Climate Induced Hatchery Upgrades

Black Rock Hatchery

Alternatives Analysis Submittal

Final Report
Revision No. 4

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Revision Log

Revision No.	Date	Revision Description
0	4/29/2024	65% Draft Internal Technical Review
1	5/7/2024	65% Draft for CDFW Review
2	8/13/2024	100% Draft for CDFW and Internal Technical Review
3	10/31/2024	Final Submittal to CDFW
4	1/31/2025	Final Submittal to CDFW, ADA Accessible Document

Appendices

The appendices that accompany this document are not ADA compliant. For access to the following appendices, contact Fisheries@wildlife.ca.gov. If assistance is needed for an ADA compliant version of the appendices, please include that in the email.

- Appendix A. Site Visit Report
- Appendix B. Bioprogramming
- Appendix C. Concept Alternative Drawings
- Appendix D. Design Criteria TM
- Appendix E. Alternatives Development TM
- Appendix F. Cost Estimates
- Appendix G. Meeting Minutes
- Appendix H. LEED and NZE Evaluations

Executive Summary

McMillen, Inc. (McMillen) was retained by the California Department of Fish and Wildlife (CDFW) to provide an assessment of 21 CDFW fish hatcheries throughout the State of California in the context of their vulnerability to the effects of climate change. Climate modeling was performed by Northwest Hydraulic Consultants (NHC).

Black Rock Hatchery has an aging infrastructure and deficiencies that need to be addressed in the near future in order to meet fish production goals. Well deficiencies, insufficient effluent pond capacity, water treatment limitations, abandoned Division Creek diversion structure, aged plumbing, insufficient incubation and early rearing space, raceway deterioration, and exposure and predation issues in the raceways are all items that have been noted to hinder current production. The effects of which will magnify with climate change.

The preferred alternative for hatchery upgrades includes upgrading the two Los Angeles Department of Water and Power wells, rebuilding the aeration tower, decommissioning the Division Creek diversion structure, upgrading the valving and piping, constructing a new hatchery building with solar panels for incubation (early and intermediate rearing), constructing new circular tank modules that are covered and use partial recirculating aquaculture systems (PRASs) for the final rearing stages, improving concrete raceways, and dredging the existing effluent ponds back to their original capacities.

The Class 5 Opinion of Probable Construction Cost (OPCC) for constructing the preferred alternative upgrades can be found in the tables below (Table 6-2 and Table 6-3 provide the Class 5 OPCC summary). The table also includes the estimated cost of photovoltaic systems to offset the energy consumption of the new equipment and maintain zero net energy. These upgrades would not significantly affect fire or flood risks at the facility, and all work would occur within already developed areas. Operationally, CDFW would need to update feeding, harvesting, and water quality monitoring protocols to accommodate the transition to partial recirculating aquaculture systems with circular tanks. These proposed upgrades would provide a solid foundation for CDFW to sustain fish production at the hatchery, even as climate change increasingly disrupts current and future operations.

Table ES - 1. Maintain Production

Project Total	$48,424,000
Photovoltaic – Net Zero Energy	$6,418,000

Table ES - 2. Maximize Production (10 cfs)

Project Total	$66,892,000
Photovoltaic – Net Zero Energy	$9,596,000

1.0 Introduction

1.1 Project Authorization

McMillen, Inc. (McMillen) was retained by the California Department of Fish and Wildlife (CDFW) to provide a climate change evaluation for 21 hatcheries operated by CDFW throughout the State of California. The contract for this Climate Induced Hatchery Upgrade Project (Project) was executed on March 21, 2023.

1.2 Project Background

California relies on CDFW hatcheries to provide recreational fishing opportunities for the public, and for the conservation of endangered or threatened species. However, climate change threatens the business-as-usual production of fish with the existing CDFW hatchery infrastructure. Climate change impacts have already affected many CDFW hatcheries, resulting in altered or inconsistent operation schedules, lowered production, and emergency fish evacuations. These climate impacts include increasing water and air temperatures, changes to groundwater availability, low flows and water shortages, increased flood and fire risks, and other second-hand impacts associated with each of these categories (i.e., emerging pathogens and non-infectious diseases, low adult salmon returns, decreased worker safety, etc.).

A total of 21 hatcheries were visited by McMillen to evaluate the existing infrastructure and fish production operations. During these visits, McMillen assessed the existing hatchery infrastructure deficiencies and replacement needs. The assessment was used to aid in determining the potential upgrades for each hatchery that would maintain the existing program production goals for the various species reared at each facility while providing conceptual alternatives for climate resilience. Climate change has had an impact worldwide and will continue to affect CDFW's statewide fish production operations. Developing technologies and methods to meet fishery conservation and sport fisheries demands is critical to CDFW's goal of maintaining hatchery productivity while conserving precious cold-water supplies for native species.

We have based our detailed work plan on achieving the following project objectives stated in the Request for Proposals (RFP). As presented in Sections 2 and 3 of our proposal, we have intentionally comprised our team of experts in all required disciplines with experience in fish husbandry and hatchery engineering and design to successfully meet all CDFW's project goals.

- **Objective 1:** Review the state of each facility via data collection, review of documents, site visits, and discussions with hatchery personnel. Identify climate change impacts that are likely to negatively impact operations at each hatchery over the next 40 years.
- **Objective 2:** Develop cost effective and programmatically viable alternatives that will maintain current fish propagation goals given climatic impacts in the future.
- **Objective 3:** Assess the risks of each alternative to natural biological systems, environmental conditions, husbandry techniques for fish health and fish safety, and potential impacts to water quality.
- **Objective 4:** Determine the short- and long-term economic costs for the modifications to each hatchery in current year dollars. Account for construction, permitting, design, operational, and maintenance costs within the overall economic analysis. Prioritize the list of alternatives and associated hatcheries based on limited annual hatchery budgets.
- **Objective 5, Phase 2 Work:** Provide complete designs with issued for construction drawings and specifications for projects at as many hatcheries as are feasible. The focus shall be on those hatcheries that are deemed most susceptible to negative climate change impacts identified from the four previous objectives.

1.3 Project Purpose

The purpose of the Project is to determine the CDFW hatcheries and the existing infrastructure conditions that are most susceptible to reduced fish production attributable to climate change and provide a prioritization of the hatcheries for improvements. With input from CDFW, designs for climate change resiliency upgrades will be advanced for as many facilities as is feasible.

1.4 Project Location Description

The Black Rock Hatchery is located in Independence, CA, in the Owens Valley of the Eastern Sierra-Nevada Mountain Range approximately 34 miles from Bishop, CA (Figure 1-1).

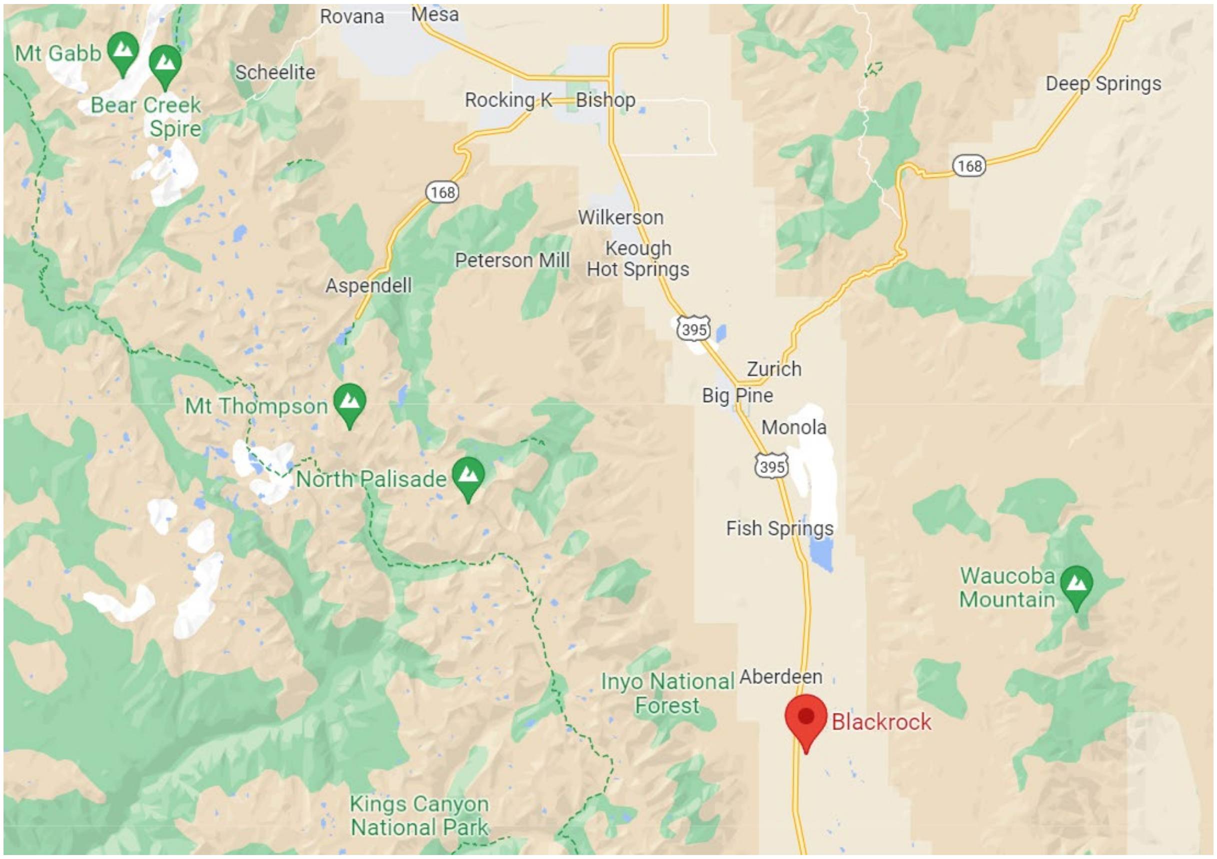

Figure 1-1. Black Rock Hatchery Location Map.

The Black Rock Hatchery first reared Rainbow Trout (Oncorhynchus mykiss) in large ponds, which were created by the City of Los Angeles by building a dam for diversion purposes near the source of Black Rock Springs in 1941. In 1976, the hatchery expanded with the addition of four concrete raceways. The Black Rock Hatchery raises three strains of Rainbow Trout with an annual production goal of approximately 100,000 pounds for their inland trout production program. The hatchery operates strictly on well water since New Zealand Mud Snails (*Potamopyrgus antipodarum*, NZMS) were detected in Division Creek. The facility has no hatchery building; eggs are incubated using upwelling jars that are plumbed directly into outdoor deep tanks where early rearing occurs. Fish are transferred from deep tanks into raceways and reared to their final target release size. The general facilities are shown in Figure 1-2. More detailed descriptions and photos of the Black Rock Hatchery facilities are described in the Site Visit Report (Appendix A).

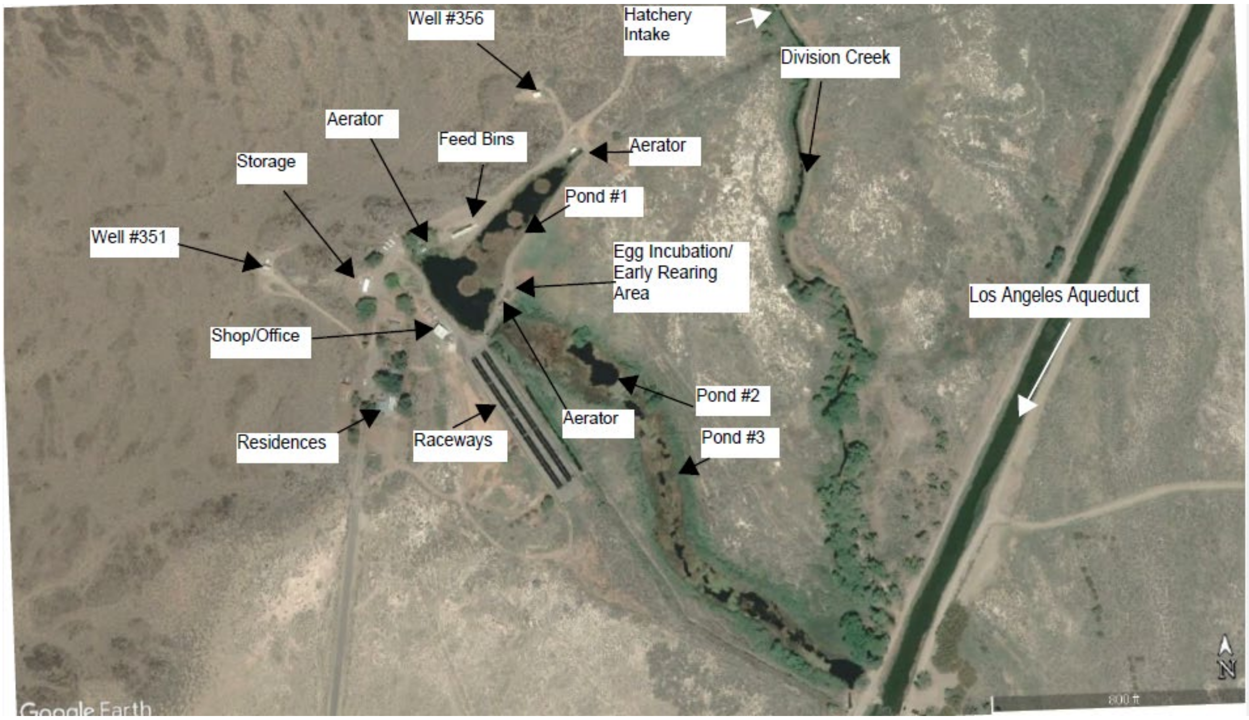

Figure 1-2. Black Rock Hatchery Facility Layout. Google Earth Image Date: June 2020.

2.0 Bioprogram

2.1 Production Goals and Existing Capacity

2.1.1 Inland Fisheries

California's hatchery production goal for inland trout is based on sport fishing licenses sold in the previous calendar year. This requirement sets a production goal for CDFW hatcheries to produce and release 2.75 pounds of trout per sport fishing license sold. The requirement stipulates that the majority of released fish be of a catchable size (2 fish per pound [fpp]) or larger and requires CDFW to achieve this goal in compliance with certain policies, including the Strategic Plan for Trout Management. Currently, CDFW achieves approximately 35% of the required production based on sport fishing license sales. CDFW is also required, to the extent possible, to establish and maintain native wild trout stocks and protect native aquatic and nonaquatic species. CDFW currently utilizes a trout triploid program (sterile trout) to avoid genetic impacts to native trout populations through the stocking program.

The Black Rock Hatchery produces several strains of Rainbow Trout. The Capacity Biological Program (Capacity Bioprogram) for the facility was developed for the Site Visit Report (Appendix A) and provides the total numbers of fish and biomass that can be produced for all rearing tanks based on tank volume, operational water flows, and size of the fish. The calculations utilize the density and flow indices previously identified for the preliminary bioprograms which encompass water temperature and elevation criteria to ensure oxygen levels appropriately align with production (Piper et al. 1982). This information is available in the Site Visit Report (Appendix A). The calculations include a 10% safety factor to provide a 90% maximum capacity based on both the density index (DI) and flow index (FI) requirements identified. The annual production goal at the Black Rock Hatchery is 102,500 pounds of Rainbow Trout with approximately 87,500 pounds of fish at 2 fish per pound (fpp; 175,000 fish) and 15,000 lbs of fish at 10 fpp (150,000 fish), or 325,000 total fish produced as provided by CDFW in the initial questionnaire. The fish production rearing capacity, determined by the Capacity Bioprogram, is shown in Table 2-1.

Table 2-1. Rainbow Trout Production Capacity of Various Rearing Units at the Black Rock Hatchery per the Capacity Bioprogram (Appendix A).

Rearing Unit (max. fish size)	Total Capacity (Fish)[a]	Limiting Factor
Deep Tanks (170 fpp/2.4 inches[b])	59,574 (350 lbs)	Rearing Volume
Raceways (10 fpp/6.3 inches)	166,011 (16,601 lbs)	Water Flow
Raceways (2 fpp/10.8 inches)	56,918 (28,459 lbs)	Water Flow

[a] This is an estimate of 90% production capacity to allow for a buffer in circumstances where more flexibility is needed for hatchery operations.
[b] This is the minimum size required for Lactococcus spp. vaccination, ideally fish can be held in deep tanks until this size per CDFW's Fish Pathology protocols.

2.2 Bioprogram Summary

The Capacity Bioprogram in the Site Visit Report (Appendix A) demonstrates the total capacity of each rearing area at the Black Rock Hatchery for several stages of fish production. The capacity of each rearing area (-10% to provide an additional safety factor), limited by water flow or available rearing volume, is shown in Table 2-1. The total capacity for the Black Rock Hatchery falls short of the production goal shown in Table 2-1; though, nuances of the timing of egg arrivals and fish stocking historically allowed production goals to be met. Recently, issues associated with aquatic invasive species (AIS) and emerging pathogens have limited production at the facility. Details about the various rearing areas and infrastructure are discussed in the Site Visit Report, found in Appendix A. In this report, we develop a Production Bioprogram to illustrate the potential maximum production that the facility is capable of while remaining within the limits set by the Capacity Bioprogram.

2.2.1 Criteria

The methods and reasoning used to determine the criteria associated with biological programming for the Black Rock Hatchery can be found in Appendix A. For reference, the established criteria are shown in Table 2-2. To model the production cycle schedule for the

Production Bioprogram, several assumptions are made and included in Table 2-3. Additional assumptions include the following:

- CDFW will have the ability to have Rainbow Trout eggs available throughout the year by either purchasing eggs from private vendors or through CDFW's own photoperiod programs.
- There will be optimal conditions for egg development and fish growth given the existing water temperatures at the facility.

Klontz (1991) provided optimal growth rates (0.04 inches per day) for Rainbow Trout at designated water temperatures. Survival rates were provided in the questionnaire completed by Black Rock Hatchery staff.

Table 2-2. Criteria Used for the Production Bioprogram. Criteria are Discussed in Detail in Appendix A.

Criteria	Value
Density Index (DI)	0.5
Flow Index (FI)	1.32
Water Temperature	Consistent 57-59°F

Table 2-3. Survival Assumptions Used for the Production Bioprogram.

Life Stage	Value
Egg-to-fry (600 fpp)	53%
Fry-to-juvenile (40 fpp)	80%
Juvenile-to-outplant (2 fpp)	98%

2.2.2 Production Bioprogram

This bioprogram (Appendix B) is meant to view hatchery operations at a high level and does not capture the nuances of the specific timing of fish transfers, grading, sorting, or stocking. The model is meant to show an example of how production may occur given the criteria and assumptions outlined in the previous section. This program uses four separate Rainbow Trout egg receivals, pulses 1 through 4, to stagger early rearing and maximize annual production with the existing infrastructure. Each pulse of eggs is received approximately 3 months after the previous pulse.

Table 2-4. End of Month Production Information for an example of Pulse 1 Bioprogram Including Realized DI and FI Values.

Production Stage/Month	Tank Type	Tanks Occupied	fpp	Length (in)	Total Fish (#)	Biomass (lbs)	Max. Flow (cfs)	DI	FI
Early Rearing - Jan/Feb	Deep Tanks	6.0	610.4	1.60	57,600	94.4	0.3	0.18	0.39
Mar	Deep Tanks	6.0	109.1	2.80	51,421	471.3	0.3	0.52[a]	1.12
Apr	Raceways	0.2	37.9	4.00	45,242	1,193.7	1.4	0.15	0.47
May	Raceways	0.4	17.0	5.30	45,142	2,655.4	1.4	0.13	0.79
June	Raceways	1.0	9.2	6.50	45,050	4,896.7	1.4	0.08	1.18[b]
Jul	Raceways	1.0	5.4	7.70	24,731	4,579.8	1.4	0.06	0.93
Aug	Raceways	2.0	3.5	9.00	24,631	7,037.4	2.8	0.04	0.61
Sep	Raceways	2.0	2.4	10.20	24,531	10,221.3	2.8	0.05	0.79
Oct	Raceways	2.0	1.7	11.40	24,431	14,371.2	2.8	0.06	0.99

[a] Fish are vaccinated and moved out to raceways as the DI threshold is approached.

[b] Before the end of June, approximately 20,811 fish will be released at a sub-catchable size (approximately 10 fpp). If the fish are held longer, the FI threshold will be exceeded.

Assuming that eggs are received in early January (pulse 1), it takes approximately 1.5 months from fertilization (i.e., green eggs) to first feeding which would begin in mid-February when fish are approximately 4,218 fpp (0.84 inches). These fish should reach approximately 170 fpp (2.44 inches) in mid to late March (Table 2-4). At this time fish can be vaccinated against Lactococcus spp. and later transferred to outdoor raceways. Some flexibility is available to keep fish in the deep tanks for slightly longer, if necessary, though fish must be moved out of the deep tanks by April for the next pulse of eggs to arrive. In this exercise, it is assumed that approximately 110,000 eggs are incubated per pulse, 57,600 fry are hatched from those eggs, and 45,242 juvenile fish are transferred to the raceways based on survival rates provided by Black Rock Hatchery staff. The 45,242 juveniles are stocked into a single 100-foot section of the raceway and provided the full raceway as they grow. Once fish reach approximately 10 fpp in June, 20,000 fish will be stocked out as sub-catchable fish. If fish are not stocked out by the end of June, the FI criteria will be exceeded for this cohort of fish in a single raceway. The remaining 24,731 fish will be split into two raceways in August and will reach the target size of 2 fpp in October. There is some flexibility within the two raceways for other cohorts to be held depending on variances in stocking schedules or sub-catchable allotments (i.e., less sub-catchable fish are stocked out and more are held for catchable sizes). Water flow is the limiting factor and impacts the ability to raise larger cohorts of fish in the raceways. Subsequent pulses (i.e., pulses 2, 3, and 4) of eggs are expected to go through the same process in the hatchery with the same survival and growth rates given the well water is constant year-round. The Production Bioprogram tables for pulses 2, 3, and 4 are located in Appendix B. The production schedule is shown in Figure 2-1. Note that the different colored blocks in the following figure correspond to the months for when each pulse of Rainbow Trout is in either the deep tanks or raceways, along with noting when eggs are retrieved and incubated. All four raceways will be in use December-January, March-April, June-July, and September-October; and these months will have the highest water demand.

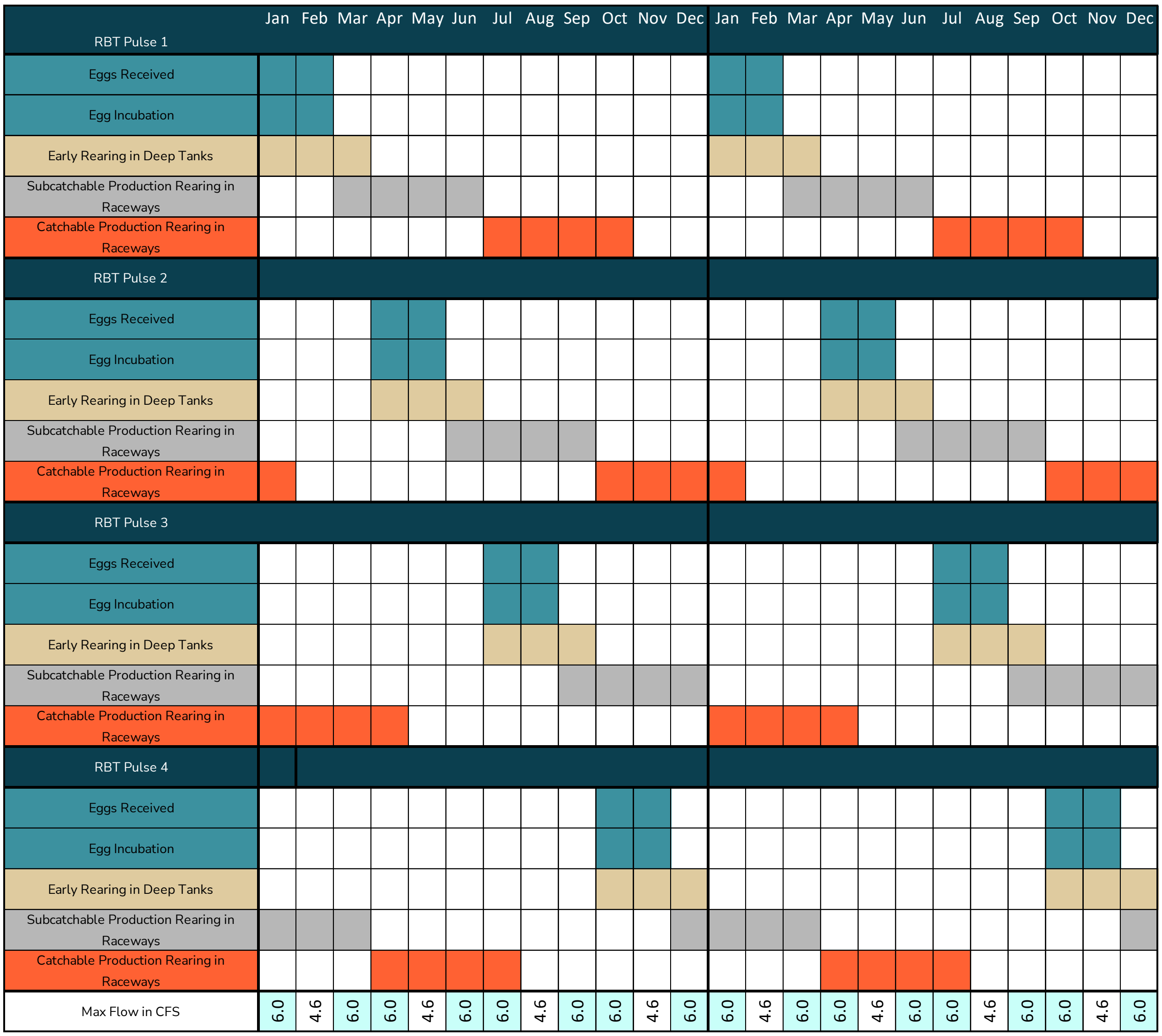

Figure 2-1. Production Rearing Schedule Over 2 Years with Peak Water Demand Re-Occurring with Peak Raceway Use in December-January, March-April, June-July, and September-October (as highlighted in the Max Flow in CFS row).

This staggered production allows for several opportunities to depopulate and clean rearing areas or to provide flexibility in changes to allotments or stocking schedules. This schedule would produce approximately 80,000 sub-catchable fish (10 fpp, 8,000 pounds) and 97,724 catchable fish (2 fpp, 48,862 pounds) annually for a total of 177,724 fish and 56,862 pounds of Rainbow Trout stocked per year. This falls short of the production goal for the facility (325,000 fish and 102,500 pounds). However, the production strategy outlined here maintains production within the recommended DI and FI criteria for the facility and achieves early rearing growth that allows for fish to be vaccinated against Lactococcus in deep tanks as opposed to raceways. There is flexibility within the program to change some sub-catchable allotments to catchable allotments. Excess rearing volume exists in the raceways, but total production is limited by the available water flow. Water demand will be relatively stable throughout the year; the water flow specified at the bottom of Figure 2-1. assumes that all rearing areas in use are supplied with the maximum water flow. In practice, once fish are transferred from early rearing to the raceways, the maximum water flow will not be required. This allows for some additional flexibility of water use throughout the hatchery.

3.0 Climate Evaluation

3.1 Introduction

In this section, climatic and hydrologic projections of conditions at the hatchery are presented for the next 20 years (2024-2043) and the following 20 years (2044-2063). These time horizons are referred to as the near-future period and the mid-century period, respectively. These projections inform the project team of potential needs for adaptive changes. Air temperature projections inform of potentially hazardous working conditions, and water temperature projections inform risks of fish rearing.

3.2 Water Sources

The hatchery's main water source is a well designated "well 356", and secondarily another well designated "well 351". The hatchery staff reports that water from either well has remained at a constant 59°F throughout the year. The hatchery raises Rainbow Trout, which have an optimal temperature range between 50°F and 60°F. Current temperatures are at the upper end of this optimal range, producing high fish growth rates. If extreme air temperatures become higher, or just more common and more prolonged in the future, the increase in water temperature through the facility may become more pronounced, resulting in a more stressful environment for fish rearing. However, the water temperature at the source is not expected to increase, given it has not in the past responded to rising air temperatures, according to hatchery staff observations.

Water from Division Creek was used in the past but is no longer used for fish production due to the presence of New Zealand Mud Snails (NZMS).

3.3 Methodology for Climate Change Evaluation

This study uses future climatic and hydrologic projections based on global climate model (GCM) simulations associated with the data set known as CMIP5, which was part of the fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC 2014). The projections in this report are based on results from 10 different global climate models under the Representative Concentration Pathway (RCP) RCP4.5 scenario of future greenhouse gas emissions, which represents a future with modest reductions in global emissions compared to current levels.

An ensemble of 10 global climate models (GCMs), listed in Table 3-1, is used for capturing a wide range of plausible climate projections. Since this project's future time horizon is limited to 40 years, the dominant source of uncertainty in climate projections is expected to be the natural variability of the earth's climate (and the variability present in every GCM model run), with the second major source of uncertainty being differences between GCMs. Using this ensemble will simultaneously address both uncertainty sources. The selection of 10 GCMs was based on tests of their ability to accurately simulate California climate, following the study of 35 CMIP5 models by (Krantz et al. 2021).

Table 3-1. List of Global Climate Models Used in This Study.

No.	GCM	Research Institution
1	ACCESS-1.0	CSIRO, Australia
2	CanESM2	Canadian Centre for Climate Modelling and Analysis, Canada
3	CCSM4	National Center for Atmospheric Research, United States
4	CESM1-BGC	National Science Foundation, Department of Energy, and National Center for Atmospheric Research, United States
5	CMCC-CMS	Centro Euro Mediterraneo per Cambiamenti Climatici, Italy
6	CNRM-CM5	Centre National de Recherches Météorologiques / Centre Européen de Recherche et Formation Avancées en Calcul Scientifique, France/European Union
7	GFDL-CM3	NOAA Geophysical Fluid Dynamics Laboratory, United States
8	HadGEM2-CC	Met Office Hadley Centre, United Kingdom
9	HadGEM2-ES	Met Office Hadley Centre, United Kingdom
10	MIROC5	Japan Agency for Marine-Earth Science and Technology, Atmosphere and Ocean Research Institute (The University of Tokyo), and National Institute for Environmental Studies, Japan

Hydrologic projections utilize daily timestep results from the Variable Infiltration Capacity (VIC) hydrologic model (Figure 3-1) that was driven by the projected daily climate time series. VIC divides the watershed into grid cells (about 5 km x 7 km in this study) where properties of the soil column and land cover and all major fluxes of water and energy are represented. Soil infiltration capacity is spatially variable within each grid cell, and baseflow is represented as a non-linear function of soil water storage.

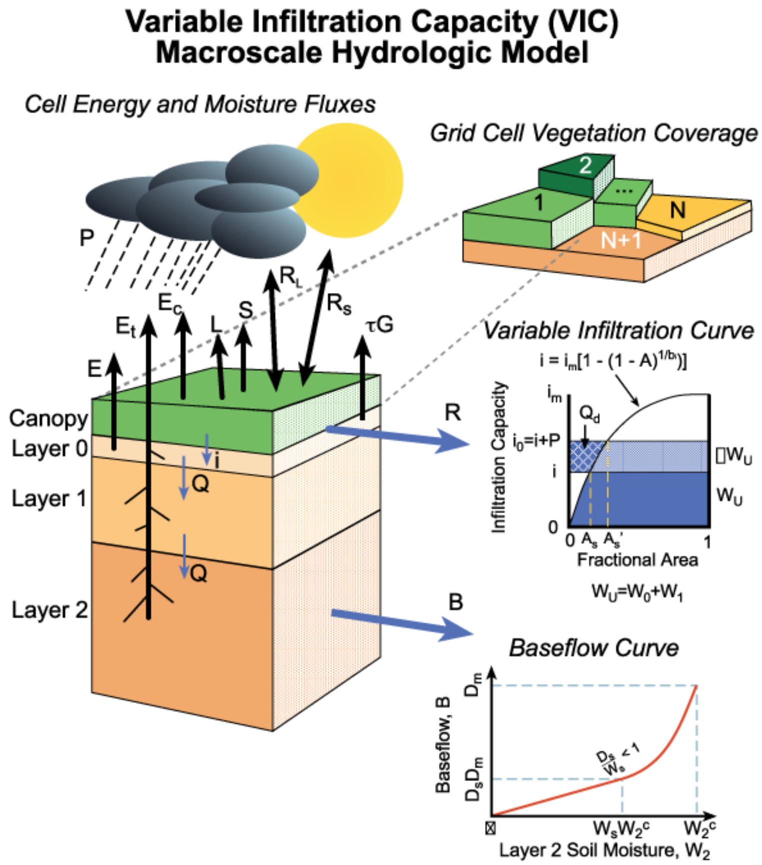

Figure 3-1. The VIC Hydrologic Model (University of Washington Computational Hydrology Group, 2021).

The methodology used for obtaining projections of climate and hydrology is summarized in Figure 3-2. The sections below provide additional detail, as well as a discussion of fire risk:

1. Projections of climatic variables (air temperature and precipitation) were based on simulations by the 10 selected CMIP5 global climate models (GCMs). The GCM projections were statistically downscaled (using different methodologies) by a consortium of research institutions and made publicly available for all of California at a grid cell special resolution of 1/16° x 1/16° (about 5 km x 7 km) (Vano et al., 2020). In this report, the downscaling methodology named “Localized Constructed Analogs” (LOCA) is used. The choice of the LOCA data set was guided by its proven ability to represent extreme values of the downscaled climatic variables (important to this study) and because the hydrologic projections made available by the same research consortium (item 2. below) used the LOCA-downscaled climate projections. The difference between greenhouse gas emissions scenarios is small for a time horizon of 20 years; therefore, it is sufficient to use one greenhouse gas emissions scenario in this study, and the moderate scenario RCP4.5 is used.

2. Projections of daily evapotranspiration and snowpack were obtained from hydrologic projections using the VIC hydrologic model made available by the same research consortium as in item 1. above (Vano et. al., 2020). These publicly available projections were obtained by driving the VIC hydrologic model with projected climatic time series.
3. Projections of wildfire risk at each hatchery site were evaluated at a high level based on the projections by Westerling (2018), which are available through the California government Cal-Adapt.org website (Cal-Adapt, 2023). In addition to the risk that fire poses to the facility, it has the effect of reducing soil permeability, increasing peaks of runoff and stream flows that impact flooding and water quality, and potentially affecting groundwater recharge.

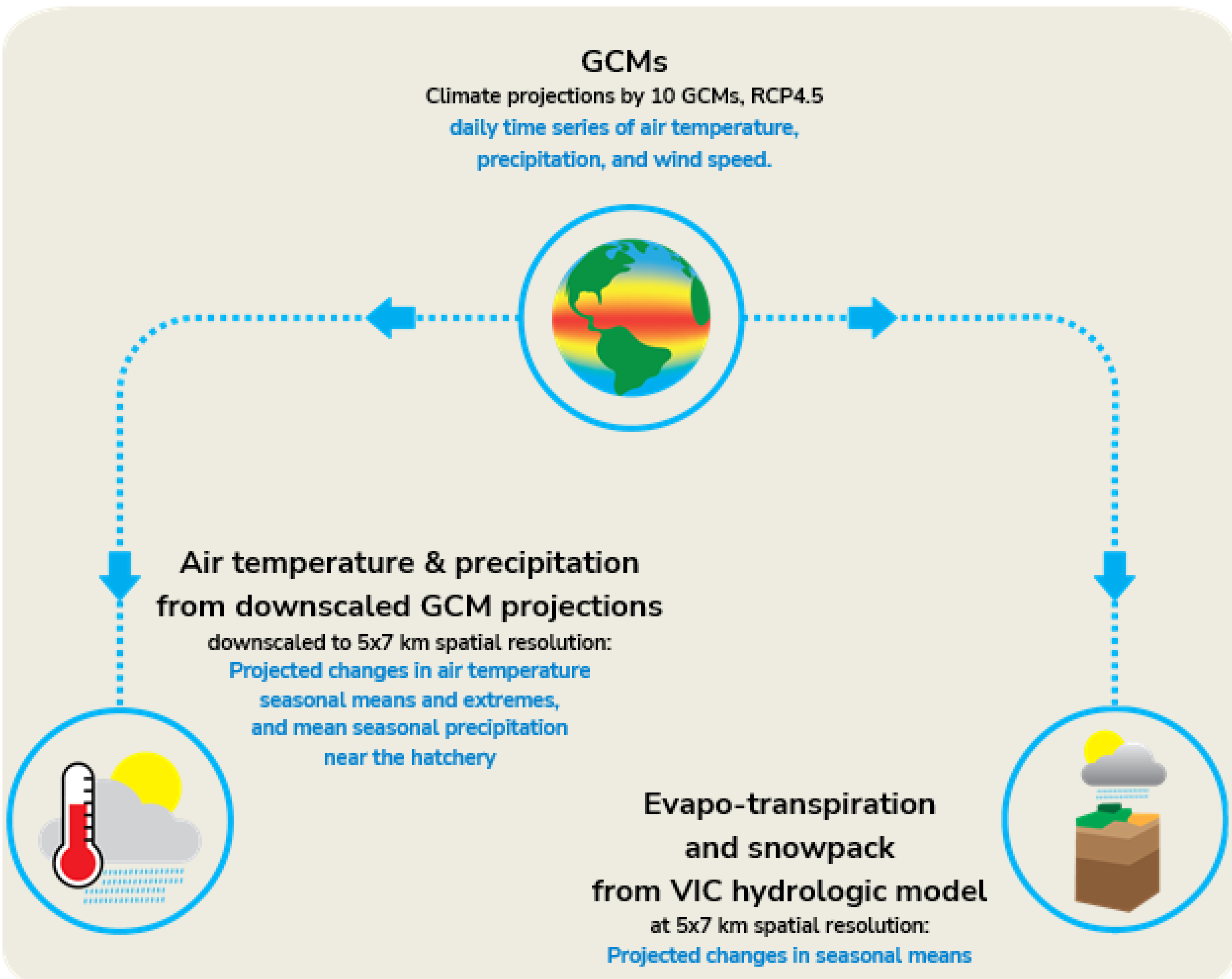

Figure 3-2. Methodology for Obtaining Projections.

3.4 Uncertainty and Limitations

It is important to acknowledge the uncertainty associated with these and any projections of climate and hydrology. While there is a need to provide climate projections for a variety of planning purposes, the underlying projections of climate change are subject to large and unquantifiable uncertainty.

The projections of air temperature, water temperature, precipitation, evapotranspiration, and wildfire risk developed in this work should therefore be considered as plausible representations of the future, given the best current scientific information, and do not represent specific predictions. The actual future realizations of these variables over the areas studied will differ from any of the projections considered here, and their differences compared to historical climate may be greater or smaller than the differences in the projections considered.

3.5 Projected Changes in Climate at the Hatchery Site

3.5.1 Air Temperature

Figure 3-3 displays the simulated mean daily air temperature (solid lines) and its range from minimum to maximum (shaded areas) for each day of the year, at the hatchery site. The near-future time period and the reference period (1984-2003) are represented in red and blue, respectively. All data are simulated by the ensemble of 10 GCMs for each time period. Higher peaks of daily temperature are seen for the near-future compared to the reference period, while the historical period has lower minima.

Table 3-2 and Table 3-3 list the projected mean seasonal air temperature for two future time periods, and the temperature change relative to the reference period. All time horizons, including the reference period, are simulated by the ensemble of 10 GCMs. The lowest and highest of the 10 GCM daily projections define the lower and upper limits of the shaded areas in Figure 3-3, and are given in Table 3-2 and Table 3-3.

Table 3-4 and Table 3-5 list the projected percentiles of highest air temperature in each day (T_{max}) for two future time periods, relative to the reference period. All time horizons, including the reference period, are simulated by the ensemble of 10 GCMs.

At the hatchery site, mean annual air temperature is projected to rise by 2.7°F in the near-future time period compared to the reference period (1984-2003), and by an additional 1.2°F in the mid-century period. The season with the most warming is the summer (Figure 3-3, Table 3-2, and Table 3-3) and the highest temperature rises are projected to occur in the hottest days (Table 3-4 and Table 3-5). Days with maximum daytime temperatures representing the 75th percentile (i.e., the upper quartile of temperatures) are projected to warm by 2.8°F in the next 20 years, relative to the reference period. The 97th percentile of the daytime maximum temperature is projected to rise even more, 3.4°F, reaching 107.6°F. These projected temperatures represent potentially hazardous outdoor working conditions at the hatchery.

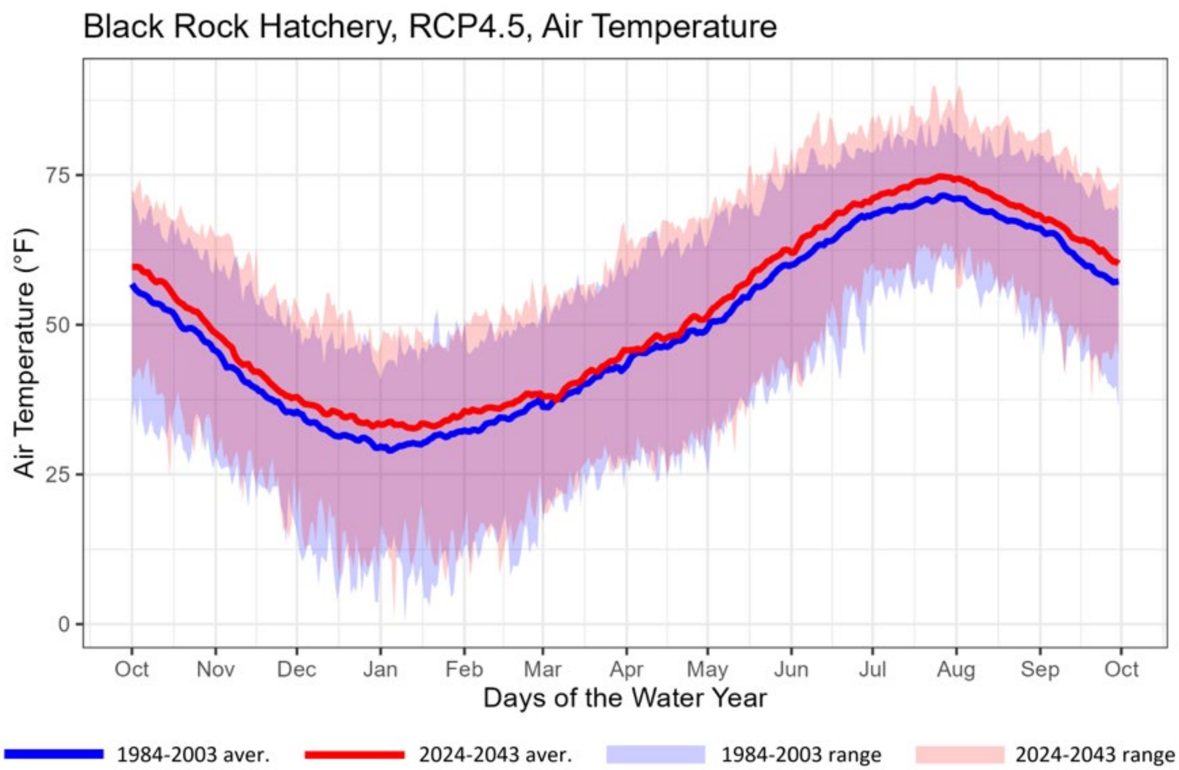

Figure 3-3. Mean Daily Air Temperature and Range for Each Day of the Year at the Hatchery Site.

Table 3-2. Projected GCM 2024-2043 Mean Seasonal Air Temperature at the Hatchery Site (change relative to 1984-2003).

GCM	Annual	Winter (DJF)	Spring (MAM)	Summ. (JJA)	Fall (SON)
Ensemble mean	64.1°F (+2.7°F)	45.9°F (+2.8°F)	61.9°F (+1.8°F)	83.1°F (+3.0°F)	65.1°F (+3.2°F)
Lowest	63.6°F (+2.2°F)	44.7°F (+1.6°F)	61.2°F (+1.1°F)	82.0°F (+1.9°F)	63.7°F (+1.8°F)
Highest	64.7°F (+3.3°F)	46.8°F (+3.7°F)	63.1°F (+3.0°F)	84.6°F (+4.5°F)	65.8°F (+3.9°F)

Table 3-3. Projected GCM 2044-2063 Mean Seasonal Air Temperature at the Hatchery Site (change relative to 1984-2003).

GCM	Annual	Winter (DJF)	Spring (MAM)	Summ. (JJA)	Fall (SON)
Ensemble mean	65.3°F (+3.9°F)	47.1°F (+4.0°F)	63.1°F (+3.0°F)	84.2°F (+4.1°F)	66.2°F (+4.3°F)
Lowest	64.6°F (+3.2°F)	46.7°F (+3.6°F)	62.3°F (+2.2°F)	83.2°F (+3.1°F)	64.5°F (+2.6°F)
Highest	66.2°F (+4.8°F)	47.7°F (+4.6°F)	63.6°F (+3.5°F)	86.0°F (+5.9°F)	67.8°F (+5.9°F)

Table 3-4. Projected GCM 2024-2043 Percentiles of Highest Air Temperature in Each Day (T_{max}) at the Hatchery Site (change relative to 1984-2003).

GCM	3rd perc.	25th perc.	50th perc.	75th perc.	97th perc.
Ensemble mean	48.2°F (+3.0°F)	64.2°F (+2.2°F)	80.0°F (+2.5°F)	96.1°F (+2.8°F)	107.6°F (+3.4°F)
Lowest	47.0°F (+1.8°F)	63.4°F (+1.4°F)	79.2°F (+1.7°F)	95.7°F (+2.4°F)	106.0°F (+1.8°F)
Highest	49.8°F (+4.6°F)	65.1°F (+3.1°F)	80.5°F (+3.0°F)	96.9°F (+3.6°F)	109.2°F (+5.0°F)

Table 3-5. Projected GCM 2044-2063 Percentiles of Highest Air Temperature in Each Day (T_{max}) at the Hatchery Site (change relative to 1984-2003).

GCM	3rd perc.	25th perc.	50th perc.	75th perc.	97th perc.
Ensemble mean	49.6°F (+4.4°F)	65.3°F (+3.3°F)	81.4°F (+3.9°F)	97.3°F (+4.0°F)	108.3°F (+4.1°F)
Lowest	48.6°F (+3.4°F)	64.7°F (+2.7°F)	80.8°F (+3.3°F)	96.6°F (+3.3°F)	107.3°F (+3.1°F)
Highest	50.9°F (+5.7°F)	66.2°F (+4.2°F)	82.2°F (+4.7°F)	98.9°F (+5.6°F)	110.0°F (+5.8°F)

3.5.2 Precipitation Minus Evapotranspiration Over the Watershed

Given the hatchery's reliance on groundwater, the atmospheric water balance given by precipitation (P) minus evapotranspiration (ET), denoted P-ET, is used here as an indicator of direction of change in groundwater recharge. The VIC hydrologic model does not represent aquifers, but it is assumed here that aquifer recharge rates will change in the same direction as the quantity P-ET. It is, however, important to keep in mind that precipitation projections are uncertain due to its large natural variability which includes multi-year periods of above-average and below-average precipitation. Precipitation over California is subject to especially large variability, experiencing large departures from the long-term mean in any given year or multi-year period. This means that natural variability may either reinforce or counteract precipitation changes driven by anthropogenic climate change, and this is true both for the actual future realization of climate and for the climate model simulations, as the models themselves contain such variability. Precipitation projections for the next 20 years vary widely between GCMs largely for this reason. Another limitation of P-ET as an indicator of future direction of groundwater recharge is that snowpack changes can influence recharge rates as well since snowmelt water infiltrates at higher fractions compared to rainfall infiltration.

The VIC grid cell where the hatchery is located, corresponding to a land surface area of about 4,400 sq. miles, was studied for its projected changes in P-ET. The mean annual P-ET is projected to moderately increase, by +6%, in the next 20 years relative to the reference period (Figure 3-4, Table 3-6, and Table 3-7, where all time periods, including the reference period, are simulated by the ensemble of 10 GCMs). Mean annual changes from the near-future period to the mid-century period are small. ET is projected to increase in all seasons except for summer (Table 3-6 and Table 3-7), where it is projected to decrease due to lower snowmelt water availability (Section 3.5.3). Seasonal changes in precipitation are influenced not only by anthropogenic climate change but also natural variability, as previously mentioned.

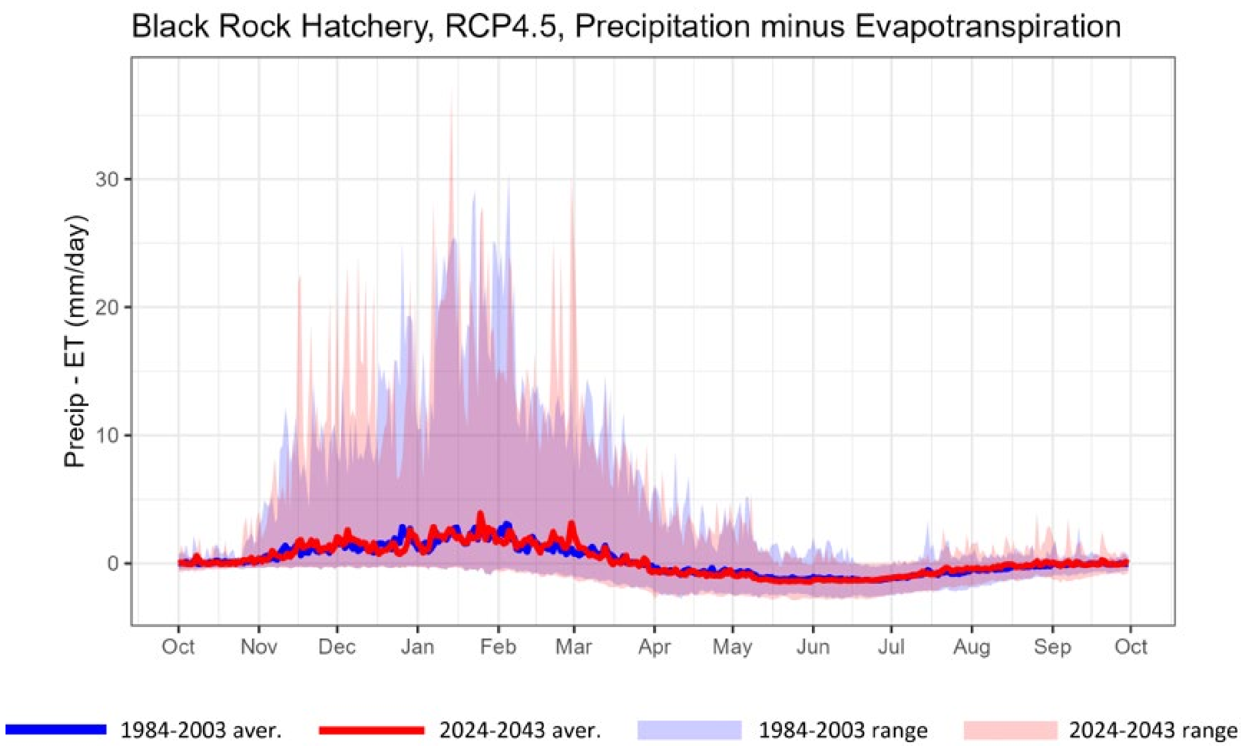

Figure 3-4. Mean Daily Precipitation Minus Evapotranspiration and Range for Each Day of the Year in the Vicinity of the Hatchery.

Table 3-6. Projected GCM 2024-2043 Percent Change in the Seasonal Total Precipitation Minus Evapotranspiration (relative to 1984-2003).

Mean	Annual	Winter (DJF)	Spring (MAM)	Summ. (JJA)	Fall (SON)
Precipitation	+4%	+4%	-3%	+9%	+9%
Evapotransp. (ET)	+3%	+8%	+6%	-4%	+7%
Precip-ET	+6%	+3%	+25%	-8%	+11%

Table 3-7. Projected GCM 2044-2063 Percent Change in the Seasonal Total Precipitation Minus Evapotranspiration (relative to 1984-2003).

Mean	Annual	Winter (DJF)	Spring (MAM)	Summ. (JJA)	Fall (SON)
Precipitation	+3%	+9%	-7%	+12%	-6%
Evapotransp. (ET)	+3%	+15%	+9%	-9%	+1%
Precip-ET	+6%	+7%	+43%	-15%	-12%

3.5.3 Snow Accumulation

Projected changes in snow accumulation in the vicinity of the hatchery are studied here using the VIC hydrologic model results for the grid cell where the hatchery is located, which has a land surface area of about 4,400 sq. miles. Figure 3-5 displays the projected mean daily snowpack (solid lines) and range from minimum to maximum (shaded areas) for each day of the year in the vicinity of the hatchery, for the near future (red) and the reference time period (blue). All data in the figure is simulated by the ensemble of 10 GCMs for both the projected and reference time periods.

The shift from snowfall to rainfall in the cold months will result in diminished snowpack and earlier snowmelt (Figure 3-5) in the future. Reflecting the increase in winter rain-to-snow ratio, the projected 2024-2043 snow accumulation is on average smaller and, given the higher spring and summer temperatures, projected snowmelt occurs about 10 days earlier on average.

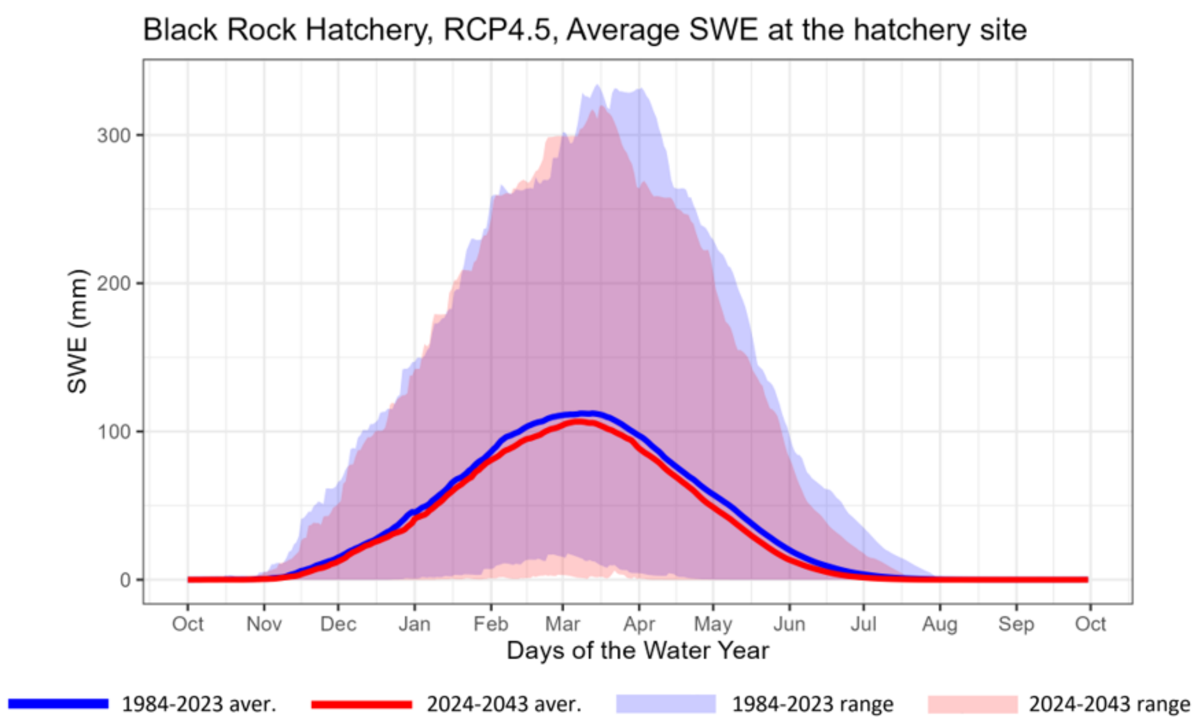

Figure 3-5. Mean Daily Snow Water Equivalent and Range for Each Day of the Year in the Vicinity of the Black Rock Hatchery.

3.5.4 Fire Risk

Historical wildfires have been documented in the surrounding uplands of the Black Rock Hatchery but have not occurred within the past twenty years (Figure 3-6). In 2011, the John

Fire came within less than a mile of the Fish Springs Hatchery with a total area of 5,800 acres. These smaller fires (between 5,000-10,000 acres) occur cyclically in the uplands, but larger fires have not been documented and are assumed to be rare. The surrounding landcover consists of sparse wildfire fuels including a mix of herbaceous and desert shrubland.

Expressing wildfire risk as a percent chance of occurring at least once in a decade, the projected wildfire risk at the hatchery site is less than 5% through mid-century (Figure 3-6). The risk increases to more than 10% in the hills above the hatchery's valley floor.

Fire-related risks to the hatchery are more limited to infrastructure risk than water supply risk, as compared to hatcheries that rely on surface water. Wildfires are expected to have a smaller impact on groundwater supply, which appears to be constant in supply and temperature over time. Fires are rarer in desert shrubland systems, but past fires at Fish Springs Hatchery indicate that proximal fires are possible in the area.

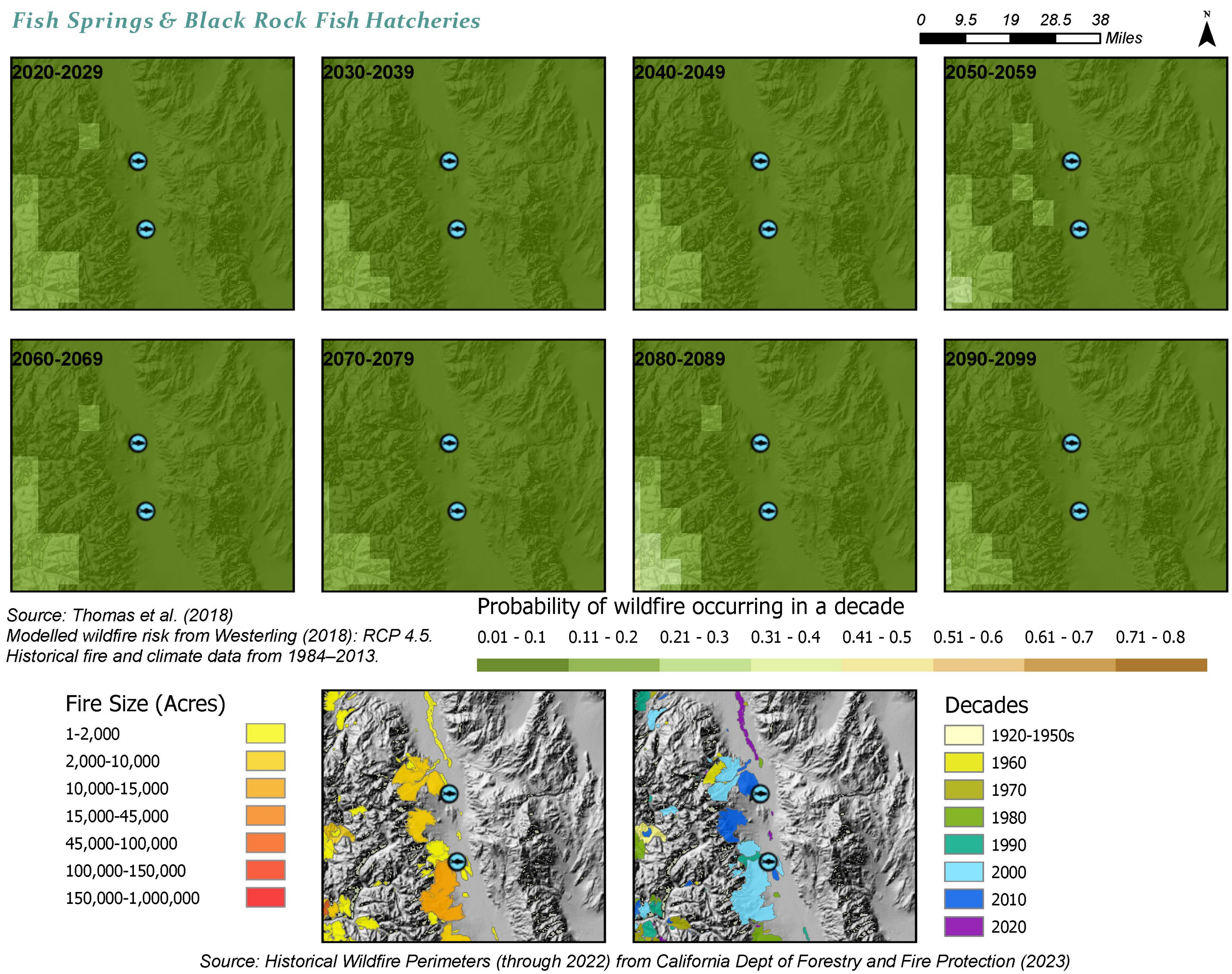

Figure 3-6. Wildfire Risk as Probability of Future Occurrence and Known Historical Fires.

3.6 Conclusions

Significant increases in air temperature are expected for the hatchery location. Mean annual air temperature is projected to rise by 2.7°F in the next 20 years (2024-2043) and by an additional 1.2°F in the mid-century period (2044-2063), compared to the reference period (1984-2003). The summer and fall will experience the most warming, and the largest temperature increases are projected to occur on the hottest days. Days with temperatures representing the 75th percentile and 97th percentile of daily temperatures are projected to warm by 2.8°F and 3.4°F, respectively, in the next 20 years, relative to the reference period, reaching 107.6°F and representing potentially hazardous outdoor working conditions at the hatchery. Such an increase in the peak air daytime temperature requires adaptation measures for the protection of hatchery workers against heat stroke and other health effects of heat exposure. Roads and roofs may also need to be replaced using more heat-resistant and reflective materials.

The hatchery reports that the well water temperature has remained in the narrow range of 59-60°F and has not responded to a rise in air temperature so far. Therefore, atmospheric warming in future may not elevate summer water temperature beyond this range. With shallow groundwater, it is generally the case that mean annual water temperature will increase by the same amount as the increase in mean annual air temperature (projected to be 2.7°F at this location in the next 20 years under scenario RCP4.5), but it appears that in these wells no water temperature rise has been experienced so far.

The future direction of groundwater recharge rates is uncertain, given the strong natural variability of precipitation over California, which includes large departures from the long-term mean not only in individual years but in multi-year periods. The projections studied in this report, based on an ensemble of 10 global climate models selected for their performance over California, indicate an increase in precipitation in a moderate increase in the difference precipitation minus evapotranspiration by 6% annually on average, despite the projected increase in evapotranspiration promoted by higher air temperatures.

The hatchery is at moderate risk of wildfires. There is a history of small fires in the uplands above the valley bottom, but proximal fires have not occurred within the past two decades, which increases the fire risk in the near future. The projected chance of at least one wildfire occurring in a 10-year period at the hatchery site is estimated as less than 5% through mid-century. Local wildfires have come within one mile of Fish Springs Hatchery nearby, indicating that fires are possible even in this desert shrubland.

4.0 Existing Infrastructure Deficiencies

While the Black Rock Hatchery is an operational facility, multiple deficiencies were identified during the site visit and described in Section 4 of the Site Visit Report (Appendix A). Section 5.4 of the Site Visit Report identified potential technologies and solutions available to address specific deficiencies that would allow the hatchery to meet production goals and provide protection against climate change. The main areas of concern for the hatchery included an insufficient generator on Well 356, inadequate settling pond capacities, insufficient early rearing space, lack of filtration and Ultraviolet (UV) Irradiation systems, raceway deterioration, and aging plumbing with insufficient water control valves throughout the facility. Biosecurity deficiencies and potential solutions for addressing these concerns were identified in Sections 3.0 and 3.2 of the Site Visit Report, respectively. These measures include treating all incoming water with filtration and UV disinfection systems and covering the outdoor rearing vessels with a solid roof structure and enclosing the sides. The details of these deficiencies are further expanded upon in Sections 4.1 and 4.2.

4.1 Water Process Infrastructure

4.1.1 LADWP Wells Deficiencies

Currently, there are two wells, Well #356 and Well #351, at the Black Rock Hatchery that supply water at a consistent temperature of 59°F. Well #356 is the main well due to a production rate of 3,819 gpm which is within the Los Angeles Department of Water and Power (LADWP) agreement of 8,000 acre-feet per year. Well #351 has a production rate of 7,916 gpm which makes it difficult to run the well continuously due to exceeding the annual water use agreement with LADWP. It is considered the backup well and requires its components to be resized to meet the LADWP agreement.

4.1.2 Insufficient Effluent Ponds

The existing effluent ponds are currently undersized. Pond 1 used to be a broodstock holding pond, but the presence of NZMS ended fish production there. Now water from Division Creek is used to further dilute effluent from the hatchery before discharging it.

4.1.3 Water Treatment Limitations

The hatchery staff have reported several fish health concerns within the hatchery. This has included L. garvieae, bacterial cold-water disease (causative agent Flavobacterium psychrophilum), bacterial gill disease (primary causative agent F. branchiophilum), Gyrodactylus spp., columnaris disease (causative agent F. columnare), and whirling disease (causative agent Myxobolus cerebralis). There are no water treatment systems to treat incoming water to Black Rock Hatchery except for an aeration tower that provides small increases in dissolved oxygen concentrations. This leaves the facility susceptible to pathogen exposure, increased turbidity, and dissolved oxygen levels below saturation. Without additional water treatment capabilities, the hatchery is also limited as a flow-through facility with no biosecure way to recirculate production water.

4.1.4 Abandoned Division Creek Diversion Structure

There is a pump station on Division Creek which was previously used for production water at Black Rock Hatchery. Due to leakage and the presence of NZMS in Division Creek, the pump station was abandoned. The hatchery now utilizes clean well water for all rearing areas. The plumbing is still connected to Black Rock Hatchery though, providing marginal biosecurity risks associated with NZMS spreading to the hatchery.

4.1.5 Aged Plumbing

The water conveyance piping and valves throughout the hatchery are functioning but should be replaced due to aging and insufficient water control valves. There have not been catastrophic failures of the systems, but there is a need for preventative maintenance to avoid issues in the future.

4.2 Rearing Infrastructure

4.2.1 Insufficient Incubation and Early Rearing Space

There is no existing hatchery building at the Black Rock Hatchery to house indoor incubation and early rearing. Six nursery deep tanks are kept outdoors and utilized for incubation and early rearing. With the current outdoor and uncovered setup, additional eggs are required to meet the hatchery’s production goals because predation and early rearing conditions lead to low survival, even with constant monitoring and effort by hatchery staff.

4.2.2 Raceway Deterioration

The existing concrete raceways are showing signs of surface deterioration. While in overall decent condition, there are signs of surface degradation below the water line, with aggregate exposure being apparent below this level.

4.2.3 Exposure and Predation Issues in Raceways

The raceways are enclosed in chain-link fencing with bird wire strung across the top. However, fish in the raceways still experience predation. In addition to losses associated with predation, predators also increase the risk of spreading pathogens to the fish. Birds and other animals can carry diseases and cause stress in the fish which can result in fish loss. With only bird wire above, the raceways experience direct sunlight during increased temperature periods in the summers. Prolonged exposure to sunlight and UV rays warms the water, can cause sunburn on the fish, and damages the infrastructure. As noted in Section 3.0, air temperatures at Black Rock Hatchery are projected to increase in the future which will only exacerbate these concerns.

5.0 Alternative Selected

5.1 Alternative Description

During the site visit, several deficiencies were identified that currently limit the hatchery's ability to meet fish production goals. These deficiencies have been summarized in Section 4.0 of this report. Appendix E (Alternatives Development TM) provides a discussion of alternative technologies that may be used to address the existing deficiencies and potentially expand production, improve biosecurity, and increase operational efficiencies. The following section presents a summary of the preferred alternative that would best utilize the alternative technologies to respond to the existing deficiencies, maximize fish production, and respond to the climate change projections described in Section 3.0. The conceptual layout of the alternative described below is shown in Appendix C.

5.1.1 Upgrades to LADWP Wells

5.1.1.1 Well #356

Well #356 is the main production well and needs to be upgraded with a new backup propane-powered generator with auto-start capabilities. A propane generator would be an acceptable option for CDFW due to better air quality in the future through the reduction of emissions. Propane is also potentially cheaper than diesel, lowering operational costs. The specific generator would be chosen to meet current air quality standards and sized to meet power needs during temporary outages. With the auto-start feature, the well would provide more reliability. Since both on-site wells are owned by LADWP, all well upgrades will require coordination and approval.

5.1.1.2 Well #351

For Well #351, the selected alternative would be to add a backup propane-powered generator. The specific generator would be chosen to meet air quality standards and sized to meet power needs of the hatchery during temporary outages. In order to reduce pump flow, the well would also require being re-sleeved or a smaller pump would need to be provided. By doing so, Well #351 could become the main production well and hatchery operation has the potential to improve while meeting the facility's 8,000-acre-foot limit on pumping. Since both on-site wells are owned by LADWP, all well upgrades will require coordination and approval.

5.1.2 Rebuild Aeration Tower

The existing aeration tower acts as the headbox and water distribution structure while providing some aeration to the hatchery's production water supply. Replacing the existing aeration tower with a new tower will help the hatchery by providing better quality production water for fish rearing. The new aeration tower would include packed columns or other media. With a new aeration tower, oxygen saturation would improve and provide the potential to increase production.

It is assumed that there would be multiple packed columns and that the water would discharge into a concrete vault head box below. Based on standard packed column design, an average of 100 gpm flow needs 1 square foot of packed column area for proper aeration/stripping. Outdoor-rated exhaust-type blowers would be mounted to the packed columns to pull air up through the packed column media, improving the gas exchange rate from air to water. Once the water is degassed and aerated, it would discharge into the head tank below where it would then be split and conveyed to specific rearing areas throughout the facility.

5.1.3 Decommission Division Creek Diversion Structure

Due to the presence of New Zealand Mud Snails in Division Creek, the diversion structure is recommended to be decommissioned. The pump station itself, all piping and valves connected to the facility, and the existing fish collection structure should be demolished in an effort to minimize biosecurity concerns at the facility. Pond No. 1 is to be dewatered and filled with decommissioning.

5.1.4 Valving and Piping

Various valves and pipes across the hatchery are more than 50 years old. The preferred alternative is to inspect valves and pipes throughout the hatchery and to replace infrastructure that is leaking, not operable, heavily aged/worn, or likely to fail in the near future. Replacing the valves and pipes would allow for better flow control and would allow for the hatchery to continue operating into the future.

5.1.5 New Production Buildings with Solar Panels

The Black Rock Fish Hatchery currently lacks a building for hatching and early rearing; therefore, all fish rearing occurs outdoors with minimal protection from the elements and predators. The preferred alternative is to construct a new enclosed production building to house incubation, early rearing, and intermediate rearing tanks. Final, or grow-out, rearing would occur in an open-sided building with chain-link fencing and predator netting on the sides. Intermediate and final rearing would occur in circular tanks operating as partial recirculating aquaculture systems (PRASs). Both the enclosed and open-sided production spaces would be pre-engineered metal building (PEMB) with standard, easy to clean finishes. Each production area in the enclosed building would have a dedicated HVAC system to maintain temperature and humidity, as well as lighting controls to aid production as needed. The open-sided building would have HVAC systems for enclosed sections that house PRAS equipment. Additionally, all new buildings would include photovoltaic systems on the roof to offset power requirements of the proposed hatchery infrastructure while decreasing operating costs.

The proposed production spaces were assessed under two different conditions:

- Maintaining current production, under the assumption that Rainbow Trout eggs are available throughout the year.
- Using all available 10 cfs of water supplied to the hatchery through LADWP's wells, while providing a ~0.5 cfs buffer.

It is important to note that the proposed upgrades include PRASs for production. PRASs require specific processes to maintain optimal rearing conditions for the fish including solids removal, gas stripping, oxygenation, and disinfection. For this report, oxygen is assumed to be sourced from on-site oxygen generation as opposed to bulk liquid oxygen (LOX) deliveries. During advanced design phases, LOX availability will be evaluated and compared to oxygen generation in a cost-benefit analysis.

There is a range of operational techniques for PRASs based on the flow rates used. The recirculation rate and hydraulic residence time (HRT) of each tank affects the water consumption. Heavy densities and feed rates may require lower recirculation rates and HRTs to maintain optimal rearing conditions within the tanks, ultimately increasing water consumption. Without a biofilter, the maximum recommended recirculation rate is 75%. The maximum recommended HRT is 45 minutes, or 1.5 water exchanges per hour in each tank for 20-foot-diameter tanks; the maximum recommended HRT for smaller tanks is 30 minutes (2 complete water exchanges per hour). To estimate maximum production using all available 10 cfs of water supply, it is assumed that all tanks are in operation simultaneously and that any PRAS uses a 75% recirculation rate. In practice, it will likely take several years for staff to gain the operational knowledge and skills required to consistently run the PRASs at these levels. More detailed modeling of exact timing of egg arrivals, growth rates, stocking efforts, and overall production cycles would occur at advanced design stages to determine a more accurate production plan and water budget.

5.1.5.1 Maintain Current Production

This alternative includes an approximately 17,700 SF production building to house incubation, early, and intermediate rearing tanks. Final rearing tanks will be housed under an approximately 22,100 SF open-sided building with chain-link fencing and predator netting on the sides. The calculations for the proposed tanks were based on utilizing four individual groups of fish (i.e., pulses) staggered throughout the year to minimize the infrastructure requirements while maintaining the current production goals of the hatchery.

Incubation and Early Rearing

The hatchery currently utilizes egg jars for incubation which are plumbed directly into deep tanks. If desired, this practice can continue based on the proposed tanks for early rearing. The production building may house 8 Heath incubator double stacks (i.e., 16 trays total) to expand early incubation capability. Eight Heath incubator double stacks would operate at approximately 40 gpm (i.e., 5 gpm per stack). The new hatchery building will include 24 deep tanks using the same tank dimensions the hatchery is currently using (i.e., 16-ft length, 2.58-ft width, and 1.33-ft depth). The deep tanks will be operated on single pass well water at a rate of 25 gpm per tank for a total flow requirement of 600 gpm. The entire deep tank system will have capacity for approximately 138,749 (925 pounds) Rainbow Trout grown to a size of 150 fpp (2.6 inches) while maintaining a DI below 0.3 and an FI below 1.5. Rearing the fish to 150 fpp in the deep tanks allows hatchery staff to administer the Lactococcus spp. vaccination bath before the fish are transferred into the intermediate rearing tanks.

Intermediate Rearing

After early rearing in the deep tanks, fish would be transferred into intermediate circular rearing tanks operating as a PRAS. A total of twenty-four, 12-foot diameter circular tanks with an operating depth of 4 feet would provide approximately 10,857 ft^3 of rearing space. The system would be intended to grow fish to a sub-catchable size of 10 fpp (6.3 inches); the total capacity of the system would be approximately 184,683 fish (18,468 pounds) while maintaining a DI below 0.3.

The tanks would be configured into three individual PRAS modules with eight tanks per module. Assuming tanks are operating at a recirculation rate of 75% with an HRT of 30 minutes, the fresh make-up water demand for the system is approximately 720 gpm (1.6 cfs). Each PRAS module would have a new microscreen drum filter, CO_2 removal, LHO, and UV disinfection. Appendix E (Alternatives Development TM) provides detailed information on the equipment components required for each PRAS module. At this rate of reuse, a biofilter would not be required.

Final Rearing

The standard size of larger dual-drain circular tanks is a 20-foot diameter tank. A total of sixteen, 20-foot diameter circular tanks with an operating depth of 6 feet would provide approximately 30,159 ft^3 of rearing volume. The system would have the capacity to hold approximately 175,888 fish (87,944 pounds) at the target catchable size of 2 fpp (10.8 inches) while maintaining a DI below 0.3.

The tanks would be configured into four individual PRAS modules with four tanks per module. Assuming tanks are operating at a recirculation rate of 75% with an HRT of 45 minutes, the fresh make-up water demand for the system is approximately 1,280 gpm (2.9 cfs). Each PRAS module would have a new microscreen drum filter, CO_2 removal, LHO, and UV disinfection. Appendix E (Alternatives Development TM) provides detailed information on the equipment components required for each PRAS module. At this rate of reuse, a biofilter would not be required.

PRASs for the Black Rock Hatchery can reduce water demand and improve water quality within the rearing environment. This alternative is meant to show how production could be maintained, assuming that Rainbow Trout eggs are available regularly throughout the year. The existing raceways could be kept as additional rearing space for use in emergencies, backup rearing space, or additional production for future CDFW expansion. Dual-drain circular tanks provide a completely mixed environment as opposed to a raceway that has a gradient of high to low dissolved oxygen (DO) along its length. This characteristic of circular tanks makes the entire volume available to the fish, as opposed to fish crowding at a raceway's head end, and thereby not using the entire raceway volume. Other benefits include self-cleaning of fish waste, concentration of fish waste in a small center drain flow that can be treated continuously, and capacity for providing exercise velocities. Enclosing the tanks within a building will also reduce heat gain and improve biosecurity.

Table 5-1. Maintained Production Scenario - Water Demand and Capacity Information.

Characteristics	Early Rearing	Intermediate	Final
Tank Type/Dimensions	Deep Tanks (16' x 2.58' x 1.33')	Circular (12' diameter, 4' depth)	Circular (20' diameter, 6' depth)
Volume Per Rearing Vessel (ft^3)	54.9	452.4 ft^3	1,885 ft^3
Fish Size at Transfer	150 fpp at 2.6 inches	10 fpp at 6.3 inches	2 fpp at 10.8 inches
Max Number of Fish in System (DI < 0.3)	138,749[a]	184,683[b]	175,888[b]
Number of Rearing Vessels	24	24	16
Total Volume (ft^3)	1,317.6 ft^3	10,857 ft^3	30,159 ft^3
Total Water Usage (gpm)	600[c] (Flow Through)	720 (HRT = 30 minutes, 75% Reuse Rate)	1,300 (HRT = 45 minutes, 75% Reuse Rate)

Note: Minimum Fresh Make-up Water Demand: 2,620 gpm (5.84 cfs)

[a] Represents the total number of fish for 1 pulse of fish.

[b] Represents the number of fish for two pulses of fish, since rearing at this life stage overlaps requiring additional tanks.

[c] Heath Incubation (8 stacks) are not included in the table for water usage. At 5 gpm/stack, a minimum of 40 gpm would be required.

5.1.5.2 Maximize Production with Available Water Supply

This scenario requires an approximately 31,700 SF building for incubation, early, and intermediate rearing tanks. Final rearing tanks will be housed under an approximately 33,300 SF open-sided building with chain-link fencing and predator netting on the sides. The number of tanks was determined by the fresh make-up water demand of all tanks and the total available water supply of 10 cfs. The alternative assumes that all rearing areas would operate simultaneously because new production cycles occur throughout the year based on the continuous availability of Rainbow Trout eggs.

Incubation and Early Rearing

The hatchery currently utilizes egg jars for incubation which are plumbed directly into deep tanks. If desired, this practice can continue based on the proposed tanks for early rearing. The production building may house 14 Heath incubator double stacks (i.e., 16 trays total) to expand early incubation capability. Fourteen Heath incubator double stacks would operate on approximately 70 gpm (i.e., 5 gpm per stack). This production scenario would include 40 deep tanks that have the same dimensions as the tanks currently in use. The total early rearing volume would be approximately 2,195 ft^3. Assuming a flow rate of 25 gpm per tank, the early rearing system would have a total flow demand of 1,000 gpm (2.2 cfs). The tanks and projected flow rates are enough to accommodate approximately 231,248 fish (1,541 pounds) to a size of 150 fpp (2.6 inches) while maintaining a DI below 0.3 and an FI below 1.5. This will allow staff to perform vaccinations in the deep tanks before fish are transferred to the intermediate system.

Intermediate Rearing

To maximize water use, 40 intermediate tanks are proposed; each tank would be 12-foot in diameter and have an operating water depth of 4 feet (~452 ft^3 per tank). The total rearing volume would be approximately 18,095 ft^3, the system would be used to grow fish to a sub-catchable size of 10 fpp (6.3 inches). The total production capacity of the system would be approximately 307,805 fish (30,780 pounds) while maintaining a DI below 0.3. Assuming a 75% recirculation rate and an HRT of 30 minutes, the fresh make-up water demand for the system is approximately 1,200 gpm (2.7 cfs).

Final Rearing

For final grow-out rearing, 24 tanks are proposed; each tank would be 20-foot in diameter and have an operating water depth of 6 feet (~1,885 ft^3). The total rearing volume of the system would be approximately 45,240 ft^3. The target size before fish release is 2 fpp (10.8 inches); the production capacity of this system would hold approximately 263,833 fish (131,916 pounds) while maintaining a DI below 0.3. Assuming a 75% recirculation rate and an HRT of 45 minutes, the fresh make-up water demand for the system is approximately 1,920 gpm (4.3 cfs).

This alternative scenario would not provide any remaining fresh incoming water flow to the remaining raceways. All incoming water would be directed to PRAS module except for egg incubation and early rearing which would be run as flow-through systems. This scenario models the use of approximately 9.18 cfs of fresh make-up water (Table 5-2) out of the 10 cfs available at the Black Rock Hatchery. The operations assume an HRT of 45 minutes for 20-foot-diameter tanks and a recirculation rate of 75% for all PRAS modules. The remaining ~0.8 cfs provides some flexibility to adjust operations as needed.

Table 5-2. Maximized Production Scenario Water Demand and Capacity Information.

Characteristics	Early Rearing	Intermediate	Final
Tank Type/Dimensions	Deep Tanks (16' x 2.58' x 1.33')	Circular (12' diameter, 4' depth)	Circular (20' diameter, 6' depth)
Volume Per Rearing Vessel (ft^3)	54.9 ft^3	452.4 ft^3	1,885 ft^3
Fish Size at Transfer	150 fpp at 2.6 inches	10 fpp at 6.3 inches	2 fpp at 10.8 inches

Characteristics	Early Rearing	Intermediate	Final
Max Number of Fish in System (DI < 0.3)	231,248 (1,541 lbs)	307,805 (30,780 lbs)	263,833 (131,916 lbs)
Number of Rearing Vessels	40	40	24
Total Volume (ft^3)	2,196.1 ft^3	18,095.6 ft^3	45,238.9 ft^3
Total Water Usage (gpm)	1,000[a] (Flow Through)	1,200 (HRT = 30 minutes, 75% Reuse Rate)	1,920 (HRT = 45 minutes, 75% Reuse Rate)

Note: Total Fresh Make-up Water Demand: 4,120 gpm (9.18 cfs)

a Heath Incubation (8 stacks) are not included in the table for water usage. At 5 gpm/stack, a minimum of 40 gpm would be required.

5.1.6 Concrete Raceway Improvements

5.1.6.1 Skim Coating and Epoxy Coating

The concrete raceways have aged and deteriorated over time resulting in pitting, roughness, and cracking. The rough and cracked concrete surfaces are not ideal for fish rearing as the surfaces can irritate fish when they contact the walls, and cracks and spalling are difficult to keep clean and disinfect. Adding a coating to the concrete can help alleviate the present issues and reduce the rate at which the concrete surface deteriorates. Raceway coatings are typically epoxy, polyurethane, or mortar based, but they all serve the same general purpose. Prior to coating the raceways, they must be emptied, cleaned, and completely dried. Additionally, any large cracks in the existing concrete will need to be fixed prior to coating. After applying, the coating will need to cure which can take anywhere from 1-14 days depending on the manufacturer's instructions and base component of the coat. Depending on factors such as weather and sun exposure, raceway coatings can last anywhere from 5-15 years. Applying a coat to the concrete creates a surface which is easier to clean, does not promote algae growth, and reduces sun and water exposure to the aging concrete underneath.

5.1.6.2 Cover Raceways with Permanent Roof Structure with Solar Panels

Covering the raceways with a solid roof structure and enclosing the sides (e.g., fine mesh chicken wire) to eliminate access to predators, ducks, etc. would improve biosecurity. The solid roof structure would also reduce the warming effects of the hot summer sun as the water passes through the 500-foot-long raceways. As mean and maximum ambient air temperatures continue to rise in the future, reducing the solar effects on water temperature in the hatchery will be critical to maintain temperatures within the range for salmonids.

A new photovoltaic power generation system would be included atop the raceway cover structure to help offset the power requirements of the new hatchery infrastructure while also lowering the overall cost of operating the hatchery.

5.1.7 Dredge Existing Effluent Ponds

Dredging the ponds to their original capacities would increase the overall life of the effluent treatment system at Black Rock Hatchery and ensure proper effluent treatment volumes are available. The amount of dilution provided prior to discharge would increase. The pond will also be cleared of overgrown brush and algae to allow discharge flows to efficiently flow away from the hatchery and reduce the risk of water backups.

5.2 Pros/Cons of Selected Alternative

Table 5-3 provides a high-level summary of the pros and cons for Black Rock Hatchery's selected alternative.

Table 5-3. Pros/Cons of Selected Alternative – Black Rock Hatchery.

Description	Pros	Cons
Upgrade the LADWP wells.	• Improves exhaust emissions. • Provides more reliability. • Improves hatchery operation to meet pumping requirements of 8000-acre-feet maximum.	• Increases costs due to generators and well re-sleeving/pump. • Requires coordination with LADWP.
Rebuild aeration tower.	• Increases the efficiency of the water distribution structure. • Improves dissolved oxygen saturation. • Potentially increases production.	• Increases cost due to redesign and installation. • Disrupts hatchery operations during construction.
Decommission Division Creek's diversion structure.	• Improves biosecurity from NZMS in Division Creek. • Provides additional space for proposed production buildings due to dewatering of Pond No. 1.	• Removes backup water supply in case of emergency with well water supply.
Upgrade defective valving and piping.	• Improves operability and control of flow. • Increases in hatchery infrastructure lifespan.	• Increases cost due to installation. • Disrupts hatchery operations during construction.

Description	Pros	Cons
Construct a new production building with solar panels.	• Provides protection with an indoor environment from predation and other outdoor elements (e.g., sunlight) with improved biosecurity. • Offsets expensive energy requirements due to solar panels.	• Increases cost due to installation and operation.
Add PRAS circular tanks for final rearing.	• Provides improved water quality and biosecurity within rearing vessels. • Provides improved flow control. • Provides a healthier rearing environment for fish. • Reduces total water required and provides flexibility. • Provides self-cleaning. • Concentrates waste for effluent treatment to meet NPDES permit.	• Increases cost due to system installation. • Requires additional training for staff. • Increases pumping needs to operate PRAS. • Requires additional components (e.g., drum screen, UV, LHO, CO2 removal). • Increases complexity.
Construct a new hatchery building with solar panels.	• Provides protection with an indoor environment from predation and other outdoor elements (e.g., sunlight) with improved biosecurity. • Allows young fish to be reared to a larger size before transferring into larger tanks with an increased number of tanks available. • Allows fish to be vaccinated prior to transfer to larger, outdoor rearing vessels. • Offsets expensive energy requirements due to solar panels.	• Increases cost due to installation and operation.

Description	Pros	Cons
Add PRAS circular tanks for intermediate rearing.	• Increases production flexibility at early life stages and throughout the lifecycle. • Requires no staff training for early rearing because staff are familiar with the process. • Provides improved water quality and biosecurity within rearing vessels. • Provides improved flow control. • Provides a healthier rearing environment for fish. • Provides self-cleaning. • Concentrates waste for effluent treatment to meet NPDES permit. • Provides an easy opportunity for staff to administer bath vaccination for Lactococcus prior to fish being moved to intermediate rearing tanks. • Allows fish to be reared in intermediate rearing tanks to a larger size (10 fpp max) with minimal water requirements (i.e., 720 gpm).	• Increases water requirements for early rearing. • Requires additional training for staff to operate intermediate PRASs. • Increases pumping needs to operate intermediate PRAS. • Requires additional components (e.g., drum screen, UV, LHO, CO2 removal). • Increases complexity.
Improve the concrete raceways.	• Provides a smoother rearing environment, reduces algae growth, and protects concrete from further deterioration due to resurfacing the raceways. • Reduces the warming of water during recirculation and reduces predation due to the cover structure. • Offsets expensive energy requirements due to solar panels installation.	• Disrupts hatchery operations during raceway resurfacing.

Description	Pros	Cons
Dredge existing effluent ponds.	• Increases effluent treatment volume.	• Disrupts effluent treatment and hatchery operation during dredging.

5.3 Alternatives for Short-Term Improvements

In the event that funding is not available to construct the preferred alternative, the following short-term improvements are recommended for continued hatchery operation.

5.3.1 Concrete Raceway Improvements

5.3.1.1 Cover Raceways with Permanent Roof Structure with Solar Panels

Covering the raceways with a solid roof structure and enclosing the sides (e.g., fine mesh chicken wire) to eliminate access to predators, ducks, etc. would improve biosecurity. The solid roof structure would also reduce the warming effects of the hot summer sun as the water passes through the 500-foot-long raceways. As mean and maximum ambient air temperatures continue to rise in the future, reducing the solar effects on water temperature in the hatchery will be critical to maintain temperatures within the range for salmonids.

A new photovoltaic power generation system would be included atop the raceway cover structure to help offset the power requirements of the new hatchery infrastructure while also lowering the overall cost of operating the hatchery.

5.3.1.2 Refurbish Concrete Raceways

The concrete in the raceways is showing signs of aging. The abrasive surface caused by aging can be harmful to fish as well as a surface that promotes algae growth. Adding a coating to the concrete can help alleviate the present issue and reduce the rate at which the concrete surface deteriorates. Raceway coatings are typically epoxy, polyurethane, or mortar based, but they all serve the same general purpose. Prior to coating the raceways, they must be emptied, cleaned, and completely dried. Additionally, any large cracks in the existing concrete will need to be fixed prior to coating. After applying, the coating will need to cure which can take anywhere from 1-14 days depending on the manufacturer's instructions and base component of the coat. Depending on factors such as weather and sun exposure, raceway coatings can last anywhere from 5 to 15 years. Applying a coat to the concrete creates a surface which is easier to clean, provides for a smoother rearing environment, improves solids movement to the tail end of the raceways, does not promote algae growth, reduces sun and water exposure to the aging concrete underneath, and protects the tanks from further deterioration.

5.3.2 Rebuild Aeration Tower

The existing aeration tower acts as the headbox and water distribution structure while providing some aeration to the hatchery's production water supply. Replacing the existing aeration tower with a new tower will help the hatchery overall by providing better quality production water for fish rearing. The new aeration tower would include packed columns or other media. With a new aeration tower, oxygen saturation would improve and the potential to increase production. See Section 5.1.2 for more details about this alternative.

5.3.3 Decommission Division Creek Diversion Structure

Due to the presence of New Zealand Mud Snails in Division Creek, the diversion structure is recommended to be decommissioned. The pump station itself and all piping and valves connected to the facility should be demolished in an effort to minimize biosecurity concerns at the facility.

5.4 Natural Environment Impacts

The proposed upgrades to the Black Rock Hatchery should have negligible impacts on the natural resources in the surrounding area. All improvements would occur within currently developed areas, avoiding requirements for additional environmental or cultural permits not identified in Section 7.0. An exception may occur if any existing structures fall under the jurisdiction of California's Office of Historic Preservation (OHP).

5.4.1 Fire and Flood Risk

The recommended upgrades to Black Rock Hatchery will change the existing infrastructure and the number of rigid structures on site. However, they will not increase or decrease the fire risk. Based on the climate change evaluation, the projected fire risk is moderate through mid-century. Historic wildfires nearby indicate that fires are possible even in this desert shrubland.

The recommended changes will increase the total impervious surface on the site but decrease the impact of flooding on the facility. This is primarily done by changing the type of rearing vessel from concrete raceways to fiberglass circular tanks. Installing circular tanks for intermediate and final rearing will provide additional flood protection. The tanks will be placed with the tank tops located 30 to 36 inches above ground. The tank height will provide protection from overland flow entering fish rearing vessels, and the ground will be graded to carry water away from the tanks to the extent feasible.

Additionally, replacing the valves and piping will provide the hatchery with better flow control of the facility. The hatchery staff will be able to manage surges in flow and prevent flooding of the rearing vessels.

5.4.2 Effluent Discharge

The recommended changes to maintain production at the hatchery do not include an overall increase in production goals at Black Rock Hatchery. This will ensure there will be no change to the NPDES permit requirements. If improvements to increase and maximize production are implemented, the NPDES permit may need to be reevaluated to maintain compliance. However, the recommended alternatives will likely improve the function of the effluent treatment system. The hatchery meets current NPDES permit requirements, but dredging the effluent ponds will increase the retention time of discharge water. The increased retention time will result in more solids dropping out of suspension, improving the effluent quality, and reducing overall impacts of the hatchery.

It is important to note that changes to existing aquaculture facilities may trigger (administratively) the requirement for new and/or updated NPDES permits. Acknowledging that waste loads are not anticipated to change with the proposed alternatives, we assume that the increase in effluent removal efficiencies provided by the upgrades will result in a net positive effect on the hatchery's discharge.

5.5 Hatchery Operational Impacts/Husbandry

Multiple groups (pulses) of Rainbow Trout will be produced starting at different times throughout the year to maximize production capability at the hatchery. Early rearing fish culture practices will continue as the hatchery has operated previously with single pass flow-through in the deep tanks with the important distinction of moving early rearing to an indoor space. As the fish outgrow the deep tanks, they will be transferred into the intermediate rearing PRAS circular tanks. A small fish pump (e.g., 2.5-inch hose diameter) would minimize handling and stress on the fish as they are transferred. If enumeration of the fish is desired, a fish counter may be utilized in conjunction with the fish pump. Linear distances from origin to destination rearing tanks may limit how fish can be transferred throughout the hatchery. Once the fish are in the final rearing PRAS circular tanks, the fish will be grown to their target release size at which time they will maximize the biomass and DI capacity of the system. Truck loading for fish release will basically continue as the hatchery has operated in the past utilizing fish pumps and dewatering towers with a few minor adjustments unique to circular tanks relative to traditional raceways.

One of the benefits of this proposed design is to provide the means for staff to maintain fish health and welfare. The intermediate rearing tanks enable the hatchery to raise young fish to a larger size to allow for vaccinations (i.e., lactococcosis) or administer chemical treatments as needed (e.g., external parasites) in a more controlled environment. The hatchery can continue to use their current methods for treatments as needed.

5.5.1 PRAS Circular Tank Operations

The intermediate and final rearing tanks will operate as PRASs, reusing up to 75% of their water flow. The hydraulic self-cleaning characteristics of the circular tanks will reduce labor associated with tank cleaning. Additional tank sweeper systems are also available and can further reduce staff labor associated with maintaining tank hygiene. Staff time will be required for monitoring PRAS components including routine water quality checks, flow adjustments, and monitoring LHO and CO_2 systems to ensure a high-quality rearing environment. Staff will make routine flow adjustments as fish grow to maintain a maximum velocity of approximately two body lengths/second (or as required for fisheries management objectives). Seine nets, clamshell crowders, or other crowder types can be used to concentrate fish for collection and handling.

Transfer of fish between tanks and for truck loading will utilize fish pumps and hosing to minimize handling and stress on the fish and decrease physical labor for staff transferring fish between tanks or loading trucks. For transferring fish into other rearing tanks requiring enumeration, a fish counter can be included at the receiving tank to obtain an accurate inventory of the fish. For fish being loaded onto a transport tanker for stocking, a dewatering tower will allow for the removal of the water through a screen prior to the fish entering the fish transport tanker. This is consistent with current hatchery practices as well as industry standards and practices and allows the hatchery to quantify fish biomass based on water displacement in the fish transport tanker. The return of the water from the dewatering tower to the PRAS module sump will be necessary to maintain the water balance within the PRAS module. Another option is to increase the fresh make-up water flow to compensate for this water loss in the module during the fish pumping process.

5.5.2 PRAS Equipment

The PRAS provides tremendous benefits in reducing the water flow requirements to produce large numbers/biomass of fish while maximizing water quality. However, these systems are more complex and require additional skillsets to monitor and maintain the equipment to ensure reliable system operations for successful fish production. Given the staggered production cycle using multiple groups of Rainbow Trout, the PRAS modules will not all be occupied at the same time, providing maintenance windows and opportunities for cleaning and disinfection. All

PRASs should be programmed into the facility's maintenance and management system to schedule, perform, and document preventative and corrective maintenance.

5.5.3 Feeding

Early rearing feeding techniques in the deep tanks can continue using the hatchery's standard feeding practices. Hatchery staff will need to transition away from the blower-style feeding systems typically used for linear raceways to a feeding system designed for circular tanks. Fish can be fed in circular tanks utilizing the simplest of methods ranging from hand-feeding to automated systems and the techniques may vary depending on the size of the circular tanks and staff preferences. In addition to staff preferences, there are pros and cons associated with the various feeding options. Hand-feeding requires more staff time compared to automated feeding systems as it is labor intensive but allows staff to observe fish feeding and overall behavior and health. Hand-feeding allows the staff to feed the fish to satiation and minimizes overfeeding by reducing wasted feed and maximizing water quality. Automated systems require an initial cost for the purchase and installation of the system. The automated feeding systems provide feed intermittently throughout the day including staff non-duty times to maximize growth and reduce staff labor. However, automatic feeding systems reduce the staff's observations during feeding, require adjustments to deliver the correct amount of feed, require preventative and corrective maintenance, and continued costs associated with these maintenance requirements. It should be noted that hand and automatic feeding systems are not mutually exclusive. Even with automatic feeding systems, culture operations should still involve regular monitoring of fish and their feeding response throughout the day.

5.6 Biosecurity

The goal of biosecurity measures is to minimize the risk of pathogens entering the facility and spreading between rearing areas at the facility. Black Rock Hatchery reported several pathogens of concern at the facility. This included Lactococcus spp., bacterial coldwater disease (causative agent Flavobacterium psychrophilum), bacterial gill disease (causative agent F. branchiophilum), Gyrodactylus spp., columnaris disease (causative agent F. columnare and other Flavobacterium spp.), and whirling disease (causative agent Myxobolus cerebralis). The most likely pathway for pathogens to enter Black Rock Hatchery and spread through the facility is through environmental exposure within the hatchery.

5.6.1 Incoming Water Supply

Black Rock Hatchery relies exclusively on groundwater sources for its water supply. Groundwater is typically the preferred source because of the low risk of pathogens and stable temperature. Historically, the hatchery used Division Creek, a surface water source, for some fish production. The Division Creek water source was abandoned once NZMS were discovered in the water.

The recommended alternatives improve biosecurity by removing the potential for NZMS to enter the facility from Division Creek. Decommissioning the Division Creek diversion structure improves biosecurity by preventing the NZMS present in Division Creek from entering rearing vessels and spreading throughout the facility. Replacing outdated valves and piping will also improve the hatchery's ability to control the flow and reduce potential debris loads entering the rearing vessels. Additionally, replacing the aeration tower will provide increased dissolved oxygen saturation in production water.

5.6.2 Environmental Exposure/Bio Vectors

The existing facility has a few areas that are potential pathways for pathogens due to environmental exposure. The existing concrete raceways are enclosed by perimeter fencing with bird wires overtop, but these structures have been minimally effective in excluding mammalian and avian predators from the raceways. The recommended alternatives reduce the risk of pathogens entering the rearing areas by reducing environmental exposure. Implementing PRAS in covered structures will limit potential pathogen vectors, such as birds, otters, etc., from entering the rearing vessels. Additionally, installing PRAS will ensure high-quality, treated water for all rearing vessels. Enclosing the rearing systems dedicated to early and intermediate life stages of fish should significantly increase biosecurity of the facility. By preventing pathogen infection in young fish, it allows for more development prior to pathogen exposure. Young fish are more susceptible to disease associated mortality relative to older fish. This improvement has the potential to significantly increase survival, reducing the total number of eggs required to reach production goals. Fewer eggs received results in fewer labor hours required, reduced feed costs, and better rearing conditions for remaining fish.

5.7 Water Quality Impacts

The recommended alternatives will improve the water quality within the existing rearing vessels. Moving production from the existing concrete raceways to dual-drain circular tanks can improve the water quality of the rearing environment. Dual-drain circular tanks provide a completely mixed environment as opposed to a raceway that has a gradient of high to low dissolved oxygen (DO) along its length. This characteristic of circular tanks makes the entire tank volume available to the fish, instead of fish crowding at a raceway's head end, thereby not using the entire raceway volume. The dual-drain system in circular tanks aids in waste removal, allowing for more effective removal of solid waste and uneaten feed. This can contribute to better overall water quality in the rearing vessels.

The other PRAS equipment will also improve the water quality within the system. The microscreen drum filters will remove the solids in the water. The LHOs will ensure the dissolved oxygen levels enter the tanks at saturation or higher. The carbon dioxide strippers will remove dissolved carbon dioxide as well as other undesirable gases. The UV unit will reduce the pathogen load of the water that returns to the tanks. Additionally, installing a rigid roof structure with bird netting will reduce heat gain during the summer months and algae growth in the rearing tanks.

Each PRAS module will concentrate the fish waste into smaller flows from the center drain and drum filter backwash. The recommended alternatives include treating this effluent waste with a settling pond. This will reduce the solids and improve the water quality of the effluent being discharged. The hatchery should continue managing the settling pond and dredge and/or clean it as necessary to maintain proper retention times of the discharge.

The recommended alternatives also include improving the incoming water quality. The rebuilt aeration tower will increase dissolved oxygen saturation entering the facility. This will improve the water quality in the proposed hatchery building, PRAS circular tank modules, and existing concrete raceways.

6.0 Alternative Cost Evaluation

6.1 Introduction

McMillen has utilized historical costs as a self-performing general contractor in the performance of similarly-technical projects, as the basis of the Preliminary Concept Planning – Opinion of Probable Construction Cost (OPCC) estimate for this Project. Additionally, McMillen has solicited pricing or utilized recently received material quotes for similar materials and equipment or components. The appropriate overhead and profit markups have been included in the project pricing. The detailed cost estimates, including assumptions and inflation information are presented in Appendix F.

6.2 Estimate Classification

This OPCC estimate is consistent with a Class 5 estimate as defined by the Association for Advancement of Cost Engineering (AACE) classification system, as shown in Table 6-1. As stated in the estimate description below, "Class 5 estimates are generally prepared based on very limited information, and subsequently have wide accuracy ranges." For purposes of this project, McMillen has utilized an accuracy range of -30% to +50% in the estimates presented in Table 6-2 and Table 6-3.

Table 6-1. AACE Class 5 Estimate Description (Source: Association for Advancement of Cost Engineering).

Criteria	Details
Description	Class 5 estimates are generally prepared based on very limited information, and subsequently have wide accuracy ranges. As such, some companies and organizations have elected to determine that due to the inherent inaccuracies, such estimates cannot be classified in a conventional and systemic manner. Class 5 estimates, due to the requirements of end use, may be prepared within a very limited amount of time and with little effort expended—sometimes requiring less than an hour to prepare. Often, little more than proposed plant type, location, and capacity are known at the time of estimate preparation.
Level of Project Definition Required	0% to 2% of full project definition.

Criteria	Details
End Usage	Class 5 estimates are prepared for any number of strategic business planning purposes, such as but not limited to market studies, assessment of initial viability, evaluation of alternate schemes, project screening, project location studies, evaluation of resource needs and budgeting, long-range capital planning, etc.
Estimating Methods Used	Class 5 estimates virtually always use stochastic estimating methods such as cost/capacity curves and factors, scale of operations factors, Lang factors, Hand factors, Chilton factors, Peters-Timmerhaus factors, Guthrie factors, and other parametric and modeling techniques.
Expected Accuracy Range	Typical accuracy ranges for Class 5 estimates are -20% to -50% on the low side, and +30% to +100% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.
Effort to Prepare (for US$20MM project)	As little as 1 hour or less to perhaps more than 200 hours, depending on the project and the estimating methodology used.
ANSI Standard Reference Z94.2-1989 Name	Order of magnitude estimate (typically -30% to +50%).
Alternate Estimate Names, Expressions, Synonyms:	Ratio, ballpark, blue sky, seat-of-pants, ROM, idea study, prospect estimate, concession license estimate, guesstimate, rule-of-thumb.

6.3 Cost Evaluation Assumptions

The following assumptions were made while developing the Class 5 cost estimates for this alternatives analysis:

- All unit costs assume the total cost for installation including any applicable taxes.
- Cost estimate is at a Class 5 level with an accuracy range of -30% to +50% and includes 25% contingency. This range accounts for current inflation variability within aquaculture projects, unforeseen conditions, and anticipated cost escalation leading up to the projected construction year.
- Prevailing wages are provided as a general increase based on past construction pricing.
- All Division costs are rounded up to the nearest $1,000.

- Length and area dimensions for the estimate were derived from scaled AutoCAD drawings of the facility and the property. Survey was not utilized for this initial estimate.
- Geotech investigation cost assumes seven bore holes (20 feet deep), material testing, piezometer installation, and a written report.
- Topographic survey cost assumption is based on $1,000/acre.
- Building joist/eve height will be 18 feet.
- Site geotechnical properties have not been evaluated but are assumed to be good for construction of the hatchery.
- Topographic survey has not been completed. Site survey will be required to establish elevations of all systems to ensure proper hydraulics can be achieved.
- A facility condition assessment was performed for the Black Rock Trout Hatchery in 2022 by Terracon (Terracon Consultants, Inc., 2022). The assessment included an inventory of all facilities and equipment, code evaluations, and upgrades required to meet the assessment including the detailed replacement value. The cost of all work items generated was $1,433,641 in 2022 dollars. The work items in the Terracon facility condition assessment are not included within this report, costs, or evaluation of facilities. Some work items from the Terracon facility condition assessment may be resolved as part of the proposed upgrades at the Black Rock Trout Hatchery, while others may still need to be addressed. The upgrades in the Terracon reports may be included in future design efforts for each facility at CDFW direction.
- Additional division specific cost evaluation assumptions may be found in Appendix F.

6.4 LEED Assessment

RIM Architects (RIM) and STŌK have reviewed and assessed this facility's location along with reviewing the combination of state law and Leadership in Energy and Environmental Building (LEED) eligibility requirements. From this review, it is determined that this location is not eligible or required under state law to pursue LEED due to the lack of human occupancy in the proposed structures and/or square footage requirements. There is insufficient scope to pursue LEED certification. Refer to Appendix H for more information.

6.5 Net Zero Energy Evaluation

The site's address could not be accurately verified for geolocation purposes; however, it appears the surrounding area contains extensive barren land. Currently, the site achieves 58%

of the required capacity for net zero energy. To bridge the gap, an additional 55,000 SF of greenspace would need to be covered with photovoltaic panels.

6.6 Alternative Cost Estimates

The following tables illustrate the estimated costs for each of the alternatives evaluated and depicted within the worksheets in Appendix C.

Table 6-2. Alternative Cost Estimate – Maintain Production.

Item	Estimate ($)
Division 01 – General Requirements	5,007,000
Division 02 – Existing Conditions	315,000
Division 03 – Concrete	2,153,000
Division 05 – Metals	320,000
Division 08 – Openings	40,000
Division 13 – Special Construction	14,688,000
Division 23 – Mechanical & HVAC	350,000
Division 26 – Electrical	4,130,000
Division 31 – Earthwork	960,000
Division 32 – Exterior Improvements	150,000
Division 33 – Utilities	40,000
Division 40 – Process Water Systems	1,686,000
Division 44 – Pumps	203,000
2024 CONSTRUCTION COST	**30,042,000**
Construction Contingency	7,511,000
Overhead	1,803,000
Profit	2,403,000
Bond Rate	301,000
2024 CONSTRUCTION PRICE	**42,060,000**
Design, Permitting, and Construction Support	6,309,000
Geotechnical	25,000
Topographic survey ($1000/acre)	30,000
PROJECT TOTAL	**48,424,000**
Accuracy Range +50%	72,700,000
Accuracy Range -30%	33,900,000
Photovoltaic – Net Zero Energy	6,418,000
Photovoltaic – Only for Proposed Roof Structures	3,724,000

Table 6-3. Alternative Cost Estimate – Maximize Production (10 cfs).

Item	Estimate ($)
Division 01 – General Requirements	6,919,000
Division 02 – Existing Conditions	323,000
Division 03 – Concrete	2,781,000
Division 05 – Metals	320,000
Division 08 – Openings	40,000
Division 13 – Special Construction	20,906,000
Division 23 – Mechanical & HVAC	602,000
Division 26 – Electrical	5,640,000
Division 31 – Earthwork	1,197,000
Division 32 – Exterior Improvements	150,000
Division 33 – Utilities	40,000
Division 40 – Process Water Systems	2,392,000
Division 44 – Pumps	203,000
2024 CONSTRUCTION COST	**41,513,000**
Construction Contingency	10,378,000
Overhead	2,491,000
Profit	3,321,000
Bond Rate	416,000
2024 CONSTRUCTION PRICE	**58,119,000**
Design, Permitting, and Construction Support	8,718,000
Geotechnical	25,000
Topographic survey ($1000/acre)	30,000
PROJECT TOTAL	**66,892,000**
Accuracy Range +50%	100,400,000
Accuracy Range -30%	46,900,000
Photovoltaic – Net Zero Energy	9,596,000
Photovoltaic – Only for Proposed Roof Structures	4,993,000

7.0 Black Rock Trout Hatchery Environmental Permitting

The proposed Project would involve the modification to the existing hatchery or construction of a new hatchery facility and associated infrastructure. Alteration of the Division Creek diversion structure may require some instream construction activities. A list of anticipated permits, agency review time, submittal requirements, and supporting documentation for the proposed project regardless of which alternative is selected are summarized in Table 7-1, Table 7-2, and Table 7-3. The review timeframes are estimated and are based on the recommendations presented in permit guidance documentation and experience with other permitting projects in California.

We reviewed each location through online mapping tools (U.S. Fish and Wildlife Service [USFWS] Information for Planning and Consultation [IPAC] and California Biogeographic Information and Observation System [BIOS]) to determine if species listed under the Endangered Species Act (ESA) and the California Endangered Species Act (CESA) potentially occur at the site. The results indicated that each site has the potential for species identified as endangered or threatened. The site does not contain critical habitat. The results of these mapping tools indicate that a Biological Assessment of the area would need to be prepared prior to consultation with the USFWS, National Oceanic and Atmospheric Administration (NOAA), and other state agencies.

The list of permits is developed at a high level and additional permits may need to be assessed as the project is advanced.

Table 7-1. Anticipated Federal Permits and Approvals for Selected Location

Agency and Permit/Approval	Submittal / Document Type	Supporting Documentation	Anticipated Time Frame	Notes
USFWS National Environmental Policy Act (NEPA) Compliance	Environmental Assessment	Analysis of potential impacts on various natural resources, Design Package	12 – 18 months	Evaluation of the selected alternative to identify if there would be a significant impact.

Agency and Permit/Approval	Submittal / Document Type	Supporting Documentation	Anticipated Time Frame	Notes
U.S. Army Corps of Engineers (USACE) Clean Water Act (CWA) Section 404 - Nationwide Permit Authorization	Pre-Construction Notification Application	Wetland and Stream Delineation Design Package	3 months	Required if jurisdictional waters of the US or wetlands are affected by the project area.
USFWS ESA Section 7 Consultation	Biological Assessment	Field surveys of affected area Design Package	4 months	All three sites have potential for species listed under the ESA to occur.
National Oceanic and Atmospheric Administration (NOAA) Section 10(a)(1)(A) of the ESA	Application	Supplemental information to include, description of proposed project, analysis of potential take and potential impact to species, proposed minimization and mitigation measures, and funding source	4 months	Authorization for scientific purposes or to enhance the propagation or survival of an endangered or threatened species.

Table 7-2. Anticipated State Permits and Approvals for Selected Location

Agency and Permit/Approval	Submittal / Document Type	Supporting Documentation	Anticipated Time Frame	Notes
Lead Agency TBD California Environmental Quality Act (CEQA)	Environmental Impact Report	Analysis of potential impacts on various natural resources Design Package	12 – 18 months	Required for issuing State permits. Potential to coordinated with the NEPA compliance for efficiency.

Agency and Permit/Approval	Submittal / Document Type	Supporting Documentation	Anticipated Time Frame	Notes
California Department of Fish and Wildlife (CDFW) California Fish and Wildlife Code Section 2081 Incidental Take	Application	Supplemental information to include, description of proposed project, analysis of potential take and potential impact to species, proposed minimization and mitigation measures, and funding source	4 months	Required for the authorization to take any species listed under the California Endangered Species Act.
California Department of Fish and Wildlife (CDFW) California Fish and Wildlife Code Section 1600 Lake and Streambed Permits	Application/ Notification	N/A	1-3 months	Required for hatchery intake diversions.
Lahontan Regional Water Quality Control Board (RWQCB) 401 Water Quality Certification	Application	Wetland and Stream Delineation USACE Review NEPA/CEQA Compliance	3 months	Required if jurisdictional waters of the US or wetlands are affected by the project area.
California Office of Historic Preservation Section 106 Review	Concurrence Request Letter	Cultural Resources Survey, Design Package	3 months	Required as part of the NEPA/CEQA process.
California Division of Water Rights Water Rights	Application or Transfer	N/A	4 months	N/A

Agency and Permit/Approval	Submittal / Document Type	Supporting Documentation	Anticipated Time Frame	Notes
California State Water Resources Control Board (SWRCB) National Pollutant Discharge Elimination System (NPDES)	Application	N/A	1 month	Required if hatchery effluent is discharged to a jurisdictional waterway.
SWRCB Construction General Permit	Application	Stormwater Pollution Prevention Plan (SWPPP)	2 months	Required if construction activities disturb greater than 1 acre.

Table 7-3. Anticipated Inyo County Permits and Approvals for Selected Location

Agency and Permit/Approval	Submittal / Document Type	Supporting Documentation	Anticipated Time Frame	Notes
Inyo County Building and Safety Construction Permits	Grading, Building, Electrical, Mechanical, Plumping Applications	Project Summary and Design Package	2 months	N/A

7.1 National Pollutant Discharge Elimination System (NPDES) Permitting

The Black Rock Trout Hatchery is classified as a cold water Concentrated Aquatic Animal Production (CAAP) facility and is eligible to operate under General Order R6V-2018-0024 issued by the Regional Water Quality Control Board, Lahontan (Region 6) and NPDES Permit No. CA0102792.

The permit identifies total suspended solids, settleable solids, and formaldehyde as potential pollutants from the hatchery. The following limitations for effluent are specified:

- Total Suspended Solids: 6.0 mg/L (monthly average)
- Settleable Solids: 0.1 mL/L (monthly average)
- Formaldehyde: 0.65 mg/L (monthly average), 1.3 mg/L (daily maximum)

7.2 Water Rights

Water right documentation can be obtained from the client if requested by an agency.

8.0 Conclusions and Recommendations

This report provides a summary of the state of the Black Rock Hatchery, identifies and quantifies the main impacts that the Hatchery could experience as a result of climate change, and provides a set of proposed facility design modifications to increase the resiliency of the hatchery, in conjunction with the associated costs and potential impacts of the proposed modifications.

The in-depth analysis of the available hydrologic and climatologic data performed by NHC provides projections to forecast changes that may be experienced at the hatchery. In general, significant increases in air temperature are expected at Black Rock Hatchery. Groundwater supply is not expected to warm appreciably, but given current temperatures in the upper range for fish rearing, additional warming may require adaptation. Additionally, the risk of wildfire is moderate.

To meet CDFW's goal of continuing to provide recreational fishing opportunities for the public and for the conservation of endangered or threatened species as the climate changes, the resiliency of existing hatcheries will need to be increased. Increased resiliency will also require updating existing infrastructure that is nearing the end of its effective lifespan.

Some recommendations that would help to achieve this goal include the following:

- Replacing each well's backup generator with a propane-powered generator has the potential to improve exhaust emissions.
- Re-sleeving or providing Well No. 351 with a smaller pump would allow the facility to use it as the main production well without exceeding the pumping limit.
- Replacing the aeration tower will improve production water quality.
- Decommissioning the Division Creek diversion structure improves biosecurity by keeping NZMS from entering the facility. Additionally, dewatering and filling Pond No. 1 provides additional space for the proposed rearing infrastructure.
- Replacing pipes and valves that are near the end of their effective lifespan or are currently inoperable due to age will provide improved flow control.
- Replacing flow-through style raceway production with circular dual-drain tanks utilizing PRAS will reduce the amount of water that is required to raise fish.
- Covering all rearing vessels with solid roofs will reduce the impacts of increased air temperatures for both the fish and the employees.

- Adding a skim and epoxy coating the concrete raceways will extend the usable life of existing rearing infrastructure.
- Dredging the effluent ponds will increase the overall life of the effluent treatment system and ensure proper effluent treatment volumes are available.
- Installing solar panels atop new structures will offset some of the power demands associated with new hatchery equipment.

Per CDFW's request, alternatives were also provided to maximize production at Black Rock Hatchery utilizing all available 10 cfs of water supplied to the hatchery through LADWP's wells. This scenario consists of the same recommendations listed above, but the quantities of incubation stacks, early rearing deep tanks, intermediate rearing circular tank PRAS modules, and final rearing circular tank PRAS modules were increased. The number of tanks was determined by the fresh make-up water demand of all tanks and the total available water supply of 10 cfs while providing a ~0.5 cfs buffer.

The proposed upgrades to the Black Rock Hatchery would have negligible impacts on the natural resources in the surrounding area. All improvements would occur within currently developed areas, which lessen the permit requirements. The total Class 5 cost estimate of the proposed design modifications is $48,424,000 to maintain production and $66,892,000 to maximize production with the available water supply.

9.0 References

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