Minnesota
Department of Natural Resources

MDNR No. 8F022
File No. FMA.00257.00.00.03
HDR No. 202386

French River Cold Water Hatchery

REHABILITATION ANALYSIS

FINAL SUBMITTAL
JULY 2013

HDR

BARR

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Final Submittal

July 23, 2013

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French River Cold Water Hatchery

I. INTRODUCTION

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I. INTRODUCTION

Project Description

The goals of the study are to evaluate the current condition of this facility and to determine renovation options to ensure that the system can be fully operational for the next 25 years and can continue to meet the statewide fish production goals. In addition, the recommended improvements were selected to help reduce operational and maintenance costs associated with the FRH. Therefore, the **French River Cold Water Hatchery Rehabilitation Analysis** consists of a review and analysis of the current facility and presents a series of conceptual improvements which will allow existing and future fish production requirements to be met. The project provides a comprehensive, systematic review of the existing FRH fish production related infrastructure. The areas of critical review include: water source(s), water distribution, supplemental oxygenation of water supplies, water treatment systems, fish rearing units, effluent management, and general facility infrastructure. This study documents the hatchery's fish propagation system facilities, minor and major maintenance needs, renovation and optimization needs, and associated opinions of probable construction cost. The report will also address the schedule and sequencing requirements related to the recommendations.

Project Authorization and Scope

This study has been developed under a consultant services contract made on January 9, 2013 by and between the State of Minnesota, acting through Commissioner of Natural Resources, 500 Lafayette Road N., St. Paul, MN 55155 and HDR Engineering, 701 Xenia Avenue South, Suite 600, Minneapolis, Minnesota 55416. The major project work tasks, as specified in the contract, are summarized below.

The following main work tasks were performed to successfully complete the evaluation and study phase of the FRH.

	Task	Task Description
Milestone 35% Submittal	**1**	**Field Work and 35% Submittal**
	1.1	Preparation for Field Trip (trip planning)
	1.2	Generate Facility Questionnaire and Send to Facility
	1.3	Management of Incoming Data
	1.4	Review and Summarize MNDNR Provided Data & Drawings
	1.5	Scan and Digitize Existing Drawings and Complete Base Study Drawings
	1.6	Obtain Floodplain, Aerial and USGS Topographical Maps
	1.7	Kickoff Meeting & Field Inspection of the FRCWH facility (4 staff, 1 travel day, 2 on-site)
	1.8	Compile Photos and Video from Field Inspection
	1.9	Follow-Up Documentation from Field Trip and Report of Findings
	1.10	35% Report Submittal Preparation and Assembly
	1.11	35% Report Internal QA/QC
	1.12	35% Report Review WebEx Meeting (Feb)
	1.13	March WebEx Meeting and Preparation

Milestone 65% Submittal	**2**	**Fish Production and FRCWH Operations Analysis**
	2.1	Review Historical (2 to 3 years) FRCWH Fish Production Data
	2.2	Production Analysis and bioprogramming of FRCWH current & future cold water production by species
	2.3	Review & Assess FRCWH Pathogen & Invasive Species / Biosecurity Requirements
	2.4	Review and Assess Existing Cost of Operations and Project Future Costs
	2.5	Review and Assess Trout Holding and Biosecure Distribution Needs and Provide Options
	2.6	Review and Assess FRCWH Personnel Needs & Provide Recommendations
	3	**Infrastructure Analysis and 65% Submittal**
	3.1	Inventory and Assess all mechanical equipment associated with hatchery operations
	3.2	Inventory & Analysis of Potential FRCWH Water Supplies & Options
	3.3	Review of Biosecurity Infrastructure HACCP Plans & MNDNR Op. Order 113 Invasive Species
	3.4	Review Water Quality, Temperature Profiles, FRCWH Water Heating & Treatment Systems
	3.5	Provide Permitting Plan for Recommended Improvements (Barr)
	3.6	Review and Analyze Fish Production Systems & Rearing Units
	3.7	Review Storage Requirements for Materials, Feed, Equipment & Fuels
	3.8	Analysis of FRCWH wastewater treatment systems
	3.9	65% Report Submittal Preparation and Assembly
	3.10	65% Report Internal QA/QC
	3.11	65% Review Meeting Preparation, Site Meeting and Follow-up
Milestone 95% Submittal	**4**	**Infrastructure Improvements, Recommendations & Final Report Submittals**
	4.1	Recommendations for Hatchery Process/Equipment Upgrades/Technology Improvements
	4.2	Develop Equipment Annual Service Plan and Equipment Replacement Schedule
	4.3	Develop Recommendations for Disease and Invasive Species Control
	4.4	Improvements to Water Supply(s) that meet temperature, biosecurity & MNDNR criteria
	4.5	Improvements & Options for reducing energy costs & alterative energy options
	4.6	Recommended Improvements to Heat Pump / Heat Recovery System (Barr)
	4.7	Recommended Improvements to Electrical, Instrumentation & Alarm Systems
	4.8	Recommended Improvements to Storage Systems Materials, Feed & Equipment
	4.9	Develop Projected Costs for all Recommended Improvements
	4.10	Prioritization of Improvements for the FRCW Hatchery
	4.11	Implementation Plan for Facility Improvements (includes time frames & possible phasing)
	4.12	95% Report Submittal Preparation and Assembly
	4.13	95% Report Internal QA/QC
	4.14	95% Review Meeting Preparation, WebEx Meeting and Follow-up
Milestone 100%	4.15	Final Report Submittal and Assembly
	4.16	Final Report and Executive Summary Internal QA/QC
	4.17	100% Level Presentation (prep, 1 presentation, 1 person, 2 days)

Acknowledgments

The following individuals have been involved in the development and review of this report entitled, **French River Cold Water Hatchery Rehabilitation Analysis.** Their cooperation and assistance is gratefully acknowledged.

Minnesota Department of Natural Resources

- Linda Erickson-Eastwood — Program Manager, DNR Fisheries
- Tim J. Goeman — Regional Fisheries Manager, DNR Fisheries
- John Filardo — Project Engineer, DNR Operation Services
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French River Cold Water Hatchery

II. EXECUTIVE SUMMARY

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II. EXECUTIVE SUMMARY

Study Overview

The primary goals of this study are to evaluate the current condition of the fish production infrastructure of the French River Cold Water Hatchery (FRH) and to provide renovation and/or replacement recommendations to ensure that the system can remain fully operational for the next 25 years. In addition, the study will evaluate whether the infrastructure can meet MNDNR current and future fish production requirements. The study included the completion of five major work tasks:

- Field Investigations and Data Collection.
- Fish Production Program Review and Operational Cost Analysis.
- Infrastructure Analysis and Assessment of Current Condition and Performance.
- Infrastructure Rehabilitation/Improvement Options and Opinions of Probable Construction Costs.
- Report Preparation including recommendations for potential facility rehabilitation, implementation plan and time requirements.

The resultant document will also be used to support efforts to pursue funding for construction. The audience for this report will include MNDNR administration, legislative representatives and staff, and the general public.

The **French River Cold Water Hatchery Rehabilitation Analysis Report** consists of a comprehensive review and analysis of the existing condition of the major fish production related components and outlines renovation and / or replacement options. The areas of critical infrastructure review include:

water source(s)	**water distribution**	**water treatment systems**	**biosecurity**
buildings	**fish rearing units**	**effluent treatment systems**	**electrical systems**
alarm and instrumentation systems	**supplemental oxygenation of water supplies**	**general facility infrastructure**	**emergency power**
energy conservation	**alternative energy options**		

This report will provide the basis to evaluate the options and costs associated with the rehabilitation of the facility. Construction cost estimates and projected time frame requirements for project implementation are also included.

Section I provides an introduction to the MNDNR French River Hatchery, this study report and acknowledgements. The recommendations and summary of the report are contained herein (**Section II**).

Section III provides a fish production program evaluation including historical, current and future production, capacity assessment, biosecurity issues, staffing and trout distribution analysis. **Section IV** provides the infrastructure assessment and component evaluation, options for rehabilitation and recommendations. Descriptions of the system-wide facility issues including water supply options, biosecurity improvements, hatchery operational and maintenance costs, energy reduction, alternative energy options and permitting are presented in the **Section V.** Finally, descriptions of estimating methods and cost contingencies (i.e., escalation, estimating, design engineering, construction engineering, and state construction) are presented in **Section VI.**

Facility Overview

The French River Cold Water Hatchery is one of five (5) cold water fish hatcheries operated by the MNDNR. The cold water hatcheries are: Crystal Springs Hatchery, Lanesboro Hatchery, Peterson Hatchery, Spire Valley Hatchery, and **French River Hatchery** (subject of this report).

The French River facility is constructed on a 17.4 acre parcel of land that includes the French River cool water hatchery originally constructed in 1928. The 1928 facility hatchery now serves as the Lower Spawning Facility and Area Headquarters for Duluth Fisheries, Lake Superior Fisheries and Fisheries Research. The Upper Hatchery area includes water treatment equipment and the main production spaces: Nursery, Burrows Ponds, and Broodstock Raceways.

Drawing FR-3 illustrates the major features of the complex which includes eight (8) buildings. Initial construction of the FRH began in 1974/1975 with various renovations occurring in 1980's, 1990's and 2000's. The facility uses Lake Superior water as its primary water supply. Lake water is pumped, treated and heated to meet cold water fish rearing requirements. Alternative water supplies (French River, well and domestic) were evaluated for this report and found not to have enough quantity or the adequate water quality for use in the facility. Continued use of Lake Superior water, after treatment, is required to operate the facility.

Lake Superior water is obtained using an intake pipeline and an 800 gpm capacity pump station. The Lake Superior raw water supply is treated by a vortex separator, a series of bag filters and an ultraviolet disinfection system before being stored in a reservoir tank. A portion of the treated water is heated and blended with cold water to meet fish rearing temperature requirements. Lake Superior water temperatures vary significantly throughout the year from 33 deg. F to over 65 deg. F. Aeration and degassing occurs using jet aspiration and mechanical aerators within the cold and hot water storage tanks. Supplemental aeration (air or oxygen diffusion) can be provided to individual rearing units.

The fish production portion of the Nursery Area in the Main Hatchery Building includes egg incubation, hatching and early rearing systems using single-pass water with operation of up to 54 circular tanks, 4 super troughs, 4 egg sorting troughs and 21 vertical flow egg incubators.

Used water from the Nursery production units is transferred by gravity to the Burrows Building where it is reconditioned for reuse using biofilters before being pumped from two clearwells to aeration/degassing headtanks. From the elevated headtanks, water flows to six recirculating Burrows Ponds. This system is one of the earliest known public fish hatcheries to employ partial pumped recirculation with biofiltration. The Burrows operate with a pumped recirculation rate of 400 gpm per raceway or 2,400 gpm total flow (or 12% to 20% recirculation rate).

Overflow from the clear wells is then transferred by gravity to the Raceway Building to operate the five (5) broodstock raceways used for the captive Knife River steelhead broodstock program. Overflow water from the broodstock raceways is piped to the outflow end of a rectangular Clarifier from which it flows on to an earthen Effluent Pond or is pumped back for heat recovery (not currently used). Overflow from the effluent polishing pond returns to the French River for use in attraction flow augmentation. Solids collected from Nursery drains, Burrows biofilters, and broodstock raceway cleanout drains are processed in the clarifier which is equipped with a chain and flight sludge transfer system.

Even by today's modern public coldwater fish hatchery standards, the FRH facility is a relatively complicated facility. It involves a variety of process treatment technologies including complex water heating, recirculation and water reuse that make this facility considerably more difficult to manage and operate than most facilities. However, due to efforts related to water conservation, many other facilities are starting to implement water reuse and recirculation systems very similar to the systems already in place at FRH. If renovation is implemented as suggested in this report, FRH should be able to provide support to the MNDNR fish production program for the next 25 years.

Fish Production Overview

Production Program

Historical fish production at French River Hatchery has included steelhead (STT), Kamloop rainbow trout (KAM), lake trout, brook trout and Chinook salmon. Total production near 70,000 lbs./year has occurred in the past. Up to 500,000 Chinook salmon were produced annually before this program was terminated for fisheries management reasons. Today, production levels at French River Hatchery have been reduced to about half of the higher historic production levels due to biosecurity concerns and changes in MNDNR cold water fisheries management needs. Starting in FY2011, production now includes STT eyed eggs for final rearing at Spire Valley Hatchery to produce fry for stocking in Lake Superior North Shore streams. Production levels for the last three fiscal years (July 1 to June 30) are summarized below:

	FY2009	FY2010	FY2011
Egg Take	1,594,044 eggs	1,599,523 eggs	1,527,914 eggs
Fry Produced from Eggs Taken	1,091,595 fry	951,202 fry	84,511 fry
Number Produced (fry, fingerlings, yearlings, stocked adults)	673,641 fish	819,212 fish	90,979 fish
Pounds Produced	34,305 lbs.	45,183 lbs.	32,573 lbs.

French River Hatchery maintains five year-classes of valuable captive Knife River STT adults (broodstock) that produce the major portion of STT eggs for the fry stocking program. Spring migratory "wild" adult STT and KAM returning to the French River are also spawned to provide eggs for further rearing. Production goals as set by MNDNR for North Shore streams are currently:

- **500,000 steelhead fry**
- **92,500 yearling Kamloop rainbow trout**

STT fry stockings augment natural steelhead reproduction in North Shore Rivers and are highly sought by anglers. This STT fishery is a catch-release program. Stocking of KAM (fin-clipped yearlings) provide the put-grow-take fishery in the lower North Shore rivers and Lake Superior and are the only rainbow trout strain that can legally be harvested from Lake Superior and its' tributaries. FRH completes the final grow-out rearing of KAM in the Burrows recirculating system from fingerlings produced at French River Hatchery (25%) and Spire Valley Hatchery (75%). Approximately 25% of the KAM quota is reared in the nursery area of FRH.

Rearing Unit Summary

The rearing volumes for each major rearing component for the Upper and Lower Rearing locations are summarized below:

NO.	Unit	Total RV
Nursery		
21	Vertical Flow Egg Incubators	NA
4	Super Troughs	200 CF
54	6ft. dia. Circular Tanks	4,320 CF
Burrows Ponds		
6	Ponds	14,544 CF
Broodstock Raceways		
5	Raceways	5,300 CF
Lower Spawning Facility		
12	Vertical Flow Incubations	NA
360	Hatchery Jars	NA
5	Spawning / Holding Tanks	2,625 CF
Total		**26,989 CF**

Production Capacity

A series of bioprogram models using density set to 3 lbs./CF, with ***constant rearing temperatures*** (41^{o}F, 45^{o}F and 50^{o}F) and ***variable temperature data*** were used to simulate KAM yearling rearing in the Nursery and Burrows. These models used available oxygen levels (AO) set to ranges of dissolved oxygen saturation (90%, 100% 110%) and minimum tank effluent level of 7.0 mg/l which are believed to be realistic values for the FRH. The rearing models were developed to **simulate** the existing FRH rearing programs to determine rearing capacity of the existing rearing unit volumes. They were also used to determine whether a 20% increase in production biomass is feasible.

Average production for the period of FY2009-FY2011 was 37,353 lbs. A 20% production increase in biomass above this average is an additional 7,470 lbs. for a total annual production level of 44,823 lbs. This level of FRH production (the MNDNR goal) proposed for the future appears to be well within the production capability of the facility given that the required infrastructure repairs/replacement outlined in this report are completed to insure operation over the next 25 years. Rearing density and dissolved oxygen (DO) will need to be adjusted to accommodate the additional production levels. Dissolved oxygen data was not available to document the performance of the present FRH water supply aeration and degassing systems. Improvements to the existing systems are likely required for consistently achieving the recommended levels of DO.

Capacity	Avg. Production	Dissolved Oxygen (% Saturation)	Density (lb/CF)* Overall average
2009-2011	37,353 lbs.	90%	2.0
20% Increase	44,823 lbs.	93%	2.37
Maximum	56,568 lbs.	95%	3.0

**Assumes Nursery & Burrows units provide18,864 CF of RV*

The “maximum estimated safe” production level estimated using a density of 3 lbs/CF is 56,568 lbs. This production level is based on the assumption that the Nursery and Burrows can operate with a 45 deg. F constant water temperature and can maintain oxygen saturation as outlined above.

Fish Holding and Distribution

MNDNR has identified the need for this study to investigate options and costs for providing temporary holding of catchable trout shipped in 7,500 lb. loads from southern Minnesota hatcheries using fleet operated semi-trailer fish hauling units. The MNDNR trout stocking period and related holding distribution period is typically completed in Mid-April, May through Mid-June and September through October each year.

The desired trout holding distribution capability must provide sufficient holding time for staff using smaller capacity transportation trucks to stock trout. Trout holding of at least 5 days per week is assumed. A holding volume in the range of 1,250 to 1,500 CF is recommended and a water flow in the range of 281 gpm, 351 gpm and 421 gpm for temperatures of 40, 45 and 50 deg. F is minimally required assuming 100% DO saturation of the water supply source.

The following alternatives were considered: Existing Tanks Lower Spawning Building; New Tanks On-Site; or New Tanks Off-Site. While space exists on the site for new holding tanks, water supply would be derived from the existing Upper rearing system and timing indicates that adequate excess water volume would not be available to serve the new tanks. Off-site tanks were considered attractive if a biosecure water supply and adequate site security could be maintained. However, costs will be higher than utilizing the existing infrastructure at FRH. Therefore, additional water treatment for the Lower Spawning Building is recommended to meet biosecurity requirements. If the filtration crib is installed at the intake, only UV treatment will be required prior to use for fish holding. The added benefit is that the water will also be treated for use by spawning activities in that same building. The existing tanks are correctly sized to serve this dual purpose. Extra biosecurity cleaning and disinfection will be required between shifting spawning and holding operations. Spawning and holding efforts will need to be closely coordinated to avoid conflicts in tank usage.

Hatchery Staffing

There has been a progressive reduction in staff size from FY2009 to the present. It is our opinion that current staffing levels at FRH with 3 full time positions are low for a facility and production program of this complexity. Comparison of production for FY2009, FY2010 and FY2011 reveals that egg production levels are very similar in all three years. We suggest that staffing level be minimally increased by 1.5 to 2.0 positions for a total of **4.5 to 5.0** staff. One new position is to provide a full-time **Assistant Manager** position. This level (Assistant Manager) is suggested to provide for a professionally educated and trained fish culture scientist with sufficient administrative capabilities to assist the Manager in daily production operations and expertise to operate the facility in the manager's absence. A 50% to 100% level **Administrative Specialist** to assist in day to day record keeping, communications and assistance to the professional staff is also recommended. The facility has sufficient operational complexity to require the help of an administrative specialist. This recommended staffing level should be able to absorb the projected 20% increase in production as evaluated in this report.

The improvements in the FRH facility infrastructure recommended in this report will help reduce maintenance time requirements. We estimate a 20% to 25% labor savings in maintenance associated with system improvements. That time will be better spent rearing fish. However, it needs to be noted that this is a complex and complicated facility and operational adjustment and maintenance of the infrastructure work will always be required.

It is recommended that if future MNDNR FRH fish production increases beyond 20%, that staffing be matched with the addition of one staff member. A second Fisheries Technician is suggested. This assumes that fry production is restored to the production program after biosecurity concerns are resolved.

Critical Issues

There are several issues that impact the continued successful operation of the French River Hatchery as a component of the MNDNR cold water hatchery system.

1.) Age and condition of the infrastructure components and determination of replacement and/or improvement needs for the next 25 years and the associated costs of those improvements.

2.) The amount of labor to maintain and operate outdated equipment.

3.) The amount of energy consumed in the operation of this facility is high. This facility has the highest operating cost in the MNDNR hatchery system.

4.) Concerns related to the biosecurity of the Lake Superior water supply source that has the potential risk of contamination from several aquatic invasive species and diseases including Viral Hemorrhagic Septicemia virus (VHS), a reportable disease of world-wide concern.

5.) Water supply biosecurity concerns limit the stocking of French River Hatchery produced fish to Lake Superior or rivers draining into the lake up to the first migration barrier.

6.) Water supply biosecurity concerns also limit fish holding/transfer opportunities at this facility.

7.) Redundancy and electrical back up for the upper water supply pumping system is required to ensure that the water supply to the facility is maintained. Loss of pumping could result in the complete loss of all fish on station including five year classes of valuable captive Knife River STT broodstock.

8.) The ability of FRH to cool lake water when required is very important component of the facility. This allows FRH to be very flexible to meet changing lake conditions in the future.

Infrastructure Assessment

The consultant team divided the property into 21 separate components for evaluation and discussion purposes. The component list starts at the main facility water supply intake and generally follows the water usage through the facility. This component numbering system was used throughout the report. These components have been denoted on the Report Drawings. Each component was evaluated to determine alternatives for fixing or minimizing the critical issues outlined above.

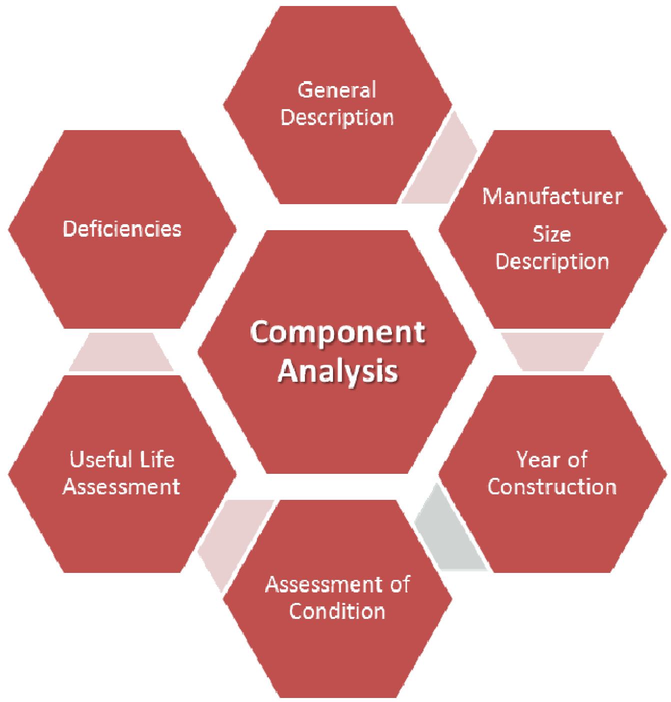
Each component was assessed to determine the expected useful life remaining with respect to both their main mechanical and electrical elements. The components and their condition are detailed in **Section IV** of this report and summarized in **Table II-1**. Each component was evaluated using the following criteria:

Table II-1. Component Assessment and Recommendations

No.	Component	Remaining Life	Condition	Recommendations	Benefits	Costs
					Total	**$7,610,000**
1	**Lake Intake**	Mechanical: 25 - Shallow Intake, 0- Deep Intake	Good Poor	Repair Intake Pipeline and Install Intake Filter	• Restoration of the ability to obtain a water supply of suitable quality and temperature for use at the Hatchery. • Minimization of the intake of sediment and debris through increased filtration, thus decreasing concerns related to effective water treatment. • Minimization of the intake of biological organisms through increased filtration, thus increasing biosecurity. • Stabilization of the pipeline to assist in prevention of future lateral migration and damage from ice, boats, or other debris.	**$374,000**
2	**Pump Station**	Mechanical: 10 Electrical: 5	Good Poor	Replace Pumps Replace Electrics	• Reduced power costs. • Longer pump life due to reduced cycling. • Longer heated water system mixing valve life due to decreased modulation. • Smaller pumps to maintain which will likely be lighter, quieter and cheaper to maintain. • Longer electrical equipment life. • Increased reliability of underground power feed. • Increased reliability of backup power system. • Reduced maintenance of backup power system.	**$390,000**
3	**Vortex Separator**	Mechanical: 10	Good	Retain Separator	• Bypassing the separator will reduce pumping head and power by avoiding its pressure drop and purge demand. • Keeping the separator ready will give some treatment if other equipment fails.	**$0**
4	**Bag Filtration System**	Mechanical: 25 - Housing 10- Pneumatics Electrical: 10	Good Fair Fair	Replace with In-lake Filters	• Reduced lake pumping power costs. • Reduced maintenance. • Deterrence of zebra mussel veligers. • Better preparation of water for Ultraviolet Disinfection. • Better overall water quality for hatchery eggs and fish and for other downstream equipment such as heated water booster pumps and heat exchangers. • Allows for lower head lake pumps which would likely be lighter and quieter and cheaper to maintain.	**$1,395,000**
5	**Ultraviolet Disinfection System**	Mechanical: 20 Electrical: 10	Good Fair	Replace with New 40 mJ Dose	• Known dose • Automatic sleeve cleaning • Management of more types of pathogens and increased biosecurity • Biosecure operation during low UV intensity or UV system failure.	**$723,000**
6	**Upper Reservoir**	Mechanical: 25 Electrical: 15	Good Good	Install Sealed Oxygen Columns	• Oxygen supersaturation.	**$79,000**

No.	Component	Remaining Life	Condition	Recommendations	Benefits	Costs
7	**Main Water Supply System**					
7a	**Coldwater Supply Piping**	Mechanical: 25	Good			**$0**
7b	**Water Heating System**	Mechanical: 18 - Oil, 5 - Wood Electrical: 10	Good Fair Fair	Convert Oil Boilers to Gas	• Slightly lower process water heating costs due to the cost of natural gas versus oil that has been used when wood boilers were frequently off for maintenance. • Less boiler maintenance. • Less maintenance associated with frequent manual balancing of flow to the heated water tank.	**$78,000**
7c	**Mixing Valves**	Mechanical: 25	Good	Install O2 Columns Install Auto Level Controls Install DO Monitoring	• All five sets of mixing valves will function properly. • Longer life for motorized mixing valves due to less frequent and less severe modulation.	**$65,000**
8	**Incubation**	Mechanical: 25	Good	None		**$0**
9	**Nursery Tanks**	Mechanical: 5	Poor	Replace Tanks	• New tanks will provide low/no maintenance rearing units.	**$153,000**
10	**Biofilter System**	Mechanical: 25 - Plumbing, 10- Structural Electrical: 10	Good Fair Fair	Replace w/ Drumfilter and MBBR	• Continuous solids removal • Reduced backwash water rate which means a lower pumped lake water rate is needed and clarifier performance will improve or the clarifier could be replaced with a smaller clarifier. • Reduced heat loss. • Ammonia nitrification will be improved.	**$1,233,000**
11	**Clearwell System**	Mechanical: 25 Electrical: 10	Good Good	Add controls to the clearwells.	• Flow control and energy costs will be reduced.	**$27,000**
12	**Recirculation Pump System**	Mechanical: 10 Electrical: 2	Fair Poor	Replace Pumps	• Lower energy costs • Fewer seals/bearings to maintain.	**$70,000**
13	**Aeration Headtank**	Mechanical: 25	Good	Install Oxygen Columns Headtank Alarm & Monitoring	• Reduced pumping energy due to lowering head requirements • Higher levels of dissolved oxygen • Monitoring and alarming of gas dissolved oxygen levels.	**$59,000**
14	**Burrow Ponds**	Mechanical: 25 Electrical: 5	Good Poor	Renovate Burrows Ponds Replace Electrical Switchgear Replace Lighting	• Concrete repair and coating will extend useful life to 25 years. • Smoother concrete surface will reduce fin erosion. • Electrical components will last 25 years. • Energy savings will be realized with the new lighting system	**$549,000**

No.	Component	Remaining Life	Condition	Recommendations	Benefits	Costs
15	**Broodstock Raceways**	Mechanical: 25 Electrical: 10	Good Good	Resurface Raceways Add Concrete Floor Renovate Emergency Pump Electrical and Controls Replace Lighting	• Biosecurity will be increased by adding the concrete floor which is easier to disinfect compared to the current gravel floor. • Spawning conditions during winter will be more tolerable with infrared heat. • The emergency recycle pump will be control with the SCADA system. • Lighting energy costs will decrease.	**$60,000**
16	**Effluent Treatment**					
16a	**Clarifier**	Mechanical: 25 - Structural, 0 - Mechanical Electrical: 0	Good Poor Poor	Renovate Clarifier and Addition of 2nd Clarifier	• Improved capacity/solids removal • Partial redundancy • Extended life	**$677,000**
16b	**Effluent Settling Pond**	Mechanical: 25 - Civil	Good	None		**$0**
17	**Instrumentation System**	Electrical: 15	Very Good	Upgrade PLC	• Hatchery will benefit from the latest firmware and the system will be expandable.	**$25,000**
18	**Heat Recovery System**	Mechanical: 20 Electrical: 10	Good Good	Add Filtration to HRS Update HRS to Operate in Cooling Mode	• Resume operating heat recovery system • Reduce energy costs • Option to add cooling to the system	**$693,000**
19	**Lower Spawning**	Mechanical: 25 Electrical: 25	Good Good	Install UV New Light Fixtures	• Biosecure water will be supplied to the Lower Spawning Building • Fish holding operations can continue at French River Hatchery • New fluorescent fixtures will reduce energy costs • Existing rearing space use is optimized	**$751,000**
20	**General Storage**	Mechanical: 25	Good	New Storage Space	• Storage capacity will be increased • Code-Compliant chemical storage will be provided	**$178,000**
21	**Oxygen Generation System**	Mechanical: 10 Electrical: 10	Fair Fair	Rent LOX Storage Tank	• Projected rearing is expected to utilize additional oxygen so a larger capacity oxygen supply will be provided. • LOX will provide oxygen during power outages • Oxygen will be provided in unlimited capacity • No maintenance of PSA system required. • LOX could be provided to a fish transport truck	**$31,000**



After the component was assessed, improvement alternatives were evaluated to determine optimal life expectancy or provide enhanced fish production operations. The following were outlined for each component:

- Improvement Alternatives
- Recommendation (Renovation or Replacement)
- Benefits

The main purpose of this study was to provide an inventory of the existing aquaculture related infrastructure and evaluate whether the equipment would last another 25 years. The life expectancy projections were evaluated based on both age of the equipment and current condition. If the equipment was found to have an expected life of less than 25 years, recommendations for either renovation or replacement are presented. Besides mechanical or electrical elements, other factors were considered when evaluating whether renovation or replacement was warranted:

- Energy efficiency
- Parts availability
- Labor intensive maintenance requirements
- Synergy with other recommendations

The recommendations also considered smaller scale improvements to address existing component deficiencies when possible.

It should be noted that not all equipment will be able to provide a life expectancy of 25 years. Most new equipment is warranted to last at most 20 years. Some pieces of equipment require routine replacement parts as part of normal maintenance. These types of routine maintenance projects will not be part of the capital replacement projects summarized in this report. Similarly, if a component or part of a component has a life expectancy 15 years or greater, it is not recommended to replace those items at this time if there is no other reason to do so. While replacement may eventually be required before 25 years, it does not make sense to remove the item's inherent value to the facility by premature replacement.

Biosecurity

MNDNR has implemented strict statewide invasive species regulations to limit the introduction, spread, and establishment of invasive species. Operational Order 113 outlines detailed policies, procedures and responsibilities of MNDNR staff to reduce the impact of invasive species. The use of the Lower Spawning Facility and established MNDNR procedures for the separation of spawning, egg disinfection, pathogen testing and confirmation of fish health status has provided important steps in establishing facility biosecurity.

The report evaluated alternative water supplies to determine if a new biosecure water supply option was available for FRH:

- Groundwater (wells) – Insufficient yield
- French River – Highly variable flow, temperature and quality
- Purchased Domestic Water – High costs and dechlorination risks
- Lake Superior – Sufficient yield but treatment required

Since the first three options do not provide adequate volume or quality, or will be too costly, continued use of Lake Superior water is required but has the following operational requirements:

- A functional lake water supply intake, pipeline and pump station with sufficient capacity and redundancy to meet water supply needs.
- Water heating is required to meet fish rearing temperature and scheduling requirements.
- Water treatment for preparation of lake water to meet fish rearing/biosecurity needs is required.

The present condition of the Lake Superior water supply intake and treatment equipment used to provide water system biosecurity and invasive species control is impacted by the following:

1. The lake intake pipe is broken at approximately 400 ft. from shore and is lying on the lake bottom without intake screening to control entry of wild fish.

2. Sediment and turbidity in lake water levels are higher at the shallower intake. The sediment and turbidity increase requires more frequent manual cleaning of the existing 230 micron bag filters.

3. The efficiency of the bag filtration and UV disinfection system is unknown.

4. Lake Superior contains known aquatic nuisance and invasive species (ANS).

Water supply treatment renovation for continued use of Lake Superior water is recommended as follows:

- **Intake Repair (Component 1):** Intake pipeline repair restores the original 1,400 feet off-shore length and re-establishes the depth to 58 feet deep (+/-).
- **Replace Bag Filter Array (Component 4)**: Replacement of the bag filtration system with an in-lake filter or other similar system at sized at 35 microns (minimum) is recommended.
- **UV Disinfection System (Component 5)**: Replacement of the system is recommended with a validated 40 mJ dose UV system with dose display, dose pacing and alarm functions. Dose of 126 mJ is a more costly level that could be justified for even broader pathogen management, if MNDNR requests, or it could be added in the future.

One of the most affordable and effective ways to minimize pathogen or invasive species introduction to a facility and inhibit regional spread is to implement a biosecurity program at the facility level. Although a certain pathogen or invasive species may provide incentive to start managing an aquaculture facility in a new way, it is important to acknowledge that biosecurity is not pathogen or species specific. Facility operations were compared with general recommended biosecurity-related best management practices. The facility has implemented most standard recommendations but the following alterations or improvements are suggested.

- Better yellow biosecurity signage at entry doors.
- Replace wooden screens.
- New foot baths.
- Recommend improvements in Annual Report to include revised cost of production and fish health data. Provide administrative help to prepare Annual Report.
- Install disinfection for influent water as recommended in the report.
- Install paved floor in broodstock spawning building.
- Provide compliant chemical storage per recommendations in this report.

Cost Summary

Capital Costs

Section IV of the report contains detailed descriptions of all the major infrastructure recommended for either renovation or replacement at FRH. The **Summary** Opinions of Probable Cost are provided at the end of this Section for the recommended alternative for each major component. Component numbers match those already presented in the text and were illustrated on the Drawings. The projected costs for the facility renovation project will be about $**6.1 million to construct**. After the budgeting contingencies are added to the total, **the project budget** will need to be about **$7.6 million**. **Section VI** provides an explanation of cost estimating methodologies, assumptions, unit prices, descriptions, and contingency explanations. Total costs assume all work will be completed in one project. If the project is broken into phases, additional costs will be realized for both design and construction.

Please note that for some components, several alternatives were reviewed for this report. Costs for each reviewed alternative are provided in the **Detailed Costs** (see Section VI) for all major reviewed components. Only the recommended solutions were totaled and brought forward in the Summary total cost projections. Alternatives reviewed but not selected are provided for MNDNR informational purposes. When moving forward with this project, MNDNR might decide to select an item that wasn't recommended by the consultant team so costs are provided to assist in making those decisions. As mentioned, some selections will have a cascading effect on other components so MNDNR will need to work closely with the consultant team to ensure that decisions do not adversely affect other recommendations in this report.

All provided costs are in **2013** dollars and will require escalation (4% per year) to the appropriate construction period. All opinions of probable costs for the facility are **preliminary**. Due to the recent natural disasters and the oil price increases, the construction industry is faced with shortages, escalated prices, and a large demand for new and renovation construction in the affected areas. Recently bid projects have seen an increase in the range of 10% to 25% above normal opinions of probable cost.

We believe the proposed FRH facility-wide rehabilitation and modernization costs, although substantial, are realistic and justifiable for the level of infrastructure enhancement and performance capability provided. The rehabilitation and improvements to the FRH as recommended in this report will insure that this facility can provide its needed production contribution to the overall needs of MNDNR in the future. Due to the age of existing hatchery infrastructure, now approaching 38 years for many components, continued reliable operation requires renovation or replacement to prevent failure. For comparison purposes, a **new cold water facility** would cost from **$15-$25 million** not including land acquisition costs. A new facility would take many more years to complete compared to the renovation effort required for this existing facility. If Lake Superior management goals do not change, it is not recommended to close FRH since its current mission and existing infrastructure are important to the MNDNR Lake Superior rainbow trout production program. Costs for renovation are very comparable to what other state and federal facilities are encountering throughout the country.

Operational Costs

The following scenarios were evaluated for fish operational and maintenance (O&M) costs:

- Current Production Levels
- Current Production Levels with Infrastructure Improvement Benefits
- Future Production Increase (plus 20% biomass)

The estimates are based on a limited amount of operational cost information provided in the FY Annual Reports. Many assumptions were used to prepare these estimates and are outlined in the report in **Section V**. Total operational and maintenance costs for the last three years were:

Date	Annual O&M Costs
FY 2009	$635,544
FY 2010	$627,885
FY 2011	$570,027

The KAM program is approximately 64% of the production cost, STT broodstock is 19.7%, and STT fry production 16.3%. Total labor costs (specific and prorated) are about 60% of the total operating cost. Prorated operating costs are about 34% ($198,731) of the total operating cost. For 2010, annual energy consumption was determined to be $178,408 or 93% of the operating costs.

Using the average fish production O&M costs reported from FY 2009 to FY2011 as a base, O&M costs were calculated for comparing average production before and after the recommended improvements are implemented and these are also compared to a 20% increase in fish production. The improvements and increased future fish production levels assumes that the improved water supply treatment infrastructure will provide assurance of fish biosecurity and control of invasive species and disease to allow the direct stocking of fry, fingerlings and yearlings produced at FRH similar to years before the stocking restrictions. However, MNDNR management will need to determine whether biosecurity and invasive species concerns have been adequately addressed before moving FRH reared fish inland. It should be noted that the projected O&M costs assume the projected 4.5 FTE staff load.

	Number of Fish	Pounds of Fish	Annual O&M Costs
Current Infrastructure	527,941	37,327	$597,851
Improvements	527,941	37,327	$523,030
20% Increase	633,529	44,792	$546,229

This exercise indicates potential cost savings related to the recommended improvements and fish production levels requested for future with respect to one another. Since averages were used, actual costs will vary from these approximations.

There are many methods that can be used for determining fish cost indices. One method of cost evaluation is to calculate the cost per unit stocked. In this case, the production is divided into KAM yearling and STT fry programs. As mentioned previously, KAM and STT production proportions are about 64% and 36%, respectively. Note that the combined STT program numbers include fry and captive broodstock program costs. The three-year average O&M costs were utilized as a baseline annual cost. The annual cost was divided by the stocking quota (goals) of 92,500 KAM yearlings and 500,000 STT fry and is summarized below. The indices are provided for the current production levels and compared with the costs after improvements have been implemented and for a 20% production biomass increase (assuming improvements were completed).

Next the total capital costs were prorated over 25 years to determine a yearly cost. Prorated costs are about $290,000 per year. These costs were added to the annual O&M costs to determine the new cost per unit stocked.

	Kamloop $/Yrling	STT $/1000
Current Infrastructure	$4.13	$430
Improvements	$3.62	$377
Improvements + Prorated Capital Costs	$5.73	$596
20% Production Increase	$3.14	$327
20% Increase + Prorated Capital Costs	$4.90	$510

Cost per unit stocked decreases 14% after the recommended infrastructure improvements have been installed. Similarly, costs per unit decrease 31% with recommended improvement along with production levels increase due to economies of scale. After improvements have been constructed, fish production is increased and prorated capital costs are added, new cost per unit is approximately 16% greater than the current cost per unit.

Labor Savings

The recommended improvements outlined in **Section IV** for each component will reduce overall labor associated with maintaining equipment that has reached the end of its service life. The current staff spends a large amount of time troubleshooting and maintaining equipment that no longer functions as programmed. Some of the mechanical equipment requires manual control. The improvements that were recommended in this report will serve to either modernize equipment or to eliminate excessive maintenance requirements when possible. Due to the nature of the equipment, some maintenance will always be required.

Energy Conservation

The recommended infrastructure improvements outlined in the report provide some overall energy savings for the facility. As mentioned, some recommended improvements for one component can cascade into energy savings for another component. As mentioned, these types of cascading cost savings are difficult to quantify but will need to be considered. Total energy savings are summarized as follows:

Improvement	Component	Annual Energy Savings
Intake Pump Replacement	2	$8,500
UV Disinfection System	5	$1,350
Boiler Conversion	7b	$17,400
Recirculation Pump Controls	12	$2,100
Burrows Building Lighting	14	$1,600
Raceways Building Lighting	15	$500
Heat Recovery System	18	$35,000
Oxygen Storage	21	$3,520
	Total Projected Savings	**$69,970**

Note that overall energy cost savings might be larger than these projections indicate since conservative equipment sizing estimates were used for this exercise.

The use of alternative energy sources at the fish hatchery is limited due to the critical nature of the fish life–support systems. Any alternative energy source, particularly natural sources such as solar and wind power, should not be relied on as the primary energy source for fish life-support purposes such as water pumping. Unfortunately, none of the evaluated alternative energy options (solar water heating, photovoltaic power generation, or geo-thermal heat pump) provides adequate payback to recommend installation at this time. However, these options should be reconsidered in 5-10 years if energy costs keep escalating and alternative energy equipment becomes more cost effective. According to the experts, future improvements to the renewable energy systems are projected to decrease the payback time requirements which will make these options more comparable to traditional energy sources. Other future advancements in technology may also point to additional areas at the site that can use renewable energy resources.

Preliminary Permitting Plan

Section V provides a preliminary permitting plan that describes the Hatchery's existing permits and the permits that may be necessary if MNDNR proceeds with rehabilitation of the Hatchery. Time frames for permit application review and potential application costs are outlined in the report. This is only a preliminary assessment of the potentially applicable permits; additional assessment will be necessary based on the rehabilitation projects that the MNDNR decides to undertake at the Hatchery. The evaluated permits include:

- NPDES/SDS Industrial Permit
- Water Appropriations Permit
- Solid Waste Utilization Project Authorization
- NPDES/SDS Construction Stormwater General Permit
- Public Waters Work Permit
- Aboveground Storage Tank Registration
- 316(b) Cooling Water Intake Structures
- County Road Crossing Permit

Implementation Plan

It is recommended that MNDNR use this report and its supporting information as a framework and guideline to direct the final design phase(s) and implement recommended capital improvements to the French River Hatchery. This report can be used to assist in obtaining appropriate funding for this project.

This is a planning document and is not intended to be used as a substitute for Construction Phase Documents, which provide detailed drawings, specifications, and construction level opinions of probable cost. These documents will be developed as a component of Final Design Phase of this project. Construction Documents must be developed to specifically define construction details, existing site conditions, site geotechnical and hydrological conditions, and to be in full compliance with all applicable Federal, State and local codes, permitting requirements, and all state agency construction guidelines. The Planning, Design, and Construction Phases of the project will involve direct participation and involvement of all the appropriate staff of MNDNR and reviewing agencies, the Consultant Design Team and Contractors throughout the execution of the project.

For planning and budgeting purposes, a **Planning and Design Engineering Contingency** budget of approximately 15% of the authorized construction cost is included in this report (See Section **VI for details**.) This engineering fee is generally divided into 8% for design and 7% for construction phase services.

Factors influencing the French River Hatchery Rehabilitation / Improvements Project implementation should be evaluated during the development of the MNDNR capital construction budget. The following issues should be included in the evaluation of infrastructure improvements and implementation plan:

- Overall water and energy conservation.
- Available construction funding or possible phased construction of project components.
- The length of time required for funding approval impacts the total project duration.
- Relatively long project lead time for Final Design, Bidding/Contract Award, Construction, and Construction Close-Out/Facility Start-Up and Testing.

- Cost Escalation of 3% to 4% per year should be expected. (Costs in the Report are in 2013 dollars)

Figure II-1 illustrates the expected project scope and tasks required to complete the French River Hatchery rehabilitation and improvements project. It also indicates the estimated length of time required to complete each task. The table below provides an overview of the entire project duration using anticipated time requirements.

Phase I – Study Phase	
Consultant Selection	2 months (completed)
Study Preparation	6 months (completed)
Phase II – Design Phase	
Funding Approval (for Design and Construction)	3 months to 2 years
Consultant Selection	3 months
Design	6-9 months
Phase III- Construction Phase	
Bidding/Tender	3 months
Construction	12 months
Start Up	1 month
Total Phase II and III	28 to 52 months (2.3 to 4.3 years)

This plan assumes that funding and execution of planning, final design engineering, and construction by project can be completed in a proposed period. The proposed implementation plan should be considered flexible and can be adjusted to meet MNDNR needs. An estimated 2.3 to 4.3 year period will be required to complete the design and construction (Phases II and III) of the proposed FRH improvements. The time required to obtain funding is the largest variable in this schedule.

It is important to state that this Implementation Plan <u>must</u> accompany continued funding of day-to-day maintenance and repair items. Critical components of fish culture system infrastructure may continue to break or fail, requiring repair before the major new facility rehabilitation outlined in this report can be completed. The MNDNR must provide funding for these repairs as well as this long-term capital improvements project. Due to the design and construction complexity and cost, we recommend that the improvements outlined in this report be completed as a major capital improvement project.

Implementation Plan Benefits

The MNDNR fisheries program will benefit from the proposed rehabilitation of French River Hatchery as follows:

Capability to Meet Stocking Requirements and Production Goals

The proposed improvements to the French River Hatchery provide long-term fish production capability needed to meet current Lake Superior management objectives. The present Lake Superior management goals require Kamloops production to sustain the put-grow-take fishery and steelhead fry production to supplement the naturalized steelhead program. It is anticipated that the goals for both steelhead and Kamloops programs will change over the next 25 years. The renovated FRH should be able to accommodate future program changes.

Biosecurity

Ability to rear and stock STT and KAM for Lake Superior and tributary streams with significantly reduced biosecurity risk (99% assurance level). Proposed treatment improvements will provide desired biosecurity to allow FRH to assume its original role of production and direct stocking of STT fry above migration barriers without off-station rearing.

Facility Maintenance

The rehabilitated facility will reduce the amount of staff time and annual operating costs associated with maintenance work needed to repair and operate antiquated systems. However, periodic annual preventative maintenance will always be required, including new or renovated systems.

Efficient Use of Water

The facility will continue to incorporate recirculation and reuse water treatment technology to permit selective water reuse and water conservation.

Efficient Use of Manpower

The improvements outlined in the report will result in more efficient use of manpower by providing higher fish production efficiency, less system maintenance time requirements, and reduced labor for some culture tasks.

Energy Cost Efficiency

The proposed improvements to the FRH will result in consistent, high-quality fish produced cost effectively. The infrastructure improvements will provide some savings in operational costs due to improvements in performance, energy savings, reduced facility maintenance costs, and improved fish production efficiency. Energy conservation and energy cost reduction features are included in rehabilitation and improvement recommendations.

Effluent Treatment

The facility will include improvements to the wastewater treatment system to allow full compliance with all applicable state and federal effluent permitting and discharge treatment requirements.

FIGURE II -1 MINNESOTA
FRENCH RIVER COLDWATER HATCHERY REHABILITATION PROJECT

PROJECT FLOW CHART

2 MONTHS
CONSULTANT SELECTION & STUDY CONTRACT AWARD

6 MONTHS (STUDY PHASE)
FRENCH RIVER REHABILITATION REPORT

3 MONTHS TO 2 YEARS*
MINNESOTA DNR APPROVAL
MINNESOTA LEGISLATURE APPROVAL
CAPITAL FOUNDLING FOR PROJECT
BIANNUAL BUDGET

KICK-OFF MEETING
- FRH PRODUCTION INFRASTRUCTURE REVIEW
- SCOPE-OF-WORK CLARIFICATIONS
- FISH PRODUCTION GOALS & HATCHERY REQUIREMENTS
- REVIEW ANNUAL FRENCH RIVER FISH PRODUCTION PROGRAM
- WATER SUPPLY REQUIREMENTS, WATER BUDGET
- INFRASTRUCTURE REQUIREMENTS
- PROJECT ADMINISTRATION & COMMUNICATION ISSUES
- OPTIONS & ALTERNATIVES
- IDENTIFY PERMITS NEEDED
- REVIEW CODES AND DESIGN REQUIREMENTS
- REVIEW SITE ISSUES AND EXISTING CONDITIONS
- OBTAIN OPERATIONAL DATA

SITE VISIT & INVESTIGATIONS
- FIELD INVESTIGATIONS
- INTAKE INVESTIGATION
- SITE INSPECTIONS:
  ELECTRICAL SERVICE
  DOMESTIC WATER/WASTEWATER
  LAKE, RIVER WELL & WATER SUPPLY OPTIONS
- WATER QUALITY REVIEW
- REVIEW DESIGN DRAWINGS AND PERFORMANCE REQUIREMENTS
- FLOOD PLAIN ISSUES
- ENVIRONMENTAL ISSUES
- UTILITY ISSUES
- DOMESTIC WATER, SEWAGE

STUDY REPORT
- SUBMITTED AT 35%, 65%, 95% AND 100% FINAL LEVELS
- FRH EXISTING & IMPROVEMENT DRAWINGS
- FLOW SCHEMATIC
- WATER SUPPLIES & DISTRIBUTION
- DRAINAGE
- WATER SUPPLY TREATMENT
- WASTEWATER SYSTEM & EFFLUENT IMPROVEMENTS
- CONCEPTUAL HATCHERY IMPROVEMENTS
- COST ESTIMATES
  - CONSTRUCTION
  - OPERATION
  - ENERGY SAVINGS

STUDY REPORT RECOMMENDATIONS
- CONFIRM REHABILITATION RECOMMENDATIONS
- CONFIRM MAJOR CAPITAL IMPROVEMENTS & SCHEDULE
- MATERIALS
- FIXED EQUIPMENT
- MOVABLE EQUIPMENT
- COST ESTIMATES

FINAL STUDY REPORT
- UPDATE COST ESTIMATES
- CONFIRM REHAB RECOMMENDATIONS
- SCHEDULE
- OPERATIONAL COSTS
- PHASING RECOMMENDATIONS
- FINALIZE RECOMMENDATIONS FOR FINAL DESIGN PHASE
- PRESENTATION OF RECOMMENDATIONS TO MINNESOTA DNR
- ENVIRONMENTAL COORDINATION AND PERMITTING

APPROVAL OF CAPITAL PROGRAM AND BUDGET

FINAL DESIGN & CONSTRUCTION FUNDING

AUTHORIZE FINAL DESIGN PHASE

FRENCH RIVER REHABILITATION / IMPROVEMENTS PROJECT (CONSTRUCTION PHASE)

6 TO 9 MONTHS
CONSTRUCTION DOCUMENTS

3 MONTHS*
TENDER (BIDDING) PHASE

12 MONTHS
CONSTRUCTION PHASE

1 MONTH

PROJECT START UP

FINAL DESIGN PHASE INFORMATION REQUIRED

DRAWINGS
- CONSTRUCTION DRAWINGS FOR ALL REHABILITATION COMPONENTS OF PROJECT 35%, 65%, 95% AND 100% SUBMITTALS
- FINAL DESIGN (BID) DOCUMENTS
- CONFIRM COST ESTIMATE
- FINAL PERMIT DRAWINGS & COORDINATION (PLANS AND SPECIFICATIONS.)
- FINAL PERMIT APPLICATIONS SUBMIT TO ALL AGENCIES
- REVIEW BY MINNESOTA DNR & MINNESOTA DOA

SPECIFICATIONS
- SPECIFICATIONS
- DOCUMENTS
- MINNESOTA CONTRACT FRONT END DOCUMENTS
- CONTRACT DOCUMENTS

1 MONTH
TENDER (BID) INVITATION
- BID ADVERTISEMENT
- PRE-BID MEETING
- SITE INSPECTION

1 MONTH
TENDER (BIDDING)
- PREPARE REVISIONS
- ADDENDUMS
- ANSWER QUESTIONS
- REVIEW BIDS

1 MONTH
CONST. CONTRACT AWARD
- BID RECOMMENDATION
- ADVISE ON BID OPTIONS
- MOBILIZATION

CONSTRUCTION
- SITE VISITS
- PRE-CONSTRUCTION MEETING
- SHOP DRAWINGS
- CONTRACTOR RFI RESPONSE
- REVIEW INFORMATION CONTRACTORS' PROPOSALS
- RECORD DRAWINGS
- O & M MANUALS

INSPECTION
- CONSTRUCTION INSPECTION
- QUALITY & CONFORMANCE
- MATERIALS TESTING

CONTRACT ADMINISTRATION
- ADVISE & CONSULT WITH MINNESOTA DNR
- PROGRESS REPORTS
- PROCESS CHANGE ORDERS
- SUBSTANTIAL COMPLETION
- PAYMENT REQUESTS
- CODE INSPECTION
- FINAL INSPECTION

POST-CONSTRUCTION PHASE AND PROJECT STARTUP
- COMPONENT TESTING & SYSTEM TESTING INCLUDING:
- MECHANICAL START-UP
- ELECTRICAL START-UP
- HYDRAULIC WATER SUPPLY TESTING AND OPERATION
- CONTRACTOR O & M MANUALS
- FISH CULTURE SYSTEMS
- O & M MANUALS & TRAINING
- WASTEWATER SYSTEM AND SAMPLING
- AS-BUILTS
- FINAL PROJECT CLOSE-OUT

HATCHERY OPERATION
- ASSIST MINNESOTA DNR WITH OPERATIONAL PROBLEMS
- WARRANTY ISSUES
- STAFF TRAINING
- OPERATIONAL TRAINING
- BEGIN PRODUCTION

* TIME REQUIREMENT MAY BE MODIFIED DEPENDING ON MINNESOTA DNR SCHEDULE REQUIREMENTS
* PROJECT FUNDING WILL REQUIRE LEGISLATIVE & MNDNR COOPERATION.

Minnesota Department of Natural Resources

HDR
HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
	04-08-13	65% SUBMITTAL
	05-16-13	95% SUBMITTAL

PRELIMINARY
NOT FOR
CONSTRUCTION

MINNESOTA DEPARTMENT OF NATURAL RESOURCES
FRENCH RIVER COLD WATER HATCHERY
REHABILITATION ANALYSIS
PROJECT NO. 8F022
FILE NO.: FMA.00257.00.00.03

FRENCH RIVER REHABILITATION PROJECT
PROJECT FLOW CHART

0" 1" 2"

FILENAME
SCALE AS NOTED

SHEET
FIG. II -1

Long-Term Operation

A rehabilitated FRH facility will provide long-term fish production operation to meet current and future fish production needs using a biosecure facility. Failure of the existing aging hatchery infrastructure could result in major losses of fish propagation activities.

Action Needed by MNDNR

In order to implement the French River Cold Water Hatchery Rehabilitation Project as outlined in this report, the MNDNR needs to perform the following generalized tasks:

- Due to the critical importance of back up power for the lake supply pumps, replace the emergency generator and associated electrical components as soon as possible.
- MNDNR to seek funding sources for construction of the recommendations outlined in this report. Options include license increases, bond bill or fish hatchery stamp.
- Provide funding and authorization of the design phase of the renovation project so that construction documents are ready whenever capital construction costs are released. Planning and Design Engineering costs will be about 8% of the authorized project construction total.
- Obtain water supply sampling and testing as recommended in this report
- Begin preparing environmental permitting documentation in conjunction with design due to long lead times for permit reviews.
- Prepare final construction documents and distribute them to all permitting agencies/bureaus requiring these documents for permit application and approval.
- Continue coordination and communication with reviewing agencies, user groups, legislative staff and the general public.

French River Cold Water Hatchery
Summary Opinions of Probable Cost
Final Submittal

6/20/2013

ITEM	DRAWING I.D. #	ROUNDED CONST COST[a]	BUDGET TOTAL COST[a]
Components	**No.**	**$6,087,000**	**$7,610,000**
Lake Intake	1	$299,000	$374,000
Pump Station	2	$312,000	$390,000
Vortex Separator	3	$0	$0
Bag Filtration System	4	$1,116,000	$1,395,000
Ultraviolet Disinfection System	5	$579,000	$723,000
Upper Reservoir	6	$63,000	$79,000
Coldwater Supply - None Needed	7a	$0	$0
Water Heating System	7b	$62,000	$78,000
Mixing Manifold	7c	$52,000	$65,000
Incubation - None Needed	8	$0	$0
Nursery Tanks	9	$122,000	$153,000
Biofilter System	10	$986,000	$1,233,000
Clearwell System	11	$21,000	$27,000
Recirculation Pumps	12	$56,000	$70,000
Recirculation Headtank	13	$47,000	$59,000
Burrows Ponds	14	$439,000	$549,000
Raceways	15	$48,000	$60,000
Clarifier	16a	$541,000	$677,000
Pond - None Needed	16b	$0	$0
Instrumentation System	17	$20,000	$25,000
Heat Recovery System (HRS)	18	$555,000	$693,000
Lower Spawning Tanks	19	$601,000	$751,000
General Storage	20	$143,000	$178,000
Oxygen Generator	21	$25,000	$31,000

[a] Rounded Construction Costs include 20% Contingency: General Conditions (5%) ; Estimating (15%). Rounded Total Costs (or **Costs Needed to Budget**) also include 25% Contingency: Planning & Design (8%); Construction Phase Engineering (7%); and State Construction (10%, Bidding and Change Order). [Total * (1.15+.05) * (1.10 + 0.08 + 0.07)]

Costs do **NOT** include: Design Reimbursables (Variable); State Agency Administrative Fee; or escalation beyond 2013 Construction.

Minnesota Department of Natural Resources

MDNR No. 8F022
File No. FMA.00257.00.00.03
HDR No. 202386

French River Cold Water Hatchery

III. FISH PRODUCTION PROGRAM EVALUATION

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III. FISH PRODUCTION PROGRAM EVALUATION

Fish Production Program Overview

The facility design is based on the use of Lake Superior water that is acquired from a 20-inch diameter ductile iron Lake Superior intake pipeline and an 800 gpm capacity pump station. The lake water supply system was designed and constructed in two phases: Phase 1 – Pump Station, 1980 and Phase 2 – 20-inch Intake Pipeline, 1981.

The Lake Superior pumped raw water supply is treated before cold water fish cultural use by a vortex grit separator, a series of bag filters and an ultraviolet disinfection system before being stored in a buried water storage reservoir tank with corrugated metal enclosure. Treated lake water from the storage reservoir tank provides a gravity flow cold water source for facility operation.

A portion of the treated cold water is heated and blended with cold water to meet fish rearing temperature requirements. Lake Superior water temperatures vary significantly through out the year from 33 deg. F to over 65 deg. F. The blending of heated lake water with cold water is completed to provide up to five different rearing temperatures in the nursery building and involves the use of two different mixing valve manifolds (originally manually controlled) that have been partially automated by a SCADA system to aid in controlling this relatively complicated process.

The facility design occurred just prior to the era of awareness of dissolved gas monitoring of hatchery water supplies and concerns related to changes in dissolved gas levels such as total dissolved gas (TDG), dissolved oxygen (DO) and dissolved nitrogen (DN) levels that can impact fish rearing conditions. The present system relies on aeration degassing within the cold and hot water storage tanks using antiquated jet aspiration and mechanical aerators. Aeration processes occur before the temperature mixing manifolds. Supplemental aeration (air or oxygen diffusion) can be applied to individual rearing units. Modern hatcheries typically provide individual temperature headboxes with all temperature adjustment and aeration/degassing applied before use. Pumping, treating, heating Lake Superior water and mixing to provide multiple temperature water supplies for fish rearing use were assumptions included in the original facility design. The age, performance and cost of operation of these systems are addressed in this report.

The fish production portion of the Nursery Area in the Main Hatchery Building includes egg incubation, hatching and early rearing systems using single-pass water with operation of up to 54 circular tanks, 4 super troughs, 4 egg sorting troughs and 21 vertical flow egg incubators.

Used water from the Nursery production units is transferred by gravity flow to the Burrows Building where it is reconditioned for reuse by biofilters that provide both solids settling and bacterial ammonia oxidation before being pumped from two clearwells to aeration/degassing headtanks. From the elevated headtanks, water flows to six recirculating Burrows Ponds. This system is one of the earliest known public fish hatcheries to employ partial pumped recirculation with biofiltration. The Burrows operate with a pumped recirculation rate of 400 gpm per raceway or 2,400 gpm total of biofiltered overflow water from the Nursery Building. There is typically 300 to 500 gpm of continuous Nursery Building inflow to the recirculation system or about 12% to 20% of the Burrow's 2,400 gpm peak flow rate.

The biofiltered overflow from the clear wells is then transferred by gravity to the Raceway Building where it is used to operate the five (5) broodstock raceways used for the captive Knife River steelhead broodstock program. Brood Raceways are operated as traditional flow through raceways. Overflow water from the broodstock raceways is piped to the outflow end of a rectangular solids collection clarifier from which it flows on to an earthen effluent polishing pond. Overflow from the effluent polishing pond returns to the French River for use in attraction flow augmentation. Solids collected from Nursery Building drains, Burrows biofilters, and broodstock raceway cleanout drains are processed in the rectangular concrete clarifier equipped with a chain and flight sludge transfer system.

These systems are illustrated in the report **Drawings (**see **Appendix A)**. Even by today's modern public cold water fish hatchery standards, the FRH facility is relatively complicated facility and involves a variety of process treatment technologies including complex water heating, recirculation and water reuse that make this facility considerably more difficult to manage and operate than most facilities.

Coldwater Production Analysis

Historical Fish Production

Historical production of cold water fish at FRH has included steelhead (STT), Kamloop rainbow trout (KAM), lake trout, brook trout, brown trout, Atlantic salmon and Chinook salmon. **Table III-1** provides a summary of historical production in numbers and pounds by species. Annual production in FY 2009 to FY 2011 has averaged approximately 37,327 pounds which is about 50% of the MNDNR reported historical maximum 70,000 pounds per year production level. This 70,000 lbs./year level has been determined to be the upper maximum production level stated in the annual production reports. Potential biosecurity risks with the use of Lake Superior as a hatchery water source, and the high cost of facility operation has impacted fish production at the hatchery.

Table III-1. FRH Historical Fish Production Summary

ID Code	Species

(Note: data extracted from MN DNR FRH 1975-2010 Alpha4 database)

ATS Atlantic Salmon	Eyed Eggs		Fry		Fingerling		Yearling		Adult	
Time Period	lbs.	Number	lbs.	Number	lbs	Number	lbs.	Number	Lbs	Number
1978-1989	91	397,344	67	192,605	874	37,953	8,039	60,849		
1990-1999	27	101,503					2,162	14,961		
2000-2010								10		
ALL YEARS	117	498,847	67	192,605	874	37,953	10,201	75,810		

BKT Brook Trout	Eyed Eggs		Fry		Fingerling		Yearling		Adult	
Time Period	lbs.	Number	lbs.	Number	lbs	Number	lbs.	Number	Lbs	Number
1978-1989	22	208,860	17	97,200	20,026	517,851	1,475	9,442	3	5
1990-1999										
2000-2010										
ALL YEARS	22	208,860	17	97,200	20,026	517,851	1,475	9,442	3	5

BNT Brown Trout	Eyed Eggs		Fry		Fingerling		Yearling		Adult	
Time Period	lbs.	Number	lbs.	Number	lbs	Number	lbs.	Number	Lbs	Number
1978-1989			3	15,625						
1990-1999										
2000-2010										
ALL YEARS			3	15,625						

CHS Chinook Salmon	Eyed Eggs		Fry		Fingerling		Yearling		Adult	
Time Period	lbs.	Number	lbs.	Number	lbs	Number	lbs.	Number	Lbs	Number
1978-1989	1,858	3,283,163	928	1,102,180	40,892	4,679,029				
1990-1999	344	647,916	108	150,183	35,956	3,006,266				
2000-2010					14,681	1,214,908				
ALL YEARS	2,202	3,931,079	1,036	1,252,363	91,529	8,900,203				

LAT Lake Trout	Eyed Eggs		Fry		Fingerling		Yearling		Adult	
Time Period	lbs.	Number	lbs.	Number	lbs	Number	lbs.	Number	Lbs	Number
1978-1989	230	1,011,452	98	400,145	4,521	487,051	9,451	218,219	1,357	357
1990-1999										
2000-2010										
ALL YEARS	230	1,011,452	98	400,145	4,521	487,051	9,451	218,219	1,357	357

RBT Rainbow Trout	Eyed Eggs		Fry		Fingerling		Yearling		Adult	
Time Period	lbs.	Number	lbs.	Number	lbs	Number	lbs.	Number	Lbs	Number
1978-1989	83	457,042	6,260	20,267,119	27,082	888,306	434,746	2,268,000	379	316
1990-1999	175	987,750	1,251	4,166,531	6,667	304,760	469,165	1,236,028	99	66
2000-2010	125	722,461			3,989	112,857	373,673	1,139,507		
ALL YEARS	383	2,167,253	7,511	24,433,650	37,738	1,305,923	1,277,584	4,643,535	478	382

STT Steelhead	Eyed Eggs		Fry		Fingerling		Yearling		Adult	
Time Period	lbs.	Number	lbs.	Number	lbs	Number	lbs.	Number	Lbs	Number
1978-1989			725	2,309,905	34	22,043	1,612	61,849		
1990-1999			727	2,589,761	156	24,546	41,231	261,304		
2000-2010	2	5,503	2,079	6,699,670	806	238,604	53,108	323,766		
ALL YEARS	2	5,503	3,531	11,599,336	995	285,193	95,951	646,919		

SPT Splake	Eyed Eggs		Fry		Fingerling		Yearling		Adult	
Time Period	lbs.	Number	lbs.	Number	lbs	Number	lbs.	Number	Lbs	Number
1978-1989	28	148,350								
1990-1999										
2000-2010	28	148,350								

PKS Pink Salmon	Eyed Eggs		Fry		Fingerling		Yearling		Adult	
Time Period	lbs.	Number	lbs.	Number	lbs	Number	lbs.	Number	Lbs	Number
1978-1989										
1990-1999	3	8,800								
2000-2010	3	8,800								

Current Production

STT fry stockings augment natural steelhead reproduction in North Shore Rivers and are highly sought by anglers. This steelhead fishery is a catch-release program. Stocking of KAM (fin-clipped yearlings) provide the put-grow-take fishery in the lower North Shore rivers and Lake Superior and are the only rainbow trout strain that can legally be harvested from Lake Superior and its' tributaries. French River Hatchery completes the final grow-out rearing of KAM in the Burrows system from fingerlings produced at French River Hatchery (25%) and Spire Valley Hatchery (75%).

Fish production data for fiscal years 2009 to 2011 (July 1 to June 30) are presented in **Tables C-1A, 1B, and 1C to C-3A, 3B, and 3C** in **Appendix C.** The egg and fish production is summarized in these tables by fiscal year (FY) to include the following subdivisions:

Part A – Species, Number and Pounds;

Part B – Overall Production Summary

Part C – Egg and Fry Summary

See **Table III-2** for an overview of the current fish production program timeline per month. Species and strains produced in the period of FY2009-FY2011 included Knife River steelhead (STT-KR) fry, French River steelhead (STT-FR) fry and KAM yearlings. Note that changes in the program occurred in FY2011 whereby eyed eggs are now shipped to Spire Valley Hatchery due to water supply biosecurity concerns at FRH. Production and stocking from FRH is now limited to only Lake Superior or below the first barrier in rivers draining into Lake Superior.

Total fish production for the entire facility for the last three fiscal years (July 1 to June 30) is summarized below:

	FY2009	**FY2010**	**FY2011**
Egg Take	1,594,044 eggs	1,599,523 eggs	1,527,914 eggs
Fry Produced from Eggs Taken	1,091,595 fry	951,202 fry	84,511 fry
Number Produced (fry, fingerlings, yearlings, stocked adults)	673,641 fish	819,212 fish	90,979 fish
Pounds Produced	34,305 lbs.	45,183 lbs.	32,573 lbs.

Of the total annual poundage production numbers, the KAM production was 33,140 lbs., 96.6% (FY2009), 43,684 lbs., 97.9% (FY2010) and 32,138 lbs., 98.6% (FY2011). Captive Knife River broodstock (5-year classes maintained) in the raceway building poundage was 2,144 lbs. (FY2009), 1,823 lbs. (FY2010) and 2,095 (FY2011) with 417 lbs., 462 lbs. and 428 lbs. of retired broodstock released in those years, respectively.

Table III-2. FRH Production Timeline (Current - no FRH direct fry stocking due to biosecurity)

		Year 1												Year 2											
Months		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rearing Program	**Location**																								
Kamloop RBT Spawning	Lower Spawning																								
Kamloop RBT Incubation	Lower then Nursery																								
Kamloop RBT Yearling	Nursery and Burrows																								
KR Captive STT Broodstock Maintain	Raceways																								
KR Captive STT Broodstock Spawning	Raceways																								
KRC STT Incubation	Raceways then Nursery																								
KRC STT Eyed Eggs & Fry BS replacement	Nursery																								
KRC STT Fry Stocking (Spire Valley)																									
French River STT Spawning	Lower Spawning																								
French River STT Incubation	Lower then Nursery																								
French River STT Eyed Eggs	Nursery																								
French River STT Fry Stocking (Spire Valley)																									

The *Fisheries Management Plan for the Minnesota Waters of Lake Superior* (MNDNR, 1995) sets the annual stocking quota of **500,000 STT fry** and **92,500 KAM yearlings** for North Shore streams.

Steelhead

STT adult spawning and fry production in FRH program includes the following six different tracked groups:

STT-FR clipped (hatchery produced)	STT-FR "wild"	STT-FR hatchery
STT-KR clipped (hatchery produced)	STT-KR "wild"	STT-KR (captive broodstock produced)

The hatchery maintains a unique strain of captive Knife River STT broodstock utilizing five-year classes of adults to produce eggs and fry for stocking Lake Superior north shore streams. The Knife River captive broodstock are fish that have been captured as smolts from the Knife River trap and transferred to the hatchery for rearing and eventually for captive adult broodstock and spawning.

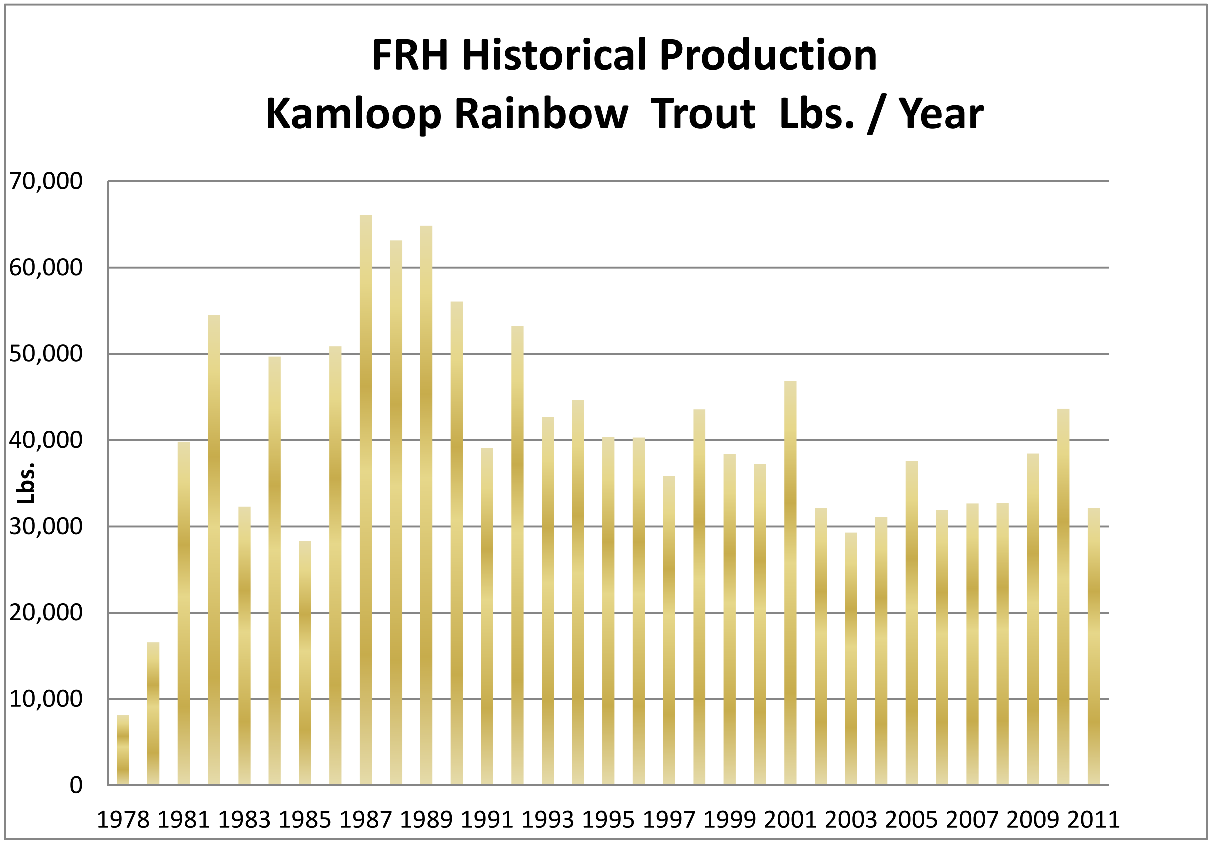
Knife River captive STT broodstock are spawned weekly from late January through mid May. Currently those eggs are incubated to produce eyed eggs (425,692 FY11) that are now shipped 110 miles to the Spire Valley Hatchery in Cass County to produce fry that are stocked in North Shore Lake Superior Streams. Spire Valley Hatchery utilizes a constant temperature secure spring water supply that does not require heating as is needed at FRH. Prior to the biosecurity concerns, fry were produced and stocked directly from FRH. Production of STT fry from Knife River captive broodstock ranged from 359,000 fry weighing 119 pounds in FY 2009 and 436,000 fry weighing 125 pounds in FY 2010. This production level appears to be typical for the Knife River broodstock program. In FY2011, only 10,000 fry weighing 7 pounds were produced for broodstock year class replacement fish. Direct stocking of Knife River STT fry by FRH has been stopped due to biosecurity concerns. Other than replacement broodstock fish, only eyed eggs are now produced. However, the level of effort to maintain, spawn and produce eyed eggs is similar to FY 2009/2010 when fry production and direct fry stocking occurred.

In addition to the captive STT program, the FRH also produces French River STT that return to the French River during spring spawning runs when KAM are collected. These returning French River STT are spawned during the KAM season from approximately the end of April to Mid May depending upon the spawning run. The STT/FR season is limited to the spawning run and is more compressed than the captive Knife River spawning which is extended from end of January to Mid-May. Production of French River "wild" STT fry ranged from 120,000 fry weighing 34 pounds to 198,000 fry weighing 61 pounds in FY 2009 and FY 2010. No French River fry were produced in 2011 due to biosecurity concerns, but 425,692 eyed eggs were produced and sent to Spire Valley Hatchery for fry production. **See Appendix C** for egg and fry production by strain.

Kamloop Rainbow Trout

KAM adult collection and spawning typically occurs for a two to three week period from about April 21-May 4 +/- annually. The Lower Spawning Facility is used in the adult KAM and STT collection, holding and spawning operations as well as the initial incubation of eggs until disease certification status is completed. The Lower Spawning Facility provides biosecure separation between the "wild" capture fish spawning and the upper FRH facility where further egg incubation, eyeing, hatching and rearing operations occur. The hatchery has produced KAM rainbow trout since 1976 and has produced fry, frylings, and yearlings. **Table C-4** in **Appendix C** provides a historical summary of KAM production and yearly fish production in pounds is summarized in **Figure III-1**. KAM historical production has been highly variable from 8,181 to 66,183 lbs. Production of yearling KAM was 103,534, (33,140 lbs.), 105,930, (43,684 lbs.), 80,641,(32,138 lbs.) in FY2009, FY2010 and FY2011 respectively. KAM yearlings are the major production biomass providing over 97.7% of the annual production poundage.

Figure III-1. Historical Kamloop Production at FRH



Rearing Unit Summary

The rearing volumes and inflows for each major rearing component for the Upper and Lower Rearing locations are summarized below:

NO.	Unit	Flow	Volume per Unit	Total RV
Nursery				
21	Vertical Flow Egg Incubators	5-7 gpm/unit	NA	NA
4	Super Troughs	15 gpm/unit	25 CF*	200 CF
54	6ft. dia. Circular Tanks	7 to 14 gpm/unit	80 CF	4,320 CF
Burrows Ponds (raceways)				
6	Ponds	400 gpm/unit	2,424 CF	14,544 CF
Broodstock Raceways				
5	Raceways	100 gpm/unit	1,060 CF	5,300 CF
			Total Upper	**24,364 CF**

Lower Spawning Facility				
12	Vertical Flow Incubations	5 gpm/unit	na	**na**
360	Hatchery Jars	2 gpm/unit	na	**na**
5	Spawning / Holding Tanks	100 gpm/unit	375 CF	2,625 CF
			Total Lower	**2,625 CF**

**= Historical Rearing Volumes used by MNDNR*

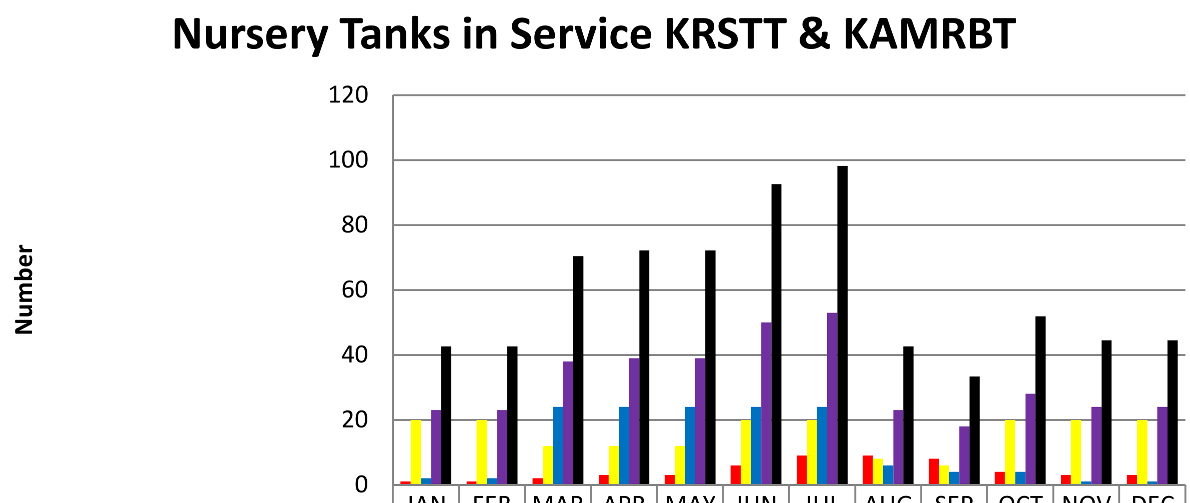
Table III-3 provides a monthly summary of rearing units in service, flows and desired temperatures for the FRH. This table provides a monthly **estimate** of the units in operation, flows and temperatures based on 2012 data provided by MNDNR. Total Nursery flows range from 183 gpm (Sept.) to 502 gpm (June). The Burrows and Raceway flows are also noted. Flows vary for each unit throughout the rearing cycle as do the water temperatures. This information will be useful for sizing treatment equipment, evaluating water heating costs and energy savings.

Next, total rearing vessel use was evaluated to determine whether any units could be retired from service**. Figures III-2, 3 and 4** illustrate the utilization of rearing units in the Nursery, Burrows and Raceways in the current program. Note that unit utilization reaches nearly 100% at all three locations to meet the current STT and KAM production. The Burrows system is the currently limited in use from April to August. Note that rearing unit utilization in public fish hatcheries rarely has 100% utilization due to the time sequencing of use is matched spawning, rearing and stocking requirements.

Production Capacity

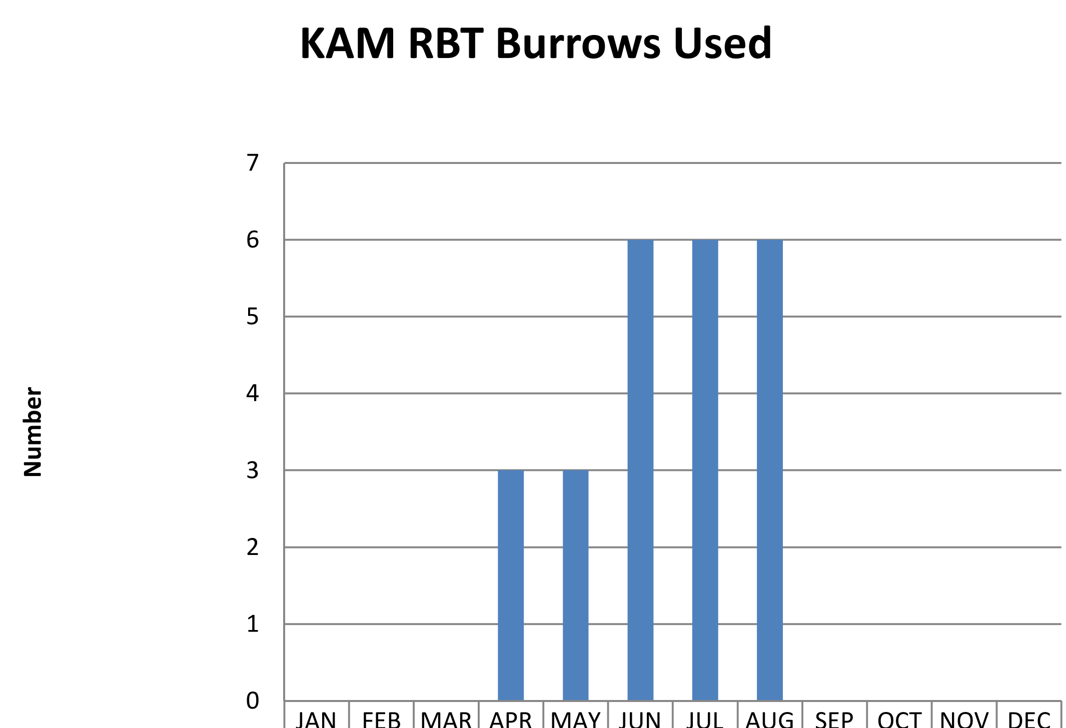
Historical FRH annual production poundage has ranged from 30,000 to over 70,000 pounds. Historically, KAM production and the Chinook salmon production of 500,000 (100 per pound pre-smolts or 5,000 lbs.) has occurred at FRH. Under these assumptions, production would have reached the 70,000 per year production level. The facility staff reports that 70,000 lbs. per year is the historical upper limit of production due to gill disease and other observed fish health / fish quality issues observed when operating at higher total pound per year production levels.

Figure III-2. Nursery Rearing Unit Yearly Use Summary



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Nursery (6' dia. Tanks) RED	1	1	2	3	3	6	9	9	8	4	3	3
Nursery (6' dia. Tanks) YELLOW	20	20	12	12	12	20	20	8	6	20	20	20
Nursery (6' dia. Tanks) BLUE	2	2	24	24	24	24	24	6	4	4	1	1
Nursey 6ft tanks TOTAL in USE	23	23	38	39	39	50	53	23	18	28	24	24
% Nursery Tanks in Use	42.6	42.6	70.4	72.2	72.2	92.6	98.1	42.6	33.3	51.9	44.4	44.4

Figure III-3. Nursery and Burrows Ponds Rearing Unit Yearly Use Summary



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Burrows Pond Used				3	3	6	6	6				

Table III-3. FRH Rearing Program Summary (MNDNR provided summary based on 2012 data)

Knife River Steelhead	Abbrev.	JAN				FEB				MAR				APR				MAY				JUN			
		# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom
PROGRAM REARING SUMMARY																									
Upper Incubation Warm	UIT	**1**	5	50	5	**2**	5	51	10	**2**	5	51	10	**2**	5	51	10	**2**	5	41	10	**1**	6	52	6
Upper Incubation Cold	UIT	**1**	5	36	5	**1**	5	36	5	**2**	5	36	10	**2**	5	37	10	**2**	5	51	10	**1**	5	46	5
Upper Incubation - Sorting Troughs	T																								
Super Troughs	ST																								
Nursery (6' dia. Tanks) RED	N	**1**	11	51	11	**1**	12	51	12	**1**	11	51	11	**2**	12	51	24	**3**	11	51	33	**3**	10	52	30
Nursery (6' dia. Tanks) YELLOW	N																								
Nursery (6' dia. Tanks) BLUE	N																								
KRSTT Nursery Summary	**flow**				**21**				**27**				**31**				**44**				**53**				**41**

Knife River Steelhead	Abbrev.	JUL				AUG				SEP				OCT				NOV				DEC			
		# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom
PROGRAM REARING SUMMARY																									
Upper Incubation Warm	UIT																								
Upper Incubation Cold	UIT																								
Upper Incubation - Sorting Troughs	T																								
Super Troughs	ST																								
Nursery (6' dia. Tanks) RED	N	**3**	10	57	30	**3**	14	58	42	**2**	10	54	20	**2**	10	49	20	**3**	9	50	27	**3**	8	50	24
Nursery (6' dia. Tanks) YELLOW	N																								
Nursery (6' dia. Tanks) BLUE	N																								
KRSTT Nursery Summary	**flow**				**30**				**42**				**20**				**20**				**27**				**24**

KAMLOOP Nursery	Abbrev.	JAN				FEB				MAR				APR				MAY				JUN			
		# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom
PROGRAM REARING SUMMARY																									
Upper Incubation Warm	UIT													**2**	5	51	10	**1**	6	51	6	**1**	6	52	6
Upper Incubation Cold	UIT													**2**	5	37	10	**1**	5	41	5	**1**	5	46	5
Upper Incubation - Sorting Troughs	T																								
Super Troughs	ST																								
Nursery (6' dia. Tanks) RED	N																					**3**	10	52	30
Nursery (6' dia. Tanks) YELLOW	N	**20**	10	43	200	**20**	9	44	180	**12**	11	43	132	**12**	10	44	120	**12**	11	47	132	**20**	9	49	180
Nursery (6' dia. Tanks) BLUE	N	**2**	16	36	32	**2**	15	39	30	**24**	9	42	216	**24**	10	42	240	**24**	9	45	216	**24**	9	49	216
KAMLOOP Nursery Summary	**flow**				**232**				**210**				**348**				**380**				**359**				**437**

KAMLOOP Nursery	Abbrev.	JUL				AUG				SEP				OCT				NOV				DEC			
		# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom
PROGRAM REARING SUMMARY																									
Upper Incubation Warm	UIT	**3**	1	57	3																				
Upper Incubation Cold	UIT	**3**	1	57	3																				
Upper Incubation - Sorting Troughs	T																								
Super Troughs	ST																								
Nursery (6' dia. Tanks) RED	N	**6**	10	57	90	**6**	14	58	84	**6**	10	54	60	**2**	10	49	20								
Nursery (6' dia. Tanks) YELLOW	N	**20**	9	58	180	**8**	14	58	112	**6**	10	51	60	**20**	9	46	180	**20**	9	46	180	**20**	8	43	160
Nursery (6' dia. Tanks) BLUE	N	**24**	9	58	216	**6**	17	58	102	**4**	10	50	40	**4**	10	44	40	**1**	9	43	9	**24**	7	42	168
KAMLOOP Nursery Summary	**flow**				**492**				**298**				**160**				**240**				**189**				**328**

NURSERY SUMMARY	Abbrev.	JAN				FEB				MAR				APR				MAY				JUN			
		# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom
PROGRAM REARING SUMMARY																									
Upper Incubation Warm	UIT	**1**	5	50	5	**2**	5	51	10	**2**	5	51	10	**3**	5	51	15	**3**	6	51	18	**2**	6	52	12
Upper Incubation Cold	UIT	**1**	5	36	5	**1**	5	36	5	**2**	5	36	10	**3**	5	37	15	**3**	5	41	15	**2**	5	46	10
Upper Incubation - Sorting Troughs #1	T	**1**	1	37	1	**1**	1	51	1	**1**	1	51	1	**1**	6	52	6	**1**	6	52	6	**1**	6	52	6
Upper Incubation - Sorting Troughs #2	T	**1**	2	37	2	**1**	2	36	2	**1**	2	37	2	**1**	2	39	2	**1**	2	48	2	**1**	2	58	2
Upper Incubation - Sorting Troughs#3&4	T									**2**	7	36	14	**2**	7	39	14	**2**	8	41	16	**2**	8	48	16
Super Troughs	ST																								
Nursery (6' dia. Tanks) RED	N	**1**	11	51	11	**1**	12	51	12	**1**	11	51	11	**2**	12	51	24	**3**	11	51	33	**6**	10	52	60
Nursery (6' dia. Tanks) YELLOW	N	**20**	10	43	200	**20**	9	44	180	**12**	11	43	132	**12**	10	44	120	**12**	11	47	132	**20**	9	49	180
Nursery (6' dia. Tanks) BLUE	N	**2**	16	36	32	**2**	15	39	30	**24**	9	42	216	**24**	10	42	240	**24**	9	45	216	**24**	9	49	216
Nursey 6ft tanks TOTAL in USE		**23**				**23**				**37**				**38**				**39**				**50**			
Nursery Summary	**flow**				**256**				**240**				**396**				**436**				**438**				**502**
Burrows Recirculating Ponds Kamloop RBT	BP													**3**	400	43	1,200	**3**	400	45	1,200	**6**	400	50	2,400
Broodstock Raceways KR captive STT	RWY	**4**	92		**368**	**5**	88		**440**	**5**	88		**440**	**5**	92		**460**	**5**	93		**465**	**5**	115		**575**

NURSERY SUMMARY	Abbrev.	JUL				AUG				SEP				OCT				NOV				DEC			
		# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom	# of Units in service	per Unit Flow in gpm	Temperature	Total flow gom
PROGRAM REARING SUMMARY																									
Upper Incubation Warm	UIT	**3**	1	57	3																				
Upper Incubation Cold	UIT	**3**	1	57	3																				
Upper Incubation - Sorting Troughs #1	T	**1**	1	59	1	**1**	1	57	1	**1**	1	50	1	**1**	1	44	1	**1**	1	43	1	**1**	1	39	1
Upper Incubation - Sorting Troughs #2	T	**1**	2	58	2	**1**	2	58	2	**1**	2	50	2	**1**	2	44	2	**1**	2	43	2	**1**	2	39	2
Upper Incubation - Sorting Troughs#3&4	T	**2**	1	59	2																				
Super Troughs	ST																								
Nursery (6' dia. Tanks) RED	N	**9**	10	57	90	**9**	14	58	126	**8**	10	54	80	**4**	10	49	40	**3**	9	50	27	**3**	8	50	24
Nursery (6' dia. Tanks) YELLOW	N	**20**	9	58	180	**8**	14	58	112	**6**	10	51	60	**20**	9	46	180	**20**	9	46	180	**20**	8	43	160
Nursery (6' dia. Tanks) BLUE	N	**24**	9	58	216	**6**	17	58	102	**4**	10	50	40	**4**	10	44	40	**1**	9	43	9	**24**	7	42	168
Nursey 6ft tanks TOTAL in USE		**53**				**23**				**18**				**28**				**24**				**47**			
Nursery Summary	**flow**				**497**				**343**				**183**				**263**				**219**				**355**
Burrows Recirculating Ponds Kamloop RBT	BP	**6**	400	60	2,400	**6**	400	58	2,400																
Broodstock Raceways KR captive STT	RWY	**5**	100		**500**	**5**	81		**405**	**4**	99		**396**	**4**	86		**344**	**4**	82		**328**	**4**	123		**492**

Figure III-4. Raceways Rearing Unit Yearly Use Summary

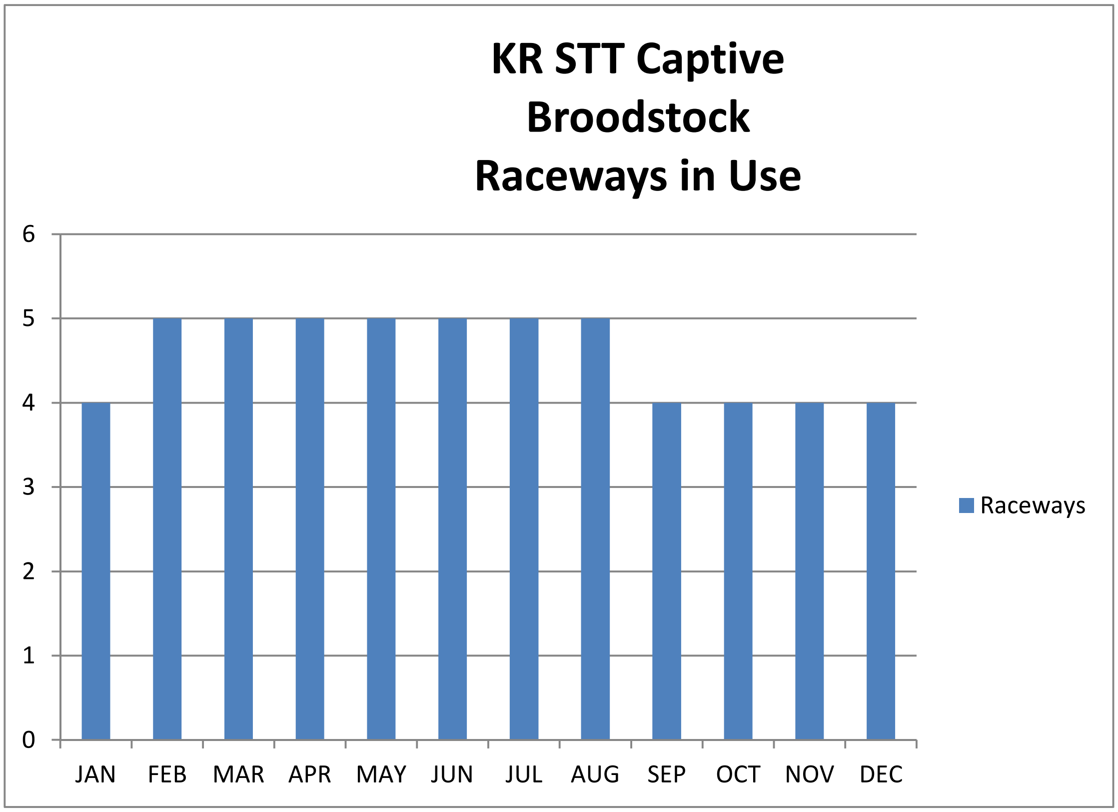


Table C-5 in **Appendix C** provides theoretical rearing unit carrying capacity values in pounds per unit based on a density range of 1 to 4 pounds per cubic foot of rearing volume. Similar Great Lakes salmonid production programs in Wisconsin and Michigan typically use rearing densities of 3 lbs./CF in nursery rearing phases and 4 lbs./CF in raceway final grow-out phase as guidelines. Discussions with FRH staff regarding currently used maximum ranges of total pounds produced per unit have indicated that the range of weights produced in the Nursery tanks has ranged from 160 lbs. per tank (2 lbs./CF) to 240 lbs. (3 lbs./CF). Burrows total pound per unit has currently ranged from 4,000 lbs. (1.6 lbs./CF) to over 7,000 lbs. per unit (2.8 lbs./CF). In the 1980s, there were several years of KAM yearling production that were in the 60,000 lbs. to 65,000 lbs. per year range indicating that Burrows pond densities have been considerably higher than the current levels. Assuming that these fish were produced in the Burrows ponds, per unit rearing was 10,000 lbs. (4.1 lbs./ CF) and 10,833 lbs. (4.4 lbs./CF) respectively. Note that total annual production can involve multiple groups (lots) of fish produced in the same rearing units during the same year so density based carrying capacity is only a window into annual production capacity guidelines and is not the only measure of capacity. The production of fall spawning species (Chinook salmon, lake and brook trout) are examples of nursery rearing followed by STT and KAM spring spawning and production. This overlapped species production was used to maximize FHR production to meet MNDNR historical requirements and total annual levels that were considerably higher than the present levels.

A series of bioprogram models using density set to 3 lbs./CF, with ***constant rearing temperatures*** of 41°F, 45°F and 50°F were used to simulate KAM yearling rearing in the Nursery and Burrows. A similar set of bioprogram models using the ***variable temperature data*** provided by MNDNR for the Nursery and Burrows were also completed. Variable temperature growth models are more complicated than constant temperature models since growth rates, oxygen levels (% saturation) and feeding rates are changing based on temperature. The model simulations are located in **Appendix C**. These models used available oxygen levels (AO) set to ranges of dissolved oxygen saturation (90%, 100% 110%) and minimum tank effluent level of 7.0 mg/l which are believed to be realistic values for the FRH. The rearing models were developed to **simulate** the FRH rearing programs.

Please note that the rearing models are a single page printed summary (EXCEL workbook) of the output of TK-Solver equation processor models that provide the actual computation of several hundred equations to arrive at simulation predictions of rearing model fish growth, monthly inputs and costs, monthly by-product generation in kilograms, rearing program summary and by-product generation estimates of concentration in mg/l.

Model OUTPUTS are subdivided in the **RED colored headings** on the tables. Note that the model INPUTS are always highlighted in yellow. These yellow input parameters and the calculation equations (TK-rules) determine the set of assumptions used in the fish growth simulations. These simulations use well established fish cultural methods to arrive at a set of rational mathematically determined facility rearing volume (size), water flow and water quality parameter conditions. The biomodel table column headers identify model output parameters (English and metric units) that should be understood by most fish culturists. HDR is available to explain any model assumptions or outputs that are not clear.

The simulations were completed to analyze the **current production capacity** (avg. 2009-2011 production levels or 37,353 lbs.) based on density criteria and rearing conditions of the FRH and to determine whether the potential for increasing production biomass to **20% above the current levels** is feasible.

Model simulations are computed in 30-day period increments that roughly approximate the actual months of annual fish rearing cycles. The single tank models illustrate what an individual rearing unit can support using the assumptions listed.

Nursery Tank Capacity

Models **CAP-1 to CAP-9** in **Appendix C** illustrate KAM rearing in nursery tanks at rearing densities set at 3 lbs./CF. This density is considered to be a “safe maximum” for FRH nursery rearing and is a density used in other similar Great Lakes salmonid hatcheries. Production per nursery tank at this density is 243 lbs. or 2,557 8-inch KAM. This translates to 13,122 lbs. or 138,078 fish for all 54 nursery tanks.

Constant Temperature Models

Model	Temperature	Dissolved Oxygen (% Saturation)	Flow Reqts. Per Tank	Meet Size Goal?	Reduce Growth Period?
CAP-1	41 ^{o}F	90%	14 gpm	No	No
CAP-2	41 ^{o}F	100%	11 gpm	No	No
CAP-3	41 ^{o}F	110%	9 gpm	No	No
CAP-4	45 ^{o}F	90%	14 gpm	Yes	No
CAP-5	45 ^{o}F	100%	11 gpm	Yes	No
CAP-6	45 ^{o}F	110%	9 gpm	Yes	No
CAP-7	50 ^{o}F	90%	20 gpm	Yes	Yes
CAP-8	50 ^{o}F	100%	14 gpm	Yes	Yes
CAP-9	50 ^{o}F	110%	11 gpm	Yes	Yes

Models CAP-1 to CAP-3 illustrate that KAM growth is not adequate to reach the target size of 8 inches at a temperature of 41 deg. F. Models CAP-4 to CAP-6 illustrate the KAM growth at 45 deg. F is adequate to reach to target size. Models CAP-7 to CAP-9 illustrate the KAM growth at 50 deg. F along with higher DO is more than adequate to reach to target size. Note that nursery tank water inflow is piping limited to 14/15gpm tank and 20gpm is over the inflow potentially possible (CAP-7). The benefit of higher temperature rearing is that growth at 50 deg. F could reduce the growing period from 410 days to 300 days.

These nursery tank models indicate that reduction of rearing tank water flow rate is potentially possible by maintaining DO levels within the range of 90% to 110% of saturation. This is significant because tank flow and the required water heating can potentially be reduced if DO levels are maintained at these suggested levels.

Models **CAP-10 to 13** are similar to Models CAP 1-9 for nursery tank rearing except that MNDNR provided variable water temperatures were used in the calculations. Again, variable temperature growth models are more complicated.

Variable Temperature Models

Model	Temperature	Dissolved Oxygen (% Saturation)	Flow Reqts. Per Tank	Meet Goal?	Reduce Growth Period?
CAP-10	Blue Variable	95%	15 gpm	Yes	No
CAP-11	Yellow Variable	95%	15 gpm	No	No
CAP-12	Yellow Variable	100%	14 gpm	Yes	No
CAP-13	Yellow Variable 16 mos.	90%	20 gpm flow too high	Yes	No

Model CAP-10 illustrates variable temperature nursery tank (Blue) rearing for 12 months using an AO of 4.0 mg/l (95%) saturation. The model indicates that KAM will reach the target size of 8 inches with a tank inflow of 15 gpm. Model CAP-11 uses the provided Yellow Nursery Tank temperature data and KAM do not reach the target size but they can if DO are increased (CAP-12). Model CAP-13 indicates that KAM cannot be reach target size using 90% DO saturation without exceeding the inflow capacity of the tanks and the 12-month duration.

DO management of the nursery tanks to maintain DO at or near saturation is critical. Data that accurately tracked DO levels in nursery tanks was not available. There is some indication from older FRH EXCEL files that that FRH has used an exiting tank (effluent) DO level of 5.5 mg/l which (although not recommended) does allow higher AO levels than the 7.0 mg/l models used in these simulations. Based on HDR's experience, DO is normally the limiting factor in rearing unit carrying capacity in older salmonid hatcheries and continuous dissolved oxygen management using oxygen gas (LOX or on-site generated) has increased the production capacity of many public hatcheries.

Burrows Pond Capacity Models

KAM are typically transferred from the nursery and final rearing occurs in the Burrows. Burrows also receive KAM fingerlings shipped from Spire Valley Hatchery. Final rearing of KAM and imprinting occurs during the Burrows rearing phase. Models **BCAP-1 to BCAP-3** illustrate final KAM final grow-out rearing in the Burrows at constant 45°F temperature for a 5-month period (typically April-August). Burrows at a density of 3 lbs./CF can produce 7,254 lbs. or 11,896 KAM. Total for six (6) units is 43,525 lbs. or 71,214 fish.

Constant Temperature Model

Model	Temperature	Dissolved Oxygen (% Saturation)	Flow Reqts. Per Tank	Meet Flow Limit?	Density (lbs./CF)	Production + 20%?
BCAP-1	45°F	90%	367 gpm	Yes	3.0	No
BCAP-2	45°F	93%	400 gpm	Yes	3.6	Yes
BCAP-3	45°F	90%	443 gpm	No	3.6	No

Model BCAP-1 illustrates KAM rearing at 45°F at 90% DO saturation. Minimum flow is 367 gpm and is within the unit design flow of 400 gpm per pond. Model BCAP-2 illustrates a potential production biomass increase of 20% above Model CAP-10. At this potential production level, density would increase to 3.6 lbs./CF and 8,697 lbs./unit. If a density of 4 lbs./CF for the Burrows upper limit is applied similar to other Great Lakes salmonid raceway final grow-out densities, capacity is 9,696 lbs./unit. Inflow rate of the Borrows Ponds (400 gpm) provides a water exchange rate of 1.3 per hour which is similar to some new circular tank recirculation systems but more information about DO dynamics and biofiltration performance in these ponds is needed to fully understand and predict their upper production capacity. For the flow to be maintained at the 400 gpm Burrows design inflow rate, DO minimum required is 93%

saturation. Model BCAP-3 is identical to BCAP-2 except that the DO is only 90% of saturation and the flow requirement increases to 443 gpm which is above the design inflow of each tank.

A 20% biomass increase in production in the Burrows is potentially possible if dissolved oxygen requirements can be met. It appears that dissolved oxygen may be limiting the operation of the Burrows currently and we recommend that DO monitoring and supplementation using the available on-site oxygen generation or a new LOX system be routinely provided. Data to accurately track and characterize the dissolved oxygen levels in the Burrows system was not available but DO supplementation using the on-site oxygen generation system is reported to occur periodically.

Models **BCAP-4 to BCAP-7** are variable temperature rearing models for the Burrows calculated using the temperature data provided by MNDNR.

Variable Temperature Models

Model	Temperature	Dissolved Oxygen AO 4 mg/l-7mg/l	Flow Reqts. Per Tank	Meet Flow Limit?	Density (lbs./CF)	Production + 20%?
BCAP-4	Variable	4 mg/l 110% sat	639 gpm	No	3.0	No
BCAP-5	Variable	5 mg/l 110% sat	511 gpm	No	3.0	No
BCAP-6	Variable	6.3 mg/l 124% sat.	400 gpm	Yes	3.0	No
BCAP-7	Variable	7.5 mg/l 136% sat	400 gpm	Yes	3.0	Yes

BCAP-4 provides an estimate of KAM final grow-out rearing in the Burrows at a density 3 lbs./CF, AO set to 4.0 mg/l and an effluent DO of 7 mg/l. The flow requirement is 639 gpm which is above the inflow capacity of the unit. BCAP-5 model is identical to BCAP-4 except that the DO was increased to 5.0 mg/l and the flow was reduced to 511 gpm but still above the design inflow of 400 gpm. BCAP-6 Model sets that AO to 6.3 mg/l and the flow drops to 400 gpm. Finally, the BCAP-7 model is a 20% production increase in KAM biomass rearing in the Burrows. To meet the 400 gpm unit design flow an AO level of 7.5 mg/l must be maintained. Modern circular tank recirculation systems can operate with supersaturated DO levels but it is not known if the present Borrows system can operate under this type of enhanced DO management. The variable Burrow models also indicate that DO management in the Burrows System is critical and should be closely monitored. Continuous DO management using the on-site oxygen generation system or LOX is recommended.

Captive Broodstock Raceways

The five (5) existing broodstock raceways used for maintaining the unique Knife River strain STT have a volume of 5,130 CF. The 3-year average total weight (FY2009-FY2011) of the 5 year classes of STT broodstock maintained is 2,020 lbs. This density (2.5lbs./CF.) is the recommended salmonid broodstock holding density recommended by Westers (**Principles of**

Intensive Fish Culture Manual, July 2002). Raceways are dedicated to captive STT broodstock maintenance and are correctly sized to meet FRH production requirements.

Summary

Average production for the period of FY2009-FY2011 was 37,353 lbs. A 20% production increase in biomass above this average is an additional 7,470 lbs. for a total annual production level of 44,823 lbs. This level of FRH production (the MNDNR goal) proposed for the future appears to be well within the production capability of the facility assuming that the required infrastructure repairs/replacements outlined in this report are completed to insure operation over the next 25 year period.

Capacity	Avg. Production	Dissolved Oxygen (% Saturation)	Flow Reqts. Per Tank	Density (lbs./CF)* Overall average
2009-2011	37,353 lbs.	90%	see models 6ft & Burrows	2.0
20% Increase	44,823 lbs.	93%	See models	2.37
Maximum	56,628 lbs.	95%	See models	3.0

**Assumes Nursery & Burrows units providing 18,864 CF of rearing volume*

Based on production capacity review using the assumptions of these simulation models, it appears that production levels at 56,628 lbs. (13,122 lbs. in the Nursery and 43,506 lbs. in the Burrows) is potentially possible and will require maintaining DO at or above 95% saturation levels and average temperature of 45^{o}F. This production level is considered the “maximum estimated safe” production level estimated using a density of 3 lbs./CF. Based on experience, this level of dissolved oxygen management typically requires continuous measurement and supplementation using oxygen rather than air-based aeration. Continuous DO supplementation, DO measurement and alarming are suggested as improvements in **Section IV** of this report.

This level is 11,745 lbs. higher than the average 20% production biomass increase desired by MNDNR using the average annual production level of FY2009 to FY2011 as a baseline. The FRH can achieve the desired increase above the current levels if the infrastructure repairs and replacement are completed. Production levels up to 56,568 lbs. per year appear to be achievable based on this analysis and the data provided to complete it. Dissolved oxygen data was not available to document the performance of the present FRH water supply aeration and degassing systems but improvements to the existing systems are likely to be required for consistently achieving these levels of dissolved oxygen.

Trout Holding and Distribution

MNDNR has identified the need for this study to investigate options and costs for providing temporary holding of catchable trout shipped in 7,500 lb. loads from southern Minnesota hatcheries using fleet operated semi-trailer fish hauling units. The MNDNR trout stocking period and related holding distribution period is typically completed in Mid-April, May through Mid-June and September through October each year. The timing overlap of early spring trout stocking (Mid-April) could potentially conflict with the Lower Spawning Building spawning operations and must be verified by MNDNR. This year (2013) spawning operations are ongoing in Mid-May. Weekly trout loads are typically transported and held during these stocking periods. The desired trout holding distribution capability must provide sufficient holding time for staff using smaller capacity transportation trucks to stock trout. Trout holding of at least 5 days per week is assumed. Trout holding volume and flow requirements are presented in **Table III-4** and were calculated using density index (D.I) and flow index (F.I.) methods described in (**Fish Hatchery Management**, Piper, 1982) using elevation and water temperature data for FRH. A holding volume in the range of 1,250 to 1,500 CF is recommended and a water flow in the range of 281 gpm, 351 gpm and 421 gpm for temperatures of 40, 45 and 50 deg. F is minimally required assuming 100% DO saturation of the water supply source.

Table III-4. Trout Holding Minimum Requirements

Trout Holding Requirements for 7,500 pound Loads FRH Trout Holding Volume Requirements		
V = W / (D x L) Fish Hatchery Mgt., Piper 1982	**L inches**	**L inches**
Trout Length Inches=	**10.000**	**12.000**
Trout Weight @ =	0.400	0.692
Trout Load Weight Lbs.	7500	7500
RV in cubic feet for Density Index 0.5 lbs./CF/inch CF=	**1500**	**1250**

	FRH Trout Holding Inflow in GPM for 7,500 pound Loads	**L inches**	**L inches**
	gpm inflow I = W /(F.I. x L) based Piper 1982	**10.000**	**12.000**
Temp °F	Calculated Flow Index (F.I.) in lbs./gpm/Inch at El. 660ft msl	gpm	gpm
40	**2.66**	**281**	**234**
45	**2.14**	**351**	**293**
50	**1.78**	**421**	**351**

Lower Spawning Building Location

Potential biosecurity and invasive species control concerns and risks associated with the use of "open" Lake Superior or French River water sources in the Lower Spawning Facility for temporary holding of trout for inland water distribution has forced MNDNR to suspend use of this facility for inland trout distribution. The Lower Spawning Facility concrete tanks were used successfully in the past to provide temporary trout holding and distribution before biosecurity and invasive species control issues became problematic. The Lower Spawning Facility contains five (5) concrete holding/spawning tanks. Of the tanks, the three (3) units on the northwest side of building were used for this function. Trout were unloaded from transport tanks through the windows using portable delivery piping. These tanks provide a volume of 375 CF. each (2,806 gallons) or 1,125 CF. (8,148 gallons) total. All 5 units provide a volume of 1,875 CF. Each unit is equipped with two 3-inch diameter water supply pipes (lake and river). Adequate tank volume, water supply flow and truck and staff access is provided by the building if biosecurity treatment of the water supply source(s) can cost effectively be applied.

The best management practice (BMP) of properly disinfecting the tank area after the annual spring spawning activities are complete will be required. Staff has indicated that steam cleaning equipment is available to complete preparation of the area for trout holding/distribution use.

The small flowing well at this location has been used with a cistern storage tank to provide transport water filling capability using water without pathogens or invasive species problems. This well water requires pH adjustment and a system is in place to perform this function.

Another potential water source option to the Lower Spawning Building is “used” overflow water from the emergency pump sump located outside the Raceway Building. Staff report that this 6-inch diameter PVC pipeline exists, but has some leakage and biofouling issues.

The development of a biosecure water source to the Lower Spawning Facility will be required if it is to be used for trout distribution. Filtration to the 35 micron level to capture potential zebra mussel veligers and UV treatment for VHS and other pathogens will likely be required. Options and costs for providing biosecure water treatment to the Lower Spawning Facility for trout holding are provided in **Section IV** of this Report.

New Trout Holding Facility On-Site

Construction of a new trout holding/distribution system using tanks or raceways separate from the Lower Spawning Facility is another potential option. This option has challenges to provide semi-truck access, biosecure water supply and would involve new construction. The undeveloped land area south of the Burrows Building appears to provide sufficient area for development, but will require a biosecure water supply. **Section IV** of this report provides a concept for a new paired trout holding raceway (1,500 CF) connected to the improved biosecure Upper FHR makeup water supply system using connection to existing piping. Trout holding raceway drainage will be handled in the existing effluent treatment system. Truck access along both sides of the paired raceway is proposed. Truck filling capability should be provided with the trout holding raceways. Oxygen would be available to increase DO and reduce trout flow requirements at the proposed site location. Unfortunately, based on preliminary analysis, it appears that excess treated lake flow capacity in the range 300 to 420 gpm (temperature dependent) to operate new trout holding is not available from the Upper FRH lake water supply system.

Off-Site Trout Holding/Distribution

Staff reports that there are some off-hatchery temporary fish holding systems used by MNDNR in fish distribution and stocking. Operation and security of this type of holding facility in a non-

24hour/7day per week standard hatchery operation mode with water supply reliability, emergency power, staff response to alarms and security is challenging. Additional information will be required regarding available off-site locations, water supplies and other utility issues to assess costs and viability of this type of option.

Hatchery Staffing Analysis

The FRH was originally designed for "intensive aquaculture". Intensive aquaculture means fish will be reared within containers, i.e., fiberglass, plastic, or concrete rearing tanks. Intensive aquaculture also results in intensive husbandry and care for the reared fish that requires adequate staffing to see this is provided. Daily cleaning and feeding, seven days a week, particularly during the early life stages, is paramount to providing a successful rearing environment. Another aspect that needs to be considered is emergency response, such as electrical or mechanical failure, and having personnel available to respond and correct those failures. Staff is also sometimes required for stocking and transport. **Table III-5** lists the historical to current staffing changes that have occurred over time.

Table III-5. Historical and Recommended Staffing Levels

Title	Historical	FY09/FY10	FY11*	FY 12	Recommended
Hatchery Manager (NR Supervisor)	1	1		1	1
Assistant Manager (Asst. Supervisor)	1	1	1		1
Hatchery Tech	3	2	2	1	1
Buildings Utilities Mechanic	1	1	1	1	1
Office Administrative Specialist	1	0.8	0.2		0.5
Total	**7**	**5.8**	**4.2**	**3.0**	**4.5**

** Hatchery Manager retired mid-year.*

There has been a progressive reduction in staff size from FY2009 to the present as indicated above. It is our opinion that current staffing levels at FRH with 3 full time positions is low for a facility of this operational / maintenance complexity and production program. Comparison of production for FY2009, FY2010 and FY2011 reveals that egg production levels are very similar in all three years. Captive Knife River STT broodstock care and maintenance is similar and has actually slightly increased in FY11 over the earlier years. KAM yearling production in total pounds is also similar in all three years. The production of fry has been the major change in the program and has been sent off-station to Spire Valley due to biosecurity concerns.

We suggest that staffing level be minimally increased 1.5 to 2.0 positions to provide for a full-time Assistant Manager Position. This level (Assistant Manager) is suggested to provide for a professionally educated and trained fish culture scientist with sufficient administrative capabilities to assist the Manager in daily production operations and expertise to operate the facility in the manager's absence. If the infrastructure improvements recommended in this report are undertaken by MNDNR, the professional staff (manager and assistant manager) will likely be involved with design and construction related issues in addition to the normal day-to day-operations.

A 50% to 100% level Administrative Specialist to assist in day to day record keeping, communications and assistance to the professional staff is recommended. The facility has sufficient operational complexity to require the help of an administrative specialist. This recommended staffing level should be able to absorb the projected 20% increase in production as evaluated in this report.

The improvements in the FRH facility infrastructure recommended in this report will help reduce maintenance time requirements. We estimate a 20% to 25% labor savings in maintenance associated with system improvements. However, it needs to be noted that this is a complex and complicated facility and operational adjustment and maintenance of the infrastructure work will always be required.

It is recommended that if future MNDNR FRH fish production increases beyond 20% of current fish production levels, that staffing be matched with the addition of one staff member. A second Fisheries Technician is suggested. This assumes that fry production is restored to the production program after biosecurity concerns are resolved.

Minnesota
Department of Natural Resources

MDNR No. 8F022
File No. FMA.00257.00.00.03
HDR No. 202386

French River Cold Water Hatchery

IV. INFRASTRUCTURE ASSESSMENT AND RECOMMENDATIONS

HDR

BARR

IV. INFRASTRUCTURE ASSESSMENT AND RECOMMENDATIONS

General Facility Description

The French River Hatchery (FRH) is located where the French River flows into Lake Superior near Duluth, St. Louis County, Minnesota (see **Figure IV-1**). The rearing station is a cold water species production facility situated on an area of approximately 17.4 acres. Initial construction of the FRH facility was in 1974 with renovations occurring in the 1980s, 1990s and 2000s. The rearing station primarily utilizes Lake Superior for its production water supply. Contact information for the facility is listed below.

Supervisor	Mark Gottwald	Mark.gottwald@state.mn.us
Technician	David Beron	David.beron@state.mn.us
Building Utilities Mechanic	Fredric Schmitz	Fredric.schmitz@state.mn.us
Facility Address	5357 North Shore Drive	Duluth, MN 55804
Telephone|Fax	218-525-0867	218-525-0866

Source: MNDNR Facility Questionnaires, 2013

The FRH design and construction was initiated in 1974. The facility was designed by John I. Thomas / Thomas A. Veschi Architects, Inc. of Duluth, MN and UMA Engineers and Biologists of Portland, OR. Construction was completed in three phases in the 1970's. The major portion of the facility fish production systems were constructed in Phase 2. The Phase 2 drawings (dated 09/27/1974) include all fish production components and systems still in use in 2013. Phase 1 and Phase 3 drawings are missing from the MNDNR historical drawing archives. The FRH facility was constructed northwest of the Lower Spawning Facility (the original French River Hatchery) that was constructed in 1924. See **Appendix A** for a list of all the historical construction documents used to prepare this report.

The hatchery currently produces about 30,000-35,000 lbs. Kamloop rainbow trout and steelhead trout. Total historical maximum production level for the facility is 70,000 pounds. Production levels above 70,000 lbs. results in gill disease and poor fish quality. Steelhead and Kamloop rainbow trout are currently stocked only in Lake Superior and north shore rivers draining into Lake Superior below migration barriers due to potential biosecurity issues and to control of invasive species.

The main issue facing the facility is the age of the aquaculture infrastructure components and the need to determine overall upgrade and/or replacement needs and associated costs. Two other issues to be considered are the amount of energy being consumed by the hatchery and the large amount of labor to maintain outdated equipment. Most of the facility is operating using 1970s equipment. Over time, fish production levels and staff have been reduced.

Figure IV-1. Hatchery Location Map

Another major concern at this facility is biosecurity of the water supply. Since Lake Superior is an open system, there is potential for contamination with aquatic invasive species (AIS) and disease, such as zebra mussels, spiny water flea and viral hemorrhagic septicemia (VHS). This potential exists in both the French River and especially Lake Superior, although there are no reports of AIS or disease at this time within the water system.

An aerial photograph and existing site plan (**Drawings FR-2 to FR-7, Appendix A**) illustrate the facility boundary and general facility infrastructure features (e.g., water supply, fish rearing units, drainage piping, production buildings, support buildings, roads, and wastewater treatment facilities). The drawings are believed to be reasonable, to-scale representations of facility resources for planning purposes. Site and construction drawings were provided by MNDNR (see **Appendix A** for Existing Drawings list). General questionnaires were also filled out by MNDNR staff to assist in developing the existing infrastructure analysis. Photographs taken at the Site Evaluation Visit (January 29-30, 2013) illustrate the existing conditions and are some of the photos are contained herein (see **Findings Report** for entire photo documentation, February 2013).

General Site Description

Site Climate

Nearby Duluth has average yearly temperature of 38.5°F, average yearly rainfall of 31 inches and average yearly snowfall of 87 inches. On average, the first freezing temperature occurs in late September, and the last at the end of May, and the first 1 inch (2.5 cm) snowfall is generally late October through mid-April. Prevailing winds are west-northwest at 11 mph; although, easterly winds are prevalent from March to June.

Building Infrastructure

There are eight buildings in use at the hatchery, including three main operations buildings and five support buildings as described below. Additionally, a residence was built on the site in 1922.

Main Office and Nursery Building

The Main Office and Nursery Building (Nursery) was originally built in 1974 with an addition in 1997. It contains 9,520 ft², 12 rooms and is in fair condition. This building is used for spawning, water treatment, office space and contains a visitor area.

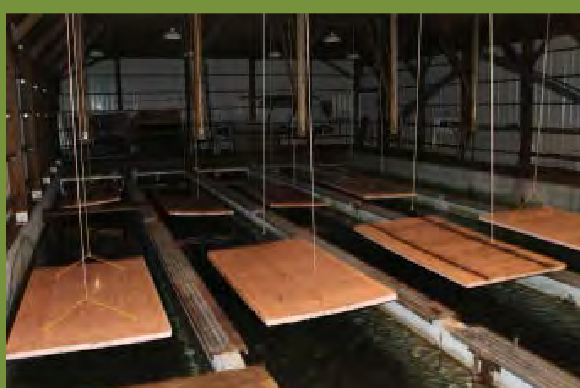
Room	Area (SF)/ Adequate Size?	Condition	Modifications Needed/ Notes
Offices (2)	Yes	Fair	Need more efficient task lighting and possibly AC
Nursery	5,540	Good	
Lab	100/ Yes	Fair	

Room	Area (SF)/ Adequate Size?	Condition	Modifications Needed/ Notes
Visitor Area	Estimated 240/ Yes	Good	Need a new video
Feed Storage	384/ Yes	Good	Includes cold storage and temperature is adequate; exterior double doors need an update; feed is brought in on pallets 7 times per year
Bathrooms (4)	380/ Yes	Fair	Floor needs work
Break Room	Estimated 170	Good	
Mechanical	1,840	Fair	Houses boilers, heat exchangers, filters, etc.
Generator Room	150	Good	Houses generator, panels, etc.

Adequate heat is provided by one wood pellet fired boiler and three oil fired boilers (1983 and 2003) which are also used for water supply heating (see also **Component 7b**). The building has adequate incandescent, high intensity discharge and fluorescent lighting, along with emergency lighting. Adequate ventilation was installed in 1974 with acceptable noise levels (belts and filters often need maintenance). The facility is equipped with an emergency generator, internet service and a telephone system. Power is used for electric heat, coolers/freezers, aquaculture water supply pumps and various additional motors. There is no air conditioning and no fire alarm system. Service water is available for rinsing tanks and fish screens. Non-chlorinated water is available to fill fish transport trucks.

Raceway Building

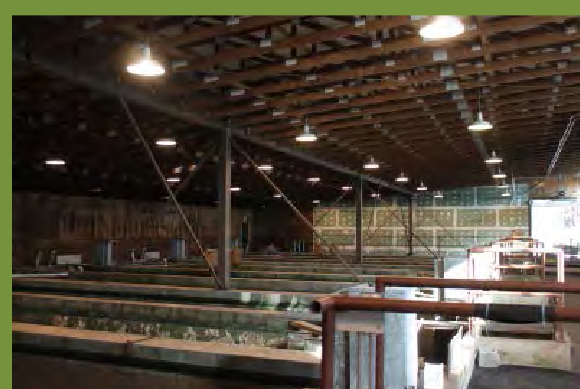
This 3,306 ft² pole building was constructed over five concrete raceways in 1998 using materials reclaimed from snow roof damage to the Burrows Building and is reported to be in fair condition. Lighting in the raceway building is high intensity discharge. Power is used for lighting and portable equipment such as portable heaters and portable motor aerators. There is no permanent heat, air conditioning, ventilation, telephone, internet service or fire alarm system. Oxygen is piped into the building from the oxygen generators in the Burrows Building for dissolved oxygen management using submersed diffusers.



Burrows Building

This 15,872 ft² building was originally built in 1974 with modifications made in 1993 to repair major snow damages to the structure. The Burrows Building contains nine rooms and is in fair condition. High-pressure non-chlorinated service water is not available for rinsing tanks and fish screens but non-chlorinated water is available to fill fish transport trucks.

Room	Area (SF)/ Adequate Size?	Condition	Notes
Clear well (2)	375 ea./ Yes	Fair	Used for recycle system reservoirs and storage of plumbing, big reds, transfer pipe fittings and stands, etc.
Oxygen Generation	300	Good	Houses air compressors and oxygen generators
Biofilter	4,500	Fair	Houses six upwelling biofilters
Feed Storage	850/ Yes	Good	No cold storage, temperature is adequate, up to 24,000 lbs. of feed is stored and distributed by hand daily
Electrical, Basement and Headtank	300 ea.	Good	Electrical Room has motor control center, SCADA panel and power distribution. Basement has Reuse Pumps and biofilter backwash pumps and their piping and valves. A two-basin headtank accessible with ladder and catwalk contains aspirators and is above most of Electric Room.



The Oxygen Generation Room is adequately heated by an electric wall heater. The Electric Room has a portable electric heater. The rest of the building is not heated. The biofilters room has exhaust fans and associated intake louvers. The heaters require little maintenance. The building has adequate incandescent and fluorescent lighting, and emergency lighting that is supplied from the emergency generator. Adequate ventilation is provided with acceptable noise levels and is in fair condition. Power is used for oxygen generation, ventilation, lighting, filter backwash pumps, motor aerators and electric heat, and recirculation supply pumps. There is no air conditioning, internet service or fire alarm system.

Lower Spawning Building

This 3,819 ft² (57′ x 67′) building is comprised of 16 rooms, including 11 offices and one lab. Boilers fueled by propane are used for heating. The heat is reported as adequate but the components are old and need to be replaced. Maintenance is not needed often. Window units installed three years ago are used for air conditioning the offices. The air conditioning is reported as adequate but the ventilation is reported as not adequate. The lighting in the building is reported as high intensity discharge and incandescent and not adequate. No emergency lighting is present in the Lower Spawning Building. There is a telephone system and internet service. There is a smoke detector fire alarm system in the building that sounds horns. It is reported as in good condition.

The sources of water include raw river water and filtered lake water with independent piping for each water source. River water can be used but it is clayey, not optimal temperature, the flow rate is highly variable and bedrock in the river gets anchor ice. Fish produced in the Upper buildings can be piped with mostly portable piping to the spawning building which has an outlet straight to French River.

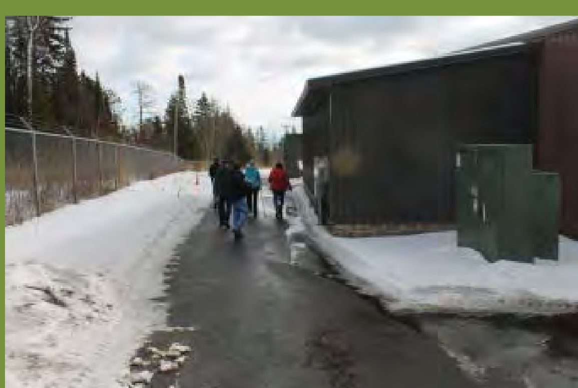
The Lower Spawning Building contains five concrete raceways. There are 360 jars and 12 vertical flow incubators located in the lower spawning building. Their condition is reported as fair to poor. No low pressure aeration or oxygen sources are reported. There is no high-pressure non-chlorinated service water available for rinsing tanks and fish screens but there is non-chlorinated water to fill fish transport trucks.

The Lower Spawning Building was previously used to raise walleye and suckers for the entire state. It was also used as a trout holding facility for southern fish before distribution in the northern region. However, biosecurity concerns have eliminated that use and it has not been used for trout holding for four years. It is currently used to hold and spawn Kamloop and Steelhead.

Heat Pump Addition

This addition to the Burrows Building was built in 2008 to house the heat pump system and is reported to be in good condition. Adequate space heat is provided by electric wall mounted heaters that are four years old and in good condition. There is fluorescent lighting. There is no emergency generator, ventilation, air conditioning, emergency lighting, telephone system, internet service or fire alarm system.

Room	Area (SF)/ Adequate Size?	Condition	Notes
Heat pump (addition 2008)	672	Good	Houses electric, controls, pumps, glycol filter, heat pumps and a trough used for system component cleaning



Lake Water Pump Electrical and Generator Building

The Lake Water Pump Electrical and Generator Building (Lake Electrical Building) (752 ft²) has three main rooms to house the electrical controls for the three lake water supply pumps located in the pump sump enclosure adjacent to this building. The building includes a generator and transfer switch, electrical switch gear for the lake water supply pumps and a 500 gallon fuel tank for the generator. Heat is provided by a space heater and heat lamp. Incandescent lighting is present and emergency lighting is provided by the emergency generator which fueled by diesel. It is reported that the generator was built in 1974 and needs to be replaced (see further discussion later in this section). There is no ventilation, air conditioning, telephone system, internet service or fire alarm system.

Shop and Storage Building

This 1,860 ft² building includes a shop room and a garage for the residence. It is reported to be in fair condition. Adequate heat is provided by propane unit heaters that are 19 years old. Their condition is reported as fair. There is incandescent and fluorescent lighting, adequate ventilation with acceptable noise levels, and emergency power is provided by the main generator. The building has a telephone system. There is no air conditioning, no emergency lighting, no internet service and no fire alarm system. Additional storage space is requested.

The shop room is 900 ft² (36′ x 25′) and used for equipment repair, welding, wood working, parts storage and Bobcat storage (2 stalls). Needed repairs and/or modifications are reported for the service doors, lighting and space needs. The second room is the residence garage. It is 960 ft² (32 x 30) and used for residence vehicle storage and miscellaneous storage.

Sludge Transfer Pump Building

The sludge transfer pump building is located partially over and adjacent to the clarifier. It was built in 1974 and is in fair condition. The clarifier building room is 150 square foot (10’ x 15’) and is used to protect sludge transfer piping and controls for the sludge transfer pumps located below. No needed repairs and/or modifications are reported. The clarifier cover is 300 square foot (10’ x 30’) and provides a weather and safety cover over the concrete rectangular clarifier. The clarifier uses a chain driven system of wooden flights as a sludge conveyor to the pumping system. The conveyor is reported as obsolete and falling apart. Flights have repeatedly broken and replacement parts are hard to get. An electric space heater purchased two years ago is used for heating. Maintenance is not needed often except for the flights. Incandescent lighting is present. The building has no air conditioning, no ventilation, no emergency lighting or generator, no telephone system, no internet access and no fire alarm system.

Domestic Water/Wastewater Systems

Domestic water is supplied from a 150 foot deep private well that was installed in 1962. The piping material is cast iron. The domestic wastewater is pressure fed to the local waste treatment plant.

Roads and Parking

The entrance road and parking areas are asphalt surfaces. Gravel roads are present as well. Roads are reported to be in fair condition with a need for resurfacing in the future.

Fencing and Security Lighting

There is a facility perimeter chain link fence for security purposes. There is site lighting owned by the facility in addition to site lighting leased from the local utility company, Minnesota Power. Poaching and vandalism were not reported as a problem.

Site Drainage and Flooding

On-site stormwater is directed down the driveway into the ditch along North Shore Drive which evaporates or infiltrates. Some of the water drains along the west edge of the hatchery and is intercepted and directed into the settling pond.

The main hatchery facilities do not lie within the 100-year floodplain according to the Flood Insurance Rate Map (FIRM) from the National Flood Insurance Program (Panel Number 2704161500C, effective February 19, 1992, see **Appendix E**). The French River floodplain located southwest of the hatchery has been designated as Zone A which is defined “areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage.”

The Area office and Lower Spawning facility is reported to be in the floodplain. There have been three times in the last 22 years that the French River has flooded the area’s parking lot. There was a large storm in June 2012 which caused murkiness in the lake for up to a month. This was a 500-year storm event that totaled ten inches of rain. Water was five feet deep over the river road below the hatchery. There was over 3,000 cubic yards of material removed from above the dam and smolt trap, and a smaller quantity removed from above the adult trap. North shore streams produced gravel beds at all lake entry points.

Utility Systems

Utility	Electrical Power	Telephone	Internet
Company	MN Power	UNK	UNK
Contact Information	218-722-2625		
Type	277/480V 3-Phase, 4 Wire		DSL
Condition	Fair		

Source: MNDNR Facility Questionnaires, 2013

The site contains three metered electric service points with underground and overhead power distribution to nine separate buildings or structures. One meter serves the Upper hatchery complex including the Burrows Building and the Nursery Building. Another meter serves the Lower complex which includes the lake water intake pumps and the Lower Spawning Building. A third meter was added to serve the heat recovery heat pump system installed in 2008. From the billing records, it is apparent the heat pump has seen very little use. The heat pump accounted for less than 1% of the energy consumed in 2010, 5% in 2011, and 4% in 2012

Electricity provided by Minnesota Power is billed under utility Rate 25. Charges for electricity under this rate structure include a cost for the actual energy consumed in addition to a demand charge. The monthly demand charge is based on the highest electric load registered during any 15 minute interval within the billing period. From the billing data for the calendar years 2010, 2011 and 2012, the electrical usage is evenly split on the Lower and Upper electric meters. Both meters register their highest demand in March and their lowest demand in the fall. Lowest electrical energy consumption at the hatchery occurs during the winter months. For the year 2012, the unit cost of electricity used at the hatchery was $0.092 per kilowatt-hour.

Some of the outdoor and area lighting is also provided by Minnesota Power. There are approximately six pole mounted area lights that the utility company owns and charges the hatchery for their use. The area lights are billed under Minnesota Power's utility rate 77.

In one of the Facility Questionnaires completed by the hatchery staff, a comment was made regarding voltage issues at the hatchery. The comment read: "*Have had a lot of high voltage 510 plus volts. Working with MN Power to resolve.*" Most likely this comment was a result of faults occurring on the variable frequency drives (VFDs) that have been installed at the hatchery within the last 10 years. A fault code is generated by a VFD when it shuts itself down due to a component failure or abnormal operating conditions. One common fault on VFDs installed in rural areas has to do with "high voltage on DC bus" or "bus over voltage trip". These faults are usually not a result of high voltage from the utility, but are caused by power quality issues on-site. These power quality issues can easily be corrected by installing input line reactors at the VFDs. If this problem has been occurring for many years, the VFD may be damaged and will need to be replaced. But if the problem is caught soon enough, an inexpensive line reactor can be installed at the VFD which will take care of the nuisance tripping problem.

Fuel Systems

Diesel and propane gas are used for heating of the site buildings, generator engines and vehicle dispensing. A 260 gallon above ground storage tank and a 15,000 gallon underground storage tank with leak protection are present on-site.

Natural gas service ends at Duluth's Lakewood drinking water plant at Lakewood Rd and HWY 61 about a mile from the hatchery. According to the Chief Engineer of Utilities, Duluth will extend natural gas service at their own cost if 50% of the potential users agree to become customers which is not uncommon since natural gas has been more economical than propane or oil. The utility company already has plans for gas extension projects in other directions; so, a gas extension east-northeast is probably 5 to 10 years away. Politics can change any of this.

The gas rate (4/6/13) for an Industrial Firm Large Volume customer (like the hatchery would be) is $0.73 per 100 cubic feet. There would also be a fixed monthly charge of $200.

Emergency Power

The average power outage is reported as two hours and occurs about three times per year. The hatchery has two diesel powered emergency generators.

One of the generators is located at the Lake Electrical Building. The lower generator backs up the lake water supply pumps. The Waukashaw generator is rated 170 kW at 480 volts. It is located within a plywood enclosure inside the pump electrical building. Both the generator and transfer switch are at least 30 years old and should be considered for replacement. According to Mark Gottwald, (June 12, 2013 telephone conversation) the generator unit overheats during operation and engine parts including the oil cooler and thermostats for the cooling system are not currently manufactured. The only replacement parts are old inventory parts that are sometimes located on the West Coast where these generators and engines were used in marine ship applications. However, parts have not been found to complete recent needed interim repairs. Sustained generator operation in an electrical service power emergency would likely result in overheating and shutdown with the attendant loss of water pumping and fish on station. The generator needs to be replaced as outlined in the report but might need to be completed as an emergency repair due to the critical nature of the issue.

The second generator is located in a dedicated room just off the main mechanical room in the Nursery Building. The generator was installed in 2007 and is in very good condition. It is rated 350 kW at 480 volts and powers all electric loads in the Nursery and Burrows Buildings.

Public Information & Education Services

The facility has a visitor information area located within the main hatchery building. There are displays, information, brochures and public viewing. Public restrooms are available. It was reported that the visitor's area could use an update and a new video. Visitor access is restricted to certain areas of the hatchery due to disease concerns.

Infrastructure Overview

The facility contains specific **Components** related to fish production. The main aquaculture infrastructure is generally associated with water treatment, fish rearing or effluent treatment. **Drawing FR-4** illustrates the main infrastructure components on the site.

Lake Superior water is pumped to the mechanical room of the Nursery building and enters a vortex separator to remove large particulates. It then goes through a bank of fine mesh bag filters to remove sediment and biological contamination and on through a UV disinfection system to inhibit pathogens. The treated water continues uphill to the covered underground concrete water storage reservoir and then flows back by gravity back to the mechanical room where it provides the treated cold water source for the facility. Turbine pumps in the lake water pumping sump are controlled by water levels in the reservoir. Flows upward of 200 gpm are pumped to a shell and tube heat exchanger where hot water circulates from boilers and boiler loop pumps. Incoming lake water can range from 33°F to 68°F and is heated to the mid 40's to high 50's. This heated water goes to an open storage tank in the mechanical room where it is aerated by an array of aspirators and agitated by 4 "bull paddle" motorized aerators for aeration and degassing. Hot water and cold water are mixed to the desired rearing temps by two separate water mixing valve manifolds: one for the Nursery Area rearing tanks and another for the egg incubation system. The original manual mixing valves have been automated to provide improved control using a SCADA system installed in 2004.

The nursery has 6-ft. diameter circular fiberglass tanks which are split into three segments: 24 blue marked tanks, 20 yellow marked tanks and 10 red marked tanks. Each set can have different temperatures and flows (up to 14 gpm per tank). The total water volume of the 54 tanks is 4,743 ft^3.

There are four Aquafarm super troughs along the north wall of the nursery building. Water volume can be varied but at full capacity they hold 112 ft^3 and the flow varies up to 21 gpm. Eggs are incubated using 6 to 10 Heath vertical flow egg incubation stacks with a flow of 5 to 7 gpm each. There are a total of 21 incubation units but only a portion of them are used in the current FRH production program. There are two supply lines and one reservoir line that reaches four stacks. Egg hatching is controlled by manipulating water temperature.

All Nursery rearing units drain or overflow to a pipe that supplies the Burrows recirculating system. The reservoir, heated water tank and floor drains are connected to a drain to the clarifier.

"Used" water flow from the nursery area comes to a splitter sump in the Burrows Building where it goes to the east or west biofilters. It enters the biofilter under the media and upwells to a sump. The sumps are piped directly to the east or west clearwells. Water from the clearwells is pumped by an array of horizontal end-suction pumps through aspiration manifolds in the aeration tower for oxygenation and degassing. The water is sprayed over a bed of oyster shells for adjusting alkalinity. Water then gravity flows into the Burrows Ponds. Each pond operates at 400 gpm. Outflow from the ponds drains along the middle wall. This water enters a sump on the south end of each unit. Water level is controlled by a standpipe. Flow over the standpipe goes back to the biofilters where it is treated and recirculated again. Outflow from the Burrows system is 100% of what comes in from the Nursery and leaves through overflows in the clearwells. This water is then piped to a headtank that supplies five broodstock raceways in the pole building. Normal overflow from the flow-through broodstock raceways goes to the outflow of the clarifier then to the settling pond. When standpipes are pulled for cleaning, the effluent goes through the clarifier where solids are collected.

Component Assessment

This Section of the report provides a description of the condition of the main components associated with the aquaculture mechanical infrastructure. The existing condition and information about each component was developed after the site inspection/meeting, and consultation with MNDNR staff. The majority of the problems at FRH are related to aging infrastructure and the associated maintenance of the equipment. Also it was noted that water temperature management and/or poor water quality were continuous problems. There are several issues that have been identified concerning the Lake Superior water source including AIS introduction, disease transmission, organic materials, and increased sediment and debris due to a broken water line in the lake. The sediment and debris plugs filters and clouds the water. There are concerns that the present infrastructure does not provide a biosecure water supply and these concerns have impacted fish distribution from the hatchery.

The consultant team divided the property into 21 separate components for evaluation and discussion purposes. The component list starts at the main facility water supply intake and generally follows the water usage through the facility. This component number system is used throughout the remainder of the report. These components have been denoted on the drawings (**Drawings FR-1 to FR-8**). It is suggested that the reader refer to drawings to become familiar with the location and scope of the components.

Each component was evaluated to determine the expected useful life remaining with respect to both their mechanical and electrical elements. First, this analysis describes each component and summarizes installation dates, manufacturers and sizing when available. Next the mechanical and electrical assessment is described along with the overall general condition. The useful life projection is listed along with noted equipment deficiencies.

The main purpose of this study was to provide an inventory of the existing aquaculture related infrastructure and evaluate whether the equipment would last another 25 years. The life expectancy projections were evaluated based on both age of the equipment and current condition. If the equipment was found to have an expected life of less than 25 years, recommendations for either renovation or replacement are presented. The rest of each Component discussion outlines renovation and/or replacement alternatives for equipment with life expectancies less than 25 years. Besides mechanical or electrical elements, other factors were considered when evaluating whether renovation or replacement was warranted:

- Energy efficiency
- Parts availability
- Labor intensive maintenance requirements
- Synergy with other recommendations

The recommendations also consider small-scale improvements to address existing component deficiencies when possible.

It should be noted that not all equipment will be able to provide a life expectancy of 25 years. Most new equipment is warranted to last at most 20 years. Some pieces of equipment require routine replacement parts as part of normal maintenance. These types of routine maintenance projects will not be part of the capital replacement projects summarized in this report. Similarly, if a component or part of a component has a life expectancy 15 years or greater, it is not recommended to replace those items at this time if there is no other reason to do so. While replacement may eventually be required before 25 years, it does not make sense to delete the item's inherent value to the facility by premature replacement.

When needed, infrastructure renovation or replacement will enhance the life expectancy of each component and the overall facility while also improving maintenance requirements at the facility. Specific energy reduction related recommendations are summarized in **Section V**.

COMPONENT NAME:

1. LAKE INTAKE

GENERAL DESCRIPTION:

The Hatchery's existing water supply intake consists of a 20-inch ductile iron pipe extending into Lake Superior. The intake pipeline was constructed in two phases during 1980 (Phase I) and 1981 (Phase II) extending approximately 1,700 feet (approximately 300 feet buried and 1,400 feet exposed) into the lake to a depth of approximately 60 feet. The pipeline terminates with a 90-degree vertical bend to elevate the intake off the lake bottom. A double-screen structure (approximately 28-inches in diameter and 24-inches tall) with 0.5-inch openings was installed on the end of the pipeline to screen out unwanted materials (primarily sediment, organic debris, and wild fish).

In 1983, a PVC butterfly valve and stainless steel screen were installed at an existing 12-inch wye on the pipeline at a depth of 15 feet to allow for intake of warmer water. However, due to issues primarily related to sediment uptake, that valve was capped in 1989.

In August 2009, P.J. Norick and Sons conducted a dive inspection to investigate the source of changes in intake water temperature and quality observed by Hatchery staff. The inspection found that the water intake pipeline was disconnected approximately 700 feet from shore (400 feet after emergence from burial) at an approximate depth of 24 feet. The breach consists of four 18-foot sections (72 feet) of pipe torn loose from their original position and relocated approximately 17 feet to the west. The inspection also noted that approximately 1,000 feet of the pipeline seemed to have shifted 3 to 4 feet to the north. Discussions with Hatchery staff suggest the breach occurred before 2008; however, the cause of the breach is unknown.

AMI Consulting Engineers conducted an engineering dive inspection on May 1, 2013 as part of this assessment effort to inspect and evaluate the condition of the existing water intake (refer to attached report in **Appendix H**.) The inspection indicated that the existing intake pipeline is generally in good condition, with the exception of the previously documented breach. Specific observations from the inspection include:

- The pipe was found to be in good condition with some areas of corrosion in the form of rust tubercles. The corrosion covers approximately 10-15% of the pipe and the largest diameter rust tubercle was approximately 1½ inch. Some light pitting was documented under the rust tubercles with a depth less than 1/16 inch; the majority of the corrosion under the rust tubercles would be considered light etching.
- The breached and misaligned section of the intake pipeline was confirmed and it was noted that the location of the disconnected section does not appear to have moved significantly from the drawing prepared by P.J. Norick and Sons (dated January 27, 2010). The broken section of the intake is located approximately 20 to 50 feet south of the current alignment of the rest of intake pipeline.

- The disconnected section of the intake pipeline is approximately 72 feet long and appears to be in good condition. No cracks, breaks, or signs of distress were documented along the length of the disconnected section; however, the open ends of the pipe have become partially filled with sediment so some areas of the pipe could not be inspected. Several of the collars joining the sections of pipe together were found to be loose but able to be repositioned and reused.
- Due to the movement of the dislocated section of the intake pipeline, a few additional sections of the pipe near the break have moved out of alignment with the rest of the pipeline; however, the collars and the pipes at these locations appear to be in good condition.
- Several grout bags were documented along the length of the intake pipeline. It appears that these bags were installed to provide support for the collars joining the sections of pipe together. Each collar was found to be supported by either the lake bottom or a stack of grout bags.
- The intake screen at the end of the pipeline was found to be in good condition with little debris or marine growth present.

As a result of the breach in the water intake pipeline, the Hatchery has been drawing water from the lake closer to shore, where water typically is warmer and contains higher quantities of sediment and debris. In particular, the Hatchery has experienced issues related to the intake of water with:

- warmer-than-desired water temperatures for prolonged periods during the summer
- decreased water clarity and increased quantities of sediment and debris, especially during storm events and heavy spring runoff

A metal plate with ½-inch diameter holes was installed at the end of the breached pipeline in 2009 in an attempt to limit the intake of debris; however, the plate had to be removed in 2011 after freezing issues resulted in loss of flow conveyance. The current intake configuration is problematic as the resulting intake of sediment and organic debris clogs the bag filtration system (**Component 4**), which must then be cleaned more frequently, and may also interfere with the effectiveness of the UV disinfection system (**Component 5**).

MANUFACTURER/SIZE INFORMATION:

20-inch Clow Ductile Iron Super-Lock Joint Pipe (Class 50)

YEAR OF CONSTRUCTION:

1980/1981	Intake Pipeline
1983	Valve for Temperature Control (Abandoned 1988)

ASSESSMENT:

Mechanical:

The deeper portion of the intake piping has been disconnected from the shallower portion approximately 700 feet from shore. Based on the May 2013 engineering dive inspection, with the exception of the breach, the intake pipeline is in good condition. Some areas of corrosion in the form of rust tubercles were noted, but damage due to the corrosion appears to be minor. No cracks, breaks, or signs of distress were documented along the length of the disconnected section.

The screened intake structure is not in use due to the breach in the piping; the engineering dive inspection found the intake screen to be in good condition with little debris or marine growth present.

Electrical:

NA

USEFUL LIFE ASSESSMENT:

Discipline	Remaining Life of Components	Condition
Mechanical	25 – Shallow Segment 0 – Deeper Portion	Good Poor
Electrical	NA	NA

DEFICIENCIES:

1. The lake water intake pipeline is completely disconnected approximately 700 feet from shore.
2. Due to the breached intake pipeline and associated lack of an intake screening system, the hatchery has experienced increased intake of sediment and debris, especially during storm events and heavy spring runoff. This has resulted in clogging of the bag filtration system and thus the need to clean the system with increased frequency; the decreased water clarity may also interfere with the effectiveness of the UV disinfection system.
3. The hatchery has experienced issues related to intake of water with warmer-than-desired temperatures for prolonged periods during recent summers. This is likely due to the intake of shallower, warmer water through the breached intake pipeline.
4. The lake water intake pipeline may not be at an adequate depth or have adequate cover or anchorage for protection from ice, boats, and other debris.
5. The Hatchery staff has expressed a desire to obtain and mix water from multiple depths for increased water temperature control.

IMPROVEMENT ALTERNATIVES:

The improvement alternatives evaluated for the lake water intake are divided into two categories for discussion:

- repair and improve existing lake intake
- addition of secondary lake intake

Repair and Improve Existing Lake Intake

Lake Superior continues to be the most viable water supply source for the Hatchery due primarily to its proximity, abundance, and general match to the desired water quality and temperature. However, as discussed, the Hatchery's existing water intake pipeline, which originally extended approximately 1,700 feet into the lake (approximately 300 feet buried and 1,400 feet exposed) to a depth of approximately 60 feet, is currently completely disconnected at approximately 700 feet from shore (400 feet after emergence from burial) and a depth of approximately 24 feet. Due to this breach, the Hatchery is drawing water from closer to the shore, which is less suitable for use at the Hatchery. Therefore, if the MNDNR decides to continue to use Lake Superior as the water supply for the Hatchery, repair of the intake pipeline is highly recommended to obtain a more suitable water supply.

The engineering dive inspection conducted in early May 2013 concluded that the existing intake pipeline appears to be in generally good condition and able to meet the demands of the Hatchery once repaired. Therefore, repair rather than replacement of the intake pipeline is recommended. This repair should include realignment and reconnection of the pipeline sections and stabilization of the pipeline to assist in prevention of a similar damage in the future. A collar or brace will likely be necessary to reconnect the pipeline pieces and it may also be necessary to trim a portion of the pipe during the repair so the disconnected section will fit into the existing gap. Once the intake pipeline is reconnected and realigned, it should be anchored to the lake bottom to prevent future lateral movement. Anchoring and stabilization of the pipeline can be accomplished via a variety of methods and should be tailored to the conditions at each desired anchorage location; possible stabilization methods include anchoring the pipe with concrete blocks or grout bags (see **Appendix H** for bracing examples).

Prior to the breach in the existing pipeline, the Hatchery rarely experienced warmer-than-desired intake water temperatures. Therefore, it is generally recommended that the intake be restored to its previous depth of approximately 60 feet deep. However, Lake Superior water temperature records could be used to determine a water depth which might provide more optimal temperatures. Specifically, Dr. Jay Austin of the University of Minnesota Duluth collects and analyzes water temperature data at various depths from a meteorological mooring approximately three miles southwest of the Hatchery's intake. Dr. Austin may be able to provide assistance related to analyzing the data he has collected to estimate an optimal intake water depth and therefore, if such optimization is desired, it is recommended that Dr. Austin be consulted during the design phase of this project.

The intake end of the existing water intake consists of a 90-degree vertical bend to elevate the intake off the lake bottom and a double-screen structure (approximately 28-inches in diameter and 24-inches tall) with 0.5-inch openings. The engineering dive inspection found the intake structure to be in good condition and thus it is expected to function as originally designed once the pipeline breach is repaired. However, it is recommended that MNDNR consider replacing the existing screened intake structure with a sand and gravel crib filter intake structure similar in design to the intake structure used by the U.S. Environmental Protection Agency's Mid-Continent Ecology Division Laboratory located approximately 7-miles southwest of the Hatchery. Similar intake structures are used at other nearby facilities along Lake Superior. The benefits of a sand and gravel crib filter intake structure over a screened intake structure include:

- increased filtration
- increased biosecurity
- increased protection from potential damage

- reduced energy consumption by eliminating the need for separator and bag filters or other inland filtration which have more head loss and backwash
- potentially less maintenance with less equipment

Based on these advantages, replacement of the existing screened intake structure with a sand and gravel crib filter intake structure is recommended.

Please note:

- This report assumes that conditions at the intake end of the pipeline are suitable for construction of a sand and gravel crib filter; additional studies may be necessary to determine applicability.
- For the opinions of probable cost, a filter loading rate of 0.15 gallons per minute per square foot of filter was assumed with a corresponding filter surface area of 5,500 square feet; the actual design filter loading rate and corresponding filter surface area may vary.

Additionally, if the MNDNR chooses to replace the existing screened intake structure with a sand and gravel crib filter intake structure, it is also recommended that a wye or tee be installed on the pipeline prior to the connection to the sand and gravel crib filter. This wye or tee would typically be capped; however, when necessary the cap could be removed by a diver and replaced by a screen, thus allowing it to serve as a "back-up" intake. This back-up intake would initially be used to allow for continued water supply during construction of the sand and gravel crib filter and could be used again in the future during repair or maintenance of the sand and gravel filter. Alternatively, a control valve could be installed on the wye/tee rather than using an interchangeable cap and screen system; however, it is anticipated that the cap and screen system would be more durable and easier to operate.

Addition of Secondary Lake Intake

The Hatchery staff also has expressed interest in adding a secondary water intake at a shallower depth from which warmer water could be obtained to mix with the water from the primary water intake. During the portions of the year when the water temperature in the lake is stratified, water from the shallower, warmer secondary intake could be mixed with water from the deeper, cooler primary intake to facilitate adjustment of unheated intake water temperatures and thus decrease the Hatchery's water heating needs.

This dual intake method of temperature adjustment would not be applicable during winter (November/December through March/April) when the lake is well-mixed, cold, and relatively uniform in temperature, or during the warmest portions of the summer (July/August/September) when the lake temperatures may be warmer than desired at both depths; however, it would be applicable and potentially beneficial for reduction of heating costs during the late spring/early summer (April/May through June/July) and fall (September/October through October/November).

The potential energy cost savings were calculated related to a shallower intake. The temperature difference was calculated between lake and hot well heating (delta T) (see **Appendix G** for data). The SCADA system does not log and record hot well flow so estimates were required to calculate heating. Hot well flow rates were assumed at 100, 150 and 200 gpm to estimate water heating requirements. BTU heating requirements were provided for 2011 by month and year. These BTU estimates were converted to wood heating requirements (tons pellets) and costs for comparison to the MNDNR heating data provided for wood pellet heating. The average monthly lake temperature for the period of record 1980-2012 was compared to the average temperature before the hatchery intake pipe breach (1980-1999 period) to the period immediately before and after the pipe breach (2000 to 2012). This comparison shows that there is a temperature differential between the pre- and post- intake breach pipe temperatures (i.e., deep vs. shallow) in the range of -0.64 to 0.96 degree F. Cost savings for water heating was estimated at $3,000 to $6,500 per year to give a baseline for the possible consideration of a dual FRH intake system. Note that cost estimates for water heating indicate that heating costs for hot well flow rates near 150 gpm ($113,486) are similar to the wood fuel and oil backup heating costs for 2010 ($112,811) so this data analysis appears to be accurate.

The probable cost of installing a secondary intake pipeline is estimated to be approximately $3.28 million. Given the annual cost savings for water heating of $3,000 to $6,000 discussed above, the 25-year cost savings would be approximately $75,000 to $150,000. Therefore, it is unlikely that the installation of a secondary intake pipeline would be cost effective so it is not recommended at this time. If the MNDNR decides to pursue the option of installing a secondary intake, further refinement of this cost analysis is recommended; consultation with Dr. Austin is also recommended to estimate optimal placement of the secondary intake based on water temperature data.

Several options exist related to the design of a secondary water intake. General design considerations and associated recommendations are as follows:

- Adjusting the flow of water through the secondary intake is necessary to control the mixing of intake waters and thus the resulting water temperatures. Therefore, it is recommended that the secondary water intake consist of a second parallel pipeline rather than a secondary opening in the existing intake pipeline.
    - While a secondary opening in the existing pipeline would be significantly less expensive than constructing a second intake pipeline, both the cost and the inconvenience of adjusting the flow through a secondary opening would be greater as it would likely require either manual adjustment of an underwater valve by a diver, manual interchange of a cap and screen system by a diver or the installation of an electronic control system.
    - The existence of two independent intake pipelines adds to the security and reliability of the water supply by supplying redundancy in the event that one of the pipelines is damaged or otherwise out of operation.
- It is recommended that the secondary intake pipeline be constructed of high-density polyethylene (HDPE) pipe for greater durability and longevity compared to metal pipe.
- Adding a secondary intake pipeline will require construction across North Shore Drive (Old Highway 61). It is recommended that this be accomplished by an open-cut trench. Using this method, it is estimated that a detour around this portion of North Shore Drive will be necessary for less than two weeks.
    - Directional boring is not recommended due to cost and the possible presence of shallow bedrock.

  - In-situ installation within the abandoned 12-inch intake pipeline is not recommended due to the unknown condition of the abandoned pipeline and the associated limitations to pipeline diameter.

- Based on hydraulic considerations and the cost of installing, operating, and maintaining additional pumps, a separate sump for the secondary intake pipeline is not recommended. Rather, it is recommended that a combined "mixing sump" be installed directly prior to the existing sump. The flow from the existing pipeline and flow from the secondary pipeline would be controlled by valves as they enter the mixing sump; the mixed water would then flow into the existing "pumping sump" to be pumped to the Hatchery.

  - Direct tie-in of the secondary pipeline to the existing sump is not recommended due to potential complications related to maintaining the operation of the intake and quality of the intake water during construction. Construction of the separate mixing sump will allow the existing pipeline and sump to continue to operate "as-is" during construction; the existing portions can be connected to the new portions at the end of the construction process.

- It would be possible to install an automated system to control mixture of water from the existing and secondary pipelines to achieve optimized water temperatures. However, this is not recommended as it introduces layers of complexity related to operation and maintenance of the automated system. Therefore, manual control of the associated valves and mixture is recommended, aided by basic temperature gages installed near the sump end of each intake pipeline.

- To maintain the water quality of the intake water, the secondary pipeline's intake structure should, at minimum, provide the same level of filtration as the existing pipeline's intake structure. Therefore, it is recommended the secondary pipeline's intake structure be designed to be similar to the existing pipeline's intake structure (e.g., if a sand and gravel crib filter intake structure is installed at the end of the existing pipeline, a similar sand and gravel crib filter should be installed at the end of the secondary pipeline).

RECOMMENDATION:

It is recommended to renovate the existing lake water intake system by repairing the breach in the existing water intake pipeline and restoring the intake to its previous depth of approximately 60 feet deep (or an alternative depth based on water temperature records). If bathymetry data and preliminary testing indicate feasibility, replace the existing screened intake structure with a sand and gravel crib filter intake structure.

Benefits:

- Restoration of the ability to obtain a water supply of suitable quality and temperature for use at the Hatchery.
- Minimization of the intake of sediment and debris through increased filtration, thus decreasing concerns related to effective water treatment.

- Minimization of the intake of biological organisms through increased filtration, thus increasing biosecurity.
- Stabilization of the pipeline to assist in prevention of future lateral migration and damage from ice, boats, or other debris.

Alternative	Recommendation
Repair Intake Pipeline	No
Repair Intake Pipeline and Install Intake Filter	Yes
Add Secondary Intake Pipeline	No

PHOTOS:

COMPONENT NAME:

2. PUMP STATION

GENERAL DESCRIPTION:

The water is pumped from the sump to the Upper Hatchery by one of two turbine pumps. A third pump in the pump station supplies water to the Lower Spawning Facility.

The two main hatchery pumps are being alternated at 800 gpm each and turned on and off by float controls to keep the Upper Reservoir (**Component 6**) full. Average water demand from the reservoir to the main hatchery is 492 gpm continuous. The upper reservoir is about 10 ft deep and the float controls have been adjusted to give a water level that ranges between 7 and 10 ft.

Two pumps are Floway brand and the 3rd is Fairbanks Morse brand. The Floway pumps were stamped Model 12 DOL, 4 stages, 50 hp, 850 gpm at 200' TDH, 1800 rpm and they have 60 hp motors. Floway curves for this pump indicate 82 to 84% efficiency at 850 gpm which is quite good. At 800 gpm efficiency is about 2% less which is still good. The pump discharge pipes have Mueller Steam Co. Model 71 check valves. Water pumped to the facility is then treated with a vortex separator, filtered, disinfected with UV light, and is heated during the cold winter months (**Components 3, 4, 5 and 7b**).

The 3rd pump is for the Lower hatchery and it pumps to a different reservoir that is float controlled. The lower hatchery has a peak continuous demand for a few weeks of 600 gpm.

MANUFACTURER/SIZE INFORMATION:

Floway and Fairbanks

YEAR OF CONSTRUCTION:

1981

ASSESSMENT:

Mechanical:

The pumps are in good condition. The existing pumps are 82% to 84% efficient. New pumps might be 85% efficient. If the pumps remain float controlled and if influent treatment equipment remains the same or is replaced with new influent treatment having the same pressure drop, there is little reason to change the pumps in the near future.

The 3 ft of upper reservoir water level fluctuation causes the water heating and mixing systems to modulate more than they would have to if the reservoir level was more consistent. This can cause unwanted temperature fluctuations and premature wear of motorized mixing valves. Simply moving the on and off floats closer together is not necessarily good practice since it would cause the lake pumps to cycle more frequently which increases wear. Automated variable speed pump controls would reduce reservoir fluctuation and would provide a more stable water heating system.

Electrical:

The pump station is fed from overhead electric lines that should be installed underground to improve reliability and reduce voltage drop. The generator and transfer switch are in need of replacement. Much of the switchgear in the pump station is abandoned with newer equipment added to keep the pumps operational. There are multiple dry type transformers located both inside and outside that are used to feed power to adjacent structures. One or more of the transformers may be abandoned in place.

USEFUL LIFE ASSESSMENT:

Discipline	Remaining Life of Components	Condition
Mechanical	10	Good
Electrical	5	Poor

DEFICIENCIES:

1. Pump sizing and controls give a reservoir level that fluctuates 3 ft and cycles the pumps more than necessary.
2. The pump station power feed is overhead making it susceptible to storm damage.
3. Panelboard is near end if its life.

4. Generator, transfer switch and fuel storage is near end of its life.
5. Pump controls are near end of their life.
6. Additional process monitoring, control, and alarms are needed .

IMPROVEMENT ALTERNATIVES:

Pump Improvements

The pumps could remain as is since they have many years of life remaining; but, this is not advised if there are changes in influent treatment as detailed later in this report. The pumps could be replaced at the current sizing to improve the likelihood that they do not have to be replaced for 25 more years; but, that would not take advantage of the life remaining and is not advised if changes are made to influent treatment.

Since the pumps have capacity greater than the hatchery demands, they could be replaced with smaller pumps with variable frequency drives automatically operated at speeds to match hatchery demand. Hatchery demand has been estimated to be 500 gpm on average and 575 gpm peak. The pumps could also be smaller in horsepower if influent treatment equipment is replaced with types of influent treatment equipment that has less pressure drop and/or lower backwash requirements. New controls would be included.

Electrical Improvements

The existing electrics in the pump house are in need of complete replacement. The only piece of switchgear recommended to remain is the fairly new, Square D Motor Control Center. Work includes: 1) remove the overhead feeders serving the pump house; 2) remove the existing Waukesha generator and Asco transfer switch; 3) remove the dry type transformers mounted both indoors and outdoors; and 4) remove all of the distribution equipment except the Model 5 motor control center.

Install a new underground feeder to the pumphouse and install a new service entrance panel. Install a new step down transformer and 120/208-volt power distribution panel. Install a new indoor generator, and transfer switch. The existing 500 gallon above ground fuel tank with containment was installed in 1998 and is functional but may need to be replaced to meet 25 year service requirements. Cost estimates include a new fuel tank for budgeting purposes. Provide variable frequency drives for the water supply pumps. Estimates include equipping one of the VFD's with isolation and bypass feature to allow operation of the pump while the drive is serviced or replaced. During the course of this study, the emergency generator has been found to be unreliable and parts are not available so replacement might need to be completed as an emergency repair due to its critical importance to the facility operation.

Another recommended improvement is to run a new fiber optic cable from the SCADA control panel to the lower pumphouse. Install a new remote I/O panel in the pumphouse. This will replace the existing hardwired controls and allow speed control of the main service pumps based on the water level in the upper reservoir. The additional panel at the pump house will allow monitoring and alarming of generator and water supply pumps.

RECOMMENDATION:

New pumps are recommended, sized to be efficient at the peak hatchery demand (including the backwash requirements of influent treatment equipment) and reduced pressure requirements of new treatment equipment. These pumps should have automated variable frequency drives to give consistent reservoir levels at varying hatchery demands. It is recommended that the electrical distribution and pump control systems be completely removed and replaced with new panels, transformers, generator and transfer switch.

Benefits:

- Reduced power costs.
- Longer pump life due to reduced cycling.
- Longer heated water system mixing valve life due to decreased modulation.
- Smaller pumps to maintain which will likely be lighter, quieter and cheaper to maintain.
- Longer electrical equipment life.
- Increased reliability of underground power feed.
- Increased reliability of backup power system.
- Reduced maintenance of backup power system.

Alternative	Recommendation
Renovate Pumps	No
Replace Pumps	Yes
Replace Electrics*	Yes

*Note: Emergency generator and associated electrical replacement might need to be completed as an emergency repair due to its critical importance to facility operation.

PHOTOS:

COMPONENT NAME:

3. VORTEX SEPARATOR

GENERAL DESCRIPTION:

The first piece of treatment equipment applied to the pumped lake water is a vortex separator with bypass. It is an inclined separator with 8” influent and effluent connections and a 2” purge connection to an open drain which is normal for this type of equipment except modern separators would likely have 1.5” purge connections. They use centrifugal force to separate solids from liquid and the liquid (free of separable solids) is drawn to a vortex up through the separator’s outlet. They are designed for a prescribed flow range and are usually for removing solids 74 microns and larger with a specific gravity of 1.8 or greater (heavy solids).

The nameplate data is painted over and the 1974 construction drawings give no details about it. Given photographs, the site location, age and name of the original installing Contractor (A.W. Kuettel, Co.), the model is identified by Lakos as Lakos Model P-2032 TS. This particular model is no longer manufactured. The model was intended for 730 to 1350 gpm and causes 4 to 13 psi head loss in that range. Lakos was surprised to learn this unit is still in use and suspects it needs replacement; but knows little about its application today. It has no moving parts except a manual valve on the purge. Sometimes the purge valves are automated in conjunction with an adjustable timer.

MANUFACTURER/SIZE INFORMATION:

Lakos Industrial TS Standard Separator; Model P-2032TS, 8”

YEAR OF CONSTRUCTION:

1974

ASSESSMENT:

Mechanical:

The separator is properly sized for the current intermittent rate of 800 gpm. Newer units would remove more solids and require less purge. Background water quality samples (particle size analysis and TSS/turbidity levels) are required to determine if this type of equipment is needed. There is a plate inside the unit that diffuses influent into a cyclonic pattern. Lakos was consulted and the only failure description they offered was detachment of the diffuser which quickly leads to excessive pressure drop. Hatchery staff did not report unusual pressured drop or pressure drop change; so, the separator is presumed in working order.

Electrical:

No electrical components.

USEFUL LIFE ASSESSMENT:

Discipline	Remaining Life of Components	Condition
Mechanical	25	Good
Electrical	NA	NA

DEFICIENCIES:

1. Particle size analysis is not available to determine whether this equipment is required. Analysis needs to be completed on storm event water, easterly wind, normal and ice/snow melt conditions.
2. The separator does not have automatic purge.
3. Separators target solids 75 micron and larger with a specific gravity of 1.8 or greater, which leaves many smaller solids and lighter solids in the influent, enough to frequently clog the bag filters downstream.
4. The single separator is too large to match to continuous hatchery demand.

IMPROVEMENT ALTERNATIVES:

First, water quality data needs to be obtained to determine whether this piece of equipment is required. MNDNR should start collecting influent samples during poor water quality events such as during large storms, easterly wind and snow melt conditions. These samples need to be sent for particle size analysis to determine whether this piece of equipment is warranted. If not, purge water flow needs will be saved and the equipment can be abandoned. Headloss through the system will also be eliminated.

If the data indicates larger particles are in the water supply, the separator could remain since there is no indication that it is not performing as intended; however, a newer model would have a smaller purge connection to promote purging less water. It was recommended to install variable speed pumping in **Component 2 – Pump Station** discussion. This separator would not work with variable speed pumping matched to hatchery demand since average and peak demands just for the fish are 500 and 575 gpm, respectively which are below the separator flow range.

The separator could be replaced with a newer model of similar size to improve grit removal and reduce purge requirements; but, it would still be oversized if the pumped water supply system was changed to one that continuously matched hatchery demand.

The single separator could be replaced with two smaller separators so that one could be operated to match continuous hatchery demand for fish and two could be operated to match the combined demand of fish and backwash demand of itself and other equipment such as the bag filters or biofilters. It would be difficult to automate the switching from one or two units and back. Motorized valves could open and shut based on a flow meter output; but, system reaction times would not be ideal. Manual switching would add to labor already excessive at the hatchery.

The separator could be eliminated if other influent filters were employed that did not need a separator. In addition, the lake intake pipeline repair might eliminate some of the larger grit coming into the system as it will not be sitting directly on the lake bottom.

RECOMMENDATION:

Unless the space that the separator occupies becomes important for something else, it is recommended the separator be kept as a backup treatment device in case other proposed equipment is employed and briefly fails. The separator appears to already have a bypass. The separator should be occasionally be un-bypassed so that it does not bio-foul or get deposition.

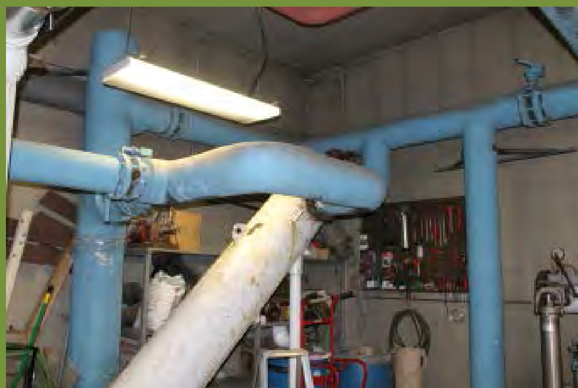
Filters recommended later in place of the bag filters do not require assistance of a separator if the lake intake screen with ½" openings is restored or improved.

Benefits:

- Bypassing the separator will reduce pumping head and power by avoiding its pressure drop and purge demand.
- Keeping the separator ready will give some treatment if other equipment fails.

Alternative	Recommendation
Retain Separator	Yes
Replace Separator	No

PHOTOS:



COMPONENT NAME:

4. BAG FILTRATION SYSTEM

GENERAL DESCRIPTION:

In the mechanical room of the hatchery, the water passes through a vortex separator to remove sand, grit, particulates, and debris (**Component 3**). The water then flows through banks of automatic backwashing bag filters (230 micron or 60 mesh) for fine particle removal. Mesh size of the bag filters was reduced from about 500 microns to 230 microns to provide filtration of spiny water flea eggs (a potential AIS species present in Lake Superior). This filtration level is not adequate to meet new AIS exclusion recommendations. One potential ANS species is Zebra mussels and the smallest life stage of this pathogen is veligers; these can be deterred with 40 micron filtration. Other MNDNR hatcheries have recently installed 35 micron filters. From the bag filtration system water enters the UV disinfection system (**Component 5**). Some UV system manufacturers or suppliers advise 50 micron screening upstream to deter shadowing.

Bag or Cartridge Filtration is a technology suitable for use in small flow systems for removing debris and turbidity. This type of filtration employs physical straining to remove particulates from the water column. The cartridge can be fitted with either a bag or cartridge unit that is generally disposed when clogged. Some systems are capable of being backwashed and do not use disposable media cartridges. Pressure operation is generally required to move the water through the bag or cartridge.

In a conventional cartridge filter system, the water flows through the thick wall of the filter where the particles are trapped throughout the complex openings in the media. The filter may be constructed of cotton, cellulose, synthetic yarns or "blown" microfibers such as polypropylene. The best depth filters have lower media density on the outside and progressively higher density toward the inside wall. The effect of this "graded density" is to trap coarser particles toward the outside of the wall and the finer particles toward the inner wall. Depth cartridge filters are usually disposable, cost-effective, and are in the particle range of 1 to 100 microns. Generally, they are not an absolute method of purification since a small amount of particles within the stated cartridge micron range may pass into the filtrate.

The existing filter was manufactured by Ronningen-Petter. There are two banks of filters each with 7 vessels and each filter is stamped SS-73-207-MX. The hatchery utilizes tri-cluster elements to meet the 230 micron filtration goals. The tri-cluster elements are fitted with fabric cloth (Part No. 7BCFT-FAB) and are rated at 510 square inches of surface area. The fabric is woven from synthetic fibers. The element is backed with a 316L SS backing to provide support during filtering and cleaning. According to the manufacturer's literature, 230 micron removes particles about the size of a grain of sand. Eaton bought Ronningen-Petter and the model that includes "207" and has tri-cluster elements is F207 which has 7 vessels filled with tri-cluster elements. Eatons' product data indicates minimum backwash flow of 90 gpm, system pressure greater than or equal to 45 psi, 5 psi clean pressure drop and backwash initiation at 15 psi drop. One vessel at a time is automatically backwashed. Hatchery staff reported that system pressure is about half of the required 45 psi.

In the spring and fall, the facility gets a lot of silt and leaf debris during storm events. The hatchery reports that in 1999 they needed to manually wash (total disassembly and pressure wash) the filters every second or third month. From 2001 through 2006, the filters were washed almost once per month. In 2007, the filters needed washing 19 times, 2008-27 times, 2009-27 times, 2010- 26 times, 2011-31 times and in 2012, they needed to wash the filters 64 times.

MANUFACTURER/SIZE INFORMATION:

Eaton Ronningen-Petter F207

YEAR OF CONSTRUCTION:

1974

ASSESSMENT:

Mechanical :

The auto backwash is inadequate when sediment load is high. This is probably due to inadequate operating pressure. The filter housings and 3-way valves are stainless steel and appear in good condition. The current 230 micron bag filter fabric does not deter Zebra mussel veligers or deter shadowing of UV light optimally.

Electrical:

Electrical controls appear to be original and operational.

USEFUL LIFE ASSESSMENT:

Discipline	Remaining Life of Components	Condition
Mechanical	25 – Housing 10 - Pneumatics	Good Fair
Electrical	10	Fair

DEFICIENCIES:

1. Zebra mussel veligers are not deterred.
2. Cleaning has become very labor intensive which has increased over time.
3. Compared to some other filters, pressure drop (head loss) is high which wastes pumping energy.
4. Preparation for UV disinfection is not optimal.
5. Electrical controls are original.

IMPROVEMENT ALTERNATIVES:

If these filters were to continue in service, water pressure to them should be increased so that they can backwash as their manufacturer intended. One way to achieve this would be to permanently throttle their effluent. Unfortunately this would reduce hatchery flow and would not proportionally reduce pumping power. A second way to achieve this would to get higher head lake pumps. Unfortunately that would increase power consumption. A third way to achieve better backwash would be to automate the throttling of their outlet so that it only occurs when they are in backwash mode. Unfortunately the existing pumps might then not keep up with fish demands all of the time and even if higher head pumps and variable speed controls were added, they would be larger than otherwise necessary and would consume more power during backwash. The existing filters do not meet current AIS exclusion recommendations so continued use is not recommended.

Several of probably dozens of filter replacement options have been considered.

One would be to put an in-lake sand filter on the lake intake pipe(s) much like the one that the EPA had installed nearby in 1996 with few reported problems since. It requires no backwash and the EPA filter has needed no maintenance other than diver inspection every couple of years since. This would also provide treatment of Lower Spawning Building water supply. See **Component 1 – Intake Replacement** for further discussion of this in-lake filter.

Gravity sand filters like the City of Duluth uses or pressure sand filters could be installed inland. With the addition of coagulants, sand filters will generally remove solids down to 5-10 microns. These would cost nearly the same as in-lake filtration; but, would also require a lot of backwash so they are not recommended.

Another alternative is to replace the bag filters with stacked disc filters like Miller-Leaman's Turbo Disc or Amaid/Arkal's Spin Klin. These filters act like depth filters which tend to filter better than single layer bag filters or screen type filters. They have a more aggressive backwash than bag filters while having a lower pressure drop. They are available with discs with as little as 20 micron grooves between them.

Bag filters like the existing ones, except with an independent backwash system, could be employed; although, Eaton's product literature still suggests a moderately high operating pressure and these filters have higher pressure drop than some stacked disc filters so they are not recommended.

The existing filter controls should be replaced if the filter system is replaced or modified.

RECOMMENDATION:

The in-lake sand filter is most attractive since it has no moving parts, no backwash requirements, very low pressure drop and low maintenance. Closer study of the lake bathymetry and its sediments is required. If selected, in-lake sand filters will allow even smaller lake pumps than the stacked disc filters.

If the lake filter is deemed unsuitable during preliminary design, we suggest stacked disc filters be employed instead of the bag filters. It is believed that the upstream separator is also not needed.

Benefits:

- Reduced lake pumping power costs.
- Reduced maintenance.
- Deterrence of zebra mussel veligers.
- Better preparation of water for Ultraviolet Disinfection.
- Better overall water quality for hatchery eggs and fish and for other downstream equipment such as heated water booster pumps and heat exchangers.
- Allows for lower head lake pumps which would likely be lighter and quieter and cheaper to maintain.
- Provides filtration of the water supply for the Lower Spawning Building

Alternative	Recommendation
Replace with In-lake Filters	Yes*
Replace with Stacked Disc Filters	No

*Note: Pending bathymetrics and sediment lake bed study

PHOTOS:

COMPONENT NAME:

5. ULTRAVIOLET DISINFECTION SYSTEM

GENERAL DESCRIPTION:

Open water supply systems with living fish populations potentially carry a wide variety of bacteria, protozoans, fish pathogens and parasites that can be infectious in the high-density rearing environment of a fish hatchery. Prior to use in sensitive rearing stages, the water can be disinfected to decrease or eliminate disease potential. Ultraviolet (UV) disinfection technology can be installed to treat a wide variety of water flow rates and piping configurations without toxic residuals. Ozonation and other chemical disinfection methods are also potentially available for specific water supply disinfection applications, but typically require more expensive and complex contacting and removal techniques. UV equipment can be of either closed vessel or open channel type. The system at FRH is closed.

The UV water treatment system is comprised of twenty-eight separate UV vessels (14 pairs), each with 2” inlet and outlet and one lamp and one ballast plugged into a 120 volt receptacle. Each is stamped UV Sanitron Model A-2400. These are presumed original from 1974. Sanitron is a series by Atlantic Ultraviolet Corp. who remains in business today. The units have manual lamp sleeve wipers. Their single lamp vessel with 2” connections in the Sanitron series is now S2400C. It is rated for 40 gpm flow, and is alleged by its manufacturer to give a dose of 30,000 microwatt seconds per square cm or 30 mJ. Every two units are piped in series and every pair is piped in parallel. The dose going through two units would be 60 mJ and rated flow through 14 pairs would be 560 gpm. It is CE certified meaning the manufacturer declares their product Conforms to European standards. The series is not alleged as 3rd party validated per US EPA standards. Without validation the dose is only a calculated dose. Although the EPA has guidelines regarding dose calculation, it is subjective and might not give the pathogen control and security desired.

MANUFACTURER/SIZE INFORMATION:

Atlantic Ultraviolet Corp., Sanitron Model A-2400

YEAR OF CONSTRUCTION:

1974

ASSESSMENT:

Mechanical :

This model is outdated and presumed similar to current model S2400C which is rated for 40 gpm flow, 5 psi maximum pressure drop, has 110 watt lamps, consumes 140 watts and is alleged by its manufacturer to give a dose of 30,000 microwatt seconds per square cm or 30 mJ to water with 90% UV transmittance. The units appear to be functioning according to the original design intent. However, the system is not validated for dosage and might not meet the latest pathogen management goals for biosecurity.

Electrical:

The ballasts used for the UV disinfection system are magnetic type. Electronic, low harmonic ballasts are preferred to magnetic ballasts to save energy, however it is unlikely these ballasts are available for this lamp due to the age of the system. If electronic ballasts are available for this lamp, it is recommended that as the ballasts fail, they are replaced with the electronic equivalent.

USEFUL LIFE ASSESSMENT:

Discipline	Remaining Life of Components	Condition
Mechanical	20	Good
Electrical	10	Fair

Note: No manufacturer's lamps or lamp sleeves will last 25 years. The industry standard lamp life is 1 year and sleeves are commonly replaced every 4 years.

DEFICIENCIES:

1. Dose is not validated and even it if were, it would not be known because the actual flow rate through each unit is not known and the UV transmittance of the water is not known.
2. The unit does not include automatic wipers, they are manual only.
3. There are no alarms or measurements of influent lake water UV transmittance.
4. For a system of this age, as the UV lamp ballasts fail, replacement ballasts may be become difficult and expensive to replace.
5. Does not maintain biosecurity upon UV failure or low UV intensity.

IMPROVEMENT ALTERNATIVES:

First, MNDNR needs to select the UV dosage level needed at FRH to ensure that biosecurity goals for the facility are met. Sources indicate that a 40 mJ dose reduces 99.9% of pathogens that infect cold water fishes such as Whirling Disease and Saprolengnia Fungi, 35 mJ affects Trichodina and 30 mJ affects the Virus IHNV/RTTO. It takes less than 30 mJ to affect VHS. Few coldwater fish pathogens are known to be affected between 40 and 100 mJ. Between 100 and 126 mJ, chum salmon virus, freshwater white spot (Ich) and Coldwater Disease are affected. Therefore, two treatment levels were considered – 40 mJ and 126 mJ.

The units could remain or be replaced with the original manufacturer's updated version or be replaced with non-validated systems by other manufacturers with manual wipers. Alternately, the units could be replaced with non-validated systems with automatic wipers. In any of these cases, the actual dose would not be assured so is not recommended.

The UV units should be replaced with validated systems so that dose is known. This will also require that flow split to multiple units is assured of being balanced or the flow must be metered. UVT (light transmission through the water) also needs to be known. It can be checked continuously with a permanently mounted meter or it can be checked periodically with a portable meter or water samples can be taken and tested in a lab. Automatic wipers are advised to reduce maintenance and deter fouling of the lamp sleeves.

Trojan Technologies is the largest UV system manufacturer in North America and offers a pair of validated UV systems (series Swift-SC, model D18) that have variable power and can be operated at 60% power to give 40 mJ dose to 670 gpm at 90% UVT while using 3 kW of power. The old UV units are rated to consume 4 kW of power so the new 40 mJ system will provide energy savings. The variable power of the Trojan system also allows for less power to be used when UVT is higher (or water is clearer) than estimated and it allows that one system be ramped up to full power to give 40 mJ dose when the other system is off for maintenance such as annual lamp replacement. A few manufacturers have systems similar to those of Trojan.

If the higher dose is requested, three Trojan series Swift-SC, model D18 units are advised to achieve 126 mJ at 850 gpm running at full power. Compared to the current UV system, energy savings will not be realized.

With the replacement of the UV system, there are a few alternatives for control and alarming. As mentioned above, dose paced controls have the potential to save energy and reduce maintenance. A new system should have alarms including low UV and system failure. Upon low UV intensity, the main water supply pumps could be automatically stopped in order to maintain biosecurity.

RECOMMENDATION:

The UV system should be replaced with a validated system sized for the 40 mJ dose unless MNDNR requires a higher dose.

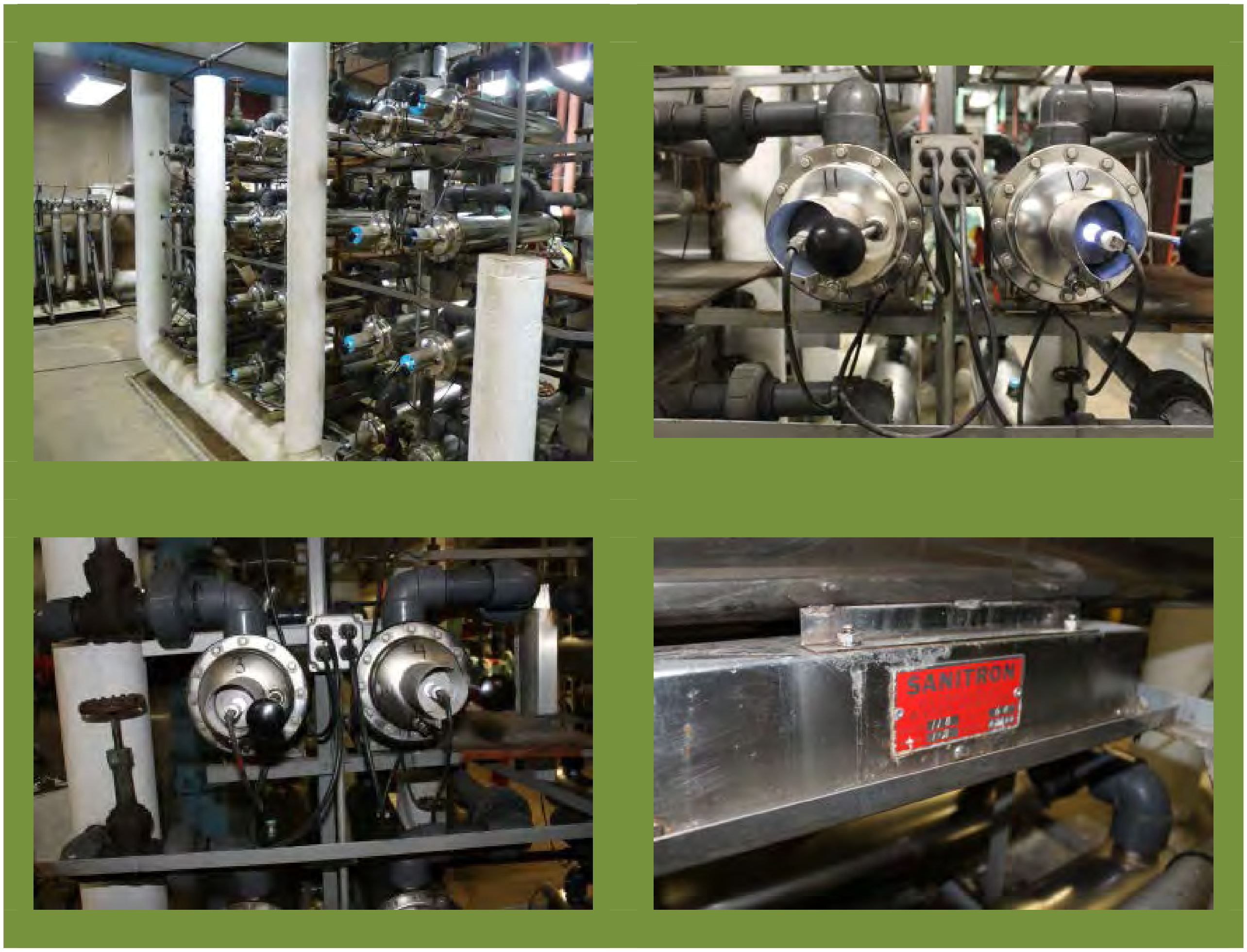
Benefits:

- Known dose
- Automatic sleeve cleaning
- Management of more types of pathogens and increased biosecurity
- Biosecure operation during low UV intensity or UV system failure.

Alternative	Recommendation
Replace with New 40 mJ Dose	Yes*
Replace with New 126 mJ Dose	No

*Note: Pending MNDNR selection of biosecurity treatment goals

PHOTOS:



COMPONENT NAME:

6. UPPER RESERVOIR

GENERAL DESCRIPTION:

Treated water from the mechanical room in the main building is routed up to the covered reservoir and flows by gravity back to the hatchery complex and provides the treated cold water supply. The 34' diameter x 10.5 ft. deep concrete tank is roughly at grade, has a catwalk and is covered with a corrugated galvanized steel un-insulated cylindrical structure with cone shaped roof – basically a grain bin. Float switches control the pumps and water level varies four feet. The water inflow is distributed into the tank through a perforated inlet pipe. The aeration effect of the water distribution pipe is unknown.

MANUFACTURER/SIZE INFORMATION:

NA

YEAR OF CONSTRUCTION:

1974

ASSESSMENT:

Mechanical :

The concrete tank, inlet pipe and its cover appear to be in good condition. There is little reason to believe that it will not last 25 more years. Dissolved oxygen levels in the water could be increased more than with the perforated inlet pipe.

Electrical:

Electrical components for the Upper Reservoir consist of float switches for alarm and control of the supply pumps. Even though very minor, these inexpensive components typically need to be replaced every 10 to 15 years.

USEFUL LIFE ASSESSMENT:

Discipline	Remaining Life of Components	Condition
Mechanical	25	Good
Electrical	15	Good

Note: Some electrical components typically require replacement every 10-15 years but are not included in the capital improvements plan

DEFICIENCIES:

1. DO performance is unknown. There is no continuous DO measurement or alarming.
2. Water level fluctuation causes unwanted flow variation downstream. Level fluctuations in the upper reservoir cause level and temperature fluctuations in the hot well. Because of pressure fluctuations caused by level changes in the storage reservoir and hot well, the motorized valves controlling water temperatures to the Nursery may have shorter service life due to hunting.

IMPROVEMENT ALTERNATIVES:

Water level fluctuation is addressed as part of **Component 2 - Lake Pumps**.

A passive aeration column(s) with plastic media or perforated plates could be added in lieu of the perforated inlet pipe to improve dissolved oxygen levels; but not as much as by adding sealed columns with oxygen injection. If provided an oxygen supply, sealed oxygenation columns would improve dissolved oxygen levels.

Continuous dissolved oxygen monitoring could be added to the reservoir. The dissolved oxygen level of the water supply could be monitored by the hatchery's alarm and monitoring system along with the water temperature. Low DO alarms could be added.

RECOMMENDATION:

Sealed oxygenation columns are advised in place of the perforated inlet pipe along with associated DO measurement and alarms.

Benefit:

- Oxygen supersaturation.

Alternative	Recommendation
Install Aeration Columns	No
Install Sealed Oxygen Columns	Yes

PHOTOS:

COMPONENT NAME:

7. MAIN WATER SUPPLY SYSTEM

GENERAL DESCRIPTION:

7a. Coldwater Supply Piping

The main water supply source is Lake Superior. The water supply temperature ranges from 31°F to 72°F and detailed water temperature historical data is available (see **Section V** for further discussion). Lake Superior rarely freezes over. Average flow is around 492 GPM with peak flow at 800 GPM. The inland aquaculture water supply site piping was installed in 1975. The 12-inch diameter inland piping is made of PVC and fiberglass and is reported to be in good condition. Piping is not routinely cleaned and cannot be easily drained. Pump hour meters or the flow meter at the upper reservoir are used to measure flow rate and/or total water use. The pipes are buried at a depth of five feet, which has historically prevented freezing. The Upper Hatchery demands pumped lake water all year long.

The water pumped from Lake Superior is treated as described earlier in this Section.

7b. Water Heating System

The hot water boiler system is used to heat the Nursery Building and process water. It is reported that this system is too large for the building heating requirements alone. A closed loop of heated water is circulated through hydronic space heaters, coils in air handlers and process water heat is exchanged at a shell and tube heat exchanger. Heated process water is pumped to the hot well which is an open storage tank.

Three oil fired boilers were installed in 2003 and 25% of their capacity was anticipated as needed for building heat. They were manufactured by L.E.S Inc., Series HCW. Two boilers are rated at 3,350 MBH output and one is rated at 1,450 MBH output. Their rated output efficiency is 83% of their rated input. These three boilers have the potential to be operated using natural gas.

There is one wood pellet fired hot water boiler, Federal Boiler Company, Inc., Model FLR 1518, dated 1983. The wood fired boiler has a material handling system with a mechanical auger system to transport wood pellets from the bulk storage to the boiler feed auger. It is reported that the wood pellet boiler needs to be updated. Maintenance is needed often for the wood pellet boiler consisting of pushing ash twice a day and doing a total clean of the unit twice per week. The Federal Boiler Company was bought by EASCO Boiler Company who has been contacted for information; but, their web site has no indication of wood fired boilers today. Comparison of the boiler nameplate input MBH to Net MBH of 3,912 suggests that the wood burning boiler is 69.5% efficient at optimum operation.

The existing Federal boiler's condition evaluation is based on normal life expectancy which is 25-30 years and the existing age of the boiler is now 30 years of operation. An internal inspection of the boiler condition was not possible because the system was in operation at the time of the visit. Electric, gas and oil boilers are more efficient in combustibility; but local power and available fossil fuel costs make the cost of wood competitive. Besides diesel fuel and wood pellet costs, costs are realized for ash storage, ash hauling and ash testing. Maintenance also occurs daily on the wood fired boiler.

7c. Mixing Manifold

Heated water from the open heated tank and un-heated water from the upper reservoir are mixed in five places where there are motorized valves to automatically control mixed water temperature. Outlets of two manifolds are separately piped to incubation and outlets of three manifolds are separately piped to three different groups of round tanks in the nursery. One of the five groups of control valves achieves considerably less consistent temperature than the others.

MANUFACTURER/SIZE INFORMATION:

Boilers: L.E.S. Inc., Federal Boiler Co.

YEAR OF CONSTRUCTION:

Piping: 1975

Boilers: 1983 and 2003

Automatic Mixing Manifolds: 2008

ASSESSMENT:

Mechanical:

The coldwater supply piping is in good condition. The water heating system functions; but, is costly to operate and maintain and the wood fired boiler is at the end of its useful life. The automatic mixing manifolds are in good condition, except one of five outlets gives unsteady temperature. The shell & tube heat exchanger and boiler loops pumps appear to be in good condition and there has been little technological advancement in this type of equipment.

Electrical:

Electrical components associated with the water supply system mainly include the supply pumps and controls, the water heating pumps and controls and the mixing manifold controls. The main supply pumps and controls are discussed in **Component 2 – Pump Station** of this section.

For the water heating component of the main water supply, cold water from the Upper Reservoir (**Component 6**) is pumped through heat exchangers into the hot well located in the main mechanical room. There are three circulations pumps, CP-1, 2, & 3 that are used divert some of the cold water through the boiler heat exchanger and fill the hot well with heated water. Two of the circulation pumps have been fitted with variable frequency drives. The staff can manually adjust the speed of two of the pumps to increase or decrease the water delivered to the hot well.

The purpose of the hot well is to provide a location for the heated water supply to be de-gassed after it has been heated. The hot well also sets the head for the heated water supply as it is mixed with the cold water supply to set the five different water temperatures delivered to the Nursery.

The hot well water level is currently manually controlled by the hatchery staff by adjusting the circulation pump speed. The variability of the head pressure to these pumps, combined with varying demands on hot and cold water due to backwashing of the biofilters, make this system very challenging and labor intensive to set up and even more challenging to adjust flow rates as production changes in the Nursery and Burrows. The process has been greatly improved with the addition of the SCADA system. Even though the SCADA system does not control this process, the ability to view the level of the hot well and monitor various flow rates has greatly assisted the staff in managing this complex water delivery arrangement. The addition of more process automation is recommended to reduce both maintenance and energy costs.

USEFUL LIFE ASSESSMENT:

	Discipline	Remaining Life of Components	Condition
7a	**Coldwater Supply**		
	Mechanical	25	Good
	Electrical	NA	
7b	**Water Heating System**		
	Mechanical	18 – Oil-Fired Boilers 5 – Wood-Fired Boiler	Good Fair
	Electrical	10	Fair
7c	**Mixing Manifold**		
	Mechanical	25	Good
	Electrical	NA	

DEFICIENCIES:

1. The wood pellet boiler is difficult to maintain.
2. The heated water aeration is inefficient.

3. Although the mixing valves are automated to give desired temperature, a lot of manual flow balancing has to occur to get proper flows along with the proper temperatures.
4. One of five mixing valves gives unsteady temperature.
5. Poor (non-existent) process controls and automation.

IMPROVEMENT ALTERNATIVES:

7a. Coldwater Supply Piping

The coldwater supply piping does not need improvement.

7b. Water Heating System

The three L.E.S. boilers have between 15-18 years of life expectancy remaining with proper maintenance. One option to reduce utility costs would be to convert the three existing oil fired boilers to natural gas burners. Another option is to replace the oil-fired boilers that are 83% efficient with newer, higher efficiency gas fired boilers; but, that would waste the remaining life of the oil-fired boilers.

Natural gas service would have to be brought to the site if the boilers are converted. Natural gas is not far away and the City of Duluth will extend it, when their labor force and equipment is available, wherever half of the potential users along the way agree to purchase the gas and finding agreeable purchasers is usually not a problem. The City does not charge for installation.

The Federal wood pellet burning boiler has about 5 years of useful operation remaining. It could be replaced with a higher efficiency wood fired boiler and controls with better fuel and ash storage and transfer systems to reduce maintenance. The new boiler could have a duel fuel capability to use wood or natural gas, depending on unit pricing between the two fuels. However, it would be less efficient than a boiler designed specifically for gas, cost more and require more space. If a new wood boiler is installed, the oil-fired boilers must remain in service for use when the wood boiler is off for maintenance.

Aspirators and motor aerators in the heated water tank could be replaced with more efficient media packed aeration columns or sealed oxygenation columns with perforated plates and an oxygen feed.

It has been estimated that the cost of process heating with natural gas in the existing L.E.S. brand boilers will be the same as heating with wood pellets when the cost of ash storage, ash hauling and ash testing are included. Boiler maintenance would be dramatically reduced. The wood boilers have been frequently shut off for maintenance and oil is burned in the L.E.S boilers then. Cost associated with that intermittent oil demand would be reduced 50% if natural gas was used instead. Natural gas would also be more economical than the propane being used to heat the residence and other buildings; although, study of that is not part of this report.

7c. Mixing Manifold

The motorized valves of the mixing manifolds would not have to modulate as frequently or at as great a range as they do now if the water levels of the reservoir and heated water tank fluctuated less. One way to reduce water level fluctuations would be to pump to overflow conditions; but, that would waste water, pumping horsepower and heat. On-Off float valves in the reservoir could be moved closer together; but, that would increase pumping cycles. A modulating float controlled valve could be added to the heated water tank to throttle the pumped, heated water; but, that would not take advantage of that pump's variable speed drive. The variable speed drive of the heated water pump could be automated to maintain a constant level in the heated water tank based on feedback from a continuous level sensor added to the tank. This would allow water to be delivered to the hot well at a constant temperature and pump only as much water as the system demands to maintain a constant level in the hot well. In conjunction, variable speed drives could be added to the lake pumps so that they too could maintain a constant level in the reservoir based on a continuous level sensor added there (see **Component 2 – Pump Station** recommendation).

The one mixing valve set that is giving erratic output temperature could be replaced or troubleshooted to determine if there is only a valve part or motor part that needs replaced or if there is a programming problem in the controls.

Continuous dissolved oxygen monitoring should be considered for the hot well. Because of the aeration that takes place in the hot well, dissolved oxygen levels as well as water temperatures could be monitored and alarmed from the Hatchery's SCADA system.

RECOMMENDATION:

MNDNR should work with the City of Duluth to get natural gas extended to the site and convert the oil fired boilers to gas fired boilers. Remove wood boiler and wood/ash storage elements. Automatic level control should be added to the heated water system similar to that already recommended at the Upper Reservoir.

The heated water tank aspirators and motors aerators should be replaced with sealed oxygenation columns with an oxygen feed. DO and temperature monitoring and alarming should be provided in the hot well.

The one mixing valve set giving erratic temperature should be evaluated by someone with experience troubleshooting industrial mixing valves and their control programs.

Benefits:

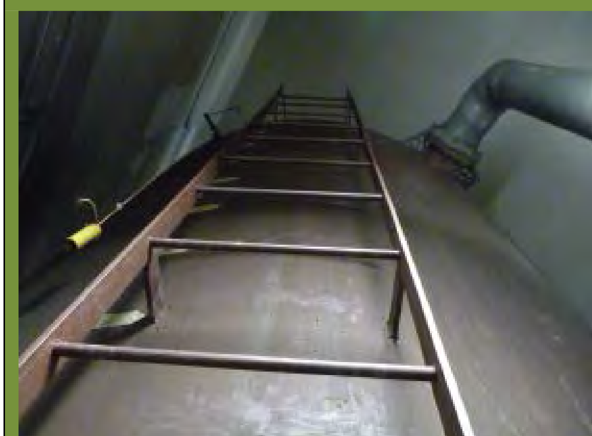
- Slightly lower process water heating costs due to the cost of natural gas versus oil that has been used when wood boilers were frequently off for maintenance.
- Less boiler maintenance.
- Less maintenance associated with frequent manual balancing of flow to the heated water tank.
- Longer life for motorized mixing valves due to less frequent and less severe modulation.
- All five sets of mixing valves will function properly.

Alternative	Recommendation
7a. Coldwater Supply	NA
7b. Water Heating System	
Convert Oil Boilers to Gas	Yes
Replace Wood Boiler	No
7c. Mixing Valves	
Install O2 Columns	Yes
Install Auto Level Controls	Yes
Install DO Monitoring	Yes

PHOTOS:


FEDERAL BOILER COMPANY, INC.
FAIRFIELD, NEW JERSEY 07006
MODEL
NAT'L BD. NO.
MFG. BY
FEDERAL
SERIAL NO.
HEATING SURFACE
STEAM SQ FT
INPUT
NET MBH
GROSS
DATE
MAXIMUM WORKING PRESSURE
LBS.STEAM
LBS. WATER


COLD WATER



COMPONENT NAME:

8. INCUBATION

GENERAL DESCRIPTION:

There are twenty–one (21) Heath vertical flow 16-tray egg incubators in the Nursery Area of the Main Building located along the south wall. Their condition is reported as fair and they appear to be the original 1975 equipment. The incubation system is supplied by heated and cold water supply piping to each incubator that is obtained from the incubation water mixing manifold (**Component 7c**) located in the mechanical room. The incubation water temperature mixing system is monitored and controlled by the SCADA system. This SCADA control replaced the original manual valve adjustment that was very difficult to control. Temperature control of incubation allows for adjustment of egg development and hatching and is an essential component of FRH production program that provides a method to deal with the extended spawning of the Knife River captive steelhead (6 months) and the timing of hatching to meet stocking schedules.

The egg incubation trays are provided with formalin fungus control chemical metering by a series of metering pumps that provide automation of chemical delivery. Flow to the incubation trays is typically 5 to 7 gpm.

In addition to the vertical flow incubators, there are four (4) fiberglass troughs located along the south wall that are used to prepare eggs for placement into incubation system. Under the reduced production program at FRCWH, 6 to 7 incubators are currently used. Substantially more incubators were required and utilized when 500,000 Chinook salmon were a part of the FRH production.

MANUFACTURER/SIZE INFORMATION:

Heath Techna: No longer manufacturing incubators or troughs.

Marisource: Parts and replacement incubators available (1-877-735-8910, www.marisource.com)

YEAR OF CONSTRUCTION:

1974

ASSESSMENT:

Mechanical:

The fish production egg incubators and troughs are old but remain useful for rearing purposes. Replacement is not required.

Electrical:

Not Applicable.

USEFUL LIFE ASSESSMENT:

Discipline	Remaining Life of Components	Condition
Mechanical	25	Good
Electrical	NA	NA

DEFICIENCIES:

1. None noted.

IMPROVEMENT ALTERNATIVES:

Incubators and troughs were inspected and are in operating condition. Parts are available from the manufacturer. Replacement, if needed, is simple and can be done by MNDNR hatchery staff. No additional design or specialized construction is needed unless the configuration needs to be changed.

RECOMMENDATION:

Replacement is not required.

PHOTOS:

COMPONENT NAME:

9. NURSERY TANKS

GENERAL DESCRIPTION:

After hatching, when the fry are at the swim-up stage they are put in fiberglass tanks with treated water and started on feed. Feedings start at eight times daily and are eventually weaned down to four feedings a day. Automatic Sweeny and belt feeders are used. The health status of the fish is observed at all times and treated when necessary according to label instructions of the products being used. Rearing units are drawn down and waste feed and fecal material are swept out daily.

The nursery area is 5,540 ft^2. There are 11 indoor holding troughs used for eggs and fry. Individual units can drain in six minutes. Oxygen is supplied at a rate of 1-6 lpm using micropore diffusers in each tank by Xorbox generators (**Component 21**) that are located in the Burrows Building. There are 54 indoor fiberglass circular rearing tanks. Individual units can drain in three minutes. Low pressure aeration is provided by spray arms or compressed air and micropore.

MANUFACTURER/SIZE INFORMATION:

Indoor Holding Tanks					
Number	Dimensions (LxWxD)	Avg. Operating Depth (in.)	Condition	Avg. Water Flow Rate (gpm)	Max. Water Flow Rate (gpm)
4 super troughs	17’x25”x24”	10	fair	6	15
4 heath troughs	7.5’x21”x12”	6	fair	5	8
3 grey troughs	7’x16”x6”	4	fair	2.5	6
Indoor Circular Rearing Tank					
Number	Diameter (ft.)	Avg. Operating Depth (ft.)	Condition	Avg. Flow Rate per unit (gpm)	Max. Flow Rate per unit (gpm)
10 Red Group	5.96	3.15	poor	3	12
20 Yellow Group	5.96	3.15	poor	3	12
24 Blue Group	5.96	3.15	poor	3	12

YEAR OF CONSTRUCTION:

1974

ASSESSMENT:

Mechanical:

The 6ft. diameter tanks are in poor shape and need to be replaced. The hatchery staff have been doing spot repairs for many years.

Electrical:

Not Applicable.

USEFUL LIFE ASSESSMENT:

Discipline	Remaining Life of Components	Condition
Mechanical	5	Poor
Electrical	NA	NA

DEFICIENCIES:

1. The 6ft. diameter fiberglass tanks are at the end of their service life.

IMPROVEMENT ALTERNATIVES:

Fiberglass repairs have been completed by MNDNR staff for many years requiring time and out-of-service impacts. One option would be for a tank manufacturer to renovate the existing tanks. However, renovation will not last another 25 years so replacement is recommended. A tank should be sent to the selected manufacturer as a template for the outlet and screen sump sizing and locating. For cost projections, the following manufacturer was contacted: Reiff Manufacturing, Walla Walla, WA, 800-835-1081, www.REIFFMAN.com

RECOMMENDATION:

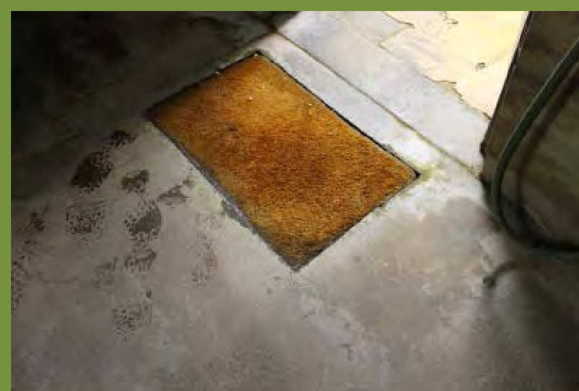
Tank replacement is recommended.

Benefits:

- New tanks will provide low/no maintenance rearing units.

Alternative	Recommendation
Renovate Tanks	No
Replace Tanks	Yes

PHOTOS:



COMPONENT NAME:

10. BIOFILTER SYSTEM

GENERAL DESCRIPTION:

The Burrows recirculation system is equipped with six 20-ft. diameter x 7-ft. deep steel sided, concrete cone-bottom biofilters. The upwelling biofilters promote settling of solids. They are also intended to nitrify ammonia with bacteria growing on a 24" thick layer of media (648 cu.ft.) contained between perforated corrugated aluminum plates. The original media was polystyrene floating bead media that was replaced with plastic Pall rings.

The biofilters are equipped with a rotary backwash spray arm under the media that is used to wash the media using a power backwash system supplied by pumps nameplated 330 gpm that use clear well water. Biofilters are typically cleaned and backwashed two times per week. Cleaning backwash is processed by the clarifier.

The biofilters are original custom fabricated and constructed units provided in the original 1974/1975 construction. Their condition is reported to be fair. Coated mild steel components such as the intermittently submerged supports for the media retention plates have dozens of small spots of rust on their horizontal surfaces and there is galvanic corrosion where stainless steel fasteners are attached. The coating on the mild steel components and insides of the tank walls appear as an original factory powder coating according to a coating specialist that HDR consulted. The coating is far less apparent on the outsides of the steel tank walls. Staff reports that maintenance of the backwashing system and media suspension components is required and this work involves taking a filter out of service and dewatering so access can be provided.

Removal of suspended solids from reuse water in aquaculture systems is prudent and common. Some reuse systems need ammonia removal and some do not because they have ample makeup water. The amount of solids removal and ammonia oxidation is unknown.

MANUFACTURER/SIZE INFORMATION:

20' dia. x 7' deep, 6 units

YEAR OF CONSTRUCTION:

1974

ASSESSMENT:

Mechanical:

The condition of the biofilters is fair. Galvanic and other corrosion needs to be addressed. The amount of solids removal and ammonia nitrification is not known.

Electrical:

NA

USEFUL LIFE ASSESSMENT:

Discipline	Remaining Life of Components	Condition
Mechanical	25 – Plumbing 10 – Structural	Good Fair
Electrical	NA	NA

DEFICIENCIES:

1. Galvanic and other corrosion threatens the life of the media retention screen support.
2. Biofilter tank wall exterior appears corroded.
3. The large surface area of the biofilters promotes loss of heat from the water that might otherwise be recovered.
4. Backwash water rate is relatively high and has to be accounted for at lake pumps and clarifier.
5. Biofilter maintenance is relatively high.

IMPROVEMENT ALTERNATIVES:

Replace Biofilters in Kind

The biofilters could be replaced in kind and their walls could be insulated; but, maintenance and backwash would remain high and the water surface would still lose a lot of heat. Media could also be replaced with a type with a moderately higher surface area to volume ratio such as Kaldnes K-3 which would give more area for beneficial nitrifying bacteria growth. However, modern equipment is available that takes less floor space and will lose less heat so in-kind replacement isn't recommended.

Refurbish Existing Biofilters

Blast and recoat the exterior of the biofilter tank walls and spot prepare and spot recoat the mild steel supporting the media retention screens. A coating specialist that HDR consulted who was shown many recent photographs advised that since the existing coating inside the biofilters has lasted 39 years it was a very good factory coating for the application and removal of all of it and recoating in the field would probably not last 25 years. That is why only spot treatment inside would be recommended.

Refurbishment would involve taking the units out of service, removing all media and retention screens and putting it all back again after the blasting, spot preparations and recoating and spot recoating were done. The coating would be a 2 mil thick reinforced epoxy based system. There is approximately 1,900 square feet of external tank surface and 1,900 square feet of internal. During this work, all mild steel components would be cleaned and inspected. Media retention screen fasteners would have plastic sleeves and plastic washers added to deter galvanic corrosion. The exterior of the biofilter tank walls could be insulated to deter heat loss; although, most of the heat loss occurs at the water surface. Media could also be replaced with a type with a moderately higher surface area to volume ratio such as Kaldnes K-3 which would give more area for beneficial nitrifying bacteria growth

Replace Biofilters with Drumfilters and Moving Bed Bioreactor

Another option is to replace the biofilters with modern aquatic recirculation components such as drumfilters and moving bed bioreactors (MBBR). Solids would be removed continuously and automatically using a backwash rate in the order of magnitude of 50 gpm instead of the 330 gpm that the existing biofilters are rated. After solids removal, water would be treated in a moving bed biofilter using air-mixed polyethylene media which provides the substrate for the ammonia nitrification bacteria much like the existing biofilter; but, the moving media would develop a stable film of bacteria that would not have to be backwashed and it would have a much higher surface area to volume ratio. The drumfilters and MBBRs are considerably smaller in foot print than the present biofilters; so, heat loss would be diminished so that more heat would be available to the broodstock downstream and more heat would be available to recover.

Improved recirculated water treatment performance and less maintenance time are potential benefits. Additional water quality monitoring for ammonia nitrogen and suspended solids data needs to be obtained to optimally size this equipment and refine its cost.

RECOMMENDATION:

Replacement of the biofilters with drumfilters and MBBR (probably two of each) is advised.

Benefits:

- Continuous solids removal
- Reduced backwash water rate which means a lower pumped lake water rate is needed and clarifier performance will improve or the clarifier could be replaced with a smaller clarifier.
- Reduced heat loss.
- Ammonia nitrification will be improved.

Alternative	Recommendation
Replace Biofilters In-Kind	No
Renovate Biofilters	No
Replace w/ Drumfilter and MBBR	Yes

PHOTOS:




COMPONENT NAME:

11. CLEARWELL SYSTEM

GENERAL DESCRIPTION:

Two 375 square feet clearwells are located in the Burrows Building and used to hold filtered return water from the biofilters. Cold makeup water and heated makeup water is provided to the clear well through float controlled valves. The condition of the clearwells is reported as good. Water needed for the

Burrows operation is pumped from the clearwells to an aerated headtank that supplies the Burrows. Water that is not pumped to the Burrows headtank overflows to the Raceways (see **Component 15**).

MANUFACTURER/SIZE INFORMATION:

NA

YEAR OF CONSTRUCTION:

1974

ASSESSMENT:

Mechanical:

The clearwell system is meeting the functions required and is in good condition. Concrete inspection of the entire clearwell basin was not completed during the inspection (units were in service) but are believed to be in good condition.

Electrical:

Electrical components include the level alarm float switches and the float controls for the makeup water supply valves. Electrical components appear to be in good condition.

USEFUL LIFE ASSESSMENT:

Discipline	Remaining Life of Components	Condition
Mechanical	25	Good
Electrical	10	Good

Note: Some electrical components typically require replacement every 10-15 years but are not included in the capital improvements plan

DEFICIENCIES:

1. The float control valves have to be overridden to keep from over-demanding the water supply which negatively affects the water temperatures upstream.

IMPROVEMENT ALTERNATIVES:

Control of the make-up water valves to the clearwells should be added to the SCADA system.

RECOMMENDATION:

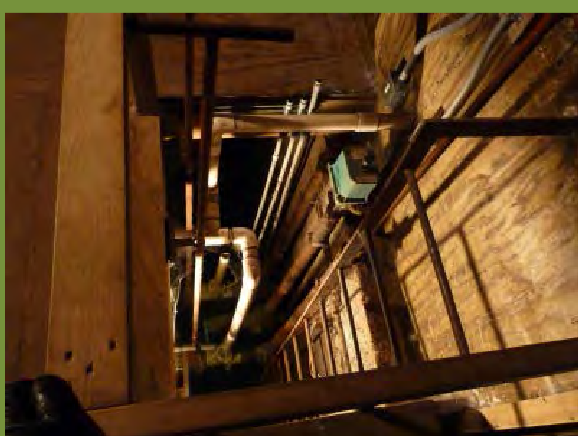
Add controls to the clearwells.

Benefits:

- Flow control and energy costs will be reduced.

Alternative	Recommendation
Add Controls	Yes

PHOTOS:



COMPONENT NAME:

12. RECIRCULATION PUMPS

GENERAL DESCRIPTION:

Nursery effluent in the range of 280 to 600 gpm flows by gravity through a splitter box in the Burrows Building to the biofilters. This flow is the primary makeup water for the Burrows recirculation system. Treatment for the recirculation system consists of biofiltration and dissolved gas management. Burrows effluent flows by gravity to the biofilters (**Component 10**). The makeup water plus Burrows effluent is combined in two clear wells (**Component 11**) and then pumped to an aspirated headtank (**Component 13**) which flows back to the Burrows. The total pumped recirculation flow rate is reported as 2,400 gpm. The recirculated water is used for the Burrows and the overflow supplies the Raceways.

There are seven close coupled pumps and one was originally intended as backup. Nameplates list 580 gpm at 65’ TDH, 15 hp, Carver Pump Co., Model 4x5x11H-31D15, 1750 rpm. One has Serial number 93576. Curves for that pump and the one Carver manufactures today that is 4x5x11 and 1750 rpm both indicate 75% efficiency at 580 gpm which is good for end suction, base-mounted pumps. Realistically, the pumps are piped in parallel to two mains that supply two parts of the headtank and with shared mains and all six primary pumps running, they will give about 400 gpm each where they are only 70% efficient. Six pump motors were replaced with 87.5% efficient motors in 2005. “New bearings 1/12” is handwritten on the motors of three pumps and “new bearings 3/25/10” on another. Handwriting on one pump says “installed 11/04, new bearings 1/4/08.”

MANUFACTURER/SIZE INFORMATION:

Carver Pump Co, Model 4x5x11H-31D15, 1750 rpm, 580 gpm at 65’ TDH

YEAR OF CONSTRUCTION:

Pumps 1974

New Pump Motors 2004-2005

ASSESSMENT:

Mechanical :

The horizontal end-suction reuse pumps have good efficiency at nameplate flow rate. The pumps appear to be in fair condition. New pumps of the same type offer little improvement except that 93% efficient motors are now available.

Electrical:

The motor starters for the recirculation pumps are installed in a General Electric Motor Control Center located in the main electric room at the Burrows Pond Building. The pump motors have power factor correction capacitors also located in the electric room. This switchgear is at the end of its useful life and should be considered for replacement.

The recirculation pumps are run to meet the circulation flow requirements of the Burrows. In order for the system to work properly, the pumps are manually started as required to maintain at least a couple feet of head over the aeration tower drain. This method of control is not only labor intensive, but wastes a considerable amount of energy.

USEFUL LIFE ASSESSMENT:

Discipline	Remaining Life of Components	Condition
Mechanical	10	Fair
Electrical	2	Poor

DEFICIENCIES:

1. The pumps are inefficient when two or more are running.
2. The pump motors are not premium efficiency.
3. Electrical Switchgear is near end of life
4. Instrumentation is lacking (e.g., flow, D.O., temp.)
5. Motor control center is obsolete.

IMPROVEMENT ALTERNATIVES:

The pump motors could be replaced with premium efficiency motors; but, this would not extend the actual pump life or gain the efficiency of adding speed control or changing to a more efficient type of pump.

The pumps in their entirety could be replaced in kind including upgrading their motors to premium efficiency; but, this would not gain the efficiency of adding speed control or changing to a more efficient type of pump.

Variable speed drives could be added to the pumps so that they maintain pumping nameplate efficiency at flow rates other than nameplate; but, this would not gain the efficiency of changing to a more efficient type of pump.

The seven horizontal reuse pumps installed aside the clear wells could be replaced with four vertical line-shaft turbine pumps, like the lake pumps, suspended over the clear wells and equipped with premium efficiency motors and variable frequency drives. Line-shaft turbine pumps could probably be found over 80% efficient. Pump efficiency would then be about 83% at all speeds and flows and motor efficiency would be about 93%. When three existing pumps are running to deliver 1200 gpm to half the headtank, they probably demand power equivalent to 37 hp. One new line-shaft turbine pump with premium efficiency motor could deliver 1200 gpm and demand only 29.5 hp.

The main switchgear should be considered for replacement due to its age and overall condition. Part of this gear includes the motor controls. With new switchgear, the material cost for a full voltage starter is not significantly different than a variable frequency drive. Implementing VFD's for the recirculation pumps would not only improve the process controls but also has the potential to save significant amounts of energy. The power factor correction capacitors should be removed if VFD's are used. The pumps should be controlled to only supply as much water as the system demands by maintaining a constant water level over the aeration tower drain. These controls would be tied into the existing SCADA system. This recommendation has been covered with **Component 14** improvement recommendations.

RECOMMENDATION:

It is advised that the seven horizontal reuse pumps aside the clear wells be replaced with four vertical line-shaft turbine pumps (equipped with premium efficiency motors and variable speed drives) atop the clear wells. To save energy and improve control, variable frequency drives (VFD) are recommended for the recirculation pumps.

Benefits:

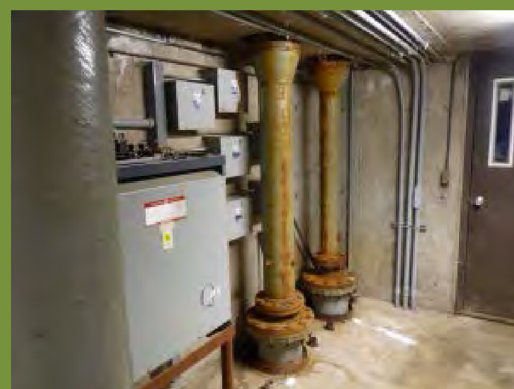
- Lower energy costs
- Fewer seals/bearings to maintain.

Alternative	Recommendation
Renovate Pumps	No
Replace Pumps In-Kind	No
Replace Pumps	Yes

PHOTOS:


MARATHON ELECTRIC
WAUSAU, WI 54401
CAT NO-M121
MODEL-8VH 254TTDX7042AB L
FR-254JP
PH-3
TYPE-TDR
AMB-40° C
INS-B
DUTY-CONT.
DES-B
HZ-60
HP-15
RPM-1745
VOLT-208-230/460
FLA-43-39.2/19.6
SF-1.15
SFA-
CODE-G
FLEF 87.5
FLPF 81.3
LOW VOLTAGE
HIGH VOLTAGE
1.0 S.F. AT 208 VOLTS
PE BRG-309
OPE BRG-207
ENC.- DP
WARNING FAILURE TO FOLLOW ALL SAFETY INFORMATION CAN RESULT IN SERIOUS PERSONAL INJURY OR DEATH. DISCONNECT ALL POWER BEFORE SERVICING. INSTALL AND GROUND PER LOCAL AND NATIONAL CODES. CONSULT QUALIFIED PERSONNEL WITH ANY QUESTIONS.
MADE IN USA


GENERAL ELECTRIC



COMPONENT NAME:

13. RECIRCULATION HEADTANK

GENERAL DESCRIPTION:

A concrete headtank with roof and walls supplies water to the Burrows. Its influent pipe is manifolded to aspirators (which are occasionally cleaned) and oxygen is diffused through micropore tubing into its effluent pipes. The headtank is dual chambered. There is a layer of oyster shells on its floor for alkalinity adjustment. It has effluent weirs and overflow standpipes. It is accessed by way of permanent ladder and catwalk. Water is pumped from clear wells (**Component 11**) to the headtank by base-mounted, end suction centrifugal pumps (**Component 12**). Flows through the headtank are manually balanced so that its floor outlet pipe stays flooded so that it does not draw nitrogen from the atmosphere and so that water does not go out the overflow standpipe.

MANUFACTURER/SIZE INFORMATION:

NA

YEAR OF CONSTRUCTION:

1974

ASSESSMENT:

Mechanical:

The roof, walls, catwalk and concrete tank appear to be in good condition. If the oyster shells have not been changed since 1974, they probably have little effect on alkalinity today, but alkalinity adjustment might not be needed. There are more efficient ways to oxygenate and degas than by pumping through aspirators (spray nozzles). The headtank provides the required function for the recirculation system.

Electrical:

Not Applicable

USEFUL LIFE ASSESSMENT:

Discipline	Remaining Life of Components	Condition
Mechanical	25	Good
Electrical	NA	NA

DEFICIENCIES:

1. Inefficient oxygenation.
2. Level control requires a lot of manual balancing. Dissolved oxygen levels are not continuously or automatically monitored or alarmed.

IMPROVEMENT ALTERNATIVES:

The aspirators could be replaced with open topped packed aeration columns; although, they would not raise the dissolved oxygen levels as high as could be with sealed columns.

Sealed oxygenation columns might oxygenate and degas the water more efficiently and with less water pressure requirement than the combination of aspirators and oxygen diffusion in use now.

Automatic level controls could be added. This is addressed in **Component 12 - Recirculation Pumps**.

Dissolved oxygen meters could be added with output to the existing SCADA system for alarming.

RECOMMENDATION:

Replacing the aspirators and diffused oxygenation with sealed oxygen columns is advised to increase oxygen absorption and reduce pumping head. Adding dissolved oxygen monitoring is also recommended. The headtank chambers should include level alarms and level controls.

Benefits:

- Reduced pumping energy due to lowering head requirements
- Higher levels of dissolved oxygen
- Monitoring and alarming of gas dissolved oxygen levels.

Alternative	Recommendation
Install Aeration Columns	No
Install Oxygen Columns	Yes
Headtank Alarm & Monitoring	Yes

PHOTOS:

COMPONENT NAME:

14. BURROWS PONDS

GENERAL DESCRIPTION:

The six (6) Burrows Ponds provide a rearing volume of 14,544 cubic feet and are operated at a recirculated flow of 400 per unit or 2,400 gpm total. Recirculated treated water is required to meet these water demands. These units provide the majority of the grow-out rearing space in the hatchery. Kamloop rainbow trout are generally feeding on the demand feeders and can consume up to 100 pounds of feed per unit per day.

Each pond is 50 feet long, 17 feet wide and 4 feet deep with an operating depth of 3 feet. The Burrows are essentially two paired (50 ft. x 8ft. x 3 ft. water depth) raceways equipped with open end mid-wall section and special flow baffling features to allow them to operate as a circulating rearing unit rather than a traditional plug-flow linear raceway. The average and maximum flow rate is 400 gpm. Individual units can drain in 35 minutes.

Source water to the Burrows is reuse water from the Nursery (**Component 9**) or treated water from the Upper Reservoir (**Component 6**). Piping for these two sources is independent. As water comes in from the Nursery it displaces water from the clearwell system (**Component 11**), which flows to the Raceways (**Component 15**). All water operating the Burrows system is pumped by the recirculation pumps (**Component 12**) and aerated in the recirculation headtanks (**Component 13**). Oxygen is used to supplement the dissolved oxygen levels in the headtanks when air-based aeration is not sufficient. Oxygen is provided by Xorbox generators (**Component 21**).

There is no high-pressure non-chlorinated service water available for rinsing tanks and fish screens but there is non-chlorinated water to fill fish transport trucks. Fish in these units are fed by 12 Sweeny feeders. The units are cleaned by hand when needed. Needed repairs and modifications reported concrete repair and resurfacing.

MANUFACTURER/SIZE INFORMATION:

6 Units at 50’x17’x4’

YEAR OF CONSTRUCTION:

1974

ASSESSMENT:

Mechanical:

The Burrows are meeting the fish production needs for the hatchery. Some concrete spalling and erosion has occurred over time.

Electrical:

The existing power distribution equipment in the Burrows Pond Building is from the original construction. Power enters the building underground to a Motor Control Center located in the electric room under the Aeration Tower. The original motor control center is GE, even though still functional, is considered beyond it’s useful life and should be replaced. There are seven, 15 HP recycle pumps and two 10 HP backwash pumps controlled out of the GE motor control center. To improve power factor, capacitors have been installed in the electric room.

USEFUL LIFE ASSESSMENT:

Discipline	Remaining Life of Components	Condition
Mechanical	25	Good
Electrical	5	Poor

DEFICIENCIES:

1. Concrete spalling and erosion has occurred in some of the ponds.
2. Certain electrical components have reached the end of their useful life.

IMPROVEMENT ALTERNATIVES:

Burrows Ponds

Chemical and physical erosion (e.g., soft water flowing continuously over concrete) has caused some of the Burrows to deteriorate. As the concrete within the ponds has etched away, the underlying aggregate has become exposed making the rearing units difficult to clean and causing fin erosion to the fish. To improve the eroded concrete surfaces within the Burrows, options include concrete repair followed by the addition of an interior surface protectant (epoxy, polyester or polyurea).

First, minor concrete repairs can be addressed by concrete resurfacing and minimal patching. The protective coating options to provide a long-term smooth coating to prevent fin erosion and provide concrete protection include a high-bond epoxy, polyester or polyurea coating or a high-build (>50 mil) multi-layer plastic coating system that can be applied to the interior surface. Prior to resurfacing the concrete, preparation is required (e.g., high-pressure water washing or sand/shot blasting). For this report, costs include the high-build coating systems and surface preparation.

Another option is to replace the Burrows with similar new rearing units or modern circular units. However, the costs for complete replacement is not warranted since hatchery staff are satisfied with the current operation and renovation will extend their use.

Electrical Improvements

Electrical improvements includes a new motor control center replacing the GE switchgear. The new equipment would include variable frequency drives for each of the recycle pumps. The power factor correction capacitors would be removed. The existing step down, 45 KVA transformer could be reused, but panel "LB" would be replaced.

The recycle pumps are currently manually controlled. The Hatchery staff determines how much water should be recycled to the aeration tower and turns on as many pumps as needed to support the Burrows operation. The new electrical systems would be designed to automate this process. Level sensors would be placed in the aeration tower and the two reservoirs. The recycle pumps could be controlled by the

VFDs to supply enough water to support the process. The PLC would control the level in the aeration tower as well as maintain a constant level in the reservoirs by controlling the fresh water make-up supply.

Lighting

Even though lighting may not be considered directly related to fish production, it is an energy conservation measure that is fairly easy to implement and would have some impact on the energy and maintenance costs. The Burrows Building is predominantly lit with incandescent lighting. There are currently approximately 41 incandescent fixtures in the Burrows tank room and another 22 incandescent fixtures in the Biofilter Room. The lamps used in these fixtures are 250-watt with a light output of 4170 lumens and a rated life of 1950 hours.

An improvement recommendation would be to remove the existing incandescent lighting and replace with damp location LED light fixtures. The proposed fixtures are rated 92% lumen maintenance at 60,000 hours with a rated life of over 100,000 hours. Replacing the incandescent lighting would reduce the electrical load by over 13 kW, and increase the light level by approximately 15%. Under the electric rate structure the Hatchery is billed, Minnesota power charges $5.86 per kW per month for demand charges, in addition to the actual energy used. This means a reduction of over $900 per year in demand charges in addition to the energy savings. Assuming a very conservative 1500 hours of operation per year, the energy saving would be $1,600 per year for the Burrows Building. In addition, lamp replacement would no longer be required.

RECOMMENDATION:

It is recommended to renovate the Burrows by shot blast cleaning, repairing spalled concrete and installing an interior polyester coating. In addition, it is recommended to replace the existing motor control center due to age. For overall energy savings, lighting can be changed in the building from incandescent to LED.

This recommendation will address the following:

- Concrete repair and coating will extend useful life to 25 years.
- Smoother concrete surface will reduce fin erosion.
- Electrical components will last 25 years.
- Energy savings will be realized with the new lighting system

Alternative	Recommendation
Renovate Burrows Ponds	Yes
Replace Burrows Ponds	No
Replace Electrical Switchgear	Yes
Replace Lighting	Yes

PHOTOS:




COMPONENT NAME:

15. RACEWAYS

GENERAL DESCRIPTION:

There are five concrete raceways used for maintaining steelhead captive broodstock in the Pole Building reported to be in fair condition. They are 60 feet long, 6 feet wide and 4 feet deep with an operating depth of 3 feet. The average and maximum flow rates are 350 (60 each) gpm and 500 (100 each) gpm, respectively. Individual units can drain in 10- 25 minutes. Source water is overflow from the Burrows (**Component 14**) or treated water from the Upper Reservoir (**Component 9**). Piping for these two sources is independent. A pump sump connected to the raceway outflow contains an emergency backup pump system that can recirculate water back to the hatchery. Emergency operational water can be pumped back through the main water treatment system to the main reservoir and fed back to the Nursery but this can only be maintained for a short amount of time. It is controlled by a variable frequency drive so it can be adjusted for the water available. It was used in February 2011 when the intake was frozen and 300 gpm was circulated until the intake was fixed hours later.

Aeration of the broodstock raceway water is provided by spray bars on inlets. Oxygen gas is also provided by the Xorbox oxygen generation system (**Component 21**) to diffusers. There is no high-pressure non-chlorinated service water available for rinsing tanks and fish screens but there is non-chlorinated water to fill fish transport trucks. Broodstock in these units are fed by ten belt feeders. The rearing units are cleaned by hand when needed, usually daily. They are completely washed annually during the spawning season.

MANUFACTURER/SIZE INFORMATION:

NA

YEAR OF CONSTRUCTION:

1974

ASSESSMENT:

Mechanical:

The raceways appear adequate for broodstock holding and spawning purposes. Concrete is the original 1974/75 construction and appears to be in better condition than the Burrows units. There is no concrete floor in the area used for spawning or egg preparation/disinfection. A floor would improve biosecurity. Portable plastic enclosures and portable heating is used. Water used in the Raceways is routed to a sump located on the south side of the pole building. From this sump, water can gravity flow to the clarifier or be pumped back to the upper water supply treatment system. This reuse capability is an important feature for emergency operation if the main lake water supply should fail. The pump is manually operated and the pumping rate can be adjusted by changing the speed of the pump motor.

Electrical:

The emergency recycle pump has recently been fitted with a variable frequency drive. The pump and pump speed is manually controlled.

The lighting in the Raceway Building is incandescent. Incandescent lamps are very energy inefficient, have a short life, and are in the process of being phased out of production. Because of the location of the fixtures over the raceways, lamp replacement is difficult. Replacement of the lighting should be considered.

USEFUL LIFE ASSESSMENT:

Discipline	Remaining Life of Components	Condition
Mechanical	25	Good
Electrical	10	Good

DEFICIENCIES:

1. Concrete is original construction from 1974/75.

2. There is no concrete floor in the spawning area (poor biosecurity).
3. No permanent heat system for spawning operations in the winter.
4. Lighting is outdated, energy inefficient and difficult to maintain

IMPROVEMENT ALTERNATIVES:

The surface of the rearing units could be resurfaced to improve cleaning and extend concrete life. See discussion for the Burrows (**Component 14**) for coating further resurfacing discussion. However, the condition of the raceways appears to be fine at this time so this might be considered in the future instead. A concrete floor should be added in the spawning location to improve biosecurity. The addition of an infrared heating system above the spawning area would provide staff comfort during winter spawning activities.

The emergency recycle pump located in the sump on the south side of building should be upgraded with new controls and alarming connected to the Hatchery SCADA system.

Replace the incandescent lighting in the Raceway building with dimmable LED lighting. LED lighting is well suited for this application because it is energy efficient, requires almost no maintenance, is instant on, dimmable, suitable for cold and wet locations, and has no UV component.

RECOMMENDATION:

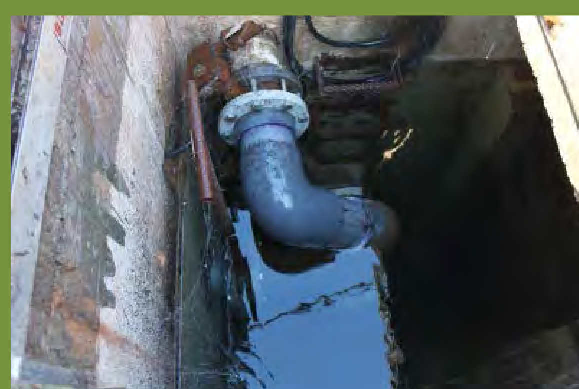
Add a concrete floor to the raceway building and heat for the spawning space. Upgrade the control and alarming for the emergency recycle pump. Replace the lighting with dimmable LED lighting.

Benefits:

- Biosecurity will be increased by adding the concrete floor which is easier to disinfect compared to the current gravel floor.
- Spawning conditions during winter will be more tolerable with infrared heat.
- The emergency recycle pump will be control with the SCADA system.
- Lighting energy costs will decrease.

Alternative	Recommendation
Resurface Raceways	No
Add Concrete Floor	Yes
Add Infrared Heat	Optional
Renovate Emergency Pump Electrical and Controls	Yes
Replace Lighting	Yes

PHOTOS:



COMPONENT NAME:

16. EFFLUENT TREATMENT

GENERAL DESCRIPTION:

The facility is currently operating under a National Permit Discharge Elimination System (NPDES)/ State Disposal System (SDS) permit (MN 0004413). The permit was issued by the Minnesota Pollution Control Agency on May 23, 2011 and expires on April 30, 2016. There is one surface discharge station (effluent water), two surface water stations (upstream and downstream) and one waste stream station (solids). Excerpts of the NPDES/SDS permit is located in **Appendix E** and summarized below.

Raceway cleaning waste is diverted to the clarifier and then flows into a treatment settling pond. Solids from the recirculating biolfilter system (approximately 330 gpm) as well as wastewater from other units at the facility are routed to the linear clarifier for settling. The NPDES/SDS permit lists the approved chemical additives. The clarified water flows into the settling pond and eventually over the dam boards and through pipe outfall 020 (Station SD001) to the French River at average and maximum rates of 0.72 and 1.52 million gallons per day (500 and 1,055 gpm), respectively, just above the fish trap. The French River flows into Lake Superior. Monitoring requirements are summarized below for SD001.

Parameter	Sample Type	Frequency
Bicarbonates	24-Hour Flow Composite	1 x year
CBOD5	Grab	1 x month
Calcium, Total	24-Hour Flow Composite	1 x year
Chloride, Total	24-Hour Flow Composite	1 x year
Flow	Measurement	2 x month

Parameter	Sample Type	Frequency
Hardness, Calcium and Magnesium	24-Hour Flow Composite	1 x year
Magnesium, Total	24-Hour Flow Composite	1 x year
pH	Grab	1 x month
Phosphorus, Total	Grab	1 x month
Potassium, Total	24-Hour Flow Composite	1 x year
Sodium, Total	24-Hour Flow Composite	1 x year
TDS	24-Hour Flow Composite	1 x year
TSS	Grab	1 x month
Specific Conductance	Measurement	1 x year
Sulfate, Total	24-Hour Flow Composite	1 x year
Water Temperature	Measurement, Instantaneous	2 x month

Solids from the linear clarifier are removed regularly and pumped to the solids storage unit (WS301: Solids to WLSSD Treatment or Compost) at a rate of approximately 116 dry pounds per year (based on amount of feed used). Solids from the storage unit are managed in accordance with the "Transported LiquidWaste" program at Western Lake Superior Sanitary District (WLSSD), are composted at WLSSD, in accordance with their Source Separated Organics Composting Facility Permit (SW-583), or are burned in the facility's on-site wood fired boiler. Transported Liquid Waste is added to the wastewater entering WLSSD, and is treated in the wastewater treatment process, which is a temperature phased anaerobic digestion process. Land application of solids from the permitted facility is not authorized under this permit.

16a Clarifier and Sludge Storage

The clarifier is 32 feet long, 10 feet wide and 9 feet deep. The raceway units are cleaned every other day and drained off to the clarifier. The biofilters are cleaned twice a week and drained to the clarifier. The clarifier has a chain and flight system which moves the settled solids to a sump where they are concentrated and then pumped into a holding vault. Flights have been breaking off. The holding vault is an in-ground reinforced concrete structure which is buried in red Lake Superior clay. The vault is tested once a year using static level over time to detect any leaking. A visual inspection is done late in the year when the vault is pumped out before winter sets in. Rebuilding the clarifier chain and flight was reported as a critical repair need since parts for the original chain and flight system are no longer available. Sludge storage capacity is 20,000 gallons and no treatment occurs on-site. About 14,500 gallons of sludge are disposed of each year. These solids are utilized by Western Lake Superior Sanitary District as a nitrogen source for their food and yard waste composting program.

16b Pond

The settling pond is 19,500 cubic feet and was installed in 1976. It is in fair condition. The effluent settling pond is equipped with a riser pipe and stoplogs that set the pond water surface. Access is provided by a metal grip strut walkway.

MANUFACTURER/SIZE INFORMATION:

NA

YEAR OF CONSTRUCTION:

1974

ASSESSMENT:

Mechanical :

The clarifier flight and chain system is at the end of its useful life. Average and peak flows for this size clarifier should be about 90 gpm and 250 gpm respectively. The clarifier structure appears sound.

Electrical:

There are minimal electrical systems associated with the existing effluent treatment. When the heat recovery (heat pump) systems were added to the hatchery a few years ago, two submersible pumps were installed at the clarifier. These pumps are fairly new and have seen almost no usage (see also **Component 18**). All other electrical components should be considered for replacement.

USEFUL LIFE ASSESSMENT:

	Discipline	Remaining Life of Components	Condition
16a	**Clarifier**		
	Mechanical	25 – Structural 0 – Mechanical	Good Poor
	Electrical	0	Poor
16b	**Pond**		
	Mechanical	25 - Civil	Good
	Electrical	NA	

DEFICIENCIES:

1. The clarifier is undersized.
2. There is no automatic sampling/flow measurement
3. A new chain & flight system is needed for the clarifier.
4. The effluent pond needs to be dredged as part of its annual maintenance.
5. Electrical components have met their useful life.

IMPROVEMENT ALTERNATIVES:

A new chain and flight system could be fitted into the existing rectangular tank; but, the system would still be considerably undersized.

A new chain and flight system could be fitted into the existing rectangular tank and a second rectangular clarifier could be added. Fitting the existing tank with a new chain and flight system and adding a second clarifier with storage basin is recommended. This will make use of the existing tank and cover and result in a second clarifier to increase capacity and be partially redundant when flows are managed properly.

Recommendation cost is based on a second clarifier of same size where peak capacity of pair would be 500 gpm. The Raceways and Biofilter drains are 6" dia. for which 500 gpm is a good rate. Each raceway is cleaned by removing a 6" dia. standpipe which could briefly flow more than 500 gpm. It might be necessary to leave the standpipe tilted in its socket or add a reducing bushing to the socket to avoid an excessive surge at the clarifier(s). The biofilter drains could also surge above 500 gpm. Their existing valves might have to be throttled to avoid excessive surges.

The submersible pump for transferring settled solids from the clarifier to existing storage will need to be replaced to get a reasonable life. The second clarifier will need its own pump. Both pumps should have dual hard shaft seals and air-filled motors to promote long life.

Alternately, one or two larger clarifiers could be installed and the existing clarifier abandoned or removed; but, this would not take advantage of the existing structure.

Continue providing routine solids removal from the pond. This is considered annual maintenance and isn't included in the capital construction projections.

New electrical should be installed.

RECOMMENDATION:

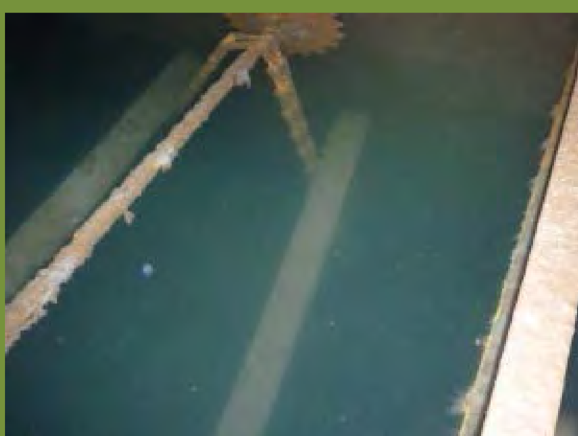
Replace flight and chain system in the existing structure and construct a second similar unit next to the existing structure. Replace the electrical as well.

Benefits:

- Improved capacity/solids removal
- Partial redundancy
- Extended life

Alternative	Recommendation
Renovate Clarifier	No
Renovate Clarifier and Addition of 2nd Clarifier	Yes
Replace Clarifier	No

PHOTOS:



COMPONENT NAME:

17. INSTRUMENTATION SYSTEM

GENERAL DESCRIPTION:

The present supervisory control and data acquisition (SCADA) system was installed in 2008/2009. The panels were built and programmed by Wunderlich-Malec Environmental in Minnetonka, Minnesota.

The system consists of three main control panels. Each of the three panels contains an Allen Bradley Micrologix PLC complete with a processor and I/O cards connected to the process control and monitoring sensors. Each of the three panels is networked via Ethernet. One of the panels is located in the main mechanical room of the Nursery Building. The second control panel is in the Burrows Building electrical room and the third panel is in the mechanical equipment room with the Heat Pump. Even though all three panels are networked with a Cat 5 cable, the panel in the Nursery Building is hardwired to control and monitor the pumps and generator in the lower pump house.

Alarms can be viewed from the interface flat screen panels mounted in the face of each of the three control panels. System alarms and control screens can also be viewed from a PC work station located in the main hatchery building. The system is tied to Sensaphone Auto Dialer for remote alarm annunciation. Each of the three panels contains a UPS power supply so the SCADA system will continue to operate and alarm through a utility power outage.

The system primarily monitors and alarms critical pumps and aquaculture systems at the hatchery such as emergency generators and process water boilers. It also monitors the level in the heated water clearwell and the east and west reservoirs. In addition to monitoring critical systems, the panels also do some process controls. The main controls include stopping and starting the lake water intake pumps to maintain the water level in the main reservoir. The SCADA system is programmed to modulate the temperature control valves for the incubation troughs and nursery tanks.

Alarms are transmitted off-site via the dialer to pagers. The system is in very good condition.

MANUFACTURER/SIZE INFORMATION:

Allen Bradley PLC and HMI; Panels built by Wunderlich-Malic

YEAR OF CONSTRUCTION:

2008/2009

ASSESSMENT:

Mechanical :

NA

Electrical:

Instrumentation system is in very good condition.

USEFUL LIFE ASSESSMENT:

Discipline	Remaining Life of Components	Condition
Mechanical	NA	NA
Electrical	15	Very Good

DEFICIENCIES:

1. Certain components are not controlled by the SCADA system - Lake Pump, Hot Well or Recirculation Pumps.

IMPROVEMENT ALTERNATIVES:

The existing SCADA system is fairly new and in excellent condition. Many of the hatchery improvements recommended and discussed elsewhere in this report include additional automation and alarming functions. These additional control improvements would be accomplished using the Hatchery's existing SCADA system, and the cost of these improvements are included with that particular line item. For example, the cost of extending a new fiber optic network to the lower pump house is included in the Pump House improvement costs. This section is limited to recommended improvements to the system not included in specific component recommendations.

The existing SCADA system utilizes an Allen Bradley Micrologix 1500 PLC. This is an industrial quality controller which should provide reliable service for many years to come. At the time the system was installed, the Micrologix 1500 was a good choice for this application. In order to reduce operating and maintenance cost, expansion of the existing hatchery process control and instrumentation is recommended. By upgrading the PLC to the Allen Bradley Control Logix platform, the hatchery will benefit from the latest firmware and be expandable to include additional control panels and Ethernet wiring to the VFDs. The existing Allen Bradley Micrologix 1500 PLC is capable of running all the new process controls proposed in this report. Its main limitation is the number of IP addresses it will accept. By upgrading the PLC platform to Control Logix, the existing program can be reused, while the new system will have much greater networking capabilities. The main area of network expansion is the new variable frequency drives proposed for main supply pumps, the recycle pumps and the emergency reuse pump at the Raceway Building. These new devices can simply be connected to an Ethernet network as opposed to installing analog and digital wiring to each VFD to control speed and monitor the drive operation. The additional cost of the new PLC will be somewhat offset by the savings in the electrical connections to the VFD's and other devices that can be networked, such as the dissolved oxygen analyzers.

RECOMMENDATION:

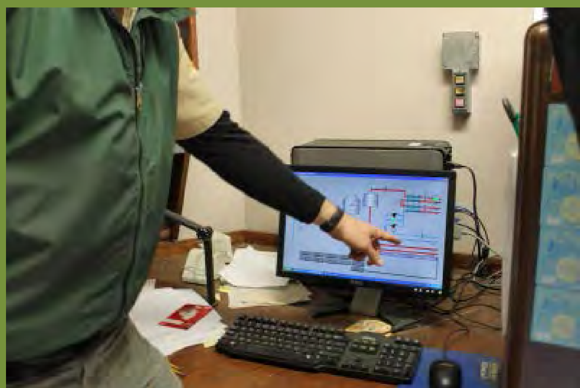
Upgrading the PLC platform to Control Logix is recommended.

Benefits:

- Hatchery will benefit from the latest firmware and the system will be expandable.

Alternative	Recommendation
Upgrade PLC	Yes

PHOTOS:



COMPONENT NAME:

18. HEAT RECOVERY SYSTEM

GENERAL DESCRIPTION:

An inspection of the existing heat recovery system was conducted on February 12, 2013. The heat recovery system piping and compressor installation was inspected as well as the plate heat exchanger and SCADA controls. However, because the pumps and compressors were not in service during the inspection, the system's overall functionality could not be observed.

Based on an evaluation of technical records, the heat recovery system was installed in 2008 and is a once-through design in terms of water influent flow. The system is operating to only recover heat from the water and has not been configured to cool any part the system. The system's heat recovery component occurs on the effluent side and the recovered heat is used to displace direct-fired energy from a boiler.

The heat recovery system includes eight heat pump compressors, each rated at 20 tons of cooling. The pump compressors are tandem-mounted (two per bay) in a single bay rack. Each pump compressor has a 15-horsepower, 480-volt motor, rated at 27 amps. The assembly is mounted within a facility building that provides good access.

The heat recovery system has integral filters on the inlet side of the heat pump piping header, which require frequent cleaning and can quickly make the heat pump system shut down if the filters plug with process material. The current piping and isolation valve arrangement allows access to clean one heat pump cooler assembly while allowing the other cooler assemblies to remain online. Cleaning the cooler assembly — removing the piping, hydroblasting the fouled surfaces, and reconnecting the piping — requires approximately eight hours.

The piping, wiring and valves were inspected to determine condition of the installation and access to equipment. This was found to be acceptable, although some piping modifications were made by the staff after the initial installation to attain better access to filters at the glycol heat pump skid.

Heat recovered by the heat recovery system is transferred to a glycol fluid and is pumped to the main facility with several glycol pumps located in the same building. The glycol pumps convey the fluid to a plate and frame heat exchanger. The heat exchanger is sized for a maximum heat rate of 1.42 million BTUs/hour. The heat exchanger appears to be in good working order and to have good insulation and no noted leaks.

The plate and frame heat exchanger was designed to allow transfer heat through the glycol header to the water system directed to the hot well. The recovery of heat is performed at a cost of the daily electrical and maintenance costs for the pumps at the heat pump skid, the compressors and the controls.

The heat pump components have the capability to be reversed and made into a cooling system, but it would require significant modification to control and operate differently from its present design arrangement.

MANUFACTURER/SIZE INFORMATION:

Trane MP580/581 Programmable Controller
ITT – Bell and Gossett Type GPX Plate Heat Exchangers
ITT – Bell and Gossett Series 1510 Glycol Pump
ITT – Bell and Gossett Glycol Make-up Unit
ITT – Bell and Gossett Series 3530 Centrifugal Pump
ITT – Bell and Gossett Pressurized Expansion Tanks
Gorman-Rupp Submersible Pump
Multistack Water Cooled Module
Qmark MUH Series Modular Unit Heater
Lakos Solids Recovery Vessel
Aqua Pass Chemical Bypass Feeders

YEAR OF CONSTRUCTION:

2008

ASSESSMENT:

Mechanical:

There are no observed issues with the condition of the heat recovery system process piping. However, it was observed that some piping modifications were made by the staff after the initial installation.

Electrical:

There are no observed issues with the electrical components.

USEFUL LIFE ASSESSMENT:

Discipline	Remaining Life of Components (years)	Condition
Mechanical	20	Good
Electrical	25	Good

The life expectancy of the motors, pipes and heat pumps based on the existing condition should be about 20 years provided good maintenance practices and vendor recommendations for operation are followed. That means their existing components still have significant life. The current system has very little run hours on it during the last three years. The question of operational cost payback and efficiency is uncertain because the system is not providing the resource for payback of the original capital investment.

Replacement Schedule

The replacement schedule for large capital components like buried piping and the heat pumps is very long, typically 20 to 25 years. The replacement schedule for more consumable items such as gaskets on heat exchangers and pump bearings is much shorter, usually in the three-to-five-year range based on run hours for the components. Pump cases and pump motors should have longer lives—typically 15 years for their current type of service (water with few or no corrosives). For the initial three to five years after this equipment was added to the facility, very little detailed maintenance for bearings and gaskets would be expected. After the first five years, though, the system components begin to need attention and specific calibration, tightening and adjustment as well as bearing rebuild on pumps and compressors become routine as part of the operation. An appropriate amount of man hours must be accounted for the staff to make these maintenance activities occur, or the equipment will not be available and in reliable condition to perform its function.

DEFICIENCIES:

1. The heat recovery system is not currently in operation because it has been unable to reliably operate and perform as intended.
2. The 2003 Feasibility Study by The Design Group recommended installation of a closed-loop system; however, an open-loop system was installed.
3. Water is not currently filtered prior to the inlet to the heat pump heat exchangers; this results in plugging of the system's integral filters with material and requires frequent cleaning of the filters.
4. Organic materials (such as algae and water mold), sediments, and other materials have been noted to accumulate on the system components when in operation, resulting in clogging of equipment and the need for frequent cleaning and maintenance.
5. It is possible to operate this type of system for both heating and cooling; however, the current heat recovery system was designed and set up to only recover heat from the water and has not been configured to cool any part the system.

IMPROVEMENT ALTERNATIVES:

Heat Recovery System Improvement Alternatives

Based on the current state of the heat recovery system, three improvement alternatives were studied to determine estimated costs and savings. The estimated costs used for these alternatives are based on the most accurate and current information available. This information led to higher than expected boiler fuel costs for the alternative that represents the current operation; however, since the same information was used throughout all of the alternatives, the comparisons should be accurate. The temperatures and flows in the table below are based on the weighted averages from the data provided by the Hatchery.

Month	Weighted Average Temp Required (°F)	Flow Rate (gpm)	Lake Temp (°F)	Effluent Temp (°F)
January	42.40	256	36.2	40.0
February	43.81	240	34.6	40.0
March	42.44	396	33.9	39.5
April	43.21	436	35.3	39.9
May	46.13	438	37.8	41.6
June	49.41	502	41.6	46.2
July	57.81	497	48.2	45.0
August	57.99	343	51.9	44.6
September	52.08	183	51.7	49.5
October	46.13	263	47.0	50.3
November	46.33	219	42.0	45.2
December	42.97	355	38.3	41.9

Some other assumptions for the analysis are shown below for reference.

- Wood Pellet Heating Value: 8061 BTU/lbm
- Wood Pellet Cost: $157/ton
- Boiler Efficiency: 69.6%
- Monthly Electricity Cost: $0.05288/kWh + $5.86/kW + $10.50

The following alternatives for the existing heat recovery system were evaluated as part of this study:

Alternative 1: Remove Heat Recovery System

This potential option would revert the system back to the state it was in prior to the addition of the heat recovery system. The advantage of this alternative is that the investment required is negligible and a small amount of the original system can be recovered with the sale of the equipment. In addition, this would allow the overall system to be simplified and potentially reduce maintenance costs.

The major disadvantages to this alternative are that the potential for heat recovery would be lost with the removal of the system and the loss of the opportunity for using the heat recovery system for cooling. Any cooling would need to be done by some other external means.

Total Savings:	$20,000 (net result of sale of equipment after removal)
Annual Savings:	$1,200 (electrical savings)
Payback:	N/A

Alternative 2: Add Filtration System

This option would install a new filtration system for filtering the effluent water from the clarifier before entering the heat pumps. This filter would need to be located in a new approximately 24’x20’ building to protect it from freezing, which could be located near the clarifier. The clarifier outlet piping would need to be routed through the filter building with isolation and bypass valves added. This would be most cost effective with the building located near the clarifier outlet pipe to minimize the material and construction cost. The filtration system would require occasional short-duration recharge cycles to automatically clean the filter. The filter would minimize the amount of organic matter and other suspended solids entering the heat pumps and greatly reduce the amount of cleaning time needed. This system addition would allow the heat recovery system to operate as intended to recover heat from the effluent for warming the influent fresh water from Lake Superior.

Based on using wood pellets for boiler fuel and estimates for the electrical cost of operating this system, the expected annual savings over the current operation would be approximately $35,000. With the system in operation, the waste heat recovery would be sufficient to provide the necessary heat for the influent water for the months of January, August, September, October, November, and December with little to no additional heat needed from the boiler. The heat recovery system would be limited by the effluent temperature in February and March and would only be able to run at partial load to prevent freezing. April-July would require additional heat from the boiler due to the higher temperature and flow rates required. However, the system would significantly reduce the boiler load during those months as well.

Total Cost:	$654,000
Annual Savings:	$35,000
Payback:	19 years

Because the frequency of backwash of the proposed filter is not known, the energy costs associated with backwash are not accounted. Including backwash costs would extend the payback. Maintenance costs are also not projected but might be similar to the existing boiler system.

Alternative 3: Add Filtration System and Use Existing Heat Exchanger

This option would install a new filtration system for filtering the effluent water from the clarifier before entering the heat exchanger (HE-2). The heat recovery system would be removed as part of this process. The effluent water would be used to heat the influent water strictly using heat transfer through the heat exchanger. The advantage to this alternative is that the removal of the heat recovery system simplifies the process and reduces electrical and maintenance costs. There are several major disadvantages to this option. First, it still requires the installation of the expensive filter system from *Alternative 2* without much of a payback. The minimal payback is due to the low average effluent temperatures. Without the use of the heat pump, the temperature differential, and thus the heat transfer, in the heat exchanger would be minimal. In addition, by removing the heat recovery system components the opportunity for using the heat pumps for cooling is lost.

Based on using wood pellets for boiler fuel, the annual savings for this alternative would be approximately $3,500, requiring an extremely long payback period. This option would only be viable if the filtration system was required for some other reason.

Cooling Alternatives

The break in the intake pipeline and the increase in Lake Superior’s water temperature have caused occasional spikes in the intake water temperature during the hot summer months. Short periods of warmer-than-desirable intake temperature can be tolerated, but longer durations of the warm intake water can be harmful to fish. Due to the increasing frequency and duration of these warm intake periods, it may be necessary to add cooling capabilities to the intake system to reduce their magnitude and duration. Three alternatives for cooling were studied.

Alternative 1: Modify Heat Recovery System to Work in Cooling Mode.

This option would require that *Alternative 2* from the Heat Recovery System Alternatives be implemented, as this requires that the heat pumps be fully operational. In addition, the effluent water would be used as a heat sink in cooling mode and would require that it be filtered prior to entering the heat pumps. The Hatchery has operated the heat pumps in cooling mode in the past, as the heat recovery system controls are set up for both heating and cooling. However, the SCADA system is currently only set up for heating. When they have operated in cooling mode, they were forced to manually control the mixing valves, which are controlled based on having the hottest water come from the heat recovery system. In cooling mode, the opposite is the case. Adding this type of cooling would require a visit from the SCADA system developer to provide engineering and controls support, but that would be the majority of the cost for the changes. Minor piping changes may be necessary, but the majority of the work required will be instrumentation and controls.

Due to the large flow volumes and high potential inlet temperatures, this system would not be able to provide enough cooling for the most extreme cases, but it would drastically reduce the frequency, magnitude, and duration of those events.

As this is an addition to the existing system and a prevention measure, there is no payback. The estimated annual operating cost of this system would require additional data on the frequency and duration of the high temperature intake periods.

Alternative 2: Install an Air Cooled Water Chiller

This option would work with any of the alternatives from the Heat Recovery System Alternatives. This option would require the installation of an outdoor air-cooled water chiller after the intake water filter to prevent similar buildup problems to those in the currently in the heat pumps from occurring in the chiller. Prior to any installation, the intake water after the filters would need to be analyzed to determine if any additional filtration is required. The outdoor chiller would be installed on a concrete pad near the location of the end use for the cooled water. Due to the large flow volumes and high potential inlet temperatures, this system would not be able to provide enough cooling for the most extreme cases, but it would drastically reduce the frequency, magnitude, and duration of those events.

As this is an addition to the existing system and a prevention measure, there is no payback. The estimated annual operating cost of this system would require additional data on the frequency and duration of the high temperature intake periods. Also, based on additional data, the chiller cooling capacity could be expanded or reduced as necessary to achieve the desired results or reduce costs. This option would add to annual maintenance costs, as it would require winterizing.

Alternative 3: Geothermal Cooling

This option would require the installation of vertical ground wells to use as a heat sink. The heat pumps would be used to transfer heat from the influent water to the fluid in the closed loop geothermal side. To reach the maximum capacity of the heat pumps in cooling mode, the geothermal system would require approximately 130 wells (based on an estimate of slightly less than 1 ton of cooling per 200-ft well). The well cost alone would be approximately $485,000, which does not include the large network of piping or pumps required to get the fluid back to the heat pump room. This would only provide half of the cooling needed by the system, which is comparable to what the other two cooling alternatives would each provide by themselves as well.

Due to the large well costs, piping and pumping costs, and the large area (>1 acre) required for this option, a detailed cost estimate was not completed.

RECOMMENDATION:

It is recommended to add a filtration system as suggested in *Alternative 2* in the **Heat Recovery System Improvement Alternatives**. The addition of the filter will allow the heat recovery system to operate as intended and begin saving on energy costs. In addition, this alternative also allows the option to add cooling capability for a relatively small cost.

Benefits:

- Resume operating heat recovery system
- Reduce energy costs
- Option to add cooling to the system

In addition to the recommendations noted above for the heat recovery system, it is recommended to update the system to allow for operation in cooling mode (as discussed in *Alternative 1* in the **Cooling Alternatives**). This would add some operating costs and have an initial cost, but it would greatly reduce the risks caused by high influent water temperature.

Due to the potential risks to the fish associated with extended periods of high temperatures, it is also recommended to install a chiller (as discussed in *Alternative 2* in the **Cooling Alternatives**). The chiller should be installed after the heat recovery system to allow the two systems to work together to further lower the temperature of the inlet water. In addition, locating it after and outside the heat recovery system allows it to function independently for use as a redundant system if necessary. The addition of the chiller may be optional if the lake water intake pipe is repaired. The lower influent temperature combined with the heat pumps operating in cooling mode may be enough to reduce the process water to the desired temperature without the use of a chiller.

Alternative	Recommendation
Heat Recovery	
Alt. 1 – Remove HRS	No
Alt. 2 – Add Filtration to HRS	Yes
Alt. 3 – Remove HRS; Direct Transfer of Effluent Heat	No
Cooling	
Alt. 1 – Update HRS to Operate in Cooling Mode	Yes
Alt. 2 – Install Chiller	No
Alt. 3 – Geothermal Cooling	No

PHOTOS:

COMPONENT NAME:

19. LOWER SPAWNING/HOLDING TANKS

GENERAL DESCRIPTION:

The Lower Spawning Building contains five concrete tanks and is currently used for spawning Kamloop and steelhead collected in the French River. The tanks had previously been utilized for holding trout shipped from southern Minnesota hatcheries before distribution in the northern east region. However, VHS and zebra mussels have eliminated that use due to biosecurity concerns and it has not been used for trout holding and distribution for four years.

The raceway dimensions are 23 x 7 x 3 feet with an average operating depth of 28 inches. The condition of the raceways is reported as good.

MANUFACTURER/SIZE INFORMATION:

NA

YEAR OF CONSTRUCTION:

1974

ASSESSMENT:

Mechanical:

Spawning operations currently occurring at this location have been acceptable and will not be evaluated further for this report. However, if trout holding and distribution operations are to be employed again, treatment of the water supply to meet biosecurity requirements must be provided. Adequate raceway volume and access for trout holding is currently provided.

Electrical:

The electrical systems are in good condition. Incandescent lighting is used in the hatchery area

USEFUL LIFE ASSESSMENT:

Discipline	Remaining Life of Components	Condition
Mechanical	25	Good
Electrical	25	Good

DEFICIENCIES:

1. Biosecure trout holding is not available.
2. Energy inefficient incandescent lighting is used.

IMPROVEMENT ALTERNATIVES:

The holding tanks require a biosecure water supply to allow continued use of the FRH as a transfer station. The following water treatment options were evaluated:

Filter and UV Existing Supply

Install filtration system to provide 35 micron level filtration and UV treatment adequate to provide disinfection for VHS virus and connect to the existing Lower Spawning Building water supply system sized at about 500 gpm. A 40 mJ dose UV system provides a four fold safety factor for 99.9% (4-log) VHS protection. This option provides influent treatment for both spawning and holding operations.

In-Lake Filtration and UV of Existing Supply

If the intake filtration crib construction feasibility is verified and this option for intake improvement is selected, only UV treatment is required to meet VHS virus inactivation. The lake crib filtration system has the added benefit of filtering all Lower Spawning Building water for all rearing purposes.

Treat French River Supply

Use of treated French River water is not considered viable due to flow variability, temperature and water quality concerns.

Supply with Raceway Emergency Pump Station

Use of “used” water from the upper captive broodstock emergency pump station was considered. This “used” water is nutrient-rich and use has been attempted in the past. Biofouling of the pipeline was problematic. This water option is not considered to be viable.

Use Treated Upper Water Supply

Interconnection of the Lower Spawning Building to treated cold water from the Upper FRH is potentially possible. This option would require a new pipeline from the treated upper reservoir to the Lower Spawning tanks or connection to the existing cold water makeup pipeline. Trout holding water requirements vary from 300 to 400 gpm depending upon lake temperature. Holding would be required in the May/June and September/October trout distribution periods. Based on Table III-3, Rearing Unit Use and Flows, it appears that trout holding occurs during lower water use periods in the upper facility. However, confirmation of water availability by MNDNR for trout holding use from the Upper treated

FRH water supply source is required. It does not appear that there is enough capacity at this time for this option to be viable.

New Trout Holding

Another option to provide trout holding and distribution at FRH is to construct a new trout holding system in the Upper portion of the site and supply it with treated cold water from Upper reservoir system. This option offers the advantage of no biosecurity water risk from spawning activities like the Lower Spawning Facility. This option involves new construction and is not enclosed in a secure building as is the Lower Spawning facility. A paired raceway (50'x5'x3' providing 1,500 CF rearing volume total) is illustrated on **Drawing FR-5**. The drawing shows potential interception to the existing treated water supply and draining systems. Transport truck access is proposed along both sides of this trout holding raceway. Truck filling capability at this location is recommended. The proposed location is in the relatively open area east of the Burrows Building. This option provides a totally new and separate trout holding/distribution at FRH. This option has high cost due to new raceways, piping and access road construction. Again, this option can only occur if excess water capacity is available from the Upper facility which does not appear to be the case. Therefore, this option was not evaluated further.

Note: If the Lower units are used for both spawning and holding, the Lower Spawning Facility will require steam cleaning or chemical disinfection to prepare it for trout holding/distribution.

Consider replacement of the incandescent lighting. One option is to use compact fluorescent (CFL), self ballasted lamps to replace the incandescent lamps. A second option is to remove the existing RLM fixtures and install new fluorescent fixtures. Incomplete information was available regarding the existing lighting system so no specific energy savings or construction costs were calculated. However, if lighting is replaced in both the Lower Spawning area and the offices, annual energy savings would be realized. A construction cost placeholder has been added but detailed costs will need to be developed during the design process.

RECOMMENDATION:

Since the in-lake filtration system has been previously recommended (**Component 4**), it is recommended to add UV treatment to the Lower Spawning Building inflow. Since tanks are currently available for holding purposes, it isn't cost effective to construct new tanks in a new location for this function. However, there might be conflicts between spawning and holding operations that will need to be coordinated. New fluorescent fixtures are recommended.

Benefits:

- Biosecure water will be supplied to the Lower Spawning Building
- Fish holding operations can continue at French River Hatchery
- New fluorescent fixtures will reduce energy costs
- Existing rearing space use is optimized

Alternative	Recommendation
Install Filtration and UV	No
Install UV	Yes
Extend Treated Water Supply	No
New Light Fixtures	Yes

PHOTOS:

COMPONENT NAME:

20. GENERAL STORAGE

GENERAL DESCRIPTION:

General storage space is available in the shop building garage and a storage room in the Burrows Building. The Nursery Building and the Burrows Building both have a room dedicated to feed storage. There is no code-compliant chemical storage area with containment and ventilation. Formalin use for egg treatment in the Nursery is equipped with a spill containment skid. Other theraputants and chemical treatments used for disease control were reported as NaCl, H_2O_2, ovidine and MS222. Site staff have suggested that approximately two additional bays of storage in the shop location would meet future storage requirements.

MANUFACTURER/SIZE INFORMATION:

NA

YEAR OF CONSTRUCTION:

1974

ASSESSMENT:

Mechanical:

Not Applicable

Electrical:

Not Applicable

USEFUL LIFE ASSESSMENT:

Discipline	Remaining Life of Components	Condition
Mechanical	25	Good
Electrical	NA	NA

DEFICIENCIES:

1. No compliant chemical storage is available.
2. Additional storage is requested by hatchery staff.

IMPROVEMENT ALTERNATIVES:

Site staff have suggested that approximately two additional bays of storage in the shop location would meet future storage requirements. Space for construction of a storage building west of the existing shop appears to be available but may require relocation of the propane and domestic water service. The electrical service and other utilities (propane or natural gas if available, and domestic water) will need to be extended from main hatchery mechanical room to the new storage building location. There is limited land area available for storage building construction on the Upper site except the area east of the Burrows Building. For the purpose of this report a two-bay pre-engineered metal insulated building (40'x 40') is recommended. Propane or natural gas unit heating is recommended for at least one-bay of storage space.

A packaged code-compliant chemical storage cabinet with packaged ventilation and spill containment is suggested for meeting chemical storage requirements.

RECOMMENDATION:

Provide new pre-engineered storage building west of the present shop building. Include a code-compliant packaged chemical storage cabinet with ventilation and spill containment in one heated bay of the building.

This recommendation will address the following:

- Storage capacity will be increased
- Code-Compliant chemical storage will be provided

Alternative	Recommendation
New Storage Space	Yes

PHOTOS:

COMPONENT NAME:

21. OXYGEN GENERATION SYSTEM

GENERAL DESCRIPTION:

The Onsite Pressure Swing Adsorption (PSA) Oxygen Generation System consists of two Xorbox (Model X-200) oxygen generators with 200 foot per hour (94 lpm) oxygen and two 15-hp Palatek rotary screw air compressors (ACFM 54). Each Xorbox generator is equipped with a 40 cubic foot oxygen storage tank.

Manufacturer/Size information:

Xorbox Corporation acquired by AirSep Corporation, Buffalo, New York. Phone: 716-691-0202. www.aircep.com.

Sullivan/Palatek, Model H15D, Michigan City, Indiana. Phone: 219-874-2947. www.sullivanpalatek.com.

Year of Construction:

System was obtained as used system from a MNDNR facility in 1998.

Assessment:

Mechanical:

The onsite oxygen generation system is capable of providing 188 lpm of 93% purity oxygen. The system is operated when Nursery or Burrows units' dissolved oxygen levels fall below 6.0 mg/l. Oxygen generation is supplied with emergency power from the upper FRH generator. The oxygen generators are in fair condition. Parts can be obtained from AirSep Corporation.

Dissolved oxygen supplementation is utilized only when rearing unit DO levels measured by portable instrumentation indicate low levels below fish culture standards.

Compressors require annual filter and oil changes. This system does not use an air dryer. It is unlikely that the components will last more than 10 years. The air compressors are also in fair condition with parts available from Sullivan Palatek.

Electrical:

NA

Useful Life Assessment:

Discipline	Remaining Life of Components	Condition
Mechanical	10	Fair
Electrical	10	Fair

Deficiencies:

1. The compressors are nearing the end of their service lives.

Improvement Alternatives:

The existing PSA will not last 25 years.

Dissolved oxygen concentrations can decrease primarily due to fish respiration as the water is used in the rearing unit. Reduced dissolved oxygen concentrations can stress fish. Studies have shown that maintaining dissolved oxygen levels at or above saturation can allow higher rearing unit loading and densities and allows maximum use of available water supply volumes.

The major benefits of dissolved oxygen management are:

- Significantly improved dissolved oxygen levels in rearing units (i.e., higher loadings and carrying capacity).
- Improved food conversion and reduced waste by-products.
- Improved fish quality and fish health.
- Control of dissolved nitrogen (gas embolism) problems.
- Emergency dissolved oxygen management (loss of flow/reduced flow).
- Potential for fish production increase without other capital improvements.
- Maintain adequate dissolved oxygen level in hatchery effluents to insure rearing waters do not experience D.O. sags due to $CBOD_5$ levels.

Dissolved oxygen is the first limiting factor in nearly all aquaculture systems. Therefore, it is paramount that dissolved oxygen levels are maintained at the highest most practical level (at or above saturation) using pure oxygen based oxygenation. **Section III** provides bioprogramming models which indicates that dissolved oxygen might be a limiting factor for optimal fish production. Therefore, consistent DO levels must be maintained.

A concentrated or high-purity oxygen source is generally 90% to 99% oxygen versus the atmospheric percentage of around 21%. Thus, systems that utilize a source of high-purity oxygen rather than atmospheric oxygen have higher oxygen transfer efficiencies. Pure oxygen can be delivered as liquid oxygen (LOX) or generated on-site.

Liquid oxygen is commercially available and can be stored in an insulated cryogenic container near the rearing units. Liquid oxygen has a very low boiling point that necessitates storage under higher pressure. Since the boiling point of LOX is -297°F (-183°C) and atmospheric temperature ranges from –10 to 110°F, it must be vaporized and used as a high-pressure gas. Otherwise, the liquid could not be contained and properly regulated. A typical LOX system includes components such as a storage tank, vaporizer, regulation valve, piping, and pressure regulators. LOX systems are generally very reliable and the gas itself is economical, depending on transportation costs; however, initial capital investments may be high for purchase of the specialized storage vessel. As an alternative, some LOX users rent the storage vessel for a monthly fee. The major advantage to utilizing LOX is the ability to consistently achieve high DO concentrations with little or no noticeable noise. In addition, LOX systems are functional during power outages since there is no power required to contact the water with the oxygen. HDR investigated the options of renting a tank and found the following potential costs: Airgas in Duluth, Minnesota, is a local LOX source. Estimated cost for LOX tank rental is $460 per month or $5,520 per year. Product cost is estimated at $0.88 per 100 cubic feet.

On-site oxygen generation systems are an alternative source of high-purity oxygen. Pressure swing adsorption (PSA) systems (existing units) and vacuum swing adsorption (VSA) units are both technologies that utilize a molecular sieve material to selectively adsorb nitrogen from the air.

Ultimately, these systems can produce a high purity stream of oxygen that can be utilized to supersaturate waters that are oxygen deprived. These systems are generally reliable when properly maintained. Large systems require moderate maintenance and can have high capital costs but smaller systems are generally economical. Small PSA systems are relatively simple to maintain, are not exceptionally loud and are more common than VSA; so, a new packaged AirSep (or similar) PSA system is proposed for use at the FRH.

Our calculations indicate that with a PSA system, oxygen can be generated at FRH at a cost of $0.84 per 100 cubic feet. The cost to maintain this PSA system is estimated to be approximately $3,000 per year. The cost of a new system complete with new compressors, oxygen generators, an air dryer, and a refurbished air receiver tank, versus the cost of an oxygen pad for a rented bulk storage tank, the difference in capital cost is about $41,130. Based on the quote from a local oxygen supplier, this initial cost differential will have a payback 14.6 years.

RECOMMENDATION:

To reduce annual maintenance cost and save initial capital costs, the bulk oxygen storage alternative is recommended. Tank rental is recommended.

Benefits:

- Projected rearing is expected to utilize additional oxygen so a larger capacity oxygen supply will be provided.
- LOX will provide oxygen during power outages
- Oxygen will be provided in unlimited capacity
- No maintenance of PSA system required.
- LOX could be provided to a fish transport truck

Alternative	Recommendation
Replace PSA	No
Purchase LOX Storage Tank	No
Rent LOX Storage Tank	Yes

PHOTOS:

Minnesota
Department of Natural Resources

MDNR No. 8F022
File No. FMA.00257.00.00.03
HDR No. 202386

French River Cold Water Hatchery

V. FACILITY-WIDE EVALUATIONS

HDR

BARR

V. FACILITY-WIDE EVALUATIONS

Water Supply Evaluation

Lake Superior Evaluation

Lake Superior is the Hatchery's current main water supply. The Hatchery's MNDNR Water Use Permit (Permit No. 1976-2262) authorizes the appropriation of up to 500 million gallons per year of water from Lake Superior for aquacultural use.

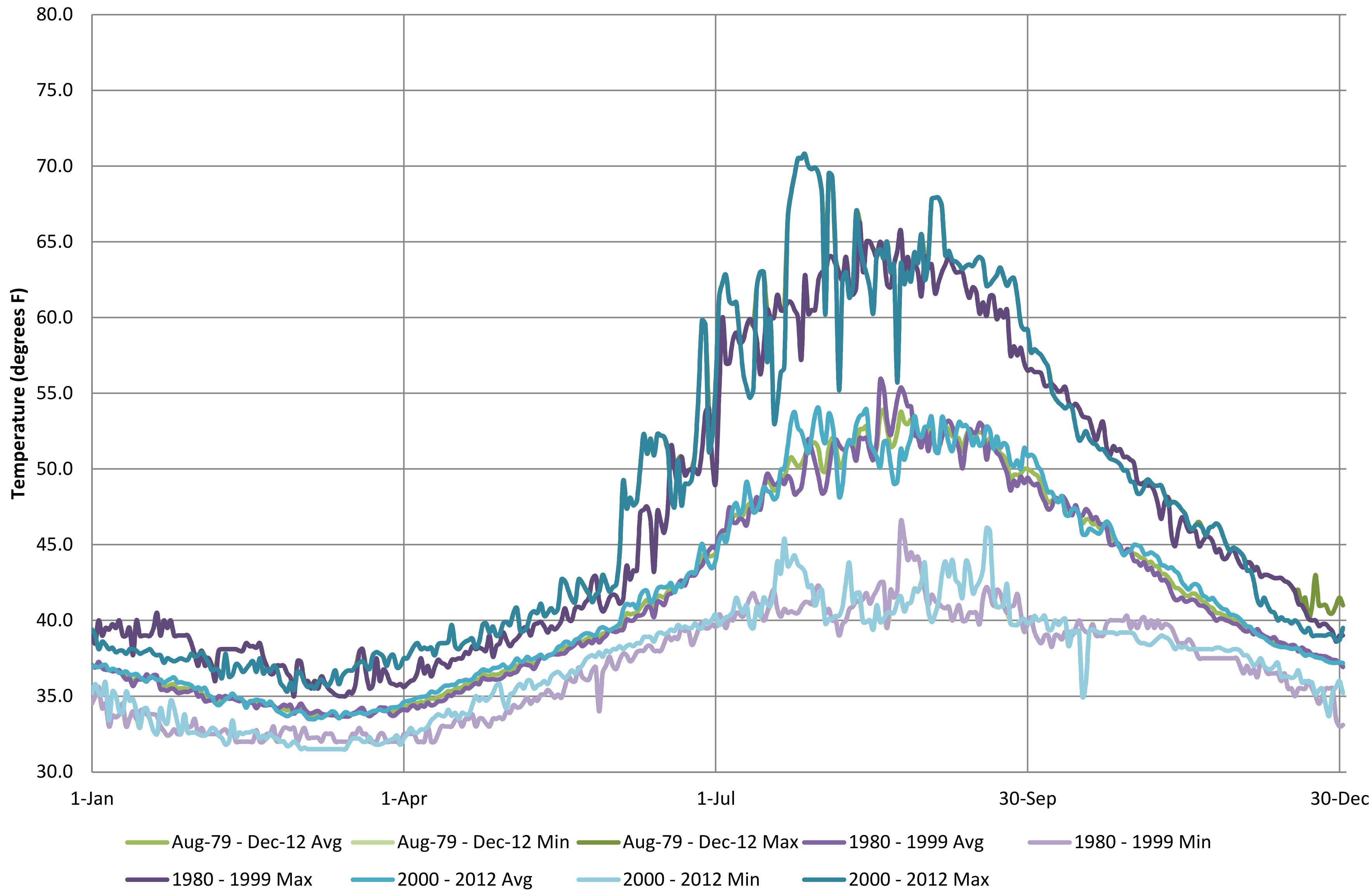
Lake Superior Water Temperature

Hatchery Temperature Data

According to Hatchery records, water withdrawn from Lake Superior over the last 10 years (2003 through 2012) during July and August averaged approximately 52°F. During July and August 2012, the highest recorded water temperature each month was approximately 70°F. According to the Hatchery Manager, the ideal temperature range for water supply is 42°F to 55°F. Although the Hatchery can adjust for brief temperature spikes to as high as 64°F, prolonged durations of warm water, such as those experienced during summer 2012, are a major concern.

Figure V-1 provides historical Lake Superior average FRH water supply temperature. The green shaded lines represent the daily average, daily maximum and daily minimum temperature from 1979-2012. The period before 1980-1999 (shades of purple) depicts average, maximum and minimum daily temperatures well before the intake pipeline breach. The 2000-2012 (the aqua shades) depicts the average, maximum, and minimum daily values for the period after the pipe breach is assumed to have occurred (2006+/-).

Figure V-1. French River Hatchery Lake Superior Intake Daily Average Unheated Water Temperature



This graphic was prepared to visualize possible temperature variations before and after the intake pipe breach in FRH water supply. It also illustrates the wide variability of the lake water supply temperatures that occurs annually for (average, maximum and minimum) temperatures.

Table V-1 provides a summary and graphic of average monthly water temperature at FRH by location within the facility for 2011. This data is from temperature logging devices placed in these hatchery locations and is the based upon compiled 24- hour daily temperature readings and daily averages used to calculate monthly average temperatures. The table illustrates the cooling of water temperature as water flows through the production units in the facility. Note that temperature at the clarifier where heat is to be recovered by the heat pump system is in the range of 4 degrees F above the combined lake water temperature.

Table V-2 presents a method of estimating water heat costs based on the estimated fish culture units in service, flows per unit and the desired culture temperature. This annual heating cost estimate was $122,918 and was prepared using data provided by the FRH staff for 2012. These heating estimate ranges are comparable to the actual heating expenditures for wood fuel and oil discussed later in this section. While costly, heating Lake Superior water is required and several of the improvement recommendations presented in **Section IV** of this report are directed at making the existing process heating system more efficient, and easier to use and maintain. The heating system controls need to be optimized so that water heating and mixing to establish rearing water temperatures is simplified and made as energy cost effective as possible.

Other Temperature Data Sources

Additional water temperature records were examined from the University of Minnesota Duluth's Nearshore Lake Superior Buoy (National Data Buoy Center Station 45027), located approximately three miles southwest of the Hatchery, and from the U.S. Environmental Protection Agency's Mid-Continent Ecology Division Laboratory, located approximately seven miles southwest of the Hatchery. Water temperature patterns similar to those observed at the Hatchery were observed at these locations with some variation based on measurement depth.

Dr. Jay Austin at the University of Minnesota Duluth (UMD) collects and analyzes water temperature data at various depths from a meteorological mooring co-located with UMD's Nearshore Lake Superior Buoy. Dr. Austin provided preliminary of analysis of this water temperature data as it may relate to selection of an optimal water intake depth at the Hatchery, including:

- During winter, water is colder than desired for use at the Hatchery, regardless of depth.
    - The surface water temperature is colder than desired during approximately 45% of the year, while the temperature at a depth of 45 meters (148 feet) is colder than desired nearly 80% of the year.
- There are short-lived downwelling events, typically during the late summer, when the entire water column is warmer than desired for use at the Hatchery.
    - Warmer-than-desired temperatures occur mainly in the top 20 meters (66 feet) of the water column.
    - The surface water temperature is warmer than desired during approximately 20% of the year.

Table V-1. FRH 2011 Temperature Data - Averages (data from MNDNR Monitoring Instruments)

2011	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lake	35.90	34.80	33.60	35.70	38.30	41.40	51.60	47.60	48.30	49.40	41.70	37.60
Hotwell	53.10	54.03	53.93	55.39	54.57	55.83	62.97	62.26	58.29	56.31	56.01	55.94
Red Tanks	47.84	47.89	48.02	48.00	49.80	52.82	54.75	52.00	51.90	52.37	52.06	52.03
Yellow Tanks	38.10	39.46	39.50	39.44	39.42	50.53	54.18	47.57	48.23	49.72	47.26	45.40
Blue Tanks	43.05	42.15	40.87	40.08	40.07	41.56	51.53	47.66	48.36	49.45	41.90	37.86
Burrows	41.64	41.76	40.87	40.56	41.71	46.57	53.08	48.74	49.55	50.60	46.69	43.88
Clarifier	39.98	39.99	39.46	39.89	41.56	46.22	nd	44.63	49.50	50.32	45.22	41.90

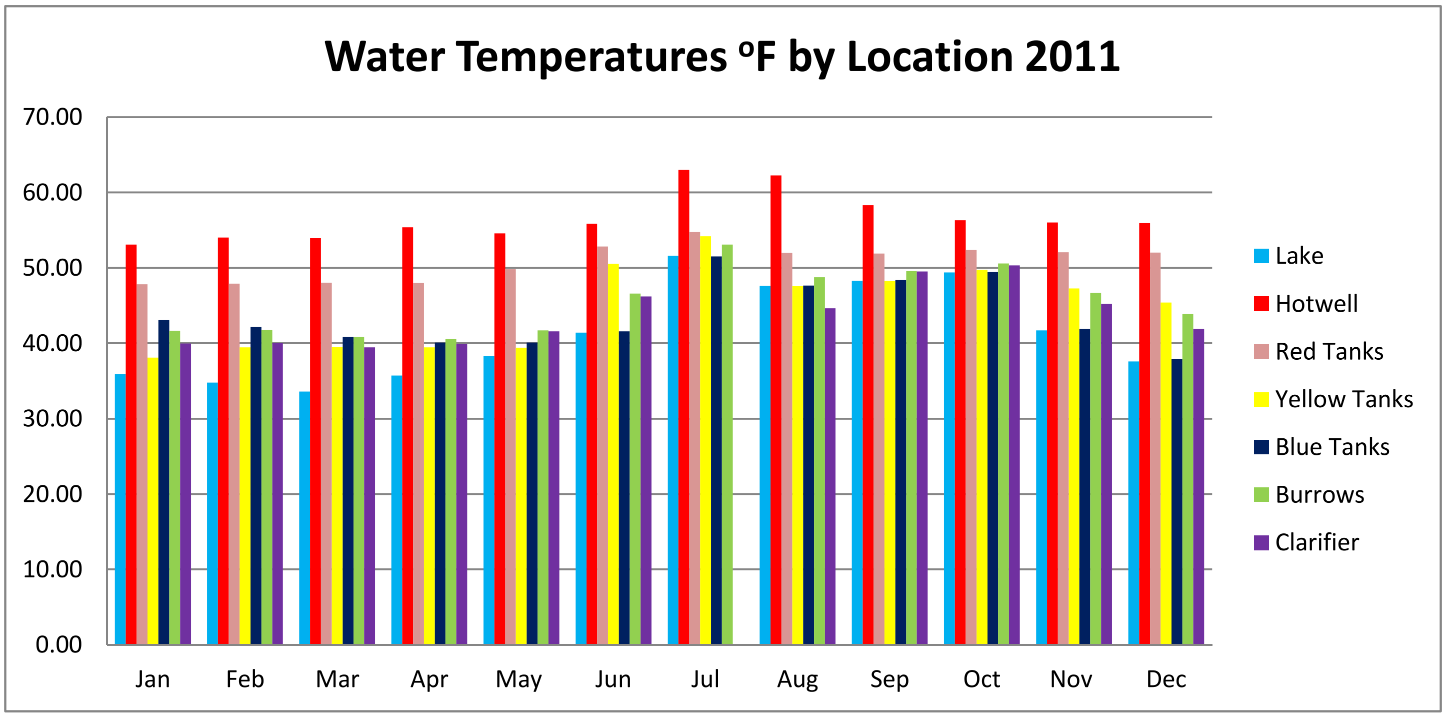


Table V-2 Estimated Water Heating using Nursery Culture Units, Flows and Temperature (data from MN DNR 2012 estimates)

NURSERY SUMMARY	Abbrev	JAN # of Units in service	JAN per Unit Flow in gpm	JAN Temperature	JAN Total flow gom	FEB # of Units in service	FEB per Unit Flow in gpm	FEB Temperature	FEB Total flow gom	MAR # of Units in service	MAR per Unit Flow in gpm	MAR Temperature	MAR Total flow gom	APR # of Units in service	APR per Unit Flow in gpm	APR Temperature	APR Total flow gom	MAY # of Units in service	MAY per Unit Flow in gpm	MAY Temperature	MAY Total flow gom	JUN # of Units in service	JUN per Unit Flow in gpm	JUN Temperature	JUN Total flow gom
PROGRAM REARING SUMMARY																									
Upper Incubation Warm	UIT	**1**	5	50	5	**2**	5	51	10	**2**	5	51	10	**3**	5	51	15	**3**	6	51	18	**2**	6	52	12
Upper Incubation Cold	UIT	**1**	5	36	5	**1**	5	36	5	**2**	5	36	10	**3**	5	37	15	**3**	5	41	15	**2**	5	46	10
Upper Incubation - Sorting Troughs #1	T	**1**	1	37	1	**1**	1	51	1	**1**	1	51	1	**1**	6	52	6	**1**	6	52	6	**1**	6	52	6
Upper Incubation - Sorting Troughs #2	T	**1**	2	37	2	**1**	2	36	2	**1**	2	37	2	**1**	2	39	2	**1**	2	48	2	**1**	2	58	2
Upper Incubation - Sorting Troughs#3&4	T									**2**	7	36	14	**2**	7	39	14	**2**	8	41	16	**2**	8	48	16
Super Troughs	ST																								
Nursery (6' dia. Tanks) RED	N	**1**	11	51	11	**1**	12	51	12	**1**	11	51	11	**2**	12	51	24	**3**	11	51	33	**6**	10	52	60
Nursery (6' dia. Tanks) YELLOW	N	**20**	10	43	200	**20**	9	44	180	**12**	11	43	132	**12**	10	44	120	**12**	11	47	132	**20**	9	49	180
Nursery (6' dia. Tanks) BLUE	N	**2**	16	36	32	**2**	15	39	30	**24**	9	42	216	**24**	10	42	240	**24**	9	45	216	**24**	9	49	216
Nursery Summary																									
				LAKE	Days / Month																				
1980-2010 AVG Monthly Lake Temeprature				36.18	31			34.55	28			33.85	31			35.30	30			37.84	31			41.60	30

JAN delta T	JAN BTU/month	JAN $	FEB delta T	FEB BTU/month	FEB $	MAR delta T	MAR BTU/month	MAR $	APR delta T	APR BTU/month	APR $	MAY delta T	MAY BTU/month	MAY $	JUN delta T	JUN BTU/month	JUN $
14	25,725,764		16	55,316,218		17	63,849,038		16	84,847,824		13	88,189,855		10	44,963,942	
0	0		1	2,437,949		2	8,004,398		2	9,187,344		3	17,646,906		4	15,852,672	
1	305,284		16	5,531,622		17	6,384,904		17	36,100,858		14	31,630,404		10	22,481,971	
1	387,190		1	975,180		3	1,973,177		3	2,377,901		10	7,639,547		16	11,457,158	
15	60,691,955		16	66,379,461		17	70,233,942		16	135,756,518		13	161,681,402		10	224,819,712	
7	507,813,926		9	571,993,229		9	449,661,041		9	376,140,672		9	450,152,474		7	479,903,616	
0	0		4	44,891,885		8	655,392,695		7	579,343,104		7	575,780,576		7	575,884,339	
BTUs	594,924,119		BTUs	747,525,542		BTUs	###########		BTUs	###########		BTUs	###########		BTUs	###########	
Oil gallons	5312	$18,591	Oil gallons	6674	$23,360	Oil gallons	11210	$39,234	Oil gallons	10926	$38,242	Oil gallons	11899	$41,648	Oil gallons	12280	$42,980
Wood tons	46	$7,242	Wood tons	58	$9,099	Wood tons	97	$15,283	Wood tons	95	$14,897	Wood tons	103	$16,223	Wood tons	107	$16,742
N.Gas THM	5949	$7,240	N.Gas THM	7475	$9,097	N.Gas THM	12555	$15,279	N.Gas THM	12238	$14,893	N.Gas THM	13327	$16,219	N.Gas THM	13754	$16,738

NURSERY SUMMARY	Abbrev	JUL # of Units in service	JUL per Unit Flow in gpm	JUL Temperature	JUL Total flow gom	AUG # of Units in service	AUG per Unit Flow in gpm	AUG Temperature	AUG Total flow gom	SEP # of Units in service	SEP per Unit Flow in gpm	SEP Temperature	SEP Total flow gom	OCT # of Units in service	OCT per Unit Flow in gpm	OCT Temperature	OCT Total flow gom	NOV # of Units in service	NOV per Unit Flow in gpm	NOV Temperature	NOV Total flow gom	DEC # of Units in service	DEC per Unit Flow in gpm	DEC Temperature	DEC Total flow gom
PROGRAM REARING SUMMARY																									
Upper Incubation Warm	UIT	**3**	1	57	3																				
Upper Incubation Cold	UIT	**3**	1	57	3																				
Upper Incubation - Sorting Troughs #1	T	**1**	1	59	1	**1**	1	57	1	**1**	1	50	1	**1**	1	44	1	**1**	1	43	1	**1**	1	39	1
Upper Incubation - Sorting Troughs #2	T	**1**	2	58	2	**1**	2	58	2	**1**	2	50	2	**1**	2	44	2	**1**	2	43	2	**1**	2	39	2
Upper Incubation - Sorting Troughs#3&4	T	**2**	1	59	2																				
Super Troughs	ST																								
Nursery (6' dia. Tanks) RED	N	**9**	10	57	90	**9**	14	58	126	**8**	10	54	80	**4**	10	49	40	**3**	9	50	27	**3**	8	50	24
Nursery (6' dia. Tanks) YELLOW	N	**20**	9	58	180	**8**	14	58	112	**6**	10	51	60	**20**	9	46	180	**20**	9	46	180	**20**	8	43	160
Nursery (6' dia. Tanks) BLUE	N	**24**	9	58	216	**6**	17	58	102	**4**	10	50	40	**4**	10	44	40	**1**	9	43	9	**24**	7	42	168
Nursery Summary																									
1980-2010 AVG Monthly Lake Temeprature				48.22	31			51.92	31			51.65	30			47.02	31			41.99	30			38.31	31

JUL delta T	JUL BTU/month	JUL $	AUG delta T	AUG BTU/month	AUG $	SEP delta T	SEP BTU/month	SEP $	OCT delta T	OCT BTU/month	OCT $	NOV delta T	NOV BTU/month	NOV $	DEC delta T	DEC BTU/month	DEC $
9	9,806,319		0	0		0	0		0	0		0	0		0	0	
9	9,806,319		0	0		0	0		0	0		0	0		0	0	
11	4,013,368		5	1,891,272		0	0		0	0		1	363,891		1	256,885	
9	6,984,303		6	4,229,301		0	0		0	0		1	511,609		1	811,609	
9	294,189,564		6	285,209,745		2	67,734,144		2	29,485,970		8	77,919,486		12	104,451,815	
10	655,392,695		6	253,519,774		0	0		0	0		4	260,055,878		5	279,372,119	
10	786,471,234		6	230,884,080		-2	0		0	0		1	3,275,018		4	230,794,728	
BTUs	###########		BTUs	775,734,171		BTUs	67,734,144		BTUs	29,485,970		BTUs	342,125,882		BTUs	615,687,156	
Oil gallons	15774	$55,208	Oil gallons	6926	$24,242	Oil gallons	605	$2,117	Oil gallons	263	$921	Oil gallons	3055	$10,691	Oil gallons	5497	$19,240
Wood tons	137	$21,505	Wood tons	60	$9,443	Wood tons	5	$825	Wood tons	2	$359	Wood tons	27	$4,165	Wood tons	48	$7,495
N.Gas THM	17667	$21,500	N.Gas THM	7757	$9,441	N.Gas THM	677	$824	N.Gas THM	295	$359	N.Gas THM	3421	$4,164	N.Gas THM	6157	$7,493

This was only a preliminary analysis, but it indicates that it would be possible to modify the depth of the Lake Superior water intake to target water temperatures that are suitable during the greatest portion of the year.

Lake Superior Water Quality

There is limited water quality data available for Lake Superior at or near the French River facility. Data sets are limited to Lake Superior water quality monitoring stations (MPCA 16-0001-00-N003 north of Duluth, Minnesota, and MPCA 16-0001-00-N001 south of Two Harbors, Minnesota). Three additional water quality data sets have been obtained from the USEPA Glenda Query System for Western Lake Superior station SU19 East of Beaver Bay, Minnesota at three different water depths. Water quality and temperature data for Lake Superior is summarized in **Appendix G**. Lake Superior water quality data was compared to the recommended fish hatchery water quality standards for a variety of parameters in **Table V-3**.

Lake Superior water quality is generally good and acceptable for aquaculture use. Alkalinity as $CaCO_3$ ranges from 40 to 52 mg/l and is on the low end of the recommended range of 50 to 300 mg/l. Total hardness as $CaCO_3$ ranges from 35 to 50 mg/l and is below the greater than 100 mg/l recommended level. The use of Lake Superior water has a 33 year history of demonstrated success at FRH and water quality is acceptable for cold water fish culture.

The facility has employed the use of oyster shell media in the Burrows recirculating system to increase alkalinity and hardness in the water recirculation system. No data was available in the facility records to document the Burrow's water quality. Sodium bicarbonate or calcium bicarbonate is used in some recirculation systems to restore alkalinity lost during ammonia nitrification. If required, an alkalinity adjustment chemical metering system could be provided. Water quality monitoring is suggested for lake water and the Burrows system to confirm information needed for further evaluating some of the proposed infrastructure improvements. Data for station SU19 have high pH and supersaturated dissolved oxygen levels that were likely caused by phytoplankton blooms.

Lake Superior Assessment

The main advantages of continuing to use water from Lake Superior for the Hatchery's water supply are its proximity, abundance, and general match to the desired water quality and temperature.

The main disadvantage of continuing to use Lake Superior water as the Hatchery's water supply is the potential presence or future presence of viral hemorrhagic septicemia (VHS) and invasive species (such as spiny water fleas and zebra mussels) in Lake Superior water. Their presence would render the water unsuitable for use in rearing fish for inland waterbodies. Currently, a **99% confidence interval** for removal of organisms is requested before fish reared in Lake Superior water can be stocked in inland waterbodies.

Also, due to the current condition of the water intake pipeline (discussed further in **Section IV, Component 1 – Lake Intake**), the Hatchery has been drawing water from the lake closer to shore, where water typically is warmer and contains higher quantities of sediment and debris. The main additional disadvantages to using Lake Superior water if the Hatchery continues to draw water from this shallower location are:

Table V-3. Lake Superior Water Quality Comparison

Water Quality Criteria for Aquaculture		LAKE SUPERIOR: Western Lake Superior (Surface: 0-13 ft), E of Beaver Bay, MN, Station SU19 (04/2000 - 08/2012)			Western Lake Superior (Mid Epilimnion: 8-36 ft), E of Beaver Bay, MN, Station SU19 (08/2001 - 08/2012)			Western Lake Superior (Deep Chlorophyll Layer: 36-106 ft), E of Beaver Bay, MN, Station SU19 (08/2003 - 08/2012)			Lake Superior, NE of Duluth, MN, MPCA 16-0001-00-N003 (05/1967 - 09/1981)			Lake Superior, S of Two Harbors, MN, MPCA 16-0001-00-N004 (10/1980 - 09/1981)		
Parameter	Concentration (mg/L)	Average (mg/L)	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)	Minimum (mg/L)	Maximum (mg/L)	Average (mg/L)	Minimum (mg/L)	Maximum (mg/L)
Temperature (C)																
Alkalinity (as CaCO3)	50-300	42.7	41	45	42.6	41	44	42.7	42	44	44.3	40	48	45.1	42	52
Aluminum (Al)	<0.01															
Ammonia (NH3-N unionized)	<0.0125 (Salmonids)										0.10	0.02	0.20	0.02	0.02	0.02
Ammonia (TAN) Cool-water fish	<1.0															
Ammonia (TAN) Warm-water fish	<3.0															
Arsenic (As)	<0.05										0.001	0.001	0.001	0.001	0.001	0.001
Barium (Ba)	<5															
Cadmium (Cd)																
Alkalinity < 100 mg/L	<0.0005										0.000022	0.000022	0.000022	0.000029	0.000029	0.000029
Alkalinity > 100 mg/L	<0.005															
Calcium (Ca)	4-160										31.6	25	36	31.9	27	38
Carbon Dioxide (CO2)																
Tolerant Species (tilapia)	<60															
Sensitive Species (salmonids)	<20															
Chlorine (Cl)	<0.003															
Copper (Cu)																
Alkalinity < 100 mg/L	0.006										0.0015	0.0015	0.0015	0.00013	0.00013	0.00013
Alkalinity > 100 mg/L	0.03															
Hardness, Total (as CaCO3)	>100				47.9	46	53				44.8	35	56	41.9	35	49
Hydrogen cyanide (HCN)	<0.005															
Hydrogen sulfide (H2S)	<0.002															
Iron (Fe)	<0.15															
Lead (Pb)	<0.02										0.0005	0.0005	0.0005	0.0004	0.0004	0.0004
Magnesium (Mg)	<15										10.7	10	12	10.6	10	12
Manganese (Mn)	<0.01															
Mercury (Hg)	<0.02										0.00018	0.00018	0.00018	0.0001	0.0001	0.0001
Nitrogen (N2)	<110% total gas pressure										0.29	0.25	0.31	0.30	0.28	0.34
	<103 % as nitrogen gas															
Nitrite (NO2)	< 1, 0.1 in soft water										0.02	0.02	0.02			
Nitrate (NO3)	0-400 or higher										0.35	0.12	0.48			
Nickel (Ni)	<0.1										0.001	0.001	0.001	0.001	0.001	0.001
Oxygen Dissolved (DO)	>5	11.6	8.4	13.6	11.1	8.4	13.2	12.4	9.4	13.2	11.7	7.5	14.4	12.5	10.9	13.9
	> 90 mm Hg partial pressure															
Ozone (03)	<0.005															
PCB's	<0.002															
pH	6.5-8.5	8.1	5.7	10.0	8.5	7.8	9.8	8.2	7.6	9.6	7.5	7.0	7.9	7.4	7.0	7.8
Phosphorous (P)	0.01-3.0	0.002	0.000	0.003	0.002	0.000	0.004	0.002	0.001	0.003	0.02	0.005	0.05	0.02	0.005	0.03
Potassium (K)	<5															
Salinity	depends on salt or fresh species															
Selenium (Se)	<0.01															
Silver (Ag)	<0.003															
Sodium (Na)	<75															
Sulfate (SO4)	*<50*										5.5	5.5	5.5	8.6	2.1	15.0
Sulfur (S)	<1															
Total dissolved solids (TDS)	<400 (site specific and species															
	specific; use as rough guideline)															
Total suspended solids (TSS)	<80										1.6	0.4	5.2	2.5	0.5	6.8
Turbidity	<50 NTU's	0.3	0.0	0.8	0.3	0.1	0.6	0.3	0.2	0.4	5.0	0.8	22.0			
Uranium (U)	<0.1															
Vanadium (V)	<0.1															
Zinc (Zn)	*<0.005*										0.0029	0.0029	0.0029	0.0058	0.0058	0.0058

Aquaculture Values Compiled from Meade 1991; Piper et al., 1982; Lawson, 1995

Note: Yellow Highlighted Values indicate Levels outside of recommended aquaculture criteria

- The occurrence of warmer-than-desired water temperatures for prolonged periods during summer.
- Intake of increased quantities of sediment and debris and thus decreased water clarity, especially during storm events and heavy spring runoff.
- Sediment and debris clog the bag filtration system, which must then be cleaned more frequently, and may also interfere with the effectiveness of the UV disinfection.

Lake Superior Conclusions

Lake Superior meets most general aquaculture related requirements to rear fish at FRH. This water supply has been used successfully over many years but recent concerns about biosecurity and open water sources have led to it being a less than ideal water supply source. However, temperature management and influent water treatment can be added to meet biosecurity requirements (see Discussion below for further biosecurity related information). In comparison, the other evaluated water supply sources (see below) either do not provide the required water quantity or they were determined to be cost prohibitive.

French River Evaluation

Many hatcheries obtain their water supplies from nearby rivers. The Upper hatchery does not currently use water from the French River as part of its water supply; however, the Lower Spawning location previously used river water for a portion of its water supply. Use of the French River as a water supply has been evaluated due to the river's proximity to the Hatchery.

French River Water Temperature

As with most Lake Superior tributaries, the French River has a highly variable flow dominated by snowmelt and precipitation with very little base flow. Between March 1994 and May 2009, the MNDNR measured the French River's flow via a gauge installed between the smolt trap and adult trap above the weir. During this period, the average measured flow was 24 cubic feet per second, the minimum flow was 0 cubic feet per second, and the maximum flow as 1,838 cubic feet per second. Low flows generally correspond with either winter or drought conditions.

During 2012, the Hatchery recorded the water temperature of the French River at two locations twice per month in accordance with their NPDES/SDS Permit (Permit No. MN0004413). Average water temperatures ranged from a minimum of approximately 32^{o}F from November through February to a maximum of approximately 74^{o}F in July. These temperatures are similar to those recorded by the MPCA during their monitoring of the French River between 2002 and 2006. As discussed previously, according to the Hatchery Manager, the ideal temperature range for a water supply is 42^{o}F to 55^{o}F. While the Hatchery can adjust to brief temperature spikes to as high as 64^{o}F, prolonged periods of warm water, such as the river water temperatures recorded in July 2012, are a major concern.

French River Water Quality

French River water quality data was compared to the recommended fish hatchery water quality standards for a variety of parameters in **Table V-4**. The data sets are limited to two MPCA sites S001-754 and S000-255 at County Road 50 at U.S. Highway 61 at the NPDES discharge station SW001.

French River water quality and temperature is characterized by high variability depending upon time of year and flow. There are small exceedences in trace metals: aluminum, cadmium, copper and zinc. Iron and manganese were above criteria in some samples. Total suspended solids (TSS) is highly variable with values of <1 mg/l to over 270. Turbidity and TSS in French River Water would require filtration to consistently meet clarity for salmonid culture.

French River Assessment

The main advantages of using water from the French River as the water supply for the Hatchery are ease of access and lower probability of containing invasive species compared to Lake Superior.

The main disadvantages of using water from the French River as the Hatchery's water supply are:

- The river has limited baseflow and a highly variable flow rate; therefore, it is doubtful that it could reliably supply the quantity of water necessary to serve as the Hatchery's sole water supply.
- Intake of increased quantities of sediment and debris and thus decreased water clarity, especially during storm events and heavy spring runoff.
- Sediment and debris clog the bag filtration system, which must then be cleaned more frequently, and may also interfere with the effectiveness of the UV disinfection system.

Table V-4 French River Water Quality Comparison

Water Quality Criteria for Aquaculture		FRENCH RIVER								
		French River upstream of French River Hatchery NPDES Station SW001 *(01/2007 - 10/2012)*			**French River at Hatchery at US-61** MPCA EDA Site S000-255 *(07/1973 - 08/2012)*			**French River at County Road 50** MPCA EDA Site S001-754 *(08/2001 - 10/2008)*		
Parameter	**Concentration** *(mg/L)*	**Average** *(mg/L)*	**Minimum** *(mg/L)*	**Maximum** *(mg/L)*	**Average** *(mg/L)*	**Minimum** *(mg/L)*	**Maximum** *(mg/L)*	**Average** *(mg/L)*	**Minimum** *(mg/L)*	**Maximum** *(mg/L)*
Temperature (C)										
Alkalinity (as CaCO3)	50-300				60.2	18	100	49.8	17	100
Aluminum (Al)	<0.01				0.21	0.21	0.21			
Ammonia (NH3-N unionized)	<0.0125 (Salmonids)				0.16	0.02	0.85			
Ammonia (TAN) Cool-water fish	<1.0									
Ammonia (TAN) Warm-water fish	<3.0									
Arsenic (As)	<0.05				0.006	0.001	0.01			
Barium (Ba)	<5				0.016	0.01	0.02			
Cadmium (Cd)										
Alkalinity < 100 mg/L	<0.0005				0.009	0.00001	0.01			
Alkalinity > 100 mg/L	<0.005									
Calcium (Ca)	4-160				41.4	16	90			
Carbon Dioxide (CO2)										
Tolerant Species (tilapia)	<60									
Sensitive Species (salmonids)	<20									
Chlorine (Cl)	<0.003									
Copper (Cu)										
Alkalinity < 100 mg/L	0.006				0.010	0.0012	0.027			
Alkalinity > 100 mg/L	0.03									
Hardness, Total (as CaCO3)	>100				65.3	24	146			
Hydrogen cyanide (HCN)	<0.005									
Hydrogen sulfide (H2S)	<0.002									
Iron (Fe)	<0.15				0.50	0.01	1.9			
Lead (Pb)	<0.02				0.011	0.0002	0.062			
Magnesium (Mg)	<15				24.1	6	60			
Manganese (Mn)	<0.01				0.019	0.005	0.082			
Mercury (Hg)	<0.02				0.0004	0.0001	0.0019			
Nitrogen (N2)	<110% total gas pressure				0.22	0.02	2.1	0.10	0.05	0.44
	<103 % as nitrogen gas									
Nitrite (NO2)	< 1, 0.1 in soft water				0.02	0.01	0.07			
Nitrate (NO3)	0-400 or higher				0.20	0.05	1.0			
Nickel (Ni)	<0.1				0.012	0.001	0.048			
Oxygen Dissolved (DO)	>5				11.5	7.4	15.2	11.3	7.3	15.0
	> 90 mm Hg partial pressure									
Ozone (03)	<0.005									
PCB's	<0.002									
pH	6.5-8.5				7.9	7.1	8.6	7.7	6.5	8.7
Phosphorous (P)	0.01-3.0	0.022	0.01	0.16	0.065	0.005	0.62	0.045	0.003	0.33
Potassium (K)	<5				1.3	0.5	2.9			
Salinity	depends on salt or fresh species									
Selenium (Se)	<0.01				0.0019	0.001	0.002			
Silver (Ag)	<0.003									
Sodium (Na)	<75				4.3	1.1	13			
Sulfate (SO4)	*<50*				9.3	3.2	24.6			
Sulfur (S)	<1									
Total dissolved solids (TDS)	<400 (site specific and species specific; use as rough guideline)				109	57	319	100	61	200
Total suspended solids (TSS)	<80	3.9	0.1	146	3.8	0.4	19	18.7	1.0	270
Turbidity	<50 NTU's				4.1	0.5	21	13.2	0.0	150
Uranium (U)	<0.1									
Vanadium (V)	<0.1									
Zinc (Zn)	*<0.005*				0.017	0.0015	0.065			

Aquaculture Values Compiled from Meade 1991; Piper et al., 1982; Lawson, 1995

Note: Yellow Highlighted Values indicate Levels outside of recommended aquaculture criteric

- The occurrence of warmer-than-desired water temperatures for prolonged periods during the summer.
- The occurrence of anchor ice on river bedrock in winter, which could interfere with water intake.

French River Conclusions

The FRH does not provide reliable, consistent flow, water quality or temperature ranges needed for cold water hatchery operation and further consideration is not recommended.

Groundwater Supply Evaluation

The FRH wishes to explore the potential for a groundwater-based water supply due to problems associated with aquatic invasive species in Lake Superior, the source of the current hatchery supply. Normal water use at the Hatchery averages about 500 gallons per minute (gpm), with peak use of about 800 gpm. During the years 2007 – 2011, the Hatchery reported total annual water use averaging about 269 million gallons per year. We understand the target yield for a replacement groundwater supply is about 200 gpm.

The following readily-available literature and data sources were reviewed in making an initial assessment of the potential for a groundwater-based water supply:

- Hydrologic Atlas HA-582
- Water appropriation permits and water use data published by the Minnesota Department of Natural Resources
- Review of water well construction records in the County Well Index (CWI), as maintained by the Minnesota Department of Health

The following paragraphs summarize and interpret the information obtained from these data sources.

Hydrogeologic Setting

Bedrock in the vicinity of the Hatchery is a very thick succession of southeastward-dipping lava flows, the North Shore Volcanic Group, that overlie the metamorphosed sedimentary rocks that are exposed in the extreme northern part of the watershed (**Figure V-2**) (Olcott, et al., 1978). In general, unweathered metamorphic and igneous rocks have very low porosity and permeability, although secondary porosity developed through fracturing and weathering can appreciably increase water-transmitting properties. Fracturing in crystalline rocks may decrease with depth (Fetter, 2001) Water is most often derived from small and/or relatively disconnected fractures in the rock that do not produce large quantities of water (Davis and DeWiest, 1966). Well yields in igneous and metamorphic rocks are typically limited to about 20 gpm in most localities (Davis and DeWiest, 1966).

Unconsolidated geologic materials above the bedrock consists of stratified clay with some silt, sand and ice-rafted boulders (**Figure V-3**) (Olcott, et al., 1978). Clay does not have sufficient permeability to yield water in the quantities needed by the Hatchery. A water supply might be developed if lenses of sand were present with sufficient permeability, thickness, and connection to a source of recharge.

Review of water appropriation data did not reveal any other permitted water users within 2 miles of the Hatchery.

On-Site Wells

There are three existing wells on the site for domestic needs and limited hatchery use:

No.	Depth	Year Installed	Casing Size	Flow	Pump Type	Location
Well No. 1	150’	1962	8”	UNK	Submersible	Near Shop Bldg.
Test Well No. 2	500’	1979	6”	UNK	None	Near Office Bldg.
Well No. 3	145’	1995	6”	UNK	Submersible	Near Lower Spawning Bldg.

Well No. 1 has three service connections and serves the upper hatchery’s domestic needs. Well No. 2 is an artesian well that contains no pump. It is reported that this flowing well is in good condition and is connected to a cistern. This water is used to fill transportation units and is free from AIS issues. The water quality is variable, especially pH and is adjusted by a treatment system in the Lower Spawning Facility. Well No. 3 is stored in a hydropneumatic tank (40 gallons). A fourth well was installed in 1930 (154’ deep) but was sealed and abandoned in 1992.

Local Area Well Logs

Local area well logs contained in the CWI were reviewed in order to confirm the geologic materials reported at a regional scale and to evaluate the potential for water-yielding formations that may not have detected at the larger scale. A total of 21 wells were identified within 1 mile of the Hatchery (**Table V-5**). The following observations are drawn from these data:

- All of the 21 wells were completed in bedrock.
- The wells ranged in depth from 52 to 653 feet below ground surface (bgs). No significant sand units were reported in any of the well logs. Bedrock was encountered in the wells from 0 to 58 feet bgs, and was encountered within 25 feet in most wells.
- All of the wells were small-diameter and relatively low capacity (i.e., 20 gpm or less).
- More than half of the wells had been test pumped. All of the wells with reported tests had very low specific capacities, i.e., 0.1 gpm/ft or less. The specific capacity is a measure of the yield of the well per foot of drawdown (water level reduction in the well).

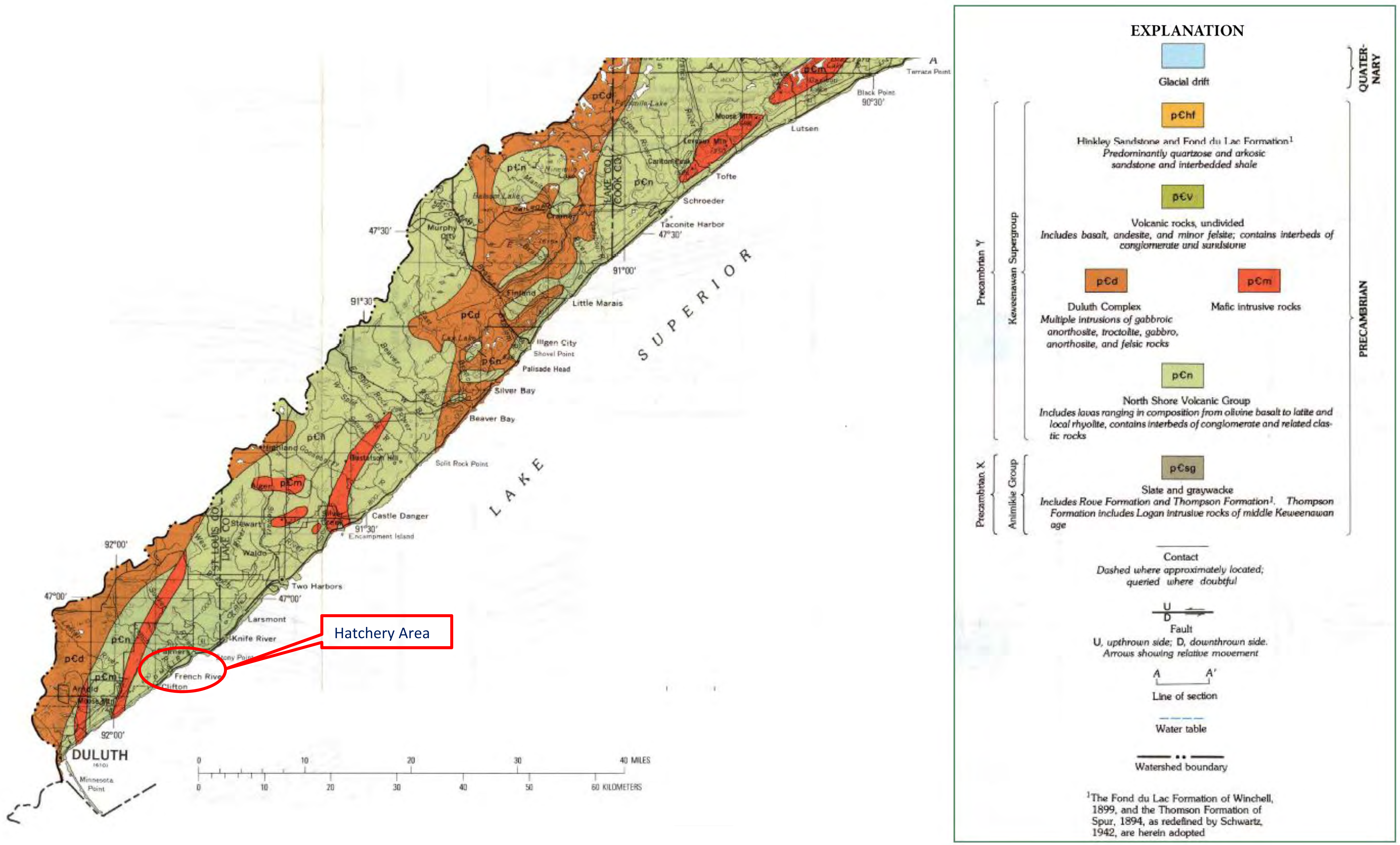


Figure V-2. Bedrock Geology (from Olcott, et al., 1968)

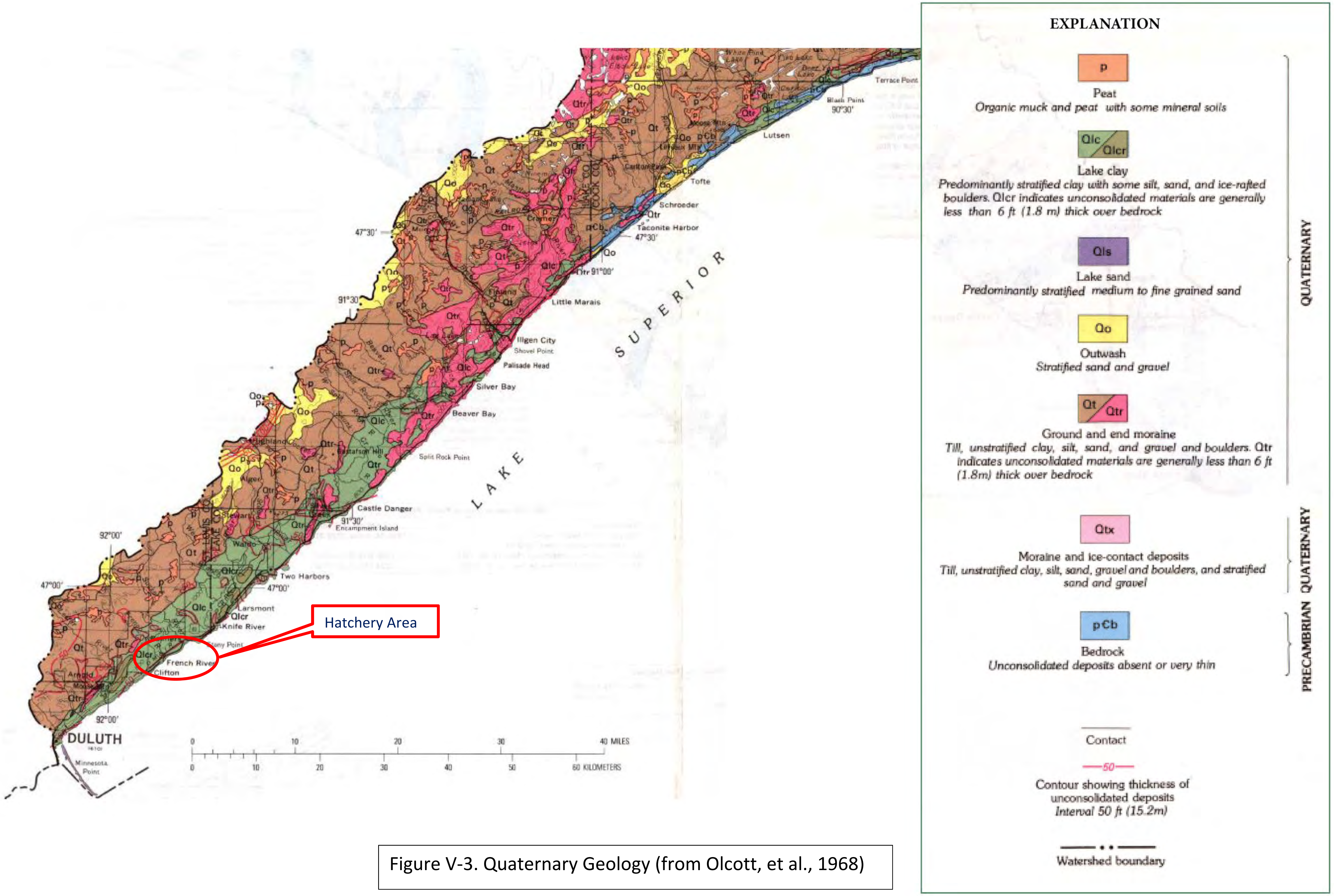


Figure V-3. Quaternary Geology (from Olcott, et al., 1968)

Table V-5. CWI Data on Nearby Wells

Unique Number	Location	Depth (ft)	Depth to Bedrock (ft)	Nominal Pump Capacity (gpm)	Specific Capacity (gpm/ft)
109514	51N 12W 18 ad	265	0	NR	NR
148984	51N 12W 18 bd	205	28	NR	0.027
199205	51N 12W 17 abc	245	35	NR	NR
249415*	51N 12W 17 ccac	643	NR	NR	NR
258149	51N 12W 17	224	NR	NR	NR
261312	51N 12W 17 ccab	653	NR	NR	NR
263074	51N 12W 16 bcad	NR	NR	NR	NR
265644	51N 12W 17 cacb	659	NR	NR	NR
412737	51N 12W 17	165	46	8	0.039
469082	51N 12W 17	285	23	NR	0.007
486817	51N 12W 17	327	5	10	0.002
493684	51N 12W 17	185	30	NR	NR
523303	51N 12W 18 adc	405	NR	7	0.106
546672	51N 12W 18	165	16	NR	0.048
557750	51N 12W 17 cbc	205	26	10	0.026
557751	51N 12W 16 bbb	245	58	10	0.022
569132*	51N 12W 17	145	7	20	NR
575469	51N 12W 18	205	14	NR	NR
579291	51N 12W 16 bbb	350	37	7	0.002
606188	51N 12W 18 ddd	185	6	NR	0.008
642900	51N 12W 19 abc	205	4	NR	0.006
654726	51N 12W 18 bad	52	17	NR	NR
656203	51N 12W 17 add	125	28	NR	NR
724530	51N 12W 17	204	58	10	NR
729492	51N 12W 17 cac	500	26	12	0.026
752770	51N 12W 19 aab	160	13	10	0.054

NR = not reported * = FRH on-site well No. 1, No. 3

Groundwater Conclusions

The observation that all of the wells in the area are completed in bedrock suggests that the unconsolidated materials overlying the bedrock are thin and not suitable for water supply development. Therefore, the shallowest and cheapest reliable source of groundwater in the area is the bedrock. Bedrock wells in the area produce small yields. Based on specific capacity information, wells producing 100's of gpm should not be expected. A water supply producing 10's of gpm may be possible, although multiple wells may be necessary to achieve this yield.

Domestic Water Supply Evaluation

Duluth's Lakewood drinking water plant is at Lakewood Rd and HWY 61, about a mile from the hatchery. Water goes farther east-northeast to McQuade Rd.

The Lakewood water plant uses a Lake Superior intake that was installed in 1890. The pipe is cast iron or steel. The intake is reported as a stone filled timber crib covered by grating. The intake is believed to be 10 ft off the bottom of the lake, 1500 ft from shore and 72 ft deep. The pipe is on the lake bed until it approaches shore. Then there is 300 ft of rock trench and then 300 ft of rock tunnel in town. The water is pumped to a settling tank and then goes to a gravity sand filter before being chlorinated.

According to the Chief Engineer of Utilities, Duluth has no plans to extend water service farther east-northeast than McQuade Rd. Normally water is only extended when the user(s) pay for all of the installation.

The hatchery has recently been averaging lake water flow of 500 gpm which is 216,000 CCF/month where the rate would be $1.93/CCF and an 8" meter would probably be needed with a fixed monthly charge of $182. Costs related to extending the water supply pipeline from McQuade Road to the hatchery would also need to be budgeted.

The city water is chlorinated. The hatchery would have to dechlorinate any water it purchased from the city for aquatic use.

Domestic Water Conclusions

It will be cost prohibitive to utilize domestic City water for hatchery production primary use both with respect to extending the pipeline and the monthly fees. In addition, the water would require dechlorination before use for fish production which is risky and can be costly to install and requires constant chemical addition and associated operational costs.

Water Supply Conclusions

Options for alternative water supply sources (French River, groundwater wells, purchased domestic source) have been examined and are not determined to be viable alternative sources to Lake Superior. Continued use of Lake Superior water is required to operate the facility. Highest priority to FRH facility improvements should be given to repair and improvements of the existing lake water intake and to the lake water treatment system. These systems are key water system components that must be addressed for long-term operation of the facility.

Biosecurity and Invasive Species Issues

The use of the Lake Superior water supply and wild capture steelhead and Kamloop rainbow trout subjects the FRH to a variety of potential aquatic invasive species and aquatic disease issues. MNDNR has implemented strict statewide invasive species regulations to limit the introduction, spread, and establishment of invasive species. Operational Order 113 outlines detailed policies, procedures and responsibilities of MNDNR staff to reduce the impact of invasive species.

Operation Order 113 provides policy and procedures for prevention and management of invasive species including intentional movement of equipment, intentional movement of organisms (fish), identifying potential invasive species and implementing management strategies at the site level. The use of the Lower Spawning Facility and established MNDNR procedures for the separation of spawning, egg disinfection, pathogen testing and confirmation of fish health status has provided important steps in establishing facility biosecurity. Additional biosecurity BMP's and infrastructure improvements will likely be required to achieve the level of biosecurity desired by MNDNR.

Biosecurity Concerns at FRH

The present condition of the Lake Superior water supply intake and treatment equipment used to provide water system biosecurity and invasive species control is impacted by the following:

1. 20-inch diameter lake intake pipe is broken at approximately 400 ft. from shore and is laying on the lake bottom without intake screening to control entry of wild fish.
2. Sediment and turbidity in lake water levels are higher than originally observed levels when the 1,400-foot long intake and elevated 90-degree intake screen with ½ inch slot openings was operational. The sediment and turbidity increase requires more frequent manual cleaning of automatic backwashing 230 micron bag filters used to control wild fish, eggs and spiny water flea (*Bythotrephes longmonies)* and zebra / quagga mussel veligers (*Dreissena polymorpha D. bugensis)*.
3. The efficiency of the bag filtration and UV disinfection system is unknown. The design dose of the present UV system is not known nor is it measured using water flow, %UVT (UV Transmittance) or measured UV intensity. However, there have been no documented instances of zebra mussel or quagga mussel veligers or adults, spiny water flea or VHS virus infestation at FRH to date.
4. The disposal and effluent processing of grit separator and bag filter backwash occurs within the present hatchery wastewater solids clarification system without any type of additional treatment to kill potentially backwashed organisms. However, no invasive species have been discovered to date in the hatchery effluent treatment system.

Zebra and Quagga mussel veliger filtration media requirements are 40 microns. MNDNR is using 35 microns at other facilities. The present level of bag filtration is 230 microns versus the 40 micron minimum recommended level which is 5.7 times smaller than the present bag filters. The inactivation of mussel veligers by UV is in the industry reported range of 100 to120 MJ which is believed to be considerably higher than the dose of the FRH UV system that is now over 33 years old. The UV dose to be applied in the improved UV system potentially has a wide range of options from 30MJ to 120MJ and is dependent upon input from MNDNR based on risk and target disease inactivation goals. This report is recommending using the 40 MJ dose for planning purposes. MNDNR will need to make a decision about what level of UV dose will be required.

Options to provide improved levels of water supply system biosecurity treatment are presented in **Section IV** of this report.

What is Biosecurity?

The USDA North Central Regional Aquaculture Center (NCRAC) describes biosecurity as:

> *The practices, procedures and policies used to prevent the introduction and spread of disease causing organisms (e.g., bacteria, viruses, fungi, parasites) as well as many aquatic invasive species (e.g., zebra mussels, rusty crayfish) (Dvorak, 2009).*

Based on these definitions, biosecurity can be a broad-spectrum first line of defense against many pathogens and invasive species. For example, Lake Superior includes Zebra and Quagga Mussels, spiny water flea, round goby, Eurasian ruffe, New Zealand mudsnail, VHS (viral hemorrhagic septicemia), and other known and unknown forms. One of the most affordable and effective ways to minimize pathogen or invasive species introduction to a facility and inhibit regional spread is to implement a biosecurity program at the facility level. Although a certain pathogen invasive species may provide incentive to start managing an aquaculture facility in a new way, it is important to acknowledge that biosecurity is not pathogen or species specific. A more detailed biosecurity overview of general issues and best management techniques is provided in **Appendix F**.

Best Management Practices Recommendations

The Biosecurity Overview (see **Appendix F**) lists 15 major examples of biosecurity Best Management Practices (BMP's) and a brief explanation of each action and how it may be used to reduce biosecurity risk. This narrative will briefly summarize the status of each action item and will identify recommended design features.

1. Facility Layout Considerations

To the extent possible, MNDNR should provide controlled access to limit staff and public access to propagation facilities. This action will limit introduction and/or spread of pathogens or AIS. This would include access control, signage, and public education.

Status: Implemented.

Recommendation: Better yellow biosecurity signage at entry doors.

2. Quarantine/Isolation Facilities

Normally, there is a requirement to provide isolation or true separation from the hatchery production area when eggs or broodstock are brought to a hatchery facility. This function is now provided by the use of the Lower Spawning Facility that allows for isolation of wild fish holding and spawning, disinfection of the eggs, and disease status verification prior to moving eggs to the main hatchery. This physical separation of systems provides a location to determine the fish health status of incoming eggs before movement to the main facility to reduce hatchery production risks. In some cases a facility may require effluent disinfection to prevent potential infection of the receiving waters. Effluent is not currently treated from the Lower Spawning Facility. The disinfection of effluent is from the Lower Spawning Facility is not warranted or required since this facility drains directly into the outlet of the French River where adults during spawning runs have access.

Status: Implemented with Lower Spawning Facility and Captive KRSTT broodstock building biosecure spawning.

3. Clean and Disinfect All Equipment on a Routine Basis

(See Item #4 narrative.)

Status: Implemented.

4. Clean and Inspect Delivery Vehicles and Equipment

Implementation plans to disinfect equipment on a routine basis should be established. Application of disinfectants and recovery of disinfection effluents should be addressed in a BMP plan along with the disinfection of fish delivery and management vehicles. The facility should include a dedicated egg disinfection area, along with equipment, and vehicle disinfection systems including safe methods of application and disposal. At FRH, recovery of disinfection effluents would require the installation of off-line underground containment vaults or a trailer mounted tank for capture of chemical effluents since drains return to the French River and Lake Superior. Disposal of captured disinfection effluent to a municipal treatment plant may be required if on-site detoxification by aeration or chemical methods is not feasible. Disinfection of equipment and tanks using UV light may be feasible but will require further investigation with a UV equipment manufacturer to confirm. The use of steam cleaning for disinfection is effective and recommended since it does not require disinfectant chemical recovery. Steam cleaning equipment is available at FRH for this purpose.

Status: Implemented. Disinfection of fish transportation vehicles occurs off station.

Recommendation: Install chemical holding vaults, utilize trailer mounted tanks or steam cleaning of equipment.

5. Choose Proper Equipment Materials

The use of porous materials that are difficult to disinfect such as wooden screens, stoplogs, and cages, should not be used. Hard surface materials are preferable as there is less chance of harboring dirt and pathogens.

Status: Replace wooden screens.

6. Minimize the Movement of Equipment (between Rearing Units and Facilities)

Separate equipment for each rearing unit should be provided and not shared with any other rearing unit. The equipment should also be disinfected prior to and after each use. Shared equipment and fish transportation vehicles should be disinfected per discussion in Items #3 and #4.

Status: Implemented-equipment is not shared and trucks disinfected per MNDNR use policy.

7. Disinfect Personnel and Visitor's Entering and Leaving

Use of footbaths, hand sanitation stations at entry points and biosecurity area signage at locations where biosecurity zone establishment is warranted should be implemented. Separate work gear when hatchery personnel work off site should be provided to minimize risk of disease transmission to the hatchery facility. Provide visitor access controls, as needed, to establish biosecurity areas.

Status: Implemented.

Recommendation: New yellow signage and new foot baths.

8. Minimize the Movement of Eggs and Animals between Sites

All wild collected eggs are to be disinfected using approved iodophors at the site of collection and again at the hatchery. Movement of fish from the wild to the hatchery should be eliminated. A biosecure isolated broodstock building is normally recommended to maintain separation of captive broodstocks from production fish. This function is being provided by the use of the Raceway Building and in-place procedures to treat and test eggs for fish health status before transfer. The use of dedicated isolation facilities can help reduce the risk of moving feral captured adults and eggs directly to production facilities before fish health status can be confirmed and disease free status verified. Isolation facility use could prevent the total depopulation and disinfection of the hatchery if a reportable disease outbreak was detected.

Status: Implemented.

9. Disease Testing and Monitoring Protocol

A disease monitoring protocol as a component of a **Hatchery Operational Plan** should be developed. Work with qualified fish health professionals to fine-tune the monitoring and reporting program as regulations and biosecurity recommendations as they evolve. MNDNR currently has fish health testing as a part of the established procedures used at the FRH.

Status: Implemented. Fish Health Monitoring system is in place.

10. Regularly Inspect and Remove Dead and Moribund Animals

Inspect and remove dead and moribund animals daily as a component of propagation sanitation. Disposal of mortalities is conducted by approved methods such as composting, incineration and landfill. We do recommend that the hatchery and satellite facilities be directed to prepare a detailed Annual Propagation Report that utilizes uniform electronic lot history data that can effectively track production statistics including mortality.

Status: Implemented.

Recommendation: Include production data in the Annual Propagation Report.

11. Disinfect Incoming and Outgoing Water

Disinfection of "open" surface water supply(s) is recommended. Unlike a groundwater source of supply, surface water is more likely to harbor pathogens including bacteria or viruses that could infect fish. With the use of UV or ozone or a combination of both, bacterial and viral outbreaks can be greatly reduced or eliminated. The Upper facility is disinfecting incoming water and new disinfection is recommended in this report for the Lower facility.

Disinfection of hatchery effluent is generally not required. However, when wild caught broodfish are brought to a hatchery and held in an isolated quarantine area for possible propagation use, the effluent of the facility could, if not disinfected, spread potential pathogens to other water resources.

Effluent disinfection is normally only required when adults are held in an isolation facility whose effluent drains into a watershed not impacted by a potential disease or invasive species. This is not the case a FRH where salmonid adults migrating out of Lake Superior are collected from the Lower French River, held and spawned in the Lower Spawning Facility whose effluent drains into the same location that the adults were collected in the river. For this reason, adults or non-certified disease free eggs are normally never moved to other watersheds. Only when a biosecurity risk to unimpacted waters downstream of a hatchery potentially impacted by disease or invasive species in the facility effluent water would effluent disinfection be required.

Disinfection of effluent from isolation facilities specifically designed to provide egg incubation and hatching until fish health testing and certification can be completed is technically feasible but generally is not required since egg treatment protocols provide for acceptable biosecurity. However, it should be noted that egg disinfection only treats pathogens on the egg surface, not inside the egg, so precautions would still be required. In specific cases where egg incubation water co-mixes with water used in other rearing units, disinfection or modification of effluent piping should be completed. Biosecurity risk to downstream water resources may influence the need to complete effluent disinfection.

Status: Incoming treatment improvements are recommended in this report. Effluent disinfection not warranted.

12. Properly Dispose of Transfer Waste and Water

This action was discussed under Items #3 and #4. Proper disinfection, disposal, and handling of transfer water are a part of providing adequate disinfection biosecurity at the hatchery facility.

Status: Implemented

13. Building Disinfection

Complete cleaning of the hatchery building should be completed once the stocking has been completed. There will be a short time period when the rearing tanks and rearing area will be de-populated and not actively be rearing or holding any fish. The area and tanks should be treated with a 1% solution of Virkon or 12.5% chlorine bleach mixture.

Status: Implemented

Recommendation: Paved floor in broodstock spawning building.

14. Maintain Good Records

We recommend that the use of consistent electronic lot history reporting for the hatchery facility be required. Biosecurity measure tracking can be added to the form for documentation. An **Annual Facility Production Report** summarizing the production highlights of the facility should be provided in a consistent format. Statistics including production, feed, stocking, cost of production, and operation and maintenance cost data should be included. Biosecurity and fish health monitoring highlights should be included in the annual report documents. A Hazard Analysis and Critical Control Points (HACCP) plan is another recommended document to specific Biosecurity actions to minimize impacts of outbreaks. FRCWH does not currently have a HACCP plan.

Status: No HACCP plan.

Recommendation: Prepare HACCP Plan. Improve Annual Production report per the above and provide staff administrative assistant to help prepare it. Recommend improvements in Annual Report to include revised cost of production and fish health data.

15. Chemical Storage

For visitor and personnel safety, code-compliant, chemical storage is recommended. Amenities include secondary spill containment and recovery, eye and emergency washing stations, complete material safety data sheets (MSDS), first aid equipment and supplies, appropriate fire extinguishing media, proper labeling and placards, proper ventilation, and absorbent materials. Proposed chemical storage should be divided and kept separate to allow for the storage of oxidizing chemicals (e.g., hydrogen peroxide and potassium permanganate). Fish therapeutant storage needs will also need to be addressed.

Status: Provide compliant chemical storage per recommendations in this report.

Water Supply Biosecurity Recommendations

Water supply biosecurity is a major operational concern for the FRH. The present Lake Superior hatchery water supply system has several required improvements that must be completed in order to provide a reliable hatchery supply source that meets biosecurity standards. Proposed treatment improvements could provide desired biosecurity to allow FRH to assume its original role of production and direct stocking of steelhead fry above migration barriers without off-station rearing. Currently, a **99% confidence interval** for removal of organisms is requested before fish reared in Lake Superior water can be stocked in inland waterbodies. As outlined in **Section IV** of this report, there are several components of the primary lake water supply system that must be improved and enhanced. These improvements include:

- Repair and enhance the existing damaged lake water supply pipeline and intake. The original pipeline is broken and operated without intake screening. Intake screening repair is needed to prevent wild fish entry into the water supply system. The broken pipeline is now located directly at the bottom of the lake and allows entry of excess sediment and turbidity. The increased sediment and turbidity negatively impacts the treatment of lake water by the vortex separator, bag filtration array and UV disinfection treatment components located in the mechanical room of the Nursery Building.

- The lake water supply treatment system consists of the slotted intake screen (currently not in service due to pipe break), pump station, vortex separator, bag filtration array and low pressure ultraviolet disinfection system. These water supply treatment components provide an unknown level of water supply biosecurity to the hatchery system. There is an unknown level of operational risk associated with the treatment system components due to their age, condition, configuration and lack of redundancy. However, there has been no known documented Lake Superior fish disease outbreaks or invasive species infestations in the FRH to date.

The performance of the present treatment system is not known and MNDNR has recognized that there is potential biosecurity rick associated with the use of the fish produced at this facility and has limited distribution to Lake Superior only or in rivers downstream of the first migration barrier. MNDNR is a member of the Great Lakes Fish Disease Control Committee established by the Great Lake Fishery Commission (GLFC) in 1973 and participates in the implementation of policies and procedures to reduce the risk of transferring serious disease agents into the Great Lakes Basin. All fish produced at French River Coldwater Hatchery are rigorously tested using established American Fisheries Society (AFS) Blue

Book Procedures for the Detection and Identification of Finfish and Shellfish Pathogens. French River Coldwater Hatchery fish health is continuously monitored by MNDNR's fish heath assessment program.

The French River Coldwater Hatchery production programs for steelhead and Kamloop rainbow trout employ recommended egg disinfection procedures and Enzyme-Linked Immunosorbent Assay (ELISA) testing for bacterial kidney disease as a routine part of all egg taking operations. MNDNR follows established procedures for the separation of wild fish spawning, double iodophore egg disinfection, pathogen testing and confirmation of the fish health status before moving gametes into FRH. The use of the Lower Spawning Facility and covered steelhead captive broodstock raceways provides physical separation of the spawning activities from the nursery production area.

However, the Lake Superior water supply source and treatment systems are unknown risk factors that need to be addressed for long-term viable operation of the facility. The discovery of Viral Hemorrhagic Septicemia IVb (VHS) virus in Lake Superior (a reportable disease of worldwide significance) is one example of a potential fish pathogen that potentially severely impacts the use of "open surface water supplies." The spiny water flea (*Bythotrephes longimanus,* zebra mussels *(Dreissena polymorpha)* and quagga mussels (*Dreissena bugensis)* are examples of Lake Superior AIS that have impacted the FRH operations.

Groundwater Supply (Wells)

The use of a constant temperature groundwater supply source certified to be free of biological material including possible infective agents is normally the recommended option for hatchery facility water source whenever possible. Unfortunately, the option to develop well(s) with hatchery production level capacities for the facility does not appear to be viable based upon the hydrogeological investigations completed in this report.

Surface Water Supply Options

The use of surface water supply options (French River or Lake Superior) both require filtration to remove biological materials / suspended matter and disinfection to kill pathogens. The use of the French River as the source water option for the French River Coldwater Hatchery has uncertain water quality, wide temperature ranges and variable seasonal flow characteristics that make its use problematic as discussed earlier in this Section.

The continued use of Lake Superior as the primary hatchery water supply option is complicated by the presence of known and unknown pathogens like viral hemorrhagic septicemia (VHS), invasive species known and unknown like spiny water flea, zebra and guagga mussels and a variety of non-endemic fishes. MNDNR has requested that this study outline options for providing a 99% confidence level for removal of invasive species and VHS in the Lake Superior water supply system. The following options outline some possible lake water treatment improvements to meet biosecurity goals. Note that some of the recommended treatment components are interrelated and require incremental steps to achieve biosecurity goals. Another design consideration is system redundancy and backup so that biosecurity is maintained under all operating conditions. **Section IV** of this report provides more detailed information about recommended improvements for each existing treatment component.

Intake Repair: Intake pipeline repair restores the original 1,400 feet off-shore length and reestablishes the depth to 58 feet deep. Thermal conditions at that depth avoid some of the summer warming events that have been problematic. Intake repair would replace the intake screen with the installation of a new intake filtration crib installed at the beginning of the pipeline in the lake similar to the one at the USEPA Duluth Minnesota Laboratory. The in-lake filtration crib provides filtering of wild-fish, many pathogens and suspended solids. It is essentially an underwater filter system consisting of graded stone, sand and perforated piping contained in a concrete crib. This type of filtration does not generally require backwashing. The potential use of an in-lake sand filter requires feasibility investigations beyond the level of this study to determine if it is viable for the FRH.

Replace Vortex Grit Separator: The existing grit separator performance and requirement for replacement can only be confirmed by more water quality testing. Plus, this requirement is dependent upon what other sediment removal system is selected for use at FRH. However, if required, a new cyclone separator technology can be sized to meet grit removal needs.

Replace Bag Filter Array: The present bag filtration system is 40 years old, rated head loss is relatively high, manufacturer ownership has changed, the new manufacturing owner has been unresponsive to operation questions and the filters have been clogging prematurely. The latter is probably due to inadequate backwash due to inadequate pressure from the lake pump which would be cost prohibitive to fix because it would increase operating cost. Existing filtration level for the spiny water flea is 230 micron media. **US Army COE Zebra Mussel Control Handbook** (Boelman, 1997) recommends 40 micron and MNDNR is using 35 micron in similar "open" hatchery water source filtration systems. The quantifiable impact of the bag filters on the hatchery's total suspended solids and water clarity which impacts the effectiveness of UV disinfection is not known. Manual cleaning of the filter media is required during storm events and is labor intensive. If the in-lake filtration system is deemed unsuitable, replacement of the bag filtration system with a stacked disc filtration system at 35 microns is one option.

UV Disinfection System: The existing UV array is composed low pressure UV lamps with manual wipers. Manufacturer-claimed dose is 30,000 micro watt seconds per square centimeter or 30 mJ but the actual performance of the system is unvalidated. There is no alarming, backup, monitoring or redundancy provided by the present system. Replacement is recommended with a validated 40 mJ dose amalgam lamp UV system with dose display, measured input, dose pacing and alarm functions. Dose pacing provides an automated method of matching the UV output of the system to the measured lake water transmittance and flow rate to maintain the UV dose at the required level. UV dose in the range of 40 mJ is the minimum recommended to provide wider UV inactivation of pathogens, protozoans and aquatic invasive species. Dose of 126 mJ is a more costly level that could be justified for even broader pathogen management explained in **Section IV**. Huber (April 2010) reported inactivation of VHS IVb virus at 99.9% (3-log reduction) requires a UV dose of 0.79 mJ and a 99.99% (4 log reduction) was achieved at 10 mJ. A recommended aquaculture hatchery UV dose of 40 mJ dose provides a safety factor of four times (4x) the 10 mJ VHSv dose and provides disinfection for some common bacteria and protozoans. This 40 mJ UV dose has been used successfully by HDR in several recent public fish hatchery designs. The proposed system can be upgraded in the future to accomplish the higher UV dose as long as provisions are provided in the design of the lower dose system. MNDNR will need to decide what level of UV dose is acceptable to meet biosecurity treatment goals.

Lower Spawning Building: Filtration and UV treatment for the Lower Spawning Facility is recommended similar to the Upper FRH if the facility is to be used for trout holding and distribution. **Section IV, Component 19** provides further details of the proposed Lower Spawning Building water treatment system alternatives.

Redundancy: The proposed in-lake filtration system will include a bypass wye to be used during construction and when filter maintenance is required. The in-lake filtration system is not redundant except that it would cover a relatively large area and have multiple perforated pipes so that some areas of the filter could clog while other areas continue to filter. The USEPA lab reports that the in-lake filter has operated since 1996 without maintenance. Diver observation of the filter indicates that only minor media loss has occurred. This type of filter would require periodic diver inspection. Filtration performance can be monitored over time and it is likely that loss of capacity will occur gradually indicating that maintenance is required. EPA was told that they might have to occasionally rake the sand filter but has seen no need yet.

The proposed stacked disc filter provides partial redundancy by the proposed subdivision of filtration into two (2) banks of filters with individual controls and backwashing booster pumps. Each bank has 16 individual filter vessels that allows some vessels to continue filtering while one or two are being backwashed or are off for maintenance.

The proposed UV treatment system provides partial UV treatment redundancy by subdivision of the system into two (2) separate units with dose pacing. At 60% power level each unit will provide 40mJ UV dose. When a UV unit is being maintained the remaining unit on line can operate at the 100% power level and provide UV treatment capacity near the design flow rate.

Other filters and UV units and configurations are possible and should be further evaluated during the design when better lake water quality data (including % UVT) has been obtained to correctly size the systems. If additional redundancy is requested, the in-lake crib and stacked disc filter could both be installed to provide back-up for each other. This would increase overall project costs though.

Risk / Benefits: This system provides a low maintenance in-lake filtration system that would also benefit the Lower Spawning Facility if it continues to share the intake. The in-lake system does not require backwash and causes less head loss; so, total flow requirements and pumping energy would be reduced. If the in-lake sand filter did break, it might be infeasible to repair quickly. This sand filter would probably even give cleaner output than stacked disc filters which would allow lower UV power and benefit almost everything downstream. This is the recommended filtration option but it needs to be evaluated further during design. Filtration is assumed to be adequate for the pre-conditioning of water for UV treatment but this must be confirmed by testing.

Hatchery System Operational Costs

Historical O&M Costs

Tables I-1A, 2A and 3A in **Appendix I** provide a cost of production summary and percent of total costs for the KAM, STT fry and fingerling and steelhead broodstock programs for fiscal years 2009, 2010 and 2011 respectively. Total operational and maintenance costs for the last three years were:

Date	Annual O&M Costs
FY 2009	$635,544
FY 2010	$627,885
FY 2011	$570,027
Average	**$611,152**

The portion of the production cost for each production program is illustrated in the tables. The KAM program is approximately 64% of the production cost, STT broodstock is 19.7%, and STT fry production 16.3%. If the STT fry and captive broodstock program costs are combined, they are 36% of the operating cost.

Tables I-1B, 2B and 3B in **Appendix I** provide the cost and percentage of the production costs assigned to each species program by MNDNR program cost categories for: specific labor, specific supplies, prorated labor, prorated operating cost, stocking labor, stocking expenses and hatchery renovation costs. Total labor costs (specific and prorated) are in the range of 58.4% to 62.2% of the total operating cost. Prorated operating costs are in the range of 33.8% ($205,743) to 34.2% ($191,719) of the total operating cost.

For the purposes of this study, operational costs include energy using electric, oil, propane, and wood pellets. Electricity is used in all buildings for lighting and power for pumps and some space heating. Number 2 fuel oil is used primarily for process water heating and space heating in the Nursery Building and Lower Spawning Building. Fuel oil is also used for the two emergency diesel generators. Propane is used for space heating in the residence, storage building and two garages.

Monthly fuel oil usage data is only available for the year 2010. Because of this, 2010 will be used for the current baseline energy consumption. The year 2010 also has the highest fish production of the last three years that electrical and wood pellet data is available. The following is a summary of the month by month energy usage data for 2010:

MONTH	ELECTRIC		OIL		WOOD		PROPANE	
	KWH	$	GAL	$	TON	$	GAL	$
Dec	42,172	3,541	0	$0	30	$4,527	115	$197
Nov	33,118	2,781	0	$0	10	$1,509	28	$48
Oct	41,544	3,489	1	$4	8	$1,207	23	$39
Sep	41,693	3,501	31	$109	10	$1,509	21	$36
Aug	43,586	3,660	271	$949	10	$1,509	21	$36
Jul	84,438	7,091	1	$4	10	$1,509	21	$36
Jun	84,826	7,123	86	$301	45	$6,791	21	$36
May	92,911	7,802	636	$2,226	75	$11,318	21	$36
Apr	85,063	7,143	1315	$4,603	90	$13,582	21	$36
Mar	77,042	6,470	1392	$4,872	105	$15,846	21	$36
Feb	72,634	6,099	1902	$6,657	95	$14,336	21	$36
Jan	74,801	6,281	3831	$13,409	40	$6,036	25	$43
Totals	**773,828**	**$64,982**	**9466**	**$33,131**	**528**	**$79,680**	**359**	**$614**

Total Yearly Cost (2010):	
Electricity	$64,982
Oil	$33,131
Wood	$79,680
Propane	$614
Total	***$178,408***

This illustrates that most of the O&M costs are related to energy consumption at this facility. As previously mentioned, the operating costs are about 34% of the annual budget for the facility or about an average of $198,731. For the above example, 93% of the costs are associated with energy. This report provides some suggestions for reducing overall energy costs in several areas.

The following assumptions were used in this calculation.

Average Unit Cost of Energy (2010):		
Electricity	0.084	$/kwh
Oil	3.5	$/Gal.
Average Wood Cost	150.91	$/ton
Propane	1.71	$/gal.

Projected O&M Costs

Table V-6 provides a summary of the FY2009-FY2011 MNDNR reported fish production program costs for FRH and estimates of annual operating and maintenance costs for the following scenarios:

- Current Production Levels
- Current Production Levels with Infrastructure Improvement Benefits
- Future Production Increase (plus 20% biomass)

The estimates are based on a limited amount of operational cost information provided in the FY Annual Reports. Many assumptions were used to prepare these estimates including:

- Annual Cost of Inflation is 4% per year. Estimates are in 2013 dollars.
- Labor breakdown is assumed at 50% for fish production and 50% for maintenance of equipment. Proposed renovations are assumed to shift labor effort to 25% for maintenance and 75% for fish production activities. No actual labor cost savings are realized but fish production will benefit.
- Energy Savings associated with infrastructure improvements (see energy savings narrative in this section) will provide a minimum of 15% annual operational cost savings.
- FRH Hatchery production levels are based on the 3-year average of the FY2009-FY2011 production and the 20% biomass increase is also based on this average.
- The improvements and increased future fish production levels assumes that the improved water supply treatment infrastructure will provide assurance of fish biosecurity and control of invasive species and disease to allow the direct stocking of fry, fingerlings and yearlings produced at FRH similar to years before the stocking restrictions. However, MNDNR management will need to determine whether biosecurity and invasive species concerns have been adequately addressed before moving FRH reared fish inland.
- Operational Cost forecasting using the Annual Report data provided in the FY2009-FY2011 reports is accurate and is comparable to the new SWIFT MNDNR cost accounting system. Limited SWIFT cost accounting information was available to the consultant team.
- Full-Time Equivalents (FTE) ranged from 4.2 to 5.8 from FY2009-FY2011 or an average of 5.1 FTE. Recommendations in this report suggest 4.5 FTE be used for current production levels (higher than the current 3.2). O&M calculations used the 4.5 FTE.

Using the average fish production O&M costs reported from FY 2009 to FY2011 as a base, O&M costs were calculated for comparing average production before and after the recommended improvements are implemented and these are also compared to a 20% increase in fish production. These comparisons are summarized below.

Table V-6. FRH Program Cost Summary and Projections

FY2009	Program Costs	KAM	%	STT	%	STT-BRD	%	LAT-MNT	%	F-699	%	TOTAL ALL PROGRAMS	%
No. Fish	Specific Labor Cost	$100,331	25.1	$28,767	29.0	$30,204	28.4	$535	34.4	$599	32.8	$160,435	26.4
673,641	Specific Supplies Cost	$25,502	6.4	$172	0.2	$6,860	6.5	0	0.0	0	0.0	$32,534	5.3
Lbs. Fish	Prorated Labor Costs	$127,420	31.9	$32,665	33.0	$33,649	31.7	$497	31.9	$596	32.7	$194,828	32.0
34,305	Prorated Operating Cost	$134,559	33.7	$34,495	34.8	$35,534	33.4	$525	33.7	$630	34.5	$205,743	33.8
	Total Production Cost	$387,811	97.1	$96,100	97.0	$106,247	100.0	$1,557	100.0	$1,825	100.0	$593,540	97.6
	Stocking Labor	$11,406	2.9	$2,999	3.0	0	0.0	0	0.0	0	0.0	$14,405	2.4
	Stocking Expenses	$359	0.1	0	0.0	0	0.0	0	0.0	0	0.0	$359	0.1
	Total Stocking Cost	$11,765	2.9	$2,999	3.0	0	0.0	0	0.0	0	0.0	$14,764	2.4
	Grand Total Program Cost	**$399,576**	100.0	**$99,098**	100.0	**$106,247**	100.0	**$1,557**	100.0	**$1,825**	100.0	**$608,304**	100.0

Program Costs				
Specific Labor Cost	$160,435	25.2		
Specific Supplies Cost	$32,534	5.1	5.8	FTE
Prorated Labor Costs	$194,828	30.7	$355,263	All labor
Prorated Operating Cost	$205,743	32.4	$238,277	OM & supplies
Total Production Cost	$593,540	93.4	$593,540	
Stocking Labor	$14,405	2.3		
Stocking Expenses	$359	0.1		
Total Stocking Cost	$14,764	2.3		
Grand Total Program Cost	**$608,304**	95.7		
Hatchery Renovation Cost	$27,240	4.3	Hatchery Renov. $	$27,240
Total All Costs	**$635,544**	100.0	Total All Costs	**$635,544**

FY2010	Program Costs	KAM	%	STT	%	STT-BRD	%	LAT-MNT	%	F-699	%	TOTAL ALL PROGRAMS	%
No. Fish	Specific Labor Cost	$113,291	27.7	$31,715	32.5	$36,981	31.3	$0	0.0	$0	0.0	$181,987	29.1
819,212	Specific Supplies Cost	$40,251	9.8	$1,394	1.4	$4,857	4.1	0	0.0	0	0.0	$46,502	7.4
Lbs. Fish	Prorated Labor Costs	$118,195	28.9	$30,198	31.0	$35,673	30.2	$0	0.0	$0	0.0	$184,066	29.4
45,103	Prorated Operating Cost	$129,194	31.5	$33,008	33.9	$38,993	33.0	$0	0.0	$0	0.0	$201,195	32.2
	Total Production Cost	$400,931	97.9	$96,316	98.8	$116,504	98.7	$0	0.0	$0	0.0	$613,751	98.2
	Stocking Labor	$8,616	2.1	$1,119	1.1	1,503	1.3	0	0.0	0	0.0	$11,238	1.8
	Stocking Expenses	$64	0.0	12	0.0	0	0.0	0	0.0	0	0.0	$76	0.0
	Total Stocking Cost	$8,680	2.1	$1,131	1.2	1,503	1.3	0	0.0	0	0.0	$11,314	1.8
	Grand Total Program Cost	**$409,611**	100.0	**$97,446**	100.0	**$118,007**	100.0	**$0**	0.0	**$0**	0.0	**$625,065**	100.0

Program Costs				
Specific Labor Cost	$181,987	29.0		
Specific Supplies Cost	$46,502	7.4	5.2	FTE
Prorated Labor Costs	$184,066	29.3	$366,053	All labor
Prorated Operating Cost	$201,195	32.0	$247,697	OM & supplies
Total Production Cost	$613,751	97.7	$613,750	
Stocking Labor	$11,238	1.8		
Stocking Expenses	$76	0.0		
Total Stocking Cost	$11,314	1.8		
Grand Total Program Cost	**$625,065**	99.6		
Hatchery Renovation Cost	$2,820	0.4	Hatchery Renov. $	$2,820
Total All Costs	**$627,885**	100.0	Total All Costs	**$627,885**

FY2011	Program Costs	KAM	%	STT	%	STT-BRD	%	LAT-MNT	%	F-699	%	TOTAL ALL PROGRAMS	%
No. Fish	Specific Labor Cost	$78,557	23.1	$22,966	24.0	$31,099	24.9	$0	0	$0	0.0	$132,622	23.7
90,970	Specific Supplies Cost	$12,184	3.6	$1,306	1.4	$3,209	2.6	0	0	0	0.0	$16,699	3.0
Lbs. Fish	Prorated Labor Costs	$130,035	38.2	$37,707	39.5	$47,845	38.4	$0	0	$0	0.0	$215,587	38.5
32,573	Prorated Operating Cost	$115,639	34.0	$33,532	35.1	$42,548	34.1	$0	0	$0	0.0	$191,719	34.2
	Total Production Cost	$336,415	99.0	$95,511	100.0	$124,701	100.0	$0	0	$0	0.0	$556,627	99.4
FY09-FY11													
AVG No Fish	Stocking Labor	$3,552	1.0	$4	0.0	0	0.0	0	0	0	0.0	$3,556	0.6
527,941	Stocking Expenses	$0	0.0	0	0.0	0	0.0	0	0	0	0.0	$0	0.0
AVG Lbs	Total Stocking Cost	$3,552	1.0	$4	0.0	0	0.0	0	0	0	0.0	$3,556	0.6
37,327	**Grand Total Program Cost**	**$339,967**	100.0	**$95,515**	100.0	**$124,701**	100.0	**$0**	0.0	**$0**	0.0	**$560,183**	100.0

Program Costs				
Specific Labor Cost	$132,622	23.3		
Specific Supplies Cost	$16,699	2.9	4.2	FTE
Prorated Labor Costs	$215,587	37.8	$348,209	All labor
Prorated Operating Cost	$191,719	33.6	$208,418	OM & supplies
Total Production Cost	$556,627	97.6	$556,627	
Stocking Labor	$356	0.1		
Stocking Expenses	$0	0.0		
Total Stocking Cost	$3,556	0.6		
Grand Total Program Cost	**$560,183**	98.3	Hatchery Renov. $	$9,844
Hatchery Renovation Cost	$9,844	1.7	Total All Costs	**$570,027**

A	AVERAGE COST	**COST BASIS is Average PRODUCTION COSTS FY2009-FY2011**											
estimated	Cost assumptions												
2013	**Program Costs**	**KAM**	**%**	**STT**	**%**	**STT-BRD**	**%**	**LAT-MNT**	**%**	**F-699**	**%**	**TOTAL ALL PROGRAMS**	**%**
CURRENT	Specific Labor Cost	$97,393	25.4	$27,816	28.6	$32,761	28.2	$178	34.4	$200	32.8	$158,348	26.5
Production	Specific Supplies Cost	$25,979	6.8	$957	1.0	$4,975	4.3	$0	0.0	$0	0.0	$31,912	5.3
AVG No Fish	Prorated Labor Costs	$125,217	32.7	$33,523	34.4	$39,056	33.6	$166	31.9	$199	32.7	$198,160	33.1
527,941	Prorated Operating Cost	$126,464	33.0	$33,678	34.6	$39,025	33.6	$175	33.7	$210	34.5	$199,552	33.4
AVG Lbs	Total Production Cost	**$375,053**	98	**$95,975**	99	**$115,817**	100	**$519**	100	**$608**	100	**$587,972**	98
37,327													
	Stocking Labor	$7,858	2.05	$1,374	1.41	$501	0.43	$0	0.00	$0	0.00	$9,733	1.63
	Stocking Expenses	$141	0.0	$4	0.0	$0	0.0	$0	0.0	$0	0.0	$145	0.0
	Total Stocking Cost	$7,999	2.1	$1,378	1.4	$501	0.4	$0	0.0	$0	0.0	$9,878	1.7
	Grand Total Program Cost	**$383,052**	100.0	**$97,353**	100.0	**$116,318**	100.0	**$519**	100.0	**$608**	100.0	**$597,850**	100.0
		% by Program	64.1		16.3		19.5		0.1		0.1		100.0

AVERAGE COST				
Program Costs				
Specific Labor Cost	$158,348	26.9		
Specific Supplies Cost	$31,912	5.4	5.1	FTE AVG.
Prorated Labor Costs	$198,160	33.7	$356,508	All labor
Prorated Operating Cost	$199,552	33.9	$231,464	OM & supplies
Total Production Cost	$587,973	100.0	**$587,972**	
Stocking Labor	$9,733			
Stocking Expenses	$145			
Total Stocking Cost	$9,878		Hatchery Renov. $	13,301
Grand Total Program Cost	**$597,851**		Total All Costs	**$597,851**
Hatchery Renovation Cost	**$13,301**			

B	**FUTURE PRODUCTION Cost based on 3 year AVERAGE Operational Estimate with Improvements**							
NEW							Item	
Improved	**Program Costs**	**KAM**	**STT**	**STT-BRD**	**na**	**na**		**adj factor**
AVG plus 20%	Specific Labor Cost						**ASSUMPTIONS**	0.88
Increase	Specific Supplies Cost						4.5 / 5.1 FTE correction factor	1
Production	Prorated Labor Costs							0.88
No. Fish	Prorated Operating Cost						**Energy Savings minimum**	0.85
633,529	Total Production Cost							
AVG Lbs	Stocking Labor							0.88
44,792	Stocking Expenses							1.00
	Total Stocking Cost							
	Grand Total Program Cost	**$335,864**	**$85,407**	**102,174**				
		64.1	16.3	19.5	0.0	0.0		
		0.64	0.16	0.20				

Program Costs			4.5 / 5.1 FTE correction factor	
Specific Labor Cost	$139,346	26.6		
Specific Supplies Cost	$31,911.67	6.1	4.5	FTE Proposed
Prorated Labor Costs	$174,381	33.3	$313,727	All labor
Prorated Operating Cost	$169,619	32.4	$201,531	OM & supplies
Total Production Cost	**$515,258**	98.3	$515,258	
Stocking Labor	$8,565	1.6		
Stocking Expenses	$145	1.7		
Total Stocking Cost	**$8,710**	1.7		
Grand Total Program Cost	**$523,969**	100.0		
Total All Costs		**$523,969**	Total All Costs	**$523,969**

C	**FUTURE PRODUCTION PLUS 20% Increase 3 year AVERAGE Operational Estimate with Improvements**									
									Item	
NEW	**Program Costs**	**KAM**		**STT**		**STT-BRD**			**ASSUMPTIONS**	**adj factor**
AVG FY09-11	Specific Labor Cost								**no change for 20%**	1.00
Imp	Specific Supplies Cost								**20% increase 20 supplies>**	1.20
Current	Prorated Labor Costs								**no change for 20%**	1.00
Prod.	Prorated Operating Cost								**20% inrease 10% energy>**	1.10
No. Fish	Total Production Cost									
527,941	Stocking Labor								**no change for 20%**	1.00
AVG Lbs	Stocking Expenses									
37,327	Total Stocking Cost									
	Grand Total Program Cost	**$350,735**	64.1	**$89,188**	16.3	**106,698**	19.5	0.0	0.0	
			0.64		0.16		0.20			

Program Costs				
Specific Labor Cost	$139,346	25.5		
Specific Supplies Cost	$38,294.00	7.0	4.5	FTE Proposed
Prorated Labor Costs	$174,381	31.9	$313,727	All labor
Prorated Operating Cost	$186,581	34.1	$224,875	OM & supplies
Total Production Cost	**$538,603**	98.4	$538,603	
Stocking Labor	$8,565	1.6		
Stocking Expenses	$0	1.6		
Total Stocking Cost	**$8,565**	1.6		
Grand Total Program Cost	**$547,168**	100.0		
Total All Costs		**$547,168**	Total All Costs	**$547,168**

	Number of Fish	Pounds of Fish	Annual O&M Costs
Current Infrastructure	527,941	37,327	$597,851
Improvements	527,941	37,327	$523,030
20% Increase	633,529	44,792	$546,229

This exercise indicates potential cost savings related to the recommended improvements and fish production levels requested for future with respect to one another. Since averages were used, actual costs will vary from these approximations.

There are many methods that can be used for determining fish cost indices. One method of cost evaluation is to calculate the cost per unit stocked. In this case, the production is divided into KAM yearling and STT fry programs. As mentioned previously, KAM and STT production proportions are about 64% and 36%, respectively. Note that the combined STT program numbers include fry and captive broodstock program costs. The three-year average O&M costs were utilized as a baseline annual cost. The annual cost was divided by the stocking quota (goals) of 92,500 KAM yearlings and 500,000 STT fry and is summarized below. The indices are provided for the current production levels and compared with the costs after improvements have been implemented and for a 20% production increase (assuming improvements were completed).

Next the total capital costs were prorated over 25 years to determine a yearly cost. These costs were added to the annual O&M costs to determine the new cost per unit stocked.

	Kamloop $/Yrling	STT $/1000
Current Infrastructure	$4.13	$430
Improvements	$3.62	$377
Improvements + Prorated Capital Costs	$5.73	$596
20% Production Increase	$3.14	$327
20% Increase + Prorated Capital Costs	$4.90	$510

Cost per unit stocked decreases 14% after the recommended infrastructure improvements have been installed. Similarly, costs per unit decreases 31% with recommended improvements along with production levels increase due to economies of scale. After improvements have been constructed, fish production is increased and prorated capital costs are added, new cost per unit is approximately 16% greater the current cost per unit.

Labor Savings

The recommended improvements outlined in **Section IV** for each component will reduce overall labor associated with maintaining equipment that has reached the end of its service life. The current staff spends a large amount of time troubleshooting and maintaining equipment that no longer functions as programmed. Some of the mechanical equipment requires manual control. The improvements that were recommended in this report will serve to either modernize equipment or to eliminate excessive maintenance requirements when possible. Due to the nature of the equipment, some maintenance will always be required. However, ideally, the majority of hatchery staff time should be allocated to fish rearing activities. Since current staff levels are less than the historical averages and fish production total poundage is nearly the same, staff need to be able to focus on meeting MNDNR fish production goals. The discussion below outlines some of the reduced labor required if the recommended improvements are implemented.

Intake Repair: Reduce staff maintenance of grit separator and bag filters. Maintenance requires response to alarms, disassembly of filters and manual cleaning. Consistently cooler summer water temperatures reduce staff time to respond to over temperature conditions and fish life support emergency response.

Pump Station: Reduce staff maintenance of antiquated generator. Pump controls, generator and all alarms will be automated and placed on SCADA system. Electrical service improvements will reduce staff time in responding to outage.

Vortex Separator: No labor savings if retained as it. If replaced, automated backwashing reduces staff maintenance time.

Filtration System: Reduced staff time to manually disassemble and clean filtration components. Proposed stacked disc filtration option is fully automatic. Staff response requirements to emergency flow conditions should be greatly reduced or eliminated.

UV System: Proposed UV system replacement option includes automatic wipers, automated dose pacing and alarming. Although lamp replacement is required, reduced maintenance for the improved UV system operation due to automated wiping. Ballast replacement and monitoring performance is reduced by the improved UV equipment.

Upper Reservoir: Proposed automated level contracts and monitoring equipment will reduce time spent on adjusting hot well conditions due to change in storage reservoir head pressure. Dissolved oxygen monitoring and alarming will reduce staff time required for manual measurement and will provide real time data to maintain DO at optimum levels.

Main Water Supply System: Proposed automated level controls and monitoring equipment will reduce time spent adjusting flows and temperatures in the hot well system. Conversion of old boilers to natural gas and use of natural gas fired boilers will reduce maintenance time spent with wood pellet boiler system including pellet handling, boiler cleanings and storage/handling.

Incubation – NA

Nursery Tanks: Replacement of the tanks will eliminate time spent repairing fiberglass tanks.

Biofilter System: Replacement options provide reduced staff operating requirements and maintenance. Renovation option reduces time spent maintaining the present biofilter system components although time spent in backwashing and cleaning biofilters will still be required.

Clear Well – NA

Recirculation Pumps: The proposed improvements to the recirculation pumps and pump electrical and control systems will reduce staff maintenance and operational set up time for the Burrows recirculation system.

Recirculation Head Tank: The proposed improvements to the headtank system will reduce staff time spent on adjusting flows and D.O. management in the Burrows system Headtanks.

Burrow Ponds: Burrows resurfacing will improve time spent cleaning and maintaining sanitation in the units during culture activities. Concrete repairs will be eliminated.

Brookstock Raceway: Suggested concrete floor in the spawning area and infrared heating improvements in building provide for improved biosecurity and staff working environment that will make spawning and egg preparation more efficient reducing time requirements for system set up and sanitation.

Effluent Treatment: Renovation and repair of the existing clarifier will significantly reduce staff time spent dewatering, accessing and repairing the flight and chain system. An additional clarifier (if constructed) provides operational efficiency and less staff time adjusting wastewater flows to meet the clarifier treatment capacity limits. Maintaining proper clarifier operation has discharge permit compliance implications and avoids exceedences that impact administrative time to resolve and respond to MPCA.

Instrumentation System: The instrumentation system (SCADA) upgrades add additional capabilities to the system that reduce staff time in the operation and monitoring of their FRH complex. The additional new process monitoring and alarming for DO saves staff time in manual measurement. Monitoring and controlling lake pumps, hot water circulation pumps and Burrows pumps with VFD pump controls and level sensors will significantly reduce time spent adjusting these systems.

Heat Pumps: (Pending final determination of the best option for the heat pump system.) All options address the high maintenance time requirement of cleaning and operating the system.

Lower Spawning Tanks: Improvements to the water supply treatment system are intended to prepare lake water for trout holding and distribution purposes. Goal is to provide biosecure trout holding within the existing Lower Spawning Facility to provide efficient use of staff time handling and distributing trout from the FRH. The use of improved water supply treatment facility should reduce overall staff time and labor handling trout by reestablishing this site as an approved biosecure trout holding location compared to other off station options.

General Storage – NA

Oxygen Generation System: Recommended conversion to LOX based system eliminates staff time spent maintaining air compressors and PSA oxygen generators.

Facility Comparison

FRH was compared to other state and federal hatcheries with respect to production levels, complexity, labor needs and costs. HDR has worked on projects ranging from new facilities to renovation plans throughout the country over the years. The facilities raise different species and have varying production goals but most facilities contain similar layouts and functions. An ideal hatchery is sited with an abundant gravity fed spring water supply which would require no influent treatment or pumping costs. However, these are very rare and it is getting harder to find adequate water that doesn't requiring some sort of initial pumping or recirculation. FRH and many other facilities need to provide influent water supply treatment and incur the operational costs associated with initial pumping and recirculation. Water heating is also getting more common to meet specific fish rearing program needs. A brief comparison of FRH with other similar facilities is provided below:

Facility	FRH, MN	Wild Rose, WI	Hacketts-town, NJ	Les Voigt, WI	William Jack Hernandez, AK
Age	1970s	2000s	1990s	1970s	2010s
Production Size	Medium	Large	Medium	Medium	Extra Large
Project	Renovation	Replacement	New	Renovation	New
Flow (gpm)	2,400	4,000	2,000	2,100	10,000
Water Treatment	High	Moderate	Moderate	High	Moderate
Reuse/Recirc-ulation	75%	95%	90%	65%	95%
Overall Complexity	High	High	High	Moderate	High
Labor	High, Moderate after Renovation	Moderate	Moderate	Low, Moderate after Renovation	Moderate
Operational Costs[1]	$190	$180k	UNK	$140k	UNK
Capital Costs (Million)[2]	$7.6	$15	$5.4	$9.7[3]	$100

[1] Rough O&M Costs Minus Personnel *[2] Rough Escalated Costs* *[3] Proposed Renovation Costs*

Many state and federal facilities are coming of age where either replacement or renovation is required. HDR has worked on all the compared facilities over the years. Renovation is generally proposed when the majority of the infrastructure is in good condition but the equipment or rearing portions need to be modernized. Replacement occurs when a new facility is constructed at an existing site with some or none of the existing infrastructure being reused. FRH compares well to the renovation suggestions proposed for the Les Voigt facility in Wisconsin.

As already discussed in the production portion of this report, FRH is currently operating at capacity since dissolved oxygen appears to be limiting. More fish can be raised at FRH with the addition of more modern dissolved oxygen management. The other compared facilities are utilizing dissolved oxygen systems to meet optimal production levels.

Some of these facilities utilize groundwater so not as much treatment is required for the influent compared to FRH. When utilizing surface water, the other facilities have similar treatment and heating systems in place. All are incorporating water reuse or recirculation due to low volume water supplies or to provide water conservation. The influent and recirculation treatment systems are of comparable complexity with those found at FRH.

For example, the recently completed Wild Rose Hatchery in Wisconsin employs the use of a 4,800 gpm water recirculation system that employs filtration, UV disinfection, biofiltration, process water heating boilers, heat exchanging and heat recovery, recirculation water pumping, and dissolved gas management technologies all similar to the 2,400 gpm system employed in the FRH system. A similar comparison can be made to the New Jersey Hackettstown SFH that also employs a 2,000 gpm heated water recirculation system with similar treatment technologies but does not require the operation of a high-lift lake water pumping system and lake water biosecurity treatment as does the FRH. The NJ system was able to use a gravity flow spring water source. The new William Jack Hernandez Hatchery in Anchorage (2012) uses a recirculation system using the same level of makeup water pumping and heating as FRH (approximately 500-800 gpm) with a heating requirement of 20^{o}F (34^{o}F to 54^{o}F) using three boilers similar to FRH. The Anchorage Hatchery also uses filtration, UV disinfection, biofiltration, on-site oxygen generation and controlled temperature egg incubation.

The FRH facility was one of the first public fish hatcheries to employ the use of a biofiltration-based water recirculation system and the Burrows recirculation design. The Mixsawbah Hatchery in Indiana employed the use of similar bead biofilters but did not require the relatively complex process water heating and blending of water temperatures, lake water pumping and biosecurity treatment as FRH. The Les Voigt Hatchery in Bayfield Wisconsin has many similar hatchery operational issues when compared to FRH. Both facilities have biosecurity issues associated with the use Lake Superior water. The Les Voigt facility is moving toward the use of a biofiltered, heated recirculation system that uses LOX based dissolved oxygen management. In general, the egg taking, egg disinfection and effluent treatment technologies used at FRH are all very similar to those used other Midwest and East cold water hatcheries.

The new or newly renovated facilities do not require as much labor for upkeep as FRH. However, the recommendations outlined in this report should bring the levels to meet those found at the other compared facilities.

Operational costs excluding labor costs were found to be somewhat similar to those found at the other facilities (when data was available). Suggestions outlined in this report should serve to provide cost savings at FRH. Capital costs for renovation or other new construction at other facilities were comparable for the renovation program suggested for FRH. Costs for a new facility to meet this production level will run about $15-$25 million. The new facility in Alaska was over $100 million.

Renovation should be completed at FRH instead of an entire facility replacement since much of the existing infrastructure can be restored to meet the 25 year goal for operation. Plus new construction would take much longer to accomplish compared to renovation. It is not recommended to close FRH since its mission and existing infrastructure are very important to the entire MNDNR fish production program. Costs for renovation, while substantial, are very comparable to what other state and federal facilities are encountering throughout the country.

Energy Cost Reductions

Infrastructure Modifications

This section discusses the various proposed improvement projects that will reduce the hatchery's energy costs. The individual projects/improvements are discussed in greater detail in **Section IV**. For this section, the estimated savings in the hatchery's annual operating costs are calculated for the recommended projects. The projects, as noted in Section IV, may include interactions with other improvements that will affect the overall savings. For example, pump replacement sizing of the main supply pumps will depend on the filtration system selected for installation as well as the reservoir aeration system improvements. Reductions in head mean lower horsepower and lower pumping costs. Further energy saving would be realized if the biofilters were replaced with drumfilters since the backwash water volumes would be substantially lower, reducing the amount of water that would be pumped from the lake, and therefore reducing the pumping costs. These improvement have a cascading effect on energy saving that is difficult to quantify. For example, improvements in controls will reduce the amount water that is pumped, which will reduce the heating requirement, and will substantially reduce the amount of maintenance that these manual systems require. Since the controls are manual, the staff is forced to make operational decisions to insure the hatchery will operate overnight while they are not on-site to adjust flows the hot well. These types of costs are difficult to quantify but will need to be considered when making decisions about renovation alternatives. For items that could be quantified, energy savings are outlined below. Note that overall energy cost savings might be larger than these projections indicate.

Intake Pump Replacement

Annual energy savings - $8,500

Savings for this improvement assume the intake pumps will be replaced as described in **Section IV – Component 2**. The sizing assumes lower head requirements due to changes in filtration and replacement of the existing aspirators with degassing columns. Further energy saving would be realized with the pump control replacement. Instead of turning the pumps on and off full voltage to maintain a level in the reservoir between two set points, the new pump controls would maintain a constant level in the reservoir. The pumps would only deliver the amount of water demanded by the system. The same level control system would be utilized in the hot well. The level in the hot well will be maintained at a constant level. The pump speed would vary to deliver only enough water to meet demand. This would mean that the manifold temperature control valves would always operate at the same head pressure, which means the valves would require less hunting and the delivery flow rate would vary less.

UV Disinfection System

Annual energy savings - $1,350

If the existing ultraviolet disinfection section is replaced with a new system, the annual saving is energy is calculated to be $1,350 per year

Boiler Conversion

Annual energy savings - $17,400

This project includes converting the existing oil fired boilers from fuel oil to natural gas (see **Section IV-Component 7a**). All savings are attributed to the reduction in fuel oil consumption. By converting the oil fired boilers to natural gas, the wood fired boiler could remain as a back up. At today's fuel cost, heating the process water with natural gas is equivalent to heating water with wood. The wood fired boilers require constant, daily maintenance. The oil fired boilers are presently used only when the wood boiler is down for service. The energy savings are calculated assuming 85% of the heating cost is process water, and 15% is space heating. This improvement assumes the only remaining oil consumption at the hatchery building will be the stand-by generators. All heating will be done with natural gas. This improvement will mean a substantial savings in maintenance labor. The wood fired boiler requires daily maintenance to keep the auger operational. Further saving would be also result from no more ash handling and ash removal. These saving are not included in the number above.

Recirculation Pump Controls

Annual Energy Savings – $2,100

There are currently seven 10HP recirculation pumps used to transfer water from the clear wells in the Burrows Pond Building, up to the aeration tower and back to the Burrows. By converting the aspirators to aeration columns, the pumping head is reduced. The pumps are currently manually controlled to try to maintain a few feet of water over the aeration tower drain. Each pump can deliver 580 gpm, so when one pump can't meet the demand; a second pump and then third is manually turned on to meet the 1200 gpm for three Burrows units. With the proposed controls, the pumps would be powered through VFD's (see **Section IV – Component 12**). The pump speed would vary to maintain a constant head over the aeration tower drain. With this control, the pumps will run to deliver only the amount of water the system demands. Flow rates to the Burrows would be more precisely controlled since the head pressure is constant.

Burrows Building Lighting Improvements

Annual energy savings - $1,600

This project replaces the incandescent lighting in the Burrows Pond Building and the Biofilter Building with LED lighting. The energy saving are a small part of the overall operational saving when comparing a lamp with a rated life 2000 hours versus a fixture with an expected life of over 60,000 hours. These unheated, damp, buildings are a perfect application for LED lighting.

Raceway Building Lighting Improvements

Annual energy savings - $500

This project replaces the incandescent lighting in the Raceway Building with dimmable LED lighting.

Implement Heat Recovery System

Annual energy savings - $35,000

As discussed in **Section IV – Component 18,** repair of the existing heat pump / heat recovery system is recommended. This project has the greatest potential to reduce hatchery energy costs by recovering the process waste heat after the water is discharged to the effluent treatment system. Saving are calculated based on reduction in wood pellet consumption.

Oxygen Bulk Storage

Annual energy savings - $3,520

In **Section IV** of this report, replacement of the existing oxygen generator with a bulk oxygen storage tank was recommended. This recommendation was based on the anticipated additional oxygen demand to improve dissolved gas levels in the production tanks. Based on the bioprogram model, oxygen usage is projected to be over 7,000 gallons per year. There are no reliable records of current oxygen usage at, so for purposes of this report, energy saving will be calculated based on the estimated current oxygen usage which is less than outlined above or about 3,500 gallons per year. It should be noted these energy savings will be offset by the direct purchase cost of the delivered oxygen. The estimated cost from a vender would be $3,690, not including tank rental. This is the estimated cost of the oxygen delivered to the site by a local vender.

Alternative Energy Options

What is Sustainable Development?

Sustainable development was defined by the United Nations World Commission on Environment and Development (1987) as:

> *... development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*

An alternate definition describes sustainable development as using renewable resources to minimally impact the environment and relate people with the natural environment. Sustainable design can cross many fields such as architecture, engineering, landscape architecture, urban planning and design and interior design, just to name a few. The key to all sustainable design projects is to employ close integration between the design team and MNDNR at all stages of the project. This begins at facility design, material selection and project construction all the way through to facility operation with best energy use and energy savings. The complete project team can include non-traditional members such as ecologists, economists, sociologists and professionals from other disciplines, when addressing all the issues and challenges that require environmentally sustainable strategies and solutions.

Many of the improvements outlined in this report strive to use sustainable features for construction and operating the facilities. Sustainable design includes some of the following components:

- Minimization of disruption to the land (e.g., erosion control, less mowing and watering, less chemical/pesticide use) and landscaping with native trees, shrubs, flowers and grasses
- Conservation of water
- Utilization of low impact materials of higher quality and durability (e.g., non-toxic, recycled, sustainably produced)
- Healthy buildings which are not harmful to the occupants or the environment
- Reduction of waste
- Conservation of fossil fuels and use of renewable energy

All of these components need to be considered when undertaking renovation projects outlined in this report. Some of these issues will be addressed during design while others can only be addressed during or after construction. When incorporated, sustainable features will need to be refined further during the design and construction stages of the projects. O&M manuals should include guidelines for the most efficient energy use.

Specific examples of how the improvements recommended in the study are related to each component are noted next. Water conservation is addressed in the report by recommending to continue utilizing recirculated process water which uses less first use water. However, this option needs to be carefully balanced with respect to the additional capital and operational (energy) costs for the related treatment equipment. MNDNR staff, including site specific hatchery staff, will need to be included in all phases of the design process when picking specific low impact materials for the renovation project. Hatchery staff input is key to selecting durable materials that also make viable economic sense. Effluent management recommendations act to reduce or concentrate waste products. Facility specific recycling plans can also be implemented to further reduce waste generation. All renovation should strive to meet or exceed ASHRAE energy conservation recommendations. Further hatchery project specific energy reduction features are outlined below that should be considered during the design phase of the recommended facility renovations.

Energy Alternatives for Fish Production Facilities

There are generally five renewable energy sources that are being used to provide or supplement today's energy demands: solar, wind, hydro, geothermal and hydrogen. These are all considered renewable energy sources that do not deplete the world's fossil fuels. Alternative energy projects have to be carefully evaluated and compared to the existing or proposed traditional energy alternatives during the design phase of every project. Sometimes, renewable energy options can be used to supplement but not completely replace overall energy consumption. Many features can be added to renovation projects that can be considered energy conservation measures. These features will be listed to illustrate situations where these options could be added to the proposed improvement recommendations outlined in this report. However, further evaluation will be required for each project during the design phase to determine ultimate feasibility of installation. The concept of Total Cost of Operations (TOC) or life cycle costs over the life of the system should be used during the evaluation process for all potential alternatives.

The use of alternative energy sources at the fish hatchery is limited due to the critical nature of the fish life–support systems. Any alternative energy source, particularly natural sources such as solar and wind power, should not be relied on as the primary energy source for fish life-support purposes such as water pumping. Even with this restriction; however, there are possible uses of alternative energy sources at a fish facility. The following are some possible alternative energy uses that could be considered. According to the experts, future improvements to the renewable energy systems are projected to decrease the payback time requirements which will make these options even more comparable to traditional energy sources. Other future advancements in technology may also point to additional areas at the site that can use renewable energy resources.

Supplemental Solar Heating of Process Water

The use of active solar panels for fish rearing water heating is not typically recommended due to complexity and cost. For the FRH, the process heating loads continue to occur during the spring and summer months when more heat gain is available to the solar collectors, helping the system payback.

Estimates include the installation of flat plate, evacuated tube solar collectors, mounted at a fixed angle for optimum heat gain in March. The system would be filled with anti-freeze, with no thermal storage capabilities. The heated fluid from the collectors would be circulated through a heat exchanger on the water supply line to the hot well in the mechanical room, downstream of the boiler heat exchange. The circulation pump would only run when the water temperature from the solar collectors is higher than the water temperature in the upper reservoir.

For this very simple solar heating application, the system payback is greater than 30 years. This payback was calculated using a solar array consisting of 12 – 72" wide modules. It may be possible to reduce the payback by optimizing the array size, but the system payback would still to be beyond the life of the system and therefore not recommended. It should also be noted the prices for solar collectors varies by dealer and the cost of key materials such as copper, aluminum and glass, have fluctuated nearly as much as gasoline prices. Prices used for the purposes of this calculation assume a contractor installed system.

Photovoltaic Power Generation

Solar power is produced when sunlight strikes a semiconductor material and creates an electric current. According to the experts, photovoltaic solar power is one of the most promising renewable energy sources. It is non-polluting, has no moving parts, requires little maintenance or supervision, and has a life of 20-30 years with low running costs. The primary disadvantages are related to the amount of local sunlight (i.e., geographical location, time of day, season and clouds) and initial cost of the equipment.

A grid tied PV systems will have the best payback for a hatchery application. A batteryless grid-tied system has only two primary components, the PV modules and an inverter that feeds AC electricity back into the electrical system to offset some of the energy otherwise purchased from the utility. The system is very low maintenance, with no moving parts and no battery systems to maintain. It should be noted the system is not capable of providing power when the utility grid goes down.

To keep the system simple and reduce the initial cost, fixed mounted PV arrays are used in this analysis. To maximize electric generation for the Duluth area, a collector angle of -15° of the latitude yields the highest energy production. Estimates are based on the 2013 RS Means Electrical cost data for both the PV modules and the DC to AC inverter. Costs of these products have significantly dropped over the past few years and the available cost data may be somewhat high. Regardless, system payback was calculated in excess of 70 years for a contractor installed PV system.

Geo-Thermal Heat Pump

As described elsewhere in this report, a large heat pump was installed at French River in the hope of recovering waste process heat. For reasons described in detail in **Section IV – Component 14**, the heat pump never was able to work effectively and has sat idle since installed. The problem with the system was the process of recovering waste heat from the clarifier. The dirty water fouled the heat pump. Instead of abandoning the system, alternative sources of heat were studied, namely geo-thermal.

For a unit this size, the geo-thermal heat recovery component would consist of 120 wells drilled to a depth of approximately 120 feet. Piping would be looped through each of the wells to be used as a heat source for the heat pump. Due to the cost of drilling wells in this area, the initial cost is fairly high even when considering the heat pump is already installed. The payback is calculated by dividing the installed cost of the wells by the potential savings in wood used to heat the process water, minus the electrical costs to operate the heat pump and circulating pumps. Using a very conservative cost of $4,000 per well, the payback was calculated to be more than 30 years.

Energy Summary

The recommended infrastructure improvements outlined in the report provide some overall energy savings for the facility. As mentioned, some recommended improvements for one component can cascade into energy savings for another component. As mentioned, these types of cascading cost savings are difficult to quantify but will need to be considered. Total energy savings are summarized as follows:

Improvement	Component	Annual Energy Savings
Intake Pump Replacement	2	$8,500
UV Disinfection System	5	$1,350
Boiler Conversion	7b	$17,400
Recirculation Pump Controls	12	$2,100
Burrows Building Lighting	14	$1,600
Raceways Building Lighting	15	$500
Heat Recovery System	18	$35,000

Improvement	Component	Annual Energy Savings
Intake Pump Replacement	2	$8,500
UV Disinfection System	5	$1,350
Boiler Conversion	7b	$17,400
Recirculation Pump Controls	12	$2,100
Burrows Building Lighting	14	$1,600
Oxygen Storage	21	$3,520
	Total Projected Savings	**$69,970**

Note that overall energy cost savings might be larger than these projections indicate since conservative equipment sizing estimates were used for this exercise.

Unfortunately, none of the evaluated alternative energy options provides adequate payback to recommend installation at this time. However, if these options should be re-considered in 5-10 years if energy costs keep escalating and alternative energy equipment becomes more cost effective.

Preliminary Permitting Plan

This preliminary permitting plan describes the Hatchery's existing permits and the permits that may be necessary if MNDNR proceeds with rehabilitation of the Hatchery. This is only a preliminary assessment of the potentially applicable permits; additional assessment will be necessary based on the rehabilitation projects that the MNDNR decides to undertake at the Hatchery. The permits outlined in this section include:

- NPDES/SDS Industrial Permit
- Water Appropriations Permit
- Solid Waste Utilization Project Authorization
- NPDES/SDS Construction Stormwater General Permit
- Public Waters Work Permit
- Aboveground Storage Tank Registration
- 316(b) Cooling Water Intake Structures
- County Road Crossing Permit

Existing Permits and Authorizations

NPDES/SDS Industrial Permit

The Hatchery is currently authorized under Minnesota's National Pollutant Discharge Elimination System (NPDES) and State Disposal System (SDS) programs to:

- Discharge non-sewage wastewater to the French River in accordance with specified effluent limitations.
- Manage solids from the operation of a concentrated aquatic animal production facility and transport the solids to the Western Lake Superior Sanitary District (WLSSD) for treatment or compost in accordance with WLSSD's Transported Liquid Waste program.

The Hatchery's permit, NPDES/SDS Permit No. MN0004413, was most recently reissued on May 23, 2011, modified on May 18, 2012, and expires on April 30, 2016.

In accordance with the Hatchery's NPDES/SDS Permit and Minnesota Rules Chapter 7001, "no person required by statute or rule to obtain a permit may construct, install, modify, or operate the facility to be permitted, nor shall a person commence an activity for which a permit is required by statute or rule until the agency has issued a written permit for the facility or activity" (Minn. R. 7001.0030). Based on the requirements of Minnesota Rules Chapter 7001, proposed changes to the Hatchery, as a permitted facility, will likely require either a major or minor modification of the existing NPDES/SDS Permit. This applies to both proposed physical and proposed operational changes.

Modification of the NPDES/SDS Permit will likely be required if:

- Proposed "alterations or modifications to the permitted facility or activity that will result in or have the potential to result in significant alteration in the nature or quantity of permitted materials to be stored, processed, discharged, emitted, or disposed of by the permittee" (Minn. R. 7001.0170).
- Construction is proposed, unless "maintenance dictates the need for installation of new equipment, provided the equipment is the same design size and has the same design intent" (NPDES/SDS Permit No. MN0004413, Chapter 4, 1.40).
- "Substantial changes in operational procedures, activities that may alter the nature or frequency of the discharge, and/or material factors that may affect compliance with the conditions of this permit" (NPDES/SDS Permit No. MN0004413, Chapter 4, 1.41) are proposed.

The difference in the issuance of a major modification or a minor modification is the re-issuance timeline. The major or minor modification decision by the MPCA is governed by Minnesota Rules 7001.0170 and 7001.1150. Major modifications will require public notice and comment, whereas minor modifications do not. The timeline for a major modification should be six months (180 days); however, the actual timeline is dependent on the workload of the permit writers and the position in the permitting cue. Minor modifications are generally issued within two to three months after submittal of an application; this timeline is also dependent on workload of the permit writers and the position in the permitting cue. Construction projects are generally given higher priority.

Additionally, the Hatchery must notify the MPCA at least 60 days prior to “increasing the use of a chemical additive authorized by this permit, or using a chemical additive not authorized by this permit, in quantities or concentrations that have the potential to change the characteristics, nature and/or quality of the discharge” (NPDES/SDS Permit No. MN0004413, Chapter 4, 1.42). Changes related to the use of chemical additives may be authorized via written approval or the MPCA may deem it necessary to modify the NPDES/SDS Permit to restrict the use or discharge of the chemical additive.

In summary, if overall rehabilitation of the Hatchery is undertaken by the MNDNR, at least one of the facility modifications or operational changes likely will trigger a modification of the Hatchery’s NPDES/SDS Permit. Therefore, it is recommended that the MNDNR consult with the MPCA once a final action has been determined and prior to undertaking the rehabilitation project to determine whether a major or minor permit modification will be necessary. It is also recommended that this process be initiated early because the permit modification application must be submitted to the MPCA at least 180 days prior to the planned change (per Minnesota R. 7001.0040).

Water Appropriations Permit

The Hatchery is currently authorized through the MNDNR’s Water Appropriations Permit Program (Permit No. 1976-2262) to withdraw up to 500 million gallons per year of water from Lake Superior for aquacultural use. Currently, the Hatchery withdraws approximately half of this appropriation.

Modification of the Hatchery’s Water Appropriations Permit would be necessary if the Hatchery proposed to withdraw greater than 500 million gallons per year of water from Lake Superior. However, this is not currently anticipated as part of the Hatchery rehabilitation project.

Application for an additional Water Appropriations Permit would be necessary if the Hatchery proposed to withdraw water from an alternative surface water or groundwater source. However, this is not currently anticipated as part of the Hatchery rehabilitation project.

Solid Waste Utilization Project Authorization

On August 1, 2011, the Hatchery received authorization from the Minnesota Pollution Control Agency (MPCA) to implement a solid waste utilization project (#UT0037) in accordance with Minnesota Rule Chapter 7035. This project allows the Hatchery to send wood ash from the wood pellet-fired boiler off-site for beneficial use as a liming agent and fertilizer, rather than disposing of the ash as a waste at a landfill. Currently, the wood ash is transported to a local farmer for this purpose.

The proposed rehabilitation of the Hatchery is not expected to effect the composition of the wood ash from the wood pellet-fired boiler; therefore, modification of the authorization to conduct this project is not expected to be necessary. However, if renovation or replacement of the wood pellet-fired boiler is proposed which has the potential to effect the composition of the wood ash, it is recommended that the Hatchery consult with the MPCA’s Solid Waste Program to determine whether modification of the current solid waste utilization project authorization will be necessary.

Potentially Applicable Permits and Authorizations

NPDES/SDS Construction Stormwater General Permit

The MPCA regulates stormwater associated with construction activities through the NPDES/SDS permitting program. Typically, coverage is granted under the General Permit Authorization to Discharge Stormwater Associated with Construction Activity (NPDES/SDS Permit No. MN R100001), although there are certain situations when an individual permit may be issued.

Application for coverage under the Construction Stormwater General Permit (or an individual permit, if applicable) will be necessary if the construction activity associated with the Hatchery rehabilitation project includes cumulative soil disturbance of a minimum of one acre. Also, regardless of soil disturbance acreage, a permit will be necessary if the MPCA determines that a construction activity poses a risk to water resources; this may apply to construction of a secondary water intake pipeline.

It should also be noted that coverage under the Construction Stormwater General Permit requires the preparation of a construction stormwater pollution prevention plan (SWPPP) prior to submitting an application for permit coverage.

Public Waters Work Permit

The MNDNR's Public Waters Work Permit Program regulates water development activities below the ordinary high water level (OHWL) in public waters and public waters wetlands. Specifically, coverage under a Public Waters Work Permit is necessary for activities which:

- Construct, reconstruct, remove, abandon, transfer ownership of, or make any change in a reservoir, dam, or waterway obstruction on public waters.
- Change or diminish the course, current, or cross section of public waters, entirely or partially within the state, by any means, including filling, excavating, or placing of materials in or on the beds of public waters.

Depending on the activities proposed, the authorization may be granted as coverage under a general permit or as an individual permit.

Application for a Public Waters Work Permit will likely be necessary for several proposed portions of the Hatchery rehabilitation project which will occur within Lake Superior:

- Repair of the existing water intake pipeline, including placement of additional rock for stabilization.
- Construction of a lake-bottom sand and gravel crib filter intake structure (if selected).
- Construction of a secondary water intake pipeline and corresponding lake-bottom sand and gravel crib filter intake structure (if selected).

Aboveground Storage Tank (AST) Registration

Aboveground storage tanks (ASTs) which store liquid substances that may pollute the waters of the state are regulated by Minnesota Rules Chapter 7151 (if site capacity is less than one million gallons). The program associated with this rule requires registration of ASTs with a capacity of 500 gallons or more.

Currently, the Hatchery facility does not include any ASTs with a storage capacity of 500 gallons or more. Addition of an AST requiring registration is not anticipated as part of the Hatchery rehabilitation project; however, if an AST with a storage capacity greater than or equal to 500 gallons is added, registration should be completed.

316(b) Cooling Water Intake Structures

The U.S. EPA is expected to release a final Clean Water Act 316(b) rule regulating cooling water intakes in late June 2013. It is expected the rule will regulate facilities that withdraw greater than 2 million gallons per day and use at least 25% of the water exclusively for cooling purposes.

While this regulation does not seem directly applicable to the Hatchery's lake water intake, it is anticipated that the final rule will allow the permitting authority (MPCA) to regulate water intake structures within their jurisdiction on a case-by-case, professional judgment basis. Therefore, it is recommended that the MPCA be consulted to determine whether they are considering regulating intakes similar to the Hatchery's lake water intake.

County Utility Permit

If the MNDNR decides to add a secondary intake pipeline, construction across North Shore Drive (Old Highway 61) will be necessary. As discussed previously, it is recommended that this be accomplished by an open cut within the same trench across the road. It is estimated that a detour around this portion of North Shore Drive would be necessary for less two weeks.

Construction within the right-of-way of (and across) North Shore Drive will require a Utility Permit from Saint Louis County. Coordination with Saint Louis County Public Works Department is recommended as early as possible and at least one month before project bid; at minimum, one week is required to receive project approval. Closure of the road during the project will be possible, but coordination with the County related to the timing of the road closure will include consideration of special events (such as Grandma's Marathon) and other nearby road closures. The MNDNR (via their contractor) will be responsible for traffic control and restoration of the road to existing conditions.

Preliminary Assessment of Permits related to Hatchery Rehabilitation

Table V-7 presents a summary of potentially applicable permits and authorizations should the MNDNR proceed with rehabilitation of the Hatchery. Projected costs are outlined in **Table V-8**.

Table V-7. Preliminary Assessment of Potentially Applicable Permits / Authorizations

Permit / Authorization	Authorizing Agency	Purpose	Current Status	Anticipated Action	Applicability	Permitting Timeline
NPDES/SDS Industrial Permit No. MN0004413	Minnesota Pollution Control Agency	Authorizes the Hatchery to discharge non-sewage wastewater to the French River and manage solids resulting from concentrated aquatic animal production.	Existing	Modification	Modification of the current permit could be necessitated by a variety of physical or operational changes to the Hatchery. Therefore, it is anticipated that permit modification will be necessary.	• Major Modification: 6 months or greater • Minor Modification: 2-3 months
Water Appropriations Permit No. 1976-2262	Minnesota Department of Natural Resources	Authorizes the Hatchery to withdrawal up to 500 MG/year of water from Lake Superior for aquacultural use.	Existing	None or Modification	Modification of the current permit is not expected to be necessary; however, modification would be necessary if the Hatchery proposes to withdraw greater than 500 MG/year of water from Lake Superior (or from an alternative water source).	Approximately 1-2 months
Solid Waste Utilization Project #UT0037	Minnesota Pollutant Control Agency	Authorizes the off-site beneficial use of the Hatchery's wood ash as a liming agent and fertilizer.	Existing	None or Modification	Modification of the current authorization is not expected to be necessary; however, modification may be necessary if renovation/replacement of the wood pellet-fired boiler is proposed which has the potential to effect	

Table V-7. Preliminary Assessment of Potentially Applicable Permits / Authorizations

Permit / Authorization	Authorizing Agency	Purpose	Current Status	Anticipated Action	Applicability	Permitting Timeline
					the composition of the wood ash.	
NPDES/SDS Construction Stormwater General Permit MN R100001	Minnesota Pollution Control Agency	Authorizes discharge of stormwater associated with construction activities.	----	Application	Application for a permit will be necessary if the construction activity associated with the Hatchery rehabilitation project includes cumulative soil disturbance of a minimum of one acre. Also, regardless of soil disturbance acreage, a permit will be necessary if the MPCA determines that a construction activity poses a risk to water resources; this may apply to construction of a secondary water intake pipeline.	• If project is initiated prior to 8/1/2013: within 48 hours • If after initiated after 8/1/2013: within 7 days

Table V-7. Preliminary Assessment of Potentially Applicable Permits / Authorizations

Permit / Authorization	Authorizing Agency	Purpose	Current Status	Anticipated Action	Applicability	Permitting Timeline
Public Waters Work Permit	Minnesota Department of Natural Resources	Authorizes activities which: • Construct, reconstruct, remove, abandon, transfer ownership of, or make any change in a reservoir, dam, or waterway obstruction on public waters. • Change or diminish the course, current, or cross section of public waters, entirely or partially within the state, by any means, including filling, excavating, or placing of materials in or on the beds of public waters.	----	Application	Application for a permit will likely be necessary for several proposed portions of the rehabilitation project which will occur within Lake Superior: • Repair of the existing water intake pipeline, including placement of additional rock for stabilization. • Construction of a lake-bottom sand and gravel crib filter intake structure. • Construction of a secondary water intake pipeline and corresponding lake-bottom sand and gravel crib filter intake structure. Depending on the activities proposed, the permit(s) may be granted as coverage under a general permit or as an individual permit.	

Table V-7. Preliminary Assessment of Potentially Applicable Permits / Authorizations

Permit / Authorization	Authorizing Agency	Purpose	Current Status	Anticipated Action	Applicability	Permitting Timeline
Aboveground Storage Tank (AST) Registration	Minnesota Pollution Control Agency	Authorizes (through registration) aboveground storage tanks with a capacity greater than or equal to 500 gallons.	----	None or Application	Currently there are no on-site ASTs with a storage capacity greater than or equal to 500 gallons. Addition of an AST requiring registration is not anticipated; however, if an AST with a storage capacity greater than or equal to 500 gallons is added, registration should be completed.	Less than one month
316(b) Cooling Water Intake Structures	Minnesota Pollution Control Agency	Final rule anticipated in late June 2013 establishing national requirements applicable to location, design, construction and capacity for cooling water intake structures.	----	(included with NPDES/SDS Industrial Permit)	MPCA has the authority to regulate intake structures on a case by case, professional judgment basis.	TBD – If required this would prompt a major NPDES/SDS Permit modification
County Utility Permit	Saint Louis County	Authorizes construction within the right-of-way of a county road.	----	Application	Application will be necessary for construction across North Shore Drive to add a secondary intake pipeline.	One month (recommended); One week (minimum)

Table V-8. Preliminary Cost Estimate for Permit Applications

Permit / Authorization	Estimated Costs		Notes
	Application Fee	**Preparation of Application**	
NPDES/SDS Industrial Permit No. MN0004413	$2,480	$8,000	*Assumes major modification with no increase in design flow.* Application Fee Range: $1,240 (minor modification) to $9,300 (major modification with construction and increased design flow) Preparation of Application Range: $5,000 to $10,000
Water Appropriations Permit No. 1976-2262	Not Expected to be Necessary		Application Fee: $150 Preparation of Application Range: $2,000 to $5,000
Solid Waste Utilization Project #UT0037	Not Expected to be Necessary		Preparation of Application Range: $2,000 to $5,000
NPDES/SDS Construction Stormwater General Permit MN R100001	$400	$6,000	Application Fee: $400 Preparation of Application Range: $3,000 to $8,000
Public Waters Work Permit	$1,000	$5,000	Application Fee Range: $150 to $1,000 Preparation of Application Range: $3,000 to $6,000
Aboveground Storage Tank (AST) Registration	Not Expected to be Necessary		Preparation of Application Range: $500 to $2,000
316(b) Cooling Water Intake Structures	Not Expected to be Necessary		*Dependent on whether MPCA decides to exercise it's authority to require permitting.* *Application would be with application for NPDES/SDS Industrial Permit Modification.*
County Utility Permit	$150	$3,000	Application Fee: $150 Preparation of Application Range: $1,000 to $5,000
TOTAL:	**$4,030**	**$22,000**	

Minnesota
Department of Natural Resources

MDNR No. 8F022
File No. FMA.00257.00.00.03
HDR No. 202386

French River Cold Water Hatchery

VI. OPINIONS OF PROBABLE COST

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VI. OPINIONS OF PROBABLE COST

Overview and Cost Escalation

Section IV of the report contains detailed descriptions of all the major infrastructure required for either renovation or replacement at FRH. The **Summary Opinions of Probable Cost** are provided at the end of this Section for the recommended alternatives for each major component. Component numbers match those already presented in the text and were illustrated on the Drawings. The projected costs for the facility renovation project will be about $**6.1 million to construct**. After the budgeting contingencies are added to the total, **the project budget** will need to be about **$7.6 million**. This report section provides an explanation of cost estimating methodologies, assumptions, unit prices, descriptions, and contingency explanations. Total costs assume all work will be completed in one project. If the project is broken into phases, additional costs will be realized for both design and construction.

Please note that for some components, several alternatives were reviewed for this report. **Detailed Costs** are provided at the end of this Section for all major reviewed components. Only the recommended solutions were totaled and brought forward in the Summary total cost projections. Alternatives reviewed but not selected are provided for MNDNR informational purposes. When moving forward with this project, MNDNR might decide to select an item that wasn't recommended by the consultant team so costs are provided to assist in making those decisions. As mentioned, some selections will have a cascading effect on other components so MNDNR will need to work closely with the consultant team to ensure that decisions do not adversely affect other recommendations in this report.

All costs are representative of June 2013 prices and **must be escalated** to the mid-construction dates that the particular project is constructed. An escalation factor of 3% to 4% per year is recommended. For example, a project estimated at $1,000,000 in 2013 that is not appropriated until 2014 and takes one year to construct (2015) would actually cost $1,081,600 ($1,000,000 x 1.04 x 1.04). All opinions of probable costs for the facility are **preliminary**. Due to recent natural disasters (e.g., hurricanes) and the oil price increases, the construction industry is faced with shortages, escalated prices, and a large demand for new and renovation construction in the affected areas. Recently bid projects have seen an increase in the range of 10% to 25% above normal costs.

Basis of Opinions of Probable Cost

The purpose of the opinions of probable cost is to provide current information for project planning, phasing and budgeting. This Section provides opinions of probable cost information for the wide variety of items addressed in this **Rehabilitation Analysis**. The goal was to bring all major mechanical and aquaculture equipment to a level which would last up to 25 years. Recommendations were provided to either renovate or replace equipment.

Sources

Unit prices were arrived at through the assistance of the various disciplines at HDR. Manufacturers and suppliers were consulted regarding major cost items. Building construction cost data files (such as Means Estimating Handbook, 2013) were also used. Since there is no direct control over the cost of labor and materials or competitive bidding, a guarantee of the accuracy of any statement of construction cost cannot be given.

Cost Factors and Assumptions

a) Quality of Materials: Prices used are in line with the quality required for U.S. Government and State of Minnesota specifications and represent low-maintenance construction.

b) Overtime: No additional allowance has been made for overtime work.

c) Material Quality: Prices are representative of large quantity purchases. If smaller quantities are determined, the cost per unit will increase.

d) Weather Conditions: Normal conditions are assumed. No consideration has been given to unusual extremes of weather. The normal outdoor construction season in Minnesota is estimated to be from April 1 to December 1, annually.

e) Labor: Workmanship of good quality and labor is assumed available in sufficient quantity.

f) Overhead and Profit: The unit prices include 20% for overhead and profit, unless noted otherwise.

g) Remoteness: An allowance has not been made for remoteness of the sites from major sources of supply and major construction contractors.

Fish Hatchery Unit Cost Assumptions

More specific cost estimating will occur during the planning and design phase of the proposed renovation project. The main purpose of these cost projections is to provide ranges for funding requests and to budget for these major facility enhancements.

Actual capital costs at fish hatchery facilities currently under construction, as well as those at facilities recently constructed, were used as a basis for estimating the capital costs of improvements. A general unit value was assigned to each improvement item. For example, a unit cost was estimated for constructing an individual standard raceway, or a square foot of incubation building space or storage space. The unit cost was then multiplied by the number of such items planned at the fish hatchery. This approach to construction cost estimating is only appropriate in situations where a broad survey of numerous similar project costs are being made and where the projects themselves have not advanced beyond the stage of conceptual design. In actuality, the unit construction cost per raceway or per square foot of building space may vary a great deal depending upon, among other things, the scale of construction and the particular conditions at individual project sites. Costs outlined in this report are those estimated as performed by an outside contractor hired by MNDNR. In-house construction may cost less, but cannot be estimated since we are not aware of the capabilities or availability of in-house crews.

Contingency Allowance

Any construction project can have certain unpredictable expenses, including both minor and major changes in preliminary and final design, estimating errors, rapid price changes for various components, labor shortages or strikes affecting both productivity and schedules, and overlooked items. To cover the cost of these unpredictable expenses, an allowance for various contingencies must be included in the total project cost at all levels of preliminary estimating. The contingency is designed to reduce project risk and should be large enough to cover all unforeseen and unpredictable events, conditions and occurrences between preliminary and final design. The contingency will vary according to the type of project, complexity of design, and geographical location. This allowance can be reduced as the design progresses from concept through final working documents, but some of the contingencies must remain throughout the life of the project.

The following recommended contingency allowances and the usual allocation for each is summarized below.

- Estimating Contingency – 15% (Included)
- General Conditions Contingency – 5% (Included)
- Escalation Contingency – 4% per year (Not Included)
- State Construction Contingency – 10% (Included)
- Planning and Design Engineering Contingency – 8% (Included)
- Design Reimbursable Costs – Variable (Not Included)
- Construction Engineering Contingency – 7% (Included)
- State Agency Contingency – Generally 1-5% (Not Included)

Each contingency is described in detail in the following paragraphs. In general, the construction total, Estimating Contingency, General Conditions Contingency and Escalation is subtotaled and the other contingencies are then calculated and added. For example, if a project occurs three (3) years (4% escalation/year) after the completion of this study:

Example:

Construction Total = $25,000
    Estimating Contingency (10% of Construction Total) = $2,500
    General Conditions Contingency (5% of the Construction Total)-$1,250
    Escalation Contingency (12% of Construction Total) = $3,000
Subtotal = $31,750
    State Construction Contingency (10% of Subtotal) = $3,175
    Planning and Design Engineering Contingency (8% of Subtotal) = $2,540
    Construction Engineering Contingency (7% of Subtotal) = $2,222.5
Total Cost = $39,687.5
    State Agency Contingency (4% of Total Cost) = $1,587.5
Final Cost = $41,275
*Total Contingency: 59.9% = [Total * (1.1+0.05+0.12) * (1.1+0.08+0.07)* (1.04)]*

The summarized opinions of probable cost in this report include the Estimating, General Conditions, State Construction, Planning and Design Engineering and Construction Engineering contingencies for a total contingency of 50% [Total * (1.15 Estimating + 0.05 General Conditions) * (1.10 Const. Cont. + 0.08 Design Eng. + 0.07 Const. Eng.) = Total * 1.2 * 1.25].

In the Detailed Opinions of Cost, the costs are calculated by taking the number of units by cost per unit. This total is multiplied by the estimating contingency (15%) and general conditions contingency (5%). This value is shown in the fifth column of the spreadsheet and titled **Subtotal + 20% Est**. This value is generally considered the cost to construct. The next column takes the previous subtotal and multiplies it by 1.25 to include the Design and Construction Contingencies. This column is entitled **Total Cost + 25% Cont** and is generally considered to be the cost needed to budget for the project.

Overview of Included Contingencies

Estimating Contingency (Included)

Based on HDR's past experience, a minimum preliminary cost estimate contingency, or Estimating Contingency, applicable for this phase of the project is 10% and must be added to all of the opinions of probable costs. As final design is completed and more definitive costs are developed, this estimating contingency is no longer required. This contingency has been included in the probable costs presented in this report.

General Conditions Contingency (Included)

The General Contractor will include General Conditions in his/her bid for the project. General Conditions include erosion control, general sitework, mobilization to the site, storage of materials, bonds and insurance, construction trailer, temporary utilities, etc. These kinds of costs are generally not included in their materials or labor costs. Therefore, this contingency is added to the project to ensure adequate funding is acquired. This contingency has been included in the probable costs presented

State Construction Contingency (Included)

All project construction costs should provide adequate contingency funding prior to bidding so that the project may still be awarded if contractor's bids come in slightly higher than the designer's estimate. In addition, a contingency fund should be available during construction to provide for change orders required during actual construction. These types of change orders are typically for additional costs to the contractor due to unforeseen and unanticipated field conditions. Some changes occur as a result of Owner-requested items. In general, a bidding and change order contingency of 10% is added to the final opinions of probable cost. The State will need to provide the proper State Construction Contingency during the engineering phase. For example, Pennsylvania and Texas typically utilize 15% and 5%, respectively for large-scale capital projects. Approximately half of this contingency is for the bidding process and the other half is available throughout construction. This entire contingency is required throughout the design process. This contingency has been assumed at 10% in the estimates presented in this report.

Planning and Design Contingency (Included)

The design fee for the work will be negotiated and analyzed at the time that a definitive scope of services is developed. For planning and budgeting purposes, a design budget of approximately 8% of the construction budget is included in this report. The design fee does <u>not</u> include the cost of reimbursable items (see the discussion later in this section about design reimbursables).

Construction Engineering Contingency (Included)

The Construction Engineering Contingency includes construction observation, testing and construction engineering services. In general, a 7% additional fee is added to the planning estimates to cover the cost of these services. Construction observation may be intermittent (one or two days per month) to full-time depending upon the requirements of the administering agencies involved. On larger projects, it is strongly recommended that full-time engineering and inspection personnel be available to observe all construction. These personnel may either be State employees or representatives of the design-engineering firm or a combination of both. A combination of State Construction or Planning Office and design consultant provided inspection phase services is suggested. In addition, the design engineer provides construction observation during monthly site meetings. The 7% construction-engineering contingency has been added to the probable costs presented in this report.

Overview of Excluded Contingencies

Escalation Contingency (Not Included)

Due to State budgeting time requirements, construction may not occur until future years. Generally funds are requested years before construction will begin. Therefore, a cost escalation contingency of 4% per year is required to adequately address the effects of inflation. The cost escalation factor has not been included in the costs presented in this report so all cost represent 2011 prices.

Design Reimbursable Costs (Not Included)

Design reimbursable costs include aerial photography, topographic mapping and surveying; travel compensation; geotechnical soils investigation and engineering report; permit preparation and applications; archaeological investigation (if required); construction document printing; and/or start-up phase services. Each of these reimbursable items is discussed in more detail below. Not every facility will require completion of all of the reimbursable items listed in order to proceed to design. However, the items are mentioned in order to illustrate all that could be involved in a large-scale design project. Due to the variable costs associated with design reimbursables, contingencies for reimbursables have not been allocated in this study.

Aerial Photography & Topographic Mapping

Aerial photography and topographic mapping should be completed for all projects. In general, this type of work may be contracted and executed directly with an aerial services company prior to the selection of a design consultant. This work is normally completed between mid-November and mid-April to avoid vegetation and foliage interference. Topographic data will be in readable AutoCAD format for direct use in drawings and for engineering design. Regular land surveying could also be used to gather site elevations, but may not be feasible for larger-scale projects.

Geotechnical, Structural and Groundwater Investigations

It is recommended that a complete soils and geotechnical investigation report be completed for sites whenever new buildings and major structures are being constructed. Groundwater investigations will be required at locations where new wells or spring work is proposed.

Permitting & Agency Coordination

The permit application and coordination process for projects of this size and magnitude have the potential to be very involved and time-consuming. Water withdrawal and Lake Authority Approval, Wetlands, Corps of Engineers Section 404, construction, NPDES effluent and Public Health permits may be required. There may also be a substantial amount of time required for environmental impact coordination if required. Land use and electrical power agreements with the local utility companies may also need modification. Projected permitting needs are outlined in **Section V** and projected associated costs are also included.

Archaeological Investigations

Archaeological investigations may have to be completed in conjunction with design of the proposed projects. If required, these investigations should be handled directly by MNDNR and staff specialists working with the State Historical Society.

Printing

Construction document printing costs consist of providing and sending plans and specifications to all interested contractors, subcontractors, suppliers, plan houses, permitting agencies and other interested parties. It is estimated that through all phases of the construction work, from 10 to 60 sets of documents will be printed and distributed for each improvement project depending upon complexity and size. Printing may be handled by the MNDNR Construction Services Agency, but usually requires project funds to execute.

Start-Up & System Testing

Start-up phase services are especially important for a State Fish Hatchery project involving a new building, a large scale renovation or complex electrical/mechanical systems that require testing and Owner training to operate. This start-up phase service is provided by the design consultant who coordinates individual component start-up with the contractors and suppliers. System shakedown procedures are reviewed when the fish hatchery is run for two to five days within the full production design parameters of the facility. This testing also provides the fish hatchery operating personnel with component training and system capability reviews. The start-up service would be during the late stages of construction and immediately after final construction acceptance, but prior to active fish hatchery operation.

State Agency Contingency (Not Included)

Each state has specific agency contingencies that are added to the project total after all other contingencies have been accounted. This contingency has not been included in the probable costs presented in this report.

Itemized Costs Key

The summarized probable construction costs for the projects are located in at the end of this section. Some of the abbreviations found on these sheets include:

AC	Acre	LS	Lump Sum	SF	Square Feet
CF	Cubic Feet	LF	Linear Feet	SY	Square Yards
CY	Cubic Yards	MI	Miles	T	Tons
EA	Each	PKG	Package		

French River Cold Water Hatchery
Summary Opinions of Probable Cost
Final Submittal

6/20/2013

ITEM	DRAWING I.D. #	ROUNDED CONST COST[a]	BUDGET TOTAL COST[a]
Components	**No.**	**$6,087,000**	**$7,610,000**
Lake Intake	1	$299,000	$374,000
Pump Station	2	$312,000	$390,000
Vortex Separator	3	$0	$0
Bag Filtration System	4	$1,116,000	$1,395,000
Ultraviolet Disinfection System	5	$579,000	$723,000
Upper Reservoir	6	$63,000	$79,000
Coldwater Supply - None Needed	7a	$0	$0
Water Heating System	7b	$62,000	$78,000
Mixing Manifold	7c	$52,000	$65,000
Incubation - None Needed	8	$0	$0
Nursery Tanks	9	$122,000	$153,000
Biofilter System	10	$986,000	$1,233,000
Clearwell System	11	$21,000	$27,000
Recirculation Pumps	12	$56,000	$70,000
Recirculation Headtank	13	$47,000	$59,000
Burrows Ponds	14	$439,000	$549,000
Raceways	15	$48,000	$60,000
Clarifier	16a	$541,000	$677,000
Pond - None Needed	16b	$0	$0
Instrumentation System	17	$20,000	$25,000
Heat Recovery System (HRS)	18	$555,000	$693,000
Lower Spawning Tanks	19	$601,000	$751,000
General Storage	20	$143,000	$178,000
Oxygen Generator	21	$25,000	$31,000

[a] Rounded Construction Costs include 20% Contingency: General Conditions (5%) ; Estimating (15%). Rounded Total Costs (or **Costs Needed to Budget**) also include 25% Contingency: Planning & Design (8%); Construction Phase Engineering (7%); and State Construction (10%, Bidding and Change Order). [Total * (1.15+.05) * (1.10 + 0.08 + 0.07)]

Costs do **NOT** include: Design Reimbursables (Variable); State Agency Administrative Fee; or escalation beyond 2013 Construction.

Project: Cold Water Hatchery Rehabilitation Analysis
Phase: Study **Hatchery:** French River
By: Team **Date:** 6/20/2013

Detailed Opinions of Probable Cost						
Dwg. I.D.#	ITEM	NO. UNITS	UNIT MEAS.	COST PER UNIT	SUBTOTAL +20% GC/EST	TOTAL COST +25% CONT.

See Report for detailed explanation of fees & contingencies

	Facility Infrastructure					
1	**Lake Intake**				**$298,800**	**$373,500**
	Repair Existing Pipeline with Existing Intake Structure			*Subtotal*	*$208,800*	*$261,000*
	Realign and Reconnect 20-inch Ductile Iron Pipe (including materi	2	EA	$75,000.00	$180,000	$225,000
	Stabilize Pipe with Grout Bag Anchors (including materials)	3	EA	$8,000.00	$28,800	$36,000
	Repair Intake Pipeline and Install In-Lake Filter (Recommended)			*Subtotal*	*$298,800*	*$373,500*
	Realign and Reconnect 20-inch Ductile Iron Pipe (including materi	2	EA	$75,000.00	$180,000	$225,000
	Stabilize Pipe with Grout Bag Anchors (including materials)	3	EA	$8,000.00	$28,800	$36,000
	Backup Intake	1	EA	$75,000.00	$90,000	$112,500
	Sand and Gravel Crib Filter (See Component 4)				$0	$0
	Add Secondary Intake Pipeline			*Subtotal*	*$2,622,000*	*$3,277,500*
	Mixing Sump with Valves	1	EA	$50,000.00	$60,000	$75,000
	Temperature Gages (3)	1	EA	$5,000.00	$6,000	$7,500
	Furnish and Install 18-inch HDPE Pipe (underground portion; 200-	1	EA	$230,000.00	$276,000	$345,000
	Furnish and Install 18-inch HDPE Pipe with Anchors (underwater p	1	EA	$1,250,000.00	$1,500,000	$1,875,000
	Sand and Gravel Crib Filter (50-ft x 110-ft; including materials)	1	EA	$650,000.00	$780,000	$975,000
2	**Pump Station**				**$311,247**	**$389,059**
	Replace Pumps In-Kind			*Subtotal*	*$55,890*	*$69,863*
	New Pumps	2	EA	$15,000.00	$36,000	$45,000
	Factory Authorized Startup Services and Shipping, 5%	1	LS	$36,000.00	$1,800	$2,250
	Installation and Misc. Piping Modifications, 30%	1	LS	$36,000.00	$10,800	$13,500
	Overhead and Profit, 15%	1	LS	$48,600.00	$7,290	$9,113
	Replace w/ Lower Head Pumps (Recommended)			*Subtotal*	*$46,575*	*$58,219*
	New Pumps	2	EA	$12,500.00	$30,000	$37,500
	Factory Authorized Startup Services and Shipping, 5%	1	LS	$30,000.00	$1,500	$1,875
	Installation and Misc. Piping Modifications, 30%	1	LS	$30,000.00	$9,000	$11,250
	Overhead and Profit, 15%	1	LS	$40,500.00	$6,075	$7,594
	Replace Switchgear in Pumphouse (Recommended)			*Subtotal*	*$225,672*	*$282,090*
	Remove Overhead line	1	LS	$2,500.00	$3,000	$3,750
	Remove existing disconnects and panel boards	1	LS	$500.00	$600	$750
	Remove transformers	1	LS	$500.00	$600	$750
	Remove generator and transfer switch	1	LS	$500.00	$600	$750
	Misc. Demolition	1	LS	$1,000.00	$1,200	$1,500
	New feeder, 4#3/0 & #2 GRD, in 2"C					
	Trenching and backfill	150	ft	$20.00	$3,600	$4,500
	2" PVC	150	ft	$12.00	$2,160	$2,700
	#3/0	600	ft	$6.80	$4,896	$6,120
	#2	150	ft	$3.20	$576	$720

Detailed Opinions of Probable Cost						
Dwg. I.D.#	ITEM	NO. UNITS	UNIT MEAS.	COST PER UNIT	SUBTOTAL +20% GC/EST	TOTAL COST +25% CONT.
	175 kw Generator, transfer switch, & muffler	1	LS	$54,500.00	$65,400	$81,750
	Fuel System	1	LS	$3,500.00	$4,200	$5,250
	Building Modifications for generator	1	LS	$5,000.00	$6,000	$7,500
	Main Panel	8	LS	$4,000.00	$38,400	$48,000
	Transformer, est 45 kva	9	LS	$3,100.00	$33,480	$41,850
	Panel	1	LS	$2,900.00	$3,480	$4,350
	Additional MCC section	1	LS	$2,500.00	$3,000	$3,750
	VFD	2	LS	$11,800.00	$28,320	$35,400
	VFD with iso & bypass	1	LS	$18,500.00	$22,200	$27,750
	Metering	1	LS	$800.00	$960	$1,200
	Misc. Improvements	1	LS	$2,500.00	$3,000	$3,750
	Provide SCADA Panel for Pumphouse (Recommended)			*Subtotal*	*$39,000*	*$48,750*
	Fiber Optic Cable	1	EA	$8,000.00	$9,600	$12,000
	Remote I/O Panel	1	EA	$9,500.00	$11,400	$14,250
	Reservoir sensors	2	EA	$1,500.00	$3,600	$4,500
	Programming and start up	1	EA	$12,000.00	$14,400	$18,000
3	**Vortex Separator**				**$0**	**$0**
	Retain Separator (Recommended)			*Subtotal*	*$0*	*$0*
	No Changes					
	Replace Separator In-Kind			*Subtotal*	*$49,680*	*$62,100*
	New Separator, 850 gpm	1	EA	$30,000.00	$36,000	$45,000
	Installation and Misc. Piping Modifications, 20%	1	LS	$36,000.00	$7,200	$9,000
	Overhead and Profit, 15%	1	LS	$43,200.00	$6,480	$8,100
	Replace Separator Lower Flow			*Subtotal*	*$66,240*	*$82,800*
	New Separator, 425 gpm	2	EA	$20,000.00	$48,000	$60,000
	Installation and Misc. Piping Modifications, 20%	1	LS	$48,000.00	$9,600	$12,000
	Overhead and Profit, 15%	1	LS	$57,600.00	$8,640	$10,800
4	**Bag Filtration System**				**$1,116,000**	**$1,395,000**
	Replace with In-Lake Filter (Recommended)			*Subtotal*	*$1,116,000*	*$1,395,000*
	Sand and Gravel Crib Filter (50-ft x 110-ft; including materials)	1	EA	$930,000.00	$1,116,000	$1,395,000
	Replace with Stacked Disc Filter			*Subtotal*	*$508,373*	*$635,466*
	Disc Filter System	2	EA	$120,995.00	$290,388	$362,985
	Air Compressor	1	EA	$4,995.00	$5,994	$7,493
	Factory Authorized Startup Services and Shipping, 5%	1	LS	$296,382.00	$14,819	$18,524
	Installation and Misc. Piping Modifications, 30%	1	LS	$296,382.00	$88,915	$111,143
	Overhead and Profit, 15%	1	LS	$400,115.70	$60,017	$75,022
	Electrical Feeder	1	LS	$5,000.00	$6,000	$7,500
	SCADA Extension	1	LS	$3,200.00	$3,840	$4,800
	Building, Heated and Lighted Building	1	LS	$32,000.00	$38,400	$48,000

Detailed Opinions of Probable Cost						
Dwg. I.D.#	ITEM	NO. UNITS	UNIT MEAS.	COST PER UNIT	SUBTOTAL +20% GC/EST	TOTAL COST +25% CONT.
5	**Ultraviolet Disinfection System**				**$578,275**	**$722,844**
	Replace with 40 mJ Dose (Recommended)			*Subtotal*	*$578,275*	*$722,844*
	Remove Old UV Equipment	1	LS	$5,000.00	$6,000	$7,500
	UV Equipment	2	EA	$152,000.00	$364,800	$456,000
	Electrical	1	LS	$300.00	$360	$450
	SCADA- UV Intensity, Analog	1	EA	$500.00	$600	$750
	SCADA- UV Alarms, Discrete	2	EA	$300.00	$720	$900
	Factory Authorized Startup Services and Shipping, 5%	1	LS	$372,480.00	$18,624	$23,280
	Installation and Misc. Piping Modifications, 30%	1	LS	$372,480.00	$111,744	$139,680
	Overhead and Profit, 15%	1	LS	$502,848.00	$75,427	$94,284
	Replace with 126 mJ Dose			*Subtotal*	*$861,451*	*$1,076,814*
	Remove Old UV Equipment	1	LS	$5,000.00	$6,000	$7,500
	UV Equipment	3	EA	$152,000.00	$547,200	$684,000
	Electrical	1	LS	$300.00	$360	$450
	SCADA- UV Intensity, Analog	1	EA	$500.00	$600	$750
	SCADA- UV Alarms, Discrete	2	EA	$300.00	$720	$900
	Factory Authorized Startup Services and Shipping, 5%	1	LS	$554,880.00	$27,744	$34,680
	Installation and Misc. Piping Modifications, 30%	1	LS	$554,880.00	$166,464	$208,080
	Overhead and Profit, 15%	1	LS	$749,088.00	$112,363	$140,454
6	**Upper Reservoir**				**$62,850**	**$78,563**
	Install Aeration Columns			*Subtotal*	*$11,964*	*$14,955*
	Aeration Columns	2	EA	$2,600.00	$6,240	$7,800
	Installation and Misc. Piping Modifications, 50%	1	LS	$6,240.00	$3,120	$3,900
	Overhead and Profit, 15%	1	LS	$9,360.00	$1,404	$1,755
	Perforated Pipe Demo	1	LS	$1,000.00	$1,200	$1,500
	Install Oxygenation Columns (Recommended)			*Subtotal*	*$48,810*	*$61,013*
	Aeration Columns	4	EA	$3,250.00	$15,600	$19,500
	Oxygen Piping Extension	1	LS	$15,000.00	$18,000	$22,500
	Installation and Misc. Piping Modifications, 50%	1	LS	$15,600.00	$7,800	$9,750
	Overhead and Profit, 15%	1	LS	$41,400.00	$6,210	$7,763
	Perforated Pipe Demo	1	LS	$1,000.00	$1,200	$1,500
	Install DO Monitoring (Recommended)			*Subtotal*	*$14,040*	*$17,550*
	DO Sensor	1	LS	$2,000.00	$2,400	$3,000
	DO Transmitter	1	LS	$4,500.00	$5,400	$6,750
	SCADA Programming	2	LS	$500.00	$1,200	$1,500
	Wiring	1	LS	$2,500.00	$3,000	$3,750
	Replace Float Switches and Level Controls	1	LS	$1,700.00	$2,040	$2,550
7	**Main Water Supply System**				**$113,352**	**$141,689**
7a	**Coldwater Supply - None Needed**			**Subtotal**	$0	$0
7b	**Water Heating System**			**Subtotal**	**$61,662**	**$77,077**
	Convert Oil Boilers to Gas (Recommended)			*Subtotal*	*$34,990*	*$43,737*
	Disconnect oil piping and remove	1	LS	$850.00	$1,020	$1,275

Detailed Opinions of Probable Cost						
Dwg. I.D.#	ITEM	NO. UNITS	UNIT MEAS.	COST PER UNIT	SUBTOTAL +20% GC/EST	TOTAL COST +25% CONT.
	Remove Oil Burner	3	EA	$765.00	$2,754	$3,443
	From gas meter to boiler gas piping	80	LF	$35.75	$3,432	$4,290
	New gas burners	3	EA	$3,850.00	$13,860	$17,325
	Clean boilers	3	EA	$650.00	$2,340	$2,925
	Start up	1	LS	$1,200.00	$1,440	$1,800
	Warranty	1	LS	$1,000.00	$1,200	$1,500
	Shops	1	LS	$450.00	$540	$675
	Misc.	1	LS	$3,200.00	$3,840	$4,800
	Contractor's Overhead and Profit, 15%	1	LS	$30,426.00	$4,564	$5,705
	Remove Existing Wood Boiler (Recommended)			*Subtotal*	*$26,672*	*$33,340*
	Remove existing Wood Fired Boiler	1	EA	$13,600.00	$16,320	$20,400
	Remove existing flue assembly	1	LF	$1,325.00	$1,590	$1,988
	Disconnect and remove existing auger and fan ducted air	1	LS	$295.00	$354	$443
	Disconnect and remove controls	1	LS	$345.00	$414	$518
	Disconnect and remove power from boiler	1	LS	$375.00	$450	$563
	Disconnect and remove supply/Return piping from boiler	35	LF	$25.35	$1,065	$1,331
	Misc. Removal	1	LS	$2,500.00	$3,000	$3,750
	Contractor's Overhead and Profit, 15%	1	LS	$23,192.70	$3,479	$4,349
	Replace Wood Boiler			*Subtotal*	*$297,253*	*$371,566*
	New Biomass Boiler	1	EA	$48,500.00	$58,200	$72,750
	New flue assembly	20	LF	$4,200.00	$100,800	$126,000
	New auger and supply fan	1	LS	$3,750.00	$4,500	$5,625
	New Controls	1	LS	$5,800.00	$6,960	$8,700
	Reconnect supply and return piping to boiler	52	LF	$36.75	$2,293	$2,867
	Reinsulate new piping	52	LF	$10.25	$640	$800
	New concrete pad for boiler	1	LS	$750.00	$900	$1,125
	New power to boiler	1	LS	$3,200.00	$3,840	$4,800
	New ash removal auger system	1	LS	$17,850.00	$21,420	$26,775
	Start up	1	LS	$2,500.00	$3,000	$3,750
	Warranty	1	LS	$2,000.00	$2,400	$3,000
	Shops	1	LS	$650.00	$780	$975
	Misc.	1	LS	$6,500.00	$7,800	$9,750
	Contractor's Overhead and Profit, 15%	1	LS	$213,532.80	$32,030	$40,037
7c	**Mixing Manifold**			**Subtotal**	**$51,690**	**$64,613**
	Install Aeration Columns			*Subtotal*	*$4,512*	*$5,640*
	Aeration Columns	2	EA	$800.00	$1,920	$2,400
	Installation and Misc. Piping Modifications, 50%	1	LS	$1,920.00	$960	$1,200
	Overhead and Profit, 15%	1	LS	$2,880.00	$432	$540
	Aspirator Demo	1	LS	$1,000.00	$1,200	$1,500
	Install Oxygenation Columns (Recommended)			*Subtotal*	*$15,690*	*$19,613*
	Aeration Columns	2	EA	$1,000.00	$2,400	$3,000
	Oxygen Piping Extension	1	LS	$7,500.00	$9,000	$11,250
	Installation and Misc. Piping Modifications, 50%	1	LS	$2,400.00	$1,200	$1,500
	Overhead and Profit, 15%	1	LS	$12,600.00	$1,890	$2,363
	Aspirator Demo	1	LS	$1,000.00	$1,200	$1,500

Detailed Opinions of Probable Cost						
Dwg. I.D.#	ITEM	NO. UNITS	UNIT MEAS.	COST PER UNIT	SUBTOTAL +20% GC/EST	TOTAL COST +25% CONT.
	Install Automatic Level Controls (Recommended)			*Subtotal*	*$19,800*	*$24,750*
	VFD Panel w/ 3 Drives	1		$10,500.00	$12,600	$15,750
	Level Sensor in Hot Well	1		$1,500.00	$1,800	$2,250
	SCADA Mods	1		$4,500.00	$5,400	$6,750
	Install DO Monitoring (Recommended)			*Subtotal*	*$16,200*	*$20,250*
	DO Sensor	1	LS	$2,000.00	$2,400	$3,000
	DO Transmitter	1	LS	$4,500.00	$5,400	$6,750
	SCADA Programming	4	LS	$500.00	$2,400	$3,000
	Wiring	1	LS	$2,500.00	$3,000	$3,750
	Replace Float Switches and Level Controls	1	LS	$2,500.00	$3,000	$3,750
8	**Incubation - None Needed**				**$0**	**$0**
9	**Nursery Tanks**				**$121,974**	**$152,468**
	Renovate Tanks			*Subtotal*	*$0*	*$0*
	Not Recommended, Won't Last 25 Years					
	Replace Tanks (Recommended)			*Subtotal*	*$121,974*	*$152,468*
	Tanks, Delivered to Duluth	54	EA	$1,364.00	$88,387	$110,484
	Installation and Misc. Piping Modifications, 20%	1	LS	$88,387.20	$17,677	$22,097
	Overhead and Profit, 15%	1	LS	$106,064.64	$15,910	$19,887
10	**Biofilter System**				**$985,710**	**$1,232,138**
	Renovate Biofilters			*Subtotal*	*$90,000*	*$112,500*
	Internal Mild Steel Spot Renovation - Now	1	LS	$20,000.00	$24,000	$30,000
	Move Biofilter Media & Support and Reinstall	1	LS	$5,000.00	$6,000	$7,500
	Internal Mild Steel Spot Renovation - 12.5 Yrs.	1	LS	$10,000.00	$12,000	$15,000
	Move Biofilter Media & Support and Reinstall	1	LS	$5,000.00	$6,000	$7,500
	Add Plastic Sleeves and Washers to Support Fasteners	1	LS	$5,000.00	$6,000	$7,500
	Biofilter Exterior Restoration	1	LS	$30,000.00	$36,000	$45,000
	Replace w/ Drumfilters and MBBR (Recommended)			*Subtotal*	*$985,710*	*$1,232,138*
	Drumfilters in Concrete Basins	4	EA	$80,000.00	$384,000	$480,000
	Installation, 30%	1	LS	$384,000.00	$115,200	$144,000
	MBBR in Concrete Basins	4	EA	$25,000.00	$120,000	$150,000
	Installation, 30%	1	LS	$120,000.00	$36,000	$45,000
	PD Blowers	2	EA	$15,000.00	$36,000	$45,000
	Factory Authorized Startup Services and Shipping, 5%	1	LS	$36,000.00	$1,800	$2,250
	Installation, 20%	1	LS	$36,000.00	$7,200	$9,000
	Miscellaneous Piping	1	LS	$100,000.00	$120,000	$150,000
	Demo of Biofilters	1	LS	$20,000.00	$24,000	$30,000
	Electrical	1	LS	$10,000.00	$12,000	$15,000
	Instrumentation	1	LS	$2,400.00	$2,880	$3,600
	Overhead and Profit, 15%	1	LS	$844,200.00	$126,630	$158,288
11	**Clearwell System**				**$20,880**	**$26,100**
	Replace Make Up Water Supply System (Recommended)			*Subtotal*	*$20,880*	*$26,100*
	Replace Cold Water Supply Motorized Valve	2	EA	$2,500.00	$6,000	$7,500

Detailed Opinions of Probable Cost						
Dwg. I.D.#	ITEM	NO. UNITS	UNIT MEAS.	COST PER UNIT	SUBTOTAL +20% GC/EST	TOTAL COST +25% CONT.
	Replace Hot Water Supply Motorized Valve	2	EA	$2,500.00	$6,000	$7,500
	Wiring	2	LS	$1,000.00	$2,400	$3,000
	Reservoir Sensors	2	LS	$1,000.00	$2,400	$3,000
	SCADA Programming, Analog	2	LS	$500.00	$1,200	$1,500
	SCADA Programming, Discrete	8	LS	$300.00	$2,880	$3,600
12	**Recirculation Pumps**				**$55,890**	**$69,863**
	Renovate Pumps (prem motors)			*Subtotal*	*$23,100*	*$28,875*
	New Motors	7	EA	$2,000.00	$16,800	$21,000
	Installation, 25%	1	LS	$16,800.00	$4,200	$5,250
	Overhead and Profit, 10%	2	LS	$21,000.00	$2,100	$2,625
	Replace Pumps In-Kind			*Subtotal*	*$126,788*	*$158,484*
	New Pumps	7	EA	$10,000.00	$84,000	$105,000
	Factory Authorized Startup Services and Shipping, 5%	1	LS	$84,000.00	$4,200	$5,250
	Installation, 25%	1	LS	$88,200.00	$22,050	$27,563
	Overhead and Profit, 15%	1	LS	$110,250.00	$16,538	$20,672
	Replace Pumps (Recommended)			*Subtotal*	*$55,890*	*$69,863*
	New Pumps	2	EA	$15,000.00	$36,000	$45,000
	Factory Authorized Startup Services and Shipping, 5%	1	LS	$36,000.00	$1,800	$2,250
	Installation and Misc. Piping Modifications, 30%	1	LS	$36,000.00	$10,800	$13,500
	Overhead and Profit, 15%	1	LS	$48,600.00	$7,290	$9,113
13	**Recirculation Headtank**				**$46,800**	**$58,500**
	Install Aeration Columns			*Subtotal*	*$14,820*	*$18,525*
	Aeration Columns	2	EA	$3,000.00	$7,200	$9,000
	Installation and Misc. Piping Modifications, 50%	1	LS	$7,200.00	$3,600	$4,500
	Overhead and Profit, 15%	1	LS	$10,800.00	$1,620	$2,025
	Aerators Demo	1	LS	$2,000.00	$2,400	$3,000
	Install Oxygenation Columns (Recommended)			*Subtotal*	*$35,520*	*$44,400*
	Aeration Columns	4	EA	$3,750.00	$18,000	$22,500
	Oxygen Piping Extension	1	LS	$1,500.00	$1,800	$2,250
	Installation and Misc. Piping Modifications, 50%	1	LS	$18,000.00	$9,000	$11,250
	Overhead and Profit, 15%	1	LS	$28,800.00	$4,320	$5,400
	Aerators Demo	1	LS	$2,000.00	$2,400	$3,000
	DO Monitoring (Recommended)			*Subtotal*	*$11,280*	*$14,100*
	Float Switches	2	EA	$200.00	$480	$600
	DO Sensor	1	EA	$1,000.00	$1,200	$1,500
	DO Transmitter	2	EA	$4,000.00	$9,600	$12,000
14	**Burrows Ponds**				**$438,654**	**$548,318**
	Renovate Burrows Ponds (Recommended)			*Subtotal*	*$317,400*	*$396,750*
	Move Metal Turning Vanes and Reinstall	1	LS	$10,000.00	$12,000	$15,000
	Patching and Coating	1	LS	$220,000.00	$264,000	$330,000
	Overhead and Profit, 15%	1	LS	$276,000.00	$41,400	$51,750

Detailed Opinions of Probable Cost						
Dwg. I.D.#	ITEM	NO. UNITS	UNIT MEAS.	COST PER UNIT	SUBTOTAL +20% GC/EST	TOTAL COST +25% CONT.
	Replace Electrical Switchgear (Recommended)			*Subtotal*	*$90,066*	*$112,583*
	Remove Motor Control Center	1		$2,500.00	$3,000	$3,750
	Remove Panel LB	1		$500.00	$600	$750
	Remove Feeder	1		$500.00	$600	$750
	Misc. Demolition	1		$1,000.00	$1,200	$1,500
	New feeder, 3#2/0 & #2 GRD, in EX C					
	#2/0	800	ft	$5.60	$5,376	$6,720
	#2	250	ft	$3.10	$930	$1,163
	Rework conduit	1	LS	$200.00	$240	$300
	MCC, 8 sections	8	LS	$2,000.00	$19,200	$24,000
	Drives	9	LS	$2,900.00	$31,320	$39,150
	Panel	1	LS	$3,500.00	$4,200	$5,250
	SCADA Modifications	1	LS	$12,000.00	$14,400	$18,000
	Sensors, Clearwells	3	LS	$2,500.00	$9,000	$11,250
	Replace Lighting (Recommended)			*Subtotal*	*$31,188*	*$38,985*
	Burrows Pond Building					
	Remove Incandescent Lighting	41	EA	$30.00	$1,476	$1,845
	Remove Induction Light	1	EA	$40.00	$48	$60
	Install LED Fixture, Lithonia I-Beam, IBL WD - LP740 DLC	20	EA	$600.00	$14,400	$18,000
	Labor and Chain Mounting	20	EA	$80.00	$1,920	$2,400
	Biofilter Building					
	Remove Incandescent Lighting	22	EA	$15.00	$396	$495
	Install LED Fixture, Lithonia I-Beam, IBL WD - LP740 DLC	22	EA	$395.00	$10,428	$13,035
	Labor and Chain Mounting	42	EA	$50.00	$2,520	$3,150
15	**Raceways**				**$47,340**	**$59,175**
	Add Concrete Floor and Infrared Heat (Recommended)			*Subtotal*	*$21,000*	*$26,250*
	Concrete Floor	1	LS	$7,500.00	$9,000	$11,250
	Infrared Heating Unit, Installed	1	LS	$10,000.00	$12,000	$15,000
	Renovate Emergency Pump Electrical and Controls (Recommended)			*Subtotal*	*$7,560*	*$9,450*
	Extend SCADA I/O to Raceway Building	1	LS	$2,400.00	$2,880	$3,600
	Network VFD	1	LS	$700.00	$840	$1,050
	Replace VFD	1	LS	$3,200.00	$3,840	$4,800
	Replace Lighting (Recommended)			*Subtotal*	*$18,780*	*$23,475*
	Remove Incandescent Fixtures	30		$65.00	$2,340	$2,925
	Install new LED Fixtures	18		$650.00	$14,040	$17,550
	Dimming Controls	1		$2,000.00	$2,400	$3,000
16	**Effluent Treatment**				**$540,815**	**$676,019**
16a	**Clarifier**			**Subtotal**	**$540,815**	**$676,019**
	Renovate Clarifier			*Subtotal*	*$156,300*	*$195,375*
	Retrofit Chain and Flight Materials	1	LS	$75,000.00	$90,000	$112,500
	Installation, Shipping and Startup, 40%	1	LS	$90,000.00	$36,000	$45,000
	Electrical Rehabilitation	1	LS	$4,500.00	$5,400	$6,750
	Replace Pump	1	LS	$5,000.00	$6,000	$7,500

Detailed Opinions of Probable Cost						
Dwg. I.D.#	ITEM	NO. UNITS	UNIT MEAS.	COST PER UNIT	SUBTOTAL +20% GC/EST	TOTAL COST +25% CONT.
	Overhead and Profit, 15%	1	LS	$126,000.00	$18,900	$23,625
	Renovate Clarifier and Add 2nd Rect. Clarifier (Recommended)			*Subtotal*	*$540,815*	*$676,019*
	Retrofit and New Chain and Flight Materials	2	LS	$75,000.00	$180,000	$225,000
	Installation, Shipping and Startup, 40%	1	LS	$180,000.00	$72,000	$90,000
	Overhead and Profit, 15%	1	LS	$252,000.00	$37,800	$47,250
	Concrete Tank for Clarifier	1	LS	$100,000.00	$120,000	$150,000
	Concrete Tank for Sludge Storage	1	LS	$25,000.00	$30,000	$37,500
	Insulated Cover	1	LS	$50,000.00	$60,000	$75,000
	Installation	1	LS	$9,750.00	$11,700	$14,625
	Overhead and Profit, 15%	1	LS	$71,700.00	$10,755	$13,444
	Miscellaneous Piping	1	LS	$3,800.00	$4,560	$5,700
	Pumps	2	EA	$5,000.00	$12,000	$15,000
	Electrical Rehabilitation	1	LS	$5,000.00	$2,000	$2,500
	Replace Clarifier with Circular Clarifier			*Subtotal*	*$722,760*	*$903,450*
	Clarifier Arm	1	LS	$125,000.00	$150,000	$187,500
	Installation, Shipping and Startup, 40%	1	LS	$150,000.00	$60,000	$75,000
	Overhead and Profit, 15%	1	LS	$210,000.00	$31,500	$39,375
	Circular Tank	1	LS	$100,000.00	$120,000	$150,000
	Insulated Cover	1	LS	$140,000.00	$168,000	$210,000
	Installation	1	LS	$27,000.00	$32,400	$40,500
	Overhead and Profit, 15%	1	LS	$200,400.00	$30,060	$37,575
	Electrical	1	LS	$14,300.00	$17,160	$21,450
	Instrumentation	1	LS	$3,200.00	$3,840	$4,800
	Miscellaneous Piping	1	LS	$7,500.00	$9,000	$11,250
	Self-Priming Trash Pumps	2	EA	$7,500.00	$18,000	$22,500
	Sludge Storage Tank	1	LS	$25,000.00	$30,000	$37,500
	Sludge Storage Tank Cover	1	LS	$35,000.00	$42,000	$52,500
	Overhead and Profit, 15%	1	LS	$72,000.00	$10,800	$13,500
16b	**Pond - None Needed**					
17	**Instrumentation System**				**$19,440**	**$24,300**
	Upgrade PLC (Recommended)			*Subtotal*	*$19,440*	*$24,300*
	Replace PLC at HB	1	LS	$15,000.00	$18,000	$22,500
	Transfer Program	1	LS	$1,200.00	$1,440	$1,800
18	**Heat Recovery System (HRS)**				**$554,400**	**$693,000**
	Remove HRS			*Subtotal*	*-$24,000*	*-$30,000*
	Sale of Heat Recovery System Components	1	EA	-$20,000.00	-$24,000	-$30,000
	Add Filtration and Renovate HRS (Recommended)			*Subtotal*	*$523,200*	*$654,000*
	Filtration System (600 gpm)	1	EA	$375,000.00	$450,000	$562,500
	Pipe/Fittings/Valves	1	EA	$28,000.00	$33,600	$42,000
	Building	1	EA	$29,000.00	$34,800	$43,500
	Controls/Electrical	1	EA	$4,000.00	$4,800	$6,000
	Add Filtration and Utilize Existing Heat Exchangers			*Subtotal*	*$499,200*	*$624,000*
	Filtration System (600 gpm)	1	EA	$375,000.00	$450,000	$562,500
	Pipe/Fittings/Valves	1	EA	$28,000.00	$33,600	$42,000

Detailed Opinions of Probable Cost						
Dwg. I.D.#	ITEM	NO. UNITS	UNIT MEAS.	COST PER UNIT	SUBTOTAL +20% GC/EST	TOTAL COST +25% CONT.
	Building	1	EA	$29,000.00	$34,800	$43,500
	Controls/Electrical	1	EA	$4,000.00	$4,800	$6,000
	Sale of Heat Recovery System Components	1	EA	-$20,000.00	-$24,000	-$30,000
	Modify HRS for Cooling Mode (Recommended)			*Subtotal*	*$31,200*	*$39,000*
	Manufacturer Support	1	EA	$8,000.00	$9,600	$12,000
	Pipe/Fittings/Valves	1	EA	$3,000.00	$3,600	$4,500
	Controls/Electrical	1	EA	$15,000.00	$18,000	$22,500
	Install Water Chiller			*Subtotal*	*$218,400*	*$273,000*
	Water Testing/Feasibility	1	EA	$13,000.00	$15,600	$19,500
	Pipe/Fittings/Valves	1	EA	$10,000.00	$12,000	$15,000
	Controls/Electrical	1	EA	$4,000.00	$4,800	$6,000
	Concrete Pad	1	EA	$5,000.00	$6,000	$7,500
	Air-Cooled Water Chiller	1	EA	$150,000.00	$180,000	$225,000
19	**Lower Spawning Tanks**				**$600,231**	**$750,289**
	Install Water Treatment (Recommended)			*Subtotal*	*$573,231*	*$716,539*
	Stacked Disc Filter			*Subtotal*	*$462,233*	*$577,791*
	Stacked Disc Filter System	2	EA	$120,995.00	$290,388	$362,985
	Air Compressor	1	EA	$4,995.00	$5,994	$7,493
	Factory Authorized Startup Services and Shipping, 5%	1	LS	$296,382.00	$14,819	$18,524
	Installation and Misc. Piping Modifications, 30%	1	LS	$296,382.00	$88,915	$111,143
	Overhead and Profit, 15%	1	LS	$400,115.70	$60,017	$75,022
	Electrical	1	LS	$1,200.00	$1,440	$1,800
	SCADA Modifications	1	LS	$300.00	$360	$450
	Wiring	1	LS	$250.00	$300	$375
	UV System			*Subtotal*	*$573,231*	*$716,539*
	UV Equipment	2	EA	$152,000.00	$364,800	$456,000
	SCADA- UV Intensity, Analog	1	EA	$500.00	$600	$750
	SCADA- UV Alarms, Discrete	2	EA	$300.00	$720	$900
	Electrical	1	LS	$3,500.00	$4,200	$5,250
	Factory Authorized Startup Services and Shipping, 5%	1	LS	$366,120.00	$18,306	$22,883
	Installation and Misc. Piping Modifications, 30%	1	LS	$366,120.00	$109,836	$137,295
	Overhead and Profit, 15%	1	LS	$498,462.00	$74,769	$93,462
	Extend Treated Water Supply			*Subtotal*	*$90,000*	*$112,500*
	New Pipeline from Upper Hatchery	1	LS	$75,000.00	$90,000	$112,500
	Replace Lighting (Recommended)			*Subtotal*	*$27,000*	*$33,750*
	Note: Incomplete Information Available for Costing					
	Placeholder for Lighting Replacement TBD	1	LS	$22,500.00	$27,000	$33,750
20	**General Storage**				**$142,200**	**$177,750**
	New Storage Space (Recommended)			*Subtotal*	*$142,200*	*$177,750*
	New Storage Building (2 bays, 40x40)	1,600	SF	$65.00	$124,800	$156,000
	Utility Connection	1	LS	$2,500.00	$3,000	$3,750
	Code-Compliant Chemical Storage	100	SF	$120.00	$14,400	$18,000

Detailed Opinions of Probable Cost						
Dwg. I.D.#	ITEM	NO. UNITS	UNIT MEAS.	COST PER UNIT	SUBTOTAL +20% GC/EST	TOTAL COST +25% CONT.
21	**Oxygen Generator**				**$24,150**	**$30,188**
	Replace PSA			*Subtotal*	*$65,280*	*$81,600*
	15 HP Rotary Screw Compressor, mat'l	2	LS	$10,500.00	$25,200	$31,500
	Install and pipe compressors	1	LS	$2,000.00	$2,400	$3,000
	Duplex Compressor Control	1	LS	$1,200.00	$1,440	$1,800
	Air Dryer	1	LS	$2,800.00	$3,360	$4,200
	Oil Filter	1	LS	$400.00	$480	$600
	Auto Drain Valves	2	LS	$200.00	$480	$600
	Refurbish Receiver Tank	1	LS	$400.00	$480	$600
	Oxygen Generators, AirSep AS-250	2	LS	$6,500.00	$15,600	$19,500
	Heat Recovery System	1	LS	$3,500.00	$4,200	$5,250
	Mass O2 Flow Meter	1	LS	$4,500.00	$5,400	$6,750
	SCADA, Analog	1	LS	$500.00	$600	$750
	SCADA Discrete	5	LS	$300.00	$1,800	$2,250
	Electrical	1	LS	$3,200.00	$3,840	$4,800
	Install LOX Storage Tank			*Subtotal*	*$170,775*	*$213,469*
	New LOX Tank and Tank Accessories, Material	1	LS	$85,000.00	$102,000	$127,500
	New LOX Tank and Tank Accessories, Installation, 25%	1	LS	$102,000.00	$25,500	$31,875
	Pad, Fence Installed	1	LS	$17,500.00	$21,000	$26,250
	O&P, 15%	1	LS	$148,500.00	$22,275	$27,844
	Rent LOX Storage Tank (Recommended)			*Subtotal*	*$24,150*	*$30,188*
	Pad, Fence Installed	1	LS	$17,500.00	$21,000	$26,250
	O&P, 15%	1	LS	$21,000.00	$3,150	$3,938

Minnesota
Department of Natural Resources

MDNR No. 8F022
File No. FMA.00257.00.00.03
HDR No. 202386

French River Cold Water Hatchery

A. REPORT DRAWINGS AND INDEX OF EXISTING DATA

B. POTENTIAL IMPROVEMENT PHOTOS AND MANUFACTURER DATA

C. FISH PRODUCTION DATA

D. PRODUCTION THEORY

E. EXCERPTS FROM NPDES PERMIT, EXAMPLE DMR, AND FLOODPLAIN MAP

F. BIOSECURITY OVERVIEW

G. WATER QUALITY AND TEMPERATURE DATA

H. INTAKE DIVE REPORT

I. OPERATING COST DATA

J. CITED LITERATURE

APPENDICES

HDR

BARR

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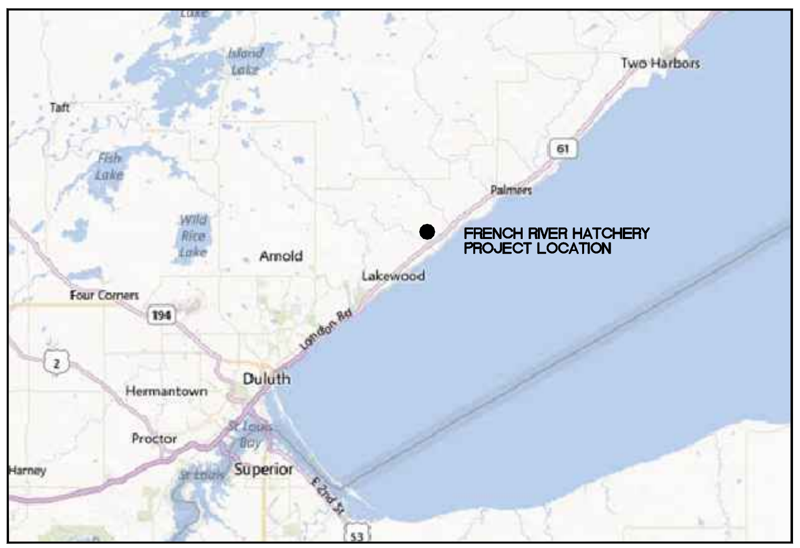
BARR

FRENCH RIVER COLD WATER HATCHERY

REHABILITATION ANALYSIS
DNR PROJECT 8F022

INDEX OF SHEETS

FR-1	COVER SHEET
FR-2	AERIAL PHOTO
FR-3	AERIAL PHOTO AND TOPO
FR-4	ORIGINAL SITE UTILITY PLAN
FR-5	SITE AND COMPONENTS PLAN
FR-6	EXISTING NURSERY BUILDING
FR-7	EXISTING BURROWS BUILDING
FR-8	FLOW DIAGRAM



LOCATION MAP
NTS

AERIAL PHOTOGRAPH
NTS

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	04-08-13	65% SUBMITTAL
	05-16-13	95% SUBMITTAL

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MINNESOTA DEPARTMENT OF NATURAL RESOURCES
FRENCH RIVER COLD WATER HATCHERY
REHABILITATION ANALYSIS
PROJECT NO. 8F022
FILE NO.: FMA.00257.00.00.03

FRENCH RIVER
COVER SHEET

0" 1" 2"

FILENAME

SCALE NO SCALE

SHEET
FR-1

1 2 3 4 5 6 7 8

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FRENCH RIVER
AERIAL PHOTO

0" 1" 2"

FILENAME

SCALE 1"=50'-0"

SHEET
FR-2

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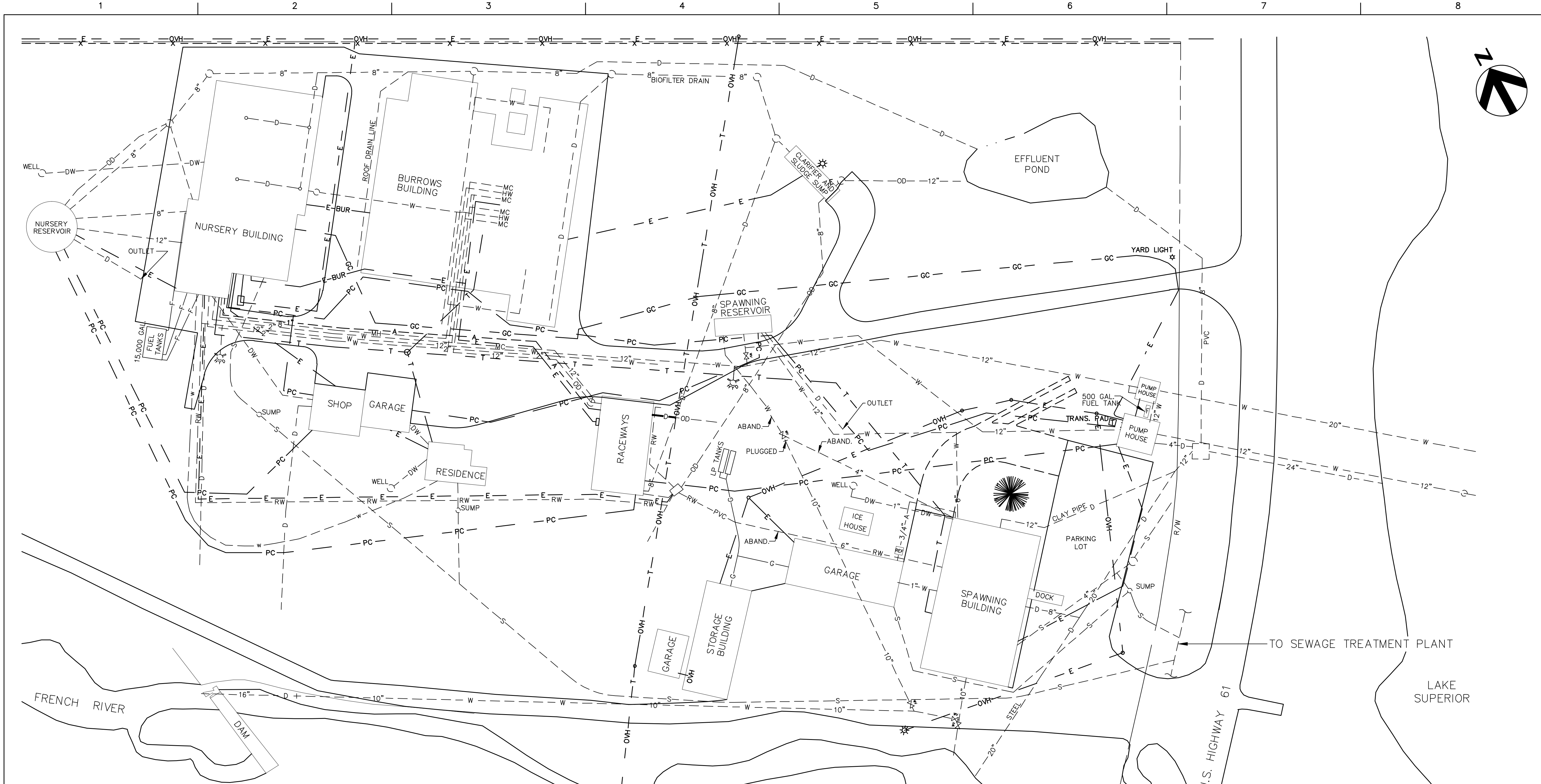
FRENCH RIVER
AERIAL PHOTO AND TOPO

0" 1" 2"

FILENAME

SCALE 1"= 30'-0"

SHEET
FR-3



KEY

DW — 1"	DRINKING WATER LINE
W — 12"	WATER SUPPLY LINE
RW — 12"	RECYCLED WATER LINE
D — 12"	DRAIN LINE
OD — 12"	OVERFLOW DRAIN LINE
MH — 12"	MAKE-UP SUPPLY LINE - HOT
MC — 12"	MAKE-UP SUPPLY LINE - COLD
← ABAND.	INDICATES EXISTING ABANDONED LINE
PC	BURIED PUMP CONTROL LINE
GC	GATE CONTROL LINE
OX — 1"	AIR LINE
T	BURIED TELEPHONE LINE
E	BURIED ELECTRIC LINE
OVH — E	OVERHEAD ELECTRIC LINE
S	SEWER LINE
F	FUEL LINE
G	GAS LINE

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FRENCH RIVER
ORIGINAL SITE UTILITY PLAN

0" 1" 2"

FILENAME

SCALE 1"=30'-0"

SHEET FR-4

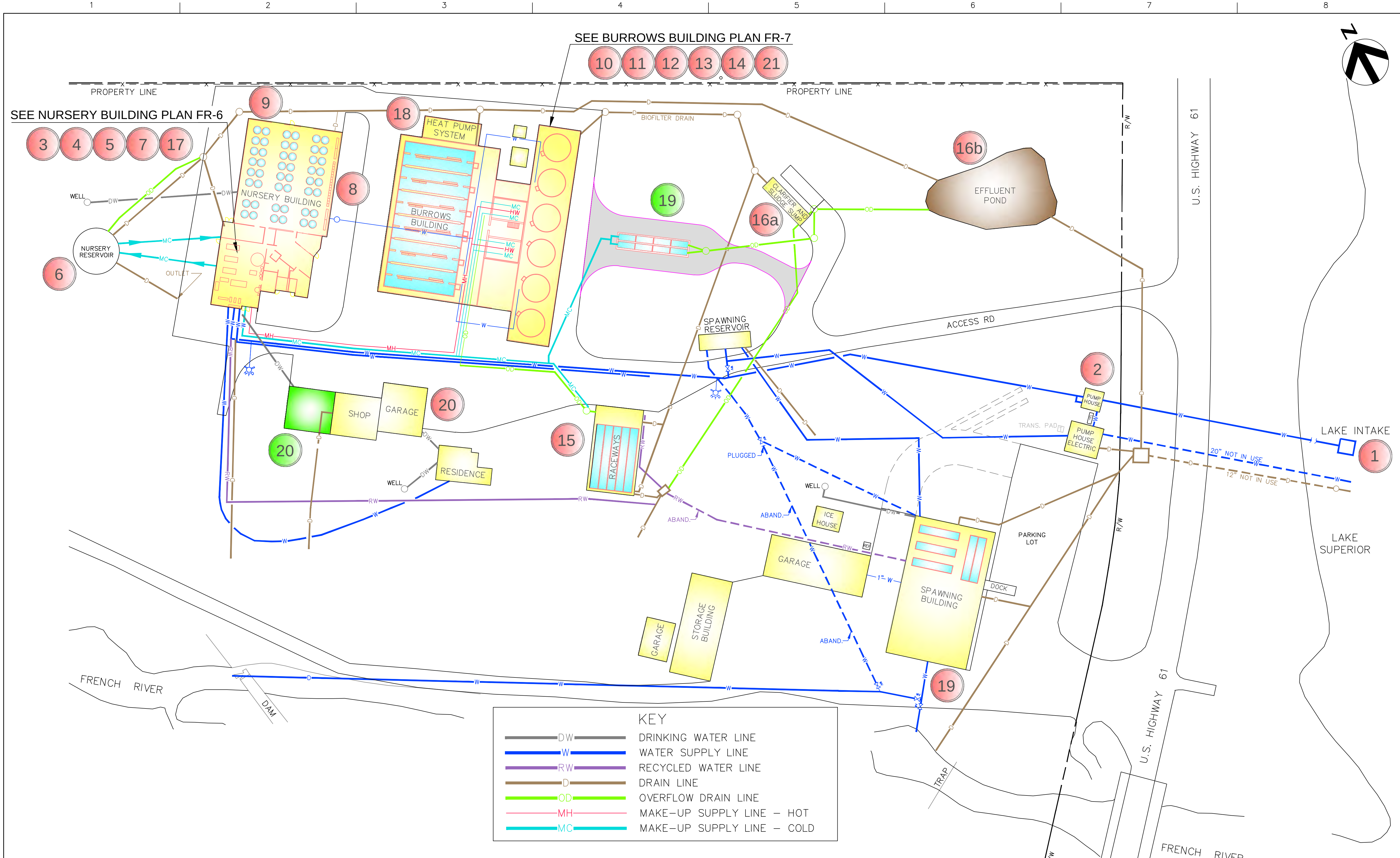
French River Cold Water Hatchery

Rehabilitation Analysis

Legend

No.	Components
1	Lake Intake
2	Pump Station
3	Vortex Separator
4	Bag Filtration System
5	Ultraviolet Disinfection System
6	Upper Reservoir
7a	Coldwater Supply - None Needed
7b	Water Heating System
7c	Mixing Manifold
8	Incubation - None Needed
9	Nursery Tanks
10	Biofilter System
11	Clearwell System
12	Recirculation Pumps
13	Recirculation Headtank
14	Burrows Ponds
15	Raceways
16a	Clarifier
16b	Pond - None Needed
17	Instrumentation System
18	Heat Recovery System (HRS)
19	Lower Spawning Tanks
20	General Storage
21	Oxygen Generator

Note: Green Bubbles Indicate Improvements



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FRENCH RIVER
SITE AND COMPONENTS PLAN

0" 1" 2"

FILENAME

SCALE 1"= 30'-0"

SHEET
FR-5

French River Cold Water Hatchery

Rehabilitation Analysis

Legend

No.	Components
1	Lake Intake
2	Pump Station
3	Vortex Separator
4	Bag Filtration System
5	Ultraviolet Disinfection System
6	Upper Reservoir
7a	Coldwater Supply - None Needed
7b	Water Heating System
7c	Mixing Manifold
8	Incubation - None Needed
9	Nursery Tanks
10	Biofilter System
11	Clearwell System
12	Recirculation Pumps
13	Recirculation Headtank
14	Burrows Ponds
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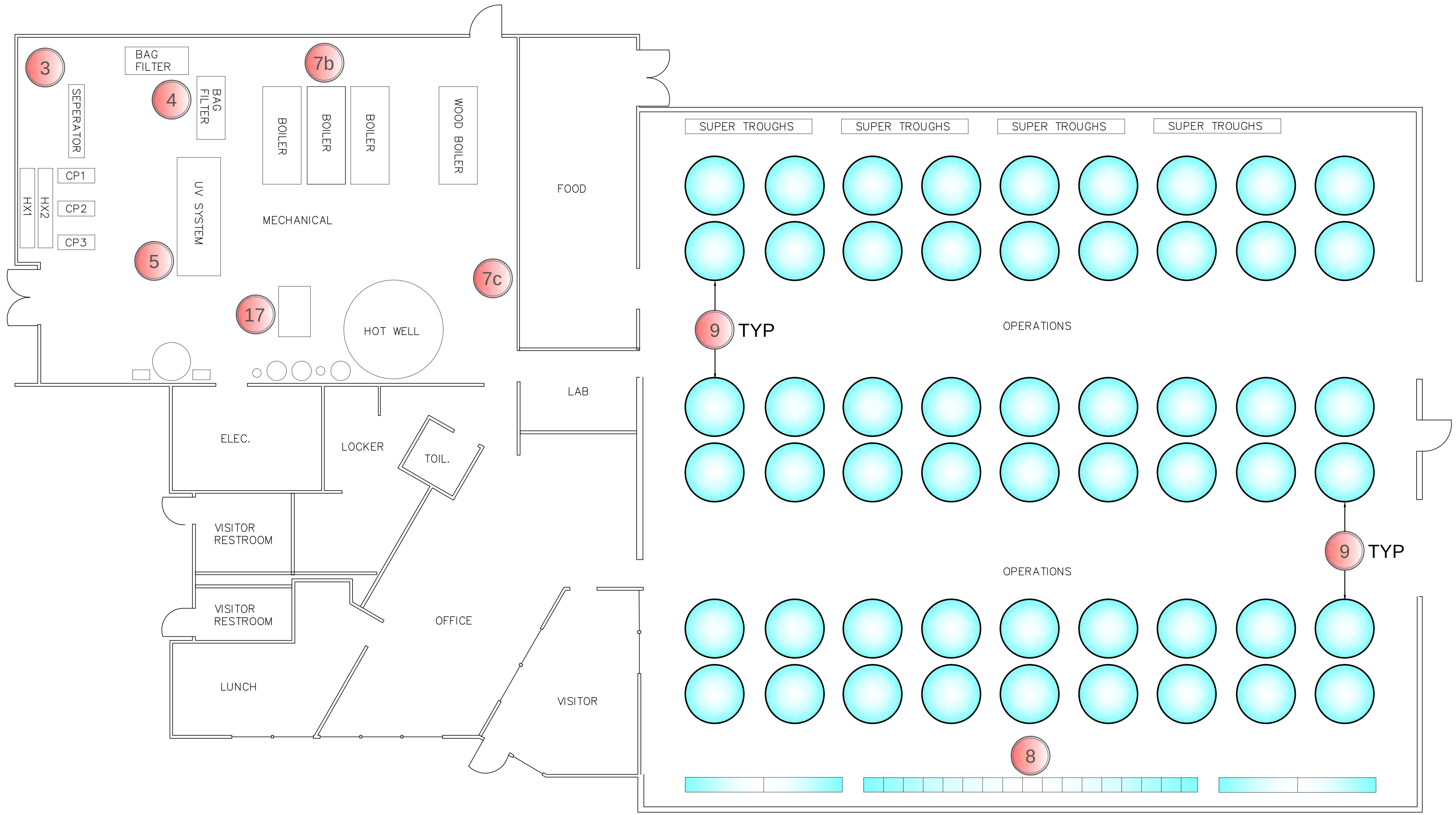
Note: Green Bubbles Indicate Improvements



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REHABILITATION ANALYSIS
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FRENCH RIVER
EXISTING NURSERY BUILDING

0" 1" 2"

FILENAME

SCALE 3/16" = 1'-0"

SHEET
FR-6

French River Cold Water Hatchery

Rehabilitation Analysis

Legend

No.	Components
1	Lake Intake
2	Pump Station
3	Vortex Separator
4	Bag Filtration System
5	Ultraviolet Disinfection System
6	Upper Reservoir
7a	Coldwater Supply - None Needed
7b	Water Heating System
7c	Mixing Manifold
8	Incubation - None Needed
9	Nursery Tanks
10	Biofilter System
11	Clearwell System
12	Recirculation Pumps
13	Recirculation Headtank
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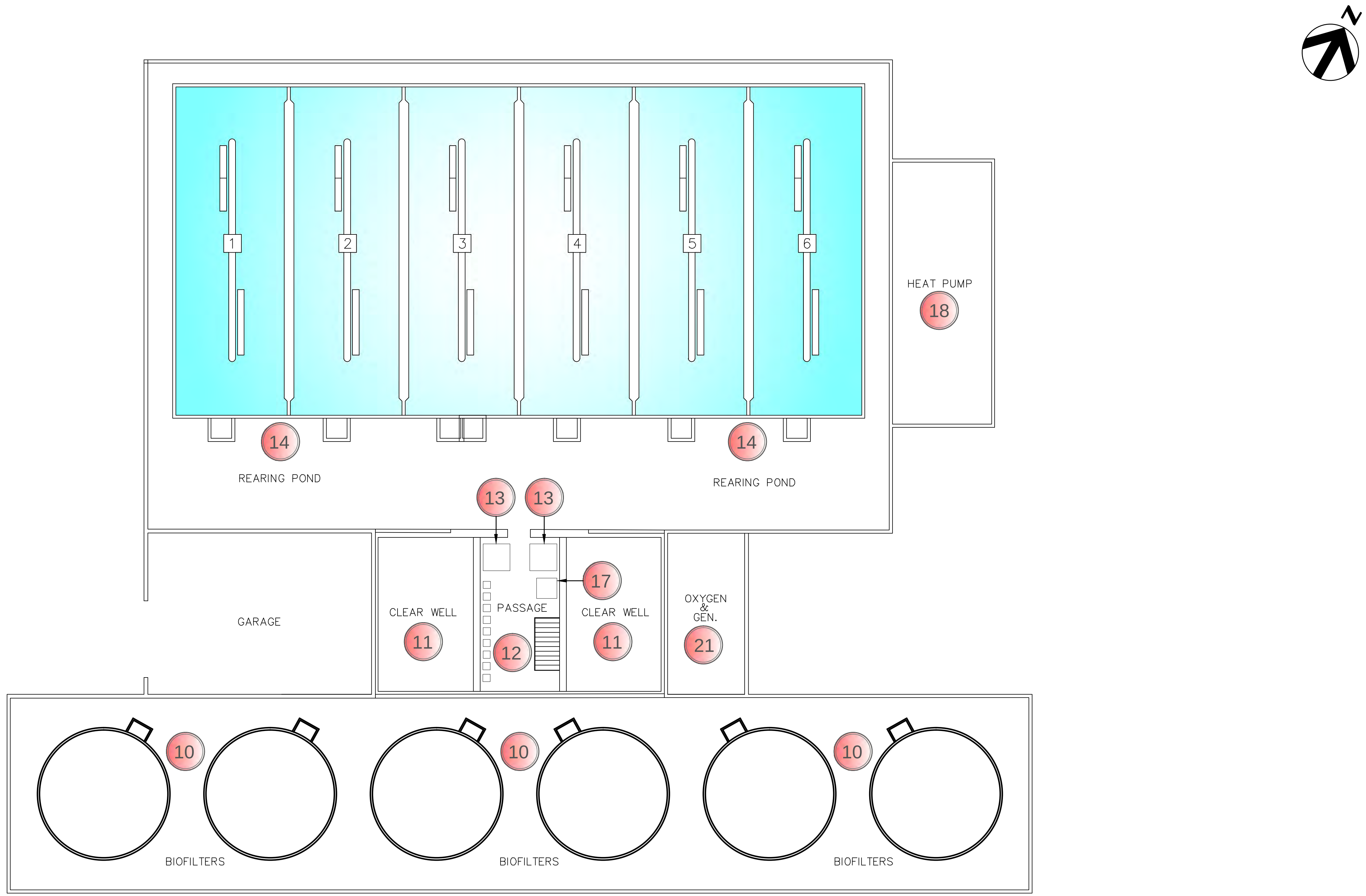
Note: Green Bubbles Indicate Improvements



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FRENCH RIVER COLD WATER HATCHERY
REHABILITATION ANALYSIS
PROJECT NO. 8F022
FILE NO.: FMA.00257.00.00.03

FRENCH RIVER
EXISTING BURROWS BUILDING

0" 1" 2"

FILENAME

SCALE 1/8" = 1'-0"

SHEET
FR-7

French River Cold Water Hatchery
Rehabilitation Analysis

Legend

No.	Components
1	Lake Intake
2	Pump Station
3	Vortex Separator
4	Bag Filtration System
5	Ultraviolet Disinfection System
6	Upper Reservoir
7a	Coldwater Supply - None Needed
7b	Water Heating System
7c	Mixing Manifold
8	Incubation - None Needed
9	Nursery Tanks
10	Biofilter System
11	Clearwell System
12	Recirculation Pumps
13	Recirculation Headtank
14	Burrows Ponds
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16a	Clarifier
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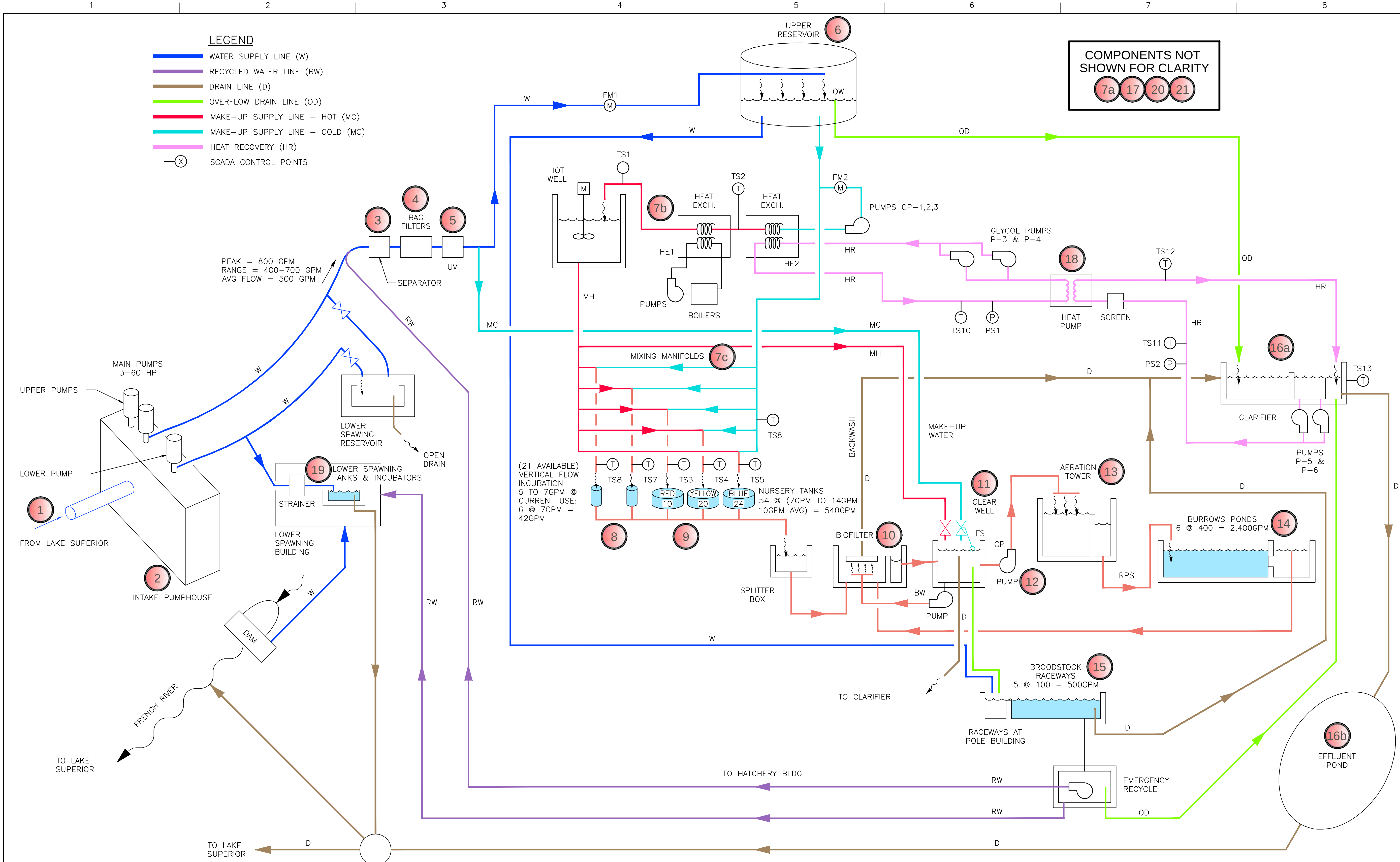

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FRENCH RIVER COLD WATER HATCHERY
REHABILITATION ANALYSIS
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FRENCH RIVER FLOW DIAGRAM

0" 1" 2"

FILENAME

SCALE NOT TO SCALE

SHEET FR-8

Inventory of Information and Data

04-08-13

Inventory of Information and Data Received to Date

- Hatchery's records of Average Daily Temperature of Unheated Lake Superior Water (1980 through 2012)
- Annual Report of Water Use, 2011 (No. 1976-2262)
- Hatchery NPDES permit (No. MN0004413, expires 04/30/16)
- Hatchery's NPDES Discharge Monitoring Reports (December 2011 – December 2012), which include twice monthly temperature data for the French River
- Facility Questionnaires (Facility, Burrows Hatchery Building, Hatchery Office Nursery, Steelhead Raceways, Spawning Building, Heat Pump, Pump Generator, Shop/Storage, Sludge Pump, Water Quality). HDR forms filled out by hatchery staff.
- PDF drawings – 1998 Improvements (22 Drgs, Roof Replacement)
- PDF drawings – Energy Recovery System and Installation, 2008 (24 Drgs)
- PDF drawings – Phase II (25 Drgs, Undated)
- CAD files – Heat Pump Building Parking (2 Drgs, 2006)
- CAD files – Heat Pump System & Generator (1 Drg. M100, 2007)
- CAD file – Existing Utilities and Existing Site Plan (2 Drgs, 2003)
- Hatchery Data – Folders: Chemical Use, Feed, Heat Costs, Fish Production Data
- Bag Cartridge manufacturer data (3 pages)
- Energy Consumption Reports (hardcopies, 6 pages from Rob Burgh)
- Manager's Financial Report (hardcopies, 3 pages)
- Compiled manufacturer operation and maintenance documents for components of the Heat Pump System
- Historical documents related to the Lake Superior Water Intake System:
    - Documents related to construction of the pipeline (1980-1981):
        - Hatchery Water Supply Pipeline Drawings:
            - Sheet 17 – Reinforcing Bar Schedule (1979-11-15)
            - Sheet 14 – General Plan and Location Map (1980-02-28)
            - Sheet 15 – Pump Station Layout (1980-02-28)
            - Sheet 16 – Reinforcing Details Pump Station (1980-02-28)

        - Sheet 17 – Reinforcing Bar Schedule (Pump Station) (1980-05-01)
        - Sheet 18 – Electrical Details (1980-05-01)
        - Sheet 20 – Intake Screen (1981-06-01)
        - Sheet 20 – Intake Screen (1981-07-10)
    - 20" Intake Pipe Extension – Sheet 19 – Plan Profile and Location Map (1981-06-18)
    - Sketches of Support for Pipeline and Screen (1981-11-19 and 1981-12-15)
    - Preliminary Cost Estimate (1979-11-15)
    - Specifications for Water Inlet System (1980-05-02)
    - Addendum 1 to Specifications for Water Inlet System (1980-05-21)
    - Specifications for Water Inlet System Phase II (1981-07-24)
    - Addendum 1 to Specifications for Water Inlet System Phase II (1981-08-07)
    - Application for Department of Army Permit for Construction of Pipeline (1979-07-24)
    - DNR Permit for Construction of Sump Station and Waterline (1979-11-02)
    - St. Louis County Highway Department Permit Application for Water Inlet Construction (1980-01-14)
    - St. Louis County Highway Department Permit of Installation of Pipeline (1980-01-16)
    - Correspondence with St. Louis County Highway Engineer per construction of pipeline (1980-06-10 and 1980-10-15)
    - Miscellaneous DNR office memorandums
    - Miscellaneous correspondence between DNR and Contracting Northwest
    - Miscellaneous correspondence between DNR and Older Construction
- Documents related to the joint repair due to sand infiltration (1990):
    - 20x20x12 Joint Repair and Related Measurements Drawing (1990-06-04)
    - DNR correspondence related to bid package for pipeline repair for water inlet system (1990-01)
    - DNR Solicitation and Submittal of Bids (1990-02-13)
    - Miscellaneous DNR office memorandums
    - Miscellaneous correspondence between DNR and Clow Ductile Manufacturing
    - Miscellaneous correspondence between DNR and J. Norick
- Documents related to underwater inspections:
    - Phase I Dive Log (1981-06-04 to 1981-08-05)

    - Note per Phase I Divers Report (1981-07-27)
    - Phase II Dive Log (1981-11-02 to 1983-08-27)
    - Dive Log (1982-06-03)
    - Dive Log (1983-10-06 to 1988-10-14)
    - 3 sets of underwater photos with unknown dates
    - Underwater Camera Inspection Summary (2008-12-01)
    - Dive Inspection Summary (2009)
    - Photographs from 2009 Dive Inspection
    - Video from 2009-08-09 Dive Inspection
    - Letter from J. Norick per Intake Pipe Inspection (2010-01-28)
    - Drawing of Damaged Intake Pipe (2012-01-28)
- The design basis document for the heat pump system.
- French River flow data
- Information about where the lake water temperature was taken (excel dataset, daily readings, monthly avgs for about 10 years)
- Existing Well Logs, groundwater quality data
- Fish Production data as requested.
- Utility Information from Utility Company

Minnesota
Department of Natural Resources

MDNR No. 8F022
File No. FMA.00257.00.00.03
HDR No. 202386

French River Cold Water Hatchery

A. REPORT DRAWINGS AND INDEX OF EXISTING DATA

B. POTENTIAL IMPROVEMENT PHOTOS AND MANUFACTURER DATA

C. FISH PRODUCTION DATA

D. PRODUCTION THEORY

E. EXCERPTS FROM NPDES PERMIT, EXAMPLE DMR, AND FLOODPLAIN MAP

F. BIOSECURITY OVERVIEW

G. WATER QUALITY AND TEMPERATURE DATA

H. INTAKE DIVE REPORT

I. OPERATING COST DATA

J. CITED LITERATURE

APPENDICES

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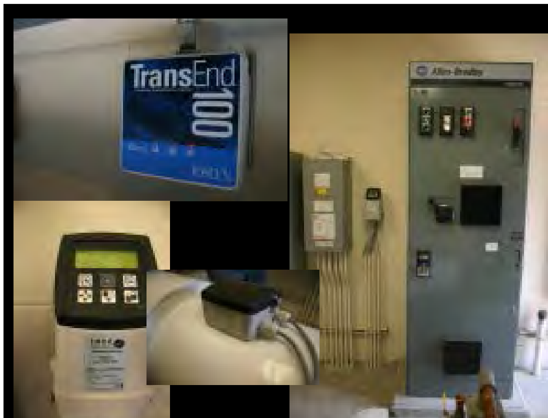
Appendix B
French River Hatchery
Potential Improvement
Examples

Pump Station Turbine Pump and Remote Control Panel



Pump Station Electrical VFD Drive, Mag Flow Meter And Surge Suppression

Intake and Screen Examples

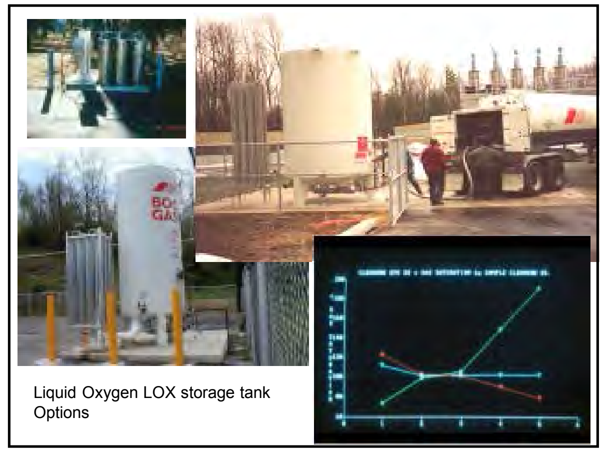
S.S. Intake Screen Options & Air Backwash

Brush cleaning

Turbo Disk Filtration System with Booster Pump Backwash

Pressure Filtration Systems
TSS, Turbidity & Iron / Manganese Removal


Chamber Type UV Disinfection Units & Power Supplies


Liquid Oxygen LOX storage tank Options

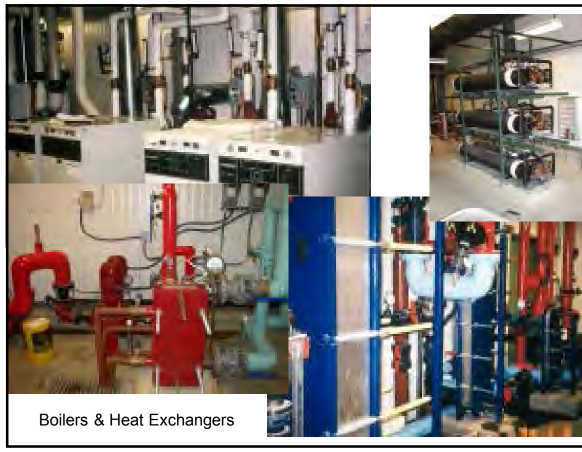

1,500 LOX TANK WITH PORTABLE LIQUID FILLING STATION
OXYGEN SERVICE & CERAMIC DIFFUSERS


The Quad Family
The Workhorse Series
Large Output & Small Output PSA on-site Oxygen Generation & Air Preparation Equipment.


OXYGEN PURITY
Vacuum VSA On-site Oxygen Generation


HACH –NON-MEMBRANE DISSOVED OXYGEN MEASUREMENT


Boilers & Plate Heat Exchangers and Related Components


Boilers & Heat Exchangers


1.4 MBTU/hr High Efficiency Natural Gas Boilers


Emergency Generator, transfer Switch & Controls in Electrical Room

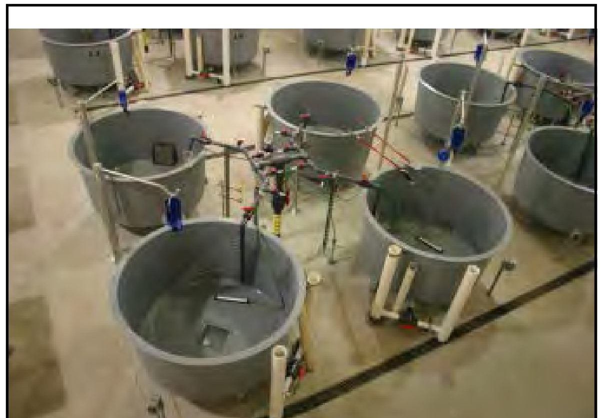

Biosecurity Areas Egg Disinfection & Handling

Biosecurity Signage

Rend Lake Biosecurity Workshop


Biosecurity Egg Disinfection Room & Disinfection Accessories


Circular fiberglassTanks ---Nursery


Circualr Tanks with Feeders & Oxygen Diffusers

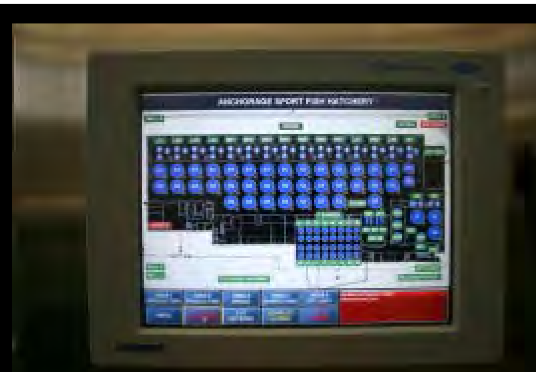

Coldwater Hatchery Bldg.   6ft diameter tanks, & Feeders

Gas Management Towers for Carbon dioxide Stripping and Aeration / Degassing

Biofilter with Plastic Media

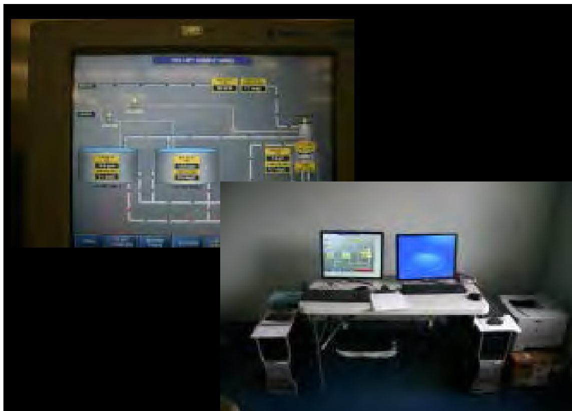
Moving Bed Biofilter (MBBR) & Media with Aeration Manifold

Recirculation Pumps, VFD Pump Controls and Instrumentation Panel

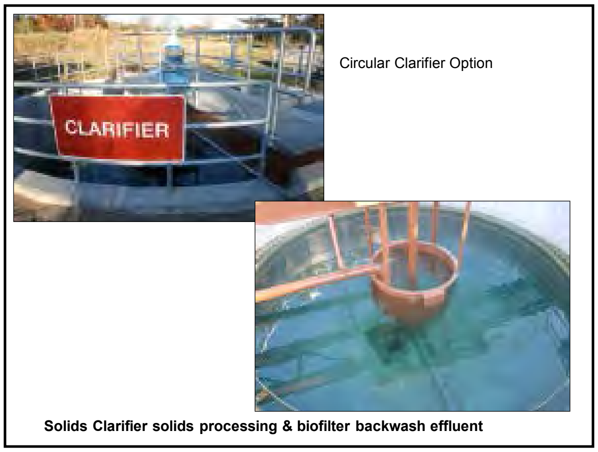


SCADA Hatchery Process Instrumentation PLC based Instrumentation, Alarm & Data Collection/ Storage

Process System Training and Testing using PLC system

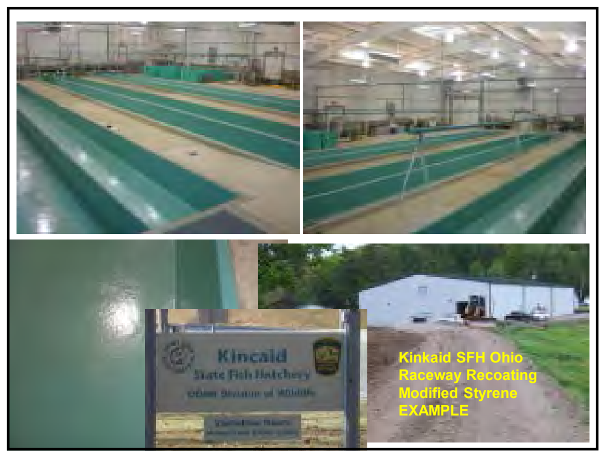


Hatchery Computer System Linked to Process Monitoring & Alarm


CLARIFIER
Circular Clarifier Option
Solids Clarifier solids processing & biofilter backwash effluent

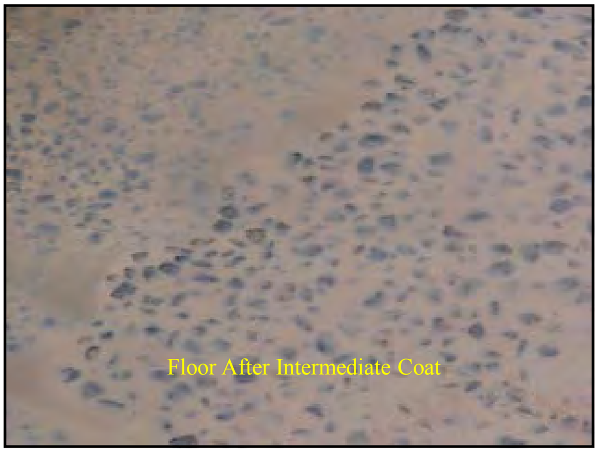

Clarifier, Sludge Storage and Composite Sampler Examples


RAS Temp A & B
2,400 gpm 65 deg F
2,400 gpm 75 deg F
2-Stage Water Heating
Heat Recovery
Finish Heating


Kincaid
State Fish Hatchery
Kinkaid SFH Ohio
Raceway Recoating
Modified Styrene
EXAMPLE


Abrasive Blasting to Prepare Surfaces
Walhalla Hatchery SCDNR Raceway Resurfacing


Applying Prime Coat



Floor After Intermediate Coat

Spraying Final Coat

Complete

FISH HOLDING PAVILION & TRUCK FILL STATION

Covered Fish Holding and Distribution Tanks

Minnesota Department of Natural Resources

MDNR No. 8F022
File No. FMA.00257.00.00.03
HDR No. 202386

French River Cold Water Hatchery

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Table C-1A. FRH Fish Production FY2009

FISH RELEASED TO MNDNR PROGRAMS:

	FRY		FINGERLINGS		YEARLINGS		ADULTS	
Species/ Strain	**Number**	**Pounds**	**Number**	**Pounds**	**Number**	**Pounds**	**Number**	**Pounds**
RBT/KAM	-	-	13,377	416	103,534	33,140	-	-
STT/FCH	9,451	3	-	-	-	-	-	-
STT/KCH	6,406	1	-	-	-	-	-	-
STT/FRW	120,699	34	-	-	-	-	-	-
STT/FRH	0	-	-	-	-	-	-	-
STT/KRW	6,879	2	-	-	-	-	-	-
STT/KCB	359,262	119	53,875	159	-	-	76	417
CHS/SUP	0	-	-	-	-	-	-	-
CHS/HUR	0	-	-	-	-	-	-	-
RBT/PRO	0	-	-	-	82	14	-	-
SUBTOTAL	**502,697**	**159**	**67,252**	**575**	**103,616**	**33,154**	**76**	**417**

FISH GRANTED TO UNIVERSITIES AND OTHER AGENCIES

	FRY		FINGERLINGS		YEARLINGS	
Species/ Strain	**Number**	**Pounds**	**Number**	**Pounds**	**Number**	**Pounds**
STT/KCB	0	0	0	0	0	0
RBT/KAM	0	0	0	0	0	0
SUBTOTAL	**0**	**0**	**0**	**0**	**0**	**0**

FISH SOLD TO PRIVATE OPERATORS

	FRY		FINGERLINGS		YEARLINGS	
Species/ Strain	**Number**	**Pounds**	**Number**	**Pounds**	**Number**	**Pounds**
KAMLOOP	0	0	0	0	0	0
STT/KCB	0	0	0	0	0	0
SUBTOTAL	**0**	**0**	**0**	**0**	**0**	**0**

TOTAL ALL FISH	**673,641**		**TOTAL ALL POUNDS**	**34,305**

FISH RECEIVED BY TRANSFER

	FRY		FINGERLINGS		YEARLINGS	
Species/ Strain	**Number**	**Pounds**	**Number**	**Pounds**	**Number**	**Pounds**
NONE	0	0	0	0	0	0

Table C-1B. Production Summary FY2009

Eggs:

Eggs Taken		1,594,043
Eggs Transferred In		0
Eggs Sold		0
Eggs Transferred to MNDNR Programs		24,675

Fry:

Fry Produced		1,091,595
Fry Transferred in		0
Fry Sold		0
Fry Transferred to MNDNR Programs		502,697
Fry Transferred Agencies		0
		0

Production Fish:

Total Pounds Released By Transfer		34,323
Pounds Received from other Hatcheries		0
Net Pounds of Production Fish		34,323

Broodstock:

Total Pounds on Hand		1,727
Pounds released by transfer		417
Pounds of broodstock maintained		2,144

Net Poundage		36,467

Production Fish-Broodstock Ratios:

Net Pounds of Production Fish/Net Poundage =	94.10%
Pounds of Broodstock Maintained/Net Poundage =	5.90%

Table C-1C. EGG & FRY Production FY2009

EGG AND FRY PRODUCTION			**NUMBER OF EGGS**		
Species/ Strain	**Taken**	**Received**	**Green Eggs Released**	**Eyed Eggs Released**	**Number of Fry Produced**
RBT/KAM	787,828	-	-	24,675	530,748
STT/FRW	151,333	-	-	-	125,869
STT/FCH	14,464	-	-	-	11,779
STT/KCH	-	-	-	-	-
STT/KRW	2,379	-	-	-	1,986
CHS/SUP	-	-	-	-	-
CHS/HUR	-	-	-	-	-
RBT/CROSSES	-	-	-	-	-
TOTAL EGG & FRY	**956,004**	**-**	**-**	**24,675**	**670,382**

from BROODSTOCK REARING			**NUMBER OF EGGS**		
Species/ Strain	**Taken**	**Received**	**Green Eggs Released**	**Eyed Eggs Released**	**Number of Fry Produced**
STT/FRH	-	-	-	-	
STT/KCB	638,040	-	-	-	421,213
TOTAL BROODSTOCK	**638,040**	-	-	-	**421,213**
GRAND TOTAL	**1,594,044**	-	-	**24,675**	**1,091,595**

Table C-2A. FRH Fish Production FY2010

FISH RELEASED TO MNDNR PROGRAMS:

	FRY		FINGERLINGS		YEARLINGS		ADULTS	
Species/ Strain	**Number**	**Pounds**	**Number**	**Pounds**	**Number**	**Pounds**	**Number**	**Pounds**
RBT/KAM			14,369	568	105,930	43,684		
STT/FCH	3,845	1						
STT/KCH								
STT/FRW	198,943	61						
STT/FRH								
STT/KRW								
STT/KCB	436,693	125	59,338	282			94	462
CHS/SUP								
CHS/HUR								
RBT/PRO								
SUBTOTAL	**639,481**	**187**	**73,707**	**850**	**105,930**	**43,684**	**94**	**462**
FISH GRANTED TO UNIVERSITIES AND OTHER AGENCIES								
	FRY		FINGERLINGS		YEARLINGS			
Species/ Strain	**Number**	**Pounds**	**Number**	**Pounds**	**Number**	**Pounds**		
STT/KCB								
RBT/KAM								
SUBTOTAL								
FISH SOLD TO PRIVATE OPERATORS								
	FRY		FINGERLINGS		YEARLINGS			
Species/ Strain	**Number**	**Pounds**	**Number**	**Pounds**	**Number**	**Pounds**		
KAMLOOP								
STT/KCB								
SUBTOTAL								
TOTAL ALL FISH	**819,212**		**TOTAL ALL POUNDS**	**45,183**				
FISH RECEIVED BY TRANSFER								
	FRY		FINGERLINGS		YEARLINGS			
Species/ Strain	**Number**	**Pounds**	**Number**	**Pounds**	**Number**	**Pounds**		
NONE								

Table C-2B. Production Summary FY2010

Eggs:

Eggs Taken		1,599,523
Eggs Transferred In		0
Eggs Sold		0
Eggs Transferred to MNDNR Programs		177,720

Fry:

Fry Produced		951,202
Fry Transferred in		0
Fry Sold		0
Fry Transferred to MNDNR Programs		339,481
Fry Transferred Agencies		0
		0

Production Fish:

Total Pounds Released By Transfer		44,721
Pounds Received from other Hatcheries		0
Net Pounds of Production Fish		44,721

Broodstock:

Total Pounds on Hand		1,361
Pounds released by transfer		462
Pounds of broodstock maintained		1,823

Net Poundage		47,006

Production Fish-Broodstock Ratios:

Net Pounds of Production Fish/Net Poundage =	95.10%
Pounds of Broodstock Maintained/Net Poundage =	3.90%

Table C-2C. EGG & FRY Production FY2010

EGG AND FRY PRODUCTION

Species/ Strain	NUMBER OF EGGS Taken	Received	Green Eggs Released	Eyed Eggs Released	Number of Fry Produced
RBT/KAM	792,185	-	-	177,720	311,721
STT/FRW	238,601	-	-	-	198,943
STT/FCH	3,913	-	-	-	3,845
STT/KCH	0	-	-	-	-
STT/KRW	0	-	-	-	1,986
CHS/SUP		-	-	-	-
CHS/HUR	-	-	-	-	-
RBT/CROSSES	-	-	-	-	-
TOTAL EGG & FRY	**1,034,699**	**-**	**-**	**177,720**	**514,509**

from BROODSTOCK REARING

Species/ Strain	NUMBER OF EGGS Taken	Received	Green Eggs Released	Eyed Eggs Released	Number of Fry Produced
STT/FRH	-	-	-	-	
STT/KCB	564,824	-	-	-	436,693
TOTAL BROODSTOCK	**564,824**	-	-	-	**436,693**
GRAND TOTAL	**1,599,523**	-	-	**177,720**	**951,202**

Table C-3A. FRH Fish Production FY2011

FISH RELEASED TO MNDNR PROGRAMS:

	FRY		FINGERLINGS		YEARLINGS		ADULTS	
Species/ Strain	**Number**	**Pounds**	**Number**	**Pounds**	**Number**	**Pounds**	**Number**	**Pounds**
RBT/KAM					80,641	32,138		
STT/FCH								
STT/KCH								
STT/FRW								
STT/FRH								
STT/KRW								
STT/KCB	10,240	7					89	429
CHS/SUP								
CHS/HUR								
RBT/PRO								
SUBTOTAL	**10,240**	**7**			**80,641**	**32,138**	**89**	**429**
FISH GRANTED TO UNIVERSITIES AND OTHER AGENCIES								
	FRY		**FINGERLINGS**		**YEARLINGS**			
Species/ Strain	**Number**	**Pounds**	**Number**	**Pounds**	**Number**	**Pounds**		
STT/KCB	0	0	0	0	0	0		
RBT/KAM	0	0	0	0	0	0		
SUBTOTAL	**0**	**0**	**0**	**0**	**0**	**0**		
FISH SOLD TO PRIVATE OPERATORS								
	FRY		**FINGERLINGS**		**YEARLINGS**			
Species/ Strain	**Number**	**Pounds**	**Number**	**Pounds**	**Number**	**Pounds**		
KAMLOOP	0	0	0	0	0	0		
STT/KCB	0	0	0	0	0	0		
SUBTOTAL	**0**	**0**	**0**	**0**	**0**	**0**		
TOTAL ALL FISH	**90,970**		**TOTAL ALL POUNDS**	**32,573**				
FISH RECEIVED BY TRANSFER								
	FRY		**FINGERLINGS**		**YEARLINGS**			
Species/ Strain	**Number**	**Pounds**	**Number**	**Pounds**	**Number**	**Pounds**		
RBT/KAM	0	0	0	0	0	0		
STT/KCB	**10,007**	3.315						

Table C-3B. Production Summary FY2011

Eggs:

Eggs Taken		1,527,914
Eggs Transferred In		0
Eggs Sold		0
Eggs Transferred to MNDNR Programs		725,236

Fry:

Fry Produced		49,717
Fry Transferred in		10007
Fry Sold		0
Fry Transferred to MNDNR Programs		339,481
Fry Transferred Agencies		0
		0

Production Fish:

Total Pounds Released By Transfer		32,138
Pounds Received from other Hatcheries		4402
Net Pounds of Production Fish		27,735

Broodstock:

Total Pounds on Hand		2,095
Pounds released by transfer		428
Pounds of broodstock maintained		2,515
		28163

Net Poundage		47,006

Production Fish-Broodstock Ratios:

Net Pounds of Production Fish/Net Poundage =	91.70%
Pounds of Broodstock Maintained/Net Poundage =	8.30%

Table C-3C. EGG & FRY Production FY2011

EGG AND FRY PRODUCTION

Species/ Strain	Taken	Received	Green Eggs Released	Eyed Eggs Shipped	Number of Fry Produced
	NUMBER OF EGGS				
RBT/KAM	813,942	-	-	175,061	80,420
STT/FRW	133,326	-	-	102961	0
STT/FCH	7,329	-	-	6706	0
STT/KCH	16161	-	-	14816	0
STT/KRW	0	-	-	-	0
CHS/SUP		-	-	-	-
CHS/HUR	-	-	-	-	-
RBT/CROSSES	-	-	-	-	-
TOTAL EGG & FRY	**970,758**	**-**	**-**	**299,544**	**80,420**

from BROODSTOCK REARING

Species/ Strain	Taken	Received	Green Eggs Released	Eyed Eggs Shipped	Number of Fry Produced
	NUMBER OF EGGS				
STT/FRH	-	-	-	425692	4091
STT/KCB	557,156	-	-	-	4,091
TOTAL BROODSTOCK	**557,156**	-	-	-	**4,091**
	1527914				
GRAND TOTAL	**1,599,523**	-	-	**725,236**	**84,511**

biosecurity program change

Table C-4. Kamloop Rainbow Trout History at FRH (1978-Present)

YEAR	NUMBER FEMALES SPAWNED	TOTAL GREEN EGGS	AVE. NO. EGGS / QUART	AVE. NO. EGGS/ FEMALE	PERCENT EYE-UP	EYED EGGS REDUCED	EYED EGGS KEPT	TOTAL NO. FRY PRODUCED	% SURVIVAL: EYED EGG TO HATCH	FRY FISH/LB.	LENGTH IN INCHES	NO. OF FRY REDUCED	NO.OF FRY STARTED IN HATCHERY	FISH PRODUCED FINGERLINGS	FISH PRODUCED YEARLINGS	LENGTH IN INCHES FINGERLINGS	LENGTH IN INCHES YEARLINGS	% SURVIVAL FROM FRY STARTED	TOTAL % SURVIVAL FROM GREEN
1978	N.A.	154,198	11,683		81.14%	0	132485	128,620	97.08%	3,362	0.871	0	128,620	0	98,736		5.689	76.77%	64.03%
1980	127	431,151	10,939	3,395	67.05%	0	332202	325,179	97.89%	3,458	0.863	116,422	204,617	0	174,477		5.959	85.27%	67.47%
1981	74	399,339	12,789	5,396	65.69%	0	262326	221,432	84.41%	3,344	0.873	0	221,432	0	153,428		8.326	69.29%	38.42%
1982	100	476,709	11,794	4,767	73.74%	0	351525	311,650	88.66%	3,399	0.868	0	311,650	102,694	193,684	3.684	8.430	95.10%	62.17%
1983	129	724,018	12,170	5,613	79.59%	0	576246	488,414	84.76%	3,571	0.854	161,597	326,817	127,026	195,003	3.324	7.010	98.53%	66.80%
1984	146	892,870	10,575	6,116	74.76%	0	667510	482,510	72.29%	3,078	0.897	265,174	217,339	16,998	186,936	3.216	8.377	93.83%	52.54%
1985	174	995,564	13,140	5,722	82.38%	0	820146	693,027	84.50%	3,469	0.862	438,194	254,883	46,679	160,899	3.241	7.255	81.44%	64.86%
1986	234	1,358,094	13,373	5,804	84.18%	0	1143243	945,356	82.69%	3,990	0.823	644,384	300,972	106,757	189,462	3.576	8.297	98.42%	69.26%
1987	131	659,402	12,974	5,034	66.14%	0	436129	388,256	89.02%	3,544	0.856	134,639	253,617	4,312	172,861	4.555	9.466	69.86%	47.29%
1988	267	1,429,126	13,033	5,353	70.29%	130000	874533	738,701	84.47%	3,385	0.869	463,909	274,792	13,952	194,119	3.809	8.959	75.72%	54.01%
1989	359	1,976,712	12,674	5,506	60.52%	110000	1086306	803,888	74.00%	3,612	0.851	410,082	393,806	185,454	159,421	3.836	9.430	87.57%	42.06%
1990	255	1,589,850	12,660	6,235	62.45%	303980	688881	636,785	92.44%	3,820	0.835	249,521	387,264	210,666	136,614	3.629	9.430	89.68%	54.10%
1991	332	2,019,090	12,044	6,082	46.37%	301238	731274	675,328	92.35%	3,764	0.839	445,647	229,681	112,710	94,347	2.772	9.643	90.15%	47.66%
1992	203	1,245,000	13,008	6,133	83.86%	0	1044084	1,000,296	95.81%	4,043	0.819	763,557	236,739	86,647	131,042	3.295	9.579	91.95%	78.81%
1993	156	872,078	13,777	5,590	63.29%	0	615668	548,260	89.05%	4,066	0.818	352,617	195,643	67,462	113,650	3.112	9.350	92.57%	61.20%
1994	128	626,507	13,848	4,895	80.94%	0	507094	458,820	90.48%	4,070	0.817	263,236	195,584	50,422	118,705	3.502	9.356	86.47%	69.01%
1995	65	328,617	12,864	5,056	80.48%	0	264471	231,056	87.37%	3,977	0.824	16,594	214,462	62,811	119,672	3.241	9.014	85.09%	60.58%
1996	98	558,112	12,826	5,695	67.39%	0	376112	323,066	85.90%	3,576	0.853	101,501	221,565	62,757	111,609	3.353	9.213	78.70%	49.43%
1997	131	715,870	13,860	5,465	80.20%	0	574128	409,070	71.25%	4,081	0.817	233,362	175,708	48,062	104,931	2.972	9.073	87.07%	53.97%
1998	99	474,345	13,566	4,791	85.08%	180770	222813	195,840	87.89%	3,996	0.822	34,504	161,336	29,552	98,368	2.715	9.929	79.29%	62.02%
1999	107	707,138	11,591	6,609	51.70%	0	365590	315,136	86.20%	3,121	0.893	174,004	150,326	30,477	107,543	3.024	9.232	91.81%	44.12%
2000	149	916,945	12,291	6,154	79.90%	0	732639	654,932	89.39%	3,504	0.859	460,252	199,325	62,890	104,769	2.362	9.215	84.11%	68.48%
2001	130	693,432	12,699	5,334	72.17%	0	500462	427,065	85.33%	3,656	0.847	271,573	146,141	13,219	119,077	3.701	9.545	90.53%	58.24%
2002	138	721,379	12,492	5,227	70.18%	111828	394436	311,774	79.04%	3,677	0.845	133,698	178,076	36,000	122,230	3.223	8.313	88.86%	51.94%
2003	149	779,283	11,838	5,230	82.73%	104822	539917	487,479	90.29%	3,631	0.849	335,257	152,222	40,990	104,456	3.028	8.493	95.55%	73.66%
2004	159	925,182	12,271	5,819	79.93%	106873	497402	376,871	75.77%	3,658	0.847	236,713	160,657	52,285	104,282	3.242	8.645	97.45%	49.69%
2005	159	933,744	13,018	5,873	64.24%	111189	488682	383,978	78.57%	3,618	0.850	234,422	149,556	45,612	100,208	3.467	9.342	97.50%	49.99%
2006	168	985,374	11,639	5,865	55.49%	110029	545836	340,859	62.45%	3,295	0.877	180,319	160,540	39,299	104,162	3.135	8.751	89.36%	41.14%
2007	184	1,005,080	13,134	5,462	74.07%	0	744461	615,422	82.67%	3,927	0.827	468,579	146,843	23,228	100,805	4.656	8.868	84.47%	58.96%
2008	164	758,581	12,593	4,625	76.62%	0	581225	500,166	86.05%	3,999	0.822	352,486	147,680	13,337	103,922	4.100	8.845	79.40%	61.92%
2009	171	743,876	11,879	4,350	79.13%	24675	563954	535,436	94.94%	3,633	0.849	383,133	152,303	14,369	109,978	4.440	9.149	81.64%	71.21%
2010	166	792,173	11,807	4,772	64.19%	177720	336503	311,721	92.64%	3,678	0.845	275,195	36,526		105,930				73.96%
TOTAL	5052	27,888,839				1773124	1.8E+07	15,266,393				8,600,571	6,686,722	1,706,667	4,195,326				
AVE.			12527	5520	70.89%				84.82%	3656.29	0.847				Averages	3.436	8.716	88.26%	57.12%
															RATE:	54.78	3.36		

Table C-5. Rearing Unit Data & Capacity for French River Cold Water Hatchery (Upper & Lower Spawning Facility)

French River Cold Water Hatchery REARING UNIT DATA

Trout Egg Incubation

	# units	Flow / unit	Total gpm
Heath Vertical Flow Egg Incubation	21	5	105
Egg Sorting Troughs	4	5	20
			125

typically only use 6 to 7 16-tray stacks in current production

Nursery Tanks Main Hatchery Building

Nur. Circular Tks.	Radius	Dia.	Depth		cuft	gallons	# Units	Total cuft	gpm (MNDNR Operating Flows)	R=	R=1 (Hourly Exchange Rate)	R=2	R=3	R=4
6ft	3	6.00	4		113.097336	846	54	6,107						
Usable Vol	3	6.00	3		84.8230016	634	54	4,580	10	gpm@	11	21	32	42
RV used by MNDNR historically=					80			4,320	540	gpmTot.	571	1,142	1,713	2,284
RV in Cubic Meters per tank=					2.40				Flow range is 6 to 14 gpm					
TOTAL RV=					129.76									

Theoretical Carrying Capacity DATA

	D	D	D	D	D	D	D	
	lbs /CF	lbs /CF	lbs /CF	lbs /CF	lbs /CF	lbs /CF	lbs /CF	
Density lbs/CF	1.0	1.5	2.0	2.5	3.0	3.5	4.0	
PER unit LBS=	80	120	160	200	240	280	320	Lbs / unit
Total Lbs	4,320	6,871	9,161	11,451	12,960	23,750	27,143	T-Lbs.
Ld lbs/gpm	8.0	12.0	16.0	20.0	24.0	28.0	32.0	LD lbs/gpm

MBM range is 160-240 lbs Tank historically (M.Gottwald)

Super Troughs Main Hatchery Building

Super Troughs 17' x 25.25" x 9.5"	Length	Width	Depth		Cuft	Gallons		Total cuft	MNDNR Operating Flows		R=1	R=2	R=3	R=4
17' x 2.10' x .79'	17	2.10	0.79		28.203	211	4	113						
Usable Vol	17	2.10	0.79		28.203	211	4	113	12	gpm@	4	5	7	14
RV used by MNDNR historically=					25			100	48	gpmTot.	14	19	28	56
RV in Cubic Meters per tank=					0.80				GPM is 3 to 12 gpm depending on circular tank gpm(M. Gottwald)					
TOTAL RV=					3.20									

Theoretical carrying Capacity DATA

	D	D	D	D	D	D	D	
	lbs /CF	lbs /CF	lbs /CF	lbs /CF	lbs /CF	lbs /CF	lbs /CF	
Density lbs/CF	1.0	1.5	2.0	2.5	3.0	3.5	4.0	
PER unit LBS=	25	38	50	63	75	88	100	Lbs / unit
Total Lbs	100	169	226	282	300	350	400	T-Lbs.
Ld lbs/gpm	2.1	3.1	4.2	5.2	6.3	7.3	8.3	LD lbs/gpm

Burrows Recirculating Raceways (Recirculation Building)

Raceways	Length	Width	Depth		Cuft	Gallons		Total cuft	MNDNR Operating Flows		R=1	R=2	R=3	R=4
	50	16.16	4		3232	24,175	6	19,392						
Usable Vol	50	16.16	3		2424	18,132	6	14,544	400	gpm@	302	403	604	1,209
		1.00							2,400	gpmTot.	1,813	2,418	3,626	7,253
RV used by MNDNR historically=					2424			14,544						
RV in Cubic Meters per tank=					68.67				Recirculation is 2,400gpm / 500 gpm makeup				20% makeup	
TOTAL RV=					412.01									

Theoretical carrying Capacity DATA

	D	D	D	D				
	lbs /CF	lbs /CF	lbs /CF	lbs /CF	lbs /CF	lbs /CF	lbs /CF	
Density lbs/CF	1.0	1.5	2.0	2.5	3.0	3.5	4.0	
PER unit LBS=	2,424	3,636	4,848	6,060	7,272	8,484	9,696	Lbs / unit
Total Lbs	14,544	21,816	29,088	36,360	43,632	50,904	58,176	T-Lbs.
Ld lbs/gpm	6.1	9.1	12.1	15.2	18.2	21.2	24.2	LD lbs/gpm

MBM range is 4,000-7,000 lbs/RWY historically (M.Gottwald)

Captive Knife River Steelhead Broodstock Raceways (Covered Broodstock Building)

Priority 2 Broodstock Building														
Raceways	Length	Width	Depth		Cuft	Gallons		Total cuft	MNDNR Operating Flows		R=1	R=2	R=3	R=4
	60	6.00	3		1080	8,078	5	5,400		gpm@				
Usable Vol	57	6.00	3		1026	7,674	5	5,130	100	gpm@	128	171	256	512
									450	gpmTot.	640	853	1,279	2,558
RV used by MNDNR historically=					1060			5,300						
RV in Cubic Meters per tank=					29.07				GPM Flow is in range of 300 to 450 gpm depending on HB usage					
TOTAL RV=					145.33									

Theoretical carrying Capacity DATA BROODSTOCK STT

	D	D	D	D				
	lbs /CF	lbs /CF	lbs /CF	lbs /CF	lbs /CF	lbs /CF	lbs /CF	
Density lbs/CF	0.25	0.50	0.75	1.00	1.25	1.50	1.75	
PER unit LBS=	265	530	770	1,060	1,325	1,590	1,855	Lbs / unit
Total Lbs	1,325	2,565	3,848	5,130	6,625	7,950	9,275	T-Lbs.
Ld lbs/gpm	2.7	5.3	7.7	10.6	13.3	15.9	18.6	LD lbs/gpm

Captive STT Knife River Strain Broodstock Low Density

24,264 Total RV in cubic feet

Lower Hatchery MNDNR Duluth Area Regional Office

Vertical Flow Incubators	12	5	60
Hatching Jars	360	2	720
			780

Lower Hatchery Adult Holding Tanks - Spawning tanks

Spawning Tanks	Length	Width	Depth		Cuft	Gallons		Total cuft	MNDNR Operating Flows		R=1	R=2	R=3	R=4
	23	7.00	3		483	3,613	5	2,415		gpm@				
Usable Vol	23	7.00	2.33		375.13	2,806	5	1,876	100	gpm@	47	62	94	187
RV used by MNDNR historically=					375			1,875		gpmTot.	234	312	468	935
RV in Cubic Meters per tank=					10.63				GPM Flow is in range of estimated ??? to ??? gpm					

Theoretical carrying Capacity DATA

	D	D	D	D				
	lbs /CF	lbs /CF	lbs /CF	lbs /CF	lbs /CF	lbs /CF	lbs /CF	
Density lbs/CF	1.0	1.5	2.0	2.5	3.0	3.5	4.0	
PER unit LBS=	375	563	750	938	1,125	1,313	1,500	Lbs / unit
Total Lbs	1,875	2,813	3,751	4,689	5,627	6,563	7,500	T-Lbs.
Ld lbs/gpm	3.8	5.6	7.5	9.4	11.3	13.1	15.0	LD lbs/gpm

CAP 1

Title: FRH 6ft Nursery Tank Capacity Density Set 3 lbs/cuft. D.O.= 90%,   AO=4.6   Temp 41 deg F, Flow 12 gpm

Rearing Model

approx. end of Month	Element	DAY	inches	cm	lbs@	grams@	# / LB.	#/Kg	cm/m	inches/m	# FISH	Tot.lbs.	Tot.Kgs	%bwfeed	feed lbs/day	feed Kg/day
	1	1	1	2.6	0	0.188	2413.5	5320.8	0.9	0.354	2,759	1	1	4.55	0.05	0.0
	2	30	1.4	3.4	0.001	0.451	1006.4	2218.7	0.9	0.354	2,745	3	1	3.40	0.09	0.0
	3	60	1.7	4.3	0.002	0.905	501.2	1104.9	0.9	0.354	2,732	5	2	2.70	0.15	0.1
	4	90	2.1	5.2	0.004	1.593	284.7	627.7	0.9	0.354	2,718	10	4	2.23	0.21	0.1
	5	120	2.4	6.1	0.006	2.563	177	390.2	0.9	0.354	2,704	15	7	1.91	0.29	0.1
	6	150	2.8	7.0	0.009	3.863	117.4	258.9	0.9	0.354	2,690	23	10	1.66	0.38	0.2
	7	180	3.1	7.9	0.012	5.542	81.8	180.4	0.9	0.354	2,677	33	15	1.47	0.48	0.2
	8	210	3.5	8.8	0.017	7.649	59.3	130.7	0.9	0.354	2,663	45	20	1.32	0.59	0.3
	9	240	3.8	9.7	0.023	10.23	44.3	97.7	0.9	0.354	2,649	60	27	1.20	0.72	0.3
	10	270	4.2	10.6	0.029	13.34	34	75	0.9	0.354	2,635	77	35	1.10	0.85	0.4
	11	300	4.5	11.5	0.038	17.02	26.7	58.8	0.9	0.354	2,622	98	45	1.01	0.99	0.5
	12	330	4.9	12.4	0.047	21.32	21.3	46.9	0.9	0.354	2,608	122	56	0.94	1.20	0.5
	13	360	5.3	13.3	0.058	26.28	17.3	38	0.9	0.354	2,594	150	68	0.88	1.30	0.6
	14	390	5.6	14.2	0.07	31.97	14.2	31.3	0.9	0.354	2,580	181	82	0.82	1.50	0.7
	15	410	5.8	14.8	0.08	36.19	12.5	27.6	0.9	0.354	2,571	205	93	0.79	1.60	0.7
	16	440	6.2	15.7	0.095	43.18	10.5	23.2	0.9	0.354	2,557	243	110	0.74	1.80	0.8

Element	AO mg/1	Req.Int. DO	%DOsat.	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
1	4.6	11.6	90	3.36	0.4	0.30	1	3.32	0.0	0	2.96	48.00	3.0	0.0
2	4.6	11.6	90	4.49	0.54	0.60	2	3.32	0.0	1	2.21	48.00	3.0	0.0
3	4.6	11.6	90	5.67	0.68	1.00	4	3.32	0.1	2	1.75	48.00	3.0	0.0
4	4.6	11.6	90	6.84	0.82	1.00	5	3.32	0.1	3	1.45	48.00	3.0	0.0
5	4.6	11.6	90	8.02	0.96	2	7	3.32	0.1	5	1.24	48.00	3.0	0.1
6	4.6	11.6	90	9.2	1.1	2	9	3.32	0.2	8	1.08	48.00	3.0	0.1
7	4.6	11.6	90	10.37	1.24	3	12	3.32	0.3	11	0.96	48.00	3.0	0.1
8	4.6	11.6	90	11.55	1.38	4	15	3.32	0.4	15	0.86	48.00	3.0	0.2
9	4.6	11.6	90	12.72	1.52	5	18	3.32	0.6	20	0.78	48.00	3.0	0.2
10	4.6	11.6	90	13.9	1.66	6	21	3.32	0.7	26	0.71	48.00	3.0	0.3
11	4.6	11.6	90	15.07	1.8	7	25	3.32	0.9	33	0.66	48.00	3.0	0.4
12	4.6	11.6	90	16.25	1.94	8	29	3.32	1.2	41	0.61	48.00	3.0	0.5
13	4.6	11.6	90	17.42	2.08	9	33	3.32	1.4	50	0.57	48.00	3.0	0.6
14	4.6	11.6	90	18.6	2.22	10	37	3.32	1.7	61	0.53	48.00	3.0	0.7
15	4.6	11.6	90	19.38	2.32	11	40	3.32	1.9	68	0.51	48.00	3.0	0.8
16	4.6	11.6	90	20.56	2.46	12	45	3.32	2.3	81	0.48	48.00	3.0	1.0

MODEL INPUTS

Stat	Input	Name	Outp	Unit	Com
					PROJECT: French River MNDNR
					REARING UNIT TYPE: 6ft Nursery Tank
					RV REARING VOLUME: 2.3CM or 80CF
					AVAILABLE OXYGEN = set by USER 6.0 mg/l
					D.O. IN EFFLUENT IS set by USER 7.0 is recommnded level
	48	MAXkgm3			MAXIMUM DENISTY IN KG / CUBIC METER 32, 48, 65, 80,
	2.3	UNITVOLm3			REARING UNIT VOLUME IN CUBIC METERS
	3	OPVelocity			Velocity in cm/sec (range 3.0 to 5.0 is recommended)
	11.5	UNITMETERS			REARING UNIT length in Meters
	'May2013	DATE			Date of Computer Run 'Month201996
	'Nursery6ftTank	Project			hatchery name
	8	Sizeinches			Target Size in Inches
		Number			Target Number
	'RBT	Species			fish species use 3 letter code
	'coldwater	species			oxyreq 'coldwater,cool,warm,talapia
	5	ctemp_c			enter constant water temp deg. C
		tugr	0.006		from LOOKUP TABLE tugr in cm/tu
	1.3	conv			enter food conversion 1.5
	2.54	ilength			enter in centimeters starting length
		iweight	0.181		weight calculated
		k	0.011		from LOOKUP TABLE k metric condition factor
	2759	i#fish			enter initial # of fish starting # THIS VARIABLE IS VARIED TO MEET DENSITY & FLOW
L		#fish	2759		calculated mortality= 1/2%/day/month
	30	pdays			enter # days in period ex. 30
	660	elev			enter elevation in ftMSL
	1	oxy%			enter RAW WATER supply initial DO % sa
	4.57	availoxy			enter FIXED Available DO for Operating System 3, 4, 5, 6, etc.
	7	effluentDO			enter FIXED effluent DO for System 5, 6 or 7 suggested
	7.25	pH			enter pH
	0.417	%uninh3			enter %uninh3 from AMMONIA % IONIZATION TABLE
	0.0125	AUA			enter AUA allowable unionized ammonia (range .010 to 0.025) .025 suggested
	0	bgnh3			enter background Total TAN if any

BY-PRODUCT GENERATION in Kgs.   MASS BALANCE FEED TO BY-PRODUCTS

		Month	feedkg	TSS	Total NH3	UNI NH3	co2kg	phoskg	NO3kg	BODkg
	Element	Period	Feedkg	TSSkg	TANkg	UNINH3kg	co2kg	phoskg	NO3kg	BODkg
	1.00	1.00	0.70	0.20	0.02	0.00	0.20	0.00	0.06	0.20
	2.00	2.00	1.00	0.40	0.04	0.01	0.40	0.01	0.10	0.40
	3.00	3.00	2.00	0.60	0.06	0.01	0.60	0.01	0.20	0.70
	4.00	4.00	3.00	0.90	0.09	0.01	0.80	0.01	0.30	1.00
	5.00	5.00	4.00	1.00	0.12	0.02	1.00	0.02	0.30	1.00
	6.00	6.00	5.00	2.00	0.16	0.02	1.00	0.03	0.40	2.00
	7.00	7.00	7.00	2.00	0.20	0.03	2.00	0.03	0.60	2.00
	8.00	8.00	8.00	2.00	0.24	0.03	2.00	0.04	0.70	3.00
	9.00	9.00	10.00	3.00	0.29	0.04	3.00	0.05	0.80	3.00
	10.00	10.00	12.00	3.00	0.35	0.04	3.00	0.06	1.00	4.00
	11.00	11.00	13.00	4.00	0.40	0.05	4.00	0.07	1.00	5.00
	12.00	12.00	16.00	5.00	0.47	0.06	4.00	0.08	1.00	5.00
	13.00	13.00	18.00	5.00	0.53	0.07	5.00	0.09	2.00	6.00
	14.00	14.00	20.00	6.00	0.61	0.08	6.00	0.10	2.00	7.00
	15.00	15.00	22.00	7.00	0.65	0.08	6.00	0.11	2.00	7.00
	16.00	16.00	24.00	7.00	0.73	0.09	7.00	0.12	2.00	8.00

CAP 2

Title: FRH 6ft Nursery Tank Capacity Density Set 3 lbs/cuft. D.O.= 100%,   AO=5.9   Temp 41 deg F, Flow 9 gpm

approx.						Rearing Model																								
end of	Ele	DAY	inches	cm	lbs@	grams@	# / LB.	#/Kg	cm/m	inches/m	# FISH	Tot.lbs.	Tot.Kgs	%bwfeed	feed lbs/day	feed Kg/day	AO mg/1	Req.Int. DO	%DOsat.	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
Month	Ele	DAY	inches	cm	lbs@	grams@	# / LB.	#/Kg	cm/m	inches/m	# FISH	Tot.lbs.	Tot.Kgs	%bwfeed	feed lbs/day	feed Kg/day	AO mg/1	Req.Int. DO	%DOsaturatic	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
	1	1	1	2.6	0	0.188	2413.5	5320.8	0.9	0.354	2,759	1	1	4.55	0.05	0.0	5.9	12.9	100	4.3	0.51	0.30	1	4.25	0.0	0	2.96	48.00	3.0	0.0
	2	30	1.4	3.4	0.001	0.451	1006.4	2218.7	0.9	0.354	2,745	3	1	3.40	0.09	0.0	5.9	12.9	100	5.76	0.69	0.50	2	4.25	0.0	1	2.21	48.00	3.0	0.0
	3	60	1.7	4.3	0.002	0.905	501.2	1104.9	0.9	0.354	2,732	5	2	2.70	0.15	0.1	5.9	12.9	100	7.27	0.87	0.70	3	4.25	0.1	2	1.75	48.00	3.0	0.0
	4	90	2.1	5.2	0.004	1.593	284.7	627.7	0.9	0.354	2,718	10	4	2.23	0.21	0.1	5.9	12.9	100	8.78	1.05	1.00	4	4.25	0.1	3	1.45	48.00	3.0	0.0
	5	120	2.4	6.1	0.006	2.563	177	390.2	0.9	0.354	2,704	15	7	1.91	0.29	0.1	5.9	12.9	100	10.28	1.23	1	6	4.25	0.1	5	1.24	48.00	3.0	0.1
	6	150	2.8	7.0	0.009	3.863	117.4	258.9	0.9	0.354	2,690	23	10	1.66	0.38	0.2	5.9	12.9	100	11.79	1.41	2	7	4.25	0.2	8	1.08	48.00	3.0	0.1
	7	180	3.1	7.9	0.012	5.542	81.8	180.4	0.9	0.354	2,677	33	15	1.47	0.48	0.2	5.9	12.9	100	13.3	1.59	2	9	4.25	0.3	11	0.96	48.00	3.0	0.1
	8	210	3.5	8.8	0.017	7.649	59.3	130.7	0.9	0.354	2,663	45	20	1.32	0.59	0.3	5.9	12.9	100	14.81	1.77	3	12	4.25	0.4	15	0.86	48.00	3.0	0.2
	9	240	3.8	9.7	0.023	10.23	44.3	97.7	0.9	0.354	2,649	60	27	1.20	0.72	0.3	5.9	12.9	100	16.31	1.95	4	14	4.25	0.6	20	0.78	48.00	3.0	0.2
	10	270	4.2	10.6	0.029	13.34	34	75	0.9	0.354	2,635	77	35	1.10	0.85	0.4	5.9	12.9	100	17.82	2.13	4	16	4.25	0.7	26	0.71	48.00	3.0	0.3
	11	300	4.5	11.5	0.038	17.02	26.7	58.8	0.9	0.354	2,622	98	45	1.01	0.99	0.5	5.9	12.9	100	19.33	2.31	5	19	4.25	0.9	33	0.66	48.00	3.0	0.4
	12	330	4.9	12.4	0.047	21.32	21.3	46.9	0.9	0.354	2,608	122	56	0.94	1.20	0.5	5.9	12.9	100	20.84	2.49	6	22	4.25	1.2	41	0.61	48.00	3.0	0.5
	13	360	5.3	13.3	0.058	26.28	17.3	38	0.9	0.354	2,594	150	68	0.88	1.30	0.6	5.9	12.9	100	22.34	2.67	7	26	4.25	1.4	50	0.57	48.00	3.0	0.6
	14	390	5.6	14.2	0.07	31.97	14.2	31.3	0.9	0.354	2,580	181	82	0.82	1.50	0.7	5.9	12.9	100	23.85	2.85	8	29	4.25	1.7	61	0.53	48.00	3.0	0.7
	15	410	5.8	14.8	0.08	36.19	12.5	27.6	0.9	0.354	2,571	205	93	0.79	1.60	0.7	5.9	12.9	100	24.85	2.97	8	31	4.25	1.9	68	0.51	48.00	3.0	0.8
	16	440	6.2	15.7	0.095	43.18	10.5	23.2	0.9	0.354	2,557	243	110	0.74	1.80	0.8	5.9	12.9	100	26.36	3.15	9	35	4.25	2.3	81	0.48	48.00	3.0	1.0

MODEL INPUTS

St	Input	Name	Outp	Unit	Com
					PROJECT: French River MNDNR
					REARING UNIT TYPE: 6ft Nursery Tank
					RV REARING VOLUME: 2.3CM or 80CF
					AVAILABLE OXYGEN = set by USER 6.0 mg/l
					D.O. IN EFFLUENT IS set by USER 7.0 is recommnded level
	48	MAXkgm3			MAXIMUM DENISTY IN KG / CUBIC METER 32, 48, 65, 80,
	2.3	UNITVOLm3			REARING UNIT VOLUME IN CUBIC METERS
	3	OPVelocity			Velocity in cm/sec (range 3.0 to 5.0 is recommended)
	11.5	UNITMETERS			REARING UNIT length in Meters
	'May2013	DATE			Date of Computer Run 'Month201996
	"nursey 6ft tank"	Project			hatchery name
	8	Sizeinches			Target Size in Inches
		Number			Target Number
	'RBT	Species			fish species use 3 letter code
	'coldwater	species			oxyreq 'coldwater,cool,warm,talapia
	5	ctemp_c			enter constant water temp deg. C
		tugr	0.006		from LOOKUP TABLE tugr in cm/tu
	1.3	conv			enter food conversion 1.5
	2.54	ilength			enter in centimeters starting length
		iweight	0.181		weight calculated
		k	0.011		from LOOKUP TABLE k metric condition factor
	2759	i#fish			enter initial # of fish starting # THIS VARIABLE IS VARIED TO MEET DENSITY & FLOW
L		#fish	2759		calculated mortality= 1/2%/day/month
	30	pdays			enter # days in period ex. 30
	660	elev			enter elevation in ftMSL
	0.95	oxy%			enter RAW WATER supply initial DO % sa
	5.86	availoxy			enter FIXED Available DO for Operating System 3, 4, 5, 6, etc.
	7	effluentDO			enter FIXED effluent DO for System 5, 6 or 7 suggested
	7.25	pH			enter pH
	0.417	%uninh3			enter %uninh3 from AMMONIA % IONIZATION TABLE
	0.0125	AUA			enter AUA allowable unionized ammonia (range .010 to 0.025) .025 suggested
	0	bgnh3			enter background Total TAN if any

BY-PRODUCT GENERATION in Kgs.   MASS BALANCE FEED TO BY-PRODUCTS

		Month	feedkg	TSS	Total NH3	UNI NH3	co2kg	phoskg	NO3kg	BODkg
	Element	Period	Feedkg	TSSkg	TANkg	UNINH3kg	co2kg	phoskg	NO3kg	BODkg
	1.00	1.00	0.70	0.20	0.02	0.00	0.20	0.00	0.06	0.20
	2.00	2.00	1.00	0.40	0.04	0.01	0.40	0.01	0.10	0.40
	3.00	3.00	2.00	0.60	0.06	0.01	0.60	0.01	0.20	0.70
	4.00	4.00	3.00	0.90	0.09	0.01	0.80	0.01	0.30	1.00
	5.00	5.00	4.00	1.00	0.12	0.02	1.00	0.02	0.30	1.00
	6.00	6.00	5.00	2.00	0.16	0.02	1.00	0.03	0.40	2.00
	7.00	7.00	7.00	2.00	0.20	0.03	2.00	0.03	0.60	2.00
	8.00	8.00	8.00	2.00	0.24	0.03	2.00	0.04	0.70	3.00
	9.00	9.00	10.00	3.00	0.29	0.04	3.00	0.05	0.80	3.00
	10.00	10.00	12.00	3.00	0.35	0.04	3.00	0.06	1.00	4.00
	11.00	11.00	13.00	4.00	0.40	0.05	4.00	0.07	1.00	5.00
	12.00	12.00	16.00	5.00	0.47	0.06	4.00	0.08	1.00	5.00
	13.00	13.00	18.00	5.00	0.53	0.07	5.00	0.09	2.00	6.00
	14.00	14.00	20.00	6.00	0.61	0.08	6.00	0.10	2.00	7.00
	15.00	15.00	22.00	7.00	0.65	0.08	6.00	0.11	2.00	7.00
	16.00	16.00	24.00	7.00	0.73	0.09	7.00	0.12	2.00	8.00

CAP 3

Title: FRH 6ft Nursery Tank Capacity Density Set 3 lbs/cuft. D.O.= 110%, AO=7.1 Temp 41 deg F, Flow 8 gpm

Rearing Model

approx. end of Month	Ele	DAY	inches	cm	lbs@	grams@	# / LB.	#/Kg	cm/m	inches/m	# FISH	Tot.lbs.	Tot.Kgs
	Ele	DAY	inches	cm	lbs@	grams@	# / LB.	#/Kg	cm/m	inches/m	# FISH	Tot.lbs.	Tot.Kgs
	1	1	1	2.6	0	0.188	2413.5	5320.8	0.9	0.354	2,759	1	1
	2	30	1.4	3.4	0.001	0.451	1006.4	2218.7	0.9	0.354	2,745	3	1
	3	60	1.7	4.3	0.002	0.905	501.2	1104.9	0.9	0.354	2,732	5	2
	4	90	2.1	5.2	0.004	1.593	284.7	627.7	0.9	0.354	2,718	10	4
	5	120	2.4	6.1	0.006	2.563	177	390.2	0.9	0.354	2,704	15	7
	6	150	2.8	7.0	0.009	3.863	117.4	258.9	0.9	0.354	2,690	23	10
	7	180	3.1	7.9	0.012	5.542	81.8	180.4	0.9	0.354	2,677	33	15
	8	210	3.5	8.8	0.017	7.649	59.3	130.7	0.9	0.354	2,663	45	20
	9	240	3.8	9.7	0.023	10.23	44.3	97.7	0.9	0.354	2,649	60	27
	10	270	4.2	10.6	0.029	13.34	34	75	0.9	0.354	2,635	77	35
	11	300	4.5	11.5	0.038	17.02	26.7	58.8	0.9	0.354	2,622	98	45
	12	330	4.9	12.4	0.047	21.32	21.3	46.9	0.9	0.354	2,608	122	56
	13	360	5.3	13.3	0.058	26.28	17.3	38	0.9	0.354	2,594	150	68
	14	390	5.6	14.2	0.07	31.97	14.2	31.3	0.9	0.354	2,580	181	82
	15	410	5.8	14.8	0.08	36.19	12.5	27.6	0.9	0.354	2,571	205	93
	16	440	6.2	15.7	0.095	43.18	10.5	23.2	0.9	0.354	2,557	243	110

Ele	%bwfeed	feed lbs/day	feed Kg/day	AO mg/1	Req.Int. DO	%DOsat.	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
Ele	%bwfeed	feed lbs/day	feed Kg/day	AO mg/1	Req.Int. DO	%DOsaturatic	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
1	4.55	0.05	0.0	7.1	14.1	110	5.22	0.62	0.20	1	5.15	0.0	0	2.96	48.00	3.0	0.0
2	3.40	0.09	0.0	7.1	14.1	110	6.98	0.84	0.40	1	5.15	0.0	1	2.21	48.00	3.0	0.0
3	2.70	0.15	0.1	7.1	14.1	110	8.81	1.05	0.60	2	5.15	0.1	2	1.75	48.00	3.0	0.0
4	2.23	0.21	0.1	7.1	14.1	110	10.63	1.27	0.90	3	5.15	0.1	3	1.45	48.00	3.0	0.0
5	1.91	0.29	0.1	7.1	14.1	110	12.46	1.49	1	5	5.15	0.1	5	1.24	48.00	3.0	0.1
6	1.66	0.38	0.2	7.1	14.1	110	14.29	1.71	2	6	5.15	0.2	8	1.08	48.00	3.0	0.1
7	1.47	0.48	0.2	7.1	14.1	110	16.11	1.93	2	8	5.15	0.3	11	0.96	48.00	3.0	0.1
8	1.32	0.59	0.3	7.1	14.1	110	17.94	2.15	2	9	5.15	0.4	15	0.86	48.00	3.0	0.2
9	1.20	0.72	0.3	7.1	14.1	110	19.77	2.36	3	11	5.15	0.6	20	0.78	48.00	3.0	0.2
10	1.10	0.85	0.4	7.1	14.1	110	21.59	2.58	4	14	5.15	0.7	26	0.71	48.00	3.0	0.3
11	1.01	0.99	0.5	7.1	14.1	110	23.42	2.8	4	16	5.15	0.9	33	0.66	48.00	3.0	0.4
12	0.94	1.20	0.5	7.1	14.1	110	25.24	3.02	5	18	5.15	1.2	41	0.61	48.00	3.0	0.5
13	0.88	1.30	0.6	7.1	14.1	110	27.07	3.24	6	21	5.15	1.4	50	0.57	48.00	3.0	0.6
14	0.82	1.50	0.7	7.1	14.1	110	28.9	3.46	6	24	5.15	1.7	61	0.53	48.00	3.0	0.7
15	0.79	1.60	0.7	7.1	14.1	110	30.11	3.6	7	26	5.15	1.9	68	0.51	48.00	3.0	0.8
16	0.74	1.80	0.8	7.1	14.1	110	31.94	3.82	8	29	5.15	2.3	81	0.48	48.00	3.0	1.0

MODEL INPUTS

St	Input	Name	Outp	Unit	Com
					PROJECT: French River MNDNR
					REARING UNIT TYPE: 6ft Nursery Tank
					RV REARING VOLUME: 2.3CM or 80CF
					AVAILABLE OXYGEN = set by USER 6.0 mg/l
					D.O. IN EFFLUENT IS set by USER 7.0 is recommnded level
	48	MAXkgm3			MAXIMUM DENISTY IN KG / CUBIC METER 32, 48, 65, 80,
	2.3	UNITVOLm3			REARING UNIT VOLUME IN CUBIC METERS
	3	OPVelocity			Velocity in cm/sec (range 3.0 to 5.0 is recommended)
	11.5	UNITMETERS			REARING UNIT length in Meters
	'May2013	DATE			Date of Computer Run 'Month201996
	nursey 6ft tank	Project			hatchery name
	8	Sizeinches			Target Size in Inches
		Number			Target Number
	'RBT	Species			fish species use 3 letter code
	'coldwater	species			oxyreq 'coldwater,cool,warm,talapia
	5	ctemp_c			enter constant water temp deg. C
		tugr	0.006		from LOOKUP TABLE tugr in cm/tu
	1.3	conv			enter food conversion 1.5
	2.54	ilength			enter in centimeters starting length
		iweight	0.181		weight calculated
		k	0.011		from LOOKUP TABLE k metric condition factor
	2759	i#fish			enter initial # of fish starting # THIS VARIABLE IS VARIED TO MEET DENSITY & FLOW
L		#fish	2759		calculated mortality= 1/2%/day/month
	30	pdays			enter # days in period ex. 30
	660	elev			enter elevation in ftMSL
	0.95	oxy%			enter RAW WATER supply initial DO % sa
	7.1	availoxy			enter FIXED Available DO for Operating System 3, 4, 5, 6, etc.
	7	effluentDO			enter FIXED effluent DO for System 5, 6 or 7 suggested
	7.25	pH			enter pH
	0.417	%uninh3			enter %uninh3 from AMMONIA % IONIZATION TABLE
	0.0125	AUA			enter AUA allowable unionized ammonia (range .010 to 0.025) .025 suggested
	0	bgnh3			enter background Total TAN if any

BY-PRODUCT GENERATION in Kgs. MASS BALANCE FEED TO BY-PRODUCTS

		Month	feedkg	TSS	Total NH3	UNI NH3	co2kg	phoskg	NO3kg	BODkg
	Element	Period	Feedkg	TSSkg	TANkg	UNINH3kg	co2kg	phoskg	NO3kg	BODkg
	1.00	1.00	0.70	0.20	0.02	0.00	0.20	0.00	0.06	0.20
	2.00	2.00	1.00	0.40	0.04	0.01	0.40	0.01	0.10	0.40
	3.00	3.00	2.00	0.60	0.06	0.01	0.60	0.01	0.20	0.70
	4.00	4.00	3.00	0.90	0.09	0.01	0.80	0.01	0.30	1.00
	5.00	5.00	4.00	1.00	0.12	0.02	1.00	0.02	0.30	1.00
	6.00	6.00	5.00	2.00	0.16	0.02	1.00	0.03	0.40	2.00
	7.00	7.00	7.00	2.00	0.20	0.03	2.00	0.03	0.60	2.00
	8.00	8.00	8.00	2.00	0.24	0.03	2.00	0.04	0.70	3.00
	9.00	9.00	10.00	3.00	0.29	0.04	3.00	0.05	0.80	3.00
	10.00	10.00	12.00	3.00	0.35	0.04	3.00	0.06	1.00	4.00
	11.00	11.00	13.00	4.00	0.40	0.05	4.00	0.07	1.00	5.00
	12.00	12.00	16.00	5.00	0.47	0.06	4.00	0.08	1.00	5.00
	13.00	13.00	18.00	5.00	0.53	0.07	5.00	0.09	2.00	6.00
	14.00	14.00	20.00	6.00	0.61	0.08	6.00	0.10	2.00	7.00
	15.00	15.00	22.00	7.00	0.65	0.08	6.00	0.11	2.00	7.00
	16.00	16.00	24.00	7.00	0.73	0.09	7.00	0.12	2.00	8.00

CAP 4

Title: FRH 6ft Nursery Tank Capacity Density Set 3 lbs/cuft. D.O.= 90%, AO=4.0 Temp 44.6 deg F, Flow 14 gpm

Rearing Model

approx. end of	Elem	DAY	inches	cm	lbs@	grams@	# / LB.	#/Kg	cm/m	inches/m	# FISH	Tot.lbs.	Tot.Kgs	%bwfeed	feed lbs/day	feed Kg/day	AO mg/1	Req.Int. DO	%DOsat.	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
Month	Elem	DAY	inches	cm	lbs@	grams@	# / LB.	#/Kg	cm/m	inches/m	# FISH	Tot.lbs.	Tot.Kgs	%bwfeed	feed lbs/day	feed Kg/day	AO mg/1	Req.Int. DO	%DOsaturatic	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
	1	1	1	2.6	0	0.191	2380	5246.9	1.26	0.496	1,159	1	0	6.34	0.03	0.0	4.0	11	90	2.1	0.25	0.20	1	2.07	0.0	0	2.94	48.00	3.0	0.0
	2	30	1.5	3.8	0.001	0.608	746.6	1646	1.26	0.496	1,153	2	1	4.31	0.07	0.0	4.0	11	90	3.1	0.37	0.50	2	2.07	0.0	1	2.00	48.00	3.0	0.0
	3	60	2	5.1	0.003	1.434	316.2	697.1	1.26	0.496	1,147	4	2	3.24	0.12	0.1	4.0	11	90	4.12	0.49	0.90	3	2.07	0.0	1	1.50	48.00	3.0	0.0
	4	90	2.5	6.3	0.006	2.795	162.3	357.8	1.26	0.496	1,142	7	3	2.59	0.18	0.1	4.0	11	90	5.15	0.62	1.00	5	2.07	0.1	2	1.20	48.00	3.0	0.0
	5	120	3	7.6	0.011	4.822	94.1	207.4	1.26	0.496	1,136	12	5	2.16	0.26	0.1	4.0	11	90	6.17	0.74	2	7	2.07	0.1	4	1.00	48.00	3.0	0.1
	6	150	3.5	8.8	0.017	7.649	59.3	130.7	1.26	0.496	1,130	19	9	1.85	0.35	0.2	4.0	11	90	7.2	0.86	3	10	2.07	0.2	6	0.86	48.00	3.0	0.1
	7	180	4	10.1	0.025	11.41	39.8	87.7	1.26	0.496	1,124	28	13	1.62	0.46	0.2	4.0	11	90	8.23	0.98	3	13	2.07	0.3	9	0.75	48.00	3.0	0.1
	8	210	4.5	11.4	0.036	16.23	27.9	61.6	1.26	0.496	1,119	40	18	1.44	0.58	0.3	4.0	11	90	9.25	1.11	4	16	2.07	0.4	13	0.67	48.00	3.0	0.2
	9	240	5	12.6	0.049	22.25	20.4	44.9	1.26	0.496	1,113	54	25	1.30	0.71	0.3	4.0	11	90	10.28	1.23	5	20	2.07	0.5	18	0.60	48.00	3.0	0.2
	10	270	5.5	13.9	0.065	29.61	15.3	33.8	1.26	0.496	1,107	72	33	1.18	0.85	0.4	4.0	11	90	11.31	1.35	6	24	2.07	0.7	24	0.55	48.00	3.0	0.3
	11	300	6	15.1	0.085	38.42	11.8	26	1.26	0.496	1,101	93	42	1.08	1.00	0.5	4.0	11	90	12.33	1.48	8	29	2.07	0.9	31	0.50	48.00	3.0	0.4
	12	330	6.5	16.4	0.108	48.84	9.3	20.5	1.26	0.496	1,096	118	54	1.00	1.20	0.5	4.0	11	90	13.36	1.6	9	33	2.07	1.1	39	0.46	48.00	3.0	0.5
	13	360	7	17.7	0.134	60.98	7.4	16.4	1.26	0.496	1,090	146	66	0.93	1.40	0.6	4.0	11	90	14.39	1.72	10	39	2.07	1.4	49	0.43	48.00	3.0	0.6
	14	390	7.4	18.9	0.165	74.99	6	13.3	1.26	0.496	1,084	179	81	0.87	1.50	0.7	4.0	11	90	15.41	1.84	12	44	2.07	1.7	60	0.40	48.00	3.0	0.7
	15	410	7.8	19.8	0.188	85.43	5.3	11.7	1.26	0.496	1,080	203	92	0.83	1.70	0.8	4.0	11	90	16.1	1.93	13	48	2.07	1.9	68	0.38	48.00	3.0	0.8
	16	440	8.3	21.0	0.227	102.8	4.4	9.7	1.26	0.496	1,074	243	110	0.78	1.90	0.9	4.0	11	90	17.12	2.05	14	54	2.07	2.3	81	0.36	48.00	3.0	1.0

MODEL INPUTS

Stat	Input	Name	Outp	Unit	Com
					PROJECT: French River MNDNR
					REARING UNIT TYPE: 6ft Nursery Tank
					RV REARING VOLUME: 2.3CM or 80CF
					AVAILABLE OXYGEN = set by USER 6.0 mg/l
					D.O. IN EFFLUENT IS set by USER 7.0 is recommnded level
	48	MAXkgm3			MAXIMUM DENISTY IN KG / CUBIC METER 32, 48, 65, 80,
	2.3	UNITVOLm3			REARING UNIT VOLUME IN CUBIC METERS
	3	OPVelocity			Velocity in cm/sec (range 3.0 to 5.0 is recommended)
	11.5	UNITMETERS			REARING UNIT length in Meters
	'May2013	DATE			Date of Computer Run 'Month201996
	nursey 6ft tank	Project			hatchery name
	8	Sizeinches			Target Size in Inches
		Number			Target Number
	'RBT	Species			fish species use 3 letter code
	'coldwater	species			oxyreq 'coldwater,cool,warm,talapia
	7	ctemp_c			enter constant water temp deg. C
		tugr	0.006		from LOOKUP TABLE tugr in cm/tu
	1.3	conv			enter food conversion 1.5
	2.54	ilength			enter in centimeters starting length
		iweight	0.181		weight calculated
		k	0.011		from LOOKUP TABLE k metric condition factor
	1159	i#fish			enter initial # of fish starting # THIS VARIABLE IS VARIED TO MEET DENSITY & FLOW
L		#fish	1159		calculated mortality= 1/2%/day/month
	30	pdays			enter # days in period ex. 30
	660	elev			enter elevation in ftMSL
	0.95	oxy%			enter RAW WATER supply initial DO % sa
	3.99	availoxy			enter FIXED Available DO for Operating System 3, 4, 5, 6, etc.
	7	effluentDO			enter FIXED effluent DO for System 5, 6 or 7 suggested
	7.25	pH			enter pH
	0.417	%uninh3			enter %uninh3 from AMMONIA % IONIZATION TABLE
	0.0125	AUA			enter AUA allowable unionized ammonia (range .010 to 0.025) .025 suggested
	0	bgnh3			enter background Total TAN if any

BY-PRODUCT GENERATION in Kgs. MASS BALANCE FEED TO BY-PRODUCTS

		Month	feedkg	TSS	Total NH3	UNI NH3	co2kg	phoskg	NO3kg	BODkg
	Element	Period	Feedkg	TSSkg	TANkg	UNINH3kg	co2kg	phoskg	NO3kg	BODkg
	1.00	1.00	0.40	0.10	0.01	0.00	0.10	0.00	0.04	0.10
	2.00	2.00	0.90	0.30	0.03	0.00	0.30	0.01	0.08	0.30
	3.00	3.00	2.00	0.50	0.05	0.01	0.40	0.01	0.10	0.50
	4.00	4.00	2.00	0.70	0.07	0.01	0.70	0.01	0.20	0.80
	5.00	5.00	4.00	1.00	0.11	0.01	1.00	0.02	0.30	1.00
	6.00	6.00	5.00	1.00	0.14	0.02	1.00	0.02	0.40	2.00
	7.00	7.00	6.00	2.00	0.19	0.02	2.00	0.03	0.50	2.00
	8.00	8.00	8.00	2.00	0.24	0.03	2.00	0.04	0.70	3.00
	9.00	9.00	10.00	3.00	0.29	0.04	3.00	0.05	0.80	3.00
	10.00	10.00	12.00	3.00	0.35	0.04	3.00	0.06	1.00	4.00
	11.00	11.00	14.00	4.00	0.41	0.05	4.00	0.07	1.00	5.00
	12.00	12.00	16.00	5.00	0.48	0.06	4.00	0.08	1.00	5.00
	13.00	13.00	18.00	6.00	0.55	0.07	5.00	0.09	2.00	6.00
	14.00	14.00	21.00	6.00	0.63	0.08	6.00	0.11	2.00	7.00
	15.00	15.00	23.00	7.00	0.68	0.09	6.00	0.11	2.00	8.00
	16.00	16.00	26.00	8.00	0.77	0.10	7.00	0.13	2.00	9.00

CAP 5

Title: FRH 6ft Nursery Tank Capacity Density Set 3 lbs/cuft. D.O.= 100%, AO=5.2 Temp 44.6 deg F, Flow 11 gpm

Rearing Model

approx. end of Month	Ele	DAY	inches	cm	lbs@	grams@	# / LB.	#/Kg	cm/m	inches/m	# FISH	Tot.lbs.	Tot.Kgs	%bwfeed	feed lbs/day	feed Kg/day	AO mg/1	Req.Int. DO	%DOsat.	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
	1	1	1	2.6	0	0.191	2380	5246.9	1.26	0.496	1,159	1	0	6.34	0.03	0.0	5.2	12.2	100	2.75	0.33	0.20	1	2.70	0.0	0	2.94	48.00	3.0	0.0
	2	30	1.5	3.8	0.001	0.608	746.6	1646	1.26	0.496	1,153	2	1	4.31	0.07	0.0	5.2	12.2	100	4.04	0.48	0.40	1	2.70	0.0	1	2.00	48.00	3.0	0.0
	3	60	2	5.1	0.003	1.434	316.2	697.1	1.26	0.496	1,147	4	2	3.24	0.12	0.1	5.2	12.2	100	5.38	0.64	0.70	3	2.70	0.0	1	1.50	48.00	3.0	0.0
	4	90	2.5	6.3	0.006	2.795	162.3	357.8	1.26	0.496	1,142	7	3	2.59	0.18	0.1	5.2	12.2	100	6.72	0.8	1.00	4	2.70	0.1	2	1.20	48.00	3.0	0.0
	5	120	3	7.6	0.011	4.822	94.1	207.4	1.26	0.496	1,136	12	5	2.16	0.26	0.1	5.2	12.2	100	8.06	0.96	1	6	2.70	0.1	4	1.00	48.00	3.0	0.1
	6	150	3.5	8.8	0.017	7.649	59.3	130.7	1.26	0.496	1,130	19	9	1.85	0.35	0.2	5.2	12.2	100	9.4	1.12	2	8	2.70	0.2	6	0.86	48.00	3.0	0.1
	7	180	4	10.1	0.025	11.41	39.8	87.7	1.26	0.496	1,124	28	13	1.62	0.46	0.2	5.2	12.2	100	10.74	1.29	3	10	2.70	0.3	9	0.75	48.00	3.0	0.1
	8	210	4.5	11.4	0.036	16.23	27.9	61.6	1.26	0.496	1,119	40	18	1.44	0.58	0.3	5.2	12.2	100	12.08	1.45	3	13	2.70	0.4	13	0.67	48.00	3.0	0.2
	9	240	5	12.6	0.049	22.25	20.4	44.9	1.26	0.496	1,113	54	25	1.30	0.71	0.3	5.2	12.2	100	13.42	1.61	4	15	2.70	0.5	18	0.60	48.00	3.0	0.2
	10	270	5.5	13.9	0.065	29.61	15.3	33.8	1.26	0.496	1,107	72	33	1.18	0.85	0.4	5.2	12.2	100	14.76	1.77	5	19	2.70	0.7	24	0.55	48.00	3.0	0.3
	11	300	6	15.1	0.085	38.42	11.8	26	1.26	0.496	1,101	93	42	1.08	1.00	0.5	5.2	12.2	100	16.1	1.93	6	22	2.70	0.9	31	0.50	48.00	3.0	0.4
	12	330	6.5	16.4	0.108	48.84	9.3	20.5	1.26	0.496	1,096	118	54	1.00	1.20	0.5	5.2	12.2	100	17.44	2.09	7	26	2.70	1.1	39	0.46	48.00	3.0	0.5
	13	360	7	17.7	0.134	60.98	7.4	16.4	1.26	0.496	1,090	146	66	0.93	1.40	0.6	5.2	12.2	100	18.78	2.25	8	30	2.70	1.4	49	0.43	48.00	3.0	0.6
	14	390	7.4	18.9	0.165	74.99	6	13.3	1.26	0.496	1,084	179	81	0.87	1.50	0.7	5.2	12.2	100	20.12	2.41	9	34	2.70	1.7	60	0.40	48.00	3.0	0.7
	15	410	7.8	19.8	0.188	85.43	5.3	11.7	1.26	0.496	1,080	203	92	0.83	1.70	0.8	5.2	12.2	100	21.02	2.51	10	37	2.70	1.9	68	0.38	48.00	3.0	0.8
	16	440	8.3	21.0	0.227	102.8	4.4	9.7	1.26	0.496	1,074	243	110	0.78	1.90	0.9	5.2	12.2	100	22.36	2.67	11	41	2.70	2.3	81	0.36	48.00	3.0	1.0

MODEL INPUTS

St	Input	Name	Outp	Com
				PROJECT: French River MNDNR
				REARING UNIT TYPE: 6ft Nursery Tank
				RV REARING VOLUME: 2.3CM or 80CF
				AVAILABLE OXYGEN = set by USER 6.0 mg/l
				D.O. IN EFFLUENT IS set by USER 7.0 is recommnded level
	48	MAXkgm3		MAXIMUM DENISTY IN KG / CUBIC METER 32, 48, 65, 80,
	2.3	UNITVOLm3		REARING UNIT VOLUME IN CUBIC METERS
	3	OPVelocity		Velocity in cm/sec (range 3.0 to 5.0 is recommended)
	11.5	UNITMETERS		REARING UNIT length in Meters
	'May2013	DATE		Date of Computer Run 'Month201996
	nursey 6ft tank	Project		hatchery name
	8	Sizeinches		Target Size in Inches
		Number		Target Number
	'RBT	Species		fish species use 3 letter code
	'coldwater	species		oxyreq 'coldwater,cool,warm,talapia
	7	ctemp_c		enter constant water temp deg. C
		tugr	0.006	from LOOKUP TABLE tugr in cm/tu
	1.3	conv		enter food conversion 1.5
	2.54	ilength		enter in centimeters starting length
		iweight	0.181	weight calculated
		k	0.011	from LOOKUP TABLE k metric condition factor
	1159	i#fish		enter initial # of fish starting # THIS VARIABLE IS VARIED TO MEET DENSITY & FLOW
L		#fish	1159	calculated mortality= 1/2%/day/month
	30	pdays		enter # days in period ex. 30
	660	elev		enter elevation in ftMSL
	0.95	oxy%		enter RAW WATER supply initial DO % sa
	5.21	availoxy		enter FIXED Available DO for Operating System 3, 4, 5, 6, etc.
	7	effluentDO		enter FIXED effluent DO for System 5, 6 or 7 suggested
	7.25	pH		enter pH
	0.417	%uninh3		enter %uninh3 from AMMONIA % IONIZATION TABLE
	0.0125	AUA		enter AUA allowable unionized ammonia (range .010 to 0.025) .025 suggested
	0	bgnh3		enter background Total TAN if any

BY-PRODUCT GENERATION in Kgs. MASS BALANCE FEED TO BY-PRODUCTS

		Month	feedkg	TSS	Total NH3	UNI NH3	co2kg	phoskg	NO3kg	BODkg
	Element	Period	Feedkg	TSSkg	TANkg	UNINH3kg	co2kg	phoskg	NO3kg	BODkg
	1.00	1.00	0.40	0.10	0.01	0.00	0.10	0.00	0.04	0.10
	2.00	2.00	0.90	0.30	0.03	0.00	0.30	0.01	0.08	0.30
	3.00	3.00	2.00	0.50	0.05	0.01	0.40	0.01	0.10	0.50
	4.00	4.00	2.00	0.70	0.07	0.01	0.70	0.01	0.20	0.80
	5.00	5.00	4.00	1.00	0.11	0.01	1.00	0.02	0.30	1.00
	6.00	6.00	5.00	1.00	0.14	0.02	1.00	0.02	0.40	2.00
	7.00	7.00	6.00	2.00	0.19	0.02	2.00	0.03	0.50	2.00
	8.00	8.00	8.00	2.00	0.24	0.03	2.00	0.04	0.70	3.00
	9.00	9.00	10.00	3.00	0.29	0.04	3.00	0.05	0.80	3.00
	10.00	10.00	12.00	3.00	0.35	0.04	3.00	0.06	1.00	4.00
	11.00	11.00	14.00	4.00	0.41	0.05	4.00	0.07	1.00	5.00
	12.00	12.00	16.00	5.00	0.48	0.06	4.00	0.08	1.00	5.00
	13.00	13.00	18.00	6.00	0.55	0.07	5.00	0.09	2.00	6.00
	14.00	14.00	21.00	6.00	0.63	0.08	6.00	0.11	2.00	7.00
	15.00	15.00	23.00	7.00	0.68	0.09	6.00	0.11	2.00	8.00
	16.00	16.00	26.00	8.00	0.77	0.10	7.00	0.13	2.00	9.00

CAP 6

Title: FRH 6ft Nursery Tank Capacity Density Set 3 lbs/cuft. D.O.= 110%, AO=6.4 Temp 44.6 deg F, Flow 9 gpm

Rearing Model

approx. end of Month	Elem	DAY	inches	cm	lbs@	grams@	# / LB.	#/Kg	cm/m	inches/m	# FISH	Tot.lbs.	Tot.Kgs	%bwfeed	feed lbs/day	feed Kg/day	AO mg/1	Req.Int. DO	%DOsat.	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
	Elem	DAY	inches	cm	lbs@	grams@	# / LB.	#/Kg	cm/m	inches/m	# FISH	Tot.lbs.	Tot.Kgs	%bwfeed	feed lbs/day	feed Kg/day	AO mg/1	Req.Int. DO	%DOsaturatic	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
	1	1	1	2.6	0	0.191	2380	5246.9	1.26	0.496	1,159	1	0	6.34	0.03	0.0	6.4	13.4	110	3.37	0.4	0.10	1	3.32	0.0	0	2.94	48.00	3.0	0.0
	2	30	1.5	3.8	0.001	0.608	746.6	1646	1.26	0.496	1,153	2	1	4.31	0.07	0.0	6.4	13.4	110	4.96	0.59	0.30	1	3.32	0.0	1	2.00	48.00	3.0	0.0
	3	60	2	5.1	0.003	1.434	316.2	697.1	1.26	0.496	1,147	4	2	3.24	0.12	0.1	6.4	13.4	110	6.61	0.79	0.50	2	3.32	0.0	1	1.50	48.00	3.0	0.0
	4	90	2.5	6.3	0.006	2.795	162.3	357.8	1.26	0.496	1,142	7	3	2.59	0.18	0.1	6.4	13.4	110	8.26	0.99	0.90	3	3.32	0.1	2	1.20	48.00	3.0	0.0
	5	120	3	7.6	0.011	4.822	94.1	207.4	1.26	0.496	1,136	12	5	2.16	0.26	0.1	6.4	13.4	110	9.9	1.18	1	5	3.32	0.1	4	1.00	48.00	3.0	0.1
	6	150	3.5	8.8	0.017	7.649	59.3	130.7	1.26	0.496	1,130	19	9	1.85	0.35	0.2	6.4	13.4	110	11.55	1.38	2	6	3.32	0.2	6	0.86	48.00	3.0	0.1
	7	180	4	10.1	0.025	11.41	39.8	87.7	1.26	0.496	1,124	28	13	1.62	0.46	0.2	6.4	13.4	110	13.2	1.58	2	8	3.32	0.3	9	0.75	48.00	3.0	0.1
	8	210	4.5	11.4	0.036	16.23	27.9	61.6	1.26	0.496	1,119	40	18	1.44	0.58	0.3	6.4	13.4	110	14.84	1.78	3	10	3.32	0.4	13	0.67	48.00	3.0	0.2
	9	240	5	12.6	0.049	22.25	20.4	44.9	1.26	0.496	1,113	54	25	1.30	0.71	0.3	6.4	13.4	110	16.49	1.97	3	13	3.32	0.5	18	0.60	48.00	3.0	0.2
	10	270	5.5	13.9	0.065	29.61	15.3	33.8	1.26	0.496	1,107	72	33	1.18	0.85	0.4	6.4	13.4	110	18.14	2.17	4	15	3.32	0.7	24	0.55	48.00	3.0	0.3
	11	300	6	15.1	0.085	38.42	11.8	26	1.26	0.496	1,101	93	42	1.08	1.00	0.5	6.4	13.4	110	19.78	2.37	5	18	3.32	0.9	31	0.50	48.00	3.0	0.4
	12	330	6.5	16.4	0.108	48.84	9.3	20.5	1.26	0.496	1,096	118	54	1.00	1.20	0.5	6.4	13.4	110	21.43	2.56	5	21	3.32	1.1	39	0.46	48.00	3.0	0.5
	13	360	7	17.7	0.134	60.98	7.4	16.4	1.26	0.496	1,090	146	66	0.93	1.40	0.6	6.4	13.4	110	23.07	2.76	6	24	3.32	1.4	49	0.43	48.00	3.0	0.6
	14	390	7.4	18.9	0.165	74.99	6	13.3	1.26	0.496	1,084	179	81	0.87	1.50	0.7	6.4	13.4	110	24.72	2.96	7	27	3.32	1.7	60	0.40	48.00	3.0	0.7
	15	410	7.8	19.8	0.188	85.43	5.3	11.7	1.26	0.496	1,080	203	92	0.83	1.70	0.8	6.4	13.4	110	25.82	3.09	8	30	3.32	1.9	68	0.38	48.00	3.0	0.8
	16	440	8.3	21.0	0.227	102.8	4.4	9.7	1.26	0.496	1,074	243	110	0.78	1.90	0.9	6.4	13.4	110	27.46	3.29	9	34	3.32	2.3	81	0.36	48.00	3.0	1.0

MODEL INPUTS

Stat	Input	Name	Outp	Unit	Com
					REARING UNIT TYPE: 6ft Nursery Tank
					RV REARING VOLUME: 2.3CM or 80CF
					AVAILABLE OXYGEN = set by USER 6.0 mg/l
					D.O. IN EFFLUENT IS set by USER 7.0 is recommnded level
	48	MAXkgm3			MAXIMUM DENISTY IN KG / CUBIC METER 32, 48, 65, 80,
	2.3	UNITVOLm3			REARING UNIT VOLUME IN CUBIC METERS
	3	OPVelocity			Velocity in cm/sec (range 3.0 to 5.0 is recommended)
	11.5	UNITMETERS			REARING UNIT length in Meters
	'May2013	DATE			Date of Computer Run 'Month201996
	nursey 6ft tank	Project			hatchery name
	8	Sizeinches			Target Size in Inches
		Number			Target Number
	'RBT	Species			fish species use 3 letter code
	'coldwater	species			oxyreq 'coldwater,cool,warm,talapia
	7	ctemp_c			enter constant water temp deg. C
		tugr	0.006		from LOOKUP TABLE tugr in cm/tu
	1.3	conv			enter food conversion 1.5
	2.54	ilength			enter in centimeters starting length
		iweight	0.181		weight calculated
		k	0.011		from LOOKUP TABLE k metric condition factor
	1159	i#fish			enter initial # of fish starting # THIS VARIABLE IS VARIED TO MEET DENSITY & FLOW
L		#fish	1159		calculated mortality= 1/2%/day/month
	30	pdays			enter # days in period ex. 30
	660	elev			enter elevation in ftMSL
	0.95	oxy%			enter RAW WATER supply initial DO % sa
	6.4	availoxy			enter FIXED Available DO for Operating System 3, 4, 5, 6, etc.
	7	effluentDO			enter FIXED effluent DO for System 5, 6 or 7 suggested
	7.25	pH			enter pH
	0.417	%uninh3			enter %uninh3 from AMMONIA % IONIZATION TABLE
	0.0125	AUA			enter AUA allowable unionized ammonia (range .010 to 0.025) .025 suggested
	0	bgnh3			enter background Total TAN if any

BY-PRODUCT GENERATION in Kgs. MASS BALANCE FEED TO BY-PRODUCTS

		Month	feedkg	TSS	Total NH3	UNI NH3	co2kg	phoskg	NO3kg	BODkg
	Element	Period	Feedkg	TSSkg	TANkg	UNINH3kg	co2kg	phoskg	NO3kg	BODkg
	1.00	1.00	0.40	0.10	0.01	0.00	0.10	0.00	0.04	0.10
	2.00	2.00	0.90	0.30	0.03	0.00	0.30	0.01	0.08	0.30
	3.00	3.00	2.00	0.50	0.05	0.01	0.40	0.01	0.10	0.50
	4.00	4.00	2.00	0.70	0.07	0.01	0.70	0.01	0.20	0.80
	5.00	5.00	4.00	1.00	0.11	0.01	1.00	0.02	0.30	1.00
	6.00	6.00	5.00	1.00	0.14	0.02	1.00	0.02	0.40	2.00
	7.00	7.00	6.00	2.00	0.19	0.02	2.00	0.03	0.50	2.00
	8.00	8.00	8.00	2.00	0.24	0.03	2.00	0.04	0.70	3.00
	9.00	9.00	10.00	3.00	0.29	0.04	3.00	0.05	0.80	3.00
	10.00	10.00	12.00	3.00	0.35	0.04	3.00	0.06	1.00	4.00
	11.00	11.00	14.00	4.00	0.41	0.05	4.00	0.07	1.00	5.00
	12.00	12.00	16.00	5.00	0.48	0.06	4.00	0.08	1.00	5.00
	13.00	13.00	18.00	6.00	0.55	0.07	5.00	0.09	2.00	6.00
	14.00	14.00	21.00	6.00	0.63	0.08	6.00	0.11	2.00	7.00
	15.00	15.00	23.00	7.00	0.68	0.09	6.00	0.11	2.00	8.00
	16.00	16.00	26.00	8.00	0.77	0.10	7.00	0.13	2.00	9.00

CAP 7

Title: FRH 6ft Nursery Tank Capacity Density Set 3 lbs/cuft. D.O.= 90%, AO=3.0 Temp 50 deg F, Flow 20 gpm

Rearing Model

approx. end of Month	Elem	DAY	inches	cm	lbs@	grams@	# / LB.	#/Kg	cm/m	inches/m	# FISH	Tot.lbs.	Tot.Kgs	%bwfeed	feed lbs/day	feed Kg/day	AO mg/1	Req.Int. DO	%DOsat.	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
	1	1	1	2.6	0	0.195	2330.9	5138.7	1.8	0.709	444	0	0	9.00	0.02	0.0	3.0	9.9	90	1.1	0.13	0.20	1	1.07	0.0	0	2.92	48.00	3.0	0.0
	2	30	1.7	4.3	0.002	0.905	501.2	1104.9	1.8	0.709	442	1	0	5.39	0.05	0.0	3.0	9.9	90	1.83	0.22	0.50	2	1.07	0.0	0	1.75	48.00	3.0	0.0
	3	60	2.4	6.1	0.006	2.563	177	390.2	1.8	0.709	440	2	1	3.81	0.09	0.0	3.0	9.9	90	2.59	0.31	1.00	4	1.07	0.0	1	1.24	48.00	3.0	0.0
	4	90	3.1	7.9	0.012	5.542	81.8	180.4	1.8	0.709	437	5	2	2.95	0.16	0.1	3.0	9.9	90	3.35	0.4	2.00	6	1.07	0.1	2	0.96	48.00	3.0	0.0
	5	120	3.8	9.7	0.023	10.23	44.3	97.7	1.8	0.709	435	10	4	2.40	0.24	0.1	3.0	9.9	90	4.11	0.49	2	9	1.07	0.1	3	0.78	48.00	3.0	0.0
	6	150	4.5	11.5	0.038	17.02	26.7	58.8	1.8	0.709	433	16	7	2.03	0.33	0.2	3.0	9.9	90	4.86	0.58	3	13	1.07	0.2	5	0.66	48.00	3.0	0.1
	7	180	5.3	13.3	0.058	26.28	17.3	38	1.8	0.709	431	25	11	1.75	0.44	0.2	3.0	9.9	90	5.62	0.67	4	17	1.07	0.2	8	0.57	48.00	3.0	0.1
	8	210	6	15.1	0.085	38.42	11.8	26	1.8	0.709	429	36	16	1.55	0.56	0.3	3.0	9.9	90	6.38	0.76	6	22	1.07	0.3	12	0.50	48.00	3.0	0.1
	9	240	6.7	16.9	0.119	53.82	8.4	18.6	1.8	0.709	426	50	23	1.38	0.70	0.3	3.0	9.9	90	7.14	0.85	7	27	1.07	0.5	17	0.45	48.00	3.0	0.2
	10	270	7.4	18.7	0.161	72.87	6.2	13.7	1.8	0.709	424	68	31	1.25	0.85	0.4	3.0	9.9	90	7.9	0.95	9	33	1.07	0.6	23	0.41	48.00	3.0	0.3
	11	300	8.1	20.5	0.212	95.95	4.7	10.4	1.8	0.709	422	89	40	1.14	1.00	0.5	3.0	9.9	90	8.66	1.04	10	39	1.07	0.8	30	0.37	48.00	3.0	0.4
	12	330	8.8	22.3	0.272	123.4	3.7	8.1	1.8	0.709	420	114	52	1.05	1.20	0.5	3.0	9.9	90	9.42	1.13	12	46	1.07	1.1	38	0.34	48.00	3.0	0.5
	13	360	9.5	24.1	0.343	155.8	2.9	6.4	1.8	0.709	417	143	65	0.97	1.40	0.6	3.0	9.9	90	10.18	1.22	14	53	1.07	1.4	48	0.32	48.00	3.0	0.6
	14	390	10.2	25.9	0.426	193.3	2.3	5.2	1.8	0.709	415	177	80	0.90	1.60	0.7	3.0	9.9	90	10.94	1.31	16	61	1.07	1.7	59	0.29	48.00	3.0	0.7
	15	410	10.7	27.1	0.488	221.3	2	4.5	1.8	0.709	414	201	92	0.86	1.70	0.8	3.0	9.9	90	11.44	1.37	18	67	1.07	1.9	67	0.28	48.00	3.0	0.8
	16	440	11.4	28.9	0.592	268.4	1.7	3.7	1.8	0.709	412	243	110	0.81	2.00	0.9	3.0	9.9	90	12.2	1.46	20	76	1.07	2.3	81	0.26	48.00	3.0	1.0

MODEL INPUTS

Stat	Input	Name	Output	Unit	Com
					REARING UNIT TYPE: 6ft Nursery Tank
					RV REARING VOLUME: 2.3CM or 80CF
					AVAILABLE OXYGEN = set by USER 6.0 mg/l
					D.O. IN EFFLUENT IS set by USER 7.0 is recommnded level
	48	MAXkgm3			MAXIMUM DENISTY IN KG / CUBIC METER 32, 48, 65, 80,
	2.3	UNITVOLm3			REARING UNIT VOLUME IN CUBIC METERS
	3	OPVelocity			Velocity in cm/sec (range 3.0 to 5.0 is recommended)
	11.5	UNITMETERS			REARING UNIT length in Meters
	'May2013	DATE			Date of Computer Run 'Month201996
	nursery 6ft tank	Project			hatchery name
	8	Sizeinches			Target Size in Inches
		Number			Target Number
	'RBT	Species			fish species use 3 letter code
	'coldwater	species			oxyreq 'coldwater,cool,warm,talapia
	10	ctemp_c			enter constant water temp deg. C
		tugr	0.006		from LOOKUP TABLE tugr in cm/tu
	1.3	conv			enter food conversion 1.5
	2.54	ilength			enter in centimeters starting length
		iweight	0.181		weight calculated
		k	0.011		from LOOKUP TABLE k metric condition factor
	444	i#fish			enter initial # of fish starting # THIS VARIABLE IS VARIED TO MEET DENSITY & FLOW
L		#fish	443.9		calculated mortality= 1/2%/day/month
	30	pdays			enter # days in period ex. 30
	660	elev			enter elevation in ftMSL
	1	oxy%			enter RAW WATER supply initial DO % sa
	2.95	availoxy			enter FIXED Available DO for Operating System 3, 4, 5, 6, etc.
	7	effluentDO			enter FIXED effluent DO for System 5, 6 or 7 suggested
	7.25	pH			enter pH
	0.417	%uninh3			enter %uninh3 from AMMONIA % IONIZATION TABLE
	0.0125	AUA			enter AUA allowable unionized ammonia (range .010 to 0.025) .025 suggested
	0	bgnh3			enter background Total TAN if any

BY-PRODUCT GENERATION in Kgs. MASS BALANCE FEED TO BY-PRODUCTS

		Month	feedkg	TSS	Total NH3	UNI NH3	co2kg	phoskg	NO3kg	BODkg
	Element	Period	Feedkg	TSSkg	TANkg	UNINH3kg	co2kg	phoskg	NO3kg	BODkg
	1.00	1.00	0.20	0.07	0.01	0.00	0.07	0.00	0.02	0.08
	2.00	2.00	0.60	0.20	0.02	0.00	0.20	0.00	0.06	0.20
	3.00	3.00	1.00	0.40	0.04	0.01	0.40	0.01	0.10	0.40
	4.00	4.00	2.00	0.60	0.06	0.01	0.60	0.01	0.20	0.70
	5.00	5.00	3.00	1.00	0.10	0.01	0.90	0.02	0.30	1.00
	6.00	6.00	4.00	1.00	0.13	0.02	1.00	0.02	0.40	2.00
	7.00	7.00	6.00	2.00	0.18	0.02	2.00	0.03	0.50	2.00
	8.00	8.00	8.00	2.00	0.23	0.03	2.00	0.04	0.70	3.00
	9.00	9.00	9.00	3.00	0.29	0.04	3.00	0.05	0.80	3.00
	10.00	10.00	12.00	3.00	0.35	0.04	3.00	0.06	1.00	4.00
	11.00	11.00	14.00	4.00	0.41	0.05	4.00	0.07	1.00	5.00
	12.00	12.00	16.00	5.00	0.49	0.06	5.00	0.08	1.00	5.00
	13.00	13.00	19.00	6.00	0.56	0.07	5.00	0.09	2.00	6.00
	14.00	14.00	22.00	6.00	0.65	0.08	6.00	0.11	2.00	7.00
	15.00	15.00	23.00	7.00	0.70	0.09	7.00	0.12	2.00	8.00
	16.00	16.00	27.00	8.00	0.80	0.10	7.00	0.13	2.00	9.00

CAP 8

Title: FRH 6ft Nursery Tank Capacity Density Set 3 lbs/cuft. D.O.= 90%, AO=4.1 Temp 50 deg F, Flow 20 gpm

Rearing Model

approx. end of Month	Elen	DAY	inches	cm	lbs@	grams@	# / LB.	#/Kg	cm/m	inches/m	# FISH	Tot.lbs.	Tot.Kgs	%bwfeed	feed lbs/day
	1	1	1	2.6	0	0.195	2330.9	5138.7	1.8	0.709	444	0	0	9.00	0.02
	2	30	1.7	4.3	0.002	0.905	501.2	1104.9	1.8	0.709	442	1	0	5.39	0.05
	3	60	2.4	6.1	0.006	2.563	177	390.2	1.8	0.709	440	2	1	3.81	0.09
	4	90	3.1	7.9	0.012	5.542	81.8	180.4	1.8	0.709	437	5	2	2.95	0.16
	5	120	3.8	9.7	0.023	10.23	44.3	97.7	1.8	0.709	435	10	4	2.40	0.24
	6	150	4.5	11.5	0.038	17.02	26.7	58.8	1.8	0.709	433	16	7	2.03	0.33
	7	180	5.3	13.3	0.058	26.28	17.3	38	1.8	0.709	431	25	11	1.75	0.44
	8	210	6	15.1	0.085	38.42	11.8	26	1.8	0.709	429	36	16	1.55	0.56
	9	240	6.7	16.9	0.119	53.82	8.4	18.6	1.8	0.709	426	50	23	1.38	0.70
	10	270	7.4	18.7	0.161	72.87	6.2	13.7	1.8	0.709	424	68	31	1.25	0.85
	11	300	8.1	20.5	0.212	95.95	4.7	10.4	1.8	0.709	422	89	40	1.14	1.00
	12	330	8.8	22.3	0.272	123.4	3.7	8.1	1.8	0.709	420	114	52	1.05	1.20
	13	360	9.5	24.1	0.343	155.8	2.9	6.4	1.8	0.709	417	143	65	0.97	1.40
	14	390	10.2	25.9	0.426	193.3	2.3	5.2	1.8	0.709	415	177	80	0.90	1.60
	15	410	10.7	27.1	0.488	221.3	2	4.5	1.8	0.709	414	201	92	0.86	1.70
	16	440	11.4	28.9	0.592	268.4	1.7	3.7	1.8	0.709	412	243	110	0.81	2.00

Elen	feed Kg/day	AO mg/1	Req.Int. DO	%DOsat.	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
1	0.0	4.1	11.1	100	1.52	0.18	0.10	1	1.49	0.0	0	2.92	48.00	3.0	0.0
2	0.0	4.1	11.1	100	2.54	0.3	0.30	1	1.49	0.0	0	1.75	48.00	3.0	0.0
3	0.0	4.1	11.1	100	3.6	0.43	0.70	3	1.49	0.0	1	1.24	48.00	3.0	0.0
4	0.1	4.1	11.1	100	4.65	0.56	1.00	4	1.49	0.1	2	0.96	48.00	3.0	0.0
5	0.1	4.1	11.1	100	5.71	0.68	2	7	1.49	0.1	3	0.78	48.00	3.0	0.0
6	0.2	4.1	11.1	100	6.76	0.81	2	9	1.49	0.2	5	0.66	48.00	3.0	0.1
7	0.2	4.1	11.1	100	7.82	0.93	3	12	1.49	0.2	8	0.57	48.00	3.0	0.1
8	0.3	4.1	11.1	100	8.87	1.06	4	16	1.49	0.3	12	0.50	48.00	3.0	0.1
9	0.3	4.1	11.1	100	9.93	1.19	5	19	1.49	0.5	17	0.45	48.00	3.0	0.2
10	0.4	4.1	11.1	100	10.98	1.31	6	24	1.49	0.6	23	0.41	48.00	3.0	0.3
11	0.5	4.1	11.1	100	12.03	1.44	7	28	1.49	0.8	30	0.37	48.00	3.0	0.4
12	0.5	4.1	11.1	100	13.09	1.57	9	33	1.49	1.1	38	0.34	48.00	3.0	0.5
13	0.6	4.1	11.1	100	14.14	1.69	10	38	1.49	1.4	48	0.32	48.00	3.0	0.6
14	0.7	4.1	11.1	100	15.2	1.82	12	44	1.49	1.7	59	0.29	48.00	3.0	0.7
15	0.8	4.1	11.1	100	15.9	1.9	13	48	1.49	1.9	67	0.28	48.00	3.0	0.8
16	0.9	4.1	11.1	100	16.96	2.03	14	54	1.49	2.3	81	0.26	48.00	3.0	1.0

MODEL INPUTS

Stat	Input	Name	Outpu	Unit	Com
					PROJECT: French River MNDNR
					REARING UNIT TYPE: 6ft Nursery Tank
					RV REARING VOLUME: 2.3CM or 80CF
					AVAILABLE OXYGEN = set by USER 6.0 mg/l
					D.O. IN EFFLUENT IS set by USER 7.0 is recommnded level
	48	MAXkgm3			MAXIMUM DENISTY IN KG / CUBIC METER 32, 48, 65, 80,
	2.3	UNITVOLm3			REARING UNIT VOLUME IN CUBIC METERS
	3	OPVelocity			Velocity in cm/sec (range 3.0 to 5.0 is recommended)
	11.5	UNITMETERS			REARING UNIT length in Meters
	'May2013	DATE			Date of Computer Run 'Month201996
	nursey 6ft tank	Project			hatchery name
	8	Sizeinches			Target Size in Inches
		Number			Target Number
	'RBT	Species			fish species use 3 letter code
	'coldwater	species			oxyreq 'coldwater,cool,warm,talapia
	10	ctemp_c			enter constant water temp deg. C
		tugr	0.006		from LOOKUP TABLE tugr in cm/tu
	1.3	conv			enter food conversion 1.5
	2.54	ilength			enter in centimeters starting length
		iweight	0.181		weight calculated
		k	0.011		from LOOKUP TABLE k metric condition factor
	444	i#fish			enter initial # of fish starting # THIS VARIABLE IS VARIED TO MEET DENSITY & FLOW
L		#fish	443.9		calculated mortality= 1/2%/day/month
	30	pdays			enter # days in period ex. 30
	660	elev			enter elevation in ftMSL
	1	oxy%			enter RAW WATER supply initial DO % sa
	4.1	availoxy			enter FIXED Available DO for Operating System 3, 4, 5, 6, etc.
	7	effluentDO			enter FIXED effluent DO for System 5, 6 or 7 suggested
	7.25	pH			enter pH
	0.417	%uninh3			enter %uninh3 from AMMONIA % IONIZATION TABLE
	0.0125	AUA			enter AUA allowable unionized ammonia (range .010 to 0.025) .025 suggested
	0	bgnh3			enter background Total TAN if any
	60	pumphorsepower			enter pump horsepower if pumped water system or 0 zero gravity flow
	0.01	%makeup			enter % makeup water for reuse as DECIMAL percent 0.10 = 10% makeup by flow rate recirc syste
	0.01	reusehorsepower			enter estimate of reuse system running horsepower 0 zero if none
	0	deltatemp			enter the Heat EXCHANGER DELTA deg F for recovery heating 2 deg F is suggested

BY-PRODUCT GENERATION in Kgs. MASS BALANCE FEED TO BY-PRODUCTS

		Month	feedkg	TSS	Total NH3	UNI NH3	co2kg	phoskg	NO3kg	BODkg
	Element	Period	Feedkg	TSSkg	TANkg	UNINH3kg	co2kg	phoskg	NO3kg	BODkg
	1.00	1.00	0.20	0.07	0.01	0.00	0.07	0.00	0.02	0.08
	2.00	2.00	0.60	0.20	0.02	0.00	0.20	0.00	0.06	0.20
	3.00	3.00	1.00	0.40	0.04	0.01	0.40	0.01	0.10	0.40
	4.00	4.00	2.00	0.60	0.06	0.01	0.60	0.01	0.20	0.70
	5.00	5.00	3.00	1.00	0.10	0.01	0.90	0.02	0.30	1.00
	6.00	6.00	4.00	1.00	0.13	0.02	1.00	0.02	0.40	2.00
	7.00	7.00	6.00	2.00	0.18	0.02	2.00	0.03	0.50	2.00
	8.00	8.00	8.00	2.00	0.23	0.03	2.00	0.04	0.70	3.00
	9.00	9.00	9.00	3.00	0.29	0.04	3.00	0.05	0.80	3.00
	10.00	10.00	12.00	3.00	0.35	0.04	3.00	0.06	1.00	4.00
	11.00	11.00	14.00	4.00	0.41	0.05	4.00	0.07	1.00	5.00
	12.00	12.00	16.00	5.00	0.49	0.06	5.00	0.08	1.00	5.00
	13.00	13.00	19.00	6.00	0.56	0.07	5.00	0.09	2.00	6.00
	14.00	14.00	22.00	6.00	0.65	0.08	6.00	0.11	2.00	7.00
	15.00	15.00	23.00	7.00	0.70	0.09	7.00	0.12	2.00	8.00
	16.00	16.00	27.00	8.00	0.80	0.10	7.00	0.13	2.00	9.00

CAP 9

Title: FRH 6ft Nursery Tank Capacity Density Set 3 lbs/cuft. D.O.= 110%, AO=5.2 Temp 50 deg F, Flow 11 gpm

Rearing Model

approx. end of Month	Elem	DAY	inches	cm	lbs@	grams@	# / LB.	#/Kg	cm/m	inches/m	# FISH	Tot.lbs.	Tot.Kgs	%bwfeed
Month	Elem	DAY	inches	cm	lbs@	grams@	# / LB.	#/Kg	cm/m	inches/m	# FISH	Tot.lbs.	Tot.Kgs	%bwfeed
	1	1	1	2.6	0	0.195	2330.9	5138.7	1.8	0.709	444	0	0	9.00
	2	30	1.7	4.3	0.002	0.905	501.2	1104.9	1.8	0.709	442	1	0	5.39
	3	60	2.4	6.1	0.006	2.563	177	390.2	1.8	0.709	440	2	1	3.81
	4	90	3.1	7.9	0.012	5.542	81.8	180.4	1.8	0.709	437	5	2	2.95
	5	120	3.8	9.7	0.023	10.23	44.3	97.7	1.8	0.709	435	10	4	2.40
	6	150	4.5	11.5	0.038	17.02	26.7	58.8	1.8	0.709	433	16	7	2.03
	7	180	5.3	13.3	0.058	26.28	17.3	38	1.8	0.709	431	25	11	1.75
	8	210	6	15.1	0.085	38.42	11.8	26	1.8	0.709	429	36	16	1.55
	9	240	6.7	16.9	0.119	53.82	8.4	18.6	1.8	0.709	426	50	23	1.38
	10	270	7.4	18.7	0.161	72.87	6.2	13.7	1.8	0.709	424	68	31	1.25
	11	300	8.1	20.5	0.212	95.95	4.7	10.4	1.8	0.709	422	89	40	1.14
	12	330	8.8	22.3	0.272	123.4	3.7	8.1	1.8	0.709	420	114	52	1.05
	13	360	9.5	24.1	0.343	155.8	2.9	6.4	1.8	0.709	417	143	65	0.97
	14	390	10.2	25.9	0.426	193.3	2.3	5.2	1.8	0.709	415	177	80	0.90
	15	410	10.7	27.1	0.488	221.3	2	4.5	1.8	0.709	414	201	92	0.86
	16	440	11.4	28.9	0.592	268.4	1.7	3.7	1.8	0.709	412	243	110	0.81

Elem	feed lbs/day	feed Kg/day	AO mg/1	Req.Int. DO	%DOsat.	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
Elem	feed lbs/day	feed Kg/day	AO mg/1	Req.Int. DO	%DOsaturatic	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
1	0.02	0.0	5.2	12.2	110	1.92	0.23	0.10	0	1.88	0.0	0	2.92	48.00	3.0	0.0
2	0.05	0.0	5.2	12.2	110	3.21	0.38	0.30	1	1.88	0.0	0	1.75	48.00	3.0	0.0
3	0.09	0.0	5.2	12.2	110	4.54	0.54	0.50	2	1.88	0.0	1	1.24	48.00	3.0	0.0
4	0.16	0.1	5.2	12.2	110	5.87	0.7	0.90	3	1.88	0.1	2	0.96	48.00	3.0	0.0
5	0.24	0.1	5.2	12.2	110	7.2	0.86	1	5	1.88	0.1	3	0.78	48.00	3.0	0.0
6	0.33	0.2	5.2	12.2	110	8.53	1.02	2	7	1.88	0.2	5	0.66	48.00	3.0	0.1
7	0.44	0.2	5.2	12.2	110	9.86	1.18	3	10	1.88	0.2	8	0.57	48.00	3.0	0.1
8	0.56	0.3	5.2	12.2	110	11.19	1.34	3	12	1.88	0.3	12	0.50	48.00	3.0	0.1
9	0.70	0.3	5.2	12.2	110	12.52	1.5	4	15	1.88	0.5	17	0.45	48.00	3.0	0.2
10	0.85	0.4	5.2	12.2	110	13.85	1.66	5	19	1.88	0.6	23	0.41	48.00	3.0	0.3
11	1.00	0.5	5.2	12.2	110	15.18	1.82	6	22	1.88	0.8	30	0.37	48.00	3.0	0.4
12	1.20	0.5	5.2	12.2	110	16.51	1.97	7	26	1.88	1.1	38	0.34	48.00	3.0	0.5
13	1.40	0.6	5.2	12.2	110	17.84	2.13	8	30	1.88	1.4	48	0.32	48.00	3.0	0.6
14	1.60	0.7	5.2	12.2	110	19.17	2.29	9	35	1.88	1.7	59	0.29	48.00	3.0	0.7
15	1.70	0.8	5.2	12.2	110	20.05	2.4	10	38	1.88	1.9	67	0.28	48.00	3.0	0.8
16	2.00	0.9	5.2	12.2	110	21.38	2.56	11	43	1.88	2.3	81	0.26	48.00	3.0	1.0

MODEL INPUTS

Stat	Input	Name	Outpu	Unit	Com
					REARING UNIT TYPE: 6ft Nursery Tank
					RV REARING VOLUME: 2.3CM or 80CF
					AVAILABLE OXYGEN = set by USER 6.0 mg/l
					D.O. IN EFFLUENT IS set by USER 7.0 is recommnded level
	48	MAXkgm3			MAXIMUM DENISTY IN KG / CUBIC METER 32, 48, 65, 80,
	2.3	UNITVOLm3			REARING UNIT VOLUME IN CUBIC METERS
	3	OPVelocity			Velocity in cm/sec (range 3.0 to 5.0 is recommended)
	11.5	UNITMETERS			REARING UNIT length in Meters
	'May2013	DATE			Date of Computer Run 'Month201996
	nursery 6ft tank	Project			hatchery name
	8	Sizeinches			Target Size in Inches
		Number			Target Number
	'RBT	Species			fish species use 3 letter code
	'coldwater	species			oxyreq 'coldwater,cool,warm,talapia
	10	ctemp_c			enter constant water temp deg. C
		tugr	0.006		from LOOKUP TABLE tugr in cm/tu
	1.3	conv			enter food conversion 1.5
	2.54	ilength			enter in centimeters starting length
		iweight	0.181		weight calculated
		k	0.011		from LOOKUP TABLE k metric condition factor
	444	i#fish			enter initial # of fish starting # THIS VARIABLE IS VARIED TO MEET DENSITY & FLOW
L		#fish	443.9		calculated mortality= 1/2%/day/month
	30	pdays			enter # days in period ex. 30
	660	elev			enter elevation in ftMSL
	1	oxy%			enter RAW WATER supply initial DO % sa
	5.17	availoxy			enter FIXED Available DO for Operating System 3, 4, 5, 6, etc.
	7	effluentDO			enter FIXED effluent DO for System 5, 6 or 7 suggested
	7.25	pH			enter pH
	0.417	%uninh3			enter %uninh3 from AMMONIA % IONIZATION TABLE
	0.0125	AUA			enter AUA allowable unionized ammonia (range .010 to 0.025) .025 suggested
	0	bgnh3			enter background Total TAN if any
	0	bgnh3			enter background Total TAN if any
	60	pumphorsepower			enter pump horsepower if pumped water system or 0 zero gravity flow
	0.01	%makeup			enter % makeup water for reuse as DECIMAL percent 0.10 = 10% makeup by flow rate recirc syste
	0.01	reusehorsepower			enter estimate of reuse system running horsepower 0 zero if none
	0	deltatemp			enter the Heat EXCHANGER DELTA deg F for recovery heating 2 deg F is suggested

BY-PRODUCT GENERATION in Kgs. MASS BALANCE FEED TO BY-PRODUCTS

		Month	feedkg	TSS	Total NH3	UNI NH3	co2kg	phoskg	NO3kg	BODkg
	Element	Period	Feedkg	TSSkg	TANkg	UNINH3kg	co2kg	phoskg	NO3kg	BODkg
	1.00	1.00	0.20	0.07	0.01	0.00	0.07	0.00	0.02	0.08
	2.00	2.00	0.60	0.20	0.02	0.00	0.20	0.00	0.06	0.20
	3.00	3.00	1.00	0.40	0.04	0.01	0.40	0.01	0.10	0.40
	4.00	4.00	2.00	0.60	0.06	0.01	0.60	0.01	0.20	0.70
	5.00	5.00	3.00	1.00	0.10	0.01	0.90	0.02	0.30	1.00
	6.00	6.00	4.00	1.00	0.13	0.02	1.00	0.02	0.40	2.00
	7.00	7.00	6.00	2.00	0.18	0.02	2.00	0.03	0.50	2.00
	8.00	8.00	8.00	2.00	0.23	0.03	2.00	0.04	0.70	3.00
	9.00	9.00	9.00	3.00	0.29	0.04	3.00	0.05	0.80	3.00
	10.00	10.00	12.00	3.00	0.35	0.04	3.00	0.06	1.00	4.00
	11.00	11.00	14.00	4.00	0.41	0.05	4.00	0.07	1.00	5.00
	12.00	12.00	16.00	5.00	0.49	0.06	5.00	0.08	1.00	5.00
	13.00	13.00	19.00	6.00	0.56	0.07	5.00	0.09	2.00	6.00
	14.00	14.00	22.00	6.00	0.65	0.08	6.00	0.11	2.00	7.00
	15.00	15.00	23.00	7.00	0.70	0.09	7.00	0.12	2.00	8.00
	16.00	16.00	27.00	8.00	0.80	0.10	7.00	0.13	2.00	9.00

CAP 10

Title: FRH 6ft Nursery Tank Capacity Density Set 3 lbs/cuft. AO=4.0 BLUE TANKS Temp VARIABLE TEMP deg F, Flow 15 gpm

approx. end of Month	Eleme	DAY	vtemp_	inches	cm	Rearing Model lbs@	grams@	# / LB.	#/Kg	wt /1000	cm/m	inches/m	# FISH	Tot.lbs.	Tot.Kgs	%bwfeed	feed lbs/d
	Eleme	DAY															
	1	1	6	1.0	2.5	0.00	0.181	2500	5512	0.4	1	0.39	1,619	0.60	0.30	5.1	0.0
	2	30	7	1.4	3.5	0.00	0.487	931.4	2053	1.1	1	0.46	1,611	2.00	0.80	4.3	0.1
	3	60	10	1.8	4.7	0.00	1.139	398.4	878.3	2.5	2	0.65	1,603	4.00	2.00	4.6	0.2
	4	90	14	2.5	6.3	0.01	2.815	161.1	355.3	6.2	2	0.91	1,595	10.00	4.00	4.7	0.5
	5	120	14	3.4	8.6	0.02	7.154	63.4	139.8	15.8	2	0.91	1,587	25.00	11.00	3.5	0.9
	6	150	10	4.3	11	0.03	14.557	31.2	68.7	32.1	2	0.65	1,579	51.00	23.00	2.0	1.0
	7	180	7	5.0	12.6	0.05	22.174	20.5	45.1	48.9	1	0.46	1,571	77.00	35.00	1.2	0.9
	8	210	6	5.4	13.8	0.06	28.846	15.7	34.7	63.6	1	0.39	1,563	99.00	45.00	0.9	0.9
	9	240	6	5.8	14.8	0.08	35.53	12.8	28.1	78.3	1	0.39	1,554	122.00	55.00	0.9	1.1
	10	260	2	6.2	15.7	0.10	43.176	10.5	23.2	95.2	0	0.13	1,549	147.00	67.00	0.3	0.4
	11	270	4	6.3	16.1	0.10	45.949	9.9	21.8	101.3	1	0.26	1,546	156.00	71.00	0.5	0.8
	12	300	6	6.6	16.7	0.11	51.846	8.7	19.3	114.3	1	0.39	1,538	175.00	80.00	0.8	1.3
	13	330	6	7.0	17.7	0.14	61.605	7.4	16.2	135.8	1	0.39	1,530	207.00	94.00	0.7	1.5
	14	360	7	7.4	18.7	0.16	72.518	6.3	13.8	159.9	1	0.46	1,522	243.00	110.00	0.8	1.9

Eleme	feed Kg/day	AO mg/1	Req.Int. DO	%DOsaturation	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
1	0.02	4	11	88	2.64	0.32	0.20	0.9	2.64	0.01	0.20	3.0	48.0	3.0	0.003
2	0.03	4	11	90	3.14	0.38	0.50	2.0	2.26	0.02	0.60	2.2	48.0	3.0	0.007
3	0.08	4	11	99	2.92	0.35	1.00	5.0	1.58	0.04	1.00	1.6	48.0	3.0	0.017
4	0.21	4	11	109	2.82	0.34	4.00	13.0	1.13	0.09	3.00	1.2	48.0	3.0	0.041
5	0.39	4	11	109	4	0.46	6.00	25.0	1.13	0.24	8.00	0.9	48.0	3.0	0.103
6	0.45	4	11	99	6.83	0.82	7.00	28.0	1.58	0.48	17.00	0.7	48.0	3.0	0.208
7	0.41	4	11	90	11.23	1.34	7.00	26.0	2.26	0.73	26.00	0.6	48.0	3.0	0.315
8	0.42	4	11	88	14.3	1.71	7.00	26.0	2.64	0.94	33.00	0.6	48.0	3.0	0.408
9	0.48	4	11	88	15.33	1.83	8.00	30.0	2.64	1.20	41.00	0.5	48.0	3.0	0.5
10	0.18	4	11	81	49.08	5.87	3.00	11.0	7.92	1.40	49.00	0.5	48.0	3.0	0.606
11	0.38	4	11	83	25.05	3.00	6.00	24.0	3.96	1.50	52.00	0.5	48.0	3.0	0.644
12	0.61	4	11	88	17.39	2.08	10.00	38.0	2.64	1.70	59.00	0.5	48.0	3.0	0.722
13	0.68	4	11	88	18.42	2.20	11.00	43.0	2.64	2.00	69.00	0.4	48.0	3.0	0.854
14	0.89	4	11	90	16.67	1.99	15.00	55.0	2.26	2.30	81.00	0.4	48.0	3.0	1

MODEL INPUTS

Statu	Input	Name	Outp	Unit	Com
					PROJECT: FRCWH
					REARING UNIT TYPE: Nursery Tanks BLUE VTEMP
					RV REARING VOLUME: 2.3m3 80 CF
					AVAILABLE OXYGEN = set by USER 7.0 mg/l
					D.O. IN EFFLUENT IS set by USER 7.0 is recommnded level
	48	MAXkgm3			MAXIMUM DENISTY IN KG / CUBIC METER 32, 48, 65, 80,
	2.3	UNITVOLm3			REARING UNIT VOLUME IN CUBIC METERS
	3	OPVelocity			Velocity in cm/sec (range 3.0 to 5.0 is recommended)
		UNITMETERS			REARING UNIT length in Meters
	'May2013003	DATE			Date of Computer Run 'Month201996
	6ft Nursery	Project			hatchery name
	8	Sizeinches			Target Size in Inches
		Number			Target Number
	'RBT	Species			fish species use 3 letter code
	'coldwater	species			oxyreq 'coldwater,cool,warm,talapia
L	1	vtemp_c			enter Variable water temp deg. C in LIST vtemp_c
		tugr	0.006		from LOOKUP TABLE tugr in cm/tu
	1.3	conv			enter food conversion 1.5
	2.54	ilength			enter in centimeters starting length
		iweight	0.181		weight calculated
		k	0.011		from LOOKUP TABLE k metric condition factor
	1619	i#fish			enter initial # of fish starting # THIS VARIABLE IS VARIE
L		#fish	1619		calculated mortality= 1/2%/day/month
	30	pdays			enter # days in period ex. 30
	660	elev			enter elevation in ftMSL
	0.9	oxy%			enter RAW WATER supply initial DO % sa
	4	availoxy			enter FIXED Available DO for Operating System 3, 4, 5, 6, et
	7	effluentDO			enter FIXED effluent DO for System 5, 6 or 7 suggested
	7.25	pH			enter pH
	0.417	%uninh3			enter %uninh3 from AMMONIA % IONIZATION TABLE
	0.0125	AUA			enter AUA allowable unionized ammonia (range .010 to 0.025)
	0	bgnh3			enter background Total TAN if any

BY-PRODUCT GENERATION in Kgs. MASS BALANCE FEED TO BY-PRODUCTS

		Month	feedkg	TSS	Total NH3	UNI NH3	co2kg	phoskg	NO3kg	BODkg
	Element	Period	Feedkg	TSSkg	TANkg	UNINH3kg	co2kg	phoskg	NO3kg	BODkg
	1.00	1.00	0.40	0.10	0.01	0.00	0.10	0.00	0.04	0.20
	2.00	2.00	1.00	0.30	0.03	0.00	0.30	0.01	0.09	0.30
	3.00	3.00	3.00	0.80	0.08	0.01	0.70	0.01	0.20	0.90
	4.00	4.00	6.00	2.00	0.19	0.02	2.00	0.03	0.60	2.00
	5.00	5.00	12.00	4.00	0.36	0.04	3.00	0.06	1.00	4.00
	6.00	6.00	13.00	4.00	0.41	0.05	4.00	0.07	1.00	5.00
	7.00	7.00	12.00	4.00	0.37	0.05	3.00	0.06	1.00	4.00
	8.00	8.00	13.00	4.00	0.38	0.05	4.00	0.06	1.00	4.00
	9.00	9.00	14.00	4.00	0.43	0.05	4.00	0.07	1.00	5.00
	10.00	10.00	5.00	2.00	0.16	0.02	2.00	0.03	0.50	2.00
	11.00	11.00	11.00	3.00	0.34	0.04	3.00	0.06	1.00	4.00
	12.00	12.00	18.00	6.00	0.55	0.07	5.00	0.09	2.00	6.00
	13.00	13.00	21.00	6.00	0.62	0.08	6.00	0.10	2.00	7.00
	14.00	14.00	27.00	8.00	0.80	0.10	7.00	0.13	2.00	9.00

CAP 11

Title: FRH 6ft Nursery Tank Capacity Density Set 3 lbs/cuft. AO=4.0 YELLOW TANKS Temp VARIABLE TEMP deg F, Flow 15 gpm

Rearing Model

approx. end of Month	Eleme Element	DAY	vtemp_	inches	cm	lbs@	grams@	# / LB.	#/Kg	wt /1000	cm/m	inches/m	# FISH	Tot.lbs.	Tot.Kgs
	1	1	7	1.0	2.5	0	0.181	2500	5512	0.4	1	0.46	1,142	0.50	0.20
	2	30	8	1.5	3.7	0.001	0.559	812.1	1790	1.2	1	0.52	1,136	1.00	0.60
	3	60	10	2.0	5	0.003	1.396	324.8	716.1	3.1	2	0.65	1,131	3.00	2.00
	4	90	14	2.6	6.7	0.007	3.278	138.4	305.1	7.2	2	0.91	1,125	8.00	4.00
	5	120	14	3.5	9	0.018	8.004	56.7	124.9	17.6	2	0.91	1,119	20.00	9.00
	6	150	11	4.4	11.3	0.035	15.912	28.5	62.8	35.1	2	0.72	1,114	39.00	18.00
	7	180	8	5.2	13.1	0.055	24.891	18.2	40.2	54.9	1	0.52	1,108	61.00	28.00
	8	210	8	5.7	14.4	0.073	33.199	13.7	30.1	73.2	1	0.52	1,102	81.00	37.00
	9	240	6	6.2	15.7	0.095	43.176	10.5	23.2	95.2	1	0.39	1,097	104.00	47.00
	10	260	6	6.6	16.7	0.114	51.846	8.7	19.3	114.3	1	0.39	1,093	125.00	57.00
	11	270	7	7.0	17.7	0.136	61.605	7.4	16.2	135.8	1	0.46	1,091	148.00	67.00
	12	300	6	7.4	18.9	0.164	74.454	6.1	13.4	164.1	1	0.39	1,085	178.00	81.00
	13	330	7	7.8	19.9	0.191	86.794	5.2	11.5	191.3	1	0.46	1,079	206.00	94.00
	14	360	8	8.3	21	0.227	102.831	4.4	9.7	226.7	1	0.52	1,074	243.00	110.00

Element	%bwfeed	feed lbs/da	feed Kg/day	AO mg/1	Req.Int. DO	%DOsaturation	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
1	5.9	0.0	0.01	4	11	90	2.26	0.27	0.20	0.8	2.26	0.00	0.20	3.0	48.0	3.0	0.002
2	4.6	0.1	0.03	4	11	95	2.88	0.34	0.50	2.0	1.98	0.01	0.50	2.1	48.0	3.0	0.006
3	4.3	0.2	0.07	4	11	99	3.13	0.37	1.00	4.0	1.58	0.03	1.00	1.5	48.0	3.0	0.014
4	4.5	0.4	0.17	4	11	109	2.97	0.36	3.00	10.0	1.13	0.08	3.00	1.1	48.0	3.0	0.033
5	3.3	0.7	0.30	4	11	109	4	0.48	5.00	19.0	1.13	0.19	7.00	0.8	48.0	3.0	0.081
6	2.1	0.8	0.37	4	11	102	6.4	0.77	6.00	23.0	1.44	0.37	13.00	0.7	48.0	3.0	0.161
7	1.3	0.8	0.36	4	11	95	10.21	1.22	6.00	23.0	1.98	0.57	20.00	0.6	48.0	3.0	0.25
8	1.2	1.0	0.44	4	11	95	11.24	1.34	7.00	27.0	1.98	0.76	27.00	0.5	48.0	3.0	0.331
9	0.8	0.9	0.39	4	11	88	16.36	1.96	6.00	24.0	2.64	0.99	35.00	0.5	48.0	3.0	0.429
10	0.8	1.0	0.44	4	11	88	17.39	2.08	7.00	27.0	2.64	1.20	42.00	0.5	48.0	3.0	0.513
11	0.8	1.3	0.57	4	11	90	15.79	1.89	9.00	36.0	2.26	1.40	49.00	0.4	48.0	3.0	0.609
12	0.7	1.2	0.55	4	11	88	19.62	2.35	9.00	34.0	2.64	1.70	59.00	0.4	48.0	3.0	0.732
13	0.8	1.6	0.71	4	11	90	17.7	2.12	12.00	44.0	2.26	2.00	69.00	0.4	48.0	3.0	0.849
14	0.8	2.0	0.90	4	11	95	16.38	1.96	15.00	56.0	1.98	2.30	81.00	0.4	48.0	3.0	1

MODEL INPUTS

Statu	Input	Name	Outp	Unit	Com
					PROJECT: FRCWH
					REARING UNIT TYPE: Nursery Tanks VTEMP YELLOW
					RV REARING VOLUME: 2.3m3 80 CF
					AVAILABLE OXYGEN = set by USER 7.0 mg/l
					D.O. IN EFFLUENT IS set by USER 7.0 is recommnded level
	48	MAXkgm3			MAXIMUM DENISTY IN KG / CUBIC METER 32, 48, 65, 80,
	2.3	UNITVOLm3			REARING UNIT VOLUME IN CUBIC METERS
	3	OPVelocity			Velocity in cm/sec (range 3.0 to 5.0 is recommended)
		UNITMETERS			REARING UNIT length in Meters
	'May2013003	DATE			Date of Computer Run 'Month201996
	VTEMP 6ft	Project			hatchery name
	8	Sizeinches			Target Size in Inches
		Number			Target Number
	'RBT	Species			fish species use 3 letter code
	'coldwater	species			oxyreq 'coldwater,cool,warm,talapia
L	1	vtemp_c			enter Variable water temp deg. C in LIST vtemp_c
		tugr	0.006		from LOOKUP TABLE tugr in cm/tu
	1.3	conv			enter food conversion 1.5
	2.54	ilength			enter in centimeters starting length
		iweight	0.181		weight calculated
		k	0.011		from LOOKUP TABLE k metric condition factor
	1142	i#fish			enter initial # of fish starting # THIS VARIABLE IS VARIE
L		#fish	1142		calculated mortality= 1/2%/day/month
	30	pdays			enter # days in period ex. 30
	660	elev			enter elevation in ftMSL
	0.9	oxy%			enter RAW WATER supply initial DO % sa
	4	availoxy			enter FIXED Available DO for Operating System 3, 4, 5, 6, et
	7	effluentDO			enter FIXED effluent DO for System 5, 6 or 7 suggested
	7.25	pH			enter pH
	0.417	%uninh3			enter %uninh3 from AMMONIA % IONIZATION TABLE
	0.0125	AUA			enter AUA allowable unionized ammonia (range .010 to 0.025)
	0	bgnh3			enter background Total TAN if any

BY-PRODUCT GENERATION in Kgs. MASS BALANCE FEED TO BY-PRODUCTS

	Month	feedkg	TSS	Total NH3	UNI NH3	co2kg	phoskg	NO3kg	BODkg
Element	Period	Feedkg	TSSkg	TANkg	UNINH3kg	co2kg	phoskg	NO3kg	BODkg
1.00	1.00	0.40	0.10	0.01	0.00	0.10	0.00	0.03	0.10
2.00	2.00	0.90	0.30	0.03	0.00	0.20	0.00	0.08	0.30
3.00	3.00	2.00	0.60	0.06	0.01	0.60	0.01	0.20	0.70
4.00	4.00	5.00	1.00	0.15	0.02	1.00	0.03	0.40	2.00
5.00	5.00	9.00	3.00	0.27	0.03	3.00	0.05	0.80	3.00
6.00	6.00	11.00	3.00	0.33	0.04	3.00	0.06	1.00	4.00
7.00	7.00	11.00	3.00	0.33	0.04	3.00	0.05	0.90	4.00
8.00	8.00	13.00	4.00	0.39	0.05	4.00	0.07	1.00	4.00
9.00	9.00	12.00	3.00	0.35	0.04	3.00	0.06	1.00	4.00
10.00	10.00	13.00	4.00	0.39	0.05	4.00	0.07	1.00	4.00
11.00	11.00	17.00	5.00	0.51	0.06	5.00	0.09	1.00	6.00
12.00	12.00	17.00	5.00	0.50	0.06	5.00	0.08	1.00	6.00
13.00	13.00	21.00	6.00	0.64	0.08	6.00	0.11	2.00	7.00
14.00	14.00	27.00	8.00	0.81	0.10	8.00	0.14	2.00	9.00

CAP 12

Title: FRH 6ft Nursery Tank Capacity Density Set 3 lbs/cuft. AO=4.0 Temp VARIABLE TEMP deg F, Flow 15gpm

Rearing Model

approx. end of	Eleme	DAY	vtemp_	inches	cm	lbs@	grams@	# / LB.	#/Kg	wt /1000	cm/m	inches/m	# FISH	Tot.lbs.
Month	Eleme	DAY	vtemp_	inches	cm	lbs@	grams@	# / LB.	#/Kg	wt /1000	cm/m	inches/m	# FISH	Tot.lbs.
	1	1	7	1.0	2.5	0	0.181	2500	5512	0.4	1.16	0.46	1,142	0.50
	2	30	8	1.5	3.7	0.001	0.559	812.1	1790	1.2	1.32	0.52	1,136	1.00
	3	60	10	2.0	5	0.003	1.396	324.8	716.1	3.1	1.65	0.65	1,131	3.00
	4	90	14	2.6	6.7	0.007	3.278	138.4	305.1	7.2	2.31	0.91	1,125	8.00
	5	120	14	3.5	9	0.018	8.004	56.7	124.9	17.6	2.31	0.91	1,119	20.00
	6	150	11	4.4	11.3	0.035	15.912	28.5	62.8	35.1	1.82	0.72	1,114	39.00
	7	180	8	5.2	13.1	0.055	24.891	18.2	40.2	54.9	1.32	0.52	1,108	61.00
	8	210	8	5.7	14.4	0.073	33.199	13.7	30.1	73.2	1.32	0.52	1,102	81.00
	9	240	6	6.2	15.7	0.095	43.176	10.5	23.2	95.2	0.99	0.39	1,097	104.00
	10	260	6	6.6	16.7	0.114	51.846	8.7	19.3	114.3	0.99	0.39	1,093	125.00
	11	270	7	7.0	17.7	0.136	61.605	7.4	16.2	135.8	1.16	0.46	1,091	148.00
	12	300	6	7.4	18.9	0.164	74.454	6.1	13.4	164.1	0.99	0.39	1,085	178.00
	13	330	7	7.8	19.9	0.191	86.794	5.2	11.5	191.3	1.16	0.46	1,079	206.00
	14	360	8	8.3	21	0.227	102.831	4.4	9.7	226.7	1.32	0.52	1,074	243.00

Eleme	Tot.Kgs	%bwfeed	feed lbs/da	feed Kg/day	AO mg/1	Req.Int. DO	%DOsaturation	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
Eleme	Tot.Kgs	%bwfeed	feed lbs/da	feed Kg/day	AO mg/1	Req.Int. DO	%DOsaturation	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
1	0.2	5.9	0.0	0.01	4	11	90	2.26	0.27	0.20	0.8	2.26	0.00	0.20	2.99	48.0	3.0	0.002
2	0.6	4.6	0.1	0.03	4	11	95	2.88	0.34	0.50	2.0	1.98	0.01	0.50	2.06	48.0	3.0	0.006
3	2.0	4.3	0.2	0.07	4	11	99	3.13	0.37	1.00	4.0	1.58	0.03	1.00	1.51	48.0	3.0	0.014
4	4.0	4.5	0.4	0.17	4	11	109	2.97	0.36	3.00	10.0	1.13	0.08	3.00	1.14	48.0	3.0	0.033
5	9.0	3.3	0.7	0.30	4	11	109	4	0.48	5.00	19.0	1.13	0.19	7.00	0.85	48.0	3.0	0.081
6	18.0	2.1	0.8	0.37	4	11	102	6.4	0.77	6.00	23.0	1.44	0.37	13.00	0.67	48.0	3.0	0.161
7	28.0	1.3	0.8	0.36	4	11	95	10.21	1.22	6.00	23.0	1.98	0.57	20.00	0.58	48.0	3.0	0.25
8	37.0	1.2	1.0	0.44	4	11	95	11.24	1.34	7.00	27.0	1.98	0.76	27.00	0.53	48.0	3.0	0.331
9	47.0	0.8	0.9	0.39	4	11	88	16.36	1.96	6.00	24.0	2.64	0.99	35.00	0.48	48.0	3.0	0.429
10	57.0	0.8	1.0	0.44	4	11	88	17.39	2.08	7.00	27.0	2.64	1.20	42.00	0.45	48.0	3.0	0.513
11	67.0	0.8	1.3	0.57	4	11	90	15.79	1.89	9.00	36.0	2.26	1.40	49.00	0.43	48.0	3.0	0.609
12	81.0	0.7	1.2	0.55	4	11	88	19.62	2.35	9.00	34.0	2.64	1.70	59.00	0.40	48.0	3.0	0.732
13	94.0	0.8	1.6	0.71	4	11	90	17.7	2.12	12.00	44.0	2.26	2.00	69.00	0.38	48.0	3.0	0.849
14	110.0	0.8	2.0	0.90	4	11	95	16.38	1.96	15.00	56.0	1.98	2.30	81.00	0.36	48.0	3.0	1

MODEL INPUTS

Statu	Input	Name	Outp	Unit	Com
					PROJECT: FRCWH
					REARING UNIT TYPE: Nursery Tanks VTEMP 16 MONTHS
					RV REARING VOLUME: 2.3m3 80 CF
					AVAILABLE OXYGEN = set by USER 7.0 mg/l
					D.O. IN EFFLUENT IS set by USER 7.0 is recommnded level
	48	MAXkgm3			MAXIMUM DENISTY IN KG / CUBIC METER 32, 48, 65, 80,
	2.3	UNITVOLm3			REARING UNIT VOLUME IN CUBIC METERS
	3	OPVelocity			Velocity in cm/sec (range 3.0 to 5.0 is recommended)
		UNITMETERS			REARING UNIT length in Meters
	'May2013003	DATE			Date of Computer Run 'Month201996
	VTEMP 6ft	Project			hatchery name
	8	Sizeinches			Target Size in Inches
		Number			Target Number
	'RBT	Species			fish species use 3 letter code
	'coldwater	species			oxyreq 'coldwater,cool,warm,talapia
L	1	vtemp_c			enter Variable water temp deg. C in LIST vtemp_c
		tugr	0.006		from LOOKUP TABLE tugr in cm/tu
	1.3	conv			enter food conversion 1.5
	2.54	ilength			enter in centimeters starting length
		iweight	0.181		weight calculated
		k	0.011		from LOOKUP TABLE k metric condition factor
	592	i#fish			enter initial # of fish starting # THIS VARIABLE IS VARIE
L		#fish	591.9		calculated mortality= 1/2%/day/month
	30	pdays			enter # days in period ex. 30
	660	elev			enter elevation in ftMSL
	0.9	oxy%			enter RAW WATER supply initial DO % sa
	4	availoxy			enter FIXED Available DO for Operating System 3, 4, 5, 6, et
	6	effluentDO			enter FIXED effluent DO for System 5, 6 or 7 suggested
	7.25	pH			enter pH
	0.417	%uninh3			enter %uninh3 from AMMONIA % IONIZATION TABLE
	0.0125	AUA			enter AUA allowable unionized ammonia (range .010 to 0.025)
	0	bgnh3			enter background Total TAN if any

BY-PRODUCT GENERATION in Kgs. MASS BALANCE FEED TO BY-PRODUCTS

	Month	feedkg	TSS	Total NH3	UNI NH3	co2kg	phoskg	NO3kg	BODkg
Element	Period	Feedkg	TSSkg	TANkg	UNINH3kg	co2kg	phoskg	NO3kg	BODkg
1.00	1.00	0.40	0.10	0.01	0.00	0.10	0.00	0.03	0.10
2.00	2.00	0.90	0.30	0.03	0.00	0.20	0.00	0.08	0.30
3.00	3.00	2.00	0.60	0.06	0.01	0.60	0.01	0.20	0.70
4.00	4.00	5.00	1.00	0.15	0.02	1.00	0.03	0.40	2.00
5.00	5.00	9.00	3.00	0.27	0.03	3.00	0.05	0.80	3.00
6.00	6.00	11.00	3.00	0.33	0.04	3.00	0.06	1.00	4.00
7.00	7.00	11.00	3.00	0.33	0.04	3.00	0.05	0.90	4.00
8.00	8.00	13.00	4.00	0.39	0.05	4.00	0.07	1.00	4.00
9.00	9.00	12.00	3.00	0.35	0.04	3.00	0.06	1.00	4.00
10.00	10.00	13.00	4.00	0.39	0.05	4.00	0.07	1.00	4.00
11.00	11.00	17.00	5.00	0.51	0.06	5.00	0.09	1.00	6.00
12.00	12.00	17.00	5.00	0.50	0.06	5.00	0.08	1.00	6.00
13.00	13.00	21.00	6.00	0.64	0.08	6.00	0.11	2.00	7.00
14.00	14.00	27.00	8.00	0.81	0.10	8.00	0.14	2.00	9.00

CAP 13 **Title: FRH 6ft Nursery Tank Capacity Density Set 3 lbs/cuft. AO=4.0 Temp VARIABLE TEMP deg F, Flow 21gpm**

Rearing Model

approx. end of Month	Eleme	DAY	vtemp_(	inches	cm	lbs@	grams@	# / LB.	#/Kg	wt /1000	cm/m	inches/m	# FISH	Tot.lbs.	Tot.Kgs	%bwfeed	feed lbs/da	feed Kg/day	AO mg/1	Req.Int. DO	%DOsaturation	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
Month	Eleme	DAY	vtemp_	inches	cm	lbs@	grams@	# / LB.	#/Kg	wt /1000	cm/m	inches/m	# FISH	Tot.lbs.	Tot.Kgs	%bwfeed	feed lbs/da	feed Kg/day	AO mg/1	Req.Int. DO	%DOsaturation	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
	1	1	7	1.0	2.5	0	0.181	2500	5512	0.4	1.16	0.46	592	0.20	0.1	5.9	0.0	0.01	4	10	82	2.26	0.27	0.10	0.4	2.26	0.00	0.08	2.99	48.0	3.0	0.001
	2	30	8	1.5	3.7	0.001	0.559	812.1	1790	1.2	1.32	0.52	589	0.70	0.3	4.6	0.0	0.02	4	10	86	2.88	0.34	0.30	1.0	1.98	0.01	0.20	2.06	48.0	3.0	0.003
	3	60	10	2.0	5	0.003	1.396	324.8	716.1	3.1	1.65	0.65	586	2.00	0.8	4.3	0.1	0.04	4	10	90	3.13	0.37	0.60	2.0	1.58	0.02	0.60	1.51	48.0	3.0	0.007
	4	90	14	2.6	6.7	0.007	3.278	138.4	305.1	7.2	2.31	0.91	583	4.00	2.0	4.5	0.2	0.09	4	10	99	2.97	0.36	1.00	5.0	1.13	0.04	1.00	1.14	48.0	3.0	0.017
	5	120	14	3.5	9	0.018	8.004	56.7	124.9	17.6	2.31	0.91	580	10.00	5.0	3.3	0.3	0.16	4	10	99	4	0.48	3.00	10.0	1.13	0.10	3.00	0.85	48.0	3.0	0.042
	6	150	11	4.4	11.3	0.035	15.912	28.5	62.8	35.1	1.82	0.72	577	20.00	9.0	2.1	0.4	0.19	4	10	92	6.4	0.77	3.00	12.0	1.44	0.19	7.00	0.67	48.0	3.0	0.083
	7	180	8	5.2	13.1	0.055	24.891	18.2	40.2	54.9	1.32	0.52	574	31.00	14.0	1.3	0.4	0.19	4	10	86	10.21	1.22	3.00	12.0	1.98	0.30	11.00	0.58	48.0	3.0	0.129
	8	210	8	5.7	14.4	0.073	33.199	13.7	30.1	73.2	1.32	0.52	571	42.00	19.0	1.2	0.5	0.23	4	10	86	11.24	1.34	4.00	14.0	1.98	0.40	14.00	0.53	48.0	3.0	0.172
	9	240	6	6.2	15.7	0.095	43.176	10.5	23.2	95.2	0.99	0.39	568	54.00	25.0	0.8	0.4	0.20	4	10	80	16.36	1.96	3.00	13.0	2.64	0.51	18.00	0.48	48.0	3.0	0.222
	10	260	6	6.6	16.7	0.114	51.846	8.7	19.3	114.3	0.99	0.39	566	65.00	29.0	0.8	0.5	0.23	4	10	80	17.39	2.08	4.00	14.0	2.64	0.61	22.00	0.45	48.0	3.0	0.266
	11	270	7	7.0	17.7	0.136	61.605	7.4	16.2	135.8	1.16	0.46	565	77.00	35.0	0.8	0.7	0.30	4	10	82	15.79	1.89	5.00	18.0	2.26	0.73	26.00	0.43	48.0	3.0	0.316
	12	300	6	7.4	18.9	0.164	74.454	6.1	13.4	164.1	0.99	0.39	563	92.00	42.0	0.7	0.6	0.29	4	10	80	19.62	2.35	5.00	18.0	2.64	0.87	31.00	0.40	48.0	3.0	0.379
	13	330	7	7.8	19.9	0.191	86.794	5.2	11.5	191.3	1.16	0.46	560	107.00	49.0	0.8	0.8	0.37	4	10	82	17.7	2.12	6.00	23.0	2.26	1.00	36.00	0.38	48.0	3.0	0.44
	14	360	8	8.3	21	0.227	102.831	4.4	9.7	226.7	1.32	0.52	557	126.00	57.0	0.8	1.0	0.47	4	10	86	16.38	1.96	8.00	29.0	1.98	1.20	42.00	0.36	48.0	3.0	0.518
	15	390	10	8.8	22.3	0.272	123.445	3.7	8.1	272.1	1.65	0.65	554	150.00	68.0	1.0	1.4	0.66	4	10	90	13.93	2	11.00	41.0	2	1.40	50.00	0.34	48.0	3.0	0.619
	16	420	14	9.4	24	0.337	152.868	3	6.5	337	2.31	0.91	551	185.00	84.0	1.3	2.3	1.10	4	10	99	10.69	1	17.00	66.0	1	1.80	62.00	0.32	48.0	3.0	0.763
	17	450	14	10.4	26.3	0.444	201.415	2.3	5	444	2.31	0.91	548	243	110.0	1.142	2.8	1.30	4	10	99	11.71	1.4	21.00	79	1.131	2.3	81.00	0.29	48	3	0.999

MODEL INPUTS

Statu	Input	Name	Outp	Unit	Com
					PROJECT: FRCWH
					REARING UNIT TYPE: Nursery Tanks VTEMP 16 MONTHS
					RV REARING VOLUME: 2.3m3 80 CF
					AVAILABLE OXYGEN = set by USER 7.0 mg/l
					D.O. IN EFFLUENT IS set by USER 7.0 is recommnded level
	48	MAXkgm3			MAXIMUM DENISTY IN KG / CUBIC METER 32, 48, 65, 80,
	2.3	UNITVOLm3			REARING UNIT VOLUME IN CUBIC METERS
	3	OPVelocity			Velocity in cm/sec (range 3.0 to 5.0 is recommended)
		UNITMETERS			REARING UNIT length in Meters
	'May2013003	DATE			Date of Computer Run 'Month201996
	VTEMP 6ft	Project			hatchery name
	8	Sizeinches			Target Size in Inches
		Number			Target Number
	'RBT	Species			fish species use 3 letter code
	'coldwater	species			oxyreq 'coldwater,cool,warm,talapia
L	1	vtemp_c			enter Variable water temp deg. C in LIST vtemp_c
		tugr	0.006		from LOOKUP TABLE tugr in cm/tu
	1.3	conv			enter food conversion 1.5
	2.54	ilength			enter in centimeters starting length
		iweight	0.181		weight calculated
		k	0.011		from LOOKUP TABLE k metric condition factor
	592	i#fish			enter initial # of fish starting # THIS VARIABLE IS VARIE
L		#fish	591.9		calculated mortality= 1/2%/day/month
	30	pdays			enter # days in period ex. 30
	660	elev			enter elevation in ftMSL
	0.9	oxy%			enter RAW WATER supply initial DO % sa
	4	availoxy			enter FIXED Available DO for Operating System 3, 4, 5, 6, et
	6	effluentDO			enter FIXED effluent DO for System 5, 6 or 7 suggested
	7.25	pH			enter pH
	0.417	%uninh3			enter %uninh3 from AMMONIA % IONIZATION TABLE
	0.0125	AUA			enter AUA allowable unionized ammonia (range .010 to 0.025)
	0	bgnh3			enter background Total TAN if any

BY-PRODUCT GENERATION in Kgs. MASS BALANCE FEED TO BY-PRODUCTS

		Month	feedkg	TSS	Total NH3	UNI NH3	co2kg	phoskg	NO3kg	BODkg
	Element	Period	Feedkg	TSSkg	TANkg	UNINH3kg	co2kg	phoskg	NO3kg	BODkg
	1.00	1.00	0.20	0.06	0.01	0.00	0.05	0.00	0.02	0.06
	2.00	2.00	0.50	0.10	0.01	0.00	0.10	0.00	0.04	0.20
	3.00	3.00	1.00	0.30	0.03	0.00	0.30	0.01	0.09	0.40
	4.00	4.00	3.00	0.80	0.08	0.01	0.70	0.01	0.20	0.90
	5.00	5.00	5.00	1.00	0.14	0.02	1.00	0.02	0.40	2.00
	6.00	6.00	6.00	2.00	0.17	0.02	2.00	0.03	0.50	2.00
	7.00	7.00	6.00	2.00	0.17	0.02	2.00	0.03	0.50	2.00
	8.00	8.00	7.00	2.00	0.20	0.03	2.00	0.03	0.60	2.00
	9.00	9.00	6.00	2.00	0.18	0.02	2.00	0.03	0.50	2.00
	10.00	10.00	7.00	2.00	0.20	0.03	2.00	0.03	0.60	2.00
	11.00	11.00	9.00	3.00	0.27	0.03	2.00	0.04	0.80	3.00
	12.00	12.00	9.00	3.00	0.26	0.03	2.00	0.04	0.70	3.00
	13.00	13.00	11.00	3.00	0.33	0.04	3.00	0.06	1.00	4.00
	14.00	14.00	14.00	4.00	0.42	0.05	4.00	0.07	1.00	5.00
	15.00	15.00	20.00	6.00	0.59	0.07	6.00	0.10	2.00	7.00
	16.00	16.00	32.00	9.00	0.95	0.12	9.00	0.16	3.00	11.00
	17.00	17.00	38.00	11.00	1.13	0.14	11.00	0.19	3.00	13.00

BCAP 1

Title: FRH Burrows RWYCapacity Density Set 3 lbs/cuft. D.O.= 90%, AO=3.9 Temp 45 deg F, Flow 369 gpm

Rearing Model

approx. end of	Elen	DAY	inches	cm	lbs@	grams@	# / LB.	#/Kg	cm/m	inches/m	# FISH	Tot.lbs.	Tot.Kgs	%bwfeed	feed lbs/day	feed Kg/day	AO mg/1
Month	Elen	DAY	inches	cm	lbs@	grams@	# / LB.	#/Kg	cm/m	inches/m	# FISH	Tot.lbs.	Tot.Kgs	%bwfeed	feed lbs/day	feed Kg/day	AO mg/1
	1	1	7.5	19.1	0.17	77.07	5.9	13	1.296	0.51	18,350	3,111	1,414	0.88	27.50	12.5	3.9
	2	30	8	20.3	0.206	93.25	4.9	10.7	1.296	0.51	18,262	3,746	1,703	0.83	31.00	14.1	3.9
	3	60	8.5	21.6	0.247	112.2	4	8.9	1.296	0.51	18,170	4,486	2,039	0.78	34.90	15.9	3.9
	4	90	9	22.9	0.295	133.6	3.4	7.5	1.296	0.51	18,079	5,315	2,416	0.74	39.00	17.7	3.9
	5	120	9.5	24.2	0.347	157.6	2.9	6.3	1.296	0.51	17,987	6,236	2,834	0.70	43.40	19.7	3.9
	6	150	10.1	25.5	0.406	184.2	2.5	5.4	1.296	0.51	17,896	7,254	3,297	0.66	47.90	21.8	3.9

Elen	Req.Int. DO	%DOsat.	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
Elen	Req.Int. DO	%DOsaturatic	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
1	10.9	90	14.7	1.76	212.00	804	1.96	29.5	1,040	0.40	48.00	3.0	0.4
2	10.9	90	15.67	1.87	239.00	909	1.96	35.5	1,253	0.37	48.00	3.0	0.5
3	10.9	90	16.67	1.99	269.00	1,023	1.96	42.5	1,500	0.35	48.00	3.0	0.6
4	10.9	90	17.66	2.11	301.00	1,143	1.96	50.3	1,777	0.33	48.00	3.0	0.7
5	10.9	90	18.66	2.23	334	1,270	1.96	59.1	2,085	0.31	48.00	3.0	0.9
6	10.9	90	19.66	2.35	369	1,402	1.96	68.7	2,426	0.30	48.00	3.0	1.0

MODEL INPUTS

Sta	Input	Name	Outpu	Unit	Com
					PROJECT: French River MNDNR
					REARING UNIT TYPE: Burrows
					RV REARING VOLUME: 68.67CM or 2424cf
					AVAILABLE OXYGEN = set by USER 6.0 mg/l
					D.O. IN EFFLUENT IS set by USER 7.0 is recommnded level
	48	MAXkgm3			MAXIMUM DENISTY IN KG / CUBIC METER 32, 48, 65, 80,
	68.67	UNITVOLm3			REARING UNIT VOLUME IN CUBIC METERS
	3	OPVelocity			Velocity in cm/sec (range 3.0 to 5.0 is recommended)
	11.5	UNITMETERS			REARING UNIT length in Meters
	'May2013	DATE			Date of Computer Run 'Month201996
	Burrows RWY	Project			hatchery name
	8	Sizeinches			Target Size in Inches
		Number			Target Number
	'RBT	Species			fish species use 3 letter code
	'coldwater	species			oxyreq 'coldwater,cool,warm,talapia
	7.2	ctemp_c			enter constant water temp deg. C
		tugr	0.006		from LOOKUP TABLE tugr in cm/tu
	1.3	conv			enter food conversion 1.5
	19.05	ilength			enter in centimeters starting length
		iweight	76.54		weight calculated
		k	0.011		from LOOKUP TABLE k metric condition factor
	18353	i#fish			enter initial # of fish starting # THIS VARIABLE IS VARIED TO MEET DENSITY & FLOW
L		#fish	18350		calculated mortality= 1/2%/day/month
	30	pdays			enter # days in period ex. 30
	660	elev			enter elevation in ftMSL
	1	oxy%			enter RAW WATER supply initial DO % sa
	3.88	availoxy			enter FIXED Available DO for Operating System 3, 4, 5, 6, etc.
	7	effluentDO			enter FIXED effluent DO for System 5, 6 or 7 suggested
	7.25	pH			enter pH
	0.417	%uninh3			enter %uninh3 from AMMONIA % IONIZATION TABLE
	0.0125	AUA			enter AUA allowable unionized ammonia (range .010 to 0.025) .025 suggested
	0	bgnh3			enter background Total TAN if any

BY-PRODUCT GENERATION in Kgs. MASS BALANCE FEED TO BY-PRODUCTS

		Month	feedkg	TSS	Total NH3	UNI NH3	co2kg	phoskg	NO3kg	BODkg
	Element	Period	Feedkg	TSSkg	TANkg	UNINH3kg	co2kg	phoskg	NO3kg	BODkg
	1.00	1.00	373.00	112.00	11.21	1.40	105.00	1.87	32.00	127.00
	2.00	2.00	422.00	127.00	12.66	1.58	118.00	2.11	37.00	143.00
	3.00	3.00	475.00	143.00	14.25	1.78	133.00	2.38	41.00	162.00
	4.00	4.00	531.00	159.00	15.93	1.99	149.00	2.66	46.00	181.00
	5.00	5.00	590.00	177.00	17.69	2.21	165.00	2.95	51.00	200.00

BCAP 2

Title: FRH Burrows RWY Capacity Density Set 3.6 lbs/cuft. D.O.= 93%, AO=4.3 Temp 45 deg F, Flow 400 gpm

Rearing Model

approx. end of Month	Eler	DAY	inches	cm	lbs@	grams@	# / LB.	#/Kg	cm/m	inches/m	# FISH	Tot.lbs.	Tot.Kgs	%bwfeed	feed lbs/day	feed Kg/day	AO mg/1	Req.Int. DO	%DOsat.	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
	1	1	7.5	19.1	0.17	77.07	5.9	13	1.296	0.51	22,001	3,730	1,696	0.88	32.90	15.0	4.3	11.3	93	16.26	1.94	229.00	872	2.16	29.4	1,040	0.48	57.60	3.6	0.4
	2	30	8	20.3	0.206	93.25	4.9	10.7	1.296	0.51	21,895	4,492	2,042	0.83	37.20	16.9	4.3	11.3	93	17.32	2.07	259.00	985	2.16	35.4	1,252	0.45	57.60	3.6	0.5
	3	60	8.5	21.6	0.247	112.2	4	8.9	1.296	0.51	21,786	5,379	2,445	0.78	41.90	19.0	4.3	11.3	93	18.43	2.2	292.00	1,109	2.16	42.4	1,499	0.42	57.60	3.6	0.6
	4	90	9	22.9	0.295	133.6	3.4	7.5	1.296	0.51	21,676	6,372	2,897	0.74	46.80	21.3	4.3	11.3	93	19.53	2.34	326.00	1,240	2.16	50.3	1,776	0.40	57.60	3.6	0.7
	5	120	9.5	24.2	0.347	157.6	2.9	6.3	1.296	0.51	21,567	7,477	3,398	0.70	52.00	23.6	4.3	11.3	93	20.63	2.47	362	1,377	2.16	59.0	2,084	0.38	57.60	3.6	0.9
	6	150	10.1	25.5	0.406	184.2	2.5	5.4	1.296	0.51	21,457	8,697	3,953	0.66	57.40	26.1	4.3	11.3	93	21.74	2.6	400	1,520	2.16	68.6	2,424	0.36	57.60	3.6	1.0

MODEL INPUTS

Sta	Input	Name	Outpu	Unit	Com
					PROJECT: French River MNDNR
					REARING UNIT TYPE: Burrows
					RV REARING VOLUME: CM 68.67
					AVAILABLE OXYGEN = set by USER 6.0 mg/l
					D.O. IN EFFLUENT IS set by USER 7.0 is recommnded level
	57.6	MAXkgm3			MAXIMUM DENISTY IN KG / CUBIC METER 32, 48, 65, 80,
	68.67	UNITVOLm3			REARING UNIT VOLUME IN CUBIC METERS
	3	OPVelocity			Velocity in cm/sec (range 3.0 to 5.0 is recommended)
	11.5	UNITMETERS			REARING UNIT length in Meters
	'May2013	DATE			Date of Computer Run 'Month201996
	Burrows RWY	Project			hatchery name
	8	Sizeinches			Target Size in Inches
		Number			Target Number
	'RBT	Species			fish species use 3 letter code
	'coldwater	species			oxyreq 'coldwater,cool,warm,talapia
	7.2	ctemp_c			enter constant water temp deg. C
		tugr	0.006		from LOOKUP TABLE tugr in cm/tu
	1.3	conv			enter food conversion 1.5
	19.05	ilength			enter in centimeters starting length
		iweight	76.54		weight calculated
		k	0.011		from LOOKUP TABLE k metric condition factor
	22005	i#fish			enter initial # of fish starting # THIS VARIABLE IS VARIED TO MEET DENSITY & FLOW
L		#fish	22001		calculated mortality= 1/2%/day/month
	30	pdays			enter # days in period ex. 30
	660	elev			enter elevation in ftMSL
	1	oxy%			enter RAW WATER supply initial DO % sa
	4.29	availoxy			enter FIXED Available DO for Operating System 3, 4, 5, 6, etc.
	7	effluentDO			enter FIXED effluent DO for System 5, 6 or 7 suggested
	7.25	pH			enter pH
	0.417	%uninh3			enter %uninh3 from AMMONIA % IONIZATION TABLE
	0.0125	AUA			enter AUA allowable unionized ammonia (range .010 to 0.025) .025 suggested
	0	bgnh3			enter background Total TAN if any

BY-PRODUCT GENERATION in Kgs. MASS BALANCE FEED TO BY-PRODUCTS

		Month	feedkg	TSS	Total NH3	UNI NH3	co2kg	phoskg	NO3kg	BODkg
	Element	Period	Feedkg	TSSkg	TANkg	UNINH3kg	co2kg	phoskg	NO3kg	BODkg
	1.00	1.00	373.00	112.00	11.21	1.40	105.00	1.87	32.00	127.00
	2.00	2.00	422.00	127.00	12.66	1.58	118.00	2.11	37.00	143.00
	3.00	3.00	475.00	143.00	14.25	1.78	133.00	2.38	41.00	162.00
	4.00	4.00	531.00	159.00	15.93	1.99	149.00	2.66	46.00	181.00
	5.00	5.00	590.00	177.00	17.69	2.21	165.00	2.95	51.00	200.00

BCAP 3

Title: FRH Burrows RWYCapacity Density Set 3.6 lbs/cuft. D.O.= 90%, AO=3.9 Temp 45 deg F, Flow 442 gpm

Rearing Model

approx. end of Month	Eler Element	DAY	inches	cm	lbs@	grams@	# / LB.	#/Kg	cm/m	inches/m	# FISH	Tot.lbs.	Tot.Kgs	%bwfeed	feed lbs/day	feed Kg/day	AO mg/1	Req.Int. DO	%DOsat.	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
	1	1	7.5	19.1	0.17	77.07	5.9	13	1.296	0.51	22,001	3,730	1,696	0.88	32.90	15.0	3.9	10.9	90	14.7	1.76	254.00	964	1.96	29.4	1,040	0.48	57.60	3.6	0.4
	2	30	8	20.3	0.206	93.25	4.9	10.7	1.296	0.51	21,895	4,492	2,042	0.83	37.20	16.9	3.9	10.9	90	15.67	1.87	287.00	1,089	1.96	35.4	1,252	0.45	57.60	3.6	0.5
	3	60	8.5	21.6	0.247	112.2	4	8.9	1.296	0.51	21,786	5,379	2,445	0.78	41.90	19.0	3.9	10.9	90	16.67	1.99	323.00	1,226	1.96	42.4	1,499	0.42	57.60	3.6	0.6
	4	90	9	22.9	0.295	133.6	3.4	7.5	1.296	0.51	21,676	6,372	2,897	0.74	46.80	21.3	3.9	10.9	90	17.66	2.11	361.00	1,371	1.96	50.3	1,776	0.40	57.60	3.6	0.7
	5	120	9.5	24.2	0.347	157.6	2.9	6.3	1.296	0.51	21,567	7,477	3,398	0.70	52.00	23.6	3.9	10.9	90	18.66	2.23	401	1,522	1.96	59.0	2,084	0.38	57.60	3.6	0.9
	6	150	10.1	25.5	0.406	184.2	2.5	5.4	1.296	0.51	21,457	8,697	3,953	0.66	57.40	26.1	3.9	10.9	90	19.66	2.35	442	1,681	1.96	68.6	2,424	0.36	57.60	3.6	1.0

MODEL INPUTS

Sta	Input	Name	Outpu	Unit	Com
					PROJECT: French River MNDNR
					REARING UNIT TYPE: 6ft Nursery Tank
					RV REARING VOLUME: 2.3CM or 80CF
					AVAILABLE OXYGEN = set by USER 6.0 mg/l
					D.O. IN EFFLUENT IS set by USER 7.0 is recommnded level
	57.6	MAXkgm3			MAXIMUM DENISTY IN KG / CUBIC METER 32, 48, 65, 80,
	68.67	UNITVOLm3			REARING UNIT VOLUME IN CUBIC METERS
	3	OPVelocity			Velocity in cm/sec (range 3.0 to 5.0 is recommended)
	11.5	UNITMETERS			REARING UNIT length in Meters
	'May2013	DATE			Date of Computer Run 'Month201996
	FRnursey 6ft	Project			hatchery name
	8	Sizeinches			Target Size in Inches
		Number			Target Number
	'RBT	Species			fish species use 3 letter code
	'coldwater	species			oxyreq 'coldwater,cool,warm,talapia
	7.2	ctemp_c			enter constant water temp deg. C
		tugr	0.006		from LOOKUP TABLE tugr in cm/tu
	1.3	conv			enter food conversion 1.5
	19.05	ilength			enter in centimeters starting length
		iweight	76.54		weight calculated
		k	0.011		from LOOKUP TABLE k metric condition factor
	22005	i#fish			enter initial # of fish starting # THIS VARIABLE IS VARIED TO MEET DENSITY & FLOW
L		#fish	22001		calculated mortality= 1/2%/day/month
	30	pdays			enter # days in period ex. 30
	660	elev			enter elevation in ftMSL
	1	oxy%			enter RAW WATER supply initial DO % sa
	4.29	availoxy			enter FIXED Available DO for Operating System 3, 4, 5, 6, etc.
	7	effluentDO			enter FIXED effluent DO for System 5, 6 or 7 suggested
	7.25	pH			enter pH
	0.417	%uninh3			enter %uninh3 from AMMONIA % IONIZATION TABLE
	0.0125	AUA			enter AUA allowable unionized ammonia (range .010 to 0.025) .025 suggested
	0	bgnh3			enter background Total TAN if any

BY-PRODUCT GENERATION in Kgs. MASS BALANCE FEED TO BY-PRODUCTS

		Month	feedkg	TSS	Total NH3	UNI NH3	co2kg	phoskg	NO3kg	BODkg
	Element	Period	Feedkg	TSSkg	TANkg	UNINH3kg	co2kg	phoskg	NO3kg	BODkg
	1.00	1.00	448.00	134.00	13.43	1.68	125.00	2.24	39.00	152.00
	2.00	2.00	506.00	152.00	15.18	1.90	142.00	2.53	44.00	172.00
	3.00	3.00	570.00	171.00	17.09	2.14	159.00	2.85	50.00	194.00
	4.00	4.00	637.00	191.00	19.10	2.39	178.00	3.18	55.00	216.00
	5.00	5.00	707.00	212.00	21.21	2.65	198.00	3.54	62.00	240.00

BCAP 4

Title: FRH Burrows RWY Capacity Density Set 3 lbs/cuft. AO=4.0 Temp VARIABLE TEMP deg F, Flow 639 gpm

Rearing Model

approx. end of Month	Element	DAY	vtemp_(	inches	cm	lbs@	grams@	# / LB.	#/Kg	wt /1000	cm/m	inches/m	# FISH	Tot.lbs.	Tot.Kgs	%bwfeed	feed lbs/da	feed Kg/day	AO mg/1	Req.Int. DO	%DOsaturation	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
	1	1	6.1	7.5	19.1	0.169	76.544	5.9	13.1	168.7	1.01	0.40	16,631	2,801	1273.0	0.7	19.2	8.70	4	11	88	19.47	2.33	144	546.0	2.60	26.50	937.00	0.40	48.0	3.0	0.387
	2	30	6.1	7.9	20.1	0.197	89.328	5.1	11.2	196.9	1.01	0.40	16,551	3,253	1478.0	0.7	21.2	9.60	4	11	88	20.50	2.45	159	603.0	2.60	30.80	1,088.00	0.38	48.0	3.0	0.449
	3	60	7.2	8.3	21.1	0.228	103.463	4.4	9.7	228.1	1.19	0.47	16,468	3,748	1704.0	0.7	27.5	12.50	4	11	91	18.24	2.18	205	781.0	2.20	35.50	1,254.00	0.36	48.0	3.0	0.517
	4	90	10	8.8	22.3	0.269	121.976	3.7	8.2	268.9	1.65	0.65	16,385	4,397	1999.0	1.0	42.4	19.30	4	11	99	13.88	1.66	317	1,204.0	1.58	41.60	1,470.00	0.34	48.0	3.0	0.607
	5	120	15.5	9.4	23.9	0.333	151.172	3	6.6	333.3	2.56	1.01	16,303	5,422	2465.0	1.4	75.4	34.30	4	11	112	10	1.15	564	2,143.0	1.02	51.30	1,813.00	0.32	48.0	3.0	0.748
	6	150	14.4	10.4	26.5	0.452	205.078	2.2	4.9	452.1	2.38	0.94	16,220	7,318	3326.0	1.2	85.4	38.80	4	11	110	11.46	1.37	639	2,427.0	1.10	69.30	2,447.00	0.29	48.0	3.0	1.01

MODEL INPUTS

Statu	Input	Name	Outp	Unit	Com
					PROJECT: FRCWH
					REARING UNIT TYPE: Burrows Recirculating VTEMP
					RV REARING VOLUME: 2.3m3 80 CF
					AVAILABLE OXYGEN = set by USER 7.0 mg/l
					D.O. IN EFFLUENT IS set by USER 7.0 is recommnded level
	48	MAXkgm3			MAXIMUM DENISTY IN KG / CUBIC METER 32, 48, 65, 80,
	68.6	UNITVOLm3			REARING UNIT VOLUME IN CUBIC METERS
	3	OPVelocity			Velocity in cm/sec (range 3.0 to 5.0 is recommended)
		UNITMETERS			REARING UNIT length in Meters
	'May2013003	DATE			Date of Computer Run 'Month201996
	FRCWH Burrows	Project			hatchery name
	8	Sizeinches			Target Size in Inches
		Number			Target Number
	'RBT	Species			fish species use 3 letter code
	'coldwater	species			oxyreq 'coldwater,cool,warm,talapia
L	1	vtemp_c			enter Variable water temp deg. C in LIST vtemp_c
		tugr	0.006		from LOOKUP TABLE tugr in cm/tu
	1.3	conv			enter food conversion 1.5
	19.05	ilength			enter in centimeters starting length
		iweight	76.54		weight calculated
		k	0.011		from LOOKUP TABLE k metric condition factor
	16634	i#fish			enter initial # of fish starting # THIS VARIABLE IS VARIE
L		#fish	16631		calculated mortality= 1/2%/day/month
	30	pdays			enter # days in period ex. 30
	660	elev			enter elevation in ftMSL
	0.9	oxy%			enter RAW WATER supply initial DO % sa
	4	availoxy			enter FIXED Available DO for Operating System 3, 4, 5, 6, et
	7	effluentDO			enter FIXED effluent DO for System 5, 6 or 7 suggested
	7.25	pH			enter pH
	0.417	%uninh3			enter %uninh3 from AMMONIA % IONIZATION TABLE
	0.0125	AUA			enter AUA allowable unionized ammonia (range .010 to 0.025)
	0	bgnh3			enter background Total TAN if any

BY-PRODUCT GENERATION in Kgs. MASS BALANCE FEED TO BY-PRODUCTS

	Month	feedkg	TSS	Total NH3	UNI NH3	co2kg	phoskg	NO3kg	BODkg
Element	Period	Feedkg	TSSkg	TANkg	UNINH3kg	co2kg	phoskg	NO3kg	BODkg
1.00	1.00	262.00	79.00	7.87	0.98	73.00	1.31	23.00	89.00
2.00	2.00	289.00	87.00	8.68	1.09	81.00	1.45	25.00	98.00
3.00	3.00	375.00	112.00	11.24	1.41	105.00	1.87	33.00	127.00
4.00	4.00	578.00	173.00	17.34	2.17	162.00	2.89	50.00	197.00
5.00	5.00	1,028.00	309.00	30.85	3.86	288.00	5.14	89.00	350.00
6.00	6.00	1,165.00	349.00	34.95	4.37	326.00	5.83	101.00	396.00

BCAP 5

Title: FRH Burrows RWY Capacity Density Set 3 lbs/cuft. AO=5.0 Temp VARIABLE TEMP deg F, Flow 511gpm

Rearing Model

approx. end of Month	Element	DAY	vtemp_(	inches	cm	lbs@	grams@	# / LB.	#/Kg	wt /1000	cm/m	inches/m	# FISH	Tot.lbs.	Tot.Kgs
	Element														
	1	1	6.1	7.5	19.1	0.169	76.544	5.9	13.1	168.7	1.01	0.40	16,631	2,801	1273.0
	2	30	6.1	7.9	20.1	0.197	89.328	5.1	11.2	196.9	1.01	0.40	16,551	3,253	1478.0
	3	60	7.2	8.3	21.1	0.228	103.463	4.4	9.7	228.1	1.19	0.47	16,468	3,748	1704.0
	4	90	10	8.8	22.3	0.269	121.976	3.7	8.2	268.9	1.65	0.65	16,385	4,397	1999.0
	5	120	15.5	9.4	23.9	0.333	151.172	3	6.6	333.3	2.56	1.01	16,303	5,422	2465.0
	6	150	14.4	10.4	26.5	0.452	205.078	2.2	4.9	452.1	2.38	0.94	16,220	7,318	3326.0

Element	%bwfeed	feed lbs/da	feed Kg/day	AO mg/1	Req.Int. DO	%DOsaturation	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
1	0.7	19.2	8.70	5	11	88	24.34	2.91	115	437.0	3.25	26.50	937.00	0.40	48.0	3.0	0.387
2	0.7	21.2	9.60	5	11	88	25.63	3.07	127	482.0	3.25	30.80	1,088.00	0.38	48.0	3.0	0.449
3	0.7	27.5	12.50	5	11	91	22.80	2.73	164	625.0	2.75	35.50	1,254.00	0.36	48.0	3.0	0.517
4	1.0	42.4	19.30	5	11	99	17.34	2.07	254	963.0	1.98	41.60	1,470.00	0.34	48.0	3.0	0.607
5	1.4	75.4	34.30	5	11	112	12	1.44	451	1,714.0	1.28	51.30	1,813.00	0.32	48.0	3.0	0.748
6	1.2	85.4	38.80	5	11	110	14.32	1.71	511	1,942.0	1.38	69.30	2,447.00	0.29	48.0	3.0	1.01

MODEL INPUTS

Statu	Input	Name	Outp	Unit	Com
					PROJECT: FRCWH
					REARING UNIT TYPE: Burrows Recirculating
					RV REARING VOLUME: 2424 CF
					AVAILABLE OXYGEN = set by USER 7.0 mg/l
					D.O. IN EFFLUENT IS set by USER 7.0 is recommnded level
	48	MAXkgm3			MAXIMUM DENISTY IN KG / CUBIC METER 32, 48, 65, 80,
	68.6	UNITVOLm3			REARING UNIT VOLUME IN CUBIC METERS
	3	OPVelocity			Velocity in cm/sec (range 3.0 to 5.0 is recommended)
		UNITMETERS			REARING UNIT length in Meters
	'May2013003	DATE			Date of Computer Run 'Month201996
	'Burrows	Project			hatchery name
	8	Sizeinches			Target Size in Inches
		Number			Target Number
	'RBT	Species			fish species use 3 letter code
	'coldwater	species			oxyreq 'coldwater,cool,warm,talapia
L	1	vtemp_c			enter Variable water temp deg. C in LIST vtemp_c
		tugr	0.006		from LOOKUP TABLE tugr in cm/tu
	1.3	conv			enter food conversion 1.5
	19.05	ilength			enter in centimeters starting length
		iweight	76.54		weight calculated
		k	0.011		from LOOKUP TABLE k metric condition factor
	16634	i#fish			enter initial # of fish starting # THIS VARIABLE IS VARIE
L		#fish	16631		calculated mortality= 1/2%/day/month
	30	pdays			enter # days in period ex. 30
	660	elev			enter elevation in ftMSL
	0.9	oxy%			enter RAW WATER supply initial DO % sa
	5	availoxy			enter FIXED Available DO for Operating System 3, 4, 5, 6, et
	6	effluentDO			enter FIXED effluent DO for System 5, 6 or 7 suggested
	7.25	pH			enter pH
	0.417	%uninh3			enter %uninh3 from AMMONIA % IONIZATION TABLE
	0.0125	AUA			enter AUA allowable unionized ammonia (range .010 to 0.025)
	0	bgnh3			enter background Total TAN if any

BY-PRODUCT GENERATION in Kgs. MASS BALANCE FEED TO BY-PRODUCTS

		Month	feedkg	TSS	Total NH3	UNI NH3	co2kg	phoskg	NO3kg	BODkg
	Element	Period	Feedkg	TSSkg	TANkg	UNINH3kg	co2kg	phoskg	NO3kg	BODkg
	1.00	1.00	262.00	79.00	7.87	0.98	73.00	1.31	23.00	89.00
	2.00	2.00	289.00	87.00	8.68	1.09	81.00	1.45	25.00	98.00
	3.00	3.00	375.00	112.00	11.24	1.41	105.00	1.87	33.00	127.00
	4.00	4.00	578.00	173.00	17.34	2.17	162.00	2.89	50.00	197.00
	5.00	5.00	1,028.00	309.00	30.85	3.86	288.00	5.14	89.00	350.00
	6.00	6.00	1,165.00	349.00	34.95	4.37	326.00	5.83	101.00	396.00

BCAP 6

Title: FRH Burrows RWY Capacity Density Set 3 lbs/cuft. AO=6.3 Temp VARIABLE TEMP deg F, Flow 400gpm

Rearing Model

approx. end of Month	Element	DAY	vtemp_	inches	cm	lbs@	grams@	# / LB.	#/Kg	wt /1000	cm/m	inches/m	# FISH	Tot.lbs.	Tot.Kgs
	Element														
	1	1	6.1	7.5	19.1	0.169	76.544	5.9	13.1	168.7	1.01	0.40	16,631	2,801	1273.0
	2	30	6.1	7.9	20.1	0.197	89.328	5.1	11.2	196.9	1.01	0.40	16,551	3,253	1478.0
	3	60	7.2	8.3	21.1	0.228	103.463	4.4	9.7	228.1	1.19	0.47	16,468	3,748	1704.0
	4	90	10	8.8	22.3	0.269	121.976	3.7	8.2	268.9	1.65	0.65	16,385	4,397	1999.0
	5	120	15.5	9.4	23.9	0.333	151.172	3	6.6	333.3	2.56	1.01	16,303	5,422	2465.0
	6	150	14.4	10.4	26.5	0.452	205.078	2.2	4.9	452.1	2.38	0.94	16,220	7,318	3326.0

Element	%bwfeed	feed lbs/da	feed Kg/day	AO mg/1	Req.Int. DO	%DOsaturation	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
1	0.7	19.2	8.70	6.38	12.4	99	31.06	3.72	90	343.0	4.14	26.50	937.00	0.40	48.0	3.0	0.387
2	0.7	21.2	9.60	6.38	12.4	99	32.70	3.91	99	378.0	4.14	30.80	1,088.00	0.38	48.0	3.0	0.449
3	0.7	27.5	12.50	6.38	12.4	102	29.10	3.48	129	490.0	3.51	35.50	1,254.00	0.36	48.0	3.0	0.517
4	1.0	42.4	19.30	6.38	12.4	112	22.13	2.65	199	755.0	2.53	41.60	1,470.00	0.34	48.0	3.0	0.607
5	1.4	75.4	34.30	6.38	12.4	127	15	1.83	354	1,343.0	1.63	51.30	1,813.00	0.32	48.0	3.0	0.748
6	1.2	85.4	38.80	6.38	12.4	124	18.28	2.19	400	1,522.0	1.75	69.30	2,447.00	0.29	48.0	3.0	1.01

MODEL INPUTS

Statu	Input	Name	Outp	Unit	Com
					PROJECT: FRCWH
					REARING UNIT TYPE: Burrows Recirculating
					RV REARING VOLUME: 2.3m3 80 CF
					AVAILABLE OXYGEN = set by USER 7.0 mg/l
					D.O. IN EFFLUENT IS set by USER 7.0 is recommnded level
	48	MAXkgm3			MAXIMUM DENISTY IN KG / CUBIC METER 32, 48, 65, 80,
	68.6	UNITVOLm3			REARING UNIT VOLUME IN CUBIC METERS
	3	OPVelocity			Velocity in cm/sec (range 3.0 to 5.0 is recommended)
		UNITMETERS			REARING UNIT length in Meters
	'May2013003	DATE			Date of Computer Run 'Month201996
	FRCWH Burrows	Project			hatchery name
	8	Sizeinches			Target Size in Inches
		Number			Target Number
	'RBT	Species			fish species use 3 letter code
	'coldwater	species			oxyreq 'coldwater,cool,warm,talapia
L	1	vtemp_c			enter Variable water temp deg. C in LIST vtemp_c
		tugr	0.006		from LOOKUP TABLE tugr in cm/tu
	1.3	conv			enter food conversion 1.5
	19.05	ilength			enter in centimeters starting length
		iweight	76.54		weight calculated
		k	0.011		from LOOKUP TABLE k metric condition factor
	16634	i#fish			enter initial # of fish starting # THIS VARIABLE IS VARIE
L		#fish	16631		calculated mortality= 1/2%/day/month
	30	pdays			enter # days in period ex. 30
	660	elev			enter elevation in ftMSL
	0.9	oxy%			enter RAW WATER supply initial DO % sa
	6.38	availoxy			enter FIXED Available DO for Operating System 3, 4, 5, 6, et
	6	effluentDO			enter FIXED effluent DO for System 5, 6 or 7 suggested
	7.25	pH			enter pH
	0.417	%uninh3			enter %uninh3 from AMMONIA % IONIZATION TABLE
	0.0125	AUA			enter AUA allowable unionized ammonia (range .010 to 0.025)
	0	bgnh3			enter background Total TAN if any

BY-PRODUCT GENERATION in Kgs. MASS BALANCE FEED TO BY-PRODUCTS

		Month	feedkg	TSS	Total NH3	UNI NH3	co2kg	phoskg	NO3kg	BODkg
	Element	Period	Feedkg	TSSkg	TANkg	UNINH3kg	co2kg	phoskg	NO3kg	BODkg
	1.00	1.00	262.00	79.00	7.87	0.98	73.00	1.31	23.00	89.00
	2.00	2.00	289.00	87.00	8.68	1.09	81.00	1.45	25.00	98.00
	3.00	3.00	375.00	112.00	11.24	1.41	105.00	1.87	33.00	127.00
	4.00	4.00	578.00	173.00	17.34	2.17	162.00	2.89	50.00	197.00
	5.00	5.00	1,028.00	309.00	30.85	3.86	288.00	5.14	89.00	350.00
	6.00	6.00	1,165.00	349.00	34.95	4.37	326.00	5.83	101.00	396.00

BCAP 7 **Title: FRH Burrows RWY 20% increase Capacity Density Set 3.6 lbs/cuft. AO=7.59 Temp VARIABLE TEMP deg F, Flow 400gpm**

Rearing Model

approx. end of Month	Eleme	DAY	vtemp_	inches	cm	lbs@	grams@	# / LB.	#/Kg	wt /1000	cm/m	inches/m	# FISH	Tot.lbs.	Tot.Kgs	%bwfeed
	1	1	6.1	7.5	19.1	0.169	76.544	5.9	13.1	168.7	1.01	0.40	19,752	3,326	1512.0	0.7
	2	30	6.1	7.9	20.1	0.197	89.328	5.1	11.2	196.9	1.01	0.40	19,657	3,863	1756.0	0.7
	3	60	7.2	8.3	21.1	0.228	103.463	4.4	9.7	228.1	1.19	0.47	19,558	4,452	2024.0	0.7
	4	90	10	8.8	22.3	0.269	121.976	3.7	8.2	268.9	1.65	0.65	19,460	5,222	2374.0	1.0
	5	120	15.5	9.4	23.9	0.333	151.172	3	6.6	333.3	2.56	1.01	19,361	6,439	2927.0	1.4
	6	150	14.4	10.4	26.5	0.452	205.078	2.2	4.9	452.1	2.38	0.94	19,263	8,691	3950.0	1.2

Eleme	feed lbs/da	feed Kg/day	AO mg/1	Req.Int. DO	%DOsaturation	max. lbs/gpm	max.kg/lpm	min.GPM	min.LPM	FI lbs/gpm/in	RV VOLm3	RV CF	DI lbs/cuft/in	KG/M3	LBS/cuft	Tot. UNITS
1	22.8	10.40	7.59	13.6	109	36.95	4.42	90	342.0	4.93	26.20	927.00	0.48	57.6	3.6	0.383
2	25.2	11.50	7.59	13.6	109	38.91	4.65	99	377.0	4.93	30.50	1,077.00	0.45	57.6	3.6	0.444
3	32.6	14.80	7.59	13.6	112	34.62	4.14	129	489.0	4.17	35.10	1,241.00	0.43	57.6	3.6	0.512
4	50.3	22.90	7.59	13.6	123	26.33	3.15	198	754.0	3.01	41.20	1,455.00	0.41	57.6	3.6	0.601
5	89.6	40.70	7.59	13.6	139	18	2.18	353	1,341.0	1.94	50.80	1,795.00	0.38	57.6	3.6	0.741
6	101.5	46.10	7.59	13.6	136	21.74	2.60	400	1,519.0	2.09	68.60	2,422.00	0.34	57.6	3.6	1

MODEL INPUTS

Statu	Input	Name	Outp	Unit	Com
					PROJECT: FRCWH
					REARING UNIT TYPE: Burrows Recirculating
					RV REARING VOLUME: 2.3m3 80 CF
					AVAILABLE OXYGEN = set by USER 7.0 mg/l
					D.O. IN EFFLUENT IS set by USER 7.0 is recommnded level
	57.6	MAXkgm3			MAXIMUM DENISTY IN KG / CUBIC METER 32, 48, 65, 80,
	68.6	UNITVOLm3			REARING UNIT VOLUME IN CUBIC METERS
	3	OPVelocity			Velocity in cm/sec (range 3.0 to 5.0 is recommended)
		UNITMETERS			REARING UNIT length in Meters
	'May2013003	DATE			Date of Computer Run 'Month201996
	FRCWH Burrows	Project			hatchery name
	8	Sizeinches			Target Size in Inches
		Number			Target Number
	'RBT	Species			fish species use 3 letter code
	'coldwater	species			oxyreq 'coldwater,cool,warm,talapia
L	1	vtemp_c			enter Variable water temp deg. C in LIST vtemp_c
		tugr	0.006		from LOOKUP TABLE tugr in cm/tu
	1.3	conv			enter food conversion 1.5
	19.05	ilength			enter in centimeters starting length
		iweight	76.54		weight calculated
		k	0.011		from LOOKUP TABLE k metric condition factor
	19755	i#fish			enter initial # of fish starting # THIS VARIABLE IS VARIE
L		#fish	19752		calculated mortality= 1/2%/day/month
	30	pdays			enter # days in period ex. 30
	660	elev			enter elevation in ftMSL
	0.9	oxy%			enter RAW WATER supply initial DO % sa
	7.59	availoxy			enter FIXED Available DO for Operating System 3, 4, 5, 6, et
	6	effluentDO			enter FIXED effluent DO for System 5, 6 or 7 suggested
	7.25	pH			enter pH
	0.417	%uninh3			enter %uninh3 from AMMONIA % IONIZATION TABLE
	0.0125	AUA			enter AUA allowable unionized ammonia (range .010 to 0.025)
	0	bgnh3			enter background Total TAN if any

BY-PRODUCT GENERATION in Kgs. MASS BALANCE FEED TO BY-PRODUCTS

		Month	feedkg	TSS	Total NH3	UNI NH3	co2kg	phoskg	NO3kg	BODkg
	Element	Period	Feedkg	TSSkg	TANkg	UNINH3kg	co2kg	phoskg	NO3kg	BODkg
	1.00	1.00	312.00	93.00	9.35	1.17	87.00	1.56	27.00	106.00
	2.00	2.00	344.00	103.00	10.31	1.29	96.00	1.72	30.00	117.00
	3.00	3.00	445.00	134.00	13.35	1.67	125.00	2.23	39.00	151.00
	4.00	4.00	686.00	206.00	20.59	2.58	192.00	3.43	60.00	233.00
	5.00	5.00	1,221.00	366.00	36.64	4.58	342.00	6.11	106.00	415.00
	6.00	6.00	1,384.00	415.00	41.51	5.19	387.00	6.92	120.00	470.00

Minnesota
Department of Natural Resources

MDNR No. 8F022
File No. FMA.00257.00.00.03
HDR No. 202386

French River Cold Water Hatchery

A. REPORT DRAWINGS AND INDEX OF EXISTING DATA

B. POTENTIAL IMPROVEMENT PHOTOS AND MANUFACTURER DATA

C. FISH PRODUCTION DATA

D. PRODUCTION THEORY

E. EXCERPTS FROM NPDES PERMIT, EXAMPLE DMR, AND FLOODPLAIN MAP

F. BIOSECURITY OVERVIEW

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APPENDICES

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Appendix D - Production Theory

The following text is intended to provide a primer for the terminology and equations that were applied to the analysis of carrying capacities at the FRH.

Production Goals

As defined by Westers (1984) in *Principles of Intensive Fish Culture*, there are four major types of fish production goals:

1. Stocking of produced fish for species restoration, recreational and commercial purposes in natural and man-made waters.
2. Production of food (protein)
3. Production of bait fish
4. Production of ornamental fish

The production of coldwater fish by the MNDNR Hatchery System provides a fisheries management tool in the establishment and maintenance of recreational fisheries in the State of Minnesota.

Fish hatcheries, whose products are employed to fish-management programs, must meet precise requirements for their fish. They must be available at the right time and be of the right size, species, genetic strain and numbers. Shortages as well as excesses create problems both for managers in the field and possibly even more so for program planners, policy makers and administrators. The goal should be to attain the highest possible degree of accuracy and efficiency in the production of these fish (Westers, 1984).

This goal can be achieved by adhering to the following criteria:

1. Quality fish
2. Target numbers
3. Target size
4. Proper accounting (fish enumeration) techniques
5. Feeding efficiency
6. Energy efficiency
7. Labor efficiency

Target Numbers

A goal to be within five to ten percent of the target is reasonable. Past hatchery management records serve to determine the numbers of fish that must be maintained throughout the rearing cycle.

A rearing cycle can be divided into a number of distinct phases, each with its own requirements and typical mortality rate. Such phases may include the following life stages in a hatchery cycle:

1. Incubation
2. Sac fry
3. Feeding fry
4. Early rearing
5. Intermediate rearing
6. Final rearing

It is imperative that accurate records be kept. From these, a survival curve can be constructed after each rearing cycle had been completed. When "abnormal" mortalities occur during the rearing cycle, its cause (s) should be identified so corrective and/or preventative measures can be applied.

Target Size

Fish produced for management must often meet rather precise size requirements. This means that exact size goals must be attained within a definite period of time. The goals must be realistic, of course, and they must fall within the inherent growth potential of the species. While the growth rate for FRH appears to meet management goals, some hatchery management manipulations can be applied to help accomplish the size objectives. Additionally, some conditions inherent at each facility may provide for growth rates that vary depending on time of year and availability of water.

Having enough water to operate their hatcheries to full production potential appears to be the biggest challenge for the MNDNR. When enough water is not available, hatchery managers have a limited amount of options to address the problem. They can: 1. Reduce the feed rates, which results in decreased growth. 2. Increase oxygen levels through mechanical aeration or low pressure air generation. 3. Locate an additional water source. 4. Reduce the density and loadings of the rearing units by removing fish.

Coolwater and warmwater intensive culture follows the same basic principals as those in coldwater. Just like in coldwater intensive culture, better control of environmental factors can be possible such as dissolved oxygen, temperature control, nutrient loading and predator impacts, unlike extensive pond culture as these environmental factors are difficult to control. However, intensive culture requires a consistent high quality water supply, whereas in pond or extensive culture the initial filling is the highest water demand requirement. Once filled, the pond is affected by atmospheric heat and cold, sunlight and clouds all which directly effect productivity and success of fish production.

Another condition that can control growth rate is the manipulation and control of the water temperature. Mechanical methods of temperature control can be expensive but it may not be necessary to do this during the entire rearing cycle. Increasing or lowering the water temperature just during incubation may be all that is necessary. At this time, the flow requirements are quite low. For instance, at the Marquette State Fish Hatchery in Michigan, which produces lake trout yearlings, the goal is to have these fish to a size of 14 cm (5.5 inches) by May. This goal could not be met until well water, with a constant temperature of 7°C (45°F) was installed for incubation and early rearing purposes. Compared with incubating the eggs on creek water, it resulted in approximately a two-month growth advantage over the rearing system. Similarly, the Shepherd of the Hills facility currently incorporates chillers to manipulate lake and well water incubation temperatures in the hatchery building. The process allows the staff to control the rate of growth to better match infrastructure and management needs.

Another approach, in those cases where growth rates tend to fall short, is the production of sufficient extra fish to allow selection of the fastest-growing individuals. A normal curve for size distribution will occur in a hatchery population. By excluding the left portion of the curve, the hatchery manager may be able to meet the size requirement. This could mean that as many as two-thirds of the population may have to be removed at a particular time in the production cycle. It is best, economically, to do this as early in the cycle as possible. However, if a reasonably good use can be made of this excess product for some specific management program, one may want to carry these fish to a size desired for that particular use.

It should be emphasized that, whenever the size falls short by the stocking dates (usually in the spring), it is important to release the fish at that time --- rather than keeping them longer in the hatchery. By retaining fish beyond optimum stocking dates, environmental conditions in the natural waters often have become so unfavorable that high losses can be expected. The most serious problem, for salmonids, is that of too high water temperatures. All options must be explored and evaluated in order to select the best hatchery management procedures to meet the objectives both from an economic and productive point of view.

Proper Accounting Techniques

It is the responsibility of the hatchery manager to have as accurate information on the number of fish in inventory as possible. This is accomplished through regular sampling procedures, accurate mortality records, and occasional total inventories.

Feeding Efficiency

A good method to determine feeding levels is imperative. Levels and frequencies should be worked out by trial and error and from available hatchery management records in order to derive the utilization of the food.

Fish biomass increases exponentially, but requirements for food, expressed in percent body weight, decrease. Normally, there will be a net increase in amount of food to be fed which requires frequent adjustments. How often adjustments should be made depends on growth rates and total biomass. Based on a known conversion rate and rate of growth, calculations can readily provide a feeding regime based on daily adjustments, if desirable.

Such calculations can be used to determine the total food requirements for each rearing cycle by species. Abnormal losses would require reprogramming and, if these occur early enough in the rearing cycle, adjustments in food orders can be made to avoid surplus food. If surplus food does occur at a particular hatchery, it should be programmed into system-wide hatchery production as early as possible, whenever such options exist.

Energy Efficiency

Energy cost is often a significant portion of the operating expenses of a modern hatchery. Although fish health should never be jeopardized, water should not be pumped, aerated or heated beyond what is required to meet program goals. To do the best possible job, the hatchery manager must know the options the water supply and rearing systems in his/her facility offer. Since, the health of the fish must not be endangered, the manager must know the limits to which his/her fish can be exposed in terms of flows, oxygen, etc. He/She must know the biomass of fish he/she has in the system and their specific requirements. Precise information is needed by species, sizes, etc., concerning the environmental requirements throughout an entire hatchery life cycle.

Labor Efficiency

The hatchery manager is responsible for the utilization of his/her people to their fullest potential. He/She should think in terms of training as well as in terms of tangible output. To avoid having people become locked into their job, they must be challenged on a regular basis. It is inescapable that certain parts of the job become more or less automatic. These are the mundane tasks that need to be performed from day to day such as handling food, filling feeders, cleaning tanks and raceways, collecting morts, etc. On the other hand, there is the need to use one's head, not only to figure out how to improve on manual tanks, but even more so in a learning process through experience, training, etc., so that the practical culturist will become an expert in his/her field and that optimum fish husbandry is accomplished. This requires on-the-job training, which is the responsibility of the organization at large.

Hatchery Production Capacity

Methods to define and quantify fish hatchery production capacity are the subject of a substantial volume of aquaculture literature. There are several sources of literature that provide critically needed reference information and calculations for the determination of hatchery carrying capacity and factors limiting carrying capacity. We are listing these sources here in this study to document our specific reference to methods and criteria used to assess the production levels of FRH. The reader is urged to become familiar with these literature resources as we are only extracting principles and excerpts from them.

> Colt, J., K. Orwicz, and G. L. Bouck, 1991. *Water Quality Considerations and Criteria for High Density Fish Culture with Supplemental Oxygen*, American Fisheries Society Symposium 10:372-385.
>
> Krise, W.F., 1991. *Hatchery Management of Lake Trout Exposed to Chronic Dissolved Gas Supersaturation*, American Fisheries Society Symposium 10:368-371.
>
> Meade, J.W., 1985. *Allowable Ammonia for Fish Culture*, Progressive Fish Culturist 47, 135-145.
>
> Piper, R.G., I.B. McElwain, L.E. Orme, J.P. McCraren, L.G. Fowler, and J.R. Leonard, 1982. **Fish Hatchery Management**, United States Department of the Interior, Fish and Wildlife Service, Washington, D.C.
>
> Wedmeyer, G.A., 1996. **Physiology of Fish in Intensive Fish Culture Systems**, Chapman and Hall, New York, NY.
>
> Westers, H., 1984. *Principles of Intensive Fish Culture* (A Manual for Michigan's State Fish Hatcheries), Fisheries Division, Michigan Department of Natural Resources, Lansing, MI.
>
> Westers, H., 2001. *Principles of Intensive Fish Culture – A Bioengineering Approach To Fish Production Facility Design and Operation* (a training manual), 1st Edition, Aquaculture Bioengineering, Inc. Rives Junction, MI.

Carrying capacity by ecological definition is the maximum number of individuals that the resources of a particular habitat can support. Production capacity or capability in aquaculture systems can be expressed in four ways. Each way is valid and all integrate with each other.

1. **Production expressed as maximum weight of fish per unit of flow**. This is defined as LOADING (Ld) either as kg/lpm or lbs/gpm.
2. **Production expressed as maximum weight of fish per unit of rearing space**. This is defined as DENSITY (D) either as kg/m^3 or lbs/ft^3.
3. **Production expressed as maximum carrying capacity**. This is defined as the one time MAXIMUM BIOMASS (MBM) a facility can support, either in kg or lbs.
4. **Production expressed as maximum annual output**. This is defined as the maximum ANNUAL PRODUCTION (AP) a facility can deliver, either as kg, lbs or # fish.

Loading (Ld)

Production in terms of weight per unit of flow is defined as LOADING (Ld) and is expressed either as kg fish per lpm (kg/lpm) or as lbs per gpm (lbs/gpm). The maximum allowable loading that can be realized depends on many factors, the most important ones are:

1. Species and its weight
2. Fish size
3. Source water quality characteristics – of special importance are dissolved oxygen, temperature, pH, and alkalinity.
4. Tolerance towards metabolic waste product build-up in the rearing water – of special importance are ammonia nitrogen, carbon dioxide, and particulate and dissolved solids.

The incoming flow of water into a rearing unit (RU) delivers oxygen while the effluent flow removes the metabolic waste products from the unit. Of these waste products, suspended and dissolved solids, ammonia nitrogen, its products nitrite and nitrate nitrogen, and carbon dioxide are of primary importance to the quality of the rearing water. Solids, biochemical oxygen demand (BOD), nitrogenous compounds and phosphorus in the effluent may represent environmental concerns. These are the typical parameters regulated by NPDES discharge permits.

Feed is responsible for negative changes in rearing water quality beyond the background quality. The amount of feed that can be added per unit of flow depends on how much oxygen is required to metabolize this feed, and how much ammonia, carbon dioxide, and solid waste this feed generates, and at what point one or more of these components render the water quality unacceptable. **In other words, the carrying capacity of intensive aquaculture systems should be rated on how much feed they can "process" before predetermined water quality parameters are exceeded.**

This method is called the mass-balance approach and it uses the identification and quantification of critical environmental factors to determine the physiological requirements of fish metabolism. These critical environmental factors are sometimes termed "limiting factors" and each will be discussed to define their impact to the fish production program. Production Models for trout production may be prepared (and will be included in Appendix of the report) that will reflect the calculations presented in the text of this report. Understanding the theory is crucial to determination of the existing and potential future carrying capacity of the MNDNR hatcheries.

Westers (2001) has defined the relationship between loading (Ld) and density (D). It can be expressed by using the number of water turnovers per hour (R), also called the exchange rate, as the variable with:

Metric: $$Ld = \frac{D \times 0.06}{R}; \quad D = \frac{Ld \times R}{0.06}; \quad R = \frac{D \times 0.06}{Ld} \qquad (1)$$

Ld = kg/lpm; D = kg/m³

English: $$Ld = \frac{D \times 8}{R}; \quad D = \frac{Ld \times R}{8}; \quad R = \frac{D \times 8}{Ld} \qquad (1a)$$

Ld = lb/gpm; D = lb/ft³

Flows, such as lpm or gpm, will be represented by the letter Q. Rearing volume (RV) will be given in units m^3 or ft^3. We can now express the relationship between exchange rate (R), flow rate (Q), and rearing volume (RV) by means of these equations:

Metric: $\mathbf{R = \frac{Q \times 0.06}{RV}}$; $\mathbf{Q = \frac{RV \times R}{0.06}}$; $\mathbf{RV = \frac{Q \times 0.06}{R}}$ (2)

Q = lpm; RV = m³

English: $\mathbf{R = \frac{Q \times 8}{RV}}$; $\mathbf{Q = \frac{RV \times R}{8}}$; $\mathbf{RV = \frac{Q \times 8}{R}}$ (2a)

Q = gpm; RV = ft³

The constant (0.06) in equations 1 and 2 represents 0.06 m^3. A one lpm flow rate exchanges 60 1iters (0.06 m^3) in one hour (60 minutes). The constant (8) in the English equations, 1a and 2a, represents one gpm for one hour (60 gal), which is equivalent to 8.02 ft^3.

The relationship expressed with equations 1 and 2 are very useful in establishing rational design and operational parameters for intensive, flow-through, fish production systems.

Example 1:

If the maximum allowable loading (MLd) is 1.5 kg/lpm (12 lb/gpm) and the maximum density (MD) is 96 kg/m^3 (6 lb/ft^3), then the rearing unit should be operated at an exchange rate (R) of about four (4) water turnovers per hour.

Metric: $R = \frac{96 \times 0.06}{1.5} = \frac{5.76}{1.5} = 3.84$ English: $R = \frac{6 \times 8}{12} = \frac{48}{12} = 4.0$

* Using ambient oxygen conditions

In these two equations, loading, density, and exchange rate must balance once maximum allowable values for loading and density have been established and a desirable exchange rate has been determined. Once this has been accomplished, facility design and operational mode can follow. These factors are the driving force in facility design.

Maximum values for loading density can be selected for different phases of a production program. Phases can include various life stages and/or cohorts for sequential rearing strategies. Facility design must accommodate such phases.

A method developed by (Westers, 2001) can be used to establish “rational” maximum values for loading and density and how to balance such values along with exchange rates. Loading relates to flow rate (Q), while density relates to rearing volume (RV). Maximum biomass (MBM) and required flow can be determined using equations 3 and 4.

$$\mathbf{MBM = D \times RV} \quad (3)$$

$$\mathbf{Q = \frac{MBM}{MLd}} \quad (4)$$

Example 2:

For a rearing volume (RV) of 10 m³ (353 ft³)

Metric: $MBM = 96 \times 10 = 960$ kg

$Q = \frac{960}{1.5} = 640$ lpm

English: $MBM = 6 \times 353 = 2{,}118$ lb

$Q = \frac{2{,}118}{12} = 176$ gpm

Dissolved Oxygen (DO)

In most cases, reduced dissolved oxygen is the first factor limiting water quality. Unless reaeration or oxygenation is applied, the fish will have used up the available oxygen (AO) well before concentrations of metabolic wastes have reached critical levels. Improved dissolved oxygen (DO) management is proposed at all five trout production facilities to reduce or eliminate DO as a limiting water quality factor.

The amount of oxygen per unit of feed is relatively constant for a particular species and independent of fish size and water temperature. For many salmonids and many other species, this oxygen amount ranges from 200 to 280 g per kg feed *(0.20 to 0.25 lb per lb feed or 114 g/lb).* In the examples presented, 250 g/*kg (114 g/lb)* will be used and designated as OF.

The loading equations for feed per unit of flow (Ld_F) are:

Metric: $$\textbf{Ld feed} = Ld_F = \frac{AO}{OF}; \qquad (5)$$

English: $$\textbf{Ld feed} = Ld_F = \frac{3.8 \times AO}{OF} \qquad (5a)$$

AO is available oxygen for the fish (mg/l). This is the difference between the incoming dissolved oxygen concentration (DO_{IN}) and the minimum allowable effluent concentration (DO_{OUT}).

$$AO = DO_{IN} - DO_{OUT} \qquad (6)$$

In these equations, 1.0 lpm at 1.0 mg/l delivers 1,440 mg or 1.44 g per day, because there are 1,440 minutes in a day (60 minutes x 24 hours). If a 16.7-hour day is used instead of a 24-hour day, 1.0 lpm at 1.0 mg/l delivers 1,002 mg or 1.0 g per "day". Westers considers this a feeding day, a period of greatest activity. The result is a more conservative approach because, instead of 1.44 g oxygen, only 1.0 g is considered available. In above equations, AO represents 1.0, from 1.0 mg/l DO available per gpm. The conversion factor for liters to gallons is 3.785 so this factor (or 3.8) is used in Equation 5a.

Example 3:

For values OF = 250 *(114)* and AO =1.0 mg/l, the following amounts of feed can be fed per lpm (gpm):

Metric: $Ld_F = 1.0/250 = 0.004$ kg/lpm

English: $Ld_F = 3.8/114 = 0.033$ lbs/gpm

Note: 1.0 kg/lpm equated to 8.3 lbs/gpm.

To convert the "feed loading" equation to a fish loading equation, we must know how much feed the fish require. Most often this is expressed as percent body weight (% BW). If they require 1.0 BW, then the loading for fish is 100 times the loading for feed.

Percent BW to feed can be calculated using Equation 7 or taken from feeding tables often provided by the feed manufacturer.

Metric: $$\mathbf{\%\ BW = Temp \times (300 \times Tugr \times FC)\ \%} \tag{7}$$

Where:	Temp	Water Temperature, C°
	Tugr	Temperature units per cm of growth (0.004 to 0.008)
	FC	Food conversion
	L	Fish Length, cm
	300	Conversion of length to weight gain ($W=KL^3$)
	K	Metric Condition Factor

The loading equation for fish is:

Metric: $$\mathbf{Ld = \frac{AO \times 100}{OF \times \%BW}} \tag{8}$$

English: $$\mathbf{Ld = \frac{3.8 \times AO \times 100}{OF \times \%BW}} \tag{8a}$$

Example 4:

For 1.0 AO and 1.0 %BW,

Metric: $Ld = \dfrac{1.0 \times 100}{250 \times 1.0} = 0.4$ kg/lpm English: $Ld = \dfrac{3.8 \times 1.0 \times 100}{114 \times 1.0} = 3.3$ lb/gpm

Ammonia Nitrogen

Ammonia (NH_3) is the end product of protein metabolism and is excreted primarily across the gills. As the ambient ammonia concentration builds-up, the rate of ammonia excretion decreases and feeding is reduced. Ammonia is usually the second limiting factor after oxygen.

Ammonia is a weak base and exists both as an un-ionized (NH_3) and ionized (NH_4+) form. The un-ionized form is much more toxic to the fish than the ionized form and water quality criteria are written in terms of the un-ionized form (NH_3).

Fish excrete NH_3, which reacts with the water to form NH_4+ ions. Not all of the NH_3 becomes NH_4+, the less toxic form, but, fortunately in most culture waters by far the largest percentage changes to the ammonium ion. The two forms together are known as total ammonia nitrogen (TAN) and all ammonia is measured as TAN. In most culture water, the un-ionized portion of TAN ranges from 0.2 to 3.0 percent. It is pH and temperature dependent where a higher pH or temperature increases the percent un-ionized ammonia.

Table D1 provides the percent NH_3 in aqueous ammonia (TAN) solutions for 0-30° and pH range of 6-10.

Table D1. Percent NH3 in Aqueous Ammonia Solutions for 0-30°C and pH 6-10

Temp. (°C)	pH								
	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
0	.00827	.0261	.0826	.261	.820	2.55	7.64	20.7	45.3
1	.00899	.084	.0898	.284	.891	2.77	8.25	22.1	47.3
2	.00977	.0309	.0977	.308	.968	3.00	8.90	23.6	49.4
3	.0106	.0336	.106	.335	1.05	3.25	9.60	25.1	51.5
4	.0115	.0364	.115	.363	1.14	3.52	10.3	26.7	53.5
5	.0125	.0395	.125	.394	1.23	3.80	11.1	28.3	55.6
6	.0136	.0429	.135	.427	1.34	4.11	11.9	30.0	57.6
7	.0147	.0464	.147	.462	1.45	4.44	12.8	31.7	59.5
8	.0159	.0503	.159	.501	1.57	4.79	13.7	33.5	61.4
9	.0172	.0544	.172	.542	1.69	5.16	14.7	35.3	63.3
10	.0186	.0589	.186	.586	1.83	5.56	15.7	37.1	65.1
11	.0201	.0637	.201	.633	1.97	5.99	16.8	38.9	66.8
12	.0218	.0688	.217	.684	2.13	6.44	17.9	40.8	68.5
13	.0235	.0743	.235	.738	2.30	6.92	19.0	42.6	70.2
14	.0254	.0802	.253	.796	2.48	7.43	20.2	44.5	71.7
15	.0274	.0865	.273	.859	2.67	7.97	21.5	46.4	73.3
16	.0295	.0933	.294	.925	2.87	8.54	22.8	49.3	74.7
17	.0318	.101	.317	.996	3.08	9.14	24.1	50.2	76.1
18	.0348	.108	.342	1.07	3.31	9.78	25.5	52.0	77.4
19	.0369	.117	.368	1.15	3.56	10.5	27.0	53.9	78.7
20	.0396	.125	.396	1.24	3.82	11.2	28.4	55.7	79.9
21	.0427	.135	.425	1.33	4.10	11.9	29.9	57.5	81.0
22	.0459	.145	.457	1.43	4.39	12.7	31.5	59.2	82.1
23	.0493	.156	.491	1.54	4.70	13.5	33.0	60.9	83.2
24	.0530	.167	.527	1.65	5.03	14.4	34.6	62.6	84.1
25	.0569	.180	.566	1.77	5.38	15.3	36.3	64.3	85.1
26	.0610	.193	.607	1.89	5.75	16.2	37.9	65.9	85.9
27	.0654	.207	.651	2.03	6.15	17.2	39.6	67.4	86.8
28	.0701	.221	.697	2.17	6.56	18.2	41.2	68.9	87.5
29	.0752	.237	.747	2.32	7.00	19.2	42.9	70.4	88.3
30	.0805	.254	.799	2.48	7.46	20.3	44.6	71.8	89.0

Source: Emerson et al., Ammonia Equilibrium pH and Temperature, *J. Fish.Res.Board, Can.*, Vol. 32/12/1975

The amount of TAN generated per kg feed (TAN_F) depends on the protein content, or diet composition, i.e., protein – energy ratio and species of fish. Generally, it ranges from 25 to 30 g per kg feed (*11.4 to 13.6 g per lb. feed or 0.025 to 0.03 lbs/lb feed*).

Example 3 shows that for AO = 1.0 and OF = 250, 0.004 kg feed can be fed per lpm (*or 0.033 lbs/gpm*). Using TAN_F = 30, 0.12 g of TAN is generated (or Ld_F x TAN_F or 0.004 x 30). Similarly, 0.45 g TAN is generated using English units (*0.033 x 13.5 g is 0.45 g TAN or 0.001 lbs of TAN*).

The equation for TAN in the form of a concentration, mg/l (TAN_C) is:

Metric: $$\mathbf{TAN_C = (AO/OF) \times TAN_F/1.0} \quad (9)$$

English: $$\mathbf{TAN_C = (3.8\ AO/OF) \times TAN_F/3.8} \quad (9a)$$

Simplified, when AO = 1.0 mg/l, the equations both become:

$$\mathbf{TAN_C = (TAN_F) / (OF)} \quad (10)$$

Example 4:

For values OF = 250 *(114)* and AO =1.0 mg/l, the following amounts of TAN_C are generated:

Metric: TAN_C = 30/250 = 0.12 mg/l English: TAN_C = 13.6/114 = 0.119 or 0.12 mg/l

In both cases, the concentration of TAN is 0.12 mg/l (0.12/1.0 and .45/3.8). Again, this is based on a "feeding day" of 16.7 hours. Peak TAN production occurs about four (4) hours after feeding. Recall, this is per one AO. These values must be multiplied by the AO values. Thus, the equations should be for both metric and English units:

$$\mathbf{TAN_C = (AO \times TAN_F) / (OF)} \quad (11)$$

The concentration of un-ionized ammonia (UA_C) is the concentration of TAN times the percent un-ionized ammonia divided by 100.

$$\mathbf{UA_C = [(AO \times TAN_F) / (OF)] \times [(\%UA) / 100]} \quad (12)$$

Simplified:

$$\mathbf{UA_C = [(AO \times TAN_F \times \%\ UA) / (100 \times OF)]} \quad (13)$$

In both cases, the concentration of TAN is 0.12 mg/l (0.12/1.0 and .45/3.8). Again, this is based on a "feeding day" of 16.7 hours. Peak TAN production occurs about four (4) hours after feeding. Recall, this is per one AO. These values must be multiplied by the AO values. Thus, the equations should be for both metric and English units:

$$\mathbf{TAN_C = (AO \times TAN_F) / (OF)} \quad (11)$$

The concentration of un-ionized ammonia (UA_C) is the concentration of TAN times the percent un-ionized ammonia divided by 100.

$$\mathbf{UA_C = [(AO \times TAN_F) / (OF)] \times [(\%UA) / 100]} \quad (12)$$

Simplified:

$$\mathbf{UA_C = [(AO \times TAN_F \times \%\ UA) / (100 \times OF)]} \quad (13)$$

Example 5:

For values OF = 250 *(114),* AO =1.0 mg/l and UA = 1.0%, the following amounts of un-ionized ammonia are generated:

Metric: UA_C = (1.0 x 30 x 1.0) / (100 x 250) = 0.0012 mg/l

English: UA_C = (1.0 x 13.6 x 1.0) / (100 x 114) = 0.00119 or 0.0012 mg/l

Finally, it is necessary to decide the maximum concentration of allowable un-ionized ammonia acceptable for the fish (particular species). This is designated as AUA. This value has been widely studied (Meade 1985) but it is generally agreed to be in the range of 0.0125 to 0.025 mg/l. Wedemeyer (1996) suggests a value of 0.02 mg/l and an effluent DO of 6.0 mg/l as appropriate for salmonids.

It is shown that, per 1.0 mg/l AO, and the values used in the examples, the UA_C is 0.0012. For an AO value of 2.0, this concentration would be 0.0024 (2 x 0.0012), etc.

Therefore, the maximum oxygen that can be made available (MAO) can be calculated as follows:

$$\mathbf{MAO = (AUA) / (UA_C)} \qquad (14)$$

Example 6:

For values UA_C = 0.0012 and AUA = 0.02 mg/l, the MAO is:

MAO = (0.02) / (0.0012) = 16.7 mg/l

Recall that it is based on a one percent un-ionized ammonia value (% UA = 1.0). Should this value be 0.5%, twice as much oxygen can be made available and at 2.0%, only half the amount. The loadings can be calculated for the MAO determined above, using equations 8 and 8a.

Example 7:

For values OF = 250 *(114),* AO =1.0 mg/l and %BW = 1.0%:

Metric: Ld = (16.7 x 100) / (250 x 1.0) = 6.6 kg/lpm

English: Ld = (3.8 x 16.7 x 100) / (114 x 1.0) = 55.6 lbs/gpm

The next expression for carrying capacity is related to rearing volume requirements.

Density (D)

Carrying capacity, as it relates to rearing space, is expressed as DENSITY in kg fish per cubic meter rearing volume or as pounds per cubic foot. The maximum allowable or safe rearing density depends on many factors, but the species and its size, are the primary ones. Determining the optimum density is still a rather subjective decision driven by personal convictions and/or experiences, traditions, and/or reports in the literature. Even the terminology of “low” and “high” rearing density is an uncertain one, because what someone might consider a low density, someone else may consider high.

To bring some uniformity into this rather arbitrary situation the use of a density index (DI) has been proposed. This index relates the length of the fish directly proportional to an allowable, or optimum, rearing density. The longer the fish, the greater the density it can tolerate, thus the DI multiplied with the length of the fish provides the density.

For metric equivalents, a density index of 3.2 means that a 10 cm fish can be reared at a density of 32 kg/ m^3. For English equivalents the DI is 0.5, thus a 4" fish (10 cm) can be reared at 2 lbs/ft^3. One pound per cubic foot equates with 16 kg per cubic meter.

Low rearing densities require much rearing space (expensive) and often this results in low water turnover rates, low R values, and poor hydraulics.

Ideally, there should be a balance between loading, density and exchange rates. This balance has previously been expressed in equations (1) and (1a). Loading (Ld) can be determined rationally (see equations 8 and 8a).

The selection of density is subjective, but a choice must be made. Density values for different phases of rearing are often selected. Once this is accomplished, the exchange rate (R) follows. Conservation hatcheries have been traditionally designed to rear non-anadromous salmonids in the density range of 30-80 kg/m^3 (1.8 to 5 lb/ft^3).

Both equations include loading and exchange rate, and, once these have been determined, the rearing density is fixed (equations 1 and 1a). It now becomes a matter of selecting the best values for loading and exchange rates to accomplish acceptable system efficiency.

As discussed in Wedemeyer (1991) density tolerance has been difficult to quantify. In many cases, densities have been identified as problematic when loadings and exchange rates were really the limiting factors. The pathogen load of the water supply is also as relevant to density tolerance as it is to carrying capacity but is difficult to quantify. When possible, the use of a specific pathogen free water supply avoids the pathogen load problems associated with open water supplies.

For flow-through systems, design-driving forces also include loading and exchange rates, which may include the need for serial reuse design to efficiently balance loadings, densities and exchange rates according to equations 1 and 1a.

The third and fourth way to express production capability is by means of determining the maximum biomass a system can support (MBM) and how this relates to a maximum annual production capability (AP).

Maximum One-Time, Biomass (MBM)

The maximum biomass a system can support is expressed in kg or lbs. Once this biomass has been reached, fish must be removed at the daily rate of weight gain. A facility is used most efficiently if it can maintain this maximum biomass continuously by daily harvesting the addition of weight. For instance, if the maximum biomass is 1000 kg and the daily feed level is one percent, 10 kg of feed is added daily. For a feed efficiency of 70 percent (feed conversion of 1.4), the daily gain in fish weight is 7.0 kg. If this were possible to do throughout a year (365 days) the annual output would be 2555 kg, which is 2.55 times the maximum biomass of 1000 kg. This method is not always appropriate with the state production programs but is used in some food fish production facilities.

Maximum Annual Output (AP)

Batch culture strategy rears a group of same age fish (a cohort) and grows them until they have reached stocking or market size. This is followed by another batch. There can be some overlapping of batches, but they will not be mixed. This strategy is most commonly used by public hatcheries that raise fish for stocking into natural waters. The natural life cycle of the fish in mimicked. Many species reproduce but once a year making a new cohort available but once a year. This is especially true in the temperate zones with its seasons. However, some manipulations are possible.

Rearing Unit Water Velocity

A water velocity of 3 cm/sec (0.1 ft/sec) is the minimum velocity that will prevent solids (fecal material and uneaten food) from settling out and helping to keep linear rearing units clear. Water velocity is a direct function of exchange rate (R) and raceway length (L). High R values are required to achieve self-cleaning in rectangular raceways.

Metric, for V cm/sec $$\mathbf{V = \frac{L\ (Meters) \times R}{36}} \quad (15)$$

English, for V ft/sec $$\mathbf{V = \frac{L\ (Feet) \times R}{3600}} \quad (15a)$$

Example 8:

For a typical raceway 100' x 8' x 2' raceway (RV = 1,600 ft^3):

R=2: $V\ ft/sec = \frac{100' \times 2}{3600} = 0.056\ ft/sec$

R=4: $V\ ft/sec = \frac{100' \times 4}{3600} = 0.10\ ft/sec$

R=3.6: $Q = \frac{RV \times R}{8} = \frac{1600 \times 3.6}{8} = 720\ gpm$

Minnesota
Department of Natural Resources

MDNR No. 8F022
File No. FMA.00257.00.00.03
HDR No. 202386

French River Cold Water Hatchery

A. REPORT DRAWINGS AND INDEX OF EXISTING DATA

B. POTENTIAL IMPROVEMENT PHOTOS AND MANUFACTURER DATA

C. FISH PRODUCTION DATA

D. PRODUCTION THEORY

E. EXCERPTS FROM NPDES PERMIT, EXAMPLE DMR, AND FLOODPLAIN MAP

F. BIOSECURITY OVERVIEW

G. WATER QUALITY AND TEMPERATURE DATA

H. INTAKE DIVE REPORT

I. OPERATING COST DATA

J. CITED LITERATURE

APPENDICES

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STATE OF MINNESOTA

Minnesota Pollution Control Agency

Industrial Division
National Pollutant Discharge Elimination System (NPDES)/
State Disposal System (SDS) Permit MN0004413

PERMITTEE:	Minnesota Department of Natural Resources
FACILITY NAME:	MDNR French River Hatchery
RECEIVING WATER:	French River (Class 1B,2A,3B,3C,4A,4B,5,6 water)

CITY OR TOWNSHIP:	Duluth	**COUNTY:**	St. Louis
ISSUANCE DATE:	May 23, 2011	**EXPIRATION DATE:**	April 30, 2016
MODIFICATION DATE:	**May 18, 2012**		

The state of Minnesota, on behalf of its citizens through the Minnesota Pollution Control Agency (MPCA), authorizes the Permittee to operate a disposal system at the facility named above and to discharge from this facility to the receiving water named above, in accordance with the requirements of this permit.

The goal of this permit is to reduce pollutant levels in point source discharges and protect water quality in accordance with Minnesota and U.S. statutes and rules, including Minn. Stat. chs. 115 and 116, Minn. R. chs. 7001, 7050, 7053, 7060, 7090, and the U.S. Clean Water Act.

This permit is effective on the issuance date identified above, as modified on May 18, 2012. This permit expires at midnight on the expiration date identified above.

Signature: ______________________________

Jeff Udd, P.E.
Supervisor, Water Quality Permits Unit
Water Section
Industrial Division

for The Minnesota Pollution Control Agency

Submit DMRs to:
Attention: Discharge Monitoring Reports
Minnesota Pollution Control Agency
520 Lafayette Rd N
St Paul, MN 55155-4194

Submit Other WQ Reports to:
Attention: WQ Submittals Center
Minnesota Pollution Control Agency
520 Lafayette Rd N
St Paul, MN 55155-4194

Questions on this permit?

- For DMR and other permit reporting issues, contact: Belinda Nicholas, 651-757-2613.
- For specific permit requirements or permit compliance status, contact: John Thomas, 218-302-6616.
- General permit or NPDES program questions, contact: MPCA, 651-282-6143 or 1-800-657-3938.

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Facility Description

The Minnesota Department of Natural Resources' French River State Fish Hatchery (Facility) is located at T51N, R12W, Section 17, Duluth, St. Louis County, Minnesota. The principal activity at this Facility is the production of cold-water fish species (trout and salmon) for stocking purposes, at an annual maximum and average production of 72,142 and 43,046 pounds, respectively. The Facility consists of all fish production areas and non-sewage wastewater disposal systems within the area designated on the map below. Sanitary waste water from the Facility is handled by the North Shore Sanitary District.

Water for the Facility is pumped from Lake Superior, via a gravity flow through a 400-foot long 20-inch diameter steel pipe from 26 feet deep on the lake bottom to a sump. The water is pumped from the sump to the hatchery by one of two turbine pumps. These pumps can move 800 gallons per minute, and are only run individually. Water pumped to the facility is then filtered, treated by ultraviolet radiation, and is heated during the cold winter months.

In the mechanical room of the hatchery, the water passes through a separator to remove sand, grit, particulates, and debris. The water then flows through a bank of 250-micron mesh fine filters before passing through a large spray pipe to aerate it. This clean water then gravity flows back to the mechanical room to a header where it is divided into the hot loop or supply lines for various rearing units. The heated water is remixed with the cold water to get desired rearing temperatures in the rearing units.

In the nursery, eggs are incubated in heath trays where formalin is added every other day as a fungicide. After hatching, when the fry are at the swim-up stage they are put in tanks and started on feed. Feedings start at 8 times daily and are eventually weaned down to 4 feedings a day. The health status of the fish is observed at all times and treated when necessary according to label instructions of the products being used. Rearing units are drawn down and waste feed and fecal material are swept out daily.

Water leaves the nursery after one pass and flows to the recirculating burrows system. The water first goes through the biofilters where a lot of solids concentrate and settle out. The bacteria growing on the surface media in the biofilters also break down the ammonia the fish have added to the water. The water is then held in reservoirs called clear wells. Water is pumped from the clear wells to the aeration tower where carbon dioxide is allowed to escape and oxygen is incorporated. It then flows to six large rearing units at the rate of 400 gallons per minute. These units provide the majority of the grow-out space in the hatchery. Fish are generally feeding on the demand feeders and can consume up to 100 pounds of feed per unit per day.

As water comes in from the nursery it displaces water from the burrows system, which flows to the five pole building raceways. Fish in these units are fed by hand, by belt feeders, or by demand feeders. The units are cleaned every other day. When cleaning, the water is diverted to the clarifier, otherwise it flows to the outlet from the clarifier and flows into the settling pond.

Solids from the recirculating biofilter system as well as wastewater from other units at the facility are routed to a linear clarifier for settling. The clarified water flows into the settling pond and eventually over the dam boards and through pipe outfall 020 (Station SD001) to the French River (class 1B, 2A, 3B, 4A, 4B, 5 & 6 waters) at average and maximum rates of 0.72 and 1.52 million gallons per day, respectively just above the fish trap. The French River flows into Lake Superior (class 1B, 2A, 3A, 3C, 4A, 4B, 5 & 6 waters), an Outstanding Resource Value Water.

The units are cleaned every other day and drained off to the clarifier. The biofilters are cleaned twice a week and drained to the clarifier. The clarifier has wooden sweeps, which move the settled solids to a sump where they are concentrated then pumped into a holding vault. These solids are utilized by Western lake Superior Sanitary District as a nitrogen source for their food and yard waste composting program. Solids from the linear clarifier are removed regularly and pumped to the solids storage unit (WS301: Solids to WLSSD Treatment or Compost) at a rate of approximately 116 dry pounds per year (based on amount of feed used). Solids from the storage unit are managed in accordance with the "Transported Liquid Waste" program at Western Lake Superior Sanitary District (WLSSD), are composted at WLSSD, in accordance with their Source Separated Organics Composting Facility Permit (SW-583), or are burned in the facility's on-site wood fired boiler. Transported Liquid Waste is added to the wastewater entering WLSSD, and is treated in the wastewater treatment process -- a temperature phased anaerobic digestion process. Land application of solids from the permitted Facility is not authorized under this permit.

The holding vault is an in ground re-enforced concrete structure which is buried in red Lake Superior clay. The vault is tested once a year using static level over time to detect any leaking. A visual inspection is done late in the year when the vault is pumped out before winter sets in.

Chemical additives approved for use at the Facility are included in Chapter 1, Aquaculture in the permit language. Use of these chemicals will not exceed the rates permitted by this permit language. Any change in use of these chemical additives must be approved by the MPCA prior to altering usage at the Facility.

There are two Aboveground Storage Tanks (AST) on-site, but both are smaller than the threshold which would be covered by an AST permit. On-site stormwater is directed down the driveway into the ditch along North Shore Drive which evaporates or infiltrates. Some of the water drains along the west edge of the hatchery that is intercepted and directed into the settling pond. This Facility is not required to have coverage under the Industrial Stormwater Multi-Sector General Permit.

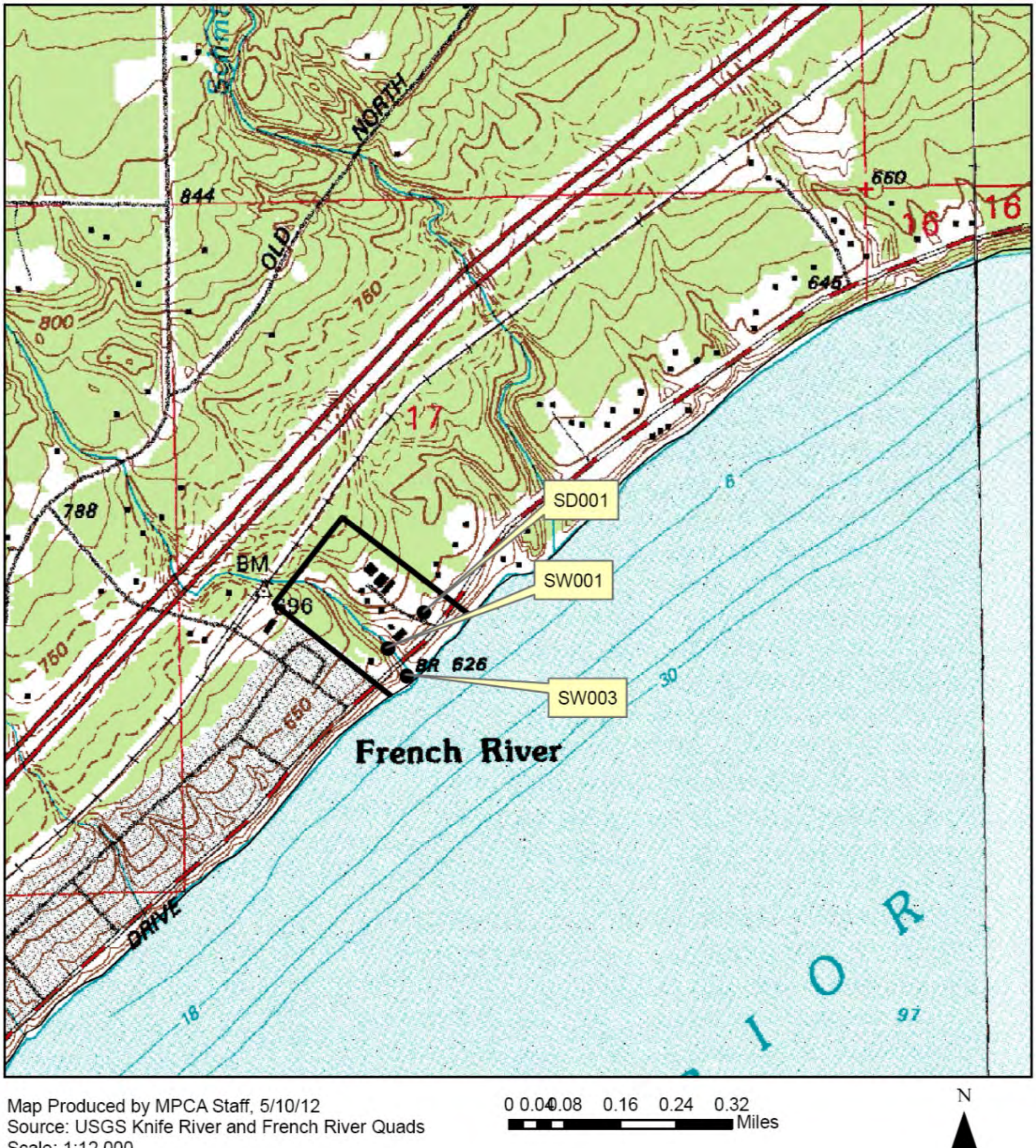
The location of designated monitoring stations is specified on the "Summary of Stations and Station Locations." The location of the facility is shown on the "Topographical Map of Permitted Facility."

In accordance with MPCA rules regarding nondegradation for all waters that are not Outstanding Resource Value Waters, nondegradation review is required for any new or expanded significant discharge (Minn. R. 7050.0185). A significant discharge is: (1) a new discharge (not in existence before January 1, 1988) that is greater than 200,000 gallons per day to any water other than a Class 7 water or (2) an expanded discharge that expands by greater than 200,000 gallons per day that discharges to any water other than a Class 7 water or (3) a new or expanded discharge containing any toxic pollutant at a mass loading rate likely to increase the concentration of the toxicant in the receiving water by greater than one percent over the baseline quality. The flow rate used to determine significance is the design **maximum daily** flow. The January 1, 1988, calculated design **maximum daily** flow for this Facility is 1.52 mgd

This Permit also complies with Minn. R. 7053.0275 regarding anti-backsliding. Any point source discharger of sewage, industrial, or other wastes for which a NPDES permit has been issued by the MPCA that contains effluent limits more stringent than those that would be established by Minn. R. 7053.0215 to 7053.0265 shall continue to meet the effluent limits established by the permit, unless the permittee establishes that less stringent effluent limits are allowable pursuant to federal law, under section 402(o) of the Clean Water Act, United States Code, title 33, section 1342.

Topographical Map of the Permitted Facility

MN0004413 MDNR French River Hatchery
T51N, R12E, Section 17
Duluth, St. Louis County, Minnesota



Map Produced by MPCA Staff, 5/10/12
Source: USGS Knife River and French River Quads
Scale: 1:12,000

MDNR French River Hatchery
Summary of Stations

Waste Stream Stations

Station	Type of Station	Local Name	PLS Location
WS301	Solids to Land Treatment/Application	Solids to WLSSD for Treatment or Compost	SW Quarter of the Section 17, Township 51 North, Range 12 West

Surface Discharge Stations

Station	Type of Station	Local Name	PLS Location
SD001	Effluent To Surface Water	Discharge 020	SW Quarter of the NE Quarter of the SW Quarter of Section 17, Township 51 North, Range 12 West

Surface Water Stations

Station	Type of Station	Local Name	PLS Location
SW001	Stream/River/Ditch, Upstream	French River upstream station 701	NW Quarter of the NE Quarter of the SW Quarter of Section 17, Township 51 North, Range 12 West
SW003	Stream/River/Ditch, Downstream	French River downstream station 702	NE Quarter of Section 17, Township 51 North, Range 12 West

The Permittee shall comply with the limits and monitoring requirements as specified below.

SD 001: Discharge 020

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Bicarbonates (HCO3)	Monitor Only	mg/L	Calendar Year Maximum	Jan-Dec	24-Hour Flow Composite	1 x Year	2
BOD, Carbonaceous 05 Day (20 Deg C)	Monitor Only	kg/day	Calendar Month Average	Jan, Apr, Jul, Oct	Grab	1 x Month	
BOD, Carbonaceous 05 Day (20 Deg C)	25	mg/L	Calendar Month Average	Jan, Apr, Jul, Oct	Grab	1 x Month	
BOD, Carbonaceous 05 Day (20 Deg C)	Monitor Only	kg/day	Daily Maximum	Jan, Apr, Jul, Oct	Grab	1 x Month	
BOD, Carbonaceous 05 Day (20 Deg C)	50	mg/L	Daily Maximum	Jan, Apr, Jul, Oct	Grab	1 x Month	
Calcium, Total (as Ca)	Monitor Only	mg/L	Calendar Year Maximum	Jan-Dec	24-Hour Flow Composite	1 x Year	2
Chloride, Total	Monitor Only	mg/L	Calendar Year Maximum	Jan-Dec	24-Hour Flow Composite	1 x Year	2
Flow	Monitor Only	mgd	Calendar Month Average	Jan-Dec	Measurement	2 x Month	
Flow	Monitor Only	MG	Calendar Month Total	Jan-Dec	Measurement	2 x Month	
Flow	Monitor Only	mgd	Daily Maximum	Jan-Dec	Measurement	2 x Month	
Hardness, Calcium & Magnesium, Calculated (as CaCO3)	Monitor Only	mg/L	Calendar Year Maximum	Jan-Dec	24-Hour Flow Composite	1 x Year	2
Magnesium, Total (as Mg)	Monitor Only	mg/L	Calendar Year Maximum	Jan-Dec	24-Hour Flow Composite	1 x Year	2
pH	8.5	SU	Instantaneous Maximum	Jan, Apr, Jul, Oct	Grab	1 x Month	1
pH	6.5	SU	Instantaneous Minimum	Jan, Apr, Jul, Oct	Grab	1 x Month	1
Phosphorus, Total (as P)	2.5	kg/day	Calendar Month Average	Jan, Apr, Jul, Oct	Grab	1 x Month	
Phosphorus, Total (as P)	1.0	mg/L	Calendar Month Average	Jan, Apr, Jul, Oct	Grab	1 x Month	
Potassium, Total (as K)	Monitor Only	mg/L	Calendar Year Maximum	Jan-Dec	24-Hour Flow Composite	1 x Year	2
Sodium, Total (as Na)	Monitor Only	mg/L	Calendar Year Maximum	Jan-Dec	24-Hour Flow Composite	1 x Year	2
Solids, Total Dissolved (TDS)	Monitor Only	mg/L	Calendar Year Maximum	Jan-Dec	24-Hour Flow Composite	1 x Year	2
Solids, Total Suspended (TSS)	Monitor Only	kg/day	Calendar Month Average	Jan, Apr, Jul, Oct	Grab	1 x Month	
Solids, Total Suspended (TSS)	30	mg/L	Calendar Month Average	Jan, Apr, Jul, Oct	Grab	1 x Month	
Solids, Total Suspended (TSS)	Monitor Only	kg/day	Daily Maximum	Jan, Apr, Jul, Oct	Grab	1 x Month	
Solids, Total Suspended (TSS)	60	mg/L	Daily Maximum	Jan, Apr, Jul, Oct	Grab	1 x Month	
Specific Conductance	Monitor Only	umh/cm	Calendar Year Maximum	Jan-Dec	Measurement	1 x Year	2
Sulfate, Total (as SO4)	Monitor Only	mg/L	Calendar Year Maximum	Jan-Dec	24-Hour Flow Composite	1 x Year	2
Temperature, Water (F)	Monitor Only	Deg F	Calendar Month Average	Jan-Dec	Measurement, Instantaneous	2 x Month	
Temperature, Water (F)	Monitor Only	Deg F	Daily Maximum	Jan-Dec	Measurement, Instantaneous	2 x Month	

The Permittee shall comply with the limits and monitoring requirements as specified below.

SW 001: French River upstream station 701

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Temperature, Water (F)	Monitor Only	Deg F	Calendar Month Average	Jan-Dec	Measurement, Instantaneous	2 x Month	
Temperature, Water (F)	Monitor Only	Deg F	Daily Maximum	Jan-Dec	Measurement, Instantaneous	2 x Month	

SW 003: French River downstream station 702

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Temperature, Water (F)	Monitor Only	Deg F	Daily Maximum	Jan-Dec	Measurement, Instantaneous	2 x Month	
Temperature, Water (F)	50	Deg F	Calendar Month Average	Oct-Apr	Measurement, Instantaneous	2 x Month	5
Temperature, Water (F)	Monitor Only	Deg F	Calendar Month Average	May-Sep	Measurement, Instantaneous	2 x Month	4

WS 301: Solids to WLSSD for Treatment or Compost

Parameter	Limit	Units	Limit Type	Effective Period	Sample Type	Frequency	Notes
Chloride, Dry Weight (as Cl)	Monitor Only	mg/kg	Single Value	Sep-Aug	Composite	1 x Year	3
Nitrogen, Ammonia, Dry Weight	Monitor Only	%	Single Value	Sep-Aug	Composite	1 x Year	3
Nitrogen, Kjeldahl, Total, Solid Fraction, Dry Weight	Monitor Only	%	Single Value	Sep-Aug	Composite	1 x Year	3
Oil & Grease, Total	Monitor Only	mg/kg	Single Value	Sep-Aug	Composite	1 x Year	3
pH, Sludge	Monitor Only	SU	Single Value	Sep-Aug	Composite	1 x Year	3
Phosphorus, Total, Dry Wt (as P2O5)	Monitor Only	%	Single Value	Sep-Aug	Composite	1 x Year	3
Sodium, Dry Weight (as Na)	Monitor Only	mg/kg	Single Value	Sep-Aug	Composite	1 x Year	3
Sodium, Total (as Na)	170	lbacyr	Single Value	Sep-Aug	Composite	1 x Year	3
Solids, Total	Monitor Only	%	Single Value	Sep-Aug	Composite	1 x Year	3
Solids, Total Volatile, Percent of Total	Monitor Only	%	Single Value	Sep-Aug	Composite	1 x Year	3

The Permittee shall comply with the limits and monitoring requirements as specified below.

Notes:
1 -- Analyze immediately.
2 -- Following monitoring for two years, the facility may submit a request for MPCA to review data and reevaluate frequency of monitoring.
3 -- Refer to Table 2 of the 'Tables for Industrial By-Products Chapter' appendix of this permit to determine the minimum frequency of analysis for these analytes. Samples must be representative of the industrial by-product land applied, and in some cases, the minimum frequencies of analysis will not be adequate to achieve a representative sample. In this case, additional analysis may be required.
4 -- The temperature for this station shall not exceed the corresponding monthly average temperature established for the upstream monitoring station (SW001: French River upstream station 701).
5 -- This is a site specific standard as determined in 2004. The temperature limitation applies for this station, except if the temperature for the same period for the upstream monitoring station (SW001: French River upstream station 701) exceeds 50 deg F. In that case, the temperature for this station shall not exceed the temperatures at the upstream monitoring station, based on their respective monthly average temperatures.

FACILITY NAME/ADDRESS:
MDNR French River Hatchery
5357 N Shore Dr
Duluth,MN 55804

STATION INFORMATION:
SD-001 (Discharge 020)
Surface Discharge, Effluent To Surface Water

No Discharge ('Yes' or 'No'): No

WASTEWATER TREATMENT
DISCHARGE MONITORING REPORT

PERMIT#	LIMIT STATUS	FORMER #
MN0004413	FINAL	

	MONITORING PERIOD		
	YEAR|MO|DAY		YEAR|MO|DAY
FROM:	2012-11-01	TO:	2012-11-30

PERMITEE NAME/ADDRESS:
MDNR French River Hatchery
5357 N Shore Dr
Duluth,MN 55804

PARAMETER		QUANTITY		UNITS	CONCENTRATION			UNITS	FREQUENCY OF ANALYSIS		SAMPLE TYPE
Flow	SAMPLE VALUE	******	14.26	MG	******	0.475	0.475	mgd	2	Month	Measur
50050	PERMIT REQ	******	REPORT CalMoTot		******	REPORT CalMoAvg	REPORT DailyMax		2x	Month	Measur
Temperature, Water (F)	SAMPLE VALUE	******	******	****	******	45.0	46.0	Deg F	2	Month	MeaIns
00011	PERMIT REQ	******	******		******	REPORT CalMoAvg	REPORT DailyMax		2x	Month	MeaIns

COMMENTS:

FACILITY NAME/ADDRESS:
MDNR French River Hatchery
5357 N Shore Dr
Duluth,MN 55804

WASTEWATER TREATMENT
DISCHARGE MONITORING REPORT

PERMITEE NAME/ADDRESS:
MDNR French River Hatchery
5357 N Shore Dr
Duluth,MN 55804

PERMIT#	LIMIT STATUS	FORMER #
MN0004413	FINAL	

STATION INFORMATION:
SW-001 (French River upstream station 701)
Surface Water, Stream/River/Ditch, Upstream

	MONITORING PERIOD		
	YEAR|MO|DAY		YEAR|MO|DAY
FROM:	2012-11-01	TO:	2012-11-30

No Flow ('Yes' or 'No'): No

PARAMETER		QUANTITY		UNITS	CONCENTRATION			UNITS	FREQUENCY OF ANALYSIS		SAMPLE TYPE
Temperature, Water (F)	SAMPLE VALUE	******	******	****	******	32.0	32.0	Deg F	2	Month	MeaIns
00011	PERMIT REQ	******	******		******	REPORT CalMoAvg	REPORT DailyMax		2x	Month	MeaIns

COMMENTS:

FACILITY NAME/ADDRESS:
MDNR French River Hatchery
5357 N Shore Dr
Duluth,MN 55804

WASTEWATER TREATMENT
DISCHARGE MONITORING REPORT

PERMITEE NAME/ADDRESS:
MDNR French River Hatchery
5357 N Shore Dr
Duluth,MN 55804

PERMIT#	LIMIT STATUS	FORMER #
MN0004413	FINAL	

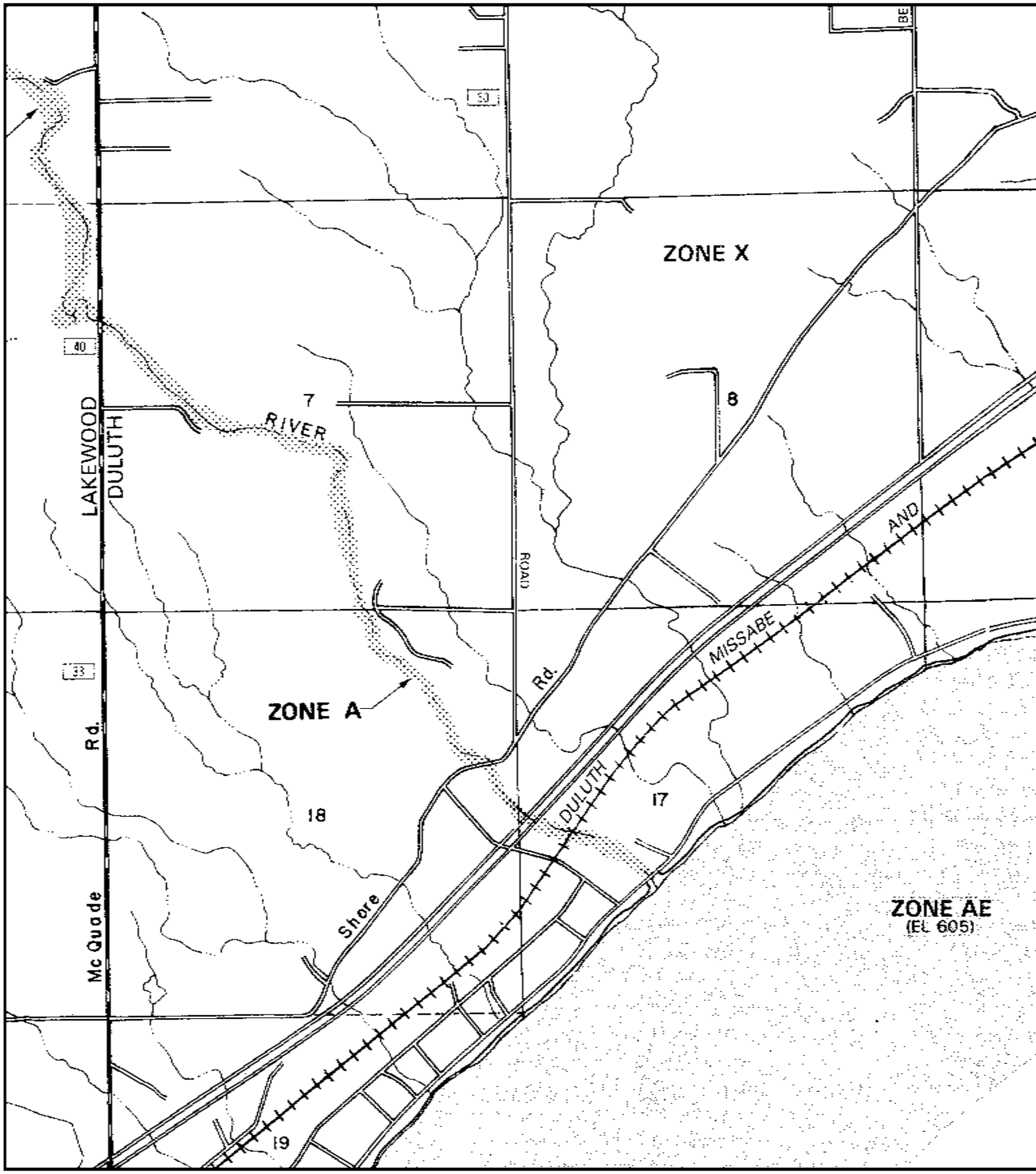
STATION INFORMATION:
SW-003 (French River downstream station 702)
Surface Water, Stream/River/Ditch, Downstream

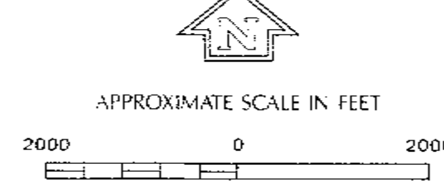
	MONITORING PERIOD		
	YEAR|MO|DAY		YEAR|MO|DAY
FROM:	2012-11-01	TO:	2012-11-30

No Flow ('Yes' or 'No'): No

PARAMETER		QUANTITY		UNITS	CONCENTRATION			UNITS	FREQUENCY OF ANALYSIS		SAMPLE TYPE
Temperature, Water (F)	SAMPLE VALUE	******	******	****	******	35.5	37.0	Deg F	2	Month	MeaIns
00011	PERMIT REQ	******	******		******	50 CalMoAvg	REPORT DailyMax		2x	Month	MeaIns

COMMENTS:





NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

ST. LOUIS COUNTY, MINNESOTA
(UNINCORPORATED AREAS)

PANEL 1500 OF 1675
(SEE MAP INDEX FOR PANELS NOT PRINTED)

INCLUDES:

TOWNSHIP NAME	NUMBER
DULUTH	270731
GNESEN	270737
LAKEWOOD	270738
RICE LAKE	270742

COMMUNITY–PANEL NUMBER:
270416 1500 C

EFFECTIVE DATE:
FEBRUARY 19, 1992

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

Minnesota Department of Natural Resources

MDNR No. 8F022
File No. FMA.00257.00.00.03
HDR No. 202386

French River Cold Water Hatchery

A. REPORT DRAWINGS AND INDEX OF EXISTING DATA

B. POTENTIAL IMPROVEMENT PHOTOS AND MANUFACTURER DATA

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H. INTAKE DIVE REPORT

I. OPERATING COST DATA

J. CITED LITERATURE

APPENDICES

HDR

BARR

Appendix F – Biosecurity Overview

Background

The discovery of Viral Hemorrhagic Septicemia (VHS) in 2005 in freshwater fishes of the Great Lakes watershed and the continuing spread of Asian carp has provided the catalyst for the development of biosecurity recommendations for every state. Biosecurity objectives are to provide practical tools to the aquaculture industry that will aid in implementing biosecurity and best management practices (BMPs) at the facility and statewide level.

It is vitally important that all management and fish culturists be cognizant of, and understand that their actions have implications not only to their facility, and the aquaculture community, but to the entire state of Minnesota and the surrounding region as well. An aquaculturist should want to accept the *Guiding Principles of Responsible Aquaculture* as outlined in **Table F1** or an equivalent accepted version to demonstrate their commitment to the Minnesota aquaculture community. For this document, *Points 6 and 7* are particularly relevant.

Table F1. A typical code of conduct is the Guiding Principles of Responsible Aquaculture of the Global Aquaculture Alliance. Source: Boyd (1999).

Companies and individuals engaged in aquaculture, singularly and collectively:

1) Shall coordinate and collaborate with national, regional, and local governments in the development and implementation of policies, regulations, and procedures necessary and practical to achieve environmental, economic, and social sustainability of aquaculture operations.

2) Shall utilize only those sites for aquaculture facilities whose characteristics are compatible with long term sustainable operation with acceptable ecological effects, particularly avoiding unnecessary destruction of mangroves and other environmentally significant flora and fauna.

3) Shall design and operate aquaculture facilities in a manner that conserves water resources, including underground sources of freshwater.

4) Shall design and operate aquaculture facilities in a manner that minimizes effects of effluent on surface and ground water quality and sustains ecological diversity.

5) Shall strive for continuing improvements in feed use and shall use therapeutic agents judiciously in accordance with appropriate regulations and only when needed based on common sense and best scientific judgment.

6) Shall take all reasonable measures necessary to avoid disease outbreak among culture species, between local farm sites, and across geographic areas.

7) Shall take all reasonable steps to ascertain that permissible introductions of exotic species are done in a responsible and acceptable manner and in accordance with appropriate regulations.

8) Shall cooperate with others in the industry in research and technological and educational activities intended to improve the environmental compatibility of aquaculture.

9) Shall strive to benefit local economies and community life through diversification of the local economy, promotion of employment, contributions to the tax base and infrastructure, and respect for artisanal fisheries, forestry, and agriculture.

Biosecurity concepts and programs are not new; information has been available for years in terrestrial agriculture farming which has implemented programs on large scales in many different sectors. The motivation to implement biosecurity programs seems to be a result of a crisis, such as a disease outbreak as VHS. This usually precipitates a need for paying closer attention to measures that can be implemented to protect one's animals.

Regulations

As an industry, aquaculture is under the purview of various levels of governmental regulation including international, national, state, industry, and individual facility production practices. Examples of federal and state governmental controls include regulations that require testing and documentation prior to the culture of certain species, issuance of permits for movement of animals across state or national boundaries, or agreement to adhere to strict management practices. In addition to governmental controls, aquaculture producers have the ability to implement further measures at the state and facility level. The goals at the facility level are ultimately the same as the higher levels of control: to reduce the probability that a pathogen or organism will infect or manifest itself in the animals or on the farm.

Aquatic animal health regulations represent the minimum standards that must be met by the entire United States aquaculture industry. By putting these standards into state or federal legislation, a given industry ensures that all current and future operations adhere to these minimum standards. Failure to adhere to the minimum standards can put the entire industry at risk.

Regulation of aquatic animal health crosses multiple jurisdictional boundaries at the federal and state level. Aquatic animal health is federally regulated by several agencies as described below. Each of the regulatory agencies maintains independent regulatory programs that work to cooperatively ensure animal health within the aquaculture industry. The prevention and control of aquatic nuisance species (ANS) also requires policy and the implementation of control measures at various levels of government. The Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (P.L. 101-646) (NANPCA), amended by the National Invasive Species Act of 1996 (NISA) (P.L. 104-332) is the primary piece of legislation for the prevention and control of the unintentional introduction of nuisance nonindigenous aquatic species.

International Biosecurity Regulations

World Health Organization (WHO) and Office International Des Epizooties (OIE). The OIE is the intergovernmental organization responsible for improving animal health worldwide. Regulations from the OIE are set forth in the *Aquatic Animal Health Code*.

Federal Biosecurity Regulations

United States Department of Agriculture - Animal and Plant Health Inspection Service (APHIS). The USDA Animal and Plant Health Inspection Service (APHIS), is the lead agency responsible for providing federal oversight of health programs for aquatic animals. Under the authority of the Animal Health Protection Act (AHPA, 7 U.S.C. 8301 et seq.), APHIS has regulatory authority over all aquatic animal pests and diseases that have the potential to affect livestock, including farmed aquatic animals. Specifically, APHIS also has authority to regulate imports, exports, and interstate commerce of all animals should they pose a risk to other livestock. APHIS also maintains the authority to hold, seize, treat, or prohibit and restrict the movement of any farm-raised animals should they deem necessary. In response to an emergency, the Administrator of APHIS also possesses the ability to issue a Federal Order to protect agriculture or prevent the entry and establishment of a pest or disease into the United States.

One example of an emergency Federal Order is the Interim Rule on Viral Hemorrhagic Septicemia (VHS); Interstate Movement and Import Restrictions on Certain Live Fish. This order specifically addresses VHS as it is a reportable disease to APHIS. Violations of APHIS orders fall under the Animal Health Protection Act (AHPA) that was signed into law as part of the 2002 Farm Bill.

United States Fish and Wildlife Service (USFWS). The USFWS primary authority in aquatic animal health is based on the Lacey Act (18 U.S.C. 42) which prohibits the possession or importation of any animal or plant deemed to be injurious to human beings, wildlife, wildlife resources, or to the interests of agriculture, horticulture, forestry, or to wildlife or the wildlife resources of the United States (USFWS 2007).

Regulations defined under the Lacey Act (50 CFR Part 16.13, known as "Title 50"), protect wild and cultured fish in the United States from viruses that may be imported with live or dead salmonids or their products. These regulations require all members of the salmonid family (live or dead; and their fertilized eggs or gametes) to be free of certain viral pathogens before importation into the United States.

United States Environmental Protection Agency (USEPA). The Environmental Protection Agency (EPA) is authorized to regulate aquaculture operations under the Clean Water Act (33 U.S.C. 1251 et seq.). The EPA has established regulations for the discharge of wastewater into waters of the United States from concentrated aquatic animal production facilities. This gives the EPA the authority to require a National Pollutant Discharge Elimination System (NPDES) permit for operations in the United States.

Health and Human Services - Food and Drug Administration (FDA). The FDA has the responsibility of ensuring that all food is safe and wholesome to eat under the Food, Drug, and Cosmetic Act (21 U.S.C. 301 et seq). The approval of drugs for use on aquatic animals falls under the regulatory purview of FDA.

Aquatic Nuisance Species (ANS). The Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPCA) have been established to prevent new ANS introductions and to limit the dispersal of aquatic nuisance species already in U.S. waters. The federal legislation also calls upon each state to develop and implement their own comprehensive management plans for the prevention and control of aquatic nuisance species. The act established for the prevention and control of the unintentional introduction of ANS, is based on the following five objectives:

- to prevent further unintentional introductions of nuisance nonindigenous aquatic species;
- to coordinate federally funded research, control efforts and information dissemination;
- to develop and carry out environmentally sound control methods to prevent, monitor and control unintentional introductions;
- to understand and minimize economic and ecological damage; and
- to establish a program of research and technology development to assist state governments.

Diseases and Invasive Species Overview

Diseases and invasive species are an important consideration for the biosecurity of aquaculture facilities. The following section summarizes major concerns, and briefly introduces diseases and aquatic nuisance species important to consider when developing biosecurity plans.

VHS

Recently, VHS has become an emerging disease of freshwater fish in the Great Lakes region of North America directly affecting the states of Indiana, Illinois, Michigan, Minnesota, New York, Ohio, Pennsylvania, Wisconsin, and the Canadian Provinces of Ontario and Quebec. The virus was apparently introduced into this region in 2003 and fish deaths have been reported since 2005 (Kipp and Ricciardi, 2006). Massive die-offs have occurred in some wild species.

The fact that VHS is a reportable disease has significant trade implication on a national and international level. The United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Veterinary Services issued an Emergency Rule in October 2006 that basically restricted the movement of all fish to and from the eight Great Lakes states and two Canadian Provinces. An interim rule was published September 9, 2008 in the Federal Register, 9 CFR Parts 71, 83, and 93 that is still in effect.

The emergence of VHS in the Great Lakes Basin has had a significant impact on the wild fish populations of the Great Lakes Basin. Massive mortality events have occurred in some fish species. Because VHS is one of the few fish pathogens to be listed as a reportable organism by the World Health Organization for Animal Health (OIE), the impact of VHS has also extended into commercial aquaculture in the form of regulations designed to limit the spread of VHS beyond its current geographic distribution. As a disease caused by a virus, VHS is not treatable. Currently the only practical means to avoid losses is to avoid the pathogen.

Viral hemorrhagic septicemia (VHS) is a serious systemic disease of fish. It has been described as one of the most devastating fish diseases on a worldwide basis (Bowser, 2009). VHS is caused by the Viral Hemorrhagic Septicemia Virus (VHSV), a member of the virus family *Rhabdoviridae*. This virus is carried by at least 50 species of marine and freshwater fish. The infection is subclinical in some species, but it is associated with severe disease and high mortality rates in others (Kipp and Ricciardi, 2006).

The VHS clinical disease has been reported in freshwater and marine species. Until recently, most warm-water fish were thought to be resistant to this disease; however, warm-water species such as drum and perch have been affected in recent outbreaks in the Great Lakes (Kipp and Ricciardi, 2006). Some fish are identified by APHIS as species that the VHSV has been isolated from by cell cultures, with confirmation of strain identity through molecular detection (9 CFR Parts 83.1- 83.7 and 93.9).

Other Diseases of Concern

Although VHS is the major focus, there are many other bacterial, viral, and parasitic diseases that affect fish in the Great Lakes Region. **Tables F2- F4** list clinical signs of illness and affected species for diseases.

Aquatic Nuisance Species

Aquatic nuisance species (ANS) are a significant threat to the integrity of marine and freshwater ecosystems of the United States.

The sea lamprey (*Petromyzon marinus*) invasion in the 1940s resulted in substantial economic losses to recreational and commercial fisheries, and has required annual expenditures of millions of dollars to finance control programs. During the 1940s and 1950s, the sea lamprey, a top predator which kills a fish by attaching to it and feeding on its body fluids, devastated populations of whitefish and lake trout. The predation of the sea lamprey on this valuable commercial fishery permitted populations of commercially less valuable fish to proliferate and likely permitted the explosion of alewife (see below) by reducing lake trout predators.

The alewife (*Alosa pseudoharengus*) populations increased rapidly in the Great Lakes in the 1940s and the 1950s because of the suitability of the habitat and the fact that predators were not sufficiently abundant to check their growth. Consequently, periodic die-offs fouled recreational beaches and blocked municipal and industrial water intakes. While alewife out-competed and suppressed whitefish, yellow perch, emerald shiners and rainbow smelt, it subsequently became a fish preyed upon by introduced trout and salmon. The alewife has permanently altered the predator-prey relationships in the Great Lakes ecosystem.

The ruffe (*Gymnocephalus cernuus*), a Eurasian fish of the perch family, was introduced to North America in the 1980s, most likely through the ballast water of a seagoing vessel. This aquatic nuisance species has few predators, no commercial or recreational value, and is replacing valuable native fishes. Since its introduction, it has become established in the nearshore waters of western Lake Superior. By the fall of 1994, ruffe populations were found in Michigan waters of Lake Superior and in August of 1995, three ruffe were discovered in a commercial harbor in northern Lake Huron (Thunder Bay River, MI). It appears that ruffe may be in competition with yellow perch and whitefish populations. Walleye populations are affected indirectly through a change in the food chain composition brought on by the proliferation of the ruffe.

Table F2. Selected Bacterial Diseases of Concern (Thoesen, 1994)

Bacteria	Vulnerable Species	Clinical Signs	OIE Status
Bacterial Gill Disease	Salmonids, some coolwater species (i.e. walleye, tiger musky); & warm water species reared under intensive conditions	Lethargy, loss of appetite, increased gill activity, extended gill opercula, and fusion of gill filaments.	Unlisted
Coldwater Disease	Salmonids	Lethargy, spiral swimming, dorsal swelling, dark pigmentation on one side of body, skin and muscle lesions near the peduncle area, exposure of the vertebral column.	Unlisted
Columnaris Disease	Catfish, other freshwater fishes	External lesions on the body surface and/or gills. On scaled fish, lesions occur initially as grayish-white cutaneous foci on the fins, head, and body. Affected gill tissue becomes bleached and necrotic, and may be yellow or orange in color. On scaleless fish, the center of the lesion appears dark milky blue with a defined red tinge around the margin.	Unlisted
Edwardsiella Tarda Septicemia	Channel catfish, carp, goldfish, largemouth bass, brown bullhead, striped bass, Chinook salmon, rainbow trout, tilapia, and eels	Cutaneous lesions that become large abscesses within the muscle; generalized septicemia, loss of pigmentation, fluid in the abdominal cavity, a protruding hemorrhaged anus, and opaqueness in the eyes. Small white nodules may be present in the kidney, liver spleen, and gills.	Unlisted
Enteric Redmouth Disease	Salmonids, goldfish, largemouth bass, emerald shiners, sturgeon, fathead minnows, walleye, cisco and crayfish	Severe congestion and hemorrhage in the head tissues with erosion of the lower jaw being common. The spleen, kidney, and intestine can also be infected.	Unlisted
Enteric Septicemia	Catfish and salmonids	Ulceration in frontal bones "Hole in Head"; external lesions- hemorrhage around the mouth, body, and fins; pale gills; refusal of feed, and spiral movement.	Concern
Furunculosis - Aeromonas Salmonicida	Many species of freshwater fishes	Formation of furuncules, (boil-like lesions). In acute cases, fish may darken and go off feed. Internally, the viscera are hemorrhagic, kidney tissue is very soft, the spleen is enlarged, and the liver is pale or mottled.	Unlisted
Vibriosis	Many species of freshwater fishes	Erythema (i.e. redness) and hemorrhaging at the base of fins, the vent, and around or in the mouth; Ulcerative hemoragic lesions often develop in later stages of the disease.	Unlisted
Coldwater Vibriosis	Atlantic salmon and rainbow trout	External hemorrhaging of the skin, the area around the gills, and the vent. Internal hemorrhaging in organs and at times, in the muscle; pale liver and sometimes necrosis in the kidney, muscles, gastro-intestinal tract, spleen, and gills.	Unlisted
Bacterial Kidney Disease	All Salmonids	Exophthalmos, abdominal distension, skin petechiation, and vesicles in the skin. Internal signs: enlarged kidney that may appear grey and corrugated; off- variabled sized white lesions on the kidneys, liver, and spleen; an opaque false membrane over the kidney, liver, spleen, or gonads.	Concern
Streptococcal Disease	Salmonids, golden shiner, eel, tilapia, sturgeon, and striped bass	Erratic swimming; loss of buoyancy control; lethargy; darkening; uni- or bilateral exophthalmia; corneal opacity (whitish eyes); hemorrhages in or around eye, gill plate, base of fins, vent/anus, or elsewhere on the body; ascites (i.e., distended abdomen or bloating); and ulcerations.	Unlisted

Table F3. Selected Viral Diseases of Concern (Thoesen, 1994)

Virus	Vulnerable species	Clinical Signs	OIE Status
Channel Catfish Virus Disease	Ictalurids (especially fry and fingerlings)	Effected fish will display a loss of equilibrium, spiral swimming movement, and assume a vertical position in the water column. Gill, skin, and internal organ hemorrhages and abdominal distension occur. The disease affects the liver, spleen, kidney, and digestive tract.	Concern
Erythrocytic Inclusion Body Syndrome	Salmonids	Diseased fish are usually anemic and lethargic. Pale gills and pigmentation abnormalities may be observed. Internal tissues exhibit signs associated with anemia.	Unlisted
Herpesvirus Diseases of Salmonids (HVS)	Salmonids	Darkening of the body, a slightly distended abdomen, and occasional exophthalmia. A mild ascetic fluid, pink discoloration of liver and adipose tissues accompanied by a flaccid condition of visceral organs and skeletal muscle resulting from edema	Unlisted
Infectious Hematopoietic Necrosis (IHN)	Salmonids and northern pike	Dark discoloration of the dorsal surface and tail fin; abdomen may be distended; hemorrhaging at the base of the fins, on the operculum and around the eyes; Weakened swimming capability; white discharge from the anus; and pale internal organs and/or pin-point bleeding in the musculature and fatty tissues.	Notifiable
Infectious Pancreatic Necrosis (IPN)	Salmonids and other freshwater species	The first sign of IPN in is the sudden onset of mortality. Clinical signs include darkening of the lower third of the body, small swellings on the head, a pronounced distended abdomen, and corkscrewing swimming motions. Some fish may also show ‘pop-eye’ deformities. The pancreas, esophagus, and stomach may also become ulcerated and hemorrhagic as well.	Concern
Viral Erythrocytic Necrosis	Many species of freshwater fishes	Anemia, which can be observed as pate gills and internally as a general pallor of visceral organs.	Unlisted
Viral Hemorrhagic Septicemia (VHS)	Salmonids and northern pike	The disease becomes apparent in three stages. The first stage is characterized by high mortality in fish that are dark, lethargic and have hemorrhages at the base of fins and gills. The second stage is recognized by very dark colored, anemic fish. Pale gills and exophthalmos is common. The third stage is characterized by atypical swimming behavior (looping) and a swollen and discolored kidney.	Notifiable
Spring Viraemia of Carp	Numerous carp and cyprinid species	Infections are manifested in spring as water temperatures reach 11-17 °C. Poor physical condition of overwintering fish appears to be a significant factor. Viral multiplication occurs in the endothelial cells resulting in edema and hemorrhage impairing tissue osmoregulation. Kidney, spleen, gill, and brain are the organs in which SVCV is most commonly affected during infection.	Notifiable
Largemouth Bass Virus (LMBV)	Centrachcids and esocids	Fish will be near surface, have trouble staying upright, and having difficulty swimming. LMBV will infect the swim bladder and will appear as thick yellow or brown exude, or it could only be slightly red and over inflated. Sometimes it will look normal. For precise diagnosis a DNA based test must be preformed.	Unlisted

Table F4. Selected Parasitic Diseases of Concern (Thoesen, 1994)

Parasitic Diseases	Vulnerable Species	Clinical Signs	OIE Status
Ichthyophthirius	Many warm-water and cold water species	Appears as white spot on the fish. Flashing often results. Heavy infections of the gill will interfere with respiratory exchange and may cause infected fish to gasp for air at surface.	Unlisted
Ichthyobodiasis	Many warm-water and cold water species	Excess mucus production, complete removal of epithelium and loss of pigmentation is common. Infected fish may flash or scrape against objects, stop eating and gasp at water surface	Unlisted
Hexamitasis	Many warm-water and cold water species	Fish may be anorexic, weak, excessively nervous, or whirling. External signs: emaciation, dull and dark color, red vent, pale shiny feces, abdominal distension, and exophthalmia	Unlisted
Pleistophoriasis	Golden shiner, fathead minnow, sculpins	Ovaries of prespawning fish infected with Pleistophara have a conspicuously white marbling or translucent opaque spots.	Unlisted
Salmonid Ceratomyxosis	Salmonids	Anorexia, lethargy, darkening, distended abdomen, exophthalmia, a swollen and hemorrhagic vent, and emaciation.	Unlisted
Whirling Disease	Salmonids	Frenzied, tail-chasing behavior, particularly when being fed or when startled. Posterior trunk and tail of young fingerlings may turn dark, especially in fish exposed at an early age, (blacktail). As the fish grows, the primary signs of the disease can be skeletal changes such as misshapen skulls and twisted spines.	Unlisted
Proliferative Gill Disease	Channel catfish	Anorexia, listlessness and increased susceptibility to low dissolved oxygen levels. The principal external sign of PGD is massive degeneration of the primary filaments of the gill. In early stages, the filaments appear pale and swollen, progressing to a state of filament breakage and loss.	Unlisted
Proliferative Kidney Disease	Salmonids	Behavioral changes: lethargy and anemia, External gross signs: exophthalmia, lateral body swelling, a distended abdomen, and pale gills	Unlisted
External Ciliated Parasite Infection	Many warm-water and cold water species	Infected fish may go off feed, scrape against objects, display flashing behavior, and may gasp at the water surface. Skin may display changes in pigmentation and have excess mucus production, may produce bloody lesions on scaled fish and erosion of fins and spines in all species. Gills may appear swollen, hemorrhagic, or with heavy mucus.	Unlisted
Monogenean Disease	Salmonids, Ictulurids, and Cyprinids	In salmonids and cyprinids the general body surface and or gills are affected while in catfish the barbells, underside of the head, and fins are prone to attack. External signs in heavy infections: darkening in color, erosion of the fins (particularly the dorsal fin), pale discolored flanks and thickened cuticle, obvious secretions of mucus sometimes described as a blue/grey slime, and emaciation	Unlisted
Bothriocephalosis	Most cyprinids	Occasionally, fry hang listlessly around the edge of the pond. Heavily infected golden shiners appear emaciated with a swelling in the anterior portion of the abdomen. Weakened fish often develop bacterial problems, bloating and raised scales may also occur with massive tapeworm infections.	Unlisted
Lernaeid Parasitism	Cyprinids & Centrachids	Behavioral changes: flashing, listlessness, and eventual morbidity. Parasites are readily apparent. They appear as bristle-like projections attached to the body surface. Attachment sites will usually show some degree of inflammation and ulceration.	Unlisted

The round goby (*Neogobius melanostomus*) and the **tubenose goby (*Proterorhinus marmoratus*)** were introduced via ballast water into the St. Clair River, near Detroit in 1990. The tubenose goby has not thrived, but the round goby has spread into all five of the Great Lakes. The primary concern with the round goby is the tremendous range expansion exhibited since its introduction in 1990. It is a very aggressive fish and feeds voraciously upon the eggs of bottom dwelling fishes (e.g., sculpin, darters and log perch), as well as on snails, mussels and aquatic insects. The Great Lakes fisheries, particularly those in lakes Michigan and Erie, are threatened by this aquatic nuisance species due to its robust characteristics and ability to displace native species from prime habitat and spawning areas. The round goby has left the confines of Lake Michigan, has been found 12 miles downstream of Lake Michigan in the Calumet River (U.S. Fish and Wildlife Service, 1996) and is poised to enter the Illinois River system and the interior of the United States.

The spiny water flea (*Bythotrephes longimanus*), a likely ballast water introduction, is a tiny crustacean with a sharp, doubly barbed tail spine. This northern Europe native was first found in Lake Huron in 1984. It is now found throughout the Great Lakes and some inland lakes. Although researchers do not know what effect this predacious zooplankter will have on the ecosystem, resource managers suspect that the water flea competes directly for food with small fish such as perch.

Another spiny water flea (*Daphnia lumholtzi*), a native of southern Asia, Africa and parts of Australia, was first discovered in the state of Texas in 1991. Since its discovery, it has spread to five states including Wisconsin. *Daphnia lumholtzi* was thought to be primarily a lake species, but is now established in the Illinois River and was found in 1996 by INHS researchers only 30 river miles south of Lake Michigan in the Cal-Sag channel (Stoeckel, unpublished, 1997). The potential for invasion of the Great Lakes by *D. lumholtzi* is high, and may already have occurred. Its effects on the ecosystem are unknown, but its length of 3-5 mm and its spike helmet and tail presumably deter predation, and may impact the zooplankton community structure and the diets of zooplankton eating fish.

The zebra mussel (*Dreissena polymorpha*), another ballast water introduction, is one of the best known invaders of the Great Lakes region and other areas of the country where it has spread. This aquatic nuisance species has caused serious economic and ecosystem impacts. The zebra mussel, a highly opportunistic mollusk, reproduces rapidly and consumes microscopic aquatic plants and animals from the water column in large quantities. The potential impact on the fishery can be profound due to changes in food availability and spawning areas, to name a few. Economic impacts are as pervasive as the ecosystem impacts. Municipalities, utilities and industries in the Great Lakes as well as elsewhere, due to the infestation of the zebra mussel in their intake/discharge pipes have significant costs associated with monitoring, cleaning and controlling infestations.

The white perch (*Morone americana*) is native to Lake Ontario and the Atlantic Slope drainages of northern North America. It has invaded the upper Great Lakes reaching the Chicago area in 1988.

Purple loosestrife (*Lythrum salicaria*) is a wetland plant from Europe and Asia that was introduced to the east coast of North America in the 1800s. It is now found in at least 40 states and Canada (Webb, 2005). Purple loosestrife invades marshes and lake shores replacing cattails and other wetland plants. This nuisance non-indigenous plant is unsuitable to meet habitat needs - such as cover, food, or nesting sites - for a wide range of native wetland animals including ducks, geese, rails, bitterns, muskrats, frogs, toads, and turtles.

Eurasian milfoil (*Myriophyllum spicatum*), unintentionally introduced to North America from Europe, has spread into inland lakes, primarily by boat traffic. Milfoil can proliferate in high densities, producing habitat conditions that cause serious impairments to commercial fishing and water recreation such as boating, fishing, and swimming. The plant's surface canopy can out-compete and eliminate native aquatic vegetation, and threaten native fish and wildlife populations. In Illinois, this plant has been involved in a substantial fish kill when the dense plant population collapsed during a period of hot weather, thus reducing the oxygen level in the lake to zero.

Biosecurity Plans

Changes to industry practices, such as increased attention to biosecurity, contribute to the successful containment of these pathogens and minimization of further negative impact. Developing and implementing a unique and site specific biosecurity plan for every facility is the largest single step that can help minimize the risks; however, it is important to remember that even the best biosecurity plan will only minimize the risks, not eliminate them entirely.

Effectiveness of a biosecurity plan will be maximized when strategies are tailored for specific sites, with consideration given to the diverse range of environmental impacts, aquaculture systems, species cultured, geographical location, farm size, financial situation, and production goals. Long-term strategies must also account for evolving technology and ecology. Development and implementation of a biosecurity plan should be a continuous process so that new approaches can be considered as technology changes and new diseases or ANS emerge.

Best Management Practices

Despite the multitude of potential ways a pathogen or ANS can be introduced to a facility, there are some basic yet essential practices that will help to greatly minimize those risks. Some steps can be implemented directly on the facility for maximum effect, while others may require cooperative implementation with neighboring facilities and regulatory enforcement. This section summarizes some of the best management practices (BMPs) that can be taken to minimize risk.

The following BMPs are examples of actions that can be taken along with a brief explanation of each action and how it may be used to reduce the risk at the facility. Each action can and should be implemented with the understanding that they will work in synergy with each other to better address, not only a single risk, but will have the advantage of addressing multiple risks when implemented together. Exactly how these steps are implemented and which ones are utilized depends on the design of the facility, the animal and life stage being cultured, and the level of risk that can be accepted at the particular site.

Facility Layout Considerations – Accommodations to minimize the influences from outside vectors such as vehicular and pedestrian traffic should be considered. A fenced, paved area with a continuous curb would be advantageous to control access and would effectively isolate staff and the public. Limiting access in this manner will minimize the potential introduction of pathogens or ANS. Another option is to configuring a facility according to biosecurity risks such that lower risk fish would be located downstream of higher risk fish.

Quarantine/Isolation Facilities – Another consideration would be to have a separate site, or less optimally, an isolated, secure area on site to hold incoming fish for a period of time to ascertain their health status. It would be desirable to treat the effluent water prior to being discharged to a receiving stream or be discharged directly to a municipal sewer system. This would be the time to have a fish health inspection conducted, if they are not from a certified disease free source, prophylactic treatments for parasites and bacterial infections could be conducted prior to stocking onto the hatchery facility.

Clean and disinfect all equipment on a routine basis– Routine cleaning and disinfection of equipment helps to prevent the unintentional spread of pathogens, and other organisms on the farm and off. At a minimum, all equipment should be cleaned and disinfected after being used with sick animals. MNDNR staff disinfect equipment on a routine basis, regardless of whether contact with sick animals occur. Having separate equipment available for each rearing unit will further minimize transfer of disease and unwanted organisms. Equipment to be considered for routine cleaning and disinfection includes nets, seines, tables, rain gear, boots, boats, and any other items used in the aquaculture operation. Prior to disinfection, it is important to clean the equipment since disinfectants often only work on the surface and cannot penetrate dirt or other matter that may be encrusting the equipment, resulting in incomplete disinfection. It is also important to select an appropriate disinfectant that will treat a specific pathogen or disease.

Disinfectants should be used per the manufacturer's instructions and specific instructions that a veterinarian or aquatic animal health professional may prescribe. Time of exposure and concentration of the solution are important factors in determining the effectiveness of the disinfectant. One should not modify the time or concentration of a disinfectant unless the modification is approved by the manufacturer, aquatic animal health professional or veterinarian. For example, if the manufacturer's instructions say to mix the disinfectant at a concentration of 1 cup of disinfectant per 10 gallons of water and to soak equipment for 10 minutes, mixing a batch of disinfectant at 2 cups per 10 gallons of water does not mean that the time can be reduced to 5 minutes. This new concentration of disinfectant may prove harmful to those working with it, or to the animals.

Clean, disinfect and inspect delivery vehicles and equipment – Trucks, hauling tanks, pumps, nets, buckets, waders, or anything that may come in contact with the delivery site water should be inspected, cleaned and disinfected prior to coming back on the facility. Not only may the equipment be subject to pathogens and aquatic hitchhiker organisms, but if the vehicle is backed into the water for any reason, there may be a possibility of picking up unwanted vegetation material in the wheel rims, bumper assemblies, or axles.

Choose proper equipment materials – When purchasing or making equipment to be used on the farm, choices need to be made regarding the materials of that equipment. When considering cleaning and disinfection, porous materials (e.g., wood) are not good as they are difficult to disinfect. Biofilter media is an exception since it is specifically designed to provide habitat for micro-organisms.

Minimize the movement of equipment– This is applicable for farms that have multiple sites such as ponds. It is in the best interest of the farmer to eliminate or reduce the transfer of equipment that can act as vectors for pathogen movement. It is best to have separate equipment for each site, such as nets, pumps, monitoring gear, etc. If equipment must be shared between sites, it should be used at the lowest risk facility first and then moved on progressively to higher risk sites. All equipment shared between sites should be cleaned and disinfected prior to entering and leaving each site.

Disinfect personnel and visitors entering and leaving – People are one of the most common ways that disease and organisms can be spread from site to site. For disease prevention, protocols should be established to prevent human mediated transmission. This can be done by establishing and using footbaths and hand sanitation stations at entry and exit points. If employees are moving between facilities or sites, all outer gear such as boots and rain gear should be cleaned and disinfected prior to moving to the next facility or site. Having separate gear for each facility is the best way to minimize the risk of transmission from site to site.

Minimize the movement of animals between sites – It is best whenever possible to minimize the movement of animals between sites. When movements are necessary, there are some basic principles that should be followed.

1. Animals should be packed and transported utilizing methods that reduce stress to the animals that could potentially precipitate a pathogen outbreak.

2. Movement between watersheds, and states should be avoided if at all possible. If unavoidable, fish should come from a certified disease-free source. Animals brought in from other watersheds or states have an increased likelihood of importing an exotic disease.

3. Whenever possible, new animals should only be imported onto your farm from certified disease free facilities (ask for a copy of the aquatic animal health inspection and keep it on file at your farm).

4. All animals coming onto your farm should have a health inspection from a qualified aquatic animal health professional or veterinarian (see #3).

5. All animals imported onto your farm should be quarantined prior to being introduced to the general population. The exception to this is when you are stocking a new system or a previously depopulated and cleaned system from a certified disease free source.

6. Do not stock sick or dead animals.

7. All in- All out Stocking – Stocking a given farm site or facility section with animals from only a single cohort is preferred. The reason for this is that over time animals will develop natural immunities to common pathogens in their environment. Whenever you introduce new and naïve animals to others that have developed a resistance or tolerance to common pathogens, you have a higher risk of infecting the naïve animals which could raise levels of the pathogens to sufficient level to overcome the acquired immune defenses of the older population. By only having animals of similar age and stocking date on the site there is less chance of perpetuating the pathogens.

Develop a disease testing and monitoring protocol – It is important that a disease testing and monitoring program be established. This allows for the early detection of a disease and allows for timely measures to be taken in order to minimize the impacts of the outbreak on the farm.

Regularly inspect and remove dead and moribund animals – Dead and moribund animals often act as reservoirs and factories for pathogen production, even if they did not or are not dying from the specific pathogen. By removing these animals from the general population, you are preventing them from potentially spreading disease to a much wider extent among the population. These animals should be stored and disposed of with care in order to prevent the accidental spread of infection.

Maintain separate intake and discharge lines – For land based facilities that draw and discharge water, care should be taken in placing the location of the intake and discharge lines. In particular, avoid placing the intake line downstream from the discharge. There should also be a sufficient separation between the two lines so that the intake line is not siphoning in water that was just discharged and thereby creating a recycling loop between the two pipes.

Disinfect incoming and outgoing water – Separating water lines as discussed above can help reduce the risk of recirculating pathogens within land based facilities. In addition, facilities should screen and disinfect all incoming open surface water whenever possible to prevent importing a pathogen or invasive species into the facility via the water. All outgoing water should be disinfected where possible. This prevents the spread of any pathogen in the facility to nearby waters. Once a pathogen is in nearby waters, the likelihood of it getting into another facility is increased.

Predator and Animal Control – Predator and animal access to rearing ponds and tanks should be controlled. Not only do predatory animals negatively effect production and monetary returns, they have the potential for introducing and spreading disease to and around a hatchery facility. Fencing and netting may be put around and over rearing units in an attempt to restrict access from ground dwelling and flying animals.

Properly dispose of transfer waste and water – It is important to follow all federal, state and local laws when disposing of waste and water from harvesting operations. If allowed by law, it is easy to discharge both directly from the process facility or transfer/hauling tank to the receiving water. However, this has the potential for creating a problem because the water that was used in harvesting and processing operations and associated waste often contains pathogens. By directly discharging the water, the potential for pathogens to be introduced to the environment is increased. All harvesting and processing waste should be disposed of properly, either by bagging and removing from the site or on site burial. The water should be contained and disinfected prior to being discharged overboard or taken to a specified site away from the production facility or ponds and discharged onto the ground where there is no possibility of that water to flow into an open stream or lake.

Maintain good records – Standard operating procedures (SOPs) and a method of recordkeeping is important. Records of completed actions can occur in the form of equipment logs, maintenance logs, written journals or any other form that can document the procedure actually occurred and can be verified by somebody else at a later date. In operations where employees may be performing some of the actions outlined in the biosecurity plan, keeping accurate records allows the manager or owner to verify that employees are carrying out the tasks as they are directed to do.

In addition to the records for biosecurity procedures, it is also important to keep detailed records on the history of all animals. These records should include as much information as possible such as the origin of each animal or group of animals, what sites the animals may have encountered, when they were moved between sites; how and when they have been handled, treated or manipulated; if they are fed, how much, what type, and when they have been fed; and other pertinent information. The OIE Health Code states that a biosecurity plan should include production and stock records, feed sources, traceability, surveillance results, visitor logbook, morbidity and mortality history, medications, vaccinations, documentation of training and any other criteria necessary for evaluation of risk mitigation. The reason for such records is that in the case of a disease outbreak this type of information may help to identify specific individuals or groups of individuals that may be at greater risk and isolate them from the rest of the population. This information can also be used to identify possible risk factors that led to the outbreak. Future action may be determined from this information to minimize the indentified risk factors. In general, this type of information can be used to help improve culture operation and maximize profits.

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Minnesota
Department of Natural Resources

MDNR No. 8F022
File No. FMA.00257.00.00.03
HDR No. 202386

French River Cold Water Hatchery

A. REPORT DRAWINGS AND INDEX OF EXISTING DATA

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APPENDICES

HDR

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Table G-1. FRH 2011 Temperature Data - Averages (data from MNDNR Monitoring Instruments)

2011	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
lake	35.90	34.80	33.60	35.70	38.30	41.40	51.60	47.60	48.30	49.40	41.70	37.60
hotwell	53.10	54.03	53.93	55.39	54.57	55.83	62.97	62.26	58.29	56.31	56.01	55.94
red tanks	47.84	47.89	48.02	48.00	49.80	52.82	54.75	52.00	51.90	52.37	52.06	52.03
yellow tanks	38.10	39.46	39.50	39.44	39.42	50.53	54.18	47.57	48.23	49.72	47.26	45.40
Blue Tanks	43.05	42.15	40.87	40.08	40.07	41.56	51.53	47.66	48.36	49.45	41.90	37.86
Burrows	41.64	41.76	40.87	40.56	41.71	46.57	53.08	48.74	49.55	50.60	46.69	43.88
Clarifier	39.98	39.99	39.46	39.89	41.56	46.22	nd	44.63	49.50	50.32	45.22	41.90

	Days	31	28	31	30	31	30	31	31	30	31	30	31			
	2011	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
	lake	35.90	34.80	33.60	35.70	38.30	41.40	51.60	47.60	48.30	49.40	41.70	37.60			
	hotwell	53.10	54.03	53.93	55.39	54.57	55.83	62.97	62.26	58.29	56.31	56.01	55.94			
	Delta T	17.20	19.23	20.33	19.69	16.27	14.43	11.37	14.66	9.99	6.91	14.31	18.34	BTU	wood tons	$
gpm	100	640,351,872	646,644,902	756,881,021	709,407,072	605,728,195	519,895,584	423,302,371	545,788,282	359,927,712	257,257,642	515,572,128	682,793,798	6,663,550,679	330.7	$51,913
gpm	150	867,573,504	1,073,892,427	1,098,698,256	1,099,580,962	879,282,864	805,838,155	634,953,557	792,273,312	557,887,954	373,438,512	799,136,798	5,584,464,000	14,567,020,451	722.8	$113,486
gpm	200	1,280,703,744	1,293,289,805	1,513,762,042	1,418,814,144	1,211,456,390	1,039,791,168	846,604,742	1,091,576,563	719,855,424	514,515,283	1,031,144,256	13,546,828,800	25,508,342,562	1,265.8	$198,725

Historical

	Days	31	28	31	30	31	30	31	31	30	31	30	31			
	1980-2012	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
	lake	36.18	33.90	33.91	33.45	37.97	41.16	48.58	51.98	51.45	48.86	41.98	38.27			
	hotwell	53.10	54.03	53.93	55.39	54.57	55.83	62.97	62.26	58.29	56.31	56.01	55.94			
	Delta T	16.92	20.13	20.02	21.94	16.60	14.67	14.39	10.28	6.84	7.45	14.03	17.67	BTU	wood tons	$
gpm	100	629,927,539	676,909,094	745,339,795	790,471,872	618,014,016	528,542,496	535,736,246	382,721,933	246,436,992	277,361,712	505,484,064	657,849,859	6,594,795,719	327.2	$51,377
gpm	150	853,450,214	1,124,152,603	1,081,944,864	1,225,231,402	897,117,120	819,240,869	803,604,370	555,564,096	381,977,338	402,621,840	783,500,299	5,584,464,000	14,512,869,164	720.2	$113,064
gpm	200	1,259,855,078	1,353,818,189	1,490,679,590	1,580,943,744	1,236,028,032	1,057,084,992	1,071,472,493	765,443,866	492,873,984	554,723,424	1,010,968,128	13,788,221,760	25,662,113,480	1,273.4	$199,923

Before Intake Breach

	Days	31	28	31	30	31	30	31	31	30	31	30	31			
	1980-1999	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
	lake	36.08	33.85	33.92	34.01	37.97	40.19	48.21	52.25	49.55	46.79	40.22	38.33			
	hotwell	53.10	54.03	53.93	55.39	54.57	55.83	62.97	62.26	58.29	56.31	56.01	55.94			
	Delta T	17.02	20.18	20.01	21.38	16.60	15.64	14.76	10.01	8.74	9.52	15.79	17.61	BTU	wood tons	$
gpm	100	633,650,515	678,590,438	744,967,498	770,295,744	618,014,016	563,490,432	549,511,258	372,669,898	314,891,712	354,427,315	568,894,752	655,616,074	6,825,019,751	338.7	$53,171
gpm	150	858,494,246	1,126,944,835	1,081,404,432	1,193,958,403	897,117,120	873,410,170	824,266,886	540,972,432	488,082,154	514,491,264	881,786,866	5,584,464,000	14,865,392,958	737.6	$115,810
gpm	200	1,267,301,030	1,357,180,877	1,489,934,995	1,540,591,488	1,236,028,032	1,126,980,864	1,099,022,515	745,339,795	629,783,424	708,854,630	1,137,789,504	13,809,839,040	26,148,646,395	1,297.5	$203,714

After Intake Breach

	Days	31	28	31	30	31	30	31	31	30	31	30	31			
	2000-2012	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
	lake	36.32	33.95	33.89	34.64	38.21	40.71	49.14	51.61	50.15	46.95	41.18	38.23			
	hotwell	53.10	54.03	53.93	55.39	54.57	48.58	62.97	62.26	58.29	56.31	56.01	55.94			
	Delta T	16.78	20.08	20.04	20.75	16.36	7.87	13.83	10.65	8.14	9.36	14.83	17.71	BTU	wood tons	$
gpm	100	624,715,373	675,227,750	746,084,390	747,597,600	609,078,874	283,546,656	514,887,581	396,496,944	293,274,432	348,470,554	534,307,104	659,339,050	6,433,026,407	319.2	$50,117
gpm	150	846,388,570	1,121,360,371	1,083,025,728	1,158,776,280	884,146,752	439,497,317	772,331,371	575,560,080	454,575,370	505,844,352	828,176,011	5,584,464,000	14,254,146,352	707.3	$111,048
gpm	200	1,249,430,746	1,350,455,501	1,492,168,781	1,495,195,200	1,218,157,747	567,093,312	1,029,775,162	792,993,888	586,548,864	696,941,107	1,068,614,208	13,773,810,240	25,321,184,955	1,256.5	$197,267

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Delta T	0.24	0.10	-0.03	0.63	0.24	0.52	0.93	-0.64	0.60	0.16	0.96	-0.10

after breach shallow vs deep intake temperature difference based on average temperatures

Per Year Savings	$3,054
Shallow Intake	$4,762
	$6,446

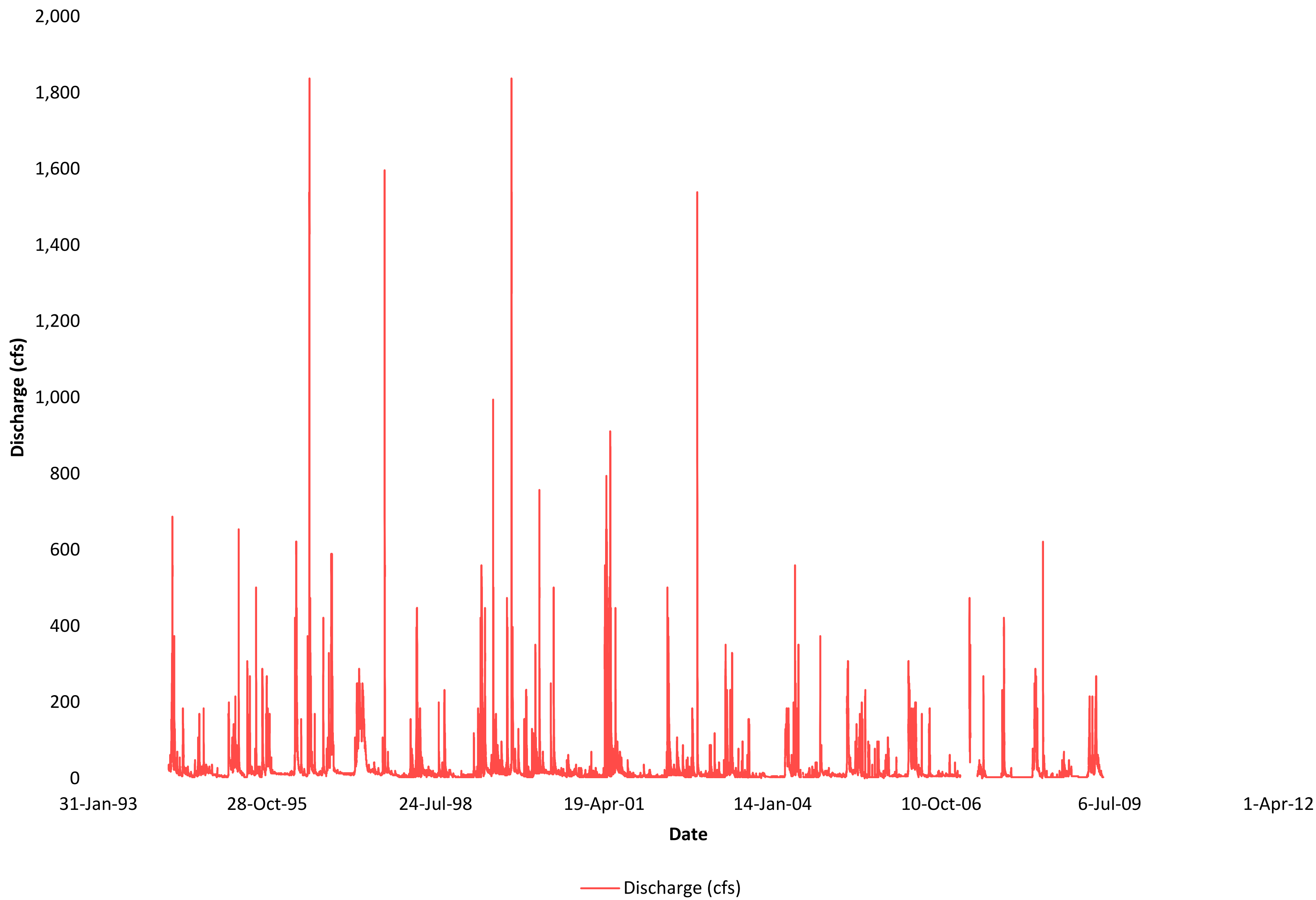
LAKE SUPERIOR - Water Quality - Summary of Available Data

Tab	Location	Date Range	Collected By	Source
MPCA-N003	Lake Superior, NE of Duluth, MN (16-0001-00-N003)	May 1967 to Sept. 1981	MPCA *(MPCA Stream Monitoring Program Project)*	http://www.pca.state.mn.us/customPHP/eda/stationInfo.php?ID=16-0001-00-N003&ORG=MNPCA
MPCA-N004	Lake Superior, S of Two Harbors, MN (16-0001-00-N004)	Oct. 1980 to Sept. 1981	MPCA *(MPCA Stream Monitoring Program Project)*	http://www.pca.state.mn.us/customPHP/eda/stationInfo.php?ID=16-0001-00-N004&ORG=MNPCA
MDH-BeachTurbidity	Beach MN570174: Lake Superior, 42nd Avenue in Duluth (16-0001-B010)	May 2003 to Sept. 2010	MDH *(Beach Monitoring Program)*	http://www.mnbeaches.org/general/download.html
		May 2003 to Aug. 2012		http://www.pca.state.mn.us/customPHP/eda/stationInfo.php?ID=16-0001-00-B010&ORG=MNPCA
	Beach MN713581: Lake Superior, Lester River Mouth in Duluth (16-0001-B011)	May 2003 to Sept. 2010	MDH *(Beach Monitoring Program)*	http://www.mnbeaches.org/general/download.html
		May 2003 to Aug. 2012		http://www.pca.state.mn.us/customPHP/eda/stationInfo.php?ID=16-0001-00-B011&ORG=MNPCA
	Beach MN918956: Lake Superior, Brighton Beach (Kitchi Gammi Park) in Duluth (16-0001-B012)	May 2003 to Sept. 2012	MDH *(Beach Monitoring Program)*	http://www.pca.state.mn.us/customPHP/eda/stationInfo.php?ID=16-0001-00-B012&ORG=MNPCA
	Beach MN372694: Lake Superior, French River Mouth NE of Duluth (16-0001-B013)	May 2003 to Sept. 2010	MDH *(Beach Monitoring Program)*	http://www.mnbeaches.org/general/download.html
		May 2003 to Aug. 2012		http://www.pca.state.mn.us/customPHP/eda/stationInfo.php?ID=16-0001-00-B013&ORG=MNPCA
	Beach MN891405: Lake Superior, Bluebird Landing NE of Duluth (16-0001-B014)	May 2003 to Sept. 2010	MDH *(Beach Monitoring Program)*	http://www.mnbeaches.org/general/download.html
		May 2003 to Aug. 2012		http://www.pca.state.mn.us/customPHP/eda/stationInfo.php?ID=16-0001-00-B014&ORG=MNPCA
	Beach MN966726: Lake Superior, Stony Point NE of Duluth (16-0001-B015)	May 2003 to Sept. 2010	MDH *(Beach Monitoring Program)*	http://www.mnbeaches.org/general/download.html
		May 2003 to Aug. 2012		http://www.pca.state.mn.us/customPHP/eda/stationInfo.php?ID=16-0001-00-B015&ORG=MNPCA
	Beach MN409498: Lake Superior, Knife River Marina SW of Two Harbors (16-0001-B035)	Aug. 2003 to Sept. 2009	MDH *(Beach Monitoring Program)*	http://www.mnbeaches.org/general/download.html
		Aug. 2003 to Aug. 2012		http://www.pca.state.mn.us/customPHP/eda/stationInfo.php?ID=16-0001-00-B035&ORG=MNPCA
EPA-Turbidity	EPA-MED Lake Superior Intake Unheated Water - Sand Filtered	Oct. 2006 to Nov. 2008	EPA-MED	EPA-MED

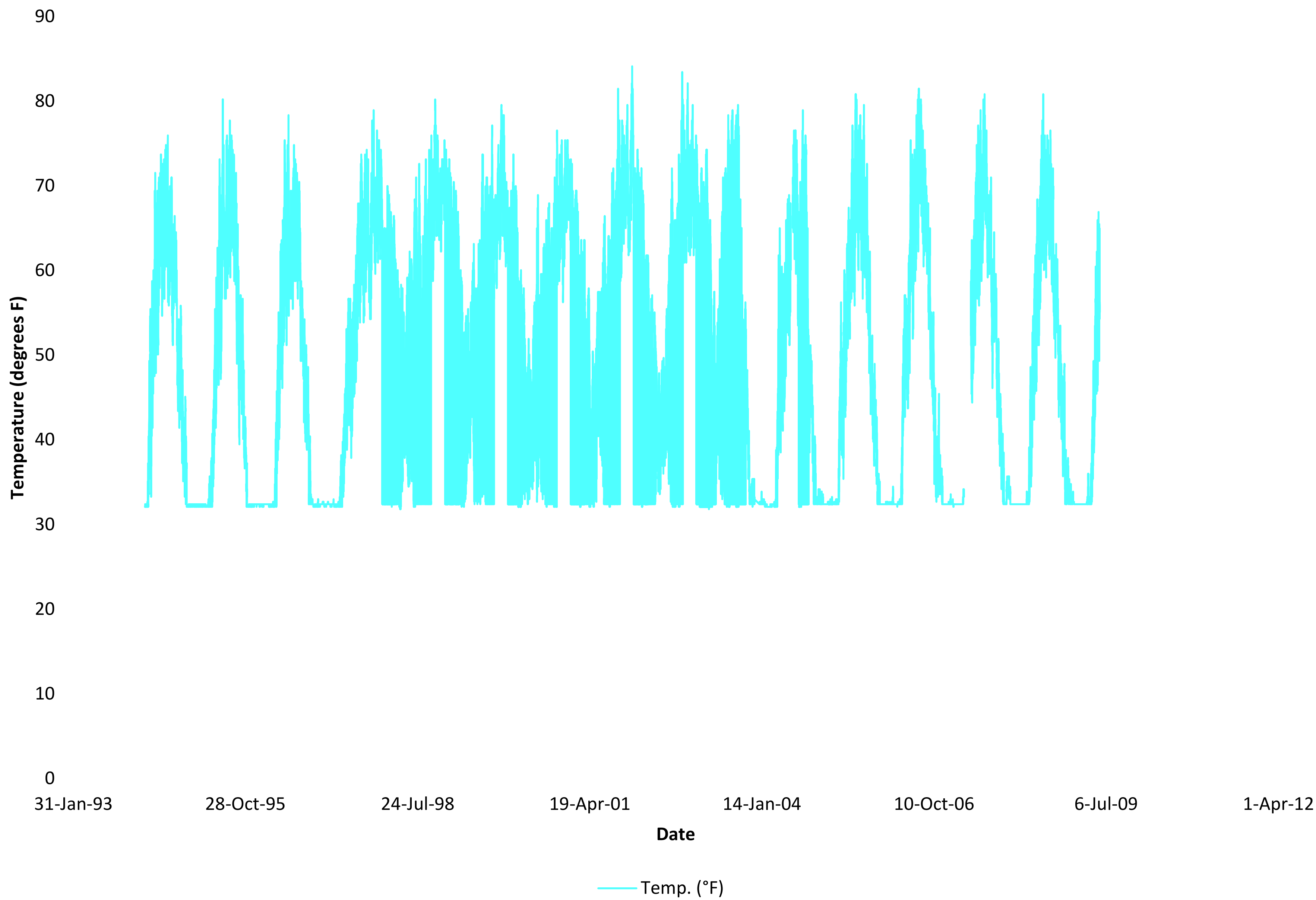
FRENCH RIVER - Summary of Available Data

Tab	Data Type	Location	Date Range	Collected By	Source
Flow-MDNR	Flow	French River between Fish Traps near French River Hatchery	Mar. 1994 to Dec. 2009	MDNR	MDNR
Temp-MDNR	Temperature	French River between Fish Traps near French River Hatchery	Mar. 1994 to Dec. 2009	MDNR	MDNR
Temp-NPDES	Temperature	French River at French River Hatchery NPDES Stations SW001 (upstream station 701) & SW003 (downstream station 702)	Dec. 2011 to Dec. 2012	MDNR	MDNR
WQ-NPDES	Water Quality	French River at French River Hatchery NPDES Station SW001 (upstream station 701)	July 2007 to Oct. 2012	MDNR	MDNR
WQ-MPCA-S000-255	Water Quality	French River at Hatchery at US-61, NE OF Duluth (S000-255)	July 1973 to Aug. 2012	MPCA *(MPCA Stream Monitoring Program Project)*	http://www.pca.state.mn.us/customPHP/eda/stationInfo.php?ID=S000-255&ORG=MNPCA
WQ-MPCA-S001-754	Water Quality	French River at St. Louis County Highway 50, 7-miles N of Duluth, MN (S001-754)	Aug. 2001 to Oct. 2008	MPCA *(Citizen Stream Monitoring Program)*	http://www.pca.state.mn.us/customPHP/eda/stationInfo.php?ID=S001-754&ORG=MNPCA
WQ-MPCA-S003-986	Water Quality	French River Mouth to Lake Superior, 7-miles NE of Duluth, MN (S003-986)	June 1990 to Oct. 1991	MPCA *(Western Lake Superior Sanitary District Monitoring)*	http://www.pca.state.mn.us/customPHP/eda/stationInfo.php?ID=S003-986&ORG=MNPCA
WQ-MPCA-S006-280	Water Quality	French River just downstream of McQuade Road, 12-miles NE of Duluth, MN (S006-280)	June 1998 to Aug. 1999	MPCA *(Region, landscape and scale effects on Lake Superior tributary water quality)*	http://www.pca.state.mn.us/customPHP/eda/stationInfo.php?ID=S006-280&ORG=MNPCA

MDNR Discharge Recordings between French River Fish Traps



MDNR Temperature Recordings between French River Fish Traps



Minnesota Department of Natural Resources

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File No. FMA.00257.00.00.03
HDR No. 202386

French River Cold Water Hatchery

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B. POTENTIAL IMPROVEMENT PHOTOS AND MANUFACTURER DATA
C. FISH PRODUCTION DATA
D. PRODUCTION THEORY
E. EXCERPTS FROM NPDES PERMIT, EXAMPLE DMR, AND FLOODPLAIN MAP
F. BIOSECURITY OVERVIEW
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French River Fish Hatchery Intake Inspection

French River, MN

AMI

Consulting Engineers P.A.

91 Main Street
Superior, WI 54880
PH: (715) 718-2193 / FAX (877) 761-7058

French River Fish Hatchery Intake Inspection
AMI Project #121205

French River, MN
May 13, 2013

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Drawings .... Appendix A

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Purpose of Inspection

AMI Consulting Engineers, P.A. (AMI) was contacted by Barr Engineering to inspect the water intake for the French River Fish Hatchery which is operated by the Minnesota DNR (MnDNR) in French River, MN. From previous inspection reports, a section of the intake was broken and has moved out of alignment with the other pipe sections. The purpose of the inspection was to assess the broken and unbroken sections of the intake and determine if the intake could be repaired and still meet the demands of the facility.

Procedures Used for Inspections

The AMI Engineering inspection team consisted of one professional engineer diver and two divers/tenders. Surface supplied diving techniques were utilized during all phases of the inspection process to meet OSHA, US Coast Guard, and Association of Commercial Diving International Standards to insure proper safety was incorporated at all times. The divers used an underwater helmet mounted video camera to document the existing condition of the intake for future review by AMI, Barr Engineering, and MnDNR. Pertinent video clips, photos and drawings (links are in blue text) will be used in the report to illustrate the condition of the intake. The diver performed a Level I inspection which includes a visual inspection looking for any damage, deterioration, or defects to the intake.

Existing Construction

The existing intake was constructed of 20 inch diameter steel pipe sections which were each approximately 18 feet long. At the end of each pipe section a metal collar was installed to connect the pipe sections together. The intake became exposed approximately 300 feet from the shore line and was exposed for remaining length of the intake. The total length of the exposed section of the intake was approximately 1400 feet. See drawing D1.0 for an overall layout and location of the intake.

Site Conditions

On May 1, 2013, AMI mobilized to the site to perform an underwater inspection of the steel intake pipe. AMI began its inspection near the shore and inspected the intake as the diver worked away from shore. The steel pipe was found to be in good condition with some areas of corrosion in the form of rust tubercles. The corrosion covered approximately 10-15% of the pipe steel and the largest diameter of the rust tubercle was approximately 1 ½”. Some light pitting was documented under the rust tubercles with a depth less than 1/16”. The majority of the corrosion under the rust tubercles would be considered light etching.

Previous dive inspections noted a section of the intake had become broken and moved out of alignment from the rest of the intake. This condition was confirmed by AMI and the location of the broken section does not appear to have moved significantly from a drawing prepared by Jerry

Norick dated January 27th, 2010. The broken section of the intake was located 20 to 50 feet south of the current location of the intake. The broken section of the intake is approximately 72 feet long and appears to be in good condition. No cracks, breaks, or signs of distress were documented along the length of the broken section but the open ends of the pipe have become partially filled with sediment so some areas of the pipe could not be inspected. Several of the collars joining the sections of pipe together were found to be loose but these collars could be repositioned and reused. See drawing 1/D1.0 for location of the broken pipe section.

Due to the movement of the broken section of the intake, a few additional sections of the pipe near the break have moved out of alignment with the rest of the intake but the collars and the pipes at these locations appear to be in good condition. The sections of pipes which have moved out of alignment can be seen on drawing 1/D1.0.

An old intake screen cover was also found at the end of the broken section of the intake which was still connected to the pump house. The screen was constructed of an aluminum plate with a series of ½" diameter holes drilled into the face of the plate. The aluminum screen was found lying in front of the intake and not connected to the intake. The diver was unable to reattach the intake screen to the intake due to weight of the screen.

Several grout bags were documented along the length of the intake. It appears that these bags were installed to provide support for the collars joining the sections of pipe together. The spacing of the grout bags varied greatly depending on if the section of the intake was supported by the lake bottom. Each collar was found to be supported by either the lake bottom or a stack of grout bags.

An intake screen was also documented on the far end of the pipe. A 90 degree elbow with a basket screen was attached to the end of the intake. The basket screen was approximately 2'-4" in diameter and was approximately 2'-0" tall. The screen was found to be in good condition with very little debris or marine growth present. See drawing 2/D1.0 for details on the intake screen.

Recommendations & Conclusions

After reviewing all of the data and assessing the existing site conditions, AMI Consulting Engineers makes the following recommendations and conclusions. The pipes which make up the intake appear to be in good condition and can still meet the demands of the facility once repaired. The inside and very ends of the open sections of the intake should be cleaned out and re-inspected for areas of damage or deterioration which were not visible due to sediment buildup.

The broken section of the intake and the sections of the pipe which have become out of alignment could be lifted and moved back into position. One section pipe may need to be trimmed during the repair so the broken section of pipe can fit back into the existing gap. A special collar would then need to be installed on the trimmed section of pipe so no gaps are present in the intake.

Once the intake is reconnected and realigned, the intake should be anchored to the lake bottom to prevent any future lateral movement. This restraint can be accomplished by many different methods and systems. The lake bottom along the length of the intake consisted of sections of sand, rubble, and exposed bedrock so the type of anchorage system might be different at each section. The size and spacing of the restraint will also depend on the system used and the condition of the lake bottom. One example of an anchorage system is given on drawing D1.1.

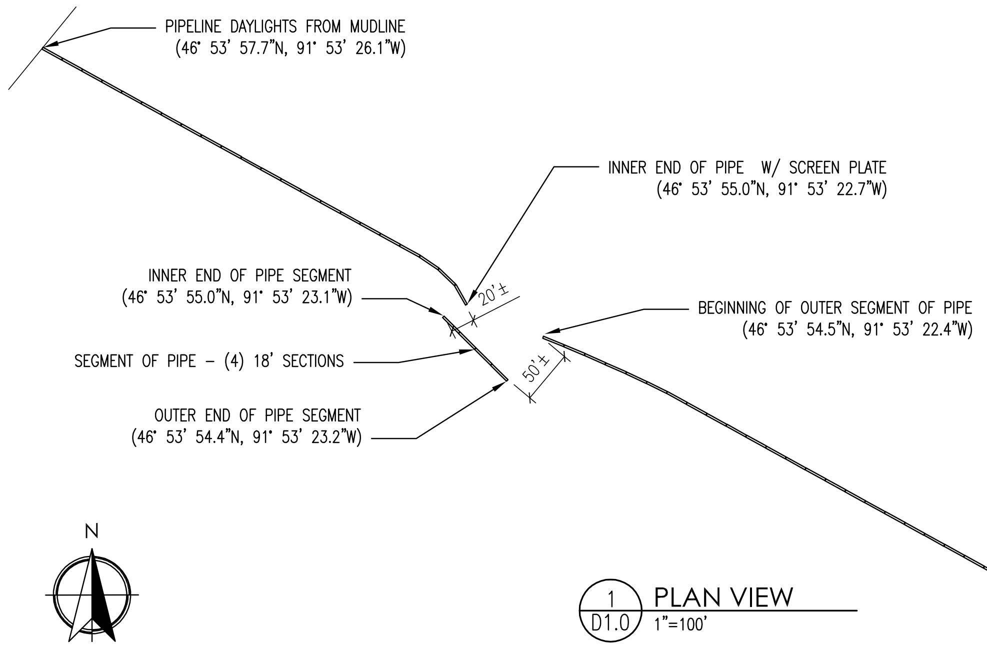
This assessment of the intake utilized available information from existing drawings, current engineering knowledge, and AMI's field investigations. If requested, precise data, analysis and new design layouts can be produced. If any questions arise or you wish to discuss the options presented, please feel free to contact AMI at your convenience.

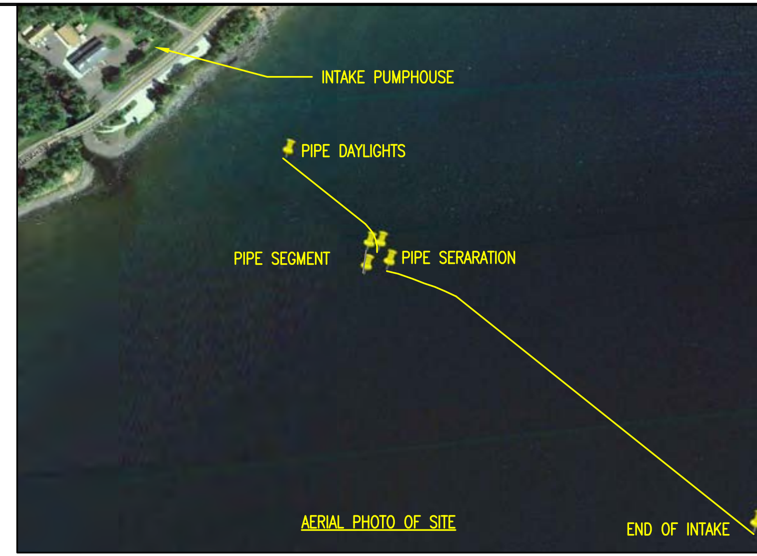
Respectfully Submitted,
Chase Dewhirst, PE

Reviewed By,
Chad Scott, PE
Principal

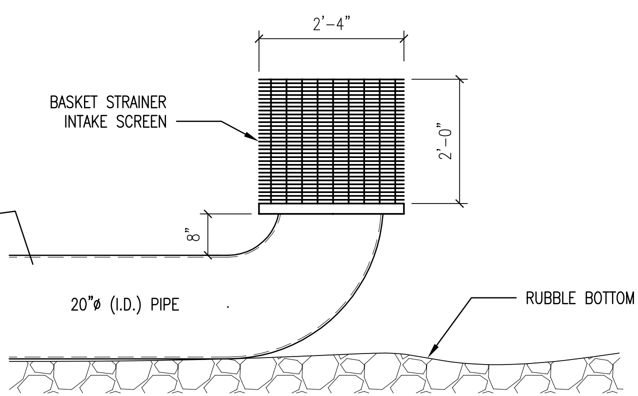
APPENDIX A Drawings

AMI Drawings .... .D1.0 – D1.1





1 D1.0 PLAN VIEW
1"=100'



2 D1.0 INTAKE DETAIL
1"=1'–0"

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DATE:	REV:	DESCRIPTION	BY:

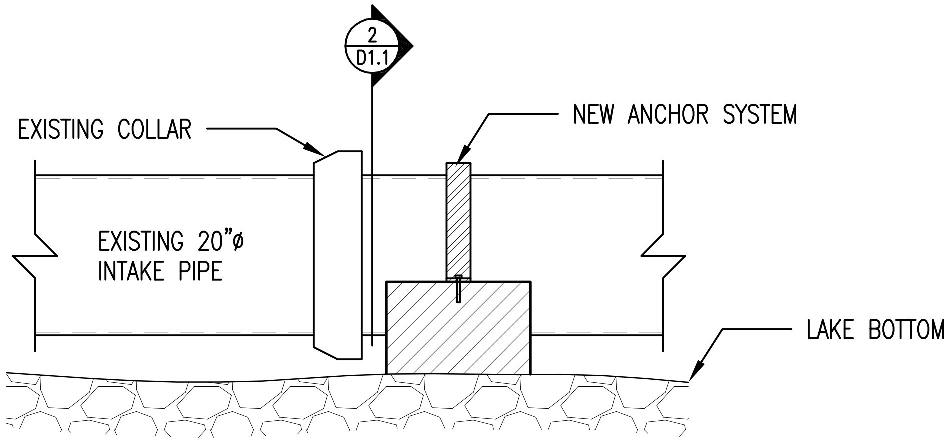
MN Department of Natural Resources
French River Fish Hatchery
Intake Pipe Inspection

Inspection Findings
Plan & Detail

JOB No: 121205
DATE: 5/13/13
DRAWN BY: SAJ
DESIGNED BY: CAD

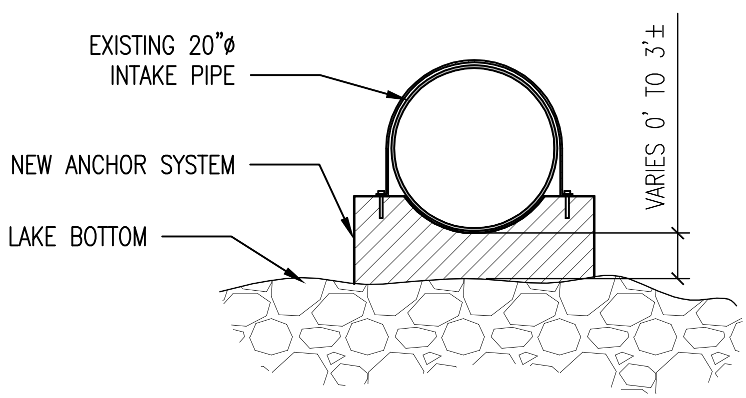
SHEET: D1.0

3/8/2011 2:31 PM
Z:\2012\121205 MNDNR French River Hatchery\Drawings\D1.0.dwg



1 / D1.1 Proposed Anchor Sysytem
1"= 1'-0"

TYPE, SIZE, AND SPACING OF ANCHOR SYSTEM TO BE DETERMINED BY DESIGN ENGINEER TO RESTRAIN INTAKE FROM LATERAL MOVEMENT



2 / D1.1 Proposed Anchor Sysytem
1"= 1'-0"

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MN Department of Natrural Resources
French River Fish Hatchery
Intake Pipe Inspection

Proposed Intake
Anchor System

JOB No: 121205
DATE: 5/13/13
DRAWN BY: SAJ
SHEET: D1.1

Minnesota
Department of Natural Resources

MDNR No. 8F022
File No. FMA.00257.00.00.03
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French River Cold Water Hatchery

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Table I-1A. FRH Expenditure Summary FY2009

PROJECT	FISCAL COST	%	FISCAL PRODUCTS
KAMLOOP:			
KAM-07 YEAR CLASS			47,379 summer yearlings for French River for future brood.
KAM-08 YEAR CLASS			13,377 fall fingerlings for inland stream trout lakes and spring yearlings for Lake Superior and inland stream trout lakes.
KAM-08 YEAR CLASS			56,155 yearlings for Lester River, McQuade Access and inland stream trout lakes.
TOTAL KAMLOOP	**$387,811**	61.0	
STEELHEAD: FRY & FINGERLINGS:			
FRW			120,699 fry for French River and tributaries to Lake Superior.
FCH			9,451 fry for tributaries to Lake Superior.
KCB			359,262 fry for tributaries to Lake Superior and 53,875 fingerlings for the French River.
KCH			6,406 fry for MNDNR research project.
KRW			6,879 fry for MNDNR research project.
TOTAL STT FRY & FINGERLINGS	**$96,100**	15.1	
STEELHEAD BROOD:	**$106,247**	16.7	1,000 adults of Knife River origin kept on hand to produce fry and fingerlings for tributaries to Lake Superior.
TOTAL CULTURE:	$590,158	92.9	
DIST. - INLAND LAKES	$2,294	0.04	Rate and load out 12,785 Kamloop yearlings.
DIST. - LAKE SUPERIOR	$12,470	1.96	Rate and load out fry and fingerling steelhead and Kamloop yearlings. Finclipping of the Kamloop yearlings included for hatchery staff.
MOUNTAIN LAKE TROUT	$1,557	0.02	Shuttle eggs from Beaver Bay to St. Paul office building.
F699 RESEARCH PROJECT	$1,825	0.03	Periodic care of fry and fingerlings located at Duluth Area Fisheries Station.
HATCHERY RENOVATION	$27,240	0.43	Construction meetings and blueprint review for emergency generator and heat pump projects.
TOTAL ALL COSTS:	**$635,544**	**100.00**	

Note: The electrical costs to run the Duluth Area Fisheries complex ($3,258.74) is included in the above lot costs.

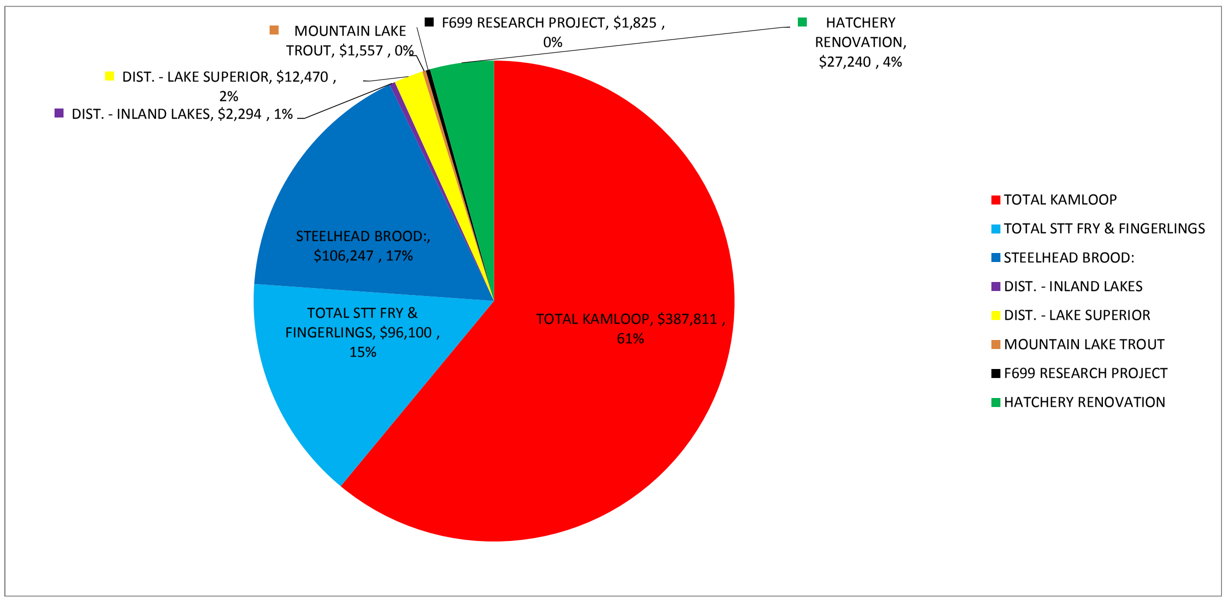

Table I-1B. FRH Program Costs FY2009

Program Costs	KAM	%	STT	%	STT-BRD	%	LAT-MNT	%	F-699	%	TOTAL ALL PROGRAMS	%
Specific Labor Cost	$100,331	25.1	$28,767	29.0	$30,204	28.4	$535	34.4	$599	32.8	$160,435	26.4
Specific Supplies Cost	$25,502	6.4	$172	0.2	$6,860	6.5	0	0.0	0	0.0	$32,534	5.3
Prorated Labor Costs	$127,420	31.9	$32,665	33.0	$33,649	31.7	$497	31.9	$596	32.7	$194,828	32.0
Prorated Operating Cost	$134,559	33.7	$34,495	34.8	$35,534	33.4	$525	33.7	$630	34.5	$205,743	33.8
Total Production Cost	$387,811	97.1	$96,100	97.0	$106,247	100.0	$1,557	100.0	$1,825	100.0	$593,540	97.6
Stocking Labor	$11,406	2.9	$2,999	3.0	0	0.0	0	0.0	0	0.0	$14,405	2.4
Stocking Expenses	$359	0.1	0	0.0	0	0.0	0	0.0	0	0.0	$359	0.1
Total Stocking Cost	$11,765	2.9	$2,999	3.0	0	0.0	0	0.0	0	0.0	$14,764	2.4
Grand Total Program Cost	**$399,576**	100.0	**$99,098**	100.0	**$106,247**	100.0	**$1,557**	100.0	**$1,825**	100.0	**$608,304**	100.0

Hatchery Renovation Cost	$27,240
Total All Costs	**$635,544**

Program Costs		
Specific Labor Cost	$160,435	25.2
Specific Supplies Cost	$32,534	5.1
Prorated Labor Costs	$194,828	30.7
Prorated Operating Cost	$205,743	32.4
Total Production Cost	$593,540	93.4
Stocking Labor	$14,405	2.3
Stocking Expenses	$359	0.1
Total Stocking Cost	$14,764	2.3
Grand Total Program Cost	**$608,304**	95.7
Hatchery Renovation Cost	$27,240	4.3
Total All Costs	**$635,544**	100.0

Table I-2A. FRH Expenditure Summary FY2010

PROJECT	FISCAL COST	%	FISCAL PRODUCTS
KAMLOOP:			
KAM-09 YEAR CLASS			
KAM-10 YEAR CLASS			
KAM-11 YEAR CLASS			
TOTAL KAMLOOP	**$400,995**	63.9	
STEELHEAD: FRY & FINGERLINGS:			
FRW			
FCH			
KCB			
KCB			
KCH			
TOTAL STT FRY & FINGERLINGS	**$96,327**	15.3	
STEELHEAD BROOD:	**$116,504**	18.6	
TOTAL CULTURE:	**$613,827**	97.8	
DIST. Inland lakes	$2,275	0.004	
DIST. - LAKE SUPERIOR	$8,963	1.43	
MOUNTAIN LAKE TROUT	$0		
F699 RESEARCH PROJECT	$0		
HATCHERY RENOVATION	$2,820	0.04	
TOTAL ALL COSTS:	**$627,885**	**100.00**	

Note: The electrical costs to run the Duluth Area Fisheries complex ($3,258.74) is included in the above lot costs.

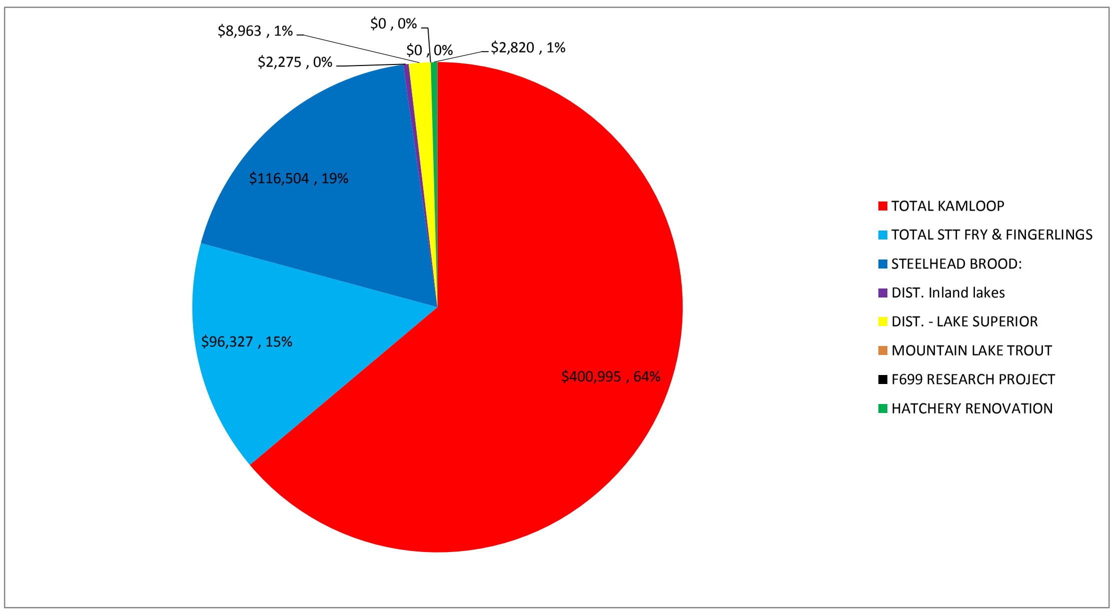

Table I-2B. FRH Program Costs FY2010

Program Costs	KAM	%	STT	%	STT-BRD	%	LAT-MNT	%	F-699	%	TOTAL ALL PROGRAMS	%
Specific Labor Cost	$113,291	27.7	$31,715	32.5	$36,981	31.3	$0	0.0	$0	0.0	$181,987	29.1
Specific Supplies Cost	$40,251	9.8	$1,394	1.4	$4,857	4.1	0	0.0	0	0.0	$46,502	7.4
Prorated Labor Costs	$118,195	28.9	$30,198	31.0	$35,673	30.2	$0	0.0	$0	0.0	$184,066	29.4
Prorated Operating Cost	$129,194	31.5	$33,008	33.9	$38,993	33.0	$0	0.0	$0	0.0	$201,195	32.2
Total Production Cost	$400,931	97.9	$96,316	98.8	$116,504	98.7	$0	0.0	$0	0.0	$613,751	98.2
Stocking Labor	$8,616	2.1	$1,119	1.1	1,503	1.3	0	0.0	0	0.0	$11,238	1.8
Stocking Expenses	$64	0.0	12	0.0	0	0.0	0	0.0	0	0.0	$76	0.0
Total Stocking Cost	$8,680	2.1	$1,131	1.2	1,503	1.3	0	0.0	0	0.0	$11,314	1.8
Grand Total Program Cost	**$409,611**	100.0	**$97,446**	100.0	**$118,007**	100.0	**$0**	0.0	**$0**	0.0	**$625,065**	100.0

Hatchery Renovation Cost	$2,820
Total All Costs	**$627,885**

Program Costs		
Specific Labor Cost	$181,987	29.0
Specific Supplies Cost	$46,502	7.4
Prorated Labor Costs	$184,066	29.3
Prorated Operating Cost	$201,195	32.0
Total Production Cost	$613,751	97.7
Stocking Labor	$11,238	1.8
Stocking Expenses	$76	0.0
Total Stocking Cost	$11,314	1.8
Grand Total Program Cost	**$625,065**	99.6
Hatchery Renovation Cost	$2,820	0.4
Total All Costs	**$627,885**	100.0

Table I-3A. FRH Expenditure Summary FY2011

PROJECT	FISCAL COST	%	FISCAL PRODUCTS
KAMLOOP:			
KAM-09 YEAR CLASS			58,141 summer yearlings for FrenchRiver and McQuade Access
KAM-10 YEAR CLASS			22,500 yearlings for French River and McQuade Access
KAM-11 YEAR CLASS			175,061 eyed eggs to Sprire Valley SFH
TOTAL KAMLOOP	**$339,967**	59.3	
STEELHEAD: FRY & FINGERLINGS:			
FRW			102,961 eyed eggs to Spire Valley SFH
FCH			6,706 eyed eggs shipped to Spire Valley
KCB			425,692 eyed eggs shipped to Spire Valley
KCB			14,816 eyed eggs shipped to Amity Creek
KCH			14,816 eyed eggs shipped to Spire Valley
TOTAL STT FRY & FINGERLINGS	**$95,515**	16.7	
STEELHEAD BROOD:	**$124,701**	21.7	1,100 adults of Knife River origin kept to produce fry for northshore streams
TOTAL CULTURE:	**$560,183**	97.7	
DIST. - INLAND LAKES	$0	0.00	
DIST. - LAKE SUPERIOR	$3,556	0.62	Rate and load out STTfry and Kamloop yearlings. Finclipping of Kamloop Yearlings included for hatchery staff
MOUNTAIN LAKE TROUT			
F699 RESEARCH PROJECT			
HATCHERY RENOVATION	$9,844	0.17	Replace emergency backup pump. Replumbing heat pump to allow cleaning while running.
TOTAL ALL COSTS:	**$573,583**	**100.00**	

Note: The electrical costs to run the Duluth Area Fisheries complex ($3,258.74) is included in the above lot costs.

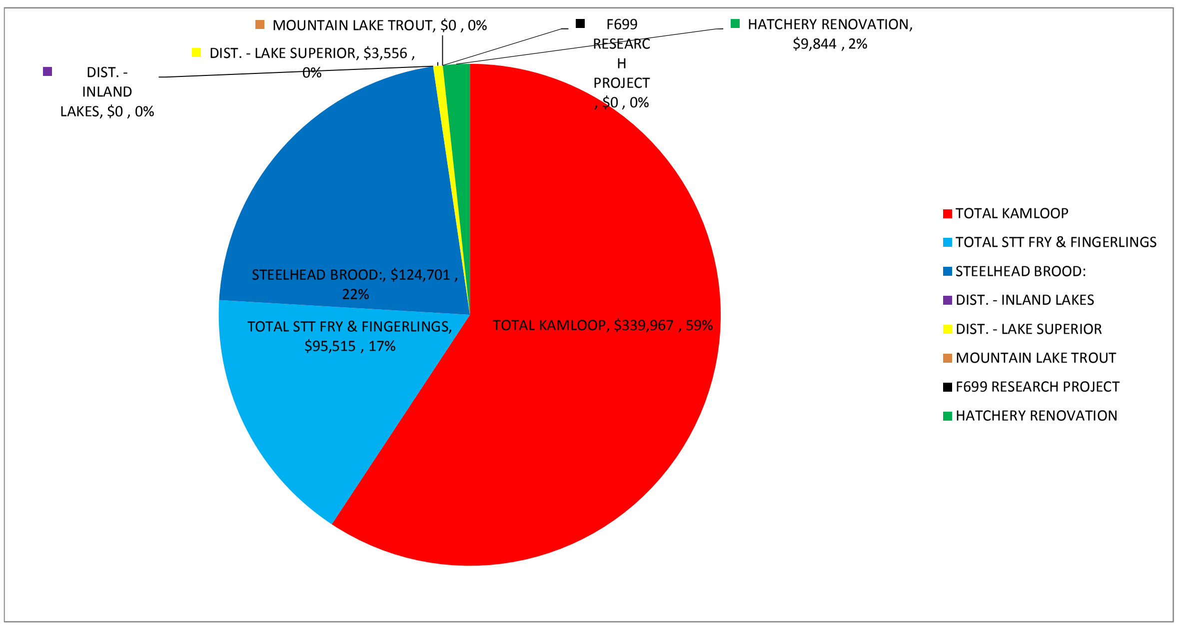

Table I-3B. FRH Program Costs FY2011

Program Costs	KAM	%	STT	%	STT-BRD	%	LAT-MNT	%	F-699	%	TOTAL ALL PROGRAMS	%
Specific Labor Cost	$78,557	23.1	$22,966	24.0	$31,099	24.9	$0	0	$0	0.0	$132,622	23.7
Specific Supplies Cost	$12,184	3.6	$1,306	1.4	$3,209	2.6	0	0	0	0.0	$16,699	3.0
Prorated Labor Costs	$130,035	38.2	$37,707	39.5	$47,845	38.4	$0	0	$0	0.0	$215,587	38.5
Prorated Operating Cost	$115,639	34.0	$33,532	35.1	$42,548	34.1	$0	0	$0	0.0	$191,719	34.2
Total Production Cost	$336,415	99.0	$95,511	100.0	$124,701	100.0	$0	0	$0	0.0	$556,627	99.4
Stocking Labor	$3,552	1.0	$4	0.0	0	0.0	0	0	0	0.0	$356	0.1
Stocking Expenses	$0	0.0	0	0.0	0	0.0	0	0	0	0.0	$0	0.0
Total Stocking Cost	$3,552	1.0	$4	0.0	0	0.0	0	0	0	0.0	$3,556	0.6
Grand Total Program Cost	**$339,967**	100.0	**$95,515**	100.0	**$124,701**	100.0	**$0**	0.0	**$0**	0.0	**$560,183**	100.0

Hatchery Renovation Cost	$9,844
Total All Costs	**$570,027**

Program Costs		
Specific Labor Cost	$132,622	23.3
Specific Supplies Cost	$16,699	2.9
Prorated Labor Costs	$215,587	37.8
Prorated Operating Cost	$191,719	33.6
Total Production Cost	$556,627	97.6
Stocking Labor	$356	0.1
Stocking Expenses	$0	0.0
Total Stocking Cost	$3,556	0.6
Grand Total Program Cost	**$560,183**	98.3
Hatchery Renovation Cost	$9,844	1.7
Total All Costs	**$570,027**	100.0

Minnesota Department of Natural Resources

MDNR No. 8F022
File No. FMA.00257.00.00.03
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French River Cold Water Hatchery

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