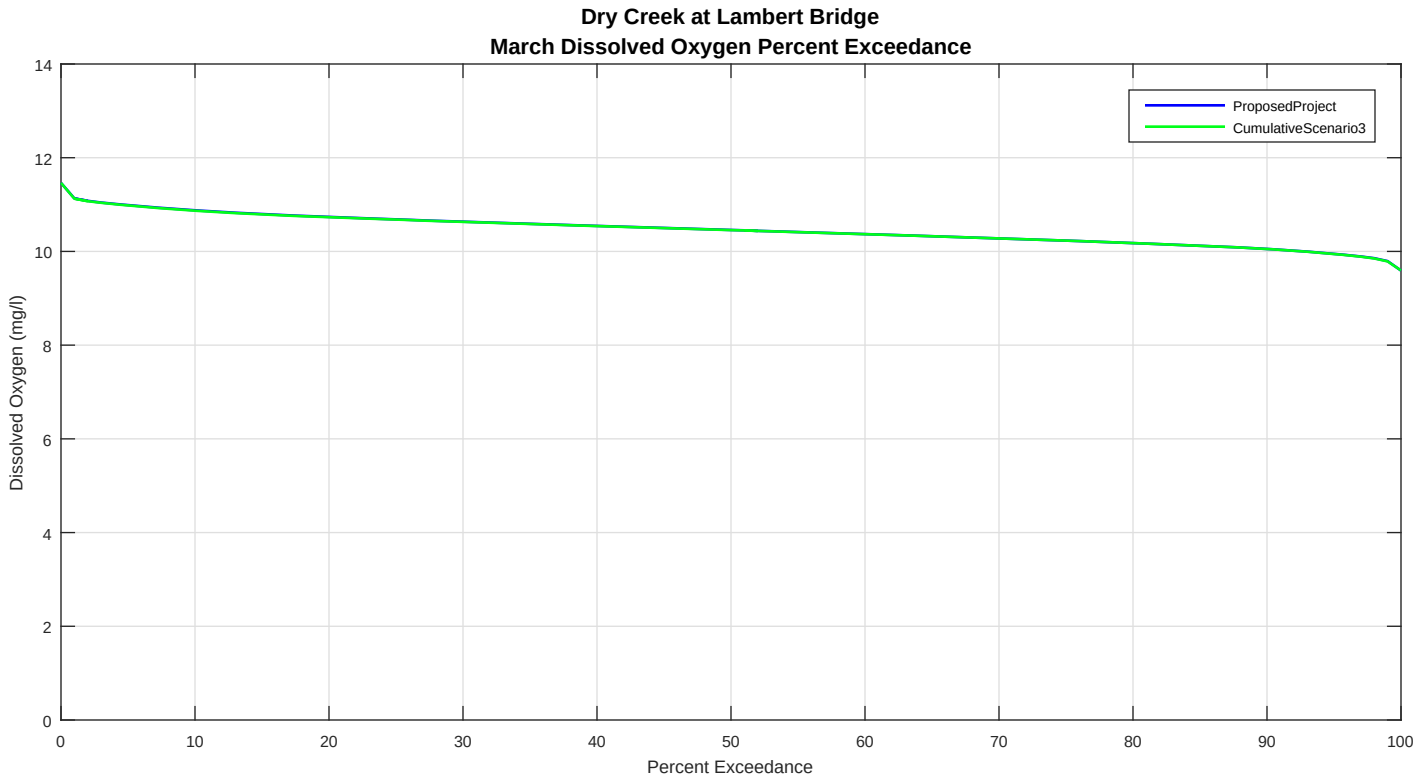
Dry Creek at Lambert Bridge
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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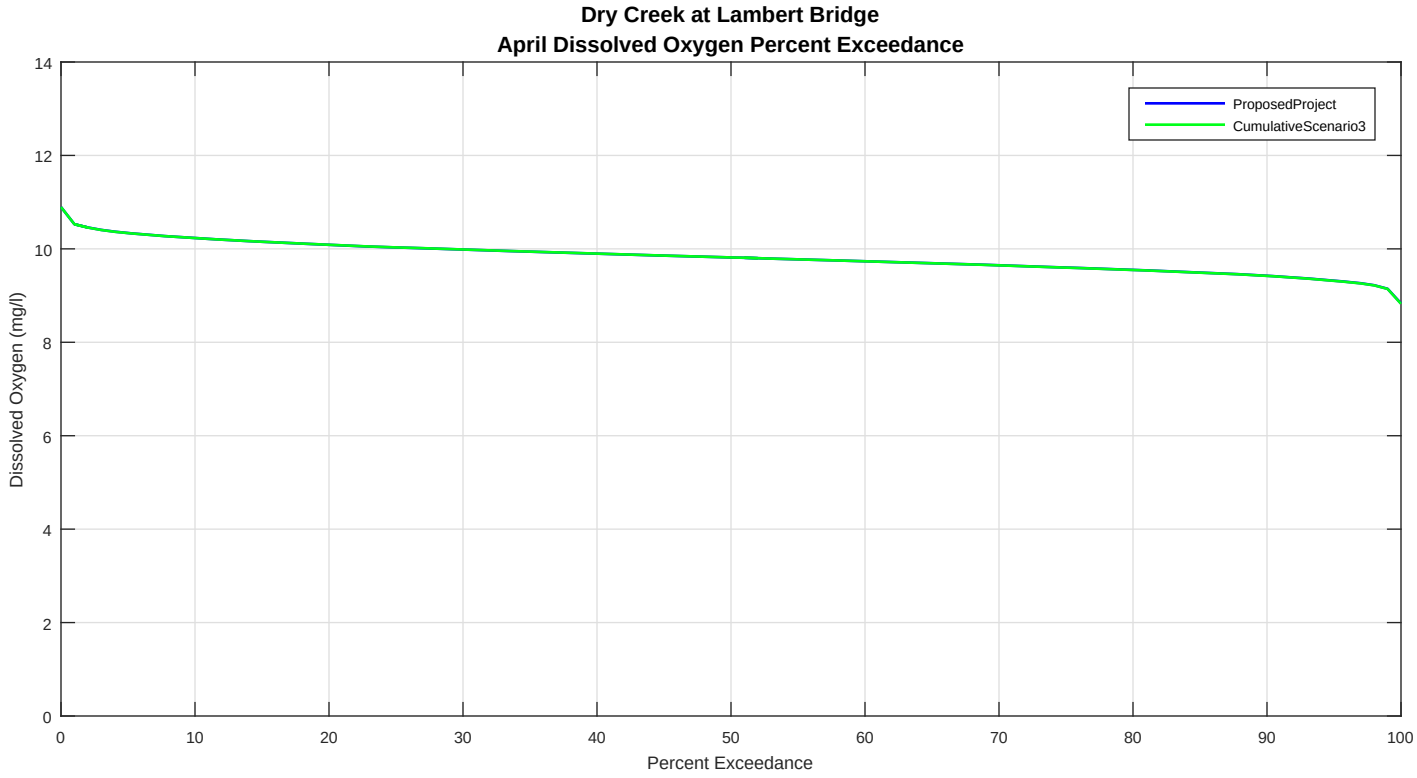
Dry Creek at Lambert Bridge
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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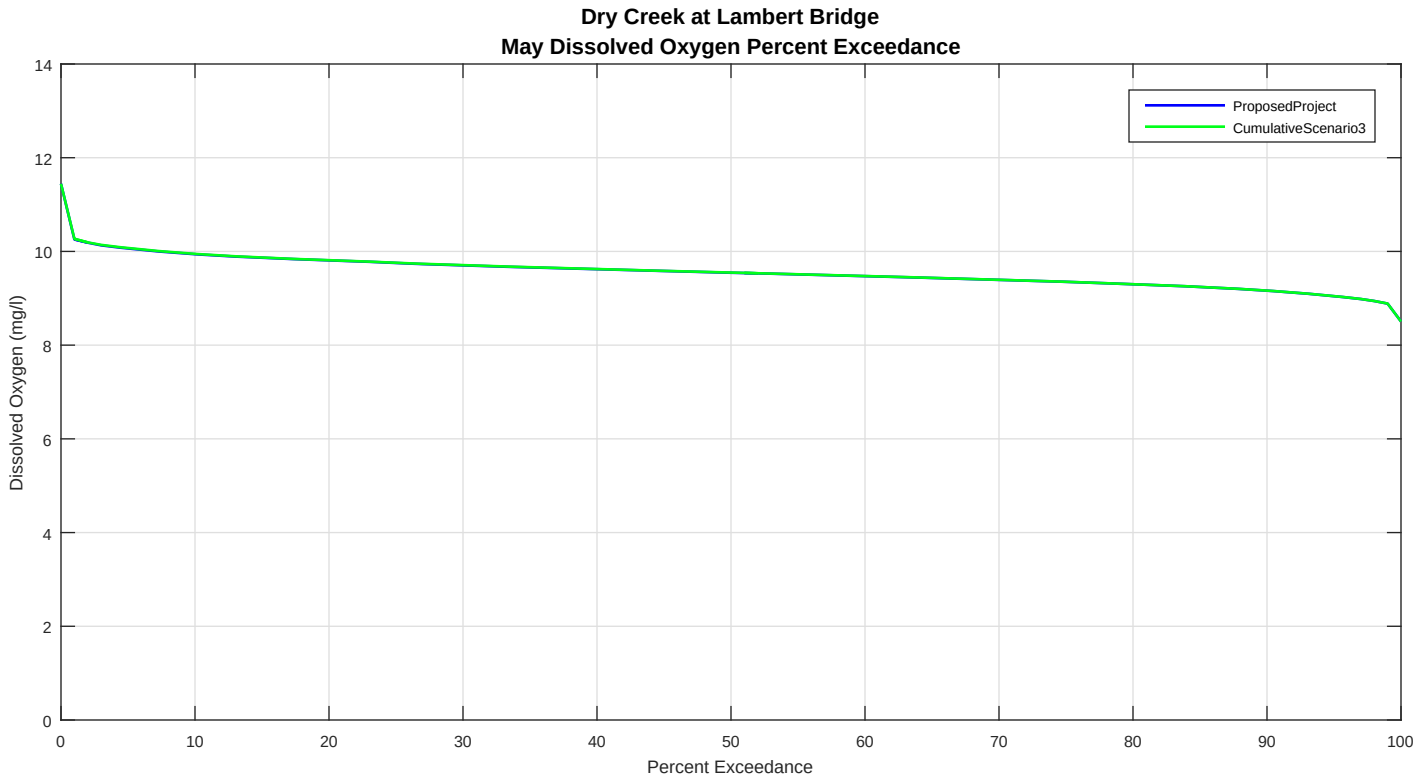
Dry Creek at Lambert Bridge
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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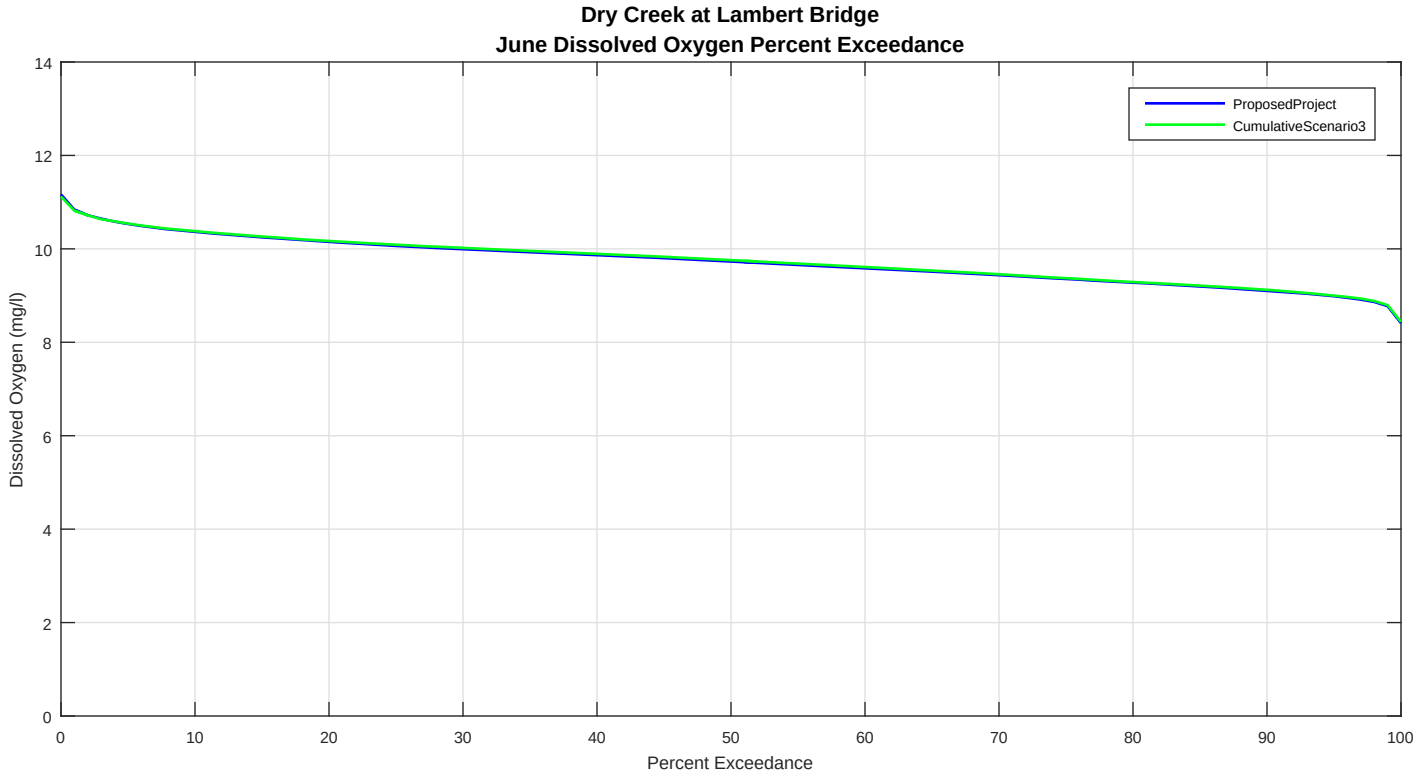
Dry Creek at Lambert Bridge
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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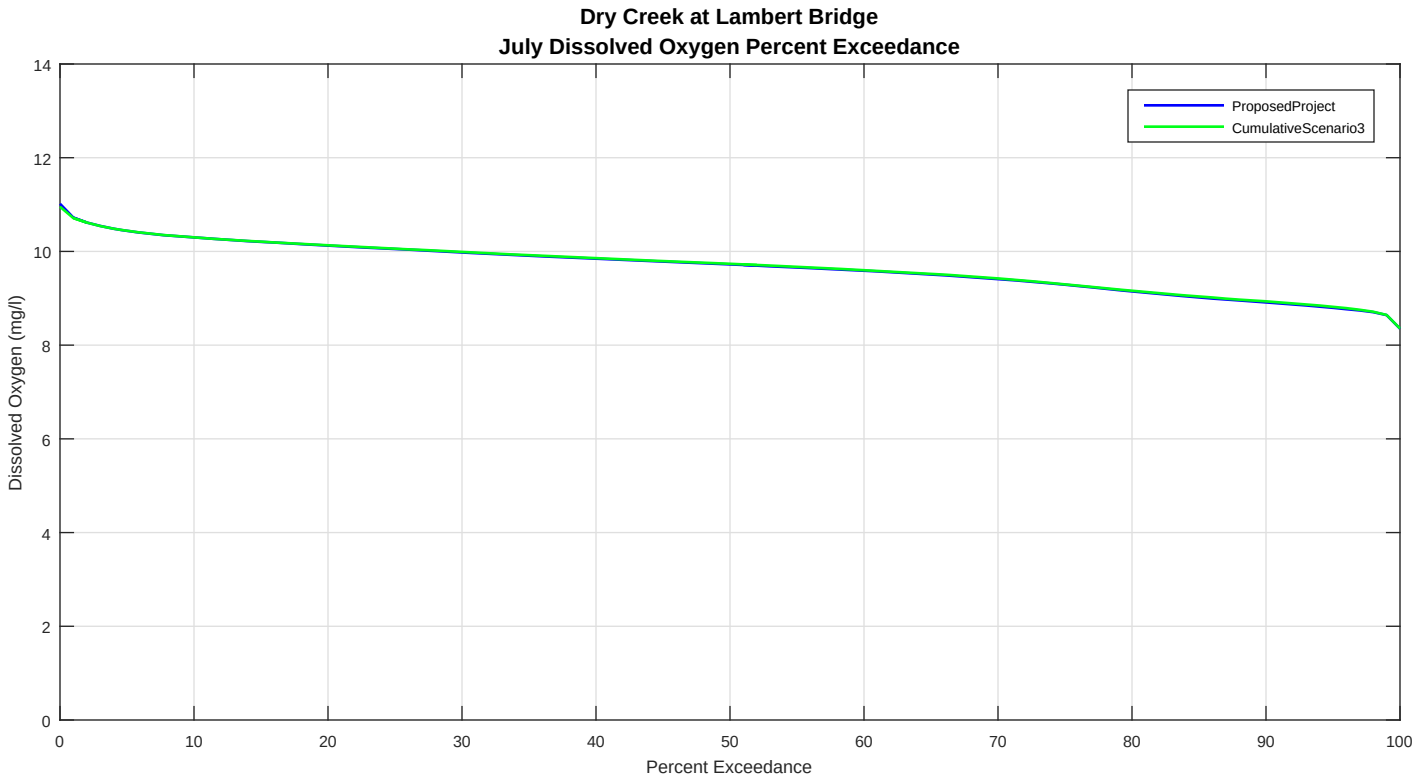
Dry Creek at Lambert Bridge
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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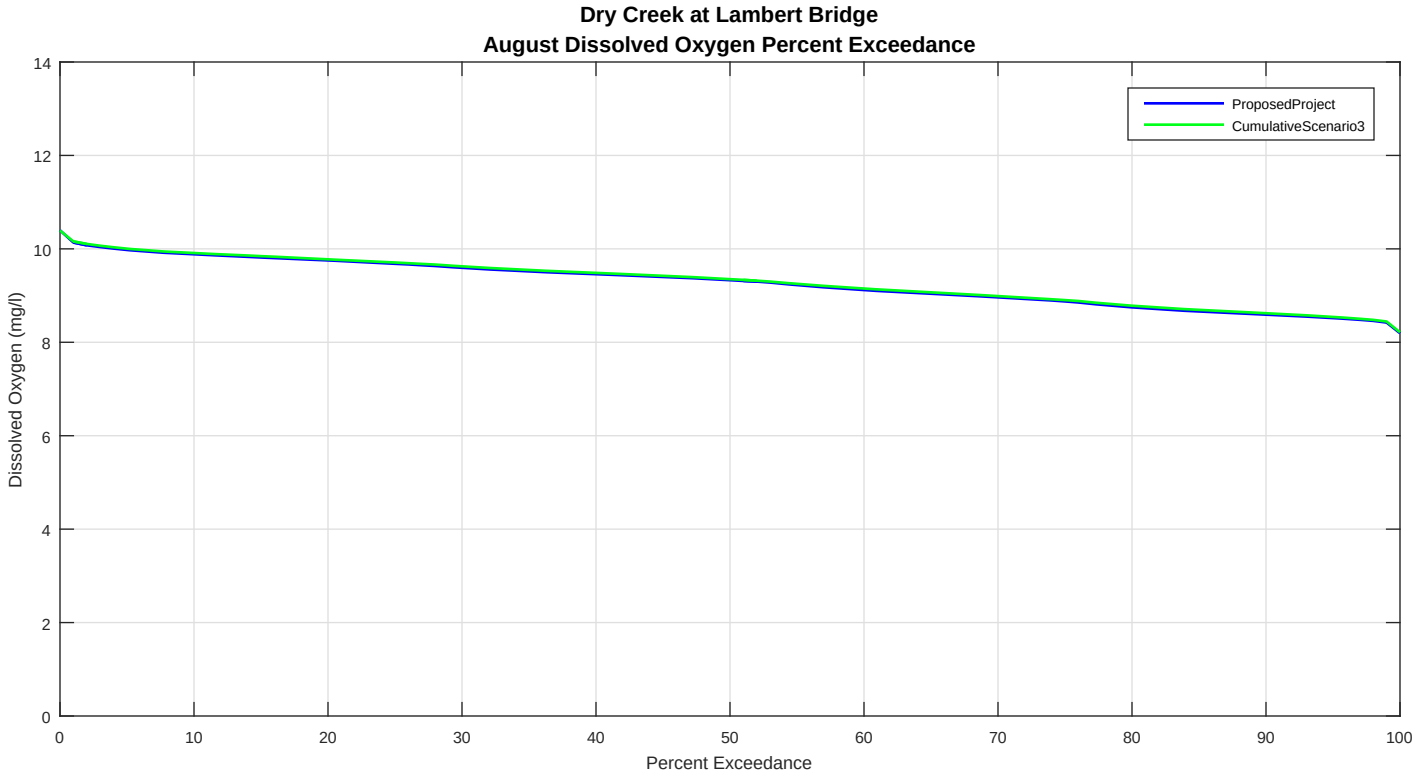
Dry Creek at Lambert Bridge
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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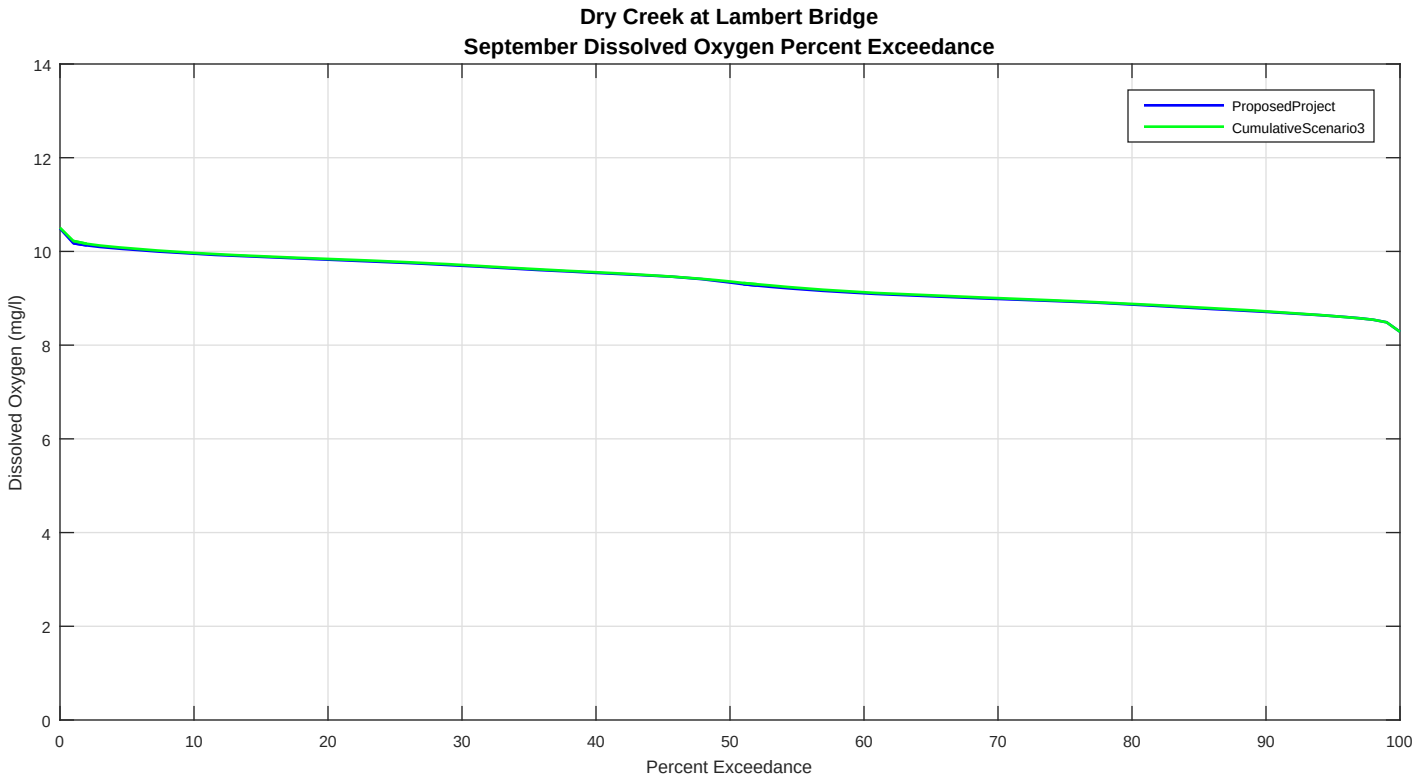
Dry Creek at Lambert Bridge
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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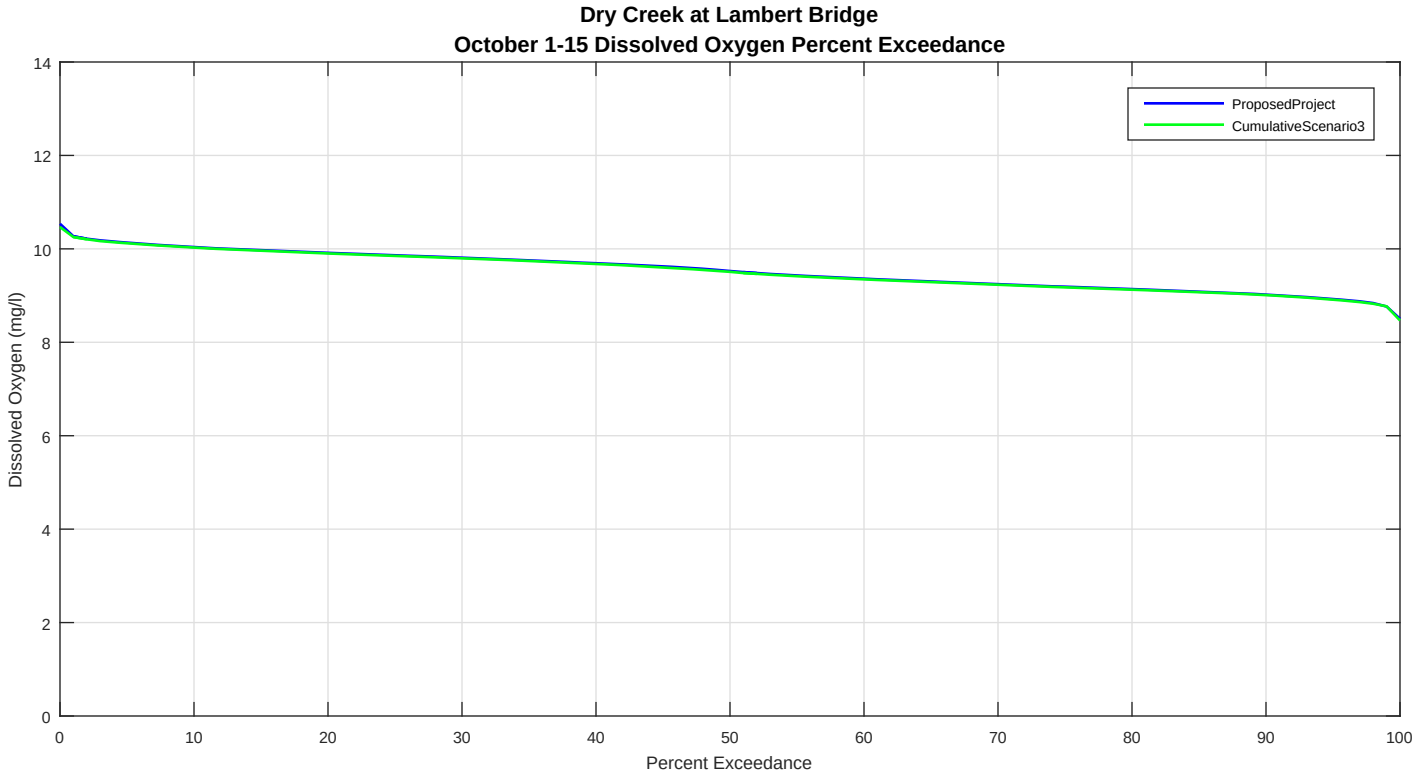
Dry Creek at Lambert Bridge
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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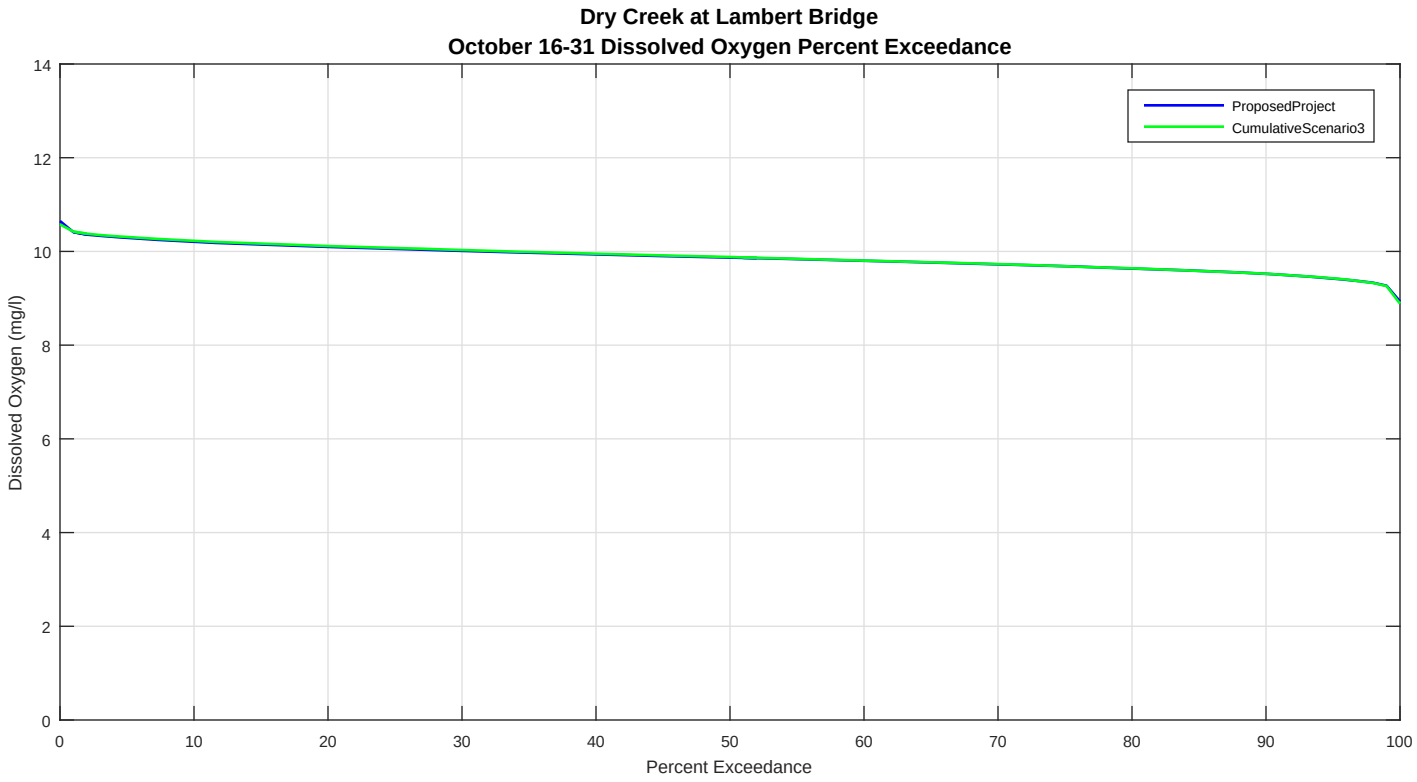
Dry Creek at Lambert Bridge
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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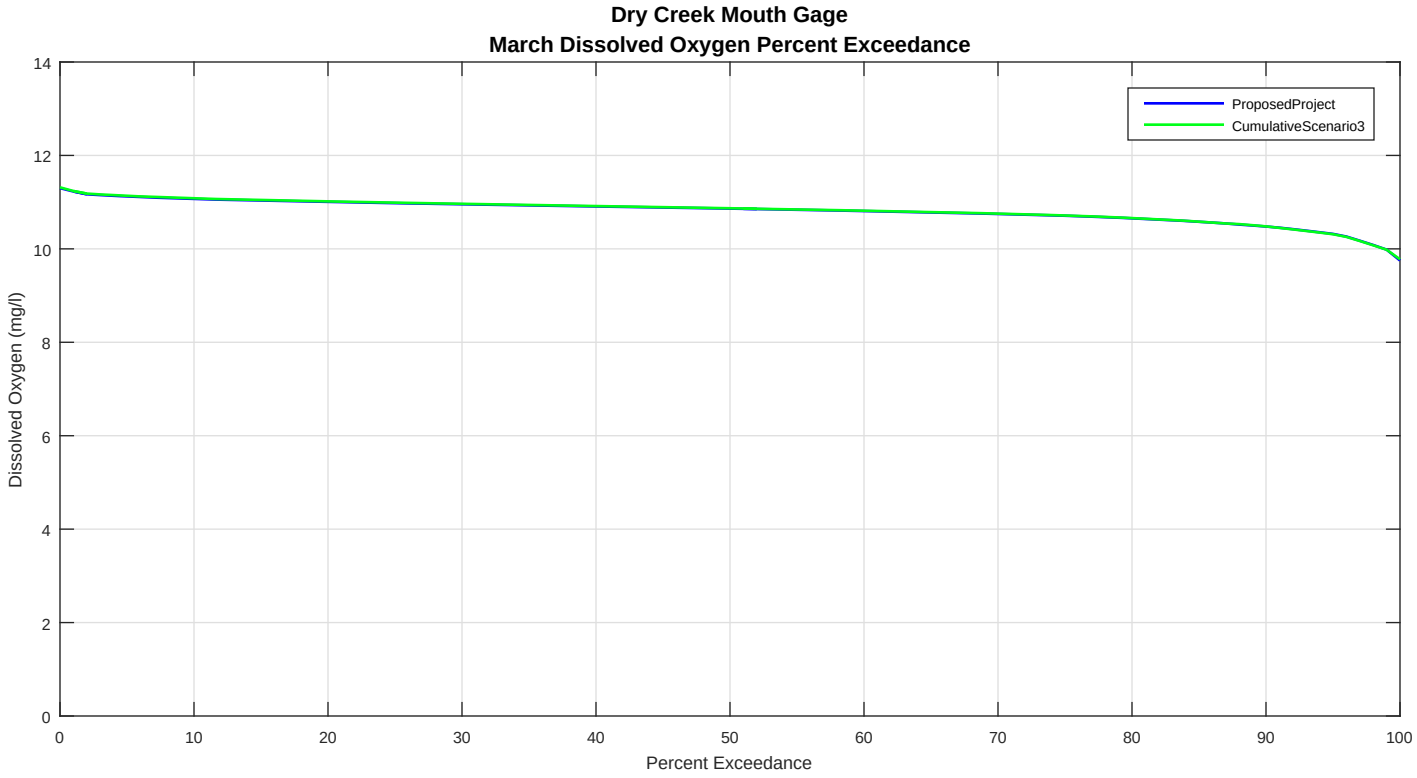
Dry Creek Mouth Gage
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
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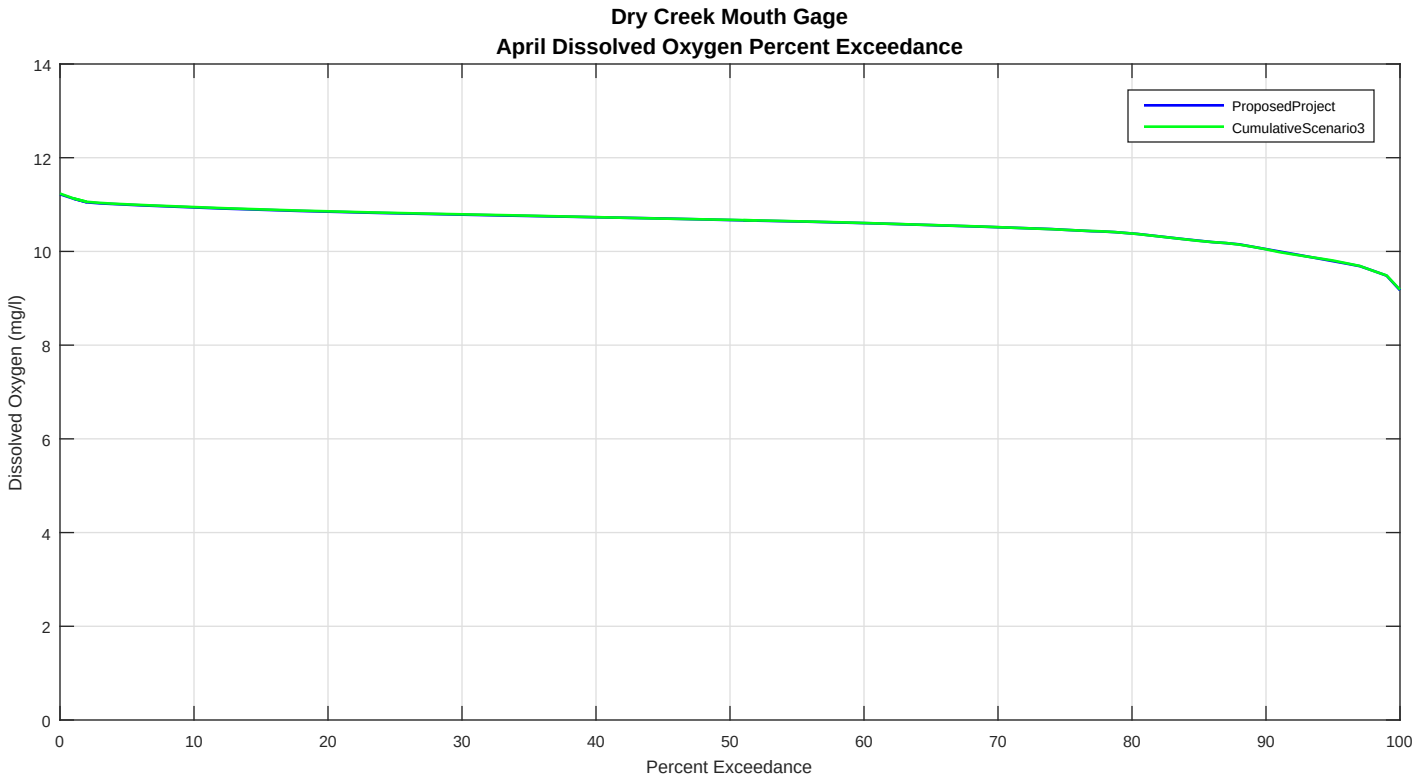
Dry Creek Mouth Gage
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
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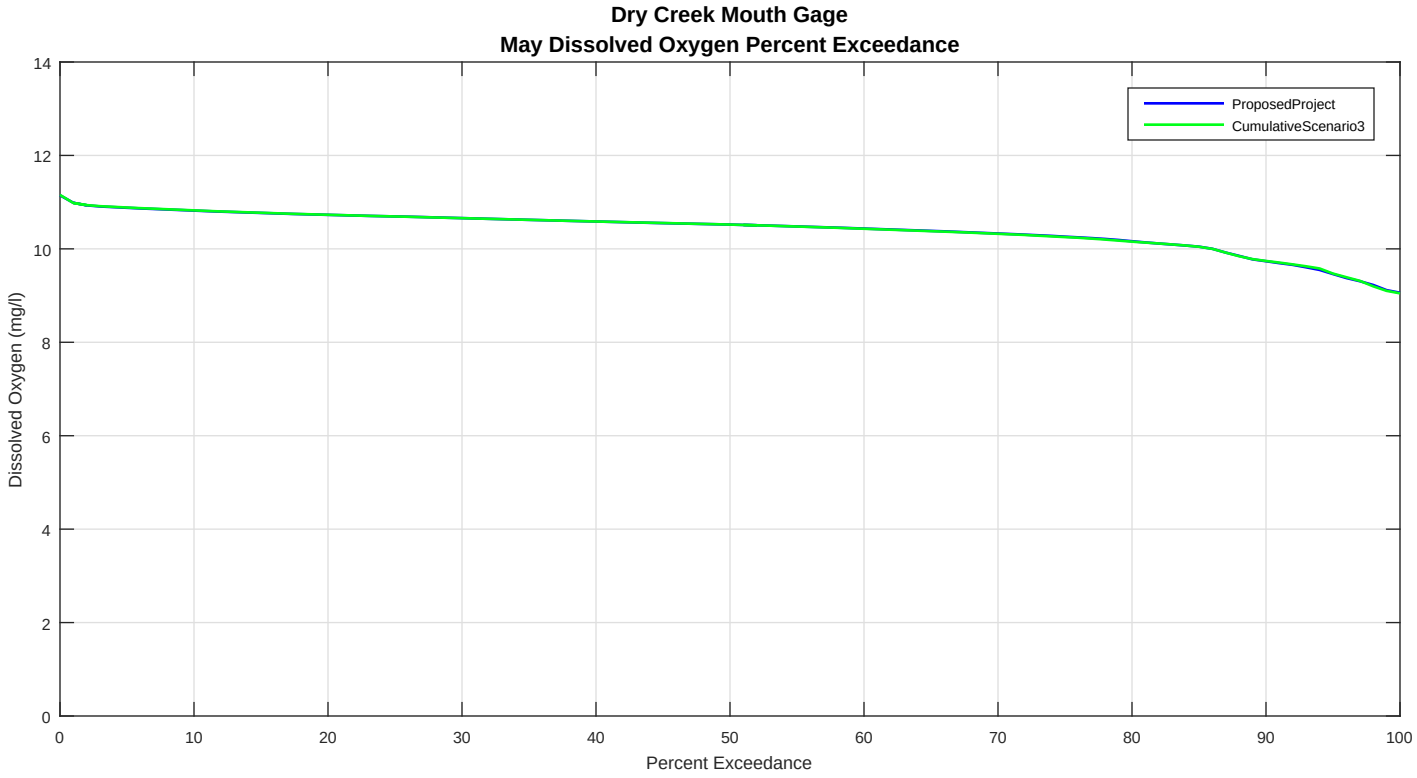
Dry Creek Mouth Gage
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CumulativeScenario3
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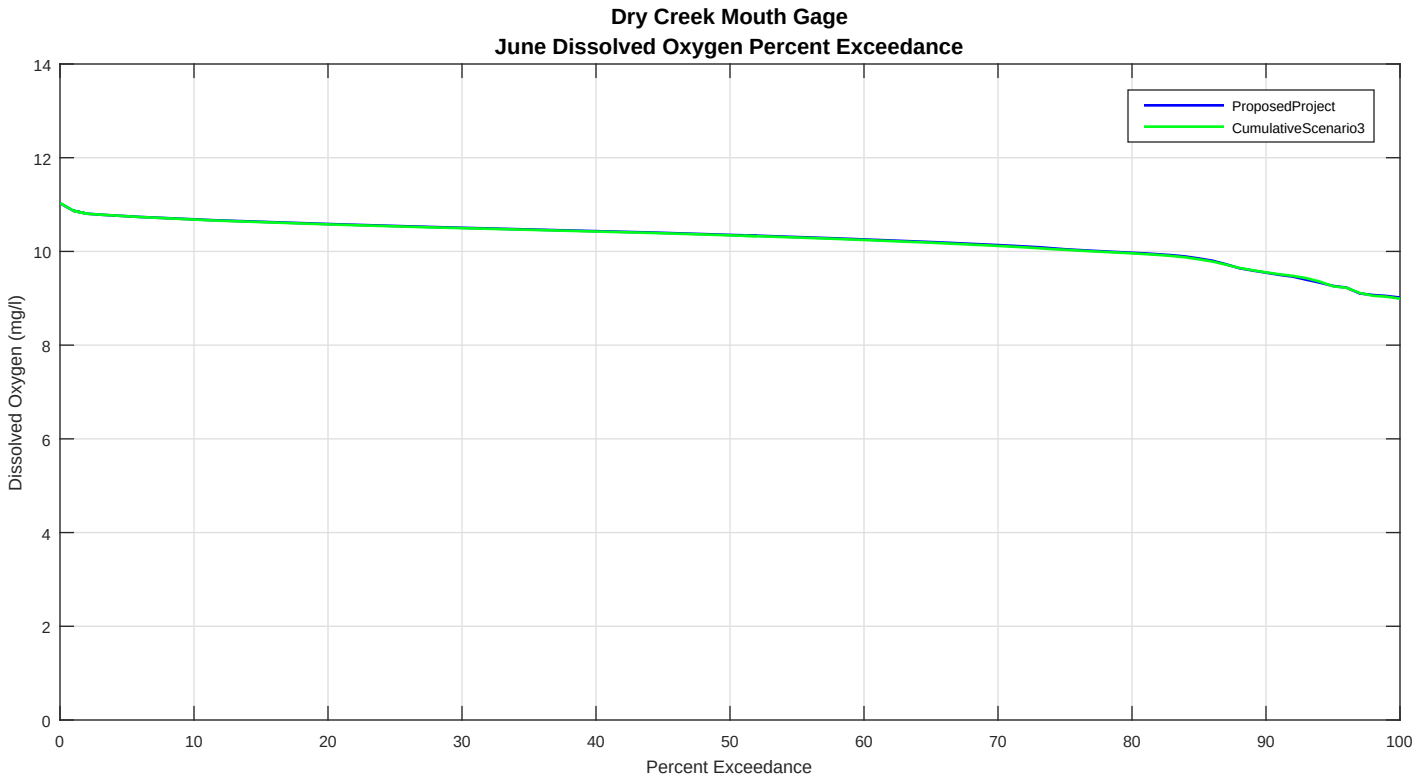
Dry Creek Mouth Gage
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ProposedProject
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Dissolved Oxygen (mg/l)
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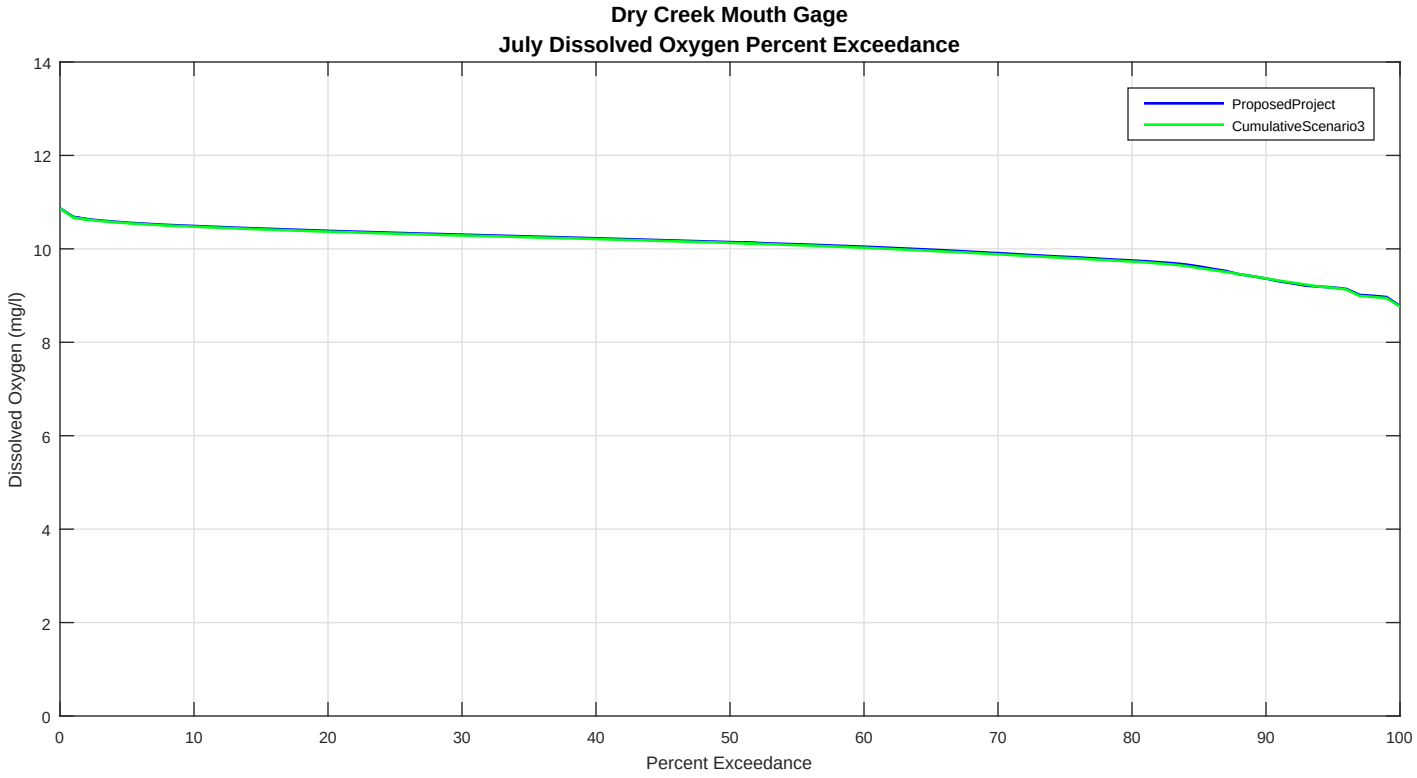
Dry Creek Mouth Gage
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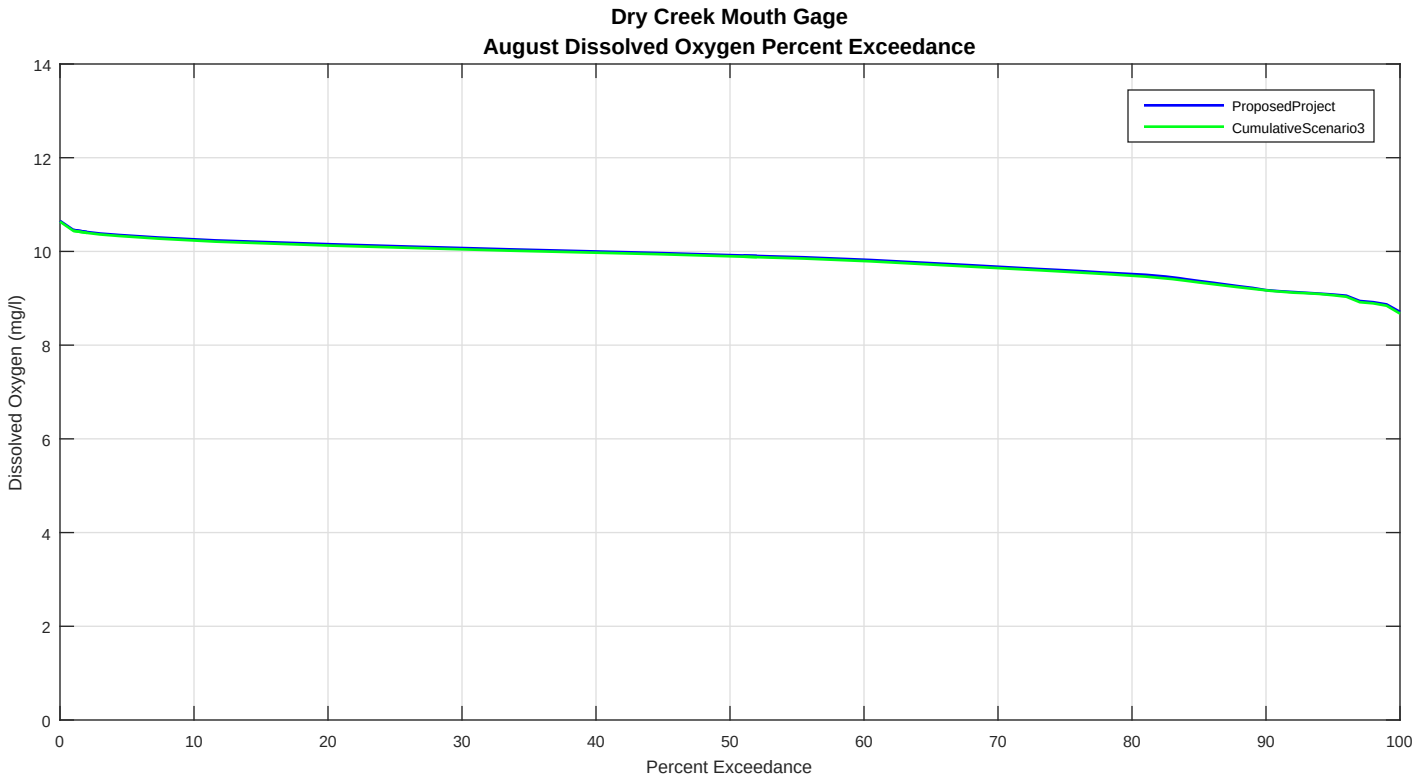
Dry Creek Mouth Gage
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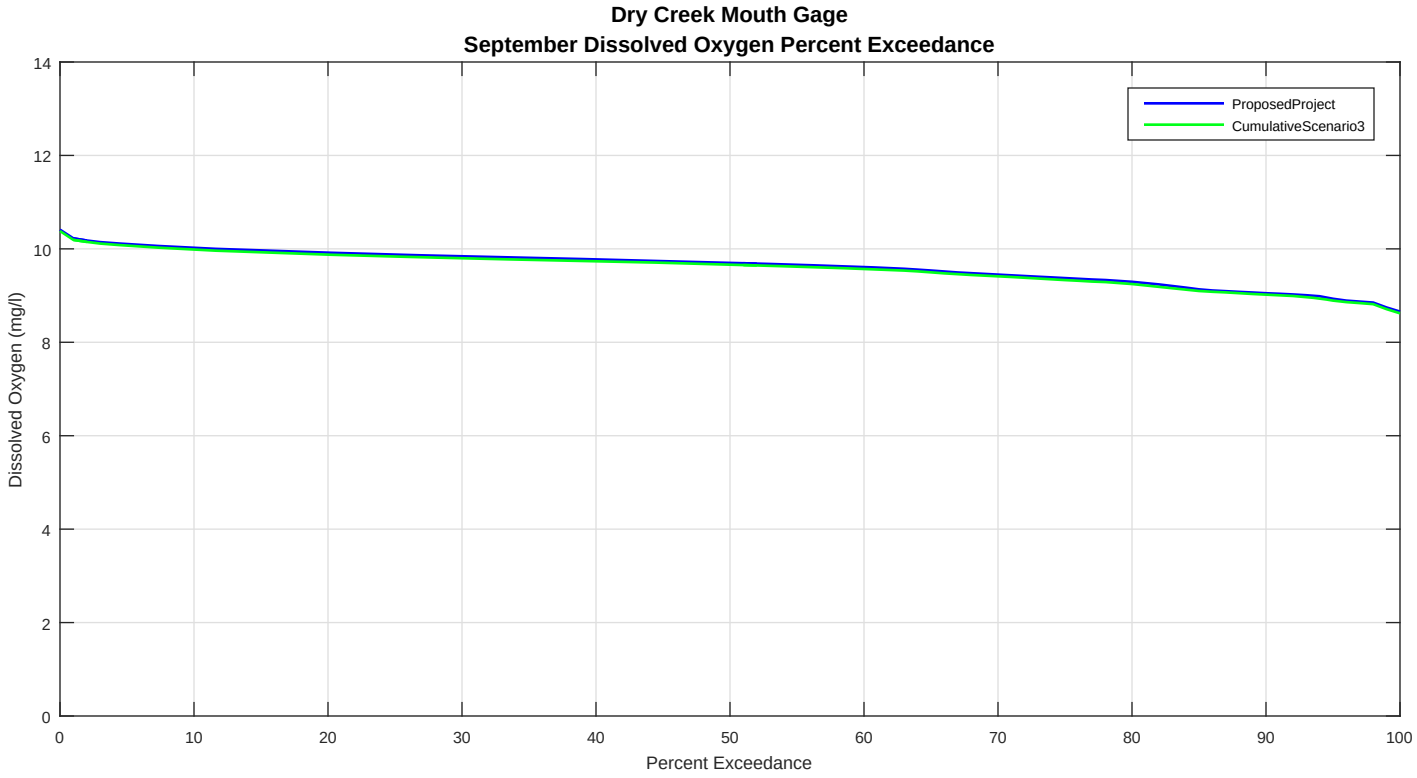
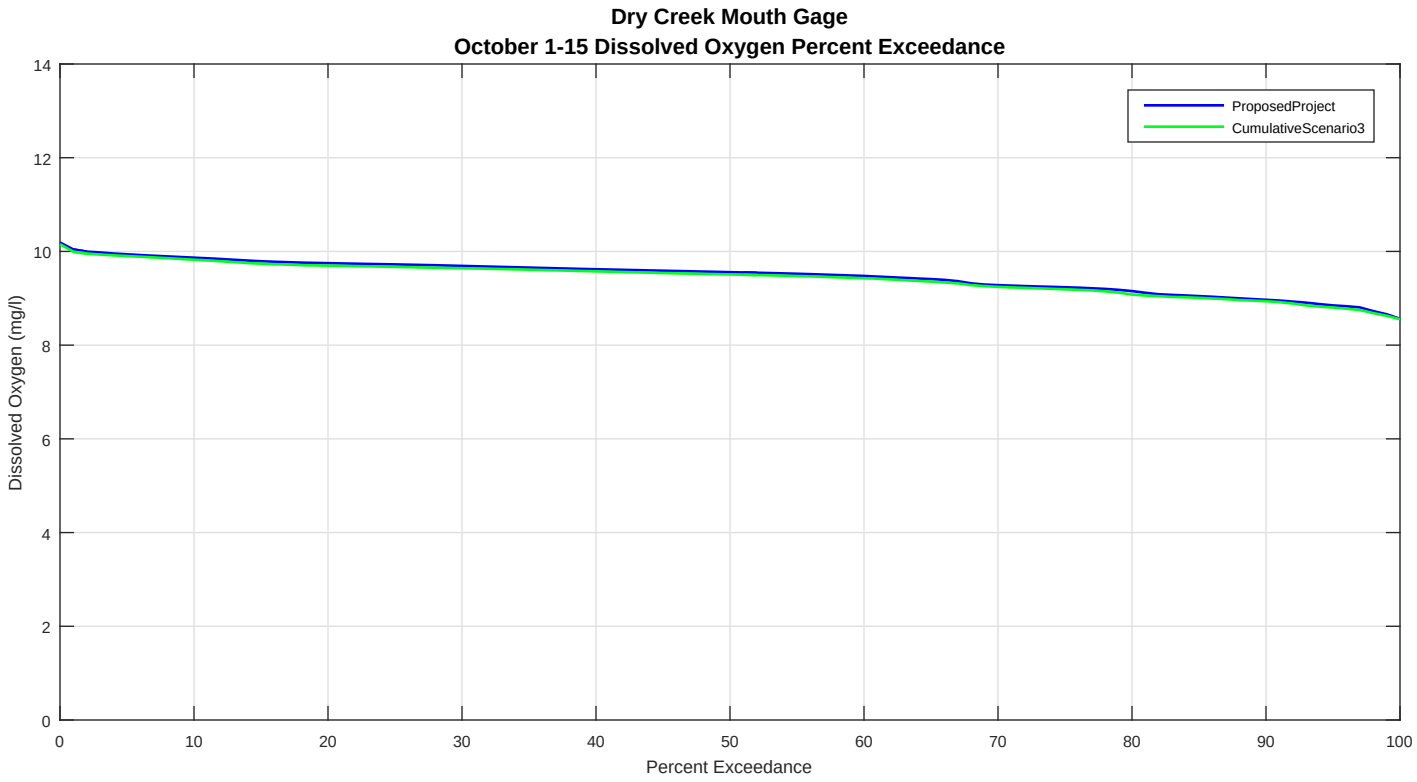
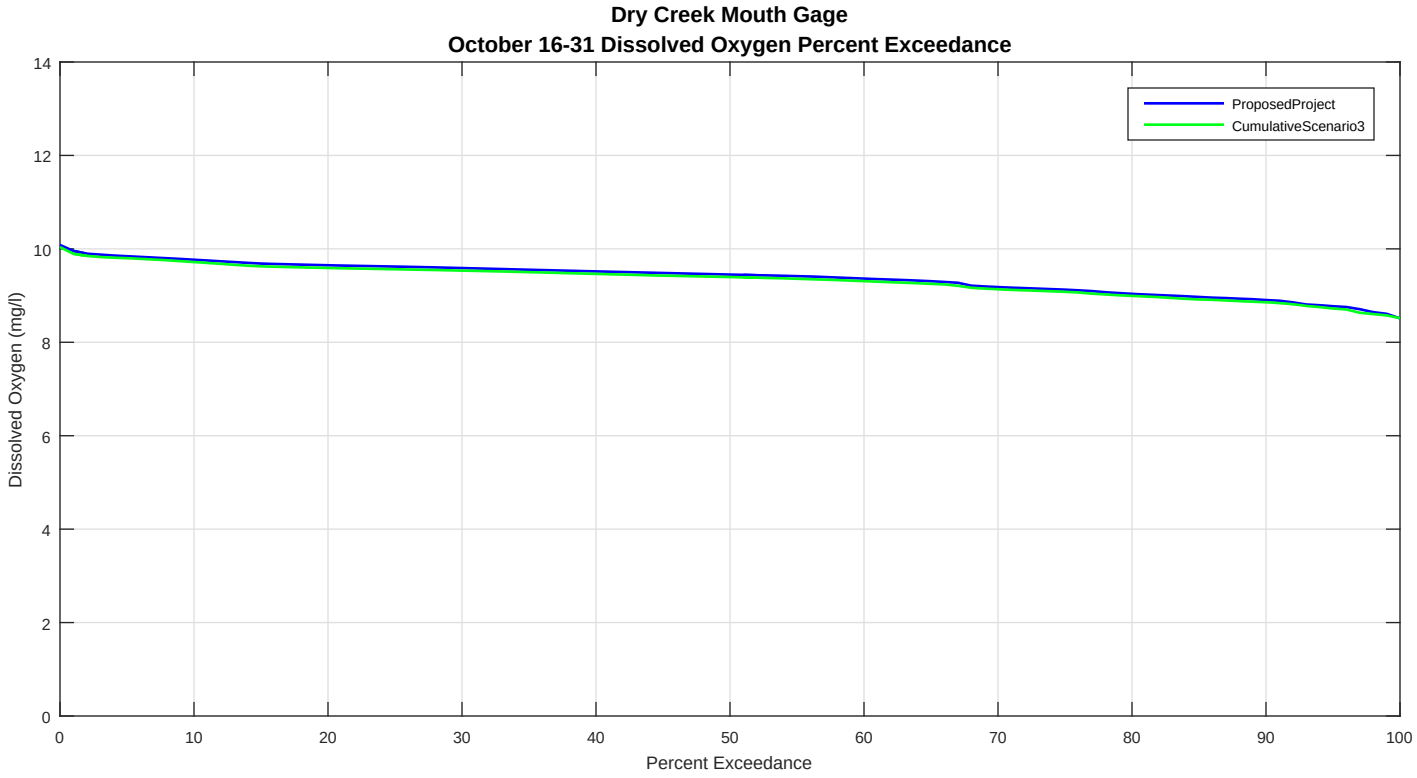
90
100


Dry Creek Mouth Gage
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100


Dry Creek Mouth Gage
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario3
Dissolved Oxygen (mg/l)
Percent Exceedance
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

Attachment 7: Model Results, Cumulative 4 Scenario

FISH FLOWS EIR
RR ResSim Modeling Results Summary Report

Cumulative Analysis No PVP Imports, City of Ukiah EIR, and 2015 UWMP
Proposed Hydrologic Index
5-Sched Flow18 Min Flows
Max Water Right Demand: 75K AF

PLOT LEGEND	ProposedProject	CumulativeScenario4
Alt Name	2275i61860	2275i61860
Sim Begin Date	2/1/1910	2/1/1910
Sim End Date	12/31/2013	12/31/2013
ResSim Network	Base v2.2	Base v2.2
LM Storage Curve	2001	2040
LS Storage Curve	1984	2040
WSD Hatchery Flow (cfs)	70	70
Local Flow	USGS6.0	USGS6.0
Distributed Loss	RR System Losses POR 10011909 to 12312013 v06302015.dss	RR System Losses POR 10011909 to 12312013 v06302015.dss; HoplandLosses_UkiahEIR_POR_160602.dss
Windsor Demand	RR System Losses POR 10011909 to 12312013 v06302015.dss, SCWA Windsor 75K POR 10011909 to 12312013 v06302015.dss	UWMP_2016_Datasets.dss
Windsor Vol (Ac-ft/yr)	5,639	3,935
Demand Year	2035	2040
Demand Desc	Max Water Right Demand	UWMP 2040 Demand
SCWA Demand	SCWA Windsor 75K POR 10011909 to 12312013 v06302015.dss	UWMP_2016_Datasets.dss
SCWA Vol (Ac-ft/yr)	69,361	71,871
Demand Year	2035	2040
Demand Desc	Max Water Right Demand	UWMP 2040 Demand
PVP Simulation	150217_V25_E5_Sed2006_RPA-TS_150max	0 Pvp Flows
LP Storage Curve	2006	2040
PVP Max Diversion	150	0
PVP Simulation Desc	Average operating conditions 10/1/2006 to 12/31/2014; Incorporated observed diversions and LP storage post 10/1/2006	0 Pvp Flows
Hydrologic Index	HI6	HI6
Index Desc	Cum LM Inflow Jan-Sep + LM Stor Cond Jun-De	Cum LM Inflow Jan-Sep + LM Stor Cond Jun-De
Min Flows UR	SCWA6	SCWA6
Min Flow Desc	Flows derived from sensitivity analysis	Flows derived from sensitivity analysis
Min Flows LR	LR6	LR6
Min Flow Desc	Flows derived from sensitivity analysis	Flows derived from sensitivity analysis

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Daily Average Temperature… 13

Daily Average Dissolved Oxygen… 20

Coyote Valley Dam Outlet

Monthly Flow Exceedance Frequency… 29

Monthly Temperature Exceedance Frequency… 106

Monthly D.O. Exceedance Frequency… 164

Forks

Monthly Flow Exceedance Frequency… 33

Monthly Temperature Exceedance Frequency… 110

Monthly D.O. Exceedance Frequency… 168

2 Miles Downstream of Forks

Monthly Temperature Exceedance Frequency… 115

Monthly D.O. Exceedance Frequency… 173

4 Miles Downstream of Forks

Monthly Temperature Exceedance Frequency… 117

Monthly D.O. Exceedance Frequency… 175

Hopland

Monthly Flow Exceedance Frequency… 38

Monthly Stage Exceedance Frequency… 74

Monthly Temperature Exceedance Frequency… 119

Monthly D.O. Exceedance Frequency… 177

Cloverdale

Monthly Flow Exceedance Frequency… 42

Monthly Stage Exceedance Frequency… 78

Monthly Temperature Exceedance Frequency… 123

Monthly D.O. Exceedance Frequency… 181

Geyserville

Monthly Temperature Exceedance Frequency… 128

Monthly D.O. Exceedance Frequency… 186

Healdsburg

Monthly Flow Exceedance Frequency… 47

Monthly Stage Exceedance Frequency… 83

Monthly Temperature Exceedance Frequency… 132

Monthly D.O. Exceedance Frequency… 190

Russian River at Dry Creek

Monthly Flow Exceedance Frequency… 51

Monthly Temperature Exceedance Frequency… 137

Monthly D.O. Exceedance Frequency… 195

Hacienda

Monthly Flow Exceedance Frequency… 56

Monthly Stage Exceedance Frequency… 87

Monthly Temperature Exceedance Frequency… 141

Monthly D.O. Exceedance Frequency… 199

Warm Springs Dam Outlet

Monthly Flow Exceedance Frequency… 60

Monthly Temperature Exceedance Frequency… 146

Monthly D.O. Exceedance Frequency… 204

Dry Creek at Geyserville Gage

Monthly Flow Exceedance Frequency… 65

Monthly Stage Exceedance Frequency… 92

Monthly Temperature Exceedance Frequency… 150

Monthly D.O. Exceedance Frequency… 208

Dry Creek at Lambert Bridge

Monthly Temperature Exceedance Frequency… 155

Monthly D.O. Exceedance Frequency… 213

Dry Creek Mouth

Monthly Flow Exceedance Frequency… 69

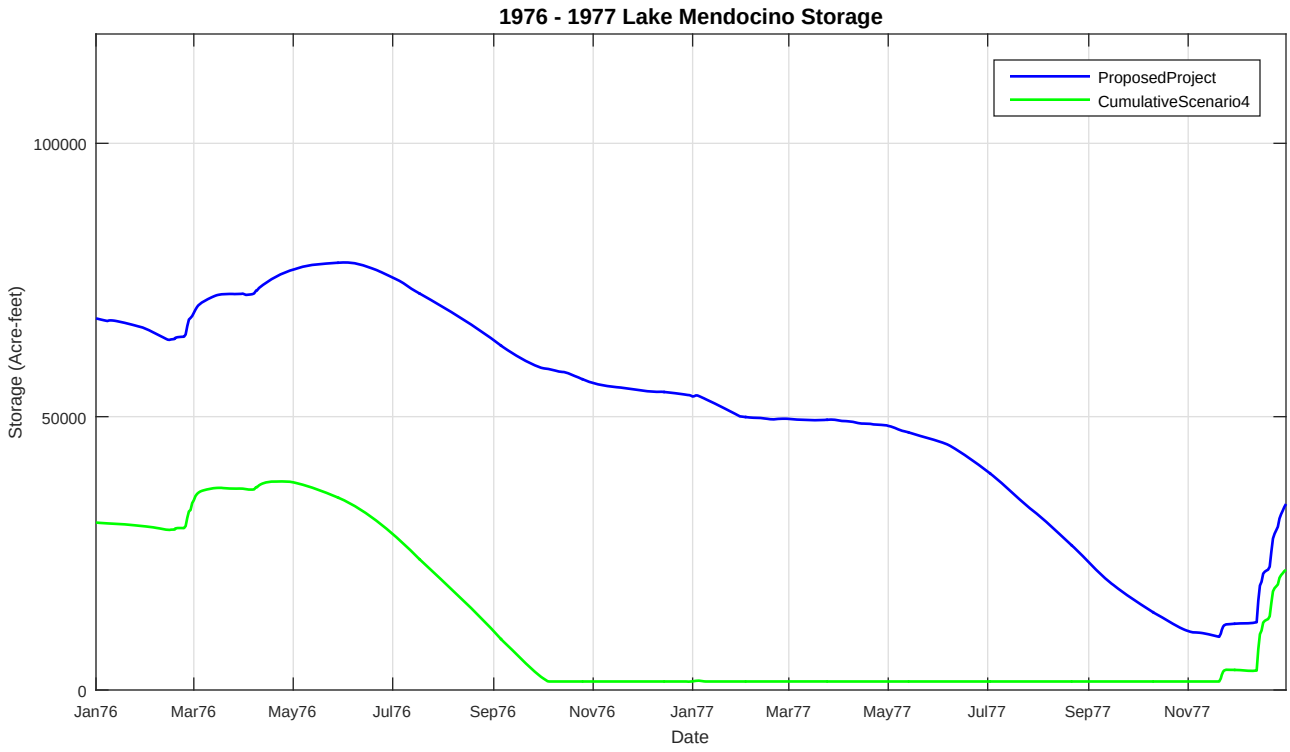
Monthly Temperature Exceedance Frequency… 159

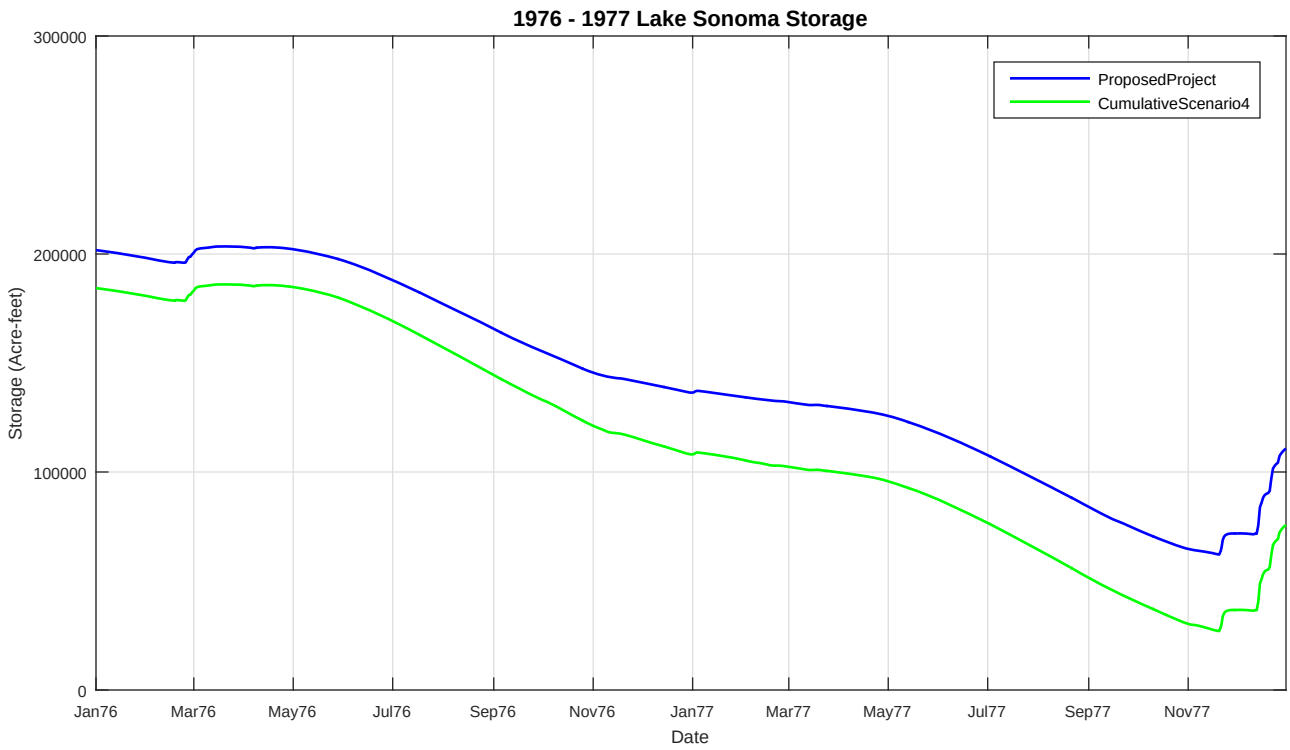
Monthly D.O. Exceedance Frequency… 217

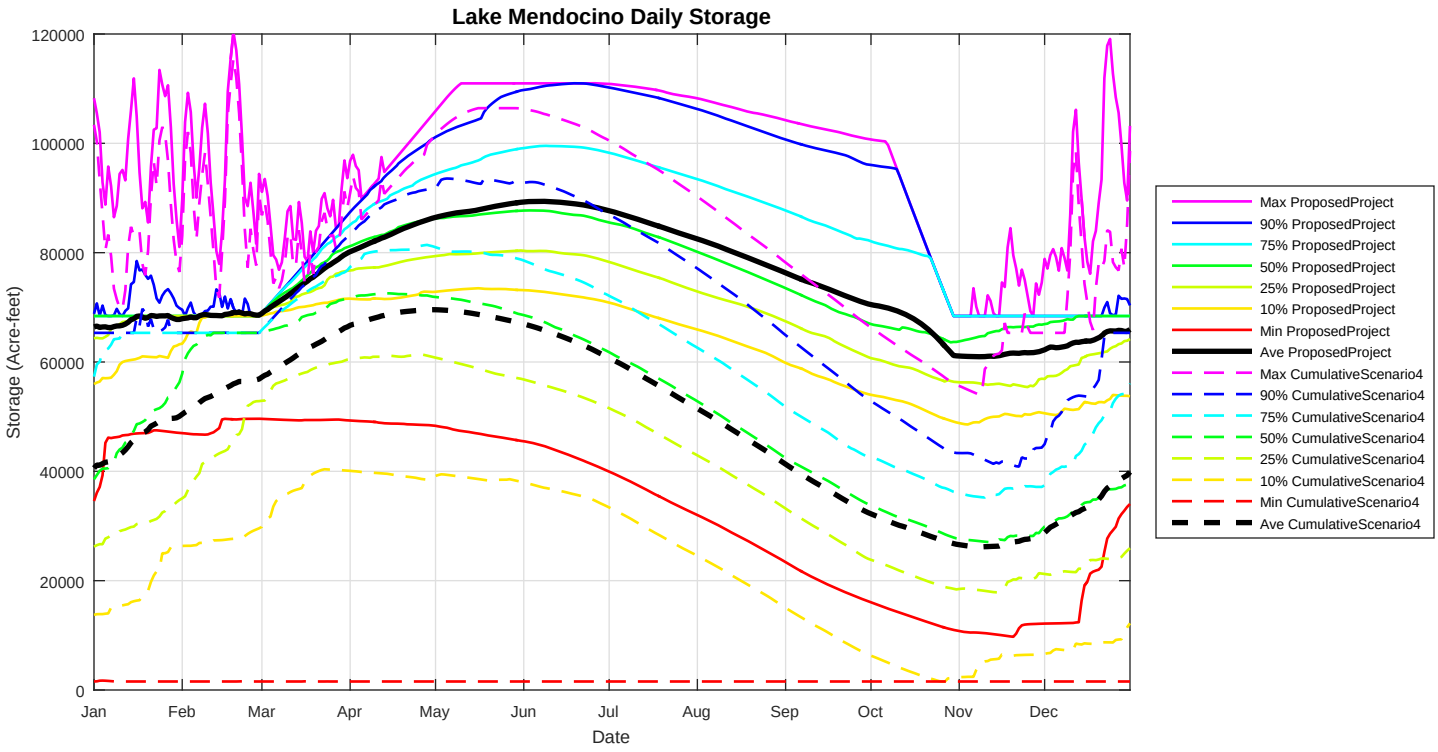
Monthly Power Production Exceedance Frequencies

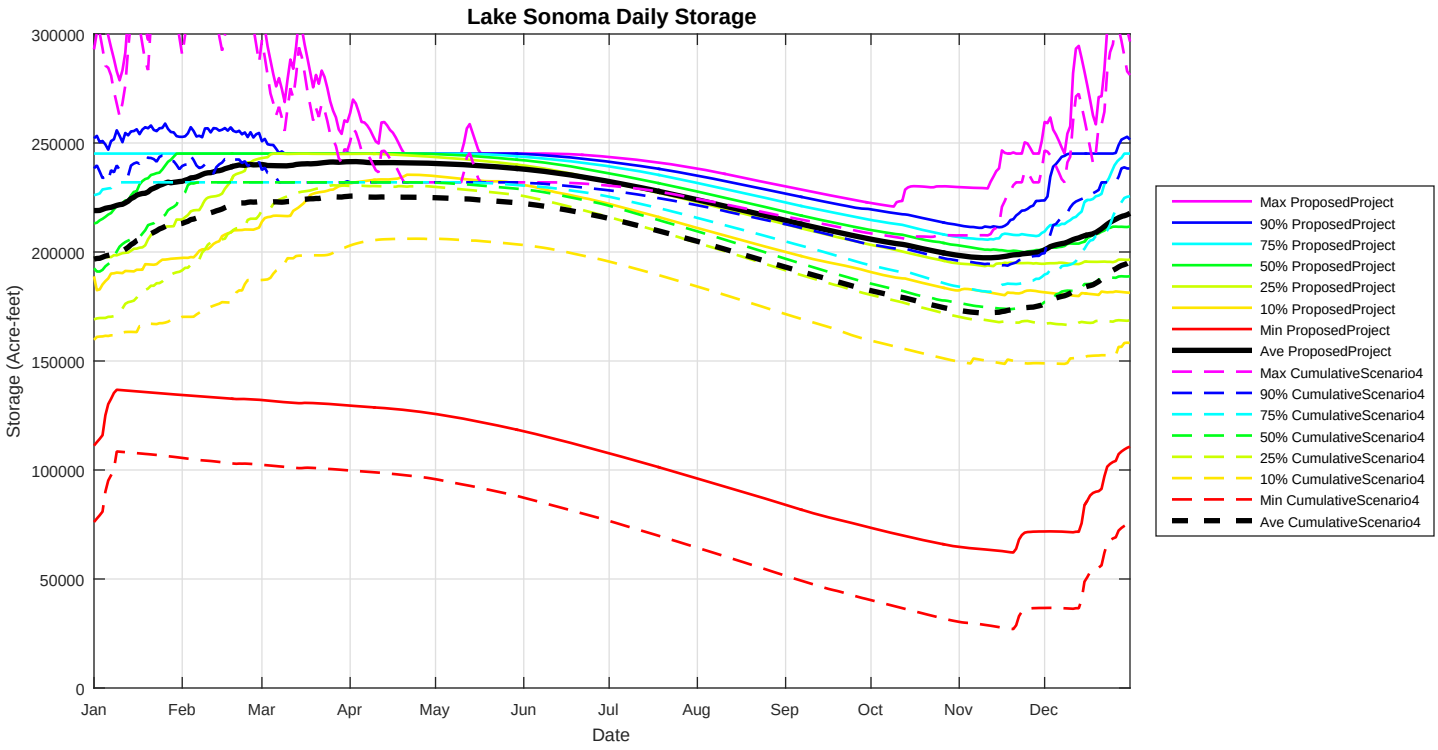
Coyote Valley Dam… 97

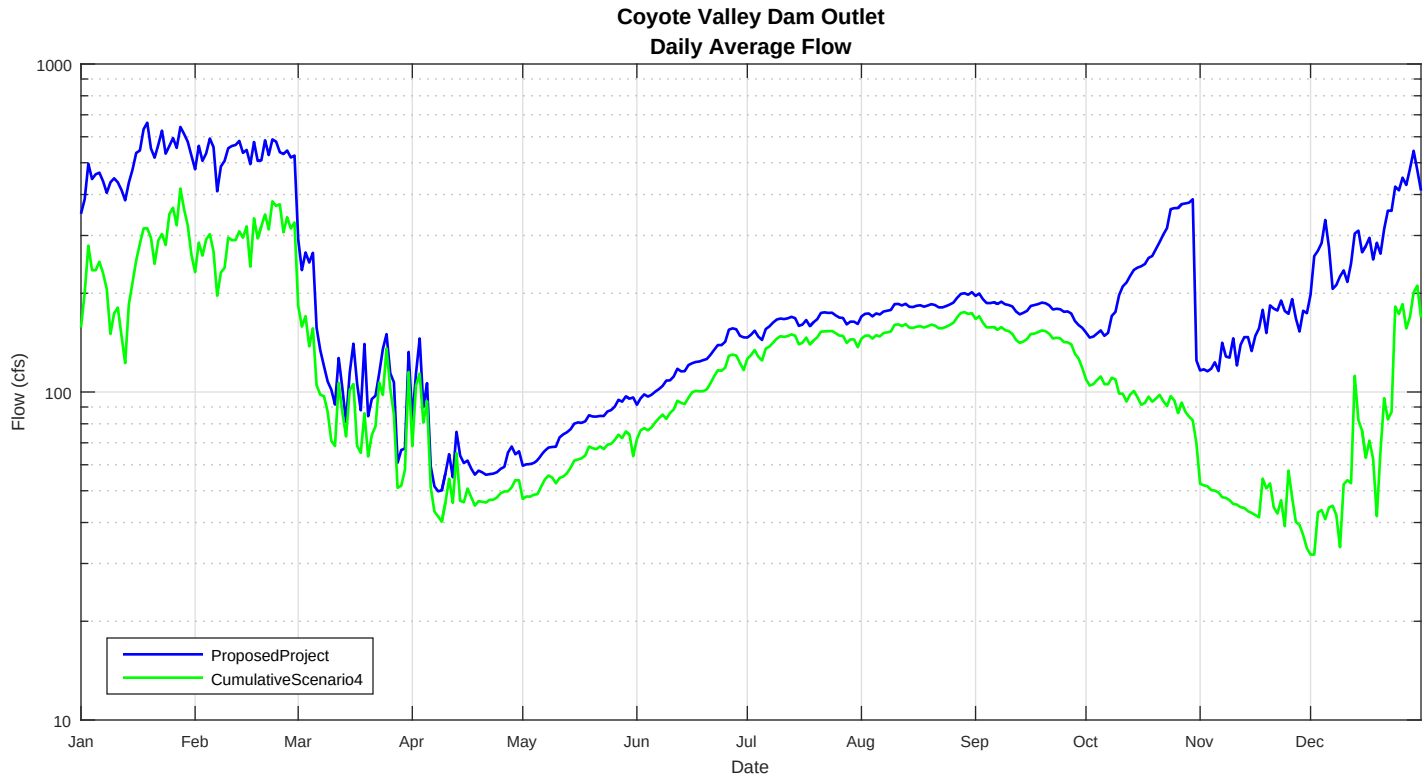
Warm Springs Dam… 101

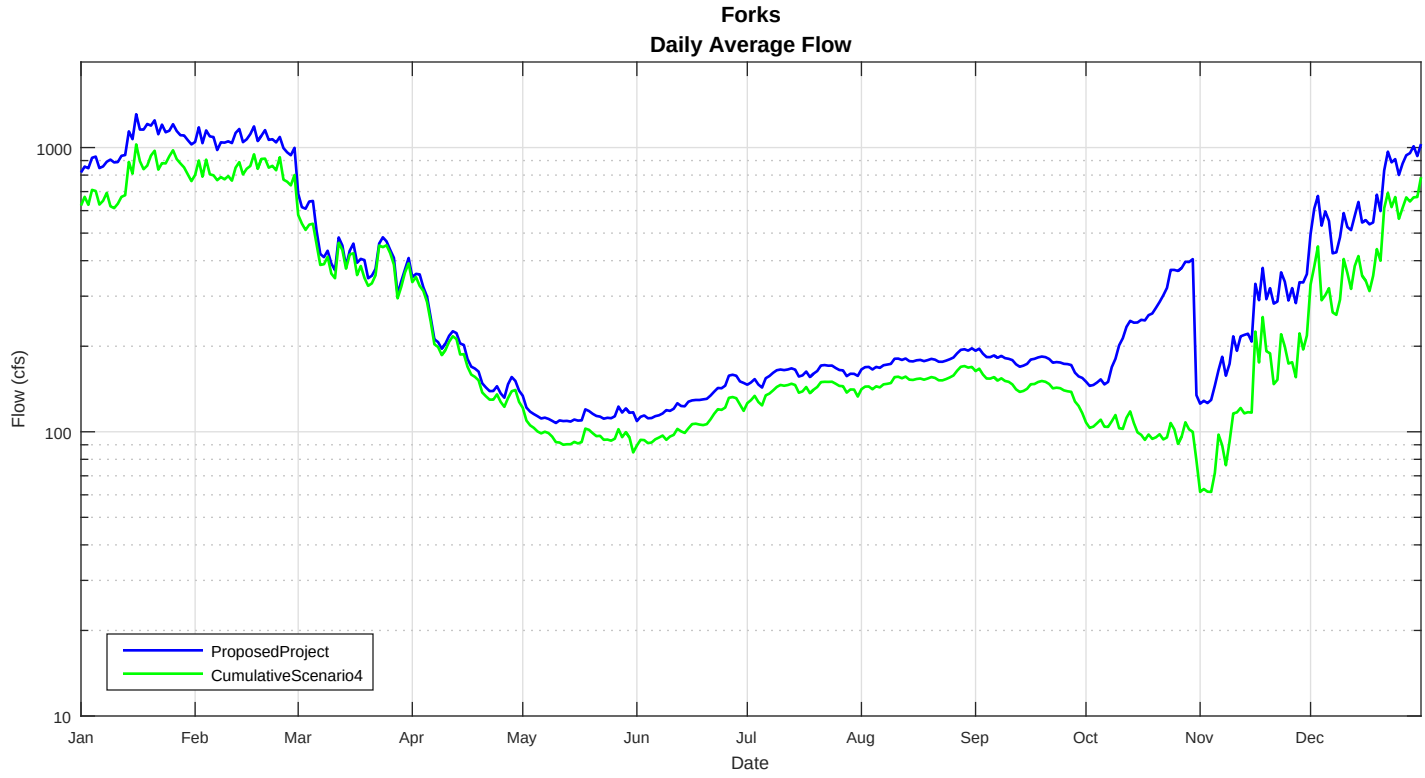

1976 - 1977 Lake Mendocino Storage
ProposedProject
CumulativeScenario4
Storage (Acre-feet)
100000
50000
0
Jan76
Mar76
May76
Jul76
Sep76
Nov76
Jan77
Mar77
May77
Jul77
Sep77
Nov77
Date

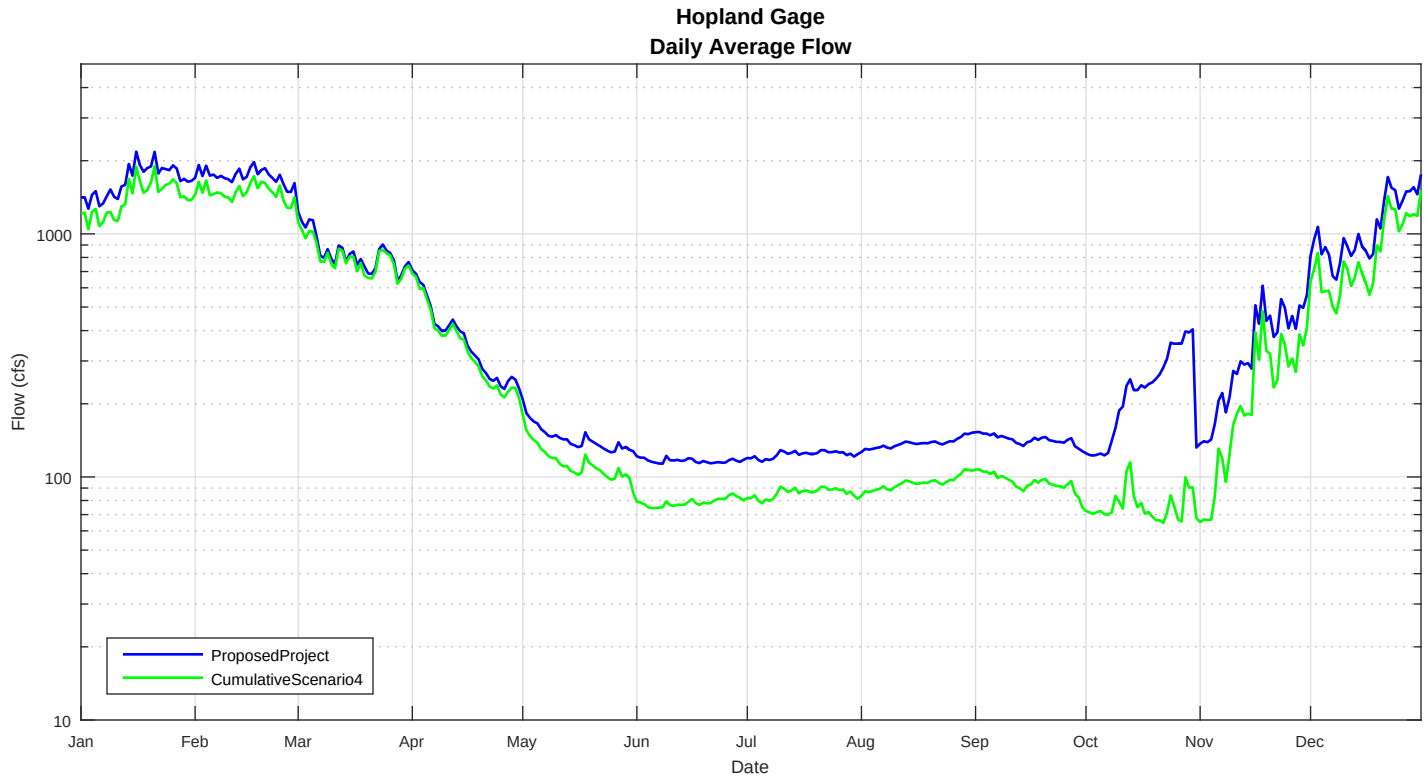

1976 - 1977 Lake Sonoma Storage
ProposedProject
CumulativeScenario4
Storage (Acre-feet)
300000
200000
100000
0
Jan76
Mar76
May76
Jul76
Sep76
Nov76
Jan77
Mar77
May77
Jul77
Sep77
Nov77
Date

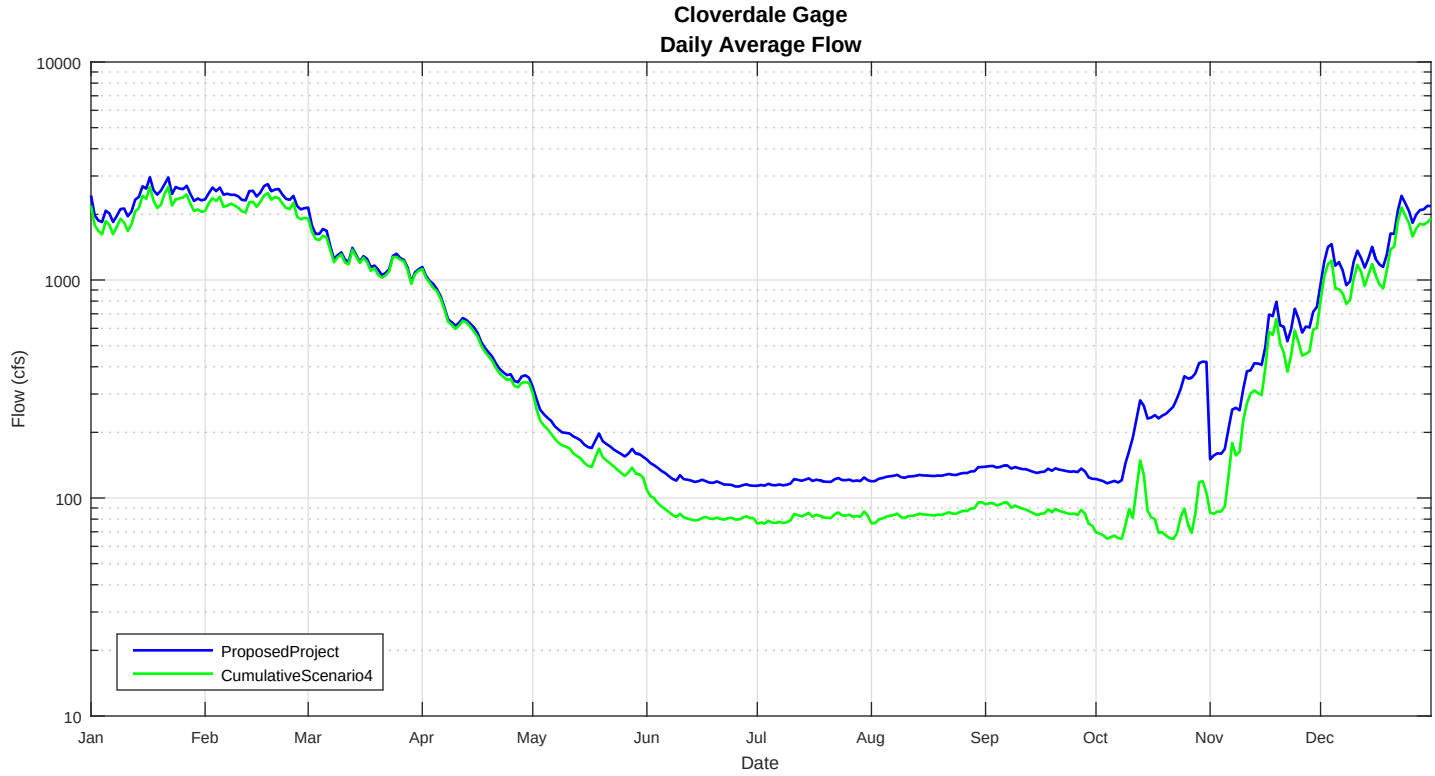

Lake Mendocino Daily Storage
Storage (Acre-feet)
120000
100000
80000
60000
40000
20000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Max ProposedProject
90% ProposedProject
75% ProposedProject
50% ProposedProject
25% ProposedProject
10% ProposedProject
Min ProposedProject
Ave ProposedProject
Max CumulativeScenario4
90% CumulativeScenario4
75% CumulativeScenario4
50% CumulativeScenario4
25% CumulativeScenario4
10% CumulativeScenario4
Min CumulativeScenario4
Ave CumulativeScenario4

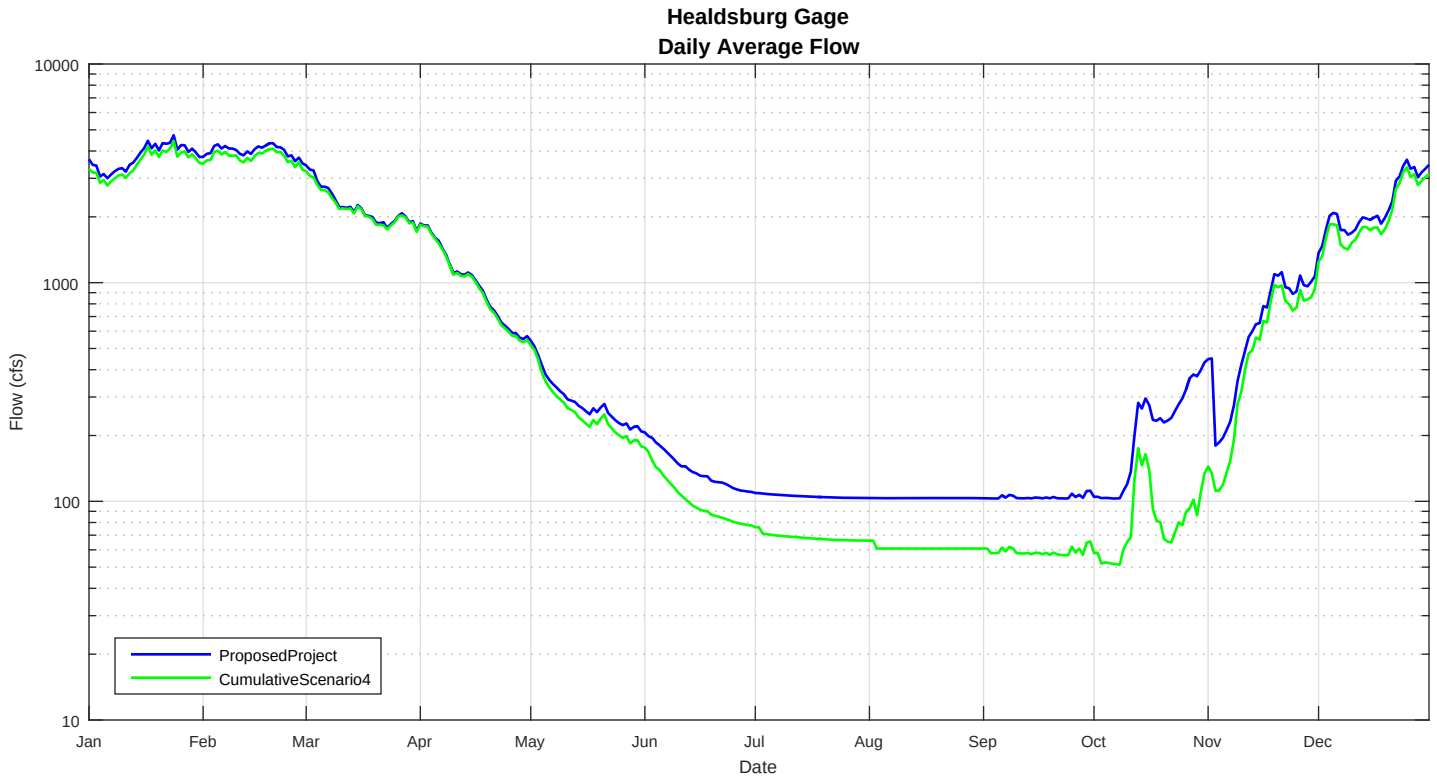

Lake Sonoma Daily Storage
Storage (Acre-feet)
300000
250000
200000
150000
100000
50000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
Max ProposedProject
90% ProposedProject
75% ProposedProject
50% ProposedProject
25% ProposedProject
10% ProposedProject
Min ProposedProject
Ave ProposedProject
Max CumulativeScenario4
90% CumulativeScenario4
75% CumulativeScenario4
50% CumulativeScenario4
25% CumulativeScenario4
10% CumulativeScenario4
Min CumulativeScenario4
Ave CumulativeScenario4

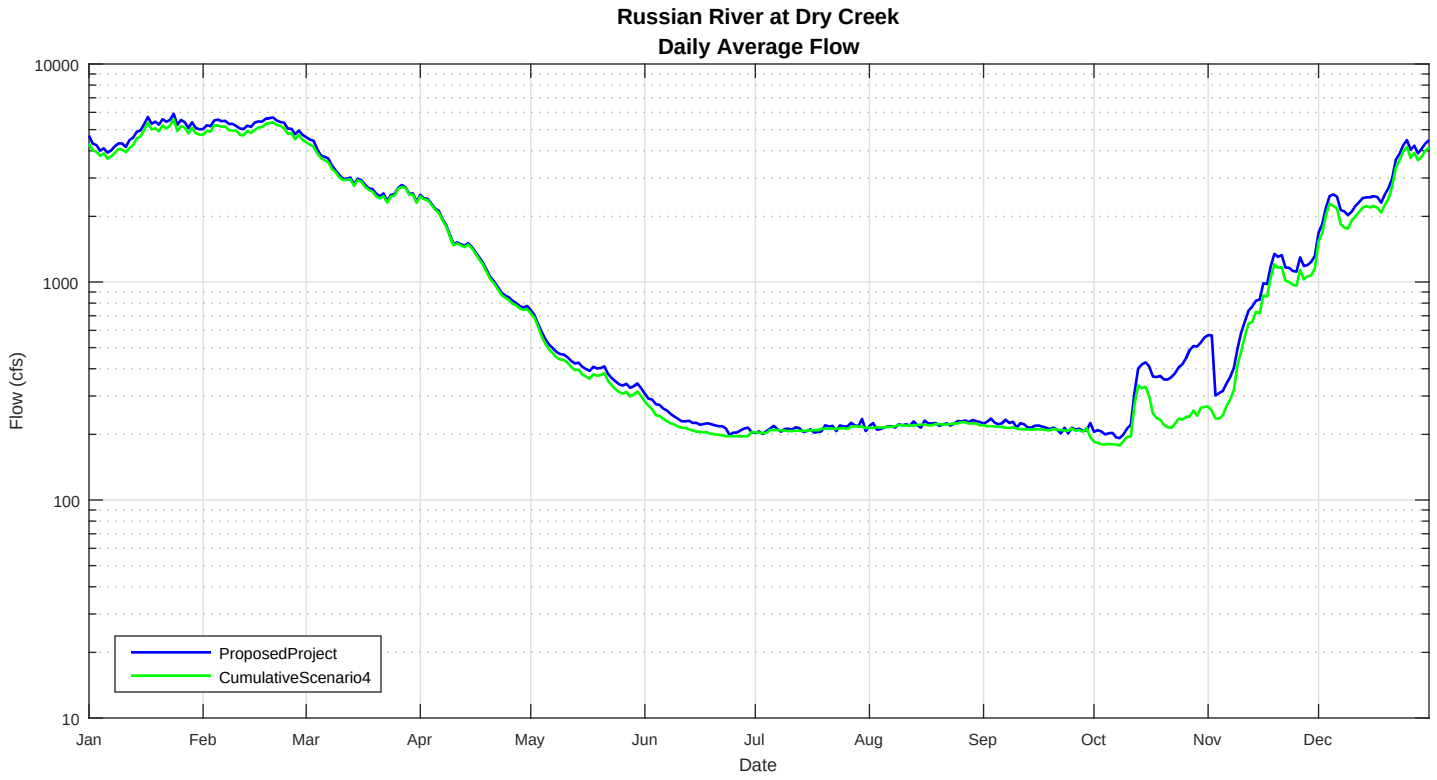

Coyote Valley Dam Outlet
Daily Average Flow
1000
100
10
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario4

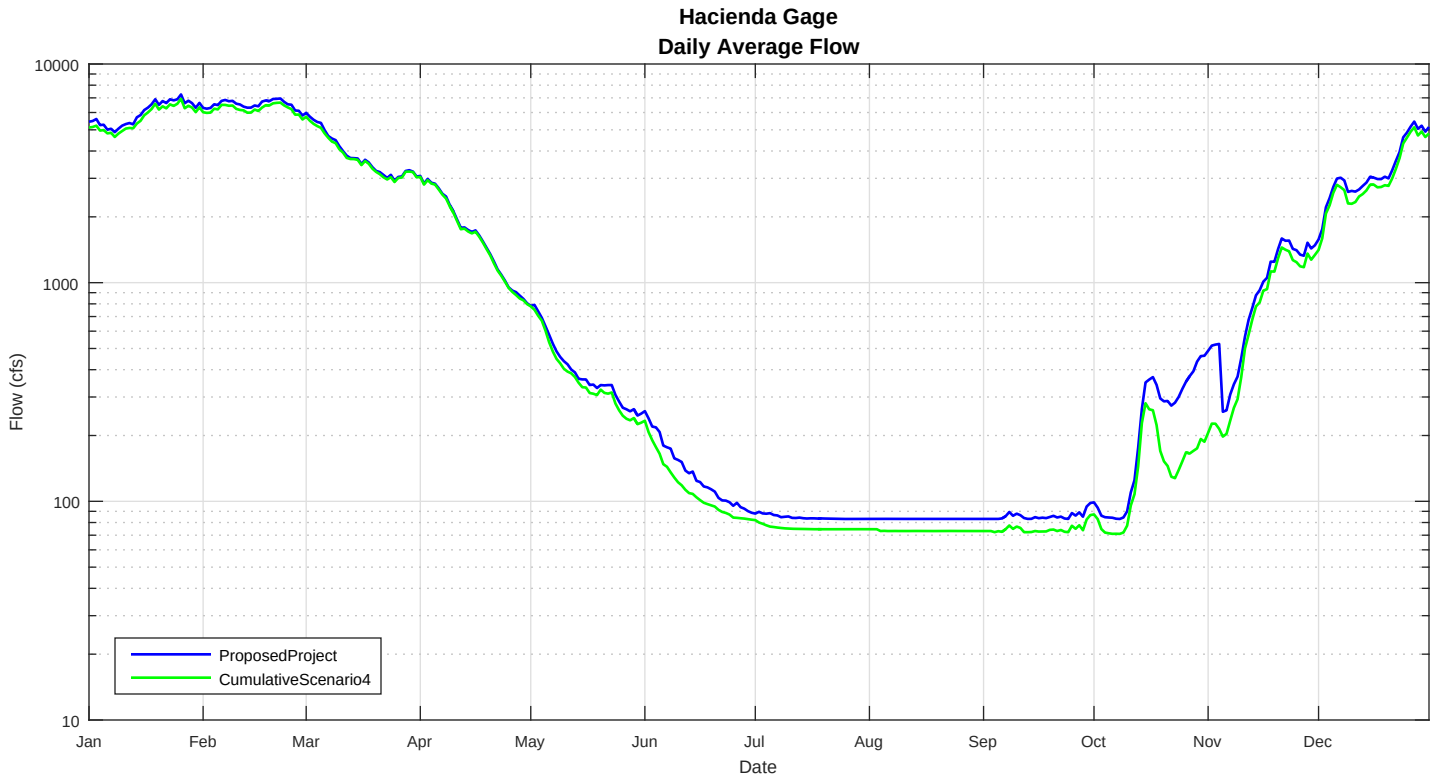

Forks
Daily Average Flow
1000
100
10
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario4

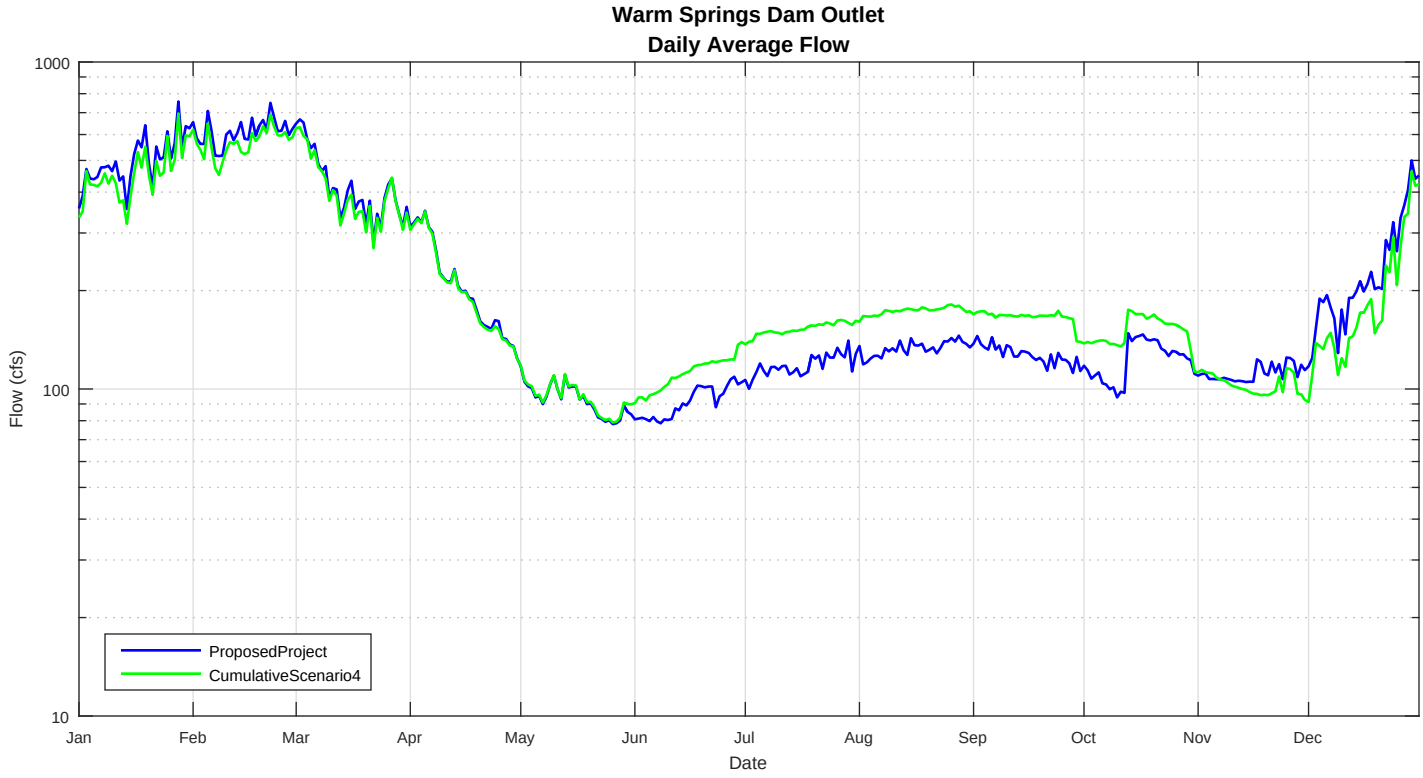

Hopland Gage
Daily Average Flow
Flow (cfs)
1000
100
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario4

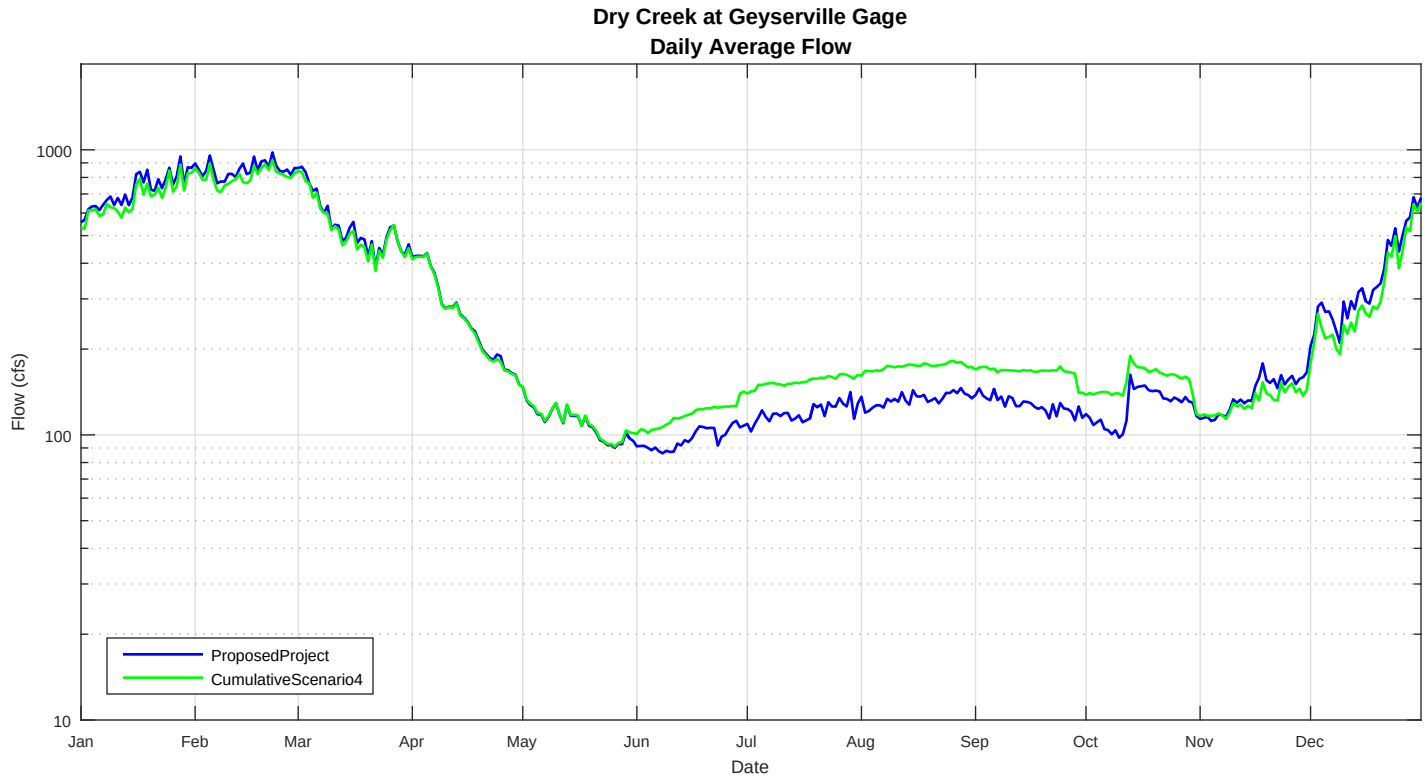

Cloverdale Gage
Daily Average Flow
Flow (cfs)
10000
1000
100
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario4

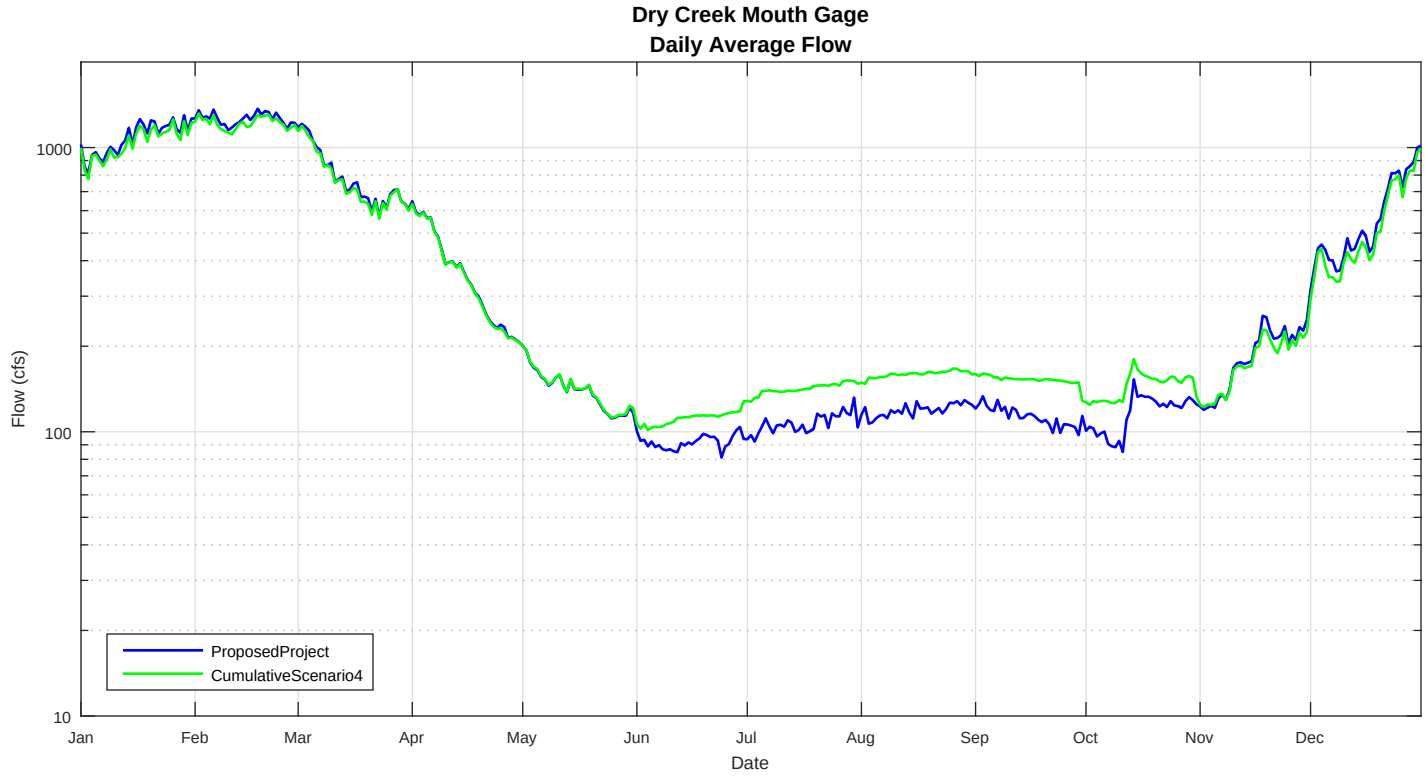

Healdsburg Gage
Daily Average Flow
10000
1000
100
10
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario4

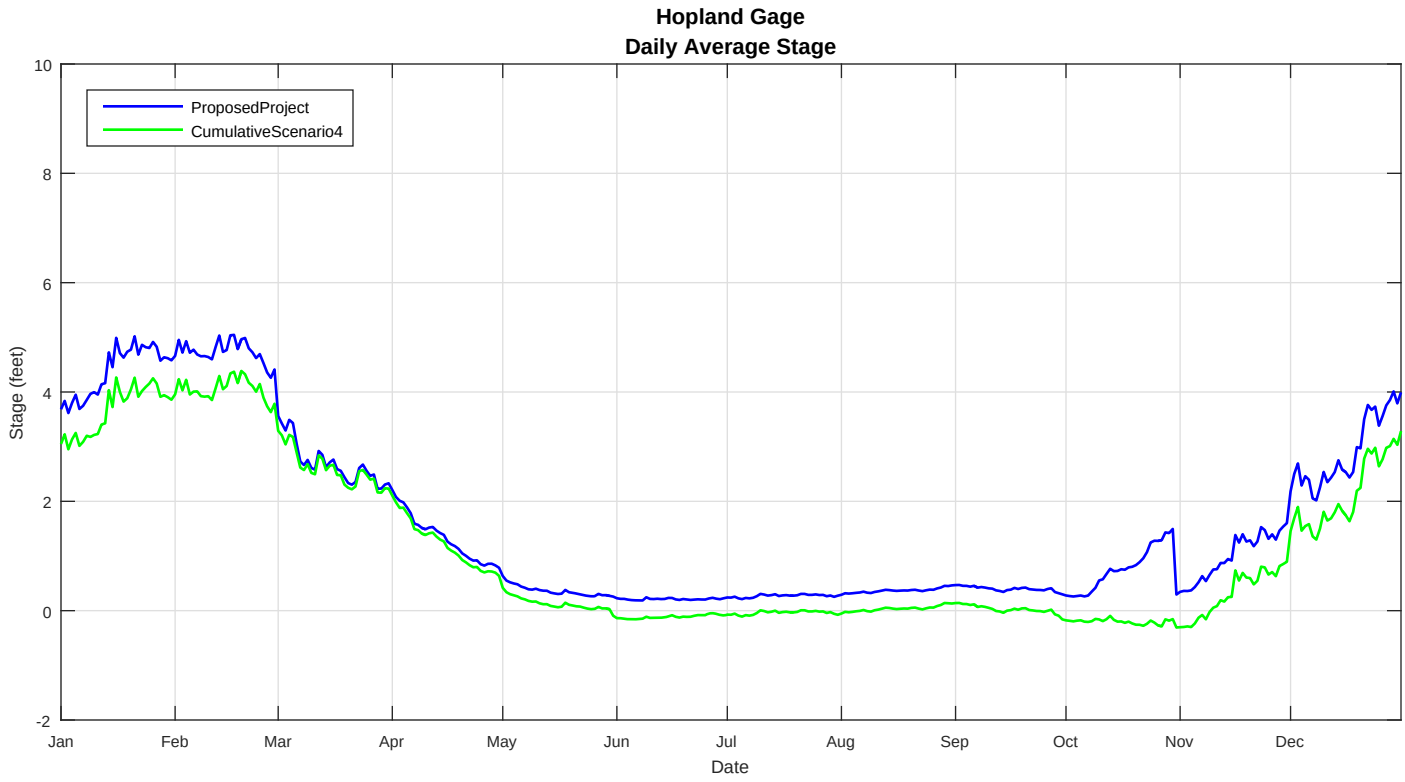

Russian River at Dry Creek
Daily Average Flow
10000
1000
100
10
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario4

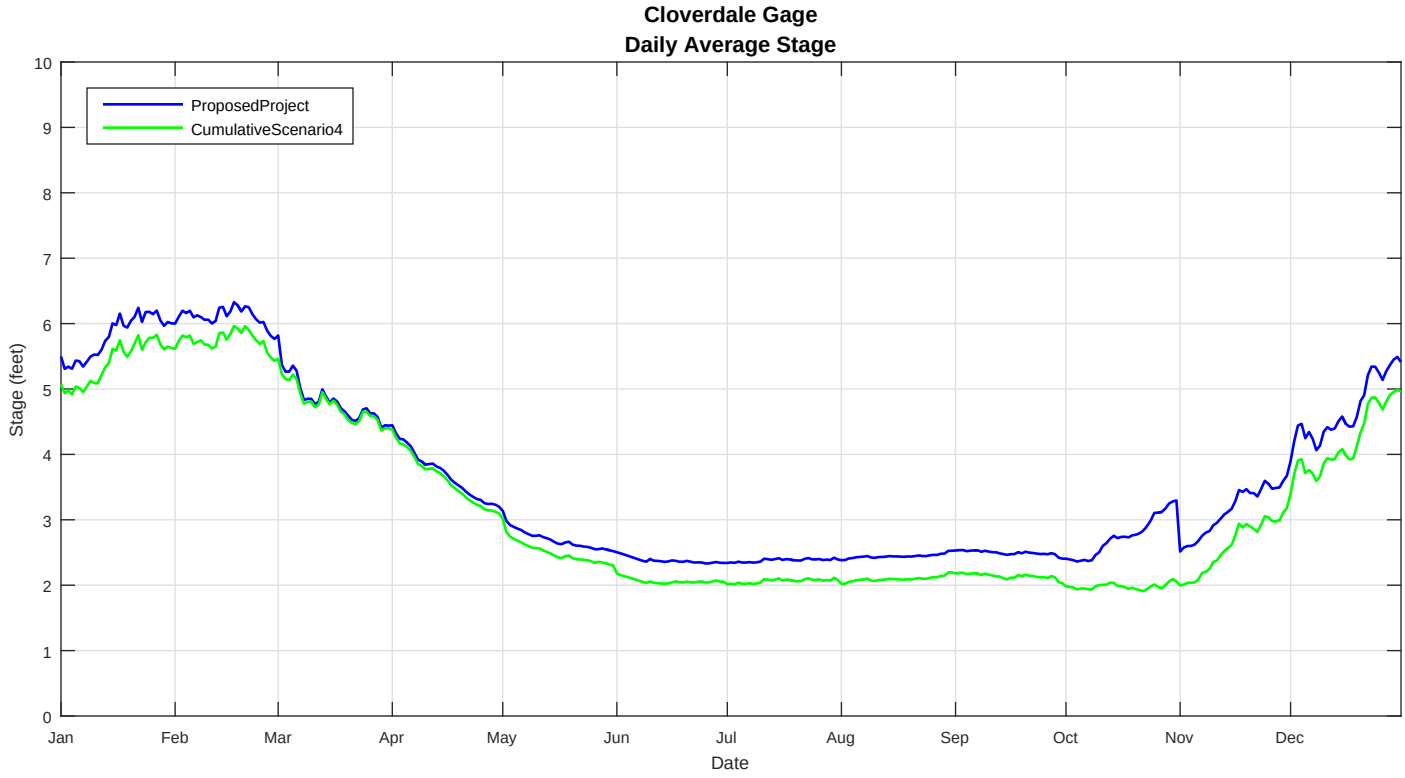

Hacienda Gage
Daily Average Flow
10000
1000
100
10
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario4

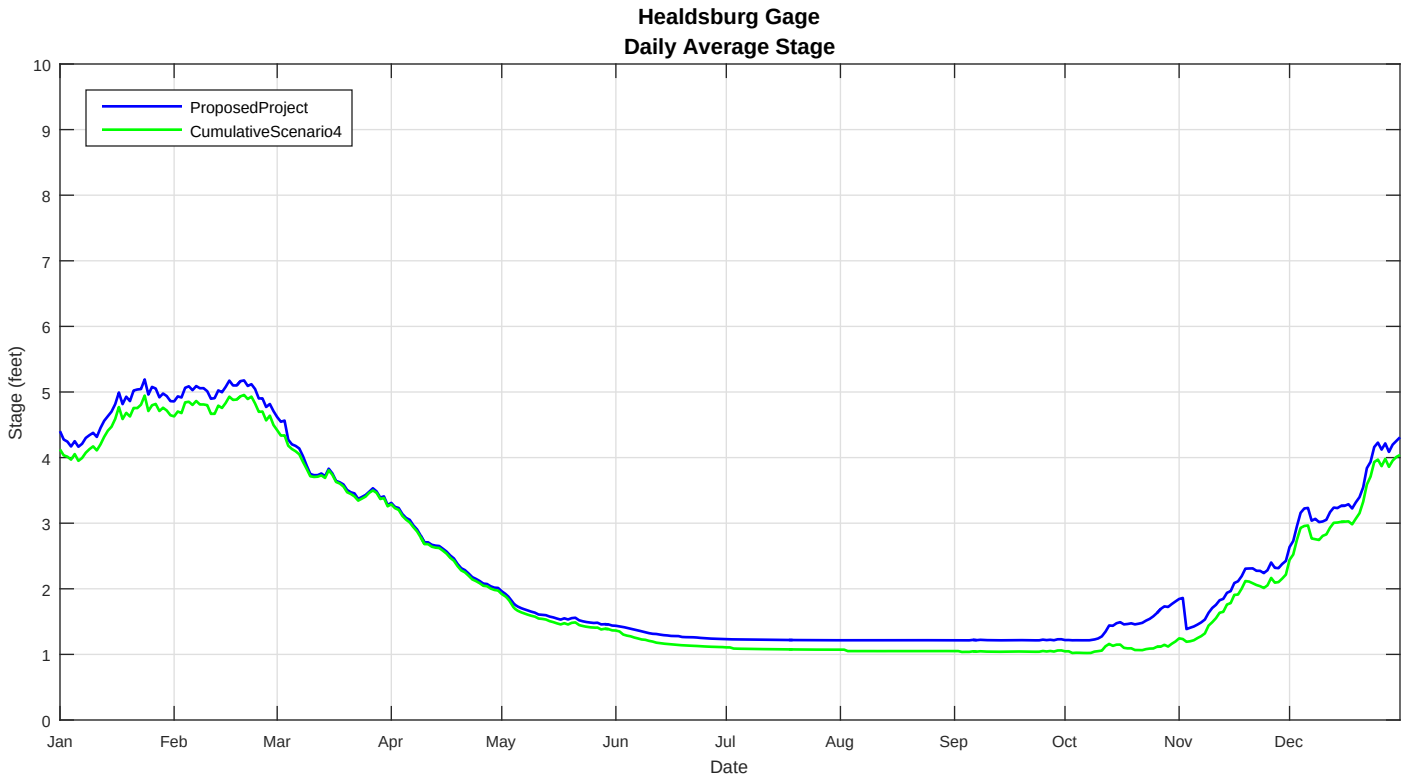

Warm Springs Dam Outlet
Daily Average Flow
1000
100
10
Flow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario4

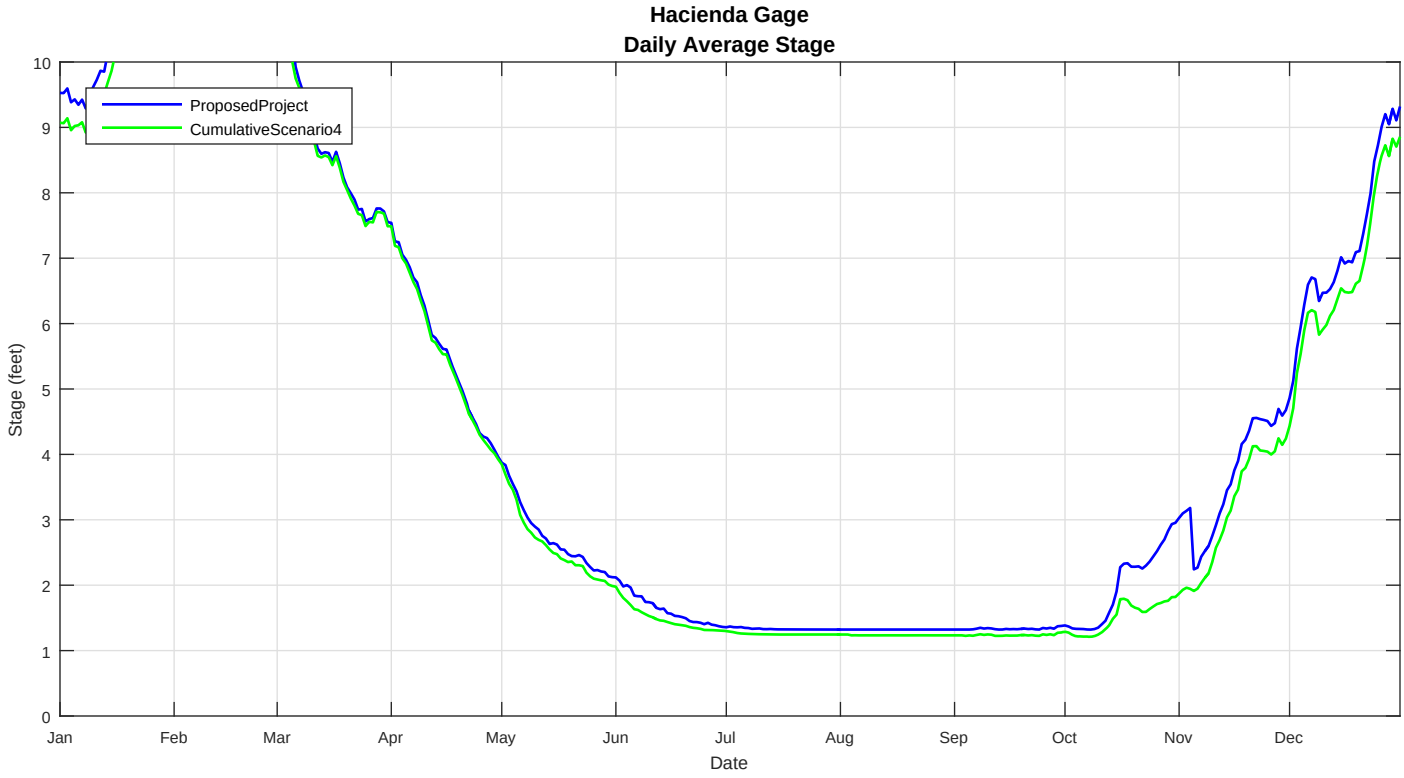

Dry Creek at Geyserville Gage
Daily Average Flow
Flow (cfs)
1000
100
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario4

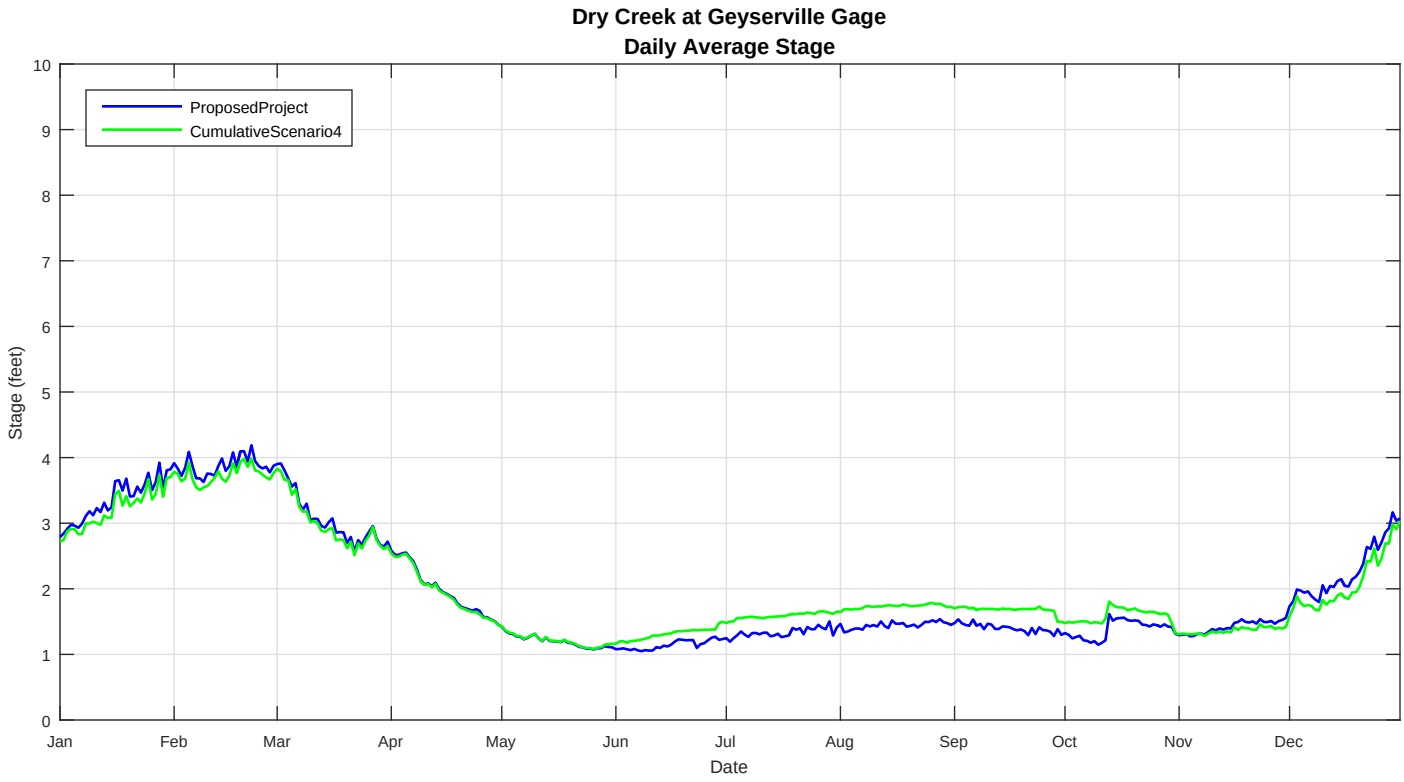

Dry Creek Mouth Gage
Daily Average Flow
Flow (cfs)
1000
100
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date
ProposedProject
CumulativeScenario4

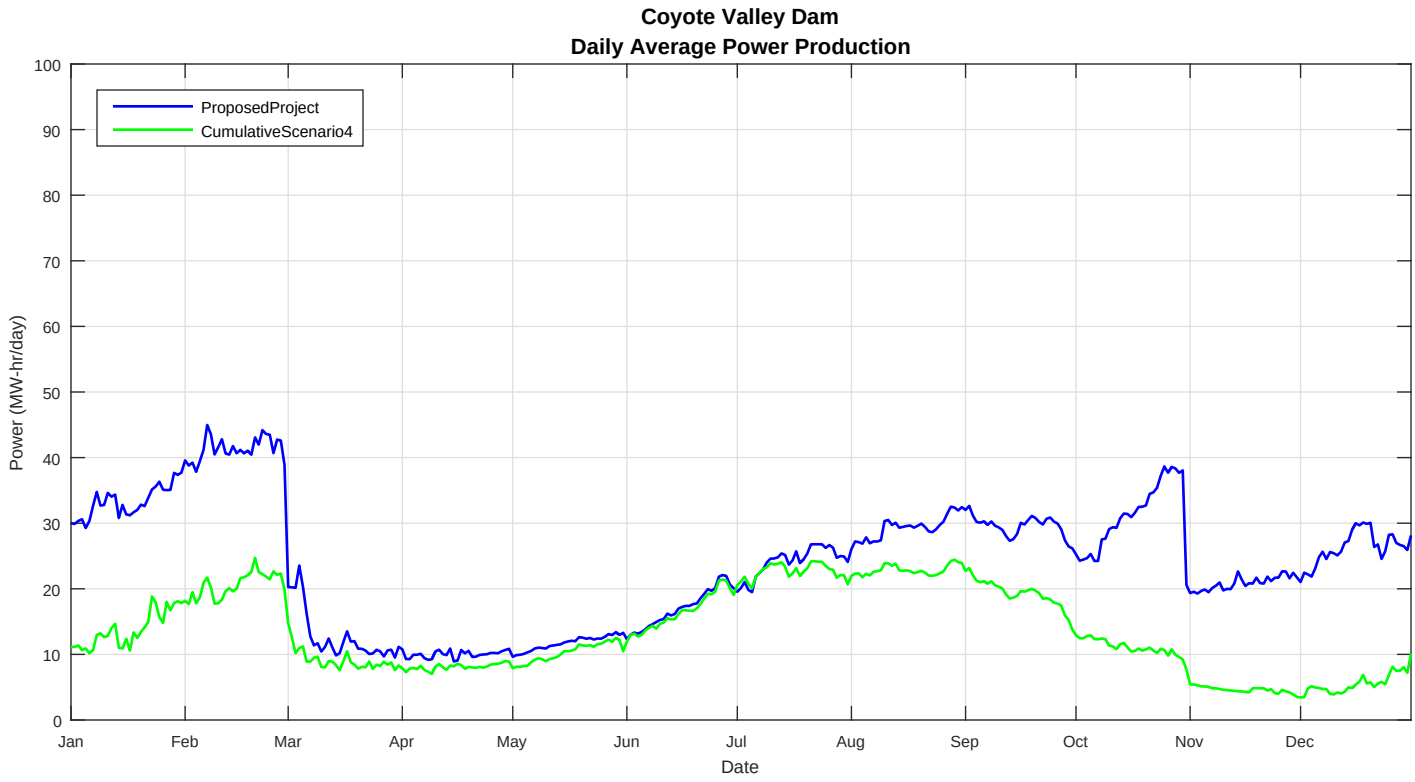

Hopland Gage
Daily Average Stage
ProposedProject
CumulativeScenario4
Stage (feet)
10
8
6
4
2
0
-2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

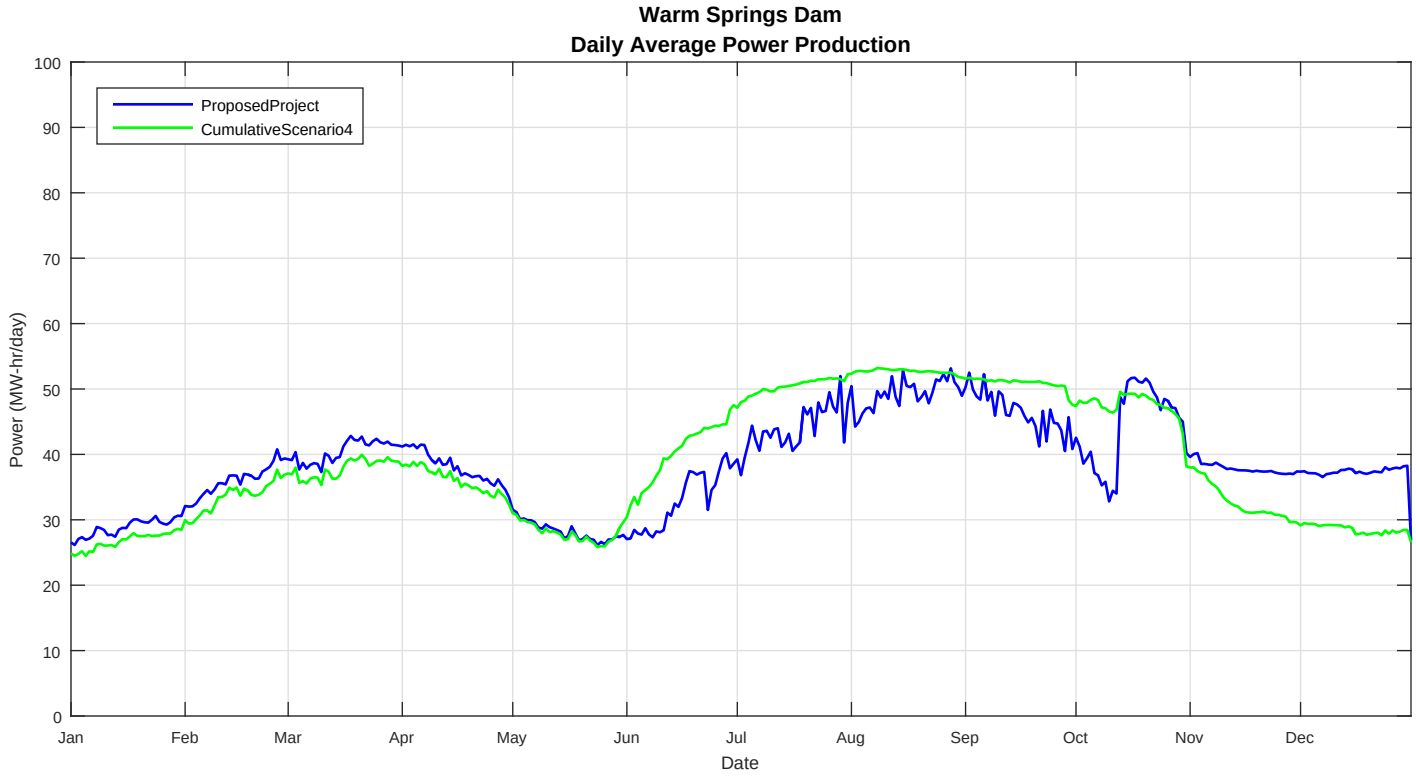

Cloverdale Gage
Daily Average Stage
ProposedProject
CumulativeScenario4
Stage (feet)
10
9
8
7
6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

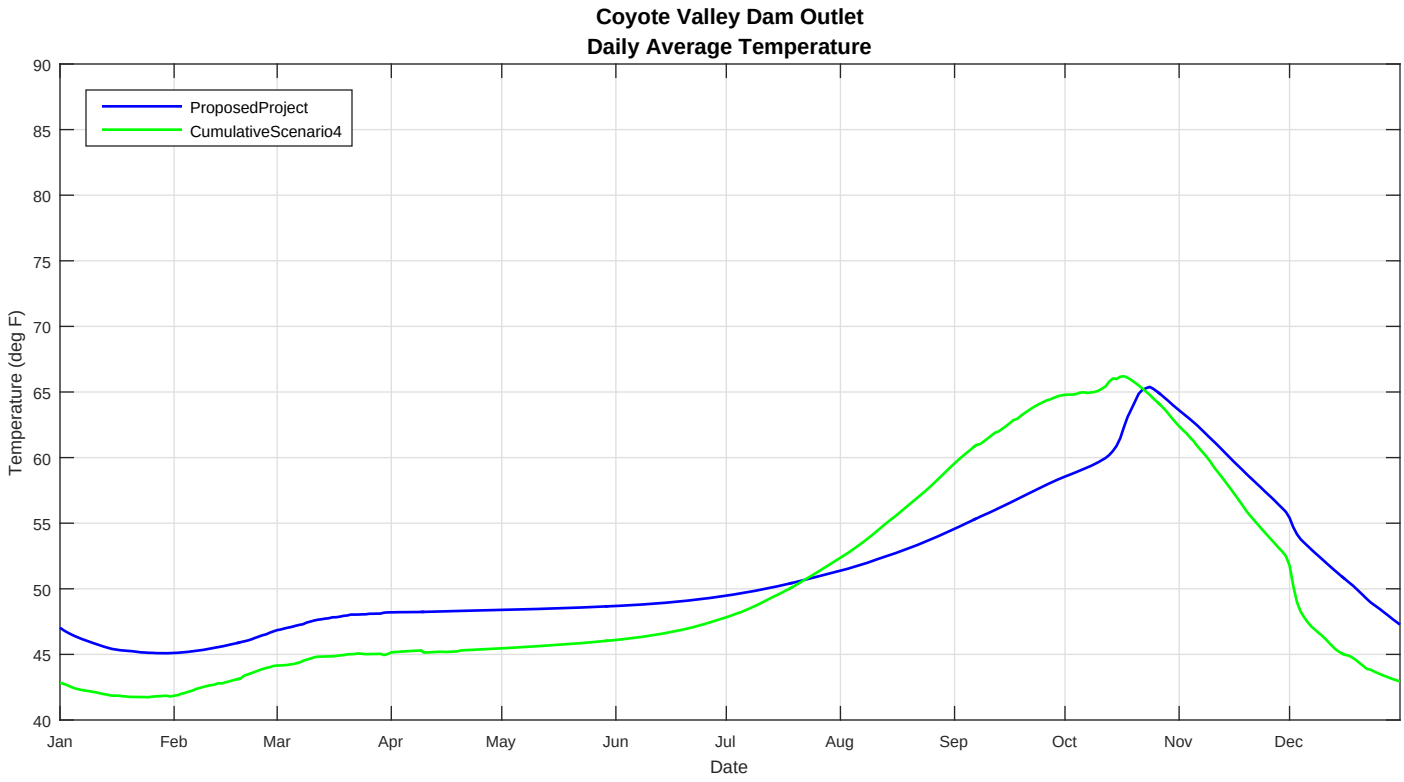

Healdsburg Gage
Daily Average Stage
ProposedProject
CumulativeScenario4
Stage (feet)
0
1
2
3
4
5
6
7
8
9
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

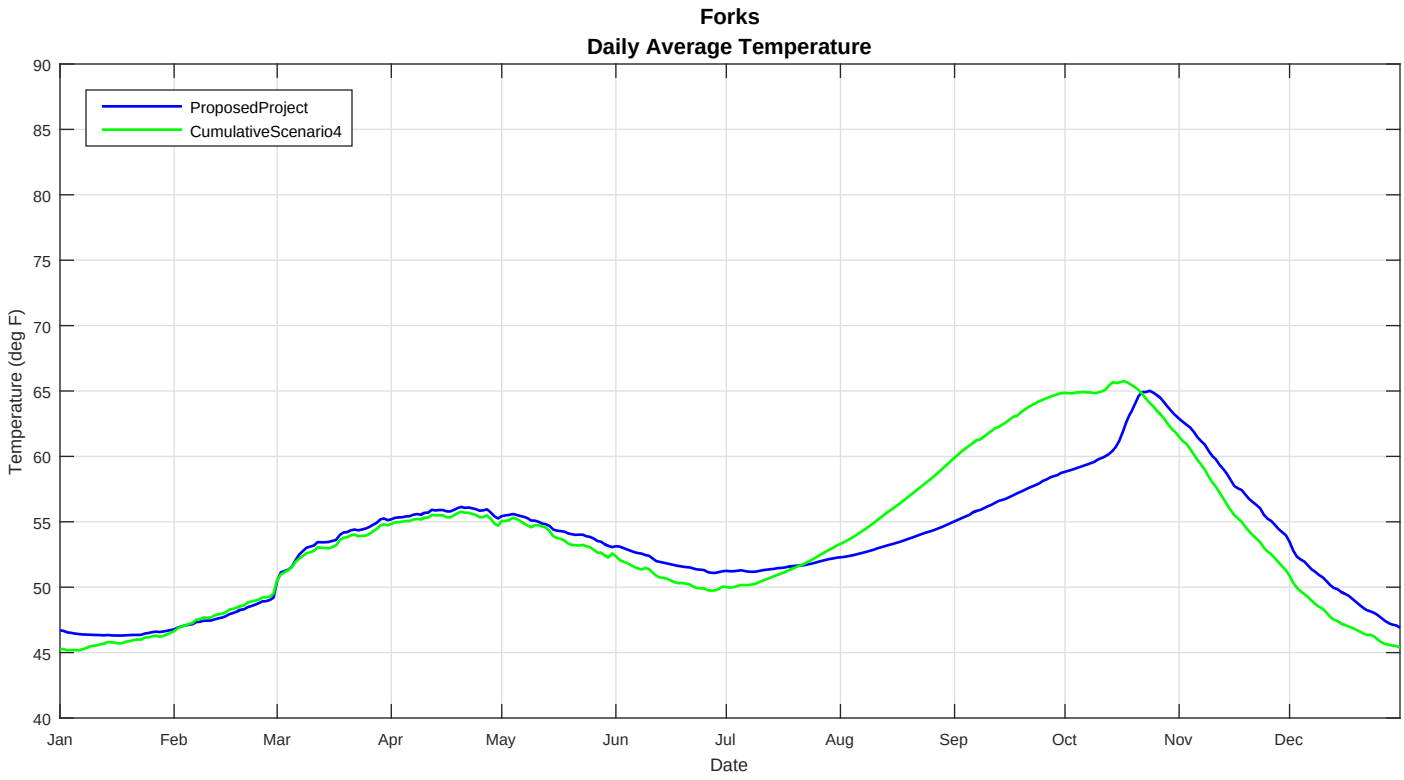

Hacienda Gage
Daily Average Stage
ProposedProject
CumulativeScenario4
Stage (feet)
0
1
2
3
4
5
6
7
8
9
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

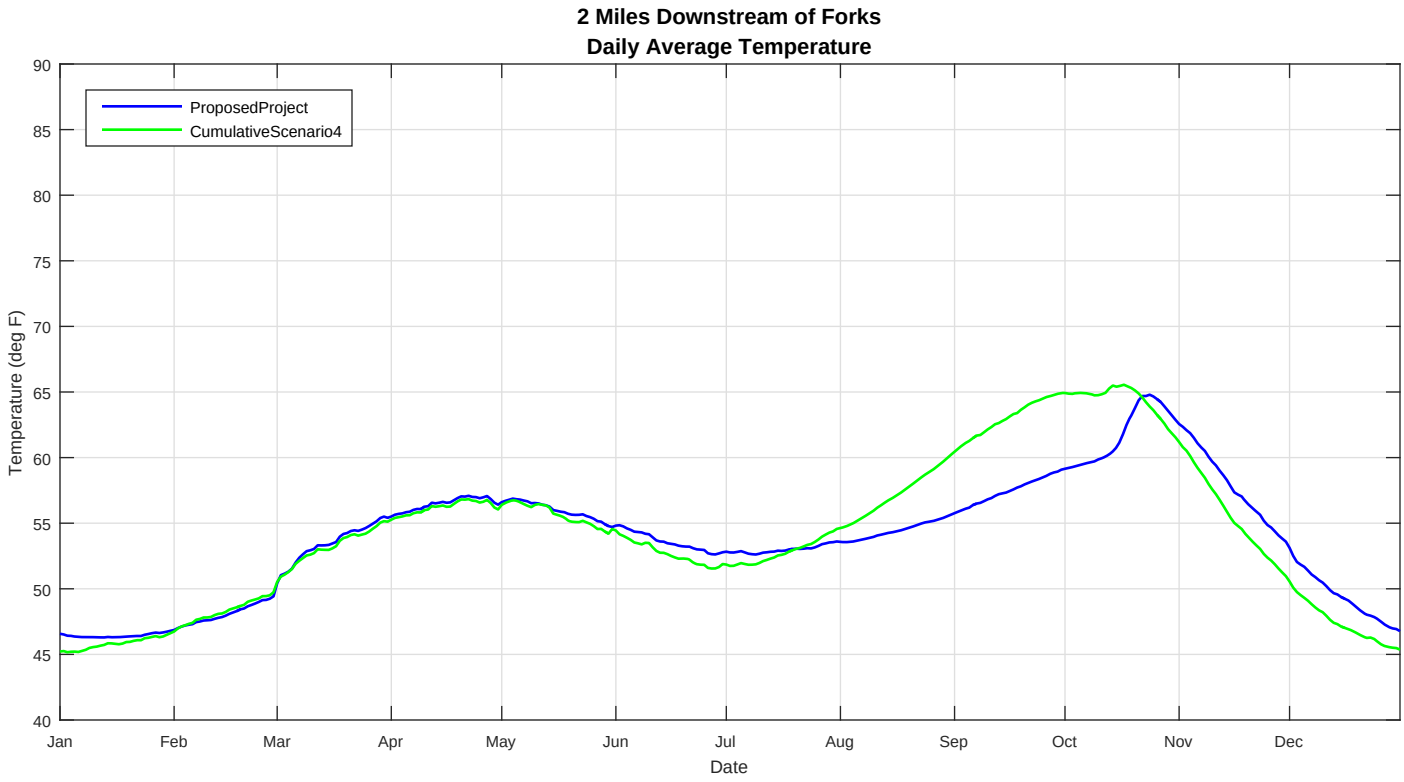

Dry Creek at Geyserville Gage
Daily Average Stage
ProposedProject
CumulativeScenario4
Stage (feet)
0
1
2
3
4
5
6
7
8
9
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

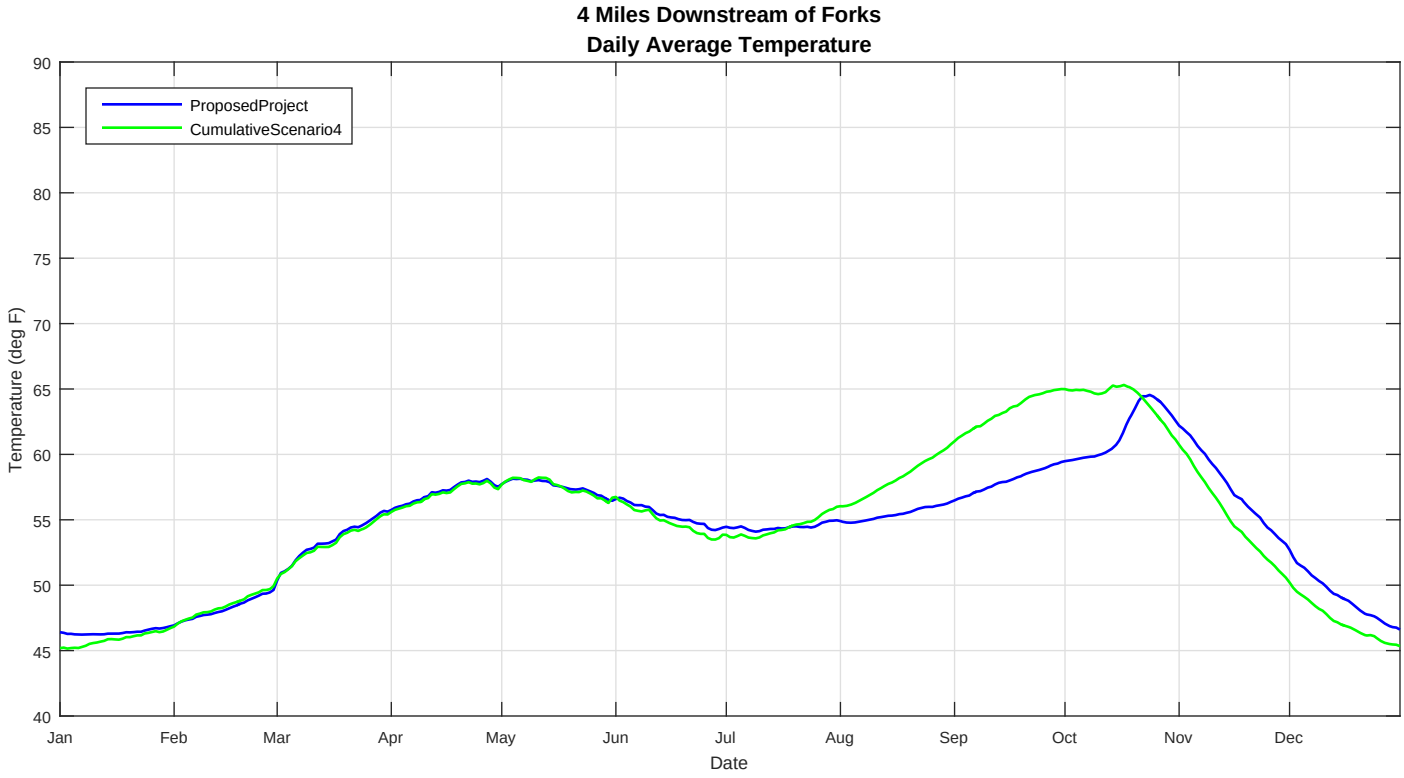

Coyote Valley Dam
Daily Average Power Production
ProposedProject
CumulativeScenario4
Power (MW-hr/day)
0
10
20
30
40
50
60
70
80
90
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

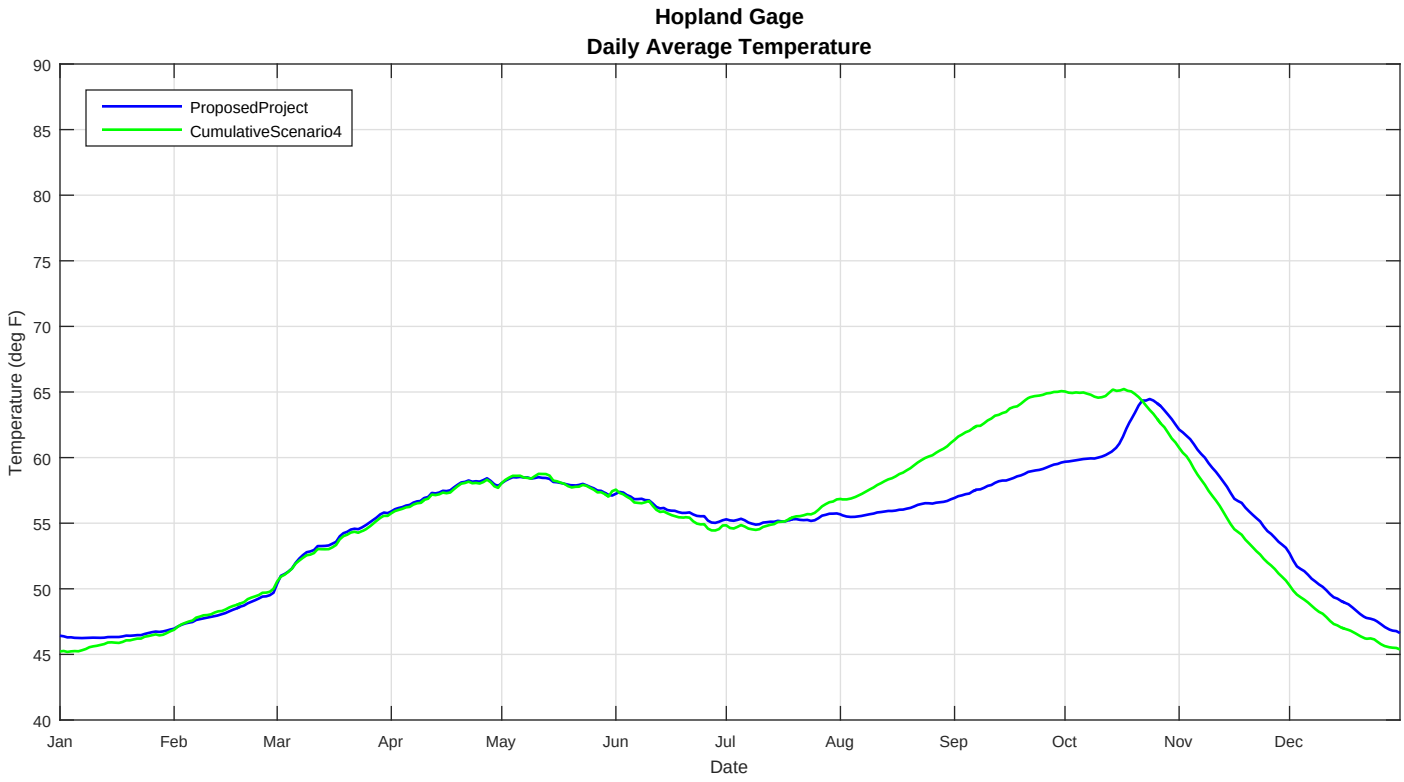

Warm Springs Dam
Daily Average Power Production
ProposedProject
CumulativeScenario4
Power (MW-hr/day)
0
10
20
30
40
50
60
70
80
90
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

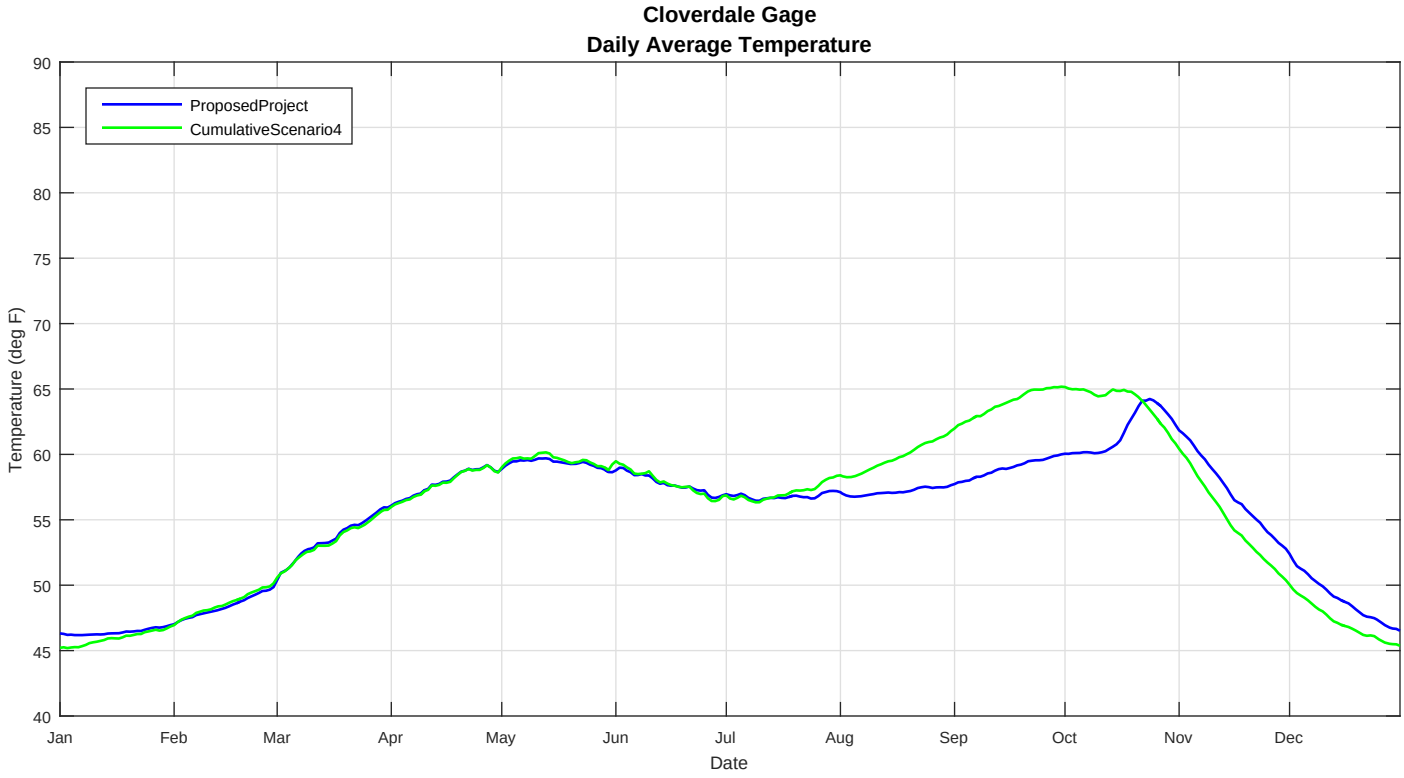

Coyote Valley Dam Outlet
Daily Average Temperature
ProposedProject
CumulativeScenario4
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

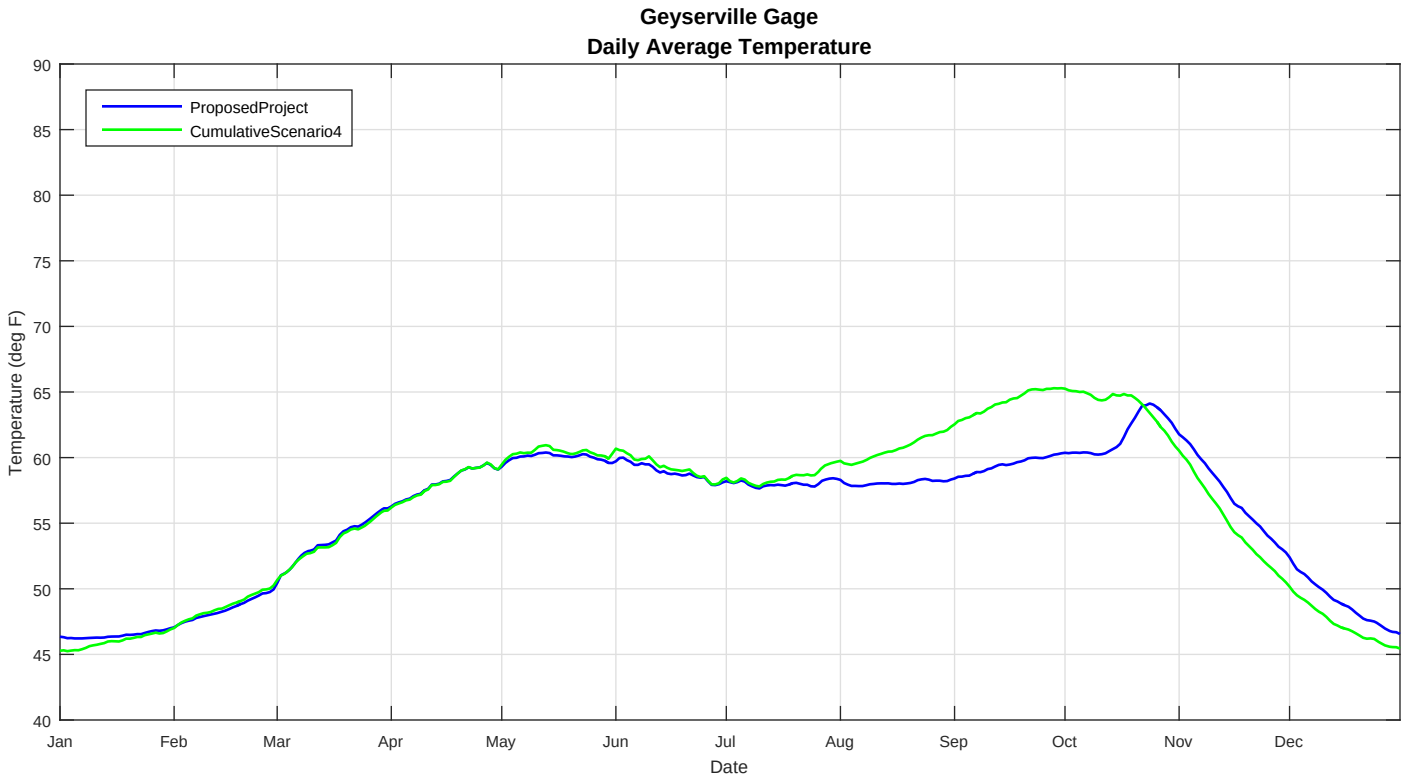

Forks
Daily Average Temperature
ProposedProject
CumulativeScenario4
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

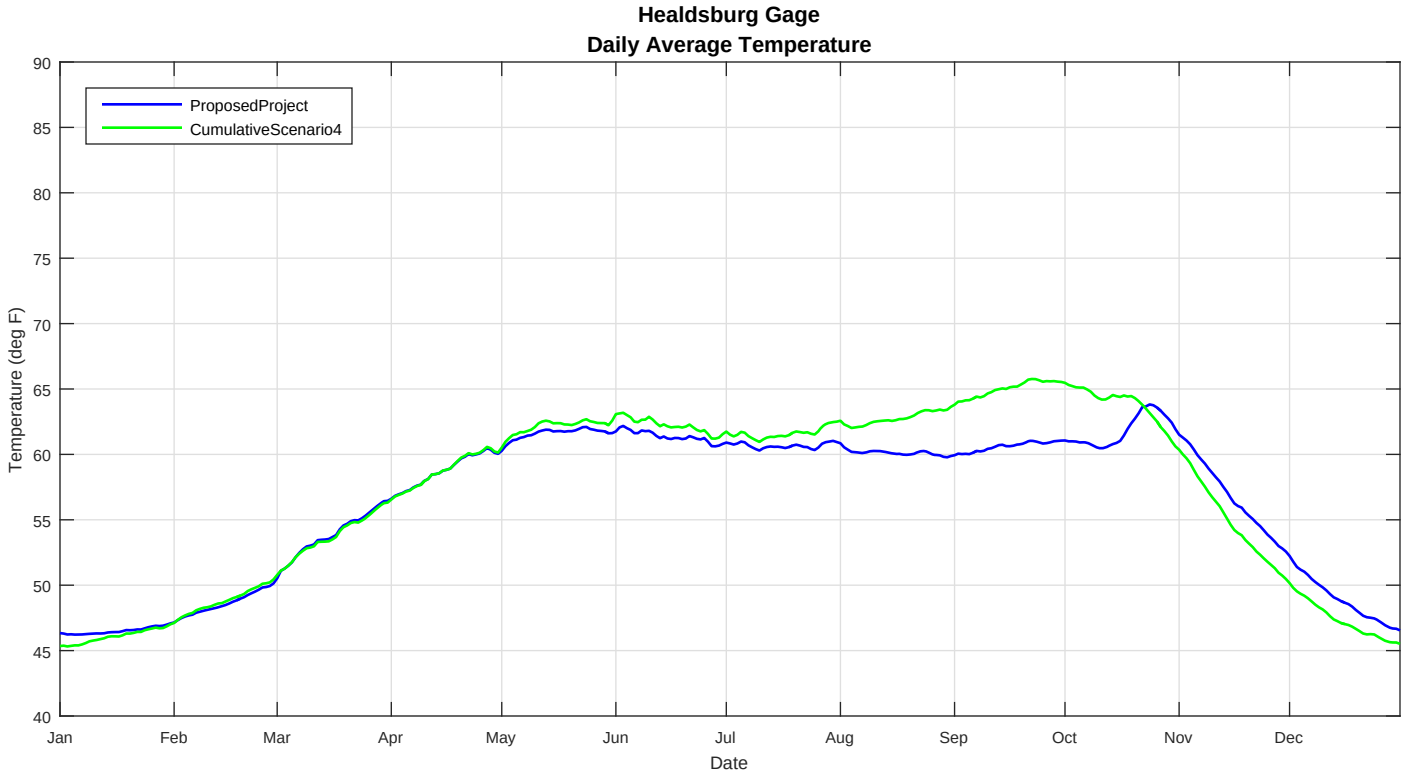

2 Miles Downstream of Forks
Daily Average Temperature
ProposedProject
CumulativeScenario4
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

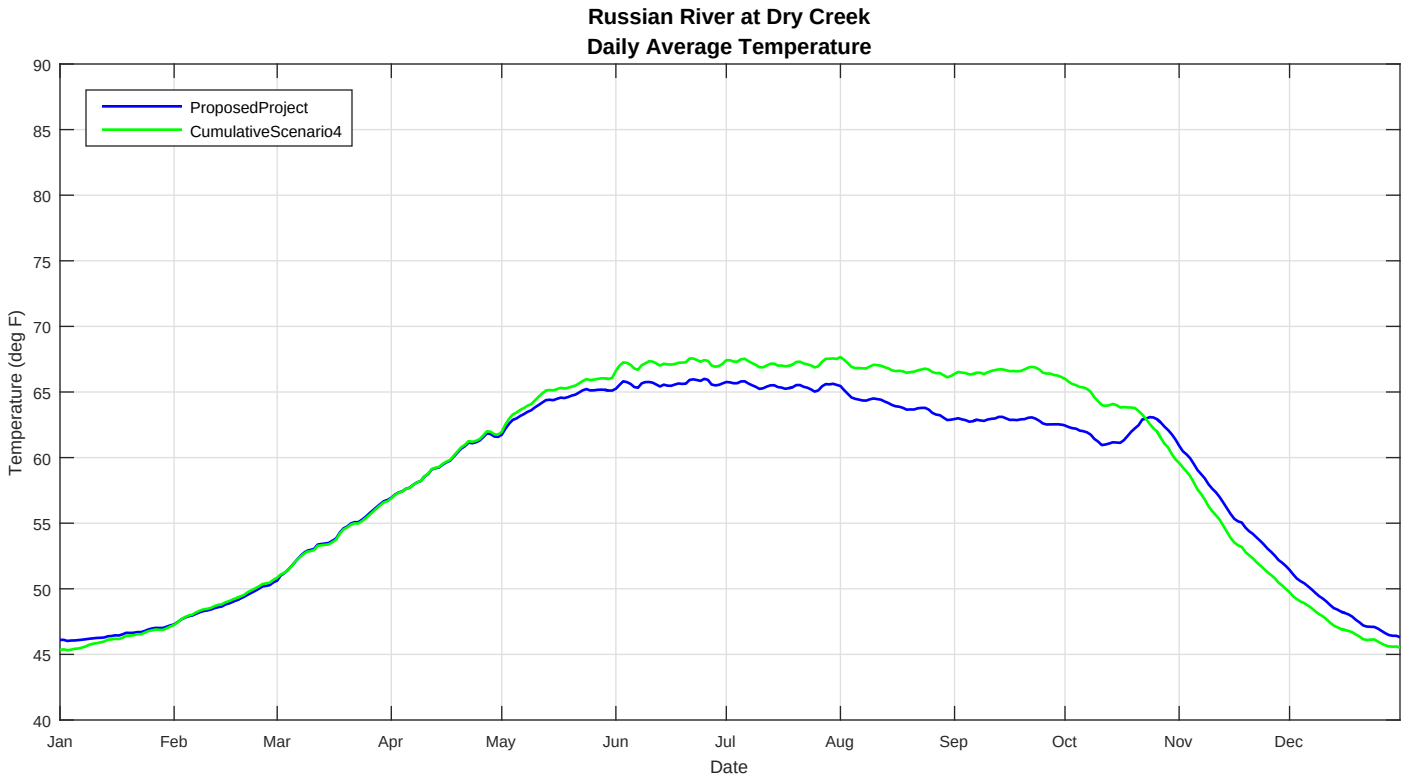

4 Miles Downstream of Forks
Daily Average Temperature
ProposedProject
CumulativeScenario4
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

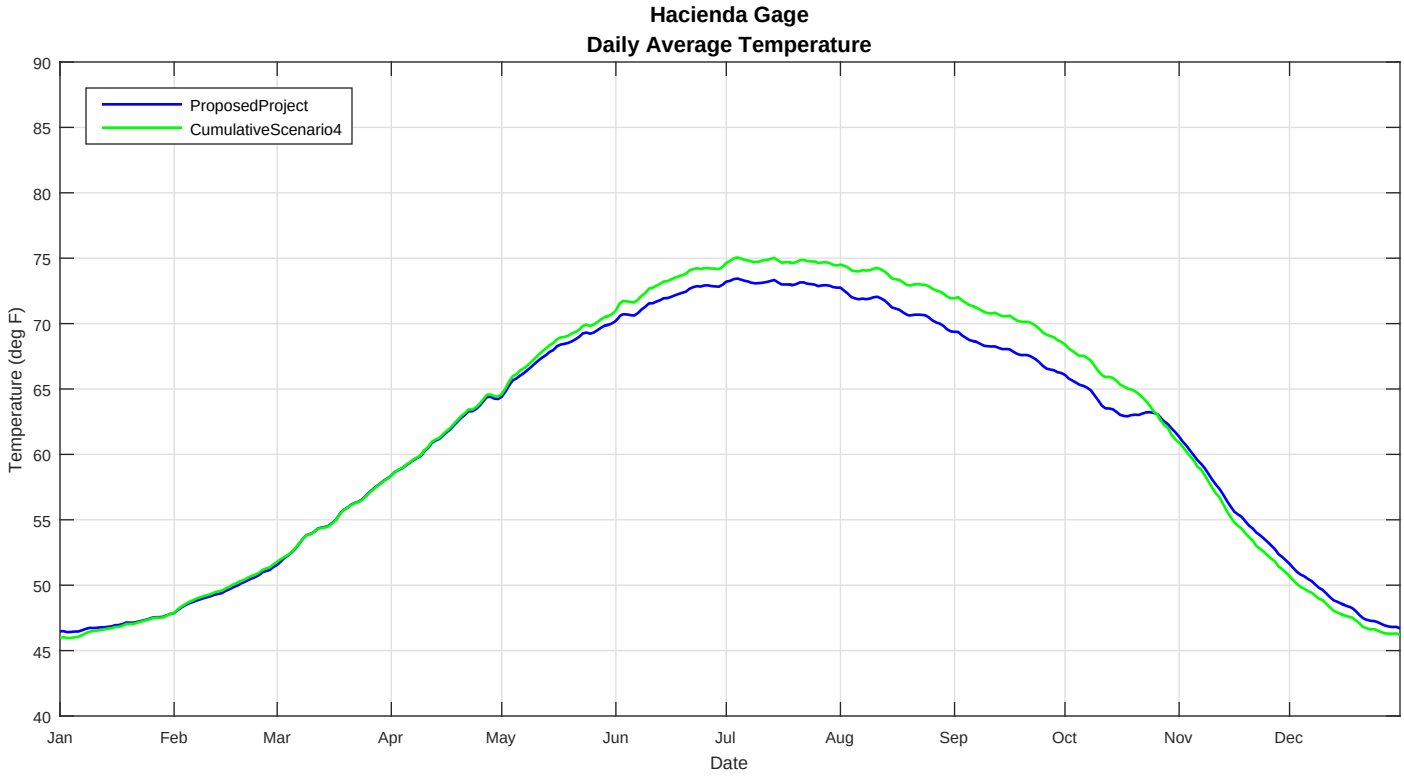

Hopland Gage
Daily Average Temperature
ProposedProject
CumulativeScenario4
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

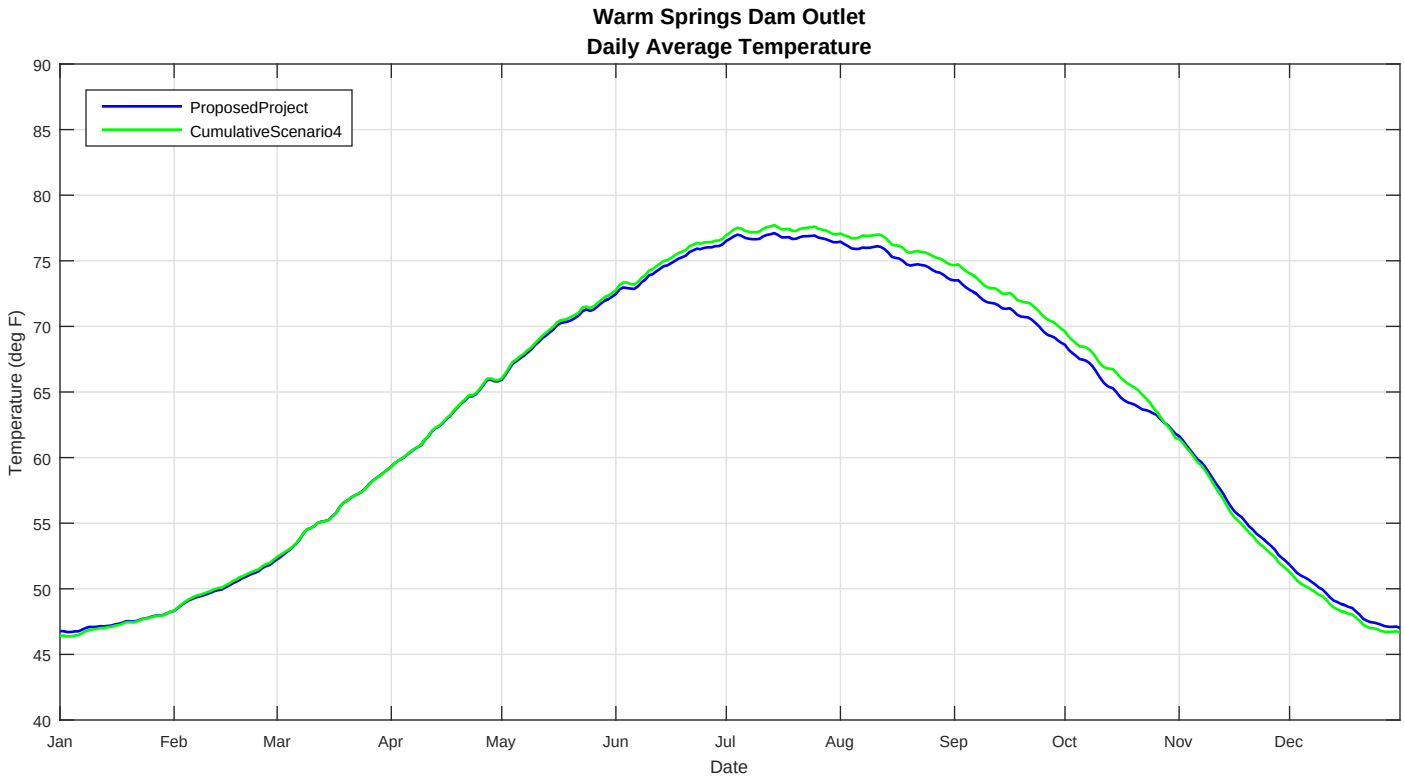

Cloverdale Gage
Daily Average Temperature
ProposedProject
CumulativeScenario4
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

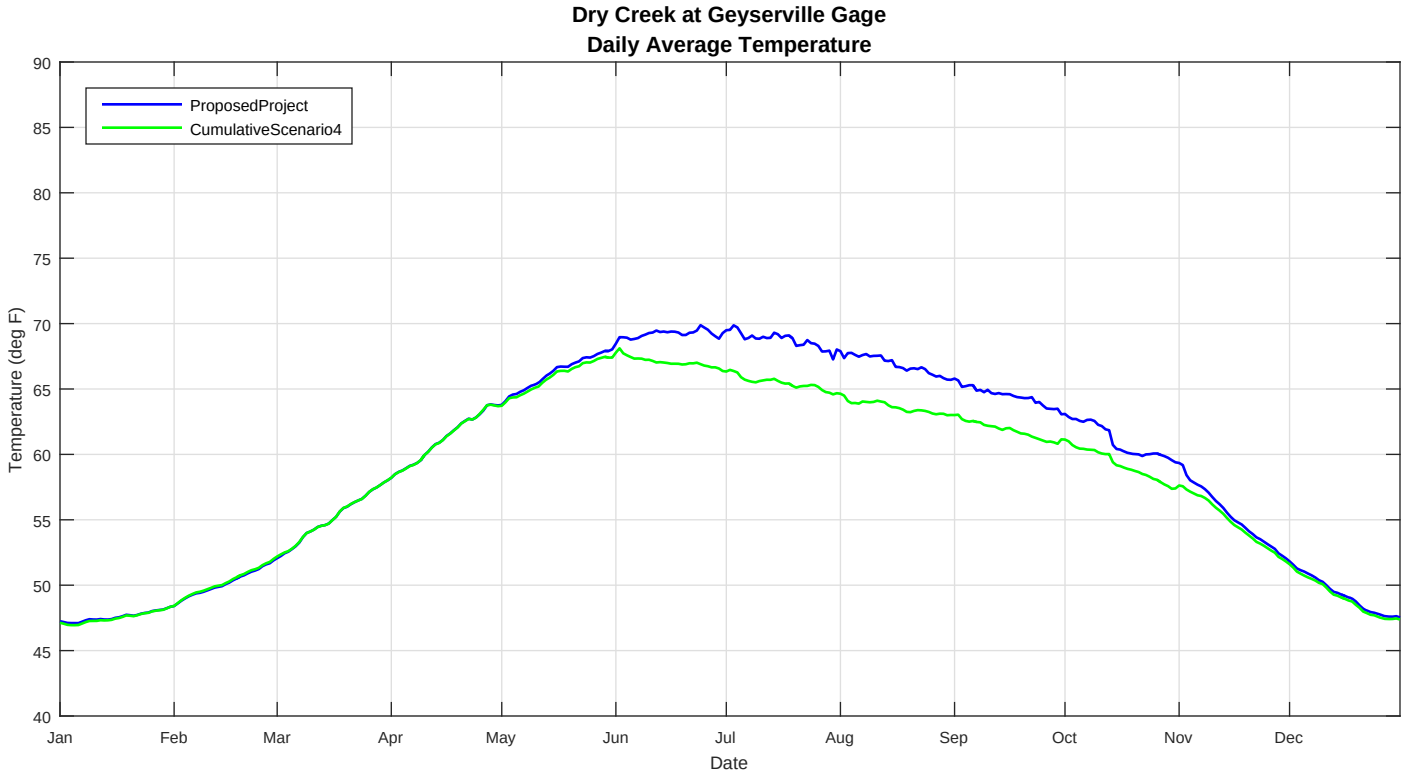

Geyserville Gage
Daily Average Temperature
ProposedProject
CumulativeScenario4
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

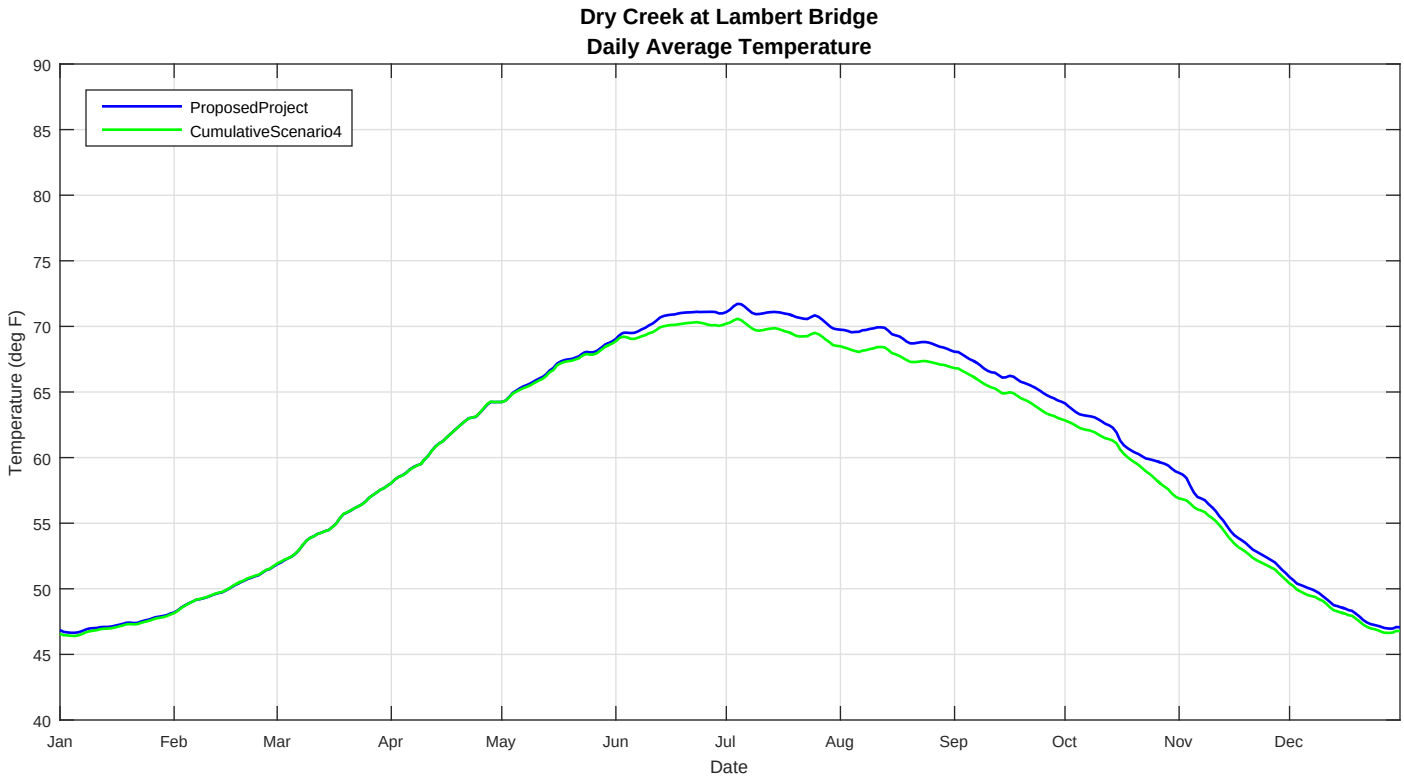

Healdsburg Gage
Daily Average Temperature
ProposedProject
CumulativeScenario4
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

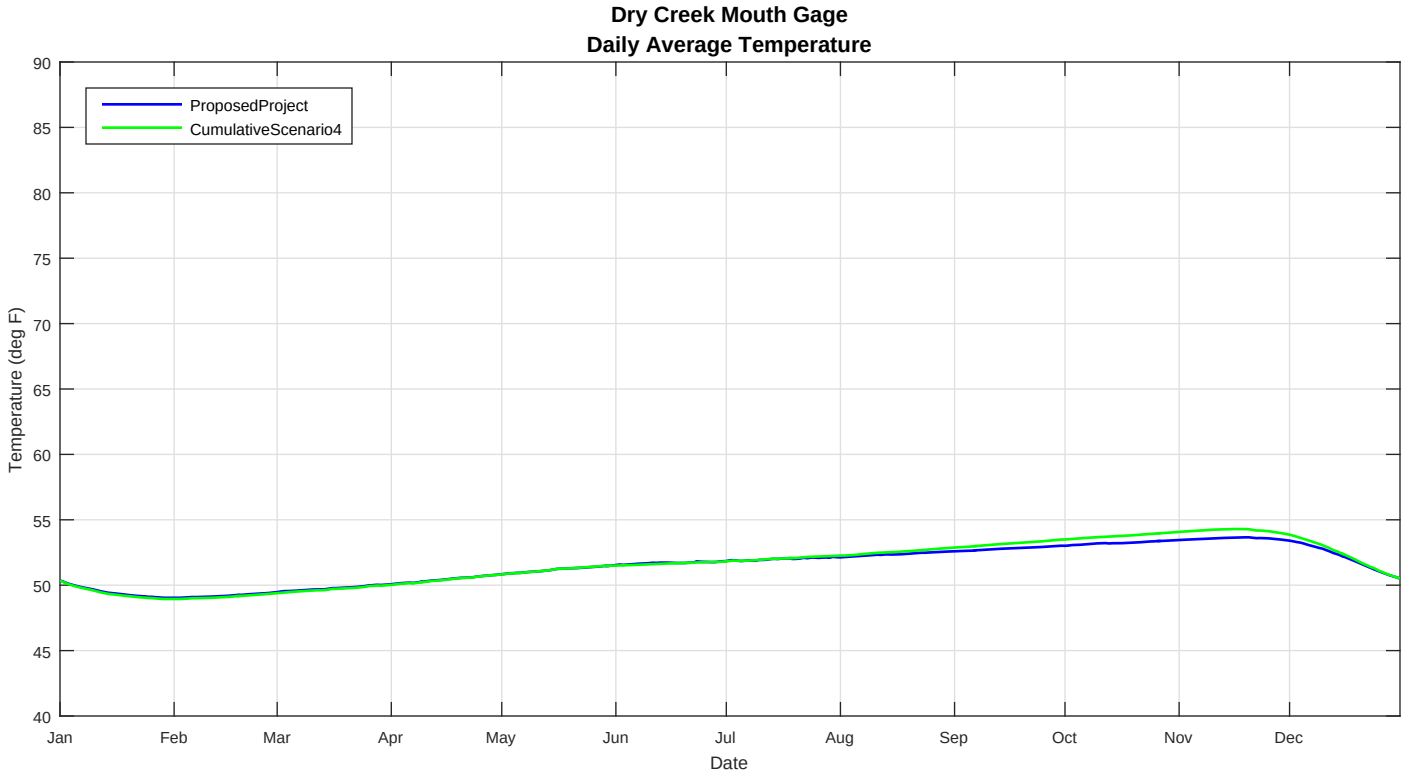

Russian River at Dry Creek
Daily Average Temperature
ProposedProject
CumulativeScenario4
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

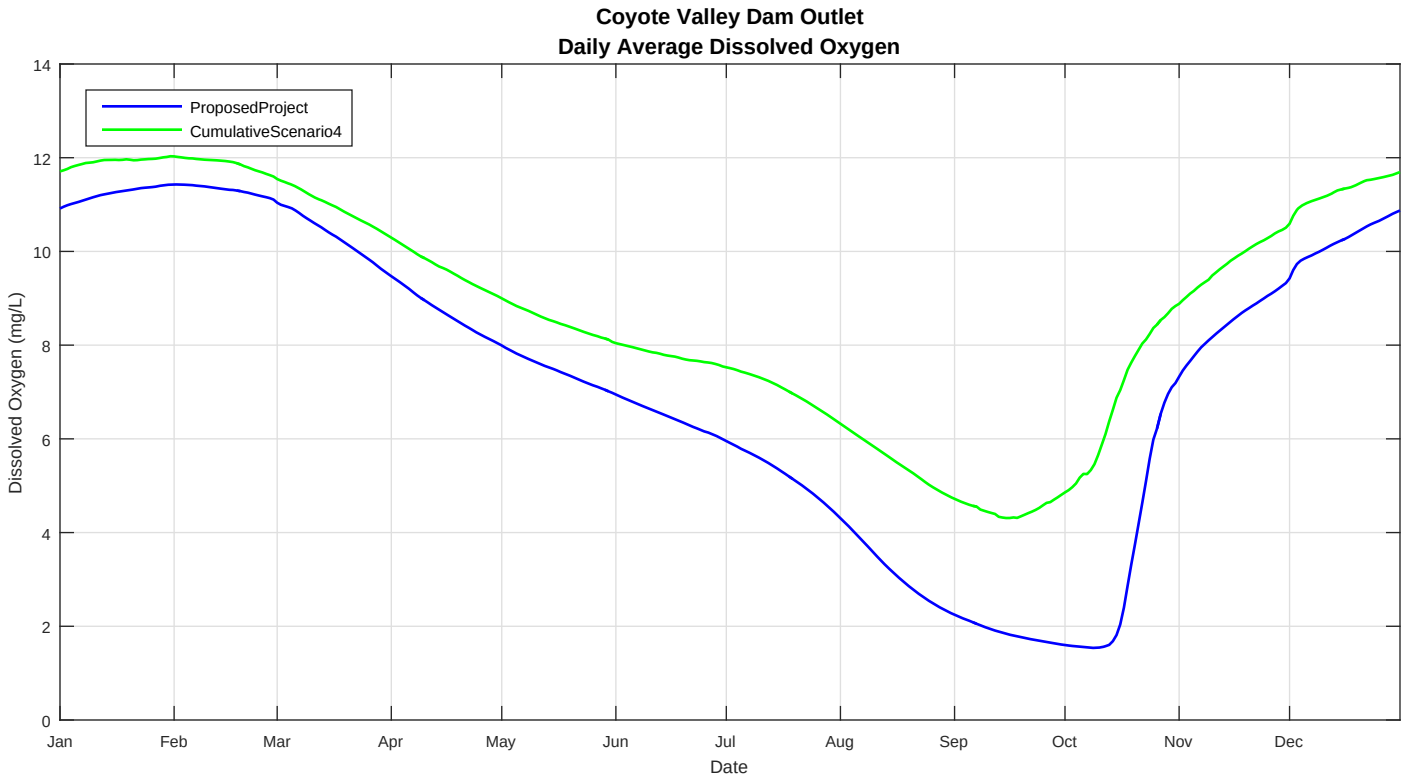

Hacienda Gage
Daily Average Temperature
ProposedProject
CumulativeScenario4
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

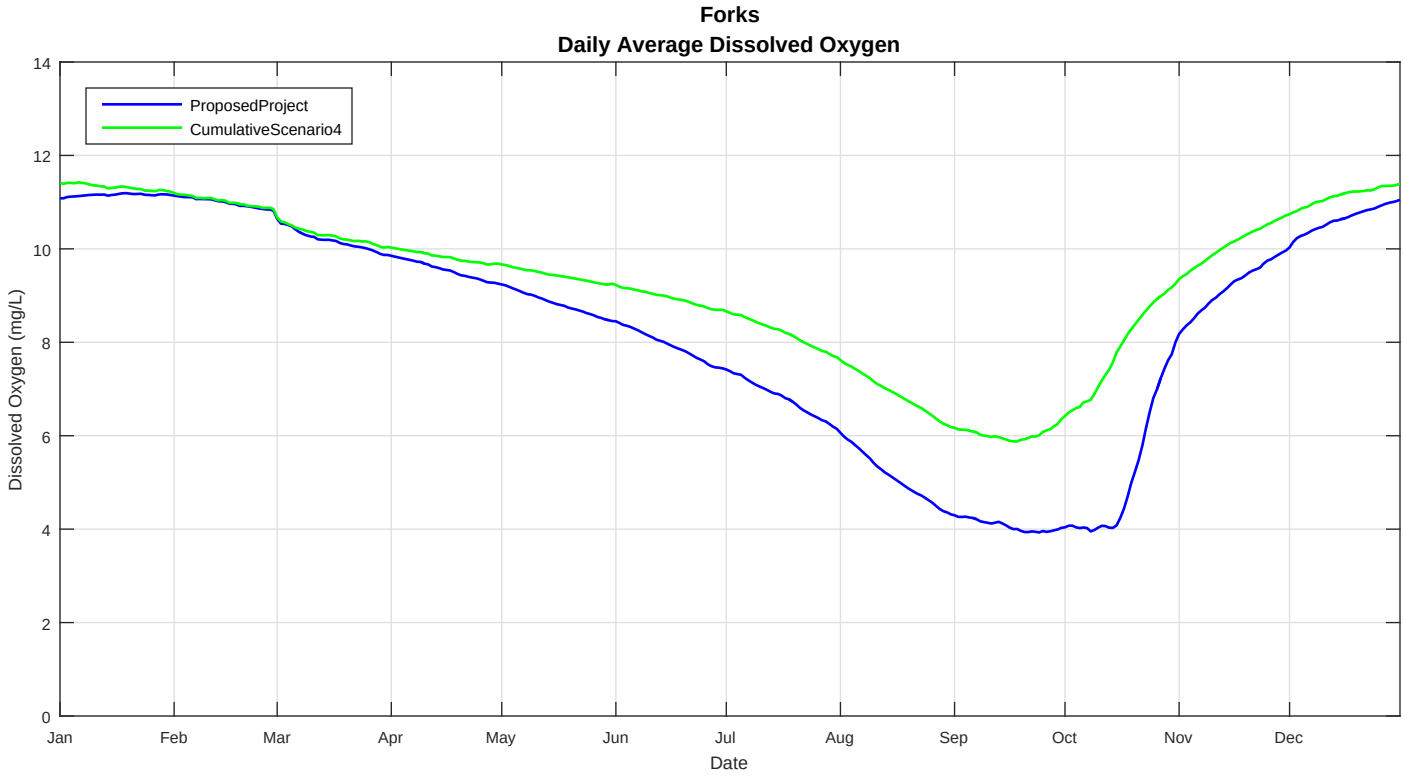

Warm Springs Dam Outlet
Daily Average Temperature
ProposedProject
CumulativeScenario4
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

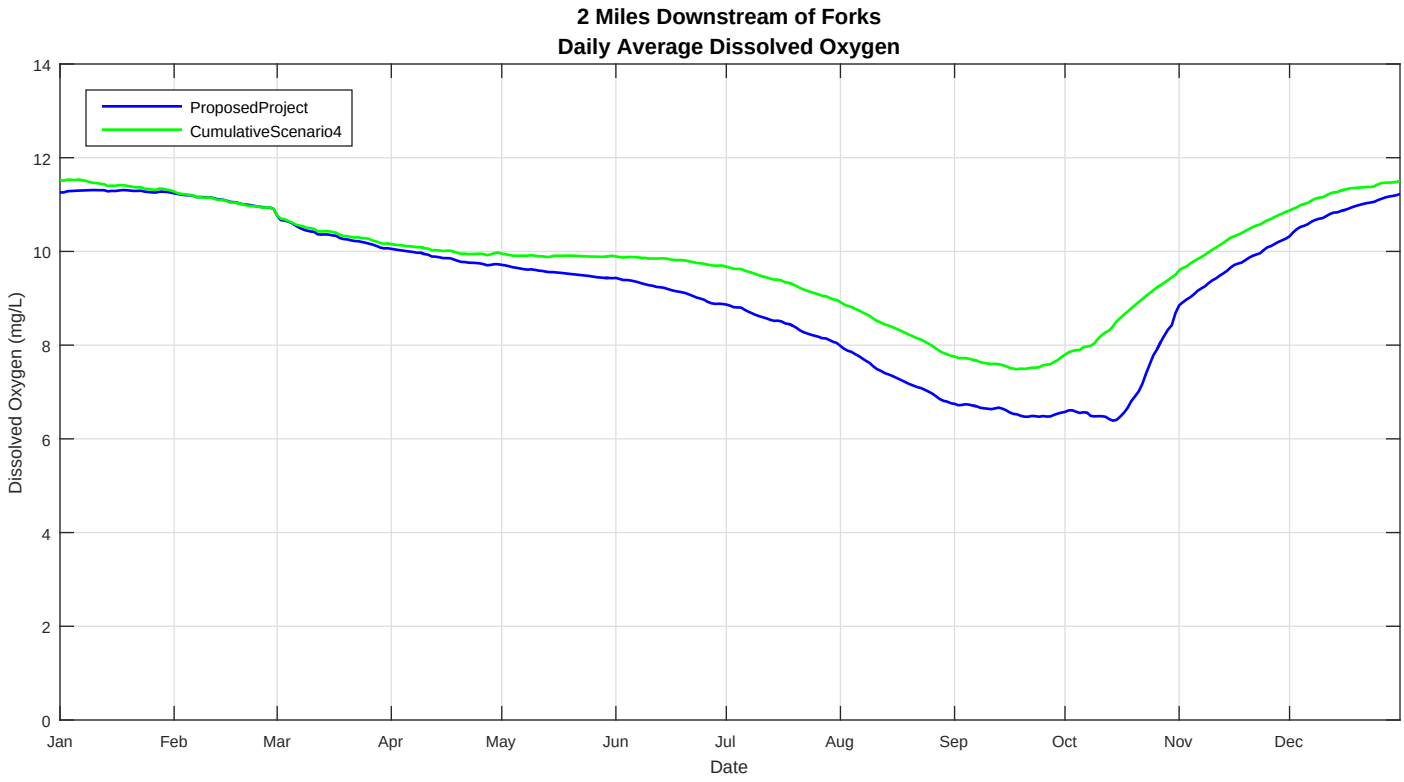

Dry Creek at Geyserville Gage
Daily Average Temperature
ProposedProject
CumulativeScenario4
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

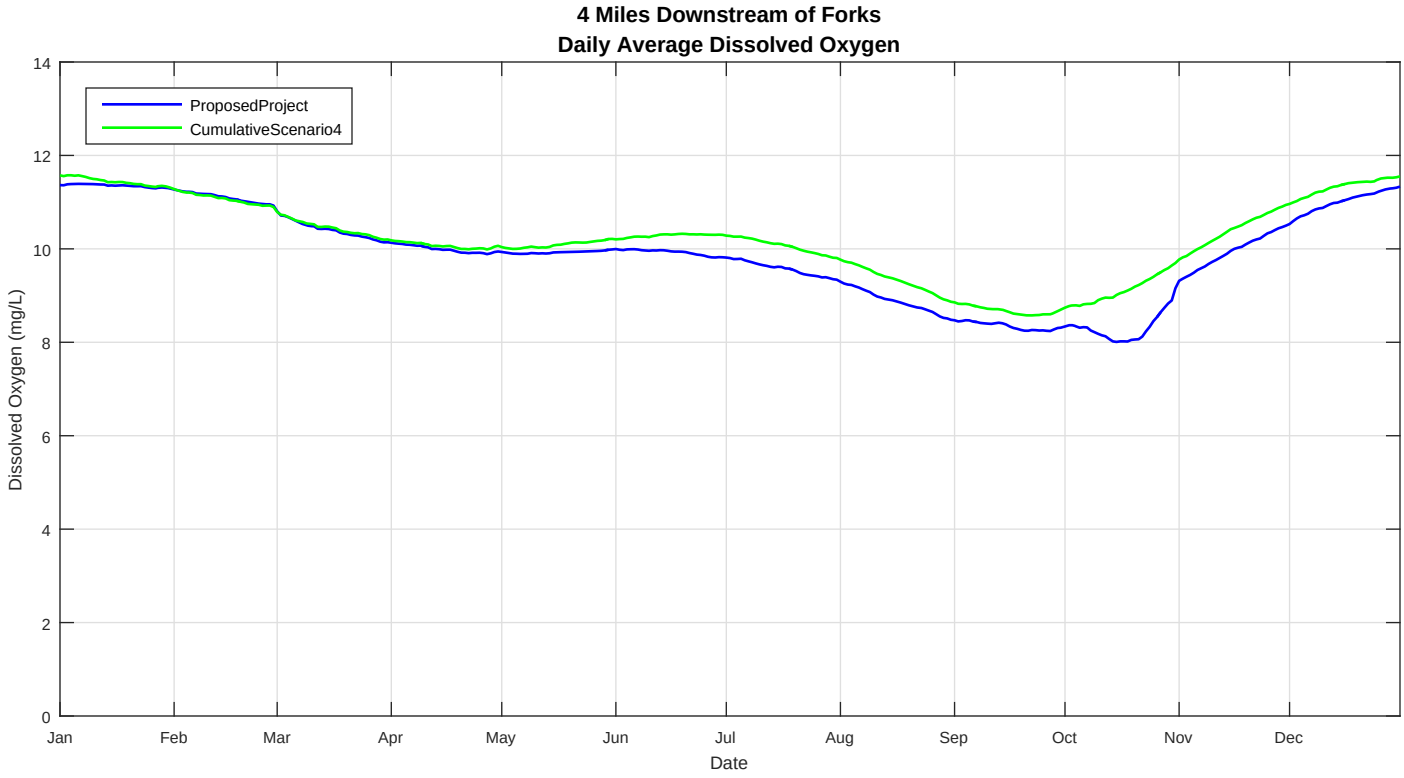

Dry Creek at Lambert Bridge
Daily Average Temperature
ProposedProject
CumulativeScenario4
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

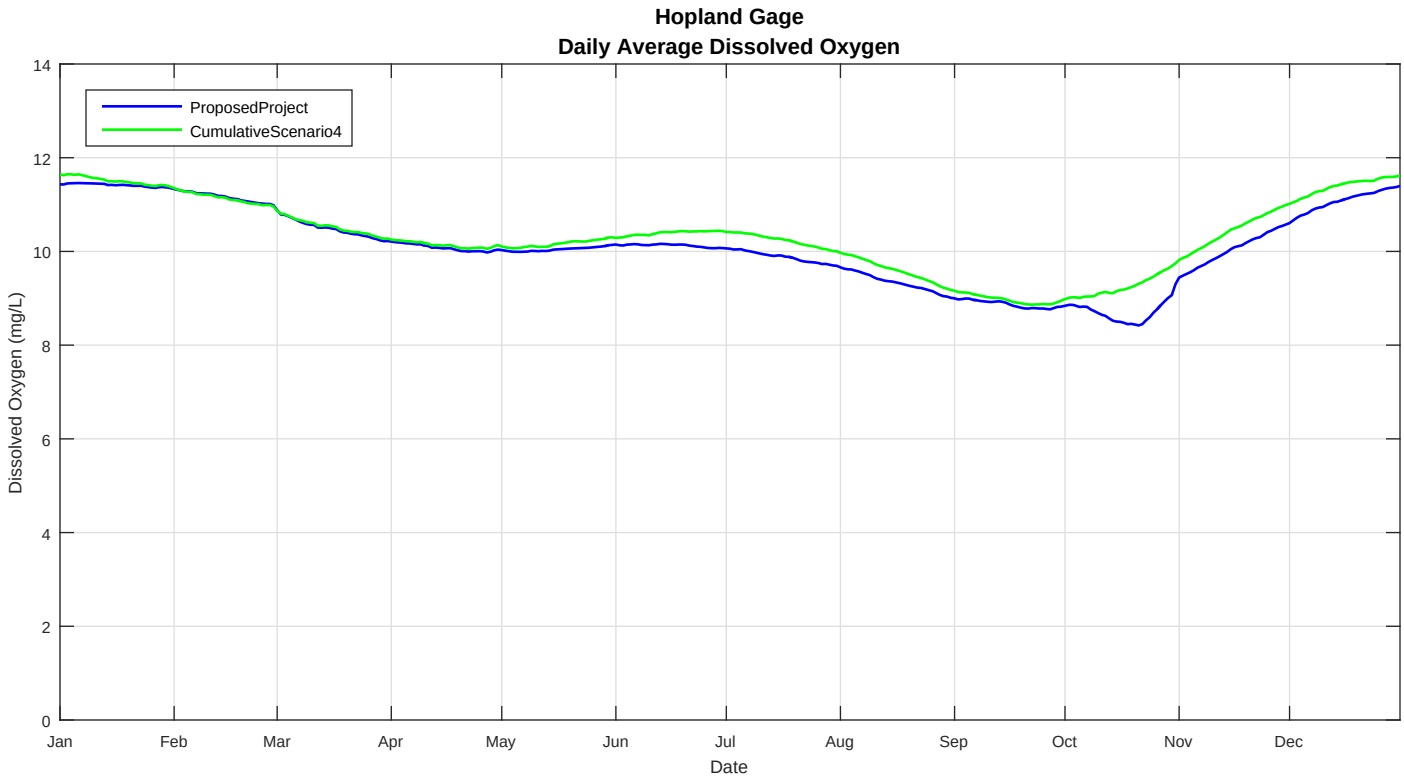

Dry Creek Mouth Gage
Daily Average Temperature
ProposedProject
CumulativeScenario4
Temperature (deg F)
90
85
80
75
70
65
60
55
50
45
40
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

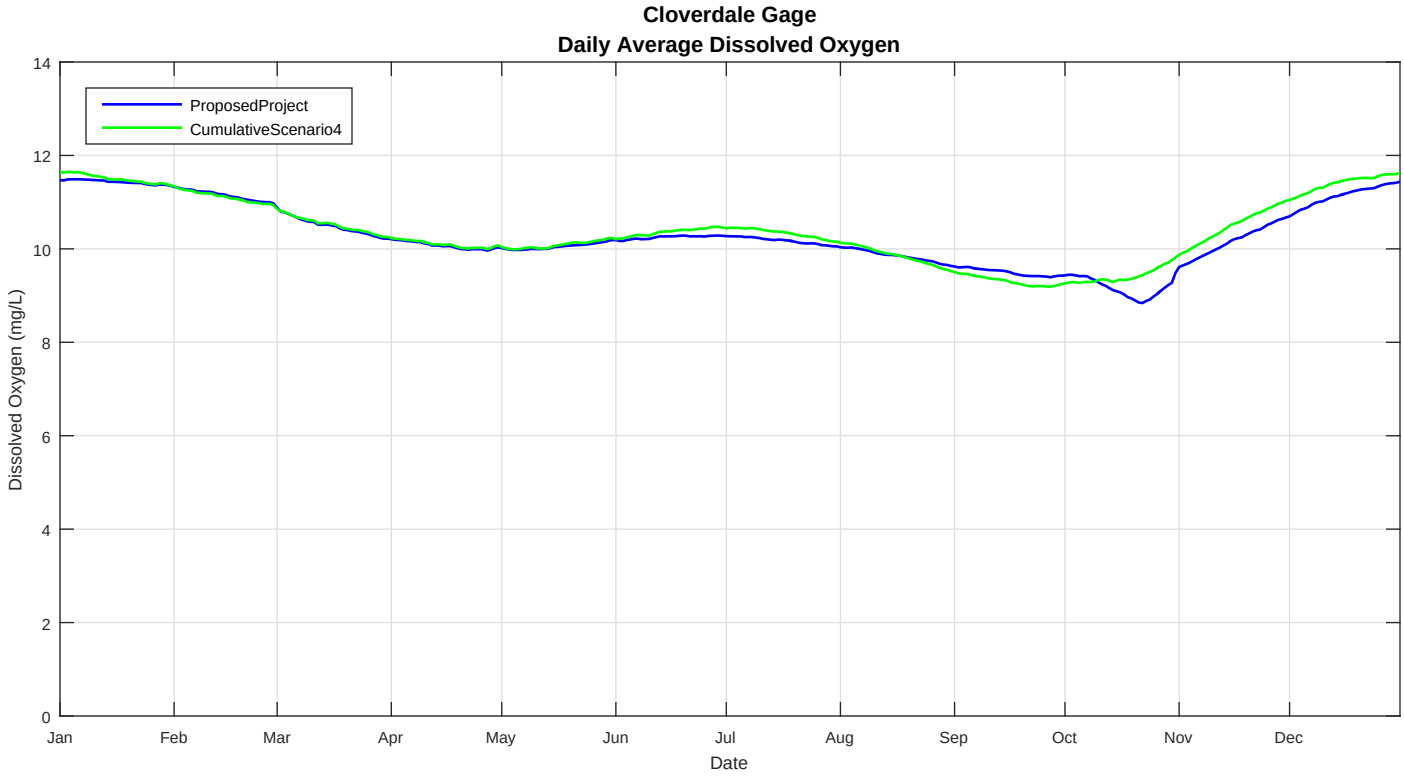

Coyote Valley Dam Outlet
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

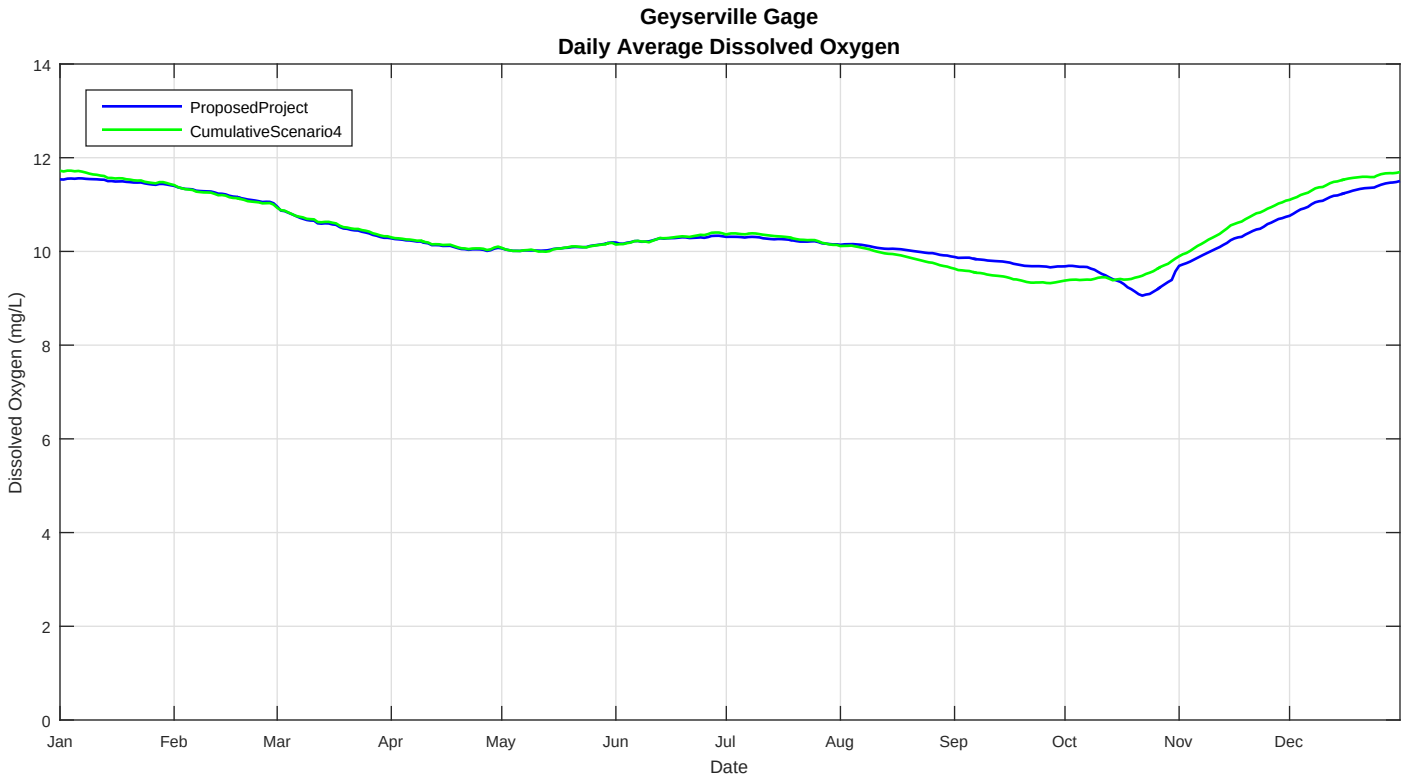

Forks
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

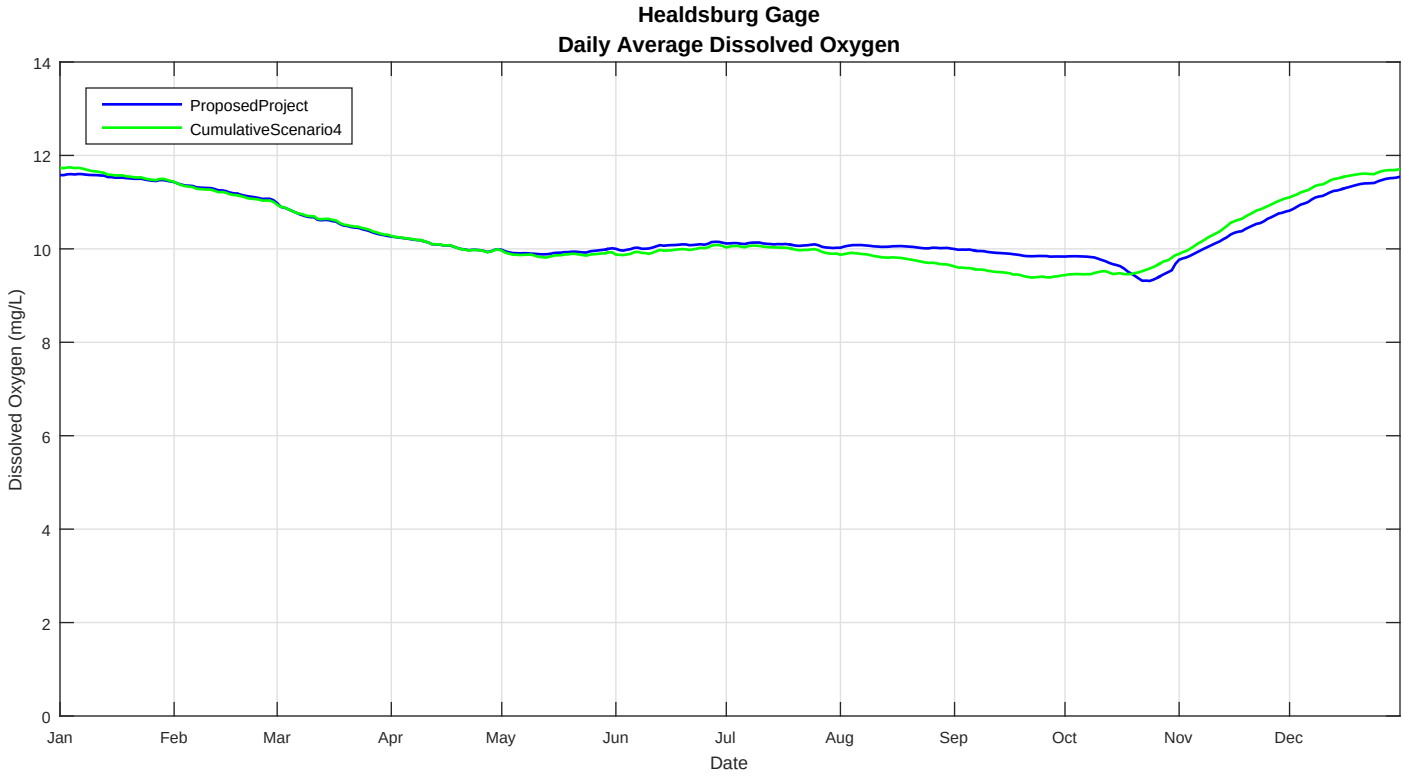

2 Miles Downstream of Forks
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

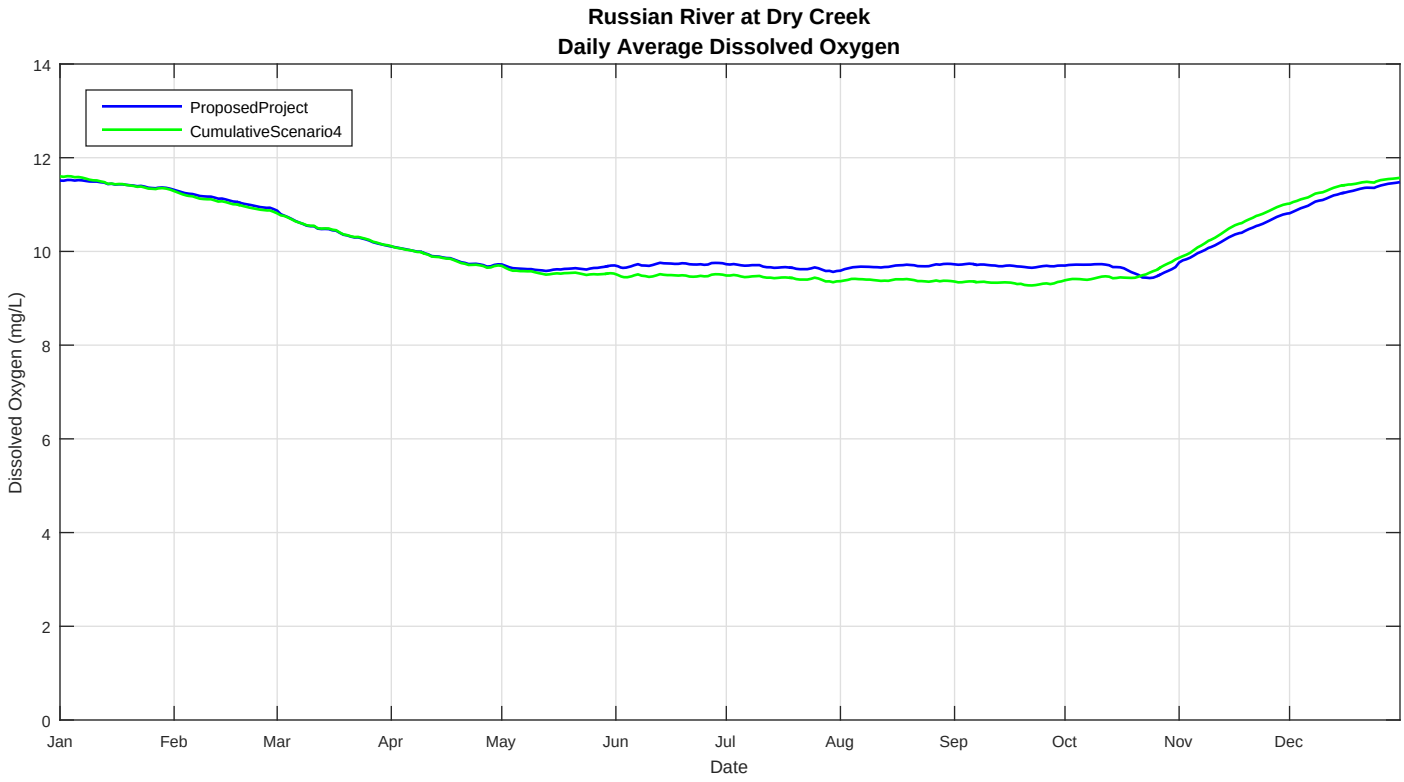

4 Miles Downstream of Forks
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

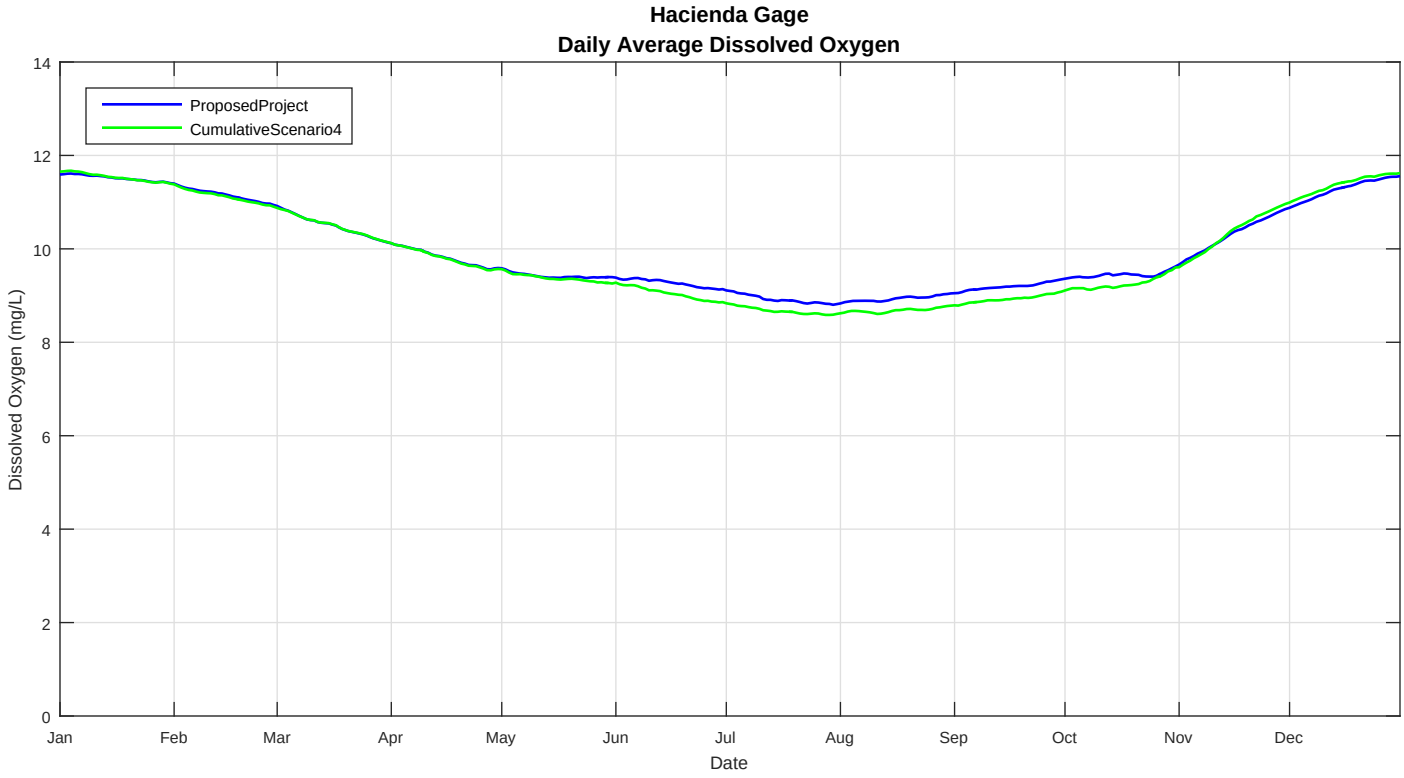

Hopland Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

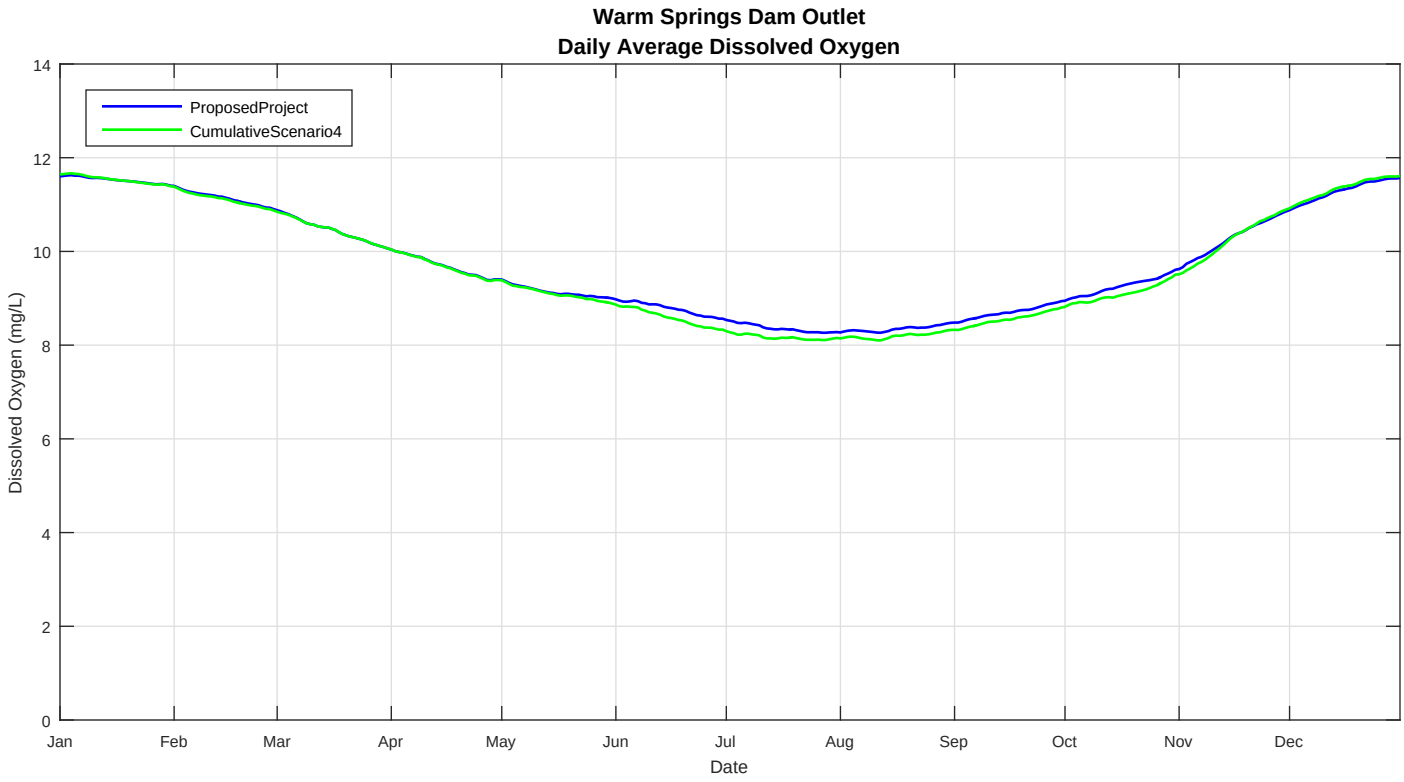

Cloverdale Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

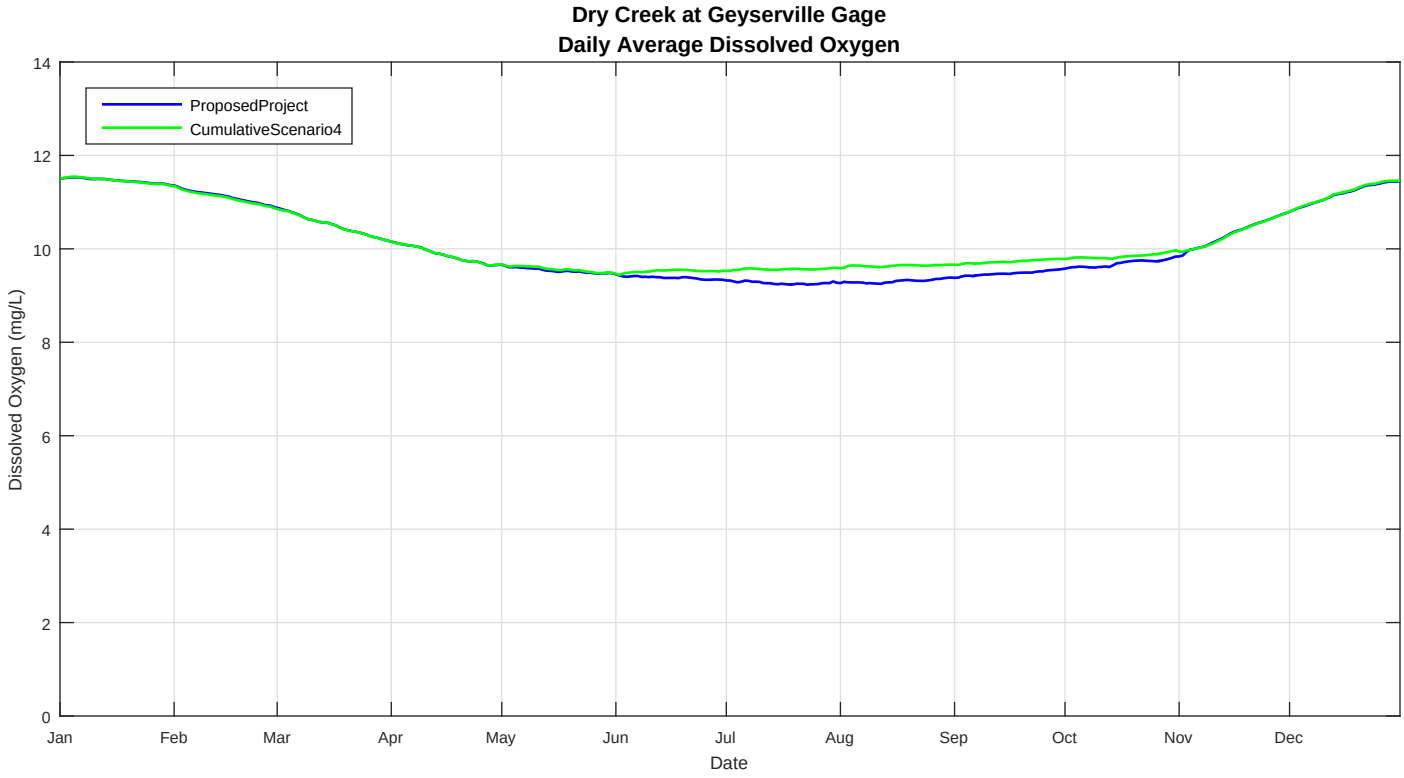

Geyserville Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

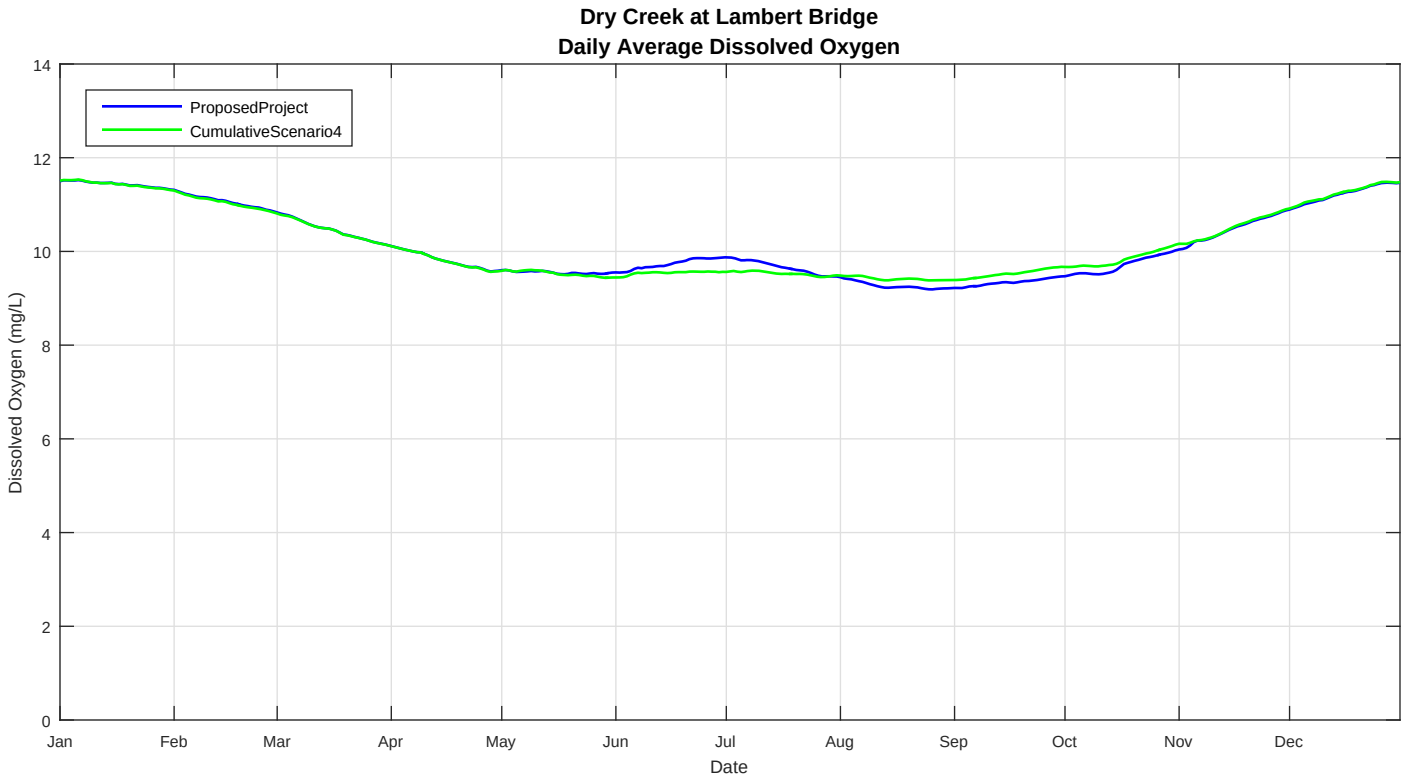

Healdsburg Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

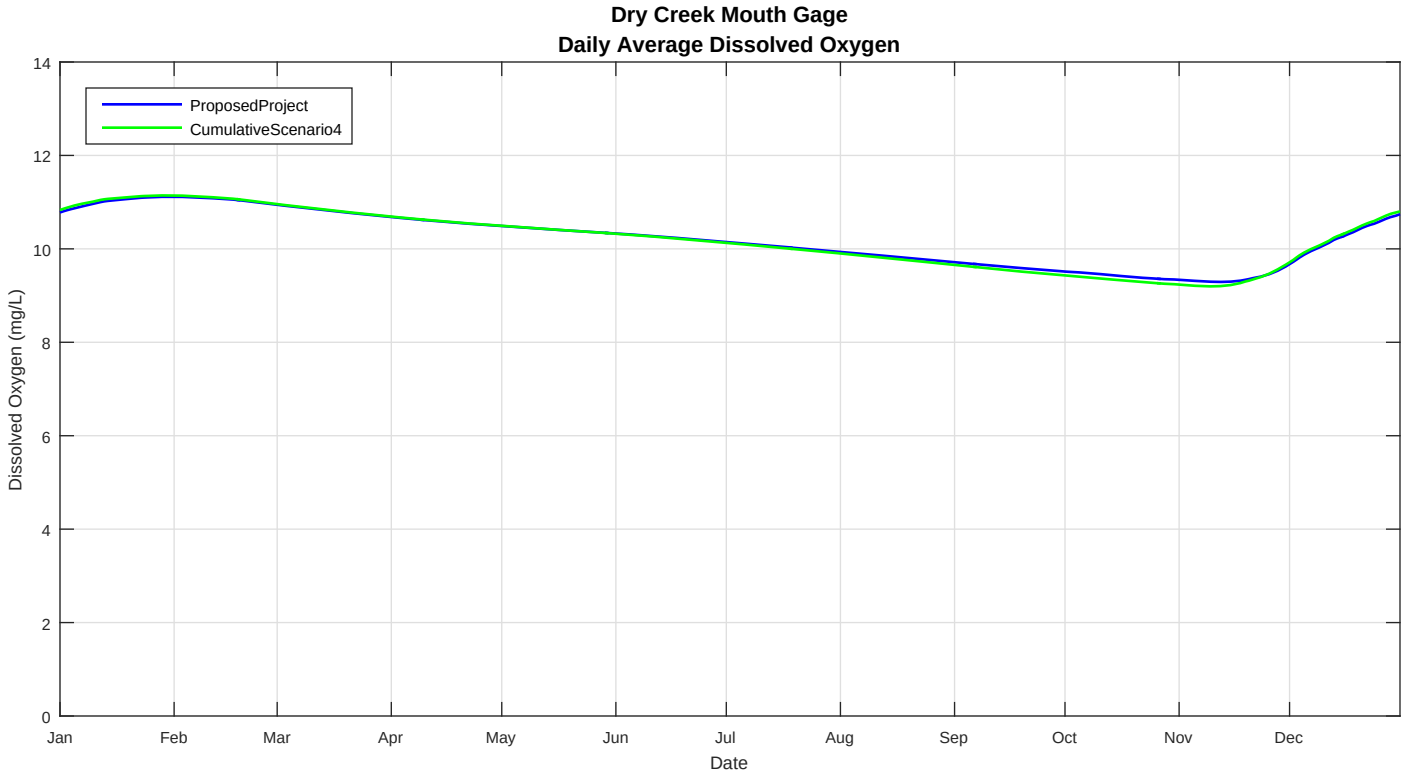

Russian River at Dry Creek
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

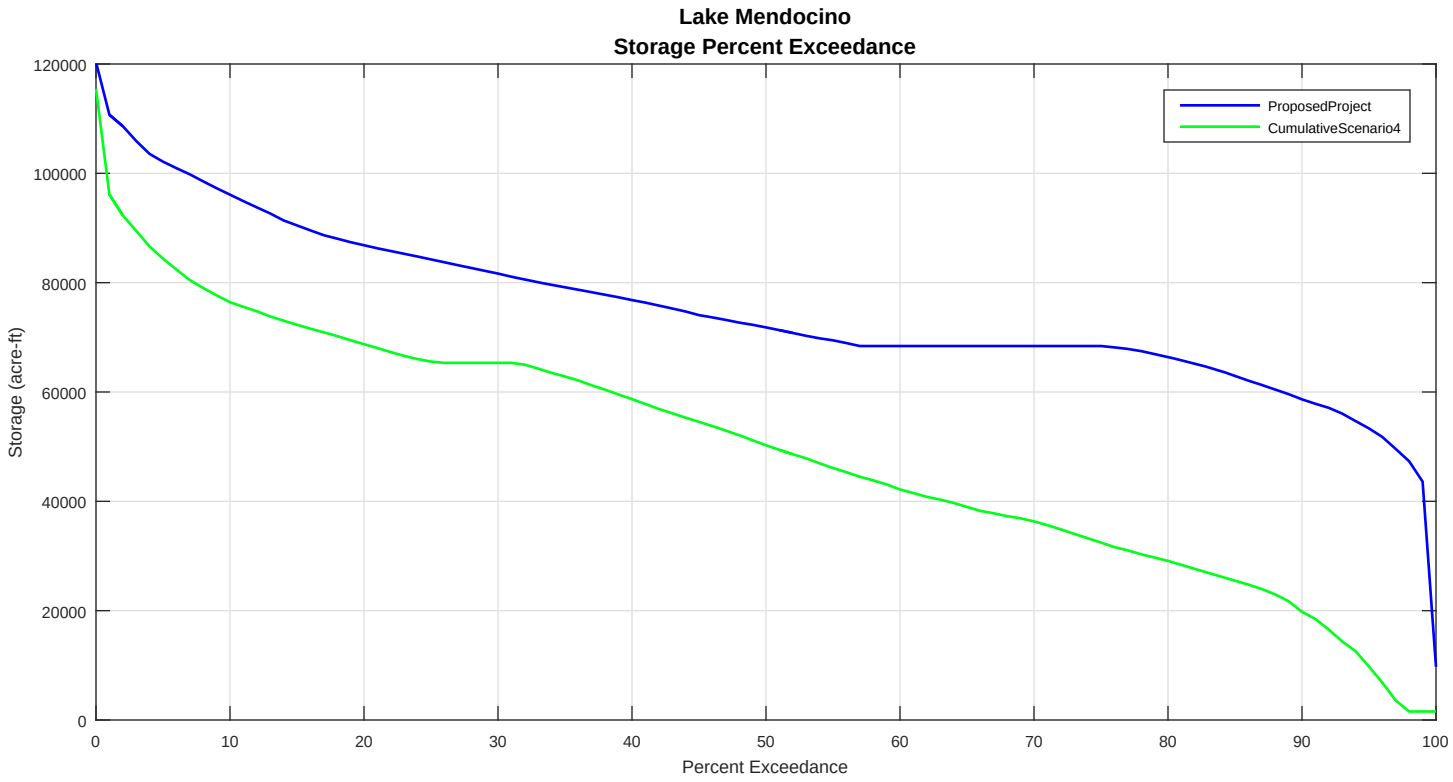

Hacienda Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

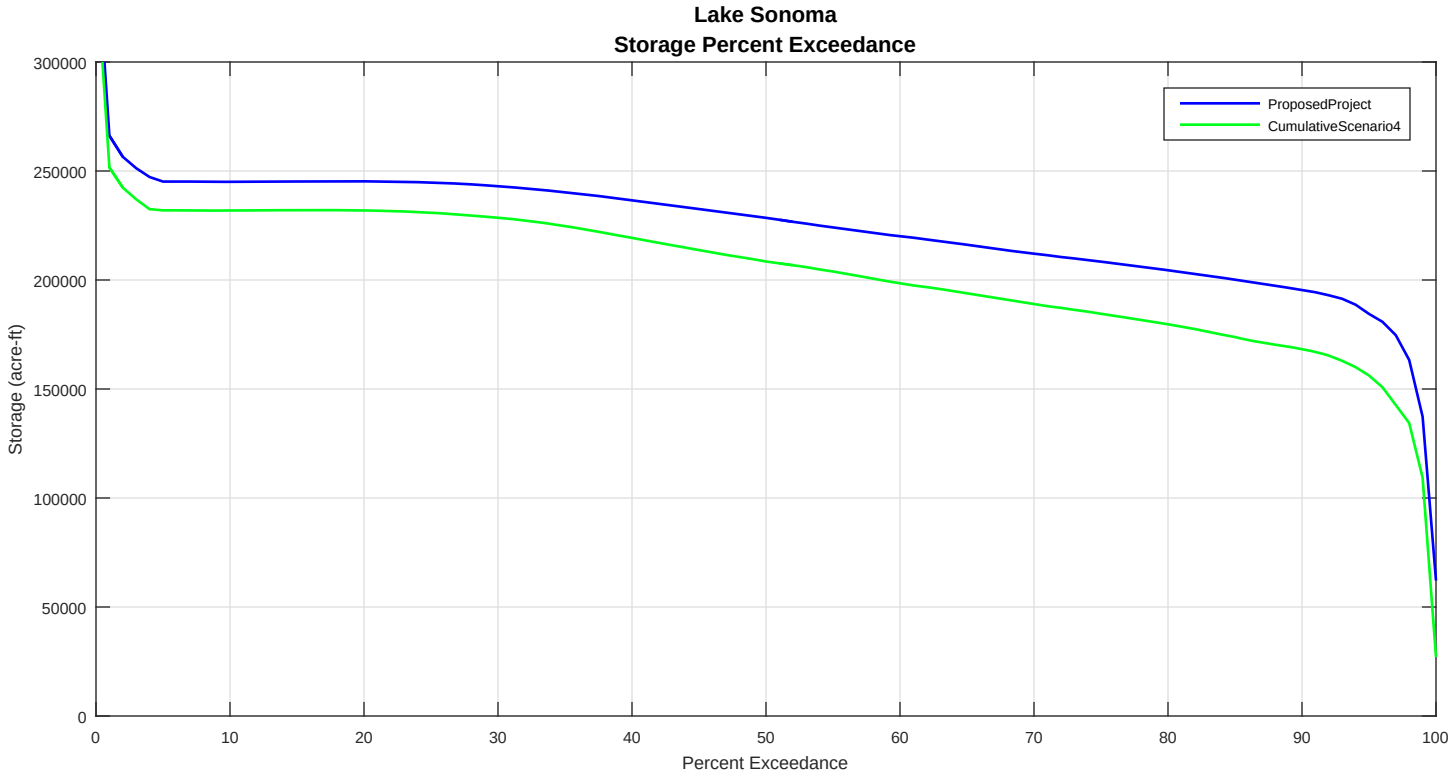

Warm Springs Dam Outlet
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

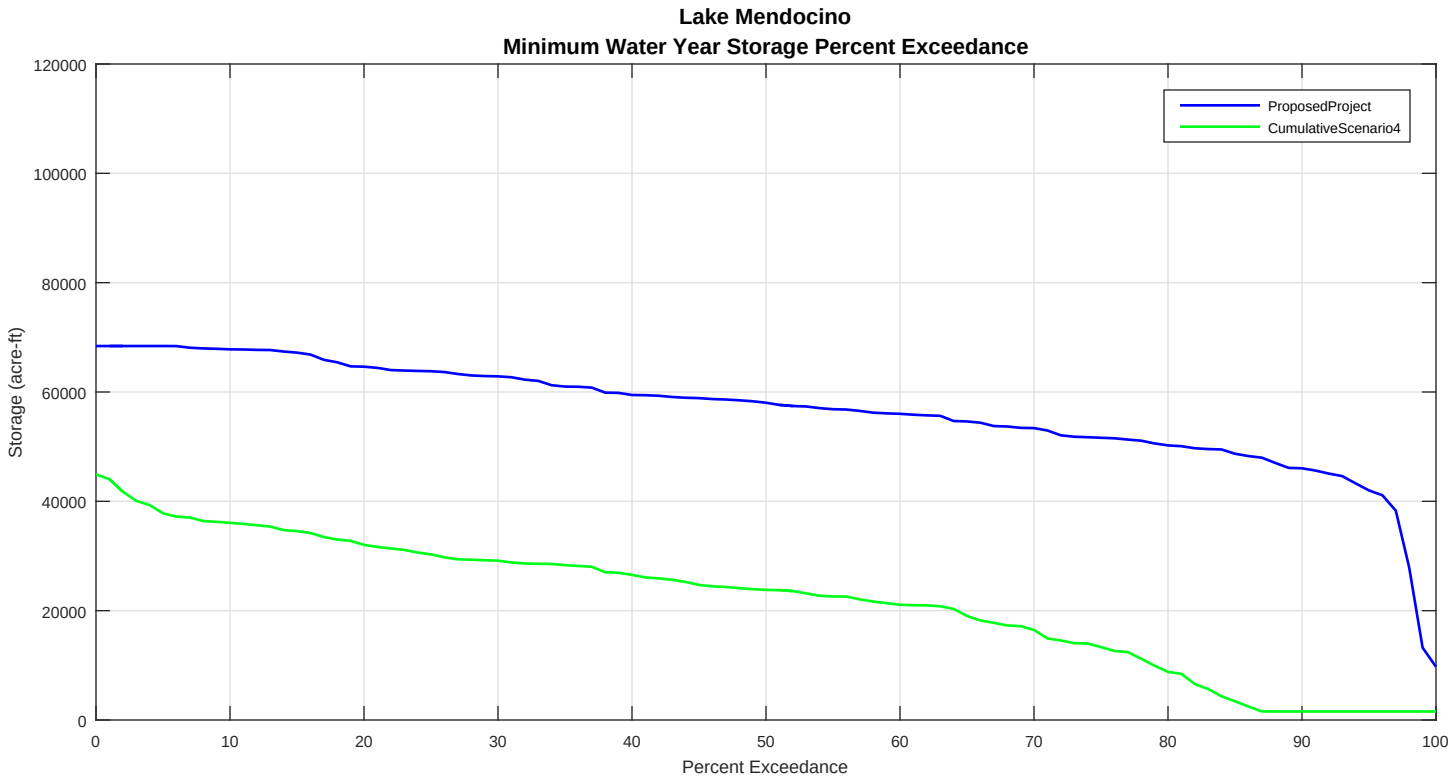

Dry Creek at Geyserville Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

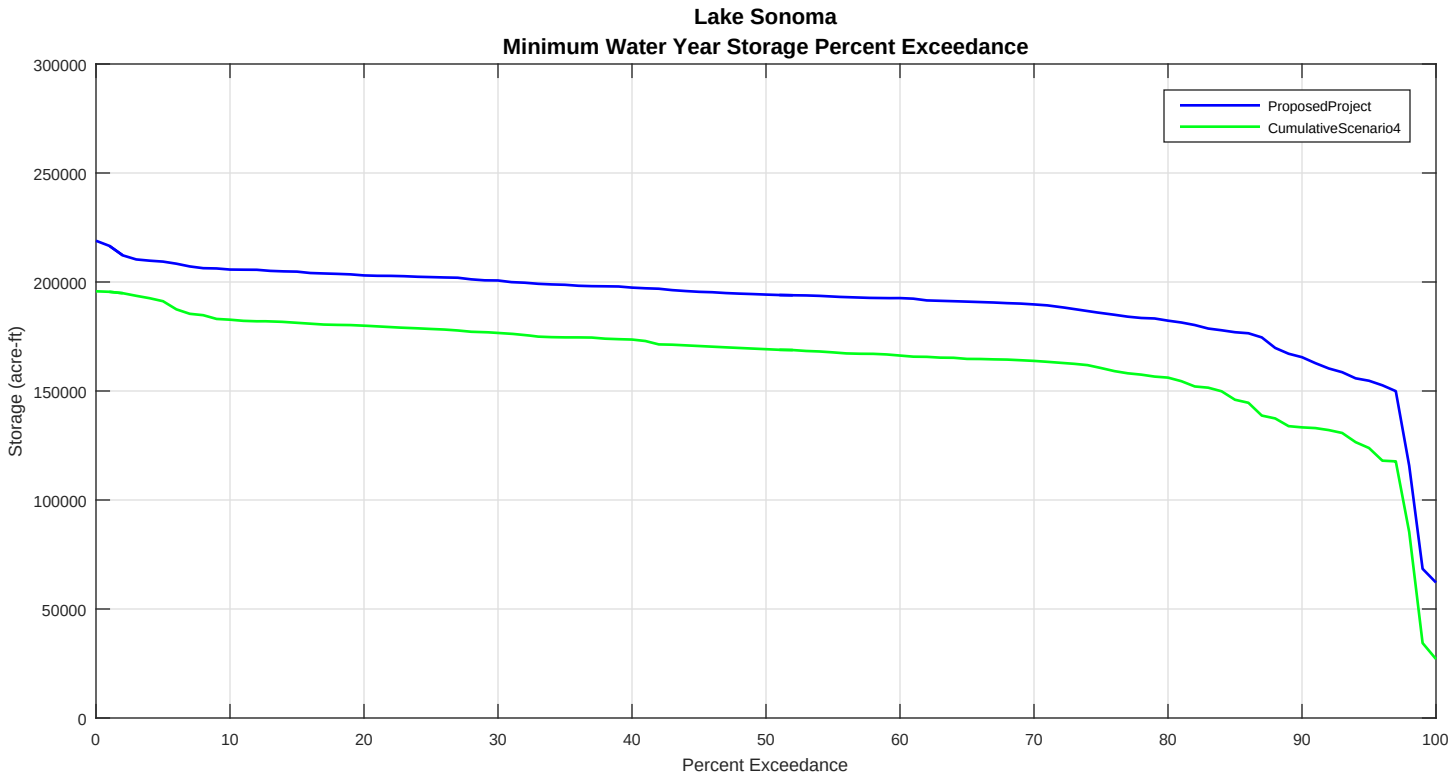

Dry Creek at Lambert Bridge
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

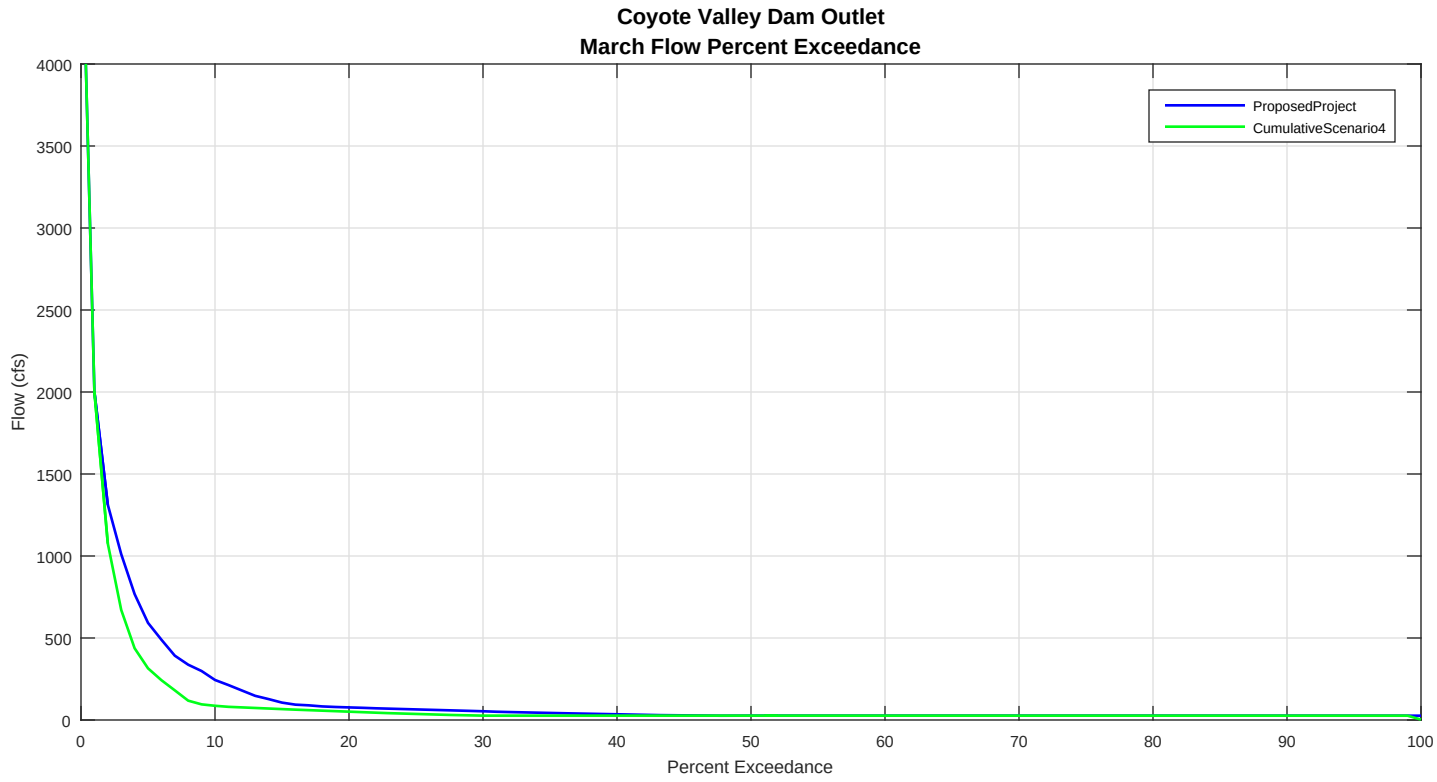

Dry Creek Mouth Gage
Daily Average Dissolved Oxygen
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
14
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Date

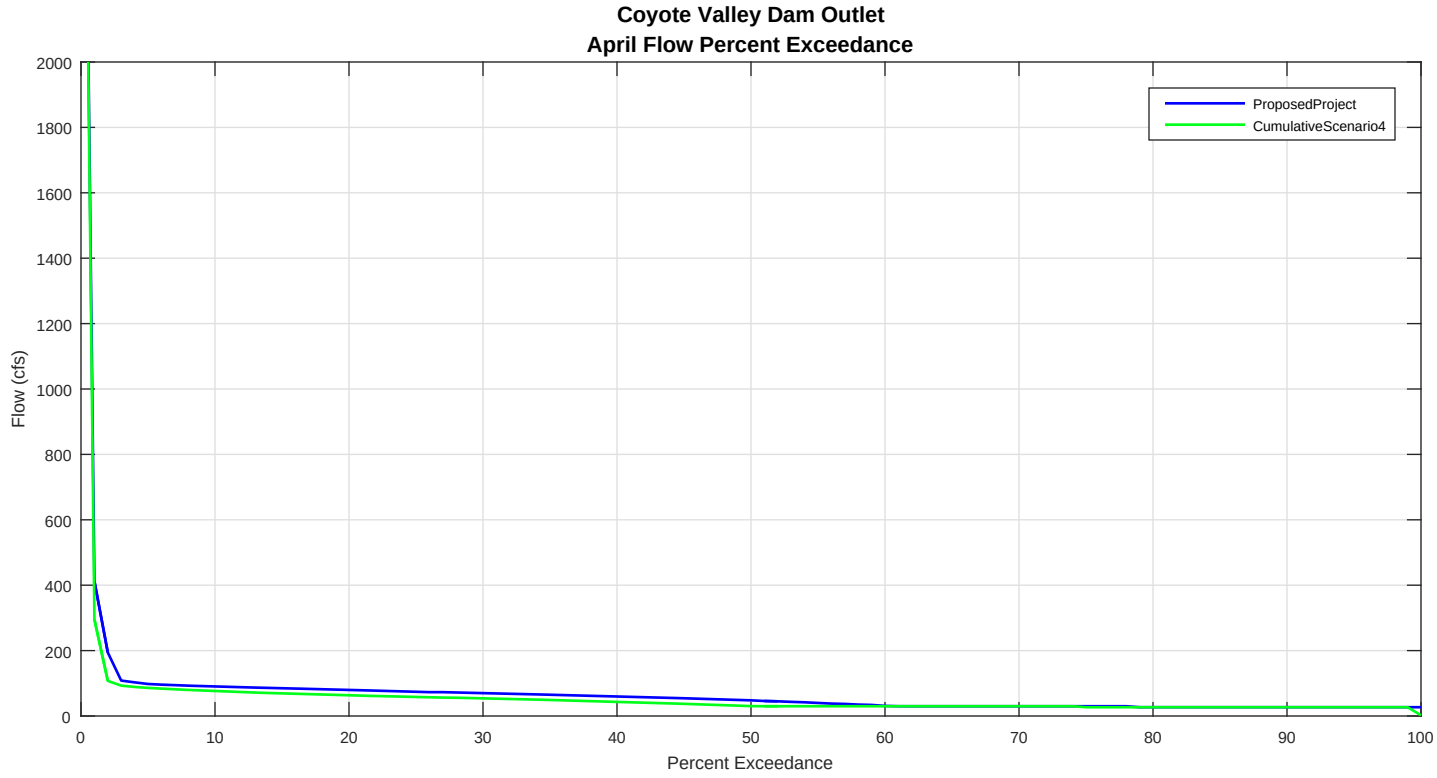

Lake Mendocino
Storage Percent Exceedance
Storage (acre-ft)
Percent Exceedance
ProposedProject
CumulativeScenario4
0
20000
40000
60000
80000
100000
120000
0
10
20
30
40
50
60
70
80
90
100

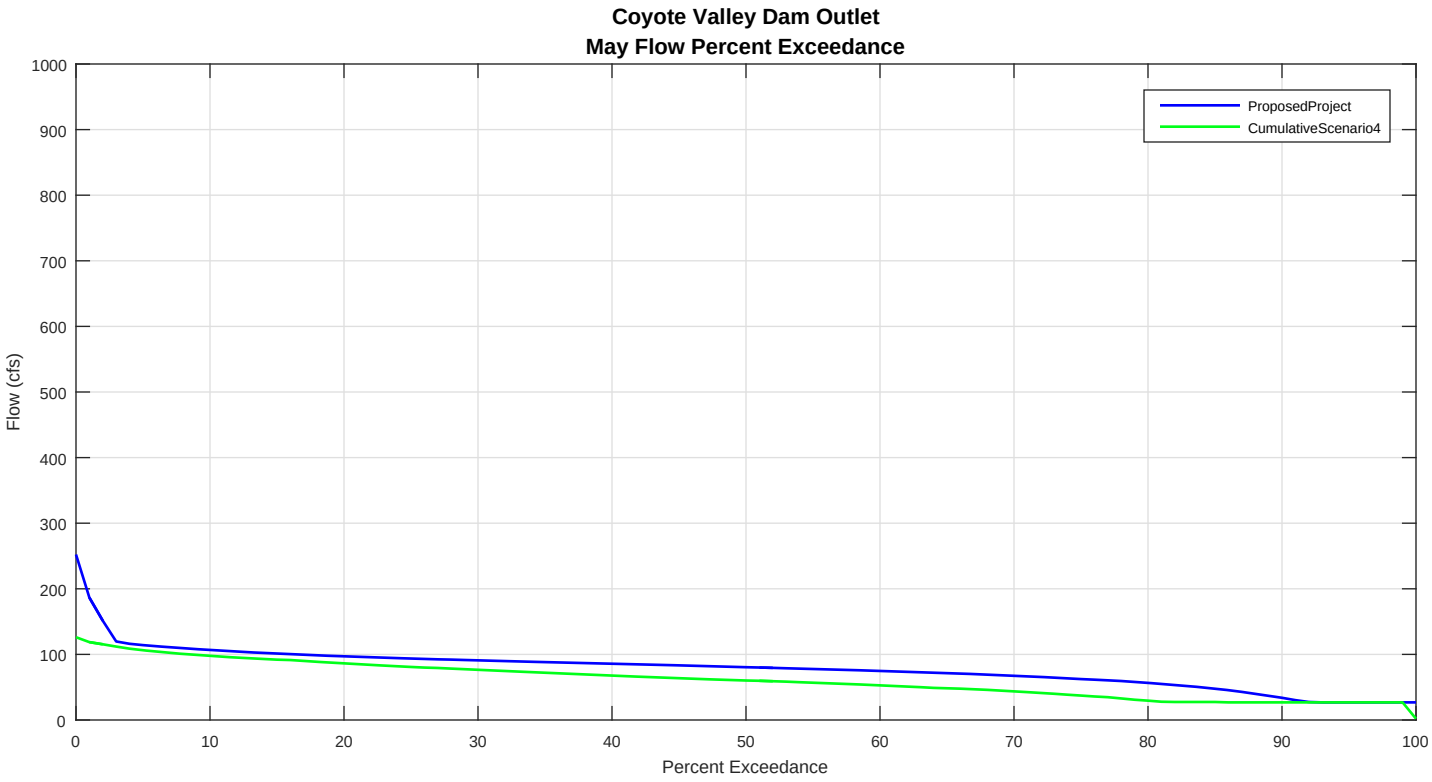

Lake Sonoma
Storage Percent Exceedance
Storage (acre-ft)
Percent Exceedance
ProposedProject
CumulativeScenario4
0
50000
100000
150000
200000
250000
300000
0
10
20
30
40
50
60
70
80
90
100

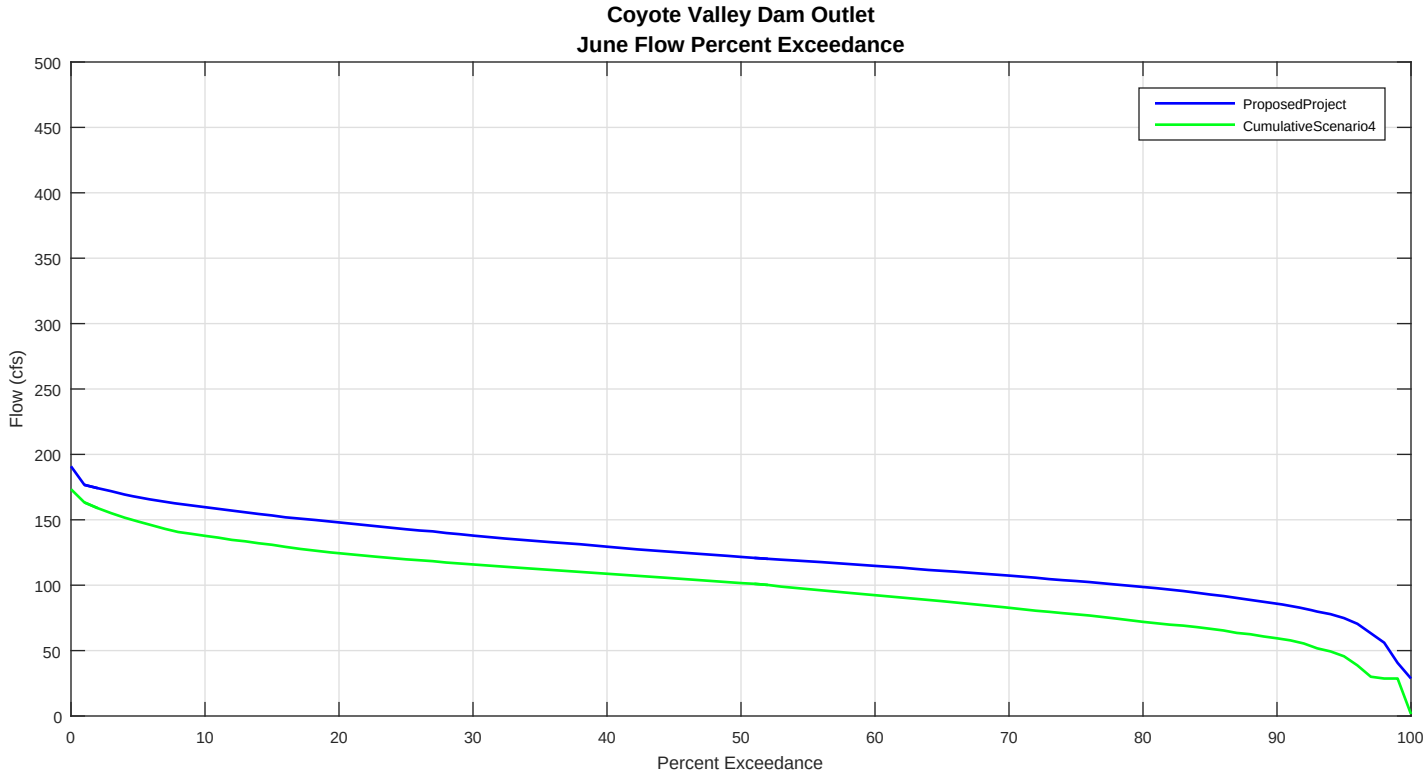

Lake Mendocino
Minimum Water Year Storage Percent Exceedance
ProposedProject
CumulativeScenario4
Storage (acre-ft)
Percent Exceedance
0
20000
40000
60000
80000
100000
120000
0
10
20
30
40
50
60
70
80
90
100

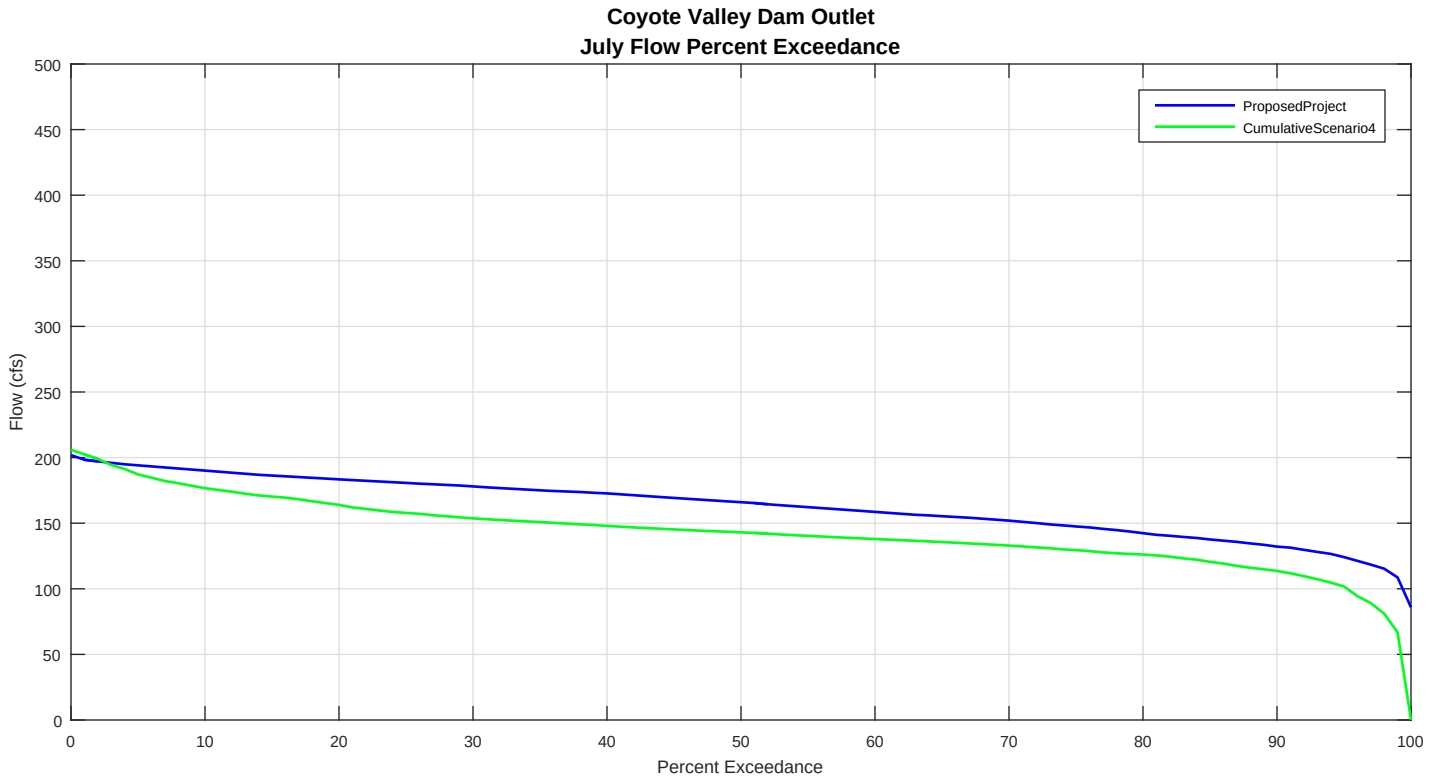

Lake Sonoma
Minimum Water Year Storage Percent Exceedance
ProposedProject
CumulativeScenario4
Storage (acre-ft)
Percent Exceedance
0
50000
100000
150000
200000
250000
300000
0
10
20
30
40
50
60
70
80
90
100

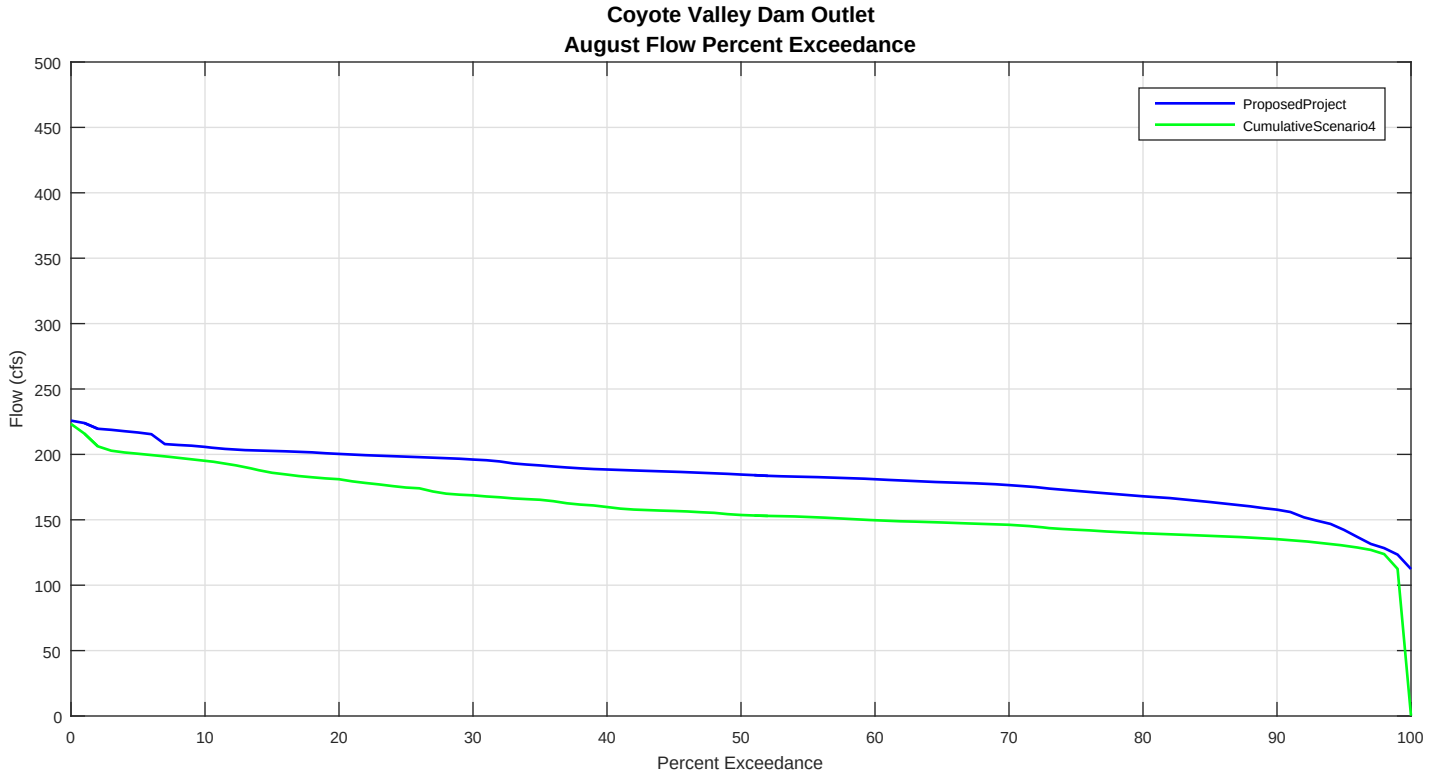

Coyote Valley Dam Outlet
March Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
0
500
1000
1500
2000
2500
3000
3500
4000
0
10
20
30
40
50
60
70
80
90
100

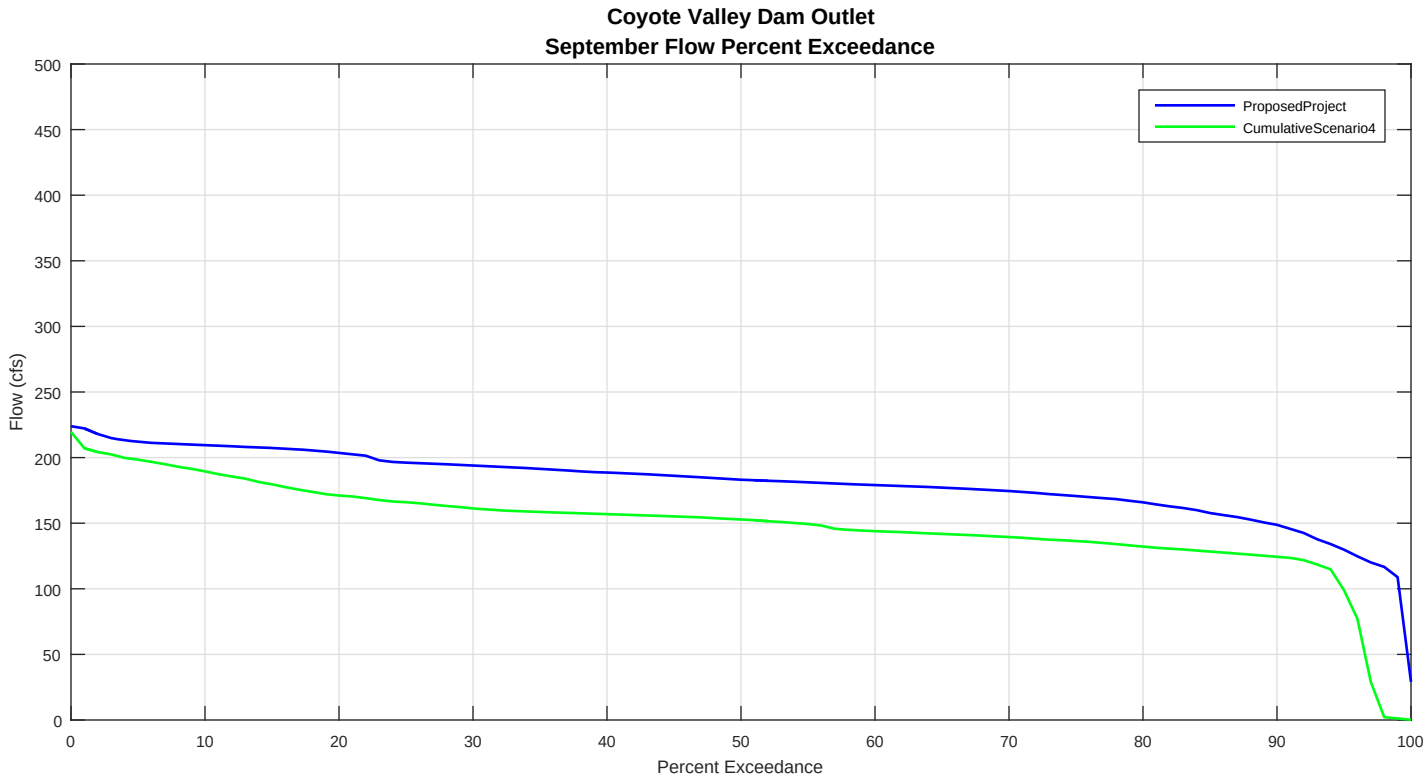

Coyote Valley Dam Outlet
April Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100

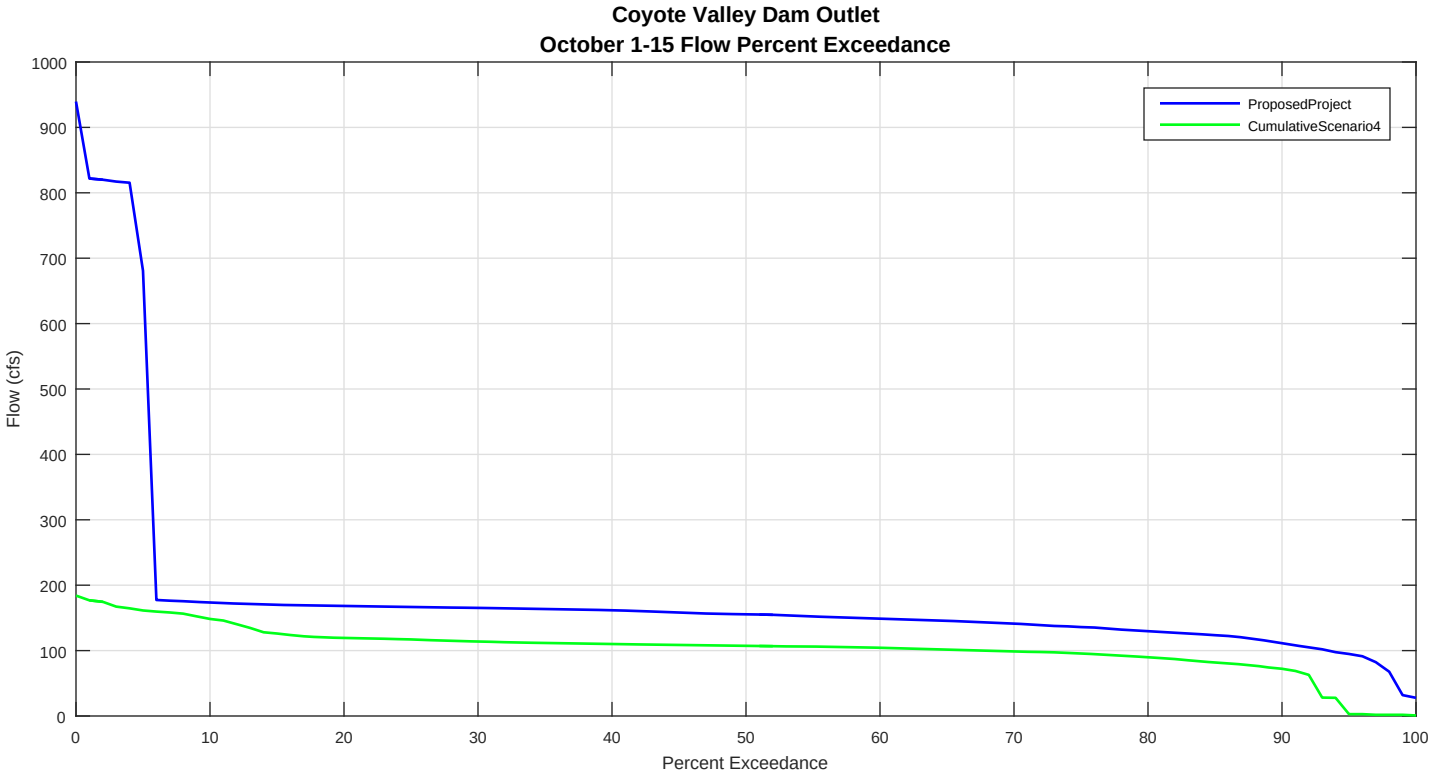

Coyote Valley Dam Outlet
May Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
June Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
July Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
August Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
September Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam Outlet
October 1-15 Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
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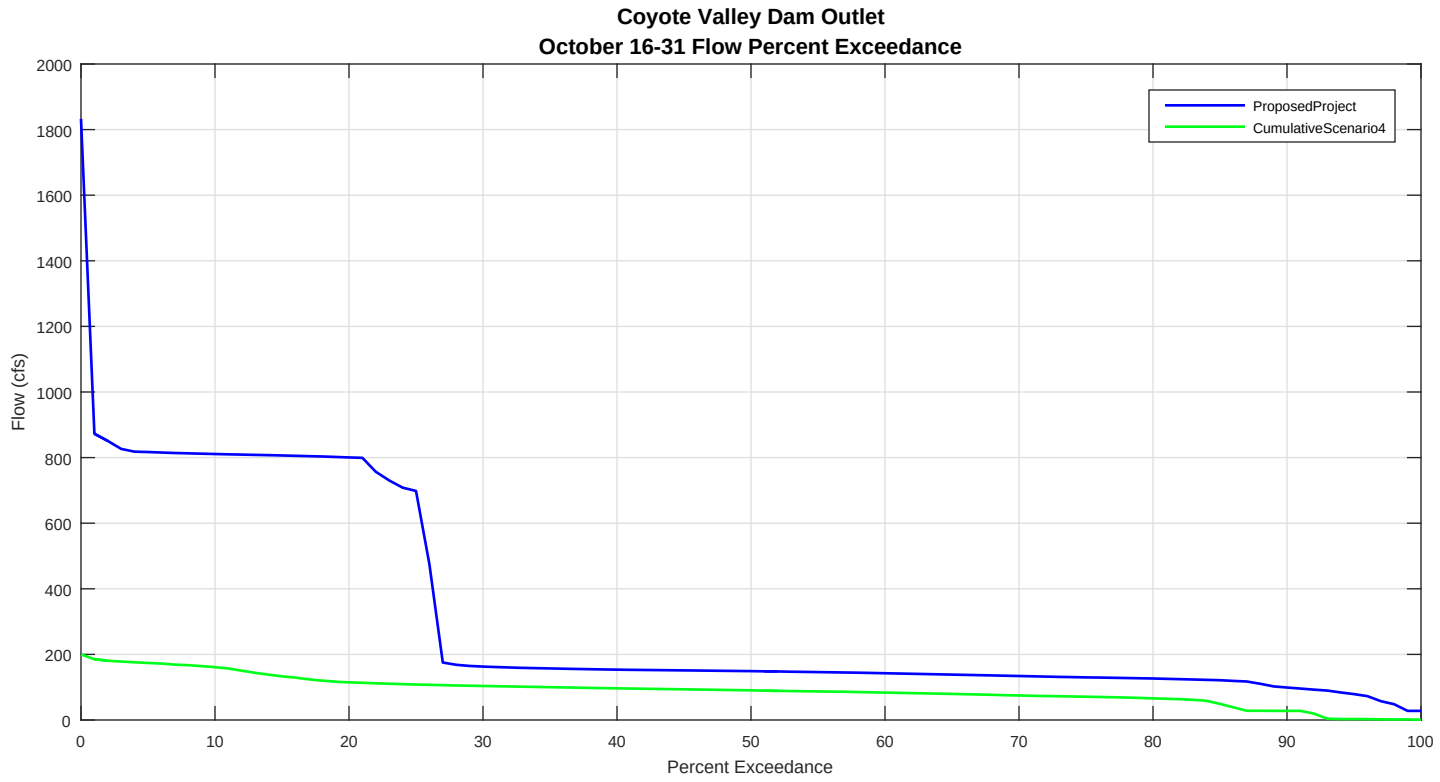
Coyote Valley Dam Outlet
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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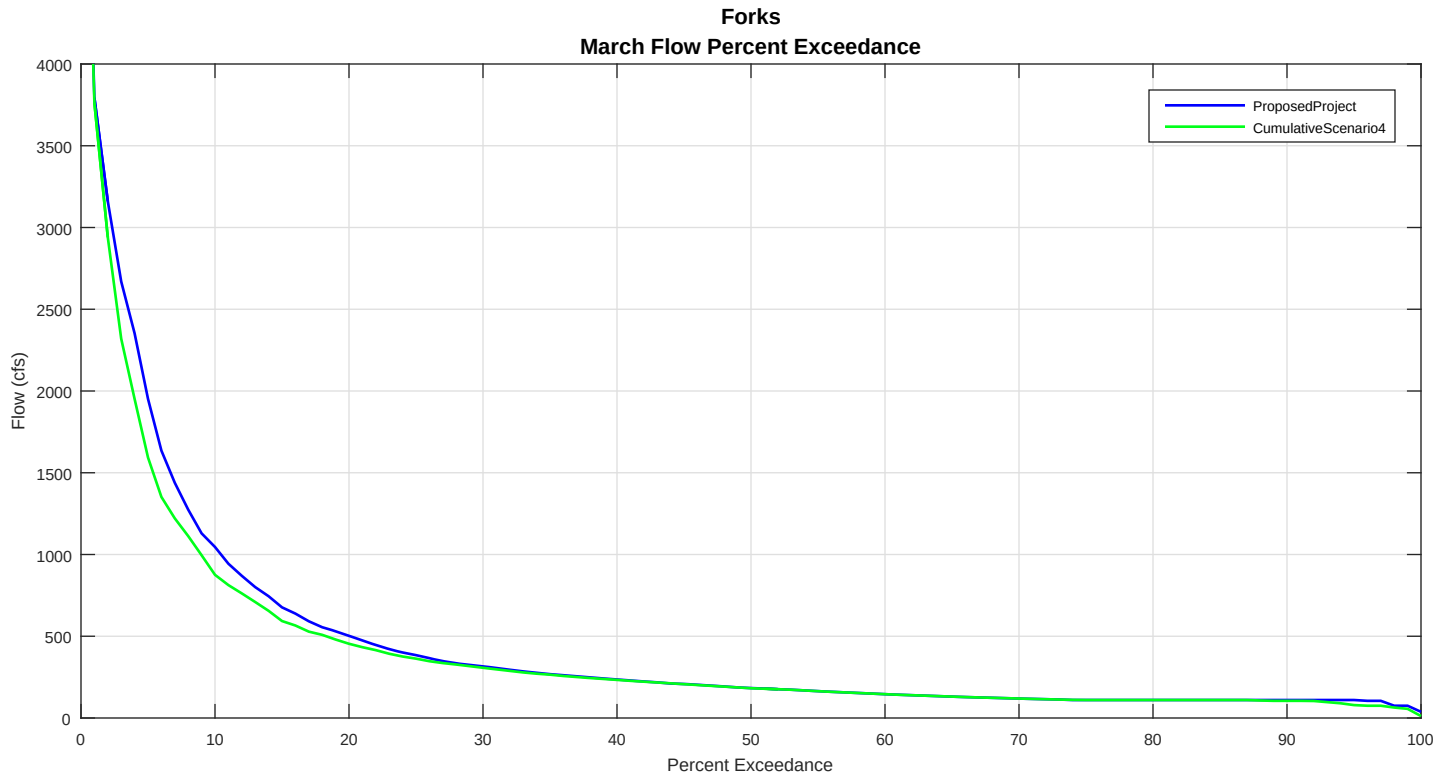
Forks
March Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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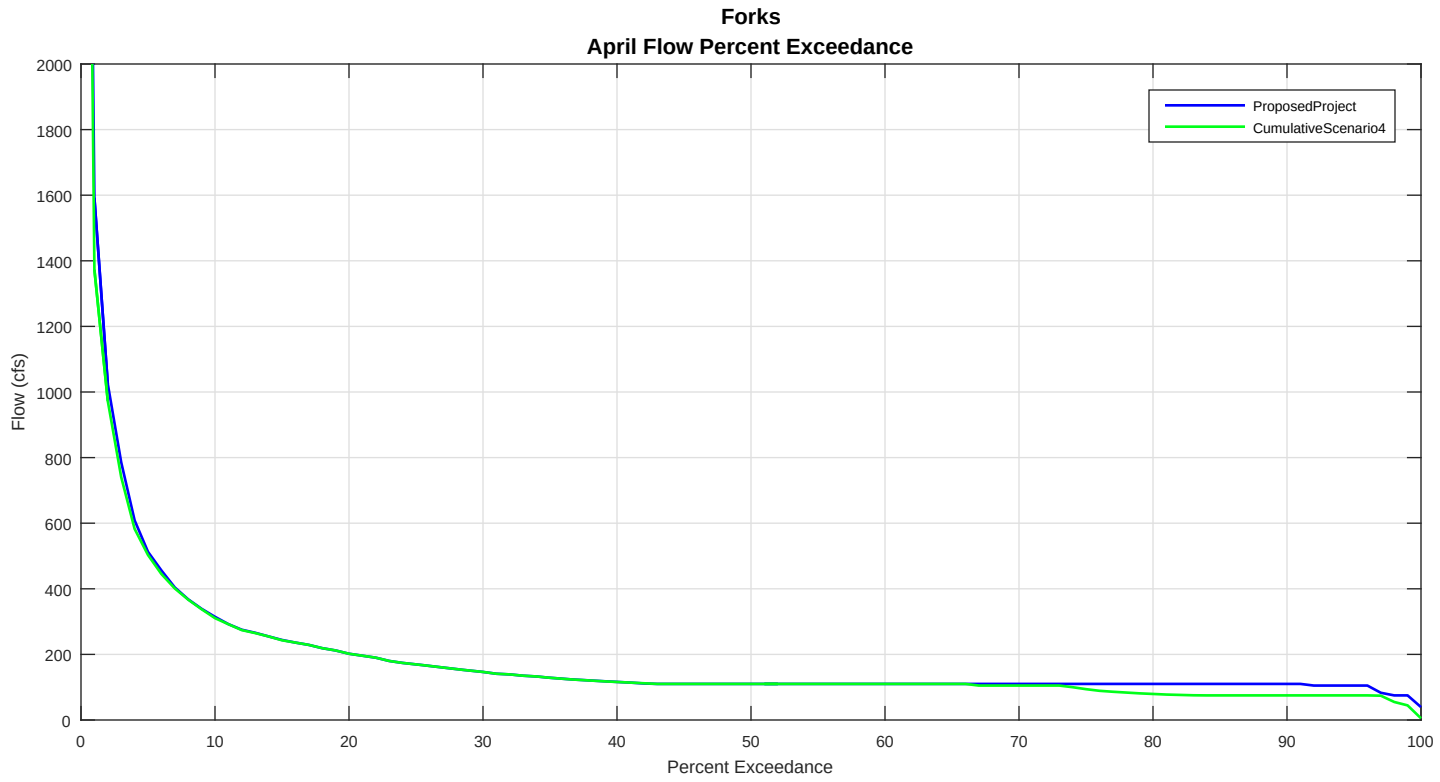
Forks
April Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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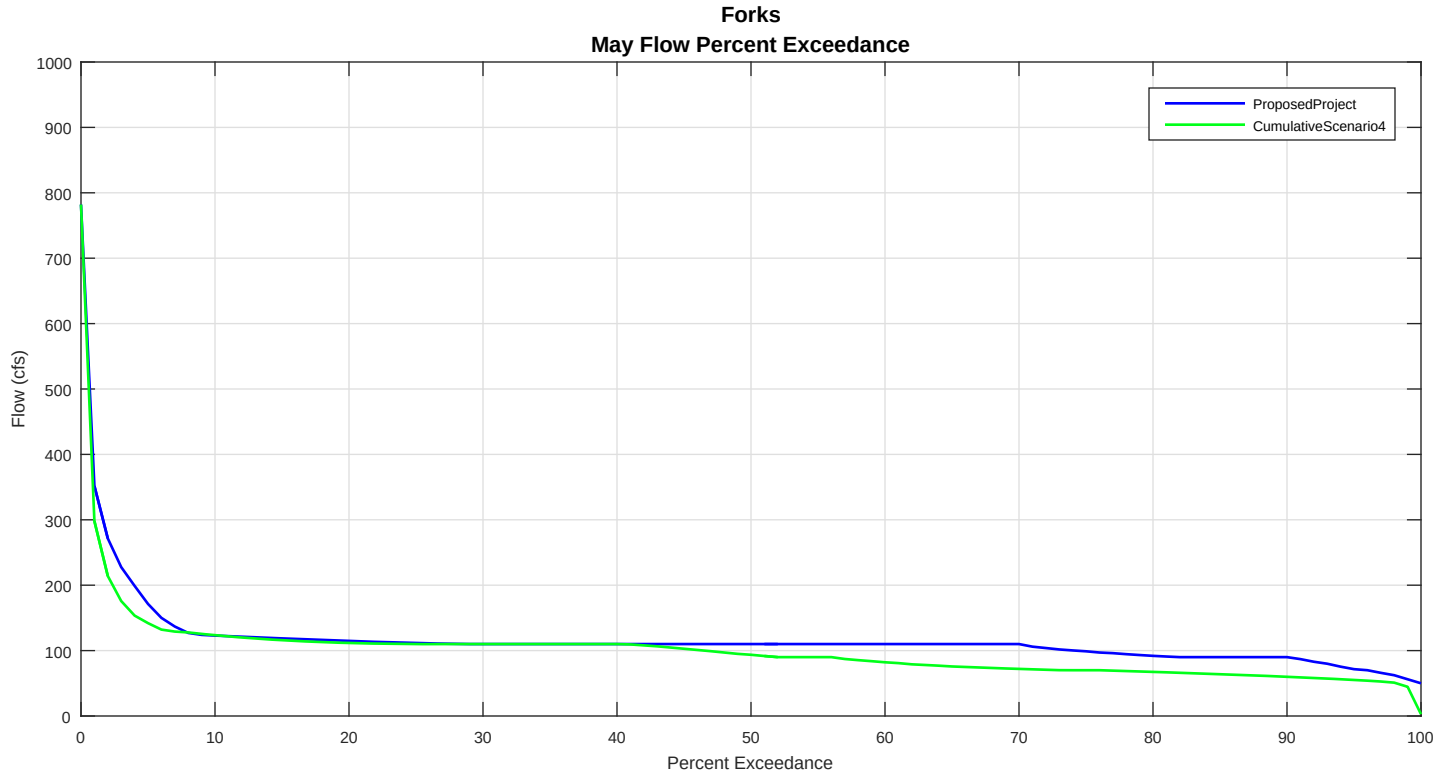
Forks
May Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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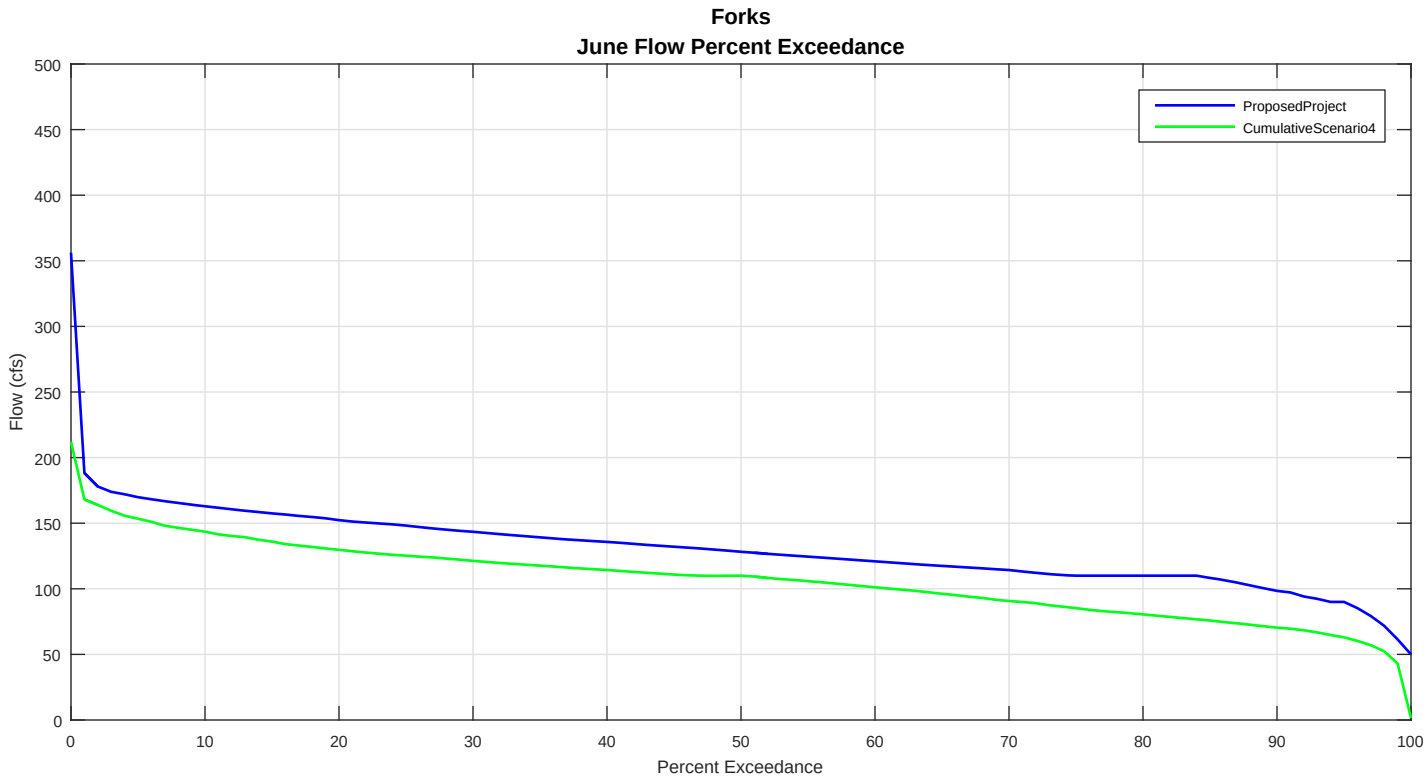
Forks
June Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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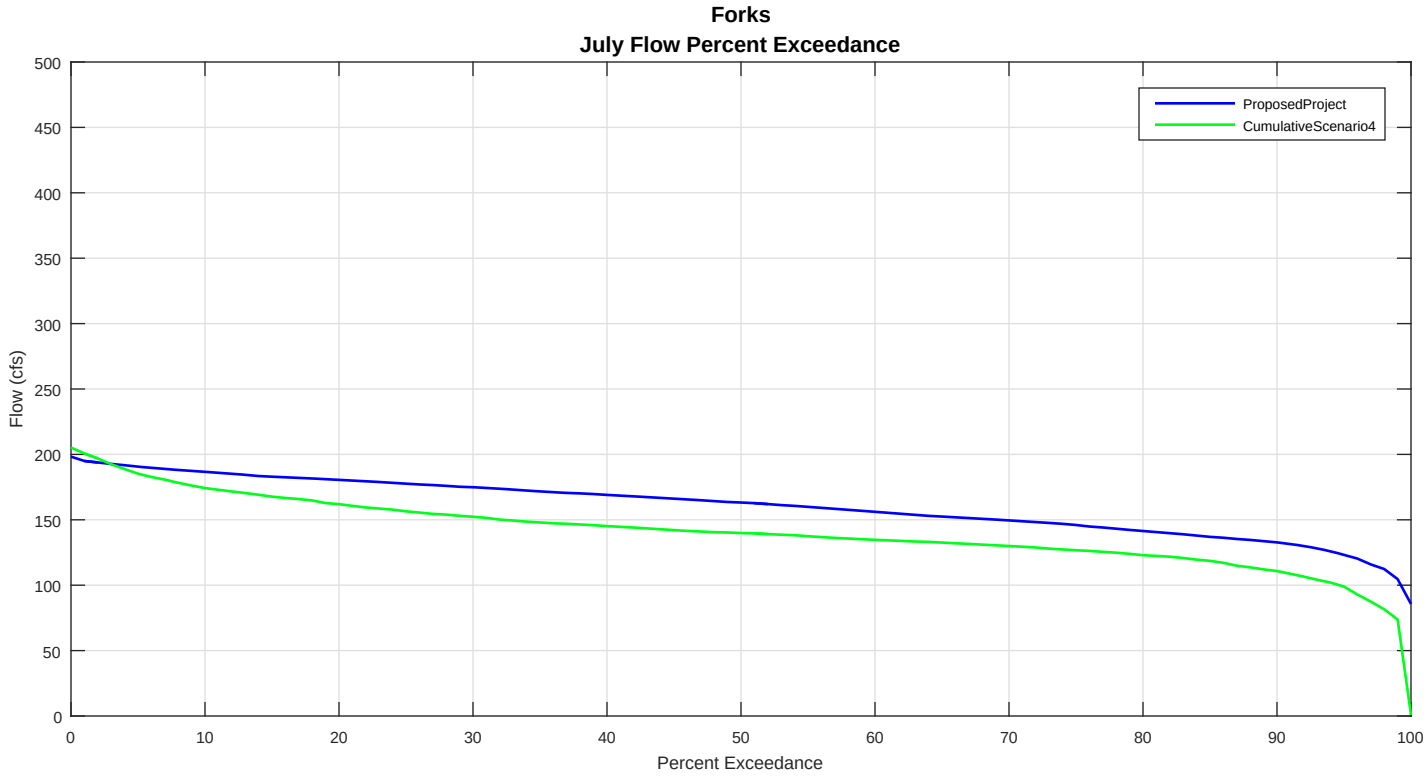
Forks
July Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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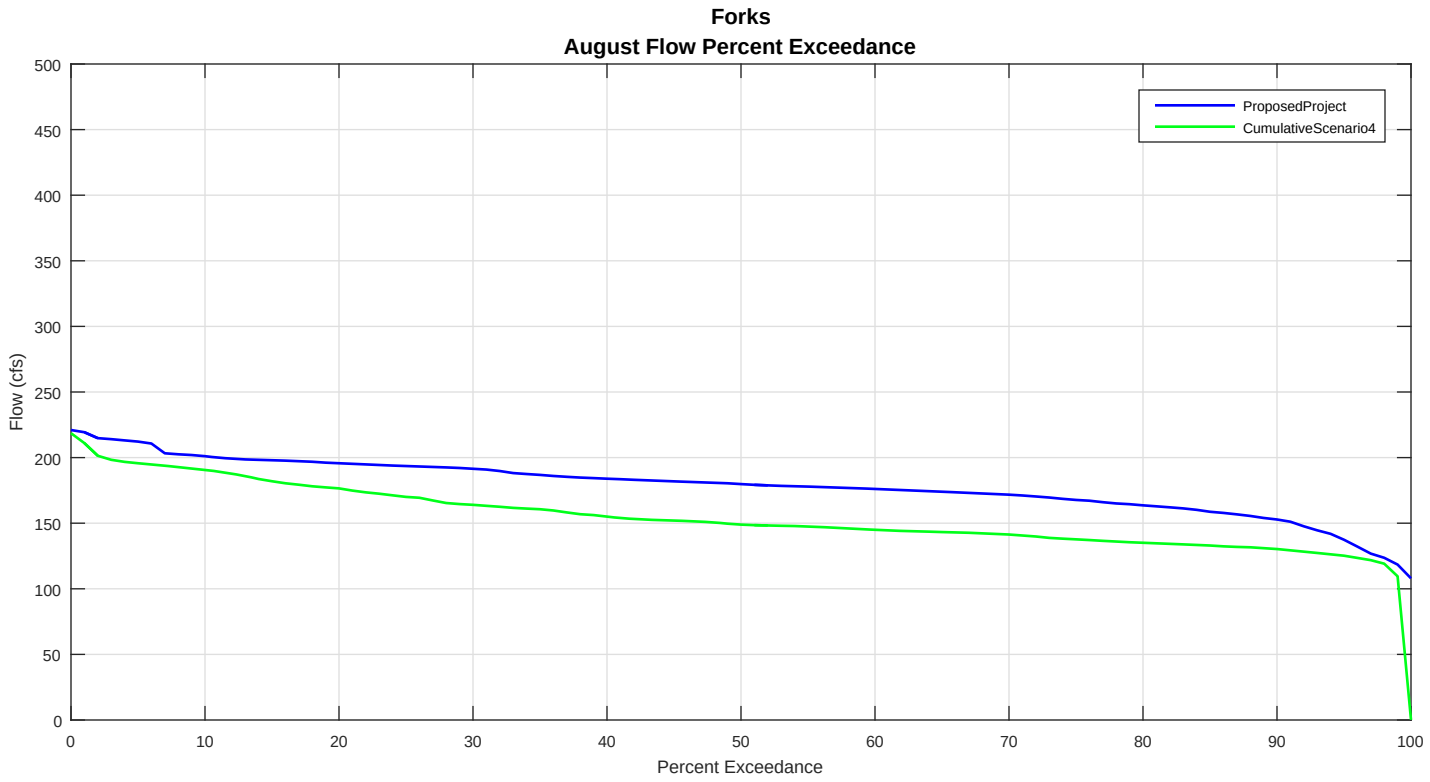
Forks
August Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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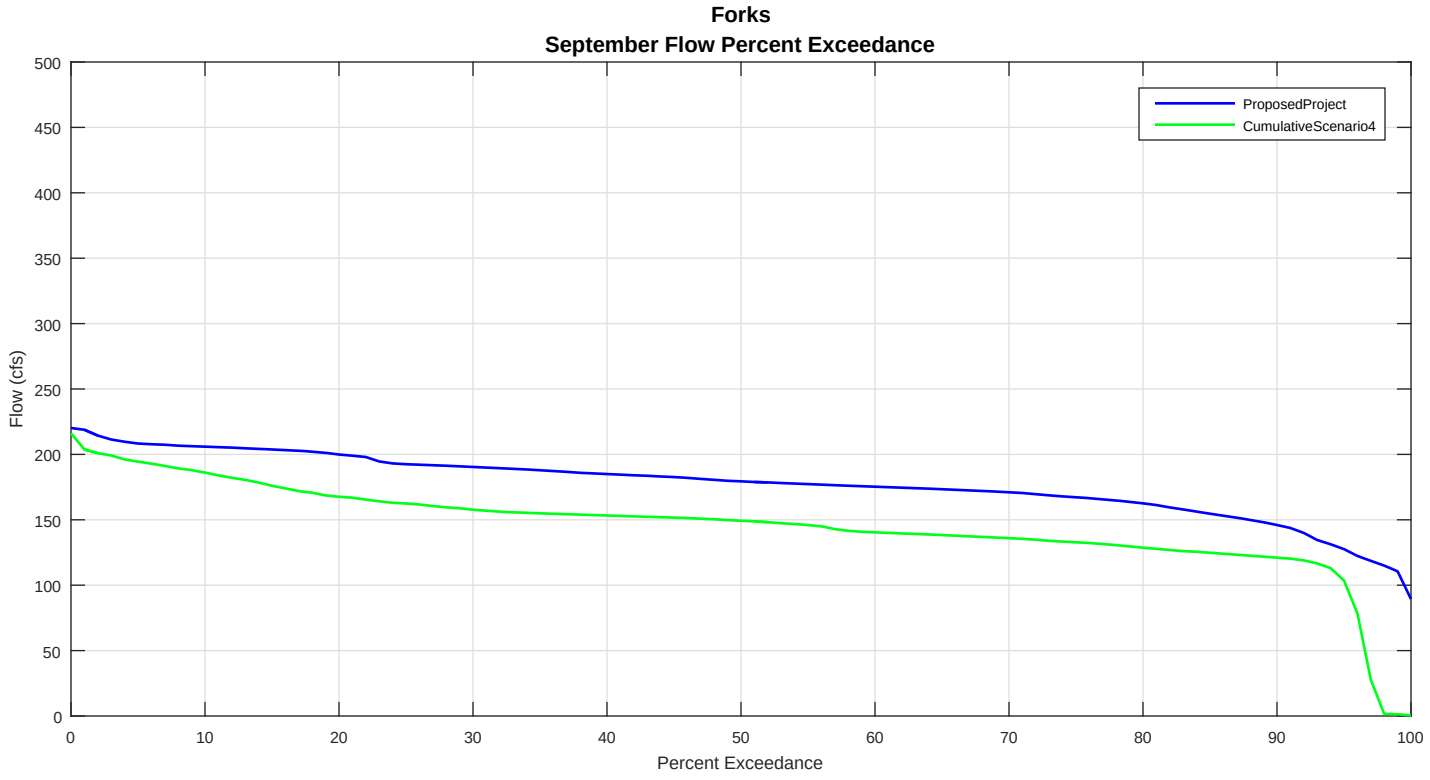
Forks
September Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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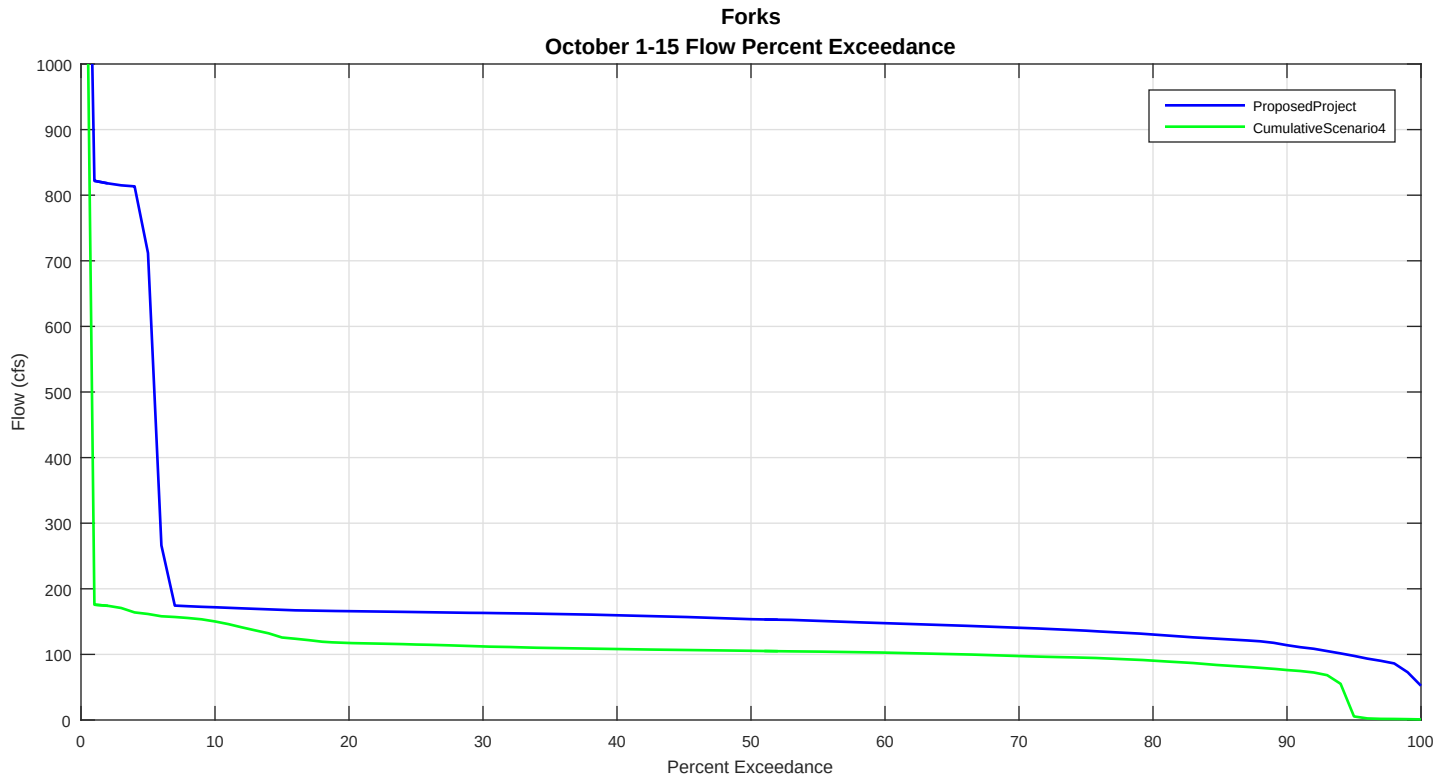
Forks
October 1-15 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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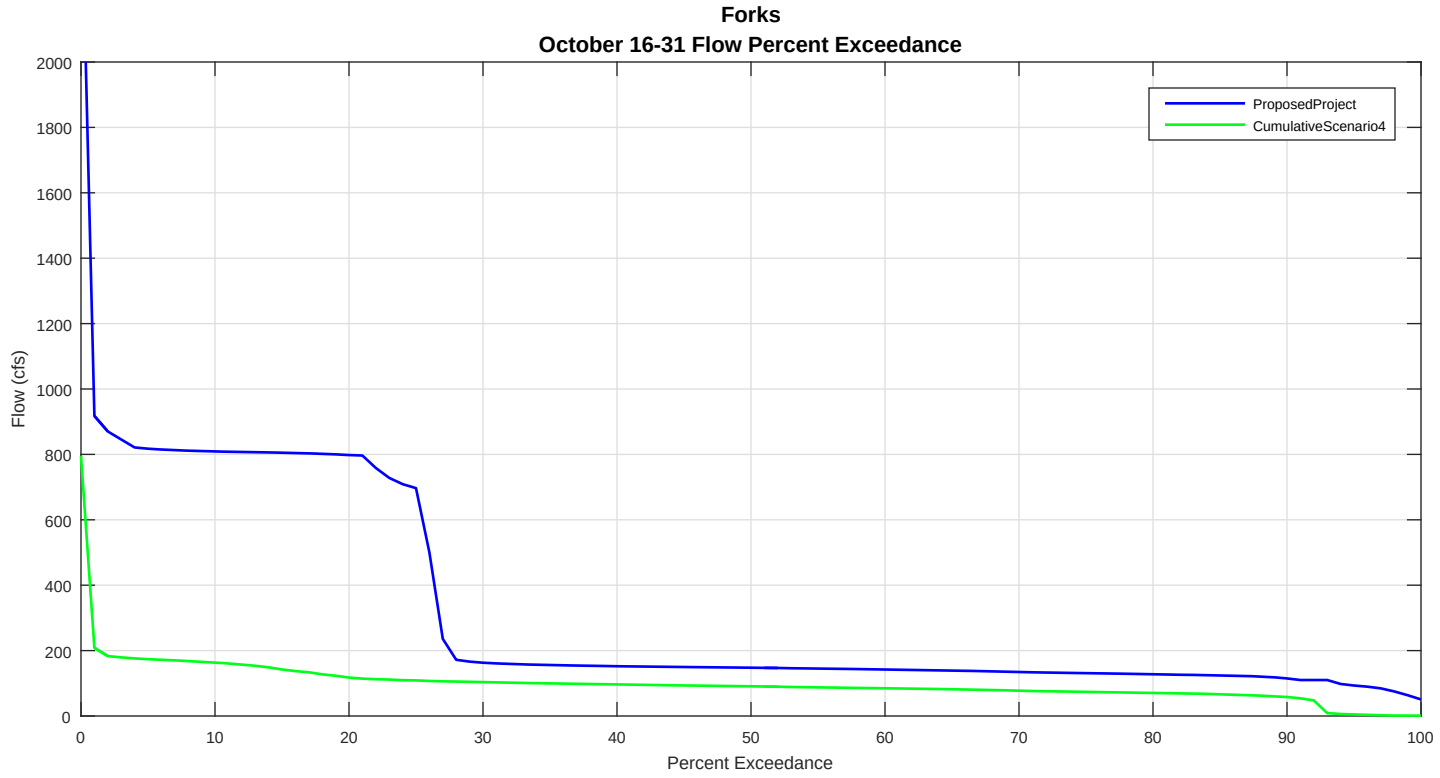
Forks
October 16-31 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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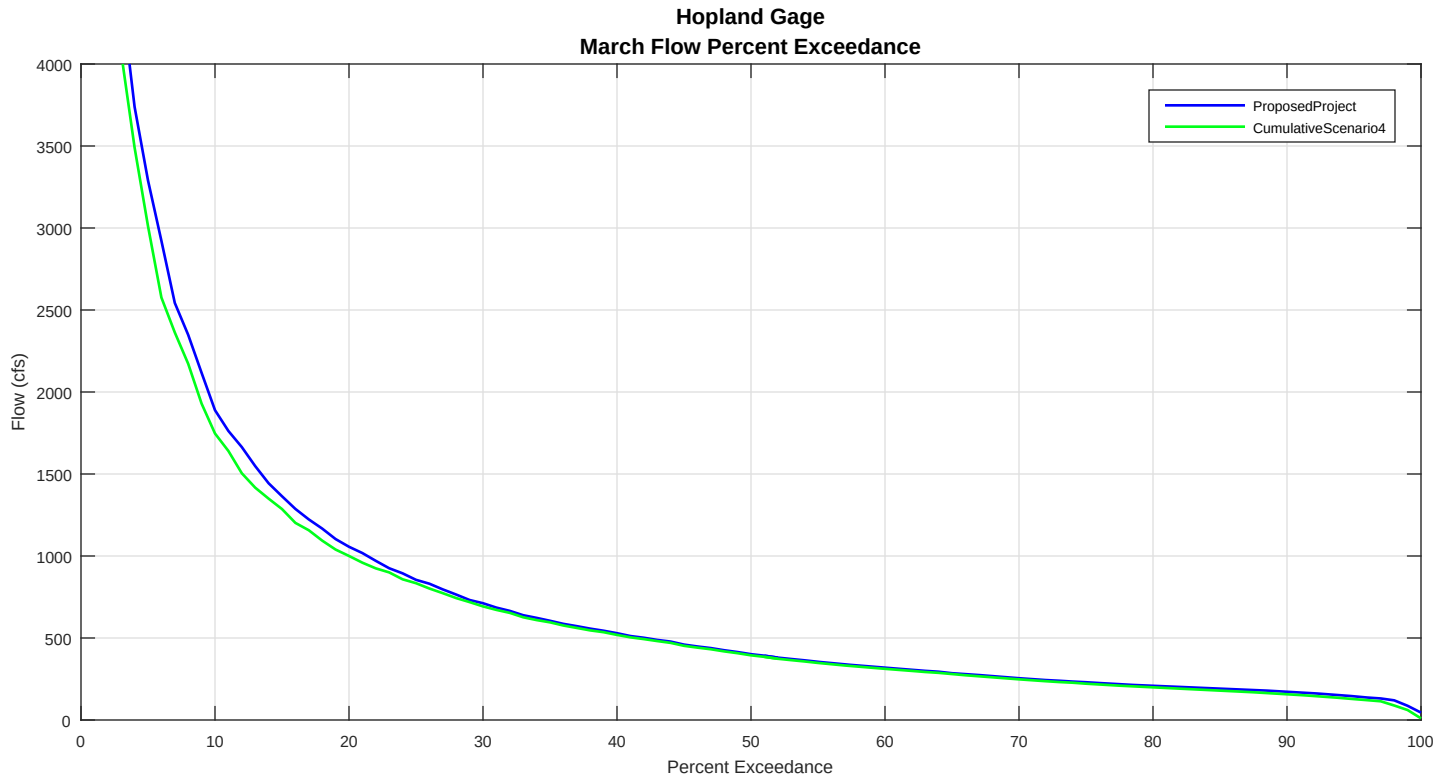
Hopland Gage
March Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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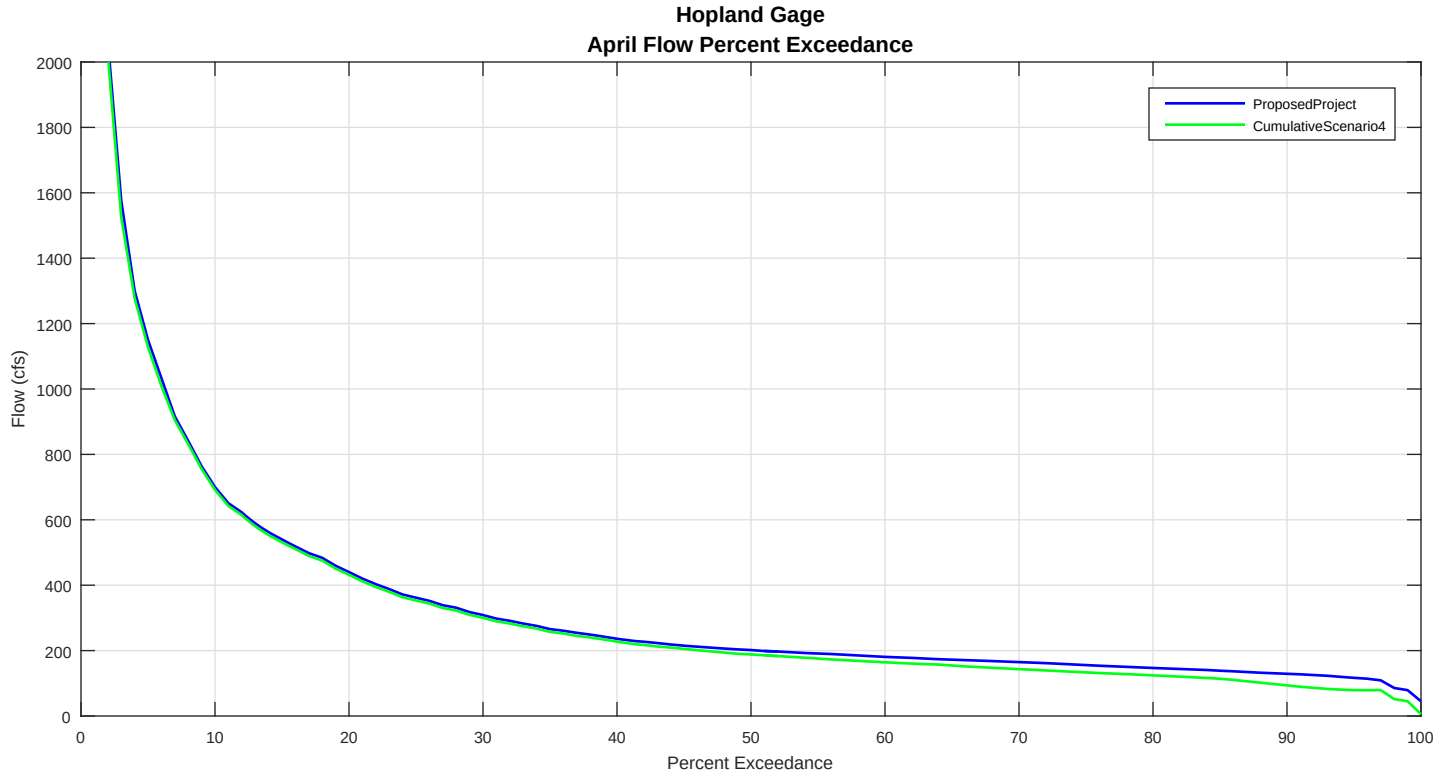
Hopland Gage
April Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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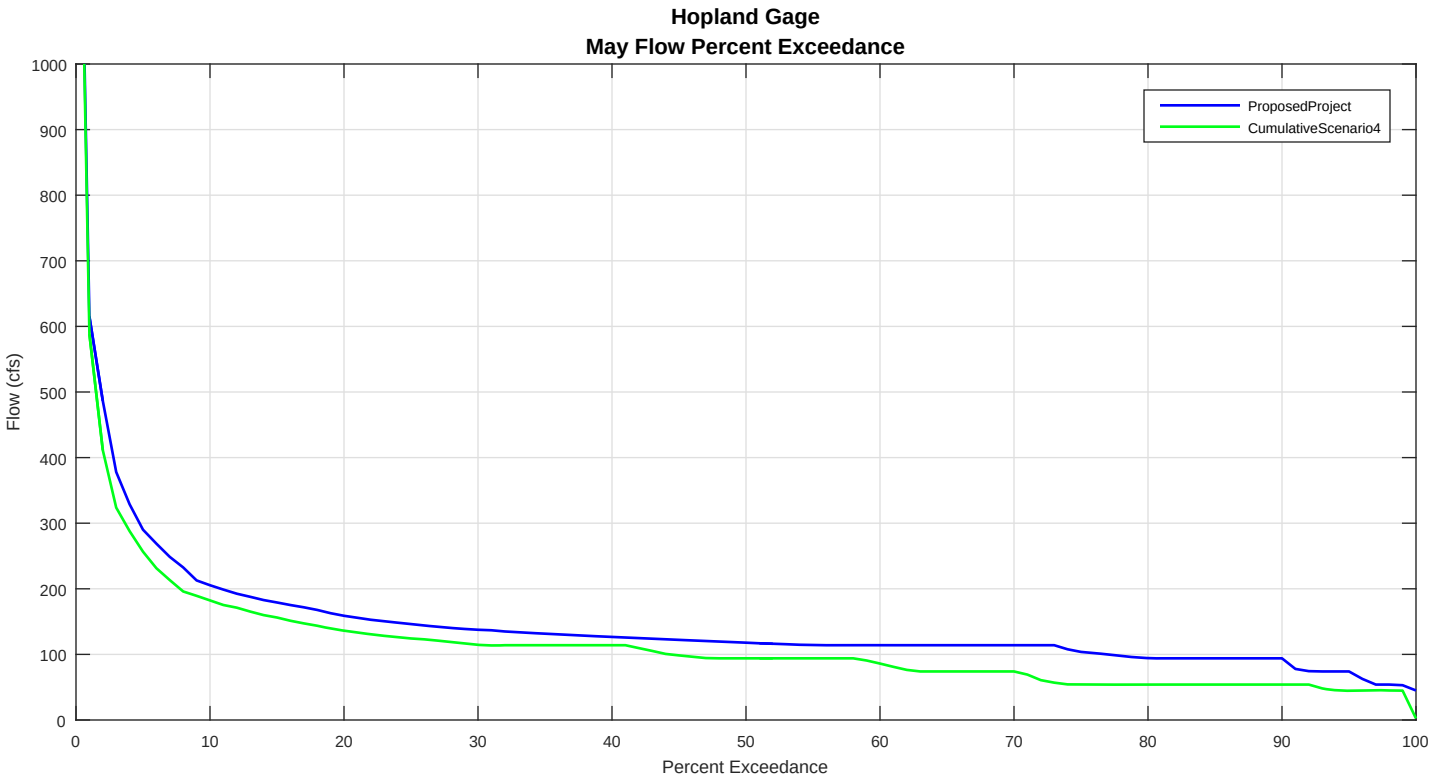
Hopland Gage
May Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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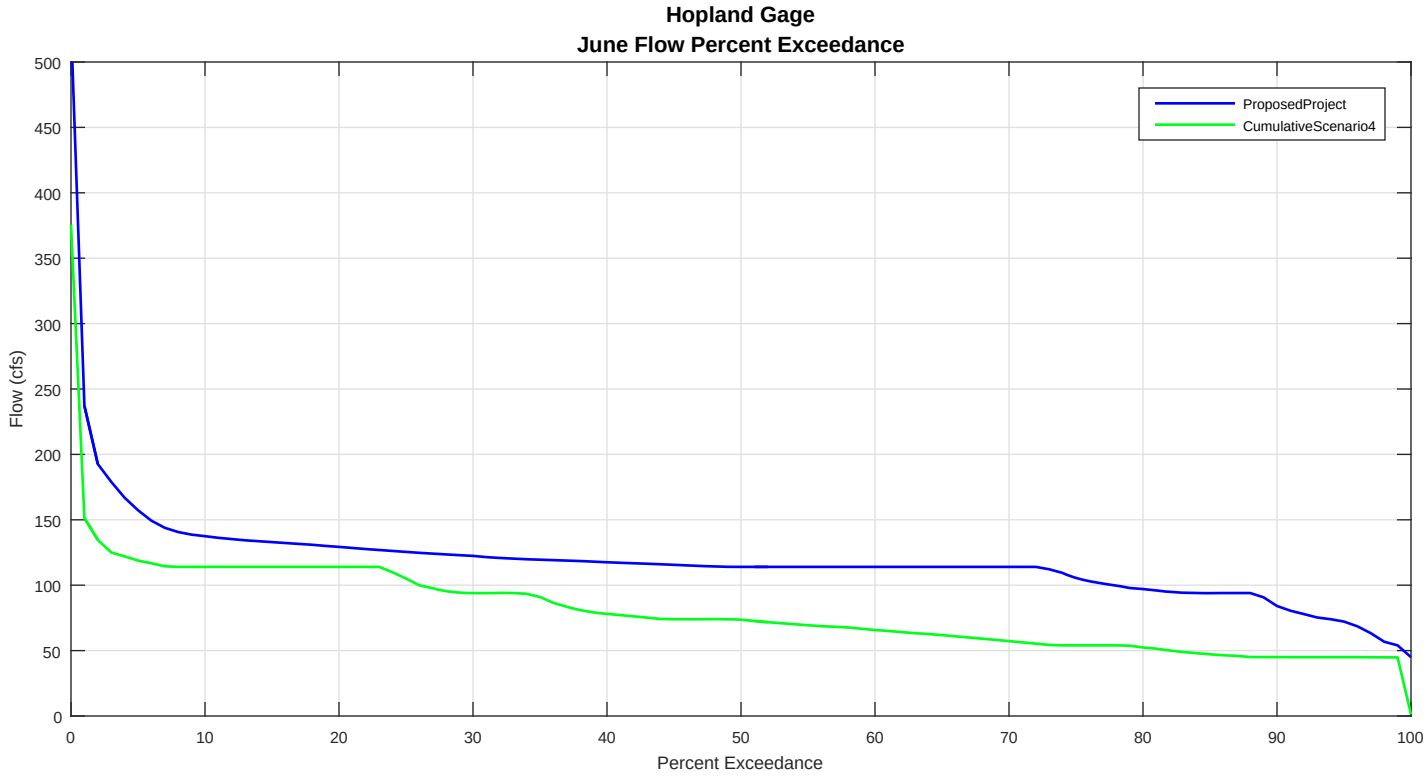
Hopland Gage
June Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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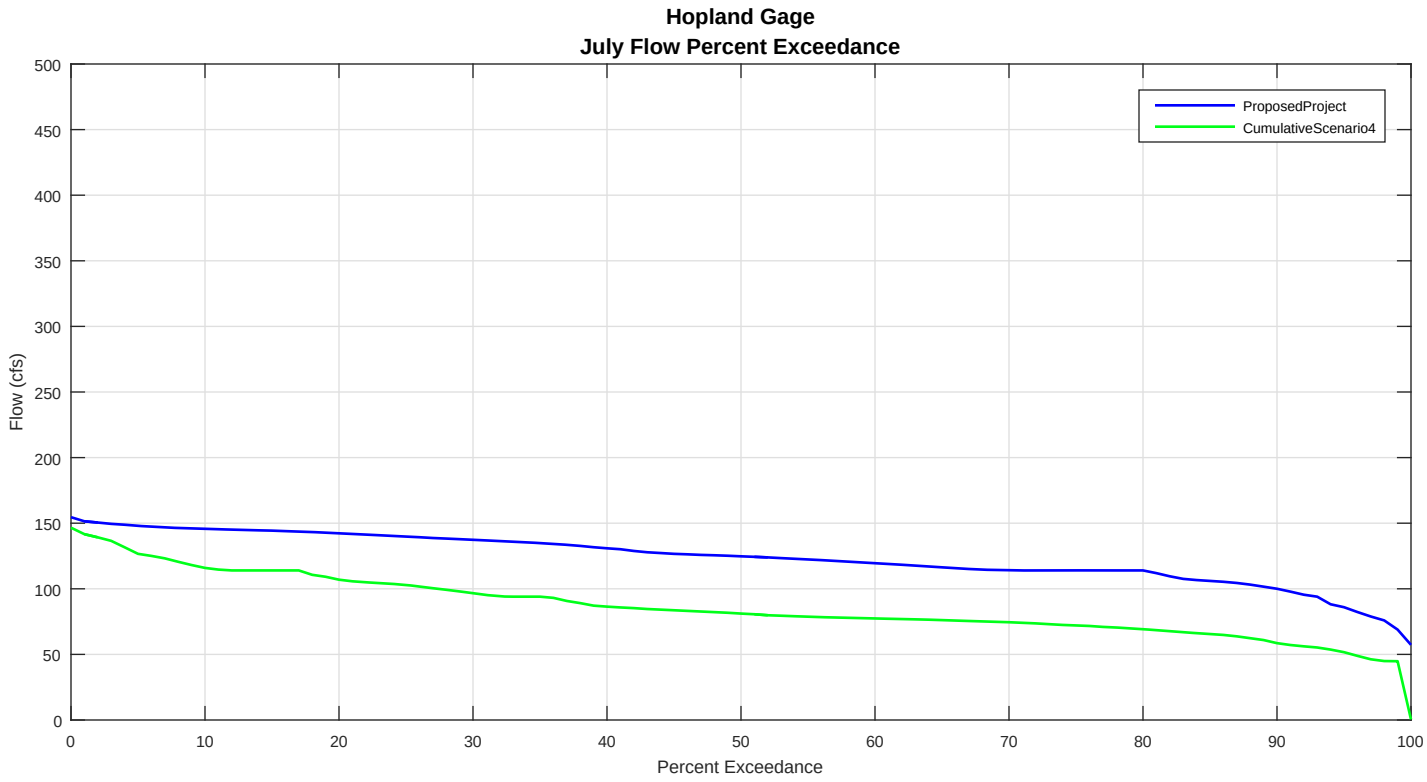
Hopland Gage
July Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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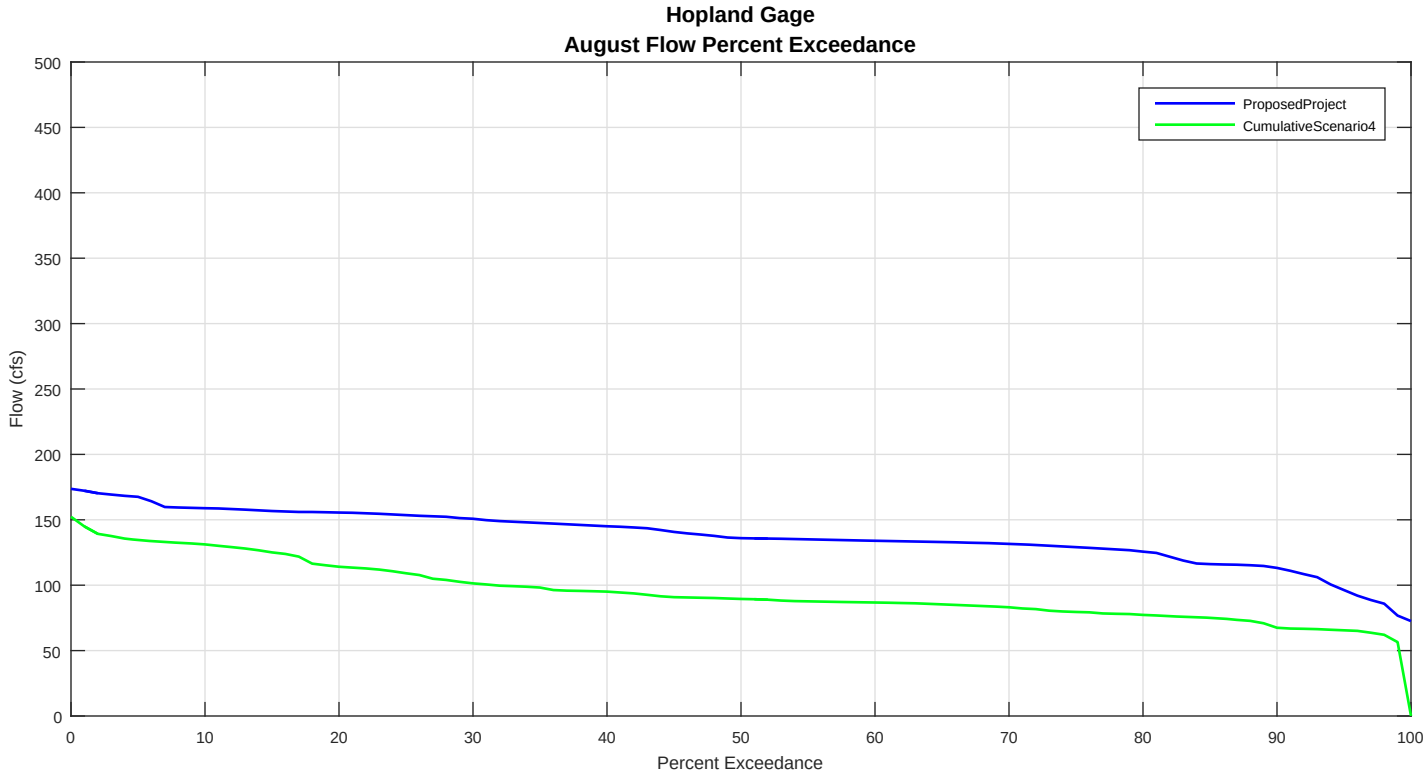
Hopland Gage
August Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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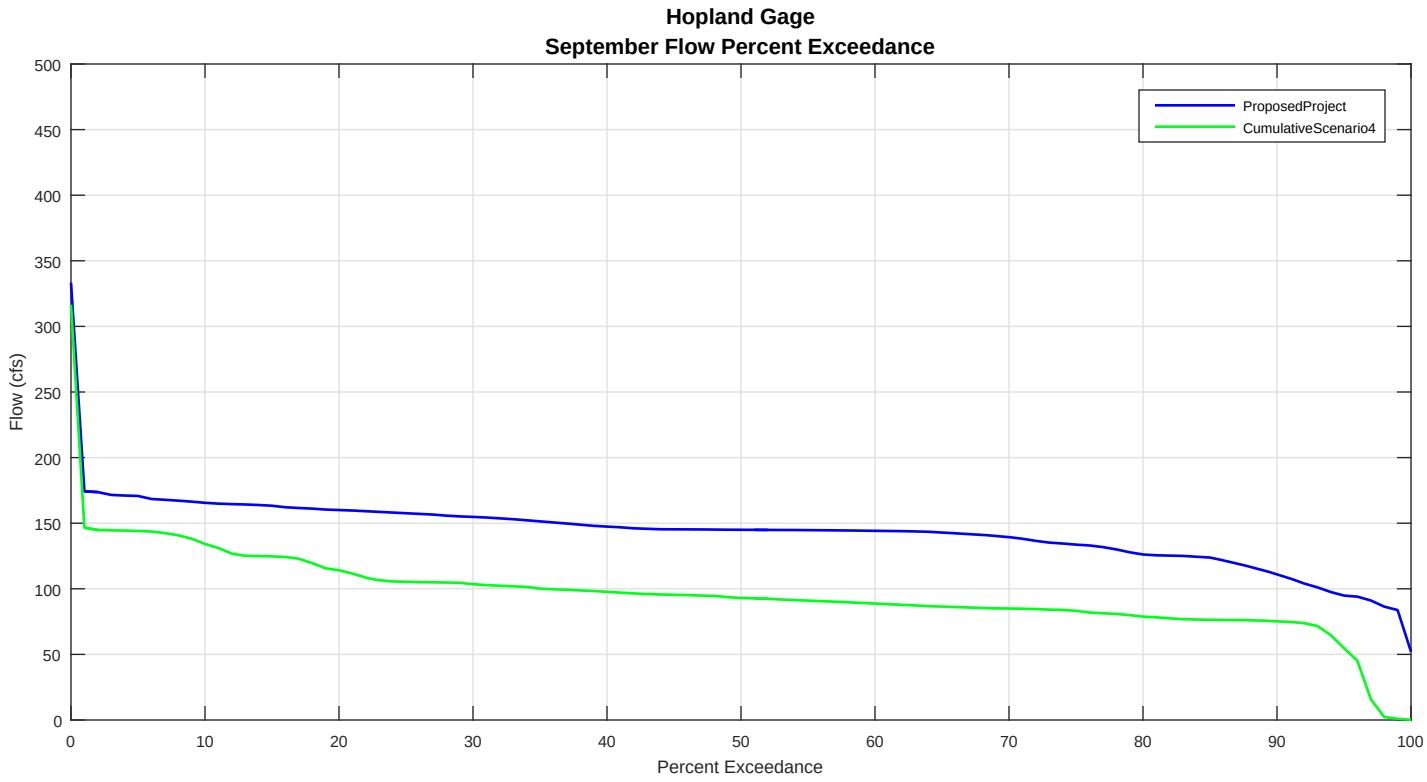
Hopland Gage
September Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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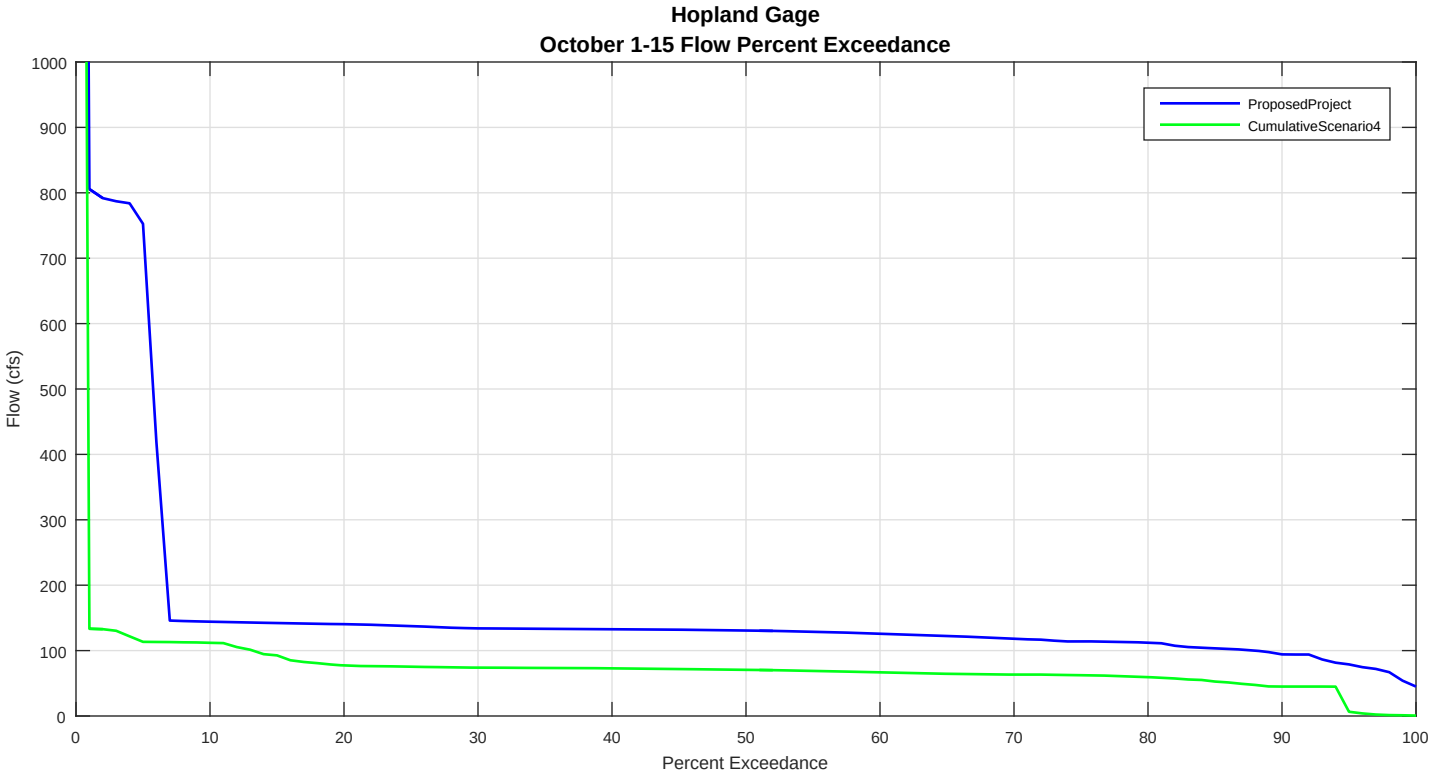
Hopland Gage
October 1-15 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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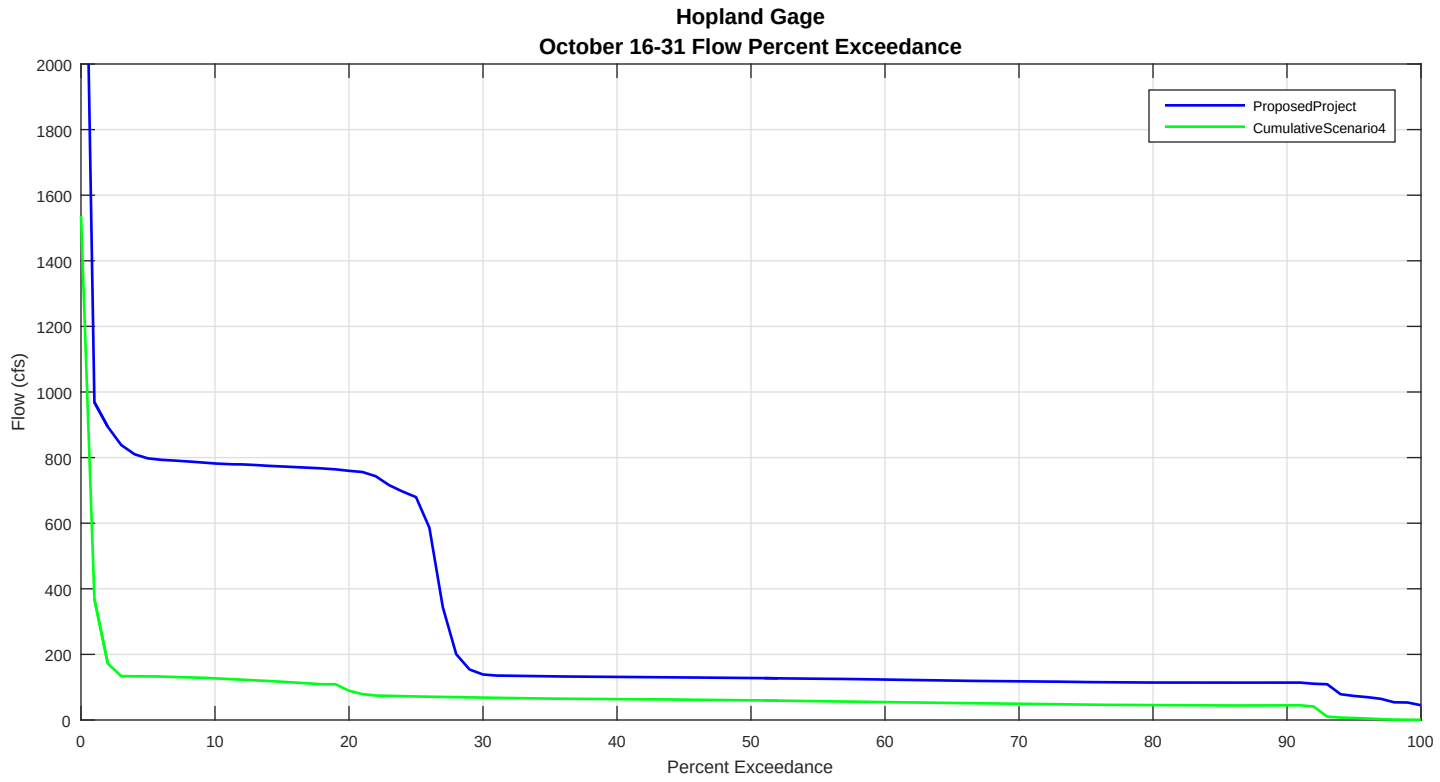
Hopland Gage
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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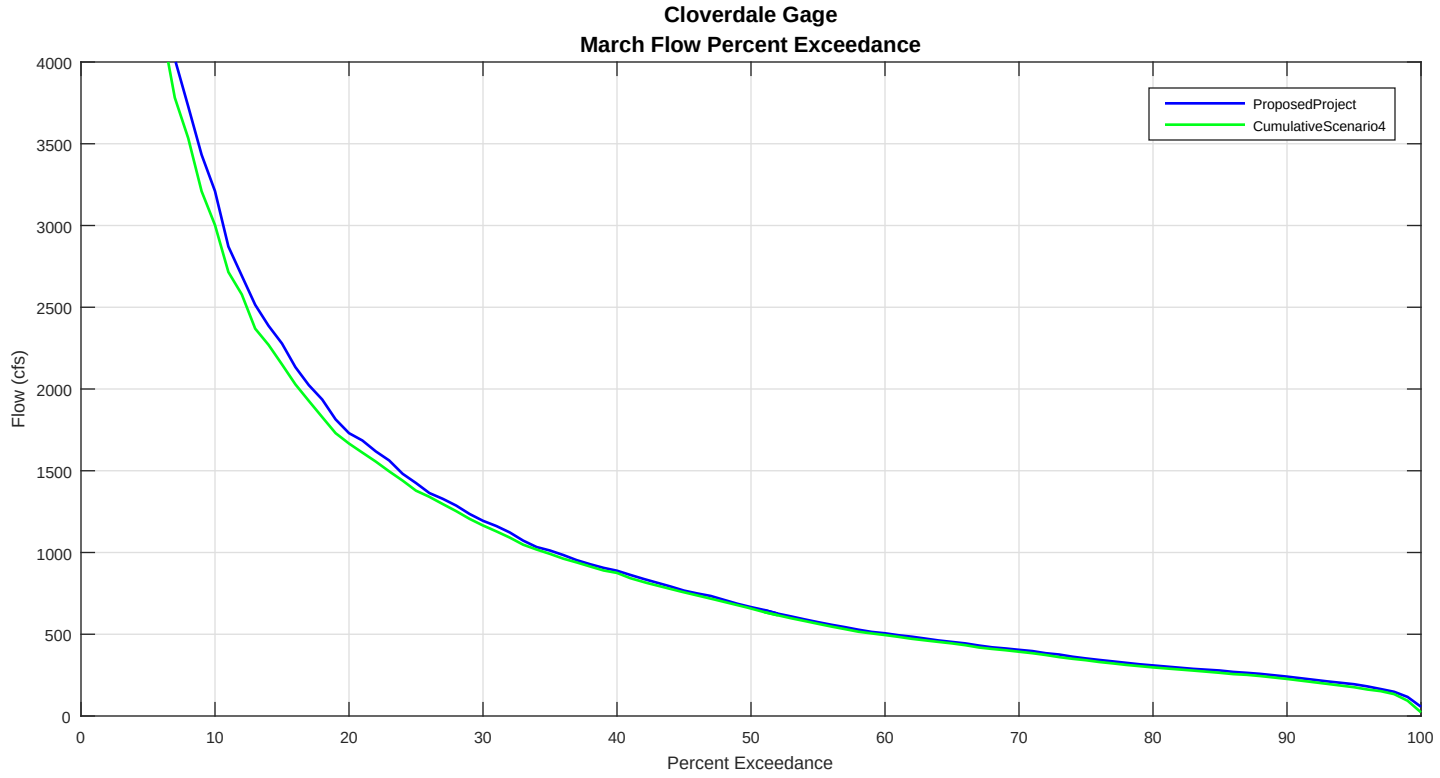
Cloverdale Gage
March Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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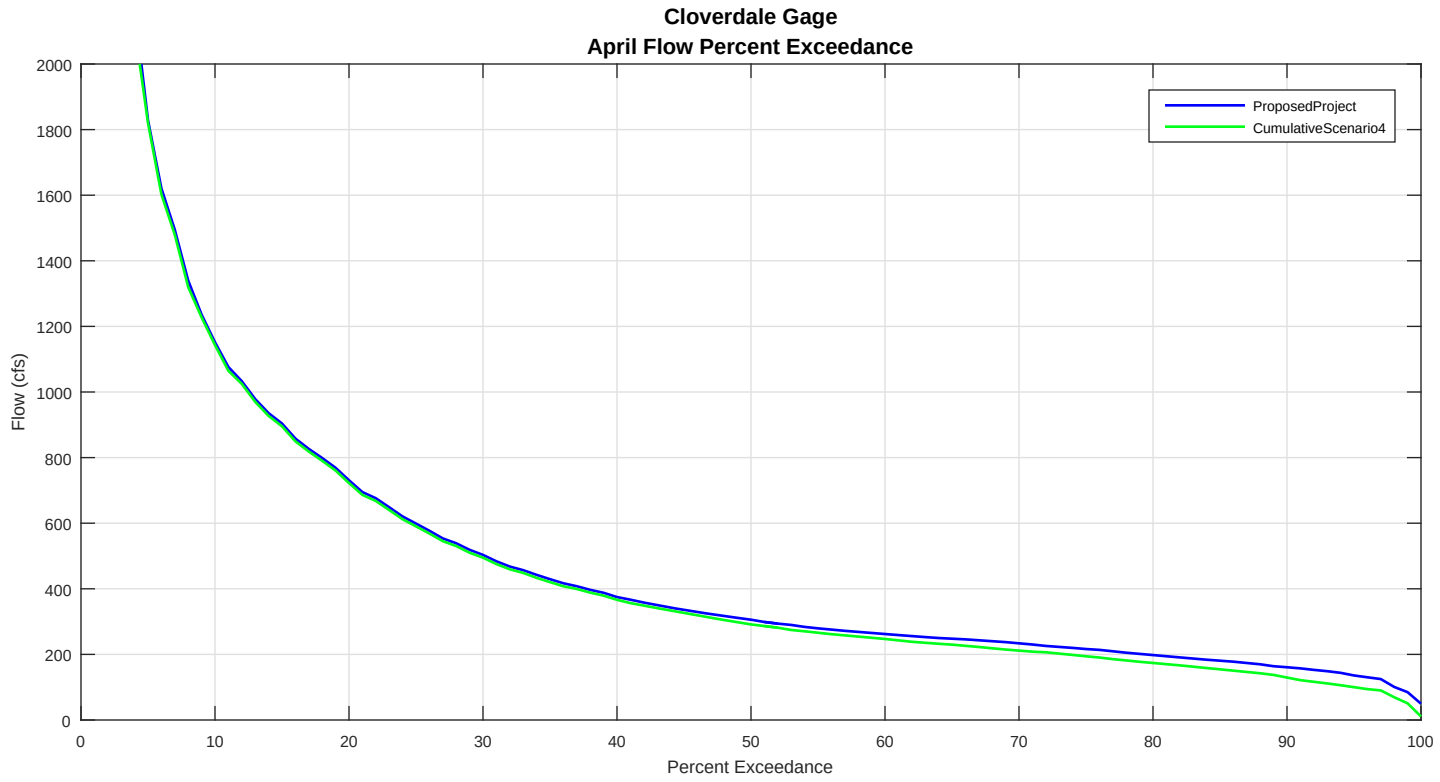
Cloverdale Gage
April Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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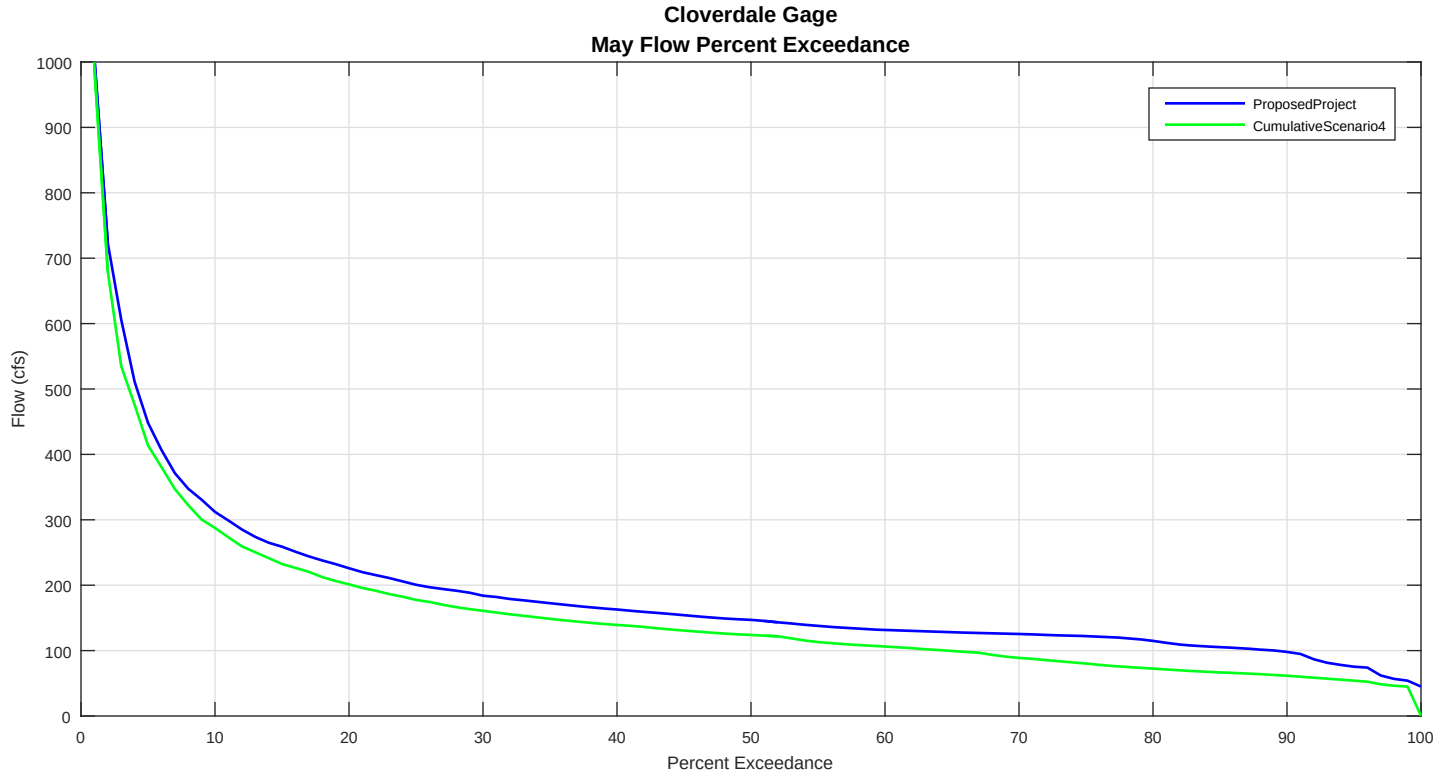
Cloverdale Gage
May Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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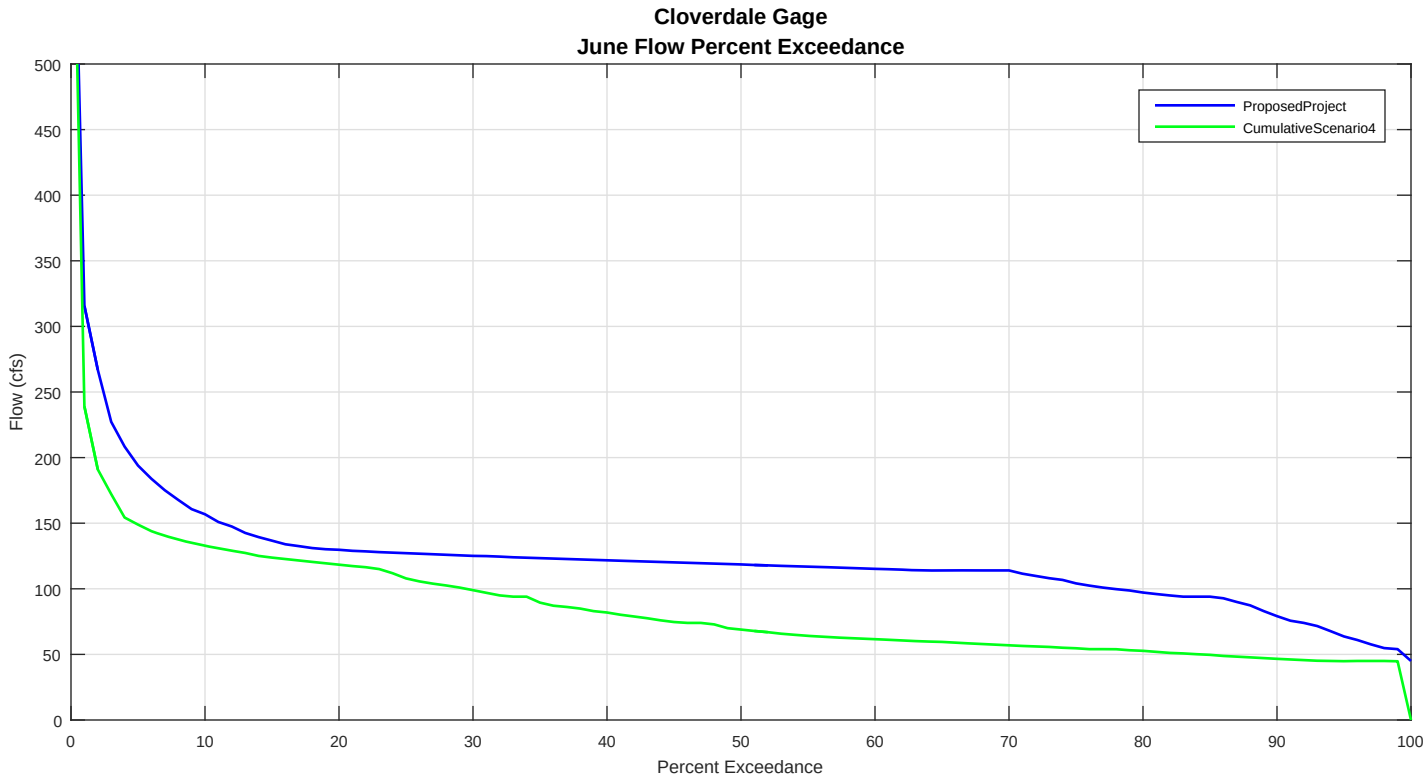
Cloverdale Gage
June Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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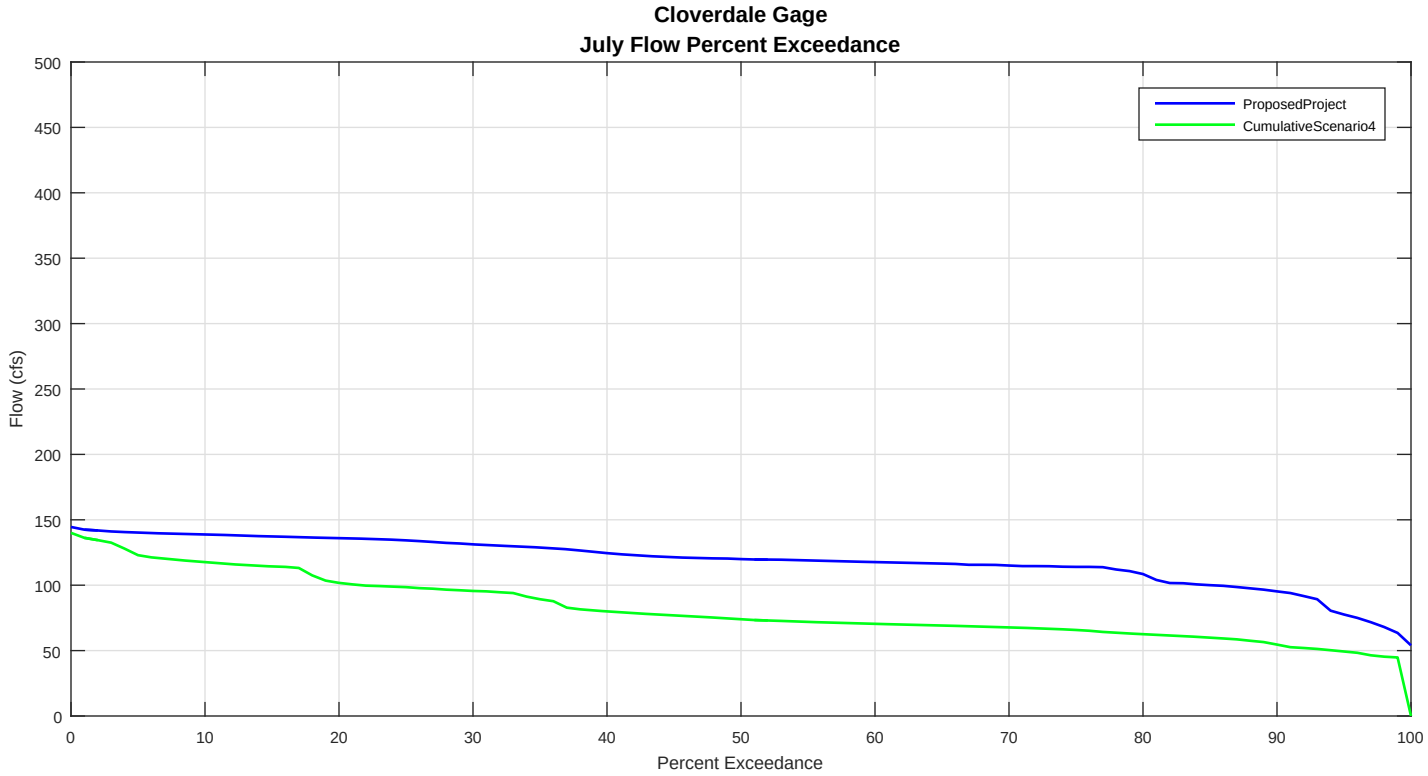
Cloverdale Gage
July Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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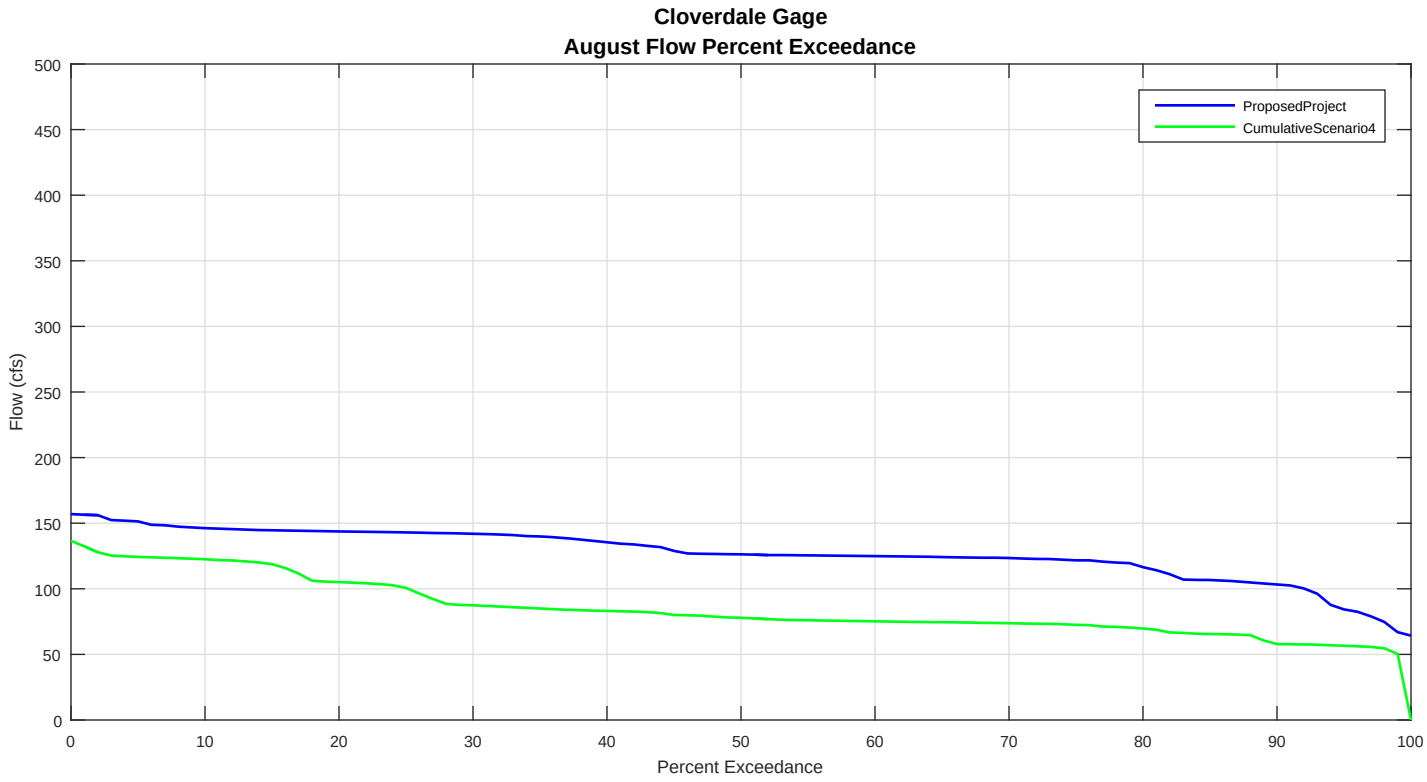
Cloverdale Gage
August Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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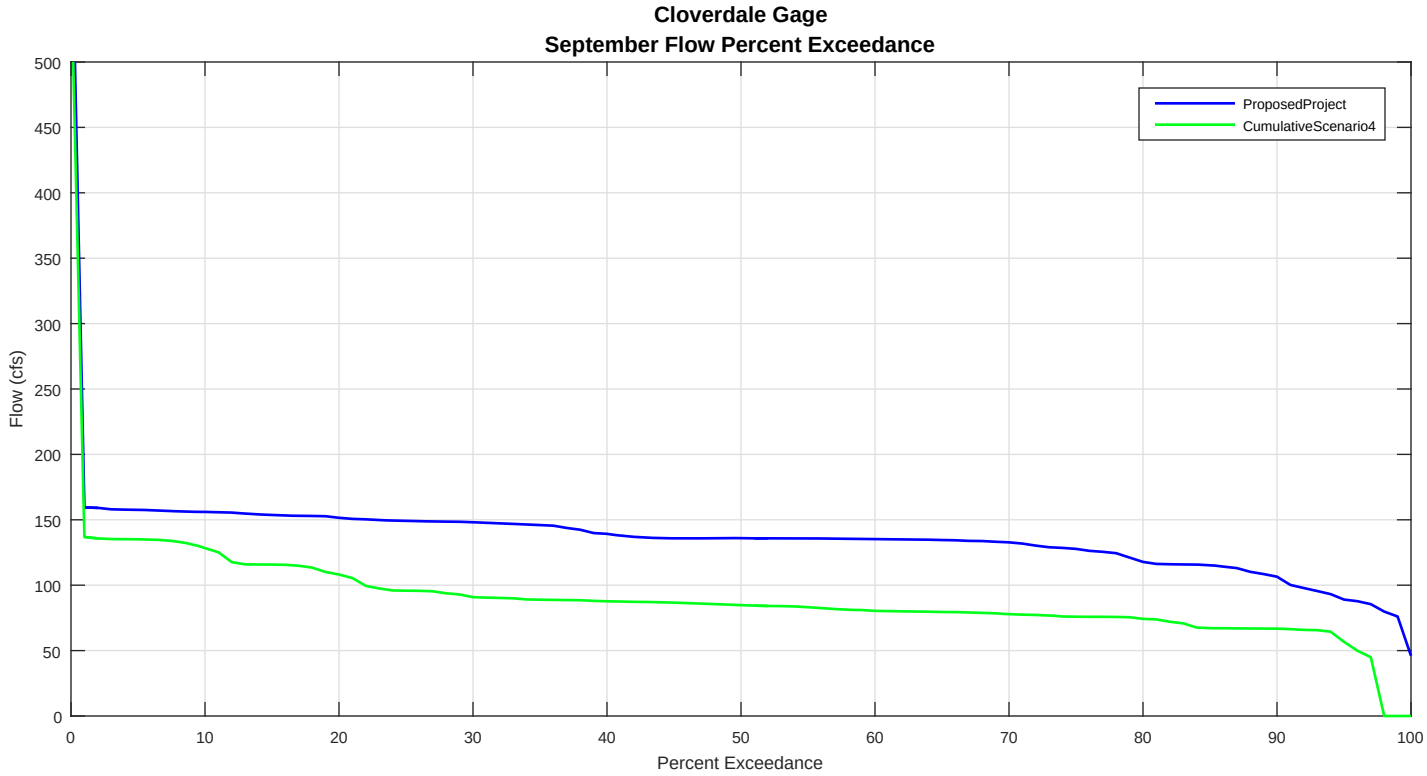
Cloverdale Gage
September Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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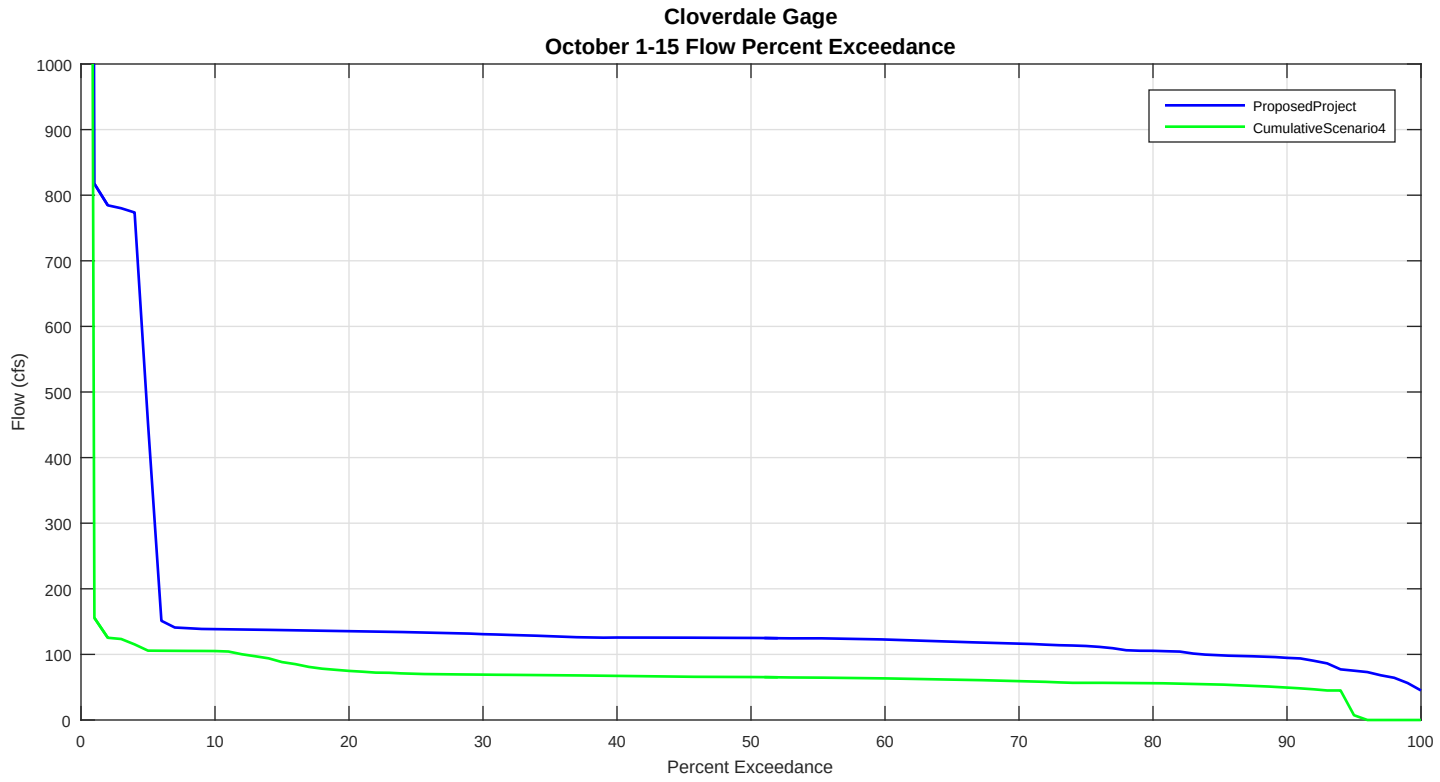
Cloverdale Gage
October 1-15 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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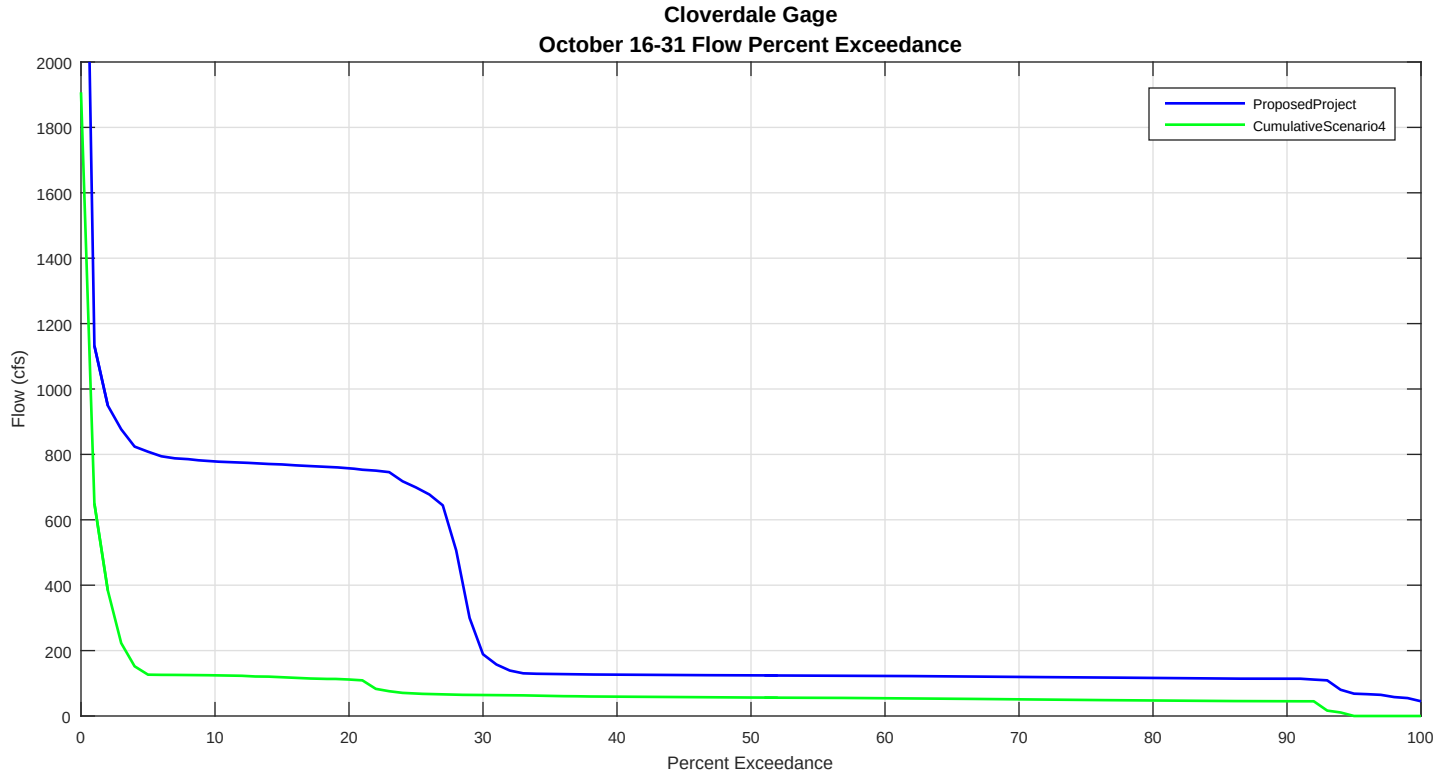
Cloverdale Gage
October 16-31 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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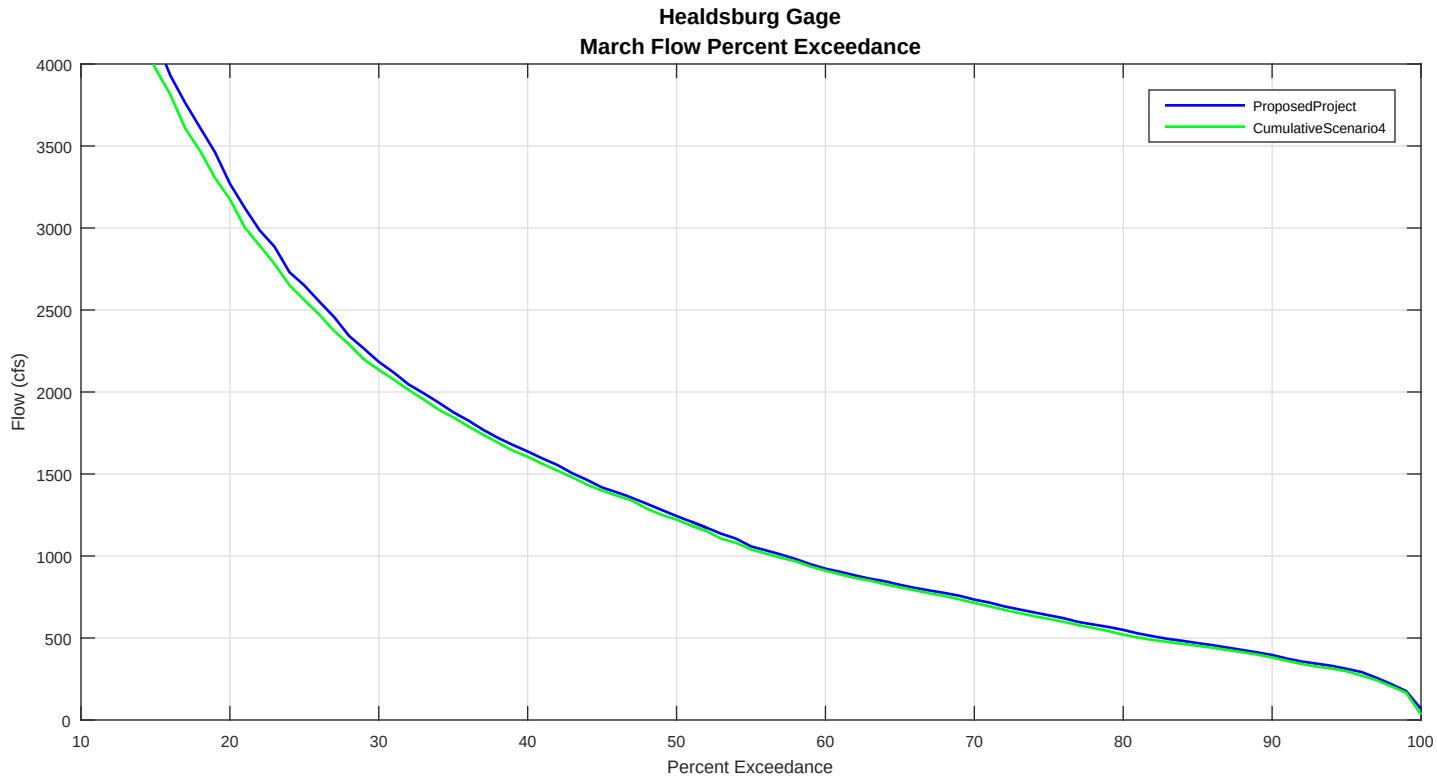
Healdsburg Gage
March Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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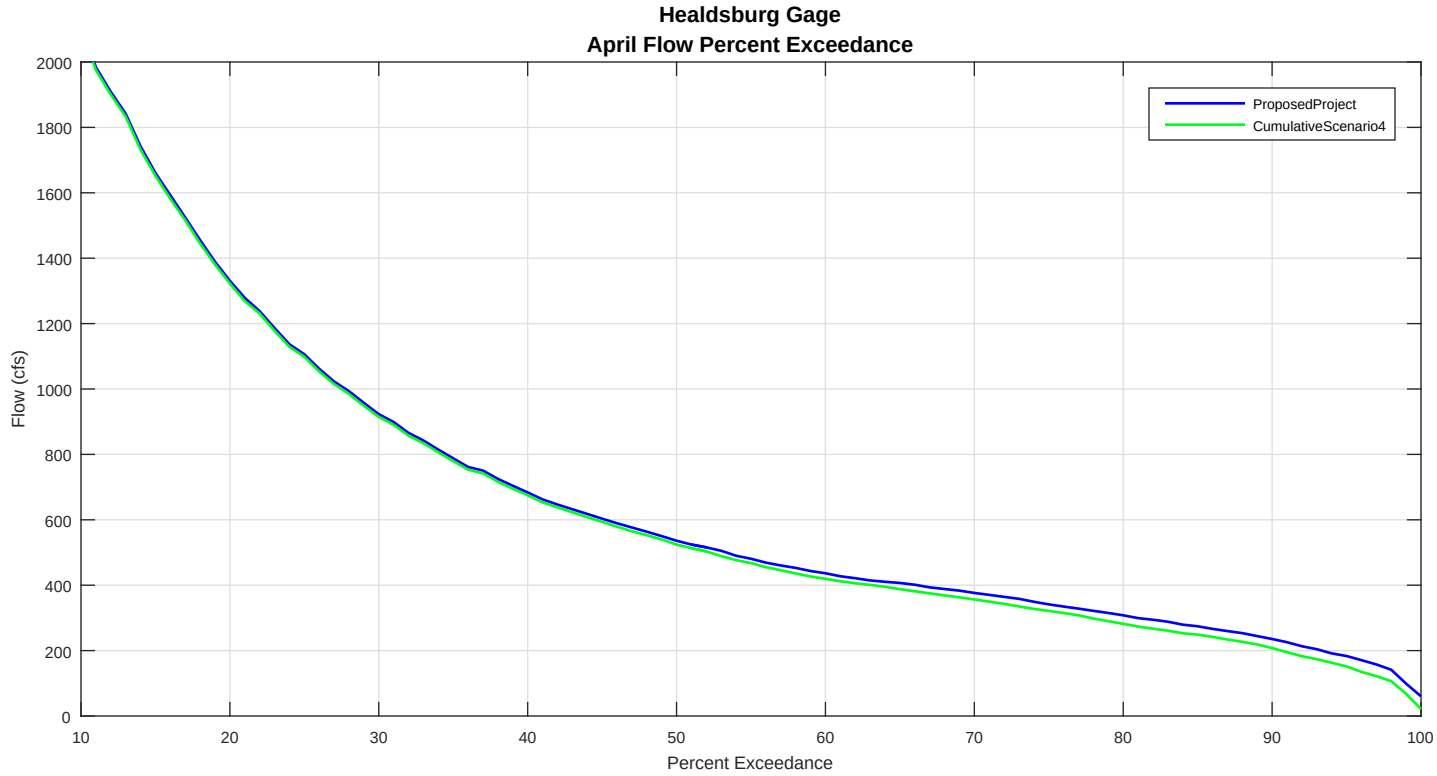
Healdsburg Gage
April Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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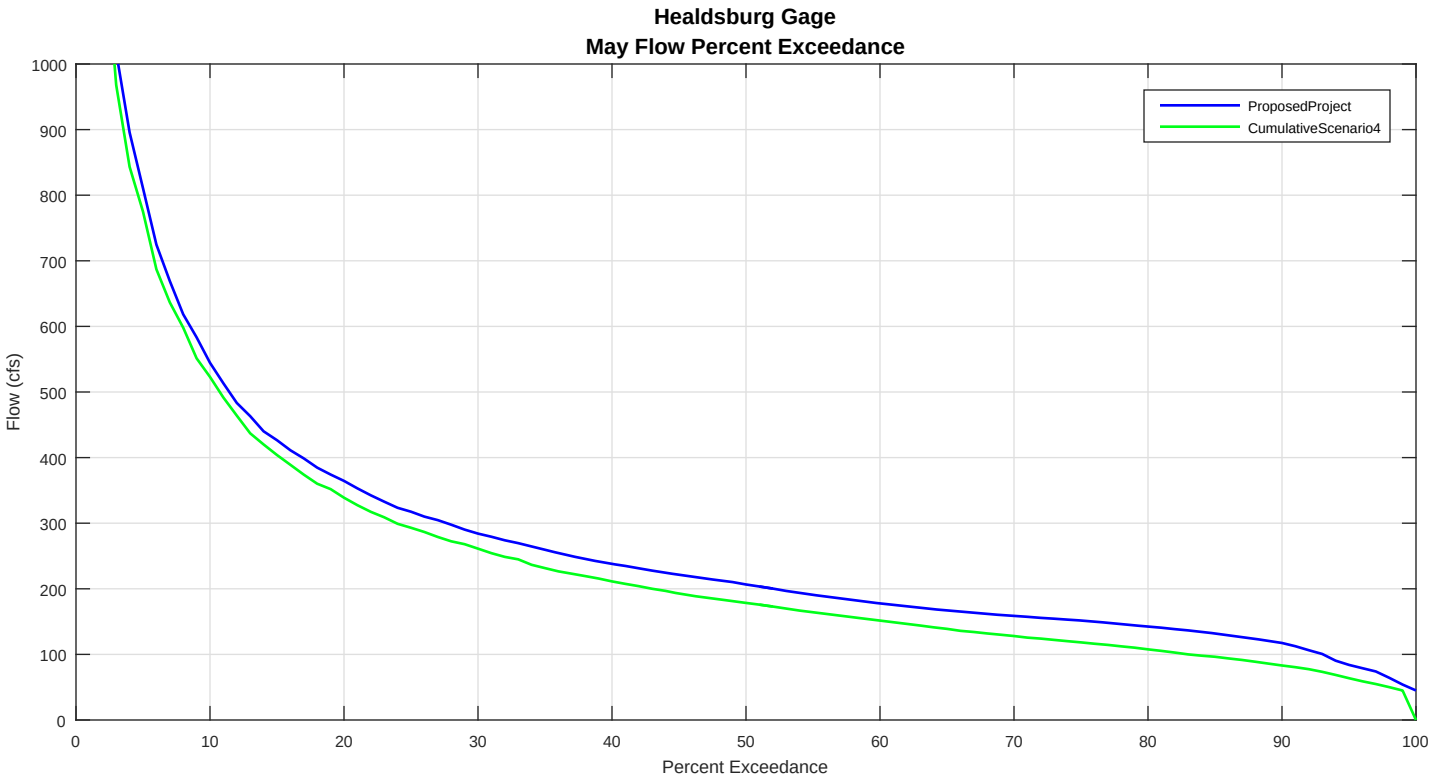
Healdsburg Gage
May Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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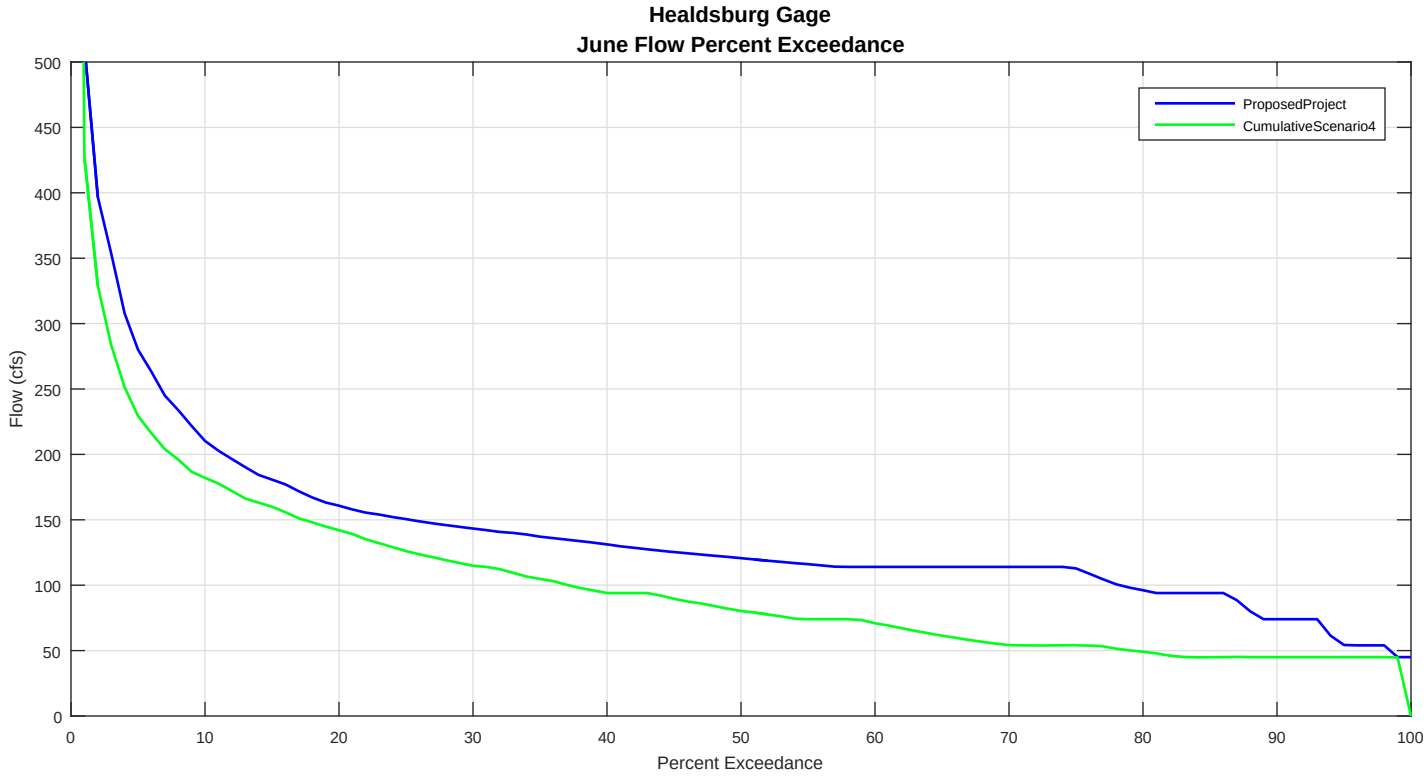
Healdsburg Gage
June Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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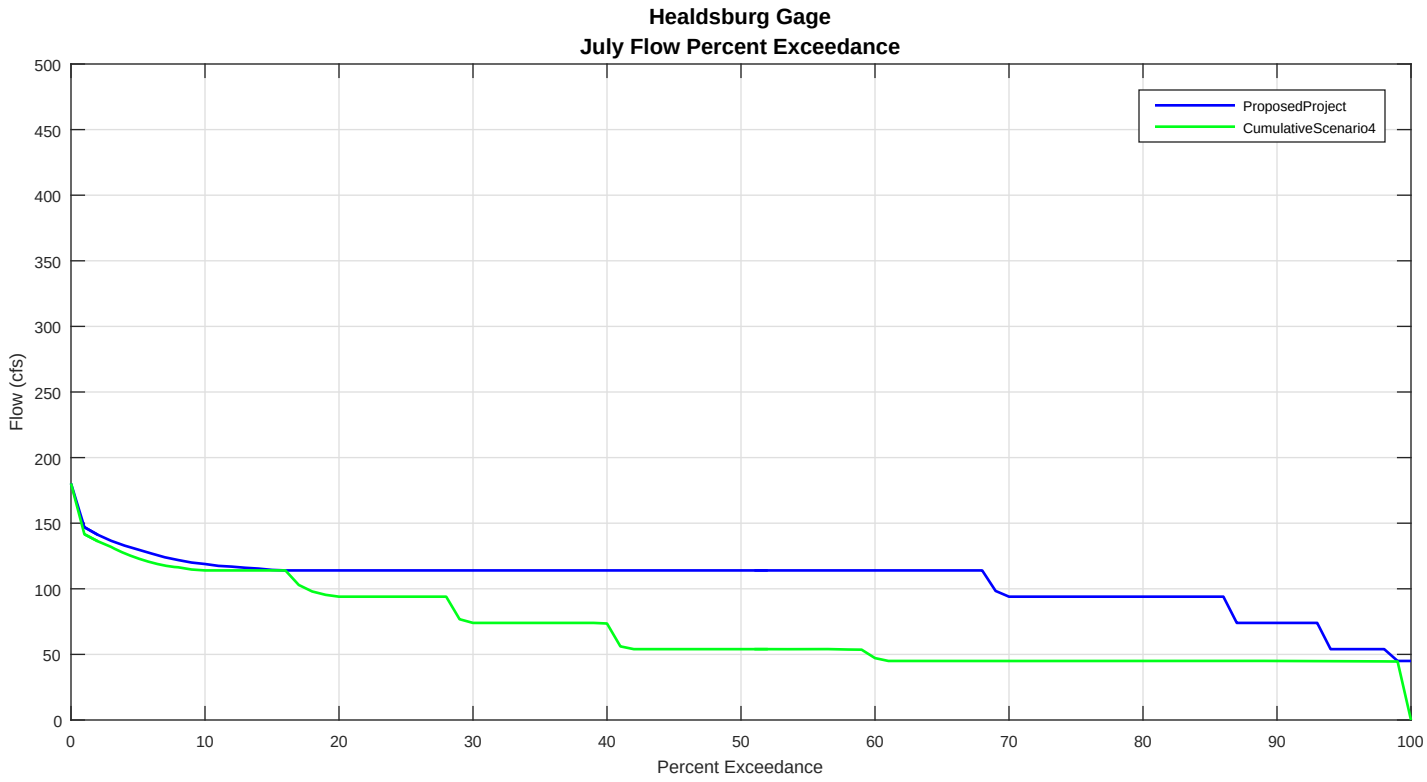
Healdsburg Gage
July Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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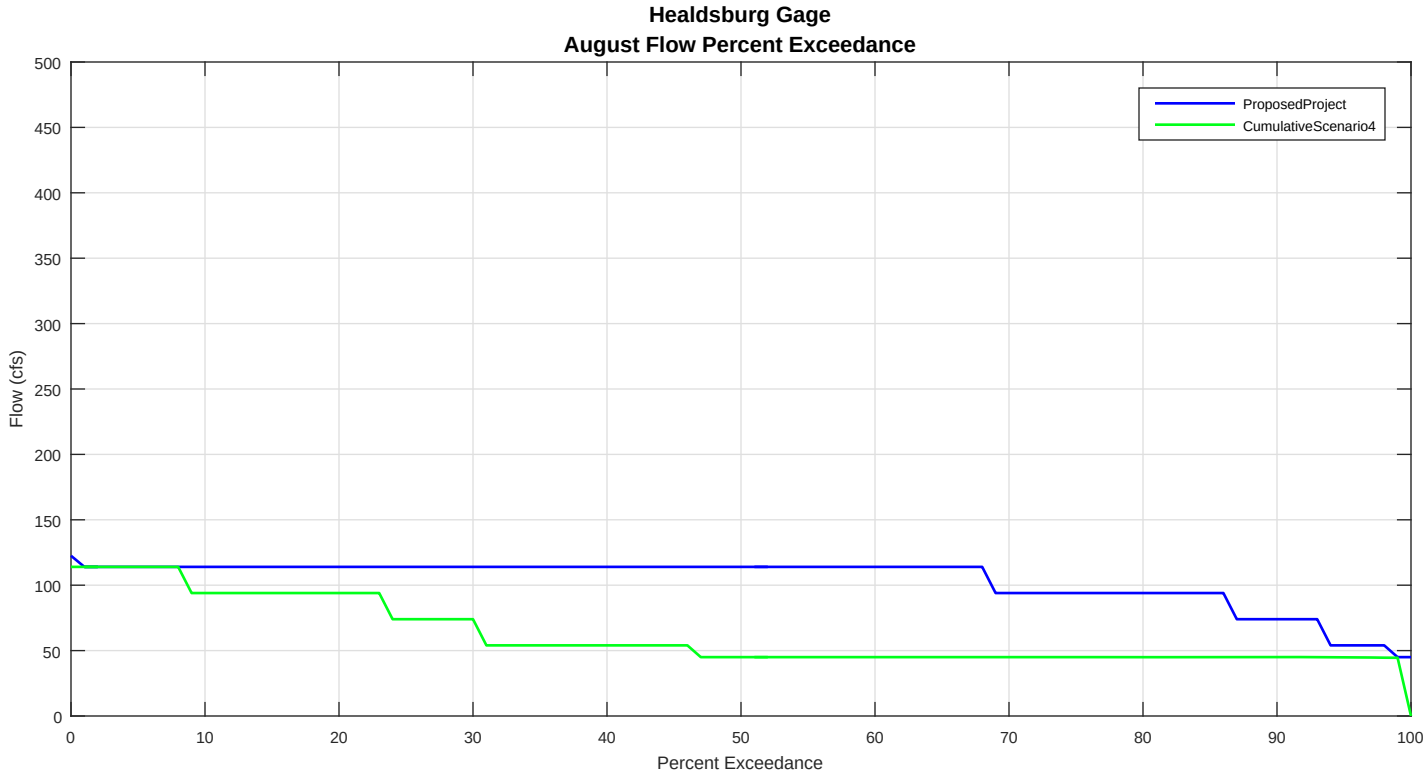
Healdsburg Gage
August Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
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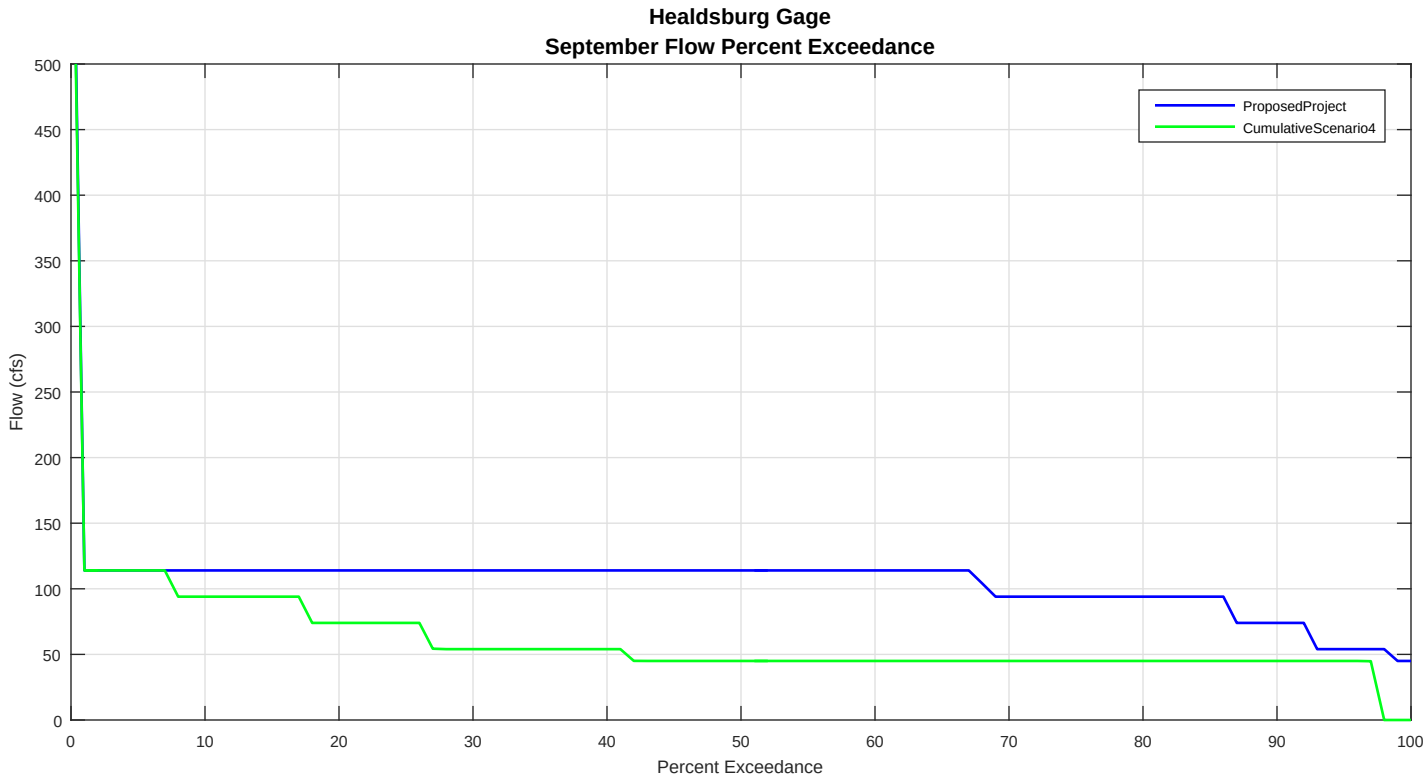
Healdsburg Gage
September Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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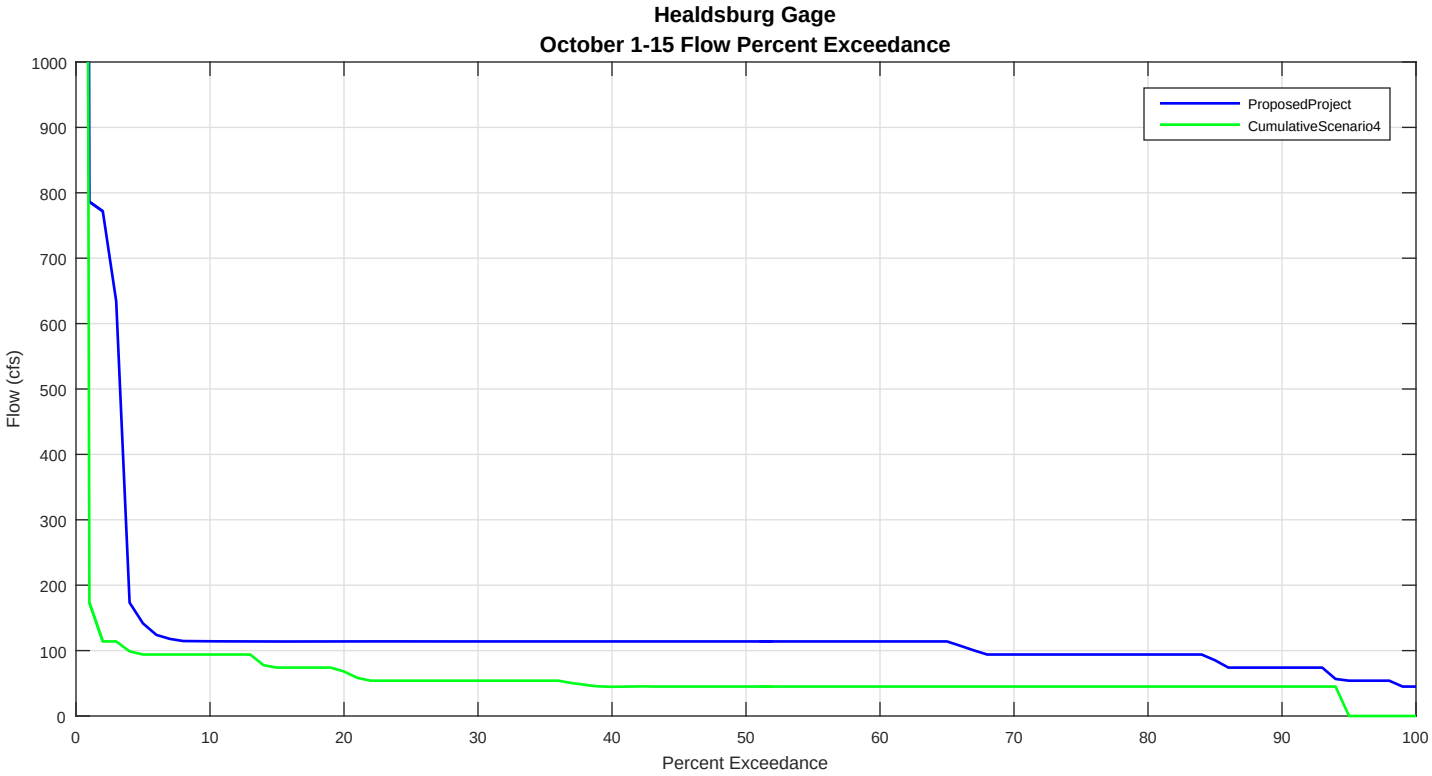
Healdsburg Gage
October 1-15 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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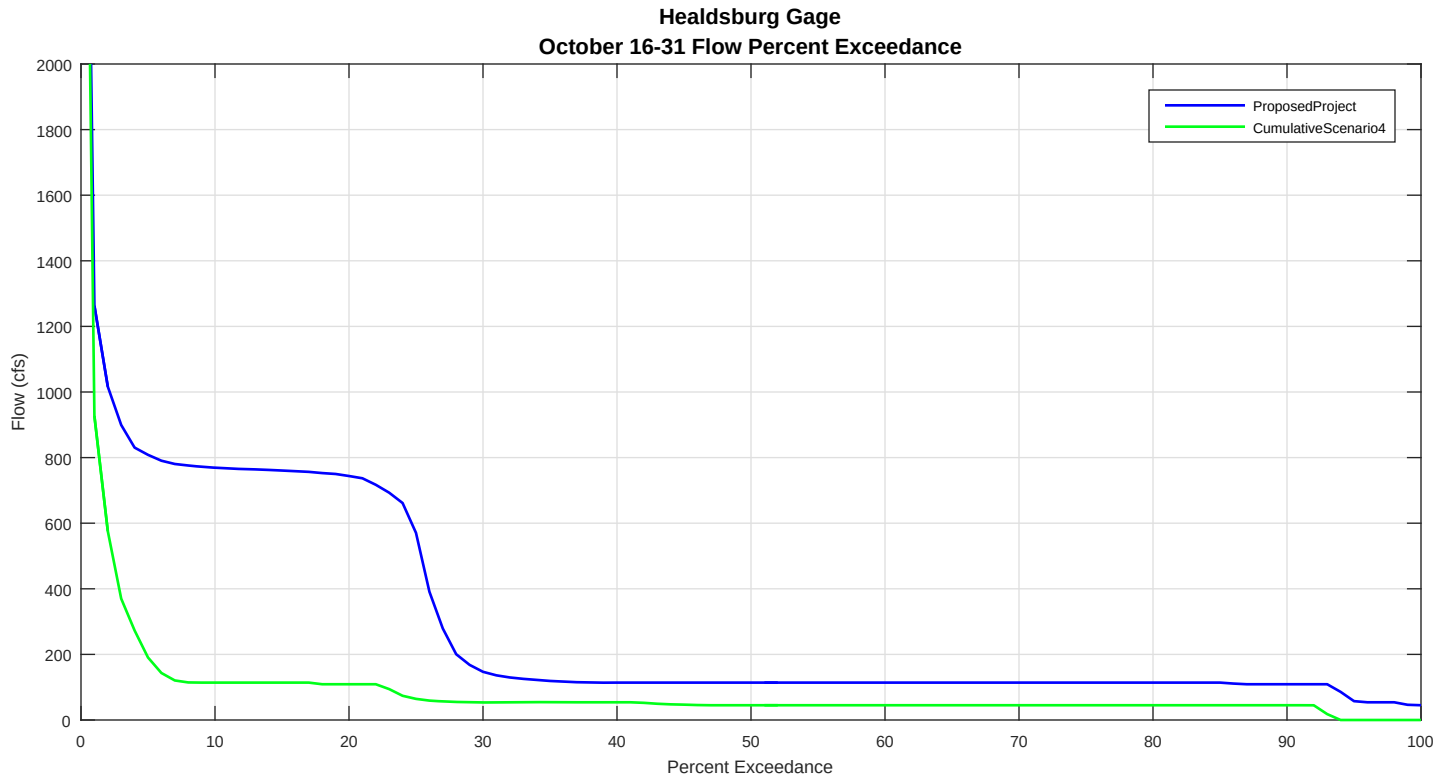
Healdsburg Gage
October 16-31 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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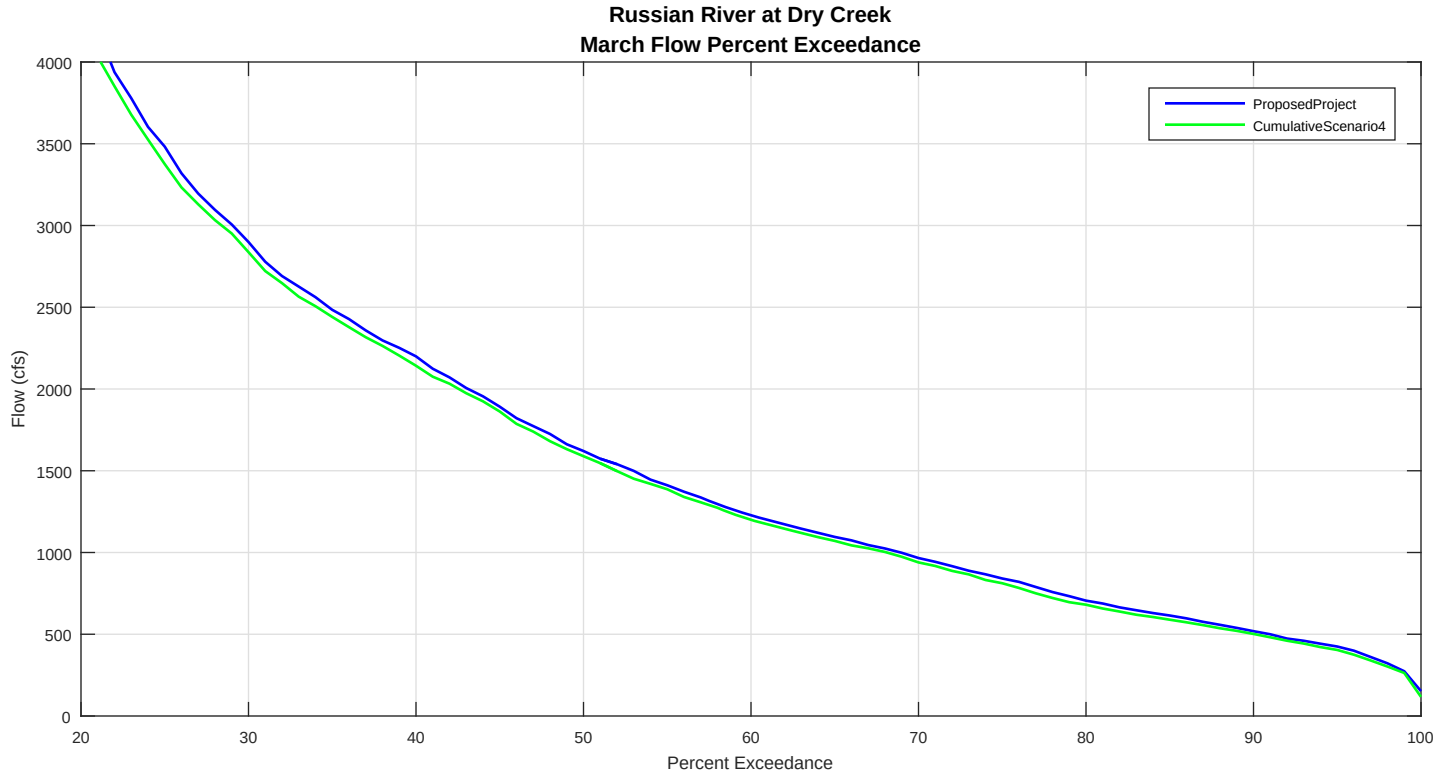
Russian River at Dry Creek
March Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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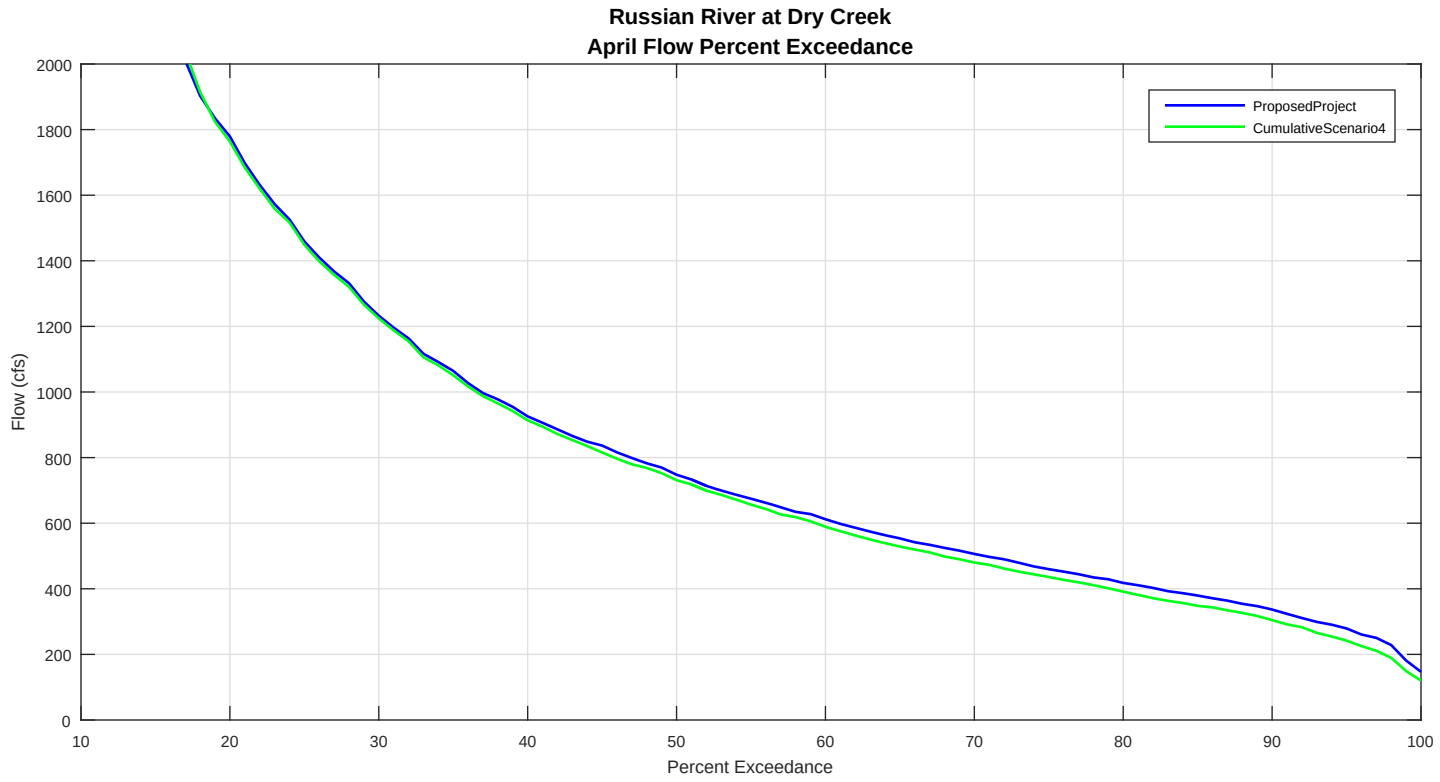
Russian River at Dry Creek
April Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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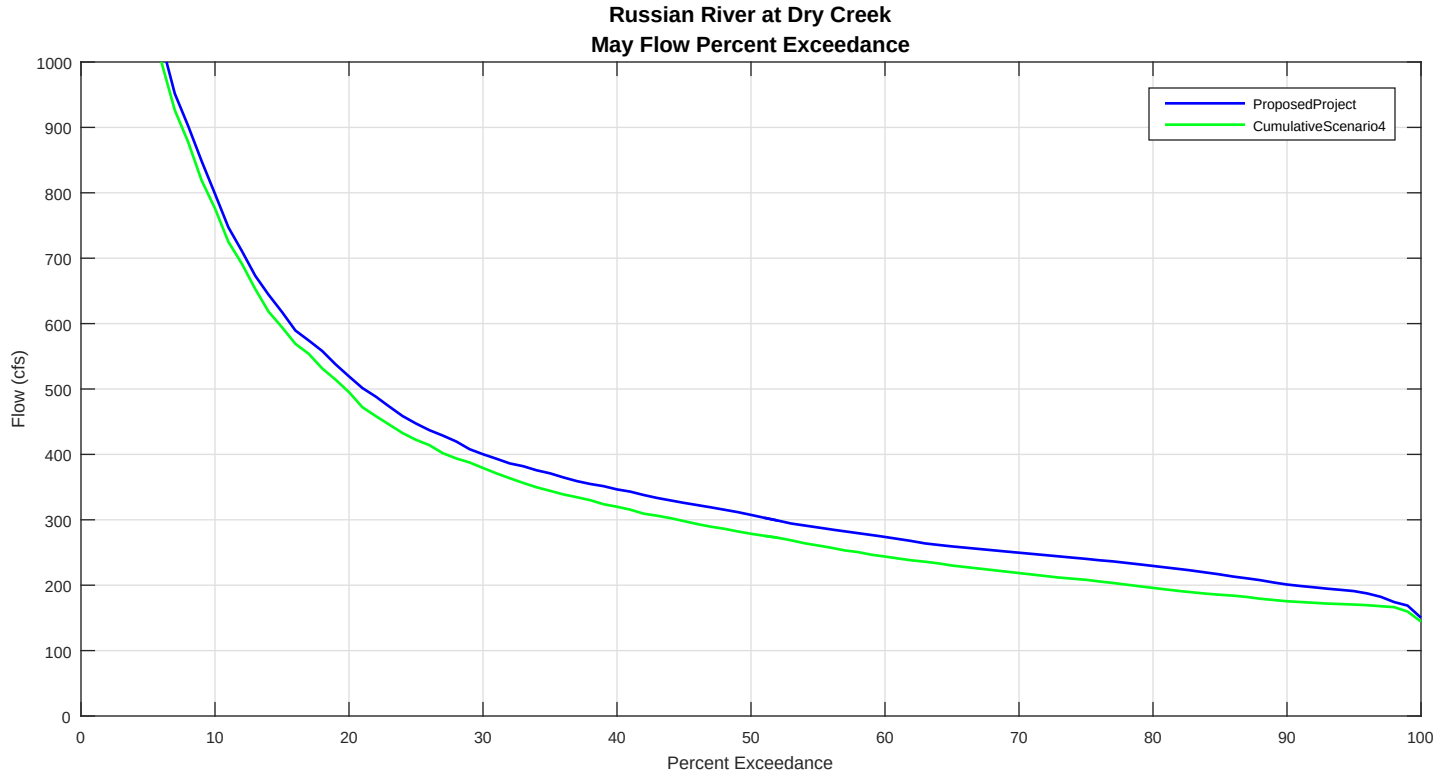
Russian River at Dry Creek
May Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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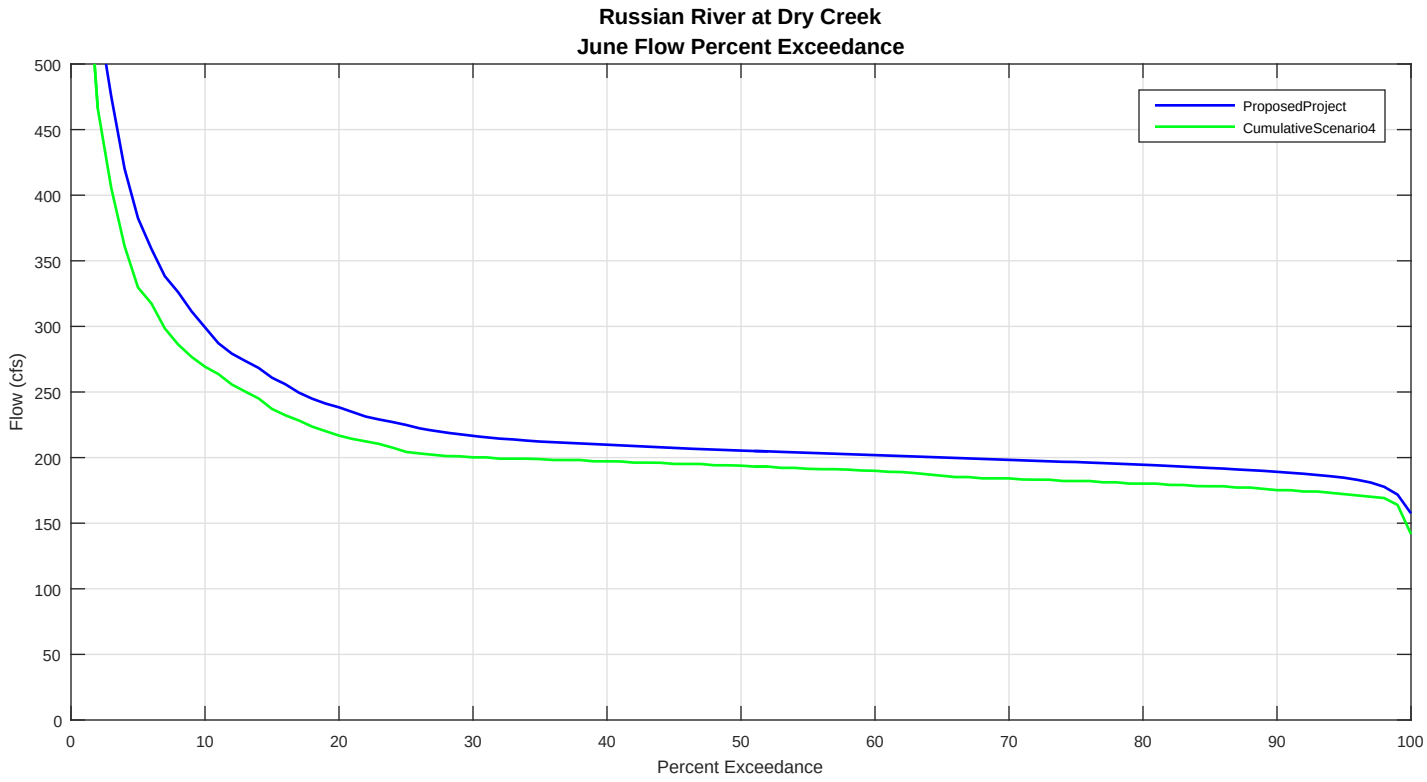
Russian River at Dry Creek
June Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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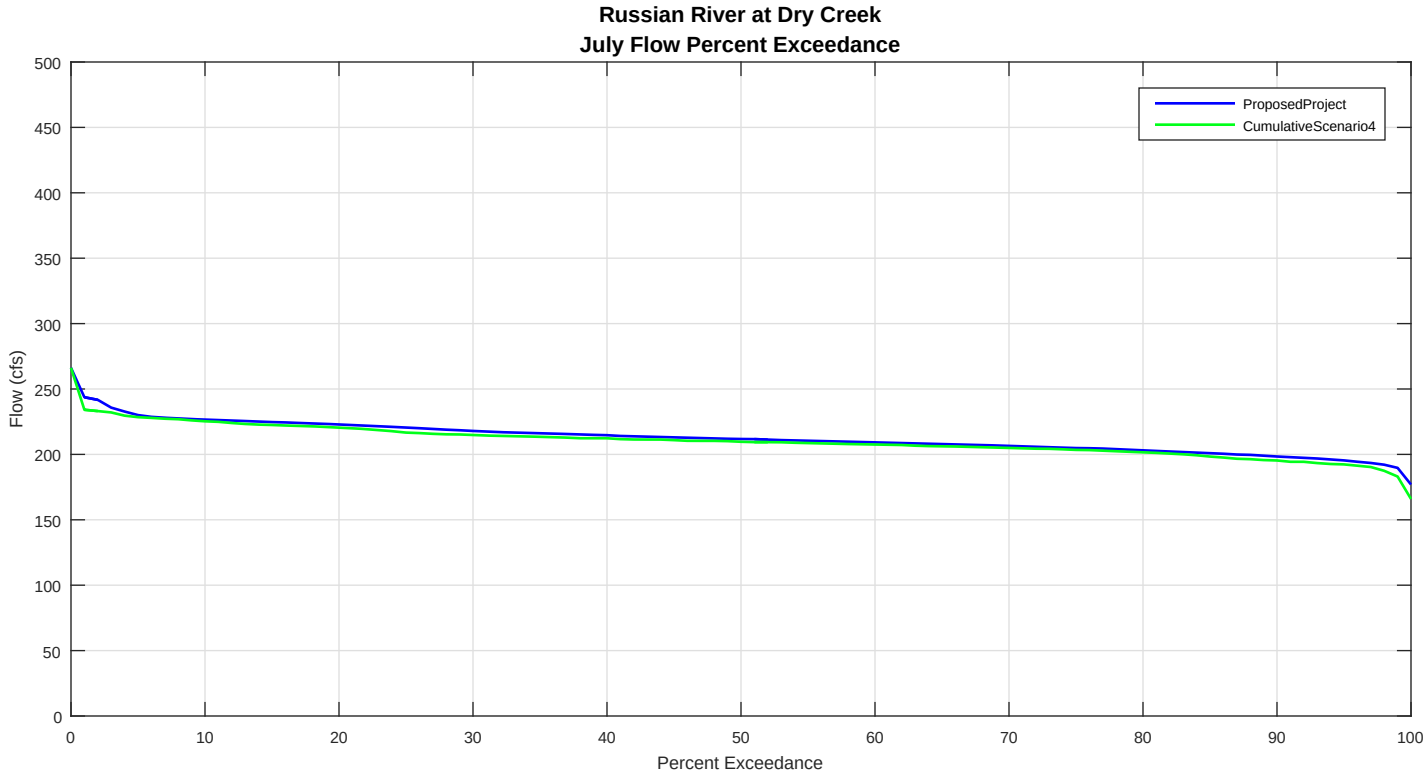
Russian River at Dry Creek
July Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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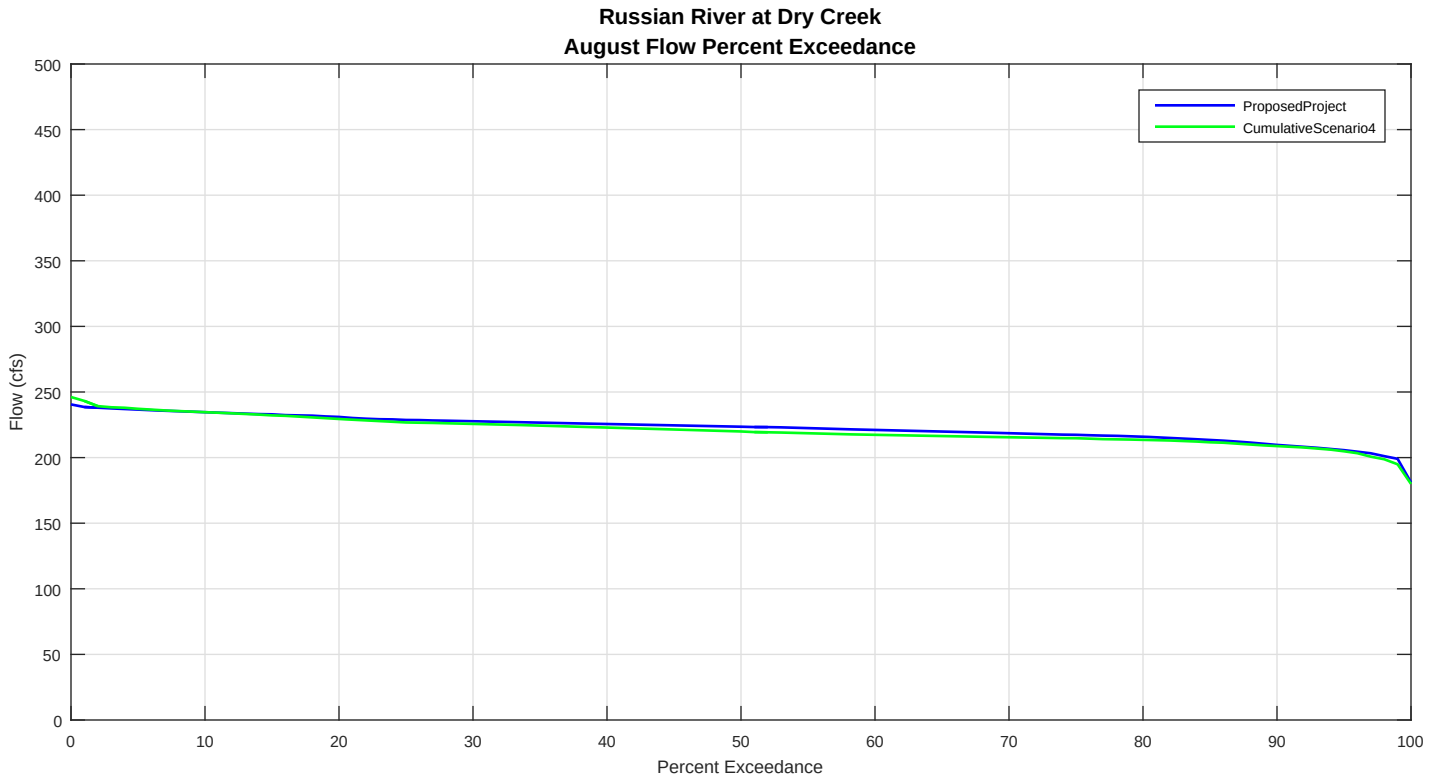
Russian River at Dry Creek
August Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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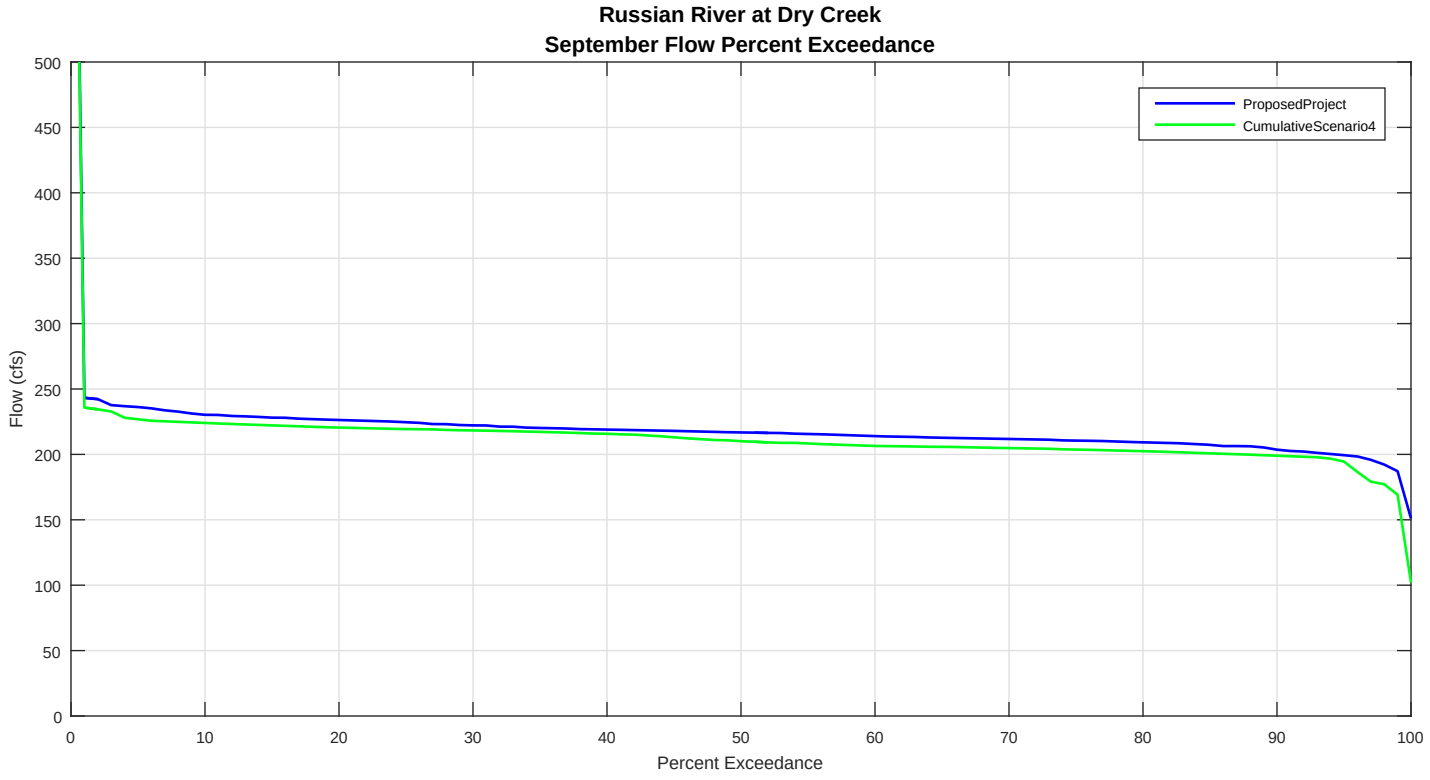
Russian River at Dry Creek
September Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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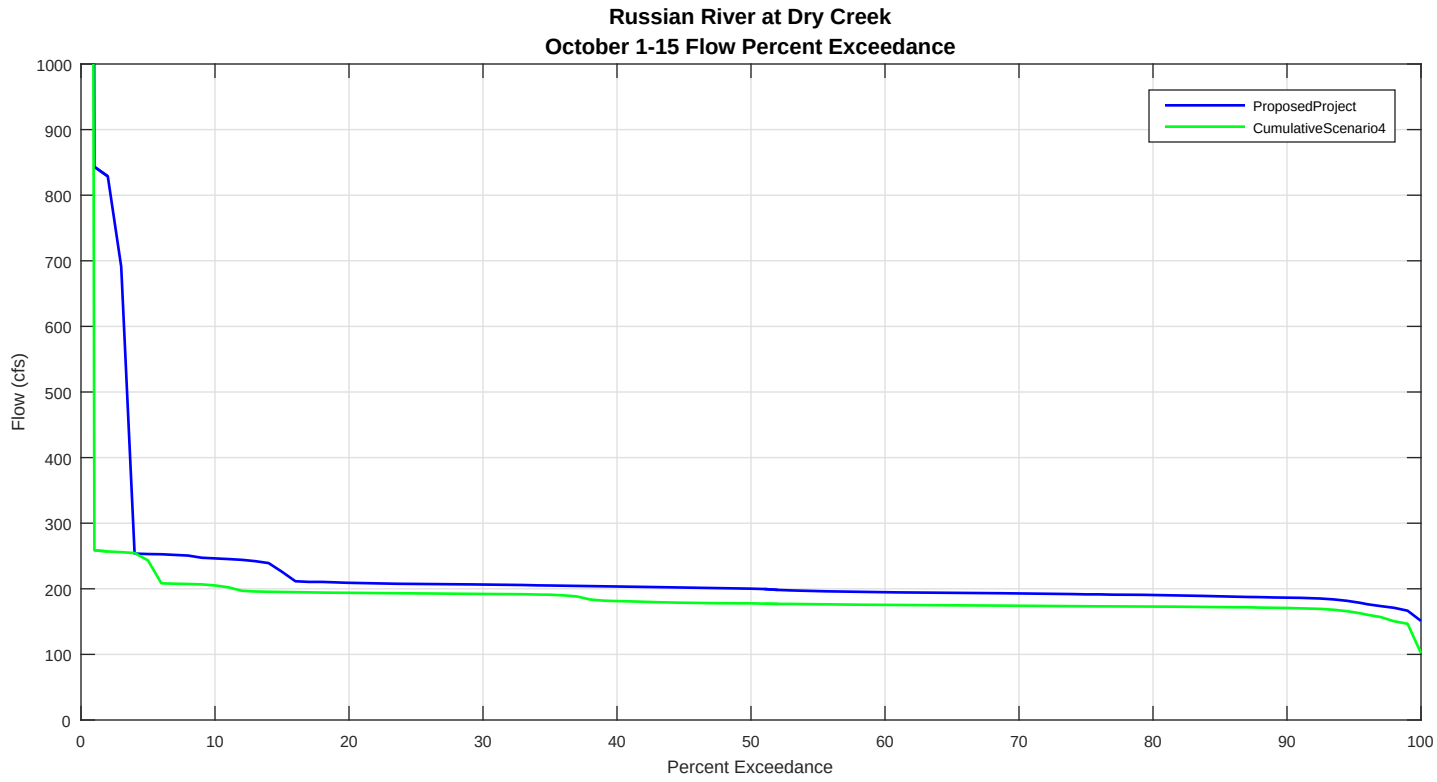
Russian River at Dry Creek
October 1-15 Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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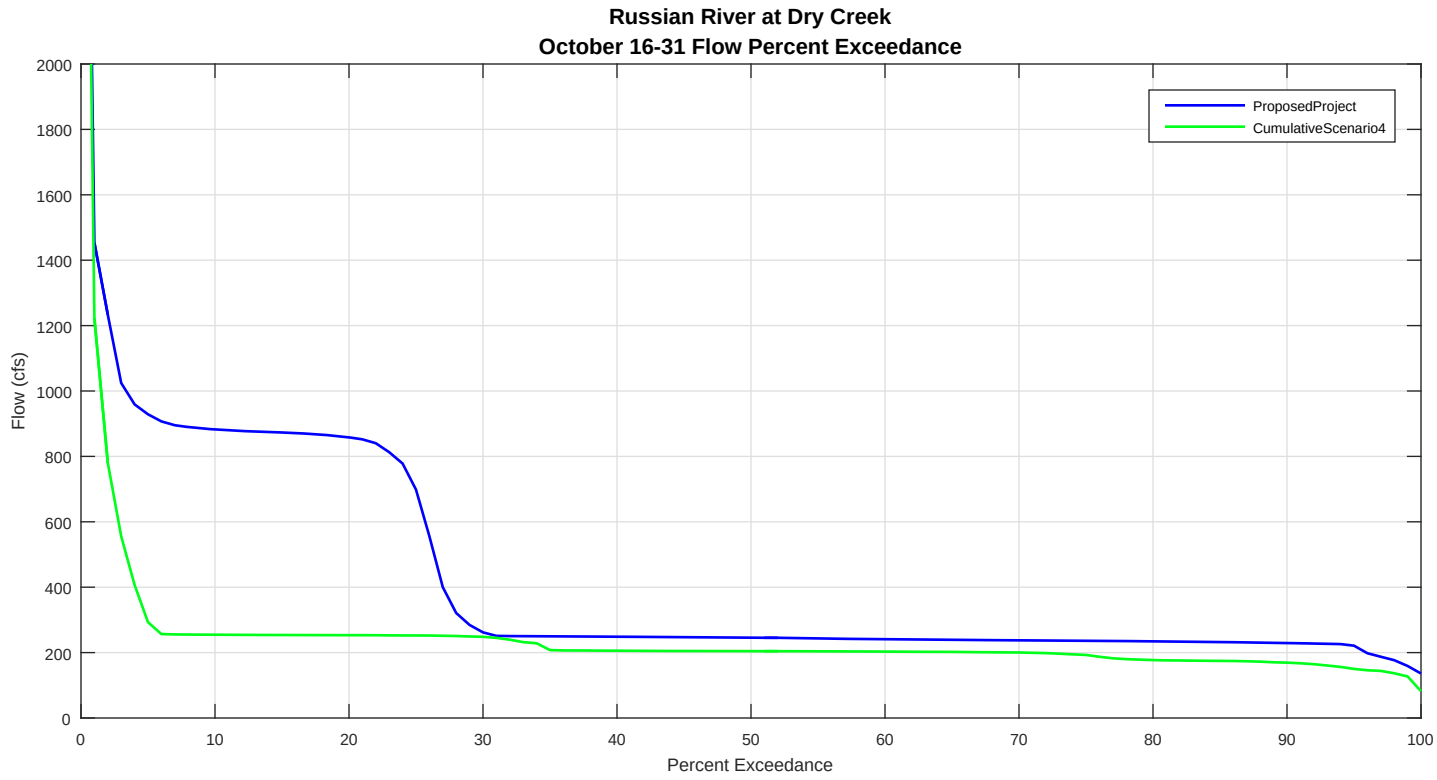
Russian River at Dry Creek
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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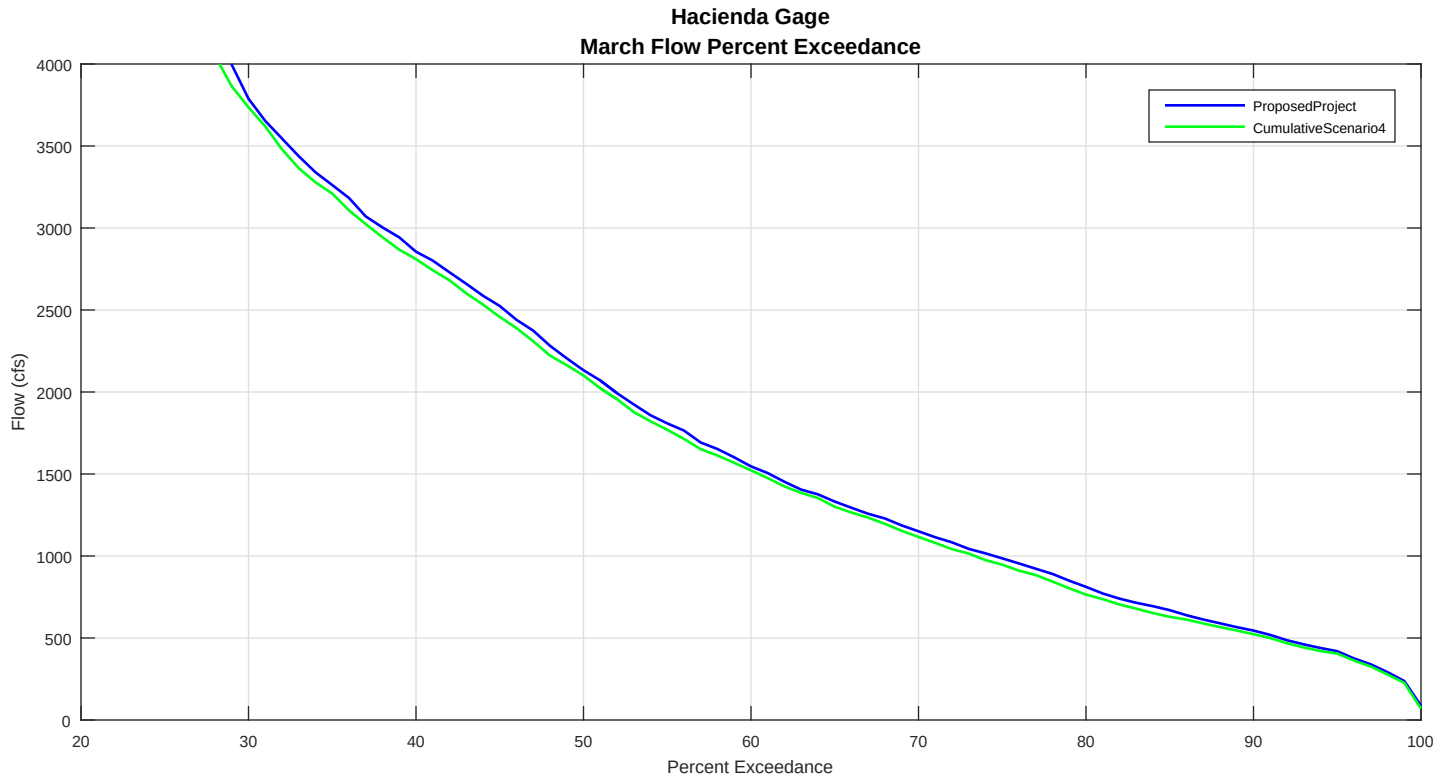
Hacienda Gage
March Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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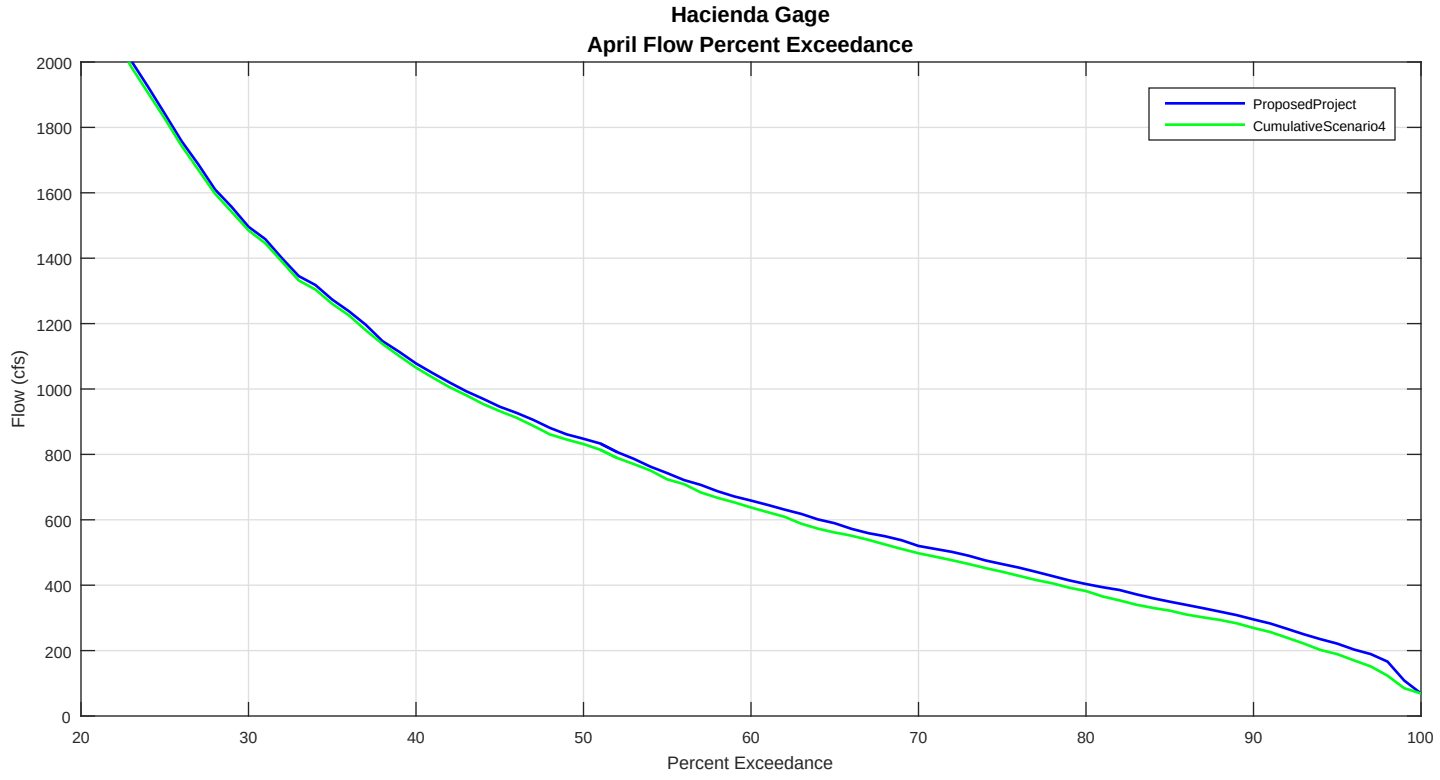
Hacienda Gage
April Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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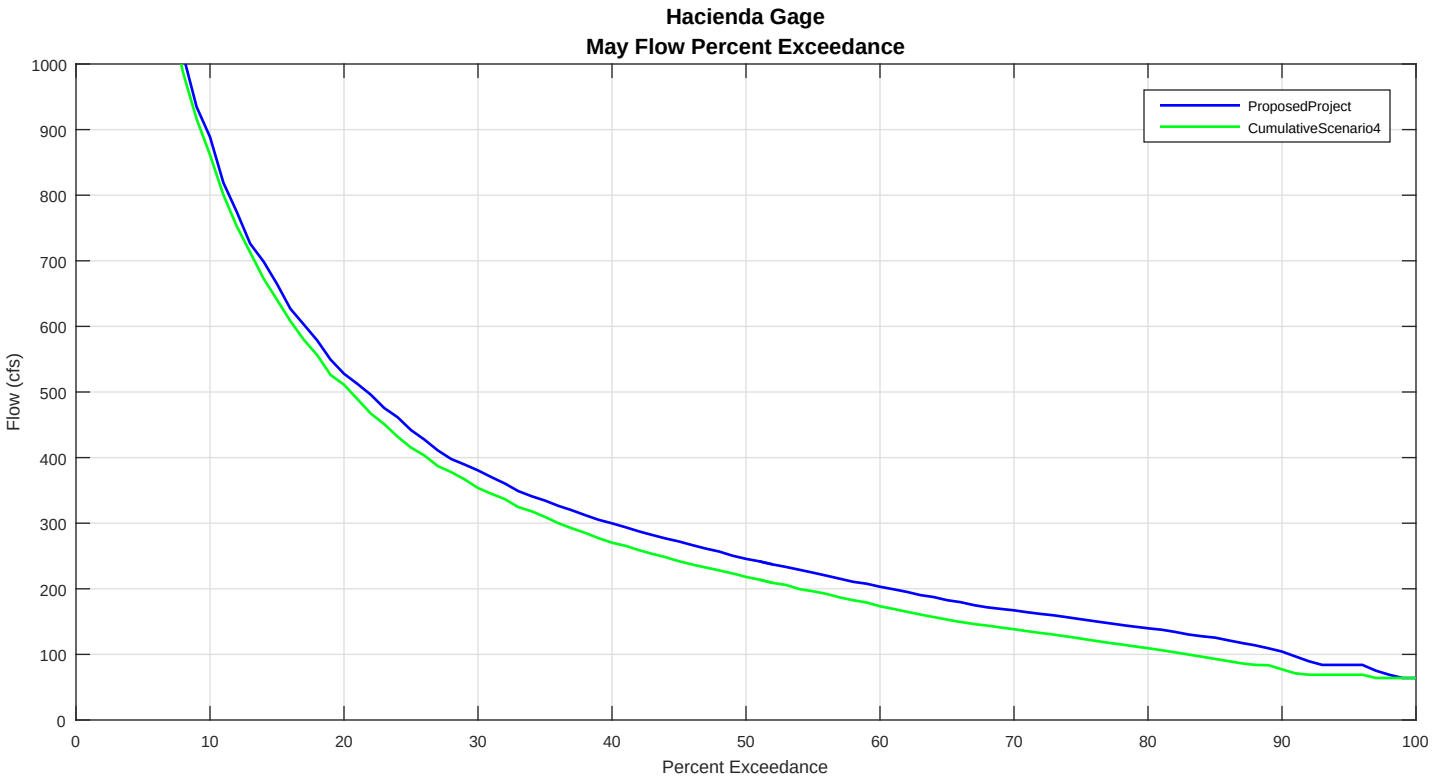
Hacienda Gage
May Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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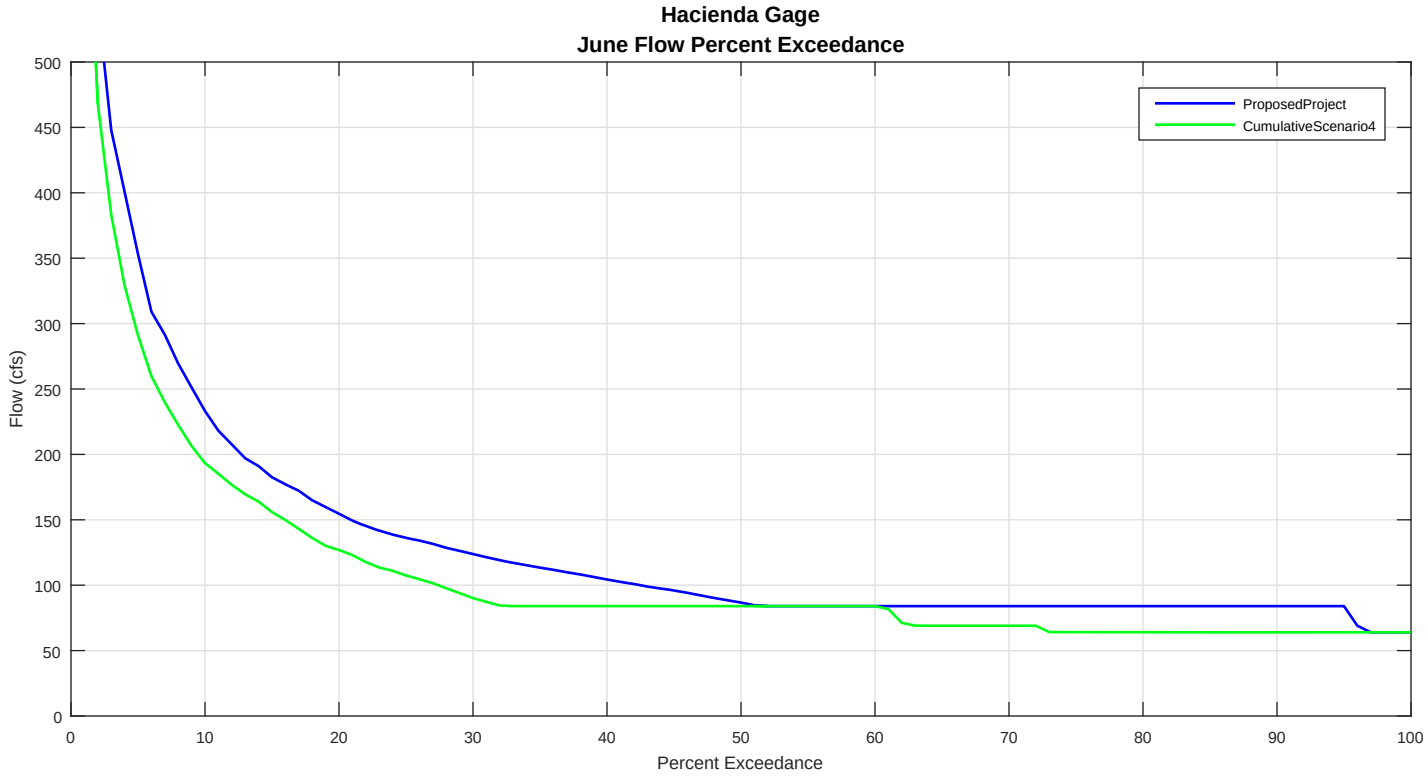
Hacienda Gage
June Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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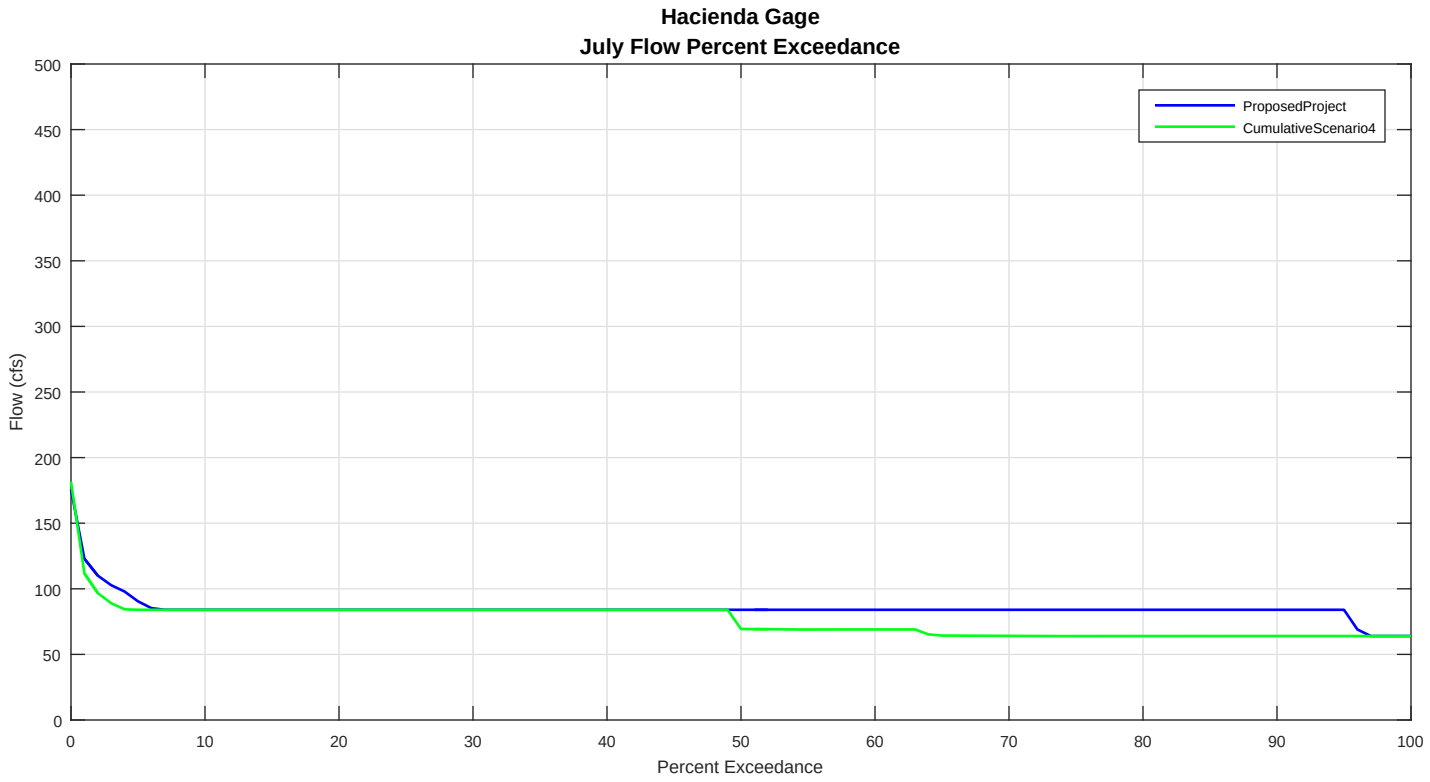
Hacienda Gage
July Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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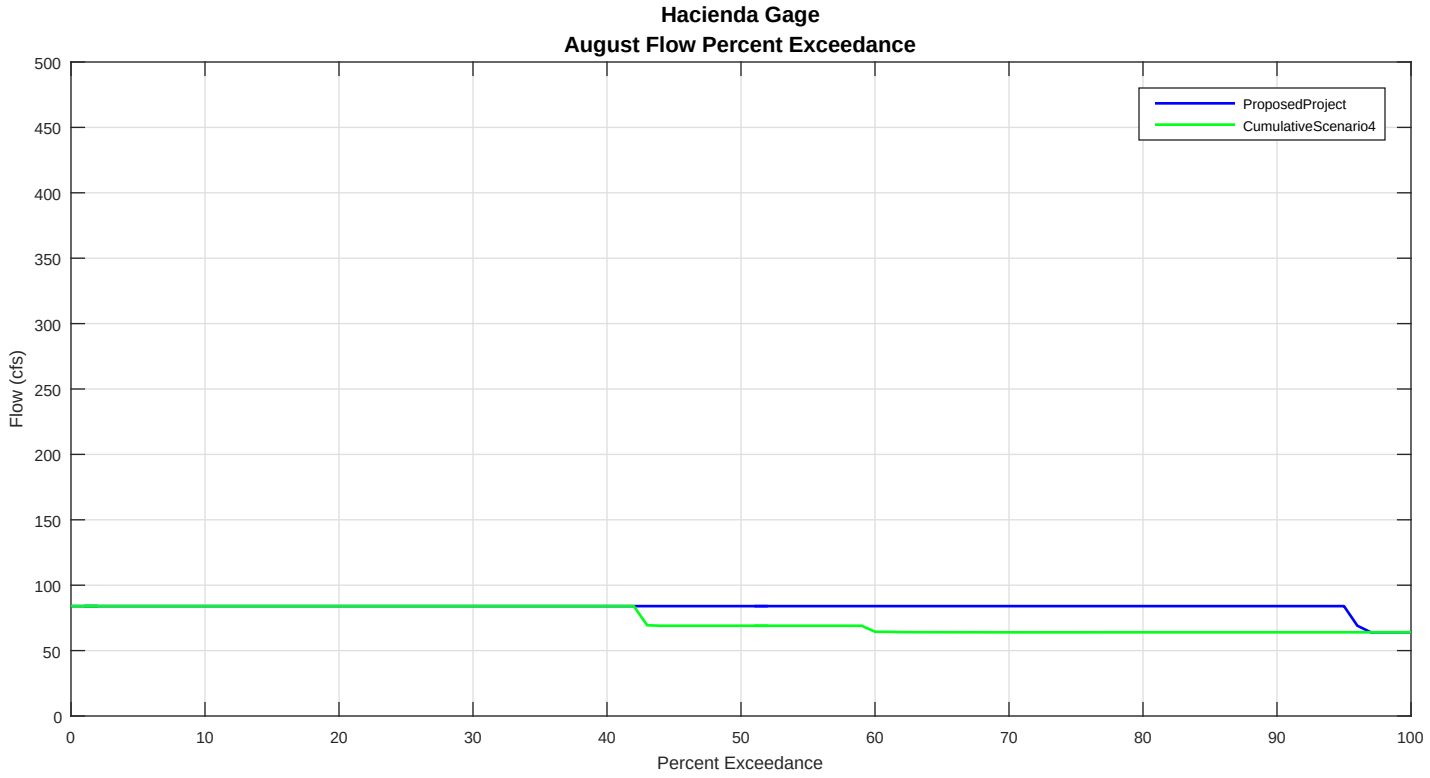
Hacienda Gage
August Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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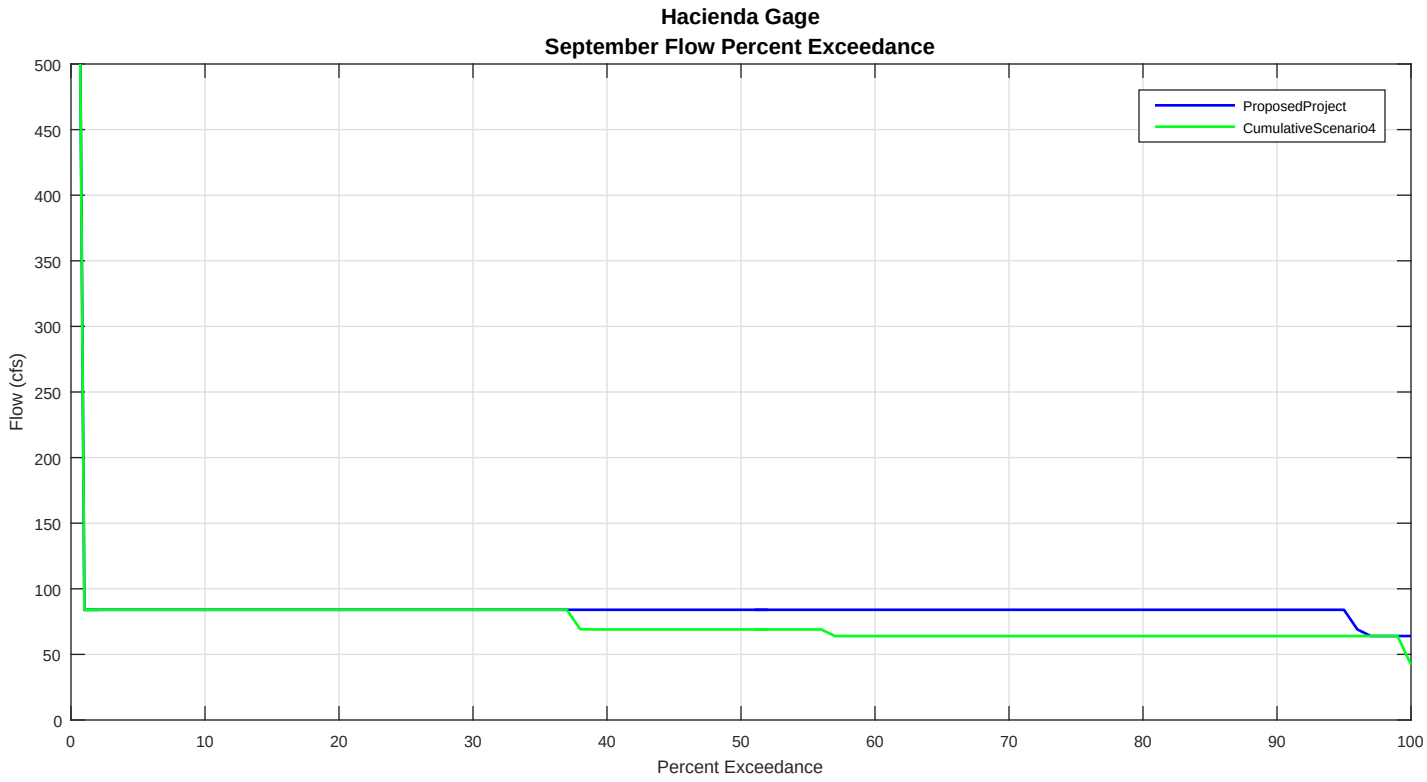
Hacienda Gage
September Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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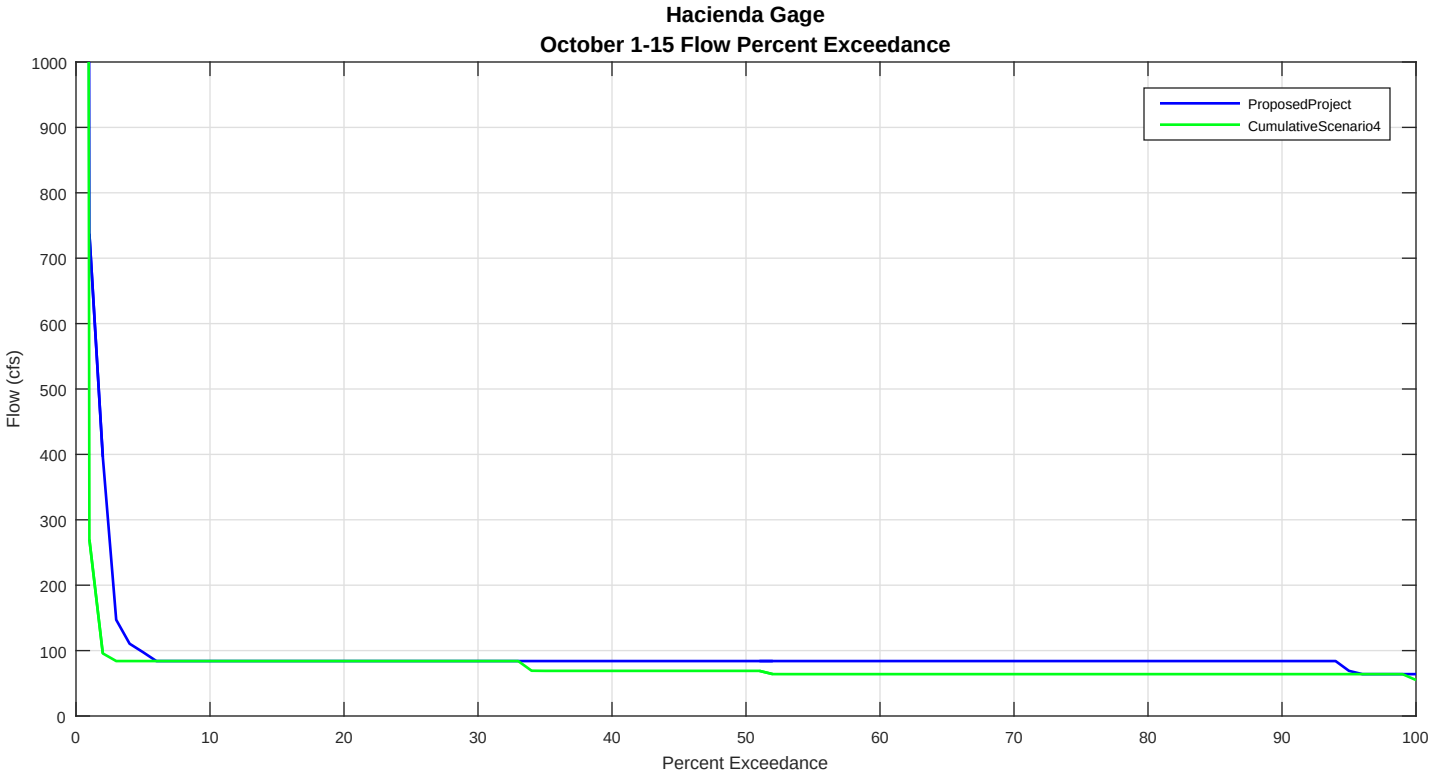
Hacienda Gage
October 1-15 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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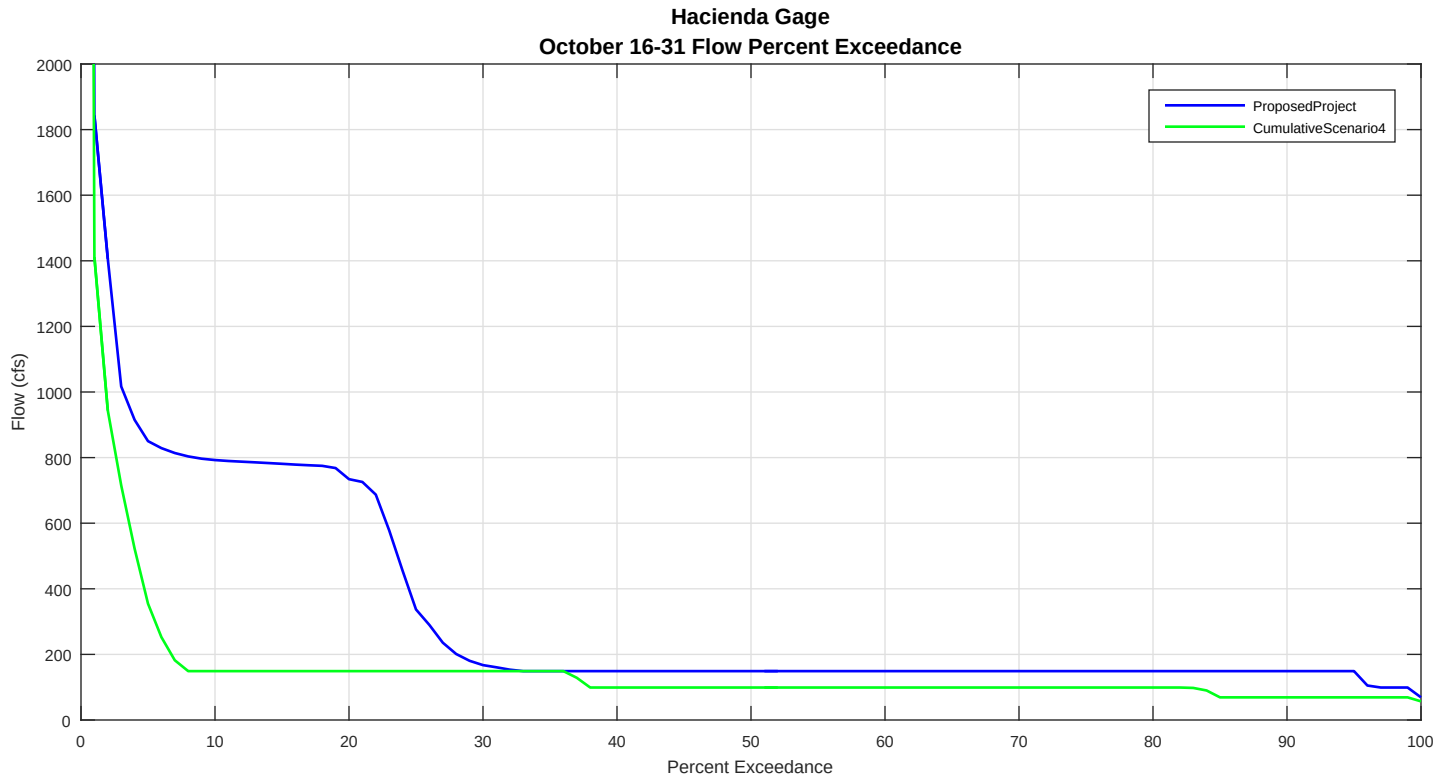
Hacienda Gage
October 16-31 Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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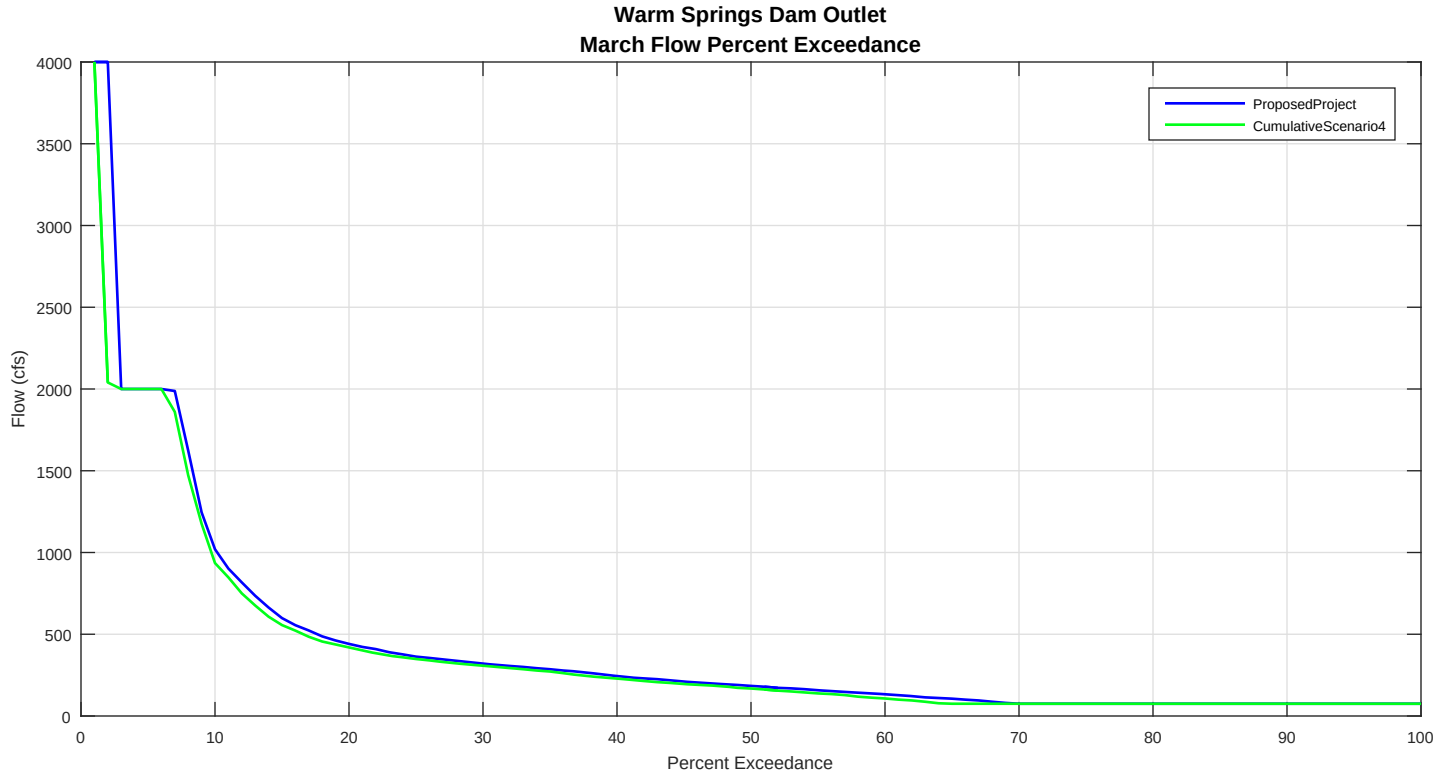
Warm Springs Dam Outlet
March Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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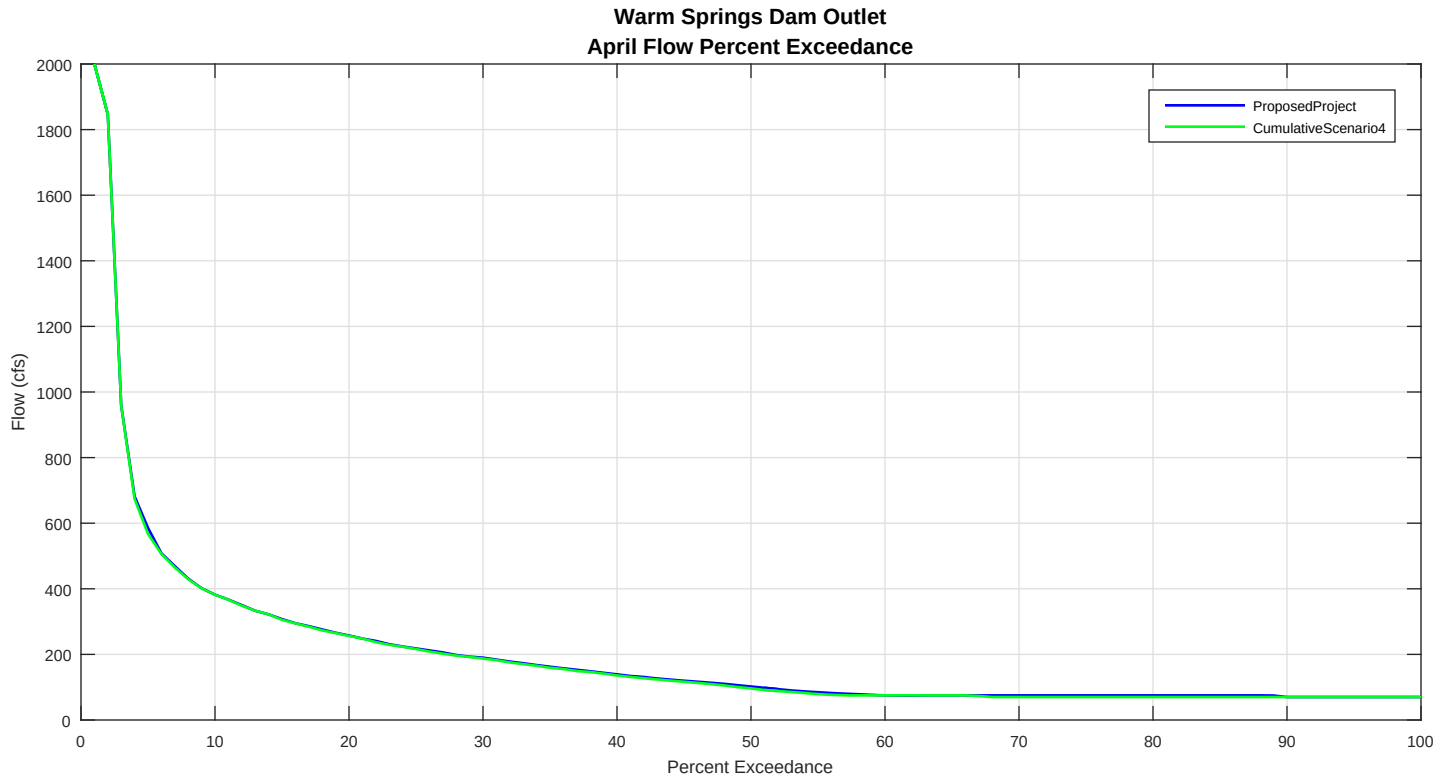
Warm Springs Dam Outlet
April Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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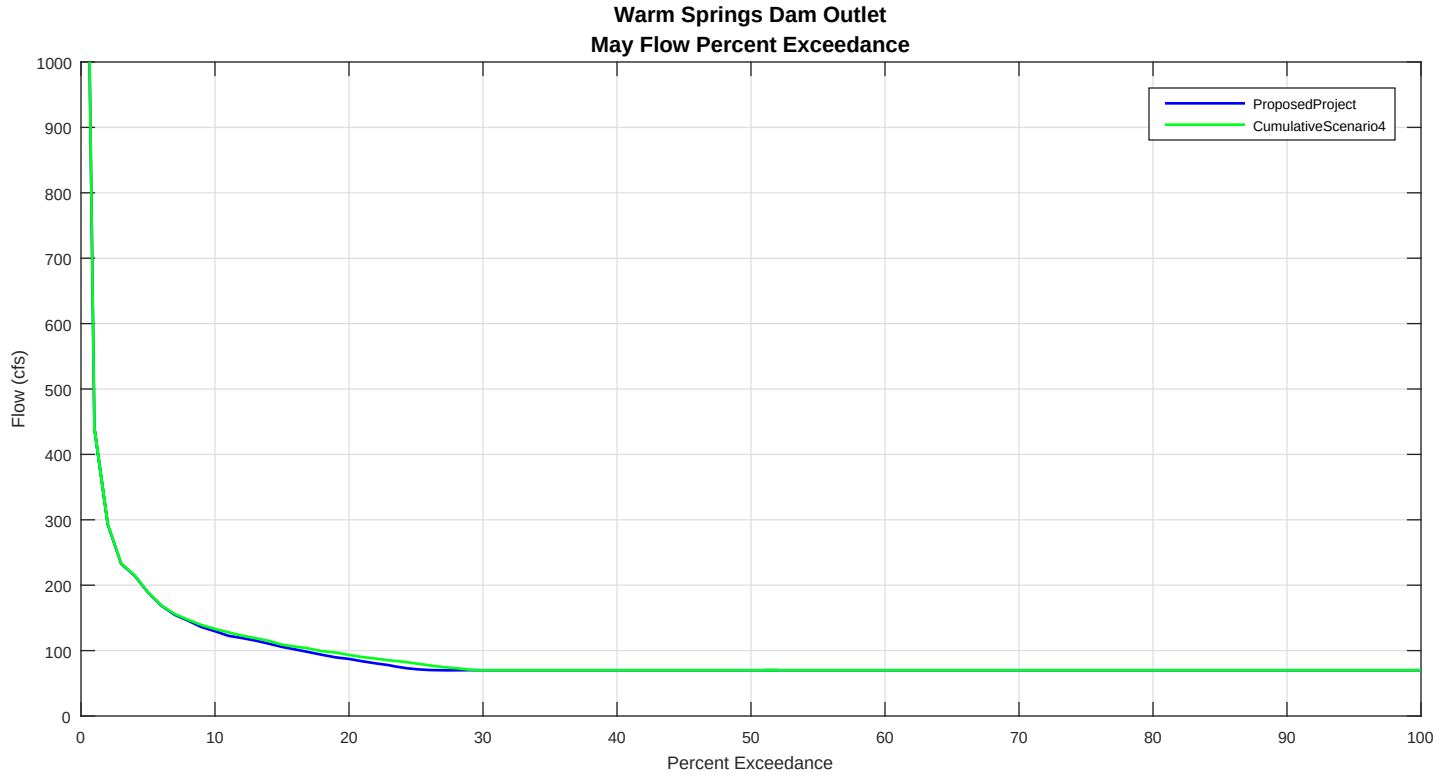
Warm Springs Dam Outlet
May Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
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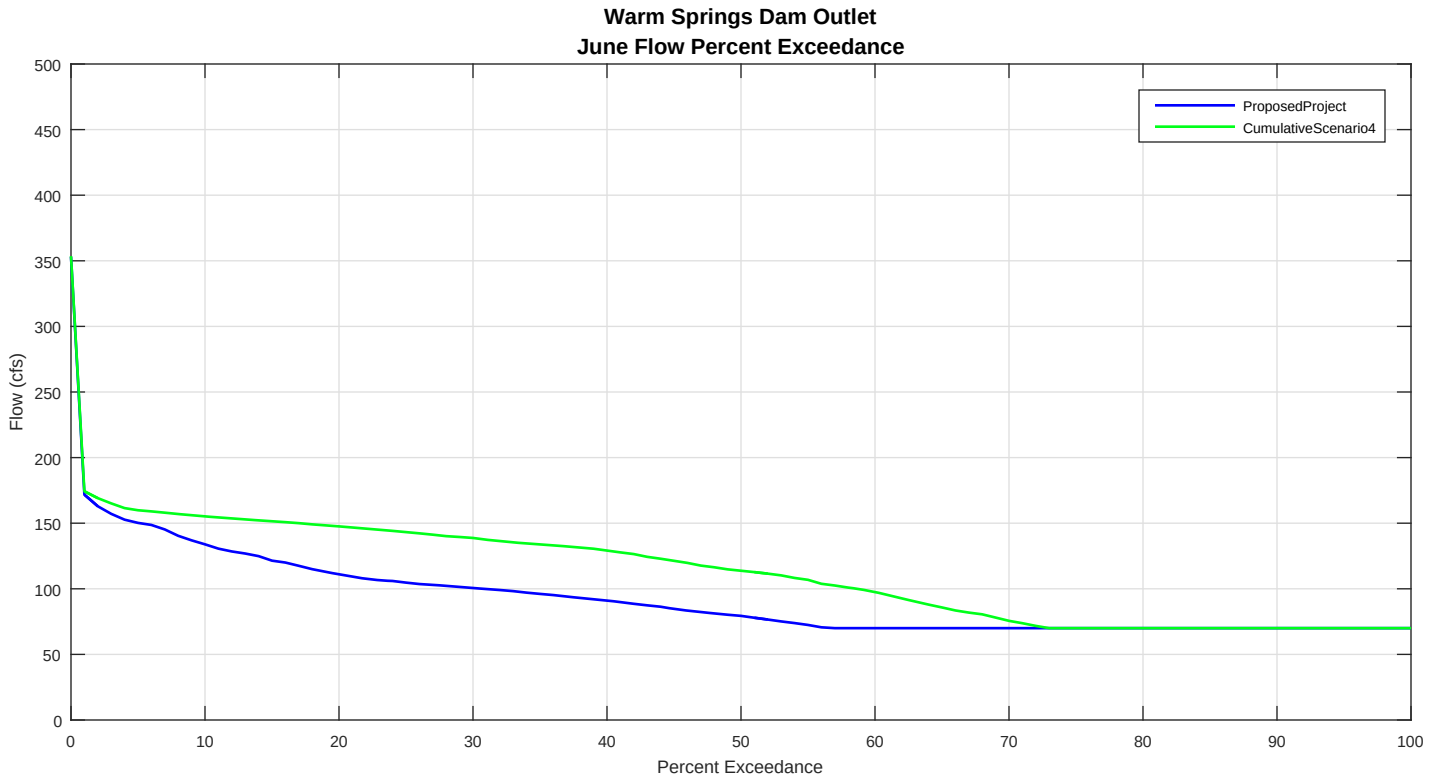
Warm Springs Dam Outlet
June Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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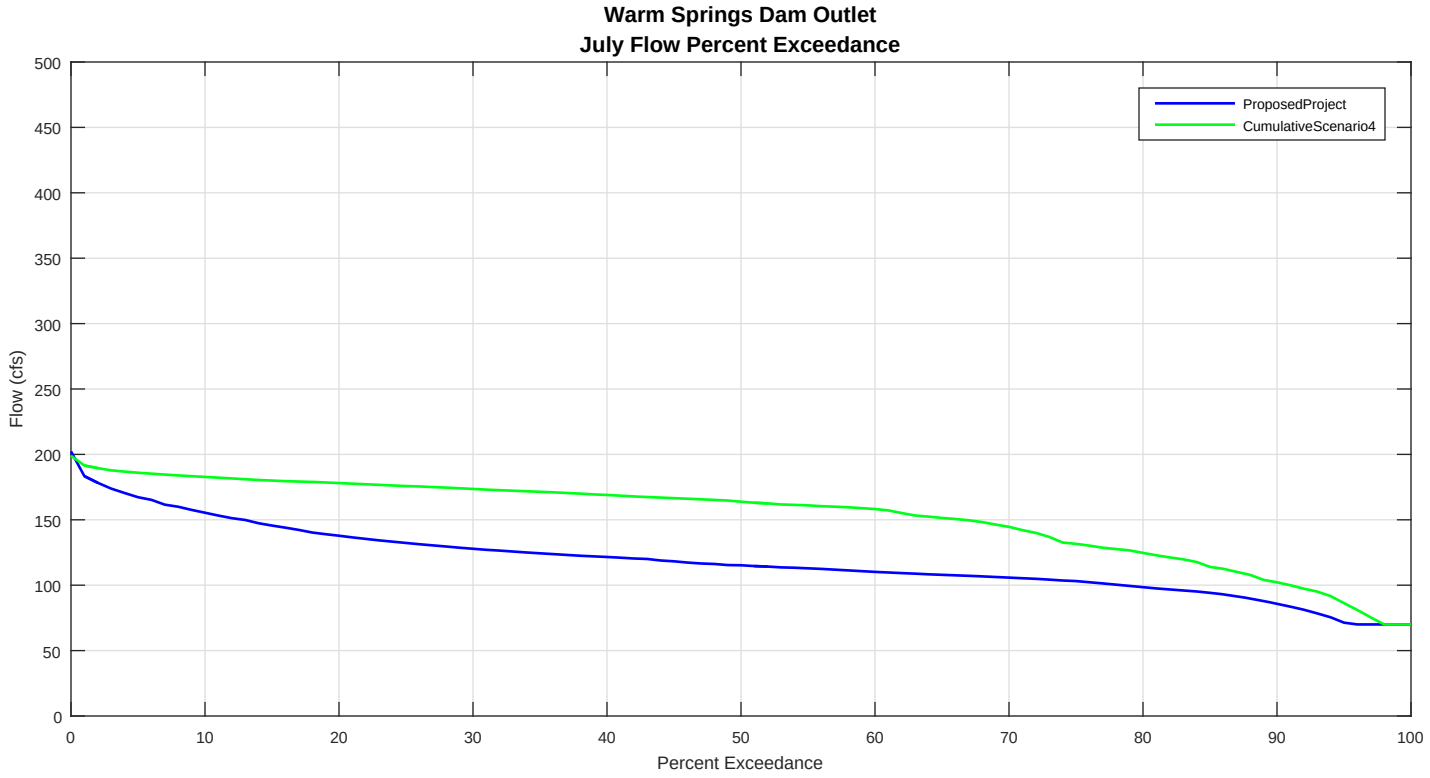
Warm Springs Dam Outlet
July Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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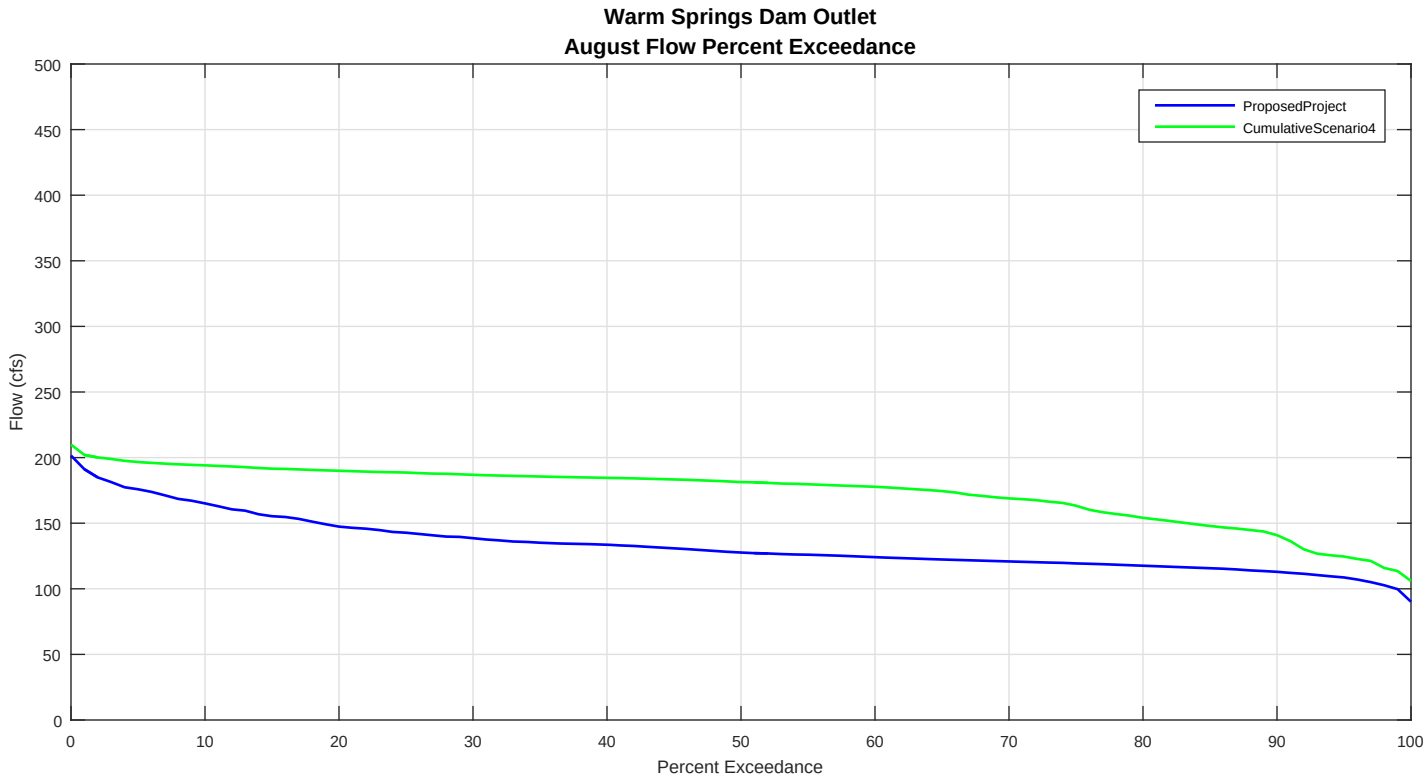
Warm Springs Dam Outlet
August Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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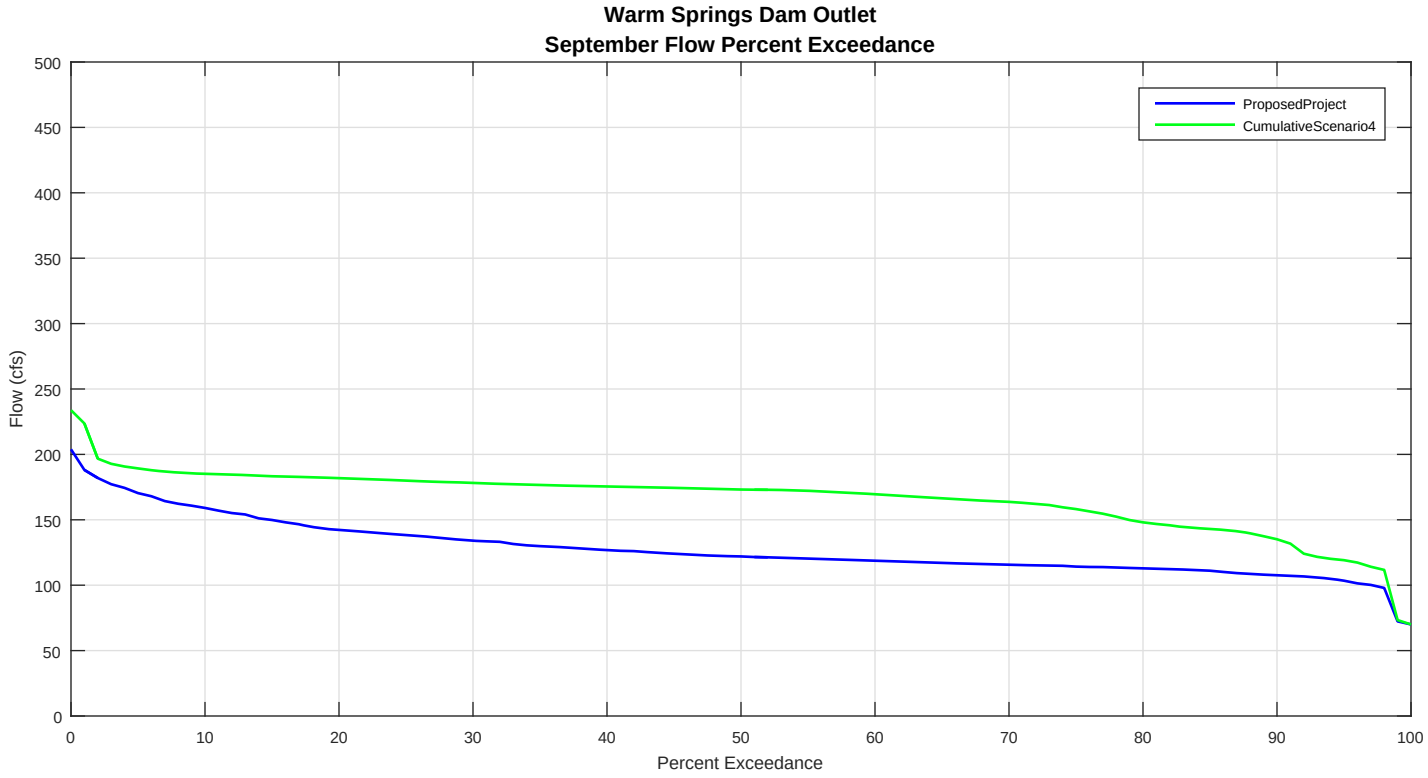
Warm Springs Dam Outlet
September Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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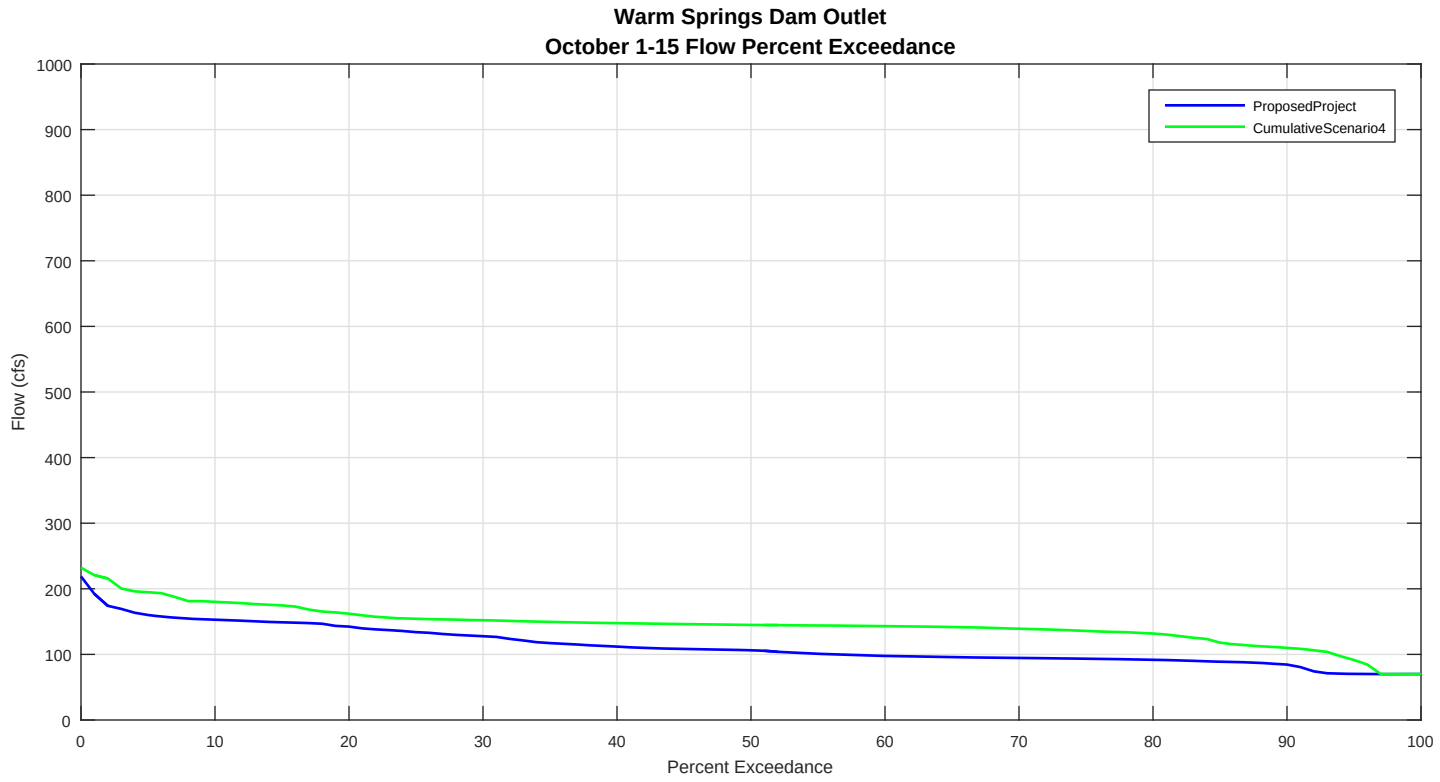
Warm Springs Dam Outlet
October 1-15 Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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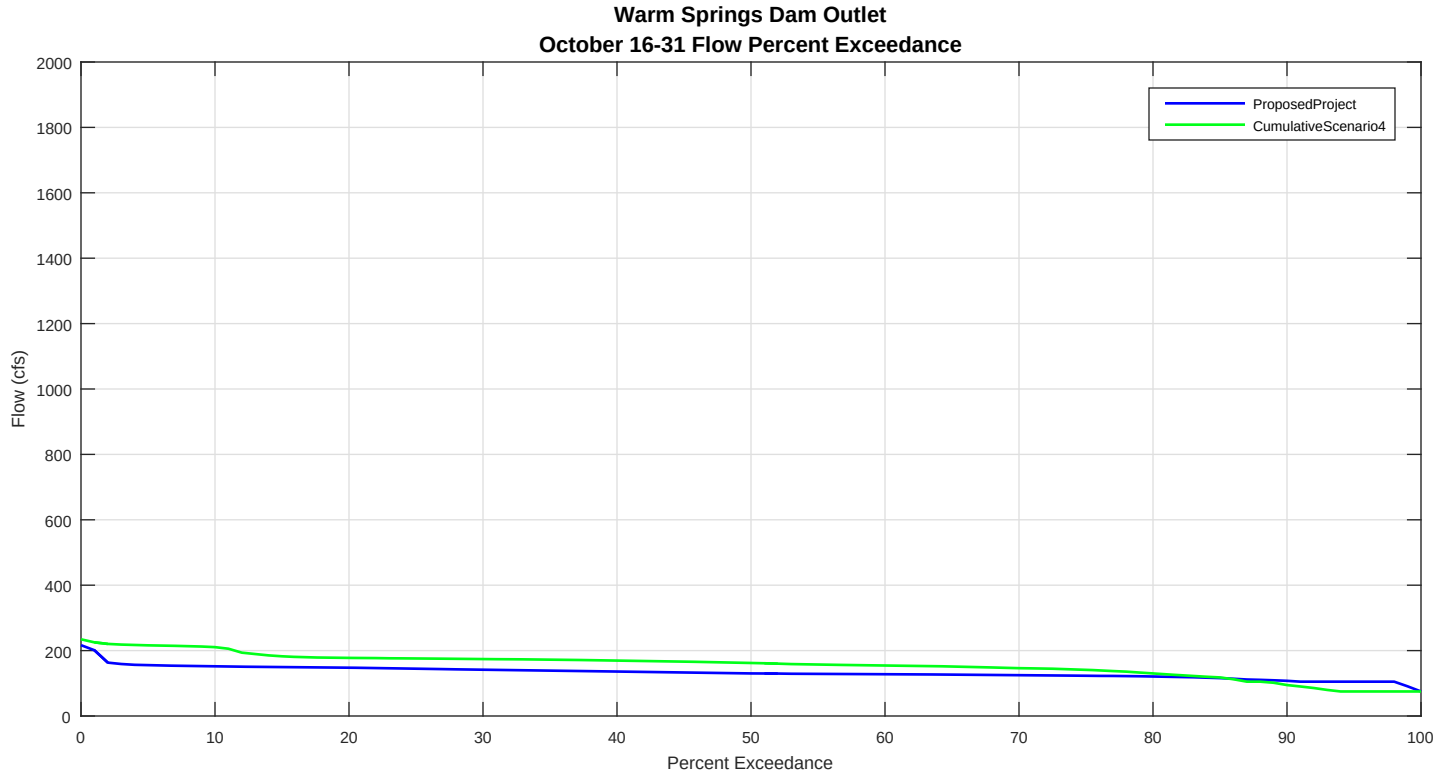
Warm Springs Dam Outlet
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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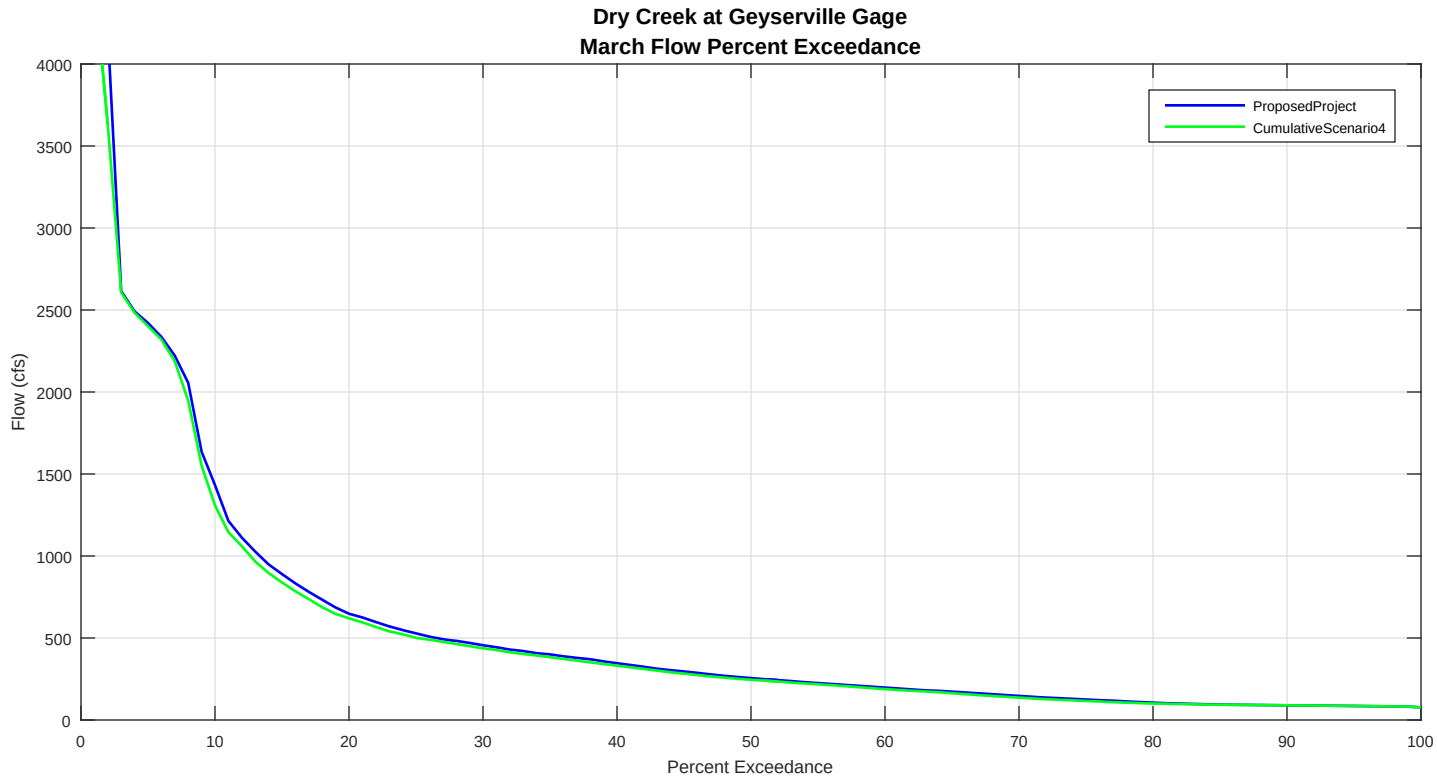
Dry Creek at Geyserville Gage
March Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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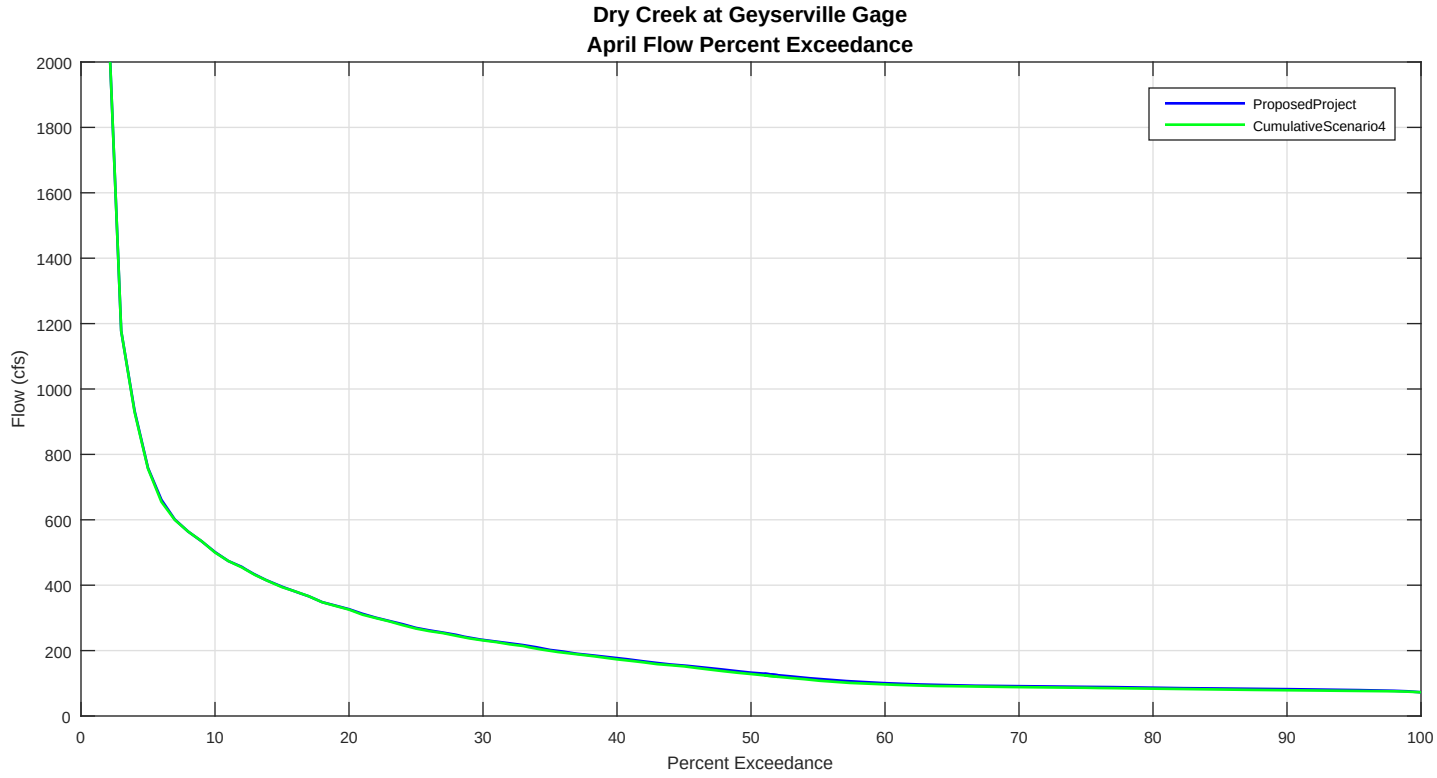
Dry Creek at Geyserville Gage
April Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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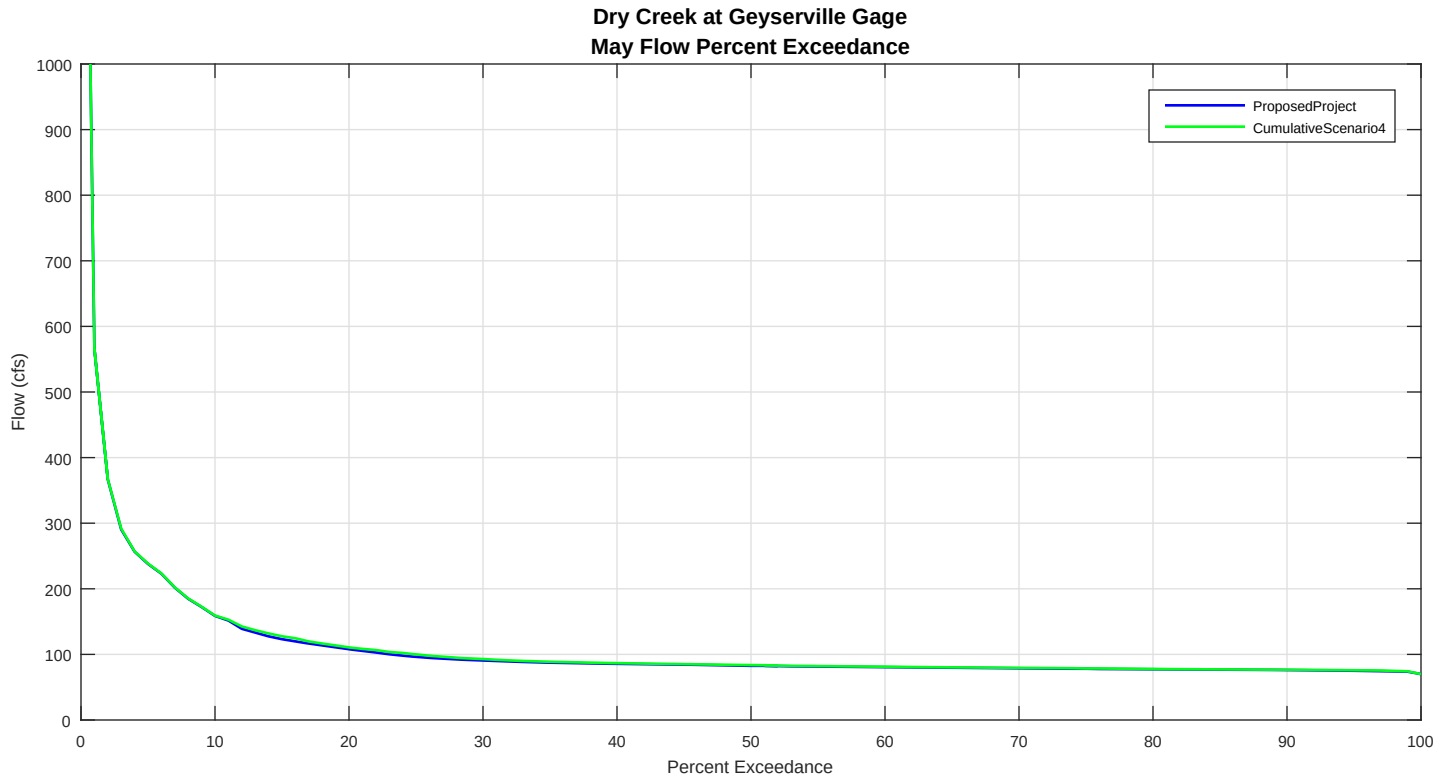
Dry Creek at Geyserville Gage
May Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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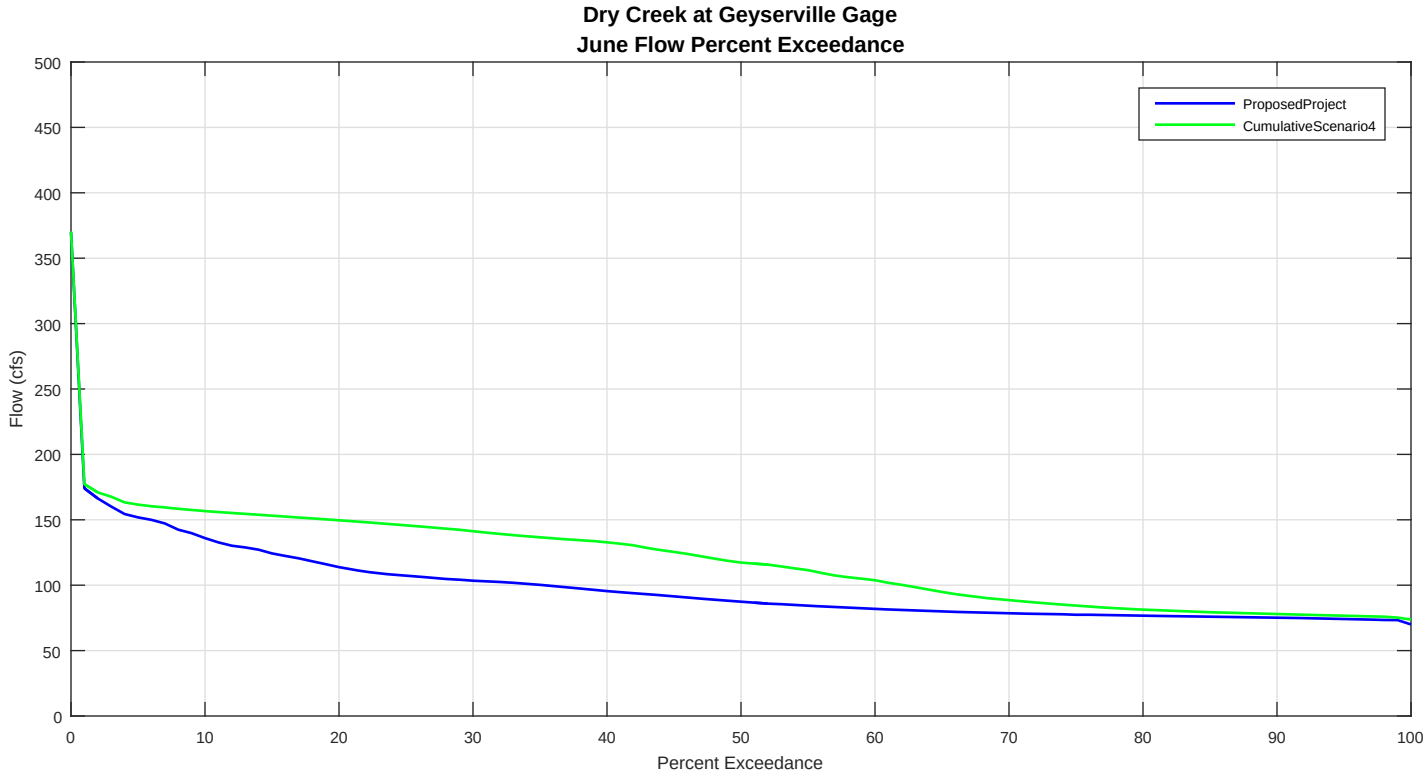
Dry Creek at Geyserville Gage
June Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
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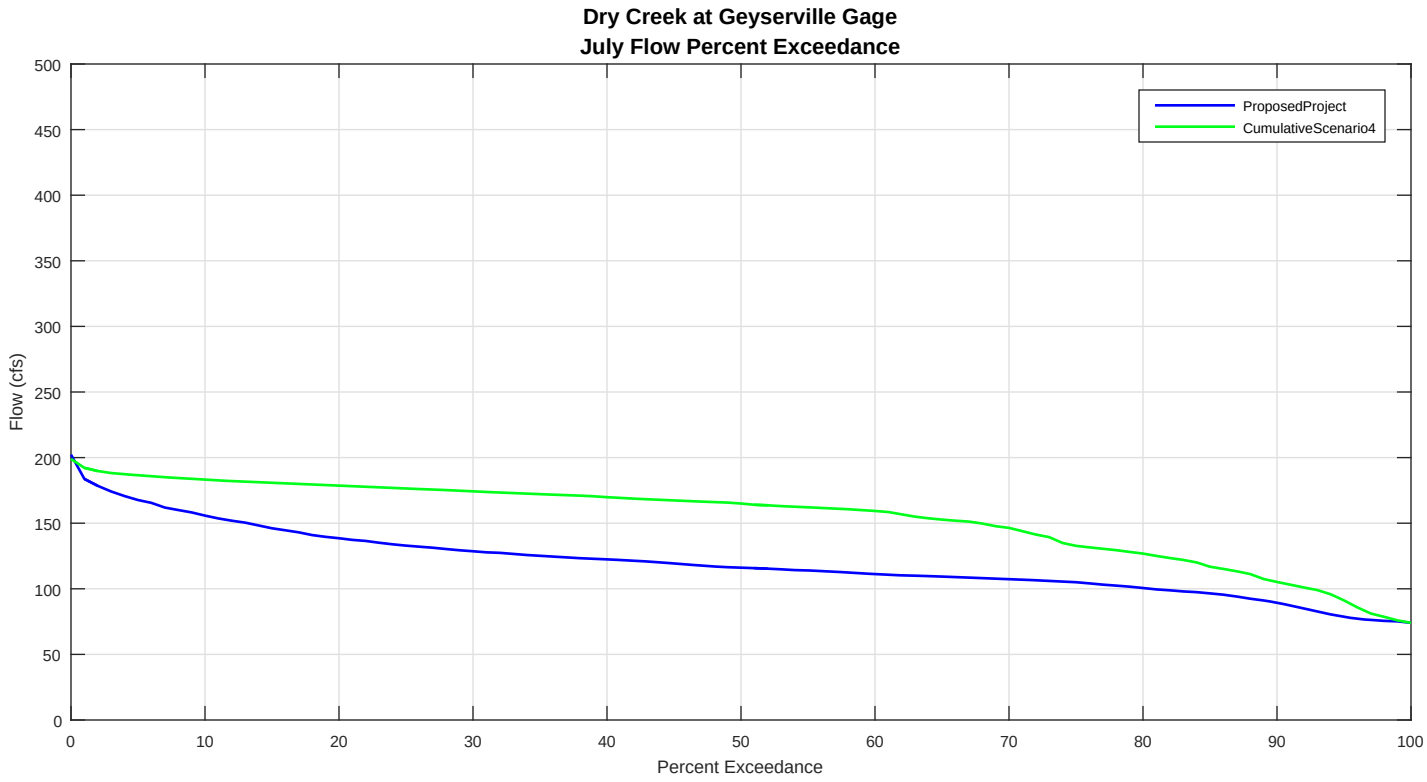
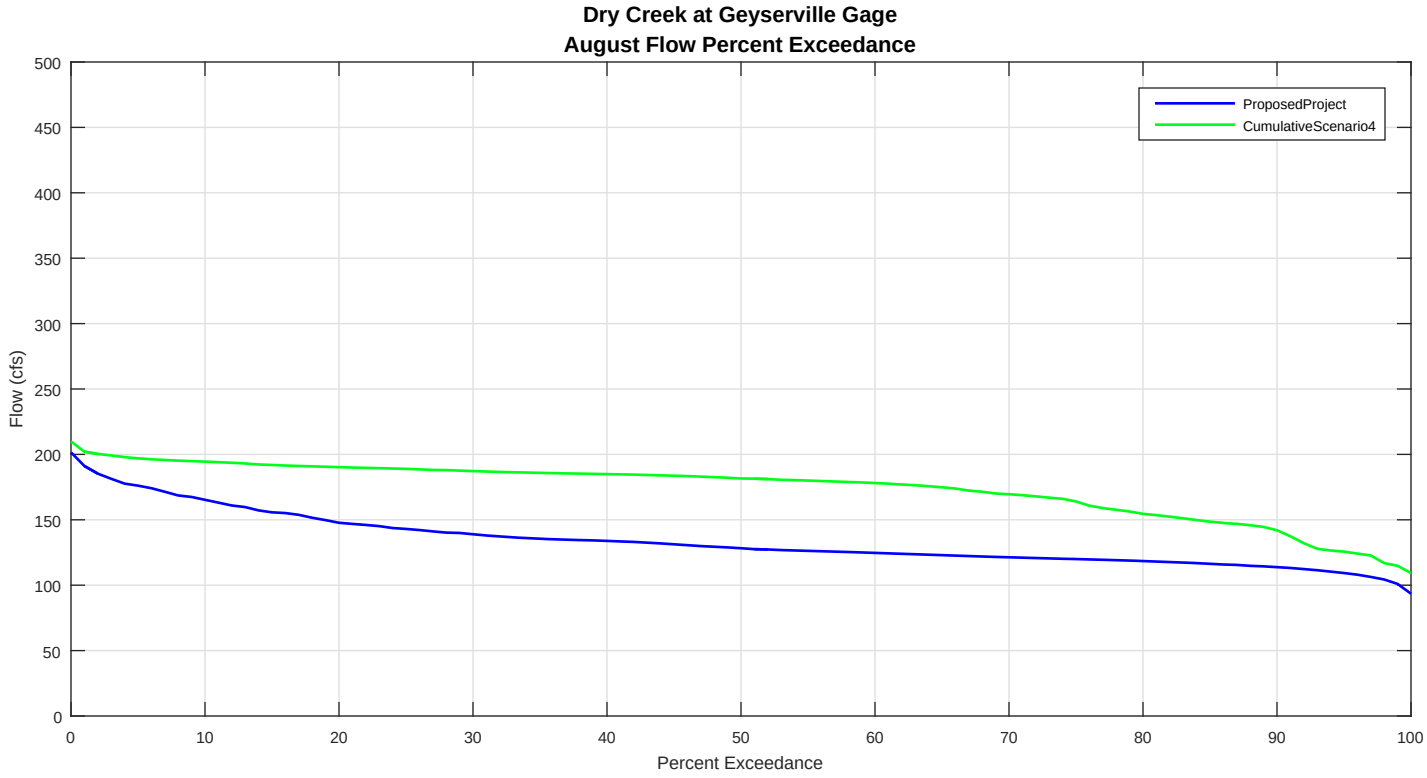
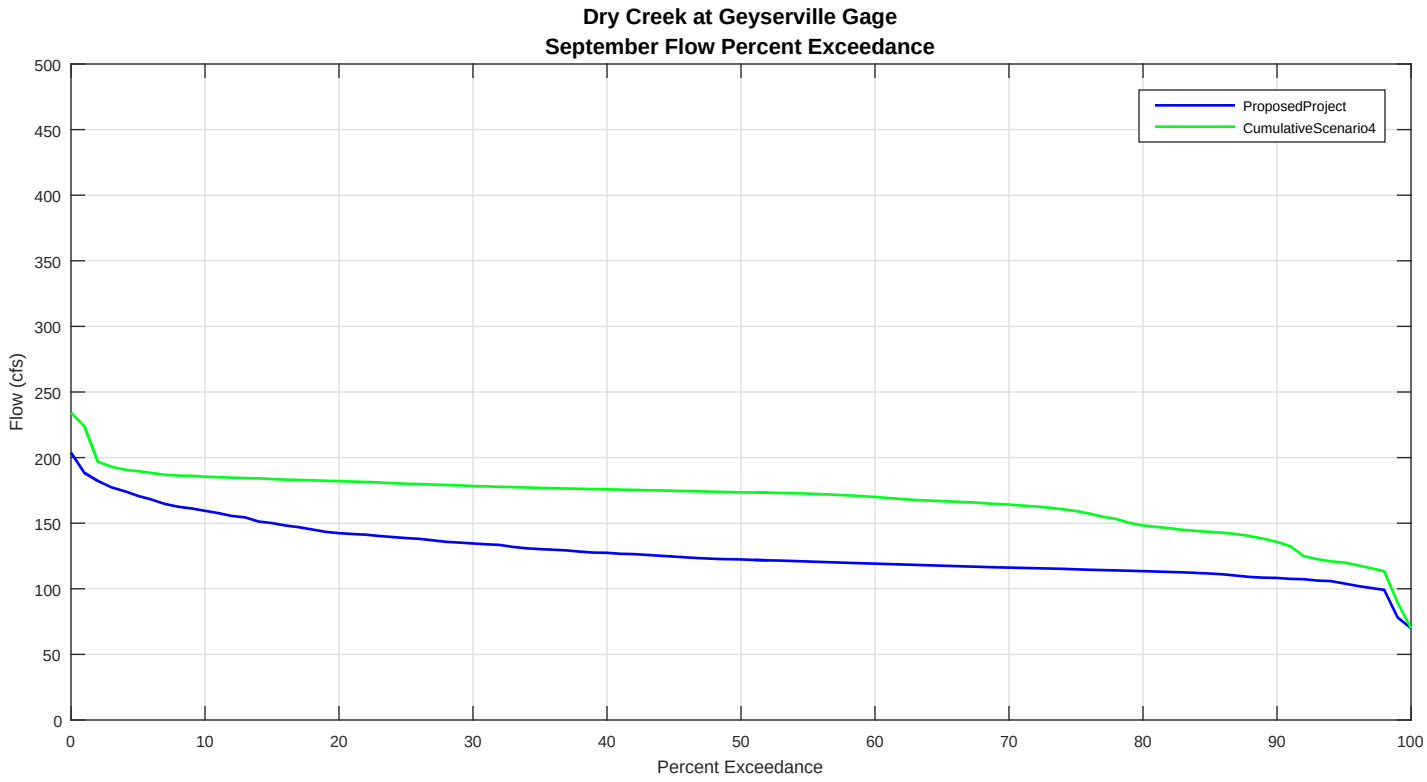
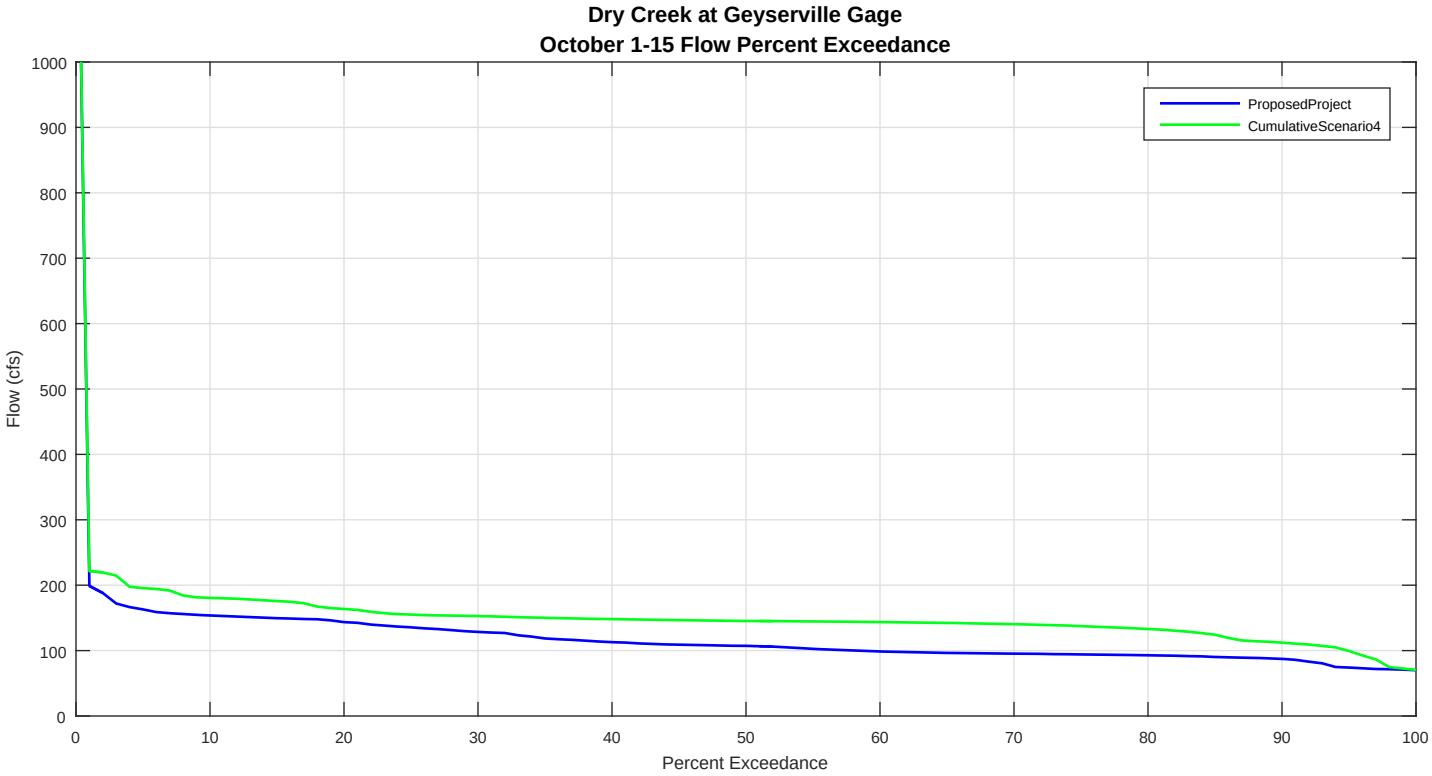
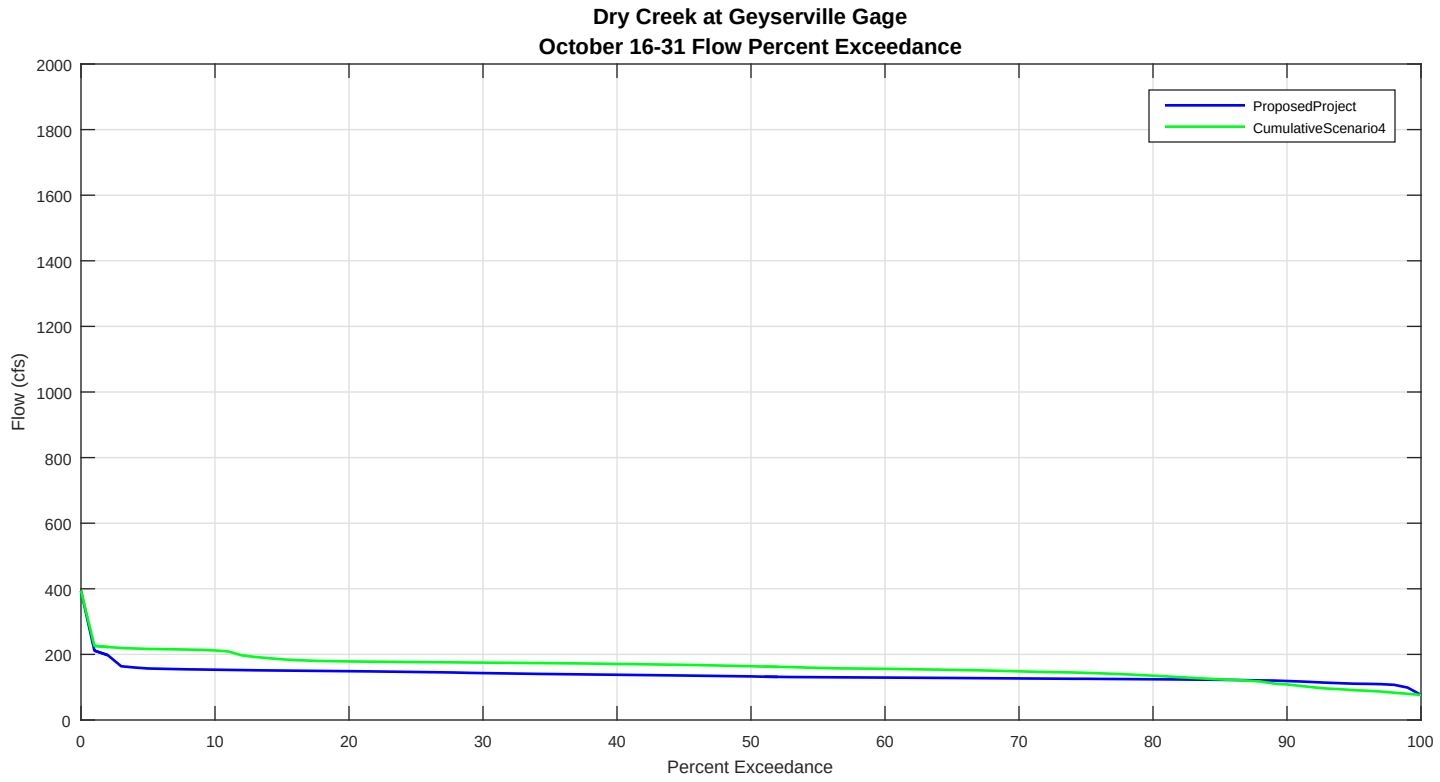
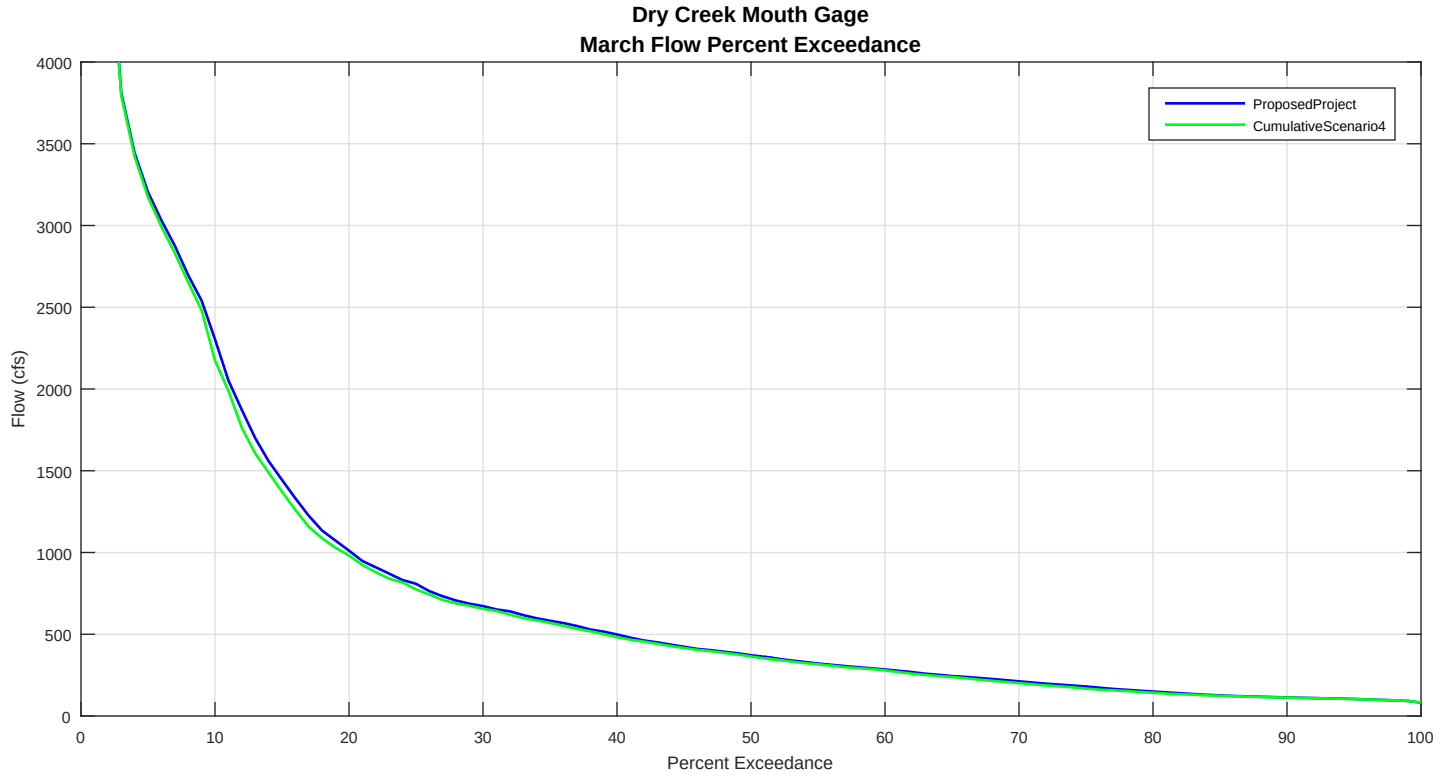

Dry Creek at Geyserville Gage
July Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

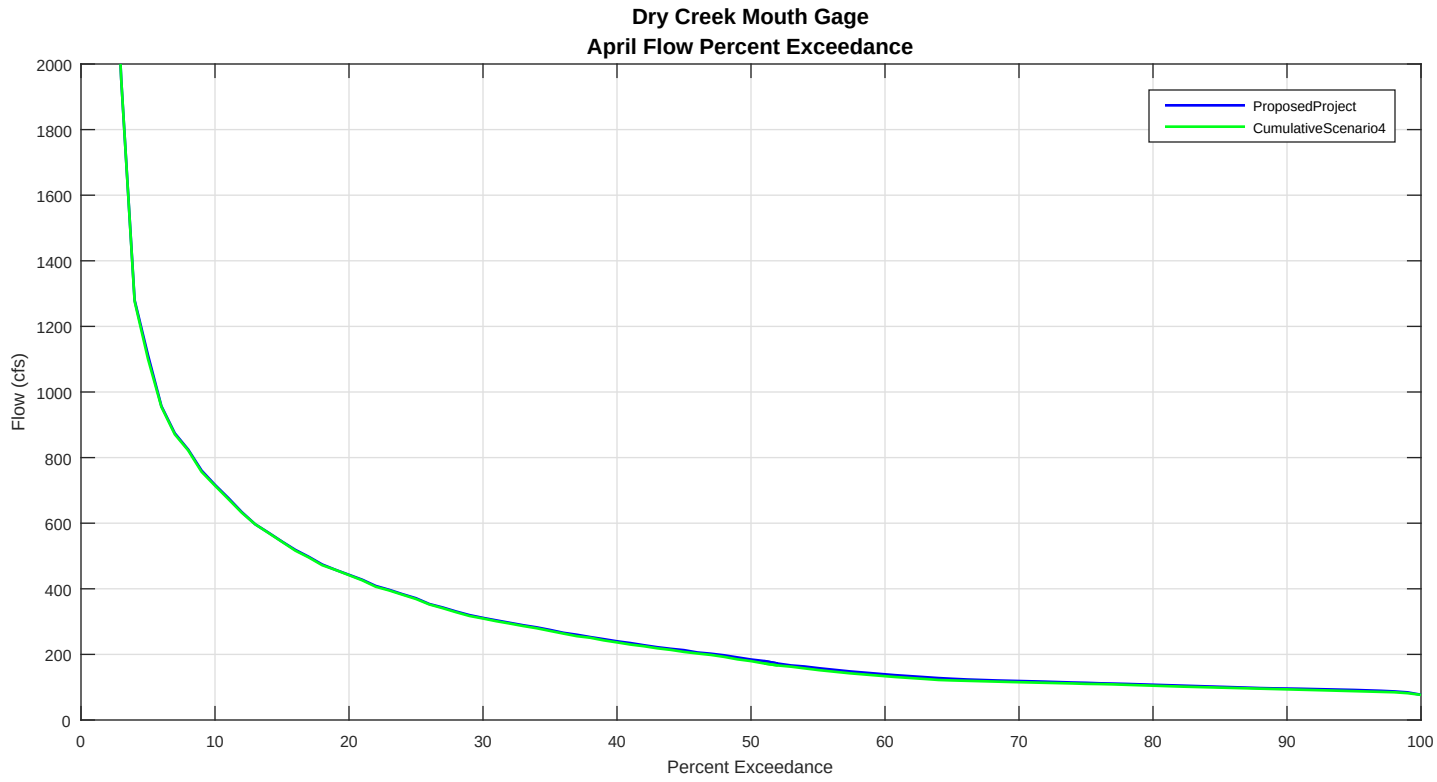

Dry Creek at Geyserville Gage
August Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

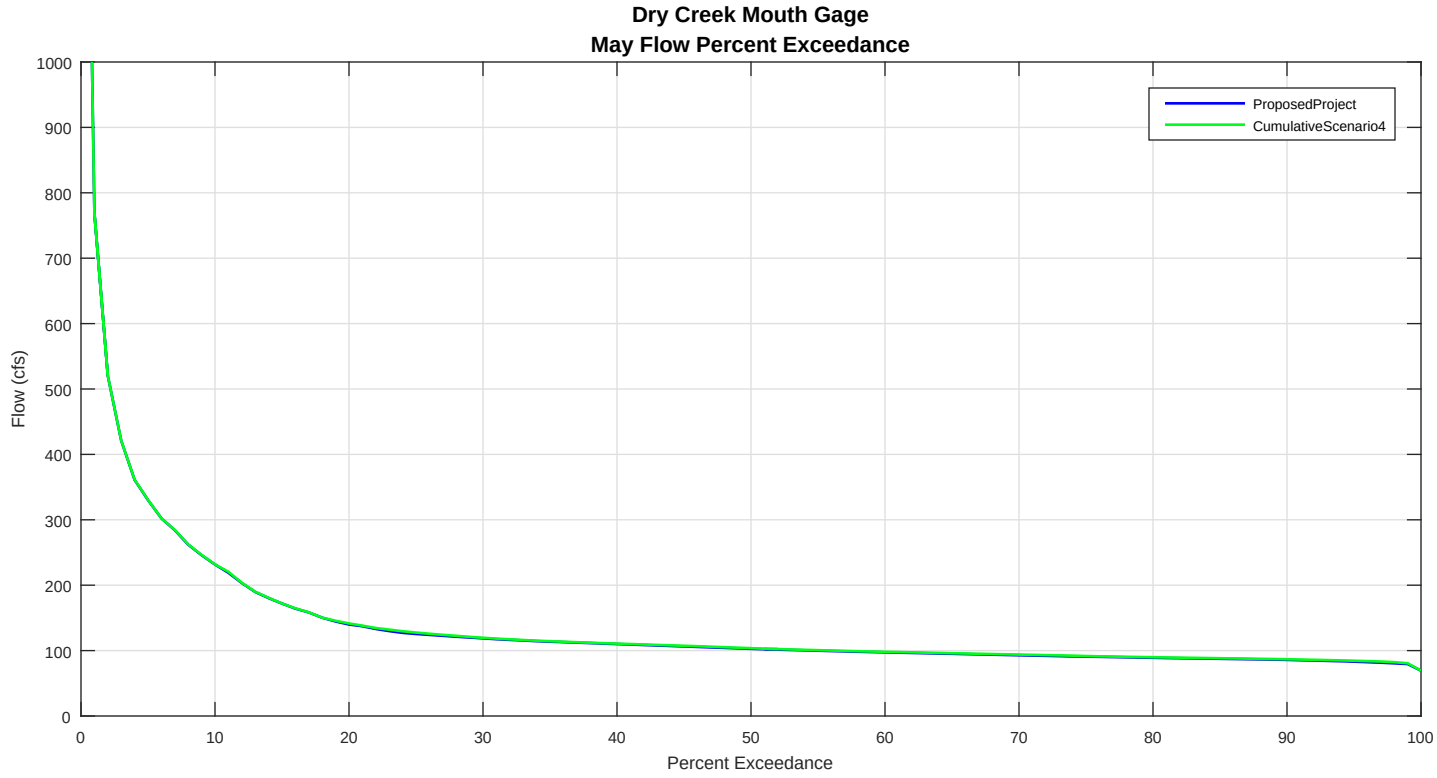

Dry Creek at Geyserville Gage
September Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

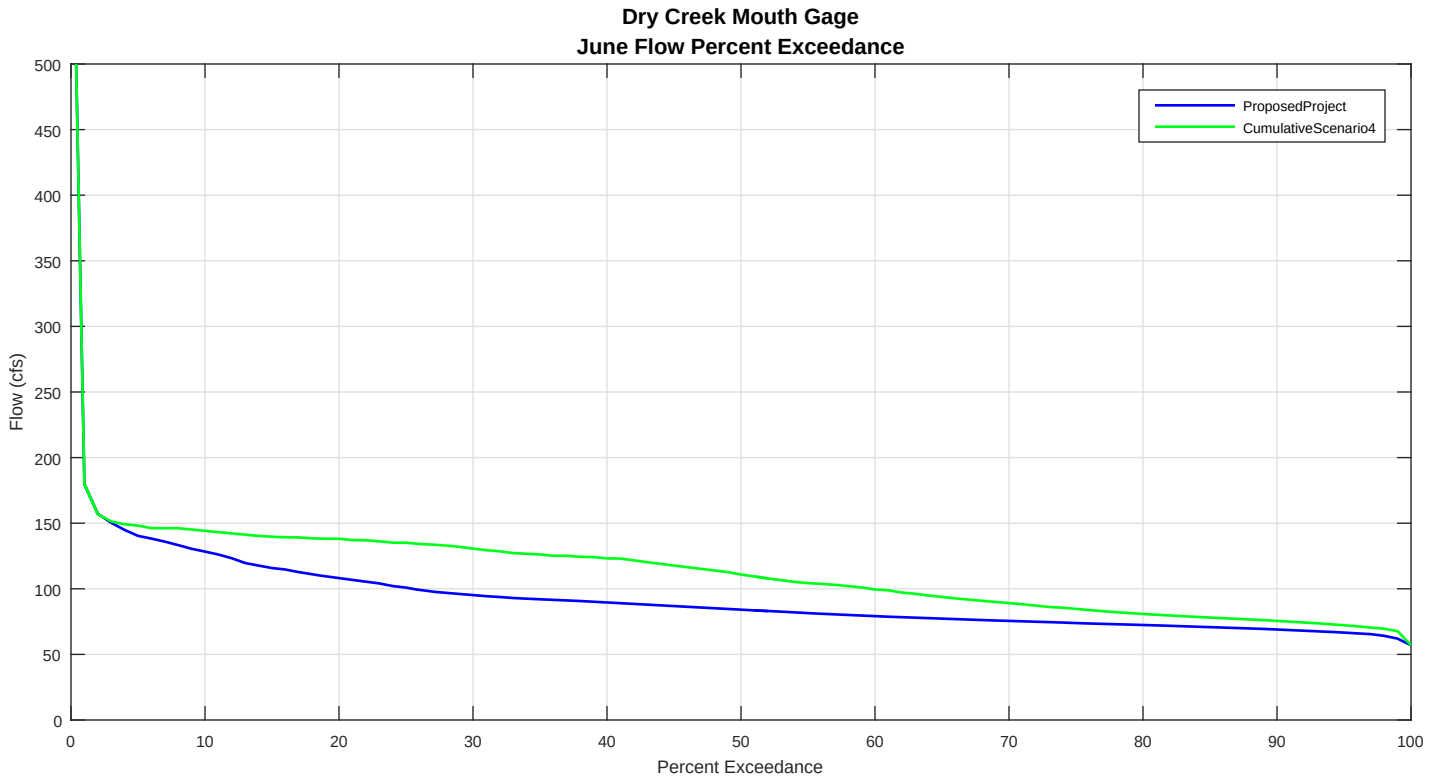

Dry Creek at Geyserville Gage
October 1-15 Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100

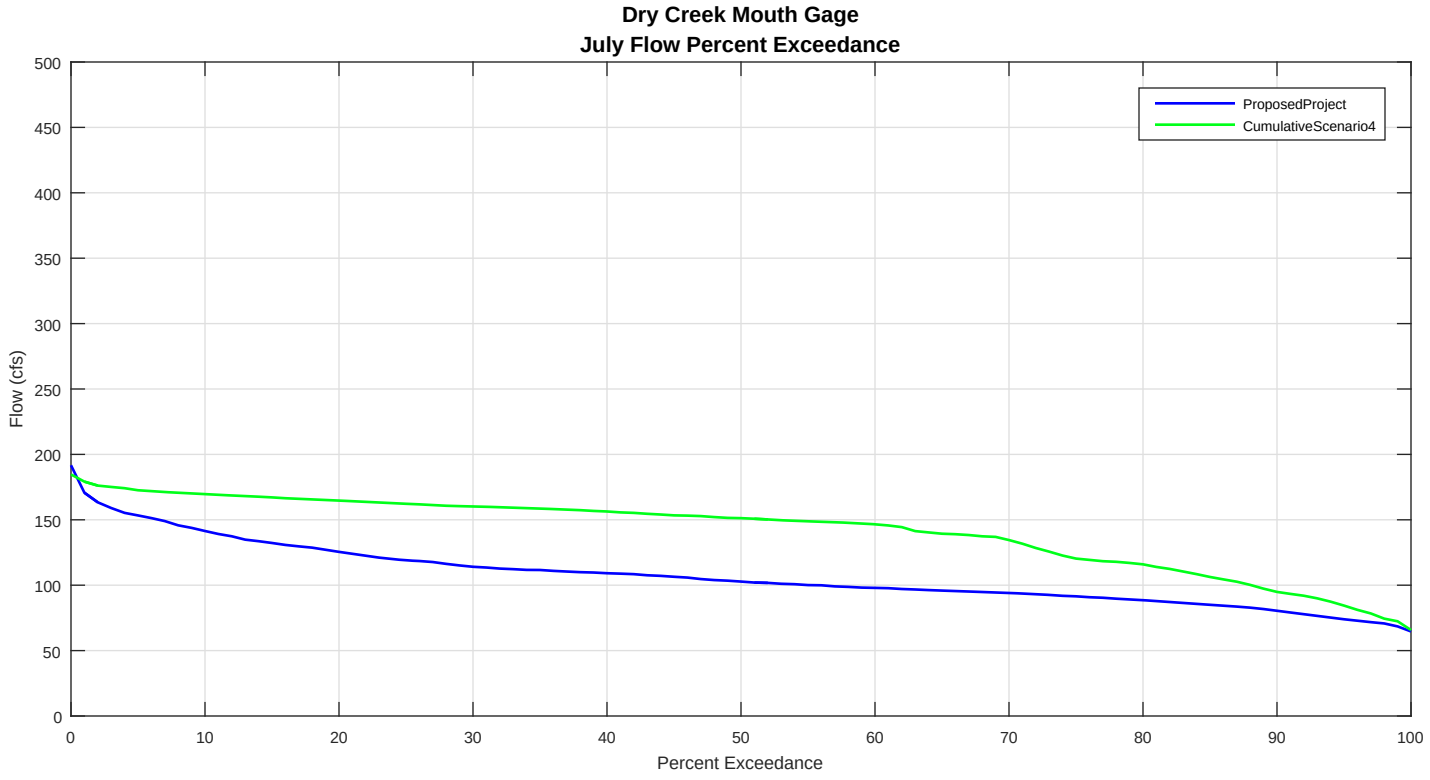

Dry Creek at Geyserville Gage
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100

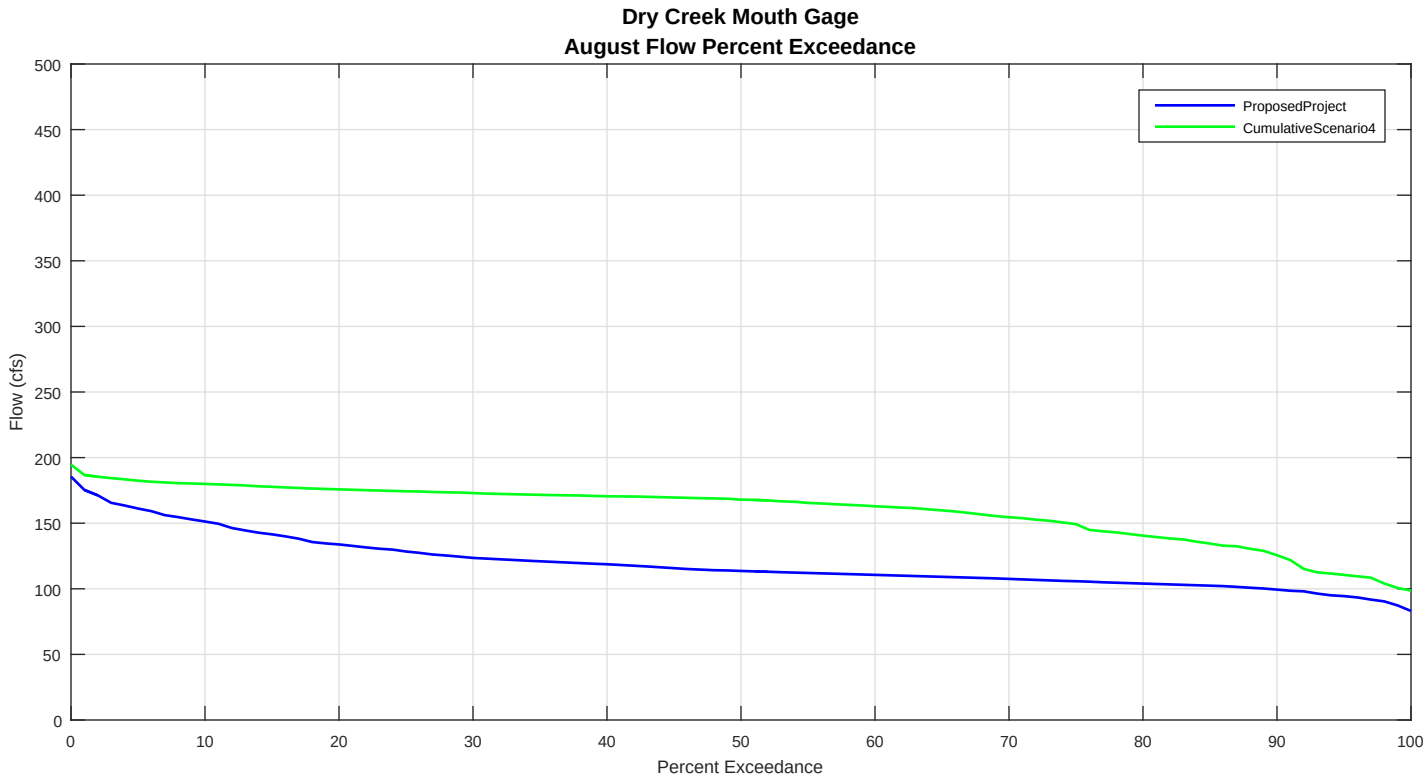

Dry Creek Mouth Gage
March Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
0
500
1000
1500
2000
2500
3000
3500
4000
0
10
20
30
40
50
60
70
80
90
100

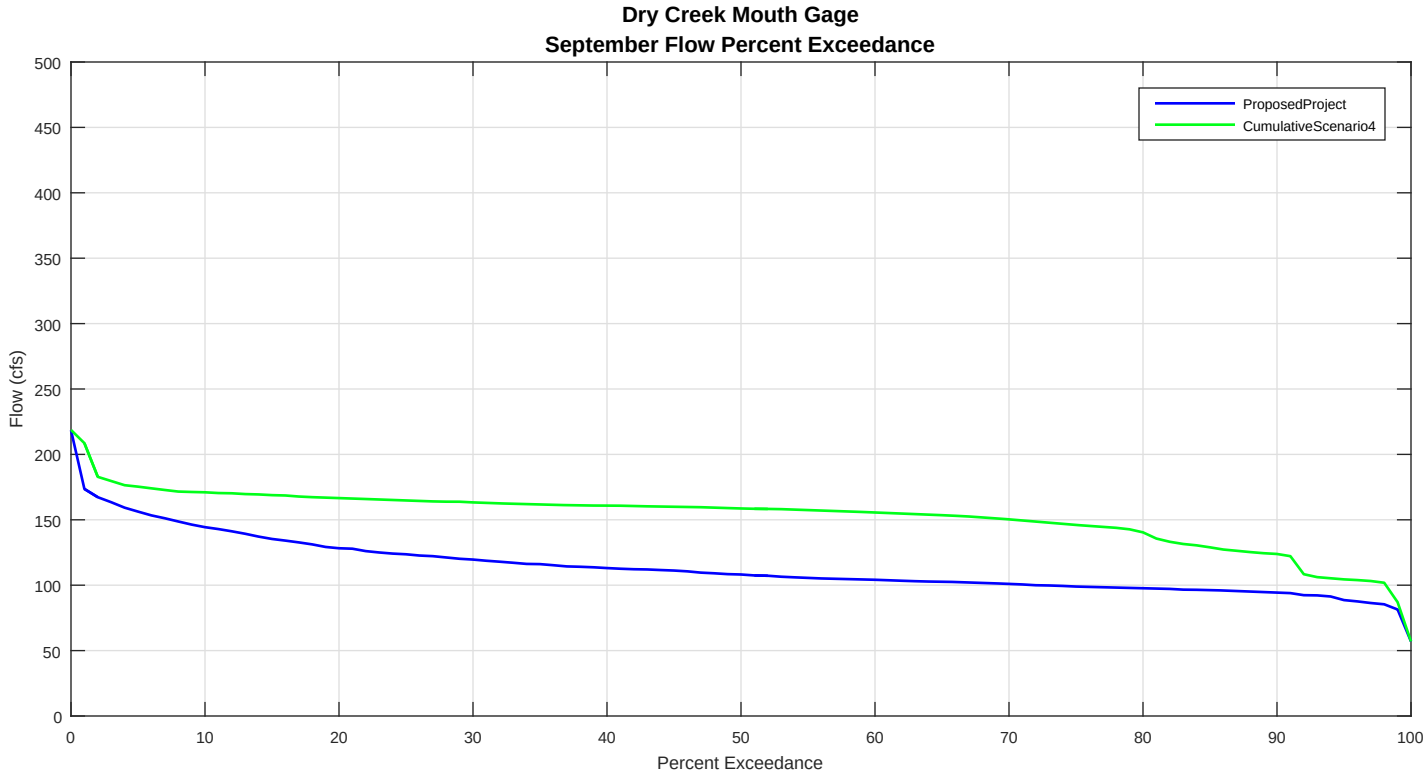

Dry Creek Mouth Gage
April Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100

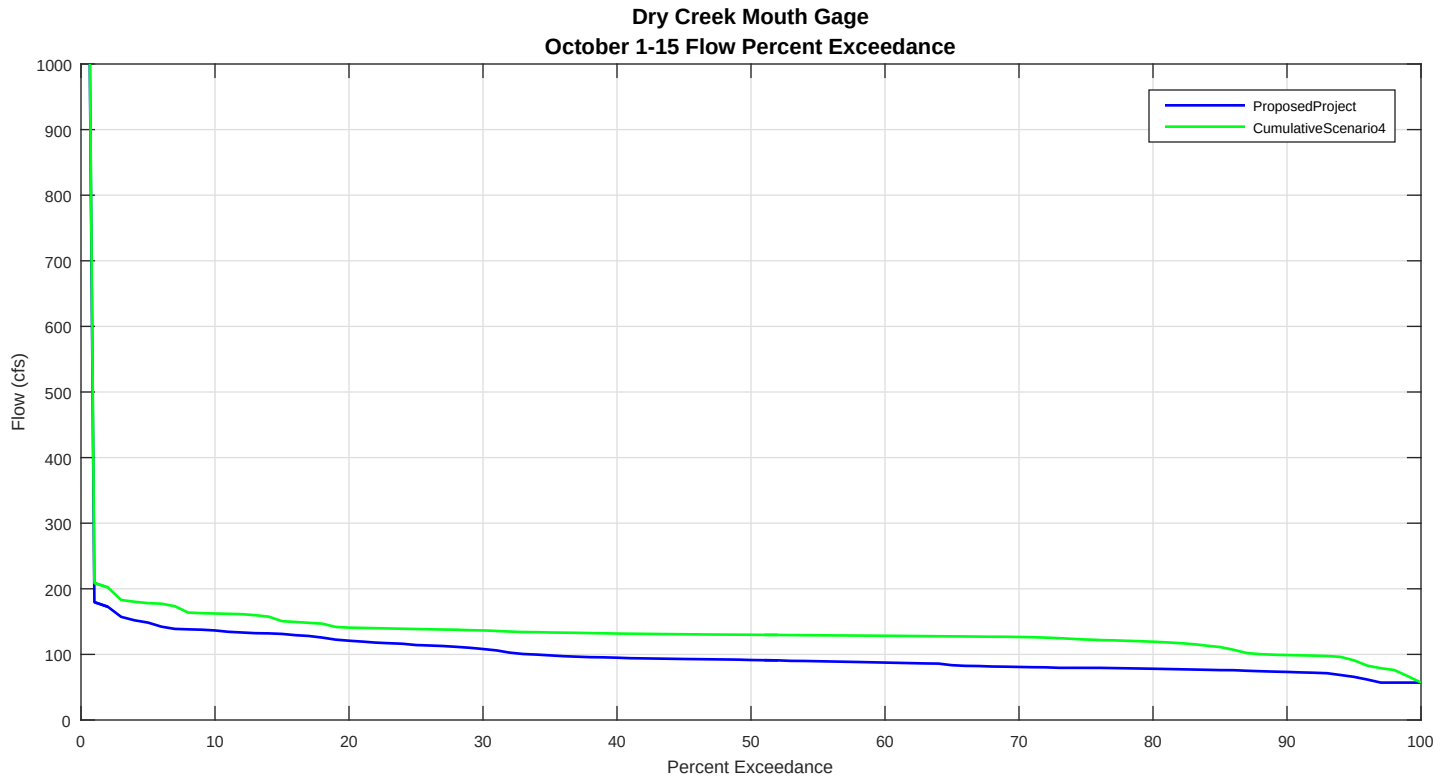

Dry Creek Mouth Gage
May Flow Percent Exceedance
Flow (cfs)
Percent Exceedance
ProposedProject
CumulativeScenario4
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100

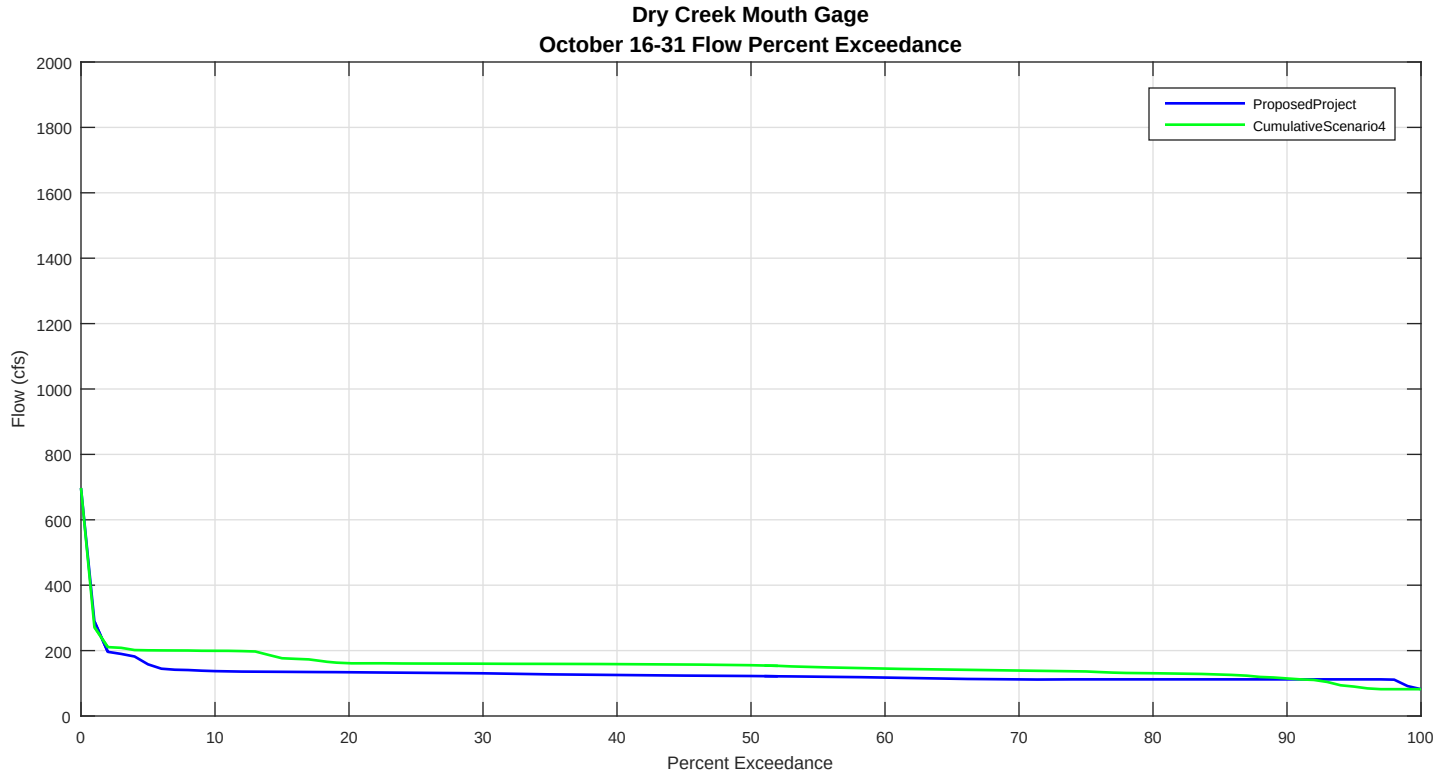

Dry Creek Mouth Gage
June Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

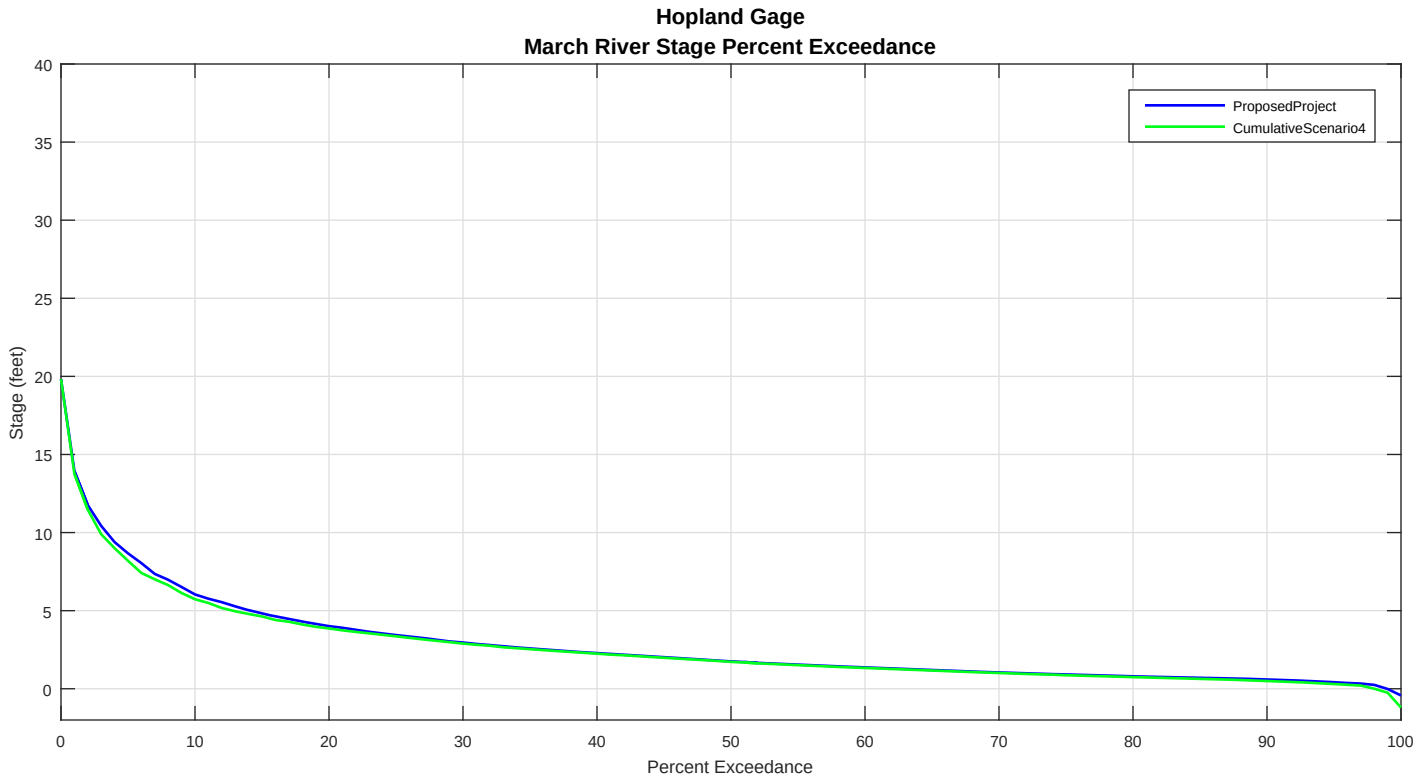

Dry Creek Mouth Gage
July Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

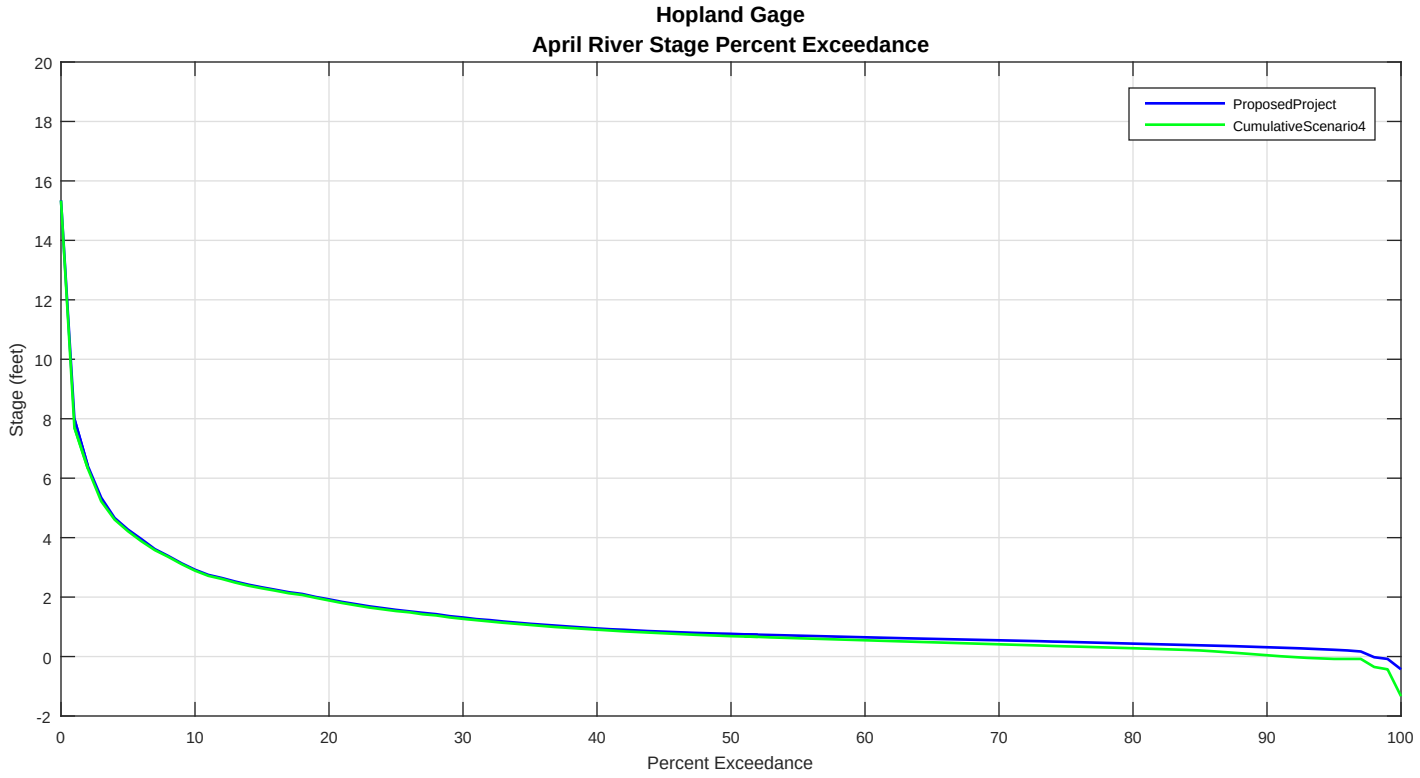

Dry Creek Mouth Gage
August Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

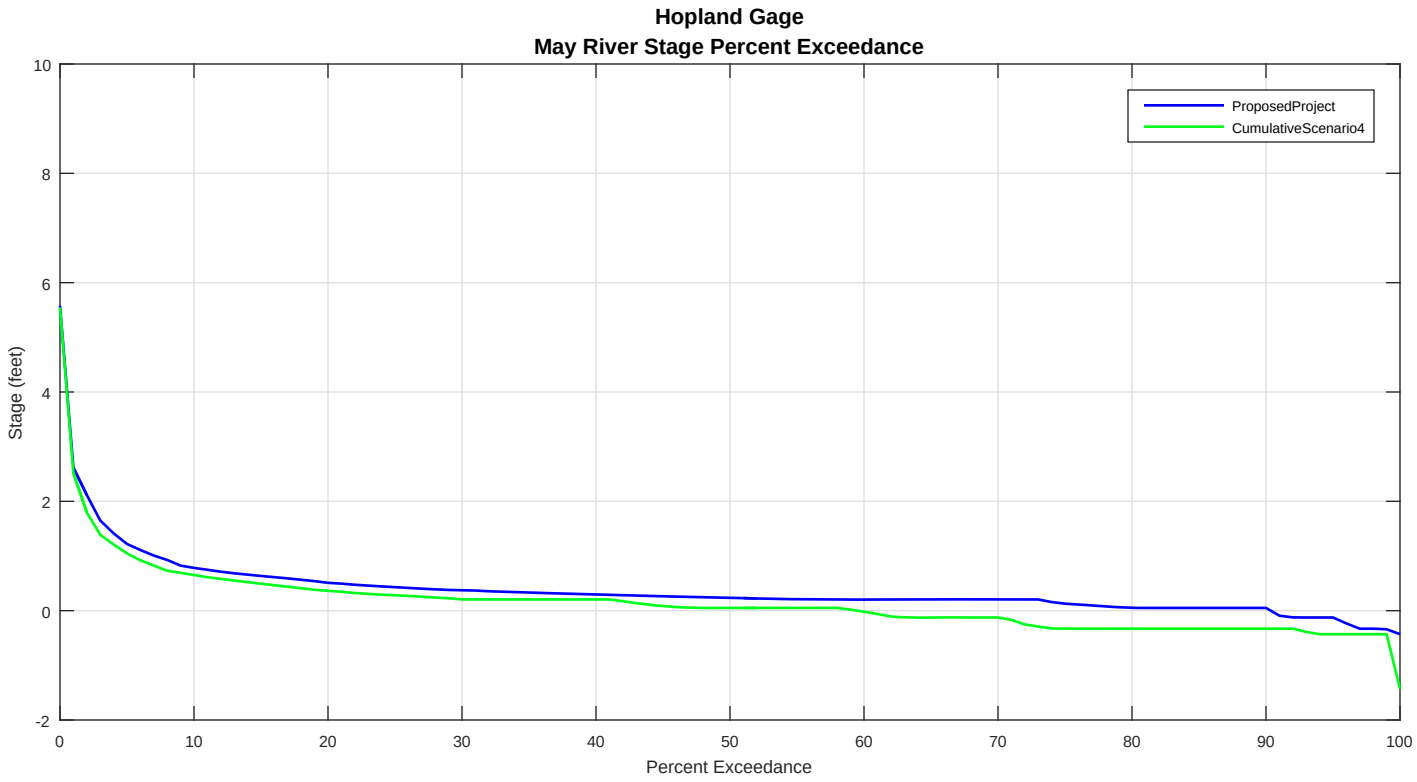

Dry Creek Mouth Gage
September Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
80
90
100

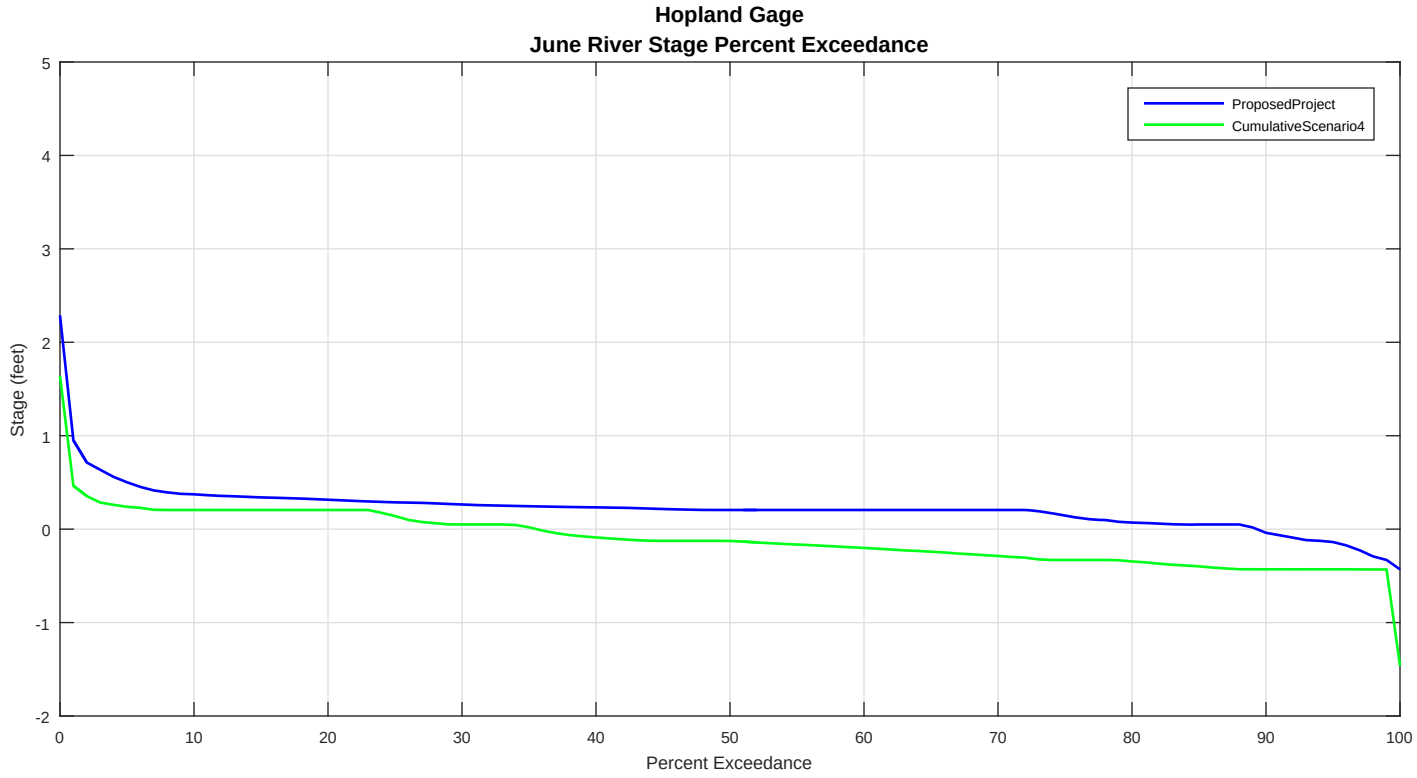

Dry Creek Mouth Gage
October 1-15 Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
0
100
200
300
400
500
600
700
800
900
1000
0
10
20
30
40
50
60
70
80
90
100

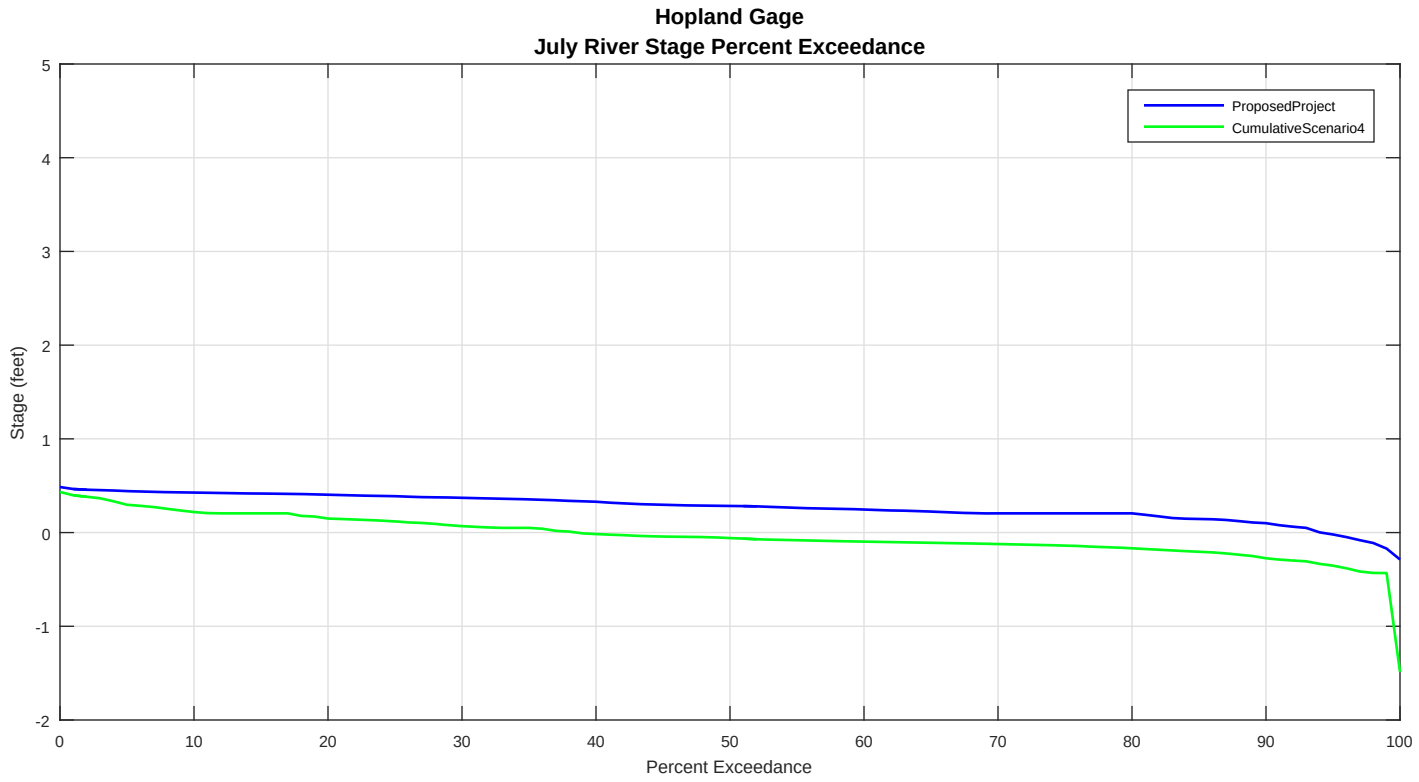

Dry Creek Mouth Gage
October 16-31 Flow Percent Exceedance
ProposedProject
CumulativeScenario4
Flow (cfs)
Percent Exceedance
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
10
20
30
40
50
60
70
80
90
100

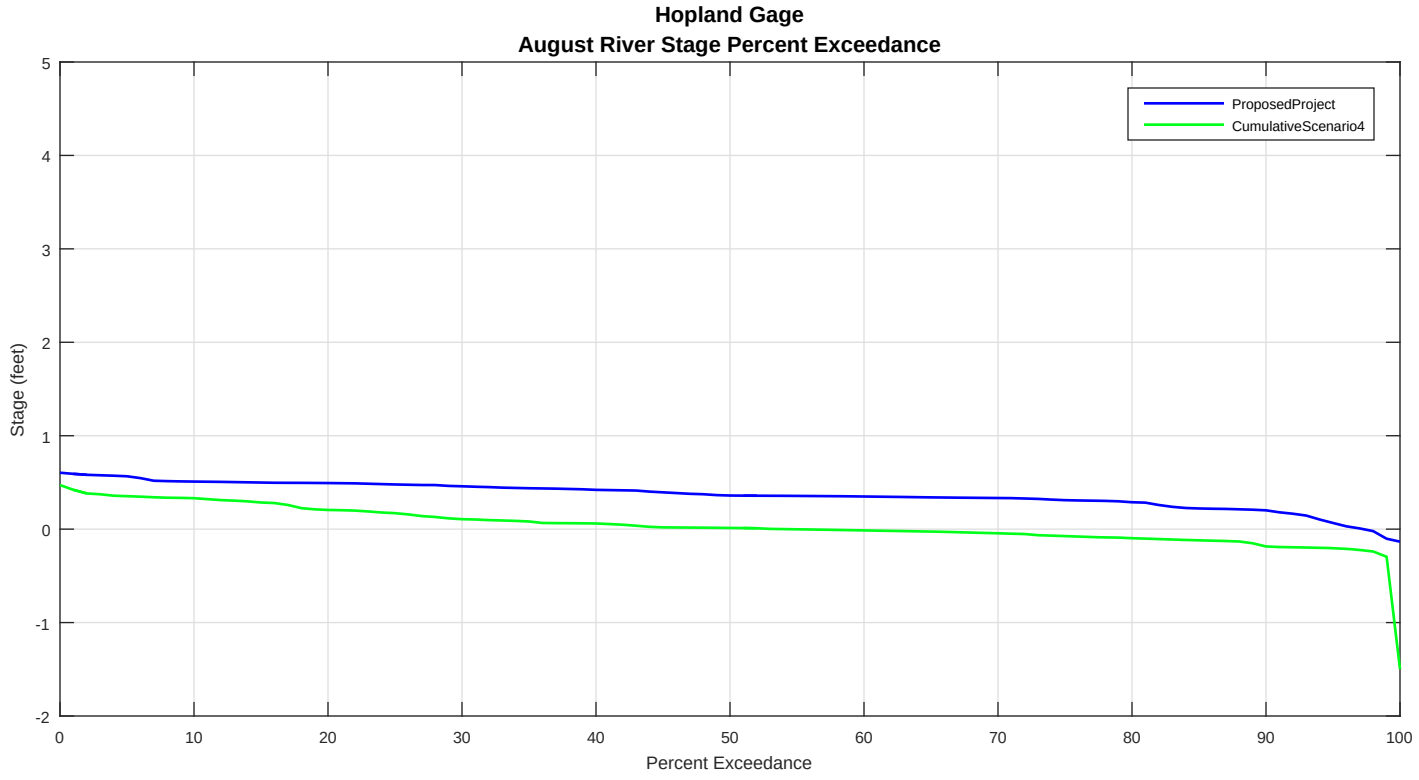

Hopland Gage
March River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100

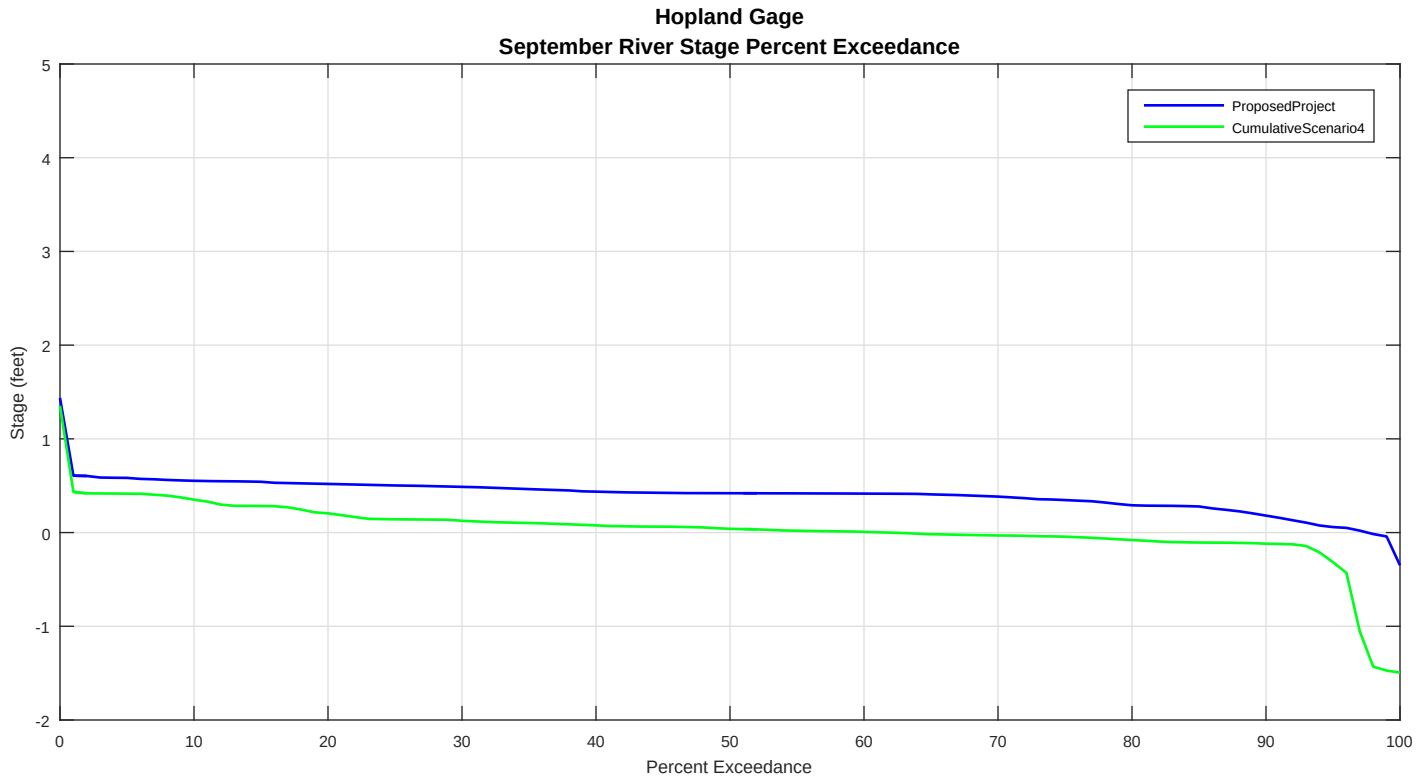

Hopland Gage
April River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
20
18
16
14
12
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

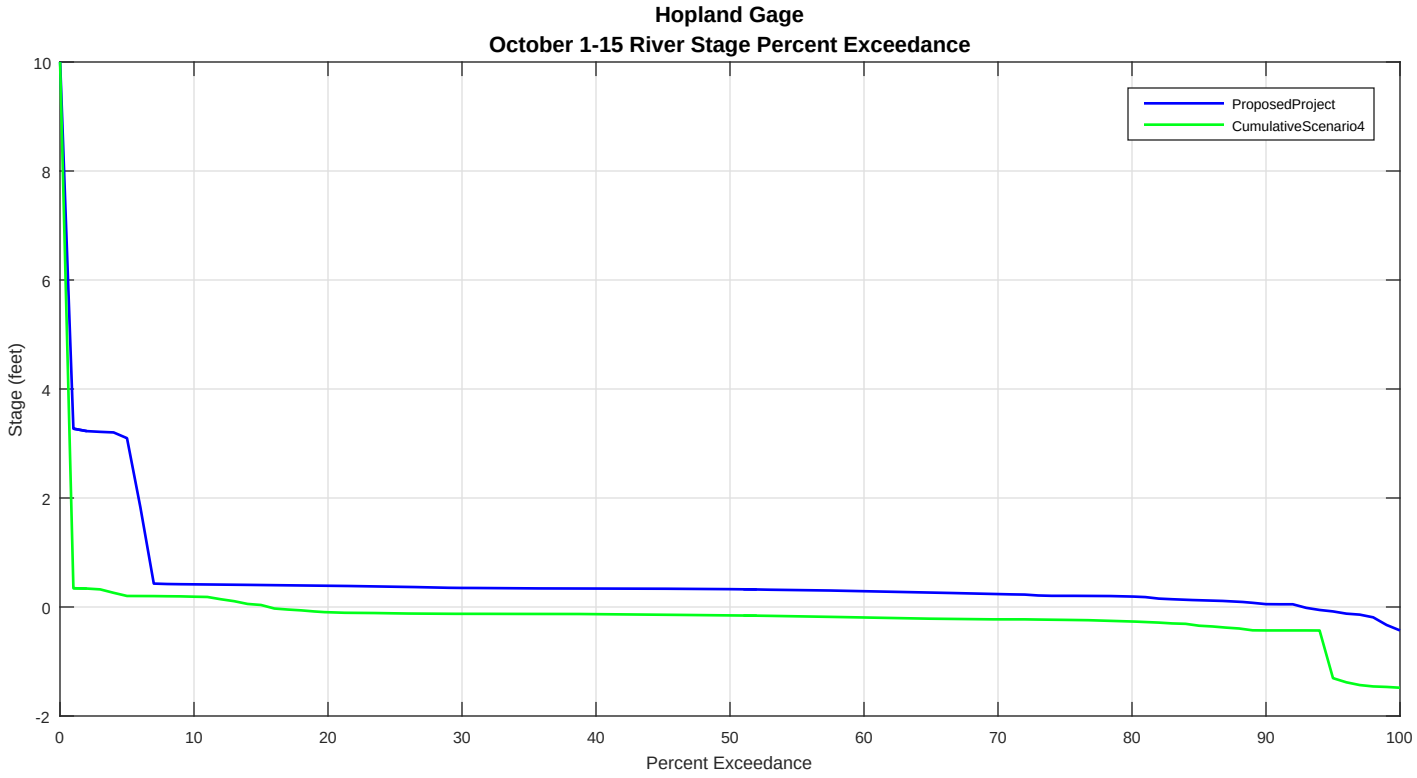

Hopland Gage
May River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

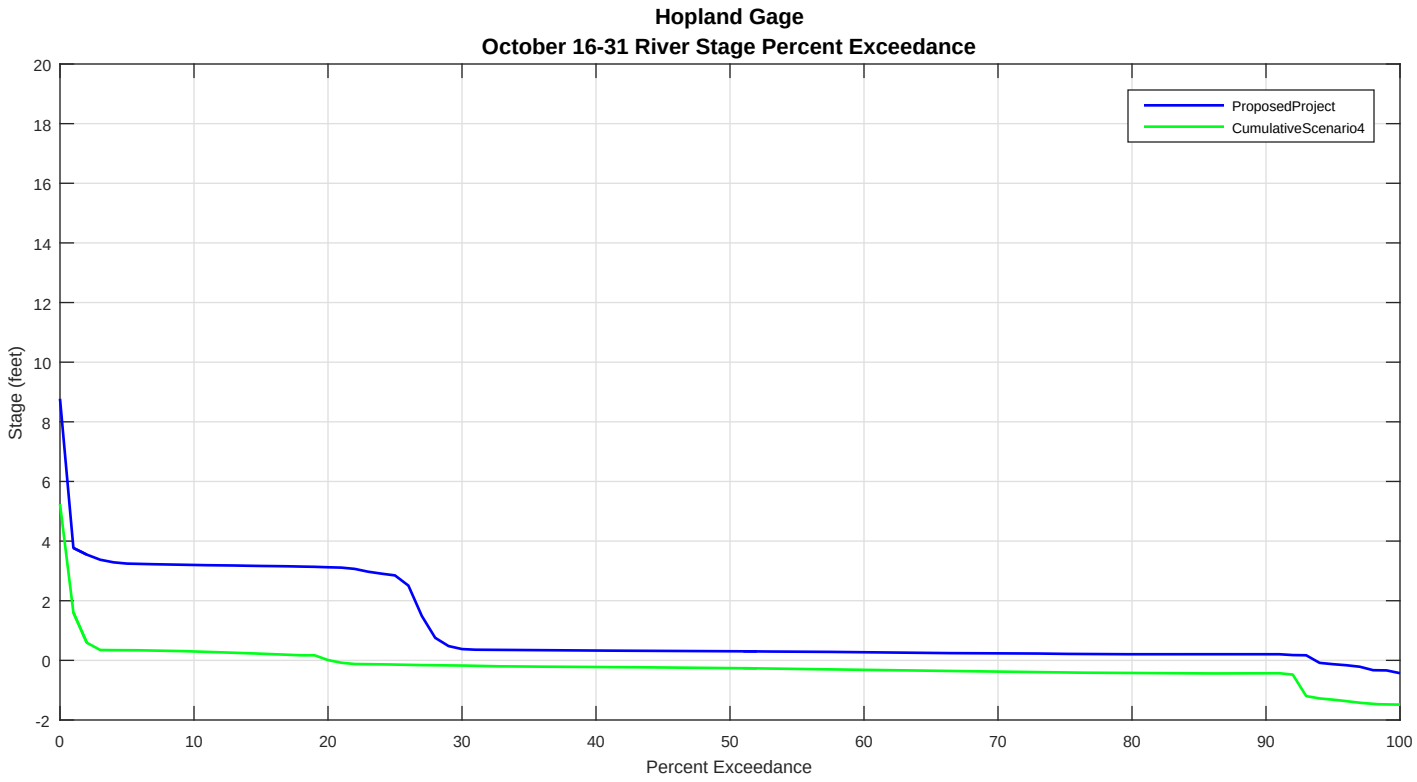

Hopland Gage
June River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

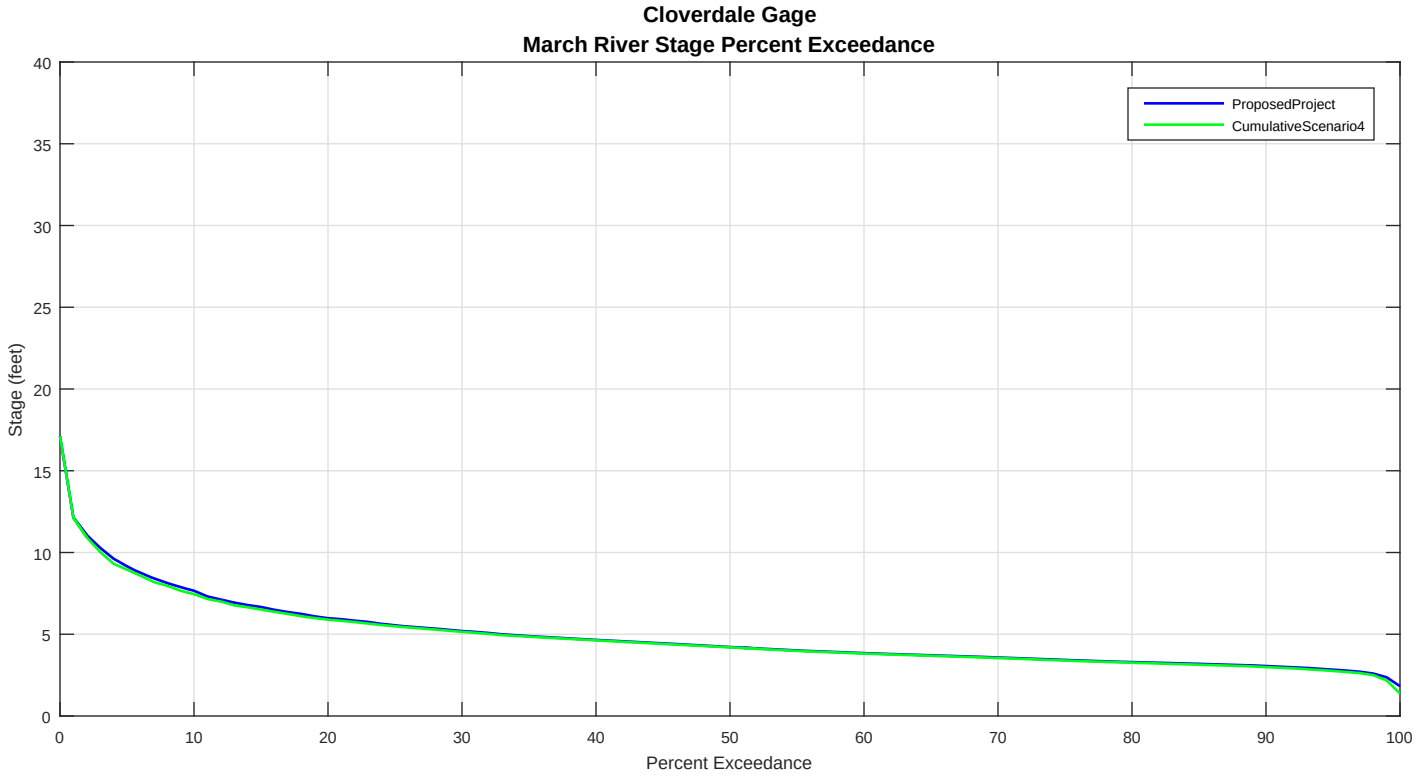

Hopland Gage
July River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

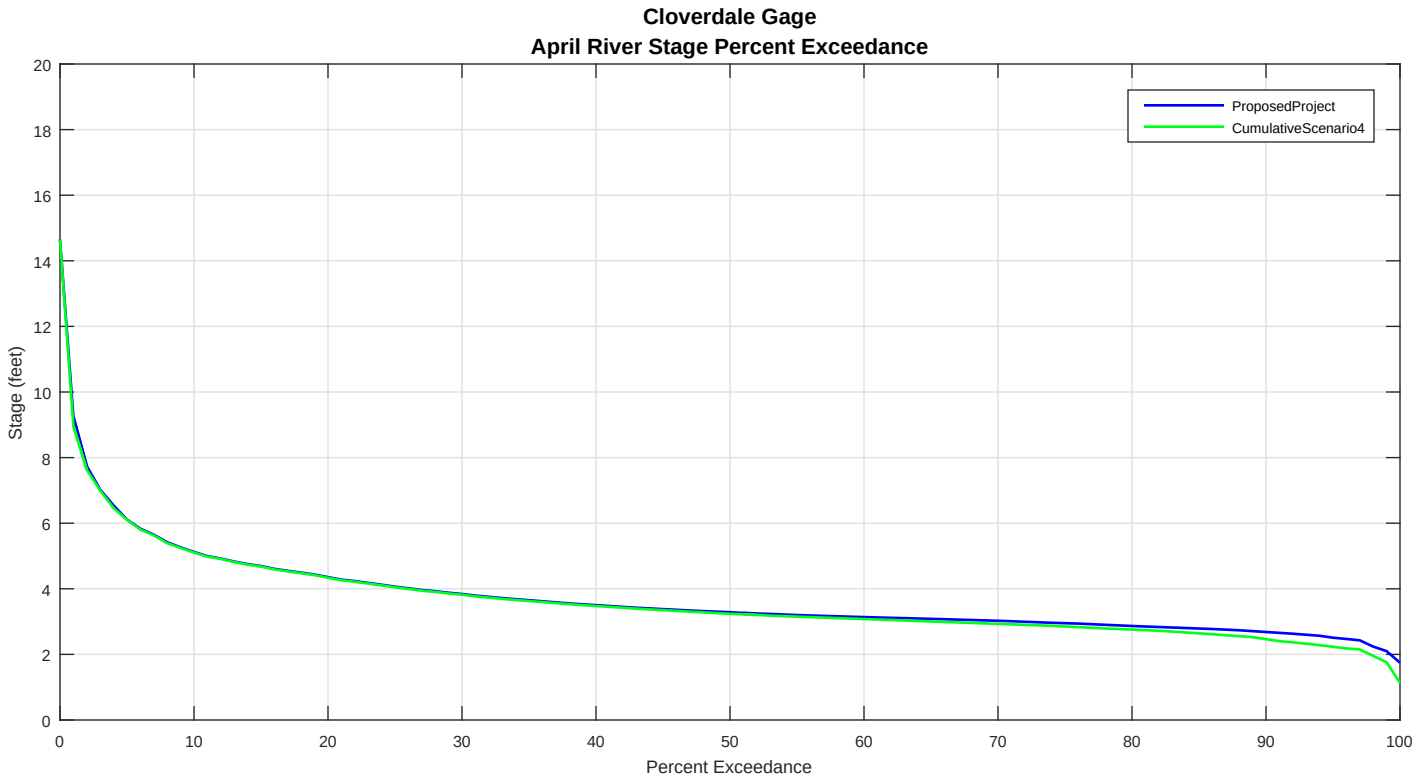

Hopland Gage
August River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

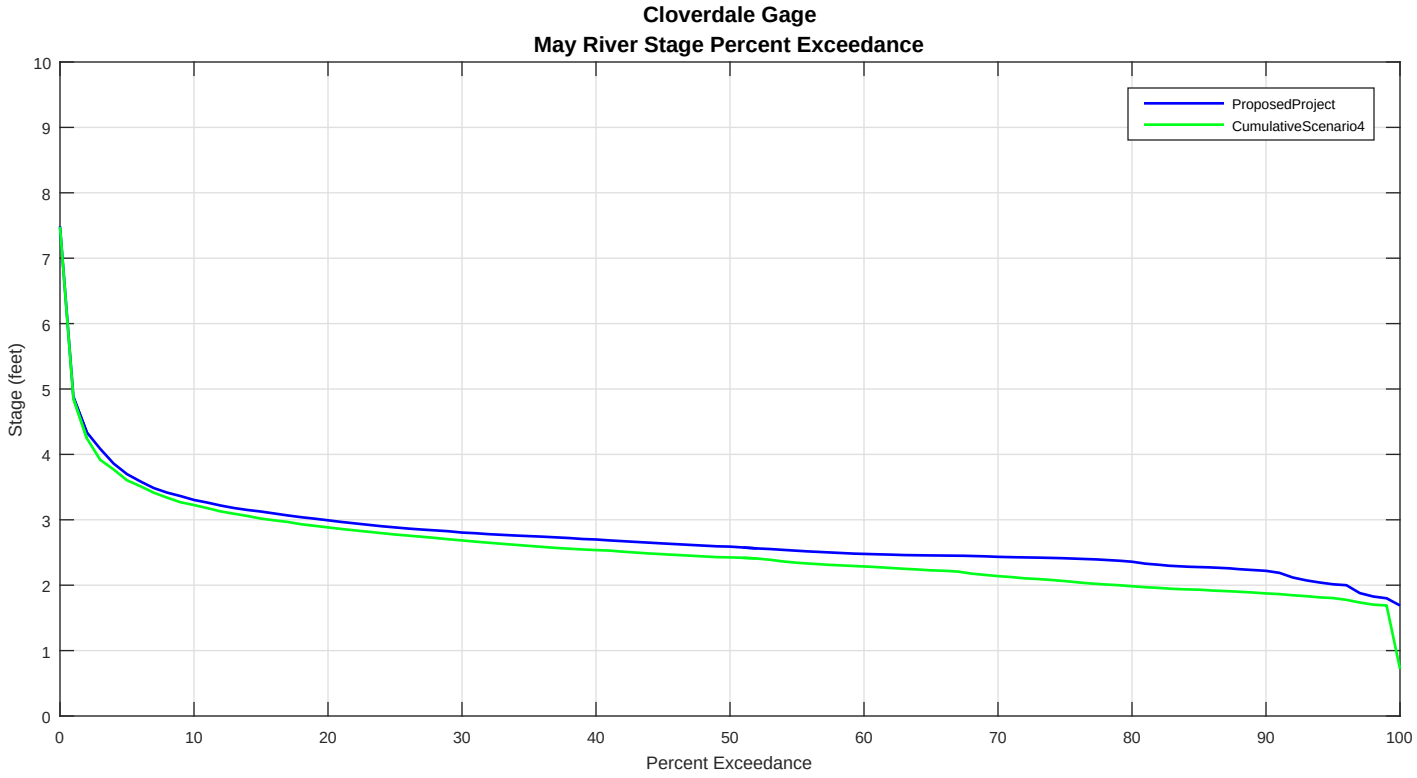

Hopland Gage
September River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100

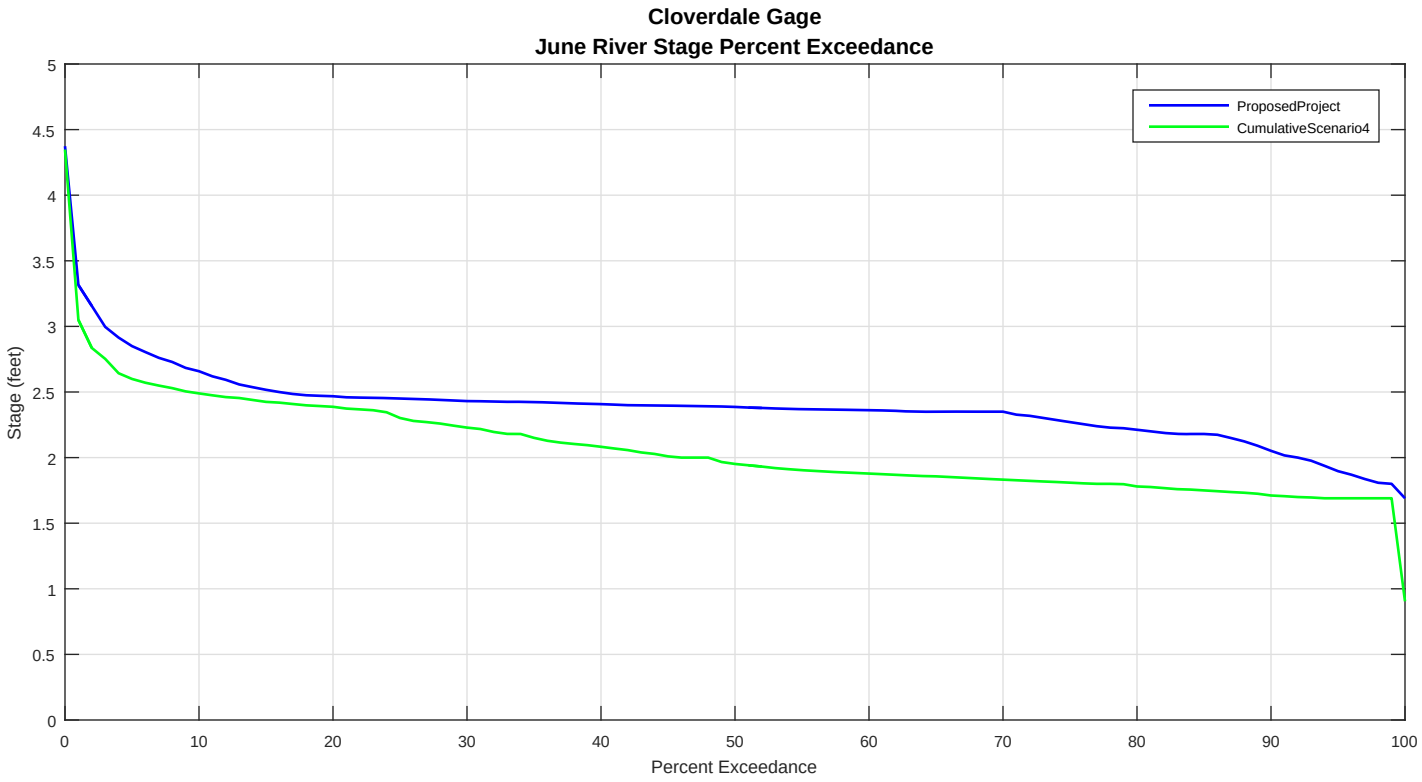

Hopland Gage
October 1-15 River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

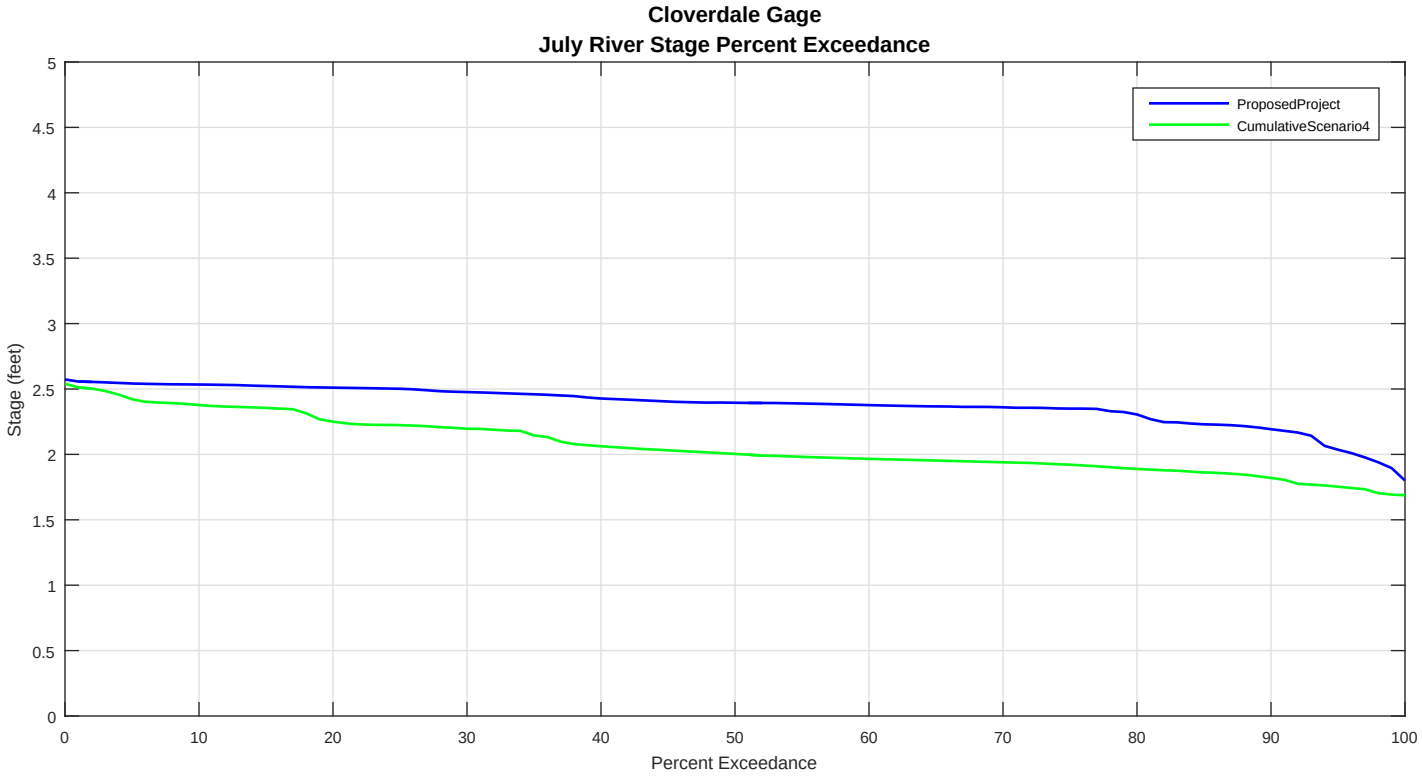

Hopland Gage
October 16-31 River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
20
18
16
14
12
10
8
6
4
2
0
-2
0
10
20
30
40
50
60
70
80
90
100

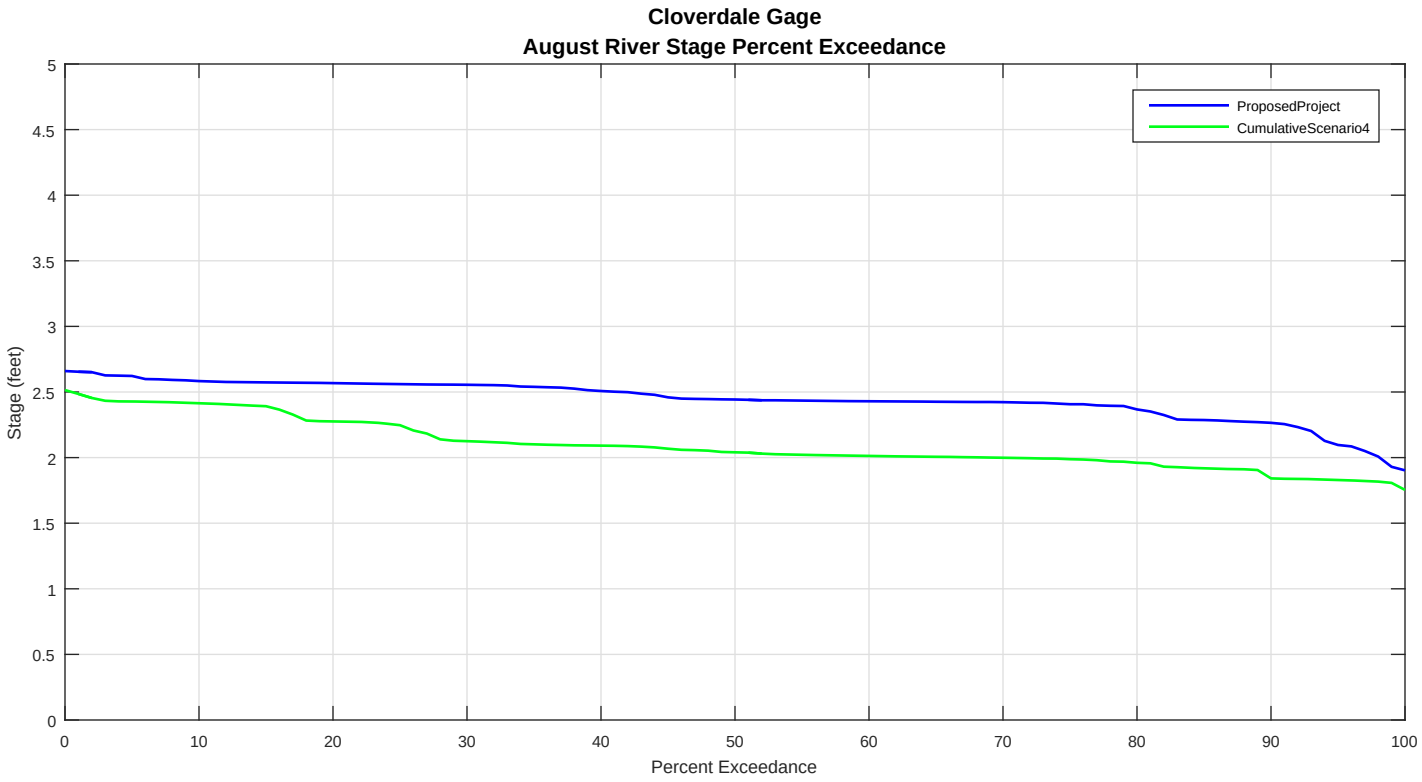

Cloverdale Gage
March River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100

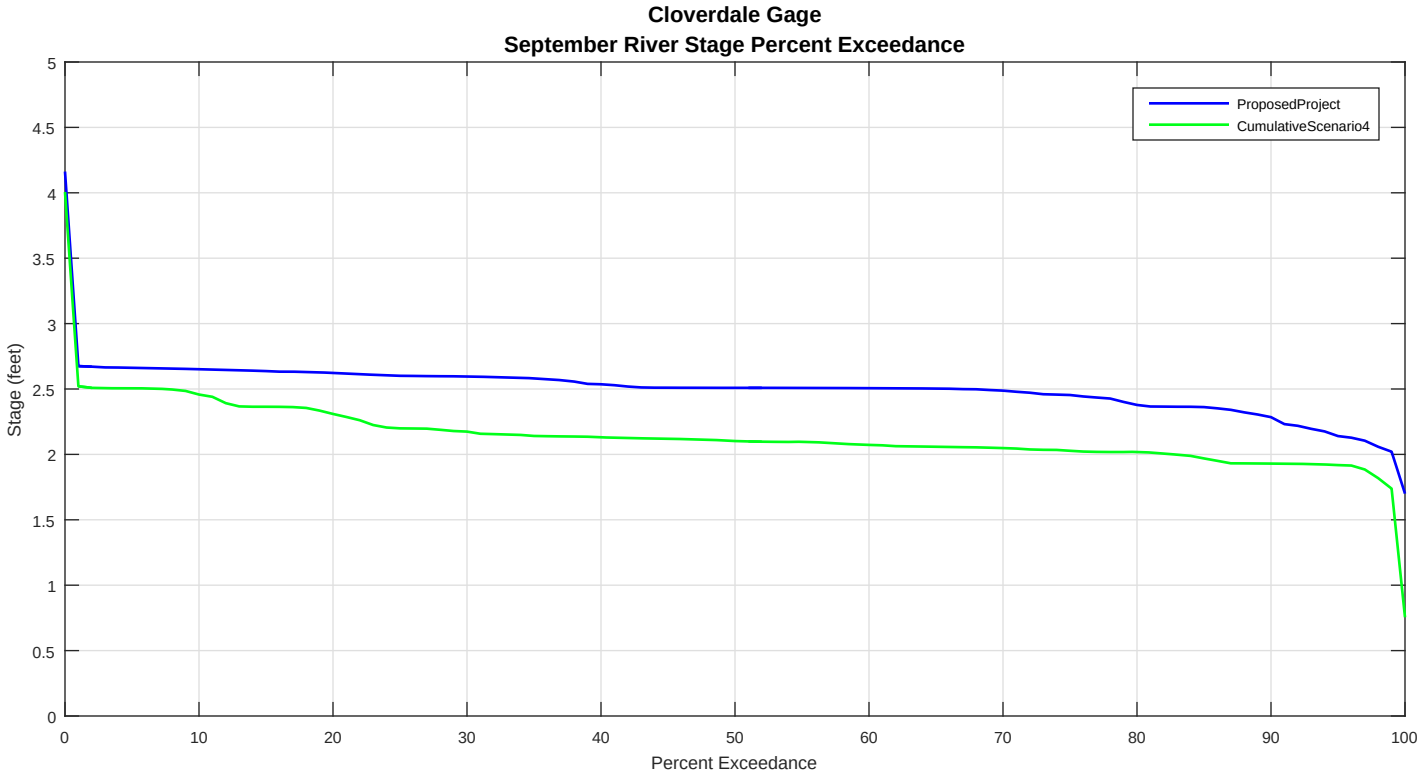

Cloverdale Gage
April River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

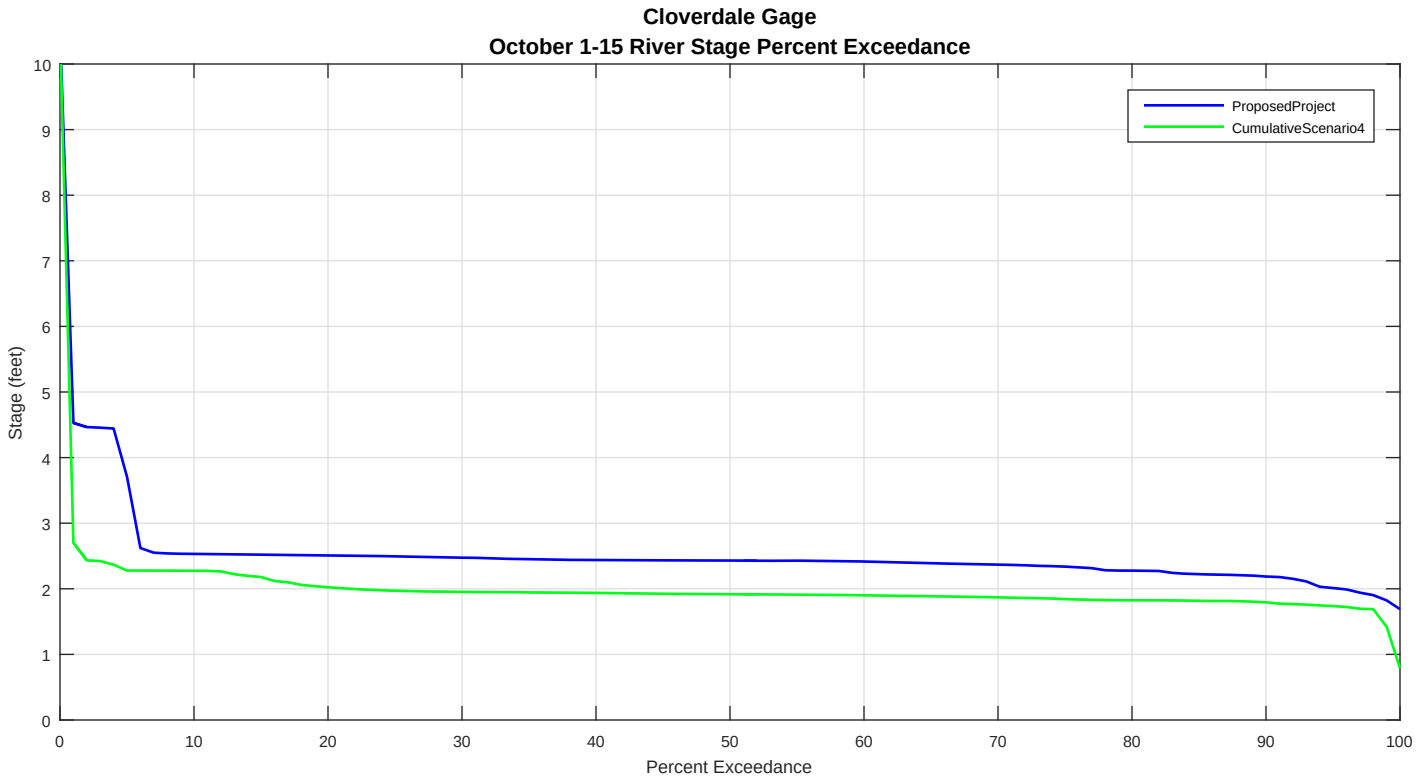

Cloverdale Gage
May River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

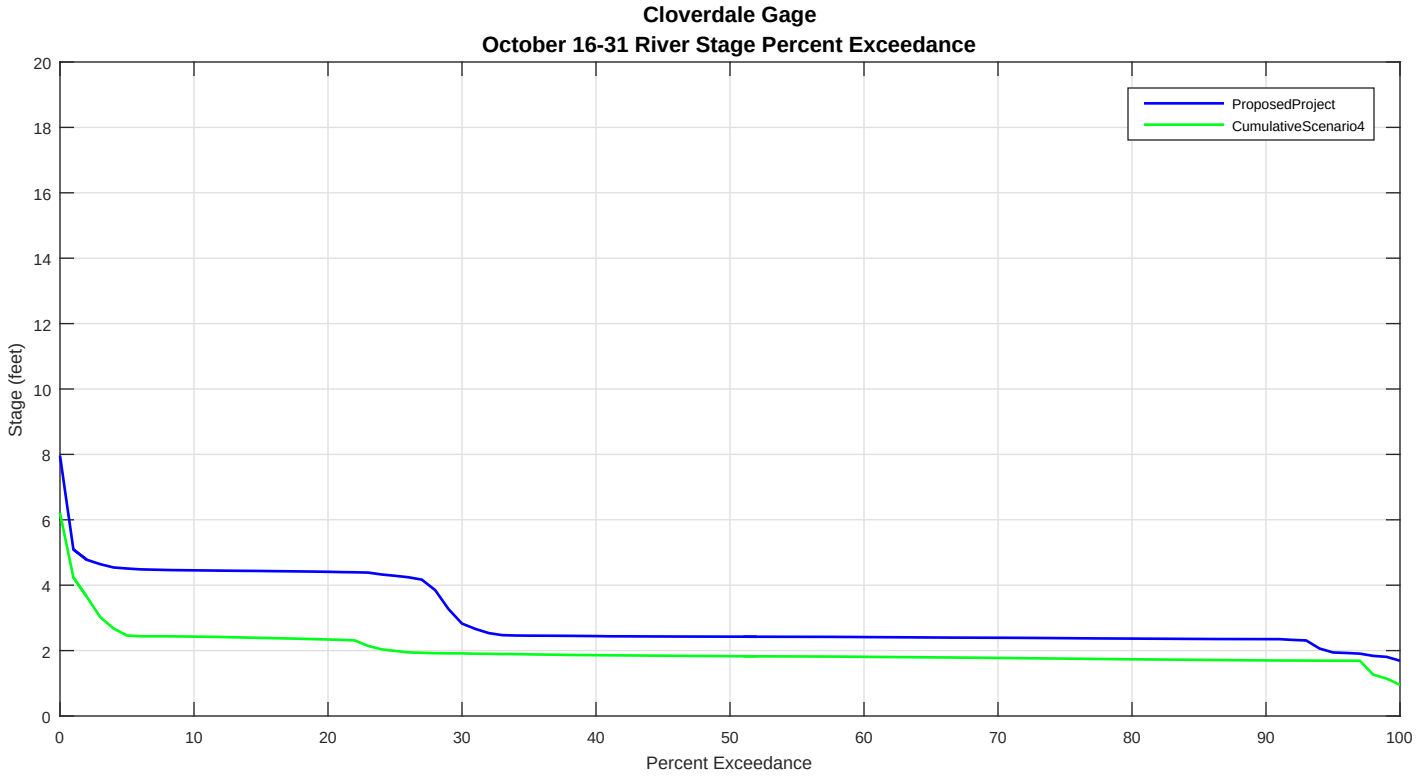

Cloverdale Gage
June River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

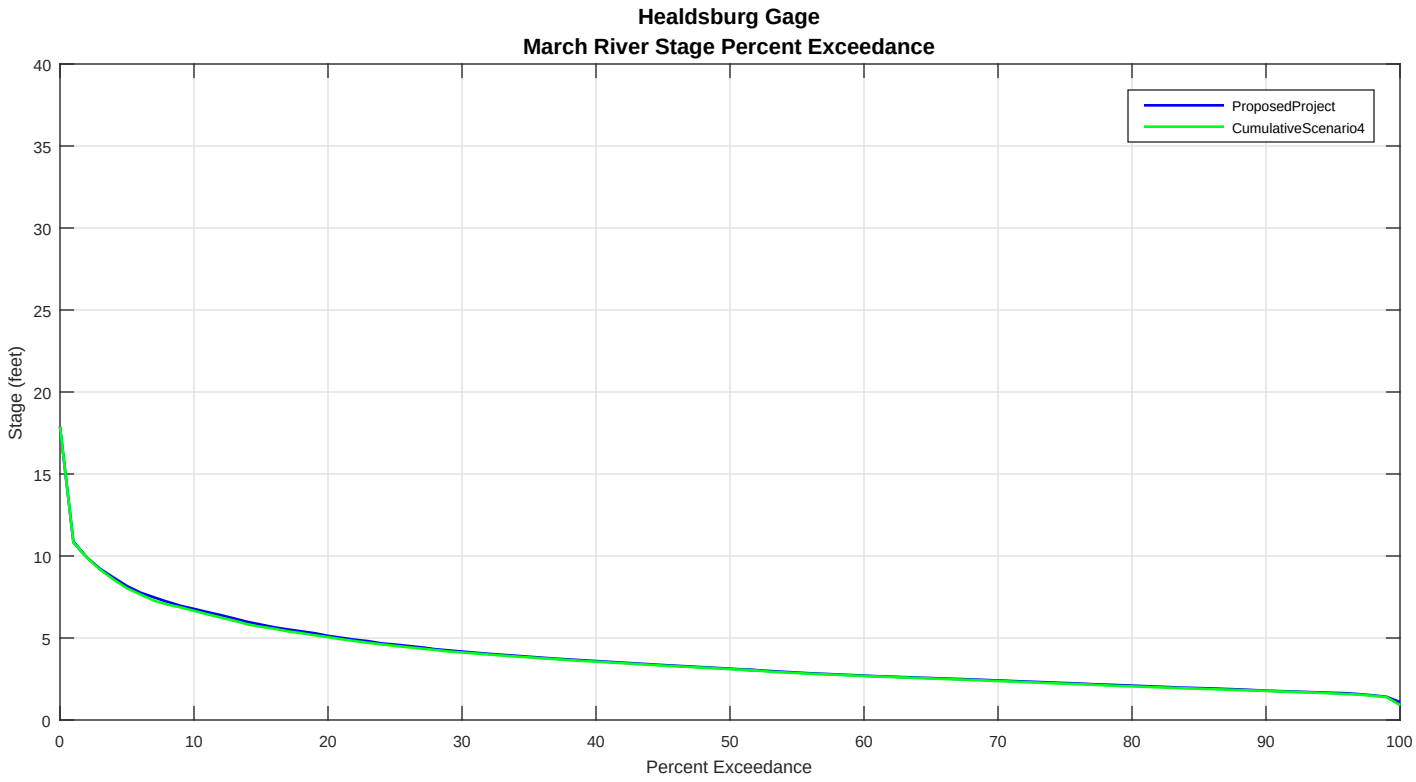

Cloverdale Gage
July River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

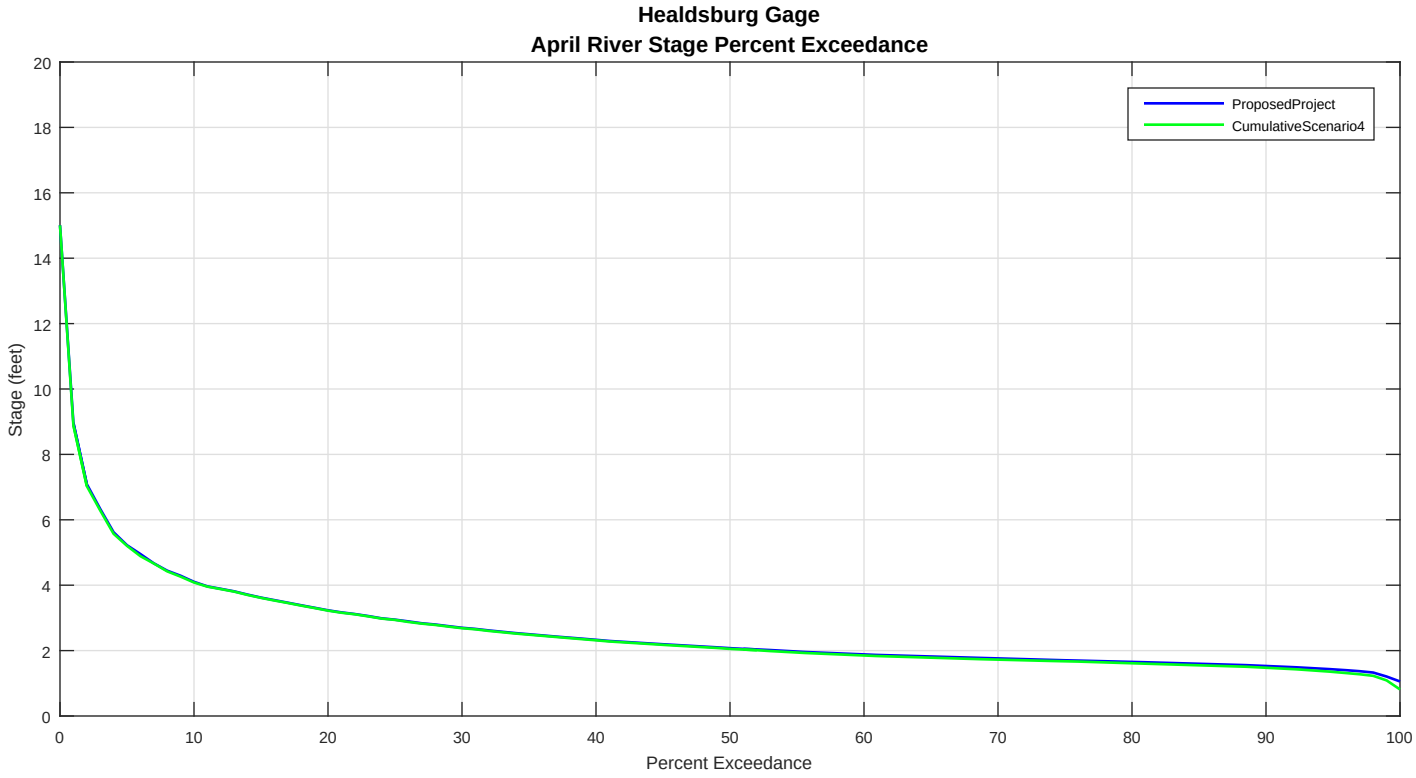

Cloverdale Gage
August River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

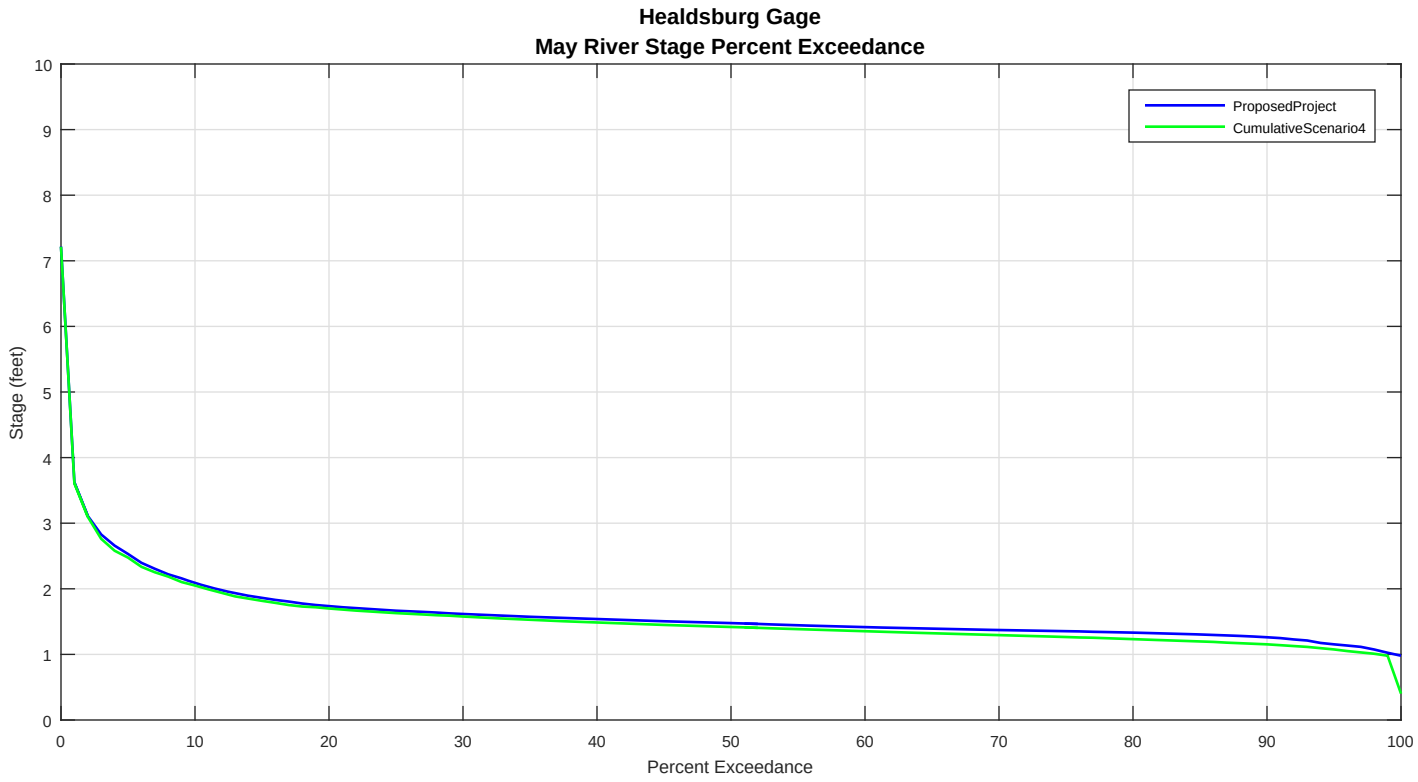

Cloverdale Gage
September River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

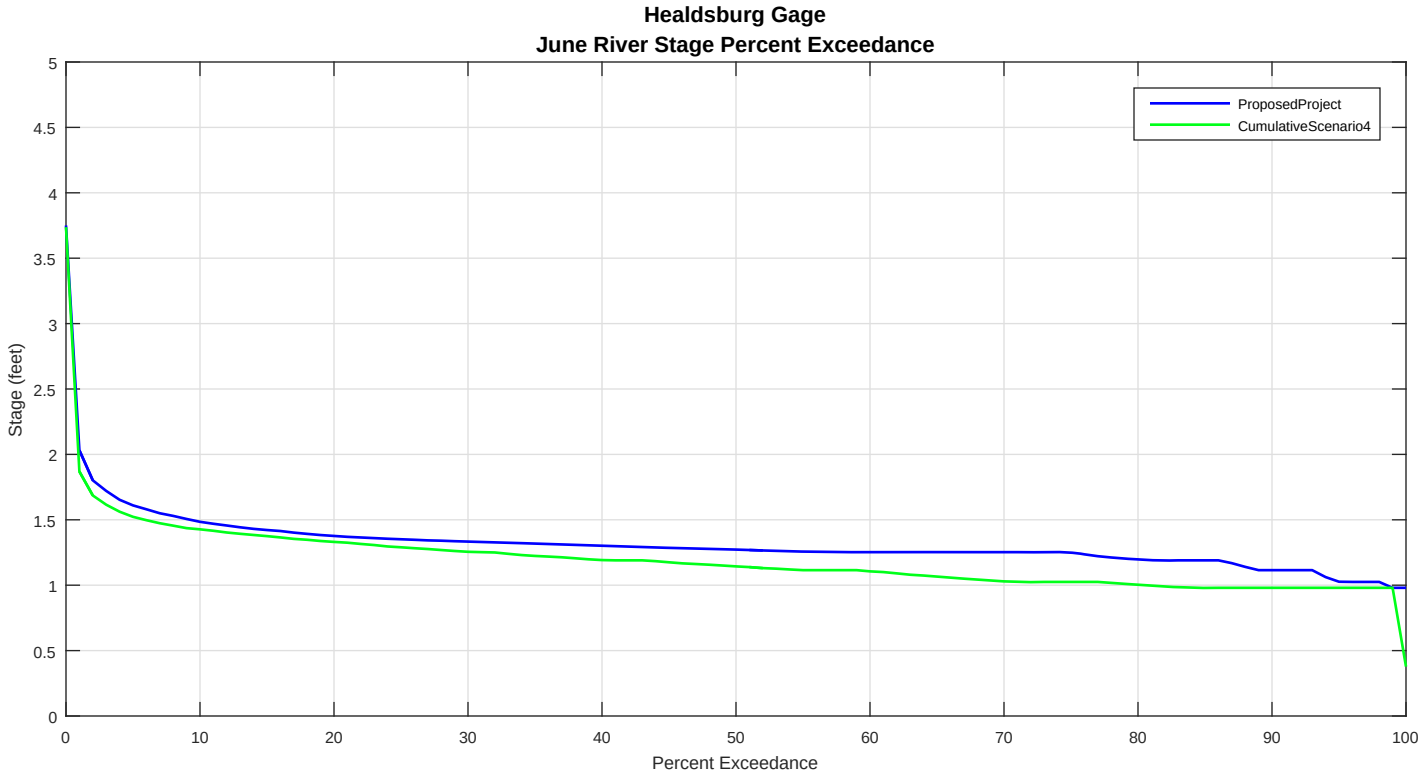

Cloverdale Gage
October 1-15 River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

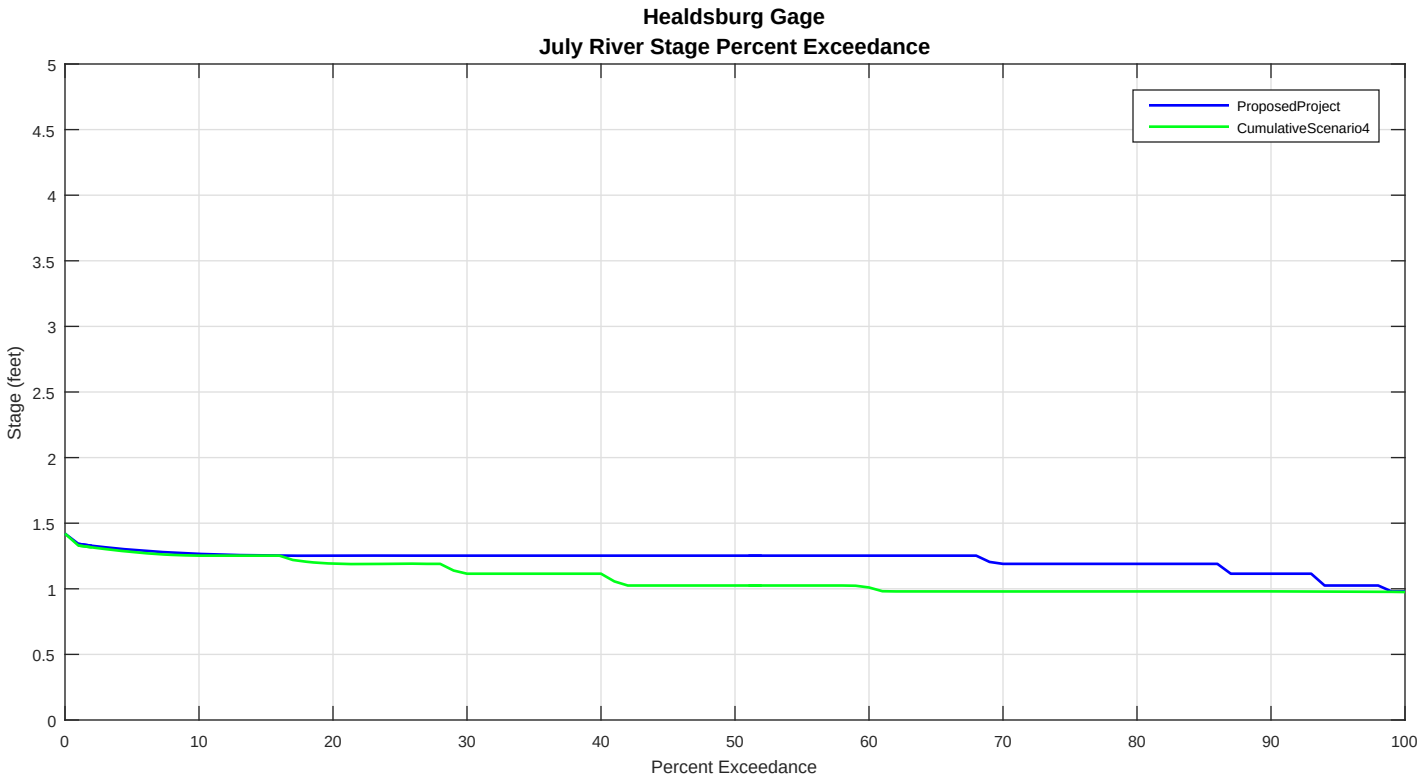

Cloverdale Gage
October 16-31 River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

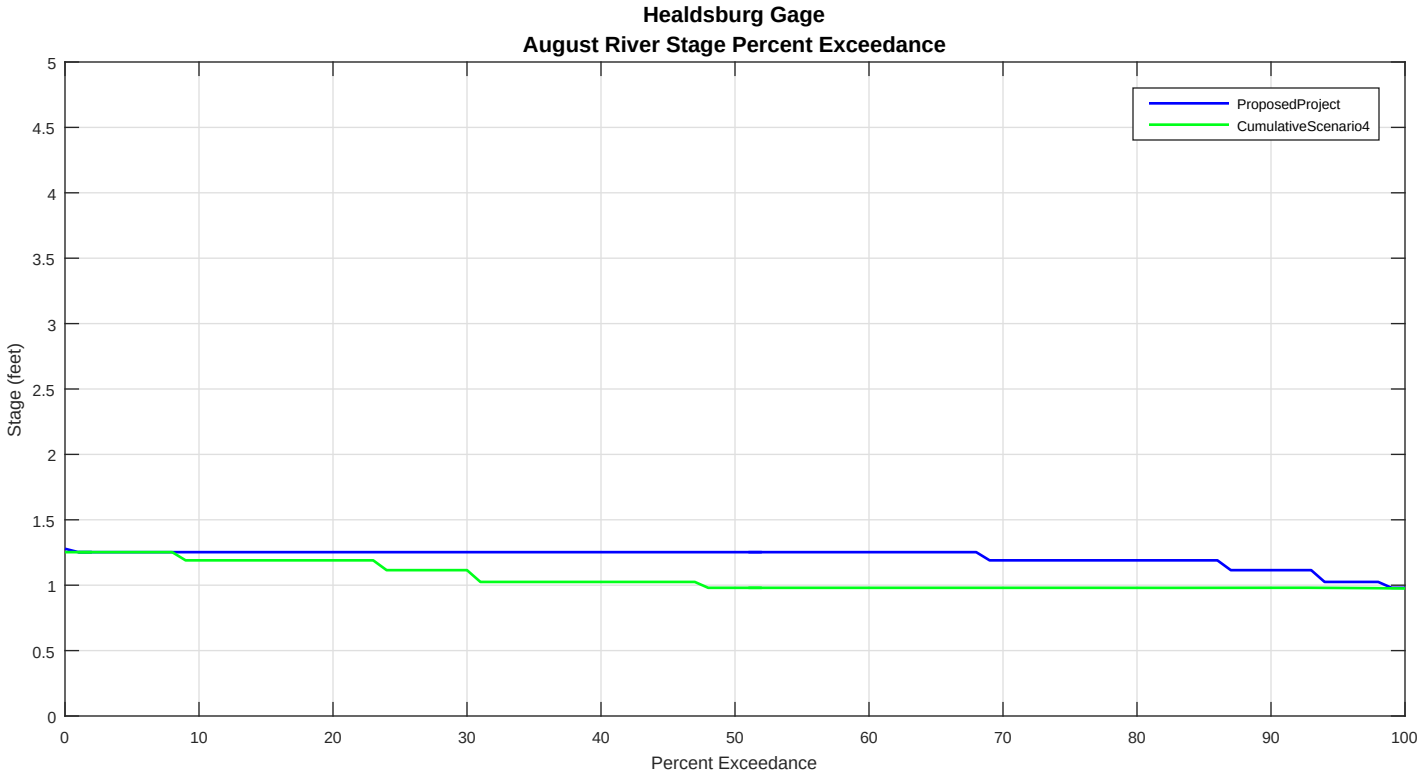

Healdsburg Gage
March River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80
90
100

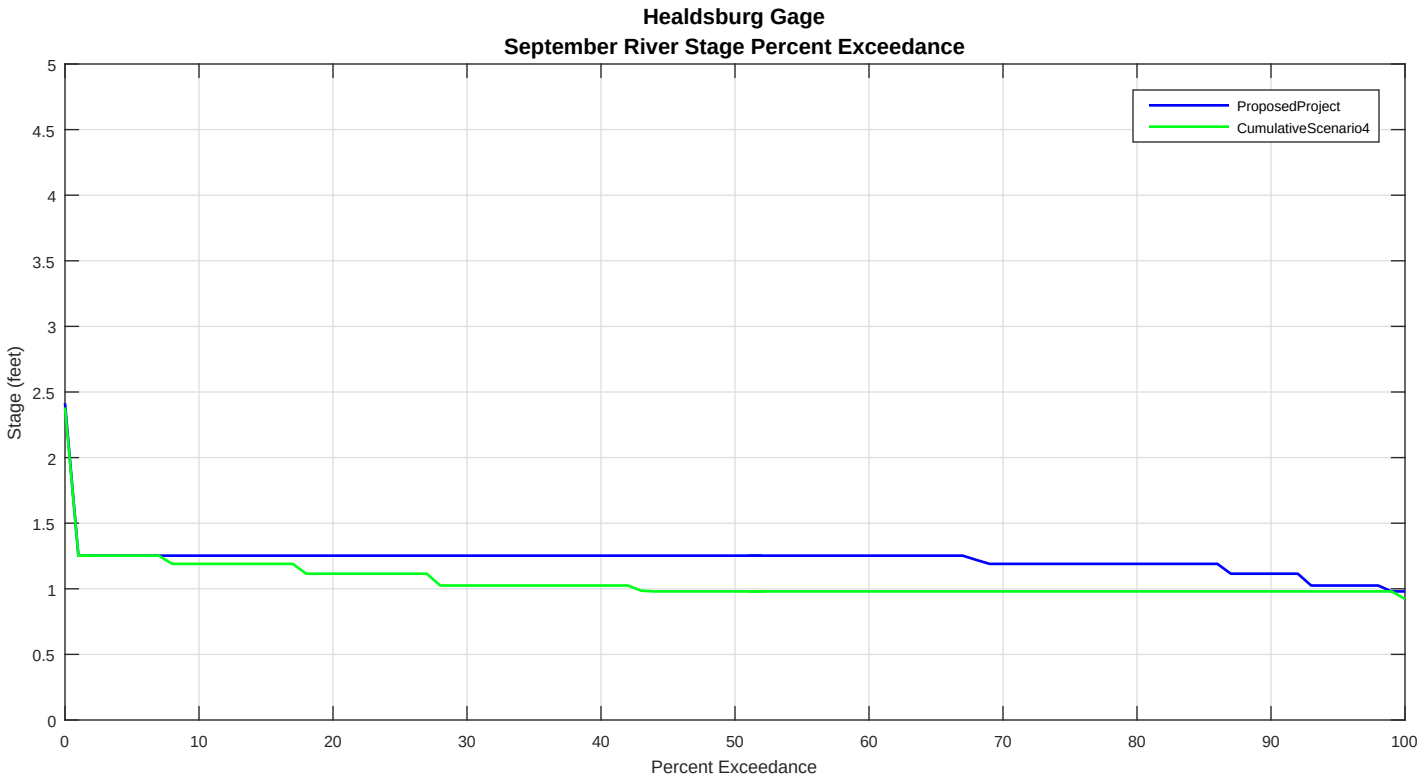

Healdsburg Gage
April River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

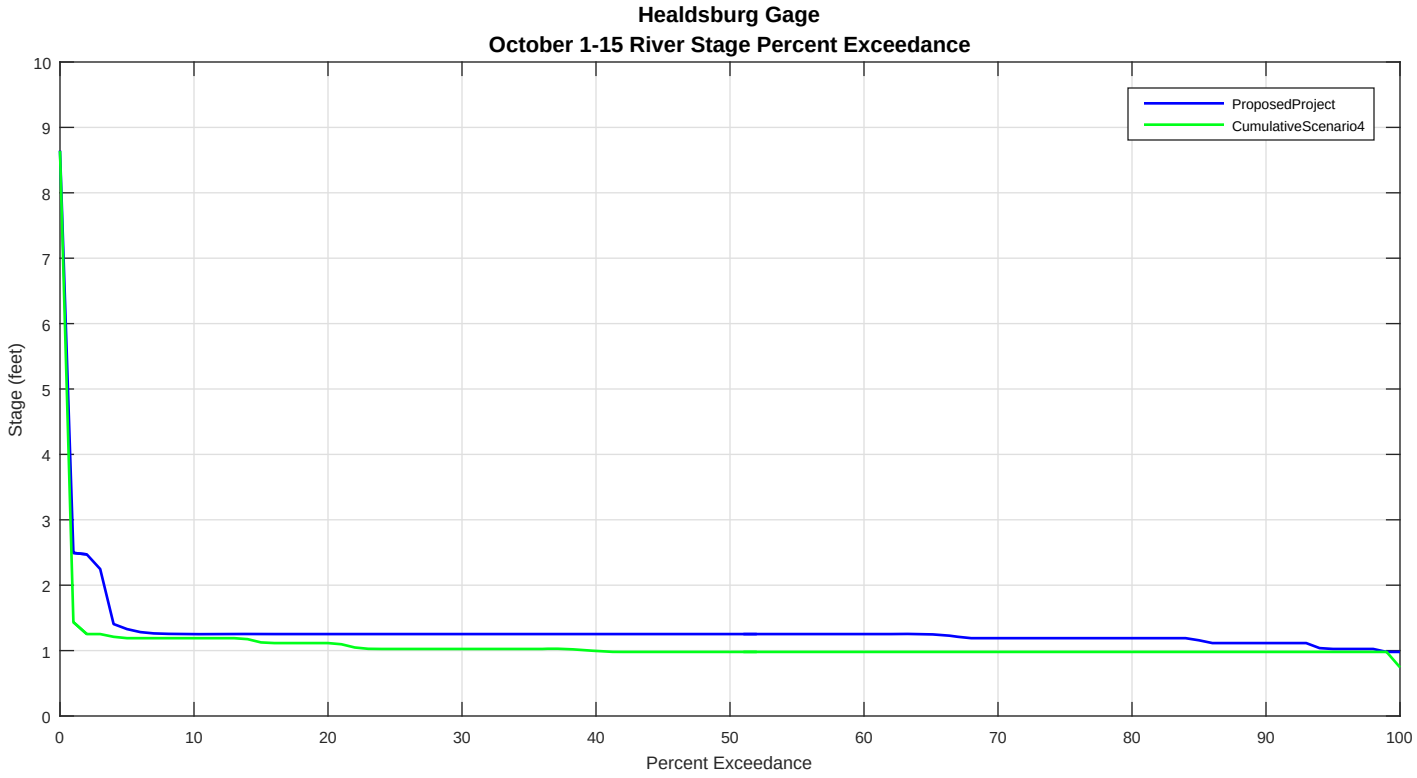

Healdsburg Gage
May River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

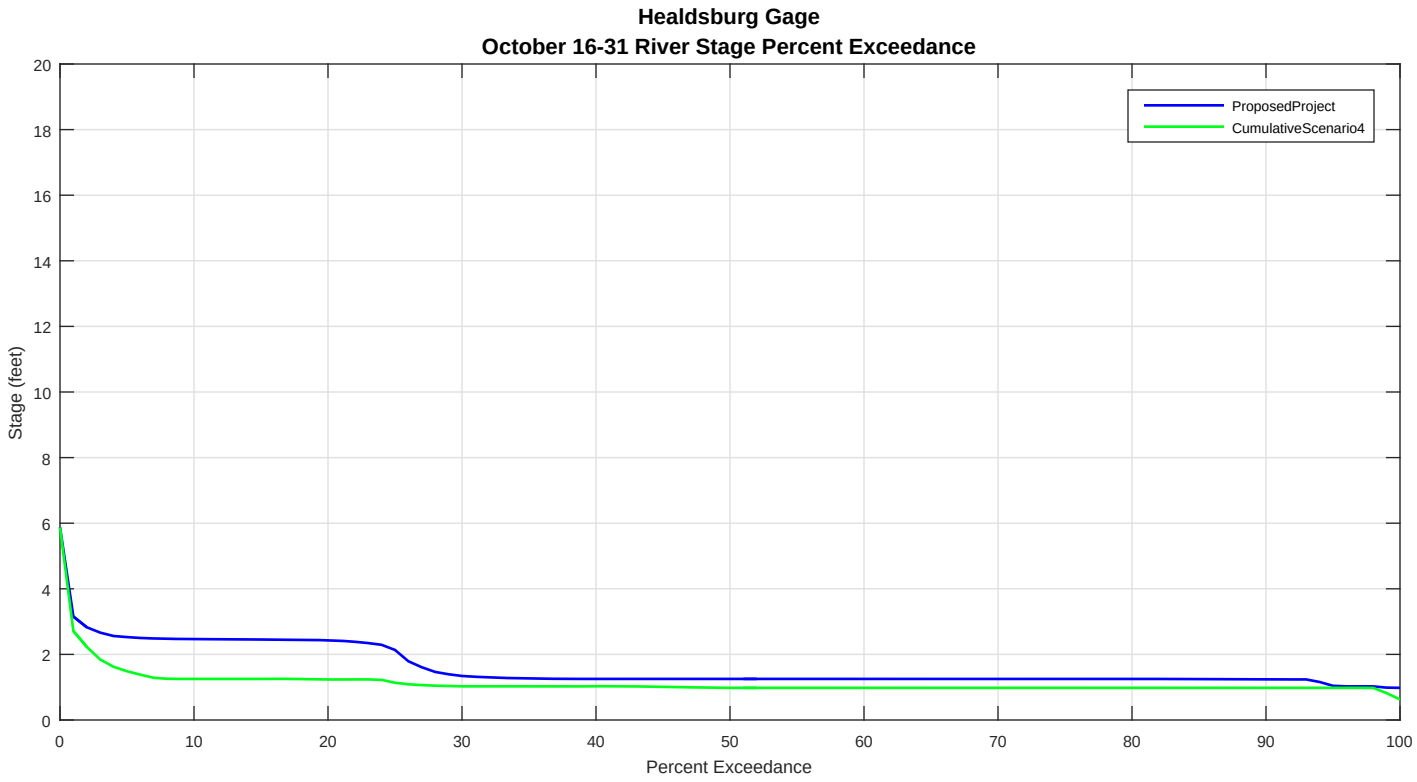

Healdsburg Gage
June River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

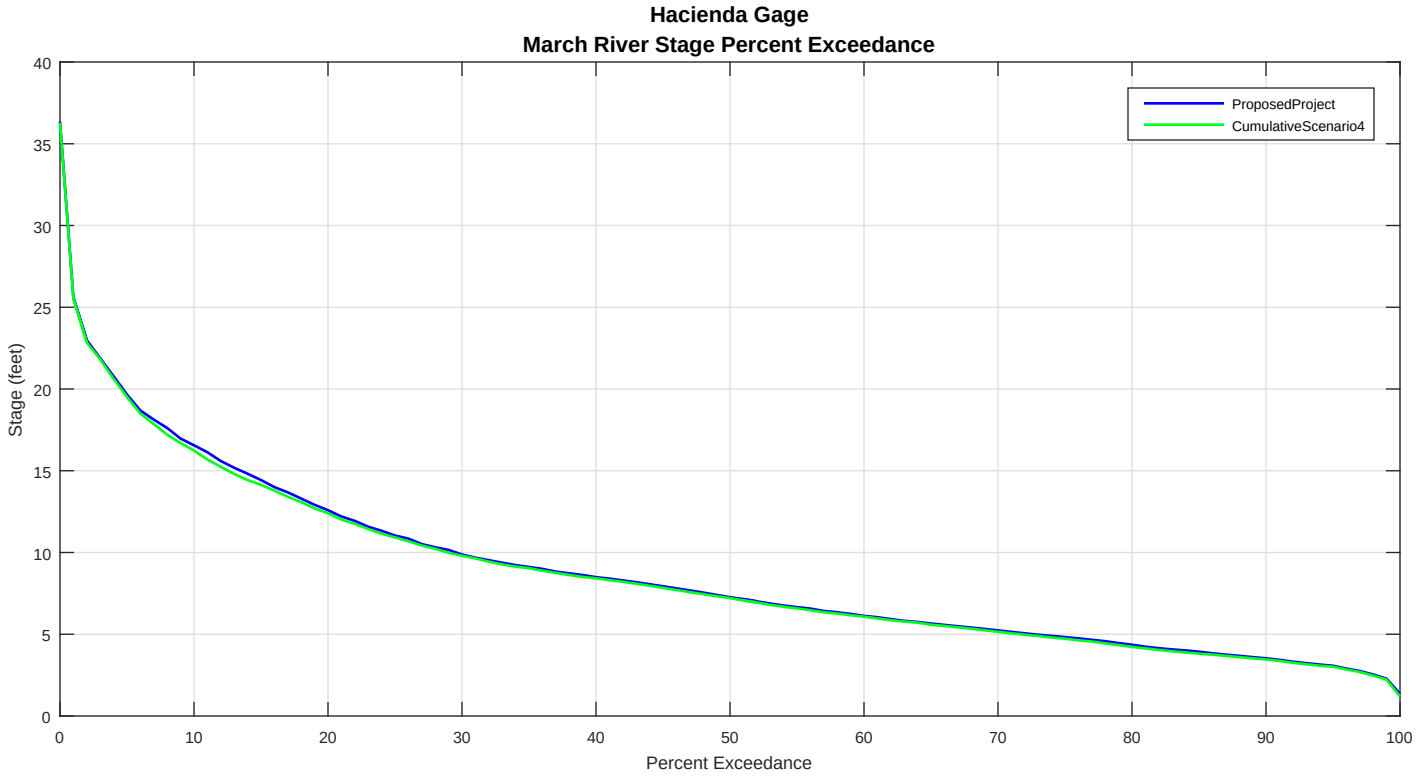

Healdsburg Gage
July River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

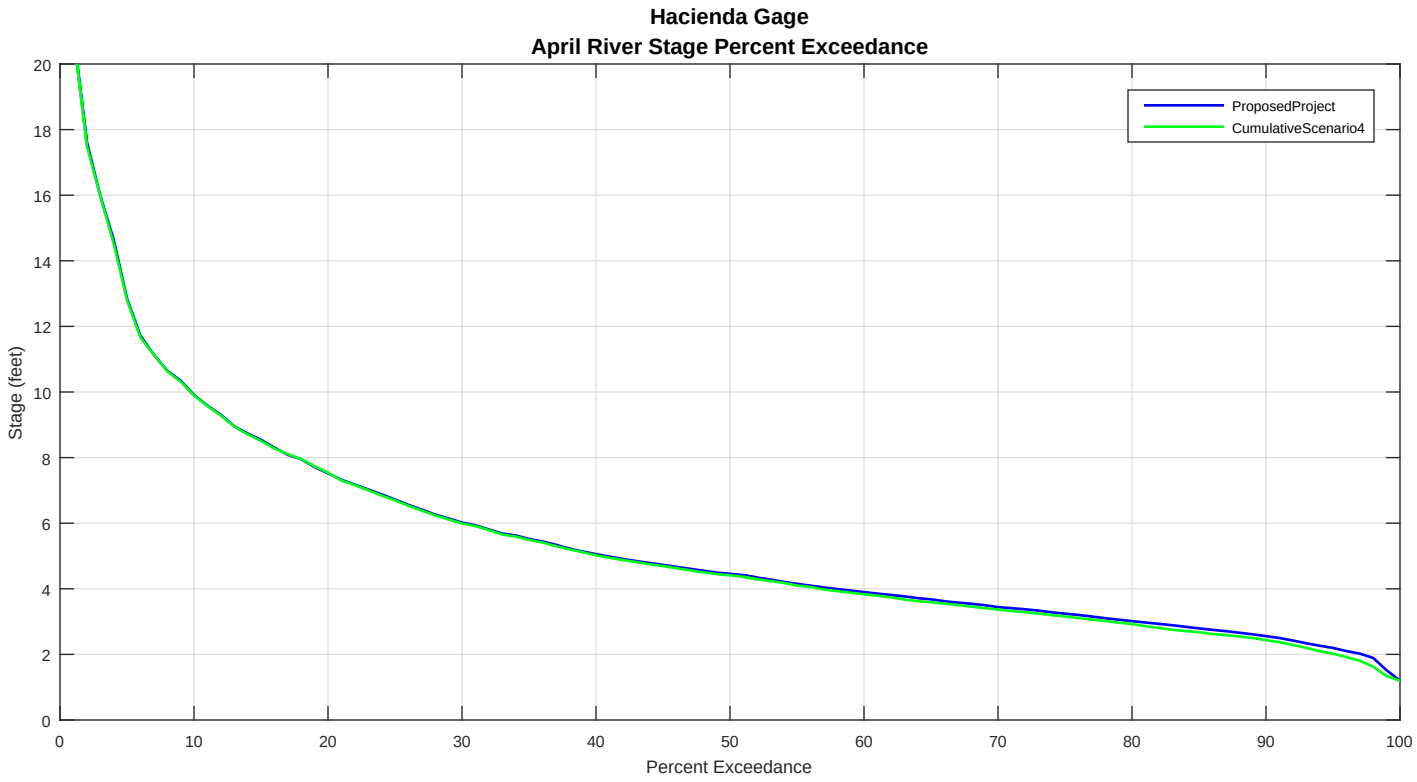

Healdsburg Gage
August River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

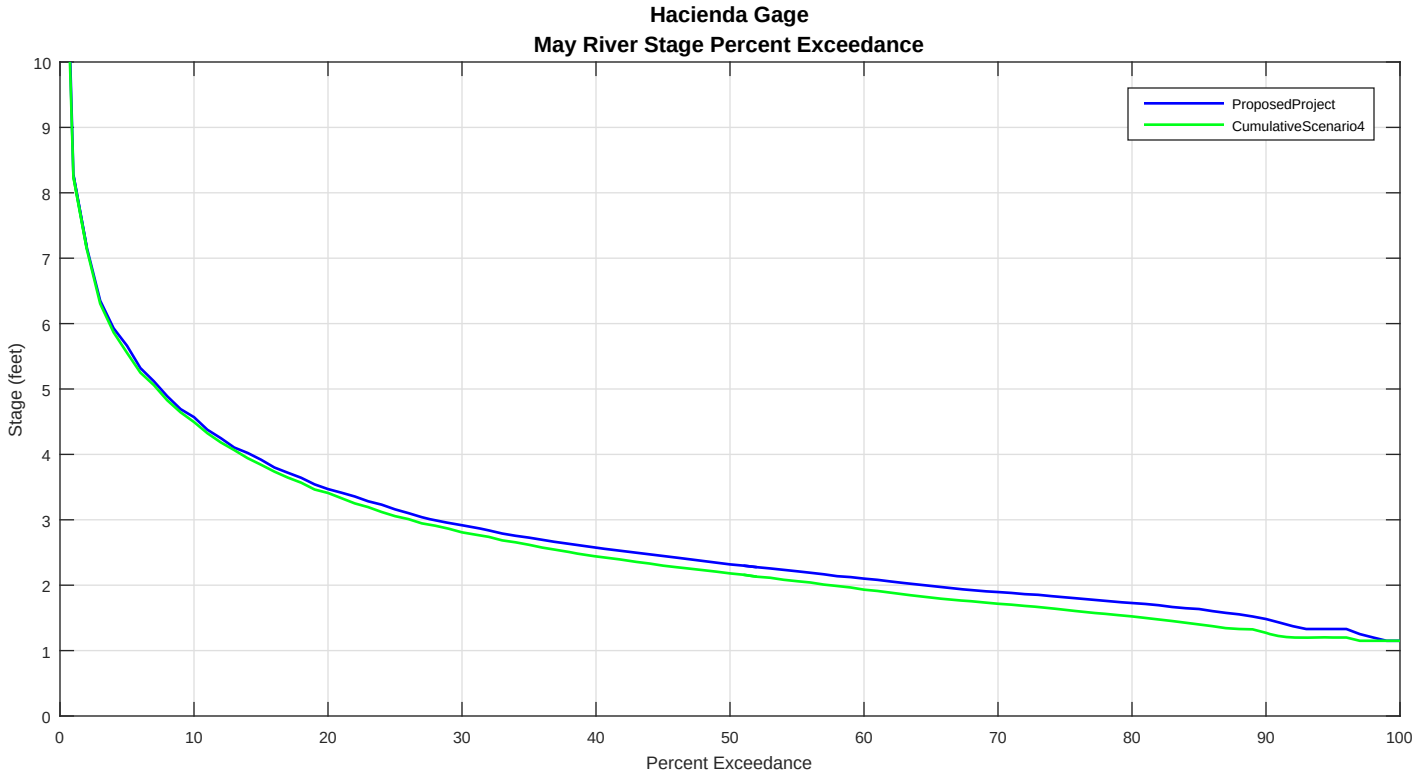

Healdsburg Gage
September River Stage Percent Exceedance
Stage (feet)
Percent Exceedance
ProposedProject
CumulativeScenario4
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

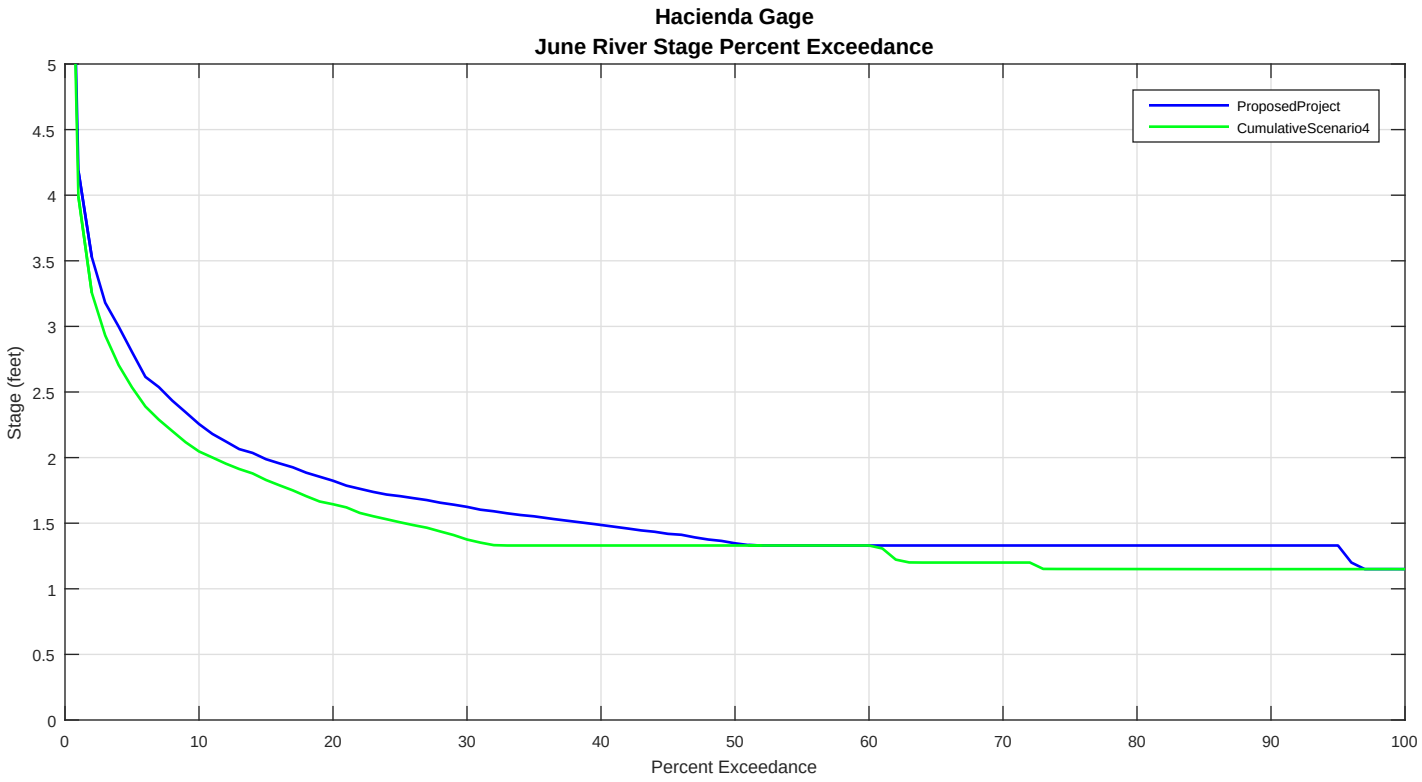

Healdsburg Gage
October 1-15 River Stage Percent Exceedance
Stage (feet)
Percent Exceedance
ProposedProject
CumulativeScenario4
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

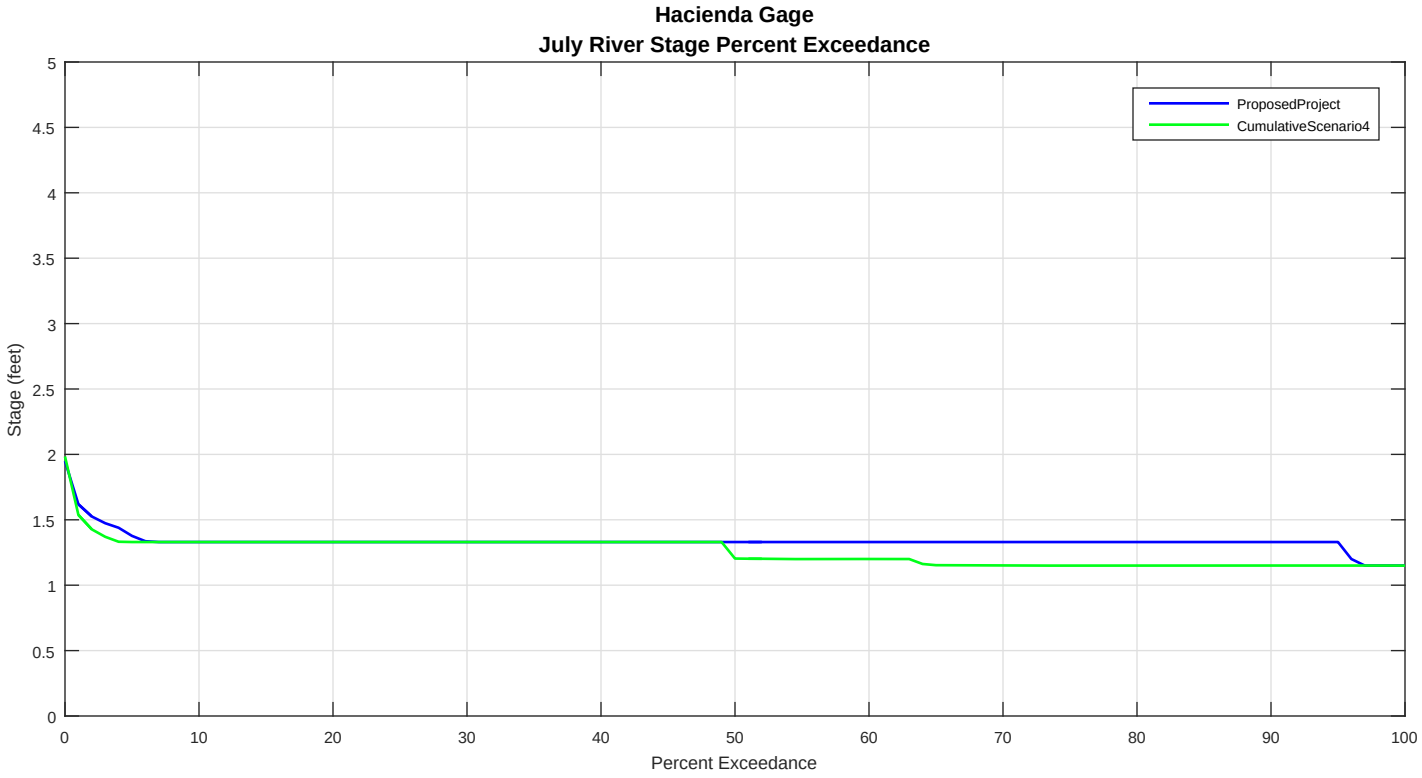

Healdsburg Gage
October 16-31 River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

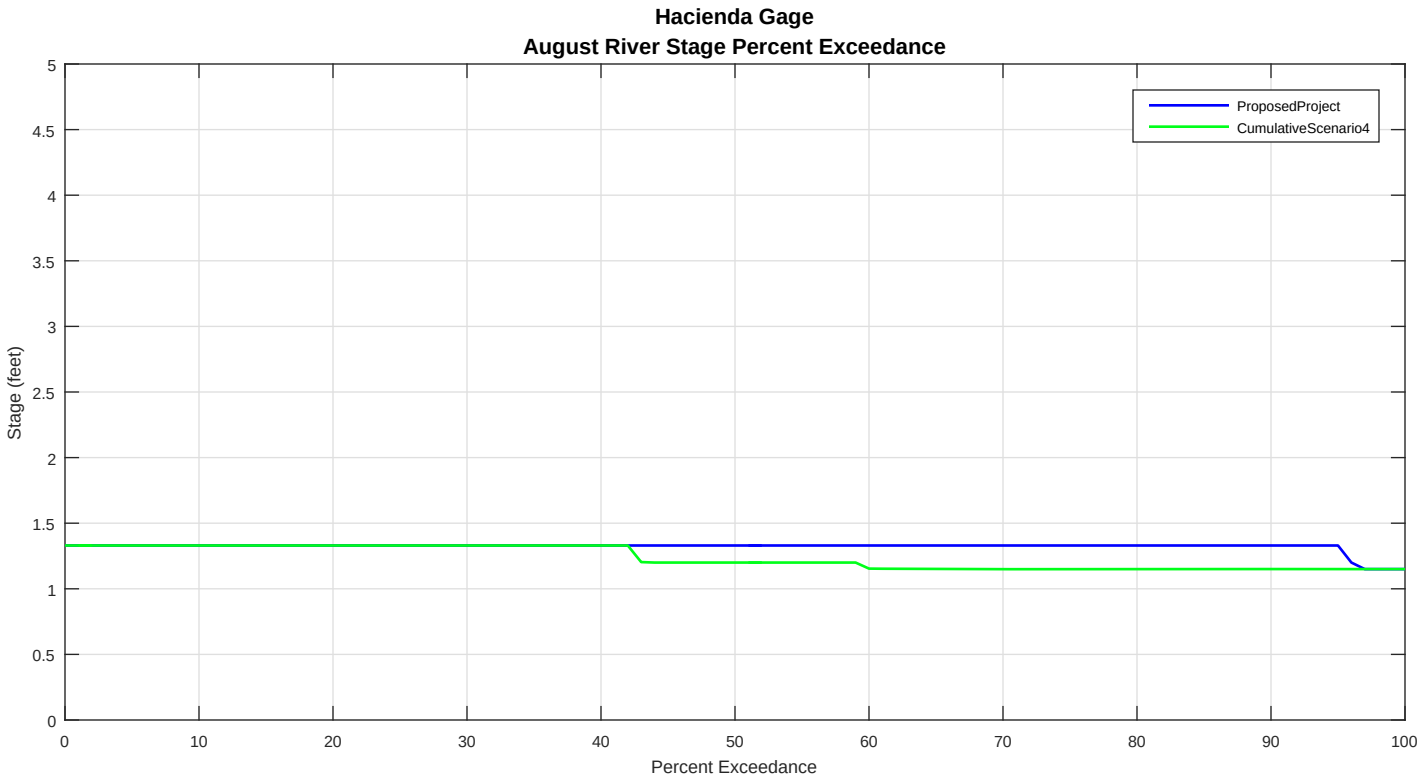

Hacienda Gage
March River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80
90
100

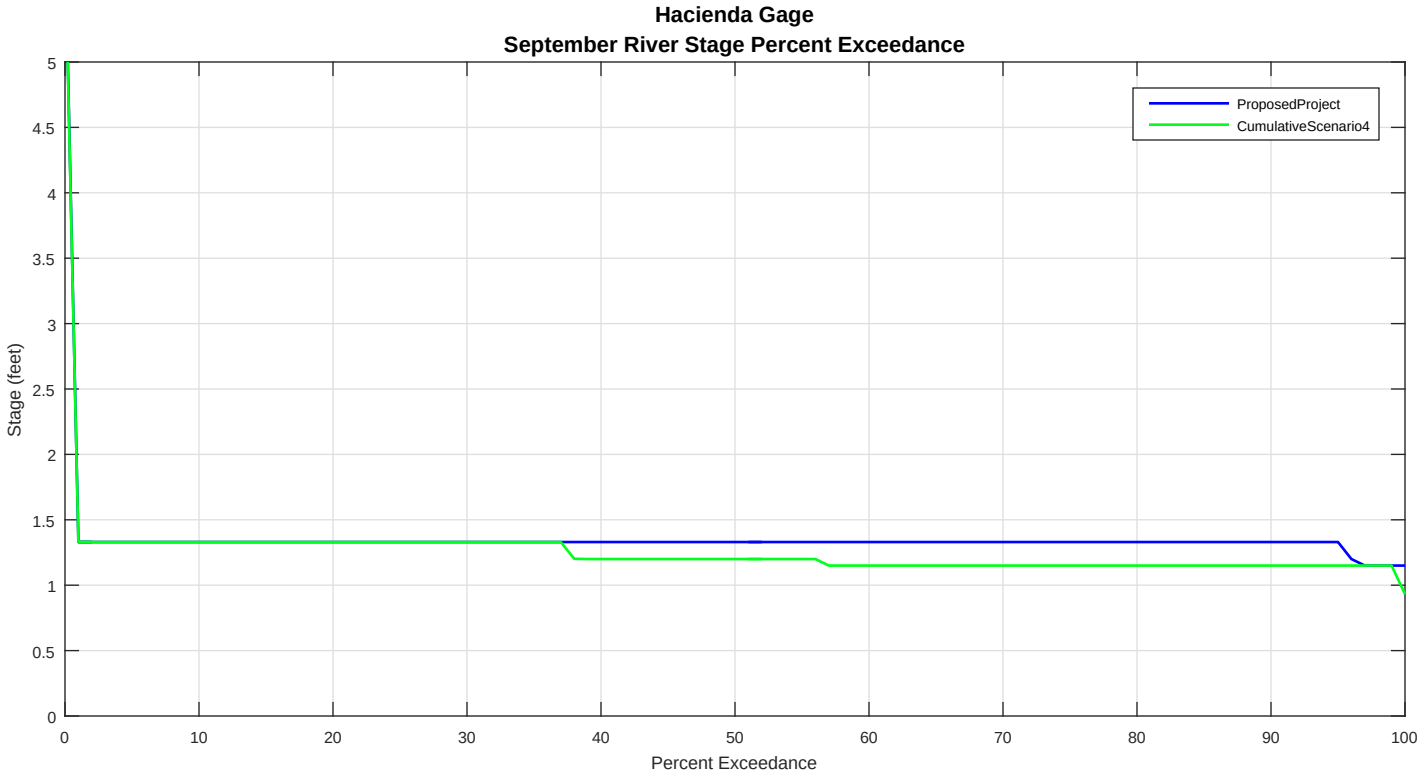

Hacienda Gage
April River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

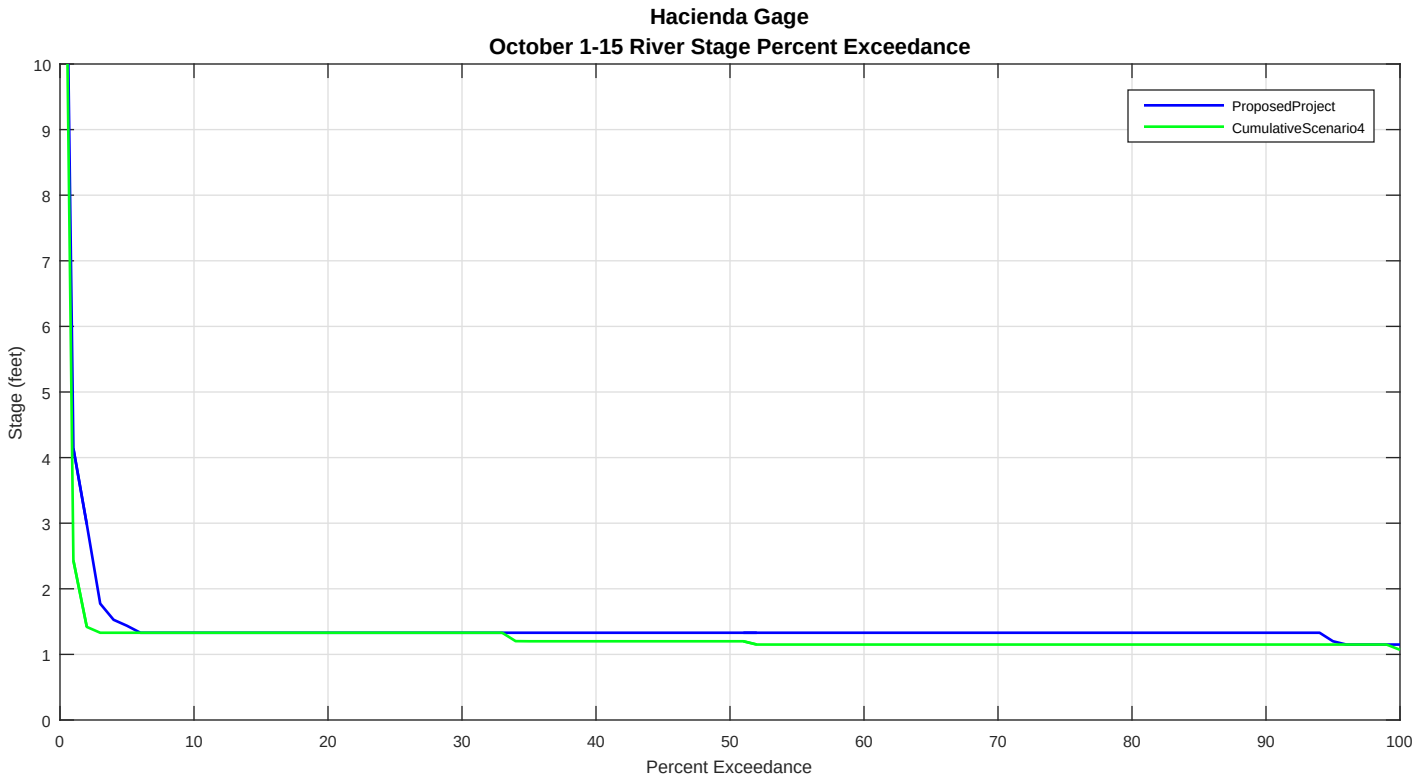

Hacienda Gage
May River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

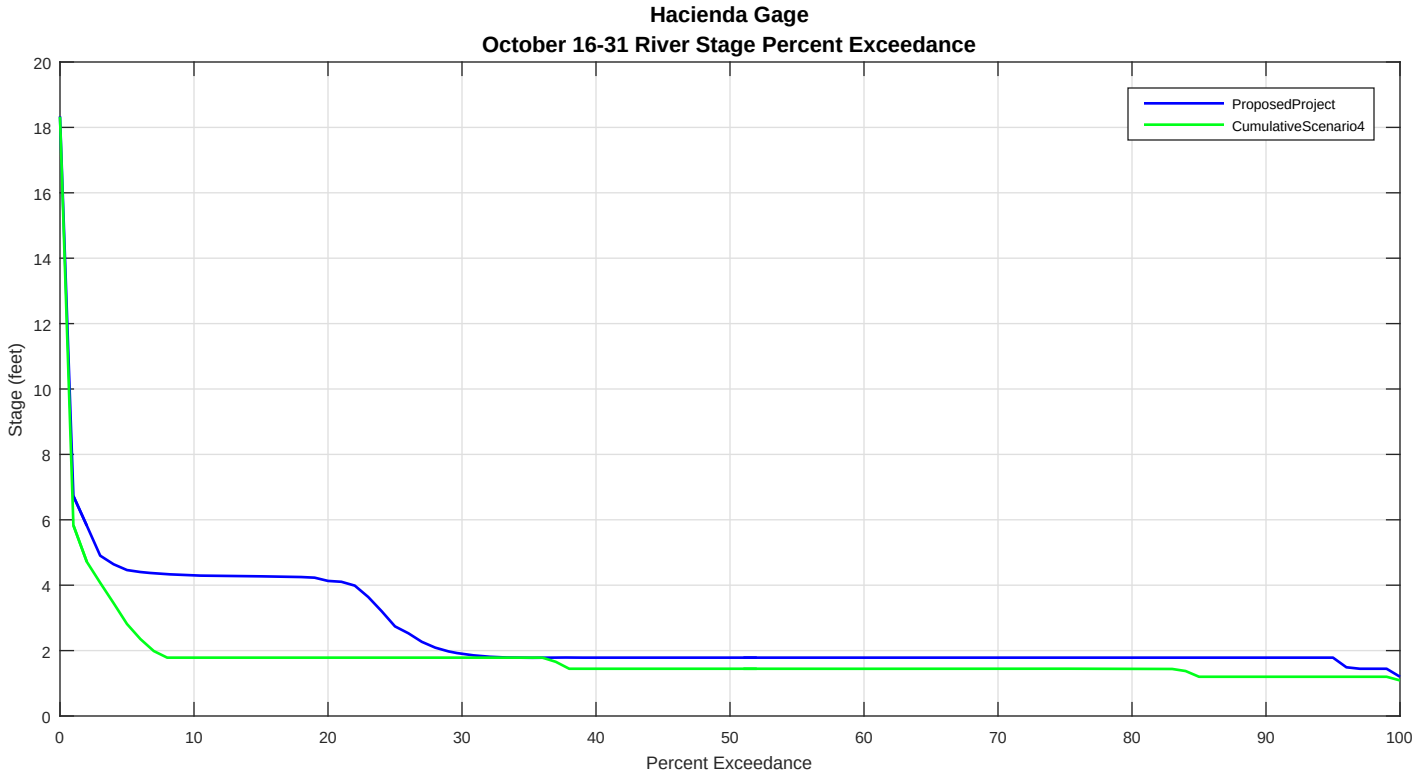

Hacienda Gage
June River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

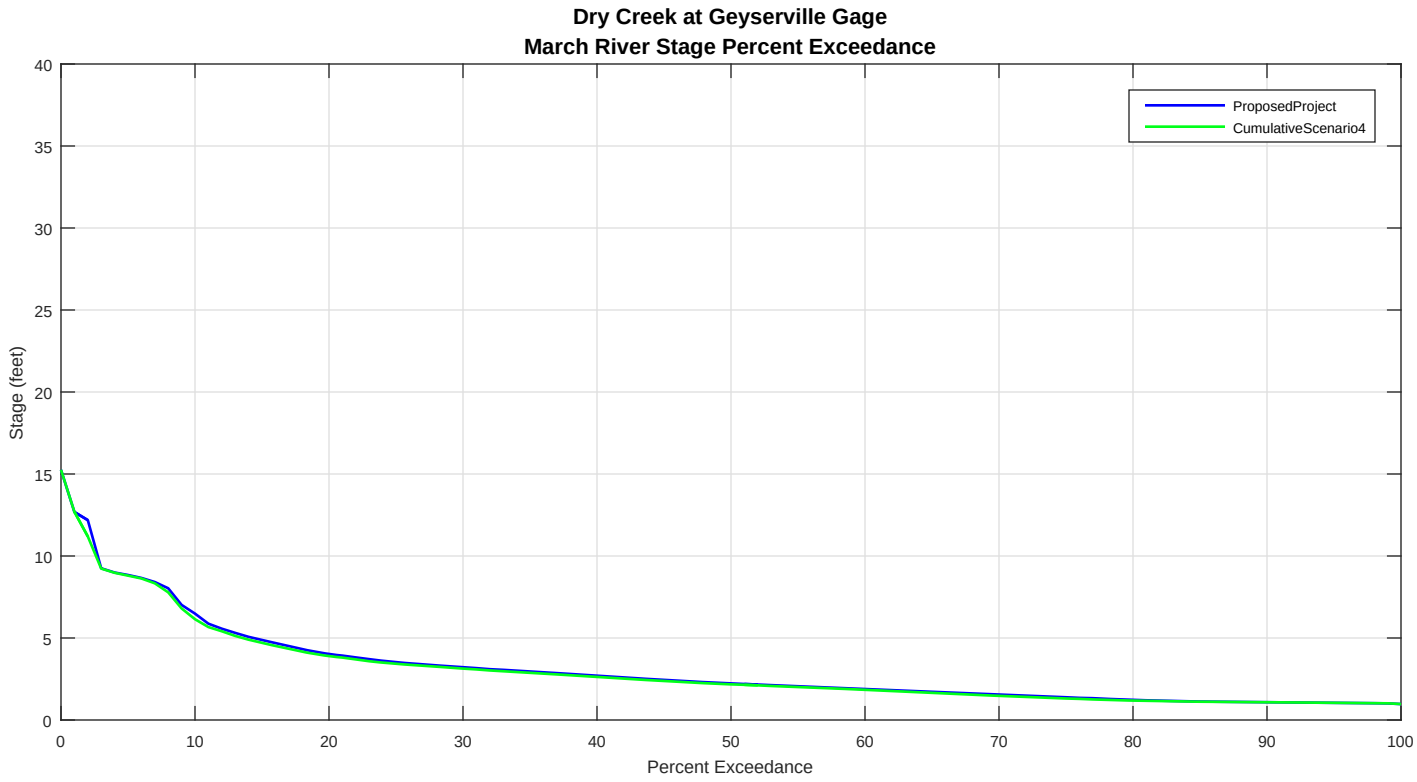

Hacienda Gage
July River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

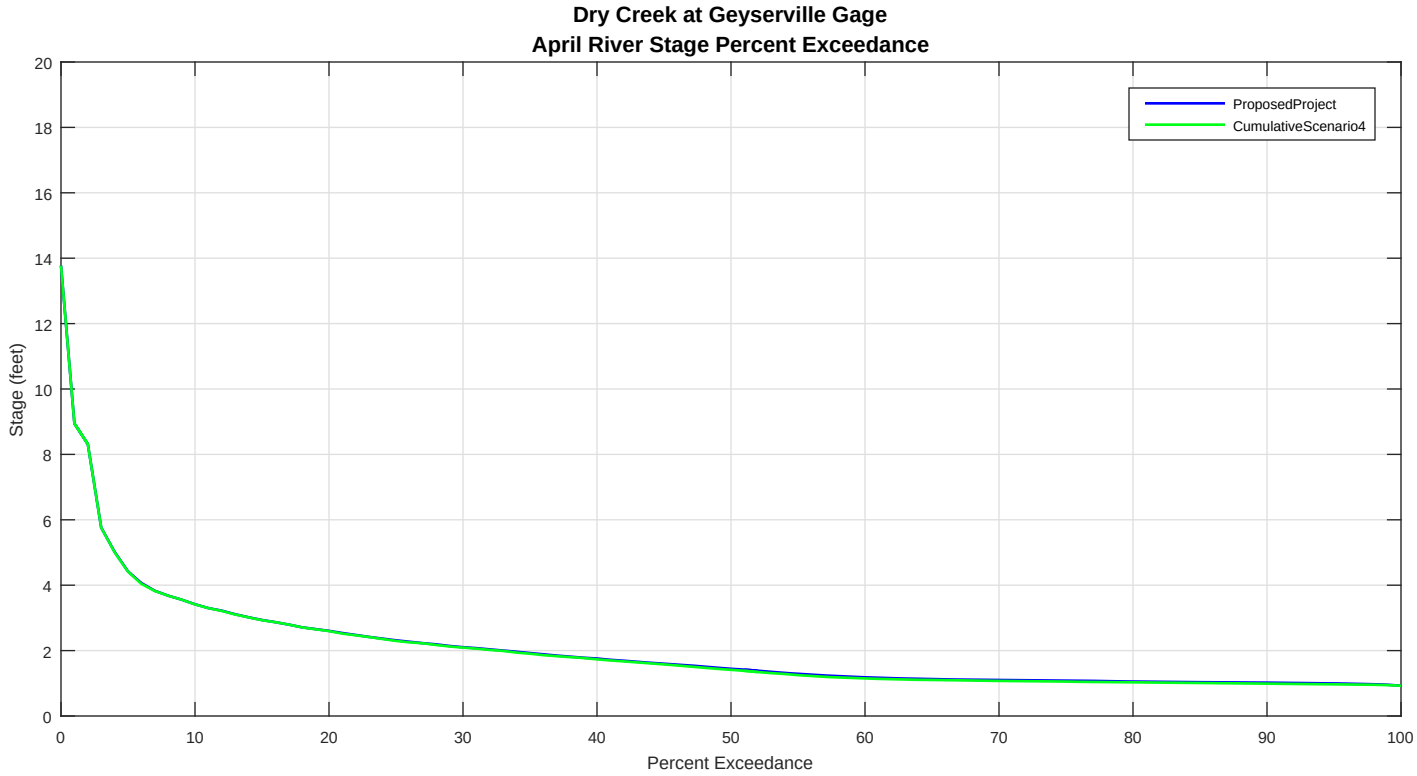

Hacienda Gage
August River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

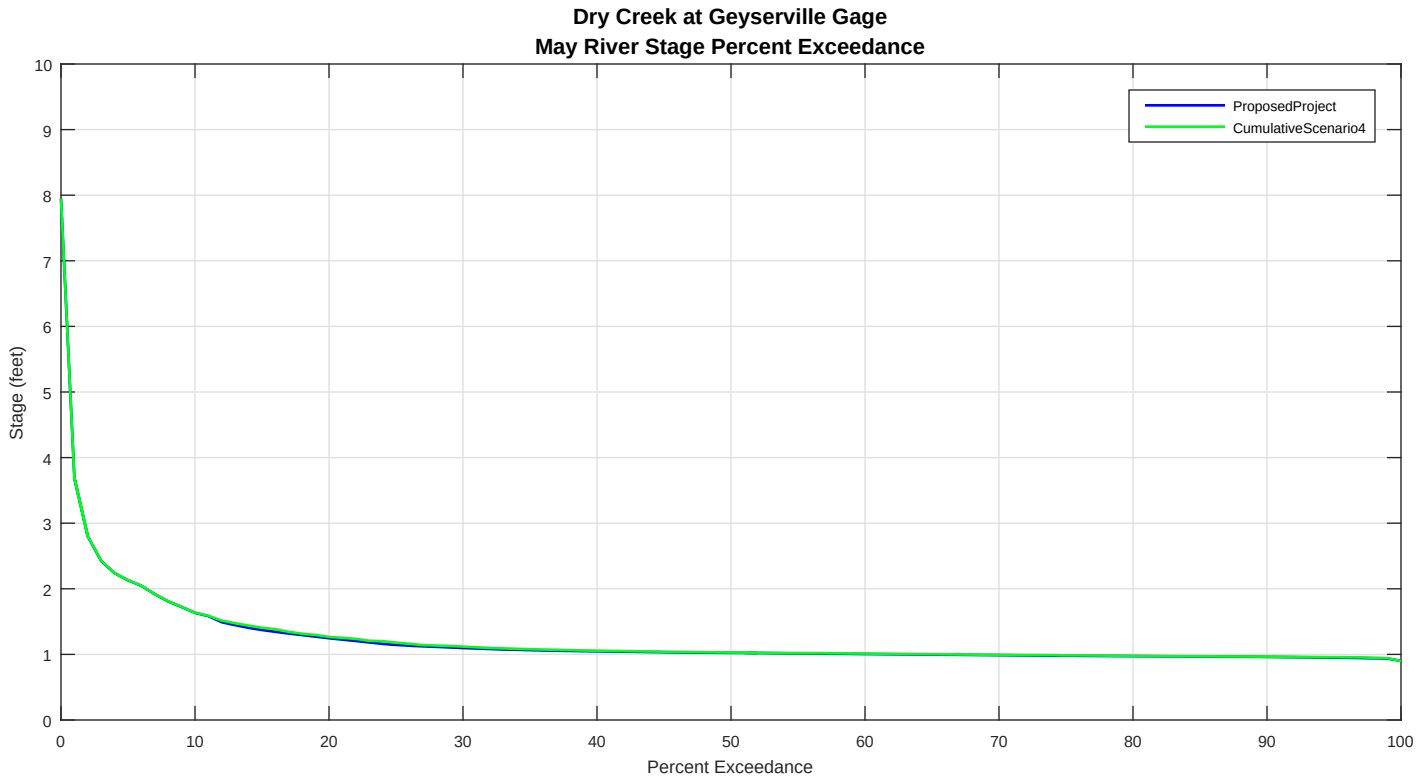

Hacienda Gage
September River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

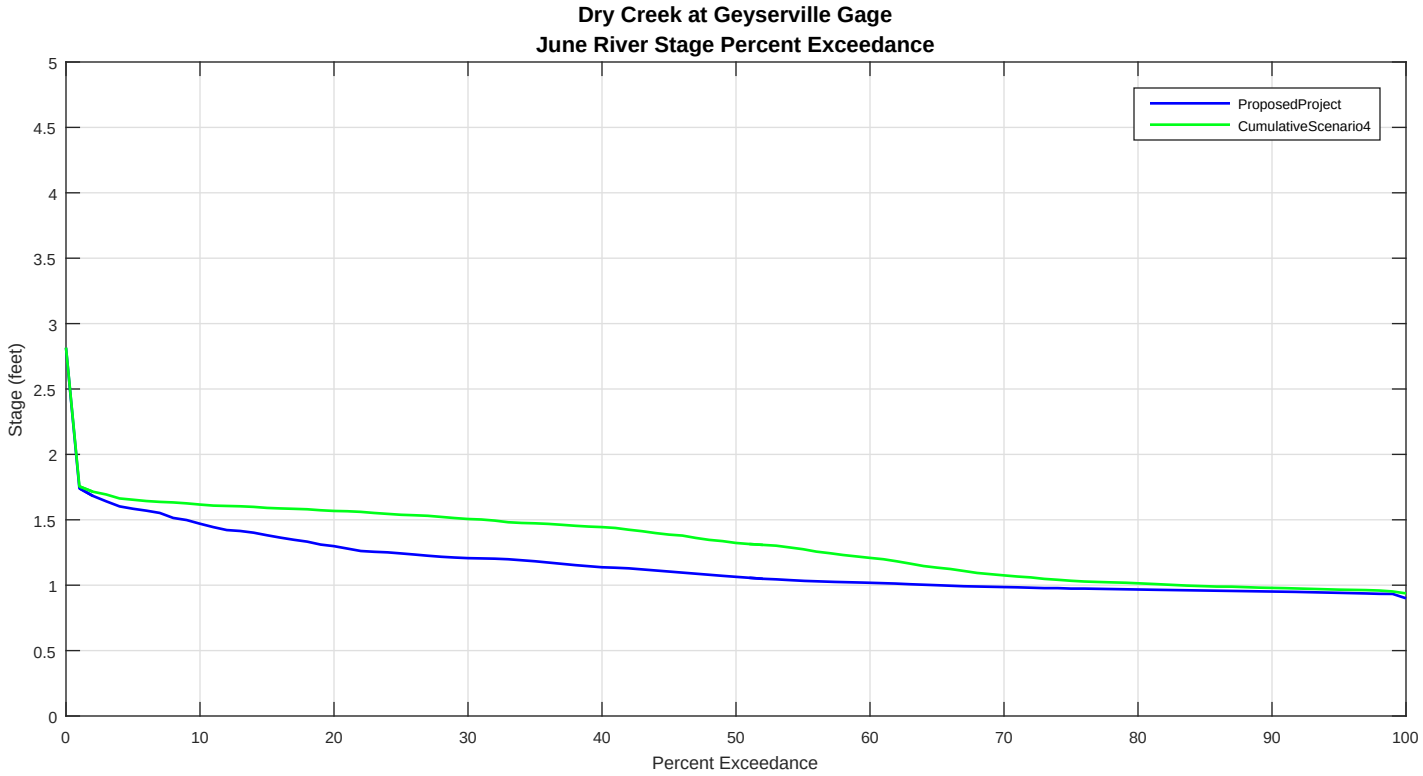

Hacienda Gage
October 1-15 River Stage Percent Exceedance
Stage (feet)
Percent Exceedance
ProposedProject
CumulativeScenario4
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

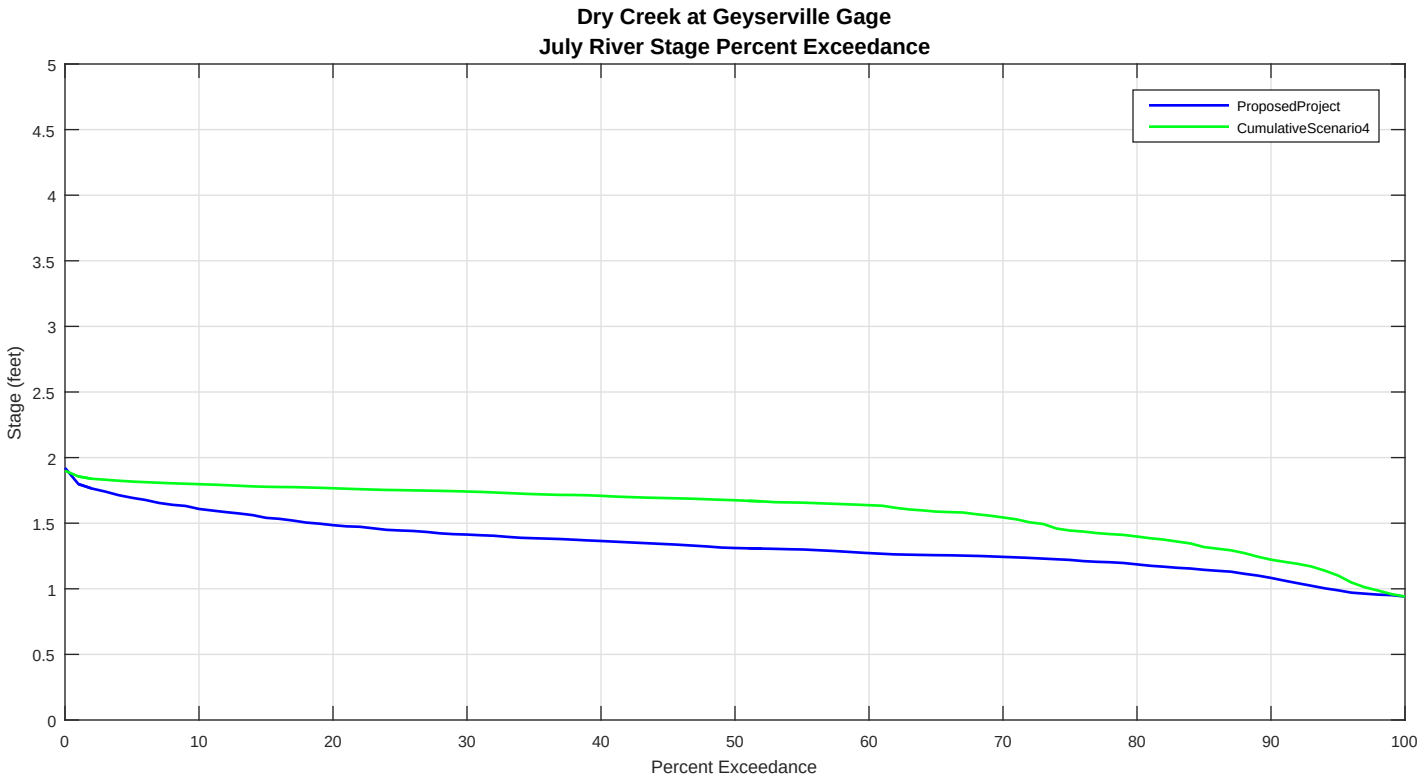

Hacienda Gage
October 16-31 River Stage Percent Exceedance
Stage (feet)
Percent Exceedance
ProposedProject
CumulativeScenario4
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

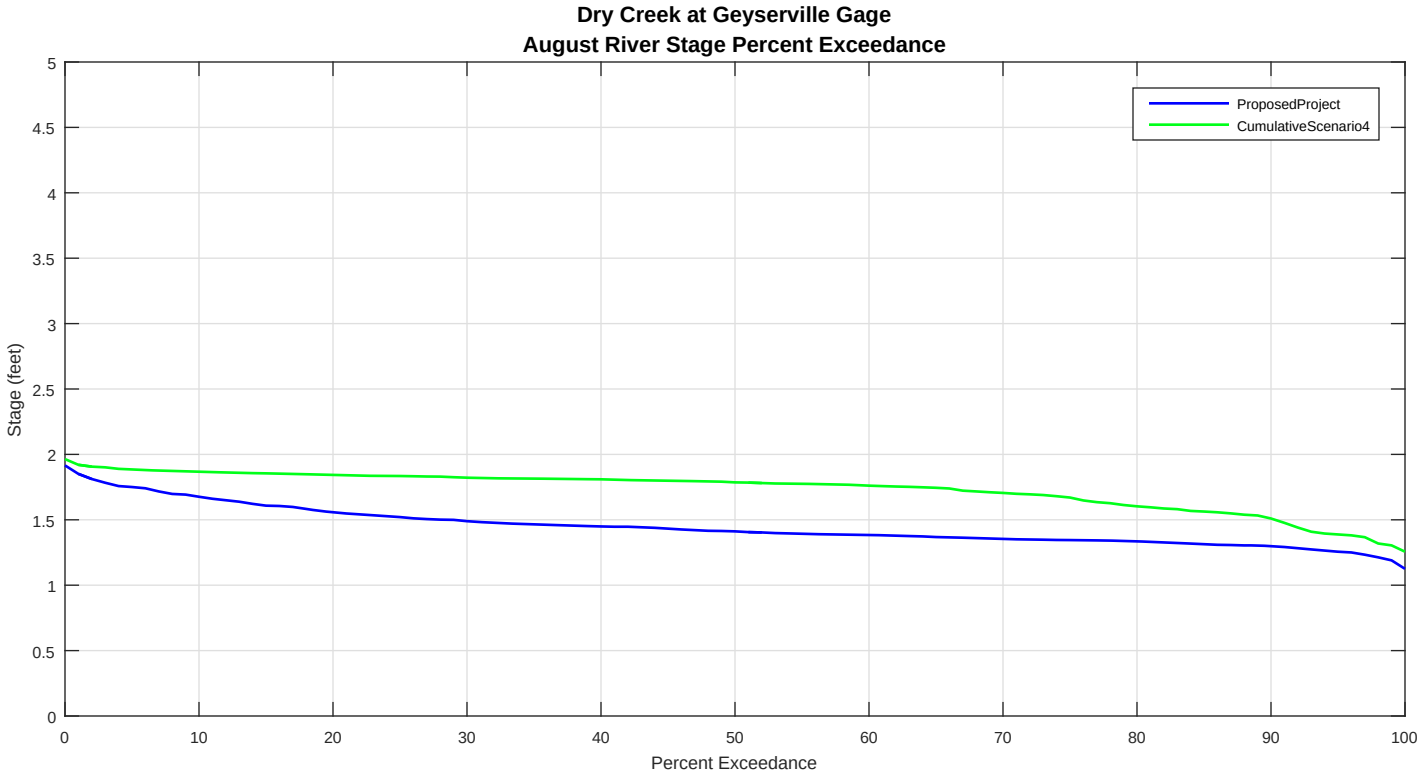

Dry Creek at Geyserville Gage
March River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80
90
100

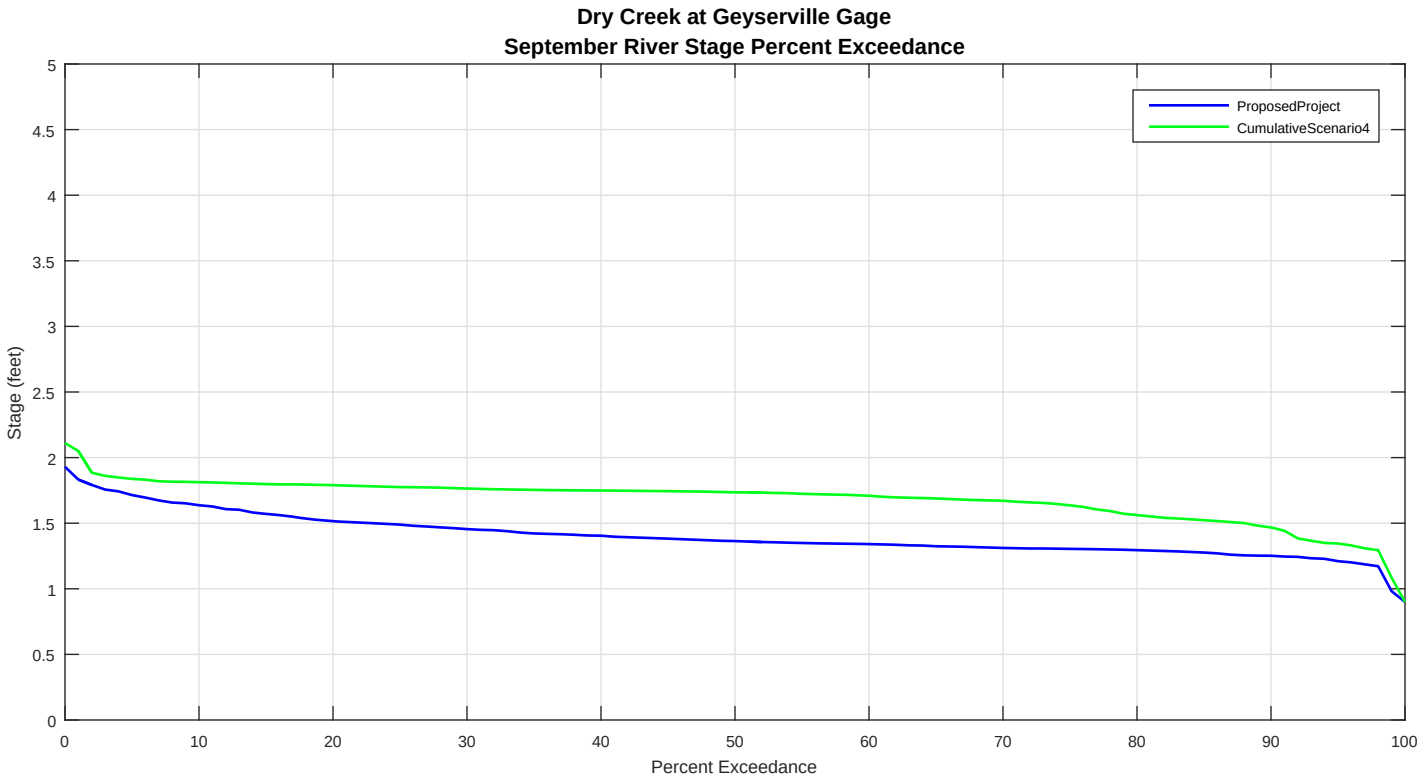

Dry Creek at Geyserville Gage
April River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

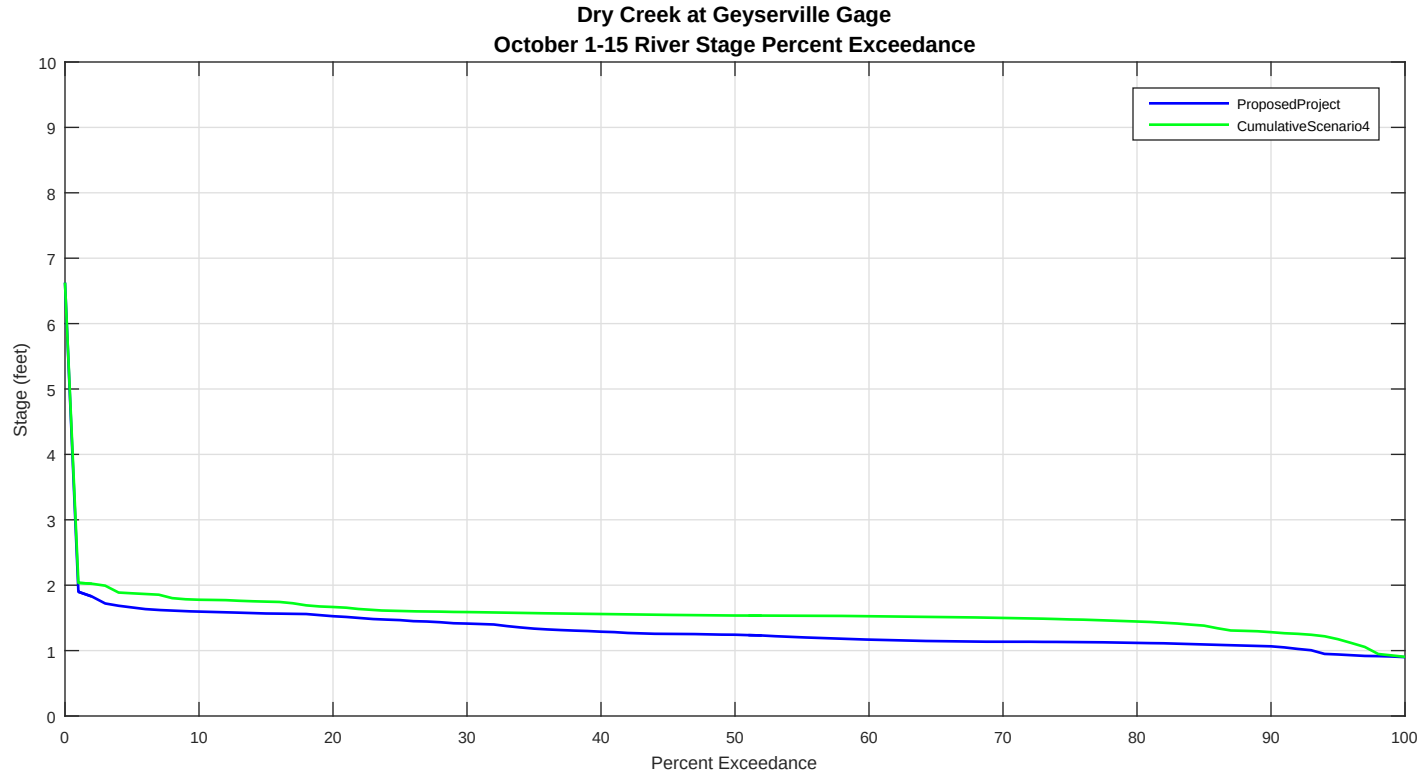

Dry Creek at Geyserville Gage
May River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

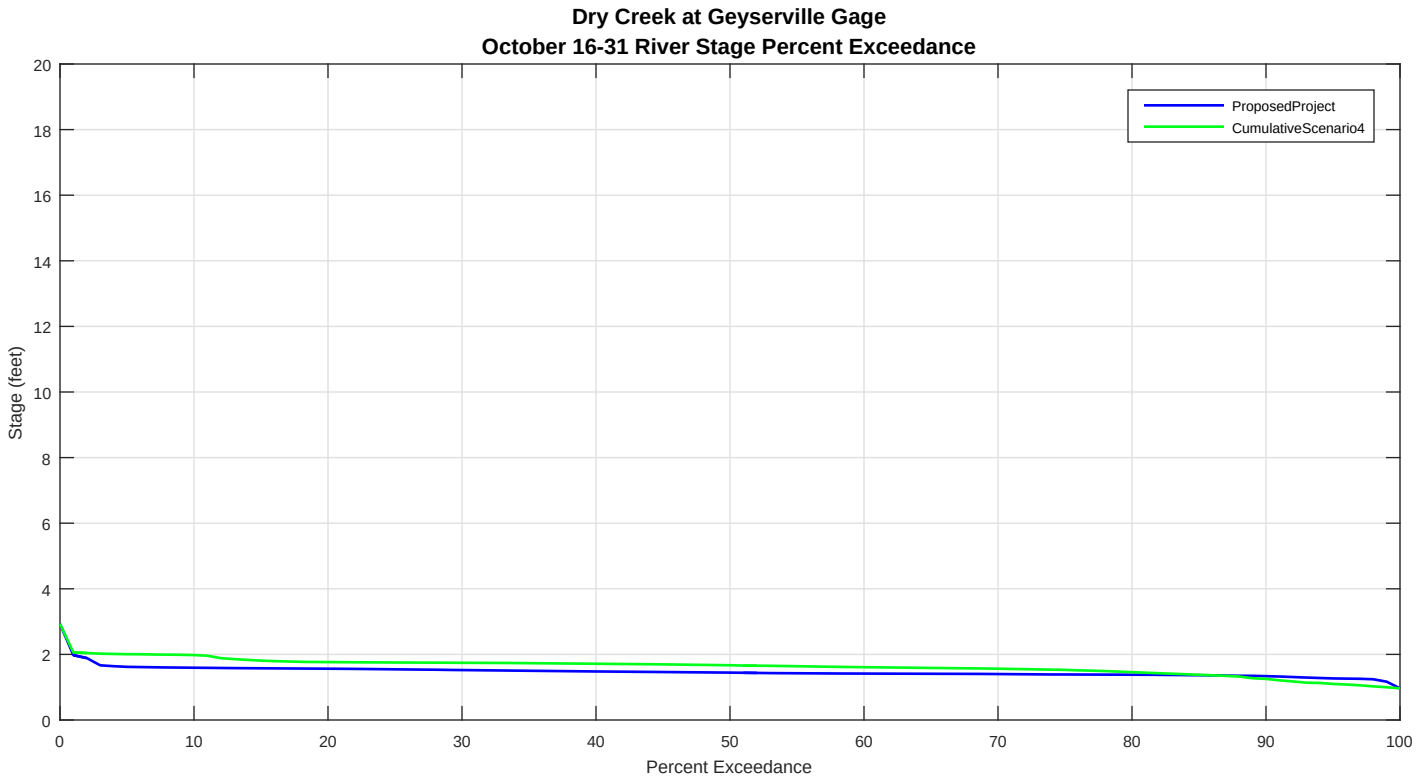

Dry Creek at Geyserville Gage
June River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

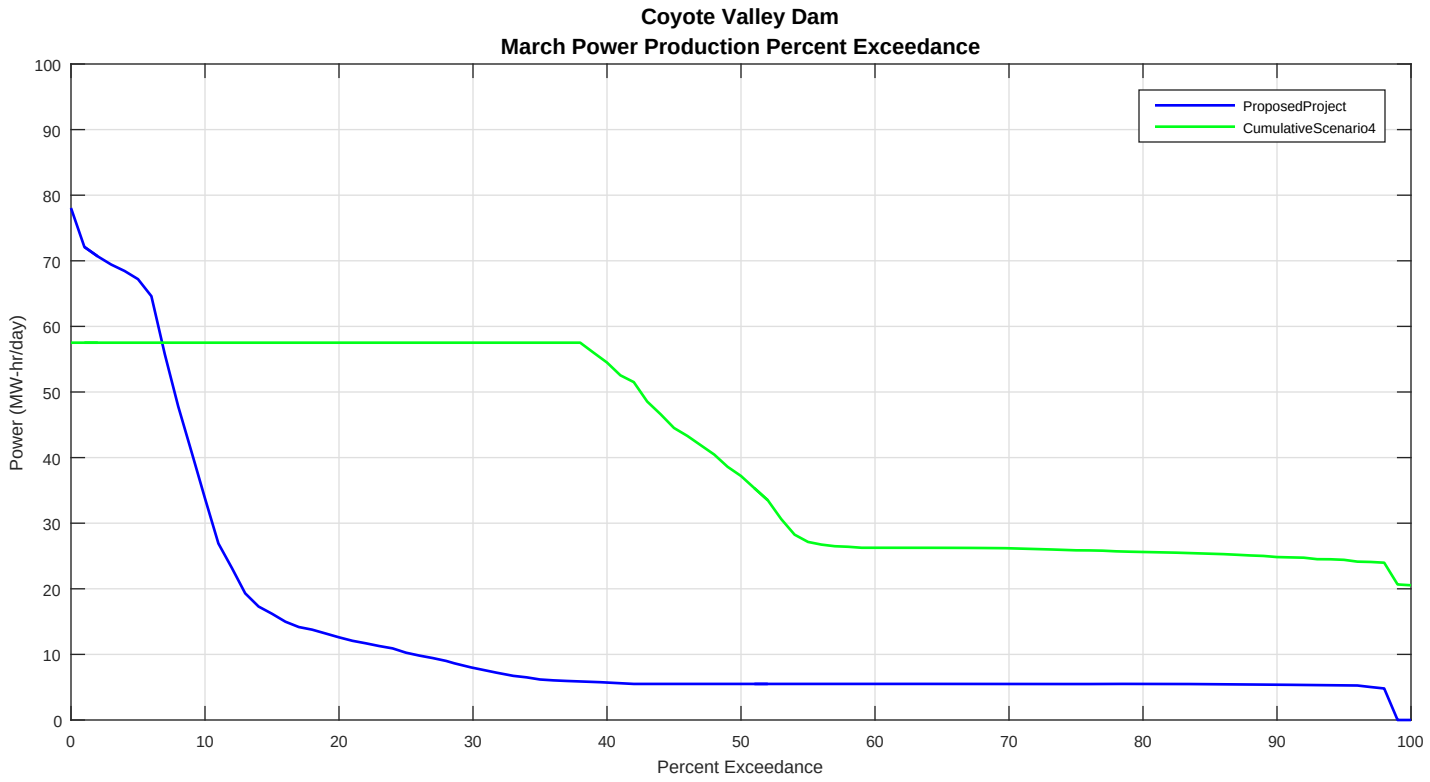

Dry Creek at Geyserville Gage
July River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

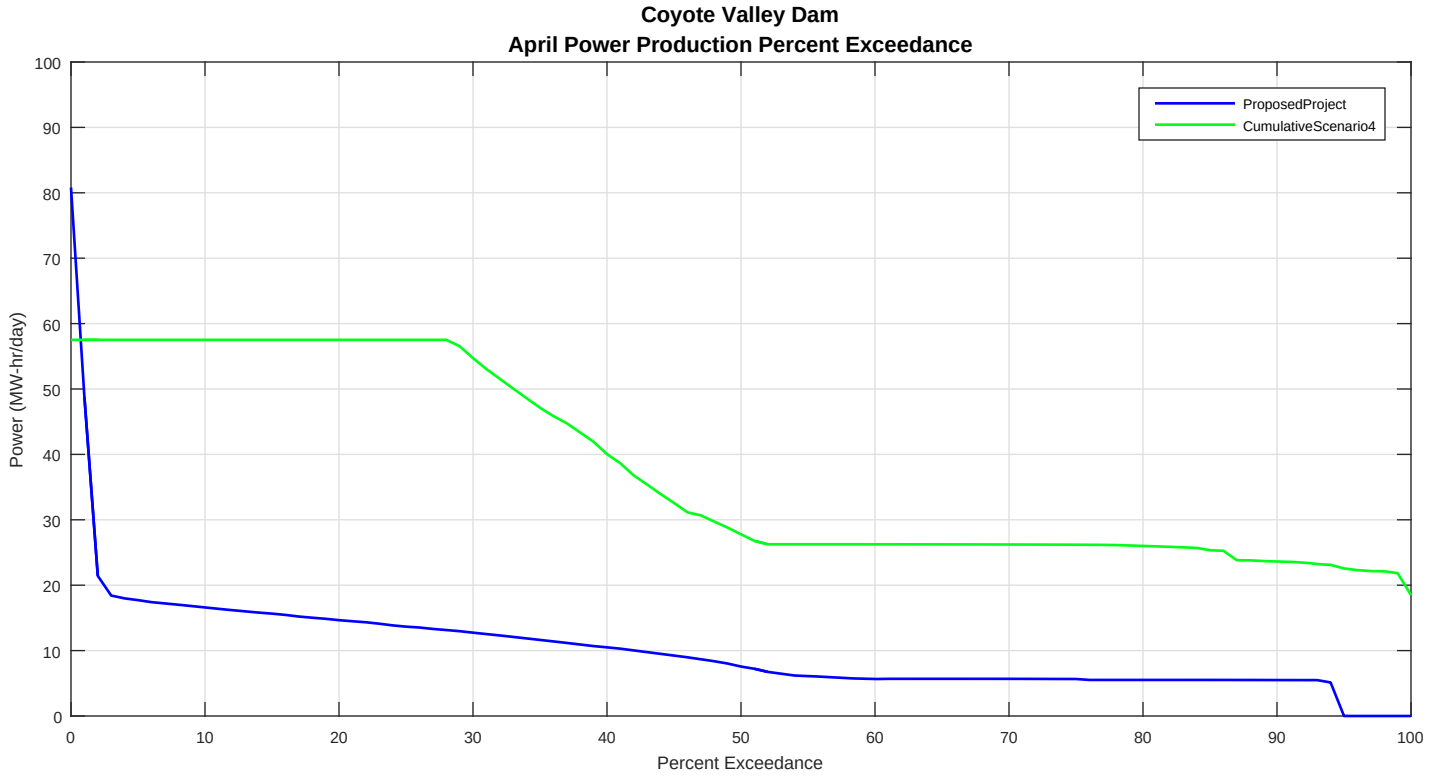

Dry Creek at Geyserville Gage
August River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

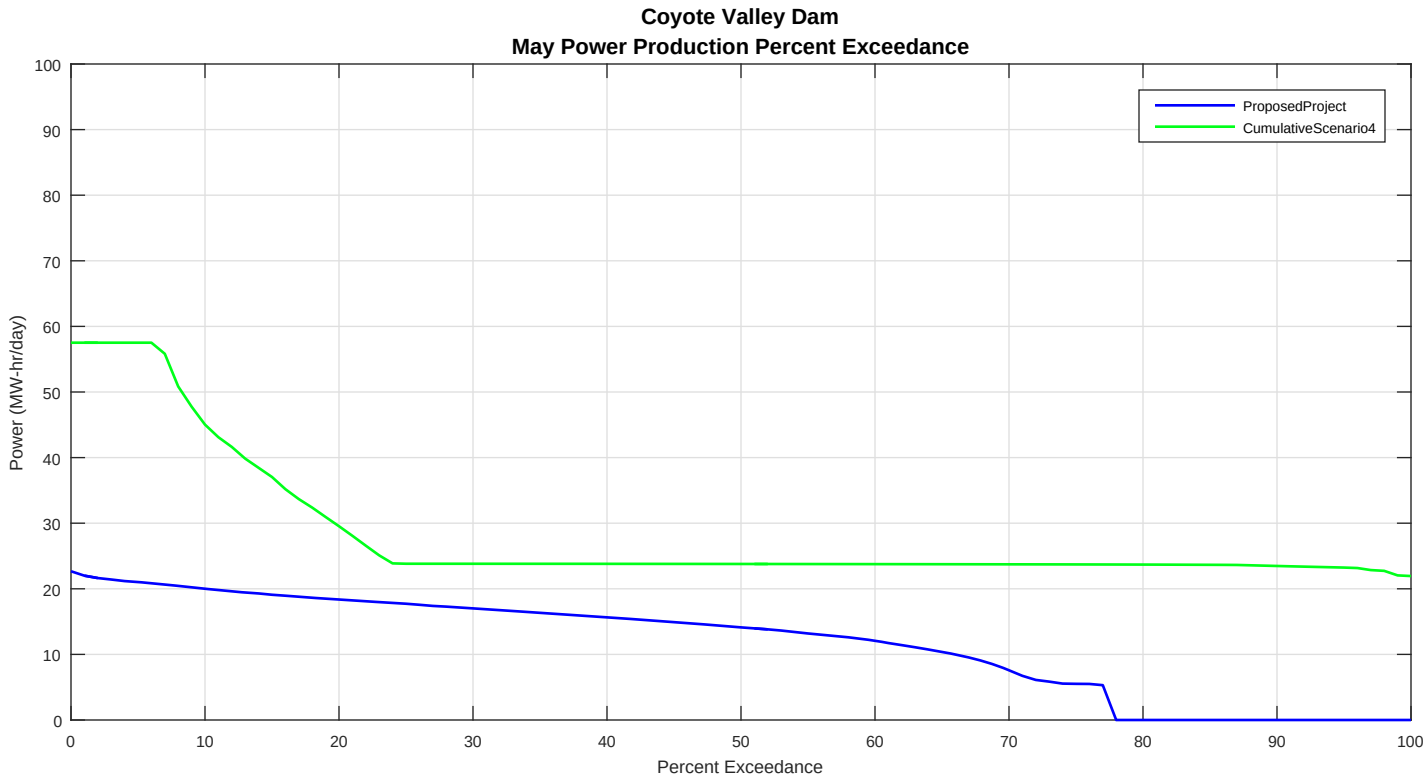

Dry Creek at Geyserville Gage
September River Stage Percent Exceedance
Stage (feet)
Percent Exceedance
ProposedProject
CumulativeScenario4
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
10
20
30
40
50
60
70
80
90
100

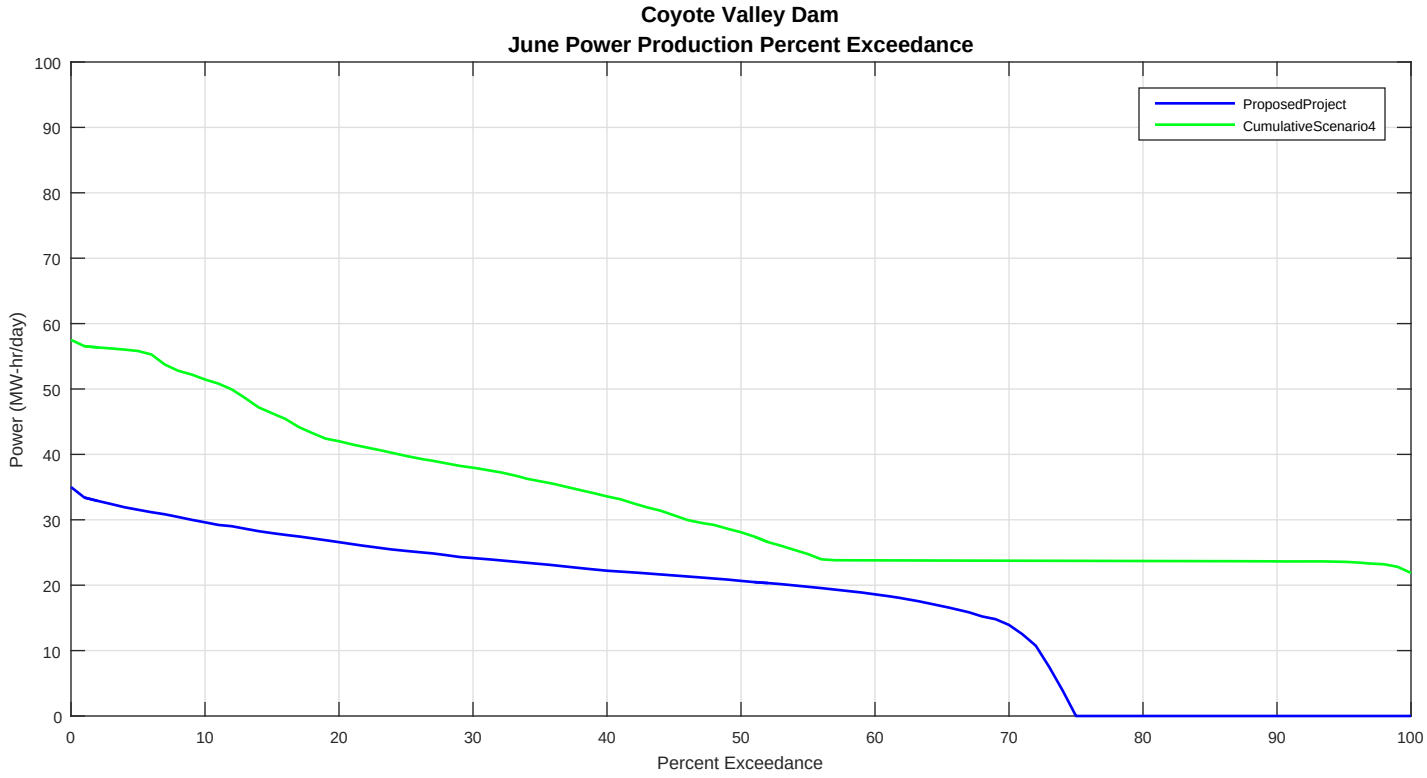

Dry Creek at Geyserville Gage
October 1-15 River Stage Percent Exceedance
Stage (feet)
Percent Exceedance
ProposedProject
CumulativeScenario4
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
90
100

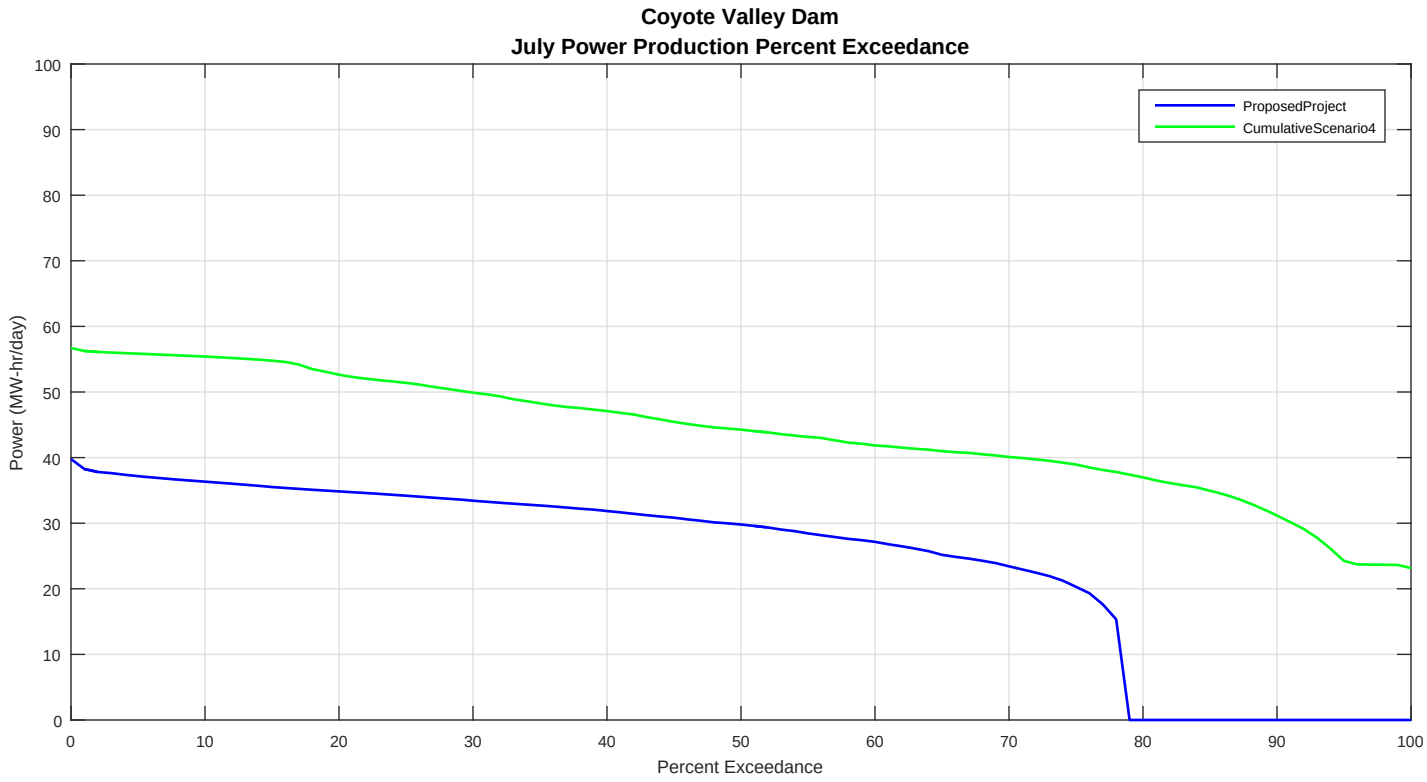

Dry Creek at Geyserville Gage
October 16-31 River Stage Percent Exceedance
ProposedProject
CumulativeScenario4
Stage (feet)
Percent Exceedance
0
2
4
6
8
10
12
14
16
18
20
0
10
20
30
40
50
60
70
80
90
100

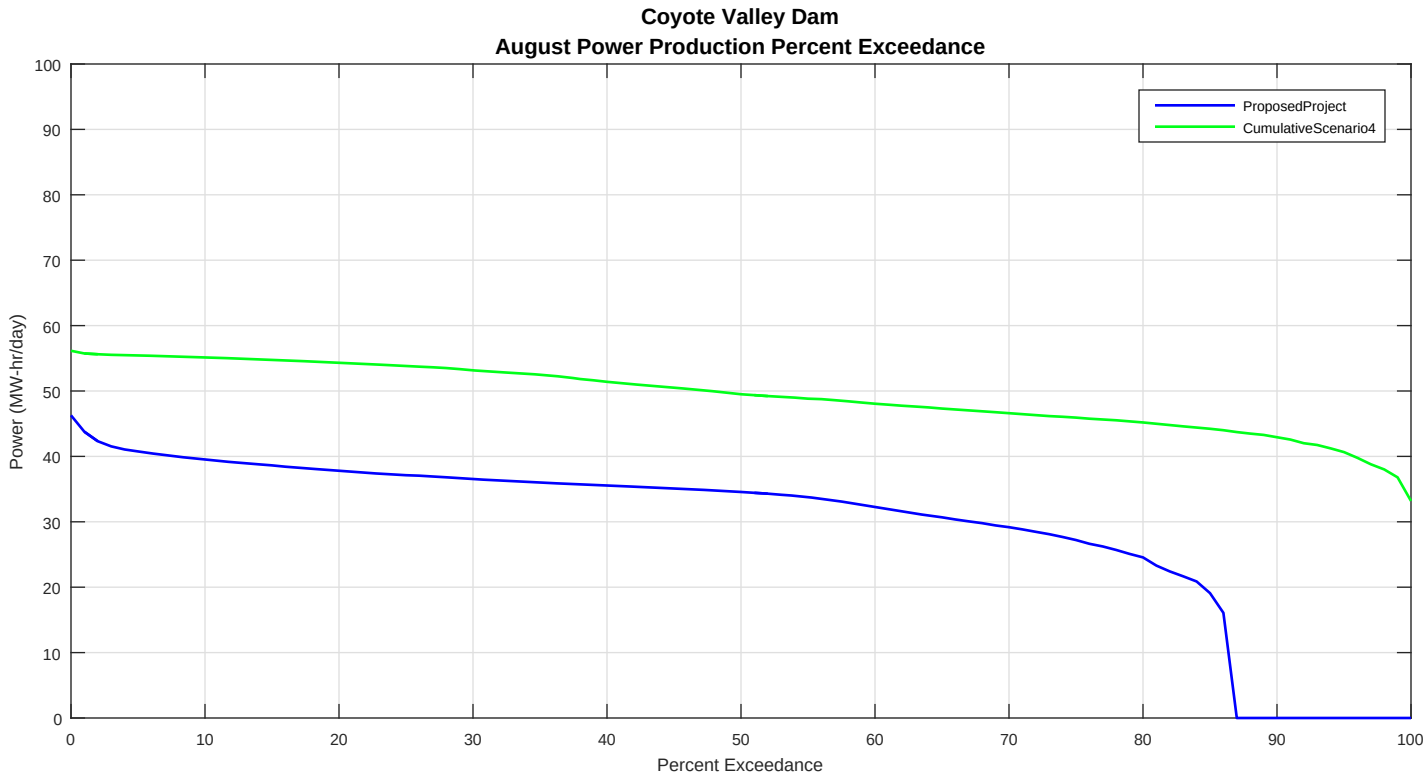

Coyote Valley Dam
March Power Production Percent Exceedance
ProposedProject
CumulativeScenario4
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

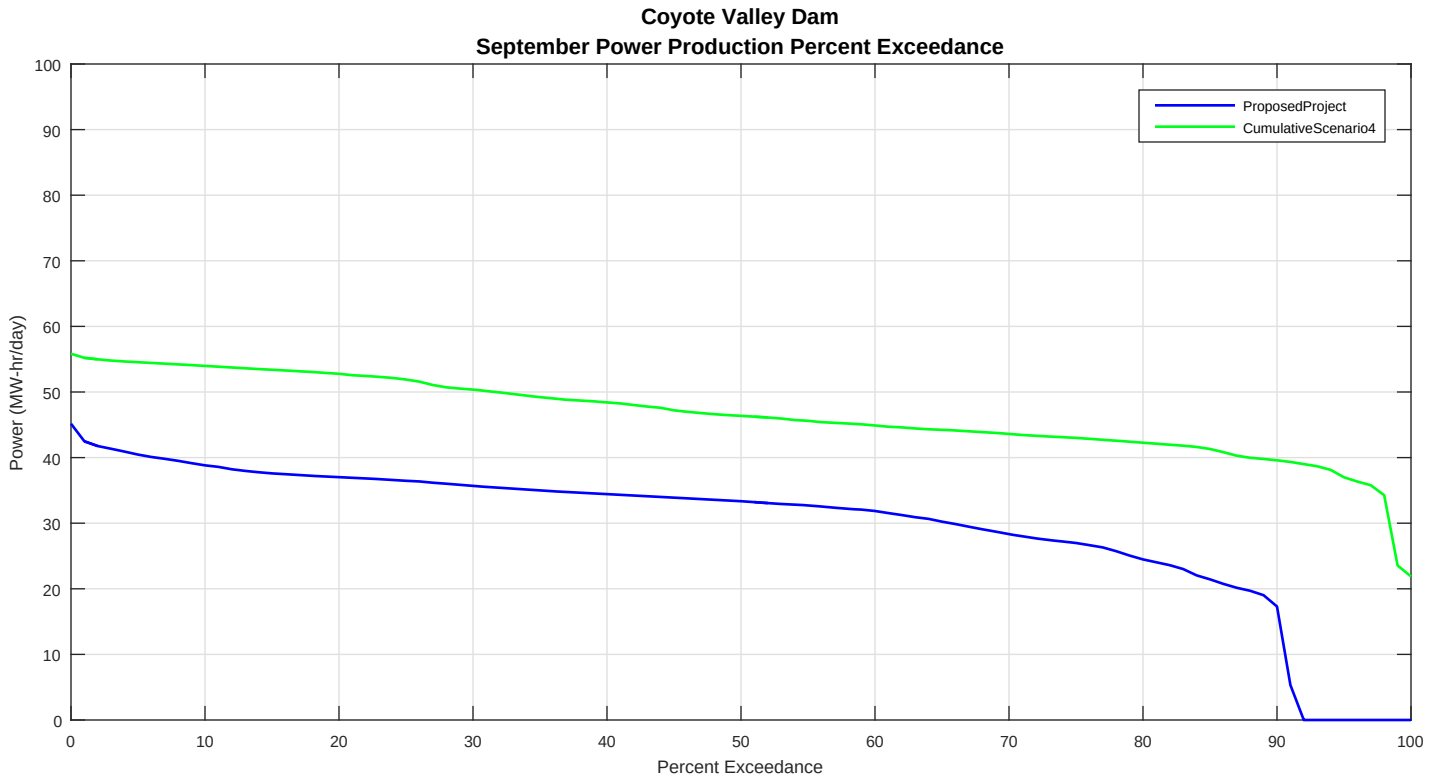

Coyote Valley Dam
April Power Production Percent Exceedance
ProposedProject
CumulativeScenario4
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

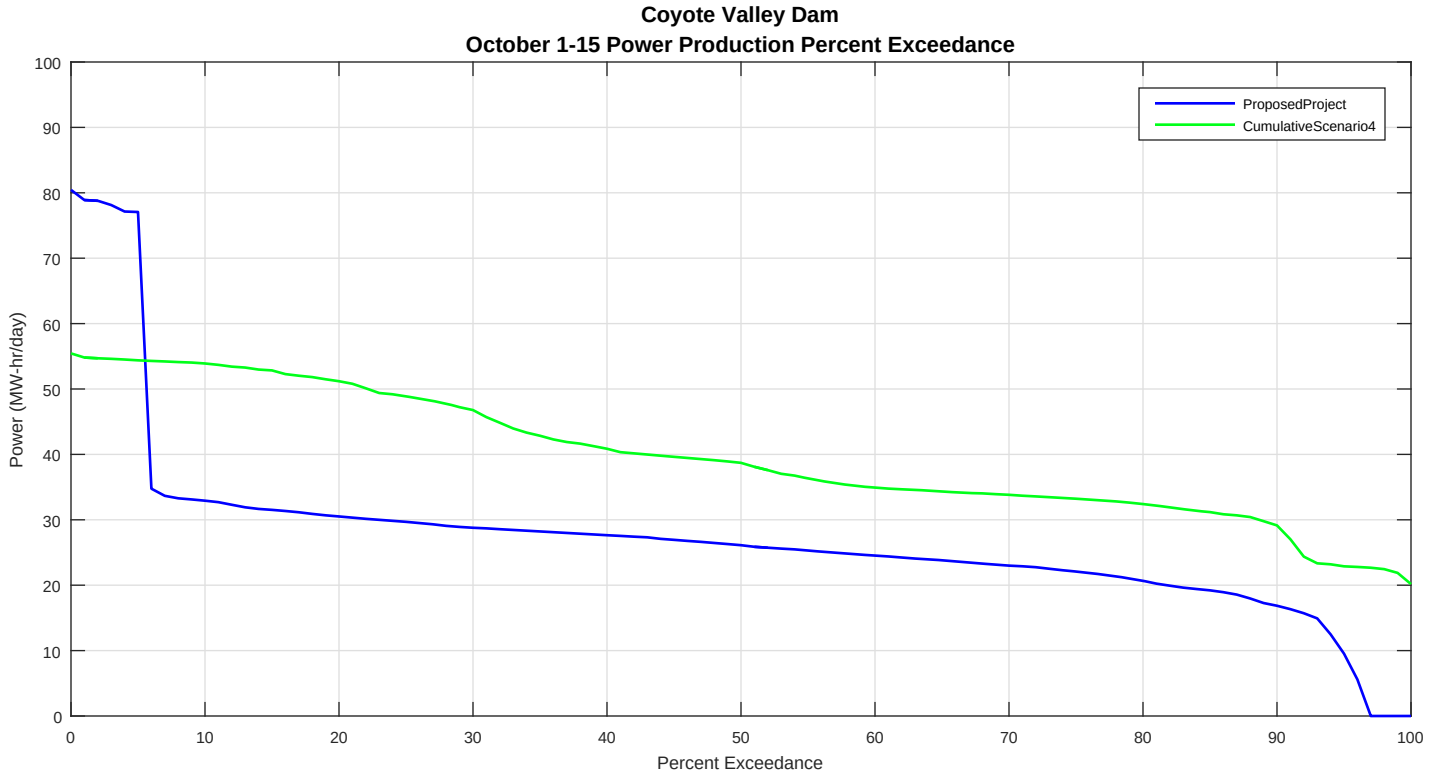

Coyote Valley Dam
May Power Production Percent Exceedance
ProposedProject
CumulativeScenario4
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

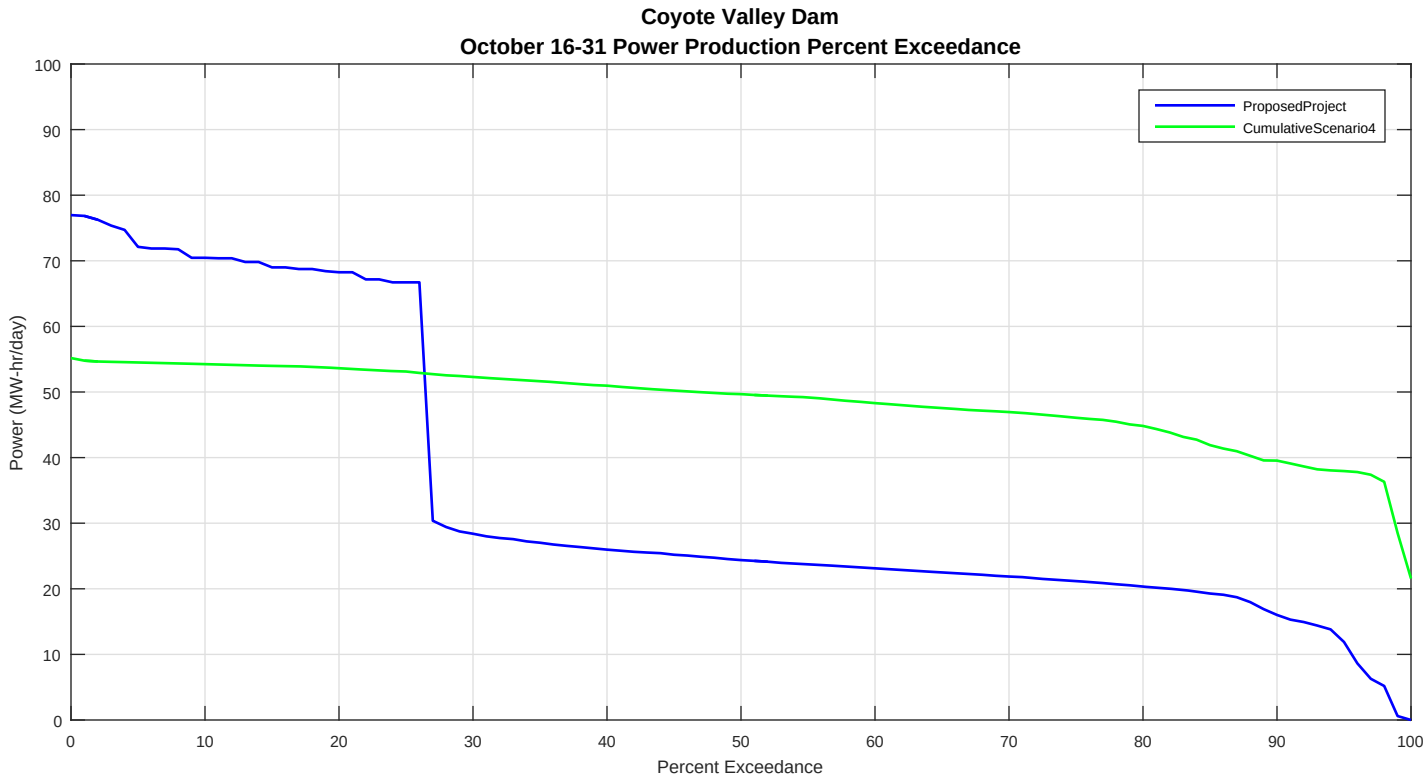

Coyote Valley Dam
June Power Production Percent Exceedance
ProposedProject
CumulativeScenario4
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

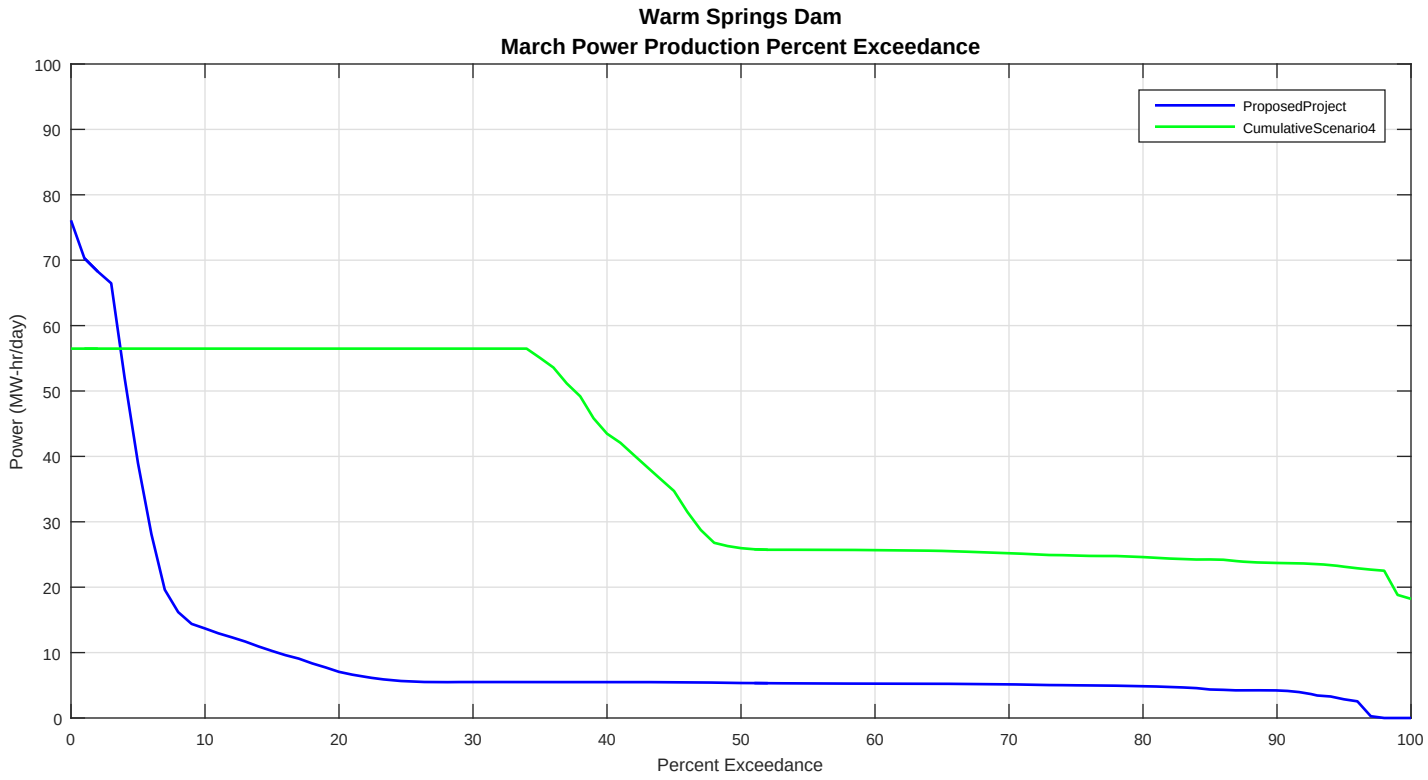

Coyote Valley Dam
July Power Production Percent Exceedance
ProposedProject
CumulativeScenario4
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100

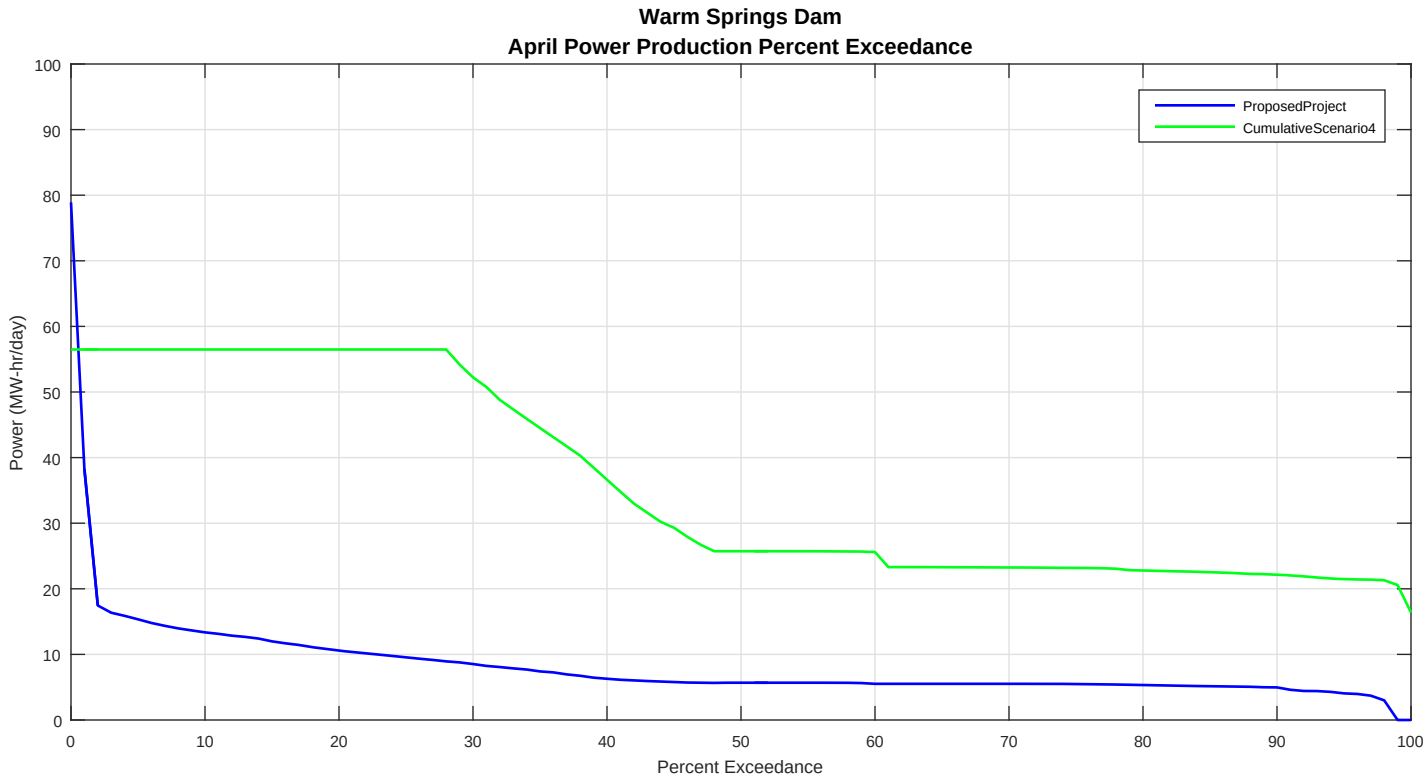

Coyote Valley Dam
August Power Production Percent Exceedance
ProposedProject
CumulativeScenario4
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam
September Power Production Percent Exceedance
ProposedProject
CumulativeScenario4
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam
October 1-15 Power Production Percent Exceedance
ProposedProject
CumulativeScenario4
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100


Coyote Valley Dam
October 16-31 Power Production Percent Exceedance
ProposedProject
CumulativeScenario4
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100


Warm Springs Dam
March Power Production Percent Exceedance
ProposedProject
CumulativeScenario4
Power (MW-hr/day)
Percent Exceedance
0
10
20
30
40
50
60
70
80
90
100


Warm Springs Dam
April Power Production Percent Exceedance
Power (MW-hr/day)
Percent Exceedance
ProposedProject
CumulativeScenario4
0
10
20
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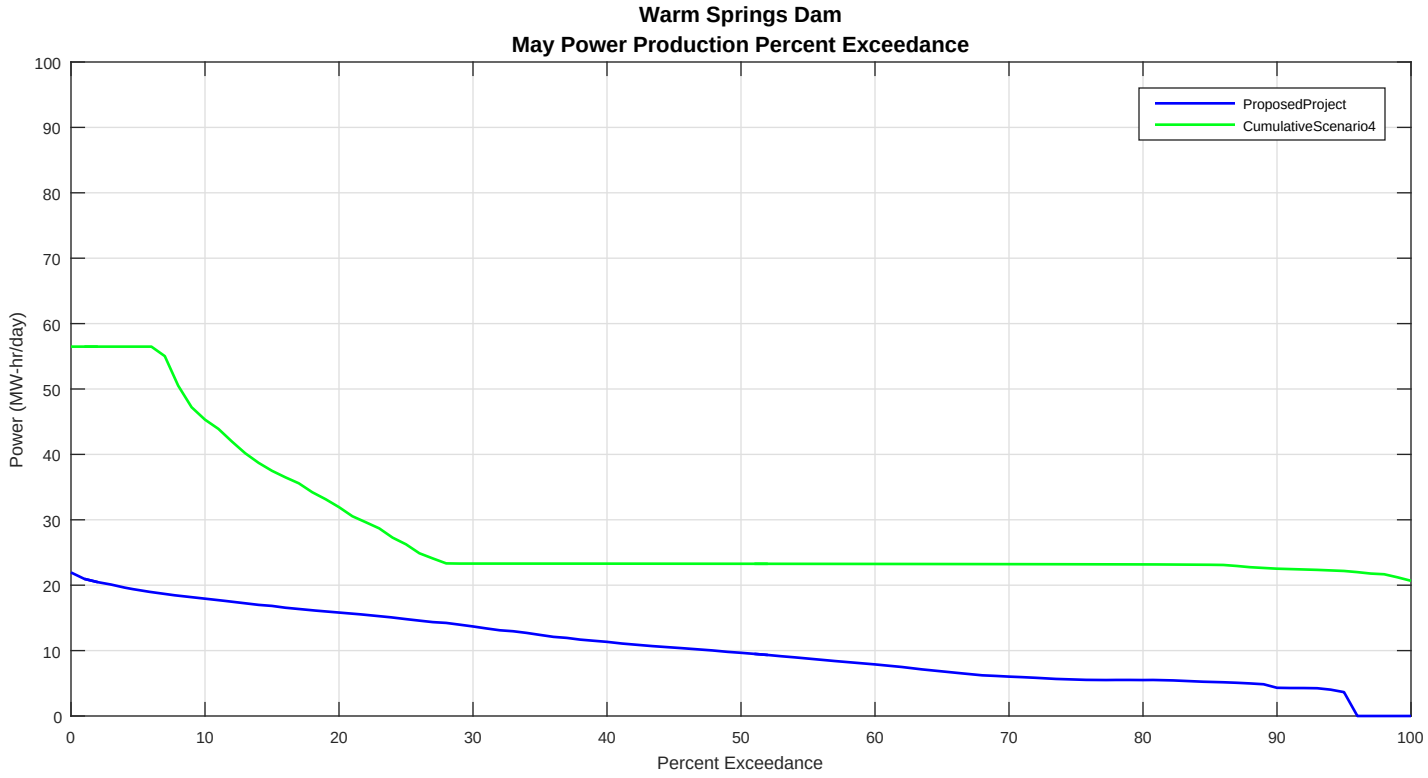
Warm Springs Dam
May Power Production Percent Exceedance
Power (MW-hr/day)
Percent Exceedance
ProposedProject
CumulativeScenario4
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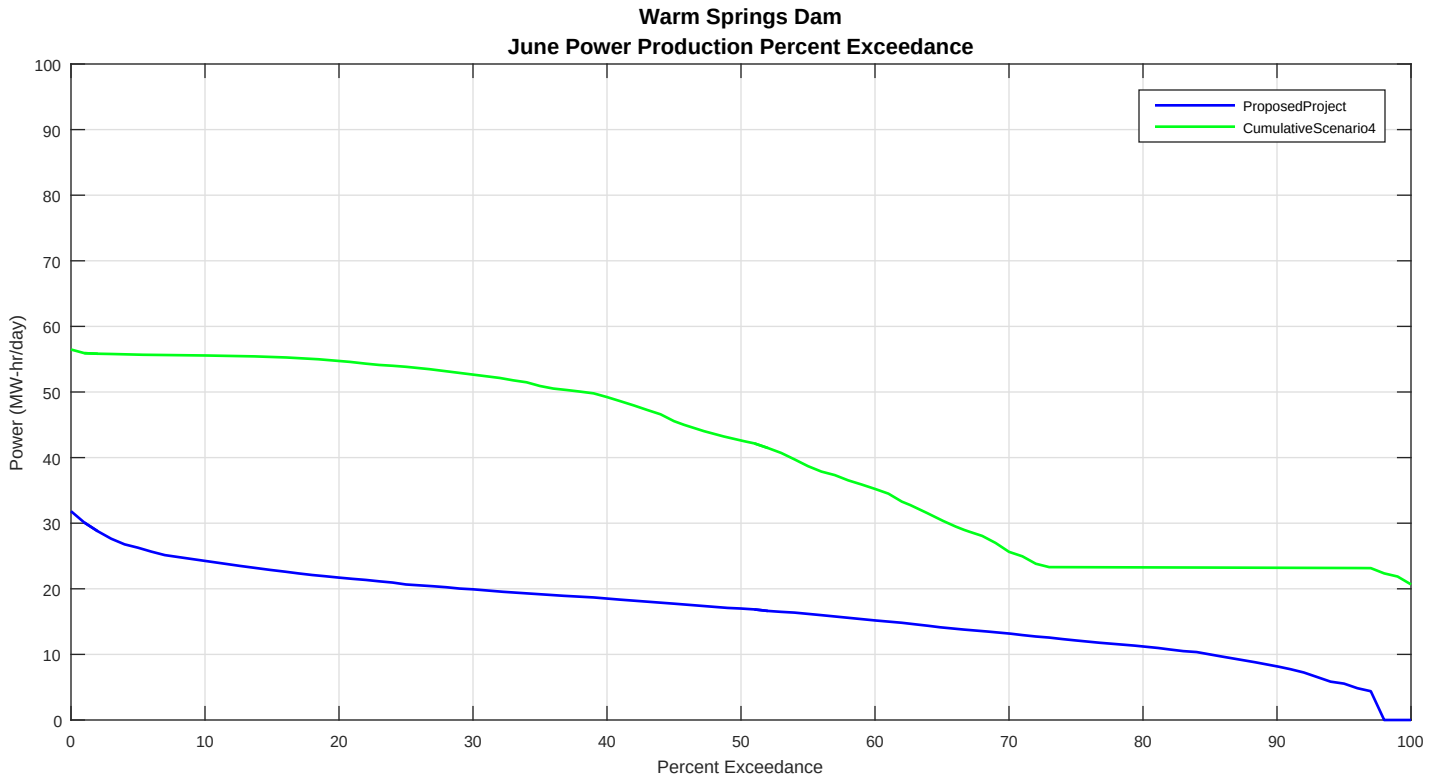
Warm Springs Dam
June Power Production Percent Exceedance
ProposedProject
CumulativeScenario4
Power (MW-hr/day)
Percent Exceedance
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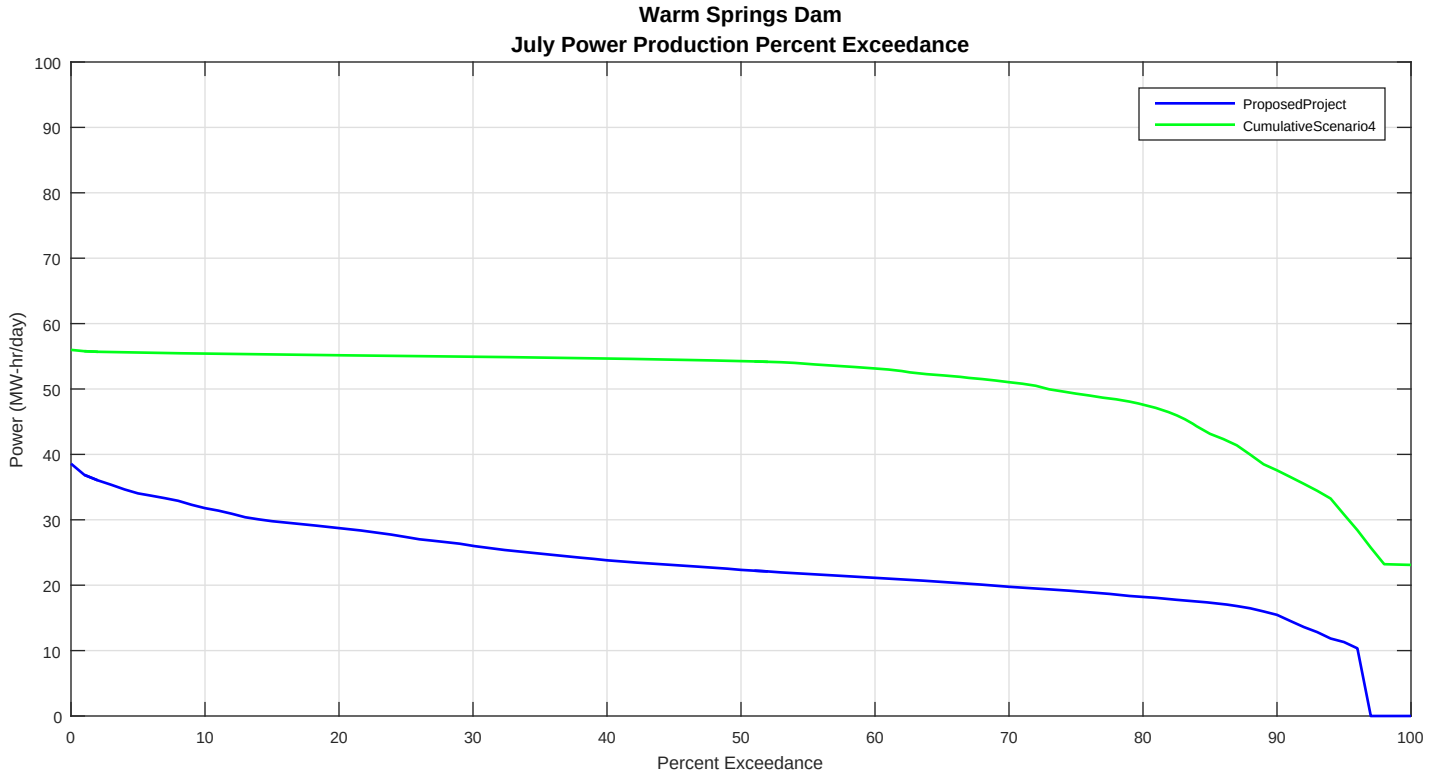
Warm Springs Dam
July Power Production Percent Exceedance
ProposedProject
CumulativeScenario4
Power (MW-hr/day)
Percent Exceedance
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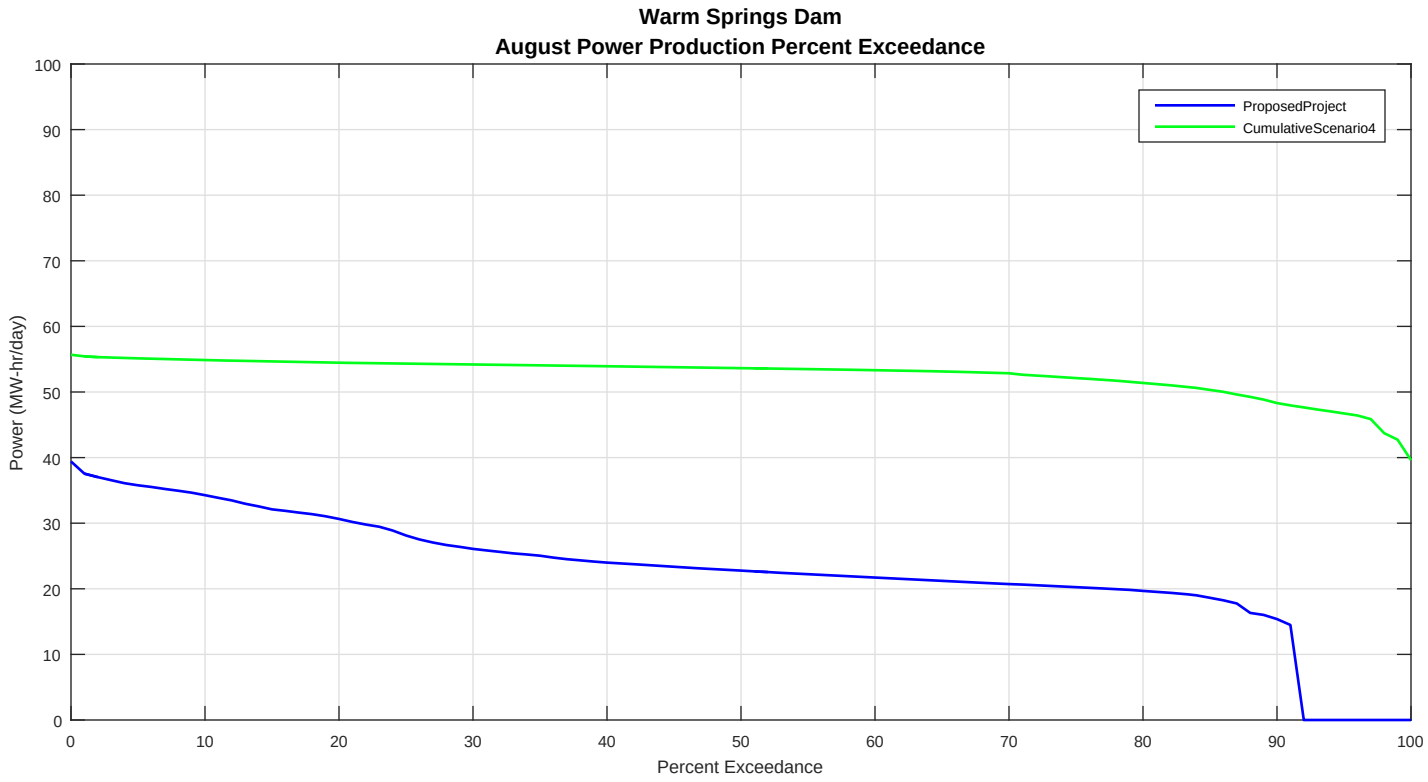
Warm Springs Dam
August Power Production Percent Exceedance
ProposedProject
CumulativeScenario4
Power (MW-hr/day)
Percent Exceedance
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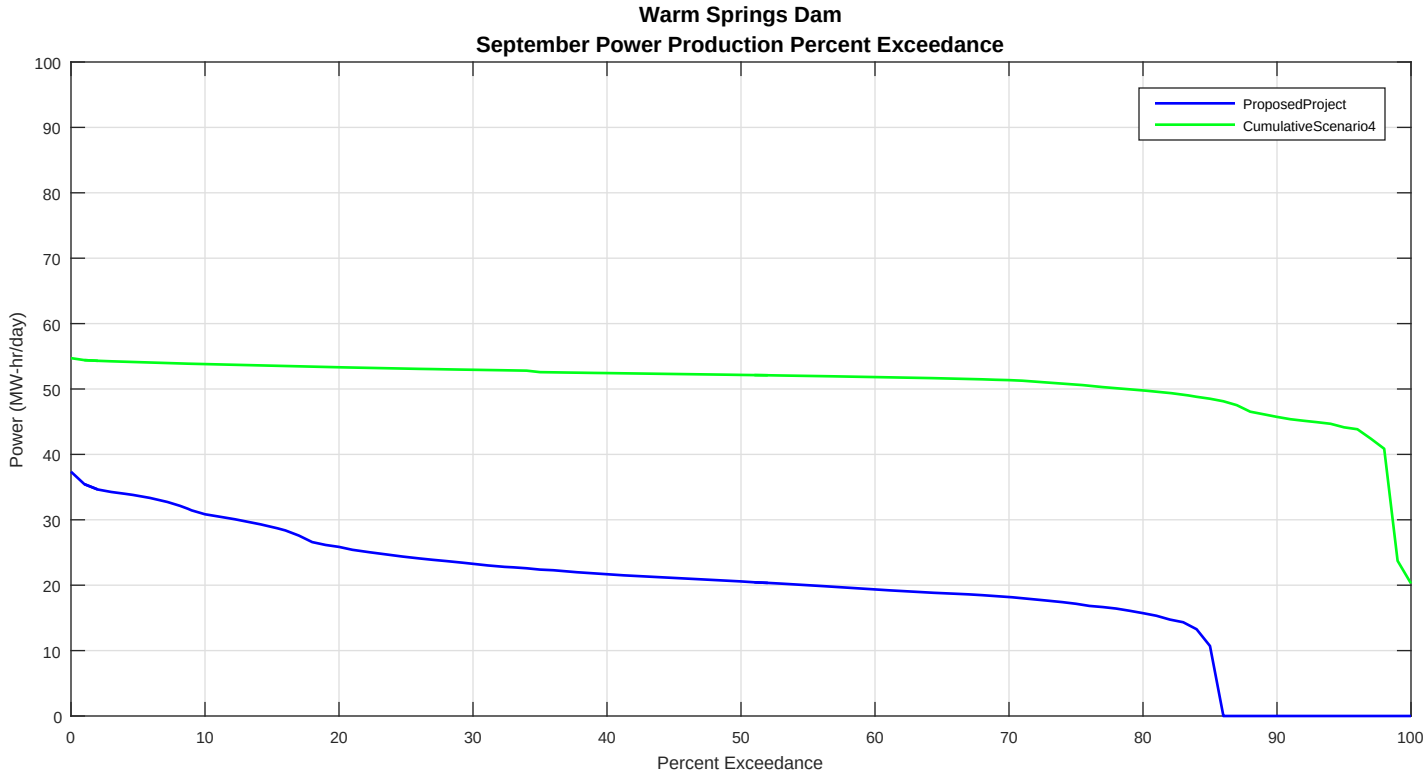
Warm Springs Dam
September Power Production Percent Exceedance
ProposedProject
CumulativeScenario4
Power (MW-hr/day)
Percent Exceedance
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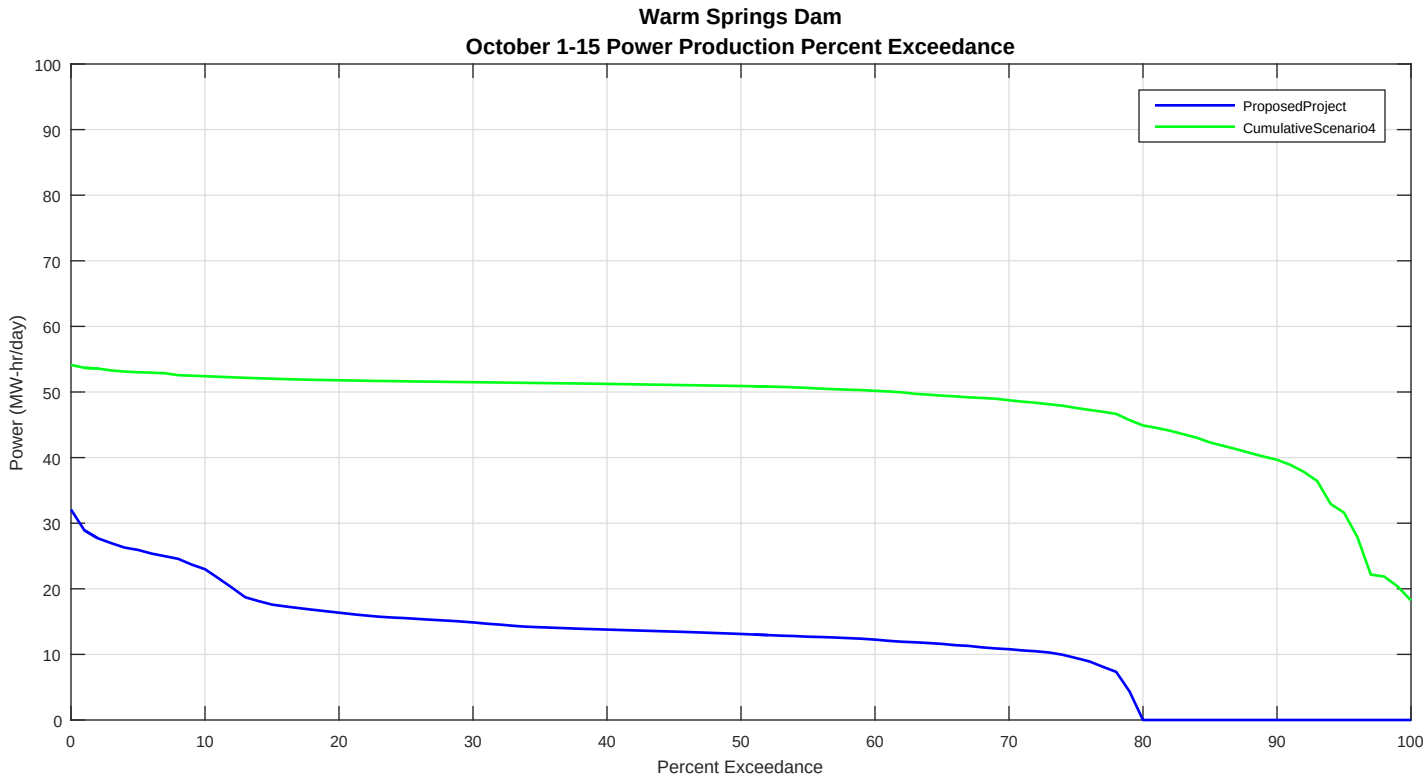
Warm Springs Dam
October 1-15 Power Production Percent Exceedance
ProposedProject
CumulativeScenario4
Power (MW-hr/day)
Percent Exceedance
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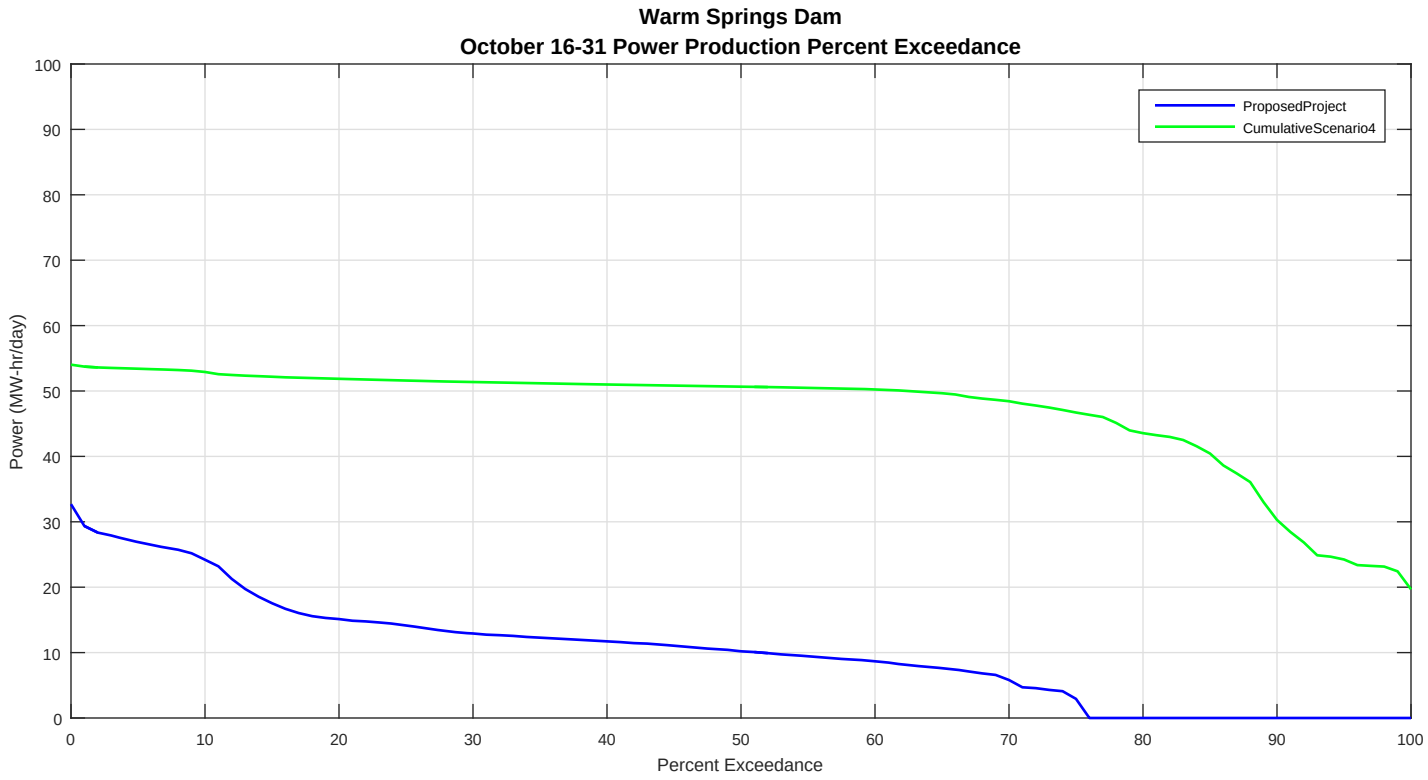
Warm Springs Dam
October 16-31 Power Production Percent Exceedance
ProposedProject
CumulativeScenario4
Power (MW-hr/day)
Percent Exceedance
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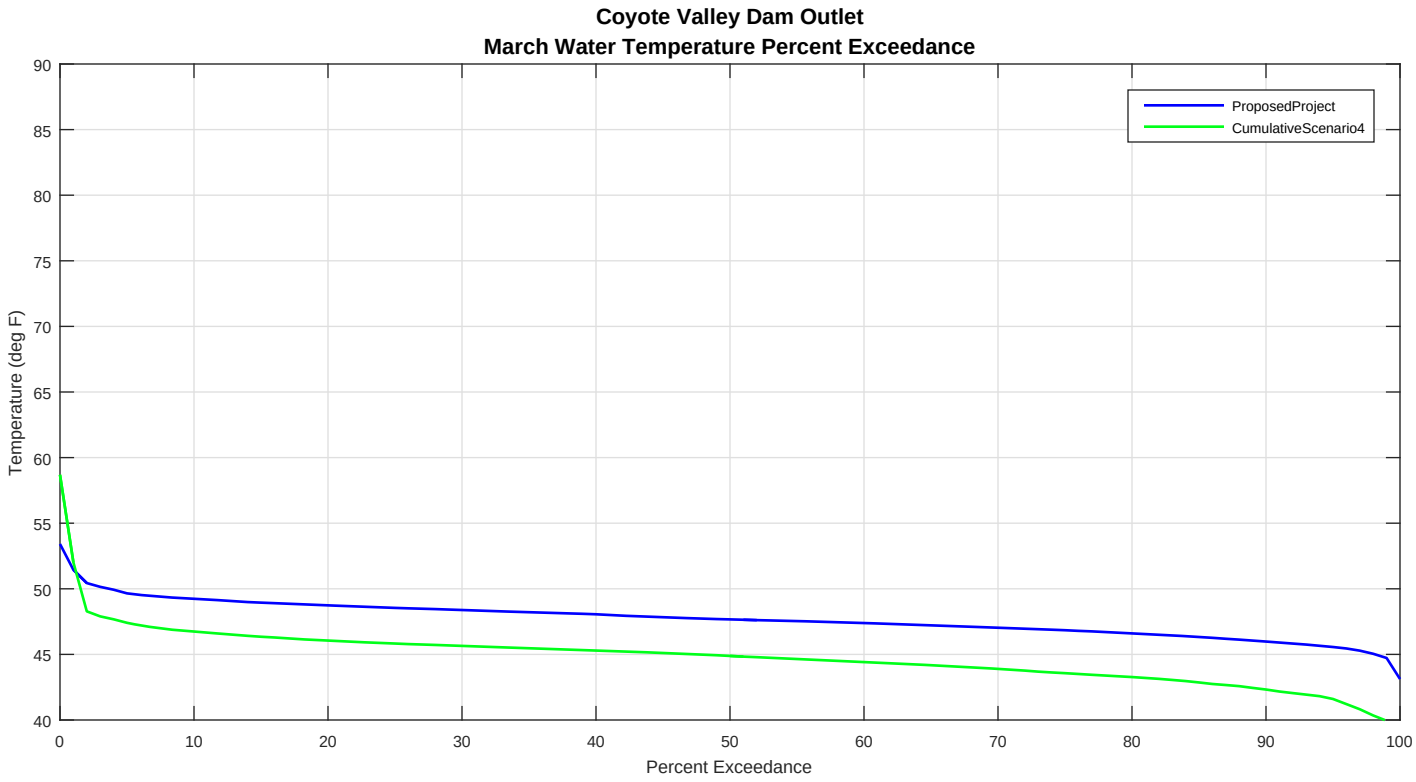
Coyote Valley Dam Outlet
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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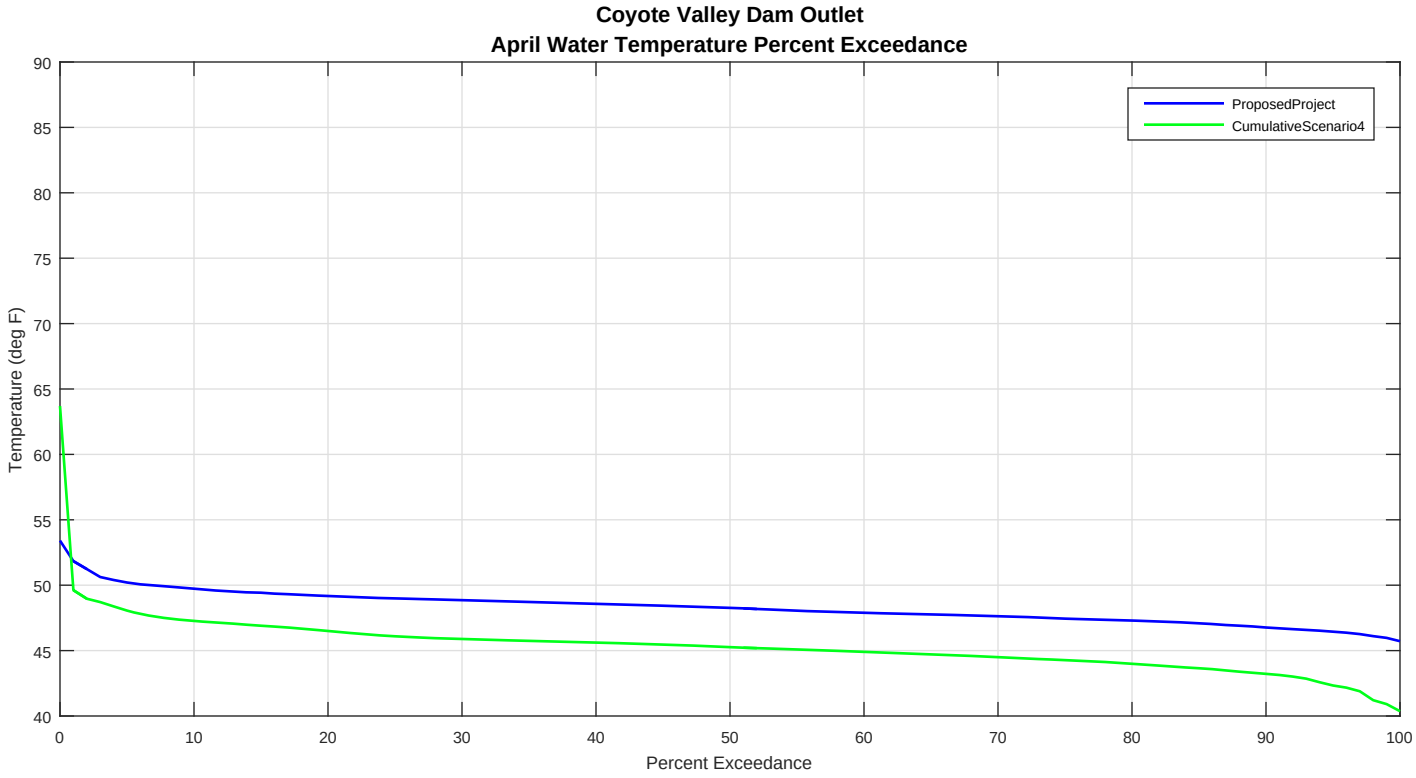
Coyote Valley Dam Outlet
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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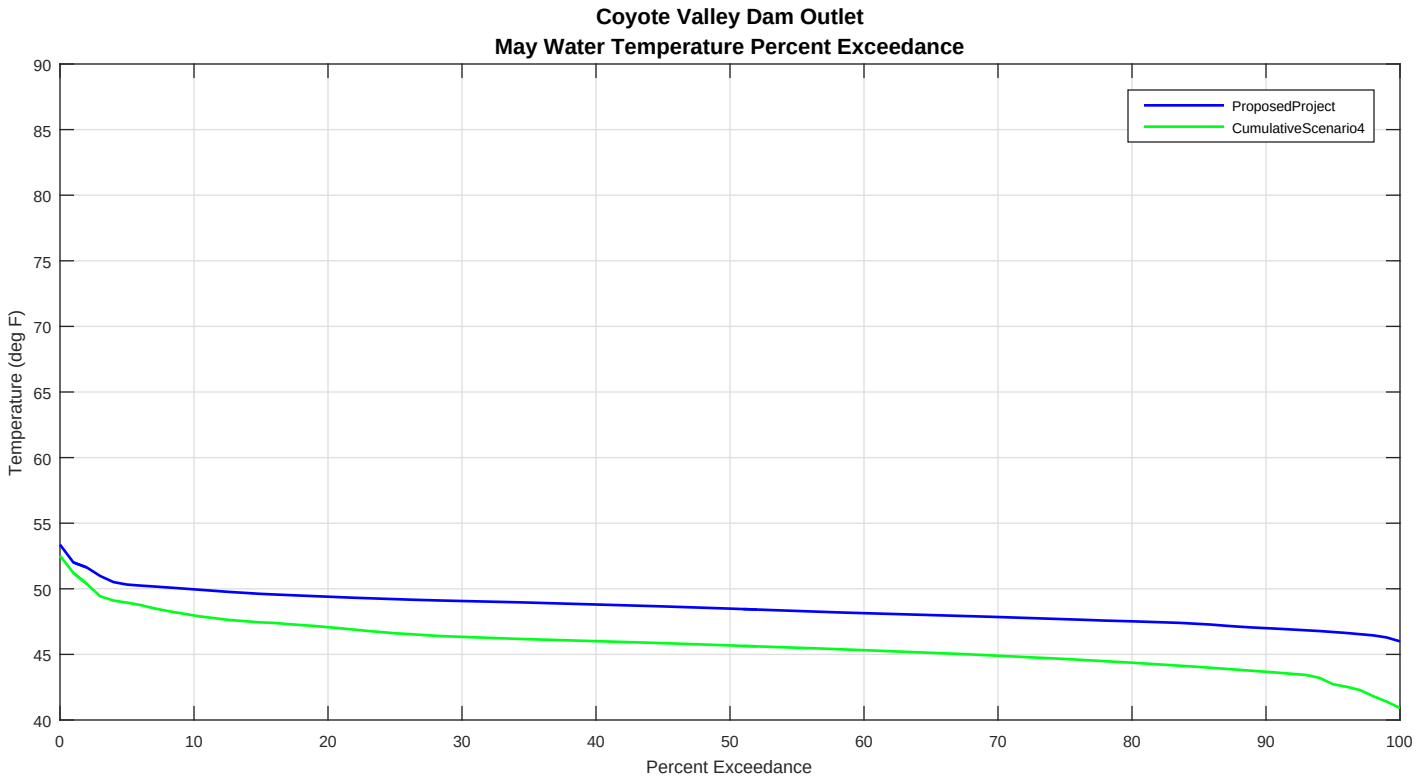
Coyote Valley Dam Outlet
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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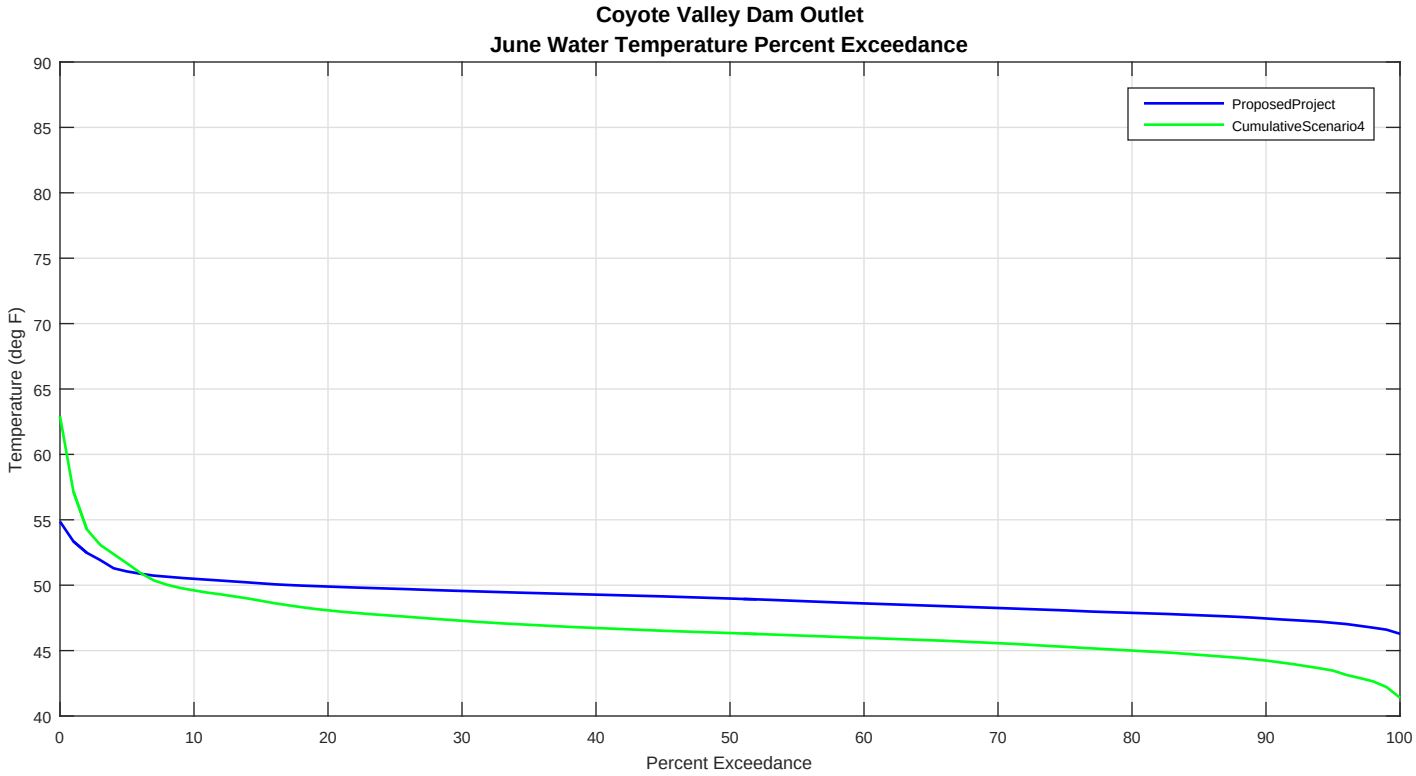
Coyote Valley Dam Outlet
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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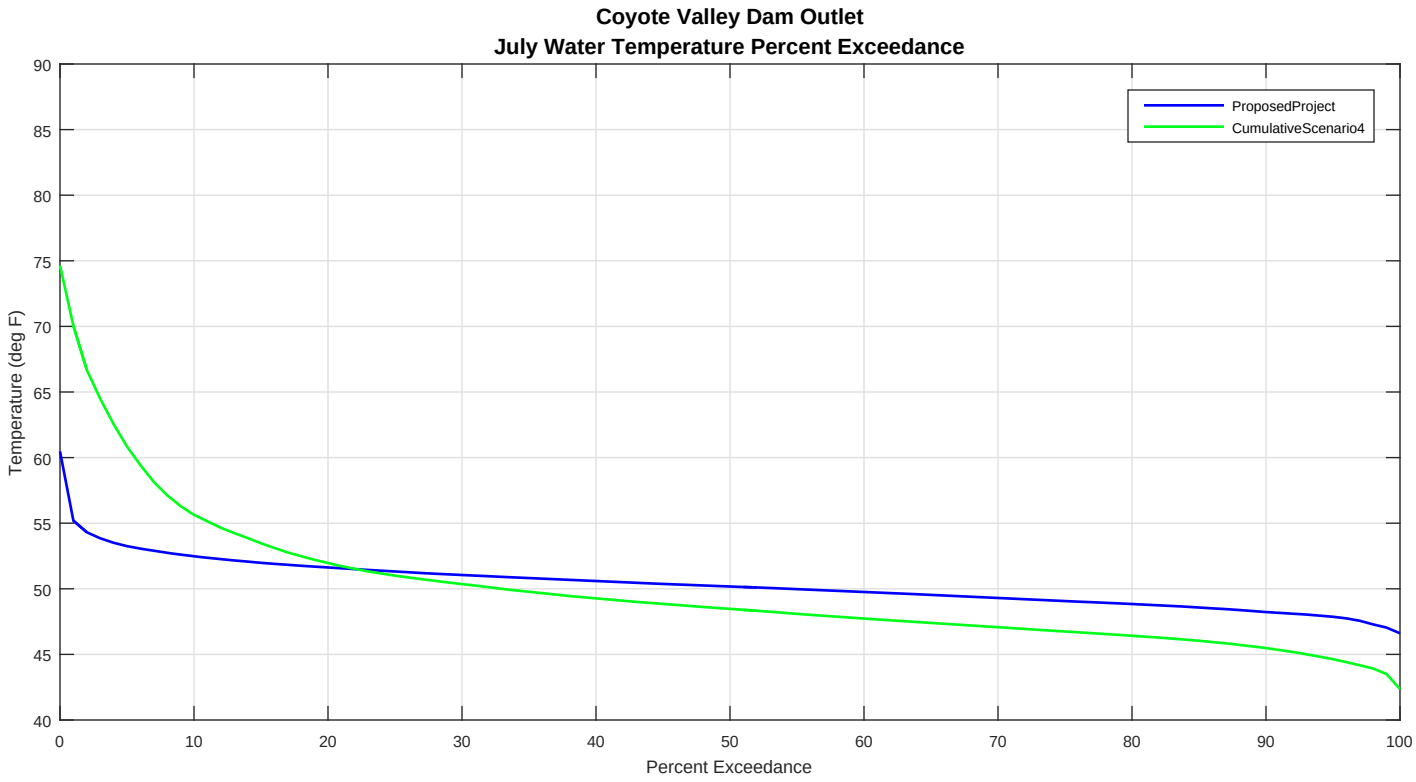
Coyote Valley Dam Outlet
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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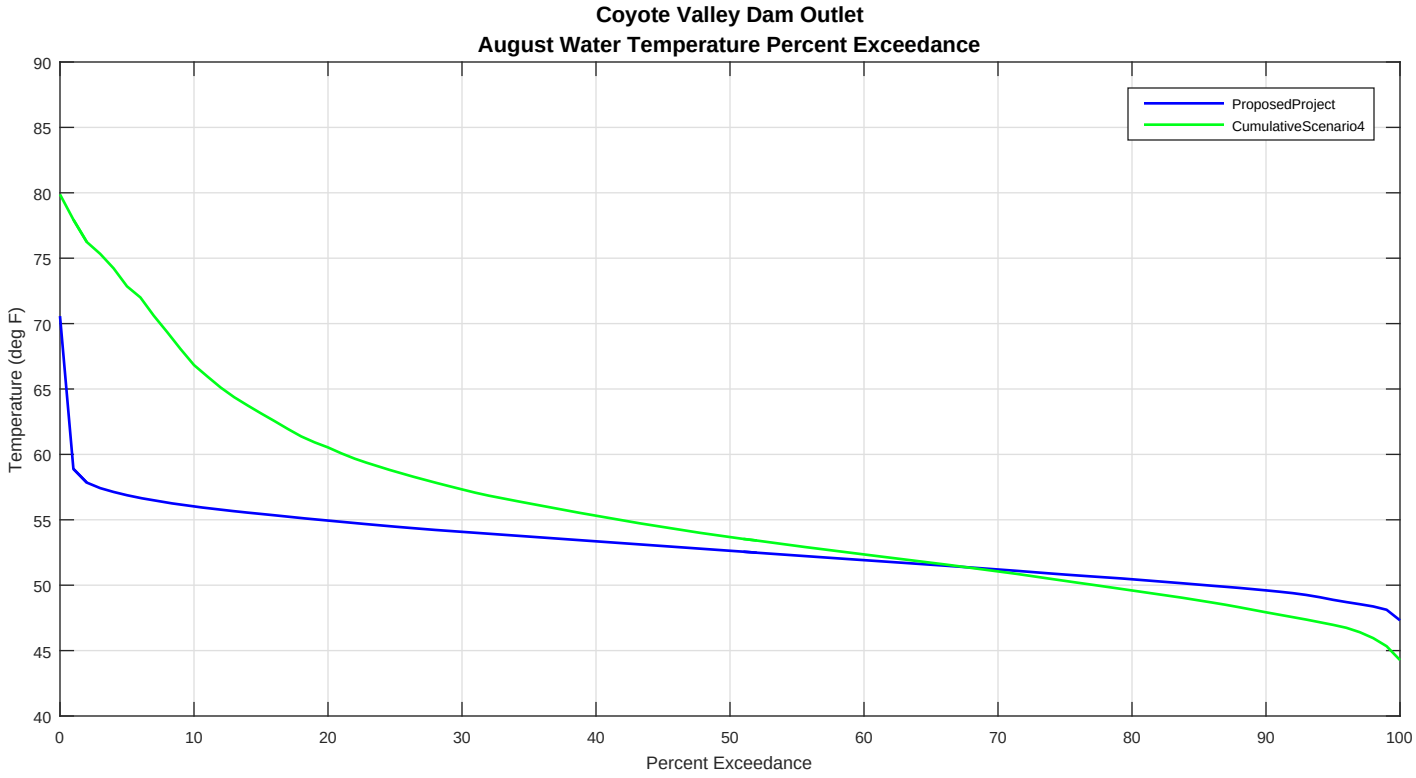
Coyote Valley Dam Outlet
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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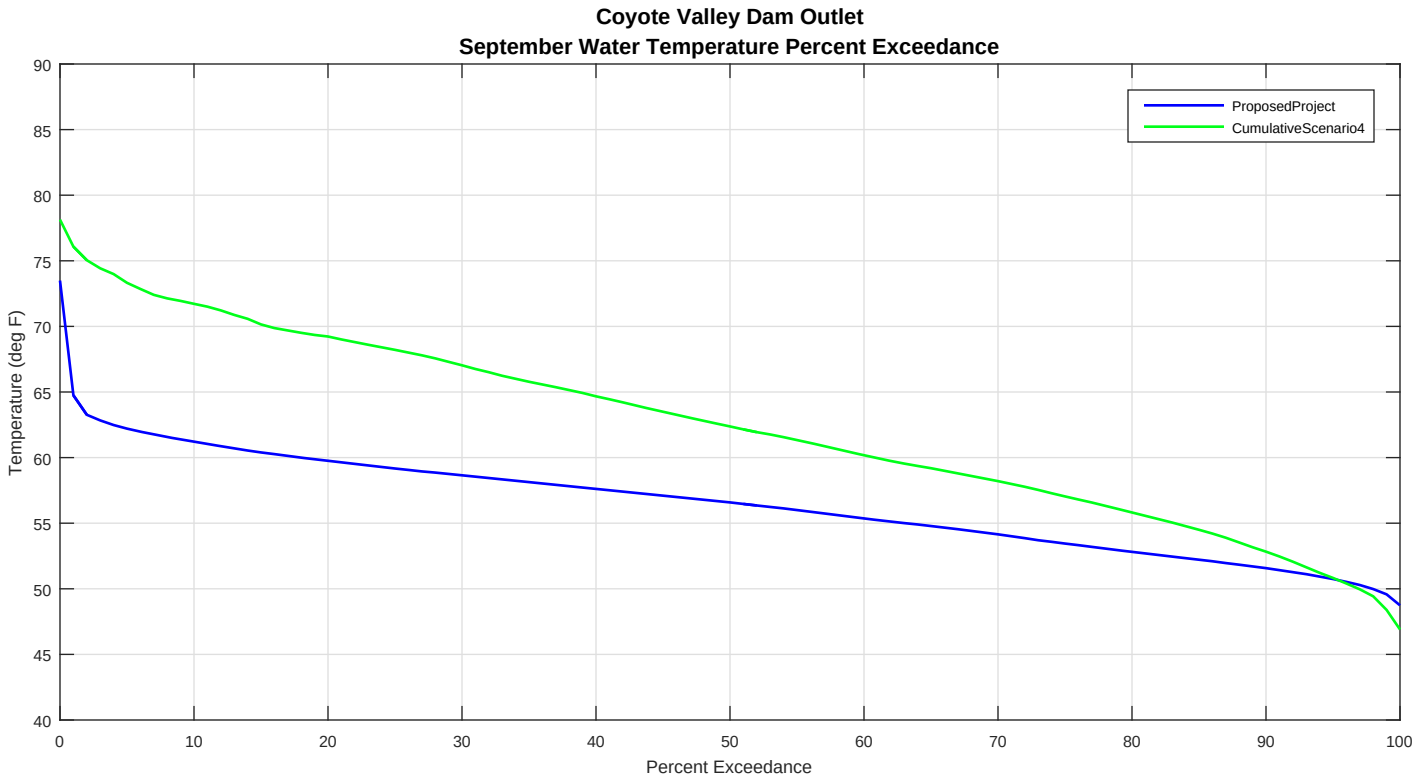
Coyote Valley Dam Outlet
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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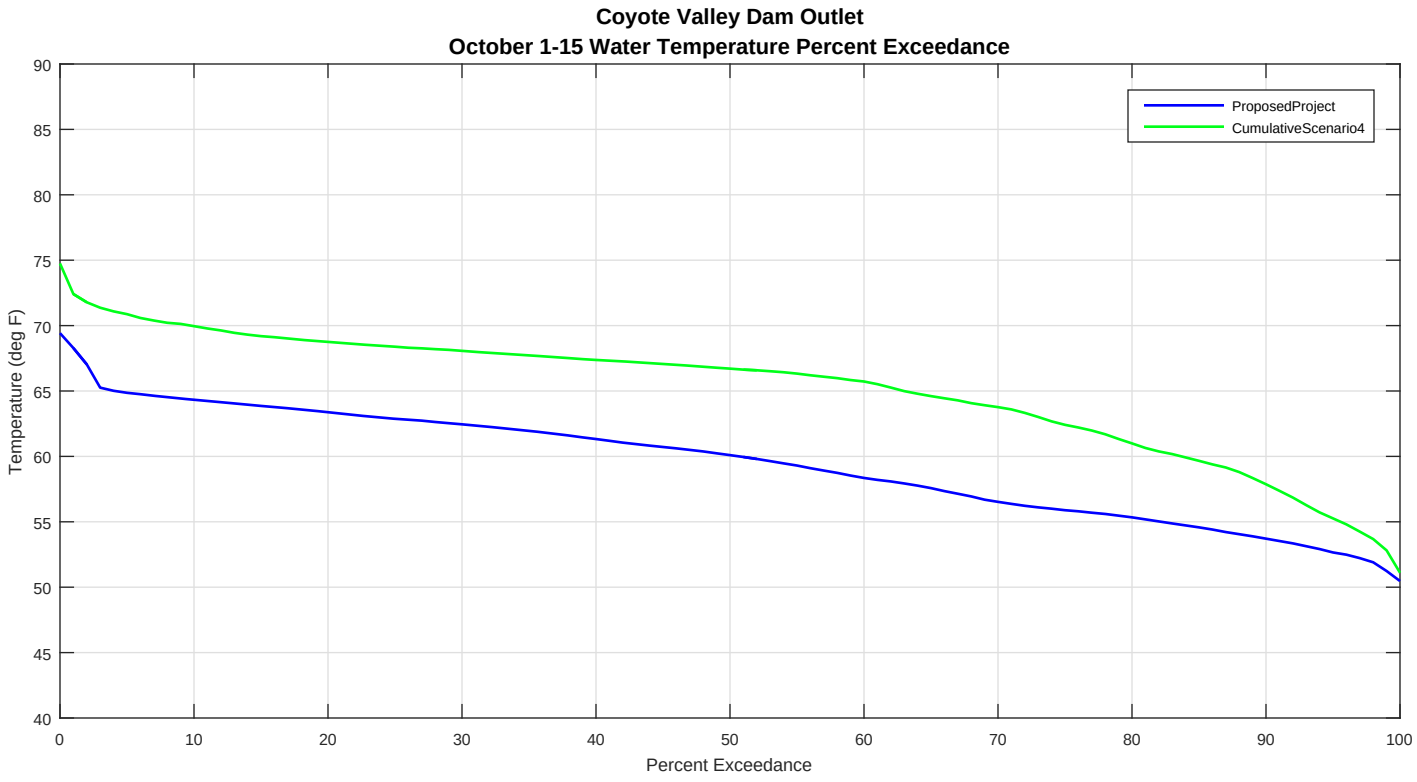
Coyote Valley Dam Outlet
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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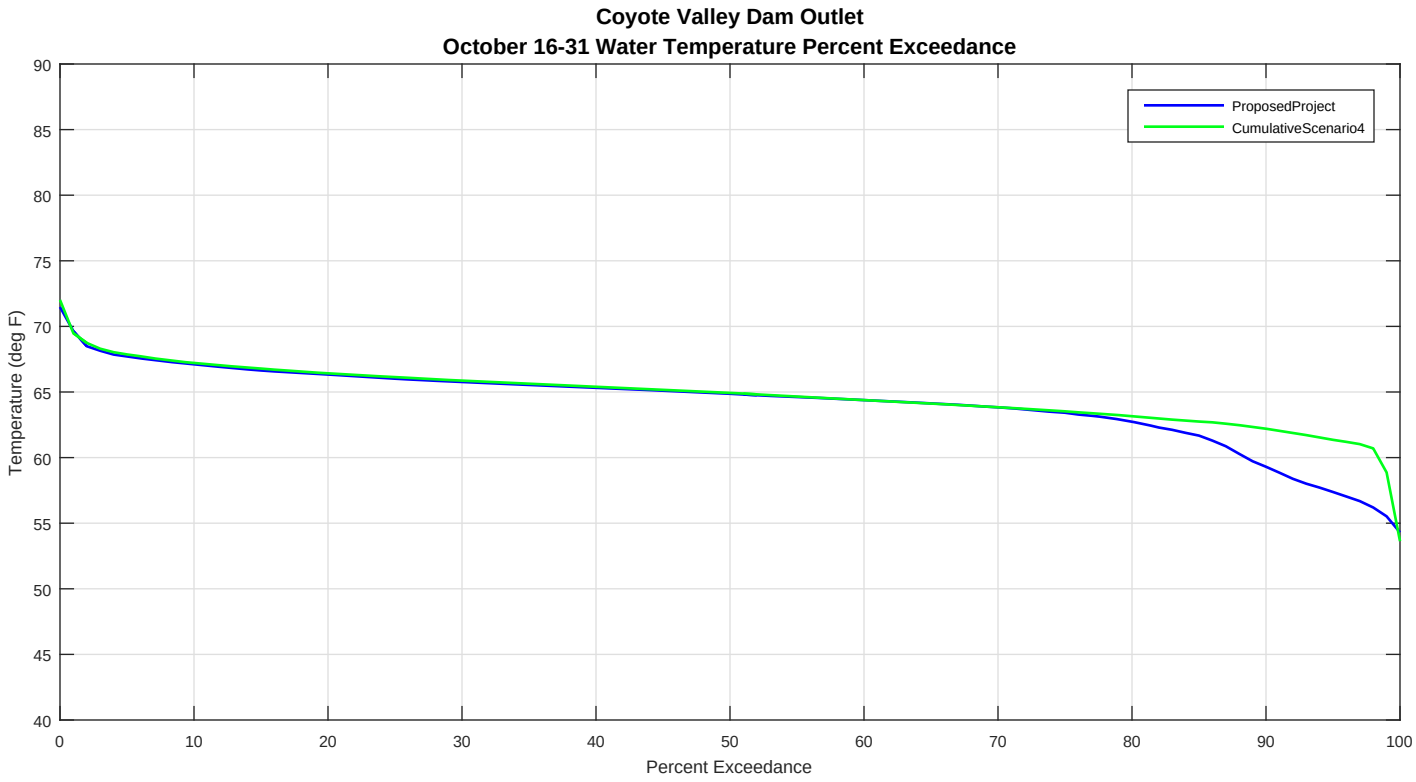
Coyote Valley Dam Outlet
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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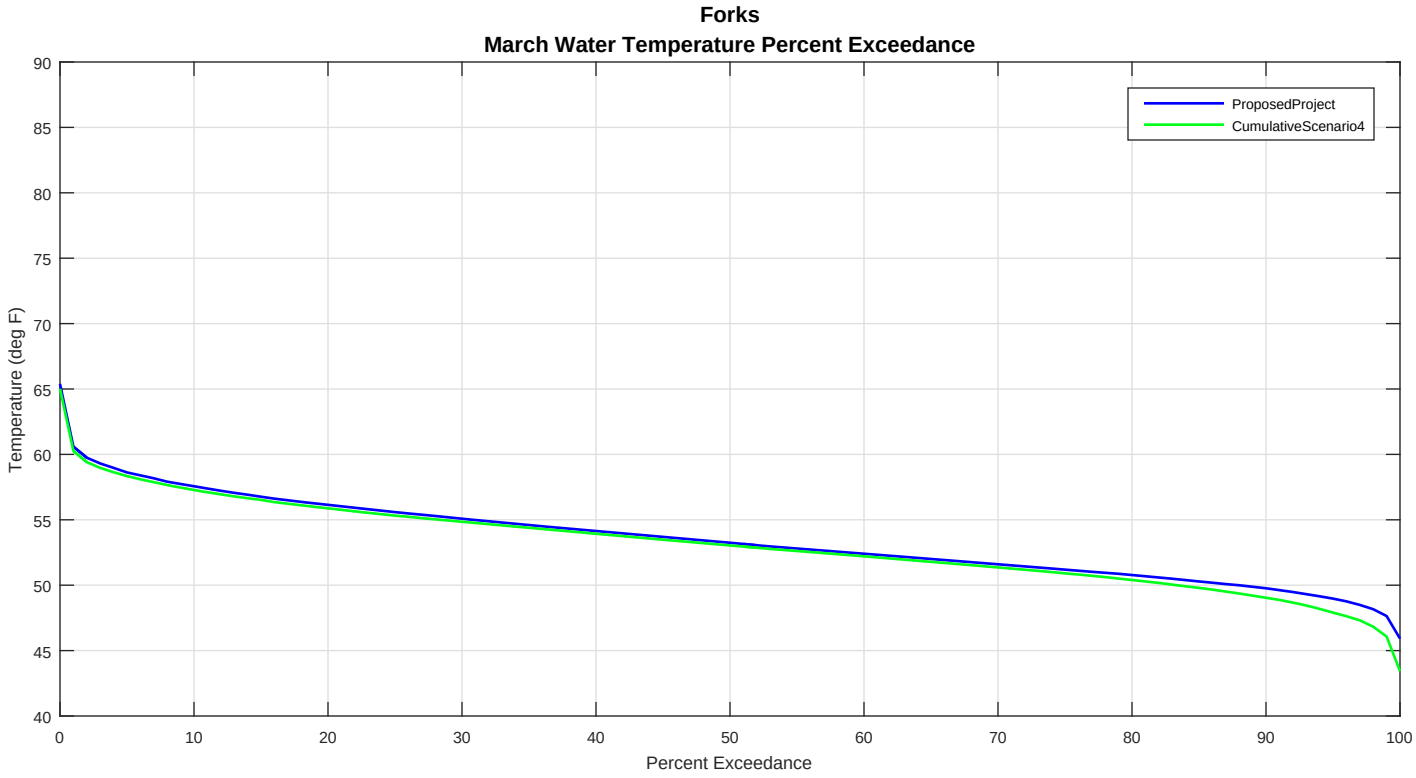
Forks
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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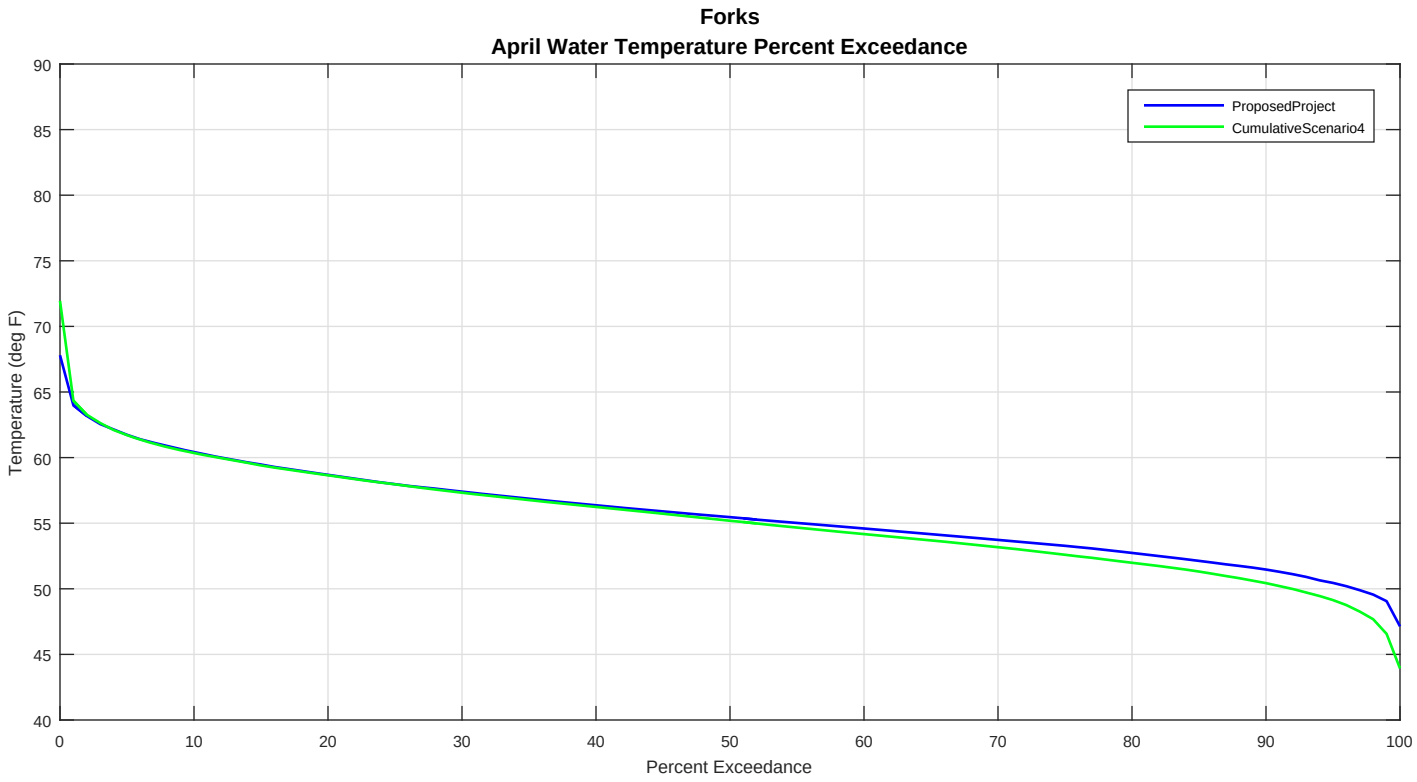
Forks
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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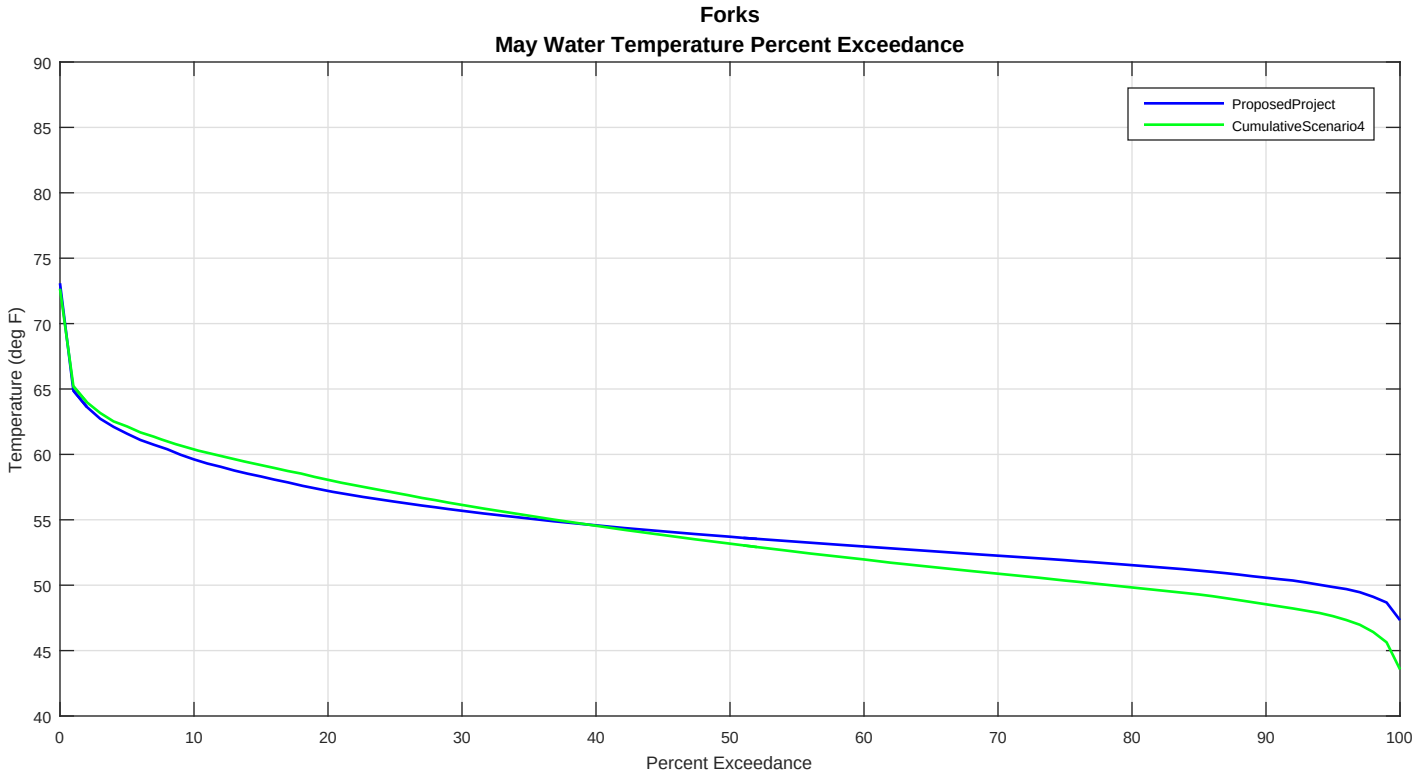
Forks
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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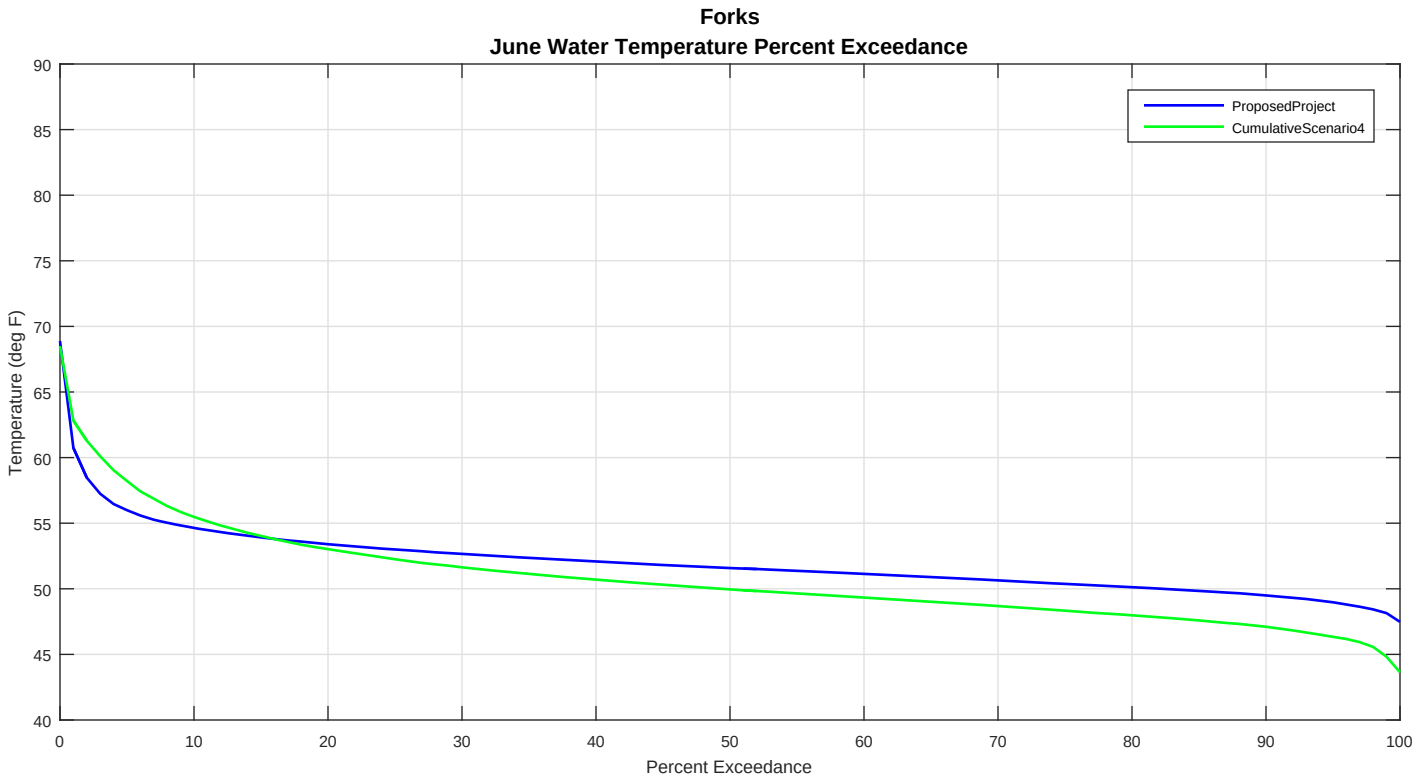
Forks
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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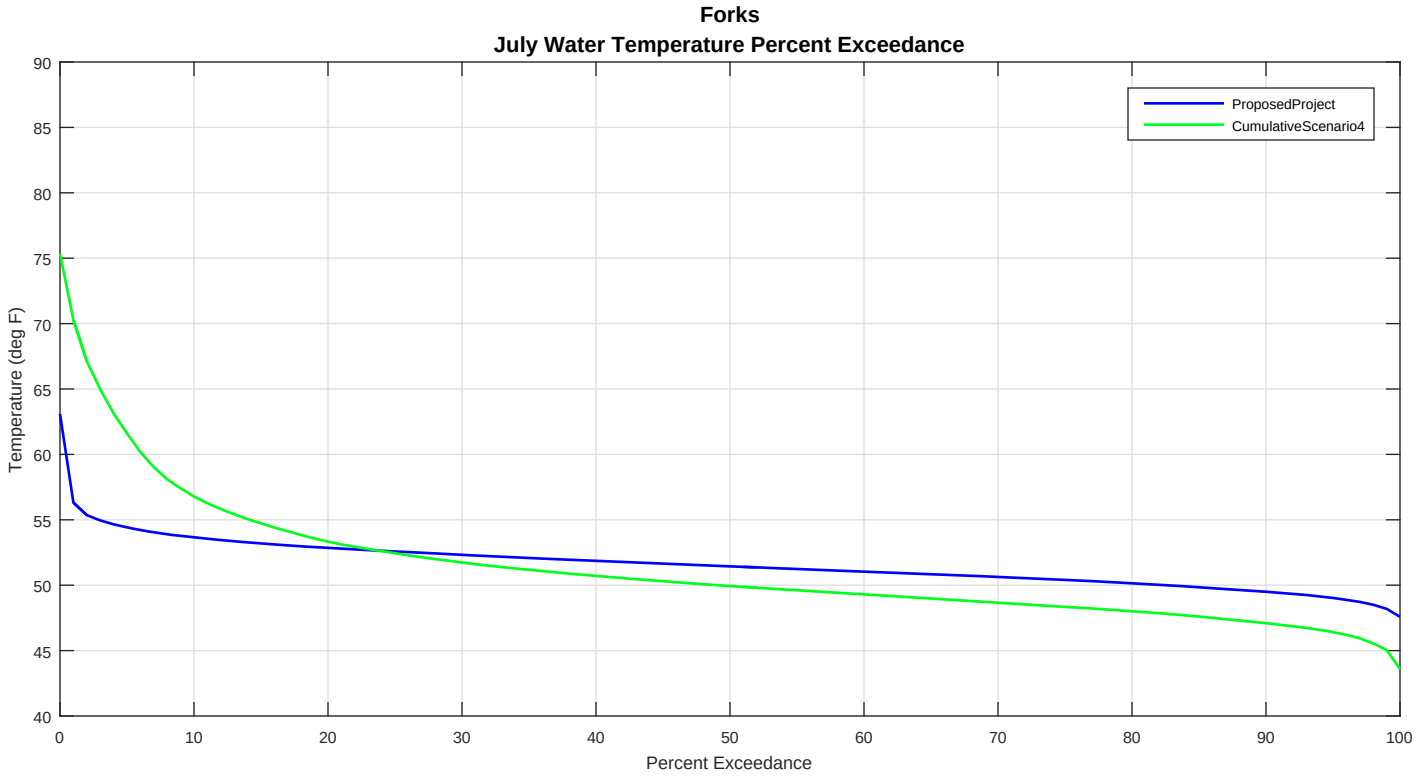
Forks
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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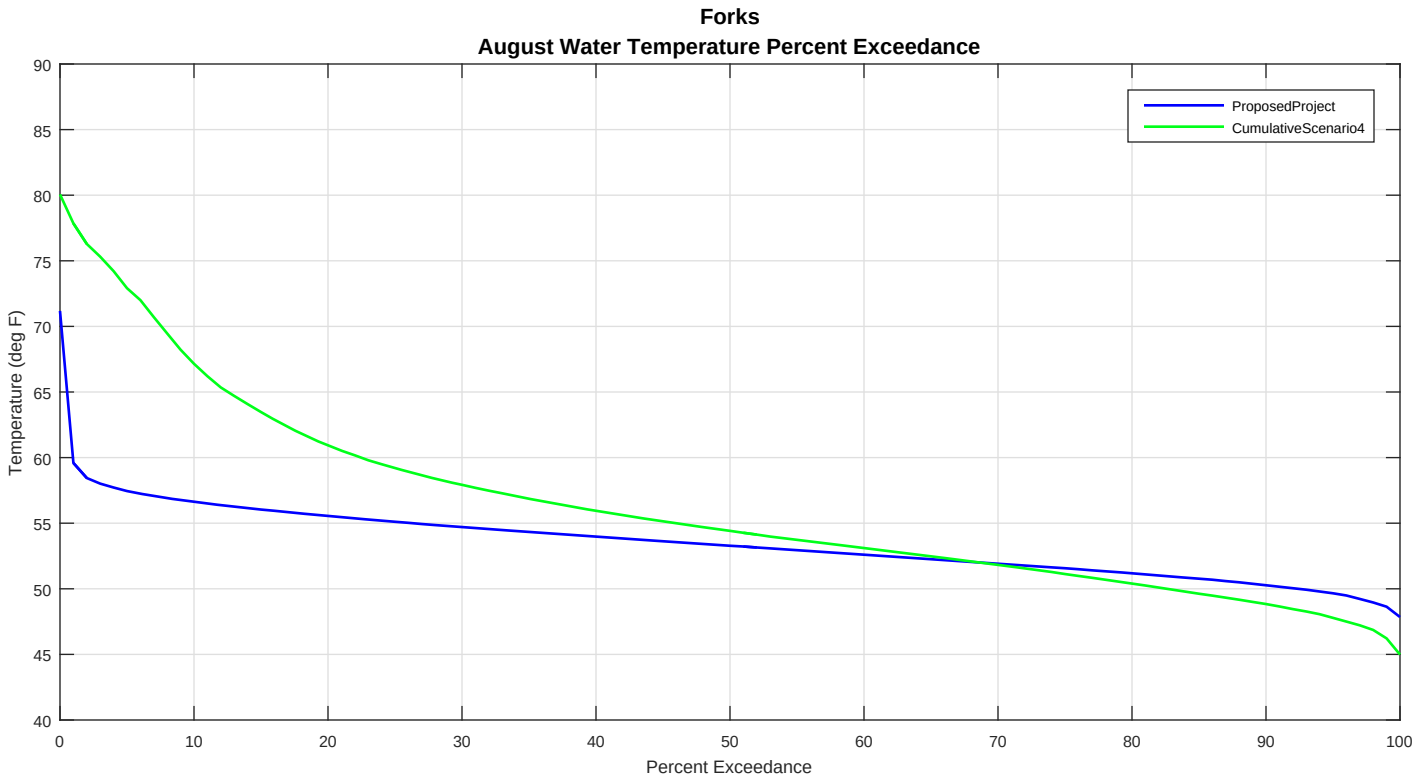
Forks
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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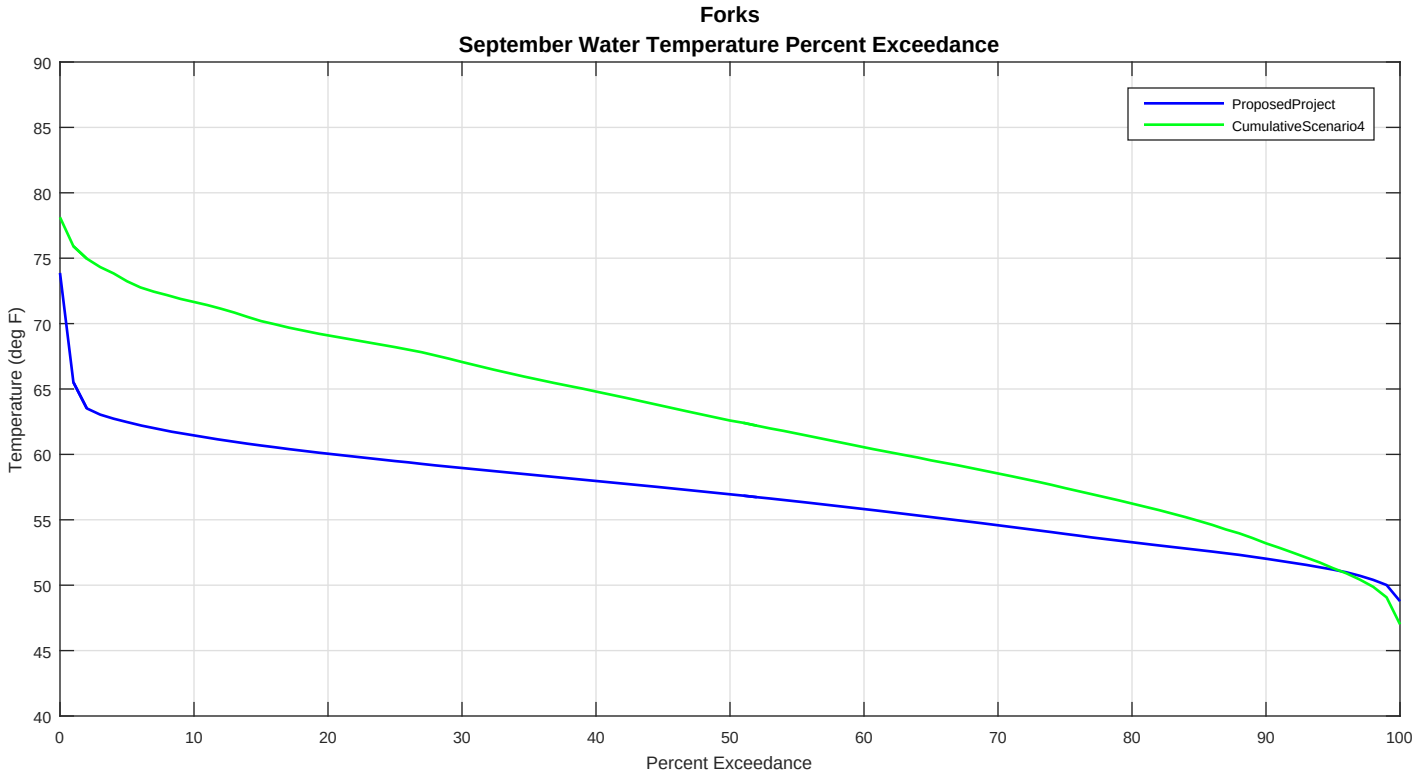
Forks
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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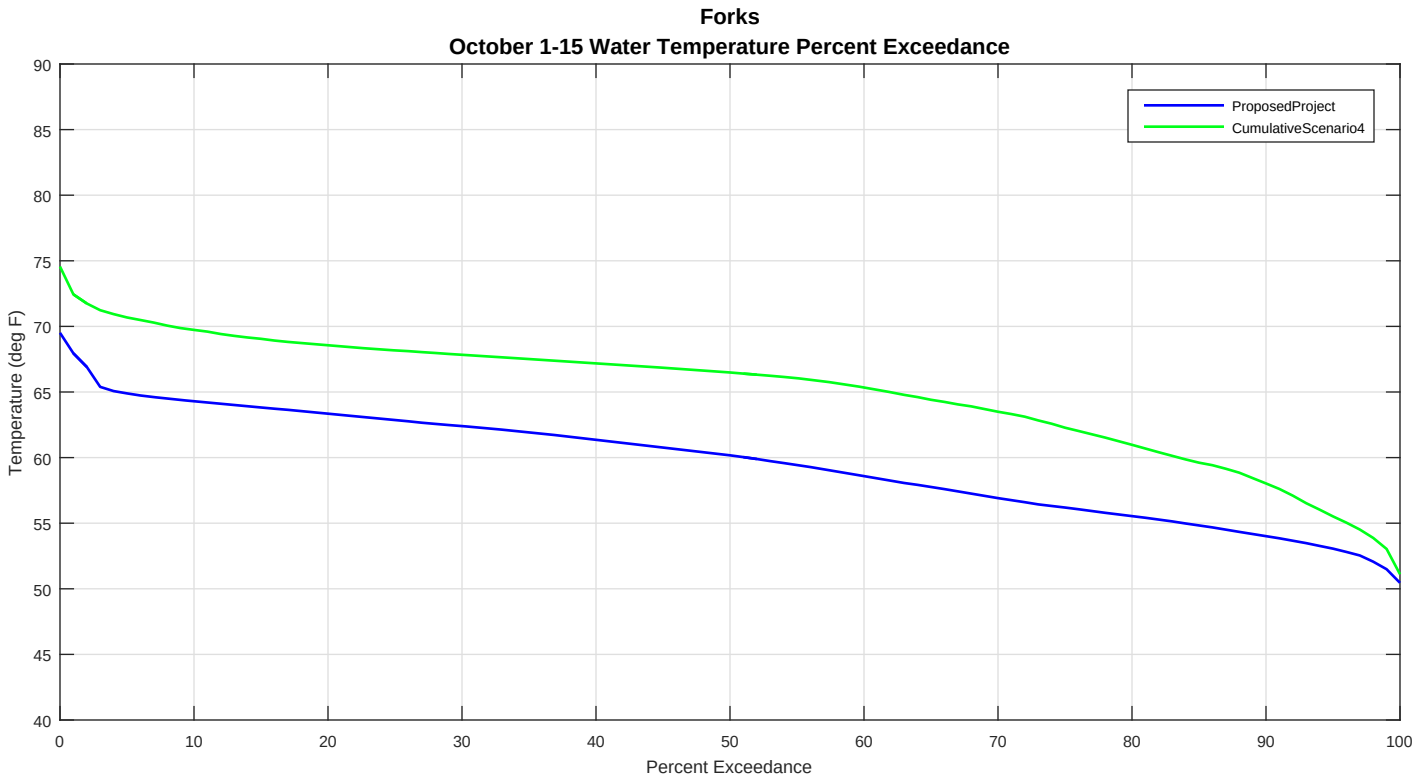
Forks
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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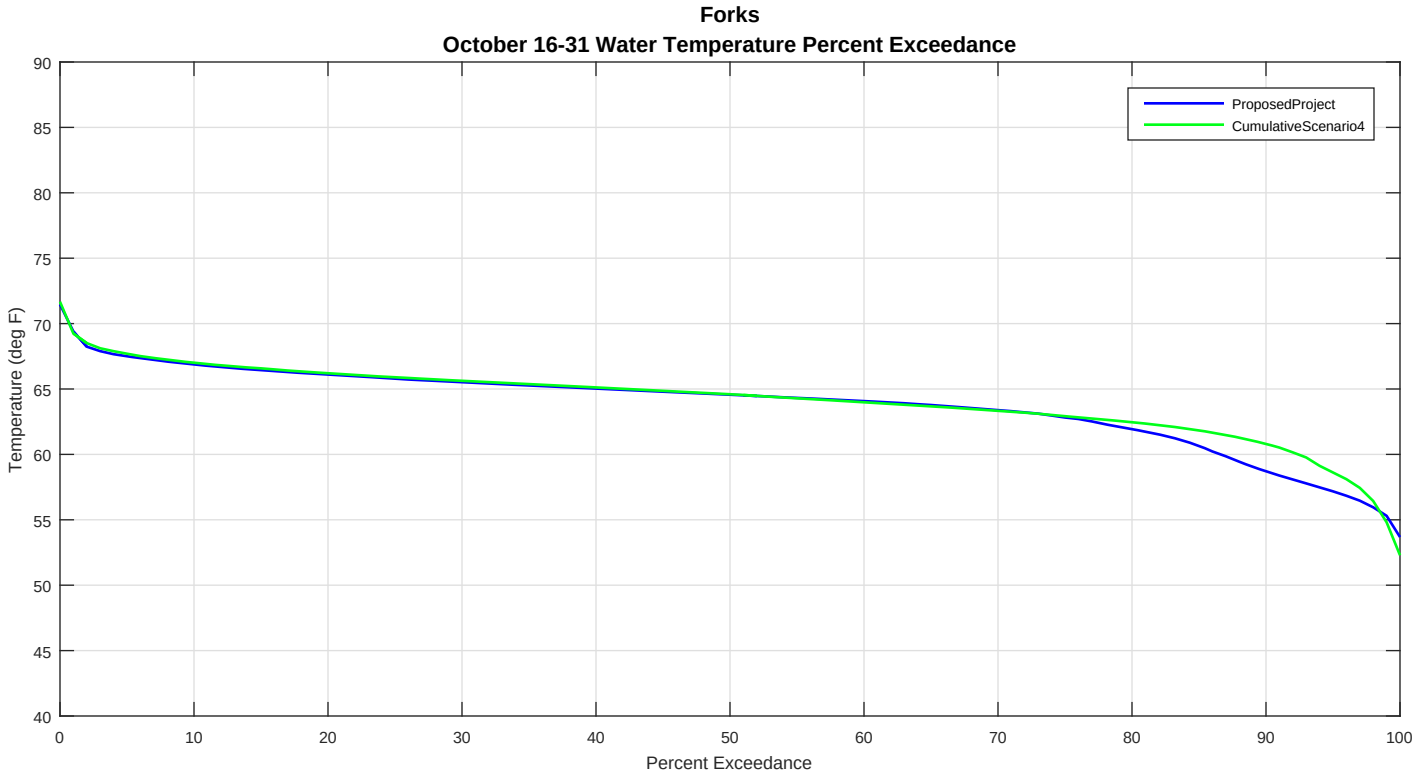
Forks
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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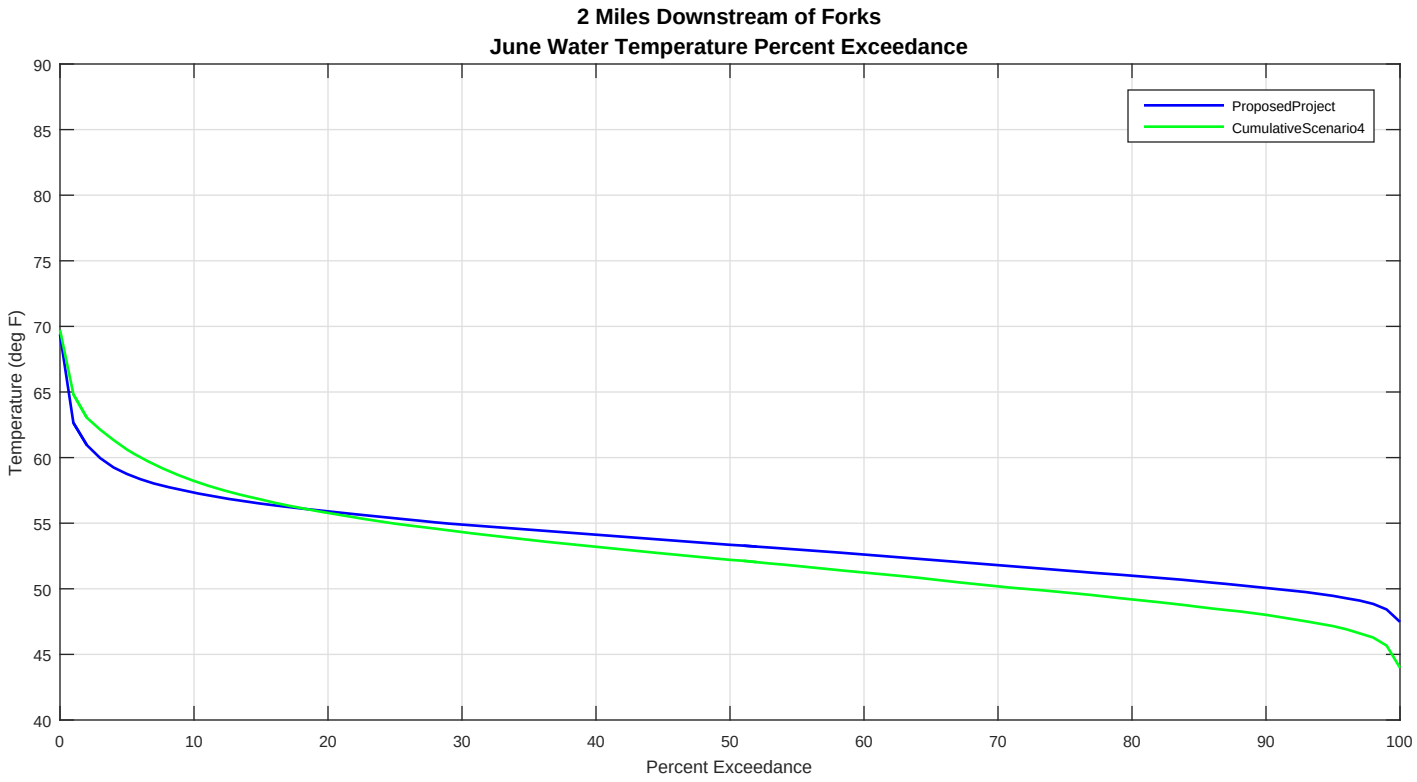
2 Miles Downstream of Forks
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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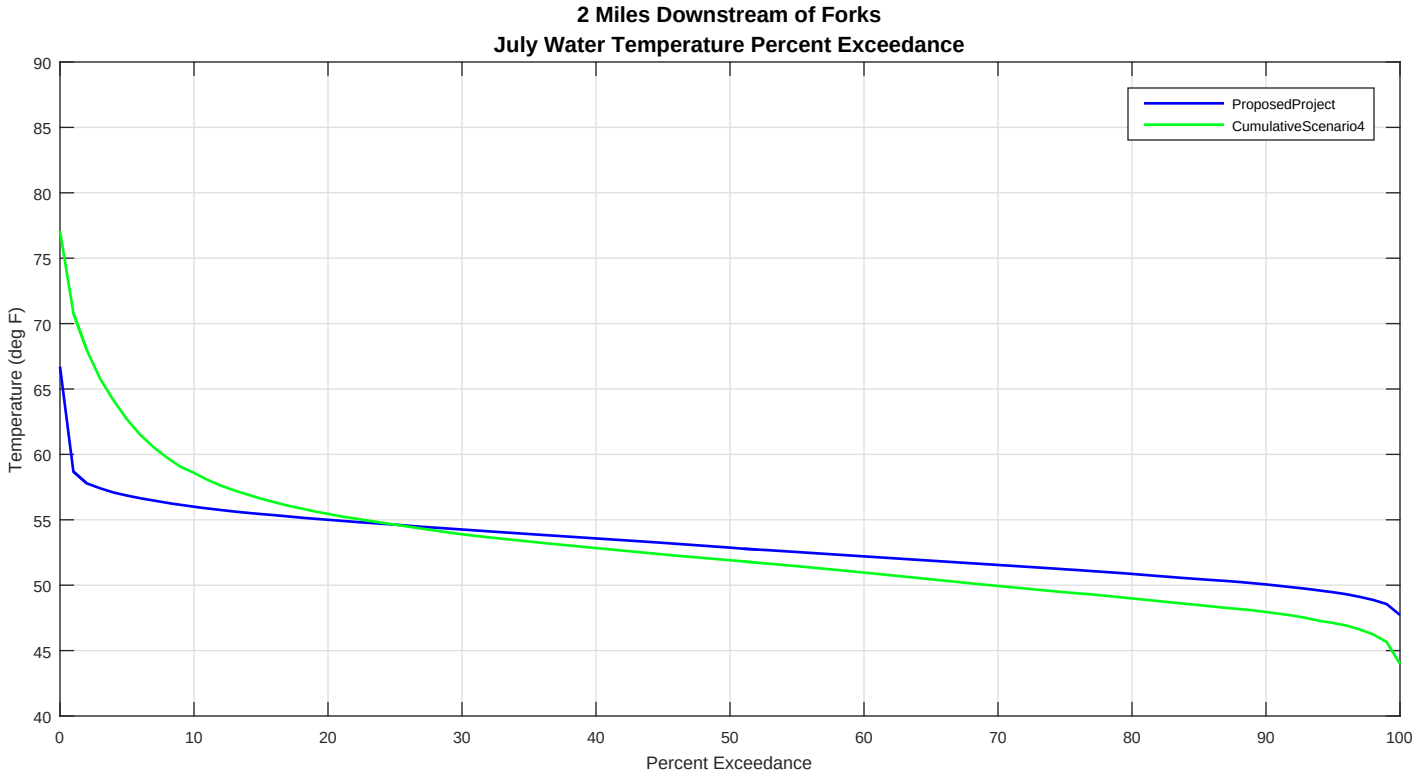
2 Miles Downstream of Forks
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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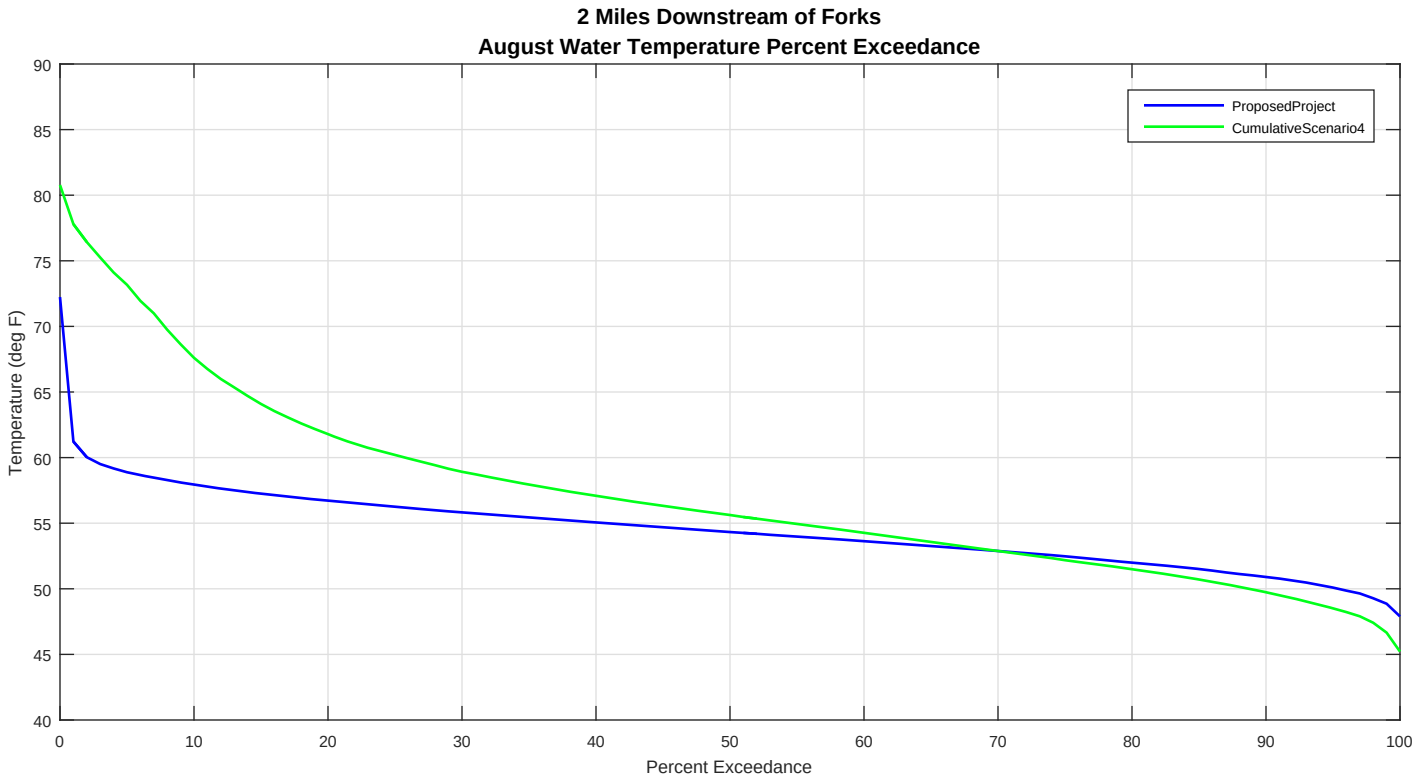
2 Miles Downstream of Forks
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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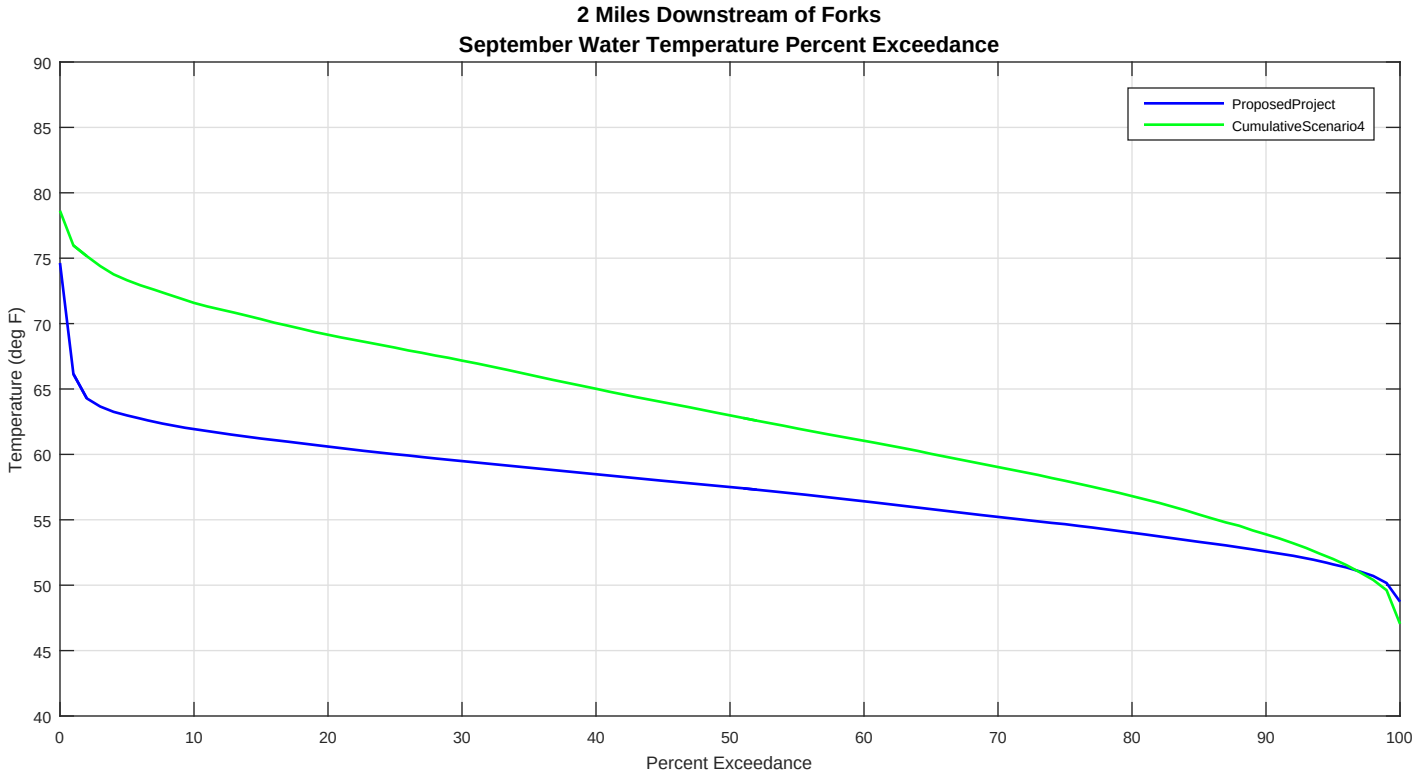
2 Miles Downstream of Forks
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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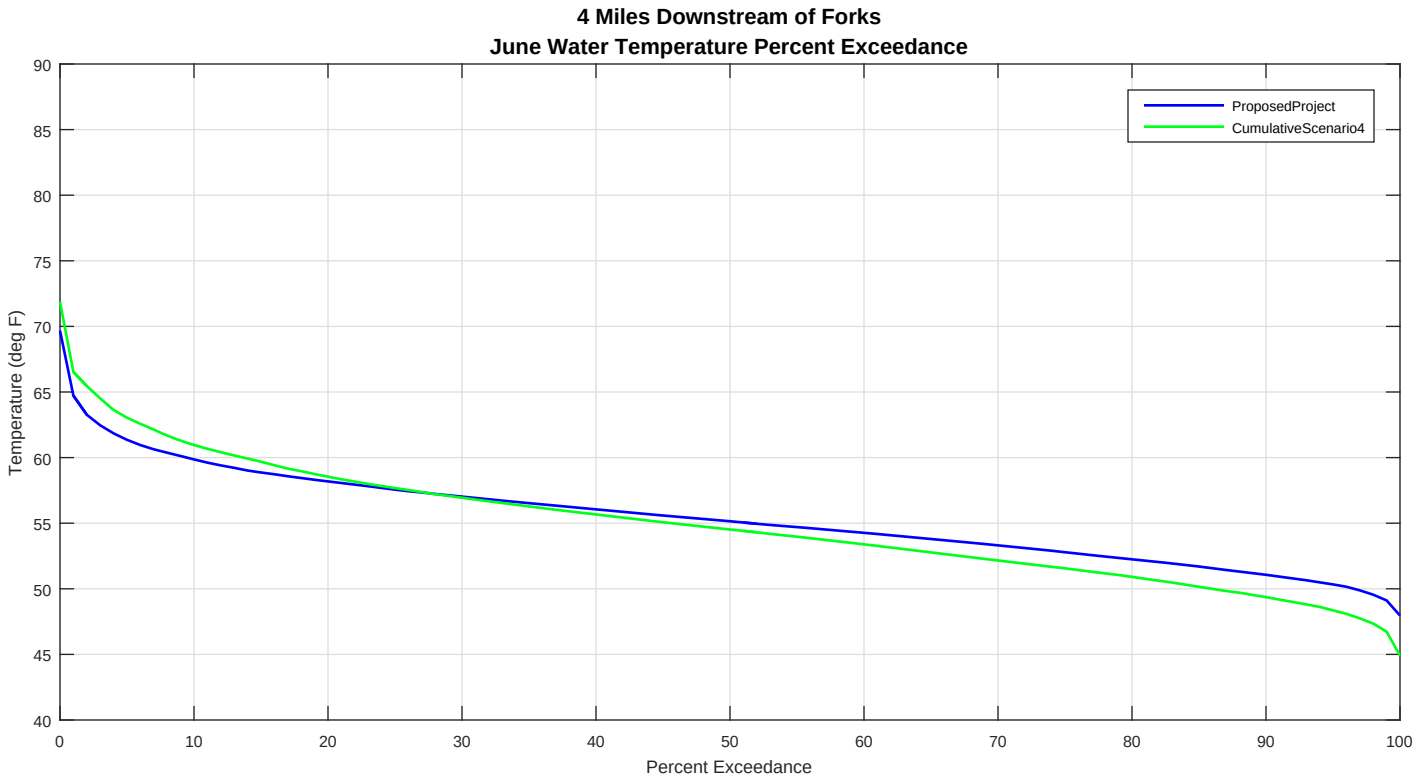
4 Miles Downstream of Forks
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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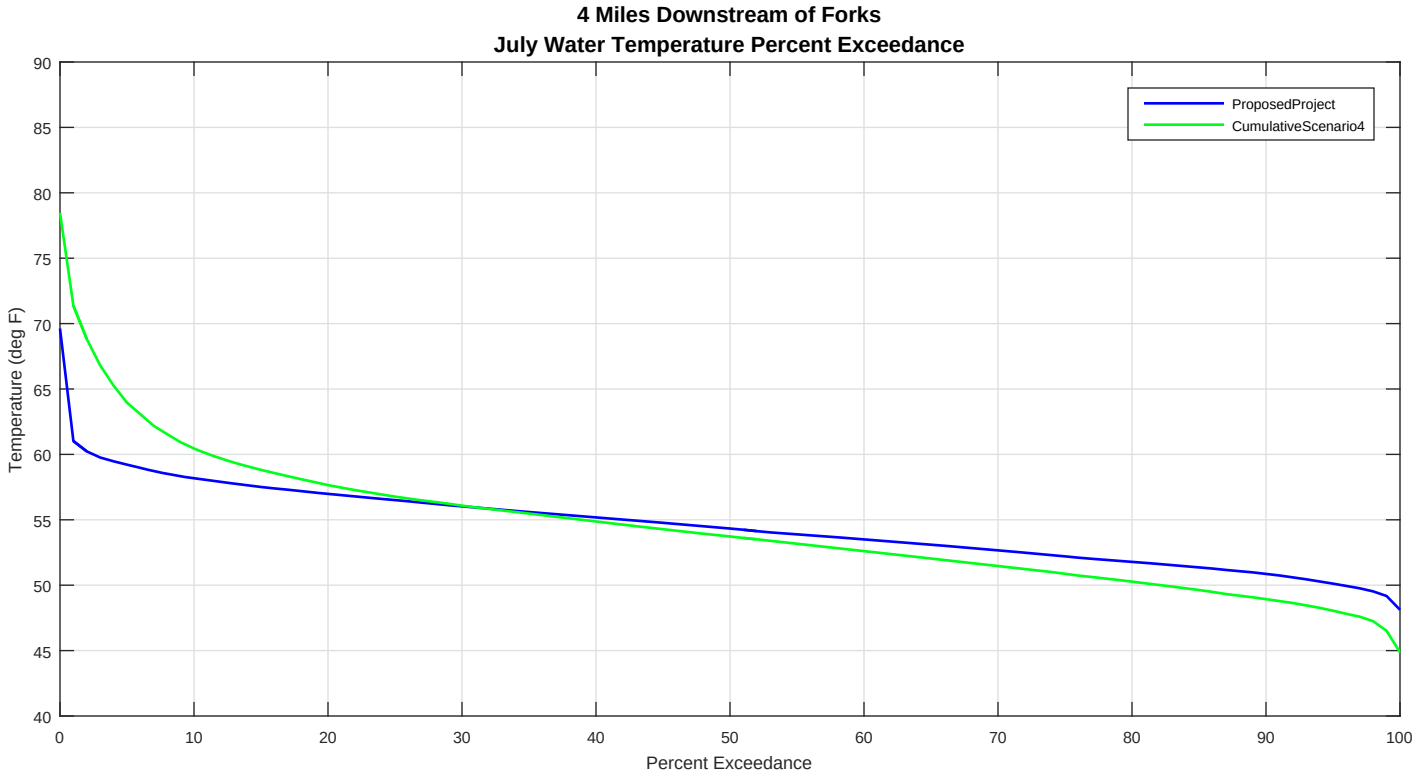
4 Miles Downstream of Forks
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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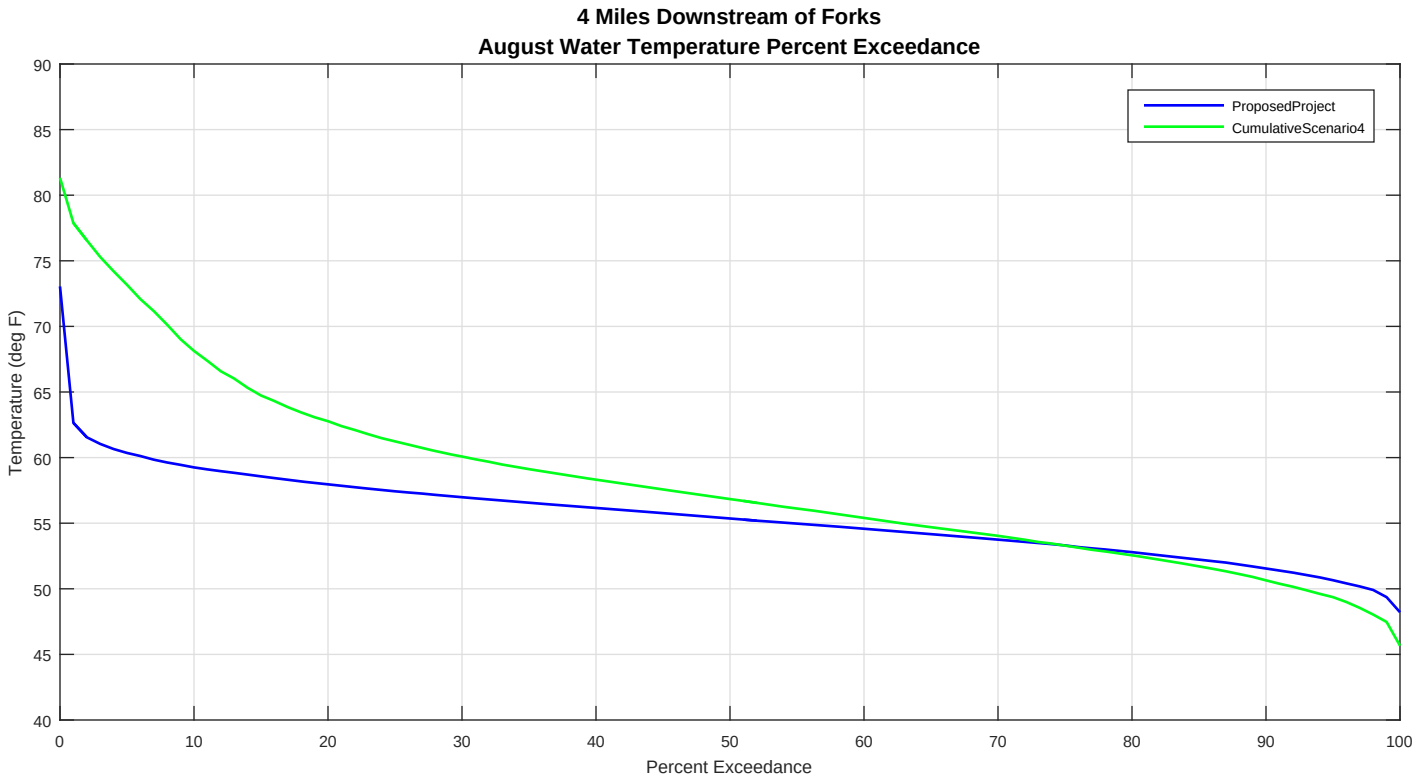
4 Miles Downstream of Forks
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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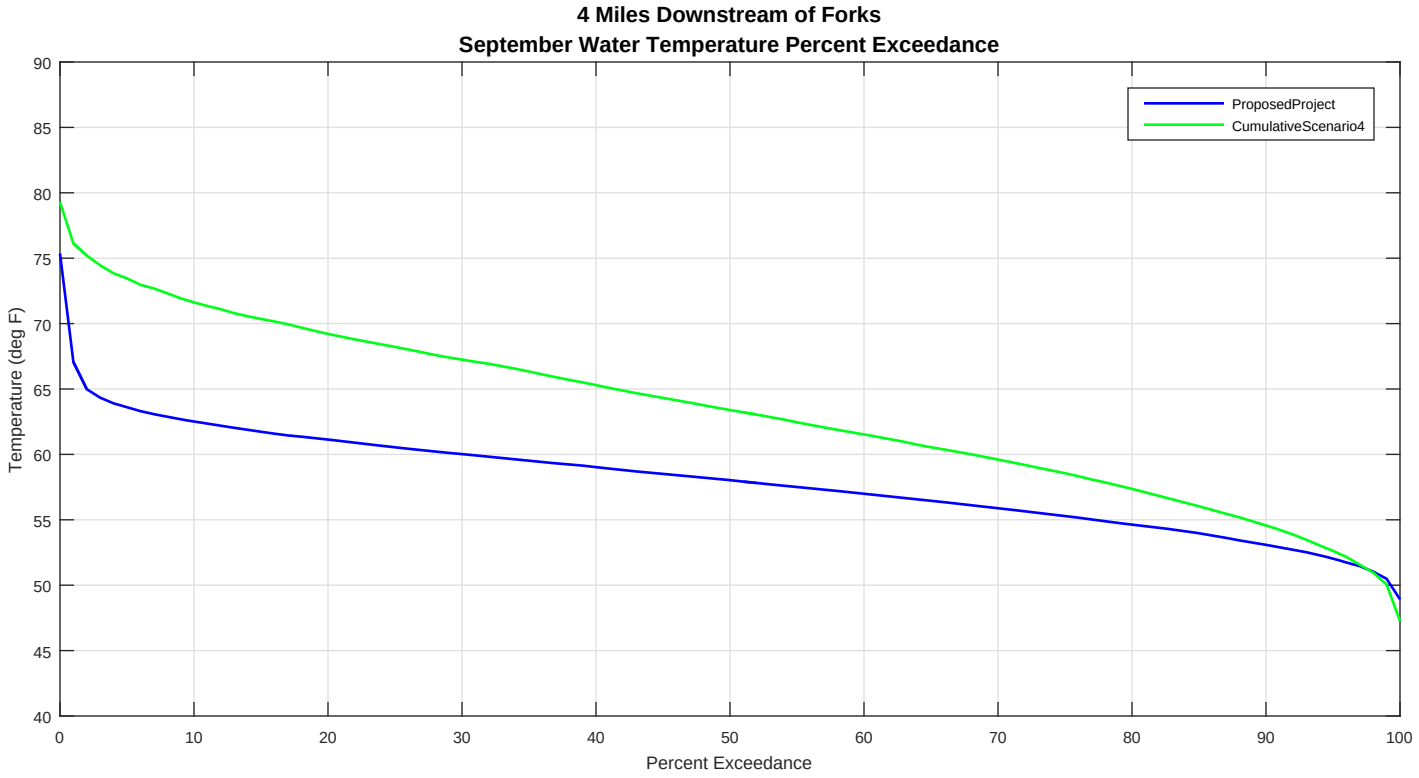
4 Miles Downstream of Forks
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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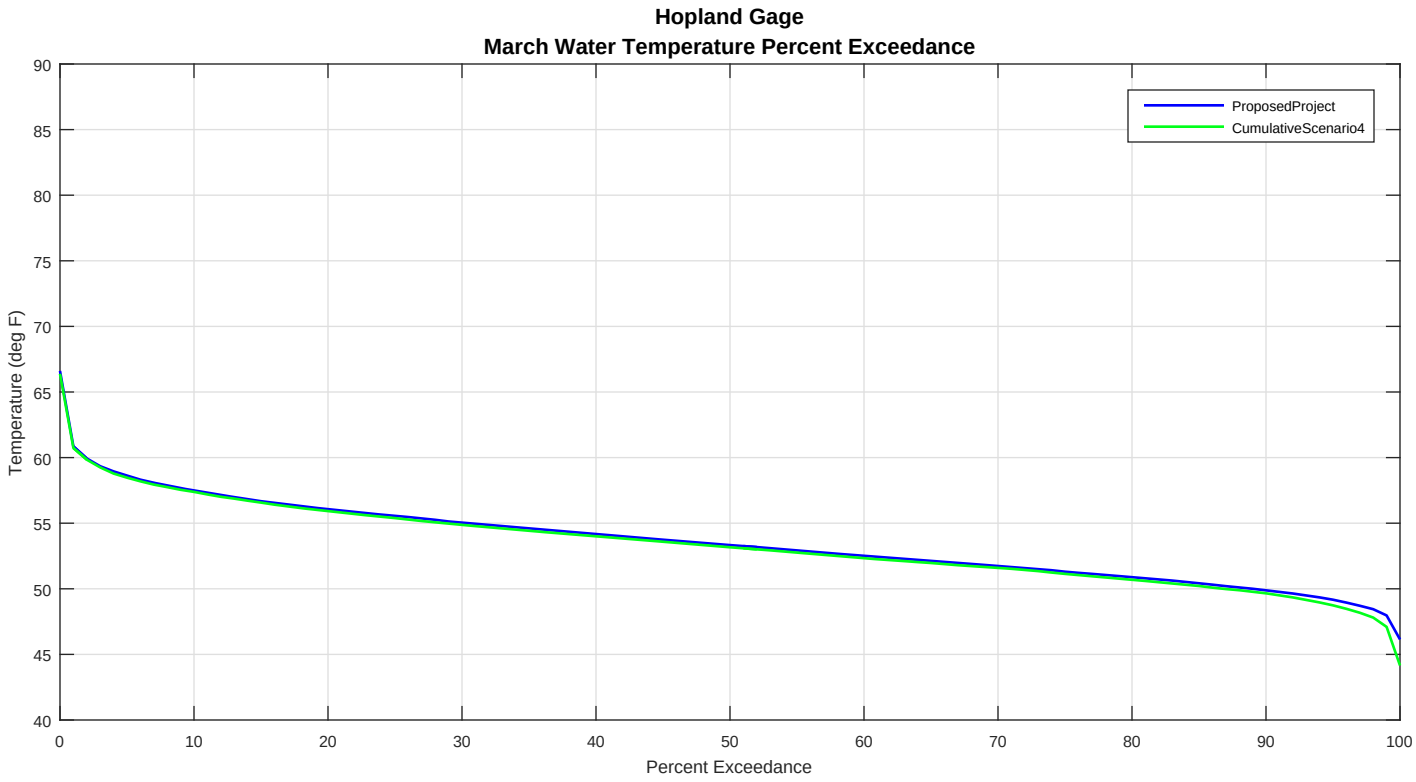
Hopland Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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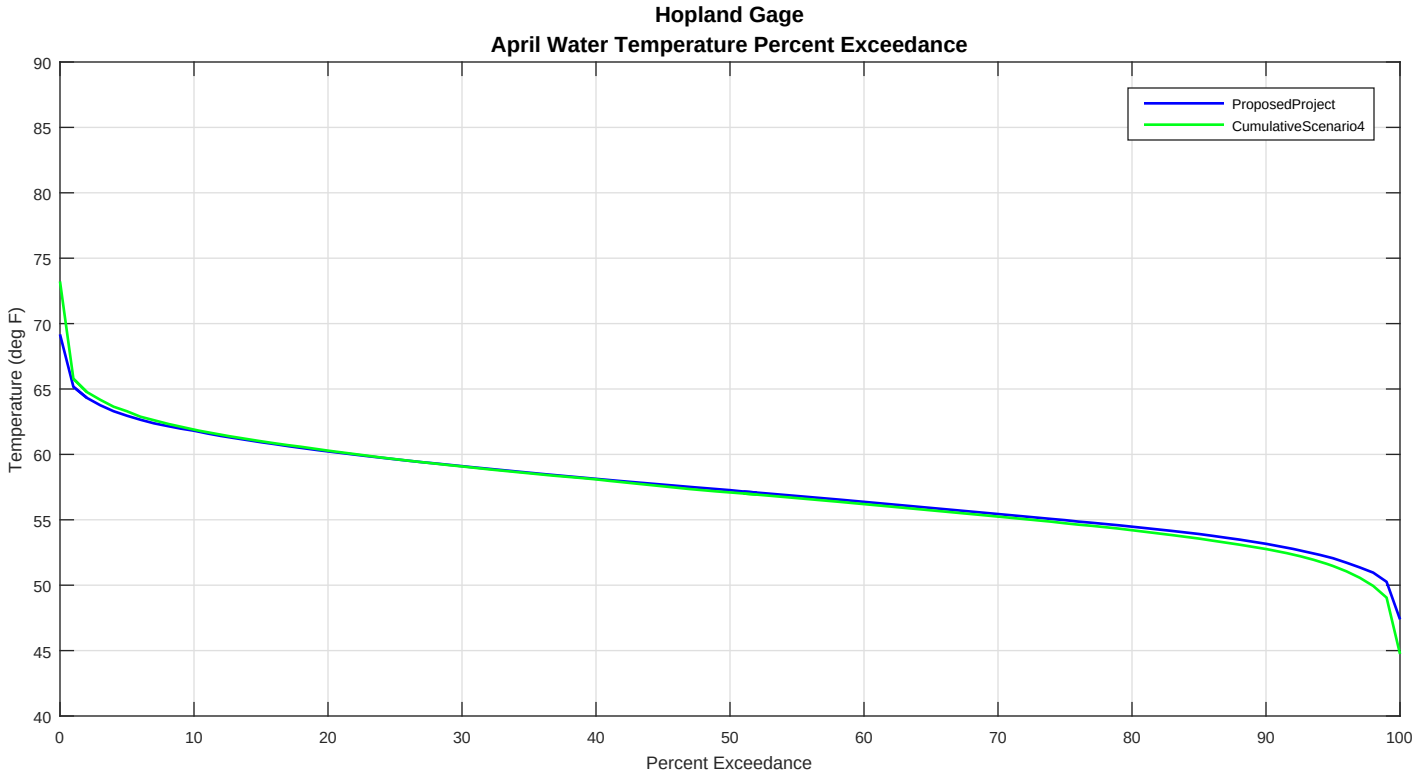
Hopland Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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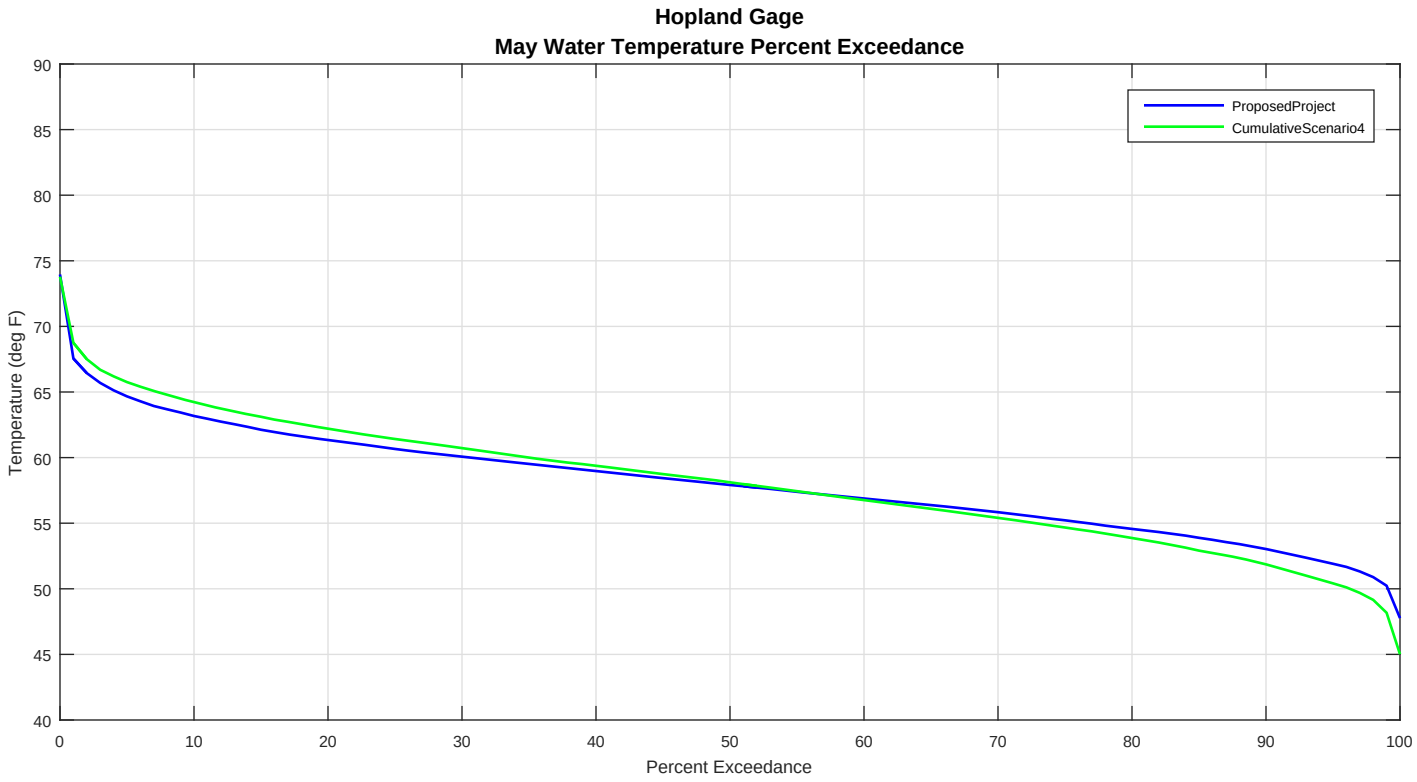
Hopland Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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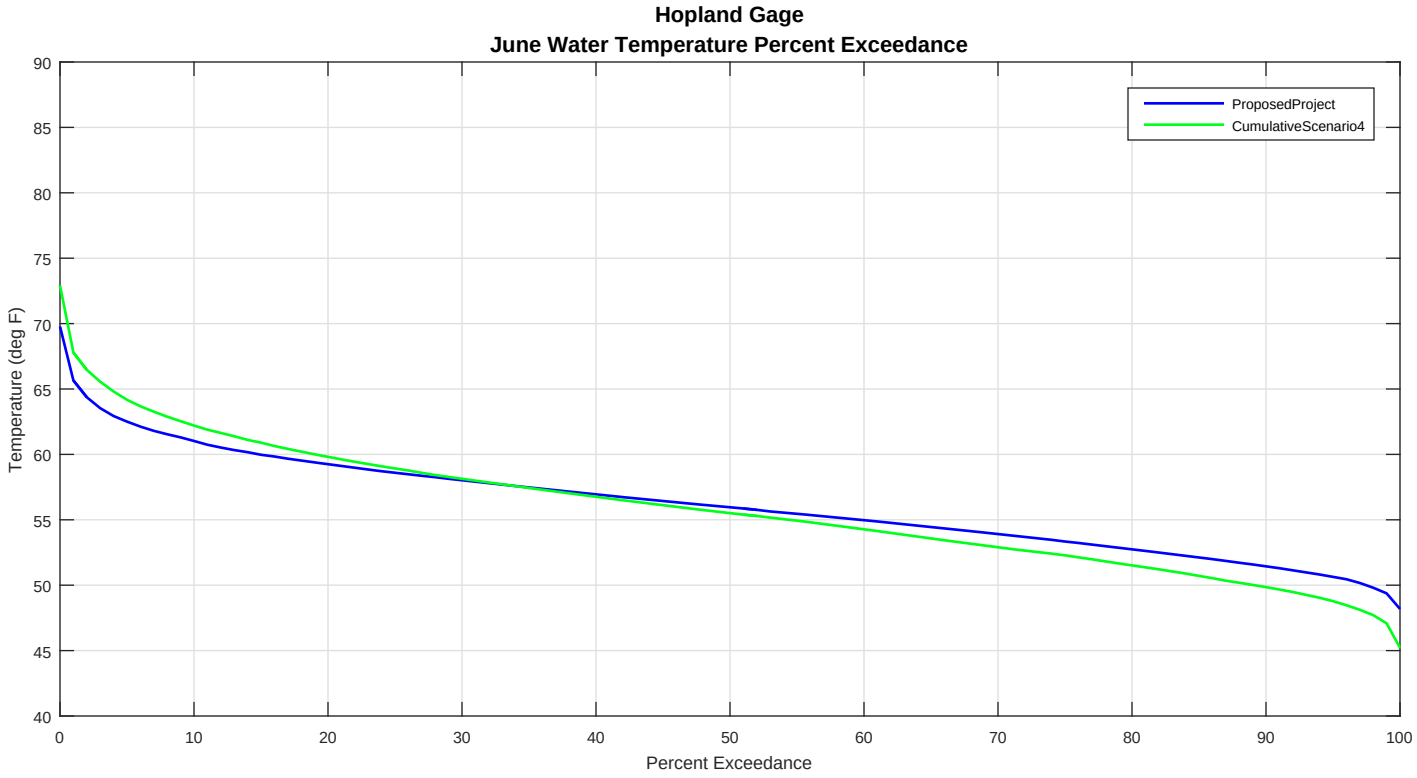
Hopland Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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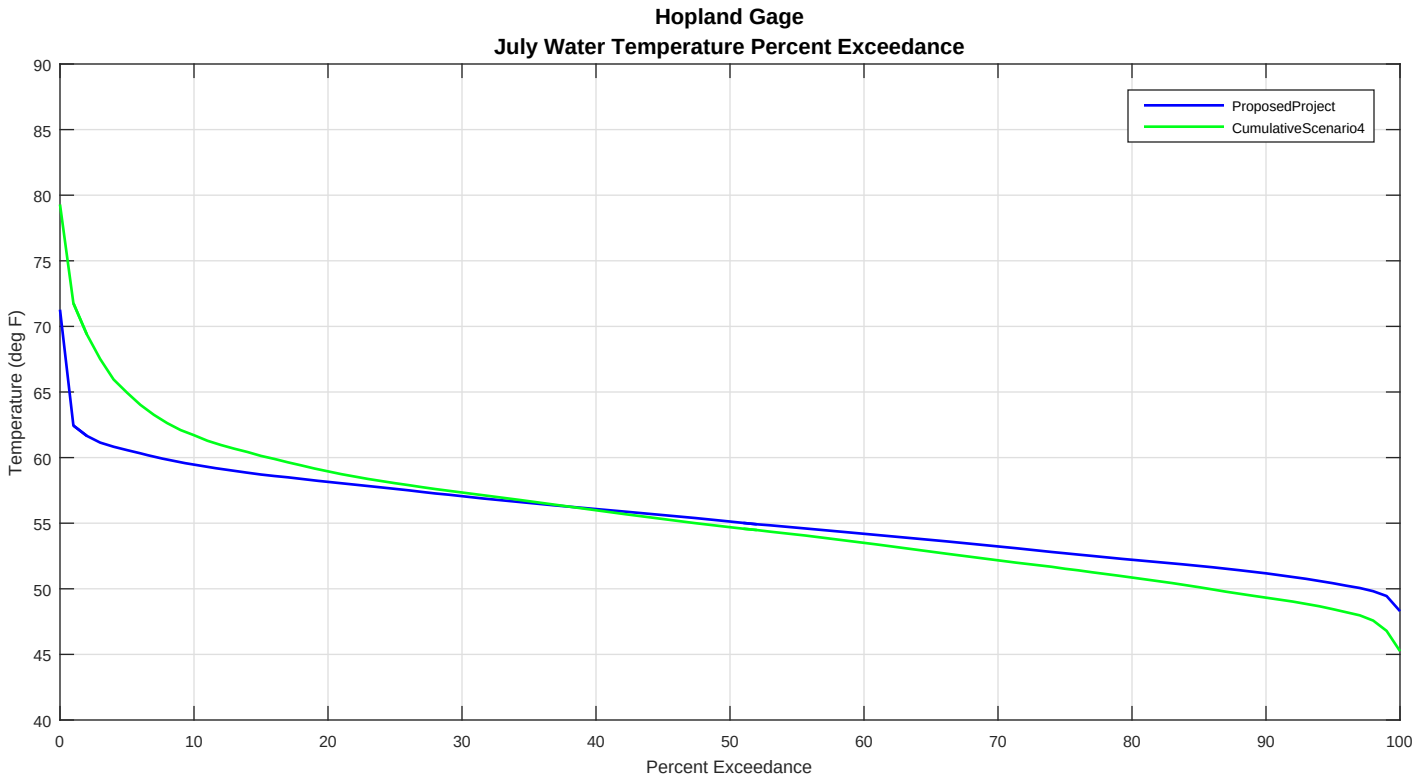
Hopland Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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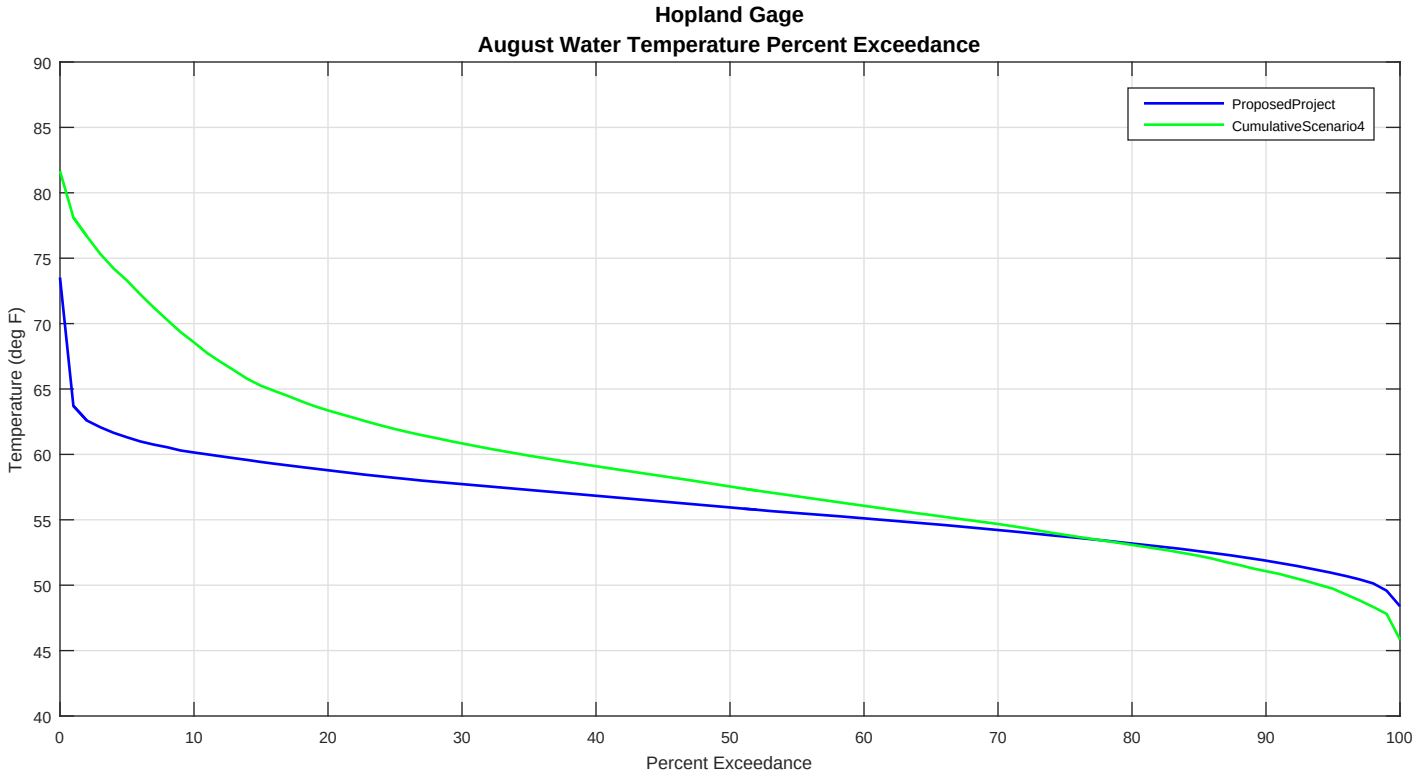
Hopland Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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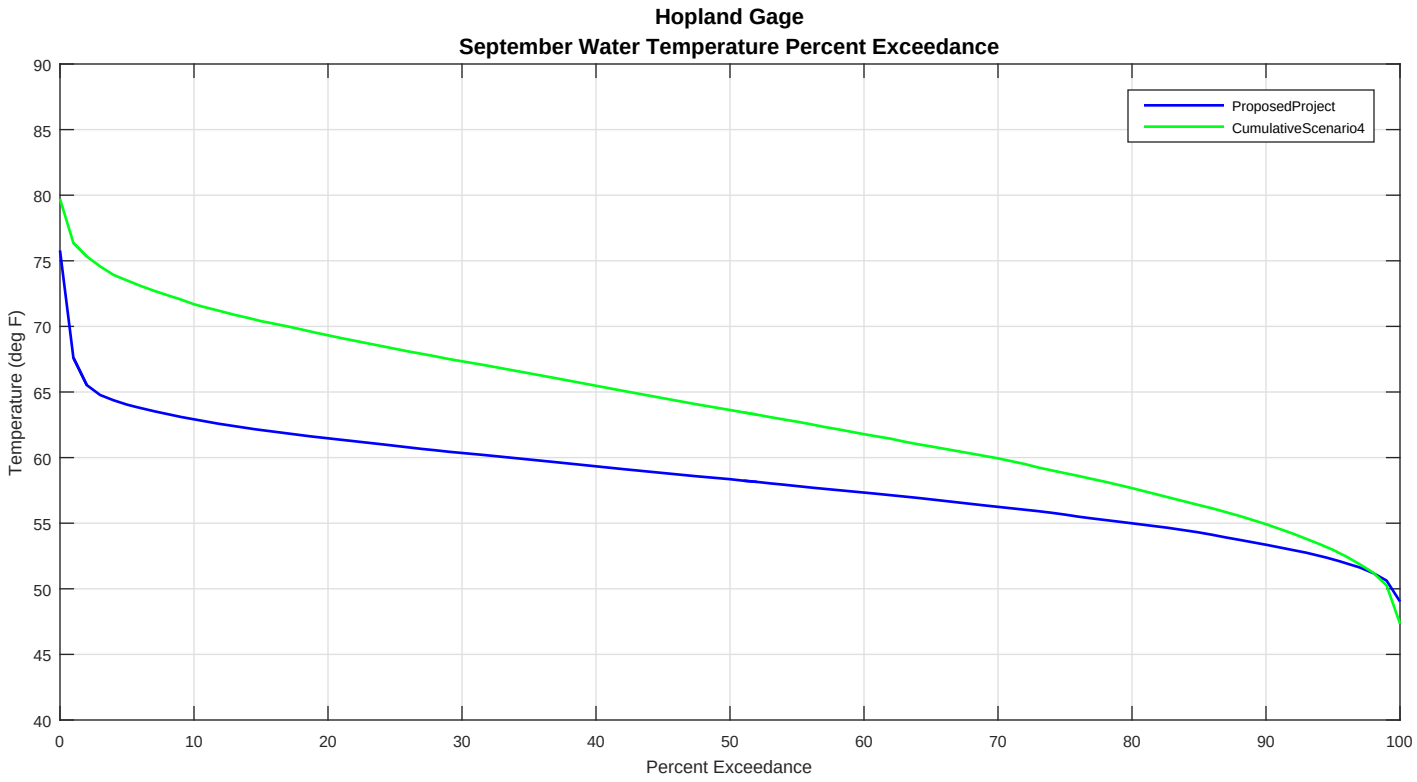
Hopland Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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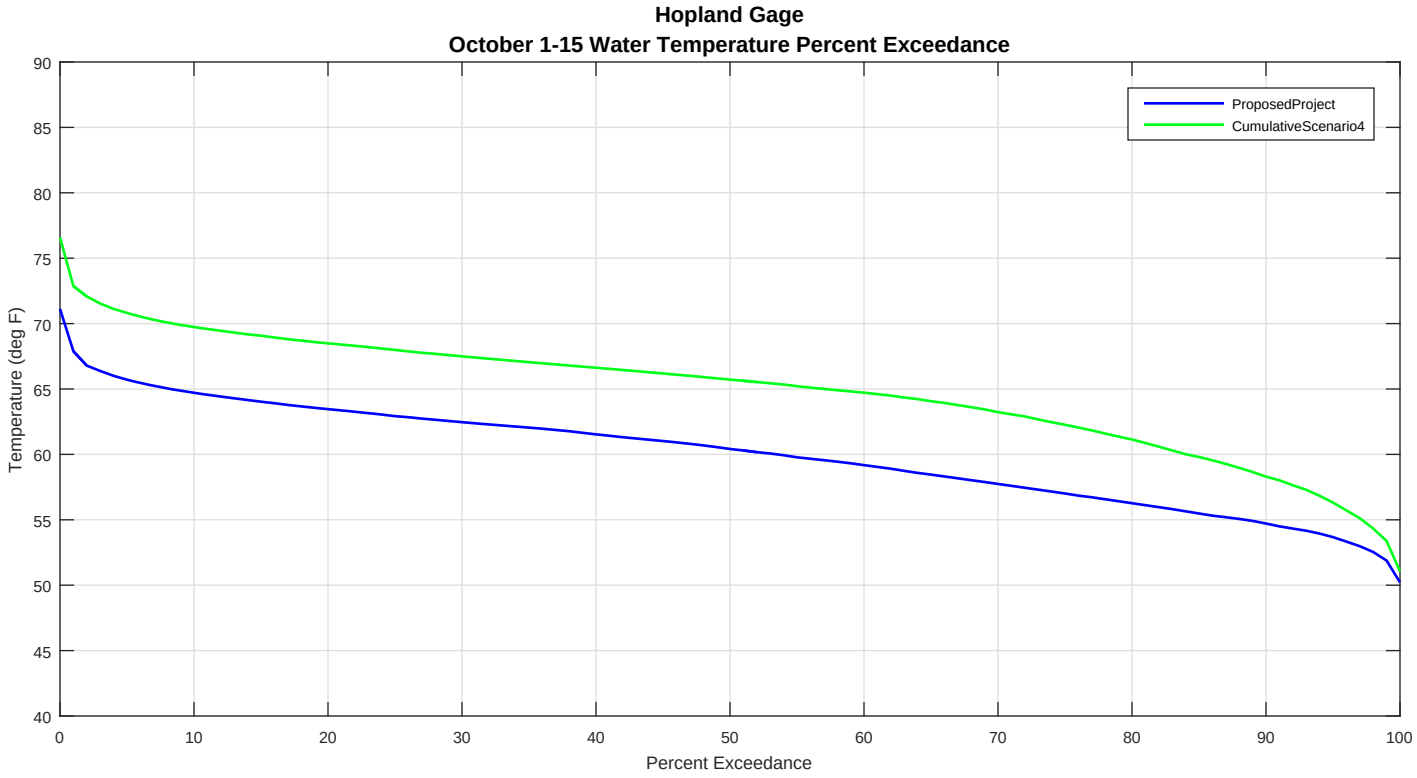
Hopland Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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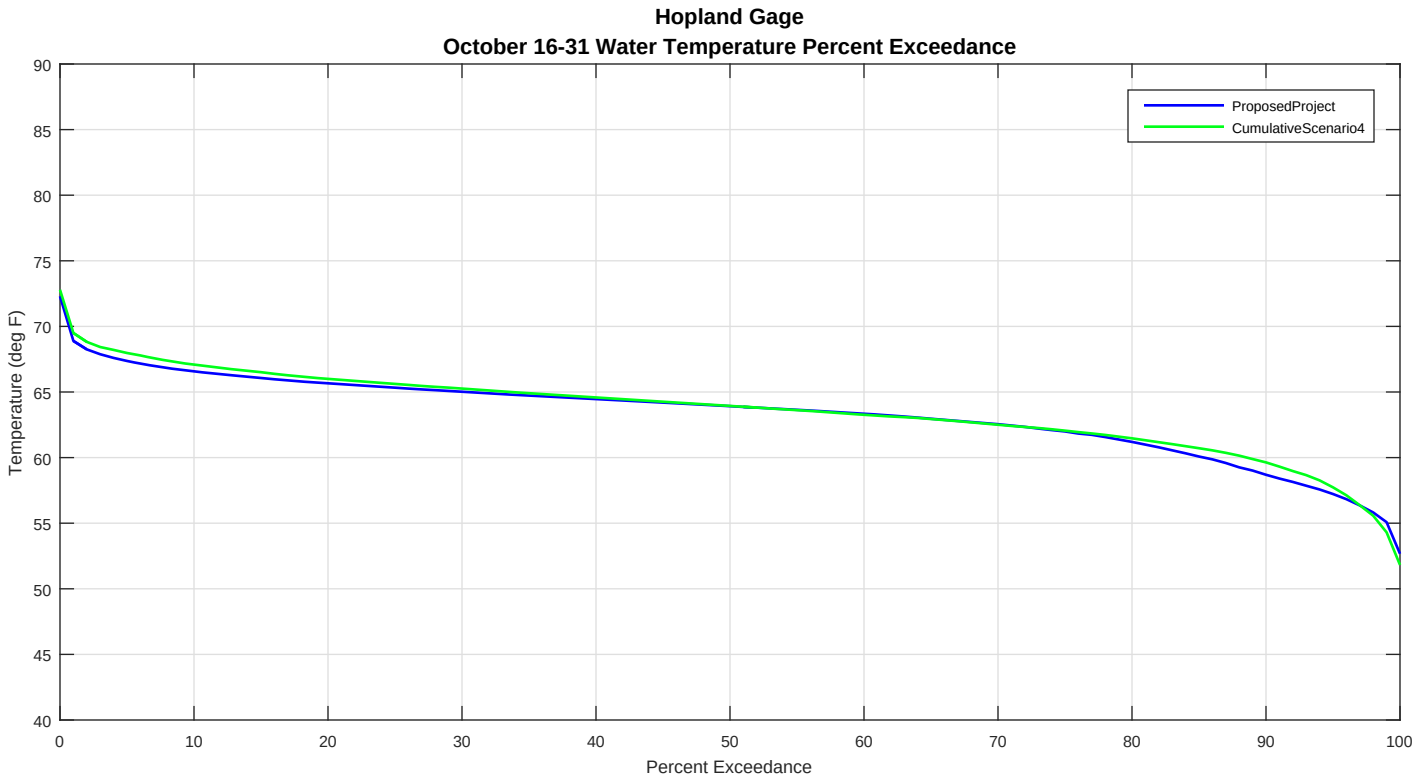
Hopland Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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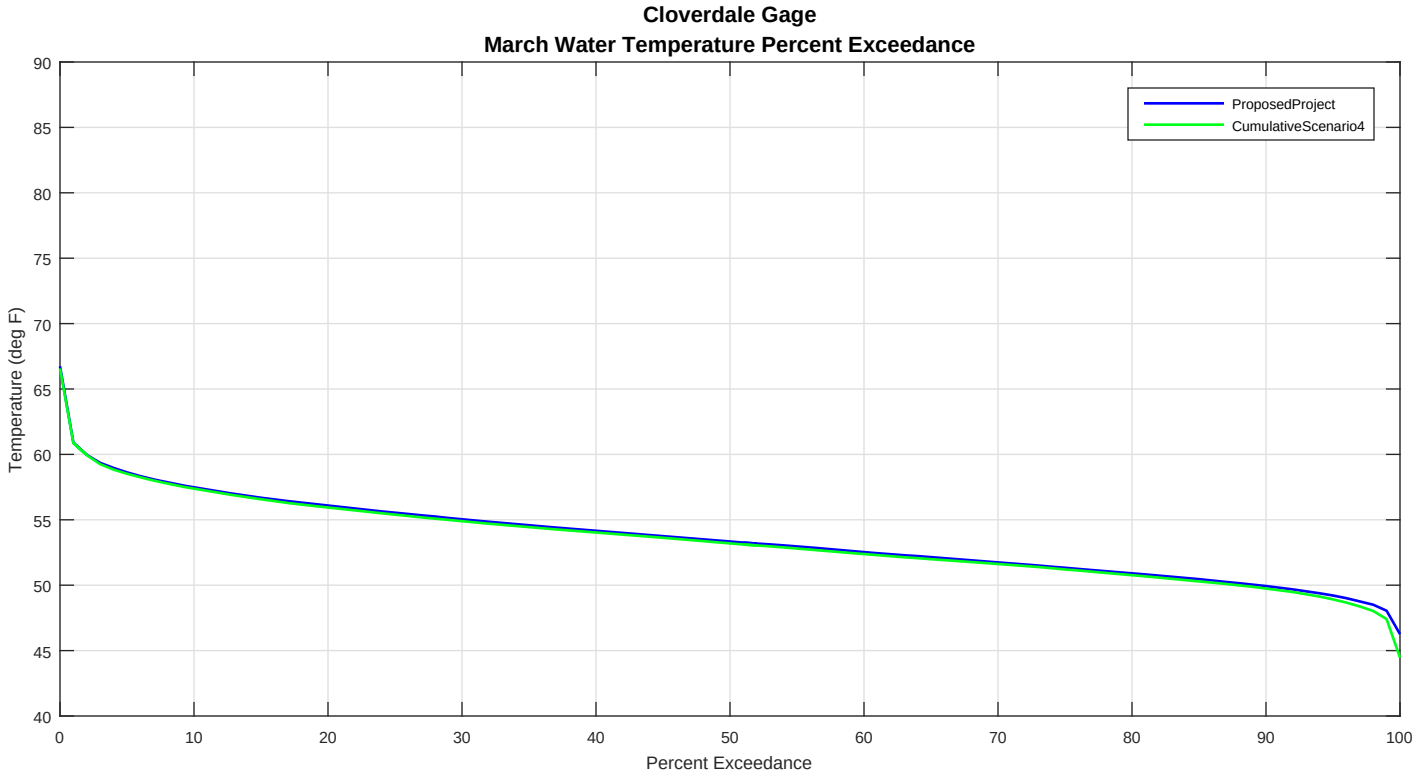
Cloverdale Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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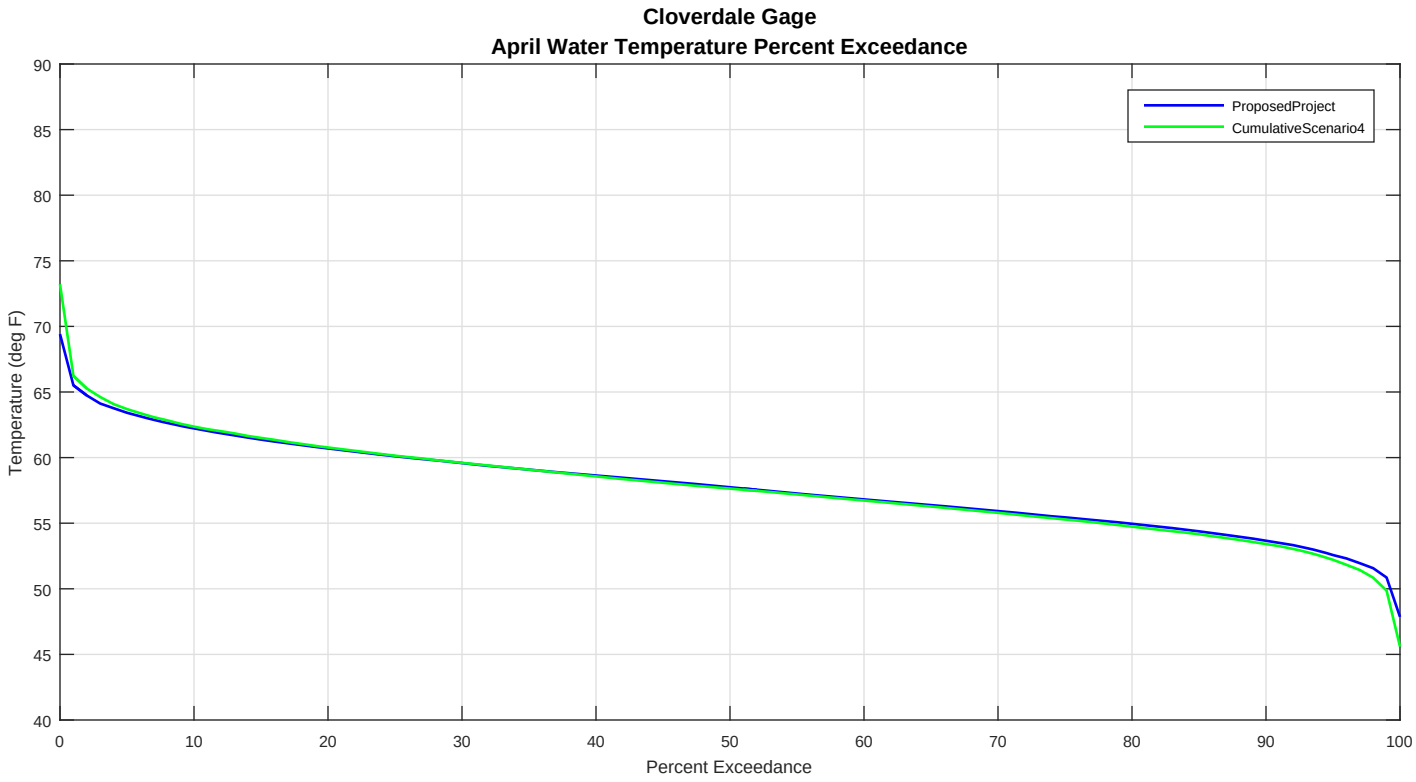
Cloverdale Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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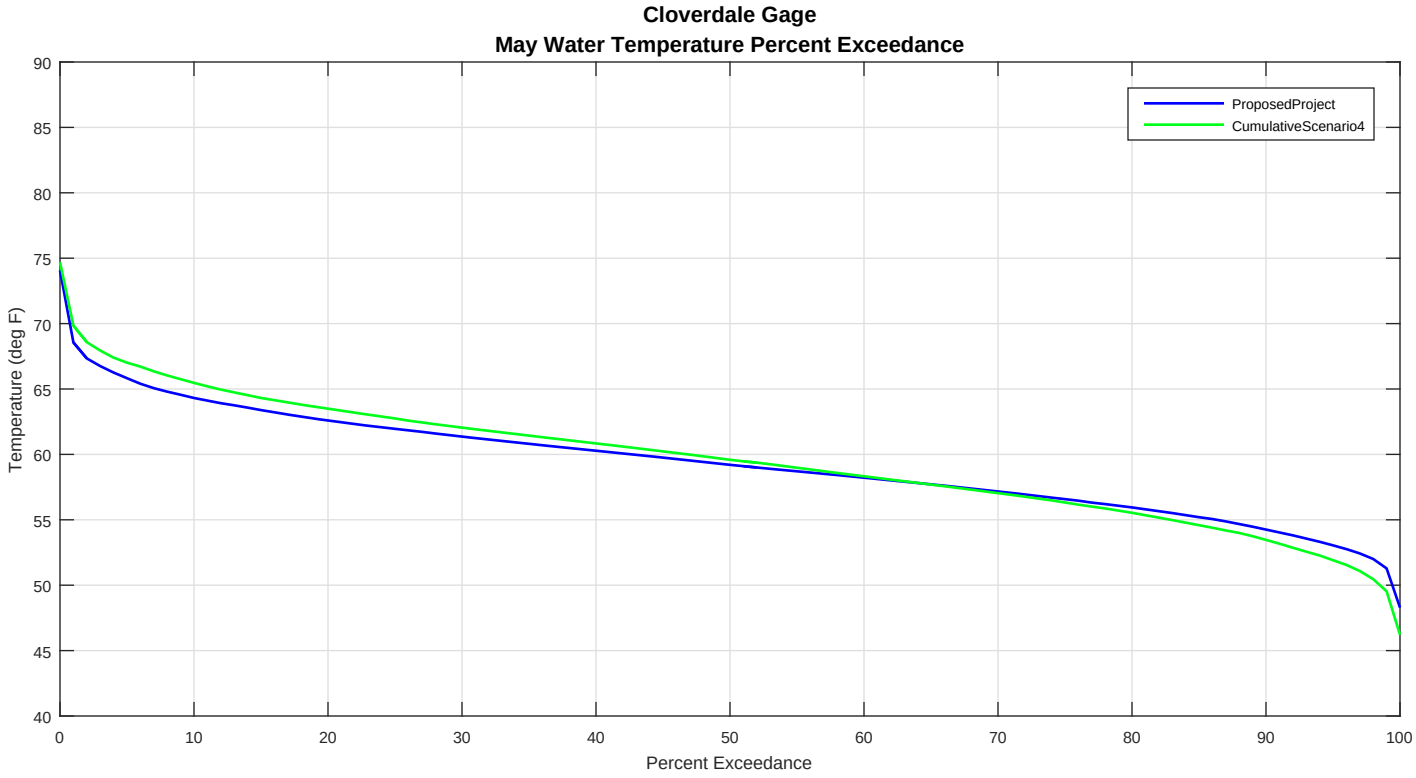
Cloverdale Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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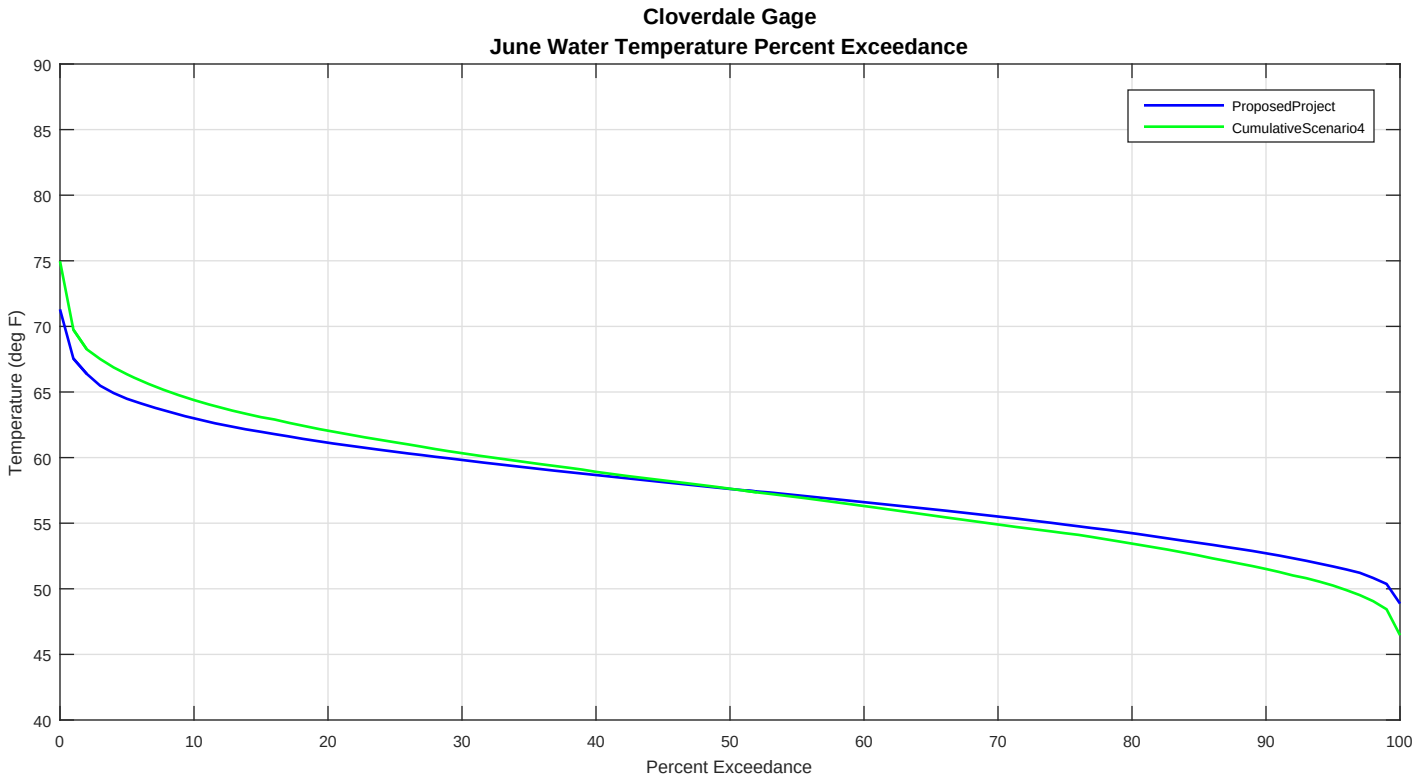
Cloverdale Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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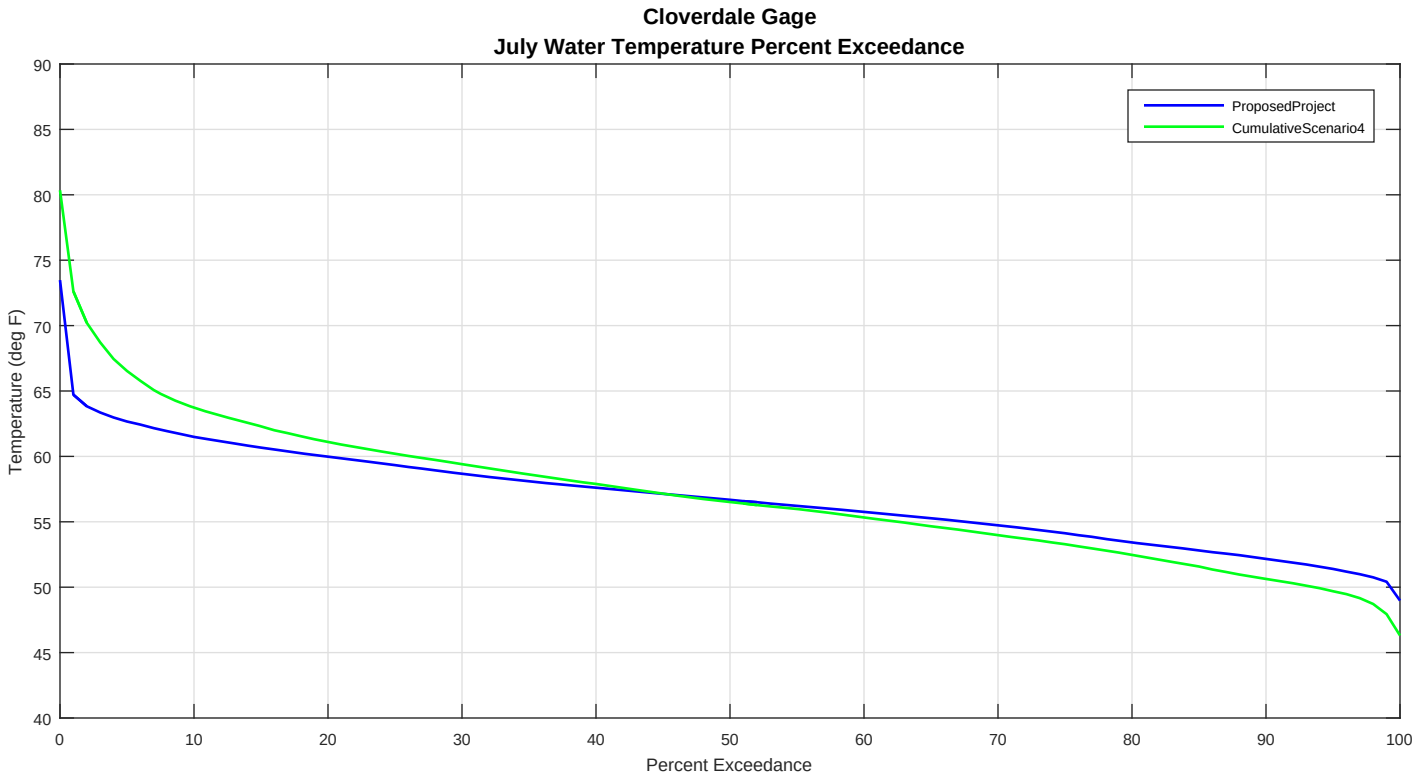
Cloverdale Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
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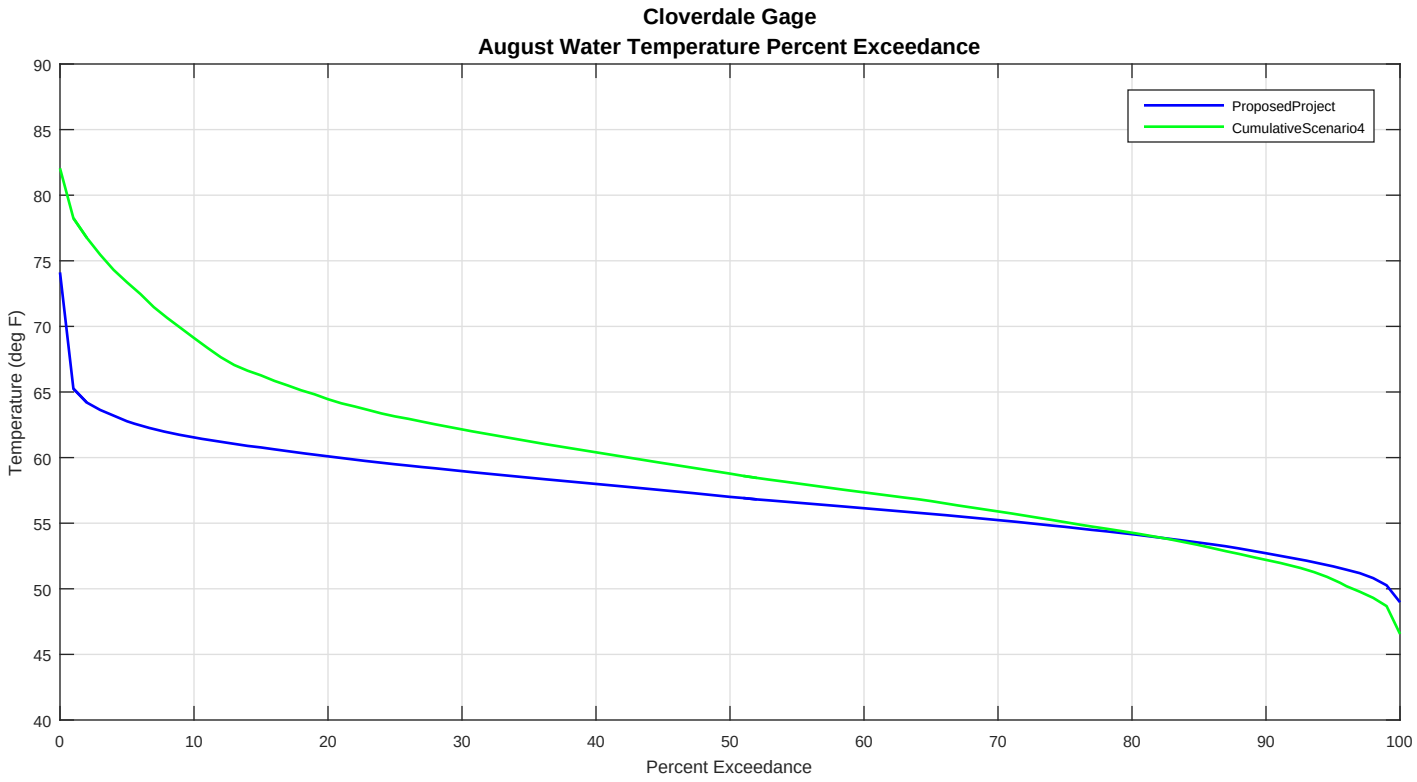
Cloverdale Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
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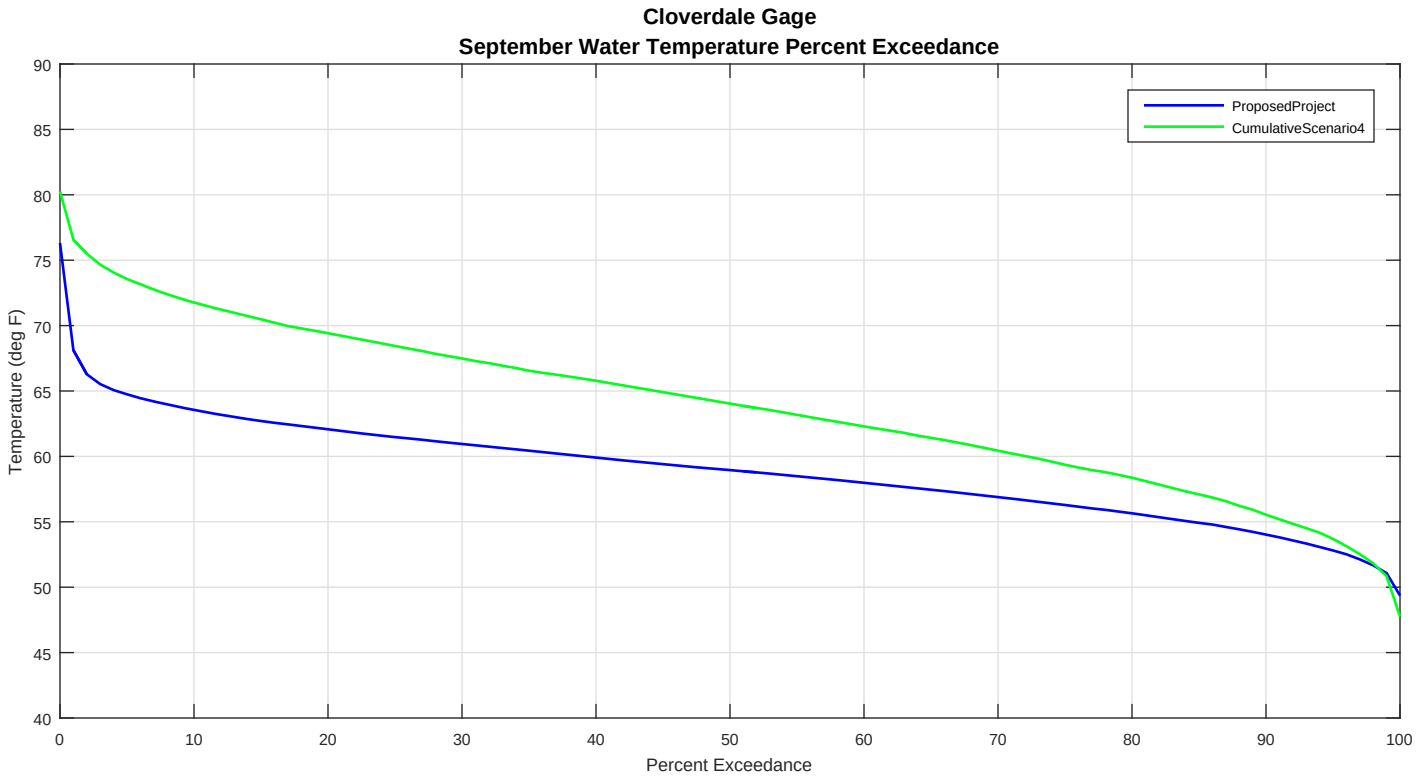
Cloverdale Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
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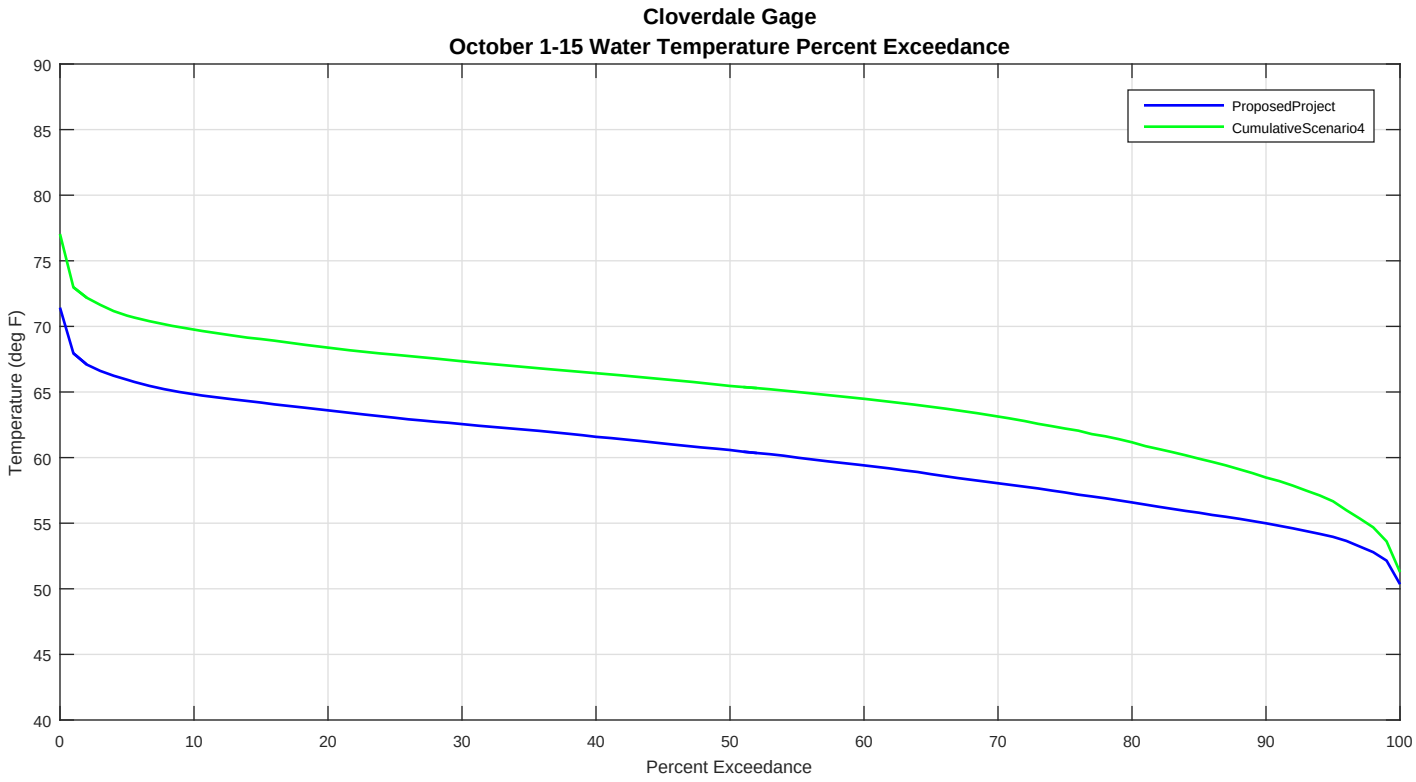
Cloverdale Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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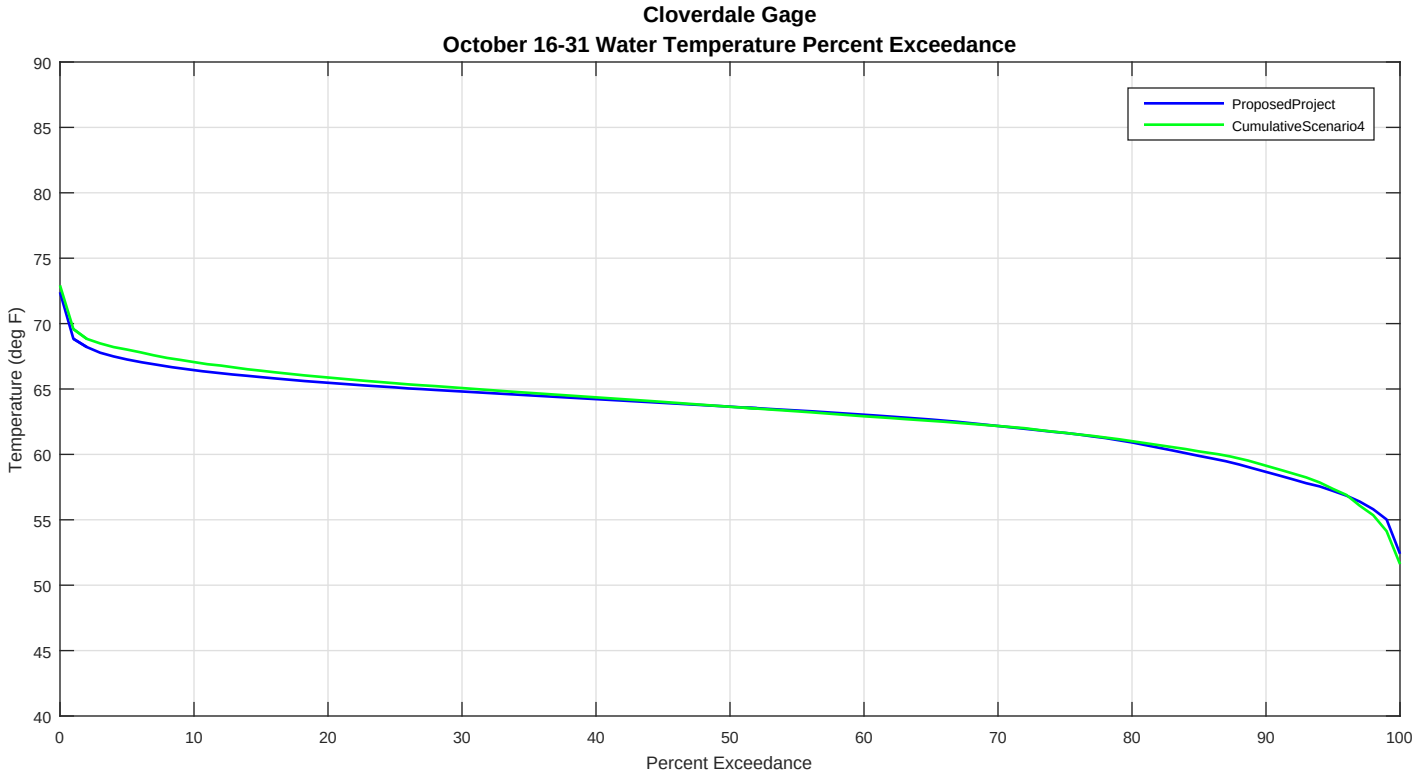
Cloverdale Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
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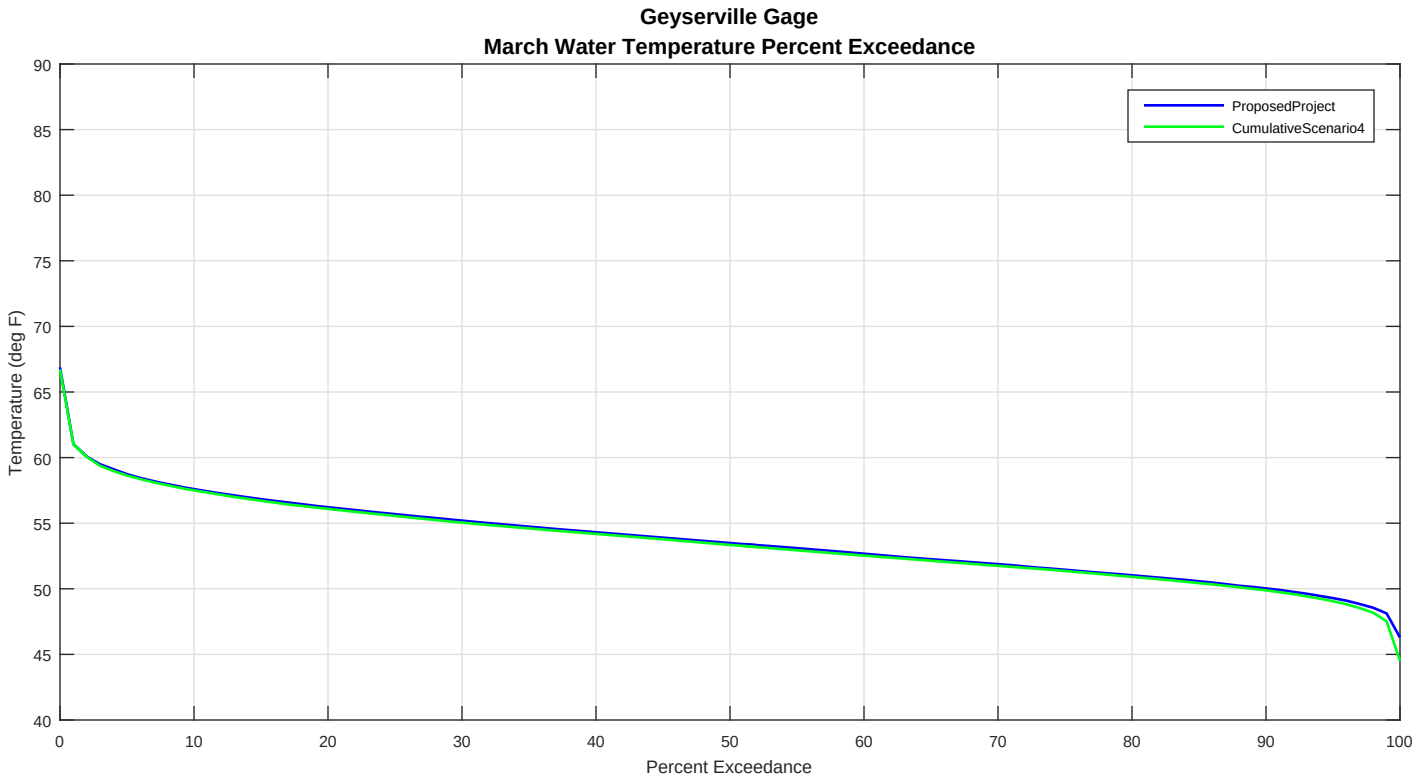
Geyserville Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
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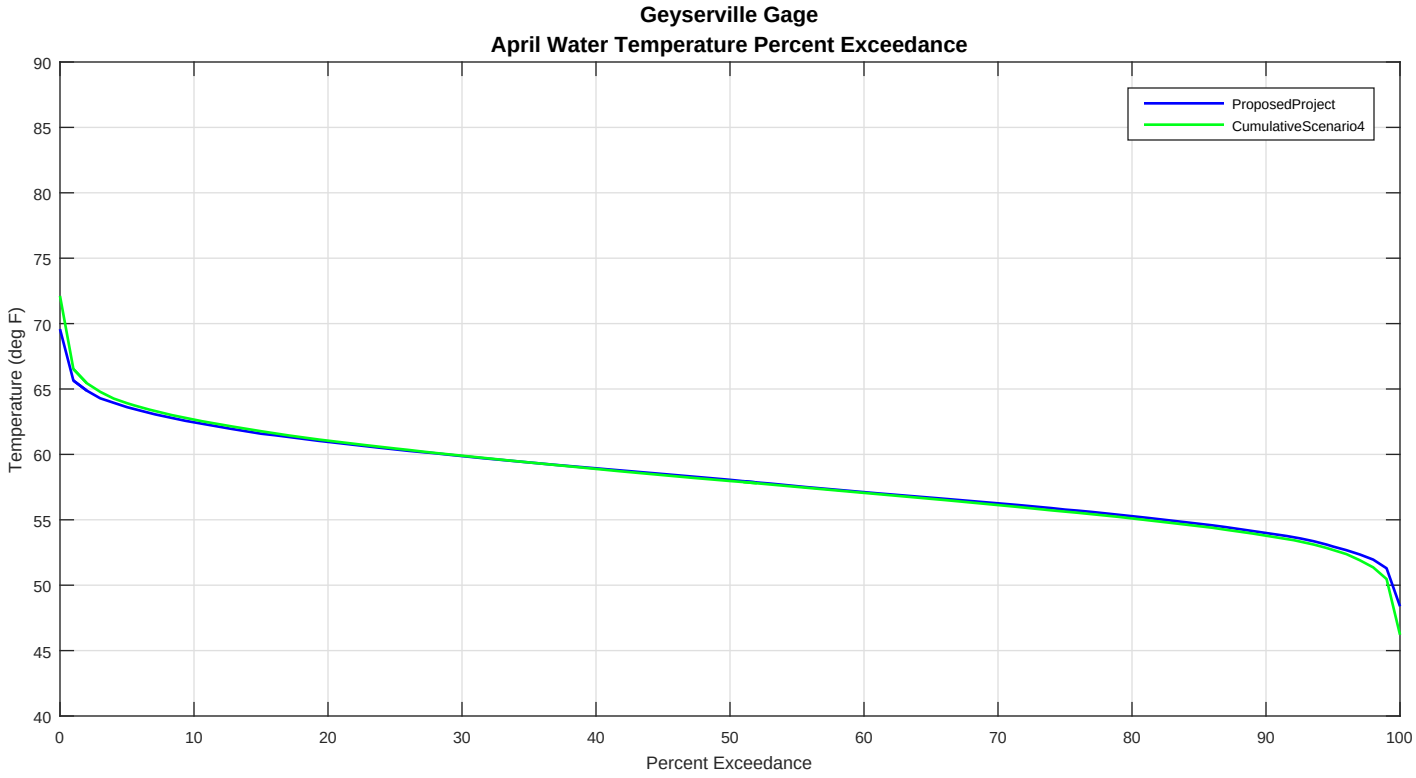
Geyserville Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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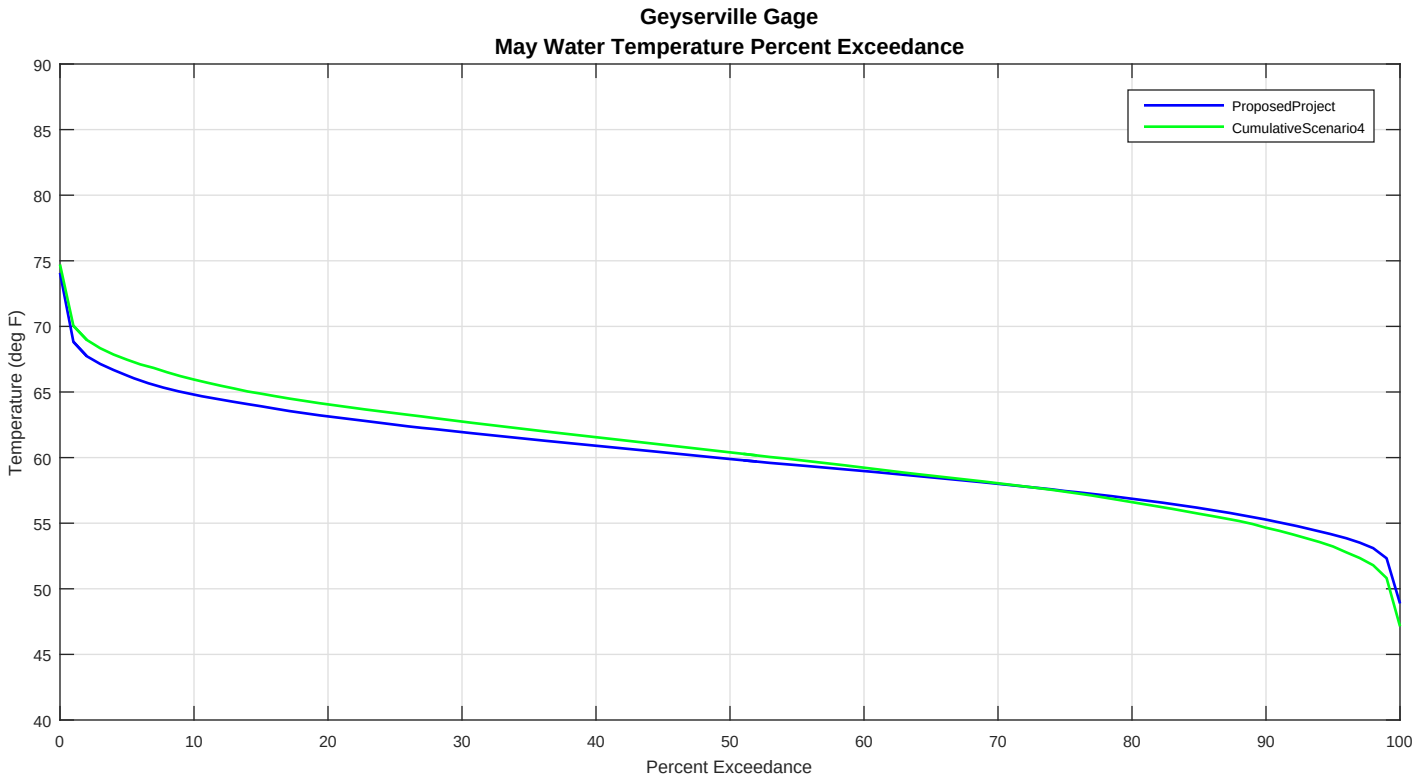
Geyserville Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
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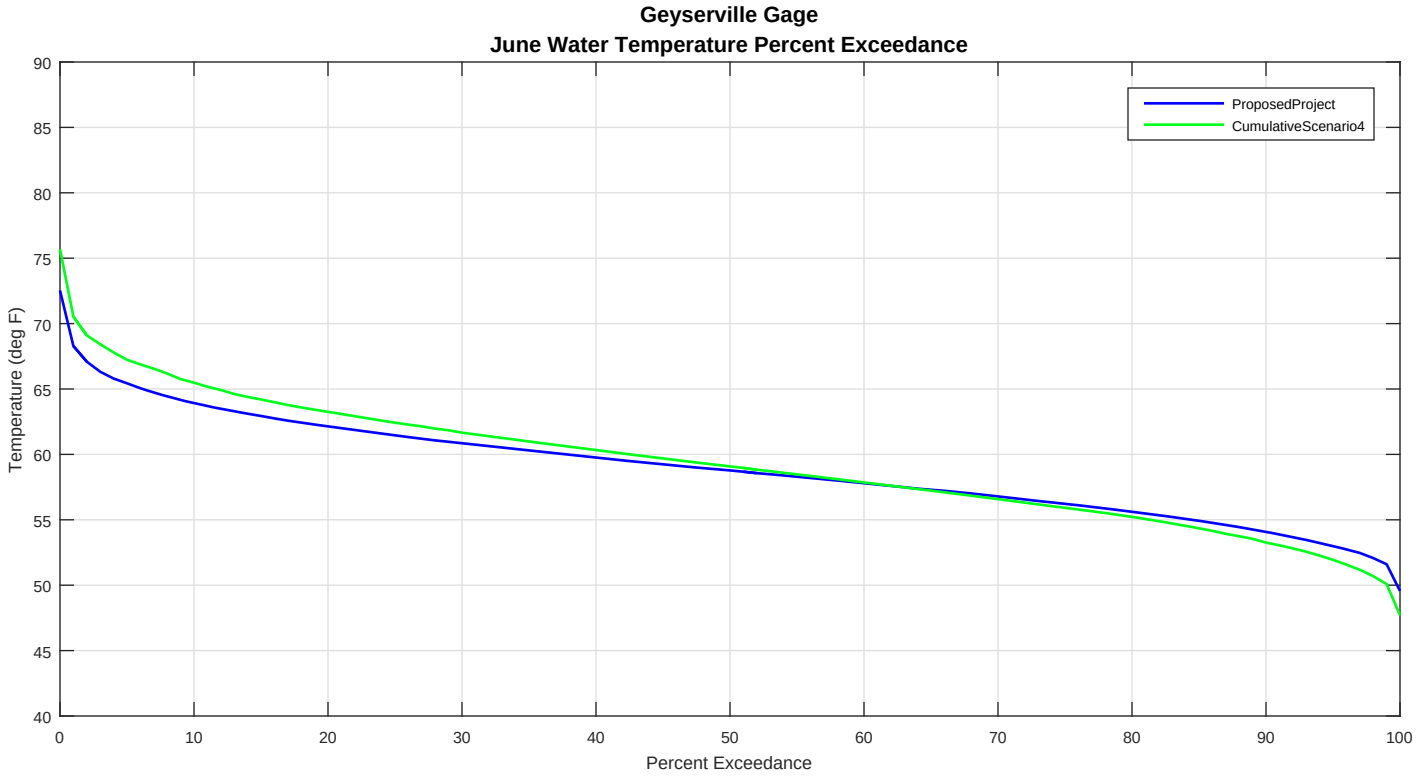
Geyserville Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
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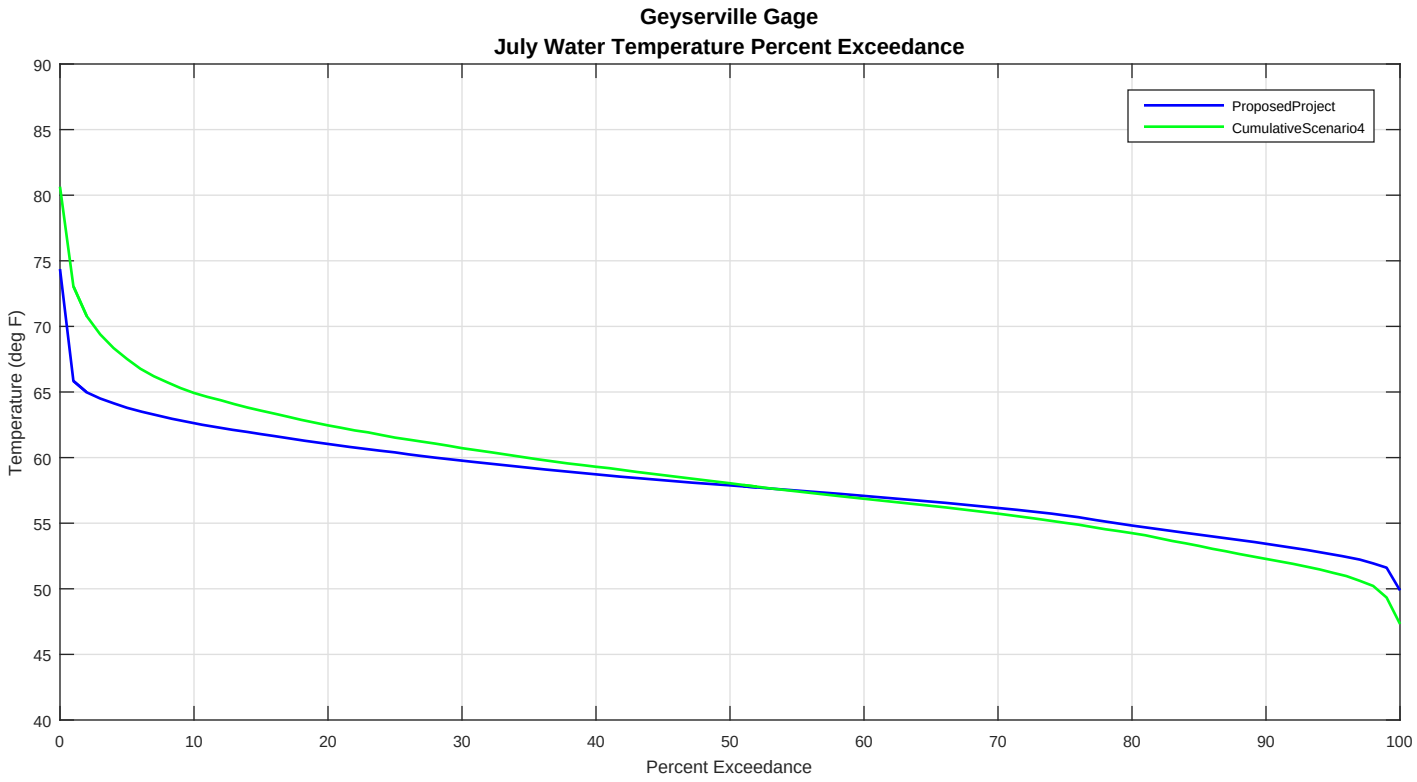
Geyserville Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
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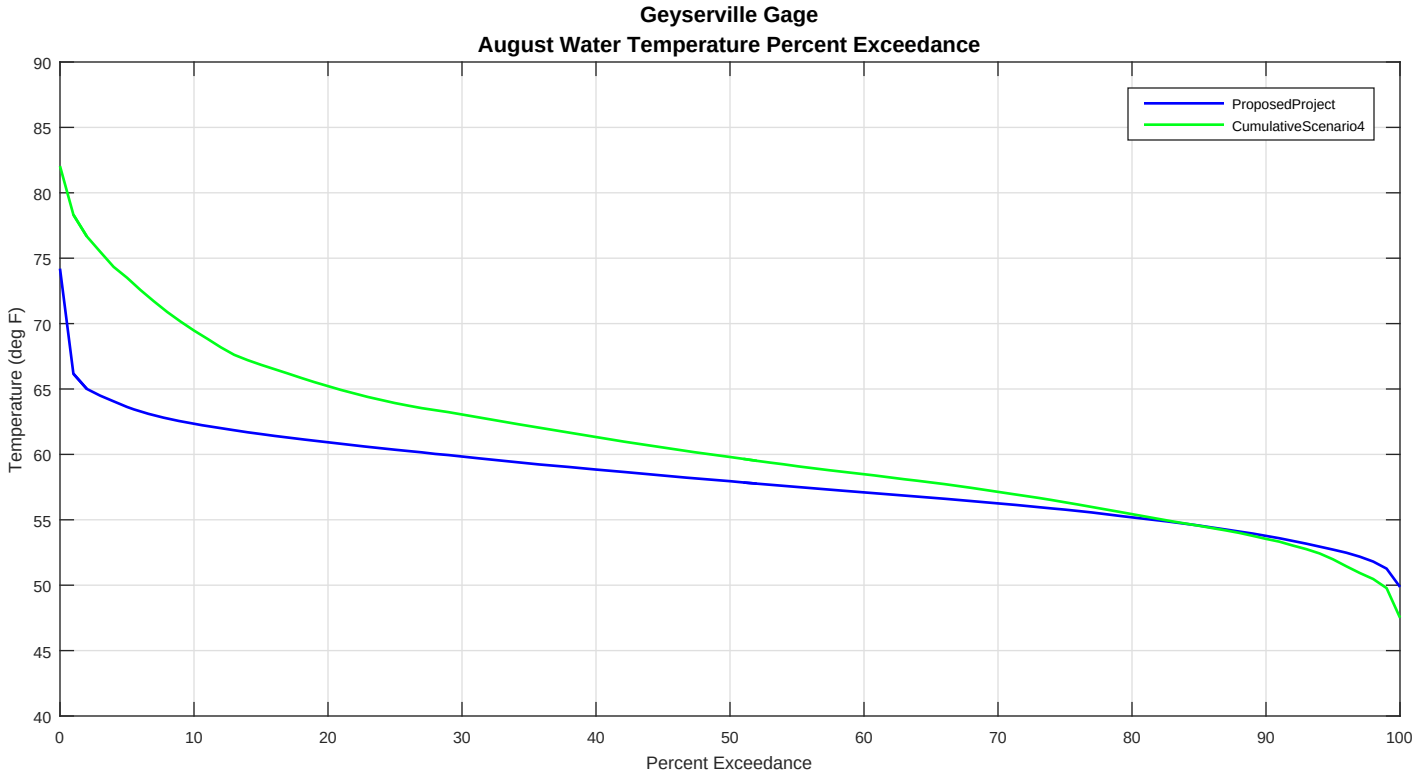
Geyserville Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
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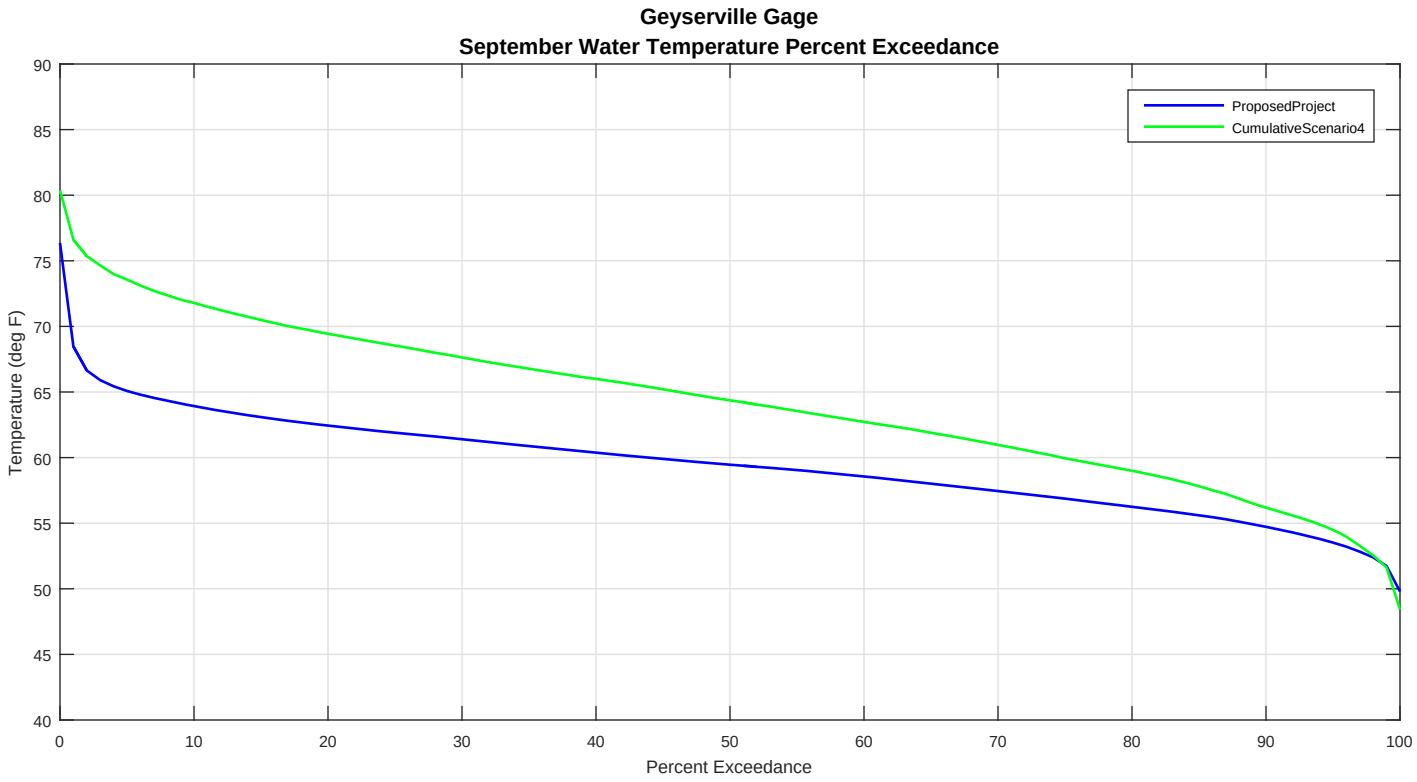
Geyserville Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
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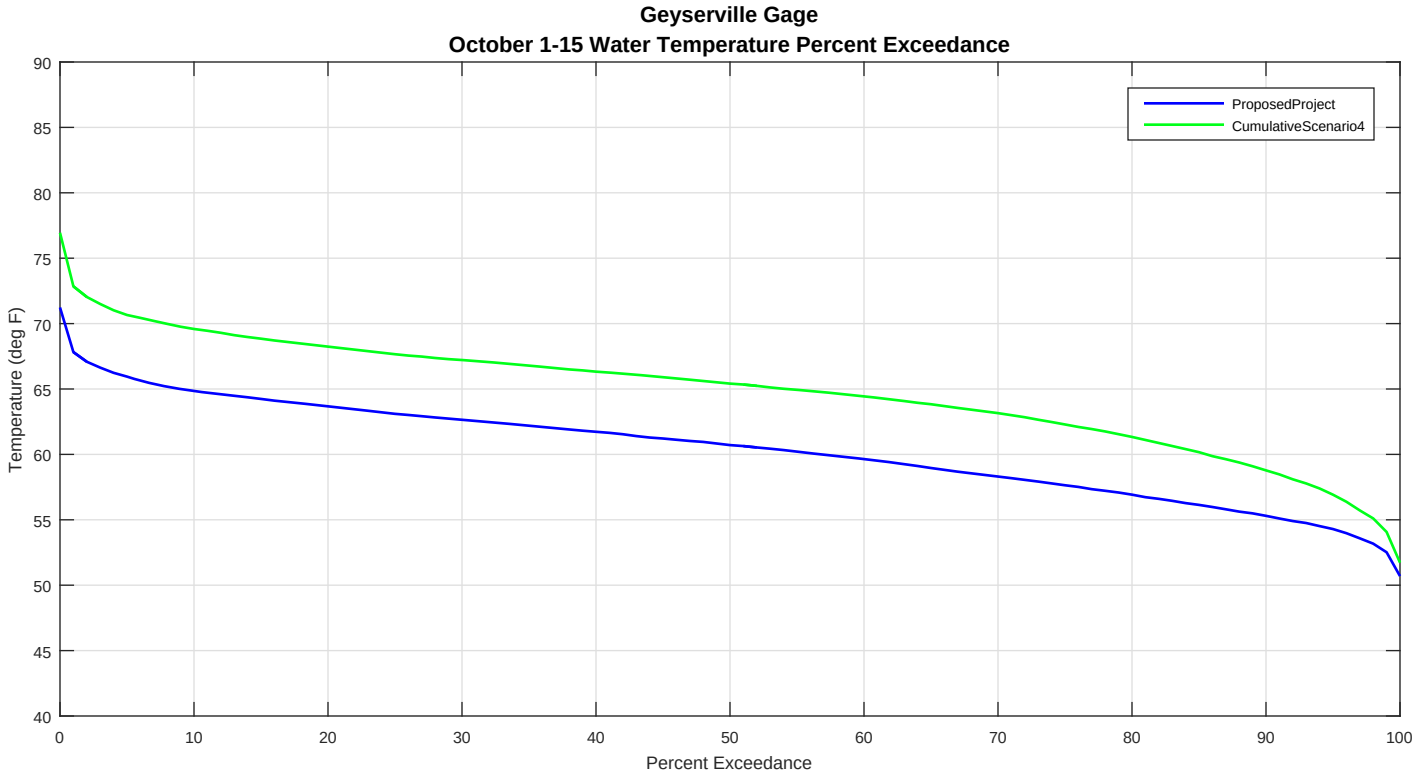
Geyserville Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
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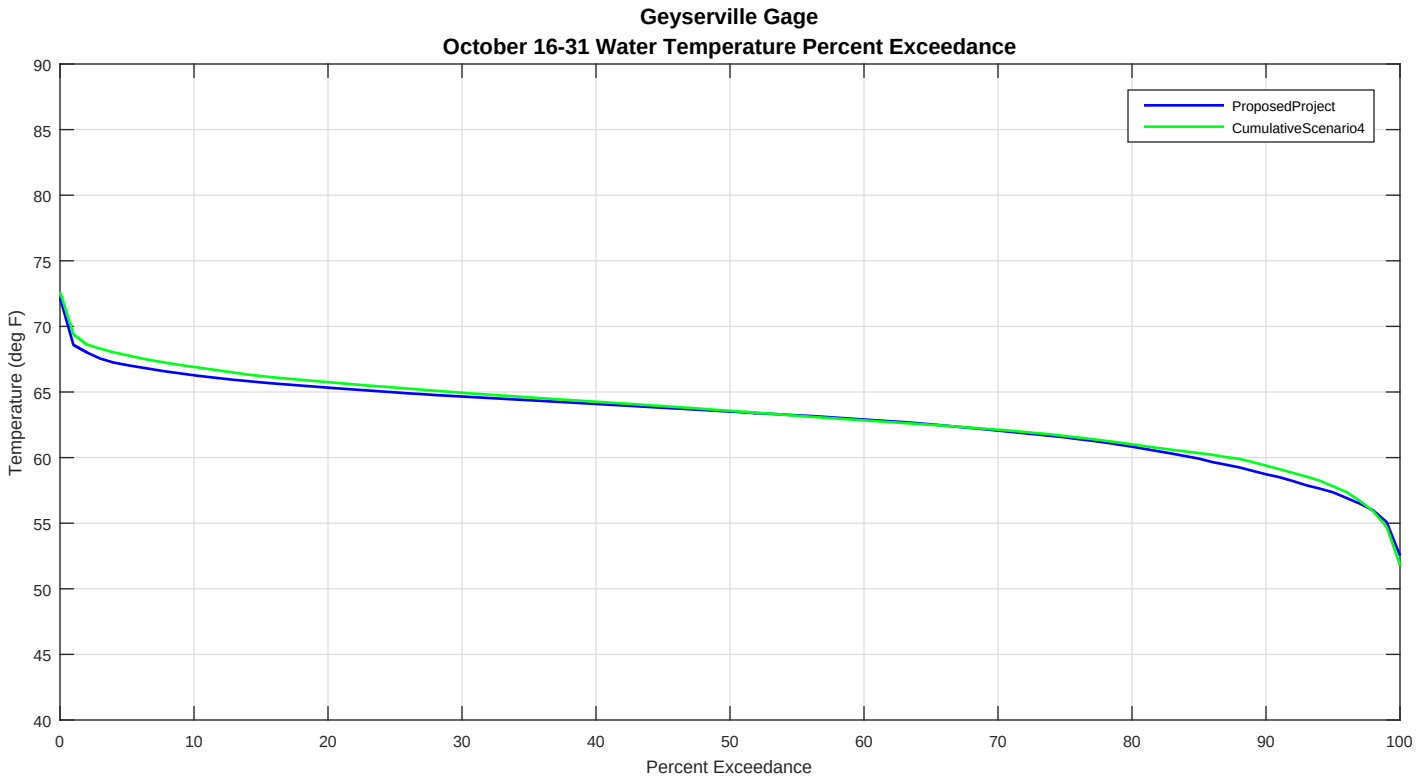
Geyserville Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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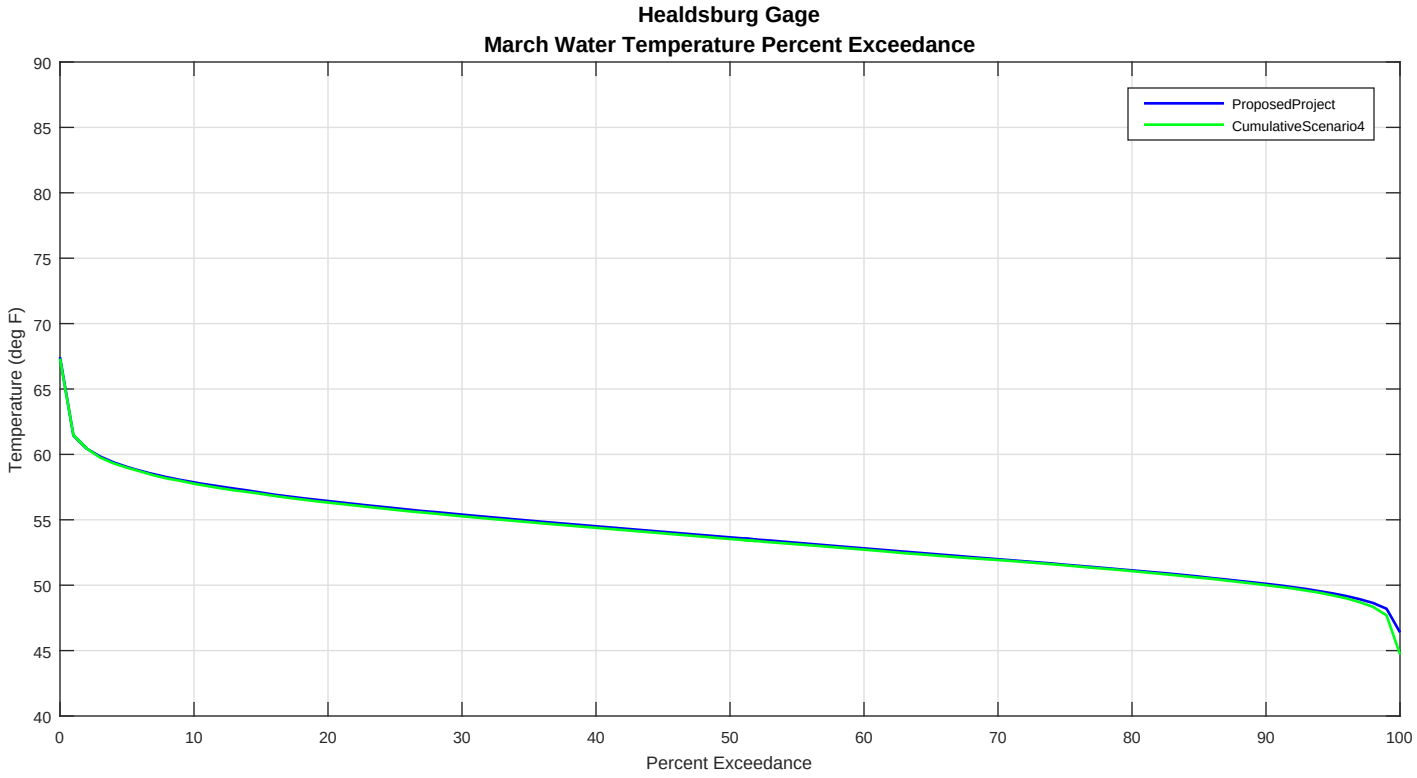
Healdsburg Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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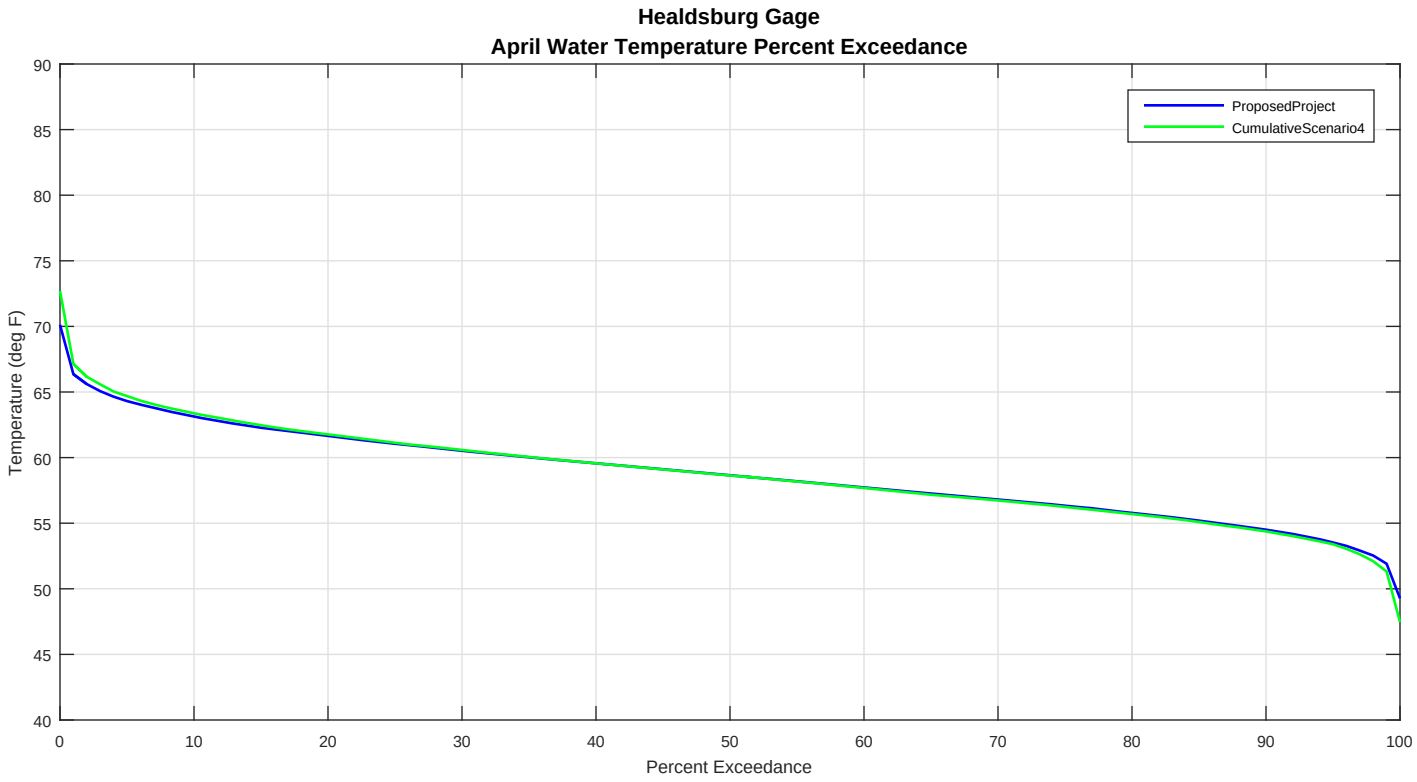
Healdsburg Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
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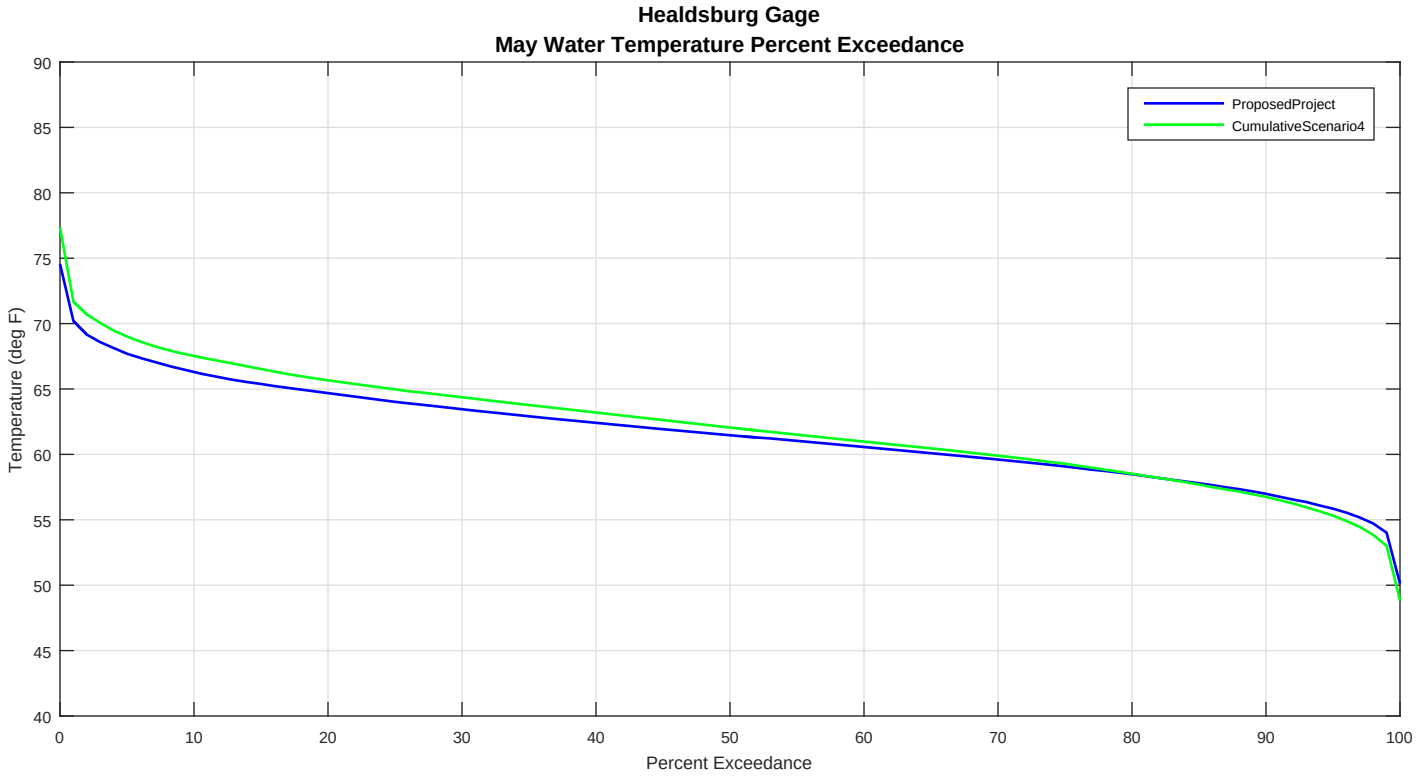
Healdsburg Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
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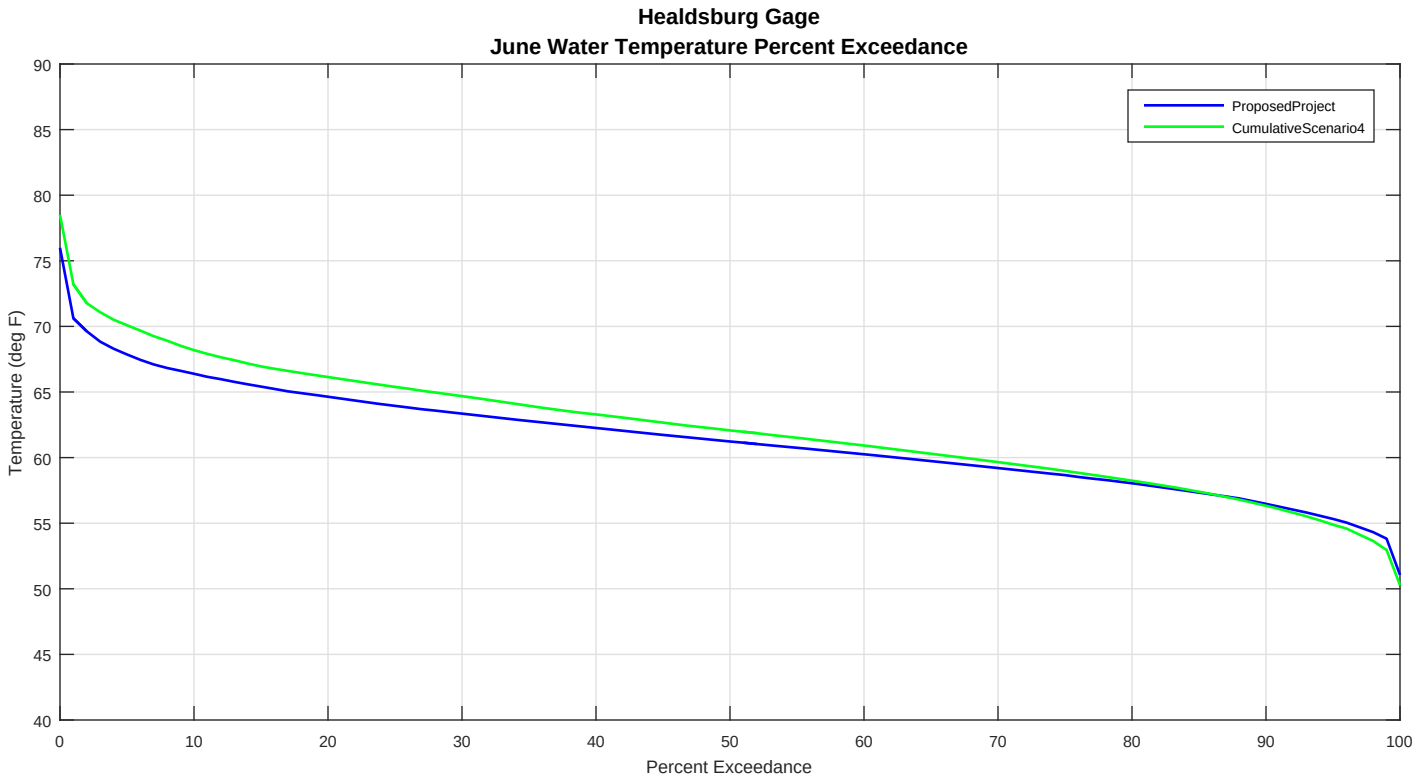
Healdsburg Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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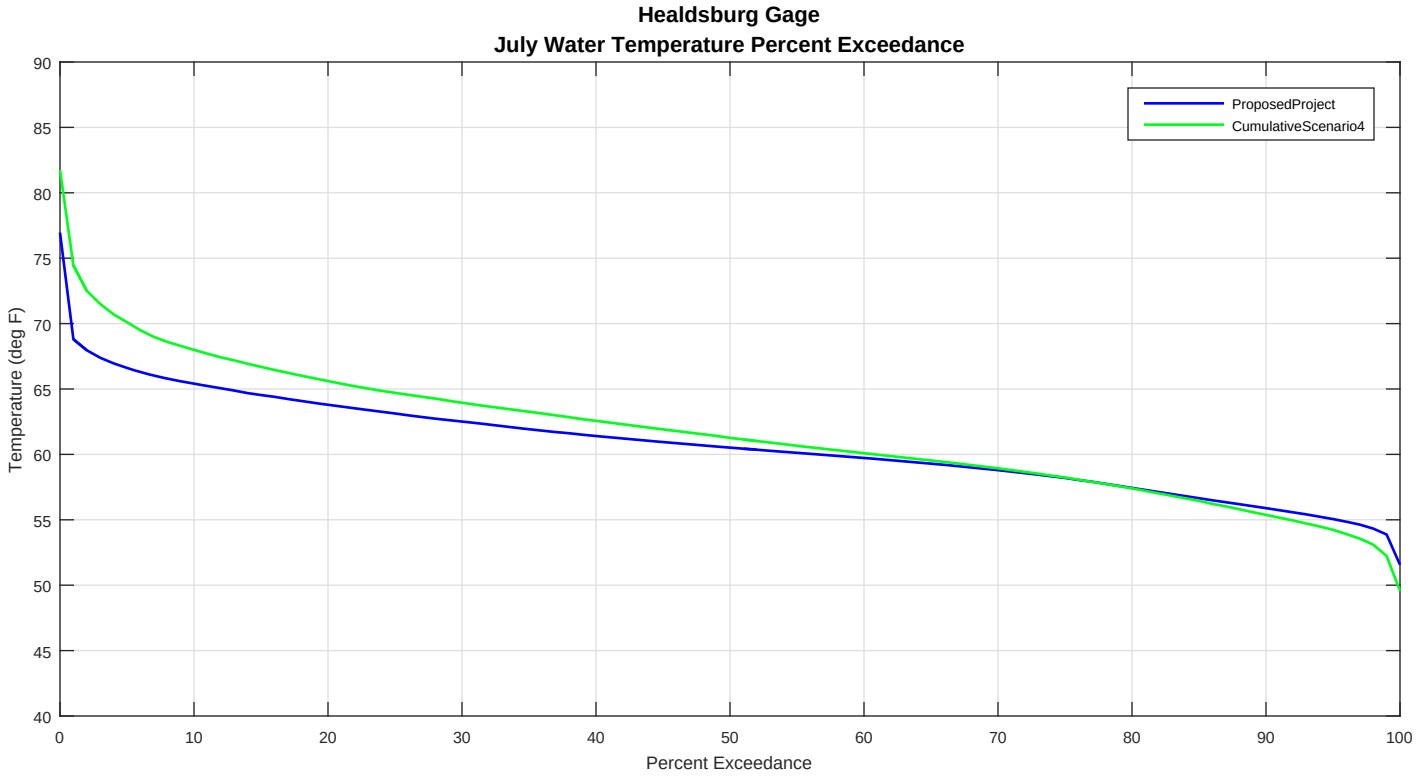
Healdsburg Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
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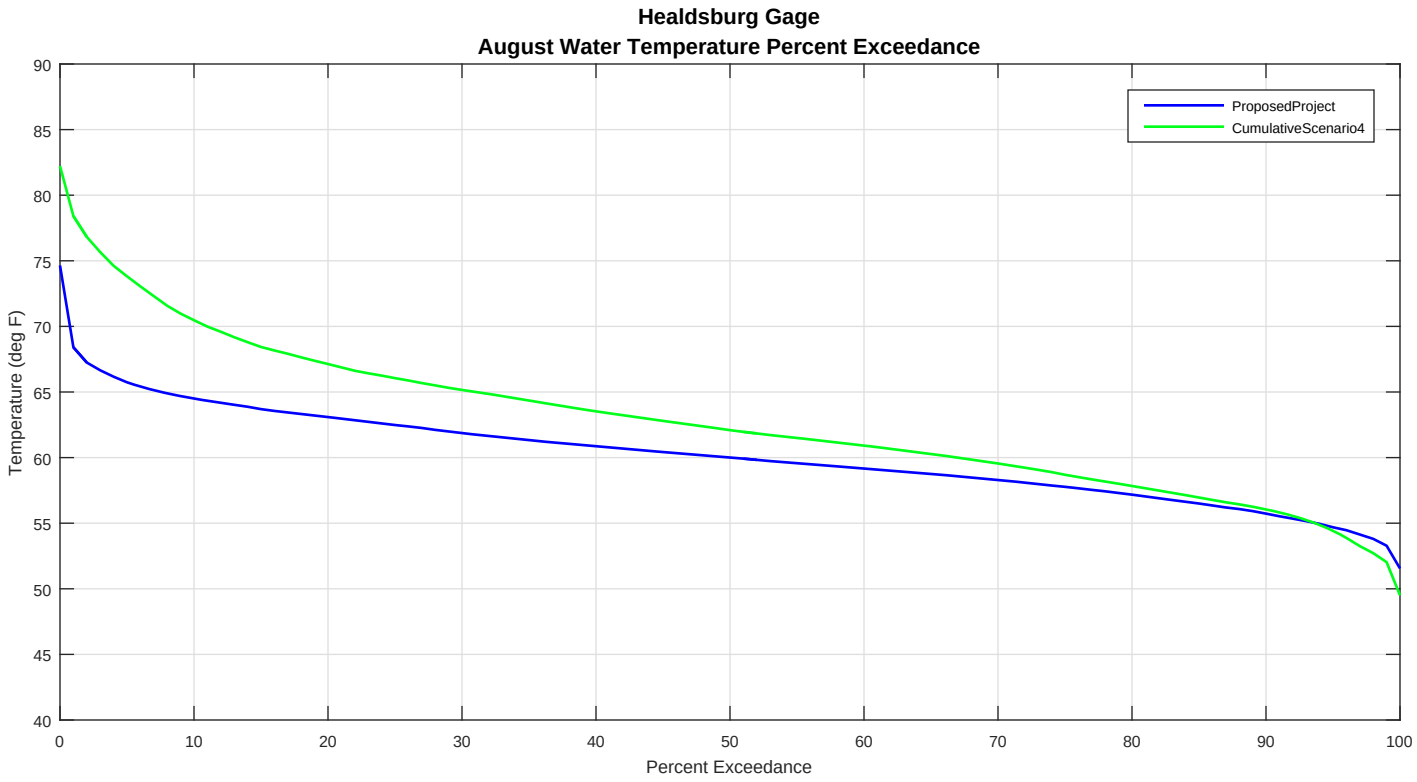
Healdsburg Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
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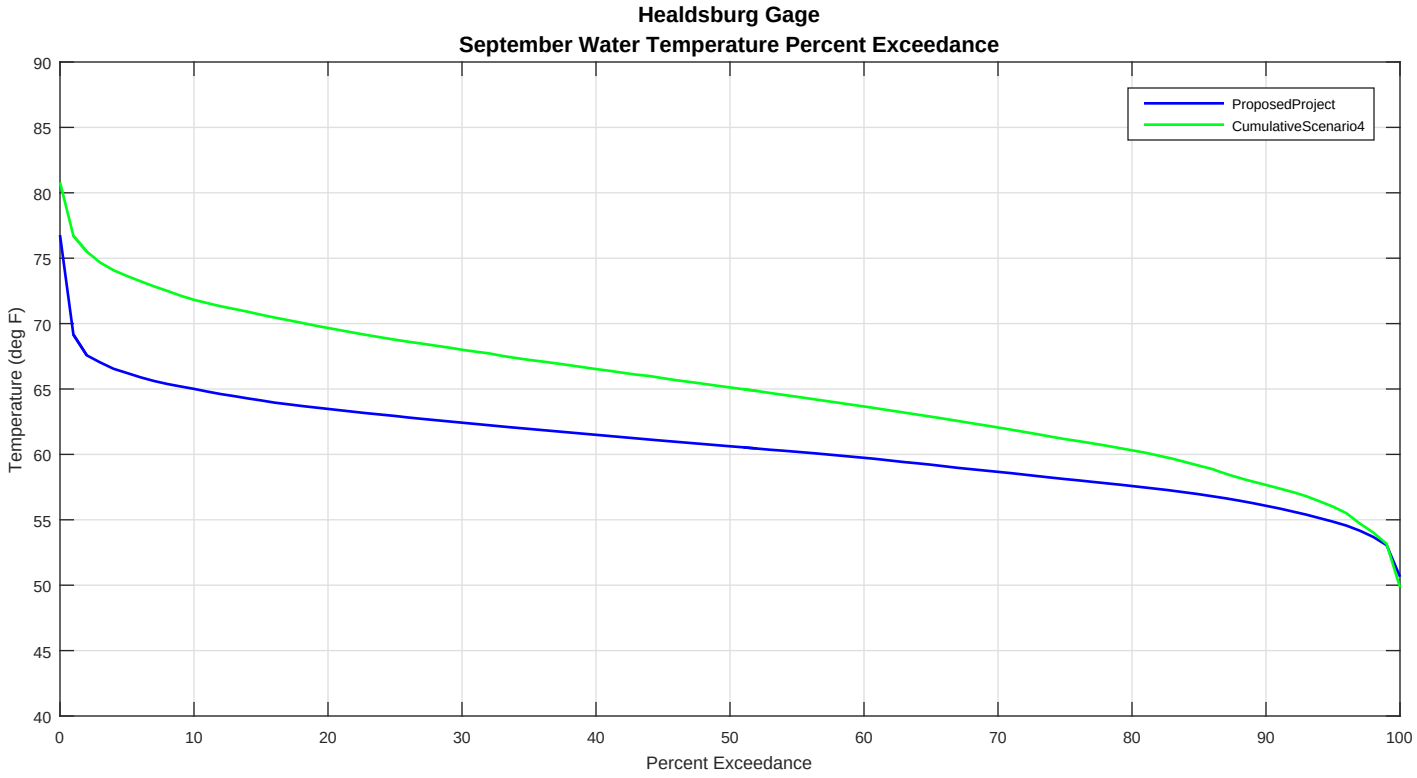
Healdsburg Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
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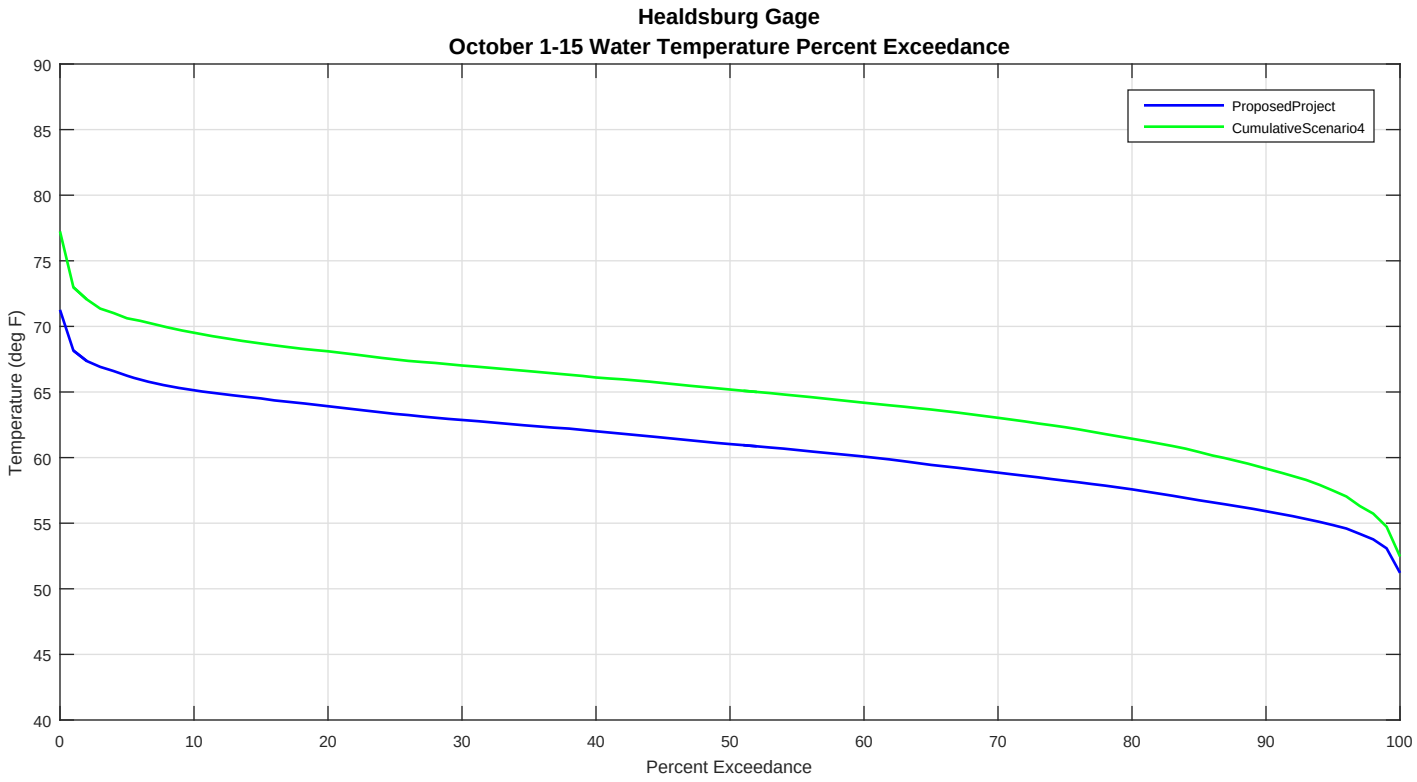
Healdsburg Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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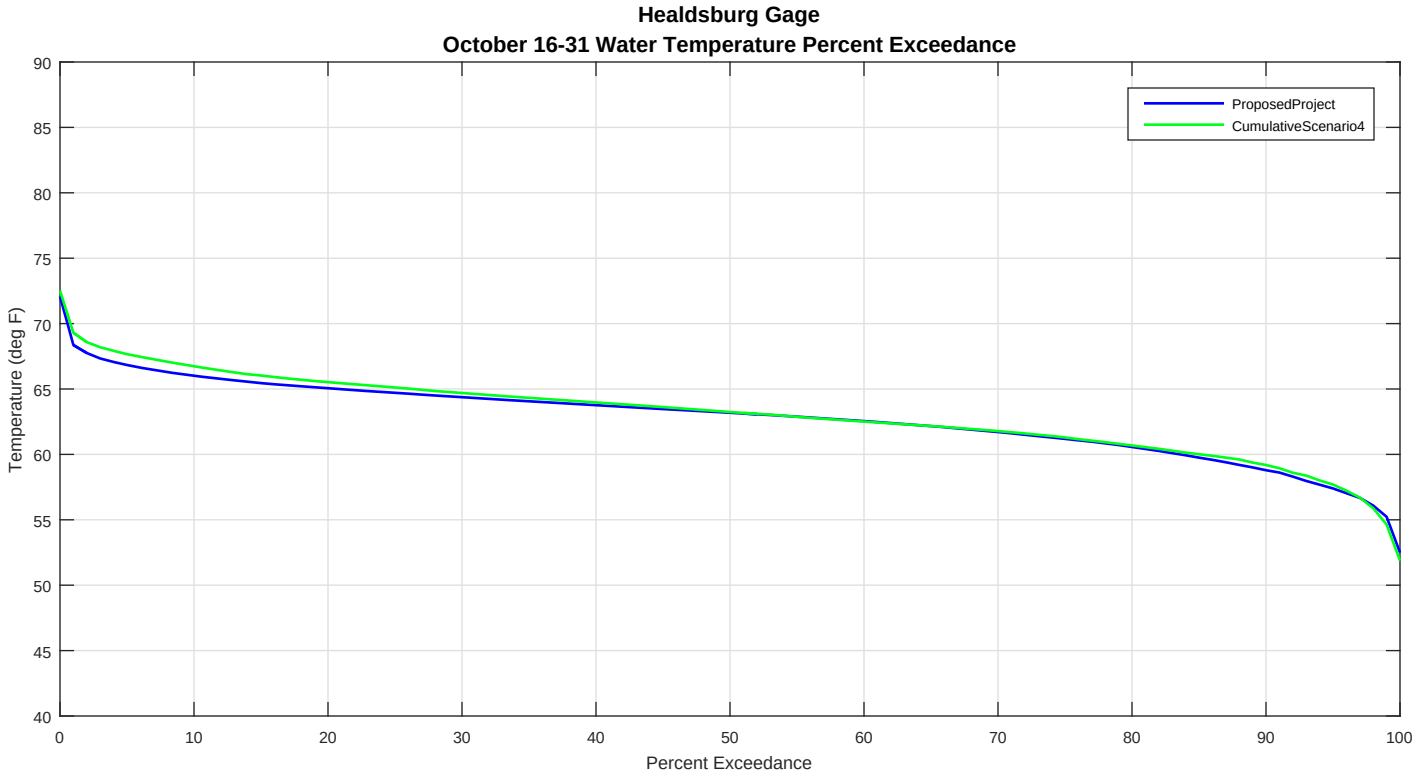
Healdsburg Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
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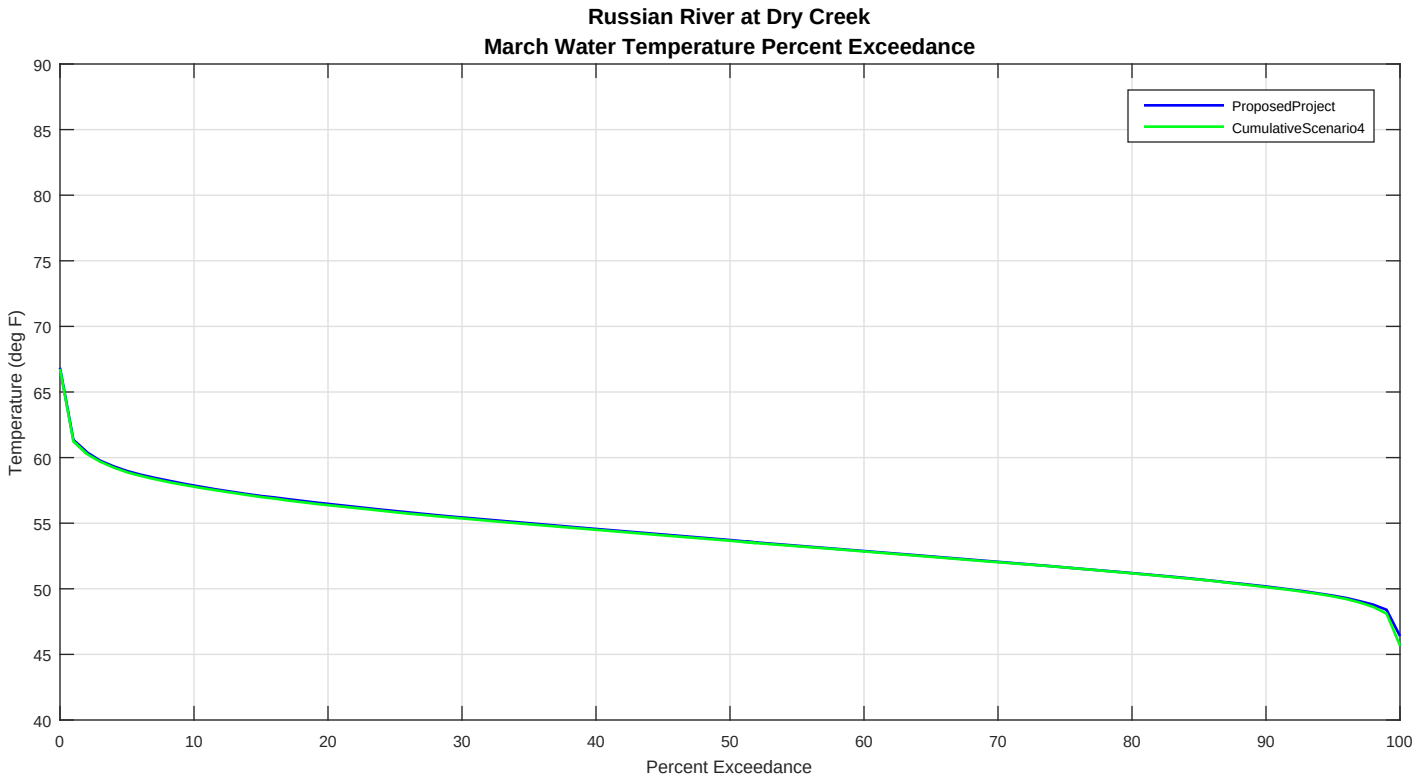
Russian River at Dry Creek
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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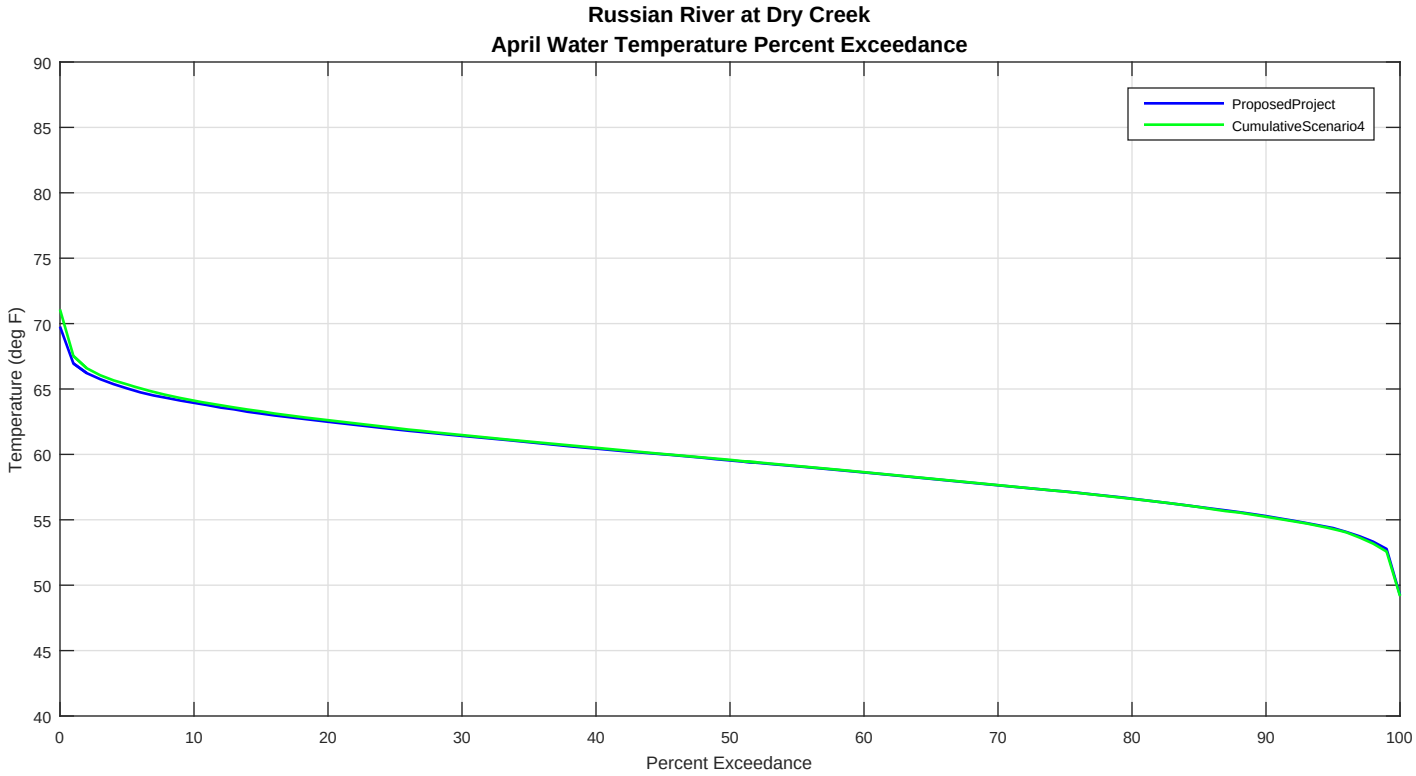
Russian River at Dry Creek
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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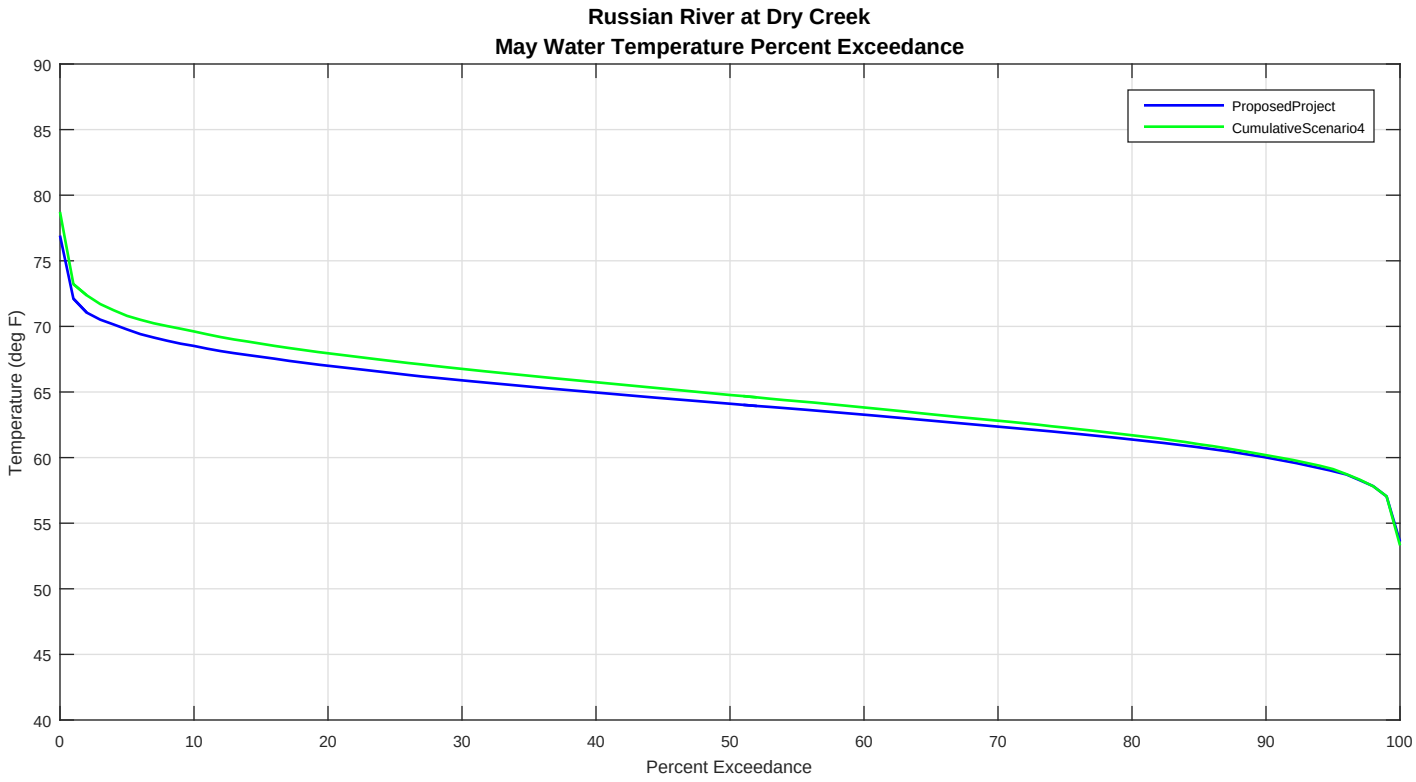
Russian River at Dry Creek
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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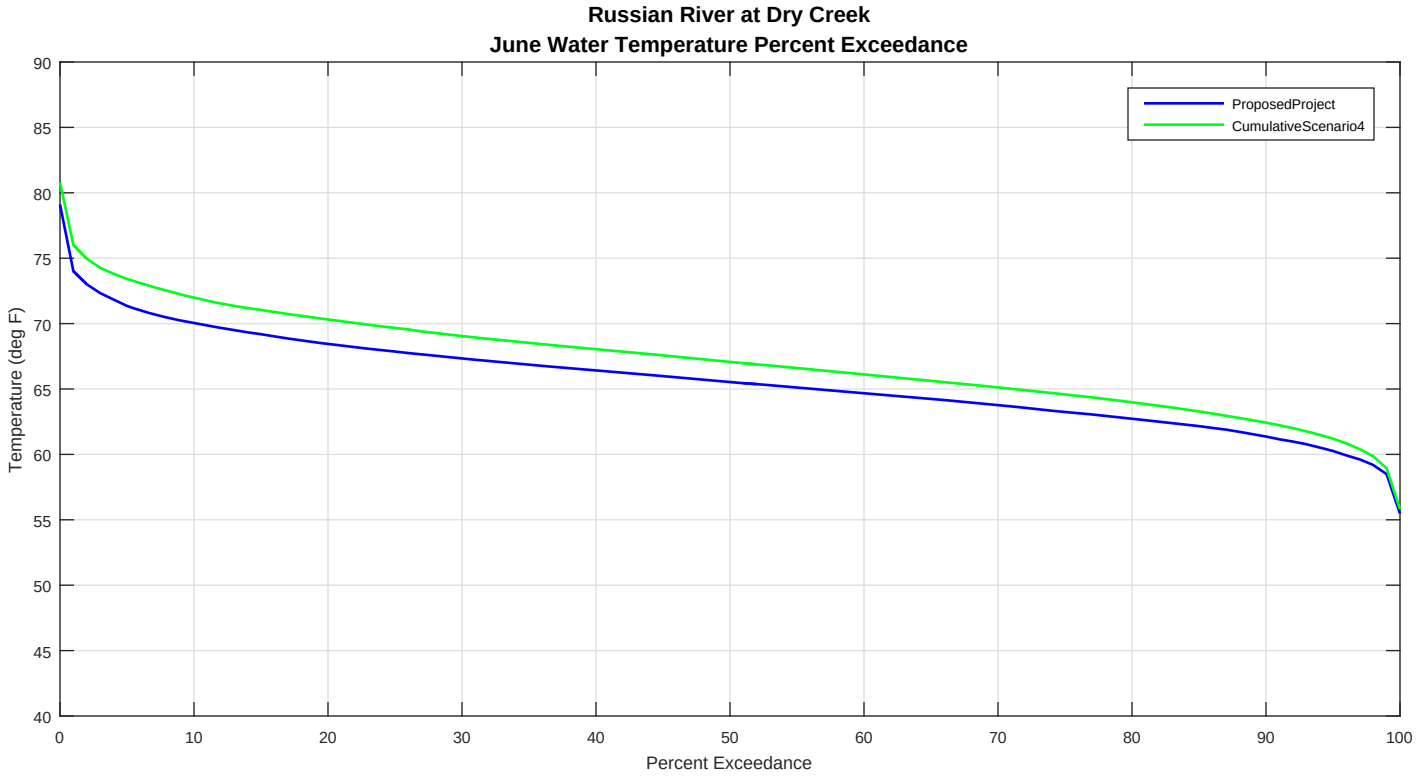
Russian River at Dry Creek
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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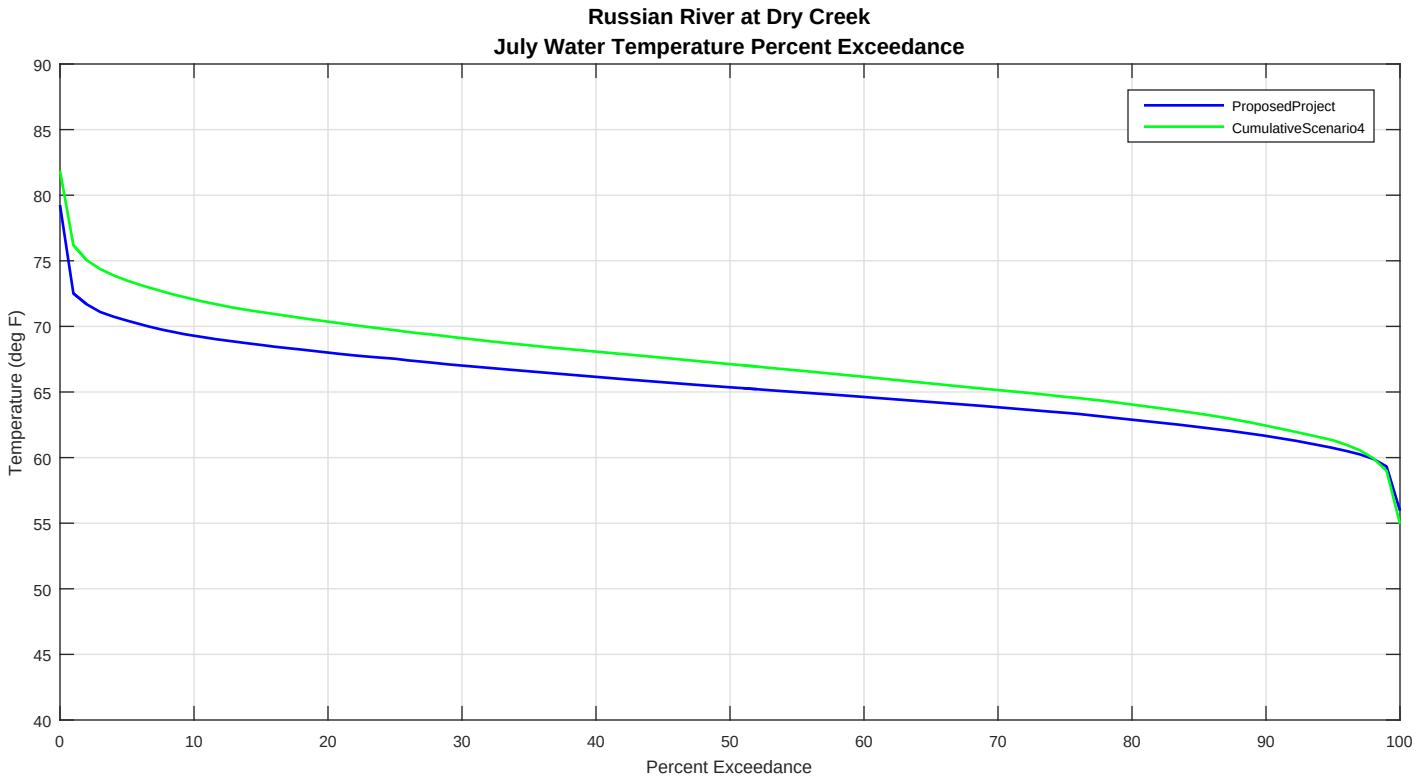
Russian River at Dry Creek
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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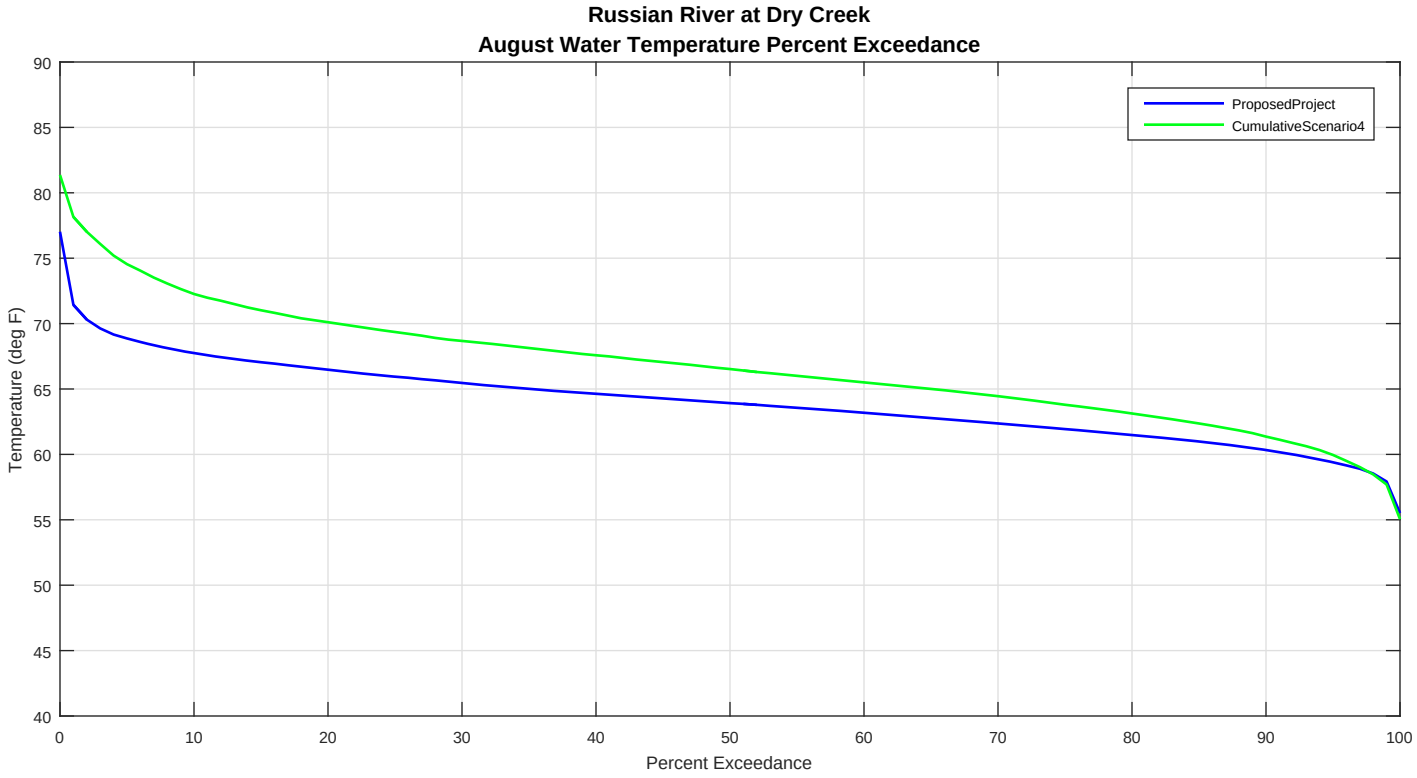
Russian River at Dry Creek
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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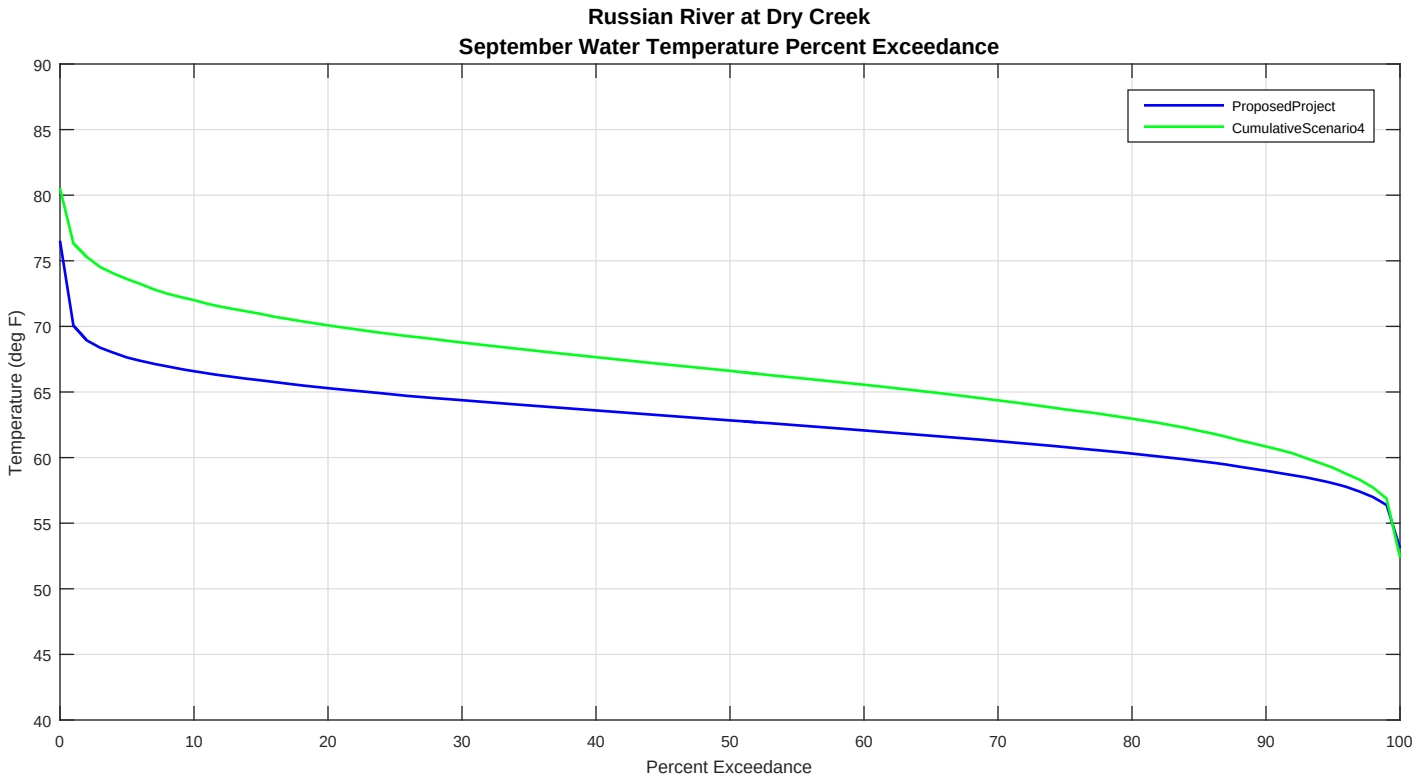
Russian River at Dry Creek
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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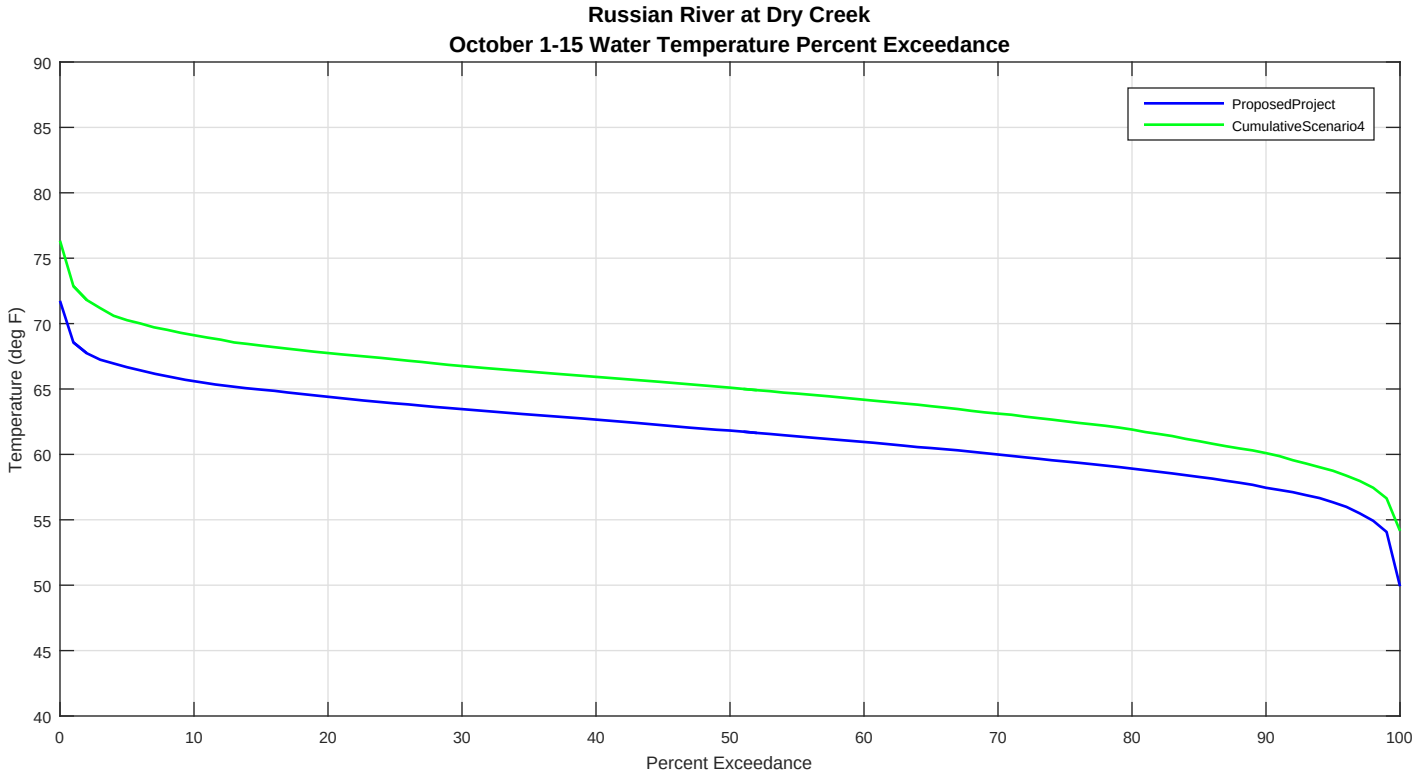
Russian River at Dry Creek
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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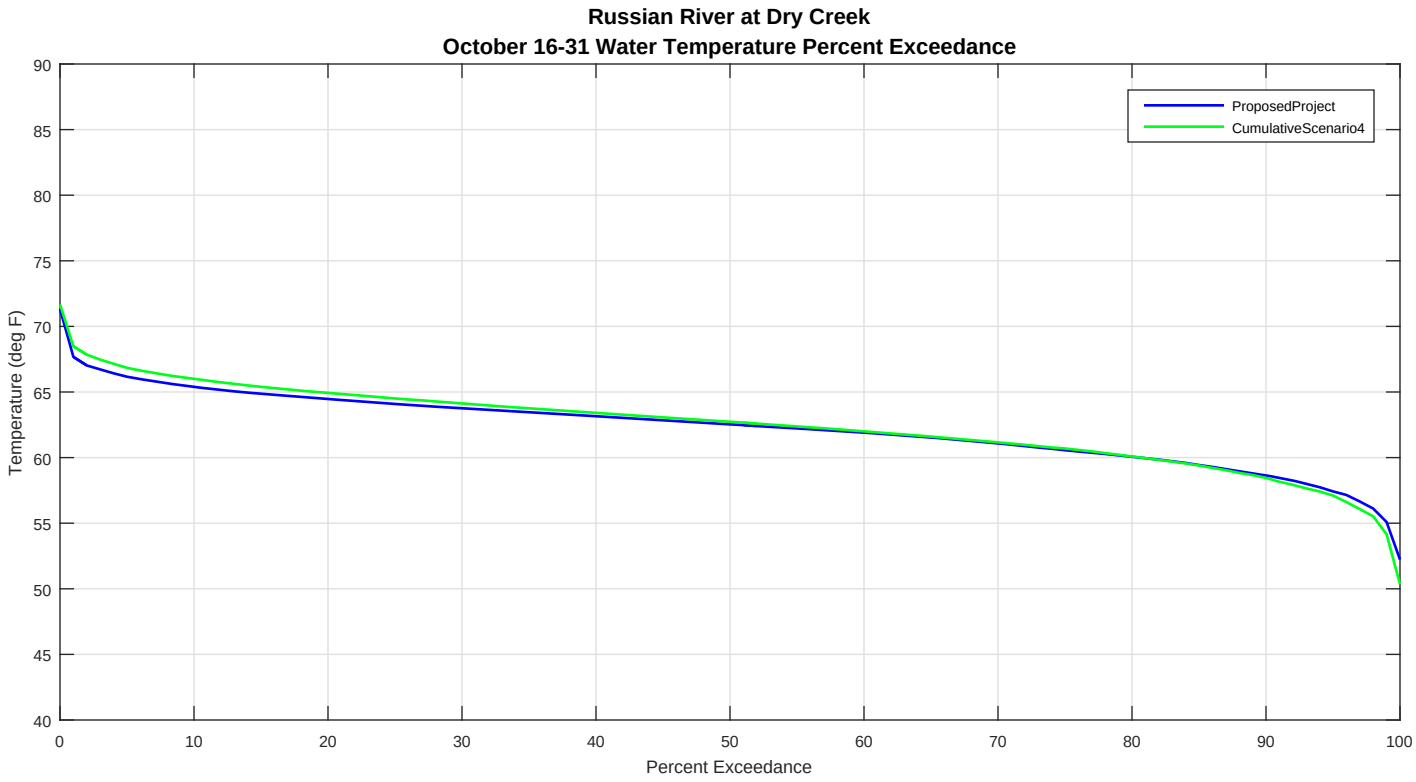
Russian River at Dry Creek
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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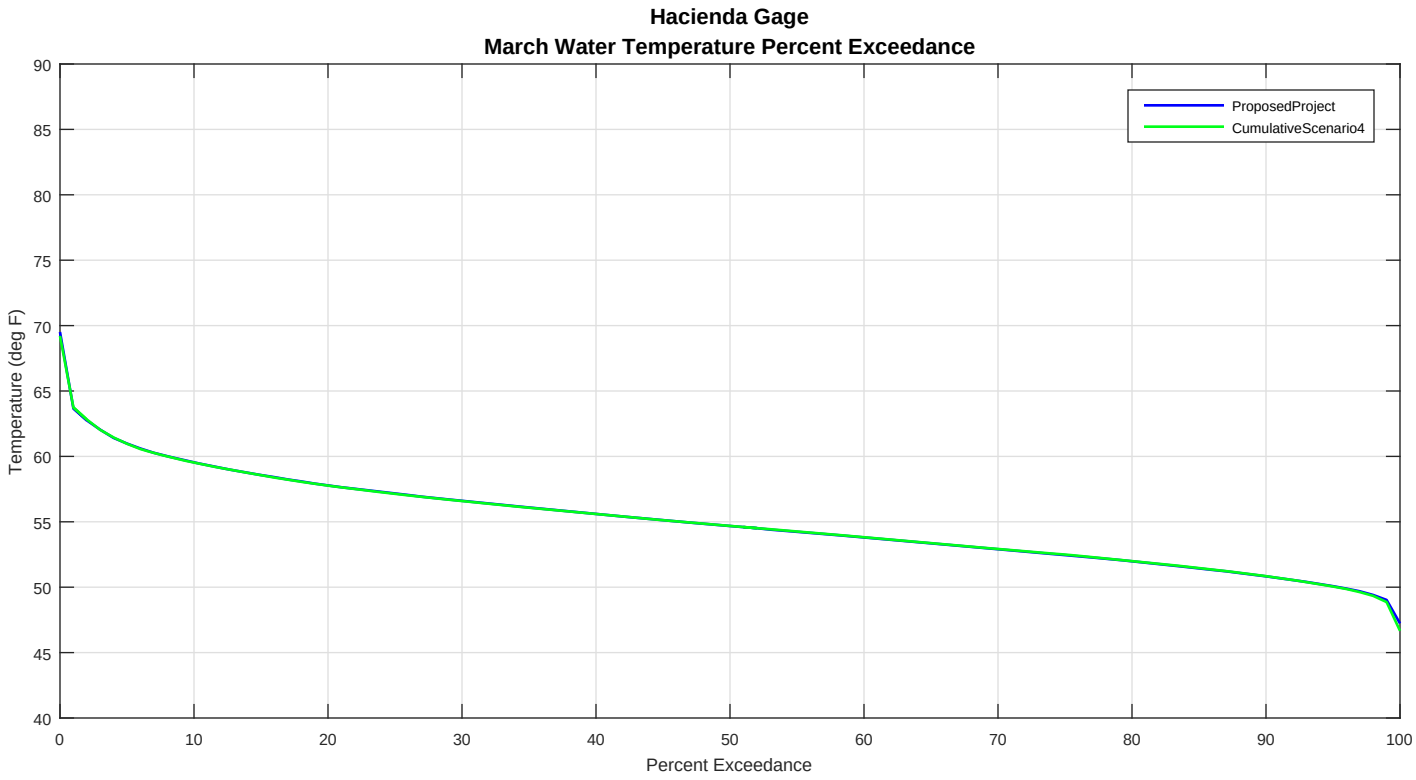
Hacienda Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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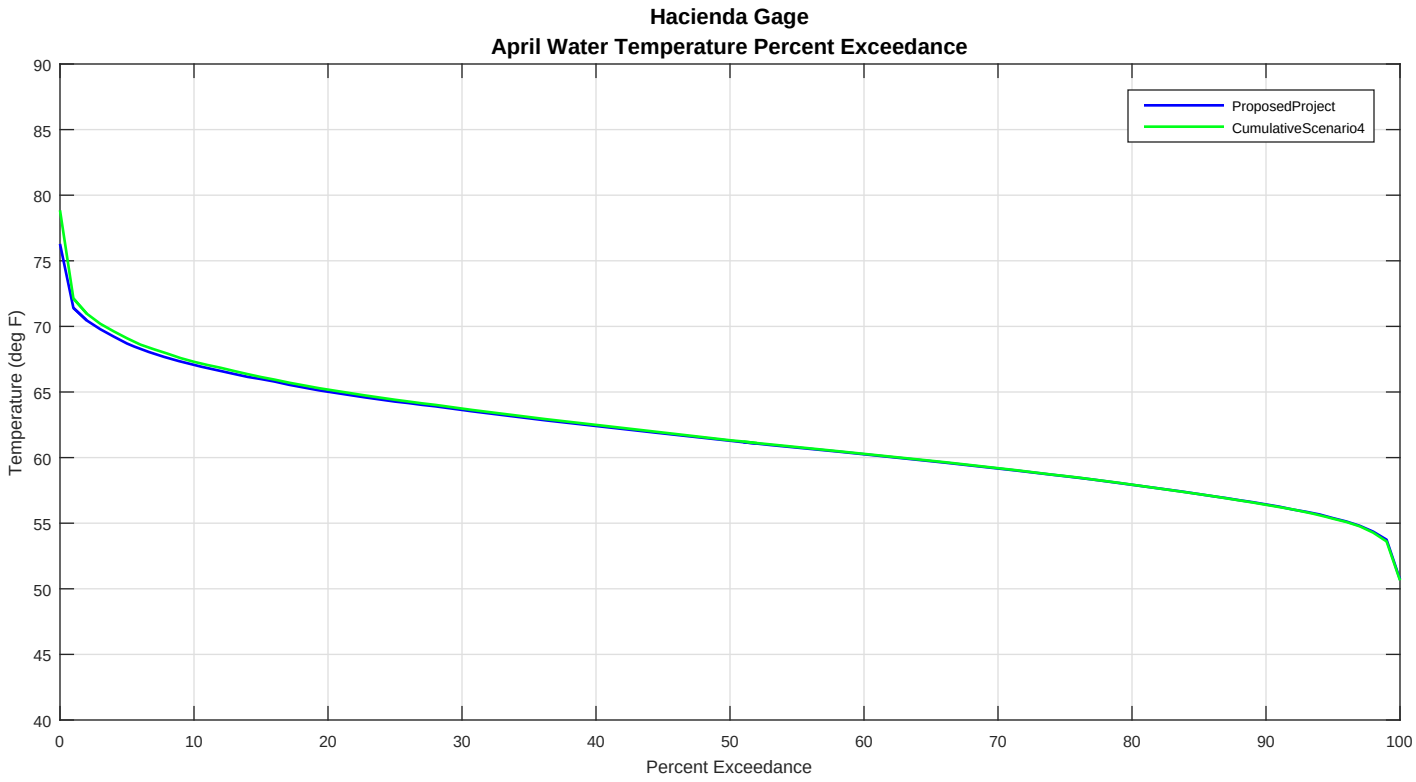
Hacienda Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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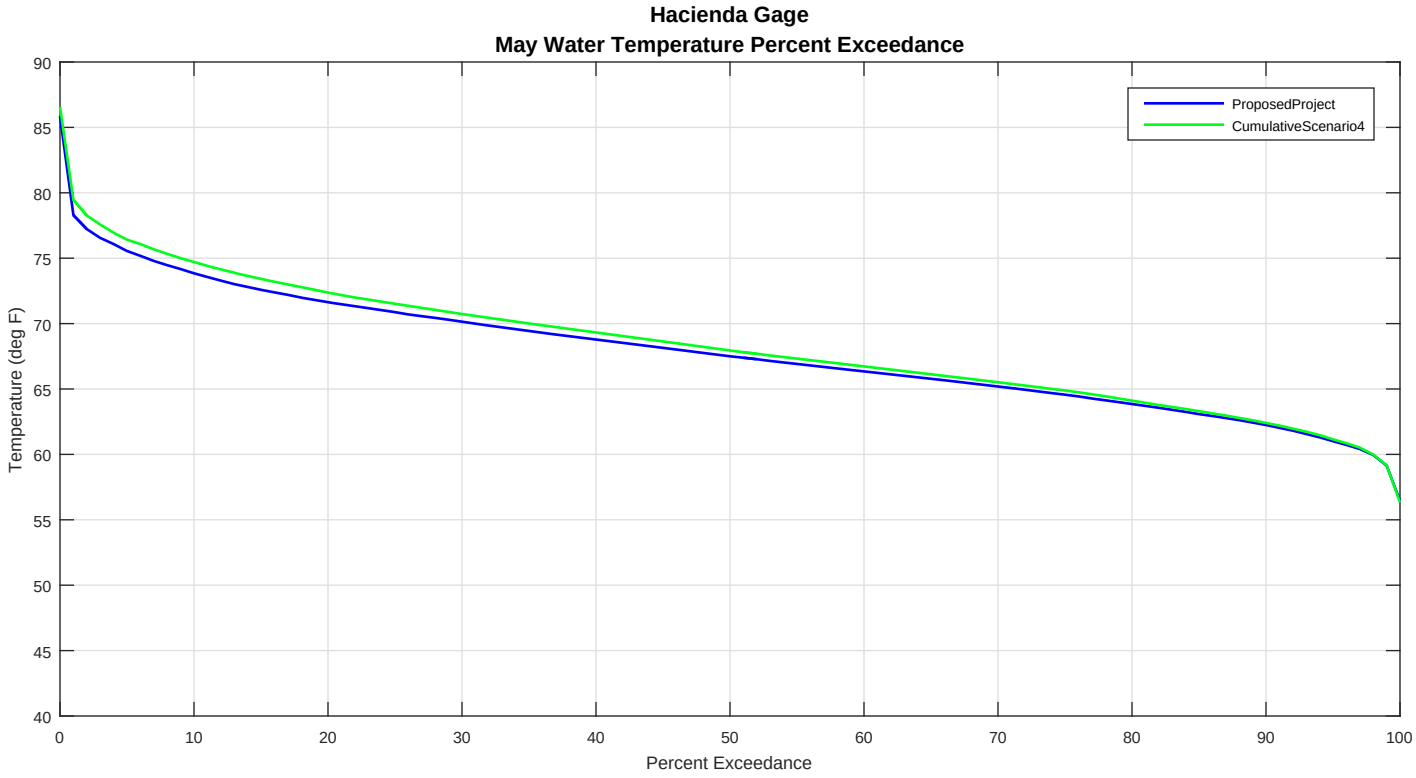
Hacienda Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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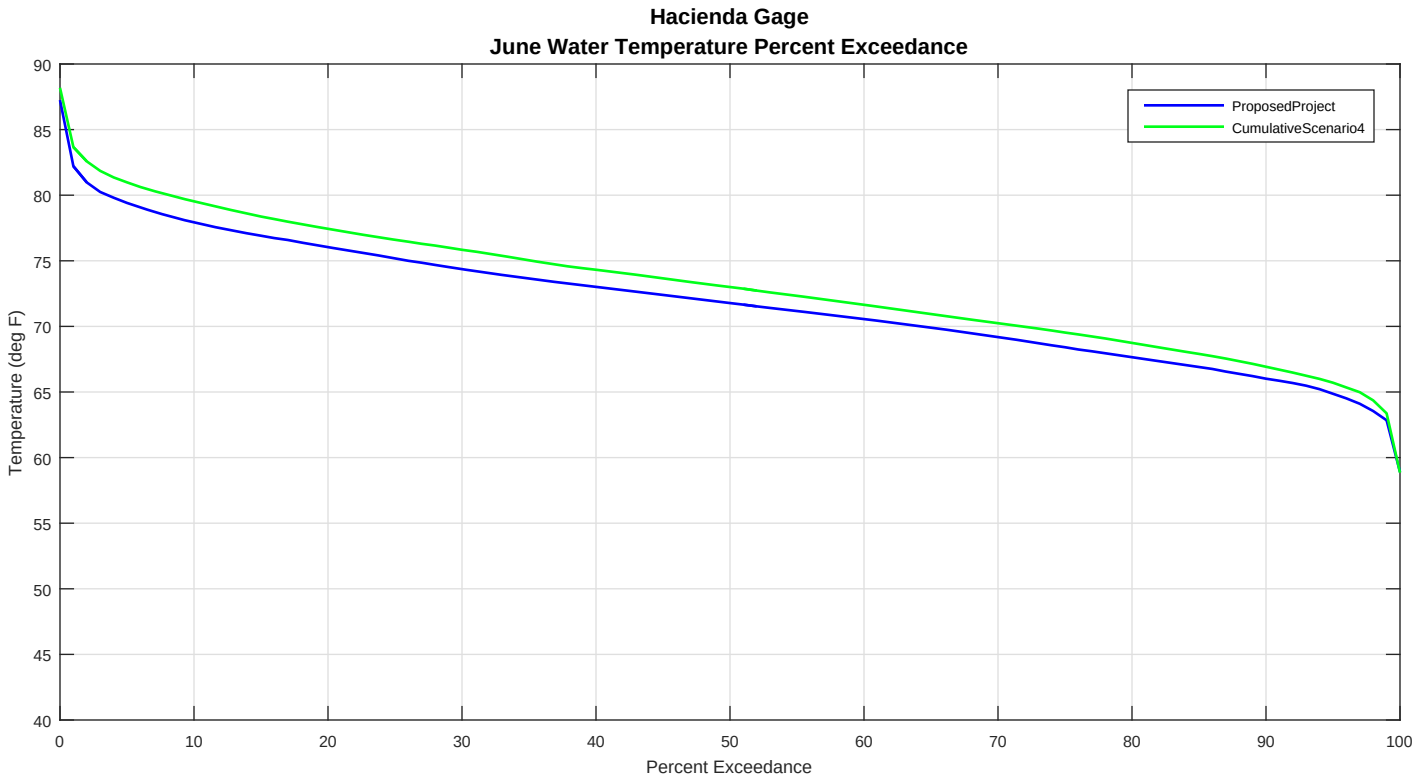
Hacienda Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
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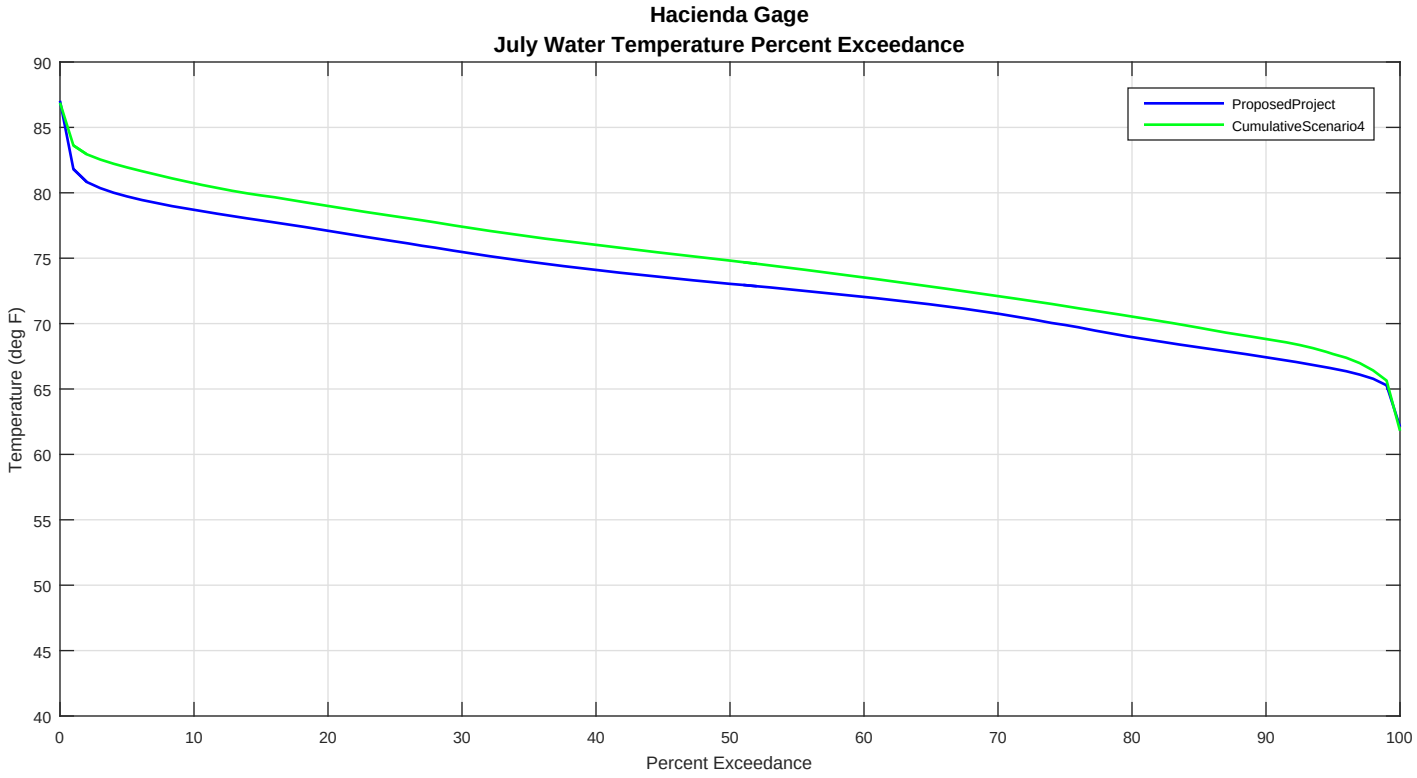
Hacienda Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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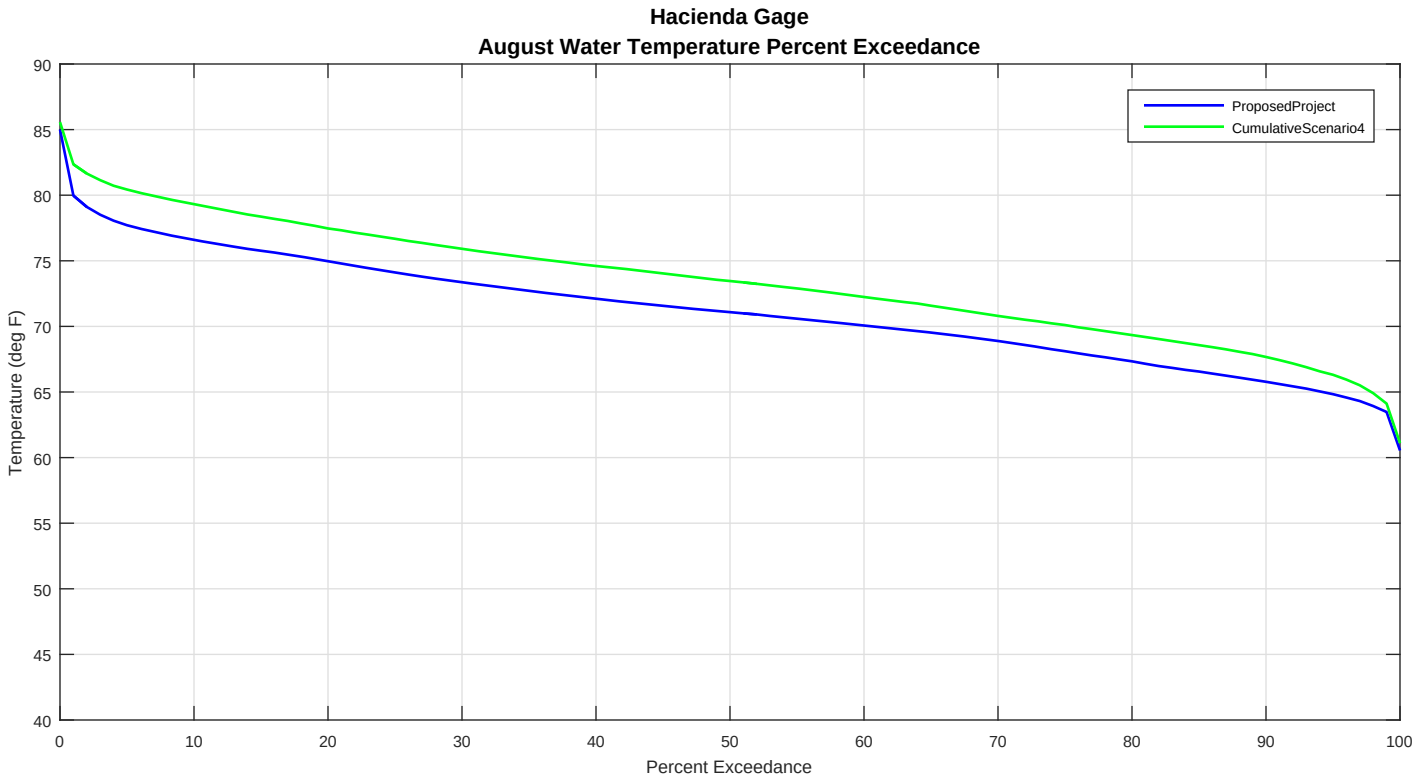
Hacienda Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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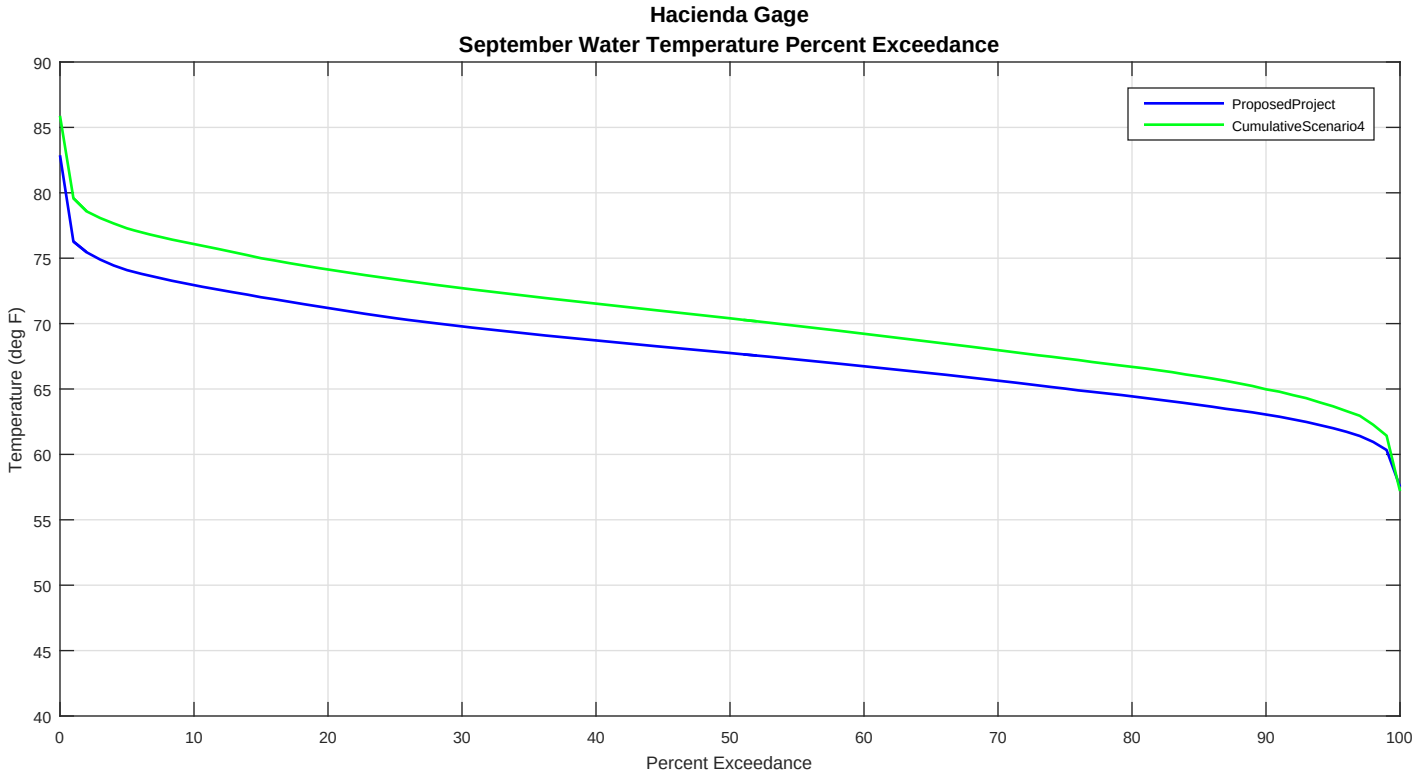
Hacienda Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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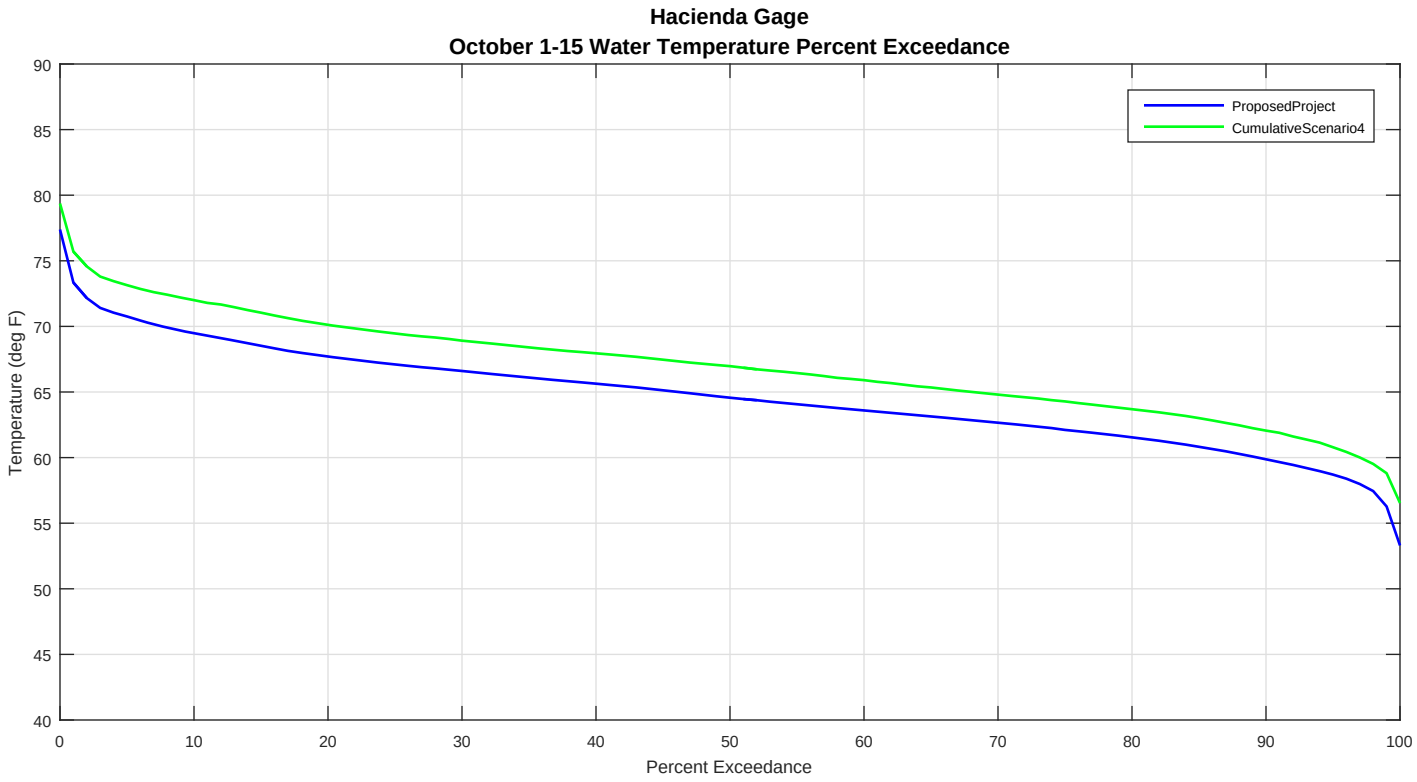
Hacienda Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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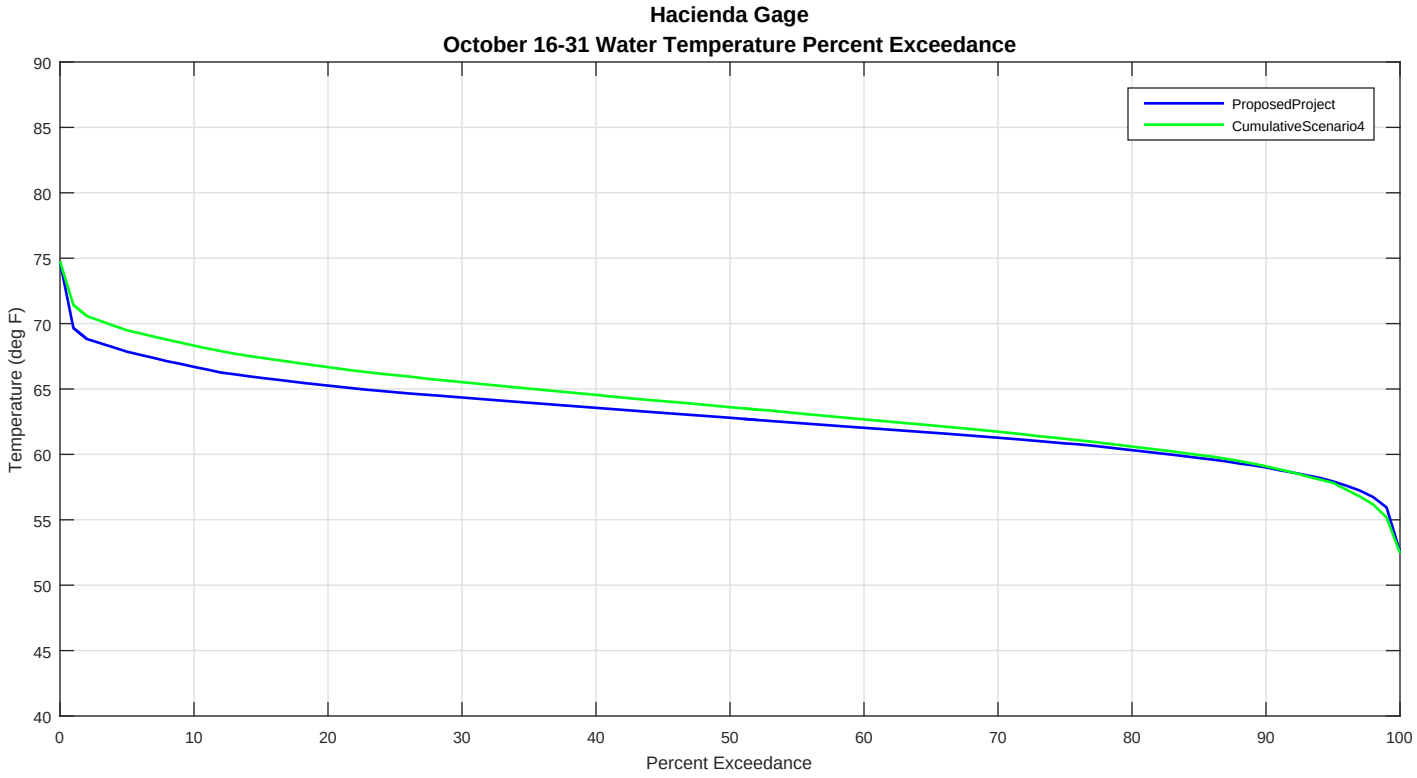
Hacienda Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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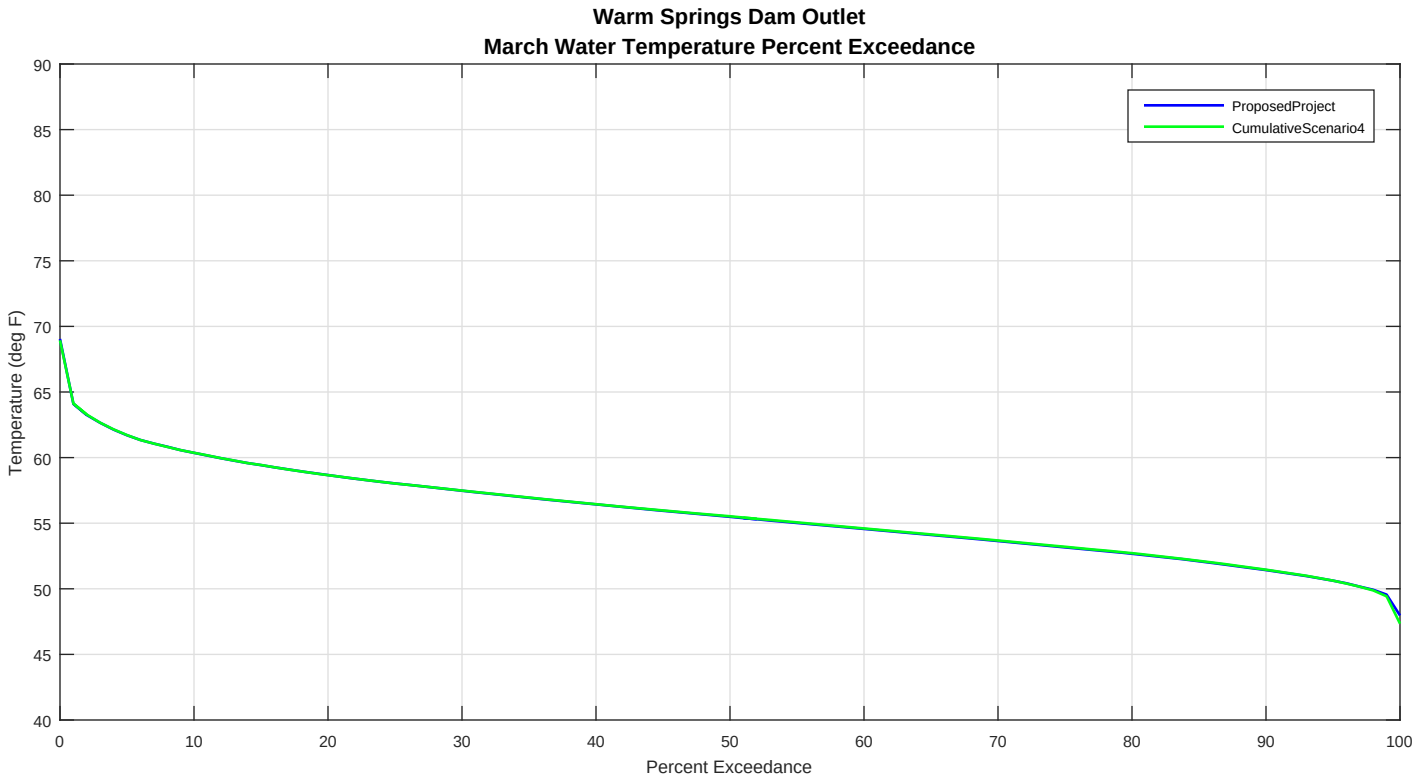
Warm Springs Dam Outlet
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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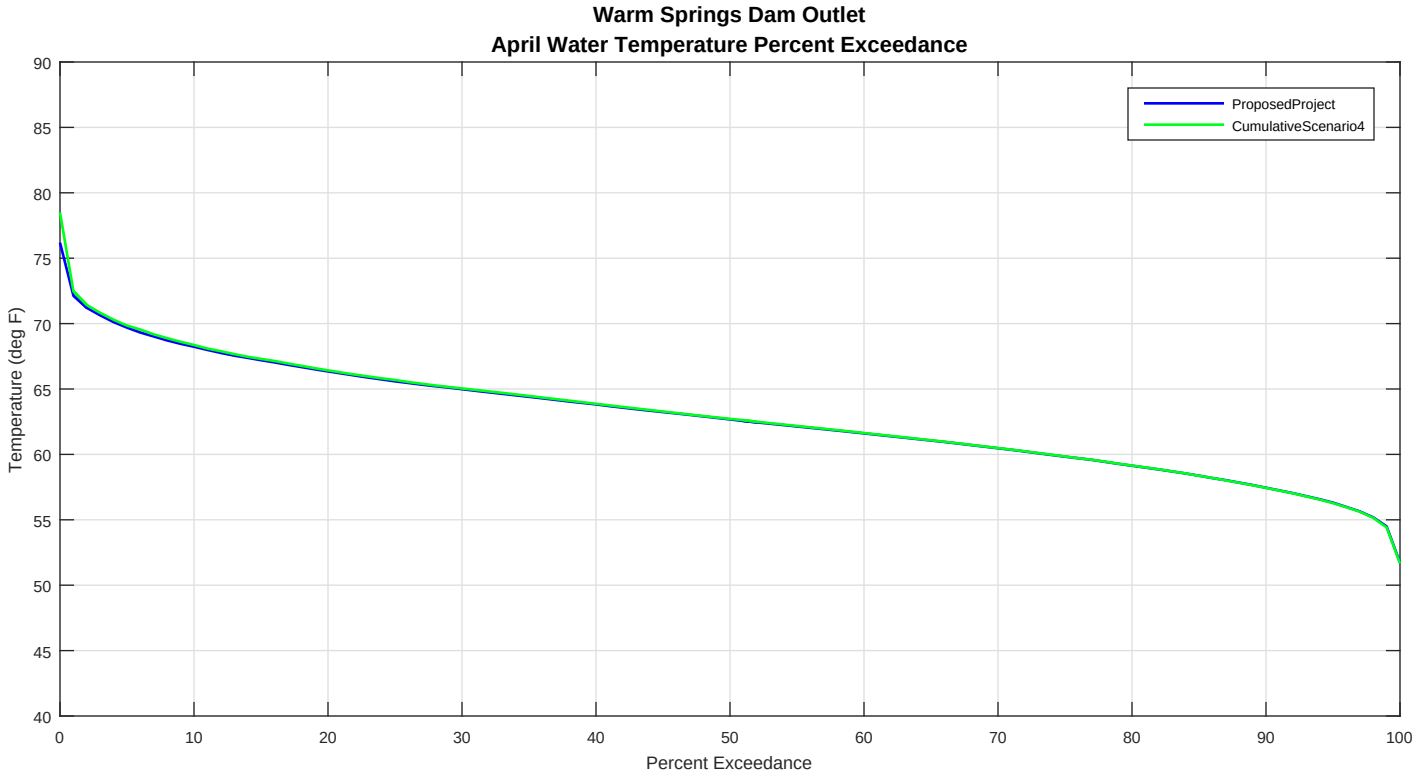
Warm Springs Dam Outlet
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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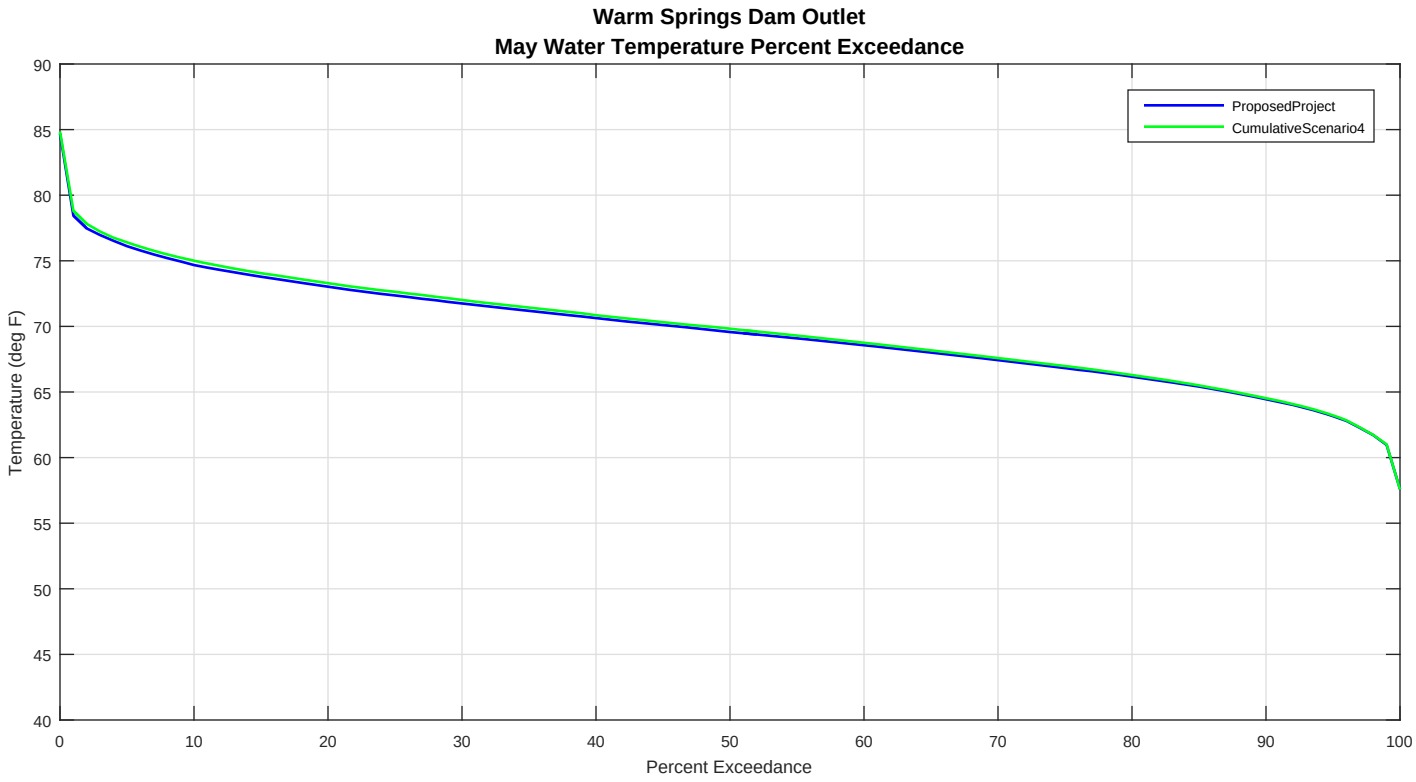
Warm Springs Dam Outlet
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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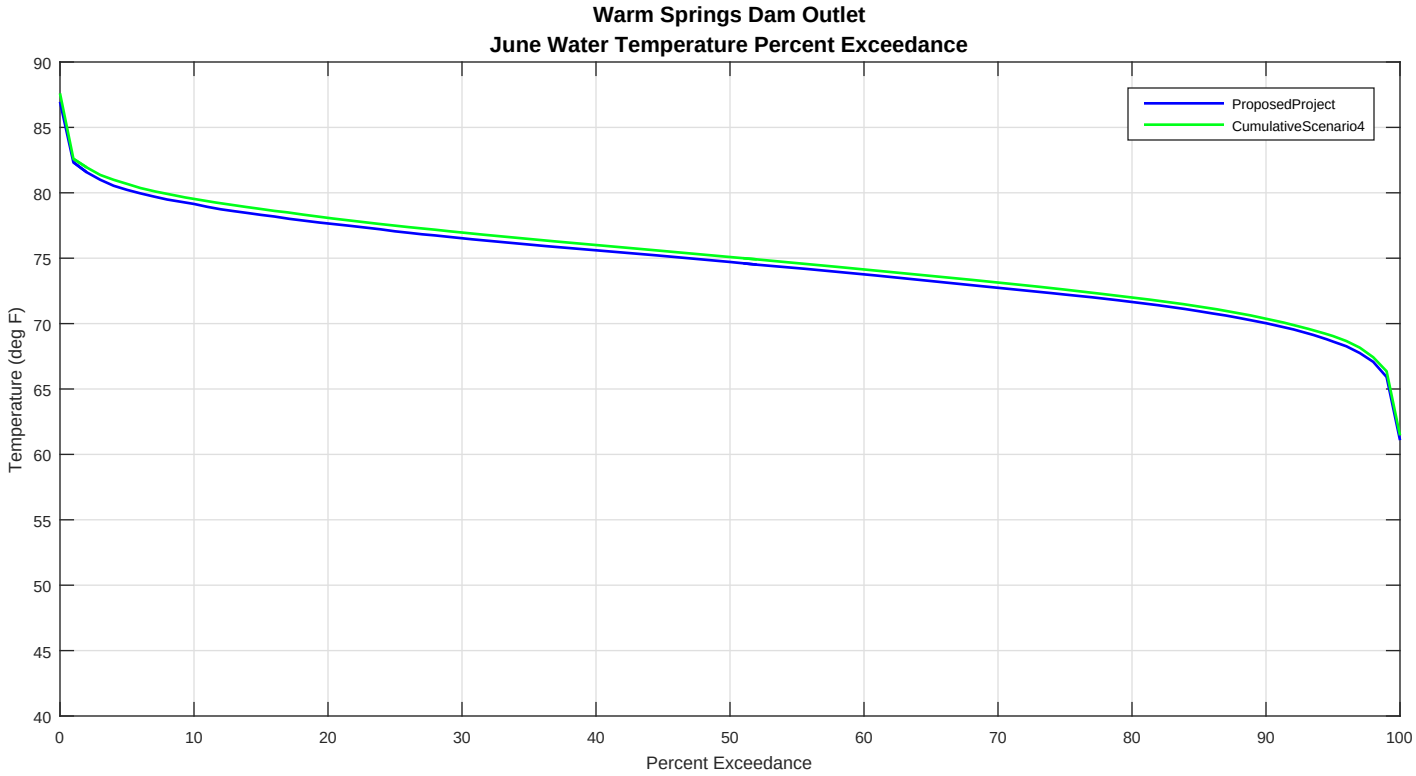
Warm Springs Dam Outlet
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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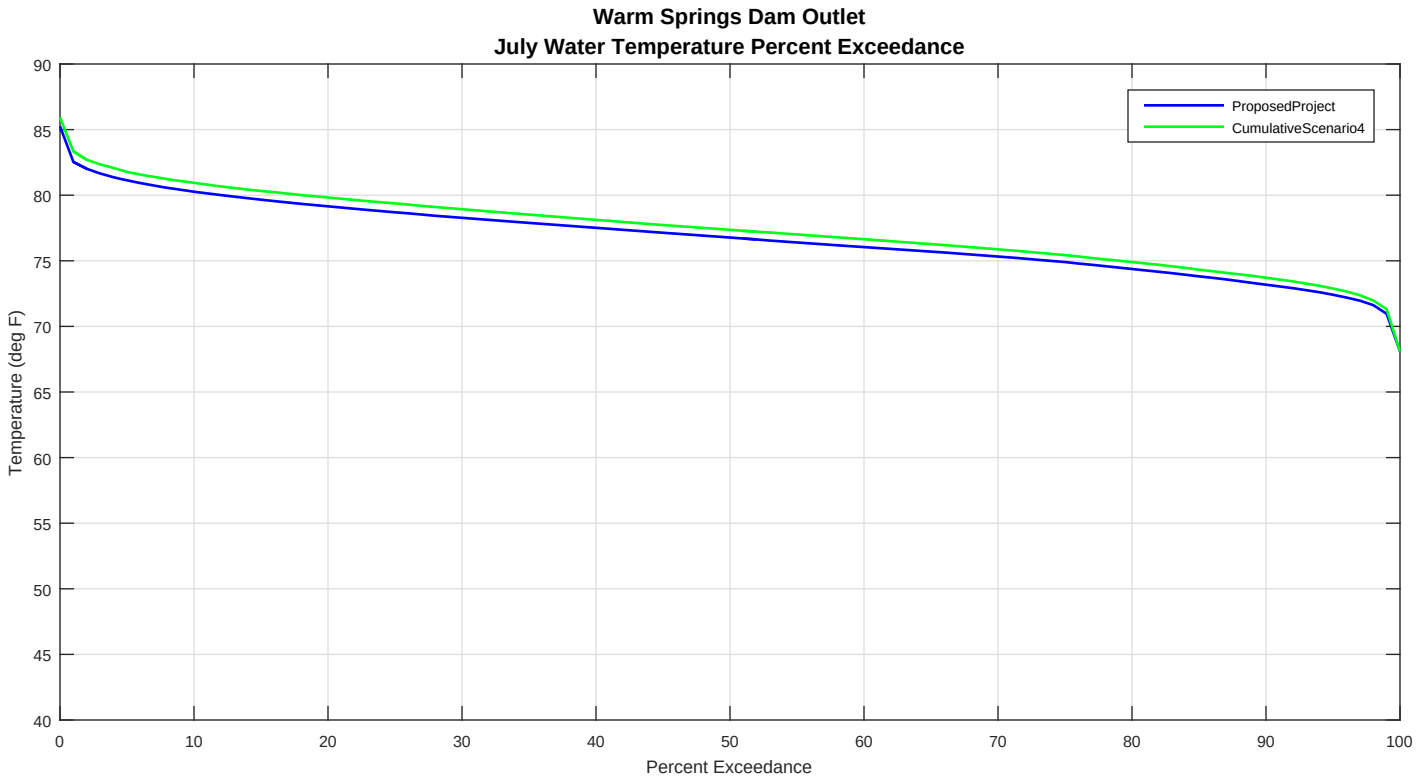
Warm Springs Dam Outlet
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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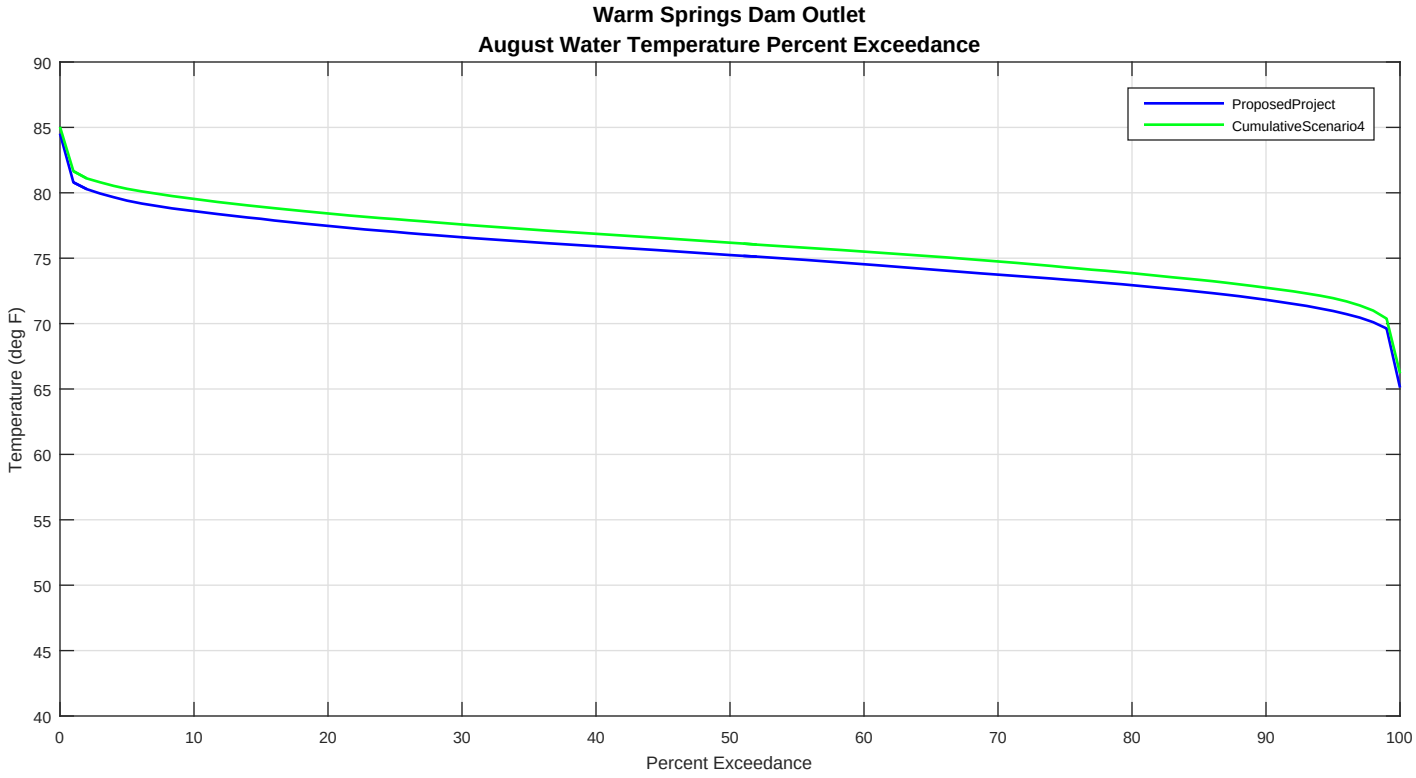
Warm Springs Dam Outlet
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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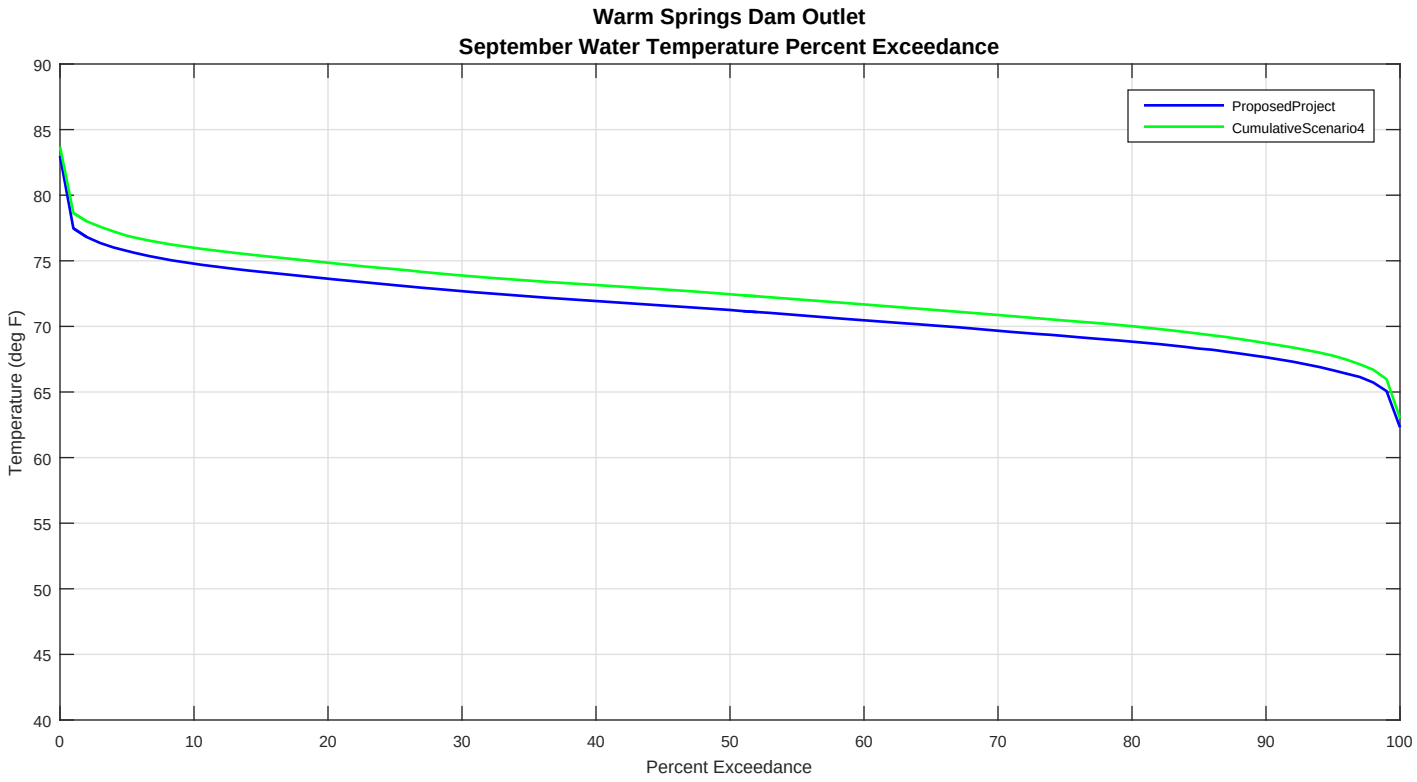
Warm Springs Dam Outlet
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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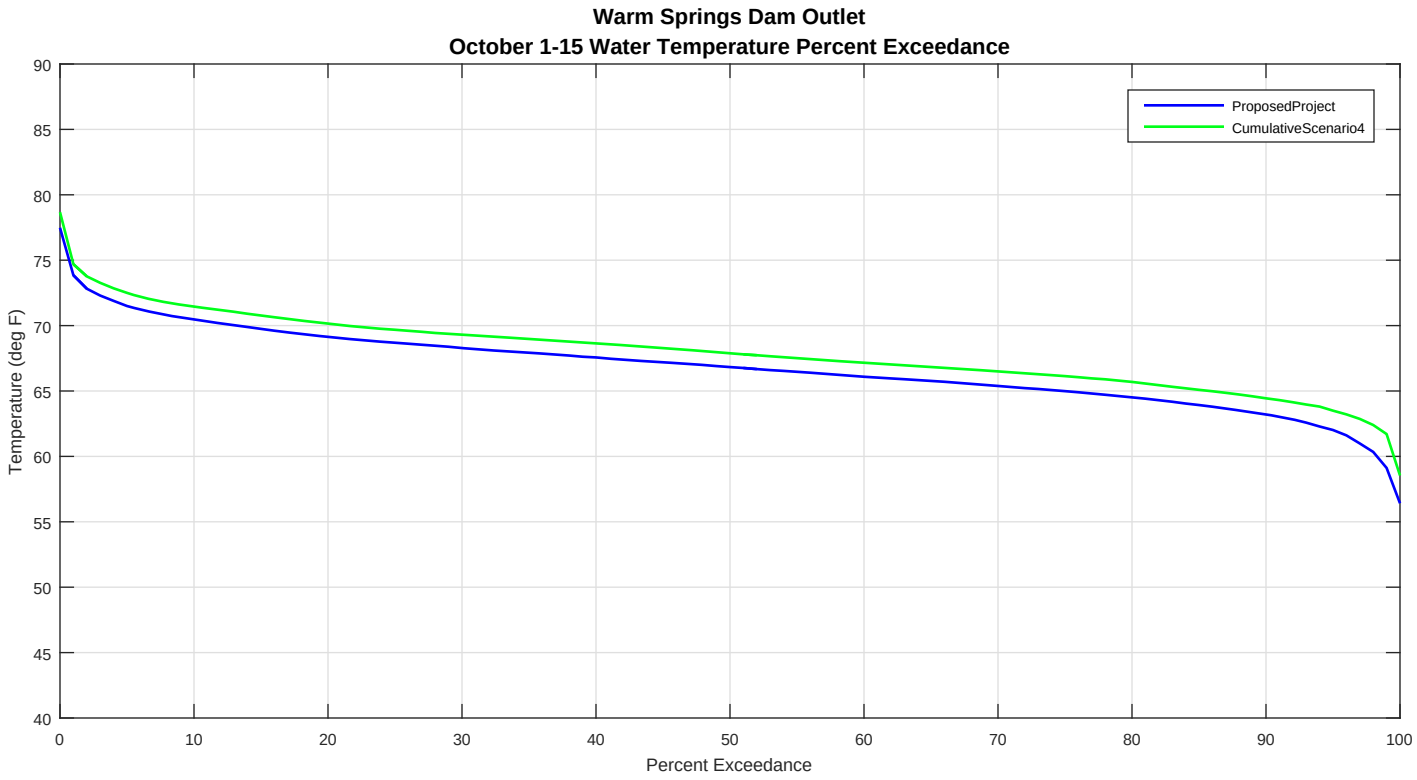
Warm Springs Dam Outlet
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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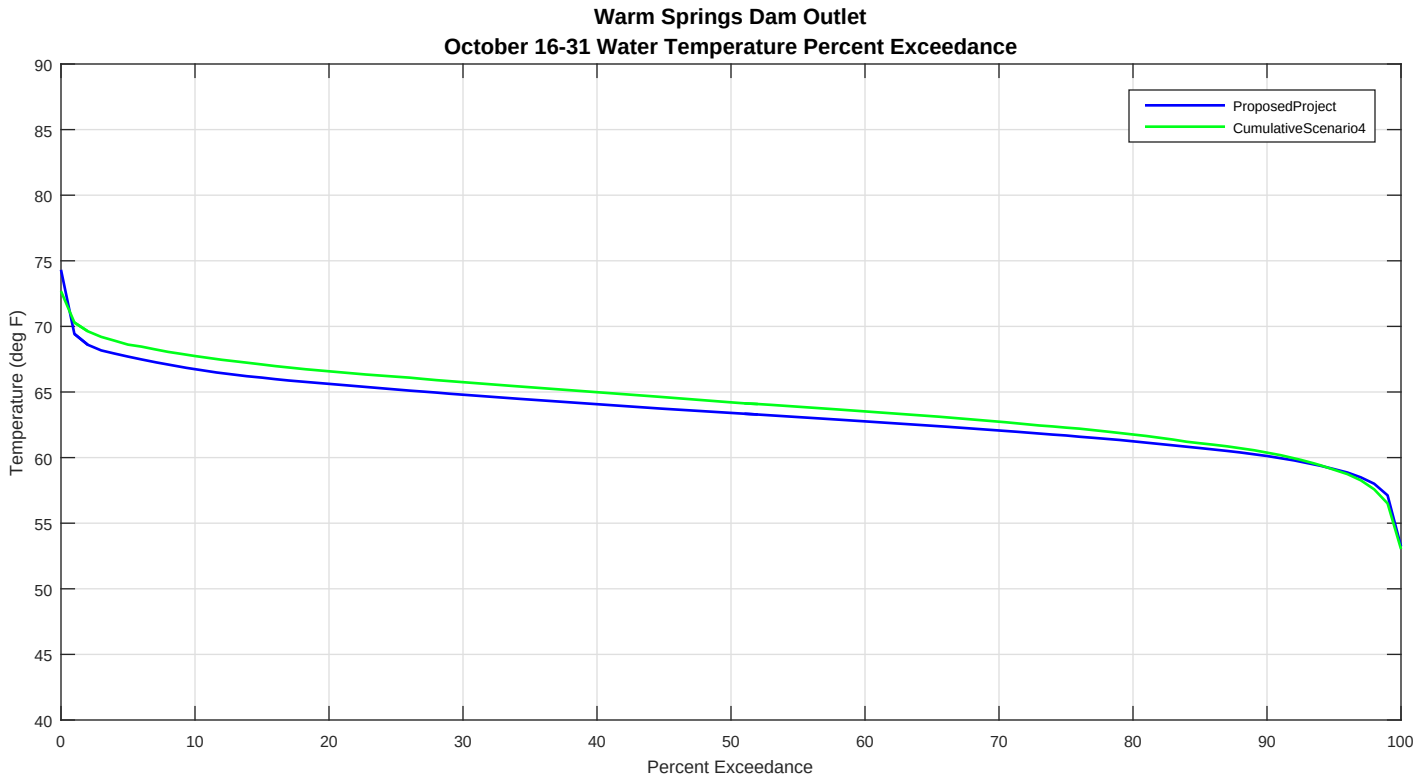
Warm Springs Dam Outlet
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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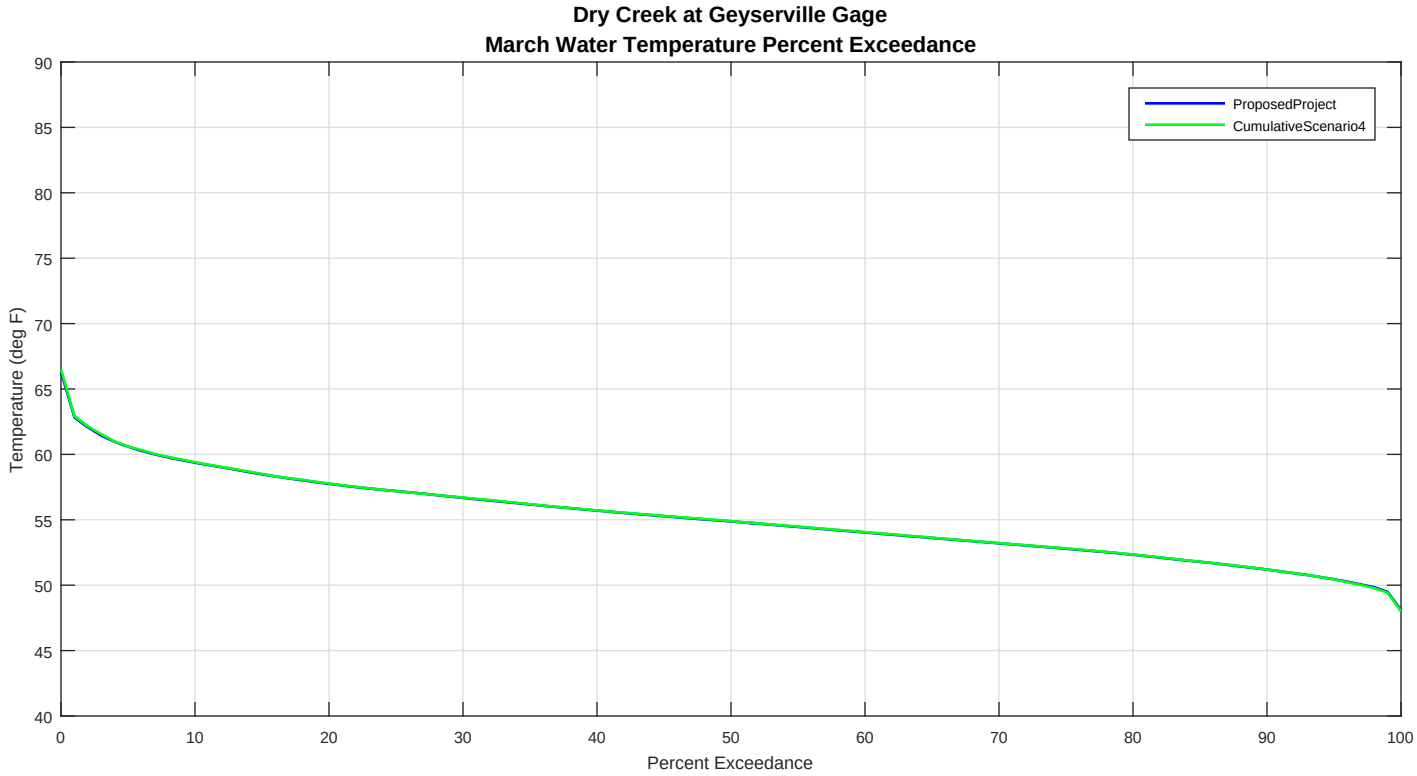
Dry Creek at Geyserville Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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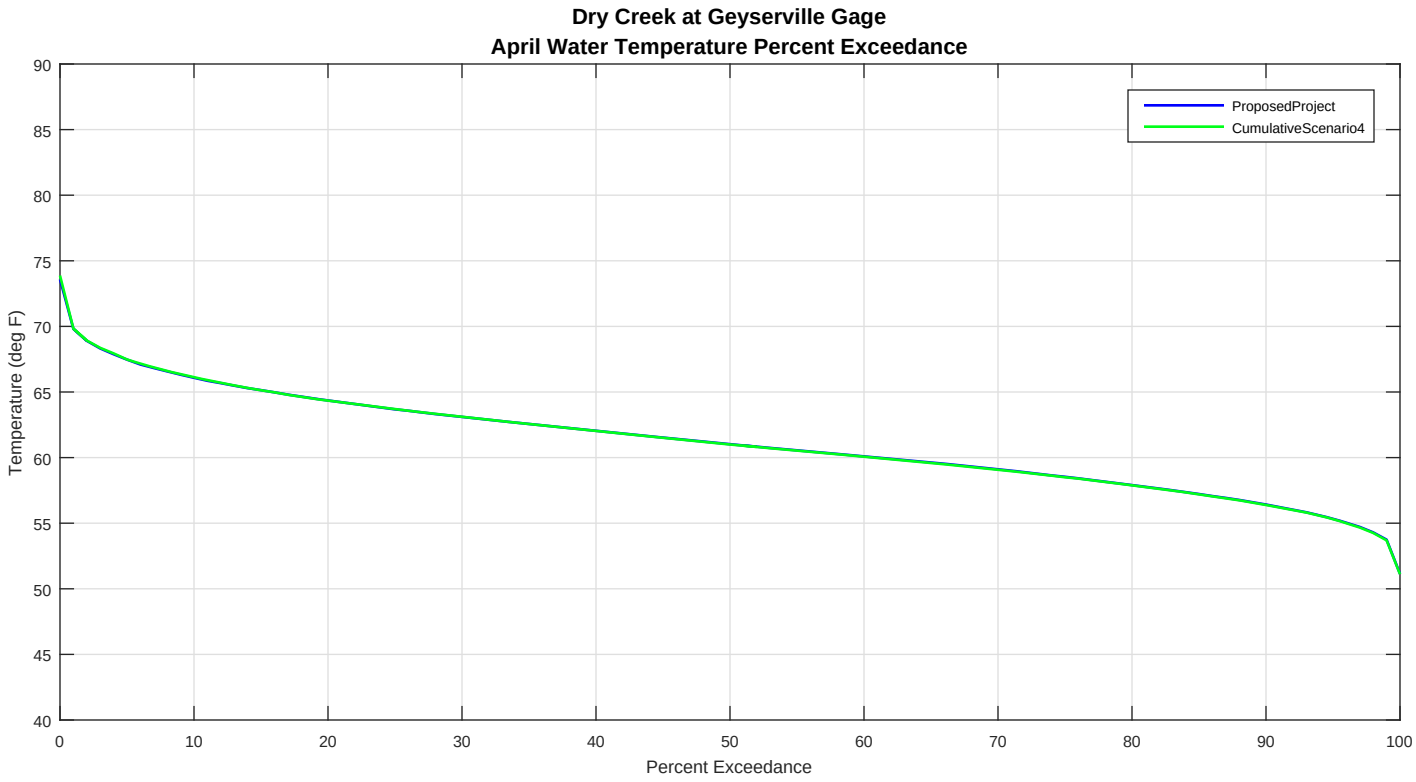
Dry Creek at Geyserville Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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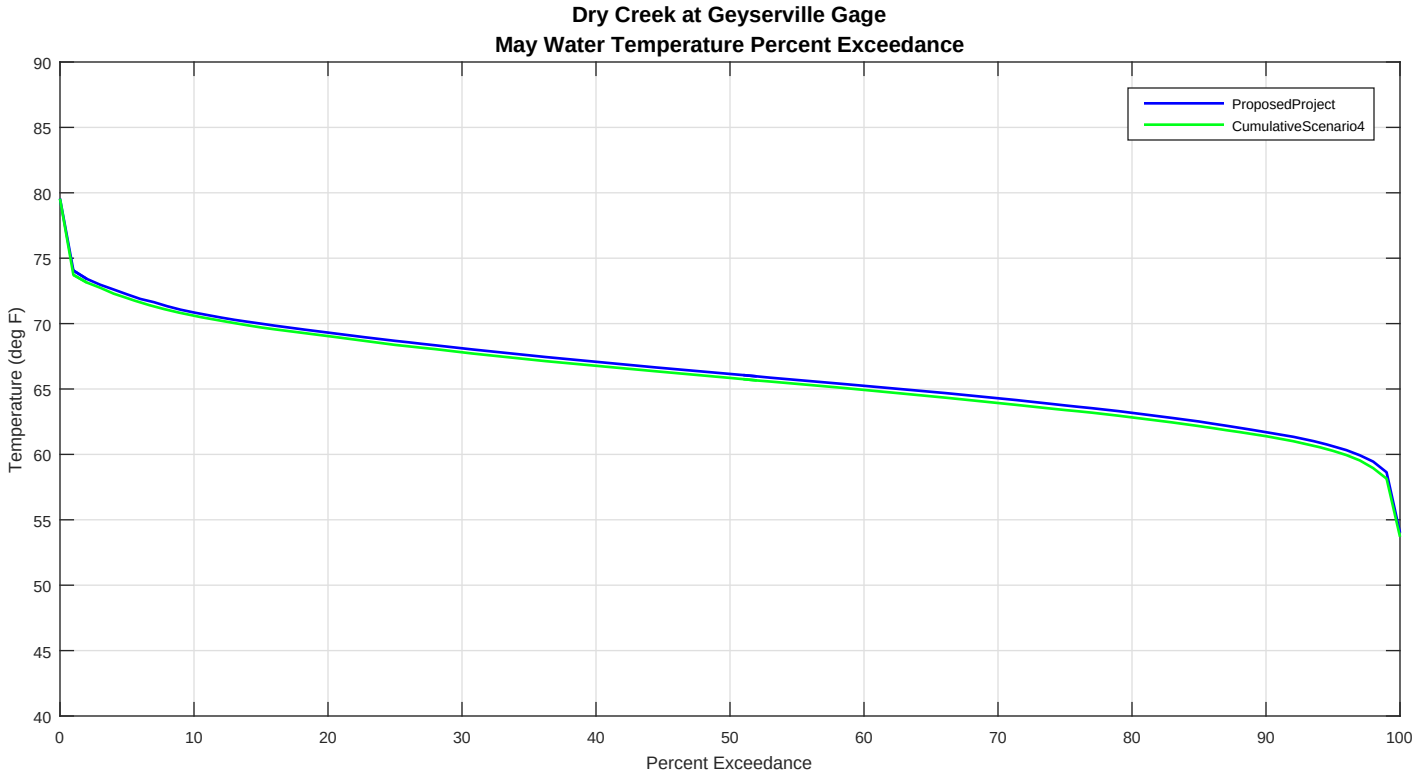
Dry Creek at Geyserville Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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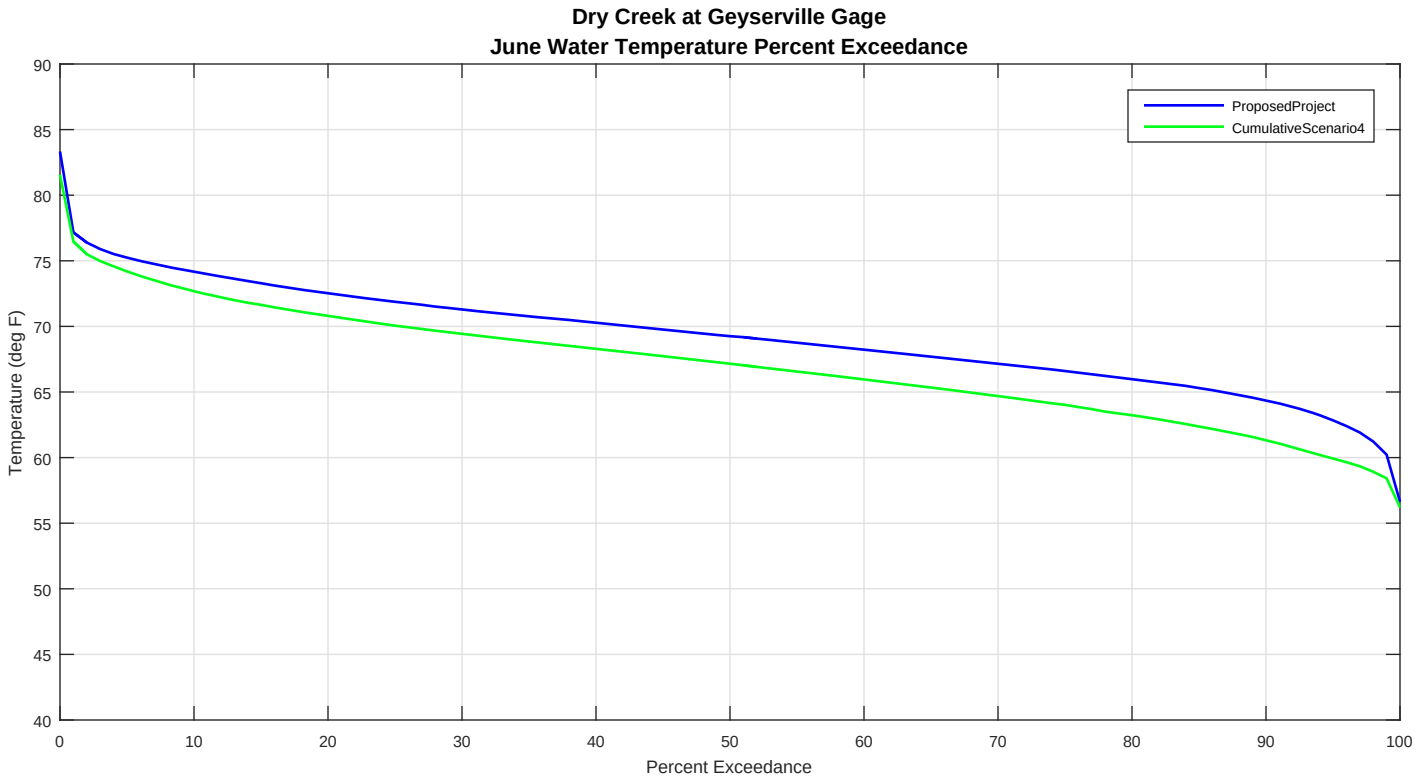
Dry Creek at Geyserville Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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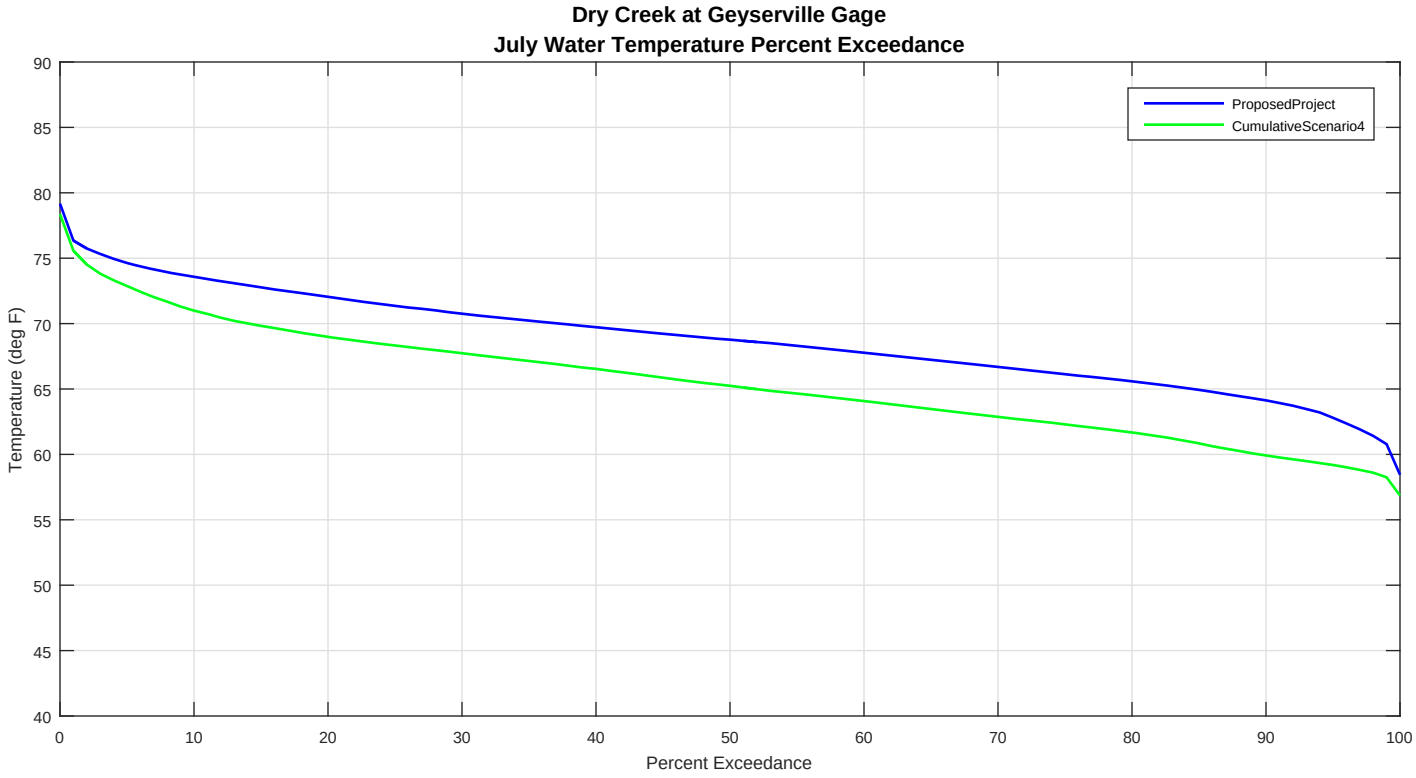
Dry Creek at Geyserville Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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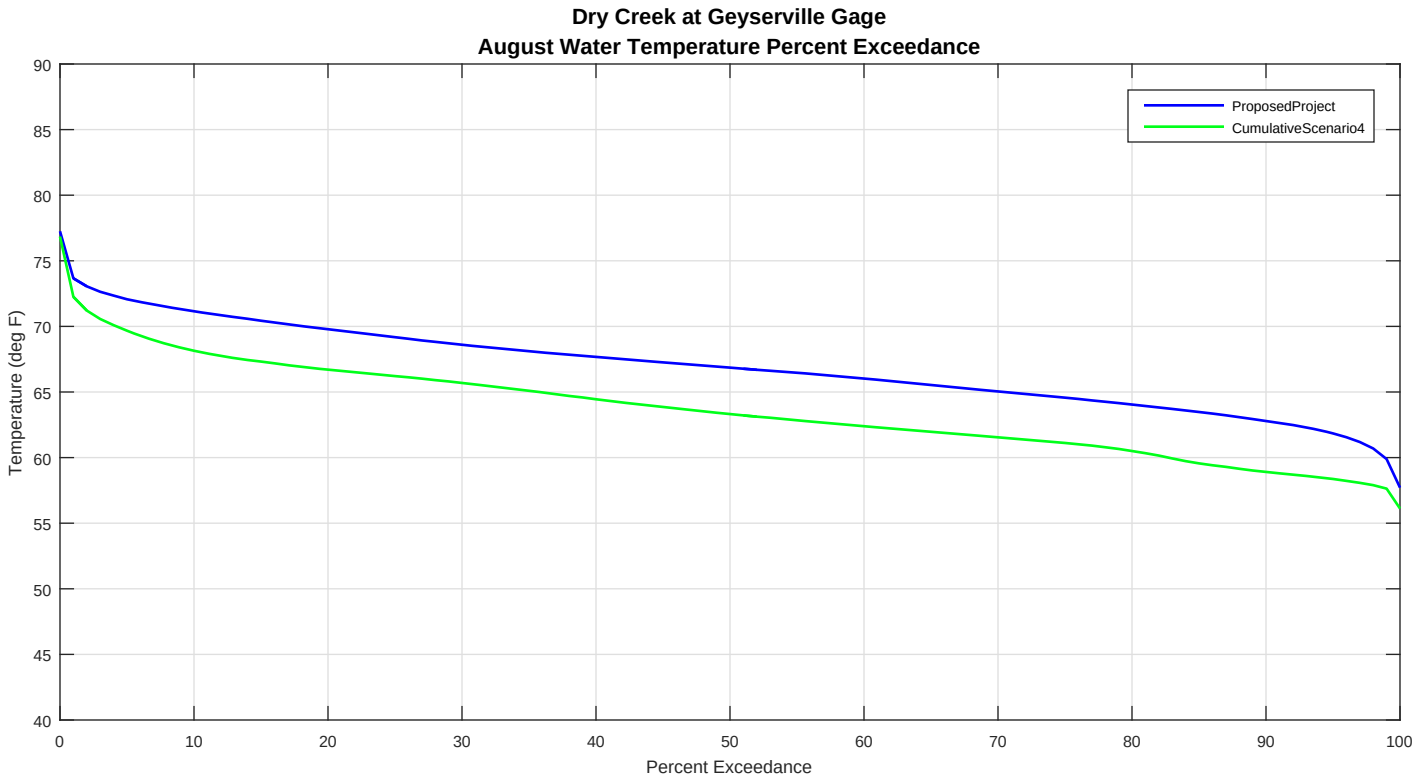
Dry Creek at Geyserville Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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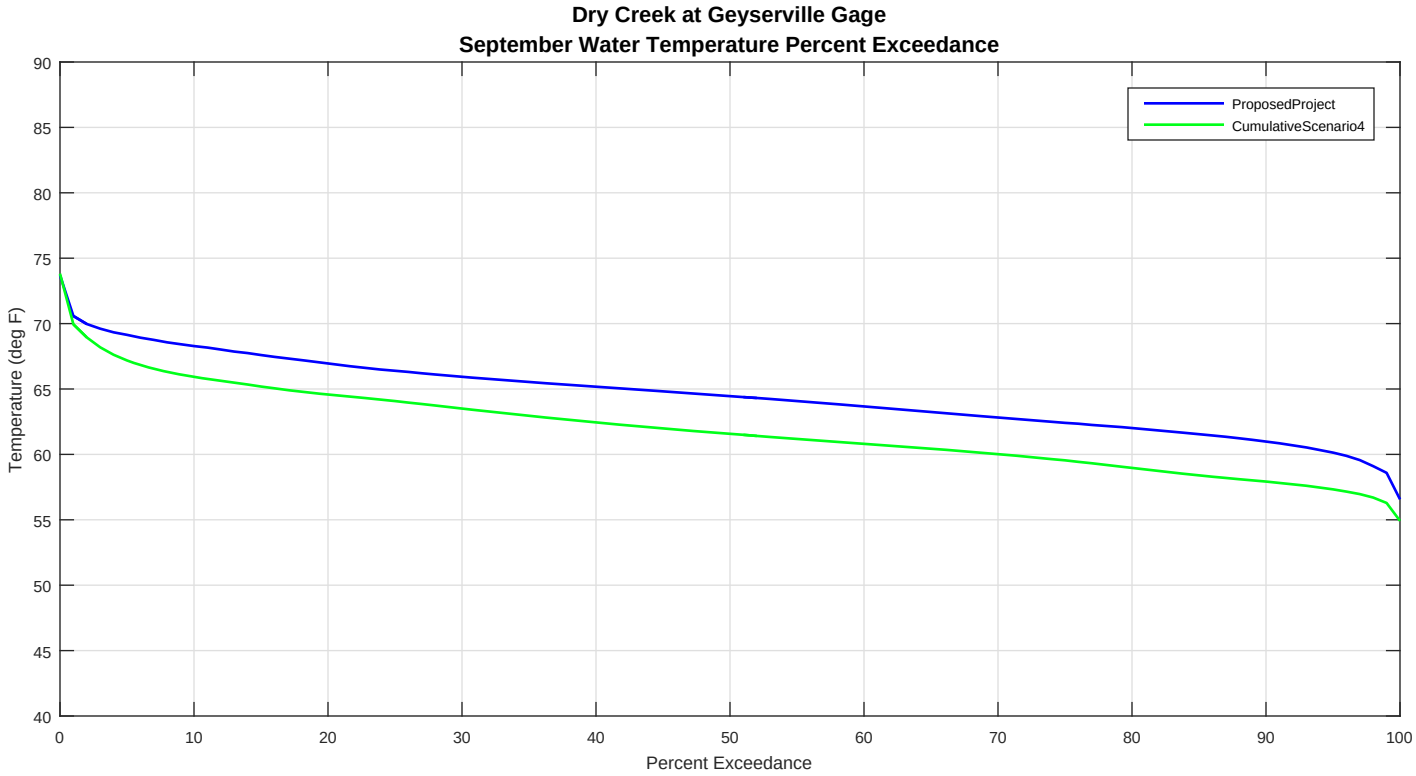
Dry Creek at Geyserville Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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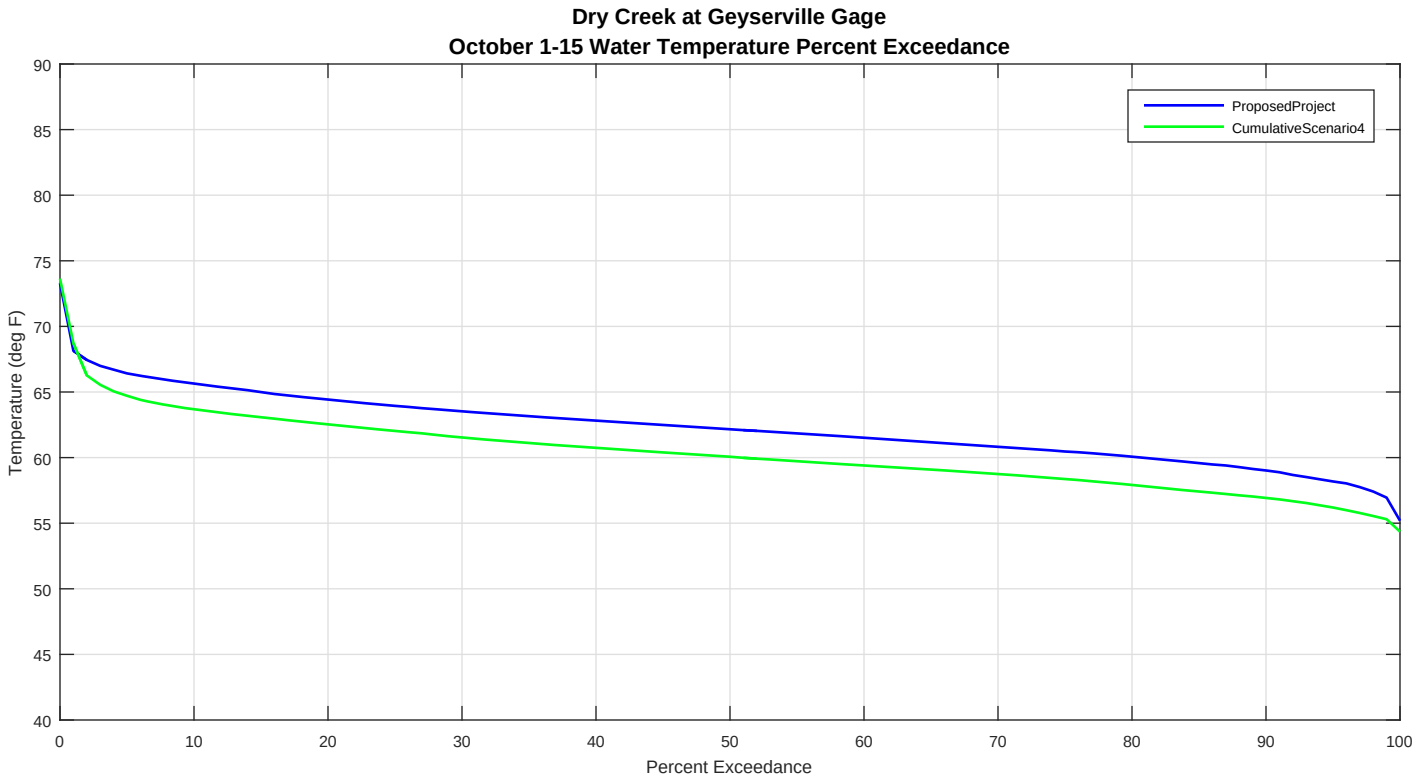
Dry Creek at Geyserville Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
90
85
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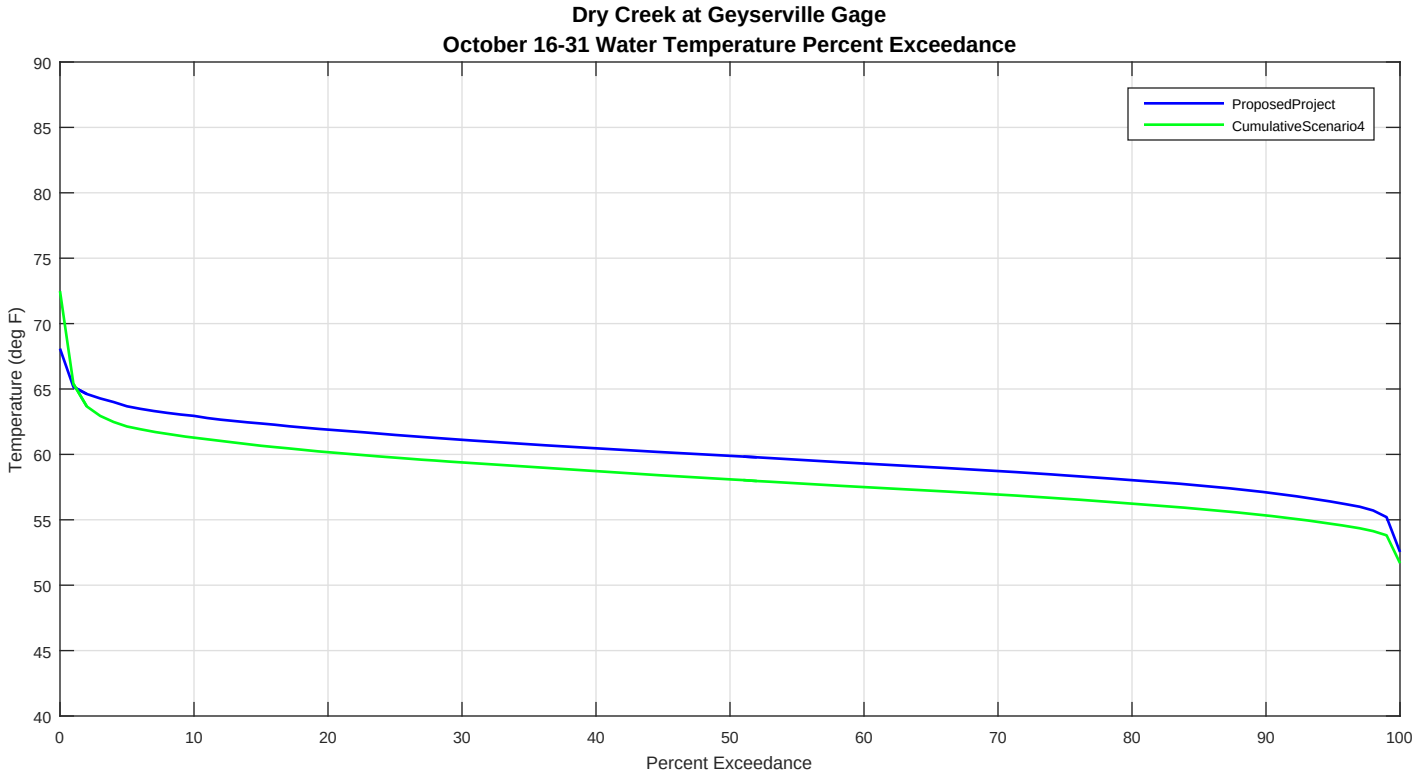
Dry Creek at Geyserville Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
90
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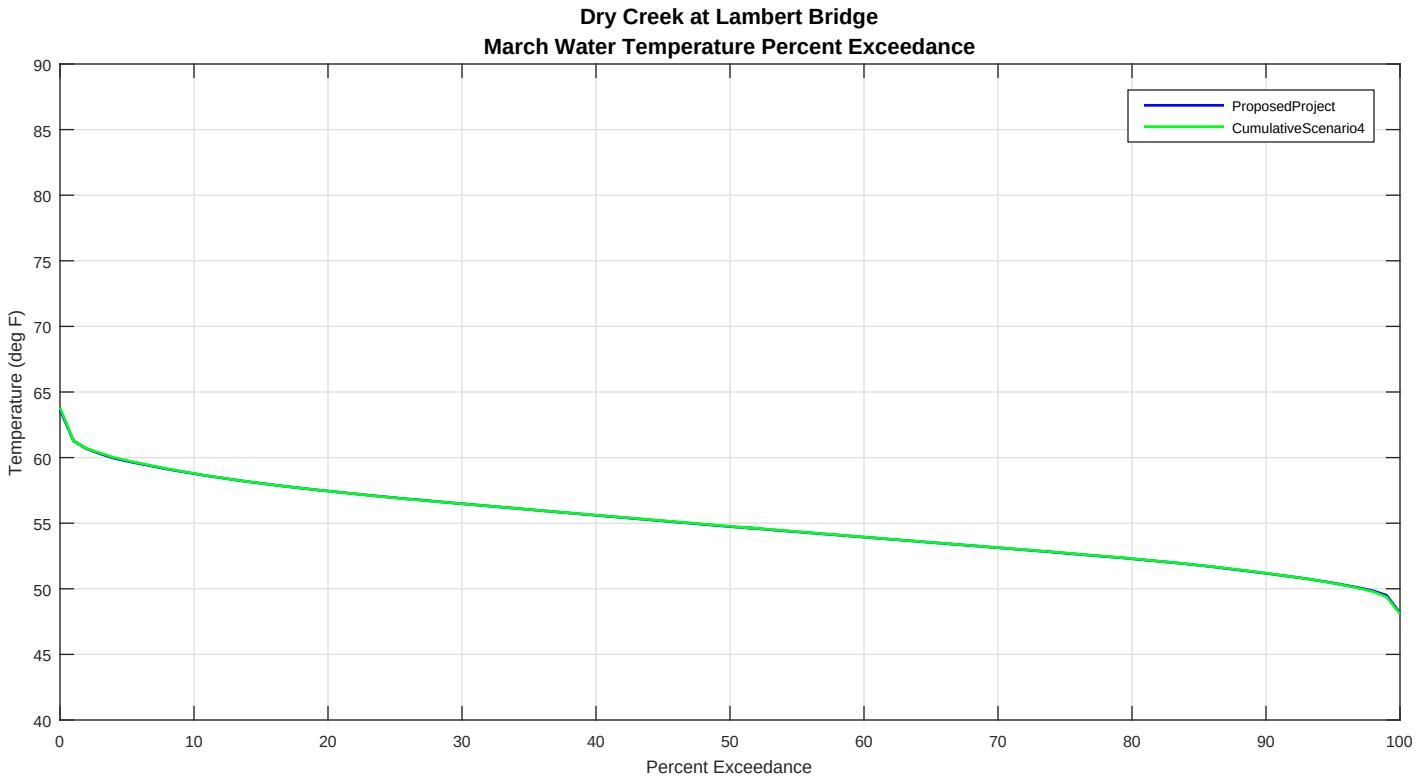
Dry Creek at Lambert Bridge
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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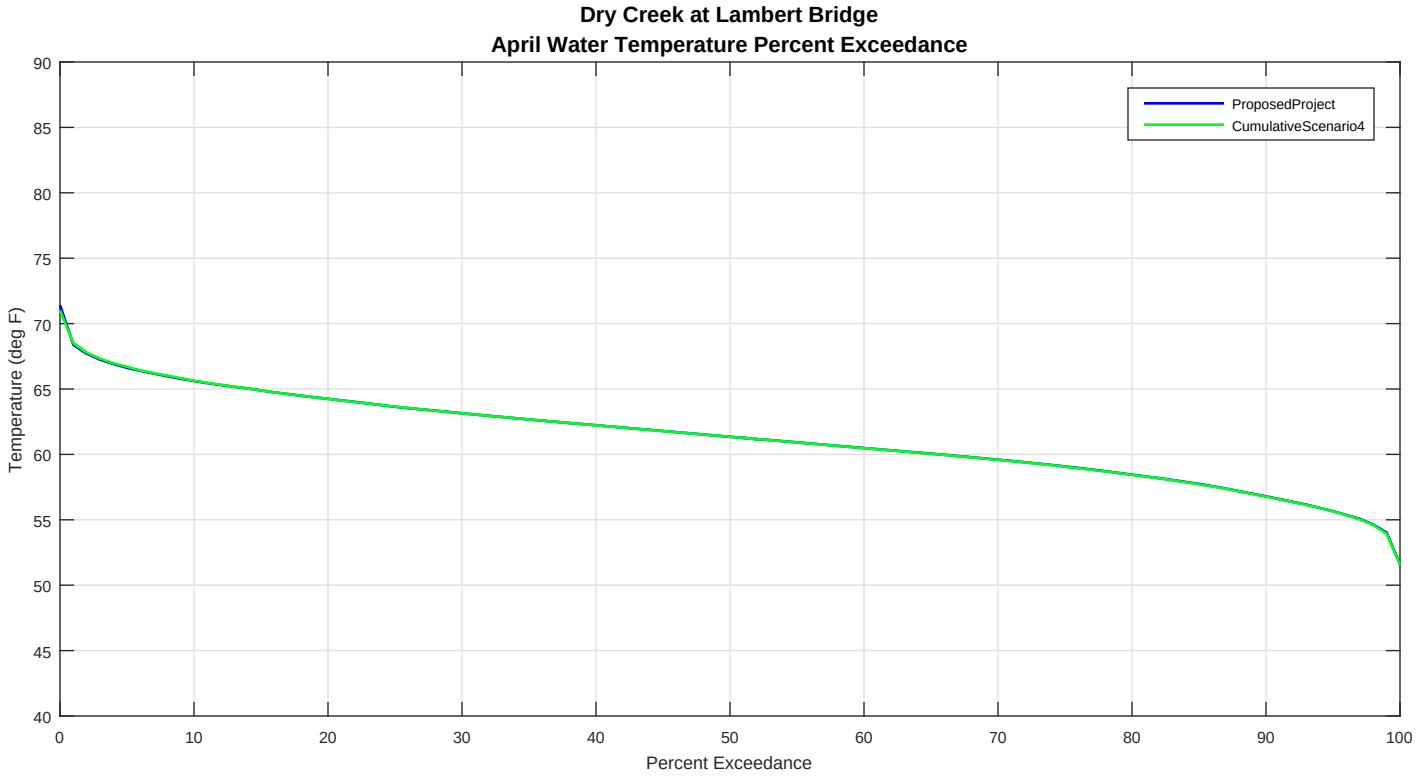
Dry Creek at Lambert Bridge
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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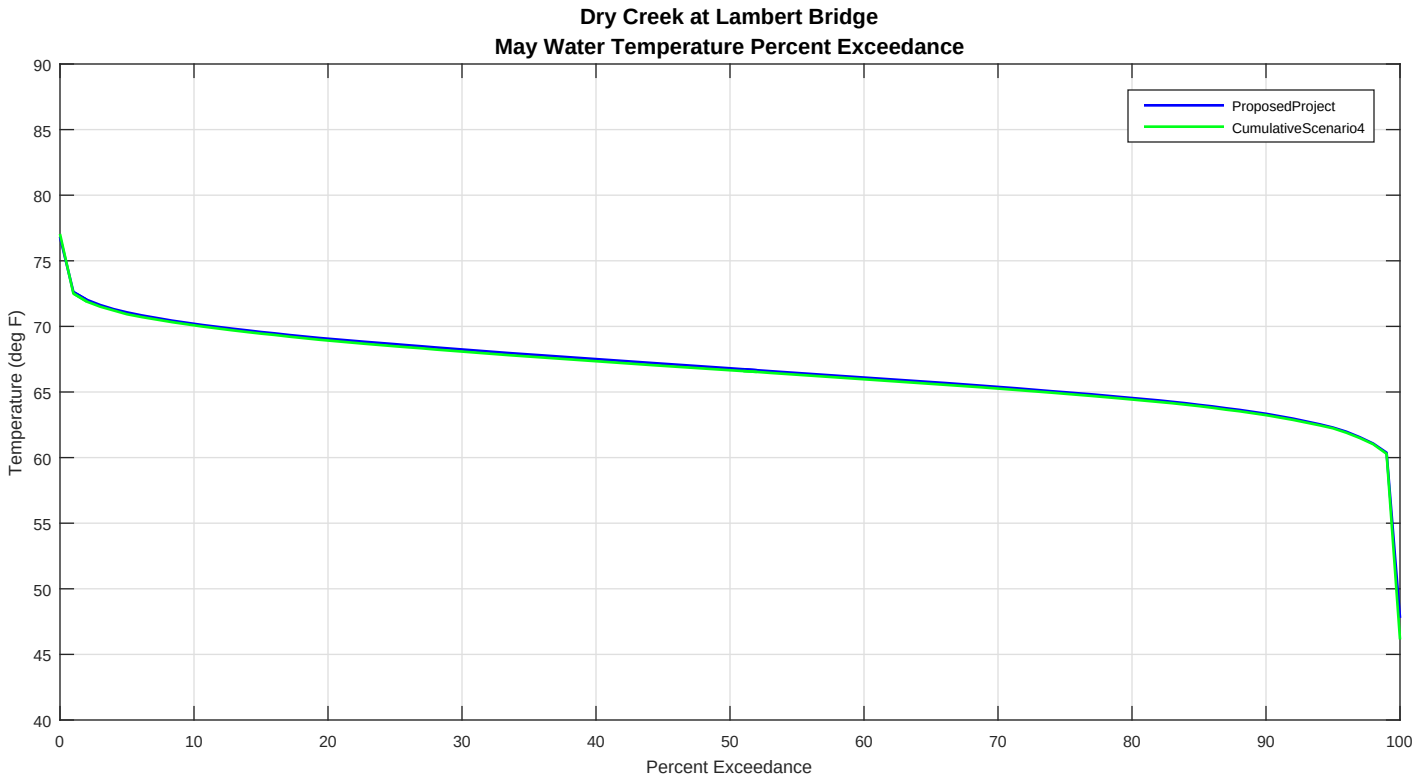
Dry Creek at Lambert Bridge
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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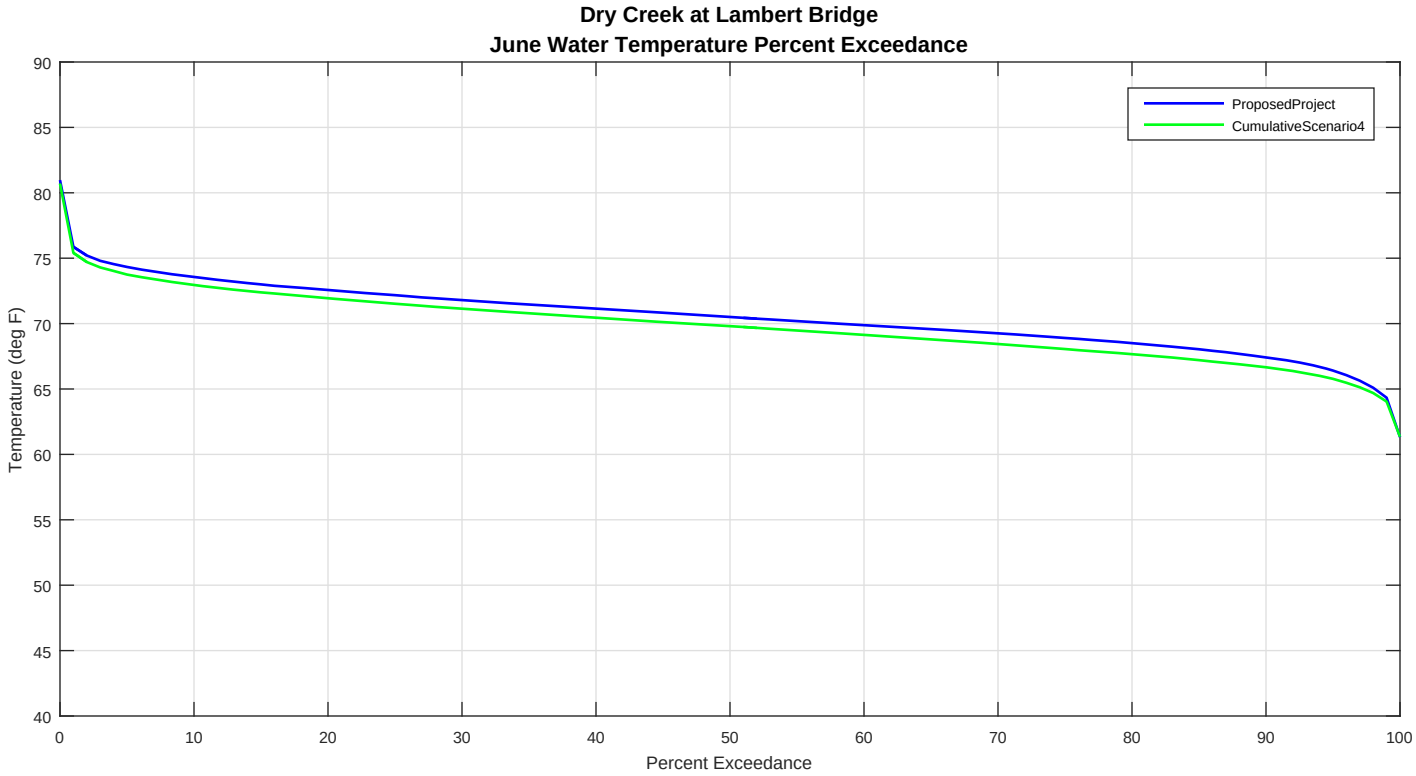
Dry Creek at Lambert Bridge
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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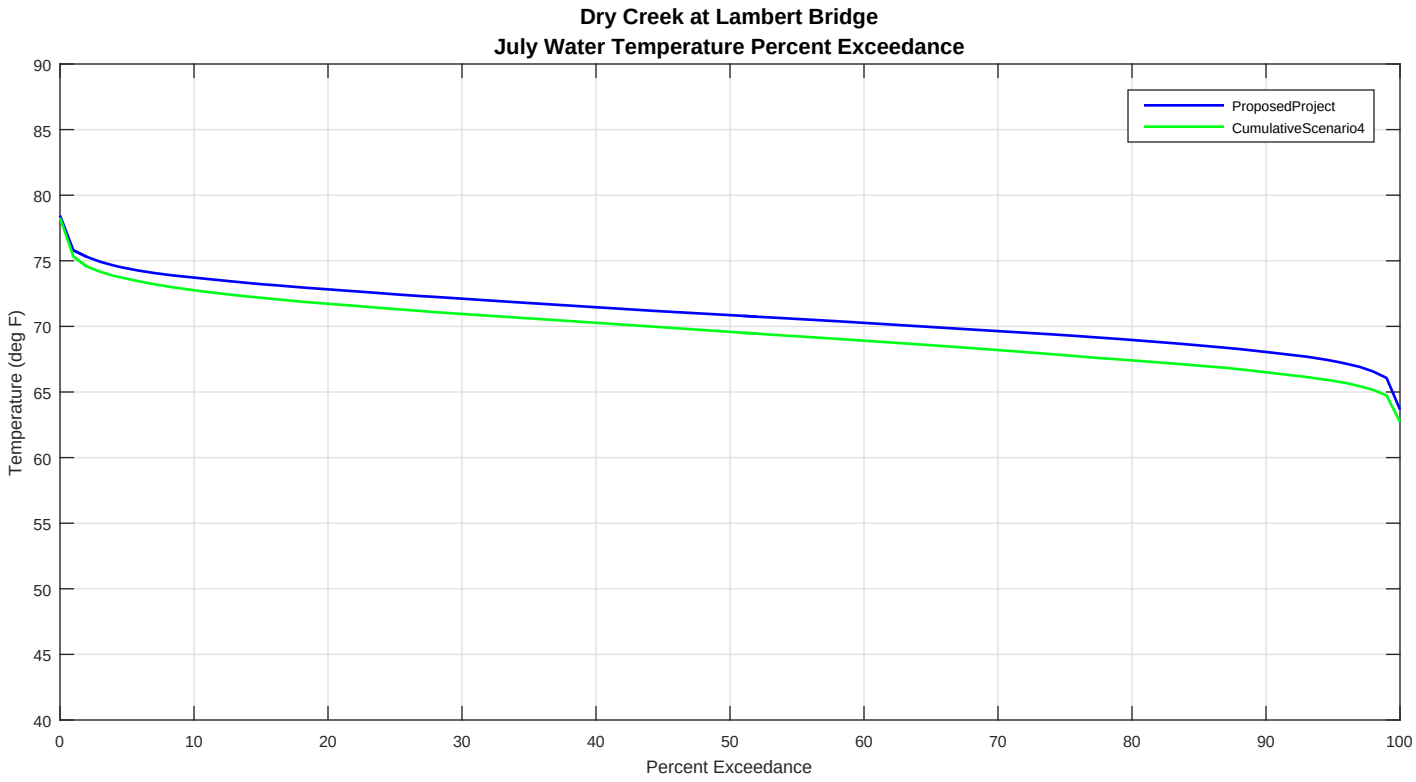
Dry Creek at Lambert Bridge
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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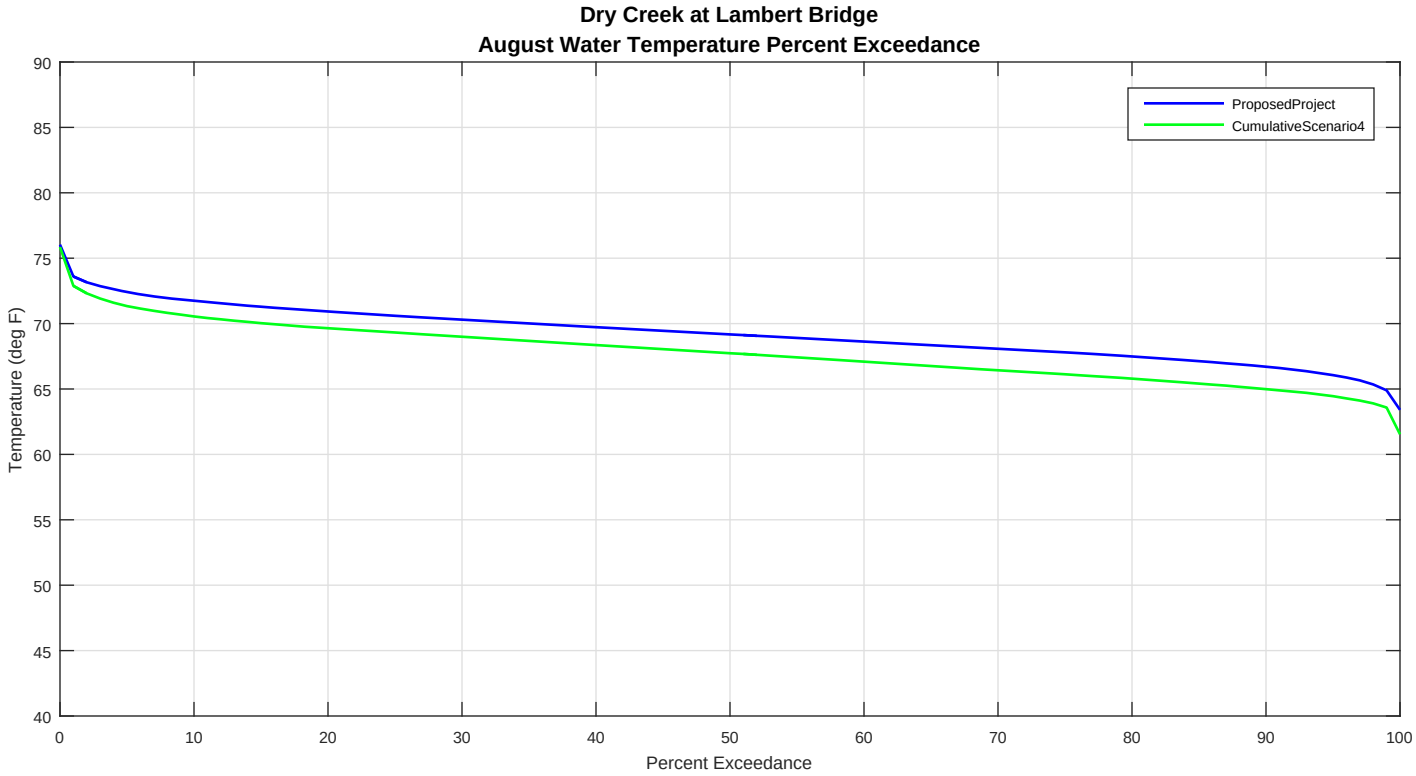
Dry Creek at Lambert Bridge
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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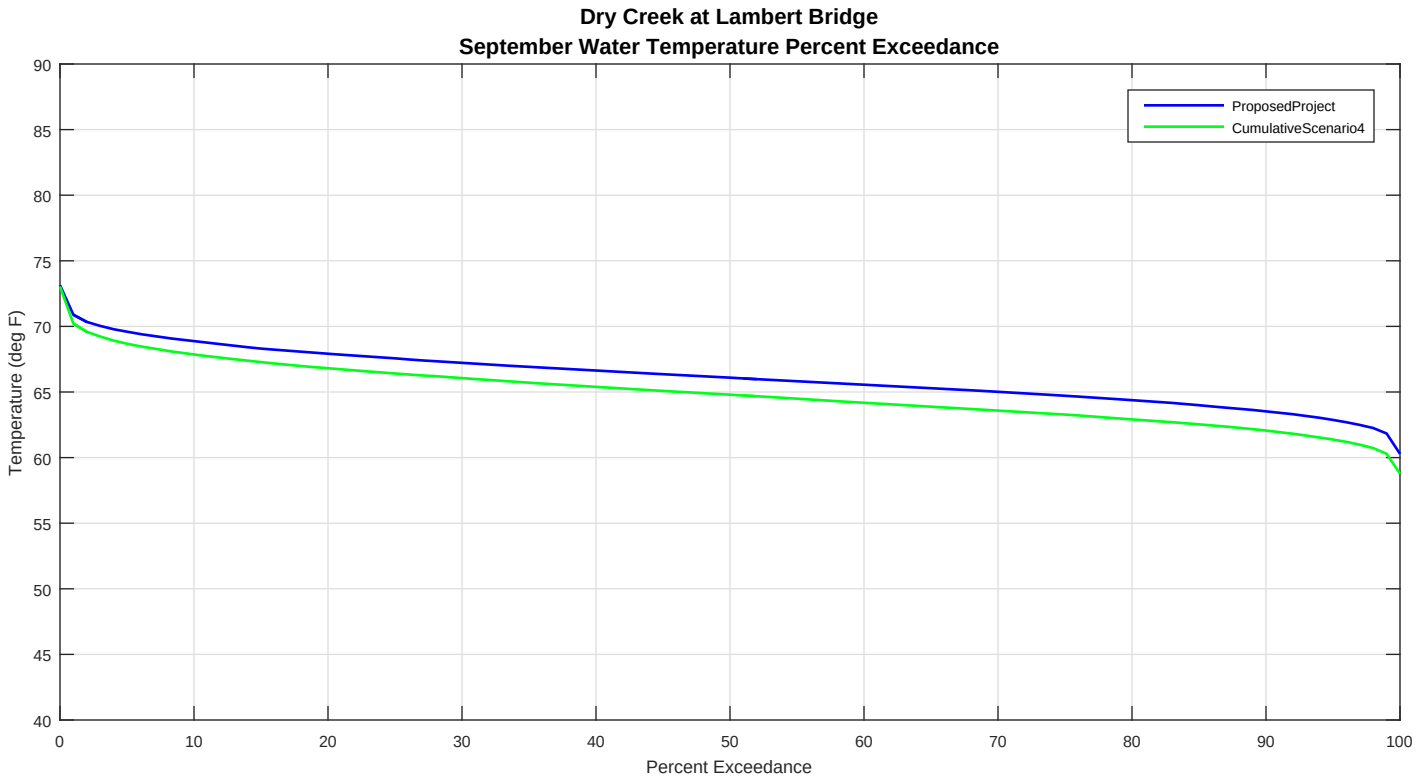
Dry Creek at Lambert Bridge
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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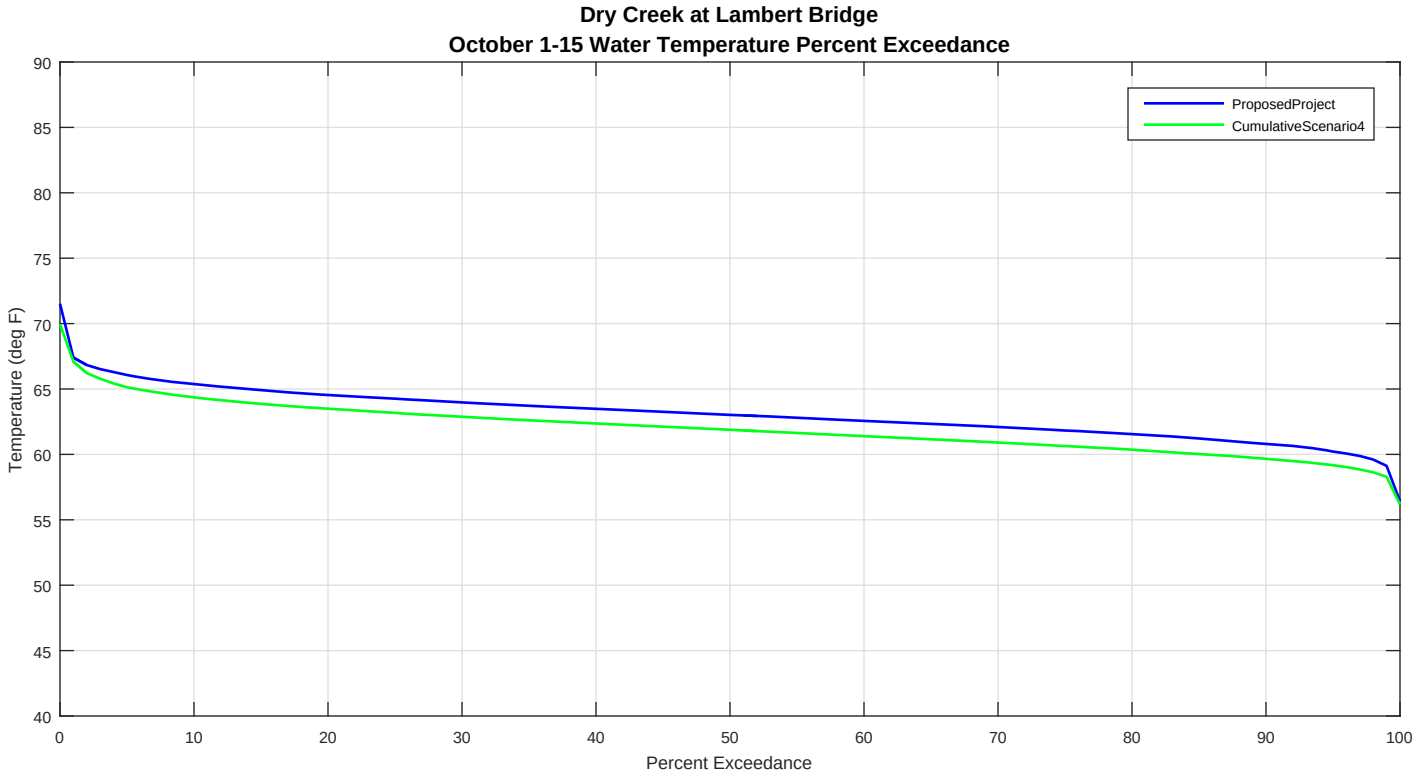
Dry Creek at Lambert Bridge
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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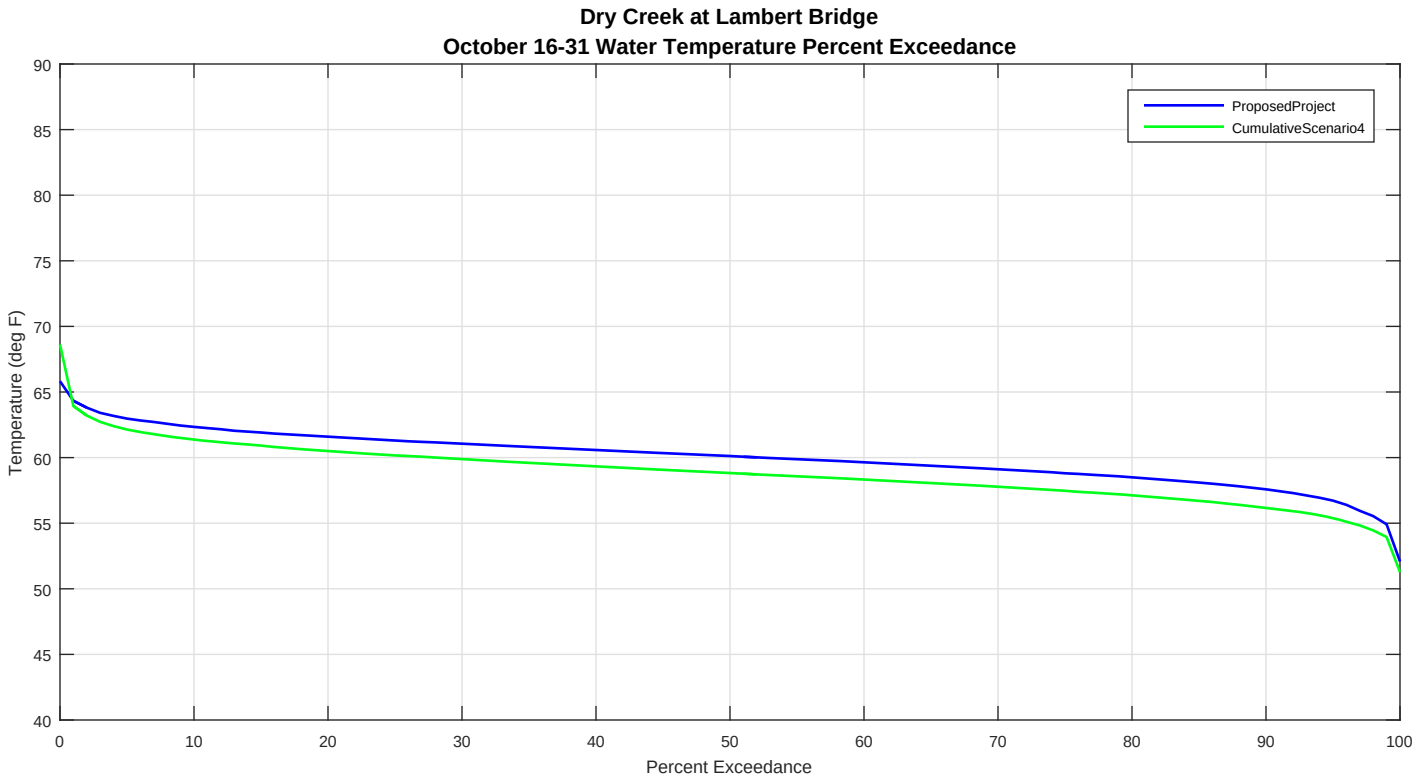
Dry Creek at Lambert Bridge
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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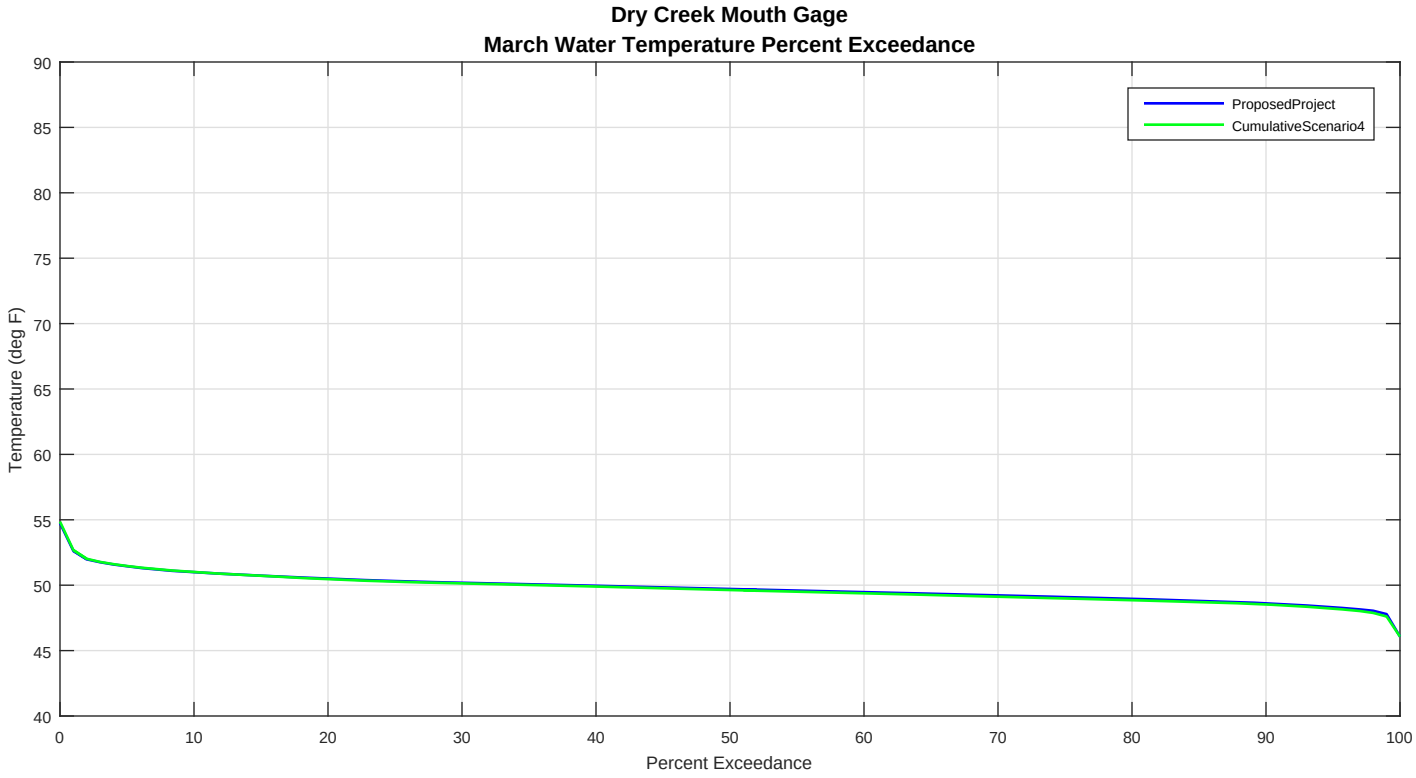
Dry Creek Mouth Gage
March Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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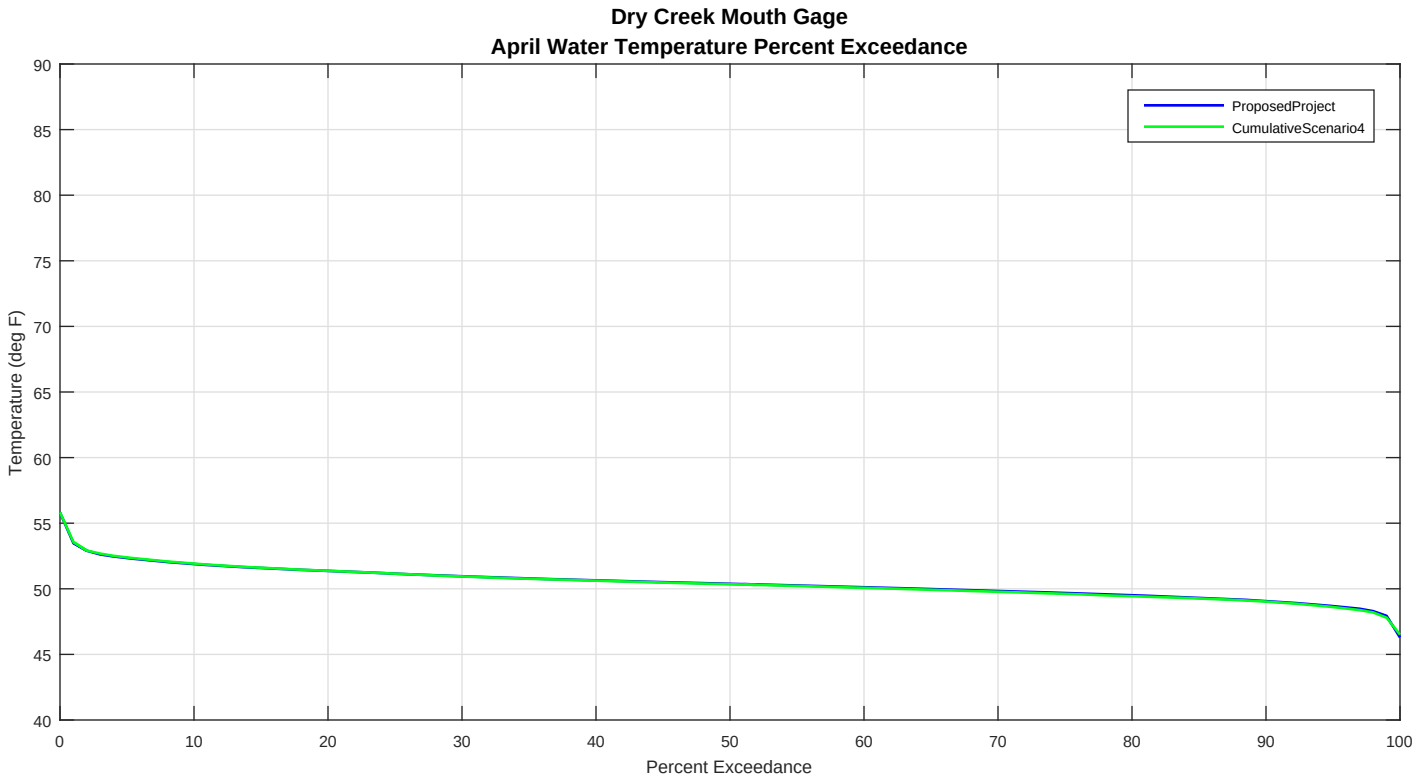
Dry Creek Mouth Gage
April Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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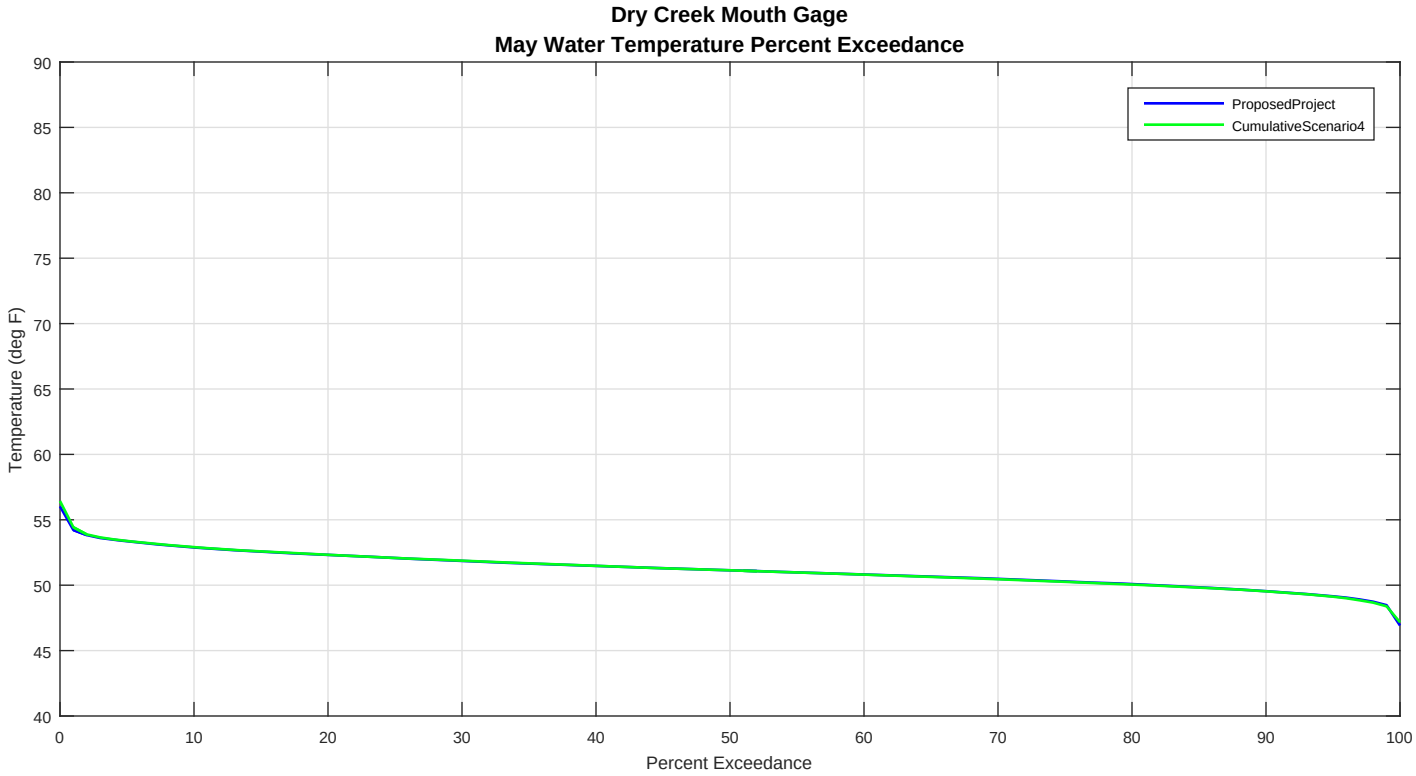
Dry Creek Mouth Gage
May Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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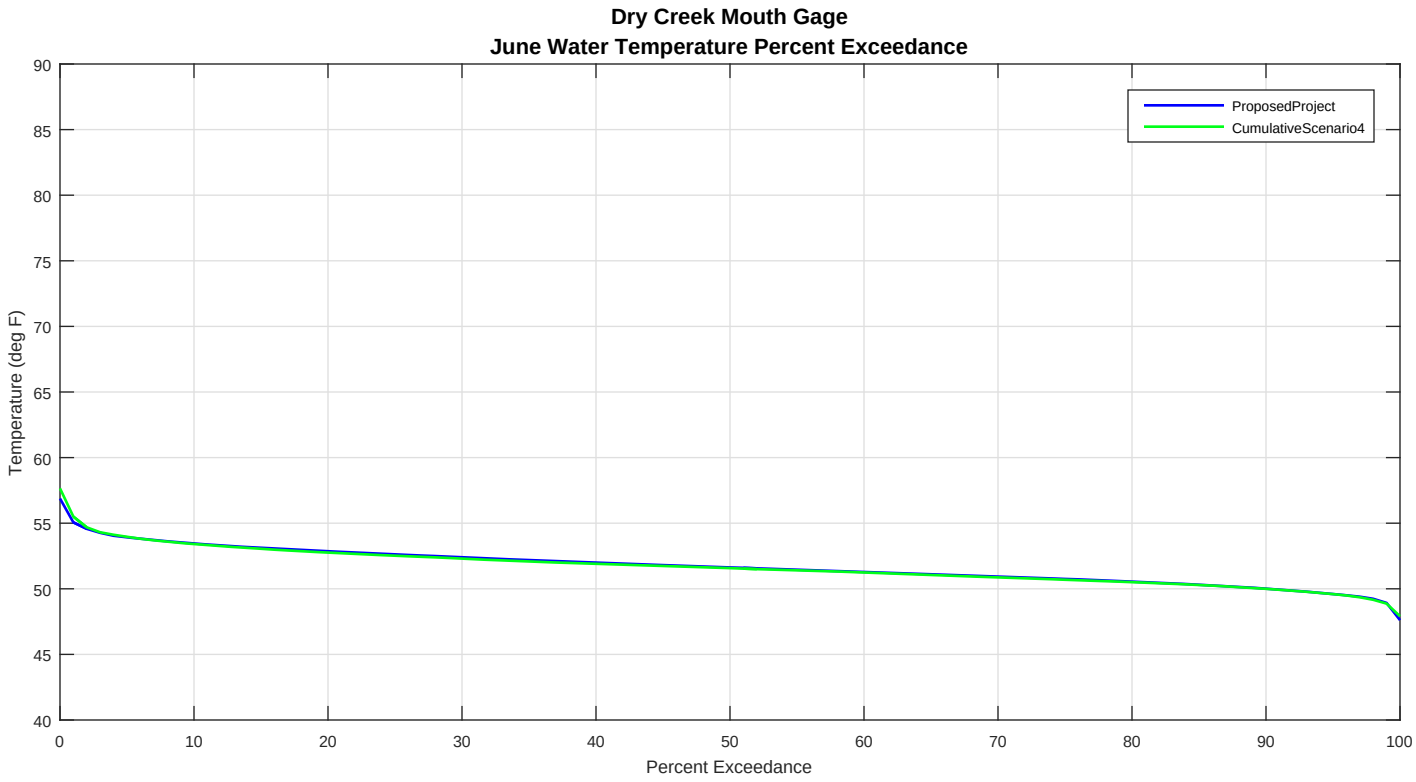
Dry Creek Mouth Gage
June Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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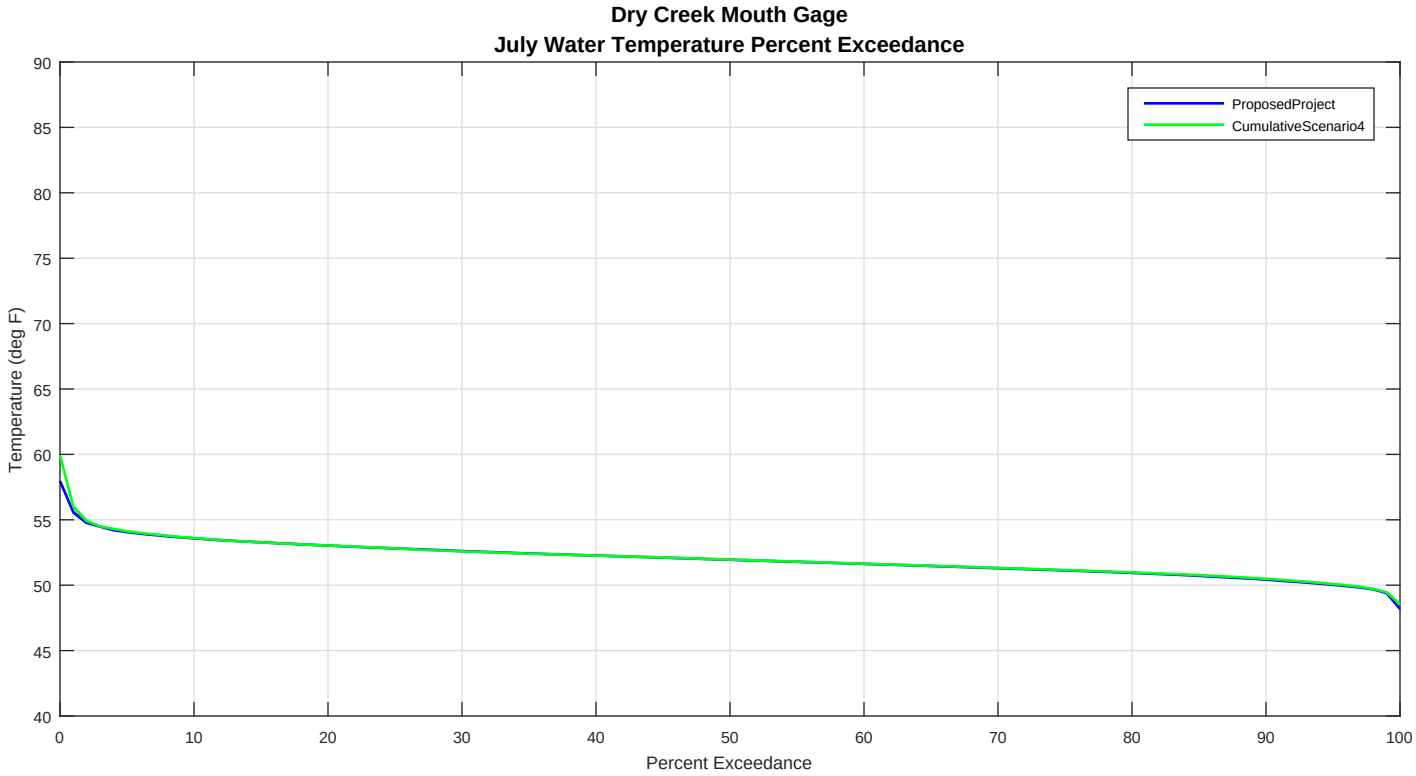
Dry Creek Mouth Gage
July Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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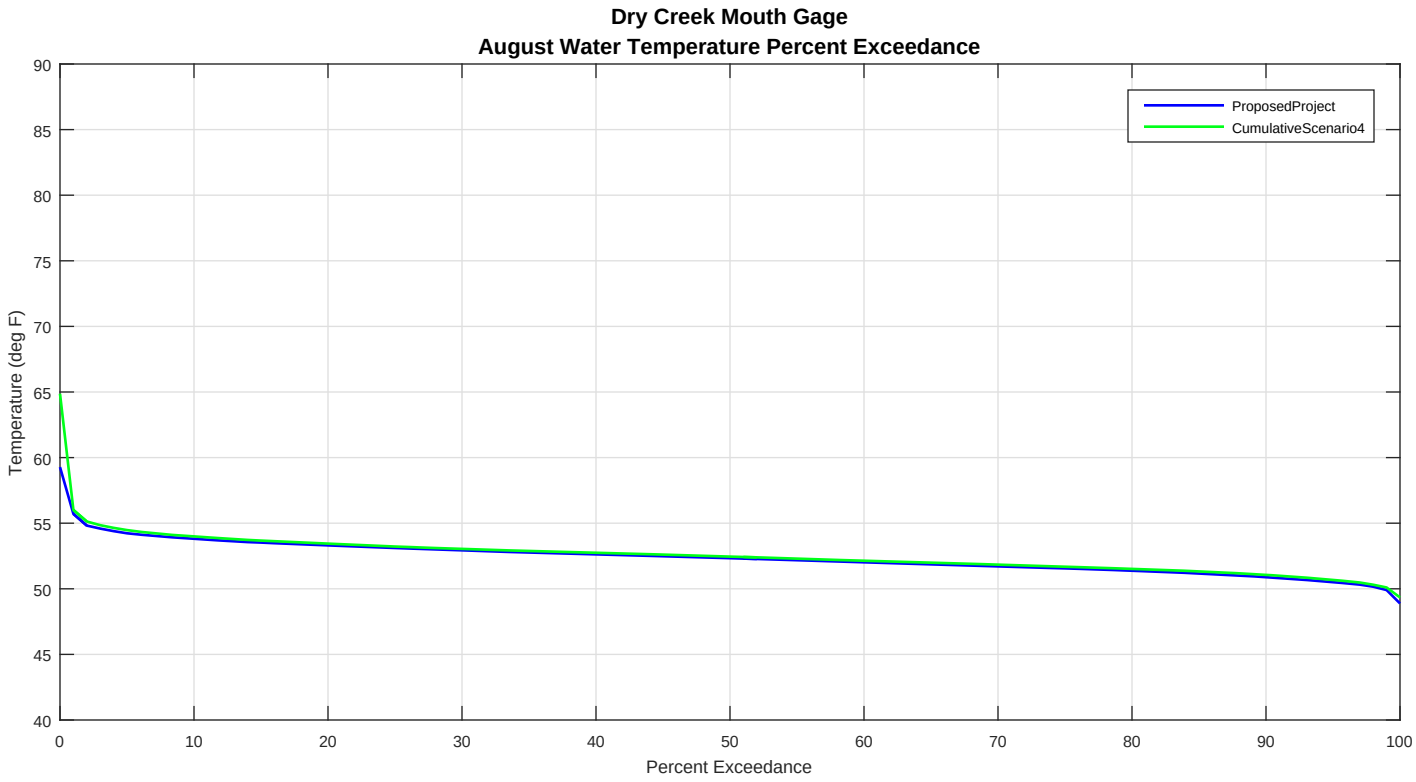
Dry Creek Mouth Gage
August Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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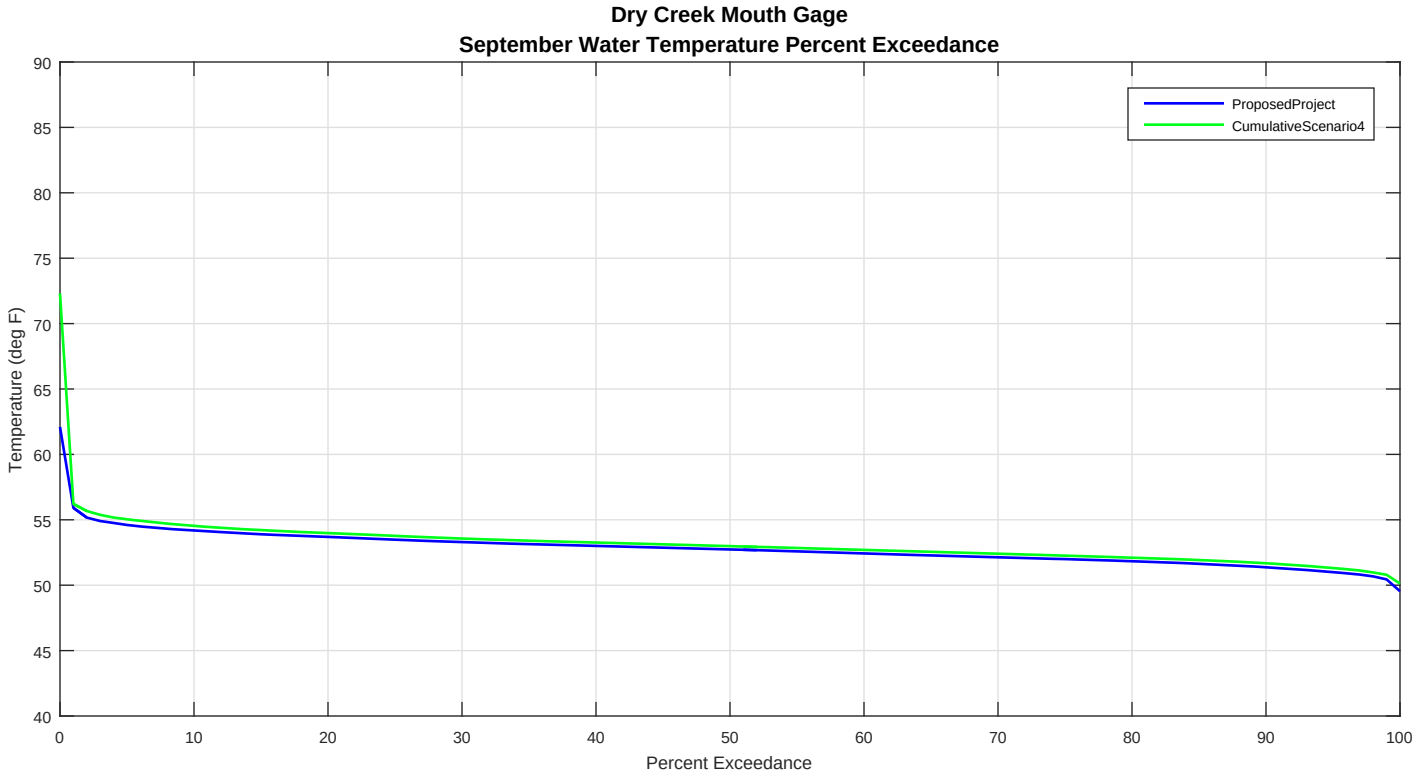
Dry Creek Mouth Gage
September Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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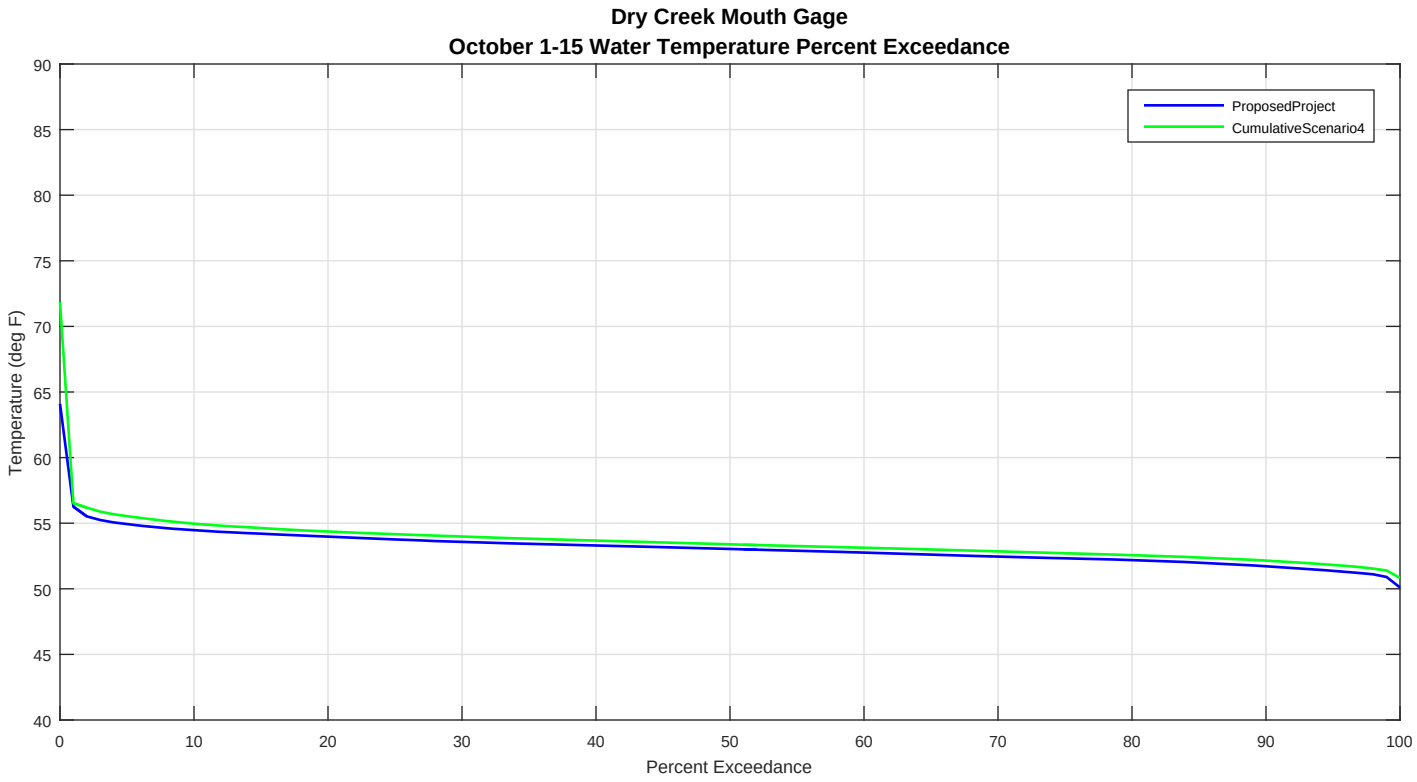
Dry Creek Mouth Gage
October 1-15 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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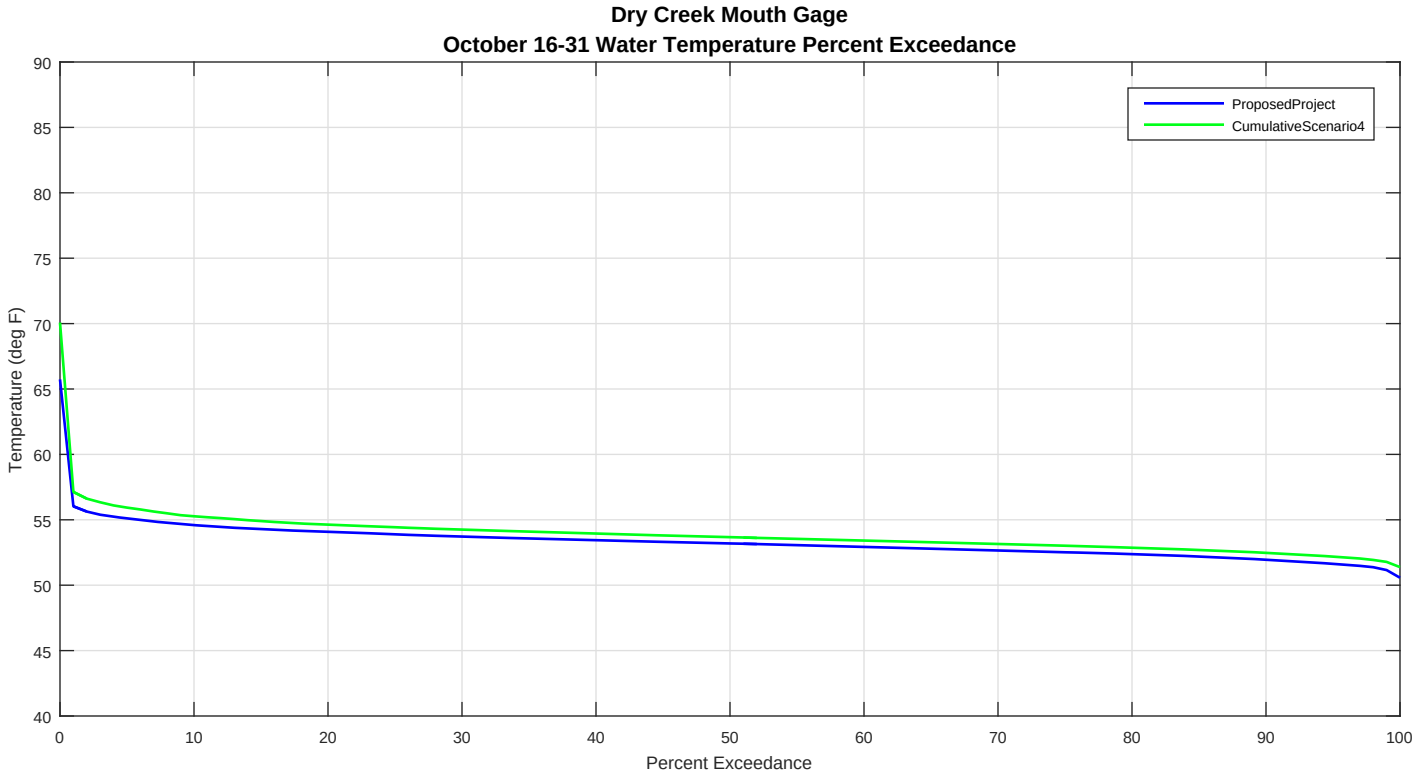
Dry Creek Mouth Gage
October 16-31 Water Temperature Percent Exceedance
ProposedProject
CumulativeScenario4
Temperature (deg F)
Percent Exceedance
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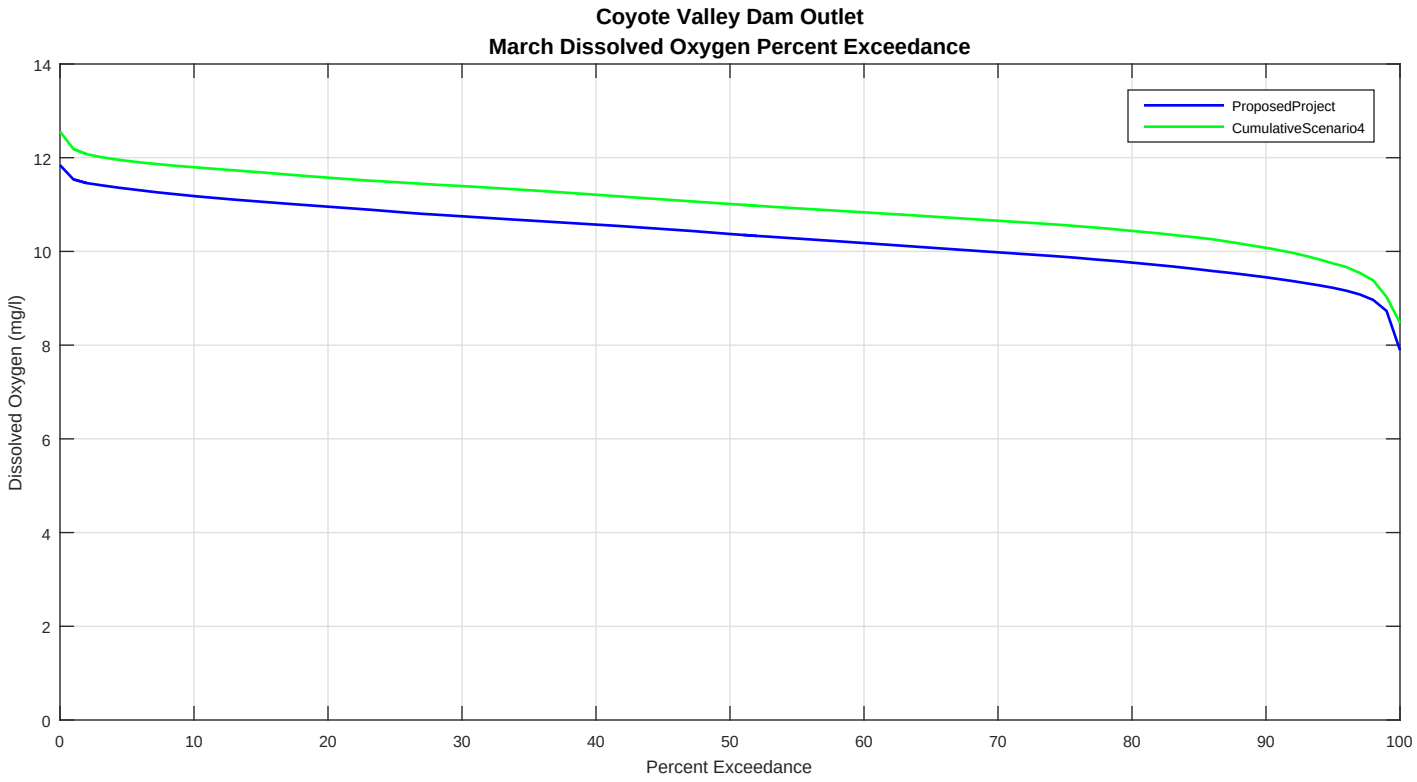
Coyote Valley Dam Outlet
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
0
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4
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8
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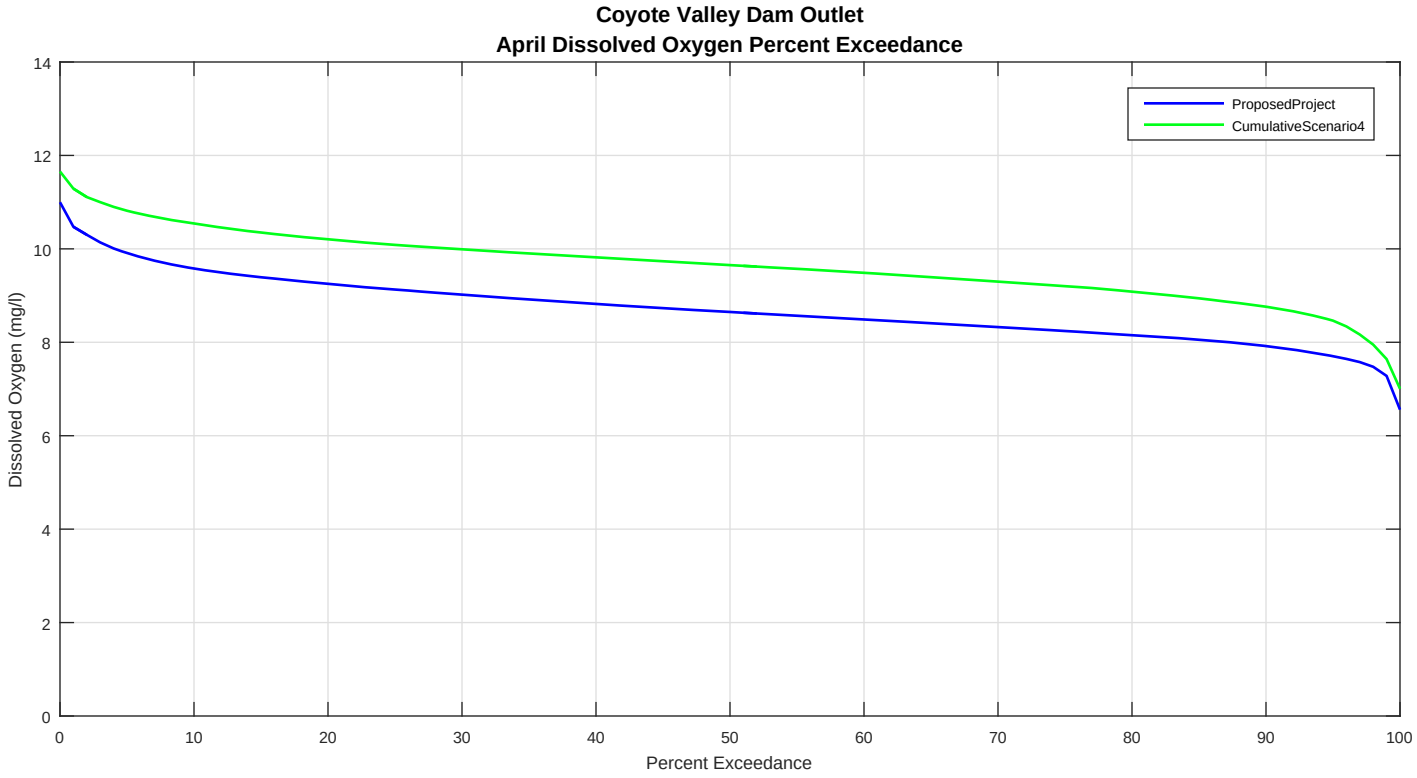
Coyote Valley Dam Outlet
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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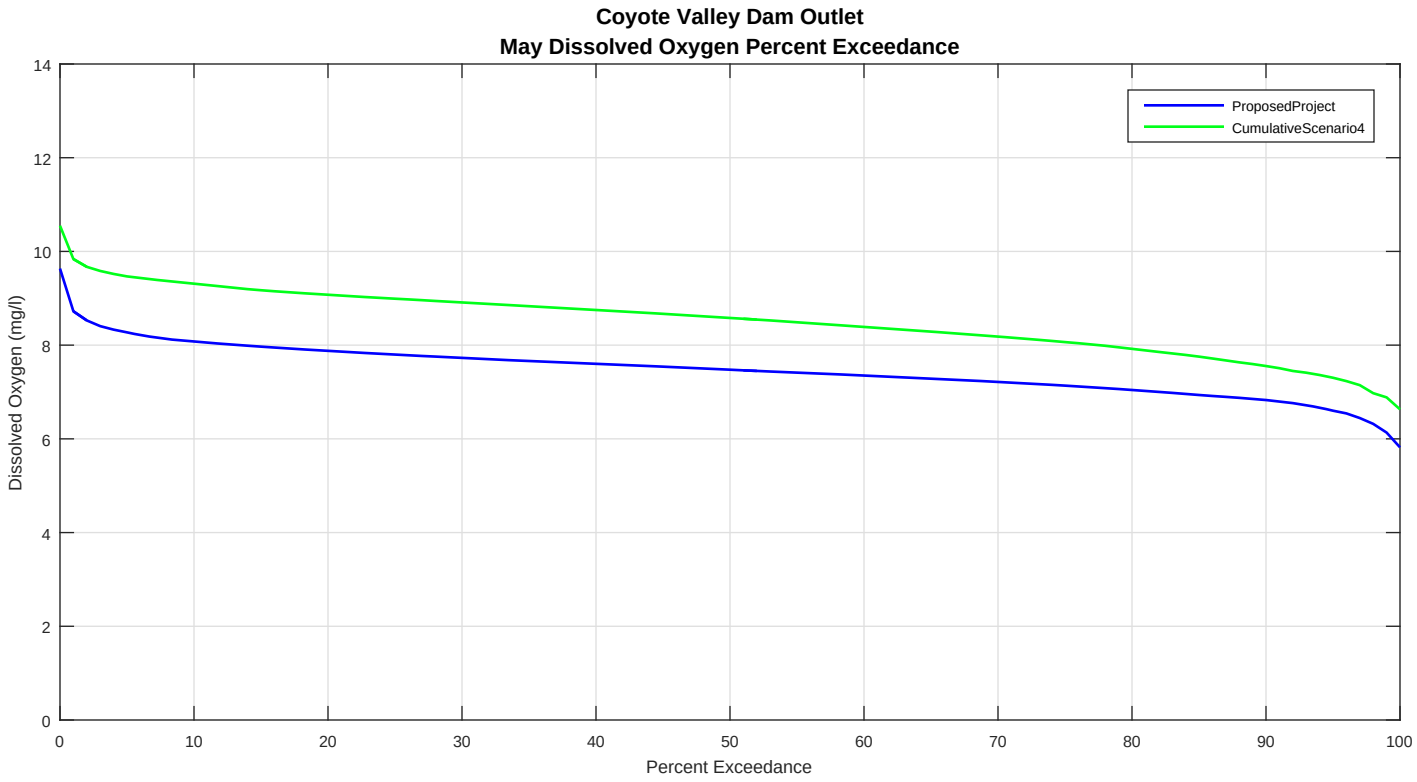
Coyote Valley Dam Outlet
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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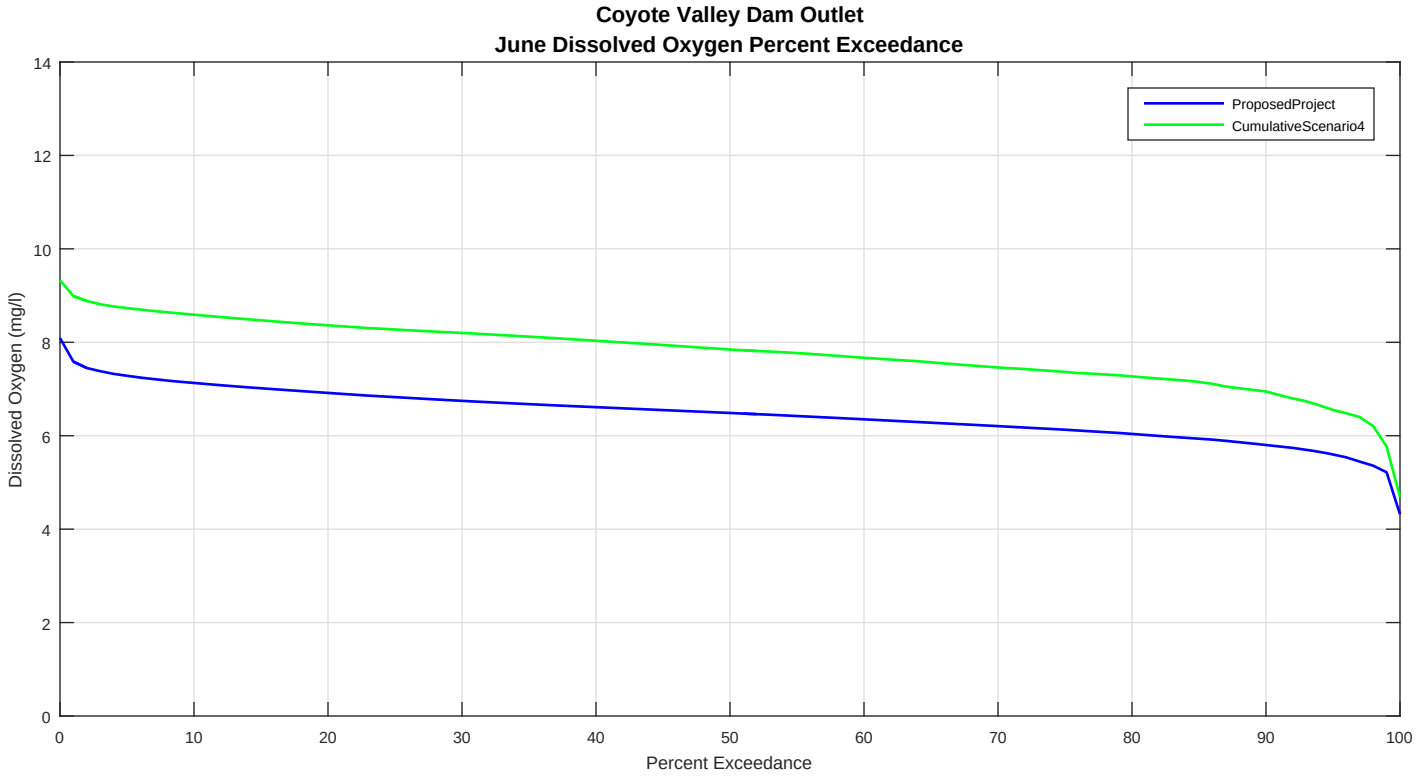
Coyote Valley Dam Outlet
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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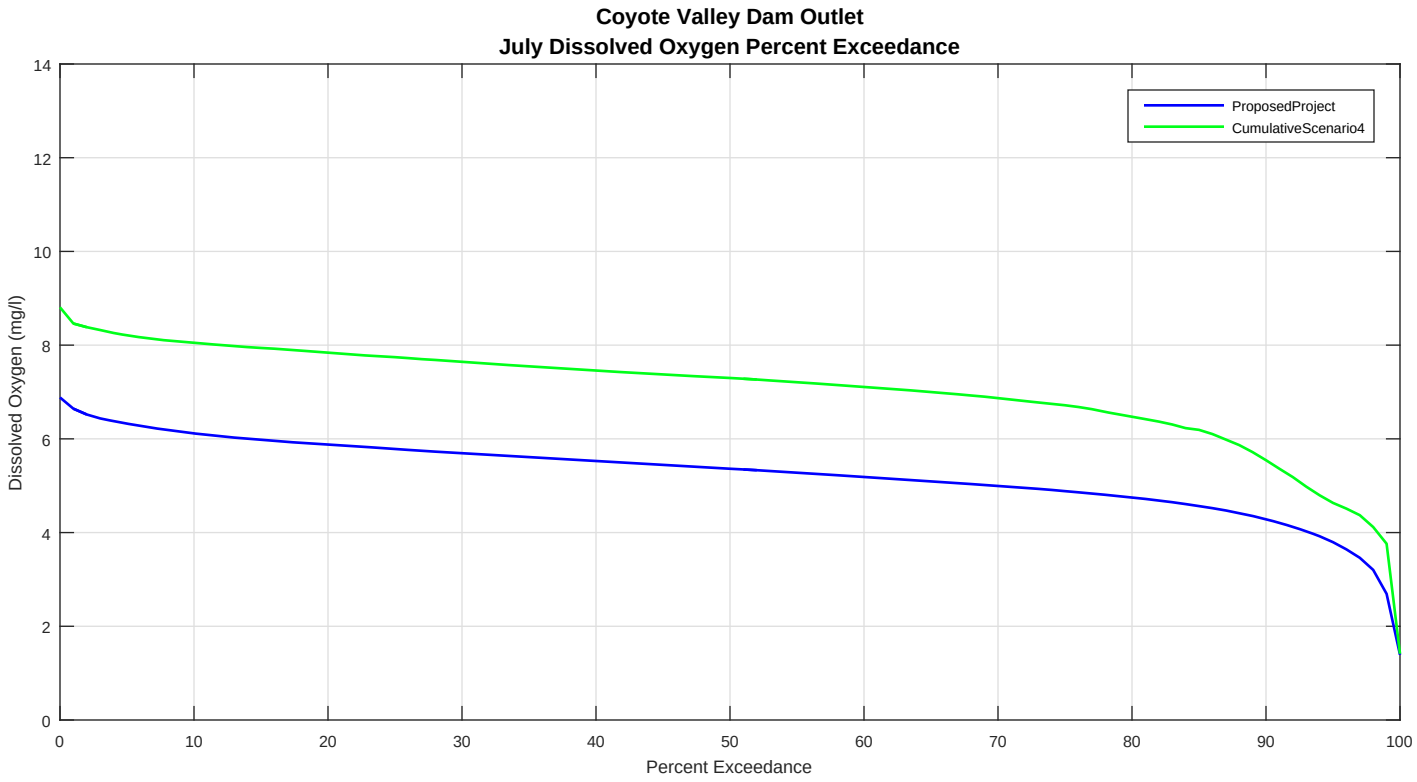
Coyote Valley Dam Outlet
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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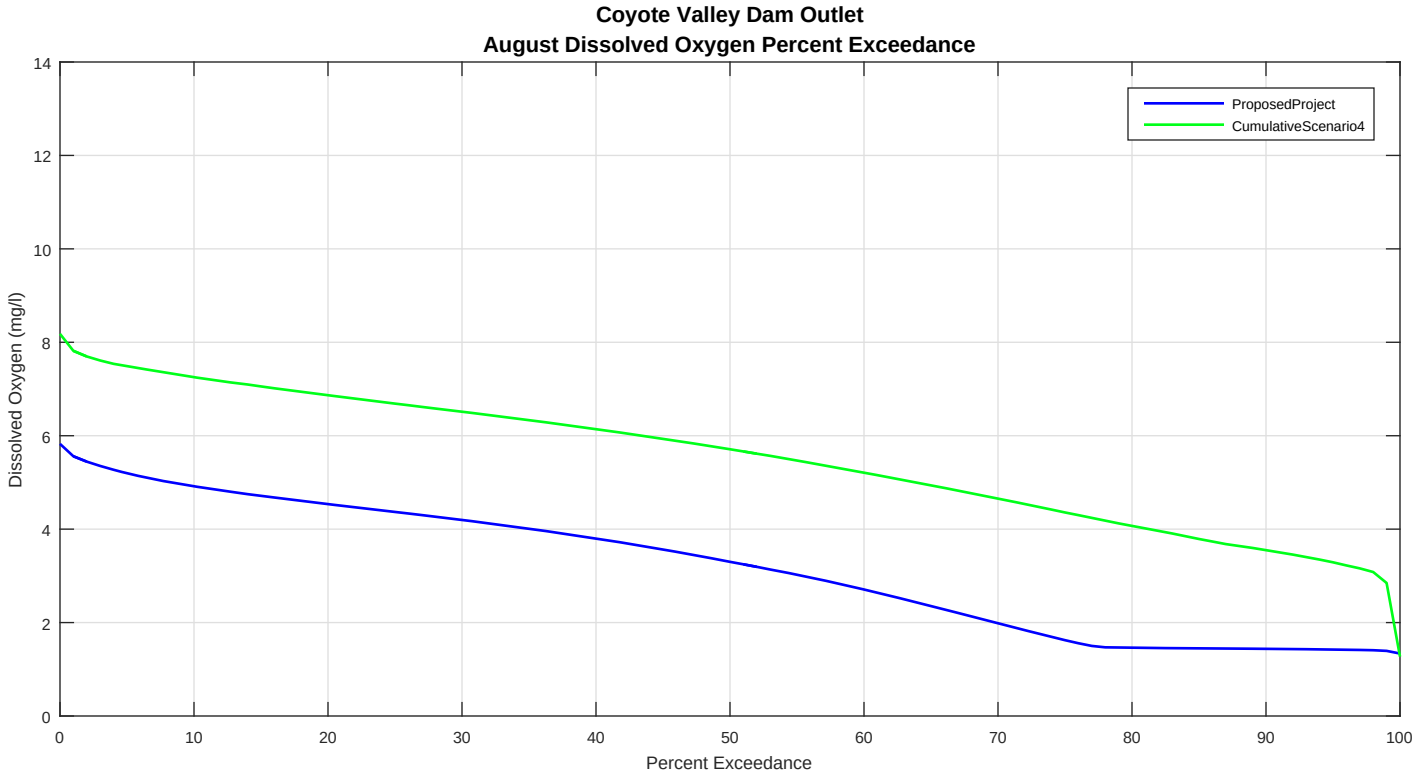
Coyote Valley Dam Outlet
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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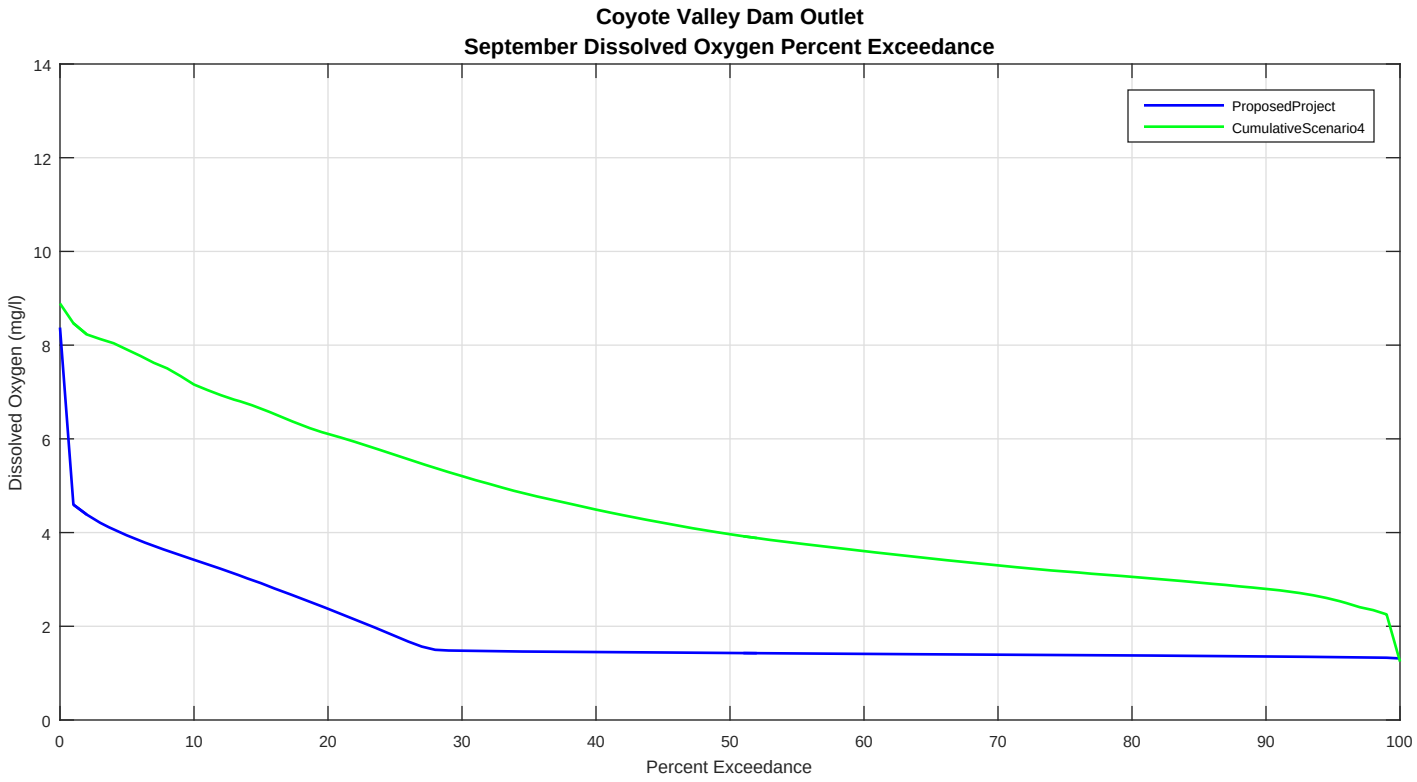
Coyote Valley Dam Outlet
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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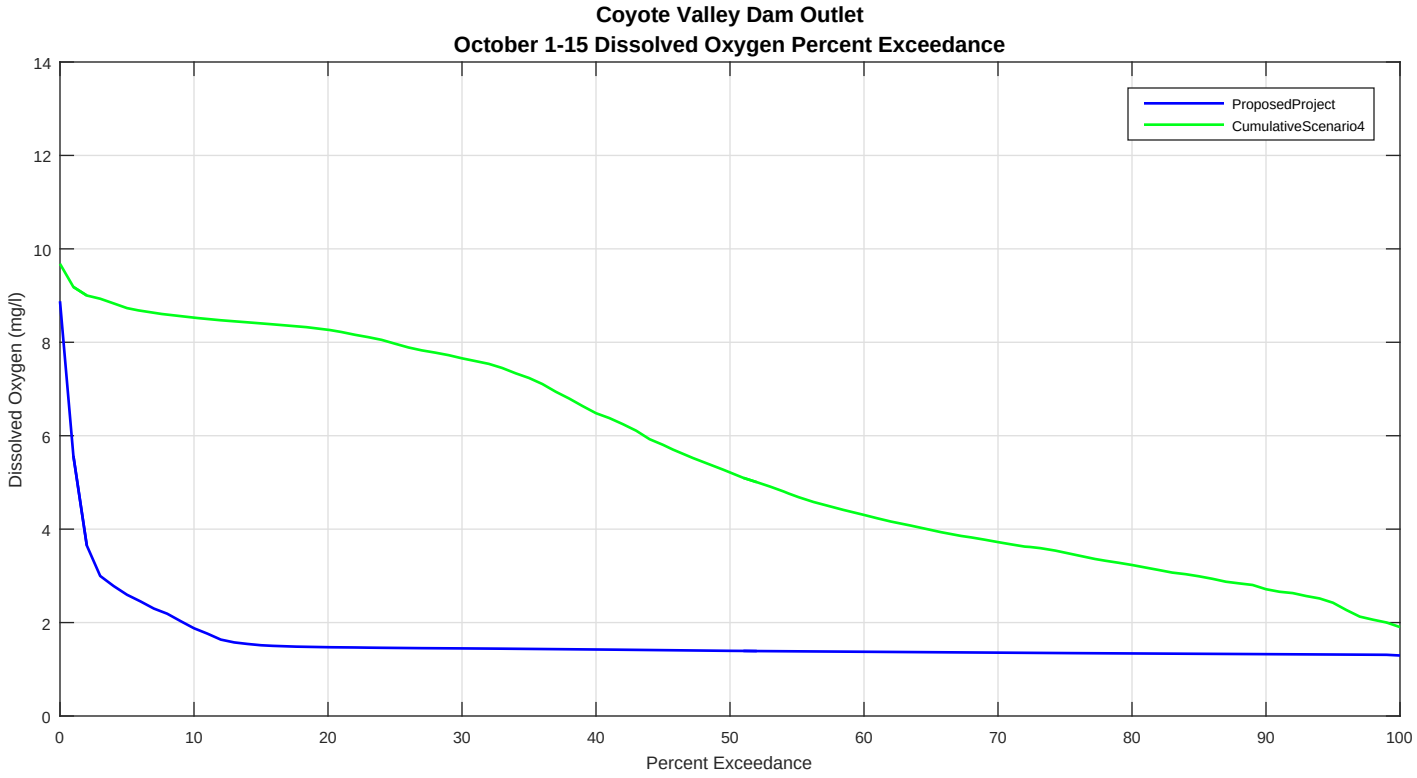
Coyote Valley Dam Outlet
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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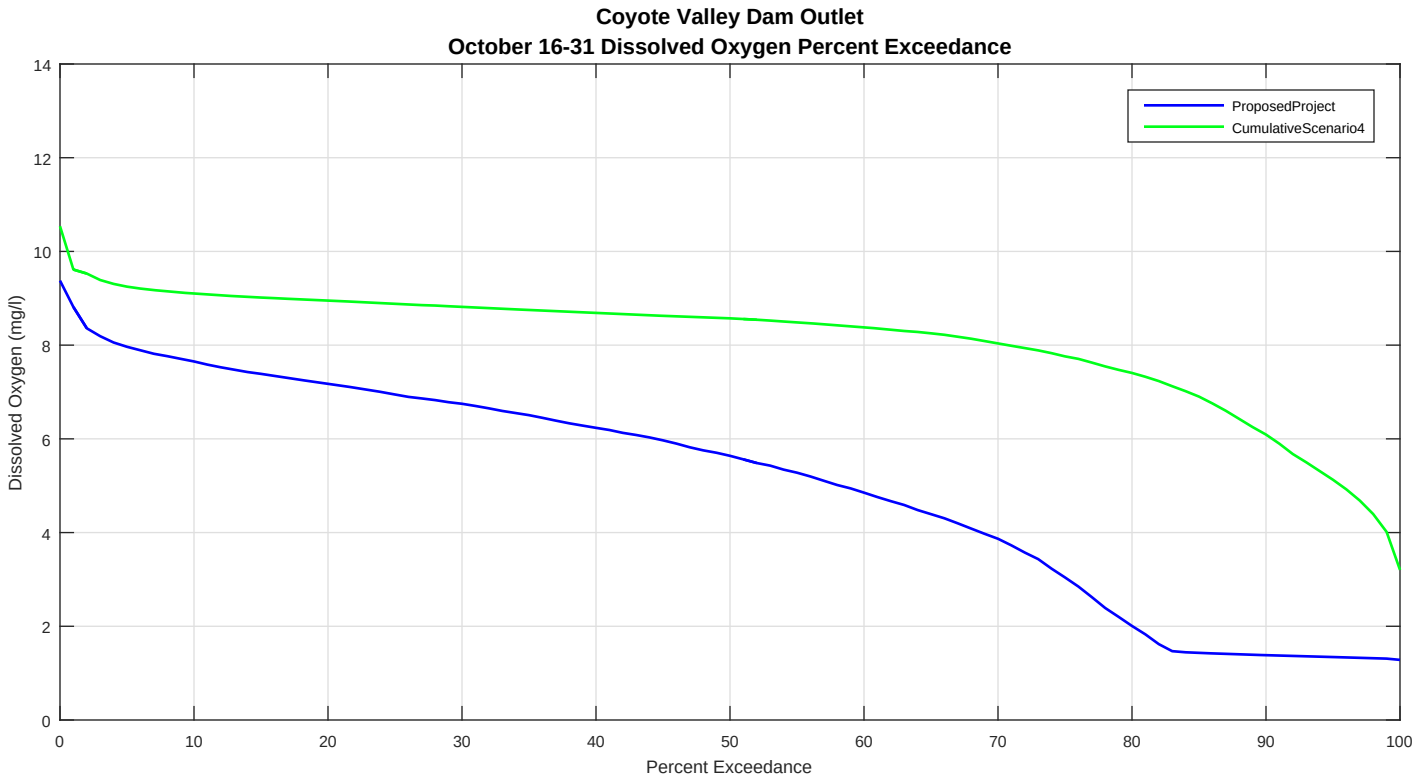
Coyote Valley Dam Outlet
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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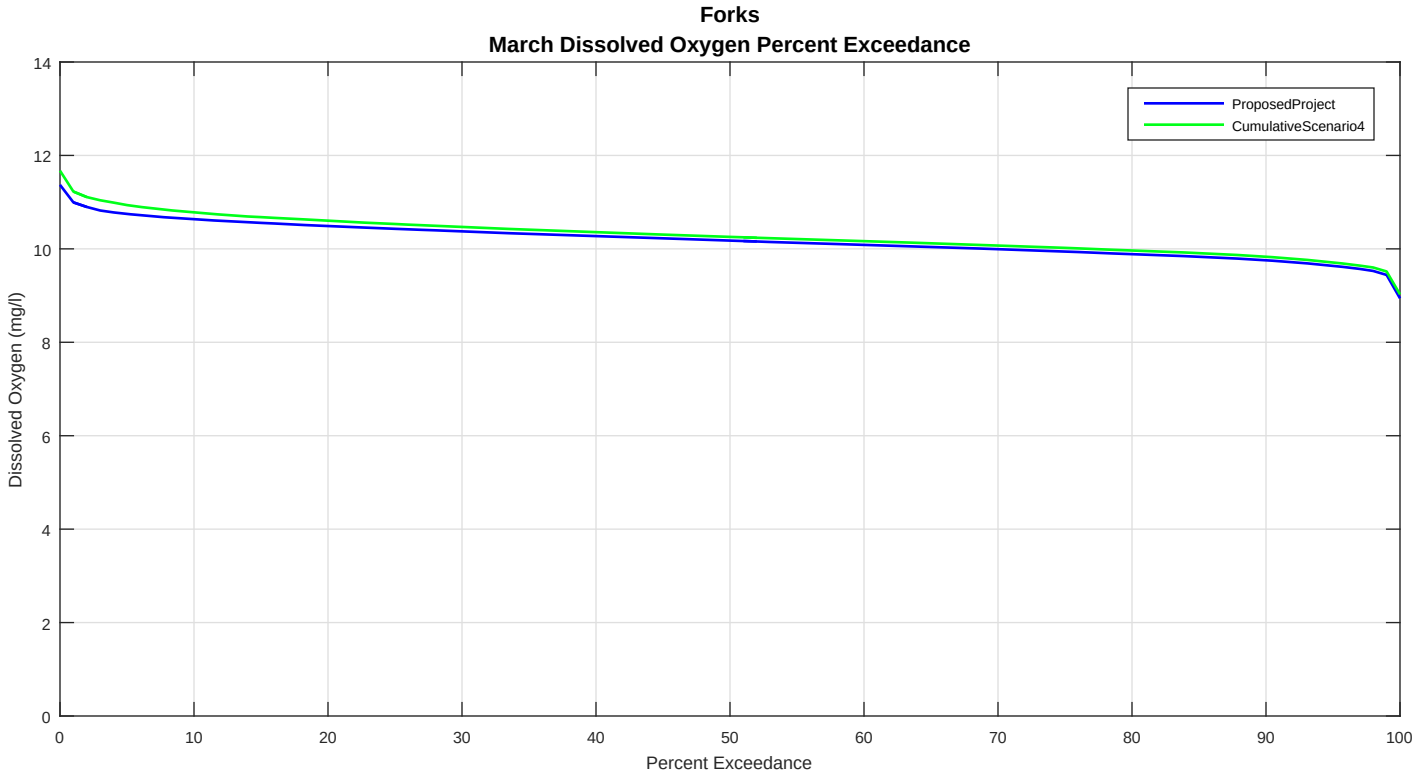
Forks
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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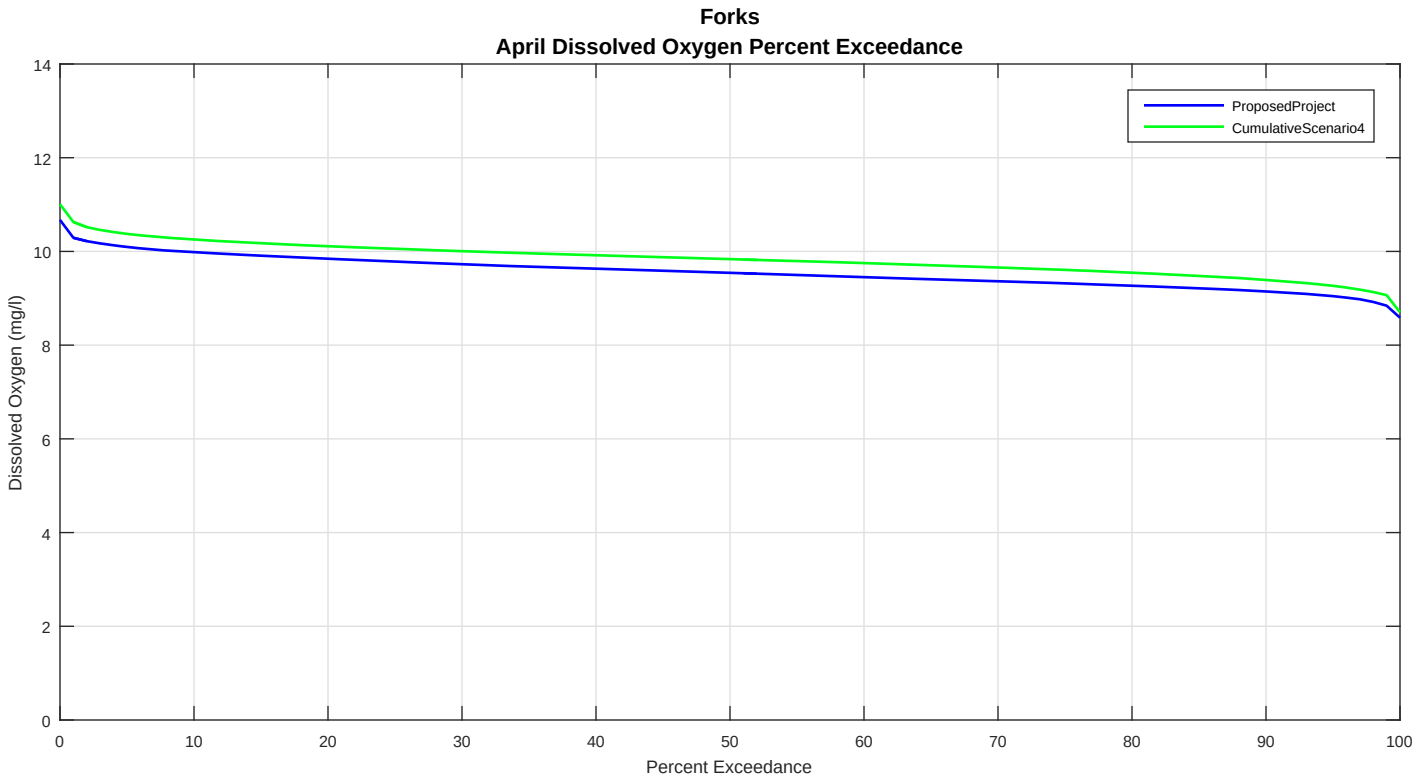
Forks
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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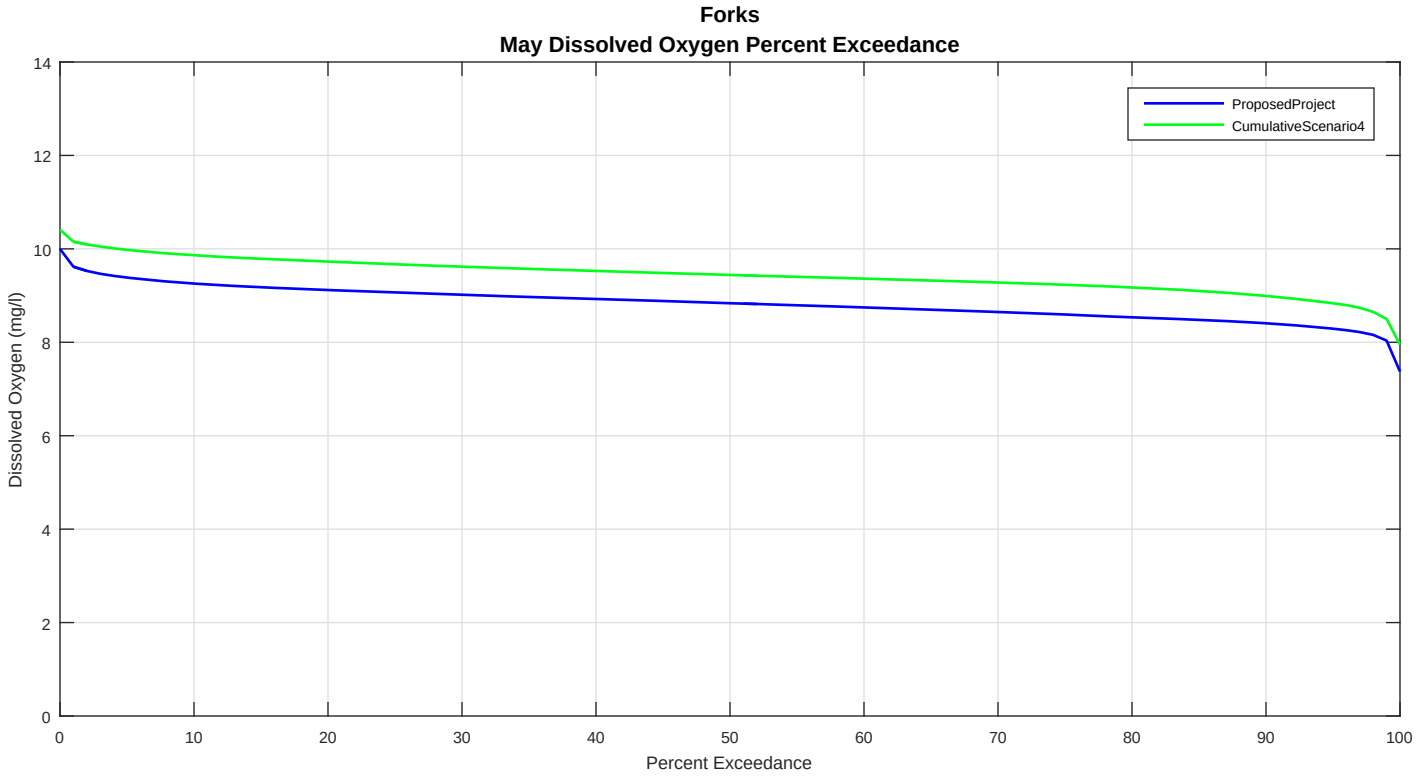
Forks
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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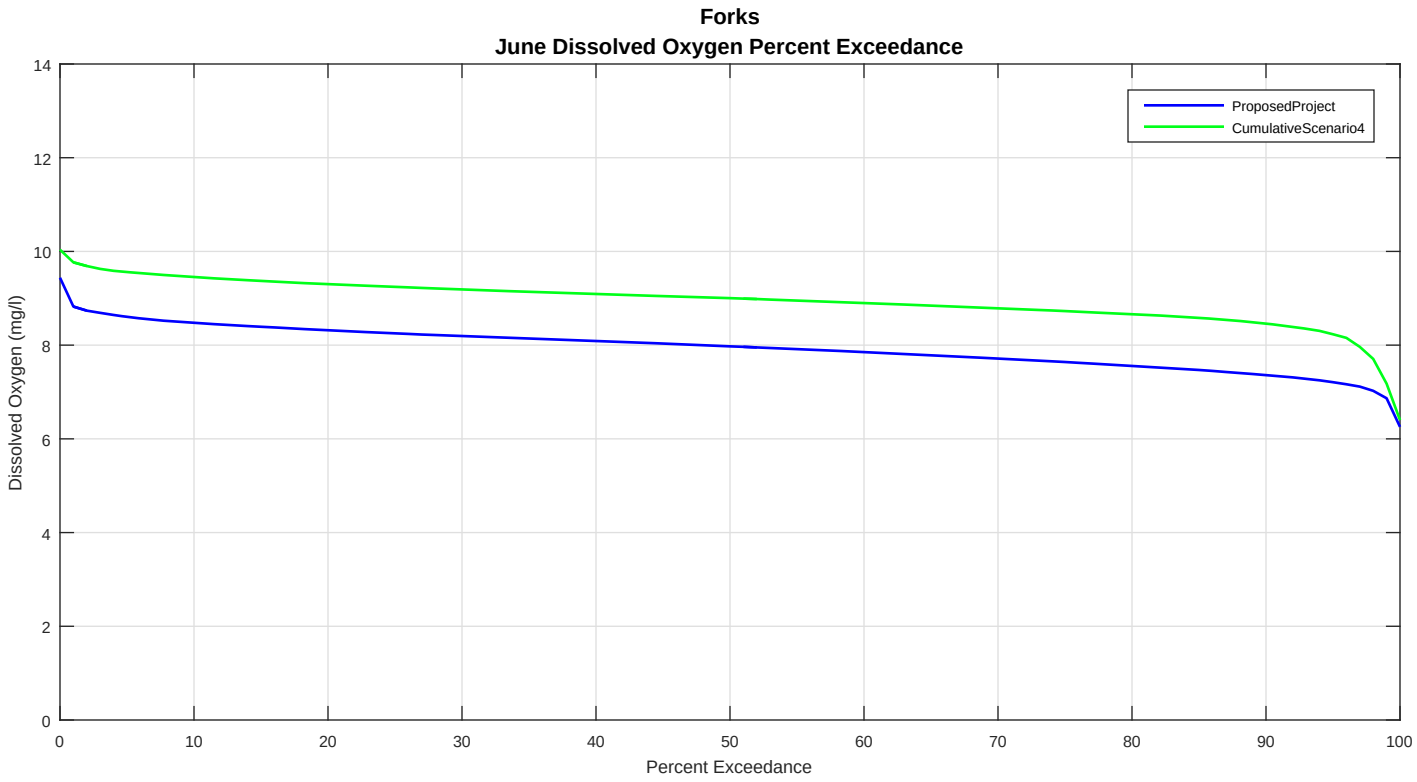
Forks
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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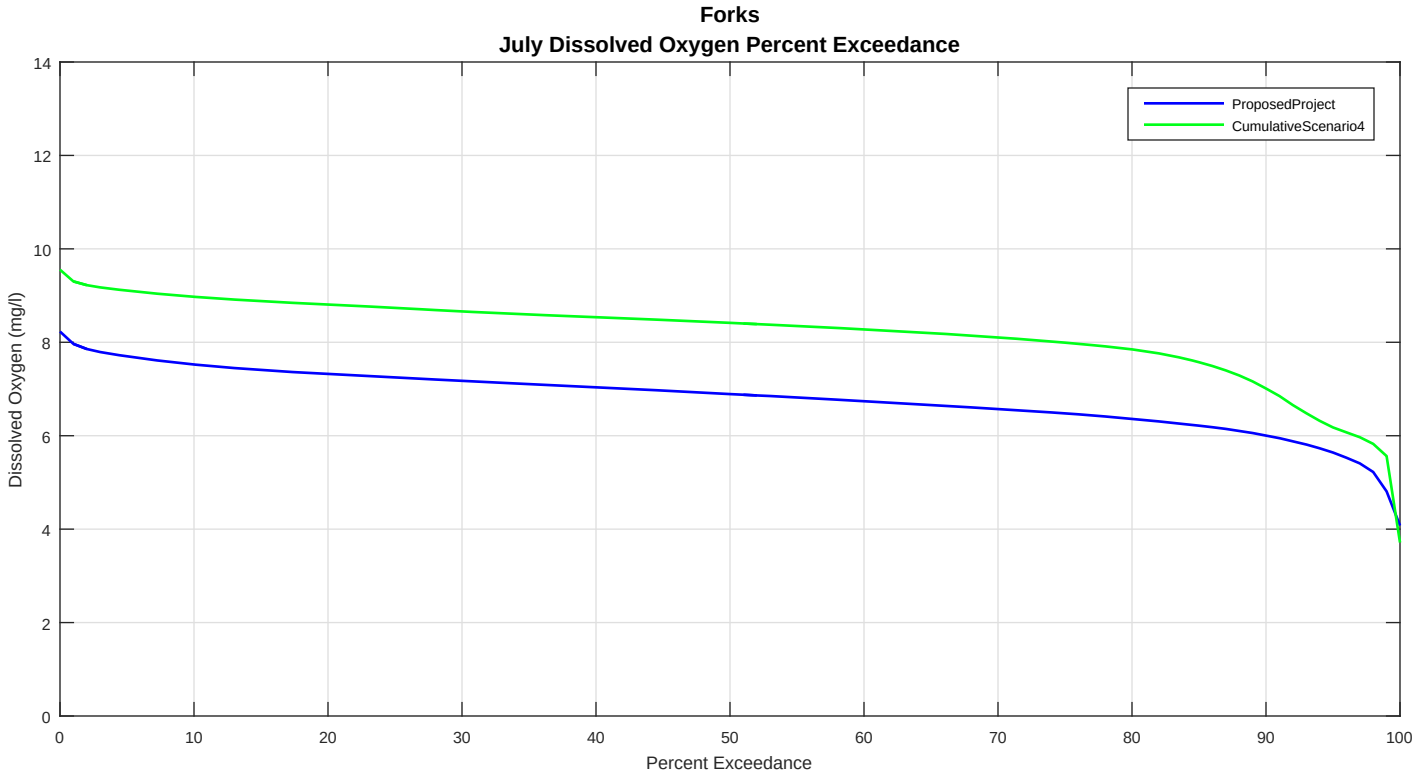
Forks
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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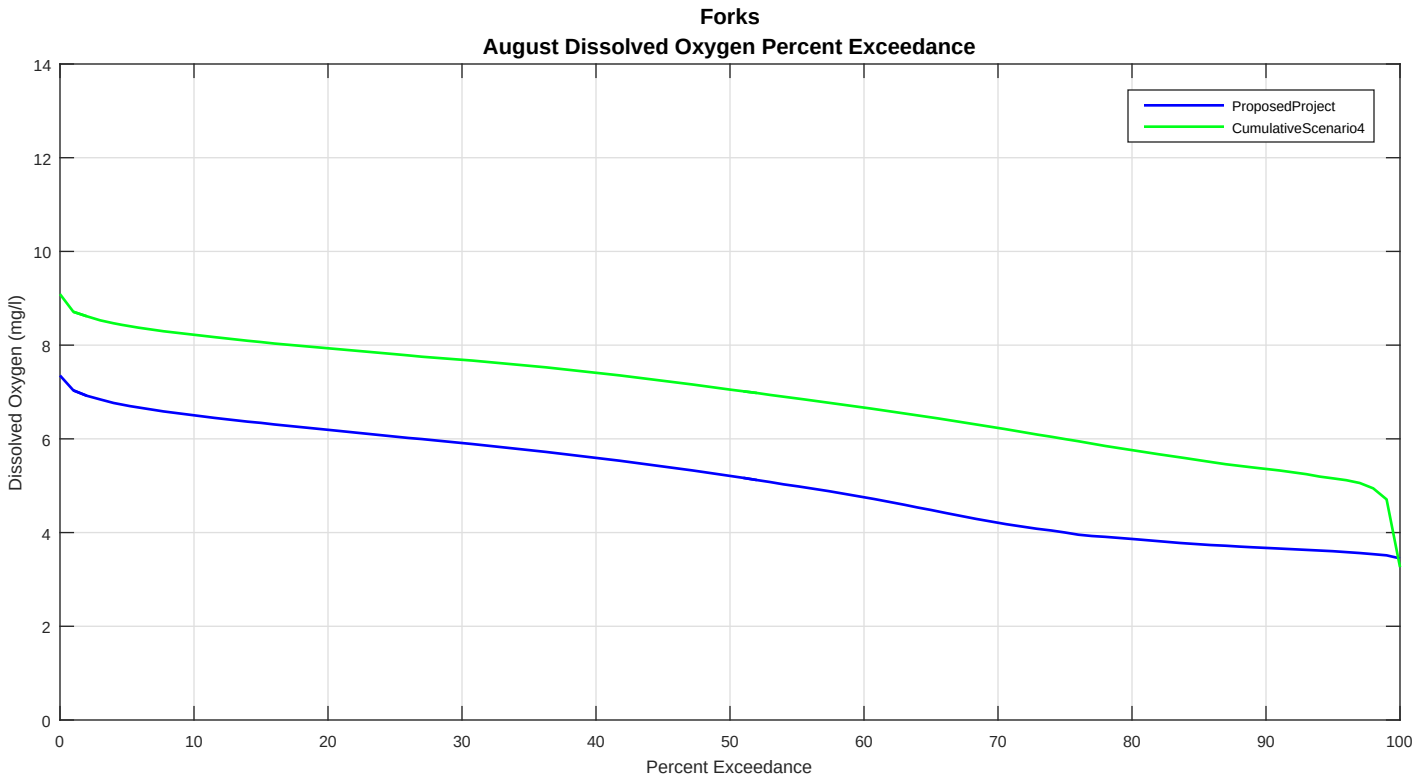
Forks
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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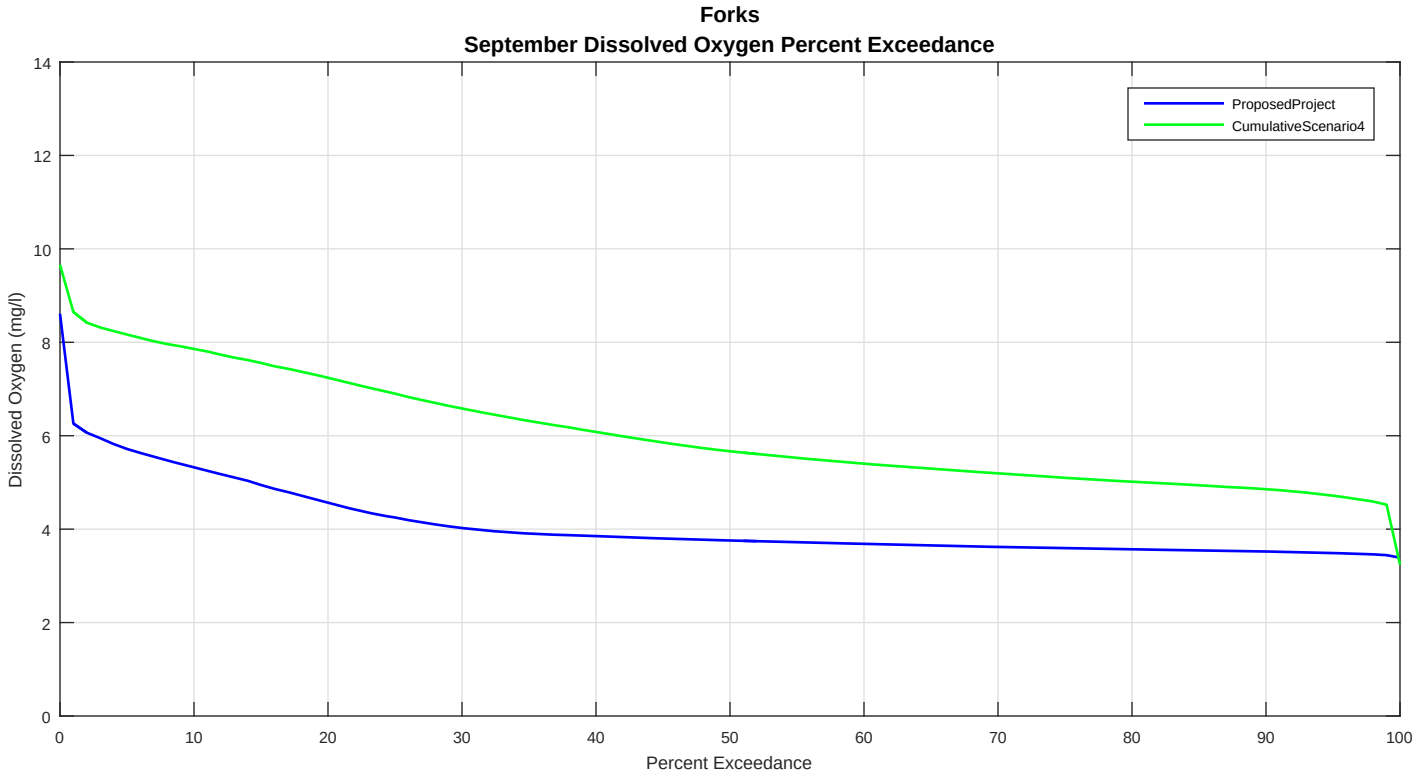
Forks
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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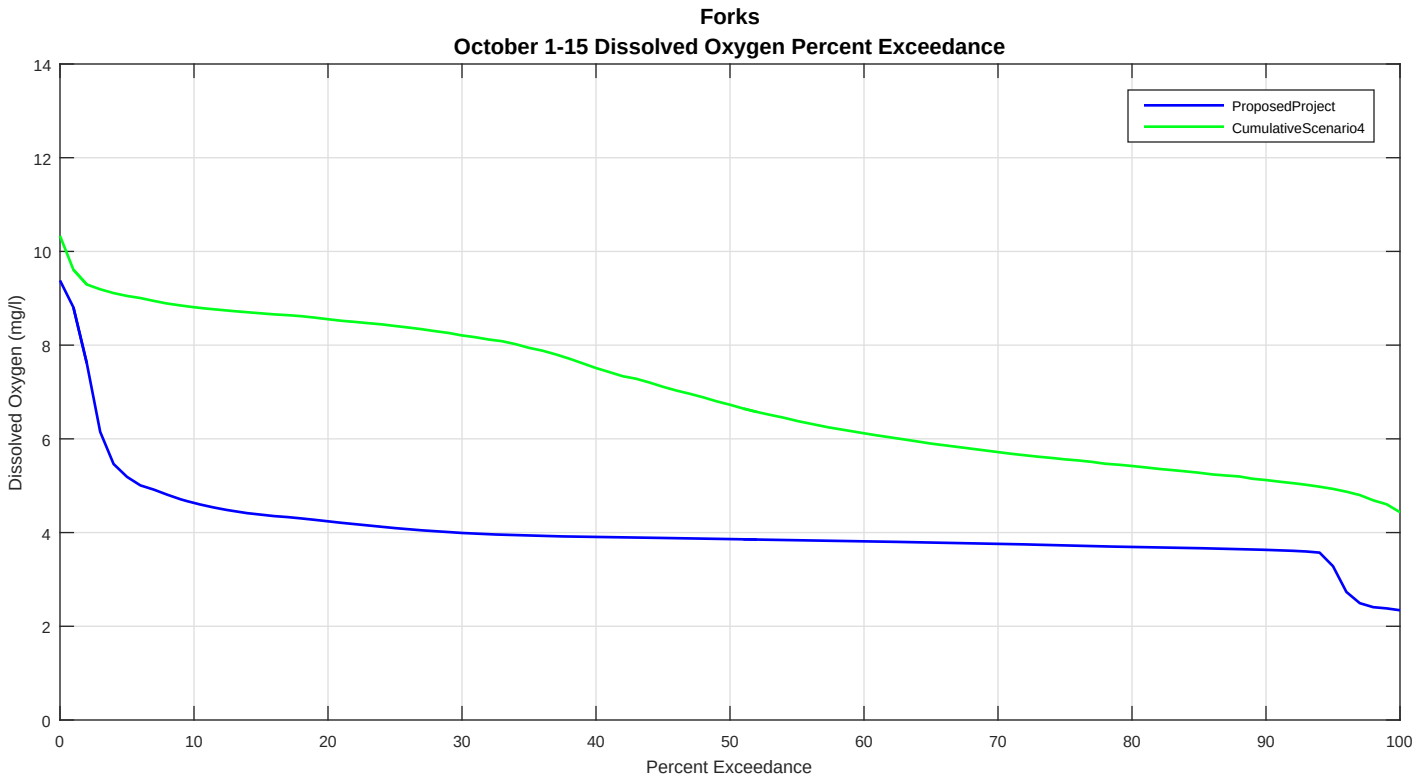
Forks
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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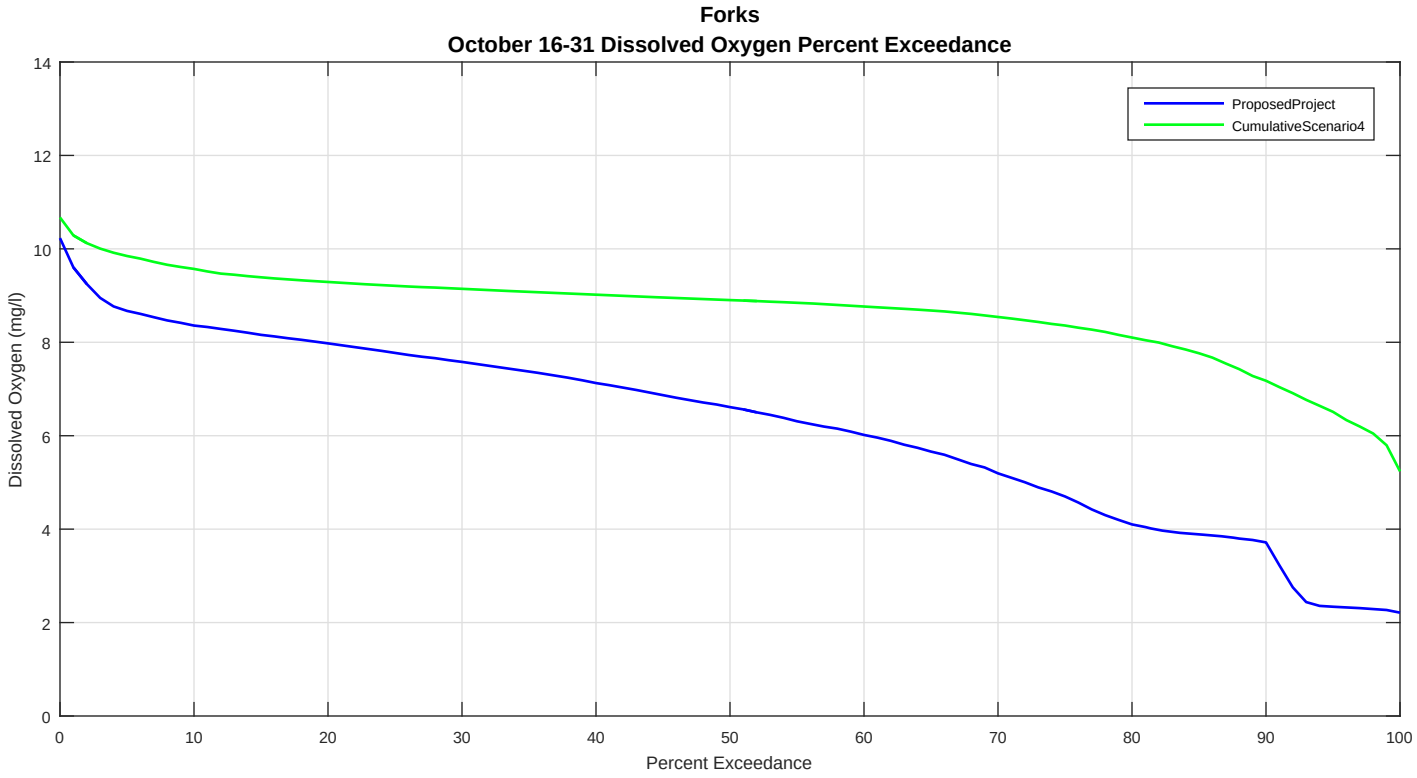
Forks
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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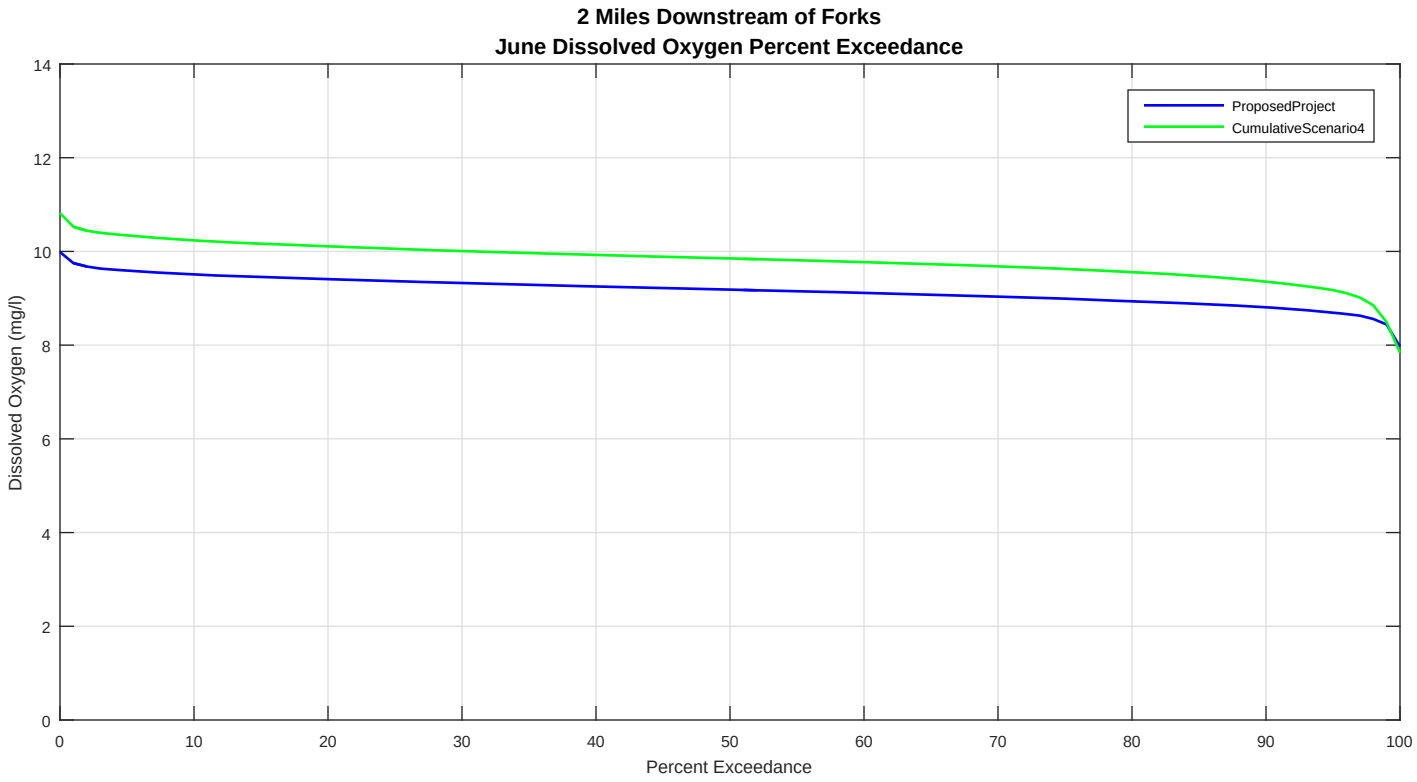
2 Miles Downstream of Forks
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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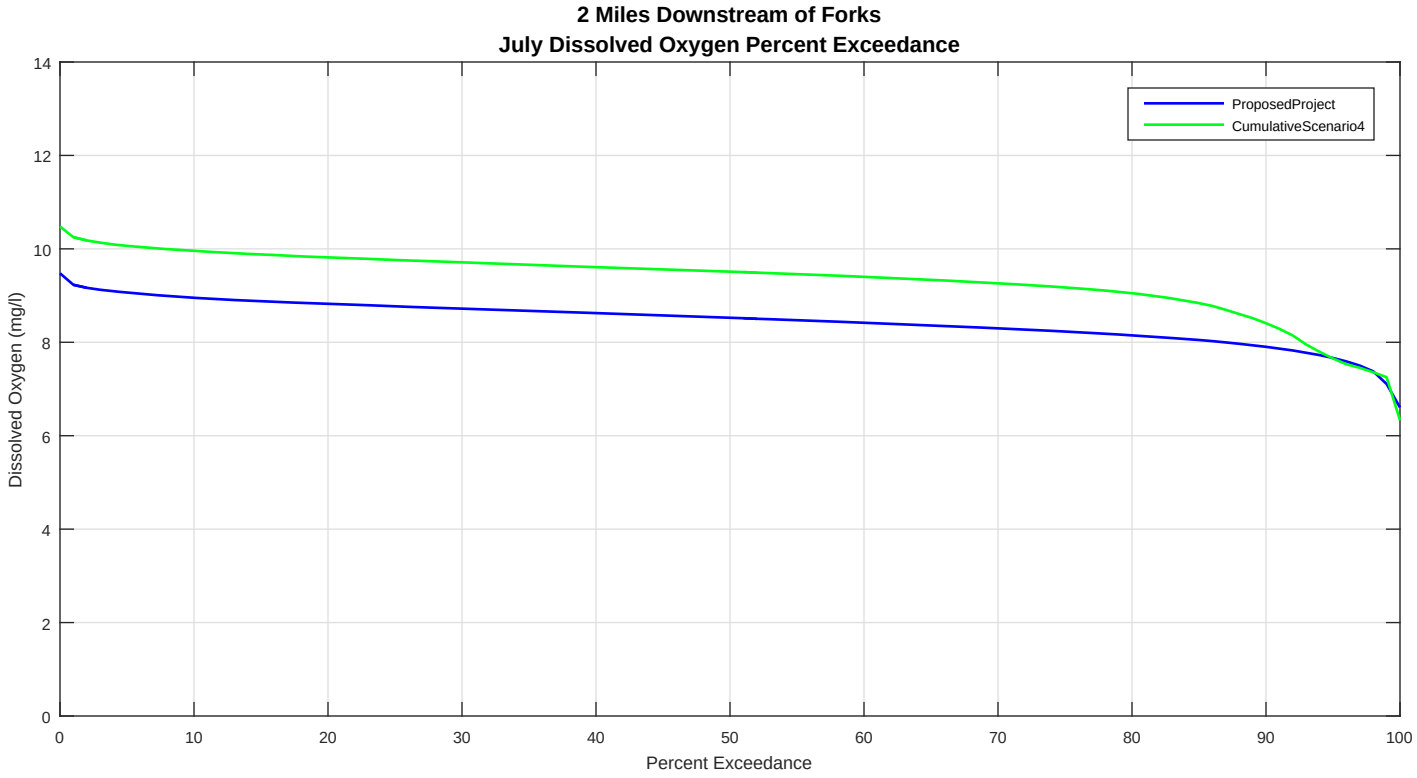
2 Miles Downstream of Forks
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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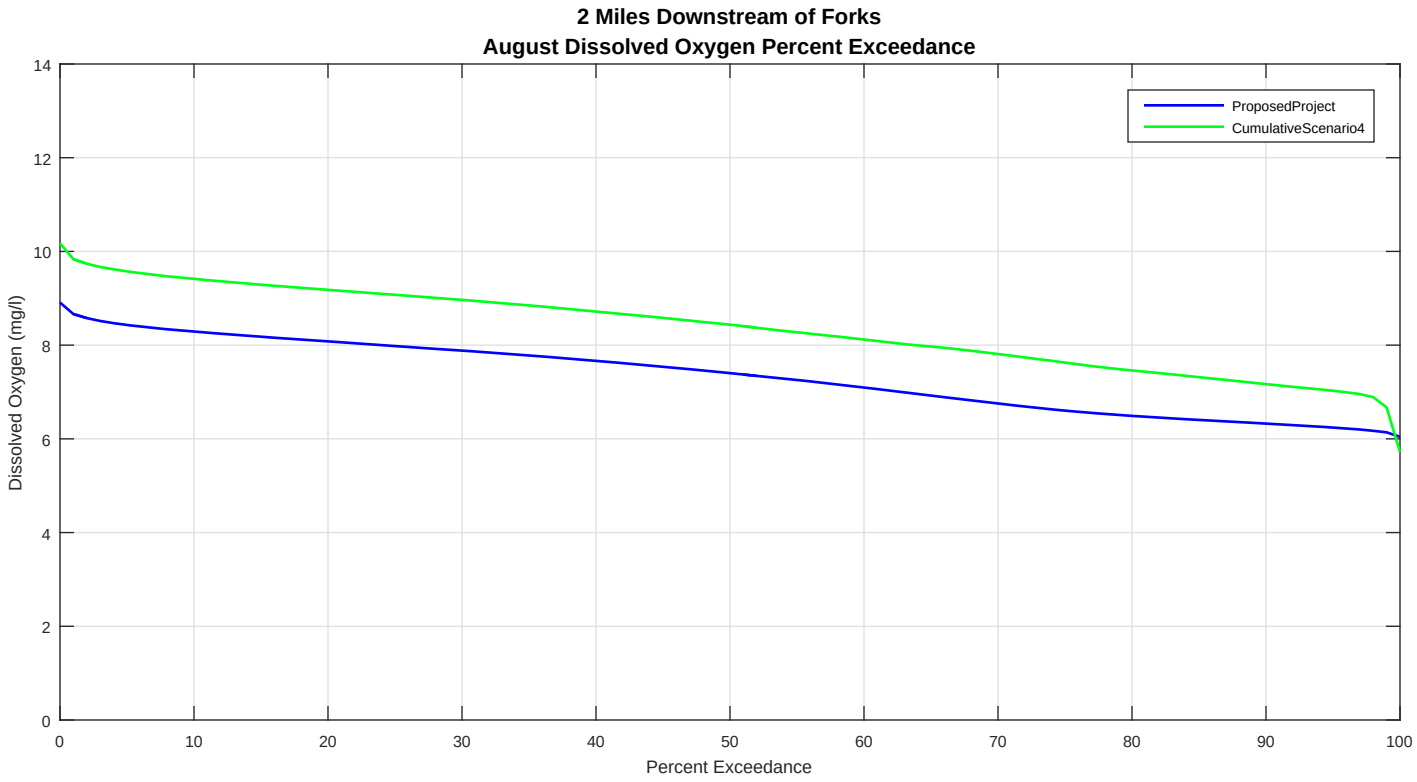
2 Miles Downstream of Forks
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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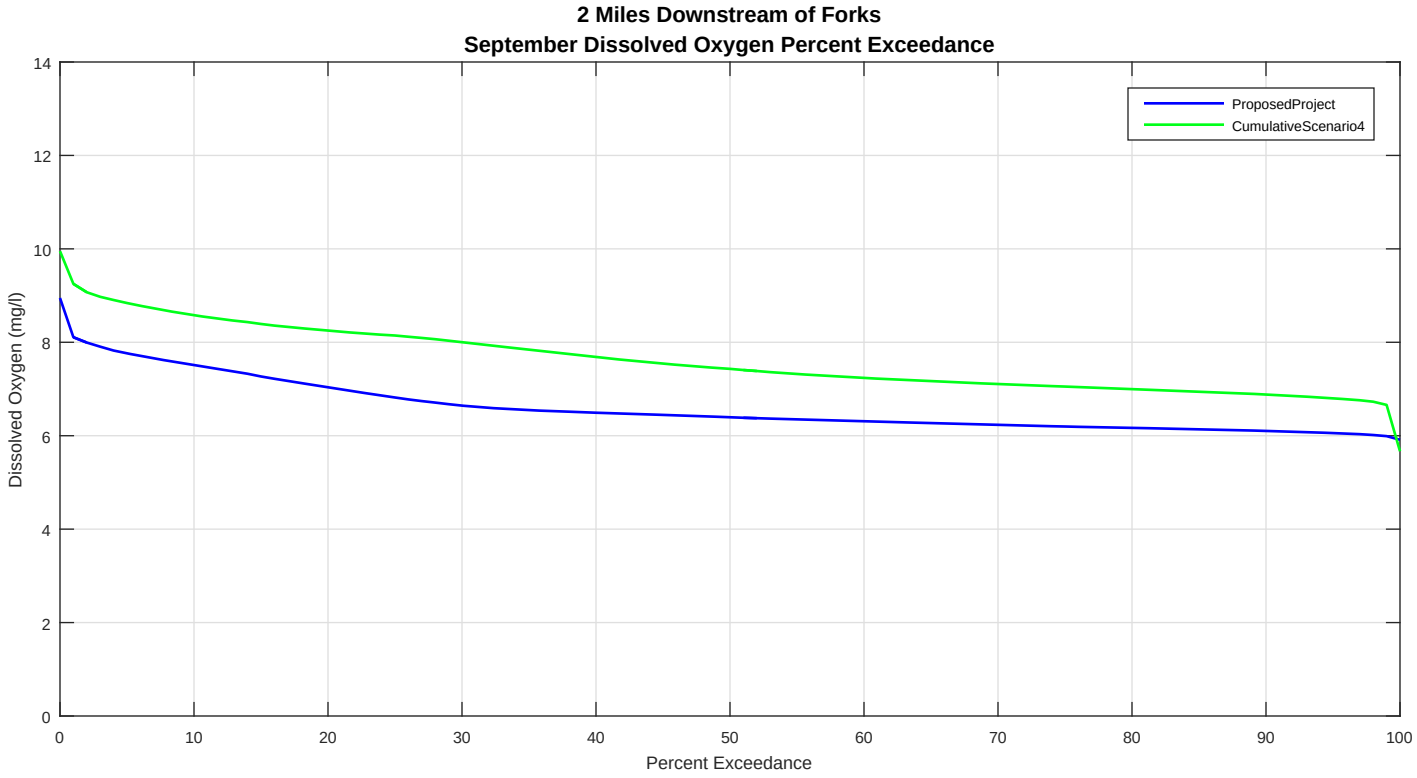
2 Miles Downstream of Forks
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
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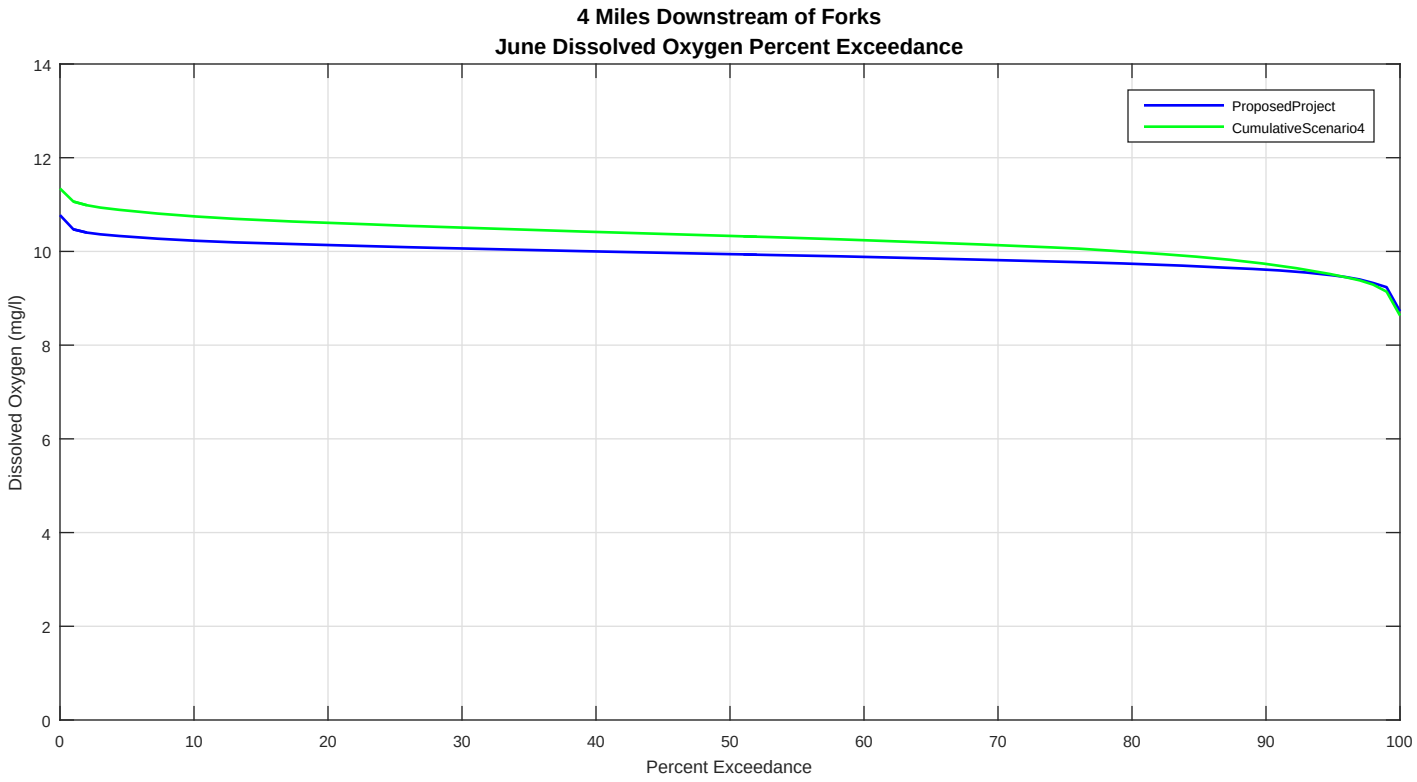
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June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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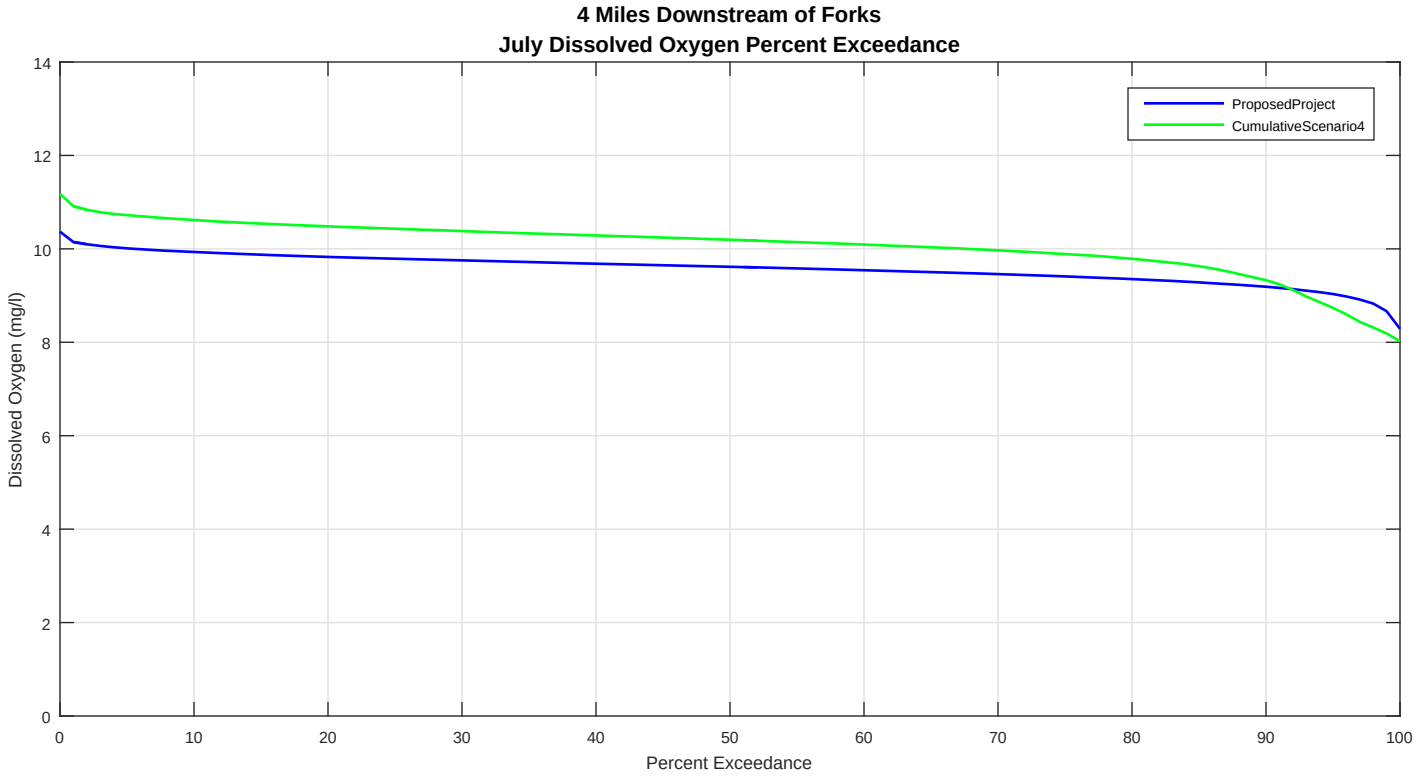
4 Miles Downstream of Forks
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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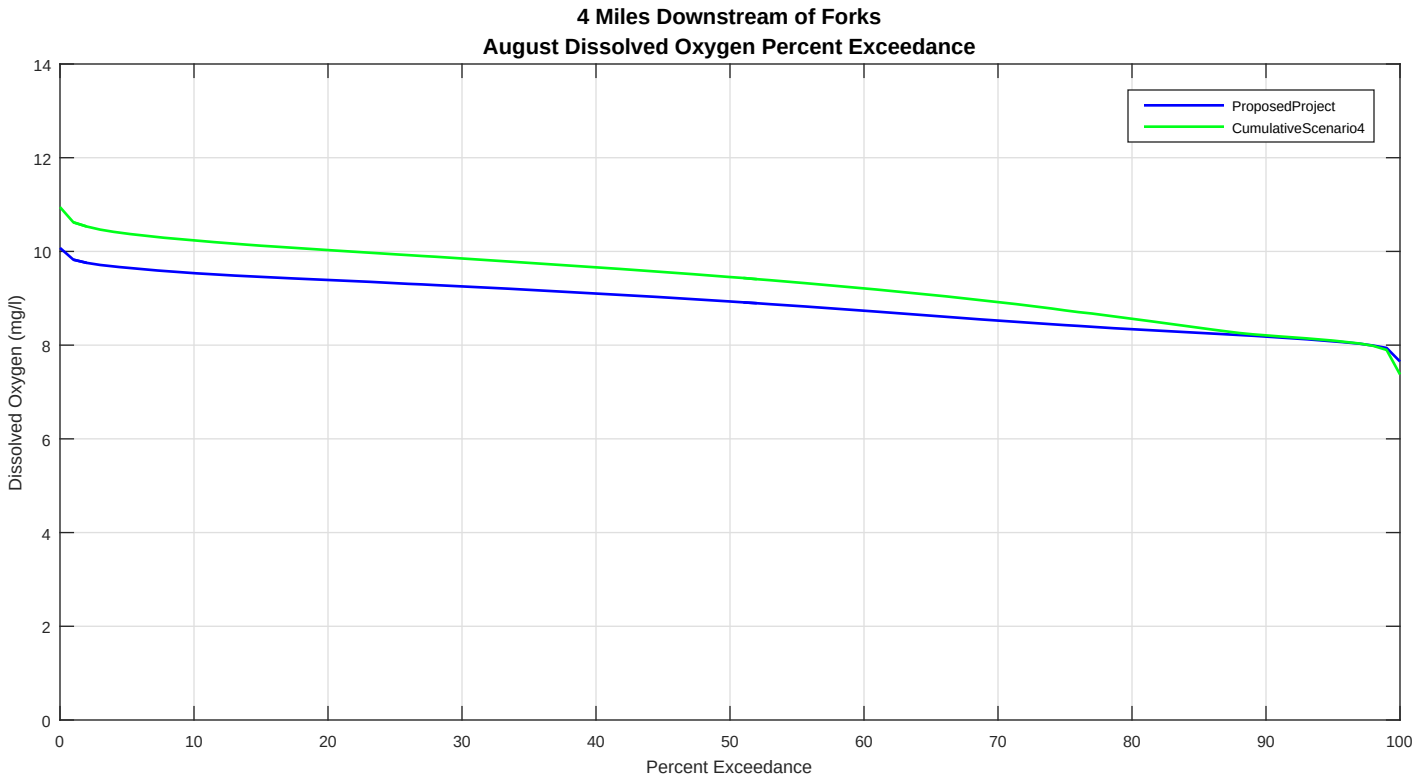
4 Miles Downstream of Forks
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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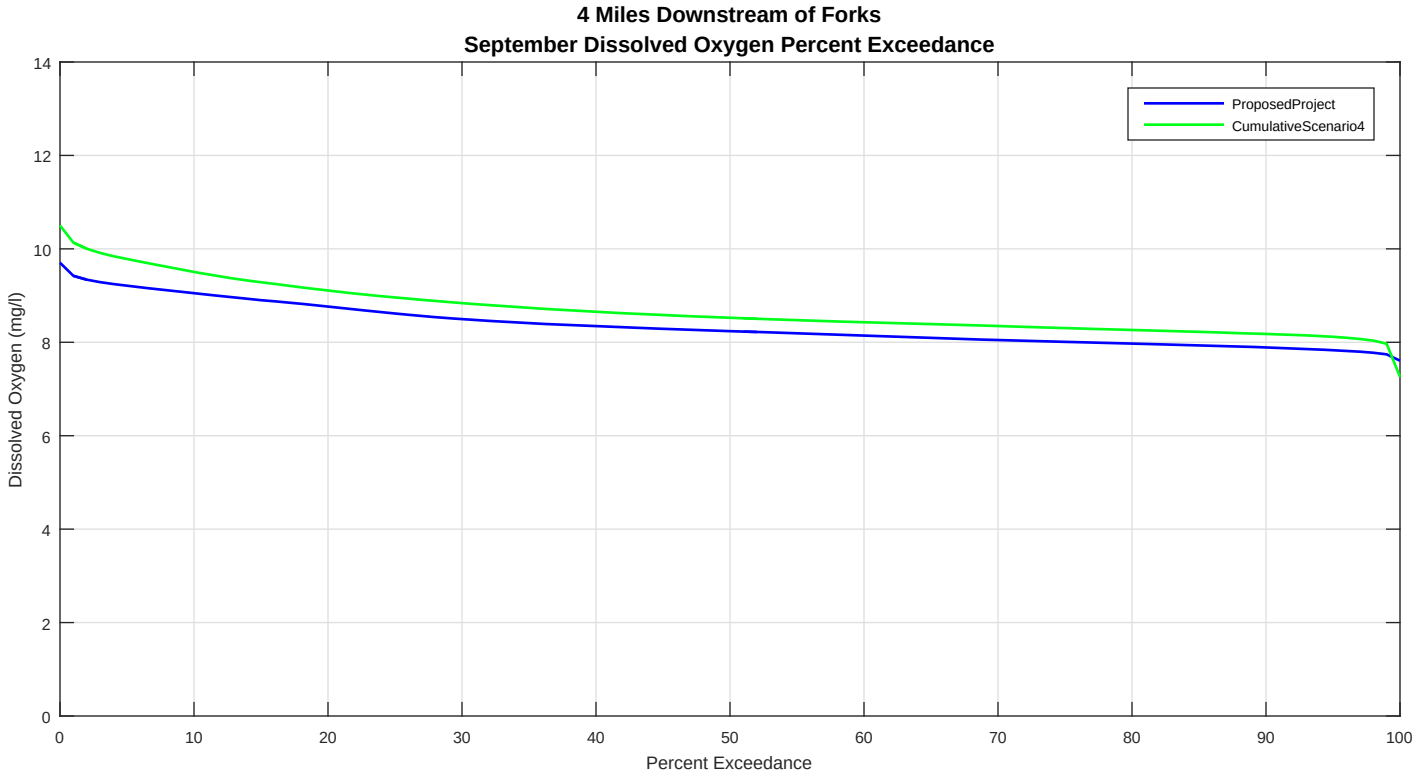
4 Miles Downstream of Forks
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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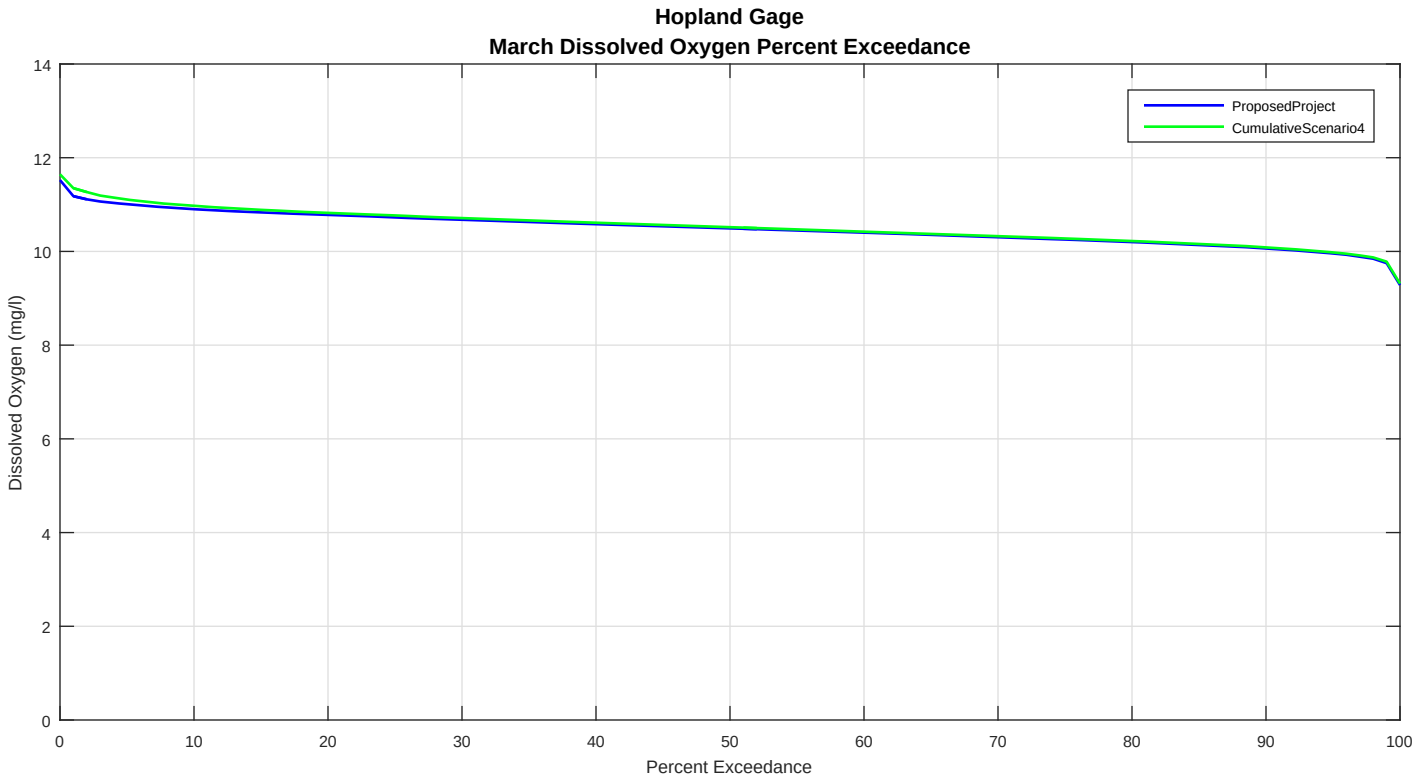
Hopland Gage
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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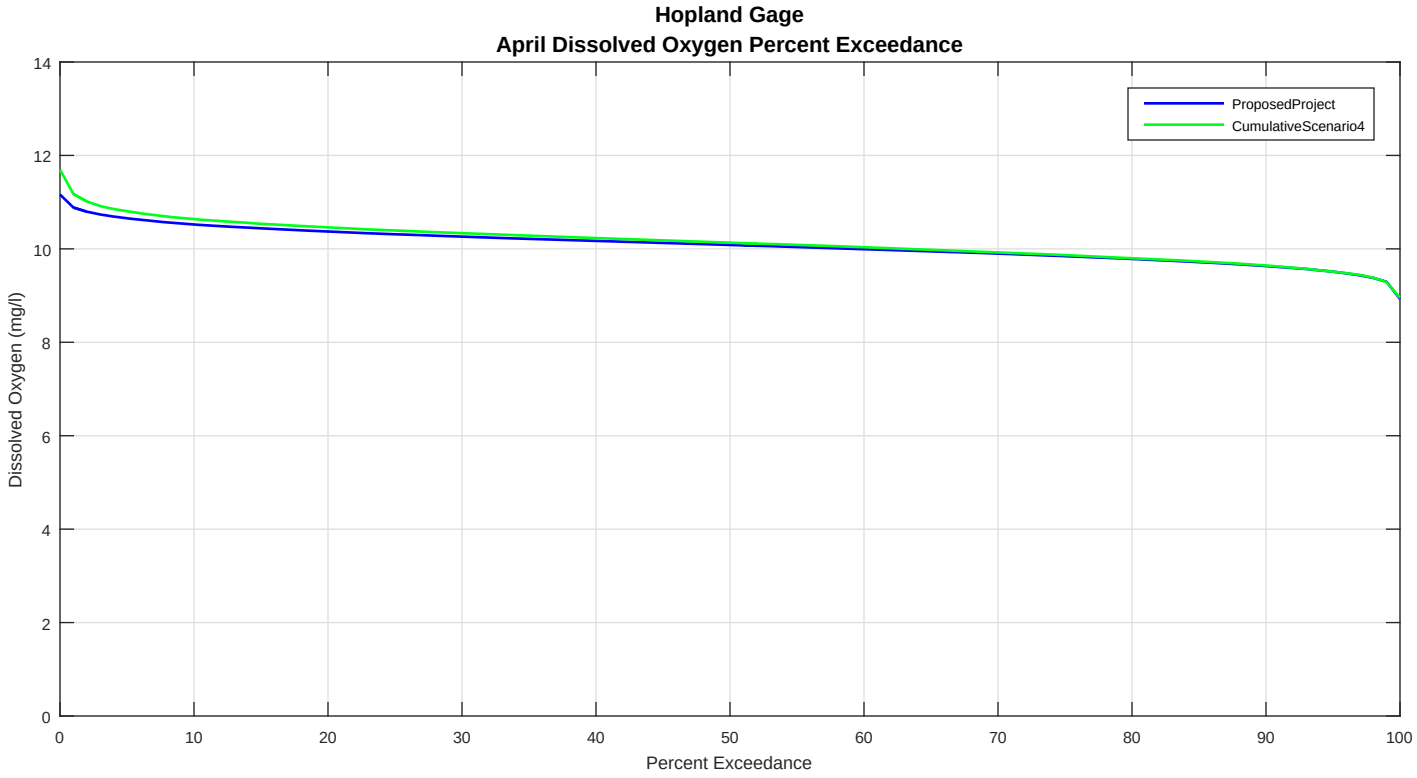
Hopland Gage
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
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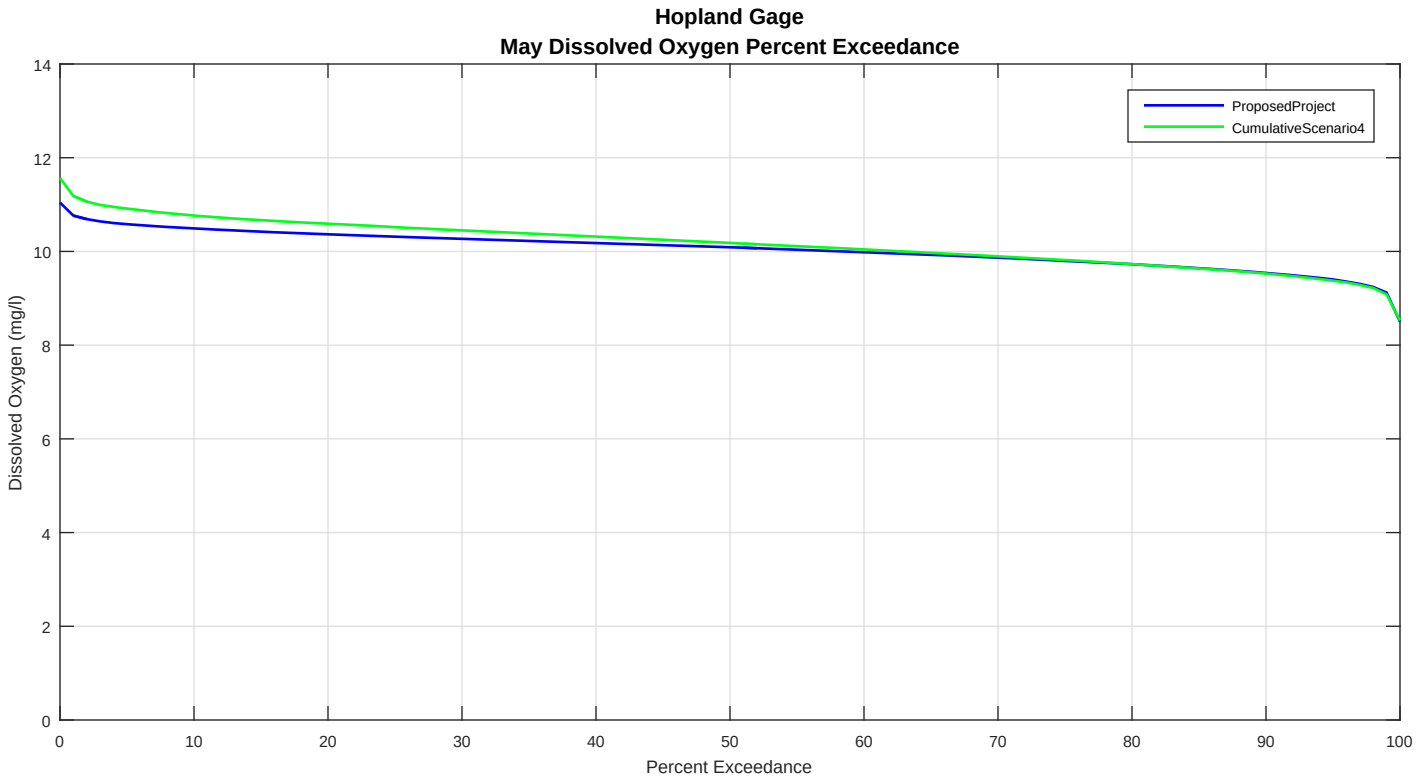
Hopland Gage
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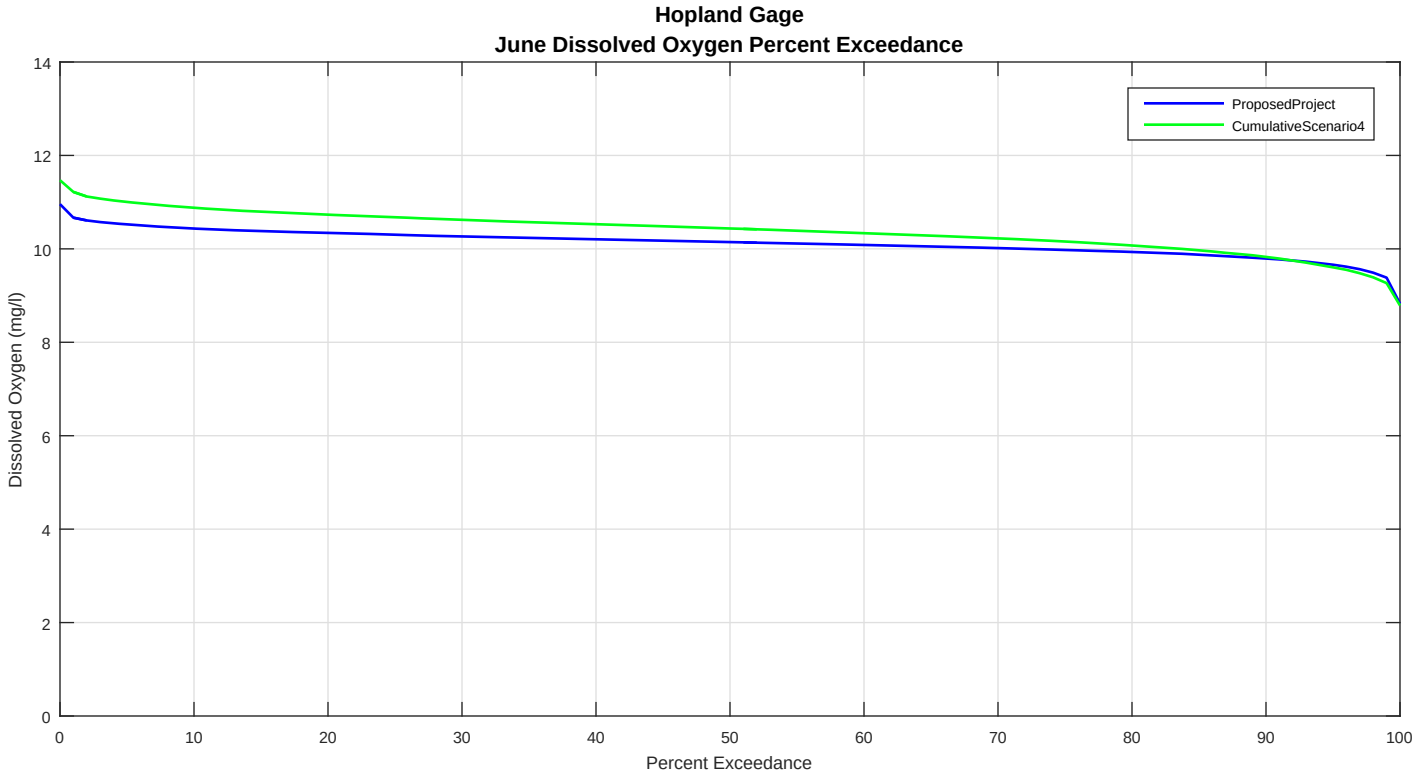
Hopland Gage
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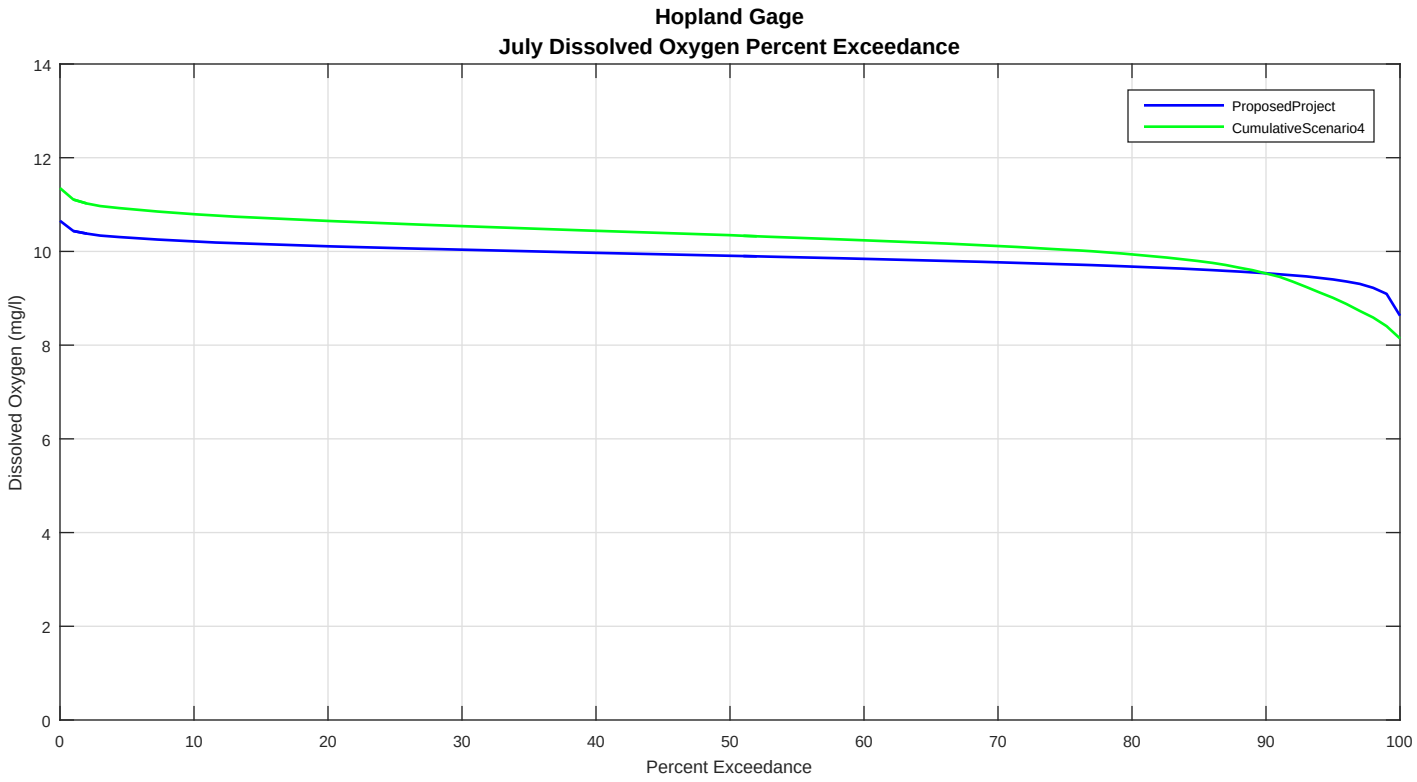
Hopland Gage
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
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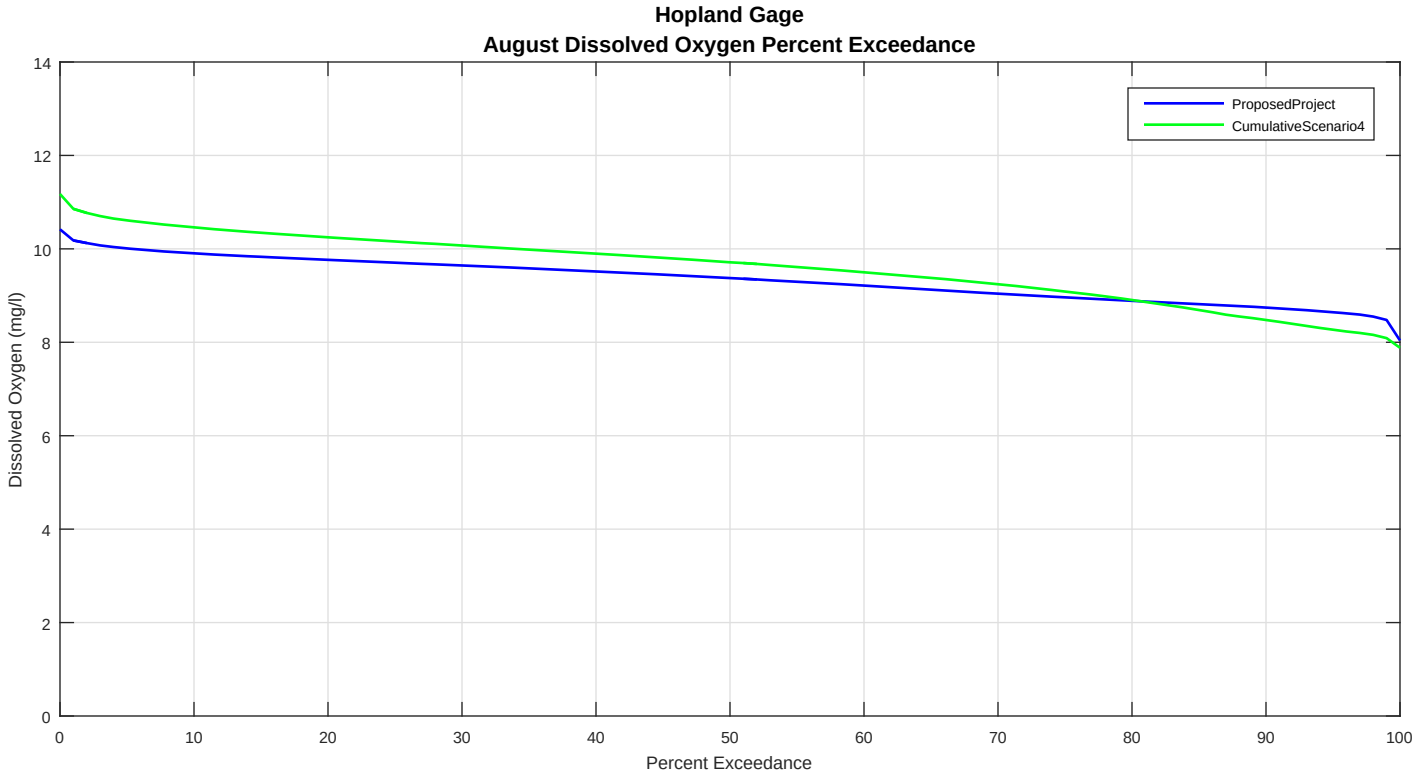
Hopland Gage
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ProposedProject
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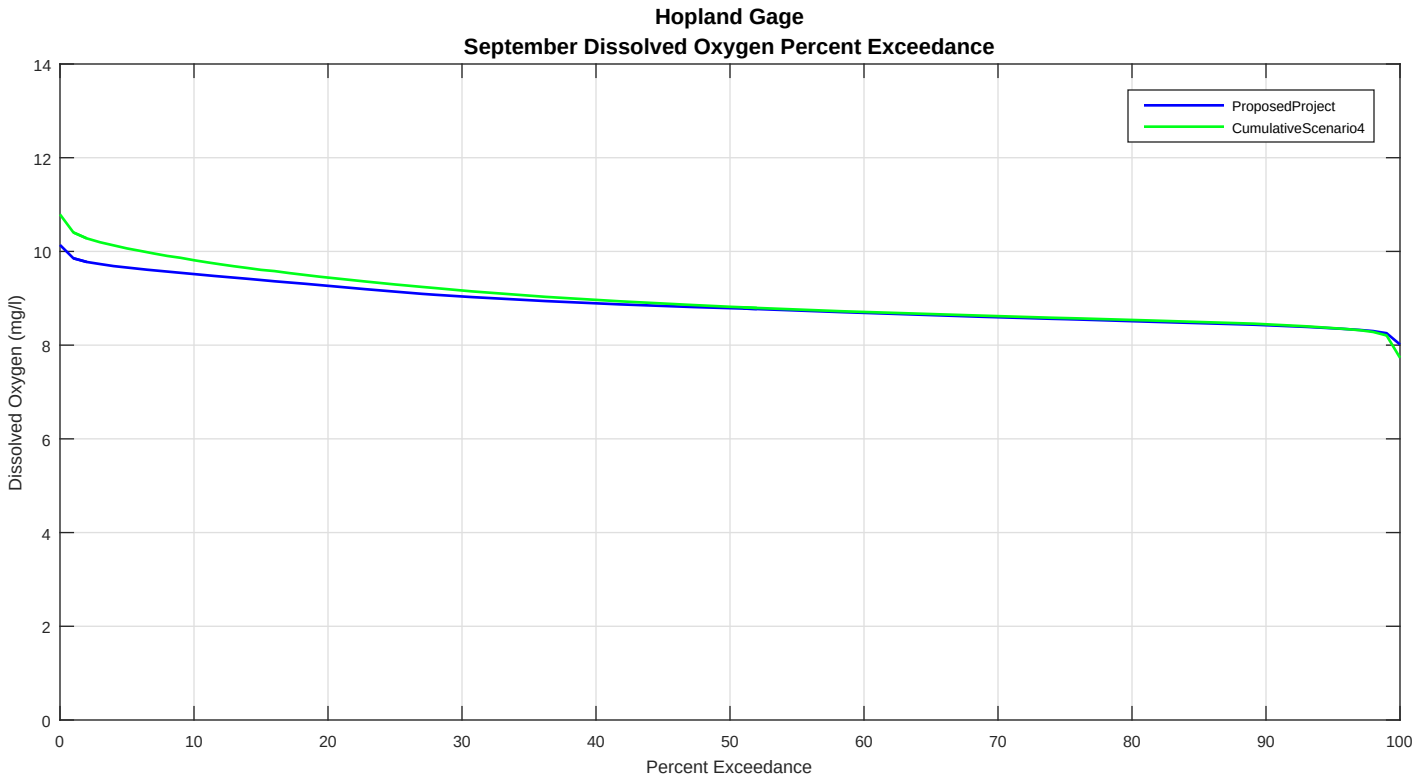
Hopland Gage
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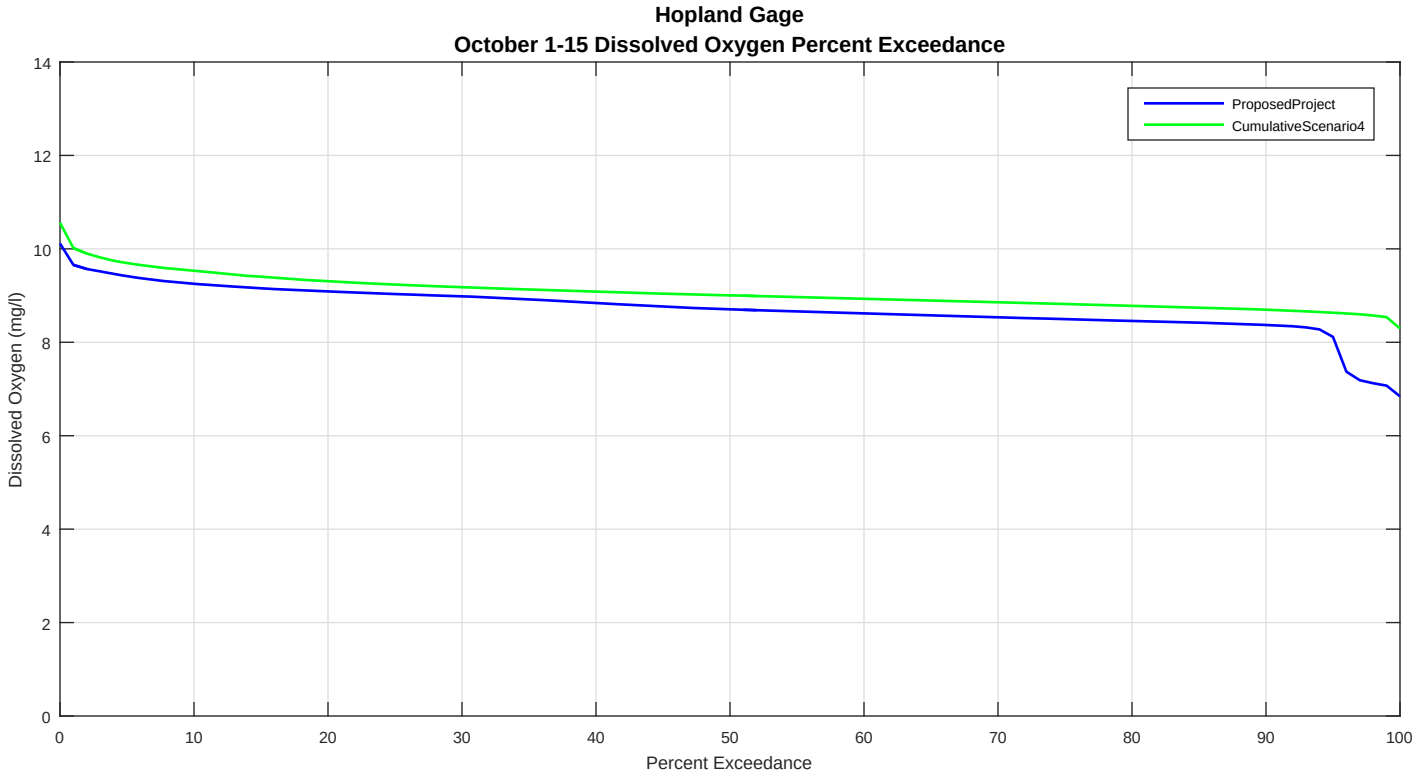
Hopland Gage
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
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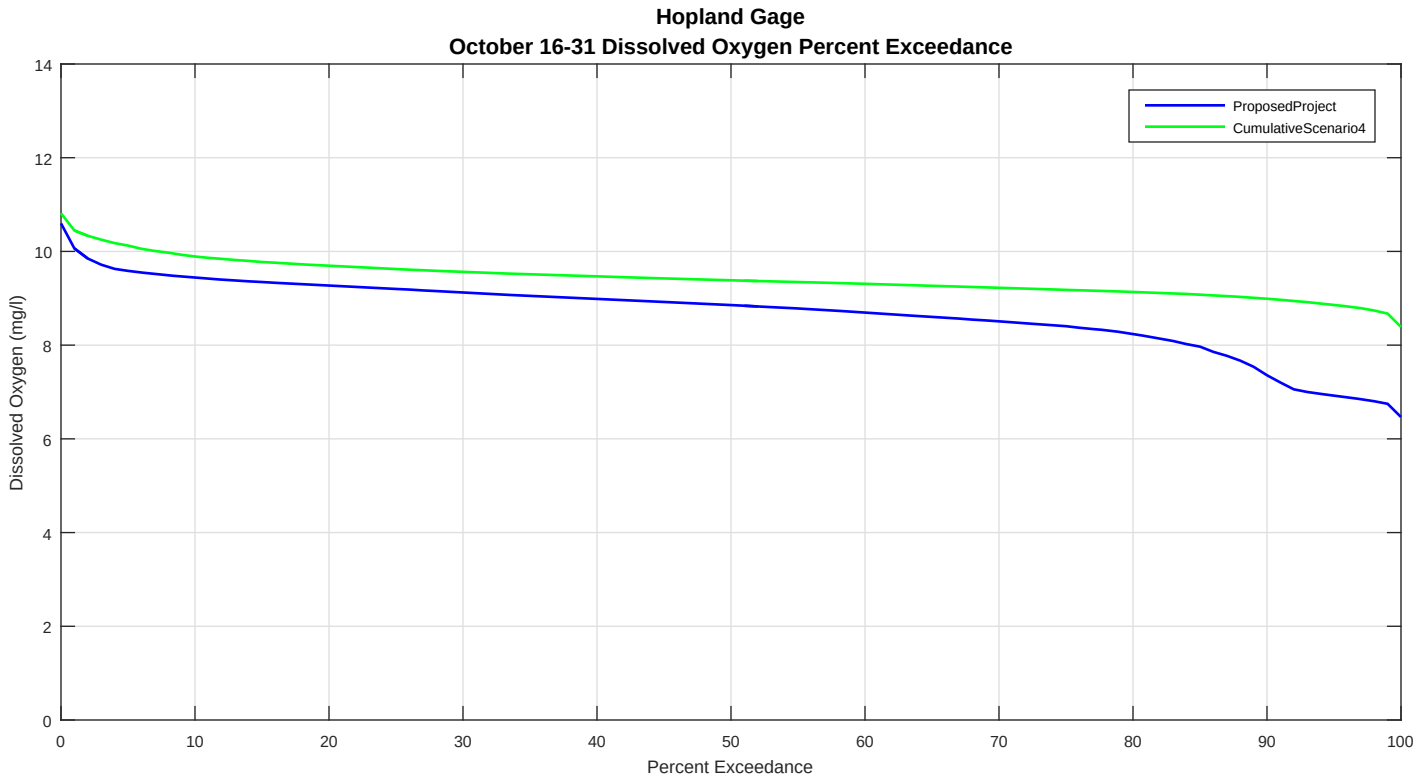
Hopland Gage
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
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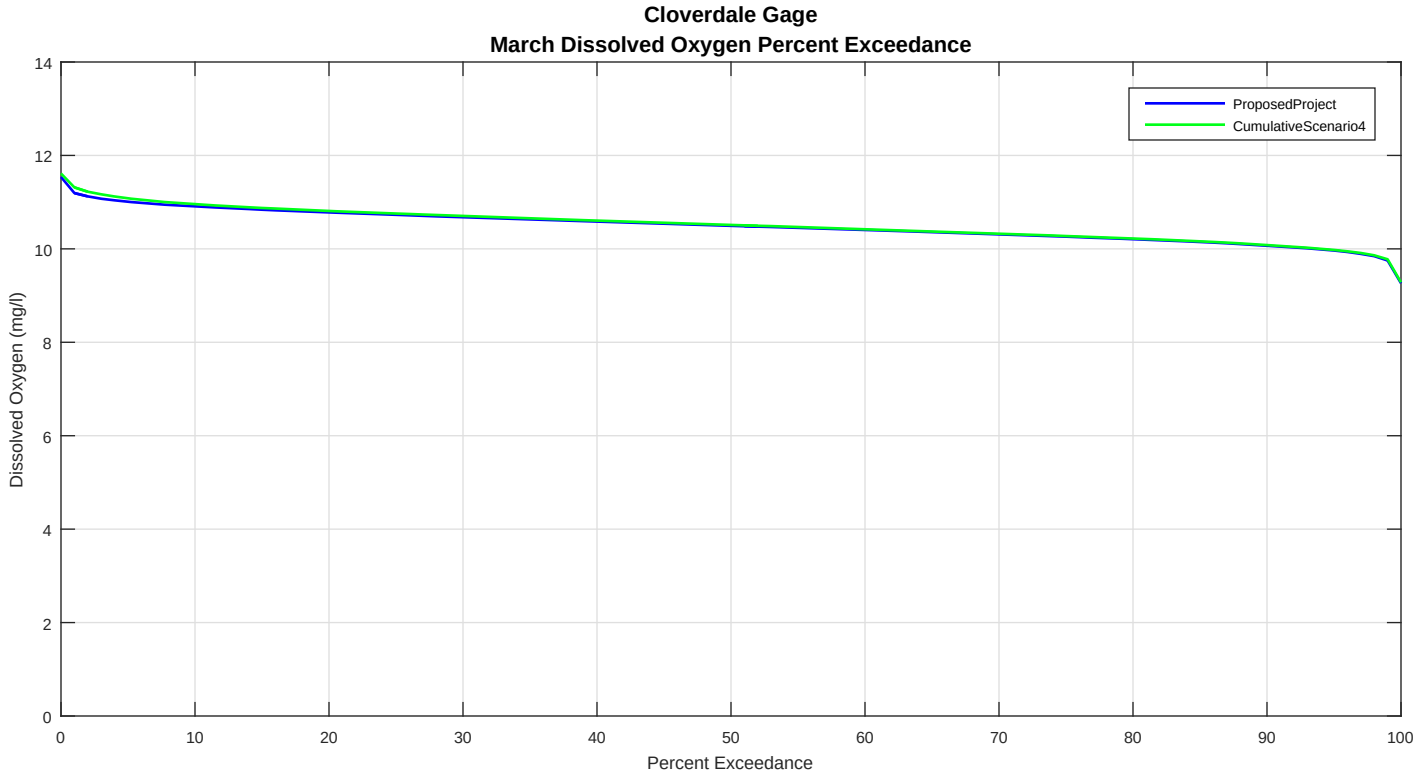
Cloverdale Gage
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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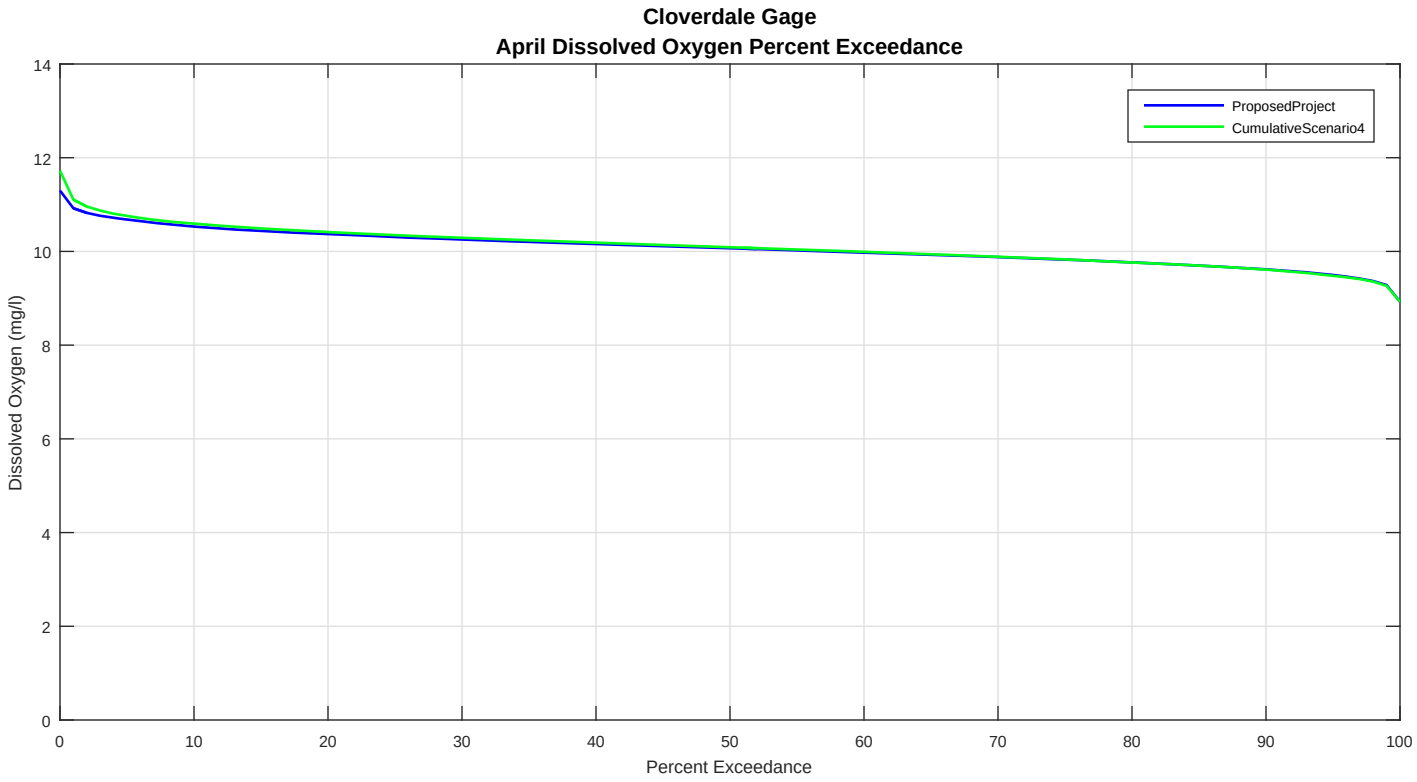
Cloverdale Gage
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
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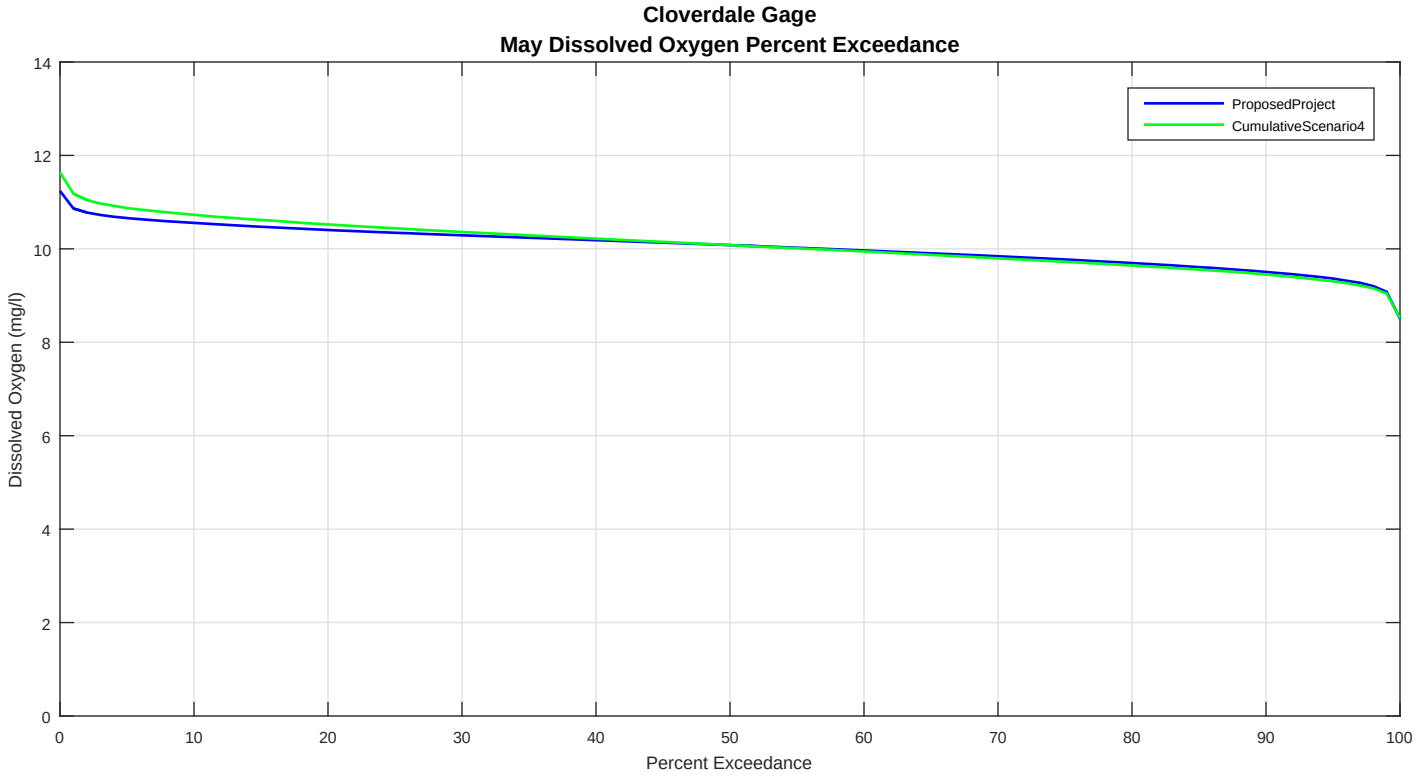
Cloverdale Gage
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
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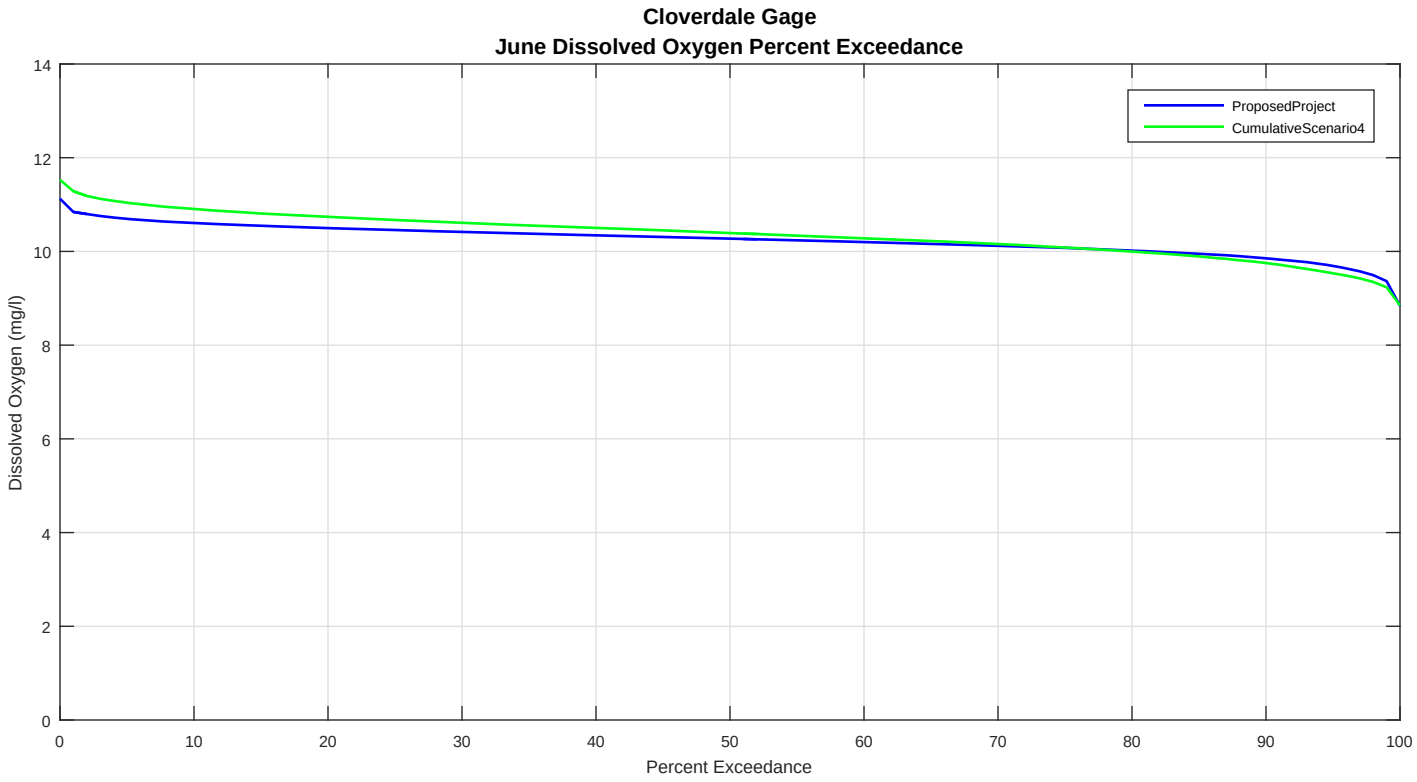
Cloverdale Gage
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
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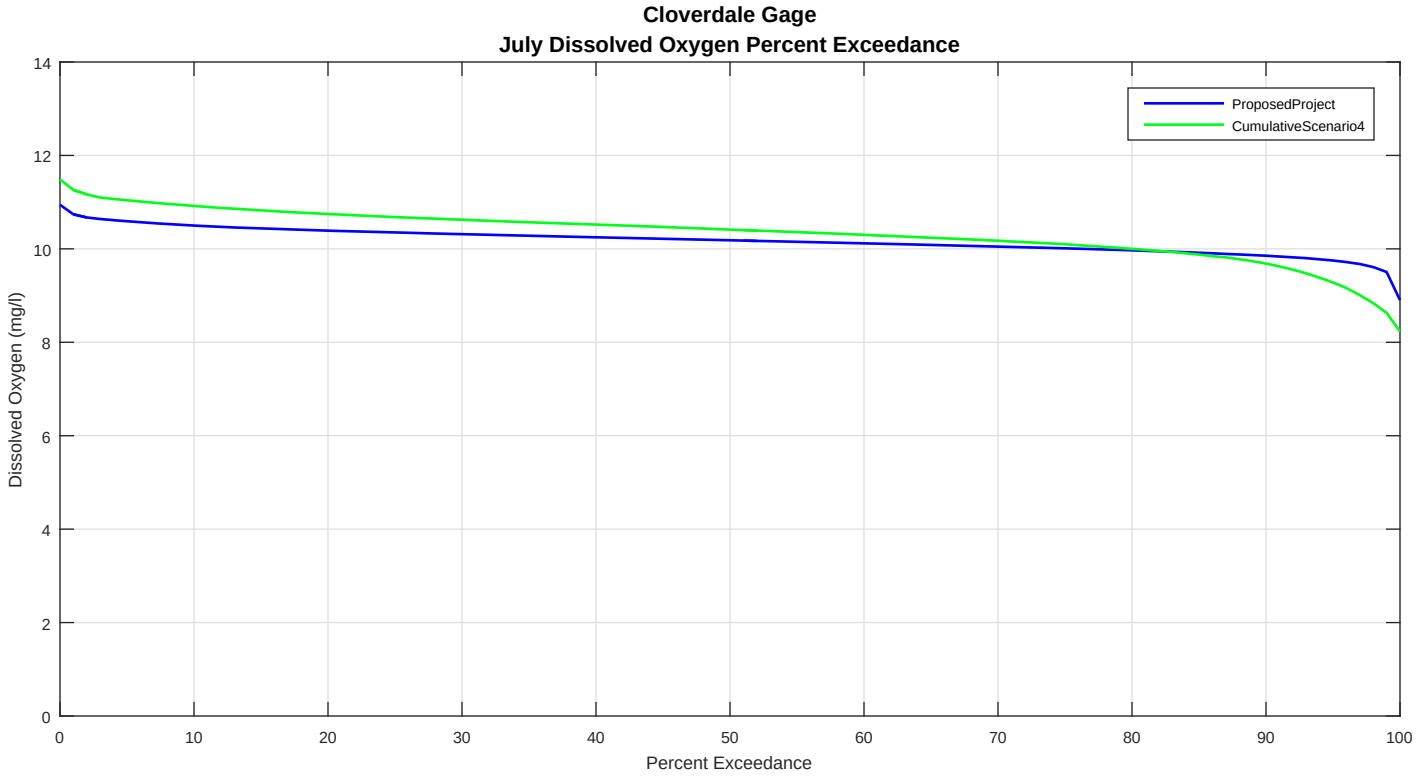
Cloverdale Gage
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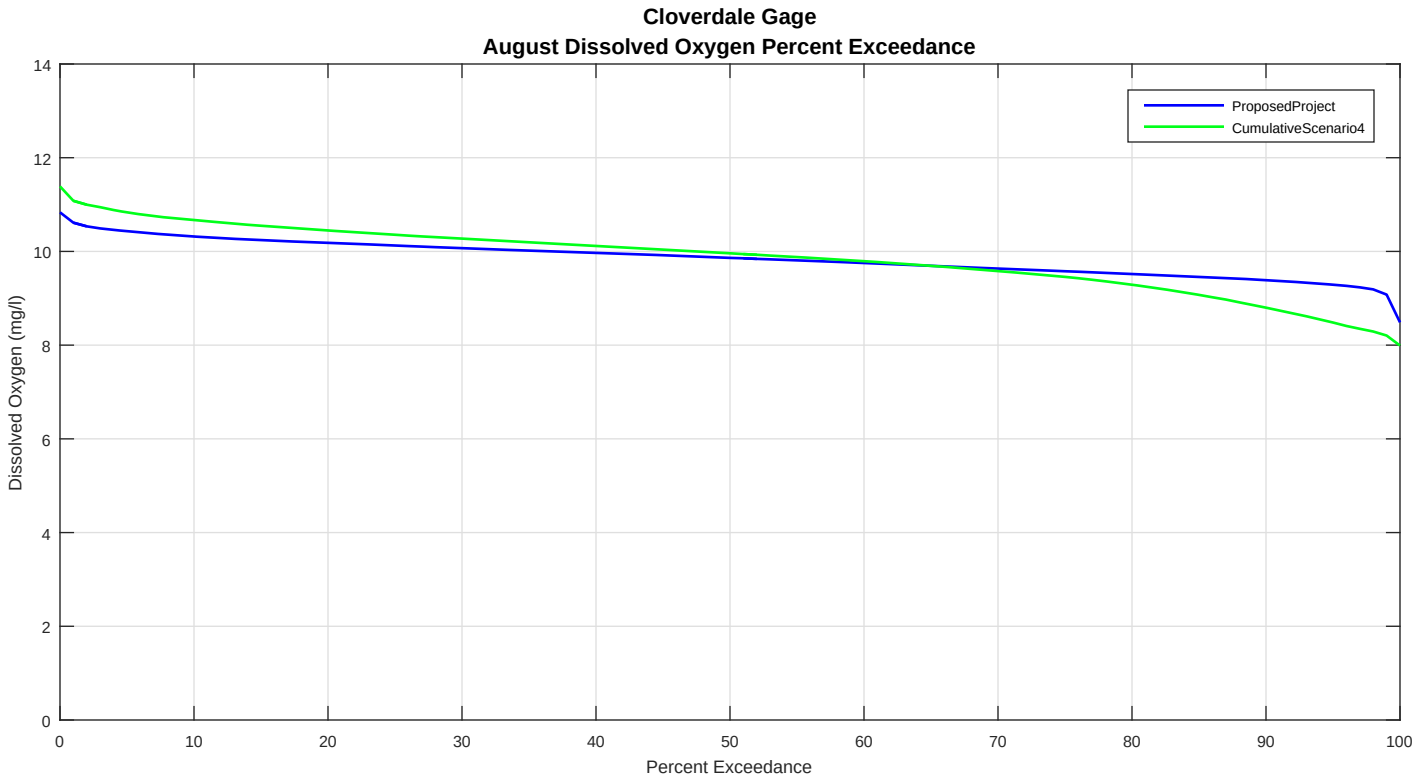
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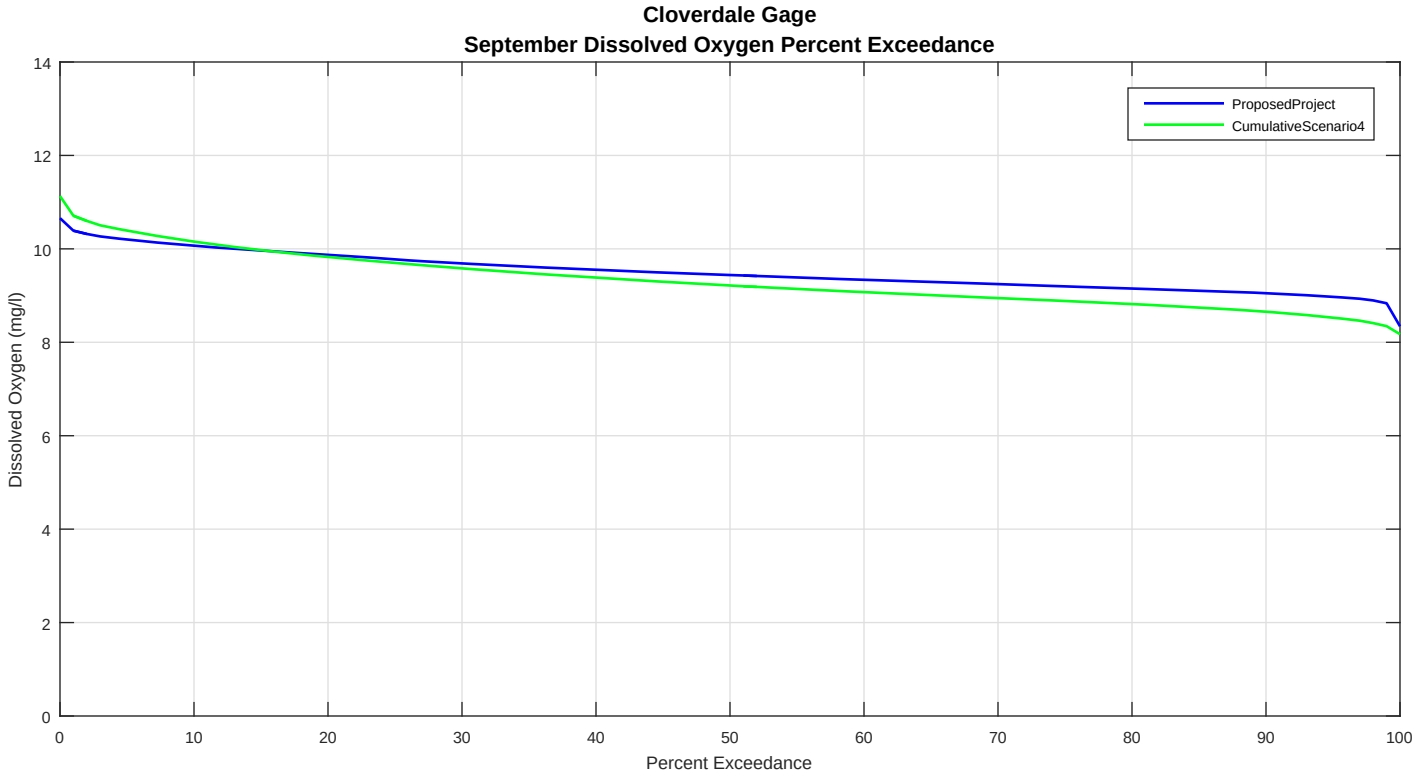
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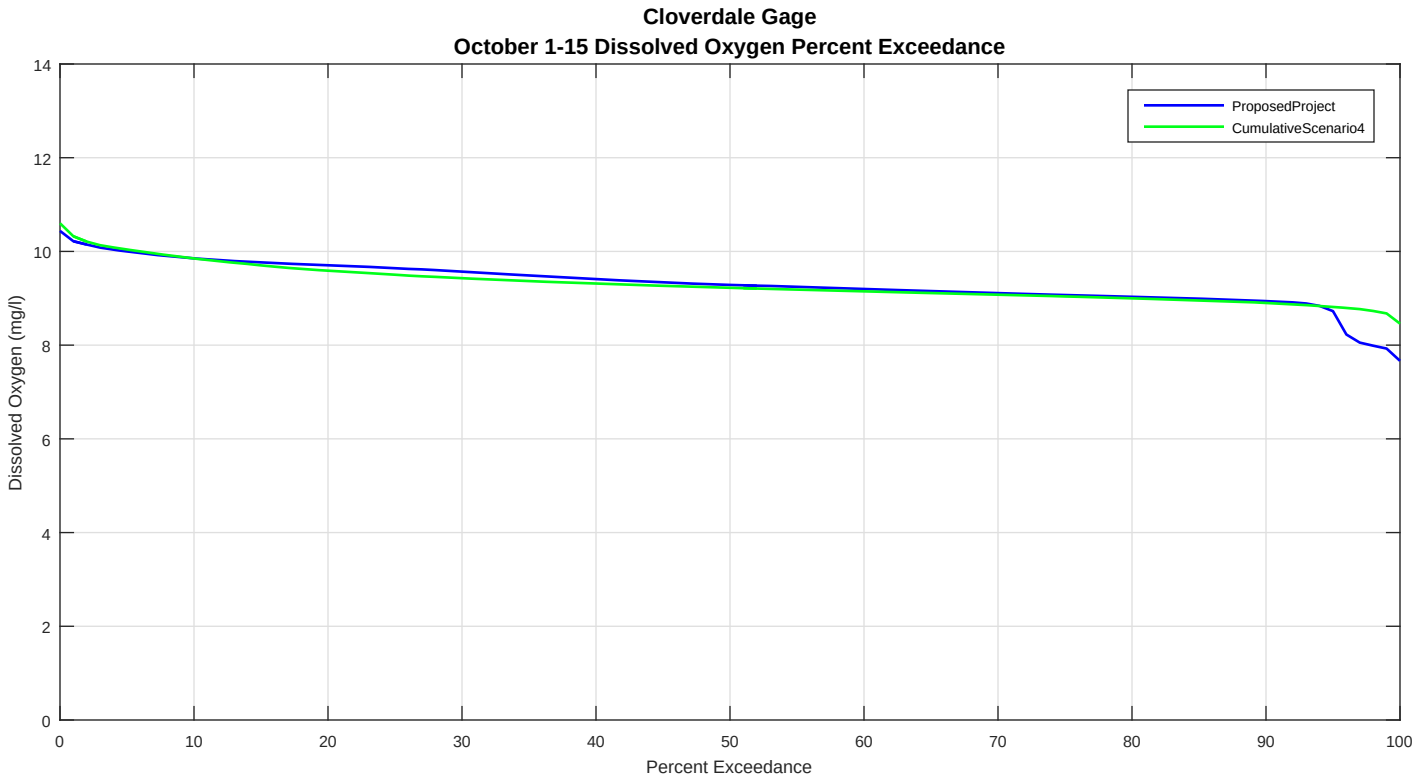
Cloverdale Gage
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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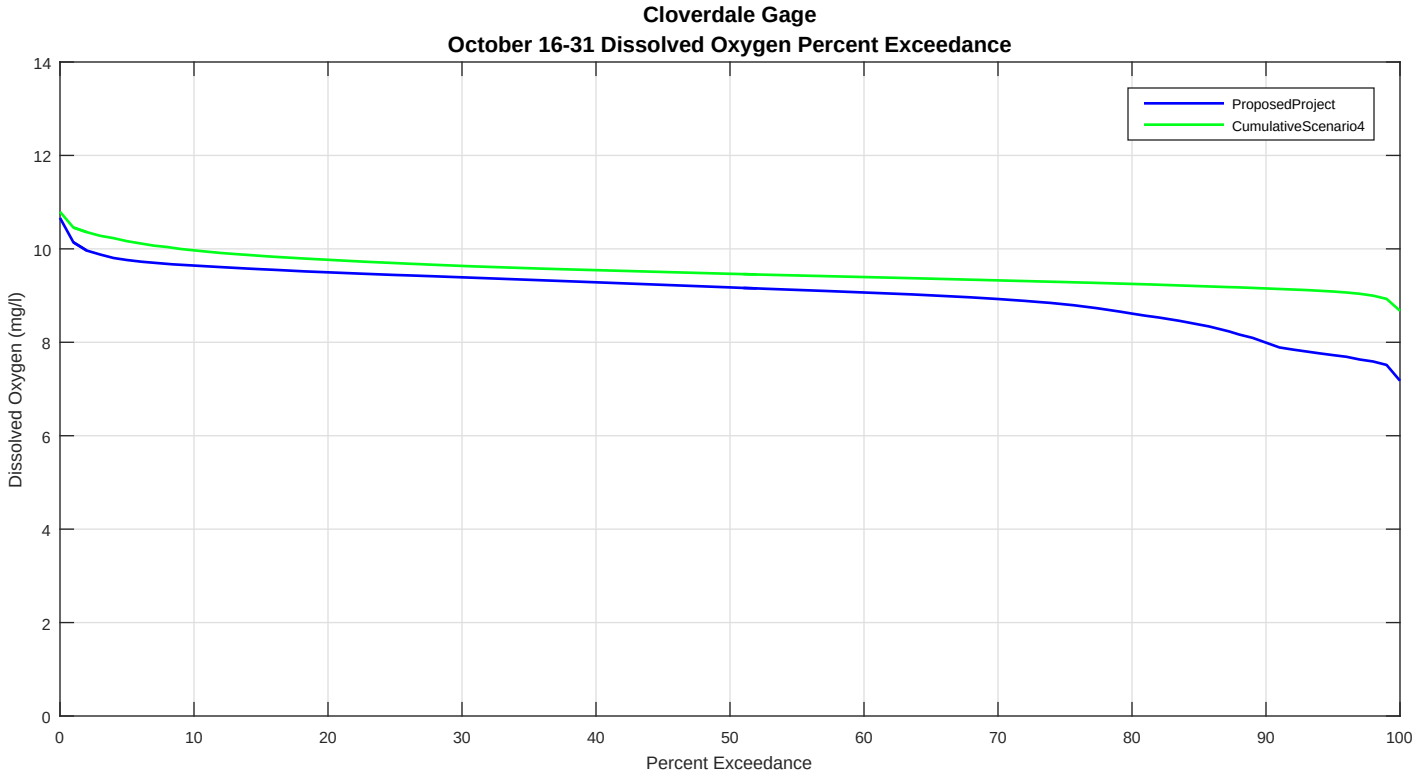
Cloverdale Gage
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
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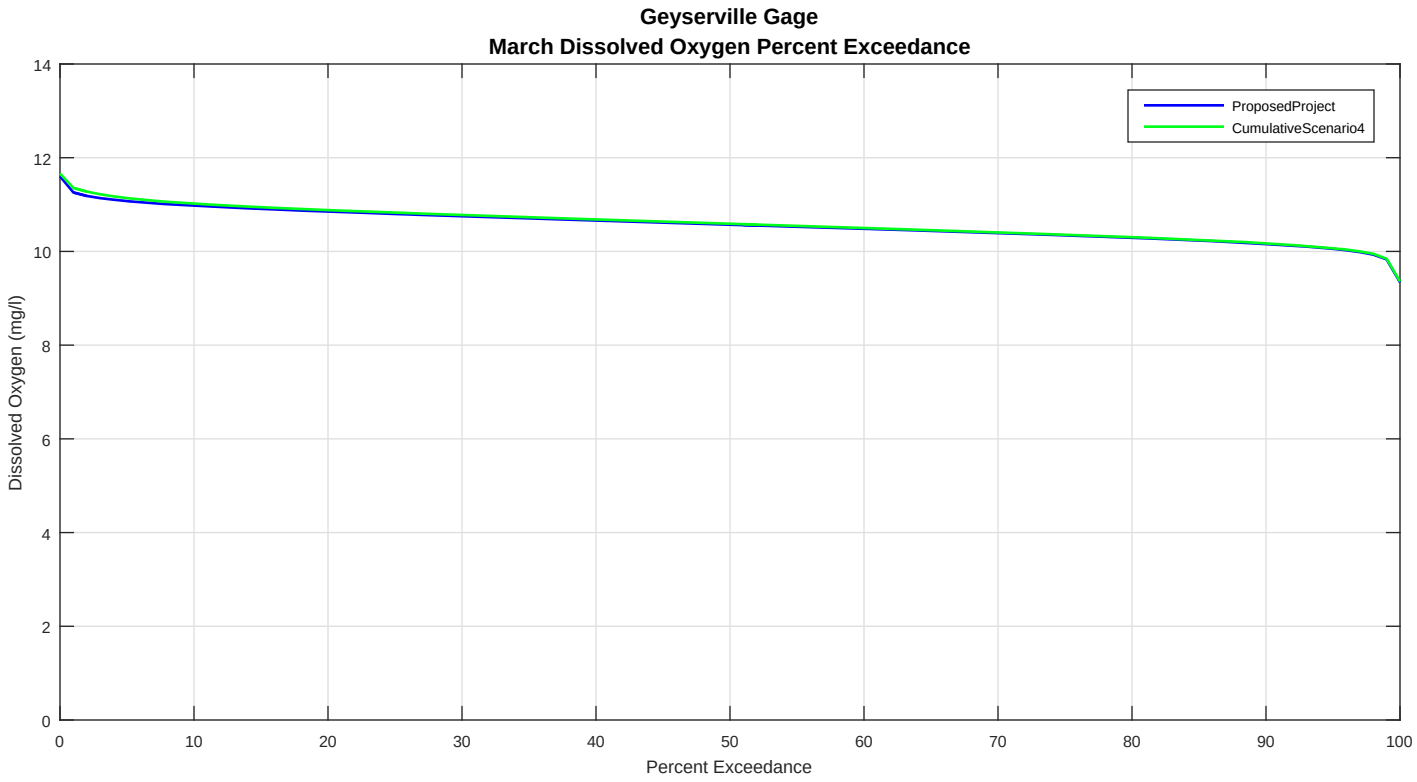
Geyserville Gage
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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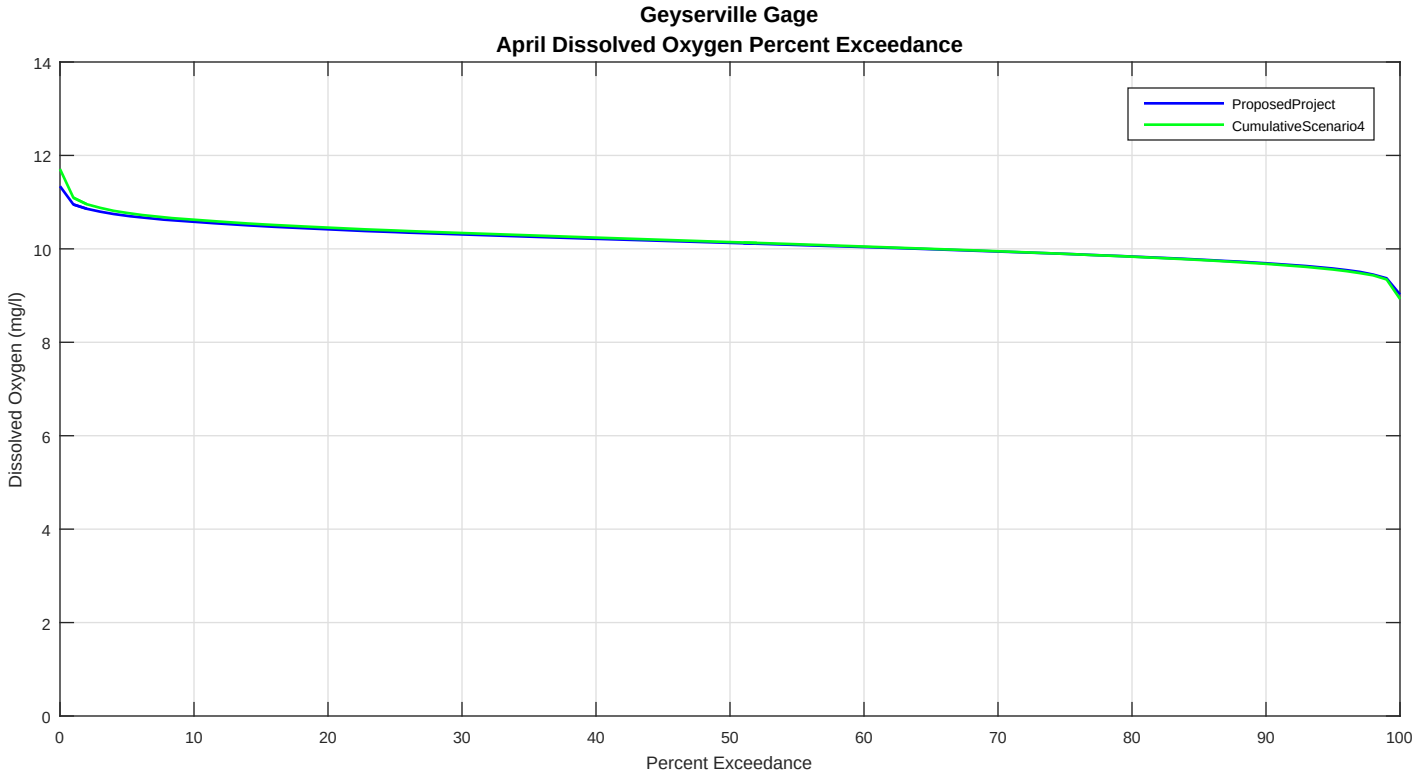
Geyserville Gage
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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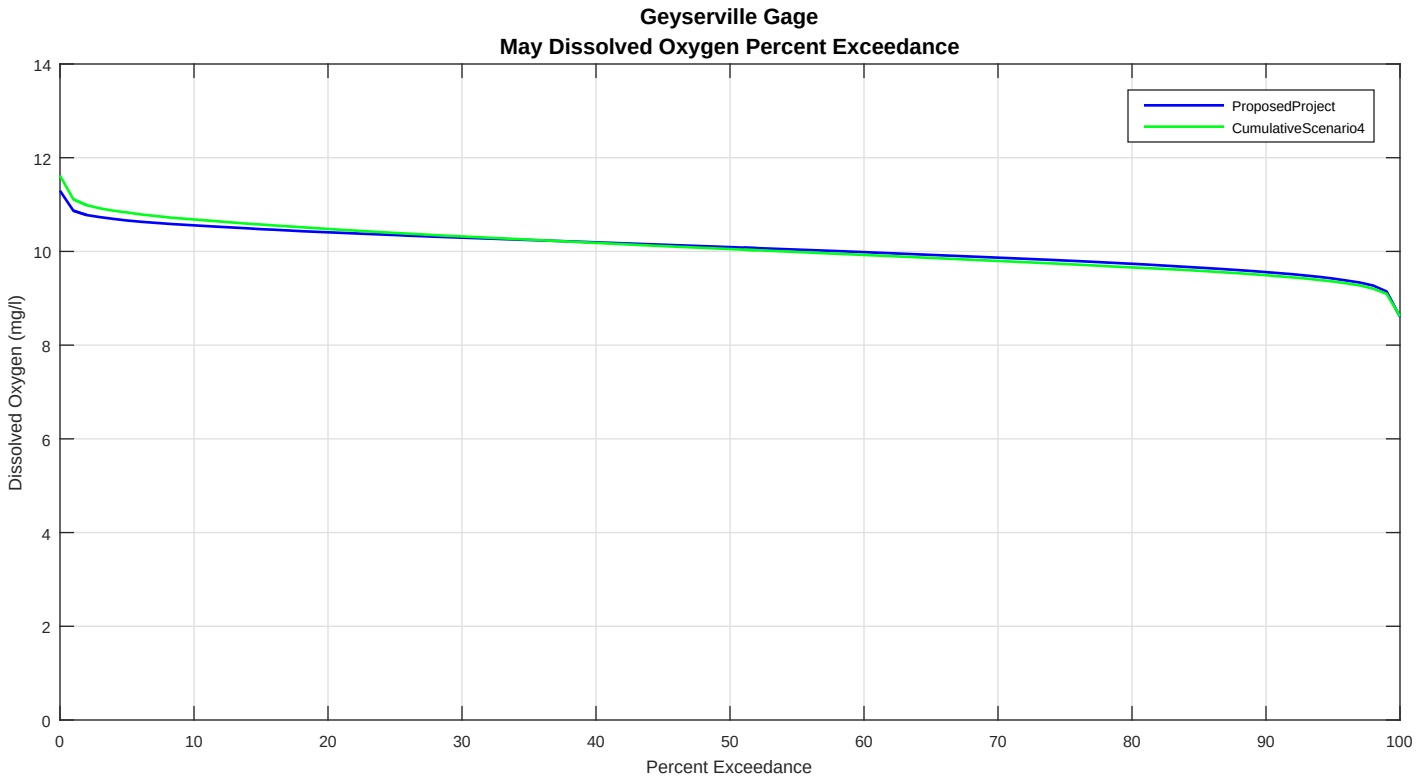
Geyserville Gage
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
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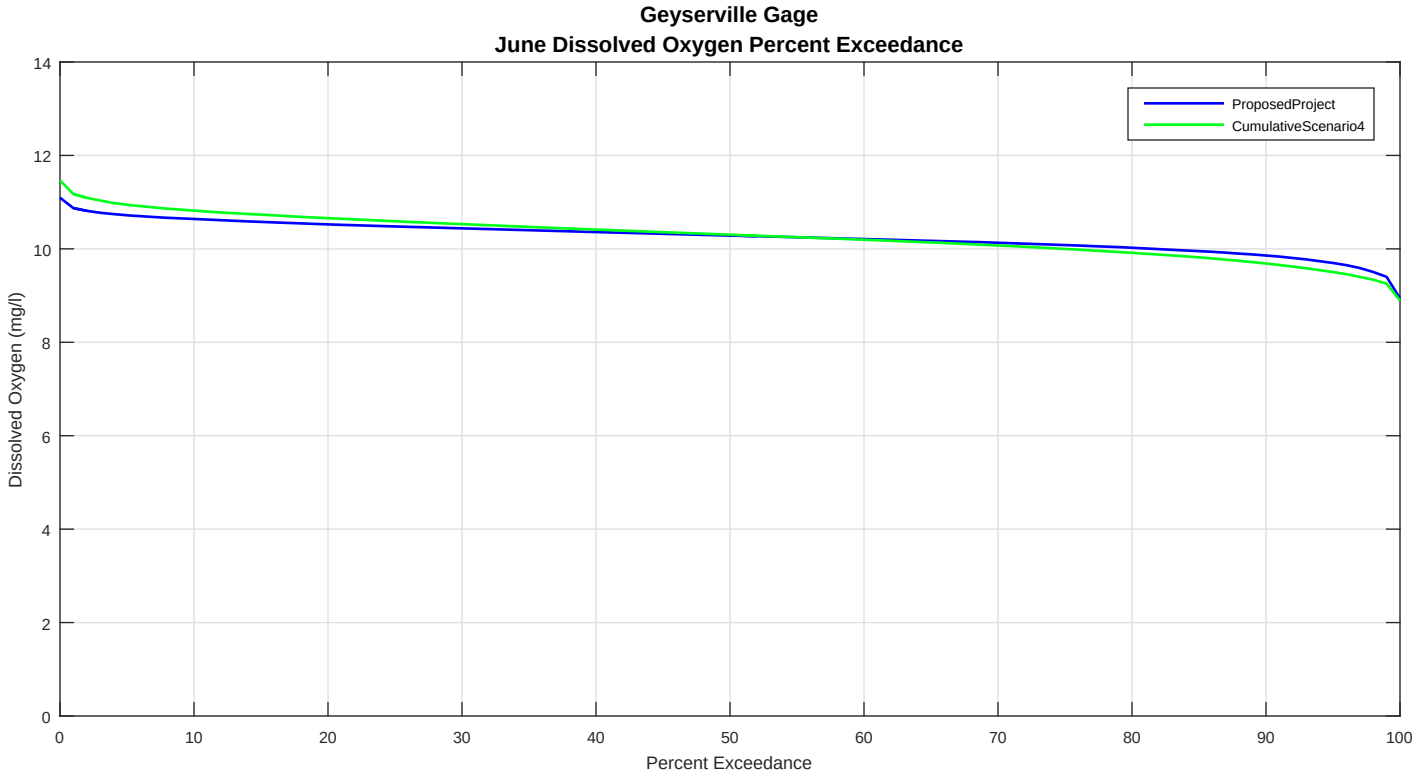
Geyserville Gage
June Dissolved Oxygen Percent Exceedance
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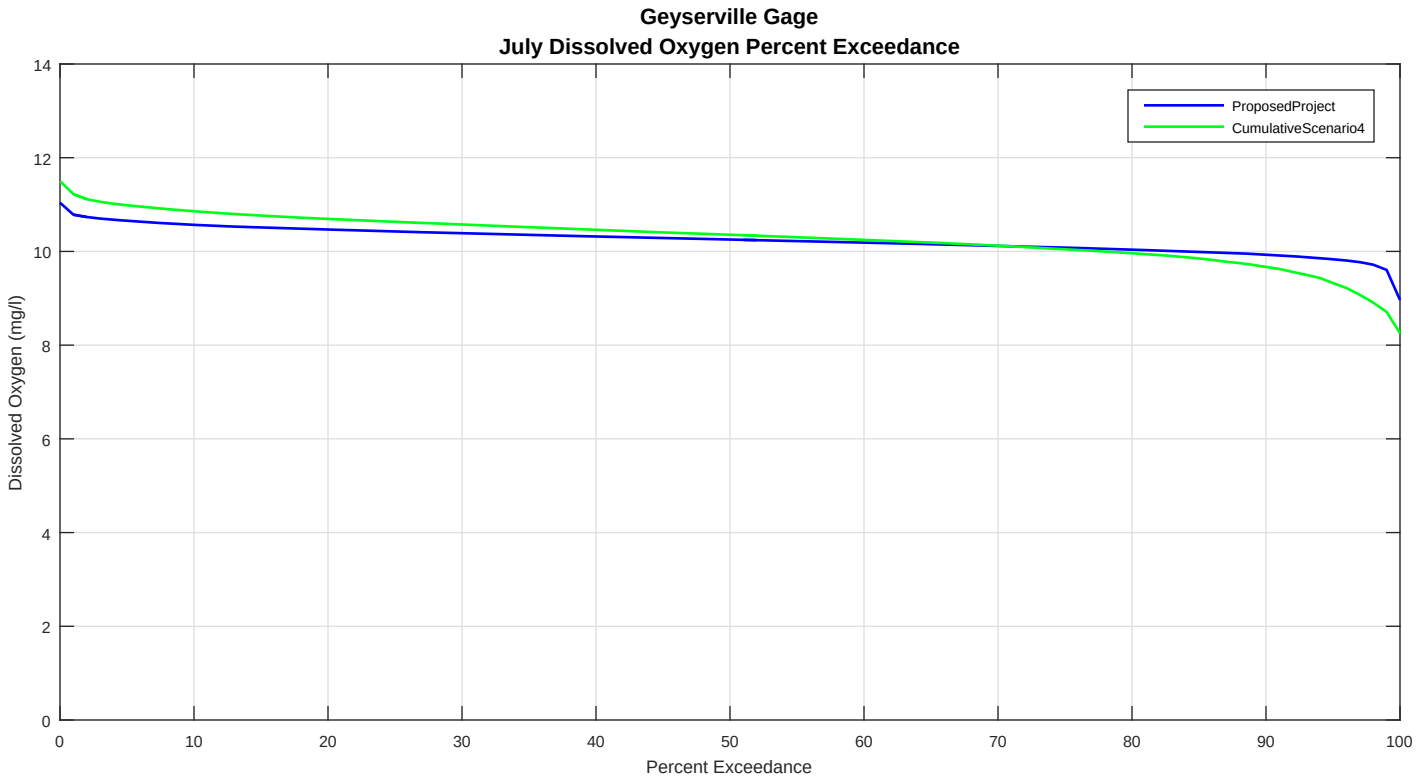
Geyserville Gage
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CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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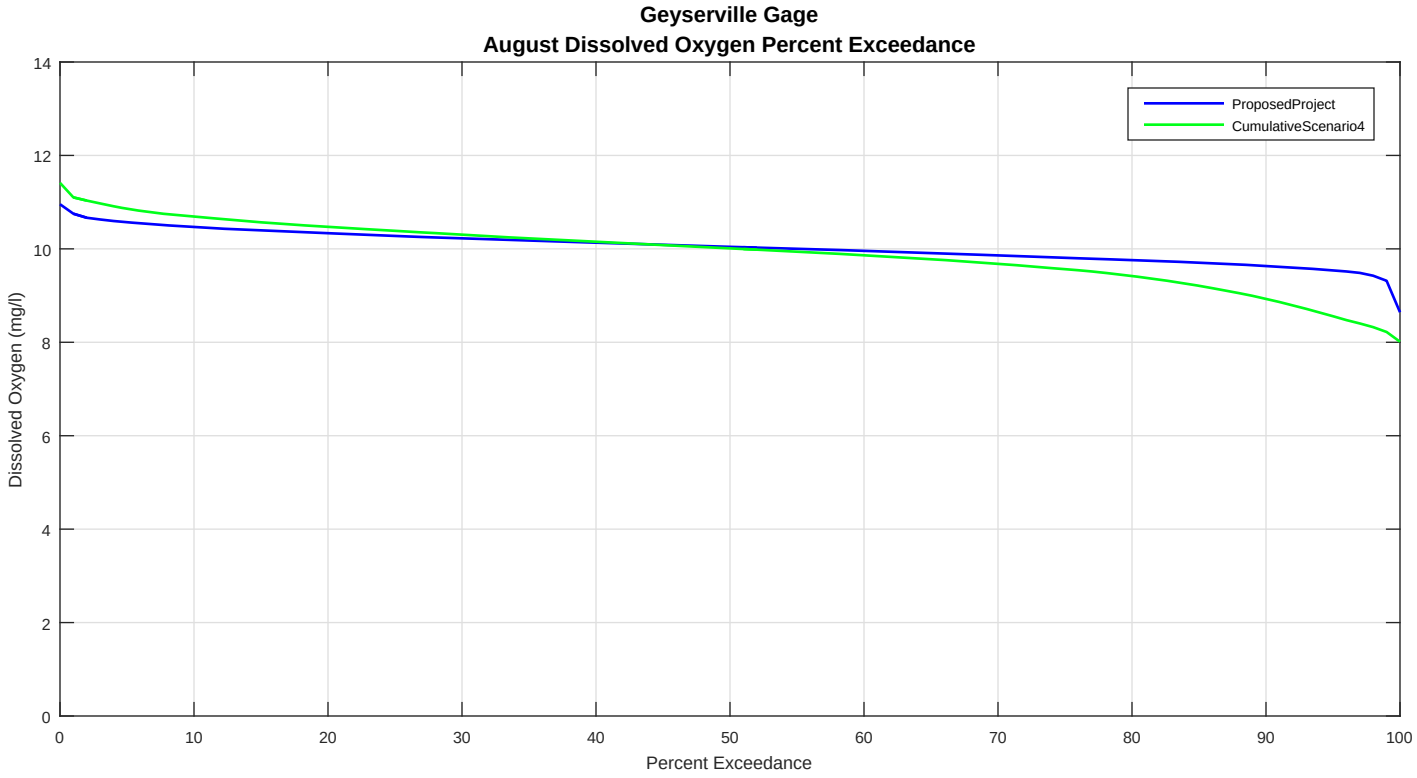
Geyserville Gage
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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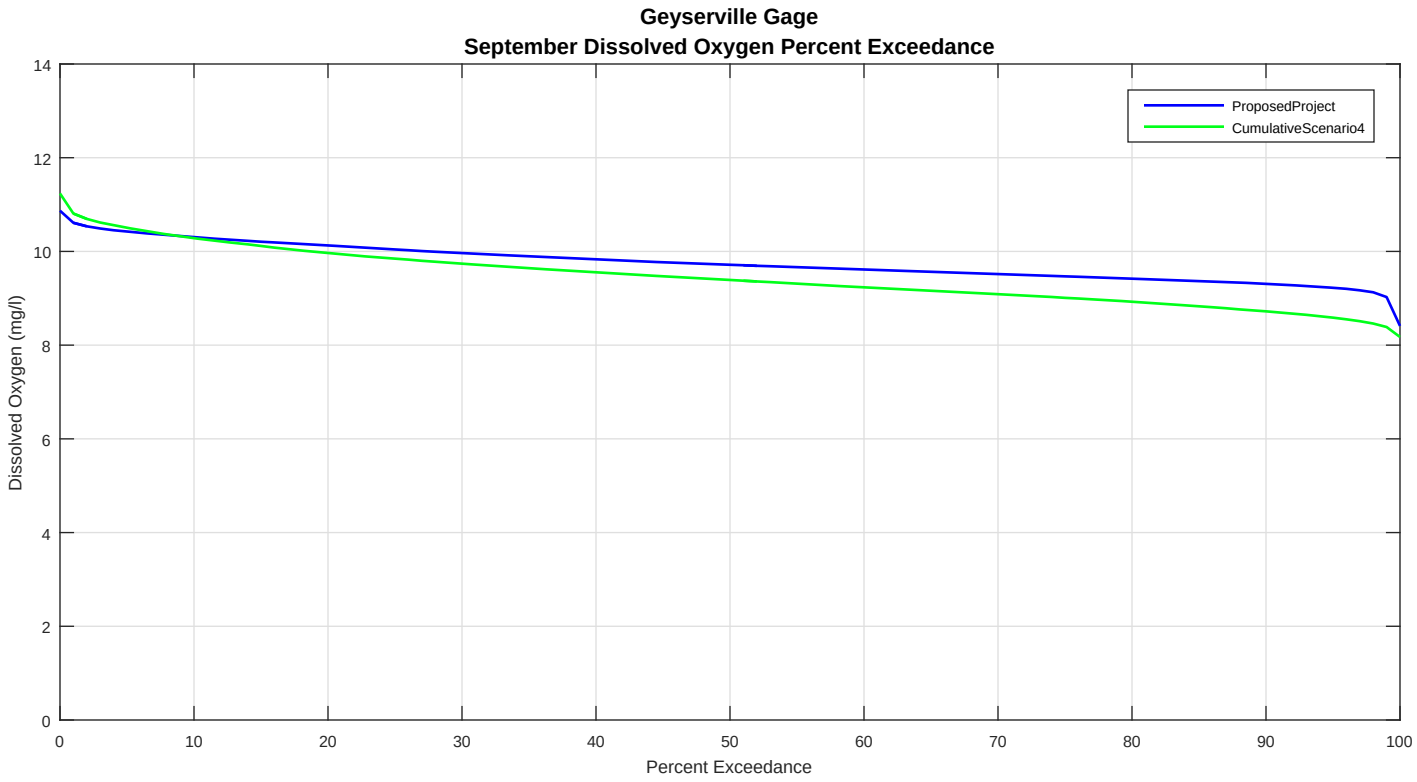
Geyserville Gage
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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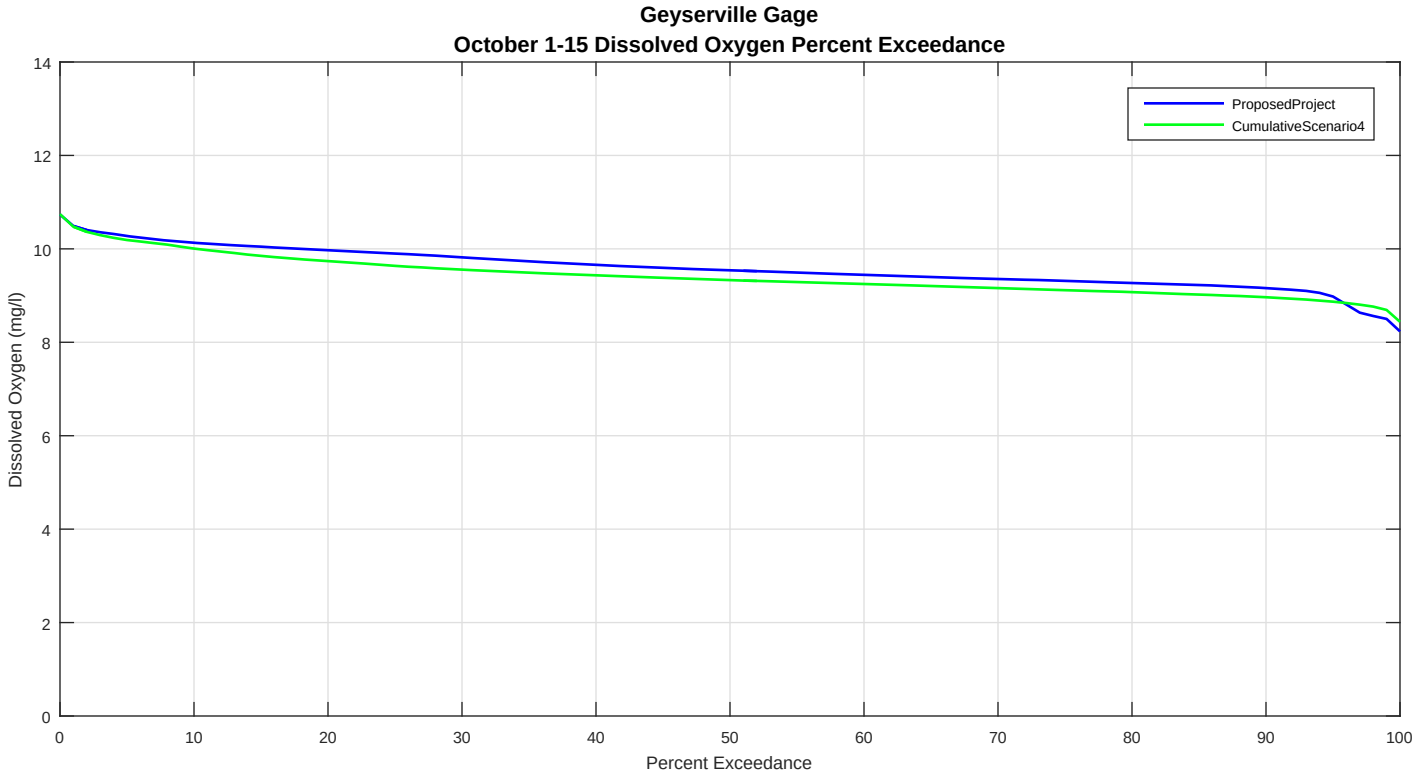
Geyserville Gage
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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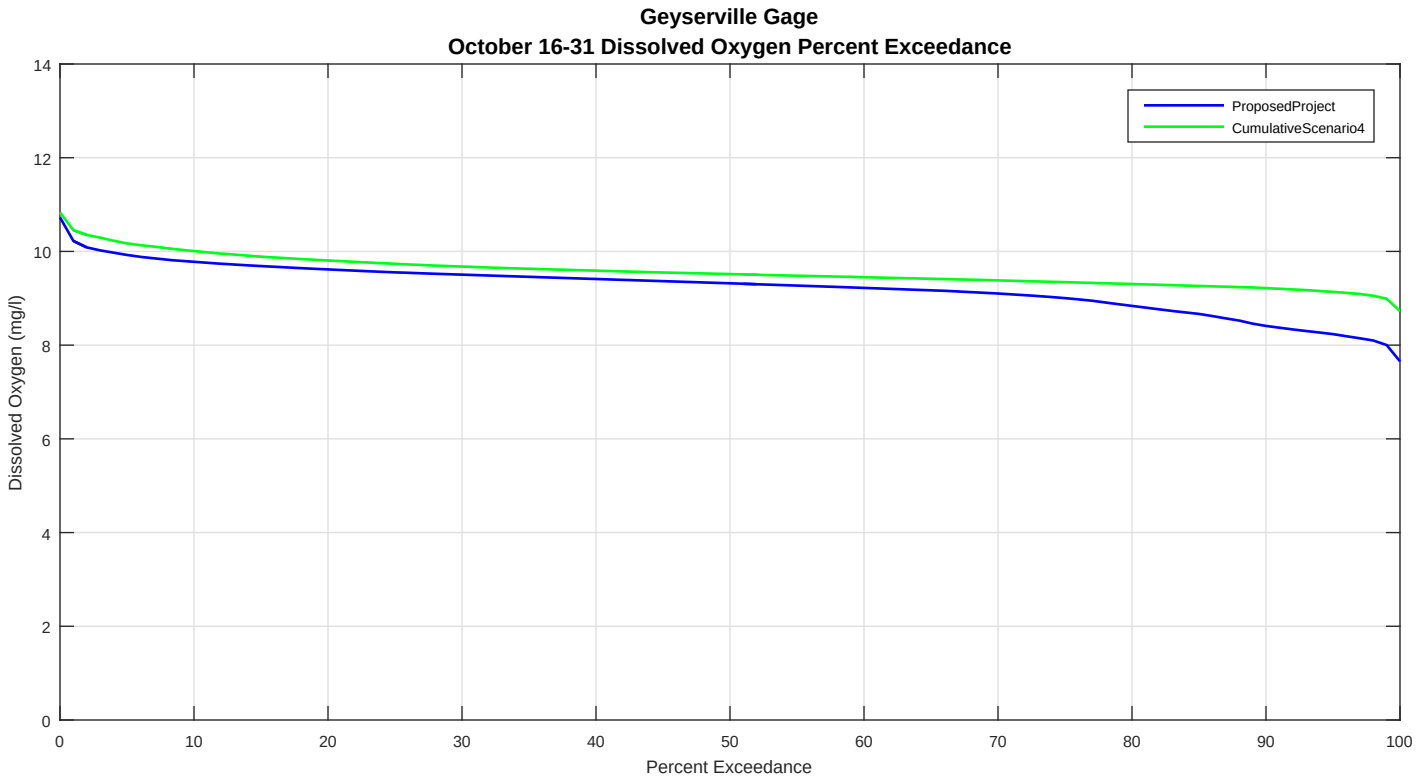
Geyserville Gage
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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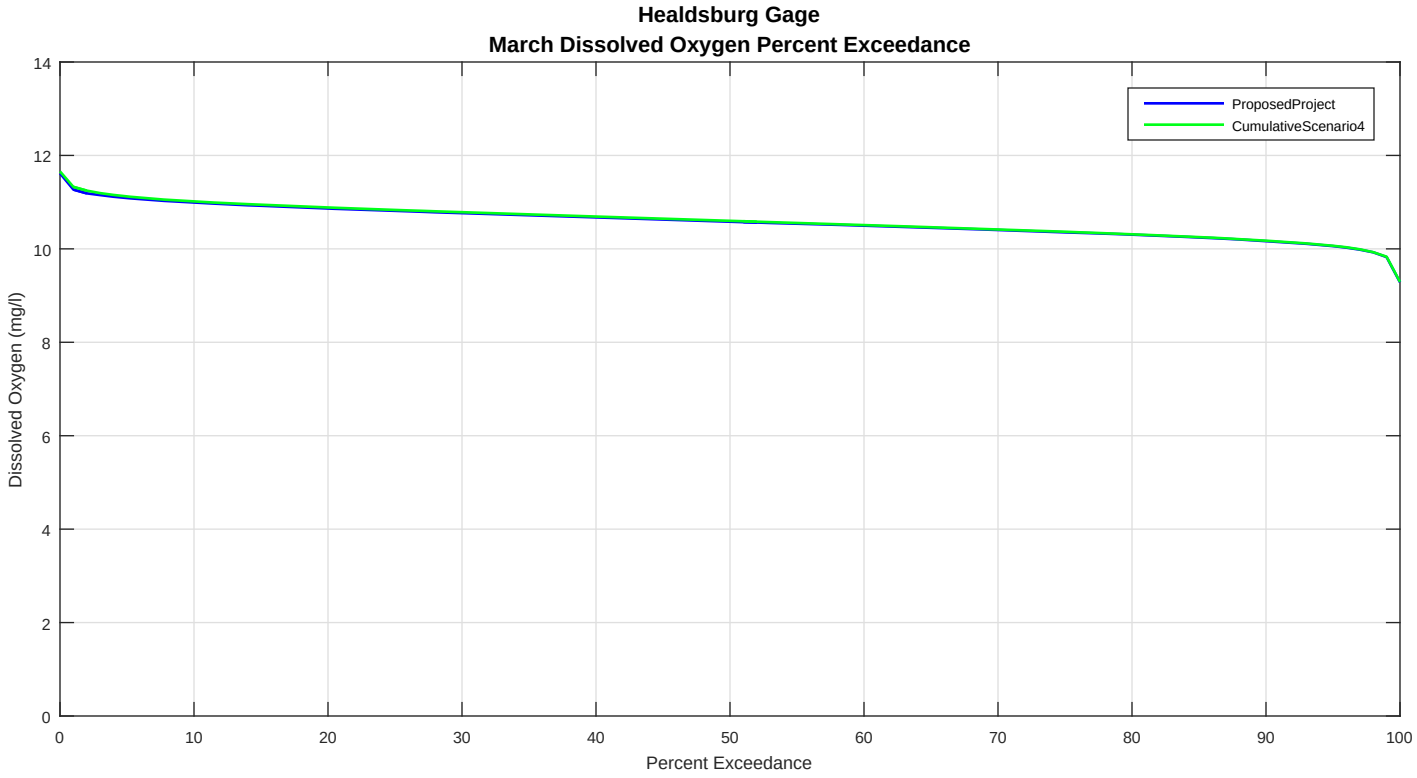
Healdsburg Gage
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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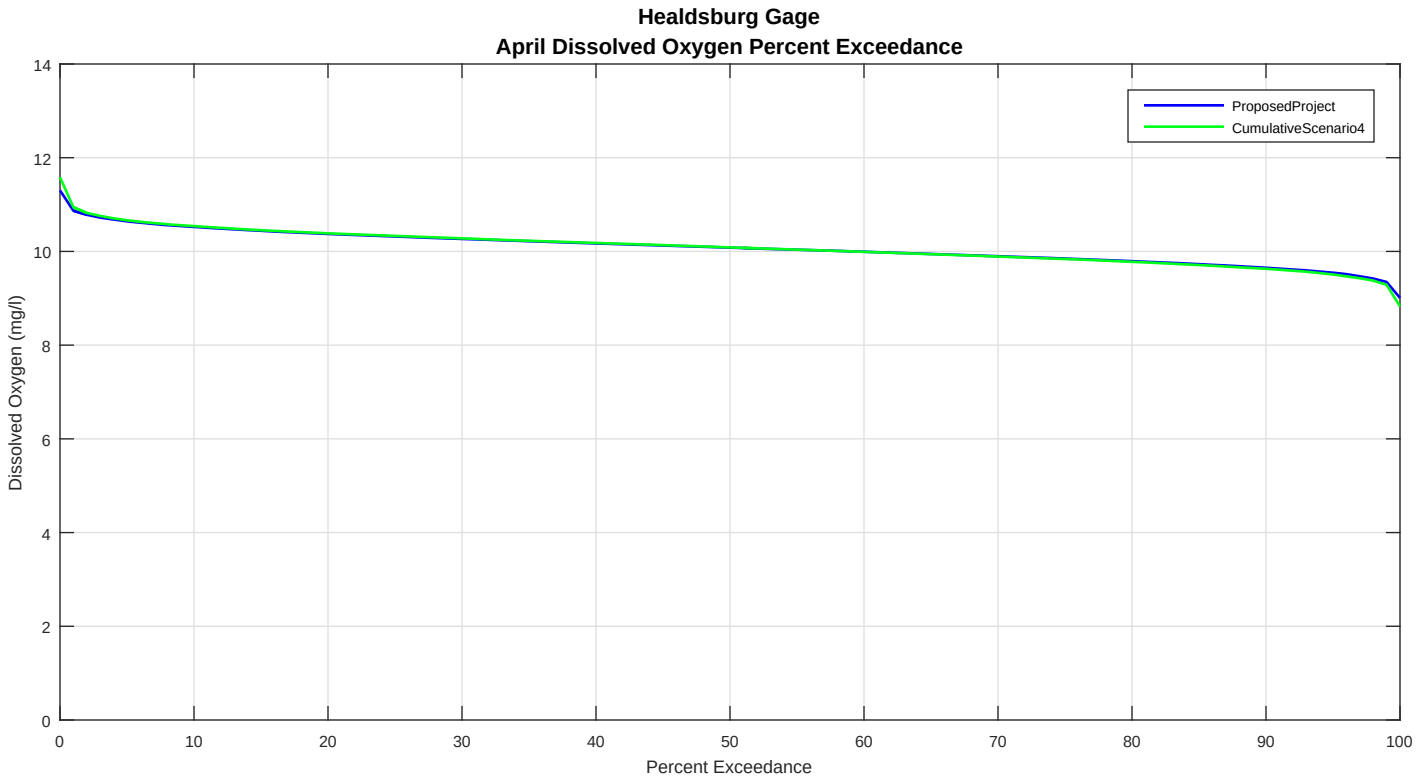
Healdsburg Gage
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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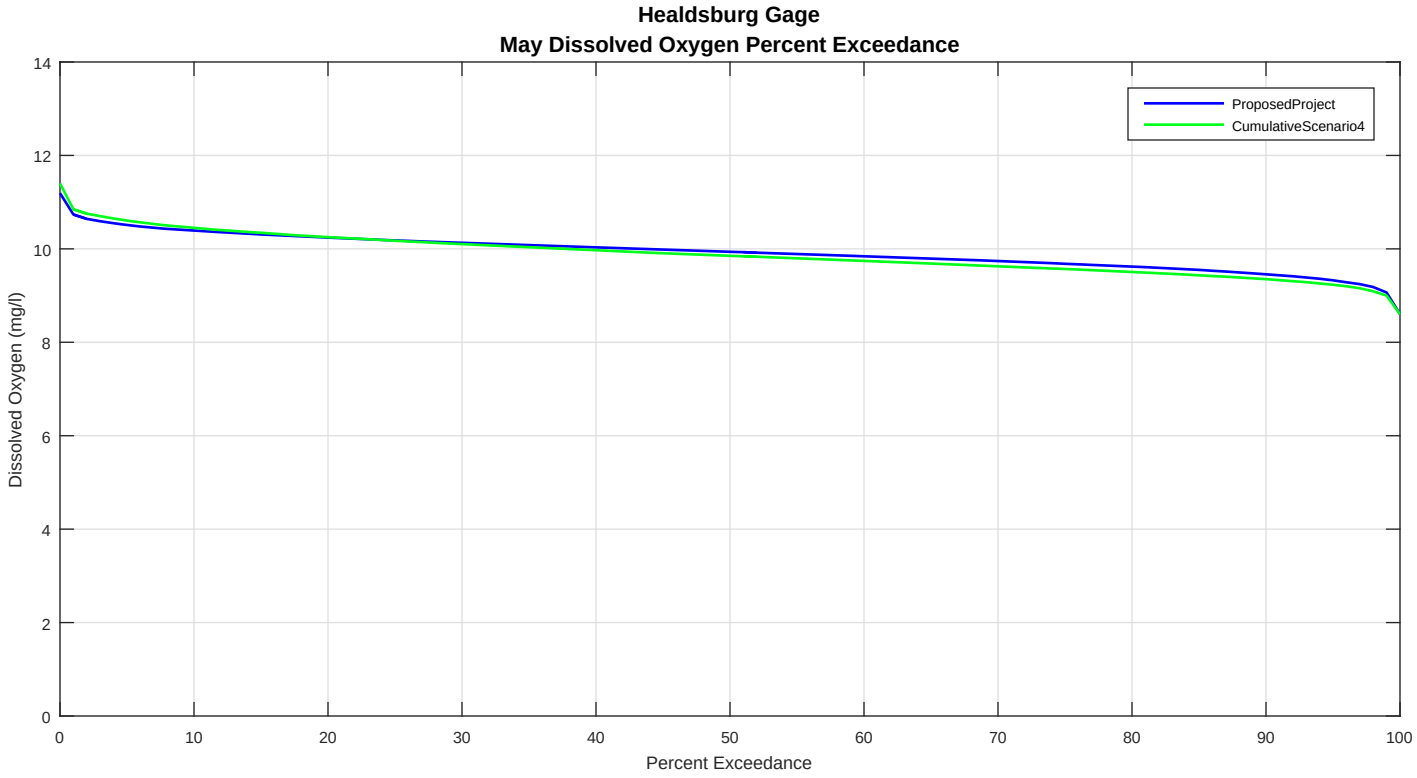
Healdsburg Gage
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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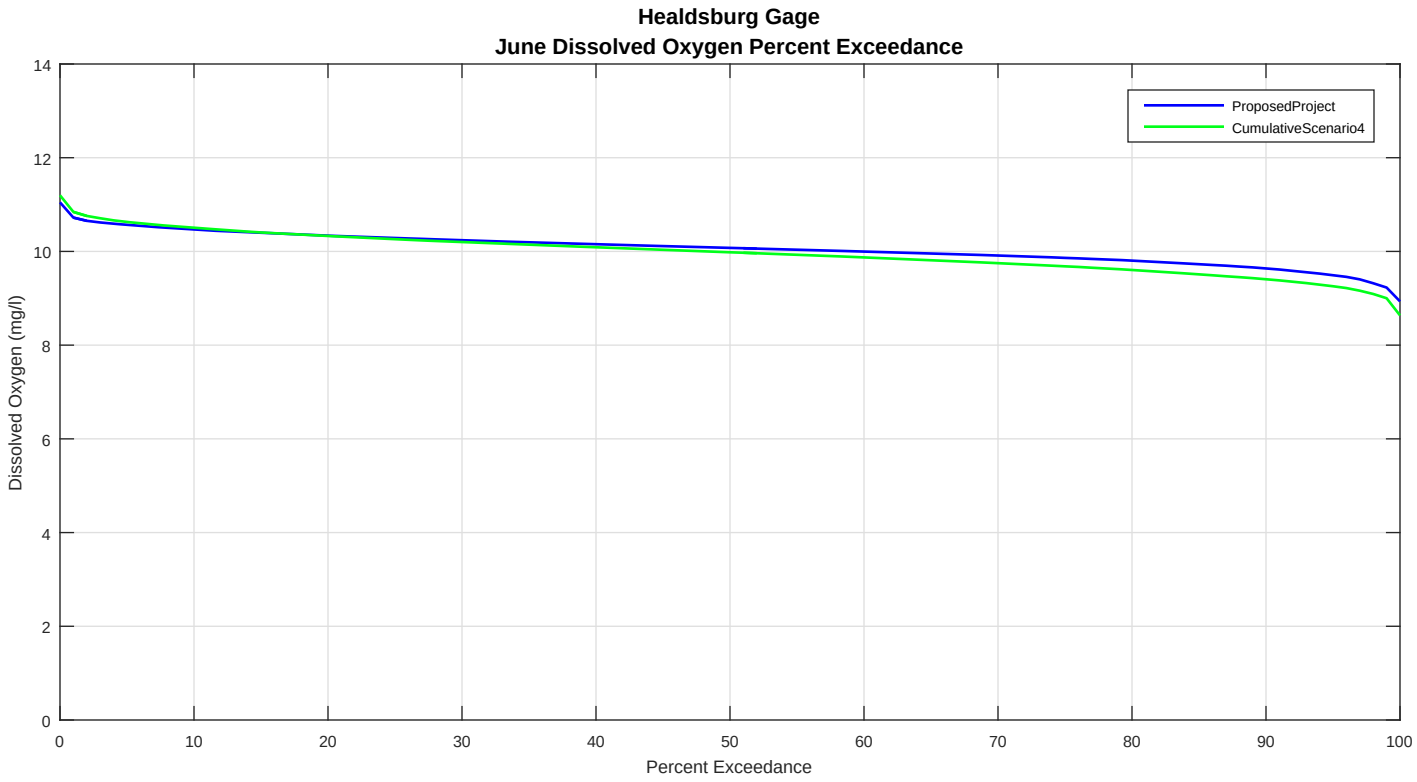
Healdsburg Gage
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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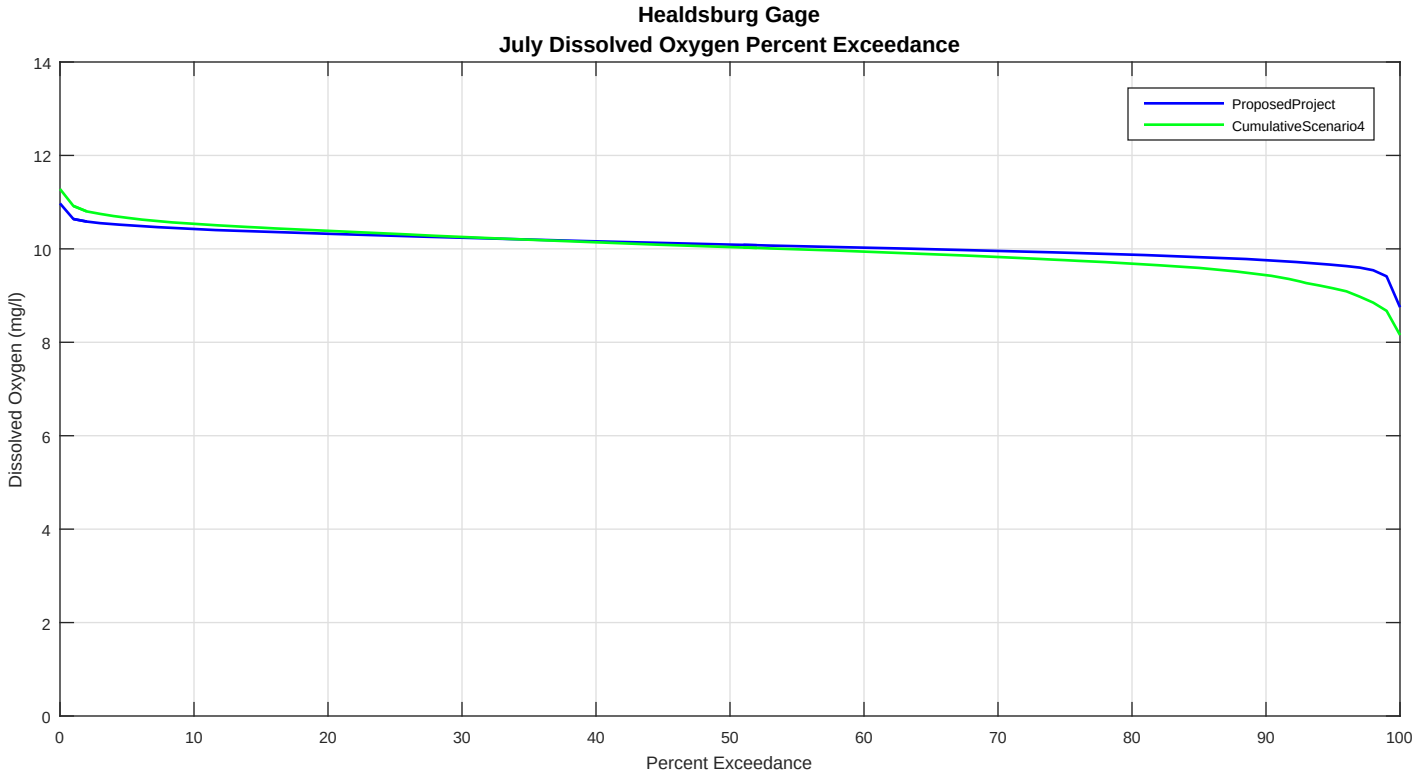
Healdsburg Gage
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
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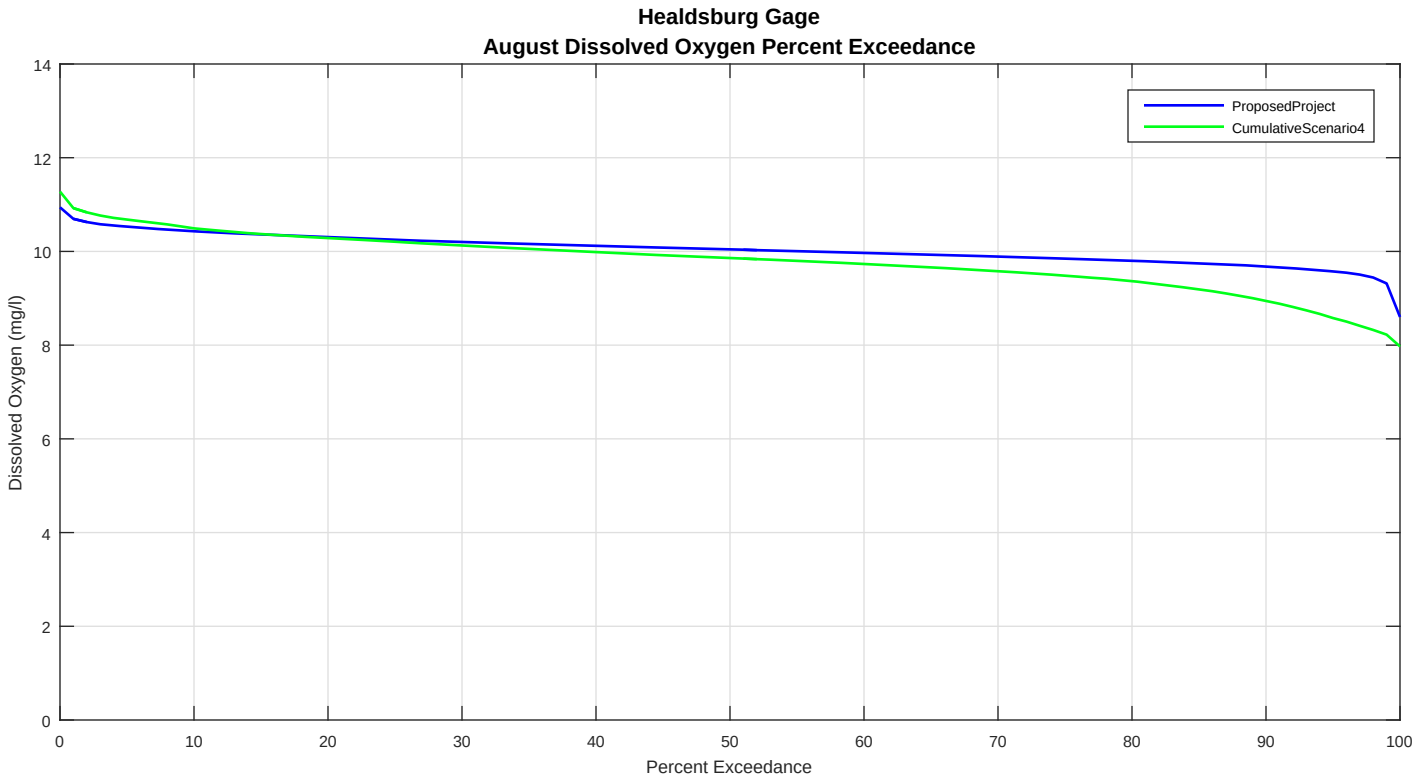
Healdsburg Gage
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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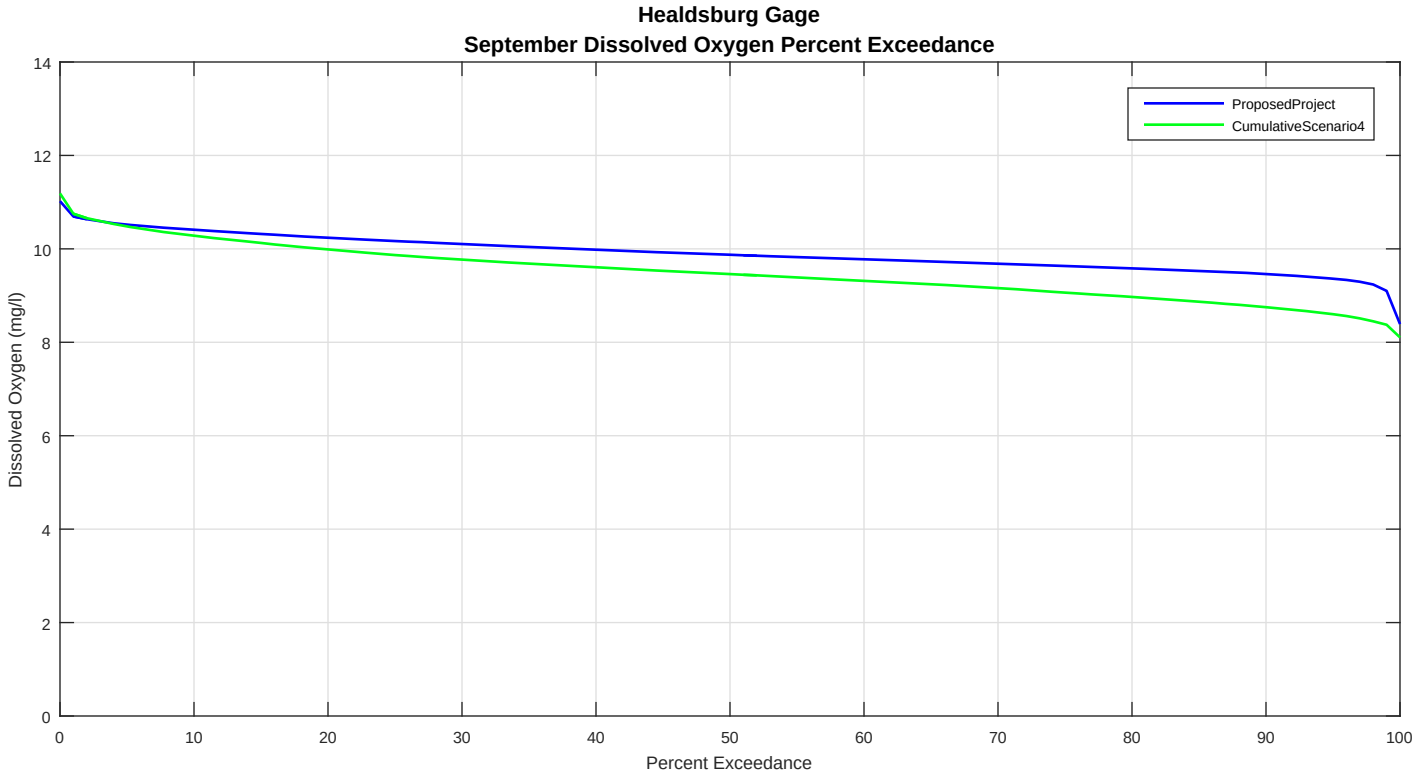
Healdsburg Gage
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
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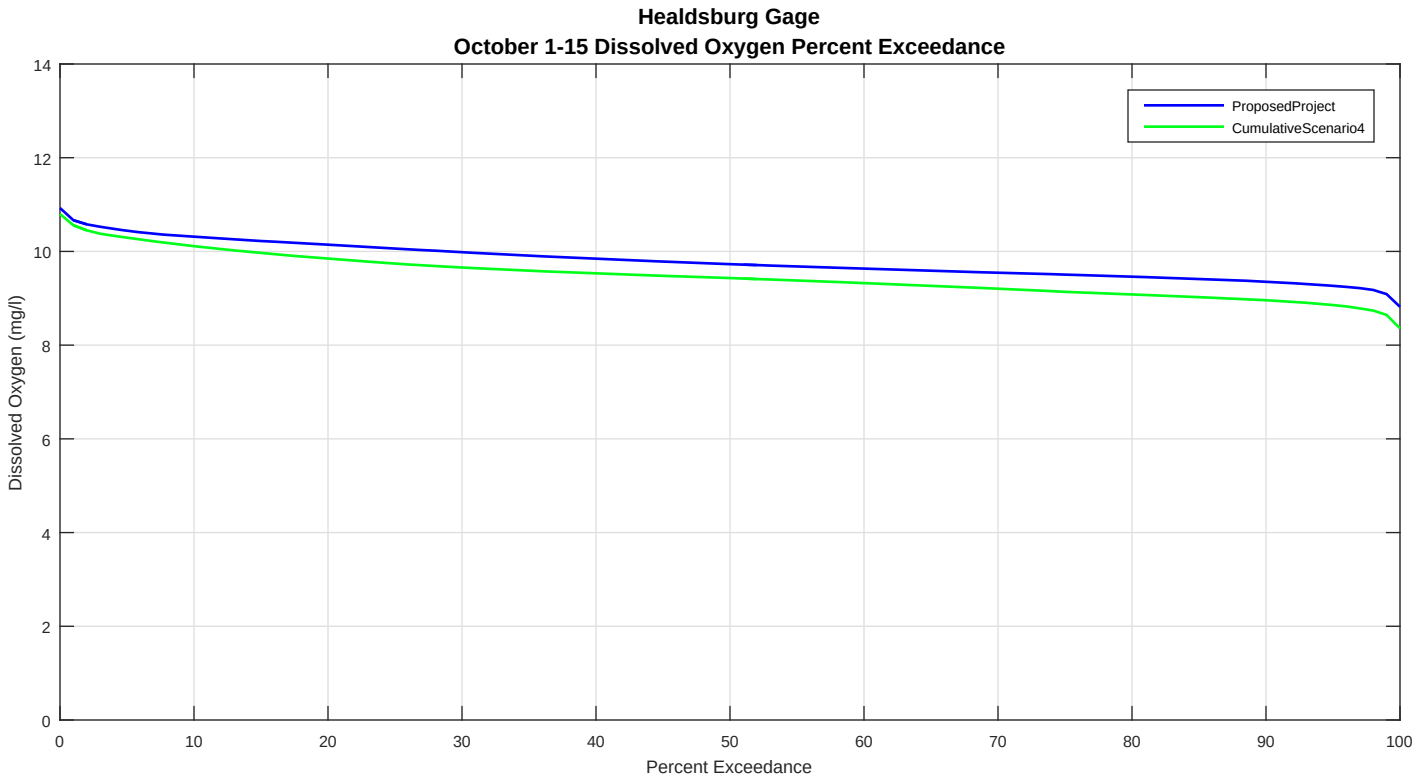
Healdsburg Gage
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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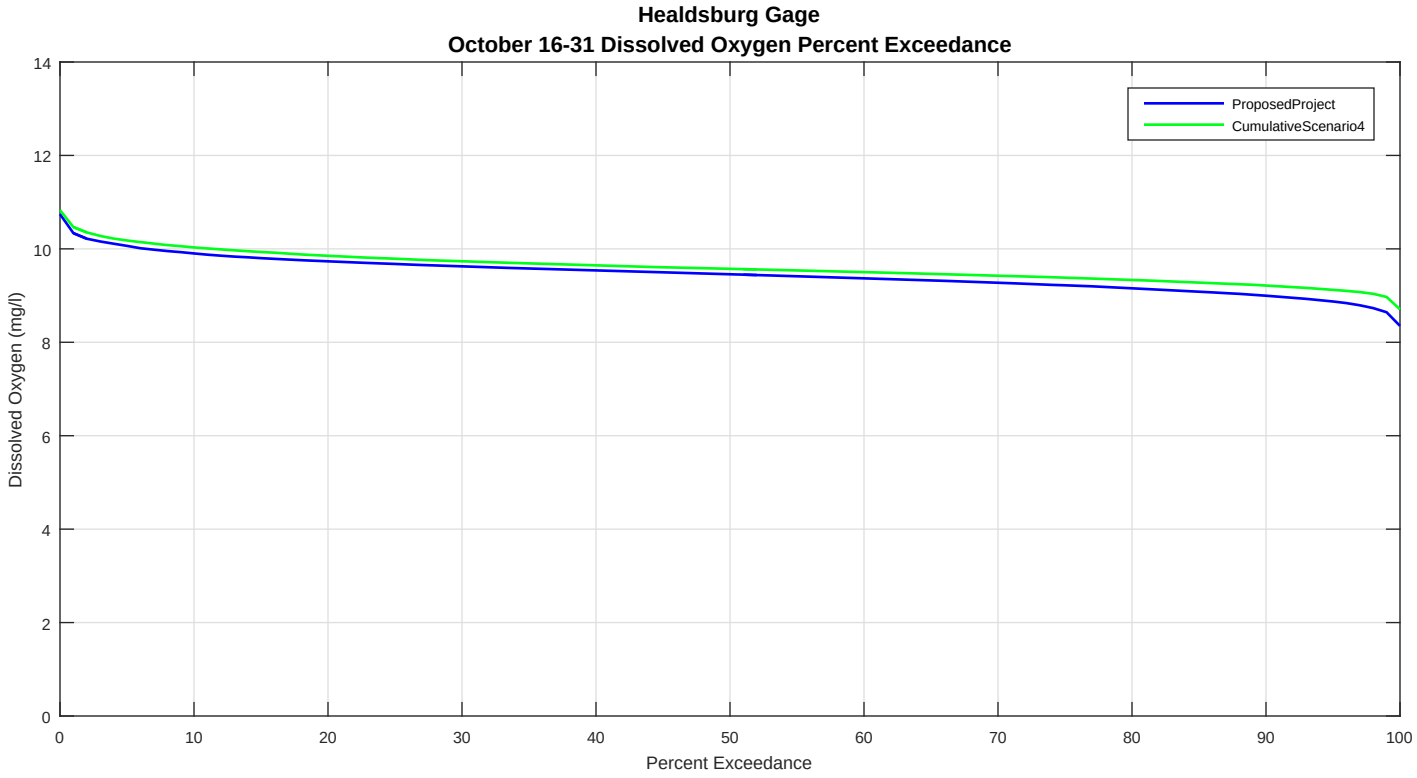
Healdsburg Gage
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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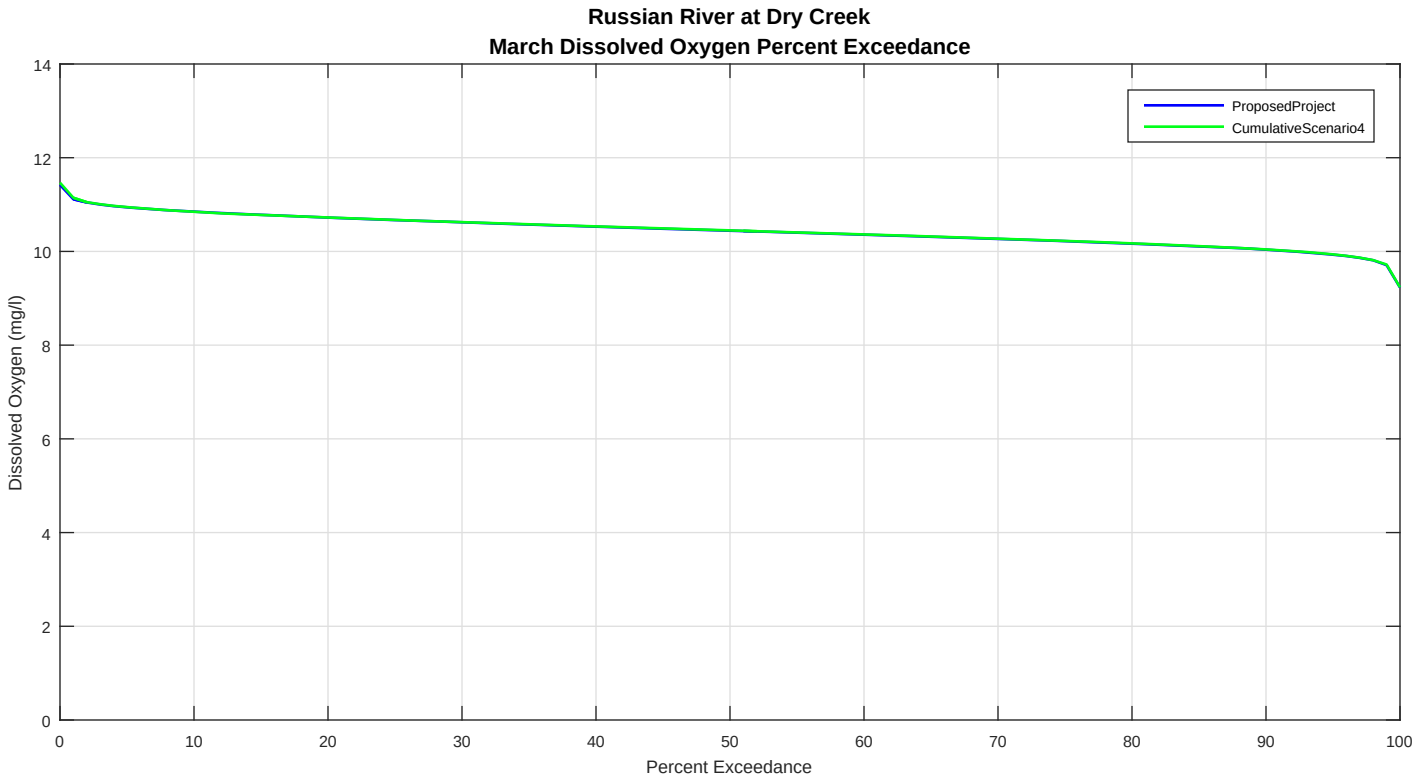
Russian River at Dry Creek
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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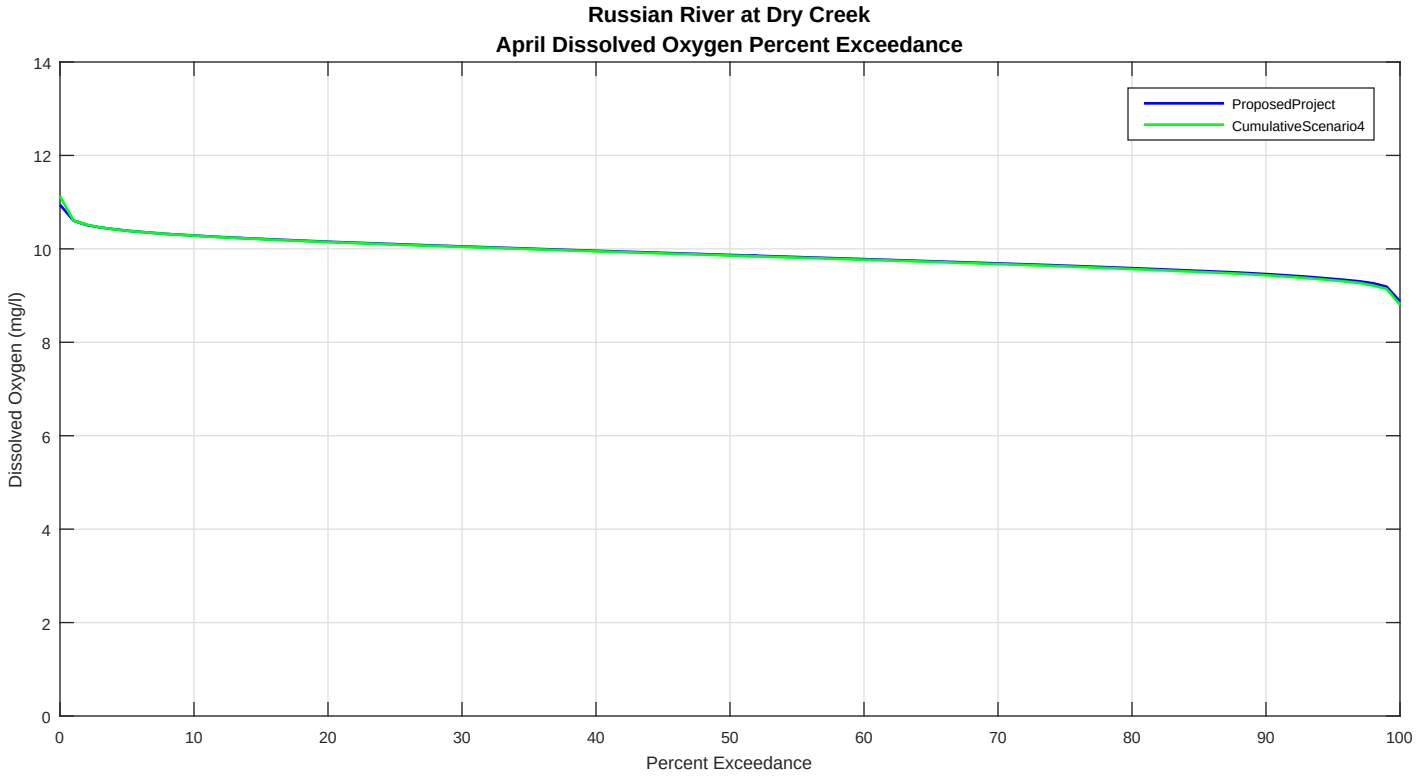
Russian River at Dry Creek
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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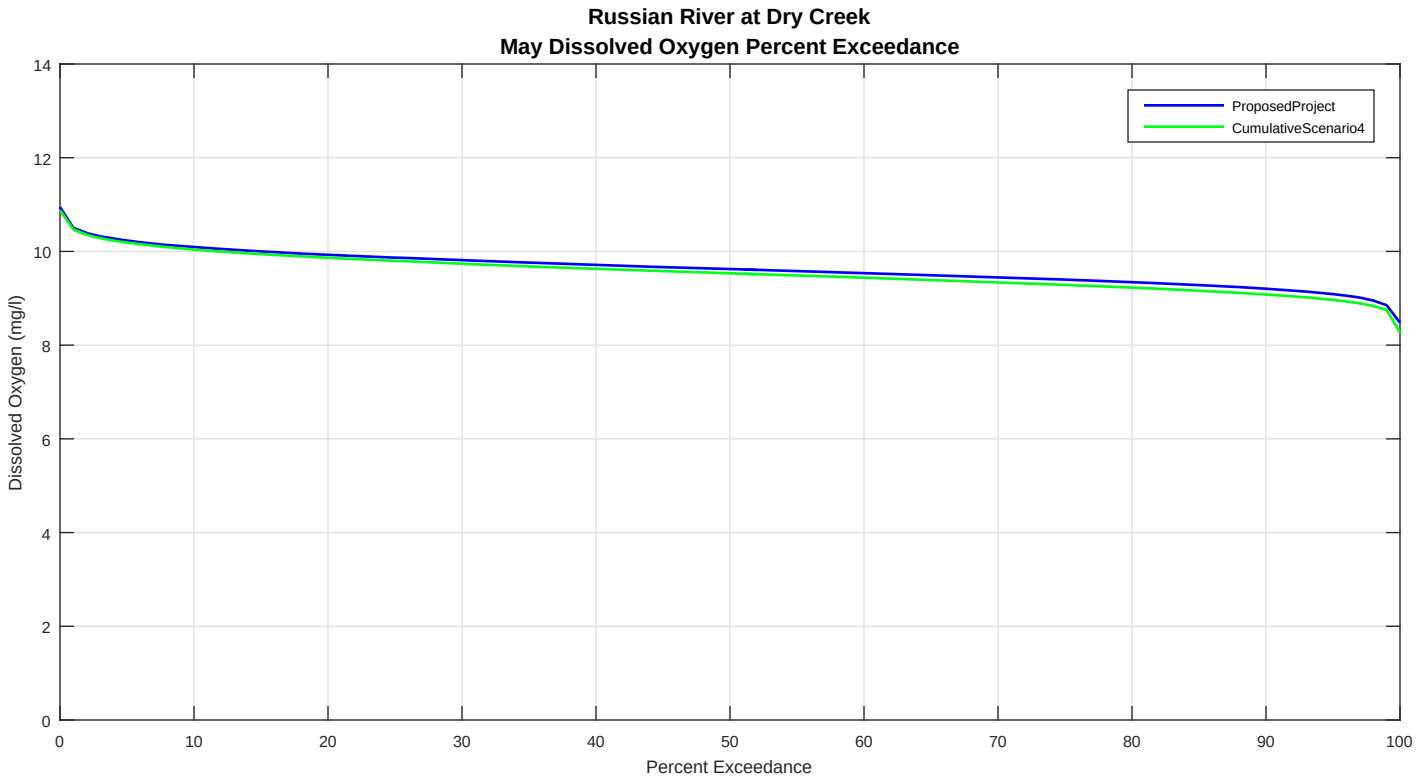
Russian River at Dry Creek
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
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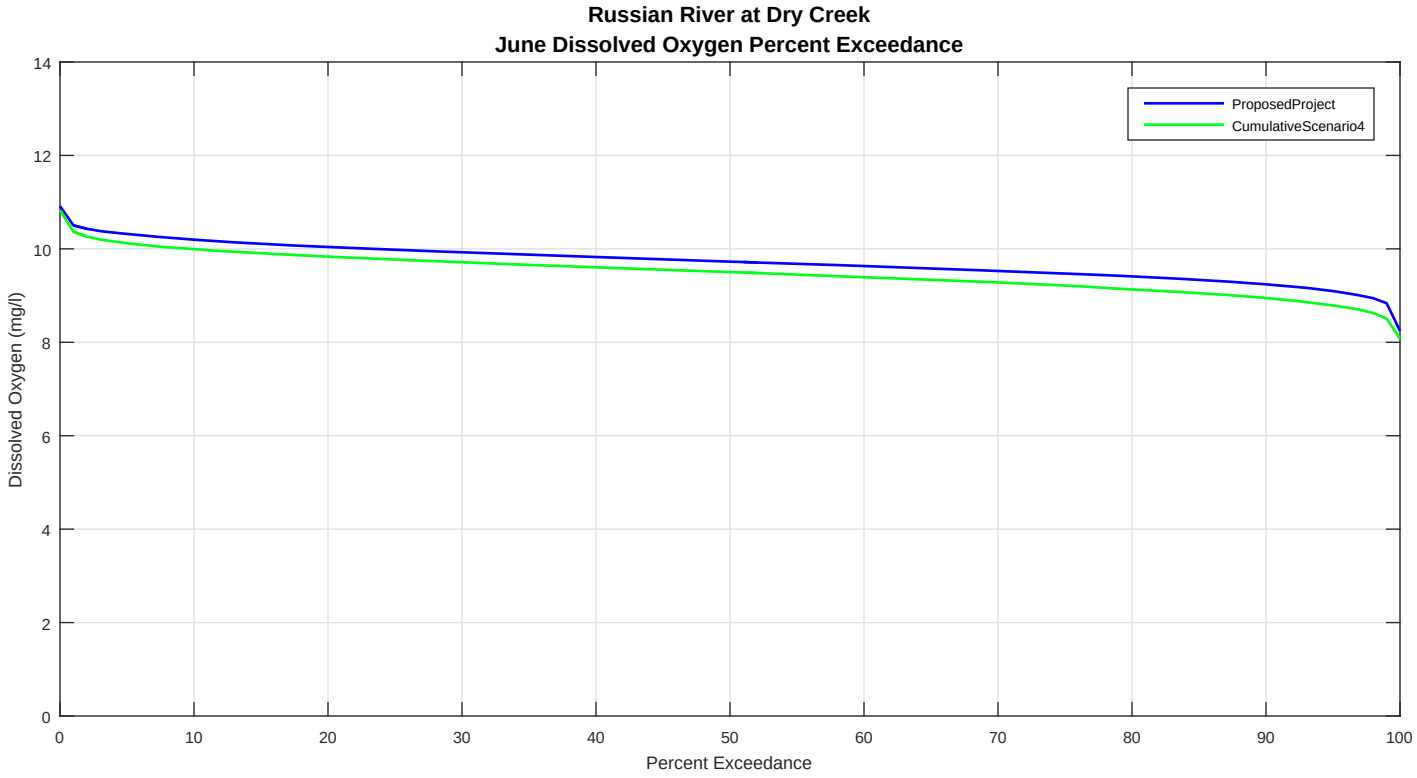
Russian River at Dry Creek
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
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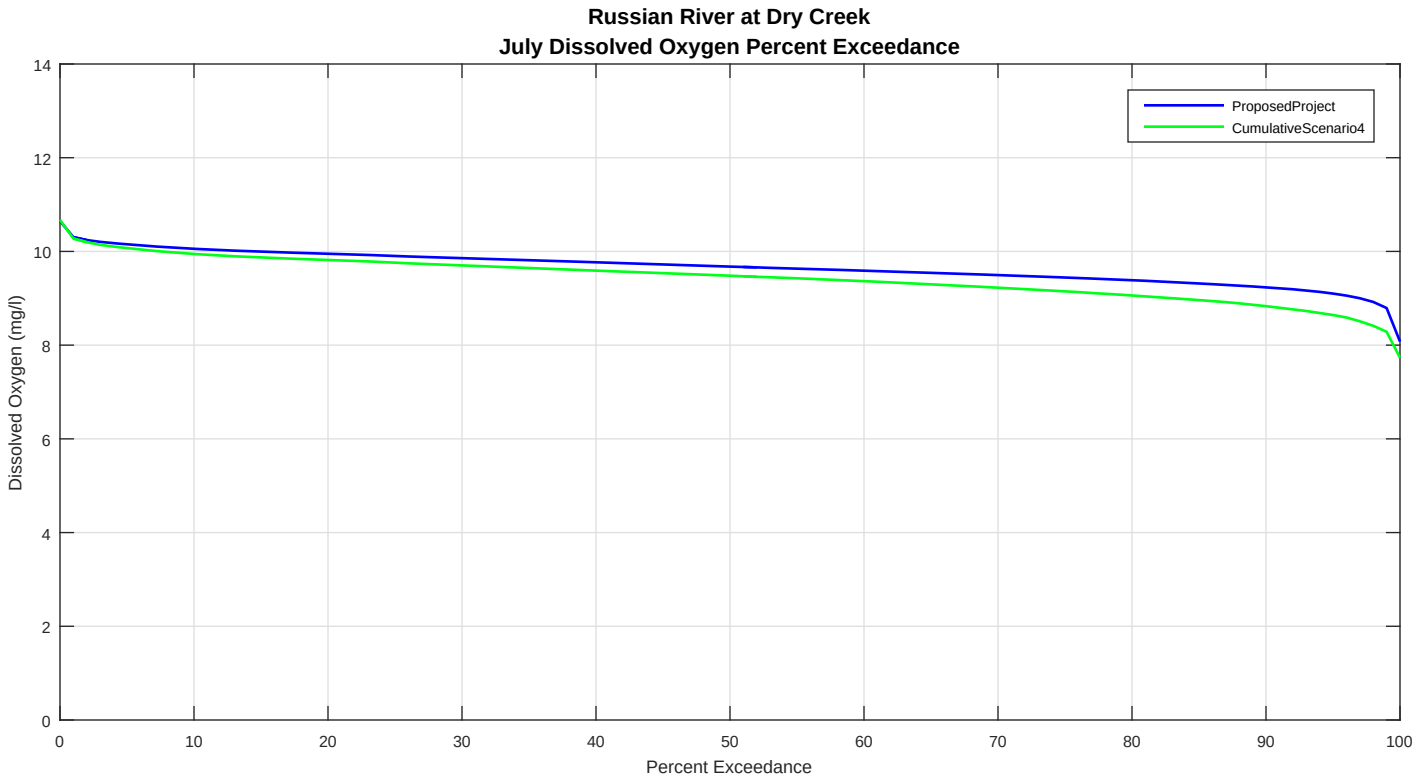
Russian River at Dry Creek
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
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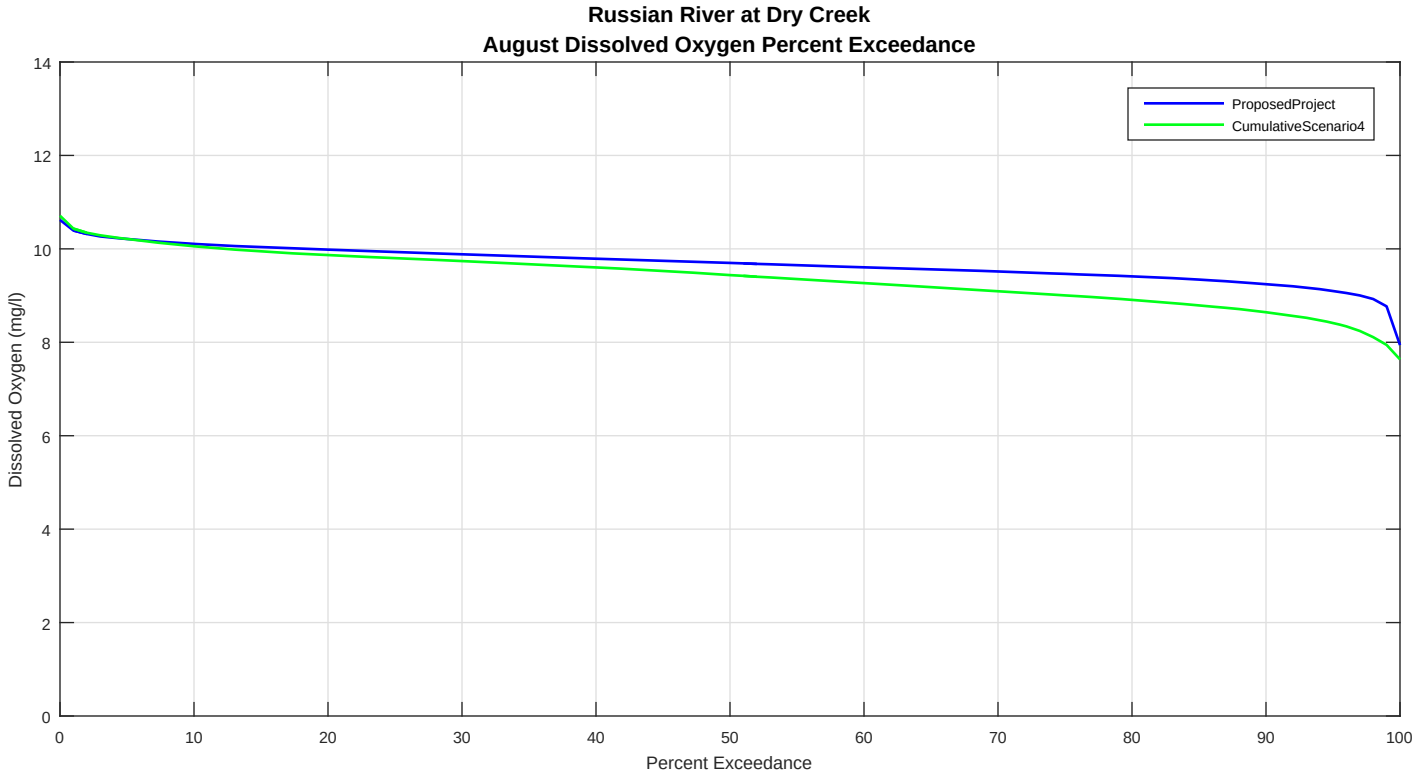
Russian River at Dry Creek
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
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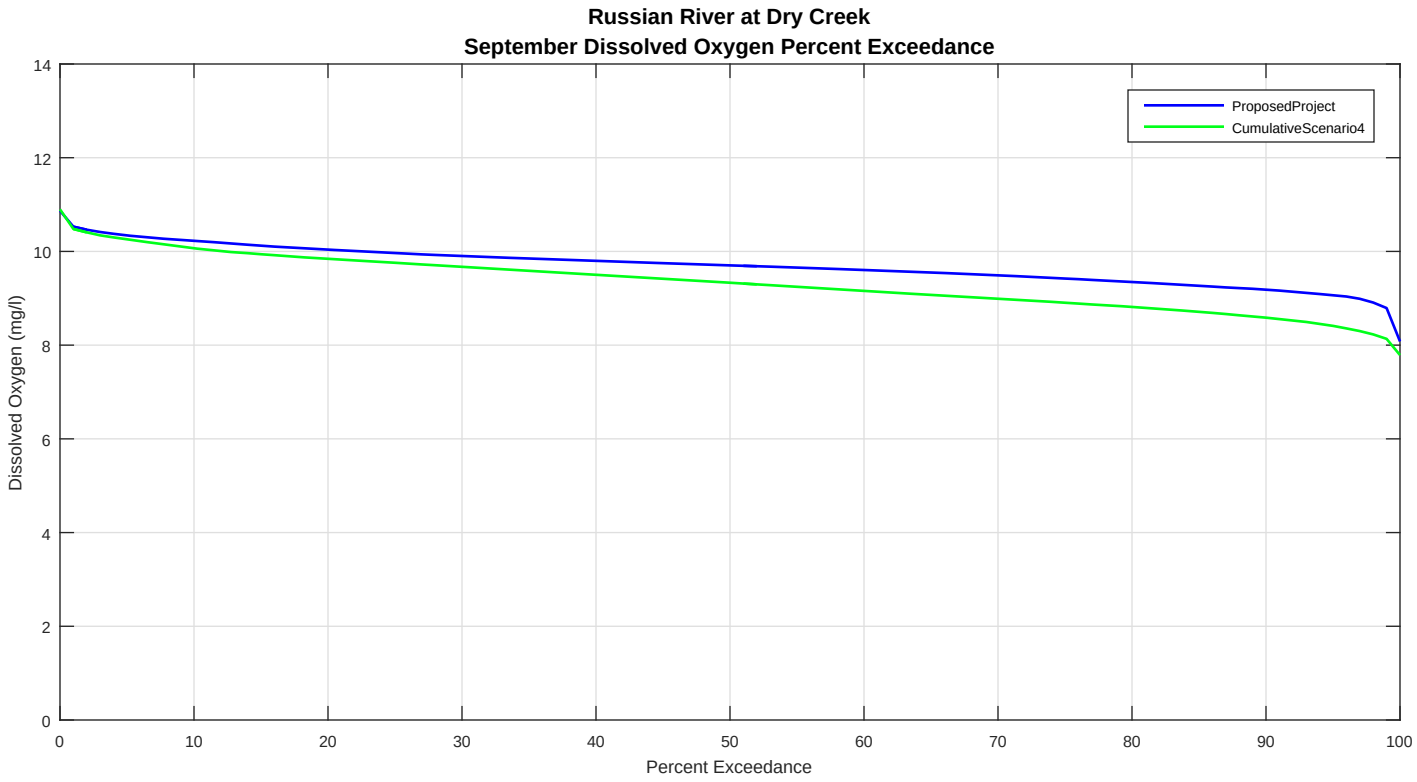
Russian River at Dry Creek
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
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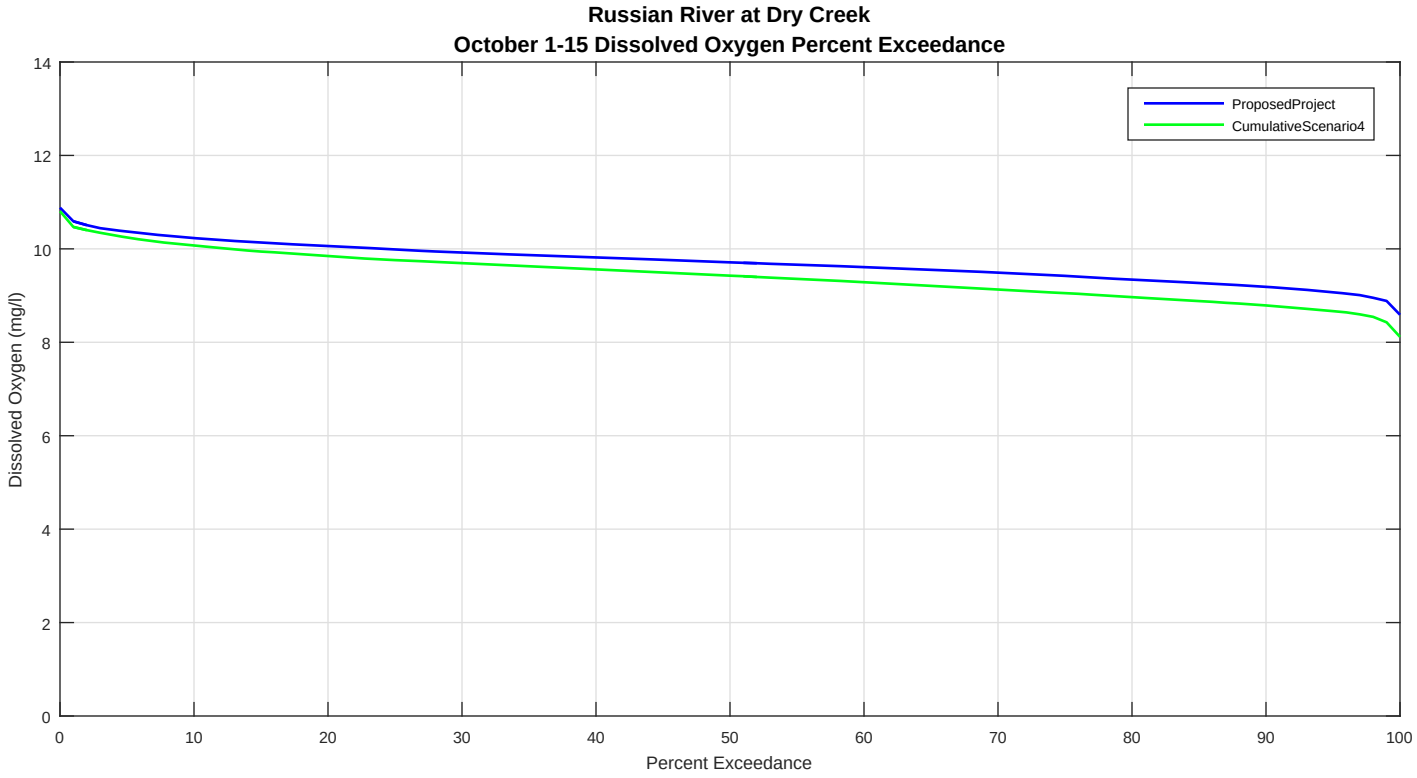
Russian River at Dry Creek
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
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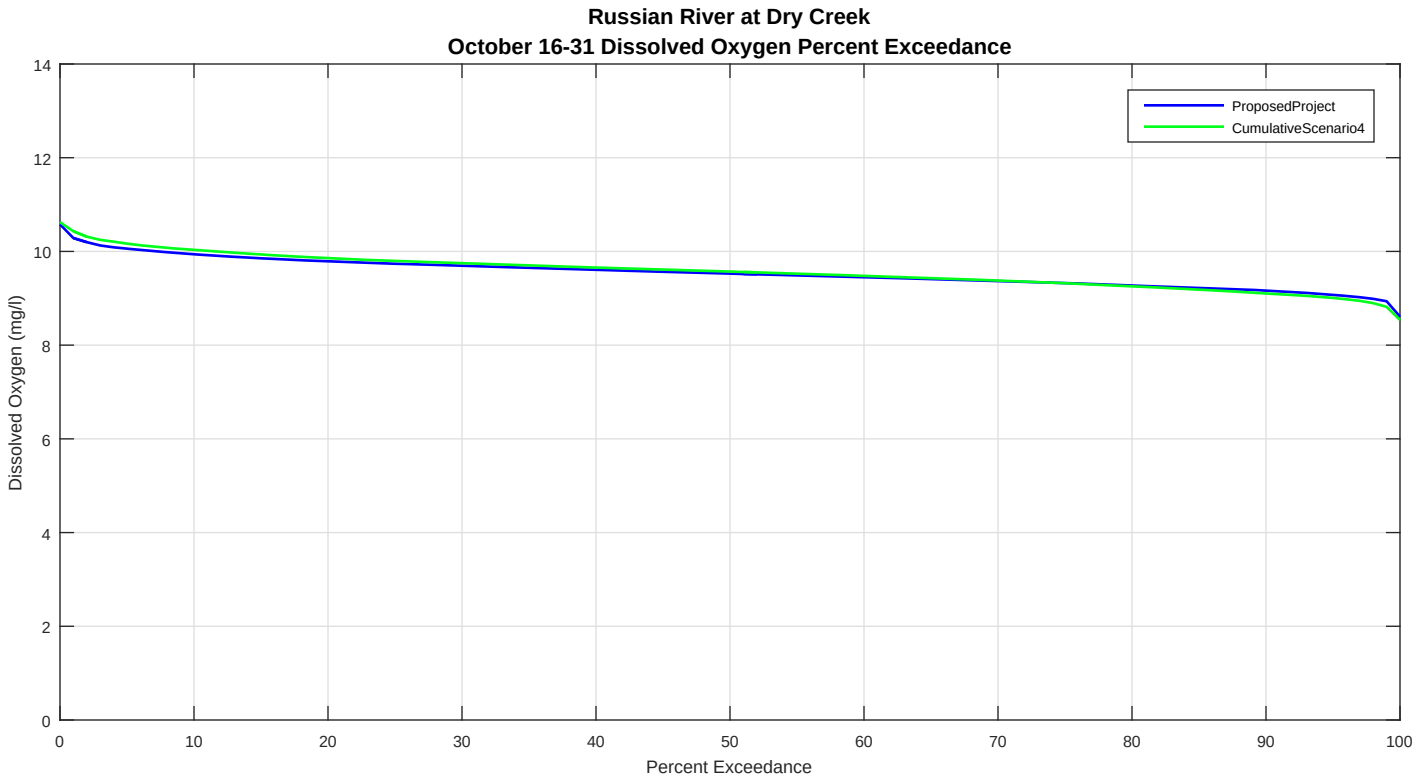
Russian River at Dry Creek
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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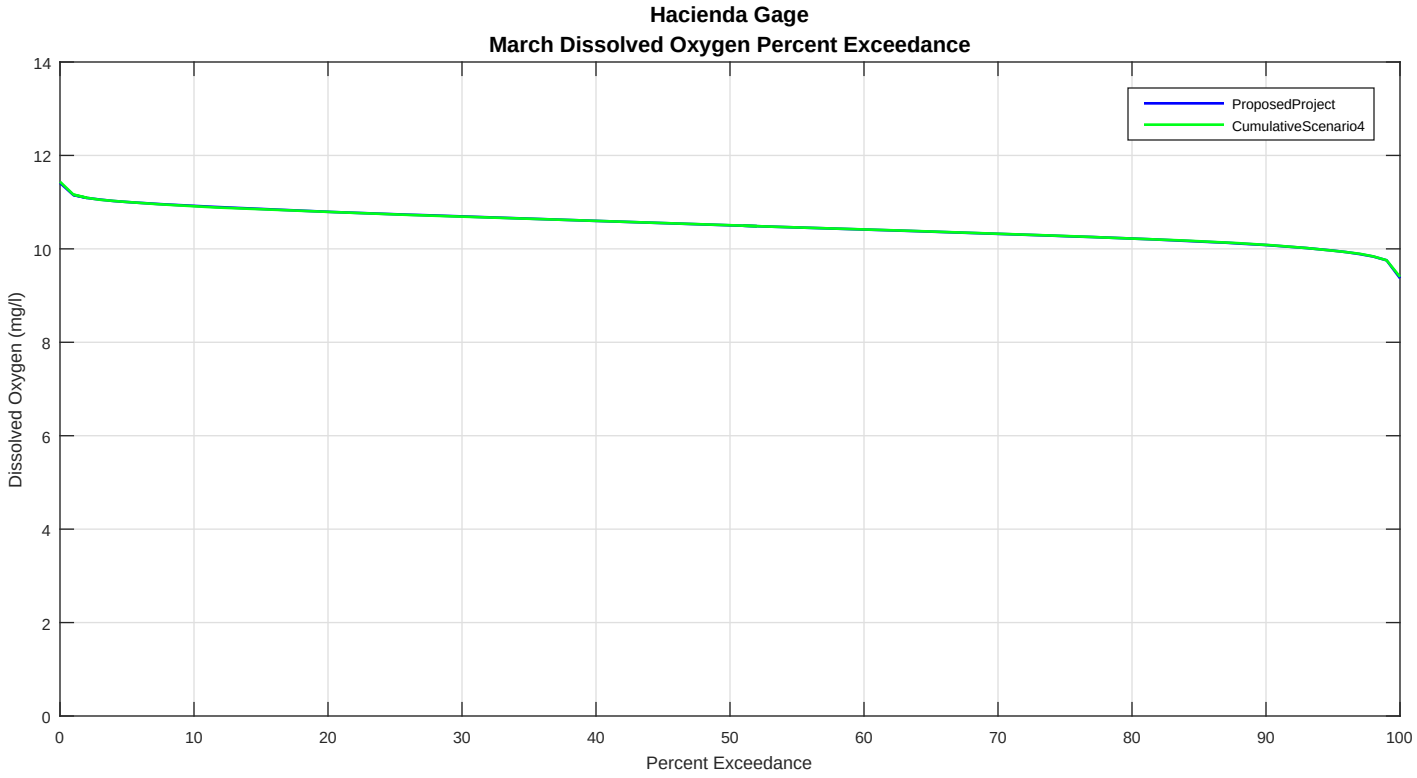
Hacienda Gage
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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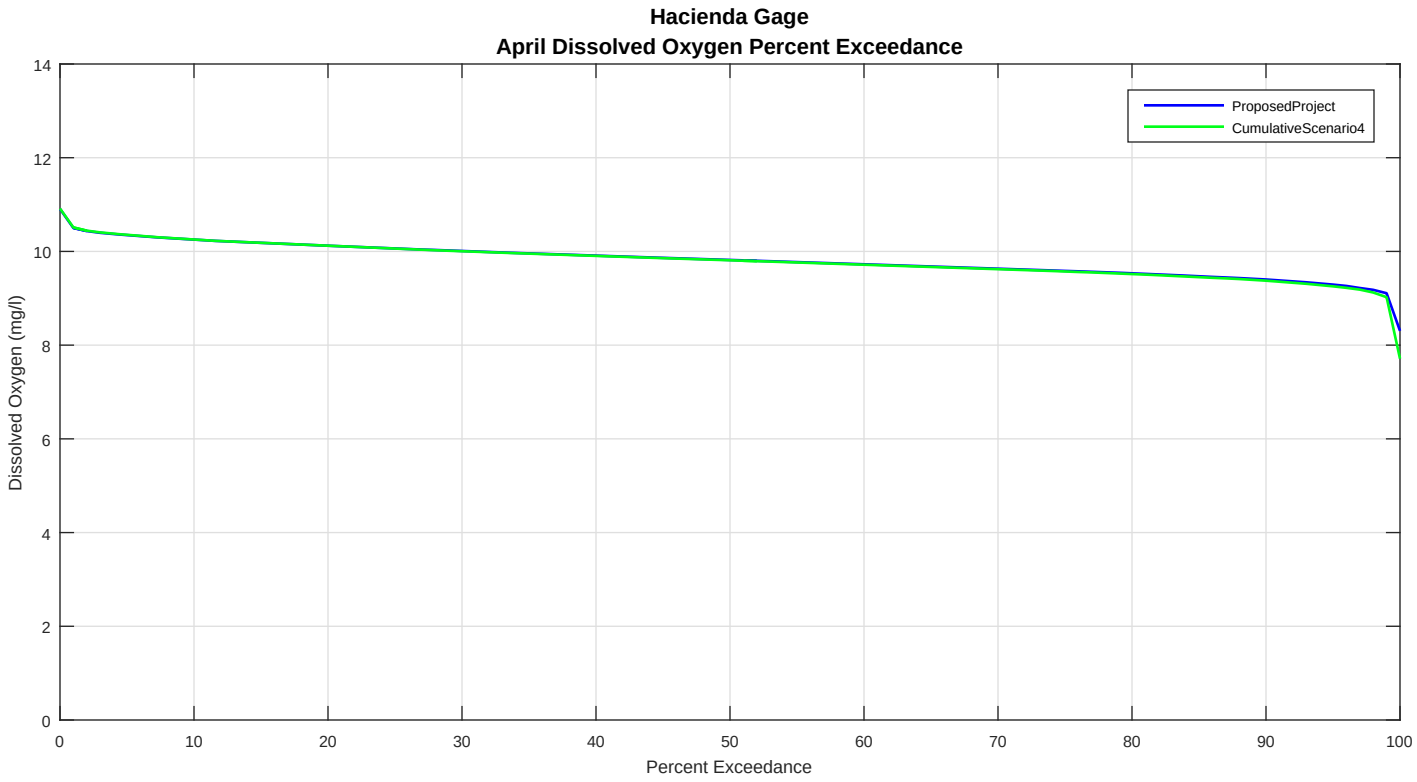
Hacienda Gage
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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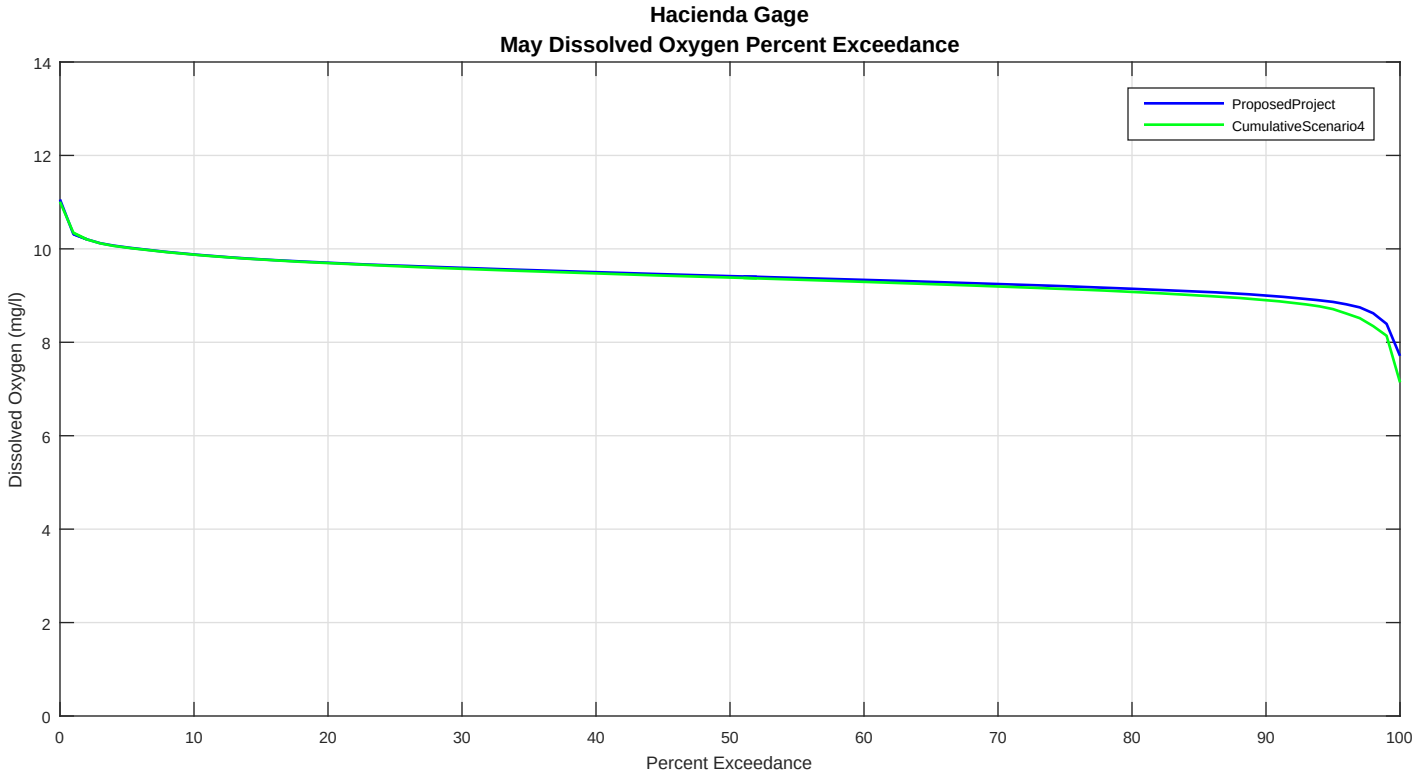
Hacienda Gage
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
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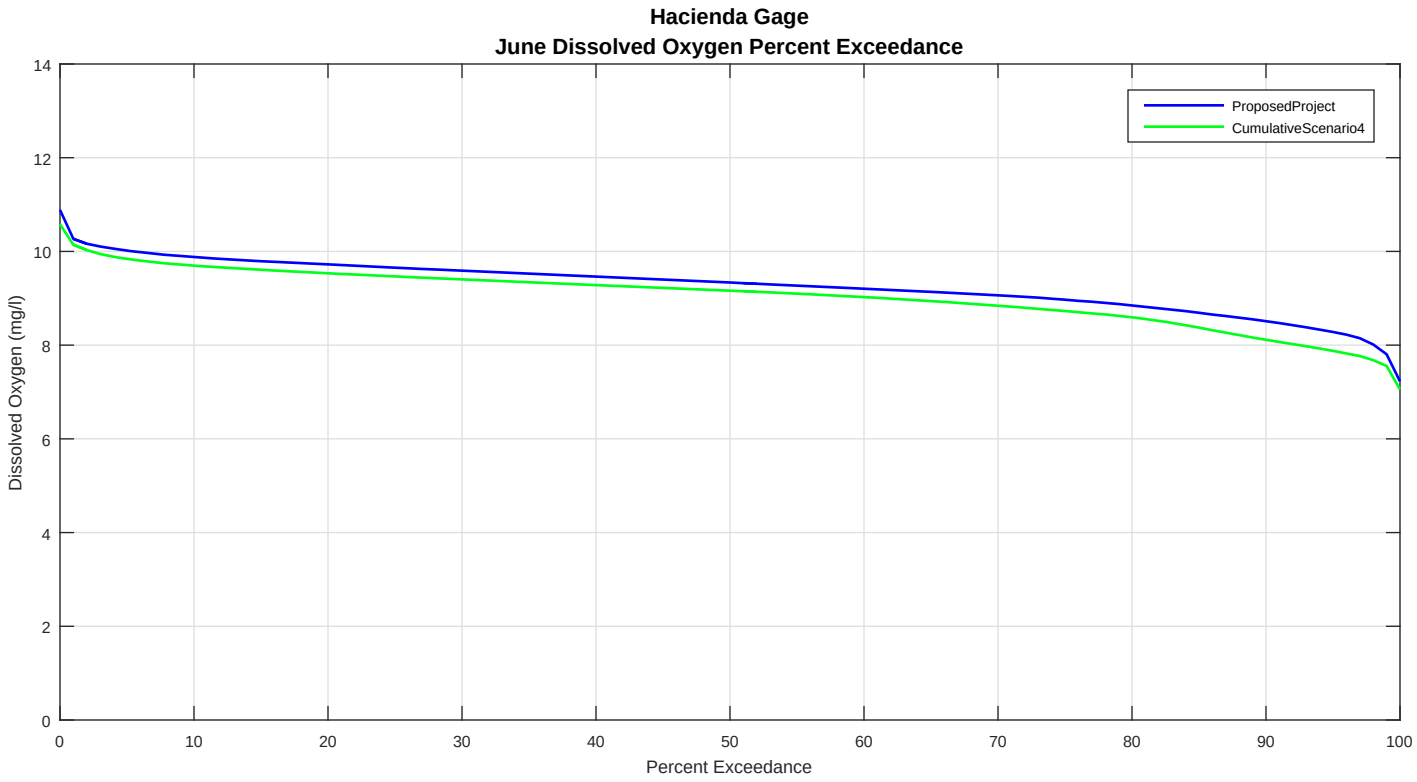
Hacienda Gage
June Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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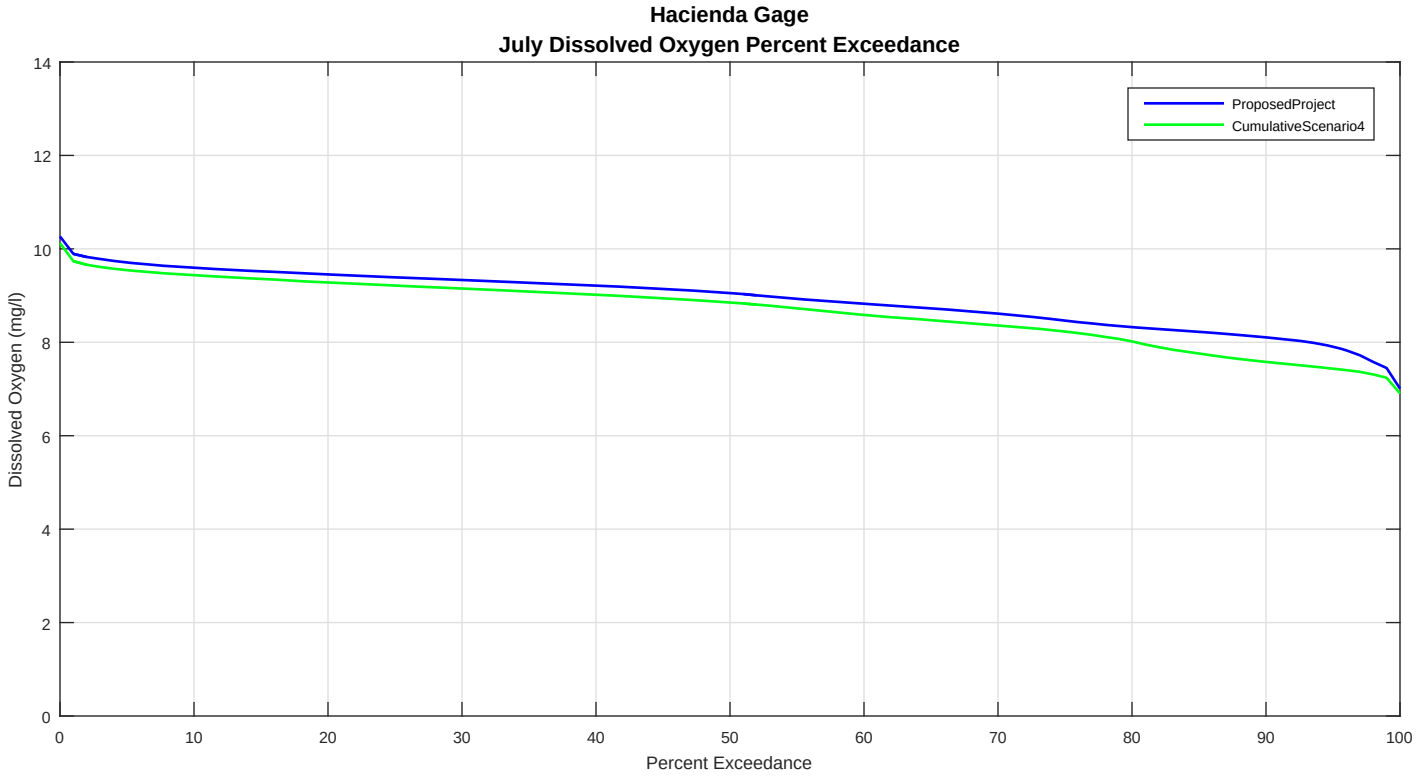
Hacienda Gage
July Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
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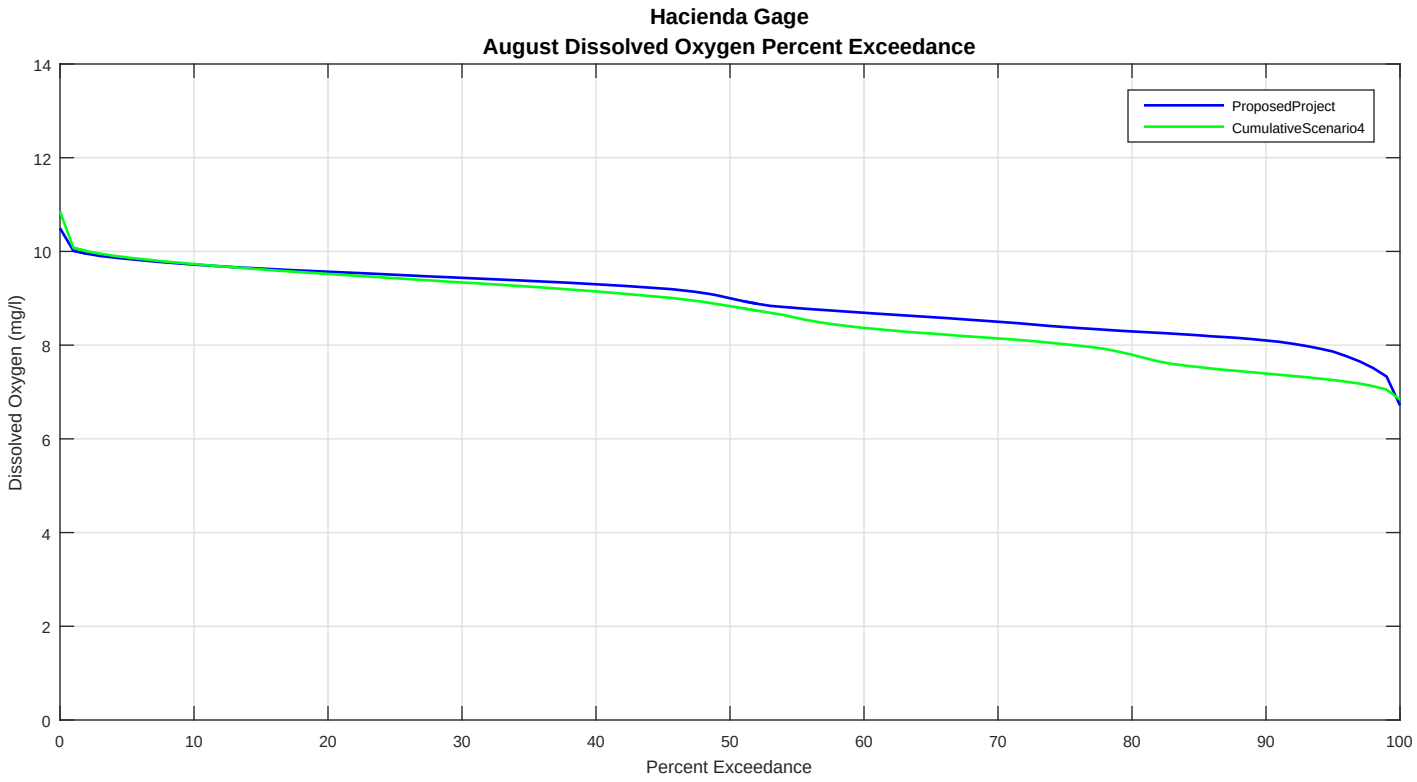
Hacienda Gage
August Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
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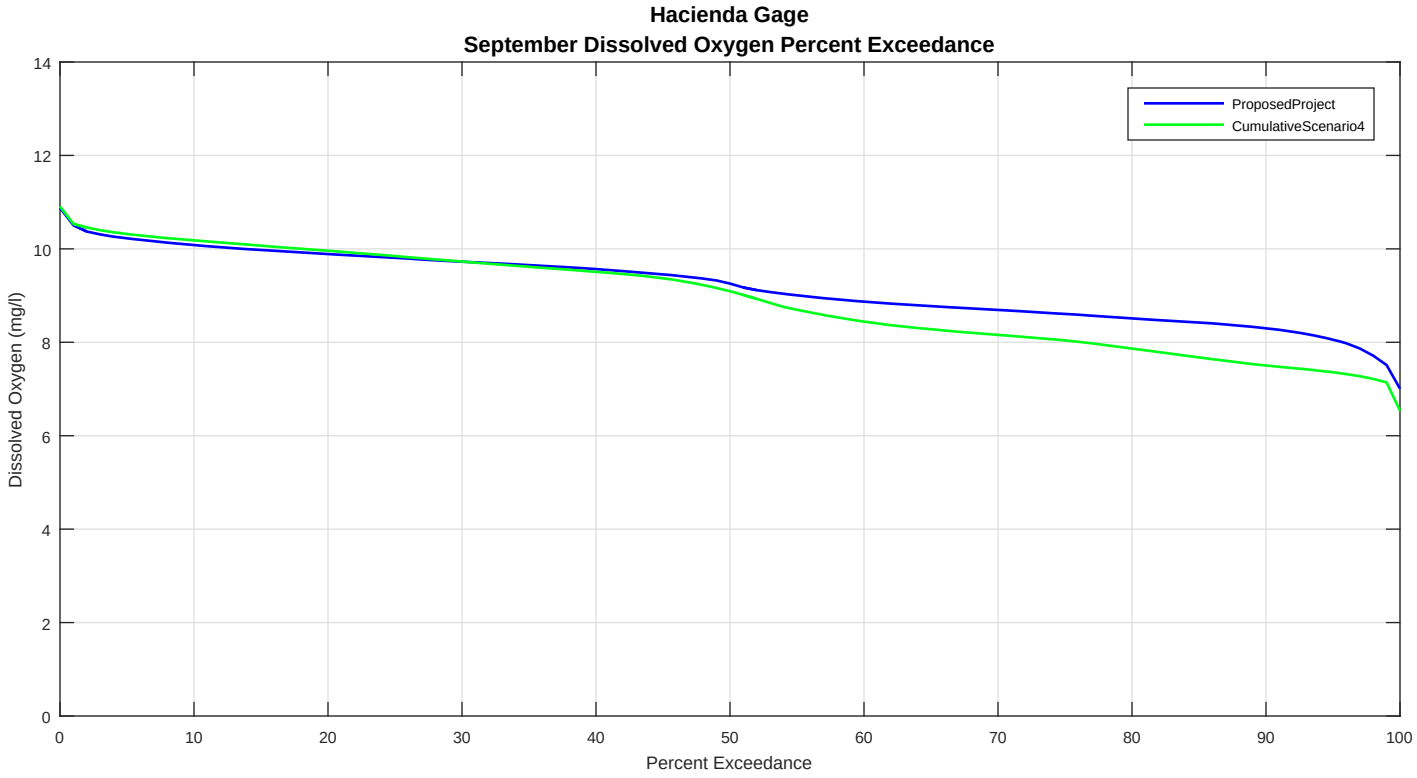
Hacienda Gage
September Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
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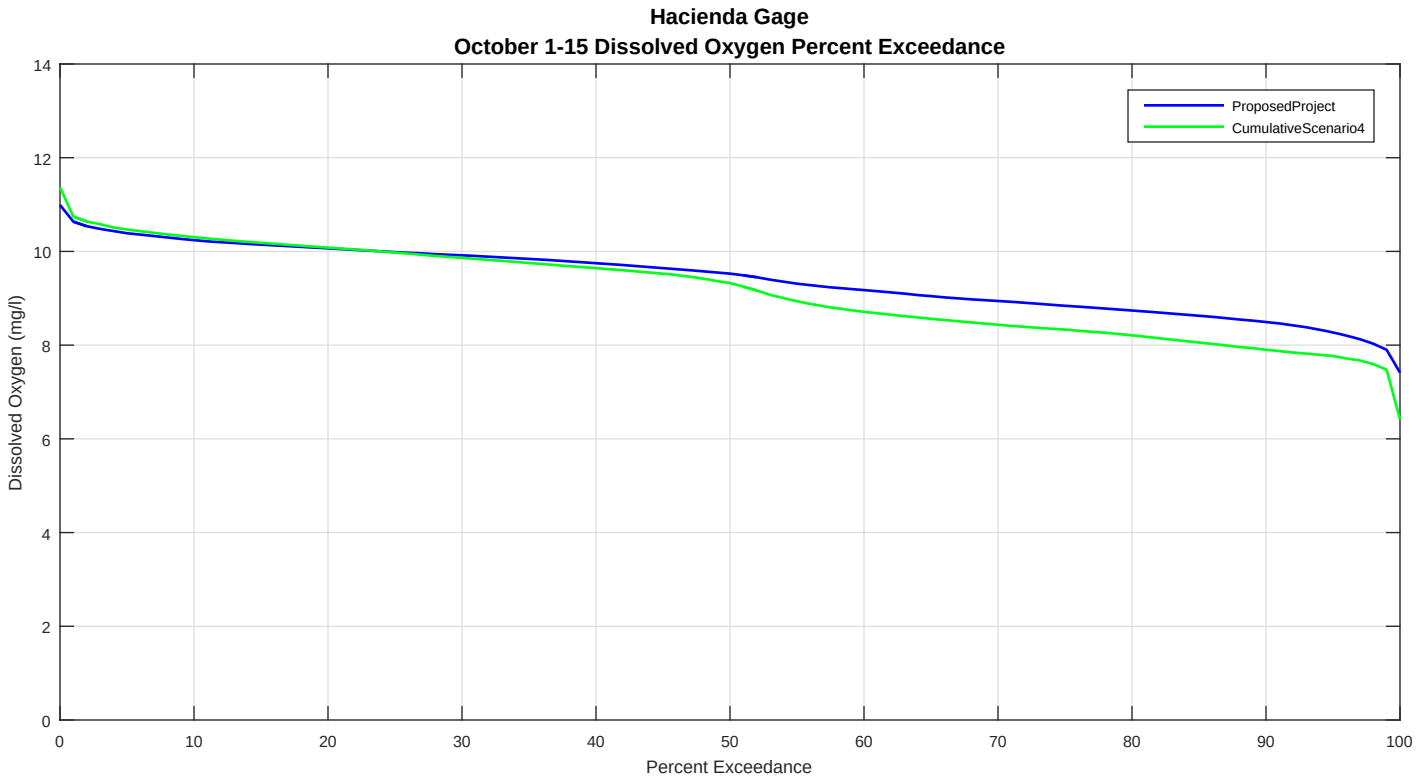
Hacienda Gage
October 1-15 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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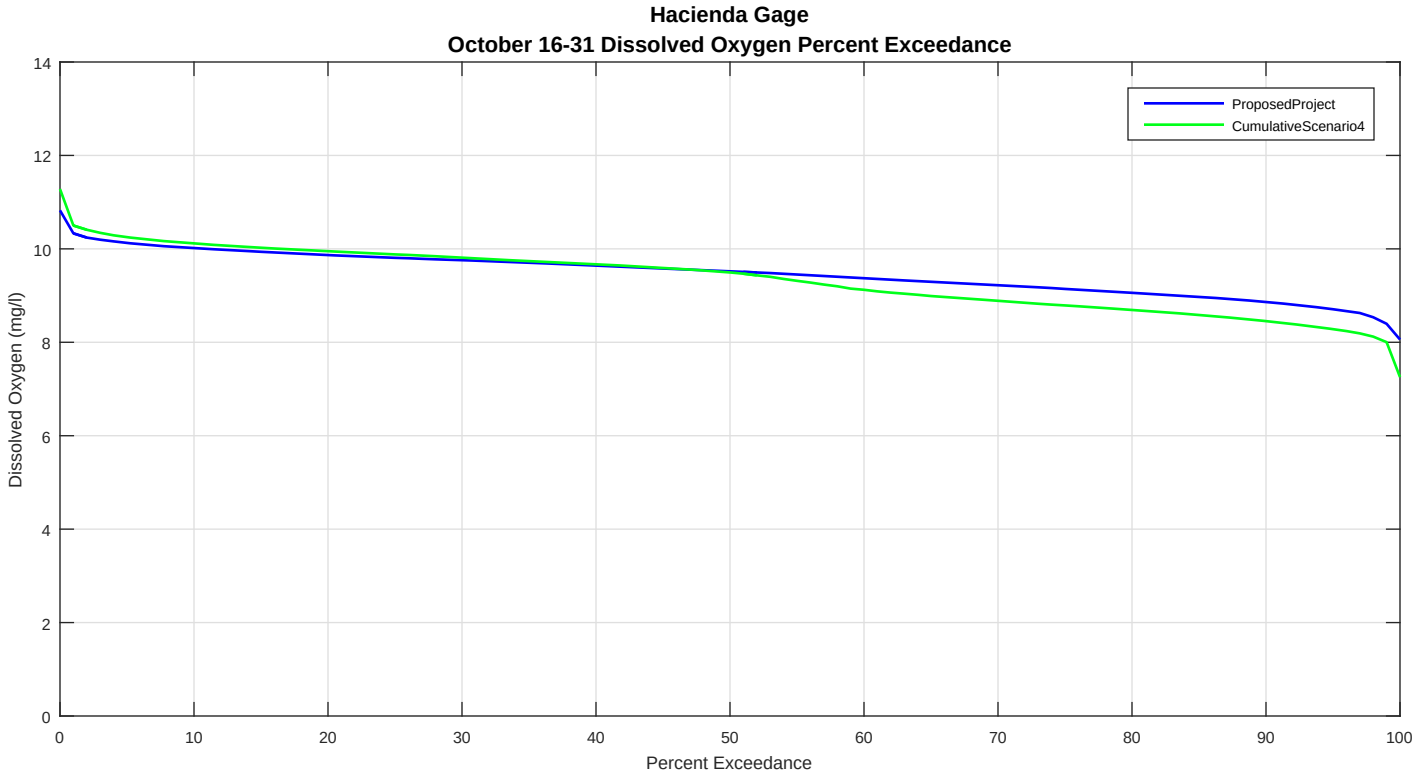
Hacienda Gage
October 16-31 Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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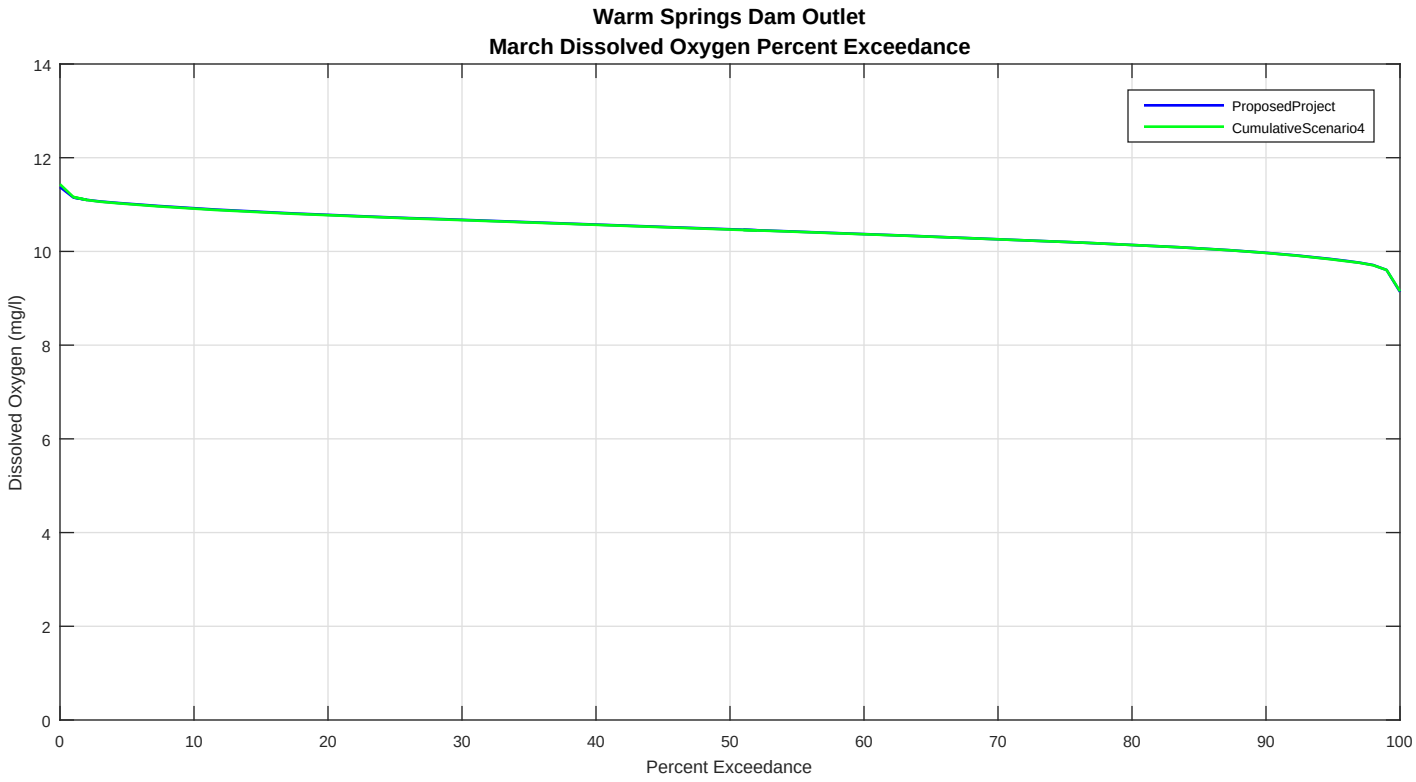
Warm Springs Dam Outlet
March Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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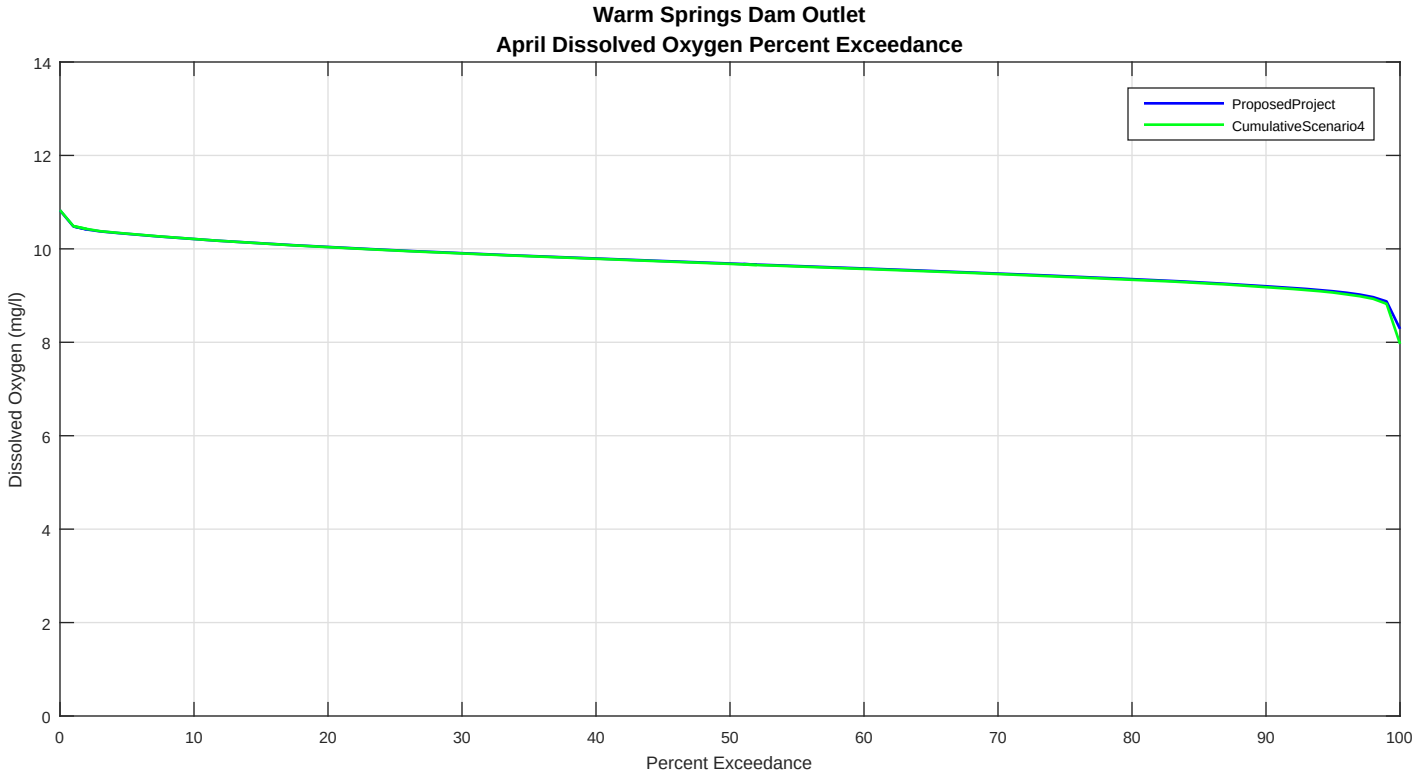
Warm Springs Dam Outlet
April Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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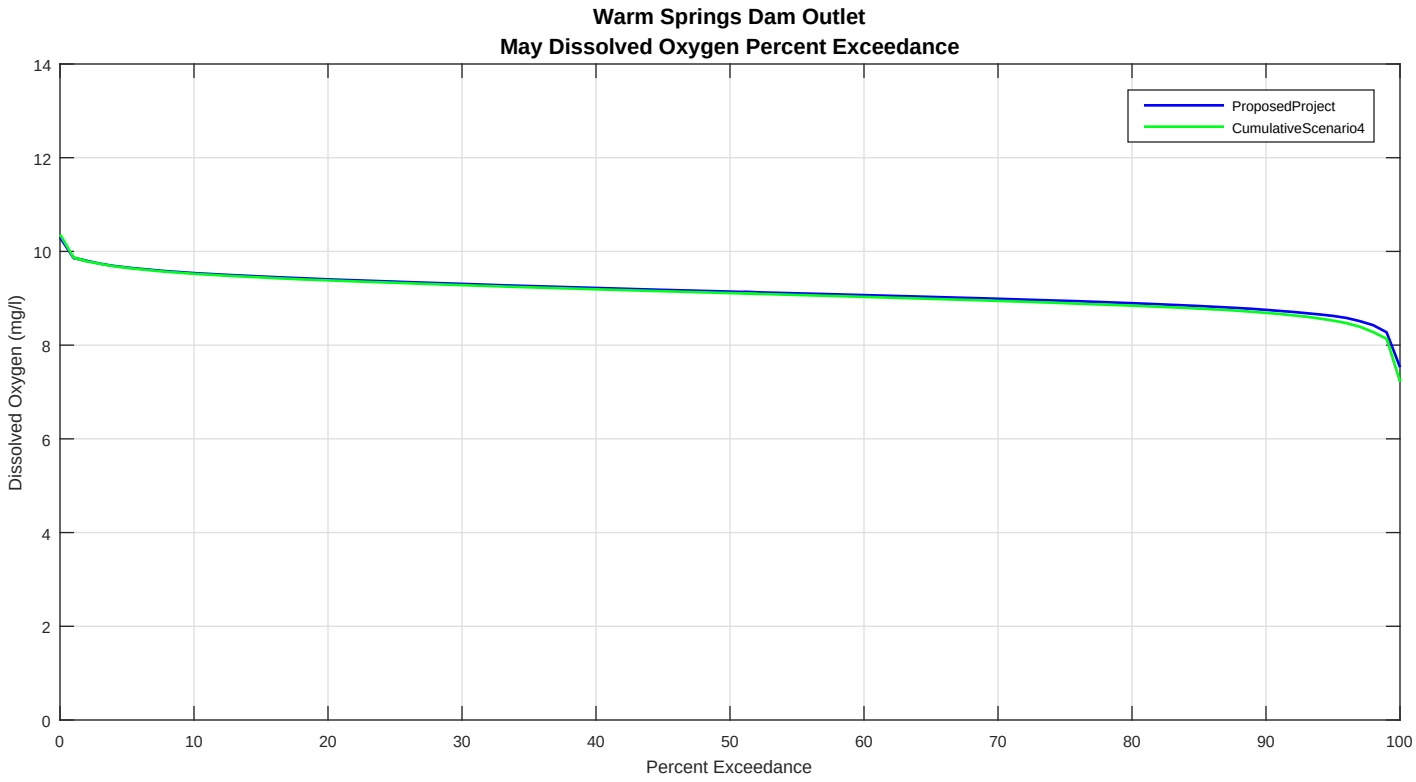
Warm Springs Dam Outlet
May Dissolved Oxygen Percent Exceedance
ProposedProject
CumulativeScenario4
Dissolved Oxygen (mg/l)
Percent Exceedance
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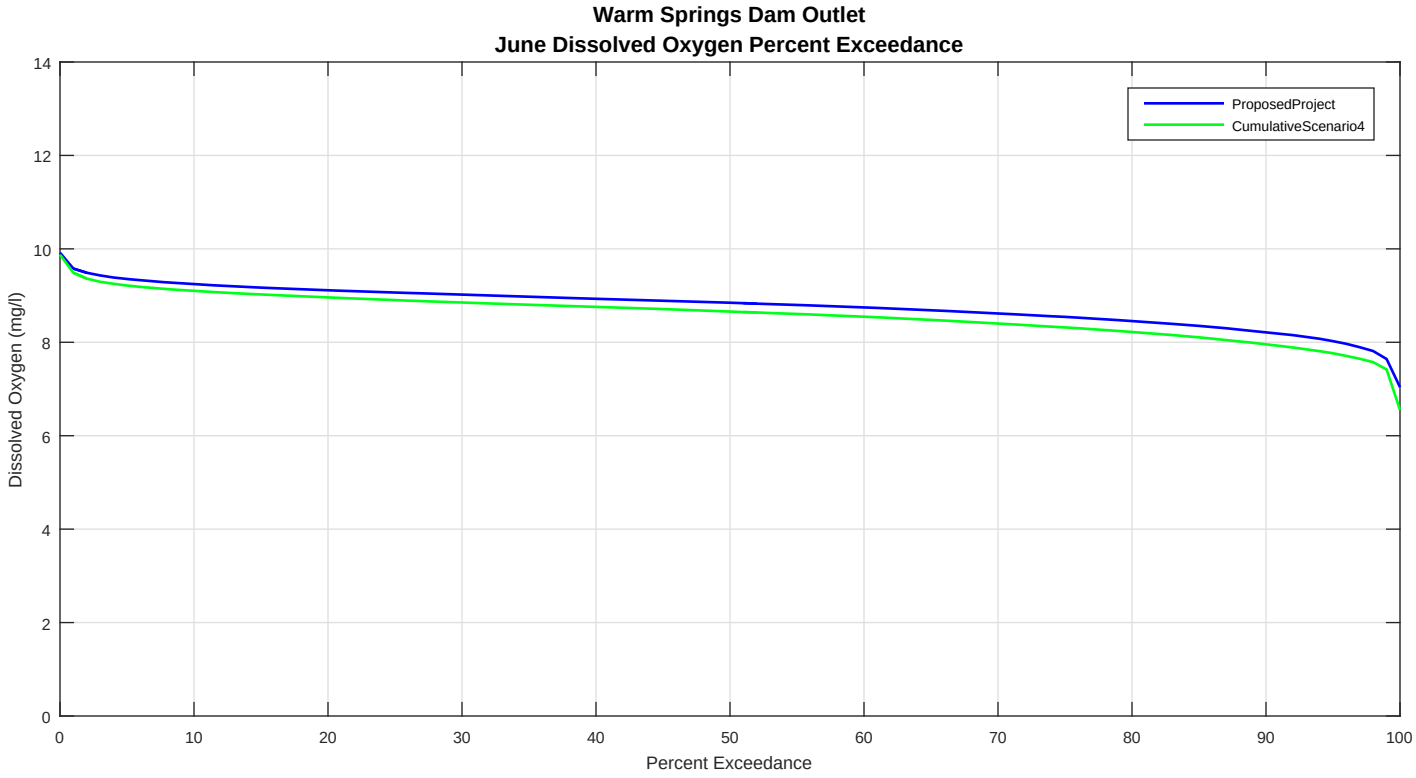
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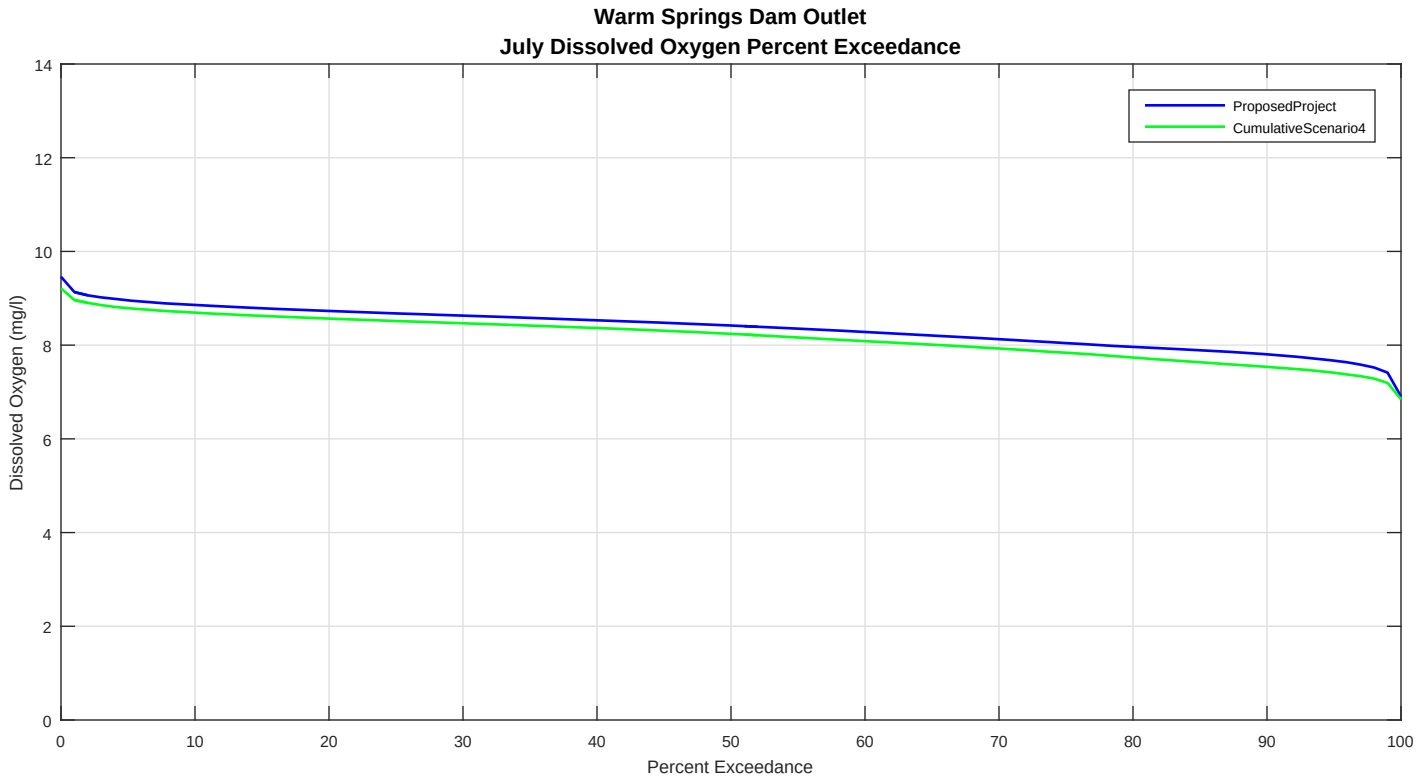
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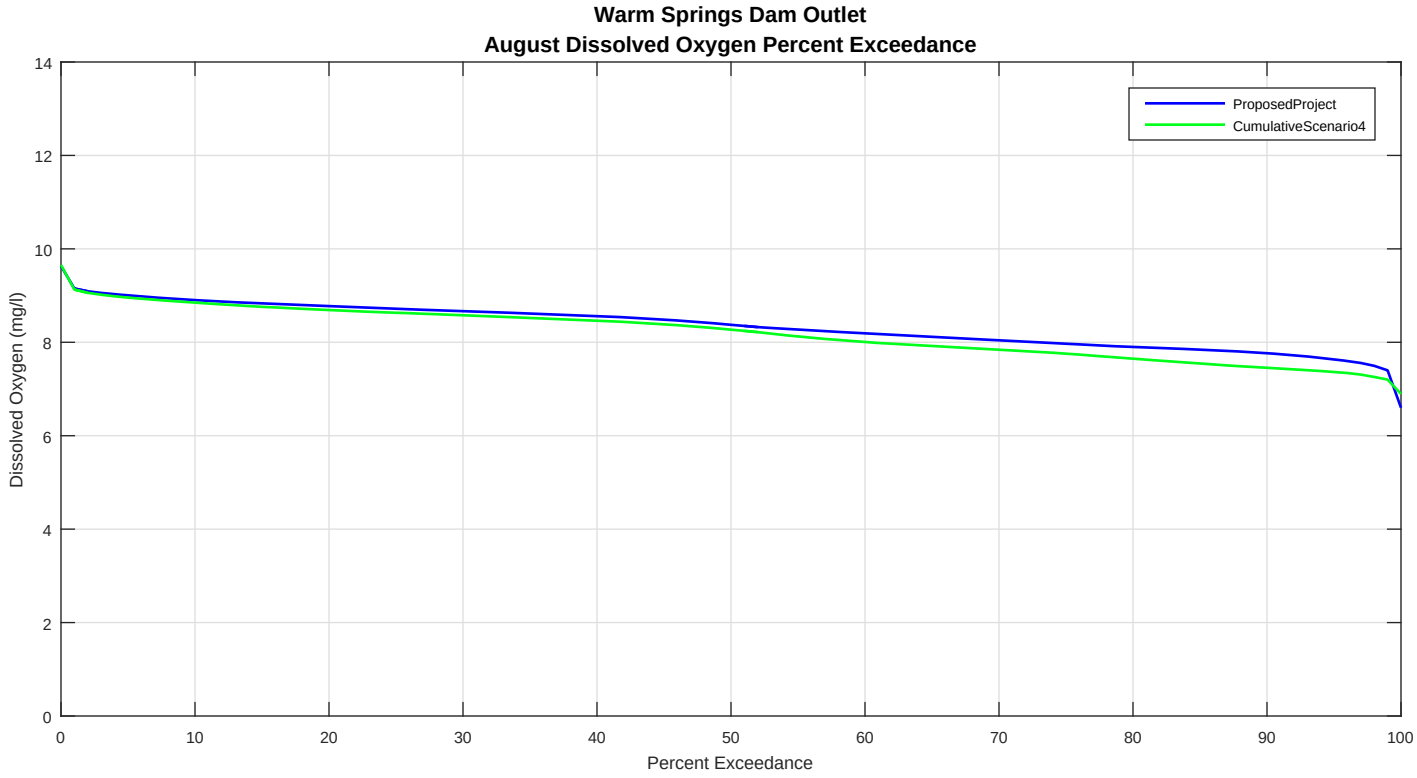
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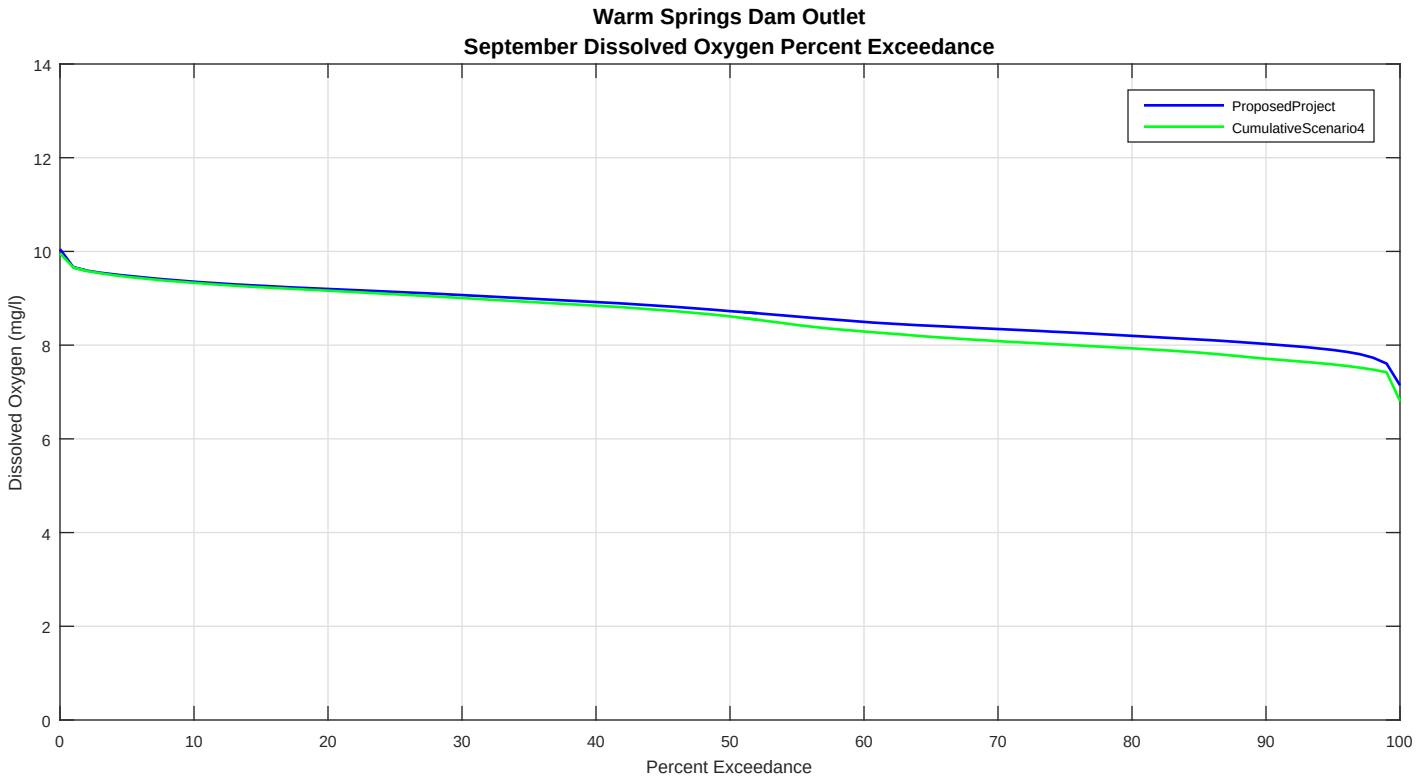
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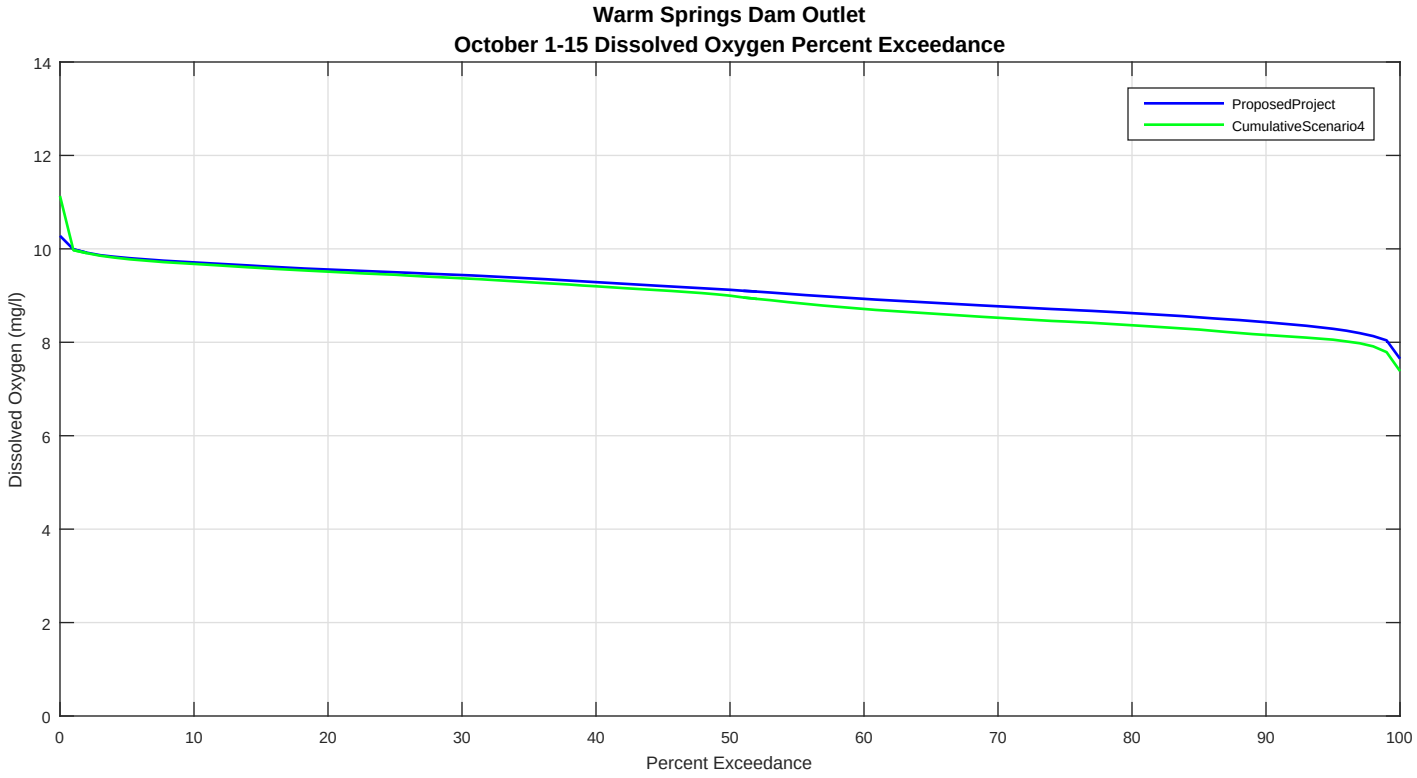
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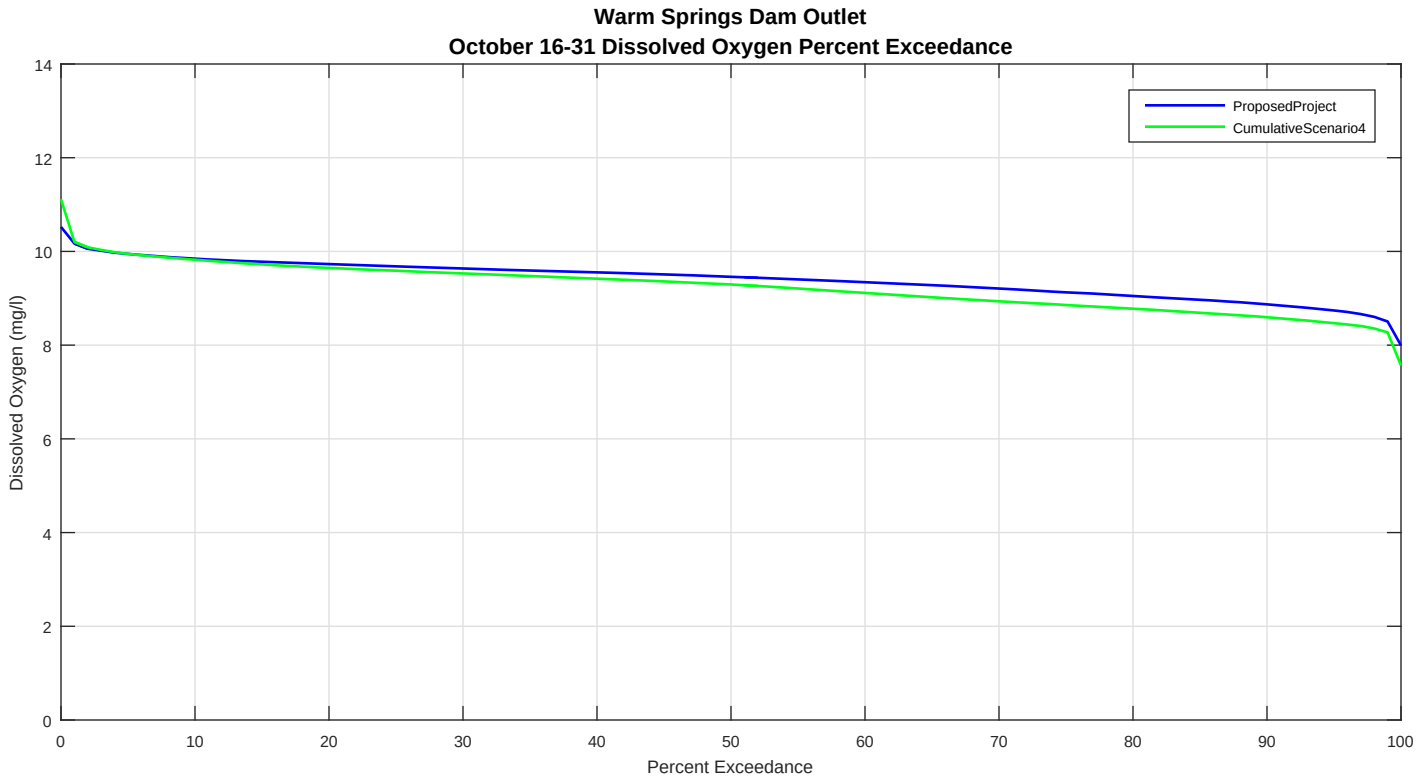
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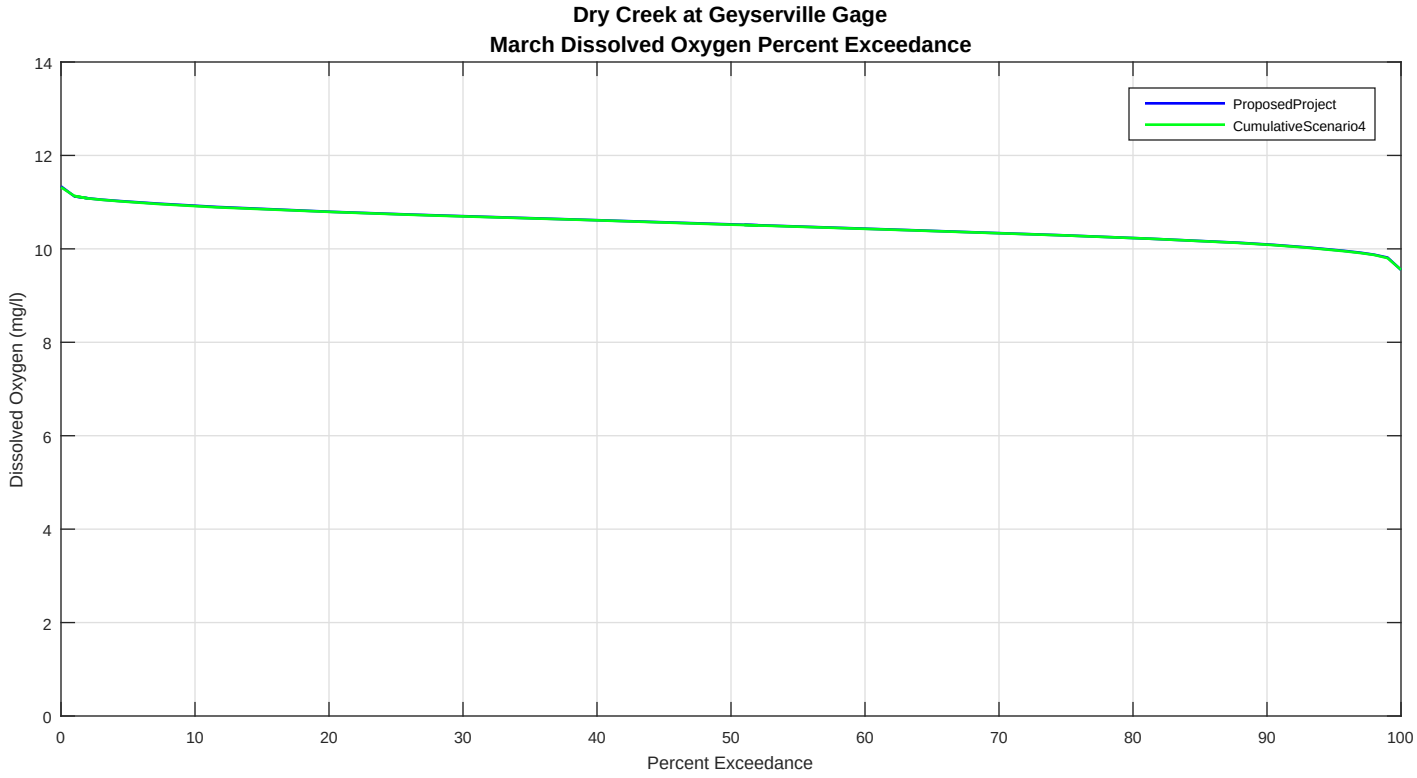
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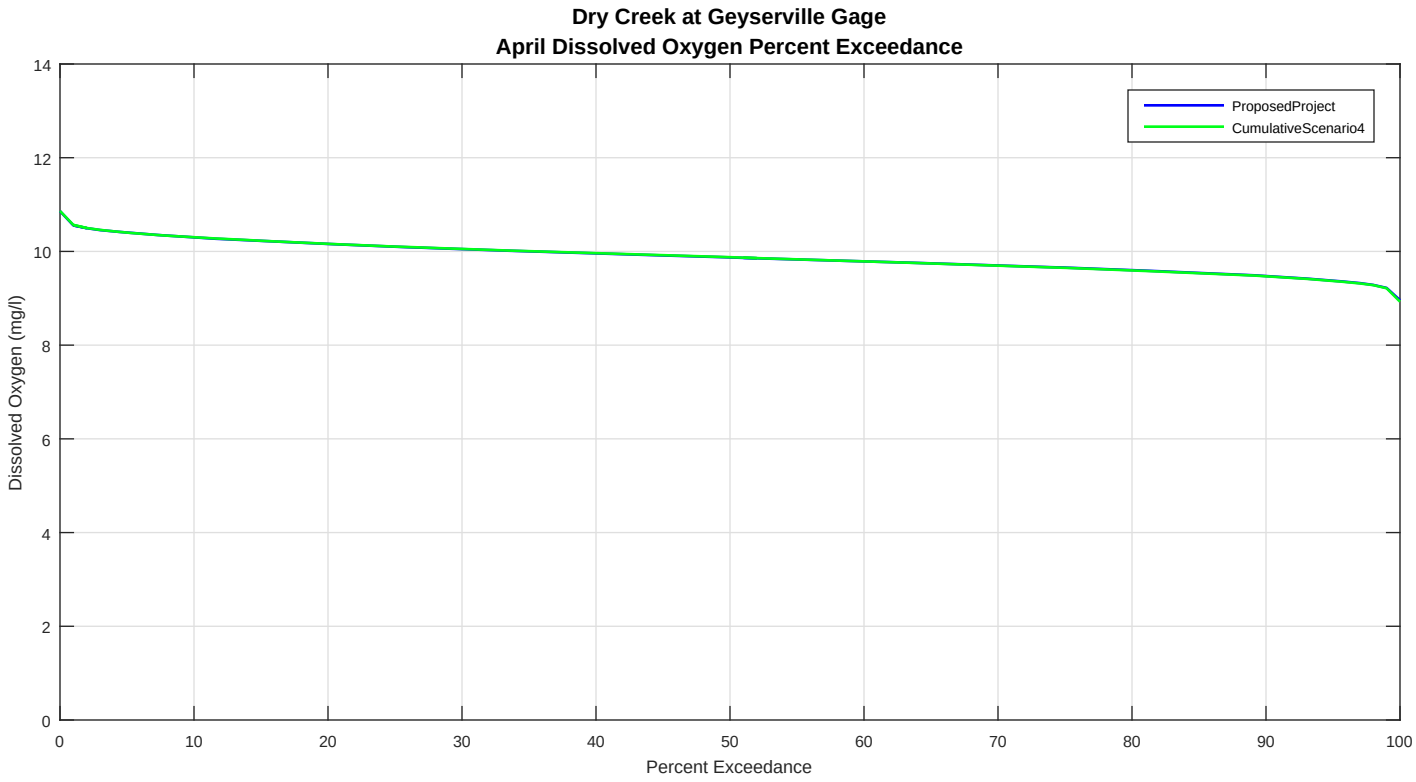
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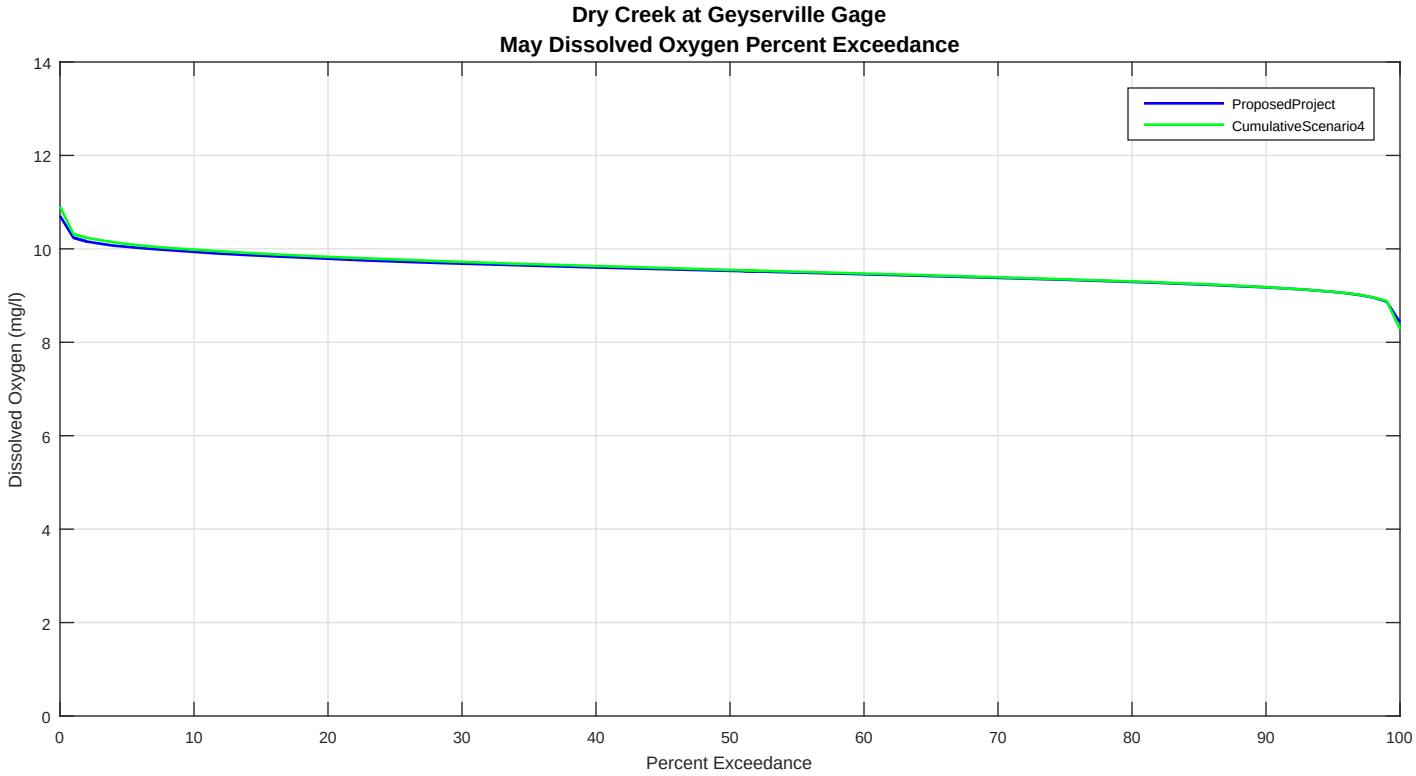
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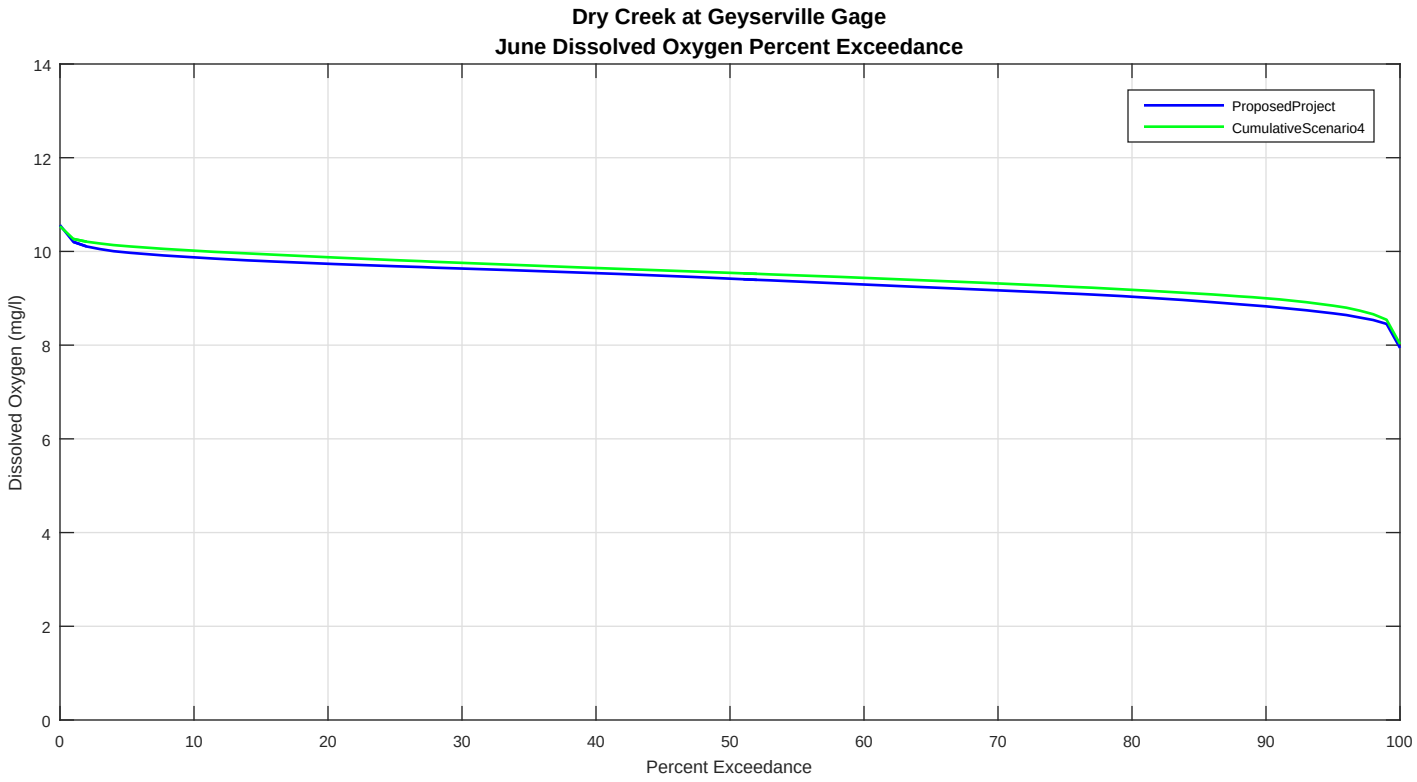
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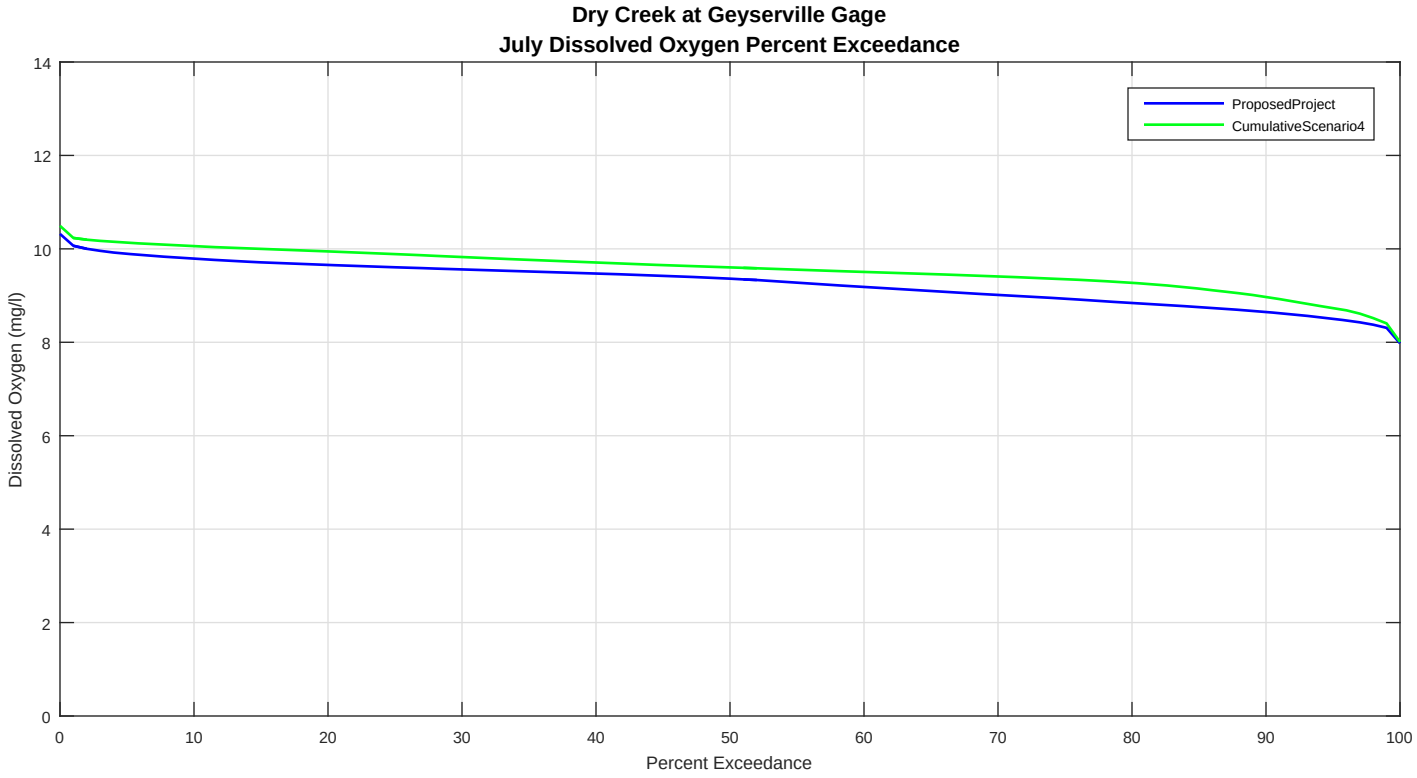
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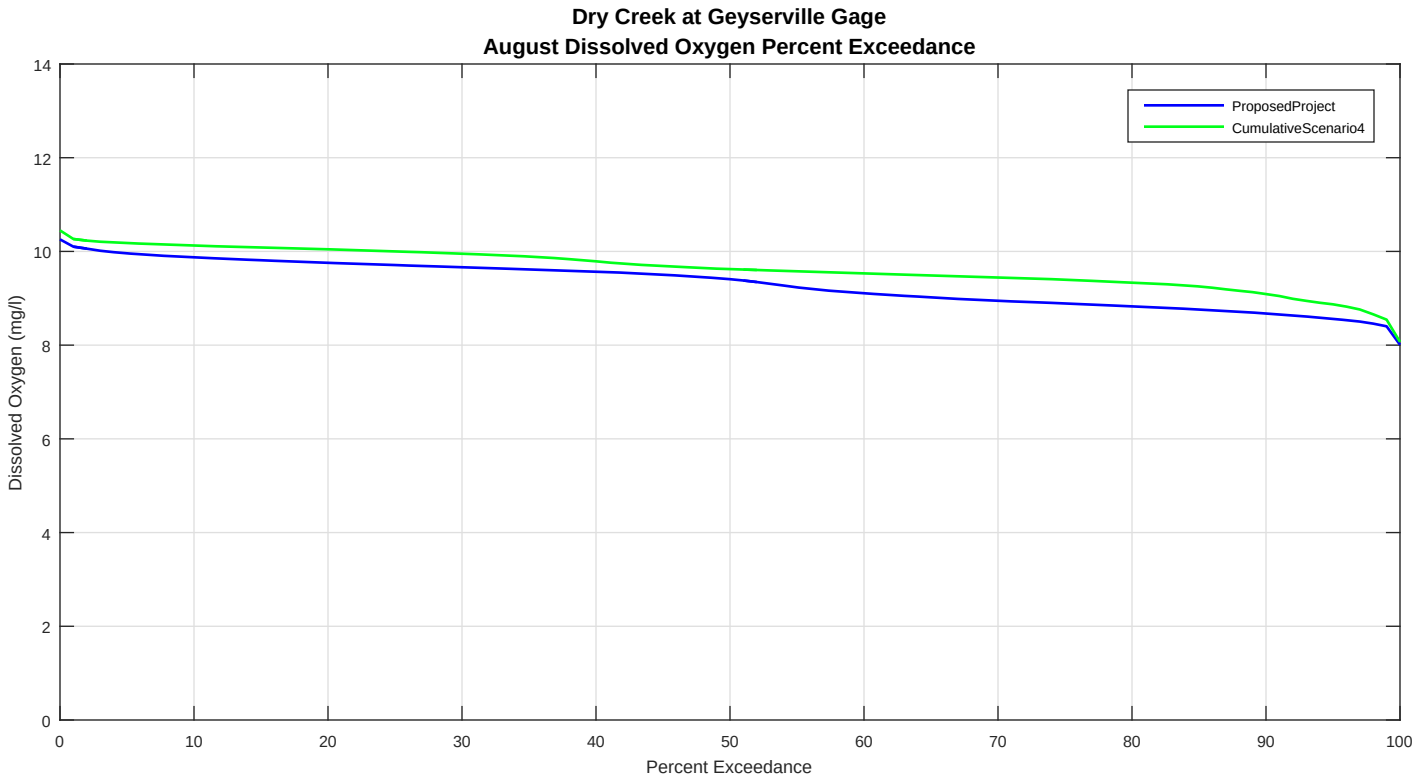
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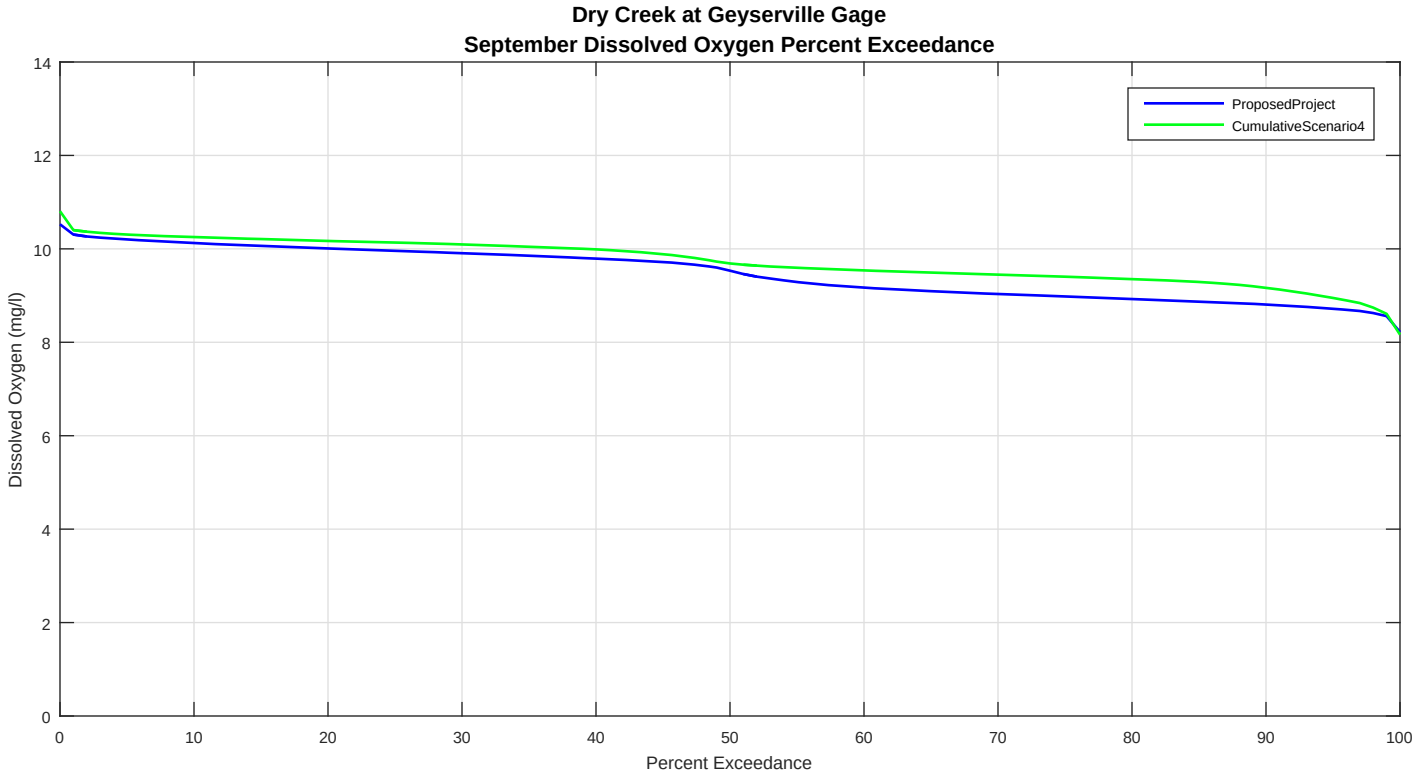
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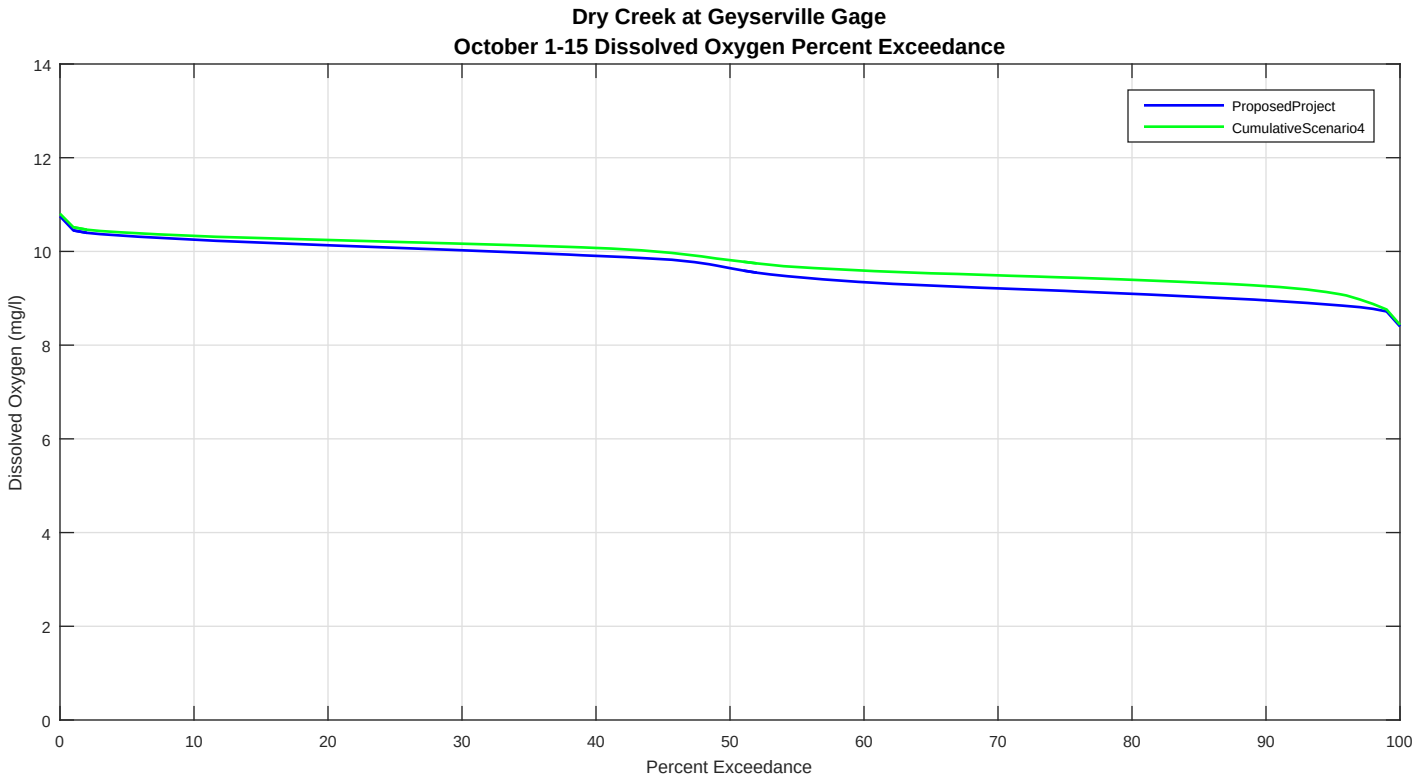
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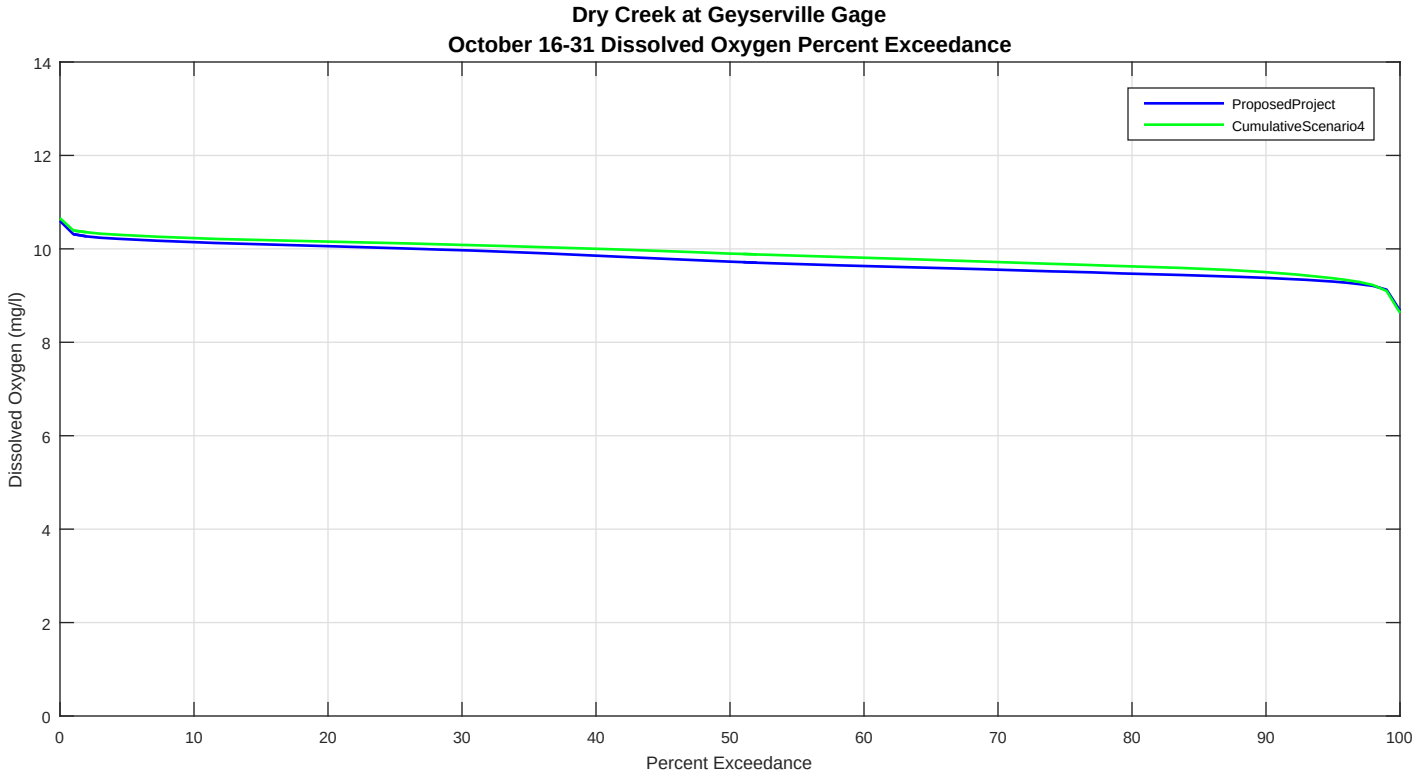
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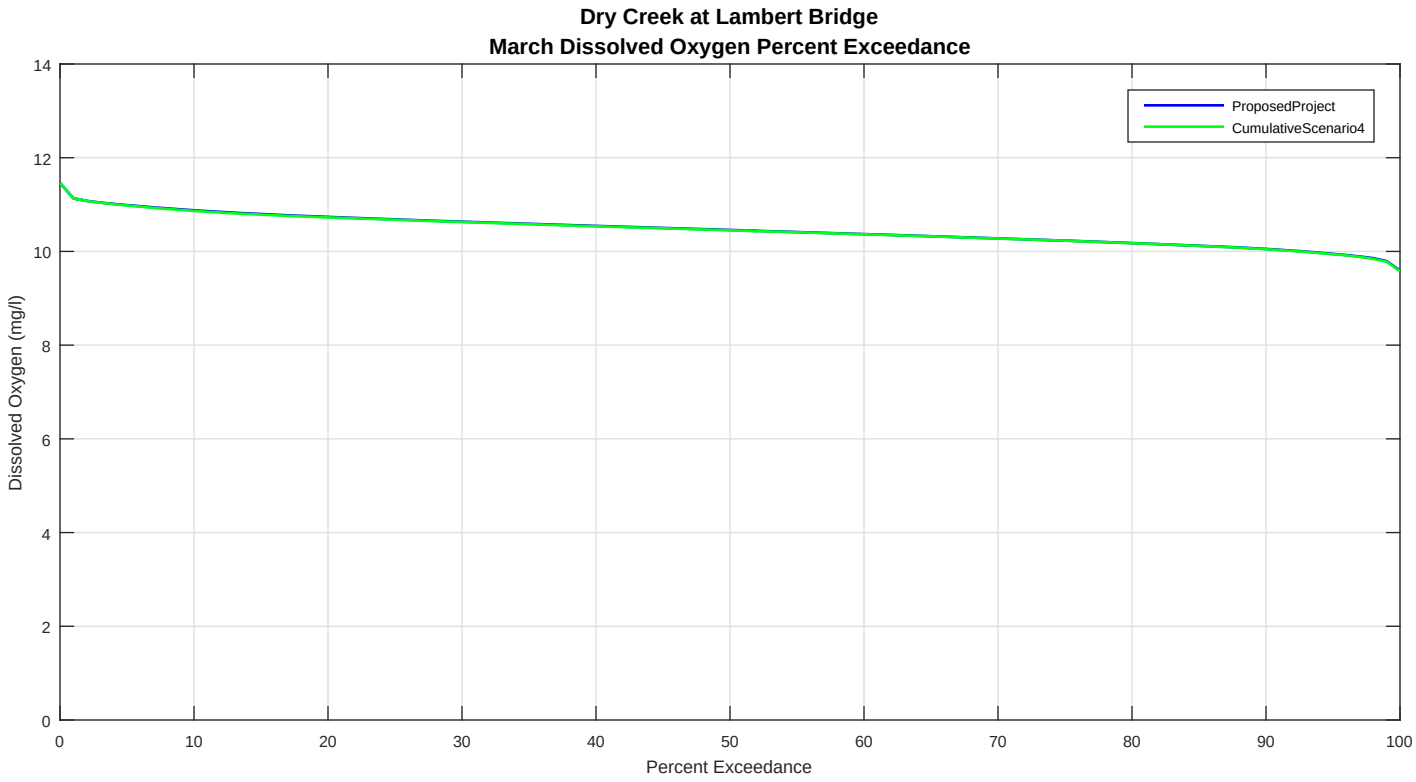
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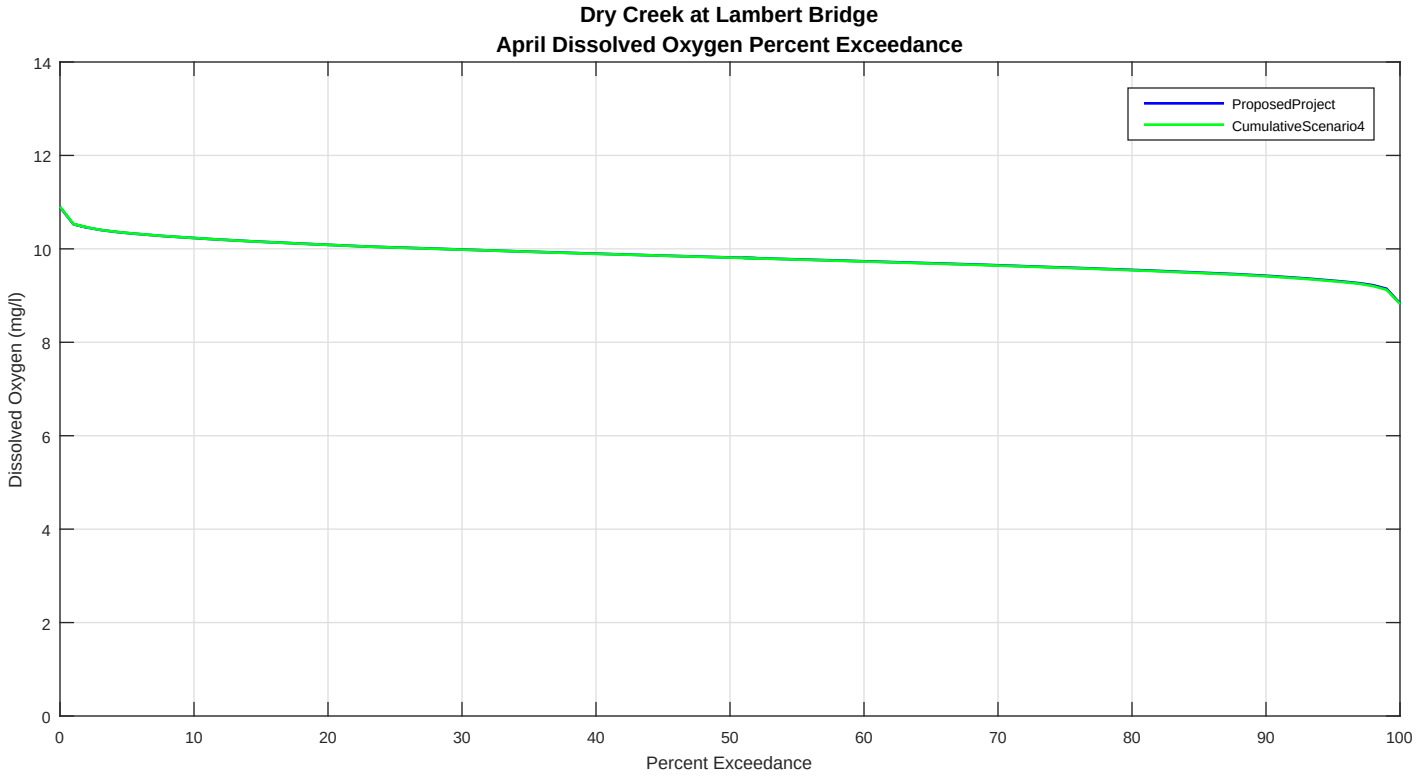
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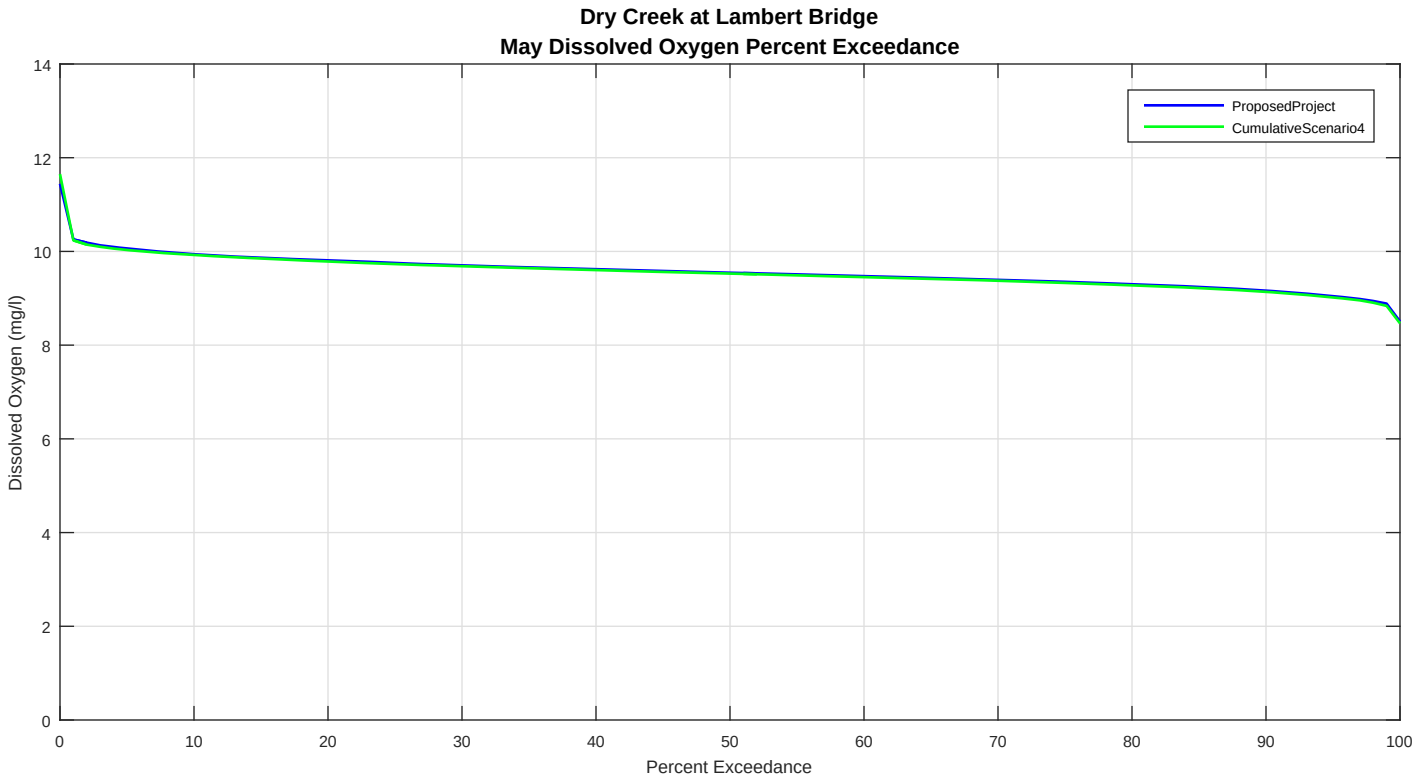
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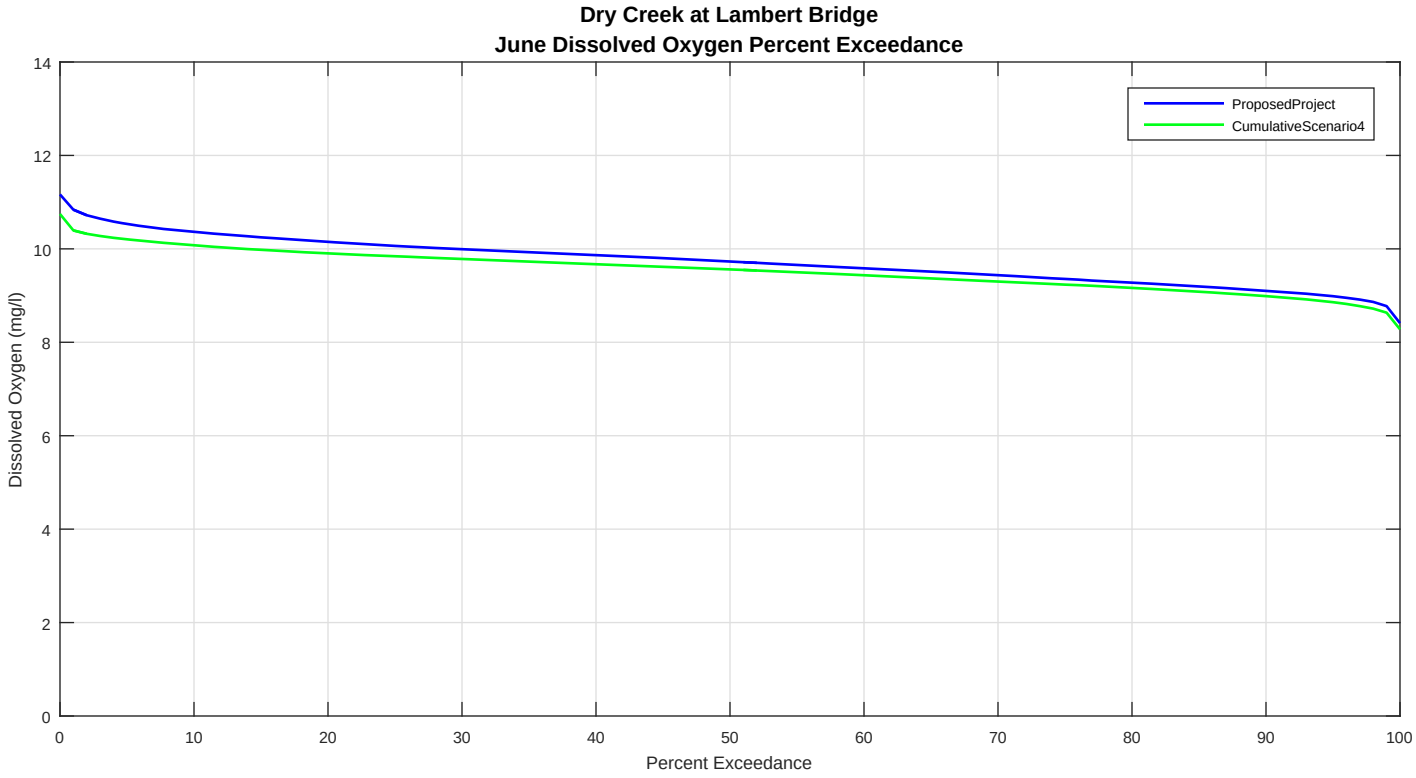
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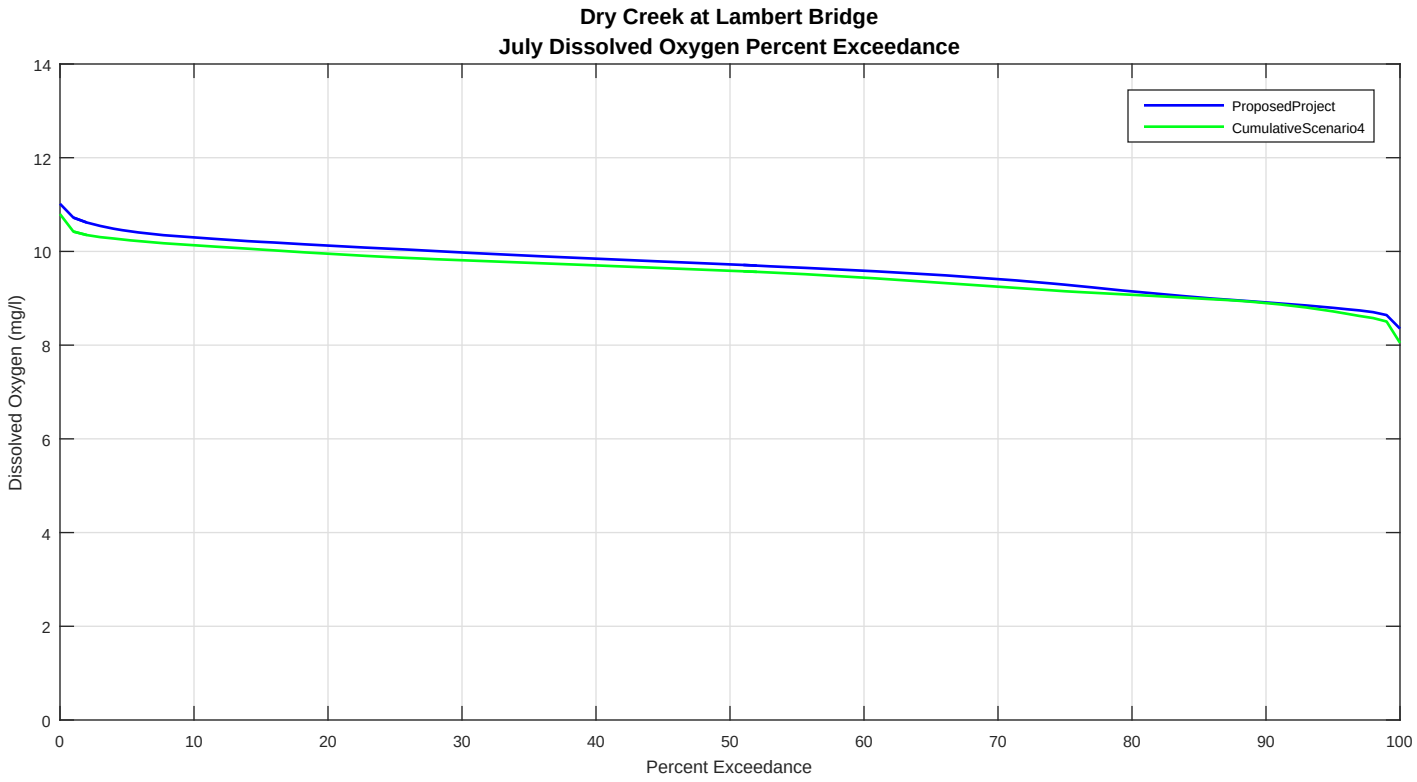
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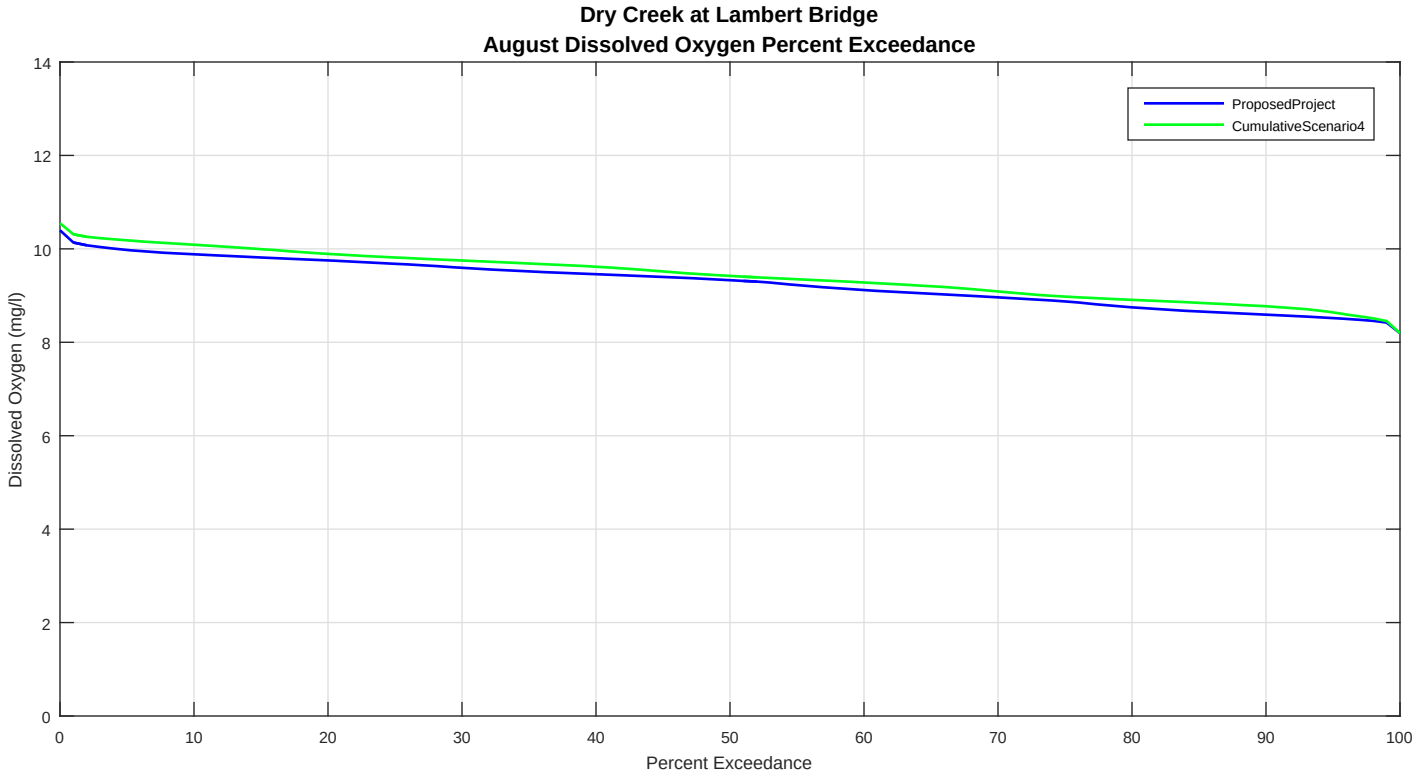
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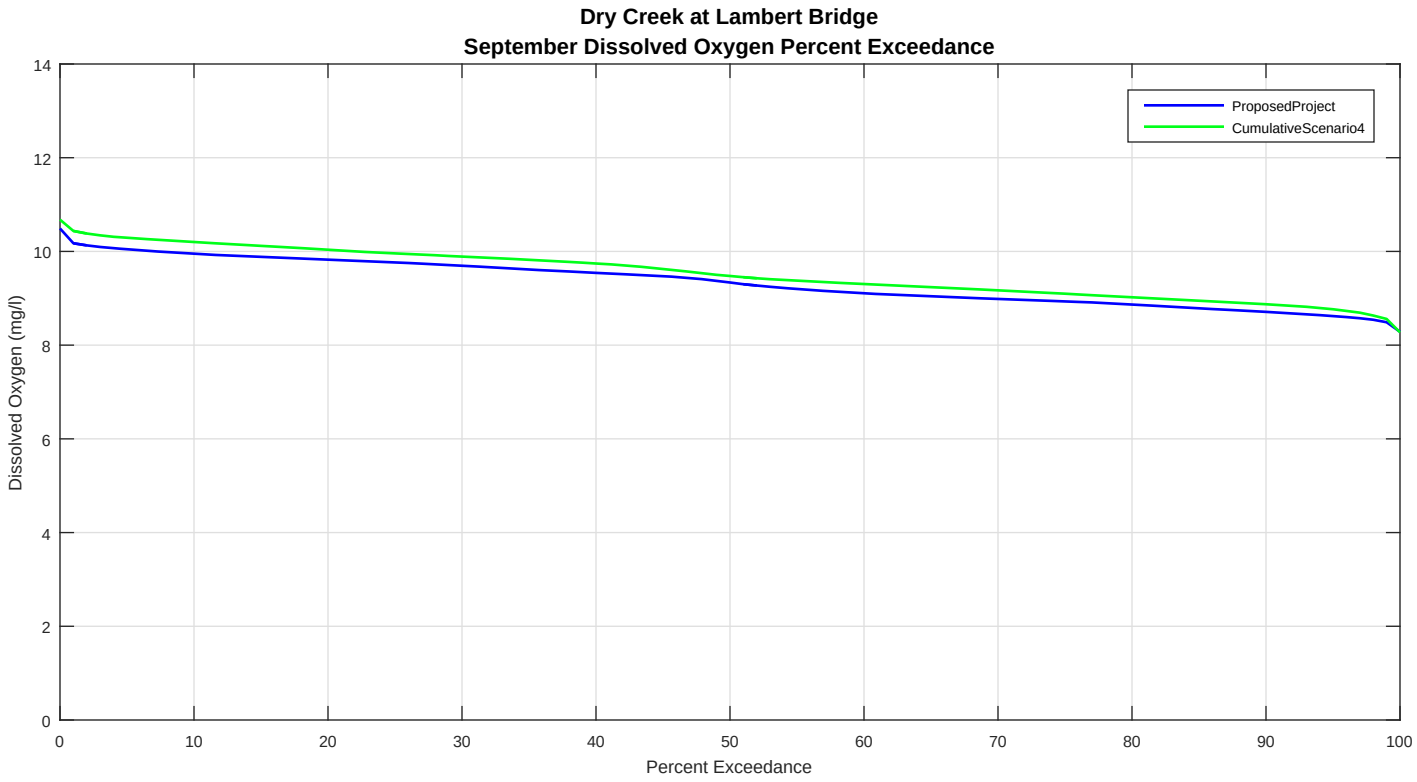
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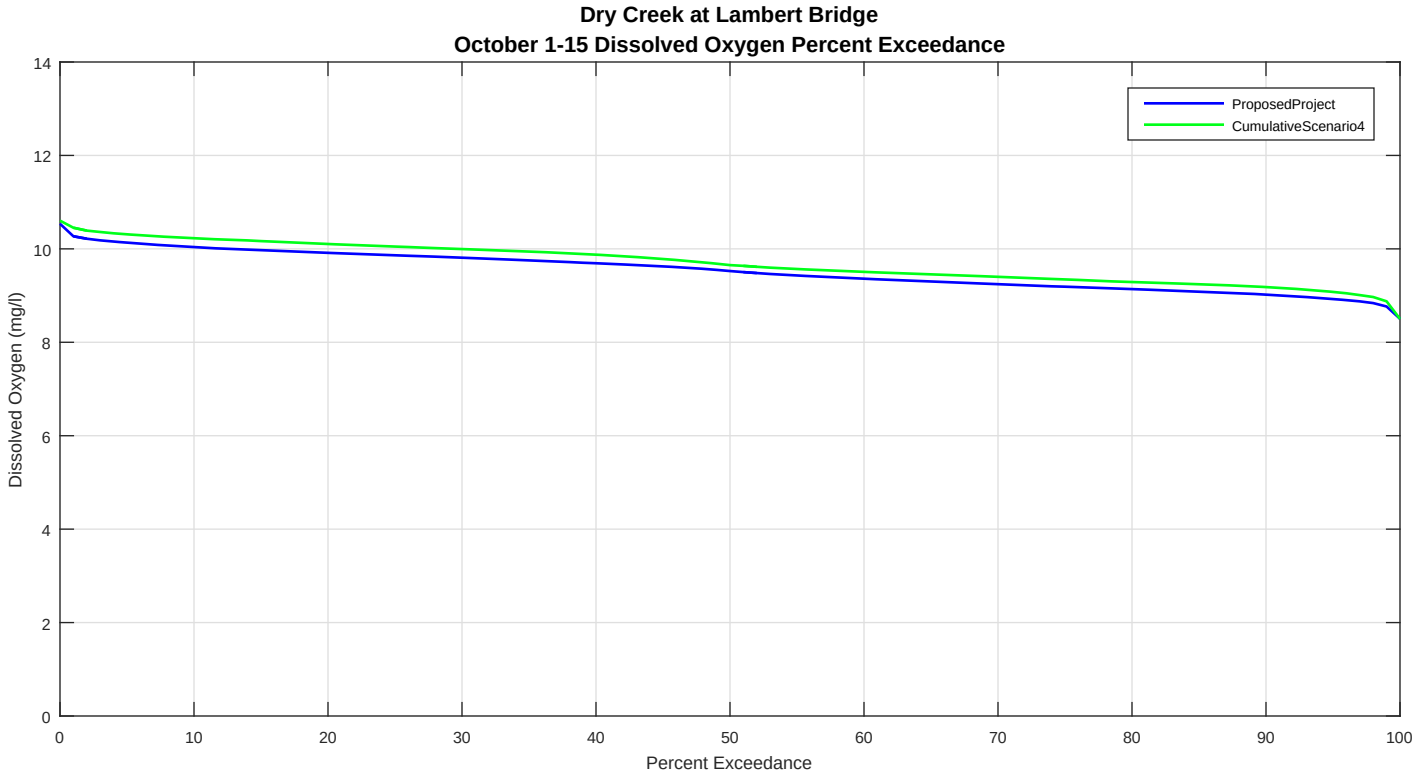
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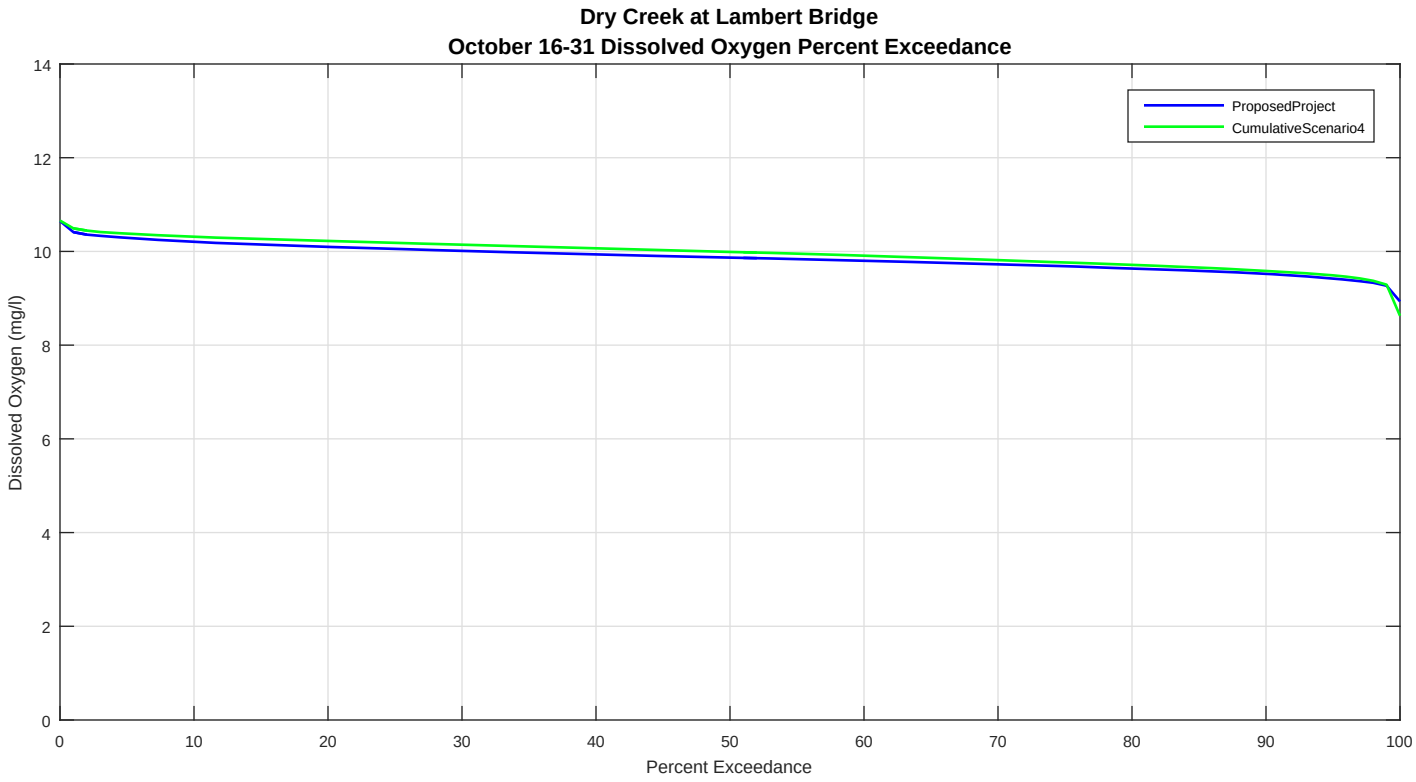
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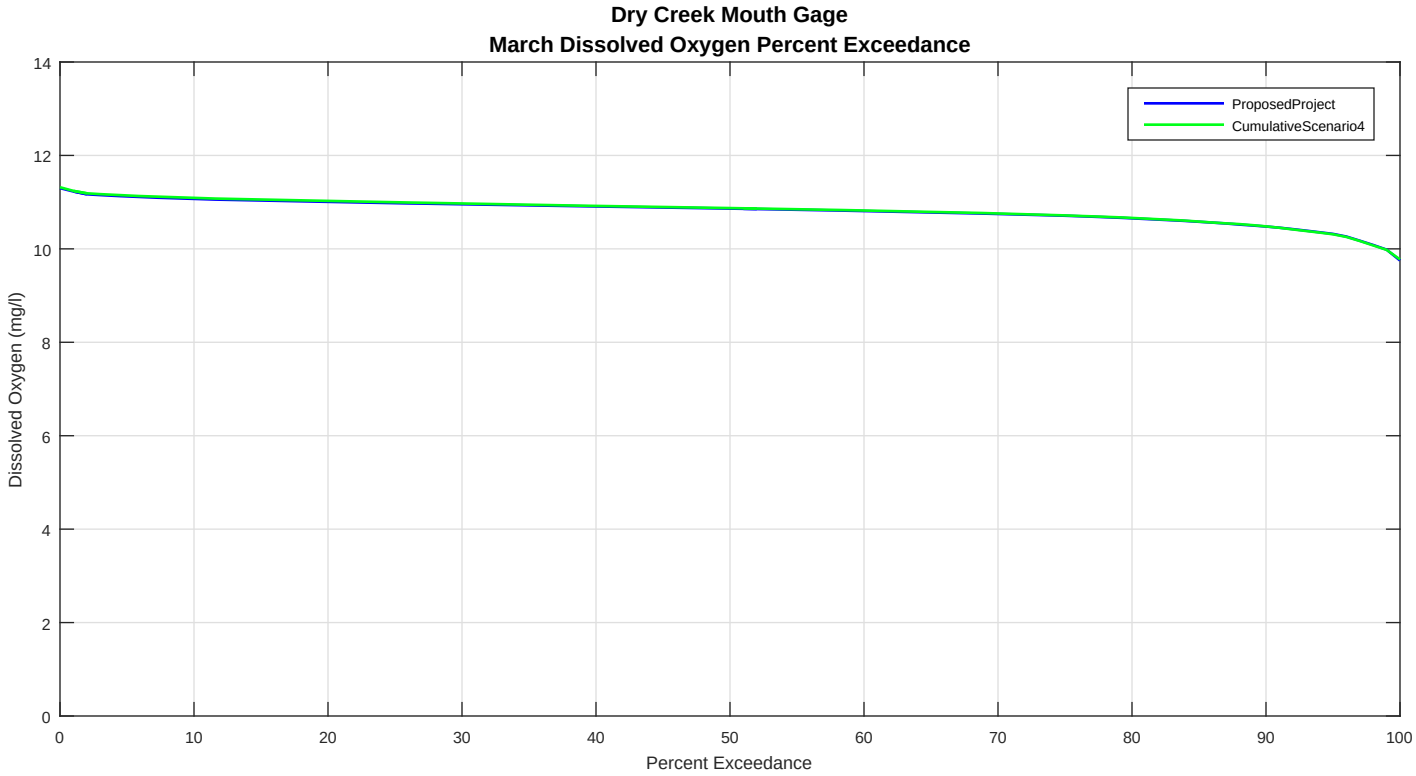
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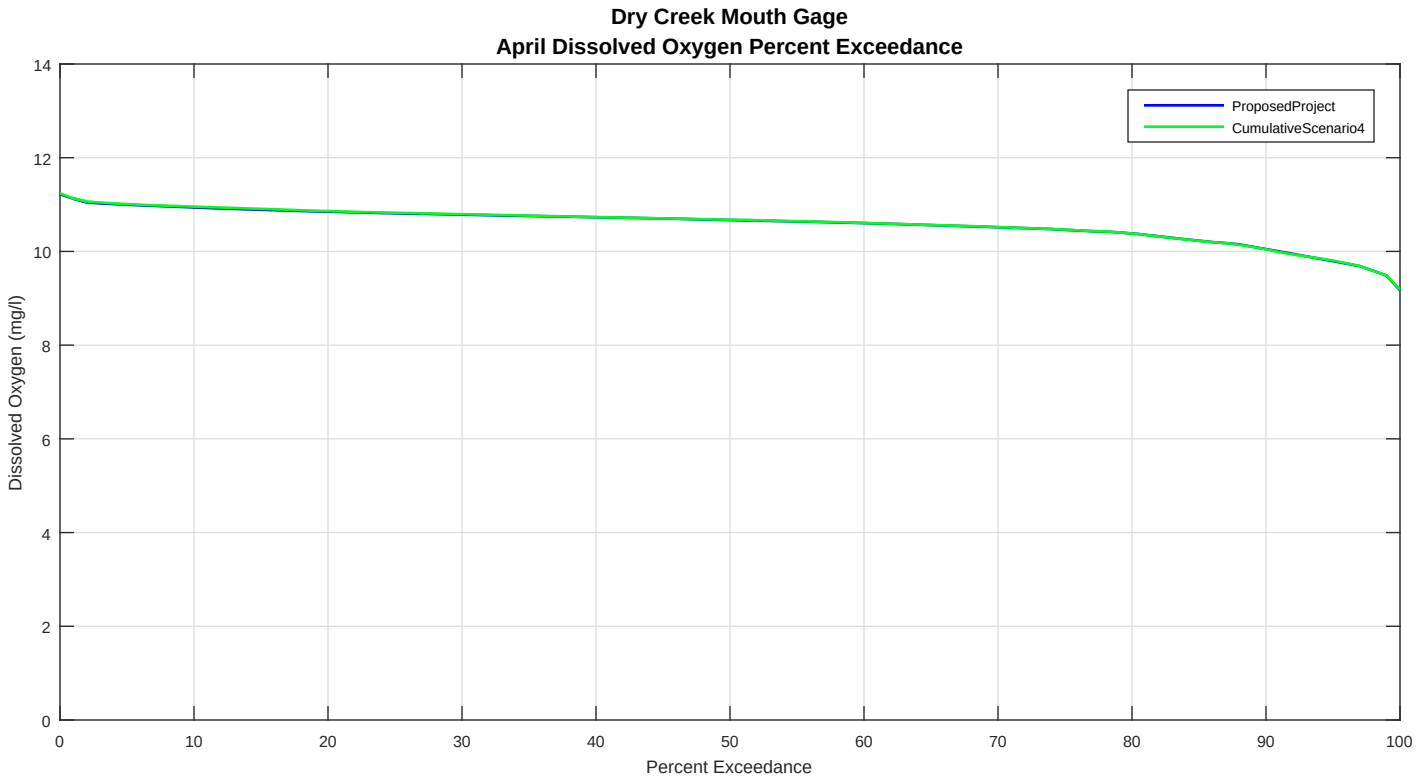
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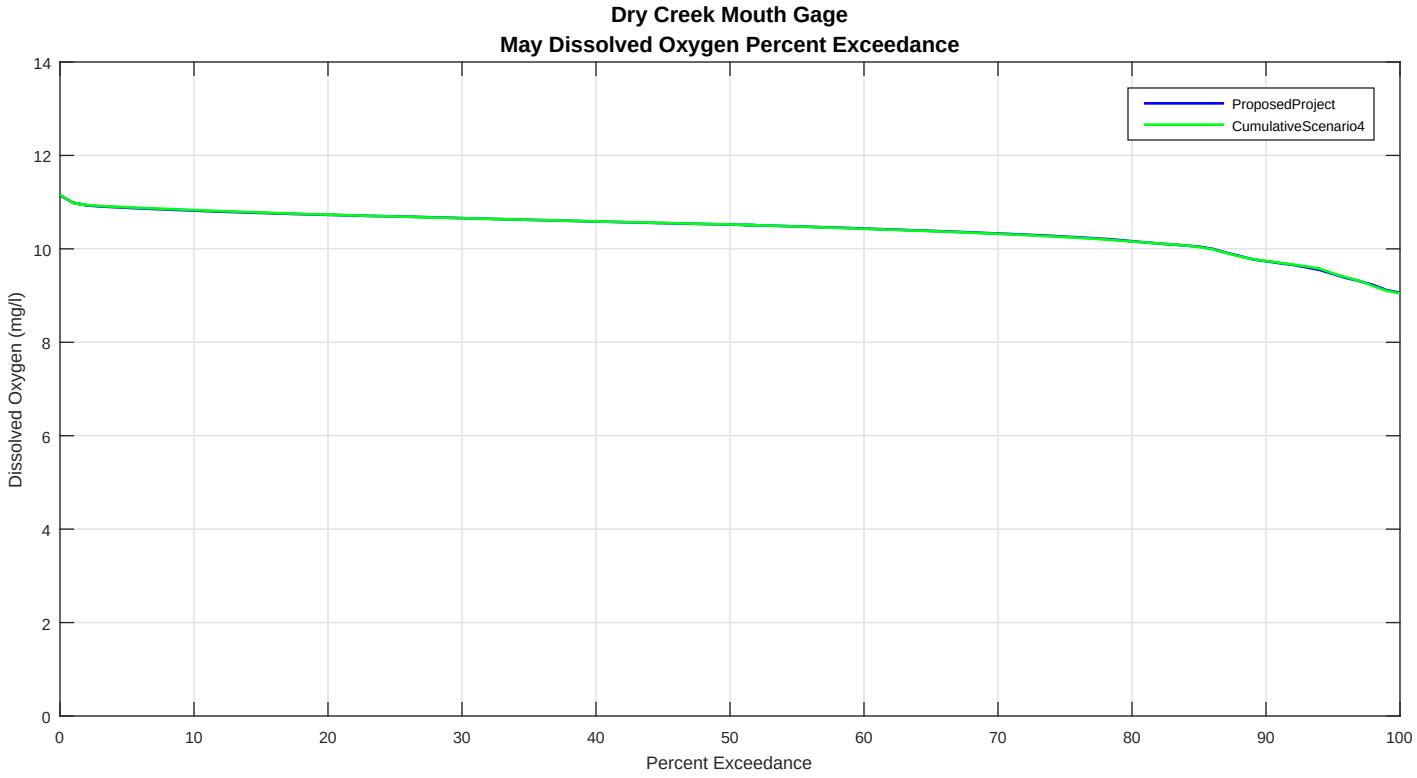
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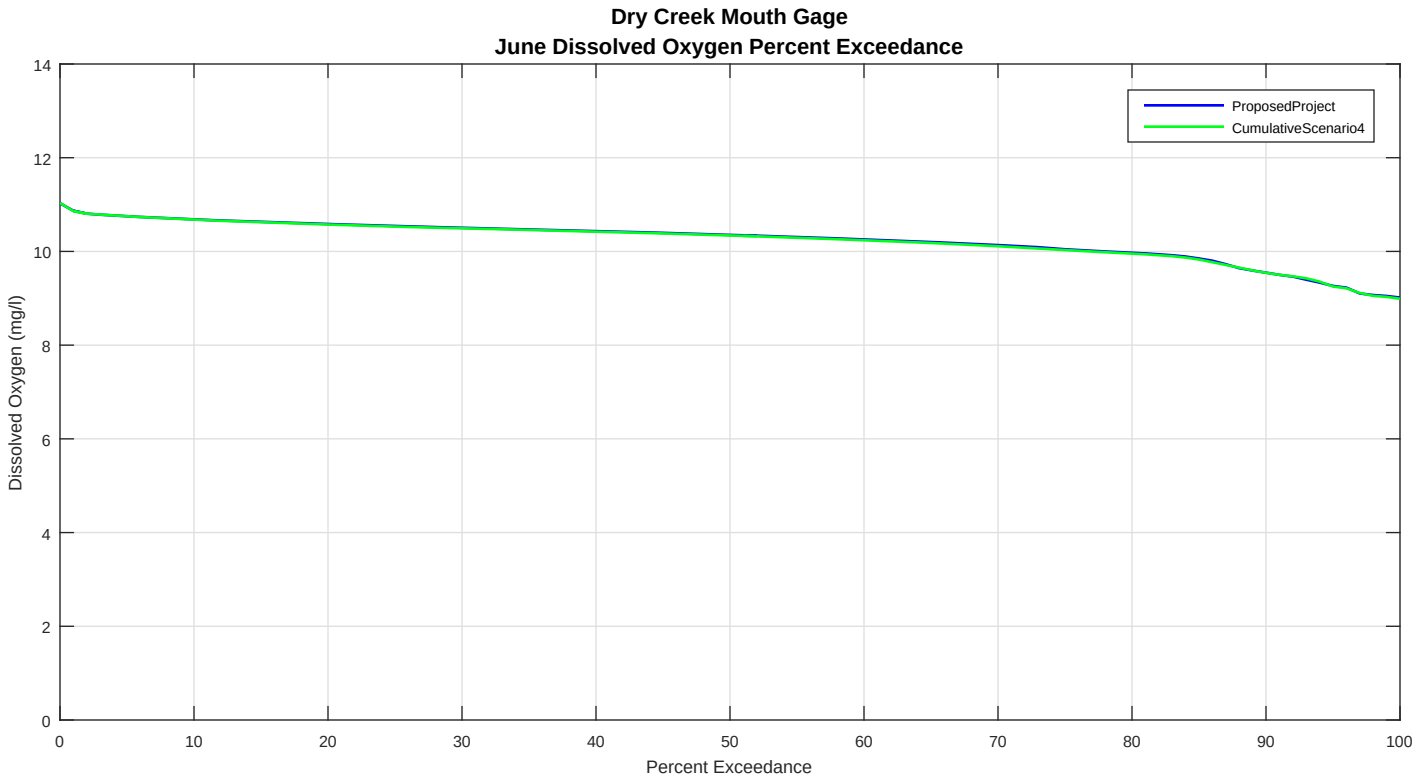
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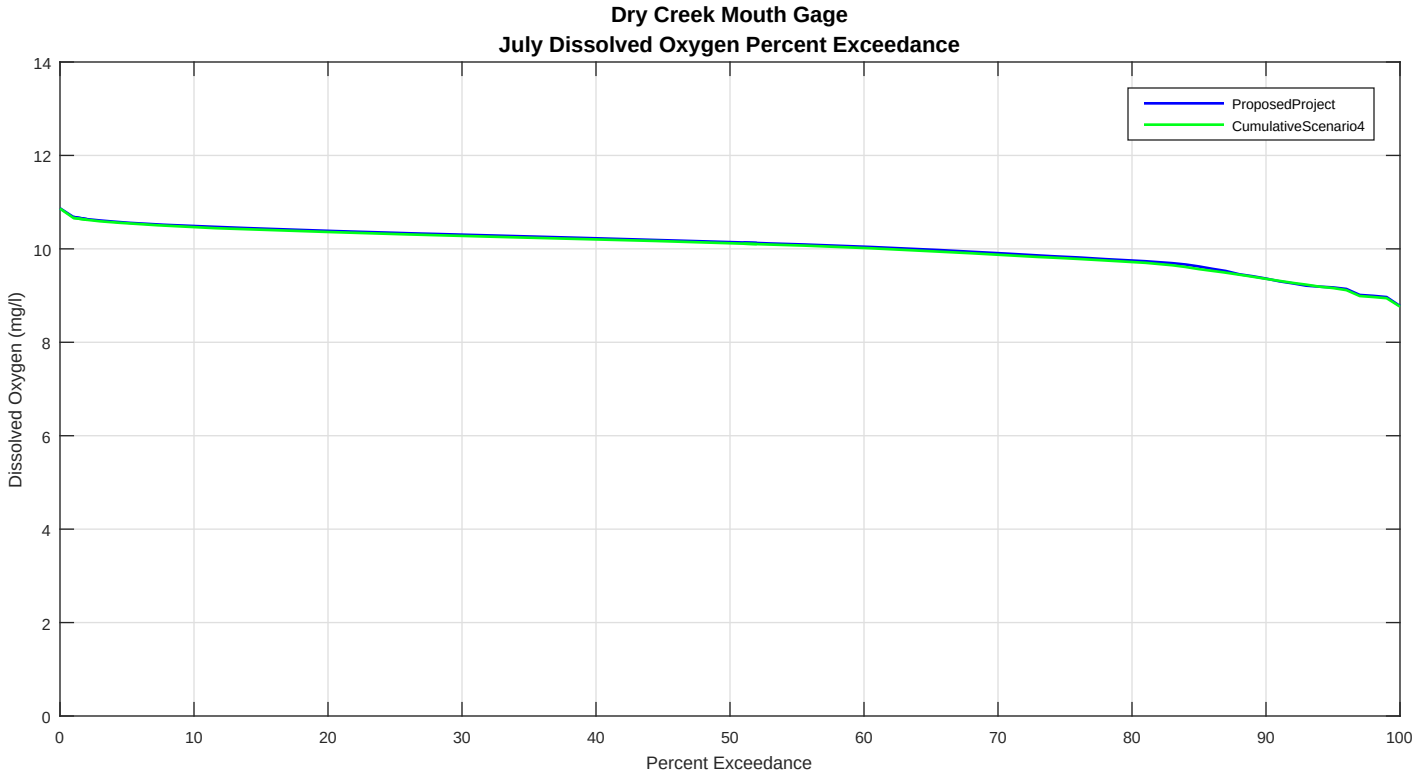
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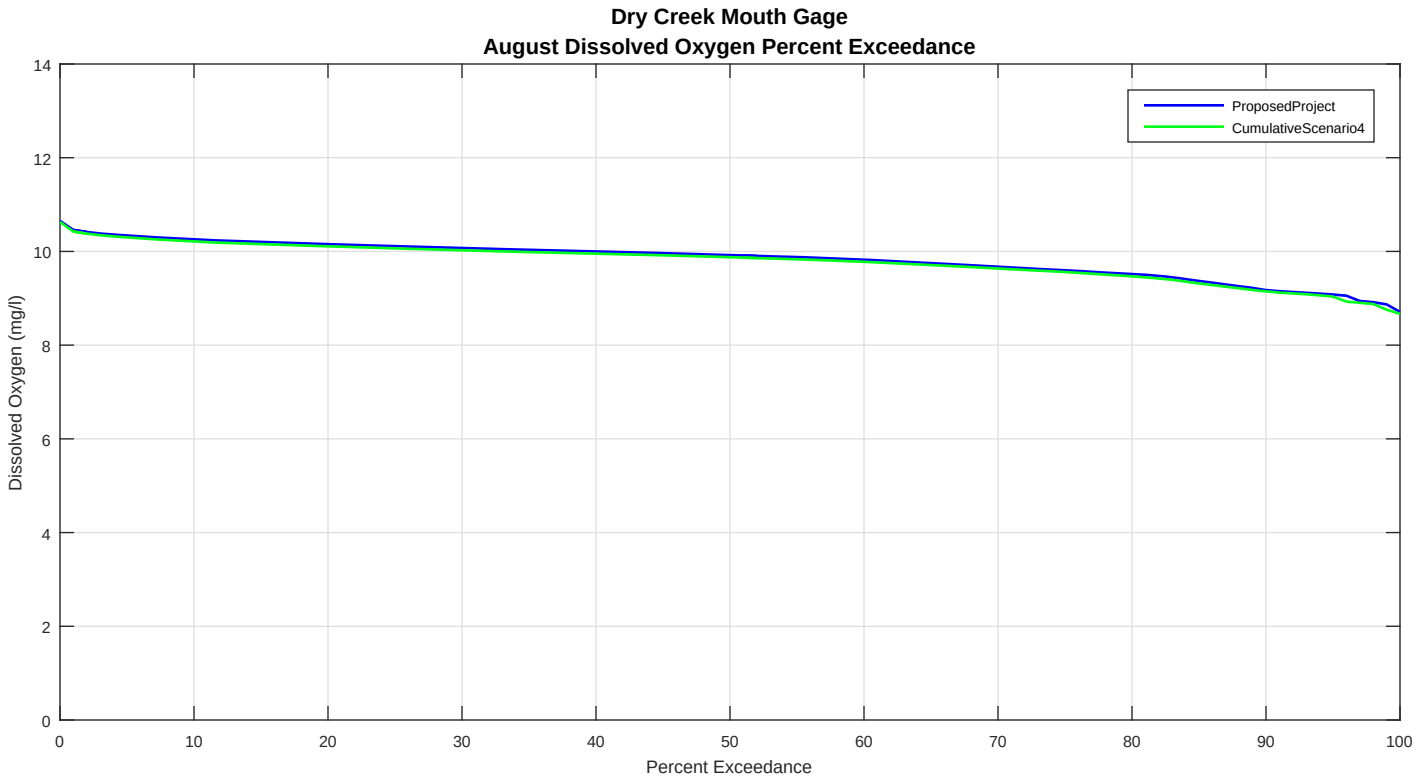
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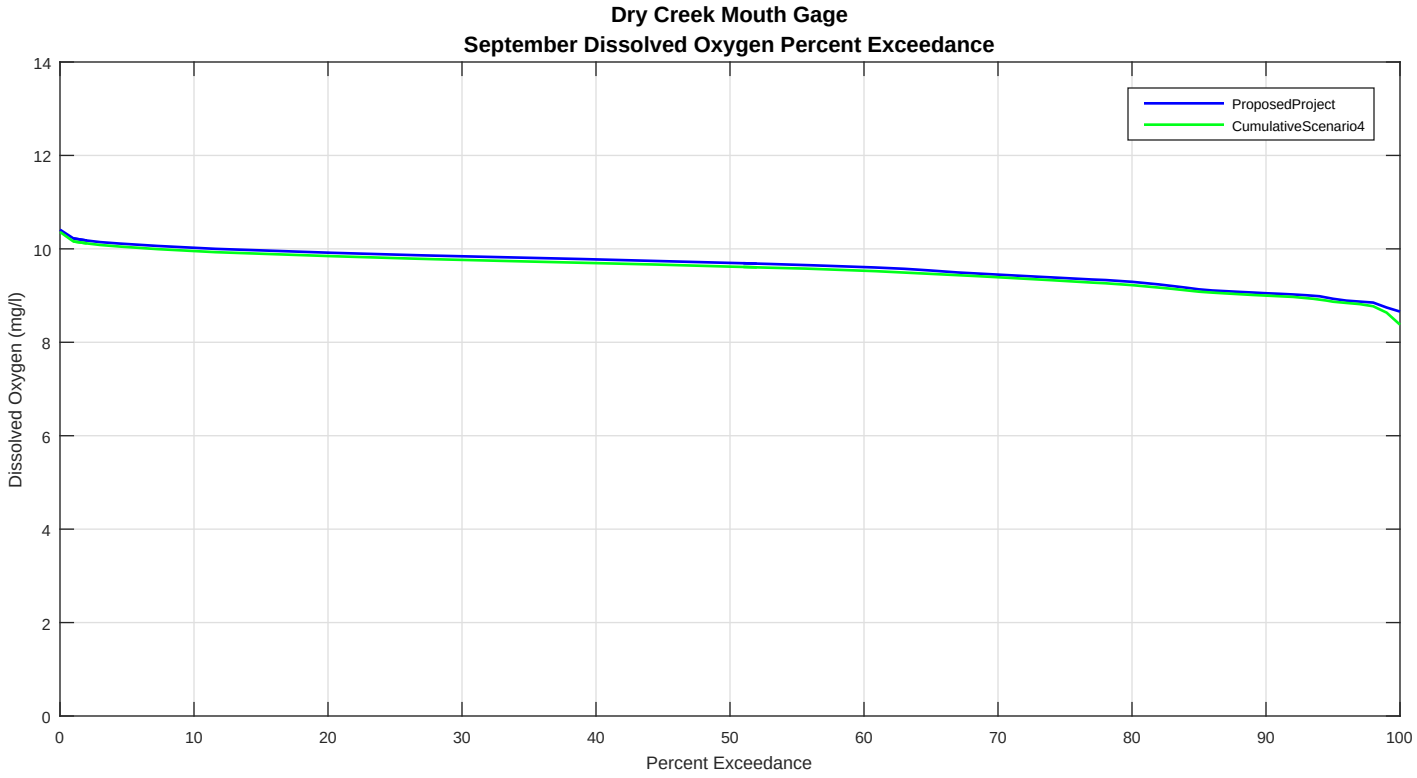
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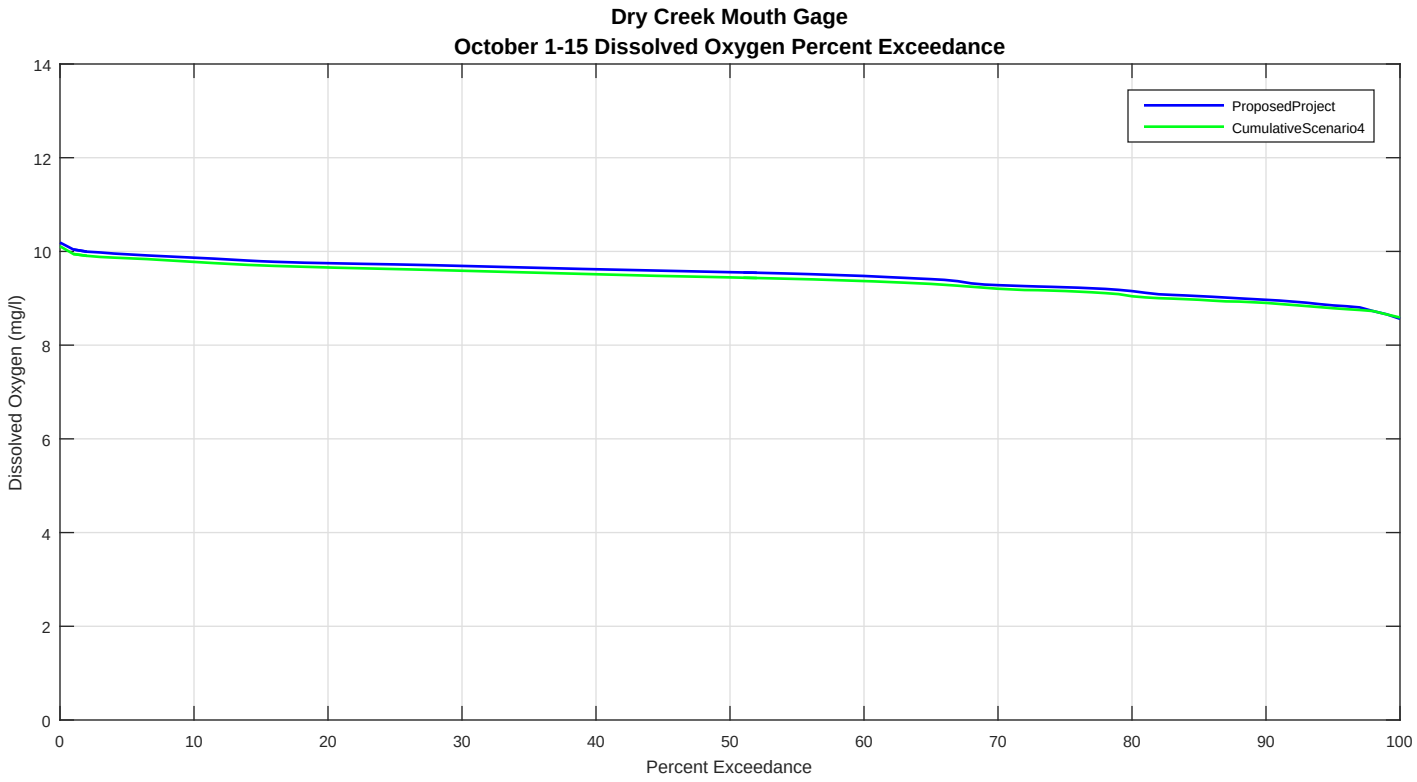
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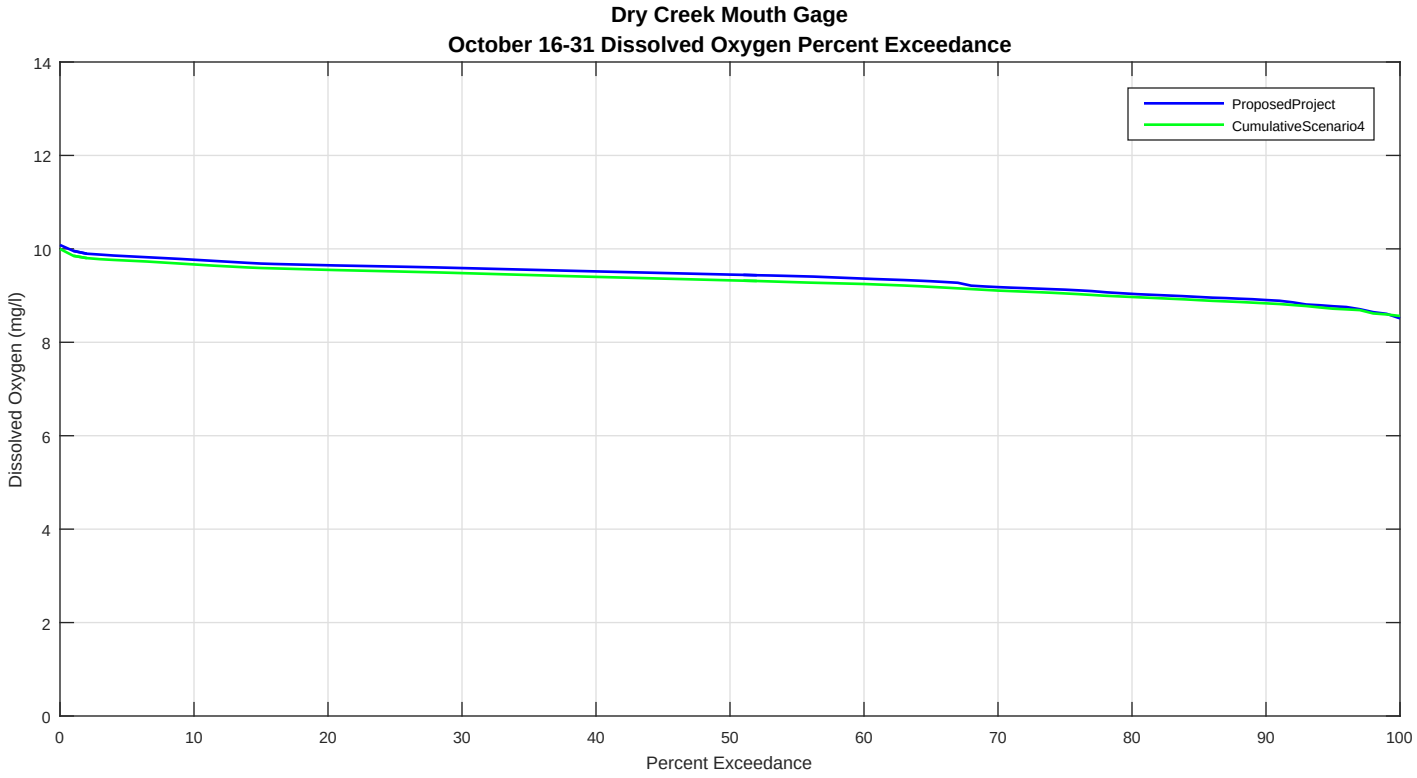
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Development of the Russian River Hydrologic Index for the Fish Habitat Flows and Water Rights Project

August 2016

Prepared by:

Sonoma County Water Agency
404 Aviation Boulevard
Santa Rosa, CA 95406
Contact: Chris Delaney
707-547-1946

Suggested Reference

Sonoma County Water Agency. 2016. Development of the Russian River Hydrologic Index for the Fish Habitat Flows and Water Rights Project. August 2016.

American Disabilities Act Compliance

This Draft Environmental Impact Report for the Sonoma County Water Agency's Fish Habitat Flows and Water Rights Project has been prepared to be compliant with requirements under the Americans with Disabilities Act (ADA). The ADA mandates that reasonable accommodations be made to reduce "discrimination on the basis of disability." As such, the Sonoma County Water Agency is committed to ensuring that documents we make publicly available online are accessible to potential users with disabilities, particularly blind or visually impaired users who make use of screen reading technology.

This disclaimer is provided to advise that portions of the document, including the figures, charts, and graphics included in the document, are non-convertible material, and could not reasonably be adjusted to be fully compliant with ADA regulations. For assistance with this data or information, please contact the Water Agency, at (707) 526- 5370 and reference the Draft Environmental Impact Report for the Sonoma County Water Agency's Fish Habitat Flows and Water Rights Project, dated July 2016.

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1 Introduction

This report describes the proposed Russian River Hydrologic Index and its development. The Russian River Hydrologic Index is a component of the proposed project evaluated in the Fish Habitat Flows and Water Rights Project (Fish Flow Project) Environmental Impact Report (EIR) (SCWA, 2016). The hydrologic index is a metric that is intended to represent hydrologic conditions for a given period and is used to set the minimum instream flow schedule (Flow Schedule) for the Russian River system.

The State Water Resources Control Board's (SWRCB) Decision 1610 approved a hydrologic index for the Russian River watershed in 1986. The hydrologic index defined in Decision 1610 is included as terms in the Water Agency's water right permits and will be identified as the D610 Hydrologic Index (D1610 Index). The D1610 Index is comprised of three schedules (*Normal, Dry* and *Critical*) and is based on cumulative inflow into Lake Pillsbury in the Eel River watershed. There are three variations of the *Normal* water supply condition based on combined storage in Lake Pillsbury and Lake Mendocino on May 31. These three variations of the *Normal* water supply condition determine the required minimum instream flows for the Upper Russian River from the confluence of the East Fork and the West Fork to the Russian River's confluence with Dry Creek beginning on June 1.

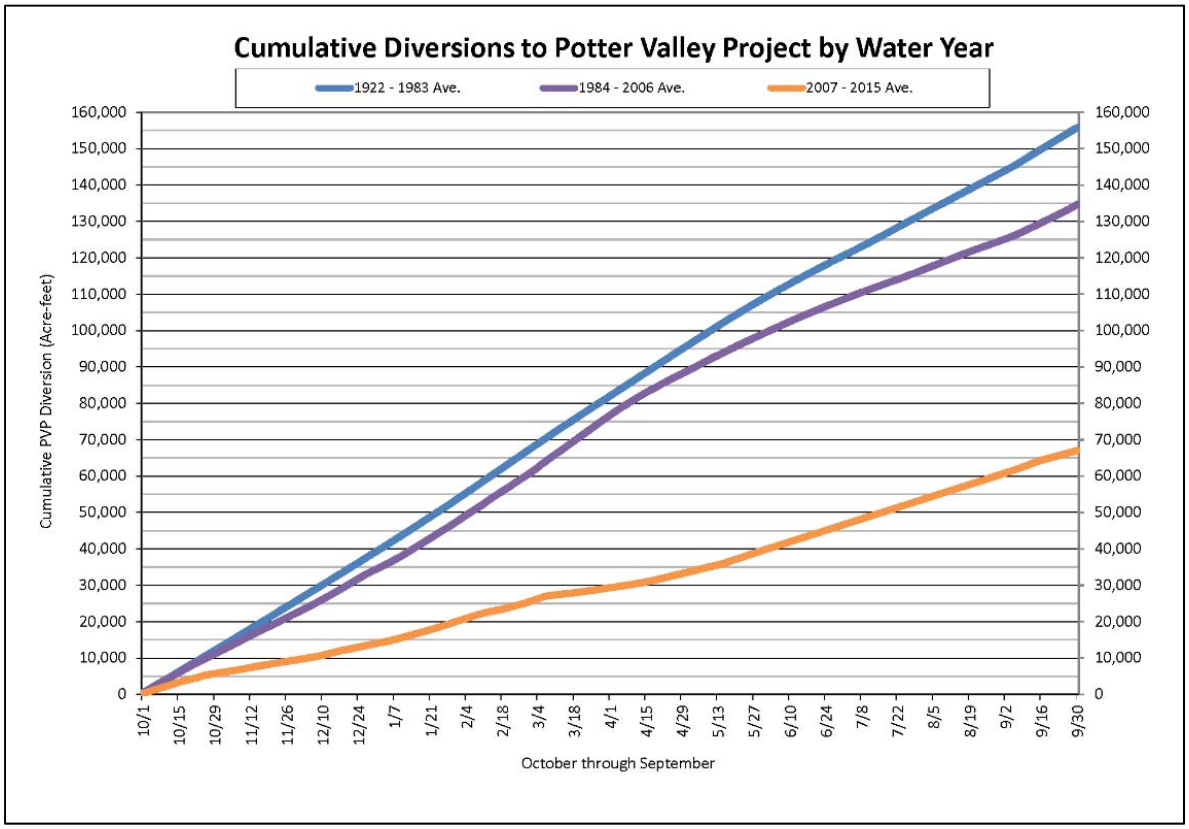

Figure 1-1. Cumulative Diversions to the Potter Valley Project in acre-feet.

On January 28, 2004, the Federal Energy Regulatory Commission (FERC) issued an Order amending Pacific Gas & Electric Company's (PG&E) license for the PVP. Terms in the amended license, which were not fully implemented until 2006, have resulted in significant reductions of water transferred from the Eel River into the East Fork Russian River. When D1610 Index was developed and incorporated into the Water Agency's water right permits, diversions from the Eel River through Pacific Gas and Electric Company's (PG&E) Potter Valley Project (PVP) averaged over 150,000 acre-feet annually (Figure 1-1). Annual diversions of Eel River water through PVP now average around 67,000 acre-feet. Figure 1-1 shows the average cumulative diversions through PVP by water year[1] for three periods: 1922-1983; 1984-2006; and 2007-2015. The observed reductions in diversions for the most recent period shown in Figure 1-1 has significantly impacted the water supply reliability of Lake Mendocino. Consequently, cumulative inflow into Lake Pillsbury, and therefore, the D1610 Index is no longer reflective of water supply conditions in the Upper Russian River. The problem is well documented by the frequency the Water Agency has filed Temporary Urgency Change Petitions (TUCP) with SWRCB to preserve storage in Lake Mendocino by reducing minimum instream flow requirements set by to the D1610 Index that would have otherwise resulted in very low storage levels in Lake Mendocino. Since FERC amended PG&E's license for PVP, the Water Agency has filed TUCPs in 2007, 2009, 2013, 2014, and 2015 due to inadequate storage in Lake Mendocino to support releases to minimum instream flow requirement.

[1] Water year is defined as the 12-month period beginning on October 1 for any given year and end September 30 of the following year. The water year designation is defined as calendar year in which it ends. For example if water year 2016 began on October 1, 2015 and ends September 30, 2016.

2 Hydrologic Index Technical Advisory Group

In 2011 the Water Agency convened a technical advisory group to aid in the development and evaluation of hydrologic index alternatives. The group consisted of representatives from state and federal agencies and consultants to the Water Agency. The involved federal agencies included: (1) National Oceanic and Atmospheric Administration (NOAA) National Weather Service; (2) NOAA Hydrometeorology Testbed; (3) United States Geological Survey (USGS); and (4) United States Army Corps of Engineers (USACE). California State agencies included: (1) California Department of Water Resources; and (2) University of California at Berkeley. Consultants included Steve Grinnell and Alan Lily from Barkiewicz, Kronick and Shanahan, P.C. Staff from USACE Hydrologic Engineering Center (HEC) acted as the technical lead. The technical advisory group met four times to review and provide input on the technical analysis being completed by HEC with support from the Water Agency. The first technical advisory group meeting was held in January of 2011 and the final meeting was held in March of 2012. Based on discussions at the January 2011 meeting, the technical advisory group concurred that the D1610 Index no longer accurately reflected the water supply condition of the Russian River System and that a new index should be developed to replace it.

During the technical advisory group process, HEC and the Water Agency analyzed a number of hydrologic index alternatives including:

- Lake Mendocino Cumulative Inflow;
- Lake Mendocino Storage;
- Separate Hydrologic Indices;
    - Upper Russian River based on Lake Mendocino cumulative inflow
    - Lower Russian River based on Lake Sonoma storage
- Water Balance Index that incorporated long-range flow forecast from the NOAA California Nevada River Forecast Center and a simple water balance model to forecast available water and set the hydrologic condition.

In this study, HEC also investigated variations to other components of the hydrologic index, such as the frequency of evaluation (monthly, semi-monthly, and weekly) and the number of flow schedules. Three schedules are used by the D1610 Index and additional schedules were reviewed to provide smaller incremental changes to the minimum instream flow requirements. HEC completed a report in 2012 that summarized their analysis and findings (HEC, 2012).

Building off of the analysis completed by HEC and recommendations from the technical advisory group, the Water Agency completed further evaluation of hydrologic index alternatives. Results of this evaluation determined that a hydrologic index that incorporates Lake Mendocino inflow and storage provides significant improvements in water supply reliability while also providing stable flow regimes for reaches downstream of Lake Mendocino and Lake Sonoma. This led to the development of the Russian River Hydrologic Index that was incorporated into the Proposed Project of the Fish Flow Project EIR and described in further detail in this report.

3 Overview of Russian River Hydrologic Index

The proposed Russian River Hydrologic Index is comprised of five minimum instream flow schedules (Flow Schedule): *Schedule 1*, *Schedule 2*, *Schedule 3*, *Schedule 4*, and *Schedule 5*. Flow *Schedule 1* being the wettest hydrology and *Schedule 5* being the driest hydrology. The Upper Russian River, Lower Russian River, and the Dry Creek reaches each have a set of five Flow Schedules. The schedules are determined based on Lake Mendocino Cumulative Inflow Condition (Inflow Condition) beginning October 1 and evaluated each month starting on January 1 and continuing to October 1. Beginning June 1, the Flow Schedule for the Upper Russian River would be determined by both the Inflow Condition and by the Lake Mendocino Storage Condition.

On the first day of each month starting January 1, cumulative inflow into Lake Mendocino is evaluated monthly through October 1 for a total of ten condition evaluation dates each year to determine the Inflow Condition. Cumulative inflow into Lake Mendocino is calculated for each water year[2] as the daily accumulation beginning on October 1 of the sum of the releases from Lake Mendocino, increases in storage in Lake Mendocino and evaporation from Lake Mendocino that occurred on that day. Under certain circumstances, the calculation of cumulative inflow shall be adjusted on the January 1, February 1 or March 1 evaluation dates. Such adjustments are made if the calculated cumulative inflow into Lake Mendocino exceeds a maximum cumulative inflow limit value (Cumulative Inflow Limit). If any such exceedance occurs, then cumulative inflow into Lake Mendocino for that date is set equal to the Cumulative Inflow Limit. The Cumulative Inflow Limit was developed to discount inflow that is not usable. For this report, usable inflow is defined as inflow that is stored for more than 30 days or released for beneficial use. Inflow that is not usable is inflow that is stored in the reservoir for a short period, but due to flood control operations of Lake Mendocino is released downstream to maintain flood space in the reservoir. Development of the Cumulative Inflow Limit is discussed in more detail in Section 4.3.2 below.

Cumulative inflow is evaluated against a series of 5 thresholds to determine the Inflow Condition number (*Condition 1 to Condition 5*). For the Lower Russian River and Dry Creek reaches, the Inflow Condition number is used to set the Flow Schedule for all of the evaluation dates from January 1 to October 1. For the Upper Russian River the Inflow Condition number is used to set the Flow Schedule for the evaluation dates from January 1 to May 1.

On the first day of each month from June 1 through December 1, the Lake Mendocino Storage Condition (Storage Condition) will be determined by evaluating storage in Lake Mendocino against 4 storage condition thresholds to determine the Storage Condition number (*Condition 1 to Condition 5*) . The Upper Russian River Flow Schedule will be determined through an assessment of both the Inflow Condition and the Storage Condition. The Flow Schedule for the Upper Russian River will be determined by the Storage Condition number, but can only be adjusted one schedule drier (higher in number) than the Inflow Condition number for the period of June through September. From October through December the Storage Condition number

[2] The water year begins on October1 and ends September 30.

can adjust the Flow Schedule more than one Flow Schedule drier than the Inflow Condition number. The rate of adjustment of the Flow Schedule to be greater than the Inflow Condition can only occur one schedule per month during the period. Development of the Lake Mendocino Storage Condition thresholds is discussed in more detail in Section 4.4 below.

4 Hydrologic Index Development

The Russian River Hydrologic Index was developed using the Water Agency's Russian River Reservoir System Simulation (Russian River ResSim) model. A description of the Russian River ResSim model may be found in the report, *Russian River Hydrologic Modeling for the Fish Habitat Flow and Water Rights Project* (Fish Flow Project Modeling Report), prepared by the Sonoma County Water Agency (SCWA, 2016). The sub-sections below describe how each component of the hydrologic index were developed.

The Russian River Hydrologic Index is incorporated with the proposed project of the Fish Flow Project EIR. The proposed project also includes the preferred Flow Schedules analyzed in the Fish Flow Project EIR. The Flow Schedules for the Proposed Project are summarized in Tables Table 4-1 to

Table 4-3 for the Upper Russian River, Lower Russian River and Dry Creek. The model assumptions used to simulate the proposed project (Proposed Project) scenario are described in the Fish Flow Project Modeling Report).

Table 4-1. Proposed Project scenario Upper Russian River minimum instream flow requirements.

Water Supply	Upper Russian River Monthly Minimum Instream Flow Requirements (cfs)												
Schedule	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct 1-15	Oct 16-31	Nov	Dec
1	105	105	105	105	105	105	105	105	105	105	105	105	105
2	105	105	105	105	85	85	85	85	85	85	105	105	105
3	100	100	100	100	65	65	65	65	65	65	100	100	100
4	70	70	70	70	45	45	45	45	45	45	45	70	70
5	25	25	25	25	25	25	25	25	25	25	25	25	25

Table 4-2. Proposed Project scenario Lower Russian River minimum instream flow requirements.

Water Supply	Lower Russian River Monthly Minimum Instream Flow Requirements (cfs)												
Schedule	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct 1-15	Oct 16-31	Nov	Dec
1	135	135	135	135	70	70	70	70	70	70	135	135	135
2	135	135	135	135	70	70	70	70	70	70	135	135	135
3	135	135	135	135	70	70	70	70	70	70	135	135	135
4	85	85	85	85	50	50	50	50	50	50	85	85	85
5	35	35	35	35	35	35	35	35	35	35	35	35	35

Table 4-3. Proposed Project scenario Dry Creek minimum instream flow requirements.

Water Supply	Dry Creek Monthly Minimum Instream Flow Requirements (cfs)												
Schedule	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct 1-15	Oct 16-31	Nov	Dec
1	75	75	75	75	50	50	50	50	50	50	105	105	105
2	75	75	75	75	50	50	50	50	50	50	105	105	105
3	75	75	75	50	50	50	50	50	50	50	75	75	75
4	75	75	75	50	50	50	50	50	50	50	75	75	75
5	75	75	75	50	50	50	50	50	50	50	75	75	75

The design of the Inflow Condition and Storage Condition thresholds relies heavily on the assumptions and model simulation results of the Proposed Project scenario. These assumptions were developed to simulate Proposed Project under existing hydrologic conditions of the Russian River System including current operational practices of the PVP, existing reach losses from consumptive use and natural causes not associated with Water Agency water

diversions, and existing storage capacity levels of the reservoirs. The Proposed Project scenario assumes a Water Agency demand of 75,000 acre-feet per year.

In following sub-sections and the model results presented in Section 0, the Proposed Project scenario is compared baseline conditions of the Fish Flow Project EIR, which incorporates the D1610 Index. The model assumptions used to simulate baseline conditions (Baseline Conditions) scenario are described in the Fish Flow Project Modeling Report. In summary, the Baseline Conditions scenario assumes the minimum instream flow requirements defined in the Water Agency's water rights permits, which are summarized in Tables Table 4-4 to Table 4-6 for the Upper Russian River, Lower Russian River and Dry Creek. The Baseline Conditions scenario also assumes a Water Agency demand of 55,200 acre-feet per year which is the average demand from 2009 to 2014.

Table 4-4. Baseline Conditions scenario Upper Russian River minimum instream flow requirements.

Water Supply	Upper Russian River Monthy Minimum Instream Flow Requirements (cfs)											
Condition	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal	150	150	150	185	185	185	185	185	150	150	150	150
Normal-Dry Spring 1						150	150	150	150	150	150	150
Normal-Dry Spring 2										75	75	75
Normal-Dry Spring 3						75	75	75	75	75	75	75
Dry	75	75	75	75	75	75	75	75	75	75	75	75
Critical	25	25	25	25	25	25	25	25	25	25	25	25

Table 4-5. Baseline Conditions scenario Lower Russian River minimum instream flow requirements.

Water Supply	Lower Russian River Monthy Minimum Instream Flow Requirements (cfs)											
Condition	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal	125	125	125	125	125	125	125	125	125	125	125	125
Dry	85	85	85	85	85	85	85	85	85	85	85	85
Critical	35	35	35	35	35	35	35	35	35	35	35	35

Table 4-6. Baseline Conditions scenario Dry Creek minimum instream flow requirements.

Water Supply	Dry Creek Monthy Minimum Instream Flow Requirements (cfs)											
Condition	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Normal	75	75	75	75	80	80	80	80	80	80	105	105
Dry	75	75	75	25	25	25	25	25	25	25	75	75
Critical	75	75	75	25	25	25	25	25	25	25	75	75

4.1 Hydrologic Index Schedules and Evaluation Dates

The Russian River Hydrologic Index uses 5 schedules of minimum instream flows, which differs from the D1610 Index, which uses 3-schedules of minimum instream flow requirements. The 5-schedule system allows for smaller incremental changes in minimum instream flows over the 3-schedule system. This results in the Russian River Hydrologic Index better matching minimum instream flow requirements to available water supply and helps reduce large changes in minimum instream flows, which could impact habitat and other beneficial uses.

The Russian River Hydrologic Index was also designed to be more responsive to changes in hydrologic conditions than the D1610 Index by increasing the number of evaluation dates. The D1610 Index evaluates cumulative inflow in Lake Pillsbury on the first of the month from

January 1 to June 1 for a total of 6 evaluation dates. As described in Section 3, the proposed index evaluates the Inflow Condition on the first of the month from January 1 to October 1 for a total of 10 evaluation dates per year. With the Mediterranean climate of Northern California, unimpaired flow hydrology is consistently low from June to October for most years, however, Eel River transfers through the PVP can vary during this period based on FERC license requirements, reductions in minimum instream flows due to low storage levels in Lake Pillsbury, or infrastructure maintenance. The additional evaluation dates from July through October results in the proposed index being responsive to variability in Eel River transfers through the PVP.

As described in Section 3, the Upper Russian River Flow Schedules are evaluated on the first of the month from January 1 to December 1 for a total of 12 evaluation dates. From January 1 to May1 Upper Russian River Flow Schedules are determined by Inflow Condition similar to the Lower Russian River and Dry Creek. From June 1 to December 1 Upper Russian River Flow Schedules are determined through an evaluation of the Storage Condition and the Inflow Condition. The evaluation of Lake Mendocino storage from June 1 to October 1 allow for changes in Upper Russian River Flow Schedules to respond low storage levels resulting from high downstream demands which would not be reflected by the Inflow Condition. The allowance for additional adjustments to Upper Russian River Flow Schedules through the evaluation of storage levels from November 1 to December 1 (as described in Section 3) enables the Russian River Hydrologic Index to respond to years with low fall and early winter rainfall.

4.2 Hydrologic Index Development Criteria

Two primary criteria were used in the development of the Russian River Hydrologic Index: 1) maximize the occurrence of instream flow conditions favored for salmonid habitat and other beneficial uses, and 2) reliably provide releases from Lake Mendocino and Lake Sonoma for a 1 in 100 dry year scenario.

4.2.1 Instream Flow Conditions

A criteria for the development of the Inflow Condition thresholds and Storage Condition thresholds was to maximize the occurrence of *Schedule 1* and minimize the occurrence of *Schedule 5* Flow Schedules. *Schedule 1* flows are considered to provide the range of flows most favorable for salmonid rearing habitat in the dry season and spawning and migration habitat for the remainder of the year. *Schedule 5* flows are generally considered unfavorable for aquatic habitat and other beneficial uses and are designed to only occur during the most critically dry periods within the Russian River ResSim model simulation period.

4.2.2 1 in 100 Dry Year Reliability

The 1 in 100 dry year hydrology developed by Stephen Grinnell (Grinnell, 2016) was used in the modeling for the development of the Russian River Hydrologic Index. The 1 in 100 dry year hydrology was developed as daily average unimpaired flows for the Russian River watershed from October 1 to September 30 for a single year. The methodology for developing the 1 in 100 dry year hydrology is further discussed in report, *Sonoma County Water Agency Russian River*

Operations Model: Synthetic 1 in 100 Year Inflow Development, prepared by Stephen Grinnell (Grinnell, 2016). Model scenarios were developed that incorporated the 1 in 100 dry year hydrology to create a 15-month model simulation. This was completed by taking flows from October 1 to December 31 of the 1 in 100 dry year hydrology and appending this to the end of the 12-month water year 1 in 100 dry year hydrology dataset, and creating a 15-month dataset that extends to the end of the calendar year. This allowed for the evaluation of an entire water year (defined as October 1 of the previous year to September 30) plus the period in the fall/early winter (October 1 to December 31) when conditions can often be dry in the Russian River watershed, even in a wet year. The 1 in 100 dry year hydrology was incorporated with the Proposed Project scenario of the Fish Project EIR to evaluate the Russian River Hydrologic Index and its ability to reliably release water from Lake Mendocino and Lake Sonoma under the 1 in 100 dry year scenario conditions.

4.3 Lake Mendocino Cumulative Inflow Condition Threshold Design

As described in Section 3, Lake Mendocino Inflow Condition is determined through the evaluation of daily cumulative inflow into Lake Mendocino beginning October 1 to September 30 of each water year. Cumulative inflow into Lake Mendocino is evaluated against a series of monthly thresholds on the first of the month from January 1 to October 1 to determine Flow Schedules for the Upper Russian River, Lower Russian River, and Dry Creek reaches. The Inflow Condition is used to determine the Flow Schedule for the Upper Russian River from January 1 to May 30[3], and for the Lower Russian River and Dry Creek from January 1 to December 31.

To develop the Lake Mendocino cumulative inflow thresholds, simulated Lake Mendocino inflow from 1910 to 2013 (104 years of historical hydrology) was calculated as the sum of modeled PVP diversions and unimpaired inflows into Lake Mendocino. Modeled PVP diversions were developed using the Eel River Model version 2.5 (ER2.5) to approximate current operations of PVP for the historical simulation period. Development of these modeled diversions is further discussed in Fish Flow Project Modeling Report. Unimpaired flow into Lake Mendocino from 1910 to 2013 was estimated by the United States Geological Survey (USGS) using the Basin Characterization Model. This analysis is further described in the report Fish Flow Project Modeling Report (SCWA, 2016).

Lake Mendocino cumulative inflows were determined by calculating the cumulative sum of daily modeled Lake Mendocino inflow for each water year (beginning on October 1 of each year and ending on September 30 of the following calendar year) from 1910 to 2013. Thresholds of cumulative inflow were determined for each schedule of the hydrologic index by estimating percentiles of first of the month cumulative inflow that best met the criteria discussed in Section 4.2, to maximize the occurrence of *Schedule 1* (wettest condition) minimum instream flows, minimize the occurrence of *Schedule 5* minimum flows (most critically dry flows), and reliably

[3] Beginning June 1 the Flow Schedules for the Upper Russian River are determined using both Inflow Condition and Storage Condition.

maintain releases from Lake Sonoma and Lake Mendocino for the 1 in 100 dry year scenario. The hydrologic index schedule thresholds are provided as Table 4-7 and provided graphically in Figure 4-1.

Table 4-7. Lake Mendocino Cumulative Inflow Conditions 2 to 5 Thresholds.

Date	Condition 2	Condition 3	Condition 4	Condition 5
January 1	22,100	13,000	10,800	10,500
February 1	37,500	24,900	18,000	13,700
March 1	54,500	42,100	31,900	19,500
April 1	64,100	56,400	50,200	23,900
May 1	73,200	63,200	55,700	32,700
June 1	80,600	70,200	62,200	37,700
July 1	87,100	74,600	66,600	40,000
August 1	93,500	79,400	70,700	42,000
September 1	99,800	82,600	74,900	44,000
October 1	105,000	86,700	78,600	44,000

Note: Lake Mendocino Cumulative Inflow values for the evaluation dates are calculated using data recorded on midnight of the previous day.

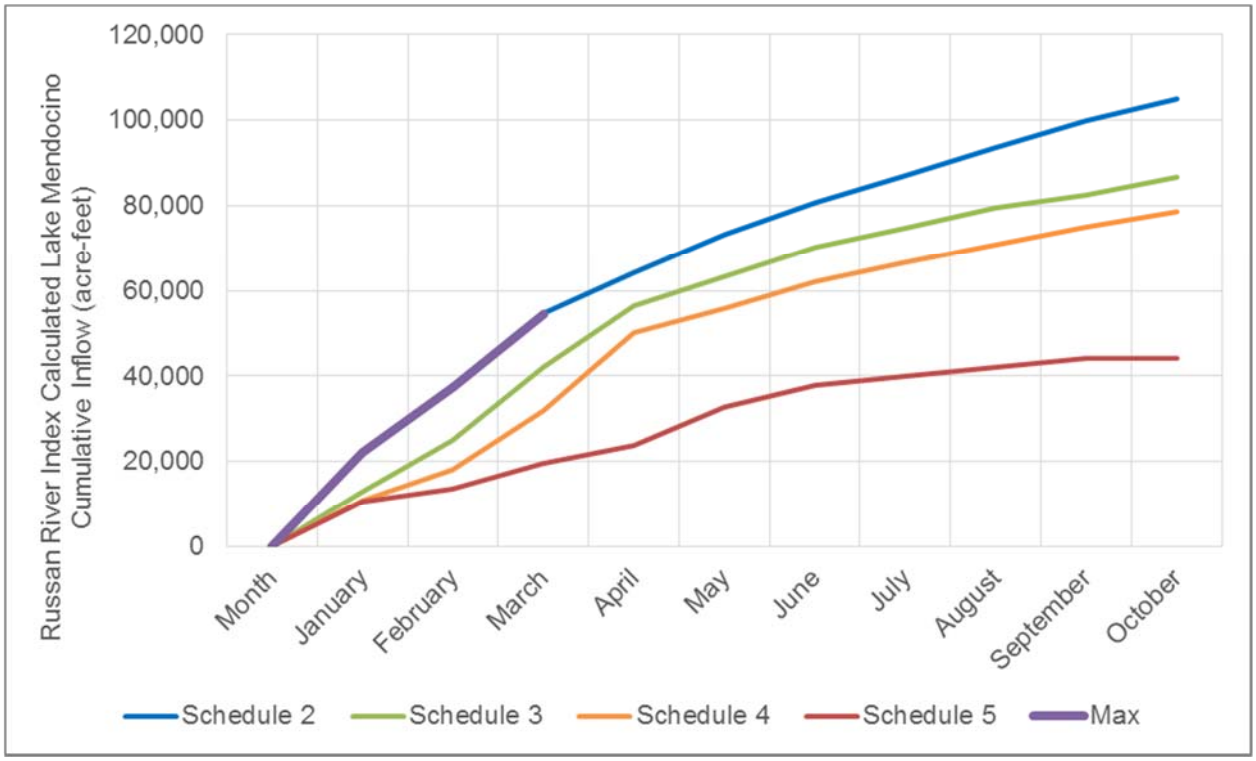

Figure 4-1. Lake Mendocino Cumulative Inflow Condition Thresholds in acre-feet.

4.3.1 Occurrence of Minimum Instream Flow Schedules

The monthly percentage of occurrence of the Flow Schedules for the 104-year model simulation period under the Proposed Project scenario is provided in Table 4-8 below. The bottom row of Table 4-8 provides a summation of the average percent occurrence of *Schedules 1* and *2*, and *Schedules 3* and *4*. This summation is provided as a comparison of modeled Flow Schedules for the Russian River Hydrologic Index (Table 4-8) to the percentage of occurrence of Water Supply Conditions under Baseline Conditions (

Table 4-9). The combined percentage of occurrence of *Schedule 1* and *Schedule 2* is 89%, which approximates the 87% occurrence of the *Normal* water supply condition under Baseline Conditions (as shown in Tables Table 4-8 and

Table 4-9). The combined percentage of occurrence of *Schedule 3* and *Schedule 4* under the Proposed Project scenario is 10%, which is equal to the percentage of occurrence of the *Dry* water supply condition under Baseline Conditions. The 1% average percent occurrence of *Schedule 5* simulated with the Proposed Project scenario is less than the 3% occurrence of the *Critical* condition under Baseline Conditions. Additionally, the percentage of occurrence of each Flow Schedule for the Russian River Hydrologic Index is more evenly distributed over the months. This is an improvement over Baseline Conditions, which results in the percentage of occurrence of *Critical* water supply conditions varying between 2% and 8% over the year and with the percentage of occurrence of *Dry* and *Critical* water supply conditions disproportionately higher in February. This is not ideal as the month of February is a critical period in the life cycle for Steelhead for spawning and egg incubation.

Table 4-8. Monthly Percentage of Occurrence (%) for the 104-year historical hydrology model simulation of Minimum Instream Flow *Schedule 1* through *Schedule 5* for the Proposed Project model scenario that incorporates the Russian River Hydrologic Index.

Monthly	***Schedule 1***	***Schedule 2***	***Schedule 3***	***Schedule 4***	***Schedule 5***
January	68	20	7	4	1
February	68	20	7	4	1
March	68	20	7	4	1
April	68	20	7	4	1
May	69	19	7	4	1
June	68	20	7	4	1
July	68	20	7	4	1
August	68	20	7	4	1
September	68	21	6	4	1
October	69	20	6	4	1
November	69	20	6	4	1
December	69	20	6	4	1
Sub-total	***68***	***20***	***6***	***4***	***1***
Total	***89***		***10***		***1***

Table 4-9. Monthly percentage of occurrence (%) of for the 104 year model simulation of *Normal*, *Dry*, and *Critical* water supply conditions of the Decision 1610 Hydrologic Index as defined by the Water Agency's water right permits.

Month	*Normal*	*Dry*	*Critical*
January	88	9	4
February	79	14	8
March	87	10	4
April	88	10	3
May	88	11	2
June	88	10	2
July	88	10	2
August	88	10	2
September	88	10	2
October	89	10	2
November	89	10	2
December	89	10	2
Average	***87***	***10***	***3***

4.3.2 Maximum Cumulative Inflow Limit Design

The Russian River Hydrologic Index sets a maximum limit on the calculation of Lake Mendocino Cumulative Inflow (Cumulative Inflow Limit) for the January 1, February 1, and March 1 evaluation dates. If the calculation of cumulative inflow into Lake Mendocino exceeds a Cumulative Inflow Limit value for the months of January, February, and March, then this calculation will be set equal to the Cumulative Inflow Limit value. Additionally if Lake Mendocino cumulative inflow is equal to a Cumulative Inflow Limit value, then the Flow Schedule will be set to *Schedule 1*. The Cumulative Inflow Limits are provided in Table 4-10. Lake Mendocino Maximum cumulative Inflow Limits..

Table 4-10. Lake Mendocino Maximum cumulative Inflow Limits.

Date	Cumulative Inflow Limit
January 1	22,100
February 1	37,500
March 1	54,500

The Cumulative Inflow Limit is a critical feature of the Russian River Hydrologic Index. Due to flood operation requirements defined in the Lake Mendocino Water Control Manual (USACE, 1986), the maximum reservoir storage level for water supply is 68,400 acre-feet from November 1 to March 1, approximately 60% of the total reservoir storage capacity of 116,500 acre-feet. Storage increases to 111,000 acre-feet from May 10 to October 1 during the dry season months based on reduced risk of flooding during this period. The water supply storage limit for the wet season months (November through February) can mean that for certain wet winters much of the inflow into the reservoir cannot be stored for water supply purposes, but instead is released during flood control operations. This can be problematic if the wet winter is followed by a dry spring with very little rainfall and therefore low inflow into Lake Mendocino past March 1. This creates reservoir storage levels more consistent with dry year patterns. Due to these operational constraints, the Cumulative Inflow Limit is designed to limit the calculation of Lake Mendocino Cumulative Inflow to a value that represents actual usable inflow into the reservoir.

Without the Cumulative Inflow Limit the calculation of Lake Mendocino cumulative inflow could reach very high levels during wet winters, setting *Schedule 1* minimum instream flow requirements that cannot be sustained if an extended dry period persists after March 1 of that year.

The Cumulative Inflow Limit was developed through an iterative process by estimating limit values that maintain an even percentage of occurrence of Flow Schedules for the different months of the year as presented in Table 4-10. The Cumulative Inflow Limit also allows the calculation of cumulative inflow into Lake Mendocino to reasonably approximate cumulative usable inflow into the reservoir. Usable inflow is defined as inflow that is stored for more than 30 days or released for beneficial uses. Figure 4-2 provides Lake Mendocino Cumulative Inflow calculated using the Russian River Hydrologic Index by applying the Cumulative Inflow Limits plotted versus modeled cumulative usable inflow with scatter points color coded by the Inflow Condition. Figure 4-2 shows that much of the variability in the approximation of cumulative usable inflow occurs in *Inflow Condition 1* months due to high end of water year storage for consecutive wet weather years. Months with *Inflow Condition 2* to *Condition 5* show a much closer agreement to modeled cumulative usable inflow.

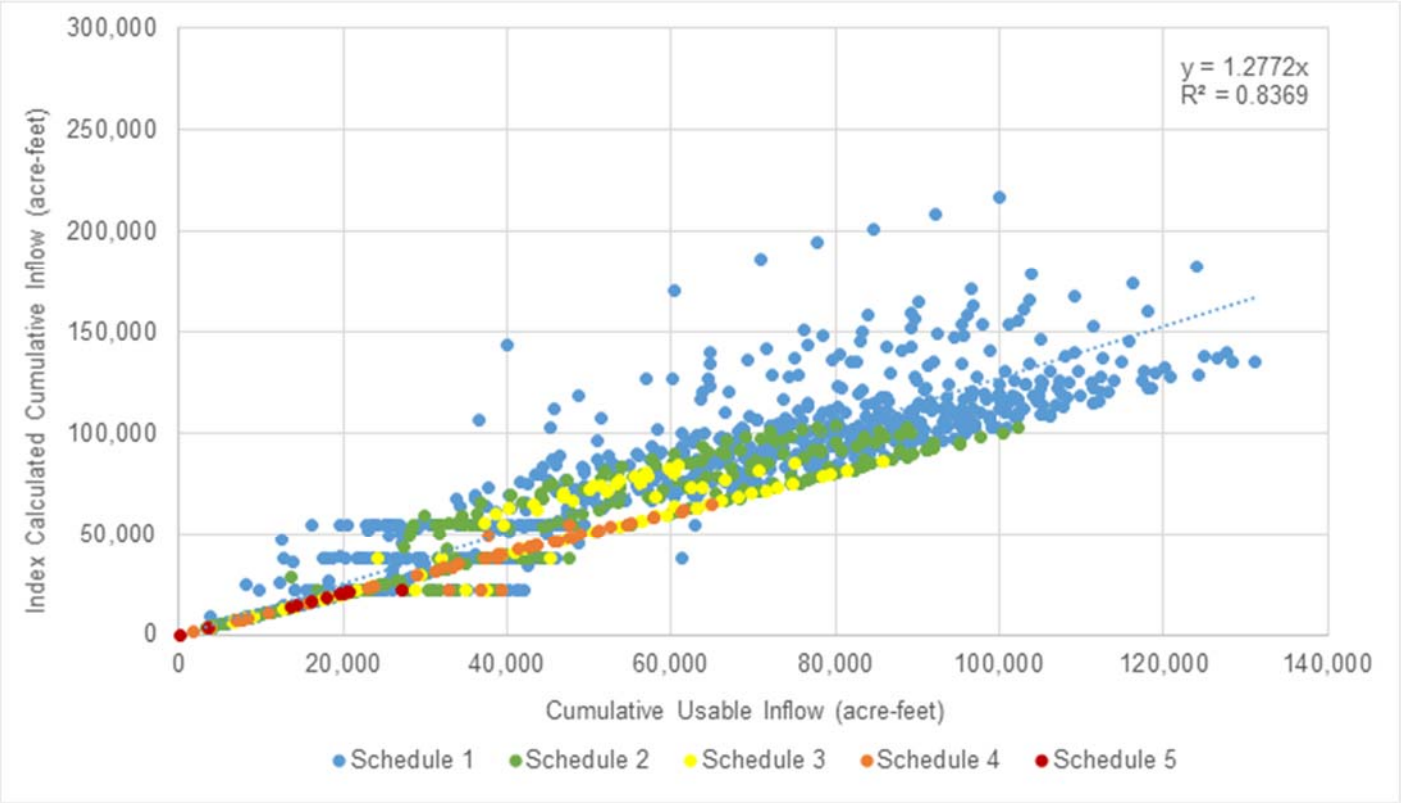

Figure 4-2. Comparison of monthly cumulative usable inflow (acre-feet) and cumulative inflow calculated in the Russian River Hydrologic Index with the Cumulative Inflow Limit applied

4.4 Lake Mendocino Storage Condition Threshold Design

The Russian River Hydrologic Index evaluates storage levels in Lake Mendocino from June 1 to December 1 against a series of 4 storage thresholds to determine the Lake Mendocino Storage Condition (Storage Condition) as a component for determining the Flow Schedules for the Upper Russian River. The Storage Condition is used in conjunction with the Inflow Condition to set the Upper Russian River Flow Schedule. The proposed Storage Condition thresholds are provided in Table 4-11 and graphically in Figure 4-3.

Table 4-11. Lake Mendocino Storage Condition thresholds (acre-feet) to determine the *Condition 1* through *Condition 5* storage conditions under the Russian River Hydrologic Index.

Date	*Condition 2*	*Condition 3*	*Condition 4*	*Condition 5*
June 1	78,900	73,500	70,000	67,100
July 1	76,100	70,700	66,800	62,800
August 1	70,400	65,100	61,200	57,000
September 1	64,600	60,200	55,500	50,600
October 1	58,500	54,200	49,100	42,600
November 1	54,500	50,000	45,700	40,800
December 1	54,400	51,500	45,600	41,700

Note: Lake Mendocino Storage Condition is evaluated using storage levels recorded by the USACE on midnight of the previous day.

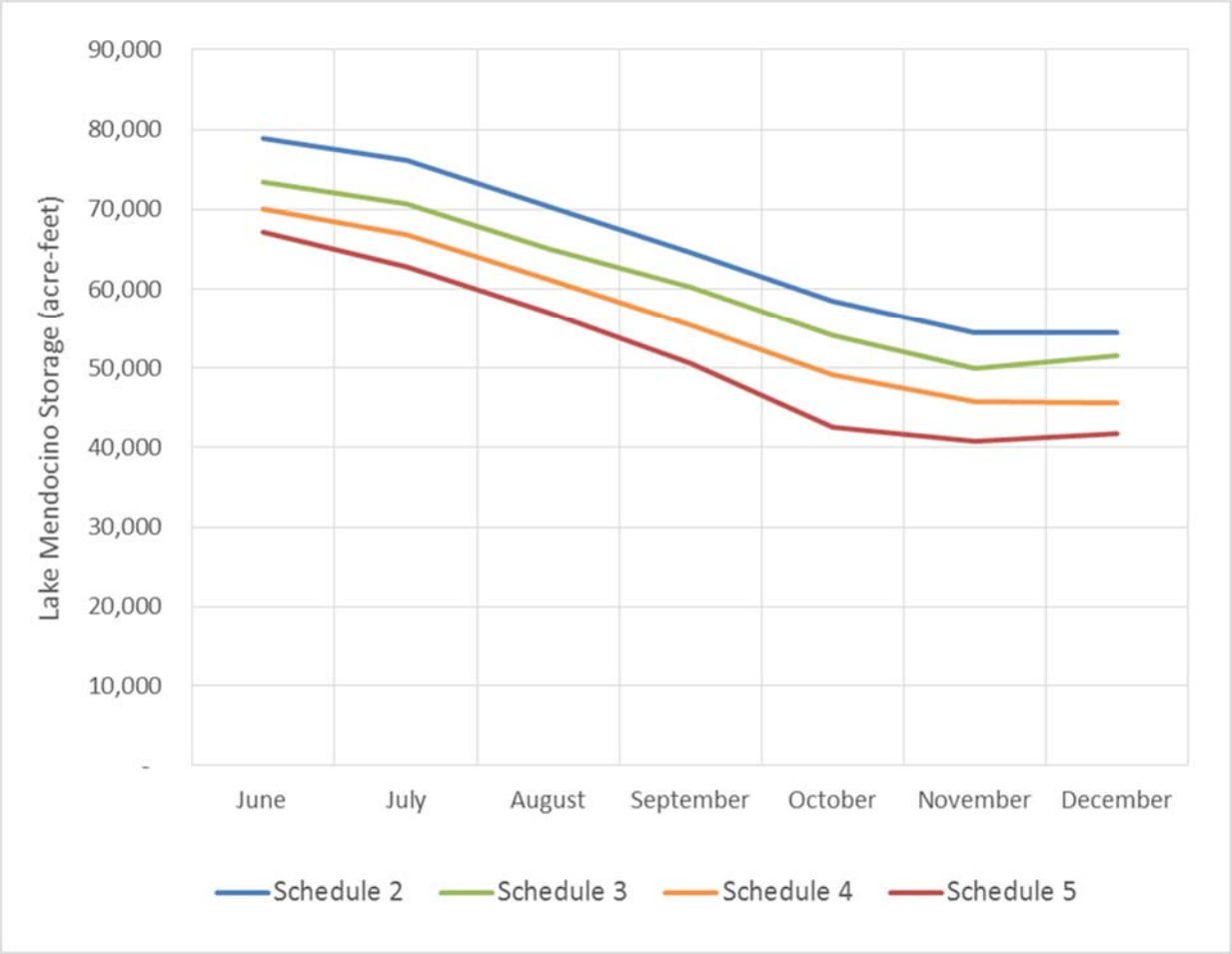

Figure 4-3. Lake Mendocino Storage Condition thresholds (acre-feet) to determine the Schedule 1 through Schedule 5 storage conditions under the Russian River Hydrologic Index.

The Storage Condition is used to set the Flow Schedule of the Upper Russian River if the Storage Condition is greater (drier) than Inflow Condition. From June 1 to September 1, the Storage Condition can only increase the Upper Russian River Flow Schedule by one schedule greater than the Inflow Condition level. For instance if on June 1 Inflow Condition is *Condition 1* and Storage Condition is *Condition 3* the Flow Schedule for the Upper Russian River will be set to *Schedule 2*. This Flow Schedule restriction is to ensure that the Flow Schedules of the Upper Russian River from June through September are aligned with the Flow Schedules of the Lower Russian River and Dry Creek which are determined by just Inflow Condition. This is to prevent and limit excessive releases from Warm Springs Dam that could result in violation of the Incidental Take Statement for dam releases established in the Russian River Biological Opinion (NMFS, 2008). It should be noted that model simulations of the Proposed Project scenario of the Fish Flow Project EIR which incorporates the Russian River Hydrologic Index do not show any periods where the Storage Condition and Inflow Condition were greater than 2 condition levels apart.

From October 1 to December 1, the Storage Condition can set the Flow Schedule for the Upper Russian River multiple schedules above the Inflow Condition level, but can only do so at a rate

of one schedule per month. For example if on October 1 the Storage Condition is a *Condition 4*, the Inflow Condition is a *Condition 1*, and the previous month Upper Russian River Flow Schedule was *Schedule 2* then the Flow Schedule would be set to *Schedule 3*. The allowance of the Storage Condition to set the Upper Russian River Flow Schedule multiple schedules above the Inflow Condition level from October through December is to respond to years with late rainfall to allow increases in Flow Schedule (or reductions in minimum instream flow requirements) in the Upper Russian River to reduce releases from Coyote Valley Dam and conserve storage in Lake Mendocino. This component is especially important should the late onset of rainfall actually be the beginning of a long-period drought when conservation of storage in Lake Mendocino would become critically important. The rate restriction of limiting the change of Flow Schedules above the Inflow Condition to a rate of one schedule per month is to help prevent sudden changes in flow conditions in the Upper Russian River which could impact migration spawning Chinook Salmon.

Storage Condition can only set the Upper Russian River Flow Schedule to be greater than or Inflow Condition. For example if on June 1 Storage Condition is a *Condition1* and Inflow Condition is *Condition 2* then the Flow Schedule for the Upper Russian River will be set to a *Schedule 2* as determined by the Inflow Condition.

Development of the Lake Mendocino Storage Condition thresholds were completed through an iterative modeling process of adjusting the storage thresholds to maximize the occurrence of *Schedule 1* (wettest) minimum flows and minimize the occurrence of *Schedule 5* minimum flows (driest). Another goal was to maintain an even percentage of occurrence of schedules throughout the year. Modeled conditions of the Baseline Conditions scenario of the Fish Flow Project EIR show a high occurrence of *Dry* schedule minimum instream flow requirements. The percent occurrence for the 104-year period of model simulation for *Normal, Dry*, and *Critical* Flow Schedules is provided in Table 4-12. To obtain the results provided in Table 4-12, any periods where conditions result in *Dry* Flow Schedules (75 cfs in the Upper Russian River) have been included with periods of *Dry* water supply conditions. This includes periods of *Normal Dry Spring 2* which set the flows to 75 cfs in the Upper Russian River from June 1 to December 31. This also includes periods of *Normal Dry Spring 1* conditions and Lake Mendocino storage levels drop below 30,000 acre-feet any time from October 1 to December 31. These conditions also results in *Dry* schedule flows of 75 cfs for the Upper Russian River. By including these *Normal Dry Spring 1 & 2* periods with the *Dry* water supply condition periods, it emphasizes the high occurrence of *Dry* Flow Schedules, which increase from 11 percent occurrence in May to 23 percent occurrence beginning in June, increasing again to 36 percent occurrence beginning in October and again to 44 percent occurrence in November. This inter-annual distribution of Water Supply Conditions under Baseline Conditions scenario operations does not align well with fish habitat needs for the Upper Russian River where the percent occurrence of *Dry* schedule minimum flows in June occurs at the beginning of the rearing season for Steelhead juveniles, and the fall increase (October to December) in occurrence of *Dry* schedule minimum flows occurs during the Chinook Salmon spawning migration period.

In the development of the Russian River Hydrologic Index one of the primary goals was to improve the uneven distribution of Flow Schedules that occurs under the Baseline Conditions

scenario. The percent occurrence of Upper Russian River Flow Schedules simulated with the Proposed Project model scenario of the Fish Flow Project EIR is provided in Table 4-13. The Proposed Project scenario incorporates Russian River Hydrologic Index and the preferred Flow Schedules analyzed in the Fish Flow Project EIR. Comparing Tables Table 4-12 and Table 4-13 it can be seen that the inter-annual distribution of Upper Russian River Flow Schedules is more even for Proposed Project scenario than the simulated occurrence of Flow Schedules of the Baseline Conditions model scenario. The bottom row of Table 4-13 provides a summation of the average percent occurrence of the *Schedule 1* and *Schedule 2*, and *Schedule 3* and *Schedule 4*. This summation is provided to facilitate the comparison of modeled conditions for Proposed Project (Table 4-13) to the percentage of occurrence of simulated Water Supply Conditions and *Normal Dry Spring* Conditions under Baseline Conditions defined in the Water Agency's water right permits. It can be seen that the average percent combined occurrence of *Schedule 1* and *Schedule 2* of 12 percent is much lower than the combined occurrence of *Dry* and *Normal Dry Spring 1 & 2* Water Supply Conditions of 22 percent under baseline operations.

Table 4-12. Percent occurrence (%) of *Normal*, *Dry*, and *Critica*l schedule flows, of the Baseline model scenario.

Monthly	***Normal***	***Dry***	***Critical***
January	87	9	4
February	79	14	8
March	87	10	4
April	88	10	3
May	87	11	2
June	75	23	2
July	75	23	2
August	75	23	2
September	75	23	2
October	62	36	2
November	54	44	2
December	61	37	2
Average	***75***	***22***	***3***

Table 4-13. Percent occurrence (%) of *Schedule 1* through *Schedule 5* Upper Russian River minimum instream flow schedules under the Russian River Hydrologic Index.

Monthly	***Schedule 1***	***Schedule 2***	***Schedule 3***	***Schedule 4***	***Schedule 5***
January	68	20	7	4	1
February	68	20	7	4	1
March	68	20	7	4	1
April	68	20	7	4	1
May	69	19	7	4	1
June	68	17	7	6	2
July	68	18	7	5	2
August	67	19	7	5	2
September	67	19	6	6	2
October	65	20	8	5	2
November	65	21	5	7	2
December	64	21	7	7	1
Average	***67***	***20***	***7***	***5***	***1***
Total	***87***		***12***		***1***

4.4.1 1 in 100 Dry Year Scenario

The Lake Mendocino Storage Condition thresholds were evaluated with the 1 in 100 dry year scenario, discussed in Section 4.2.2, to evaluate whether the proposed thresholds would provide reliable releases from Lake Mendocino. The Proposed Project scenario was used to develop 4 drought simulations. To evaluate water supply reliability under varied initial conditions, each simulation was initialized with a different Upper Russian River Flow Schedule (*Schedule 1* through *Schedule 4*). The initial Lake Mendocino storage for each scenario was set to the minimum allowable storage level for the Flow Schedule being evaluated. For example, under the *Schedule 1* scenario, initial October 1 Lake Mendocino model storage volume was set to 58,500 acre-feet. This is the minimum allowable storage for a Flow Schedule of *Schedule 1* on October 1. The same approach was applied for the *Schedule 2* through *Schedule 4* scenarios. Results of this analysis are provided in

Table 4-14 and presented as hydrographs in Figure 4-4. These results demonstrate that the Russian River Hydrologic Index with the proposed minimum instream flow requirements could reliably provide releases from Lake Mendocino to the end of the calendar year if the 1 in 100 dry year scenario occurred.

Table 4-14. Lake Mendocino minimum initial storage and minimum storage levels simulated with the 1 in 100 dry year scenario.

Upper Russian River Flow Schedule	**Starting Storage (acre-feet)**	**Minimum Storage (acre-feet)**
1	58,500	11,311
2	54,200	7,366
3	49,100	8,884
4	42,600	4,875

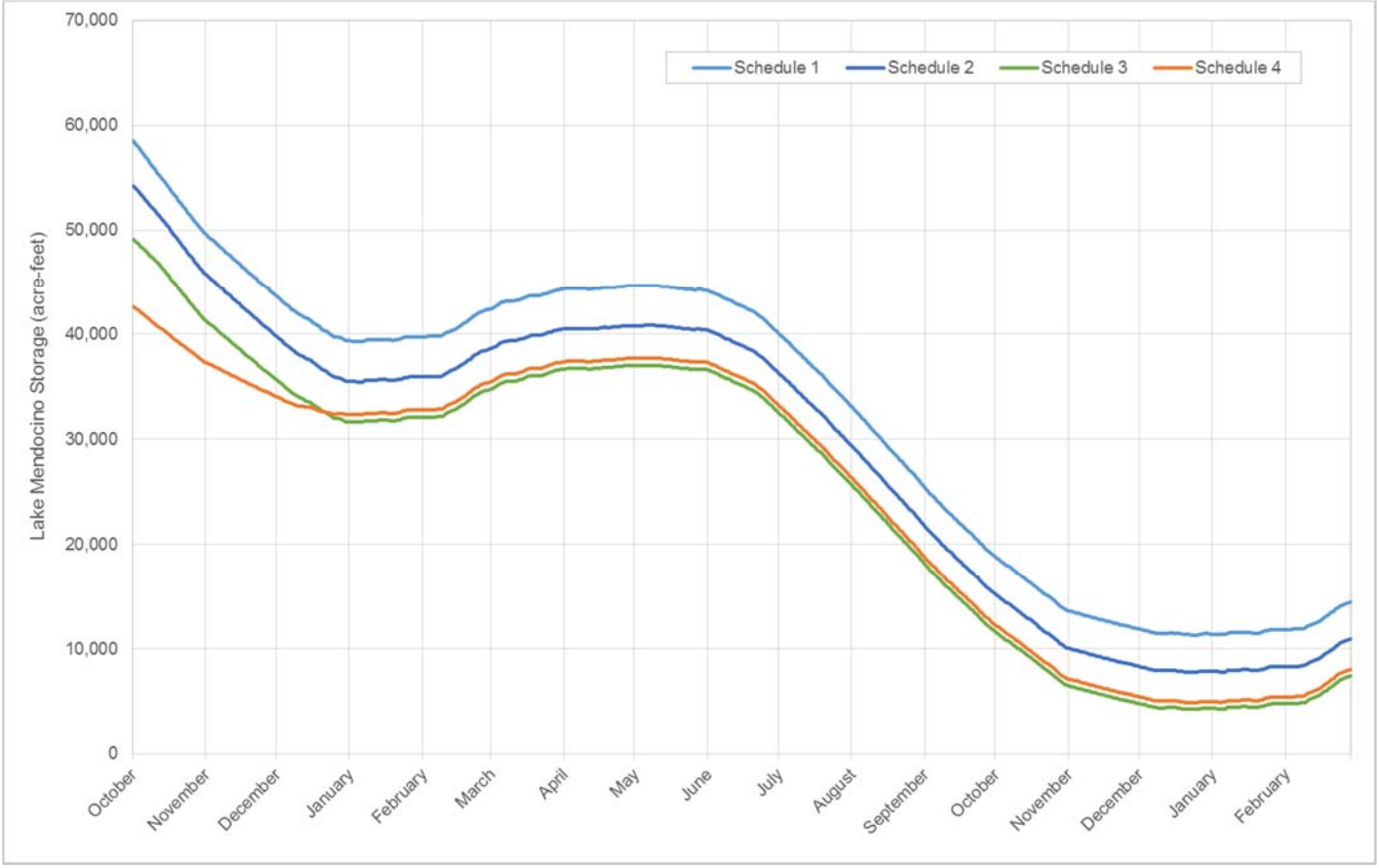

Figure 4-4. Lake Mendocino storage levels (acre-feet) simulated with the 1 in 100 dry year scenario.

For all of the 1 in 100 dry year scenarios Lake Sonoma was initialized with a storage level of approximately 84,500 acre-feet. This is the minimum simulated storage level for the Baseline Conditions scenario of the Fish Flow Project EIR, which occurs in the model year 1977, the driest single year of the 104-year simulation period. This is a very conservative initial storage for this considering the severity of the 1977 drought. Under this very conservative assumption,

Lake Sonoma does not reach the dead storage level in the reservoir for any of the 1 in 100 dry year scenarios.

5 Model Simulation Results

Model simulation results of the Proposed Project scenario of the Fish Flow Project EIR are provided to demonstrate the benefits of the Russian River Hydrologic Index. As a basis of comparison, results are compared against results of the Baseline Conditions scenario of the Fish Flow Project EIR. These scenarios are further described in Section 0 and the Fish Flow Project Modeling Report. In summary, the Baseline Conditions scenario assumes the minimum instream flow requirements defined in the Water Agency's water rights permits, which are summarized in Tables Table 4-4 to Table 4-6 for the Upper Russian River, Lower Russian River and Dry Creek. The Baseline Conditions scenario also assumes a Water Agency demand of 55,000 acre-feet per year which is the average demand from 2009 to 2014. A more detailed description of this scenario is provided in the Fish Flow Project EIR.

5.1 Water Supply Reliability

5.1.1 Lake Mendocino

As discussed in Section 0, reductions in imports from the Eel River since 2007 have reduced the water supply reliability of Lake Mendocino. A goal in the design of the Russian River Hydrologic Index was to develop an index which was more aligned with current system hydrology and improve the water supply reliability of Lake Mendocino. A hydrograph of Lake Mendocino storage from 1910 to 2013 for the Baseline Conditions scenario and the Proposed Project scenario is provided in Figure 5-1. Percent exceedance of minimum water year storage is provided in Figure 5-2, which shows increases in minimum water year storage for all years simulated with the RR ResSim model. Average end of water year storage for the Proposed Project scenario is approximately 70,619 acre-feet, which is a 58% increase over the Baseline Conditions scenario of 44,693 acre-feet.

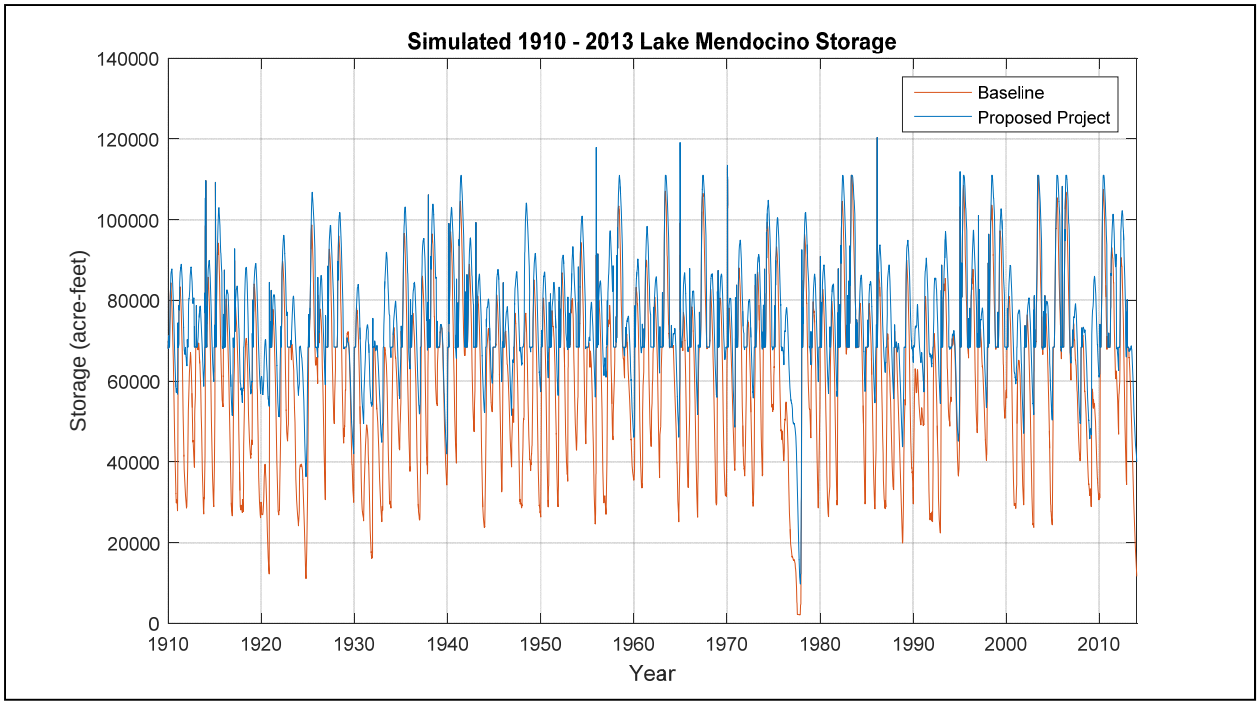

Figure 5-1. Simulated Lake Mendocino storage in acre-feet from 1910 to 2013 for the Baseline Conditions scenario and the Proposed Project scenario.

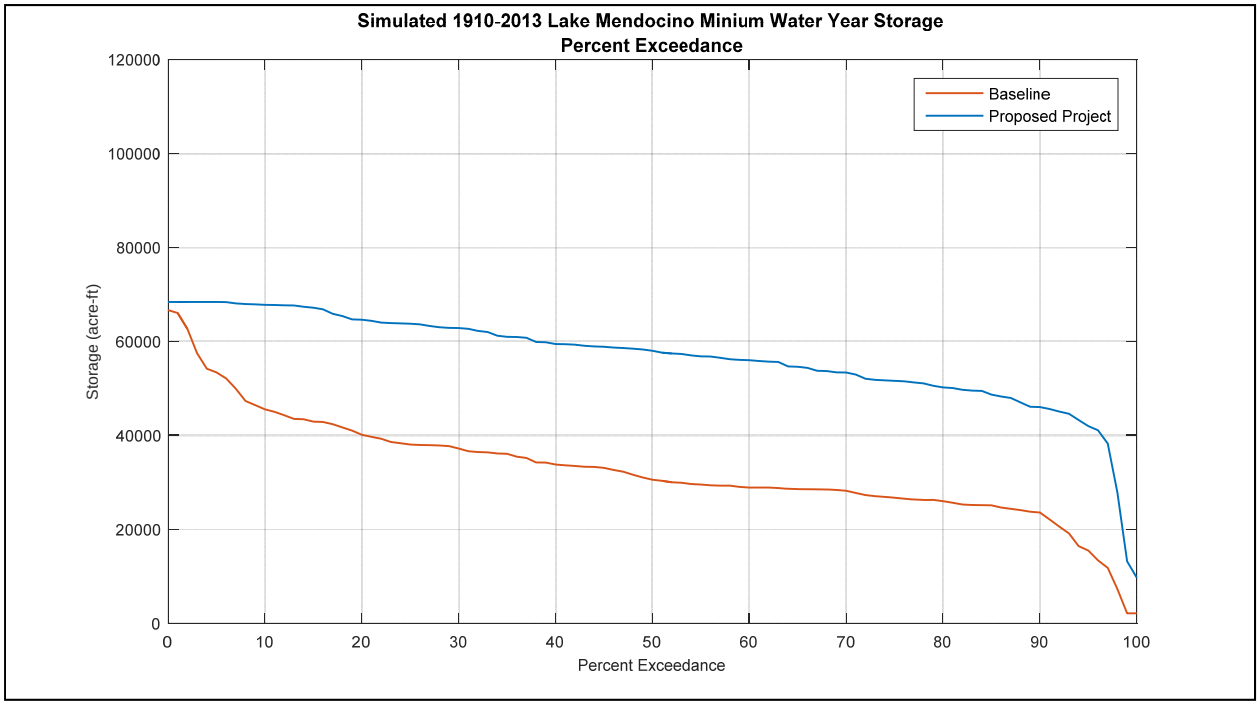

Figure 5-2. Simulated minimum water year Lake Mendocino storage in acre-feet from 1910 to 2013 shown as percent exceedance for the Baseline Conditions scenario and the Proposed Project scenario.

5.1.2 Lake Sonoma

A hydrograph of Lake Sonoma storage from 1910 to 2013 for the Baseline Conditions scenario and the Proposed Project scenario is provided in Figure 5-3. Percent exceedance of minimum water year storage is provided in Figure 5-4. Simulated storage levels for the 2 scenarios are very close with the exception of results above the 90% exceedance levels where there is a small reduction in minimum water year storage for the Proposed Project. The Proposed Project assumes a higher Water Agency demand over Baseline Conditions, but this is balanced by the reduction in minimum instream flow requirements for the Lower River and Dry Creek.

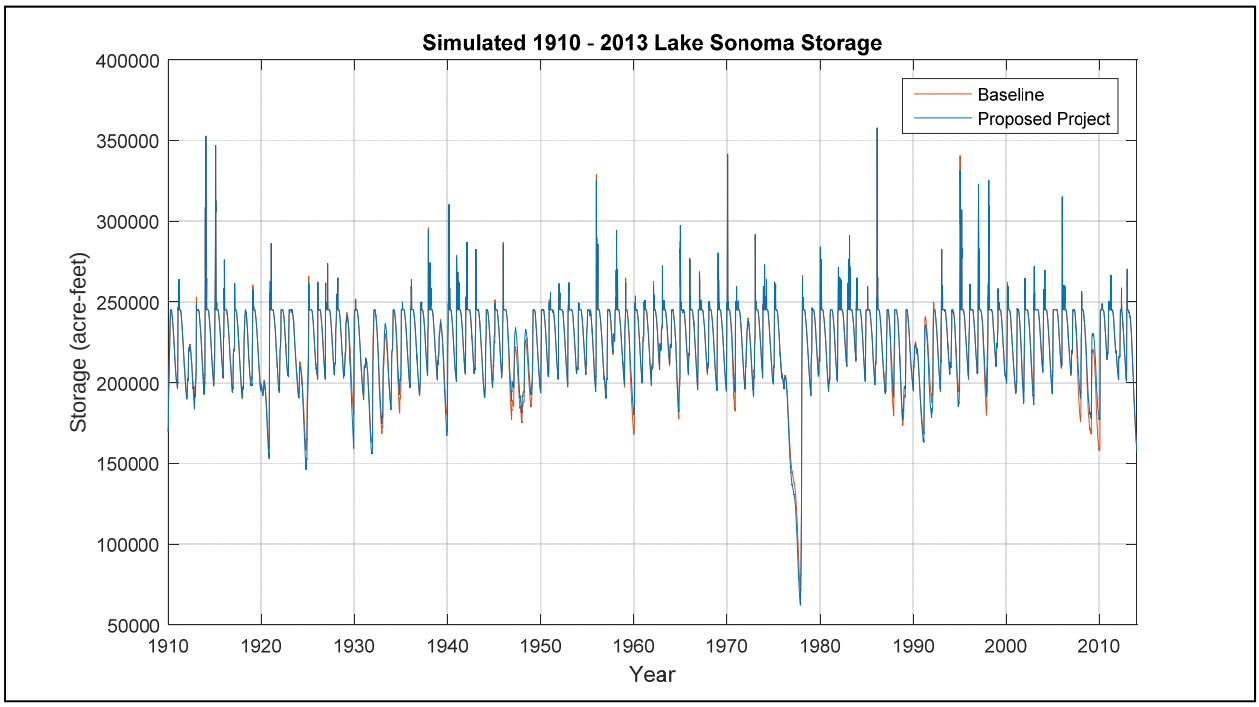

Figure 5-3. Simulated Lake Sonoma storage in acre-feet from 1910 to 2013 for the Baseline Conditions scenario and the Proposed Project scenario.

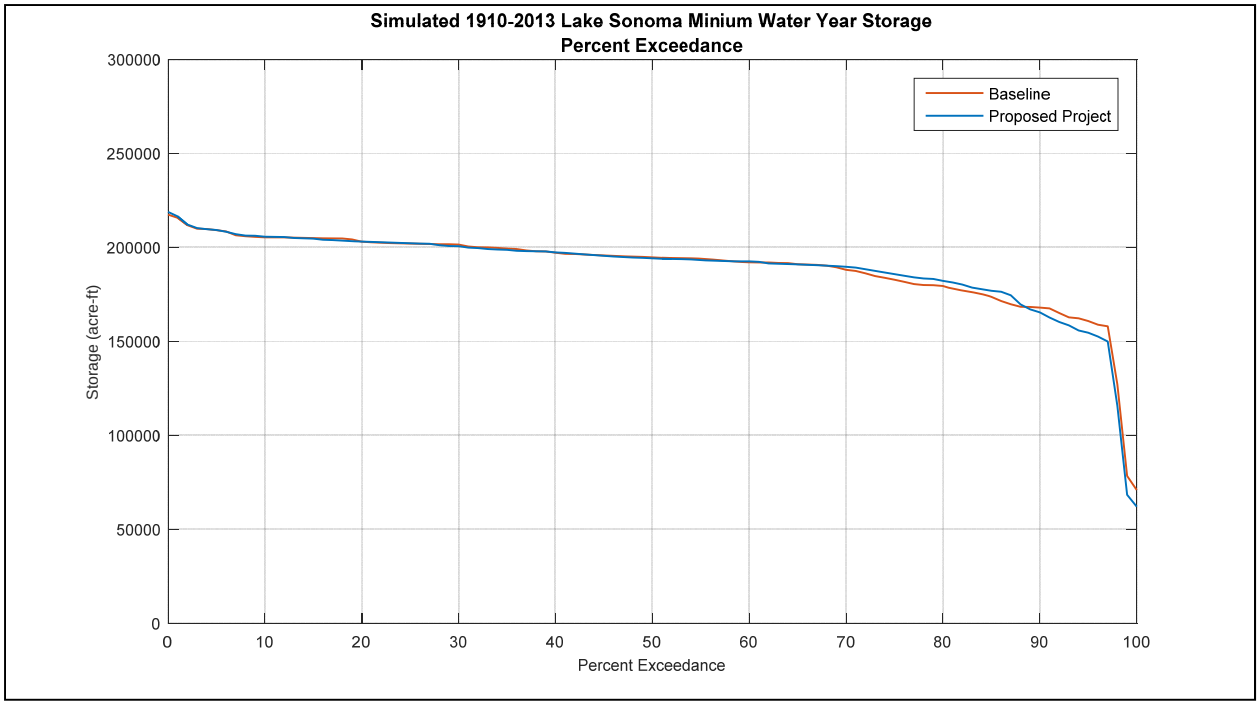

Figure 5-4. Simulated minimum water year Lake Sonoma storage in acre-feet from 1910 to 2013 shown as percent exceedance for the Baseline Conditions scenario and the Proposed Project scenario.

5.2 Dry Spring Years

As discussed in Section 4.3.2, an important feature of the proposed Russian River Hydrologic Index is the maximum limit set on the Lake Mendocino Cumulative Inflow calculation for the January 1, February 1 and March 1 evaluation dates. The importance of this feature is highlighted in dry spring years 1988 and 2013, where almost all of the annual precipitation occurred relatively early in the rainy season between December through March with very little precipitation in the spring. A hydrograph of simulated Lake Mendocino storage levels for the Baseline Conditions scenario and the Proposed Project scenario is provided in the top panel of Figure 5-5. This figure shows storage levels from December through March reaching the top of the Water Supply Pool but not exceeding this level based on the Guide Curve defined in the USACE Water Control Manual of Lake Mendocino (USACE, 1986). The RR ResSim model is constrained by this requirement and does not allow reservoir storage to exceed this level except for short periods during flood control operations. Storage levels do not increase from March to May due to the very low springtime inflows in 2013.

The middle panel of Figure 5-5 is a hydrograph of simulated Lake Mendocino cumulative inflow. The blue line shows the cumulative inflow calculations consistent with the methods of the Russian River Hydrologic Index with the Cumulative Inflow Limits applied in January and February. The green dotted line shows cumulative inflow without the Cumulative Inflow Limits applied. The Cumulative Inflow Limit and the Inflow Condition thresholds are shown as dashed lines. The middle panel of Figure 5-5 shows that a large amount of inflow was received in the reservoir in December and January, which according to the top panel, much of this inflow was not stored but released during flood operations. The Cumulative Inflow Limit is designed to limit

the calculation of the Lake Mendocino Cumulative Inflow index to not include this water that was released during flood control operations. Due to very low rainfall amounts in the spring, cumulative inflow does not increase significantly past March for 2013 which causes the Lake Mendocino Cumulative Inflow index to cross two index thresholds. Upper Russian River Flow Schedules for 2013 for the Baseline Conditions scenario and the Proposed Project scenario are provided in the bottom panel of Figure 5-5. The bottom panel shows that because the Lake Mendocino Cumulative Inflow index reaches the Cumulative Inflow Limit constraint for the January 1 and February 1 evaluation dates, *Schedule 1* minimum instream flows are set for those months. On March 1 the index is below the Cumulative Inflow Limit therefore *Schedule 2* flows are set. On April 1 the index is below the *Schedule 3* threshold triggering yet another increase in Flow Schedule. The bottom panel of Figure 5-5 shows three additional changes in schedule past June 1, but these changes are actually the result of Lake Mendocino Storage Condition index.

The Flow Schedule for the Baseline Conditions scenario is also included in the bottom panel of Figure 5-5 which shows that *Normal* schedule flows were triggered for the Upper Russian River from January to June. The D1610 Index does not have a maximum limit for Lake Pillsbury cumulative inflow, therefore the high levels of Lake Pillsbury inflows for December of 2012 and January of 2013 set the *Normal* schedule flows, even though water was not actually available in Lake Mendocino to sustain these minimum instream flow requirements. This results in the reservoir to draw down to low enough levels by May 31 to result in a *Normal Dry Spring* 2 condition and *Dry* schedule flows for the remainder of the calendar year.

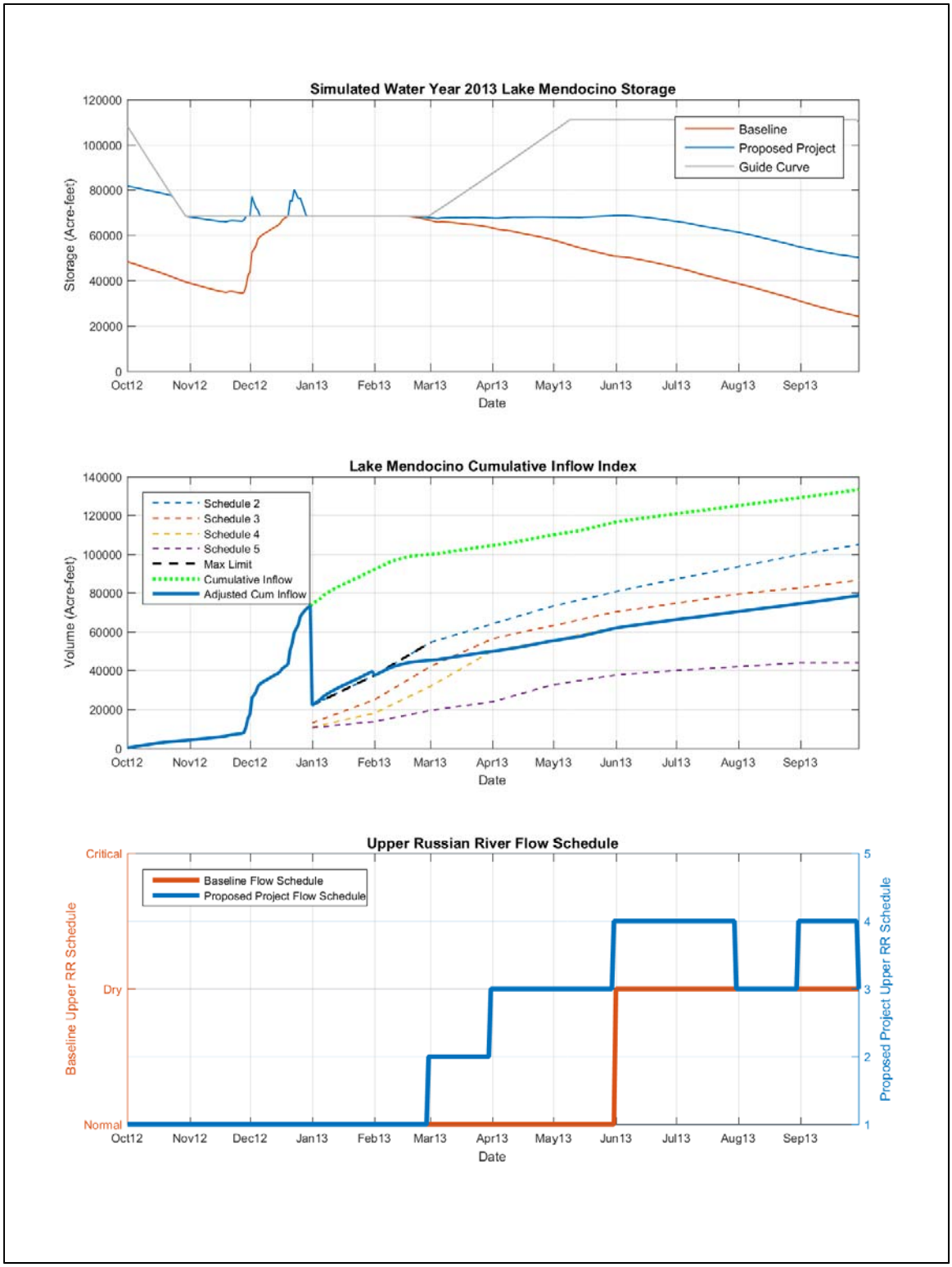

Figure 5-5. Upper Russian River conditions for Water Year 2013 for Baseline Conditions scenario and Proposed Project scenario with Lake Mendocino storage (acre-feet) in the upper panel, Lake Mendocino cumulative inflow with Inflow Conditions thresholds (acre-feet) in the middle panel and *Upper Russian River Flow Schedule* in the lower panel.

5.3 Lake Mendocino Storage Condition

As discussed in Section 3, from June 1 to December 1 Upper Russian River Flow Schedules are determined from both Inflow Condition and Storage Condition. The implementation of the Storage Condition can be demonstrated by the model simulation year 1932. A hydrograph of Lake Mendocino storage for the Proposed Project scenario for 1932 is provided in the top panel of Figure 5-6. Lake Mendocino Storage Condition thresholds are also included in this hydrograph. Upper Russian River Flow Schedules for 2013 are provided in the bottom panel of Figure 5-6. The bottom panel also includes the Inflow Condition. The bottom panel shows that the Inflow Condition set a *Schedule 2* flow for the Upper Russian River from January through March and increased to a *Schedule 3* from April through May. On June 1 the top panel indicates that simulated storage is below the *Condition 4* storage threshold and the bottom panel shows the Inflow Condition to be a *Condition 1*. Due to the constraints described in Section 3 and 4.4, the Upper Russian River flow schedule was set to a *Schedule 3* as shown in the bottom panel. Based on the combined results of the Inflow Condition and Storage Condition the flow schedule remains at *Schedule 3* through November.

The fall and early winter of 1932 received lower than normal rainfall causing Lake Mendocino storage to continue to decline into mid-December. As shown in the top panel of Figure 5-6 Lake Mendocino Storage levels are below the *Schedule 4* threshold on December 1. Because Storage Condition can cause multiple Flow Schedule increases from October 1 to December 1, the Upper Russian River Flow Schedule increases from *Schedule 3* to *Schedule 4* beginning December 1, which can be seen on the bottom panel of Figure 5-6. This allowance of multiple schedule increases in the Upper Russian River beginning October 1 to December 1 is important to respond to years with late rainfall especially if such conditions are actually the beginning of a multi-year drought. The rate of change that the Upper Russian River Flow Schedule can increase above the Inflow Condition is constrained to a rate of one schedule per month in order to limit potential habitat impacts of reducing flows this time of year.

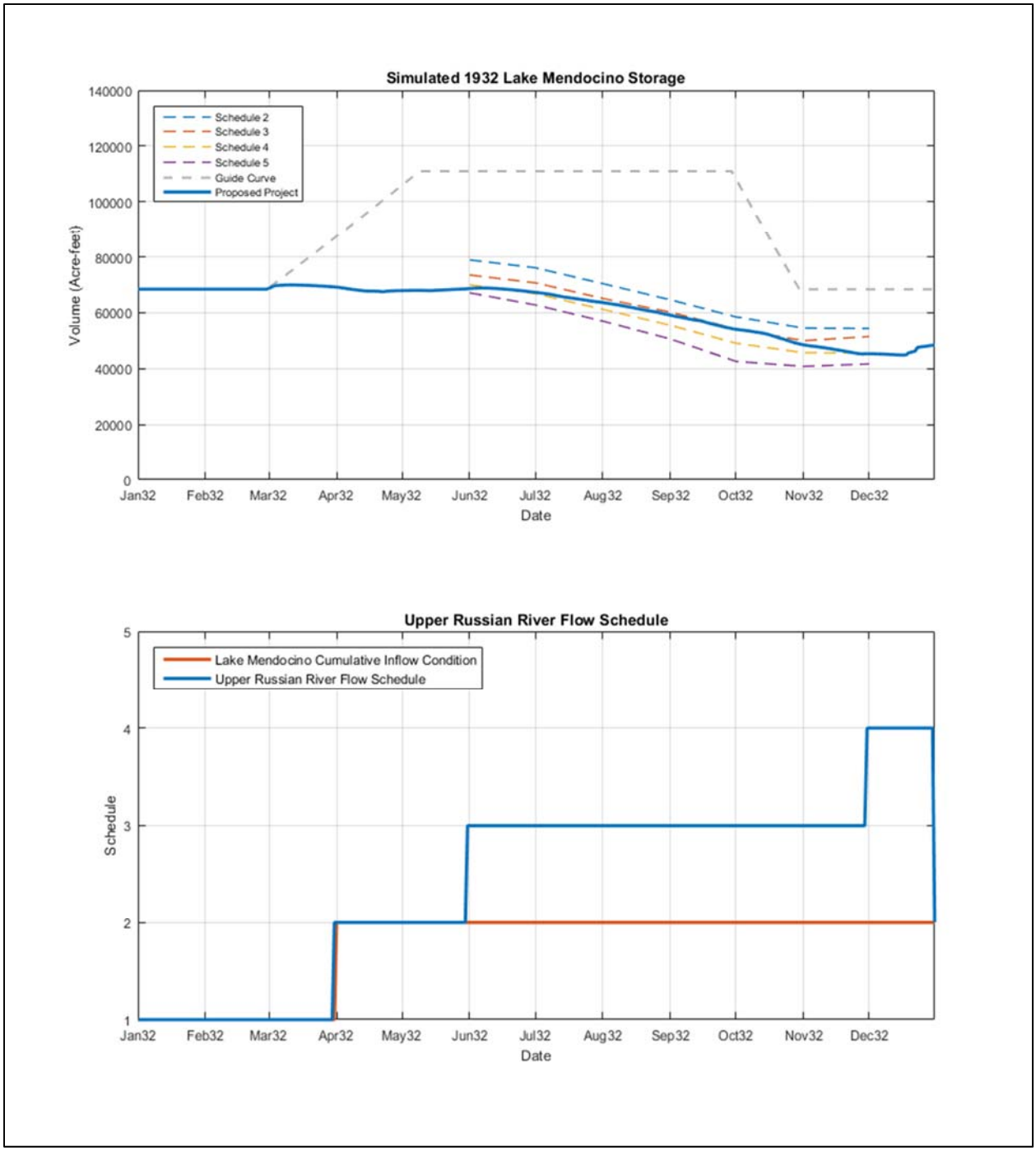

Figure 5-6. 1932 Upper Russian River conditions for the Proposed Project scenario with Lake Mendocino storage (acre-feet) with Storage Condition thresholds in the upper panel, and Upper Russian River Flow Schedule and Inflow Condition in the lower panel.

5.4 Index Stability

Index stability is measured by how frequently a hydrologic index changes flow schedules to respond to changes in water availability. An index that changes frequently can improve water supply reliability but can impact aquatic and riparian species due to frequent Flow Schedule changes.

The Inflow Condition is an important component of the proposed index to help provide index stability. A metric based on cumulative flow tends to be stable because cumulative flow cannot decline, but can only increase or level off. In contrast a metric tied to reservoir storage is more dynamic especially for a reservoir such as Lake Mendocino due to its relative small size compared to its annual water duty. Given the decline in Lake Mendocino's water supply reliability due to the recent changes in PG&E's FERC license for PVP, it was important that the Russian River Hydrologic Index also consider Lake Mendocino storage to make schedule adjustments to reflect actual storage conditions. The Storage Condition allows for consideration of storage to adjust the minimum instream flows for Upper Russian River from June to December, but to limit potential instability of flows due to the dynamic nature of storage, it is tied to the more stable Inflow Condition through the constraints set on flow schedule determination as discussed in Sections 3 and 4.4.

To measure index stability an analysis of Flow Schedules changes was completed. This analysis was performed for the Baseline Conditions and Proposed Project scenarios to compare stability of the Russian River Hydrologic Index to the D1610 Index. This analysis computed the daily cumulative change in flow schedule for the different reaches of the Russian River System for the entire simulation period (1910-2013). The river reaches analyzed include the Upper Russian River, the Lower Russian River and Dry Creek. The daily cumulative change in schedule was computed by calculating the running accumulation of the absolute value of flow schedule change. If a schedule changes from a 3 to a 2 from one day to the next then 1 is added to the accumulation even though the schedule decreased. Similarly if the schedule changes from a 2 to a 3 from one day to the next then 1 is added for this case as well. Since the D1610 Index is a 3 schedule system, changes in flow schedule were counted as 2.

The cumulative change in Flow Schedules for the Upper Russian River for the Baseline Conditions and the Proposed Project scenarios are provided in Figure 5-7. For the analysis of the Baseline Conditions scenario for the Upper Russian River, periods that result in *Dry* Flow Schedules (75 cfs in the Upper Russian River) were considered to be equivalent to *Dry* water supply condition periods. This includes periods of *Normal Dry Spring 2* which set the flows to 75 cfs in the Upper Russian River from June 1 to December 31. This also includes periods of *Normal Dry Spring 1* conditions and Lake Mendocino storage levels drop below 30,000 acre-feet any time from October 1 to December 31. The results shown in Figure 5-7 indicate a reduction in simulated changes in Flow Schedules for the Proposed Project scenario for the Upper Russian River with an end of simulation total of 233 schedule changes which is 37% less than the Baseline Conditions scenario with an end of simulation total of 372 schedule changes. These results for the Upper Russian River indicate that the issues of disproportionate annual distribution of *Dry* schedule flows of the Baseline Conditions scenario caused by *Normal Dry Spring 2* conditions occurring on June 1 and *Normal Dry Spring 1* conditions occurring after October (as discussed in Section 4.4) have been improved with the Russian River Hydrologic Index.

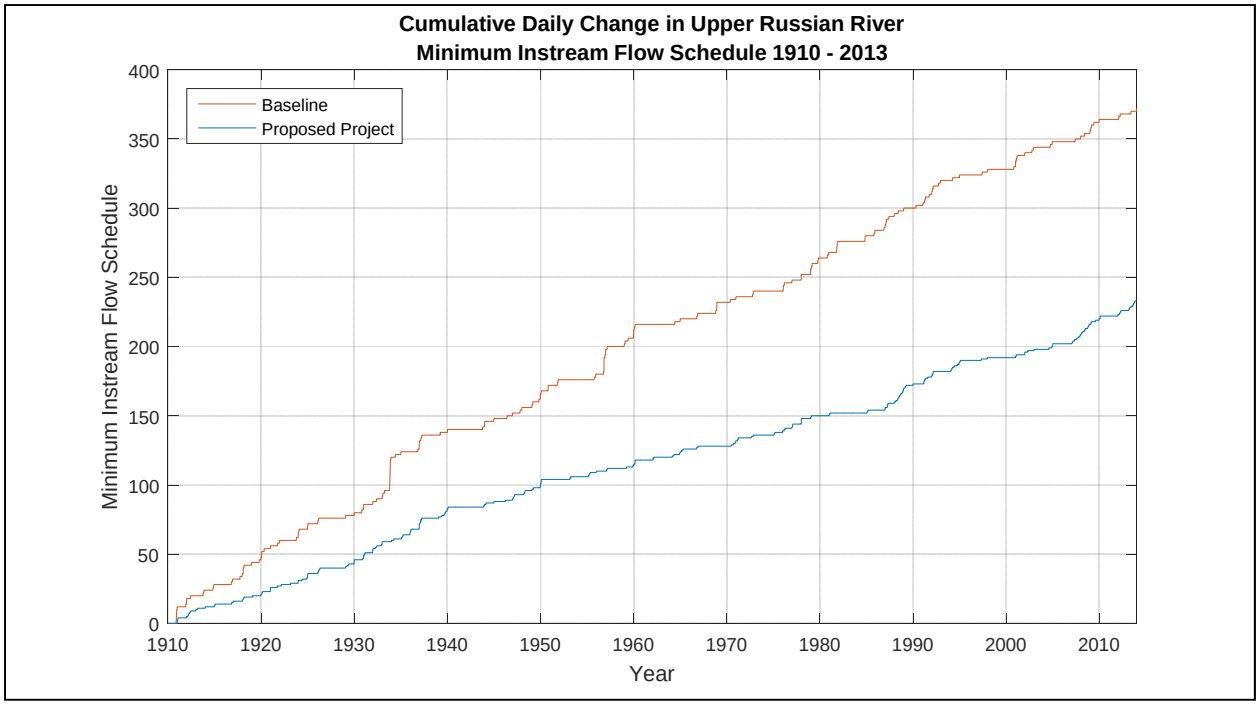

Figure 5-7. Upper Russian River cumulative change in Flow Schedule from 1910 to 2013.

The cumulative change in Flow Schedules for the Lower Russian River for the Baseline Conditions and the Proposed Project scenarios are provided in Figure 5-8. For the analysis of the Proposed Project scenario for the Lower Russian River changes in schedule between *Schedule 1* to *Schedule 3* were not accounted in the cumulative calculation because *Schedule 1* to *Schedule 3* have the same minimum instream flows requirements. The results shown in Figure 5-8 indicate a reduction in simulated changes in Flow Schedules for the Lower Russian River with an end of simulation total of 55 schedule changes which is 60% less than the Baseline Conditions scenario with an end of simulation total of 140 schedule changes.

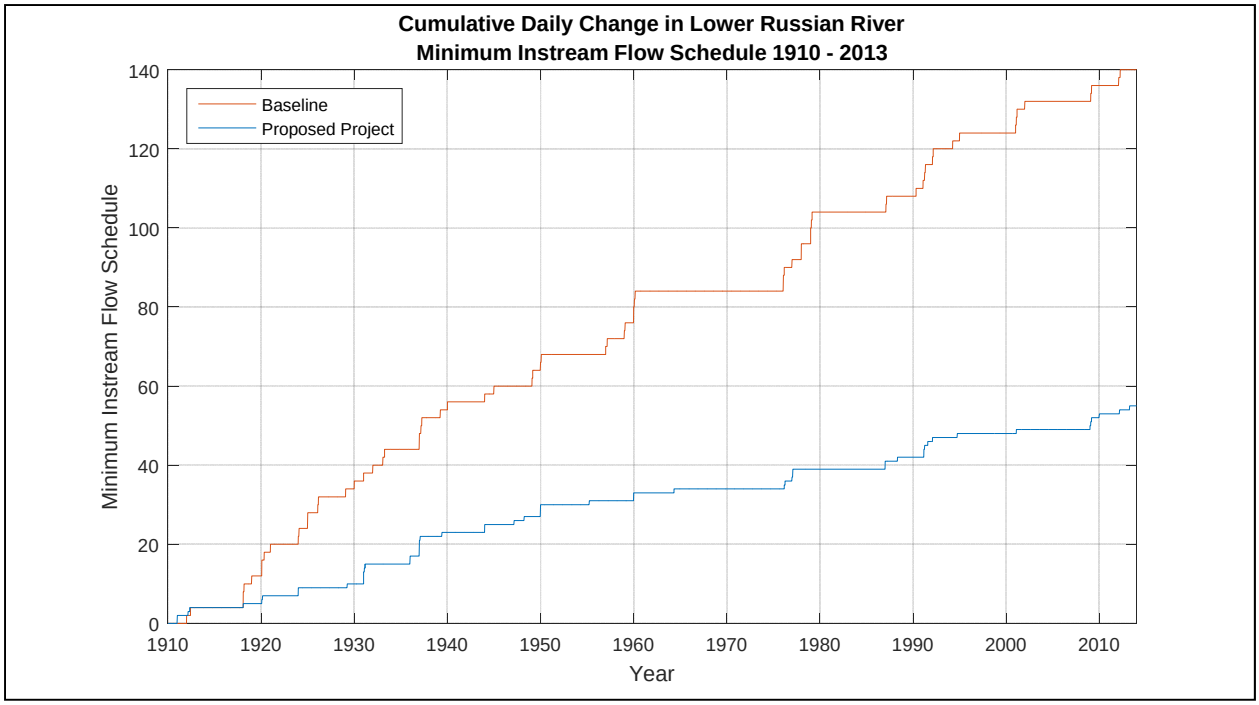

Figure 5-8. Lower Russian River cumulative change in Flow Schedule from 1910 to 2013.

The cumulative change in Flow Schedules for the Dry Creek reach for the Baseline Conditions and the Proposed Project scenarios are provided in Figure 5-9. For the analysis of the Proposed Project scenario for Dry Creek only changes from *Schedule 2* to *Schedule 3* or from *Schedule 3* to *Schedule 2* were accounted in the accumulation, because *Schedule 1* and *Schedule 2* have the same minimum instream flow requirements as do *Schedule 3* to *Schedule 5*. Similarly for the Baseline Conditions scenario since *Dry* and *Critical* conditions have the same minimum instream flow requirements, only changes from *Normal* to *Dry* were accounted in the accumulation. The results shown in Figure 5-9 indicate a reduction in simulated changes in Flow Schedules for Dry Creek with an end of simulation total of 88 schedule changes which is 19% less than the Baseline Conditions scenario with an end of simulation total of 108 schedule changes.

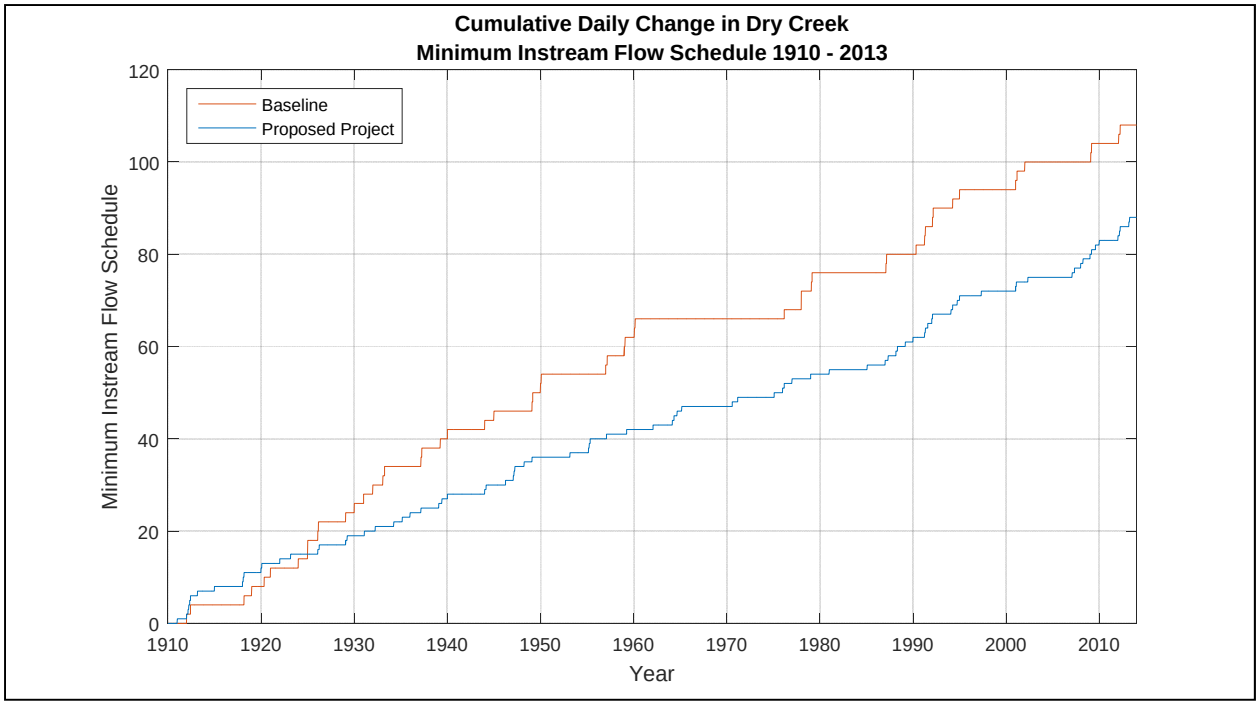

Figure 5-9. Dry Creek cumulative change in Flow Schedule from 1910 to 2013.

5.5 Index Resiliency

Index Resiliency can be evaluated through examination of how well the proposed index responds to changes in hydrologic conditions. The 104 year hydrologic dataset of the RR ResSim model estimates hydrologic conditions from 1910 to 2013. This period contains extreme years of wet and dry weather. The most extreme drought year in this period is 1977 where the watershed received very little rainfall. Model results for these for the 1977 drought is further examined in Section 5.5.1 below.

The Russian River Hydrologic Index is designed to respond to variability in downstream demands. To analyze for this, the RR ResSim model incorporates demand variability. Resiliency of the proposed hydrologic index to variability in demand is further discussed in Section 5.5.2.

5.5.1 Drought Conditions for 1977

Water year 1977 is the driest single year in the model simulation period. According to the unimpaired flow dataset prepared by the USGS (USGS, 2015), the simulated total annual basin (at the Hacienda model junction) flow was 65,694 acre-feet. According to the drought analysis completed by Grinnell the 1 in 500-year annual volume is 75,761 acre-feet. This indicates that the 1977 drought was greater in frequency than a 1 in 500 year event for the Russian River system. Not only was this year an extreme year for unimpaired flow, it was also an extreme year in terms of low transfers from the Eel River through the PVP. Modeled total water year PVP diversions are provided in Figure 5-10. Model simulation results show no power production diversions would be made and releases through the PVP Tunnel would be consistent with *Critical* conditions under PG&E's FERC license for PVP.

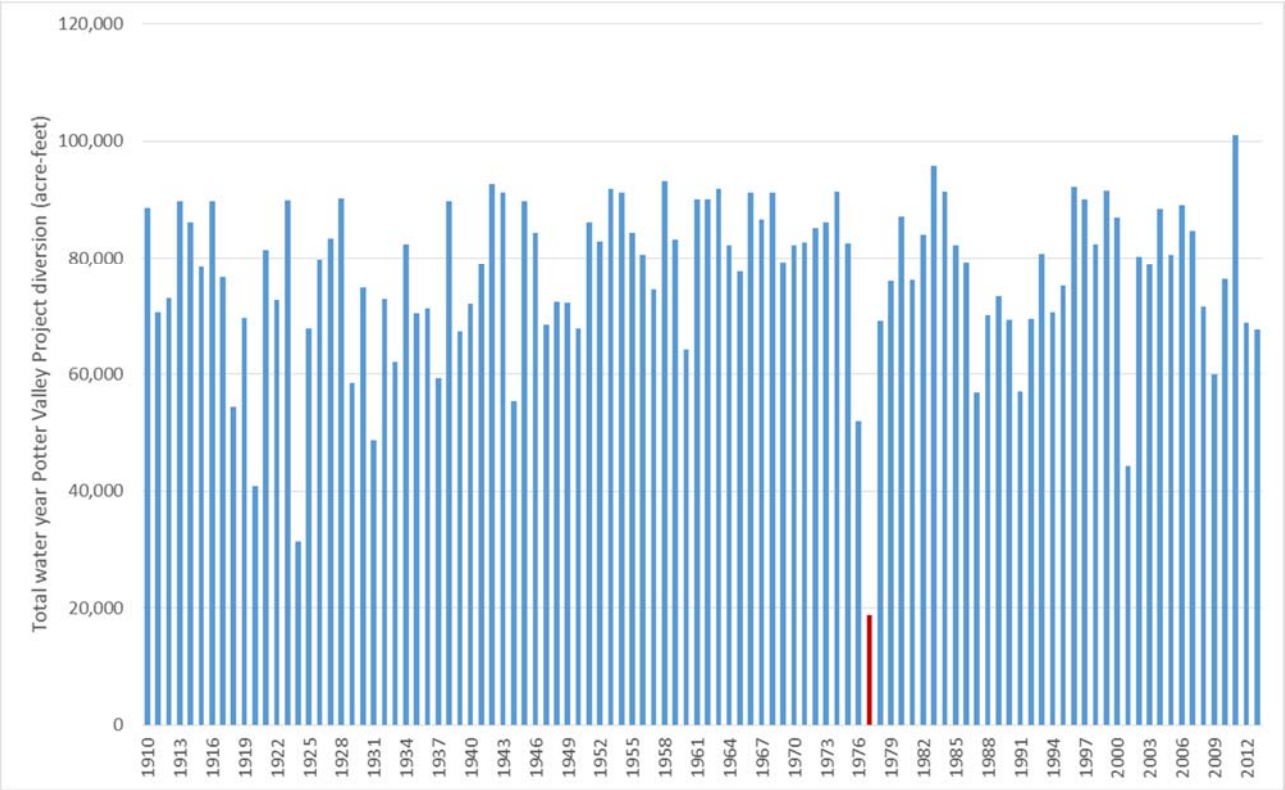

Figure 5-10. Modeled cumulative water year PVP diversions from 1910 to 2013.

A storage hydrograph of water years 1976 and 1977 is provided in the top panel of Figure 5-11. Model simulation results for the Proposed Project show that Lake Mendocino would reach a minimum storage level of 9,731 acre-feet in November of 1977, which represents a significant improvement over the Baseline Conditions scenario which shows Lake Mendocino reaching the dead pool storage level (approximately 2,000 acre-feet) by mid-July and remaining at this level for 63 days until storage starts to recover around mid-November. The increased water supply reliability resulting from the minimum instream flows and hydrologic index of the Proposed

Project create significantly higher storage levels at the beginning of water year 1976, which is at the top of the water supply pool. This carry over storage plays an important role in preventing the Lake Mendocino from going dry for this extreme event.

Upper Russian River Flow Schedules for water years 1976 and 1977 for the Baseline Conditions scenario and the Proposed Project scenario are provided in the bottom panel of Figure 5-11. This figure shows that the Proposed Project begins responding to the drought conditions by entering into *Schedule 3* flows in March and then *Schedule 4* flows in April and staying in *Schedule 4* for the remainder of 1976. By entering into a *Schedule 4* in spring of 1976 the Proposed Project scenario reduces releases below the Baseline Conditions scenario. This reduction in releases is made possible with a 5-schedule index system and the addition of the *Schedule 4* minimum instream flows for the Upper Russian River. This example helps demonstrate the importance of additional flow schedules for maintaining reliable water supply for this event.

Operations for 1977 are very similar for the Baseline Conditions and Proposed Project scenarios because both scenarios are in their driest flow schedule most of the year. *Critical* minimum instream flows for the Upper Russian River (25 cfs) for the Baseline Conditions scenario are equivalent to *Schedule 5* flows for the Proposed Project scenario. The Baseline Conditions scenarios enters into a *Critical* water supply condition on January 1, and the Proposed Project scenario is in a *Schedule 3* for January but transitions to a *Schedule 5* in February and remains at that schedule for the remainder of the water year.

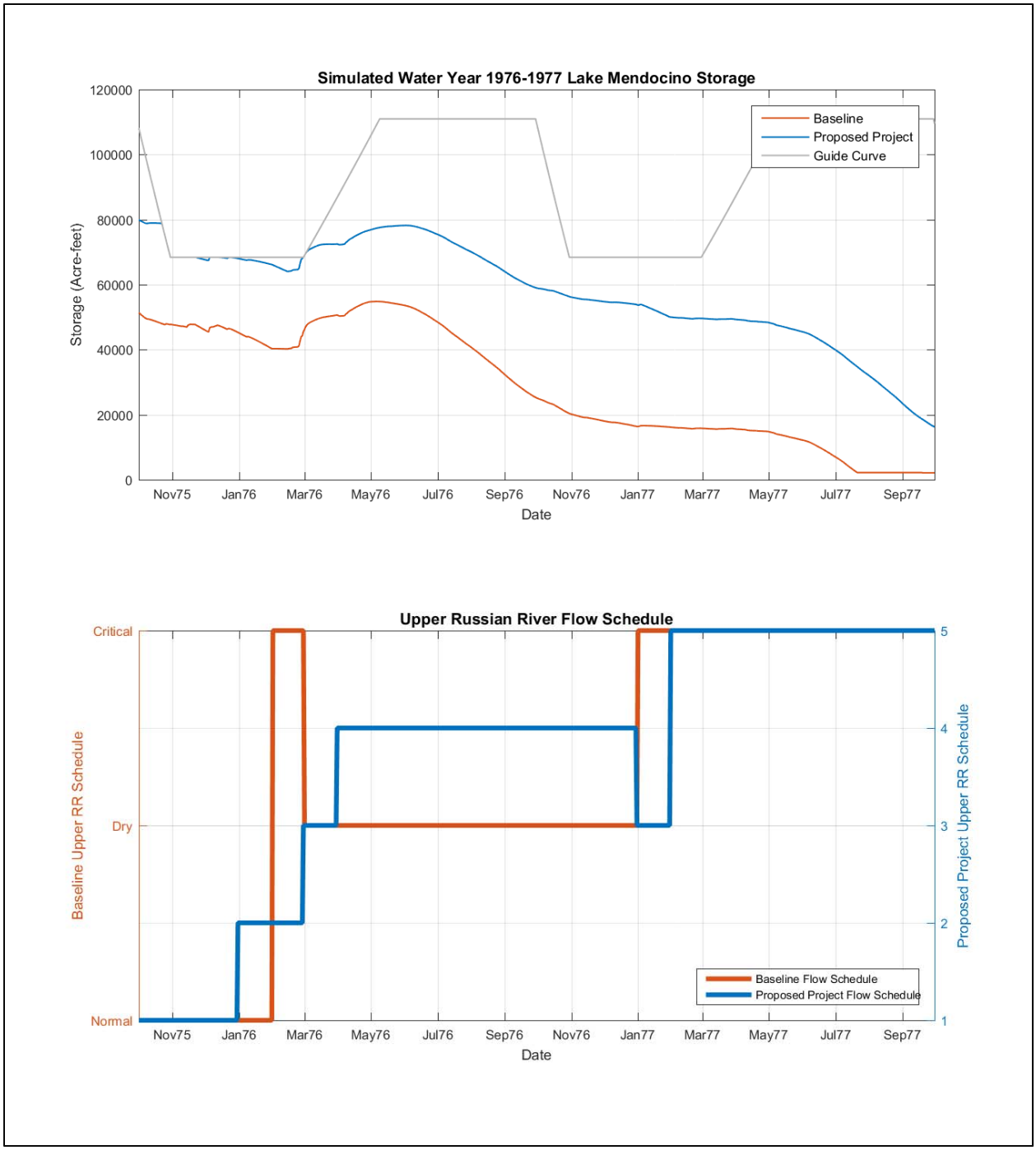

Figure 5-11. Upper Russian River conditions for Water Year 1976 - 1977 for Baseline Conditions scenario and Proposed Project scenario with Lake Mendocino storage (acre-feet) in the upper panel and Upper Russian River Flow Schedule in the lower panel.

5.5.2 Demand Variability

Storage levels in Lake Mendocino are highly a function of inflow into the reservoir. The Inflow Condition of the Russian River Hydrologic Index accounts for inflow variability, but the Storage Condition is a very important component of the proposed index to account for variability in downstream demand. The Reach Depletions Analysis completed by Stephen Grinnell (Grinnell, 2016) found that observed dry season (May-October) reach losses correlate to spring (April-June) precipitation where demand increases with decreasing springtime precipitation. To account for this variability Grinnell developed annual reach loss hydrographs for a wet and dry year types. Year types were determined for the models simulation years through an analysis of observed precipitation. This analysis is further described in (Grinnell S. , 2016). Having this demand variability in the model ensured the Storage Condition thresholds accounted for downstream demand variability consistent with observed variability.

6 Conclusions

The proposed Russian River Hydrologic index provides an improved metric for setting the Flow Schedules for the Russian River System and more accurately reflect current hydrology and water availability. Based on sensitivity analyses, the Russian River Hydrologic Index will improve reliability of the Russian River System over the D1610 Index with respect to: (1) the high occurrence of *Dry* schedule flows for the Upper Russian during periods that are detrimental to salmonid habitat and other beneficial uses; (2) potential changes in PVP transfers from the Eel River; (3) dry spring years; (4) below average fall and early winter precipitation; and (5) uncertainty in downstream demands by Russian River water users. The Russian River Hydrologic Index will provide more stable flow regimes to reaches downstream of Lake Mendocino and Lake Sonoma, which are designed for fishery life stage needs and also will provide dependable releases from Lake Mendocino and Lake Sonoma during extreme drought years.

7 References

Grinnell. (2016). *Sonoma County Water Agency Russian River Operations Model: Synthetic 1 in 100 Year Inflow Development.* Stephen Grinnell.

NMFS. (2008). *Biological Opinion for Water Supply, Flood Control Operations, and Channel Maintenance conducted by the USACE, the SCWA, and the MCRRFCWCID in the Russian River Watershed.* Santa Rosa, California: National Marine Fisheries Service.

SCWA. (2016). *Russian River Hydrologic Modeling for the Fish Habitat Flows and Water Rights Project.* Santa Rosa, California: Sonoma County Water Agency.

SCWA. (August 2016). *Fish Habitat Flows and Water Rights Project Draft Environmental Impact Report.* Santa Rosa, California: Sonoma County Water Agency.

USACE. (1986). *Coyote Valley Dam and Lake Mendocino Russian River, Californina, Water Control Manual.* U.S. Army Corps of Engineers, Sacramento District.

USGS. (2015). *Provisional Simulated Unimpaired Mean Daily Streamflow in the Russian River and Upper Eel River Basins, California, under Historical (1910-2013) and Projected Future (2001-2099) Climates.* U.S. Geologic Survey.

USGS. (2016, June 8). *Streamflow Measurements for California*. Retrieved from National Water Information System: Web Interface: http://waterdata.usgs.gov/ca/nwis/measurements/

(Title Page)

Provisional Simulated Unimpaired Mean Daily Streamflow in the Russian River and Upper Eel River Basins, California, under Historical (1910-2013) and Projected Future (2001-2099) Climates: U.S. Geological Survey Data Release

Prepared in cooperation with the Sonoma County Water Agency

By Lorraine E. Flint, Alan L. Flint, Jennifer A. Curtis, Chris Delaney, and John Mendoza

Citation: Flint, L.E., Flint, A.L., Curtis, J.A., Delaney, C., and Mendoza, J., 2015, Provisional simulated unimpaired mean daily streamflow in the Russian River and Upper Eel River Basins, California, under historical and projected future climates: U.S. Geological Survey Data Release, doi.org/10.5066/F71C1TX4

(Purpose and Scope)

The Sonoma County Water Agency (SCWA) has a need for information regarding ongoing and future changes in streamflow, in order to provide input to revisions of the outdated Decision 1610 issued by the State Water Resources Control Board in 1986. Future streamflow research is necessary so that SCWA can optimize the balance of water needs among instream flows, flood protection, and public water supply on the basis of the most scientifically defensible information that reflects potential future hydrologic conditions. As with most local water agencies throughout the country, the SCWA has a need to plan for water-resource changes that may occur as a result of changing climate or climate variability. This dataset was developed as input to their water management model so they can assess water management and delivery options under various management scenarios and future climate scenarios.

(Introduction)

Water demand and allocation in the Russian River basin for human, agricultural, and ecological benefits is becoming increasingly challenging in the 21st century. Water-resource managers and regulators need tools and datasets to plan for changes in water resources that may result from projected climate change and variability. The purpose of this study was to estimate unimpaired daily flows for the Russian River, California, using the Basin Characterization Model (Flint and others, 2013) that has been revised to a daily timestep and calibrated to historical measured flow and using projections of future climate from Global Climate Models. The dataset was developed in cooperation with SCWA.

The SCWA requires information for long-term water management planning. However, this data release is being provided prior to formal publication of the dataset because SCWA has used the data as input to a reliability study that addresses the vulnerability of water storage in Lake Mendocino (fig. 1) that will be released this spring to the California State Water Resources Control Board (SWRCB). Lake Mendocino is located in the East Fork of the Russian River. Flows from Lake Pillsbury in the Eel River are diverted to the East Fork via the Potter Valley Project and are temporarily stored in Lake Mendocino. Releases from Lake Mendocino sustain spring, summer, and fall flows in the upper Russian River. Depletion of water storage in Lake Mendocino could reduce reservoir releases and affect the quantity and quality of upper Russian River flows. Improved understanding of the hydrologic response to climate is a high priority in the Russian River because of likely more-restrictive limits on diversions, increased populations, updated biological requirements, increasing climate variability, and changing land uses. The SCWA is preparing the reliability study, at the request of the SWRCB, with the goal of optimizing the amount of water allocated for instream flows and public water supply by using the most scientifically defensible information that reflects potential changes in mean daily streamflow under future hydrologic conditions. Long-term uses of the dataset are for input to the SCWA water management model (HEC-RESSIM; Klipsch and Hurst, 2007) to assess various scenarios for water management throughout the basin, including changes in land use, population, climate, and policy.

This data release includes two datasets: (1) a daily time-series of simulated unimpaired streamflow from 1/1/1910 to 12/31/2013 based on historical climate input, and, (2) a daily time-series of simulated unimpaired streamflow from 1/1/2001 to 12/31/2099 for four different future climate scenarios. The

two datasets include simulated flows for a series of node locations representing all of the Russian River's largest tributary basins and four segments of the mainstem.

The unimpaired flows in this dataset were used to develop an understanding of how streamflow responded to changes in historical climate and water demand and for a range of future climate projections. Mean daily unimpaired streamflow was estimated by using a daily water-balance model that was calibrated to historical daily and monthly streamflow; estimates of stream losses owing to agricultural demand; and, regression analyses. These data will support water-resource planning and numerous ongoing flow-ecology and climate-vulnerability studies.

(Methods)

Development of the Russian River mean daily unimpaired flows used a modified version of a published monthly water-balance model (Basin Characterization Model, BCM; Flint and others, 2013), and a series of post-processing steps, to estimate unimpaired streamflow from recharge and runoff calculated by the BCM. The BCM is a regional water-balance model that deterministically calculates how precipitation is converted into infiltration into soils, evapotranspiration, runoff, and percolation (below the root zone) that recharges the groundwater system. Climate inputs, bedrock permeability, and soil properties (fig. 2), all components of the daily water budget, and hydrologic response variables are calculated at a 270-m grid cell resolution. Hydrologic response variables include recharge and runoff that are used to calculate basin discharge, and climatic water deficit (CWD), a variable related to crop water demand that is used in calibration.

Development of Daily Climate Inputs

Downscaled historical climate data were developed by using daily station data and monthly data from the Precipitation-Elevation Regression on Independent Slope Method (PRISM; Daly et al 2008). These data were used with a method that is modified from that described in Flint and Flint (2012) in order to incorporate daily station data (Flint and others, in preparation). Future-climate data were developed by using methods developed and described by Flint and Flint (2012).

Estimating Daily Basin Discharge

In order to develop daily unimpaired flows using a series of calibrations, daily basin discharge was estimated using the BCM for 10 Russian River reaches and 2 Eel River reaches defined by the contributing area upstream from 12 USGS gaging stations (fig. 1; table 1). Daily results for all grid cells upstream of the stream gage were summed to create time series for runoff and recharge. To transform these results into a form that can be compared to the pattern and amount of gaged streamflow, the water balance is conceptualized as consisting of three groundwater reservoirs that are hydraulically connected (Flint and others, 2013). The surface reservoir is responsive to daily storm events and snowmelt. The shallow groundwater reservoir consists of the shallow saturated zone that varies seasonally and provides much of the dry-season baseflow. Following large storm events, the shallow groundwater reservoir can account for much of the recession flow that occurs. The deep groundwater reservoir represents the regional aquifer in most locations and may contribute some flow to the shallow groundwater reservoir over long time frames.

A series of equations describing the various parts of the hydrograph were derived (Flint and others, 2013) to optimize the match between the simulated and measured daily hydrograph for the various seasons when surface flows, shallow flows, and deep flows have proportionally different effects on hydrograph responses. These empirical discharge equations use exponential notation and scaling factors to define recession flows and the system losses to groundwater. For additional details see Flint and others (2013).

Calibration of Daily Streamflow Model

Converting the BCM estimated basin discharge into unimpaired flows was performed in three steps by using measured tributary and mainstem flow data. In the first calibration step, the BCM-calculated monthly flows were calibrated to measured unimpaired flows from the upland tributaries; 11460940 Russian R at Redwood Valley, 11462700 Feliz Creek, 11464860 Warm Springs Cr nr Asti Ca, 11463900 Maacama Cr nr Kellogg Ca, and 11465000 Dry Creek at Warm Springs Dam (fig. 1). During this initial calibration, bedrock permeability (fig. 3) was adjusted iteratively until acceptable relative proportions of recharge and runoff were achieved to provide matches to the monthly hydrographs for these upstream gages (Flint and others, 2013). The resulting bedrock permeability map developed from the first calibration step using the monthly model was then used in the application of the daily BCM measured and estimated flows (fig. 3*A*).

The second calibration step was to develop regression equations to estimate monthly gage-to-gage losses in streamflow related to agricultural demand for each of the 10 Russian River tributary and mainstem reaches. This was done to account for seasonal losses-to-demand in the calibration and to ensure more accurate representation of unimpaired flows during the irrigation season. Regression coefficients were selected iteratively to optimize the match between total simulated and measured streamflow volume at flow nodes. This was done using measured streamflow data and aggregated seasonal volumes to accurately represent flow seasonality (fig.3B). Streamflow loss due to agricultural demand was correlated to CWD, a hydrologic response variable that represents the seasonal soil moisture deficit calculated as potential minus actual evapotranspiration. The correlation between gage-to-gage loss and CWD was used to estimate agricultural demand during the primary irrigation season from May to October and to develop an equation that can be used to estimate streamflow losses due to agricultural demand under future climates. The estimated seasonal loss of streamflow related to agricultural demand was subtracted from the BCM discharge estimates to optimize the match to the measured hydrograph at each stream gage. Total volumes of measured and simulated flows for 1958-2013 matched to within 0.5 percent for each flow node.

In the third calibration step, a conditioning method was developed to optimize the match between simulated and measured streamflow that addressed the lack of fit for both high and low flows (fig. 3C). Unimpaired flows for periods with relatively little agricultural demand, November through April, were empirically estimated and extrapolated to the impaired season, May through October, by using a regression method available in Matlab (Mathworks; Bootstrap AGGregatING ; Aslam and others, 2007). This regression tool correlates the unimpaired-flow error (empirically estimated unimpaired flow minus the BCM unimpaired flow) for each flow location to the estimated BCM unimpaired flows, to reduce the error, bias, and variance between measured and simulated estimates.

Tabulated calibration results are shown for 12 reaches, along with USGS stream gages and overall goodness-of-fit results, in table 1. Goodness-of-fit results are not included for Dry Creek, owing to only having seasonal measurements, or for Mark West, owing to the short period of record. Estimates for these two reaches were developed iteratively in the calibration for the Guerneville reach Goodness-of-

fit for daily flows is generally poor for reaches with dam operations–daily calibration statistics are not applicable at gages below dams because the simulated unimpaired flows are not intended to represent managed flows. However, monthly and annual calibration statistics are appropriate at these gages. Daily peak flows are consistently underestimated by this daily model because of the inability to characterize the localized peak rainfall volumes with few raingages, and because of the inability of the model to represent runoff in response to high intensity, hourly rainfall by using a daily time step. In contrast to daily flows, the monthly volumes are well represented (table 1). Monthly flow volumes represent time periods during which flows are capable of filling surface water reservoirs managed by SCWA, and low flows are reasonably well represented in the mainstem channel reaches.

(Dataset)

Unimpaired Streamflow under Historic Climate

Unimpaired flows are represented as local flows (between flow nodes) in the spreadsheet. These are represented in figures 4-7 as average daily for 1981-2010 in comparison to future mid-century and end-of-century 30-year periods. Data are available as downloads of Excel spreadsheets or space-delimited text files.

Unimpaired Streamflow under Projected Future Climates

The calibrated BCM was used to estimate daily unimpaired streamflow by using four future daily climate projections from the 4th IPCC Assessment (IPCC, 2007). We selected four climate projections capable of simulating the recent historical climate, particularly the distribution of monthly temperatures and the strong seasonal cycle of precipitation that exists in the region (Knowles and Cayan, 2002; Cayan and others, 2008, 2009). The four scenarios include two global climate models (GCMs) and two greenhouse gas emissions scenarios. We selected the Parallel Climate Model (PCM) developed by National Center for Atmospheric Research (NCAR) and Department of Energy (DOE) (Washington and others 2000; Meehl and others, 2003), and the National Oceanic and Atmospheric Administration (NOAA) Geophysical Fluid Dynamics Laboratory CM2.1 model (GFDL) (Delworth and others, 2006; Stouffer and others, 2006). The choice of emissions scenarios included A2 (this scenario represents a continuation of current emission practices, referred to as a “business as usual” scenario) and B1 (this scenario represents mitigated emissions relative to current practices). These climate projections were downscaled and applied to the calibrated BCM. Mean annual hydrographs and cumulative daily streamflow are shown for the historical 30-year period (1981-2010) and mid- and late- century 30-year periods (2040-2069 and 2070-2099) for each projection for the two basins upstream of reservoirs (East Fork and Warm Springs Dam) and for two mainstem gage locations representing upper and lower Russian River basin reaches (Healdsburg, and Guerneville) (figs. 4-7).

(References)

Aslam, J.A. Popa, R.A., and Rivest, R.L., 2007, On estimating the size and confidence of a statistical audit: Proceedings of the Electronic Voting Technology Workshop (EVT '07), Boston, MA.

Cayan, D.R., Maurer, E.P., Dettinger, M.D., Tyree, M., Hayhoe, K., 2008, Climate change scenarios for the California region: Climatic Change 87(Iss 1 Sppl):21– 42. doi 10.1007/s10584–007–9377–6.

Cayan, D.R., Tyree, M., Dettinger, M.D., Hidalgo, H., Das, T., 2009, California climate change scenarios and sea level rise estimates for the California 2008 Climate Change Scenarios Assessment: California Energy Commission Report No. CEC–500–2009– 014–F.

Delworth, T.L. and others, 2006, GFDL's CM2 global coupled climate models. Part 1. Formulation and simulation characteristics: Journal of Climate 19:643–674.

Flint, L.E. and Flint, A.L., 2012, Downscaling climate change scenarios for ecologic applications: Ecological Processes, 1:1.

Flint, L.E., Flint, A.L., Thorne, J.H., and Boynton, R., 2013, Fine-scale hydrologic modeling for regional landscape applications: the California Basin Characterization Model development and performance: Ecol. Processes 2:25.

IPCC, 2007, IPCC Fourth Assessment Report: Climate change 2007; synthesis report. Core writing team, Pachauri, R. K. and Reisinger A. (Eds). International Panel on Climate Change, Geneva Switzerland.

Klipsch, J.D., and Hurst, M.B., 2007, HEC-ResSim Reservoir System Simulation User's Manual Version 3.0: USACE, Davis, CA, 512 p.

Knowles, N. and Cayan, D., 2002, Potential effects of global warming on the Sacramento–San Joaquin watershed and the San Francisco Estuary:, Geophysical Research Letters 29(18):1891. doi:10.1029/2001GL014339.

Meehl, G.A., Washington, W.M., Wigley, T.M.L., Arblaster, J.M., and Dai, A., 2003, Solar and greenhouse gas forcing and climate response in the twentieth century: Journal of Climate 16(3):426–444.

Stouffer, R.J. and others, 2006, GFDL's CM2 global coupled climate models. Part 4. Idealized climate response: Journal of Climate 19:723–740.

Washington, W.M., Weatherly, J.W., Meehl, G.A., Semtner, A.J., Bettge, T.W., Craig, A.P., Strand, W.G., Arblaster, J., Wayland, V.B., James, R., and Zhang, Y., 2000, Parallel climate model (PCM) control and transient simulations: Climate Dynamics 16:755–774.

Sonoma County Water Agency Russian River Operations Model:

Streamflow Depletion Time Series Development

AUGUST 2016

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1 INTRODUCTION

The Sonoma County Water Agency (SCWA) has developed a water balance/operations model (Model) to simulate the hydrology of the Russian River from Lake Mendocino to Jenner and Dry Creek from Lake Sonoma to the Russian River confluence. The model is coded using the United States Army Corps of Engineers ResSim modeling platform. Unimpaired inflows used in the modeled system have been developed by the United States Geological Survey (USGS). Along with inflow hydrology and system operational rules, direct and indirect diversions and depletions of streamflow need to be developed to account for streamflow losses that are known through direct measurement, or are not directly measured but can be determined through indirect methods. Streamflow losses in excess of measured diversions have been observed indirectly through calculation of stream reach water balances. This technical report documents the methods and data used to compile the complete set of stream depletions and documents the results that are used as inputs to the model.

1.1 System Overview

The Russian River watershed model encompasses from Lake Mendocino to Jenner for the Russian River and from Lake Sonoma to the confluence with the Russian River on Dry Creek (a tributary of the Russian River). **Figure 1** (following page) is a map of the area covered by the model with key nodes identified. The Model is coded using the US Army Corps of Engineers ResSim modeling platform. Unimpaired inflows (watershed runoff) to the modeled system within the Russian River watershed have been developed by the USGS and are used as one of the datasets in this analysis. The Model nodes that have local inflows assigned to them are designated with a green arrow in figure 1. USGS prepared the inflow hydrology for the period January 1910 to September 2013, excluding the Potter Valley Project inflows which were derived from a separate model of that system. **Table 1** lists the inflow node locations for the USGS local inflows in the Model and the Potter Valley inflow, and the average annual inflow volume for each inflow location for the water year based period of record of 1911 to 2013 (1910 is not a complete water year in the datasets).

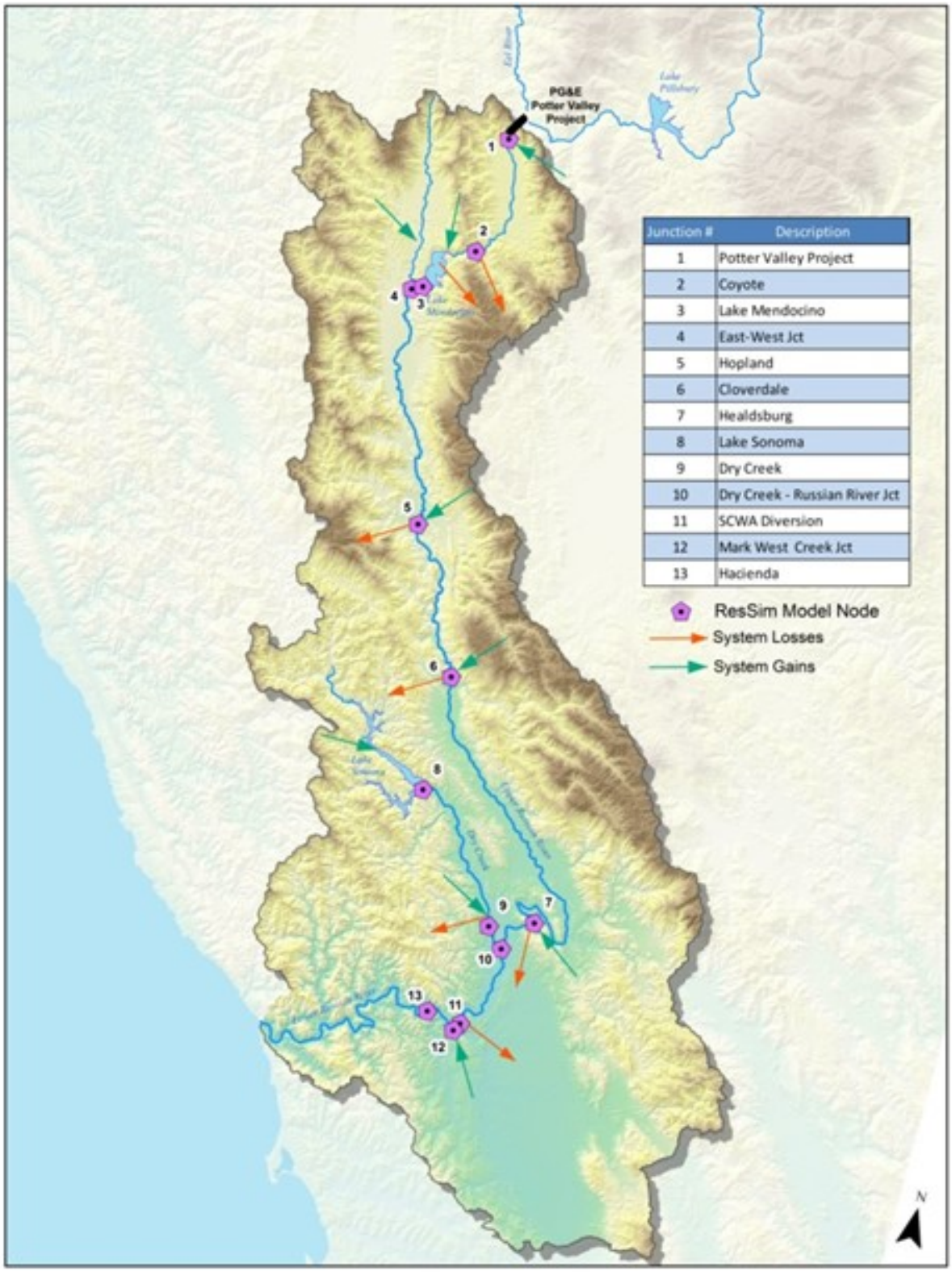

Figure 1: Russian River Watershed with Modeled Inflow Locations

Table 1: Model Local Inflow Nodes Average Annual Inflow Volume (acre-ft)

Watershed/Inflow	Junction # in Figure 1	Average Annual Inflow Volume (AF)
DRY CREEK	9/10*	109,107
GUERNEVILLE	11	96,505
LAKE SONOMA	8	182,076
MARK WEST	12	192,601
CLOVERDALE	6	159,295
HEALDSBURG	7	324,824
HOPLAND	5	144,057
LAKE MENDOCINO	3	106,998
POTTER VALLEY	1	83,758
WEST FORK	4	114,908
TOTAL ALL INFLOWS		**1,514,129**

**Dry Creek inflow is split with a portion of the inflow assigned to below Lake Sonoma and a portion assigned to the Dry Creek confluence with the Russian River*

The Model uses mean daily flows for inflows, and runs on a daily time step. The hydrology for the inflow record of 1910 to 2013 has varied greatly. The total average annual inflow for the entire watershed excluding inflow from the Potter Valley Project is 1,430,371 acre-ft, and has ranged from a low in 1977 of 69,781 acre-ft, which is less than 5% of the annual average, to a high of 3,535,036 acre-ft in 1983, almost 250% of the annual average. The entire watershed excluding imports of the Potter Valley Project is rainfall runoff driven and does not produce significant base flow in the mid to late summer in all but the wettest years. **Figure 2** is a graph of the monthly average inflow volume for the entire watershed excluding the Potter Valley Project imports. The figure shows that almost all of the inflow occurs in the months of December through March, with lesser amounts in the shoulder months of November, April and May and essentially no inflow from June through October. Later in this report the shift in this pattern in dry years will be discussed.

1.2 Analysis Objective

The objective of the work described in this report is to develop a time series of nodal diversions and reach depletions that quantify the total stream system losses represented in the model. System water losses includes all water that is removed from the system and include natural processes (e.g. riparian vegetation, evapotranspiration, and surface-groundwater interactions) and human uses such as diversions made for domestic, municipal/industrial (M&I), and agricultural purposes. The model accounts for system losses at seven geographic points in the Russian River. System loss locations in the model are shown as orange arrows provided in Figure 1. System losses accounted for in the Model include Municipal and Industrial (M&I) diversions, agricultural diversions, riparian vegetation, lake evaporation and water balance calculated losses.

The primary focus of the analytical work was developing nodal time series for reach depletions that are not directly measured and which require analysis to determine daily amounts of streamflow loss. Examination of stream gage data demonstrates that reach losses in the late spring, summer and early fall are greater than the amounts quantified by measured depletions. Diversions through

various in-river or near river facilities that are assumed to directly divert river flow or underflow are measured by various water purveyors. However, stream gage data show that a significant amount of streamflow is lost due to undetermined causes, but are assumed to be either direct depletion through diversion of streamflow, diversion of underflow, or indirect stream depletion due to stream-aquifer interaction. Because the cumulative effect of these unmeasured stream diversions and depletions have a substantial impact on SCWA reservoir operations at both Warms Springs Dam on Dry Creek and at Coyote Dam on the Russian River, quantification of these stream losses are needed to complete a calibrated, valid watershed and reservoir operations model.

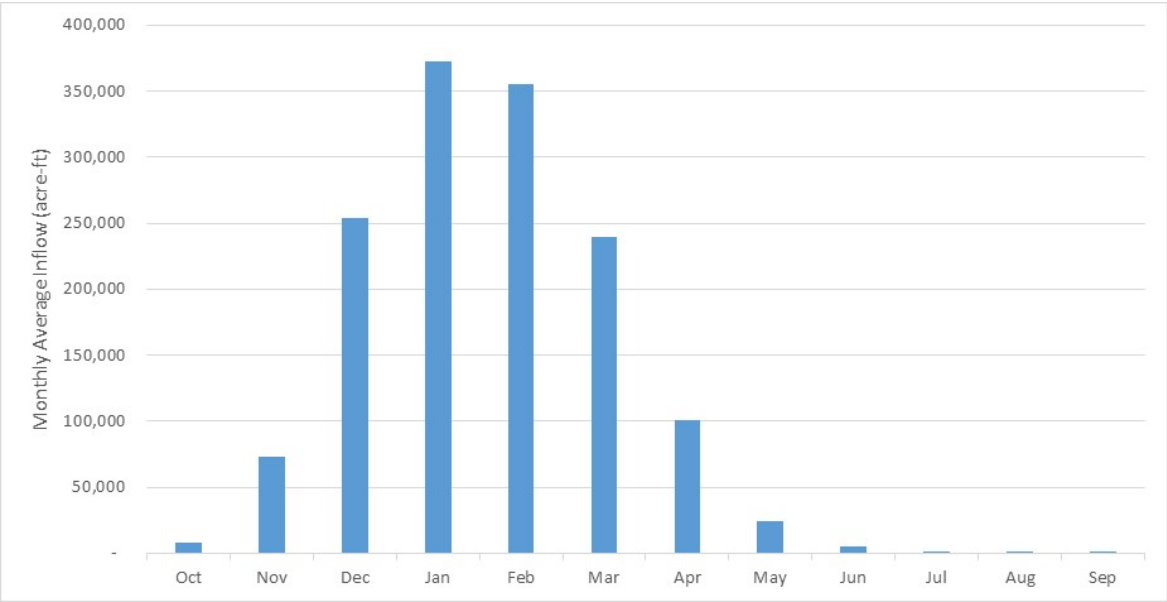

Figure 2: Monthly Average Inflow Volume for the Russian River Watershed (acre-ft)

2 METHODOLOGY

The basic steps completed in the analysis for determining reach depletions consisted of the following (each step is described in more detail in the following sections);

1. Assemble available known metered depletions, consisting mostly of wells near the river
2. Assemble agricultural water demands using a land use based methodology for agricultural activities within the river corridor that are assumed to deplete streamflow
3. Assemble USGS stream gage mean daily flow data for locations along the river corresponding to the node points that connect each reach in the analysis
4. Calculate a monthly water balance for each reach for the period of analysis
5. Establish a dry and wet year type classification and identify each year of the period of record for year type for applying different loss time series for each node
6. Determine representative dry year and wet year monthly volumes of reach losses from the results of step 4.

7. Select representative dry year and wet year daily loss patterns for each reach and adjust the daily pattern volumes so that the resulting monthly volumes of each adjusted pattern equals the monthly volumes of calculated nodal loss for representative dry and wet years in step 5. The results of this step are a set of dry year daily losses for each reach and a set of wet year daily losses for each reach.
8. For each year of the period of simulation of 1911 to 2013 for each reach (nodal loss) create an annual repeating pattern time series of dry and wet year losses using the results of step 6.

The land use based agricultural water demands that have been quantified by Davids Engineering (described in section 2.2.1) generally are less than the calculated reach water balance losses (minus known municipal water demands for the relevant reach). The May through October water balance loss that is in excess of known municipal and estimated agricultural losses is classified for this analysis as an additional agricultural water demand loss of stream flow. The results of the analysis provide a set of loss time series that are confirmed through the use of measured streamflow data. This method ensures that the stream depletions that affect operations for all system demands including water supply and instream flows are grounded in measured stream conditions through the use of historical stream gage data.

Unless otherwise specifically identified, when describing a reach, the reach name is taken from the name of the downstream node of the reach as used in the ResSim model.

2.1 Municipal Water Demands

Water demands for municipal and industrial water use were established for the nine public water systems that have water supplies composed of surface water and groundwater wells in the alluvial aquifer along the river corridor. Other than the City of Healdsburg which receives a portion of its water from Dry Creek, the systems use water available along the mainstem corridor in the Upper Russian River watershed. Based on annual Public Water System Statistics (PWSS) reports submitted to California Department of Water Resources (DWR), the total service population for these systems is approximately 55,000. The City of Ukiah serves the largest population with 16,000 persons. Overall, the Upper Russian River watershed has an estimated population of 55,706 based on data from the 2010 U.S. Census.

For the upper Russian River from Ukiah to Healdsburg municipal demands were aggregated by affected reach and were included in the reach loss time series. **Table 2** provides a listing of current annual water demands for these systems quantified by affected reach and used in the analysis of reach losses. For the lower Russian River below Healdsburg and for Dry Creek, the municipal system demands are established as separate diversion time series at the appropriate model node. These separate time series of municipal demands are; Russian River County Water District, City of Windsor, City of Healdsburg (Dry Creek wells and Fitch Mountain wells as separate series) and SCWA Wohler-Mirabel observed diversions. The approach to compiling these datasets as input time series of diversions are described below.

Table 2: Reach Aggregated Municipal Demands

Model Node (downstream of affected reach)	**Municipal System Annual Water Production (**acre-ft per year)
Hopland	5,837
Cloverdale	308
Healdsburg	3147

The lower Russian River diversions of City of Windsor, City of Healdsburg at Dry Creek wells, City of Healdsburg at and Fitch Mountain wells and SCWA Wohler-Mirabel diversions are metered and recorded daily. The Russian River County Water District diversions were compiled as a monthly time series. An examination of historical diversion trends and patterns was done for the SCWA Wohler-Mirabel diversions to determine the appropriate time period to use as a basis for calculating representative diversions for all of the of the lower Russian River M&I diversions in the model. M&I diversions in the lower Russian River area are characterized by a build-up in the 1990's and peaking in the early 2000's before conservation efforts had a significant impact on diversion volumes in the mid to late 2000's. Prior to 2007, SCWA annual diversion volumes were often above 60,000 acre-ft. Diversion volumes trended downward from 2007-2008 and later. Because of the downward trend in diversion volumes due to conservation efforts, only the most recent years are applicable to current day diversion rates and volumes. For the modeled M&I diversion of the lower Russian River the 2009 to 2014 period was selected to characterize current diversions. **Figure 3** is a plot of the annual SCWA Wohler-Mirabel diversion volumes for 2005 to 2014 with lines for the 2005 to 2014 annual average of 54,100 acre-ft and the 2009 to 2014 annual average of 51,400 acre-ft. The daily values for 2009 through 2014 are averaged to obtain the daily time series of diversions for each of the M&I purveyors of the City of Windsor, City of Healdsburg at Dry Creek wells, City of Healdsburg at and Fitch Mountain wells and SCWA Wohler-Mirabel diversions. For Russian River County Water District diversions monthly values calculated as constant daily rates by month we determined by averaging the monthly volumes for the years 2009 through 2014.

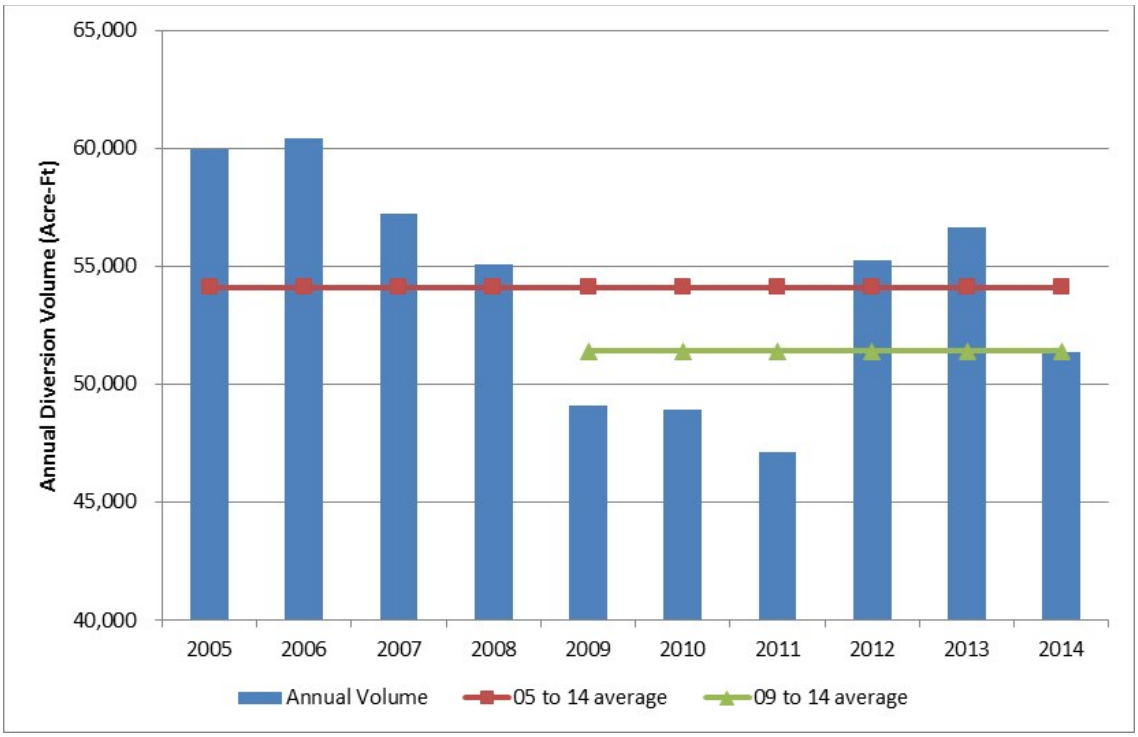

Figure 3: SCWA Wohler-Mirabel Annual Diversion Volumes for 2005 to 2014 with 2005 to 2014 and 2009 to 2014 Annual Averages

2.2 Agricultural Water Demands

2.2.1 Agricultural Applied Water Estimates

Measured agricultural diversion data is generally not available for the study area. Agricultural diversions were estimated through land used based methods in an analysis completed for the SCWA in 2013 by Davids Engineering (Davids Engineering, 2013). In this study, estimates of historical irrigation demands were developed using an agricultural irrigation demand model and a soil moisture accounting model.

Estimates of daily applied water and riparian vegetation losses were developed by estimating total daily crop evapotranspiration (ET). Daily total crop ET was calculated for different crop types using unique crop coefficients derived from a 2008 analysis of actual ET (ETa), based on the Surface Energy Balance Algorithm for Land (SEBAL®) model, coupled with quality-controlled reference ET (ETo) data from the California Irrigation Management Information System (CIMIS).

The Soil-Water-Atmosphere-Plant (SWAP) model was used to calculate a daily root zone water balance and estimate applied water depths from 2002 to 2008 for agricultural fields and within the Applied Water Analysis Zone (AWAZ). The AWAZ represents the area within which diversion or consumption of water is either known or presumed to have immediate effects on Russian River flows. The analysis and results of the agricultural water demands affecting stream flow are further described in Davids Engineering 2013.

2.2.2 Water Balance Losses

The need for a water balance estimate of stream losses in the Russian River is demonstrated by the fact that known municipal system demands and agricultural applied water estimates alone do not explain the amount of streamflow loss that occurs for the upper Russian River reaches from Ukiah to Healdsburg and on Dry Creek. The water balance of a stream reach is defined as the known inflows minus the known outflows. The known inflows are the stream reach upstream node gaged flow and local runoff inflow. The know outflows are the reach downstream node gaged flow, municipal system demands (e.g. well records) and the agricultural applied water estimates for the AWAZ that affect the reach. The local runoff flows are the nodal unimpaired flows determined by the USGS as part of their work to develop the Model hydrology data set. This data is more fully discussed in SCWA 2016.

The unimpaired flow for most reaches typically diminishes to low or no flow conditions by early to mid-May in dry years and June in wetter years. During the wet season unimpaired flows are large and the magnitude of these flows are significantly greater than the magnitude of losses. Because of these differences, gage error and unimpaired flow estimation error can be significant compared with the magnitude of losses and obscure a reliable calculation of water balance derived losses. Additionally, in the springtime of wetter years, agricultural water use is very low so that corresponding stream losses are also low making water balance loss calculations unreliable. For these reasons, water balance losses are only calculated for the months of May through October for use in the loss time series.

An example of the data and analysis methodology for the water balance loss calculation can be seen in the following. **Figure 4** is a plot of components of the water balance for the Hopland reach for 2002. The plot shows the gross water balance from the reach gages, which are the downstream gage USGS 11462500 Russian River Near Hopland mean daily flow minus the upstream gage flows at USGS 11461000 Russian River Near Ukiah (which measures West Fork Russian River flow), minus the mean daily release from Lake Mendocino (which measures East Fork Russian River flow). The plot also includes the local inflow at Hopland from the USGS inflow dataset, the agricultural applied water estimate, plotted as a negative flow and the municipal system demand plotted as a negative flow. The plot shows that in April and May the water balance tracks the local flow, and then in June the water balance loss increases and is substantially more negative than the agricultural applied water estimate.

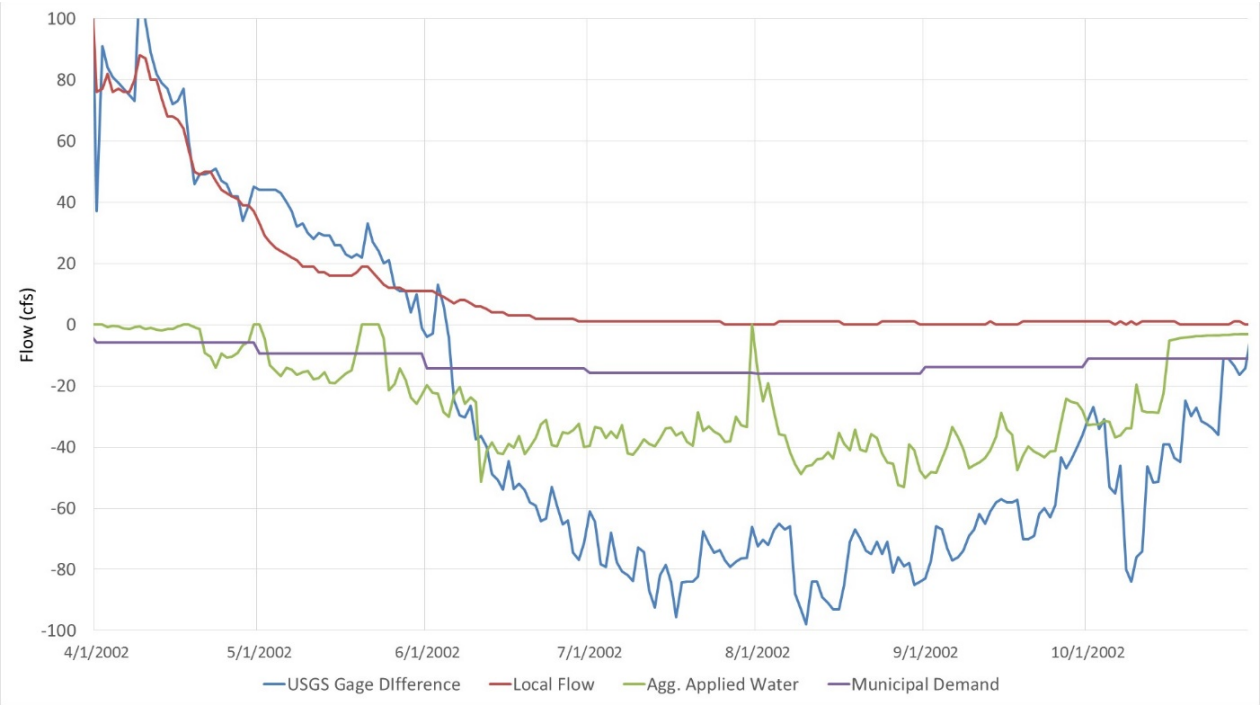

Figure 4: USGS Gage Difference, Local Flow Agricultural Applied Water Estimate and Municipal System Demand for the Hopland Reach for April through October 2002

To show a clearer picture of the relative magnitude of the known losses versus the total water balance loss **Figure 5** plots these two calculated quantities which are the combination of the data shown in Figure 3.

The known losses in figure 4 are the agricultural applied water estimate plus the municipal system demand plotted as negative numbers and the total water balance loss is the USGS gage difference (downstream minus upstream) minus the local flow. The plot shows that for May the total water balance is slightly positive, suggesting that gage error or the local flow estimate is not capturing all of the local flow that is occurring at this time. For July and August, the total water balance loss is greater than the know depletions for agricultural and municipal uses, showing that more stream loss is occurring than is quantified by the know losses. For portions of these months the total water balance loss is more than 20 cfs greater than the know losses. The plot demonstrates the need to quantify the unknown losses than can only be estimated through a water balance of the stream reaches.

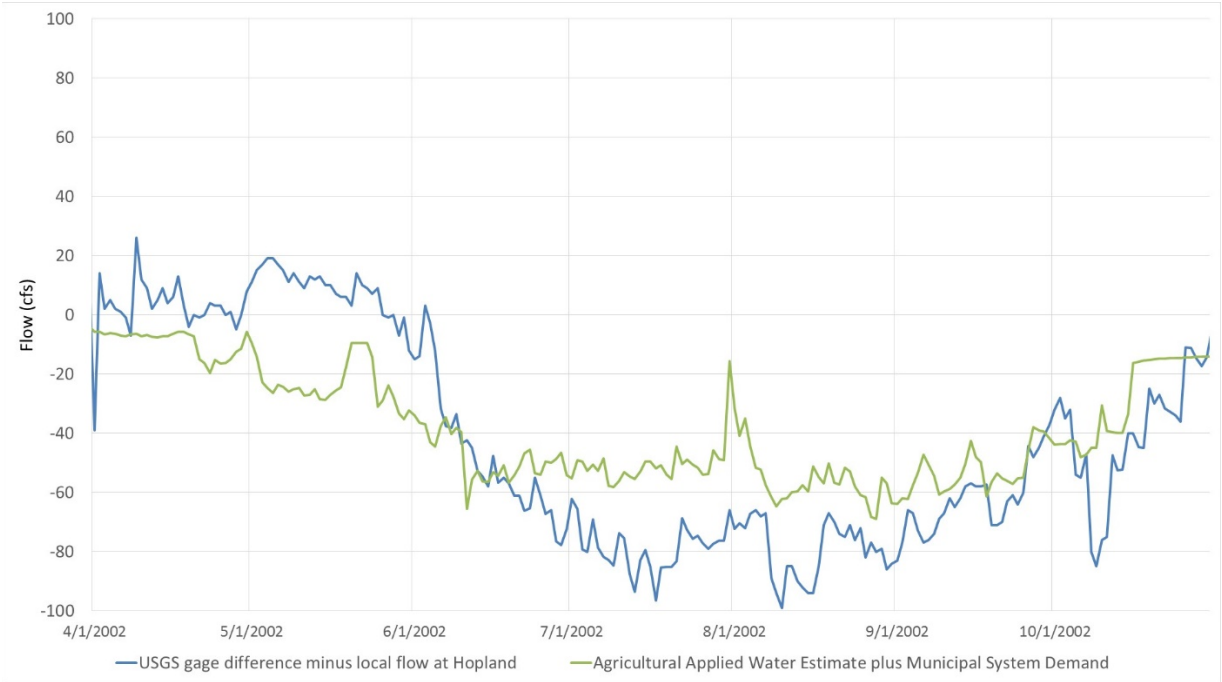

Figure 5: USGS Gage Difference minus Local Flow versus Agricultural Applied Water Estimate plus Municipal System Demand (as negatives) for the Hopland Reach April through October 2002

A water balance analysis of all stream reaches was completed for the period 2002 to 2013 for the months May through October to estimate the total observed loss for each reach in the system. This analysis incorporated multiple datasets including observed upstream and downstream flows, estimated reach gains (local flows) as quantified by the unimpaired flows, known reach losses for M&I, estimated diversions from agriculture as estimated by Davids Engineering, and estimated losses from riparian vegetation. The total water balance loss for a reach is the result of subtracting the gage record of an upstream reach from a downstream reach and subtracting the local inflows that contribute to that reach. The net water balance loss is the total water balance loss that cannot be accounted for from observed M&I diversions, estimated agricultural diversions and estimated losses to riparian vegetation. Although water balance losses cannot be directly accounted for by observed direct diversions from the river, for this study it is assumed that the net water balance loss is the result of the cumulative impact of water being pumped from groundwater wells or diverted from tributaries.

For application of the AWAZ losses to reach losses applied at model nodes, two methods were used. For the Jenner Reach where losses are applied at model node “Hacienda”, the daily AWAZ applied water estimates developed by Davids Engineering for the period 2002 to 2008 were averaged into a single time series. These demands were then combined with the municipal demands for this reach to obtain a total reach loss. No water balance losses were calculated for this reach because no consistent pattern of water balance reach loss could be identified. For the model reaches of Hopland, Cloverdale and Healdsburg on the upper river and for Dry Creek, the agricultural applied water estimate losses for the AWAZ were combined with the municipal system demands and with the net water balance losses to determine a total nodal loss time series. As discussed in more detail in the following sections, water balance losses were only determined for

May through October. For the months of November through April only the agricultural applied water estimate losses and known municipal system demands were included in the nodal loss time series, and these were developed as average monthly rates.

For the upper Russian River nodes of Hopland, Cloverdale and Healdsburg, the AWAZ applied water estimates were first used to determine if a net water balance loss was present. If the calculation of net water balance loss results in a monthly loss (i.e. greater than zero) for the months of May to October then the AWAZ applied water estimate is included with the net water balance loss, which also includes any applicable municipal demand. If a net water balance loss is not identified (i.e. less than zero), then the total loss for that month for that reach is the sum of the AWAZ applied water estimate and any municipal demand complied for that reach only.

2.2.3 Water Loss Due to Frost Protection

Flow losses due to diversions made by agricultural producers for the protection of crops from frost damage were estimated through an analysis of observed flow depletions at USGS discharge gages during the periods March 15 to May 15 for the years 2004, 2007, and 2008. A number of frost events were analyzed for each gage using 15-minute interval flow data.

A complete observed flow record for the entire model period of simulation is not available to directly analyze frost protection depletions. In order to develop datasets of loss due to frost protection practices for use in the model, an analysis of daily minimum temperatures was completed for observed historical climate. For historical climate minimum daily temperature data was analyzed from different National Weather Service weather stations in the Russian River basin. These stations include the Ukiah Station, Ukiah Airport Station, Cloverdale Station, Healdsburg Station, and the Santa Rosa Airport Station. Collectively these stations provide a continuous record of minimum daily temperature for the entire historical simulation period (1910-2013) for the study area. The result is a times series of daily frost protection based losses for the following reaches; 1) Calpella (applied at Coyote), 2) Hopland, 3) Coverdale, 4) Healdsburg and 5) Dry Creek. The water losses due to frost protection agricultural activities for the five locations listed above are added to the nodal loss time series for inclusion in the model. The analysis and results of water loss due to frost protection is further detailed in SCWA 2016.

2.3 Water Loss Year Types

Examination of the calculated total water balance losses show a pattern of increased losses in the springtime and early summer resulting in increased annual losses for years when springtime precipitation was low. Conversely, in wet springtime years either no water balance loss could be detected in the spring months of May and sometimes June, or lower total annual loss volumes were observed. The nodal loss time series are derived from the average of multiple years. Because streamflow conditions in drier hydrologic years are important for the examination of system operations, it was determined that quantification of the increased loss amounts in dry years was needed to approximate the greater demand on the Russian River water supply system when runoff volumes are low and the system is stressed. Therefore, the nodal loss time series were separately calculated for dry and wet precipitation springtime years based on springtime precipitation patterns.

2.3.1 Precipitation Patterns

A historical analysis of observed system loss for the upper river from 1970 to 2013 was completed to identify patterns in system loss versus springtime precipitation. Results of this analysis indicate that springtime precipitation (April to June) for the upper Russian River appears to correlate with total basin dry season loss (June to October). Precipitation data from the National Weather Service National Climate Data Center for Ukiah, Cloverdale Healdsburg and Guerneville weather stations was examined. Additionally, this analysis indicates that there are envelopes of demand consistent with wet and dry year types. **Figure 6** provides a summary of this analysis with scatter plot of springtime precipitations versus dry season losses for the more recent period of 1990 to 2008 where dry season losses decrease with increasing springtime precipitation. The plot includes a linearly interpolated trend line and boxed areas showing the envelopes of system loss representing wet and dry year types. A graphical approach was used to identify the basic relationship of springtime precipitation and dry season losses.

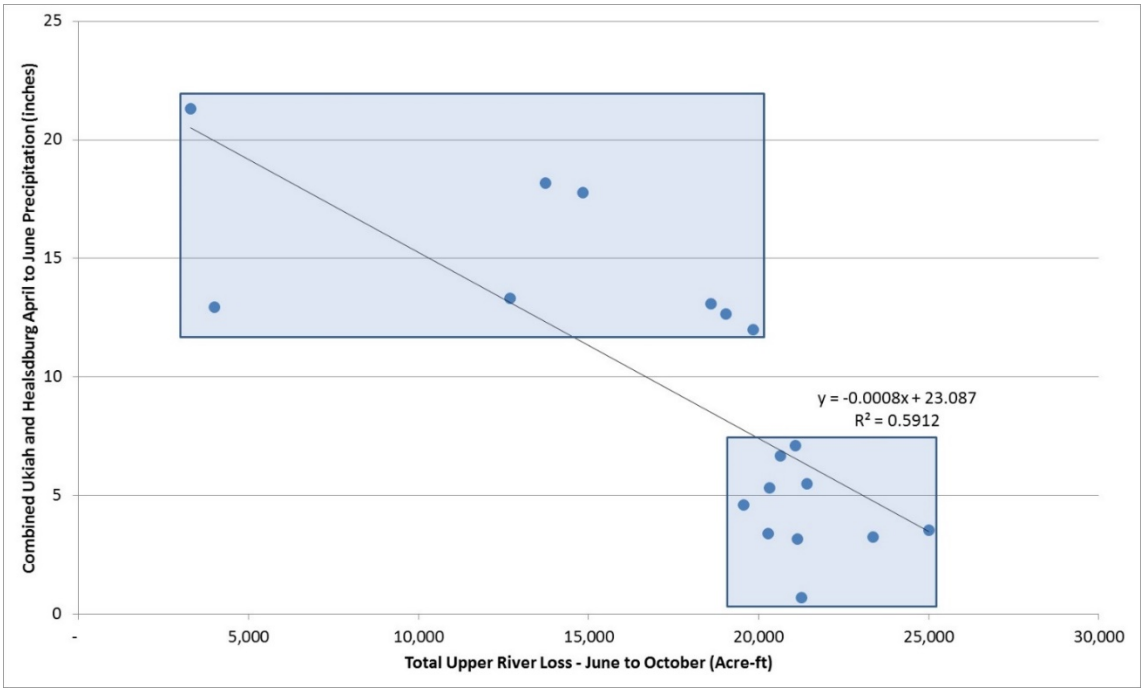

Figure 6: Combined Ukiah and Healdsburg April to June Precipitation versus Total Upper River Loss - June to October

2.3.2 Representative Rain Gaging Data

Rain gage data for four sites, Ukiah, Cloverdale Healdsburg and Guerneville were compiled for a range of individual and mutable station spring month volumes and compared with total June through October water balance losses for the upper Russian River reaches. Graphical and linear regression methods were used to identify relationships between the precipitation and water balance loss data sets. The best correlation of springtime precipitation and water balance loss is the total April, May and June precipitation volume for the combined Ukiah and Healdsburg rain gages versus June to October total upper Russian River water balance losses.

2.3.3 Dry and Wet Year Determination for Period of Record

The purpose of identifying dry years as they relate to water balance loss volume is to ensure that higher loss rates of low spring precipitation years are applied to the system in years which also have low runoff. Although low runoff volumes for a year are directly related to low precipitation, annual loss volumes are more closely tied to low spring precipitation. A clear example of the direct relationship of spring precipitation versus water balance loss but counter to annual runoff volume is 1997. 1997 had very large annual runoff due to the new year's flood of that year, but then experienced a dry spring. The June to October water balance loss for the upper Russian River for that year was 20,321 acre-ft, 30% more than the average loss.

A threshold value for April to June combined Ukiah and Healdsburg precipitation of 9 inches was selected as the metric for designating years as dry or wet. The threshold of 9 inches of combined Ukiah plus Healdsburg precipitation results with 70 of 104 years as dry. **Table 3** lists the years corresponding water loss year type for the model simulation period of record.

Table 3: Water Loss Year Types for Model Period of Record 1910 to 2013

Year	Type	Year	Type	Year	Type	Year	Type	Year	Type	Year	Type
1910	DRY	1930	DRY	1950	DRY	1970	DRY	1990	WET	2010	WET
1911	DRY	1931	DRY	1951	DRY	1971	DRY	1991	DRY	2011	DRY
1912	WET	1932	DRY	1952	DRY	1972	DRY	1992	DRY	2012	DRY
1913	WET	1933	DRY	1953	WET	1973	DRY	1993	WET	2013	DRY
1914	DRY	1934	DRY	1954	WET	1974	DRY	1994	DRY		
1915	WET	1935	WET	1955	WET	1975	DRY	1995	WET		
1916	DRY	1936	WET	1956	DRY	1976	DRY	1996	WET		
1917	DRY	1937	DRY	1957	WET	1977	DRY	1997	DRY		
1918	DRY	1938	DRY	1958	WET	1978	WET	1998	DRY		
1919	DRY	1939	DRY	1959	DRY	1979	DRY	1999	DRY		
1920	WET	1940	DRY	1960	DRY	1980	DRY	2000	WET		
1921	DRY	1941	WET	1961	DRY	1981	DRY	2001	DRY		
1922	DRY	1942	WET	1962	DRY	1982	WET	2002	DRY		
1923	WET	1943	DRY	1963	WET	1983	WET	2003	WET		
1924	DRY	1944	WET	1964	DRY	1984	DRY	2004	DRY		
1925	WET	1945	DRY	1965	WET	1985	DRY	2005	WET		
1926	WET	1946	DRY	1966	DRY	1986	DRY	2006	WET		
1927	WET	1947	DRY	1967	WET	1987	DRY	2007	DRY		
1928	DRY	1948	WET	1968	DRY	1988	DRY	2008	DRY		
1929	DRY	1949	DRY	1969	DRY	1989	DRY	2009	DRY		

2.4 Compilation of Reach Loss Time Series

The compilation of a loss time series for most of the model reaches, which is applied to the downstream node of the corresponding reach in the model, consisted of determining two sets of monthly loss volumes for each reach, one for dry years and one for wet years and then selecting a representative daily loss pattern from the calculated reach daily water balance losses, and adjusting the pattern so that the monthly volume of the pattern losses equaled the compiled dry and wet year

monthly loss volumes. For three reaches this approach was not used. Summer water balance losses could not be detected for the Russian River reaches from Healdsburg to Dry Creek, from Dry Creek to Hacienda, and from Hacienda to Jenner. Therefore, only municipal demands and AWAZ agricultural applied water estimated losses were identified for these reaches. The following sections describe the use of daily loss patterns adjusted to calculated monthly loss volumes to determine the nodal loss time series for the model for the remaining model reaches.

2.4.1 Daily Loss Patterns

One of the significant factors affecting operation of the Russian River water supply system is the daily variation in flow due to highly varying losses downstream of the release points of Coyote and Warm Springs dams, and the operations to adjust releases to ensure compliance with required instream flows at downstream control points. Development of a daily loss pattern that is taken from observed gage data provides a more realistic model simulation of the river system, the change in depletions from day to day and operations to adjust to this daily varying loss of river flow. In addition, with the differentiation of dry and wet years for loss volumes, separate dry and wet year daily loss patterns where also developed. **Figure 7** is an example of the calculated water balance loss for the Healdsburg reach for June through October 2008 that shows that streamflow depletions vary significantly from day to day. For this time period and reach, the maximum day to day change in loss is 15 cfs. When Lake Mendocino releases are being made to comply with the Healdsburg required minimum instream flow, the daily reach loss variation of the Hopland, Cloverdale and Healdsburg reaches can combine to more than 30 cfs of day to day variation in stream loss.

For wet years for the Cloverdale and Healdsburg reaches, the net water balance loss calculation (total calculated water balance loss minus known municipal system demands and AWAZ agricultural applied water estimates) did not provide meaningful results. Because these reaches did not have water balance based loss volumes which are derived from daily stream gage records, no water balance based daily loss patterns could be determined. Therefore, for these two reached for wet years, the losses are the monthly volumes of municipal system demands plus the AWAZ agricultural applied water estimates computed as uniform daily flow loss rate values for each month.

Figure 7: Total Calculated Daily Mean Water Balance Loss for the Healdsburg Reach June to October 2008

An example of a dry year loss pattern is shown in **Figure 8** which is the pattern for the Healdsburg reach. The dry year loss pattern for the Healdsburg reach utilizes an average of water balance losses for the years 2002, 2004, 2007 and 2008. Figure 7 shows the dry year loss pattern for the Healdsburg reach for May to October. As stated above, a final step in the development of the time series is to adjust the pattern so that the volume of the daily loss for each month equals the volume calculated for dry years in the monthly volume analysis. The pattern shown have not been adjusted for monthly loss volume.

Figure 8: Dry Year Loss Pattern for the Healdsburg Reach May to October

2.4.2 Monthly Loss Volumes

The daily loss patterns explain the day to day variability of stream losses, but without some volumetric adjustment the daily patterns could not be applied to each reach for the period of simulation and accurately represent the water supply demands that stream losses put on the system. The monthly loss volumes provide the water supply demands that support a water balance operations model which reasonably simulates stream conditions and water supply operations. The monthly loss volumes are comprised of three components, the AWAZ agricultural applied water estimates, the municipal system demands, and the unknown stream losses that are calculated using the water balance methods described in Section 2.2.2. The analysis of monthly loss volumes included the years 2002 through 2008 for the agricultural applied water estimates and 2002 through 2013 water balance loss. The municipal system demands used in the monthly loss volumes where a water balance calculation is used are the average of the period 2009 to 2013 to provide a more recent estimate of municipal water uses that affect stream flow than would be quantified with the use of earlier years. The use of 2009 to 2013 also provides a basis for estimating future municipal system demand scenarios by applying factors to the 2009 to 2013 average demand to account for growth as well as conservation efforts. The individual municipal system demands for the lower river, which are described in Section 3.1.4 were compiled using 2009 to 2014 data to capture the water demands of 2014, a very dry, recent year.

For some months the results of the water balance calculation were clear outliers due to factors such as late runoff of local flow that obscures the losses in some months of some years, as well as loss results that show stream gains rather than losses. For these months, changes and adjustments from the methods described in the previous sections were used for some of the calculations. These changes and adjustments are described in the follow sections that address specific reaches.

3 REACH SUMMARY AND RESULTS

3.1 Reach Loss Time Series Compilation

For all of the time series including the results of the water balance analysis and compilation of municipal system demand time series and agricultural applied water estimates, an additional step is needed to expand those series to the full period of simulation of 1910 to 2013. To complete this expansion of single year series for dry and wet years to the full period an Excel based tool was created to automate this process. The time series builder tool uses the year types as shown in Section 2.3.3 to apply the corresponding dry and wet series of nodal losses to the appropriate year type. In addition, the tool modifies the nodal loss time series to account for the frost protection losses described in Section 2.2.3. The results of the tool are output to an HEC .dss file that can be used in the Model.

The following sections describe the specific calculations and results of reach losses.

3.1.1 Calpella Losses

The Calpella reach losses are applied at model node “Coyote” and include Potter Valley Irrigation District diversions quantified through the water balance calculation. Unlike the upper Russian River reaches which used a daily pattern that was adjusted to monthly volumes of loss, these reach losses were directly calculated by averaging separate dry year and wet year daily water balance results. The dry year water balance loss time series is the average of daily values for years 2002, 04, 07, 08, 11, 12 and 13 for the months of May through October. The wet year water balance loss time series is the average of daily values for years 2003, 05, 06, and 10 for the months June through October. The Calpella Reach water balance is calculated by subtracting the USGS 11461500 East Fork Russian River near Calpella gage (downstream node outflow) from the Potter Valley Project diversions from the Eel River (upstream node inflow) plus the local flow as determined from the USGS runoff model. The water balance which is determined by subtracting downstream node flow from upstream node plus local flow, results in a positive value for stream loss, which is the correct sign for inclusion in the model as a nodal diversion. **Figure 9** is the daily loss time series for dry and wet years for the Calpella Reach. **Figure 10** is the monthly loss volumes for dry and wet years for the Calpella reach.

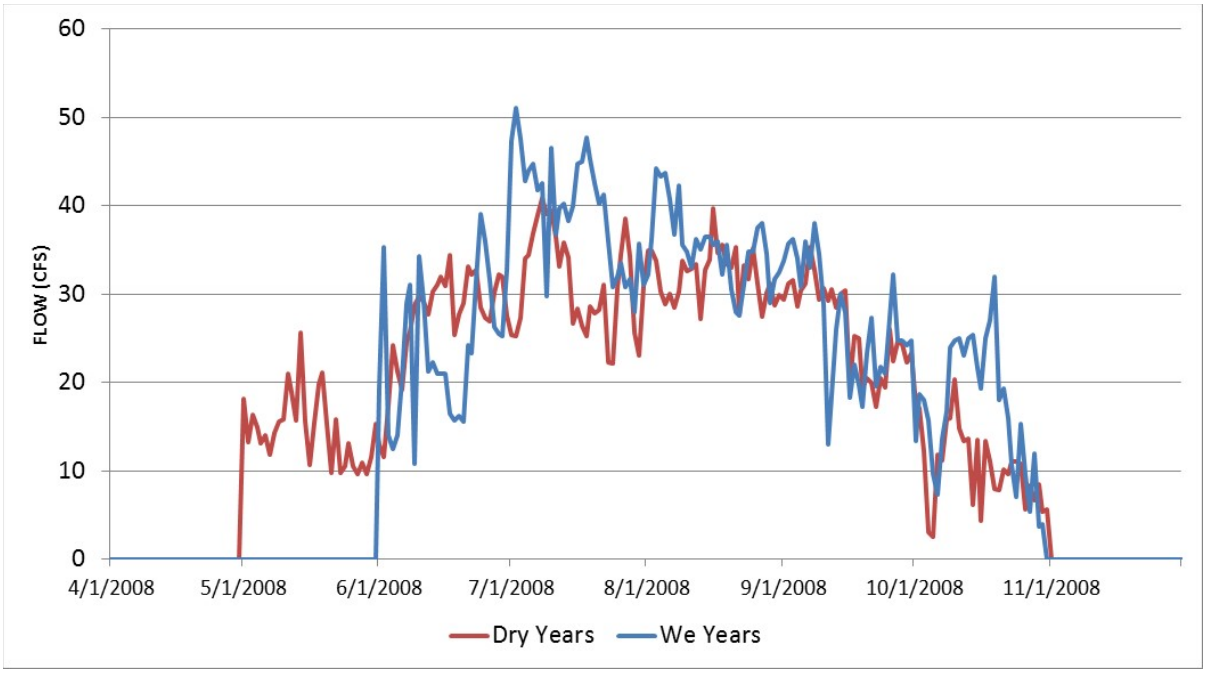

Figure 9: Calpella Reach Daily Loss Time Series for Dry and Wet Years

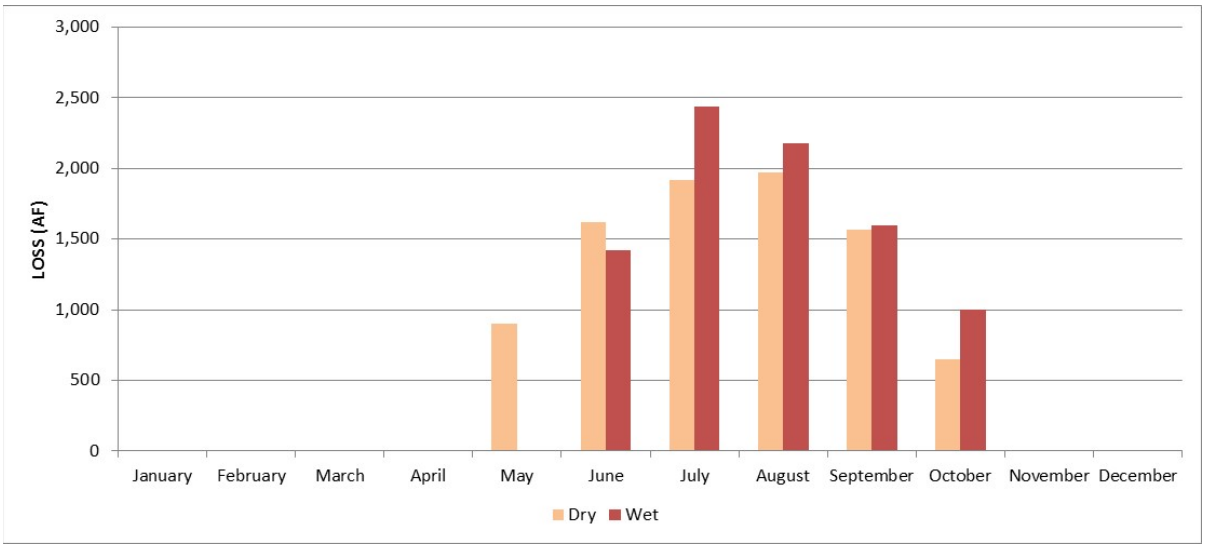

Figure 10: Calpella Reach Monthly Loss Volumes for Dry and Wet Years (acre-ft)

3.1.2 Upper Russian River Reach Losses

Losses for the Hopland, Cloverdale and Healdsburg reaches were calculated using the identical method. The general form of the method used has been described in sections 2.1 and 2.2. Due to irregular results of the water balance calculation for the month of May, a replacement value is used for this month that is the ratio of the May agricultural applied water estimate to the total June through October agricultural applied water estimate times the June through October net water balance loss (i.e. total water balance loss minus municipal and agricultural losses). The rational for this replacement is that the magnitude of water balance loss is linearly related to the agricultural water use. The monthly loss volumes for dry and wet years for the Hopland, Cloverdale and

Healdsburg reaches are shown in **Figures 11, 12 and 13** respectively. The months of May through October include the water balance loss volumes while the months of January through April, November and December are the agricultural applied water estimates plus municipal system demands and do not include water balance amounts.

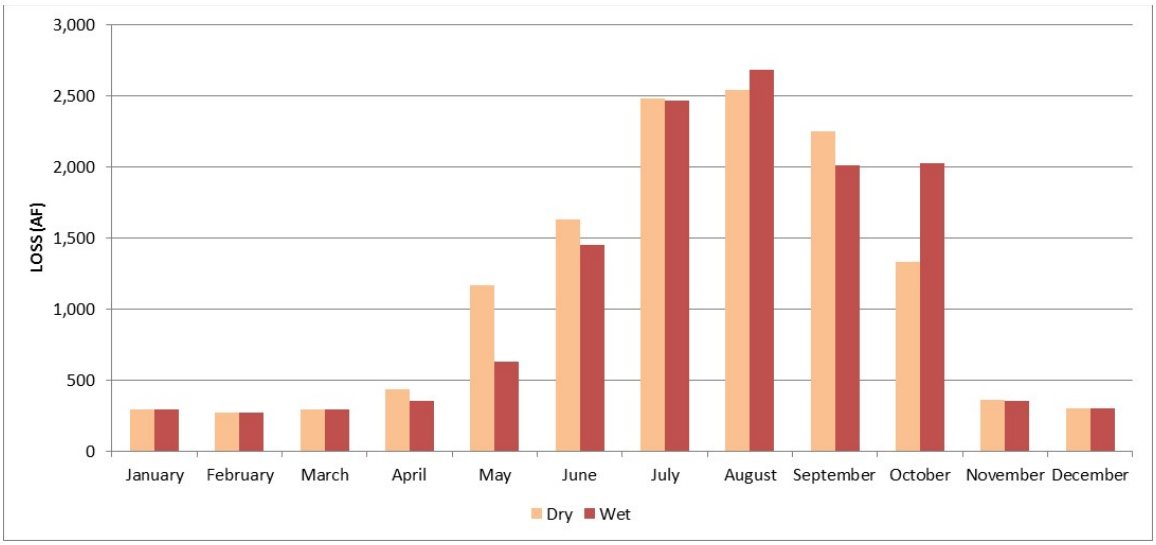

Figure 11: Hopland Reach Monthly Loss Volumes for Dry and Wet Years (acre-ft)

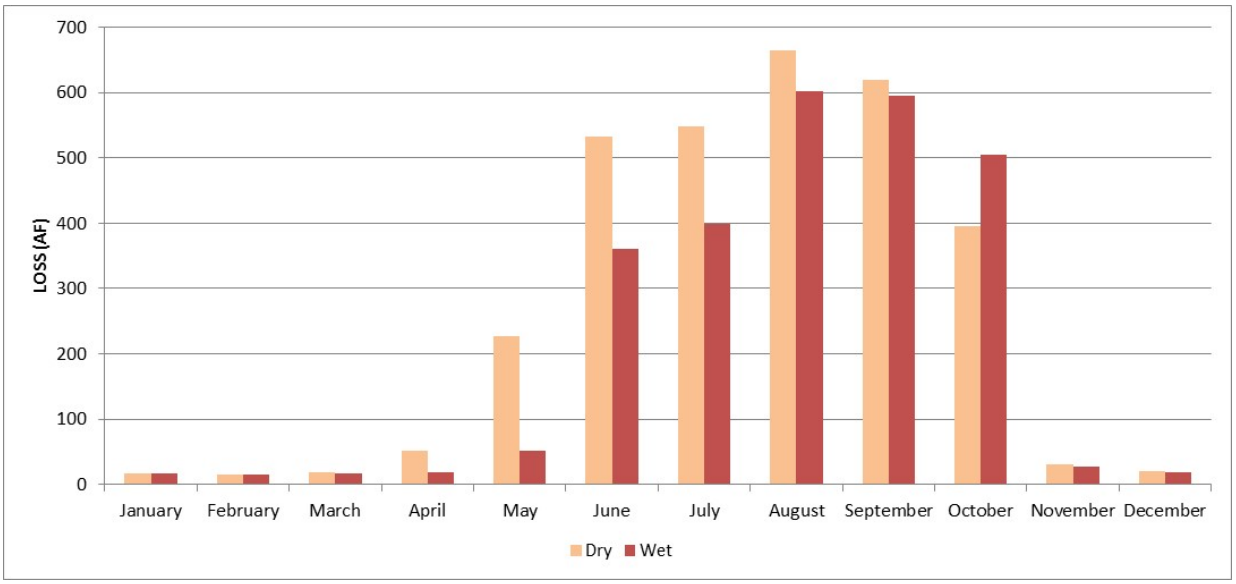

Figure 12: Cloverdale Reach Monthly Loss Volumes for Dry and Wet Years (acre-ft)

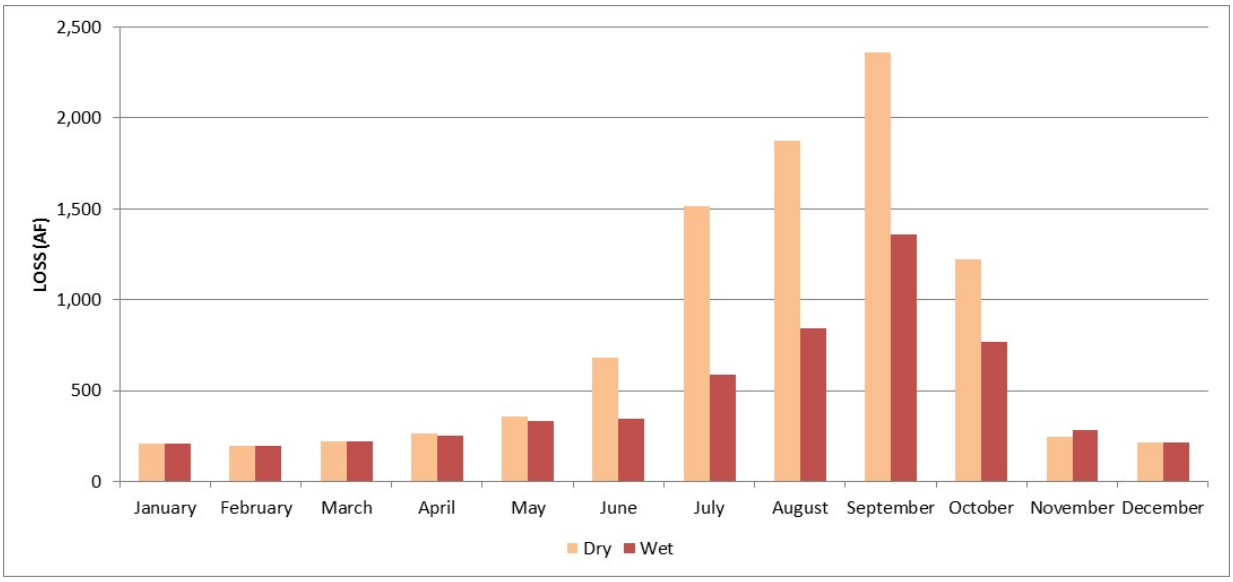

Figure 13: Healdsburg Reach Monthly Loss Volumes for Dry and Wet Years (acre-ft)

3.1.3 Dry Creek Reach Losses

Losses in the Dry Creek reach from Warm Spring Dam to the confluence with the Russian River consist of an agricultural applied water estimate and a water balance calculated loss. The municipal system demand that affects Dry Creek flow, the City of Healdsburg Dry Creek wells, are provided for model input as a separate time series of daily values that are an average of 2009 to 2014 daily well production readings.

The Dry Creek reach monthly loss volumes are a combination of the dry and wet year averages for the period of 2002 to 2008 for the agricultural applied water estimate and 2002 to 2013 for the water balance loss. Agricultural applied water estimates are included for the months of April to November, while water balance losses are for the months of May through October. The total annual dry and wet year loss volumes are 4,363 acre-ft and 4,468 acre-ft respectively. **Figure 14** is a plot of the monthly loss volumes for dry and wet years for the Dry Creek reach.

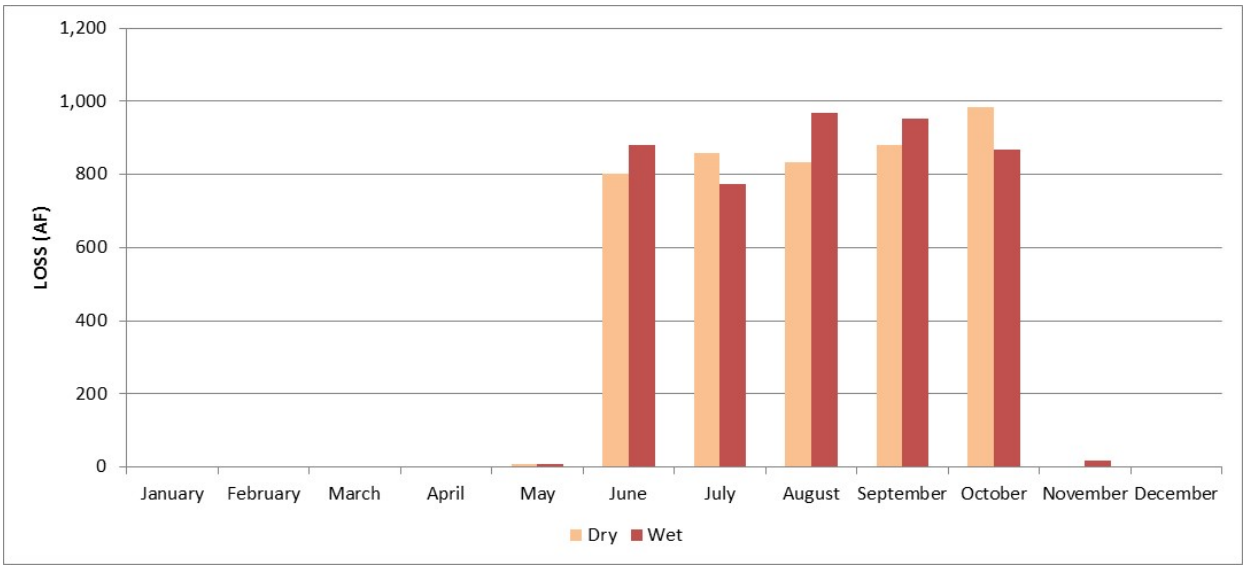

Figure 14: Dry Creek Reach Monthly Loss Volumes for Dry and Wet Years (acre-ft)

3.1.4 Lower Russian River Reach Losses

The Lower Russian River consists of the river reaches below Healdsburg to Jenner. This portion of the Russian River has a more complex hydrology for calculating a water balance than the upper portion of the river above Healdsburg and most of the losses in this reach can be explained by known losses. As seen in **Figure 15**, a plot of the total water balance for the reach from the Dry Creek confluence to Hacienda, losses for the period of May through October 2007 (shown as a positive amount) are mostly explained by the municipal system demands which is shown as a red line. The agricultural applied water estimate for this reach is an additional loss of about 15 to 25 cfs, which when added to the municipal demand would equal or exceed the total water balance loss. Therefore, the losses for this reach do not include a water balance loss.

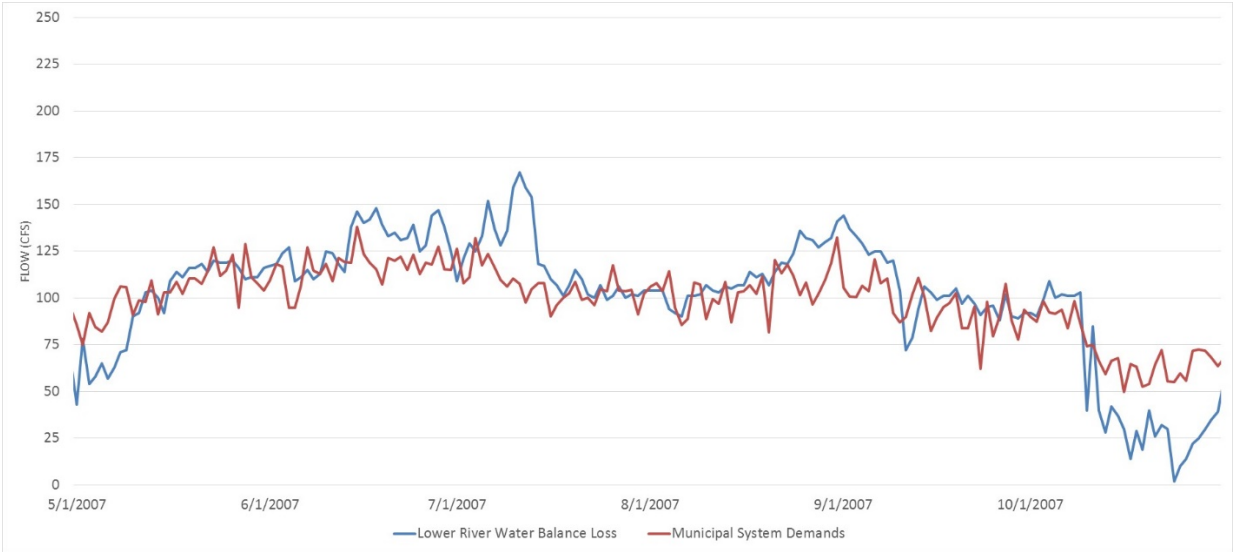

Figure 15: Dry Creek to Hacienda Reach Total Water Balance Loss versus Municipal System Demands for May to October 2007

The Dry Creek to Hacienda Reach (Hacienda Node) losses are the following;

- SCWA Wohler-Mirabel
- Russian River County Water District
- City of Windsor
- City of Healdsburg Fitch Mountain Wells
- Hacienda Agricultural Applied Water Estimates

For the four municipal system demands the time series is calculated using the average daily diversion amounts for the period of 2009 to 2014.

3.2 Total Simulated Losses

The Russian River ResSim model nodal loss time series consist of six dry years and six wet years of nodal time series and six nodal time series that are applied to both dry and wet years resulting in twelve nodal loss time series for each year. **Table 4** lists the monthly volumes of dry year losses, wet year losses, losses that apply to all years and then total system losses (excluding model calculated reservoir surface evaporation) for dry and wet years. The table listing shows a total system loss in dry years of 99,079 acre-ft and a wet year loss of 93,118. **Figure 16** is a plot of the dry and wet year monthly total losses.

Table 4: Monthly System Losses applied to Dry Years, Wet Years, All Years and Totals

	DRY YEARS	WET YEARS	ALL YEARS	DRY YEAR TOTAL	WET YEAR TOTAL
January	521	521	3,891	4,412	4,412
February	476	476	3,666	4,142	4,142
March	531	529	3,866	4,396	4,395
April	754	619	4,156	4,910	4,775
May	2,700	1,046	5,466	8,166	6,512
June	5,269	4,470	5,657	10,926	10,127
July	7,854	6,668	6,210	14,064	12,878
August	9,170	7,924	6,010	15,181	13,934
September	8,718	7,209	5,623	14,340	12,831
October	4,851	5,388	4,829	9,680	10,217
November	653	690	3,825	4,478	4,514
December	536	533	3,848	4,384	4,381
Annual	**42,034**	**36,072**	**57,046**	**99,079**	**93,118**

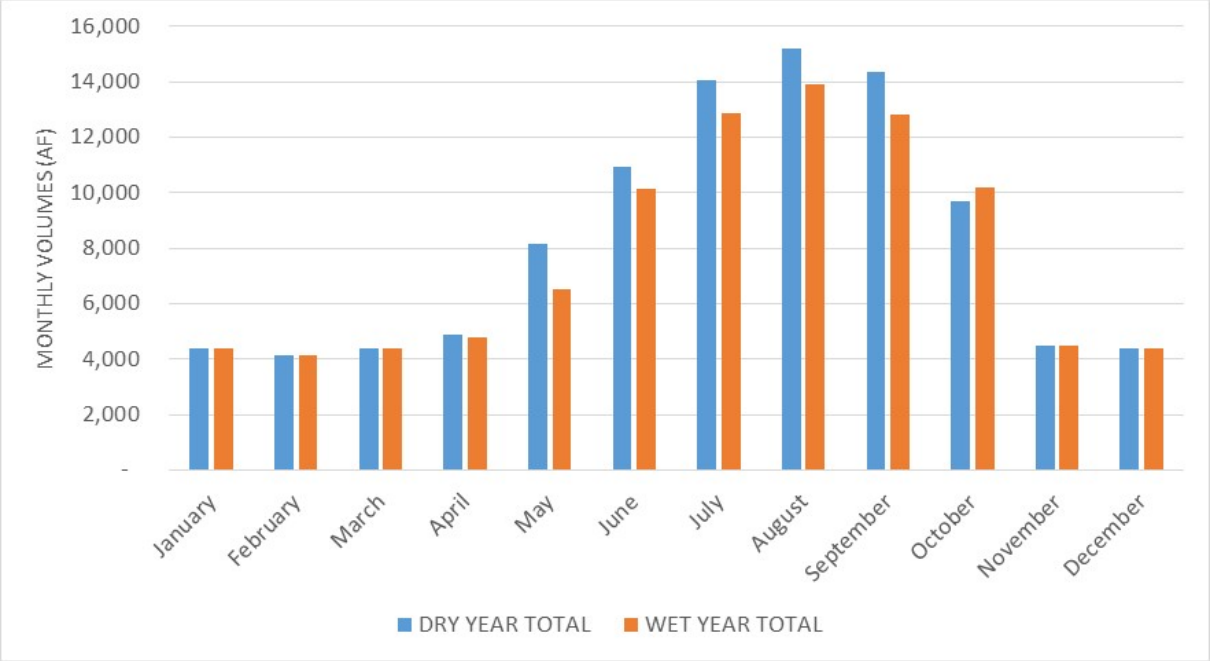

Figure 16: Dry and Wet Year Total Monthly System Losses (acre-ft)

4 REFERENCES

Davids Engineering 2013. “Russian River Applied Water Estimates”, David Engineering, March 2013

SCWA 2016. "Russian River Hydrologic Modeling for the Fish Habitat Flow and Water Right Project", Sonoma County Water Agency, July 2016

Russian River

Applied Water Estimates

Development Report

Prepared for

Sonoma County Water Agency

March 2013

Prepared by

DAVIDS ENGINEERING, INC

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Executive Summary

Introduction

Sonoma County Water Agency (SCWA, or Agency) supplies water to eight cities and special districts, which, in turn, provide municipal water supplies to about 600,000 residents in Sonoma and Marin Counties. The Agency commissioned development of agricultural applied water estimates for incorporation into the Russian River ResSim Model to account for unmetered agricultural diversions explicitly rather than as a component of system loss. The Russian River ResSim model supports the Agency's reservoir and river operations and is being used to formulate and evaluate proposed changes to Decision D-1610, according to a water rights petition filed with the State Water Resources Control Board (Water Board). Incorporating applied water estimates into the Russian River ResSim model supports improved river operations by narrowing the loss estimate to only those flow components that cannot be otherwise measured or estimated.

Applied Water Estimates

Estimates of historical irrigation diversions were developed using an agricultural irrigation demand model and a soil moisture accounting model. The assumption made was that irrigation application efficiency is 100 percent, so that irrigation diversions are the same as estimated applied water. This assumption is reasonable given the fact that essentially all irrigation water is applied by drip systems and that vineyards are aggressively deficit irrigated, so that deep percolation of applied water is negligible. By implication, it was assumed that all water applied for irrigation is consumed and that return flows can therefore be ignored.

Estimates of daily applied water were developed by first estimating total daily crop evapotranspiration (ET). This was accomplished utilizing the land use mapping completed by the SCWA to identify the crop at the agricultural field scale. Then, the portions of the total daily ET that were supplied from applied irrigation water and from precipitation stored in the root zone, respectively, were estimated. The analysis was performed for subareas (or zones) within the Russian River Basin defined by unique combinations of crop, soil and climatic conditions. The analysis was performed for 2002 through 2008 because land use records from this period are considered to be reliable.

Within each zone, daily total crop ET was calculated for different crop types using unique crop coefficients derived from a 2008 analysis of actual ET (ET_a), based on the Surface Energy Balance Algorithm for Land (SEBAL®) model, coupled with quality-controlled reference ET (ET_o) data from the California Irrigation Management Information System (CIMIS). The dominant crop throughout the basin is wine grapes.

The Soil-Water-Atmosphere-Plant[1] (SWAP) root zone model was used to calculate a daily root zone water balance so that total ET could be parsed into the portions derived from stored precipitation and from applied irrigation water. The SWAP model was configured uniquely for each combination of crop, soil and climatic conditions.

[1] The SWAP model is a public domain model that has been thoroughly tested, peer-reviewed and documented, and is well adapted to mechanistic modeling over a wide range of conditions (Kroes, et al., 2008).

Recent literature was reviewed and interviews were conducted with vineyard irrigation management experts and wine grape growers to serve as a basis for parameterizing the SWAP model. Studies with published average applied water values for crops in Mendocino County and Sonoma County were found in the literature. One grower interviewed confirmed that the published average applied water values found in the reviewed literature for Sonoma County were approximately equal to his average applied water values over a wide range of wine grape varietals and soil types. However, the wide variation in growing conditions and ultimate use of the wine grapes results in significant variability in applied water among individual vineyards.

Applied water depths for vineyards and orchards estimated using the SWAP model with SEBAL-derived actual crop coefficients (K_{cs}) were calibrated to within 10 percent of average reported values. Only a single measurement of applied water for pasture was found in the literature review and this value was significantly higher than the modeled applied water results. However, the area in pasture is small compared to vineyard and orchard areas and has been decreasing. Because there is generally little or no rain during the growing season and regulated deficit irrigation is practiced to maintain a desired stress level on the grapes, the total annual applied water volume is strongly dependent on the irrigation start date. The SWAP calibrated model ET_a was within accepted error bounds, averaging four percent less and ranging from one to six percent less than the SEBAL ET_a for February 1 through October 15, 2008 (Table ES.1).

Applied Water Analysis Zone

By definition, the Applied Water Analysis Zone (AWAZ) represents the area within which diversion or consumption of water is either known or presumed to have immediate effects on Russian River or Dry Creek flows. The AWAZ includes all agricultural fields known to have surface water diversions and fields where groundwater pumping from the alluvium is believed to have immediate or nearly immediate effects on stream flow. Information on Russian River diversion points from eWRIMS together with information on agricultural fields developed by SCWA was used to define the AWAZ.

The AWAZ confines the analysis of applied water to a specific area within the Russian River watershed where diversions are known to occur and the impacts on Russian River and Dry Creek surface water flows are direct. The timing and precise impact on Russian River and Dry Creek surface water flows of groundwater pumping to areas outside the AWAZ are less certain.

Water balance studies completed by others indicate that additional Russian River flow depletions occur beyond those caused by estimated surface water diversions within the AWAZ. One such study (Grinnell, 2013) of gaged reaches of the mainstem of the Russian River and Dry Creek downstream of Warm Springs Dam estimated total reach losses by using observed discharge data collected by the U.S. Geological Survey (USGS), records of pumping from municipal and industrial diverters, estimated unimpaired flow data developed by the USGS, and the applied water estimates described in this report. The study found that total reach losses typically exceed applied water estimates from the AWAZ for the months June through October. Additional work is needed to determine the causes of these additional depletions.

Stream Corridor Vegetation ET

Stream corridor (or riparian) vegetation along the Russian River and Dry Creek also consumes water from the river. ET by stream corridor vegetation was estimated based on the same SEBAL analysis conducted for irrigated agricultural crops. The stream corridor vegetation area was delineated by visual interpretation and digitization of the observed boundaries in recent aerial photos that were collected for the Russian River Geographic Information System (GIS). This area represents a total of approximately 6,018 acres within the Russian River watershed.

Table ES.1. Comparison of SWAP Calibrated Model Results to Applied Water Estimates and SEBAL ET_a for the February 1 Through October 15, 2008, Time Period

Model Run	Calibration Applied Water Depth (af/ac)	Area Weighted Average SWAP Applied Water Depth (af/ac)	SWAP Applied Water Depth (af/ac)	Difference	Average SEBAL ET_a, inches	SWAP ET_a ($Kcs*ET_o$) inches	Difference
vinehi1	0.61	0.66	0.67	8%	22.1	21.93	-1%
vinelo1			0.62		18.2	17.96	-1%
vinehi2	0.4	0.39	0.35	-2%	20.2	19.6	-3%
vinelo2			0.30		19.5	18.91	-3%
vinehi3			0.55		24.1	23.18	-4%
vinelo3			0.33		20.2	18.91	-6%
pasthilo1*	3.31*	2.35	2.35	-29%*	32	31.36	-2%
pasthi2&3			1.84		24.5	23.73	-3%
pastlo2&3			1.34		17.9	17.2	-4%
orchhilo1	2.31	2.48	2.48	7%	37	36.42	-2%
orchhilo2&3	1.82	1.83	1.83	1%	22.7	21.42	-6%

*Only one reported volume of applied water was found for comparison.

The process of developing stream corridor ET estimates involved intersecting the delineated stream corridor vegetation boundaries with the climate zones to get stream corridor acreage by climate zone, and then multiplying the acreages by water use coefficients (K_{cs}) derived from the 2008 SEBAL analysis.

Conclusions

Applied water estimates were prepared for the AWAZ, an area along the Russian River and Dry Creek defined by fields whose irrigation diversions are known to have immediate or nearly immediate effects on Russian River and Dry Creek flows. The applied water estimates were calculated by multiplying crop acreages by crop-specific ET_a estimates derived from the SEBAL energy balance model applied to Landsat satellite images. The applied water estimates were

corroborated through interviews with local experts and growers. Stream Corridor Vegetation ET was also estimated based on ET_a estimates from the SEBAL model. Water balance studies completed by others indicated that more Russian River depletion was occurring than was accounted for by applied water estimates within the AWAZ and Stream Corridor Vegetation ET combined. The applied water estimates for the AWAZ have been incorporated in the Russian River ResSim operations model. Studies to bring about additional future improvements are in the planning stage.

Recommendations

The following recommendations are expected to result in further improvement of applied water estimates.

Recommendation 1: Validate Applied Water Estimates

SCWA should validate the calculated estimates of applied water through comparisons to measured values. This would involve compiling all available reported irrigation diversions for 2002 through 2008, linking the data to a water using area, reviewing this data for completeness and performing an accuracy assessment. Based on the accuracy assessment, some reported diversions may be removed from the reported diversion data set. Once the reported diversion data set is finalized, the reported diversions will be compared with estimates of applied water for the areas corresponding with the reported diversion data set. As reported irrigation diversions become available, a combined data set of reported diversions and applied water estimates should be used with ResSim. The reported data set is expected to increase and its accuracy improve with time.

Recommendation 2: Refine Delineation of the Applied Water Analysis Zone

As noted earlier, evaluation of reach water balances performed by others indicates that Russian River and Dry Creek stream flow depletions typically exceed the applied water estimates within the currently defined AWAZ during the months of June through October. The pattern of stream flow depletions suggests that irrigation diversions (including groundwater pumping) outside of the currently defined AWAZ are also causing these depletions. Expanding the AWAZ successively to include additional agricultural fields, so that the pattern of observed stream flow depletion more closely follows a typical pattern of loss due to seepage would improve the separation of losses from unmetered diversions and improve confidence in projections of how losses might change with future changes in land use and climate.

1 Introduction

Sonoma County Water Agency (SCWA, or Agency) was created as a special district in 1949 by the California Legislature to act as the local sponsor for federal flood protection and water supply facilities known collectively as the Russian River Project. SCWA supplies water to eight cities and special districts, which, in turn, provide municipal water supplies to about 600,000 residents in Sonoma and Marin Counties.

The Agency stores water in Lake Mendocino and Lake Sonoma and diverts water from the 110-mile-long Russian River, which drains 1,485 square miles, mostly in Sonoma and Mendocino Counties. Five principal tributaries (East Fork Russian River, Big Sulphur Creek, Mark West Creek, Maacama Creek, and Dry Creek) flow into the Russian River. In addition, the Pacific Gas and Electric Company's Potter Valley Project diverts water from the Eel River into the East Fork of the Russian River.

The Agency has filed a petition with the State Water Resources Control Board (Water Board) proposing changes to Decision D-1610. The proposed changes are permanent reductions in the required minimum flows in the Russian River and Dry Creek. The Russian River Biological Opinion determined that lower flows in the Russian River are beneficial for endangered or threatened salmon and steelhead and required the Agency to request these permanent reductions in flows.

The Russian River ResSim model supports the Agency's reservoir and river operations and is being used to formulate and evaluate the proposed changes to Decision D-1610. During the summer months, agricultural water demands along the Russian River become a significant factor that must be considered in reservoir releases to meet the instream flow targets. Thus, the Agency commissioned development of agricultural applied water estimates for incorporation into the Russian River ResSim Model to account for unmetered agricultural diversions. Accounting for the diversions explicitly rather than as a component of system loss supports improved river operations by narrowing the loss estimate to only those flow components that cannot otherwise be measured.

2 Data Development and Results

2.1 Applied Water Estimates

2.1.1 Overview

Water is diverted from the Russian River and Dry Creek directly and by pumping groundwater from the alluvium for application to agricultural crops. The diversions are typically unmeasured, and records of the few measured diversions are generally unavailable to the Agency. Water must be released from Lake Mendocino and Lake Sonoma to supply the unmeasured irrigation diversions, meet known urban water diversions and satisfy minimum instream flow. Estimates of the unmeasured diversions are required to determine the correct release amount. The simplifying assumption was made that water diverted, but not consumed by the crop, returns to the stream, such that the applied water represents the "real" loss from the Russian River and Dry Creek. This section describes the analyses performed to develop estimates of historical applied water depths on a per acre basis. These estimates combined with the definition of the area for which applied water depletes the Russian River and Dry Creek are used to calculate the loss from the two streams due to agricultural water use.

Estimates of daily irrigation applied water were developed by first estimating total daily crop evapotranspiration (ET) and then estimating the portions of the total daily ET that were supplied from applied irrigation water and from precipitation stored in the root zone, respectively. The analysis was performed for subareas (or zones) with the Russian River Basin defined as having unique crop, soil and climatic conditions. The analysis was performed for the 2002 through 2008 period because the most current, reliable records of land use are from this period.

Within each zone, daily total crop ET was calculated for different crop types using unique crop coefficients derived from a 2008 analysis of actual evapotranspiration using the Surface Energy Balance Algorithm for Land (SEBAL®), coupled with quality-controlled reference ET (ET_o) data from the California Irrigation Management Information System (CIMIS). The dominant crop throughout the basin is wine grapes.

The Soil-Water-Atmosphere-Plant (SWAP) root zone model[2] was used to calculate daily root zone water balances so that total ET could be parsed into the portions derived from stored precipitation and from applied irrigation water. The SWAP model was configured to represent the unique soil conditions used to delineate the various analysis zones.

Primarily to obtain calibration data sets for the root zone modeling, recent literature was reviewed and two vineyard irrigation management experts and one large and one small grower were interviewed. Average applied water values for Mendocino County and Sonoma County were found in the literature. The large grower interviewed confirmed that the values found in the literature for Sonoma County were approximately equal to his average applications over a wide range of wine grape varieties and soils.

[2] The SWAP model is a public domain model that has been thoroughly tested, peer-reviewed and documented, and is well adapted to mechanistic modeling over a wide range of conditions (Kroes, et al., 2008).

Water use coefficients for stream corridor vegetation were also derived from the 2008 SEBAL analysis and used to develop daily estimates of stream flow depletion due to stream corridor vegetation ET.

2.1.1.1 SEBAL Analysis to Compute Actual ET for the Russian River Basin

SEBAL is an extensively validated and peer-reviewed remote sensing technique that employs energy balance methodology to estimate actual ET from the earth's surface. A series of nine cloud-free Landsat images encompassing the study area were processed to compute water consumption from February 1 through October 15, 2008. Each image was used to represent approximately a one-month period. The SEBAL ET results were combined with land use data to characterize the spatial and temporal patterns of actual ET throughout the study area. Although primary emphasis was on irrigated crop areas, the analysis also provided ET estimates for native vegetation and stream corridor vegetation. This information was used for calibrating the SWAP root zone model, and increased the overall confidence in the applied water analysis. See Appendix A for a detailed report on the SEBAL analysis.

2.1.1.2 Delineation of Crop Groups, Soil Groups, and Climate Zones

2.1.1.2.1 Analysis of Factors Influencing ET

The crop, soil and climate are the primary factors influencing ET_a volumes. Distance from the river[3], height above the river, and field slope are three other physical factors that are known throughout the basin that could affect ET_a volumes. The first step in delineating analysis zones was to analyze the relationship between actual evapotranspiration (ET_a) from the SEBAL analysis and these three other physical factors. Distance from the river, height above the river, and field slope were correlated with ET_a. In general, fields farther from the river, fields higher in elevation above the river, and fields on steeper slopes all tended to have lower seasonal ET_a. These three physical factors were also correlated with shallower soils which tend to have lower soil available water holding capacities. Review of these relationships indicated that the soil available water holding capacity adequately captured this variability in the SWAP root zone modeling.

Although irrigation tended to start earlier on fields with lower available water holding capacities, these fields also tended to be planted with varieties that were stressed more to meet the wine production quality objective. This combination of factors led to the counter intuitive result that fields that started irrigating earlier had lower ET and lower applied water depths.

2.1.1.2.2 Crop Groups

Crop groups were defined based on land use data provided by SCWA in the form of an ESRI shapefile delineating individual agricultural fields within and neighboring the Russian River Basin. Attributes of the shapefile include crop identification for individual years from 2000 through 2008. For a typical field, the crop was identified during one of the years, but a crop was not identified for every year. Current crops were identified by selecting the most recent crop description from the annual columns. Crop descriptions from the SCWA land use data were grouped as shown in the following table (Table 2.1).

[3] In this discussion, river refers to Dry Creek in the Reach from Lake Sonoma to the Russian River and the Russian River in all other reaches.

Table 2.1. Crop Groups Within the Russian River Basin (Source: SCWA Land Use Data)

Crop Group	Number of Fields	Total Acres	Average Field Size (ac)
Vineyard (wine grapes)	10,720	61,262	6
Orchard	1,855	6,266	3
Pasture and Other	1,148	15,296	13
TOTAL	13,723	82,824	6

The group Pasture and Other includes primarily fields identified as pasture but also includes dairies and livestock operations, as well as miscellaneous unclassified perennial and annual crops. A summary of land use descriptions included in the Pasture and Other category is provided in Table 2.2. The distribution of crop groups within the Basin is shown in Figure 2.1.

Table 2.2. Land Use Descriptions Included in Pasture and Other Crop Group

Land Use Description	Number of Fields	Total Acres	Average Field Size (ac)
Pasture	499	10,722	21
Dairy & Livestock	60	2,160	36
Other Irrigated Land	384	1,482	4
Non-Perennial Agriculture	147	664	5
Perennial Agriculture	45	186	4
Possible Irrigated Land	13	82	6
TOTAL	**1,148**	**15,296**	**13**

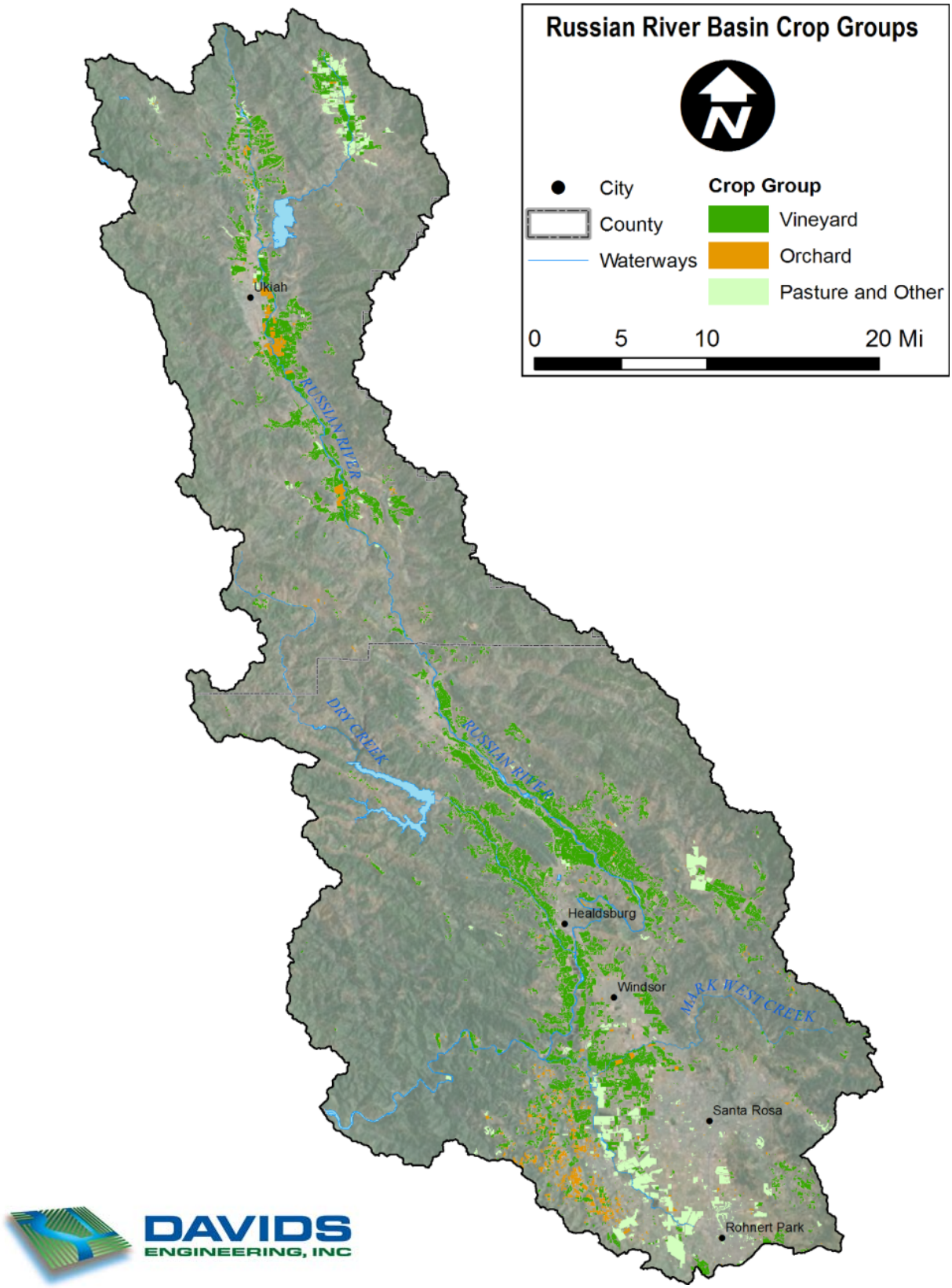


Figure 2.1. Distribution of Crop Groups within Russian River Basin

2.1.1.2.3 Soil Groups

Soil groups were defined based on the NRCS Soil Survey Geographic (SSURGO) Database. Data from soil surveys for Sonoma County (CA097) and for the eastern portion of Mendocino County (CA687) were merged in a Geographic Information System (GIS) and intersected with the SCWA agricultural field polygons. For each field, the dominant soil type was identified and its characteristics were assumed to be representative of the entire field.

For each soil type, the total available water holding capacity (AWHC) was determined by summing the total AWHC for all layers above bedrock, cemented, indurated, or other limiting layers, to a maximum depth of 60 inches. A frequency distribution of total AWHC within the soil profile is provided in Figure 2.2.

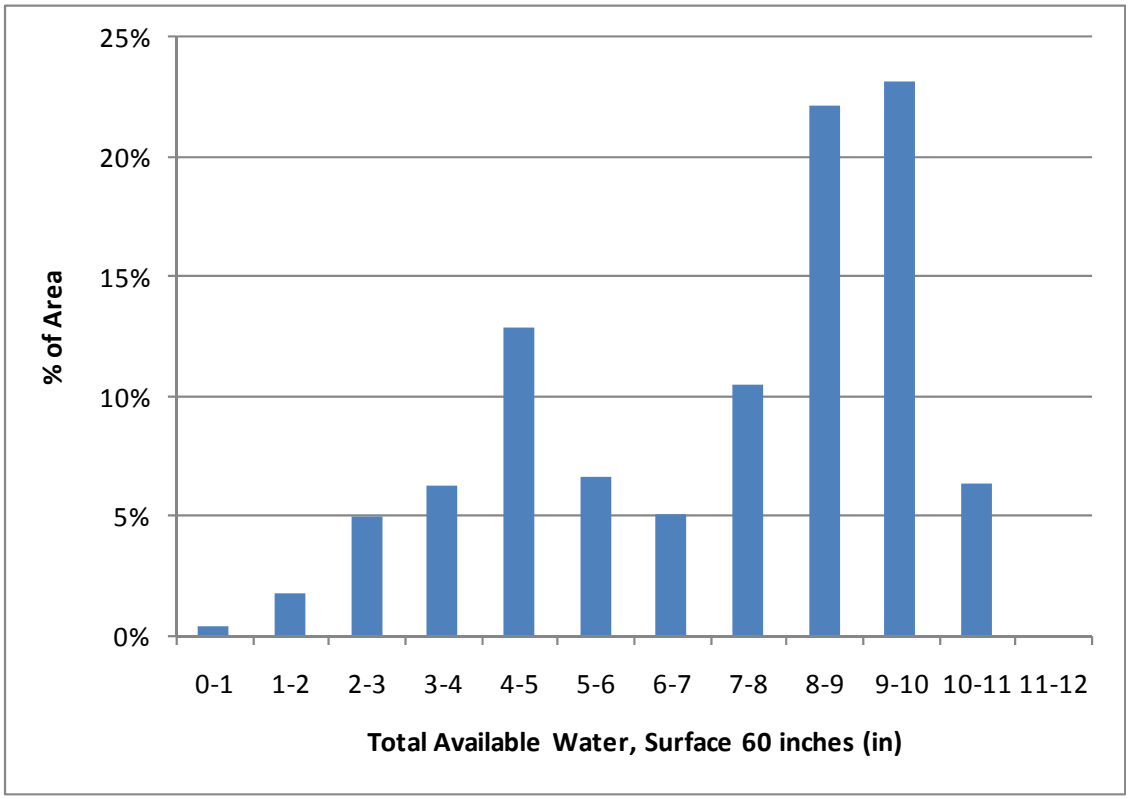


Figure 2.2. Frequency Distribution of Total Available Water Holding Capacity in Surface 60 Inches for Russian River Basin Agricultural Fields

From inspection of Figure 2.2, it appears that there is a bimodal distribution of waterholding capacity within the Basin, with a division between modes at an AWHC of approximately 7 inches. Approximately 38 percent of the area exhibits AWHC less than 7 inches, and 62 percent of the area exhibits AWHC greater than 7 inches, up to approximately 11 inches. Based on these results, two soil groups were defined corresponding to low AWHC (≤ 7 inches) and high AWHC (> 7 inches). A map showing the distribution of low and high AWHC soil groups is shown in Figure 2.3.

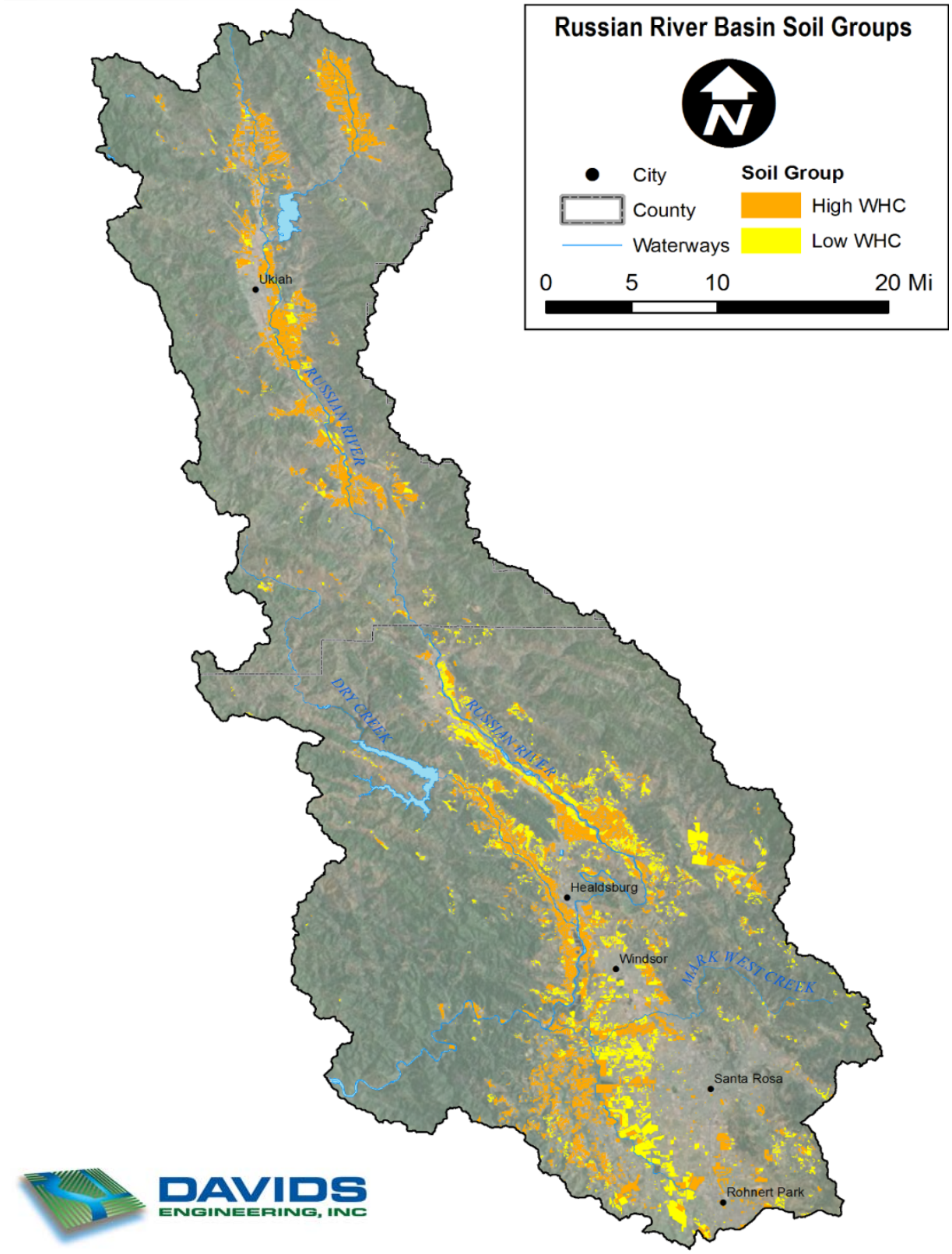


Figure 2.3. Low and High AWHC Soil Groups for Russian River Basin Agricultural Fields

2.1.1.2.4 Climate Zones

Climate zones were delineated based on the presence and location of CIMIS stations within the Basin, along with consideration of topographic and climate variability in the region. In general, the southern portion of the basin experiences coastal influence due to its close proximity to the Pacific Ocean to the west and the San Francisco Bay to the south. Moving northward within the basin, coastal influence decreases due to increasing distance from the Ocean and Bay, and increasing elevation. Additionally, north of the Sonoma-Mendocino County Line, the Russian River gorge narrows and there is an area without substantial cropping, dividing the Basin into north and south zones.

Six CIMIS stations are located within the Basin, including Healdsburg (#51), Santa Rosa (#83), Hopland FS (#85), Windsor (#103), Sanel Valley (#106), and Bennett Valley (#158). The Healdsburg station was not considered for this analysis because it is currently inactive. The Hopland FS station does not report ET_o and was thus also not selected. The Bennett Valley station is not located within a primary agricultural area and was likewise not selected for the analysis. The remaining three stations (Santa Rosa, Windsor, and Sanel Valley) were used for the analysis of climate zones.

Typical methods for developing climate zones include the assignment of a defined area to a weather station, use of inverse distance weighting to determine the influence of a weather station at a location and development of a weather surface from the existing weather stations and known physical factors. The inverse distance weighting method was not chosen because it is based solely on distance to each weather station with no consideration of the physical and topographic factors described earlier that lead to a varied climate across the Basin. The development of a weather surface was not chosen because it requires a model and results in weather data for individual fields, a level of effort unlikely to improve the accuracy of total applied water estimates. So, to reflect climate differences within the Basin on crop water demands and resulting Russian River diversions, climate zones were delineated by assigning a defined area to a weather station. Given the alignment of topography and physical factors with the river reach designations, climate zones were developed by assigning various reaches to a CIMIS station.

Areas that lie primarily within the Redwood Valley area along the Russian River north of Ukiah along the West Fork of the Russian River are not included in the analysis area and, thus, are not in a climate zone. A summary of reaches included with each climate zone and the associated CIMIS stations is provided in Table 2.3.

Climate Zone 1 was defined to include areas north of the Sonoma-Mendocino county line, and the Sanel Valley CIMIS station was selected for use in the computation of crop coefficients and subsequent estimation of crop water demands over time. Climate Zone 2 was defined to include reaches south of the county line but north of the Russian River-Dry Creek confluence, and the Windsor CIMIS station was selected for crop coefficient and subsequent crop ET calculations. Climate Zone 3 was defined to include reaches south of the Russian River-Dry Creek confluence, and the average ET_o from the Windsor and Santa Rosa CIMIS stations was used for the crop coefficient and crop ET calculations.

Table 2.3. Russian River Reaches, Climate Zones and Association with CIMIS Weather Stations

Reach ID	Climate Zone	Representative Area	Representative CIMIS Station(s)
0	1	Redwood Valley, Russian River (west fork) north of Ukiah	106
10	1	Coyote (or, East Fork Russian River)	106
20	1	Upper Russian River above Hopland Gage	106
30	1	Upper Russian River below Hopland Gage	106
40	2	Middle Russian River	103
60	2	Lower Russian River (Guerneville)	83, 103
65	2	Lower Russian River (Mouth)	83, 103
52	3	Lower Dry Creek	103

Crop coefficients were developed for the crop-soil-climate groups. For each group, crop coefficients were calculated for individual 30 meter pixels based on the SEBAL analysis of actual evapotranspiration for the 2008 growing season. Prior to extracting SEBAL ET_a, field boundaries were buffered inward by 60 meters to avoid errors in crop coefficient estimation due to the effects of satellite pixels crossing field boundaries, which represent a combination of actual ET within and outside of the field. As a result of the buffering, many small fields were not included in the crop coefficient analysis and the assumption was made that crop coefficients derived from large fields were also representative of small fields. Crop-soil-climate groups were defined in order to guarantee that at least 10 fields were included in the calculation of crop coefficients for a given group for all image dates in the analysis. The number of fields with available SEBAL data varied across image dates due to partial cloud coverage of the basin for some time periods.

In some cases, it was necessary to combine climate or soil groups in order to provide an adequate number of fields for calculation of crop coefficients. For vineyards, it was possible to maintain all possible combinations of climate zone and soil group due to extensive vineyard cropping in the Basin. For Pasture and Other, fields in Climate Zone 1 were grouped together regardless of soil type due to a very small number of fields planted on low waterholding capacity soils. For Orchards, fields in Climate Zone 1 were likewise grouped together without regard to waterholding capacity because very few orchards are grown on low waterholding capacity soils.

A summary of the crop-soil-climate groups, along with the number of fields with available SEBAL data following buffering and masking of clouds for each image date is provided in Table 2.4. All possible combinations of crop, soil group, and climate zone are provided, with groups selected for the crop coefficient analysis shaded to demonstrate grouping across soil groups or climate zones. Final crop-soil-climate groups and resulting field counts by image date are provided in Table 2.5. The use of crop coefficients in the SWAP modeling is discussed in later in this section and includes examples of crop coefficients for selected groups.

Table 2.4. Crop-Soil-Climate Groups Indicating Available Fields for SEBAL Crop Coefficient Analysis by Image Date

by Image Date.

Crop Group	Soil Group	Climate Zone	SEBAL Image Date 2/13/08	3/24/08	4/25/08	5/11/08	6/4/08	6/28/08	7/30/08	8/31/08	9/24/08
Vineyard	High WHC	1	628	415	629	630	622	630	630	630	623
Vineyard	Low WHC	1	63	49	63	63	62	63	63	63	62
Vineyard	High WHC	2	552	626	626	626	535	626	626	626	550
Vineyard	Low WHC	2	363	406	406	406	331	406	406	406	339
Vineyard	High WHC	3	396	465	465	465	376	227	465	465	387
Vineyard	Low WHC	3	258	299	299	299	241	141	299	299	245
Pasture & Other	High WHC	1	129	18	129	129	129	129	129	129	129
Pasture & Other	Low WHC	1	5	4	5	5	5	5	5	5	5
Pasture & Other	High WHC	2	10	10	10	10	10	10	10	10	10
Pasture & Other	Low WHC	2	7	8	8	8	7	8	8	8	7
Pasture & Other	High WHC	3	99	102	102	102	89	18	102	102	90
Pasture & Other	Low WHC	3	93	103	103	103	93	21	103	103	93
Orchard	High WHC	1	54	47	54	54	54	54	54	54	54
Orchard	Low WHC	1	3		3	3	3	3	3	3	3
Orchard	High WHC	2		3	3	3	3	3	3	3	3
Orchard	High WHC	3	82	91	91	91	75	10	91	91	74
Orchard	Low WHC	3	14	17	17	17	12	3	17	17	13

Table 2.5. Final Crop-Soil-Climate Groups for SEBAL Crop Coefficient Analysis and Field Counts by Image Date

Crop Group	Soil Group	Climate Zone	SEBAL Image Date 2/13/08	3/24/08	4/25/08	5/11/08	6/4/08	6/28/08	7/30/08	8/31/08	9/24/08
Vineyard	High WHC	1	628	415	629	630	622	630	630	630	623
Vineyard	Low WHC	1	63	49	63	63	62	63	63	63	62
Vineyard	High WHC	2	552	626	626	626	535	626	626	626	550
Vineyard	Low WHC	2	363	406	406	406	331	406	406	406	339
Vineyard	High WHC	3	396	465	465	465	376	227	465	465	387
Vineyard	Low WHC	3	258	299	299	299	241	141	299	299	245
Pasture & Other	High & Low WHC	1	134	22	134	134	134	134	134	134	134
Pasture & Other	High WHC	2 & 3	109	112	112	112	99	28	112	112	100
Pasture & Other	Low WHC	2 & 3	100	111	111	111	100	29	111	111	100
Orchard	High & Low WHC	1	57	47	57	57	57	57	57	57	57
Orchard	High & Low WHC	2 & 3	96	111	111	111	90	16	111	111	90

2.1.1.3 Russian River Basin Applied Water Data

An extensive literature review was conducted and irrigation management experts and growers were interviewed to characterize irrigation management in the Russian River Basin. This effort concentrated on vineyards due to their dominance in the basin. Technical papers and reports were obtained and reviewed for applied water data sets to use in calibrating the SWAP root zone model. Two irrigation management experts and two growers (one large and one small) were interviewed with the objectives of confirming that the data sets found in the literature were representative of actual production conditions and obtaining additional calibration data.

2.1.1.3.1 Literature Review

This section summarizes the key findings of the literature review conducted to support the estimates of irrigation water applied to the major crops in the Russian River Basin. Publications, identified through an internet literature search, were obtained and reviewed. Relevant publications are discussed in this section and included in the references at the end of this report. Glenn McGourty, University of California Cooperative Extension Viticulture & Plant Science Advisor for Mendocino County, was interviewed by phone. Rhonda Smith, University of California Cooperative Extension Viticulture Farm Advisor for Sonoma County, was also interviewed. Average applied water values for Mendocino County and Sonoma County were found in the literature. In addition, applied water values for five vineyards in the Napa Valley for 2006 were found.

The literature review concentrated on identifying data sets of measured applied water for vineyards in the Russian River Valley. One measured vineyard applied water data set and two data sets from surveys were found.

Lewis, et al. (2008) of the University of California Cooperative Extension measured applied water data on vineyards, pears and pasture in the Mendocino County portion of the Russian River watershed Mendocino County. These researchers worked with 15 cooperating growers to measure applied water to 33 wine grape blocks covering 300 acres. This area included blocks in the Hopland area and in the Redwood, Ukiah and Potter Valleys. Measurements of applied water to seven pear orchard blocks managed by four growers in the Potter and Ukiah Valleys and to a single small irrigated pasture were also reported.

The applied water for wine grapes and pears averaged 0.61 and 2.31 acre-feet per acre, respectively (Table 2.6). Pasture required 3.31 acre-feet per acre of applied water. The researchers noted that the pasture use "…was consistent with an average use of 4.13 acre-feet per acre documented by the Potter Valley Irrigation District (PVID, 2008)."

Table 2.6. Water Applied to Wine Grapes and Other Crops in the Russian River Valley

Year	Crop	Area	Mean, af/Acre	Standard Deviation	Minimum	Maximum	No.	Method	Source
2007	Wine Grapes	Mendocino County	0.61	0.25	0.19	1.31	33	Measured	Lewis, et al. (2008)
	Pears		2.31	0.81	1.42	3.44	7	Measured	
---	Wine Grapes	North Sonoma County	0.60	---	---	---	6	Interview	Wagner& Bosignore (2007)
2006	Wine Grapes	Russian River	0.35	---	0	> 1.67	71	Survey	Greenspan (2007)
2007	Wine Grapes	Russian River	0.40	---	0	> 1.17	34	Survey	Greenspan (2008)

The researchers assumed a contribution from soil water (precipitation stored in the soil) of 0.13 and 0.21 acre-feet per acre from upland (shallow soil) and lowland (deep soil) sites, respectively, from July 1 to November 4, 2007. The average applied amount for nine upland blocks was 0.49 acre-feet per acre compared with 0.65 acre-feet per acre for 24 lowland blocks. Water applications for white and red grape varieties were not found to differ significantly. Generally, white varieties require more water and are grown on deep lowland soils with higher water holding capacities. Red varieties require less water, but tend to be grown on shallower upland soils with lower water holding capacities. Thus, white varieties utilize more soil water and consequently can be grown with less water stress than red varieties without significantly greater applied water applications.

The North Sonoma County Agricultural Reuse Feasibility study reported 0.6 acre-feet per acre as the average applied water from six interviews in the Alexander Valley. Surveys conducted following the 2006 and 2007 irrigation seasons indicated average applied water amounts of 0.35 and 0.40 acre-feet per acre, respectively. For orchards, the North Sonoma County Agricultural Reuse Feasibility study used the California Department of Water Resources CUP-E model to simulate irrigation demand. Their results ranged from 1.35 acre-feet per acre in the Dry Creek area to 1.82 acre-feet per acre in the Alexander Valley. These volumes were used for calibration of the SWAP root zone model as described later in this document. In addition, vineyard applied water in the Alexander Valley was measured as part of a demonstration project in 2009 and found to be 0.33 acre-feet per acre with irrigation starting on July 15 (Greenspan, 2009).
Pierce (2007) measured applied water to six vineyard blocks in 2006 in the Napa Valley. The six blocks averaged 0.32 acre-feet per acre and ranged from 0.14 to 0.65 acre-feet per acre of applied water. These applied water volumes were not used for the SWAP calibration, but are cited as further support that the applied water volumes found in the literature review and the expert and grower interviews (described in the following sections) are reasonable.

2.1.1.3.2 Expert Interviews

This section summarizes the key findings of the expert interviews conducted to support the estimates of irrigation water applied and irrigation start dates for vineyards in the Russian River Basin. Glenn McGourty, University of California Cooperative Extension Viticulture & Plant Science Advisor for Mendocino County, was interviewed by telephone. Rhonda Smith, University of California Cooperative Extension Viticulture Farm Advisor for Sonoma County, was interviewed at her office in Santa Rosa.

Rhonda Smith has more than 20 years of experience in Sonoma County and is very well informed with regard to the theory and practice of vineyard water management. This section describes the practices discussed with Smith that pertain to the estimation of vineyard irrigation applied water amounts in the Russian River mainstem. In Smith's opinion, soil and climate variability are the major drivers of applied water variability. In general, Smith's opinion is that applied irrigation water ranges from zero to four inches in western Sonoma County. Although she acknowledged that some growers apply 0.6 acre-feet per acre and more, she felt that average applied water amounts are less than 0.6 acre-feet per acre even for the higher evaporative demand areas like Ukiah Valley. The applied water volume is strongly related to the desired characteristic of wine. For example, if the desired outcome is a high quality, distinctive wine, less water is applied. If the desired outcome is production tonnage with less emphasis on quality, more water is applied. Irrigation start dates in June and July are common in the Alexander Valley, but dry springs can lead to earlier start dates.

Although Smith has found grapevine roots as deep as nine feet, the general rule of thumb for effective root depth is three feet. The root distribution depends on the rootstock parentage; for example, St. George rootstock is known for its deep rooting characteristic. It was noted that white varietals tend to be irrigated earlier and more frequently. Irrigation management methods used by growers include CIMIS with crop coefficients computed based on an estimate of shaded area developed by Larry Williams, pressure chambers, soil moisture measurements and visual clues such as shoot tip growth.

Glenn McGourty has more than 15 years of experience in Mendocino County. He felt that in Mendocino County soil characteristics, specifically available water holding capacity, and the variety, white versus red, were the two greatest factors impacting the irrigation start dates. Mendocino County has many micro-climates and this leads to growers irrigating primarily based on visual assessment. According to McGourty, no one irrigates the red varieties until after bloom, but the white varieties sometimes are given an irrigation after bud break. Typical start dates for red varieties would be late June. Often growers will continue irrigating until the leaves drop off in the fall. Eighty to ninety percent of the vineyards in Mendocino County have a cover crop and overhead sprinklers are commonly used for irrigation. Whites tend to be at lower elevation and are often irrigated through a river diversion. The red varieties tend to be planted farther from the river, at higher elevations, and are often irrigated from a pond. He estimates that at least 50 percent of the area irrigated in Mendocino County is served by a direct diversion.

2.1.1.3.3 Grower Interviews

The objective of conducting grower interviews was to characterize existing irrigation practices and to gather applied water records for validating the root zone model. The interviews took

place in the offices of the various growers or near their fields. The average length of each interview was roughly 60 to 90 minutes.

An interview form (Appendix B) was developed to provide a guide for carrying out the interviews. The interview form was not used or filled out during the face-to face interviews. Instead of following a script, the interviews were carried out in a free flowing conversational manner that covered the points of interest. The vineyard manager for one large grower was interviewed and one small, independent grower was interviewed. Both growers were located in the Alexander Valley.

The vineyard manager for the large grower tracks applied irrigation water and schedules irrigations for 550 acres of vineyard blocks at the interview location. He oversees more than a thousand acres of vineyard in both Sonoma and Mendocino Counties. Although the discussion focused on the 550 acres of vineyard at the interview location, the irrigation management methods discussed are used throughout the grower's holdings. The vineyard manager displayed examples of detailed applied water records for a few blocks and summary records for 2003 through 2007 (Table 2.7). Summaries were not available for the water records for 2008 and 2009. The area of young vines in 2003 and 2004 had a significant impact on the average applied water in 2003 and 2004 at this location. In every year, some blocks were not irrigated at all.

Table 2.7. Average Recorded Applied Water to Selected Vineyard Blocks in the Alexander Valley

Year	Applied Water (af/ac)			Notes
	Average	Minimum	Maximum	
2003	0.12	0	N/A	More young vineyards
2004	0.12	0	N/A	More young vineyards and very wet spring
2005	0.19	0	N/A	Started irrigations in July
2006	0.17	0	0.44	
2007	0.20	0	N/A	
Average	0.16	0.00	0.44	
Average (2005-2007)	0.19	0.00	0.44	

N/A = not available

These volumes, for a single location under common management, are lower than the volumes found in the literature review. These averages include both red and white varieties grown at this location. The manager noted that because white varieties require less stress, more water is applied to them. Approximately 80 percent of the vineyard soils at this location were in the high available water holding capacity soil category.

The objective of irrigation is to maintain a soil water content that results in the desired level of stress in each block. Methods used to indicate stress include pressure chamber measurements of leaf water potential (typically taken weekly), porometer measurements of stomatal conductance, soil moisture measurements using aquapro and neutron probe instruments, visual

observations and historical knowledge of how vines in a given block react to climate conditions. A second drip line has been added to many of the irrigation blocks to fine tune water application amounts within a block to keep all vines uniformly stressed at the desired level. To prevent vines from being overstressed by higher temperatures, they try to be proactive by applying a small volume of water prior to a forecasted heat spell.

The small, independent vineyard grower interviewed manages 30 acres of terraced, hillside vineyard divided into 18 blocks. Savignon Blanc, Merlot and Cabernet Sauvignon varietals are drip irrigated with a single two gallon per hour emitter per vine. Water is applied uniformly within all blocks with each block receiving eight hours of water every seven days during the peak summer demand period. Based on irrigation practices discussed during the interview, the average applied irrigation water was estimated to be about 0.6 acre-feet per acre. Although the grower reported using visual observations to schedule irrigation, he also reported that he begins irrigation within a seven to ten day window during the last week of May and the first week of June. Although the grower characterized the blocks as having deep soil, the soil underlying all 30 acres was classified as low available water holding capacity based on the SSURGO data.

2.1.1.4 Root Zone Model Configuration and Calibration

The Soil, Water, Atmosphere and Plant (SWAP) model simulates vertical transport of water, solutes and heat in variably saturated soils (Kroes, et al., 2008). The program simulates these transport processes at field scale throughout one or more growing seasons. In the vertical direction the model domain reaches from a plane just above the canopy to a plane at the bottom of plant roots, this domain is often termed the "root zone." In the root zone the transport processes are predominantly vertical; therefore SWAP is a one-dimensional, vertically directed model. Daily weather conditions, such as evapotranspiration and rainfall, serve as sufficient input data at the top of the soil column. At the soil column bottom various forms of head and flux based boundary conditions are used.

In the horizontal direction, vegetation type, soil type, and drainage conditions are assumed to be uniform. Time steps in SWAP can be as small as a few seconds for fast transport processes such as those associated with intensive rainfall with runoff or flow in soils with large macropores. For this study, a daily time step was used to develop daily estimates of applied water.

The model was configured for eleven unique combinations of soil, crop, and climate (derived from the analyses described earlier), including provisions to simulate regulated deficit irrigation practices. The model was calibrated to the measured applied water data sets found in the literature and confirmed by expert and grower interviews. The remainder of this section describes the SWAP model configuration and calibration.

2.1.1.4.1 SWAP Model Configuration

Four files are required to set up a SWAP model run (Table 2.8). The SWAP model was used to develop estimates of applied water for each of the 11 crop-soil-climate zones. Modeling of solutes, heat flows and lateral drainage was not required; thus, these SWAP capabilities were not utilized.

Table 2.8. Model Set-Up Files

Input File Extension	Description
*.bat	Batch file—Text file containing commands for operation of each model run
*.swp	Main input
*.crp	Crop growth
*.YYY	Weather data

2.1.1.5 Main Inputs (.swp file)*

The main input file contains the basic information used to run the model and is organized into eight sections. The Lateral Drainage, Heat Flow and Solute modeling capabilities were not used, so these sections were used to turn off these three modeling algorithms. The remaining five sections and the main model configurations are described below.

The general section contains input file locations, simulation period (1/1/2002-12/31/2008), output dates and output file locations. The meteorology section specifies the source of reference ET data. Rather than computing ET_o from weather data inputs, the model was configured to use quality controlled CIMIS ET_o directly from an input file.

The crop modeling start and end dates and crop file name references are specified in the crops section of the main input file. The start and end dates used to define the modeled crop period for all model runs was from February 1 through October 15. This period was selected to match the time period for which the SEBAL analysis determined actual ET.

The soil water section specifies the soil hydraulic parameters, initial soil storage conditions, and soil run-off and run-on settings. Soil hydraulic parameters were developed by extracting soil texture data from SSURGO[4]. Soil hydraulic parameters for the model were estimated with the ROSETTA[5] model using the soil textures from SSURGO. The main objective of the modeling was to accurately characterize the volume of rainfall stored in the root zone. Because rainfall intensity was not modeled and an accurate division between runoff and deep percolation of rainfall volume in excess of the soil water holding capacity was not required, the soil run-off was set to zero. This was done by specifying a maximum pond depth before run-off of 100 cm. Run-on (flow on to a field from an upslope field) was also set to zero. The bottom boundary condition specified in the model was free drainage of the soil profile.

2.1.1.6 Crop Growth (.crp file)*

SWAP provides two modeling options for crop growth, the simple crop growth model and the WOFOST model. The simple crop growth model represents a green canopy that intercepts precipitation, transpires and shades the ground and is recommended for use when crop water use is more important than accurate simulation of crop yield. The WOFOST model is a detailed

[4] Soil Survey Geographic Database available from NRCS

[5] The ROSETTA model is used to estimate unsaturated hydraulic properties from surrogate soil data such as soil texture data and bulk density. The model is available through the USDA Agricultural Research Service.

crop growth model that partitions biomass between the various crop parts, such as roots, stems and leaves.

SWAP computes transpiration and evaporation as separate values by using the leaf area index or fractional cover to divide ET into transpiration and evaporation. A fractional cover coefficient of one was assumed since most vineyards in the Basin maintain a cover crop (Davids Engineering, 2005). A fixed length crop cycle of 258 days (February 1 through October 15) was selected for plant growth to model crop water use for a time period matching the available SEBAL results. SEBAL-derived actual crop coefficients (K_{cs}) developed through the SEBAL analysis were used as crop factors in the model (Figure 2.4). Rooting depths were set to the depth necessary to obtain irrigation start dates and applied water estimates consistent with the literature review and grower interviews. These settings are discussed in more detail in the Calibration Section.

Irrigations in SWAP can be set to occur at specified times or they can be scheduled by the simulation according to specified criteria. For vineyards, irrigation was allowed between May 1 and November 1. The timing of irrigation was triggered by setting an allowable daily stress.

This was accomplished by using the SEBAL-derived actual crop coefficient, which represents the actual stress level, as the crop factor as described below.

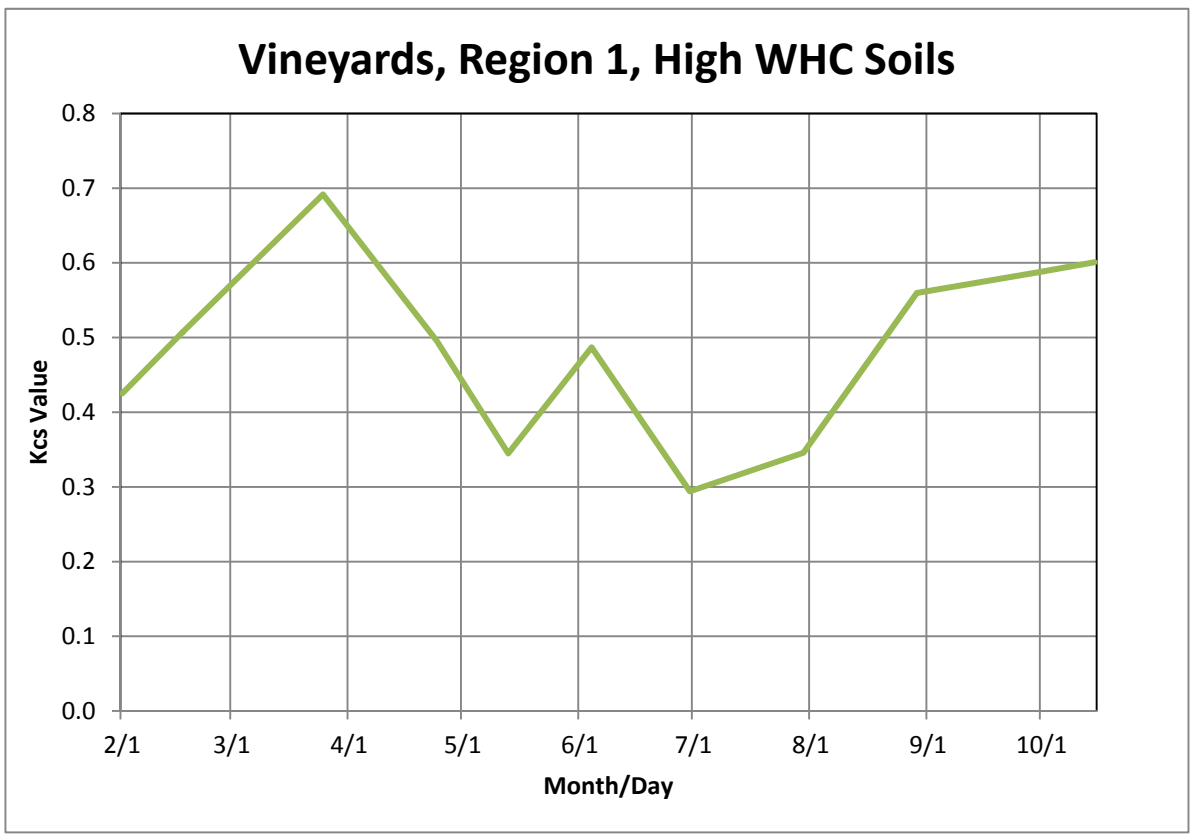


Figure 2.4. K_{cs} Example

The SWAP model calculates ET by multiplying ET_o by a crop factor. The resulting ET is divided between potential transpiration and potential evaporation based on a soil cover fraction. As discussed earlier, a soil cover fraction of one was assumed resulting in all ET being assigned to potential transpiration. By utilizing the SEBAL-derived actual crop coefficient as the SWAP crop factor, the SWAP "potential" transpiration became the transpiration resulting when the stress was exactly equal to the actual stress level indicated by the SEBAL-derived crop coefficient. The model also computes an actual transpiration based on modeled stress factors. When the water volume available in the root zone drops below the water volume available at the "potential" transpiration, the actual transpiration drops below the "potential" transpiration. When this occurred, irrigation was triggered and a fixed irrigation depth was applied. To keep the modeled stress near the actual stress and to develop daily applied water estimates, the fixed irrigation amount was set equal to an estimate of the average daily modeled transpiration during the irrigation period. Thus, the model was set up so that irrigation would on average satisfy daily transpiration leading to a daily irrigation frequency once irrigation was initiated. Although a different fixed irrigation depth could be assigned for each soil-climate zone, the depth was the same for both soil groups in climate zones one and two. Also, the same fixed irrigation depth was used in all years of the simulation.

The orchard and pasture model files were configured and calibrated similar to the vineyard modeling with the exception of the irrigation timing and depth criteria. Both orchard and pasture irrigation was triggered when the soil moisture reached an allowable depletion set to 50 percent of the soil readily available water in the root zone. The irrigation volume applied was determined by the model as the volume required to increase soil moisture to field capacity (zero depletion).

2.1.1.6.1 Root Zone Model Calibration

The modeled applied water for vineyards was calibrated to match the applied water data sets from the literature review, corroborated by expert and grower interviews. The applied water was calibrated by changing the root zone depth to vary the irrigation start date. The calibration was then checked by reviewing the irrigation start dates to ensure that they were within the range of start dates determined from the literature review and expert and grower interviews. Finally, the actual ET estimates from the 2008 SEBAL analysis were compared to the modeled vineyard ET_a to verify the results of the modeling process.

Because there is generally little or no rain during the growing season and regulated deficit irrigation is practiced to maintain a desired stress level on the grapes, the total applied water volume is heavily influenced by the irrigation start date. The assumed rooting depth was adjusted so that the modeled irrigation start dates resulted in applied water depths comparable to the values determined from the literature review and expert and grower interviews.

By requiring close agreement between SEBAL average ET_a and SWAP modeled ET_a, applied water depths were calibrated to be within between 10 percent of the average reported values for vineyards and orchards (Table 2.9). For pasture, representing 18 percent of cropped area in the Russian River Basin, the applied water depth required to match the SEBAL average pasture ET_a was 29 percent lower than the single measurement found in the literature. Since only one reported applied water depth was found, the pasture applied water was calibrated so that the SWAP ET_a matched the average pasture ET_a from the SEBAL analysis. For vineyards, a rooting

Table 2.9. SWAP Applied Water Depth Calibration Summary

Model Run	Crop Group	Soil Group	Climate Zone	Calibration Applied Water Depth (af/ac)	Area Weighted Average SWAP Applied Water Depth (af/ac)	SWAP Applied Water Depth (af/ac)	Difference
vinehi1	Vineyard	High WHC	1	0.61	0.66	0.67	8%
vinelo1	Vineyard	Low WHC	1			0.62	
vinehi2	Vineyard	High WHC	2	0.4	0.39	0.35	-2%
vinelo2	Vineyard	Low WHC	2			0.30	
vinehi3	Vineyard	High WHC	3			0.55	
vinelo3	Vineyard	Low WHC	3			0.33	
pasthilo1*	Pasture	All	1	3.31*	2.35	2.35	-29%*
pasthi2&3	Pasture	High WHC	2 & 3			1.84	
pastlo2&3	Pasture	Low WHC	2 & 3			1.34	
orchhilo1	Orchard	All	1	2.31	2.48	2.48	7%
orchhilo2 &3	Orchard	All	2 & 3	1.82	1.83	1.83	1%

*Only one reported applied water depth for pasture was found

depth of 1.8 meters, or nearly six feet, was required to delay irrigation start dates enough to obtain applied water depths that match those generally reported. Although the rule of thumb for effective rooting depth utilized during the irrigation period is three feet, it is not surprising that the grapes utilize water from a deeper root zone prior to the start of irrigation. Supporting this conclusion, a recent comprehensive literature synthesis by Smart et al. (2006) concludes that"… the depth distribution of grapevine roots in the vadose zone [are] among the deepest observed for plants worldwide."

The modeled irrigation start dates for vineyards ranged from late May to early September (Table 2.10). In 2005, irrigation was not triggered in two crop-soil-climate combinations. Generally, these irrigation start dates, which result in applied water estimates within 10 percent of reported values obtained through literature review and expert and grower interviews are slightly later than the typical values reported.

Table 2.10. SWAP Calibrated Model Irrigation Start Dates

Model Run	2002	2003	2004	2005	2006	2007	2008
vinehi1	6/11	7/30	8/11	8/8	7/14	7/26	5/18
vinelo1	6/30	8/22	9/5	8/28	8/1	8/24	5/29
vinehi2	8/9	8/22	8/7	10/4	8/10	8/13	7/12
vinelo2	8/14	8/27	8/14	NI**	8/16	8/19	7/16
vinehi3	7/28	8/10	7/20	9/26	8/2	7/28	7/6
vinelo3	9/1	8/31	8/12	NI**	8/24	8/24	7/16
pasthi2&3	4/13	5/21	4/6	6/7	5/12	3/31	3/25
pasthilo1	4/3	5/22	4/7	5/4	5/10	4/1	3/31
pastlo2&3	4/15	5/24	4/8	6/13	5/15	4/2	3/26
orchhilo1	4/21	5/29	4/30	6/13	5/18	5/9	4/13
orchhilo2&3	4/25	6/9	4/15	6/24	6/1	4/8	4/3

Notes:
NI = Not Irrigated

For February 1 through October 15, 2008, the SWAP calibrated model ET_a and the SEBAL ET_a were closely matched, averaging four percent less and ranging from one to six percent less (Table 2.11). Fields with lower available water holding capacities tend to be planted with varieties that are stressed more to meet the wine production quality objective leading to later irrigation start dates and lower ET_a and correspondingly lower volumes of applied water. When compared to the two- and four-week SEBAL period ET_a values, the SWAP modeled values, as shown in this example for vineyard, climate zone 2 and high WHC soils, also matched reasonably well with 0.63 inches being the greatest absolute difference (Table 2.12).

2.1.1.7 Applied Water Estimates

To obtain estimates of the total volume of applied water for irrigation, the estimates of historical irrigation applications per acre are applied to the irrigated area within the Applied Water Analysis Zone (AWAZ; described in Section 2.2). The daily total applied water volume for each agricultural field within the AWAZ is determined by summing the product of the field area and the unit ET_a for each crop-soil-climate zone. The AWAZ encompasses about 22,300 acres of agricultural fields. Applied water to agricultural fields in the AWAZ ranged from 10,000 to 25,000 acre-feet for calendar years 2002 through 2008 (Table 2.13).

2.2 Delineation of Applied Water Analysis Zone

2.2.1 Definition

By definition, the Applied Water Analysis Zone (AWAZ) represents the area within which diversion or consumption of water is either known or presumed to have immediate effects on Russian River or Dry Creek flows. The AWAZ includes all agricultural fields known to have surface water diversions and fields where groundwater pumping from the alluvium is believed to have immediate or nearly immediate effects on stream flow. Information on Russian River diversion points from eWRIMS together with information on agricultural fields developed by SCWA was used to define the AWAZ.

Table 2.11. Comparison of SEBAL ET_a and Swap Calibrated Model ET_a for the February 1 Through October 15, 2008 Time Period

Crop Group	Soil Group	Climate Zone	Model Run	Average SEBAL	SWAP ET_a	Difference
Vineyard	High WHC	1	vinehi1	22.1	21.93	-1%
Vineyard	Low WHC	1	vinelo1	18.2	17.96	-1%
Vineyard	High WHC	2	vinehi2	20.2	19.6	-3%
Vineyard	Low WHC	2	vinelo2	19.5	18.91	-3%
Vineyard	High WHC	3	vinehi3	24.1	23.18	-4%
Vineyard	Low WHC	3	vinelo2	20.2	18.91	-6%
Pasture and Other	High and Low WHC	1	pasthilo1	32	31.36	-2%
Pasture and Other	High WHC	2 & 3	pasthi2&3	24.5	23.73	-3%
Pasture and Other	Low WHC	2 & 3	pastlo2&3	17.9	17.2	-4%
Orchard	High and Low WHC	1	orchhilo1	37	36.42	-2%
Orchard	High and Low WHC	2 & 3	orchhilo2&3	22.7	21.42	-6%

Table 2.12. Example of SWAP and SEBAL ET_a Calibration Results (Vineyard, Region 2, High WHC)

Period	Start Date	End Date	SWAP ETact (inches)	SEBAL ETact (inches)	Absolute Difference	Difference
1	2/1/2008	3/4/2008	0.67	0.65	0.02	4%
2	3/5/2008	4/14/2008	1.99	2.55	-0.56	-22%
3	4/15/2008	5/3/2008	0.49	0.29	0.20	68%
4	5/4/2008	5/23/2008	1.54	1.62	-0.08	-5%
5	5/24/2008	6/16/2008	2.84	2.73	0.11	4%
6	6/17/2008	7/14/2008	4.76	5.39	-0.63	-12%
7	7/15/2008	8/15/2008	3.26	2.67	0.59	22%
8	8/16/2008	9/12/2008	3.05	3.39	-0.34	-10%
9	9/13/2008	10/15/2008	1.00	0.92	0.08	9%
Total			**19.60**	**20.21**	**-0.61**	**-3%**

Table 2.13 Estimated Total Applied Water for Agricultural Fields in the AWAZ (Volumes in Acre-Feet)

Calendar Year	Unmetered Ag Diversions
2002	20,000
2003	15,000
2004	16,000
2005	10,000
2006	16,000
2007	16,000
2008	25,000

The AWAZ confines the analysis of applied water to a specific area within the Russian River watershed where diversions are known to occur and the impacts on Russian River and Dry Creek surface water flows are direct. The timing and precise impact on Russian River and Dry Creek surface water flows of groundwater pumping to areas outside the AWAZ are less certain.

Water balance studies completed by others indicate that additional Russian River flow depletions occur beyond those caused by estimated surface water diversions within the AWAZ. One such study (Grinnell, 2013) of gaged reaches of the mainstem of the Russian River and Dry Creek downstream of Warm Springs Dam estimated total reach losses by using observed discharge data collected by the U.S. Geological Survey (USGS), records of pumping from municipal and industrial diverters, estimated unimpaired flow data developed by the USGS, and the applied water estimates described in this report. The study found that total reach losses typically exceed applied water estimates from the AWAZ for the months June through October. Additional work is needed to determine the causes of these additional depletions.

2.2.2 Data

2.2.2.1 Background

The State Water Resources Control Board (SWRCB) maintains the Electronic Water Rights Information Management System (eWRIMS), a database that contains detailed information on all water rights in the State of California. Each water right identifies a point (or points) of diversion (POD) and includes a map of a place (or places) of use (POU).

POU maps were scanned and then the images were geo-referenced by SCWA GIS staff based on available points of reference. Not all mapping had adequate reference points and the resulting digitized place of use map file that was developed has uncertain accuracy. The digitization efforts used the best available geographic information and cross-referenced information available from the eWRIMS database for the individual water rights about their locations, such as parcel numbers and public land survey system data. Information on the locations of water use in this POU layer, provided by SCWA, was used in defining the AWAZ. The data utilized to define the AWAZ are described in the following sections of this report.

2.2.2.2 eWRIMS Data

The source from which water may be diverted to each POU is included in the eWRIMS database. POUs were evaluated for inclusion in the AWAZ when one of the following sources of water was listed:

- Dry Creek
- Dry Creek Subterranean
- Dry Creek Underflow
- East Fork Russian River
- Lake Mendocino
- Powerhouse Canal (Potter Valley Project)
- Russian River
- Russian River Subterranean Flow
- Russian River Underflow

2.2.3 Spatial Data

The following spatial datasets were provided by SCWA and used to delineate the AWAZ:

- Sonoma and Mendocino County Assessor's parcel boundaries, with riparian parcels identified
- Agricultural fields within the Russian River watershed
- POUs within the Russian River watershed
- PODs within the Russian River watershed
- Mapped stream channel alluvial deposits (Stetson Engineers, 2008)

The following section of this report describes the methodology that was applied to the spatial datasets for purposes of delineating the AWAZ.

2.2.4 Methodology

Based on a review of available literature and multiple discussions with SCWA staff, the AWAZ was defined as the area within the geographic perimeter that encloses the following PODs, POUs, fields, parcels, and the stream alluvial deposit zone as mapped in an engineering report on the Russian River Basin by Stetson Engineers (Stetson Engineers, 2008):

- PODs and associated POUs with the following sources of water listed in eWRIMS
  - Dry Creek
  - Dry Creek Subterranean
  - Dry Creek Underflow
  - East Fork Russian River
  - Lake Mendocino
  - Powerhouse Canal
  - Russian River
  - Russian River Subterranean Flow
  - Russian River Underflow
- Riparian parcels, defined as parcels containing or adjacent to the river that are not "right-of-way" parcels (one example of a right-of-way parcel is a long, narrow parcel crossing the

Russian River, that was identified as the right-of-way associated with a railroad). For this analysis, riparian parcels have been identified and flagged as parcels that are intersected by the river and additional parcels that, based on aerial photo review, "touch the riverbank."
- Agricultural fields that intersect riparian parcels
- PODs and POUs located near or adjacent to the Russian River or Dry Creek inside the boundary of the stream alluvial deposit zone defined by Stetson Engineers (Stetson Engineers, 2008).
- Agricultural fields that intersect the boundary of the aforementioned stream alluvial deposit zone

The following PODs, POUs, and parcels were excluded from the AWAZ:

- PODs with one of the eight sources listed above that were designated as geographic outliers based on their distance from the river
- POUs for metered diverters, such as Potter Valley Irrigation District and Redwood Valley County Water District
- Parcels identified as rights of way

The results of the AWAZ delineation process are presented in the following section of this report.

2.2.5 Results

The AWAZ as defined by the methodology previously described contains approximately 51,370 acres within the Russian River watershed, including 22,334 acres of agricultural fields. Table 2.14 summarizes the acreage of the AWAZ and agricultural acreage within the AWAZ by reach.

There were 1,068 PODs included in the AWAZ delineation process.

The AWAZ is the study area defined to evaluate applied water estimates that impact Russian River flows immediately or nearly so. The AWAZ contains points of diversion, places of use, agricultural fields, and riparian parcels whose diversion or consumption of water has direct impact on the Russian River or Dry Creek. The AWAZ confines the analysis of applied water estimates and related water "losses" to a specific area within the Russian River watershed boundaries thought to directly impact Russian River flows. The reliability of AWAZ delineation depends in part on the accuracy and completeness of the information that is used in the delineation process. The AWAZ can and should be updated as improvements are made to the available data.

2.3 Stream Corridor Vegetation Depletion Estimates

Stream corridor vegetation ET along the Russian River and Dry Creek was estimated based primarily on the SEBAL analysis. The stream corridor vegetation area was delineated by visual interpretation and digitization of the boundaries on aerial photos in the Russian River GIS. This area represents a total of approximately 6,018 acres within the Russian River watershed.

Table 2.14. Total Area of Applied Water Analysis Zone and Area of Agricultural Fields by Stream Reach

Reach ID	Reach Description	Total AWAZ Area (acres)	Area of Ag Fields within AWAZ (acres)
10	East Fork (Coyote)	8,174	4,301
20	Upper Russian (Ukiah)	6,156	3,737
30	Upper Russian (Hopland)	3,301	1,985
40	Middle Russian (Alexander Valley)	16,828	6,731
52	Lower Dry Creek	3,933	2,718
60	Lower Russian (Santa Rosa)	7,594	2,610
65	Lower Russian (Coast)	4,607	252
	Total	51,370	22,334

This area was then overlaid on the SEBAL analysis and the climate zones developed earlier. Water use coefficients defined as ET_a/ET_o (K_{cs}) were computed for each pixel in each climate zone in each image for the stream corridor vegetation area. In climate zone one, the average water use coefficient remained nearly constant throughout the year. However, the tenth percentile of K_{cs} values decreased nearly to zero and the ninetieth percentile increased and stayed high into the fall (Figure 2.6). This linear crop coefficient is unusual and may be the result of a stream corridor vegetation area that is wider than the area that actually impacts the stream. The decreasing ET_a as the season progresses seen in the tenth percentile is expected of vegetation with reduced water availability. This is indicative of areas that are not replenished by stream leakage as the season progresses. These areas are likely distant from the river and consideration should be given to removing them from the Stream Corridor Vegetation area.

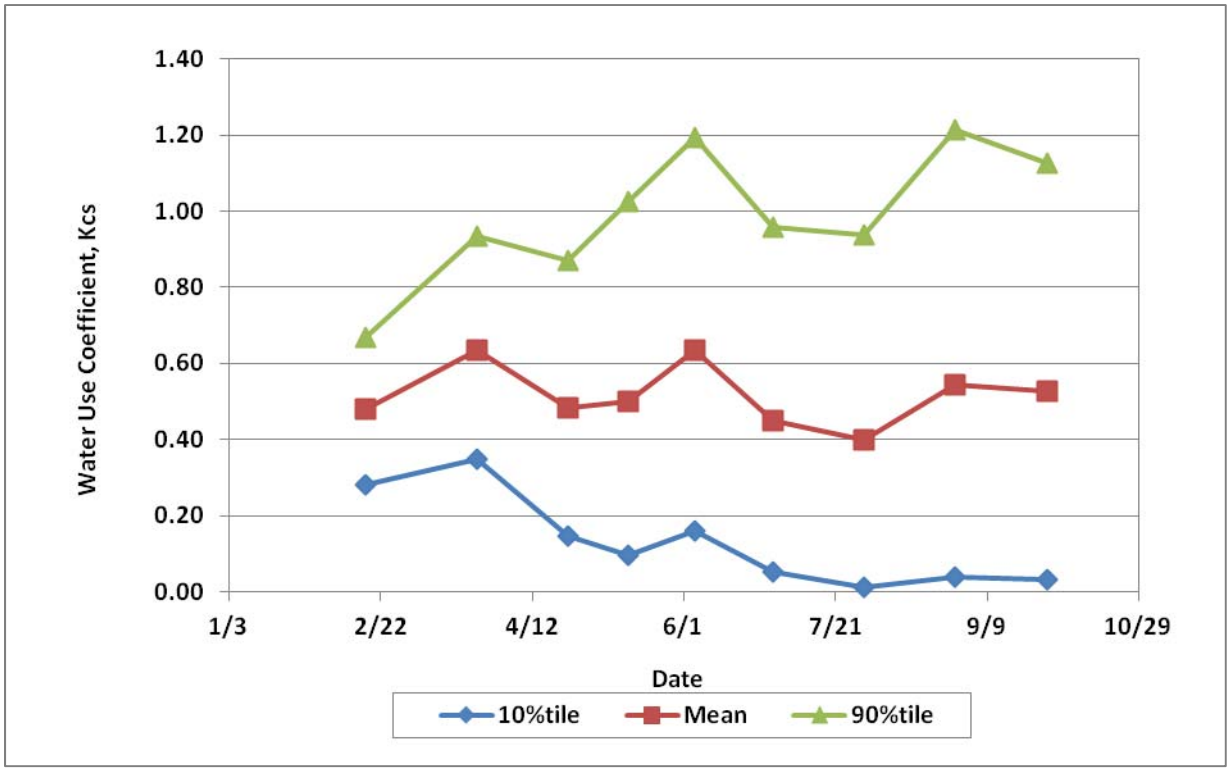


Figure 2.6. Climate Zone One Stream Corridor Vegetation Water Use Coefficient Based On SEBAL Analysis

The water use coefficient for climate zone two followed a typical crop water use curve with water use increasing in the summer and decreasing again in the fall and the tenth and ninetieth percentiles following the same pattern (Figure 2.7). The water use coefficients for climate zone three followed a pattern similar to those in climate zone two, except that the values increased sooner in the spring and did not fall as fast in the fall (Figure 2.8). These two water use coefficients are more typical of a Stream Corridor Vegetation area that is fully replenished by stream leakage.

For climate zone 1, the mean water use coefficient value of all the periods was computed and used for every day of the year. For climate zones 2 and 3, polynomials were developed by regression analysis to enable computation of a unique water use coefficient for every day between the first and last images of the SEBAL analysis. The water use coefficient value for the day of the first SEBAL image was used for all days in the year prior to that image. For all days in the year following the last image, the water use coefficient for the last image was used. The crop coefficients for climate zone 3 are significantly greater than for the climate zones one and two (Figure 2.9).

The water use coefficients are multiplied by the reference ET for each climate zone to obtain a daily water use depth. These daily depths for each climate zone are stored in a database.

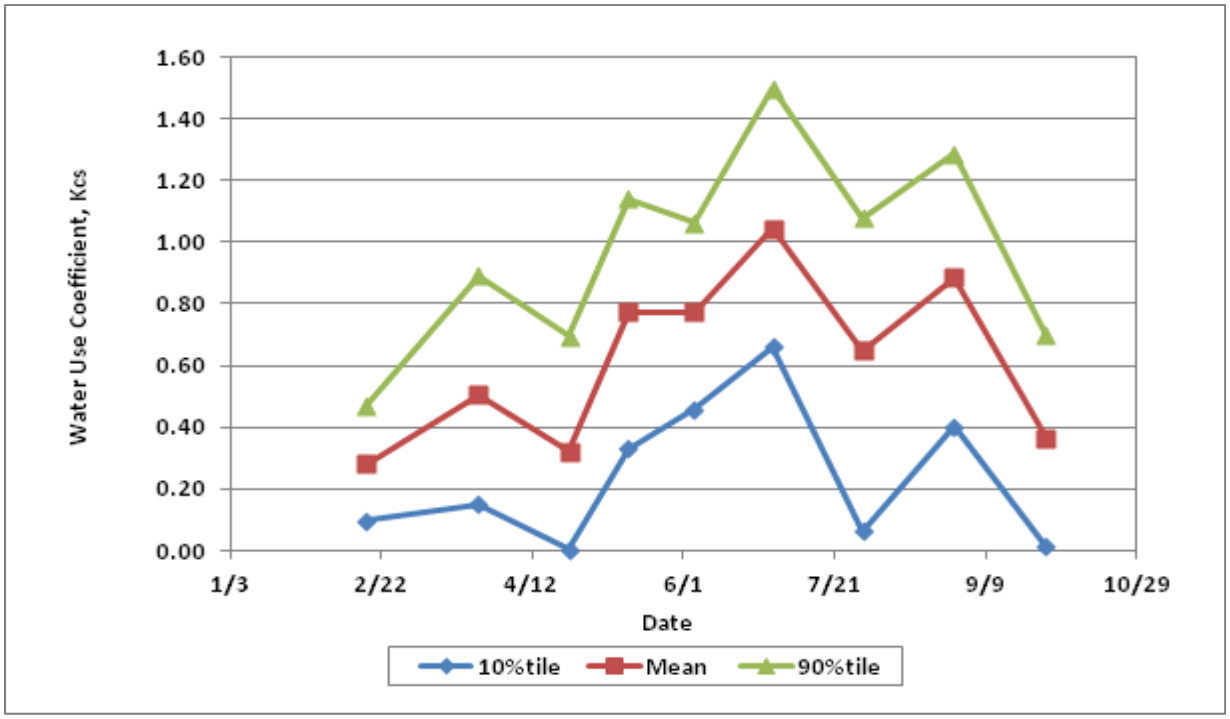


Figure 2.7. Climate Zone Two Stream Corridor Vegetation Water Use Coefficient Based on SEBAL Analysis

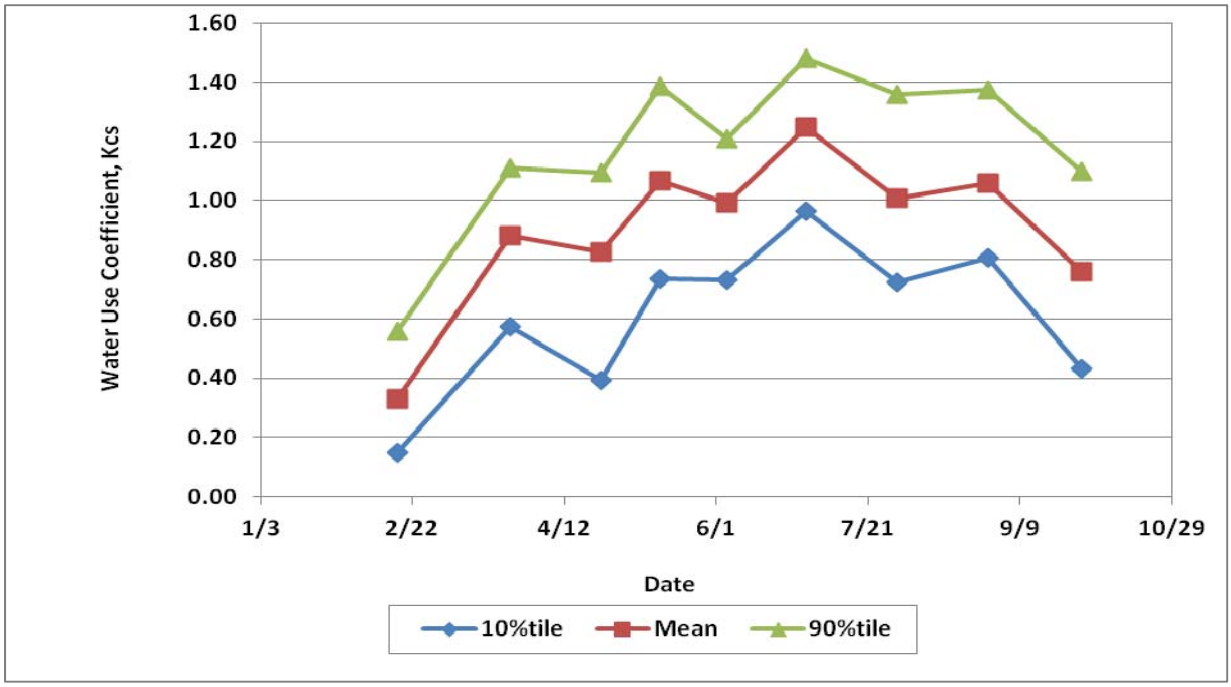


Figure 2.8. Climate Zone Three Stream Corridor Vegetation Water Use Coefficient Based on SEBAL Analysis

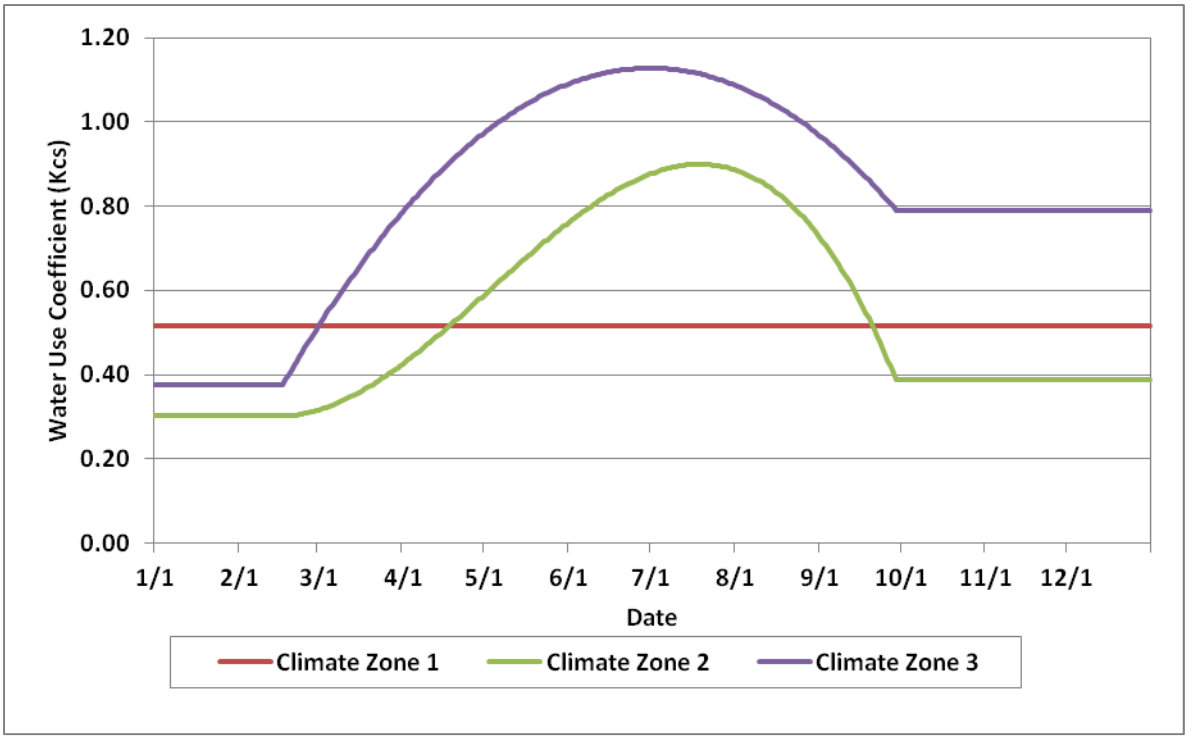


Figure 2.9. Stream Corridor Vegetation Daily Water Use Coefficients for Climate Zones 1, 2 and 3

As a check, the results for 2008 using the water use coefficients were compared to the actual ET measured by SEBAL (Table 2.15). The totals for the time period of the SEBAL results February 1 through September 30, 2008 were less than three percent different than the results using the water use coefficients.

Table 2.15. Total Depth of Stream Corridor Vegetation ET February 1, 2008, through September 30, 2008, by Climate Zone

Climate Zone	Area (ac)	Average ETa (SEBAL) (inches)	Average ETa (Kcs*ETo) (inches)	Difference (inches)	Percent Difference
1	1,275	23.9	23.3	0.6	2.5%
2	2,843	30.3	30.4	-0.1	-0.3%
3	1,900	41.3	41.3	0.0	0.0%

For stream corridor vegetation, which is not irrigated, the ETa is dependent on the availability of water in the stream corridor. Thus, the water use coefficients developed for 2008, a dry year with limited water availability, may underestimate the water consumed by stream corridor vegetation in wetter years. This is especially true for Climate Zone 1, where less water was consumed in some areas in the stream corridor vegetation area as the season progressed. Thus, during the early part of a season with more rainfall in April and May than occurred in 2008, the water use by the stream corridor vegetation may be slighty higher in Climate Zone 1 than the water use coefficient estimate. Climate Zones 2 and 3 did not show this pattern of reduction in

water consumption as the season progressed and thus, the water use coefficients are expected to provide a good estimate for water consumption in all years of this study.

2.4 Summary of Applied Water Estimates and Stream Vegetation Corridor ET

Table 2.16 provides a summary of applied water and stream vegetation corridor ET by calendar year. All volumes are in acre-feet and have been rounded to the nearest 1,000 acre-feet recognizing the uncertainty in the estimates.

Table 2.16. Applied Water Estimates and Stream Vegetation Corridor ET

Year	Applied Water Estimates	Stream Vegetation Corridor ET
2002	20,000	14,000
2003	15,000	13,000
2004	16,000	13,000
2005	10,000	12,000
2006	16,000	13,000
2007	16,000	14,000
2008	25,000	14,000

3 Conclusions

Applied water estimates were prepared for the AWAZ, an area along the Russian River and Dry Creek defined by fields whose irrigation diversions are known to have immediate or nearly immediate effects on Russian River and Dry Creek flows. The applied water estimates were calculated by multiplying crop acreages by crop-specific ET_a estimates derived from the SEBAL energy balance model applied to Landsat satellite images. The applied water estimates were corroborated through interviews with local experts and growers. Stream Corridor Vegetation ET was also estimated based on ET_a estimates from the SEBAL model. Water balance studies completed by others indicated that more Russian River depletion was occurring than was accounted for by applied water estimates within the AWAZ and Stream Corridor Vegetation ET combined. The applied water estimates for the AWAZ have been incorporated in the Russian River ResSim operations model. Studies to bring about additional future improvements are in the planning stage.

4 Recommendations

The following recommendations would result in further improvement of applied water estimates.

4.1 Recommendation 1: Prepare a Data Set of Reported Diversions and Associated Area for Comparison with Applied Water Estimates

SCWA should validate the calculated estimates of applied water through comparisons to measured values. This would involve compiling all available reported irrigation diversions for 2002 through 2008, linking the data to a water using area, reviewing this data for completeness and performing an accuracy assessment. Based on the accuracy assessment, some reported diversions may be removed from the reported diversion data set. Once the reported diversion data set is finalized, the reported diversions will be compared with estimates of applied water for the areas corresponding with the reported diversion data set. As reported irrigation diversions become available, a combined data set of reported diversions and applied water estimates should be used with ResSim. The reported data set is expected to increase and its accuracy improve with time.

4.2 Recommendation 2: Evaluate the Area of the Demand Impacting the Russian River

As noted earlier, evaluation of reach water balances performed by others indicates that Russian River and Dry Creek stream flow depletions typically exceed the applied water estimates within the currently defined AWAZ during the months of June through October. The pattern of stream flow depletions suggests that irrigation diversions (including groundwater pumping) outside of the currently defined AWAZ are also causing these depletions. Expanding the AWAZ successively to include additional agricultural fields, so that the pattern of observed stream flow depletion more closely follows a typical pattern of loss due to seepage would improve the separation of losses from unmetered diversions and improve confidence in projections of how losses might change with future changes in land use and climate.

5 References

Davids Engineering, Inc. 2005. Russian River Watershed Land Use Study and GIS Tool Task 3 – Field Studies Technical Memorandum: Vineyard Water Use and Irrigation Demands. March 2005. Prepared for Sonoma County Water Agency, Santa Rosa, CA. 58 p.

Farrar, C. D., L. F. Metzger, T. Nishikawa, K. M. Koczot, and E. G. Reichard. 2006. Geohydrologic Characterization, Water-chemistry, and Ground-water Flow Simulation Model of the Sonoma Valley area, Sonoma County, California, with a section on basement rock configuration interpreted from gravity data by Victoria E. Langenheim: U.S. Geological Survey Scientific Investigations Report 2006-5092, 167 p.

Greenspan, M. 2008. Water use in Vineyards: Russian River Basin Growers In a survey of growers, water use was found to vary from zero to excessive. 15 p.

Greenspan, M. 2007. Vineyard Water User Report. 7 p.

Grinnell, S. Forthcoming. Review of Russian River Reach Water Balances. Prepared for Sonoma County Water Agency, Santa Rosa, CA. xx p.

Johnson. L., L. Pierce, A. Michaelis, T. Scholasch, and R. Nemani. 2006. Remote Sensing and Water Balance Modeling in California Drip-Irrigated Vineyards Proceedings, ASCE World Environmental & Water Resources Congress, Omaha NE, 21-25 May 2006. 9 p.

Johnson, L. L, Pierce, R. Nemani. VSIM - Vineyard Soil Irrigation Model – release 3/1/06 - User Guide.

Johnson, L. and T. Scholasch. 2005. Remote Sensing of Shaded Area in Vineyards. Hort Technology, October-December 2005 15 (4). P. 859-863.

Lewis, D. J., G. McGourty, J. Harper, R. Elkins, J. Christian-Smith, J. Nosera, P. Papper, R. Sanford, L. Schwankl, and T. Prichard. 2008. Meeting irrigated agriculture water needs in the Mendocino County portion of the Russian River. University of California Cooperative Extension Mendocino County, University of California Davis Department of Land Air and Water Resources, and University of California Kearny Agricultural Center. 56 p.

Metzger, L. F., C. D. Farrar, K. M. Koczot, and E. G. Reichard. 2006, Geohydrology and Water Chemistry of the Alexander Valley, Sonoma County, California: U.S. Geological Survey Scientific Investigations Report 2006-5115, 83 p.

Mapping shows continued vineyard expansion in premium wine-growing areas. 2008. http://CaliforniaAgriculture.ucop.edu. January–March 2008. Research news.

Pierce, L. 2007. Proposition 50 Final Project Report. California University Monterey Bay Foundation, Monterey, CA.

PVID. 2008. Information regarding water use in Potter Valley. Potter Valley Irrigation District.

Potter Valley, California. 4 pages. Cited by Lewis, et al. 2008.

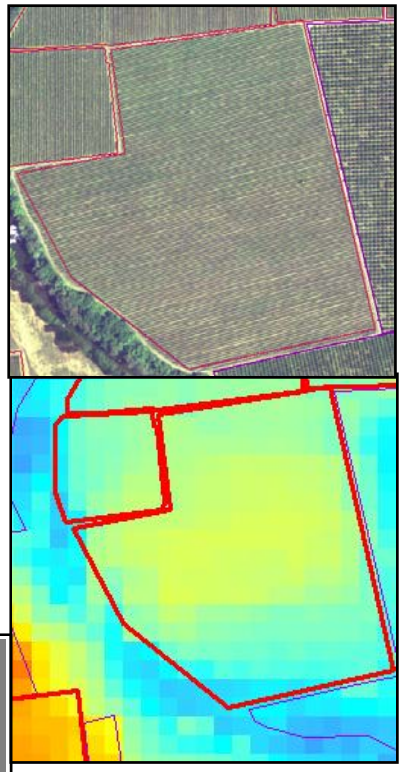
Smart, D.R., E. Schwass, A Lakso and L Morano. 2006. Grapevine Rooting Patterns: A Comprehensive Analysis and a Review. *Am. J. Enol. Vitic.* 2006; 57: 89-104.

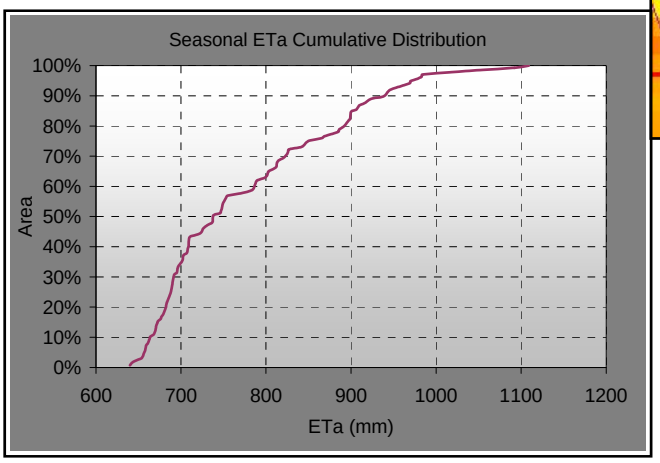
Stetson Engineers, Inc. 2008. Approach to Delineate Subterranean Streams and Determine Potential Streamflow Depletion Areas. Technical Memorandum prepared by Stetson Engineers, Inc. for the State Water Resources Control Board.

Wagner & Bonsignore. 2007. Volume I - Draft Report, North Sonoma County, Agricultural Reuse Project, Feasibility Study, July 2007. Prepared for Sonoma County Water Agency, Santa Rosa, CA. 84 p.

Appendix A. SEBAL Processing Report

Spatial Mapping of ET in the Russian River Basin of California Using SEBAL®





June 2009

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Introduction

Background

The Russian River originates in central Mendocino County, approximately 15 miles north of Ukiah. It drains 1,485 square miles including much of Sonoma and Mendocino counties, and reaches the Pacific Ocean at Jenner, 20 miles west of Santa Rosa (Figure 1). Its main channel is 110 miles long and flows generally southward from its headwaters near Redwood and Potter Valleys, to Mirabel Park, where the direction of flow changes to generally westward as it crosses part of the Coast Range. There are five principal tributaries: East Fork of the Russian River, Big Sulphur Creek, Mark West Creek, Maacama Creek, and Dry Creek.

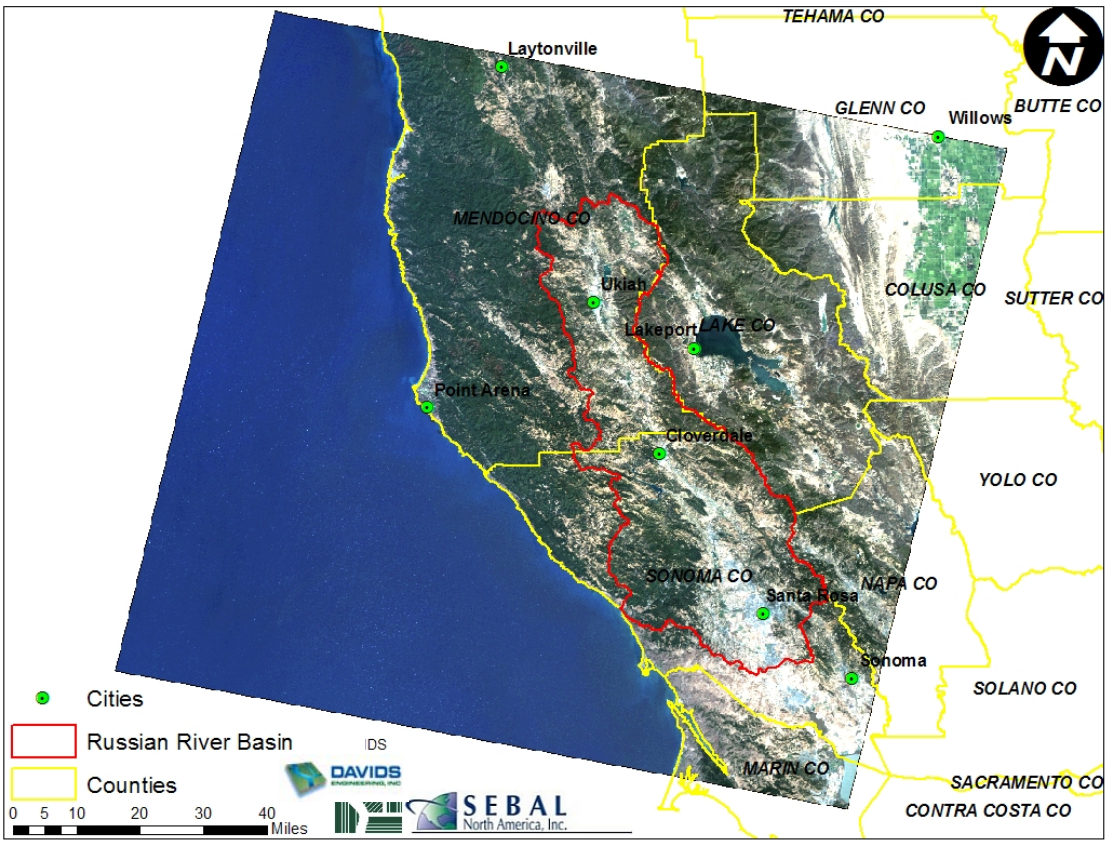


Figure 1. Russian River Basin and Neighboring Areas (Landsat Path 45, Row 33)

The Sonoma County Water Agency (SCWA) was created as a special district in 1949 by the California Legislature to act as the local sponsor for federal flood protection and water supply projects known collectively as the Russian River Project. The Agency commissioned development of agricultural applied water estimates for incorporation into the Russian River ResSim Model to account for unmetered agricultural diversions separately from system loss. The Russian River ResSim model supports the Agency's reservoir and river operations. Incorporating applied water estimates into the Russian River ResSim model supports improved river operations by narrowing the loss estimate to only those flow components that cannot be otherwise measured or estimated.

Accurate *actual* evapotranspiration (ET) estimates are critically important to accurately estimating applied water. Especially important in the Russian River watershed because wine grapes, the major crop in the region, are often deficit irrigated leading to overestimation of water consumption by traditional crop ET estimation methods. The Surface Energy Balance Algorithm for Land (SEBAL®) has been selected to compute *actual* ET (ET_a) via remote sensing at 30 meter pixel resolution in the Basin, inherently accounting for deficit irrigation.

SEBAL North America Inc. processed nine Landsat images (Landsat 5 and 7) to estimate ET_a for the 2008 crop growing season (February – September) in the Russian River Basin (Table 1). The false color composites of the satellite images for selected dates are provided in Figure 2. These images show near-infrared radiation, indicative of green vegetation growth, in red.

Table 1. Selected Landsat Images from Path 45, Row 33

Date	Sensor/Satellite	*Cloud Cover %	Comments
February 13th , 2008	ETM+/7	0	Clear in the basin
March 24th , 2008	TM/5	10	Clouds over the ocean and in upper north portion of the basin
April 25th, 2008	TM/5	0	Haze over the ocean, mostly clear in the basin except a small group of cumulus clouds on its N-E edge
May 11th, 2008	TM/5	0	Mostly clear in the basin except few small cumulus clouds on its N-E edge
June 4th, 2008	ETM+/7	57	Clouds mostly over the ocean
June 28th, 2008	TM/5	0	Mostly clear in the basin except some clouds in its south portion
July 30th, 2008	TM/5	23	Clouds over the ocean only
August 31st, 2008	TM/5	0	Clear in the basin
September 24th, 2008	ETM+/7	1	Clear in the basin

* From USGS website (http://glovis.usgs.gov).

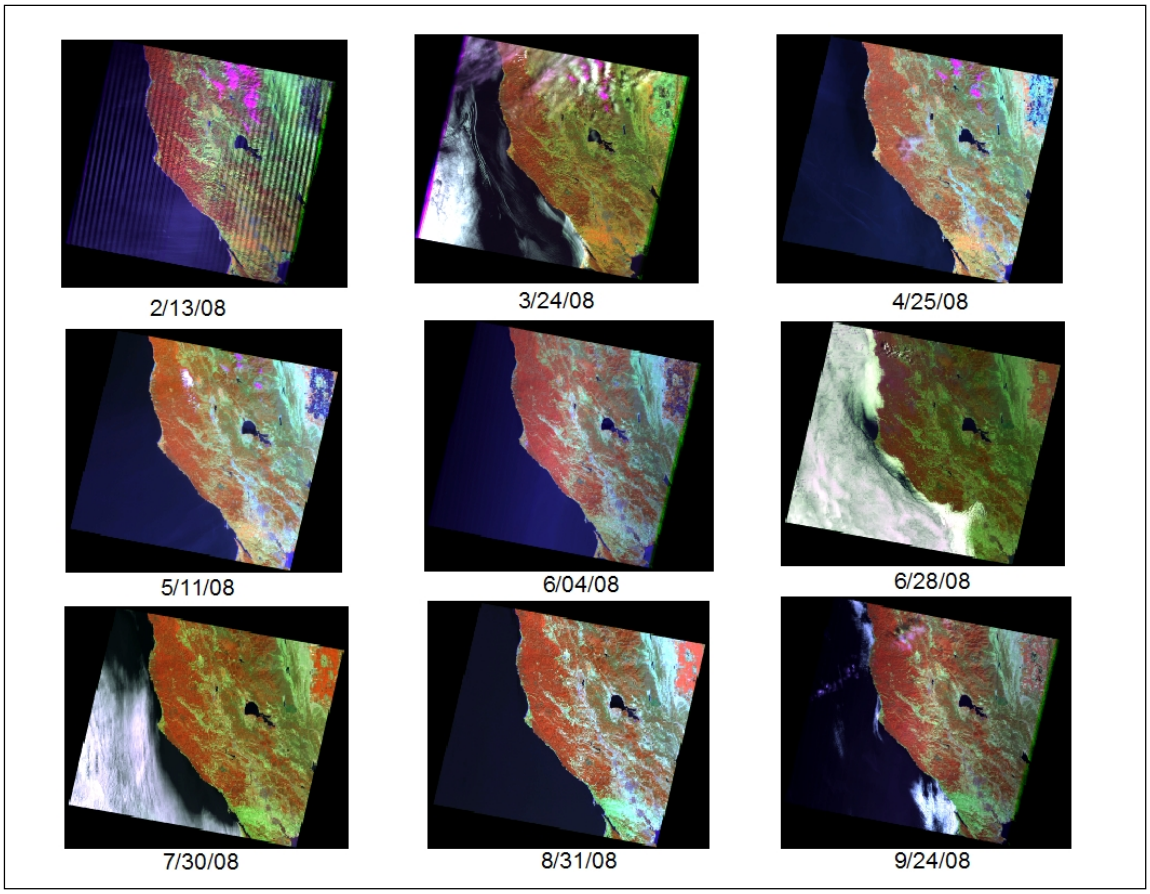


Figure 2. Landsat False Color Composite Images (Path 45, Row 33)

SEBAL uses MeteoLook (Voogt, M.P., 2006), a collection of algorithms developed at WaterWatch, Inc. in the Netherlands, to interpolate point weather observations based on the surface and terrain characteristics coupled with physically-based models. Processes that influence surface weather conditions such as elevation, surface roughness, albedo, incoming radiation, land wetness, and distance to water bodies are represented in MeteoLook. This improved spatial distribution of weather data and the resulting *actual* ET results obtained from the SEBAL are expected to improve the ability to estimate water demand and use in the Russian River Basin.

The SEBAL ET coverages will be combined with land use data to characterize the spatial and temporal patterns of ET_a throughout the study area. While primary emphasis will be on irrigated crop areas, the analysis will also provide ET estimates for native vegetation and stream corridor vegetation. This information will provide data for calibration of a root zone model and will increase overall confidence in the depletion and diversion analysis. The data will also be used to support the development of reach level water budgets for the determination of natural flow availability subject to assumptions regarding region wide ET, precipitation and groundwater parameters.

SEBAL Products

This report is accompanied by the following spatially distributed grids:

a) ET_a – Actual ET grids for each image date, for the period represented by each image, and for the season as a whole.
b) ET_p – Potential ET grids for each image date, for the period represented by each image, and for the season as a whole.
c) K_c – Crop coefficient grids calculated as ET_p/ET_o for each image date. ET_o is the spatially distributed reference ET (short reference crop) calculated within SEBAL models from weather grids generated by MeteoLook.
d) K_s – Stress coefficient grids calculated as ET_a/ET_p for each image date.

These deliverables are summarized briefly in Table 2. Additional details are provided in the Methodology section of this report. The deliverables are provided as Arc Info grids projected in UTM Zone 10N with WGS84 datum and units of meters.

Table 2. Brief Description of SEBAL Deliverables

Product	Timescale	Units
Actual ET, ET_a	Daily, Periodic, Seasonal	Millimeters (mm)
Crop coefficient, K_c	Daily	dimensionless
Stress Coefficient, K_s	Daily	dimensionless
Potential ET, ET_p	Daily, Periodic, Seasonal	Millimeters (mm)

Methodology

Data Sources and Preprocessing

Multispectral satellite imagery, ground-based meteorological observations, a digital elevation model (DEM), and land cover classifications were utilized in the SEBAL application. These input data were obtained from sources including USGS (imagery and DEM) and MDA Geospatial Services (imagery). Meteorological data was obtained from a combination of weather stations networks that included the California Irrigation Management Information System (CIMIS), Remote Automated Weather Stations (RAWS), National Weather Service (NWS), and Private Weather Stations (PWS). Landuse information for the Russian River basin was provided by SCWA, and additional information was obtained from a 2007 land use map developed by the USDA National Agricultural Statistics Service. Standard quality checks and quality assurance measures were completed before utilization of any data. Additional information describing these data, quality control and assurance measures, and a brief description of pre-processing steps required for SEBAL are included herein.

Multispectral Satellite Imagery

The satellite data include raster images in visible, near-infrared, and thermal bands of the electromagnetic spectrum acquired by the onboard Landsat 5 and Landsat 7 Thematic Mapper (TM) and Enhanced Thematic Mapper (ETM+) sensors, respectively. The spectral and spatial resolution details of the acquired data are presented in Table 3.

Table 3. Landsat Band Designations and Spatial Resolution

Bands	Wavelength, micrometers		Resolution, meters (m)
	TM (Landsat 5)	ETM + (Landsat 7)	
1	0.45 – 0.52	0.450 – 0.515	30
2	0.52 – 0.60	0.525 – 0.605	30
3	0.63 – 0.69	0.630 – 0.690	30
4	0.76 – 0.90	0.760 – 0.900	30
5	1.55 – 1.75	1.550 – 1.750	30
6	10.40 – 12.50	10.40 – 12.50	120[1]/60[2]
7	2.08 – 2.35	2.080 – 2.35	30
8	-	0.52 – 0.92	15

[1] Original resolution for TM, resampled to 30m using the nearest neighbor method.
[2] Original resolution for ETM+. Band 6 on Landsat 7 is divided into two bands, high and low gain.

The Landsat raster grids were supplied by the vendors (MDA-Geospatial services and USGS) in geotiff (.tif) format. All individual grids were imported into ERDAS Imagine software and converted into '.img' format. The six rasters in the visible and near-infrared bands for each date were spatially stacked using the Spatial Modeler in ERDAS Imagine to obtain composite images for image processing and display of multispectral false color composite (FCC). The two thermal bands for each Landsat 7 image were stacked separately.

Pixel fitting was performed to ensure that pixels from consecutive image dates for each path and row have the same location. Pixel fitting is a two step process performed in order to minimize the spatial mismatch among the individual images. First, a reference FCC is selected and the FCCs for the other dates are adjusted to match the reference image at pixel scale. Then the thermal band is pixel fitted to its respective FCC. The pixel fitting procedure is repeated for all image dates. The resulting pixel alignment among the FCC images prevents overlap between different locations, thereby reducing potential error in the ET estimates that could occur when analyzing individual pixel results.

Meteorological Data

Measurements of incoming solar radiation (R_s), air temperature (T_a), relative humidity (RH) and wind speed (W_s) are used in the SEBAL analysis. These meteorological data are analyzed at instantaneous (time of the satellite overpass), daily (average for the image date), and periodic (average for the period represented by an individual image date) time steps. These parameters were obtained from the following meteorological data sources:

- California Irrigation Management Information System (CIMIS). CIMIS is a network of over 120 automated weather stations distributed across the State of California, operated by the Department of Water Resources and its partner agencies.
- Remote Automated Weather Stations (RAWS). RAWS is a network of more than 2,200 weather stations operated by the US Forest Service. RAWS data were obtained from Weather Underground (www.wunderground.com).
- National Weather Service (NWS). The NWS operates weather stations at airports and other locations throughout the United States. NWS data were obtained from Weather Underground (www.wunderground.com).

- Personal Weather Stations (PWS). A limited number of personal weather stations were identified to enhance the spatial coverage of weather data in the Basin. PWS data were obtained from Weather Underground (www.wunderground.com).

Fourteen CIMIS and eleven Weather Underground stations within or surrounding the Landsat scene extent were selected for the SEBAL analysis (Table 4a & 4b and Figure 3). As described below, weather data from each station were reviewed and corrected when necessary, following accepted, scientific procedures (Allen, et al 1996, FAO 1997 and Allen et al., 2005). Quality controlled weather data were interpolated based on elevation and other surface characteristics using MeteoLook to develop spatially distributed grids of the weather parameters for input into SEBAL.

Quality Control of Meteorological Data

Data downloaded for each weather station were quality checked according to the guidelines specified in Appendix-D of the ASCE Task Committee Report on the Standardized Reference Evapotranspiration Equation (Allen et al., 2005). These checks are described briefly in this section, and samples of weather data used in the analysis are provided.

Incoming Solar Radiation. Incoming solar radiation (R_s) data were available for the CIMIS stations only. Values for each station were compared to the estimated clear sky solar radiation (R_{so}) for both hourly time steps on the image date and for daily time steps throughout the period of analysis. Comparison of reported R_s to theoretically estimated R_{so} shows that R_s falls below R_{so} at times possibly due to clouds or haze; however, observed R_s values should approach R_{so} on clear days. The data are examined to look for consistent biases throughout the period of interest and to look for abrupt changes that could result from changes to the pyranometer such as cleaning, re-calibration, or re-leveling.

Stations that revealed significantly low solar radiation measurements over a sustained period of time e.g., Sanel Valley CIMIS station (Figure 4) were adjusted using appropriate constants or functions obtained from comparison of estimated R_{so} values and observed R_s values.

Air Temperature. Daily air temperature observations were checked by comparing the average values obtained from the daily extremes (T_{max} and T_{min}) with the average values directly recorded by the data loggers and calculated from hourly values. The average is expected to fall within 2 degrees C, except potentially in cases of precipitation, change in prevailing wind, or other variable conditions where the estimates could differ by more than 3° C. Samples of the temperature differences calculated for Esparto Station are provided in Figure 5.

Deviations in excess of 2° C on certain days are apparent in Figure 5; however these deviations do not appear to indicate errors in measurement because they do not occur chronically over an extended period of time. It is suspected that these deviations could be due to changes in weather conditions.

Table 4a. Summary of CIMIS Weather Stations Selected

ID	Station	County	Activation Date	Status	Elevation (ft)	Lat	Long
32	Colusa	Colusa	13-Jan-83	Active	55	39.23	-122.02
61	Orland	Glenn	13-May-87	Active	198	39.69	-122.15
77	Oakville	Napa	1-Mar-89	Active	190	38.43	-122.41
83	Santa Rosa	Sonoma	1-Jan-90	Active	80	38.40	-122.80
85	Hopland FS	Mendocino	23-Sep-89	Active	1160	39.01	-123.08
103	Windsor	Sonoma	14-Dec-90	Active	85	38.53	-122.83
106	Sanel Valley	Mendocino	1-Feb-91	Active	525	38.98	-123.09
109	Carneros	Napa	11-Mar-93	Active	5	38.22	-122.35
123	Suisun Valley	Solano	18-Aug-94	Active	35	38.23	-122.12
144	Petaluma East	Sonoma	25-Aug-99	Active	97	38.27	-122.62
158	Bennett Valley	Sonoma	1-Oct-00	Active	270	38.42	-122.66
170	Concord	Contra Costa	6-Apr-01	Active	35	38.00	-122.02
187	Black Point	Marin	1-Jun-03	Active	1	38.09	-122.53
196	Esparto	Yolo	15-Apr-05	Active	174	38.69	-122.14

Table 4b. Summary of Weather Underground Stations Selected

ID	Station	County	Network	Elevation (ft)	Lat	Long
MBNVC1	Boonville	Mendocino	RAWS	642	38.987	-123.349
KCAMANCH 1	Irish Beach	Mendocino	PWS	212	39.023	-123.689
MRDVC1	Rodeo Valley	Mendocino	RAWS	2423	39.668	-123.320
MECKC1	Alder Springs	Glenn	RAWS	4552	39.651	-122.724
KCACLEAR2	Clearlake Oaks	Lake	PWS	1300	39.020	-122.710
MSYWC1	Stonyford	Colusa	RAWS	1256	39.367	-122.573
MMCGC1	Mcguires	Mendocino	RAWS	590	39.353	-123.601
MCZCCA	Cazadero	Sonoma	PWS	1557	38.610	-123.220
KCAMENDO 1	Mendocino	Mendocino	PWS	80	39.307	-123.799
MHWKC1	Hawkeye	Sonoma	RAWS	2020	38.735	-122.837
KUKI	Ukiah	Mendocino	NWS	614	39.130	-123.200

Remote Automated Weather Stations (RAWS)
National Weather Service (NWS)
Private Weather Stations (PWS)

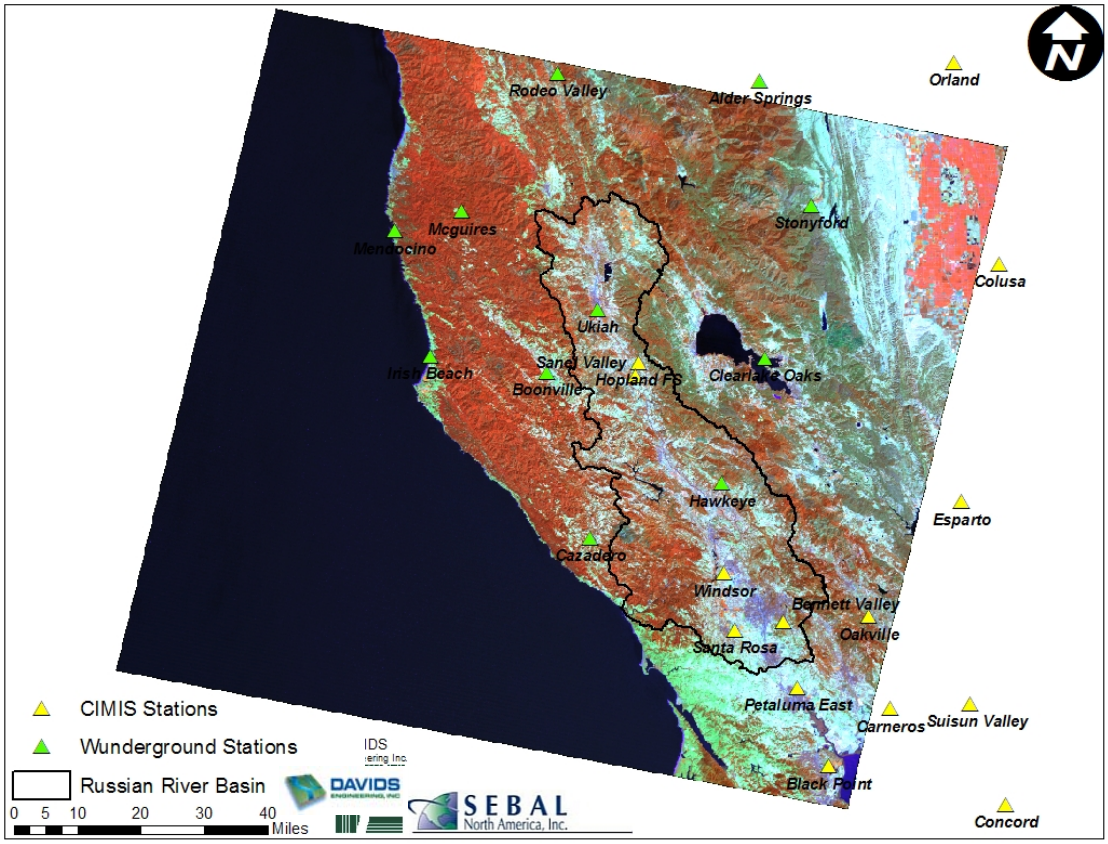
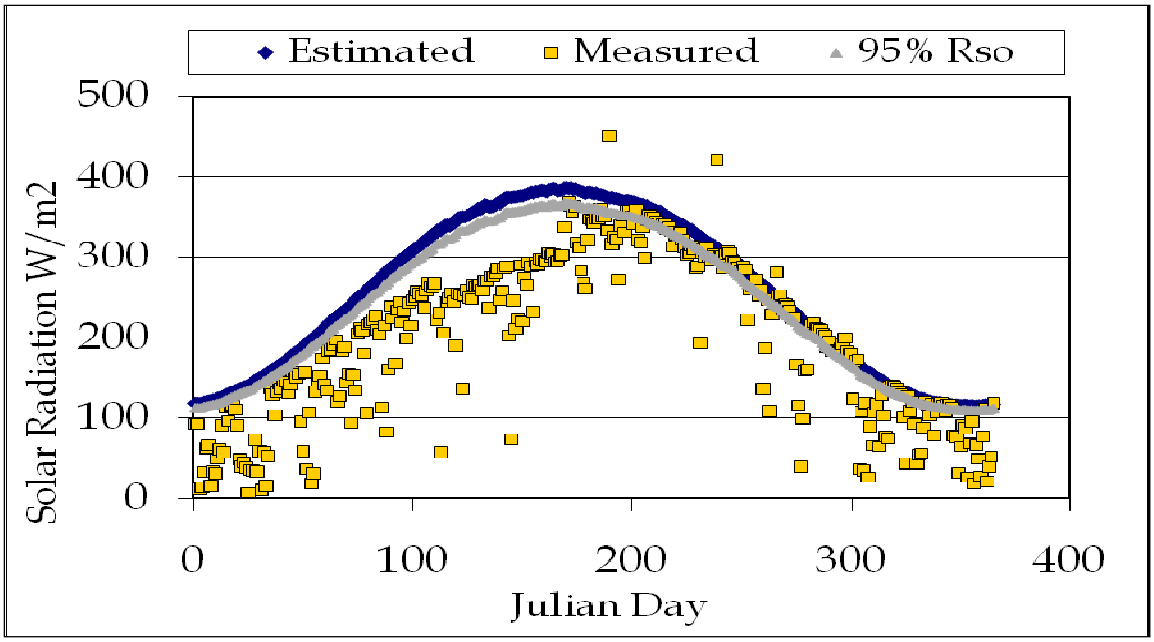


Figure 3. Selected CIMIS and Weather Underground Stations (Landsat Path 45, Row 33)



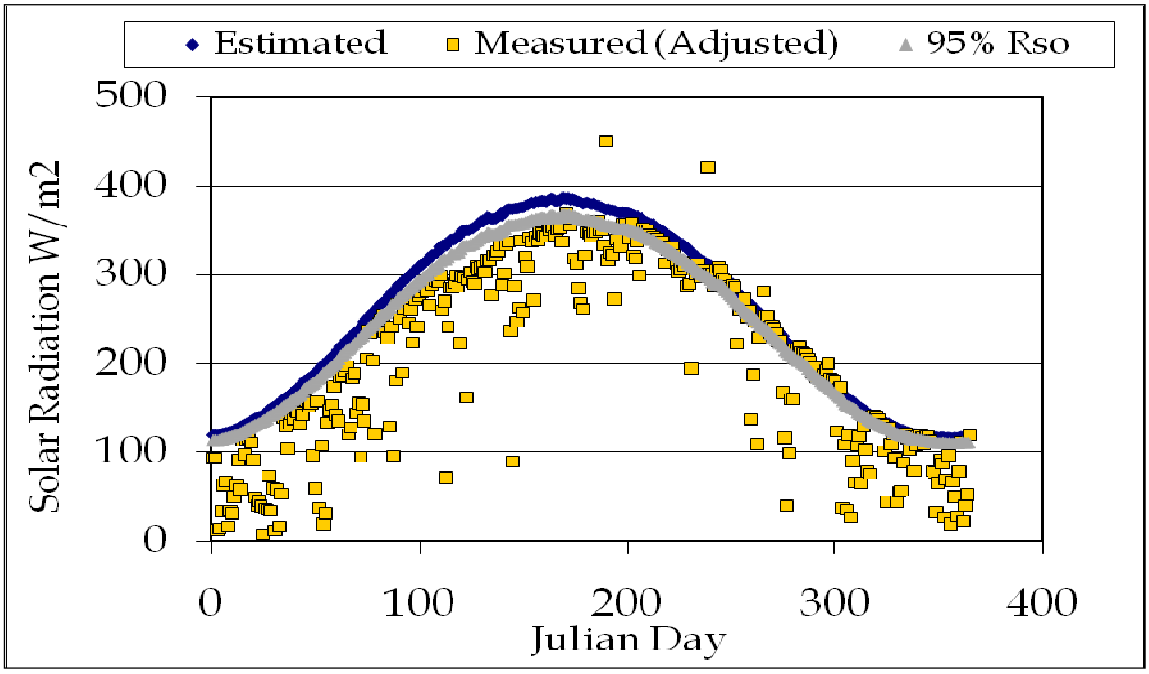


Figure 4. Incoming Solar Radiation (R_s) and Theoretical Clear Sky Radiation (R_{so}) Observed at Sanel Valley Station (CIMIS Station #106) during 2008 (top) and Adjusted R_s (bottom)

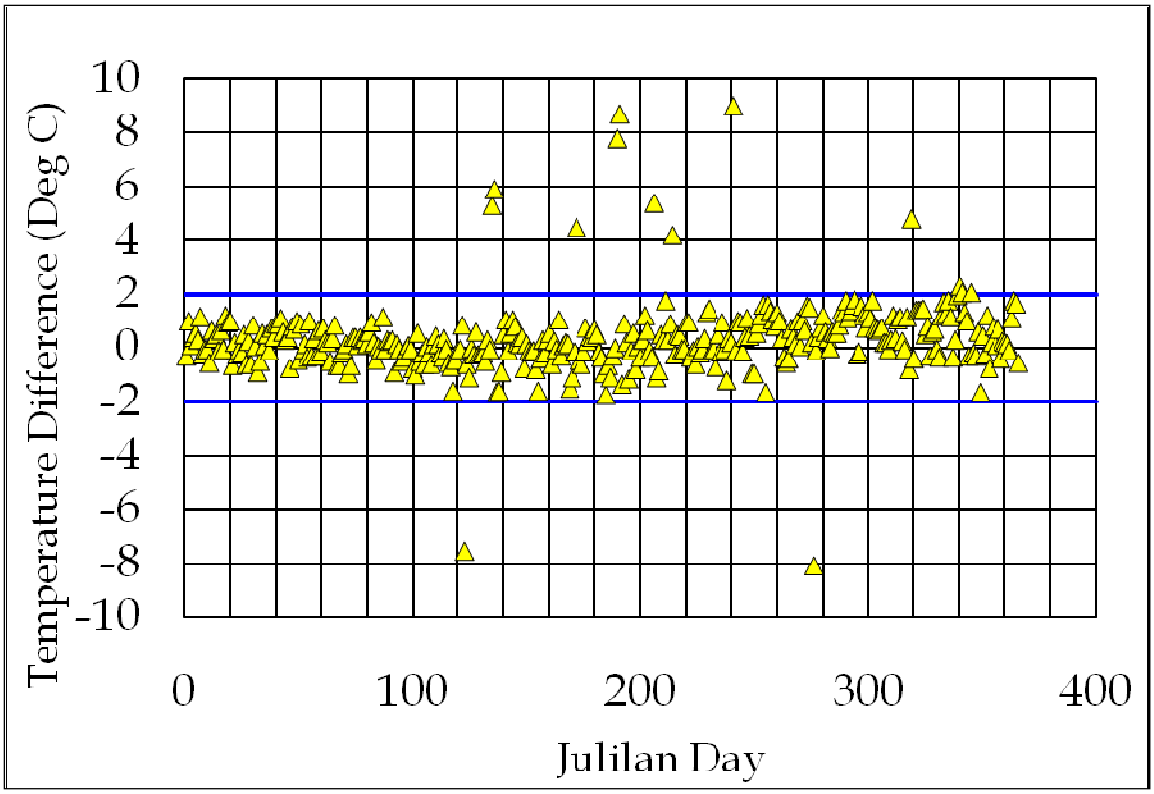


Figure 5. Difference between Daily Average Temperature Based on Daily Extremes and Hourly Values at Esparto Station (CIMIS Station #196) for 2008

Relative Humidity. Relative humidity (RH) data were reviewed for each station. Daily average RH values were plotted along with precipitation, and the data were visually inspected to identify values less than 25-30% and greater than 100% as recommended by Allen et al. (2005) for sub humid regions. A sample plot for the Orland Station is provided in Figure 6. Additionally, reported RH values were checked to confirm an increase following a heavy precipitation event.

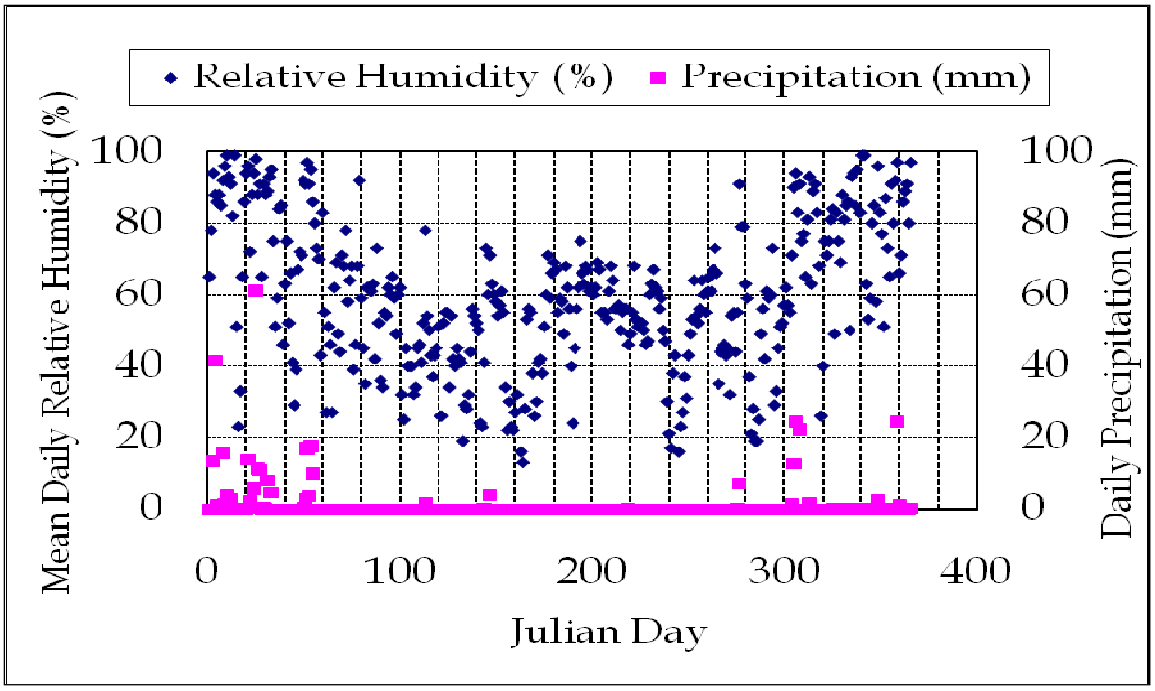


Figure 6. Mean Daily Relative Humidity and Total Precipitation from Orland Station (CIMIS Station #61) for 2008

Wind Speed. Mean daily wind speed observations for all stations were plotted and inspected for consistently low values of 0.5 meters per second or less, which typically represent a failed anemometer. Mean daily wind speed observations for the Oakville Station are provided in Figure 7.

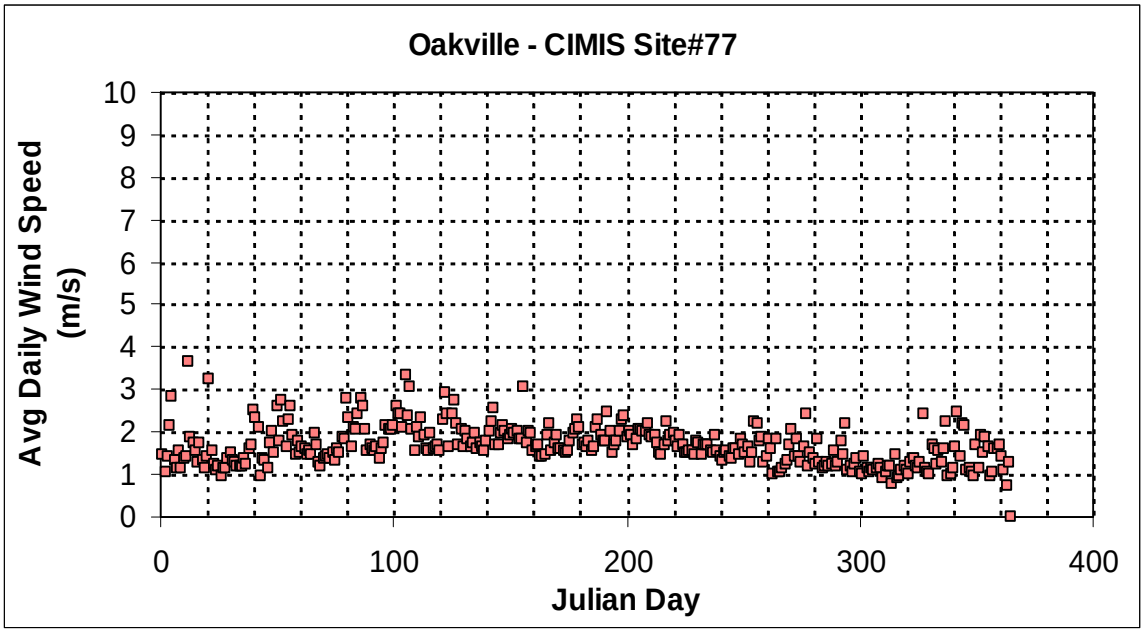


Figure 7. Mean Daily Wind Speed Measured at Oakville (CIMIS Station #77) for 2008

Additionally, daily wind gust factors (ratio of maximum wind speed to mean daily wind speed) were checked for each station. Sudden increases in the gust factor can indicate anemometer bearing failure, while a sudden drop to a gust factor of 1.0 can indicate seizure or electronic failure of the anemometer. The daily gust factors for the Oakville Station are provided in Figure 8.

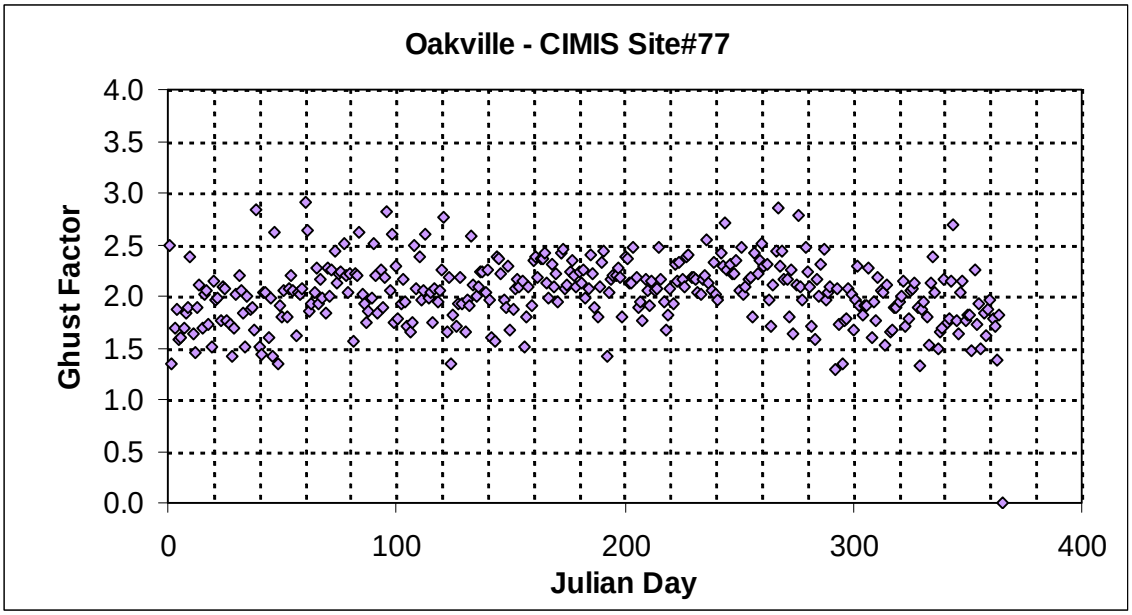


Figure 8. Gust Factor at Oakville (CIMIS Station #77) for 2008

Development of Weather Grids

Weather observations from ground stations represent point measurements that may be representative of the surrounding area; however, in many cases, particularly for heterogeneous regions, the point data may not be suitable to represent weather conditions of the surrounding area. To overcome this limitation, spatially distributed weather grids were developed based on specialized interpolation to better represent the variability in the surface weather conditions that drive ET.

MeteoLook (Voogt, M.P., 2006) is a collection of algorithms developed at WaterWatch, Inc., the Netherlands (original developer of SEBAL) that interpolate point weather observations based on the knowledge of surface and terrain characteristics coupled with physically-based models. Processes that influence surface weather conditions such as elevation, surface roughness, albedo, incoming radiation, land wetness, and distance to water bodies are included in MeteoLook. MeteoLook is used to spatially distribute observed surface air temperature, relative humidity, and wind speed from the selected weather stations, generating grids of the respective parameters encompassing the satellite image area.

Spatially distributed grids of incoming solar radiation were developed from spatially distributed transmissivity and estimates of extra-terrestrial radiation (incoming solar radiation before it enters Earth's atmosphere). The transmissivity at each station over time was calculated by dividing the observed incoming solar radiation by the estimated extra-terrestrial radiation. Transmissivity estimates at each station location were then interpolated using MeteoLook.

Finally, incoming solar radiation grids were developed based on grids of extra-terrestrial radiation and transmissivity.

Digital Elevation Model (DEM)

A DEM of 1 arc-second resolution (approximately 30 m) developed as part of the Shuttle Radar Topography Mission (SRTM) was downloaded from the USGS seamless data distribution system (seamless.usgs.gov) for the image area. Gap filling was performed for the missing data within the DEM. Then, individual quads were mosaicked, re-projected and resampled to 30 m pixel size to match the pixel size and alignment of the other SEBAL inputs. The DEM encompassing the study area is shown in Figure 9.

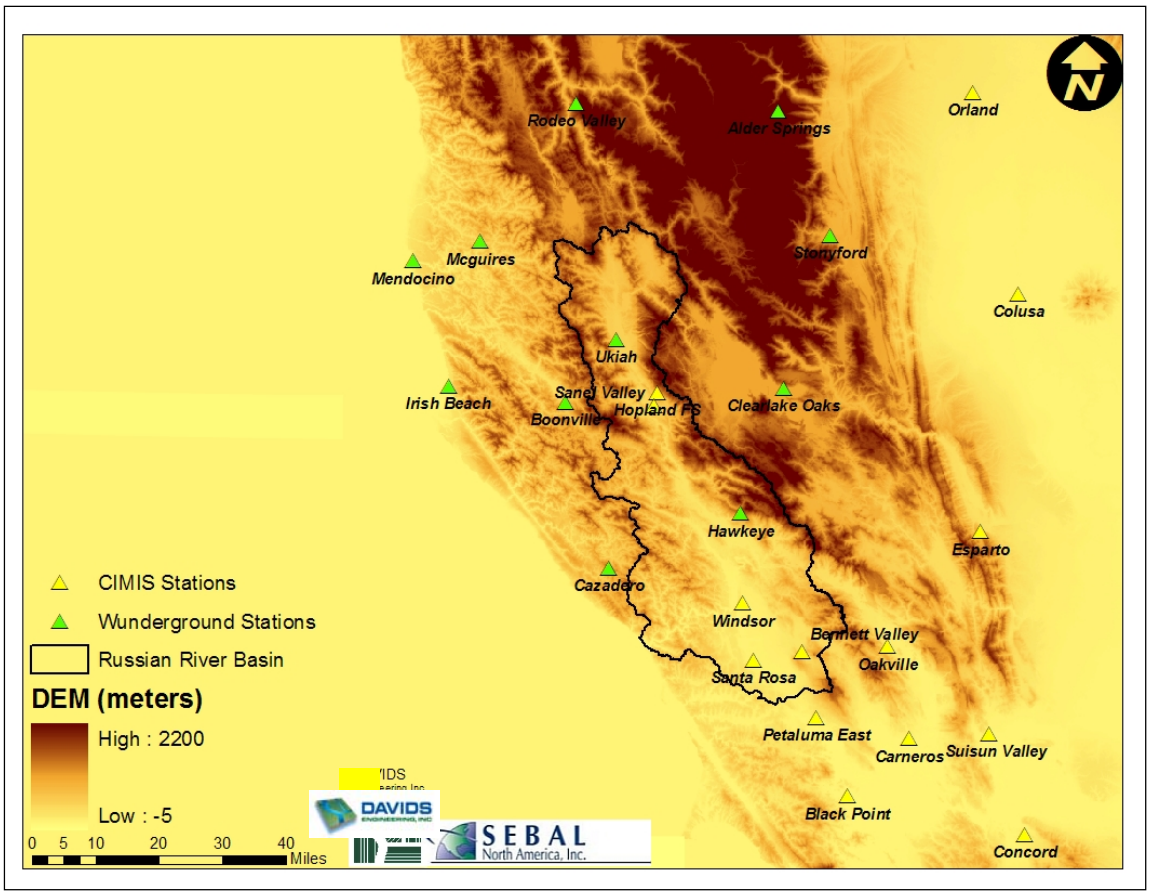


Figure 9. Digital Elevation Model for the Russian River Basin

Landuse Classification

Landuse data are used in SEBAL to parameterize the roughness lengths across the land surface. In the absence of available landuse data, roughness lengths may be approximated based on general knowledge of the area of study. For studies in the U.S., SNA uses data from the National Land Cover Dataset (NLCD), or more detailed data if available.

Information describing landuse types within the Russian River basin was derived from a crop/landuse survey provided by SCWA in a geodatabase format. The geodatabase was converted into raster format based on unique crop/landuse class to be consistent with other

inputs for SEBAL. Areas not included in the SCWA landuse coverage were classified using the National Agricultural Statistics Service 2007 California Cropland Data Layer landuse coverage obtained from the NRCS geospatial data gateway at datagateway.nrcs.usda.gov. The landuse coverages were combined to obtain a landuse map covering the entire area falling within the selected Landsat scenes.

Figure 10 provides a subset of the combined landuse map for the basin and neighboring areas.

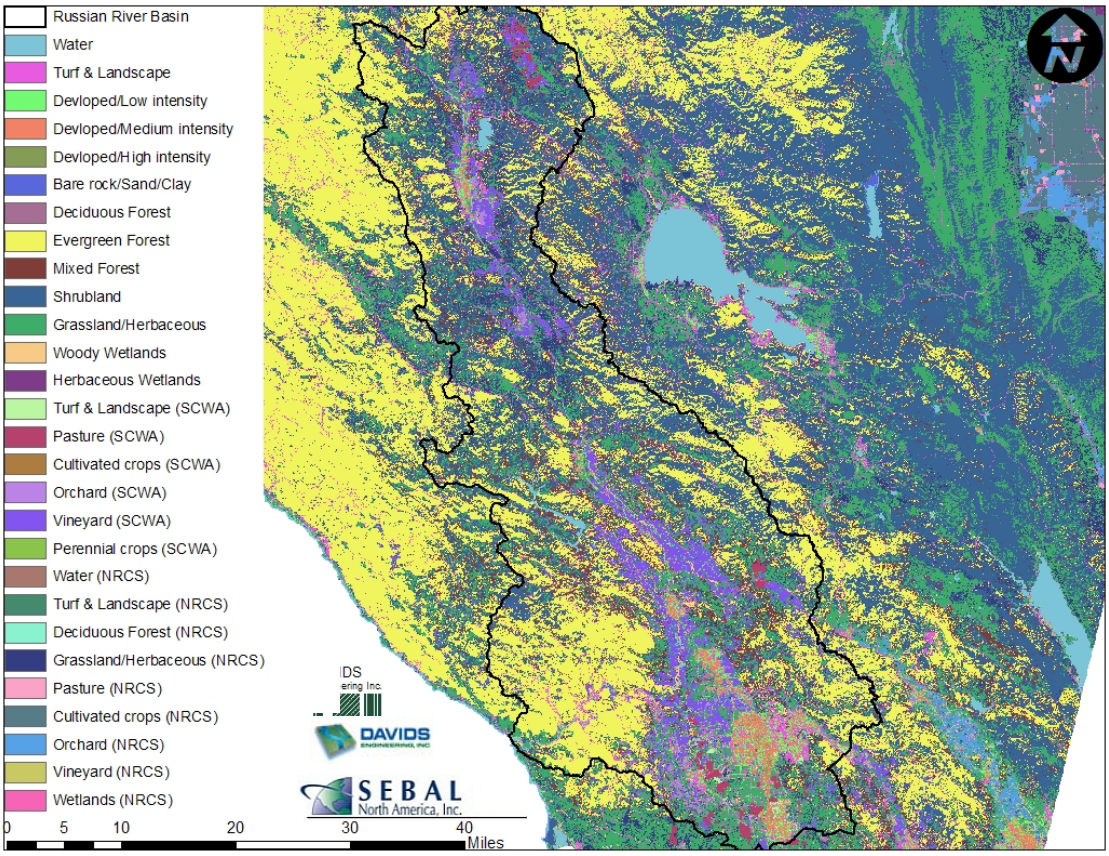


Figure 10. Landuse Map for Russian River Basin

A maximum crop height was assigned to each landuse class. Table 5 provides the assigned crop heights and approximate acreage for selected landuse types. These heights were assigned to each respective class from the landuse map, and a linear relation was used to adjust the crop heights according to the growing stage at the image date. This linear relation was derived using the Normalized Difference Vegetation Index (NDVI) grid for the particular image date assuming that maximum crop height was reached at an NDVI value of 0.75.

Table 5. Maximum Heights and Approximate Extent of Selected Landuse Classes within the Russian River Basin

LU Code	Crop type	Height (meter)	Total Acres
11	water	0.0002	6,624
21	turf and landscape	0.15	47,954
22	developed/low intensity	1.5	19,615
23	developed/medium intensity	3	15,074
24	developed/high intensity	5	1,853
31	bare rock/sand/clay	0.01	1,411
41	deciduous forest	5	16,647
42	evergreen forest	7	252,254
43	mixed forest	6	86,649
52	Scrub/shrubland	1.5	227,846
71	grassland/herbaceous	0.5	142,323
90	woody wetlands	1.5	3,648
95	herbaceous wetlands	1	858
121	turf and landscape, SCWA	0.15	1,491
181	pasture, SCWA	0.5	10,762
182	cultivated crops, SCWA	1	553
183	orchard, SCWA	3	6,264
184	vineyard, SCWA	1.5	60,655
185	perennial crops, SCWA	1.5	185
211	water, NRCS	0.0002	6
221	turf and landscape, NRCS	0.15	7
241	deciduous forest, NRCS	5	1
271	grassland/herbaceous, NRCS	0.5	42,097
281	pasture, NRCS	0.5	1,034
282	cultivated crops, NRCS	1	1,536
283	orchard, NRCS	3	1,235
284	vineyard, NRCS	2	2,266
		Total Acres:	950,848

Overview of SEBAL

SEBAL (Surface Energy Balance Algorithm for Land) was developed by Dr. Wim Bastiaanssen of The Netherlands (Bastiaanssen et. al., 1998a, 1998b and 2005). SEBAL uses spectral radiances recorded by satellite-based sensors, plus ordinary meteorological data, to solve the energy balance at the Earth's surface (Figure 11). SEBAL computes actual evapotranspiration (ET_a) for each pixel in a multispectral satellite image by applying radiative, aerodynamic and energy balance physics in 25 computational steps incorporated into 19 models.

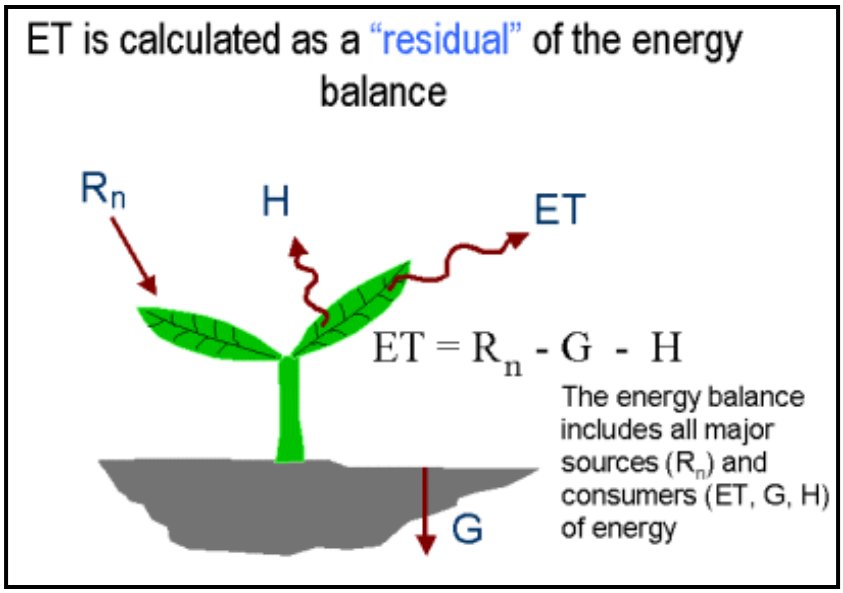


Figure 11. Conceptual Schematic of the Surface Energy Balance

SEBAL offers three distinct advantages compared to the generally accepted "K_c x ET_o" method for computing ET:

1. SEBAL computes actual evapotranspiration (ET_a), inherently accounting for the effects of salinity, deficit irrigation, disease, poor plant stands, etc., on the ET flux. Including these influences in the standard K_c x ET_o computation requires considerable additional data (typically unavailable) as well as substantial time and effort.
2. SEBAL does not need crop type to solve the energy balance, so precise records of cropping patterns are not needed.
3. The acreage of water-using land is observed directly from the satellite image, so accurate landuse is implicit to the process. These features overcome the typical difficulty of assembling accurate records of irrigated areas and cropping patterns, particularly for historical analyses.

The resulting ET_a and crop coefficient raster images can be imported directly into GIS for spatial analysis, in combination with landuse and other data. High spatial resolution (30 m) enables analysis within irrigated fields facilitating water use and crop production uniformity assessments. Additional information describing SEBAL is found in Bastiaanssen et al., 2005.

SEBAL Outputs

The primary output of SEBAL is actual ET (ET_a). The additional products generated as part of the SEBAL process are described in this section.

Reference (ET_o) and Potential (ET_p) Evapotranspiration

ET_o is estimated from spatially distributed meteorological data using the ASCE Standardized Penman – Monteith grass reference equation (Equation 1). ET_o is calculated from Equation 1 based on a hypothetical grass reference surface with an assumed fixed height of 0.12 m, a bulk surface resistance of 70 seconds per meter, and an albedo of 0.23.

$$ET_o = \left\{ \frac{\Delta(R_n - G) + k_{time}\rho_a c_p \dfrac{(e_s - e_a)}{r_a}}{\Delta + \gamma\left(1 + \dfrac{r_s}{r_a}\right)} \right\} / (\lambda \rho_w) \qquad (1)$$

where

ET_o = reference evapotranspiration (mm/d or mm/hr),
R_n = net radiation (MJ/m²/d or MJ/m²/hr),
G = soil heat flux (MJ/m²/d or MJ/m²/hr),
$(e_s - e_a)$ = vapor pressure deficit of the air (KP_a),
e_s = saturation vapor pressure of the air (KP_a),
e_a = actual vapor pressure of the air (KP_a),
ρ = mean air density at constant pressure (kg/m³),
c_p = specific heat capacity of the air (MJ/Kg/°C),
Δ = slope of the saturation vapor pressure-temperature curve (KP_a/ °C),
γ = psychrometric constant (KP_a/ °C),
r_s = (bulk) surface resistance (s/m),
r_a = aerodynamic resistance (s/m),
λ = latent heat of vaporization (MJ/Kg),
ρ_w = density of water, (Mg/m³),
k_{time} = unit conversion, equal to 86,400 s/d for ET in mm/d and equal to 3600 s/h for ET in mm/h.

ET_p is also calculated from Equation 1, except that a variable minimum bulk surface resistance is used instead of a constant value of 70 s/m. This variable minimum bulk surface resistance is derived from spatially distributed estimates of leaf area index (LAI). ET_p represents the potential ET based on the LAI of vegetation at the time of the image. Note that if chronic stress has reduced the LAI, the ET_p will be less than it would be if the vegetation had been continuously healthy.

Crop (K_c) and Stress (K_s) Coefficients

The crop coefficient (K_c) is calculated as the ratio between ET_p/ET_o and represents no acute stress. Note that unlike the traditional concept of K_c, which represents a crop free from stress, the crop coefficient calculated by SEBAL reflects the impact of chronic stresses prior to the image date that may have stunted crop development. The stress coefficient, K_s (ET_a/ET_p), takes into consideration acute stresses due limited water supply or other environmental as well as management effects. The product of K_c and K_s (ET_a/ET_o) provides a lumped crop coefficient representing actual field conditions.

Development of Period Outputs

The SEBAL model derives instantaneous energy fluxes for the time of satellite image acquisition. Instantaneous ET values are extrapolated to daily and longer period using average weather conditions, available energy (R_n – G) for the period, and the evaporative fraction, which is assumed to remain constant during the daytime hours in the absence of advection. These

daily and periodic ET values are then adjusted for advection effects. Period outputs representing accumulative ET over a period of days were developed for each image date. A total of 9 sets of periodic outputs were generated. The periods represented by each image in the periodic outputs are described in Table 6.

Table 6. Periods Represented by Each Landsat Image Date

Image Date	Period Represented	Total No. of Days
February 13th , 2008	Feb 1-Mar4	33
March 24th , 2008	Mar 5 - Apr 14	41
April 25th, 2008	Apr 15 - May 3	19
May 11th, 2008	May 4 - May 23	20
June 4th, 2008	May 24 - June 16	24
June 28th, 2008	June 17 - July 14	28
July 30th, 2008	July 15 - Aug 15	32
August 31st, 2008	Aug 16 - Sept 12	28
September 24th, 2008	Sept 13 - Oct 15	33

Cloud Masking and Scan Line Corrector (SLC) Gaps

Cloud masking was performed for the areas (in the respective image dates) that were obscured by clouds and haze. Cloud masking was performed prior to SEBAL processing. Individual polygons were digitized over areas obscured by clouds or haze in each image, and a cloud mask was developed for each image. The cloud masks were then utilized to remove the areas from the SEBAL calculations to avoid any errors caused by reflectance properties exhibited by clouds, masking ground conditions, within the multispectral and thermal bands of the satellite images. In general, the study area (Russian River Basin) was cloud free for most of the images selected; however, some portions of the Basin were affected by clouds or haze for the March 24th and June 28th images. As a result, SEBAL calculations were not performed for these areas.

Additionally, gaps present in the Landsat 7 images (February 13th, June 4th and September 24th) which result from a malfunction of the Scan Line Corrector (SLC) in 2003 were masked out of the SEBAL calculations. Landsat 7 images were used in the analysis to provide adequate temporal coverage because even with the malfunction of the SLC, approximately 75% of the data remains and is unaffected.

Summary of Results

SEBAL models were run for instantaneous, daily and periodic time scales. The periodic grids for ET_a and ET_p were spatially added to obtain the season totals for each. The seasonal totals were obtained for the period of February 1st through October 15th, 2008. A description of the analysis results follows.

Seasonal ET_a Totals

A map of spatially distributed seasonal ET_a (February 1st – October 15th, 2008) for the cloud and scan line-free area of the Russian River Basin is presented in Figure 12. Variability in ET_a within and among the fields is apparent in the insets provided in Figure 12.

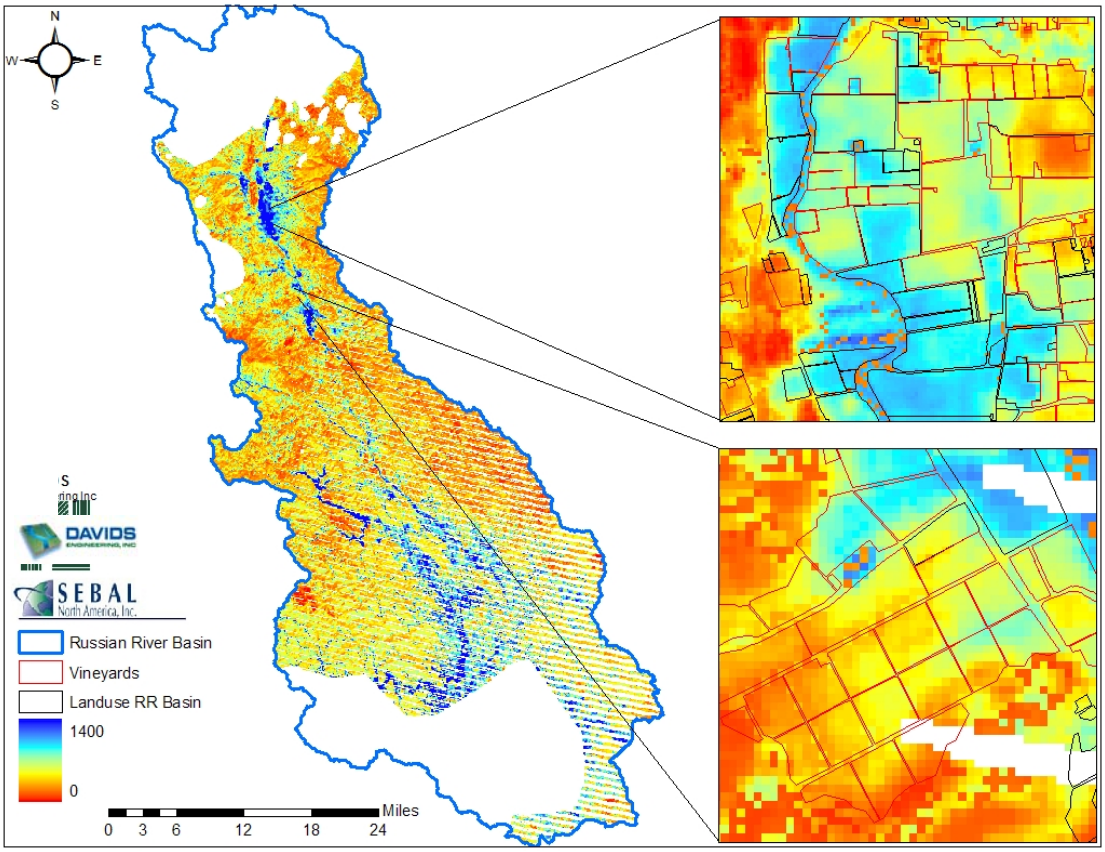


Figure 12. Seasonal ET_a (April–September '08) Bitmap for the Russian River Basin

Average values of seasonal total ET_a for selected landuse classes within the Russian River Basin were calculated for the cloud-free and gap-free areas for the period of analysis (February 1st – October 15th, 2008) and are provided in Figure 13. Additionally, ASCE standardized evapotranspiration for a short reference crop (ET_{os}) was calculated on a daily basis for the Santa Rosa, Hopland FS, Windsor, Sanel Valley, Petaluma East and Bennett Valley CIMIS stations.

The daily ET_{os} values estimated from the aforementioned CIMIS stations were summed for the individual periods represented by each image, and an average seasonal total ET_{os} (February 1st – October 15th, 2008) was obtained. This average seasonal total for ET_{os} is presented in Figure 13a, along with the estimates of precipitation for the water year (WY) 2008 (October '07 – September '08) and seasonal ET_a averages (February 1st – October 15th, 2008) for selected landuse classes in the basin.

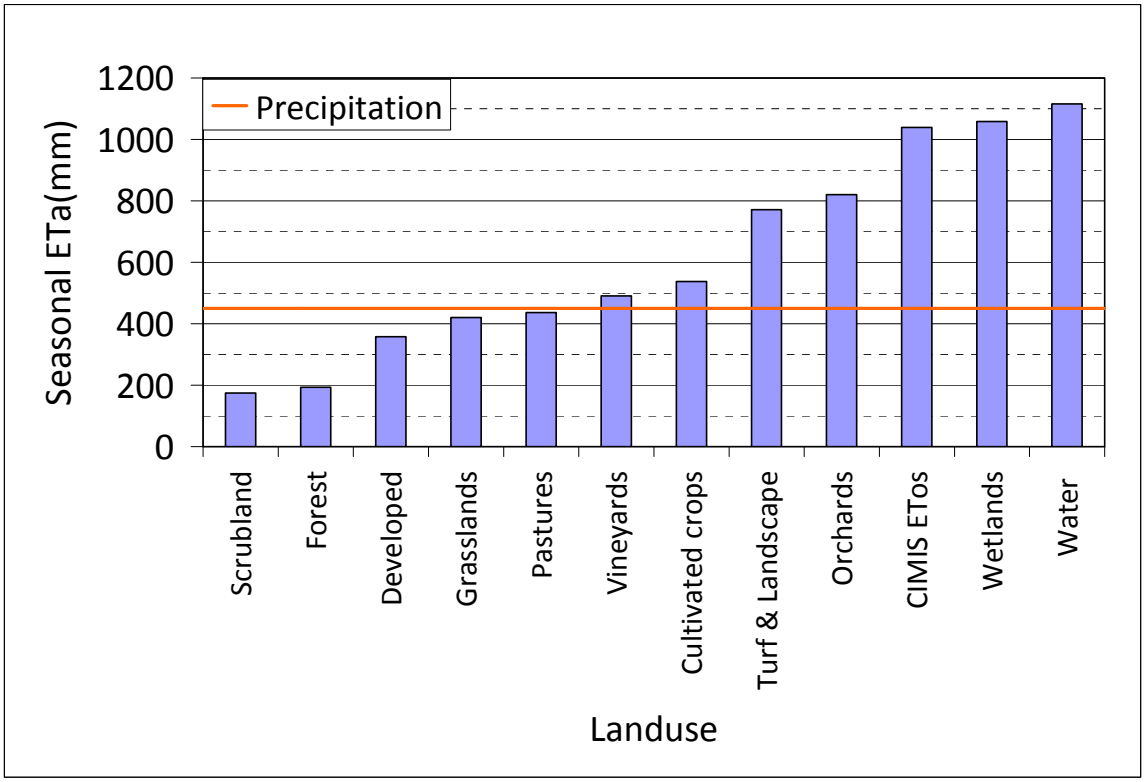


Figure 13a. Total Seasonal ET_a (February 1st –October 15th '08) by Landuse Type, Reference ET, and Precipitation (WY'08) for the Russian River Basin

The average precipitation for the WY 2008 was obtained from Tropical Rainfall Measuring Mission (TRMM) website. TRMM is a joint mission between NASA and Japan's Aerospace Exploration Agency to monitor rainfall across the globe through a combination of satellite measurements of atmospheric water vapor and ground based measurements. TRMM data can be obtained as GIS grids (pixel size of 25 km) or as ASCII files containing area averaged values. Rainfall data from TRMM was selected as more representative of the accumulated precipitation for the entire basin than the average value from available CIMIS stations.

The area averaged (basin and neighboring areas along its periphery) monthly accumulated rainfall values from TRMM and precipitation recorded at selected CIMIS stations for the WY 2008 are similar (Figure 13b).

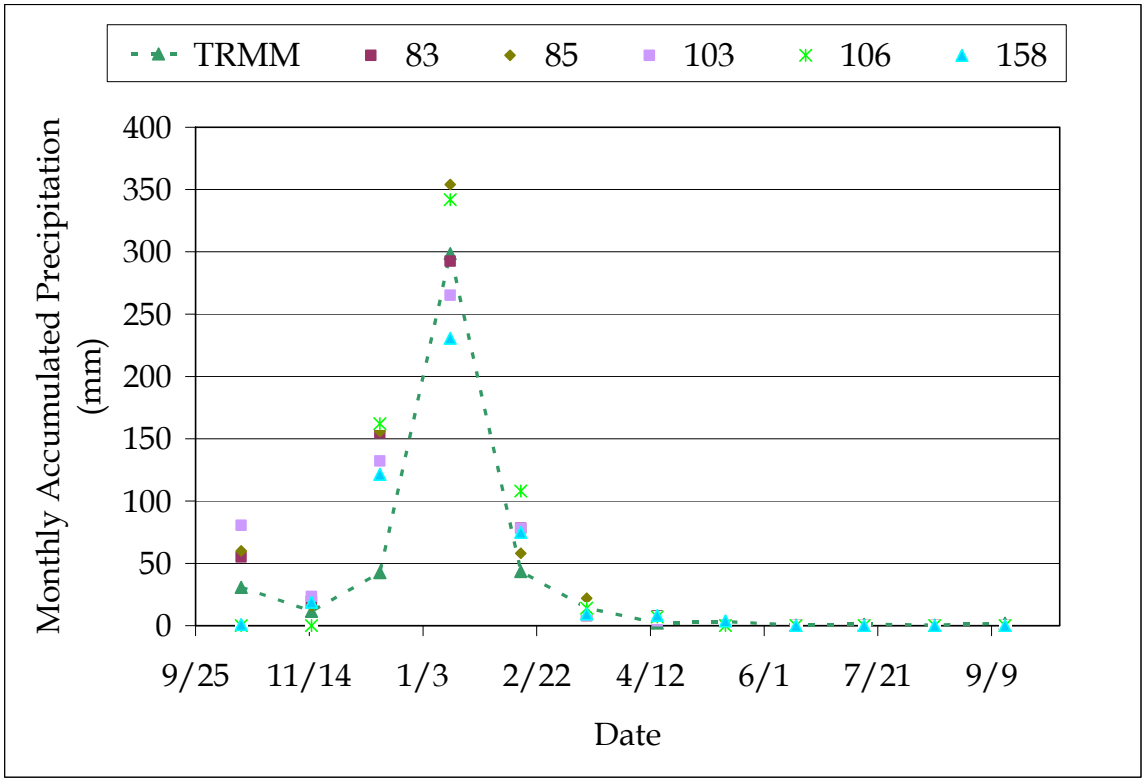


Figure 13b. Total Precipitation for WY 2008 (October'07 –September '08)

Seasonal ET_a Distributions

Cumulative distributions and summary statistics of seasonal ET_a (February 1st – October 15th, 2008) for selected major landuse classes within the Russian River Basin are presented in Figure 14 and Table 7 respectively. Only those pixels that were not masked out by clouds/haze and scan lines across all the image dates were considered for extracting the seasonal ET_a cumulative distributions and summary statistics.

The summary statistics presented in Table 7 for cultivated crops, orchards, vineyards, turf and landscape, and pasture are were extracted for the extent of the landuse data provided by SCWA. Results for water, wetlands, forest, grasslands, shrubland, and developed areas were extracted based on the landuse data obtained from NRCS. Acreages shown under the column entitled Total Area in Table 7 represent the total area of each landuse class within the basin based on the source landuse data, including areas covered by clouds or scan lines in some images. The areas sampled in the preparation of the summary results correspond to pixel locations without cloud or scan line effects in any of the images processed. Additionally, for landuse classes covering very large areas, a subset of available pixels were sampled. The areas sampled are listed in Table 7 under the column entitled Area Sampled. To make extraction and calculation of the results more efficient, only selected number of pixels for Forest, Grasslands and Vineyards

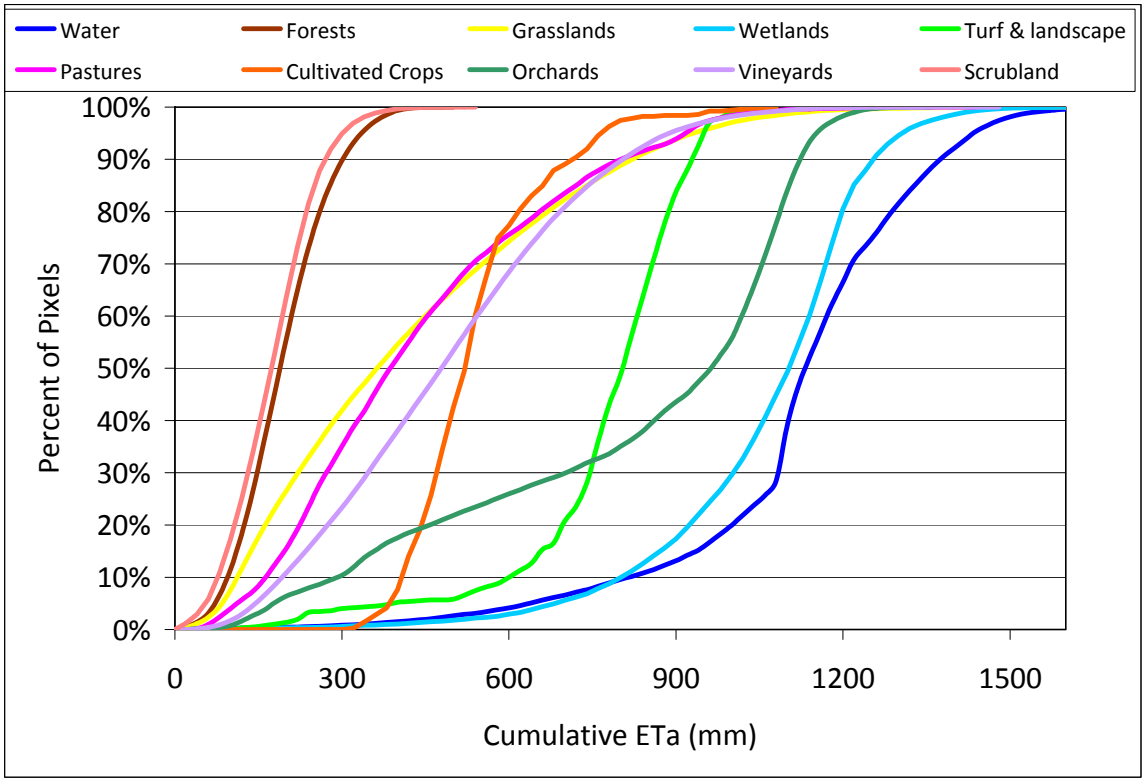


Figure 14. Cumulative Distributions of Seasonal ET_a (February 1st –October 15th, 2008) by Landuse Type for the Russian River Basin

Table 7. Summary Statistics of the Seasonal ET_a (February 1st – October 15th, 2008) for Selected Major Landuse Classes

Landuse	Landuse Code	Total Area (ac)	Area Sampled (ac)	Summary Statistics of Seasonal ETa (mm)						
				Mean	Median	Min	Max	Std. Dev.	10%tile	90%tile
Cultivated crops	182	553	124	532	514	316	1,073	122	401	711
Developed	22, 23, 24	36,542	9,369	361	326	2	1,694	255	52	712
Forest	41,42,43	355,551	37,109	192	187	0	482	79	94	300
Grasslands	71, 271	184,420	20,801	451	396	2	1,767	291	119	872
Orchards	183	6,264	1,967	812	951	22	1,346	323	289	1,122
Pasture	181	10,762	1,947	431	380	19	1,421	244	158	795
Scrubland	52	227,846	12,566	174	174	0	536	75	77	269
Turf & Landscape	121	1,491	167	762	793	108	1,040	164	573	925
Vineyards	184	60,655	29,431	489	477	4	1,501	228	191	799
Water	11, 211	6,630	3,105	1,106	1,124	3	1,760	232	808	1,368
Wetlands	90,95	4,506	1,671	1,047	1,087	122	1,601	198	784	1,247

Landuse classes were utilized and the acreages for these selected pixels are provided in Table 7 under 'Selected Area' column.

These distributions demonstrate a wide variability in ET_a within individual landuse types across the Russian River Basin. The distributions for orchards, turf & landscapes and other cultivated crops are typical for irrigated conditions. The variation in ET_a within these land

types may be caused by non-uniform or inadequate water application, variation in fertility, environmental stresses such as pests or disease, or other factors. The wider variation in ET_a displayed in the distributions for grasslands and wetlands are typical of natural vegetation with widely varying water availability. In these classes, the areas with higher ET_a are possibly in areas of shallow water tables or seepage from adjoining surface water bodies and, thus, greater water availability. Areas with lower seasonal ET_a could be distant from ground or surface water sources, relying solely on infiltrated precipitation.

The ET_a estimates for forests and scrublands were adjusted based on the ET_a of native grasses adjacent to these areas. This adjustment was performed to correct for apparent overestimation of ET_a in forests and scrublands due to the incorrect surface temperature measurements in these areas. A detailed explanation of Landsat data limitations for sensing of surface temperatures in such areas is provided in Attachment A, along with a description of the procedures used to correct the ET estimates.

It should be noted that the grasslands shown in Figures 13, 14 and in Table 7 respectively were derived from the landuse map and are different from the native vegetation landuse class that was used to correct the forest ET. The native vegetation areas used in for correcting the ET in forests were located adjacent to the forests and were digitized using high resolution NAIP imagery.

Distributions of Daily ET_a Rates and Lumped Crop Coefficients (K_{cs}) for Vineyards

The ET_a rates and lumped crop coefficients (K_cK_s, or K_{cs}) for vineyards are presented in Figures 15a and 15b, respectively.

In Figure 15a, the mean and median daily ET_a rates are shown for each satellite image date. The relative frequency distributions of pixel average ET_a and K_{cs} values are shown vertically along the axis of the satellite image dates in Figures 15a and 15b, respectively. These figures depict both spatial and temporal variations in the distributions of ET_a rates and K_{cs} values at various stages of the growing season for vine grapes.

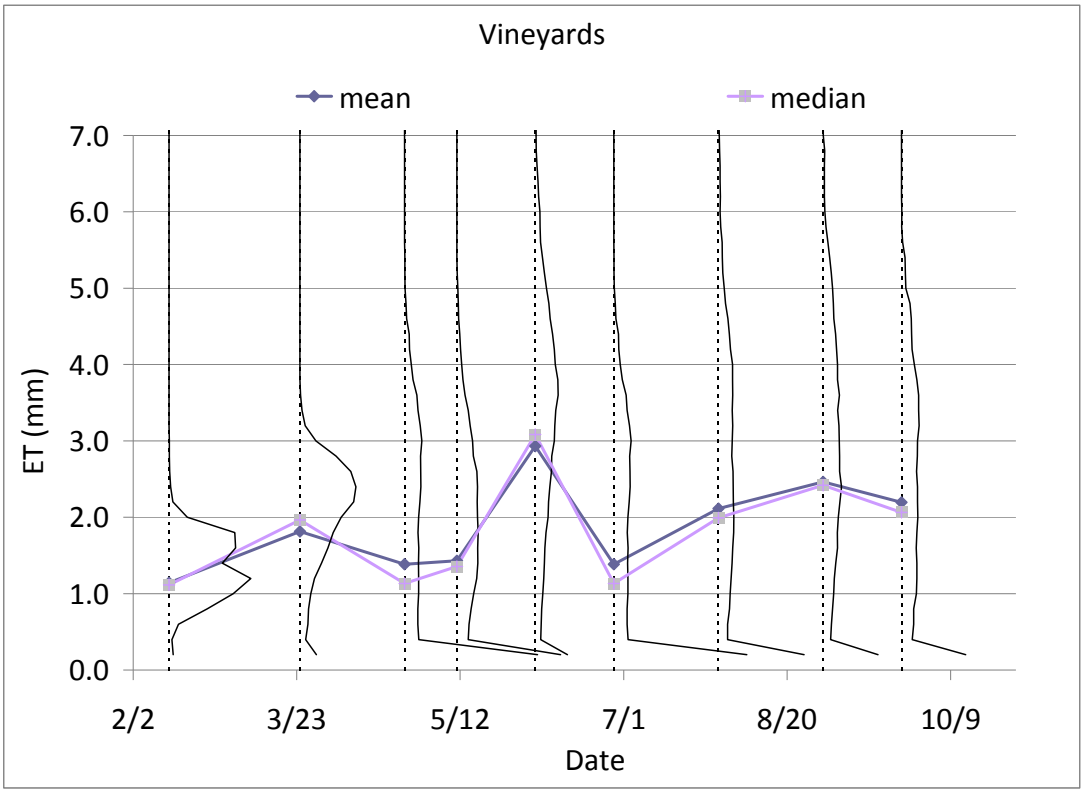


Figure 15a. Distributions of Daily ET_a Rates for Wine Grapes in the Russian River Basin

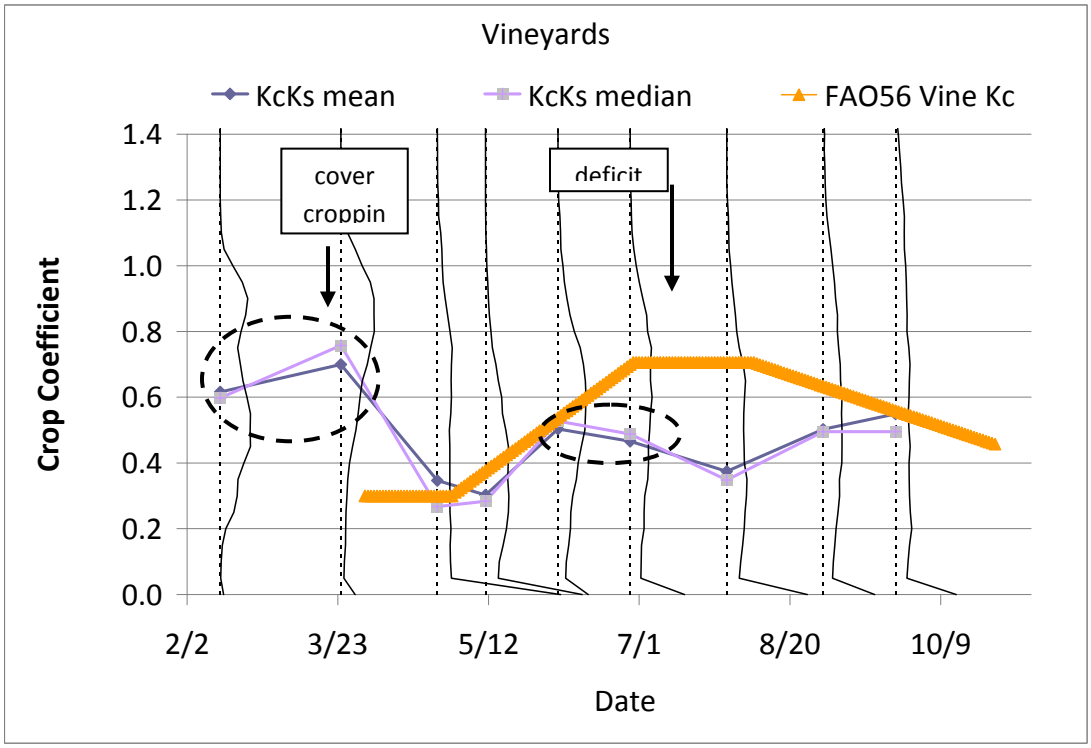


Figure 15b. Distributions of Daily Crop Coefficients for Vineyards in the Russian River Basin

The mean daily K_{cs} obtained for wine grapes on the individual satellite image dates were compared with the published crop coefficient (K_c) values provided in FAO Irrigation and Drainage Paper No. 56 (Allen et. al., 1997). The relatively high K_{cs} values apparent in Figure 15b on February 13th and March 24th image dates could be due to the presence of cover crops. High NDVI values (Figure 16) on these dates suggest the presence of a cover crop before the growing season commences for many vineyards. Daily mean K_{cs} values for vineyards followed closely the K_c values suggested by Allen et. al., during the early development stage but are, on-average, well below the K_c values for midseason and early senescence periods. The lower K_{cs} values compared to the published K_c values later in the season are due to deficit irrigation practices to maintain and control the quality of wine grapes.

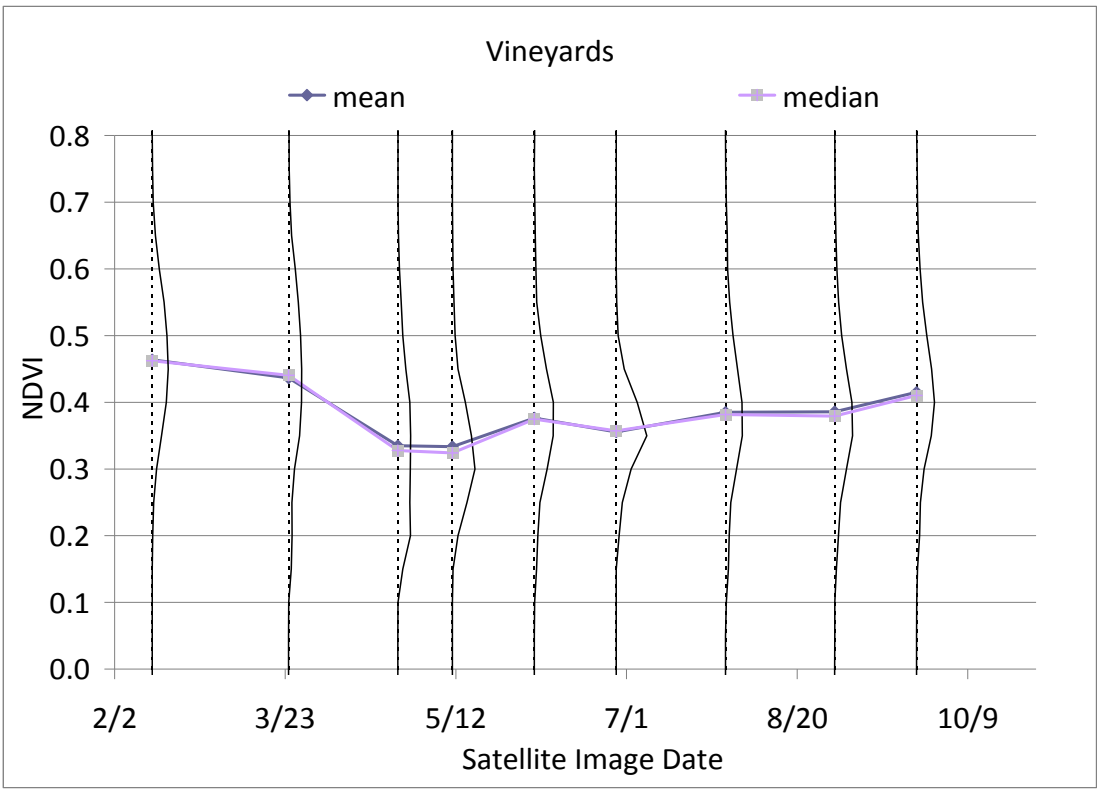


Figure 16. Distributions of NDVI for Vineyards in the Russian River Basin

Comparison of ET_a Rates for Turf Farms & Landscapes to ASCE Standardized Reference ET for a Short Reference Crop, ET_{os}

For each period, total ET_a values for turf farms & landscapes, within the Russian River Basin were compared to period total ET_{os} values computed as the average of the Santa Rosa, Hopland FS, Windsor, Sanel Valley, Petaluma East and Bennett Valley CIMIS stations. Allen, et. al, (2005) defined ET_{os} as the "reference ET for a short crop with an approximate height of 0.12 m (similar to clipped, cool-season grass)." The authors go on to define reference ET as "the ET rate from a uniform surface of dense, actively growing vegetation having specified height and surface resistance, not short of soil water…." ET_a results from turf and landscape surfaces were reviewed and compared to ET_{os} because well managed turf and landscape is similar to the reference surface described by Allen et al. Comparisons were made between ET_{os} and both the 97.5th percentile and median ET_a values for turf and landscape surfaces to evaluate how closely

the remotely sensed ET_a values agree with theoretical values calculated for a short reference crop.

The rationale for using 97.5th percentile ET_a values for the comparison rather than 100th percentile values was to select values that are representative of maximum ET_a within the turf and landscape landuse classes while avoiding extremely high ET_a values that could reflect erroneous landuse classification (e.g., water classified as turf) or anomalous model results. The 97.5th percentile ET_a for turf and landscape areas is expected to approach or exceed ET_{os}, while median values of ET_a are expected to be less than idealized reference conditions.

The comparisons of 97.5th percentile and median turf and landscapes area ET_a to ET_{os} are presented in Figures 17 and 18, respectively. Period total 97.5th percentile ET_a values for turf and landscape areas tend to slightly exceed the calculated ET_{os} values for most periods (Figure 17). The median ET_a values for turf and landscape areas fall below the idealized ET_{os} for most of the periods, as expected (Figure 18).

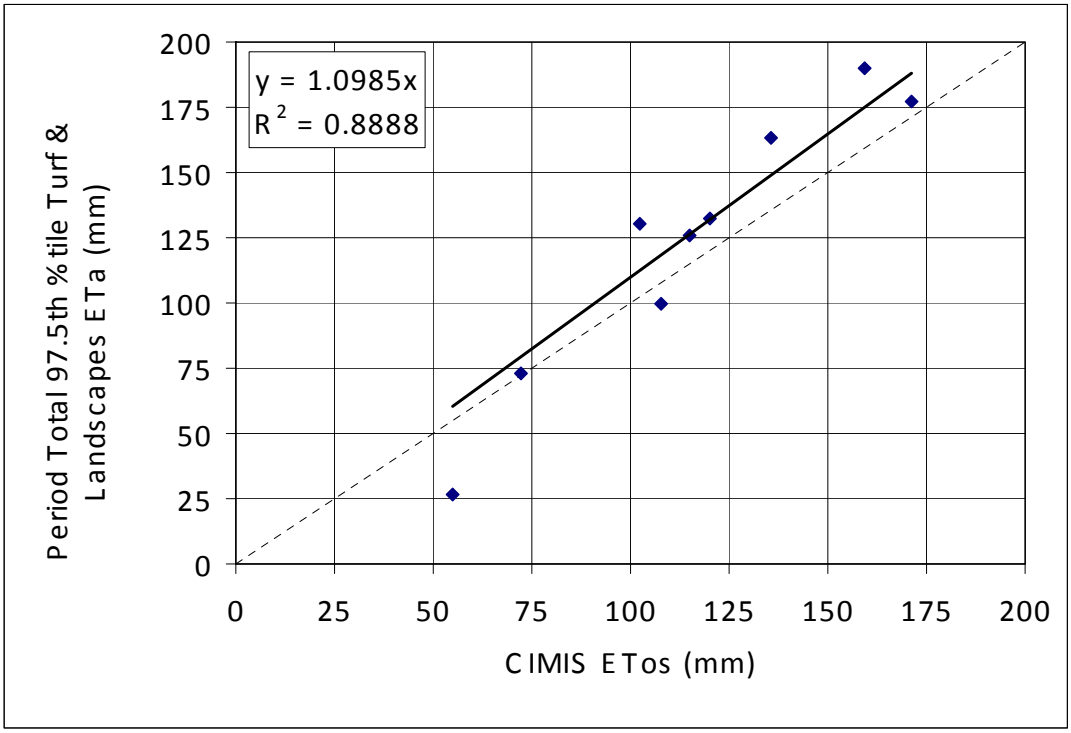


Figure 17. Comparison of 97.5th Percentile SEBAL ET_a of Turf and Landscape Areas to CIMIS ET_{os} for Each Period

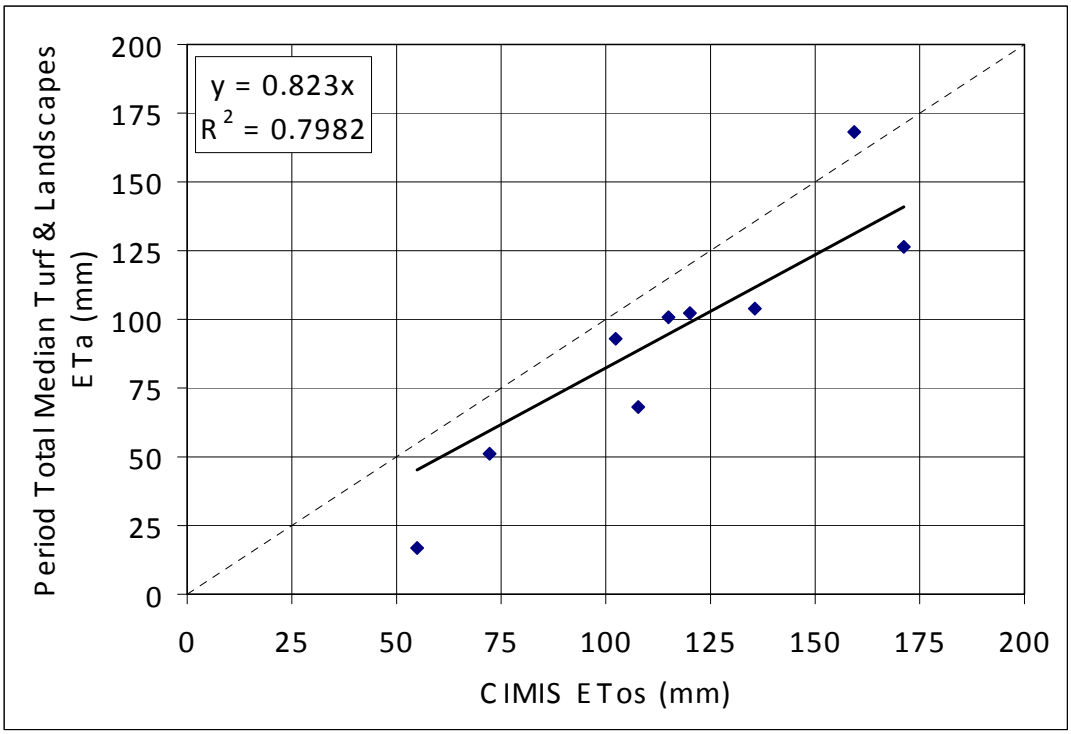


Figure 18. Comparison of Median SEBAL ET_a of Turf and Landscape Areas to CIMIS ET_{os} for Each Period

Differences between 97.5th percentile ET_a values and theoretical potential may result from various causes including inaccuracies in estimation of ET_a and ET_{os} and differences between actual and idealized growing conditions.

The seasonal total 97.5th percentile ET_a for turf and landscape areas within the Russian River Basin estimated by SEBAL was 1119 mm. The average seasonal ET_{os} calculated for the CIMIS stations of Santa Rosa, Hopland FS, Windsor, Sanel Valley, Petaluma East and Bennett Valley was 1038 mm (Figure 19). As expected, these values are in close agreement, with the SEBAL 97.5th percentile ET_a being approximately 8% more than the CIMIS ET_{os}.

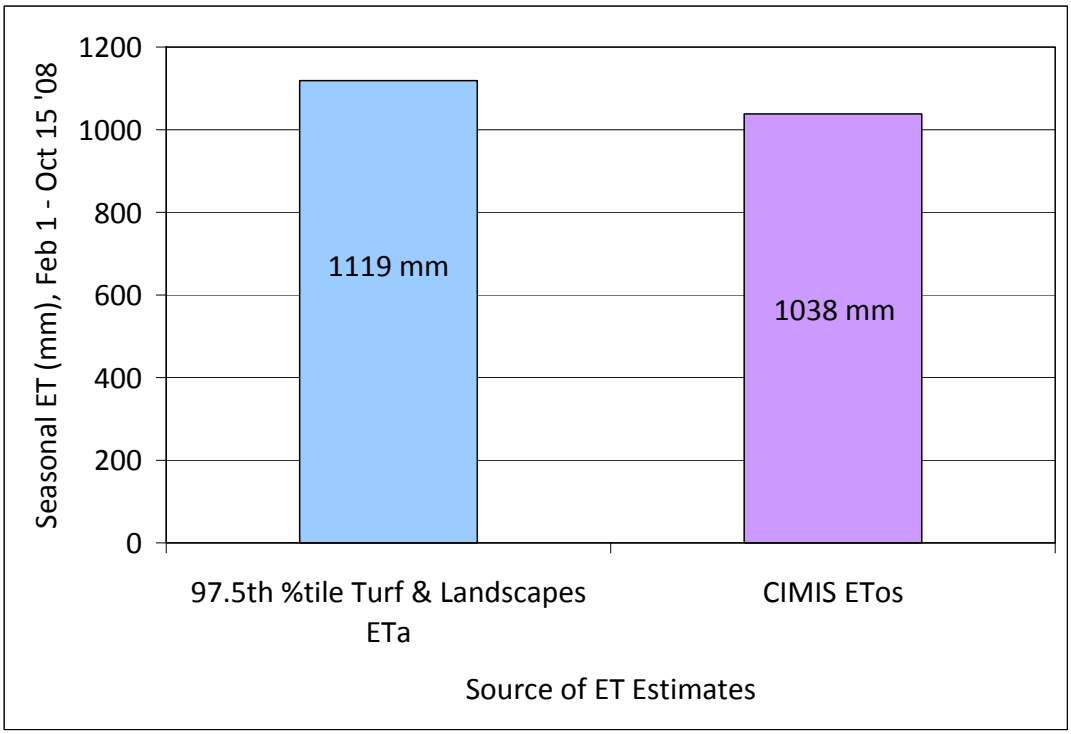


Figure 19. Comparison of Seasonal CIMIS ET_{os} and 97.5th Percentile SEBAL ET_a for Turf and Landscape Areas

References

Allen, R.G., Pereira, L.S., Raes, D., and Smith, M. (1998). "Crop evapotranspiration, guidelines for computing crop water requirements." FAO Irrigation and Drainage Paper 56, Food and Agriculture Organization of the United Nations (FAO), Rome.

Allen, R.G., Walter. I. A., Elliot, R., Howell, T., Itenfisu, D., Jensen, M. (2005). "*The ASCE Standardized Reference Evapotranspiration Equation.*" Publication, American Society of Civil Engineers.

Bastiaanssen, W.B., Noordman, E.J.M., Pelgrum H., Davids, G., Thoreson, B.P., Allen, R.G., (2005). "*SEBAL Model with Remotely Sensed Data to Improve Water Resources Management under Actual Field Conditions.*" J. Irrig. Drain. Eng., 131(1), 85-93.
Bastiaanssen, W.B., Ali, S., (2003). "*A new crop yield forecasting model based on satellite measurements applied across the Indus Basin, Pakistan.*" J. Agriculture, Ecosystem and Environment, 94 (2003), 321-340.

Bastiaanssen, W. G. M., Meneti, M., Feddes, R. A., Holtslag, A. A. M. (1998a). "*A remote sensing surface energy balance algorithm for land (SEBAL), Part 1: Formulation.*" *J. Hydrol.*, 212-213, 198–212.

Bastiaanssen, W. G. M., Pelgrum, H., Wang, J., Ma, Y., Moreno, J., Roerink, G. J., van der Wal, T. (1998b). "*A remote sensing surface energy balance algorithm for land (SEBAL), Part 2: Validation.*" *J. Hydrol.*, 212-213, 213–229.

California Irrigation Management Information System (CIMIS), Department of Water Resources, Office of Water Use Efficiency, California.

United States Geological Survey (USGS).

Voogt, M.P. (2006). "*Meteolook, a physically based regional distribution model for measured meteorological variables.*" MSc Thesis, TU Delft.

Attachment A: Limitations of Landsat Thermal Infrared Band in Forested Areas/Scrublands and Correction of ET_a

A limitation in the ability of Landsat thermal imagery to accurately estimate relative surface temperature within a given image was encountered during the course of this study. The result of the limitation was to underestimate the relative surface temperature of forested areas and scrublands, leading to overestimation of ET_a. The nature of the limitation is described in greater detail herein.

Discussion of Limitations in Landsat Thermal Imagery and Model Implications

The thematic mapper (TM) and enhanced thematic mapper (ETM+) sensors on-board the Landsat 5 and Landsat 7 satellites, respectively, capture the reflected and emitted radiances from ground features in the form of a digital number (DN) ranging from 0 to 255 for each band. The DN is representative of the intensity of emitted radiation in each band (which represents a range of wavelengths). The DNs are converted to reflectance values and surface temperature values (in case of thermal infrared band) using appropriate coefficients and atmospheric corrections.

The satellite at the time of image acquisition is assumed to be at nadir (directly overhead) with the sun being at its maximum zenith angle. This condition is necessary to minimize sensing of shadows cast by objects suspended above the ground surface including tree canopies and buildings.

The sun and satellite elevation angles are not always the same, resulting in sensing of shadows by the satellite sensor. The result of these shadows can be an error in the remotely sensed radiances and reflectances, particularly in the thermal band. Errors in the thermal band result in errors in estimation of the surface temperature of shaded areas relative to areas without suspended objects shading the ground surface. The net effect of the sensing of shadows in the thermal band is underestimation of surface temperature, which results in overestimation of ET_a when SEBAL is applied without special corrections. A more detailed explanation of the effect of underestimation of surface temperature on the SEBAL results follows.

SEBAL uses the surface temperature band (band 6) in a unique way to estimate sensible heat flux. The sensible heat flux (H) is scaled between two "extremes" of surface temperature. The first extreme is the "hot pixel" where ET flux is zero (or a small residual evaporation as determined by a soil water balance) and all available energy (R_n – G) is consumed in heating up the air (sensible heat flux). The hot pixel represents a with no ET and is selected from areas of bare soil. The second extreme is the "cold pixel", at which the sensible heat flux is zero and all available energy (R_n – G) is utilized for the combined process of evaporation and transpiration (ET flux). The cold pixel is selected from a water body. A more detailed description of this methodology is provided in Bastiaanssen et al., 2005.

It should be noted that absolute values of surface temperature are not utilized while scaling the sensible heat flux between the two extremes (hot and cold pixel temperature) but rather a

temperature difference term, ΔT which is obtained through a linear relationship with the surface temperature is utilized. The use of relative surface temperatures within an image allows for cancellation of errors that could result from global biases in surface temperature within the image. To obtain ΔT, surface temperature is adjusted to a common reference elevation (sea level) using elevation data from DEM from which a lapse-rate corrected surface temperature image is obtained. The lapse-rate correction is performed in order to avoid the misinterpretation of cooler temperatures at high elevations as having higher ET.

A result of the calibration process is that the surface temperature at a given pixel within the image influences the calculated ET_a effectively "scaling" the ET between the hot (ET_a = 0) and cold (ET_a = maximum) pixel values. Shading effects can lead to errors in the **relative** surface temperatures between pixels, which require additional correction to avoid errors in the final ET_a estimates.

Illustration of Surface Temperature Underestimation for Forested Area and Scrublands

Figure A-1 shows a subset of the surface temperature image acquired April 25th, 2008, where black outlined polygons represent native grasses with forest and adjacent scrublands to the east. In the image, the grassland surface temperature estimates appear unaffected by shadow effects, but forest and scrubland surface temperatures are very low and appear underestimated. The surface temperatures of these areas are expected to be similar with small differences resulting from differences in emissivity; however, large differences in surface temperature exist, with the forest and scrubland exhibiting surface temperatures as cold as or colder than a small lake shown in the southwest corner of the surface temperature map.

Many of the images available for the current analysis were similarly affected. As described previously, underestimated surface temperatures in the forests and scrublands induced errors in ET_a estimation for these areas that would result in overestimation of ET without correction. A procedure was developed to adjust forest and scrubland ET_a for these areas to provide reasonable estimates of ET_a. This procedure is described in the following section.

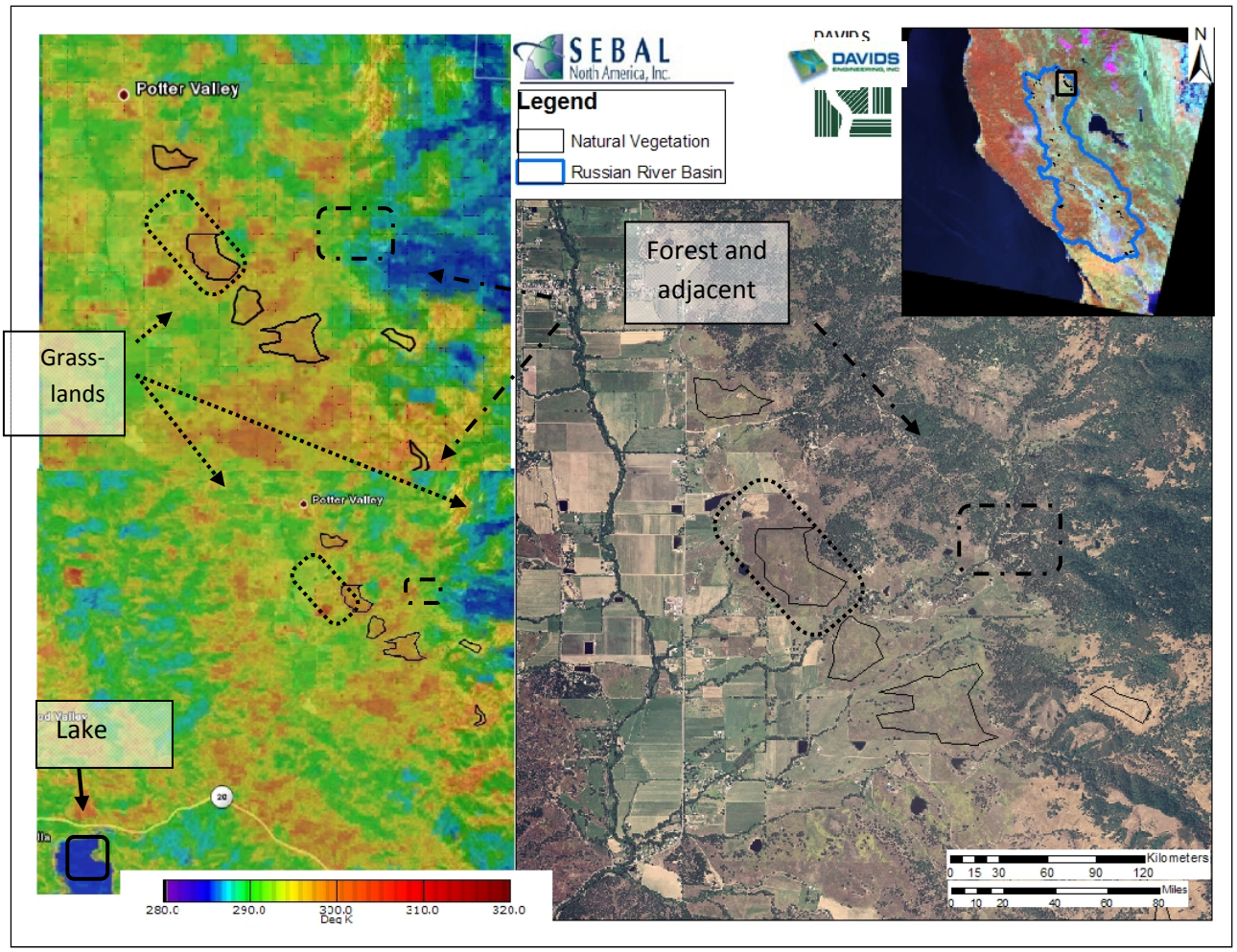


Figure A-1. Surface Temperature Map for April 25th, 2008 Image Date, Landsat TM5, Thermal Infrared Band (band 6)

Procedure to Adjust Forest and Scrubland ET_a Estimates to Correct for Underestimation of Surface Temperature

Generally, areas of native vegetation above the valley floor are expected to derive ET from infiltrated soil moisture stored within the root zone. Moisture stored in the root zone during the rainy season is depleted once the vegetation begins to grow and transpire in the spring, and transpiration decreases and ceases once the available soil moisture has been depleted. As a result, it is expected that seasonal ET in native, non-irrigated grasslands would be similar to adjacent forested areas with possibly some greater ET in the forested areas resulting from a deeper root zone and access to additional soil moisture.

Based on professional experience and judgment, an empirical approach was followed to correct ET in the forests. This approach is based on the assumption that both native grasses and adjacent forest rely on the same source of water (stored soil moisture from precipitation) and hence forest ET should be similar to native grasses. As a check, total ET should be significantly less than total precipitation due to runoff from precipitation not being stored in the soil profile.

The following relation (Eq. A-1) was applied for each image in which the raw forest ET_a calculated using SEBAL greatly exceeded that of adjacent native grasses:

$$ET_{a,\,forest,corrected} = \frac{\overline{ET_{a,grass}}}{\overline{ET_{a,\,forest}}} ET_{a,\,forest} \qquad \text{(A-1)}$$

where $ET_{a,\,forest,corrected}$ is the corrected ET_a for forested areas, calculated on a pixel by pixel basis for each corrected image and areas classified as having a forest land use class; $\overline{ET_{a,grass}}$ is the average native grassland ET_a for each corrected image based on known native grasslands delineated through visual image interpretation; $\overline{ET_{a,\,forest}}$ is the average raw forest ET_a for each corrected image based on areas classified as forests; and $ET_{a,\,forest}$ is the raw forest ET_a for each corrected pixel. An analogous procedure was applied to correct ET in scrublands by replacing forest ET_a with the ET_a estimates for scrublands in equation A-1.

Comparison of SEBAL Forest ET_a Estimates to Oak Savanna Flux Tower Measurements

Corrected forest ET estimates were compared with flux tower measurements of actual ET for an oak savanna woodland east of the study areas in the foothills of the Sierra Nevada Mountains. The flux tower is a part of the AmeriFlux network and is situated in Ione, CA. AmeriFlux is a network of flux towers that provides continuous observations of ecosystem level exchanges of CO_2, water, energy and momentum spanning diurnal, synoptic, seasonal, and interannual time scales (http://public.ornl.gov/ameriflux/) (Baldocchi, 2006).

The available daily ET_a data from the flux tower was not available for 2008 but rather corresponds to the year 2002. For comparison, the daily ET_a data from the flux tower was summed for the periods represented by an individual satellite image in the SEBAL analysis, and average daily ET_a was estimated for each period. This average daily ET for each period from the flux tower was compared with the corrected average daily forest ET_a (Figure A-2). Additionally, the seasonal ET_a totals (February 1st – October 15th, 2008) for forests and native vegetation (landuse class that was used to correct the ET_a in forest), along with total precipitation for the basin (October '07 – September '08) and the seasonal ET from flux tower (February 1st – October 15th, 2002) are provided in Figure A-3.

Corrected SEBAL ET_a results for the Russian River Basin forested areas agree reasonably well for periods 1 and 2 (February 1 – April 14) and for periods 8 and 9 (August 16 – October 15); however the period average daily ET_a rates for periods 3 through 7 differ substantially. These substantial differences are likely explained by differences in available soil moisture in addition to differences in evaporative demand, soil water storage characteristics, and shallow groundwater characteristics between the area represented by the flux tower and the Russian River Basin.

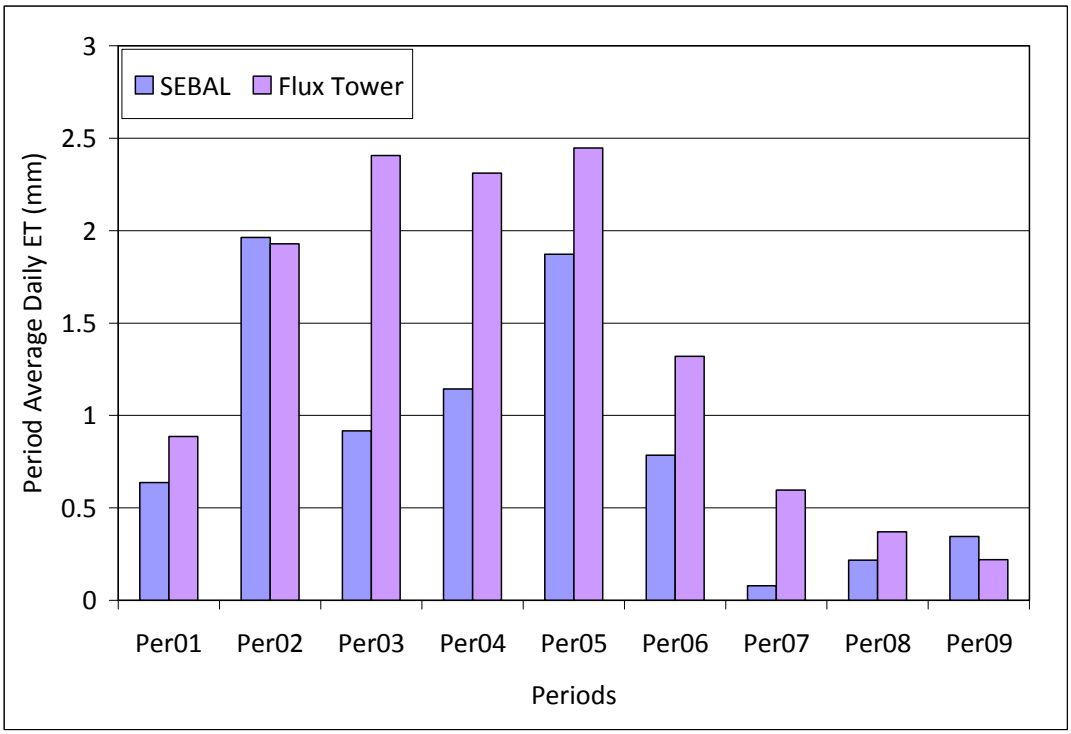


Figure A-2. Average Daily Forest ET (2008) and ET Measured at Flux Tower (2002) for Individual Periods

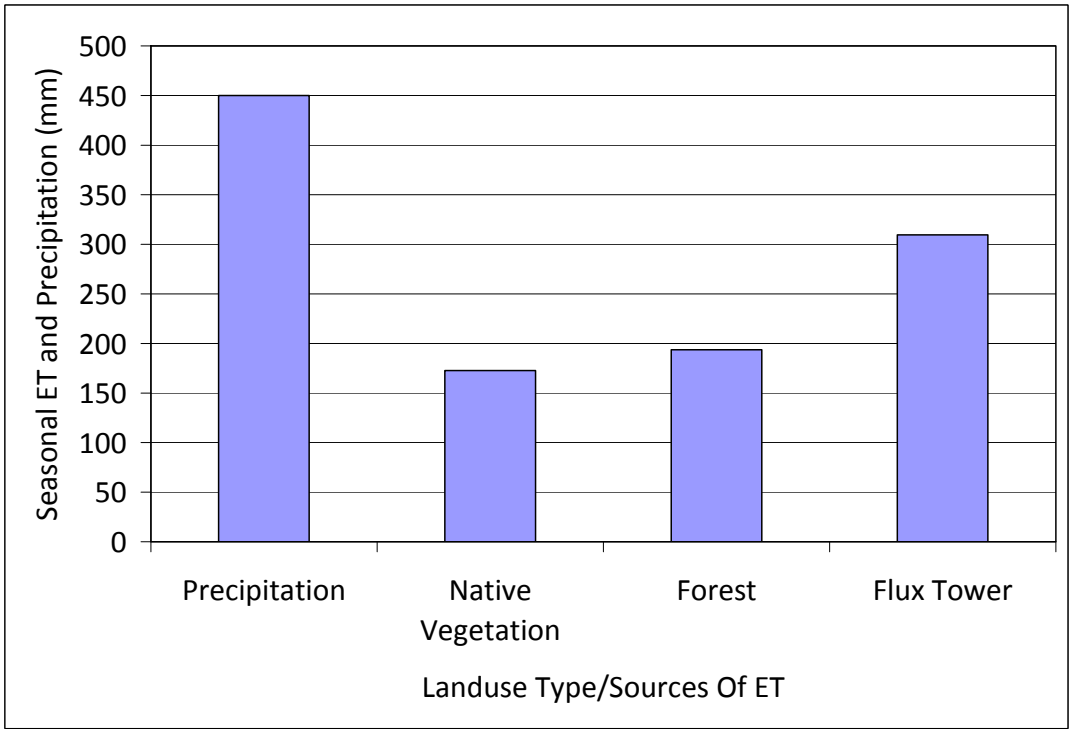


Figure A-3. Seasonal ET_a for Forests and Native Vegetation (February 1st – October 15th, 2008), Precipitation (October '07 – September '08) and Seasonal ET Measured at the Flux Tower (February 1st – October 15th, 2002)

References

Baldocchi, D. (2006). "Measuring and Modeling Carbon, Water Vapor and Energy Exchange over Grassland and Tree/Grass Ecosystems." Tonzi Ranch Document, AmeriFlux Site: Ione, CA , August 10th, 2006.

Bastiaanssen, W.B., Noordman, E.J.M., Pelgrum H., Davids, G., Thoreson, B.P., Allen, R.G., (2005). "*SEBAL Model with Remotely Sensed Data to Improve Water Resources Management under Actual Field Conditions.*" J. Irrig. Drain. Eng., 131(1), 85-93.

Appendix B. Growers Questionnaire

INTERVIEWS

Interview Objectives

1) Characterize grower decisions with respect to:

    a) When to begin irrigation
    b) Frequency of irrigation
    c) How much water is applied
    d) Water source (groundwater only, surface water only, or blend)
2) Obtain information about how growers determine how much water has been applied.
3) Characterize existing irrigation practice.
4) Obtain applied water records.
5) Obtain actual ET measurements from vineyards (from specialists).

Interview Protocol

1) Interview 5-10 growers and vineyard managers.
2) SCWA representative to call selected growers and vineyard managers to schedule a time and place to meet. (See Interview Scheduling below)
3) Meet growers and vineyard managers where convenient for them, preferably at their farm, however, office, home, evenings, coffee shop, pickup tailgate are all OK.
4) Use form to guide interview and record answers, however, interviews will be in the form of an informal conversation, i.e. the questions will not be read one after another.
5) Begin with an explanation of the project and reason for the interviews to inform each grower and allow them to become comfortable. (See Grower Setup below)

Interview Scheduling

A SCWA staff person will call selected growers and vineyard managers to schedule the interviews. The person making the call should begin with an introductory statement similar to the sample below:

"Hello, I'm _____ _____ with Sonoma County Water Agency. The Water Agency is a regional water resources agency that serves the public as a wholesale water supplier. Managing the water supplies stored in Lake Sonoma and Lake Mendocino, the Agency controls releases from these reservoirs to maintain stream levels in the Russian River supporting recreation and habitat for fish and wildlife. Given this responsibility, the Agency conducts a multitude of scientific studies and planning studies within the Russian River watershed. One area that the Agency focuses on is optimizing the beneficial use of the scarce resources that are available. This requires a better understanding of how the supplies and demands within the watershed vary geographically and over time. The Agency is currently working on a project that involves estimating water use at vineyards. As part of the process, we are interviewing growers to learn how irrigation decisions are made. A member of the project team would like to meet

Interview # _____Date _____ By _____

you at your farm or another convenient location at a time convenient for you to learn more about how you decide when and how much to irrigate. The interview may require up to an hour of your time. If you are willing, I'd like to schedule a time on (date TBD) and answer any questions you may have."

Context Statement

(Note: this statement will be recited more or less verbatim by the interviewer to specialists or growers to put the interview into context, and to invite the interviewer to ask any additional questions needed to address any concerns, before beginning.)

"At the direction of the State Water Resources Control Board (SWRCB), the Sonoma County Water Agency (the Agency) is developing a Russian River Operations Model (ResSim). Accurate estimates of applied water are necessary for estimating irrigation water depletions from the River. The current technique for estimating depletions was developed by DWR in the 1980s and does not account for recent improvements in irrigation techniques and modern vineyard deficit irrigation practices. Improving the Agency's ability to estimate irrigation water depletions will enable more accurate estimation of the Russian River depletions and better scheduling of releases from Lake Sonoma and Lake Mendocino, leading to enhanced management of the Russian River.

"An important step in the process of improving estimates of depletions is a series of discussions to be held with vineyard managers and experts in vineyard irrigation management. These discussions are designed to provide the Agency with applied water data sets for the 2008 irrigation season for specific locations in the Russian River Basin. Additional information on grape variety, management objectives and any other factors that you consider when determining when and how much irrigation water to apply will be useful. These applied water data sets should indicate when vineyard managers initiated irrigation and how much water was applied throughout the season. Information from these discussions, together with data from other sources, will be used to develop improved estimates of irrigation water use.

"Are there any questions you would like to ask before beginning?"

(Note: record any concerns or issues below.)

Questions

1. What do you irrigate?
    - How many fields? Field size(s)?
    - What varietals?
    - What are the ages of the vines? How long do they remain in production?

Interview # _____Date _____ By _____

2. What are the water sources used for the various water needs?
    - Wells?
        - Depth? Size?
    - Direct river diversions?
        - Size?
    - Ponds?
        - Size?

3. How do you decide when to begin irrigating each season?
    - Methods/indicators (soil, plant, pressure bomb, etc.?)
    - When does irrigation typically begin? Earliest and latest start dates? What are the primary drivers of the irrigation start date?
        - Importance of spring rains
        - Soil depth and AWHC
        - Root stock variety and rooting depth
        - Cover crop
        - Vine spacing and trellis configuration
        - Other factors??

4. Once you begin irrigating, how do you decide how frequently to irrigate and how much to apply?
    - Verify irrigation method (99% drip)
    - What level of stress are you trying to achieve and why? How does this vary with variety, location and other factors?
    - Scheduling methods
    - Does this change over growing season or with changes to weather conditions?

Interview # _____Date _____ By _____

5. How much water do you typically apply in a season?
    - Frost control? Drivers, variability from season to season?
    - Pre-harvest? Drivers, variability from season to season?
    - Post-harvest? Drivers, variability from season to season?
    - Heat protection?
    - How determined?
        - Meter?
        - Hours of operation (with known application rate)?
        - Other?

Interview # _____Date _____ By _____

RMA

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HEC-5Q Russian River Basin Model Demonstration

Prepared for the

Sonoma County Water Agency

Santa Rosa, California

April 2016

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1 INTRODUCTION

During previous modeling efforts, temperature and water quality in the Russian River system was simulated using HEC-5/HEC-5Q (reservoir operation and water quality models, respectively) (RMA, 2001, RMA, 2007). The HEC-5 model provided all hydrologic data required by the HEC-5Q model.

The HEC-5 model interfaced with the SCWA modeling system (RR-Sim) RR-Sim was historically used for water supply planning in the basin. RR-Sim was originally developed by the Agency in the 1980s with numerous revisions over subsequent years. The modeling system consists of three separate computer models. These three computer models account for different portions of the Russian River System: the Potter Valley Project, the Upper Russian River basin, and the Lower Russian River Basin. These models use a historical hydrologic dataset from 1910 to 2004 to perform water balance routing through the Russian River system and to simulate the effects of various demand and operational criteria. Water supply demands were superimposed upon a historic sequence of hydrologic conditions using present day operating criteria and streamflow requirements.

Historical flows may not represent current land use and climate conditions. Additionally, climate change analysis has become an important factor in long term analysis for both flow and water temperature. Therefore, the SCWA opted to develop a physically based runoff model to provide hydrologic inputs for the temperature and water quality analysis.

The SCWA elected to retire the RR-Sim model and utilize the Corps HEC-ResSim model. The ResSim model is a public domain reservoir model that is well suited to represent the Russian River System (System). The HEC-5Q model also interfaces with the ResSim model.

The initial ResSim model of the Russian River was developed by RMA in 2009. The model includes reservoirs, routing reaches and operating rules that serve as a flexible planning tool for the System. The Russian River ResSim model includes all of the reservoir/river components that were included in the original HEC-5/HEC-5Q model as well as the operating rules that were embedded in the Upper and Lower River operation model (RR-Sim). The Water Agency further refined the model for the purpose of developing system operation alternatives.

The ResSim Model includes the East Fork Russian River between Potter Valley Power Plant and Lake Mendocino that was not included in previous versions of HEC-5Q. As part of their current effort, SCWA developed a revised hydrologic data set that relies in part upon estimated unimpaired flow data developed by the USGS using the Basin Characterization Model.

The HEC-5Q Russian River model network has been updated to interface with the ResSim model.

Demonstration of model capabilities was deemed necessary to add credibility to the current updated version of the HEC-5Q model. For this effort, results produced by the verified ResSim model (SCWA 2016) that utilized historical inflows and demands were used. Since reservoir operation was based on ResSim rules, the ResSim results do not always match historical operation. Therefore, the HEC-5Q modeling discussed herein is

referred to a model demonstration rather than a strict calibration. For the majority of the time, however, the results from the verified model representative of observed conditions for comparable hydrology and operation.

Current model inputs were developed through 2013. Main stem temperature and dissolved oxygen data for the 2000 – 2013 period were compiled for use in the model demonstration. This period coincides with the ResSim model validation. The boundary condition inputs for temperature, nutrients and dissolved oxygen were extended from those described in the previous HEC-5Q calibration report (RMA, 2007) Meteorological conditions developed from 1-hour CIMIS data from stations at Hopland and Santa Rosa for 1989 – 2013 were input at 6-hour intervals. The model demonstration utilized 2000 – 2013 reservoir temperature and Dissolved Oxygen (DO) profile data and 2000 – 2013 continuous stream temperature and DO data. Minor adjustments were made to rate coefficients, diffusion in the reservoirs, the benthic algae standing crop, and benthic source rates to achieve the best representation of observed conditions.

The principal water quality constituents simulated were temperature, ammonia, nitrate, phosphate, phytoplankton (reported as chlorophyll a), benthic algae, dissolved oxygen, dissolved and particulate organic matter, and inorganic particulate matter. The current benthic algae representation included population dynamics that are based on environmental factors and available nutrients. All flows are daily average and tributary inflows are allocated to individual streams based on drainage area. All water quality simulations utilized 6-hour time steps with daily average flows.

A graphical user interface, HWMS (Hydrologic Water quality Modeling System) is used to provide run management and model result visualization for the HEC-5Q river-reservoir water quality model.

1.1 PROJECT OBJECTIVES

The objective of this modeling effort is to demonstrate the capability of the new version of the Russian River model, which interfaces HEC-5Q with ResSim and includes the East Fork between Potter Valley Power Plant and Lake Mendocino.

2 RUSSIAN RIVER HEC-5Q MODEL DESCRIPTION

A full description of the HEC-5Q model is provided in *HEC-5Q Simulation of Water Quality in the Russian River Basin* (RMA, 2007). Refer to the HEC-5Q training document and user's manual (HEC, 1999; HEC, 2001) for model relationships and capabilities.

Reservoir release rates are computed by ResSim and are based on reservoir operations that respond to downstream demands and minimum flow requirements.

The HEC-5Q model was developed to meet the specific needs of the Russian River System. The most recent revisions to the model allow interface with ResSim. Daily average values from ResSim include:

- Potter Valley Power Plant release;
- East Fork Russian River above Lake Mendocino (inflow and demands);
- Lake Mendocino (elevation, storage and outflow);
- East Fork Russian River below Coyote Dam (inflow and demands);
- West Fork Russian River inflow;
- Russian River above Dry Creek (inflow and demands);
- Lake Sonoma (inflow, storage, elevation and outflow);
- Dry Creek (inflow and demands); and
- Russian River below Dry Creek (inflow and Santa Rosa diversion).

2.1 MODEL REPRESENTATION OF THE PHYSICAL SYSTEM

For application of HEC-5 and HEC-5Q, rivers and reservoirs comprising the Russian River System were represented as a network of reservoirs and streams and discretized into sections within which flow and water quality were simulated. Control points (CP) represent reservoirs and selected stream locations. Flows, elevations, volumes, etc. were computed at each control point.

The previous version of the Russian River model network was modified for compatibility with ResSim. The following changes were made.

- Non-ResSim control points were removed from the Russian River downstream of Lake Mendocino.
- A stream reach was added on the East Fork Russian River upstream of Lake Mendocino.
- As a result of the above change, Lake Mendocino inflow temperatures are now computed in the up-stream East Fork reach rather than defined explicitly.
- The downstream boundary was moved from the ocean up to Monte Rio to avoid the stream section that is affected by periodic closing of the ocean outlet. The one dimensional nature of the stream model precludes simulation of ambient thermal and chemical stratification.

Aside from the addition of the upstream East Fork Russian River stream reach, geometric representation of streams and reservoirs remains the same as in the previous

model version. A map of the Russian River model is shown in Figure 2-1. The seasonal dam at Healdsburg is represented by an equivalent stream reach.

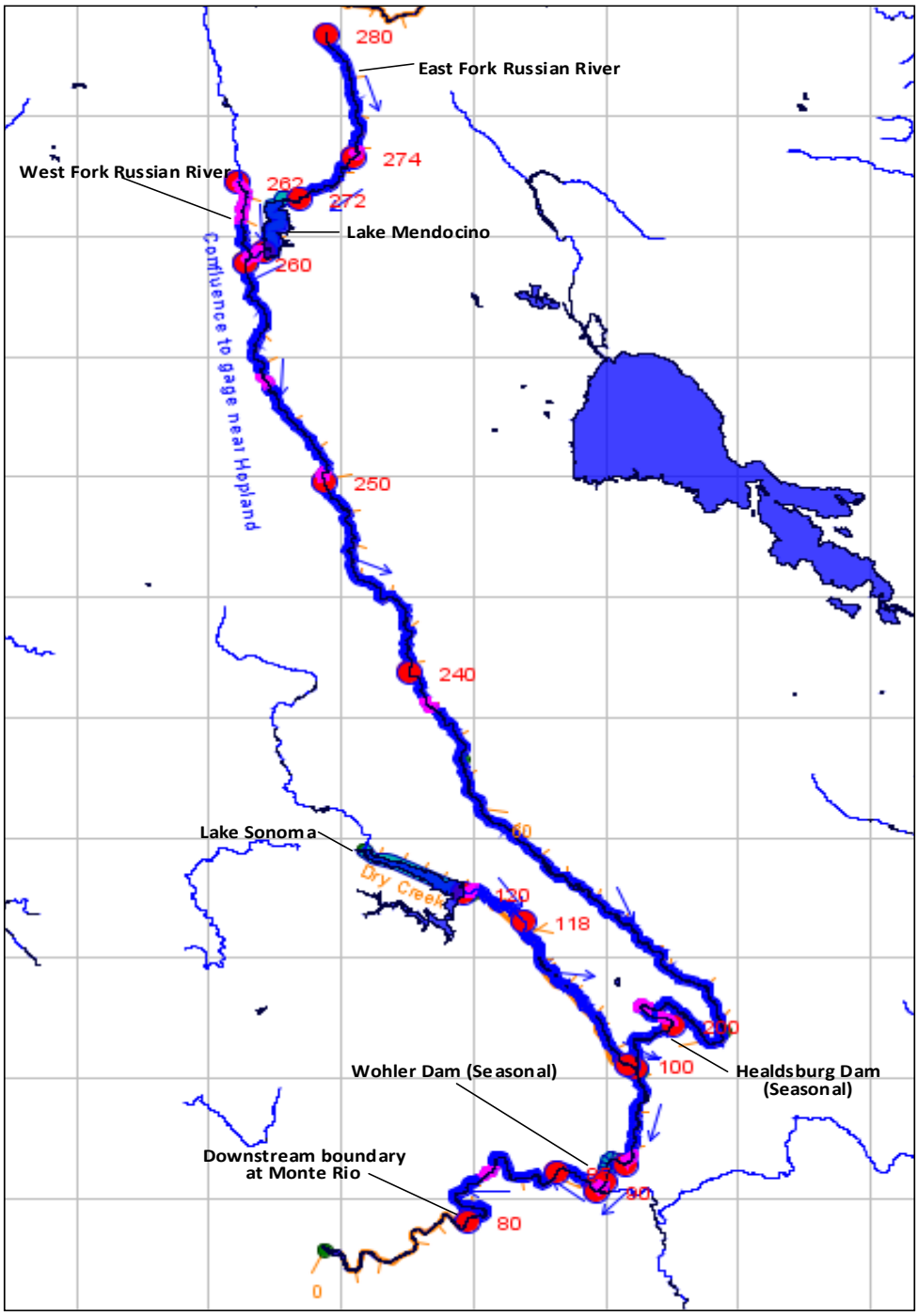

Figure 2-1 Map of Russian River – Dry Creek Model.

2.2 HYDROLOGIC BOUNDARY CONDITIONS

The ResSim model flows are based on intended or predicted operation of the System rather than strict adherence to historical operation. The operation rules that may not match historical operation resulted in some volume and flow discrepancies in Lake Mendocino. These discrepancies are generally within the accuracy one would expect from a hydrologic model calibration but may have some dam release temperature and dissolved oxygen ramifications. These ramifications are noted in the model demonstration section. Because of the larger storage volume of Lake Sonoma, the small departure from historical operation has little impact of temperature and water quality within the Lake and Dry Creek.

Allocation of inflows is summarized in Table 2-1. Channel depletions (Consumptive Uses) associated with each reach are assumed uniformly distributed over the stream reach. The only diversion specifically represented as a point withdrawal is the Santa Rosa diversion below Dry Creek (Mirabel & Wohler Collectors facilities) and the small diversion above Lake Mendocino.

Table 2-1 Model inflow allocation and water quality codes (see Table 2-2 for definition of water quality codes).

River Reach	ResSimDSS pathname B part	Control point	river mile	inflow allocation	Water Quality Code *	System Gains/Point Withdrawals
East Fork Russian River, Potter Valley to Lake Mendocino inflows						
	Potter Valley Project	280	110.7	100%	8	Potter Valley Power
	Mendocino Inflow	272	103	100%	4	Lake Mendocino Local
West Fork Russian River inflows						
	East-West jct	260	96	100%	7	West Fork @ Mendocino Bridge
Russian River, Confluence to Hopland inflows						
	Abv Hopland	250	93.2	22%	3	Ackerman Creek
		250	91.6	17%	3	Sulfur Creek
		250	89.7	16%	3	Talmage Creek
		250	86.8	29%	3	Robinson Creek
		250	80.4	16%	3	McNab Creek
Russian River, Hopland to Cloverdale inflows						
	abv Cloverdale	240	74.6	57%	3	Feliz Creek
		240	70.2	30%	3	Pieta Creek
		240	67.5	13%	3	Cummiskey Creek
Russian River, Cloverdale to Healdsburg inflows						
	Abv Healdsburg	200	63	35%	2	Big Sulfur Creek
		200	58.5	17%	2	Runoff above Geyserville
		200	45	16%	2	local runoff
		200	41.3	29%	2	Maacaca Creek
		200	36.5	3%	2	Local runoff
Russian River, Healdsburg to Dry Creek inflows						
	Dry Creek RR	100	30.7	100%	2	Local Runoff
Dry Creek, Lake Sonoma inflows						
	Sonoma Inflow	120	50	60%	5	Dry Creek
		120	50	40%	6	Warm Springs Creek
Dry Creek,Warm Springs Dam to Geyserville Gauge inflows						
	Dry Creek near Geyserville	118	42	19%	9	Dutcher Creek
		118	41	81%	9	Pene Creek
Dry Creek above Russian River confluence inflows						
	Abv DC Div Dam	110	37.9	7%	9	Grape Creek
		110	36.8	11%	9	Crane Creek
		110	34.8	8%	9	Kelly Creek
		110	33.5	10%	9	Smith Creek
		110	31.7	64%	9	Mill Creek
Dry Creek, confluence to SCWA withdrawal						
	SCWA withdrawal	92	24	100%	na	SCWA Point Diversion
Russian River, SCWA withdrawal to Mark West Creek inflows						
	Mark West Creek	90	22.5	100%	1	Mark West Creek
Russian River, Mark West Creek to Hacienda Bridge inflows						
	Hacienda	85	21.3	100%	1	Green Valley Creek

* Water quality types are defined in Table 2-2

2.3 WATER QUALITY BOUNDARY CONDITIONS INPUT DATA

A new boundary condition at the upstream end of the East Fork Russian River (Potter Valley) is required for the new model network. We are unaware of any site specific data for the Potter Valley discharge, therefore the inflow characteristics were estimated based on typical values for sources influenced by upstream reservoirs (Lake Pillsbury on the Eel River) and the observed temperatures and water quality conditions directly above Lake Mendocino. Characteristics of the runoff between the Potter Valley Power Plant and the lake were adjusted to better represent observed temperature and dissolved oxygen profiles within Lake Mendocino. All other quality boundary conditions were unchanged from the 2007 study.

HEC-5Q requires that flow rates and water quality be defined for all inflows. Inflow rates may be defined explicitly or as a fraction of the incremental local flow to the control point as defined by ResSim. The flow fraction method was used for most stream inflows. Table 2-1 lists fractions of the total incremental inflow assigned to each of the individual tributaries to each reservoir and stream reach. This table also includes the location and water quality type code associated with each stream inflow. Water quality type codes are described in Table 2-2.

Water temperature, dissolved oxygen, nutrients, phytoplankton, benthic algae, dissolved and particulate organic matter, and inorganic particulate matter were simulated by HEC-5Q. A temporally and spatially varying benthic algae standing crop was defined. Nutrient concentrations were coupled with benthic algae, phytoplankton, dissolved organic matter (DOM) and organic suspended solids concentrations. DO concentrations were coupled with benthic algae, phytoplankton, DOM, total suspended solids (TSS) and ammonia (NH_3).

Table 2-2 Average, maximum and minimum inflow quality for water quality codes associated with Table 2-1.

Water Quality Code		Temperature ºF	TDS mg/L	NO3-N mg/L	PO4-P mg/L	NH3–N mg/L	Algae µg/L	DO mg/L	Labile DOM mg/L	Refractory DOM mg/L	TSS mg/L
1	Avg	57.4	327.1	0.498	0.060	0.04	0.804	9.3	1.00	2.00	4.2
	Max	76.0	349.9	0.751	0.096	0.04	1.400	12.5	1.00	2.00	107.7
	Min	34.7	150.0	0.249	0.024	0.04	0.200	7.5	1.00	2.00	0.8
2	Avg	57.0	237.0	0.190	0.050	0.03	0.503	9.8	0.50	1.50	3.2
	Max	73.9	275.0	0.350	0.082	0.03	0.900	12.9	0.50	1.50	166.7
	Min	36.0	150.0	0.100	0.018	0.03	0.100	8.1	0.50	1.50	0.4
3	Avg	58.1	234.9	0.141	0.050	0.03	0.503	9.2	0.50	1.50	1.7
	Max	77.3	250.0	0.300	0.082	0.03	0.900	12.5	0.50	1.50	119.7
	Min	34.8	150.0	0.050	0.018	0.03	0.100	7.4	0.50	1.50	0.4
4	Avg	54.0	248.4	0.148	0.060	0.03	0.503	9.7	0.50	1.00	0.4
	Max	73.2	249.7	0.290	0.088	0.03	0.900	12.8	0.50	1.00	0.4
	Min	32.9	194.1	0.060	0.032	0.03	0.100	7.7	0.50	1.00	0.4
5	Avg	58.3	250.0	0.158	0.060	0.03	0.503	9.2	0.25	0.50	0.4
	Max	77.7	250.0	0.220	0.087	0.03	0.900	12.5	0.25	0.50	0.4
	Min	34.8	250.0	0.100	0.033	0.03	0.100	7.4	0.25	0.50	0.4
6	Avg	60.1	350.0	0.158	0.060	0.03	0.503	9.0	0.25	0.50	0.9
	Max	82.3	350.0	0.220	0.087	0.03	0.900	12.5	0.25	0.50	92.1
	Min	34.8	350.0	0.100	0.033	0.03	0.100	7.1	0.25	0.50	0.4
7	Avg	60.8	237.6	0.141	0.050	0.03	0.503	9.0	0.50	1.50	1.3
	Max	84.8	250.0	0.300	0.082	0.03	0.900	12.5	0.50	1.50	97.7
	Min	34.5	150.0	0.050	0.018	0.03	0.100	6.9	0.50	1.50	0.4
8	Avg	53.1	236.6	0.356	0.127	0.03	0.503	9.8	0.50	1.00	0.4
	Max	66.9	250.0	0.400	0.150	0.03	0.900	12.7	0.50	1.00	0.4
	Min	33.6	217.3	0.280	0.080	0.03	0.100	8.3	0.50	1.00	0.4
9	Avg	55.7	262.1	0.190	0.050	0.03	0.503	10.0	0.50	1.50	0.5
	Max	70.7	275.0	0.350	0.082	0.03	0.900	13.3	0.50	1.50	29.7
	Min	33.9	150.0	0.100	0.018	0.03	0.100	8.4	0.50	1.50	0.4

Tributary stream inflow water quality characteristics were developed during the previous modeling exercise from data through 2005. Data from subsequent years were such that no change was deemed necessary. The sparseness of the ambient water quality data makes it impossible to explicitly define the inflow water quality of all tributary streams. Therefore, the water quality of streams within a geographical region was combined to provide typical water quality characteristics for the streams of that region. Table 2-2 summarizes the average, maximum and minimum water quality concentrations for each of the different tributary types as referred to in Table 2-1. The variations in concentration are a result of the following definitions.

- Temperature – function of equilibrium temperature, inflow and seasonal distribution at 6-hour intervals
- EC - seasonal
- Nitrate – seasonal, harmonic or constant
- Phosphate – harmonic
- Ammonia – constant
- Phytoplankton as Chlorophyll a – harmonic
- Dissolved Oxygen – percent of saturation
- Labile and refractory DOM – constant
- Particulate Material – function of flow

2.4 METEOROLOGICAL DATA

The meteorological data developed in previous efforts were extended through 2013 using the same data sources (various CIMIS stations) and extrapolation methods.

3 RUSSIAN RIVER RESSIM MODEL IMPLEMENTATION

RMA has developed a ResSim model of the Russian River System compatible with the existing SCWA HEC-5Q model, and which also accommodates new features or constraints of the System as required by the ongoing Environmental Impact Report (EIR) process.

The implementation of the ResSim Model for the System includes reservoirs, routing reaches and operating rules that are needed to serve as a flexible planning tool for the System. ResSim operating rules were derived from the existing SCWA RR-Sim model implementation and related documentation. The capacity to quantify power production at the Warm Springs dam was added to ResSim model output – power plant characteristics and operational constraints were added solely to evaluate power production ramifications in model output and not as constraints on System operation.

3.1 RUSSIAN RIVER RESSIM MODEL

The Russian River ResSim network consists of physical and operational elements that model the Russian River watershed, including Lake Mendocino in Mendocino County and Lake Sonoma in Sonoma County. Lake Mendocino is formed by the Coyote Dam on the East Fork of the Russian River, and Lake Sonoma is formed by the Warm Springs Dam on Dry Creek.

The ResSim model of the physical system consists of two reservoirs, five diversion locations (four uniformly distributed consumptive use diversions computed by the USGS watershed model and the SCWA point diversion below Dry Creek), and a series of 14 connecting river reaches and 21 junctions. River reaches and routing coefficients are listed in Table 3-1. Storage and diversion elements are summarized in Table 3-2. A screen capture from ResSim, shown in Figure 3-2, displays the physical characteristics of the reservoirs.

There are two major reservoirs, Lake Mendocino and Lake Sonoma, that provide water supply for the Russian River System which are included in the ResSim network. Additionally the basin receives diversions from the Eel River through the Potter Valley Project owned and operated by Pacific Gas and Electric (PG&E). Diversions from the Eel River are explicitly defined in the ResSim model as a boundary time series. These Eel River diversion flows and Lake Pillsbury storage values are estimated using the Eel River model which was originally developed by Natural Resources Consulting Engineers, Inc. and further refined by SCWA and the Round Valley Indian Tribes to properly account for operating requirements of the 2004 FERC license amendment. The ResSim model of the Russian River System is illustrated in Figure 3-1. At the northeastern boundary (Site #1, Headwater in the Figure), inflow from Lake Pillsbury is introduced as two time series, with flow from the Potter Valley Power Plant separated from the main Lake Pillsbury inflow into the System. The northwestern boundary is the inflow location for the West Fork of the Russian River (Site #2). The confluence of the Russian River with Dry Creek (Site #3) is where outflow from Lake Sonoma (Site #4) joins the Russian River. The southeastern boundary of the model is on the Russian River at Hacienda Bridge.

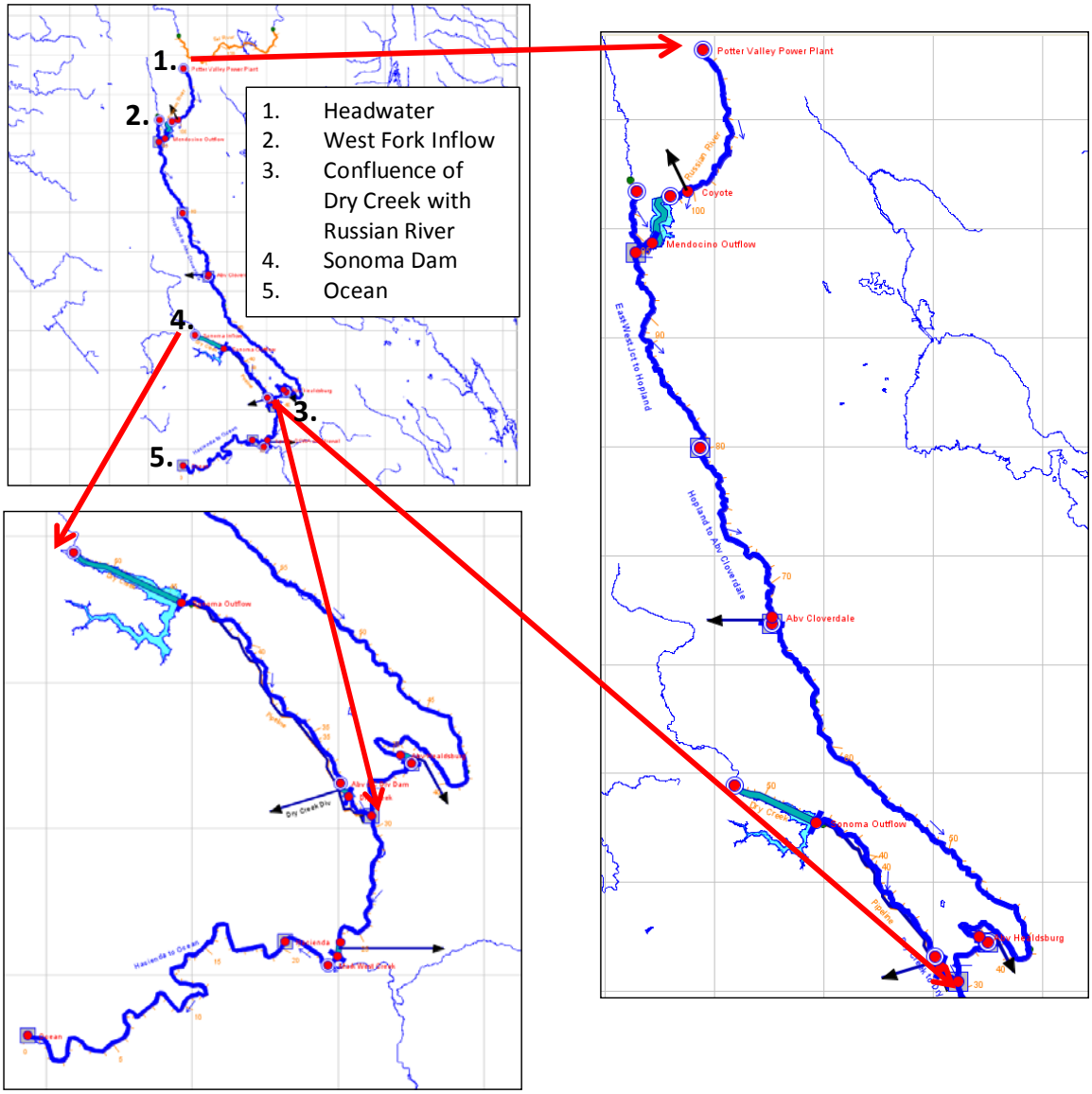

Figure 3-1 Extent of the ResSim Russian River System Model illustrated in the ResSim network. Sections of the entire network in the upper left hand corner have been enlarged in the figures at right and below.

Table 3-1 River Reaches and Routing Coefficients

From:	To:	Routing Type	Coefficients
Potter Valley PP	Coyote	Coefficient	Time Step 1 = 0.8 Time Step 2 = 0.2
West Fork Inflow	East-West Junction	Null	N/A
Mendocino Outflow	East-West Junction	Null	N/A
East-West Junction	Hopland	Coefficient	Time Step 1 = 0.8 Time Step 2 = 0.2
Hopland	Above Cloverdale	Coefficient	Time Step 1 = 0.8 Time Step 2 = 0.2
Cloverdale	Above Healdsburg	Coefficient	Time Step 1 = 0.6 Time Step 2 = 0.4
Healdsburg	Dry Creek RR	Coefficient	Time Step 1 = 0.9 Time Step 2 = 0.1
Sonoma Outflow	Above Dry Creek Div Dam	Coefficient	Time Step 1 = 0.8 Time Step 2 = 0.2
Dry Creek RR	Upstream SCWA Withdrawal	Coefficient	Time Step 1 = 0.85 Time Step 2 = 0.15
SCWA withdrawal	Mark West Creek	Coefficient	Time Step 1 = 0.95 Time Step 2 = 0.05
Mark West Creek	Hacienda	Coefficient	Time Step 1 = 0.8 Time Step 2 = 0.2
Coyote	Mendocino Inflow	Null	N/A
Dry Creek	Dry Creek RR	Null	N/A

Table 3-2 Storage and Diversion Elements of Watershed Network

Reservoirs	**# Zones**	**Zone Change by Year Type**	**Max Capacity All Outlets**	**Power Plant**
Mendocino	Four	Conservation Zone	33,000 cfs	7000 cfs 3.5 MW
Sonoma	Six	No	36,190 cfs	190 cfs 70 MW
Diversion Dams	**# Zones**	**Diversion Name**	**Max Capacity Outlet**	
Upper Russian	Two	Upper Russian	100,000 cfs	
Middle Russian	Two	Middle Russian	100,000 cfs	
Dry Creek	Two	Dry Creek	100,000 cfs	
SCWA	Two	Santa Rosa	100,000 cfs	
Diversions			Specification	
Coyote Basin			Time series	

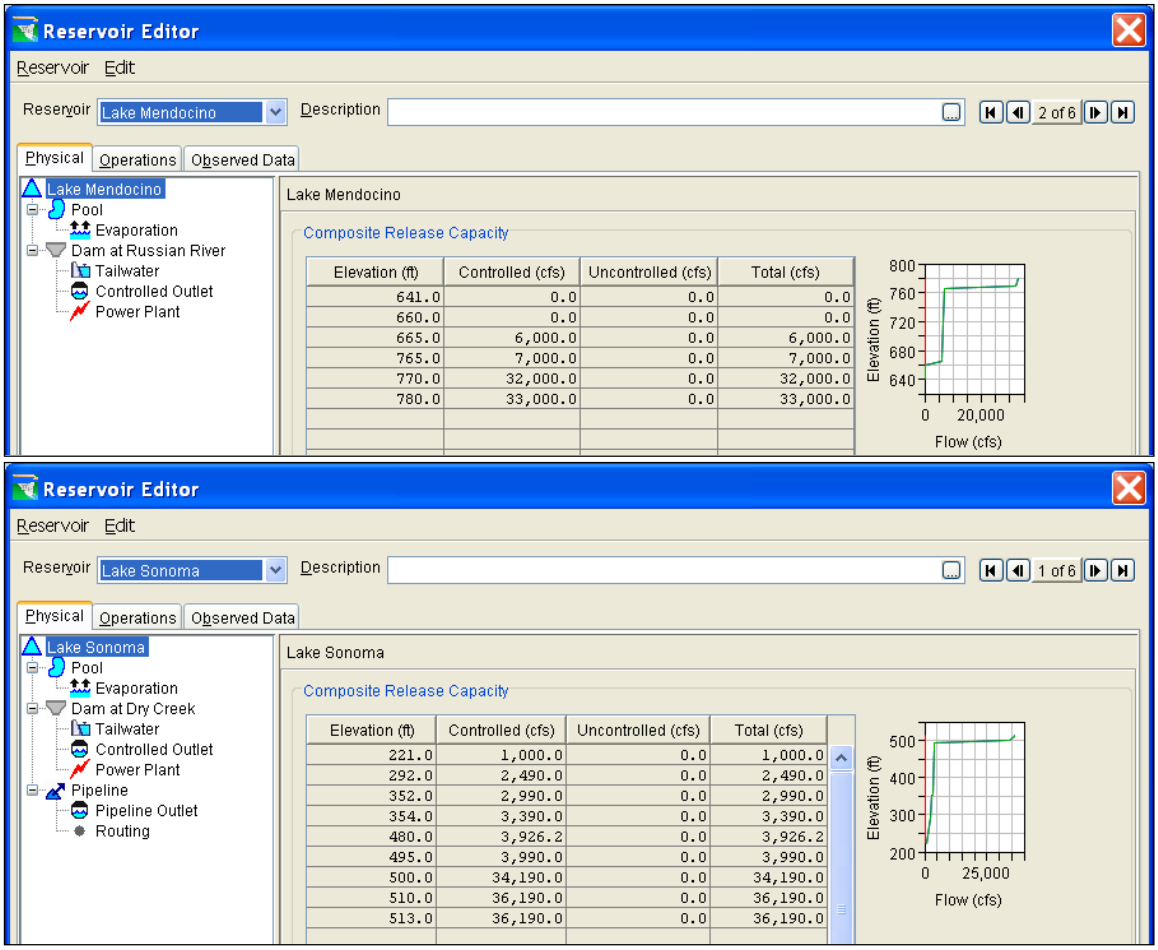

Figure 3-2 Physical characteristics of Lake Mendocino (upper) and Lake Sonoma (lower) in the ResSim model.

3.2 DEFINITION OF BOUNDARY CONDITIONS

Table 3-3 lists the boundary conditions used in the model. In the specification of the System operation, the level of Lake Pillsbury, its “Storage State”, is implemented as a state variable and used as a condition for determining the level of reservoir releases in the dry spring subcategory of normal water years.

Table 3-3 Boundary Time Series

Name	Variable Type	Type	Location	Factor
Water Supply	Year Type Flag	Condition	Lakes Mendocino and Sonoma Downstream Flow Rules	N/A
Local Dummy (Mendocino)	Inflow	Known flow	Potter Valley Power Plant	1.0
Potter Valley	Inflow	Known flow	Potter Valley Power Plant	1.0
West Fork	Inflow	Known flow	West Fork Headwater	1.0
Upper RR	Inflow	Known flow	Hopland Local	0.48
Upper RR	Inflow	Known flow	Cloverdale Local	0.52
Middle RR	Inflow	Known flow	Healdsburg Local	1.0
Lake Sonoma	Inflow	Known Flow	Dry Creek Headwater	1.0
Dry Creek (Local)	Inflow	Known Flow	Above Dry Creek Div Dam	1.0
Santa Rosa	Inflow	Known Flow	Mark West Creek-Laguna	1.0
Coyote Subunit	Diversion	Demand	Coyote Basin	-
Santa Rosa	Diversion	Demand	SCWA Diversion Dam	-
Upper Russian	Diversion	Demand	Upper Russian Diversion Dam	-
Middle Russian	Diversion	Demand	Middle Russian Diversion Dam	-
Dry Creek	Diversion	Demand	Dry Creek Diversion Dam	-

3.3 OPERATING RULES

The original criteria governing minimum flows for the System, i.e., the operational criteria, were defined in 1986 in Decision 1610 of the (California) State Water Resources Control Board. Operating rules for the initial ResSim model were primarily based on information documented in the manual for the SCWA RR-Sim (Flugum, J., 1996). Operating criteria are detailed by year type indicators - critically dry, dry and normal year types. The water year conditions depend on monthly cumulative unimpaired inflow to Lake Pillsbury. Within the normal year type, a subset of criteria specifies downstream flow criteria in a dry spring normal year type which depends on the combined storage levels in Lake Pillsbury and Lake Mendocino on May 31. Flood Control release criteria are detailed for Lake Mendocino and Lake Sonoma.

The operating rules in current ResSim model are based on the current operation requirements as implemented by SCWA.

3.4 RESERVOIRS: LAKES MENDOCINO AND SONOMA

The "Storage State" of Lake Pillsbury (a year type flag) and the calculated storage in Lake Mendocino are used to set flags for operations that implement minimum flow requirements for the Upper Russian River (Coyote Valley Dam to the Dry Creek Confluence) releases during the dry spring category of the normal year type. The criteria for setting this flag are given in Table 3-4 below. Figure 3-3 demonstrates the organization of the operating rules by zone in the Sonoma reservoir (left figure) and the Mendocino Reservoir (split figure on the right). Table 3-5 lists the operating rules applied to Lake Sonoma and Table 3-6 lists the operating rules applied to Lake Mendocino.

Table 3-4 Criteria for establishing the Storage State identification flags for the dry spring year type on May 31 in a normal year type.

State ID =	IF Condition 1	OR Condition 2	Lake Mendocino Rules	Lake Sonoma Rules
1	Mendocino + Pillsbury >= 150,000 Ac-Ft	Mendocino + Pillsbury > 90% of total	NormalMin2-WestJct. NormalMin2-Hopland NormalMin2-Cloverdale NormalMin2- Healdsburg	Normal Min Min85- Jct. Dry Creek Min85 Ocean
2	Mendocino + Pillsbury = 130,000 - 150,000 Ac-Ft	Mendocino + Pillsbury = 80 - 90% of total	NormalMin4-WestJct. NormalMin4-Hopland NormalMin4-Cloverdale NormalMin4- Healdsburg	Normal Min Min85- Jct. Dry Creek Min85 Ocean
3	Mendocino + Pillsbury 130,000 - 150,000 Ac-Ft	Mendocino < 30000 Ac-Ft and Mendocino + Pillsbury = 80 - 90% of total	NormalMin4-WestJct. NormalMin4-Hopland NormalMin4-Cloverdale NormalMin4- Healdsburg	Normal Min Min85- Jct. Dry Creek Min85 Ocean
4	Mendocino + Pillsbury < 130,000 Ac-Ft	Mendocino + Pillsbury < 80% of total	NormalMin4-WestJct. NormalMin4-Hopland NormalMin4-Cloverdale NormalMin4- Healdsburg	Normal Min Min85- Jct. Dry Creek Min85 Ocean

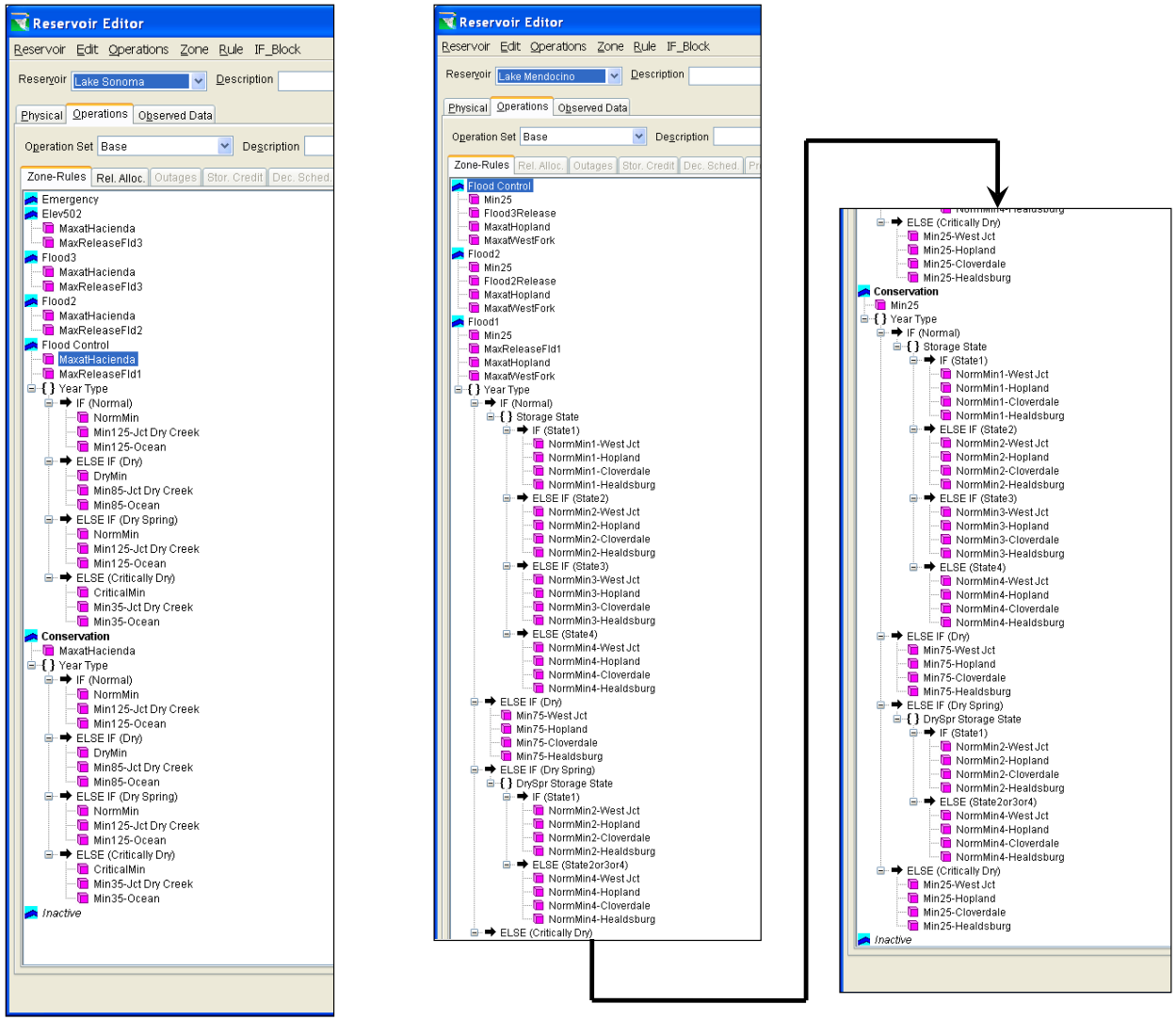

Figure 3-3 Organization of Operating rules for Lakes Sonoma (left) and Mendocino (right).

Table 3-5 Operating Rules Lake Sonoma Reservoir.

Name	Type of Rule	Interpolation	Value (cfs)	Reservoir Elevation Range (ft)
Max at Hacienda	Maximum downstream flow constraint	Linear	35,000	292.7 - 502
Max Release Fld3	Maximum release	Linear	6,000	468.9 - 495
Max Release Fld2	Maximum release	Linear	6,000	456.7 - 468.9
Max Release Fld1	Maximum release – function of previous value of Lake Sonoma elevation	Linear	2000 2800 4000	451.3 451.3 – 452.0 452.0 – 456.7
Name	**Year Type: Type of Rule**	**Interpolation**	**Value (cfs)**	**Annual Start Date**
Normal Min	Minimum release by date	Step	75 80 105	01Jan 01May 01Nov
Dry Min	Minimum release by date	Step	75 25 75	01Jan 01Apr 01Nov
Min125- Jct. Dry Creek	Minimum downstream flow constraint	Linear	125	01Jan
Min85- Jct. Dry Creek	Minimum downstream flow constraint	Linear	85	01Jan
Min35- Jct. Dry Creek	Minimum downstream flow constraint	Linear	35	01Jan
Min125 Ocean	Minimum downstream flow constraint	Linear	125	01Jan
Min85 Ocean	Minimum downstream flow constraint	Linear	85	01Jan
Min35 Ocean	Minimum downstream flow constraint	Linear	35	01Jan

Table 3-6 Operational Rules Lake Mendocino Reservoir

Name	Type of Rule	Interpolation	Value (cfs)	Reservoir Elevation Range (ft)
Min 25	Minimum downstream flow constraint	Linear	25	665.0 – 771.0
Max at Hopland	Maximum downstream flow constraint	Linear	8000	665.0 – 771.0
Max at West Fork	Maximum downstream flow constraint	Linear	2500	665.0 – 771.0
Flood3Release	Maximum release	Linear	6400	755.0 – 771.0
Flood2Release	Maximum release	Linear	4000	747.21 – 755.0
Max Release Fld1	Maximum release – function of previous value of Lake Mendocino Pool elevation	Linear	2000 3000 3900 4000	735.66 735.66 – 740.0 740.0 – 746.0 746.0 – 747.1
Name	**Type of Rule**	**Interpolation**	**Value (cfs)**	**Annual Start Date**
NormalMin1-WestJct. NormalMin1-Hopland NormalMin1-Cloverdale NormalMin1- Healdsburg	Minimum release by date	Step	150 185 185 150	01Jan 01Apr 01Jun 01Sept
NormalMin2-WestJct. NormalMin2-Hopland NormalMin2-Cloverdale NormalMin2- Healdsburg	Minimum release by date	Step	150 185 150	01Jan 01Apr 01Jun
NormalMin3-WestJct. NormalMin3-Hopland NormalMin3-Cloverdale NormalMin3- Healdsburg	Minimum release by date	Step	150 185 150 75	01Jan 01Apr 01Jun 01Oct

Name	Type of Rule	Interpolation	Value (cfs)	Annual Start Date
NormalMin4-WestJct. NormalMin4-Hopland NormalMin4-Cloverdale NormalMin4- Healdsburg	Minimum release by date	Step	150 185 75	01Jan 01Apr 01Jun
Min75-West Jct. Min75-Hopland Min75-Cloverdale Min75-Healdsburg	Minimum downstream flow constraint	Linear	75	01Jan
Min25-West Jct. Min25-Hopland Min25-Cloverdale Min25-Healdsburg	Minimum downstream flow constraint	Step	25	01Jan

3.5 RESSIM – HEC-5Q LINKAGE

The ResSim model relies upon character strings to identify computational points (location names) while the HEC-5Q model assigns a control point number (CP) to each computational point. The linkage between these referencing systems is provided by two text data files that are specified in the HEC-5Q run file. The first file referred to as the "Network Report" is generated by the ResSim program Alternative Editor (Figure 3-4). Selecting the "HEC-5Q" tab and "Generate Network Report" will create the file. The second file is user prepared and referred to as the "Cross Reference / Linkage Table" This table provides the cross reference between the two model naming conventions. These two HEC-5Q input data files normally reside in the HEC-5Q model directory and are referenced by each run.

Network Report

An excerpt from the Network Report (Verify2260wCalpella.txt) is shown in Figure 3-5. Note that comments are identified by "##" in the Network Report. The Network Report may be used for multiple alternatives as long as the CP naming and linkage does not change. Information utilized from the Network Report includes the following. Note that the sequence of records within the Network Report is not necessarily upstream to downstream.

- **RES:POOL:Lake Mendocino**,IN,5,OUT,6,– The area-capacity curve follows the **RES: POOL:** record. The area-capacity table is imported to HEC-5Q by placing this line (bold portion) in the 5Q data file. For reservoirs with hypothetical area-capacity curves in ResSim (e.g., Wholer Dam), the traditional RE, RA & RS data are required in HEC-5Q.
- The **JNC:** and **RCH:** define junctions and reaches respectively. A reach is bounded by two adjacent junctions and often coincide with the reach definition in HEC-5Q. Both of these records, as well as the "**RES:POOL:"** record contain "**IN,#**" and "**OUT,#**" that is used to define the linkage throughout the ResSim model representation. The "**OUT.6**" on the "**RES:POOL:"** record that identifies Lake Mendocino / Coyote Dam (line 11) is automatically linked in HEC-5Q to the downstream reach by the "**IN.6**" of the reach definition record (line 19).
- **DIV:** and **RES:DIVOUT:** both indicate diversions. The first is a point diversion explicitly defined by a DSS record while the second is a diverted outlet that would normally represent channel depletions.
- The reach to junction naming consistency is a requirement for HEC-5Q applications. Lines 21 and 22 are an example of this requirement where both records contain "East-West Jct,Russian River".

Cross Reference / Linkage Table

A portion of the user generated cross reference file (Verify2260wCalpella.tab) that defines the linkage between the two models and their respective naming conventions is seen in Figure 3-6. Unlike in the Network Report, the order of CP entries must

coincide with the computational sequence (upstream to downstream) in HEC-5Q as defined by the S2 Records in the HEC-5Q input data file.

In addition to the CP cross-reference, the ResSim simulation DSS output is named (e.g., “SIM_Fpart: VERIFY22600”). The DSS F part is renamed in the HEC-5Q run file (e.g., “SIM: VERIFY22600”) so that a separate cross reference table is not required for each run (alternative). In Figure 3-6, the “SIM_Fpart:replace” is a place holder that is overwritten with the DSS F part named from the run file

Like all HEC-5Q related text files, comments are allowed but must take the form of “c” in column 1. Blank lines are not interpreted as comments. The comments in the cross reference table are intended to provide insight into the preparation of the file.

Lines 7 through 18 are required when there are conflicts in the naming convention. In ResSim, the flow records for the East Fork above Lake Mendocino reference both “Coyote” and “Calpella” This flexibility does not exist in HEC-5Q so duplicate records are created in the “simulation.dss” file so that all required records have the “Calpella” DSS B part reference.

A typical linkage specification is seen on line 28. The location and river name must reference the names of a “**JNC:**” record in the Network Report (line 2, Figure 3-5). Line 29 defines the volume of the dummy reservoir that represents the potter valley project in HEC-5Q. HEC-5Q requires that any upstream reach is headed by a reservoir. There is no such requirement in ResSim.

Log file

The records of the Cross Reference / Linkage Table coordinate with the Network Report to define all of the hydrology required by HEC-5Q. A log output file is produced that documents the DSS pathnames generated by these two files. Excerpts from the log file (ResSim_5Q_2.log) are provided in Figure 3-7. Lines 1 through 20 lists lines extracted from the Network Report that are associated with each control point listed in the Linkage Table plus the volume override and explicitly defined diversion path names. The “out#’ and “in#” identify the outflow and inflow. Lines 22 through 41 lists the corresponding DSS pathnames that are generated to access the DSS data required by HEC-5Q that resides in the “simulation.dss” ResSim output file. The first 10 values (last 8 values omitted in Figure 3-7 due to width concerns) serve as a quick check on the DSS data. The two-character ID at the left identifies the type of record as follows.

- HW – headwater
- OD – explicitly defined diversion
- SJ – stream junction flow
- SR – stream reach flow
- RE – reservoir evaporation
- RS – reservoir storage

A more complete listing of flows components by control point follows. Thirty values evenly spaced through the simulation period can often identify simulation errors. Four flow components and volumes are listed. They include:

- QL – Incremental local inflow

- QN – Control point flow
- QD – Diversion flow
- EV – Reservoir evaporation in cfs
- Vol – Reservoir volume

One will notice that there are no explicit references to inflows in the Linkage Table. The inflows to headwater control points (Potter Valley Project: line 23 – HW & line 43 - QL) is defined as the junction flow. For all other control points (CP) locations, the inflow is computed as the difference between the ResSim flows for the reach above (two reaches for confluences) and the junction. As an example, referring to lines 40, 41 & 39) the local inflow at the East – West Fork confluence is computed as SJ260 – both of the SR260s.

For the Calpella location, the local inflow is computed in a similar fashion, however the flow at Calpella includes the explicitly defined diversion (lines 5 & 27). Therefore the ResSim JNC flow includes the effect (reduction) due to the diversion. For this situation, the diversion is added to the JNC flow before subtracting the RCH flow to get the incremental inflow rate (i.e., OD274 + SJ274 – SR274). The diversion is defined by a DSS pathname following the key word "diversion:" in the Linkage Table (Figure 3-6, line 39).

Reservoir volumes and evaporation rates are assigned when the flag "RES_5Q" (line 47) is included in the stream name column (field 33-64). When the ResSim volume and evaporation is realistic (e.g., Lake Sonoma and Mendocino), the DSS output data are used. For all other reservoirs, a realistic volume must be set using the "Set Volume =" record. For Wholer Dam, the volume is set to 400 AF and the wintertime dam removal is not considered. When the volume is set, the evaporation rate is set to zero. HEC-5Q requires that the upstream stream reach be headed by a reservoir, therefore, the West Fork and Potter Valley power must be represented by a reservoir with a nominal volume. The volume set option is used to define a small volume of 10 AF. For these small (dummy) reservoirs, the HEC-5Q model assigns the inflow quality to the outflow. The reservoir outflow is defined as the dam JNC flow.

In addition to explicitly defined diversion, ResSim may compute the diversion rate based on operational constraints using a "Diverted Outlet". The "Hopland div dam" is an example where the diversion above Hopland is computed and is assumed to represent channel depletions over the upstream stream reach (East-West confluence to Hopland). Referring to lines 21, 22, 23 & 25 of Figure 3-5, the incremental inflow is computed as the above Hopland less the East-West confluence flows. The diversion is not explicitly defined; however the flow at Hopland includes the diversion. Therefore, the diversion is the difference between the Hopland and above Hopland flows. Since the "Hopland div dam" is not simulated in HEC-5Q, it is not referenced in the Linkage Table.

Wholer Dam is also represented as a diverted outlet but the diversion is a point withdrawal and must be allocated to the reservoir instead of the upstream stream reach. This is accomplished by defining the flow for both the inflow ("upstream SCWA withdrawal") and the outflow ("SCWA withdrawal") and the flow imbalance is the point

diversion that is distributed over the reservoir instead of the upstream reach. The even distribution is justified since there is a water transfer through the stream substrate instead of above bed intake.

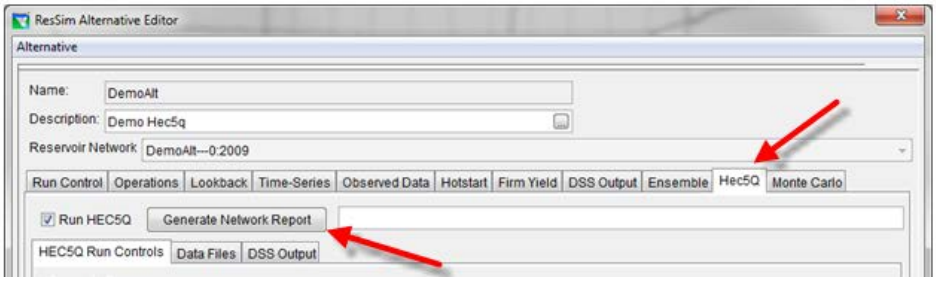

Figure 3-4 ResSim Alternative Editor that creates the Network Report.

```
##-------------------------------------------------------
JNC:Potter Valley Project,Russian River,108.767,IN,62,OUT,16,
LOC:Potter Valley Release
RCH:Potter Valley Power Plant to Calpella,Russian River,108.767,99.601,IN,16,OUT,69
JNC:Calpella,Russian River,99.601,IN,69,71,211,OUT,70,
LOC:Calpella Local
RCH:Calpella to Mendocino Inflow,Russian River,99.601,98.560,IN,70,OUT,30
JNC:Mendocino Inflow,Russian River,98.560,IN,30,55,OUT,5,
LOC:Lake Mendocino Local
RES:Lake Mendocino,1,Russian River,98.560,95.030
RES:POOL:Lake Mendocino,IN,5,OUT,6,
   Elevation      Storage          Area
          ft        ac-ft          acre
      644.00        27.12         11.84
      645.00        38.96         15.98
##-------------------------------------------------------
RES:DIVOUT:Lake Mendocino,Redwood Valley Div,END
RES:Lake Mendocino,END
JNC:Lake Mendocino Outflow,Russian River,95.030,IN,6,OUT,7,
RCH:Mendocino Outflow to East-West Jct,Russian River,95.030,94.400,IN,7,OUT,32
JNC:East-West Jct,Russian River,94.400,IN,32,131,OUT,18,
RCH:East-West Jct to Abv Hopland,Russian River,94.400,80.755,IN,18,OUT,157
JNC:Abv Hopland,Russian River,80.755,IN,157,166,OUT,159,
LOC:Hopland Local
RES:Hopland Div Dam,1,Russian River,80.755,80.093
RES:POOL:Hopland Div Dam,IN,159,OUT,160,
   Elevation      Storage          Area
          ft        ac-ft          acre
        0.00         0.00          0.00
      100.00        1.0E8        100.00
RES:DAM:Hopland Div Dam,Dam at Russian River,Russian River,80.093,100.0,1000.0,ft
RES:OUTLET:Hopland Div Dam,Controlled Outlet 1,1, , ,cfs/hr
   Elevation      Capacity
          ft          cfs
         0.0     100000.0
       100.0     100000.0
RES:DAM:Hopland Div DamDam at Russian River,END
RES:DIVOUT:Hopland Div Dam,Hopland Div
RES:OUTLET:Hopland Div Dam,Hopland Loss,1, , ,cfs/hr
   Elevation      Capacity
          ft          cfs
         0.0      50000.0
       100.0      50000.0
RES:DIVOUT:Hopland Div Dam,Hopland Div,END
RES:Hopland Div Dam,END
JNC:Hopland,Russian River,80.093,IN,160,OUT,20,
RCH:Hopland to Abv Cloverdale,Russian River,80.093,67.887,IN,20,OUT,88
JNC:Abv Cloverdale,Russian River,67.887,IN,88,148,OUT,90,
LOC:Cloverdale Local
RES:Cloverdale Div Dam,1,Russian River,67.887,67.546
```

Figure 3-5 ResSim Network Report file **"Verify2260wCalpella.txt ".**

```
c. comments take the following form.  The "c." is required since blank lines are program flags
c. The following line (comment) is the Run file control and is included as an example
c. RESSIM_5Q:..\Verify2260wCalpella.txt;..\Verify2260wCalpella.tab;..\simulation.dss
c. SIM:VERIFY22600
c. duplicate simulation.dss record to comply with naming protocol for referencing
c. HEC5Q control points to ResSim character strings that identify computational point
rename DSS record   01JAN2000                5115
c. starting date    ^^^^^^^^^^^^^^^^^^^^
c. Record length (tabulate for MM)      ^^^^^^^^^^
c. ResSim path name followed by duplicate record path name
//POTTER VALLEY POWER PLANT TO COYOTE/FLOW////
//POTTER VALLEY POWER PLANT TO Calpella/FLOW////
//COYOTE TO MENDOCINO INFLOW/FLOW////
//Calpella TO MENDOCINO INFLOW/FLOW////
end rename
c. This is a place holder record.  The F Parts differs to the "RESSIM_5Q:" text file
c.  (e.g., "ResSim_Verify2260wCalpellaR.txt")
SIM_Fpart:replace
c... All blank lines are required
                                                                                                  blank
c... Enter control point ID per the network file (Verify2260wCalpella.txt)
c.    The order must be the same as the HEC5Q input file control point sequence (RS_HEC5Q.dat)
c... The ResSim location name and HEC5Q control point number form the linkage between the two models.
c.    This is why the duplicate records at Capella are required
c... Hydrology and operation is transferred via DSS (simulation.dss)
c... Upstream limit represented by dummy reservoir that needs a volume defined via "set volume =     10."
c. Name                          Stream Name                              Control Pt
Potter Valley Project           Russian River                                280
set volume =     10.
                                                                                                  blank
C.abv Calpella                    Russian River no_5Q                          274
C.
c... distributed diversion allocated over stream reach 280 to 274 rather than irrigation canal diversions
c... Local inflows are also distributed uniformly above Calpella
Calpella                        Russian River                                274
c. The diversion at Calpella is computed, therefor, the F Part will changed (i.e., "F=replace") with
c.   the simulation.  This is not always the case since the diversion may be defined explicitly.
c. F parts other than "F=replace" will NOT be replaced.
diversion: A= B=CALPELLA DIV-CALPELLA DIV CNTRL C=flow E=1DAY F=replace
                                                                                                  blank
c... No local flow to lake Mendocino, all inflow is provided by the East Fork -
Mendocino Inflow                Russian River                                272
                                        blank
c... Lake Mendocino and Lake Mendocino outflow share the
c.      same CP # (270) to define volume, evaporation and Coyote Dam release
c... The "RES_5Q" is required for non-dummy reservoirs.
Lake Mendocino                  Russian River RES_5Q                         270
                                                                                                  blank
Lake Mendocino Outflow          Russian River                                270
```

Figure 3-6 ResSim – HEC-5Q Linkages Table "**Verify2260wCalpella.tab".**

```
POTTER VALLEY PROJECT           RUSSIAN RIVER                                280
  other:    SET VOLUME =     10.
  out#  16: JNC:POTTER VALLEY PROJECT,RUSSIAN RIVER,108.767,IN,62,OUT,16,
CALPELLA                        RUSSIAN RIVER                                274
  other:    DIVERSION: A= B=CALPELLA DIV-CALPELLA DIV CNTRL C=FLOW E=1DAY F=REPLACE
  out#  70: JNC:CALPELLA,RUSSIAN RIVER,99.601,IN,69,71,211,OUT,70,
  in#   69: RCH:POTTER VALLEY POWER PLANT TO CALPELLA,RUSSIAN RIVER,108.767,99.601,IN,16,OUT,69
MENDOCINO INFLOW                RUSSIAN RIVER                                272
  out#   5: JNC:MENDOCINO INFLOW,RUSSIAN RIVER,98.560,IN,30,55,OUT,5,
  in#   30: RCH:CALPELLA TO MENDOCINO INFLOW,RUSSIAN RIVER,99.601,98.560,IN,70,OUT,30
LAKE MENDOCINO                  RUSSIAN RIVER RES_5Q                         270
  out#   6: RES:POOL:LAKE MENDOCINO,IN,5,OUT,6,
  in#    5: JNC:MENDOCINO INFLOW,RUSSIAN RIVER,98.560,IN,30,55,OUT,5,
LAKE MENDOCINO OUTFLOW          RUSSIAN RIVER                                270
  out#   7: JNC:LAKE MENDOCINO OUTFLOW,RUSSIAN RIVER,95.030,IN,6,OUT,7,
  in#    6: RES:POOL:LAKE MENDOCINO,IN,5,OUT,6,
EAST-WEST JCT                   RUSSIAN RIVER                                260
  out#  18: JNC:EAST-WEST JCT,RUSSIAN RIVER,94.400,IN,32,131,OUT,18,
  in#   32: RCH:MENDOCINO OUTFLOW TO EAST-WEST JCT,RUSSIAN RIVER,95.030,94.400,IN,7,OUT,32
  in#  131: RCH:WEST FORK INFLOW TO EAST-WEST JCT,WF RUSSIAN RIVER,96.068,94.400,IN,17,OUT,131
##---------------------------------------------- deleted lines ----------------------------------------
*tabSCW: *tabSCW;xxPOTTER VALLEY PROJECT          RUSSIAN RIVER                                  280
HW   280  A=  B=POTTER VALLEY PROJECT  C=FLOW  E=1DAY  F=VERIFY22600          302.      305.      305.
Set volume =RE X 280        0.
Set volume =RS X 280         10.
*tabSCW: *tabSCW;xxCALPELLA                       RUSSIAN RIVER                                  274
OD   274  A= B=CALPELLA DIV-CALPELLA DIV CNTRL C=FLOW E=1DAY F=REPLACE          0.        0.        0.
SJ   274  A=  B=CALPELLA  C=FLOW  E=1DAY  F=VERIFY22600                       658.      499.      477.
SR   274  A=  B=POTTER VALLEY POWER PLANT TO CALPELLA  C=FLOW  E=1DAY  F      302.      305.      305.
*tabSCW: *tabSCW;xxMENDOCINO INFLOW               RUSSIAN RIVER                                  272
SJ   272  A=  B=MENDOCINO INFLOW  C=FLOW  E=1DAY  F=VERIFY22600               699.      537.      515.
SR   272  A=  B=CALPELLA TO MENDOCINO INFLOW  C=FLOW  E=1DAY  F=VERIFY22      658.      499.      477.
*tabSCW: *tabSCW;xxLAKE MENDOCINO                 RUSSIAN RIVER RES_5Q                           270
RE   270  A=  B=LAKE MENDOCINO-POOL  C=FLOW-EVAP  E=1DAY  F=VERIFY22600         0.        2.        2.
RS   270  A=  B=LAKE MENDOCINO-POOL  C=STOR  E=1DAY  F=VERIFY22600          69970.    70852.    71818.
*tabSCW: *tabSCW;xxLAKE MENDOCINO OUTFLOW         RUSSIAN RIVER                                  270
SJ   270  A=  B=LAKE MENDOCINO OUTFLOW  C=FLOW  E=1DAY  F=VERIFY22600         100.       89.       25.
*tabSCW: *tabSCW;xxEAST-WEST JCT                  RUSSIAN RIVER                                  260
SJ   260  A=  B=EAST-WEST JCT  C=FLOW  E=1DAY  F=VERIFY22600                  696.      469.      361.
SR   260  A=  B=MENDOCINO OUTFLOW TO EAST-WEST JCT  C=FLOW  E=1DAY  F=VE      100.       89.       25.
SR   260  A=  B=WEST FORK INFLOW TO EAST-WEST JCT  C=FLOW  E=1DAY  F=VER      596.      380.      336.
##---------------------------------------------- deleted lines ----------------------------------------
 QL       280    302.0    305.0    305.0    305.0    310.0    300.0    282.0    310.0    285.0    310.0
 QN              302.0    305.0    305.0    305.0    310.0    300.0    282.0    310.0    285.0    310.0
 EV                0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.0
 Vol              10.0     10.0     10.0     10.0     10.0     10.0     10.0     10.0     10.0     10.0
 QD                0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.0
```

Figure 3-7 ResSim – HEC-5Q output Log file (ResSim_5Q_2.log)

4 MODEL DEMONSTRATION

The HEC-5Q model was previously calibrated using water quality field observations measured in 1990 – 2005.

The goal of the current effort is to demonstrate that the model continues to produce reasonable results with the new configuration and with flows generated by the ResSim verified model. Model results are compared with observed temperature and DO data to determine their reasonableness. Although the verified model does an excellent job of reproducing observed flows and storages, the ResSim flows are not purely based on historical data. Therefore, this model demonstration cannot be considered a calibration but rather a "Model Demonstration"

The following data sets were utilized for comparison with model results.

- Lake Sonoma and Lake Mendocino temperature and dissolved oxygen profiles (Water Quality Control Board, 2000 – 2013).
- Continuous river temperature and dissolved oxygen (USGS, Water Quality Control Board, Mendocino County Water District, SCWA and USGS, 2000 – 2013) at locations shown in Figure 4-1.

The meteorology and inflow water quality conditions described in the 2007 model calibration report (RMA, 2007) were extended through 2013 and Potter valley inflow and associated water quality were added, as discussed in section 2.3.

The seasonal response of nutrients and other water quality constituents were similar to those reported in the 2007 report (RMA, 2007) documenting the results of the previous calibration effort and are included by reference. They are not presented herein.

ResSim flows and storage volumes are determined by operating rules and are not identical to historical flows. During the 2000-2013 ResSim calibration effort, river flows were shown to realistically represent observed conditions. The ResSim calibration model results are identified by the DSS F part of VERIFY22600. Deviations from observed storages can typically be attributed to periods in which the Corps allowed for encroachment into the flood control pool while ResSim follows a strict adherence to the guide curve. The differences between the computed and observed flow would generally have a minimal impact on temperature and dissolved oxygen. However, thermal and DO profiles and reservoir outflow temperatures are sensitive to reservoir volumes that result from small changes in inflow and outflow rate. For the model demonstration, the observed profiles were adjusted vertically so that observed profiles consistent with the model elevation. This adjustment was generally a few feet or less.

4.1 HEC-5Q MODEL DEMONSTRATION RESULTS

The following sections provide a brief discussion of the model demonstration results for reservoirs and streams by water quality parameter.

RESERVOIR RESULTS

Temperature

Computed and observed vertical temperature profiles for several sampling events per year during 2000 – 2013 are plotted for Lake Mendocino and Lake Sonoma in Figure 4-2 through Figure 4-12. In many of the plots more than one distinct profile is seen because the data are for multiple locations within the lakes. These locations can be in different arms of the lakes and provide an insight to the spatial variation that cannot be represented in the model. The goal of the calibration was to achieve an average of the observed data profiles.

In Lake Mendocino, in Figure 4-2 through Figure 4-7, the model shows good agreement with observed location of the thermocline. The hypolimnion and epilimnion temperatures are generally well represented. The destratification of Lake Mendocino in the fall tends to be delayed in the model, resulting in slightly low hypolimnion temperatures in September or October of some years. With the upstream boundary condition applied at Potter Valley and the inflow to the lake computed by the stream model, the computed inflow temperatures to Lake Mendocino later in the year are now on average cooler than the defined temperatures in the previous version of the model. These cooler inflows may contribute to delayed lake overturn. Cooler water entering Lake Mendocino late in the year enters the lake at depth, prolonging stratification. The volume of cooler water is a small fraction of the total reservoir capacity and the resulting delayed destratification would result in only slightly cooler release temperatures in October and November. The dissolved oxygen plot for the East Fork below Coyote Dam (Figure 4-39)

Lake Sonoma reservoir temperature profiles, in Figure 4-8 through Figure 4-12 show excellent agreement with observed data throughout the year. Hypolimnion temperatures are generally not measured for 2000 – 2002, but both the model results and available data indicate near isothermal conditions below the thermocline. In 2007 the model begins to destratify slightly ahead of observed, but is in good agreement with observed data by the end of October.

Dissolved Oxygen (DO)

Computed and observed vertical DO concentration profiles for several sampling events per year from 2000 through 2013 are plotted for Lake Mendocino and Lake Sonoma in Figure 4-13 through Figure 4-23. As with the temperature plots, multiple distinct lines in the profile data represent multiple locations within the lakes. These locations can be in different arms of the lake and provide an insight to the spatial variation that cannot be represented in the model. There is often a greater variation in observed DO within the lake than for temperature since dissolved oxygen is sensitive to an array of environmental factors while temperature is physically based on predictable density relationships. The goal of the calibration was to achieve an average of the observed data profiles.

Simulated vertical dissolved oxygen profiles in Lake Mendocino are shown in Figure 4-13 through Figure 4-15. The model's delayed destratification, which was seen in the temperature results, is evident in the DO results as well. The October 11, 2001 plots for temperature and DO shows that anoxic conditions can persist with only minor temperature stratification. During May of 2000 - 2002 and 2009, algae production in the

model results in elevated DO approximately 20 feet from the surface. There is evidence of this in the observed data in 2000 and 2001, but to a lesser degree.

The Lake Mendocino temperature and DO calibration emphasized the short DO record below Coyote Dam during the summer and fall of 2013 (2009 data suggests a similar condition). The calibration goal was to achieve the low DO in the fall to capture the most adverse potential impact. The calibrated model predicts the low DO for each year generally in late September or early October of each year. It also arrives at the minimum DO earlier than observed in most years (July - August). The model results that are discussed further in the stream section should be considered as the worst case condition for DO in the reach below the dam.

In Lake Sonoma computed DO profiles are in good agreement with observed data throughout much of the simulation period, as shown in Figure 4-19 through Figure 4-23. During May and June of each year plotted, computed DO profiles tend to show surface concentrations 1 to 2 mg/L higher than observed. The model seems to have too much productivity (initial algal bloom) at the surface during this time, causing the elevated DO in the epilimnion. As the algae settles into the metalimnion and out of the euphotic zone, the algae respires and depresses the DO. Note that for the earlier years, most of the observed DO profiles within Lake Sonoma terminate at about 70 feet. Comparison with hypolimnion DO measurements in 2007 shows generally good agreement, with the greatest discrepancies of approximately 1 mg/L seen during the summer months of 2007 and 2008. The profile of October and December 2007 provide the only indication of depressed DO in the Lake Sonoma hypolimnion.

STREAM RESULTS

Simulated temperature and dissolved oxygen are plotted at 6-hour intervals with observed data in Figure 4-26 - Figure 4-44 at locations shown in Figure 4-1. These plots cover time periods during 2000 – 2013 when observed data are available.

Temperature

Stream temperature calibration results for 2000 – 2013 are plotted with observed data in Figure 4-26 - Figure 4-38. Computed temperature time series closely match observed data in magnitude, and daily and seasonal variation at most locations.

In the East Fork Russian River at Redwood Valley, shown in Figure 4-24, comparison with summer water temperature data shows that during June through mid-August, computed temperatures are as much as 10° F lower than observed, with less diurnal variation, but in good agreement later in August and through September during most years with available data. The cooler computed temperature is necessary to adequately represent the observed thermal condition in Lake Mendocino. Temperatures below Coyote Dam are plotted in Figure 4-25. The model tends to under-predict peak fall temperatures by up to 3° F during years with available data. In the West Fork Russian River at Lake Mendocino Drive, in Figure 4-26, computed temperatures are generally in good agreement with observed data, with less daily variation than observed during some months. Both this location and the Redwood Valley location are near the upstream boundaries and are, therefore, very dependent on the boundary conditions imposed in the model. Available data are limited to the low flow summer period at both locations. These differences do not

appear to have an important impact on the calibration results downstream of the confluence since the largest differences are for very low flows.

In Figure 4-27, simulated temperatures at the confluence of the East and West Forks of the Russian River are compared with observed temperatures during the fall of 2009. These results are similar to those seen in the West Fork, with the model falling below the seasonal peak by several degrees.

In the Russian River at Granite Talmage (Figure 4-28), the computed temperatures are generally in good agreement with available observed data. The model lags behind the observed seasonal temperature increase in August – September 2000, and computed peak 2004 temperatures are up to 5° F below peak observed. Excellent results are achieved at Hopland, shown in Figure 4-29. In Figure 4-30, the computed agrees well with the observed maximum and minimum temperature. At locations downstream of Commisky Station, in Figure 4-31 through Figure 4-35, temperatures are governed by meteorological conditions and the model results are generally in excellent agreement with observed data, except during the winter when computed temperatures tend to be lower than observed by as much as 5º F but are generally within 2º F. The mid-winter temperature differences may be attributable to winter storm runoff with ill-defined temperature. Computed seasonal peak temperatures at Guerneville (Figure 4-35) are several degrees below observed during some years possibly attributable to too little warming of the Dry Creek flows.

Computed and observed temperatures in Dry Creek below Warm Springs Dam are plotted in Figure 4-36. The Warm Springs Dam outlet is operated to a 52º F target temperature so the withdrawal depth (and outlet DO) varies over time. The model demonstration did not consider actual operation or observed outflow temperature targets, thus there are differences between the computed and observed temperatures. The differences between computed and observed temperatures below the dam are reflected downstream in Dry Creek below Lambert Bridge and near the mouth, as shown in in Figure 4-37 and Figure 4-38. Limited data sets are available at these locations.

Dissolved Oxygen (DO)

Stream oxygen calibration results for 2002 - 2013 are plotted with available observed data in Figure 4-39 through Figure 4-45. Computed and observed DO below Coyote Dam is plotted in Figure 4-39 for 2009 and 2013 when data are available. The computed results are somewhat offset in time reaching minimum DO levels sooner and recovering sooner than observed, but the concentrations match fairly well. Model departure from observed Lake Mendocino volumes at low levels may contribute to the difficulty in getting proper timing of the end of the low DO outflows observed below Coyote Dam. In 2009, the same temperature recorder was used below the dam and at the confluence. The apparent offset in the computed and observed below the dam actually reflects the end of the 2009 record. Figure 4-40 provides a better indication of the end of the low DO period.

The computed Coyote Dam outflow DO (Figure 4-39) assumes a deficit reduction factor of 0.125 [DO below Dam = outlet DO + .125*(DO saturation – outlet DO)]. Computed and observed DO at the East and West Fork Russian River confluence is plotted in Figure 4-40 for 2009. In stream reaeration was set in the model based on comparison of the limited 2009 data sets for the below dam and confluence locations, which suggests a 2

mg/l recovery between the Dam and confluence. Since the same recorder was used at both locations, there is no time overlap. Below dam data cover June – August 2009 and confluence data cover September – October 2009. This is a limited data set upon which to calibrate stream reaeration so additional data would be helpful. In the absence of additional, this simulation results must be considered worst case.

Computed DO at Hopland, in Figure 4-41 and Digger Bend, in Figure 4-42, shows reasonable agreement with observed seasonal trends, but much less diurnal variation. Between 2002 and 2009 the observed data at Hopland show a trend of decreasing oxygen concentration which is not reflected in the model. This could be real or could be meter or location "drift". The data appears to "reset" to higher concentrations in 2010. At RDS inflatable, in Figure 4-43, observed data show large fluctuations and seasonal trends that are not well represented by the model. The model cannot approximate noisy data. Computed results at Guerneville, in Figure 4-44, show generally good agreement with observed data in magnitude and seasonal variation. The model results show much less diurnal variation.

Computed and observed DO in Dry Creek below Lambert Bridge is plotted in Figure 4-45 for 2012 and 2013. Computed DO is generally within range of observed daily maximum and minimum but without the 1 to 2 mg/L diurnal variations. Computed Warm Springs Dam outflow assumes a deficit reduction factor of 0.8, which has remained the same throughout the life of the sequence of modeling efforts. A DO profile plot from Warm Springs to Wohler is shown Figure 4-46. To produce this plot, all 2000 – 2013 results were compiled and sorted to produce average and 5%, 25%, 75% and 95% exceedance profiles. For sensitivity testing, DO profiles shown in Figure 4-47 were computed for a 0.5 deficit reduction ratio. With the 0.5 assumption, DO less than 7.0 mg/L is limited to just below Warm Springs Dam 5% of the time. A very tranquil power house discharge condition would need to exist to create a DO deficits issue that appears to exist below Coyote Dam.

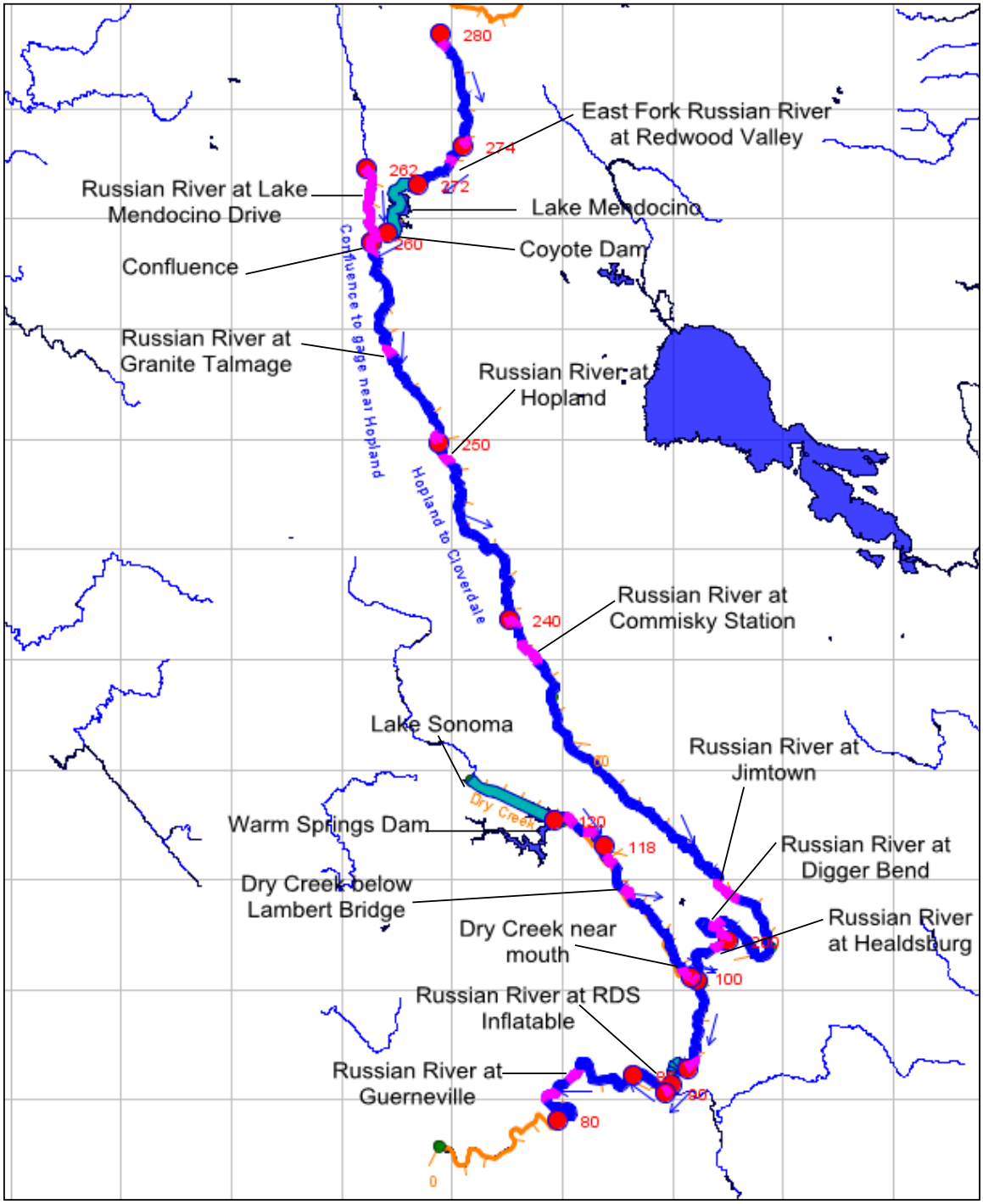

Figure 4-1 Map showing locations of water quality monitoring stations used in the model demonstration.

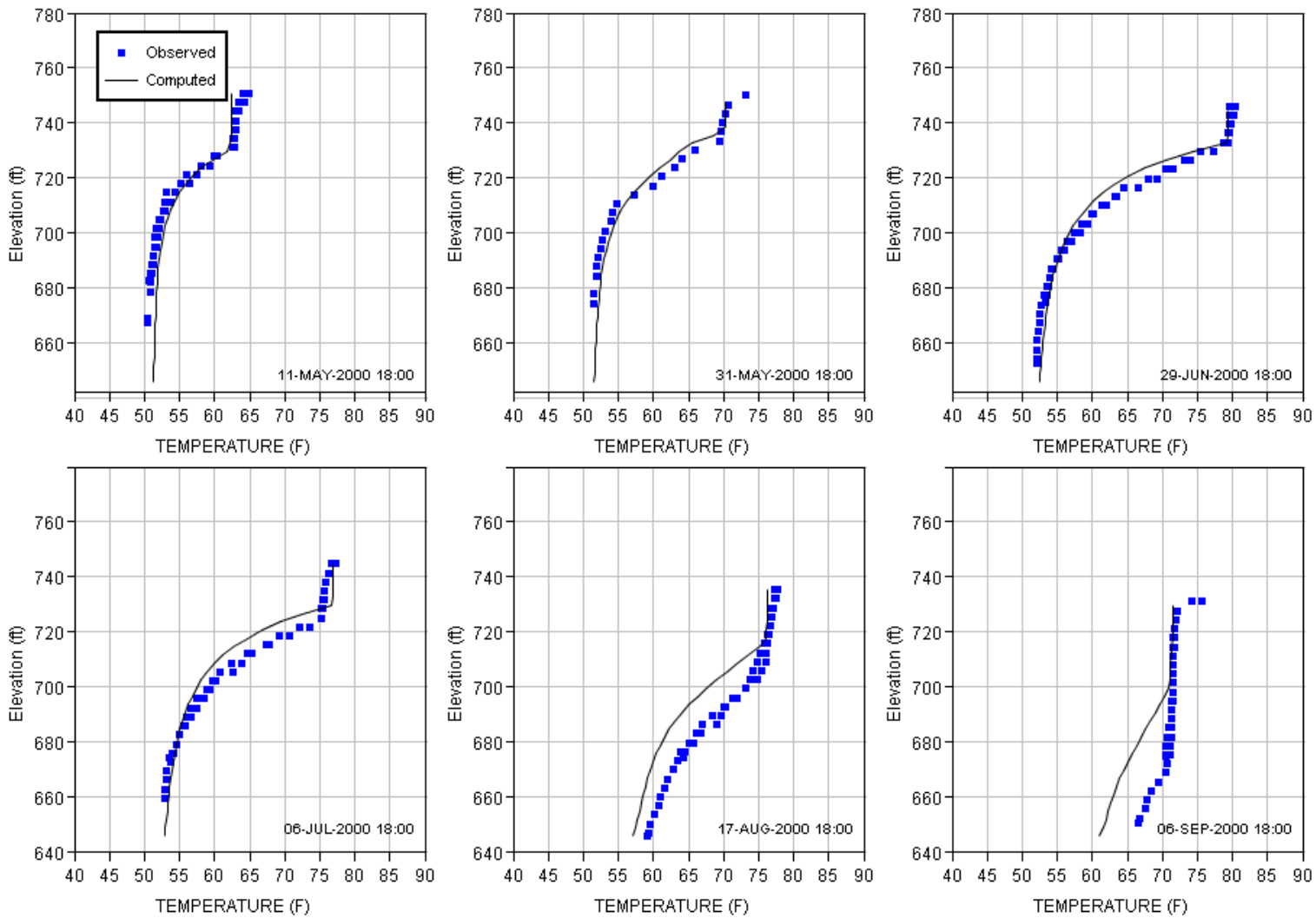

Figure 4-2 Computed and observed temperatures in Lake Mendocino for 2000.

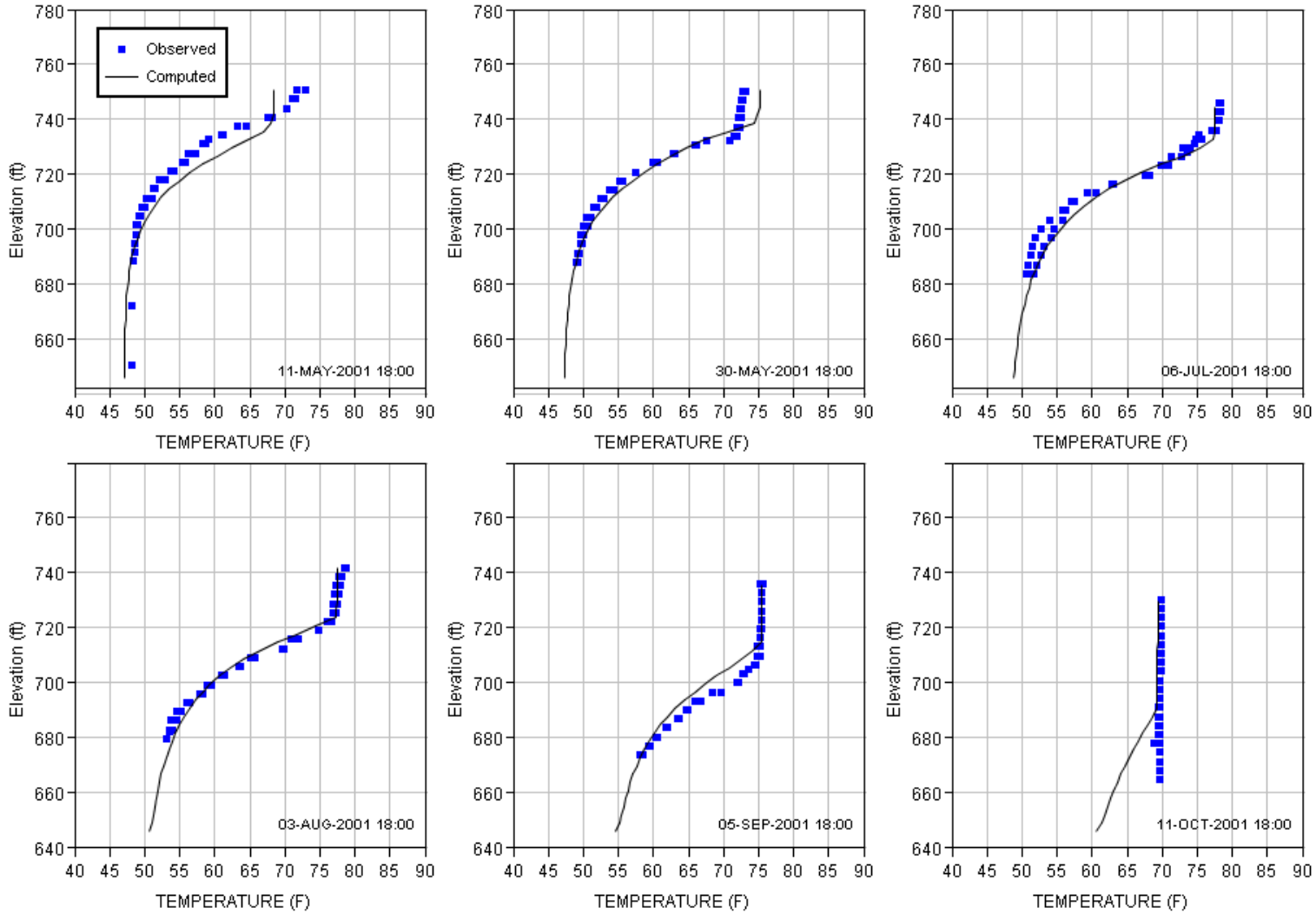

Figure 4-3 Computed and observed temperatures in Lake Mendocino for 2001.

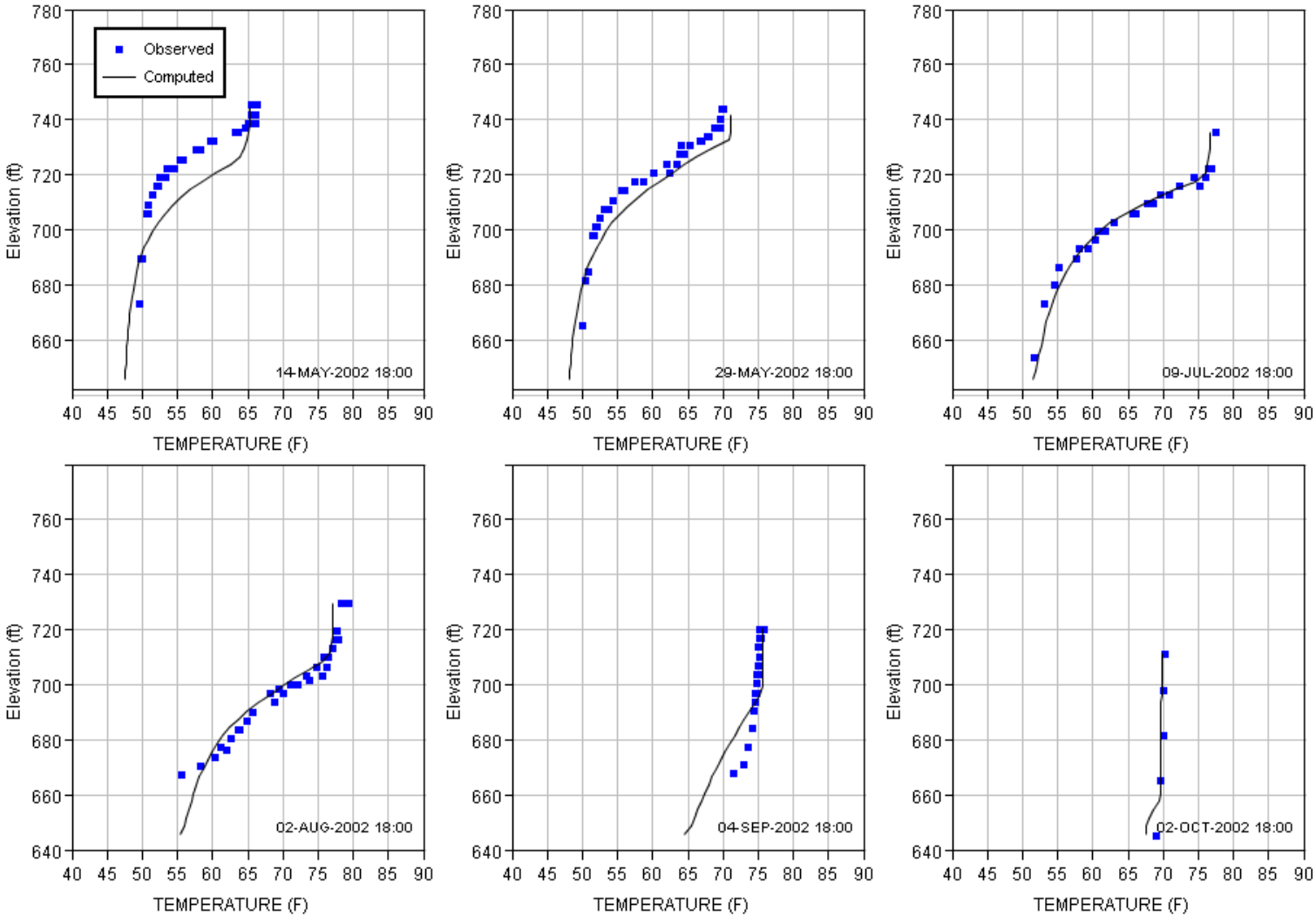

Figure 4-4 Computed and observed temperatures in Lake Mendocino for 2002.

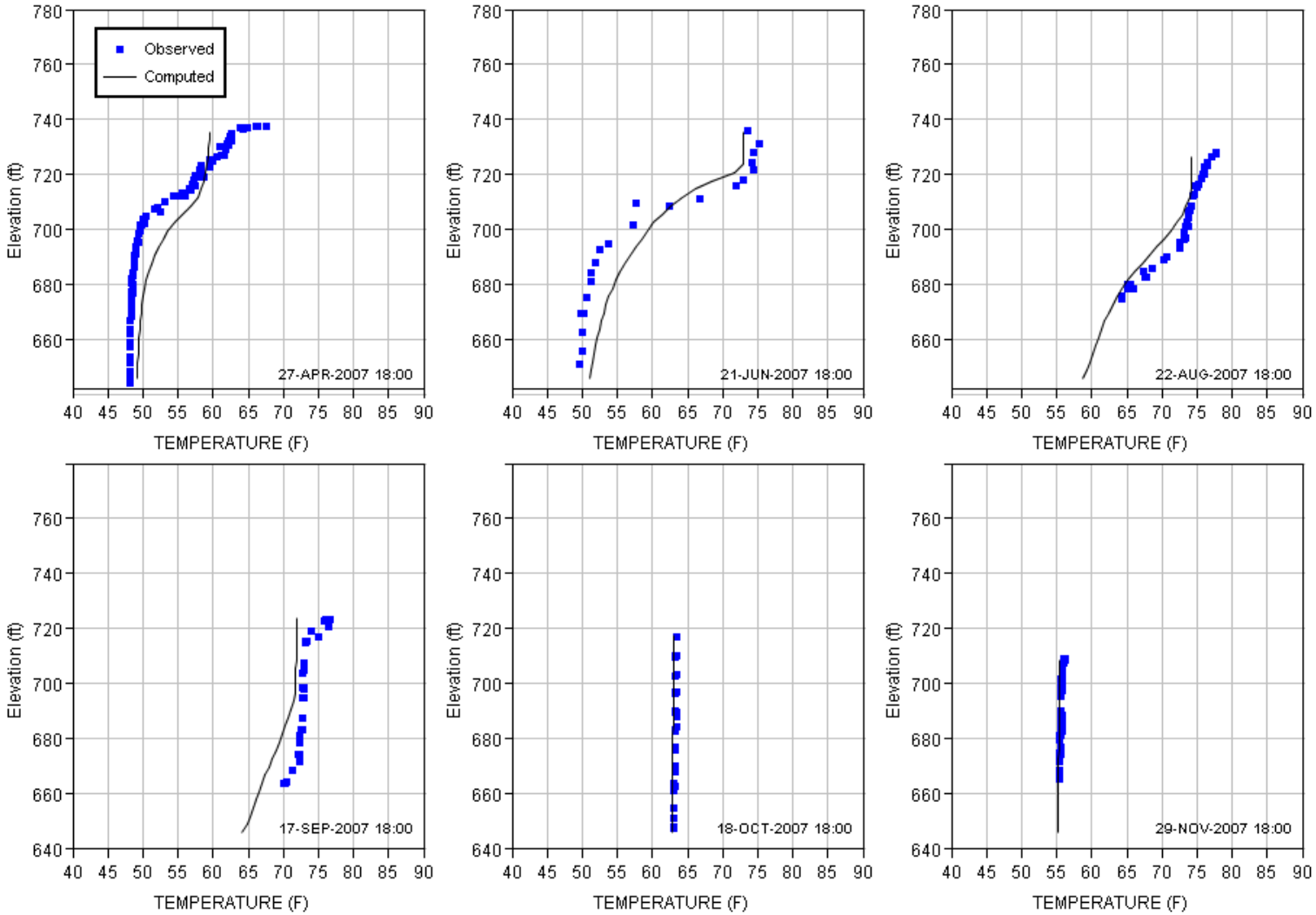

Figure 4-5 Computed and observed temperatures in Lake Mendocino for 2007.

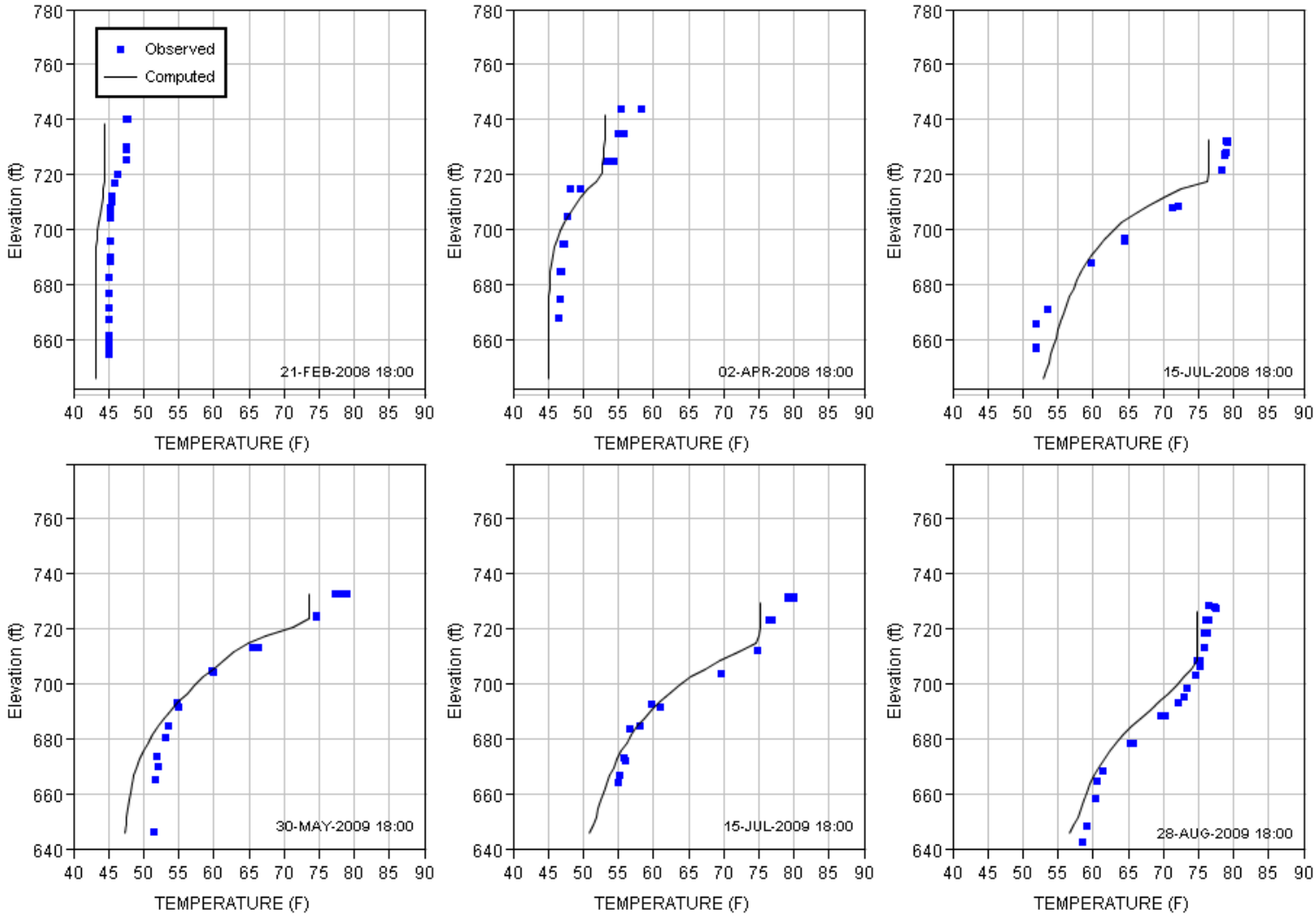

Figure 4-6 Computed and observed temperatures in Lake Mendocino for 2008 and 2009.

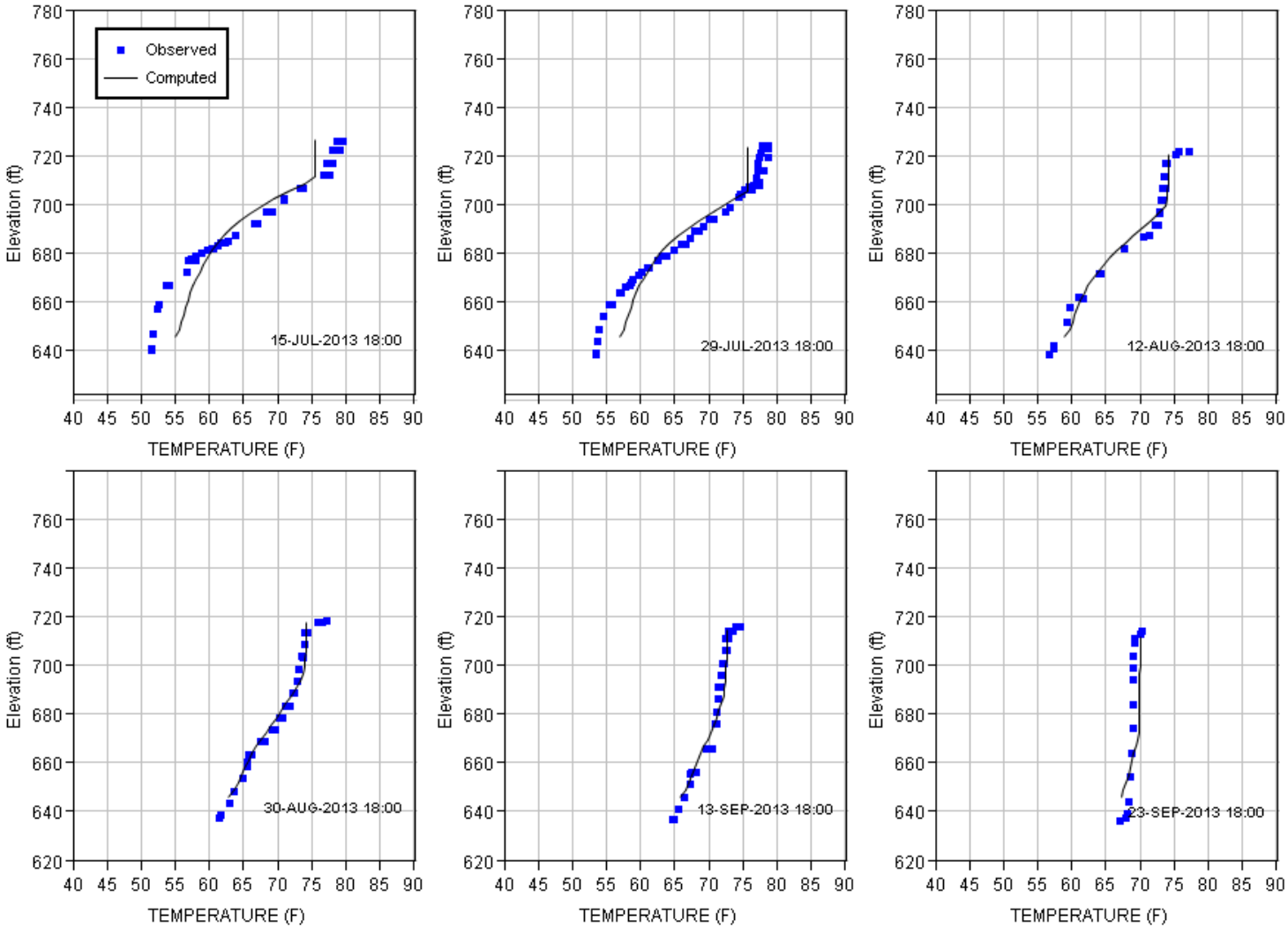

Figure 4-7 Computed and observed temperatures in Lake Mendocino for 2013.

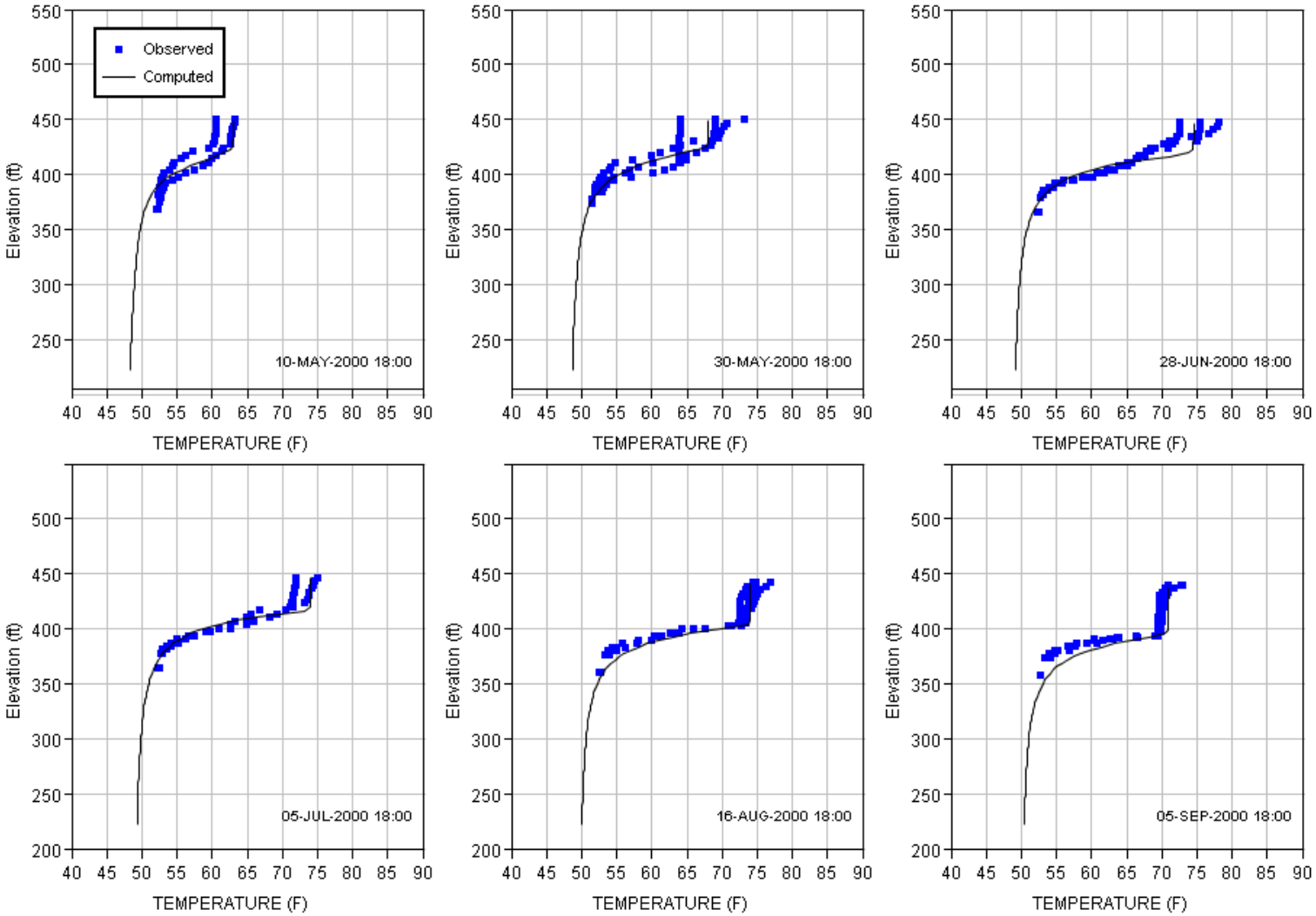

Figure 4-8 Computed and observed temperatures in Lake Sonoma for 2000.

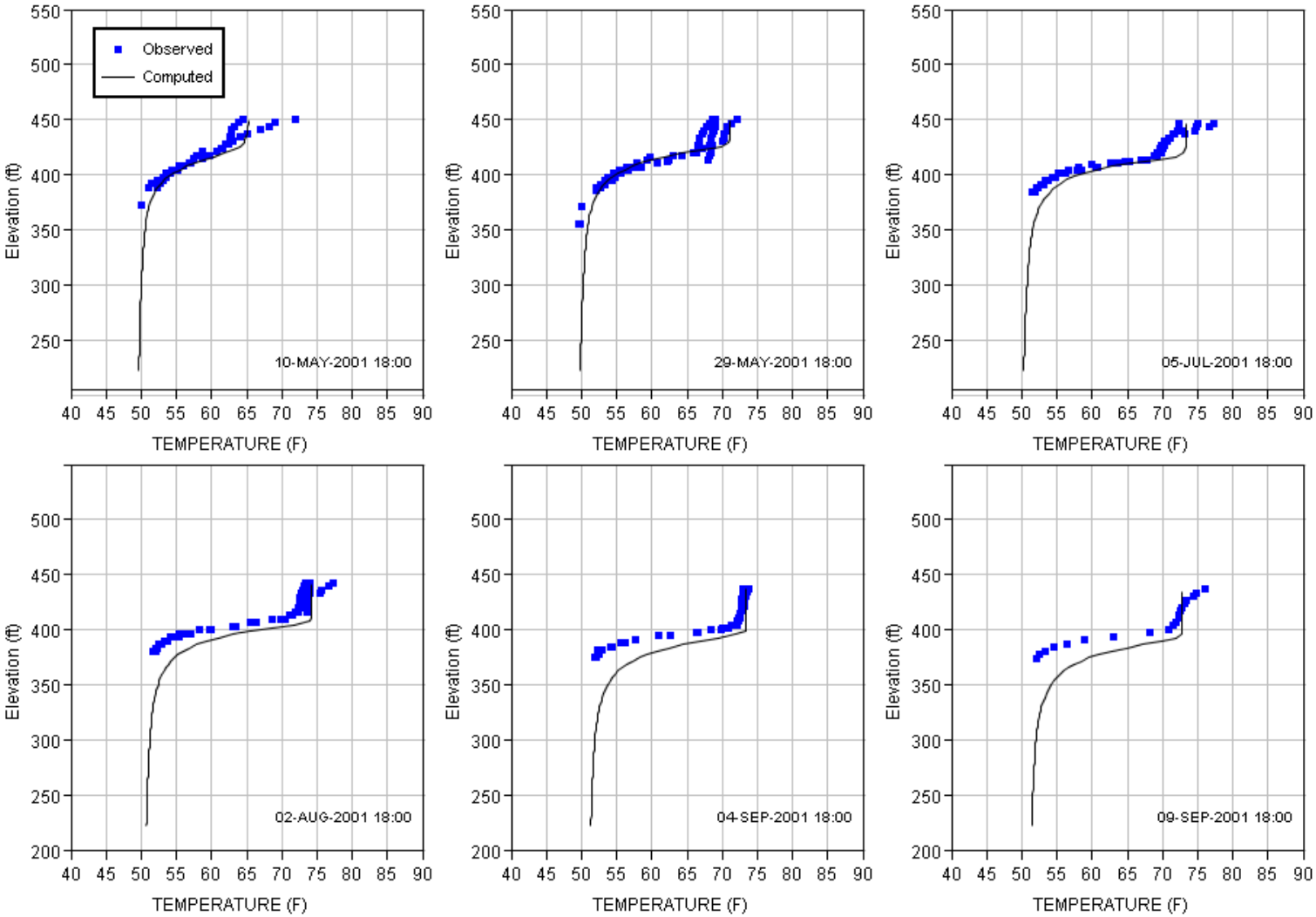

Figure 4-9 Computed and observed temperatures in Lake Sonoma for 2001.

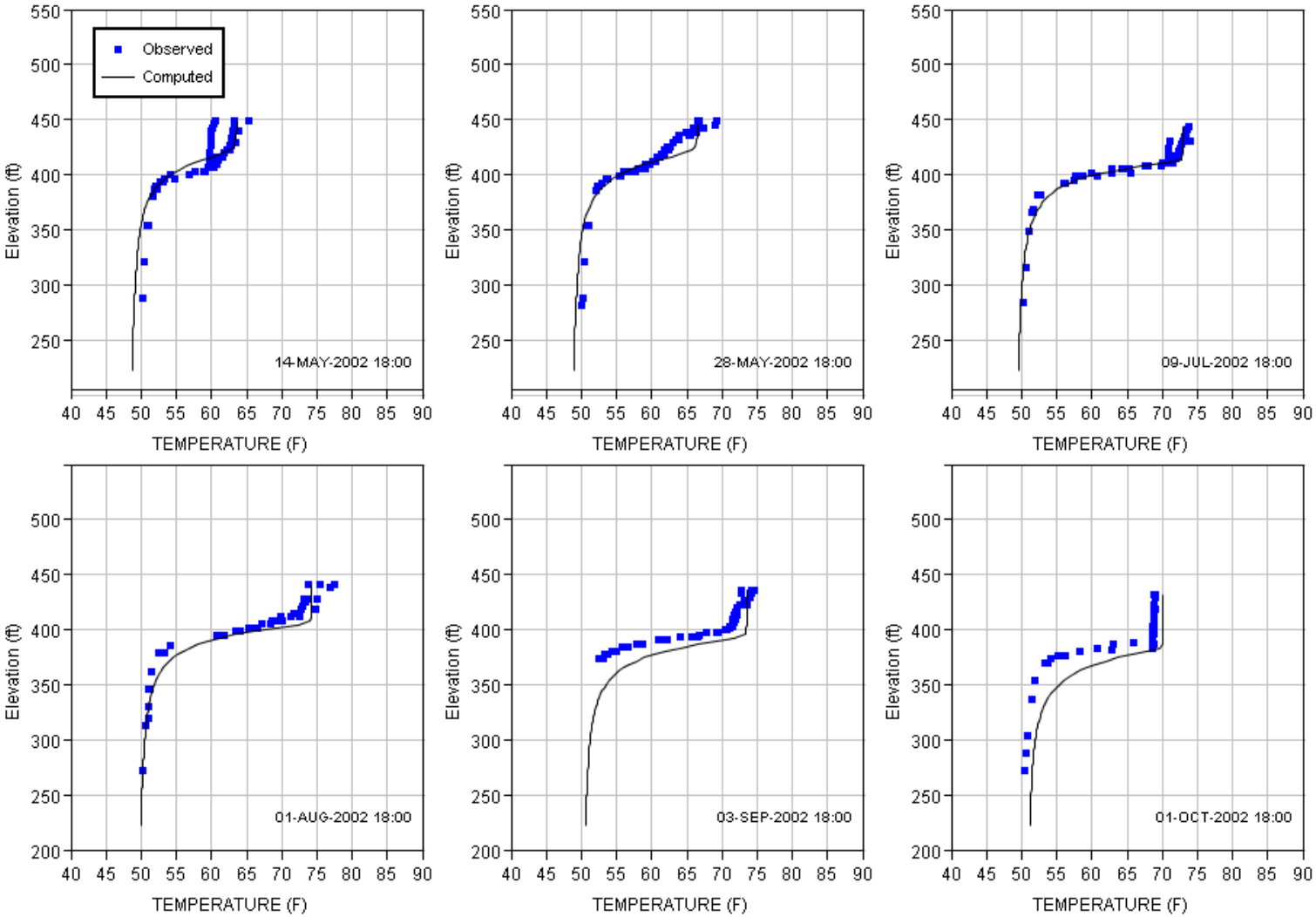

Figure 4-10 Computed and observed temperatures in Lake Sonoma for 2002.

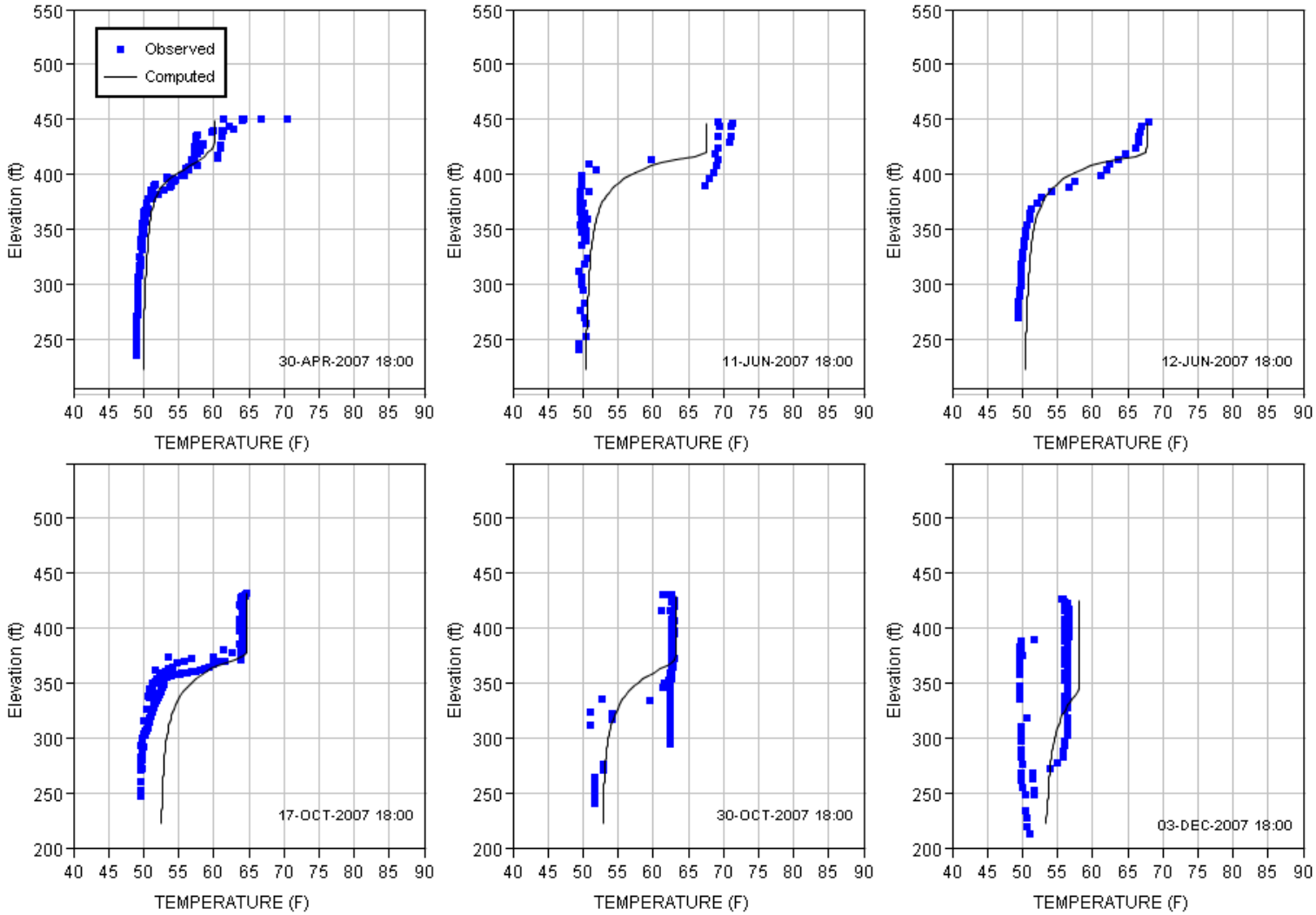

Figure 4-11 Computed and observed temperatures in Lake Sonoma for 2007.

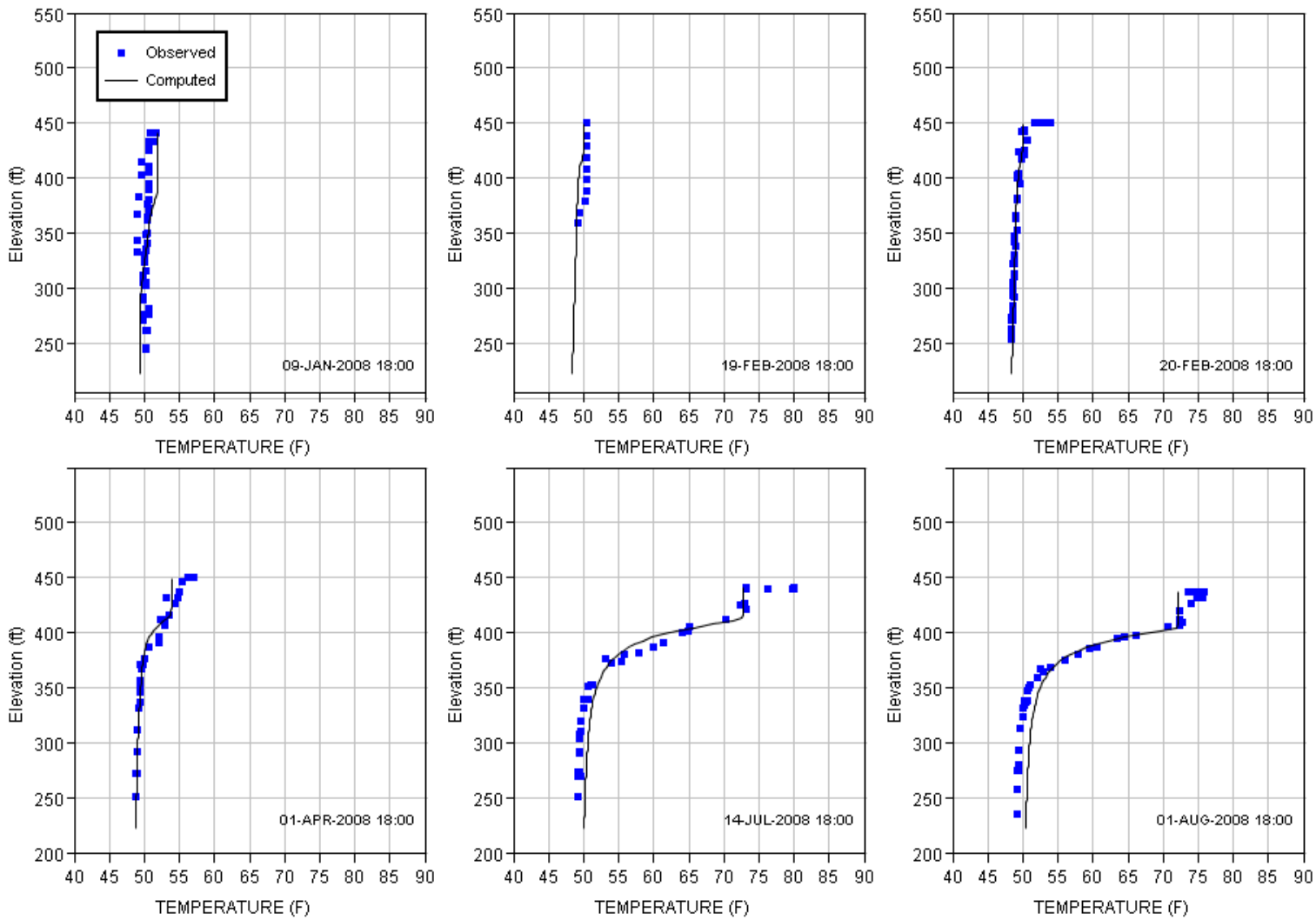

Figure 4-12 Computed and observed temperatures in Lake Sonoma for 2008.

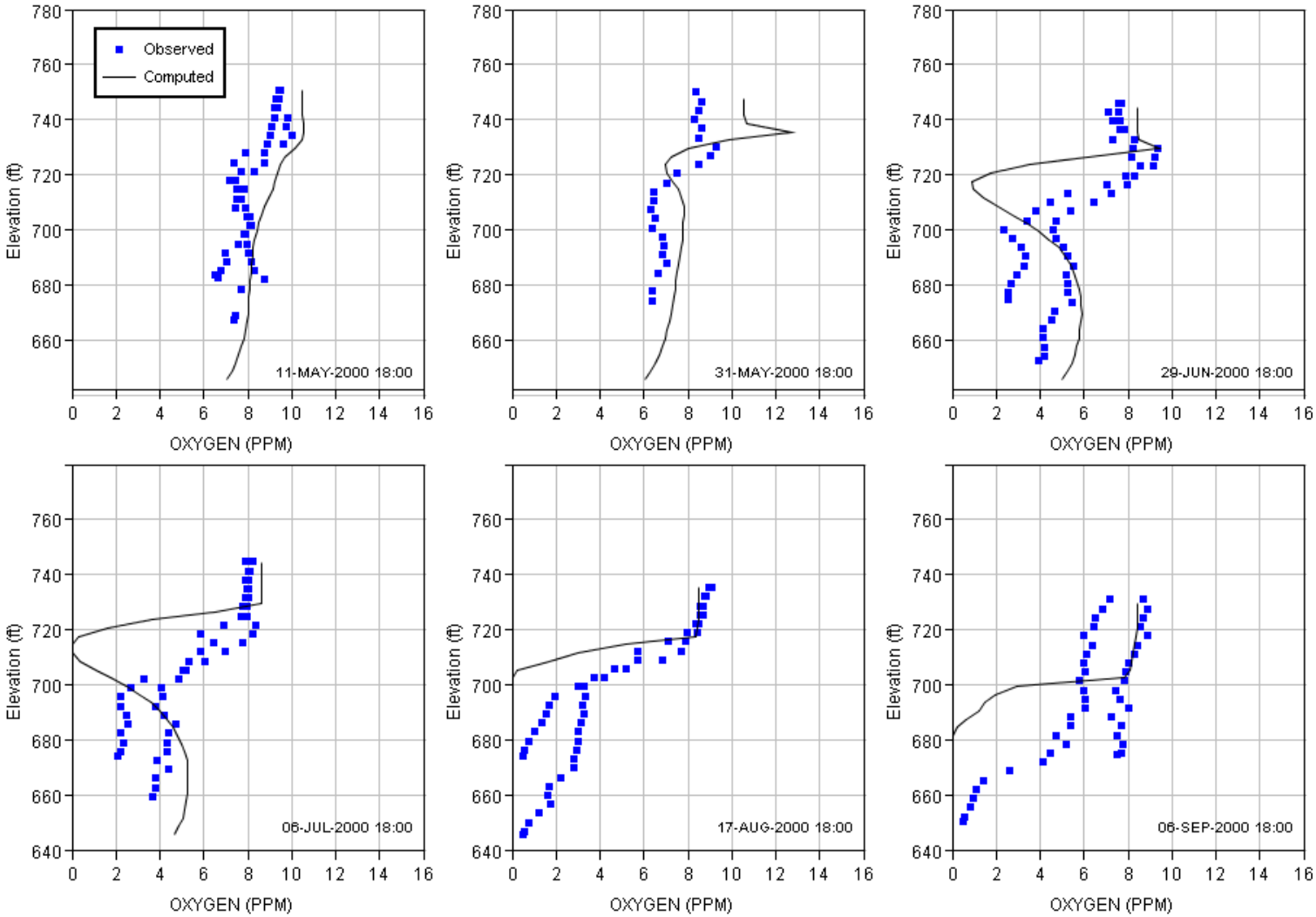

Figure 4-13 Computed and observed dissolved oxygen in Lake Mendocino for 2000.

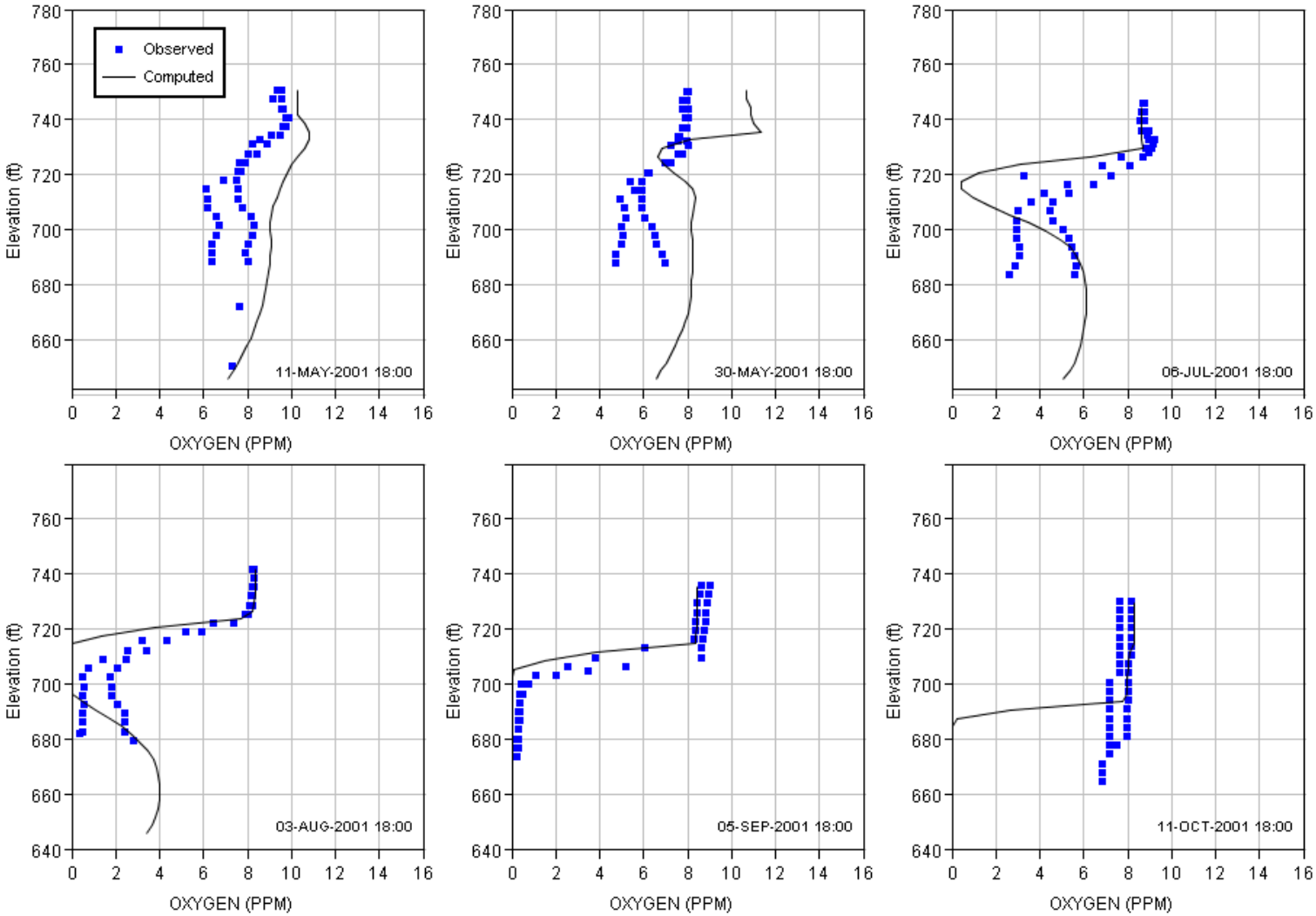

Figure 4-14 Computed and observed dissolved oxygen in Lake Mendocino for 2001.

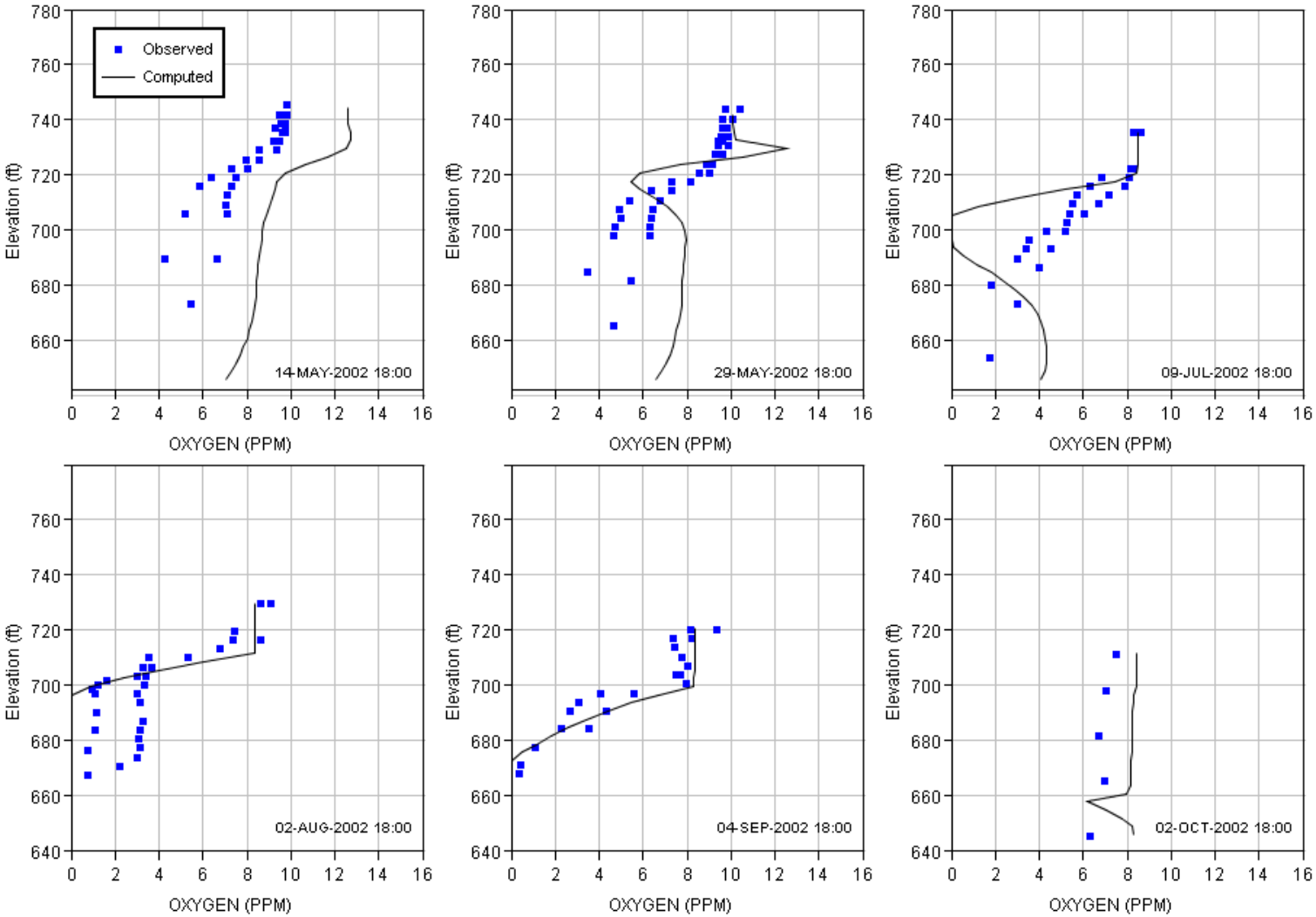

Figure 4-15 Computed and observed dissolved oxygen in Lake Mendocino for 2002.

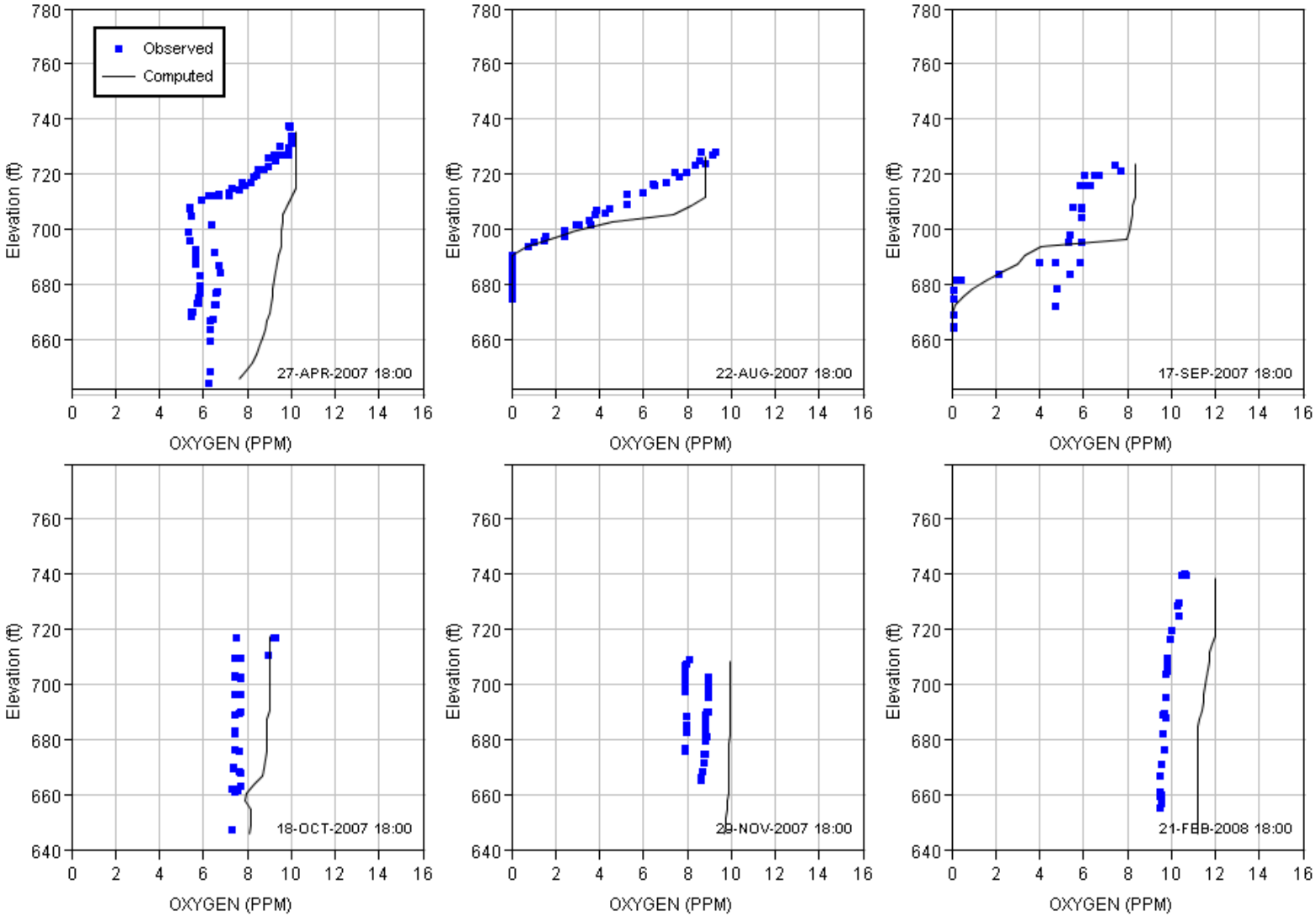

Figure 4-16 Computed and observed dissolved oxygen in Lake Mendocino for 2007-2008.

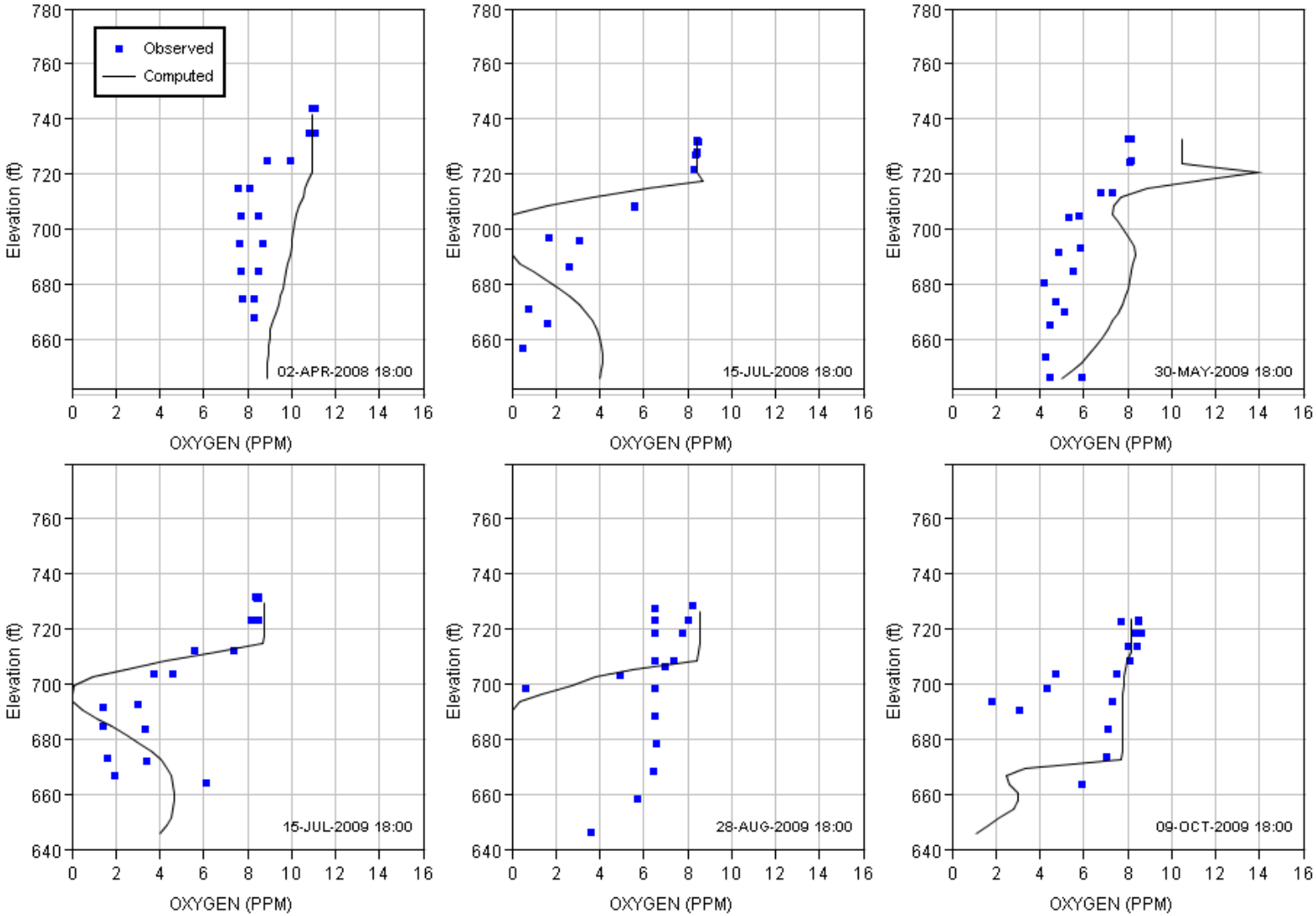

Figure 4-17 Computed and observed dissolved oxygen in Lake Mendocino for 2008-2009.

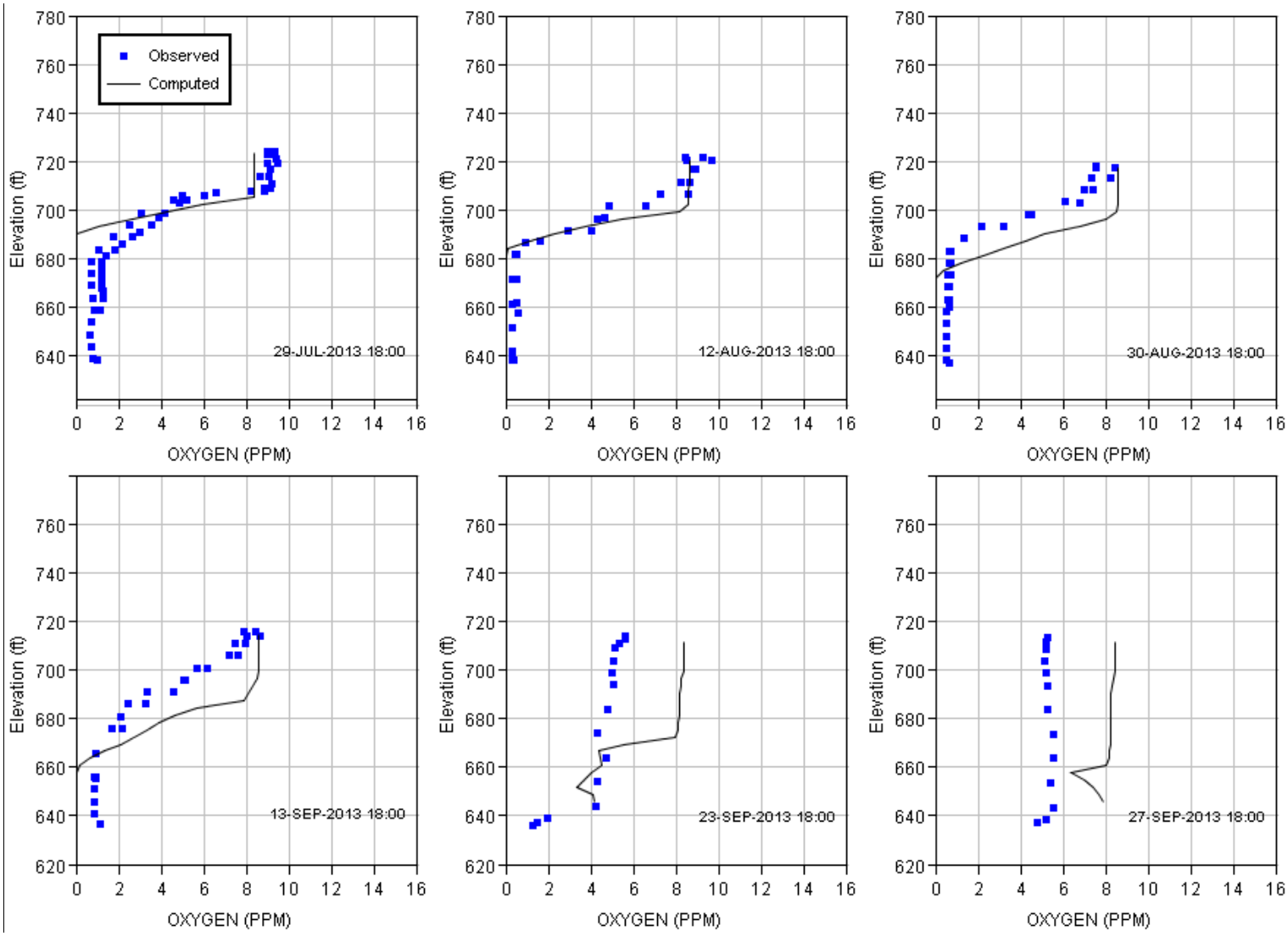

Figure 4-18Computed and observed dissolved oxygen in Lake Mendocino for 2013.

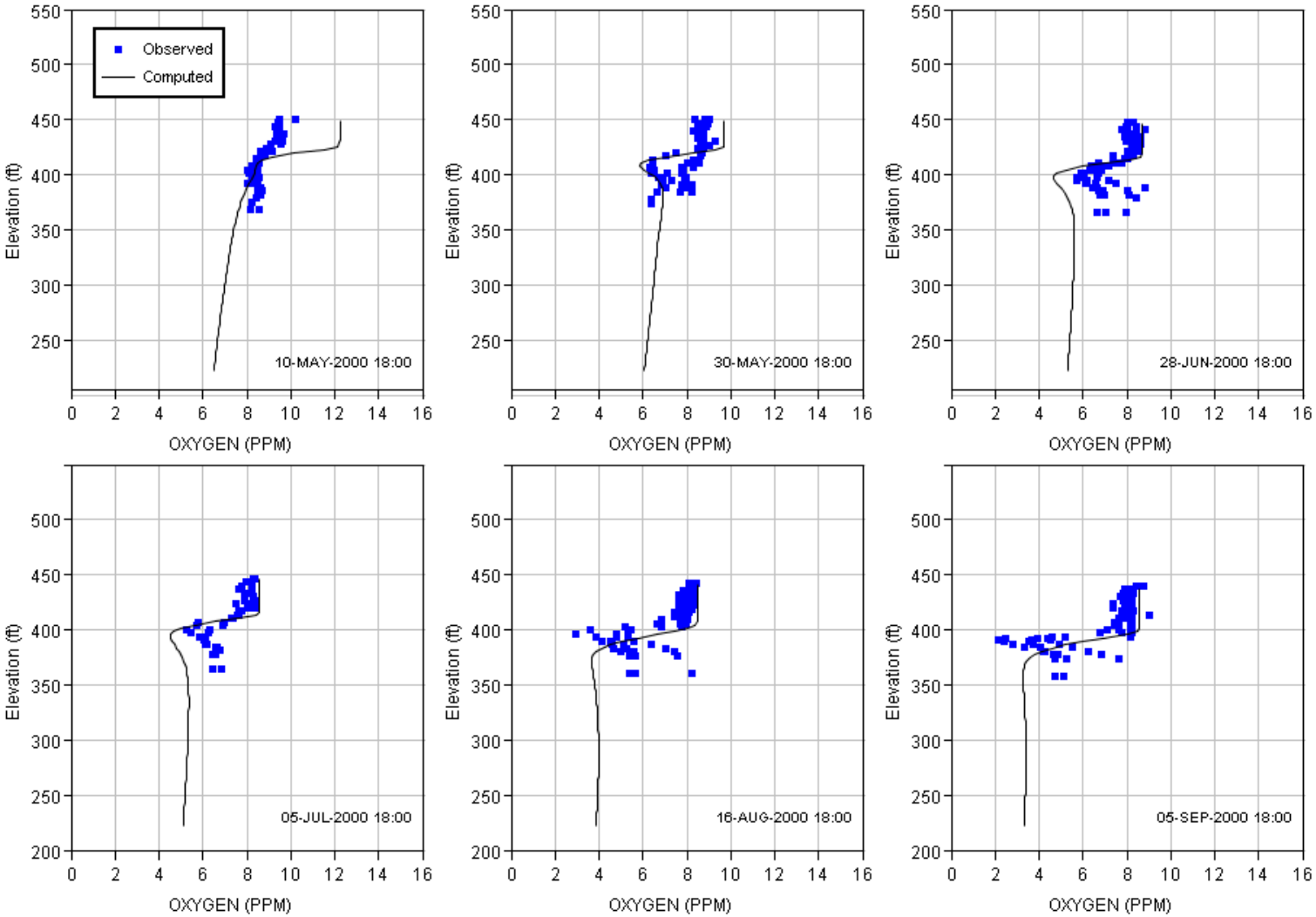

Figure 4-19 Computed and observed dissolved oxygen in Lake Sonoma for 2000.

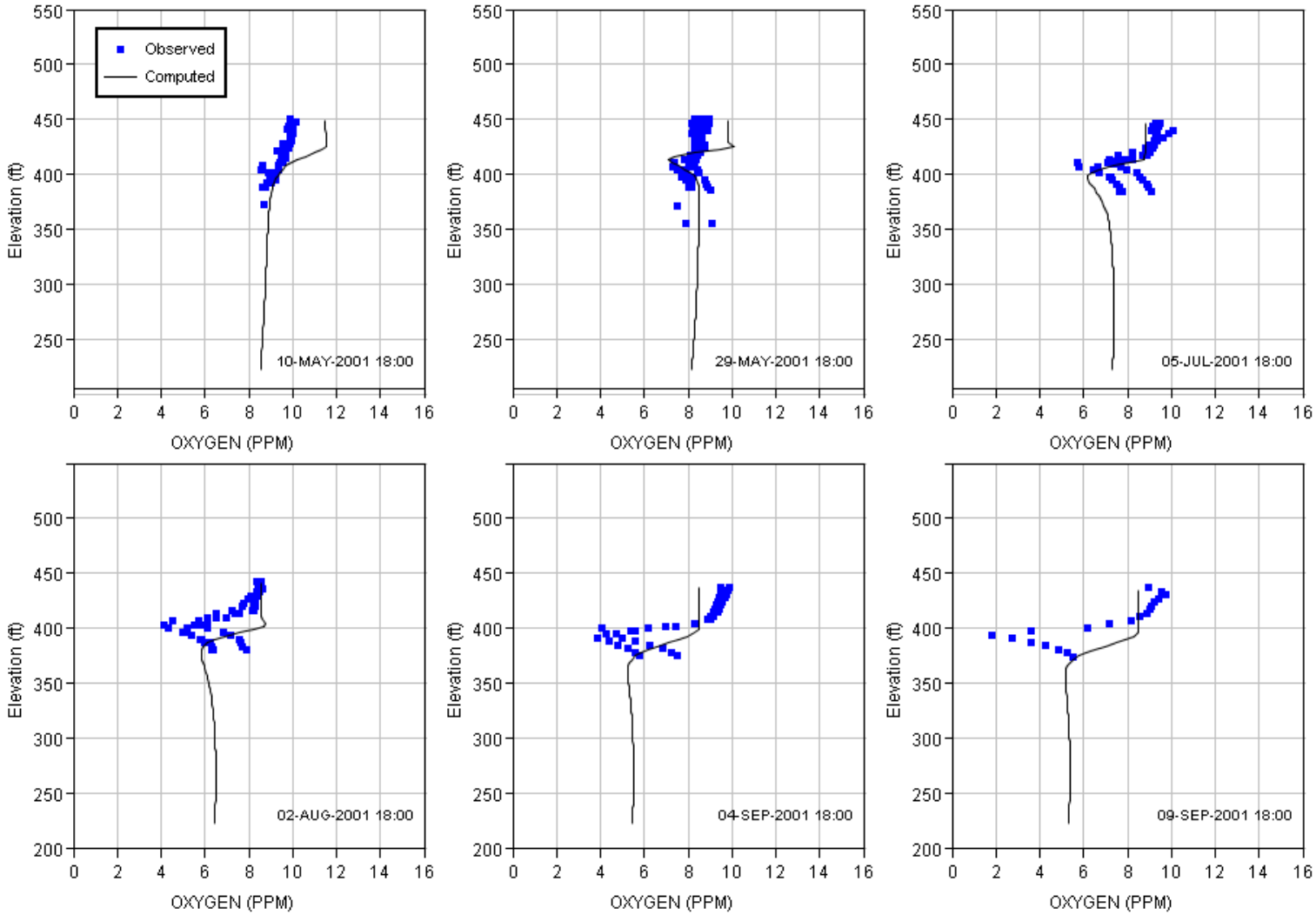

Figure 4-20 Computed and observed dissolved oxygen in Lake Sonoma for 2001.

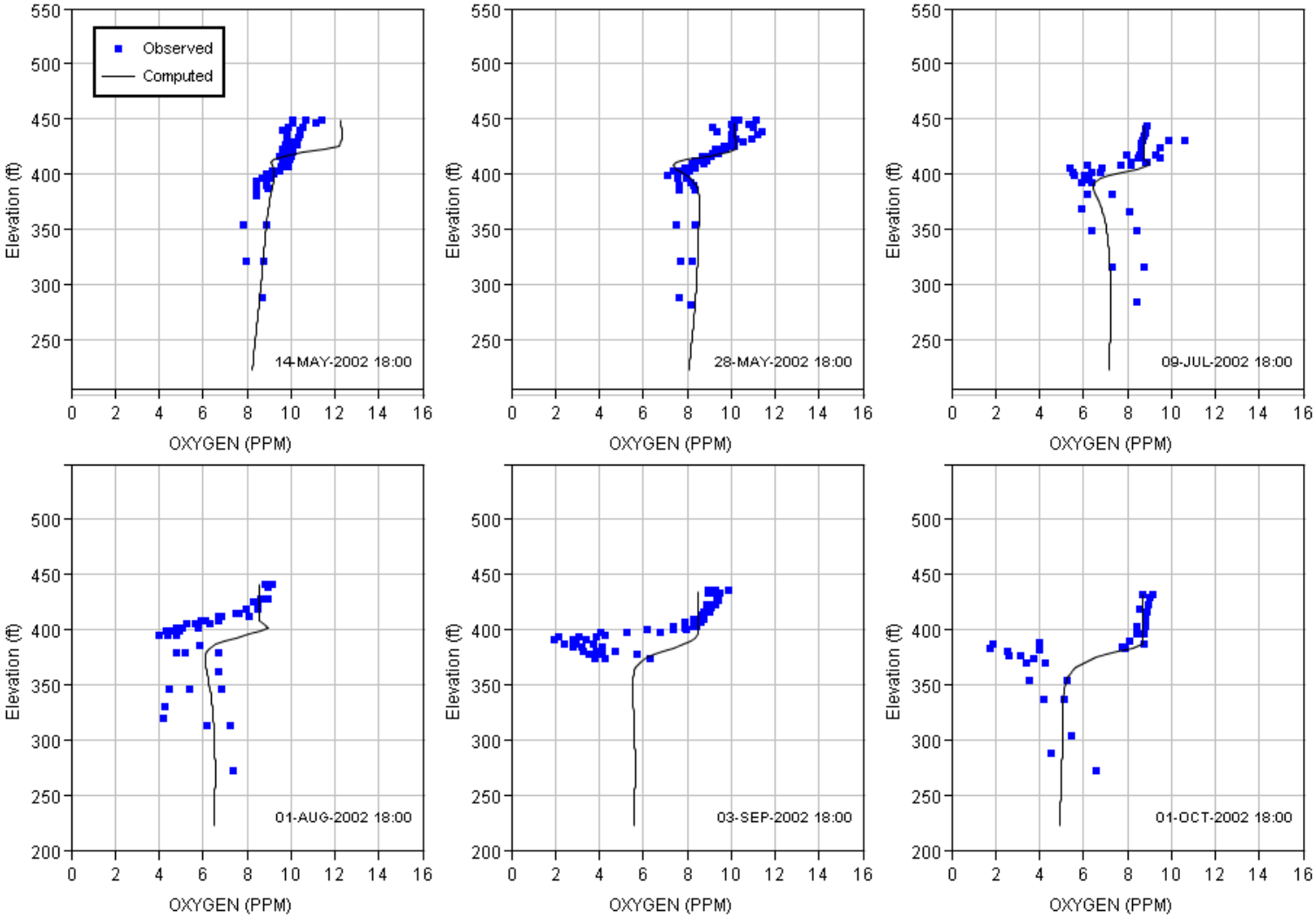

Figure 4-21 Computed and observed dissolved oxygen in Lake Sonoma for 2002.

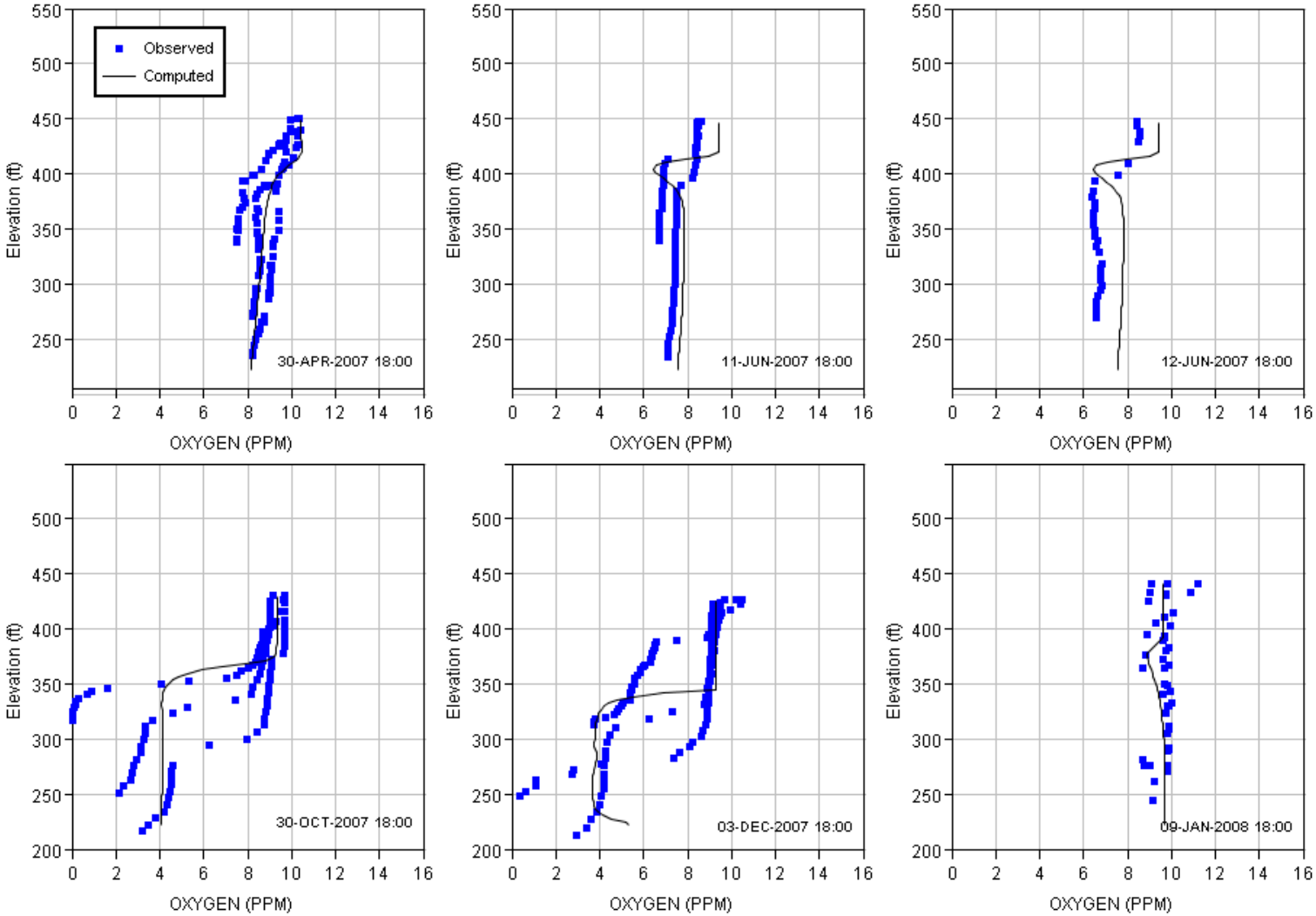

Figure 4-22 Computed and observed dissolved oxygen in Lake Sonoma for 2007-2008.

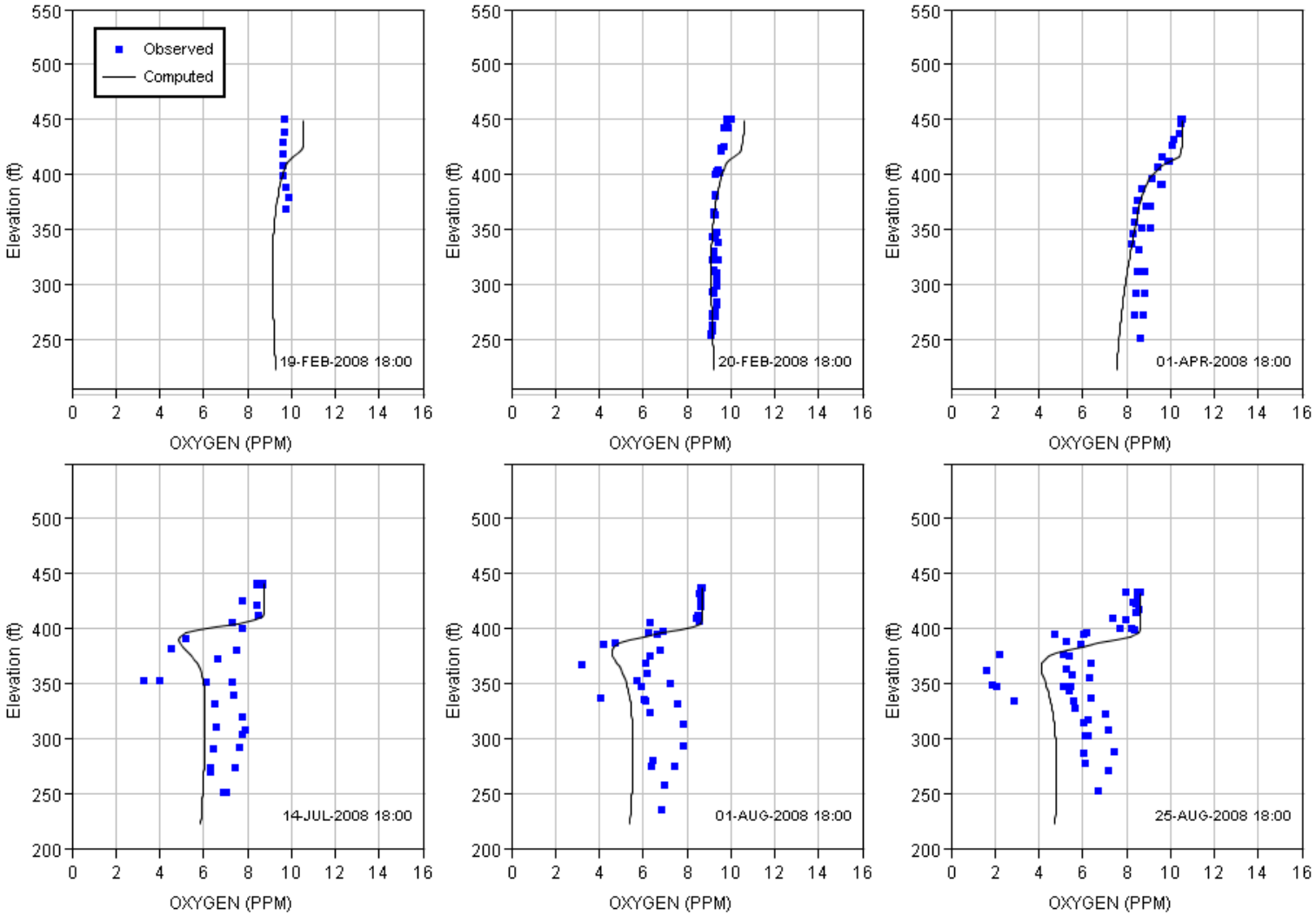

Figure 4-23 Computed and observed dissolved oxygen in Lake Sonoma for 2008.

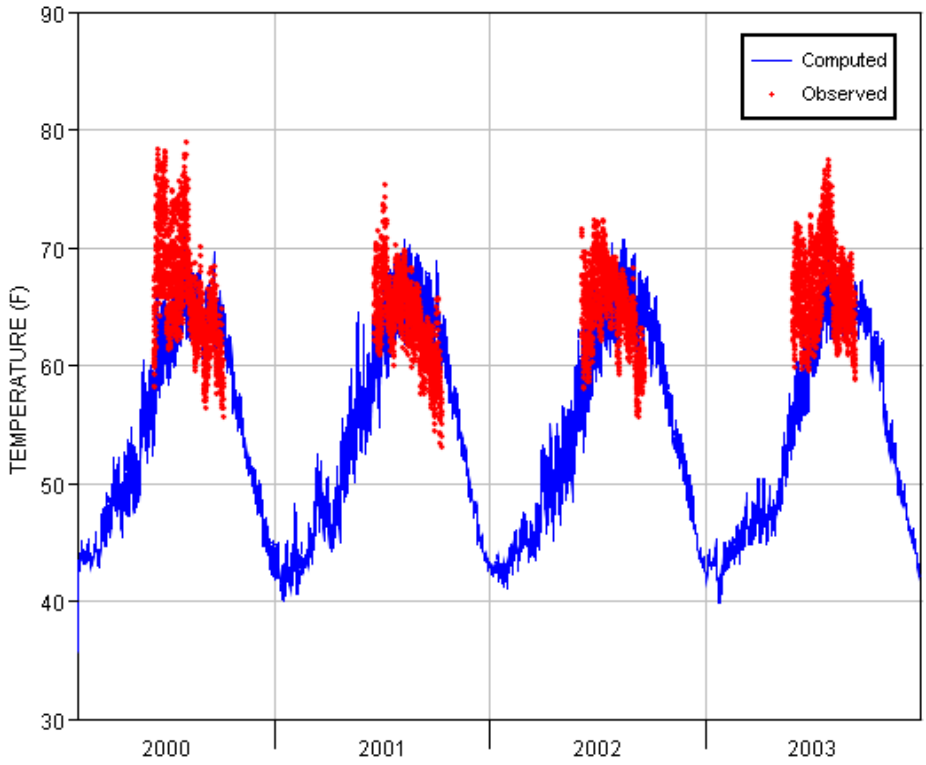

Figure 4-24 Computed and observed temperatures in East Fork Russian River at Redwood Valley.

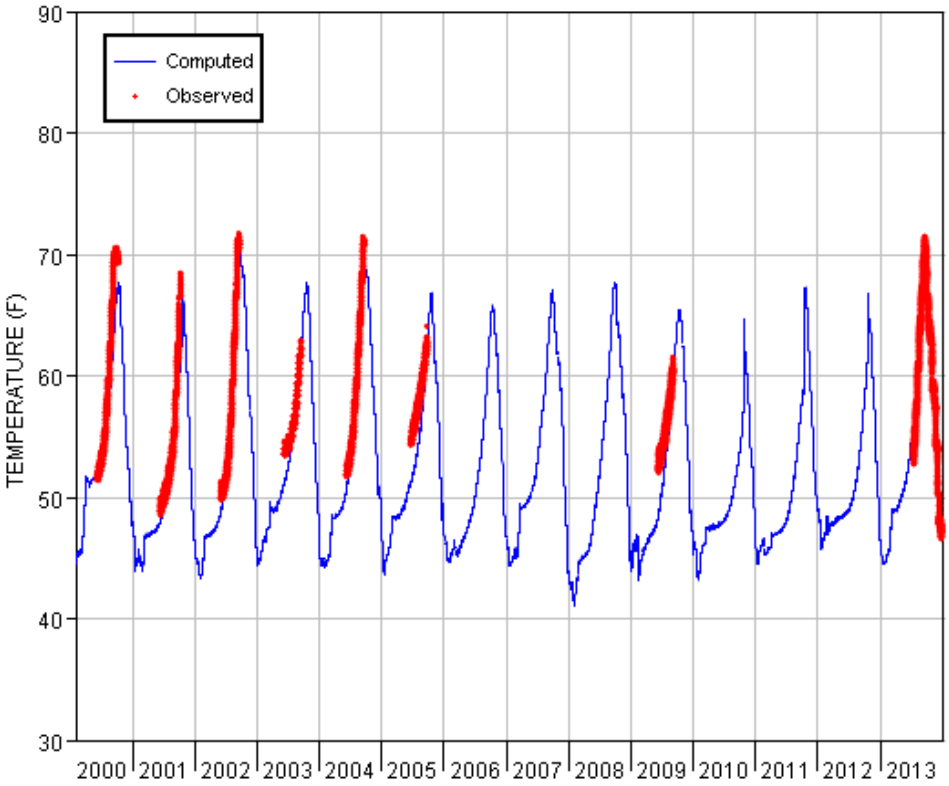

Figure 4-25 Computed and observed temperature below Coyote dam.

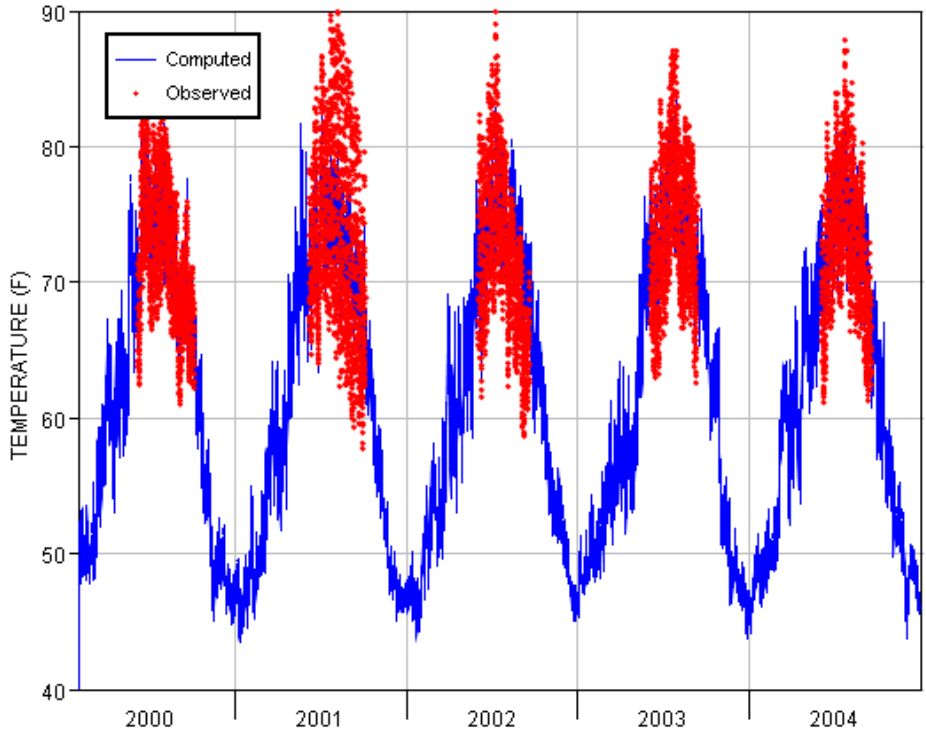

Figure 4-26 Computed and observed stream temperatures in the Russian River at Lake Mendocino Drive.

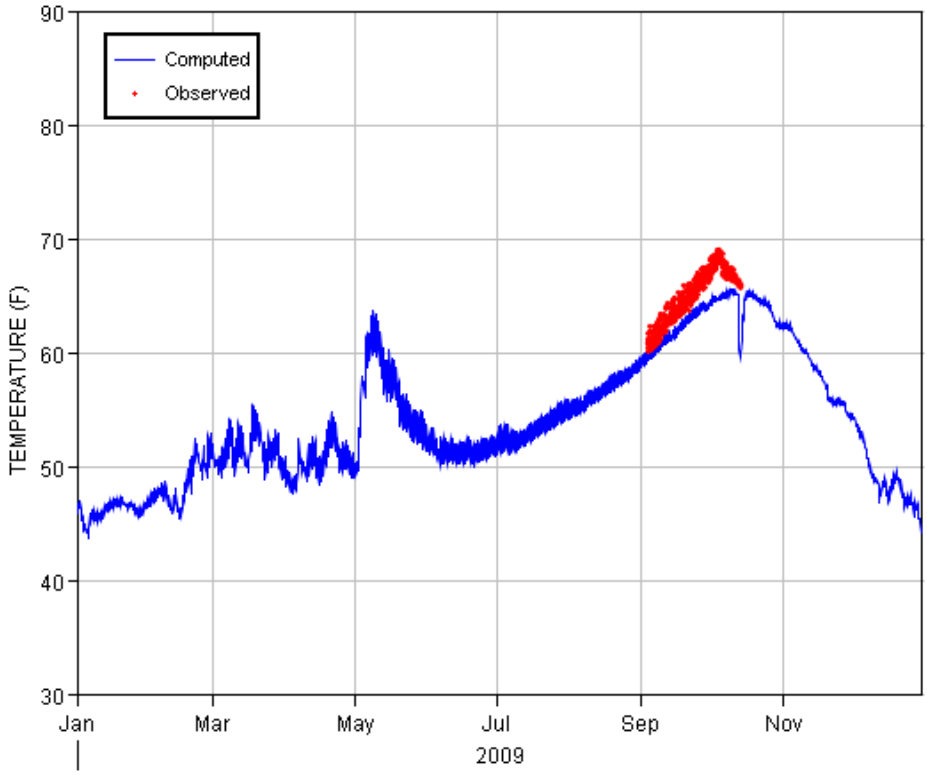

Figure 4-27 Computed and observed stream temperatures in Russian River at the East and West Fork confluence.

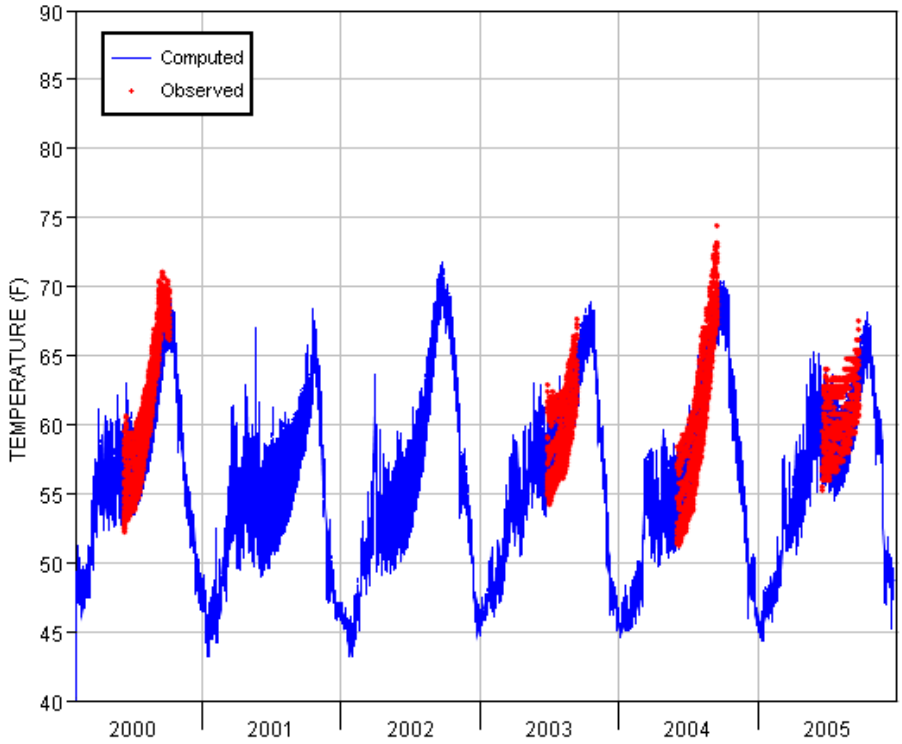

Figure 4-28 Computed and observed stream temperatures in the Russian River at Granite Talmage.

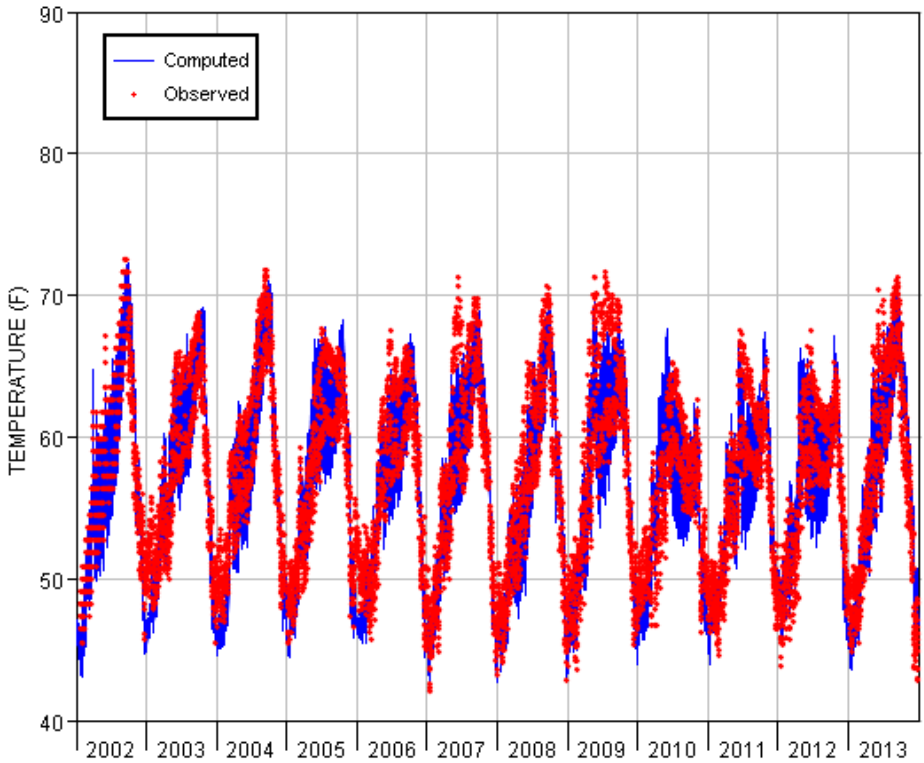

Figure 4-29 Computed and observed stream temperatures in the Russian River at Hopland.

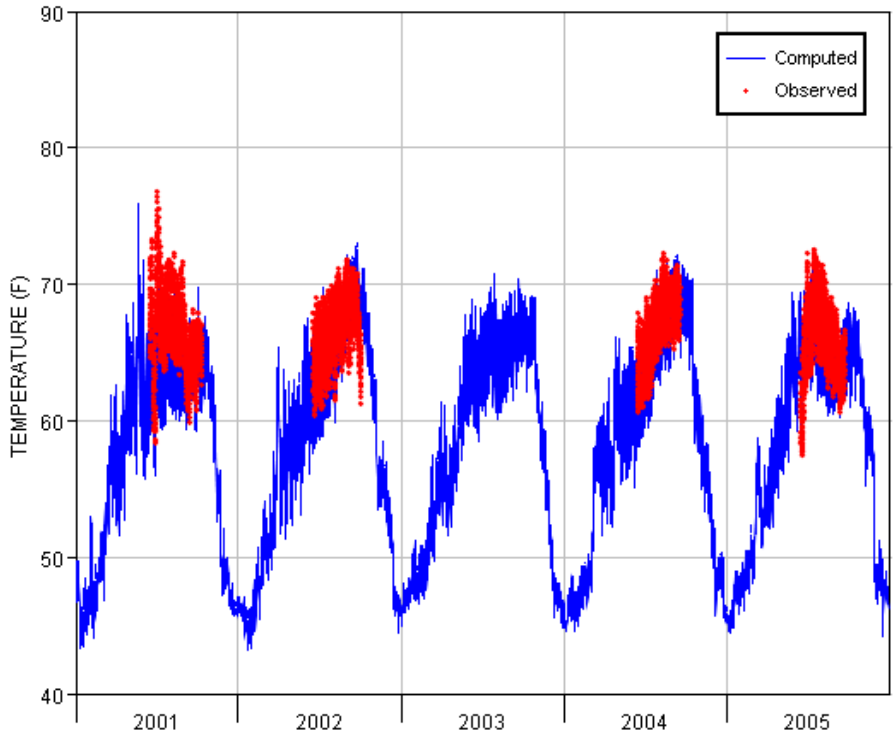

Figure 4-30 Computed and observed stream temperatures in the Russian River at Commisky Station.

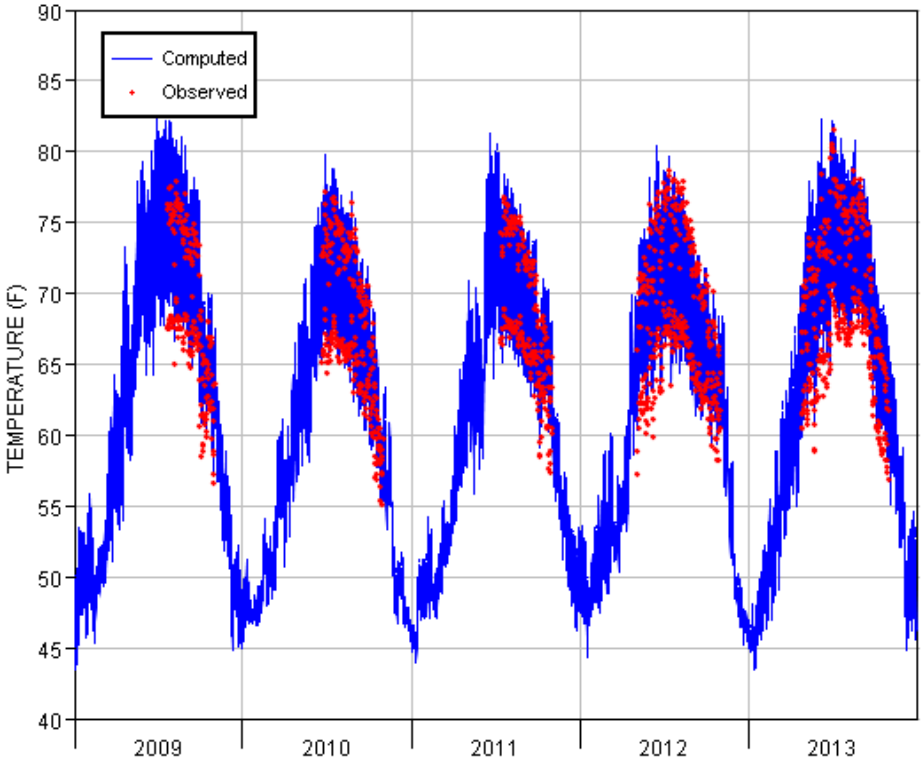

Figure 4-31 Computed and observed max/min temperatures in the Russian River at Jimtown.

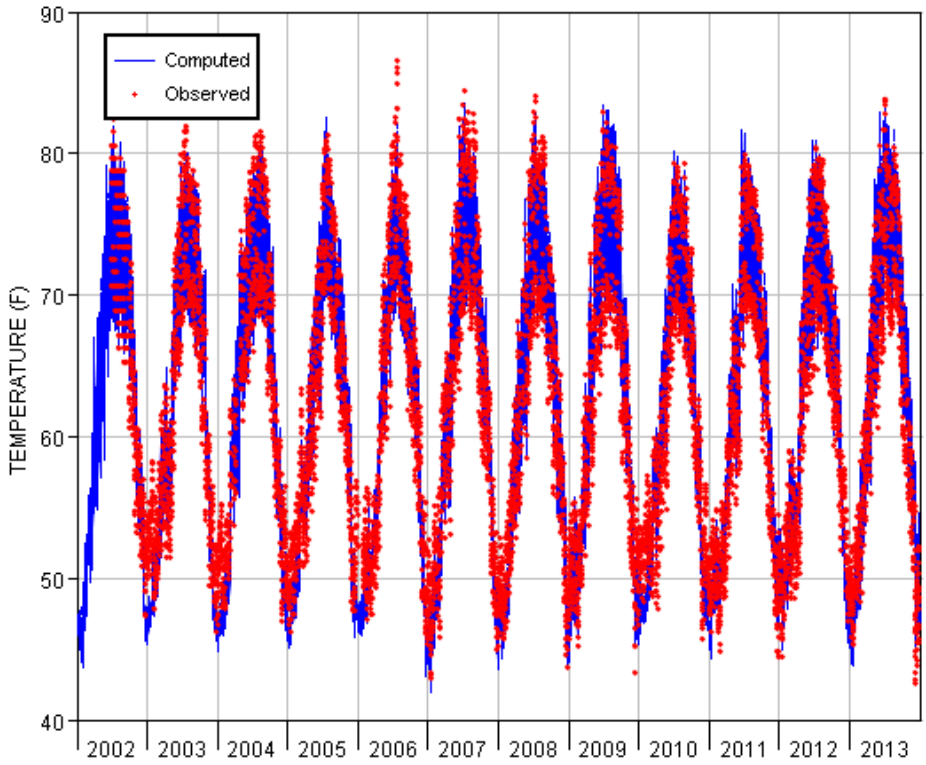

Figure 4-32 Computed and observed max/min temperatures in the Russian River at Digger Bend.

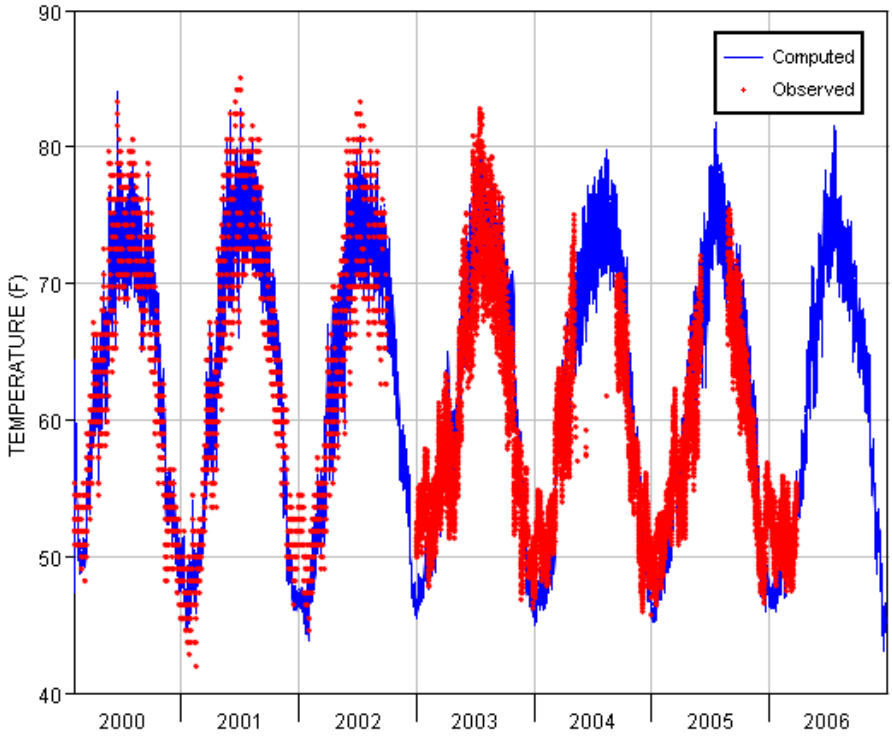

Figure 4-33 Computed and observed stream temperatures in the Russian River at Healdsburg.

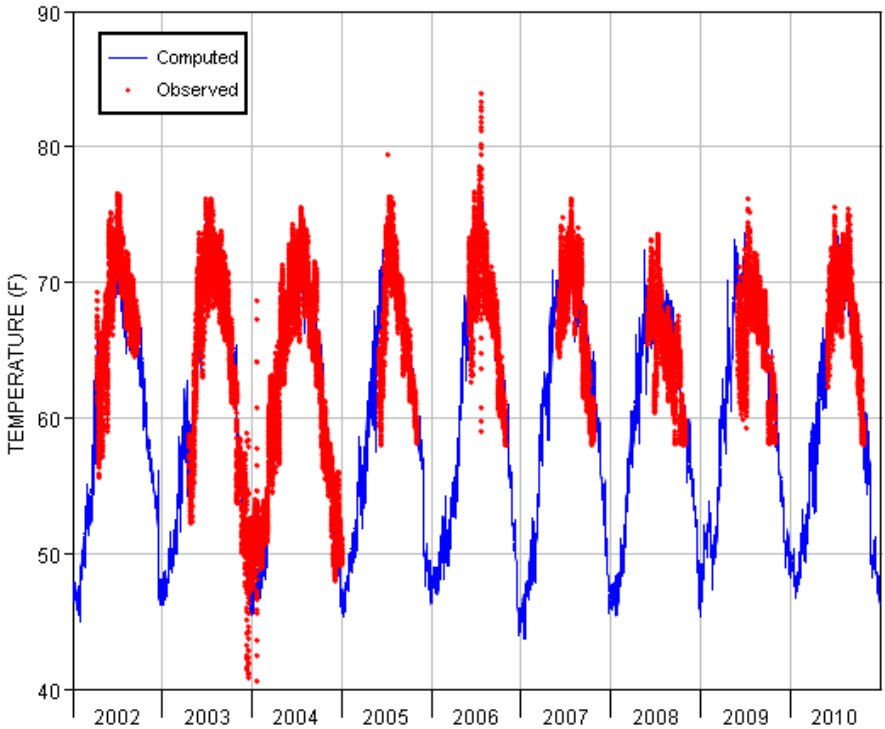

Figure 4-34 Computed and observed stream temperatures in the Russian River at RDS inflatable.

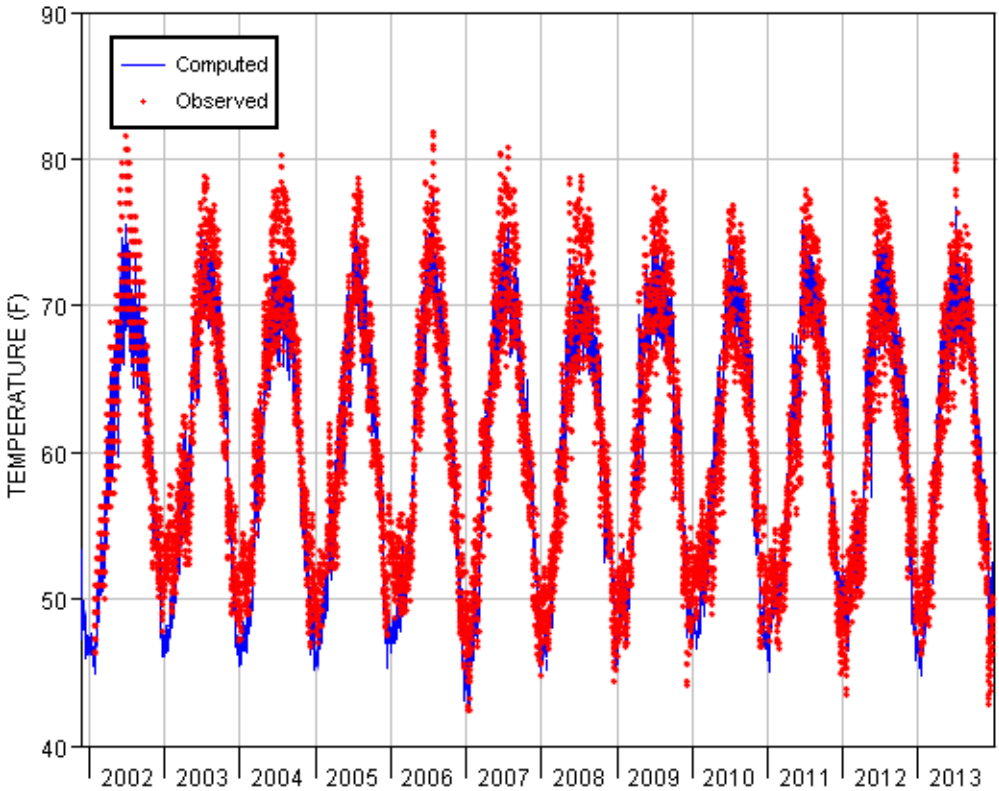

Figure 4-35 Computed and observed stream temperatures in the Russian River at Guerneville.

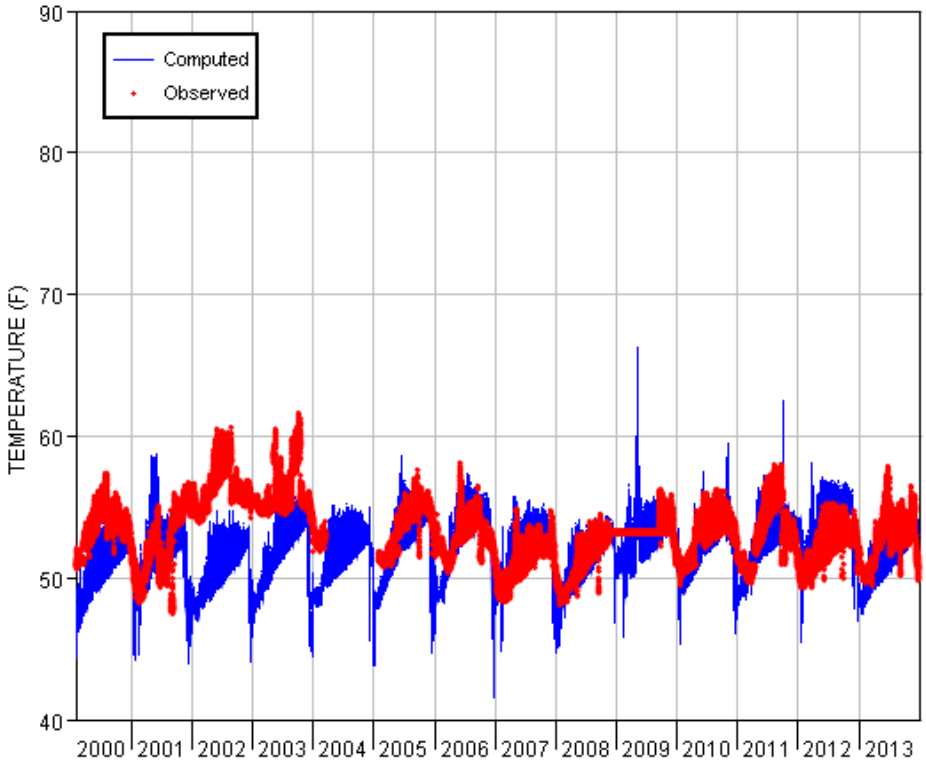

Figure 4-36 Computed and observed temperature below Warm Springs dam.

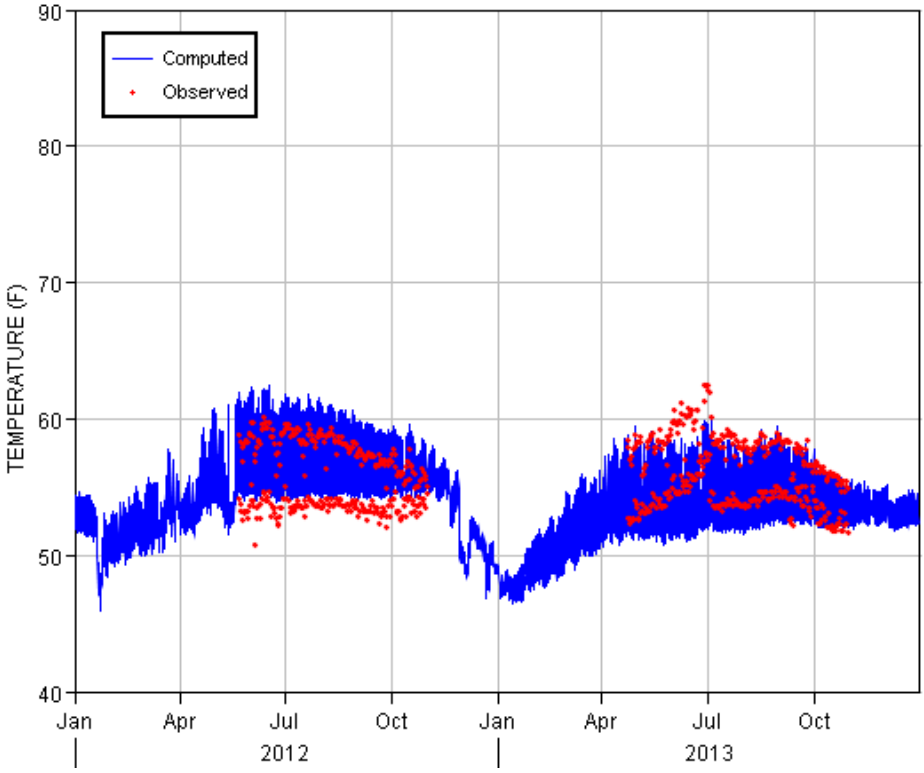

Figure 4-37 Computed and observed max/min temperature in Dry Creek below Lambert Bridge.

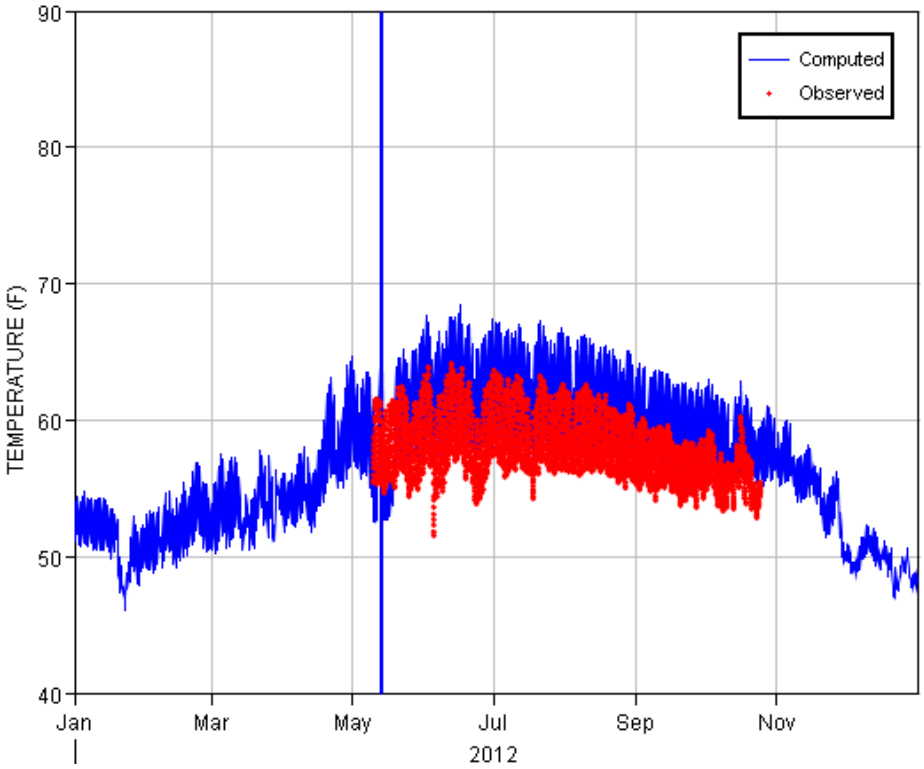

Figure 4-38 Computed and observed temperature in Dry Creek near mouth.

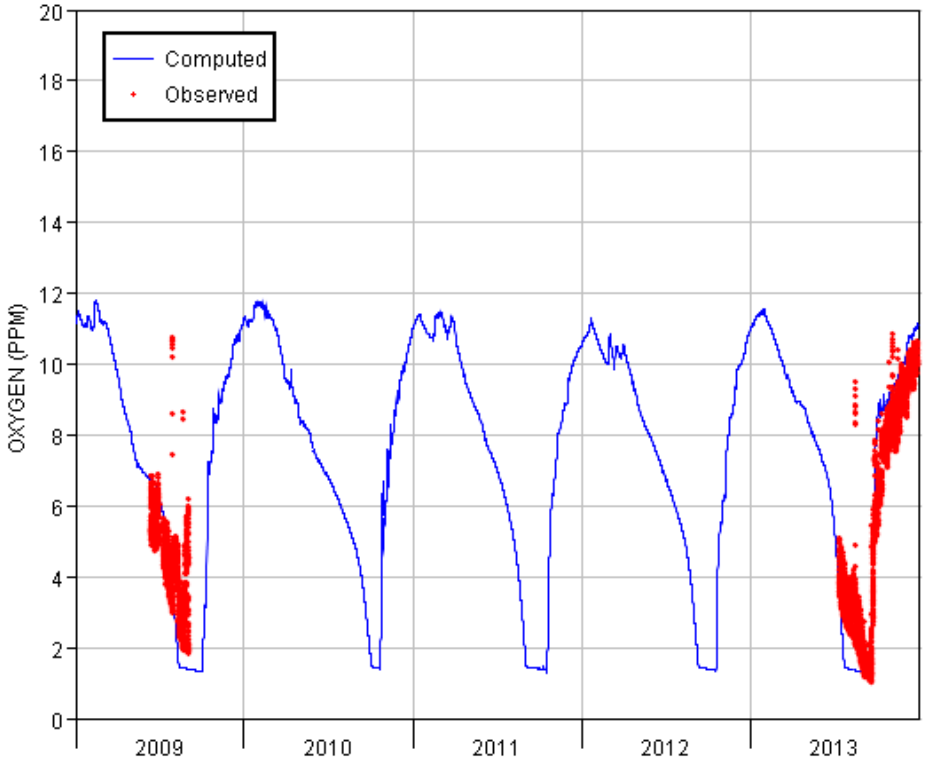

Figure 4-39 Computed and observed Dissolved Oxygen below Coyote Dam.

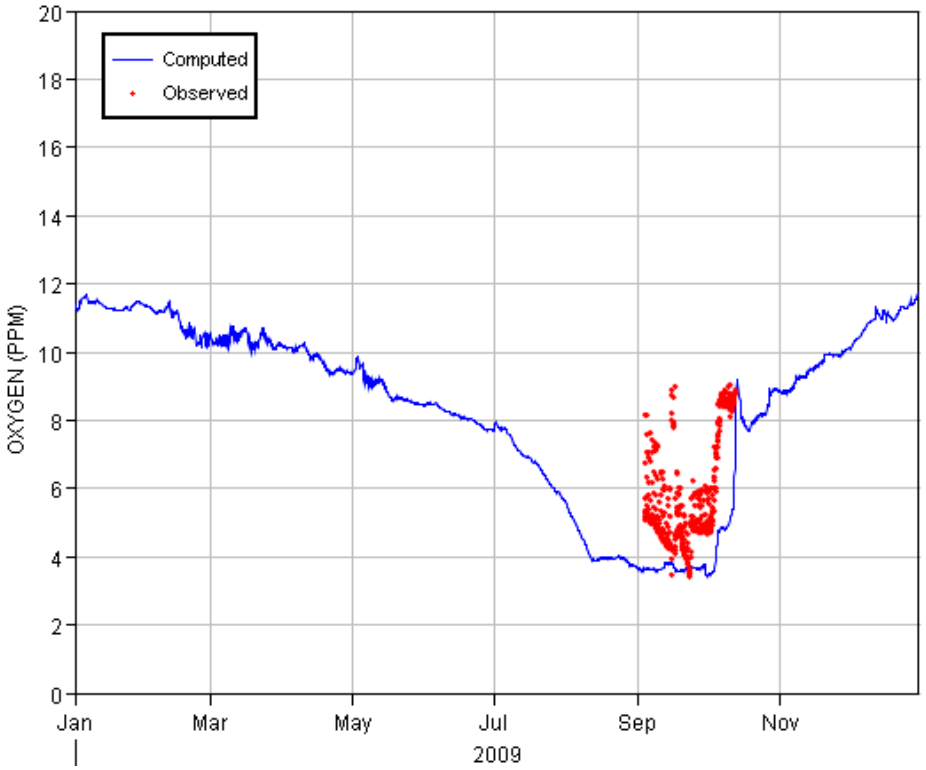

Figure 4-40 Computed and observed Dissolved Oxygen at the East and West Fork Russian River confluence.

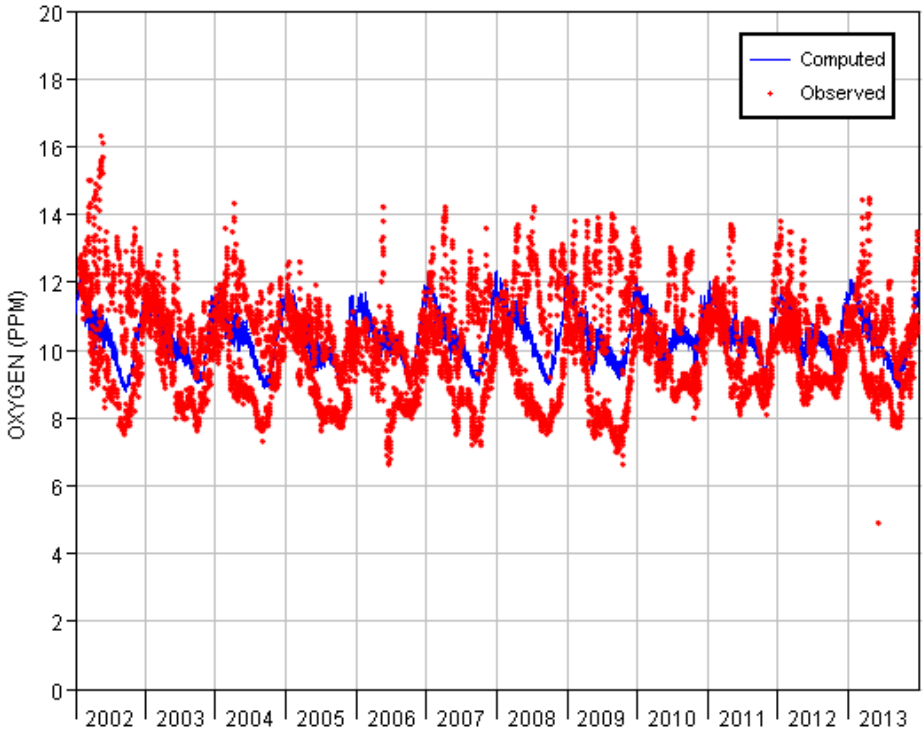

Figure 4-41 Computed and observed Dissolved Oxygen in the Russian River at Hopland.

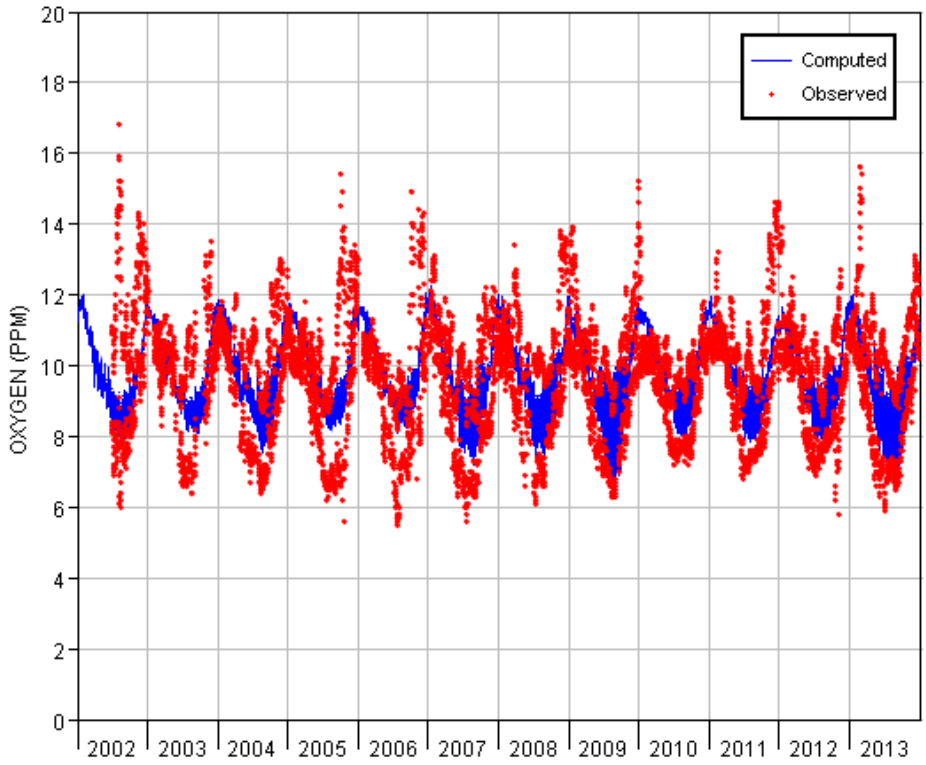

Figure 4-42 Computed and observed Dissolved Oxygen in the Russian River at Digger Bend.

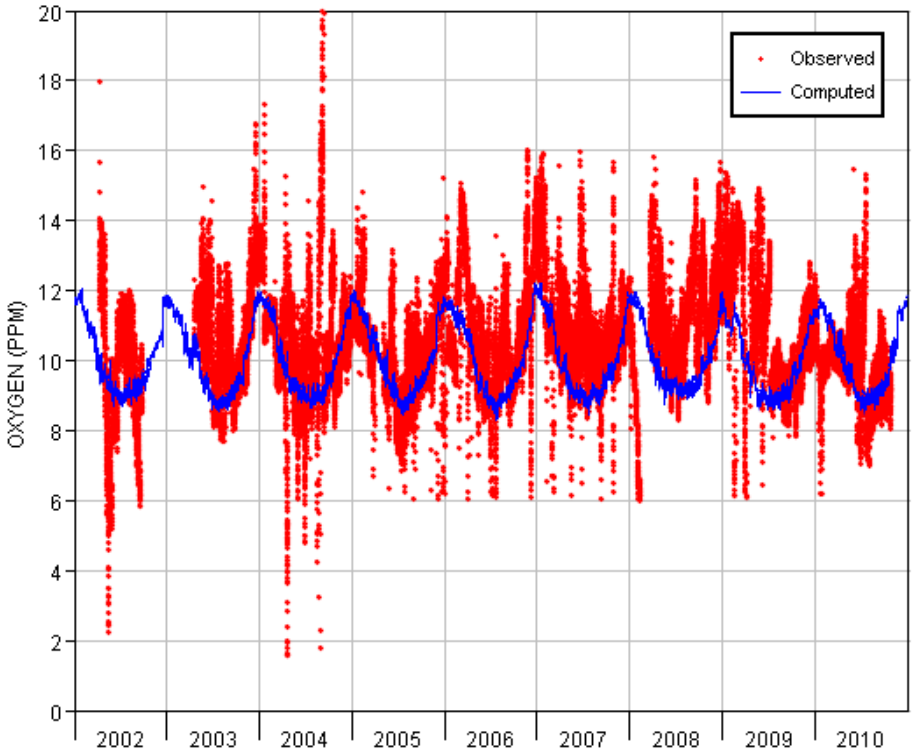

Figure 4-43 Computed and observed Dissolved Oxygen in the Russian River at RDS inflatable.

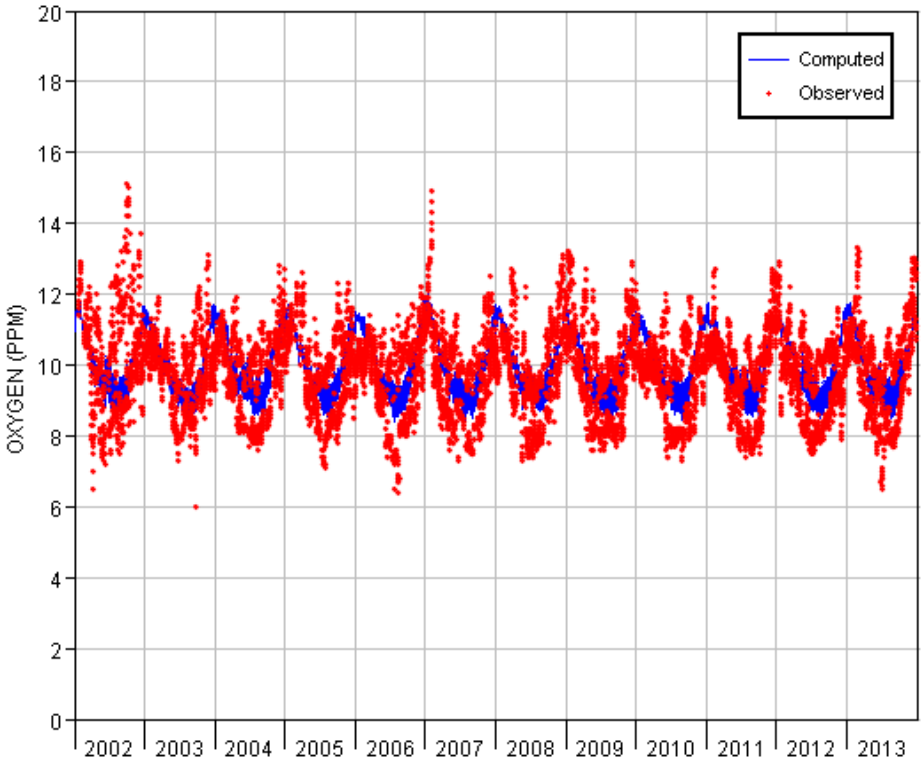

Figure 4-44 Computed and observed Dissolved Oxygen in the Russian River at Guerneville.

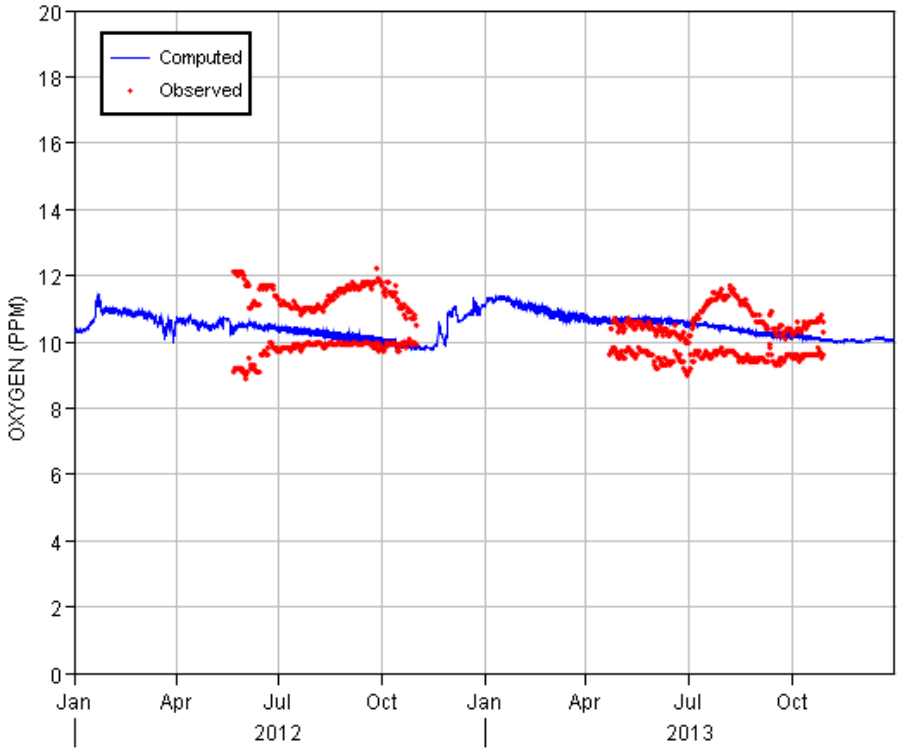

Figure 4-45 Computed and observed max/min Dissolved Oxygen in Dry Creek below Lambert Bridge.

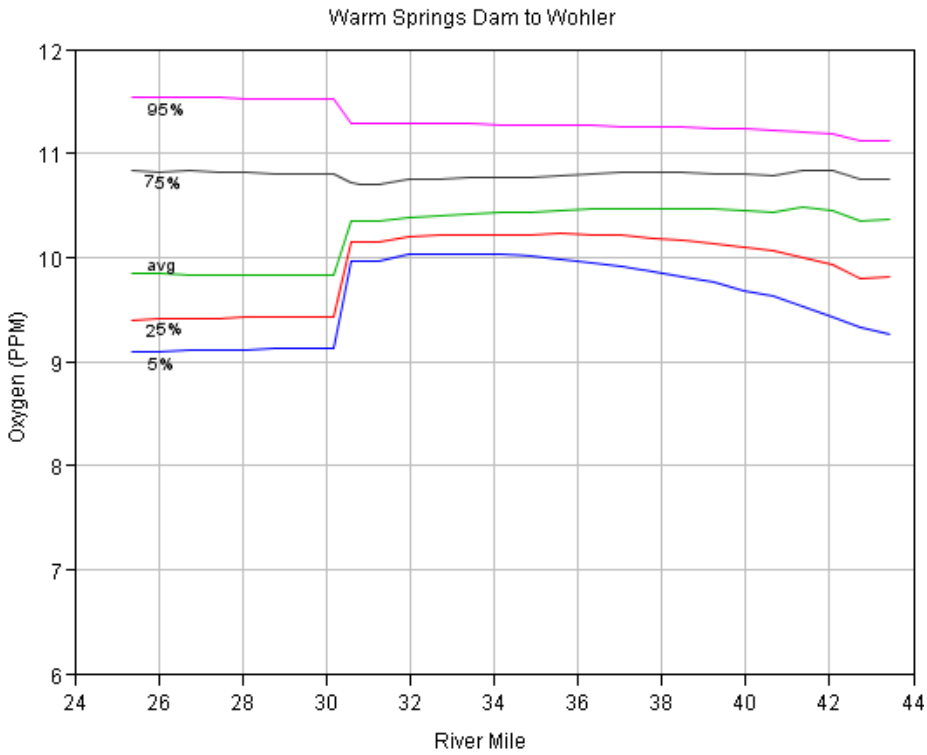

Figure 4-46 DO profiles from Warm Springs Dam (River Mile 43.8) to Wohler Dam (River Mile 25.0) with a DO deficit reduction factor of 0.8 used in the model calibration.

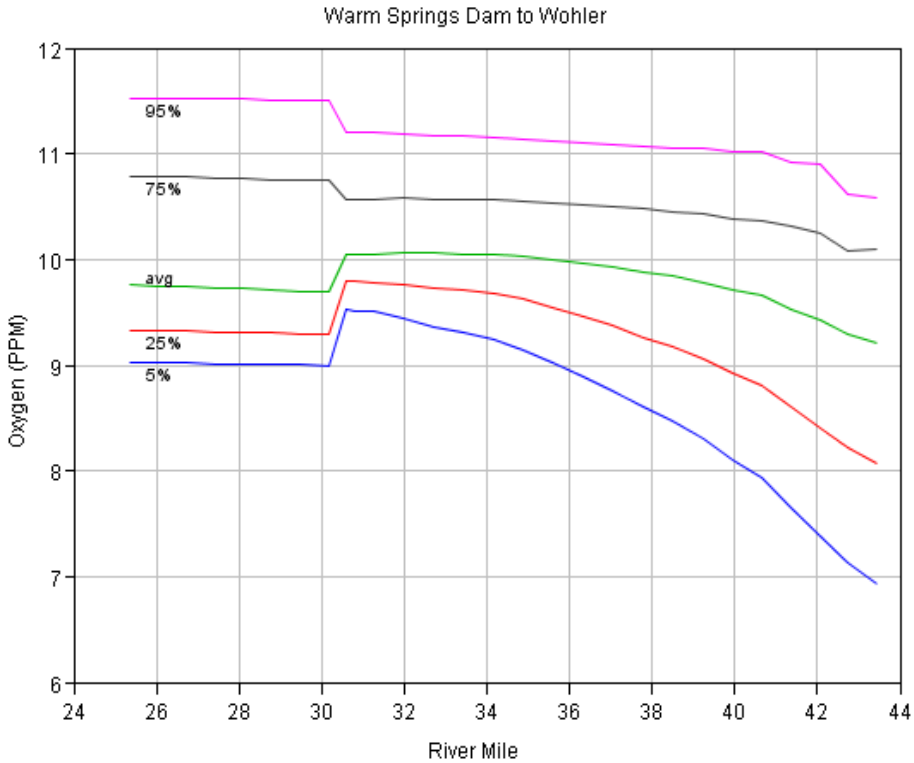

Figure 4-47 DO profiles from Warm Springs Dam (River Mile 43.8) to Wohler Dam (River Mile 25.0) using DO deficit reduction factor of 0.5 for sensitivity testing.

5 REFERENCES

Flugum, J., SCWA. 1996. “Russian River System Model (A water balance computer model of the Russian River System)”

Hydrologic Engineering Center (HEC). 1999. “Water Quality Modeling of Reservoir System Operations Using HEC-5, Training Document”, Davis, CA.

Hydrologic Engineering Center (HEC). 2000. “HEC-5, Simulation of Flood Control and Conservation Systems, Appendix on Water Quality Analysis”, Davis, CA.

Resource Management Associates (RMA). 2001 “HEC-5Q Simulation of Water Quality in the Russian River Basin”

Resource Management Associates (RMA). 2007 “HEC-5Q Simulation of Water Quality in the Russian River Basin”

Sonoma County Water Agency (SCWA). 2016. “Russian River Hydrologic Modeling for the Fish Habitat Flow and Water Rights Project”

Sonoma County Water Agency Russian River Operations Model:

Synthetic 1 in 100 Dry Year Inflow Development

Prepared for:
Sonoma County Water Agency

Prepared by:
Stephen E. Grinnell, P.E.

May 2016

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Sonoma County Water Agency Russian River Operations Model: Synthetic 1 in 100 Dry Year Inflow Development

1 INTRODUCTION

The Sonoma County Water Agency (SCWA) has developed a water balance/operations model (Model) to simulate the hydrology of the Russian River from Lake Mendocino to Jenner and on Dry Creek (a tributary of the Russian River) from Lake Sonoma to the confluence with the Russian River. The purpose of the work documented in this report was to develop a synthetic extreme drought year hydrologic time series for use in the Model. The synthetic drought year is designed to be representative of runoff conditions that would be expected to occur an average of once in every 100 years.

The SCWA is using the Model to develop and analyze alternative minimum instream flows on the Russian River and Dry Creek in order to comply with the National Marine Fisheries Service (NMFS) 2008 Biological Opinion. The Biological Opinion requires the SCWA to develop new minimum instream flows and to petition the State Water Resources Control Board to replace the instream flow requirements currently in SCWA's water right permits with the newly developed flows. The minimum instream flow requirements currently in SCWA's water right permits are a set of flow schedules that are implemented using a water year type index. Along with developing new instream flow schedules, SCWA is developing a new hydrologic based index to be used with the new flow schedules. The index is needed to determine which of the flow schedules will govern operations in a particular period within a range of hydrologic conditions. Along with the protection of Endangered Species Act listed fish, implementation of the flow schedules and hydrologic index must not result in draining reservoir storage or result in significant impacts to water supply operations. In other words, SCWA must be reasonably assured that it can operate the system to meet the new instream flows, provide for local water supplies and not deplete Lake Mendocino or Lake Sonoma.

To test the resilience of SCWA's water operations system to meet new instream flows, the Model is used to simulate operations under historical hydrology. Typically, with a long enough period of record of hydrology, a representative range of hydrologic conditions is available for simulation. The Russian River watershed has experienced a wide range of hydrologic conditions, and SCWA has historical hydrology for use in the model from water year 1910 to 2013. However, within that period there has only been one extreme drought event in 1977. That year's dry conditions were very rare and would only be expected to occur an average of less than once in every 500 years. The next driest year was 1924. The dry conditions of 1924 are expected to occur about once in every 30 years. The conditions of 1977 are so rare that using these very dry conditions as the basis for determining water operations risk and development of the minimum flows and associated index would be very conservative. In addition, using hydrologic conditions that are too conservative for designing the flows and index could result in limiting the effectiveness of the new minimum instream flows in many years by triggering the lowest flows in more years than needed to protect water supplies. Conversely, using conditions such as the hydrology of 1924 as the basis of the

index design could result in depleting reservoir storage several times in a lifetime as drier conditions occur. In addition to using hydrologic conditions that occur more frequently for system design and analysis, given the inaccuracies of projecting future conditions from the historical record, and adding the complexities of uncertain climate change impacts, using the 1924 hydrology for the worst case condition for instream flow and index design could lead to periodic catastrophic conditions. A one percent chance of occurrence, i.e. a one in one hundred return period for dry conditions has been selected as the preferred design assumption for water supply and reservoir operations risk. This occurrence level is used extensively throughout the west in planning for rare events, with flood protection throughout the Unites States as one of the more widely used applications of the one percent change event.

1.1 System Overview

The Russian River watershed Model encompasses from Lake Mendocino to Jenner for the Russian River and from Lake Sonoma to the confluence with the Russian River on Dry Creek (a tributary of the Russian River). **Figure 1** (following page) is a map of the area covered by the model with key nodes identified. The Model is coded using the US Army Corps of Engineers ResSim modeling platform. Unimpaired inflows (watershed runoff) to the modeled system within the Russian River watershed have been developed by the United States Geological Survey (USGS) and are used as the dataset of inflows in this analysis. The nodes that have local inflows assigned to them are designated with a green arrow in the figure. USGS prepared the inflow hydrology for the period January 1910 to September 2008 for the inflow nodes of the model, excluding the Potter Valley Project inflows which were derived from a separate model of that system. **Table 1** lists the inflow node location for the USGS local inflows in the Model and the Potter Valley inflow, and the average annual inflow volume for the period of record of water year 1911 to 2008. This is the period of record used in the analysis and used for the remainder of this report.

Table 1: Model Local Inflow Nodes Average Annual Inflow Volume (acre-ft)

Watershed/Inflow	Junction # in Figure 1	Average Annual Inflow Volume (AF)
DRY CREEK	9/10*	135,905
GUERNEVILLE	11	88,747
LAKE SONOMA	8	176,480
MARK WEST	12	199,641
CLOVERDALE	6	164,735
HEALDSBURG	7	335,944
HOPLAND	5	150,525
LAKE MENDOCINO	3	99,054
POTTER VALLEY	1	83,758
WEST FORK	4	123,339
TOTAL ALL INFLOWS		**1,558,126**

**Dry Creek inflow is split with a portion of the inflow assigned to below Lake Sonoma and a portion assigned to the Dry Creek confluence with the Russian River*

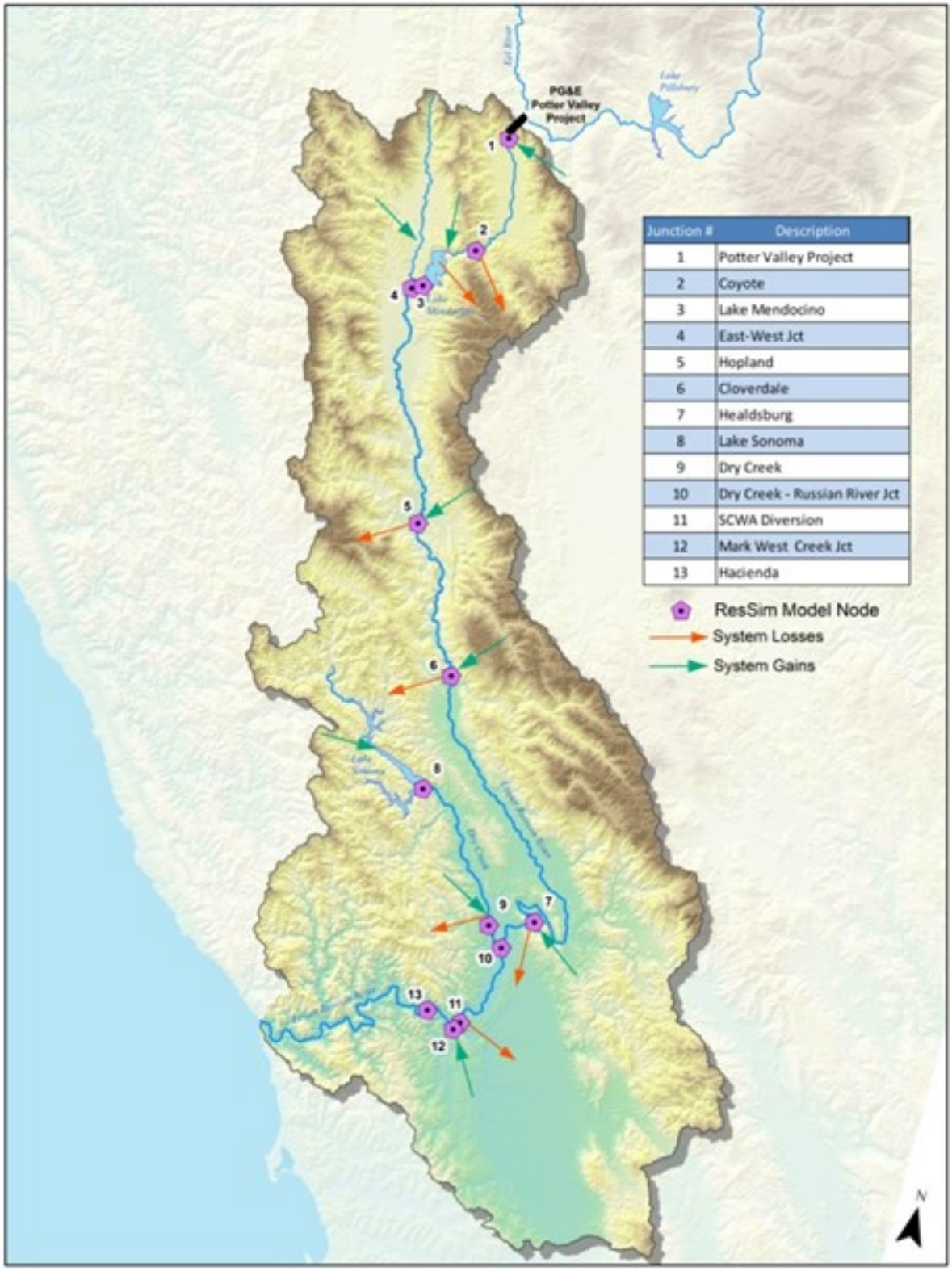

Figure 1: Russian River Watershed with Modeled Inflow Locations

The Model uses mean daily flows for inflows, and runs on a daily time step. The hydrology for the inflow record of 1911 to 2013 has varied greatly. The total average annual inflow for the entire watershed excluding inflow from the Potter Valley Project is 1,474,369 acre-ft, and has ranged from a low in 1977 of 65,694 acre-ft, which is less than 5% of the annual average, to a high of 3,883,527 acre-ft in 1983, almost 250% of the annual average. The entire watershed excluding imports of the Potter Valley Project is rainfall runoff driven and does not produce significant base flow in the mid to late summer in all but the wettest years. **Figure 2** is a graph of the monthly average inflow volume for the entire watershed excluding the Potter Valley Project imports. The figure shows that almost all of the inflow occurs in the months of December through March, with lesser amounts in the shoulder months of November, April and May and essentially no inflow from June through October. Later in this report the shift in this pattern in dry years will be discussed.

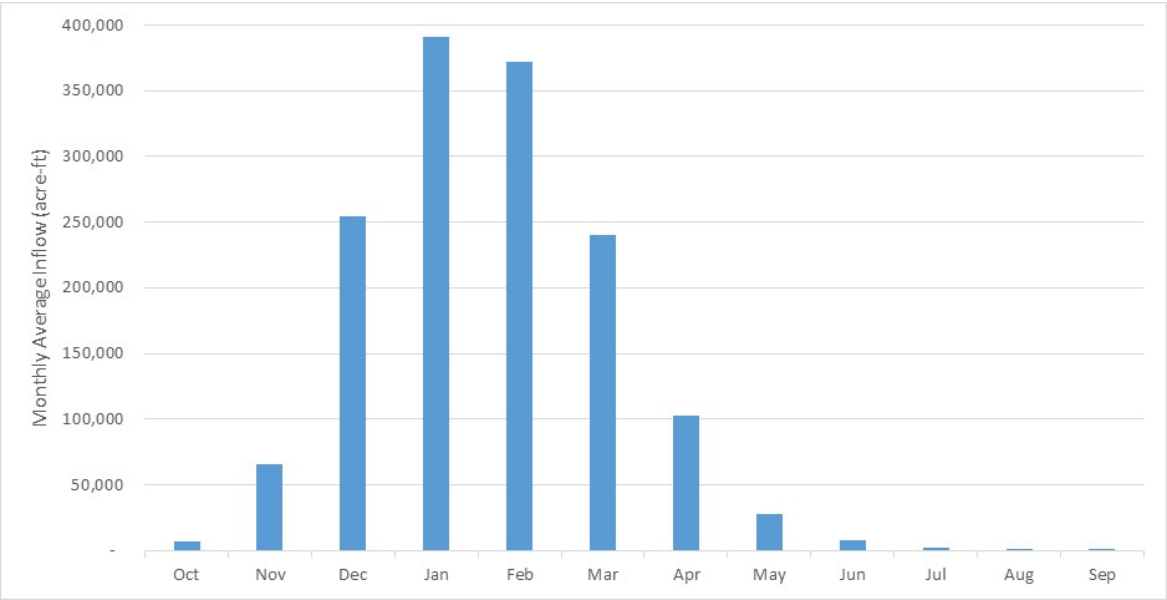

Figure 2: Monthly Average Inflow Volume for the Russian River Watershed (acre-ft)

2 METHODOLOGY

In order to develop a 1 in 100 dry year condition that is representative of the most likely hydrology for such a rare occurrence, three factors must be examined that are most important for model simulation; 1) the geographic distribution of the inflow, 2) the temporal pattern of the inflow and 3) the total volume of inflow for the entire watershed for the return period of concern. Each of these factors are described in the following sections. Because the Potter Valley Project inflow is a regulated inflow that includes operation to water year specific minimum flows, this inflow is not included in the analysis of a synthesized 1 in 100 inflow and instead is treated separately in another analysis. Therefore for the remainder of this memorandum the Potter Valley inflow is excluded from the analysis and discussion.

2.1 Geographic Distribution of Inflow

The Russian River watershed covers 1,485 square miles and the main channel of the river is 110 miles long. Across this area the geography, land cover and geologic conditions vary greatly. This variability could have an impact on the relative occurrence of rainfall runoff in extreme drought condition for portions of the watershed. A key question in developing a 1in 100 dry hydrologic time series is; "Does a 1 in 100 dry year in one location occur in the same year and in the same relative magnitude as in other locations of the watershed?" The location at which inflow occurs has a significant impact on water supply operations. Inflow behind dams can be stored and used across seasons and even years. Inflow to the river below dams, or below points of diversion or key fish habitat areas may provide limited benefits and not significantly benefit water supply operations.

One consideration in determining the distribution of inflow is whether the watershed has similar inflow characteristics for drought conditions across all locations where a 1 in 100 synthesized inflow time series can be developed using a single statistical relationship. For the analysis of the Russian River watershed the inflow time series for individual locations as well as summed series for the lower watershed (Dry Creek to the Mouth of the Russian River) and the upper watershed (Lake Mendocino to Healdsburg) were analyzed and compared to the runoff of the entire watershed. For natural runoff conditions, characterization of the occurrence of runoff is many times done using the Log Pearson Type III distribution, which is a log-normal distribution with skew. The Log Pearson Type III distribution is used to fit the annual inflow volume data in this analysis. Other distributions are possible, including Gumbel and Log Normal distributions, and these distributions were examined and discarded in favor of the Log Pearson Type III distribution. Table 2 lists the summary statistics for the annual inflow volumes for each of the inflow locations as well as the summed inflows of the upper and lower watersheds and for the entire watershed.

Table 2: Annual Inflow Volume Summary Statistics

Inflow Area/Node	Average Annual Inflow Volume (AF)	Log of Flow Volume	Standard Deviation	Skew
DRY CREEK	135,905	5.133	0.306	-0.129
GUERNEVILLE	88,747	4.948	0.253	-0.146
LAKE SONOMA	176,480	5.247	0.226	0.023
MARK WEST	199,641	5.300	0.251	-0.180
LOWER WATERSHED	**598,717**	**5.686**	**0.308**	**-0.838**
CLOVERDALE	164,735	5.217	0.230	-0.029
HEALDSBURG	335,944	5.526	0.251	-0.135
HOPLAND	150,525	5.178	0.246	-0.006
LAKE MENDOCINO	99,054	4.996	0.237	0.014
WEST FORK	123,339	5.091	0.217	0.044
UPPER WATERSHED	**870,302**	**5.940**	**0.308**	**-1.004**

TOTAL WATERSHED	**1,493,245**	**6.174**	**0.300**	**-0.935**

The summary statistics of the annual inflow volume data show similar standard deviation and skew terms across all inflows, indicating the shape of the distributions for occurrence of events overall, and occurrence of rare events, are quite similar. A comparison of the Lower Watershed, Upper Watershed and Total Watershed shows that the standard deviation and skew of these three area runoff distributions are also similar. The Total Watershed runoff volumes are a sum of the Upper and Lower Watersheds, so if these two areas have similar distributions then the Total Watershed annual runoff will provide a reasonable representation of the statistical distribution of annual runoff for the range of hydrologic conditions throughout the watershed, and can be used to formulate a 1 in 100 year annual runoff volume.

A graphical comparison of the Upper and Lower Watershed annual inflow volumes is presented in Figures 3 and 4 respectively. These figures are graphs of binned (the counting of the occurrences within set, identical ranges) occurrences of the log of annual inflow volumes. The average of log annual inflow volumes as well as one positive and negative standard deviation limits for the log annual inflow volumes are also plotted. Comparison of these two plots shows that although the relative magnitude of the annual inflow is higher in the Upper Watershed, i.e. shifted to the right on the x axis compared to the Lower Watershed, the shape of the distribution for occurrence of annual inflow volumes is similar between the Upper and Lower Watersheds. This leads to the conclusion that to develop individual sub-watershed 1 in 100 year inflows, the return period inflow volumes of the entire watershed are reasonably representative of the sub watersheds.

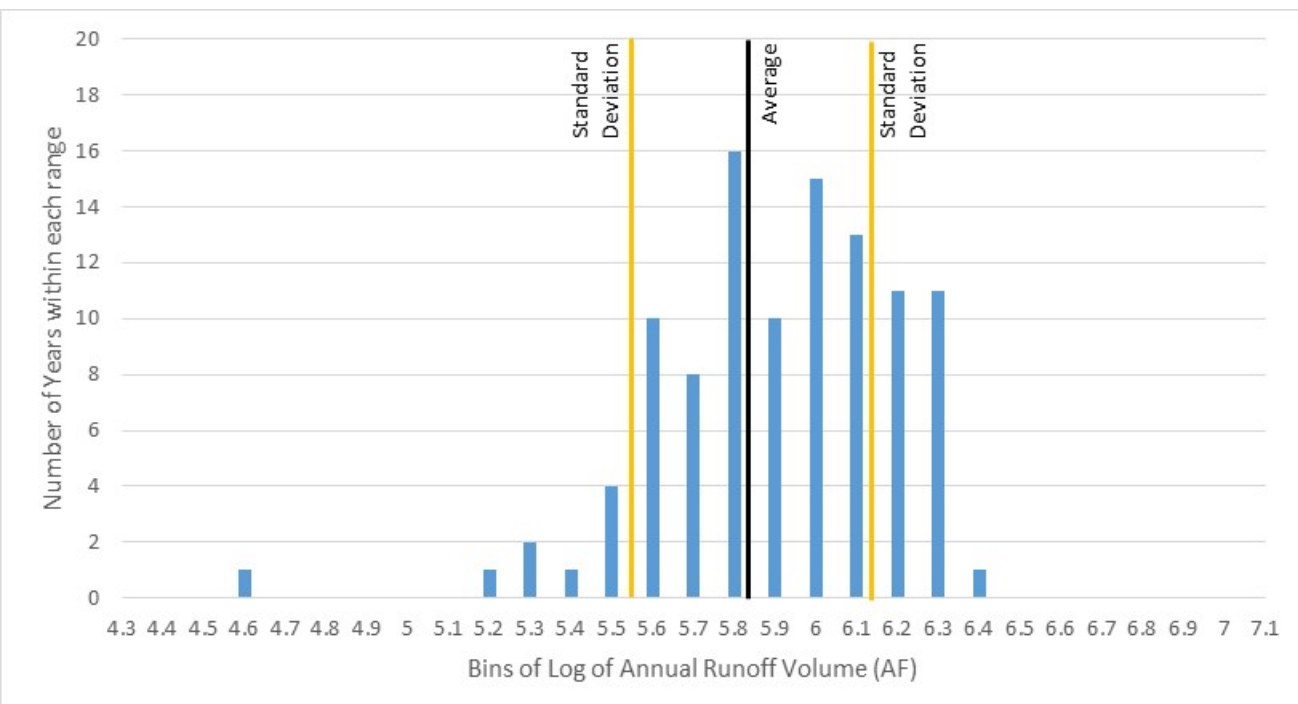

Figure 3: Binned distribution of log of Annual Inflow Volume of the Upper Russian River Watershed

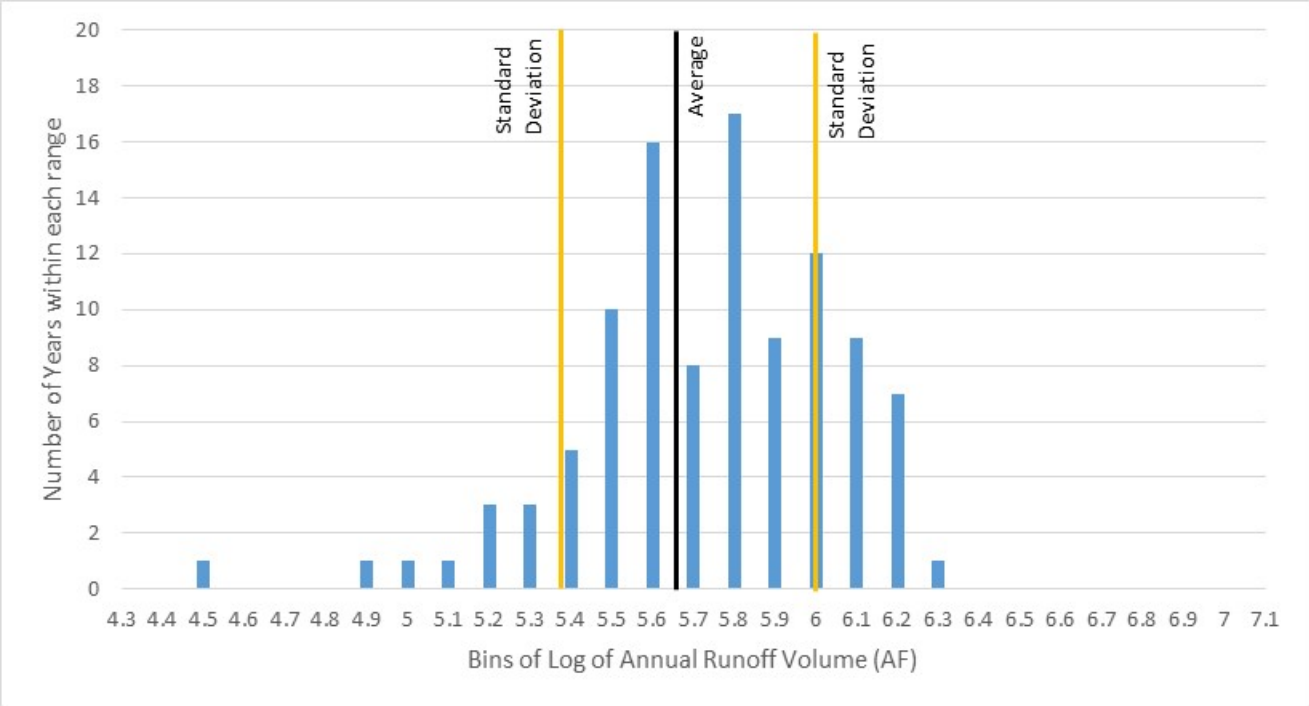

Figure 4: Binned distribution of log of Annual Inflow Volume of the Lower Russian River Watershed

2.2 Temporal Pattern of Russian River Watershed Runoff

As shown in the system overview section of this report, the overall seasonal pattern of inflow to the Russian River is dominated by mid-winter rainfall runoff. For the average condition, the peak runoff months are January and February, with significant contribution of runoff from the shoulder months of December and March. However, since this analysis is concerned with the drier years, examination of the pattern of inflow in this type of year is needed to determine a representative seasonal pattern of inflow for use in modeling the 1 in 100 dry year. Seasonality plays a significant role in reservoir operations for instream flows and water supply. The timing of runoff can determined if inflow to a reservoir can be stored or must be bypassed, and can determine if the natural runoff is effectively supporting operations to meet instream flows or water diversions.

The average annual total Russian River inflow is 1,474,369 acre-ft for the 1911 to 2013 period of record. The driest one third of those years have seen less than 900,000 acre-ft of inflow. Examination of recent years with less than 900,000 acre-ft of inflow provides evidence that the seasonal pattern of runoff shifts in drier years. **Figure 5** is graph of average monthly total watershed inflow for all years (blue bars) and for dry years (orange bars) with less than 900,000 acre-ft of runoff in the past 25 years, which includes the 8 years of 1990, 1991, 1992, 1994, 2001, 2007, 2009 and 2012.

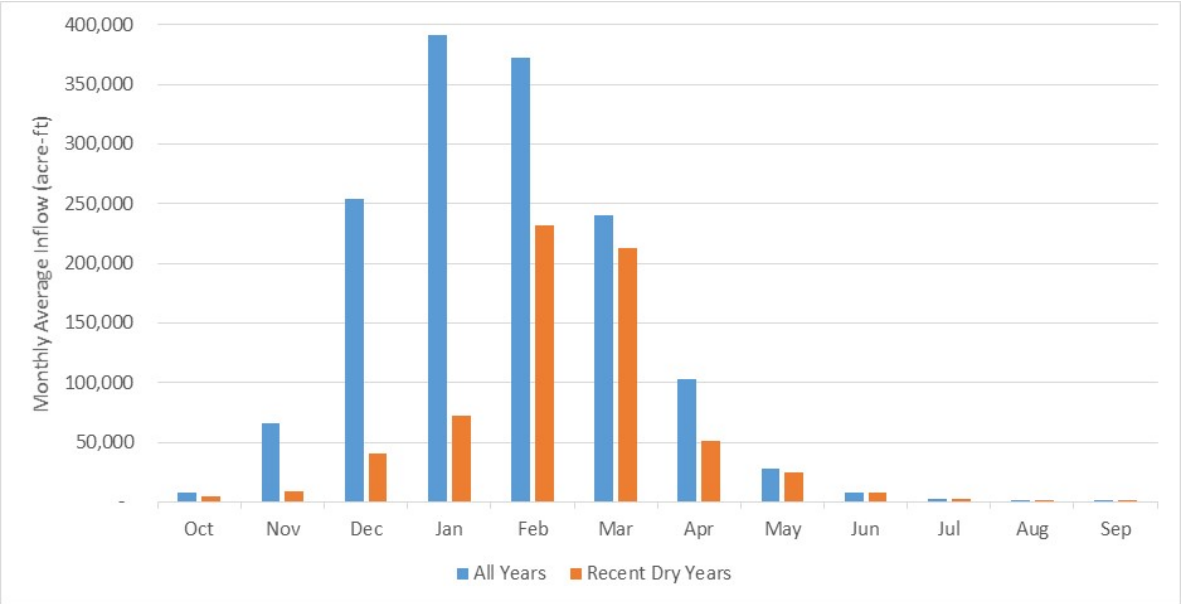

Figure 5: Average Monthly Total Russian River Inflow Volume (acre-ft) for all Years from 1911 to 2013 and for Recent Dry Years

As seen in the figure the months with the greatest inflow volume shifts to the months of February and March for the dry years. While two thirds of the total annual inflow volume occurs over the three highest months of December, January and February for all years, in the driest years two thirds of the total annual inflow volume occurs in only two months, February and March.

Because of the significant shift in the timing of inflow from the mid-winter for all years to the late-winter/early spring of drier years, the appropriate pattern for the 1 in 100 year inflow needs to be patterned on the drier years. In order to also incorporate, as much as possible from the historical record, any recent climate change effects, the drier years with total inflow volumes less than 900,000 acre-ft for the most recent 25 year period were selected to provide the daily/seasonal pattern of inflow from which the 1 in 100 dry year is constructed.

2.3 Inflow Volume Development

The calculation method employed for obtaining a 1 in 100 daily inflow time series for all inflow locations involves transforming the representative dry years to the 1 in 100 flow by scaling each day of the representative year by the ratio of the representative year annual runoff volume to the 1 in 100 year annual inflow volume. Previous report sections have shown that the total Russian River watershed inflow is representative of the timing and relative magnitude of the individual inflow sub areas, so the total annual volume of the entire Russian River watershed inflow for the selected representative years can be used with the 1 in 100 annual Russian River watershed inflow volume as the scaling factor for the representative year daily inflows. Section 2.2 demonstrated the need to use recent dry years, with the eight recent dry years of the past 25 years with less than 2/3 of the long term average annual inflow volume selected as the representative years. The average of the daily inflows values for the recent eight dry years are used as the representative year time series.

The 1 in 100 annual inflow volume can be estimated statistically from the historical record of inflow as derived by the USGS. **Figure 6** is a plot of the total Russian River annual inflow volume for the period 1911 to 2013. The data is plotted as a ranked series using Weibull plotting position for percentage exceedance, and includes an inset graph that is a magnification of the 80% to 99% percent exceedance data. The magnified inset graph clearly shows the disparity between the series of annual inflow volumes between 80 and 98% and the single data point for the 99% exceedance at 65,694 acre-ft (orange point), which is the volume for 1977. This graph indicates the inaccuracy of using a simple Weibull plotting position for the probability of occurrence for these historically derived inflow volumes. The likely explanation for the disparity is that although the sample period is 104 years, the historical record includes only a very few dry years that would be expected over a very long term sample. A more rigorous statistical method than plotting position is used to estimate the low probability dry year occurrence of inflow, including the 1 in 100 dry year occurrence.

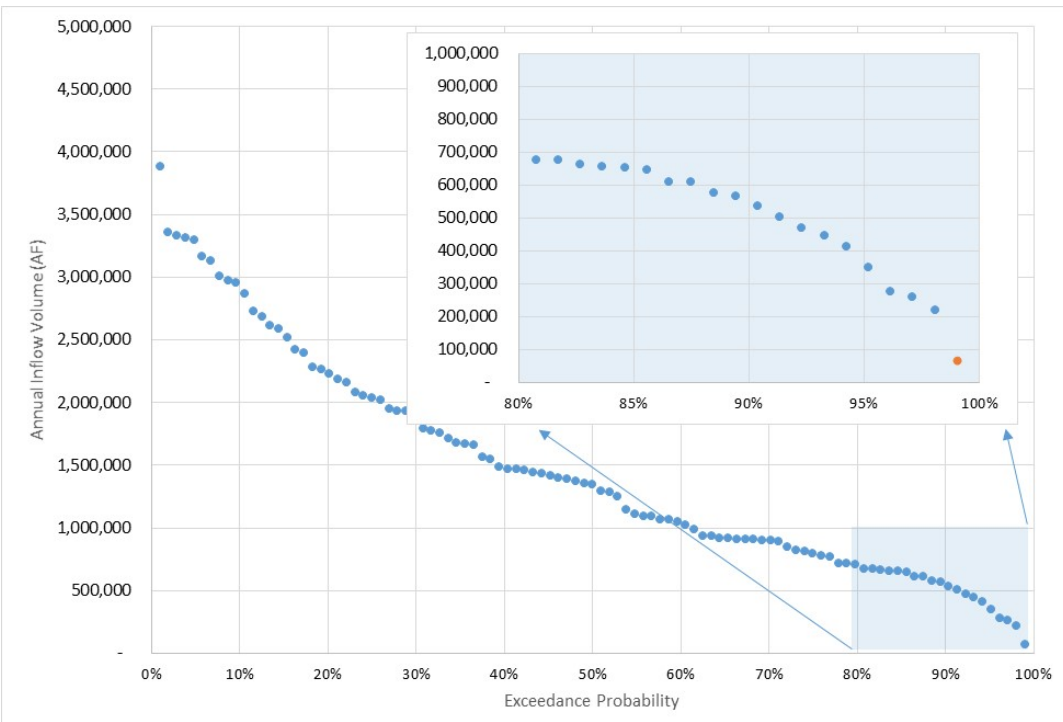

Figure 6: Total Russian River Annual Inflow Volume for the Period 1911 to 2008 Ranked and Plotted with Weibull Plotting Position (*x/(n+1)*) on the X Axis.

2.3.1 Statically Derived 1 in 100 Year Volume

Statistical analysis of hydrologic data can use a variety of distributions to fit a set of observations. Standard practice for analysis of natural hydrologic occurrences is to use a Log Pearson Type III distribution to fit the observed data. For this analysis a log normal distribution without skewness was also examined, and rejected. **Figure 7** is the lower half of an exceedance probability plot of the annual Russian River inflow volume data with a log normal distribution and a Log Pearson Type III distribution. The plot shows that the log normal distribution with its straight line on a log graph does not represent the skew of the data for the extreme dry years, while the Log Pearson Type III distribution tends to closely follow the drier year trajectory.

Another method typically employed in hydrologic analysis is to use a regional skew value that has been computed for many locations within the region rather than using the skew value calculated from the data set. However, most of the work in compiling regional skew values is focused on flood events, and the rare, wettest conditions. These regional skew values do not fit the observed Russian River data set very well for the dry year volumes, and instead the calculated data set skew is used in this analysis.

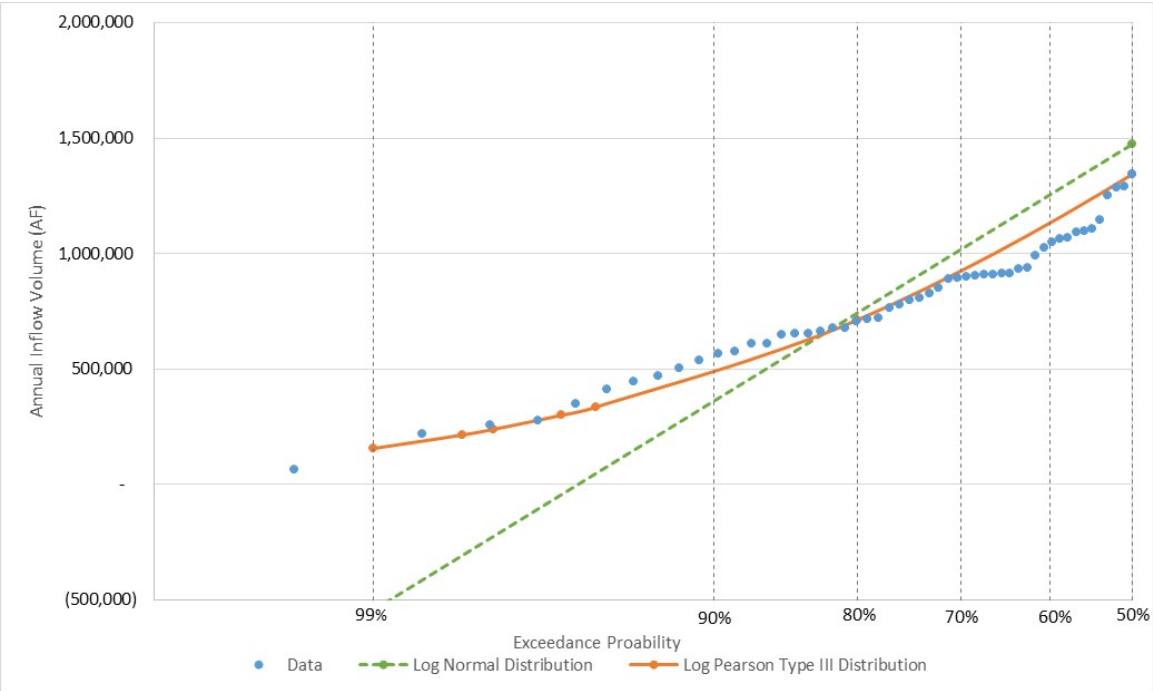

Figure 7: Exceedance Probability Plot of Total Annual Inflow with Log Normal Distribution and Log Pearson Type III Distribution for Driest 50% of Years

Figure 8 is a plot of the Russian River annual inflow volume data and the selected Log Pearson Type III distribution that uses the average, standard deviation and skew of the logs of the annual inflow volumes for 1911 to 2013. The plot is for only the driest 50% of years and is plotted against percent change exceedance on the X axis.

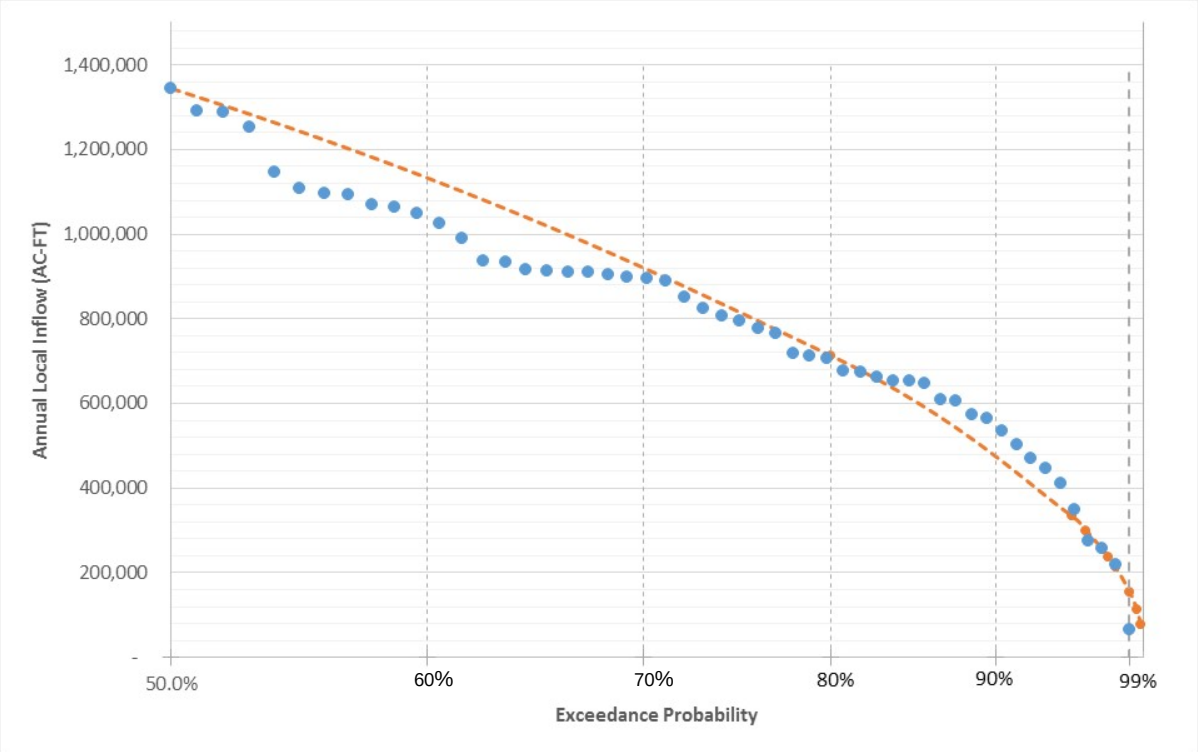

Figure 8: Exceedance Probability Plot of Total Annual Inflow with Log Pearson Type III Distribution for Driest 50% of Years

Table 3 is the annual Russian River inflow volumes for the listed return periods and exceedance probabilities calculated using the statistical distribution. The average, standard deviation and skew of the log values of annual Russian River inflow volumes used are 6.0823, .2999 and -0.935 respectively. The 1 in 100-year inflow volume from the statistical distribution is 154,371 acre-ft and the average is 1,344,043 acre-ft, as compared to the average calculated from the data set of 1,474,369 acre-ft. Note that the statistically derived 1 in 500-year annual volume is 75,761 acre-ft, compared with a USGS derived inflow volume for 1977 of 65,694 acre-ft.

Table 3: Annual Russian River Inflow Volumes for the listed return periods and exceedance probabilities Calculated using the Log Pearson Type III Distribution

Exceedance Probability (%)	Return Period (1 in x years)	Annual Inflow Volume (Acre-ft)
99.8%	**500**	75,761
99.5%	**200**	113,012
99.0%	**100**	154,371
98.0%	**50**	213,074
97.5%	**40**	237,010
96.0%	**25**	298,160
95.0%	**20**	333,453
80.0%	**5**	712,650
50.0%	**2**	1,344,043

3 RESULTS

The results of statistical analysis to estimate the 1 in 100 dry year annual Russian River inflow volume provides the numerator of the ratio for converting the reference year daily flows for each of the inflow locations to a time series of 1 in 100 dry year inflows. The form of the formula for calculating the 1 in 100 dry year daily inflow volumes is as follows:

$$[I_{100x}] = [I_{rx}]\frac{V_{100}}{V_r}$$

Where;

$[I_{100x}]$ = The time series for location x of 1 in 100 dry year daily flows (cfs)

$[I_{rx}]$ = The time series for location x of reference year dry year daily flows (cfs)

V_r = Annual Russian River Inflow volume for the Reference Year (acre-ft)

V_{100} = Annual Russian River Inflow volume for the 1 in 100 Dry Year (acre-ft)

The reference year daily inflows for each of the inflow locations are the average of the selected eight years of daily inflows for each location and the reference year inflow volume is the total annual inflow volume of the averaged selected eight years daily inflows for each location, which equals 663,007 acre-ft or 45% of the average inflow volumes for the period of record. With a 1 in 100 dry year inflow volume of 154,371 acre-ft the ratio or scaling factor for each daily inflow value is 154,371/663,007 or .2328. Therefore the 1 in 100 dry year inflows are 23.28% of the average daily flows of the eight driest years of the past 25 years.

Figures 9 and 10 shows the resulting mean daily inflows for the 1 in 100 dry year for the upper Russian River and lower Russian River and Dry Creek respectively.

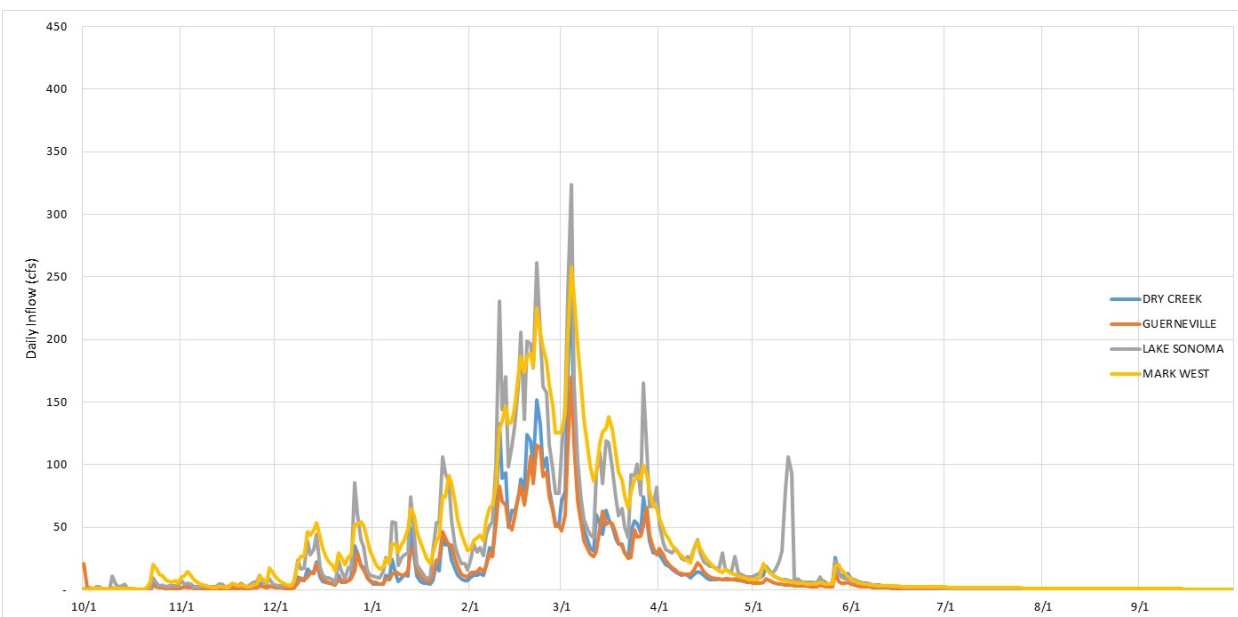

Figure 9: Mean Daily Inflows for the 1 in 100 Dry Year for the upper Russian River Locations (cfs)

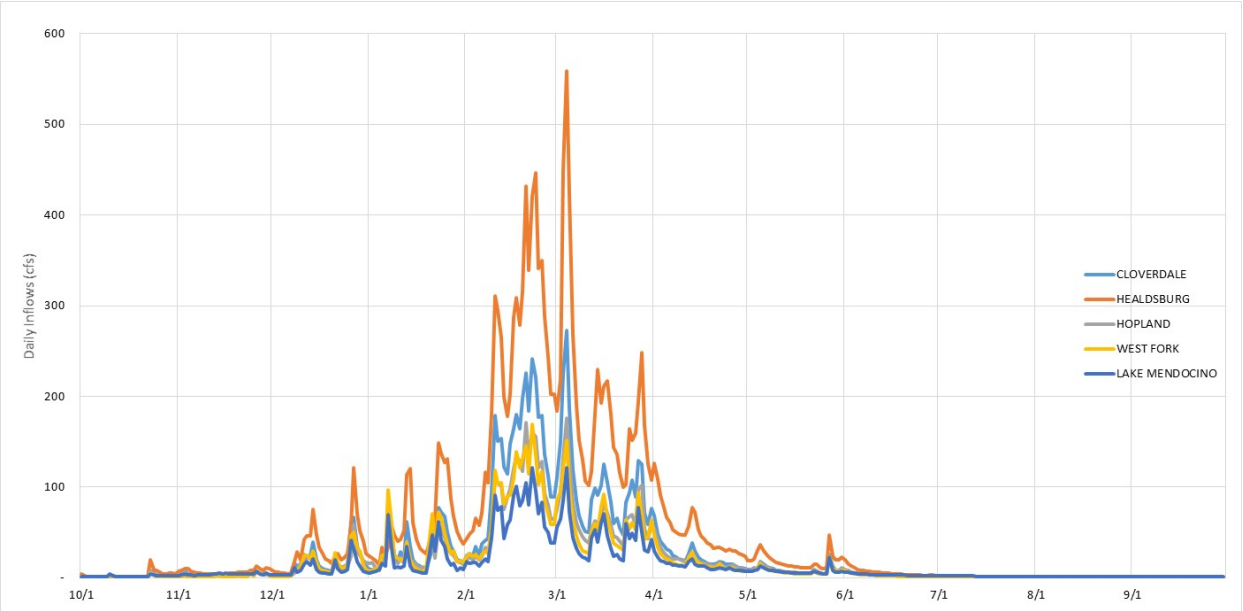

Figure 10: Mean Daily Inflows for the 1 in 100 Dry Year for the lower Russian River and Dry Creek Locations (cfs)

The mean daily inflow figures 9 and 10 show that the majority of inflow is centered on the mid-February to mid-March period and the dominant inflow is at Healdsburg. Figure 11 is a graph of the annual inflow volume contribution for the 1 in 100 dry year from each of the locations on the Russian River and Dry Creek, excluding the Potter Valley inflow.

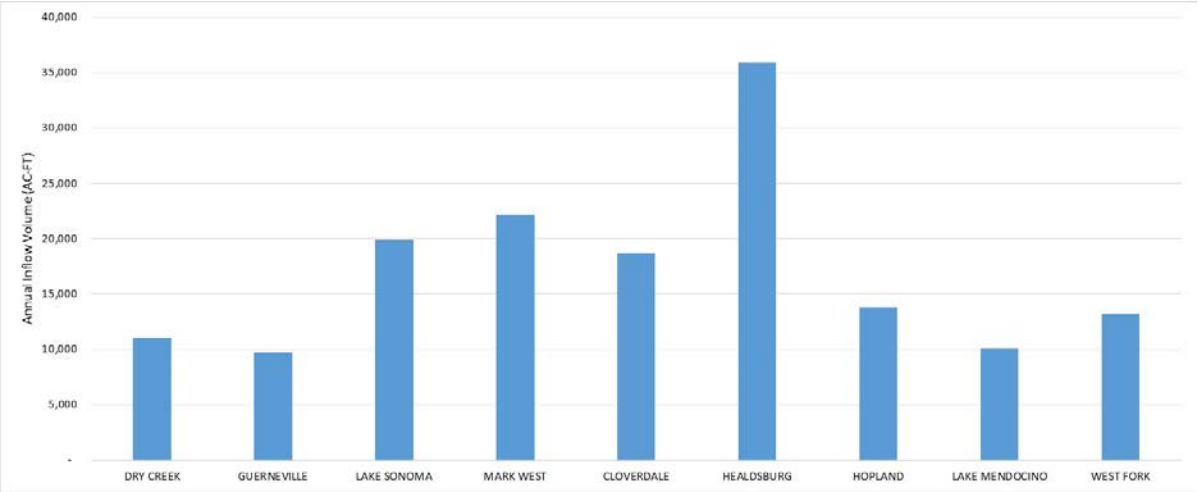

Figure 11: Annual Inflow Volume for the 1 in 100 Dry Year by Location (acre-ft)

Using an average of eight years tends to smooth out the daily variation in flow, however as seen in figures 9 and 10, there is a clear cycle of increased inflow about every two weeks, which is similar to the cyclical weather patterns observed in the historical record. An early March rain event

from one of the eight years, 1991, produces the peak inflow for the 1 in 100 year for the lower Russian River, and about equal to the peak inflow of February for the upper Russian River.

The 1 in 100 year inflow is a very low volume of runoff compared to the normal range of flow seen in the Russian River and Dry Creek. The total volume of inflow excluding any Potter Valley Project inflow expressed as an annual flow rate is only 229 cfs, and 2/3 of this volume occurs in the months of February and March. The 1 in 100 dry year inflow volume is a little more than 10% of the average inflow for the period of record, with the dry year inflow volume spatially distributed about the same as the average year inflow.

4 SUMMARY

A 1 in 100 dry year inflow time series for each of the Model inflow locations excluding the Potter Valley inflow was developed for use in modeling the Russian River system under extreme drought conditions. The hydrology of the Russian River inflow can be represented using statistical methods to estimate extreme events based on the historical record. The results provide a reasonable approximation of inflow volume as well as spatial and temporal distribution. The 1 in 100 dry year inflows are roughly 10% of the average inflow volume, but are more concentrated temporally on the winter months of mid-February to March, likely resulting in less opportunity for utilization of natural runoff for meeting instream beneficial uses of water and further stressing the system in such a dry year.