Climate Induced Hatchery Upgrades

Fillmore Hatchery

Alternatives Analysis Submittal

Final Report
Revision No. 4

February 2025

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Revision Log

Revision No.	Date	Revision Description
0	2/26/2024	65% Draft Internal Technical Review
1	3/1/2024	65% Draft for CDFW Review
2	8/16/2024	100% Draft for CDFW and Internal Technical Review
3	10/31/2024	Final Submittal to CDFW
4	2/14/2025	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).

Fillmore Hatchery has an aging infrastructure and deficiencies that need to be addressed in the near future in order to meet production goals. The following deficiencies were identified at the hatchery during the site visit:

- The existing aeration tower does not provide sufficient head pressure to provide water to the existing hatchery building. Additional degassing and aeration capacity needs to be added that could assist in increasing the head pressure.
- Groundwater has lifted the existing raceways resulting in significant cracking and water leaking into the raceways from underneath.
- The existing effluent pond can frequently become full of solids and vegetation causing water to back up into the raceways and reduce the production capacity.
- The cost to access and pump water for the facility has seen significant increases over the years and is likely to continue this trend into the future.

The preferred alternative for hatchery upgrades includes constructing a new hatchery building for incubation and early rearing with the addition of an intermediate rearing space and circular tanks supplied with partial recirculating aquaculture systems (PRASs). A new grow-out area replacing the existing concrete raceways with circular tanks and PRAS would also be included. The hatchery building would be a fully enclosed pre-engineered metal building (PEMB), and the grow out area would be covered with a solid roof and include predation netting and fencing on the sides. Additionally, a photovoltaic system would be included to help offset future energy costs and to meet current California LEED requirements. The existing raceways, hatchery building, and aeration tower would remain in place for use during construction of the new facility and for future hatchery needs.

The Class 5 Opinion of Probable Construction Cost (OPCC) for constructing the preferred alternative upgrades can be found in the table below (Table 6-2 provides 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 to 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. The 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.

Project Total	Photovoltaic – Zero Net Energy
$ 53,522,000	$ 12,438,900

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 to 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 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 documentation, 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 evaluation in 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 Fillmore Hatchery is located in Fillmore, CA along the Santa Clara River approximately 45 miles northwest of Los Angeles. Figure 1-1 shows the Fillmore Hatchery location map.

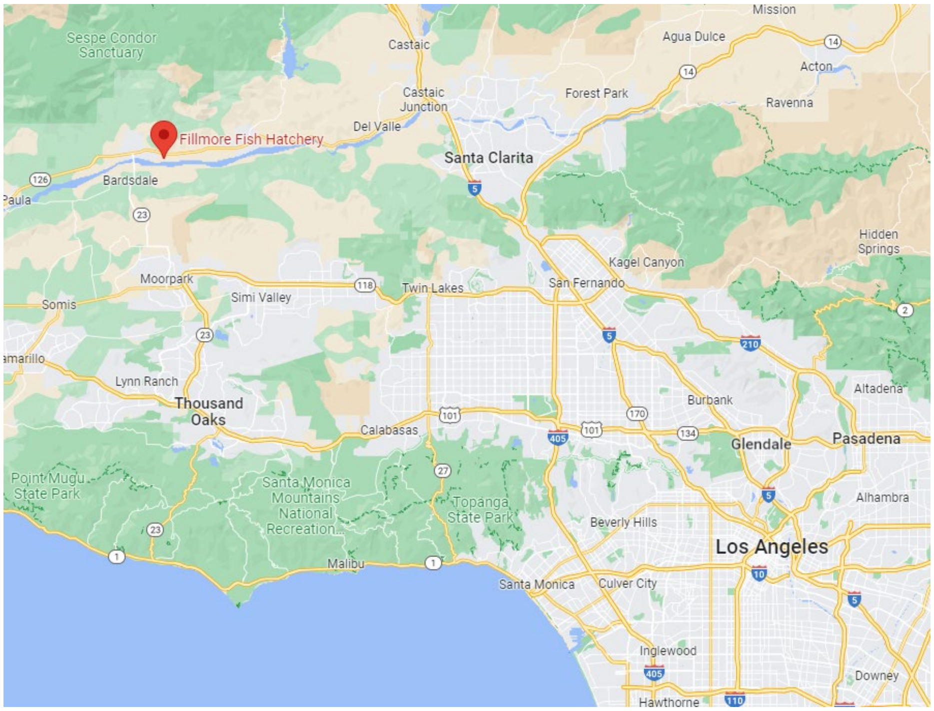

Figure 1-1. Fillmore Hatchery Location Map.

The Fillmore Hatchery was originally constructed in 1942 with earthen ponds, four cottages, a feed room, and a garage building. In 1968 and 1972, Fillmore Hatchery renovated the earthen ponds into four 1,000-foot concrete raceways and two additional wells to modernize the facility and provide additional rearing space. The Fillmore Hatchery raises Rainbow Trout (*Oncorhynchus mykiss*) with an annual production goal of approximately 200,000 pounds of catchable-sized releases into local lakes and streams primarily in Southern California. The hatchery utilizes pumped well water from four wells supplying water for all fish rearing activities. The wells produce water with a constant temperature of 60°F year-round. The general facilities are shown in Figure 1-2. More detailed descriptions and photos of the Fillmore Hatchery are described in the Site Visit Report (Appendix A).

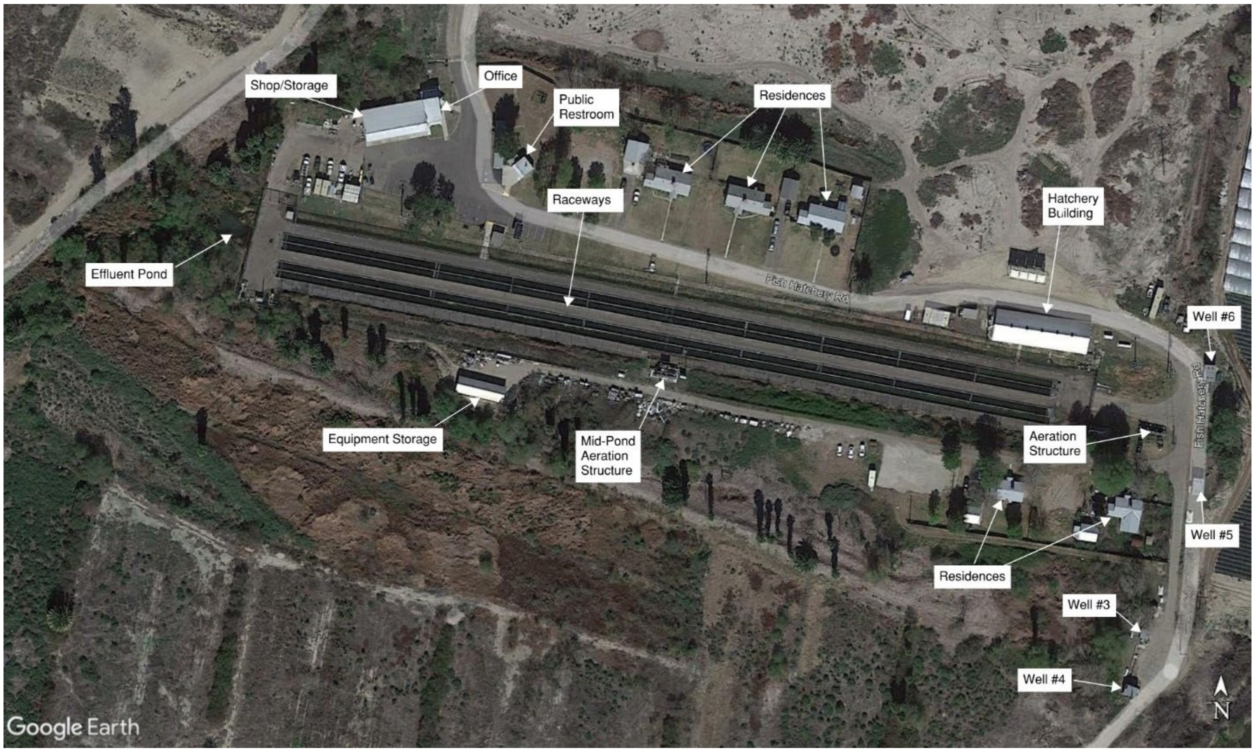

Figure 1-2. Fillmore Hatchery Facility Layout.

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) 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 Fillmore Hatchery produces exclusively Rainbow Trout (*Oncorhynchus mykiss*). 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. 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 Fillmore Hatchery is 200,000 lbs. of catchable Rainbow Trout at 2 fish per pound (fpp) each (400,000 fish total), with the expectation of an additional contract to raise 80,000 fish to 1 fpp (80,000 lbs) in the future. This production goal reflects reduced overall production due to infrastructure issues and the requirement for the Fillmore Hatchery to produce fingerling fish (60 fpp) for the Mojave Hatchery as part of Lactococcosis management. The fish production goal, and rearing capacity determined by the Capacity Bioprogram is shown in Table 2-1.

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

Rearing Unit (max. fish size)	Total Capacity (Fish)[a]	Limiting Factor
Deep Tanks (200 fpp/2.6 inches)	309,504 (1,548 lbs)	Rearing Volume
Raceways (60 fpp/3.9 inches) Mojave River Transfers	1,292,241 (21,537 lbs)	Water Flow
Raceways (2 fpp/10.8 inches)	132,537 (66,269 lbs)	Water Flow
Raceways (1 fpp/15.1 inches)	83,388 (83,388 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.

2.2 Bioprogram Summary

The Capacity Bioprogram in the Site Visit Report (Appendix A) demonstrates the total capacity of each rearing area at the Fillmore 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 Fillmore Hatchery falls short of the production goals shown in Table 2-1; nuances of the timing of egg arrivals and fish stocking allows for annual production to exceed the capacity listed, but production still falls short of the set goal. Details about the various rearing areas and infrastructure are discussed in the Site Visit Report, found in Appendix A.

In this current report, we developed an initial Production Bioprogram (Appendix B) 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 Fillmore 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:

- The ability of CDFW to have production 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.
- The Mojave River Hatchery requires fish to be transferred at approximately 60 fpp.
- A contract with a private purchaser requires that Fillmore produces 80,000 fish per year at approximately 1 fpp (80,000 lbs).
- Water reconditioned through the mid-pond aeration system for the lower 500 feet sections of raceways has the same carrying capacity as the water in the upper 500 feet sections in terms of FI.

Klontz (1991) provided optimal growth rates (approximately 0.68 inches per month = 17 months from first feeding to 12 inches per CDFW) for Rainbow Trout at designated water temperatures. Survival rates were provided in the questionnaire completed by Fillmore Hatchery staff.

Table 2-2. Criteria Used for the Production Bioprogram.

Criteria	Value
Density Index (DI)	0.3
Flow Index (FI)	1.18
Water Temperature	Consistent 60°F

Table 2-3. Assumptions Used for the Production Bioprogram

Life Stage	Value
Egg-to-fry	67%
Fry-to-juvenile (200 fpp)	67%
Juvenile-to-outplant (2 fpp)	80%
Catchable-to-Super-catchable (1 fpp)	100%

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 two separate Rainbow Trout egg receivals, pulse 1 and pulse 2, to stagger early rearing and maximize annual production.

Assuming that eyed eggs are received in early January (pulse 1), it takes approximately 1 month to first feeding which would begin in February when fish are approximately 4,218 fpp (0.84 inches). These fish should reach approximately 170 fpp (2.7 inches) in early May (Table 2-4). At this time fish can be vaccinated, held, and eventually transferred to outdoor raceways before the end of the month to avoid exceeding the FI criteria. In this exercise, it is assumed that approximately 679,000 eggs are incubated, 455,000 fry are hatched from those eggs, and approximately 300,000 juvenile fish are transferred to the raceways based on survival rates provided by Fillmore Hatchery staff.

The juvenile fish are stocked into a single 500-foot section of raceway in May. Before the end of June, approximately 125,000 of these fish will be transferred to the Mojave River Hatchery at 60 fpp (3.9 inches). The fish remaining at Fillmore will be split among more raceway sections as they grow and will occupy four 500-foot sections when they reach 2 fpp (12 inches) the following June. Approximately 100,000 fish will be stocked out at 2 fpp while 40,000 fish will be kept as a super-catchable allotment. The super-catchable fish will be held in two 500 ft raceway sections until they reach their target stocking size of 1 fpp (15 inches) in November.

The second pulse of eggs will arrive in July and will move through the hatchery in the same process. The production schedule is shown in Figure 2-1; the 18-month production cycle requires each pulse to overlap itself in the production raceways. The overlaps are differentiated by A and B groups for each pulse. For pulse 1, the A group will be transferred to raceways as the B group is stocked out as catchable fish in June. For pulse 2, the A group will be transferred to raceways as the B group is stocked out as catchable fish in December. Super-catchable fish will be released in November (pulse 1) and May (pulse 2) each year. The maximum flow rates required, and the number of 500-foot raceway sections used is shown at the bottom of Figure 2-1. Peak water demand will occur from March through May and September through November of each year, when all four 1,000-foot raceways are in use and the hatchery building is full (Figure 2-1).

Table 2-4. End of Month Production Information for Rainbow Trout (Pulses 1 and 2) Bioprogram Including Realized DI and FI Values.

Pulse 1	Pulse 2	Tank Type	Tanks Occupied	fpp	Length (in)	Total Fish (#)	Biomass (lbs)	Max. Flow (cfs)	DI	FI
Early Rearing Jan/Feb	Early Rearing Jul/Aug	Deep Tanks	40.0	1,728.0	1.26	404,965	234.4	1.3	0.09	0.31
Mar	Sep	Deep Tanks	40.0	474.0	1.94	354,913	748.8	1.3	0.18	0.64
Apr	Oct	Deep Tanks	40.0	197.0	2.60	304,861	1,547.5	1.3	0.28	0.99
May	Nov	Deep Tanks	40.0	98.0	3.28	300,506	3,066.4	1.3	0.43[a]	1.56[a]
June	Dec	Raceways	1.0	57.0	3.94	296,151	5,195.6	2.9	0.13	1.01
Jul	Jan	Raceways	1.0	35.0	4.62	171,151	4,890.0	2.9	0.10	0.81
Aug	Feb	Raceways	1.0	23.0	5.31	168,518	7,326.9	2.9	0.13	1.06
Sep	Mar	Raceways	2.0	16.2	5.97	165,885	10,239.8	5.8	0.08	0.66
Oct	Apr	Raceways	2.0	11.8	6.65	163,252	13,834.9	5.8	0.10	0.80
Nov	May	Raceways	2.0	8.9	7.31	160,619	18,047.1	5.8	0.12	0.95
Dec	Jun	Raceways	2.0	6.8	7.99	157,986	23,233.2	5.8	0.14	1.12
Jan	Jul	Raceways	3.0	5.3	8.67	155,353	29,311.9	8.7	0.11	0.87
Feb	Aug	Raceways	3.0	4.3	9.29	152,720	35,516.3	8.7	0.12	0.98
Mar	Sep	Raceways	3.0	3.5	9.97	150,087	42,882.0	8.7	0.14	1.10
Apr	Oct	Raceways	4.0	2.9	10.63	147,454	50,846.2	11.6	0.11	0.92
May	Nov	Raceways	4.0	2.4	11.31	144,821	60,342.1	11.6	0.13	1.03

Pulse 1	Pulse 2	Tank Type	Tanks Occupied	fpp	Length (in)	Total Fish (#)	Biomass (lbs)	Max. Flow (cfs)	DI	FI
Jun	Dec	Raceways	4.0	2.0	11.97	142,188	71,094.0	11.6	0.14	1.14
Jul	Jan	Raceways	2.0	1.7	12.65	40,000	23,529.4	5.8	0.09	0.72
Aug	Feb	Raceways	2.0	1.5	13.34	40,000	26,666.7	5.8	0.10	0.77
Sep	Mar	Raceways	2.0	1.3	14.00	40,000	30,769.2	5.8	0.10	0.85
Oct	Apr	Raceways	2.0	1.1	14.68	40,000	36,363.6	5.8	0.12	0.95
Nov	May	Raceways	2.0	1.0	15.34	40,000	41,666.7	5.8	0.13	1.04

[a] This DI and FI exceeds the biological criteria set forth however fish will be stocked out into raceways as they are vaccinated, alleviating densities and flow requirements in the hatchery building.

This staggered production allows for several opportunities to depopulate and clean a single 1,000-foot raceway (in January, February, July, and August) and would provide 250,000 fingerlings to the Mojave River Hatchery, 80,000 super-catchable Rainbow Trout (1 fpp, 15 inches), and approximately 204,000 catchable Rainbow Trout (2 fpp, 12 inches) per year (highlighted in red). This scenario produces only half of the total catchable production goal for the facility (400,000 fish) and Mojave River Hatchery transfers (500,000 fingerlings), but it maintains production within recommended DI and FI criteria for the water temperatures at the facility. There is flexibility within the program to raise additional fish since fish numbers reflect 90% of the approximate total capacity. This flexibility was included in case of year-to-year changes in production strategies or allotment goals and reflects an additional safety factor to account for the reconditioned water used in the lower 500-foot sections of the raceways. The facility is limited by the available water flows to the raceways, which is evident in the calculated FI at the end of each month in Table 2-4; the calculated DI remains well below the threshold of 0.3. Note that the different colored blocks in the following figure correspond to the months for when each pulse is in the deep tanks or in the raceways, along with noting when eggs are received and incubated.

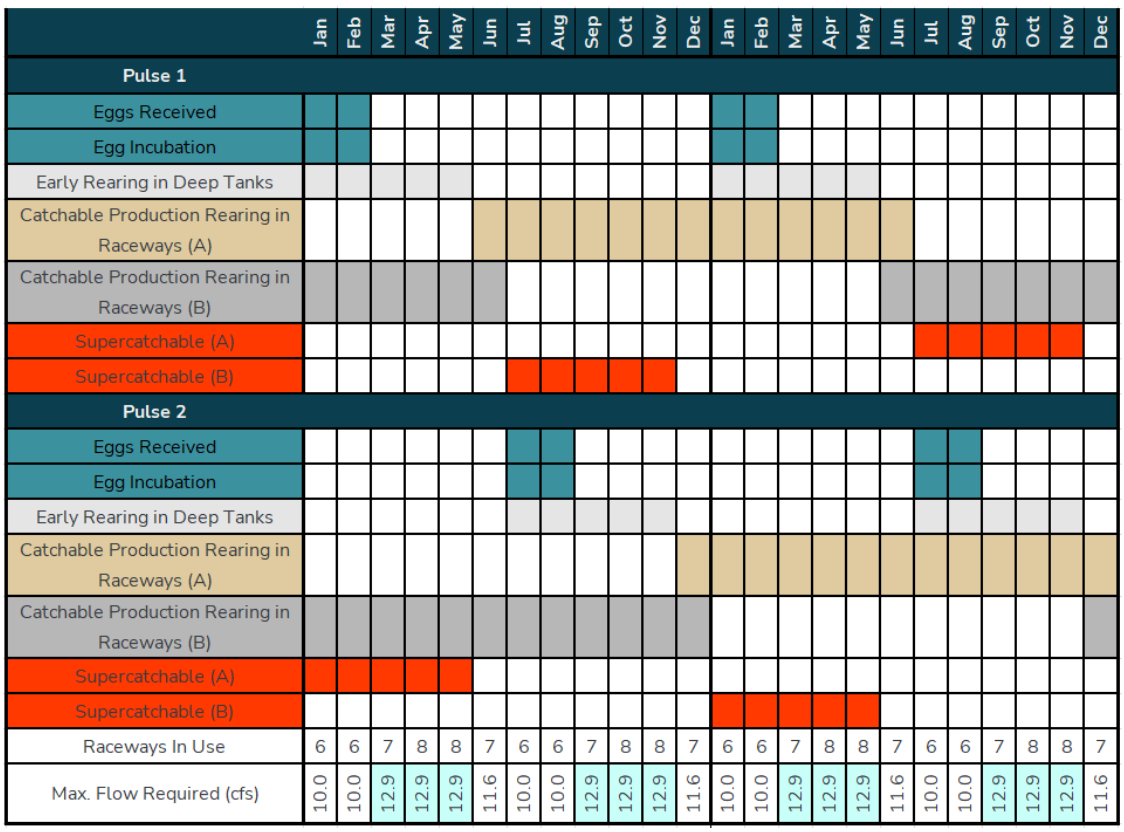

Figure 2-1. Production Rearing Schedule Over 2 Years with Peak Water Demand Occurring Annually from March through May and September through November. A and B Refer to Separate Year Classes of the Same Pulse(as highlighted in the Max Flow Required row).

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 of risks to fish rearing.

3.2 Water Sources

The hatchery's water sources are wells located on site. Water is plentiful and produces springs in wet years. Well water temperature varies little, remaining at 59°F-60°F. At the end of the raceways, water temperature may reach 62°F during the hottest days of the year. The Fillmore 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 strong fish growth rates. If extreme air temperatures became higher, or just more common and more prolonged in 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.

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 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 VIC hydrologic model (Figure 3-1) that was driven by the projected daily climate time series. VIC divides the watershed into grid cells (about 5x7 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.

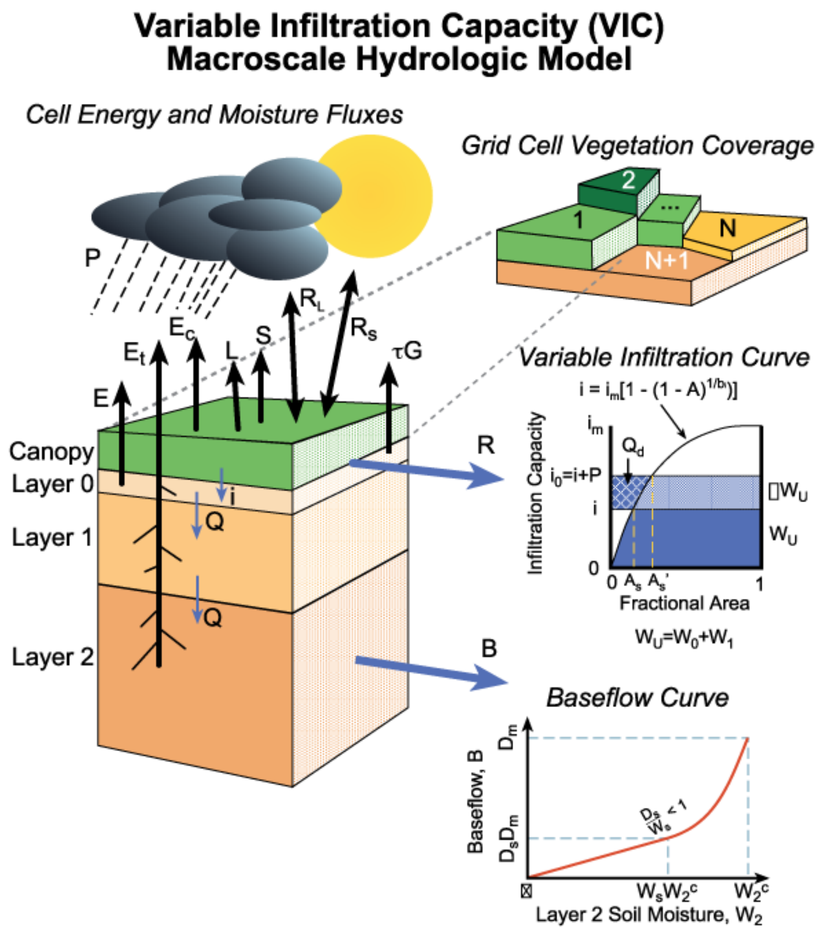

Figure 3-1. The VIC Hydrologic ModelFigure Source: University of Washington, 2021.

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

- **Projections of climatic variables** (air temperature, precipitation and evapotranspiration) 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 spatial 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 (b) 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.

- **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 decreasing groundwater recharge.

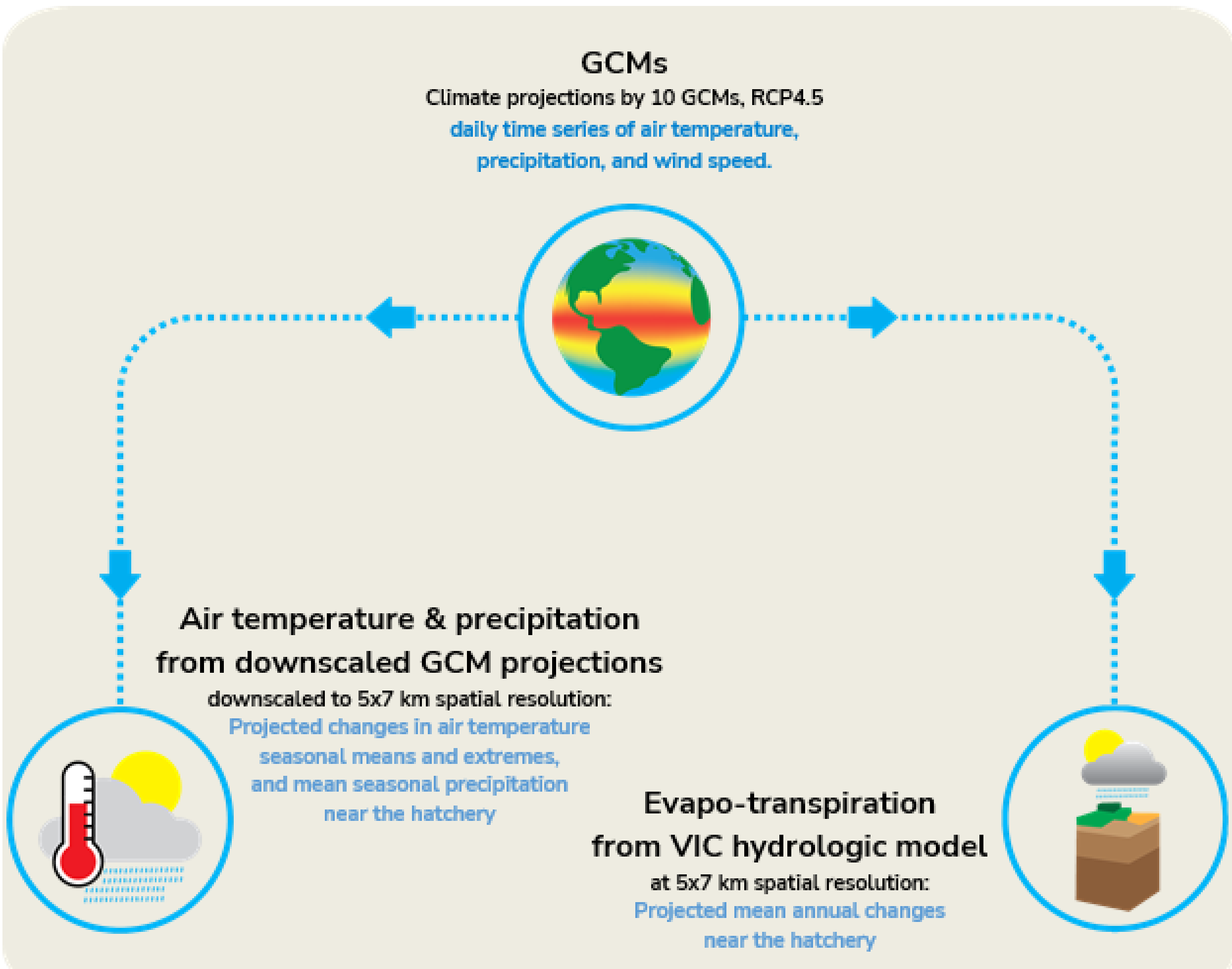

Figure 3-2. Methodology for Obtaining Projections.

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 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 period compared to the reference period (1984-2003), and by an additional 0.8°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 by even more, 3.5°F, reaching 95°F. These projected temperatures represent potentially hazardous outdoor working conditions at the hatchery.

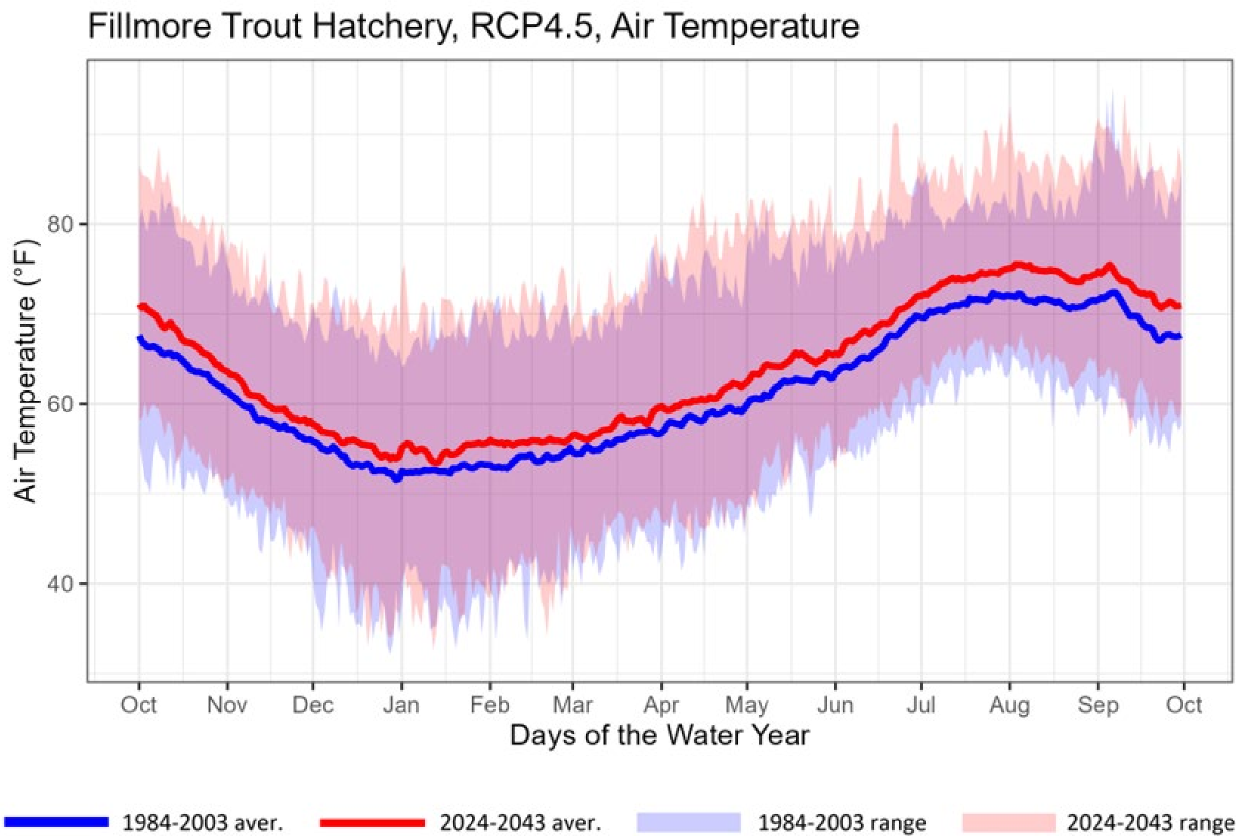

Figure 3-3. Mean Daily Air Temperature and Range for Each Day of the Year at Fillmore Hatchery.

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

GCM	Annual	Winter (DJF)	Spring (MAM)	Summ. (JJA)	Fall (SON)
Ensemble mean	64.2°F (+2.7°F)	55.6°F (+2.1°F)	61.4°F (+2.1°F)	72.3°F (+3.0°F)	66.4°F (+2.7°F)
Lowest	63.3°F (+1.8°F)	54.5°F (+1.0°F)	60.5°F (+1.2°F)	70.9°F (+1.6°F)	65.5°F (+1.8°F)
Highest	64.8°F (+3.3°F)	56.6°F (+3.1°F)	62.5°F (+3.2°F)	73.5°F (+4.2°F)	66.8°F (+3.1°F)

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

GCM	Annual	Winter (DJF)	Spring (MAM)	Summ. (JJA)	Fall (SON)
Ensemble mean	65.0°F (+3.5°F)	56.7°F (+3.2°F)	62.8°F (+3.5°F)	73.3°F (+4.0°F)	67.3°F (+3.6°F)
Lowest	64.1°F (+2.6°F)	55.7°F (+2.2°F)	61.3°F (+2.0°F)	72.3°F (+3.0°F)	66.1°F (+2.4°F)
Highest	66.0°F (+4.5°F)	57.6°F (+4.1°F)	63.7°F (+4.4°F)	74.9°F (+5.6°F)	68.3°F (+4.6°F)

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

GCM	3rd perc.	25th perc.	50th perc.	75th perc.	97th perc.
Ensemble mean	59.9°F (+2.1°F)	69.9°F (+2.0°F)	77.1°F (+2.3°F)	84.0°F (+2.8°F)	95.0°F (+3.5°F)
Lowest	58.9°F (+1.1°F)	69.2°F (+1.3°F)	76.6°F (+1.8°F)	83.1°F (+1.9°F)	93.6°F (+2.1°F)
Highest	61.4°F (+3.6°F)	70.5°F (+2.6°F)	77.5°F (+2.7°F)	85.1°F (+3.9°F)	96.5°F (+5.0°F)

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

GCM	3rd perc.	25th perc.	50th perc.	75th perc.	97th perc.
Ensemble mean	61.1°F (+3.3°F)	70.9°F (+3.0°F)	78.3°F (+3.5°F)	85.1°F (+3.9°F)	95.9°F (+4.4°F)
Lowest	60.4°F (+2.6°F)	70.3°F (+2.4°F)	77.3°F (+2.5°F)	84.2°F (+3.0°F)	94.2°F (+2.7°F)
Highest	62.4°F (+4.6°F)	71.7°F (+3.8°F)	79.5°F (+4.7°F)	86.5°F (+5.3°F)	97.0°F (+6.5°F)

3.5.2 Precipitation Minus Evapotranspiration Over the Watershed

Projected annual precipitation minus evapotranspiration (E-ET) aggregated over the hatchery vicinity (an area of 4,426 sq. miles surrounding the hatchery) is projected to decline slightly, a change by -5%, in the next 20 years, and by -9% in the mid-century period, 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).

This variable E-ET is an indicator of future direction of change in groundwater recharge rates but has large associated uncertainty given that precipitation in California is subject to great natural variability, experiencing large departures from the mean in any given year or multi-year period. Mimicking this natural variability, precipitation projections for the next 20 years vary widely between different GCM runs and are subject to great uncertainty.

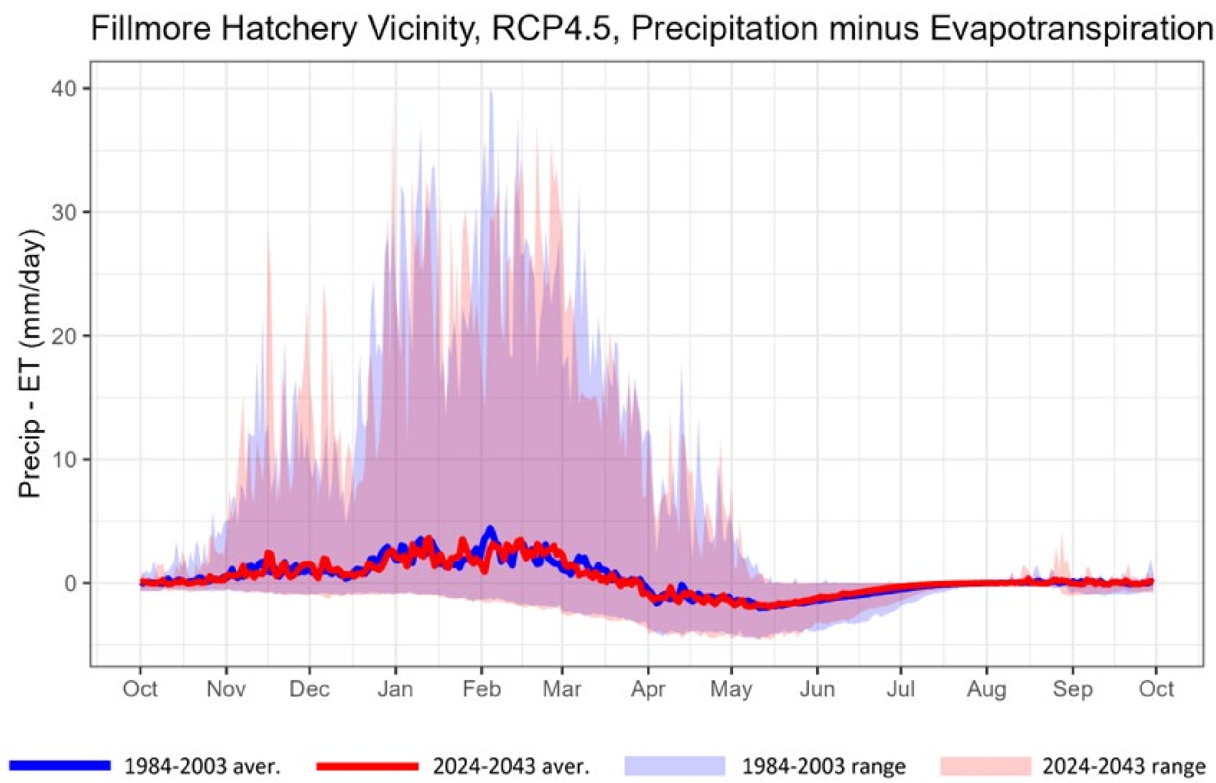

Figure 3-4. Mean Daily Precipitation Minus Evapotranspiration and Range for Each Day of the Year in the Vicinity of Fillmore Hatchery

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

GCM	Annual	Winter (DJF)	Spring (MAM)	Summ. (JJA)	Fall (SON)
Ensemble mean	-5%	-1%	+17%	-28%	-8%

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

GCM	Annual	Winter (DJF)	Spring (MAM)	Summ. (JJA)	Fall (SON)
Ensemble mean	-9%	-5%	+22%	-47%	-15%

3.5.3 Fire Risk

Historical wildfires have been documented both in the immediate vicinity of the hatchery and within the watershed perimeter, as mapped in Figure 3-5. Frequent cyclical fires are common in the surrounding shrubland and grasslands. Most of the watershed has burned since 2000, and multiple times before then. There is a history of large fires in the surrounding area, including local wildfires such as the Thomas and Day fires, which burned more than 150,000 areas in 2005 and 2017, respectively. The immediate surrounding uplands last burned in 2003 and 2007 and got within 0.25 miles of the facility. Shrub and grass fuels can regenerate within two to ten years depending on burn severity.

Expressing wildfire risk as a percent chance of occurring at least once in a decade, the projected wildfire risk at the hatchery site is between 25 and 30% through mid-century (Figure 3-5). Across the watershed, the projected average fire risk is 20%, with localized areas increasing to 44% through the end of the century.

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. Repeat fires in the immediate vicinity suggest that cyclical wildfire activity is common in the watershed uplands on the order of decades. The lack of fire since 2007 and cyclical nature of occurrence in the immediate uplands suggests that repeat fires are possible within the near future.

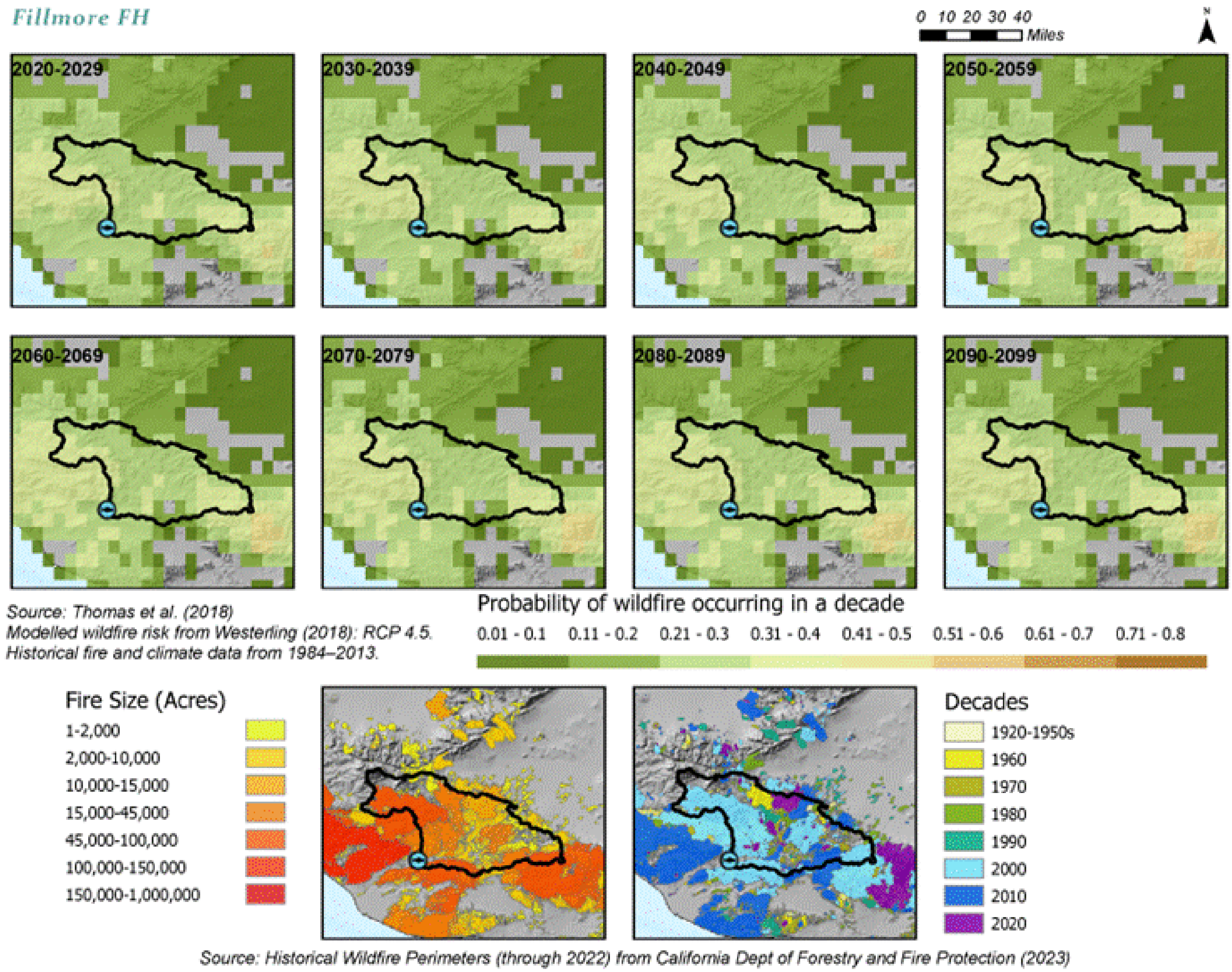

Figure 3-5. Summary of Wildfire Risks and Observations in the Vicinity of Fillmore FH

3.6 Conclusions

Significant increases in air temperature are expected for the Fillmore 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 0.8°F in the mid-century period (2044-2063), compared to the reference period (1984-2003). The summer 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 3.5°F, respectively, in the next 20 years, relative to the reference period, reaching 95°F and representing potentially hazardous outdoor working conditions at the hatchery. Such an increase in the peak air daytime temperature requires adaptation measures for 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 well water temperature has remained at a steady 59°F-60°F and has not responded to rise in air temperature so far. Therefore, atmospheric warming in future may not elevate summer water temperature beyond this range.

The hatchery is at significant risk of wildfires. There is a history of large fires in the watershed and surrounding uplands and, given the absence of fire at these locations since year 2007, there is increasing risk of fire at the hatchery 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 20% through mid-century. Across the watershed, this risk is estimated as 25 to 30% on average, with localized areas increasing to more than 40% risk.

4.0 Existing Infrastructure Deficiencies

While the Fillmore 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 deteriorating raceways, inadequate drainage for groundwater seeps, unreliable well water production, undersized effluent pond, reduced oxygen levels in lower raceway sections, double pumping of water to supply the hatchery building, limited water pressure in the hatchery building, and extremely high energy and water consumption costs. Biosecurity deficiencies and potential solutions for addressing these concerns were identified in Sections 3.0 and 3.2 of the Site Visit Report, respectively. The details of these deficiencies are further expanded upon in Sections 4.1 and 4.2.

4.1 Water Process Infrastructure

4.1.1 Water and Energy Costs

Water use at the Fillmore Hatchery can cost CDFW more than $1 million annually, with half of the cost paid to Southern California Edison for electrical power and half paid to the United Water Conservation District as water fees. Operating costs remain high even while using a mid-pond aeration system to recondition and reuse water for the lower raceway sections. Both power and water use rates have increased in recent years and are expected to continue increasing in the future.

4.1.2 Effluent Ponds

The existing effluent ponds have been reported to frequently fill with solids, contributing to water backing up into the raceways. This prevents staff from raising fish in some lower raceways, reducing overall production. Lower raceways that are constantly wet from backed up effluent also pose a biosecurity risk by providing reservoirs for pathogens in the rearing area. The effluent pond is only 50 feet from the raceways and does not drain well to the downstream drainage area. The drainage area is shared with other CDFW divisions and requires coordination for any temporary dredging work. Dredging and solids removal have occurred in the past, but the pond quickly fills in with solids and issues persist.

4.1.3 Double Pumping Water Supply to Hatchery Building

Well water is pumped up through the aeration tower and into a concrete vault underneath. Water then flows by gravity through the raceways from the vault. The current aeration structure and vault do not provide enough head pressure to direct water to the hatchery building. Instead, water for egg incubation and early rearing is pumped again from the vault up a small hill to the southeast corner of the hatchery building. This increases electrical costs for the facility and requires additional backup power and pumps to provide redundancies.

4.1.4 Well Pump and Motor Reliability

During the initial site visit, two wells were being rehabilitated (#3 and #4) with the remaining two wells (#5 and #6) being prepared to be contracted out for rehabilitation. According to CDFW staff, rehabilitation includes the replacement of pumps and motors, the addition of VFDs, and the addition of flow meters. At the time of the site visit, well #5 was used for the entire facility; historically it produced 5,400 gpm but was only capable of production 2,600 gpm because of aging equipment. Well #6 was reserved only as a backup source because of a malfunctioning electric motor that overheated within 20 minutes of operation. The four wells on site are the only water source used for the facility.

4.1.5 Hatchery Building Water Pressure

The Fillmore Hatchery recently increased its production in their hatchery building to accommodate the Mojave River Hatchery’s demand for fingerlings. Additional deep tanks were plumbed into existing supply lines in the hatchery building. There are concerns that the available water pressure for the building is not capable of operating all the necessary deep tanks or hatchery jars simultaneously.

4.2 Rearing Infrastructure

4.2.1 Deteriorating Raceways

There is inadequate drainage around the low elevation areas of the facility. Groundwater seeps are present during wet years and cause erosion and damage to the raceways. Due to significant deterioration and cracking in the raceways, groundwater seeps up between the asphalt and concrete during heavy precipitation years. Plant and algal growth are present throughout the raceway area. Additionally, 4 years ago, the raceways buckled and lifted approximately 10-inches due to excess groundwater beneath them. The presence of groundwater not only impacts the infrastructure of the hatchery, but also limits accessibility for the visiting public.

4.2.2 Raceway Predation Concerns

The raceways experience predation and in addition to the losses associated with predation, these predators also increase the risk of pathogens. 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.

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 or effectively use the existing infrastructure on-site. 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 Existing Infrastructure

The Fillmore Hatchery currently pumps groundwater to an aeration tower where it can be distributed to the existing raceways and hatchery building. The cost of purchasing and then pumping this water is significant and is increasing year over year. In addition, the existing raceways, hatchery building, and aeration tower are not able to meet the current fish production needs of the hatchery. The raceways are currently subject to uplift and/or subsurface erosion due to the presence of uncaptured springs in years where groundwater levels are high. Water from the effluent pond is prone to backing up into the existing raceways leaving the tail end of the raceways inoperable and reducing total rearing capacity. And finally, the existing aeration tower does not provide sufficient head to direct the flows needed to the existing hatchery building to support both early rearing and incubation.

The preferred alternative includes construction of a new hatchery building, grow out area, PRAS equipment, aeration tower, and a photovoltaic system. The existing raceway, hatchery building, and aeration tower would be maintained in place and connected to the new infrastructure for future hatchery needs.

5.1.2 Hatchery Building

A new 14,570 SF hatchery building is proposed that will house incubation and early rearing, intermediate rearing, and six (6) dedicated PRAS rooms. This would be a pre-engineered metal building (PEMB) with standard, easy to clean finishes. Each production room would have a dedicated HVAC system to maintain temperature and humidity, as well as lighting controls to aid production as needed.

The new building will be outfitted with 40 new deep tanks. The existing hatchery building and its deep tanks will be retained to provide additional production space and/or operational flexibility for the facility. The new hatchery building's deep tanks will provide incubation and early rearing space for 425,000 fish up to 300 fpp (2.2 inches) while keeping the DI below 0.3, a similar population size started in the deep tanks in Table 2-1. The deep tank system will be designed to operate with a total flow rate of 600 gpm (1.3 cfs), with 15 gpm of flow per tank; this will maintain an FI below 1.04. The space provided will allow the Fillmore Hatchery to receive and incubate up to 600,000 eggs in a single shipment, assuming their current approximate survival rate of 70% from egg to 300 fpp fingerling.

Once the fish are approximately 300 fpp, they can be transferred to the intermediate rearing system which will operate with 6 dedicated PRASs with 4 circular tanks each. Fish must readily accept pelleted feed to avoid water quality and equipment fouling issues associated with crumble feeds in a PRAS. The intermediate rearing system will consist of 24 circular tanks, each with a 10-foot-diameter, 3-foot water depth, and 4-foot wall height for a volume of 235 ft^3 (total system volume of 5,655 ft^3). The system will provide enough space to raise approximately 375,000 fish to 60 fpp (3.9 inches) before they are transferred to the grow-out system. The tanks will be organized into six modules (four tanks each module); each module will have associated water conditioning equipment including pumps, filtration, degassing, UV disinfection, chilling, and oxygenation.

Flow rates required for the intermediate system are based on the hydraulic residence time (HRT) of each tank, or the amount of time it takes to completely turn over the water in the circular tank. Timmons et al. (2018) suggest an HRT of 30 minutes for small to medium circular tanks that the intermediate system will have. A flow rate of approximately 60 gpm per tank is required for an HRT of 30 minutes. Each module of four tanks would then require a process flow rate of 240 gpm, or 1,440 gpm (3.2 cfs) for the entire system.

It is recommended that operations begin with a recirculation rate of 50% or less. As staff gain knowledge of the equipment and systems, recirculation can be increased to 75% without a biofilter. Recirculation equipment would be sized to accommodate a range of flow rates to operate up to a recirculation rate of 75%. Each module's recirculation equipment would be sized to treat and recondition a flow rate up to 180 gpm, with 60 gpm of fresh makeup water added to the module for a process flow rate of 240 gpm. The total fresh makeup water requirement for the intermediate rearing system would be 360 gpm while operating at 75% reuse.

Each system within this building will be equipped with sensors to track water quality and flow, and alarms to alert staff when a problem is detected. A supervisory control and data acquisition (SCADA) system would also be included to allow hatchery staff to record and adjust flows and water quality parameters as needed to maintain optimal rearing environments. This system could be set up to allow staff to monitor and make system adjustments remotely or from the hatchery office.

5.1.3 Grow-out System

A new 22,880 SF grow-out area will be included to house the grow-out system. The grow-out area will include a pre-engineered metal roof structure with chain-link fencing and predation netting on the sides.

The grow-out system will raise fish from 60 fpp to their final stocking size of 2 fpp (12 inches, catchable size) or 1 fpp (15.3 inches, super-catchable size) depending on the allotment. The grow-out system will have an approximate footprint of 22,880 SF and house 30 circular tanks each with a 20-foot diameter, 6-foot water depth, and 7-foot wall height for a tank volume of approximately 1,885 ft^3 (total rearing volume of 56,550 ft^3). The tanks will be organized into five (5) modules, each with six (6) tanks (11,304 ft^3) and their own dedicated PRAS. The PRAS will be housed in a separate PEMB building located adjacent to the grow-out area.

Flow rates for the grow-out system require an HRT of 45 minutes, according to guidance for larger circular tanks (Timmons et al., 2018). A single tank requires a total process flow rate of approximately 325 gpm, each module requires a flow rate of approximately 2,275 gpm (5 cfs), and the entire system a flow rate of 9,100 gpm (20.3 cfs). Implementing reuse systems will ensure that only a fraction of the process water will be made up of water pumped from the facility's wells.

It is recommended that early operations begin with a recirculation rate of 50% or less. As culturists gain knowledge of the equipment and systems the rate can be increased up to 75% without the need for a biofilter. Recirculation equipment including pumps, filtration, degassing, oxygenation, chilling, and UV disinfection systems would be sized to accommodate a range of flow rates to operate up to a recirculation rate of 75%. Each module's recirculation equipment would be sized to treat and recondition a flow rate up to 1,725 gpm (3.8 cfs), with 550 gpm of fresh makeup water added to the module to achieve a total process flow rate of 2,275 gpm. The entire grow-out system's fresh makeup water requirement would be 2,200 gpm (4.9 cfs) if all tanks were operating at the same time at a 75% recirculation rate.

The grow-out system will be equipped with sensors to track water quality and flow, and alarms to alert staff when a problem is detected. The grow-out system will also be connected to the new SCADA system previously discussed.

A summary of tank sizes and numbers for each proposed rearing system is shown in Table 5-1. The makeup water requirements for both 50% and 75% water reuse scenarios are included as well. The total makeup water requirements for 50% reuse is 13 cfs (5,835 gpm) and 7 cfs (3,145 gpm) for 75% reuse. During operations, it is unlikely that all systems and tanks within each system will be used simultaneously. The total flows are presented to represent the potential water requirements in a worst-case scenario. If CDFW prefers to maximize the use of the systems in the future, or if water costs increase significantly, the PRASs could be upgraded to full RASs (recirculation rates greater than 75%) by adding biofilters to each module. A biofilter would allow for higher recirculation rates and significant water savings, at the expense of increased complexity of the culture systems.

Table 5-1. Summary of Proposed Rearing Systems.

System	Tank Diameter (feet)	Number of Tanks	Total Rearing Volume (ft^3)	Makeup Water Requirements 50% Reuse	Makeup Water Requirements 75% Reuse
Early Rearing	Deep Tanks: 16’ long x 2.6’ wide x 1.3’ deep	40	2,163	1.3 cfs	1.3 cfs
Intermediate System	10	24	5,655	1.6 cfs	0.8 cfs
Grow-Out System	20	30	56,550	10.1 cfs	4.9 cfs

5.1.4 Water Supply

The existing well water supply line would be rerouted to deliver the required flows to a new aeration tower and head tank located between the new hatchery building and grow out area. Each well connected to the system will be upgraded to include variable frequency drives (VFDs) to provide increased flexibility and control of the hatchery water supply. The VFDs will be connected to the new SCADA system allowing staff to monitor and adjust incoming flows as needed based on production needs. The new aeration tower will include UV treatment for Costia, be designed to increase dissolved oxygen in the supply water to the desired level, and then deliver the treated water by gravity to each of the production areas or PRAS rooms as needed.

5.1.5 Power Supply

New propane-fed backup power generators would be installed to maintain production operations in the hatchery building and grow out areas during periods of power outages. The generators will be chosen to meet current air quality standards required for this area and sized to meet power needs of the hatchery during temporary outages. A new photovoltaic power generation system is also included to help offset the power requirements of the new hatchery infrastructure while also lowering the overall cost to operate the hatchery.

5.1.6 Effluent System

Discharge from the new hatchery building, grow-out area, and each of the PRAS modules will be piped to a new outfall located adjacent to the existing wetland pond the hatchery currently discharges to. The pond will be cleared of overgrown brush 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 5-2 provides a high-level summary of the pros and cons for Fillmore Hatchery's selected alternative.

Table 5-2. Pros/Cons of Selected Alternative – Fillmore Hatchery.

Description	Pros	Cons
Build a new hatchery building with solar power.	• Provides protection from predation and other outdoor elements (e.g., sunlight). • Improves biosecurity. • Offsets expensive energy requirements due to solar panels.	• Increases cost due to construction. • Does not use gravity flow. • May have permitting challenges.

Description	Pros	Cons
Add PRAS circular tanks for intermediate rearing.	• Allows young fish to be reared to a larger size before transferring into larger tanks with an increased number of tanks available. • Provides a healthier rearing environment for fish. • Provides an easy opportunity for staff to administer bath vaccinations. • Reduces the total pumping requirement and annual water cost. • Increases production flexibility at early life stages and throughout the lifecycle. • Can be expanded if needed. • Provides self-cleaning. • Concentrates waste for effluent treatment.	• Increases water requirements for early rearing. • Increases pumping needs. • Requires additional components (e.g., drum screen, UV, LHO, CO_2 removal). • Increases complexity.
Build a final rearing area with a covered roof with solar panels and a chain-link fence surrounding the area.	• Provides protection from predation and other elements (e.g., sunlight). • Offsets expensive energy requirements due to solar panels.	• Increases cost due to construction. • May have permitting challenges. • Slightly reduces rearing volume.
Connect wells to the headtank structure.	• Adds supply lines that are sized for appropriate pressure to operate all equipment. • Reduces total water use and cost.	• Increases cost. • Disrupts hatchery operations during construction.
Potential installation of solar panels (in addition to the solar installed on rooftops).	• Reduces annual power costs. • Has potential to sell back extra power generated from the photovoltaic system to the grid.	• Increases the footprint. • Increases cost due to construction.

Description	Pros	Cons
Upgrade the effluent system.	• Uses existing effluent discharge pond. • Increases effluent treatment volume.	• Disrupts effluent treatment and hatchery operation during dredging. • Requires coordination with adjacent landowners.
Add backup power generator(s).	• Provides power to all life support systems in the event of a power outage.	• Increases cost. • Increases complexity. • Increases maintenance. • Increases the risk of fish loss if system fails in a power outage.

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.

Booster Pump Installation: Due to a lack of driving head between the existing aeration tower and the existing hatchery building, a small booster pump is recommended to increase the supply line pressure to the deep tanks without losing the necessary flow.

UV Treatment: UV is recommended to be added to the existing system to treat incoming water for Costia.

Skim Coat Concrete Raceways: The existing concrete raceways are beginning to spall and deteriorate due to their age. The exposed rough aggregate can be harmful to fish, can promote increased algae growth, and be difficult for the hatchery staff to clean efficiently. Adding a coating to the concrete can help alleviate the spalling issues and reduce the rate at which the concrete surface continues to deteriorate. 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 caused by uplift from seasonal springs 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.

Effluent Pond Maintenance: The current pond used for effluent discharge is overgrown and not flowing efficiently. This causes discharge water to back up into the raceways and reduces production volume. The overgrown brush should be cleared to re-establish flows leaving the pond and allowing the raceway effluent to discharge as originally designed. Coordination with other entities within CDFW would likely be required.

5.4 Natural Environment Impacts

The proposed upgrades to the Fillmore Fish 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 Fillmore Fish Hatchery will change the existing infrastructure and the number of rigid structures onsite. However, they will not increase or decrease the fire risk. Based on the climate change evaluation, the projected fire risk will likely increase slightly over the coming decades.

Flooding is not a major risk associated with the hatchery; the facility's water is all supplied from well production. The area does have a relatively shallow water table, evident by seepage in the raceway area. The recommended changes will slightly increase the total impervious surface of the site, but it will not have a significant impact of flood risk at the facility. All upgrades will be designed to ensure stormwater runoff is directed away from hatchery infrastructure and towards approved discharge areas, effectively decreasing the impact of flooding on the facility. All fish production will occur in covered areas, reducing the susceptibility of damage to rearing infrastructure associated with the high-water table and natural springs.

5.4.2 Effluent Discharge

The hatchery is not connected to any surface waters and therefore does not fall under the regulation of NPDES requirements. Use of recirculating equipment will increase the concentration of solids waste in the discharge stream for the hatchery. The proposed upgrades include piping the new production systems to a new outfall and remediation of the existing effluent ponds. The upgrades will result in a more effective effluent area that requires less maintenance. Additionally, fish production will occur further away from the effluent area, eliminating negative impacts currently experienced with effluent water backing up into production raceways. In the future, a separate non-hatchery specific division of CDFW may designate the effluent area as an ecological reserve. This may require some management alterations for the Fillmore Hatchery (e.g., pumping additional water), but it should not impact hatchery production and have minimal impacts on the effluent system. Any management changes would be negotiated within CDFW by the Fillmore Hatchery and ecological reserve management.

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. 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. The intermediate rearing tanks would be located adjacent to the grow-out system, allowing for a fish pump to be used for the second transfer. 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 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 early rearing tanks enable the hatchery to raise young fish to the appropriate size for initial Lactococcosis vaccinations, or administer other chemical treatments as needed. Four vaccination/transfer tanks will be included in the early rearing and intermediate rearing area to use for bath/dip vaccination treatments and as short-term holding tanks for other fish culture activities (i.e., harvest, enumeration, etc.). Once fish are vaccinated, they will be transferred to the intermediate rearing tanks and eventually the grow-out system. Once in the grow-out system, fish will require additional handling to perform the injection vaccine to prevent Lactococcosis. Space is available in the grow-out system to leave some tanks empty as fish approach the target size of 20 fpp for their second vaccination. This would allow hatchery staff to vaccinate fish directly into an empty circular tank to optimize workflow. Alternatively, block nets or net cages may be used within the circular tanks to segregate fish pre- and post-vaccination or for other operational needs.

5.5.1 PRAS Circular Tank Operations

The intermediate and final rearing tanks will operate as PRAS systems 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. 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. The staggered production cycle provides some maintenance windows and opportunities for cleaning and disinfection. All PRASs should be programmed into the facilities 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 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, reduces staff labor (but reduces the staff's observations during feeding), requires adjustments to deliver the correct amount of feed, requires preventative and corrective maintenance and continued cost 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. The Fillmore Fish Hatchery reported several pathogens of concerns at the facility including Lactococcosis (causative agent *Lactococcus* spp.), Costia (*Ichthyobodo* spp.), bacterial gill disease (causative agent *Flavobacterium* spp.), and bacterial coldwater disease (causative agent *Flavobacterium psychrophilum*). The most likely pathways for pathogens to enter the Fillmore Hatchery and spread through the facility is transfer from the environment to existing water supply infrastructure through animals, birds, or people.

5.6.1 Incoming Water Supply

Fillmore currently has limited measures to prevent pathogens from entering the facility. However, the recommended alternatives improve biosecurity by managing and treating the incoming water supply before entering the hatchery building. The proposed upgrades also include a new head tank and aeration tower; these will be covered and protected to reduce the risk of exposing the water supply to pathogens in the environment.

5.6.2 Environmental Exposure/Bio Vectors

The primary source of exposure for potential pathogens is the existing aeration tower, concrete raceways, and routine fish culture activities. The proposed upgrades would transition production away from the exposed raceways and into a covered structure with tighter predator exclusion infrastructure. Staff have recently experienced issues with pathogens in the hatchery building; the proposed upgrades for the facility would incorporate UV disinfection for the hatchery building water supply. Water treatment will reduce pathogen loads for the water supplied to early life stages of fish most susceptible to infection and disease. Upgrades for the aeration tower and proposed head tank will also provide a more protected water distribution system relative to the current aeration tower. Maintaining clean water distribution equipment will lower the risk of harboring pathogens that could be spread through the hatchery's water supply.

5.7 Water Quality Impacts

Replacing the existing concrete raceways with 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.

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, and 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 waste will be directed to a new outfall to the remediated effluent area. The current water supply is already of relatively high quality, but the recommended alternatives would still offer some improvements. The new head tank and aeration tower will be more protected from the environment, reducing potential for algal growth on the equipment. The hatchery building's water supply will also be treated with a UV disinfection system to reduce pathogen loads. Improved intake structures will reduce the debris entering the facility and improve the water quality in the hatchery building, production areas, and broodstock rearing. Furthermore, the repaired drum screen and UV water treatment system on the upper raceways will reduce solids and risk of pathogens.

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 contingency, overhead, profit, and bond rate 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 below. For purposes of this project, McMillen has utilized an accuracy range of -30% to +50% in the estimates presented in Table 6-2.

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.
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.

Criteria	Details
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 total cost for installation including any applicable taxes.
- The cost estimate is at a Class 5 level with an accuracy range of -30% to +50% and includes a 35% 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 Fillmore Fish 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 $1,110,641 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 Fillmore Fish 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 has a significant amount of barren land. With strategic planning and development, the site is well-positioned to meet its energy needs, currently reaching 78% of the required capacity. To achieve net-zero energy, an additional 55,000 square feet of green space would need to be covered with PV panels.

6.6 Alternative Cost Estimate

The following table illustrates the estimated costs for the alternative evaluated and depicted within the figures in Appendix C.

Table 6-2. Alternative Cost Estimate.

Item	Estimate
Division 01 - General Requirements	$ 5,540,000
Division 02 – Existing Conditions	$ 50,000
Division 03 - Concrete	$ 2,510,000
Division 05 - Metals	$ 370,000
Division 08 - Openings	$ 160,000
Division 13 – Special Construction	$ 15,891,000
Division 23 - Mechanical & HVAC	$ 654,000
Division 26 - Electrical	$ 5,040,000
Division 31 - Earthwork	$ 425,000
Division 32 – Exterior Improvements	$ 263,000
Division 40 – Process Water Systems	$ 2,340,000
2024 CONSTRUCTION COST	**$ 33,243,000**
Contingency (25%)	$ 8,311,000
Overhead (6%)	$ 1,995,000
Profit (8%)	$ 2,659,000
Bond Rate (1%)	$ 333,000
2024 CONSTRUCTION PRICE	**$ 46,541,000**
Design (10%), Permitting (2.5%) and Construction Support (2.5%)	$ 6,981,000
Geotechnical	$ 25,000
Topographic survey ($1000/acre)	$ 20,000
PROJECT TOTAL	**$ 53,522,000**
Accuracy Range +50%	$ 80,283,000
Accuracy Range -30%	$ 37,466,000
Photovoltaic (Full kW Required)	$ 12,438,900
Photovoltaic (Space Available kW)	$ 9,579,600

7.0 Fillmore Trout Hatchery Environmental Permitting

The proposed Project would involve modifications to the existing hatchery supply water delivery and the construction of new hatchery facilities and associated infrastructure. A list of anticipated permits, agency review time, submittal requirements, and supporting documentation for the proposed project are summarized in Table 7-1, Table 7-2, and Table 7-3. The review timeframes are estimates and are based on the recommendations presented in permit guidance documentation and experience with other permitting projects in the State of California.

We have reviewed the hatchery location through online mapping tools (USFWS IPAC and California 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 indicate that the site does have the potential for species to be present that have been 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 likely need to be prepared prior to consultation with federal and state agencies.

This list was developed at a high level for this phase of the project. Some permits may be eliminated while the need for 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
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

Agency and Permit/Approval	Submittal / Document Type	Supporting Documentation	Anticipated Time Frame	Notes
USFWS ESA Section 7 Consultation	Biological Assessment	Field surveys of affected area, Design Package	4 months	The site has 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 be 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	NA	1-3 months	Required for hatchery intake diversions.
Los Angeles 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	NA	4 months	NA

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	NA	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 one acre.

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

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

7.1 National Pollutant Discharge Elimination System (NPDES) Permitting

The Fillmore Trout Hatchery is not classified as a cold water Concentrated Aquatic Animal Production (CAAP) facility and is not connected to any state waters. EPA recommends coordinating with CDFW to determine NPDES coverage needs for non-CAAP facilities.

7.2 Water Rights

Water rights documentation can be obtained from CDFW if requested by an agency.

8.0 Conclusions and Recommendations

This report provides a summary of the state of the Fillmore 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 provide projections to forecast changes that may be experienced at the hatchery. In general, significant increases in air temperatures are expected at Fillmore. Additionally, there will be an increasing risk of wildfire as the climate changes.

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. Increasing 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:

- Constructing a hatchery building to house incubation, early rearing, and intermediate rearing will eliminate early rearing conflicts and allow for indoor vaccinations.
- Replacing flow-through style raceway production with circular dual-drain tanks utilizing PRAS can reduce the amount of water that is pumped to raise fish and provides improved effluent handling and treatment.
- Improving the treatment of the incoming water will provide improved flow control and protection against pathogens such as Costia.
- Replacing pipes and valves that are near the end of their effective lifespan, are currently inoperable, or leaking due to age.
- Covering all rearing vessels with solid roofs or fully enclosed buildings will reduce the impacts of increased heat for both the fish and the employees.
- Adding backup power generators will ensure that hatchery staff can maintain production operations during periods of power outages.
- Improving the effluent system will allow discharge flows to efficiently flow away from the hatchery and reduce the risk of water backups.
- Installing solar panels atop new structures and in available space onsite will offset some of the power demands associated with new hatchery equipment.

The proposed upgrades to Fillmore 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 cost estimate of the proposed design modifications is $53,522,000.

9.0 References

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