APPENDIX E-1

SUPPORTING DOCUMENTATION FOR DEVELOPMENTAL ANALYSIS, PREFERRED PLAN AND ALTERNATIVES PROPOSED BY OTHERS

ATTACHMENT E

PURPOSE, DESCRIPTION, AND PRELIMINARY LAYOUT OF PROPOSED FALL-RUN CHINOOK SALMON RESTORATION HATCHERY

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PURPOSE, DESCRIPTION, AND PRELIMINARY LAYOUT OF PROPOSED FALL-RUN CHINOOK SALMON RESTORATION HATCHERY

DON PEDRO PROJECT
FERC NO. 2299



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Modesto Irrigation District

Prepared for:
Turlock Irrigation District – Turlock, California
Modesto Irrigation District – Modesto, California

Prepared by:
HDR, Inc.
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September 2017

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1.0 STATEMENT OF PURPOSE AND NEED

The viability of the Tuolumne River fall-run Chinook salmon population would benefit from the supplementation and genetic management provided by creating a Tuolumne River Fall-run Chinook Restoration Hatchery Program (Attachment A and B). The current regulatory status and general abundance of fall-run Chinook in the Tuolumne River is not in peril and the population is not listed under the Endangered Species Act; however, specific issues exist that would benefit from forward-looking planning and action. Researchers, notably Lindley et al. (2007), have identified that the long-term management of a healthy population of fish species is composed of many factors that include population demographics (e.g., abundance, population growth, distribution) and genetic integrity (McElhany et al. 2000). Conventional hatchery management programs have focused primarily on production and resulting abundance of salmon within the respective river as a key indicator of health. Managing the health of the Tuolumne River fall-run Chinook population based solely on abundance may not be a sufficient standard of measurement.

A primary reason that abundance is an insufficient metric of population health is the influx of returning fall-run hatchery Chinook errantly entering the Tuolumne River, when their origin is from another basin hatchery (i.e., Merced, Mokelumne, and Coleman [Battle Creek] hatcheries). These strays inflate population counts, alter the genetic integrity of the Tuolumne River origin fall-run Chinook, and may result in degradation of the natural population. Lindley et al. (2007) caution that reproducing hatchery fish that are not actively managed may be a potentially serious threat to a local in-river population where traits are shifted away from local populations towards broader distributions (Emlen 1991; Lynch and O'Hely 2001; Ford 2002; Goodman 2005).

The rate of out-of-basin hatchery straying into the Tuolumne River was highlighted in a recent otolith study conducted by Modesto Irrigation District (MID) and Turlock Irrigation District (TID) in 2016. The microchemistry of salmon earstones or otoliths can be examined to determine if the individual was naturally produced in-river or from a hatchery. It is important to note that any hatchery fish in the Tuolumne River is from out-of-basin, as there is currently not any local hatchery supplementation in the reach of river below the La Grange Diversion Dam. The study examined five years of otolith samples collected from the Tuolumne River provided by CDFW ranging from 1998-2000, 2003, and 2009. Combining the outmigration year unmarked hatchery contribution estimates with the known marked fish from subsequent escapement year surveys found that the total estimated hatchery contribution ranged from 39 to 100 percent, with a mean of 67 percent and generally increased hatchery contribution in later years (Table 1.0-1). Results from the 2016 study (Table 1.0-1) indicate that the proportion of hatchery fish was lowest in 2000 (39 percent) and peaked in 2010 (100 percent). Following 2010, the 2011 and 2012 years respectively marked the second and fifth highest proportions of hatchery fish overall.

Table 1.0-1. Estimated total hatchery contribution to annual escapement for spawner years corresponding to the five outmigration years included in the otolith study.

Spawner Year	CDFW Spawner Surveys			Including Unmarked Hatchery Fish (All Otolith Samples)			Including Unmarked Hatchery Fish (Age-3 Otolith Samples Only)		
	Escape-ment[1]	Fraction Marked[2]	Marked Fish[2]	Unmarked Hatchery	Total Hatchery	Fraction Hatchery	Unmarked Hatchery	Total Hatchery	Fraction Hatchery
2000	17,873	6%	1,157	5,742	6,899	39%	5,207	6,364	36%
2001	9,222	16%	1,464	2,466	3,930	43%	2,667	4,131	45%
2002	7,125	31%	2,175	1,824	3,999	56%	1,566	3,742	53%
2005	719	11%	82	396	477	66%	396	477	66%
2006	625	1%	7	481	488	78%	-	-	-
2010	766	32%	245	521	766	100%	-	-	-
2011	2,847	55%	1,566	982	2,548	90%	982	2,548	90%
2012	2,120	29%	615	753	1,367	65%	-	-	-
Mean						67%	Mean		58%

[1] Data source: Stillwater Sciences (2013).
[2] Data sources: Annual CDFW spawning survey reports (e.g., CDFG 2010) and annual FISHBIO weir monitoring reports (e.g., Wright et al. 2013).

TID and MID installed two fish counting weirs in the Tuolumne River near the La Grange facilities. The weirs operated almost continually from September 23, 2015 to April 15, 2016 (2015 season) and September 15, 2016 to April 30, 2017 (2016 Season). Overall, 28.2 and 28.5 percent of Chinook salmon observed at the tailrace and main channel weirs were ad-clipped for the 2015 and 2016 monitoring seasons, respectively. The ad clip signifies hatchery origin. Hatchery marking protocol requires for 25 percent of Central Valley fall-run Chinook salmon to be marked annually. Since, there is no hatchery in the Tuolumne River, this suggests that nearly all Chinook salmon entering the lower Tuolumne River and in the vicinity of the La Grange facilities during the study period were hatchery strays.

Lindley et al. (2007) suggest that out-of-basin hatchery strays should not exceed 5 percent of the total return and that 10 percent was considered a 'high risk' to population viability. In the lower Tuolumne River, the lower end of the range of stray contribution (39 percent) was relatively high, but the upward trend (e.g., 39 percent in 2000 and 100 percent in 2010, Table 1.0-1) and high mean (67 percent) suggest that the proportions of strays are increasing over time. In addition, the reported straying rates were further supported by other research by Barnett-Johnson et al. (2007) and Johnson et al. (2011), which showed similar levels of straying in the Central Valley. At these stray rates, assuming similar contribution rates, the traits within the local population would be more influenced by the external hatcheries than the local environment.

The future of the Tuolumne River fall-run Chinook salmon population is challenged by minimal levels of natural in-basin reproduction and an overwhelming influx of strays promoting competition for resources and increasing population introgression. Only when the hatchery contribution is from an in-basin wild broodstock program using best management practices, is the hatchery enhancement benefit realized (Lindley et al. 2007). The influence and impact of out-of-basin Chinook will be reduced by prioritizing naturally produced local broodstock through conservation hatchery management and processing practices.

While a restoration hatchery can lower the ratio of adult hatchery strays (by increasing the potential for local origin Chinook) and improve genetic integrity, there are other challenges for fall-run Chinook salmon that include predation (both in- and out-of-basin) and out-of-basin water quality conditions in the San Joaquin River and Bay-Delta. These issues or unnatural disturbances contribute to lower survival of fall-run Chinook and may impact the long-term success of developing a local fall-run Chinook salmon population in the Tuolumne River (NMFS 2015). Separate actions are planned to address in-basin predation. The proposed Tuolumne River Restoration Hatchery Program does not directly address out-of-basin issues; however, a restoration hatchery will improve the resiliency of the local population. Resiliency, described as the ability for a population to remain unchanged during or after a disturbance (Elmqvist et al. 2003), will be improved by supporting population numbers through production of genetically diverse local stock.

Currently, the local stock of fall-run Chinook in the Tuolumne River is not genetically managed. Creating a restoration hatchery will be part of actively managing basin production, prioritizing Tuolumne-origin adult broodstock, and reducing the potential for stray-dominated production. The restoration hatchery may serve to supplement the current escapement size, however, the primary goals are to enhance phenotypic diversity and bolster self-sustaining, naturally reproducing, local origin salmon in the lower Tuolumne River. The long-term goal of the restoration facility will be to maximize genetic diversity and increase life history diversity of a local origin stock. Implementing elements of naturalized rearing, and variable hatchery releases (i.e., fry, parr, or smolt) are intended to improve post-release survival. Enacting this forward-looking management approach will allow for flexibility, adaptive management, and a greater potential for sustained healthy runs of fall-run Chinook in the lower Tuolumne River.

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PURPOSE, DESCRIPTION, AND PRELIMINARY LAYOUT OF PROPOSED FALL-RUN CHINOOK SALMON RESTORATION HATCHERY

ATTACHMENT A

PROGRAM DESCRIPTION AND PERFORMANCE INDICATORS

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PURPOSE, DESCRIPTION, AND PRELIMINARY LAYOUT OF PROPOSED FALL-RUN CHINOOK SALMON RESTORATION HATCHERY

PROGRAM DESCRIPTION AND PERFORMANCE INDICATORS

DON PEDRO PROJECT
FERC NO. 2299



TID WATER & POWER
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MID Modesto Irrigation District

Prepared for:
Turlock Irrigation District – Turlock, California
Modesto Irrigation District – Modesto, California

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1.0 PROGRAM DESCRIPTION

As part of the FERC relicensing proceeding of the Don Pedro Hydroelectric Project, which is owned by the Modesto Irrigation District and Turlock Irrigation District, Protection, Mitigation, and Enhancement (PM&E) measures for fish and aquatic resources are being proposed. A PM&E measure under consideration is a facility that artificially propagates fall-run Chinook salmon to support the restoration of the local Tuolumne River stock. This restoration program, titled the Fall Chinook Program, is the subject of this plan, with guiding principles and operational parameters developed in collaboration with hatchery technical experts. Central to this program will be the construction and operation of a Tuolumne River Fall-run Chinook Restoration Hatchery (Tuolumne Restoration Hatchery). The Tuolumne Restoration Hatchery is conceived of as a restoration-oriented, adaptively managed program based on sound, salmonid-specific genetic and ecological principles to maximize genetic diversity, enhance natural life-history strategies and to improve post-release survival.

The Fall Chinook Program goal would be to enhance the phenotypic diversity (e.g., behavioral life-history) and population size of the self-sustaining, naturally-reproducing salmon population in the lower Tuolumne River. Fall-run Chinook salmon used as broodstock would be collected locally from the lower Tuolumne River. Temporary holding and screening would be associated with adult collections, with unwanted individuals (e.g., strays from other hatcheries) returned to the river. Broodstock selection will likely be the most significant operational activity modulating program success and must be a focus of biological planning processes. Juveniles would be released from the facility at various life-stages and across release strategies in order to facilitate performance evaluations. Production and release goals underlying the Fall Chinook Program are based on supporting documents (e.g., NMFS 2014[1]) and scientific best-practices.

The Districts propose to fund CDFW's operation of the hatchery for a period of 20 years. The hatchery's role of supplementation would be reevaluated at that time and either cease operations or continue, depending on the health of the Tuolumne River fall-run Chinook population.

1.1 Scope of Operations

From a design perspective, spawning 250 pairs of Chinook salmon annually would equate to an effective size of greater than 500 (or manipulated to be). An effective size of 500 (per generation) is a threshold consistent with a recovered population (NMFS 2014). Therefore, using 250 pairs annually for spawning would be conservative. Total broodstock would be acquired from adults screened weekly over a duration of 2-3 months. The capacity of temporary holding facilities is being designed to accommodate 500-1,000 adults weekly from which spawners will be acquired, although adult returns are expected to vary annually and may not reach projections. Approximately 800,000 juveniles in total are expected to be released annually from the facility at various life-stages given the broodstock target.

[1] National Marine Fisheries Service. 2014. Recovery plan for the evolutionarily significant units of Sacramento River winter-run Chinook salmon and Central Valley spring-run Chinook salmon and the distinct population segment of California Central Valley steelhead. California Central Valley Area Office. July 2014.

1.2 Operations

Adults returning to the facility would be considered for use as broodstock, where screening for both maturity status and origin would occur. Fish kept for brood would be those that met biological plan criteria for being appropriate broodstock candidates. Initially, there would be limited means to evaluate broodstock source, other than collection locality and physical indications of hatchery origin (e.g., adipose fin absence; presence of coded wire tag). Nevertheless, fish originating from hatcheries external to Tuolumne River Hatchery-origin would be excluded from broodstock to the extent possible. Use of Tuolumne Restoration Hatchery program fish, wild Tuolumne River fall-run and wild non-Tuolumne River fall-run Chinook salmon will be prioritized in biological plans. It seems reasonable to assume that regional monitoring requirements external to the project described here (e.g., Hatchery Reform) will enable all hatchery fish to be identified through genetic or other means. Therefore, over the course of the restoration program, the capability of the Tuolumne Restoration Hatchery Program to exclude foreign hatchery and non-local fish will increase. To the degree possible, information regarding origin should be used in order to promote the maximum inclusion of diverse Tuolumne River produced fall-run Chinook. Mechanistically, adults returning over a 2-3 month window would need to be temporarily held in various staging areas. Age-3 and Age-4 adults would be preferably used for spawning. During development of biological plans the use of Age-2 (mini-jacks) should be evaluated, but these fish likely would be excluded from broodstock, if possible. Fish not incorporated into the program as broodstock would likely be released, but sacrifice or some other form of adult management can be agreed to during planning phases in consultation with fishery agencies.

Spawning (mating) is expected to be performed in standard 1 to 1 crosses, unless diversity measures indicate a partial-factorial design is required. Mate selection procedures (e.g., relatedness based) would likely occur to ameliorate the potential for unintentional mating of relatives. With a robust mating scheme implemented, husbandry could progress similarly to a standard production hatchery. While the facility would not necessarily need to explicitly manage individual families during early rearing, flexibility in how families are housed would be needed in order to enable evaluation of life-history diversification.

Juveniles are expected to be released from the facility into the lower Tuolumne River at various life-stages without the use of specific acclimations site(s). Current projections are for 73,000, 260,000, 307,000, and 122,000 juveniles to be released as remote site incubators, fry, parr, and smolts, respectively. Adding a 5 percent contingency would equate to an 800,000 projected total release size annually. Releases should have no overlap of family groups (siblings) across release strategies in order to facilitate performance evaluations using genotype tagging and parentage methods.

2.0 MONITORING AND EVALUATING PERFORMANCE INDICATORS

Program performance standards will be developed as part of the biological planning processes. The performance standards agreed to will dictate the monitoring variables to collect in order to evaluate the indicators of performances. Given the need to develop general program operating costs, preliminary monitoring standards will be listed as a means to document rationale for costs.

- Increase life-history diversity of Tuolumne River fall-run Chinook.
- Genetic characteristics of broodstock are representative of desired source.
- Genetic diversity within hatchery-produced juvenile fish is representative of source.
- Improve post-release survival of hatchery-produced juvenile fish.
- Performance assessment conducted using sufficient and scientifically defensible design.
- Facility operated in compliance with fish health policies and guidelines.

2.1 Estimated Program Costs

Genetic data production to support program operation would be on the order of $300,000 annually (including potential for otolith microchemistry). An additional $100,000 annually would likely be required for program coordination and evaluation of performance indicators. Metrics included in this annualized cost are shown in Table 2.1-1. Hatchery performance costs do not include hatchery staff (e.g., brood collection), but these costs would be included in facility design documentation. Broodstock would likely be PIT tagged, which would enable a practical connection between any given fish and its genetic information prior to spawning. Minimal incremental costs would be associated with PIT tagging broodstock. Further, all juveniles released from the facility would be genetically tagged (intrinsically) as a result of broodstock selection activities. Therefore, no costs would be incurred for juvenile tagging unless physical tags are requested for a purpose other than described here.

There are activities external to the hatchery itself that will be required to evaluate hatchery performance. These activities may be included within other fish and aquatic PM&E measures. Key activities are shown in Table 2.1-2. Annual O&M costs would primarily be associated with spawner census and juvenile production estimation. Implementation of hatchery parental-based tagging (PBT) Central Valley wide as part of regional monitoring enhancements would also provide operational benefits to the Tuolumne Restoration Hatchery by improving broodstock selection capability. Full implementation of PBT (Central Valley wide) would be on the order of $350,000 annually. These costs should not be included within the Don Pedro Hydroelectric Project relicensing agreement. The PBT cost share associated with the Don Pedro Hydroelectric Project relicensing agreement is already incorporated into the genetic data production O&M costs above. Funds to implement PBT outside the Tuolumne River program would likely be derived from State (Department of Water Resources) and Federal (U.S. Bureau of Reclamation) sources responsible for protected species monitoring in association with State Water Project and Central Valley Project operations. Additional funds could be derived from facility specific O&M agreements.

Table 2.1-1. A summary of performance indicators for evaluating program.

Indicator	Population Segment	Method	Annual O&M Cost
Broodstock origin	Hatchery broodstock	Population assignment Parentage	$100,000
Broodstock relatedness	Hatchery broodstock	Relatedness	
Successful breeders census	In-river population	Rarefaction	$100,000
Effective number of breeders	Hatchery broodstock In-river population	Parentage Linkage disequilibrium	
Recruits per spawner	In-river population Release treatment	Parentage	
Survival by life-history strategy	Release treatment	Parentage	
Factors effective recruitment	Tuolumne River	GLM	
Relative recruitment	TBD	Parentage	
Total Annual O&M			$200,000

Table 2.1-2. A summary of indicators related to proposed restoration hatchery program.

Indicator	Population Segment	Method	Annual O&M Cost
Spawner escapement	Tuolumne River	TBD (carcass survey)	Costs included in separate document
Broodstock origin	Central Valley	Parentage	N/A
Juvenile production	Tuolumne River	Rotary screw trap	Costs included in separate document
Recruits per spawner	Tuolumne River	Rotary screw trap	Costs included in separate document
Sex ratio	Inferred from carcass recoveries	Inferred from successful breeders Inferred from juvenile genotypes	Costs included in separate document
pHOS	Hatchery broodstock In-river population	Marking and tagging	Costs included in separate document
Natal reconstruction of escapement	Hatchery broodstock In-river population	Otolith microchemistry	$200,000
Size at emigration	Tuolumne River	Otolith microchemistry	
Survival by life-history strategy	Tuolumne River	Otolith microchemistry	
Total Annual O&M			$200,000

PURPOSE, DESCRIPTION, AND PRELIMINARY LAYOUT OF PROPOSED FALL-RUN CHINOOK SALMON RESTORATION HATCHERY

ATTACHMENT B

CONCEPT-LEVEL DESIGN

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PURPOSE, DESCRIPTION, AND PRELIMINARY LAYOUT OF PROPOSED FALL-RUN CHINOOK SALMON RESTORATION HATCHERY

CONCEPT-LEVEL DESIGN
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1.0 OVERVIEW

The information contained in this document summarizes a concept-level design for the Tuolumne River Fall-run Chinook Restoration Hatchery. The facility is conceived of as a restoration-oriented, adaptively managed program based on sound, salmonid-specific genetic and ecological principles to maximize genetic diversity, enhance natural life-history strategies, and to improve post-release survival. The design of the facility is to be more nature-like with the ultimate goal of transitioning to zero use of hatchery origin fish.

1.1 Location

The location is tentatively sited on the north side of the Tuolumne River across from the town of La Grange. It is east of La Grange Road and west of Gasburg Creek (Figure 1.1-1, on page B-15). The site is approximately four miles downstream from La Grange Diversion Dam. The location is tentative, subject to verification of ownership, availability, and suitability for hatchery operations, as field investigations, environmental assessments, and other permitting requirements have not been determined.

1.2 Biological Program

1.2.1 Phenotypic Diversity

One stock of fall Chinook will be propagated, with the capability of partitioning production into two separate divisions (groups). Additional female adults will be held (295) to account for pre-spawning mortality (15 percent) providing the target of 250 pairs annually for spawning as discussed in Attachment A (Program Description and Performance Indicators) of this document. The 250 pairs will produce 1,250,000 eggs, which will provide the required 1,110,000 eggs (550,000 per group). Any excess eggs/fish will be evaluated for providing additional releases or removed from the program. The fish would be genotype tagged (parental based tagging). Families will not be completely segregated during rearing within the facility (except during incubation), although any given family will not be present in greater than one release strategy. The two primary groups will be kept separate. Spawning 500 adults (250 females) is projected to produce 800,000 juveniles that will be released annually into the Tuolumne River at different life stages (eggs, fry, parr, and smolts). There will be no offsite acclimation facilities associated with this program.

1.2.2 Broodstock

Broodstock for the hatchery will be collected at the barrier weir located at River Mile (RM) 25.5 and trucked to the hatchery. Adults collected (3 and 4 year olds are preferred) will be segregated between ripe and non-ripe. Fish not suitable for the program may be returned to the river or their fate may be determined in consultation with the appropriate regulatory agency. There will be no captive broodstock program. Broodstock would be acquired on a weekly basis in the fall over a duration of two to three months.

1.2.3 Space and Flow Calculations

Specifications and assumptions for a restoration type facility are presented in Table 1.2-1. This information forms the basis of determining the amount of space for all life stages and the flow requirements for each life stage.

Eight-hundred thousand (800,000) juveniles have been segregated into the following release strategy:

Eyed Eggs (released into remote site incubators – RSIs):	76,650
Fry	273,000
Parr	322,350
Smolts	128,100
Total	800,100

These releases form the basis of determining the number of eggs/fish required over time, which incorporates a prescriptive mortality from the specifications and assumptions. The number of eggs/fish held on site for any given week is presented in Tables 1.2-2, 1.2-3, and 1.2-4, on pages B-5 and B-7. Note that all offspring from a single mated pair will reside completely within a single release strategy. Tables 1.2-2, 1.2-3, and 1.2-4 present the most conservative approach where the spawn date is on November 13, which is the middle of the returning adult run. Actual operations will experience spawning over multiple weeks, which will stagger use of the facility over time. Tables 1.2-2, 1.2-3, and 1.2-4 reflect Group 1, which is half the total program. Group 2 rearing is a duplication of Tables 1.2-2, 1.2-3, and 1.2-4. Therefore, all numbers in Tables 1.2-2, 1.2-3, and 1.2-4 are doubled to reflect the actual space and flow requirements.

Table 1.2-1. Specifications and assumptions.

Target Number at Transfer		Target	Target +5% Cont.	Group 1	Group 2
	RSI	73,000	76,650	38,325	38,325
	Fry	260,000	273,000	136,500	136,500
	Parr	307,000	322,350	161,175	161,175
	Smolt	122,000	128,100	64,050	64,050
		762,000	800,100	400,050	400,050
Anticipated Survival					
		Green to first feed	First feed to release		
	Chinook	**72.2%**	**75.0%**	(HDR 2012)[1]	
			Adult prespawning		
			85.0%		
Incubation					
Female fecundity		**5,000 / female**	(HDR 2012)[1]		
Single stack flow rate					
	Chinook	**6 gpm**	HDR Recommendation		
Temperature units – fert. to first feed					
	Chinook	**1,440 TU**	(HDR 2013)[2]		
Rearing					
Length at first feeding					
	Chinook	**1.45 in.**	(HDR 2012)[1]		
Fish per pound at first feeding					
	Chinook	**1,116 fish/lb**	(HDR 2012)[1]		

Condition factor					
	Chinook	**2.96E-04 C=**	(Piper et al. 1982)[3]		
Temperature units/inch growth					
	Chinook	**650 TU/in**	(HDR 2012)[1]		
Maximum density index for early rearing troughs, raceways, and circulars					
>= 600 fpp	Chinook	**0.30 lb/cf/in**	(HDR 2012)[1]		
<600 fpp	Chinook	**0.15 lb/cf/in**	(HDR 2012)[1]		
Feed conversion					
	Chinook	**1.0:1**	(HDR 2012)[1]		
Adult Holding					
		Area Req.			
	Chinook	**10 cf/adult**	(HDR 2013)[2]		
		Inflow Req.			
	Chinook	**1.0 gpm/adult**	(HDR 2013)[2]		
Rearing Units					
		Available Rearing Volume (cf)	Unit Design Flow Rate (gpm)	Exchange Rate per Hour	
Early rearing (16x3x2.5 linear)		139.5	60.0	4	Max exchange rate for design flow
Growout (16' circular)		704	175.0	2	Max exchange rate for design flow
Site Specifications/Flow Calculations					
Site elevation	283 ft				
Available total inflow	15 cfs				
Salinity	0.00 Assumed				
Ammonia	0.00 Assumed				
pH	7.3 Assumed				

Water Temperature Profile

Code	**Month**	**River °F**	**Fl @ 0 MSL**
1	Jan	52	1.67
2	Feb	52	1.67
3	Mar	53	1.61
4	Apr	54	1.55
5	May	54	1.55
6	Jun	56	1.45
7	Jul	56	1.45
8	Aug	57	1.41
9	Sep	56	1.45
10	Oct	54	1.55
11	Nov	54	1.55
12	Dec	53	1.61

Temperature profile based on data from client.

Flow index values from Piper et al. (1982).[3] Flow index (Fi) maintains minimum of five p.p.m. effluent D.O.

[1] Source: HDR Engineering, Inc. 2012. Biological and Design Criteria for the San Joaquin Conservation and Research Facility. Prepared for The California Department of General Services and The California Department of Fish and Game.
[2] Source: HDR Engineering, Inc. 2013. Wells Hatchery Modernization Master Plan, Volume 1. Prepared for Douglas County Public Utility District No. 1.
[3] Source: Piper, R.G., I.B. McElwain, L.E. Orme, J.P. McCraren, L.G. Fowler, and J.R. Leonard. 1982. *Fish Hatchery Management*. U.S. Fish and Wildlife Service, Washington, D.C.

To summarize, the number of single stack incubators required is 32 (16 per group). The fry trough requirement is 18 (9 per group). An additional six fry troughs have been included for sorting, grading, and additional space for family tracking if necessary. The circular tank requirement is 10 (5 per group). An additional two tanks are provided, with additional space for reasons listed above. Flow requirements are presented in Tables 1.2-2, 1.2-3, and 1.2-4. Note that for the troughs and circular tanks the minimum gpm required is based upon oxygen consumption, while the flow utilized (Tables 1.2-2, 1.2-3, and 1.2-4) is based upon exchanges per hour, which is necessary to maintain a minimum sweeping velocity for settle-able solids.

Table 1.2-2. Number of juvenile fish in Group 1 based on life stage.

Life Stage	Number of Fish
Total Eyed Eggs	38,325
Total Fry	136,500
Total Parr	161,175
Total Smolt	64,050
Total Group 1	400,050

Table 1.2-3. Group 1 space and flow requirements (incubation).

Incubation													
Date	**Event**	**Location**	**Incuba-tion Days**	**River Temp (°F)**	**TU**	**Cumula-tive TU**	**# Released**	**Req'd Eggs[1]**	**Req'd Females**	**Families per Tray**	**# of Trays**	**# Single Stacks[2]**	**GPM Req'd**
11/13/2016	Spawn	Heath Trays	1	54	22			554,086	111	1	111	16	96
11/20/2016		Heath Trays	7	54	154	176		554,086		1	111	16	96
11/27/2016		Heath Trays	14	54	154	330		554,086		1	111	16	96
12/4/2016		Heath Trays	21	53	147	477		554,086		1	111	16	96
12/11/2016		Heath Trays	28	53	147	624		554,086		1	111	16	96
12/18/2016		Heath Trays	35	53	147	771		554,086		1	111	16	96
12/25/2016		Heath Trays	42	53	147	918		554,086		1	111	16	96
1/1/2017		Heath Trays	49	52	140	1,058		554,086		1	111	16	96
1/8/2017	RSI Release	Heath Trays	56	52	140	1,198	38,325	554,086		1	111	16	96
1/15/2017		Heath Trays	63	53	147	1,345		515,761		1	104	15	90
1/22/2017		Heath Trays	70	54	154	1,499		515,761		1	104	15	90

1 Approximately 12 percent egg surplus for contingency.
2 Assumes seven trays are utilized.

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Table 1.2-4. Group 1 space and flow requirements (growout).

Growout																
Date	**Event**	**Location**	**Days Post Hatch**	**River Temp (°F)**	**Length (in)**	**Fish per Pound**	**# Released**	**# Fish**	**Weight (lbs)**	**Min GPM Req'd**	**Flow Index**	**Flow Utilized**	**Rearing Volume Req'd (cf)**	**Density Index (lbs/cf/in)**	**Min Units Req'd**	**Units Utilized**
1/22/2017	Transfer to Troughs	Rearing Troughs	1	52	1.4	1,291.7		450,493	348	168	1.505	180	621	0.407	3.1	3
1/29/2017		Rearing Troughs	7	52	1.5	986.3		441,454	447	197	1.505	240	797	0.372	4	4
2/5/2017		Rearing Troughs	14	52	1.6	770.1		430,909	558	227	1.505	300	996	0.342	4.9	5
2/12/2017		Rearing Troughs	21	52	1.8	612.8		420,363	685	257	1.505	360	1,221	0.317	6.1	6
2/19/2017		Rearing Troughs	28	52	1.9	495.5		409,818	825	289	1.505	420	1,472	0.296	7.3	7
2/26/2017	Fry Release	Rearing Troughs	35	52	2	406.4	136,500	399,272	981	322	1.505	540	1,749	0.277	8.7	9
3/5/2017	Transfer to Circulars	Circular Tanks	42	52	2.1	372		228,794	614	195	1.505	350	1,493	0.197	2.1	2
3/12/2017		Circular Tanks	49	53	2.2	310.5		228,337	734	231	1.433	525	1,785	0.186	2.5	3
3/19/2017		Circular Tanks	56	53	2.4	259.6		227,803	876	260	1.433	525	2,130	0.175	3	3
3/26/2017		Circular Tanks	63	53	2.5	219.3		227,270	1,034	290	1.433	700	2,515	0.165	3.6	4
4/2/2017		Circular Tanks	70	53	2.6	186.9		226,736	1,210	322	1.433	700	2,944	0.157	4.2	4
4/9/2017	Parr Release	Circular Tanks	77	54	2.8	160.6	161,175	226,203	1,405	372	1.368	875	3,418	0.149	4.9	5
4/16/2017		Circular Tanks	84	54	2.9	136.7		64,937	474	119	1.368	175	846	0.192	1.2	1
4/23/2017		Circular Tanks	91	54	3.1	118.4		64,808	546	131	1.368	175	974	0.183	1.4	1
4/30/2017		Circular Tanks	98	54	3.2	103.3		64,656	625	143	1.368	350	1,114	0.175	1.6	2
5/7/2017		Circular Tanks	105	54	3.3	90.6		64,505	710	155	1.368	350	1,267	0.168	1.8	2
5/14/2017		Circular Tanks	112	54	3.5	79.9		64,353	803	169	1.368	350	1,433	0.161	2	2
5/21/2017		Circular Tanks	119	54	3.6	70.9		64,202	904	182	1.368	350	1,612	0.155	2.3	2
5/28/2017	Smolt Release	Circular Tanks	126	54	3.8	63.1	64,050	64,050	1,012	196	1.368	525	1,806	0.149	2.6	3

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1.2.4 Nature-Like Facility Design Considerations

The facility will have rearing densities set at values, which are low in comparison to densities used in conventional, production-oriented rearing programs for fall-run Chinook. These values require additional space for the program. Parr and smolt rearing vessels will be circular tanks as opposed to rectangular raceways used in conventional rearing. Circular tanks require two exchanges per hour, which provides a higher flow to the vessel, elevating minimum dissolved oxygen levels over conventional flow calculations to rectangular vessels. Additional nature-like features such as tank coloration, substrate material, natural photoperiod, automated feeding, tank covers, etc., will be considered during the design process.

1.2.5 Adult Holding

Returning fall-run Chinook adults will require a maximum of 5,240 cubic feet of holding space (Table 1.2-5).

Table 1.2-5. Adult holding space requirements.

Species	Number[1]	Cubic Feet per Adult[2]	Space Required (cf)[3]	Flow (gpm)
Chinook Group 1	295	10	2,950	295
Chinook Group 2	295	10	2,950	295
Total Adults	590		5,900[4]	590[4]

1 Assumes a 50:50 sex ratio and incorporates a 15 percent pre-spawning mortality.
2 Source: HDR Engineering, Inc. 2013. Wells Hatchery Modernization Master Plan, Volume 1. Prepared for Douglas County Public Utility District No. 1.
3 Fish holding between Oct. 1 and Jan. 15.
4 Two additional raceways are provided for sorting, additional age class holding and fish returns to river or for disposal. Actual available space and flow requirements for the four holding raceways are 11, 800 cf and 1,180 gpm.

Four raceways are provided with the dimensions being 60 feet long x 10 feet wide and a water depth of 5 feet (12,000 cubic feet). The total depth is nine feet. A water spray mechanism is incorporated to prevent jumping, fright response, and sunburn. Two raceways will contain the total number of adults at any given time (6,000 cubic feet) with two additional raceways for sorting, additional age class holding and short-term holding of fish returns to the river. Each pair of raceways will have an open-sided cover for shading and predation control. These covers will extend over the spawning area, which contains a concrete area with drains, water supply, equipment storage and spawning tables.

1.3 Water Supply

Water supply for this facility will be pumped from the Tuolumne River located adjacent to the site. The intake structure will be located within the river with rotating drum screens providing screening as per National Marine Fisheries Service (NMFS) guidelines to prevent impingement/impairment of fish. It is anticipated that the maximum flow requirement, if all rearing/holding facilities were in operation, would be approximately 2,600 gpm. The intake structure would have three pumps; two pumps would provide 1,300 gpm each. The third would be a backup pump.

A second option for water supply would be to connect to the retired MID Main Canal downstream of the hillside gates. A new bulkhead with appropriate controls would be required. A pipeline would extend from this bulkhead within the canal to the hatchery. Currently as designed, water is required at the hatchery from September 15 through June 15. A backup river water supply may still be required, although not as robust as what is described in the preceding paragraph. This option has not been included in the opinion of probable construction cost (OPCC) until field inspections can be performed. Either option may require a water right amendment.

Water temperatures in the Tuolumne River are expected to be between 52 and 54°F as shown in Tables 1.2-2, 1.2-3, and 1.2-4 (TID/MID 2017[2]). These temperatures set the growth rate over a 6 ½-month period. These temperatures are considered to be within the desirable range for rearing of fall-run Chinook.

It is anticipated that a National Pollutant Discharge Elimination System (NPDES) permit would not be required, as the facility would be producing less than 5,000 pounds of fish per year. Effluent treatment is not planned for the facility; however, it could be incorporated if deemed necessary. Water from the facility would be discharged directly back to the Tuolumne River just downstream of the intake, minimizing any flow reduction in the Tuolumne River.

1.4 Site Layout

The hatchery building was developed in a rectangular fashion to take advantage of the identified property shape. The floor plan (Figure 1.4-1, on page B-16) separates the three rearing areas (incubation, fry, and fingerling). Biosecurity measures are incorporated into the design, which include a separate processing or prep room for incoming eggs to the facility. The administrative layout also isolates visitors from the rearing areas.

Additional facilities include an aeration headtank, vehicle storage/workshop/emergency generator building, and the adult holding raceway complex. These facilities, along with the river intake/pump station and paved areas, are indicated on Figure 1.4-2, on page B-17.

1.5 Opinion of Probable Construction Cost

An initial concept design has been developed for an OPCC (Table 1.5-1). The tentative site has not been inspected nor had any investigations performed. Certain costs in Table 1.5-1 such as site work, utilities, and other project costs such as field investigations, are preliminary estimates and may be revised as the project progresses. The following assumptions apply to the OPCC:

- A contingency of 40 percent is added to the base facility construction cost to cover variations that may occur due to unknown site conditions, regulatory agency requirements, and prior to engineering design. The contingency factor will reduce as information is collected during preliminary design and estimated costs can be verified.

[2] Turlock Irrigation District and Modesto Irrigation District (TID/MID). 2017. Lower Tuolumne River Temperature Model Study Report (W&AR-16). Prepared by HDR Engineering, Inc. September 2017.

- Inflation has not been factored into these numbers, as they are 2017 costs.
- Remote location construction conditions have been considered in the OPCC.
- No housing is provided as it is assumed that staff will reside in the local area.
- Monitoring and alarms are provided for emergency conditions to alert staff of issues.
- An oxygen backup system (in addition to the emergency generator) will operate independent of power providing oxygen to the rearing vessels until power is restored to the pumping system.
- It is assumed that primary power (3 phase) is available to the site.
- The site does not have any significant geotechnical, floodplain, endangered species, hazardous waste, or cultural resource issues.
- The project has an allowance in the OPCC of 5 percent ($855,171) for environmental review and permitting.
- The site layout accommodates additional facilities for program functions such as research, monitoring and evaluation.

Public information and education components are not part of this facility.

Table 1.5-1. Opinion of probable construction cost.

Item	Quantity	Unit	Cost ($)	Amount	Total ($)
Land Acquisition					500,000
Land Acquisition	1.00	LS	500,000	500,000	
Sitework					409,677
Clear & Grub Brush including Stumps	1.20	Acre	11,325	13,590	
Finish Grading	52	MSF	41	2,132	
Excavation	1,000	CY	30	30,000	
Fill	500	CY	15	7,500	
Asphalt Surfacing – Roads & Parking Areas					
3” Asphalt	2,679	SY	29	77,691	
3” Crushed Surfacing Top Course	2,679	SY	8	21,432	
6” Compacted Crushed Base Course	2,679	SY	14	37,506	
6’ H 9 GA Aluminized Stl Chainlink Fence w/Barb Wire Top	1,140	LF	60	68,400	
20’ W Dbl Chainlink Gate, 6’ H	1	EA	2,400	2,400	
12’ W Chainlink Gate, 6 ’H	1	EA	1,800	1,800	
3’W Chainlink Man Gate, 6’ H	2	EA	713	1,426	
Erosion Control, Silt Fence	1,200	LF	3	3,600	
Erosion Control, Staked Hay Bales	300	LF	9	2,700	
Dewatering	1	LS	45,000	45,000	
Hydroseeding	1,500	SY	4	6,000	
Stormwater System	1.2	AC	67,500	81,000	
Site Clean-Up	1	LS	7,500	7,500	
Utilities					190,000
3-Phase Power	1	LS	100,000	100,000	
Septic Systems	1	LS	60,000	60,000	
Domestic Water Supply Well	1	LS	22,500	22,500	
Domestic Water Pressure System	1	LS	7,500	7,500	
Hatchery Building (13,779 SF)					3,815,175

Item	Quantity	Unit	Cost ($)	Amount	Total ($)
Excavation	971	CY	30	29,130	
Backfill	480	CY	15	7,200	
Haul Excess Excavation	491	CY	15	7,365	
Foundations	13,779	SF	26	358,254	
Building Shell	13,779	SF	50	688,950	
Interior Finish	13,779	SF	17	234,243	
Mechanical / HVAC	13,779	SF	65	895,635	
Electrical, Communications and Security	13,779	SF	30	413,370	
Rectangular Troughs					
Trough	24	EA	4,953	118,872	
Shipping	24	EA	488	11,712	
Installation	24	EA	2,250	54,000	
Trough Interstitial Piping	24	EA	7,500	180,000	
16’ Dia Circulars					
Tank	24	EA	10,236	245,664	
Shipping	24	EA	960	23,040	
Installation	24	EA	3,750	90,000	
Circular Interstitial Piping	12	EA	7,500	90,000	
Incubators	32	EA	2,820	90,240	
Incubation Head Troughs and Piping	70	LF	750	52,500	
Liquid Oxygen System	1	LS	100,000	100,000	
Lab Cabinets and Equipment	1	LS	125,000	125,000	
R&ME Building (1,950 SF)					469,092
Excavation	267	CY	30	8,010	
Backfill	228	CY	15	3,420	
Haul Excess Excavation	94	CY	15	1,410	
Asphalt Surfacing – Roads & Parking Areas					
3” Asphalt	152	SY	29	4,408	
3” Crushed Surfacing Top Course	152	SY	8	1,216	
6” Compacted Crushed Base Course	152	SY	14	2,128	
Foundations	1,950	SF	42	81,900	
Building Shell	1,950	SF	92	179,400	
Interior Finish	1,950	SF	18	35,100	
Mechanical / HVAC	1,950	SF	54	105,300	
Electrical, Communications and Security	1,950	SF	24	46,800	
Aquaculture Equipment					750,000
Aquaculture Equipment	1	LS	750,000	750,000	
Shop/Storage Building (1,950 SF)					521,340
Excavation	267	CY	30	8,010	
Backfill	228	CY	15	3,420	
Haul Excess Excavation	94	CY	15	1,410	
Foundations	1,950	SF	42	81,900	
Building Shell	1,950	SF	92	179,400	
Interior Finish	1,950	SF	18	35,100	
Mechanical / HVAC	1,950	SF	54	105,300	
Backup Generator, 100 kW	1	LS	60,000	60,000	
Electrical, Communications and Security	1,950	SF	24	46,800	
Aeration Headtank (256 SF)					363,255
Excavation	139	CY	30	4,170	
Backfill	82	CY	15	1,230	
Haul Excess Excavation	57	CY	15	855	
Structure	256	SF	750	192,000	

Item	Quantity	Unit	Cost ($)	Amount	Total ($)
Equipment	1	LS	112,500	112,500	
Piping	1	LS	52,500	52,500	
Raceways (4) 10' x 60' x 5' Wtr Dpth w/Cover					2,123,480
Excavation	914	CY	30	27,420	
Backfill	308	CY	15	4,620	
Haul Excess Excavation	606	CY	15	9,090	
Structure (Raceways , Two Pair)	3,450	SF	263	907,350	
Raceway Covers (2)	3,450	SF	100	345,000	
Mechanical Crowder	4	EA	127,500	510,000	
Mechanical / Piping	1	LS	100,000	100,000	
Spray System	1	LS	100,000	100,000	
Spawning Equipment	1	LS	120,000	120,000	
River Intake and Pump Station					1,085,600
Dewatering	1	LS	80,000	80,000	
Excavation	600	CY	40	24,000	
Backfill	415	CY	20	8,300	
Haul Excess Excavation	185	CY	20	3,700	
Riprap	42	CY	400	16,800	
Structure	500	SF	800	400,000	
Screens	1	LS	140,000	140,000	
Pumps	3	EA	90,000	270,000	
Variable Frequency Drive (VFD)	3	EA	17,600	52,800	
Controls	3	EA	30,000	90,000	
Yard Piping					570,000
River Supply Main	600	LF	200	120,000	
Supply Piping	1	LS	250,000	250,000	
Drain Piping	1	LS	200,000	200,000	
				Subtotal	**10,797,619**
Instrumentation and Alarm (6% of Other Constr. Costs)					647,857
	1	LS	647,857	647,857	
Electrical (14% of Other Const. Costs)					1,511,667
	1	LS	1,511,667	1,511,667	
				Extended Subtotal	**12,957,143**
Mobilization (9%)					1,166,143
General Conditions (9%)					1,166,143
Bond (2%)					259,143
General Contractors Overhead and Profit (12%)					1,554,857
				Total Base Facility Construction Costs	**17,103,428**
				Contingency (40%)	6,841,371
				Total Base Facility with Contingency	**23,944,800**
				State Tax (7.875%)	1,885,653
				Total Base Facility with Tax	**25,830,453**
				Other Project Costs	
				Geotechnical Site Investigation (2%)	342,069
				Topographic Survey (1%)	171,034
				Cultural Resource Survey	50,000
				Hydraulic & Floodplain Analysis (2%)	342,069
				Design (12%)	2,052,411
				Permitting (5%)	855,171
				Construction Oversight (7%)	1,197,240

Item	Quantity	Unit	Cost ($)	Amount	Total ($)
Client Administrative Cost (10%)					1,710,343
Site Equipment (3%)					513,103
Total Other Project Costs					**7,233,440**
Other Project Costs Contingency (40%)					2,893,376
Total Other Project Costs with Contingency					**10,126,816**
Total Project Costs and Other Costs w/Contingencies					**35,957,269**

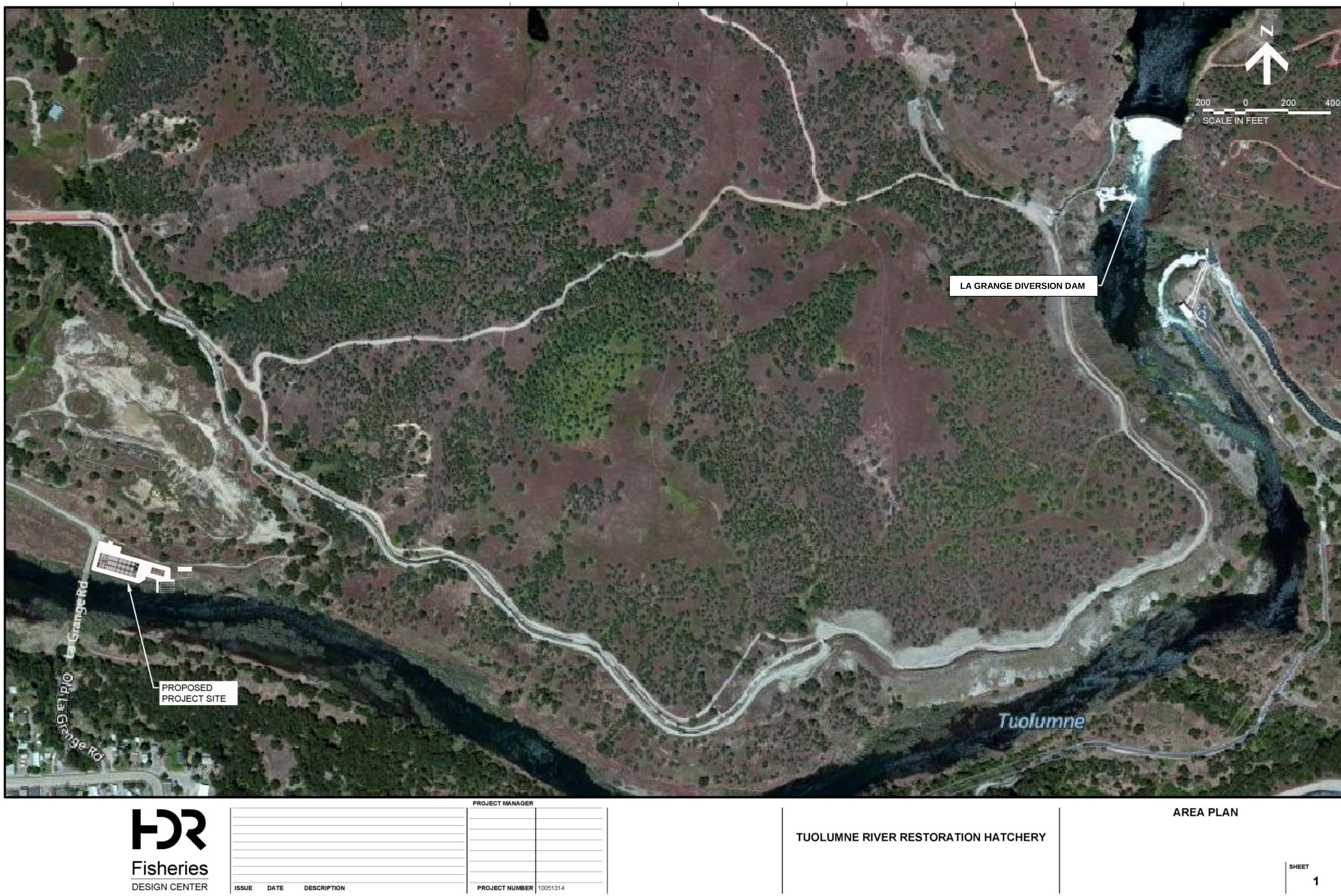

Figure 1.1-1. Tuolumne River restoration hatchery – area plan.

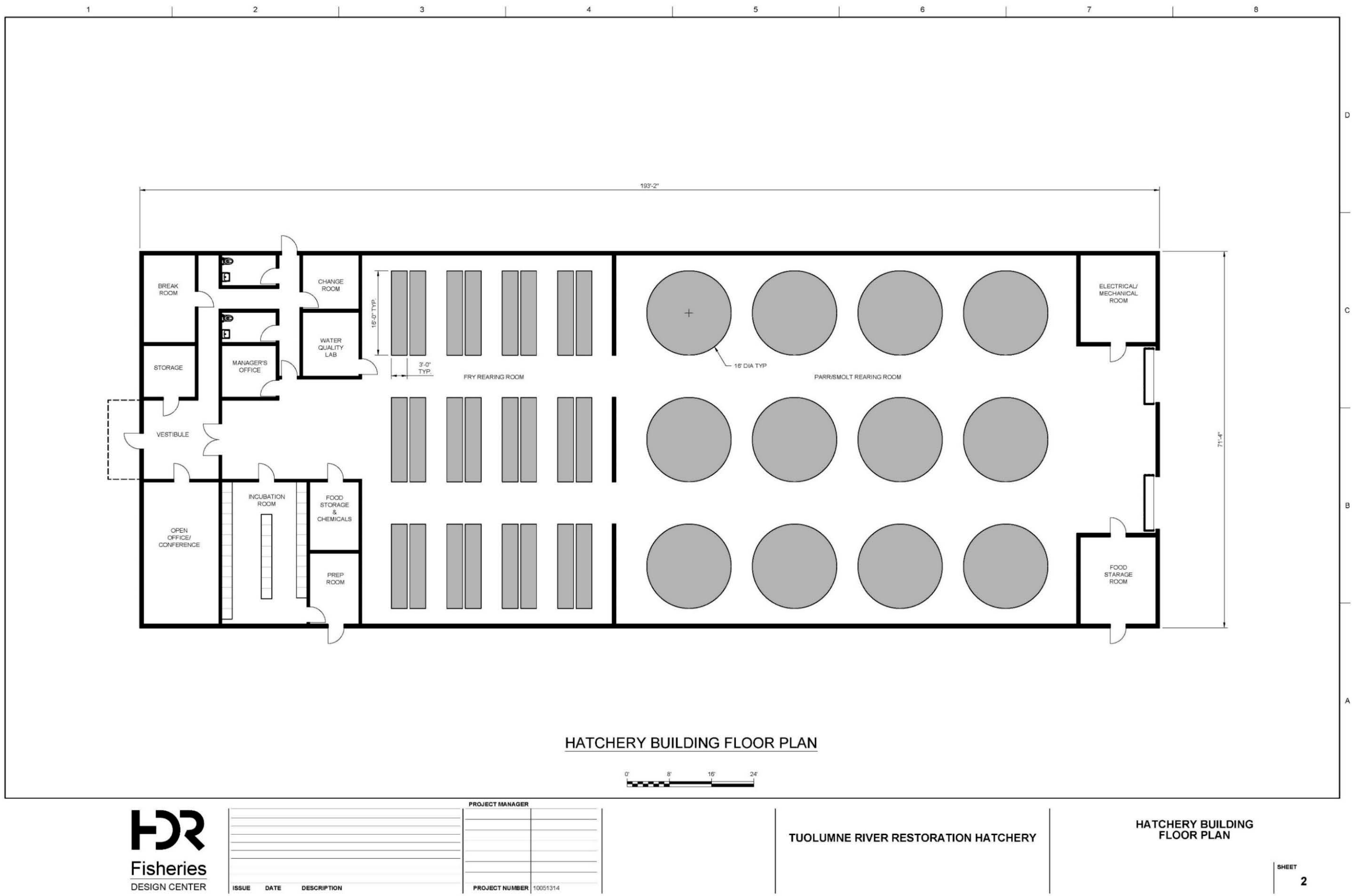

Figure 1.4-1. Hatchery building floor plan.

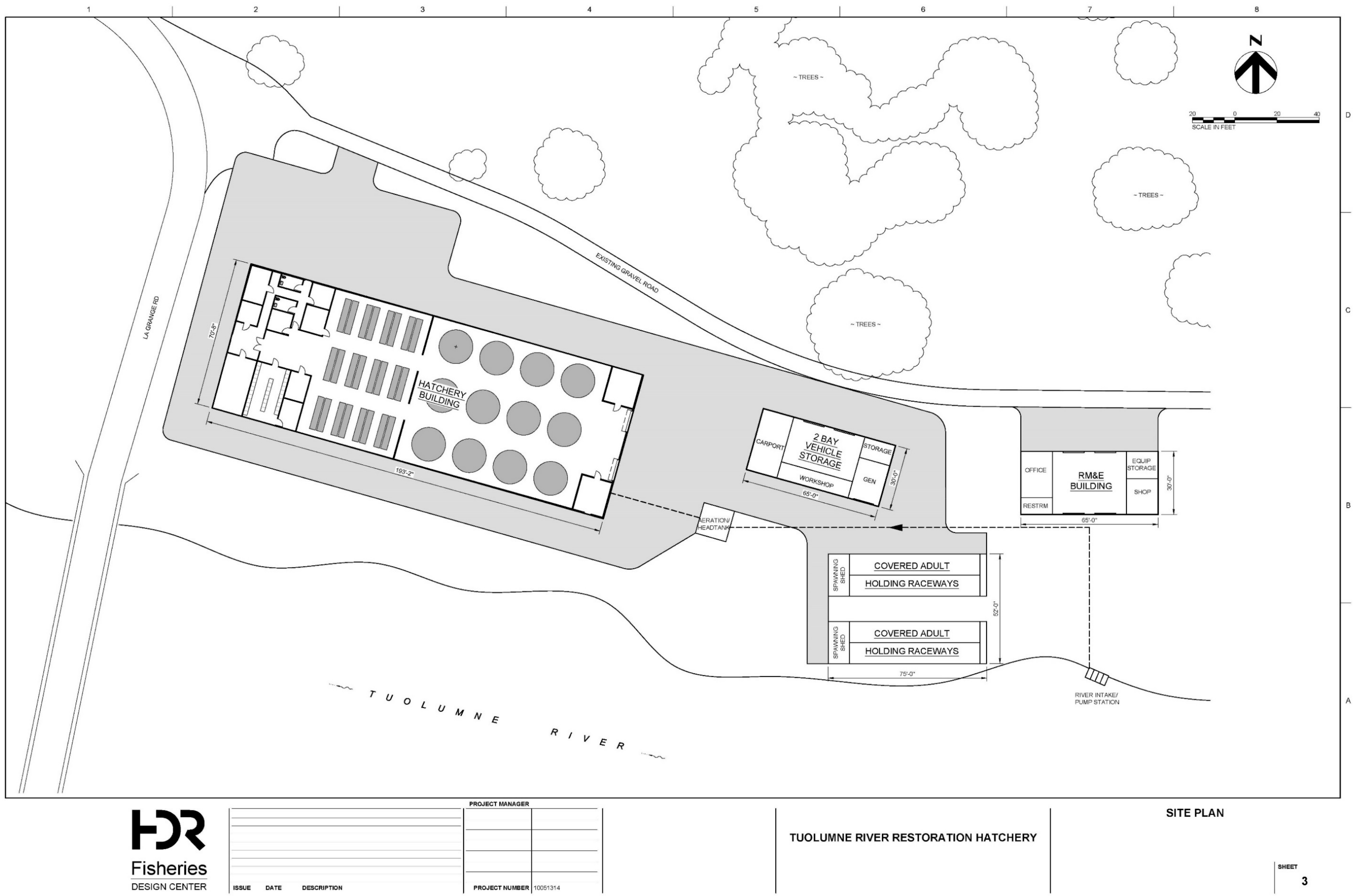

Figure 1.4-2. Tuolumne River restoration hatchery – site plan.

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