Statewide Hatchery Evaluation

New Hampshire Fish and Game Department

New Hampshire
December 13, 2023

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Abbreviations

AACE	Association for the Advancement of Cost Engineering
EPA	Environmental Protection Agency
HVAC	Heating, Ventilation and Air Conditioning
NHDES	New Hampshire Department of Environmental Services
NHFGD	New Hampshire Fish and Game Department
NPDES	National Pollution Discharge Elimination System
NPV	Net Present Value
O&M	Operation and Maintenance
OPCC	Opinion of Probable Construction Cost
PRAS	Partially Recirculating Aquaculture System
RAS	Recirculating Aquaculture System
SFH	State Fish Hatchery
TP	Total Phosphorus
UV	Ultraviolet Light

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Executive Summary

New Hampshire Fish and Game Department (NHFGD) operates six fish hatcheries in the State of New Hampshire: Powder Mill, Berlin, New Hampton, Milford, Twin Mountain, and Warren. This system of facilities produces approximately 400,000 lbs of fish annually to serve the State's demand. The largest of the State's producers is Powder Mill with 120,000 lbs annually. Berlin, New Hampton, and Milford all produce roughly 70,000 to 75,000 lbs annually, and Twin and Warren combined produce roughly 45,000 lbs annually.

Total phosphorus (TP) effluent limits imposed on the Powder Mill State Fish Hatchery in 2021 were the driving factor for this comprehensive study. These limits were given to Powder Mill due to the receiving water body (several impoundments on the Merrymeeting River) having been listed on New Hampshire's 303(d) list as impaired due to cyanobacteria in the preceding years. Cyanobacteria is harmful to human health and fueled by excess phosphorus, thus leading to what is one of the lowest TP effluent limits in the country faced by a fish hatchery at 12 µg/L TP.

In addition, the Berlin State Fish Hatchery (SFH) is currently facing a new discharge permit; however, the limits have not yet been finalized by the EPA for this facility. Although exact limits are currently unknown, it is likely that this facility will be required to decrease current production numbers to meet the new effluent permit requirements.

Due to this regulatory pressure on two of the State's major hatcheries, NHFGD retained HDR Engineering Inc. (HDR) to evaluate existing conditions, develop modernization alternatives for each individual hatchery, and look at the entire system as a whole to find the most efficient way to meet production and stocking goals while maintaining permit compliance. In 2022-2023, HDR completed the condition assessments, a piloting effort at Powder Mill, and modernization evaluations for each of the six hatcheries.

Characterization of the speciation of total phosphorus in hatchery effluent was undertaken at Powder Mill and Berlin given the concentrations of each species significantly influences the treatment mechanism necessary when such a low TP target is desired. Data on phosphorous speciation in hatchery effluent is not readily available in literature since such a low TP effluent limit has never been faced by a hatchery before. It was found that Powder Mill's effluent contained all three phosphorous species that comprise total phosphorus in roughly equivalent values. Each individual species was found in levels higher than the permitted total limit. Since each species requires a different form of treatment, this means three different treatment methods are required to approach meeting such low limits.

A pilot effluent treatment study was executed at Powder Mill to determine if it was even technologically achievable to meet the required TP limits. The study found that the limits could be achieved by ultrafiltration, chemical addition, and ion exchange processes in series. However, the cost to implement these technologies at Powder Mill was not the most efficient way to meet production and stocking goals and cost more than current available funding.

Concurrently, evaluations of each of the hatcheries were conducted and utilized to develop system wide alternatives to evaluate how production can be relocated within the existing system to meet both effluent permit limits and the state's production demand. Given the mission of NHFGD, it is desirable that most of the available funding be expended on modernizing fish production facilities that discharge less TP rather than construct advanced effluent treatment facilities to serve outdated and failing hatchery technology.

Three key issues drive achieving 400,000 lbs of production within the State's system of six hatcheries; permit compliance, water supply (quantity and quality), and the condition of the existing infrastructure.

- Permit Compliance – The low limits already in place for Powder Mill and the potential for similar at Berlin dictate the need for any of the larger hatcheries to include effluent treatment. The scale and complexity of the treatment will be determined by the location of the facility, the amount of treated recirculation water, and existing or potential future limits. Production capabilities that have been estimated in this document outline potentials based on fish rearing and infrastructure requirements but the ultimate levels of production achievable at each location will be driven by permit compliance.

- Water Supply – Powder Mill is the only facility within the state with ample water supply. All other sites have limited water supplies that are currently being utilized to the maximum extent possible for the existing systems which were designed for flow through with multiple passes. Thus, for any of the other five facilities, recirculating aquaculture systems (RAS) that include water treatment are required. Additionally, Milford has limits on the amount of water that can be withdrawn, and that water is high in iron and manganese causing increased maintenance within the facility. However, some facilities such as Twin Mountain, while small, has a high-quality water supply that would be suitable for broodstock use.

- Infrastructure – Existing infrastructure has been driven to the end of its useful life. Major investments to maintain permit compliance, efficient operation, and address water supply issues should be done in conjunction with modernized rearing facilities to maximize the investment of the state's dollars and protect the production capabilities of the system.

After review of multiple alternatives at all six facilities, as well as development and evaluation of statewide alternatives, an approach to the improvements required to continue to support NHFGD's production goals in the interim is clear. Immediate investments should occur at New Hampton to construct a new recirculating aquaculture system (RAS) facility to accommodate 150,000 lbs in production plus house Brook and Brown Trout broodstock and Landlocked Atlantic Salmon egg rearing. The centralized location of the facility, capability to complete major renovation within the existing footprint, and the ability to utilize RAS make the location ideal for major infrastructure investments. This project increases production by 108% based on lbs per year at New Hampton. With additional future funding, this facility has the potential to increase production up to 250,000 lbs per year with the use of higher rearing densities and a relocation of the effluent discharge to the Pemigewasset River.

Investment to construct a Rainbow Trout broodstock facility at Twin Mountain should be executed concurrently or shortly after completion of construction at New Hampton. A new biosecure building capable of housing an internal Rainbow Trout program would eliminate the need to import poor quality eggs from other programs outside of New Hampshire, resulting in a huge cost savings in labor and operation in addition to better control of egg quality.

These two recommended projects at New Hampton and Twin Mountain allow NHFGD to meet 359,000 lbs of production after consideration of the anticipated losses required at Powder Mill and Berlin. There are multiple pathways available to meet the overall statewide production goals that have been determined as part of this study:

- New Hampton Phase 2 – Relocation of the effluent discharge from Dickerman Brook to the Pemigewasset River could allow this facility to produce up to 250,000 lbs with minimal rearing system improvements by carrying an increased density within the existing rearing units.
- Milford Rehabilitation – Rebuild of Milford including source water treatment to reach 100,000 lbs in production.
- Powder Mill Re-Evaluation – Evaluate use of a dilution zone coupled with recirculating technology. Additional evaluation of less advanced forms of TP removal may also be justified.
- Berlin/New Northern Facility – Depending on the regulatory pressure on Berlin, re-evaluation of a new Northern Facility may be justified.

However, given the uncertainty remaining regarding the regulatory environment as well as further engineering study required to determine the most cost-effective path forward, additional evaluation should be undertaken prior to implementing a long-term plan to meet the states entire 400,000 lb goal for production.

While major projects at New Hampton and Twin Mountain are recommended as part of the interim plan and multiple other pathways exist to reach the State's 400,000 lb production goal, it is critical to understand that reinvestment into the entire statewide system is overdue. The State's existing hatcheries have provided an enormous environmental, social, and economic impact over their life span. Per year, the New Hampshire Hatchery System produces roughly 1.5 million fish for stocking. Extrapolating that by the average 20-year lifespan of a facility typically assigned in engineering studies, results in roughly 30 million fish! These systems have served New Hampshire for significantly longer than 20 years, having an average age of 88 years, and now need significant reinvestment to continue to provide these benefits.

The implementation timeline for the interim plan is extremely condensed and will require significant capital investment within the State's hatchery systems over the course of the next five years to maintain production goals, with even more investment necessary to reach the long-term goals. The recommended timeline for the interim plan is as follows:

- <u>Phase 1 – 2025</u>:
  - Powder Mill – Reduction in annual production from 118,000 lbs to 30,000 lbs (75% reduction) to meet effluent TP limits.

  - Berlin – Slight reduction in annual production from 74,000 lbs to roughly 64,000 lbs (13.5% reduction). If further reduction is deemed necessary after receiving the final EPA discharge permit this facility may shift its focus to Brook Trout broodstock only as a viable alternative to meet new effluent TP limits.

- Phase 2 – 2025/2026:
  - New Hampton – New RAS facility to accommodate 150,000 lbs in production plus house Brook and Brown Trout broodstock and Landlocked Atlantic Salmon egg rearing.

- Phase 3 – 2026/2027:
  - Twin Mountain – Slight reduction in production to focus on Rainbow Trout broodstock.

- Phase 4 – 2027-2030:
  - Reevaluation of the statewide system to determine the best way to meet production goals. Depending on the selected long-term approach, major rehabilitation at other facilities should be undertaken to maintain production capabilities at existing facilities.

The opinion of probable construction costs (OPCC) summary for each phase of implementation of the interim plan are shown below in Table ES-1.

Table ES-1: Recommended Interim Plan OPPCs by Phase

	Phase 1 **2025**	**Phase 2** **2025/2026**	**Phase 3** **2026/2027**
Powder Mill	$2,800,000		
Belin			
New Hampton		$50,900,000	
Milford			
Twin			$ 4,000,000
Warren			
Total	$2,800,000	$50,900,000	$4,000,000

Notes: 1. Opinion of Probable Construction Costs do not include required design engineering and design services during construction fees. Determination of project funding requirements will necessitate the inclusion of these fees.

Implementing significant improvements to New Hampton and Twin Mountain will allow NHFGD to continue to effectively carry out its mission of conserving, managing, and protecting the State's fish and wildlife resources and their habitats; informing and educating the public about these resources; and providing the public with opportunities to use and appreciate these resources until further information is known. Furthermore, reevaluation of the remaining alternatives to reach the State's goal of 400,000 lbs ensures that the best overall long-term solution is implemented so that NHFGD can continue to provide the enormous environmental, social, and economic impact in the most cost-effective way for the next 25 to 50 years.

1 Introduction

The State of New Hampshire utilizes fish stocking as one of several essential tools to provide statewide fisheries resource management and recreational opportunity. These are two of the many functions of the New Hampshire Fish and Game Department (NHFGD), and it is accomplished by the operation of fish hatcheries and rearing stations. The major objective of these facilities is to produce the requested number of trout and Landlocked Atlantic Salmon to support recreational sport fishing in the state. Species produced, transferred, and stocked include Brown Trout, Rainbow Trout, Brook Trout, and Landlocked Atlantic Salmon. Other objectives of these facilities include:

- Supplementation in public waters where natural recruitment is low.
- Reintroductions of populations following fish kills.
- Restoration of various fish populations where human-influenced factors caused declines in fish abundance.
- Increase angler opportunities for higher-than-average catch rates or larger-than-average sized trout.

Six state-operated facilities focus on providing high quality fish to meet State objectives: Powder Mill, Berlin, New Hampton, Milford, Twin Mountain, and Warren. (Figure 2-1). Lack of investment in these facilities has occurred over the last several decades resulting in significant deferred necessary maintenance, costly emergency repairs, ineffective infrastructure, and labor-intensive operations. The average age of the facilities is 88 years and the last major infrastructure improvement to these facilities was to consolidate outfalls and provide better removal and storage of solids. However, the consistent lack of investment in these facilities has resulted in all six facilities requiring significant rehabilitation to meet the State's recreational sport fishing goals. In addition, some of these facilities are facing stricter effluent limits which will also require significant investment to attain permit compliance.

Powder Mill Fish Hatchery, the largest in the State's system (in pounds of fish produced), received a new NPDES (National Pollution Discharge Elimination System) Permit in January 2021 with concentration and load-based total phosphorus (TP) limits for the hatchery effluent discharged to Merrymeeting River. A monthly average TP discharge concentration limit of 12 µg/L was established for each of Powder Mills outfalls along with cumulative load-based limits of 227 lb/year and 19 lb/month. It is important to note that this limit is believed to be one of the lowest in the country for a fish hatchery. While treatment of the existing hatchery effluent to this limit has been shown to be technically achievable, it is significantly cost prohibitive. Additionally, the Berlin Fish Hatchery is anticipated to receive new effluent limits for TP in 2024 which could also pose compliance challenges.

To maximize fish production while minimizing impacts to the environment, modernization within the system must occur. In general terms modernization involves upgrading fish culture infrastructure, utilizing fish production water efficiently, providing healthy fish rearing environments, enhancing effluent treatment, and improving the fish culturist's work environment.

A comprehensive evaluation of the NHFGD system was undertaken to determine how to best meet stocking and production goals and comply with total phosphorous (TP) effluent limits at Powder Mill and Berlin through the following efforts:

- Review of current production and stocking levels.
- Condition assessments of all six facilities.
- Bench scale and pilot testing for effluent TP removal.
- Modernization evaluations of all six facilities.

The following pages discuss the results from these efforts and present alternative approaches for meeting statewide objectives through different combinations of improvements at each individual hatchery.

2 Existing Facilities Summary

The NHFGD hatchery system consists of six hatcheries: Powder Mill, Berlin, New Hampton, Milford, Twin Mountain, and Warren. The Nashua National Fish Hatchery supports the six NHFGD facilities. A general overview of the production levels and locations of these hatcheries is provided in Table 2-1 and Figure 2-1.

Table 2-1: Statewide Fish Production Averages from NHFGD Hatcheries Between 2016 and 2021

Facility	Number	Pounds	% of Total Pounds Produced
Powder Mill	344,007	117,590	31
Berlin	292,033	74,165	20
New Hampton	424,809	72,123	19
Milford	158,275	68,108	18
Warren	166,695	23,685	6
Twin Mountain	57,112	20,838	5
Nashua *	26,544	4,441	1
System Totals	**1,469,475**	**380,950**	**100**

*Currently, the Nashua National Fish Hatchery rears half of the statewide Landlocked Atlantic Salmon.

Figure 2-1: New Hampshire Fish and Game Department Statewide Hatcheries.

2.1 Powder Mill State Fish Hatchery

Powder Mill State Fish Hatchery (SFH) is in the Town of New Durham on the southern tip of Merrymeeting Lake in Strafford County, New Hampshire (Figure 2-2). The hatchery resides on approximately 95.55 acres of state-owned land. It consists of 99 exterior ponds/raceways, a hatchery building, and several support buildings. The facility currently manages only early rearing and final growout phases of fish rearing. Powder Mill no longer utilizes its hatchery building for its intended purpose. Infrastructure available for production includes seven primary areas:

1. Indoor hatchery building
2. Outdoor 25' circular tanks
3. A-D Series outdoor linear raceways
4. E-F Series outdoor linear raceways
5. Outdoor Woods Ponds
6. Outdoor Show Ponds
7. Outdoor Bass Ponds

Water is supplied by gravity flow from Merrymeeting Lake (1,111 surface acres) located just north of the facility. Water temperature varies monthly and throughout the hatchery. The average yearly water temperature for the entire site is 48°F. Water temperatures for December through March are below 38°F, and limited fish growth occurs during this period. In summer months, temperatures can reach 59°F, which often results in less oxygen carrying capacity. Two recently installed flow meters exist at this facility, one at discharge 001 and the other at discharge 002. Monthly water usage ranges from 3,800 to 4,065 gallons per minute (gpm), with an average monthly use of 3,950 gpm, not to exceed 4,500 gpm.

The hatchery building is not currently utilized for incubation or early rearing. The building houses Heath incubator trays and 10 circular rearing units. Each circular tank is 5' diameter with an operating depth of 1.6'. The water flow to each tank is 10 gpm, and the circular tanks are being used as mixing tanks for lime addition to the culture water for series E, F, and G to assist in stabilizing pH and meeting effluent limits.

The hatchery maintains 99 concrete and earthen rearing units. The upper portion of the facility contains seven banks of raceways (labeled Series A through G). These concrete raceways utilize serial reuse and are fed source water at two locations, the east of Series E and the west of Series A. The raceways do not currently have integral aeration systems but do contain electrical distribution. On average, the flow through each series of raceways is as follows: Series A - 150 gpm, Series B - 800 gpm, Series C - 600 gpm, Series D - 300 gpm, Series E - 300 gpm, and Series F - 300 gpm. The upper portion of the facility also contains four earthen ponds called the Show Ponds, which are used for rearing large yearling fish. The water supply for the Show Ponds is the discharge from the Series A through D raceways.

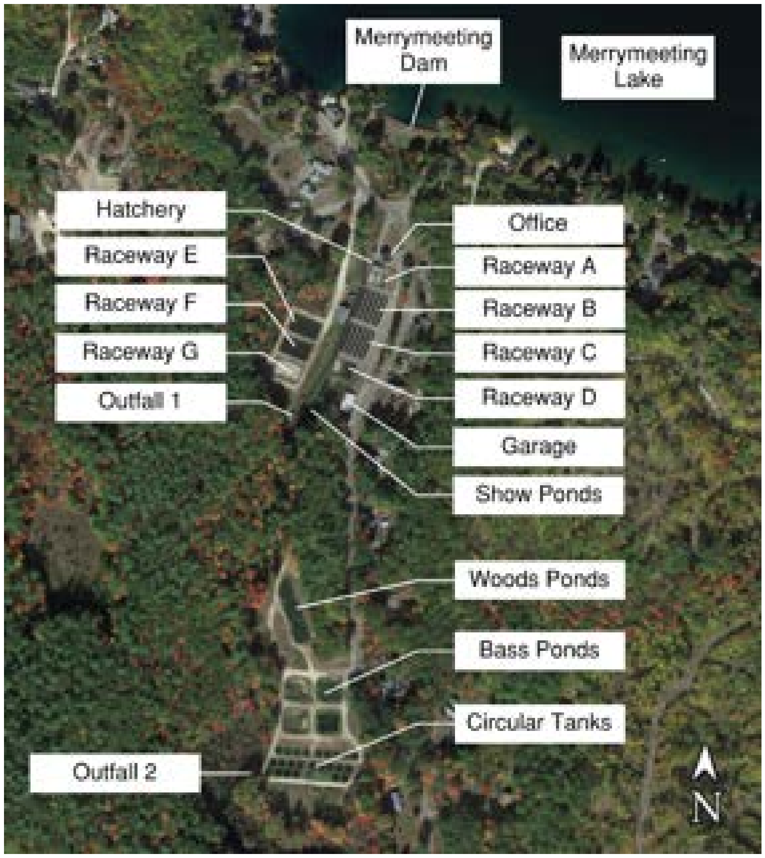


Figure 2-2: Powder Mill State Fish Hatchery Aerial Image.

The lower portion of the facility contains four earthen ponds called the Woods Ponds, four earthen ponds called Bass Ponds, and 27 circular 25’ diameter rearing units. Discharge from the Show Ponds is serially reused in the Woods Ponds, Bass Ponds, and 25’ circular rearing units. The Woods Ponds are no longer utilized due to the extreme level of predation experienced. The Bass Ponds were previously used for broodstock holding, but they have recently been serving as settling and storage basins for vacuumed fish waste. Each 25’ circular rearing unit is 2.25 feet deep on average with the deepest point in the middle. The flow into each unit is approximately 18 gpm. Four of the circular tanks are currently being utilized for storage and solids settling of the vacuumed fish waste. All rearing units for Powder Mill SFH are summarized in Table 2-2.

Table 2-2: Powder Mill Rearing Unit Summary

Rearing Unit	Quantity	Unit Volume (ft³)[1]	Total Volume (ft³)[1]
Indoor Facility			
5’ Circular Tank	10	29	290
Subtotal			290
Outdoor Facility			
Series A Linear Raceways	10	233	2,330
Series B Linear Raceways	6	1,920	11,520
Series C Linear Raceways	6	1,920	11,520
Series D Linear Raceways	8	612	4,896
Series E Linear Raceways	10	681	6,810
Series F Linear Raceways	10	681	6,810
Series G Linear Raceways	10	681	6,810
Show Pond	4	1,426	5,707
Woods Pond	4	5,560	21,839
Bass Pond	4	18,315	73,260
25’ Circular Tanks	27	860	23,220
Subtotal			*167,912*
Total			**168,202**

1) Unit Volume and Total Volume refer to the total available volume, not the operating volume.

2.2 Berlin State Fish Hatchery

Berlin State Fish Hatchery (SFH) is in the Town of Berlin located within the Kilkenny Valley in the White Mountain National Forest in Coos County, New Hampshire (Figure 2-3). The hatchery resides on an approximately 365 acres of federally owned land. The site is leased and operated by NHFGD. The facility consists of groundwater and surface water supplies, 51 outdoor concrete rectangular raceways, a hatchery building with 24 concrete rectangular raceways and 48 aluminum rearing troughs, and numerous support buildings. The facility manages the following phases of rearing: broodstock management, egg incubation, early rearing, and final grow out, which is accomplished utilizing an indoor hatchery building and outdoor concrete raceways.

Figure 2-3: Berlin State Fish Hatchery Aerial Image.

The water supplies for Berlin SFH are Cold Brook, Diversion Pond, the West Branch of the Upper Ammonoosuc River, Third Brook, No. 9 Brook, and two production wells. Hatchery personnel report that flow rates can be estimated over weirs at the facility. Currently, no flow meters exist. The flow rates from the surface water supplies vary seasonally, ranging between 400 and 2,800 gpm depending on the water source. The production wells produce between 200 and 400 gpm. Surface waters supply most of the water, while the wells supplement Cold Brook both in the summer, when flows are low, and in the winter, when water is too cold or frozen. HDR completed additional preliminary phosphorus sampling on the source waters and effluent at Berlin SFH between March and April of 2022. Results from three sampling events showed large variations in total phosphorus (TP) and phosphorus (P) speciation between each of the sources and each of the sampling events. These results suggested that there is enough TP in the sources to impact the TP in the effluent at a significant level and further sampling should be undertaken.

Cold Brook and the wells supply the Hatchery Building, Young's Raceway, and Foster's Raceway. The West Branch of the Upper Ammonoosuc River and Third Brook supply the Upper Canal

Raceways. Overflow from the Canal Raceways and No. 9 Brook feed Diversion Pond, which supplies the West Branch Raceways. Appendix B provides a proposed site layout for Berlin including an overview the water sources, flow splits, and outfalls.

The Hatchery Building uses an average flow of 50 gpm, not to exceed 100 gpm. It contains 24 concrete raceways and 48 aluminum troughs for early rearing, as well as trough inserts for egg incubation. The concrete raceways each measure 26.6’ x 2.6’ x 1.7’, and the aluminum troughs each measure 13’ x 1.1.6’ x 0.38’ at operating depth. The average water flow per trough is 20 gpm. The average water flow per raceway is 30 gpm, with a maximum rate of 75 gpm.

The hatchery maintains 51 concrete raceways that are split into four series: Young’s Raceways, Foster’s Raceways, West Branch Raceways, and the Upper Canals. Young’s Raceways consist of 12 raceways that each measure 76’ x 8’ x 1.8’ at operating depth and average a flow of 480 gpm, with a maximum flow of 600 gpm. Foster’s Raceways consist of 16 raceways that each measure 73’ x 8’ x 1.7’ at operating depth and average a flow of 450 gpm, with a maximum flow of 600 gpm. The West Branch Raceways are a set of 20 raceways that each measure 107’ x 8’ x 1.8’ at operating depth and average a flow of 800 gpm, with a maximum flow of 1,050 gpm. The Upper Canals consist of three raceways that each measure 335’ x 12’ x 2.7’ at operating depth and average a flow of 1,865 gpm, with a maximum flow of 2,800 gpm. All rearing units for Berlin SFH are summarized in Table 2-3.

Table 2-3: Berlin Rearing Unit Summary

Rearing Unit	Quantity	Unit Volume (ft^3)[1]	Total Volume (ft^3)[1]
Indoor Facility			
Concrete Raceways	24	118	2,832
Aluminum Troughs	48	6	288
Subtotal			*3,120*
Outdoor Facility			
Foster's Raceways	16	1,200	19,200
Young's Raceways	12	1,162	13,944
West Branch Raceways*	20	1,715	34,300
Upper Canals	3	4,100	12,301
Subtotal			*79,745*
Total			**82,865**

1 Unit Volume and Total Volume refer to the volume available at operating depths.

* Currently empty

2.3 New Hampton State Fish Hatchery

New Hampton State Fish Hatchery (SFH) is in the Town of New Hampton on the western edge of Belknap County, New Hampshire (Figure 2-4). The hatchery resides on approximately 163 acres of state-owned land and consists of 75 rearing units, a hatchery building, a water supply pond, and various springs with driven well heads. The facility manages the following phases of rearing: brood production, egg incubation, early rearing, and final grow out, which is accomplished utilizing five primary areas that include:

1. Indoor hatchery building
2. Outdoor 25' circular tanks
3. Outdoor 46' rearing rectangular raceways
4. Outdoor 50' rearing rectangular raceways
5. Outdoor 100' rearing rectangular raceways

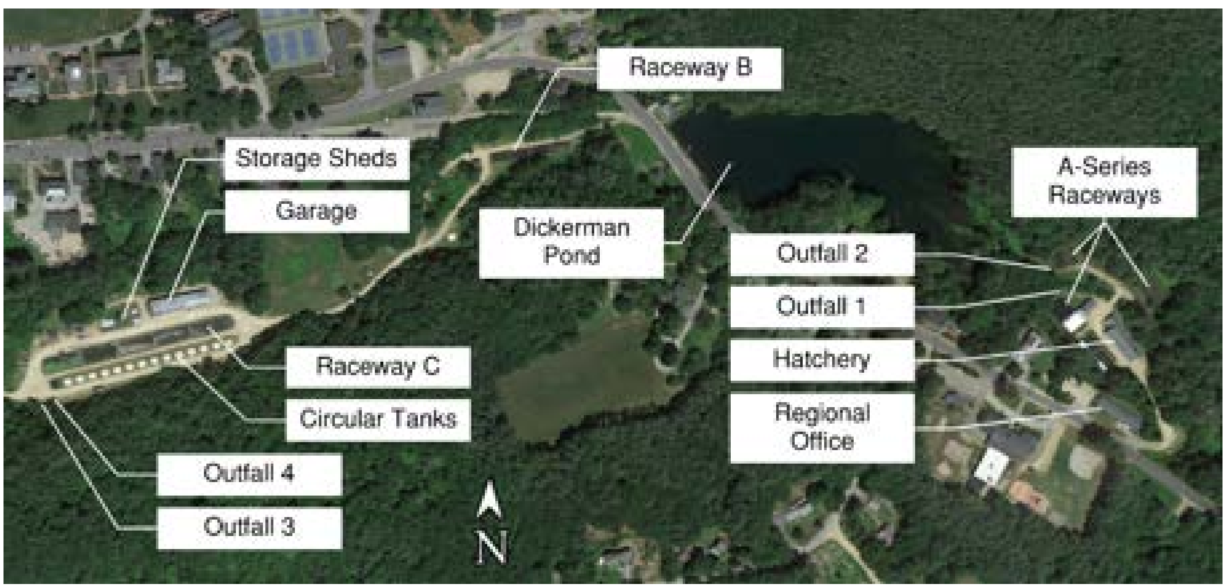


Figure 2-4: New Hampton State Fish Hatchery Aerial Image.

Various artesian springs and a small creek impoundment supply water to the hatchery via gravity flow. Located at the east end of the hatchery property, these springs supply water to the upper portion of the station, including the hatchery building. The main supply of water for the lower portion of the station is Dickerman Pond. In general, water temperatures in the upper series are consistently between 45°F and 49°F, while temperatures in the lower series are much more variable, between 36°F and 59°F. No flow meter exists for the measurement of hatchery water supply flow rates. It is estimated that the hatchery utilizes a flow rate of approximately 600 to 1,800 gpm, with an average flow of 1,200 gpm.

The hatchery building contains 160 Heath vertical incubation trays and 28 concrete rearing tanks. The Heath trays are divided into stacks of eight. The 14 upper tanks are 15' x 2.75' x 1.75' and flow serially into the 14 lower tanks, which measure 12' x 2.75' x 1.6'.

The hatchery maintains 60 concrete rectangular raceways (Series A, B, and C) and 15 circular tanks. Series A consists of 27 raceways, but they are not currently used for rearing fish due to their poor structural condition. Series B contains 13 concrete raceways (8’ x 63’ x 2’). The peak water flow to Series B is approximately 400 gpm that flows serially through the raceways and reaches a maximum water temperature of 58°F. Series C consists of 20 raceways (5’ x 100’ x 1.5’) and 15 circular tanks (25’ x 1.3’). Water flow is serially reused throughout the concrete raceways. All rearing units for New Hampton SFH are summarized in Table 2-4.

Table 2-4: New Hampton Rearing Unit Summary

Rearing Unit	Quantity	Unit Volume (ft^3)[1]	Total Volume (ft^3)[1]
Indoor Facility			
Heath Incubation Trays	160	1	160
12’ Rearing Tanks	14	63	885
15’ Rearing Tanks	14	90	1,260
Subtotal			*2,145*
Outdoor Facility			
A-2 Raceways	14	412	5,768
A-3 Raceways	5	600	3,000
A-5 Raceways	8	752	6,016
B Raceways	13	600	7,800
C Raceways	20	735	14,700
25’ Circular Tanks	15	627	9,405
Subtotal			*46,689*
Total			**48,834**

1) Unit Volume and Total Volume will vary based on operating depths.

2.4 Milford State Fish Hatchery

Milford State Fish Hatchery (SFH) is in the Town of Milford on the northwest edge of Hillsborough County, New Hampshire (Figure 2-5). The hatchery resides on approximately 165 acres of state-owned land and consists of sixty (60) 25' diameter circular tanks, earthen ponds, a hatchery building, support buildings, and production water supply wells. The facility manages the following phases of rearing: egg incubation, early rearing, and final grow out.

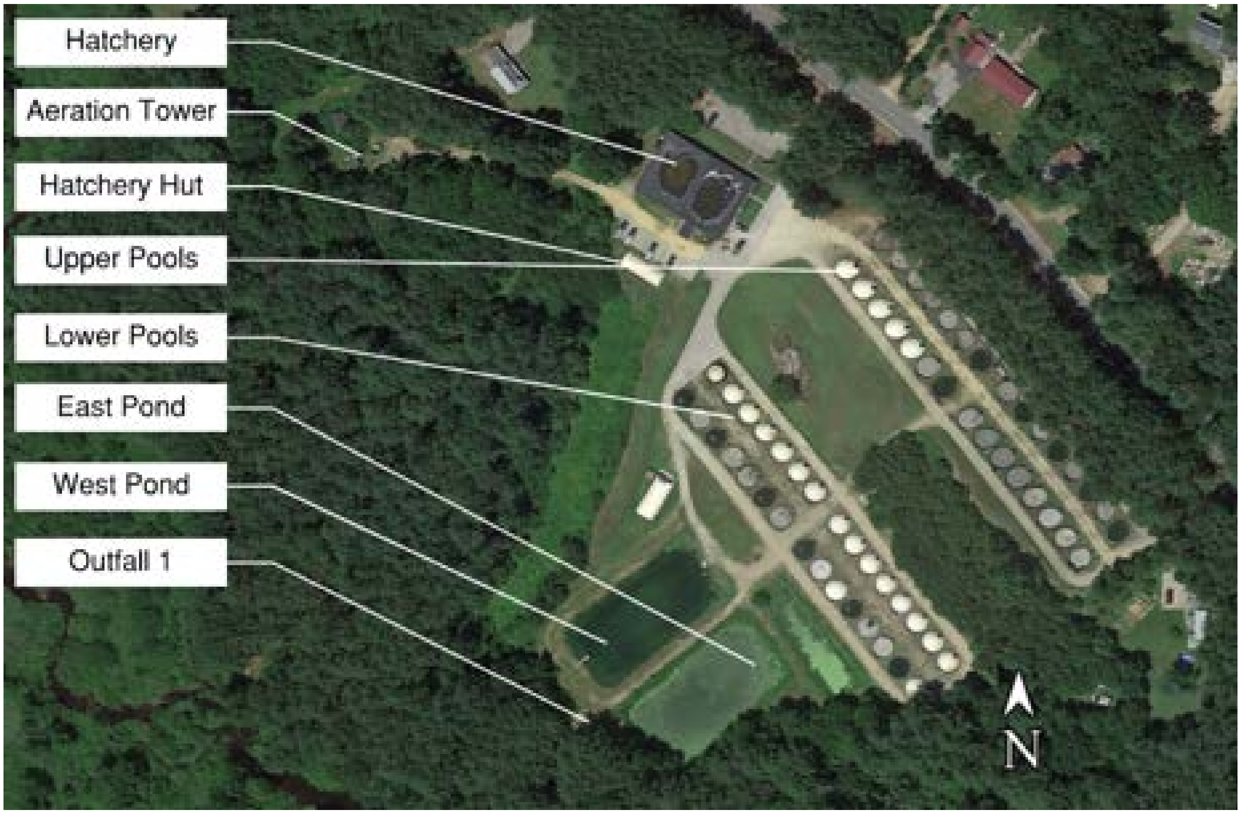


Figure 2-5: Milford State Fish Hatchery Aerial Image.

Water is supplied to the hatchery via two production wells, which are located southwest of the hatchery. A total of five production wells have been installed and used over the years; however, only two of the wells (Field and River) are currently in operation. The remaining have been discontinued due to iron and manganese problems. For aeration and degassing, water from the two wells is piped independently to a pair of towers acting as packed columns atop elevated head tanks with overflow standpipes inside. The towers were built in 2011 for a combined typical flow of 1,325 gpm and maximum of 1,700 gpm. The River Well provides up to 1,150 gpm, and the Field Well provides approximately 550 gpm. River Well water historically was high in manganese and moderately high in iron, which would foul the column packing. The well is now throttled in the well vault resulting in a reduction in manganese, but unfortunately, the manganese is not low enough to be considered non-influential. Field Well water appears to be higher in iron due to the column packing getting orange faster. Because of the minerals, both packed columns should be cleaned every one to two years. Historically, this only occurs as often as funding allows. When the well pumps are restarted after having been off for a time, such as for well cleaning, the piping is flushed to deter surging depositional material from the wells or their force-mains into the columns.

There is currently no flow meter installed at Milford SFH, and a weir system is currently used to collect flow data for NPDES reporting. A new flow meter was purchased in 2022, but the design of the West Pond discharge pipe complicates installation and requires engineering. According to 2021 data, peak flow rates vary from 1,000 to 1,400 gpm, although no data were available during some months.

The hatchery building contains 128 Heath vertical incubation trays, 4 circular tanks, and 20 concrete rectangular rearing tanks. There is an outdoor nursery building with 12 circular tanks, which has been abandoned due to corrosion of the galvanized tanks. The Heath trays are divided into stacks of eight, and the average flow rate per tray is 5 gpm. The 12 circular tanks are 8' in diameter and are operated at depths between 2-2.5'. The average water flow per circular tank varies from 1 to 6 gpm with a maximum rate of 20 gpm. The 20 concrete rearing tanks measure 26' x 2.2' x 2.4' but are typically operated at depths of 1.7'. Water flow per concrete tank varies from 18 to 20 gpm.

The hatchery maintains sixty (60) 25' diameter circular tanks that typically operate at 1.5' water depth. The units are divided into an upper and lower area, with 30 units in each area. Maximum flow to the circular units is 50 to 60 gpm. These circular tanks are operated at two-thirds the recommended flow rate of one exchange per hour, or 82 gpm. A West Pond and East Pond are located below the 25' circular tanks. Both ponds were originally installed as waste settling ponds, but the West Pond is now utilized for rearing space. All rearing units for Milford SFH are summarized in Table 2-5.

Table 2-5: Milford Rearing Unit Summary

Rearing Unit	Quantity	Unit Volume (ft^3)	Total Volume (ft^3)
Indoor Facility			
Heath Incubation Trays	128	1	128
6' Circular Tanks	4	56	224
Raceways	20	95	1,900
Outdoor Nursery (Abandoned)	12	100	1,200
Subtotal			*3,452*
Outdoor Facility			
25' Circular Tank	60	736.3	44,178
West Pond	1	61,800	61,800
Subtotal			*105,978*
Total			**109,430**

1) Unit Volume and Total Volume will vary based on operating depths.

2.5 Twin Mountain State Fish Hatchery

Twin Mountain State Fish Hatchery (SFH) is located about a mile north of Twin Mountain in the Town of Carroll, along Route 3 in Coos County, New Hampshire (Figure 2-6). The hatchery resides on approximately 28 acres of state-owned land and consists of 22 outdoor rectangular concrete raceways, three covered broodstock circular tanks, a brood house, a hatchery building with 11 concrete raceways, and Heath egg incubators. The facility manages the following phases of rearing: egg incubation, early rearing, and final grow out. The program is accomplished utilizing two primary areas that include an indoor hatchery building and outdoor concrete raceways.

Figure 2-6: Twin Mountain State Fish Hatchery Aerial Image.

Production water for Twin Mountain SFH is provided by several springs. The springs are located on the west side of Route 3 in three separate clusters of artesian well points. A 6" diameter production well yields about 300 gpm and directly influences the flow from the springs. Another spring located near the brood house yields 45 gpm that is used in the broodstock holding tanks.

In total, the well and springs yield about 820 gpm. The temperature of the spring and production well waters vary from 42°F to 52°F.

The hatchery building contains Heath vertical incubation trays and 11 concrete rectangular rearing raceways. Five of the raceways measure 33’ x 2.7’ x 1.25’ at operating depth and average a flow of 6 to 20 gpm, with a maximum flow of 60 gpm. The other six raceways measure 33’ x 2.75’ x 1.25’ at operating depth and average a flow of 6 to 20 gpm, with a maximum flow of 60 gpm.

The hatchery has 22 outdoor concrete raceways that are split into Series A and Series B. Series A, which consists of 12 raceways, is no longer in use due to the failing condition of the concrete. The 10 raceways in Series B each measure 50’ x 10’ x 1.75’ at operating depth, with an average flow of 280 to 480 gpm. Series B operates under a 10-pass serial reuse system. All rearing units for Twin Mountain SFH are summarized in Table 2-6.

Table 2-6: Twin Mountain Rearing Unit Summary

Rearing Unit	Quantity	Unit Volume (ft^3)[1]	Total Volume (ft^3)[1]
Indoor Facility			
Raceways 1-11	11	110	1,210
Subtotal			*1,210*
Outdoor Facility			
Series A Raceways	12	Abandoned	Abandoned
Series B Raceways	10	875	8,750
Subtotal			*8,750*
Total			**9,960**

1) Unit Volume and Total Volume will vary based on operating depths.

2.6 Warren State Fish Hatchery

Warren State Fish Hatchery (SFH) is in the Town of Warren about a mile to the south of the center of town along Old Route 25 in Grafton County, New Hampshire (Figure 2-7). The hatchery resides on approximately 134 acres of state-owned land and consists of 13 rearing units, display ponds, and a hatchery building with five concrete rectangular raceways and 80 Heath vertical tray egg incubators. The facility manages the early rearing and final grow out. The hatchery building is no longer utilized due to past flooding events and resulting unresolved mold issues.

Figure 2-7: Warren State Fish Hatchery Aerial Image.

Supply water for Warren SFH is provided by several springs and three production wells. The springs are free flowing (artesian) and produce between 200 gpm and 400 gpm. Wells 1, 2, and 3 produce up to 100, 200, and 500 gpm respectively. The temperature of production wells varies from 38°F to 60°F.

The hatchery building contains 6 concrete raceways and 80 Heath vertical incubation trays. The Heath trays average a total flow of 150 gpm. Four of the concrete raceways measure 15' x 3' x 1.5' at operating depth, and the other two measure 25' x 3' x 1.5' at operating depth.

The hatchery maintains 13 outdoor raceways, which are mostly concrete, and a few earthen ponds that now have concrete bottoms. All operate under serial reuse. The raceways are divided into three blocks, and the dimensions of each raceway vary; volumes can be found below in Table

2-7. The average flow rate of the outdoor raceways is 325 gpm but can vary between 250 to 500 gpm. All rearing units for Warren SFH are summarized in Table 2-7.

Table 2-7: Warren Rearing Unit Summary

Rearing Unit	Quantity	Unit Volume (ft^3)[1]	Total Volume (ft^3)[1]
Indoor Facility			
Raceways 1-4	4	135	540
Raceways 5-6	2	112	224
Heath Incubation Trays	80	-	-
Subtotal			*764*
Outdoor Facility			
Upper Reservoir (A)	1	5,472	5,472
Middle Reservoir (B)	1	2,325	2,325
Lower Reservoir (C)	1	5,280	5,280
Above Bridge (D)	1	2,787	2,787
Bridge (E)	1	2,226	2,226
Below Bridge (F)	1	2,112	2,112
No. 8 (G)	1	2,944	2,944
Long (M)	1	2,565	2,565
Spring (K)	1	2,563	2,563
Round (L)	1	2,226	2,226
First Little (H)	1	1,400	1,400
Second Little (I)	1	1,393	1,393
Rainbow (J)	1	2,520	2,520
Subtotal			*35,813*
Total			**36,577**

1) Unit Volume and Total Volume refer to the volume available at operating depths.

3 Existing Stocking and Production Summary

The State of New Hampshire annually produces and stocks an average of 1.4 million fish weighing approximately 380,950 pounds (2016-2021 average). The goal for the statewide program is to stock fish between 8 and 10 inches, at a minimum. A maximum of 583 waterbodies receive fish produced by the State's six hatcheries. Four primary salmonid species are stocked in New Hampshire including Rainbow Trout, Brook Trout, Brown Trout, and Landlocked Atlantic Salmon. Landlocked Atlantic Salmon were formerly produced at Powder Mill, but because of the new TP limits, a portion of the salmon are now produced at the Nashua National Fish Hatchery through a cooperative agreement in addition to New Hampton. While Nashua is not a facility operated by NHFGD, the salmon numbers are included to reflect the overall program needs for the State. Table 3-1 shows the six-year annual average for total number and total pounds produced from 2016-2021. The table also displays the percentage of total pounds that each six-year facility average contributed to the entire system.

Table 3-1: Statewide Yearly Production Averages from NHFGD Hatcheries During 2016-2021.

Facility	Rainbow Trout		Brown Trout		Brook Trout		Landlocked Atlantic Salmon		Facility Total		
	Number	Pounds	Number	Pounds	Number	Pounds	Number	Pounds	Number	Pounds	% of Total Lbs.
Powder Mill	91,447	42,622	47,970	18,275	164,032	52,062	40,558	4,631	**344,007**	**117,590**	**31**
Berlin	87,536	27,910	46,925	17,070	157,572	29,185	-	-	**292,033**	**74,165**	**20**
New Hampton	37,132	19,040	177,045	12,745	204,583	39,596	6,049	742	**424,809**	**72,123**	**19**
Milford	54,118	28,741	33,204	15,925	70,953	23,442	-	-	**158,275**	**68,108**	**18**
Warren	18,303	7,421	11,098	4,146	135,094	11,520	2,200	598	**166,695**	**23,685**	**6**
Twin Mountain	34,858	11,467	-	-	22,254	9,371	-	-	**57,112**	**20,838**	**5**
Nashua	-	-	-	-	-	-	26,544	4,441	**26,544**	**4,441**	**1**
Species Total	**323,394**	**137,201**	**316,242**	**68,161**	**754,488**	**165,176**	**75,351**	**10,412**	**1,469,475**	**380,950**	**100**

[1] – The Nashua National Fish Hatchery is currently producing all Landlocked Atlantic Salmon for The State of New Hampshire but is not a NHFGD facility.

As seen in Table 3-1, production amounts vary among NHFGD hatcheries and can vary slightly year to year. Powder Mill SFH and Berlin SFH account for the highest production totals over a six-year period, producing over 117,000 and 74,000 pounds of fish, respectively. New Hampton SFH very closely follows Berlin's average pounds produced, with over 72,000 pounds of fish produced from 2016-2021. It should be noted that the difference in production between Berlin and New Hampton are negligible, and in some years reviewed, New Hampton's production exceeded Berlin's. Twin Mountain and Warren had the lowest production totals from 2016-2021, with slightly more than 44,500 pounds produced.

Stocking also varies between NHFGD hatcheries. Based on data from the 2016-2021 stocking season, a total of 583 bodies of water (BOW) are stocked by NHFGD staff (Table 3-2). Based on the six-year production totals, Powder Mill stocks the most BOW, followed by New Hampton, Milford, Berlin, Warren, and Twin Mountain, respectively. Despite having the second-highest production total, Berlin SFH only stocks the fourth most BOW (151). Fish stocked at Berlin in 2022 were predominately Brook Trout. Twin Mountain stocks the least number of BOWs, as well as the fewest number of Rainbow Trout, Brown Trout, and Brook Trout when compared to the other NHFGD hatcheries.

Table 3-2: Average Number of Waterbodies Stocked by Each NHFGD State Fish Hatchery from 2016-2021.

Facility	Rainbow Trout	Brown Trout	Brook Trout	Landlocked Atlantic Salmon	Average BOW Stocked per Year
Powder Mill	65	34	150	9	**258**
New Hampton	4	2	27	2	**34**
Milford	3	3	15	-	**20**
Berlin	3	1	14	-	**18**
Warren	1	2	15	1	**20**
Twin Mountain	1	-	5	-	**6**
Nashua[1]	-	-	2	7	**9**
Average BOW Stocked per Year	**77**	**42**	**228**	**19**	**365**

[1] – The Nashua National Fish Hatchery is producing Landlocked Atlantic Salmon for Powder Mill SFH

Table 3-3 shows the total BOW stocked for each hatchery location, as well as the total number of square miles that each hatchery covers. In addition to stocking the largest number of BOW, Powder Mill also covers the largest area at 5,972 square miles which is indicative of the activity for the hatchery. Milford SFH covers more square miles than New Hampton SFH, despite New Hampton stocking a larger number of BOW. Twin Mountain covers the smallest area.

Travel distances are farthest from Powder Mill SFH and Berlin SFH to their respective stocking points, with Powder Mill SFH having two stocking locations that are between three and three and a half hours roundtrip and Berlin SFH having one stocking location that is approximately four hours round trip. All other stocking locations are within two hours or less of their respective hatcheries. The travel distances from each NHFGD hatchery and their respective stocking points were found to be within acceptable timeframes with the types of trucks and oxygen supplementation utilized by NHFGD staff. Figure 3-1 shows the NHFGD hatcheries, their stocking locations throughout the state, and is color coded based on the hatchery that stocks the water body.

Table 3-3: Size of Areas Stocked by Each NHFGD State Fish Hatchery.

Facility	Areas Stocked/Covered (sq. miles)
Powder Mill	5,972
Milford	3,338
New Hampton	3,295
Berlin	2,903
Warren	959
Twin Mountain	529
Nashua[1,2]	See Powder Mill
Total	**16,996**

[1] – The Nashua National Fish Hatchery is producing Landlocked Atlantic Salmon for Powder Mill SFH
[2] – The Nashua trips were completed by Powder Mill and are within the total area covered by Powder Mill

While the six-year average of production across all NHFGD facilities is just below 381,000 pounds, the peak production across all hatcheries during this same period is approximately 470,500 pounds. Nevertheless, the maximum carrying capacity of the NHFGD system is roughly 773,000 pounds. Powder Mill SFH produces the most fish out of the six state hatcheries, with Berlin SFH being capable of the second-most production and Twin Mountain being capable of the least production. While these facilities have the capacity to produce more than the current production amounts by way of rearing volume, the facilities are limited primarily by flow rate, as well as hatchery effluent.

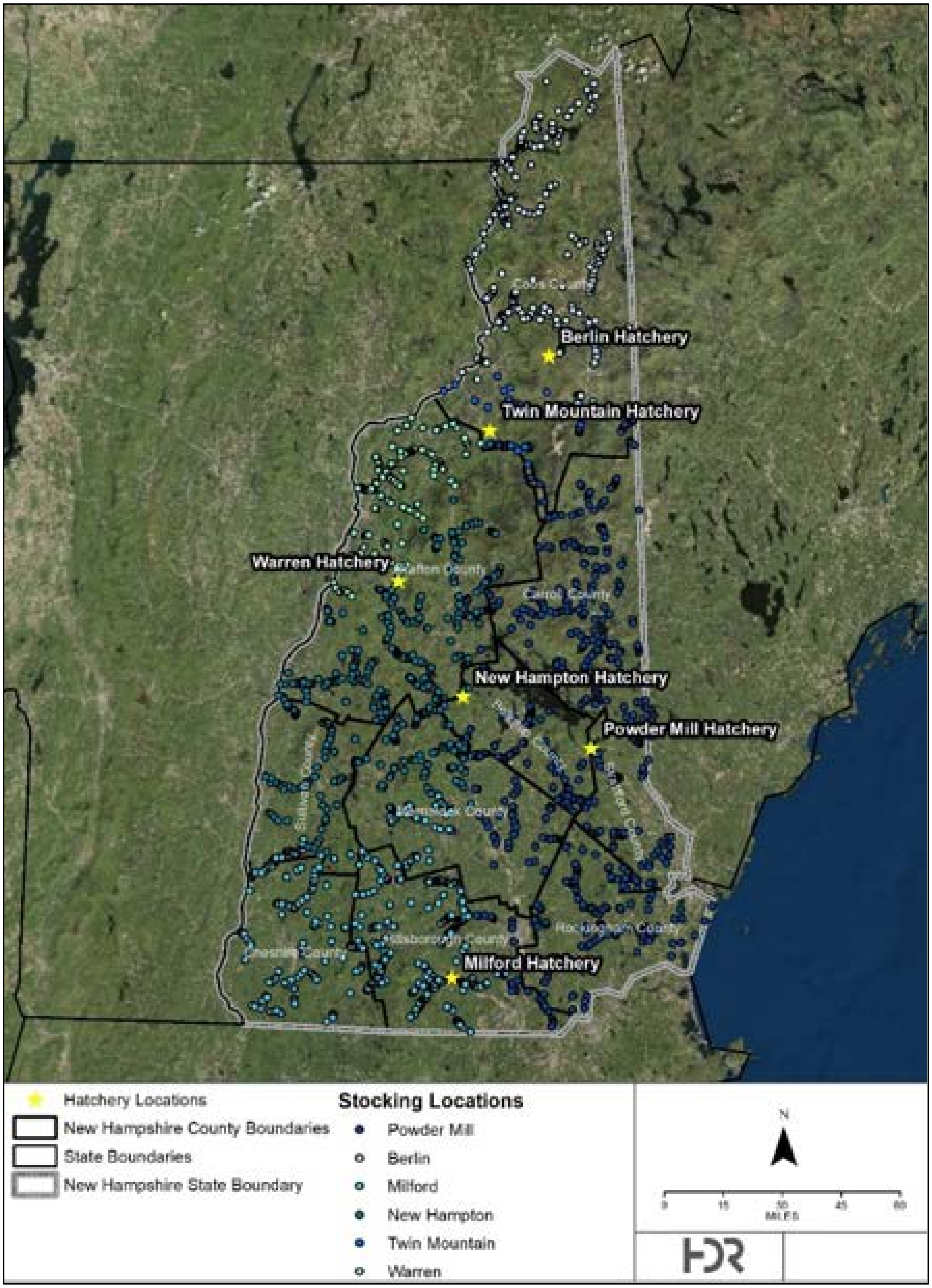


Figure 3-1: New Hampshire Stocking Locations.

3.1 Broodstock, Egg Transfers, and Fish Transfers

The NHFGD hatcheries do not operate independently but rather as a single system, with fish and resources shared between the facilities at key points throughout the year. Providing quality eggs in sufficient quantity to support the NHFGD program is vital for hatchery managers to produce a consistent product in time for stocking waterbodies in New Hampshire with quality trout. Currently, NHFGD maintains broodstock for Brown Trout and Brook Trout but does not actively maintain broodstock for Rainbow Trout. Some light-controlled indoor spaces were available for broodstock spawning operations, but dedicated, biosecure broodstock facilities are not consistently provided at each broodstock location.

Rainbow Trout eggs are acquired from other states to support the program. The eggs available to New Hampshire are often poorer quality, surplus, or eggs that become available outside of ideal production timing. For these reasons, it is difficult for NHFGD staff to properly plan for Rainbow Trout production. In addition to unpredictable timing of the surplus eggs, the poor quality often leads to unpredictable, insufficient results and increased labor costs.

The facility-to-facility fish transfers are also a vital part of the system-wide operation. Fingerling fish may be moved between facilities to optimize rearing space or take advantage of water quality conditions that are more favorable for fish growth at one facility versus another. The interrelationship of the facilities is not reflected in the annual production totals but is tracked and accounted for within the records kept by NHFGD. In 2022, more than 530,000 fingerlings were transferred between the facilities to support the growout of trout. The transfers also allow growout to be conducted in closer proximity to BOWs that will be stocked by a specific hatchery. Most transfers are produced at New Hampton. Without these transfers to other facilities to maximize the rearing space, the State’s program goals could not be met.

4 Existing Statewide Hatchery Drivers

There are four main drivers that determine the suitability of an existing site for expansion: permit compliance (with the current emphasis being TP), source water quality and availability, production and stocking goals, and geographic location. These drivers are further discussed in the following sections.

4.1 Permit Compliance (Total Phosphorus Emphasis)

The total phosphorus effluent limit imposed on Powder Mill State Fish Hatchery was the driving factor for this comprehensive study. These limits were given to Powder Mill because, since its last permit cycle, the receiving waters (several impoundments on the Merrymeeting River) have been listed on New Hampshire's 303(d) list as impaired due to cyanobacteria, which is fueled by excess phosphorus. The Berlin State Fish Hatchery will most likely face new TP effluent limits in its new NPDES permit which is currently in the process of renewal. Berlin SFH's outfall to York Pond is anticipated to receive limits low enough to require elimination of this outfall. This is because York Pond has also been classified, since the facility's last permit cycle, as an impaired water body on the State's Department of Environmental Services (NHDES) 303(d) list due to chlorophyll-a, total phosphorus, and cyanobacteria. Combining all the effluent outfalls and moving them to the West Branch of the Upper Ammonoosuc will likely allow for an increase in TP effluent limits above those required for York Pond, but that water body is classified as an Outstanding State Water Resource given its location in a national forest (NHDES). Given these two facilities are the largest fish producers in the system and these effluent limits cannot be reliably met without advanced effluent treatment systems that are too capital intensive to justify downstream of aging infrastructure, expansions must occur at locations within the state that are less environmentally sensitive to meet production and stocking goals statewide.

Table 4-1 summarizes the current receiving water body for each hatchery, along with the anticipated TP effluent limit likely required for that water body. Anticipated TP effluent limits were calculated and provided to New Hampshire Fish and Game Department (NHFGD) by New Hampshire Department of Environmental Services (NHDES) for use as guidance during this statewide study and evaluation. It is important to note that, currently, Powder Mill SFH is the only facility known to have a TP limit as low as 12 µg/L. However, effluent limits could be modified for various reasons including increases in fish production, changes to discharge location, and water quality standards. Potential effluent limits associated with the characteristics of each receiving water body need to be considered so capital investments remain viable facilities long-term. As can be seen from this information, New Hampton SFH, Milford SFH, and Warren SFH are the three existing facilities that will likely have the greatest ability for expansion based solely on the effluent TP levels.

Table 4-1: Hatchery Discharge Receiving Body Summary

Facility	Receiving Water(s)	Anticipated TP Limit
Powder Mill	Merrymeeting River	12 µg/L
Berlin	West Branch of the Upper Ammonoosuc	Unknown
New Hampton	Dickerman Brook	No Increases
	Pemigewasset River[1]	600 µg/L[1]
Milford	Purgatory Brook	No Increases
	Souhegan River[1]	140 µg/L[1]
Twin Mountain	Carroll Stream	No Increases
Warren	Patch Brook	No Increases
	Baker River[1]	128 µg/L[1]

[1] – Not the current receiving water rather a nearby possible alternative.

Feeding the fish at each facility is the central mechanism for fish production in the state. The pounds of feed introduced to the system are consumed by the fish, and the result is an increase in fish biomass. Feeding and subsequent fish growth are the primary sources of generated waste parameters that leave each facility and enter the receiving waterbody. For this reason, the feeding levels, and the rate at which the fish consume the feed, are the primary points of discussion when summarizing hatchery impacts to receiving waterbodies. Table 4-2 shows the calculated annual feeding totals, mass loadings for total phosphorus, and mass loadings total suspended solids for each of the six NHFGD hatcheries.

Table 4-2: Annual Statewide Effluent Totals from NHFGD Hatcheries (2021).

Facility	Annual Feed Fed (lbs.)	Peak Flow (gpm)[1]	Annual Total Phosphorus (lbs.)	Annual Total Suspended Solids (lbs.)
Powder Mill	103,781	4,065	373.6	31,134.3
Berlin	63,480	2,838	228.5	19,044.0
New Hampton	25,272	4,363	91.0	7,581.6
Milford	67,011	1,400	241.2	20,103.3
Warren	19,944	1,224	71.8	5,983.2
Twin Mountain	18,413	650	66.3	5,523.9
Total	**297,901**	**19,198**	**1,072.4**	**89,370.3**

[1] – The peak rearing volume demands represent the highest demand month of the year; rearing volume requirements may be less than the peak during other times of the year.

The efficiency of converting dry fish food to wet biomass of fish is known as the feed conversion (FC) or feed conversion rate (FCR). A 1:1 ratio would mean that, for each pound of food fed, the fish gained one pound. The measure is used to determine feeding efficiency and to limit overfeeding of the fish that would result in wasted food and increased effluent TP concentrations. The amount of feed administered at each facility is determined by the size of the fish and by utilizing feed tables provided by fish food manufacturers. The feeding rates can also be calculated utilizing fish culture standards.

Each hatchery in the system measures the feed conversion ratios and adjusts the feeding levels accordingly. The ratios observed in the NHFGD system were within the expected levels for fish being fed by manufacturers' recommended feeding levels, meaning that the hatchery managers are following the guidelines provided by the feed manufactures and not overfeeding by their tables. It was noted at some facilities, however, that fish growth rates were faster than expected, meaning the consumption of food was generating fish biomass ahead of schedule. For these instances, the hatchery managers have adjusted feeding levels below manufacturers' tables to avoid overfeeding.

As expected, based on the production totals in Table 3-1, Powder Mill SFH has the highest pounds of feed fed per year, highest annual TP loads, and highest annual total suspended solids loads. It should be noted that the annual TP pounds produced at Powder Mill SFH is higher than the proposed effluent limit for the facility (227 pounds annually), based on current production levels and with no treatment.

When concentration-based limits are discussed, the peak flows are important to determine the anticipated effluent concentrations in mg/L. Low-flow facilities or low-flow times of the year will generally result in higher effluent concentrations. For these reasons, the peak and low-flow periods at the point of discharge are important to review.

4.2 Source Water Quality and Availability

Another driver affecting each hatchery is source water quality and availability. The maximum allowable loading that can be realized at each hatchery depends on many factors; the most important ones are:

- Species and weight of fish.
- Target size for the produced fish.
- Source water quality characteristics including dissolved oxygen, temperature, pH, alkalinity, and other contaminates like iron and manganese.
- Tolerance towards metabolic waste product build-up in the rearing water. Ammonia nitrogen, carbon dioxide, and particulate and dissolved solids are of special importance.

In general, source water availability is the primary factor limiting carrying capacity at each facility in New Hampshire. Additional considerations impacting the actual carrying capacity include the degree of water reuse within each system, day-to-day operations, volume of rearing space, water quality, dissolved oxygen levels, and the knowledge of the hatchery manager. Nonetheless, general carrying capacity of the system can be determined by the available flow rate at each facility.

The NHFGD hatchery managers match the loading rates and carrying capacity to the available source water flows. This is standard practice for well-managed systems. However, as a system, significant reuse of water without treatment reduces the overall carrying capacity at each facility. Water is used by the fish and then serially reused multiple times at all facilities in the NHFGD system. With each reuse of water without treatment, the water quality degrades, and fish stress increases. To manage for the poorer water quality, most NHFGD facilities operate lower carrying capacities to account for the lack of sufficient water quality and flow.

Table 4-3 demonstrates the approximate carrying capacity of each facility based on density. The table assumes that all listed rearing volumes at each facility are available and does not account for the condition of the rearing units. Peak values represent the highest demand month of the year based simply on total pounds of all fish. Hatcheries may experience lower values than the peak throughout the year as fish are growing to target size. The table was generated to show the theoretical carrying capacity based strictly on the available infrastructure within the existing system. A density of 1.9 lbs/ft^3 for a 9.5” fish (density index of 0.2) was assumed for all facilities. This density was observed during the site visits and discussed with hatcheries. While the value can vary depending on the phase of rearing and between hatcheries, the generalized number provides an appropriate base.

As outlined by Westers (2001), non-salmonids in conservation-based hatcheries like the NHFGD system operate between 1.8 lbs/ft^3 and 5 lbs/ft^3, putting the NHFGD system on the lower end of the density spectrum. The density-only method provides a maximum ceiling for production and does not consider space requirements to house multiple species simultaneously and water quality factors such as dissolved oxygen and ammonia toxicity. It does provide a benchmark for production capacity based on available infrastructure.

Table 4-3: Carrying Capacities for Each Facility Using the Density-Based Models.

Facility	Peak Production Level (lbs.) from 2016-2021	Peak Flow (gpm)	Peak Carrying Capacity (lbs.)
Powder Mill	146,802	4,065	325,889
Berlin	89,648	2,838	176,286
New Hampton	91,928	4,363	106,920
Milford	89,891	1,400	83,880
Warren	27,877	1,224	63,166
Twin Mountain	24,408	650	16,620
Total	**470,554**		**772,761**

As demonstrated above, the production levels at most NHFGD facilities are below the density-based carrying capacity, indicating the water quality and water reuse are the limiting factors. If more water flow or oxygen supplementation was available within the system, a higher-production poundage could be carried within the existing infrastructure. It should be noted that density-based carrying capacity does not account for other factors such as peak fish loading, ammonia, and dissolved oxygen levels. However, improvements to the current facilities would theoretically allow for an increase in production more aligned with the estimated maximum carrying capacities if sufficient water were available. In a system with good water quality, appropriate temperatures, good management, and adequate flow rates, densities of 3.0 lbs/ft^3, 4.0 lbs/ft^3, and even 5.0 lbs/ft^3 can be achieved (Westers, 2001). Table 4-4 below includes existing water available and quality of the source water at each hatchery.

Table 4-4: Hatchery Source Water Availability and Quality Summary

Facility	Source Water	Min[1] Flow (GPM)	Max[1] Flow (GPM)	Source Water Quality
Powder Mill	Merrymeeting Lake	-	4,500	Partially treated surface water with potential for ichthyophthirius multifiliis
Berlin	Cold Brook Diversion Dam	400	1,400	Untreated surface water with low seasonal flows
	Production Wells	200	450	Untreated TP impaired groundwater with declining production
	West Branch Diversion Dam	500	2,838	Untreated surface water with low seasonal flows
	Diversion Pond	634	2,063	Untreated surface water with low seasonal flows
New Hampton	Major Springs	250	800	Untreated spring water stored in uncovered pools
	Minor Springs	100	200	Untreated spring water stored in uncovered pools
	Dickerman Pond	-	1,500	Untreated surface water and the dam is in poor condition
Milford	Field Well	-	550	Aerated ground water with declining production and iron and manganese contamination
	River Well	-	1,150	Aerated ground water with declining production and iron and manganese contamination
Warren	Well 1	90	100	Untreated ground water stored in uncovered aerated pools
	Well 2	-	200	Untreated ground water stored in uncovered aerated pools
	Well 3	-	500	Untreated ground water stored in uncovered pools
	Springs	200	400	Untreated spring water stored in uncovered pools
Twin Mountain	Springs and Production Well	-	820	Untreated spring/ground water stored in uncovered pools

[1] – Reliable flow measurement is not available at the facilities. These values represent best estimates based on permitted limits, historic operating records, and prior reports.

4.3 Production and Stocking Goals

Production and stocking goals are desired to be maintained in the future and not reduced because of effluent total phosphorus (TP) limitations or source water challenges. As such, the State of New Hampshire desires to continue the current annual production and stocking of an average of 1.4 million fish weighing approximately 380,950 pounds, with the goal to stock fish between 8 and 10 inches, minimum. Additional discussion on production and stocking goals is in Section 3.

4.4 Geographical Considerations

Geographical considerations with respect to the goals of NHFGD have two distinct impacts:

1. Travel time from hatchery to waterbody and the stress on the fish during that transit time.
2. Climate change and its impact on the water bodies in the state that can continue to support salmonid species in the long-term, particularly in the southernmost portion of the state.

4.4.1 Stocking Logistics

The State's current production and stocking practices are summarized in Section 3. Significant changes to the stocking practices are not currently desired. Table 4-5 below details the number of water bodies stocked, square miles covered by stocking, and the approximate time for the furthest stocking trip for each hatchery. When looking at alternatives for continuing to meet the State's existing production and stocking goals, it is important to consider ways of increasing stocking efficiency by producing fish closer to the BOW where they are stocked.

Table 4-5 and Figure 4-1 present the State's production and stocking data in a slightly different way from that presented in Section 3, breaking the state into three sections: Northern, Central, and Southern. While the boundaries of these three sections are arbitrary, this gives a more tangible understanding for what the production and stocking in each section would need to be to meet the State's existing goals. While it is not necessarily required that fish production match the stocking goals within these arbitrary boundaries, it provides an overview of what an ideal production and stocking scenario would look like.

Table 4-5: Hatchery Service Area Characteristics

Hatchery	# BOW	Square Miles	Furthest Roundtrip
Powder Mill	326 (32.5%)	5,972 (35%)	3.5 hrs. North
New Hampton	326 (32.5%)	3,295 (19%)	2.5 hrs. South
Milford	183 (18.3%)	3,338 (20%)	2.5 hrs. South
Berlin	151 (15.1%)	2,903 (17%)	4 hrs. North
Warren	63 (6.3%)	959 (6%)	2 hrs. North
Twin Mountain	26 (2.6%)	529 (3%)	2 hrs. East
Nashua	17 (1.7%)	2 (<1%)	NA
Total	1,200	16,998	

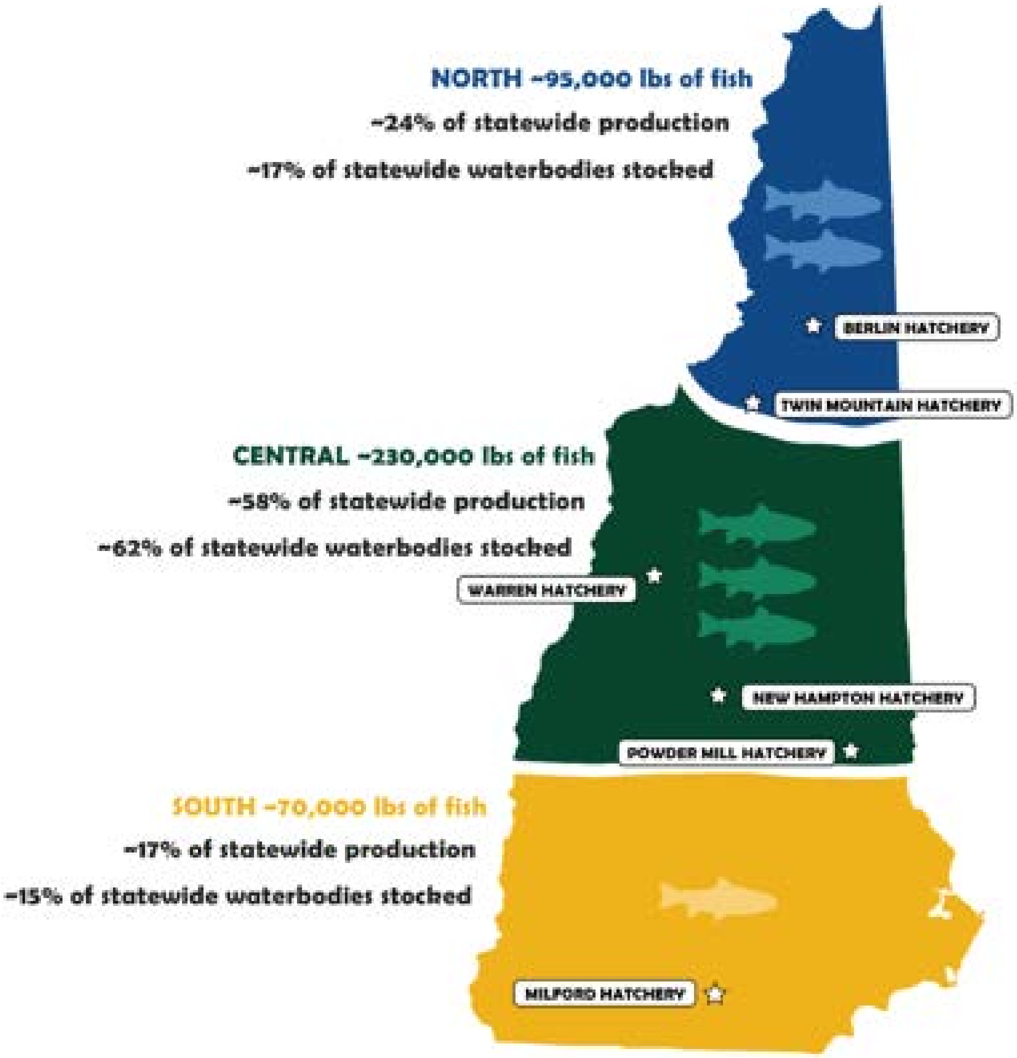


Figure 4-1: NHF&G Proposed Regional Production Map.

4.4.2 Climate Uncertainty

The primary impacts of climate uncertainty on hatchery operations and fisheries management involve impacts to water supplies that are critical for hatchery and fisheries management. Water flows, temperature, and quality can all be affected by a changing climate. These impacts occur through the following mechanisms:

- Warming surface waters and increased evaporation.
- Warming groundwater (shallow aquifers).
- Higher potential for thermal and wind impacts to hypolimnetic withdrawals from reservoirs.
- Increased rate of severe events like drought and flooding:
    - Direct flood impacts on hatcheries.
    - Indirect flood impacts due to reduced water quality if water sources receive sediment and other runoff.
    - Reduced recharge rates of groundwater aquifers due to higher rates of surface runoff during stronger storms (less infiltration opportunity for recharge).

While drought and flooding should be taken into consideration, the focus of this discussion is on warming surface and ground waters. Warming surface and ground water impact hatchery source water but can generally be corrected by adding additional raw water conditioning processes to the impacted hatchery. However, warming surface waters that serve as critical habitat for fisheries directly affect stocking suitability of impacted waters. Thus, as climate change worsens over time, adaption strategies will need to be incorporated into the State’s production and stocking plan. These strategies should be considered when developing the statewide system alternatives to ensure capital investments made are able to provide the most benefit over the longest period. To do this, it is important to understand the continuum of temperature sensitivity among the most common salmonid species:

Lake Trout → Brook Trout → Rainbow Trout → Landlocked Atlantic Salmon → Brown Trout

It is important that hatchery managers consider these temperature sensitivities for both stocking and production plans. This means that species produced and stocked may need to be modified as the State experiences more impactful temperature effects on water resources. Thus, a progression of Brook – Rainbow – Brown Trout, in increasing order of tolerance to temperature and water quality declines over time should be anticipated. Figure 4-2 notes what this might look like based on dividing the state into three sections, as presented in Section 4.4.1. Other species for consideration include Atlantic Salmon (including landlocked subspecies) and hybrids such as tiger trout or splake. NHFGD has already implemented winter and early spring put and take fisheries in waters that may become marginal for coldwater species but where there is still angler demand for coldwater fisheries. NHFGD is now working toward removing the season end date to allow for longer angler opportunities.

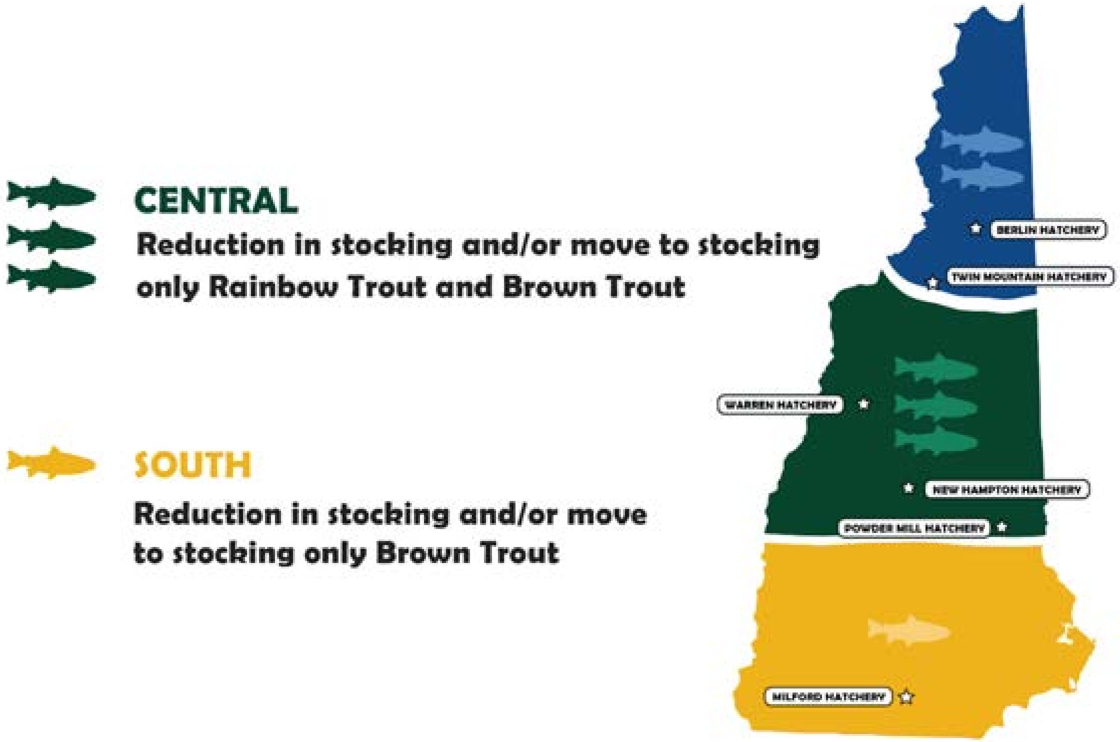


Figure 4-2: Proposed Species Stocking Regional Map

5 Hatchery Improvement and Repurposing Alternatives

As part of this overall study effort, condition assessments were undertaken at each hatchery to determine the general condition of existing infrastructure. Next, alternatives for improvements or modernization at each facility were determined, evaluation of the alternatives were performed, and recommendations were provided for the four largest hatcheries on an independent basis. At this point, enough information and understanding about the State's hatchery system as a whole was available to develop statewide alternatives that would reach the State's stocking and production goals within the constraints imposed by the drivers discussed in Section 4. The statewide alternatives then defined the alternatives that would be evaluated for the remaining two low-production hatcheries (Twin and Warren). A review of the alternatives evaluated for each hatchery is provided below. For more details regarding each of these alternatives, reference the associated modernization reports including:

- *Hatchery Modernization Development and Effluent Treatment Alternatives Evaluation Powder Mill Fish Hatchery*. HDR, 2023.
- *Hatchery Modernization Development and Effluent Treatment Evaluation Berlin Fish Hatchery*. HDR, 2023.
- *Hatchery Modernization Evaluation New Hampton & Milford Fish Hatcheries*. HDR, 2023.
- *Hatchery Modernization Evaluation Twin & Warren Fish Hatcheries*. HDR, 2023.

5.1 Powder Mill

With the primary driver of this study focused on effluent treatment for phosphorus reduction, the costs of treating the effluent to meet the extremely low permit limits is the primary consideration. Two effluent treatment alternatives were evaluated and discussed in *Hatchery Modernization Development and Effluent Treatment Alternatives Evaluation Powder Mill Fish Hatchery* (HDR, 2023) and include Alternatives A (membrane filtration with chemical dosing) and B (membrane filtration with adsorption). These effluent treatment alternatives were found to have a cost difference of less than 10 percent, with both alternatives being able to achieve compliance limits. Given the effluent treatment evaluation shows only a small difference between the two treatment alternatives, the following discussion focuses on the hatchery infrastructure alternative evaluations.

Three main alternatives were considered, along with a separate repurposing alternative:

- Alternative 1: Reuse existing rearing units with aquaculture upgrades and advanced effluent treatment (reuse existing hatchery infrastructure).
- Alternative 2: New circular rearing tanks with 75% recirculation and advanced effluent treatment (75% partial recirculation).
- Alternative 3: New circular rearing tanks with 95% recirculation and advanced effluent treatment (95% recirculation).
- Repurposing Alternative: Re-purposed approach to meeting statewide production and stocking goals (Limit production to up to 30,000 lbs annually to remain in permit compliance).

Based on the results of the evaluation performed in *Hatchery Modernization Development and Effluent Treatment Alternatives Evaluation Powder Mill Fish Hatchery* (HDR, 2023) Alternative 2 will not be considered moving forward. The goal for Powder Mill is to maintain a level of production that does not cause an exceedance of effluent permit limits, but also to consider alternatives for repurposing the hatchery to provide other critical functions for the state-wide production system. Upon careful consideration, the alternative best suited for Powder Mill is use for limited production for up to 30,000 pounds annually dependent upon remaining within permit compliance. Each of the viable alternatives are summarized and discussed in the sections below.

5.1.1 Alternative 1 – Reuse Existing Facility Infrastructure

Alternative 1 includes a new 3,750 gpm (5.4 MGD) effluent treatment plant to service the existing hatchery with minimal upgrades to the fish rearing systems. This alternative has the lowest capital cost. However, 85 percent of the investment (roughly $30 million) is directly associated with effluent treatment requirements, and about 7 percent of the investment (roughly $2.5 million) is directly associated with rearing improvements. The remaining 8 percent of costs are largely attributed to site work/improvements. This alternative does not modernize the existing conditions of the hatchery and only provides minor upgrades to sustain failing infrastructure. As is discussed in *Existing Conditions and Facility Evaluations Powder Mill Fish Hatchery Feasibility Study* (HDR, 2022), there are many deficiencies at the existing facility due primarily to the age of the infrastructure and the outdated fish culture technology in use. Most deficiencies pertain to aging buildings and fish rearing infrastructure that does not permit the staff to operate efficiently. Additional investment will be required to extend the useful life of the hatchery in addition to making investments in effluent treatment technology.

Due to its age, many “modern retrofits” to the rearing facilities are likely not feasible due to structural integrity and hydraulic grade concerns. Additionally, this alternative has the highest O&M cost of the alternatives evaluated. For comparison, the required effluent treatment plant would be similar in capacity to Portsmouth’s Pierce Island Wastewater Treatment Facility (3,333 gpm or 4.8 MGD, as reported on their website). While designed average flows would be similar, the wastewater characteristics and limits at a Powder Mill facility would necessitate a different design than Pierce Island. NHFGD is not currently equipped to own and operate a treatment plant of the size and complexity required. While this alternative meets the effluent limits and fish production goals on paper, the decision to make a large investment in effluent treatment downstream of a facility at the end of its useful life is not justifiable.

5.1.2 Alternative 2 – 75% Partial Recirculation

Alternative 2 was not considered for further evaluation because it has much higher costs. This alternative included very similar rearing infrastructure upgrades to alternative 3 and very similar effluent treatment infrastructure as alternative 1. In effect, this alternative includes the most expensive rearing upgrades paired with the most expensive effluent treatment upgrades to raise the same number of fish. While partially recirculating aquaculture systems (PRAS) are a viable fish rearing method, it does not make sense for this application.

5.1.3 Alternative 3 – 95% Recirculation

Alternative 3 includes a new 95% Recirculating Aquaculture System (RAS) hatchery building, as well as a new 693 gpm (1.0 MGD) effluent treatment plant. Alternative 3 has the highest capital cost with about 25 percent of the investment (roughly $14 million) being directly associated with the effluent treatment plant and 60 percent of the investment (roughly $34 million) being associated with the new rearing facilities. The remaining 15 percent of costs are largely attributed to site work/improvements. This alternative replaces the existing hatchery rearing units and aims to provide improved flexibility within current production levels. The alternative also has the ability to slightly increase production levels over the current average production. The key concept is utilizing recirculation technology to raise fish in less first-use water from the lake, which in turn generates less effluent to be treated. The new rearing facilities would be within a single enclosed and biosecure building, occupying a fraction of the currently utilized footprint. Since this alternative has a low water demand from Merrymeeting Lake (693 gpm) and compact site layout, the new hatchery does not need to be built on the currently developed site and could be built on undisturbed land. This alternative still requires advanced effluent treatment, albeit a much smaller treatment plant would be required in comparison to alternative 1. The staffing and operation of the treatment facility would still be a significant challenge for the NHFGD. While this alternative also meets the effluent limits and fish production goals on paper, the decision to make such a large investment to save this facility should be considered against siting a new facility at a new location not as susceptible to strict effluent requirements.

5.1.4 Alternative Comparisons of Capital, O&M, and 20-Year NPV Costs

A comparison of the capital, O&M, and 20-year net present value (NPV) costs for each alternative is shown in Table 5-1. For the purposes of this report, each hatchery infrastructure alternative is presented with the membrane filtration with adsorption alternative for effluent treatment. As discussed above, the cost differences between the effluent treatment alternatives were under 10 percent, and each alternative scales in the same fashion with respect to flow. These opinions were prepared to a variation of the standards of the Association for the Advancement of Cost Engineering (AACE) International Class 4 estimate, which outlines an added construction contingency of 50 percent for conceptual-level studies of this nature. The contingency was applied as an escalation at the individual line-item level in lieu of adding contingencies at the construction cost level, and the associated construction fees are assumed to be included in the escalation.

Table 5-1: Comparative Capital, O&M, and 20-Year NPV Costs

Alternative	Capital Cost	O&M Cost	20-Year NPV
Alternative 1	$ 43,388,000	$ 2,631,000	$ 100,092,000
Alternative 2	$ 78,284,000	$ 3,288,000	$ 147,073,000
Alternative 3	$ 60,406,000	$ 2,114,000	$ 103,600,000

5.1.5 Repurposing – Limited Production

Alternatives exist for Powder Mill to contribute to the overall NHFGD fish production program if the costs for other alternatives are deemed too high for the return on investment. That repurposed role is providing a reduced level of production. Reducing the level of production by up to 75% of the current levels would still allow for much needed production to occur but at a level low enough to achieve permit compliance.

As stated previously, Powder Mill provides the largest amount of fish for NHFGD's public stocking program in addition to stocking the most bodies of water, so the loss of production from this facility has the largest impact to the fishing public. Without compensation for the lost production, a significant reduction of stocked fish state-wide would occur. Two potential locations to replace some of this lost production are New Hampton and Milford. New water sources and discharge points would need to be analyzed to confirm suitable conditions, but locations outside of the existing discharge points utilizing river water, which must be treated for incoming debris and pathogens via UV, potentially exist in these two locations. If considered for development, most available dollars could be expended on fish production facilities rather than effluent treatment facilities.

5.2 Berlin

Berlin State Fish Hatchery may also be facing tighter total phosphorus (TP) limits. Although the future limits are currently unknown, specific effluent TP limits to the West Branch of the Upper Ammonoosuc River and York Pond may be slightly higher or lower. Neither limit is expected to significantly impact the required treatment technologies. Thus, treatment alternatives studied for Berlin were also focused on effluent treatment. The costs of treating effluent to required permit limits is the primary focus. Effluent treatment options for Berlin are the same as those developed for Powder Mill.

Two main alternatives were considered, along with a separate repurposing alternative:

- Alternative 1: Reuse existing rearing units with aquaculture upgrades and advanced effluent treatment (reuse existing hatchery infrastructure).
- Alternative 2: New circular rearing tanks with 95% recirculation and advanced effluent treatment (95% recirculation).
- Repurposing Alternative: Re-purposed approach to meeting statewide production and stocking goals (broodstock, egg take, and limited fingerling production facility only).

5.2.1 Alternative 1 – Reuse Existing Hatchery Infrastructure

Alternative 1 includes a new 3,570 gpm (5.1 MGD) effluent treatment plant to service the existing hatchery with minimal upgrades to the rearing systems. The Canal Raceways are abandoned due to their isolated location and minimal rearing capacity. Extending a collection system to convey their effluent to the treatment plant does not provide good value. Alternative 1 has the lowest capital cost, with 81 percent of the investment (roughly $38 million) directly associated with the effluent treatment requirements and about 12 percent of the investment (roughly $6 million) directly associated with rearing related improvements. The remaining 7 percent of costs are largely attributed to site work/improvements. This alternative does not modernize the existing rearing processes and only provides minor upgrades to sustain failing infrastructure. As is discussed in *Existing Conditions and Facility Evaluation Berlin Fish Hatchery Feasibility Study* (HDR, 2022), there are many deficiencies at the existing facility due primarily to the age of the infrastructure in place, lack of investment in maintenance, and the outdated fish culture technology in use. Most deficiencies pertain to aging buildings and fish rearing infrastructure that do not allow staff to operate efficiently. Additional investment associated with the deficiencies discussed will be required, in addition to the costs presented here to extend the hatchery's useful life.

Due to its age, many "modern retrofits" to the rearing facilities are likely not feasible due to structural integrity and hydraulic grade concerns. Additionally, this alternative has the highest O&M cost of the alternatives evaluated. For comparison and similar to Powder Mill, the required effluent treatment plant would be similar in capacity to Portsmouth's Pierce Island Wastewater Treatment Facility (3,333 gpm or 4.8 MGD, as reported on their website). While designed average flows would be similar, the wastewater characteristics and limits at a Berlin facility would necessitate a different design than Pierce Island. NHFGD is not currently equipped to own and operate a treatment plant of the size and complexity required. While this alternative meets the effluent limits and fish production goals on paper, the decision to make a large investment in effluent treatment downstream of a facility at the end of its useful life is not justifiable.

5.2.2 Alternative 2 – 95% Recirculation

Alternative 2 includes a new 95% RAS hatchery building as well as a new 693 gpm (1.0 MGD) effluent treatment plant. Alternative 2 has the highest capital cost, with 24 percent of the investment (roughly $14 million) directly associated with effluent treatment and 70 percent of the investment (roughly $39 million) associated with the new rearing facilities. The remaining 5 percent of costs are largely attributed to site work/improvements. This alternative replaces the existing hatchery rearing units and aims to increase production capacity and provide improved flexibility. The key concept is utilizing recirculation technology to raise fish in less water, which in turn generates less effluent to be treated. For this application, a high rate of recirculation (95%) was chosen due to source water availability and to minimize the requirements for source water/effluent treatment systems. The new rearing facilities represent an expansion of production at Berlin and would be housed within a single enclosed and biosecure building occupying a fraction of the currently utilized footprint. Since this alternative has a low water demand from Cold Brook/New Wells (693 gpm) and compact site layout, the new hatchery does not need to be built on the currently developed site and could be built on undisturbed land. This alternative still requires advanced effluent treatment, albeit a much smaller treatment plant would be required in comparison to alternative 1. The staffing and operation of the treatment facility would still be a significant challenge for the NHFGD. While this alternative also meets the effluent limits and fish production goals on paper, the decision to make such a large investment to save this facility should be considered against siting a new facility at a new location not as susceptible to strict effluent requirements. Additionally, major investments in infrastructure more centrally located could benefit fish movement state-wide.

5.2.3 Alternative Comparisons of Capital, O&M, and 20-Year NPV Costs

A comparison of the capital, O&M, and 20-year net present value (NPV) costs for each alternative is shown in Table 5-2. These opinions were prepared to a variation of the standards of the Association for the Advancement of Cost Engineering (AACE) International Class 4 estimate, which outlines an added construction contingency of 50 percent for conceptual level studies of this nature. The contingency was applied as an escalation at the individual line-item level in lieu of adding contingencies at the construction cost level, and the associated construction fees are assumed to be included in the escalation.

Table 5-2: Comparative Capital, O&M, and 20-Year NPV Costs

Alternative	Capital Cost	O&M Cost	20-Year NPV
Alternative 1	$ 46,422,000	$ 3,232,000	$ 116,441,000
Alternative 2 (130,000 lb)	$ 56,224,000	$ 2,455,000	$ 107,416,000

5.2.4 Repurposing – Broodstock, Egg Take, and Limited Fingerling Production

In this alternative, the existing hatchery building remains in operation, and the facility serves as the primary Brook Trout (EBT) broodstock, egg take, and fingerling production location for the state, continuing part of its current function that is critical to the overall state-wide program. Four-year classes of broodstock are maintained (EBT0, EBT1, EBT2, and EBT3) annually. The facility spawns fish and incubates Brook Trout eggs in a biosecure environment as its primary purpose. Two alternatives are possible under this scenario:

1. Eggs could be shipped to other facilities once they reach the eyed egg stage from Berlin.
2. Berlin could maintain broodstock, produce eggs, and also take fish to a fingerling stage of approximately two to three inches for transfer to other facilities for growout.

For alternative 1, the Young's Raceways and Foster's Raceways are maintained and utilized for the broodstock program year classes, along with the hatchery building. Existing raceway covers would be replaced to provide a biosecure area for broodstock. Enhancements to the facility could be made that include improving incoming water quality for better biosecurity. The end goal should be focused on making enhancements to provide the most biosecure broodstock facility possible within the budget available at Berlin. The remaining rearing infrastructure at Berlin is abandoned in place.

Assuming average fecundity levels for Brook Trout (400-600 per female) and acknowledging variability based on size of broodstock, the facility could nominally produce 600,000 Brook Trout eggs annually. Incubation and early rearing space would still require evaluation for suitability. Table 5-3 was developed to show the potential phosphorus loading from a broodstock operation. The numbers utilized do not reference a particular water supply and are provided only as a guideline to estimate potential impacts. This data shows that maintaining the Brook Trout broodstock program within proposed permit levels is feasible.

Table 5-3: Brook Trout Adult Space Example

Species	Number	Pounds	FPP	Fish Length	Space Required (cf)	Required Flow (gpm)	Temp (F)	%BW Feed	Feed per Day (lbs.)	Total Phos (µg/L)
EBT Year 3	1000	4,000	0.25	18	2,222	889	50	0.4%	17	
EBT Year 2	1,500	1,500	1.00	14	1,071	429	50	0.6%	8	
EBT Year 1	1,800	909	2.0	11	826	331	50	0.7%	7	
EBT Year 0	3,000	73	41.0	4	183	37	50	2.0%	1	
Total	*7,300*	*6,482*			*4,303*	*1,685*			*34*	*19.7*

For alternative 2, a modern hatchery building complete with broodstock, egg incubation, early rearing, and office spaces could be constructed to house the broodstock program for Brook Trout. If recirculation is utilized, this concept could even be expanded to include Rainbow Trout and Brown Trout. General concepts for a large broodstock building that can house Brook Trout, Rainbow Trout, and Brown Trout are provided in Appendix F for reference and future consideration.

This enhancement would modernize the office space, incubation capabilities, and provide space for early rearing facilities while still utilizing Young's and Foster's Raceways as needed within permit limits to stage fish or hold fingerling prior to transfer to other facilities. It may be possible that some production could still occur at Berlin, provided the phosphorus generated to maintain the four broodstock year classes and the fingerling production remains under the proposed limit or if an economical effluent treatment process can be added.

5.3 New Hampton

The New Hampton State Fish Hatchery provides the best current location for infrastructure expenditures and expansion of production out of the six facilities operated by the State. This position is based on site characteristics such as geographic location, water supplies, effluent discharge flexibility, likely total phosphorus (TP) effluent limits, and space available to accommodate a production increase. With the likely reductions in production at Powder Mill and Berlin due to new, low effluent phosphorus limits, additional rearing space within the state will be required to maintain statewide production levels.

Two main alternatives were considered:

- Alternative 1A: 95% recirculation.
- Alternative 1B: 95% recirculation and rehabilitate Series B and C.

5.3.1 Alternative 1A - 95% Recirculation

In this alternative, the existing hatchery infrastructure is abandoned in place, and new infrastructure is added that can more efficiently utilize the water supply available at New Hampton. A new incoming water treatment building, enclosed rearing building, and associated infrastructure for effluent treatment are constructed within the existing properties owned by NHFGD. The new facilities utilize recirculating aquaculture systems (RAS), which treat and reuse 95% of culture water. The recirculation systems reduce the required water supply demand and water supply treatment for pathogens compared to systems that do not treat and recirculate fish production water.

Flows were estimated based on fish rearing requirements and the initial layout of a modular type of facility. The initial layout provides for four independent RAS modules in the growout phase and two RAS modules for intermediate rearing. This layout has the potential to produce 130,000 pounds annually, which would be an increase over current production with a smaller overall water demand. The poundage outlined for New Hampton must also include the Brown Trout broodstock and Landlocked Atlantic Salmon program.

Dickerman Pond has been a reliable source of water throughout the historic operation of the facility. However, given that it is surface water, it is susceptible to diseases, contamination by debris, and temperature fluctuations, treatment is needed. It should be noted that water could be collected more efficiently within the A-Series and could bypass Dickerman Pond with appropriate design considerations. This could limit disease and temperature concerns. To be utilized as water supply for a new 95% recirculating aquaculture facility with or without Dickerman Pond bypass, filtration and UV disinfection are recommended. Well water is typically preferable for fish rearing if it is readily available in sufficient quantity and uncontaminated by heavy metals like iron and manganese. An investigation into production wells and groundwater quality is recommended as the preferred source water for any new facility to rule out the availability of a good groundwater source.

Alternative 1A provides the state with a facility renovation capable of increasing production over current levels, provided the use of RAS is implemented. The facilities can produce more fish with similar levels of water with the use of water treatment equipment associated with the RAS and with the use of modern circular rearing units.

5.3.2 Alternative 1B - 95% Recirculation and Rehabilitate Series B and C

The lower area of New Hampton provides a logical area for NHFGD to invest and expand production. This area includes the existing B-Series and C-Series but also adjacent, undeveloped land. It is possible NHFGD could utilize some of the existing infrastructure in B-Series and C-Series to continue operations and produce fish in the 50,000 lbs to 70,000 lb range with an additional production in a new RAS facility (up to 150,000 to 200,000 lbs pending permit level determinations) These numbers would include maintaining the Brown Trout broodstock. When modernized rearing environments are provided through renovations and new construction, as outlined in this document, fish rearing densities can be increased over current densities maintained at the current configuration of New Hampton and infrastructure is available to produce up to half of the NHFGD required fish production goals with one major infrastructure investment location.

5.3.3 Alternative Comparisons of Capital, O&M, and 20-Year NPV Costs

A comparison of the capital, O&M, and 20-year NPV costs for each Alternative is shown in Table 5-4. These opinions were prepared to a variation of the standards of the Association for the Advancement of Cost Engineering (AACE) International Class 4 estimate, which outlines an added construction contingency of fifty percent (50%) for conceptual level studies of this nature. The contingency was applied as an escalation at the individual line-item level in lieu of adding contingencies at the construction cost level, and the associated construction fees are assumed to be included in the escalation.

Table 5-4: Comparative Capital, O&M, and 20-Year NPV Costs

Alternative	Capital Cost	O&M Cost	20-Year NPV
Alternative 1A	$ 46,565,000	$ 1,428,000	$ 76,170,000
Alternative 1B	$ 49,861,000	$ 1,558,000	$ 78,409,000

5.4 Milford

The Milford State Fish Hatchery may also provide a good location for infrastructure expenditures but does have several limitations. This position is based on site characteristics such as geographic location, effluent discharge flexibility, likely total phosphorus (TP) effluent limits, and space available to accommodate a production increase. However, limitations include poor water quality. With the likely reductions in production at Powder Mill and Berlin due to new and tight phosphorus discharges, additional rearing space at Milford may be required to maintain historic production levels. A single alternative was considered: new circular rearing tanks with 95% recirculation.

5.4.1 Alternative 1 - 95% Recirculation

In this alternative, the existing hatchery infrastructure is abandoned in place, and new infrastructure is added that can more efficiently utilize the available water supply for Milford. A new incoming water treatment building, enclosed rearing building, and associated infrastructure for effluent treatment are constructed within the existing properties owned by NHFGD. The new facilities utilize recirculating aquaculture systems (RAS), which treat and reuse 95% of culture water. The recirculation systems reduce the required water supply demand and required water supply treatment for pathogens or metal concerns, such as iron at Milford.

Flows were estimated based on fish rearing requirements and the initial layout of a modular type of facility. The initial layout provides for four independent RAS modules in the growout phase and two RAS modules for intermediate rearing. This layout has the potential to produce 130,000 pounds or more annually, which would be an increase over current production with a smaller overall water demand. By carrying slightly higher rearing densities and adding additional rearing modules, the facility could support up to 200,000 lb of production within the proposed RAS concepts.

This alternative provides the State with facility renovations capable of increasing production over current levels, provided the use of RAS is implemented. The facilities can produce more fish with similar levels of water with the use of water treatment equipment associated with the RAS and with the use of modern circular rearing units.

5.4.2 Capital, O&M, and 20-Year NPV Costs

The capital, O&M, and 20-year net present value (NPV) costs for alternative 1 is shown in Table 5-5. These opinions were prepared to a variation of the standards of the Association for the Advancement of Cost Engineering (AACE) International Class 4 estimate, which outlines an added construction contingency of 50 percent for conceptual level studies of this nature. The contingency was applied as an escalation at the individual line-item level in lieu of adding contingencies at the construction cost level, and the associated construction fees are assumed to be included in the escalation.

Table 5-5: Comparative Capital, O&M, and 20-Year NPV Costs

Alternative	Capital Cost	O&M Cost	20-Year NPV
Alternative 1	$ 47,390,000	$ 1,591,000	$ 80,835,000

5.5 Twin Mountain

The available water volume and hatchery space at Twin Mountain State Fish Hatchery does not present an opportunity for major expansion. Maintaining the existing infrastructure at these facilities is the best way for these facilities to continue contributing to statewide goals and is the only alternative evaluated. The good water quality at Twin Mountain, as well as the existing infrastructure, does provide an opportunity to bring a Rainbow Trout broodstock back into New Hampshire. The existing production at Twin Mountain could be altered slightly to include broodstock in place of some of the general production currently occurring. Currently, NHFGD is producing approximately 323,000 Rainbow Trout weighing approximately 137,200 lbs. An in-state broodstock program capable of producing the eggs to supply the program could be implemented at Twin Mountain, which has a water supply conducive to good Rainbow Trout production.

One alternative was considered for this facility, along with a separate repurposing alternative:

- Alternative 1: Infrastructure rehabilitation to include Rainbow Trout broodstock and egg take facility.
- Repurposing Alternative: New broodstock and egg take facility for Rainbow Trout.

5.5.1 Alternative 1 - Infrastructure Rehabilitation

In this alternative, the existing fish rearing units are left in place, and most of the facilities remain unchanged. Repairs to the existing concrete rearing units and selected buildings would be made to the extent possible to extend their useful lives. If a broodstock is maintained, a portion of the existing raceways must be changed from catchable production to broodstock production. This has an impact on the overall pounds produced for stocking but has a positive addition to the capabilities for maintain broodstock in state. The program will need to accommodate multiple year classes of Rainbow Trout broodstock, with Year 0, 1, 2, and 3 ages likely kept isolated from each other. Year 0 would be housed in the existing building, with years 1, 2, and 3 occupying outdoor space in the pools. The priority for the site would be housing broodstock with some additional space supporting catchable production, as available. Utilizing the existing units is not ideal from a biosecurity perspective, given the open nature of the system. Predation control strategies utilizing netting or tension fabric structures could be considered.

It would be worthwhile to seriously investigate reuse of the old broodstock building, which has been abandoned for over a decade due to a collapsed roof. Efforts to rehabilitate the building would include structural, electrical, and architectural assessments as well as re-establishment of the source water and effluent discharge, since it was not picked up in the drain line consolidation project and has not been included in NPDES permits since before 2012. If this infrastructure could be rehabilitated and put back into service, additional catchable production could be achieved.

5.5.2 Opinion of Probable Construction Cost

A conceptual Opinion of Probable Construction Cost (OPCC) was developed for alternative 1 of roughly $2,300,000. Cost and quantities for equipment and repairs were developed based on information obtained from suppliers and historical reports. Costs for contingencies are included in the estimate for each individual process area, and cost of escalation to midpoint of construction and market volatility adjustment are included in subtotal cost of all process areas. There are no new ongoing O&M costs (chemical, electrical, labor, or replacement) associated with the proposed upgrades at either facility.

5.5.3 Repurposing Alternative - New Broodstock and Egg Take Facility

An ideal scenario for broodstock management would be the construction of a new dedicated broodstock building for Rainbow Trout. Unlike the general scenario for a centralized NHFGD broodstock facility, the alternative for Twin Mountain would be a building and space dedicated exclusively to Rainbow Trout. An enclosed building would allow for predation control, light control, and would provide a more biosecure location for holding broodstock. The building could also be sized to house a small amount of backup broodstock for Brook Trout and Brown Trout, if desired, for safe keeping in the event of issues with Berlin or New Hampton brood. Existing areas of the hatchery could continue to be utilized for a limited amount of production to support the statewide goals in addition to the broodstock facility.

5.6 Warren

Warren State Fish Hatchery does not have adequate receiving waters to support expansion. With the discharge from this facility into a small brook with no allowable increases in TP discharges, the need to buy property in order to relocate the discharge to the Baker River, and the increase in flooding this facility experiences, maintaining the existing infrastructure at this facility is the best way to continue contributing to statewide goals. Thus, the only alternative evaluated is infrastructure rehabilitation.

5.6.1 Alternative 1 - Infrastructure Rehabilitation

In this alternative, the existing fish rearing units are left in place, and most of the facilities remain unchanged. Repairs to the existing rearing units and selected buildings would be made to the extent possible to extend their useful lives. Eventually, the hatchery building will be abandoned in place, as flooding will likely occur more often over time, making this building nearly impossible to utilize consistently.

5.6.2 Opinion of Probable Construction Cost

A conceptual Opinion of Probable Construction Cost (OPCC) was developed for the recommended repairs of roughly $2,300,000. Cost and quantities for equipment and repairs were developed based on information obtained from suppliers and historical reports. Costs for contingencies are included in the estimate for each individual process area, and cost of escalation to midpoint of construction and market volatility adjustment are included in subtotal cost of all process area. There are no new ongoing O&M costs (chemical, electrical, labor, or replacement) associated with the proposed upgrades at either facility.

5.7 Overall Summary of Alternatives by Hatchery

To summarize the alternatives and their costs presented in the preceding sections by hatchery so comparisons can be made at a glance, see Table 5-6 below.

Table 5-6: Summary of Hatcheries' Alternatives

Powder Mill					
Alternative	**Description**	**Production (pounds/year)**	**Capital Cost**	**NPV**	**$/pound (1)**
Alternative 1	Reuse Existing Hatchery Infrastructure	118,000	$ 43,388,000	$ 100,092,000	$ 42.41
Alternative 2	75% Partial Recirculation	130,000	$ 78,284,000	$ 147,073,000	$ 56.57
Alternative 3	95% Recirculation	130,000	$ 60,406,000	$ 103,600,000	$ 39.85
Repurpose	Broodstock and Egg Take Facility	30,000	Not Yet Costed	Not Yet Costed	Not Yet Costed
Berlin					
Alternative	**Description**	**Production (pounds/year)**	**Capital Cost**	**NPV**	**$/pound (1)**
Alternative 1	Reuse Existing Hatchery Infrastructure	64,000	$ 46,422,000	$ 116,441,000	$ 95.44
Alternative 2	95% Recirculation	130,000	$ 56,224,000	$ 107,416,000	$ 41.31
Repurpose	Broodstock, Egg Take, and Fingerling Production Facility	16,000	Not Yet Costed	Not Yet Costed	N/A
New Hampton					
Alternative	**Description**	**Production (pounds/year)**	**Capital Cost**	**NPV**	**$/pound (1)**
Alternative 1A	95% Recirculation	130,000	$ 46,565,000	$ 76,170,000	$ 29.30
Alternative 1B	95% Recirculation and Rehabilitate Series B and C.	202,000	$ 49,861,000	$ 78,409,000	$ 19.41
Milford					
Alternative	**Description**	**Production (pounds/year)**	**Capital Cost**	**NPV**	**$/pound (1)**
Alternative 1A	95% Recirculation	130,000	$ 47,390,000	$ 80,835,000	$ 31.09

Table 5-6 (cont'ed)

Twin Mountain					
Alternative	**Description**	**Production (pounds/year)**	**Capital Cost**	[redacted]	[redacted]
Alternative 1	Infrastructure Rehabilitation	21,000	$ 2,300,000	[redacted]	[redacted]
Alternative 2	Broodstock and Egg Take Facility	Not Yet Estimated	Not Yet Costed	[redacted]	[redacted]
Warren					
Alternative	**Description**	**Production (pounds/year)**	**Capital Cost**	[redacted]	[redacted]
Alternative 1	Infrastructure Rehabilitation	24,000	$ 2,300,000	[redacted]	[redacted]

(1) $/pound calculated by dividing the 20-year NPV by 20 years of production.

6 Considerations for Future Investigation

There are several moving pieces regarding regulatory issues affecting these facilities, the time frame in which the chosen alternative will be implemented, and additional work that could be conducted to assist in finding potentially better, more cost-effective alternatives to reaching the State's production and stocking goals.

6.1 Addition of a Dilution Zone in Powder Mill's Permit

EPA has set the instream target for total phosphorus in Merrymeeting River at 12 µg/L. Current practice at the hatchery is that almost all flow from the source water (Merrymeeting Lake) to the river is utilized by the hatchery to rear fish. Thus, there is no dilution factor that can be considered, making the effluent limits the same as the instream target.

Two of the proposed upstream hatchery modernization alternatives being considered are to implement a recirculating aquaculture system. This type of system would significantly reduce the flow rate required from the source water and thus the effluent discharge. The recirculated water used for fish rearing is conditioned before reuse by treating for solids and ammonia. In effect, the total source water flow through in the hatchery would reduce from 6 MGD to approximately 1 MGD. This opens an opportunity for the NPDES to be modified to allow for a minimum dilution factor of 2, where the hatchery effluent could be diluted with the lake water in a dilution zone before being discharged to the river. Thus, the instream target would be disconnected from the effluent limit and could allow for potential permit modification to increase the hatchery average monthly effluent limit up to 24 µg/L. Consequently, the required TP removal would decrease from 90% to 70% in peak loadings summer months, eliminating the need for ion exchange or adsorption unit and reducing metal salt addition significantly. With such permit modification, more sustainable and cost-effective treatment solution would be possible.

6.2 Potential Additional Pilots

Many different filtration technologies are available on the market that can potentially be deployed in the hatchery for effluent treatment. These alternatives could not be tested in pilot scale due to the project time and budget constraints. However, a series of bench testing was designed to explore the feasibility of some alternate technologies to compare against the technologies piloted. Some of the technologies tested at bench scale showed promising results but did not reach the required effluent limits necessary at Powder Mill. However, it is anticipated that the performance of these technologies, specifically for filtration, might increase in a larger pilot application. Additionally, given there will be time between the issuance of Berlin's draft NPDES permit and the time in which new TP effluent limits become enforceable, a pilot of these potential technologies may be justified depending upon the TP limits imposed.

7 Paths to Achieve Statewide Production Goals

Based on the high cost of providing advanced effluent treatment at Powder Mill and Berlin, the state's two top production facilities, investments need to be made within the state's other hatcheries to maintain stocking goals and remain in permit compliance. Variables that drive the amount of production at any given site include water supply limits, water quality concerns, receiving stream TP assimilation capacity, and geographic considerations. Because all of the State's facilities have a fairly limited water supply, alternatives are inadequate without considering implementation of recirculating aquaculture systems.

In the development of the statewide alternatives, the goals desired to be achieved include:

- Total target production of 400,000 lbs annually statewide
- A mixture of existing infrastructure and new infrastructure
- The addition of dedicated infrastructure for broodstock

The statewide alternatives developed for evaluation can be briefly described as follows:

- Alternative 1 – One Large Facility at New Hampton
- Alternative 2 – One Large Facility at New Hampton with Rebuild at Milford
- Alternative 3 – Two Large Facilities at New Hampton and Powder Mill
- Alternative 4 – One Large Facility at New Hampton with New Northern Facility

These alternatives are shown in Table 7-1, and differ in the fish pounds produced at each facility. Each of these alternatives are described in more detail in the sections that follow. As can be seen, investment in New Hampton is a singular theme among all the alternatives evaluated given its availability of source water, ability to meet existing effluent discharge regulatory compliance, and proximity to a large receiving water body with more assimilative capacity for total phosphorus should it be required in the future. Conversely, Powder Mill's production is greatly reduced to maintain permit compliance focus while still providing much needed fish production at a limited scale. However, Alternative 3 presents the possibility of the construction of a new facility at Powder Mill in the future should it become a viable option.

Table 7-1: Summary of Hatchery Production in each Statewide Alternative

Hatchery	Existing	Alt 1	Alt 2	Alt 3	Alt 4
Powder Mill	124,097	30,000	30,000	150,000	30,000
Berlin	74,336	64,000	64,000	64,000	64,000
New Hampton	71,792	250,000	150,000	150,000	125,000
Milford	68,124	68,000	100,000	68,000	68,000
Twin	20,698	15,000	15,000	15,000	15,000
Warren	26,742	26,500	26,500	26,500	26,500
New Northern Facility	--	--	--	--	125,000
Total	385,789	453,500	385,500	473,500	453,500

The implementation of modifications to the hatcheries under each of these alternatives will inevitably occur in phases. For the phasing approach on all alternatives, it is expected that a reduction in production at Powder Mill is the first to take place. It is important to note that the timing of each phase will be based on a variety of factors including regulatory requirements and funding availability. Thus, no attempt has been made to define how long implementation of the entire alternative will take. Because of this, it is important to note the achievable level of production for each phase of an alternative and if it is below the statewide goals during construction any of the outlined phases is not included. With the current system near carrying capacity for pounds of fish, it's likely that some disruption of annual pounds produced will occur but will be temporary. Once all construction phases are complete, production goals should be met.

7.1 Alternative 1 – One Large Facility at New Hampton

Alternative 1 maximizes the amount of production at New Hampton to achieve statewide goals. This alternative includes the following modifications at each facility:

- Powder Mill – Reduction in production to roughly 30,000 lbs to meet effluent TP limits.
- Berlin – Slight reduction in production to 64,000 lbs, and operational changes to meet anticipated effluent TP limits.
- New Hampton – New RAS facility to accommodate 150,000 lbs in production plus house brook and brown trout broodstock and Landlocked Atlantic Salmon rearing. In a future phase of improvements thein effluent discharge can be relocated to the Pemigewasset River to allow for a potential increase in production up to 250,000 lbs with minimal additional facility improvements.
- Milford – Continue operation as is with continued investment in rehabilitation of existing infrastructure.
- Twin Mountain – Slight reduction in production to focus on and invest in Rainbow Trout broodstock.
- Warren – Continue operation as is with continued investment in rehabilitation of existing infrastructure.

This alternative brings the overall statewide production total to roughly 453,500 lbs. For the phasing approach on all alternatives, it is expected that a reduction in production at Powder Mill and Berlin are the first modifications to take place. For this alternative, phase 2 would likely be the construction and startup of a new RAS facility at New Hampton, and phase 3 is a shift to focus on broodstock at Twin along with moving the outfall at New Hampton to the Pemigewasset River to allow for increased production (see Table 7-2).

Table 7-2: Phases of Alternative 1 Production (lbs) by Facility

	Existing	Phase 1	Phase 2	Phase 3
Powder Mill	124,097	30,000	30,000	30,000
Belin	74,336	64,000	64,000	64,000
New Hampton	71,792	71,500	150,000	250,000
Milford	68,124	68,000	68,000	68,000
Twin	20,698	20,500	20,500	15,000
Warren	26,742	26,500	26,500	26,500
Total	385,789	280,500	359,000	453,500

7.2 Alternative 2 – One Large Facility at New Hampton with Rebuild at Milford

Alternative 2 slightly reduces the amount of production at the new New Hampton RAS facility and invests in a rebuild of the Milford facility to achieve statewide goals. This alternative includes the following modifications at each facility:

- Powder Mill – Reduction in production to roughly 30,000 lbs to meet effluent TP limits.
- Berlin – Slightly reduction in production to 64,000 lbs and operational changes to meet anticipated effluent TP limits.
- New Hampton – New RAS facility to accommodate 150,000 lbs in production plus house Brook Trout and Brown Trout broodstock and egg rearing of Landlocked Atlantic Salmon.
- Milford – Rebuild of Milford including source water treatment to reach 100,000 lbs in production.
- Twin Mountain – Slight reduction in production to focus on and invest in Rainbow Trout broodstock.
- Warren – Continue operation as is with continued investment in rehabilitation of existing infrastructure.

This brings the overall statewide production total to roughly 385,500 lbs. For the phasing approach on all alternatives, it is expected that a reduction in production at Powder Mill and Berlin is the first to take place. For this alternative, phase 2 would likely be the construction and startup of a new RAS facility at New Hampton, and phase 3 is a shift to focus on broodstock at Twin along with the rebuild of Milford (see Table 7-3).

Table 7-3: Phases of Alternative 2 Production (lbs) by Facility

	Existing	Phase 1	Phase 2	Phase 3
Powder Mill	124,097	30,000	30,000	30,000
Belin	74,336	64,000	64,000	64,000
New Hampton	71,792	71,500	150,000	150,000
Milford	68,124	68,000	68,000	100,000
Twin	20,698	20,500	20,500	15,000
Warren	26,742	26,500	26,500	26,500
Total	385,789	280,500	359,000	385,500

7.3 Alternative 3 – Two Large Facilities at New Hampton and Powder Mill

Alternative 3 includes a 150,000 lb RAS facility at New Hampton and a 150,000 lb RAS facility at Powder Mill. This alternative is presented in the event source water issues at other facilities are found to be too difficult to overcome or unanticipated events make this option viable in the future, such as a new method of TP removal that is more economical or regulatory modifications are successful and more affordable effluent treatment system becomes sufficient. This alternative includes the following modifications at each facility:

- Powder Mill – New 150,000 lb RAS facility with advanced effluent treatment.
- Berlin – Reduction in production to a less than 64,000 lbs, focus on Brook Trout broodstock to meet anticipated effluent TP limits.
- New Hampton – New RAS facility to accommodate 150,000 lbs in production plus house brook and brown trout broodstock and Landlocked Atlantic Salmon egg rearing.
- Milford – Continue operation as is with continued investment in rehabilitation of existing infrastructure.
- Twin Mountain – Slight reduction in production to focus on and invest in Rainbow Trout broodstock.
- Warren – Continue operation as is with continued investment in rehabilitation of existing infrastructure.

This brings the overall statewide production total to roughly 473,500 lbs. For the phasing approach on all alternatives, it is expected that a reduction in production at Powder Mill and Berlin are the first modifications to take place. For this alternative, phase 2 would likely be the construction and startup of a new RAS facility at New Hampton, phase 3 is a shift to focus on broodstock at Twin and phase 4 is the construction and startup of a new RAS facility with advanced effluent treatment at Powder Mill (see Table 7-4).

Table 7-4: Phases of Alternative 3 Production (lbs) by Facility

	Existing	Phase 1	Phase 2	Phase 3	Phase 4
Powder Mill	124,097	30,000	30,000	30,000	150,000
Belin	74,336	64,000	64,000	64,000	64,000
New Hampton	71,792	71,500	150,000	150,000	150,000
Milford	68,124	68,000	68,000	68,000	68,000
Twin	20,698	20,500	20,500	15,000	15,000
Warren	26,742	26,500	26,500	26,500	26,500
Total	385,789	280,500	359,000	353,500	473,500

Alternatively, the design production of the facilities at New Hampton and Powder Mill could be increased to 200,000 which serves to allow the flexibility to abandon lower producing hatchery sites should it become desirable in the future to reduce operational expenses.

7.4 Alternative 4 – One Large Facility at New Hampton with New Northern Facility

Alternative 4 is like Alternative 3 with the exception of instead of investing in Powder Mill as a second larger facility the investment is made in a new facility in the northern part of the state. This alternative includes the following modifications at each facility:

- Powder Mill – Reduction in production to roughly 30,000 lbs to meet effluent TP limits.
- Berlin – Slight reduction in production to 64,000 lbs and operational changes to meet anticipated effluent TP limits.
- New Hampton – New RAS facility to accommodate 125,000 lbs in production plus house Brook Trout and Brown Trout broodstock and egg rearing of Landlocked Atlantic Salmon.
- Milford – Continue operation as is with continued investment in rehabilitation of existing infrastructure.
- Twin Mountain –Reduction in production to less than 15,000 lbs, focus on and invest in Rainbow Trout broodstock.

- Warren – Continue operation as is with continued investment in rehabilitation of existing infrastructure.

- New Facility – New facility to accommodate 125,000 lbs in production, this will require determination of the best site and acquisition of land for the new facility.

This brings the overall statewide production total to roughly 453,500 lbs. For the phasing approach on all alternatives, it is expected that a reduction in production at Powder Mill is the first to take place. For this alternative, phase 2 would likely be the construction and startup of a new RAS facility at New Hampton, phase 3 is a reduction at Berlin, and phase 4 is the construction of a new northern facility (see Table 7-5).

Table 7-5: Phases of Alternative 4 Production (lbs) by Facility

	Existing	Phase 1	Phase 2	Phase 3	Phase 4
Powder Mill	124,097	30,000	30,000	30,000	30,000
Belin	74,336	64,000	64,000	64,000	64,000
New Hampton	71,792	71,500	125,000	125,000	125,000
Milford	68,124	68,000	68,000	68,000	68,000
Twin	20,698	20,5000	20,500	15,000	15,000
Warren	26,742	26,500	26,500	26,500	26,500
New facility	--				125,000
Total	385,789	280,500	334,000	328,000	453,500

Alternatively, the design production of the facilities at New Hampton and the new northern facility could be increased to 150,000 lbs which serves to allow even more flexibility to abandon lower producing hatchery sites should it become necessary in the future to reduce operational expenses.

7.5 Discussion and Recommendation

The implementation of modifications to the hatcheries under each of the proposed alternatives will inevitably occur in phases. Phasing will be required to allow NHFGD to secure project funding given that all of the alternatives require significantly more funding than what NHFGD currently has secured. Additionally, given NHFGD has historically been unable to secure funding for basic required maintenance, it is anticipated that a significant campaign to state officials as well as the public will be required to successfully secure the remaining funding required for completion of all phases. Given that the period required to secure this funding is unknown, the achievable production between phases must be looked at closely to see how it will vary. Thus, due to the anticipated extended period in which statewide production goals cannot be met, Alternative 3 and Alternative 4 are not desirable.

Alternative 1 and Alternative 2 are the remaining possible approaches. Both alternatives include the construction of a scalable 150,000 lb RAS facility at New Hampton as Phase 2. The difference then is the decision to either relocate the effluent discharge at the New Hampton RAS facility to allow for an increase in production of up to 250,000 lbs, or to reinvest in Milford. The decision between these two alternatives is hard to justify given the lack of available information at this time.

It is recommended that further evaluation of these two alternatives be conducted after the first year of operation at the proposed New Hampton RAS facility prior to settling on a course of action. While relocating the outfall at New Hampton may seem like an easier approach, this will require a significant amount of regulatory coordination, construction of an effluent pump station and effluent pipeline. In addition, investment is still required at Milford to keep the facility operating at its current capacity. Most critically, the conditions within the Hatchery Building are unsafe for employees and will require mold removal and remediation. Thus, it is likely that reinvestment in Milford would be the overall lower capital cost alternative. However, this is complicated by the high iron and manganese present in the source water.

Previous cost estimating exercises have shown that the requirement for advanced effluent treatment at Powder Mill is cost prohibitive under current conditions. However, there is a possibility of achieving regulatory relief in the form of the implementation of a dilution zone that can be achieved only if the volume of effluent discharged is reduced significantly using recirculation. Powder Mill is a significant facility in the NHFGD's system due to it being the only facility with plentiful, high quality source water. While significant production at this facility needs to be cut for the time being, it is likely that this site will once again be required to produce at a significant level within the next 15 to 50 years. This will likely be the result of source water issues becoming problematic for other facilities either from quality or quantity.

Alternative 4 would be desirable should regulatory pressures on Berlin become such that a significant reduction in production is required. This is a current concern during its NPDES permit renewal process but will also remain a concern into the future as regulatory requirements are ever changing. Given the significant amount of stocking in the northern region of the state (~95,000 lbs), shifting this production to the central region should Berlin become no longer viable would result in a significant increase in labor and transportation costs for the Department.

Given the significant amount of uncertainty faced by NHFGD from regulatory pressures, source water issues, and funding availability, it is recommended that significant investment to modernize and maximize the production at New Hampton is the best way to continue to meet the state's production needs in the interim. Prior to the implementation of any additional phases, further engineering study should be undertaken to reevaluate the regulatory environment and source water challenges and complete concept advancement for more accurate cost estimating of not just capital requirements but also an evaluation of operational expenses.

7.5.1 Implementation Phasing Approach

After careful consideration and evaluation, it is recommended that significant investment to modernize and maximize the production at New Hampton is the best way to continue to meet the state's production needs in the interim. The overall statewide approach requires modification in production and/or rehabilitation of existing facilities in addition to significant investment in a new recirculating aquaculture facility at New Hampton. The recommended system-wide long-term plan includes the following phased improvements:

- Phase 1 - 2025:
  - Powder Mill – Reduction in annual production from 118,000 lbs to 30,000 lbs (75% reduction) to meet effluent TP limits.
  - Berlin – Slight reduction in annual production from 74,000 lbs to roughly 64,000 lbs (13.5% reduction). If further reduction is deemed necessary after receiving the final EPA discharge permit this facility may shift its focus to Brook Trout broodstock only as a viable alternative to meet new effluent TP limits.
- Phase 2 – 2025/2026:
  - New Hampton – New RAS facility to accommodate 150,000 lbs in production plus house Brook and Brown Trout broodstock and Landlocked Atlantic Salmon egg rearing.
- Phase 3 – 2026/2027:
  - Twin Mountain – Slight reduction in production to focus on Rainbow Trout broodstock.
- Phase 4 – 2027/2028:
  - Reevaluation of the statewide system will likely be necessary at this time to determine the best way to meet production goals. Possible alternatives for evaluation include:
    - New Hampton Phase 2 – Relocation of the effluent discharge from Dickerman Brook to the Pemigewasset River could allow this facility to produce up to 250,000 lbs with minimal rearing improvements by carrying an increased density within the existing rearing units.
    - Milford Rehabilitation – Rebuild of Milford including source water treatment to reach 100,000 lbs in production.
    - Powder Mill Re-Evaluation – Evaluate use of a dilution zone coupled with recirculating technology. Additional evaluation of less advanced forms of TP removal may also be justified.
    - Berlin/New Northern Facility – Depending on the regulatory pressure on Berlin, re-evaluation of a new Northern Facility may be justified.

Additionally, some amount of investment in all the State’s facilities is required just to insure they can stay operational given the lack of investment they’ve received over such a significant period, leaving most existing infrastructure in a state of disrepair and failure. These improvements are deemed as critical, and funding needs to be sought for these items above and beyond the operational funding typically received every year by NHFGD. These improvements are referred to as Mission Critical Improvements and are detailed by facility below.

- Powder Mill:
    - Reduce production to remain in compliance with NPDES permitted limits.
    - Source water treatment including drum filtration and disinfection is recommended to improve bio security.
    - Flow baffles are recommended within rearing units to remain in use to improve movement of fish generated solids towards the drains.

- Berlin:
    - Reduce production to remain in compliance with NPDES permitted limits.
    - Upgrades to source waters, including either new production wells with backup power to serve as a reliable source without the need for disinfection, or a combination of new wells, existing wells, and surface waters with a new intake building including filtration and disinfection.
    - Hatchery building improvements.
    - Improve predator control systems.
    - Flow baffles for solids transport.

- Milford:
    - Replace backup generators and transfer switches.
    - Remove abandoned electrical systems in the well house.
    - Replace Field Well.
    - Improve predator control systems.
    - Concrete repair on all circular tanks.
    - Rehab the Hatchery Building.
        - Provide epoxy coating on rearing tanks.
        - Replace rusted pipe supports.
        - Replace roof.
        - Replace insulation.
        - Replace doors.
        - Replace exterior finishes.
        - Replace boiler, HVAC systems, and water heaters.
        - Remove or abate asbestos.
        - Remediate black mold.
        - Replace degraded and abandoned electrical systems.
        - Replace abandoned controls with SCADA (PLC) system.
        - Replace fluorescent lights with LEDs.
        - Provide ADA compliant access throughout publicly accessed areas.

- Twin Mountain:
    - Clean vegetation, sediment, and debris out of spring head boxes.
    - Provide or replace spring head box covers and screens.
    - Remove loose or deteriorated concrete and restore the structures to their original dimensions.
    - Replace the well/pump house floor slab and drain.
    - Rehab the Hatch House.

        - Replace furnace.
        - Replace electrical equipment.
        - Patch damaged CMU wall.
        - Replace windows.
    - Rehab the Storage Garage.
        - Replace Roof.
        - Replace existing temperature-controlled feed storage area.
        - Repair/Replace rotted windowsills.
        - Replace light fixtures with LEDs.
    - Rehab the Garage / Office Building.
        - Remove all abandoned equipment.
        - Replace panel board.
        - Replace HVAC systems and water heater.
        - Additional renovations would require a full gut renovation including structural adjustments to bring the entire building up to the current code for its current uses.

- Warren:
    - Replace heaters in the well houses.
    - Evaluate Well #2 for rehab vs replacement including a new backup generator.
    - Clean reservoirs of vegetation, sediment, and debris.
    - Repair or replace deteriorated concrete in the rearing ponds and control structures.

These Mission Critical improvements will need to be completed at the same time as the implementation of the phased approach presented above. Thus, making the implementation timeline of the recommendations extremely condensed, requiring significant capital investment within the State's hatchery systems over the course of the next five to ten years to maintain production goals.

8 Opinion of Probable Construction Cost

A Conceptual Opinion of Probable Construction Cost (OPCC) was developed for the phasing approach set forth in Section 7.5.1. The OPCCs are based on estimated quantities and unit costs. Each OPCC was generated using a combination of improvement costs referenced from previous studies and industry data, scaled costs from facilities or equipment of similar operations, and unit costs applied to quantities of materials and equipment.

These opinions of probable construction cost were prepared to the standards of the Association for the Advancement of Cost Engineering (AACE) International Class 4 estimate. At the concept development stage, contingencies of 50 percent of the construction value were applied. Contingencies at New Hampton were reduced to 44% to account for economies of scale. Percentages of construction costs were used to represent cost for the items listed below:

- Contractor’s Field General Conditions at 12% (10% used for New Hampton).
- Contractor’s Mobilization at 2%.
- Contractor’s OH&P at 10%.
- Contractor’s Bonds and Insurance at 2%.
- Escalation to Midpoint of Construction:
    - 7.43% for 2023 through 2025.
    - 4.00% for 2025 and on.
- Market volatility adjustment factor at 10% (5% used for New Hampton).

The OPCC summaries for each phase set forth in Section 7.5.1 are shown below in Table 8-1 and a detailed breakdown of each OPCC is presented in Appendix D. Mission Critical improvements at Powder Mill are included in Phase 1 as some amount of improvement will be required to implement the reduction in production and Mission Critical rehabilitation should be implemented at the same time to reduce overall construction costs.

Table 8-1: Recommended Interim Plan OPPCs by Phase

	Phase 1 **2025**	**Phase 2** **2025/2026**	**Phase 3** **2026/2027**
Powder Mill	$2,800,000		
Belin			
New Hampton		$50,900,000	
Milford			
Twin			$ 4,000,000
Warren			
Total	$2,800,000	$50,900,000	$4,000,000

Notes: 1. Opinion of Probable Construction Costs do not include required design engineering and design services during construction fees. Determination of project funding requirements will necessitate the inclusion of these fees.

Mission Critical rehabilitation necessary at Berlin, Milford, and Warren to continue operation without significant risk of complete failure should be assessed by NHFGD on a continuing basis as they work to secure additional funding.

9 Conclusion

The six hatcheries in the state operate in unison as one large system supporting the stocking goal of up to 400,000 lbs of stockable fish per year. Three key issues drive achieving 400,000 lbs of production; permit compliance, water supply (quantity and quality), and the condition of the existing infrastructure.

Permit Compliance – The low TP limits already in place for Powder Mill and the potential for similar low limits at Berlin dictate the need for any of the larger hatcheries to include effluent treatment. The scale and complexity of the treatment will be determined by the location of the facility, the amount of treated recirculation water, and existing or potential future limits. Production capabilities have been estimated in this and supporting documents that outline potentials but the ultimate levels of production achievable at each location will be driven by permit compliance.

Water Supply – Powder Mill is the only facility within the state with ample water supply. All other sites have limited water supply that are currently being utilized to the maximum extent for a system designed for flow through with multiple passes. Thus, for any of the other five facilities, treatment and recirculation of the water within the hatchery would be required to increase production.

Infrastructure – Existing infrastructure has been driven to the end of its useful life. Major investments to maintain permit compliance, efficient operation, and address water supply issues should be done in conjunction with modernized rearing facilities to maximize the investment of the state's dollars and protect the production capabilities of the system.

After review of multiple alternatives at all six facilities as well as development and evaluation of statewide alternatives, an approach to the improvements required to continue to meet most of NHFGD's production goals in the interim is clear. Immediate investments should occur at the New Hampton facility to construct a new RAS facility to accommodate 150,000 lbs in production plus house Brook and Brown Trout broodstock and Landlocked Atlantic Salmon egg rearing. The centralized location of the facility, capability to complete major renovation within the existing footprint, and the ability to utilize RAS make the location ideal for major infrastructure investments. At a minimum, production could be increased 108% based on lbs per year with a future potential to increase to between 280% and 350% based on lbs per year with the use of higher rearing densities and a relocation of the effluent discharge to the Pemigewasset River.

Investment to construct a Rainbow Trout broodstock facility at Twin Mountain should be completed in conjunction or shortly after completion of construction at New Hampton. A new biosecure building capable of housing an internal Rainbow Trout program would eliminate the need to import poor quality eggs from other programs outside of New Hampshire, resulting in a huge cost savings in labor and operation in addition to better control of egg quality.

However, these major projects at New Hampton and Twin Mountain are far from the end of the improvements required. Reinvestment into the entire statewide system is necessary. The State's existing hatcheries have provided an enormous environmental, social, and economic impact over their life span. Per year, the New Hampshire Hatchery System produces roughly 1.5 million fish for stocking. Extrapolating that by the average 20-year lifespan of a facility typically assigned in engineering studies, results in roughly 30 million fish! These systems have served New

Hampshire for significantly longer than 20 years, and now need reinvestment to continue to provide these benefits.

Investments to improve the water quality at Milford and Berlin, including the replacement of rearing units should be reviewed. Installing a modern iron removal system followed by new circular rearing units at Milford would allow the facility to increase production above the current 70,000 lb range, significantly improving the production capabilities in the southern portion of the state. Additionally, an allowance should be developed to allow for one well rehabilitation each year. Doing one each year would put the wells on a cycle of every other year individually. It is common in wells with high iron to routinely pull pumps and recharge wells. With regular maintenance and enhanced iron removal, the Milford wells could be a consistent water supply for the program.

Berlin is currently going through its permit renewal cycle and discussions with EPA have indicated that discharge to York Pond will most likely have a lower TP limit to avoid further impairments to this water body. This will result in the loss of production in the east portion of the facility. Furthermore, the main effluent discharge point is also subject to tighter TP effluent limits given the indirect receiving water body, West Branch Upper Ammonoosuc Rive, is classified as an outstanding resource water. Thus, it is anticipated that some reduction in production will be required to meet new TP permit limits. Depending on the amount of reduction required, this may result in huge rippling effects to the states system, like that faced at Powder Mill. While a reduction at Berlin is impactful, the hope is that the newly constructed New Hampton RAS and maximizing production at all the other hatcheries will enable NHFGD to meet most of the state’s required production.

Depending on what the future brings, the Warren Hatchery may or may not be required to continue operations. However, its role in the statewide system will be critical throughout implementation of the proposed phasing approach to produce as much stockable fish as possible during disruptions at other facilities. However, this site is becoming more prone to flooding. It is recommended that this risk be monitored and investment in this facility will likely need to be reevaluated over time. It may make sense given the historic significance to set this area up as a museum, or larger visitor’s center with minimal showcase production.

It is crucial to understand that the recommended approach is an interim approach and reevaluation should occur in the future given the nature of unknown regulatory compliance issues at Berlin. The future approach to New Hampton requires relocation of the existing outfall to the Pemigewasset River which has a higher TP assimilative capacity than the current receiving stream. This allows for higher TP effluent limits which is critical to being able to reach up to 250,000 lb production The anticipated reduction proposed at Berlin may turn out to be either too aggressive, or not enough. Currently, the anticipated effluent limits are still within a fairly wide range and additional evaluation will need to be completed to determine exactly what the facility will be able to produce once limits are known. Additionally, regulatory issues at the remaining facilities may emerge as permits go through the renewal cycle and need to be monitored to ensure continued viability of the state’s facilities.

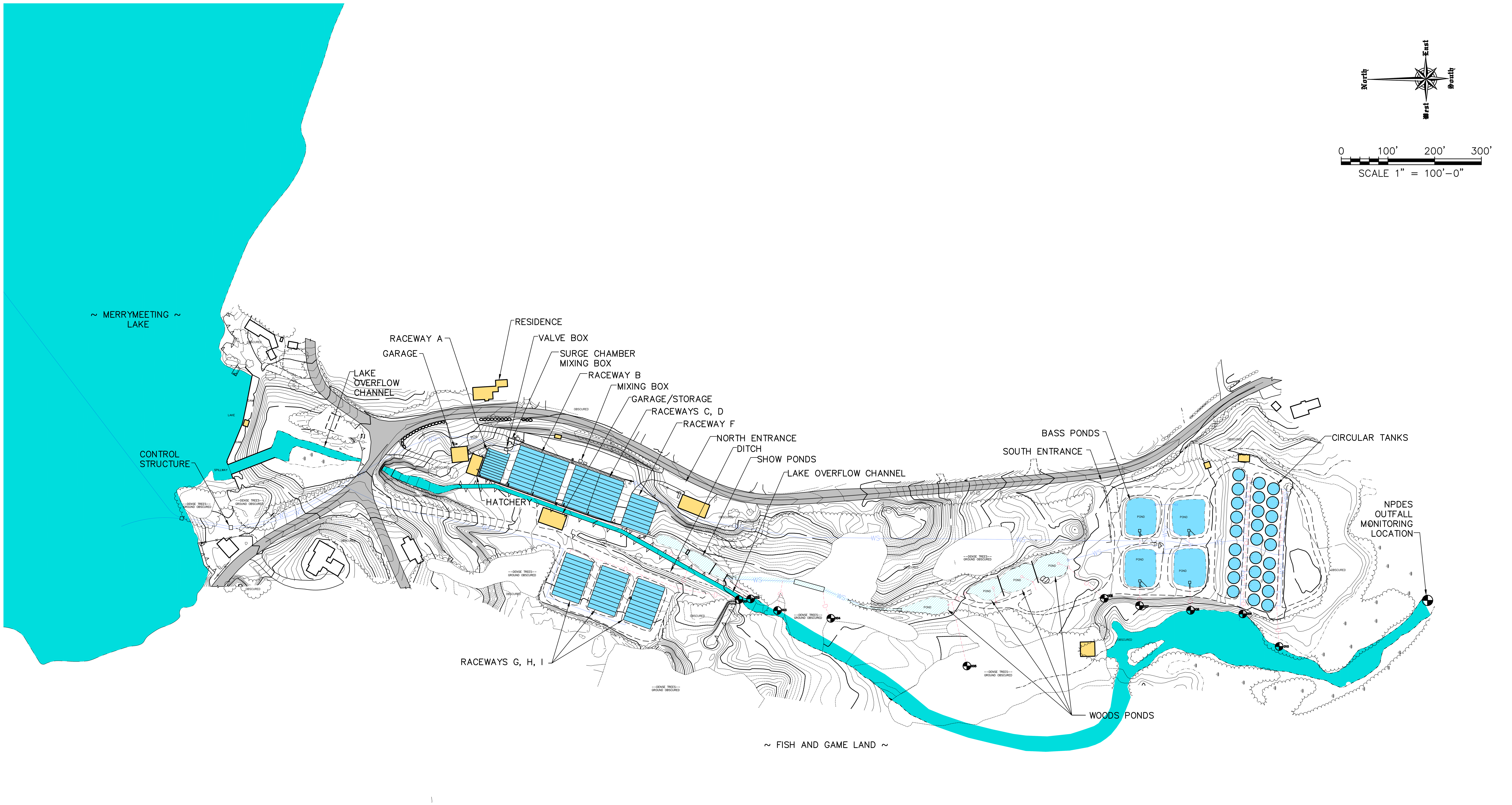
The implementation timeline for the recommended approach is extremely condensed and will require significant capital investment within the State's hatchery systems over the course of the next five years to maintain production goals.

- Phase 1 - 2025:
  - Powder Mill – Reduction in annual production from 118,000 lbs to 30,000 lbs (75% reduction) to meet effluent TP limits.
  - Berlin – Slight reduction in annual production from 74,000 lbs to roughly 64,000 lbs (13.5% reduction). If further reduction is deemed necessary after receiving the final EPA discharge permit this facility may shift its focus to Brook Trout broodstock only as a viable alternative to meet new effluent TP limits.
- Phase 2 – 2025/2026:
  - New Hampton – New RAS facility to accommodate 150,000 lbs in production plus house Brook and Brown Trout broodstock and Landlocked Atlantic Salmon egg rearing.
- Phase 3 – 2026/2027:
  - Twin Mountain – Slight reduction in production to focus on Rainbow Trout broodstock.
- Phase 4 – 2027-2030:
  - Reevaluation of the statewide system will likely be necessary at this time to determine the best way to meet production goals. Possible alternatives for evaluation include:
    - New Hampton Phase 2 – Relocation of the effluent discharge from Dickerman Brook to the Pemigewasset River could allow this facility to produce up to 250,000 lbs with minimal rearing improvements by carrying an increased density within the existing rearing units.
    - Milford Rehabilitation – Rebuild of Milford including source water treatment to reach 100,000 lbs in production.
    - Powder Mill Re-Evaluation – Evaluate use of a dilution zone coupled with recirculating technology. Additional evaluation of less advanced forms of TP removal may also be justified.
    - Berlin/New Northern Facility – Depending on the regulatory pressure on Berlin, re-evaluation of a new Northern Facility may be justified.
  - Depending on the approach taken, major rehabilitation at other facilities should be undertaken to maintain production capabilities at existing facilities.

While the recommended approach presented here only gets the State to roughly 359,000 lbs of production, there are multiple pathways still available to meet the overall statewide production goals. Implementing significant improvements to New Hampton will allow NHFGD to continue to effectively carry out its mission of conserving, managing, and protecting the State's fish and wildlife resources and their habitats; informing and educating the public about these resources;

and providing the public with opportunities to use and appreciate these resources until further information is known. Furthermore, reevaluation of the remaining alternatives to reach the State's goal of 400,000lbs ensures that the best overall long-term solution is implemented so that NHFGD can continue to provide the enormous environmental, social, and economic impact in the most cost-effective way.

Appendix A
Existing Site Maps and Hydraulic Profiles



EXISTING OUTFALL LOCATIONS

ISSUE	DATE	DESCRIPTION
-	-	-

PROJECT MANAGER XXX X. XXXXXX

PROJECT NUMBER XXXXXXXXXXXXXXX

POWDER MILL EXISTING SITE PLAN

FILENAME -

SCALE -

SHEET PM-2

NOTE:
ALL EXISTING PIPING LOCATIONS & ELEVATIONS AND WATER SURFACE ELEVATIONS ARE ESTIMATED FROM EXISTING TOPO AND OLD CONSTRUCTION DRAWINGS AND HAVE NOT BEEN VERIFIED IN FIELD.

HDR

ISSUE	DATE	DESCRIPTION
-	-	-

PROJECT MANAGER R. ELWOOD

PROJECT NUMBER 10331124

POWDER MILL FISH HATCHERY
FEASIBILITY STUDY

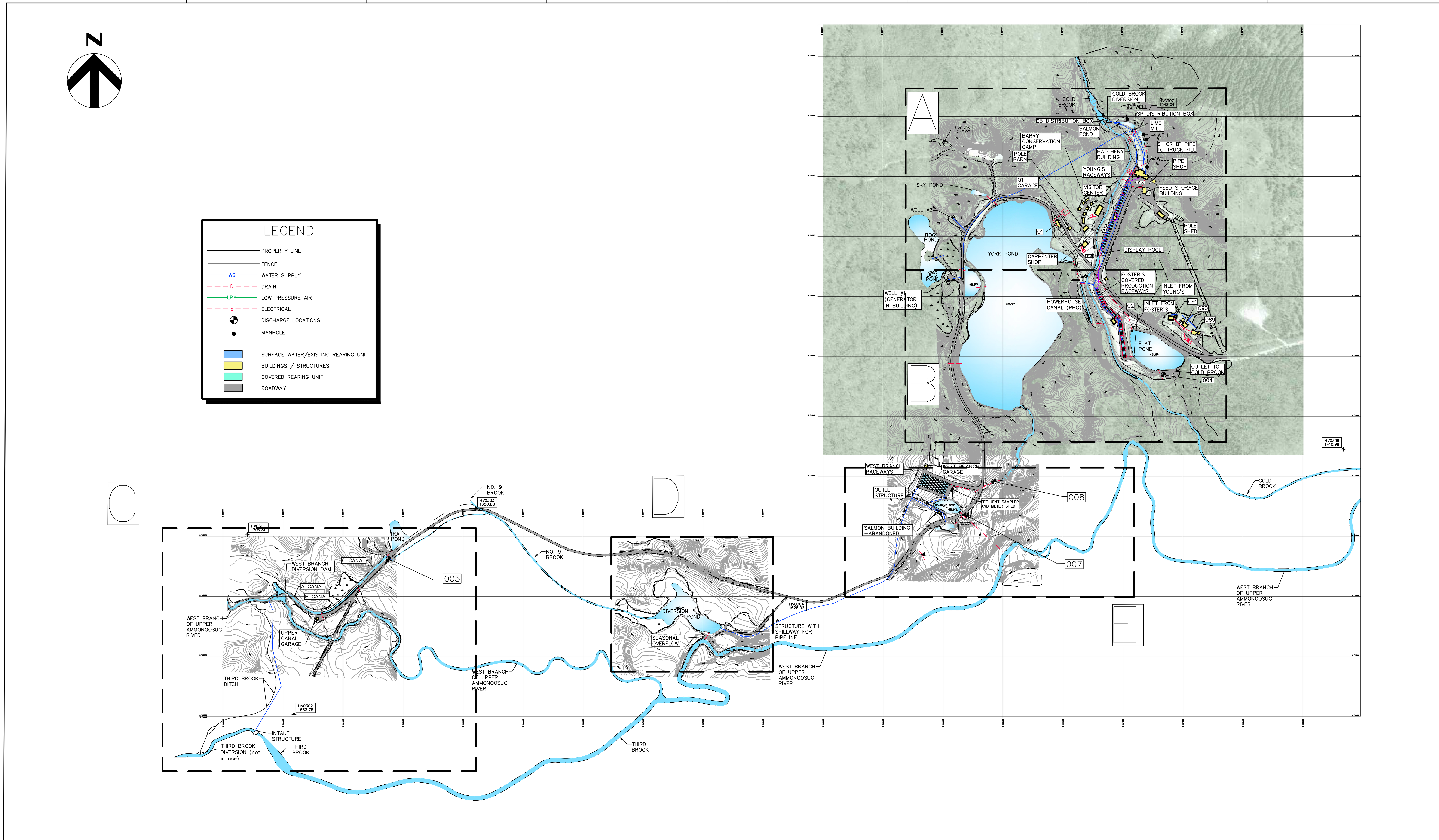
POWDER MILL
PROCESS FLOW SCHEMATIC
& HYDRAULIC FLOW DIAGRAM

0 300' 600'

FILENAME 02C-03.DWG

SCALE NTS

SHEET 02C-03



HDR

PROJECT MANAGER R. ELWOOD

ISSUE	DATE	DESCRIPTION
-	-	-

PROJECT NUMBER 10331124

POWDER MILL FISH HATCHERY FEASIBILITY STUDY

BERLIN OVERALL SITE MAP

0 380' 760'

FILENAME BERLIN-SITE PLAN.DWG

SCALE 1"=380'

SHEET **SITE PLAN**

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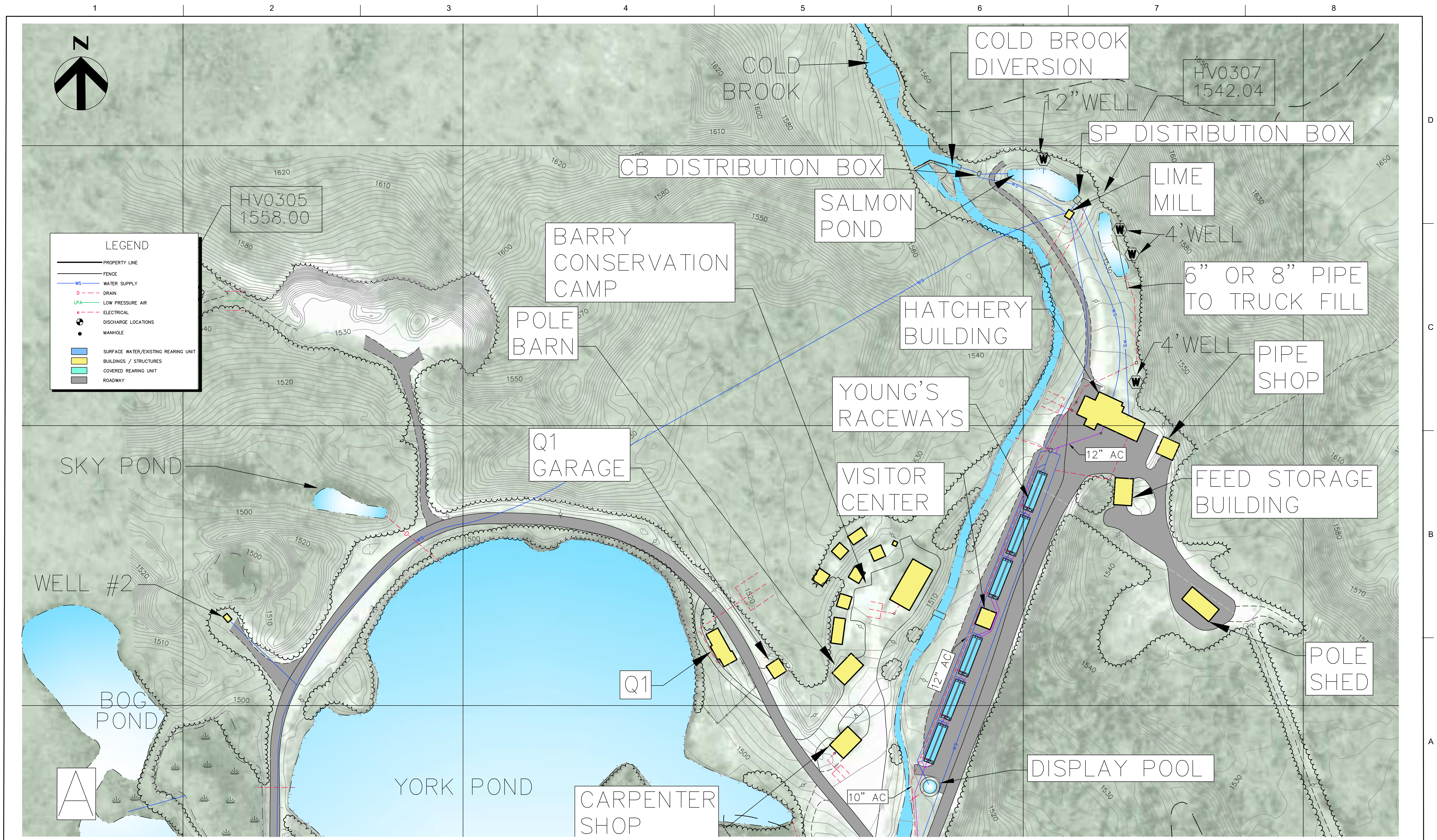


ISSUE	DATE	DESCRIPTION
-	-	-

PROJECT MANAGER R. ELWOOD

PROJECT NUMBER 10331124

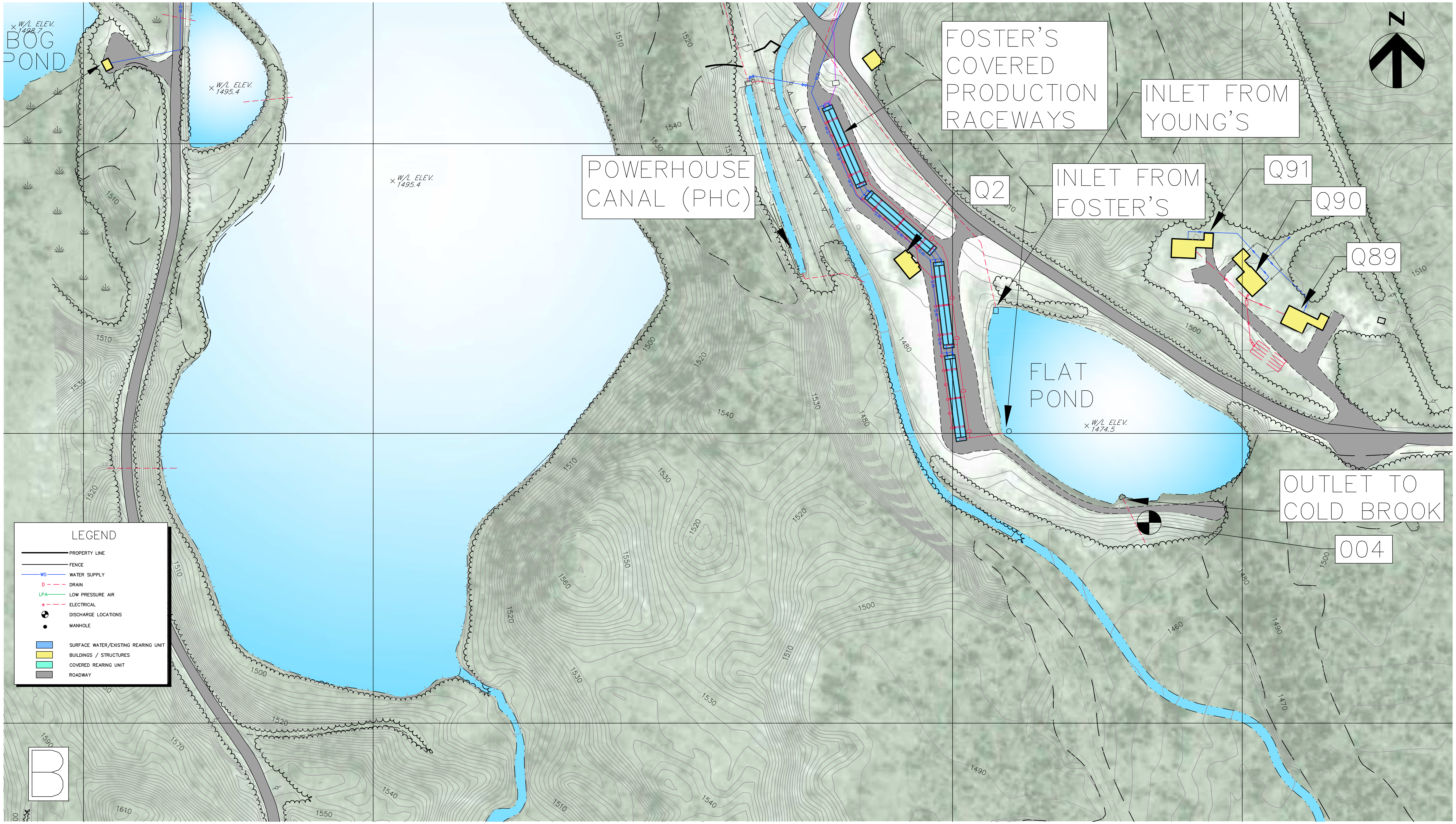
POWDER MILL FISH HATCHERY FEASIBILITY STUDY

BERLIN - A OVERALL SITE MAP

FILENAME BERLIN-SITE PLAN.DWG

SCALE 1"=80'

SHEET **SITE PLAN**



PROJECT MANAGER R. ELWOOD

ISSUE	DATE	DESCRIPTION
-	-	-

PROJECT NUMBER 10331124

POWDER MILL FISH HATCHERY FEASIBILITY STUDY

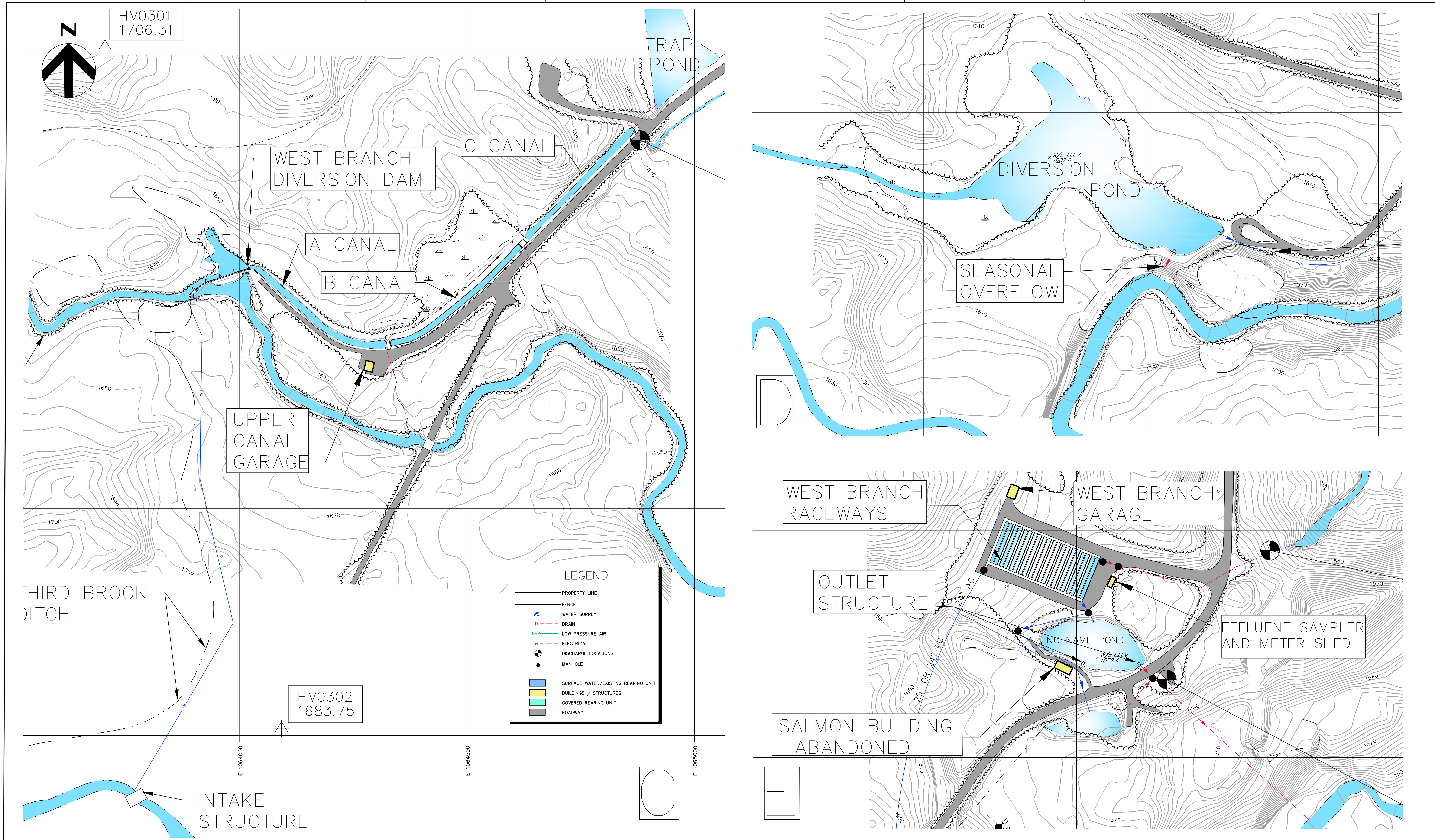
BERLIN OVERALL SITE MAP

0 80' 160'

FILENAME BERLIN-SITE PLAN.DWG

SCALE 1"=80'

SHEET **SITE PLAN**



PROJECT MANAGER	R. ELWOOD	
ISSUE	**DATE**	**DESCRIPTION**
PROJECT NUMBER	10331124	

POWDER MILL FISH HATCHERY FEASIBILITY STUDY

BERLIN OVERALL SITE MAP

0 100' 200'

FILENAME BERLIN-SITE PLAN.DWG

SCALE 1"=100'

SHEET SITE PLAN

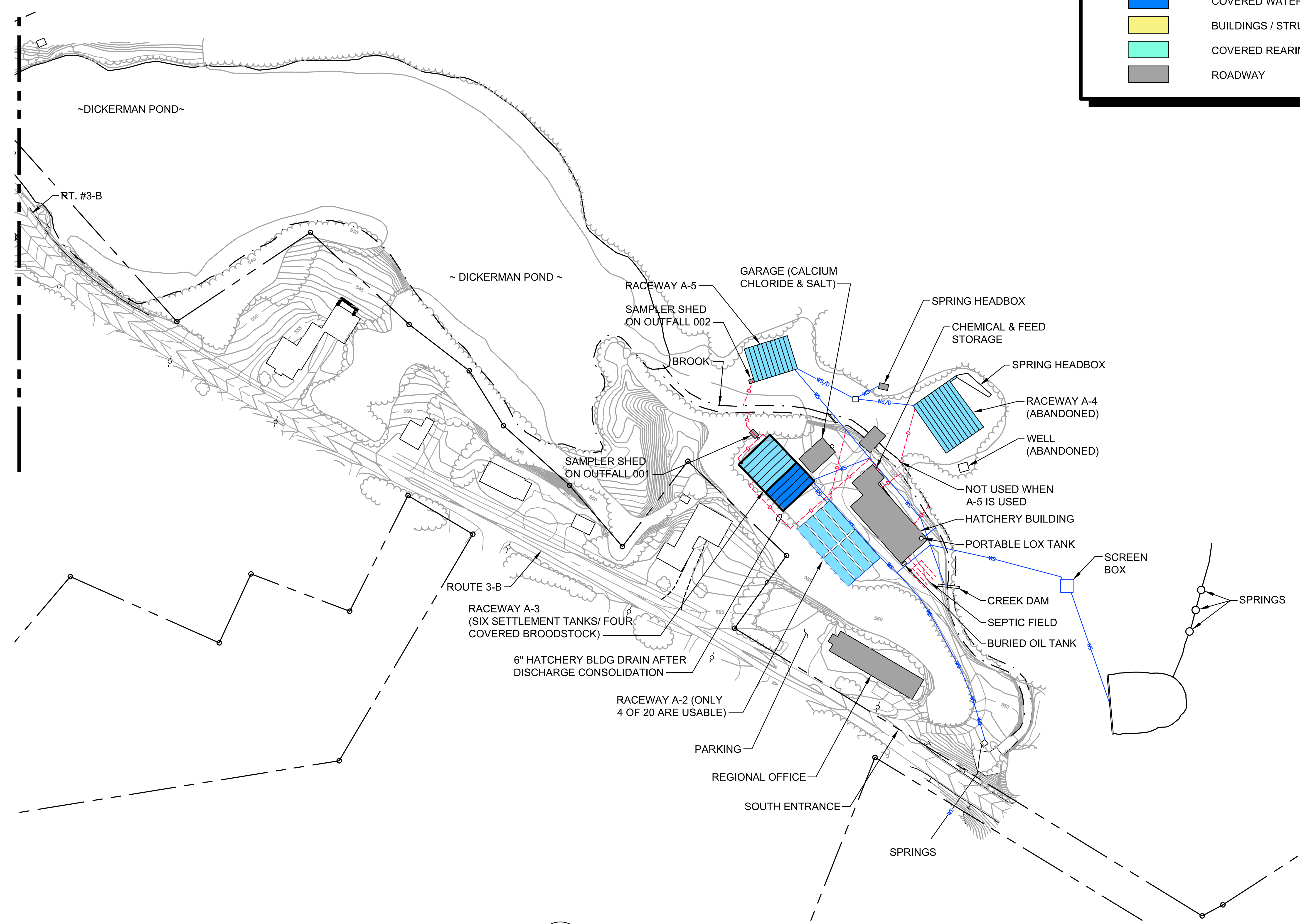
1 2 3 4 5 6 7 8

D C B A

LEGEND

—·—·—	PROPERTY LINE
—X—	FENCE
—WS—	WATER SUPPLY
- - D - -	DRAIN
—LPA—	LOW PRESSURE AIR
- - e - -	ELECTRICAL
◐	DISCHARGE LOCATIONS
	SURFACE WATER/EXISTING REARING UNIT
	COVERED WATER/EXISTING REARING UNIT
	BUILDINGS / STRUCTURES
	COVERED REARING UNIT
	ROADWAY

North
West
East
South



0 100' 200'

2 / H-2 **EXISTING CONDITIONS SITE PLAN**

SCALE: 1" = 100'-0"

ISSUE	DATE	DESCRIPTION
-	-	-

PROJECT MANAGER R. ELWOOD

PROJECT NUMBER 10331124

POWDER MILL FISH HATCHERY FEASIBILITY STUDY

NEW HAMPTON EXISTING CONDITIONS SITE PLAN

0 300' 600'

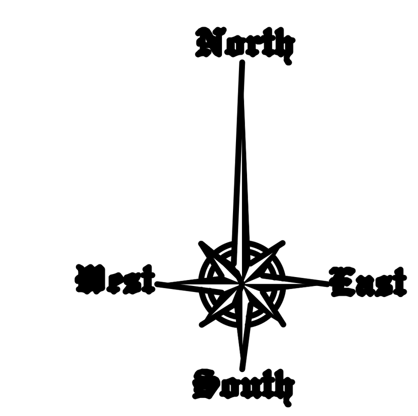
FILENAME H-2.DWG

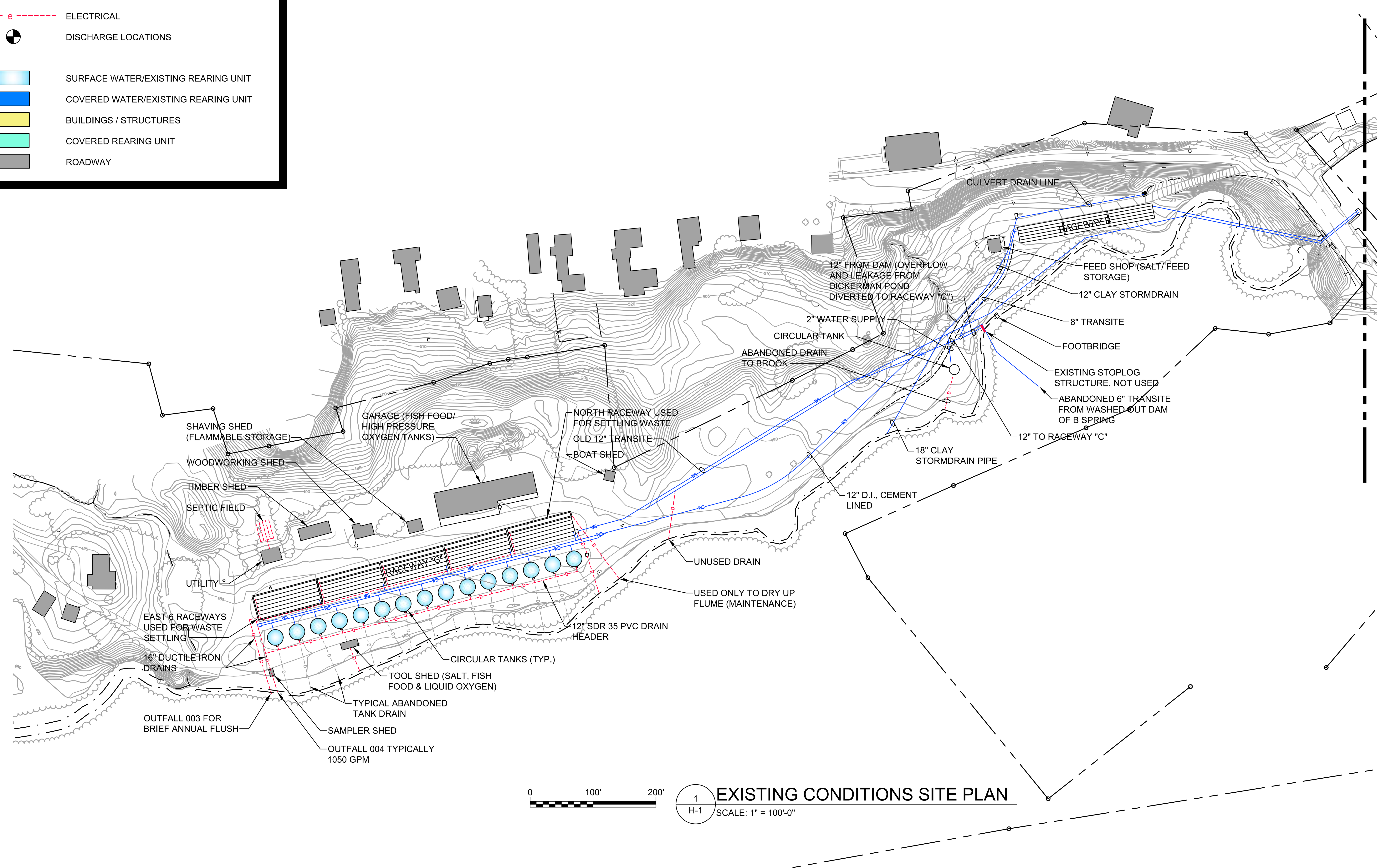
SCALE NTS

SHEET **H-2**

LEGEND

- PROPERTY LINE
- X — FENCE
- WS — WATER SUPPLY
- D — DRAIN
- LPA — LOW PRESSURE AIR
- e — ELECTRICAL
- DISCHARGE LOCATIONS
- SURFACE WATER/EXISTING REARING UNIT
- COVERED WATER/EXISTING REARING UNIT
- BUILDINGS / STRUCTURES
- COVERED REARING UNIT
- ROADWAY





1
H-1
EXISTING CONDITIONS SITE PLAN
SCALE: 1" = 100'-0"

HDR

ISSUE	DATE	DESCRIPTION
-	-	-

PROJECT MANAGER R. ELWOOD

PROJECT NUMBER 10331124

POWDER MILL FISH HATCHERY FEASIBILITY STUDY

NEW HAMPTON EXISTING CONDITIONS SITE PLAN

0 300' 600'

FILENAME H-1.DWG

SCALE NTS

SHEET H-1

HDR

PROJECT MANAGER R. ELWOOD

ISSUE	DATE	DESCRIPTION
-	-	-

PROJECT NUMBER 10331124

POWDER MILL FISH HATCHERY FEASIBILITY STUDY

MILFORD EXISTING CONDITIONS SITE PLAN

0 1" 2"

FILENAME M-1.DWG

SCALE 1" = 60'

SHEET M-1

HDR

PROJECT MANAGER R. ELWOOD

ISSUE	DATE	DESCRIPTION
-	-	-

PROJECT NUMBER 10331124

POWDER MILL FISH HATCHERY FEASIBILITY STUDY

TWIN MOUNTAIN SITE PLAN

0 1" 2"

FILENAME 05C-02.DWG

SCALE 1"=200'

SHEET **05C-02**

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HDR

ISSUE	DATE	DESCRIPTION
-	-	-

PROJECT MANAGER R. ELWOOD

PROJECT NUMBER 10331124

POWDER MILL FISH HATCHERY FEASIBILITY STUDY

WARREN SPECIAL PURPOSE FACILITY EXISTING SITE PLAN

0 300' 600'

FILENAME 06C-02.DWG

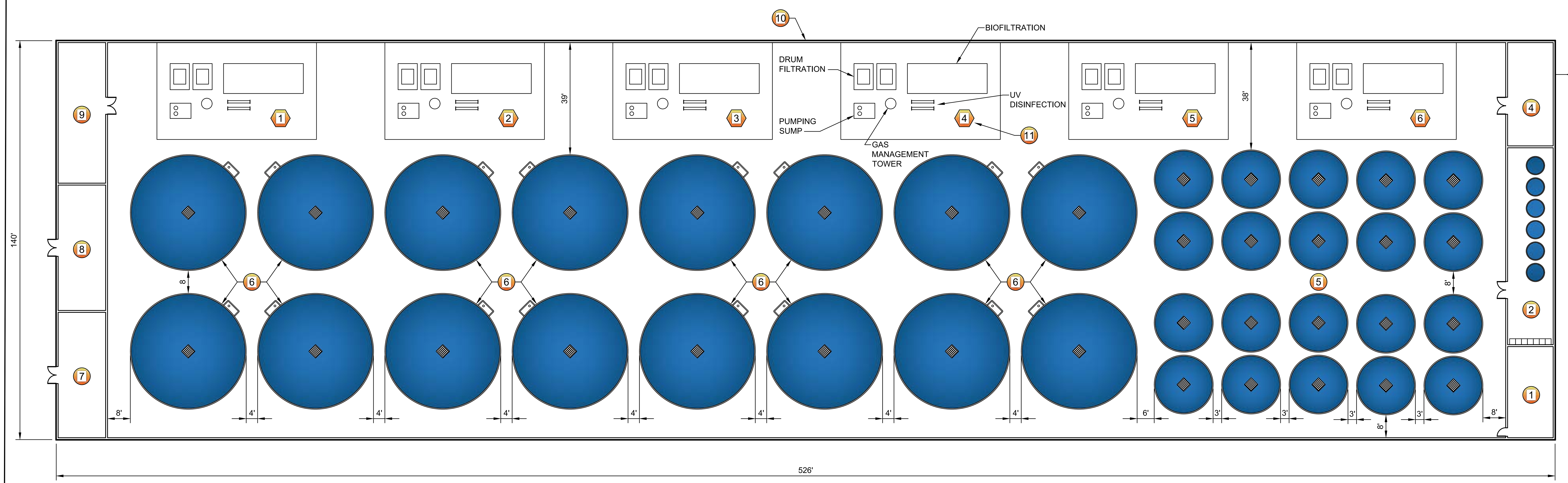
SCALE 1"=60'

SHEET 06C-02

Appendix B
Proposed Site Layouts

KEYED NOTES:

1. OFFICES AND STAFF SUPPORT SPACES IN INSULATED POWDER MILL RAS PRE-ENGINEERED BUILDING.
2. EGG INCUBATION ROOM INCLUDING BIOSECURITY EGG WASH AREA, VERTICAL FLOW EGG INCUBATORS AND CIRCULAR FEED TRAINING TANKS. THIS ROOM ON FLOW THROUGH WATER USE ONLY (NOT RAS.)
3. SHALLOW AND DEEP LAKE WATER SUPPLY LINES FOR MAKEUP WATER TO RAS SYSTEM.
4. PROCESS MECHANICAL ROOM. LAKE WATER FILTRATION, UV DISINFECTION AND MAKE-UP WATER DE-GASSING/ AERATION. SPACE INCLUDES PROCESS WATER HEATING SYSTEMS.
5. 20 FT DIAMETER INTERMEDIATE REARING TANKS WITH MODULAR RAS TREATMENT COMPONENTS. TWO (2) RAS MODULES WITH 10 TANKS PER MODULE. TANKS ARE DUAL DRAIN DESIGN.
6. 40 FT DIAMETER FINAL GROW-OUT TANKS WITH MODULAR RAS TREATMENT COMPONENTS. FOUR (4) RAS MODULES WITH 4 TANKS PER MODULE. TANKS ARE DUAL DRAIN DESIGN.
7. GENERAL EQUIPMENT STORAGE SPACE.
8. FEED STORAGE SPACE (AIR CONDITIONED).
9. ELECTRICAL EQUIPMENT ROOM. ELECTRICAL PANELS AND EMERGENCY ELECTRICAL GENERATOR. PROCESS MONITORING AND INSTRUMENTATION SYSTEM FOR ALL RAS MODULES PROVIDED.
10. PRE-ENGINEERED INSULATED METAL BUILDING WITH HVAC SYSTEMS. BUILDING SIZE IS APPROXIMATELY 65,745 SQUARE FEET.
11. RAS MODULES 6 PROVIDED. EACH MODULE INCLUDES: DUAL DRAIN CULTURE TANKS, MICROSCREEN, CIRCULATION PUMPS, BIOFILTRATION TOWER, GAS MANAGEMENT TOWER WITH CO2 & DO GAS MANAGEMENT, UV DISINFECTION, OZONE AND SYSTEM PIPING. SYSTEM IS 95% RECIRCULATION / 5% MAKE-UP BY RATE OF FLOW RAS DESIGN. RAS MODULES CAN OPERATE AS STAND-ALONE INDEPENDENT SYSTEMS.



ISSUE	DATE	DESCRIPTION
-	-	-

PROJECT MANAGER R. ELWOOD

PROJECT NUMBER 10331124

POWDER MILL FISH HATCHERY FEASIBILITY STUDY

PROPOSED RAS BUILDING

FILENAME NH CONCEPT.DWG

SCALE 1"=20'

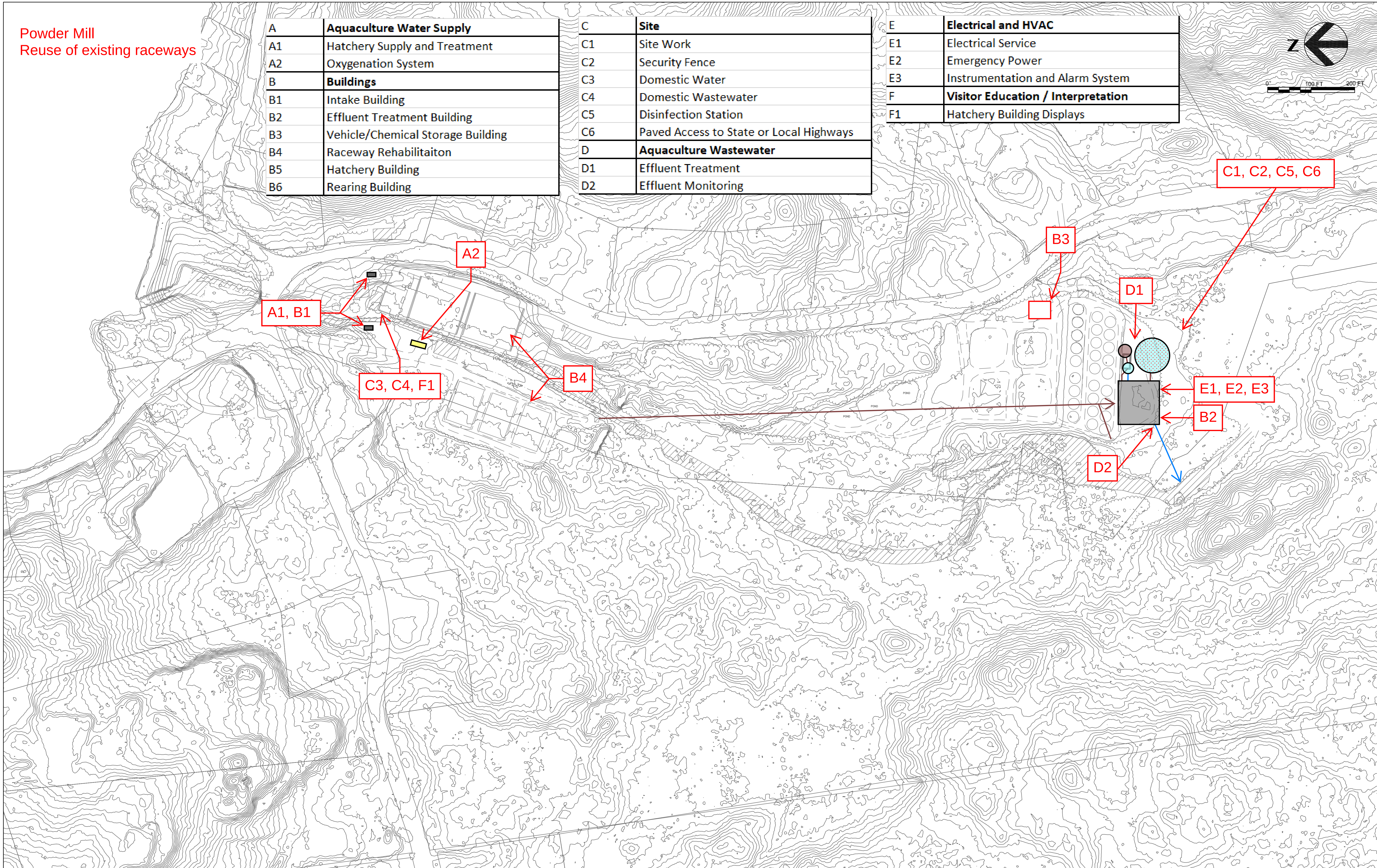
SHEET 1

Powder Mill
Reuse of existing raceways

A	**Aquaculture Water Supply**
A1	Hatchery Supply and Treatment
A2	Oxygenation System
B	**Buildings**
B1	Intake Building
B2	Effluent Treatment Building
B3	Vehicle/Chemical Storage Building
B4	Raceway Rehabilitaiton
B5	Hatchery Building
B6	Rearing Building

C	**Site**
C1	Site Work
C2	Security Fence
C3	Domestic Water
C4	Domestic Wastewater
C5	Disinfection Station
C6	Paved Access to State or Local Highways
D	**Aquaculture Wastewater**
D1	Effluent Treatment
D2	Effluent Monitoring

E	**Electrical and HVAC**
E1	Electrical Service
E2	Emergency Power
E3	Instrumentation and Alarm System
F	**Visitor Education / Interpretation**
F1	Hatchery Building Displays

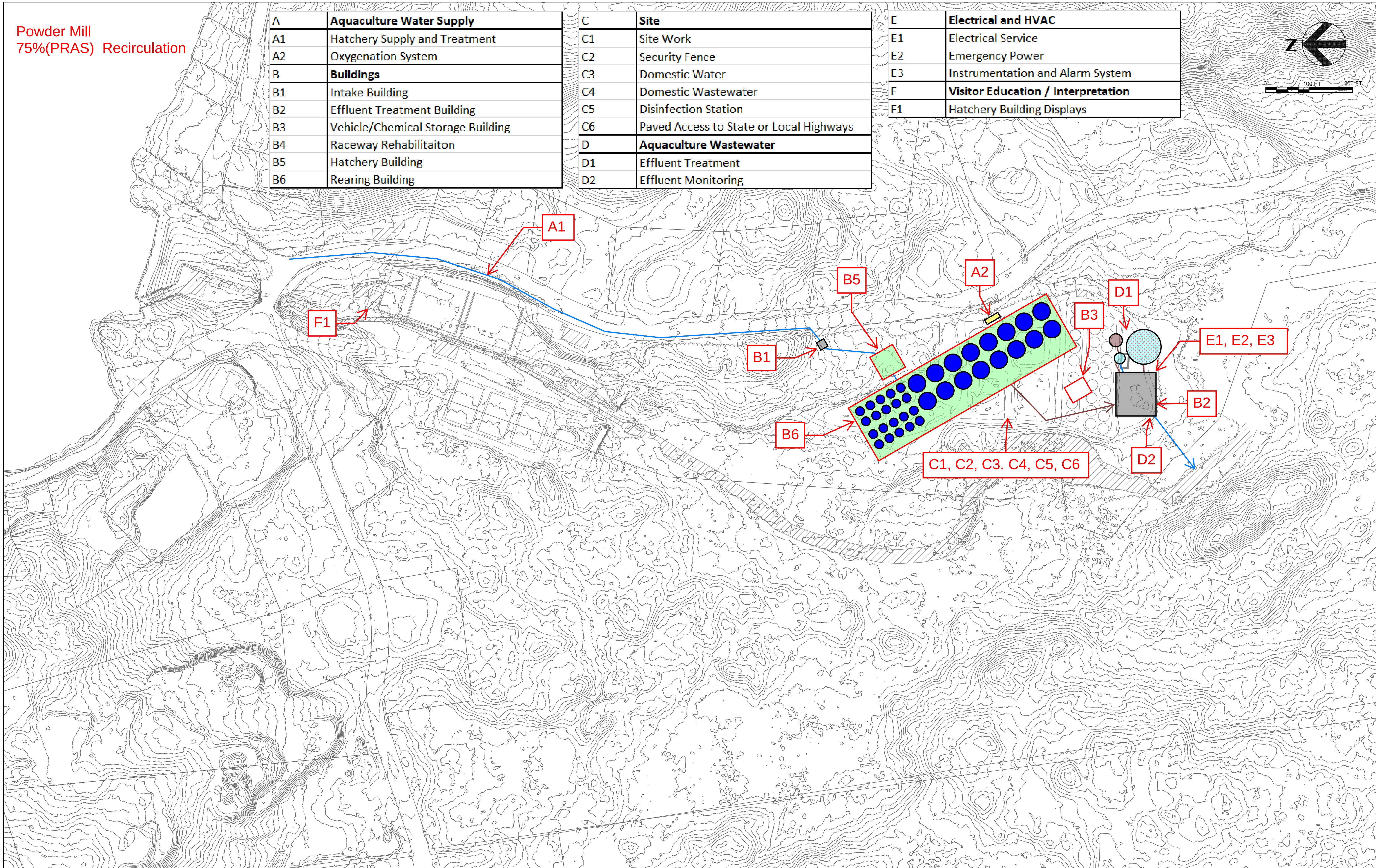


Powder Mill
75%(PRAS) Recirculation

A	**Aquaculture Water Supply**
A1	Hatchery Supply and Treatment
A2	Oxygenation System
B	**Buildings**
B1	Intake Building
B2	Effluent Treatment Building
B3	Vehicle/Chemical Storage Building
B4	Raceway Rehabilitaiton
B5	Hatchery Building
B6	Rearing Building

C	**Site**
C1	Site Work
C2	Security Fence
C3	Domestic Water
C4	Domestic Wastewater
C5	Disinfection Station
C6	Paved Access to State or Local Highways
D	**Aquaculture Wastewater**
D1	Effluent Treatment
D2	Effluent Monitoring

E	**Electrical and HVAC**
E1	Electrical Service
E2	Emergency Power
E3	Instrumentation and Alarm System
F	**Visitor Education / Interpretation**
F1	Hatchery Building Displays



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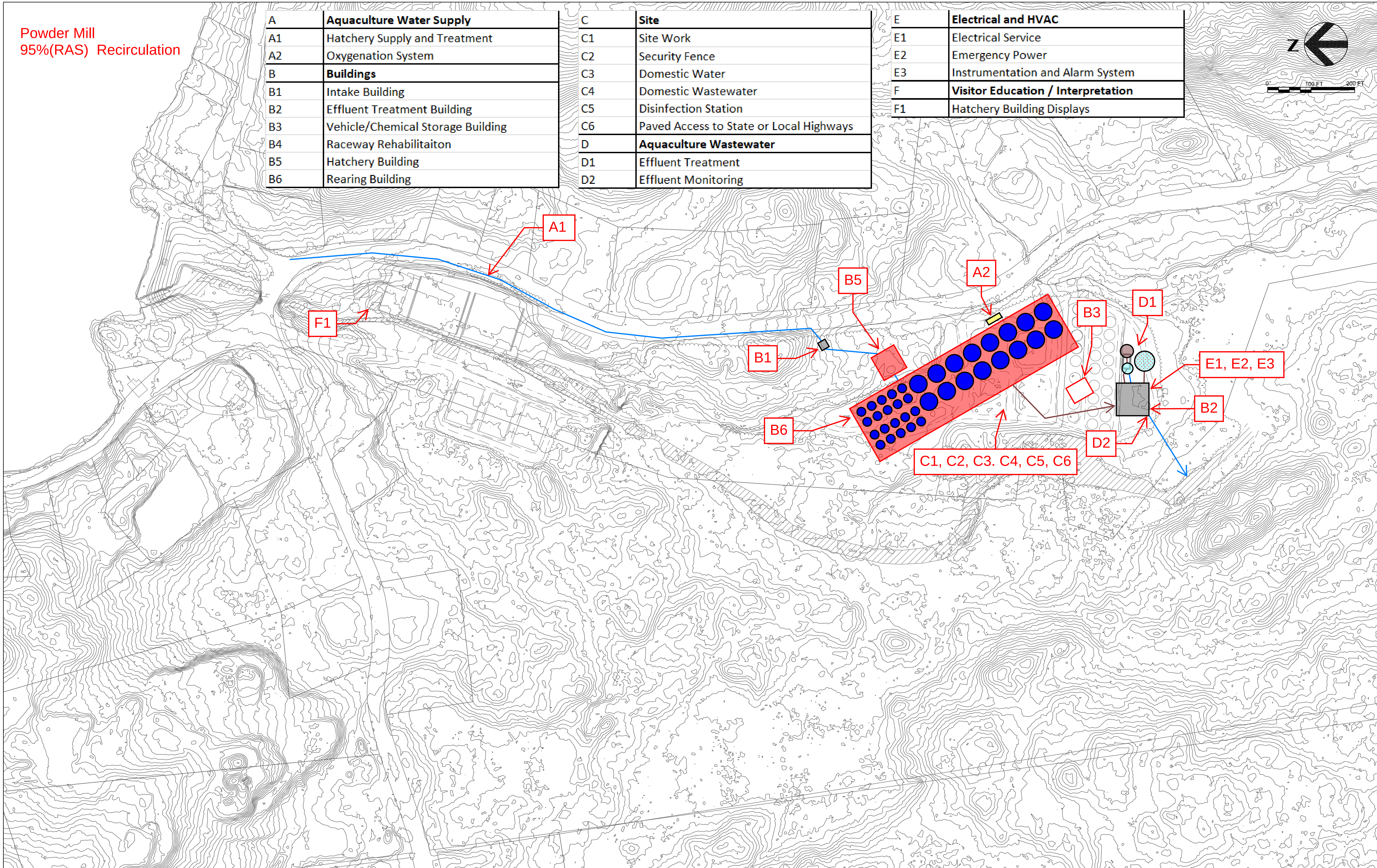
Powder Mill
95%(RAS) Recirculation

A	**Aquaculture Water Supply**
A1	Hatchery Supply and Treatment
A2	Oxygenation System
B	**Buildings**
B1	Intake Building
B2	Effluent Treatment Building
B3	Vehicle/Chemical Storage Building
B4	Raceway Rehabilitaiton
B5	Hatchery Building
B6	Rearing Building

C	**Site**
C1	Site Work
C2	Security Fence
C3	Domestic Water
C4	Domestic Wastewater
C5	Disinfection Station
C6	Paved Access to State or Local Highways
D	**Aquaculture Wastewater**
D1	Effluent Treatment
D2	Effluent Monitoring

E	**Electrical and HVAC**
E1	Electrical Service
E2	Emergency Power
E3	Instrumentation and Alarm System
F	**Visitor Education / Interpretation**
F1	Hatchery Building Displays



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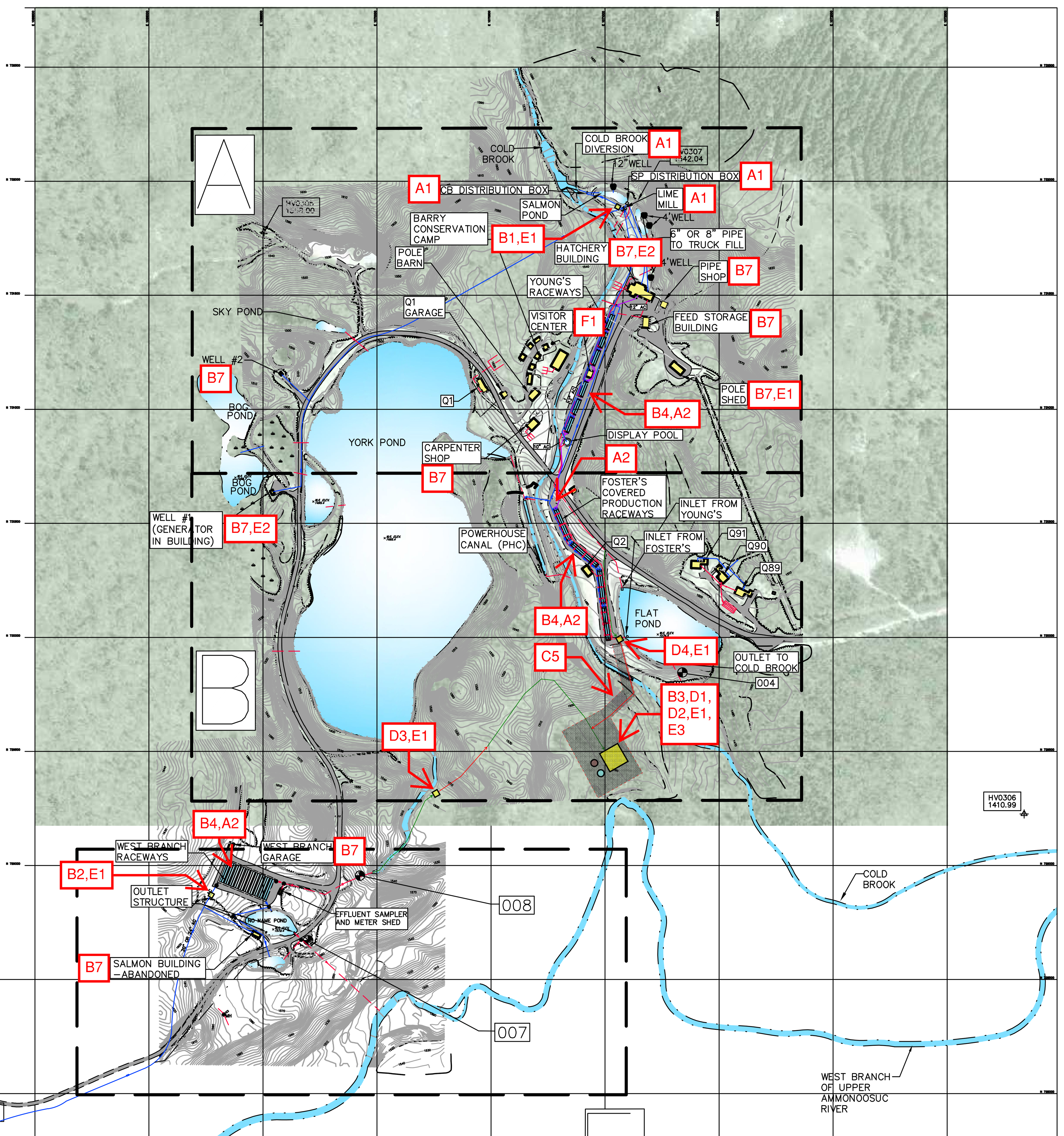
N

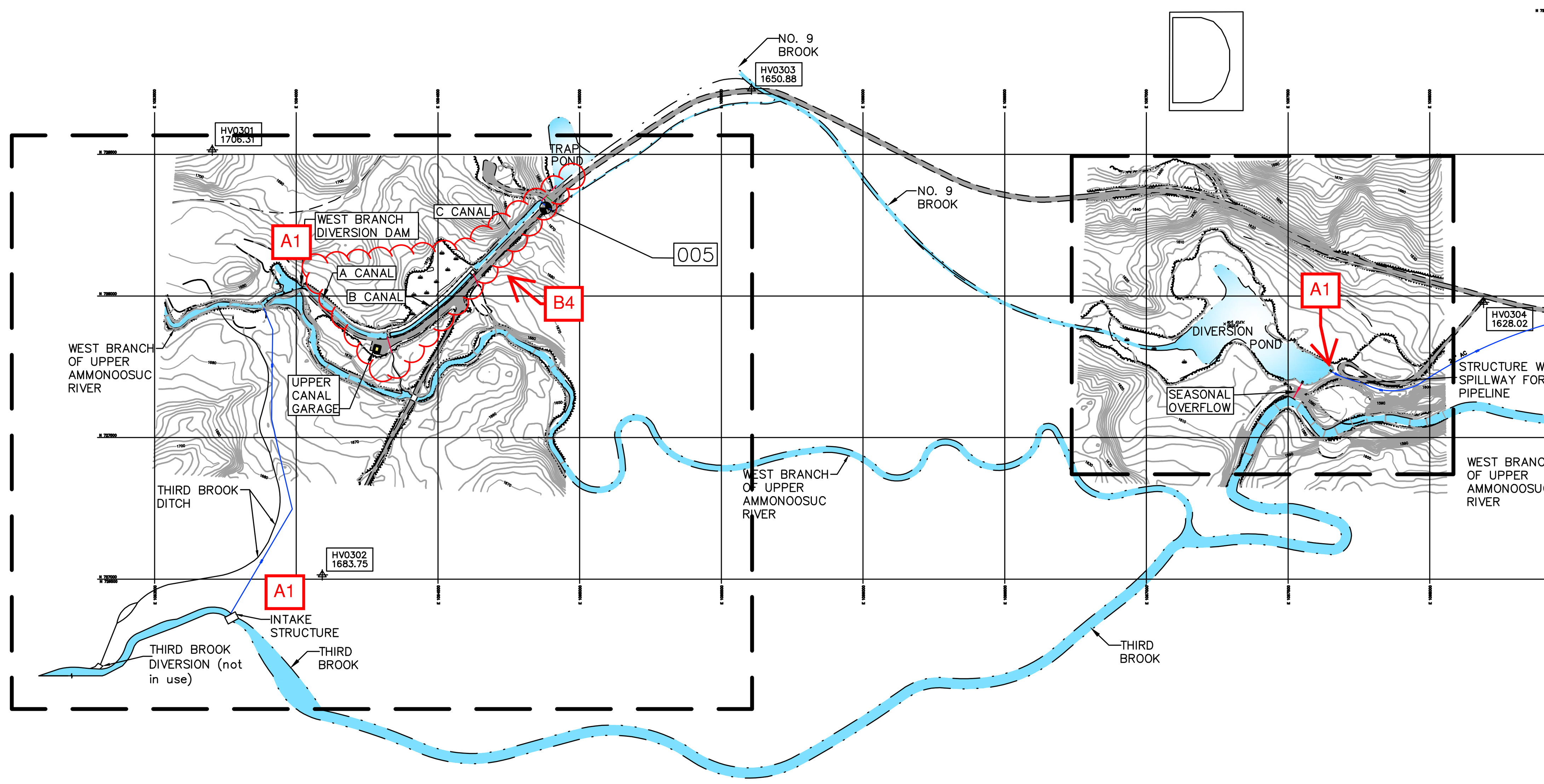
Berlin Alternative 1

A	**Aquaculture Water Supply**
A1	Hatchery Supply
A2	Oxygenation System
B	**Buildings**
B1	Cold Brook and Wells Intake Building
B2	West Branch Intake Building
B3	Effluent Treatment Building
B4	Raceways Rehabilitation
B5	Hatchery Building
B6	Rearing Building
B7	Existing Building Rehab
C	**Site**
C1	Site Work
C2	Domestic Water
C3	Domestic Wastewater
C4	Disinfection Station
C5	Paved Access to State or Local Highways
D	**Aquaculture Wastewater**
D1	Effluent Treatment
D2	Effluent Monitoring
D3	West Branch Pumping
D4	Young's and Foster's Pumping
E	**Electrical**
E1	Electrical Service
E2	Emergency Power
E3	Instrumentation and Alarm System
F	**Visitor Education / Interpretation**
F1	Visitor Center Repairs

LEGEND

- PROPERTY LINE
- FENCE
- WS — WATER SUPPLY
- D — DRAIN
- LPA — LOW PRESSURE AIR
- E — ELECTRICAL
- DISCHARGE LOCATIONS
- MANHOLE
- SURFACE WATER/EXISTING REARING UNIT
- BUILDINGS / STRUCTURES
- COVERED REARING UNIT
- ROADWAY





PROJECT MANAGER	R. ELWOOD
PROJECT NUMBER	10331124

ISSUE	DATE	DESCRIPTION
-	-	-

HDR

FISH GAME

POWDER MILL FISH HATCHERY FEASIBILITY STUDY

BERLIN OVERALL SITE MAP

0 380' 760'
380'-0"

FILENAME BERLIN-SITE PLAN.DWG

SCALE 1"=380'

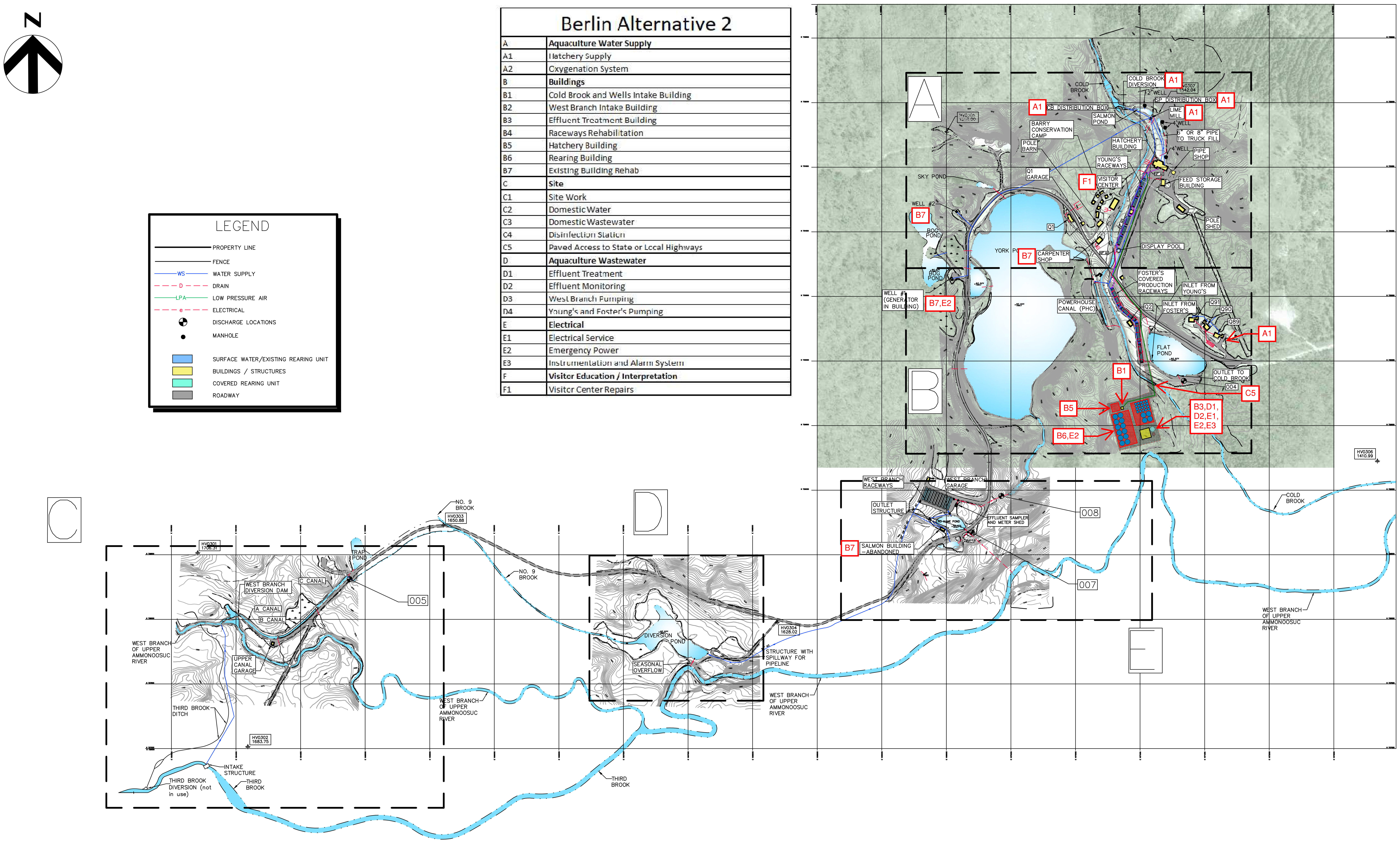
SHEET **SITE PLAN**

Berlin Alternative 2

A	**Aquaculture Water Supply**
A1	Hatchery Supply
A2	Oxygenation System
B	**Buildings**
B1	Cold Brook and Wells Intake Building
B2	West Branch Intake Building
B3	Effluent Treatment Building
B4	Raceways Rehabilitation
B5	Hatchery Building
B6	Rearing Building
B7	Existing Building Rehab
C	**Site**
C1	Site Work
C2	Domestic Water
C3	Domestic Wastewater
C4	Disinfection Station
C5	Paved Access to State or Local Highways
D	**Aquaculture Wastewater**
D1	Effluent Treatment
D2	Effluent Monitoring
D3	West Branch Pumping
D4	Young's and Foster's Pumping
E	**Electrical**
E1	Electrical Service
E2	Emergency Power
E3	Instrumentation and Alarm System
F	**Visitor Education / Interpretation**
F1	Visitor Center Repairs

LEGEND

- PROPERTY LINE
- FENCE
- WS — WATER SUPPLY
- D — DRAIN
- LPA — LOW PRESSURE AIR
- E — ELECTRICAL
- DISCHARGE LOCATIONS
- MANHOLE
- SURFACE WATER/EXISTING REARING UNIT
- BUILDINGS / STRUCTURES
- COVERED REARING UNIT
- ROADWAY



HDR

PROJECT MANAGER R. ELWOOD

ISSUE	DATE	DESCRIPTION
-	-	-

PROJECT NUMBER 10331124

POWDER MILL FISH HATCHERY FEASIBILITY STUDY

BERLIN OVERALL SITE MAP

0 380' 760' — 380'-0"

FILENAME BERLIN-SITE PLAN.DWG

SCALE 1"=380'

SHEET **SITE PLAN**

PROJECT MANAGER R. ELWOOD

ISSUE	DATE	DESCRIPTION
-	-	-

PROJECT NUMBER 10331124

POWDER MILL FISH HATCHERY FEASIBILITY STUDY

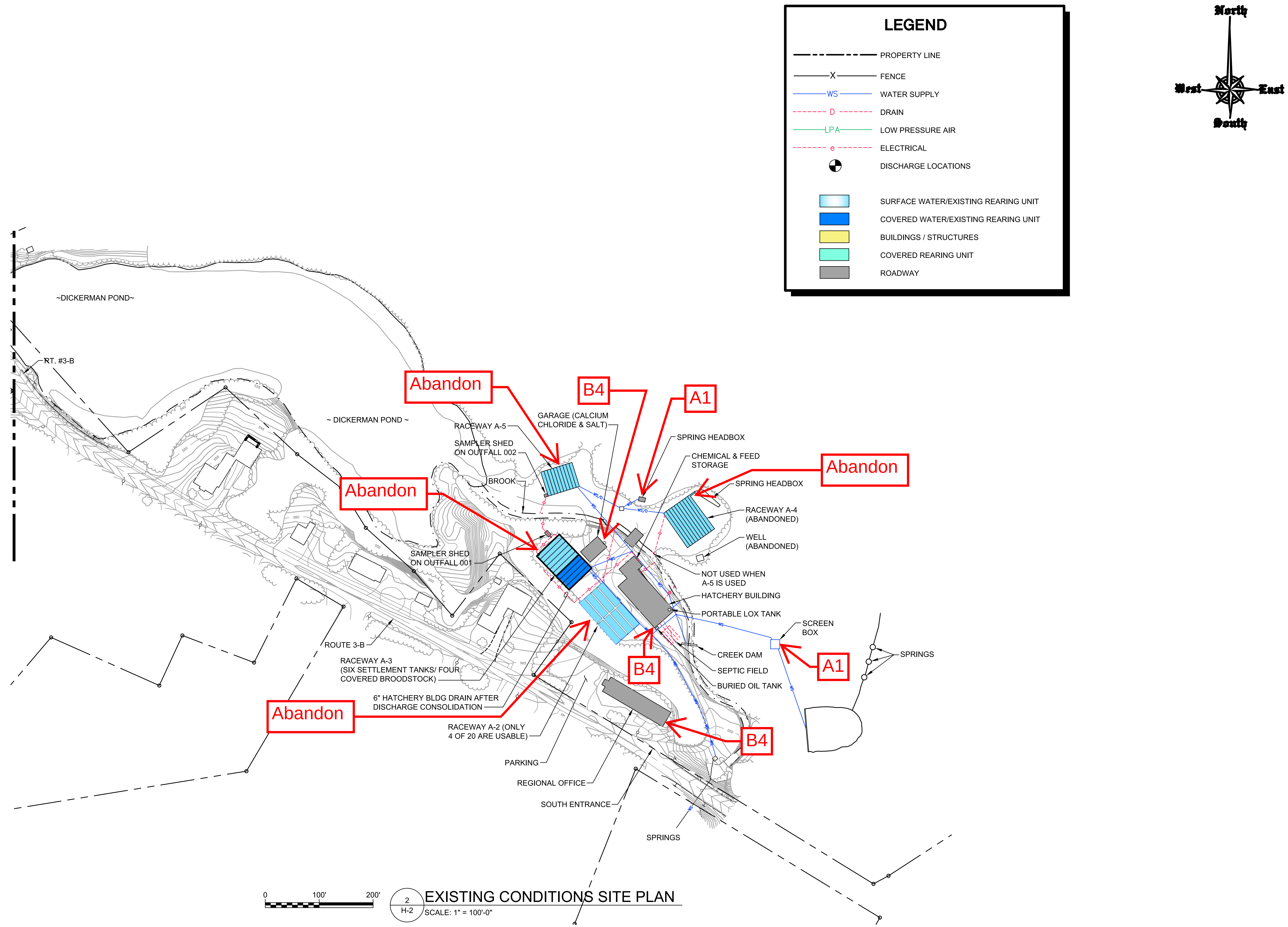
NEW HAMPTON EXISTING CONDITIONS SITE PLAN

0 300' 600'

FILENAME H-1.DWG

SCALE NTS

SHEET H-1



2 H-2 EXISTING CONDITIONS SITE PLAN
SCALE: 1" = 100'-0"

HDR

PROJECT MANAGER R. ELWOOD

ISSUE	DATE	DESCRIPTION
-	-	-

PROJECT NUMBER 10331124

FISH GAME

POWDER MILL FISH HATCHERY
FEASIBILITY STUDY

NEW HAMPTON
EXISTING CONDITIONS
SITE PLAN

0 300' 600'

FILENAME H-2.DWG

SCALE NTS

SHEET H-2

HDR

ISSUE	DATE	DESCRIPTION

PROJECT MANAGER R. ELWOOD

PROJECT NUMBER 10331124

POWDER MILL FISH HATCHERY
FEASIBILITY STUDY

MILFORD
EXISTING CONDITIONS
SITE PLAN

FILENAME M-1.DWG
SCALE 1" = 60'
SHEET M-1

PROJECT MANAGER	R. ELWOOD
PROJECT NUMBER	10331124

ISSUE	DATE	DESCRIPTION
-	-	-

POWDER MILL FISH HATCHERY FEASIBILITY STUDY

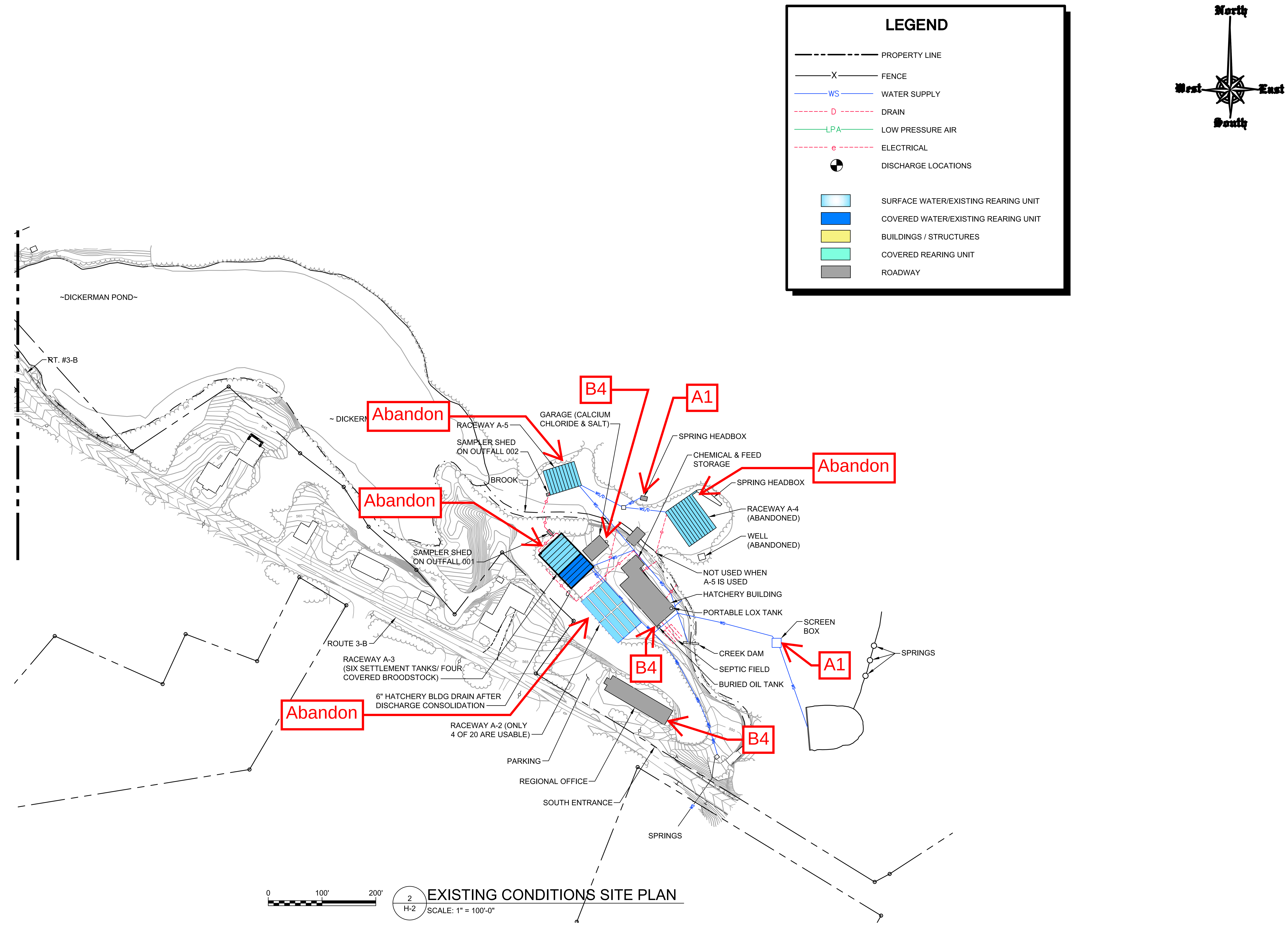
NEW HAMPTON EXISTING CONDITIONS SITE PLAN

0 300' 600'

FILENAME H-1.DWG

SCALE NTS

SHEET H-1



2 H-2 EXISTING CONDITIONS SITE PLAN
SCALE: 1" = 100'-0"

HDR

PROJECT MANAGER R. ELWOOD

ISSUE	DATE	DESCRIPTION
-	-	-

PROJECT NUMBER 10331124

POWDER MILL FISH HATCHERY
FEASIBILITY STUDY

NEW HAMPTON
EXISTING CONDITIONS
SITE PLAN

0 300' 600'

FILENAME H-2.DWG
SCALE NTS
SHEET H-2

Appendix C
Process Calculations

Circular Tank Calculations

Feed Training Tanks when in use are usually on flow thru first-use water only

REARING UNIT DATA

Tank Data										Hourly Exchange Rate		
	Radius	Dia.	Depth	cuft	gallons	# Units	Total cuft	R=	R=1	R=1.3	R=2	R=3
6' dia. Circular TKS	3	6	4	113.097	846	20	2,262	gpm@	14	19	28	42
Usable Vol	3	6	3	84.823	634	20	1,696	gpm@	11	16	21.1	32
			CM=	2.40292				gpmTot.	211	317	423	634

REARING UNIT DATA

Tank Data										Hourly Exchange Rate		
	Radius	Dia.	Depth	cuft	gallons	# Units	Total cuft	R=	R=1	R=1.3	R=2	R=3
20 ' dia. Circular TKS	10	20	4	1256.6	9,400	20	25,133	gpm@	157	209	313	470
Usable Vol	10	20	3	942.5	7,050	20	18,850	gpm@	117	176	235.0	352
			CM=	26.7				gpmTot.	2,350	3,525	4,700	7,050

REARING UNIT DATA

Tank Data										Hourly Exchange Rate		
	Radius	Dia.	Depth	cuft	gallons	# Units	Total cuft	R=	R=1	R=1.3	R=2	R=3
40 ' dia. Circular TKS	20	40	4	5026.55	37,599	16	80,425	gpm@	627	836	1,253	1,880
Usable Vol	20	40	3	3769.91	28,199	16	60,319	gpm@	470	627	940	1,410
			CM=	106.796				gpmTot.	7,520	10,026	15,039	22,559

Theoretical Carring Capacity DATA

	D	D	D	D
	lbs /CF	lbs /CF	lbs /CF	lbs /CF
Density lbs/CF	2	3	4	5
PER unit LBS=	170	254	339	424
Total Lbs	3,393	5,089	6,786	8,482
Loading LBS/GPM	10.7	16.0	21.4	26.7

Theoretical Carring Capacity DATA

	D	D	D	D
	lbs /CF	lbs /CF	lbs /CF	lbs /CF
Density lbs/CF	2	3	4	5
PER unit LBS=	1,885	2,827	3,770	4,712
Total Lbs	37,699	56,549	75,398	94,248
Loading LBS/GPM	10.7	16.0	21.4	26.7

Theoretical Carring Capacity DATA

	D	D	D	D
	lbs /CF	lbs /CF	lbs /CF	lbs /CF
Density lbs/CF	2	3	4	5
PER unit LBS=	7,540	11,310	15,080	18,850
Total Lbs	120,637	180,956	241,274	301,593
Loading LBS/GPM	12.0	18.0	24.1	30.1

			gpm
			13,551
95% recirc.	0.95		12,874
5% makeup	0.05		678
75% recirc.		0.75	10,163
25% makeup		0.25	3,388

Bio Programming to determine P Load

Option: 10% treatment efficiency, 75% recirc

Inputs and Constants

Total Phos	Parameter	
0.75	Recirculation Rate (R)	Enter facility recirculation rate
0.10	Enter treatment removal efficiency	Enter treatment removal efficiency
3464.00	gpm Flow Rate	Enter total flow rate
0.01	mg/L Background TP ($waste_{new}$)	Enter known TP in background
482.00	lb/day Daily Feed Rate	Enter daily feed in pounds
0.005	kg TP per kg feed	Enter kg TP produced per kg fed
218.63	kg/day Daily Feed Rate	Calculated
1.09	kg/day TP Generated (r_{waste})	Calculated
1093156.72	mg/day TP Generated	Calculated
2598	gpm Q recirc	Calculated gpm recirculated
866.00	gpm Q makeup	Calculated makeup

0.19	**mg/L ($waste_{out}$)**	Calculated TP discharge

Date Entry Cell
No Data Entry Cell
Result Cell

Option: 10% treatment efficiency, 95% recirc

Inputs and Constants		
Total Phos	Parameter	
0.95	Recirculation Rate (R)	Enter facility recirculation rate
0.10	Enter treatment removal efficiency	Enter treatment removal efficiency
3464.00	gpm Flow Rate	Enter total flow rate
0.01	mg/L Background TP ($waste_{new}$)	Enter known TP in background
482.00	lb/day Daily Feed Rate	Enter daily feed in pounds
0.005	kg TP per kg feed	Enter kg TP produced per kg fed
218.63	kg/day Daily Feed Rate	Calculated
1.09	kg/day TP Generated (r_{waste})	Calculated
1093156.72	mg/day TP Generated	Calculated
3290.8	gpm Q recirc	Calculated gpm recirculated
173.20	gpm Q makeup	Calculated makeup
0.40	**mg/L ($waste_{out}$)**	Calculated TP discharge

Date Entry Cell
No Data Entry Cell
Result Cell

Chemical usage and costing calculations

Coagulation gal/year chemical usage (4 months of operation from HDR modelling)			
	Alt 1	Alt 2	Alt 3
~~Ferric~~	~~*9977*~~	~~*23117*~~	~~*9855*~~
~~25% Caustic w Ferric~~	~~*13383*~~	~~*31268*~~	~~*13383*~~
Alum	12045	7908	8395
25% Caustic w Alum	10098	6570	6935

Membrane Clean gal/year chemical usage (From Membrane Proposal)			
	Alt 1	Alt 2	Alt 3
Sulfuric			
Hypo	18300	18300	6900
Citric	38500	38500	14500
Sodium Bisulfate	4400	4400	1700

	lbs/gal from supplier	$/lb from supplier	$/gal
Ferric	11.74	$ 0.26	$ 3.05
25% Caustic w Ferric	10.66	$ 0.18	$ 1.92
Alum	11.34	$ 0.16	$ 1.81
25% Caustic w Alum	10.66	$ 0.18	$ 1.92
Sulfuric	15.3	$ 0.16	$ 2.45
Hypo	10.1		***$ 2.50***
Citric	***10.35***	$ 0.80	$ 8.28
Sodium Bisulfate	11.34	$ 0.30	$ 3.40

Density from a SDS

Cost reported in $/gal from supplier

Annual Coagulation Chemical Costs			
	Alt 1 A	Alt 2 A	Alt 3 A
~~Ferric~~	~~*$ 30,452.78*~~	~~*$ 70,561.31*~~	~~*$ 30,081.40*~~
~~25% Caustic w Ferric~~	~~*$ 25,679.94*~~	~~*$ 59,997.68*~~	~~*$ 25,679.94*~~
Alum	$ 21,854.45	$ 14,348.88	$ 15,231.89
25%Caustic w Alum	$ 19,376.68	$ 12,606.52	$ 13,306.88
Coagulation totals	$ 41,231.13	$ 26,955.40	$ 28,538.77

Alum costs included in report because costs were lower

Annual Membrane Clean Chemical Costs			
	Alt 1 A & B	Alt 2 A & B	Alt 3 A & B
Sulfuric	$ -	$ -	$ -
Hypo	$ 45,750.00	$ 45,750.00	$ 17,250.00
Citric	$ 318,780.00	$ 318,780.00	$ 120,060.00
Sodium Bisulfate	$ 14,968.80	$ 14,968.80	$ 5,783.40
Mebrane Clean Totals	$ 379,498.80	$ 379,498.80	$ 143,093.40

Mix and React tank optimization and costing calculations

AVG Existing (GPM)		3745	Mixing tank volume in ft3			15019.04953			Alternative 1A No Recirculation			
Inner Radius (ft)	Outer Radius ft	Inner Diameter ft	Sidewall depth ft	Tank cubic yards		Tank Cost	Excavation yd		Excavation Cost		Tank+Excavation Cost	
10	12	20	49.8	288.5	$	432,756.65	32610.4	$	1,630,518.33	$	2,063,274.98	
10.5	12.5	21	45.4	279.2	$	418,734.70	25231.9	$	1,261,596.62	$	1,680,331.32	
11	13	22	41.5	271.2	$	406,745.56	19852.3	$	992,615.58	$	1,399,361.14	
11.5	13.5	23	38.1	264.4	$	396,530.45	15864.6	$	793,231.96	$	1,189,762.42	
12	14	24	35.2	258.6	$	387,876.35	12863.5	$	643,174.22	$	1,031,050.57	
12.5	14.5	25	32.6	253.7	$	380,606.32	10572.9	$	528,644.30	$	909,250.63	
13	15	26	30.3	249.7	$	374,572.23	8801.8	$	440,087.96	$	814,660.19	
13.5	15.5	27	28.2	246.4	$	369,649.08	7415.7	$	370,784.02	$	740,433.10	
14	16	28	26.4	243.8	$	365,730.73	6318.7	$	315,934.54	$	681,665.27	
14.5	16.5	29	24.7	241.8	$	362,726.44	5441.4	$	272,067.58	$	634,794.03	
15	17	30	23.2	240.4	$	360,558.21	4732.8	$	236,638.73	$	597,196.94	
15.5	17.5	31	21.9	239.4	$	359,158.58	4155.2	$	207,761.08	$	566,919.67	
16	18	32	20.7	239.0	$	358,468.98	3680.4	$	184,019.74	$	542,488.72	
16.5	18.5	33	19.6	239.0	$	358,438.23	3286.9	$	164,342.67	$	522,780.91	
17	19	34	18.5	239.3	$	359,021.50	2958.2	$	147,909.60	$	506,931.10	
17.5	19.5	35	17.6	240.1	$	360,179.29	2681.7	$	134,087.08	$	494,266.38	
18	20	36	16.8	241.3	$	361,876.70	2447.6	$	122,381.68	$	484,258.38	
18.5	20.5	37	16.0	242.7	$	364,082.75	2248.1	$	112,405.83	$	476,488.58	
19	21	38	15.2	244.5	$	366,769.89	2077.1	$	103,852.73	$	470,622.62	
19.5	21.5	39	14.6	246.6	$	369,913.48	1929.6	$	96,477.74	$	466,391.22	
20	22	40	14.0	249.0	$	373,491.48	1801.7	$	90,084.35	$	463,575.83	
20.5	22.5	41	13.4	251.7	$	377,484.06	1690.3	$	84,513.72	$	461,997.78	
21	23	42	12.8	254.6	$	381,873.37	1592.7	$	79,636.60	$	461,509.97	Min Total Cost
21.5	23.5	43	12.3	257.8	$	386,643.27	1506.9	$	75,347.18	$	461,990.45	
22	24	44	11.9	261.2	$	391,779.16	1431.2	$	71,558.34	$	463,337.50	
22.5	24.5	45	11.4	264.8	$	397,267.78	1364.0	$	68,197.96	$	465,465.73	
23	25	46	11.0	268.7	$	403,097.05	1304.1	$	65,206.00	$	468,303.05	
23.5	25.5	47	10.7	272.8	$	409,255.99	1250.6	$	62,532.25	$	471,788.24	
24	26	48	10.3	277.2	$	415,734.53	1202.7	$	60,134.51	$	475,869.04	
24.5	26.5	49	10.0	281.7	$	422,523.47	1159.5	$	57,977.12	$	480,500.59	
25	27	50	9.6	286.4	$	429,614.38	1120.6	$	56,029.85	$	485,644.23	

75% recirc Flow (GPM)		3566.3	Mixing tank volume ft3		14302.3862			Alternative 2A 75% recirc		
Inner Radius (ft)	Outer Radius ft	Inner Diameter ft	Sidewall Depth ft	Tank cubic yards	Tank Cost		Excavation yd	Excavation Cost	Tank+Excavation Cost	
10	12	20	47.5	276.8	$	415,238.21	28508.6	$ 1,425,430.52	$ 1,840,668.73	
10.5	12.5	21	43.3	268.1	$	402,122.70	22096.2	$ 1,104,809.26	$ 1,506,931.97	
11	13	22	39.6	260.6	$	390,951.33	17417.2	$ 870,857.97	$ 1,261,809.30	
11.5	13.5	23	36.4	254.3	$	381,477.66	13945.9	$ 697,294.63	$ 1,078,772.30	
12	14	24	33.6	249.0	$	373,498.85	11331.1	$ 566,554.33	$ 940,053.18	
12.5	14.5	25	31.1	244.6	$	366,846.39	9333.5	$ 466,676.53	$ 833,522.91	
13	15	26	28.9	240.9	$	361,379.21	7787.5	$ 389,375.80	$ 750,755.02	
13.5	15.5	27	27.0	238.0	$	356,978.30	6576.4	$ 328,820.96	$ 685,799.26	
14	16	28	25.2	235.7	$	353,542.58	5616.9	$ 280,847.37	$ 634,389.95	
14.5	16.5	29	23.7	234.0	$	350,985.62	4848.8	$ 242,439.92	$ 593,425.54	
15	17	30	22.2	232.8	$	349,233.16	4227.8	$ 211,387.77	$ 560,620.93	
15.5	17.5	31	20.9	232.1	$	348,220.95	3721.0	$ 186,050.54	$ 534,271.50	
16	18	32	19.8	231.9	$	347,893.22	3303.9	$ 165,197.49	$ 513,090.70	
16.5	18.5	33	18.7	232.1	$	348,201.23	2957.9	$ 147,895.53	$ 496,096.76	
17	19	34	17.8	232.7	$	349,102.29	2668.6	$ 133,430.31	$ 482,532.59	
17.5	19.5	35	16.9	233.7	$	350,558.78	2425.0	$ 121,249.82	$ 471,808.60	
18	20	36	16.1	235.0	$	352,537.47	2218.5	$ 110,923.79	$ 463,461.25	
18.5	20.5	37	15.3	236.7	$	355,008.86	2042.3	$ 102,114.03	$ 457,122.88	
19	21	38	14.6	238.6	$	357,946.70	1891.1	$ 94,552.66	$ 452,499.37	
19.5	21.5	39	14.0	240.9	$	361,327.55	1760.5	$ 88,025.92	$ 449,353.48	
20	22	40	13.4	243.4	$	365,130.41	1647.2	$ 82,362.01	$ 447,492.41	
20.5	22.5	41	12.8	246.2	$	369,336.39	1548.4	$ 77,421.92	$ 446,758.31	Min Total Cost
21	23	42	12.3	249.3	$	373,928.50	1461.8	$ 73,092.48	$ 447,020.98	
21.5	23.5	43	11.8	252.6	$	378,891.37	1385.6	$ 69,280.98	$ 448,172.35	
22	24	44	11.4	256.1	$	384,211.09	1318.2	$ 65,911.02	$ 450,122.11	
22.5	24.5	45	11.0	259.9	$	389,875.04	1258.4	$ 62,919.32	$ 452,794.36	
23	25	46	10.6	263.9	$	395,871.72	1205.1	$ 60,253.16	$ 456,124.88	
23.5	25.5	47	10.2	268.1	$	402,190.65	1157.4	$ 57,868.40	$ 460,059.05	
24	26	48	9.9	272.5	$	408,822.27	1114.6	$ 55,727.92	$ 464,550.19	
24.5	26.5	49	9.6	277.2	$	415,757.81	1076.0	$ 53,800.36	$ 469,558.16	
25	27	50	9.3	282.0	$	422,989.22	1041.2	$ 52,059.07	$ 475,048.29	

95% recirc Flow gpm	713.3	Mixing tank volume ft3	2860.637658			Alternative 3A		
Inner Radius (ft)	Outer Radius ft	Inner Diameter ft	Sidewall Depth ft	Tank cubic yards	Tank Cost	Excavation yd	Excavation Cost	Tank+Excavation Cost
10	12	20	11.1	90.4	$ 135,551.02	559.8	$ 27,989.98	$ 163,541.00
10.5	12.5	21	10.3	91.3	$ 136,907.07	479.7	$ 23,984.25	$ 160,891.31
11	13	22	9.5	92.5	$ 138,791.58	418.5	$ 20,923.81	$ 159,715.40
11.5	13.5	23	8.9	94.1	$ 141,155.28	370.9	$ 18,544.71	$ 159,699.99 Min Total Cost
12	14	24	8.3	96.0	$ 143,957.59	333.3	$ 16,665.94	$ 160,623.53
12.5	14.5	25	7.8	98.1	$ 147,164.82	303.2	$ 15,160.95	$ 162,325.76
13	15	26	7.4	100.5	$ 150,748.73	278.8	$ 13,939.59	$ 164,688.32
13.5	15.5	27	7.0	103.1	$ 154,685.54	258.7	$ 12,936.59	$ 167,622.13
14	16	28	6.6	106.0	$ 158,955.02	242.1	$ 12,103.95	$ 171,058.96
14.5	16.5	29	6.3	109.0	$ 163,539.88	228.1	$ 11,405.83	$ 174,945.71
15	17	30	6.0	112.3	$ 168,425.28	216.3	$ 10,815.17	$ 179,240.45
15.5	17.5	31	5.8	115.7	$ 173,598.36	206.2	$ 10,311.24	$ 183,909.60
16	18	32	5.6	119.4	$ 179,047.97	197.6	$ 9,877.98	$ 188,925.95
16.5	18.5	33	5.3	123.2	$ 184,764.36	190.1	$ 9,502.84	$ 194,267.19
17	19	34	5.2	127.2	$ 190,738.99	183.5	$ 9,175.88	$ 199,914.87
17.5	19.5	35	5.0	131.3	$ 196,964.33	177.8	$ 8,889.20	$ 205,853.53
18	20	36	4.8	135.6	$ 203,433.75	172.7	$ 8,636.40	$ 212,070.15
18.5	20.5	37	4.7	140.1	$ 210,141.33	168.2	$ 8,412.33	$ 218,553.67
19	21	38	4.5	144.7	$ 217,081.84	164.3	$ 8,212.75	$ 225,294.59
19.5	21.5	39	4.4	149.5	$ 224,250.58	160.7	$ 8,034.18	$ 232,284.76
20	22	40	4.3	154.4	$ 231,643.34	157.5	$ 7,873.73	$ 239,517.07
20.5	22.5	41	4.2	159.5	$ 239,256.36	154.6	$ 7,728.99	$ 246,985.35
21	23	42	4.1	164.7	$ 247,086.24	152.0	$ 7,597.94	$ 254,684.17
21.5	23.5	43	4.0	170.1	$ 255,129.89	149.6	$ 7,478.86	$ 262,608.75
22	24	44	3.9	175.6	$ 263,384.55	147.4	$ 7,370.32	$ 270,754.86
22.5	24.5	45	3.8	181.2	$ 271,847.67	145.4	$ 7,271.06	$ 279,118.74
23	25	46	3.7	187.0	$ 280,516.97	143.6	$ 7,180.04	$ 287,697.02
23.5	25.5	47	3.6	192.9	$ 289,390.35	141.9	$ 7,096.35	$ 296,486.70
24	26	48	3.6	199.0	$ 298,465.90	140.4	$ 7,019.18	$ 305,485.08
24.5	26.5	49	3.5	205.2	$ 307,741.85	139.0	$ 6,947.86	$ 314,689.71
25	27	50	3.5	211.5	$ 317,216.61	137.6	$ 6,881.79	$ 324,098.40

Mix/React tank constants and costing

1500	$/cy reinforced concrete tank
50	$/cy for excavation
2	ft wall thickness
1	ft over excavation
3	water 3 feet above grade.
2	ft freeboard
5	ft of tank above ground
2	2-1 excavation (1 foot down 2 foot out)
30	min of HRT
3.14159	pi

Media Costs and Vessel Requirements

Design Parameters		Influent s-phosphorus 0.02 average – 0.1 max mg/L		Influent s-phosphorus 0.08 average – 0.4 max mg/L		Influent s-phosphorus 0.1 average – 0.5 max mg/L	
Flow Rate	MGD	5.4	6.5	4.9	5.9	0.98	1.2
Flow Rate	gpm	3,750	4,514	3,403	4,097	681	833
Number of Vessels		4	4	3	3	1	1
Redundant Vessels (HDR)		*2*	*2*	*2*	*2*	*1*	*1*
Vessel Diameter	feet	12	12	12	12	10	10
Flow per Vessel	gpm	938	1128	1134	1366	681	833
Media Volume per vessel	ft3	420	420	420	420	336	336
Media Volume total onsite	ft3	3360	3360	2520	2520	672	672
Vessel Area	ft2	113	113	113	113	79	79
Bed Depth	feet	3.7	3.7	3.7	3.7	4.3	4.3
Linear Velocity:	gpm/ft2	8.3	10	10	12.1	8.7	10.6
Specific Flowrate	gpm/ft3	2.2	2.7	2.7	3.3	2	2.5
Empty Bed Contact Time	minutes	3.4	2.8	2.8	2.3	3.7	3
Projected throughput	BV	300,000	300,000	183,000	183,000	163,000	163,000
Days between exchanges	days	698	580	352	292	418	341

Based on recent pricing of other projects each vessel is estimated at $250,000 (HDR)

Budgetary cost of Vessels (HDR)	*$ 250,000.00*		***$ 1,500,000.00***		***$ 1,250,000.00***		***$ 500,000.00***
Budgetary cost of Ferrix A33E per cu ft	$500						
Cost of initial fill (Media Capital Cost)		$1,680,000	**$1,680,000**	$1,260,000	**$1,260,000**	$336,000	**$336,000**
Budgetary Cost of RAM300 per cu ft	$250						
cost per regen		$420,000	$420,000	$315,000	$315,000	$84,000	$84,000
yearly use factor: days use/year		0.52	0.63	1.04	1.25	0.87	1.07
Esimatated cost per year assuming 24/7 operation based on regeneration costs		$219,585.56	$264,315.95	$326,645.19	$393,307.47	$73,344.87	$89,810.05
Assuming 4 months operation (Media Replacement O&M, HDR)			***$88,105.32***		***$131,102.49***		***$29,936.68***

Circular Tank Calculations

Feed Training Tanks when in use are usually on flow thru first-use water only

REARING UNIT DATA

Tank Data										Hourly Exchange Rate		
	Radius	Dia.	Depth	cuft	gallons	# Units	Total cuft	R=	R=1	R=1.3	R=2	R=3
6' dia. Circular TKS	3	6	4	113.097	846	20	2,262	gpm@	14	19	28	42
Usable Vol	3	6	3	84.823	634	20	1,696	gpm@	11	16	21.1	32
			CM=	2.40292				gpmTot.	211	317	423	634

REARING UNIT DATA

Tank Data										Hourly Exchange Rate		
	Radius	Dia.	Depth	cuft	gallons	# Units	Total cuft	R=	R=1	R=1.3	R=2	R=3
20 ' dia. Circular TKS	10	20	4	1256.6	9,400	20	25,133	gpm@	157	209	313	470
Usable Vol	10	20	3	942.5	7,050	20	18,850	gpm@	117	176	235.0	352
			CM=	26.7				gpmTot.	2,350	3,525	4,700	7,050

REARING UNIT DATA

Tank Data										Hourly Exchange Rate		
	Radius	Dia.	Depth	cuft	gallons	# Units	Total cuft	R=	R=1	R=1.3	R=2	R=3
40 ' dia. Circular TKS	20	40	4	5026.55	37,599	16	80,425	gpm@	627	836	1,253	1,880
Usable Vol	20	40	3	3769.91	28,199	16	60,319	gpm@	470	627	940	1,410
			CM=	106.796				gpmTot.	7,520	10,026	15,039	22,559

Theoretical Carring Capacity DATA

	D	D	D	D
	lbs /CF	lbs /CF	lbs /CF	lbs /CF
Density lbs/CF	2	3	4	5
PER unit LBS=	170	254	339	424
Total Lbs	3,393	5,089	6,786	8,482
Loading LBS/GPM	10.7	16.0	21.4	26.7

Theoretical Carring Capacity DATA

	D	D	D	D
	lbs /CF	lbs /CF	lbs /CF	lbs /CF
Density lbs/CF	2	3	4	5
PER unit LBS=	1,885	2,827	3,770	4,712
Total Lbs	37,699	56,549	75,398	94,248
Loading LBS/GPM	10.7	16.0	21.4	26.7

Theoretical Carring Capacity DATA

	D	D	D	D
	lbs /CF	lbs /CF	lbs /CF	lbs /CF
Density lbs/CF	2	3	4	5
PER unit LBS=	7,540	11,310	15,080	18,850
Total Lbs	120,637	180,956	241,274	301,593
Loading LBS/GPM	12.0	18.0	24.1	30.1

			gpm
			13,551
95% recirc.	0.95		12,874
5% makeup	0.05		678
75% recirc.		0.75	10,163
25% makeup		0.25	3,388

Use this page to enter the required data for each month
White fields are required for the model, Yellow fields are optional

Year 2020	Feed (lbs)	Flow (gpm)	Weight Gain (lbs)	Biomass (lbs)	Total Fish (number)
Jan	2,154	2570			
Feb	2,318	2099			
Mar	3,418	2120			
Apr	3,800	2992			
May	3,805	3044			
Jun	4,957	2663			
Jul	7,404	1467			
Aug	9,309	2882			
Sep	10,538	3122			
Oct	6,161	3570			
Nov	1,951	2724			
Dec	2,026	2623			

	Feed			Flow		
	Y&F	West	Tot	Y&F	West	Tot
Jan	1530	624	2154	756	1814	2570
Feb	1646	672	2318	551	1548	2099
Mar	2661	757	3418	454	1666	2120
Apr	2490	1310	3800	747	2245	2992
May	2547	1258	3805	891	2153	3044
Jun	4564	393	4957	1041	1622	2663
Jul	7404		7404	1467		1467
Aug	8658	651	9309	1312	1570	2882
Sep	8692	1846	10538	1384	1738	3122
Oct	3303	2858	6161	1694	1876	3570
Nov	1091	860	1951	796	1928	2724
Dec	1450	576	2026	696	1927	2623
Average				982	1826	2809

* This model estimates the monthly average concentration based on fish feeding data only

Wastewater Generation Model

Blue cells are from Inputs sheet
Red cells are for calculated values

2020	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Days in Period	**31**	**28**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**
English												
Average Flow (gpm)	**2,570**	**2,099**	**2,120**	**2,992**	**3,044**	**2,663**	**1,467**	**2,882**	**3,122**	**3,570**	**2,724**	**2,623**
Number of fish at end of period												
Pounds of fish at End of Period												
Weight Gain (Pounds)												
Lbs of feed	**2,154**	**2,318**	**3,418**	**3,800**	**3,805**	**4,957**	**7,404**	**9,309**	**10,538**	**6,161**	**1,951**	**2,026**
Feed Conversion	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**
Metric												
Total Liters	**3.E+08**	**2.E+08**	**2.E+08**	**3.E+08**	**4.E+08**	**3.E+08**	**2.E+08**	**3.E+08**	**4.E+08**	**4.E+08**	**3.E+08**	**3.E+08**
Average Flow (lpm)	**9,727**	**7,945**	**8,024**	**11,325**	**11,522**	**10,079**	**5,553**	**10,908**	**11,817**	**13,512**	**10,310**	**9,928**
Weight Gain (kg)												
Kg of Fish at End of Period	**#VALUE!**	**#VALUE!**	**#VALUE!**	**#VALUE!**	**#VALUE!**	**#VALUE!**	**#VALUE!**	**#VALUE!**	**#VALUE!**	**#VALUE!**	**#VALUE!**	**#VALUE!**
Kg of Feed	**977**	**1,051**	**1,550**	**1,724**	**1,726**	**2,248**	**3,358**	**4,222**	**4,780**	**2,795**	**885**	**919**

Total Phosphorus	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Modeled Total Phosphorus (kg per month)	3.5	3.8	5.6	6.2	6.2	8.1	12.1	15.2	17.2	10.1	3.2	3.3
Modeled Total Phosphorus (lbs per month)	7.8	8.3	12.3	13.7	13.7	17.8	26.7	33.5	37.9	22.2	7.0	7.3
Modeled Total Phosphorus (Avg. lbs per day)	0.3	0.3	0.4	0.5	0.4	0.6	0.9	1.1	1.3	0.7	0.2	0.2
Modeled TP	0.012	0.017	0.022	0.018	0.017	0.027	0.070	0.045	0.048	0.024	0.010	0.011

Organic Phosphorus	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Modeled Total Phosphorus (kg per month)	2.5	2.7	4.0	4.5	4.5	5.8	8.7	10.9	12.4	7.2	2.3	2.4
Modeled Total Phosphorus (lbs per month)	5.6	6.0	8.9	9.8	9.9	12.8	19.2	24.1	27.3	16.0	5.1	5.3
Modeled Total Phosphorus (Avg. lbs per day)	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.4	0.4	0.2	0.1	0.1
Modeled Total Phosphorus (Avg. mg/l)	0.008	0.009	0.013	0.015	0.015	0.019	0.029	0.036	0.041	0.024	0.008	0.008

Inorganic Phosphorus	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Modeled Total Phosphorus (kg per month)	0.98	1.06	1.56	1.74	1.74	2.27	3.39	4.26	4.82	2.82	0.89	0.93
Modeled Total Phosphorus (lbs per month)	2.2	2.3	3.4	3.8	3.8	5.0	7.5	9.4	10.6	6.2	2.0	2.0
Modeled Total Phosphorus (Avg. lbs per day)	0.03	0.04	0.05	0.06	0.06	0.08	0.11	0.14	0.16	0.09	0.03	0.03
Modeled Total Phosphorus (Avg. mg/l)	0.003	0.004	0.005	0.006	0.006	0.008	0.011	0.014	0.016	0.009	0.003	0.003

Total Suspended Solids	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Modeled Total Suspended Solids (kg per month)	293.1	315.4	465.1	517.1	517.8	674.5	1007.5	1266.7	1434.0	838.4	265.5	275.7
Modeled Total Suspended Solids (lbs per month)	646.2	695.4	1025.4	1140.0	1141.5	1487.1	2221.2	2792.7	3161.4	1848.3	585.3	607.8
Modeled Total Suspended Solids (Avg. lbs per day)	20.8	24.8	33.1	38.0	36.8	49.6	71.7	90.1	105.4	59.6	19.5	19.6
Permitted Total Suspened Solids (lbs per day)	216.0	216.0	216.0	216.0	216.0	216.0	216.0	216.0	216.0	216.0	216.0	216.0
Modeled Total Suspended Solids (Avg. mg/L)	1.0	1.4	1.9	1.5	1.4	2.2	5.8	3.7	4.0	2.0	0.9	0.9
Permitted Total Suspened Solids (Avg. Monthly mg/l	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0

Total Ammonia Nitrogen	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Modeled Total Ammonia (kg per month)	38.6	41.6	61.3	68.1	68.2	88.9	132.7	166.9	188.9	110.4	35.0	36.3
Modeled Total Ammonia (lbs per month)	85.1	91.6	135.1	150.2	150.4	195.9	292.6	367.9	416.5	243.5	77.1	80.1
Modeled Total Ammonia (Avg. lbs per day)	2.7	3.3	4.4	5.0	4.9	6.5	9.4	11.9	13.9	7.9	2.6	2.6
Modeled Total Ammonia (Avg. mg/l)	0.1	0.2	0.2	0.2	0.2	0.3	0.8	0.5	0.5	0.3	0.1	0.1

Carbonaceous Biochemical Oxygen Demand	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Modeled CBOD5 (kg per month)	332.2	357.5	527.1	586.0	586.8	764.5	1141.8	1435.6	1625.2	950.2	300.9	312.5
Modeled CBOD5 (lbs per month)	732.4	788.1	1162.1	1292.0	1293.7	1685.4	2517.4	3165.1	3582.9	2094.7	663.3	688.8
Modeled CBOD (Avg. lbs per day)	23.6	28.1	37.5	43.1	41.7	56.2	81.2	102.1	119.4	67.6	22.1	22.2
Modeled CBOD5 (Avg. mg/l)	1.1	1.6	2.1	1.7	1.6	2.5	6.6	4.2	4.6	2.3	1.0	1.0

Circular Tank Calculations

Feed Training Tanks when in use are usually on flow thru first-use water only

REARING UNIT DATA

Tank Data										Hourly Exchange Rate		
	Radius	Dia.	Depth	cuft	gallons	# Units	Total cuft	R=	R=1	R=1.3	R=2	R=3
6' dia. Circular TKS	3	6	4	113.097	846	20	2,262	gpm@	14	19	28	42
Usable Vol	3	6	3	84.823	634	20	1,696	gpm@	11	16	21.1	32
			CM=	2.40292				gpmTot.	211	317	423	634

REARING UNIT DATA

Tank Data										Hourly Exchange Rate		
	Radius	Dia.	Depth	cuft	gallons	# Units	Total cuft	R=	R=1	R=1.3	R=2	R=3
20 ' dia. Circular TKS	10	20	4	1256.6	9,400	20	25,133	gpm@	157	209	313	470
Usable Vol	10	20	3	942.5	7,050	20	18,850	gpm@	117	176	235.0	352
			CM=	26.7				gpmTot.	2,350	3,525	4,700	7,050

REARING UNIT DATA

Tank Data										Hourly Exchange Rate		
	Radius	Dia.	Depth	cuft	gallons	# Units	Total cuft	R=	R=1	R=1.3	R=2	R=3
40 ' dia. Circular TKS	20	40	4	5026.55	37,599	16	80,425	gpm@	627	836	1,253	1,880
Usable Vol	20	40	3	3769.91	28,199	16	60,319	gpm@	470	627	940	1,410
			CM=	106.796				gpmTot.	7,520	10,026	15,039	22,559

Theoretical Carring Capacity DATA

	D	D	D	D
	lbs /CF	lbs /CF	lbs /CF	lbs /CF
Density lbs/CF	2	3	4	5
PER unit LBS=	170	254	339	424
Total Lbs	3,393	5,089	6,786	8,482
Loading LBS/GPM	10.7	16.0	21.4	26.7

Theoretical Carring Capacity DATA

	D	D	D	D
	lbs /CF	lbs /CF	lbs /CF	lbs /CF
Density lbs/CF	2	3	4	5
PER unit LBS=	1,885	2,827	3,770	4,712
Total Lbs	37,699	56,549	75,398	94,248
Loading LBS/GPM	10.7	16.0	21.4	26.7

Theoretical Carring Capacity DATA

	D	D	D	D
	lbs /CF	lbs /CF	lbs /CF	lbs /CF
Density lbs/CF	2	3	4	5
PER unit LBS=	7,540	11,310	15,080	18,850
Total Lbs	120,637	180,956	241,274	301,593
Loading LBS/GPM	12.0	18.0	24.1	30.1

			gpm
			13,551
95% recirc.	0.95		12,874
5% makeup	0.05		678
75% recirc.		0.75	10,163
25% makeup		0.25	3,388

EPA's calculation method

$$\mu g := \frac{gm}{10^6}$$

$$C_E(Q_E, Q_S, Q_D, C_D, C_S) := \frac{Q_D \cdot C_D - Q_S \cdot C_S}{Q_E}$$

CE: Effluent total phosphorus concentration

QE: Facility design Flow
QS: 7Q10 Flow upstream of the facility
QD: Combined stream flow (7Q10+effluent)
CD: Downstream phosphorus concentration target
CS: Median upstream total phosphorus concentration

Milford's estimated permit limit calculations based on Milford WWTF

$$Q_{E\_Milford} := 693\ gpm = 0.998\ mgd$$

$$Q_{S\_Milford} := \begin{bmatrix} 4.15 \\ 3.44 \end{bmatrix} mgd$$ From Milford WWTF's 2020 permit

$$Q_{D\_Milford} := Q_{E\_Milford} + Q_{S\_Milford} = \begin{bmatrix} 5.148 \\ 4.438 \end{bmatrix} mgd$$

$$C_{D\_Milford} := 0.9 \cdot 100\ \frac{\mu g}{L} = 90\ \frac{\mu g}{L}$$ Gold Book Water Quality Standard

$$C_{D\_Milford\_2} := 0.9 \cdot 10\ \frac{\mu g}{L} = 9\ \frac{\mu g}{L}$$ Eco Regional Water Quality Standard

$$C_{S\_Milford} := 0\ \frac{gm}{L}$$ From Milford WWTF's 2020 permit

$$C_{E\_Milford} := C_E(Q_{E\_Milford}, Q_{S\_Milford}, Q_{D\_Milford}, C_{D\_Milford}, C_{S\_Milford}) = \begin{bmatrix} 464.278 \\ 400.245 \end{bmatrix} \frac{\mu g}{L}$$

$$C_{E\_Milford} \cdot Q_{E\_Milford} = \begin{bmatrix} 3.867 \\ 3.333 \end{bmatrix} \frac{lb}{day}$$

$$C_{E\_Milford\_2} := C_E(Q_{E\_Milford}, Q_{S\_Milford}, Q_{D\_Milford}, C_{D\_Milford\_2}, C_{S\_Milford}) = \begin{bmatrix} 46.428 \\ 40.025 \end{bmatrix} \frac{\mu g}{L}$$

$$C_{E\_Milford\_2} \cdot Q_{E\_Milford} = \begin{bmatrix} 0.387 \\ 0.333 \end{bmatrix} \frac{lb}{day}$$

New Hampton's estimated permit limit calculations based on New Hampton's WWTF

$$Q_{E\_NewHampton} := 693\ gpm = 0.998\ mgd$$

$$Q_{S\_NewHampton} := \begin{bmatrix} 134 \\ 127.7 \end{bmatrix} \cdot \frac{ft^3}{s}$$

From 2021/2022 Permits at
Bristol WWTF
Plymouth WWTF

$$Q_{D\_NewHampton} := Q_{E\_NewHampton} + Q_{S\_NewHampton} = \begin{bmatrix} 87.604 \\ 83.533 \end{bmatrix} mgd$$

$$C_{D\_NewHampton\_Eco} := 10 \cdot \frac{\mu g}{L} \cdot 0.9$$

From Ecoregional Data

$$C_{D\_NewHampton\_GB} := .1 \cdot \frac{mg}{L} \cdot 0.9$$

From Gold Book Data

$$C_{S\_NewHampton} := 0\ \frac{gm}{L}$$

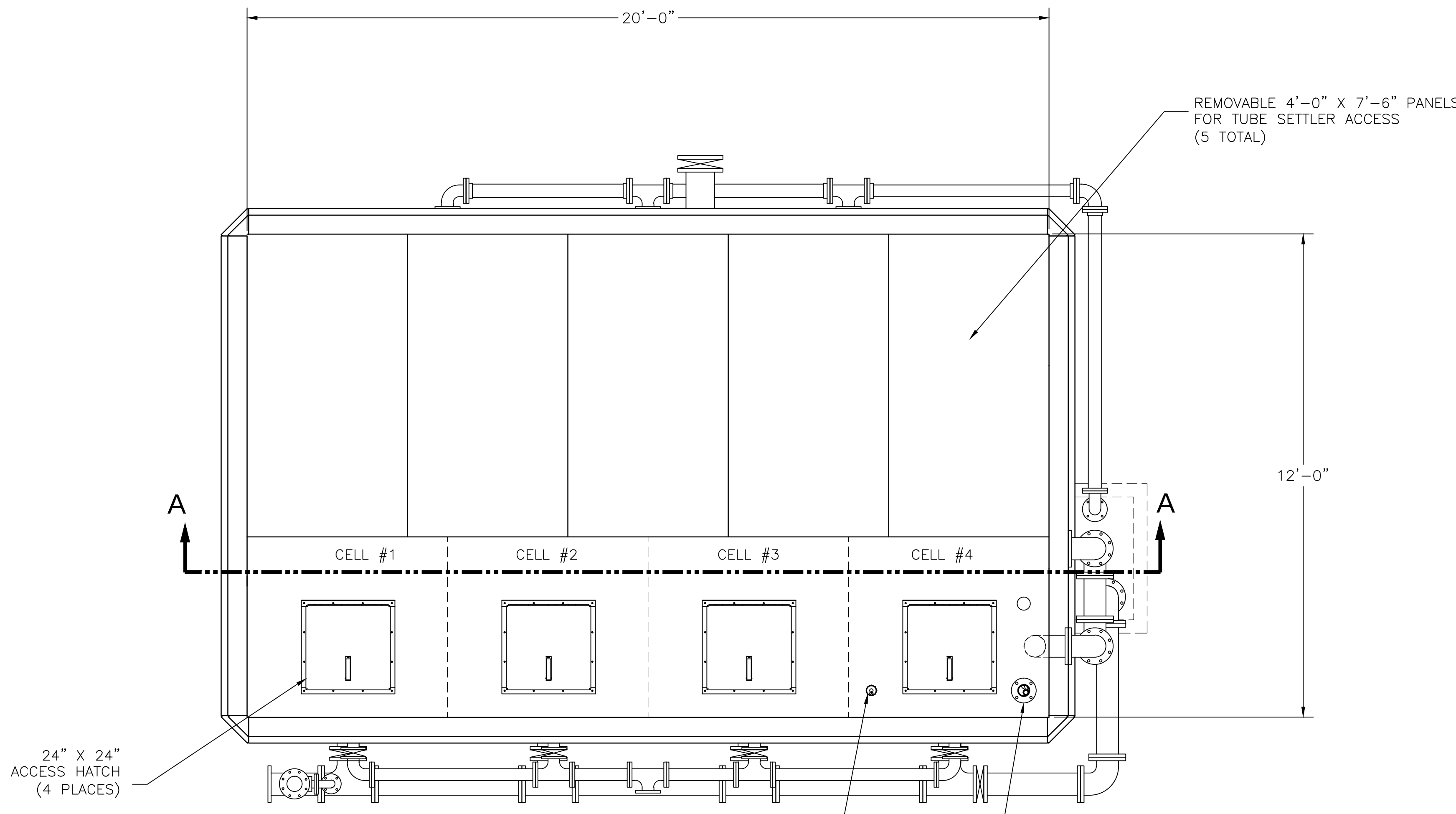
$$C_{E\_NewHampton\_Eco} := C_E\left(Q_{E\_NewHampton}, Q_{S\_NewHampton}, Q_{D\_NewHampton}, C_{D\_NewHampton\_Eco}, C_{S\_NewHampton}\right) = \begin{bmatrix} 790.083 \\ 753.36 \end{bmatrix} \frac{\mu g}{L}$$

$$C_{E\_NewHampton\_Eco} \cdot Q_{E\_NewHampton} = \begin{bmatrix} 6.58 \\ 6.274 \end{bmatrix} \frac{lb}{day}$$

$$C_{E\_NewHampton\_GB} := C_E\left(Q_{E\_NewHampton}, Q_{S\_NewHampton}, Q_{D\_NewHampton}, C_{D\_NewHampton\_GB}, C_{S\_NewHampton}\right) = \begin{bmatrix} 7.901 \cdot 10^3 \\ 7.534 \cdot 10^3 \end{bmatrix} \frac{\mu g}{L}$$

$$C_{E\_NewHampton\_GB} \cdot Q_{E\_NewHampton} = \begin{bmatrix} 65.798 \\ 62.74 \end{bmatrix} \frac{lb}{day}$$

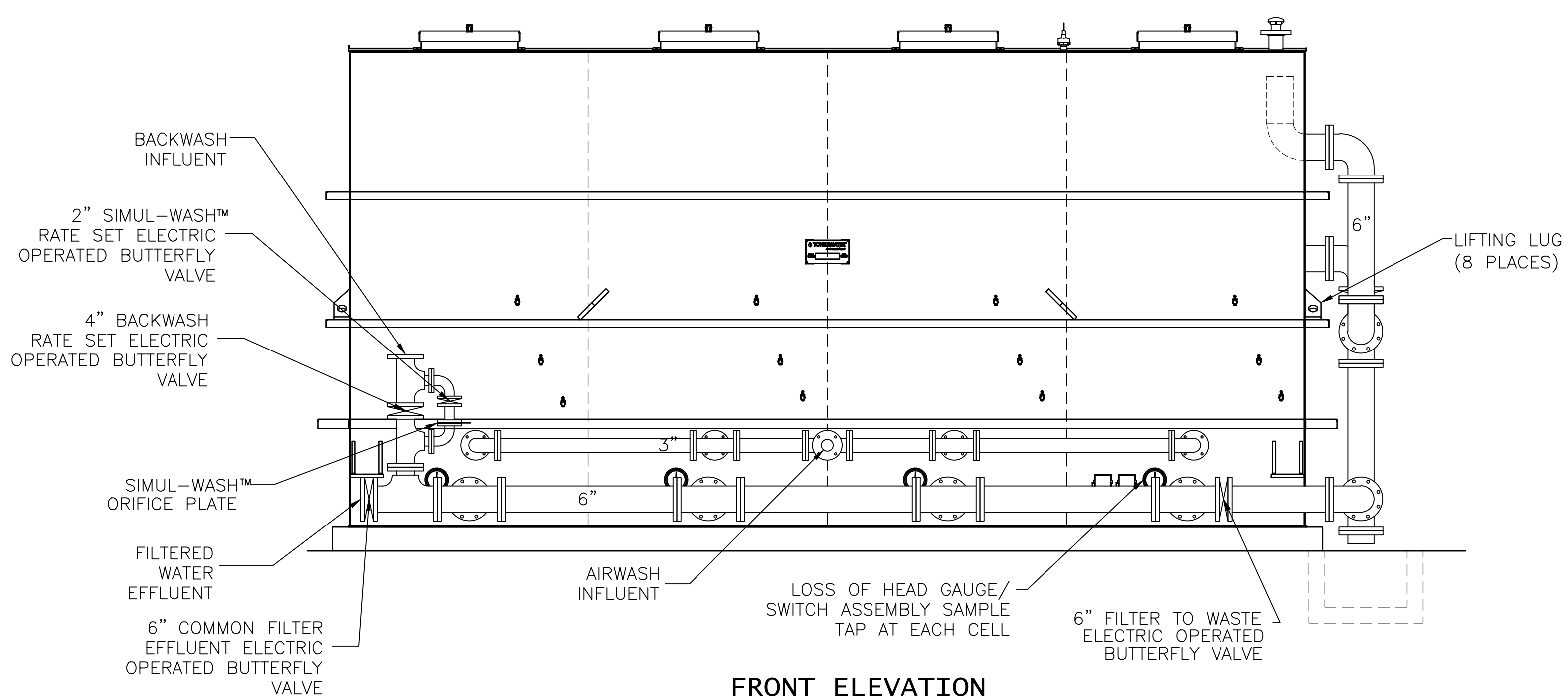
$$600\ \frac{\mu g}{L} \cdot Q_{E\_NewHampton} = 4.997\ \frac{lb}{day}$$



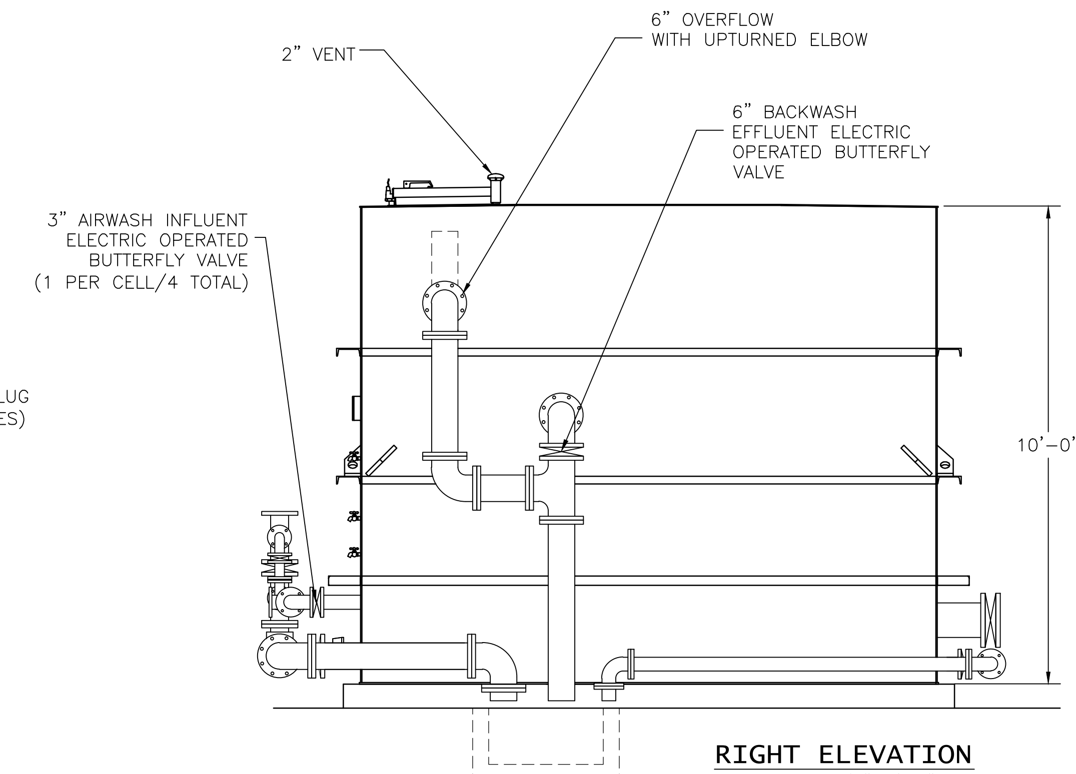
PLAN VIEW
SCALE: 1/2"=1'-0"

SPECIFICATIONS:

NO. OF CELLS:	(4) FOUR
FILTER AREA:	90 SQ. FT. – 22.5 SQ. FT./CELL
NORMAL FILTRATION RATE:	250 GPM (3.0 GPM/SQ. FT.)
TOTAL DETENTION:	41.5 MIN. @ 250 GPM
SIMUL-WASH™:	WATER: 68 GPM (5 GPM/SQ. FT.) AIR: 68 CFM (3 CFM/SQ. FT.)
RESTRATIFICATION:	225 GPM (10 GPM/SQ. FT.) APPROXIMATE, ACTUAL GPM TO BE DETERMINED IN THE FIELD DURING START-UP
SUPPORT GRAVELS:	4" – 3/4" x 1/2" GRADED GRAVELS 4" – 1/2" x 1/4" GRADED GRAVELS 4" – 1/4" x 1/8" GRADED GRAVELS 3" – .8 – 1.2 mm TORPEDO SAND
FILTER MEDIA:	18" GREENSAND PLUS 12" ANTHRACITE
UNDERDRAIN:	TONKA STANDARD PVC HEADER/LATERAL UNDERDRAIN ASSEMBLY WITH TONKA ABS DIFFUSER NOZZLES ON 12" CENTERS



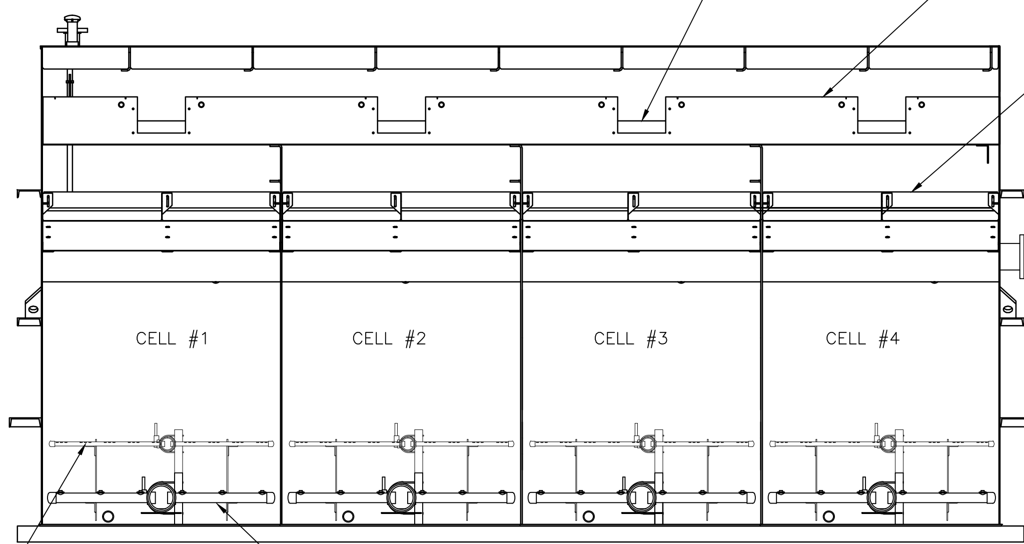
FRONT ELEVATION
SCALE: 1/2"=1'-0"



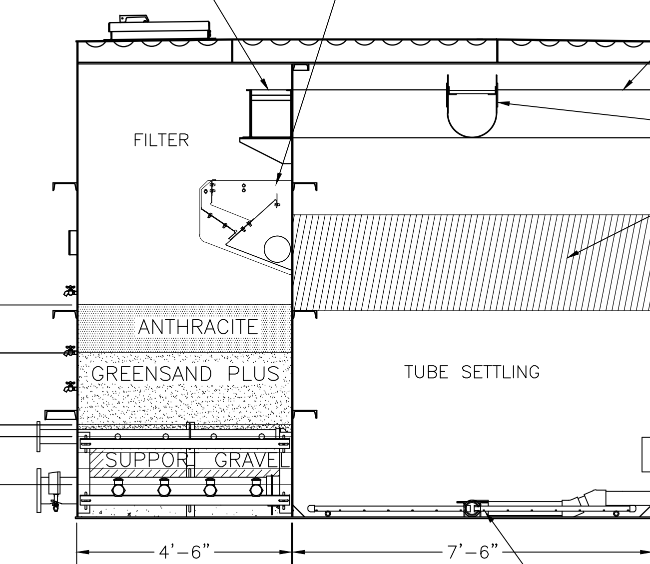
RIGHT ELEVATION
SCALE: 1/2"=1'-0"

VESSEL WITHOUT WALKWAY
SEE PAGE 3 FOR WALKWAY DETAIL

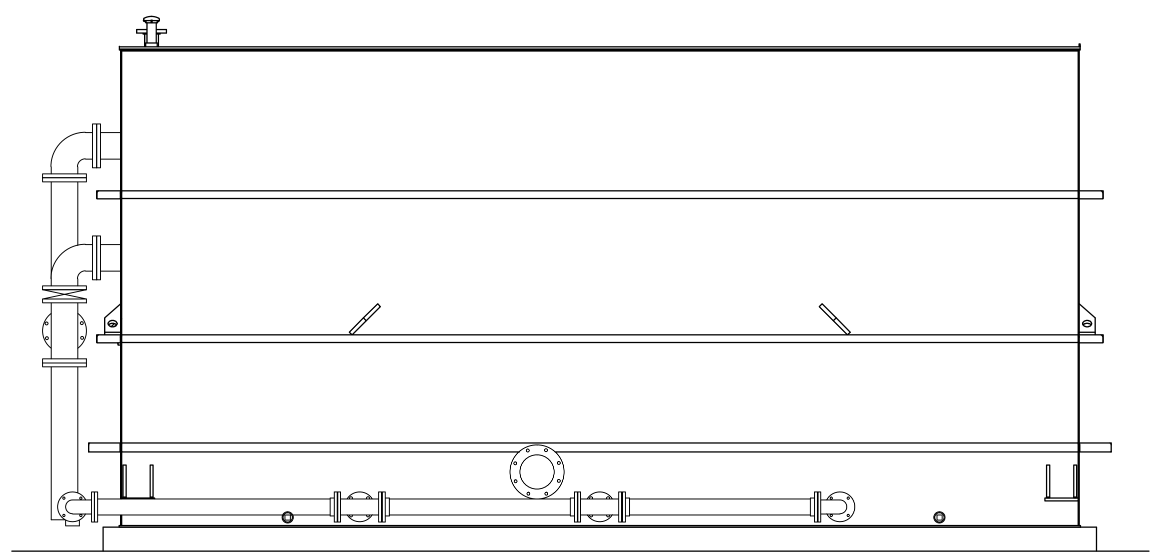
DRAWING SIZE: D	ALL RIGHTS TO MANUFACTURE, COPY, REPRODUCE OR DISPOSE OF THIS DRAWING OR ITS CONTENTS ARE RESERVED UNLESS OTHERWISE SPECIFIED IN WRITING BY KURITA AMERICA INC. DO NOT SCALE DRAWING	TONKAWATER a Kurita brand	6600 94th Avenue North Minneapolis, MN 55445 www.kuritaamerica.com
DRAWN BY: MRR	START DATE: 06/11/2021	DUALATOR® III 12'-0" WIDE X 20'-0" LONG X 10'-0" HIGH PROPOSAL DRAWING WOOD LAKE, MN	SHEET NUMBER: 1 OF 3 REV: 0
PROJECT MGR: TJS	DWG. SCALE: AS NOTED		DRAWING NUMBER: 00099603
APPR. BY:	APPR. DATE:		PROJECT NUMBER: 20377



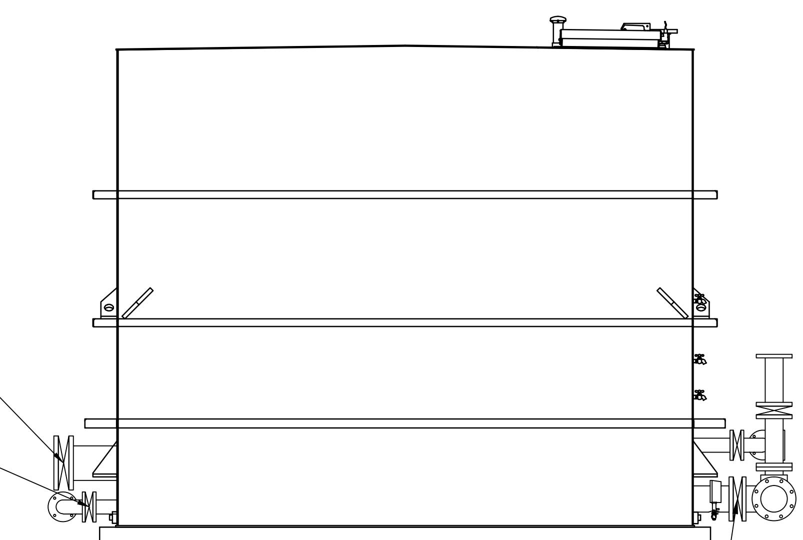
SECTION A-A
SCALE: 1/2"=1'-0"



TYPICAL SECTION
SCALE: 1/2"=1'-0"



REAR ELEVATION
SCALE: 1/2"=1'-0"



LEFT ELEVATION
SCALE: 1/2"=1'-0"

VESSEL WITHOUT WALKWAY
SEE PAGE 3 FOR WALKWAY DETAIL

DRAWING SIZE: D

DO NOT SCALE DRAWING

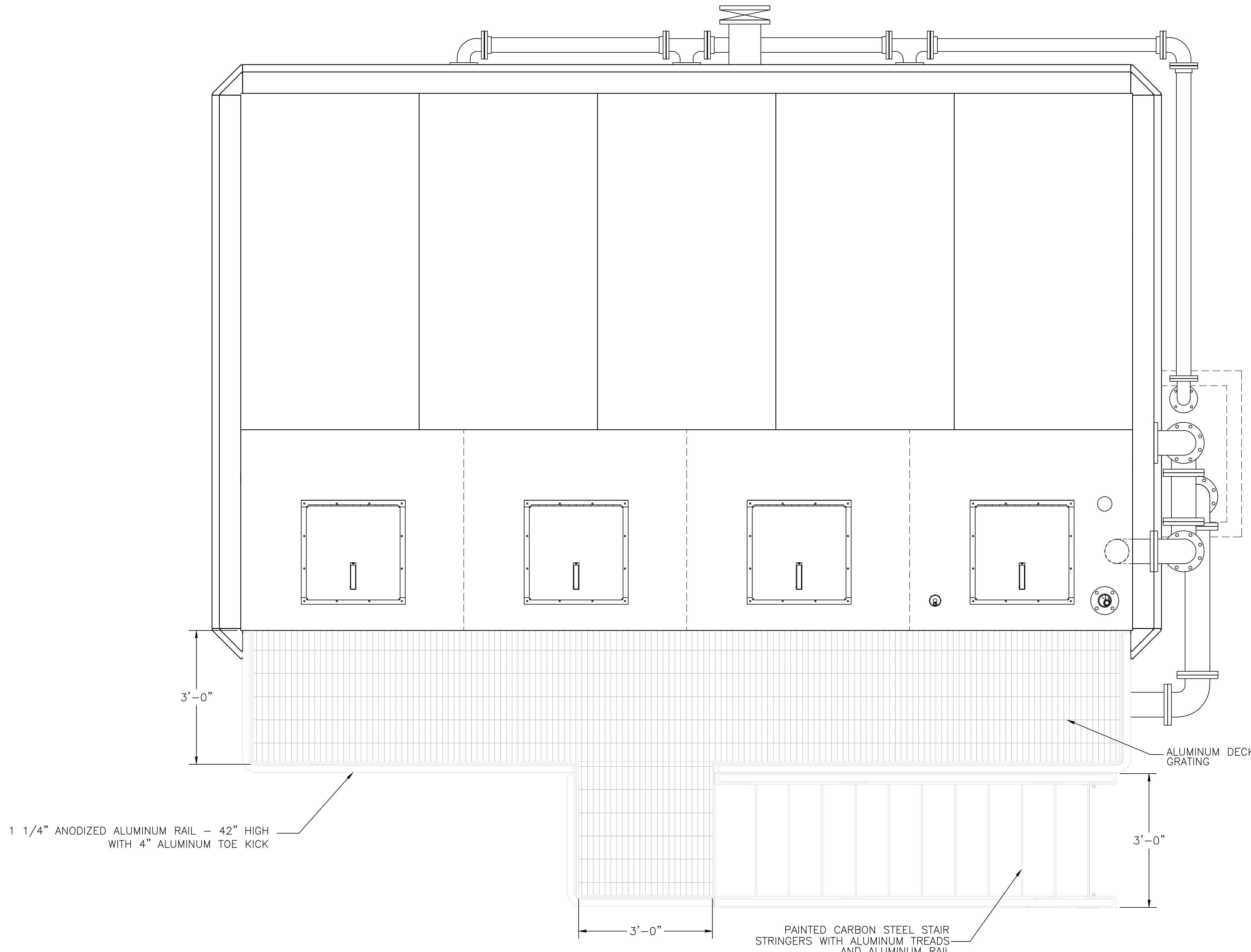
TONKAWATER a Kurita brand

6600 94th Avenue North
Minneapolis, MN 55445
www.kuritaamerica.com

DRAWN BY:	START DATE:
MRR	06/11/2021
PROJECT MGR: TJS	DWG. SCALE: AS NOTED
APPR. BY:	APPR. DATE:

DUALATOR® III
12'-0" WIDE X 20'-0" LONG X 10'-0" HIGH
PROPOSAL DRAWING
WOOD LAKE, MN

SHEET NUMBER: 2 OF 3 REV: 0
DRAWING NUMBER: 00099603
PROJECT NUMBER: 20377



PLAN VIEW
SCALE: 3/4"=1'–0"

VESSEL WITH WALKWAY

DRAWING SIZE: D	DO NOT SCALE DRAWING	TONKAWATER a Kurita brand	6600 94th Avenue North Minneapolis, MN 55445 www.kuritaamerica.com
DRAWN BY: MRR	START DATE: 06/11/2021	DUALATOR® III 12'-0" WIDE X 20'-0" LONG X 10'-0" HIGH PROPOSAL DRAWING WOOD LAKE, MN	SHEET NUMBER: 3 OF 3 REV: 0
PROJECT MGR: TJS	DWG. SCALE: AS NOTED		DRAWING NUMBER: 00099603
APPR. BY:	APPR. DATE:		PROJECT NUMBER: 20377

Appendix D
Capital Costs, O&M, and NPV Breakdowns

Client: NHFGD
Project:Powder Mill Fish Hatchery Study
Project No.: 10331124

Date: 10/13/2022
Estimator: Matt Cochran & Mario Benisch
Checked By: Jason Hill
Check Date: 12/27/2022
Revised: -

Detailed Opinions of Probable Cost

	Alternative 1	NO. UNITS	UNIT MEAS.	COST PER UNIT	Escalation cost to 2022	TOTAL COST 50% CONT.
A.	**Aquaculture Water Supply**					
A1	**Hatchery Supply**					**$ 8,448**
	Water Supply Piping and Accessories	50	LF	$ 85	$ 113	$ 8,448
A2	**Oxygenation System**					**$ 321,846**
	Bulk LOX Tank, Vaporizer, Port. Tank Fill System	1	LS	$ 70,000	$ 92,767	$ 139,151
	Fence	200	LF	$ 20	$ 27	$ 7,951
	Concrete Pad & Bollards	1	LS	$ 11,000	$ 14,578	$ 21,867
	Buried Copper Oxygen Distribution to Units	1	LS	$ 60,000	$ 79,515	$ 119,272
	Oxygen Electrical	1	LS	$ 3,000	$ 3,976	$ 5,964
	Oxygen Dissolving for Rearing Units- LHO	6	EA	$ 2,500	$ 2,906	$ 26,150
	Oxygen Flow Meter Station (raceways)	1	LS	$ 750	$ 994	$ 1,491
B.	**Buildings and Rearing Units**					
B1	**Intake Building**					**$ 1,623,787**
	New Intake Building	400	SF	$ 165	$ 218	$ 131,017
	Drumfilter					
	DRUM FILTERS	2	EA	$ 50,000	-	$ 150,000
	DRUM SUMP	1	LS	$ 75,000	-	$ 112,500
	PIPING SYSTEMS (INFLOW, DRAINS)	1	LS	$ 500,000	-	$ 750,000
	PRIMARY POWER	1	LS	$ 75,000	-	$ 112,500
	UV System		0			
	UV Channel and Lamp Package	2	EA	$ 60,000	-	$ 180,000
	UV Electrical	1	LS	$ 8,000	$ 10,602	$ 15,903
	UV Plumbing	1	LS	$ 11,000	$ 14,578	$ 21,867

	ALARMS/CONTROLS/MONITORING/PANEL/HMI	1	LS	$ 100,000	-	$ 150,000
B2	**Effluent Treatment Building**					**$ 3,378,113**
	New Effluent treatment building	9462.5	SF	$ 165	$ 238	$ 3,378,113
B3	**Vehicle/Chemical Storage Building**					**$ 704,980**
	Demo existing storage building (assumed: 51'x30'x20')					
	DEMO CMU BUILDINGS	30600	CF	$ 1	-	$ 27,081
	DEMO CONCRETE SLABS - assumed 1.5' W	53	CY	$ 210	-	$ 16,800
	DEMO CONCRETE FOOTINGS - assumed 1' W	57	CY	$ 60	-	$ 5,100
	New Storage Building (40'x50')	2000	SF	$ 165	$ 219	$ 655,999
B4	**Raceway Rehabilitation**					**$ 465,000**
	Concrete rehab of raceways (B thru G)	1	LS	$ 150,000	-	$ 225,000
	Demolish and fill in raceway A	1	LS	$ 60,000	-	$ 90,000
	Baffle Allowance	1	LS	$ 100,000	-	$ 150,000
C.	**Site**					
C1	**Site Work**					**$1,003,876.52**
	Site Clearing	2.5	AC	$2,000.00	$2,650.50	$ 9,939
	General Earthwork for Hatchery Complex	0	LS	$75,000.00	$99,393.71	$ -
	General Sitework	2	LS	$250,000.00	$331,312.38	$ 993,937
	Erosion Control	0	AC	$2,500.00	$3,313.12	$ -
	Seeding	0	AC	$1,250.00	$1,656.56	$ -
	Landscaping	0	AC	$3,000.00	$3,975.75	$ -
	Natural Gas Connection and Distribution (if available)	0	LS	$35,000.00	$46,383.73	$ -
	Stormwater Management System	0.0	AC	$3,500.00	$4,638.37	$ -
C2	**Security Fence**			$710.00		**$6,042.56**
	Site Fencing	152	LF	$20.00	$26.50	$ 6,043
C3	**Domestic Water**			$150.00		**$49,696.86**
	Domestic Water Supply	1	LS	$25,000.00	$33,131.24	$ 49,697
C4	**Domestic Wastewater**			$100,000.00		**$99,393.71**
	Domestic Wastewater System	1	LS	$50,000.00	$66,262.48	$ 99,394

C5	**Disinfection Station**					**$22,500.00**
	Truck Disinfection Station	1	LS	$15,000.00	-	$ 22,500
	Roadway Aggregate	0	SY	$15.00	-	$ -
	Electrical	0	LS	$2,500.00	-	$ -
	Detention Tank	0	LS	$5,000.00	-	$ -
C6	**Paved Access to State or Local Highways**	0		$0.00		**$0.00**
	Bituminous Paved Road	0	LS	$190,000.00	$251,797.41	$ -
	Gravel Roads	0	LS	$55,000.00	$72,888.72	$ -

D.	**Aquaculture Wastewater**					
D1	**Effluent Treatment**					**$ 31,443,671**
	Drumfilter					
	DRUM FILTERS	2	EA	$ 50,000	-	$ 150,000
	DRUM SUMP	1	LS	$ 75,000	-	$ 112,500
	PIPING SYSTEMS (INFLOW, PRAS, DRAINS)	1	LS	$ 500,000	-	$ 750,000
	PRIMARY POWER	1	LS	$ 75,000	-	$ 112,500
	Clarifier-30ft					
	Clarifier Concrete	142	CY	$ 1,500	-	$ 319,500
	Clarifer Excavation	642	CY	$ 50	-	$ 48,150
	Clarifier Equipment	1	LS	$ 108,000	$ 170,780	$ 256,170
	Clarifier Coatings	1	LS	$ 12,000	$ 18,976	$ 28,463
	Finger Weirs	1	LS	$ 6,000	$ 9,488	$ 14,232
	Duplex Pump Station	1	LS	$ 18,000	$ 28,463	$ 42,695
	3" Sch 80 PVC Pipe	100	LF	$ 36	$ 57	$ 8,539
	4" Sch 80 PVC Pipe	250	LF	$ 60	$ 95	$ 35,579
	3" Plug Valves	2	EA	$ 3,000	$ 4,744	$ 14,232
	3" Swing Check Valves	2	EA	$ 2,040	$ 3,226	$ 9,678
	Telescoping Valves	2	EA	$ 1,140	$ 1,803	$ 5,408
	6 ft precast manhole 6 ft deep	2	EA	$ 9,000	$ 14,232	$ 42,695
	4ft Precast Manhole 4 ft deep	1	EA	$ 5,040	$ 7,970	$ 11,955
	Clarifier Equipment Install	1	LS	$ 21,600	$ 34,156	$ 51,234
	Sludge Storage-30ft					

	Sludge Storage Concrete	138	CY	$ 1,500	-	$ 310,500
	Sludge storage Excavation	563	CY	$ 50	-	$ 42,225
	Sludge Mixing Pump	1	LS	$ 10,000	$ 15,813	$ 23,719
	Sludge Mixing Nozzles	1	LS	$ 35,000	$ 55,345	$ 83,018
	4" Sch 80 PVC Pipe	300	LF	$ 50	$ 79	$ 35,579
	Telescoping Valves	1	EA	$ 950	$ 1,502	$ 2,253
	3" Plug Valves	1	EA	$ 2,500	$ 3,953	$ 5,930
	3" Swing Check Valves	1	EA	$ 1,700	$ 2,688	$ 4,032
	Air Release Valve	2	EA	$ 450	$ 712	$ 2,135
	Sludge Mix & Transfer System Install	1	LS	$ 13,210	$ 20,889	$ 31,333
	WW Piping					
	WW Piping line	1500	LF	$ 85	$ 113	$ 253,454
	WW Sitework	1	LS	$ 40,000	$ 53,010	$ 79,515
	Phosphorus Removal					
	Membrane					
	Membrane Filtration System	1	EA	$ 11,480,000	-	$ 17,220,000
	Chemical Storage Membrane Cleaning	1	EA	$ 8,770	-	$ 13,155
	Membrane Install (25% of Materials)	1	LS	$ 2,872,193	-	$ 4,308,289
	Chemical Addition					
	Mixing/Reaction Tank Concrete	255	CY	$ 1,500	-	$ 573,750
	Mixing/Reaction Tank 2:1 Excavation	1593	CY	$ 50	-	$ 119,475
	Mixing/Reaction Tank MISC Piping	1	LS	$ 40,000	-	$ 60,000
	Mixing/Reaction Mixing Pumps	1	EA	$ 52,595	-	$ 78,893
	Chemical Dosing	1	EA	$ 20,000	-	$ 30,000
	Chemical Storage Coagulation	1	EA	$ 2,520	-	$ 3,780
	Chemical Addition Install (25% of Materials)	1	LS	$ 124,404	-	$ 186,606
	Adsorption					
	Adsorption Columns	6	EA	$ 250,000	-	$ 2,250,000
	Adsorption Media	3360	CF	$ 500	-	$ 2,520,000
	Asorption Install (25% of Materials)	1	LS	$ 795,000	-	$ 1,192,500
D2	**Effluent Monitoring**					**$ 64,606**
	Automated Flow Measurement Equipment	1	LS	$ 25,000	$ 33,131	$ 49,697
	Portable Composite Sampler	1	LS	$ 5,000	$ 6,626	$ 9,939

	Electrical	1	LS	$ 2,500	$ 3,313	$ 4,970
E.	**Utilities (Electrical, HVAC and Instrumentation)**					
E1	**Electrical Service**					**$ 189,757**
	Security Lighting	8	EA	$ 2,500	$ 3,313	$ 39,757
	3-phase service	1	EA	$ 100,000	-	$ 150,000
E2	**Emergency Power**					**$ 216,678**
	Emergency Generator: 100-200kW	1	LS	$ 75,000	$ 99,394	$ 149,091
	Automatic Transfer Switch	1	LS	$ 20,000	$ 26,505	$ 39,757
	Fuel Tank	1	LS	$ 14,000	$ 18,553	$ 27,830
E3	**Instrumentation and Alarm System**					**$ 347,878**
	Instrumentation, Alarm System & Communication	1	LS	$ 175,000	$ 231,919	$ 347,878
F.	**Visitor Education/Interpretation**					
F1	**Hatchery Building - Displays**					**$221,250.00**
	Display Materials	1	LS	$20,000.00	-	$ 30,000
	Visitor Center Remodel (Gut and Remodel Basement Floor)	850	SF	$ 150	-	$ 191,250
						$ 40,167,523

New Hampshire Fish and Game Department
Effluent Treatment Evaluation
Alternative 1A: No Hatchery Upgrades and Chemical Dosing
Operation and Maintenance

Estimated Annual Electricity Usage Costs

Component	HP	Quantity	Total HP	Watts	Hours/day	kW-hrs/year
Hatchery Modernization						
UV System		2		56,000	24	981,120
Drum Filter	8.0	2.0	16.00	11,931	24	104,517
Site Lighting		1		15,000	12	65,700
Effluent Treatment						
Effluent Drums	8.00	2	16.00	11,931	24	104,517
Clarifier Mechanism	0.75	1	0.75	559	24	4,899
Sludge Pump	20.00	1	20.00	14,914	24	130,647
Mixing Tank Mixer	3.00	1.00	3.00	2,237	24	19,597
Membrane Process Pumps	15.00	8.00	120.00	487,000	1	177,755
Membrane Blowers	90.00	2.00	180.00	335,000	1	122,275
Membrane CIP Pumps	15.00	1.00	15.00	116,000	1	42,340
Membrane CIP Heaters	NA			800,000	1	292,000
Membrane Backpulse Pump	60.00	2.00	120.00	70,000	1	25,550
Membrane Drain Pump	15.00	1.00	15.00	116,000	1	42,340
					kW-hrs/year =	2,113,257
					$/kW-hrs =	$0.12
						Annual Cost
						$253,590.89

Estimated Annual Replacement Costs						**Annual Cost**
Annual Equipment Replacement						**$1,609,000.00**
Estimated Annual Labor Costs	**Days per Week**	**Hours per day**	**Personnel**	**Rate**	**OH/Fringe**	**Annual Cost**
Daily Operator Attention	5	8	2	$ 25.00	$ 15.00	**$104,000**
Chemicals	**Use (gpd)**	**Annual Use (gal)**	**Cost ($/gal)**	**Replacement/yr**		**Annual Cost**
Alum		12045	1.81			$21,801.45
25% Caustic		10098	1.92			$19,388.16
Hypo		18300	2.5			$45,750.00
Citric		38500	8.25			$317,625.00
Sodium Bisulfate		4400	3.4			$14,960.00
Sulfuric						$0.00
O2 Usage - Tank refill		6000	0.6	4		$14,400
Adsorption Media Regen						$0

Estimated Annual Labor and Replacement Costs	**$1,713,000**
Estimated Annual Electricity and Chemical Usage Costs	**$687,516**
TOTAL	**$2,401,000**

New Hampshire Fish and Game Department
Effluent Treatment Evaluation
Alternative 1A: No Hatchery Upgrades and Chemical Dosing
Life Cycle Cost Analysis

		0	1	2	3	4	5	6	7	8	9
	Total	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
O&M											
Power and Chemical cost (6%/yr 2023-2026, 3%/yr 2027-2042 escalation)		$2,401,000	$2,545,060	$2,697,764	$2,859,629	$2,945,418	$3,033,781	$3,124,794	$3,218,538	$3,315,094	$3,414,547
R&R Maintenance cost (6%/yr 2023-2026, 4%/yr 2027-2042 escalation)		$556,170	$589,540	$624,913	$662,407	$688,904	$716,460	$745,118	$774,923	$805,920	$838,157
Total O&M Cost		**$2,957,170**	$3,134,600	$3,322,676	$3,522,037	$3,634,322	$3,750,241	$3,869,912	$3,993,461	$4,121,014	$4,252,704
Average Annual O&M Cost over 20 years ($/yr)	$4,367,096										
Average Annual O&M Cost over 10 years ($/yr)	$3,655,814										
Capital Cost		**$38,236,000**									
Equipment Cost		**$18,539,000**									
Net Present Value (at 5% discount rate)											
20 Year Net Present Value	$89,800,597										
10 Year Net Present Value	**$66,030,000**										
Annual Cost											
Average Annual Cost (Debt Service + O&M, 20 year basis)	$7,435,252										
Average Annual Cost (Debt Service + O&M, 10 year basis)	$8,607,551										

	10	11	12	13	14	15	16	17	18	19
	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
O&M										
Power and Chemical cost (6%/yr 2023-2026, 3%/yr 2027-2042 escalation)	$3,516,983	$3,622,493	$3,731,168	$3,843,103	$3,958,396	$4,077,148	$4,199,462	$4,325,446	$4,455,209	$4,588,866
R&R Maintenance cost (6%/yr 2023-2026, 4%/yr 2027-2042 escalation)	$871,683	$906,550	$942,812	$980,525	$1,019,746	$1,060,536	$1,102,957	$1,147,075	$1,192,958	$1,240,677
Total O&M Cost	$4,388,666	$4,529,043	$4,673,980	$4,823,628	$4,978,142	$5,137,683	$5,302,419	$5,472,521	$5,648,168	$5,829,542

New Hampshire Fish and Game Department

Effluent Treatment Evaluation

<u>Alternative 1B: No Hatchery Upgrades and Adsorption Units</u>

Operation and Maintenance

Component	HP	Quantity	Total HP	Watts	Hours/day	kW-hrs/year
Hatchery Modernization						
UV System		2		56,000	24	981,120
Drum Filter	8.0	2.0	16.00	11,931	24	104,517
Site Lighting		1		15,000	12	65,700
Effluent Treatment			0.00	0	24	0
Effluent Drums	8.00	2	16.00	11,931	24	104,517
Clarifier Mechanism	0.75	1	0.75	559	24	4,899
Sludge Pump	20.00	1	20.00	14,914	24	130,647
Mixing Tank Mixer	0.00	1.00	0.00	0	24	0
Membrane Process Pumps	15.00	8.00	120.00	487,000	1	177,755
Membrane Blowers	90.00	2.00	180.00	335,000	1	122,275
Membrane CIP Pumps	15.00	1.00	15.00	116,000	1	42,340
Membrane CIP Heaters	NA			800,000	1	292,000
Membrane Backpulse Pump	60.00	2.00	120.00	70,000	1	25,550
Membrane Drain Pump	15.00	1.00	15.00	116,000	1	42,340
					kW-hrs/year =	2,093,660
					$/kW-hrs =	$0.12
						Annual Cost
						$251,239.25

Estimated Annual Replacement Costs						Annual Cost
Annual Equipment Replacement						$1,794,000.00
Estimated Annual Labor Costs	**Days per Week**	**Hours per day**	**Personnel**	**Rate**	**OH/Fringe**	**Annual Cost**
Daily Operator Attention	5	8	2	$ 25.00	$ 15.00	**$104,000**
Chemicals	**Use (gpd)**	**Annual Use (gal)**	**Cost ($/gal)**	**event per year**		**Annual Cost**
Alum		0	1.81			$0
25% Caustic		0	1.92			$0
Hypo		18300	2.5			$45,750
Citric		38500	8.25			$317,625
Sodium Bisulfate		4400	3.4			$14,960
Sulfuric						$0
O2 Usage - Tank refill		6000	0.6	4		$14,400
Adsorption Media Regen						$88,105

Estimated Annual Labor and Replacement Costs	**$1,898,000**
Estimated Annual Electricity and Chemical Usage Costs	**$732,080**
TOTAL	**$2,631,000**

New Hampshire Fish and Game Department

Effluent Treatment Evaluation

Alternative 1B: No Hatchery Upgrades and Adsorption Units

Life Cycle Cost Analysis

		0	1	2	3	4	5	6	7	8	9
	Total	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
O&M											
Power and Chemical cost (6%/yr 2023-2026, 3%/yr 2027-2042 escalation)		$2,631,000	$2,788,860	$2,956,192	$3,133,563	$3,227,570	$3,324,397	$3,424,129	$3,526,853	$3,632,658	$3,741,638
R&R Maintenance cost (6%/yr 2023-2026, 4%/yr 2027-2042 escalation)		$620,310	$657,529	$696,980	$738,799	$768,351	$799,085	$831,049	$864,290	$898,862	$934,817
Total O&M Cost		**$3,251,310**	$3,446,389	$3,653,172	$3,872,362	$3,995,921	$4,123,482	$4,255,178	$4,391,143	$4,531,521	$4,676,455
Average Annual O&M Cost over 20 years ($/yr)	$4,802,494										
Average Annual O&M Cost over 10 years ($/yr)	$4,019,693										
Capital Cost		**$43,388,000**									
Equipment Cost		**$20,677,000**									
Net Present Value (at 5% discount rate)											
20 Year Net Present Value	$100,091,271										
10 Year Net Present Value	**$73,948,000**										
Annual Cost											
Average Annual Cost (Debt Service + O&M, 20 year basis)	$8,284,059										
Average Annual Cost (Debt Service + O&M, 10 year basis)	$9,638,638										

	10	11	12	13	14	15	16	17	18	19
	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
Power and Chemical cost (6%/yr 2023-2026, 3%/yr 2027-2042 escalation)	$3,853,887	$3,969,504	$4,088,589	$4,211,247	$4,337,584	$4,467,712	$4,601,743	$4,739,795	$4,881,989	$5,028,449
R&R Maintenance cost (6%/yr 2023-2026, 4%/yr 2027-2042 escalation)	$972,209	$1,011,098	$1,051,542	$1,093,603	$1,137,347	$1,182,841	$1,230,155	$1,279,361	$1,330,536	$1,383,757
Total O&M Cost	$4,826,097	$4,980,602	$5,140,131	$5,304,850	$5,474,931	$5,650,553	$5,831,898	$6,019,156	$6,212,525	$6,412,206

Client: NHFGD
Project:Powder Mill Fish Hatchery Study
Project No.: 10331124

Date: 10/13/2022
Estimator: Matt Cochran & Mario Benisch
Checked By: Jason Hill
Check Date: 12/27/2022
Revised: -

Detailed Opinions of Probable Cost						
	Alternative 2	NO. UNITS	UNIT MEAS.	COST PER UNIT	Escalation cost to 2022	TOTAL COST 50% CONT.
A.	**Aquaculture Water Supply**					
A1	**Hatchery Supply**					**$246,695**
	Water Supply Piping and Accessories	1460	LF	$ 85	$ 113	$ 246,695
B.	**Buildings and Rearing Units**					
B1	**Intake Building**					**$ 1,623,787**
	New Intake Building	400	SF	$165.00	$ 218	$ 131,017
	Drumfilter					
	DRUM FILTERS	2	EA	$ 50,000	-	$ 150,000
	DRUM SUMP	1	LS	$ 75,000	-	$ 112,500
	PIPING SYSTEMS (INFLOW, DRAINS)	1	LS	$ 500,000	-	$ 750,000
	PRIMARY POWER	1	LS	$ 75,000	-	$ 112,500
	UV System		0			
	UV Channel and Lamp Package	2	EA	$ 60,000	-	$ 180,000
	UV Electrical	1	LS	$ 8,000	$ 10,602	$ 15,903
	UV Plumbing	1	LS	$ 11,000	$ 14,578	$ 21,867
	ALARMS/CONTROLS/MONITORING/PANEL/HMI	1	LS	$ 100,000	-	$ 150,000
B2	**Effluent Treatment Building**					**$3,291,093.75**
	New Effluent treatment building	9,219	SF	$165.00	$ 238	$ 3,291,094

B3	**Vehicle/Chemical Storage Building**					**$ 655,999**
	New Storage Building (40'x50')	2000	SF	$ 165	$ 219	$ 655,999
B5	**Hatchery Building**					**$4,229,021.87**
	New Hatchery Building - Office Space	3700	SF	$165.00	$ 218	$ 1,211,910
	POWER AND LIGHTING	3700	SF	$ 50	$103.40	$ 573,847
	HVAC	1	LS	$ 100,000	$206,791.77	$ 310,188
	EQUIPMENT					
	FEEDERS (SWEENEY MDL AF7 W/CONTROLLER & SUPPORT)	72	EA	$ 600	$1,240.75	$ 134,001
	FG TROUGHS (12'x2'x2')	42	EA	$ 2,500	$5,169.79	$ 325,697
	INCUBATION ROOM 30 HEATH STACKS	12	EA	$ 2,500	$5,169.79	$ 93,056
	INCUBATION HEAD TROUGHS AND CONTROLS	2	LS	$ 15,000	$31,018.77	$ 93,056
	CHILLER SYSTEM AND CONTROLS	1	LS	$ 250,000	$516,979.42	$ 775,469
	FORMALIN ROOM	1	LS	$ 50,000	$103,395.88	$ 155,094
	BOOT LOCKER ROOM, W/D, BENCHES	1	LS	$ 50,000	$103,395.88	$ 155,094
	WATER QUALITY ROOM EQUIP ALLOWANCE	1	LS	$ 75,000	$155,093.83	$ 232,641
	Hatchery Building Aeration/Degassing System					
	Primary Headtank & Aeration/Degassing System	1	EA	$ 85,000	$ 112,646	$ 168,969
B6	**Rearing Building**					**$30,151,818.18**
	New Rearing Building	73,640	SF	$ 165	$ 218	$ 24,120,276
	ALARMS/CONTROLS/MONITORING/PANEL/HMI	1	LS	$ 100,000	-	$ 150,000
	VFD W/CIRCUIT BREAKER AND FULL CONTACTOR SET	2	EA	$ 25,000	-	$ 75,000
	PANEL/RACK/WIRING/CONDUITS/FEEDER	2	EA	$ 55,000	-	$ 165,000
	12" FLOW METER	2	EA	$ 18,000	-	$ 54,000
	EQUIPMENT					
	20' dia. SS Culture Tank with Foundation & Floor	20	EA	$ 35,000	-	$ 1,050,000
	40' dia. SS Culture Tank with Foundation & Floor	16	EA	$ 50,000	-	$ 1,200,000
	Drumfilter					
	DRUM FILTERS	6	EA	$ 50,000	-	$ 450,000
	DRUM SUMP	1	LS	$ 75,000	-	$ 112,500
	PRIMARY POWER	1	LS	$ 75,000	-	$ 112,500
	UV System		0			

	UV Channel and Lamp Package	6	EA	$ 60,000	-	$ 540,000
	UV Electrical	1	LS	$ 8,000	$ 10,602	$ 15,903
	UV Plumbing	1	LS	$ 11,000	$ 14,578	$ 21,867
	Recirculation					
	PIPING SYSTEMS (INFLOW, PRAS, DRAINS)	1	LS	$ 500,000	-	$ 750,000
	Lift Pump	6	EA	$ 80,000	-	$ 720,000
	4ft Precast Manhole 4 ft deep	6	EA	$ 4,200	$6,641.45	$ 59,773
	HVAC	1	LS	$ 100,000	-	$ 150,000
	GAS MANAGEMENT TOWER CO2 STRIPPER/LHO	6	EA	$ 45,000	-	$ 405,000

C.	**Site**					
C1	**Site Work**					**$835,155.69**
	Site Clearing	2.5	AC	$2,000.00	$2,650.50	$ 9,939
	General Earthwork for Hatchery Complex	1	LS	$75,000.00	$99,393.71	$ 149,091
	General Sitework	1	LS	$250,000.00	$331,312.38	$ 496,969
	Erosion Control	20	AC	$2,500.00	$3,313.12	$ 99,394
	Seeding	1	AC	$1,250.00	$1,656.56	$ 2,485
	Landscaping	1	AC	$3,000.00	$3,975.75	$ 5,964
	Natural Gas Connection and Distribution (if available)	0	LS	$35,000.00	$46,383.73	$ -
	Stormwater Management System	10.3	AC	$3,500.00	$4,638.37	$ 71,315
C2	**Security Fence**					**$3,975.75**
	Site Fencing	100	LF	$20.00	$26.50	$ 3,976
C3	**Domestic Water**					**$49,696.86**
	Domestic Water Supply	1	LS	$25,000.00	$33,131.24	$ 49,697
C4	**Domestic Wastewater**					**$99,393.71**
	Domestic Wastewater System	1	LS	$50,000.00	$66,262.48	$ 99,394
C5	**Disinfection Station**					**$22,500.00**
	Truck Disinfection Station	1	LS	$15,000.00	-	$ 22,500
	Roadway Aggregate	0	SY	$15.00	-	$ -
	Electrical	0	LS	$2,500.00	-	$ -

	Detention Tank	0	LS	$5,000.00	-	$ -
C6	**Paved Access to State or Local Highways**					**$377,696.12**
	Bituminous Paved Road	1	LS	$190,000.00	$251,797.41	$ 377,696
	Gravel Roads	0	LS	$55,000.00	$72,888.72	$ -

D.	**Aquaculture Wastewater**					
D1	**Effluent Treatment**					**$29,254,369**
	Clarifier-40ft					
	Clarifier Concrete	211	CY	$ 1,500	-	$ 474,750
	Clarifer Excavation	898	CY	$ 50	-	$ 67,350
	Clarifier Equipment	1	LS	$ 144,000	$ 227,707	$ 341,560
	Clarifier Coatings	1	LS	$ 16,000	$ 25,301	$ 37,951
	Finger Weirs	1	LS	$ 8,000	$ 12,650	$ 18,976
	Duplex Pump Station	1	LS	$ 24,000	$ 37,951	$ 56,927
	3" Sch 80 PVC Pipe	100	LF	$ 48	$ 76	$ 11,385
	4" Sch 80 PVC Pipe	250	LF	$ 80	$ 127	$ 47,439
	3" Plug Valves	2	EA	$ 4,000	$ 6,325	$ 18,976
	3" Swing Check Valves	2	EA	$ 2,720	$ 4,301	$ 12,903
	Telescoping Valves	2	EA	$ 1,520	$ 2,404	$ 7,211
	6 ft precast manhole 6 ft deep	2	EA	$ 12,000	$ 18,976	$ 56,927
	4ft Precast Manhole 4 ft deep	1	EA	$ 6,720	$ 10,626	$ 15,939
	Clarifier Equipment Install	1	LS	$ 28,800	$ 45,541	$ 68,312
	Sludge Storage-40ft					
	Sludge Storage Concrete	215	CY	$ 1,500	-	$ 483,750
	Sludge Storage Excavation	976	CY	$ 50	-	$ 73,200
	Sludge Mixing Pump	1	LS	$ 10,000	$ 15,813	$ 23,719
	Sludge Mixing Nozzles	1	LS	$ 35,000	$ 55,345	$ 83,018
	4" Sch 80 PVC Pipe	300	LF	$ 50	$ 79	$ 35,579
	Telescoping Valves	1	EA	$ 950	$ 1,502	$ 2,253
	3" Plug Valves	1	EA	$ 2,500	$ 3,953	$ 5,930
	3" Swing Check Valves	1	EA	$ 1,700	$ 2,688	$ 4,032
	Air Release Valve	2	EA	$ 450	$ 712	$ 2,135
	Sludge Mix & Transfer System Install	1	LS	$ 13,210	$ 20,889	$ 31,333

	Phosphorus Removal						
	Membrane						
	Membrane Filtration System	1	EA	$	11,480,000	-	$ 17,220,000
	Chemical Storage Membrane Cleaning	1	EA	$	8,770	-	$ 13,155
	Membrane Install (25% of Materials)	1	LS	$	2,872,193	-	$ 4,308,289
	Chemcial Addition						
	Mixing/Reaction Tank Concrete	246	CY	$	1,500	-	$ 553,500
	Mixing/Reaction Tank 2:1 Excavation	1548	CY	$	50	-	$ 116,100
	Mixing/Reaction Tank MISC Piping	1	LS	$	40,000	-	$ 60,000
	Mixing/Reaction Mixing Pumps	1	EA	$	52,595	-	$ 78,893
	Chemical Dosing	1	EA	$	20,000	-	$ 30,000
	Chemical Storage Coagulation	1	EA	$	3,215	-	$ 4,823
	Chemical Addition Install (25% of Materials)	1	LS	$	121,203	-	$ 181,804
	Adsorption						
	Adsorption Columns	5	EA	$	250,000	-	$ 1,875,000
	Adsorption Media	2520	CF	$	500	-	$ 1,890,000
	Asorption Install (25% of Materials)	1	LS	$	627,500	-	$ 941,250

D2	**Effluent Monitoring**					**$64,605.91**
	Automated Flow Measurement Equipment	1	LS	$25,000.00	$ 33,131.24	$ 49,697
	Portable Composite Sampler	1	LS	$5,000.00	$ 6,626.25	$ 9,939
	Electrical	1	LS	$2,500.00	$ 3,313.12	$ 4,970

E.	**Electrical and HVAC**					
E1	**Electrical Service**					**$189,757.49**
	Security Lighting	8	EA	$2,500.00	$ 3,313.12	$ 39,757
	3-phase service	1	EA	$ 100,000	-	$ 150,000
E2	**Emergency Power**					**$216,678.30**
	Emergency Generator: 100-200kW	1	LS	$75,000.00	$ 99,393.71	$ 149,091
	Automatic Transfer Switch	1	LS	$20,000.00	$ 26,504.99	$ 39,757

	Fuel Tank	1	LS	$14,000.00	$ 18,553.49	$ 27,830
E3	**Instrumentation and Alarm System**					**$347,878.00**
	Instrumentation, Alarm System & Communication	1	LS	$175,000.00	$ 231,918.67	$ 347,878
F.	**Visitor Education/Interpretation**					
F1	**Hatchery Building - Displays**					**$817,500.00**
	Display Materials	1	LS	$20,000.00	-	$ 30,000
	New visitor's center building (Display Area, Public Restrooms, & Mechanical spa	1500	SF	$350.00	-	$ 787,500
						$71,821,623

New Hampshire Fish and Game Department

Effluent Treatment Evaluation

Alternative 2A: 75% Recirculation with Chemical Dosing

Operation and Maintenance

Component	HP	Quantity	Total HP	Watts	Hours/day	kW-hrs/year
Hatchery Modernization						
UV System		8		56,000	24	3,924,480
Drum Filter	8.0	8.0	64.00	47,725	24	418,069
Recirc. Pump	15.0	6.0	90.00	67,113	24	587,910
Site Lighting		1		15,000	12	65,700
Miscellaneous (SCADA, Meters, etc.)		1		15,000	24	131,400
Effluent Treatment						
Clarifier Mechanism	0.75	1	0.75	559	24	4,899
Sludge Pump	20.00	1	20.00	14,914	24	130,647
Mixing Tank Mixer	3	1	3.00	2,237	24	19,597
Membrane Process Pumps	15.00	8.00	120.00	487,000	1	177,755
Membrane Blowers	90.00	2.00	180.00	335,000	1	122,275
Membrane CIP Pumps	15.00	1.00	15.00	116,000	1	42,340
Membrane CIP Heaters	NA			800,000	1	292,000
Membrane Backpulse Pump	60.00	2.00	120.00	70,000	1	25,550
Membrane Drain Pump	15.00	1.00	15.00	116,000	1	42,340
					kW-hrs/year =	5,984,962
					$/kW-hrs =	$0.12
						Annual Cost
						$718,195
Estimated Annual Replacement Costs						**Annual Cost**
Annual Equipment Replacement						**$1,762,000**
Estimated Annual Labor Costs	**Days per Week**	**Hours per day**	**Personnel**	**Rate**	**OH/Fringe**	**Annual Cost**
Daily Operator Attention	5	8	2	$ 25.00	$ 15.00	**$104,000**
Chemicals	**Use (gpd)**	**Annual Use (gal)**	**Cost ($/gal)**	**event per year**		**Annual Cost**
Alum		7908	1.81			$14,313.48
25% Caustic		6570	1.92			$12,614.40
Hypo		18300	2.5			$45,750.00
Citric		38500	8.25			$317,625.00
Sodium Bisulfate		4400	3.4			$14,960.00
Sulfuric						$0.00
O2 Usage - Tank refill	6000	0.6	$ 3,600.00	12		$43,200.00
Adsorption Media Regen						$0.00

Estimated Annual Labor and Replacement Costs	$1,866,000
Estimated Annual Electricity and Chemical Usage Costs	$1,166,658
TOTAL	$3,033,000

New Hampshire Fish and Game Department

Effluent Treatment Evaluation

Alternative 2A: 75% Recirculation with Chemical Dosing

Life Cycle Cost Analysis

	Total	0 2023	1 2024	2 2025	3 2026	4 2027	5 2028	6 2029	7 2030	8 2031	9 2032
O&M											
Power and Chemical cost (6%/yr 2023-2026, 3%/yr 2027-2042 escalation)		$3,033,000	$3,214,980	$3,407,879	$3,612,352	$3,720,722	$3,832,344	$3,947,314	$4,065,733	$4,187,705	$4,313,337
R&R Maintenance cost (6%/yr 2023-2026, 4%/yr 2027-2042 escalation)		$609,180	$645,731	$684,475	$725,543	$754,565	$784,747	$816,137	$848,783	$882,734	$918,044
Total O&M Cost		**$3,642,180**	$3,860,711	$4,092,353	$4,337,895	$4,475,287	$4,617,091	$4,763,451	$4,914,516	$5,070,440	$5,231,380
Average Annual O&M Cost over 20 years ($/yr)	$5,369,966										
Average Annual O&M Cost over 10 years ($/yr)	$4,500,530										
Capital Cost		**$74,218,000**									
Equipment Cost		**$20,306,000**									
Net Present Value (at 5% discount rate)											
20 Year Net Present Value	$137,643,717										
10 Year Net Present Value	**$108,436,000**										
Annual Cost											
Average Annual Cost (Debt Service + O&M, 20 year basis)	$11,325,410										
Average Annual Cost (Debt Service + O&M, 10 year basis)	$14,112,101										

	10 2033	11 2034	12 2035	13 2036	14 2037	15 2038	16 2039	17 2040	18 2041	19 2042
Power and Chemical cost (6%/yr 2023-2026, 3%/yr 2027-2042 escalation)	$4,442,737	$4,576,019	$4,713,299	$4,854,698	$5,000,339	$5,150,350	$5,304,860	$5,464,006	$5,627,926	$5,796,764
R&R Maintenance cost (6%/yr 2023-2026, 4%/yr 2027-2042 escalation)	$954,765	$992,956	$1,032,674	$1,073,981	$1,116,940	$1,161,618	$1,208,083	$1,256,406	$1,306,662	$1,358,929
Total O&M Cost	$5,397,502	$5,568,975	$5,745,974	$5,928,679	$6,117,280	$6,311,967	$6,512,943	$6,720,412	$6,934,588	$7,155,692

New Hampshire Fish and Game Department

Effluent Treatment Evaluation

Alternative 2B: 75% Recirculation with Adsorption Units

Operation and Maintenance

Component	HP	Quantity	Total HP	Watts	Hours/day	kW-hrs/year
Hatchery Modernization						
UV System		8		56,000	24	3,924,480
Drum Filter	8.0	8.0	64.00	47,725	24	418,069
Recirc. Pump	15.0	6.0	90.00	67,113	24	587,910
Site Lighting		1		15,000	12	65,700
Miscellaneous (SCADA, Meters, etc.)		1		15,000	24	131,400
			0.00	0	24	0
Effluent Treatment						
Clarifier Mechanism	0.75	1	0.75	559	24	4,899
Sludge Pump	20.00	1	20.00	14,914	24	130,647
Mixing Tank Mixer	0	1	0.00	0	24	0
Membrane Process Pumps	15.00	8.00	120.00	487,000	1	177,755
Membrane Blowers	90.00	2.00	180.00	335,000	1	122,275
Membrane CIP Pumps	15.00	1.00	15.00	116,000	1	42,340
Membrane CIP Heaters	NA			800,000	1	292,000
Membrane Backpulse Pump	60.00	2.00	120.00	70,000	1	25,550
Membrane Drain Pump	15.00	1.00	15.00	116,000	1	42,340
					kW-hrs/year =	5,965,365
					$/kW-hrs =	$0.12
						Annual Cost
						$715,843.78
						Annual Cost
Estimated Annual Replacement Costs						**Annual Cost**
Annual Equipment Replacement						**$1,915,000.00**
Estimated Annual Labor Costs	**Days per Week**	**Hours per day**	**Personnel**	**Rate**	**OH/Fringe**	**Annual Cost**
Daily Operator Attention	5	8	2	$ 25.00	$ 15.00	**$104,000**
Chemicals	**Use (gpd)**	**Annual Use (gal)**	**Cost ($/gal)**	**event per year**		**Annual Cost**
Alum		0	1.81			$0
25% Caustic		0	1.92			$0
Hypo		18300	2.5			$45,750
Citric		38500	8.25			$317,625
Sodium Bisulfate		4400	3.4			$14,960
Sulfuric						$0

O2 Usage - Tank refill	6000	0.6	$ 3,600.00	12		$43,200.00
Adsorption Media Regen						$131,102.49

Estimated Annual Labor and Replacement Costs	**$2,019,000**
Estimated Annual Electricity and Chemical Usage Costs	**$1,268,481**
TOTAL	**$3,288,000**

New Hampshire Fish and Game Department

Effluent Treatment Evaluation

Alternative 2B: 75% Recirculation with Adsorption Units

Life Cycle Cost Analysis

	Total	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
		2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
O&M																					
Power and Chemical cost (6%/yr 2023-2026, 3%/yr 2027-2042 escalation)		$3,288,000	$3,485,280	$3,694,397	$3,916,061	$4,033,542	$4,154,549	$4,279,185	$4,407,561	$4,539,788	$4,675,981	$4,816,261	$4,960,748	$5,109,571	$5,262,858	$5,420,744	$5,583,366	$5,750,867	$5,923,393	$6,101,095	$6,284,128
R&R Maintenance cost (6%/yr 2023-2026, 4%/yr 2027-2042 escalation)		$662,040	$701,762	$743,868	$788,500	$820,040	$852,842	$886,956	$922,434	$959,331	$997,704	$1,037,613	$1,079,117	$1,122,282	$1,167,173	$1,213,860	$1,262,414	$1,312,911	$1,365,427	$1,420,044	$1,476,846
Total O&M Cost		**$3,950,040**	$4,187,042	$4,438,265	$4,704,561	$4,853,583	$5,007,391	$5,166,141	$5,329,994	$5,499,119	$5,673,686	$5,853,873	$6,039,865	$6,231,853	$6,430,031	$6,634,604	$6,845,780	$7,063,778	$7,288,820	$7,521,139	$7,760,974
Average Annual O&M Cost over 20 years ($/yr)	$5,824,027																				
Average Annual O&M Cost over 10 years ($/yr)	$4,880,982																				
Capital Cost		**$78,284,000**																			
Equipment Cost		**$22,068,000**																			
Net Present Value (at 5% discount rate)																					
20 Year Net Present Value	$147,072,365																				
10 Year Net Present Value	**$115,395,000**																				
Annual Cost																					
Average Annual Cost (Debt Service + O&M, 20 year basis)	$12,105,738																				
Average Annual Cost (Debt Service + O&M, 10 year basis)	$15,019,118																				

Client: NHFGD
Project:Powder Mill Fish Hatchery Study
Project No.: 10331124

Date: 10/13/2022
Estimator: Matt Cochran & Mario Benisch
Checked By: Jason Hill
Check Date: 12/27/2022
Revised: -

Detailed Opinions of Probable Cost						
	Alternative 3	NO. UNITS	UNIT MEAS.	COST PER UNIT	Escalation cost to 2022	TOTAL COST 50% CONT.
A.	**Aquaculture Water Supply**					
A1	**Hatchery Supply**					**$246,695**
	Water Supply Piping and Accessories	1460	LF	$ 85	$ 113	$ 246,695
B.	**Buildings and Rearing Units**					
B1	**Intake Building**					**$ 1,623,787**
	New Intake Building	400	SF	$ 165	$ 218	$ 131,017
	Drumfilter					
	DRUM FILTERS	2	EA	$ 50,000	-	$ 150,000
	DRUM SUMP	1	LS	$ 75,000	-	$ 112,500
	PIPING SYSTEMS (INFLOW, DRAINS)	1	LS	$ 500,000	-	$ 750,000
	PRIMARY POWER	1	LS	$ 75,000	-	$ 112,500
	UV System		0			
	UV Channel and Lamp Package	2	EA	$ 60,000	-	$ 180,000
	UV Electrical	1	LS	$ 8,000	$ 10,602	$ 15,903
	UV Plumbing	1	LS	$ 11,000	$ 14,578	$ 21,867
	ALARMS/CONTROLS/MONITORING/PANEL/HMI	1	LS	$ 100,000	-	$ 150,000
B2	**Effluent Treatment Building**					**$1,959,037.50**
	New Effluent treatment building	5,488	SF	$165.00	$ 238	$ 1,959,038

B3	**Vehicle/Chemical Storage Building**					**$ 655,999**
	New Storage Building (40'x50')	2000	SF	$ 165	$ 219	$ 655,999
B5	**Hatchery Building**					**$4,229,021.87**
	New Hatchery Building - Office Space	3700	SF	$165.00	$ 218	$ 1,211,910
	POWER AND LIGHTING	3700	SF	$ 50	$103.40	$ 573,847
	HVAC	1	LS	$ 100,000	$206,791.77	$ 310,188
	EQUIPMENT					
	FEEDERS (SWEENEY MDL AF7 W/CONTROLLER & SUPPORT)	72	EA	$ 600	$1,240.75	$ 134,001
	FG TROUGHS (12'x2'x2')	42	EA	$ 2,500	$5,169.79	$ 325,697
	INCUBATION ROOM 30 HEATH STACKS	12	EA	$ 2,500	$5,169.79	$ 93,056
	INCUBATION HEAD TROUGHS AND CONTROLS	2	LS	$ 15,000	$31,018.77	$ 93,056
	CHILLER SYSTEM AND CONTROLS	1	LS	$ 250,000	$516,979.42	$ 775,469
	FORMALIN ROOM	1	LS	$ 50,000	$103,395.88	$ 155,094
	BOOT LOCKER ROOM, W/D, BENCHES	1	LS	$ 50,000	$103,395.88	$ 155,094
	WATER QUALITY ROOM EQUIP ALLOWANCE	1	LS	$ 75,000	$155,093.83	$ 232,641
	Hatchery Building Aeration/Degassing System					
	Primary Headtank & Aeration/Degassing System	1	EA	$ 85,000	$ 112,646	$ 168,969
B6	**Rearing Building**					**$31,951,818.18**
	New Rearing Building (526x140)	73,640	SF	$ 165	$ 218	$ 24,120,276
	ALARMS/CONTROLS/MONITORING/PANEL/HMI	1	LS	$ 100,000	-	$ 150,000
	VFD W/CIRCUIT BREAKER AND FULL CONTACTOR SET	2	EA	$ 25,000	-	$ 75,000
	PANEL/RACK/WIRING/CONDUITS/FEEDER	2	EA	$ 55,000	-	$ 165,000
	12" FLOW METER	2	EA	$ 18,000	-	$ 54,000
	EQUIPMENT					
	20' dia. SS Culture Tank with Foundation & Floor	20	EA	$ 35,000	-	$ 1,050,000
	40' dia. SS Culture Tank with Foundation & Floor	16	EA	$ 50,000	-	$ 1,200,000
	Drumfilter					
	DRUM FILTERS	6	EA	$ 50,000	-	$ 450,000
	DRUM SUMP	1	LS	$ 75,000	-	$ 112,500
	PRIMARY POWER	1	LS	$ 75,000	-	$ 112,500
	UV System		0			

	UV Channel and Lamp Package	6	EA	$ 60,000	-	$ 540,000
	UV Electrical	1	LS	$ 8,000	$ 10,602	$ 15,903
	UV Plumbing	1	LS	$ 11,000	$ 14,578	$ 21,867
	Recirculation					
	PIPING SYSTEMS (INFLOW, PRAS, DRAINS)	1	LS	$ 500,000	-	$ 750,000
	Lift Pump	6	EA	$ 80,000	-	$ 720,000
	4ft Precast Manhole 4 ft deep	6	EA	$ 4,200	$6,641.45	$ 59,773
	Biofilter System					
	MBBR	6	EA	$ 200,000	-	$ 1,800,000
	HVAC	1	LS	$ 100,000	-	$ 150,000
	GAS MANAGEMENT TOWER CO2 STRIPPER/LHO	6	EA	$ 45,000	-	$ 405,000

C.	**Site**					
C1	**Site Work**					**$835,155.69**
	Site Clearing	2.5	AC	$2,000.00	$2,650.50	$ 9,939
	General Earthwork for Hatchery Complex	1	LS	$75,000.00	$99,393.71	$ 149,091
	General Sitework	1	LS	$250,000.00	$331,312.38	$ 496,969
	Erosion Control	20	AC	$2,500.00	$3,313.12	$ 99,394
	Seeding	1	AC	$1,250.00	$1,656.56	$ 2,485
	Landscaping	1	AC	$3,000.00	$3,975.75	$ 5,964
	Natural Gas Connection and Distribution (if available)	0	LS	$35,000.00	$46,383.73	$ -
	Stormwater Management System	10.3	AC	$3,500.00	$4,638.37	$ 71,315
C2	**Security Fence**					**$3,975.75**
	Site Fencing	100	LF	$20.00	$26.50	$ 3,976
C3	**Domestic Water**					**$49,696.86**
	Domestic Water Supply	1	LS	$25,000.00	$33,131.24	$ 49,697
C4	**Domestic Wastewater**	1		$2,500.00		**$99,393.71**
	Domestic Wastewater System	1	LS	$50,000.00	$66,262.48	$ 99,394
C5	**Disinfection Station**					**$22,500.00**
	Truck Disinfection Station	1	LS	$15,000.00	-	$ 22,500

	Roadway Aggregate	0	SY	$15.00	-	$ -
	Electrical	0	LS	$2,500.00	-	$ -
	Detention Tank	0	LS	$5,000.00	-	$ -
C6	**Paved Access to State or Local Highways**	0		$0.00		**$377,696.12**
	Bituminous Paved Road	1	LS	$190,000.00	$251,797.41	$ 377,696
	Gravel Roads	0	LS	$55,000.00	$72,888.72	$ -
D.	**Aquaculture Wastewater**					
D1	**Effluent Treatment**					**$12,232,401**
	Clarifier-40ft					
	Clarifier Concrete	211	CY	$ 1,500	-	$ 474,750
	Clarifier Excavation	898	CY	$ 50	-	$ 67,350
	Clarifier Equipment	1	LS	$ 144,000	$ 227,707	$ 341,560
	Clarifier Coatings	1	LS	$ 16,000	$ 25,301	$ 37,951
	Finger Weirs	1	LS	$ 8,000	$ 12,650	$ 18,976
	Duplex Pump Station	1	LS	$ 24,000	$ 37,951	$ 56,927
	3" Sch 80 PVC Pipe	100	LF	$ 48	$ 76	$ 11,385
	4" Sch 80 PVC Pipe	250	LF	$ 80	$ 127	$ 47,439
	3" Plug Valves	2	EA	$ 4,000	$ 6,325	$ 18,976
	3" Swing Check Valves	2	EA	$ 2,720	$ 4,301	$ 12,903
	Telescoping Valves	2	EA	$ 1,520	$ 2,404	$ 7,211
	6 ft precast manhole 6 ft deep	2	EA	$ 12,000	$ 18,976	$ 56,927
	4ft Precast Manhole 4 ft deep	1	EA	$ 6,720	$ 10,626	$ 15,939
	Clarifier Equipment Install	1	LS	$ 28,800	$ 45,541	$ 68,312
	Sludge Storage-25ft					
	Sudge Storage Concrete	121	CY	$ 1,500	-	$ 272,250
	Sludge Storage Exavation	725	CY	$ 50	-	$ 54,375
	Sludge Mixing Pump	1	LS	$ 10,000	$ 15,813	$ 23,719
	Sludge Mixing Nozzles	1	LS	$ 35,000	$ 55,345	$ 83,018
	4" Sch 80 PVC Pipe	300	LF	$ 50	$ 79	$ 35,579
	Telescoping Valves	1	EA	$ 950	$ 1,502	$ 2,253
	3" Plug Valves	1	EA	$ 2,500	$ 3,953	$ 5,930
	3" Swing Check Valves	1	EA	$ 1,700	$ 2,688	$ 4,032

	Air Release Valve	2	EA	$ 450	$ 712	$ 2,135
	Sludge Mix & Transfer System Install	1	LS	$ 13,210	$ 20,889	$ 31,333
	Phosphorus Removal					
	Membrane					
	Membrane Filtration System	1	EA	$ 4,480,000	-	$ 6,720,000
	Chemical Storage Membrane Cleaning	1	EA	$ 7,800	-	$ 11,700
	Membrane Install (25% of Materials)	1	LS	$ 1,121,950	-	$ 1,682,925
	Chemical Addition					
	Mixing/Reaction Tank Concrete	94	CY	$ 1,500	-	$ 211,500
	Mixing/Reaction Tank 2:1 Excavation	371	CY	$ 50	-	$ 27,825
	Mixing/Reaction Tank MISC Piping	1	LS	$ 40,000	-	$ 60,000
	Mixing/Reaction Mixing Pumps	1	EA	$ 47,802	-	$ 71,703
	Chemical Dosing	1	EA	$ 20,000	-	$ 30,000
	Chemical Storage Coagulation	1	EA	$ 2,515	-	$ 3,773
	Chemical Addition Install (25% of Materials)	1	LS	$ 62,829	-	$ 94,244
	Adsorption					
	Adsorption Columns	2	EA	$ 250,000	-	$ 750,000
	Adsorption Media	672	CF	$ 500	-	$ 504,000
	Asorption Install (25% of Materials)	1	LS	$ 209,000	-	$ 313,500

D2	**Effluent Monitoring**					**$64,605.91**
	Automated Flow Measurement Equipment	1	LS	$25,000.00	$ 33,131.24	$ 49,697
	Portable Composite Sampler	1	LS	$5,000.00	$ 6,626.25	$ 9,939
	Electrical	1	LS	$2,500.00	$ 3,313.12	$ 4,970

E.	**Electrical and HVAC**					
E1	**Electrical Service**					**$189,757.49**
	Security Lighting	8	EA	$2,500.00	$ 3,313.12	$ 39,757
	3-phase service	1	EA	$ 100,000	-	$ 150,000
E2	**Emergency Power**					**$216,678.30**

	Emergency Generator: 100-200kW	1	LS	$75,000.00	$ 99,393.71	$ 149,091
	Automatic Transfer Switch	1	LS	$20,000.00	$ 26,504.99	$ 39,757
	Fuel Tank	1	LS	$14,000.00	$ 18,553.49	$ 27,830
E3	**Instrumentation and Alarm System**					**$347,878.00**
	Instrumentation, Alarm System & Communication	1	LS	$175,000.00	$ 231,918.67	$ 347,878
F.	**Visitor Education/Interpretation**					
F1	**Hatchery Building - Displays**					**$817,500.00**
	Display Materials	1	LS	$20,000.00	-	$ 30,000
	New visitor's center building (Display Area, Public Restrooms, & Mechan	1500	SF	$350.00	-	$ 787,500
						$55,267,598

New Hampshire Fish and Game Department

Effluent Treatment Evaluation

Alternative 3B: 95% Recirculation and Chemical Dosing

Operation and Maintenance

Component	HP	Quantity	Total HP	Watts	Hours/day	kW-hrs/year
Hatchery Modernization						
UV System		8		56,000	24	3,924,480
Drum Filter	8.0	8.0	64.00	47,725	24	418,069
Recirc. Pump	15.0	6.0	90.00	67,113	24	587,910
Site Lighting		1		15,000	12	65,700
Miscellaneous (SCADA, Meters, etc.)		1		15,000	24	131,400
MBBR-Blower	15.00	6	90.00	67,113	24	587,910
Effluent Treatment						
Clarifier Mechanism	0.75	1	0.75	559	24	4,899
Sludge Pump	20.00	1	20.00	14,914	24	130,647
Mixing Tank Mixer	2.00	1	2.00	1,491	24	13,065
Membrane Process Pumps	15.00	3.00	45.00	115,000	1	41,975
Membrane Blowers	90.00	1.00	90.00	123,000	1	44,895
Membrane CIP Pumps	15.00	1.00	15.00	44,000	1	16,060
Membrane CIP Heaters	NA			300,000	1	109,500
Membrane Backpulse Pump	60.00	1.00	60.00	40,000	1	14,600
Membrane Drain Pump	15.00	1.00	15.00	45,000	1	16,425
					kW-hrs/year =	6,107,534
					$/kW-hrs =	$0.12
						Annual Cost
						$732,904.11
Estimated Annual Replacement Costs						**Annual Cost**
Annual Equipment Replacement						**$1,007,000.00**
Estimated Annual Labor Costs	**Days per Week**	**Hours per day**	**Personnel**	**Rate**	**OH/Fringe**	**Annual Cost**
Daily Operator Attention	5	8	2	$ 25.00	$ 15.00	**$104,000**
Chemicals	**Use (gpd)**	**Annual Use (gal)**	**Cost ($/gal)**			**Annual Cost**
Alum		8395	1.81			$15,194.95
25% Caustic		6935	1.92			$13,315.20
Hypo		6900	2.5			$17,250.00
Citric		14500	8.25			$119,625.00
Sodium Bisulfate		1700	3.4			$5,780.00
Sulfuric						$0.00

O2 Usage - Tank refill	6000	0.6	$ 3,600.00	12		$43,200.00
Adsorption Media Regen						$0.00

Estimated Annual Labor and Replacement Costs	**$1,111,000**
Estimated Annual Electricity and Chemical Usage Costs	**$947,269**
TOTAL	**$2,059,000**

New Hampshire Fish and Game Department

Effluent Treatment Evaluation

Alternative 3A: 95% Recirculation with Chemical Dosing

Life Cycle Cost Analysis

	Total	0 2023	1 2024	2 2025	3 2026	4 2027	5 2028	6 2029	7 2030	8 2031	9 2032
O&M											
Power and Chemical cost (6%/yr 2023-2026, 3%/yr 2027-2042 escalation)		$2,059,000	$2,182,540	$2,313,492	$2,452,302	$2,525,871	$2,601,647	$2,679,697	$2,760,087	$2,842,890	$2,928,177
R&R Maintenance cost (6%/yr 2023-2026, 4%/yr 2027-2042 escalation)		$347,910	$368,785	$390,912	$414,366	$430,941	$448,179	$466,106	$484,750	$504,140	$524,306
Total O&M Cost		**$2,406,910**	$2,551,325	$2,704,404	$2,866,668	$2,956,812	$3,049,826	$3,145,802	$3,244,837	$3,347,030	$3,452,482
Average Annual O&M Cost over 20 years ($/yr)	$3,542,404										
Average Annual O&M Cost over 10 years ($/yr)	$2,972,610										
Capital Cost		**$59,051,000**									
Equipment Cost		**$11,597,000**									
Net Present Value (at 5% discount rate)											
20 Year Net Present Value	$100,905,261										
10 Year Net Present Value	**$81,654,000**										
Annual Cost											
Average Annual Cost (Debt Service + O&M, 20 year basis)	$8,280,809										
Average Annual Cost (Debt Service + O&M, 10 year basis)	$10,619,984										

	10 2033	11 2034	12 2035	13 2036	14 2037	15 2038	16 2039	17 2040	18 2041	19 2042
Power and Chemical cost (6%/yr 2023-2026, 3%/yr 2027-2042 escalation)	$3,016,022	$3,106,503	$3,199,698	$3,295,689	$3,394,559	$3,496,396	$3,601,288	$3,709,327	$3,820,607	$3,935,225
R&R Maintenance cost (6%/yr 2023-2026, 4%/yr 2027-2042 escalation)	$545,278	$567,089	$589,773	$613,363	$637,898	$663,414	$689,950	$717,548	$746,250	$776,100
Total O&M Cost	$3,561,300	$3,673,592	$3,789,470	$3,909,052	$4,032,457	$4,159,810	$4,291,239	$4,426,875	$4,566,857	$4,711,325

New Hampshire Fish and Game Department

Effluent Treatment Evaluation

Alternative 3B: 95% Recirculation and Adsorption Units

Operation and Maintenance

Component	HP	Quantity	Total HP	Watts	Hours/day	kW-hrs/year
Hatchery Modernization						
UV System		8		56,000	24	3,924,480
Drum Filter	8.0	8.0	64.00	47,725	24	418,069
Recirc. Pump	15.0	6.0	90.00	67,113	24	587,910
Site Lighting		1		15,000	12	65,700
Miscellaneous (SCADA, Meters, etc.)		1		15,000	24	131,400
MBBR-Blower	15.00	6	90.00	67,113	24	587,910
Effluent Treatment						
Clarifier Mechanism	0.75	1	0.75	559	24	4,899
Sludge Pump	20.00	1	20.00	14,914	24	130,647
Mixing Tank Mixer	0.00	1	0.00	0	24	0
Membrane Process Pumps	15.00	3.00	45.00	115,000	1	41,975
Membrane Blowers	90.00	1.00	90.00	123,000	1	44,895
Membrane CIP Pumps	15.00	1.00	15.00	44,000	1	16,060
Membrane CIP Heaters	NA			300,000	1	109,500
Membrane Backpulse Pump	60.00	1.00	60.00	40,000	1	14,600
Membrane Drain Pump	15.00	1.00	15.00	45,000	1	16,425
					kW-hrs/year =	6,094,470
					$/kW-hrs =	$0.12
						Annual Cost
						$731,336.35
Estimated Annual Replacement Costs						**Annual Cost**
Estimated Annual Replacement Costs						**Annual Cost**
Annual Equipment Replacement						**$1,062,000.00**
Estimated Annual Labor Costs	**Days per Week**	**Hours per day**	**Personnel**	**Rate**	**OH/Fringe**	**Annual Cost**
Daily Operator Attention	5	8	2	$ 25.00	$ 15.00	**$104,000**
Chemicals	**Use (gpd)**	**Annual Use (gal)**	**Cost ($/gal)**			**Annual Cost**
Alum		0	1.81			$0
25% Caustic		0	1.92			$0
Hypo		6900	2.5			$17,250
Citric		14500	8.25			$119,625
Sodium Bisulfate		1700	3.4			$5,780
Sulfuric						$0

O2 Usage - Tank refill	6000	0.6	$ 3,600.00	12		$43,200.00
Adsorption Media Regen						$29,936.68

Estimated Annual Labor and Replacement Costs	**$1,166,000**
Estimated Annual Electricity and Chemical Usage Costs	**$947,128**
TOTAL	**$2,114,000**

New Hampshire Fish and Game Department
Effluent Treatment Evaluation
Alternative 3B: 95% Recirculation with Adsorption Units
Life Cycle Cost Analysis

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	Total	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
O&M																					
Power and Chemical cost (6%/yr 2023-2026, 3%/yr 2027-2042 escalation)		$2,114,000	$2,240,840	$2,375,290	$2,517,808	$2,593,342	$2,671,142	$2,751,277	$2,833,815	$2,918,829	$3,006,394	$3,096,586	$3,189,484	$3,285,168	$3,383,723	$3,485,235	$3,589,792	$3,697,486	$3,808,410	$3,922,663	$4,040,342
R&R Maintenance cost (6%/yr 2023-2026, 4%/yr 2027-2042 escalation)		$367,230	$389,264	$412,620	$437,377	$454,872	$473,067	$491,989	$511,669	$532,136	$553,421	$575,558	$598,580	$622,524	$647,425	$673,321	$700,254	$728,265	$757,395	$787,691	$819,199
Total O&M Cost		**$2,481,230**	$2,630,104	$2,787,910	$2,955,185	$3,048,214	$3,144,209	$3,243,266	$3,345,484	$3,450,965	$3,559,815	$3,672,144	$3,788,064	$3,907,692	$4,031,148	$4,158,556	$4,290,046	$4,425,750	$4,565,805	$4,710,353	$4,859,541
Average Annual O&M Cost over 20 years ($/yr)	$3,652,774																				
Average Annual O&M Cost over 10 years ($/yr)	$3,064,638																				
Capital Cost		**$60,406,000**																			
Equipment Cost		**$12,241,000**																			
Net Present Value (at 5% discount rate)																					
20 Year Net Present Value	$103,562,072																				
10 Year Net Present Value	**$83,708,000**																				
Annual Cost																					
Average Annual Cost (Debt Service + O&M, 20 year basis)	$8,499,908																				
Average Annual Cost (Debt Service + O&M, 10 year basis)	$10,887,492																				

Client: NHFGD
Project:Powder Mill Fish Hatchery Study
Project No.: 10331124

Date: 1/12/2023
Estimator: Matt Cochran & Mario Benisch
Checked By: Jason Hill
Check Date:
Revised: -

Detailed Opinions of Probable Cost

	Alternative 1	NO. UNITS	UNIT MEAS.	COST PER UNIT	Escalation cost to 2022	TOTAL COST 50% CONT.
A.	**Aquaculture Water Supply**					
A1	**Hatchery Supply**					**$ 229,345**
	Water Supply Piping and Accessories	150	LF	$ 85	$ 113	$ 25,345
	Cold Brook Diversion Dam & Dist. Box Structural Upgrades	1	LS	$ 9,000	-	$ 13,500
	Cold Brook Diversion Dam & Dist. Box Process Upgrades	1	LS	$ 35,000	-	$ 52,500
	Salmon Pond Outlet Structural Upgrades	1	LS	$ 5,000	-	$ 7,500
	Salmon Pond Outlet Process Upgrades	1	LS	$ 15,000	-	$ 22,500
	Lime Mill Structural Upgrades	1	LS	$ 1,000	-	$ 1,500
	Lime Mill Process Upgrades	1	LS	$ 15,000	-	$ 22,500
	Third Brook Intake Structural Upgrades	1	LS	$ 2,500	-	$ 3,750
	Third Brook Intake Process Upgrades	1	LS	$ 8,000	-	$ 12,000
	West Branch Diversion Dam Structural Upgrades	1	LS	$ 8,000	-	$ 12,000
	West Branch Diversion Dam Process Upgrades	1	LS	$ 15,000	-	$ 22,500
	No.9 Brook and Diversion Pond Structural Upgrades	1	LS	$ 15,000	-	$ 22,500
	No.9 Brook and Diversion Pond Process Upgrades	1	LS	$ 7,500	-	$ 11,250
A2	**Oxygenation System**					**$ 1,022,003**
	Bulk LOX Tank, Vaporizer, Port. Tank Fill System	2	LS	$ 150,000	$ 198,787	$ 596,362
	Fence	400	LF	$ 20	$ 27	$ 15,903
	Concrete Pad & Bollards	2	LS	$ 11,000	$ 14,578	$ 43,733
	Buried Copper Oxygen Distribution to Units	2	LS	$ 60,000	$ 79,515	$ 238,545
	Oxygen Electrical	2	LS	$ 5,000	$ 6,626	$ 19,879
	Oxygen Dissolving for Rearing Units- LHO	24	EA	$ 2,500	$ 2,906	$ 104,599
	Oxygen Flow Meter Station (raceways)	2	LS	$ 750	$ 994	$ 2,982

B.	**Buildings and Rearing Units**					
B1	**Cold Brook and Wells Intake Building**					**$ 1,588,544**
	New Intake Building Cold Brook and Wells	400	SF	$ 165	$ 218	$ 131,017
	Drumfilter					
	DRUM FILTERS - Cold Brook and wells	2	EA	$ 75,000	-	$ 225,000
	DRUM SUMP	1	LS	$ 75,000	-	$ 112,500
	PIPING SYSTEMS (INFLOW, DRAINS)	1	LS	$ 500,000	-	$ 750,000
	PRIMARY POWER	1	LS	$ 75,000	-	$ 112,500
	UV System					
	UV Channel and Lamp Package - Cold Brook and wells	2	EA	$ 50,000	-	$ 150,000
	UV Electrical	1	LS	$ 8,000	$ 10,602	$ 15,903
	UV Plumbing	1	LS	$ 11,000	$ 14,578	$ 21,867
	Electrical Power and Lighting	1	LS	$ 20,000	$ 26,505	$ 39,757
	ALARMS/CONTROLS/MONITORING/PANEL/HMI	1	LS	$ 20,000	-	$ 30,000
B2	**West Branch Intake Building**					**$ 1,568,666**
	New Intake Building West Branch	400	SF	$ 165	$ 218	$ 131,017
	Drumfilter					
	DRUM FILTERS - West Branch	2	EA	$ 75,000	-	$ 225,000
	DRUM SUMP	1	LS	$ 75,000	-	$ 112,500
	PIPING SYSTEMS (INFLOW, DRAINS)	1	LS	$ 500,000	-	$ 750,000
	PRIMARY POWER	1	LS	$ 75,000	-	$ 112,500
	UV System					
	UV Channel and Lamp Package - West Branch	2	EA	$ 50,000	-	$ 150,000
	UV Electrical	1	LS	$ 8,000	$ 10,602	$ 15,903
	UV Plumbing	1	LS	$ 11,000	$ 14,578	$ 21,867
	Electrical Power and Lighting	1	LS	$ 10,000	$ 13,252	$ 19,879
	ALARMS/CONTROLS/MONITORING/PANEL/HMI	1	LS	$ 20,000	-	$ 30,000
B3	**Effluent Treatment Building**					**$ 2,943,019**
	New Effluent treatment building	8243.75	SF	$ 165	$ 238	$ 2,943,019
B4	**Raceway Rehabilitation**					**$ 1,353,750**
	Concrete rehab of the Young's and Foster's Raceways	1	LS	$ 50,000	-	$ 75,000
	Process rehab Young's and Foster Raceways	1	LS	$ 60,000	-	$ 90,000
	Concrete rehab of the West Branch Raceways	1	LS	$ 625,000	-	$ 937,500
	Process Rehab West Branch Raceways	1	LS	$ 7,500	-	$ 11,250
	Demolish and fill in Upper Canals	1	LS	$ 60,000	-	$ 90,000
	Baffle Allowance	1	LS	$ 100,000	-	$ 150,000
B7	**Existing Building Rehab**					**$ 1,145,725**
	Headquarter Office and Hatchery Building	1	LS	$ 237,500		$ 237,500
	Well House 1 (New Well, Well House & Equipment)	1	LS	$ 49,000		$ 49,000

	Well House 2 (New Well, Well House & Equipment)	1	LS	$ 49,000		$ 49,000
	Feed Storage Building	1	LS	$ 227,250		$ 227,250
	Pipe Shop	1	LS	$ 241,975		$ 241,975
	Carptenters Shop	1	LS	$ 21,000		$ 21,000
	West Branch Garage	1	LS	$ 5,000		$ 5,000
	Salmon Building - Demolish	1	LS	$ 15,000		$ 15,000
	Replace Pole Shed w/ Maintenance & Storage Garage	2000	SF	$ 150		$ 300,000
C.	**Site**					
C1	**Site Work**					**$506,907.95**
	Site Clearing	2.5	AC	$2,000.00	$2,650.50	$ 9,939
	General Earthwork for Hatchery Complex	0	LS	$75,000.00	$99,393.71	$ -
	General Sitework	1	LS	$250,000.00	$331,312.38	$ 496,969
	Erosion Control	0	AC	$2,500.00	$3,313.12	$ -
	Seeding	0	AC	$1,250.00	$1,656.56	$ -
	Landscaping	0	AC	$3,000.00	$3,975.75	$ -
	Natural Gas Connection and Distribution (if available)	0	LS	$35,000.00	$46,383.73	$ -
	Stormwater Management System	0.0	AC	$3,500.00	$4,638.37	$ -
C2	**Domestic Water**			$150.00		**$49,696.86**
	Domestic Water Supply	1	LS	$25,000.00	$33,131.24	$ 49,697
C3	**Domestic Wastewater**			$100,000.00		**$99,393.71**
	Domestic Wastewater System	1	LS	$50,000.00	$66,262.48	$ 99,394
C4	**Disinfection Station**					**$45,000.00**
	Truck Disinfection Station	1	LS	$30,000.00	-	$ 45,000
	Roadway Aggregate	0	SY	$30.00	-	$ -
	Electrical	0	LS	$5,000.00	-	$ -
	Detention Tank	0	LS	$10,000.00	-	$ -
C5	**Paved Access to State or Local Highways**	0		$0.00		**$377,696.12**
	Bituminous Paved Road	1	LS	$190,000.00	$251,797.41	$ 377,696
	Gravel Roads	0	LS	$55,000.00	$72,888.72	$ -
D.	**Aquaculture Wastewater**					
D1	**Effluent Treatment**					**$ 29,804,245**

	Drumfilter					
	DRUM FILTERS	2	EA	$ 150,000	-	$ 450,000
	DRUM SUMP	1	LS	$ 75,000	-	$ 112,500
	PIPING SYSTEMS (INFLOW, PRAS, DRAINS)	1	LS	$ 500,000	-	$ 750,000
	PRIMARY POWER	1	LS	$ 75,000	-	$ 112,500
	Clarifier-30ft					
	Clarifier Concrete	142	CY	$ 1,500	-	$ 319,500
	Clarifer Excavation	642	CY	$ 50	-	$ 48,150
	Clarifier Equipment	1	LS	$ 108,000	$ 170,780	$ 256,170
	Clarifier Coatings	1	LS	$ 12,000	$ 18,976	$ 28,463
	Finger Weirs	1	LS	$ 6,000	$ 9,488	$ 14,232
	Duplex Pump Station	1	LS	$ 18,000	$ 28,463	$ 42,695
	3" Sch 80 PVC Pipe	100	LF	$ 36	$ 57	$ 8,539
	4" Sch 80 PVC Pipe	250	LF	$ 60	$ 95	$ 35,579
	3" Plug Valves	2	EA	$ 3,000	$ 4,744	$ 14,232
	3" Swing Check Valves	2	EA	$ 2,040	$ 3,226	$ 9,678
	Telescoping Valves	2	EA	$ 1,140	$ 1,803	$ 5,408
	6 ft precast manhole 6 ft deep	2	EA	$ 9,000	$ 14,232	$ 42,695
	4ft Precast Manhole 4 ft deep	1	EA	$ 5,040	$ 7,970	$ 11,955
	Clarifier Equipment Install	1	LS	$ 21,600	$ 34,156	$ 51,234
	Sludge Storage-25ft					
	Sudge Storage Concrete	121	CY	$ 1,500	-	$ 272,250
	Sludge Storage Exavation	725	CY	$ 50	-	$ 54,375
	Sludge Mixing Pump	1	LS	$ 10,000	$ 15,813	$ 23,719
	Sludge Mixing Nozzles	1	LS	$ 35,000	$ 55,345	$ 83,018
	4" Sch 80 PVC Pipe	300	LF	$ 50	$ 79	$ 35,579
	Telescoping Valves	1	EA	$ 950	$ 1,502	$ 2,253
	3" Plug Valves	1	EA	$ 2,500	$ 3,953	$ 5,930
	3" Swing Check Valves	1	EA	$ 1,700	$ 2,688	$ 4,032
	Air Release Valve	2	EA	$ 450	$ 712	$ 2,135
	Sludge Mix & Transfer System Install	1	LS	$ 13,210	$ 20,889	$ 31,333
	WW Piping					
	WW Sitework	1	LS	$ 40,000	$ 53,010	$ 79,515
	Electrical Power and Lighting	1	LS	$ 200,000	$ 265,050	$ 397,575
	Phosphorus Removal					

	Membrane					
	Membrane Filtration System	1	EA	$ 11,078,500	-	$ 16,617,750
	Chemical Storage Membrane Cleaning	1	EA	$ 8,700	-	$ 13,050
	Membrane Install (25% of Materials)	1	LS	$ 2,771,800	-	$ 4,157,700
	Adsorption					
	Adsorption Columns	1	LS	$ 1,442,600	-	$ 2,163,900
	Adsorption Media	1	LS	$ 1,603,000	-	$ 2,404,500
	Asorption Install (25% of Materials)	1	LS	$ 761,400	-	$ 1,142,100
D2	**Effluent Monitoring**					**$ 69,576**
	Automated Flow Measurement Equipment	1	LS	$ 25,000	$ 33,131	$ 49,697
	Portable Composite Sampler	1	LS	$ 5,000	$ 6,626	$ 9,939
	Electrical	1	LS	$ 5,000	$ 6,626	$ 9,939
D3	**West Branch Pumping**					**$ 2,619,660**
	WW Piping line	1300	LF	$ 85	$ 113	$ 219,660
	West Branch Pump Station	1	LS	$ 1,600,000	-	$ 2,400,000
D4	**Young's and Foster's Pumping**					**$ 2,125,345**
	WW Piping line	150	LF	$ 85	$ 113	$ 25,345
	Young's and Foster's Pump Station	1	LS	$ 1,400,000	-	$ 2,100,000
E.	**Utilities (Electrical, HVAC and Instrumentation)**					
E1	**Electrical Service**					**$ 225,000**
	3-phase service - Effluent treatment plant	1	LS	$ 100,000	-	$ 150,000
	New Service Connections - Intakes, Pump Stations, Garage	1	LS	$ 50,000	-	$ 75,000
E2	**Emergency Power**					**$ 297,000**
	Emergency Generators: Hatchery and Wells, 100kW	2	LS	$ 75,000	-	$ 225,000
	Automatic Transfer Switch	2	LS	$ 10,000	-	$ 30,000
	Fuel Tank	2	LS	$ 14,000	-	$ 42,000
E3	**Instrumentation and Alarm System**					**$ 298,181**
	Instrumentation, Alarm System & Communication	1	LS	$ 150,000	$ 198,787	$ 298,181
F.	**Visitor Education/Interpretation**					
F1	**Visitor Center Repairs**					**$53,250.00**

	Replace egress door on north face	1	EA	$ 2,500	-	$ 3,750
	Fix / replace door sills for ADA compliance	3	EA	$ 1,000	-	$ 4,500
	Replace Carpet	1000	SF	$ 5	-	$ 7,500
	New Digital Display	1	LS	$ 5,000	-	$ 7,500
	Convert Storage Room to Bathroom	1	LS	$ 20,000	-	$ 30,000
						$ 46,422,003

Powder Mill New Facility Summary Opinions of Probable Cost

ITEM	DRAWING I.D. #	ROUNDED TOTAL COST[a]
New Facility Features		
Hatchery Supply	A1	$230,000
Oxygenation System	A2	$1,023,000
Cold Brook and Wells Intake Building	B1	$1,589,000
West Branch Intake Building	B2	$1,569,000
Effluent Treatment Building	B3	$2,944,000
Raceway Rehabilitation	B4	$1,354,000
Existing Building Rehab	B7	$1,146,000
Site Work	C1	$507,000
Domestic Water	C2	$50,000
Domestic Wastewater	C3	$100,000
Disinfection Station	C4	$45,000
Paved Access to State or Local Highways	C5	$378,000
Effluent Treatment	D1	$29,805,000
Effluent Monitoring	D2	$70,000
West Branch Pumping	D3	$2,620,000
Young's and Foster's Pumping	D4	$2,126,000
Electrical Service	E1	$225,000
Emergency Power	E2	$297,000
Instrumentation and Alarm System	E3	$299,000
Visitor Center Repairs	F1	$54,000
Subtotal		**$46,431,000**
Escalation to Midpoint of Const. @ 5%/yr for 5 years		$2,322,000
3% market volatility adjustment		$1,392,930
Total Cost		**$50,146,000**

[a] Rounded Total Costs (or Costs needed to Budget) include 50% Class 4 AACE expected accuracy range).

Costs do **NOT** include: Design Reimbursables (Variable); State Agency Administrative Fee; and land acquisition or lease.

New Hampshire Fish and Game Department
Effluent Treatment Evaluation
Alternative 1: No Hatchery Upgrades and Adsorption Units
Operation and Maintenance

Component	HP	Quantity	Total HP	Watts	Hours/day	kW-hrs/year
Hatchery Modernization						
UV System - Cold Brook		2		25,331	24	443,796
UV System - Diversion Pond		2		33,570	24	588,148
Drum Filter	8.0	4.0	32.00	23,862	24	209,035
Site Lighting		1		15,000	12	65,700
Effluent Treatment						
Effluent Drums	8.00	2	16.00	11,931	24	104,517
Clarifier Mechanism	0.75	1	0.75	559	24	4,899
Sludge Pump	20.00	1	20.00	14,914	24	130,647
Youngs and Fosters Pump						480,000
The West Branch Pump						633,600
Membrane Process Pumps				465,663	1	169,967
Membrane Blowers				322,840	1	117,837
Membrane CIP Pumps				111,870	1	40,833
Membrane CIP Heaters				771,321	1	281,532
Membrane Backpulse Pump				68,279	1	24,922
Membrane Drain Pump				111,928	1	40,854
					kW-hrs/year =	3,336,286
					$/kW-hrs =	$0.12
						Annual Cost
						$400,354.30

Estimated Annual Replacement Costs						Annual Cost
Annual Equipment Replacement						$2,261,000.00
Estimated Annual Labor Costs	**Days per Week**	**Hours per day**	**Personnel**	**Rate**	**OH/Fringe**	**Annual Cost**
Daily Operator Attention	5	8	2	$ 25.00	$ 15.00	$104,000
Chemicals	**Use (gpd)**	**Annual Use (gal)**	**Cost ($/gal)**	**event per year**		**Annual Cost**
Hypo		17646.11603	2.5			$44,115
Citric		37123.40216	8.25			$306,268
Sodium Bisulfate		4245.132743	3.4			$14,433
Sulfuric						$0
O2 Usage - Tank refill		6000	0.6	3		$10,800
Adsorption Media Regen						$90,157
Estimated Annual Labor and Replacement Costs						**$2,365,000**
Estimated Annual Electricity and Chemical Usage Costs						**$866,128**
TOTAL						**$3,232,000**

New Hampshire Fish and Game Department

Effluent Treatment Evaluation

Alternative 1: No Hatchery Upgrades and Adsorption Units

Life Cycle Cost Analysis

	Total	0 2023	1 2024	2 2025	3 2026	4 2027	5 2028	6 2029	7 2030	8 2031	9 2032
O&M											
Power and Chemical cost (6%/yr 2023-2026, 3%/yr 2027-2042 escalation		$3,232,000	$3,425,920	$3,631,475	$3,849,364	$3,964,845	$4,083,790	$4,206,304	$4,332,493	$4,462,468	$4,596,342
R&R Maintenance cost (6%/yr 2023-2026, 4%/yr 2027-2042 escalation		$781,770	$828,676	$878,397	$931,101	$968,345	$1,007,078	$1,047,362	$1,089,256	$1,132,826	$1,178,139
Total O&M Cost		**$4,013,770**	$4,254,596	$4,509,872	$4,780,464	$4,933,189	$5,090,868	$5,253,665	$5,421,749	$5,595,294	$5,774,481
Average Annual O&M Cost over 20 years ($/yr)	$5,930,564										
Average Annual O&M Cost over 10 years ($/yr)	$4,962,795										
Capital Cost		**$46,422,000**									
Equipment Cost		**$26,059,000**									
Net Present Value (at 5% discount rate)											
20 Year Net Present Value	$116,440,284										
10 Year Net Present Value	**$84,152,000**										
Annual Cost											
Average Annual Cost (Debt Service + O&M, 20 year basis)	$9,655,585										
Average Annual Cost (Debt Service + O&M, 10 year basis)	$10,974,656										

	10 2033	11 2034	12 2035	13 2036	14 2037	15 2038	16 2039	17 2040	18 2041	19 2042
Power and Chemical cost (6%/yr 2023-2026, 3%/yr 2027-2042 escalation	$4,734,232	$4,876,259	$5,022,547	$5,173,223	$5,328,420	$5,488,272	$5,652,920	$5,822,508	$5,997,183	$6,177,099
R&R Maintenance cost (6%/yr 2023-2026, 4%/yr 2027-2042 escalation	$1,225,265	$1,274,275	$1,325,246	$1,378,256	$1,433,387	$1,490,722	$1,550,351	$1,612,365	$1,676,860	$1,743,934
Total O&M Cost	$5,959,497	$6,150,534	$6,347,793	$6,551,479	$6,761,806	$6,978,994	$7,203,271	$7,434,873	$7,674,043	$7,921,033

Client: NHFGD
Project:Powder Mill Fish Hatchery Study
Project No.: 10331124

Date: 10/13/2022
Estimator: Matt Cochran & Mario Benisch
Checked By: Jason Hill
Check Date: 12/27/2022
Revised: -

Detailed Opinions of Probable Cost						
	Alternative 2	NO. UNITS	UNIT MEAS.	COST PER UNIT	Escalation cost to 2022	TOTAL COST 50% CONT.
A.	**Aquaculture Water Supply**					
A1	**Hatchery Supply**					**$488,379**
	Water Supply Piping and Accessories	2300	LF	$ 85	$ 113	$ 388,629
	Cold Brook Diversion Dam & Dist. Box Structural Upgrades	1	LS	$ 9,000	-	$ 13,500
	Cold Brook Diversion Dam & Dist. Box Process Upgrades	1	LS	$ 35,000	-	$ 52,500
	Salmon Pond Outlet Structural Upgrades	1	LS	$ 5,000	-	$ 7,500
	Salmon Pond Outlet Process Upgrades	1	LS	$ 15,000	-	$ 22,500
	Lime Mill Structural Upgrades	1	LS	$ 1,000	-	$ 1,500
	Lime Mill Process Upgrades	1	LS	$ 1,500	-	$ 2,250
B.	**Buildings and Rearing Units**					
B1	**Cold Brook and Wells Intake Building**					**$ 1,588,544**
	New Intake Building	400	SF	$ 165	$ 218	$ 131,017
	Drumfilter					
	DRUM FILTERS	2	EA	$ 75,000	-	$ 225,000
	DRUM SUMP	1	LS	$ 75,000	-	$ 112,500
	PIPING SYSTEMS (INFLOW, DRAINS)	1	LS	$ 500,000	-	$ 750,000
	PRIMARY POWER	1	LS	$ 75,000	-	$ 112,500
	UV System					
	UV Channel and Lamp Package	2	EA	$ 50,000	-	$ 150,000
	UV Electrical	1	LS	$ 8,000	$ 10,602	$ 15,903
	UV Plumbing	1	LS	$ 11,000	$ 14,578	$ 21,867

	Electrical Power and Lighting	1	LS	$ 20,000	$ 26,505	$ 39,757
	ALARMS/CONTROLS/MONITORING/PANEL/HMI	1	LS	$ 20,000	-	$ 30,000
B3	**Effluent Treatment Building**					**$1,959,037.50**
	New Effluent treatment building	5,488	SF	$165.00	$ 238	$ 1,959,038
B5	**Hatchery Building**					**$4,229,021.87**
	New Hatchery Building - Office Space	3700	SF	$165.00	$ 218	$ 1,211,910
	POWER AND LIGHTING	3700	SF	$ 50	$103.40	$ 573,847
	HVAC	1	LS	$ 100,000	$206,791.77	$ 310,188
	EQUIPMENT					
	FEEDERS (SWEENEY MDL AF7 W/CONTROLLER & SUPPORT)	72	EA	$ 600	$1,240.75	$ 134,001
	FG TROUGHS (12'x2'x2')	42	EA	$ 2,500	$5,169.79	$ 325,697
	INCUBATION ROOM 30 HEATH STACKS	12	EA	$ 2,500	$5,169.79	$ 93,056
	INCUBATION HEAD TROUGHS AND CONTROLS	2	LS	$ 15,000	$31,018.77	$ 93,056
	CHILLER SYSTEM AND CONTROLS	1	LS	$ 250,000	$516,979.42	$ 775,469
	FORMALIN ROOM	1	LS	$ 50,000	$103,395.88	$ 155,094
	BOOT LOCKER ROOM, W/D, BENCHES	1	LS	$ 50,000	$103,395.88	$ 155,094
	WATER QUALITY ROOM EQUIP ALLOWANCE	1	LS	$ 75,000	$155,093.83	$ 232,641
	Hatchery Building Aeration/Degassing System					
	Primary Headtank & Aeration/Degassing System	1	EA	$ 85,000	$ 112,646	$ 168,969
B6	**Rearing Building**					**$33,076,818.18**
	New Rearing Building (526x140)	73,640	SF	$ 165	$ 218	$ 24,120,276
	ALARMS/CONTROLS/MONITORING/PANEL/HMI	1	LS	$ 50,000	-	$ 75,000
	VFD W/CIRCUIT BREAKER AND FULL CONTACTOR SET	2	EA	$ 25,000	-	$ 75,000
	PANEL/RACK/WIRING/CONDUITS/FEEDER	2	EA	$ 55,000	-	$ 165,000
	12" FLOW METER	2	EA	$ 18,000	-	$ 54,000
	EQUIPMENT					
	20' dia. SS Culture Tank with Foundation & Floor	20	EA	$ 35,000	-	$ 1,050,000
	40' dia. SS Culture Tank with Foundation & Floor	16	EA	$ 50,000	-	$ 1,200,000
	Drumfilter					
	DRUM FILTERS	6	EA	$ 85,000	-	$ 765,000

	DRUM SUMP	1	LS	$ 75,000	-	$ 112,500
	PRIMARY POWER	1	LS	$ 75,000	-	$ 112,500
	UV System					
	UV Channel and Lamp Package	6	EA	$ 125,000	-	$ 1,125,000
	UV Electrical	1	LS	$ 8,000	$ 10,602	$ 15,903
	UV Plumbing	1	LS	$ 11,000	$ 14,578	$ 21,867
	Recirculation					
	PIPING SYSTEMS (INFLOW, PRAS, DRAINS)	1	LS	$ 500,000	-	$ 750,000
	Lift Pump	6	EA	$ 80,000	-	$ 720,000
	4ft Precast Manhole 4 ft deep	6	EA	$ 4,200	$6,641.45	$ 59,773
	Biofilter System					
	MBBR	6	EA	$ 200,000	-	$ 1,800,000
	HVAC	1	LS	$ 100,000	-	$ 150,000
	Electrical Power and Lighting	1	LS	$ 200,000	-	$ 300,000
	GAS MANAGEMENT TOWER CO2 STRIPPER/LHO	6	EA	$ 45,000	-	$ 405,000
B7	**Existing Building Rehab**					**$ 434,000**
	Well House 1 (New Well, Well House & Equipment)	1	LS	$ 49,000		$ 49,000
	Well House 2 (New Well, Well House & Equipment)	1	LS	$ 49,000		$ 49,000
	Salmon Building - Demolish	1	LS	$ 15,000		$ 15,000
	Replace Pole Shed w/ Maintenance & Storage Garage	2000	SF	$ 150		$ 300,000
	Carpenters Shop	1	LS	$ 21,000		$ 21,000

C.	**Site**					
C1	**Site Work**					**$835,155.69**
	Site Clearing	2.5	AC	$2,000.00	$2,650.50	$ 9,939
	General Earthwork for Hatchery Complex	1	LS	$75,000.00	$99,393.71	$ 149,091
	General Sitework	1	LS	$250,000.00	$331,312.38	$ 496,969
	Erosion Control	20	AC	$2,500.00	$3,313.12	$ 99,394
	Seeding	1	AC	$1,250.00	$1,656.56	$ 2,485
	Landscaping	1	AC	$3,000.00	$3,975.75	$ 5,964
	Natural Gas Connection and Distribution (if available)	0	LS	$35,000.00	$46,383.73	$ -
	Stormwater Management System	10.3	AC	$3,500.00	$4,638.37	$ 71,315
C2	**Domestic Water**					**$49,696.86**
	Domestic Water Supply	1	LS	$25,000.00	$33,131.24	$ 49,697

C3	**Domestic Wastewater**	1		$2,500.00		**$99,393.71**
	Domestic Wastewater System	1	LS	$50,000.00	$66,262.48	$ 99,394
C4	**Disinfection Station**					**$22,500.00**
	Truck Disinfection Station	1	LS	$15,000.00	-	$ 22,500
	Roadway Aggregate	0	SY	$15.00	-	$ -
	Electrical	0	LS	$2,500.00	-	$ -
	Detention Tank	0	LS	$5,000.00	-	$ -
C5	**Paved Access to State or Local Highways**	0		$0.00		**$377,696.12**
	Bituminous Paved Road	1	LS	$190,000.00	$251,797.41	$ 377,696
	Gravel Roads	0	LS	$55,000.00	$72,888.72	$ -
D.	**Aquaculture Wastewater**					
D1	**Effluent Treatment**					**$11,733,357**
	Clarifier-40ft					
	Clarifier Concrete	211	CY	$ 1,500	-	$ 474,750
	Clarifier Excavation	898	CY	$ 50	-	$ 67,350
	Clarifier Equipment	1	LS	$ 144,000	$ 227,707	$ 341,560
	Clarifier Coatings	1	LS	$ 16,000	$ 25,301	$ 37,951
	Finger Weirs	1	LS	$ 8,000	$ 12,650	$ 18,976
	Duplex Pump Station	1	LS	$ 24,000	$ 37,951	$ 56,927
	3" Sch 80 PVC Pipe	100	LF	$ 48	$ 76	$ 11,385
	4" Sch 80 PVC Pipe	250	LF	$ 80	$ 127	$ 47,439
	3" Plug Valves	2	EA	$ 4,000	$ 6,325	$ 18,976
	3" Swing Check Valves	2	EA	$ 2,720	$ 4,301	$ 12,903
	Telescoping Valves	2	EA	$ 1,520	$ 2,404	$ 7,211
	6 ft precast manhole 6 ft deep	2	EA	$ 12,000	$ 18,976	$ 56,927
	4ft Precast Manhole 4 ft deep	1	EA	$ 6,720	$ 10,626	$ 15,939
	Clarifier Equipment Install	1	LS	$ 28,800	$ 45,541	$ 68,312
	Sludge Storage-25ft					
	Sudge Storage Concrete	121	CY	$ 1,500	-	$ 272,250
	Sludge Storage Exavation	725	CY	$ 50	-	$ 54,375
	Sludge Mixing Pump	1	LS	$ 10,000	$ 15,813	$ 23,719
	Sludge Mixing Nozzles	1	LS	$ 35,000	$ 55,345	$ 83,018

	4" Sch 80 PVC Pipe	300	LF	$ 50	$ 79	$ 35,579
	Telescoping Valves	1	EA	$ 950	$ 1,502	$ 2,253
	3" Plug Valves	1	EA	$ 2,500	$ 3,953	$ 5,930
	3" Swing Check Valves	1	EA	$ 1,700	$ 2,688	$ 4,032
	Air Release Valve	2	EA	$ 450	$ 712	$ 2,135
	Sludge Mix & Transfer System Install	1	LS	$ 13,210	$ 20,889	$ 31,333
	Phosphorus Removal					
	Membrane					
	Membrane Filtration System	1	EA	$ 4,480,000	-	$ 6,720,000
	Chemical Storage Membrane Cleaning	1	EA	$ 7,800	-	$ 11,700
	Membrane Install (25% of Materials)	1	LS	$ 1,121,950	-	$ 1,682,925
	Adsorption					
	Adsorption Columns	2	EA	$ 250,000	-	$ 750,000
	Adsorption Media	672	CF	$ 500	-	$ 504,000
	Asorption Install (25% of Materials)	1	LS	$ 209,000	-	$ 313,500

D2	**Effluent Monitoring**					**$64,605.91**
	Automated Flow Measurement Equipment	1	LS	$25,000.00	$ 33,131.24	$ 49,697
	Portable Composite Sampler	1	LS	$5,000.00	$ 6,626.25	$ 9,939
	Electrical	1	LS	$2,500.00	$ 3,313.12	$ 4,970

E.	**Electrical and HVAC**					
E1	**Electrical Service**					**$225,000.00**
	3-phase service - Effluent treatment plant	1	LS	$ 100,000	-	$ 150,000
	New Service Connections - Intakes, Pump Stations, Garage	1	LS	$ 50,000	-	$ 75,000
E2	**Emergency Power**					**$590,398.67**
	Emergency Generator: 100-200kW	3	LS	$75,000.00	$ 99,393.71	$ 447,272
	Automatic Transfer Switch	3	LS	$10,000.00	$ 13,252.50	$ 59,636
	Fuel Tank	3	LS	$14,000.00	$ 18,553.49	$ 83,491
E3	**Instrumentation and Alarm System**					**$397,574.86**

	Instrumentation, Alarm System & Communication	1	LS	$200,000.00	$ 265,049.91	$ 397,575
F.	**Visitor Education/Interpretation**					
F1	**Visitor Center Repairs**					**$53,250.00**
	Replace egress door on north face	1	EA	$2,500.00	-	$ 3,750
	Fix / replace door sills for ADA compliance	3	EA	$1,000.00	-	$ 4,500
	Replace Carpet	1,000	SF	$5.00	-	$ 7,500
	New Digital Display	1	LS	$5,000.00	-	$ 7,500
	Convert Storage Room to Bathroom	1	LS	$20,000.00	-	$ 30,000
						$56,224,430

Powder Mill New Facility Summary Opinions of Probable Cost

ITEM	DRAWING I.D. #	ROUNDED CONST COST[a]
New Facility Features		
Hatchery Supply	A1	$489,000
Cold Brook and Wells Intake Building	B1	$1,589,000
Effluent Treatment Building	B3	$1,960,000
Hatchery Building	B5	$4,230,000
Rearing Building	B6	$33,077,000
Existing Building Rehab	B7	$434,000
Site Work	C1	$836,000
Domestic Water	C2	$50,000
Domestic Wastewater	C3	$100,000
Disinfection Station	C4	$23,000
Paved Access to State or Local Highways	C5	$378,000
Effluent Treatment	D1	$11,734,000
Effluent Monitoring	D2	$65,000
Electrical Service	E1	$225,000
Emergency Power	E2	$591,000
Instrumentation and Alarm System	E3	$398,000
Visitor Center Repairs	F1	$54,000
Subtotal		**$56,233,000**
Escalation to Midpoint of Const. @ 5%/yr for 5 years		$2,812,000
3% market volatility adjustment		$1,686,990
Total Cost		**$60,732,000**

[a] Rounded Total Costs (or Costs needed to Budget) include 50% Class 4 AACE expected accuracy range).

Costs do **NOT** include: Design Reimbursables (Variable); State Agency Administrative Fee; and land acquisition or lease.

New Hampshire Fish and Game Department

Effluent Treatment Evaluation

Alternative 2: 95% Recirculation with Adsorption Units

Operation and Maintenance

Component	HP	Quantity	Total HP	Watts	Hours/day	kW-hrs/year
Hatchery Modernization						
UV System		8		56,000	24	3,924,480
Drum Filter	8.0	8.0	64.00	47,725	24	418,069
Recirc. Pumping	15.0	6.0	90.00	67,113	24	587,910
Site Lighting		1		15,000	12	65,700
Miscellaneous (SCADA, Meters, etc.)		1		15,000	24	131,400
MBBR-Blower	15.00	6	90.00	67,113	24	587,910
Effluent Treatment						
Clarifier Mechanism	0.75	1	0.75	559	24	4,899
Sludge Pump	20.00	1	20.00	14,914	24	130,647
Membrane Process Pumps	15.00	3.00	45.00	115,000	1	41,975
Membrane Blowers	90.00	1.00	90.00	123,000	1	44,895
Membrane CIP Pumps	15.00	1.00	15.00	44,000	1	16,060
Membrane CIP Heaters	NA			300,000	1	109,500
Membrane Backpulse Pump	60.00	1.00	60.00	40,000	1	14,600
Membrane Drain Pump	15.00	1.00	15.00	45,000	1	16,425
					kW-hrs/year =	6,094,470
					$/kW-hrs =	$0.12
						Annual Cost
						$731,336.35
Estimated Annual Replacement Costs						**Annual Cost**
Annual Equipment Replacement						**$1,403,000.00**
Estimated Annual Labor Costs	**Days per Week**	**Hours per day**	**Personnel**	**Rate**	**OH/Fringe**	**Annual Cost**
Daily Operator Attention	5	8	2	$ 25.00	$ 15.00	**$104,000**
Chemicals	**Use (gpd)**	**Annual Use (gal)**	**Cost ($/gal)**	**Replacement t/yr**		**Annual Cost**
Hypo		6900	2.5			$17,250
Citric		14500	8.25			$119,625
Sodium Bisulfate		1700	3.4			$5,780
Sulfuric						$0
O2 Usage - Tank refill		6000	0.6	12		$43,200.00
Adsorption Media Regen						$29,936.68

Estimated Annual Labor and Replacement Costs	$1,507,000
Estimated Annual Electricity and Chemical Usage Costs	$947,128
TOTAL	$2,455,000

New Hampshire Fish and Game Department

Effluent Treatment Evaluation

Alternative 2: 95% Recirculation with Adsorption Units

Life Cycle Cost Analysis

	Total	0 2023	1 2024	2 2025	3 2026	4 2027	5 2028	6 2029	7 2030	8 2031	9 2032
O&M											
Power and Chemical cost (6%/yr 2023-2026, 3%/yr 2027-2042 escalation)		$2,455,000	$2,602,300	$2,758,438	$2,923,944	$3,011,663	$3,102,012	$3,195,073	$3,290,925	$3,389,653	$3,491,342
R&R Maintenance cost (6%/yr 2023-2026, 4%/yr 2027-2042 escalation)		$485,070	$514,174	$545,025	$577,726	$600,835	$624,869	$649,863	$675,858	$702,892	$731,008
Total O&M Cost		**$2,940,070**	$3,116,474	$3,303,463	$3,501,670	$3,612,498	$3,726,881	$3,844,936	$3,966,783	$4,092,545	$4,222,350
Average Annual O&M Cost over 20 years ($/yr)	$4,334,017										
Average Annual O&M Cost over 10 years ($/yr)	$3,632,767										
Capital Cost		**$56,224,000**									
Equipment Cost		**$16,169,000**									
Net Present Value (at 5% discount rate)											
20 Year Net Present Value	$107,415,667										
10 Year Net Present Value	**$83,844,000**										
Annual Cost											
Average Annual Cost (Debt Service + O&M, 20 year basis)	$8,845,577										
Average Annual Cost (Debt Service + O&M, 10 year basis)	$10,914,032										

	10 2033	11 2034	12 2035	13 2036	14 2037	15 2038	16 2039	17 2040	18 2041	19 2042
Power and Chemical cost (6%/yr 2023-2026, 3%/yr 2027-2042 escalation)	$3,596,083	$3,703,965	$3,815,084	$3,929,537	$4,047,423	$4,168,845	$4,293,911	$4,422,728	$4,555,410	$4,692,072
R&R Maintenance cost (6%/yr 2023-2026, 4%/yr 2027-2042 escalation)	$760,248	$790,658	$822,284	$855,176	$889,383	$924,958	$961,956	$1,000,435	$1,040,452	$1,082,070
Total O&M Cost	$4,356,331	$4,494,623	$4,637,369	$4,784,712	$4,936,806	$5,093,804	$5,255,867	$5,423,163	$5,595,862	$5,774,142

New Hampton and Milford New Facility Summary Opinions of Probable Cost Alternative 1A

ITEM	DRAWING I.D. #	ROUNDED CONST COST[a]	ROUNDED CONST COST[a]	ROUNDED CONST COST[a]
		New Hampton	**Milford**	**Combined**
New Facility Features				
Hatchery Supply	A1	$247,000	$34,000	$281,000
Intake Building	B1	$1,589,000	$2,779,000	$4,368,000
Hatchery Building	B2	$4,230,000	$4,230,000	$8,460,000
Rearing Building	B3	$33,077,000	$33,077,000	$66,154,000
Rehabilitation of other buildings on site	B4	$264,000	$828,000	$1,092,000
Raceway Rehabiltaiton	B5	$0	$0	$0
Site Work	C1	$836,000	$836,000	$1,672,000
Domestic Water	C2	$50,000	$50,000	$100,000
Domestic Wastewater	C3	$100,000	$100,000	$200,000
Disinfection Station	C4	$23,000	$23,000	$46,000
Paved Access to State or Local Highways	C5	$378,000	$378,000	$756,000
Effluent Treatment	D1	$2,055,000	$2,055,000	$4,110,000
Effluent Monitoring	D2	$65,000	$65,000	$130,000
Effluent Pumping	D3	$2,071,000	$1,666,000	$3,737,000
Electrical Service	E1	$300,000	$300,000	$600,000
Emergency Power	E2	$456,000	$456,000	$912,000
Instrumentation and Alarm System	E3	$398,000	$398,000	$796,000
Visitor Center Repairs	F1	$600,000	$289,000	$889,000
Subtotal		**$46,739,000**	**$47,564,000**	**$94,303,000**
Escalation to Midpoint of Const. @ 5%/yr for 5 years		$2,337,000	$2,378,000	$4,715,000
3% market volatility adjustment		$1,402,170	$1,426,920	$2,829,090
Total Cost		**$50,478,000**	**$51,369,000**	**$101,847,000**

[a] Rounded Total Costs (or Costs needed to Budget) include 50% Class 4 AACE expected accuracy range).

Costs do **NOT** include: Design Reimbursables (Variable); State Agency Administrative Fee; and land acquisition or lease.

Client: NHFGD
Project:Powder Mill Fish Hatchery Study
Project No.: 10331124

Date: 3/15/2023
Estimator:
Checked By:
Check Date:
Revised: -

	Detailed Opinions of Probable Cost					
	New Hampton 1.A	NO. UNITS	UNIT MEAS.	COST PER UNIT	Escalation cost to 2022	TOTAL COST 50% CONT.
A.	**Aquaculture Water Supply**					
A1	**Hatchery Supply**					**$246,660**
	Water Supply Piping and Accessories	1300	LF	$ 85	$ 113	$ 219,660
	Rehab of Major Spring Conc Structures Above Spring Pond	1	LS	$ 3,000	$ 3,000	$ 4,500
	Minor Springs Replace Inlet Box at inlet pool and cover inlet pool	1	LS	$ 15,000	$ 15,000	$ 22,500
B.	**Buildings and Rearing Units**					
B1	**Intake Building**					**$ 1,588,544**
	New Intake Building	400	SF	$ 165	$ 218	$ 131,017
	Drumfilter					
	DRUM FILTERS	2	EA	$ 75,000	-	$ 225,000
	DRUM SUMP	1	LS	$ 75,000	-	$ 112,500
	PIPING SYSTEMS (INFLOW, DRAINS)	1	LS	$ 500,000	-	$ 750,000
	PRIMARY POWER	1	LS	$ 75,000	-	$ 112,500
	UV System					
	UV Channel and Lamp Package	2	EA	$ 50,000	-	$ 150,000
	UV Electrical	1	LS	$ 8,000	$ 10,602	$ 15,903
	UV Plumbing	1	LS	$ 11,000	$ 14,578	$ 21,867
	Electrical Power and Lighting	1	LS	$ 20,000	$ 26,505	$ 39,757
	ALARMS/CONTROLS/MONITORING/PANEL/HMI	1	LS	$ 20,000	-	$ 30,000
B2	**Hatchery Building**					**$4,229,021.87**

	New Hatchery Building - Office Space	3700	SF	$165.00	$ 218	$ 1,211,910
	POWER AND LIGHTING	3700	SF	$ 50	$103.40	$ 573,847
	HVAC	1	LS	$ 100,000	$206,791.77	$ 310,188
	EQUIPMENT					
	FEEDERS (SWEENEY MDL AF7 W/CONTROLLER & SUPPORT)	72	EA	$ 600	$1,240.75	$ 134,001
	FG TROUGHS (12'x2'x2')	42	EA	$ 2,500	$5,169.79	$ 325,697
	INCUBATION ROOM 30 HEATH STACKS	12	EA	$ 2,500	$5,169.79	$ 93,056
	INCUBATION HEAD TROUGHS AND CONTROLS	2	LS	$ 15,000	$31,018.77	$ 93,056
	CHILLER SYSTEM AND CONTROLS	1	LS	$ 250,000	$516,979.42	$ 775,469
	FORMALIN ROOM	1	LS	$ 50,000	$103,395.88	$ 155,094
	BOOT LOCKER ROOM, W/D, BENCHES	1	LS	$ 50,000	$103,395.88	$ 155,094
	WATER QUALITY ROOM EQUIP ALLOWANCE	1	LS	$ 75,000	$155,093.83	$ 232,641
	Hatchery Building Aeration/Degassing System					
	Primary Headtank & Aeration/Degassing System	1	EA	$ 85,000	$ 112,646	$ 168,969
B3	**Rearing Building**					**$33,076,818.18**
	New Rearing Building (526x140)	73,640	SF	$ 165	$ 218	$ 24,120,276
	ALARMS/CONTROLS/MONITORING/PANEL/HMI	1	LS	$ 50,000	-	$ 75,000
	VFD W/CIRCUIT BREAKER AND FULL CONTACTOR SET	2	EA	$ 25,000	-	$ 75,000
	PANEL/RACK/WIRING/CONDUITS/FEEDER	2	EA	$ 55,000	-	$ 165,000
	12" FLOW METER	2	EA	$ 18,000	-	$ 54,000
	EQUIPMENT					
	20' dia. SS Culture Tank with Foundation & Floor	20	EA	$ 35,000	-	$ 1,050,000
	40' dia. SS Culture Tank with Foundation & Floor	16	EA	$ 50,000	-	$ 1,200,000
	Drumfilter					
	DRUM FILTERS	6	EA	$ 85,000	-	$ 765,000
	DRUM SUMP	1	LS	$ 75,000	-	$ 112,500
	PRIMARY POWER	1	LS	$ 75,000	-	$ 112,500
	UV System					
	UV Channel and Lamp Package	6	EA	$ 125,000	-	$ 1,125,000
	UV Electrical	1	LS	$ 8,000	$ 10,602	$ 15,903
	UV Plumbing	1	LS	$ 11,000	$ 14,578	$ 21,867
	Recirculation					
	PIPING SYSTEMS (INFLOW, PRAS, DRAINS)	1	LS	$ 500,000	-	$ 750,000
	Lift Pump	6	EA	$ 80,000	-	$ 720,000
	4ft Precast Manhole 4 ft deep	6	EA	$ 4,200	$6,641.45	$ 59,773

	Biofilter System						
	MBBR	6	EA	$ 200,000	-	$	1,800,000
	HVAC	1	LS	$ 100,000	-	$	150,000
	Electrical Power and Lighting	1	LS	$ 200,000	-	$	300,000
	GAS MANAGEMENT TOWER CO2 STRIPPER/LHO	6	EA	$ 45,000	-	$	405,000
B4	**Rehabilitation of other buildings on site**					**$**	**264,000**
	Garage Renovations	1	LS	$ 119,500		$	119,500
	Wood Working Shop Renovations	1	LS	$ 33,500		$	33,500
	C-Station Office Renovations	1	LS	$ 81,000		$	81,000
	Demo (Boat Shed, Shavings Shed, Timber Shed, Tools Shed)	1	LS	$ 30,000		$	30,000
B5	**Raceway Rehabiltaiton**					**$**	**-**
	N/A						
C.	**Site**						
C1	**Site Work**						**$835,155.69**
	Site Clearing	2.5	AC	$2,000.00	$2,650.50	$	9,939
	General Earthwork for Hatchery Complex	1	LS	$75,000.00	$99,393.71	$	149,091
	General Sitework	1	LS	$250,000.00	$331,312.38	$	496,969
	Erosion Control	20	AC	$2,500.00	$3,313.12	$	99,394
	Seeding	1	AC	$1,250.00	$1,656.56	$	2,485
	Landscaping	1	AC	$3,000.00	$3,975.75	$	5,964
	Natural Gas Connection and Distribution (if available)	0	LS	$35,000.00	$46,383.73	$	-
	Stormwater Management System	10.3	AC	$3,500.00	$4,638.37	$	71,315
C2	**Domestic Water**						**$49,696.86**
	Domestic Water Supply	1	LS	$25,000.00	$33,131.24	$	49,697
C3	**Domestic Wastewater**	1		$2,500.00			**$99,393.71**
	Domestic Wastewater System	1	LS	$50,000.00	$66,262.48	$	99,394
C4	**Disinfection Station**						**$22,500.00**
	Truck Disinfection Station	1	LS	$15,000.00	-	$	22,500
	Roadway Aggregate	0	SY	$15.00	-	$	-
	Electrical	0	LS	$2,500.00	-	$	-

	Detention Tank	0	LS	$5,000.00	-	$ -
C5	**Paved Access to State or Local Highways**	0		$0.00		**$377,696.12**
	Bituminous Paved Road	1	LS	$190,000.00	$251,797.41	$ 377,696
	Gravel Roads	0	LS	$55,000.00	$72,888.72	$ -
D.	**Aquaculture Wastewater**					
D1	**Effluent Treatment**					**$2,054,695**
	Clarifier-40ft					
	Clarifier Concrete	211	CY	$ 1,500	-	$ 474,750
	Clarifer Excavation	898	CY	$ 50	-	$ 67,350
	Clarifier Equipment	1	LS	$ 108,000	$ 170,780	$ 256,170
	Clarifier Coatings	1	LS	$ 12,000	$ 18,976	$ 28,463
	Finger Weirs	1	LS	$ 6,000	$ 9,488	$ 14,232
	Duplex Pump Station	1	LS	$ 18,000	$ 28,463	$ 42,695
	3" Sch 80 PVC Pipe	100	LF	$ 36	$ 57	$ 8,539
	4" Sch 80 PVC Pipe	250	LF	$ 60	$ 95	$ 35,579
	3" Plug Valves	2	EA	$ 3,000	$ 4,744	$ 14,232
	3" Swing Check Valves	2	EA	$ 2,040	$ 3,226	$ 9,678
	Telescoping Valves	2	EA	$ 1,140	$ 1,803	$ 5,408
	6 ft precast manhole 6 ft deep	2	EA	$ 9,000	$ 14,232	$ 42,695
	4ft Precast Manhole 4 ft deep	1	EA	$ 5,040	$ 7,970	$ 11,955
	Clarifier Equipment Install	1	LS	$ 21,600	$ 34,156	$ 51,234
	Sludge Storage-25ft					
	Sudge Storage Concrete	121	CY	$ 1,500	-	$ 272,250
	Sludge Storage Exavation	725	CY	$ 50	-	$ 54,375
	Sludge Mixing Pump	1	LS	$ 10,000	$ 15,813	$ 23,719
	Sludge Mixing Nozzles	1	LS	$ 35,000	$ 55,345	$ 83,018
	4" Sch 80 PVC Pipe	300	LF	$ 50	$ 79	$ 35,579
	Telescoping Valves	1	EA	$ 950	$ 1,502	$ 2,253
	3" Plug Valves	1	EA	$ 2,500	$ 3,953	$ 5,930
	3" Swing Check Valves	1	EA	$ 1,700	$ 2,688	$ 4,032
	Air Release Valve	2	EA	$ 450	$ 712	$ 2,135
	Sludge Mix & Transfer System Install	1	LS	$ 13,210	$ 20,889	$ 31,333
	WW Sitework	1	LS	$ 40,000	$ 53,010	$ 79,515

	Electrical Power and Lighting	1	LS	$ 200,000	$ 265,050	$ 397,575
D2	**Effluent Monitoring**					**$64,605.91**
	Automated Flow Measurement Equipment	1	LS	$25,000.00	$ 33,131.24	$ 49,697
	Portable Composite Sampler	1	LS	$5,000.00	$ 6,626.25	$ 9,939
	Electrical	1	LS	$2,500.00	$ 3,313.12	$ 4,970
D3	**Effluent Pumping**					**$2,070,701.81**
	WW Piping line	3200	LF	$ 85	$ 113	$ 540,702
	New Hampton Pump Station	1	LS	$ 1,020,000	-	$ 1,530,000
E.	**Electrical and HVAC**					
E1	**Electrical Service**					**$300,000.00**
	New 480V utility service	1	LS	$ 100,000	-	$ 150,000
	New 480V distribution	1000	LF	$ 100	-	$ 150,000
E2	**Emergency Power**					**$455,223.21**
	Emergency Generator: 100-200kW	1	LS	$200,000.00	$ 265,049.91	$ 397,575
	Automatic Transfer Switch	1	LS	$15,000.00	$ 19,878.74	$ 29,818
	Fuel Tank	1	LS	$14,000.00	$ 18,553.49	$ 27,830
E3	**Instrumentation and Alarm System**					**$397,574.86**
	Instrumentation, Alarm System & Communication	1	LS	$200,000.00	$ 265,049.91	$ 397,575
F.	**Visitor Education/Interpretation**					
F1	**Visitor Center Repairs**					**$600,000.00**
	New Visitor Center Building	1,000	SF	$350.00	-	$ 525,000
	New Displays	1	LS	$50,000.00	-	$ 75,000
						$46,732,288

HDR

New Hampshire Fish and Game Department

Effluent Treatment Evaluation

New Hampton 1A: New 95% RAS Building

Operation and Maintenance

Component	HP	Quantity	Total HP	Watts	Hours/day	kW-hrs/year
Influent						
UV System		2		56,000	24	981,120
Drum Filter	8.0	2.0	16.00	11,931	24	104,517
Hatchery Modernization						
UV System		6		56,000	24	2,943,360
Drum Filter	8.0	6.0	48.00	35,794	24	313,552
Recirc. Pumping	15.0	6.0	90.00	67,113	24	587,910
Site Lighting		1		15,000	12	65,700
Miscellaneous (SCADA, Meters, etc.)		1		15,000	24	131,400
MBBR-Blower	15.00	6	90.00	67,113	24	587,910
Effluent Treatment						
Clarifier Mechanism	0.75	1	0.75	559	24	4,899
Sludge Pump	20.00	1	20.00	14,914	24	130,647
Effluent Pumping						192,000
					kW-hrs/year =	4,957,377
					$/kW-hrs =	$0.12
						Annual Cost
						$594,885.28
Estimated Annual Replacement Costs						**Annual Cost**
Annual Equipment Replacement						**$789,000.00**
Estimated Annual Labor Costs	**Days per Week**	**Hours per day**	**Personnel**	**Rate**	**OH/Fringe**	**Annual Cost**
Daily Operator Attention	5	8	0	$ 25.00	$ 15.00	**$0**
Chemicals	**Use (gpd)**	**Annual Use (gal)**	**Cost ($/gal)**	**Replacement/yr**		**Annual Cost**
O2 Usage - Tank refill		6000	0.6	12		$43,200.00

Estimated Annual Labor and Replacement Costs	**$789,000**
Estimated Annual Electricity and Chemical Usage Costs	**$638,085**
TOTAL	**$1,428,000**

New Hampshire Fish and Game Department

Effluent Treatment Evaluation

New Hampton 1A: New 95% RAS Building

Life Cycle Cost Analysis

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	Total	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
O&M																					
Power and Chemical cost (6%/yr 2023-2026, 3%/yr 2027-2042 escalation)		$1,428,000	$1,513,680	$1,604,501	$1,700,771	$1,751,794	$1,804,348	$1,858,478	$1,914,233	$1,971,660	$2,030,809	$2,091,734	$2,154,486	$2,219,120	$2,285,694	$2,354,265	$2,424,893	$2,497,639	$2,572,569	$2,649,746	$2,729,238
R&R Maintenance cost (6%/yr 2023-2026, 4%/yr 2027-2042 escalation)		$272,760	$289,126	$306,473	$324,862	$337,856	$351,370	$365,425	$380,042	$395,244	$411,053	$427,496	$444,595	$462,379	$480,874	$500,109	$520,114	$540,918	$562,555	$585,057	$608,460
Total O&M Cost		**$1,700,760**	$1,802,806	$1,910,974	$2,025,632	$2,089,650	$2,155,718	$2,223,903	$2,294,275	$2,366,903	$2,441,863	$2,519,229	$2,599,081	$2,681,499	$2,766,568	$2,854,374	$2,945,006	$3,038,558	$3,135,124	$3,234,803	$3,337,697
Average Annual O&M Cost over 20 years ($/yr)	$2,506,221																				
Average Annual O&M Cost over 10 years ($/yr)	$2,101,248																				
Capital Cost		**$50,478,000**																			
Equipment Cost		**$9,092,000**																			
Net Present Value (at 5% discount rate)																					
20 Year Net Present Value	$80,082,517																				
10 Year Net Present Value	**$66,454,000**																				
Annual Cost																					
Average Annual Cost (Debt Service + O&M, 20 year basis)	$6,556,706																				
Average Annual Cost (Debt Service + O&M, 10 year basis)	$8,638,380																				

Client: NHFGD
Project:Powder Mill Fish Hatchery Study
Project No.: 10331124

Date: 3/15/2023
Estimator:
Checked By:
Check Date:
Revised: -

Detailed Opinions of Probable Cost						
	Milford 1.A	NO. UNITS	UNIT MEAS.	COST PER UNIT	Escalation cost to 2022	TOTAL COST 50% CONT.
A.	**Aquaculture Water Supply**					
A1	**Hatchery Supply**					**$33,794**
	Water Supply Piping and Accessories	200	LF	$ 85	$ 113	$ 33,794
B.	**Buildings and Rearing Units**					
B1	**Intake Building**					**$ 2,778,318**
	New Intake Building	1400	SF	$ 165	$ 218	$ 458,560
	Iron and Manganese Green Sand Filters	1	LS	$ 1,500,000	-	$ 2,250,000
	Electrical Power and Lighting	1	LS	$ 20,000	$ 26,505	$ 39,757
	ALARMS/CONTROLS/MONITORING/PANEL/HMI	1	LS	$ 20,000	-	$ 30,000
B2	**Hatchery Building**					**$4,229,021.87**
	New Hatchery Building - Office Space	3700	SF	$165.00	$ 218	$ 1,211,910
	POWER AND LIGHTING	3700	SF	$ 50	$103.40	$ 573,847
	HVAC	1	LS	$ 100,000	$206,791.77	$ 310,188
	EQUIPMENT					
	FEEDERS (SWEENEY MDL AF7 W/CONTROLLER & SUPPORT)	72	EA	$ 600	$1,240.75	$ 134,001
	FG TROUGHS (12'x2'x2')	42	EA	$ 2,500	$5,169.79	$ 325,697
	INCUBATION ROOM 30 HEATH STACKS	12	EA	$ 2,500	$5,169.79	$ 93,056
	INCUBATION HEAD TROUGHS AND CONTROLS	2	LS	$ 15,000	$31,018.77	$ 93,056
	CHILLER SYSTEM AND CONTROLS	1	LS	$ 250,000	$516,979.42	$ 775,469
	FORMALIN ROOM	1	LS	$ 50,000	$103,395.88	$ 155,094

	BOOT LOCKER ROOM, W/D, BENCHES	1	LS	$ 50,000	$103,395.88	$ 155,094
	WATER QUALITY ROOM EQUIP ALLOWANCE	1	LS	$ 75,000	$155,093.83	$ 232,641
	Hatchery Building Aeration/Degassing System					
	Primary Headtank & Aeration/Degassing System	1	EA	$ 85,000	$ 112,646	$ 168,969
B3	**Rearing Building**					**$33,076,818.18**
	New Rearing Building (526x140)	73,640	SF	$ 165	$ 218	$ 24,120,276
	ALARMS/CONTROLS/MONITORING/PANEL/HMI	1	LS	$ 50,000	-	$ 75,000
	VFD W/CIRCUIT BREAKER AND FULL CONTACTOR SET	2	EA	$ 25,000	-	$ 75,000
	PANEL/RACK/WIRING/CONDUITS/FEEDER	2	EA	$ 55,000	-	$ 165,000
	12" FLOW METER	2	EA	$ 18,000	-	$ 54,000
	EQUIPMENT					
	20' dia. SS Culture Tank with Foundation & Floor	20	EA	$ 35,000	-	$ 1,050,000
	40' dia. SS Culture Tank with Foundation & Floor	16	EA	$ 50,000	-	$ 1,200,000
	Drumfilter					
	DRUM FILTERS	6	EA	$ 85,000	-	$ 765,000
	DRUM SUMP	1	LS	$ 75,000	-	$ 112,500
	PRIMARY POWER	1	LS	$ 75,000	-	$ 112,500
	UV System					
	UV Channel and Lamp Package	6	EA	$ 125,000	-	$ 1,125,000
	UV Electrical	1	LS	$ 8,000	$ 10,602	$ 15,903
	UV Plumbing	1	LS	$ 11,000	$ 14,578	$ 21,867
	Recirculation					
	PIPING SYSTEMS (INFLOW, PRAS, DRAINS)	1	LS	$ 500,000	-	$ 750,000
	Lift Pump	6	EA	$ 80,000	-	$ 720,000
	4ft Precast Manhole 4 ft deep	6	EA	$ 4,200	$6,641.45	$ 59,773
	Biofilter System					
	MBBR	6	EA	$ 200,000	-	$ 1,800,000
	HVAC	1	LS	$ 100,000	-	$ 150,000
	Electrical Power and Lighting	1	LS	$ 200,000	-	$ 300,000
	GAS MANAGEMENT TOWER CO2 STRIPPER/LHO	6	EA	$ 45,000	-	$ 405,000
B4	**Rehabilitation of other buildings on site**					**$ 828,000**
	Hatchery Building Renovations	1	LS	$ 608,000		$ 608,000
	New Maintenance Garage (to replace existing Storage Building)	1600	SF	$ 125		$ 200,000
	Demolish (Storage Building Tent, Twin Mnt Rearing, Storage Shed)	1	LS	$ 20,000		$ 20,000

B5	**Raceway Rehabiltaiton**					**$ -**
	N/A					

C.	**Site**					
C1	**Site Work**					**$835,155.69**
	Site Clearing	2.5	AC	$2,000.00	$2,650.50	$ 9,939
	General Earthwork for Hatchery Complex	1	LS	$75,000.00	$99,393.71	$ 149,091
	General Sitework	1	LS	$250,000.00	$331,312.38	$ 496,969
	Erosion Control	20	AC	$2,500.00	$3,313.12	$ 99,394
	Seeding	1	AC	$1,250.00	$1,656.56	$ 2,485
	Landscaping	1	AC	$3,000.00	$3,975.75	$ 5,964
	Natural Gas Connection and Distribution (if available)	0	LS	$35,000.00	$46,383.73	$ -
	Stormwater Management System	10.3	AC	$3,500.00	$4,638.37	$ 71,315
C2	**Domestic Water**					**$49,696.86**
	Domestic Water Supply	1	LS	$25,000.00	$33,131.24	$ 49,697
C3	**Domestic Wastewater**	1		$2,500.00		**$99,393.71**
	Domestic Wastewater System	1	LS	$50,000.00	$66,262.48	$ 99,394
C4	**Disinfection Station**					**$22,500.00**
	Truck Disinfection Station	1	LS	$15,000.00	-	$ 22,500
	Roadway Aggregate	0	SY	$15.00	-	$ -
	Electrical	0	LS	$2,500.00	-	$ -
	Detention Tank	0	LS	$5,000.00	-	$ -
C5	**Paved Access to State or Local Highways**	0		$0.00		**$377,696.12**
	Bituminous Paved Road	1	LS	$190,000.00	$251,797.41	$ 377,696
	Gravel Roads	0	LS	$55,000.00	$72,888.72	$ -
D.	**Aquaculture Wastewater**					
D1	**Effluent Treatment**					**$2,054,695**
	Clarifier-40ft					
	Clarifier Concrete	211	CY	$ 1,500	-	$ 474,750

	Clarifer Excavation	898	CY	$ 50	-	$ 67,350
	Clarifier Equipment	1	LS	$ 108,000	$ 170,780	$ 256,170
	Clarifier Coatings	1	LS	$ 12,000	$ 18,976	$ 28,463
	Finger Weirs	1	LS	$ 6,000	$ 9,488	$ 14,232
	Duplex Pump Station	1	LS	$ 18,000	$ 28,463	$ 42,695
	3" Sch 80 PVC Pipe	100	LF	$ 36	$ 57	$ 8,539
	4" Sch 80 PVC Pipe	250	LF	$ 60	$ 95	$ 35,579
	3" Plug Valves	2	EA	$ 3,000	$ 4,744	$ 14,232
	3" Swing Check Valves	2	EA	$ 2,040	$ 3,226	$ 9,678
	Telescoping Valves	2	EA	$ 1,140	$ 1,803	$ 5,408
	6 ft precast manhole 6 ft deep	2	EA	$ 9,000	$ 14,232	$ 42,695
	4ft Precast Manhole 4 ft deep	1	EA	$ 5,040	$ 7,970	$ 11,955
	Clarifier Equipment Install	1	LS	$ 21,600	$ 34,156	$ 51,234
	Sludge Storage-25ft					
	Sudge Storage Concrete	121	CY	$ 1,500	-	$ 272,250
	Sludge Storage Exavation	725	CY	$ 50	-	$ 54,375
	Sludge Mixing Pump	1	LS	$ 10,000	$ 15,813	$ 23,719
	Sludge Mixing Nozzles	1	LS	$ 35,000	$ 55,345	$ 83,018
	4" Sch 80 PVC Pipe	300	LF	$ 50	$ 79	$ 35,579
	Telescoping Valves	1	EA	$ 950	$ 1,502	$ 2,253
	3" Plug Valves	1	EA	$ 2,500	$ 3,953	$ 5,930
	3" Swing Check Valves	1	EA	$ 1,700	$ 2,688	$ 4,032
	Air Release Valve	2	EA	$ 450	$ 712	$ 2,135
	Sludge Mix & Transfer System Install	1	LS	$ 13,210	$ 20,889	$ 31,333
	WW Sitework	1	LS	$ 40,000	$ 53,010	$ 79,515
	Electrical Power and Lighting	1	LS	$ 200,000	$ 265,050	$ 397,575

D2	**Effluent Monitoring**					**$64,605.91**
	Automated Flow Measurement Equipment	1	LS	$25,000.00	$ 33,131.24	$ 49,697
	Portable Composite Sampler	1	LS	$5,000.00	$ 6,626.25	$ 9,939
	Electrical	1	LS	$2,500.00	$ 3,313.12	$ 4,970
D3	**Effluent Pumping**					**$1,665,175.45**
	WW Piping line	800	LF	$ 85	$ 113	$ 135,175
	Milford Pump Station	1	LS	$ 1,020,000	-	$ 1,530,000

E.	**Electrical and HVAC**					
E1	**Electrical Service**					**$300,000.00**
	New 480V utility service	1	LS	$ 100,000	-	$ 150,000
	New 480V distribution	1000	LF	$ 100	-	$ 150,000
E2	**Emergency Power**					**$455,223.21**
	Emergency Generator: 100-200kW	1	LS	$200,000.00	$ 265,049.91	$ 397,575
	Automatic Transfer Switch	1	LS	$15,000.00	$ 19,878.74	$ 29,818
	Fuel Tank	1	LS	$14,000.00	$ 18,553.49	$ 27,830
E3	**Instrumentation and Alarm System**					**$397,574.86**
	Instrumentation, Alarm System & Communication	1	LS	$200,000.00	$ 265,049.91	$ 397,575
F.	**Visitor Education/Interpretation**					
F1	**Visitor Center Repairs**					**$288,750.00**
	Gut & Renovate	1,000	SF	$100.00	-	$ 150,000
	New Displays	1	LS	$50,000.00	-	$ 75,000
	Access Improvements	1	LS	$42,500.00	-	$ 63,750
					-	$ -
						$47,556,418

New Hampshire Fish and Game Department

Effluent Treatment Evaluation

Milford 1A: New 95% RAS Building

Operation and Maintenance

Component	HP	Quantity	Total HP	Watts	Hours/day	kW-hrs/year
Hatchery Modernization						
UV System		6		56,000	24	2,943,360
Drum Filter	8.0	6.0	48.00	35,794	24	313,552
Recirc. Pumping	15.0	6.0	90.00	67,113	24	587,910
Site Lighting		1		15,000	12	65,700
Miscellaneous (SCADA, Meters, etc.)		1		15,000	24	131,400
MBBR-Blower	15.00	6	90.00	67,113	24	587,910
Effluent Treatment						
Clarifier Mechanism	0.75	1	0.75	559	24	4,899
Sludge Pump	20.00	1	20.00	14,914	24	130,647
Effluent Pumping						192,000
					kW-hrs/year =	4,957,377
					$/kW-hrs =	$0.12
						Annual Cost
						$594,885.28

Estimated Annual Replacement Costs						Annual Cost
Annual Equipment Replacement						$952,000.00
Estimated Annual Labor Costs	**Days per Week**	**Hours per day**	**Personnel**	**Rate**	**OH/Fringe**	**Annual Cost**
Additional Daily Operator Attention	5	8	0	$ 25.00	$ 15.00	**$0**
Chemicals	**Use (gpd)**	**Annual Use (gal)**	**Cost ($/gal)**	**event per year**		**Annual Cost**
O2 Usage - Tank refill		6000	0.6	12		$43,200.00
					Estimated Annual Labor and Replacement Costs	**$952,000**
					Estimated Annual Electricity and Chemical Usage Costs	**$638,085**
					TOTAL	**$1,591,000**

New Hampshire Fish and Game Department

Effluent Treatment Evaluation

Milford 1A: New 95% RAS Building

Life Cycle Cost Analysis

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	Total	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
O&M																					
Power and Chemical cost (6%/yr 2023-2026, 3%/yr 2027-2042 escalation)		$1,591,000	$1,686,460	$1,787,648	$1,894,906	$1,951,754	$2,010,306	$2,070,615	$2,132,734	$2,196,716	$2,262,617	$2,330,496	$2,400,411	$2,472,423	$2,546,596	$2,622,994	$2,701,684	$2,782,734	$2,866,216	$2,952,203	$3,040,769
R&R Maintenance cost (6%/yr 2023-2026, 4%/yr 2027-2042 escalation)		$329,010	$348,751	$369,676	$391,856	$407,530	$423,832	$440,785	$458,416	$476,753	$495,823	$515,656	$536,282	$557,734	$580,043	$603,245	$627,374	$652,469	$678,568	$705,711	$733,939
Total O&M Cost		**$1,920,010**	$2,035,211	$2,157,323	$2,286,763	$2,359,284	$2,434,138	$2,511,400	$2,591,150	$2,673,469	$2,758,440	$2,846,152	$2,936,693	$3,030,157	$3,126,639	$3,226,238	$3,329,058	$3,435,203	$3,544,784	$3,657,913	$3,774,708
Average Annual O&M Cost over 20 years ($/yr)	$2,831,737																				
Average Annual O&M Cost over 10 years ($/yr)	$2,372,719																				
Capital Cost		**$51,369,000**																			
Equipment Cost		**$10,967,000**																			
Net Present Value (at 5% discount rate)																					
20 Year Net Present Value	$84,813,145																				
10 Year Net Present Value	**$69,409,000**																				
Annual Cost																					
Average Annual Cost (Debt Service + O&M, 20 year basis)	$6,953,718																				
Average Annual Cost (Debt Service + O&M, 10 year basis)	$9,025,239																				

New Hampton Summary Opinions of Probable Cost

ITEM	DRAWING I.D. #	ROUNDED TOTAL COST[a]
New Facility Features		
Hatchery Supply	A1	$368,000
Intake Building	B1	$1,589,000
Hatchery Building	B2	$4,230,000
Rearing Building	B3	$33,077,000
Rehabilitation of other buildings on site	B4	$264,000
Raceway Rehabilitation	B5	$2,052,000
Site Work	C1	$507,000
Domestic Water	C2	$50,000
Domestic Wastewater	C3	$100,000
Disinfection Station	C4	$45,000
Paved Access to State or Local Highways	C5	$378,000
Effluent Treatment	D1	$2,055,000
Effluent Monitoring	D2	$70,000
Effluent Pumping	D3	$2,071,000
Electrical Service	E1	$300,000
Emergency Power	E2	$456,000
Instrumentation and Alarm System	E3	$398,000
Visitor Center Repairs	F1	$600,000
Subtotal		**$48,610,000**
Escalation to Midpoint of Const. @ 5%/yr for 5 years		$2,431,000
3% market volatility adjustment		$1,458,300
Total Cost		**$52,499,000**

[a] Rounded Total Costs (or Costs needed to Budget) include 50% Class 4 AACE expected accuracy range).

Costs do **NOT** include: Design Reimbursables (Variable); State Agency Administrative Fee; and land acquisition or lease.

Client: NHFGD
Project:Powder Mill Fish Hatchery Study
Project No.: 10331124

Date: 3/15/2023
Estimator:
Checked By:
Check Date:
Revised: -

Detailed Opinions of Probable Cost						
	New Hampton 1.B	NO. UNITS	UNIT MEAS.	COST PER UNIT	Escalation cost to 2022	TOTAL COST 50% CONT.
A.	**Aquaculture Water Supply**					
A1	**Hatchery Supply**					**$ 367,966**
	Water Supply Piping and Accessories	150	LF	$ 85	$ 113	$ 25,345
	Rehab of Major Spring Conc Structures Above Spring Pond	1	LS	$ 3,000	-	$ 4,500
	Repairs/tiedowns at Raceway B and C inlet piping supports	1	LS	$ 5,000	-	$ 7,500
	Minor Springs Replace Inlet Box at inlet pool and cover inlet pool	1	LS	$ 15,000	-	$ 22,500
	Well Water Supply System, 1,000 gpm (1 wells/ 1 back up)	1	EA	$100,000.00	$ 132,525	$ 198,787
	Hydrogeological Testing Program & Report	1	LS	$55,000.00	$ 72,889	$ 109,333
A2	**Oxygenation System**					**$ 1,014,051**
	Bulk LOX Tank, Vaporizer, Port. Tank Fill System	2	LS	$ 150,000	$ 198,787	$ 596,362
	Fence	200	LF	$ 20	$ 27	$ 7,951
	Concrete Pad & Bollards	2	LS	$ 11,000	$ 14,578	$ 43,733
	Buried Copper Oxygen Distribution to Units	2	LS	$ 60,000	$ 79,515	$ 238,545
	Oxygen Electrical	2	LS	$ 5,000	$ 6,626	$ 19,879
	Oxygen Dissolving for Rearing Units- LHO	24	EA	$ 2,500	$ 2,906	$ 104,599
	Oxygen Flow Meter Station (raceways)	2	LS	$ 750	$ 994	$ 2,982
B.	**Buildings and Rearing Units**					
B1	**Intake Building**					**$ 1,588,544**
	New Intake Building Cold Brook and Wells	400	SF	$ 165	$ 218	$ 131,017
	Drumfilter					
	DRUM FILTERS	2	EA	$ 75,000	-	$ 225,000
	DRUM SUMP	1	LS	$ 75,000	-	$ 112,500

	PIPING SYSTEMS (INFLOW, DRAINS)	1	LS	$ 500,000	-	$ 750,000
	PRIMARY POWER	1	LS	$ 75,000	-	$ 112,500
	UV System					
	UV Channel and Lamp Package	2	EA	$ 50,000	-	$ 150,000
	UV Electrical	1	LS	$ 8,000	$ 10,602	$ 15,903
	UV Plumbing	1	LS	$ 11,000	$ 14,578	$ 21,867
	Electrical Power and Lighting	1	LS	$ 20,000	$ 26,505	$ 39,757
	ALARMS/CONTROLS/MONITORING/PANEL/HMI	1	LS	$ 20,000	-	$ 30,000
B2	**Hatchery Building**					**$4,229,021.87**
	New Hatchery Building - Office Space	3700	SF	$165.00	$ 218	$ 1,211,910
	POWER AND LIGHTING	3700	SF	$ 50	$103.40	$ 573,847
	HVAC	1	LS	$ 100,000	$206,791.77	$ 310,188
	EQUIPMENT					
	FEEDERS (SWEENEY MDL AF7 W/CONTROLLER & SUPPORT)	72	EA	$ 600	$1,240.75	$ 134,001
	FG TROUGHS (12'x2'x2')	42	EA	$ 2,500	$5,169.79	$ 325,697
	INCUBATION ROOM 30 HEATH STACKS	12	EA	$ 2,500	$5,169.79	$ 93,056
	INCUBATION HEAD TROUGHS AND CONTROLS	2	LS	$ 15,000	$31,018.77	$ 93,056
	CHILLER SYSTEM AND CONTROLS	1	LS	$ 250,000	$516,979.42	$ 775,469
	FORMALIN ROOM	1	LS	$ 50,000	$103,395.88	$ 155,094
	BOOT LOCKER ROOM, W/D, BENCHES	1	LS	$ 50,000	$103,395.88	$ 155,094
	WATER QUALITY ROOM EQUIP ALLOWANCE	1	LS	$ 75,000	$155,093.83	$ 232,641
	Hatchery Building Aeration/Degassing System					
	Primary Headtank & Aeration/Degassing System	1	EA	$ 85,000	$ 112,646	$ 168,969
B3	**Rearing Building**					**$33,076,818.18**
	New Rearing Building (526x140)	73,640	SF	$ 165	$ 218	$ 24,120,276
	ALARMS/CONTROLS/MONITORING/PANEL/HMI	1	LS	$ 50,000	-	$ 75,000
	VFD W/CIRCUIT BREAKER AND FULL CONTACTOR SET	2	EA	$ 25,000	-	$ 75,000
	PANEL/RACK/WIRING/CONDUITS/FEEDER	2	EA	$ 55,000	-	$ 165,000
	12" FLOW METER	2	EA	$ 18,000	-	$ 54,000
	EQUIPMENT					
	20' dia. SS Culture Tank with Foundation & Floor	20	EA	$ 35,000	-	$ 1,050,000
	40' dia. SS Culture Tank with Foundation & Floor	16	EA	$ 50,000	-	$ 1,200,000
	Drumfilter					

	DRUM FILTERS	6	EA	$ 85,000	-	$ 765,000
	DRUM SUMP	1	LS	$ 75,000	-	$ 112,500
	PRIMARY POWER	1	LS	$ 75,000	-	$ 112,500
	UV System					
	UV Channel and Lamp Package	6	EA	$ 125,000	-	$ 1,125,000
	UV Electrical	1	LS	$ 8,000	$ 10,602	$ 15,903
	UV Plumbing	1	LS	$ 11,000	$ 14,578	$ 21,867
	Recirculation					
	PIPING SYSTEMS (INFLOW, PRAS, DRAINS)	1	LS	$ 500,000	-	$ 750,000
	Lift Pump	6	EA	$ 80,000	-	$ 720,000
	4ft Precast Manhole 4 ft deep	6	EA	$ 4,200	$6,641.45	$ 59,773
	Biofilter System					
	MBBR	6	EA	$ 200,000	-	$ 1,800,000
	HVAC	1	LS	$ 100,000	-	$ 150,000
	Electrical Power and Lighting	1	LS	$ 200,000	-	$ 300,000
	GAS MANAGEMENT TOWER CO2 STRIPPER/LHO	6	EA	$ 45,000	-	$ 405,000
B4	**Rehabilitation of other buildings on site**					**$ 264,000**
	Garage Renovations	1	LS	$ 119,500		$ 119,500
	Wood Working Shop Renovations	1	LS	$ 33,500		$ 33,500
	C-Station Office Renovations	1	LS	$ 81,000		$ 81,000
	Demo (Boat Shed, Shavings Shed, Timber Shed, Tools Shed)	1	LS	$ 30,000		$ 30,000
B5	**Raceway Rehabilitation**					**$ 2,051,250**
	Concrete rehab of Raceway B series	1	LS	$ 240,000	-	$ 360,000
	Process rehab of Raceway B series	1	LS	$ 60,000	-	$ 90,000
	Concrete rehab of Raceway C series	1	LS	$ 900,000	-	$ 1,350,000
	Process Rehab of Raceway C series	1	LS	$ 7,500	-	$ 11,250
	Demolish and fill in Upper Raceways	1	LS	$ 60,000	-	$ 90,000
	Baffle Allowance	1	LS	$ 100,000	-	$ 150,000
C.	**Site**					
C1	**Site Work**					**$506,907.95**
	Site Clearing	2.5	AC	$2,000.00	$2,650.50	$ 9,939
	General Earthwork for Hatchery Complex	0	LS	$75,000.00	$99,393.71	$ -
	General Sitework	1	LS	$250,000.00	$331,312.38	$ 496,969
	Erosion Control	0	AC	$2,500.00	$3,313.12	$ -
	Seeding	0	AC	$1,250.00	$1,656.56	$ -
	Landscaping	0	AC	$3,000.00	$3,975.75	$ -

	Natural Gas Connection and Distribution (if available)	0	LS	$35,000.00	$46,383.73	$ -
	Stormwater Management System	0.0	AC	$3,500.00	$4,638.37	$ -
C2	**Domestic Water**			$150.00		**$49,696.86**
	Domestic Water Supply	1	LS	$25,000.00	$33,131.24	$ 49,697
C3	**Domestic Wastewater**			$100,000.00		**$99,393.71**
	Domestic Wastewater System	1	LS	$50,000.00	$66,262.48	$ 99,394
C4	**Disinfection Station**					**$45,000.00**
	Truck Disinfection Station	1	LS	$30,000.00	-	$ 45,000
	Roadway Aggregate	0	SY	$30.00	-	$ -
	Electrical	0	LS	$5,000.00	-	$ -
	Detention Tank	0	LS	$10,000.00	-	$ -
C5	**Paved Access to State or Local Highways**	0		$0.00		**$377,696.12**
	Bituminous Paved Road	1	LS	$190,000.00	$251,797.41	$ 377,696
	Gravel Roads	0	LS	$55,000.00	$72,888.72	$ -

D.	**Aquaculture Wastewater**					
D1	**Effluent Treatment**					**$2,054,695**
	Clarifier-40ft					
	Clarifier Concrete	211	CY	$ 1,500	-	$ 474,750
	Clarifer Excavation	898	CY	$ 50	-	$ 67,350
	Clarifier Equipment	1	LS	$ 108,000	$ 170,780	$ 256,170
	Clarifier Coatings	1	LS	$ 12,000	$ 18,976	$ 28,463
	Finger Weirs	1	LS	$ 6,000	$ 9,488	$ 14,232
	Duplex Pump Station	1	LS	$ 18,000	$ 28,463	$ 42,695
	3" Sch 80 PVC Pipe	100	LF	$ 36	$ 57	$ 8,539
	4" Sch 80 PVC Pipe	250	LF	$ 60	$ 95	$ 35,579
	3" Plug Valves	2	EA	$ 3,000	$ 4,744	$ 14,232
	3" Swing Check Valves	2	EA	$ 2,040	$ 3,226	$ 9,678
	Telescoping Valves	2	EA	$ 1,140	$ 1,803	$ 5,408
	6 ft precast manhole 6 ft deep	2	EA	$ 9,000	$ 14,232	$ 42,695
	4ft Precast Manhole 4 ft deep	1	EA	$ 5,040	$ 7,970	$ 11,955
	Clarifier Equipment Install	1	LS	$ 21,600	$ 34,156	$ 51,234

	Sludge Storage-25ft					
	Sudge Storage Concrete	121	CY	$ 1,500	-	$ 272,250
	Sludge Storage Exavation	725	CY	$ 50	-	$ 54,375
	Sludge Mixing Pump	1	LS	$ 10,000	$ 15,813	$ 23,719
	Sludge Mixing Nozzles	1	LS	$ 35,000	$ 55,345	$ 83,018
	4" Sch 80 PVC Pipe	300	LF	$ 50	$ 79	$ 35,579
	Telescoping Valves	1	EA	$ 950	$ 1,502	$ 2,253
	3" Plug Valves	1	EA	$ 2,500	$ 3,953	$ 5,930
	3" Swing Check Valves	1	EA	$ 1,700	$ 2,688	$ 4,032
	Air Release Valve	2	EA	$ 450	$ 712	$ 2,135
	Sludge Mix & Transfer System Install	1	LS	$ 13,210	$ 20,889	$ 31,333
	WW Sitework	1	LS	$ 40,000	$ 53,010	$ 79,515
	Electrical Power and Lighting	1	LS	$ 200,000	$ 265,050	$ 397,575
D2	**Effluent Monitoring**					**$ 69,576**
	Automated Flow Measurement Equipment	1	LS	$ 25,000	$ 33,131	$ 49,697
	Portable Composite Sampler	1	LS	$ 5,000	$ 6,626	$ 9,939
	Electrical	1	LS	$ 5,000	$ 6,626	$ 9,939
D3	**Effluent Pumping**					**$ 2,070,702**
	WW Piping line	3200	LF	$ 85	$ 113	$ 540,702
	New Hampton Pump Station	1	LS	$ 1,020,000	-	$ 1,530,000
E.	**Utilities (Electrical, HVAC and Instrumentation)**					
E1	**Electrical Service**					**$ 300,000**
	New 480V utility service	1	LS	$ 100,000	-	$ 150,000
	New 480V distribution	1000	LF	$ 100	-	$ 150,000
E2	**Emergency Power**					**$ 455,223**
	Emergency Generator: 100-200kW	1	LS	$200,000.00	$ 265,049.91	$ 397,575
	Automatic Transfer Switch	1	LS	$15,000.00	$ 19,878.74	$ 29,818
	Fuel Tank	1	LS	$14,000.00	$ 18,553.49	$ 27,830
E3	**Instrumentation and Alarm System**					**$ 397,575**
	Instrumentation, Alarm System & Communication	1	LS	$200,000.00	$ 265,049.91	$ 397,575

F.	**Visitor Education/Interpretation**						
F1	**Visitor Center Repairs**						**$600,000.00**
	New Visitor Center Building	1,000	SF	$350.00	-	$	525,000
	New Displays	1	LS	$50,000.00	-	$	75,000
						$	-
						$	**49,618,116**

New Hampshire Fish and Game Department

Effluent Treatment Evaluation

New Hampton 1B: New 95% RAS Building

Operation and Maintenance

Component	HP	Quantity	Total HP	Watts	Hours/day	kW-hrs/year
Hatchery Modernization						
UV System		8		56,000	24	3,924,480
Drum Filter	8.0	8.0	64.00	47,725	24	418,069
Recirc. Pumping	15.0	6.0	90.00	67,113	24	587,910
Site Lighting		1		15,000	12	65,700
Miscellaneous (SCADA, Meters, etc.)		1		15,000	24	131,400
MBBR-Blower	15.00	6	90.00	67,113	24	587,910
Effluent Treatment						
Clarifier Mechanism	0.75	1	0.75	559	24	4,899
Sludge Pump	20.00	1	20.00	14,914	24	130,647
Effluent Pumping						192,000
					kW-hrs/year =	6,043,015
					$/kW-hrs =	$0.12
						Annual Cost
						$725,161.75
Estimated Annual Replacement Costs						**Annual Cost**
Annual Equipment Replacement						**$789,000.00**
Estimated Annual Labor Costs	**Days per Week**	**Hours per day**	**Personnel**	**Rate**	**OH/Fringe**	**Annual Cost**
Daily Operator Attention	5	8	0	$ 25.00	$ 15.00	**$0**
Chemicals	**Use (gpd)**	**Annual Use (gal)**	**Cost ($/gal)**	**Replacement/yr**		**Annual Cost**
O2 Usage - Tank refill		6000	0.6	12		$43,200.00

Estimated Annual Labor and Replacement Costs	**$789,000**
Estimated Annual Electricity and Chemical Usage Costs	**$768,362**
TOTAL	**$1,558,000**

New Hampshire Fish and Game Department

Effluent Treatment Evaluation

New Hampton 1B: New 95% RAS Building and Rehab Raceways

Life Cycle Cost Analysis

	Total	0 2023	1 2024	2 2025	3 2026	4 2027	5 2028	6 2029	7 2030	8 2031	9 2032
O&M											
Power and Chemical cost (6%/yr 2023-2026, 3%/yr 2027-2042 escalation)		$768,362	$814,463	$863,331	$915,131	$942,585	$970,863	$999,989	$1,029,988	$1,060,888	$1,092,714
R&R Maintenance cost (6%/yr 2023-2026, 4%/yr 2027-2042 escalation)		$299,850	$317,841	$336,911	$357,126	$371,411	$386,268	$401,718	$417,787	$434,499	$451,879
Total O&M Cost		**$1,068,212**	$1,132,304	$1,200,243	$1,272,257	$1,313,996	$1,357,130	$1,401,707	$1,447,775	$1,495,386	$1,544,593
Average Annual O&M Cost over 20 years ($/yr)	$1,588,923										
Average Annual O&M Cost over 10 years ($/yr)	$1,323,360										
Capital Cost		**$52,499,000**									
Equipment Cost		**$9,995,000**									
Net Present Value (at 5% discount rate)											
20 Year Net Present Value	$71,234,523										
10 Year Net Present Value	**$62,557,000**										
Annual Cost											
Average Annual Cost (Debt Service + O&M, 20 year basis)	$5,801,579										
Average Annual Cost (Debt Service + O&M, 10 year basis)	$8,122,221										

	10 2033	11 2034	12 2035	13 2036	14 2037	15 2038	16 2039	17 2040	18 2041	19 2042
Power and Chemical cost (6%/yr 2023-2026, 3%/yr 2027-2042 escalation)	$1,125,496	$1,159,261	$1,194,039	$1,229,860	$1,266,756	$1,304,758	$1,343,901	$1,384,218	$1,425,744	$1,468,517
R&R Maintenance cost (6%/yr 2023-2026, 4%/yr 2027-2042 escalation)	$469,954	$488,752	$508,302	$528,634	$549,779	$571,770	$594,641	$618,427	$643,164	$668,891
Total O&M Cost	$1,595,450	$1,648,013	$1,702,340	$1,758,494	$1,816,535	$1,876,529	$1,938,542	$2,002,645	$2,068,909	$2,137,407

Twin New Facility Summary Opinions of Probable Cost

ITEM	DRAWING I.D. #	ROUNDED CONST COST[a]
New Facility Features		
Pump House & Raceway Rehabiltaiton	B1	$518,000
Rehabilitation of Hatch House	B2	$124,000
Rehabilitation of Storage Garage	B3	$442,000
Rehabilitation of Garage/Office Building	B4	$75,000
Subtotal		**$1,159,000**
Escalation to Midpoint of Const. @ 5%/yr for 5 years		$58,000
3% market volatility adjustment		$34,770
Total Cost		**$1,252,000**

[a] Rounded Total Costs (or Costs needed to Budget) include 50% expected accuracy range).

Costs do **NOT** include: Design Reimbursables (Variable); State Agency Administrative Fee; and land acquisition or lease.

Client: NHFGD
Project:Powder Mill Fish Hatchery Study
Project No.: 10331124

Date: 3/15/2023
Estimator:
Checked By:
Check Date:
Revised: -

Detailed Opinions of Probable Cost						
	Twin	NO. UNITS	UNIT MEAS.	COST PER UNIT	Escalation cost to 2023	TOTAL COST 50% CONT.
A.	**Aquaculture Water Supply**					
	N/A					
B.	**Buildings and Rearing Units**					
B1	**Pump House & Raceway Rehabiltaiton**					**$517,875**
	Tension Fabric Over Raceways	5,000	SF	$ 50	-	$ 375,000
	Concrete Rehab (Cleaning/Debris)	1	LS	$ 50,000	-	$ 75,000
	Concrete Rehab (Replacement)	1	LS	$ 37,250	-	$ 55,875
	Well House Slab Rehab	1	LS	$ 8,000	-	$ 12,000
B2	**Rehabilitation of Hatch House**					**$ 123,750**
	Replace Furnace	1	LS	$ 20,000	-	$ 30,000
	Replace Windows	5	EA	$ 1,500	-	$ 11,250
	Electrical and Lighting Upgrades	1	LS	$ 55,000	-	$ 82,500
B3	**Rehabilitation of Storage Garage**					**$ 441,300**
	Storage Garage Renovations	1	LS	$ 239,000	-	$ 358,500
	Storage Garage - Window Replacement	2	EA	$ 1,500	-	$ 4,500
	Roof Replacement (with new insulation)	2,900	SF	$ 18	-	$ 78,300

B4	**Rehabilitation of Garage/Office Building**					**$ 75,000**
	Replace HVAC system	1	LS	$ 40,000	-	$ 60,000
	Replace Hot Water Heater	1	LS	$ 10,000	-	$ 15,000
C.	**Site**					
	N/A					
D.	**Aquaculture Wastewater**					
	N/A					
E.	**Electrical and HVAC**					
	N/A					
F.	**Visitor Education/Interpretation**					
	N/A					
						$1,157,925

Warren New Facility Summary Opinions of Probable Cost

ITEM	DRAWING I.D. #	ROUNDED CONST COST[a]
New Facility Features		
Pump House Rehabiliation	B1	$81,000
Block Pond Rehabilitaiton	B2	$10,000
Show Pond and PR Pond Rehabilitaiton	B3	$555,000
Rehabilitation of Garage and Storage Area	B4	$827,000
Visitor Center Repairs	F1	$662,000
Subtotal		**$2,135,000**
Escalation to Midpoint of Const. @ 5%/yr for 5 years		$107,000
3% market volatility adjustment		$64,050
Total Cost		**$2,306,000**

[a] Rounded Total Costs (or Costs needed to Budget) include 50% expected accuracy range).

Costs do **NOT** include: Design Reimbursables (Variable); State Agency Administrative Fee; and land acquisition or lease.

Client: NHFGD
Project:Powder Mill Fish Hatchery Study
Project No.: 10331124

Date: 3/15/2023
Estimator:
Checked By:
Check Date:
Revised: -

HDR

Detailed Opinions of Probable Cost						
	Warren	NO. UNITS	UNIT MEAS.	COST PER UNIT	Escalation cost to 2023	TOTAL COST 50% CONT.
A.	**Aquaculture Water Supply**					
	N/A					
B.	**Buildings and Rearing Units**					
B1	**Pump House Rehabiliation**					**$81,000**
	Heater Replacement (Well # 1, Well # 2, and Well # 3)	1	LS	$ 1,000	-	$ 1,500
	Pump 1 Reservoir Maintanace/Cleaning	1	LS	$ 50,000	-	$ 75,000
	Investigation, Test Well (Well #2)	1	LS	$ 3,000	-	$ 4,500
B2	**Block Pond Rehabilitaiton**					**$9,750**
	Concrete Epoxy Sealing (Block Ponds 1,2,3)	650	LF	$ 10	-	$ 9,750
B3	**Show Pond and PR Pond Rehabilitaiton**					**$554,625**
	Crack Repair	1	LS	$ 18,750	-	$ 28,125
	Handle Replacement	1	LS	$ 1,000	-	$ 1,500
	PR Pond Concrete Rehabilitation	1	LS	$ 350,000	-	$ 525,000

B4	**Rehabilitation of Garage and Storage Area**					**$826,500**
	Replace Window (Warehouse)	12	EA	$ 1,500	-	$ 27,000
	Replace Door (Warehouse)	2	EA	$ 3,500	-	$ 10,500
	Replace Overhead Door (Warehouse)	2	LS	$ 50,000	-	$ 150,000
	Install Railing and Handrails (Warehouse)	1	LS	$ 1,000	-	$ 1,500
	Warehous Renovation	3000	SF	$ 100	-	$ 450,000
	Insulation (Warehouse)	3000	SF	$ 10	-	$ 45,000
	Replace HVAC system (Warehouse)	1	LS	$ 40,000	-	$ 60,000
	Replace Electrical and Lighting	1	LS	$ 55,000	-	$ 82,500
C.	**Site**					
	N/A					
D.	**Aquaculture Wastewater**					
	NA					
E.	**Electrical and HVAC**					
	N/A					
F.	**Visitor Education/Interpretation**					
F1	**Visitor Center Repairs**					**$661,350**
	Roof Replacement	1,300	SF	$ 18	-	$ 35,100
	Painting (Exterior, Doors, Window Trim)	1	LS	$ 15,000	-	$ 22,500
	Replace handware (Stainless Steel)	1	LS	$ 2,500	-	$ 3,750
	New Visitor Center Building	1,000	SF	$ 350	-	$ 525,000
	New Displays	1	LS	$ 50,000	-	$ 75,000
						$2,133,225

Appendix E
Solids Loading Calculations

Clarifier and Sludge storage tank calculation - Alternative 1

Flow and Solid Data:

Q Cold Brook and wells	1694	gpm
Drum backwash	5%	
Q WAS first Drum - Cold Brook	84.7	gpm
Q influent to Youngs and Fosters	1609.3	gpm
Q Diversion Pond	2245	gpm
Q WAS first Drum - Diversion Pond	112.3	gpm
Q influent to West brancg Raceways	2132.8	gpm
Q WAS second Drum	187.1	gpm
SG	1.05	
Solids %	5%	
Sludge TSS in clarifier	50000	mg/L
Cold Brook & wells TSS	3	mg/L
Diversion Pond	2	mg/L
Drum TSS capture	62%	
Clarifier removal rate	60%	
Feed to TSS	30%	
Note: lake TSS <2mg/l		

Mass Captured from Drum Filters:

Mass captured from Cold brook drum	1.892	lb/day
Mass captured from Riversion pond drum	1.672	lb/day

Estimated sludge Volume:

		Youngs and Fosters Raceways		West Branch Raceways								
		Feed	Mass of feed-generated	Feed	Mass of feed-generated	Second Drum WAS capture	Total WAS to clarifier	Mass removed in clarifier	Mass overflow in Clarifier	Mass of sludge from effluent treatment	Sludge Vol from clarifier	Sludge Vol from effluent treatment
Month	Days	lbs	lbs/day	lbs	lbs/day	lbs/day	lb/day	lb/day	lb/day	lb/day	gal/mo	lb/day
January	31	1,530	15	624	6	13	16	10	6.595	14.516	700	1028
February	28	1,646	18	672	7	15	19	11	7.585	17.022	728	1089
March	31	2,661	26	757	7	21	24	14	9.629	22.198	1023	1572
April	30	2,490	25	1,310	13	24	27	16	10.849	25.289	1115	1733
May	31	2,547	25	1,258	12	23	26	16	10.557	24.550	1121	1738
June	30	4,564	46	393	4	31	34	21	13.719	32.555	1410	2231
July	31	7,404	72	-	0	44	48	29	19.195	46.423	2039	3287
August	31	8,658	84	651	6	56	59	36	23.767	58.000	2524	4106
September	30	8,692	87	1,846	18	65	69	41	27.560	67.604	2832	4632
October	31	3,303	32	2,858	28	37	41	24	16.212	38.868	1722	2752
November	30	1,091	11	860	9	12	16	9	6.264	13.678	644	937
December	31	1,450	14	576	6	12	16	9	6.288	13.738	668	973
										Total sludge Vol from Clarifier	16525	
										Total sludge Vol from EFF treatment		26076
										Total Sludge Volume	**42601**	

Clarifier Estimations:

Solids Flow	384.1	gpm				
Clarifier Sizing					Solids det Avg	Overflow rate Hyd load rate
Diameter	Depth	Surface Ar	Volume		Goal>60 min	Goal<1000
ft	ft	ft2	ft3	gal	min	gpd/ft2
25	8	490.9	3927.0	29373.9	76.5	1126.6
15	8	176.7	1413.7	10574.6	27.5	3129.5
20	8	314.2	2513.3	18799.3	48.9	1760.4
30	8	706.9	5654.9	42298.4	110.1	782.4

Sludge Storage tank Estimation:

Sludge Storage Tank					
	Operating Depth for vertical wall	Total Volume		Differenece of Tank Volume and Sludge Volume	
Diameter	ft	ft3	gal	Oct-March	Apr-Sep
15.0	7.4	1373.3	10272.4	-3561.1	-18495.6
20.0	7.4	2478.2	18537.2	4703.7	-10230.7
25.0	7.4	3929.7	29394.4	15560.9	626.5

Clarifier and Sludge storage tank calculation - Alternative 2

Flow and Solid Data:

Q Lake	713.3	gpm
	1.03	MGD
Drum backwash	5%	
Q WAS first Drum	35.7	gpm
Q WAS first Drum	0.051	MGD
Q Influent	677.6	gpm
Q Influent	0.976	MGD
SG	1.05	
Solids %	5%	
Sludge TSS in clarifier	50000	mg/L
Lake TSS	2	mg/L
Q WAS of rearing system	677.6	gpm
	0.9757	MGD
Drum TSS capture	62%	
Clarifier removal rate	60%	
Feed to TSS	30%	

Mass Captured from Drum Filters:

Mass of Influent	**6.511**	lb/day
Mass Influent-captured	**10.622**	lb/day

Estimated sludge Volume:

		Youngs and Fosters Raceways		West Branch Raceways							
		Feed	Mass generated	Feed	Mass of feed-	Mass WAS to Clarifier	Total Mass WAS to Clarifier	Mass removed in Clarifier	Mass overflow in Clarifier	Slude Vol from Clarifier	Sludge Vol from eff treatment
Month	Days	lbs	lbs/day	lbs	lbs/day		lb/day	lb/day	lb/day	gal/month	gal/month
January	31	1,530	15	624	6	27.4	38.0	22.8	15.2	1613.3	25.7
February	28	1,646	18	672	7	31.3	42.0	25.2	16.8	1610.3	33.8
March	31	2,661	26	757	7	39.6	50.2	30.1	20.1	2132.9	59.1
April	30	2,490	25	1,310	13	44.5	55.1	33.1	22.1	2266.5	62.7
May	31	2,547	25	1,258	12	43.3	54.0	32.4	21.6	2292.0	60.7
June	30	4,564	46	393	4	56.1	66.7	40.0	26.7	2742.2	139.1
July	31	7,404	72	-	0	78.2	88.8	53.3	35.5	3771.6	290.6
August	31	8,658	84	651	6	96.6	107.2	64.3	42.9	4554.7	410.4
September	30	8,692	87	1,846	18	111.9	122.5	73.5	49.0	5036.5	486.4
October	31	3,303	32	2,858	28	66.1	76.8	46.1	30.7	3260.6	112.1
November	30	1,091	11	860	9	26.0	36.6	22.0	14.7	1506.4	18.3
December	31	1,450	14	576	6	26.1	36.7	22.0	14.7	1560.7	23.5
									Total sludge from Clarifier	32348	
									Total sludge from EFF treatment		1722
									Total Sludge	**34070**	

Clarifier Estimations:

Solids Flow	713.265	gpm				
Clrafier Sizing					Solids det Avg	Overflow rate Hyd load rate
Diameter	Depth	Surface Area	Volume		Goal>60 min	Goal<1000
ft	ft	ft2	ft3	gal	min	gpd/ft2
25	8	490.87	3926.99	29373.89	41.18	2092.39
15	8	176.71	1413.72	10574.60	14.83	5812.21
20	8	314.16	2513.27	18799.29	26.36	3269.37
30	8	706.86	5654.87	42298.40	59.30	1453.05
35	8	962.11	7696.90	57572.83	80.72	1067.55
40	8	1256.64	10053.10	75197.16	105.43	817.34

Sludge Storage tank Estimation:

Sludge Storage Tank					
	Operating Depth for vertical wall	Total Volume		Tank Volume	
Diameter	ft	ft3	gal	Oct-March	Apr-Sep
15.0	7.4	1373.3	10272.4	-1684.3	-11841.0
20.0	7.4	2478.2	18537.2	6580.5	-3576.2
25.0	7.4	3929.7	29394.4	17437.7	7281.0

Clarifier and sludge Storage Tank Calculation – New Hampton, Alternative 1.A

Flow and Solid Data:

Q Lake	693	gpm
	1.00	MGD
Drum backwash	5%	
Q WAS first Drum	34.7	gpm
Q WAS first Drum	0.050	MGD
Q Raceways	658.4	gpm
Q Raceways	0.948	MGD
SG	1.05	
Solids %	5%	
Sludge TSS in clarifier	50000	mg/L
Lake TSS	2	mg/L
Q WAS of rearing units	677.6	gpm
	0.9757	MGD
Drum TSS capture	62%	
Clarifier removal rate	60%	
Feed to TSS	30%	

Mass captured from Drum Filters in Intake Building:

Mass of solid in Raceway	**6.325**	lb/day
Mass Lake-captured by Drum	**10.320**	lb/day

Estimated Sludge Volume:

Month	Days	Feed lbs	Mass generated lbs/day	Mass WAS to Clarifier from Rwy	Total Mass WAS to Clarifier lb/day	Mass removed in Clarifier lb/day	Mass overflow in Clarifier lb/day	Slude Vol from Clarifier gal/month
January	31	-	-	-	-	-	-	-
February	28	2,696	28.9	35.2	45.5	27.3	18.2	1747.0
March	31	3,736	36.2	42.5	52.8	31.7	21.1	2243.0
April	30	743	7.4	13.8	24.1	14.4	9.6	989.7
May	31	2,141	20.7	27.0	37.4	22.4	14.9	1587.3
June	30	770	7.7	14.0	24.3	14.6	9.7	1000.8
July	31	-	-	-	-	-	-	-
August	31	-	-	-	-	-	-	-
September	30	-	-	-	-	-	-	-
October	31	7,700	74.5	80.8	91.2	54.7	36.5	3872.6
November	30	4,402	44.0	50.3	60.7	36.4	24.3	2493.9
December	31	3,084	29.8	36.2	46.5	27.9	18.6	1974.9
							Total sludge Clarifier	**15909**

Clarifier Estimations:

Solids Flow	713.2	gpm				
Clrafier Sizing					Solids det Avg	Overflow rate Hyd load rate
Diameter	Depth	Surface Area	Volume		Goal>60 min	Goal<1000
ft	ft	ft2	ft3	gal	min	gpd/ft2
15	8	176.7	1413.7	10574.6	14.8	5803.9
20	8	314.2	2513.3	18799.3	26.4	3264.7
30	8	706.9	5654.9	42298.4	59.4	1451.0
35	8	962.1	7696.9	57572.8	80.8	1066.0
40	8	1256.6	10053.1	75197.2	105.6	816.2

Sludge Storage Tank Estimation:

Sludge Storage Tank					
	Operating Depth for vertical wall	Total Volume		Tank Volume	
Diameter	ft	ft3	gal	Oct-March	Apr-Sep
15	7.42	1373.3	10272.4	-2059.0	6694.5
20	7.42	2478.2	18537.2	6205.8	14959.4

Clarifier and sludge Storage Tank Calculation – New Hampton, Alternative 1.B

Flow and Solid Data:

Q Lake	693	gpm
	1.00	MGD
Drum backwash	5%	
Q WAS first Drum	34.7	gpm
Q WAS first Drum	0.050	MGD
Q Raceways	658.4	gpm
Q Raceways	0.948	MGD
SG	1.05	
Solids %	5%	
Sludge TSS in clarifier	50000	mg/L
Lake TSS	2	mg/L
Q WAS of rearing units	677.6	gpm
	0.9757	MGD
Drum TSS capture	62%	
Clarifier removal rate	60%	
Feed to TSS	30%	

Mass captured from Drum Filters in Intake Building:

Mass of solid in Raceway	**6.325**	lb/day
Mass Lake-captured by Drum	**10.320**	lb/day

Estimated Sludge Volume:

Month	Days	Feed lbs	Mass generated lbs/day	Raceway B&C Feed generated lbs/day	Mass WAS to Clarifier from Rwy	Total Mass WAS to Clarifier lb/day	Mass removed in Clarifier lb/day	Mass overflow in Clarifier lb/day	Slude Vol from Clarifier gal/month
January	31	-	-	-	-	-	-	-	-
February	28	2,696	28.9	19.3	54.5	64.8	38.9	25.9	2485.9
March	31	3,736	36.2	24.1	66.6	76.9	46.1	30.8	3266.9
April	30	743	7.4	5.0	18.7	29.0	17.4	11.6	1193.4
May	31	2,141	20.7	13.8	40.9	51.2	30.7	20.5	2174.0
June	30	770	7.7	5.1	19.2	29.5	17.7	11.8	1211.9
July	31	-	-	-	-	-	-	-	-
August	31	-	-	-	-	-	-	-	-
September	30	-	-	-	-	-	-	-	-
October	31	7,700	74.5	49.7	130.5	140.8	84.5	56.3	5982.9
November	30	4,402	44.0	29.3	79.7	90.0	54.0	36.0	3700.4
December	31	3,084	29.8	19.9	56.1	66.4	39.8	26.6	2820.2
								Total sludge Clarifier	**22835**

Clarifier Estimations:

Solids Flow	713.2	gpm				
Clrafier Sizing					Solids det Avg	Overflow rate Hyd load rate
Diameter	Depth	Surface Area	Volume		Goal>60 min	Goal<1000
ft	ft	ft2	ft3	gal	min	gpd/ft2
15	8	176.7	1413.7	10574.6	14.8	5803.9
20	8	314.2	2513.3	18799.3	26.4	3264.7
30	8	706.9	5654.9	42298.4	59.4	1451.0
35	8	962.1	7696.9	57572.8	80.8	1066.0
40	8	1256.6	10053.1	75197.2	105.6	816.2

Sludge Storage Tank Estimation:

Sludge Storage Tank					
	Operating Depth for vertical wall	Total Volume		Tank Volume	
Diameter	ft	ft3	gal	Oct-March	Apr-Sep
15	7.42	1373.3	10272.4	-7983.8	5693.1
20	7.42	2478.2	18537.2	281.0	13957.9

Clarifier and sludge Storage Tank Calculation – Milford, Alternative 1.A

Flow and Solid Data:

Q Lake	693	gpm
	1.00	MGD
Drum backwash	5%	
Q WAS first Drum	34.7	gpm
Q WAS first Drum	0.050	MGD
Q Raceway	658.4	gpm
Q Raceway	0.948	MGD
SG	1.05	
Solids %	5%	
Sludge TSS in clarifier	50000	mg/L
Lake TSS	2	mg/L
Q WAS of rearing system	677.6	gpm
	0.9757	MGD
Drum TSS capture	62%	
Clarifier removal rate	60%	
Feed to TSS	30%	

Mass captured from Drum Filters in Intake Building:

Mass of Influent	**6.325**	lb/day
Mass Influent-captured	**10.320**	lb/day

Estimated Sludge Volume:

		Feed	Mass generated	Mass WAS to Clarifier from Rwy	Total Mass WAS to Clarifier	Mass removed in Clarifier	Mass overflow in Clarifier	Slude Vol from Clarifier
Month	Days	lbs	lbs/day		lb/day	lb/day	lb/day	gal/month
January	31	7,557	73	79.5	89.8	53.9	35.9	3813.8
February	28	6,721	72	78.3	88.7	53.2	35.5	3401.7
March	31	7,011	68	74.2	84.5	50.7	33.8	3589.3
April	30	5,853	59	64.9	75.2	45.1	30.1	3090.5
May	31	2,402	23	29.6	39.9	23.9	16.0	1694.6
June	30	1,476	15	21.1	31.4	18.8	12.6	1291.1
July	31	2,189	21	27.5	37.8	22.7	15.1	1607.0
August	31	3,237	31	37.7	48.0	28.8	19.2	2037.8
September	30	5,469	55	61.0	71.3	42.8	28.5	2932.6
October	31	7,552	73	79.4	89.7	53.8	35.9	3811.7
November	30	8,724	87	93.6	103.9	62.3	41.6	4270.7
December	31	8,820	85	91.7	102.0	61.2	40.8	4333.0
							Total sludge from Clarifier	**35874**

Clarifier Estimations:

Solids Flow	713.2	gpm				
Clrafier Sizing					Solids det Avg	Overflow rate Hyd load rate
Diameter	Depth	Surface Area	Volume		Goal>60 min	Goal<1000
ft	ft	ft2	ft3	gal	min	gpd/ft2
15	8	176.7	1413.7	10574.6	14.8	5803.9
20	8	314.2	2513.3	18799.3	26.4	3264.7
30	8	706.9	5654.9	42298.4	59.4	1451.0
35	8	962.1	7696.9	57572.8	80.8	1066.0
40	8	1256.6	10053.1	75197.2	105.6	816.2

Sludge Storage Tank Estimation:

Sludge Storage Tank					
	Operating Depth for vertical wall	Total Volume		Tank Volume	
Diameter	ft	ft3	gal	Oct-March	Apr-Sep
15	7.42	1373.3	10272.4	-12947.8	-2381.1
20	7.42	2478.2	18537.2	-4683.0	5883.7
25	7.42	3929.7	29394.4	6174.2	16740.9