**Monterey Peninsula Water Management District**

**Sleepy Hollow Steelhead Rearing Facility Raw Water Intake and Water Supply System Upgrade**

# Basis of Design Report

TETRA TECH

October 2015

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## PREPARED FOR

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## 1.1 INTRODUCTION

Monterey Peninsula Water Management District (MPWMD) is planning to upgrade the Sleepy Hollow Steelhead Rearing Facility (SHSRF) in order to improve water supply intake reliability and intake water quality as much as possible. Improvements to the water supply intake will address the following:

- Increase reliability and durability of the facility's water supply and treatment system.
- Address potential increases in sandy bed load in the Carmel River due to removal of the San Clemente Dam.
- Locate water supply intake pumps to allow access during high river stage.
- Provide a new self-cleaning intake screen in a new location to increase submergence and minimize sediment deposition.
- Provide treatment to remove settleable and suspended sediment from the intake water.
- Employ water reuse and treatment technologies to allow the SHSRF to operate when river flows fall below 4 cubic feet per second (cfs) and when sediment load is extraordinarily high during storm events.

The pre-design effort for the project integrates specialty design work completed to date for the intake, pump station, and aquaculture. The consultant and MPWMD facility managers and operators met on site to evaluate SHSRF conditions, make initial findings, and identify needs. Engineers reviewed existing conditions during the site visit and gathered facility information. SHSRF biological programming, facility needs, and projected production requirements were discussed. The Basis of Design report documents findings from the pre-design work so that options can be reviewed and a project description generated to begin the permit process. Further review of facility condition, design, and operating details will be made while completing the Preliminary Design Task.

For the Basis of Design report, three options for the process water system were reviewed with MPWMD, and a preferred option was determined. The report provides a detailed analysis of the preferred option (Option #3). The other options are described in less detail.

## 1.2 EXISTING FACILITY OVERVIEW

MPWMD staff designed the SHSRF in the early 1990s to hold juvenile steelhead rescued from the lower Carmel River during the low flow periods. Construction began in 1995 and was completed in 1996. The first fish were received in late 1996.

The facility occupies a broad floodplain terrace above the river that covers approximately 7 acres at an elevation 401 feet above sea level. The site is shaded by local topography, a mature canopy of coast live oak (*Quercus agrifolia*), and several large California sycamores (*Platanus racemosa*). Stream flow at the site is perennial, and augmented during dry months by releases from Los Padres Reservoir.

The facility covers 9,300 square feet, including 480 square feet for a storage/office building, 2,400 square feet for rearing pools, and 6,400 square feet for a rearing channel. The single-story office, lab, and storage building is adjacent to the tanks and rearing channel.

Water is supplied from a screened freshwater intake, located on the Carmel riverbank at a pool approximately 250 feet from the facility. The existing wet well and intake pumps deliver water to the facility via 6-inch-diameter buried PVC pipe. The current intake pump system delivers up to 900 gallons per minute (gpm). A portable irrigation pump provides an auxiliary backup water supply of 500 gpm for use in emergency situations. The intake pumps deliver river water to the top of a cooling tower. From there, water is distributed to the rearing channel and tanks. The cooling tower, installed in 2000, is operated (i.e., the fan is turned on) to provide water cooling whenever the river water temperature is greater than 58ºF. The rated capacity for the tower is to cool 900 gpm of water from 78ºF to 65ºF with a wet bulb temperature of 61ºF.

The primary fish-rearing capacity of the facility is in the natural rearing channel. The 800-foot long channel has 17 pairings of 6-foot-wide riffle and 9-foot-diameter pool sections. The approximate gross volume of the channel is 14,900 cubic feet; however, the channel is filled with cobble in almost all riffle sections, reducing the fish rearing volume significantly. It is estimated that the fish rearing volume is only 4,000 cubic feet (30,000 gallons). The facility also includes two large holding tanks (22- and 30-foot diameter), eight insulated fiberglass rearing troughs, and six 8-foot-diameter quarantine/holding tanks. These tanks are used for initial quarantine and subsequent rearing of steelhead to increase the size of fish stocked into the mixed-size population in the natural rearing channel.

Generally, the facility operates from early summer to late fall/early winter, depending on river flow and weather conditions. Once flow returns to the lower river, MPWMD staff recapture, count and release the fish back to the river.

A full description of the existing facility components and the biological program can be found in the *Rescue and Rearing Management Plan* prepared by MPWMD for review by the National Marine Fisheries Service (NMFS). The summary of the program in the following section focuses on elements that impact design of the proposed improvements.

## 1.3 BIOLOGICAL PROGRAM

The biological program for the facility starts with steelhead rescues from May or June through August or September. The majority of steelhead rescued are young-of-the-year, approximately 3 inches in length. Data indicate that young-of-the-year steelhead make up 95 percent of the fish rescued and brought to the facility. Steelhead older than one year make up only 4 percent of the fish rescued. Adult steelhead that are rescued are not brought to SHSRF; they are transported to the ocean or upstream to spawn.

The long-term average number of steelhead rescued and brought to SHSRF is 17,000 per year. However, the number is highly variable, with a high of 50,000 per year and a low of 2,000 per year. Rescued steelhead that are brought to SHSRF are held in quarantine tanks for at least 24 hours and treated with formalin. After formalin treatment, fish may be stocked into the natural rearing channel or reared in the tanks or troughs until large enough to be stocked in the mixed-size population in the rearing channel. Fish are hand-fed a Bio-Oregon trout diet and krill; hand-feeding is supplemented with belt feeders, bug zappers and natural BMI production within the rearing channel.

Steelhead are reared at the facility until December or January, after which they are captured, transported and released back to the Carmel River. Fish are released once high river flows have been established for 2 to 4 weeks. The latest that fish have been released back to the river is February.

## 1.4 BIOLOGICAL DESIGN CRITERIA

The natural rearing channel and biological program is unique to the SHSRF program, so biological design criteria that have been identified through trial and error at the facility are considered to be the current best management practice. MPWMD staff have tried different densities over the years and found that 2,000 fish per section is the maximum that does not cause negative effects. Fish densities have been tried at 500, 750, 1,000, 1,500, 2,000 and 4,000 fish per riffle and pool section by measuring total season survival. Two thousand fish per section is the maximum density used; 4,000 fish per section had negative effects.

Assuming that fish are released at a maximum average size of 6 inches (15.24 cm) and 0.086 pounds (39 g) and that the available fish-rearing volume per riffle and pool section is 235 cubic feet (6.65 cubic meters), the biomass density equivalent of 2,000 fish per section is 0.73 pounds/cubic foot (11.7 kg/cubic meter). This density matches well with other fish hatchery programs that are raising first-generation progeny.

## 1.5 WATER REQUIREMENTS

Table 1-1 shows the water budget identified in collaboration with MPWMD staff. MPWMD operators have requested a slight increase in the available flow to improve the rearing environment and operational flexibility.

**Table 1-1.** Water Budget

| Rearing Area | Flow Required (gpm) | Total Flow Desired (gpm) |
|---|---|---|
| Rearing Channel | 900 | 1,080 |
| Tank Field – 5 Quarantine Tanks | 75 | 75 |
| Tank Field – 8 Rearing Troughs | 40 | 40 |
| Tank Field – Recirculation System | 100 | 100 |
| Cushion (Reserve Capacity) | — | 55 |
| **Total** | **1,115** | **1,350** |

# 2. RIVER WATER SUPPLY

## 2.1 DESIGN CRITERIA

Table 2-1 summarizes the intake screen design criteria, which meet the requirements of *Anadromous Salmonid Passage Facility Design* (NMFS Northwest Region, Portland, Oregon, 2011). The river water intake pump station will be sized to provide the total desired flow of 1,350 gpm as described in Section 1. Redundancy will be provided such that the design flow can be delivered with the largest pump out of service.

**Table 2-1.** Intake Screen Design Criteria

| Description | Value | Note |
|---|---|---|
| Design Flow | 1,350 gpm (3.0 cfs) | See Table 1-1 |
| Maximum Screen Approach Velocity | 0.4 feet/second | For active screens (NMFS) |
| Required Screen Effective Area | 7.5 square feet | Maximum flow divided by approach velocity (NMFS) |
| Maximum Slotted Opening Width | 1.75 mm (0.069 inches) | NMFS |
| Minimum Open Area | 27% | NMFS |

Gravity conveyance piping will be sized for a full-pipe flow velocity between 2.0 and 3.0 feet/second at design flow, to minimize head loss while still transporting most sediment. Pressurized force main piping will be sized to provide adequate scouring velocities to minimize sediment deposition in the pipes. Horizontally orientated force main piping will be sized for a flow velocity between 3.5 and 6.0 feet/second at design flow. Vertically orientated force main piping will be sized for a flow velocity between 6.0 and 10.0 feet/second at design flow.

## 2.2 INTAKE SCREEN AND SEDIMENT CONTROL

The existing intake screen is a non-active horizontal tee screen with 3/32-inch wedge wire. It has required significant maintenance because it is not self-cleaning, resulting in buildup of silt, leaf debris and algae. It is located where river water submergence is an issue for river flow below 4 cfs. A new active screen meeting the latest NMFS criteria and installed in a deeper river area is recommended. The proposed replacement is a single 66-inch-diameter cone screen, as shown in Figure 2-1. It would be installed suspended over a concrete slab located at the upstream end of an existing pool in the Carmel River. Design criteria are summarized in Table 2-2.

The top of the screen will be at about the low water level in the river (elevation 385.4 feet). The bottom of screen will be at about 383.4 feet, and the concrete slab elevation will be 382 feet. A water line from the pump station will allow recirculation of river water to a spray bar manifold located next to the screen. It will operate by manually opening a valve on the flush water line to allow periodic flushing of sediment from around and under the screen. Figure 2-2 illustrates the basic layout of the proposed screen and spray bar system.

Another option for reducing sediment deposition at the screen is installing air burst piping and nozzles. This would require an air compressor, a tank, and air piping from the compressor to screen. The air burst system is not recommended due to its higher capital cost and maintenance requirements, and uncertainty as to whether it is needed. The air burst system could be added at a future date if determined to be necessary.

Low elevation vanes located in the river are being considered to direct bedload away from the screen structure (see Section 2.2.1). Recommendations for the type, size and location of vanes will be provided if modeling results indicate that they are necessary.

Manual removal of sediment and debris build-up around the screen will likely be required periodically. The required frequency is difficult to predict, but it should be significantly less than for the existing screen.

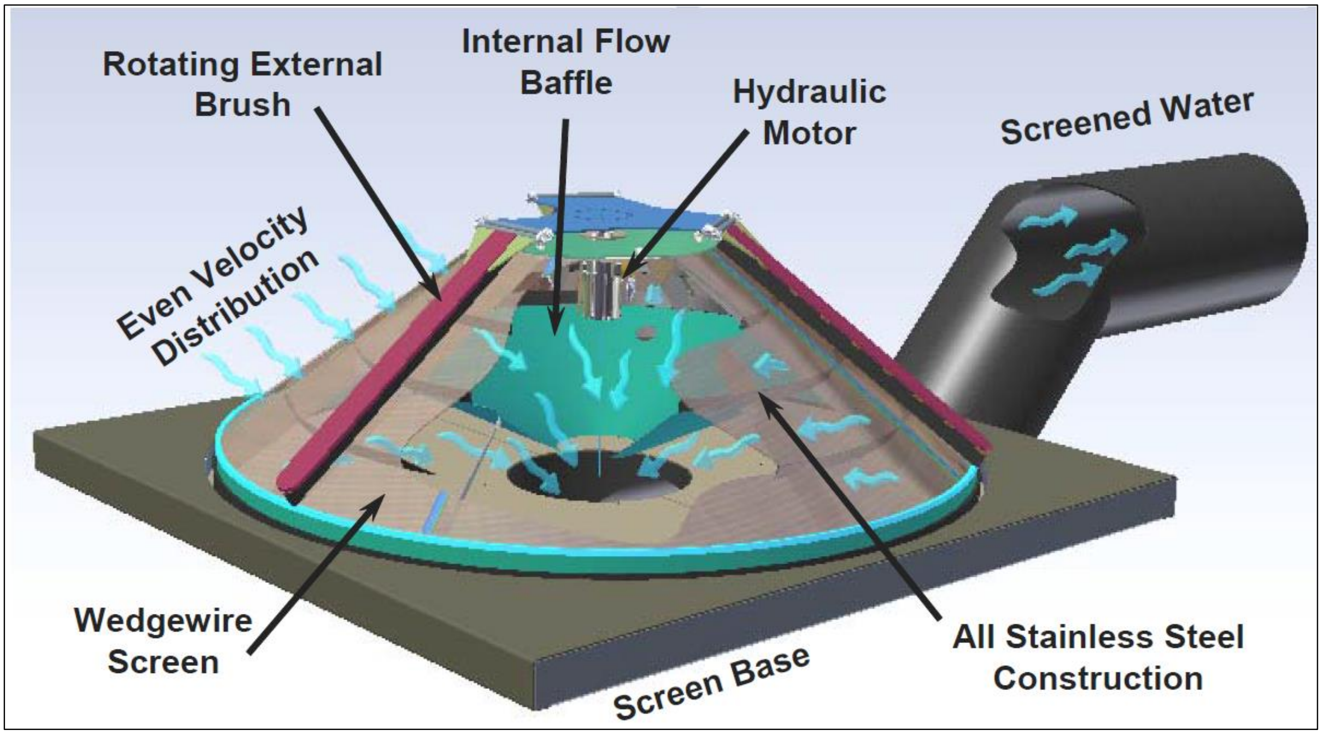


**Figure 2-1.** Proposed Cone Screen

**Table 2-2.** Cone Screen Design Criteria

| | |
|---|---|
| Number of Screens[a] | 1 |
| Screen Diameter | 66 inches |
| Screen Height | 18 inches |
| Screen Surface Area | 26.8 square feet |
| Capacity[b] | 6.7 cfs (3,000 gpm) |
| Open Area | 50% |
| Opening Width | 1.75 mm (0.069 in) |

a. Basis of design: ISI Model C66-18
b. Based on 0.5-foot/second slot velocity, and 0.25-foot/second approach velocity

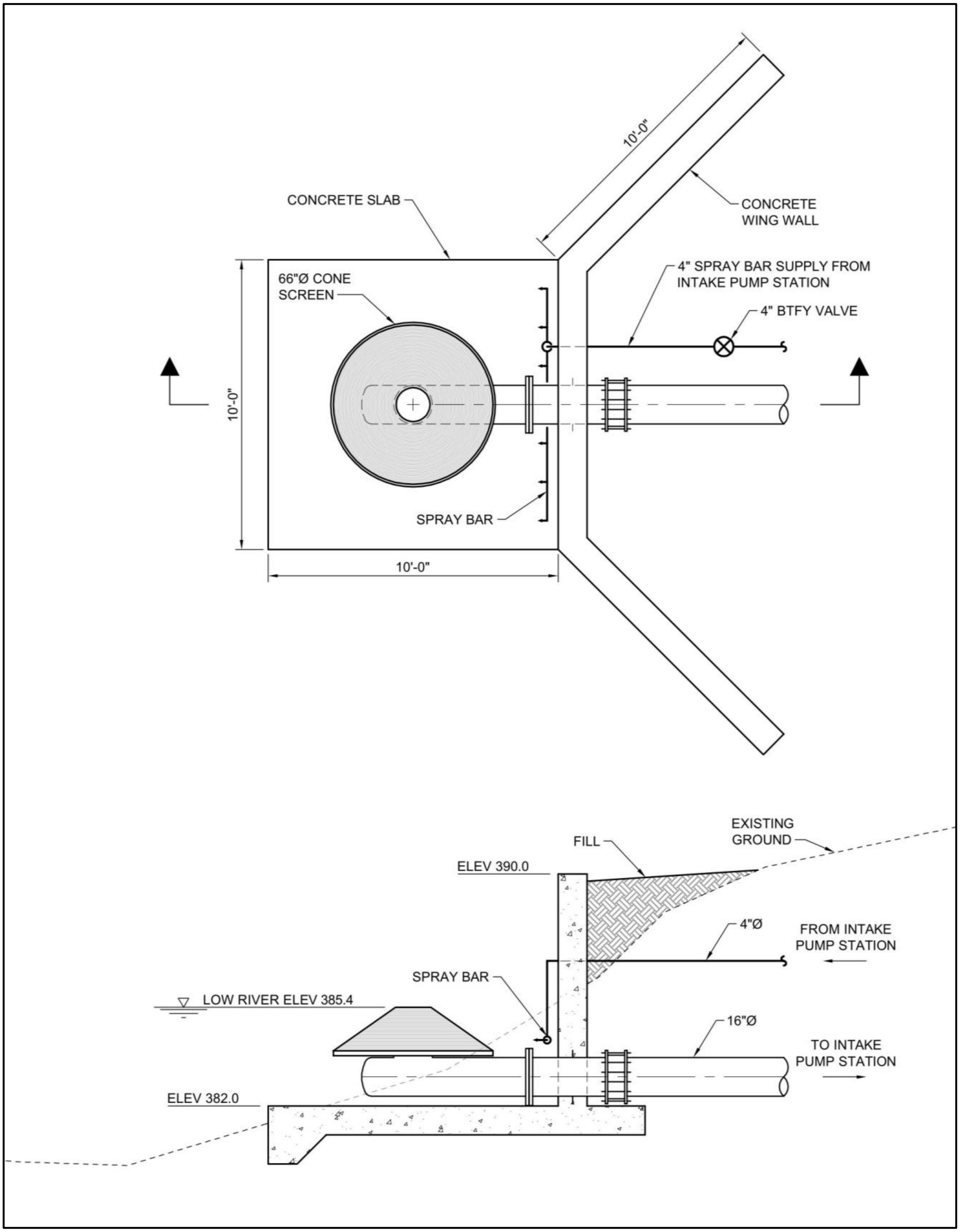


**Figure 2-2.** Layout of Proposed Screen and Spray Bar System

### 2.2.1 Hydraulic and Sediment Transport Analysis

The current design for the proposed intake has the structure located at the head of the relatively deep pool in the Carmel River, about 120 feet upstream from the present location of the outlet discharge point. The thalweg of the channel at the proposed inlet location is at an elevation of 381.6 feet and the downstream hydraulic control for the pool has an elevation of 385.4 feet; so the minimum total flow depth during low flow conditions is 3.8 feet.

An existing one-dimensional HEC-RAS hydraulic model of the Carmel River (Avila and Associates, 2012) was updated for this project using survey information collected in June 2015. Preliminary results from the updated model indicate that the average main channel hydraulic depth is about 2 feet larger than the average hydraulic depth in the upstream reach. At the median mean daily discharge of 15 cfs, the main channel hydraulic depth increases from 0.8 feet in the upstream reach to 2.9 feet at the proposed intake location. Results from the model also indicate that the main channel velocities at the intake structure are substantially lower than in the upstream reach, reducing from about 1.25 feet/second on average in the upstream reach to about 0.1 feet/second at the intake during the median mean daily flow of 15 cfs.

One of the primary concerns associated with the design of the intake is the potential for sediment to affect operations. Bedload deposition in the vicinity of the intake could raise the channel bed and bury the intake structure. High suspended sediment load concentrations could be drawn into the intake and affect pumping operations and deposit in the rearing channel. The relatively large flow depths are of benefit to the design of the intake in that it is possible to locate the intake screen in the uppermost portion of the water column where no bedload sediment transport is likely. If the intake screen is constructed in this manner, it is likely that only suspended sediment loading will affect operations over the short term. However, considering the low velocities predicted by the HEC-RAS model at the proposed location of the intake structure, prolonged bedload deposition in this area could also be of concern.

The Carmel River Reroute and Dam Removal (CRRDR) Project that is currently being constructed upstream from San Clemente Dam could increase sediment delivery to the intake area. This increased sediment loading does not appear to be a significant design constraint because some of the increase in sediment storage would occur along the overbanks during periods of high flow, and the volume of sand-sized bed material that would be of most concern to the design of the intake structure only increases by 2 percent to 5 percent (MEI, 2006 (revised 2007)).

Results from the equilibrium slope analysis that was conducted as part of the design of the CRRDR Project will be used to estimate the anticipated increase in sediment loading that would occur after construction. These estimates of sediment supply will then be input into the HEC-6T sediment routing model that was developed as part of the CRRDR analysis, and the model will be used to estimate bedload transport volumes in the vicinity of the intake structure over a range of flows.

If, based on the results from the modeling, there is a potential for bedload deposition at the intake, it will be necessary to incorporate low-elevation vanes upstream from the intake to deflect bedload away from the structure. Results from the modeling will also be used to estimate suspended sediment concentrations in the vicinity of the intake. These estimates will be compared to screen manufacturer specifications to ensure that the suspended sediments will not negatively impact screen performance.

## 2.3 PUMP STATION AND CONVEYANCE

The facility currently has two 30-hp river intake pumps, each sized to deliver 900 gpm at 85 feet of total dynamic head (TDH). In 2000, upgrades were made to add a cooling tower and a cold well sump. There are three cold well pumps—one is 10 hp and the other two are 7.5 hp. The 10 hp pump has a variable frequency drive (VFD) motor controller and is used to pump water to the rearing channel after it is cooled. The two 7.5-hp pumps also run alternately on a continuous basis to deliver water from the cold well to the rearing channel.

The existing river pump station structure is undersized for two large pumps, and it is in a flood-prone area. At river flows greater than 1,000 cfs, it cannot be accessed for maintenance. It will need to be relocated to be near the relocated intake screen and to sit at an elevation of 400 feet.

The proposed river water intake pump station will consist of two submersible non-clog pumps installed in a concrete wet-well. The number of pumps may be revisited during design to accommodate final equipment selections, layout and flow scenarios. If lower flows are desired, it may be necessary to have three smaller pumps.

River water will be conveyed from the intake screen to the wet well via a 16-inch-diameter pipe. A gate or valve will be installed on the end of the 16-inch pipeline inside the wet-well to allow dewatering and maintenance of the wet well. The valve operator nut will be accessed with a valve tool from above grade.

Pump selection will be reviewed with pump vendors to verify reduced susceptibility to sand and sediment particle wear on pump seals and wet components. Pumps will be installed on a slide rail system for easy retrieval of a single pump for maintenance without entering the wet well and while the other pump is running. A one-ton boom truck will be needed to hoist the pumps out of the wet well. The wet well inside diameter will likely be between 72 and 120 inches, depending on the number and size of pumps selected. A valve vault will be located next to the wet well, with an isolation valve, check valve, and pressure gauge for both discharge lines. Figure 2-3 shows a conceptual layout of the wet well and valve vault.

### 2.3.1 Pump Sizing

The river water intake pumps will be required to deliver a range of flows, as summarized in Table 2-3. The pump station and conveyance piping will be designed to deliver flows to multiple locations to maximize operational flexibility. Discharge locations and required static heads are summarized in Table 2-4. The maximum static lift values are based on a wet well low water elevation of 384.0 feet.

**Table 2-3.** River Water Supply Design Flows

| Scenario | Design Flow (gpm) | Design Flow (cfs) |
|---|---|---|
| Flow Through Mode (0% Re-use) | 1,350 | 3.0 |
| 50% Reuse | 810 | 1.8 |
| Operation of LAKOS Sand Separator | 525 | 1.2 |
| 75% Reuse[a] | 540 | 1.2 |
| Fish Transfer and Rearing Channel Maintenance | 200 | 0.45 |

a. Not recommended for long periods because of concern for adequate water quality in the rearing channel.

**Table 2-4.** River Water Supply Discharge Locations

| Location | Approximate Discharge Elevation | Required Residual Pressure (psi) | Maximum Static Lift[a] (feet) |
|---|---|---|---|
| Reuse Pump Station – Sedimentation Basin Inlet | 401.0 | 1 | 19 |
| Reuse Pump Station – LAKOS Sand Separator | 405.0 | 17 | 60 |
| Cooling Tower Inlet | 420.5 | 5 | 48 |
| Head Tank Oxygenation Tower | 419.0 | 1 | 37 |
| Rearing Channel Inlet | 407.0 | 1 | 25 |

a. Does not include friction losses.

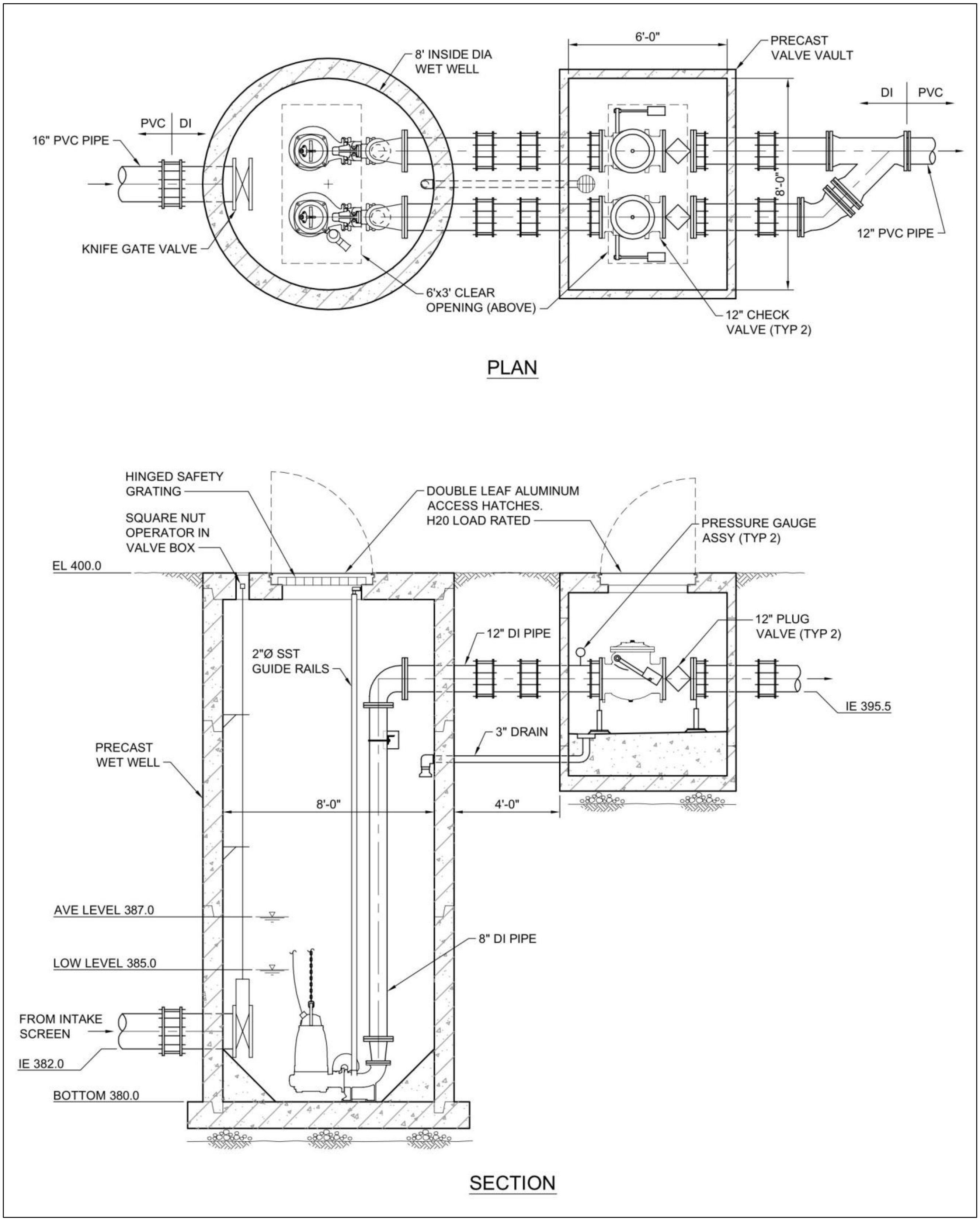


**Figure 2-3.** River Pump Station Wet Well and Valve Vault Plan and Section

If it is found to be cost-effective, the existing LAKOS centrifugal-action sand separator will be used in the revised treatment system. This would require pumps that can deliver about 17 psi additional discharge pressure. The head loss variation between purge cycles and design operating pressure will be reviewed with LAKOS in order to finalize pumping requirements.

With the addition of reuse, it is anticipated that the facility will use a combination of reuse and river water during high river turbidity events, which will make it feasible to use the existing sand separator, which has a maximum capacity of 525 gpm. It is also anticipated that sand separator use will be intermittent, occurring only during river events that mobilizes sand particles. Additional discussion of sand removal is provided in Section 3.2.

Pumps selected will be reviewed for intermittent use of the sand separator. A pump will be selected to operate near the best efficiency point of the pump curve when the sand separator is bypassed and not in use. When the sand separator is not bypassed, the added pressure loss will cause the pumps to operate on the left side of the pump curve. Operating to the left of the best efficiency point can affect pump longevity, and the tradeoffs will be reviewed with the pump manufacturer during design in order to make the best pump selection. An alternative is to use more than two pumps, and different sized pumps; however, to keep the system simplified, this is not recommended.

Pump selection requires consideration of the range of operating flow rates and discharge pressures. The operating range is compared with the minimum flow rate that a single full capacity pump can provide. This becomes more complicated when adding the sand separator operation to the system. The use of two 1,350 gpm redundant pumps will simplify the system. Depending on manufacturer recommendations, the minimum flow rate of these pumps may be as high as 540 gpm (40 percent of the maximum capacity is a rule of thumb), which would require overflowing any excess water if the required flow is less than 540 gpm. The pumps will be provided with variable frequency drives to operate one pump at a minimum continuous stable flow. In order to operate during low river flows, it is recommended that most of the overflow be discharged upstream of the pump intake. The pump size selection that results from these considerations is listed in Table 2-5.

**Table 2-5.** River Water Pump Sizing

| Description | Value |
|---|---|
| No. of River Water Pumps | 1 running (1 standby) |
| River Water Pump Design Point for Reuse | 540 gpm at 24' TDH |
| River Water Pump Design Point for Cooling Tower | 1,350 gpm at 55' TDH |
| River Water Pump Motor Size | 2 each, 30 hp |

## 2.4 OPERATIONS AND CONTROLS

The cone screen will be equipped with an external cleaning brush. It will be powered by a hydraulic system located in the screen control panel. The brush will operate on a timed interval that is set by the operator. An output from the screen control panel will allow for a general screen alarm to be input to the facility programmable logic controller (PLC). An optional level transducer can be provided to monitor river level. The PLC could compare the river level to the wet well level and generate an alarm when there is excessive difference, likely indicating a clogged screen.

In order to deliver the required range of flows between 540 gpm and 1,350 gpm, which depends on level of reuse and other facilities in operation, the river water pumps will each be controlled with a variable frequency drive. Control of the VFD can have multiple modes of operation and will be by a PLC using inputs from a flow meter and level sensors in the headbox and reuse structure. The VFD will regulate pump speed for the following modes of operation:

- Operator entered pump speed
- Operator entered flow set-point
- PLC controlled speed to maintain set-point level in the headbox
- PLC controlled speed to maintain set-point level in the reuse structure.

A submersible pressure transducer will be provided to monitor the wet well level and shut off the pumps if the water level is too low. Pump alarms will include pump motor high-temperature, motor seal leakage, low wet well level, and pump running with zero flow at the flow meter. Low level in the pump wet well and other critical parameters will be alarmed at stages allowing adequate time for operators to respond. These and other alarms and monitors for facility operation are described in Section 5.4.

# 3. RIVER WATER TREATMENT

## 3.1 DESIGN CRITERIA

River water requires treatment to control temperature, dissolved oxygen, carbon dioxide, and solids. The criteria described under water reuse (Section 4.4.1) are generally applicable; some treatment equipment will be shared with the reuse system. Additional criteria are included in the *Rescue and Rearing Management Plan* and will be reviewed during design.

## 3.2 SEDIMENT REMOVAL

Historical levels of total suspended solids (TSS) in the river have been generally low (<10 mg/L) with spikes of greater than 25 mg/L due to storm events. This will change with the removal of the San Clemente Dam due to sediment being transported more easily in the river system, making the Carmel River subject to more spikes in TSS. TSS includes a large fraction of solids smaller than 70 microns in diameter; the data in Figure 3-1 was determined from samples taken in the upstream end of the rearing channel at the Sleepy Hollow Rearing Facility.

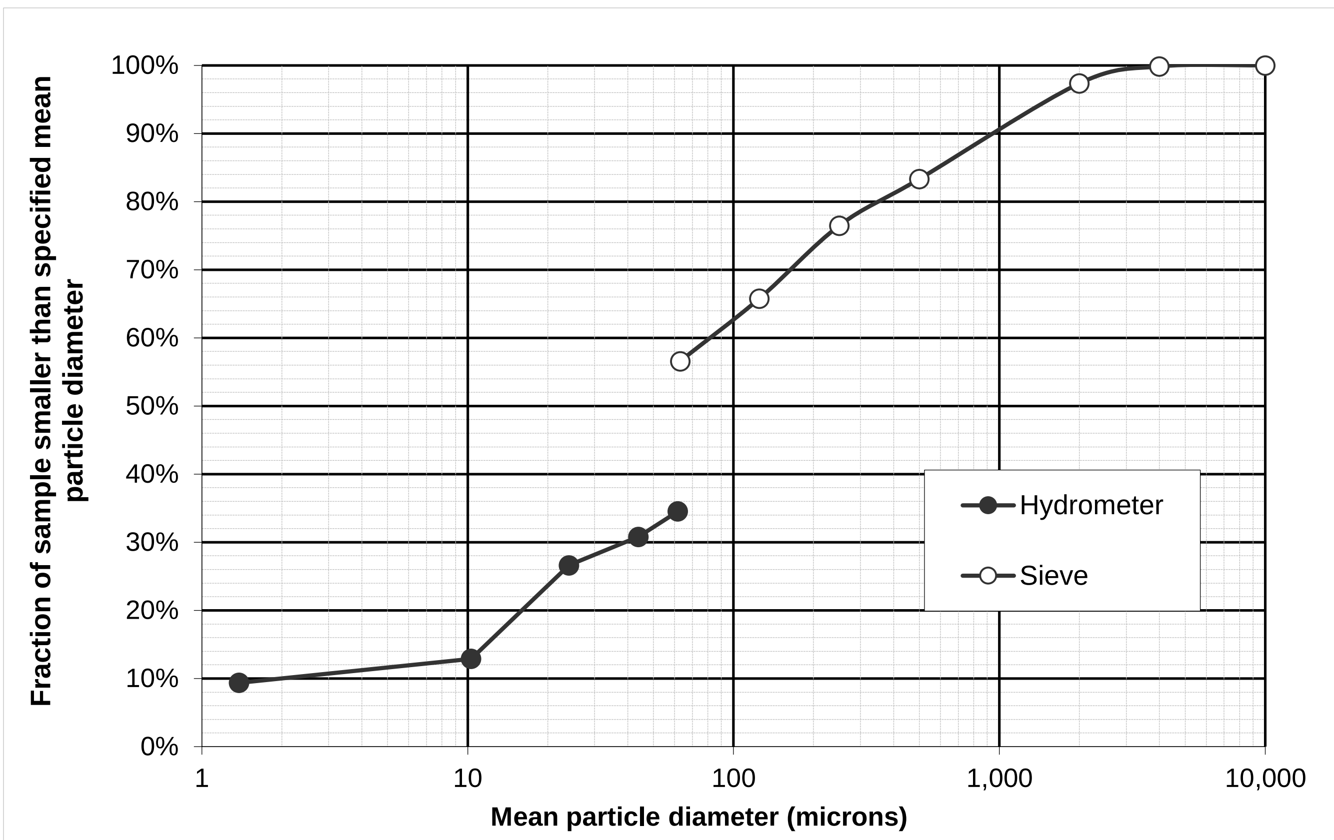


**Figure 3-1.** Averaged Sediment Particle Size Distribution

Sediment removal facilities are recommended to help reduce wear on reuse pumps, reduce sediment buildup in process systems, and increase the effectiveness of proposed UV disinfection equipment. With reuse added to the facility, sediment concerns will be reduced because the facility can run on 50-percent reuse water, withdrawing less water from the river, when the river stage, bedload and turbidity are high. The proposed systems would allow emergency operation on 100-percent reuse water for short periods (see Section 4.5).

Alternatives for sediment settling that were reviewed are the use of the existing LAKOS sand separator, addition of a sediment basin, or a combination of both. The preferred alternative is to pump raw river water to a basin for settling and filtering prior to re-pumping into the system. Use of the existing LAKOS sand separator, rated for 525 gpm, has the disadvantage that pumping water through the separator requires higher pumping head and would use more power than the sediment basin. However, the 525 gpm is adequate when used in combination with 50-percent reuse, and sediment removal would typically only be necessary when using reuse. The literature provided by LAKOS does not accurately predict efficiency of particle removal; the unit may not be as effective as the sediment basin. If the LAKOS is retained, it should be used in conjunction with a sediment basin and should be moved to the reuse pump station location, which is at a lower elevation. This would allow use of the LAKOS without increasing the river water pump size.

Settling basin sizing is based on the target particle size and its settling velocity. Settling velocity for discrete, non-flocculating particles is a function of its diameter, specific gravity, and shape. The rate at which clarified water is produced is equal to the surface area of the basin times the particle settling velocity. Additional area should be provided to account for non-uniform flow at the inlet and outlet and potential short-circuiting caused by wind on the surface. Preliminary design criteria are presented in Table 3-1.

**Table 3-1.** Settling Basin Design Criteria and Sizing

| Description | Value |
|---|---|
| Design Flow | 3 cfs (1,350 gpm) |
| Target Particle Size for Removal | 60 micron |
| Assumed Specific Gravity of Removed Particles | 2.65 |
| Estimated Particle Settling Velocity | 0.013 feet/second |
| Overflow Rate | 5.8 gpm/square foot |
| Required Area of Settling Zone | 230 square feet |
| Total Basin Area (100% Allowance for Buffer Areas / Short Circuiting) | 460 square feet |
| Basing Length to Width Ratio | 3 : 1 |
| Basin Dimensions | 35’ L x 13’ W x 4’ D |
| Detention Time at Design Flow | 10 minutes |

With the settling basin alternative, the reuse sump will be enlarged to include a chamber for raw river water settling and filtering prior to using the reuse pumps for re-pumping the river water. Under this option, the reuse pumps are sized for higher capacity so that they can pump the total flow of 1,350 gpm. In order to control solids so that UV transmissivity is increased, water will be filtered in a micro-screen filter with 40-micron screen media. The level of settling and filtration will be further evaluated during design, with initial goals of capturing 40 percent of the solids and controlling TSS to less than 10 mg/L during moderate river stages.

To select the sediment removal system, it is recommended to sample and test the river water turbidity now that the San Clemente Dam has been removed. Testing will help finalize sizing of the sediment basin, drum filter and UV equipment. The following testing is recommended on samples of both typical and high river turbidity:

- Particle size distribution analysis
- Average specific gravity of the sediment

Is the MPWMD fishery group following up on this?

- TSS of river water, unfiltered and after filtering by 30-, 60- and 90-micron screen media (filter manufacturers can provide kits to simulate filtration through various sizes of screen media)
- UV transmittance tests of the unfiltered and filtered water samples.

River water sediment and turbidity levels are highly variable and not easily predicted. Operators will monitor system parameters and make a determination on the effectiveness of each component. If a drum filter is overloaded, the water will bypass the filter. When the filter is bypassed, water depth indicators will alarm operators that the system should be checked and operations changed. Once test data is acquired, the operator will be better equipped to use field turbidity test to predict filtration and UV system effectiveness.

## 3.3 COOLING AND GAS STABILIZATION

The rated capacity for the cooling tower is to cool 900 gpm of water from 78ºF to 65ºF with a wet bulb temperature of 61ºF. The design goals are to keep maximum daily water temperature less than 65°F and maintain mean daily water temperatures below 60°F. Within the tower, warm river water sprays over and drips through a stack of plastic media trays, as a large fan pulls dry air from the bottom of the tower up through the dripping water. As the dry air passes through the dripping water, a small portion of the water evaporates, saturating the incoming air and cooling the remaining water in the process. About 50 percent of the time, when the river water temperature is greater than 58ºF, incoming water passes through the tower and the 30-hp fan is turned on to provide water cooling. This period is primarily early June through October. At other times, the incoming river water bypasses the cooling tower.

The cooling tower discharges water to a “cold well,” which is then pumped for use at the facility. Supply water is distributed between the tank systems and rearing channel by manually adjusting valves.

It is intended that the existing cooling tower will continue to be used for aeration to increase dissolved oxygen levels and reduce dissolved carbon dioxide levels, as well as cooling. It is proposed to abandon the cold well and eliminate re-pumping after the cooling tower. In order to do this, the cooling tower will need to be raised about 8 feet and a new elevated headbox will be constructed to receive the cooling tower flows before discharging to the rearing channel. The headbox will consist of a raised water tank with the bottom elevation about 5 feet above the ground. It will be used for collection of oxygenated water and flow distribution.

It is also recommended to provide a separate tower for oxygenation when the cooling tower is not in use. The oxygenation tower will consists of a packed column degasser and low-head oxygenator (see Section 4.4.3).

## 3.4 FLOW REGULATION AND DISTRIBUTION

Flow is currently distributed to the rearing channel and tank system using two pumps located in the cold well sump. One pump runs constantly and the second pump operates at variable speed to maintain a preset level in the sump. Flow to the rearing channels can be measured with an existing flow meter on the influent pipe just upstream of the rearing channels.

The upgraded pumping control system will supply flow at a controlled rate to the cooling tower, which will then gravity supply to the rearing channels and tank systems at the same flow rate. When the tank systems are in use, a manual valve will be used to split off up to 240 gpm to the tank system supply pipe. Depending on final water surface elevations in the cooling tower sump, an inline booster pump for the tank systems may be needed. Head losses in the existing tank distribution system will be reviewed to make this decision. In addition, the existing system includes a potable booster pump, drip irrigation, and firehose that will need to be supplied an adequate flow of water. A head tank downstream of the cooling tower is currently proposed.

# 4. WATER REUSE SYSTEM

## 4.1 PARTIAL WATER REUSE SYSTEM TECHNOLOGY

One solution to meet the challenges of limited water quality and quantity is the application of water reuse technologies. There are varying degrees of water reuse that can be implemented for fish rearing facilities such as SHSRF, but one technology that has been proven to work well in situations with relatively good water supplies is partial water reuse system technology. Application of this technology incorporating the existing natural rearing channel presents challenges in maintaining water quality, limiting the amount of reuse that can safely be achieved. This section provides a technology review of partial water reuse for fish hatcheries and discussion of the challenges associated with using these technologies at SHSRF.

### 4.1.1 Overview of Partial Water Reuse for Fish Culture

Partial water reuse systems minimize the water that must be supplied to fish production systems by reusing the portion of water that leaves fish rearing tanks in traditional flow-through systems, treating it and returning it to the rearing tanks. Treatment of reuse water typically includes solids filtration, carbon dioxide removal through aeration, and oxygenation.

One type of partial reuse system has been successfully demonstrated with the Cornell-style dual drain fish rearing tank (Figure 4-1). Cornell-style dual drain fish rearing tanks are circular or semi-circular tanks that have both a center drain and a sidewall drain for draining water from the tank. A Cornell-style dual drain tank functions as a swirl separator, with waste solids collecting at the tank center and flowing out the bottom center drain, while the cleaner flow exits through the sidewall drain. The sidewall drain flow typically has a suspended solids concentration 10 to 20 times less than that of the bottom center flow (Summerfelt et al., 2004). Generally, the bottom center flow is approximately 20 percent of the total water flow leaving the tank, the rest leaving through the sidewall drain to be treated for reuse.

The SHSRF cannot use Cornell-style dual drain fish rearing tanks as a partial water reuse system because the existing natural rearing channel, a linear rearing environment operated with a relatively low biomass density, is an integral part of the facility. Reuse systems applied to linear rearing units have a history of failure due to poor water quality. In these situations (e.g., Alaska Department of Fish & Game Fort Richardson Fish Hatchery Reuse System ca. 1990s) fish culture systems end up with elevated TSS and biochemical oxygen demand (BOD) due to slow solids removal and solids being stored in raceway quiescent zones. Fish feces and uneaten fish feed that settles out in these units immediately starts to degrade and leach organic acids and soluble BOD if not removed within 24 hours. When water reuse is applied to these systems, TSS and BOD increase from not being flushed out, and elevated levels become food for heterotrophic bacteria. Heterotrophic bacterial growth and death cycles cause additional solids from sloughing biofilm to accumulate, and the water quality degrades further.

Limiting the degree of water reuse can mitigate this risk, as more water is allowed to flush out problematic constituents. Partial reuse of 50 percent of the total water flow is a relatively safe level for maintaining water quality suitable for salmonids in raceway systems. This level of reuse should prevent a downward cycle in water quality that can be caused by poor solids control in linear rearing units.

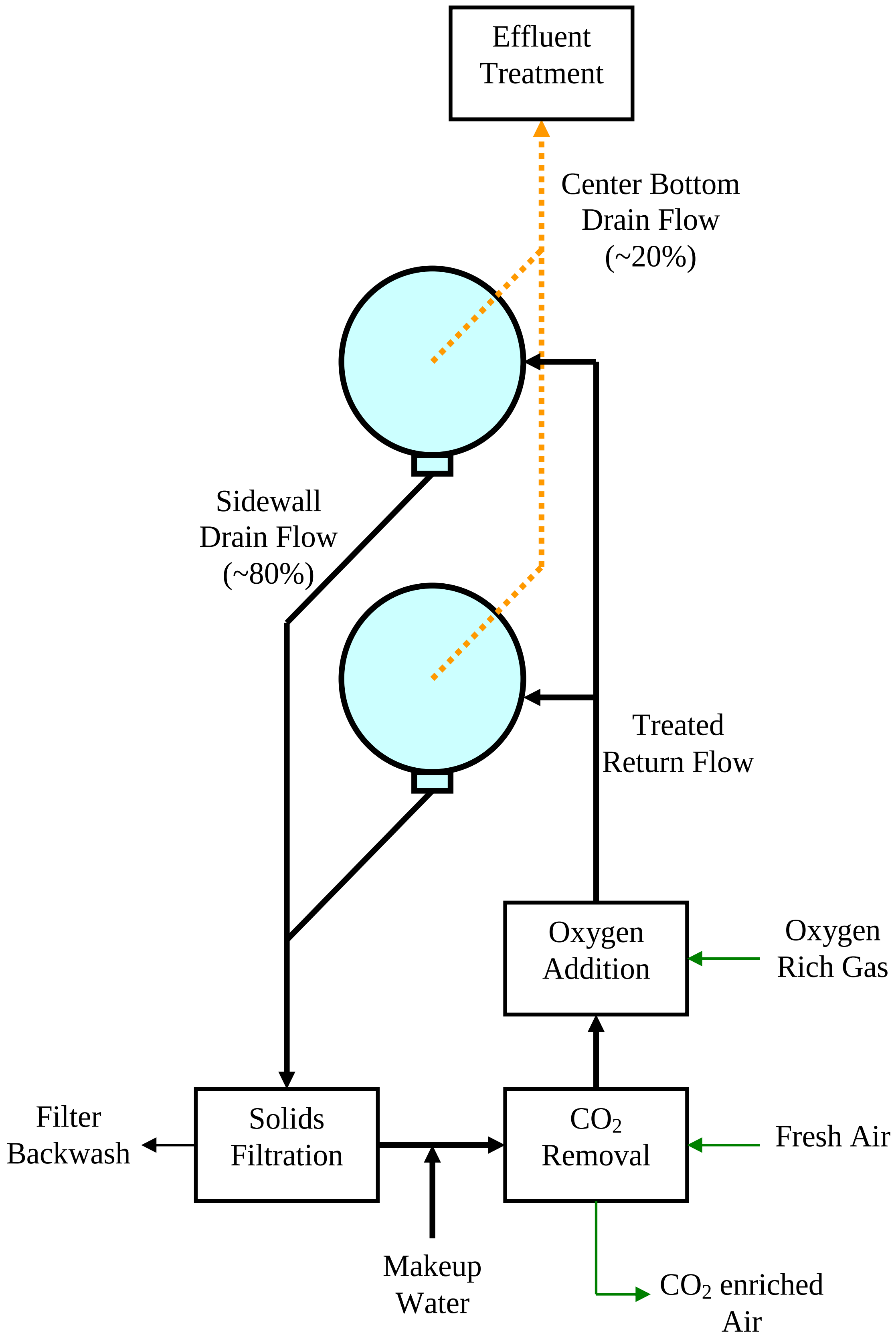


**Figure 4-1.** General Process Flow Diagram for a Fish Hatchery Partial Water Reuse System

Water requirements for partial water reuse systems are typically based on maintaining safe levels of unionized ammonia for fish culture. There are no biofiltration processes in a partial water reuse system to oxidize the ammonia produced by the fish; therefore makeup water must be added to the system to dilute the levels of ammonia from becoming toxic. The existing rearing channel with cobble substrate helps with ammonia accumulation by providing submerged surface area for attached growth nitrification. Anecdotal evidence of this nitrification capacity is evidenced by past water quality testing indicating no ammonia in the channel effluent.

Water pH also factors into ammonia toxicity. Carbon dioxide produced by fish during respiration depresses the pH and reduces the fraction of total ammonia that is unionized, or toxic. The minimum tolerable pH for fish is based on the amount of total alkalinity in the system water. High levels of alkalinity result in higher equilibrium values of carbon dioxide for a given pH and temperature. Therefore, a balance must be maintained between lower pH, ammonia toxicity, and safe levels of carbon dioxide in a partial water reuse system.

Several unit processes are required in a partial water reuse system to ensure the return of high quality water to the fish tanks:

- Solids filtration of the reuse flow ensures low levels of suspended solids in the culture water. Solids filtration is typically achieved through screen filtration utilizing screens with openings of 60 to 90 microns.
- Dissolved carbon dioxide ($CO_2$) removal maintains low levels of $CO_2$ for the fish; typical threshold levels for cold-water fish culture are 10 to 20 mg/L. Carbon dioxide removal requires large quantities of fresh air to strip dissolved $CO_2$, which is very soluble in water. Packed columns coupled with high volume, low pressure air blowers are typically used for carbon dioxide removal.
- Oxygenation of the process water achieves high levels of dissolved oxygen for fish culture. Pure oxygen technologies have been developing over the last 40 years, and a range of processes now exist that achieve oxygen absorption efficiencies of 75 percent or greater. These oxygenation processes require an oxygen-enriched feed gas that is supplied by vaporized liquid oxygen or oxygen concentrated atmospheric air.

## 4.2 DISINFECTION TECHNOLOGY

SHSRF has significant fish pathogen concerns due to the nature of its operations. Steelhead rescued by electrofishing in the natural environment are brought to the facility for refuge, often carrying pathogens with them, typically *Flavobacterium columnare*. Although all rescued steelhead go through a surface disinfection procedure to reduce pathogens upon arrival at SHSRF, the level of pathogens brought into the facility is reduced but not eliminated. Implementation of water reuse technology has the potential to increase the concentration of pathogens in the rearing channel. Therefore, it is critical that the reuse water be disinfected to reduce the concentration of pathogens in the rearing channel and mitigate the risk of disease. Following is brief review of water disinfection for fish hatcheries and the issues important for water reuse operation at SHSRF.

### 4.2.1 Overview of Water Disinfection for Fish Culture

Disinfection is the destruction of pathogens to achieve a desired pathogen reduction percentage or final pathogen concentration. Disinfection of hatchery water—both flow-through and reuse—prevents the spread of diseases at hatcheries. The main types of disinfection for fish hatchery water treatment are ozonation, chlorination and ultraviolet irradiation (Huguenin and Colt, 1989). Chlorination is not typically used for influent water treatment or reuse water treatment because of chlorine’s acute toxicity to fish.

Design of disinfection systems is based on the principle of providing a certain disinfectant intensity (dose) for a specific amount of time (contact time) to kill a target pathogen (WEF, 1996). In the case of ozone and chlorine, the disinfectant intensity is measured as a dissolved concentration that is maintained for a set amount of time to achieve the desired reduction in pathogens. Achieving the desired concentration may often require higher ozone or chlorine application rates to overcome any oxidant demand from reducing agents present in the water (WEF, 1996). UV intensity is measured as UV light output, typically in microwatts per square centimeter of contact area, which is maintained by continuous light exposure for a set amount of time. All three methods of disinfection can be described using the Chick-Watson equation for disinfection kinetics (WEF, 1996):

$$\frac{N}{N_o} = e^{-k'C_x t_i}$$

where: N microorganism population at time, $t_i$

$N_o$ microorganism population at time 0

$t_i$ time

$C_x$ disinfection residual

k′ reaction rate (1/[residual*time])

The disinfection residual for ozone and chlorine is the residual concentration maintained at the effluent of the contact vessel after any oxidant demand has been exerted by reducing agents in the water. This concentration is commonly expressed in mg/L. Disinfection residual for UV irradiation is typically expressed in microwatts per square centimeter. The Chick-Watson equation is often simplified by combining the k′ and $C_x$ terms into a single first-order disinfection rate, k (WEF, 1996):

$$\frac{N}{N_o} = e^{-kt_i}$$

Ozonation and chlorination can result in residual dissolved ozone or chlorine concentrations that are harmful to the fish being cultured or to natural populations in a receiving water body. Therefore, a critical design consideration is the concentration of residual ozone and chlorine after the contacting process is complete. Ozone and chlorine both require final treatment processes (i.e., ozone destruction, chlorine neutralization) to ensure that no residual ozone or chlorine exists that can negatively affect the fish being cultured or receiving water bodies. If this final treatment process fails, there is immediate danger to fish and/or the environment. This risk and need for the additional treatment process are the primary reasons that UV irradiation is often the preferred method for disinfection in fish hatchery systems.

However, ozone is a robust treatment process that can ensure pathogen disinfection even when water turbidity is high, which is an important consideration at SHSRF. Ozonation systems are significantly more complex to operate and maintain than similarly sized UV systems (Summerfelt et al. 2008). Ozonation requires a number of supporting systems that all must be maintained daily or weekly to ensure pathogen inactivation:

- Ozone generation system
- Oxygen supply system
- Ozone off-gas destruct systems
- Ozone air quality monitoring system
- Dissolved ozone or oxidation-reduction potential monitoring system
- Dissolved ozone air-stripping or carbon filtration removal system
- Supervisory control and data acquisition (SCADA) system
- Worker safety interlock systems

Automation and control systems, which are critical for proper operation of ozonation systems (Summerfelt et al. 2008), are sensitive to power interruption and the quality of electrical power. The skill set required for operation and maintenance of an ozonation treatment system is different than that typically needed for a fish hatchery. The skill set for operating and maintaining UV equipment is relatively basic.

## 4.2.2 UV Disinfection

UV irradiation for disinfection could be easily applied to the SHSRF influent water, the reuse water or both. UV irradiation is a physical disinfection process, not a chemical disinfection process like ozonation or chlorination. UV irradiation destroys pathogens by inducing photobiochemical changes within a microorganism. UV light is absorbed by microorganism DNA and RNA, which causes lethal effects. It is believed that the majority of damage caused by UV light absorption by DNA and RNA is the result of dimerization of adjacent bases within the nucleic acid strands (WEF, 1996).

DNA and RNA most strongly absorb UV light in the wavelength range from 240 to 260 nanometers (nm). This target wavelength range can be provided by low-pressure mercury arc lamps that are used in most UV disinfection applications. Low-pressure mercury arc lamps provide 85 percent of their output monochromatically at a wavelength of 253.7 nm. The energy associated with the lamp output at a wavelength of 253.7 nm is 112.8 kcal/Einstein, sufficiently greater than the bond dissociation energies in biological systems. The result is that UV light at this wavelength has enough energy to induce photochemical changes in microorganisms (WEF, 1996).

UV disinfection is a function of the UV intensity and exposure time. UV lamps output microwatts over a specific contact area, giving intensity in microwatts per square centimeter. The exposure is provided by hydraulic retention time in the UV reactor. The combination of intensity and contact time is the UV dosage, which is reported as microwatt-seconds per square centimeter ($\mu W\text{-}s/cm^2$). Table 4-1 lists required levels of UV dosage for the inactivation of pathogens important for fish culture at SHSRF, including parasites. The UV dosages required to destroy most disease-causing microorganisms in aquaculture are between 35,000 and 156,000 $\mu W\text{-}s/cm^2$ (Lawson, 1995). In general, the larger the microorganism, the higher the dosage required.

**Table 4-1.** UV Doses Reported for Pathogens of Importance at SHSRF.

| Pathogen | UV Dose ($\mu W\text{-}s/cm^2$) | Log Reduction | Source |
|---|---|---|---|
| Flavobacterium columnare | 22,100 | 4+ | Kimura, 1976 |
| *Aeromonas salmonicida* | 13,100–29,400 | 3+ | Bullock ,1977 |
| Yersinia ruckeri | 13,100–29,400 | 3+ | Bullock ,1977 |
| IHNV | 6,000–10,000 | $ID_{99}$ | Yoshimizu, 1991 |
| Fungus | 10,000–39,600<br>154,000–252,000 | 2+<br>Inhibit growth | Normandeau, 1968<br>Kimura, 1979 |
| Icthyophthirius sp. | 336,000 | — | Hoffman, 1974 |
| Costia necatrix | 318,000 | — | Vlasenko, 1969 |
| Trichodina sp. | 35,000<br>159,000 | Lethal dose | Hoffman, 1974<br>Vlasenko, 1969 |

UV irradiation reactors generally operate by a continuous flow of water being exposed to UV lamps. Reactor configurations include suspended lamp reactors, submerged lamp reactors, jacketed lamp reactors, Teflon tube reactors, and open channel submerged lamp reactors. Open channel submerged lamp reactors are the industry standard in wastewater disinfection and have applications in fish hatcheries as well. In this configuration, modular banks of lamps are submerged in water in relatively narrow, open channel reactors to encourage plug flow hydraulics. Lamps can be oriented horizontally or vertically, and are easily serviceable from above the channel.

Suspended lamp reactors suspend the UV lamps above water flowing in a shallow channel. Submerged lamp reactors are configured with the UV bulb submerged in a cylinder that has water flowing through it. Jacketed lamp reactors are similar to submerged lamp reactors except that the UV lamp is enclosed in a quartz cylinder that is in contact with the water. UV lamps are more readily serviced in the jacketed lamp configuration. Regardless of the configuration, UV disinfection systems are designed to achieve the required dosage based on lamp output and hydraulic retention time within the reactor.

UV lamp output considered in design should be the output at the end of the lamp's service life when its output intensity is lower. This ensures that the design dosage is met over the entire working lifespan of the lamp. Lamp output has been reported to fall sharply in the first 1,000 to 2,000 hours of operation, followed by a more gradual decline to the end of the lamp's working life. The recommended operating life of mercury arc lamps is 7,500 to 8,000 hours (WEF, 1996).

Other important considerations when designing for a specific UV dosage are the negative intensity effects of water turbidity, chlorine and iron. Specification of increased lamp output or reduced water flow may be required to combat the reduction in transmittance caused by these factors (Lawson, 1995).

The effectiveness of UV irradiation for disinfection can be increased by removal of particulates (i.e., filtration) and by use of low-dose ozonation. The removal of solids and low dose ozonation both increase water clarity and the transmittance of the UV light energy, allowing for maximum pathogen destruction. Low-dose ozonation is similar to ozonation for disinfection, but requires a much lower dose than for pathogen destruction and thereby reduces some of the risks associated with ozonation. An ozone dose of 0.34 to 0.39 mg/L was shown to be all that is needed to achieve improvements in water quality (e.g., TSS, true color, UV transmittance) in water reuse systems for fish culture (Summerfelt et al., 2009). Residual ozone levels in this case were approximately 0.020 mg/L.

Low-dose ozonation followed by UV irradiation has been shown to provide synergistic effects on bacterial reduction. The combined effect of ozone and UV was shown to reduce total coliform and total heterotrophic bacteria levels to almost zero (Sharrer and Summerfelt, 2007). UV irradiation also becomes the final treatment process to destroy any remaining ozone residual. UV doses of greater than 50,000 $\mu W\text{-}s/cm^2$ have been shown to effectively destroy residual ozone levels of 0.1 mg/L in a reuse system (Sharrer and Summerfelt, 2007).

## 4.3 WATER REUSE DESIGN OPTIONS

Three options were developed for partial water reuse technology at SHSRF. In all options, the water reuse unit processes are the same, but the integration of the river water supply is different. Process flow diagrams for the three options are presented in the Appendix as M-001, M-002, and M-003. Mass balance calculations are also presented for water reuse at the 50-percent level during estimated maximum fish loading.

### 4.3.1 Reuse Operation

In Option #1, 540 gpm of the 1,080 gpm of effluent water from the natural rearing channel would be directed to a separate water reuse sump structure for micro-screen filtration. After filtration, reuse water would be pumped through a UV irradiation unit and then to the top of the existing cooling tower. The 540 gpm of reuse water would joins 810 gpm of new river water at the existing cooling tower. In this option, cooling would only be provided when the existing cooling tower fan is operated; otherwise, the cooling tower would act only to provide aeration of the combined river water and reuse water. After the combined 1,350 gpm of process water is treated in the cooling tower for aeration/cooling, it would flow by gravity to a new head tank to supply water to the rearing channel (1,080 gpm) and tank field (270 gpm) by gravity.

In Option #2, 540 gpm of the 1,080 gpm of effluent water from the natural rearing channel would directed to a separate water reuse sump structure for micro-screen filtration. After filtration, reuse water would be joined by 810 gpm of river water that has been treated for heavy solids in a settling basin and fine solids in a micro-screen filter. The combined 1,350 gpm of process water would be pumped through a UV irradiation unit and then to the top of the existing cooling tower. In this option cooling would only be provided when the existing cooling tower fan is operated, otherwise the cooling tower would act only to provide aeration of the combined river water and reuse water. After the combined 1,350 gpm of process water is treated in the cooling tower for aeration/cooling, it would flow by gravity to a new head tank to supply water to the rearing channel (1,080 gpm) and tank field (270 gpm) by gravity.

In Option #3, 540 gpm of the 1,080 gpm of effluent water from the natural rearing channel would be directed to a separate water reuse sump structure for micro-screen filtration. After filtration, reuse water would be joined by 810 gpm of river water that has been treated for heavy solids in a settling basin and fine solids in a micro-screen filter. The combined 1,350 of process water would be pumped through a UV irradiation unit and then to the top of the existing cooling tower when cooling is required. When cooling is not required, the combined flow would bypass the existing cooling tower and be directed to a new dissolved gas conditioning tower for aeration and low-level oxygenation. After the combined 1,350 gpm of process water is treated in the cooling tower or in the dissolved gas conditioning tower, it would flow by gravity to a new head tank to supply water to the rearing channel (1,080 gpm) and tank field (270 gpm) by gravity.

### 4.3.2 Flow-Through Operation

In Option #1, when only new water from the river is used in a flow-through mode through the channel, 1,350 gpm of water would be collected in the new wet well and pumped to the existing cooling tower for aeration/cooling. In this option, cooling would only be provided when the existing cooling tower fan is operated; otherwise, the cooling tower would act only to provide aeration of the river water. After the 1,350 gpm of river water is treated in the cooling tower for aeration/cooling, it would flow by gravity to a new head tank to supply water to the rearing channel (1,080 gpm) and tank field (270 gpm) by gravity. In this option, the flow-through operational mode would be completely separate and independent from the reuse mode equipment and piping.

In Option #2, when only new water from the river is used in a flow-through mode through the channel, 1,350 gpm of water would be collected in the new wet well and pumped to a settling basin for heavy solids removal and then would flow by gravity through a micro-screen filter for fine solids removal. Once filtered, the river water would be pumped by the reuse pump station pumps through a UV irradiation unit and then to the top of the existing cooling tower. Cooling would only be provided when the existing cooling tower fan is operated; otherwise, the cooling tower would act only to provide aeration of the river water. After the 1,350 gpm of river water is treated in the cooling tower for aeration/cooling, it would flow by gravity to a new head tank to supply water to the rearing channel (1,080 gpm) and tank field (270 gpm) by gravity. In this option, the flow-through operational mode would share some of the reuse mode equipment (e.g., pumps, UV unit) and piping.

In Option #3, when only new water from the river is used in a flow-through mode through the channel, 1,350 gpm of water would be collected in the new wet well and then have two flow alternatives based on operator choice:

- In the first alternative, river water would be pumped to a settling basin for heavy solids removal and then flow by gravity through a micro-screen filter for fine solids removal. Once filtered, the river water would be pumped by the reuse pump station pumps through a UV irradiation unit and then to the top of the existing cooling tower or to a new dissolved gas conditioning tower.
- In the second alternative, river water would bypass solids removal and UV treatment and be pumped directly to the top of the existing cooling tower or to a new dissolved gas conditioning tower. This alternative would allows the operator to determine if the river water requires treatment for solids and select the appropriate process flow.

In both alternatives of this option, cooling would only be provided when process water is directed to the existing cooling tower and the fan is operated; otherwise, the cooling tower would act only to provide aeration of the river water. After the 1,350 gpm of river water is treated in the cooling tower or in the dissolved gas conditioning tower, it would flow by gravity to a new head tank to supply water to the rearing channel (1,080 gpm) and tank field (270 gpm) by gravity. In this option, the flow-through operational mode would be completely separate and independent from the reuse mode equipment and piping. This option was developed based on review with MPWMD and is a combination of Options #1 and #2.

## 4.4 RECOMMENDED SYSTEM DESIGN

Option #3 is the recommend design. This option allows for the flexibility to operate in flow-through mode with or without solids treatment. Although Option #1 would allow for operation with new river water in flow-through mode, it would not allow for solids treatment of the new river water; solids treatment would be only on the reuse water. Option #2 addressed this weakness by directing new river water to solids treatment; however, it did not allow for new river water to be pumped directly to the cooling tower when solids treatment was not required.

According to MPWMD staff, most of the time they will be able to use new river water without the need for solids treatment. This operational mode is available in Option #3, along with the ability to direct river water to solids treatment when needed. It is expected that when SHSRF is operated in reuse mode due to poor water quality from high sediment loads in the river water, solids treatment will be needed for the river water. Option #3 allows for solids-laden river water to be treated for solids and the overall use of the river water to be reduced from 1,350 gpm to 810 gpm by operating in reuse mode. Option #3 also allows for the case that SHSRF needs to operate in reuse mode because the available river water is less than 1,350 gpm, but the river water does not require solids treatment.

### 4.4.1 Partial Water Reuse System Design Criteria

Critical design values used in the development of the water reuse options for SHSRF are presented in Table 4-2.

**Table 4-2.** Sleepy Hollow Rearing Facility Reuse System Critical Design Values

| Description | Value |
|---|---|
| Total number of fish: Steelhead | 34,000 |
| Final fish size: Steelhead | 39 g (6-inch) |
| Total fish biomass | 1,326 kg |
| Maximum feed rate | 1.0% BW/day |
| Maximum feed rate | 13.3 kg/day |
| Final fish density | 11.7 kg/m3 |
| Minimum normal dissolved oxygen concentration | 80% saturation |
| Maximum dissolved carbon dioxide concentration | 15.0 mg/L |
| Maximum unionized ammonia concentration | 0.0125 mg/L |

### 4.4.2 Solids Control

Solids control will be critical for a successful reuse system at SHSRF. Any water being reused will be filtered in a micro-screen filter with a minimum of 40-micron screen media. The amount of water reuse will initially be limited to 50 percent (540 gpm), which improves the likelihood that solids will be controlled to maintain a low level of TSS (5 to 10 mg/L). However, micro-screen filters for the reuse process flow will be sized to treat the entire channel flow requirement of 1,080 gpm. This will allow for the full-range of operation, from 50 percent reuse (540 gpm) to 100 percent reuse (1,080 gpm) of the channel rearing water. Preliminary filter sizing is a Hydrotech HDF 1604 using a safety factor of 100 percent.

Micro-screen filters will also be required to treat the river water when it has a high sediment load. It is anticipated that, when there is a high sediment load in the river, the reuse system will be in operation and the river water flow that needs to be filtered will be 810 gpm. However, the river water flow that needs to be filtered could be as low as 270 gpm when 100 percent of the rearing channel water is being reused, to a high of 1,350 gpm when the entire river water flow is being treated. Micro-screen filters for the river water will be sized for the range of flows from 270 gpm to 1,350 gpm, with a minimum of 40-micron screen media. Preliminary filter sizing is a Hydrotech HDF 1604 using a safety factor of 100 percent.

### 4.4.3 Dissolved Gas Conditioning

The reuse of 50 percent of the water that has already been used in the natural rearing channel will require that dissolved oxygen levels be increased and dissolved carbon dioxide levels be decreased to maintain excellent water quality for the fish in the natural rearing channel. This is typically accomplished with an aeration process, like a packed column aerator. The SHSRF already has a force-ventilated packed column aerator in the form of its existing cooling tower. The existing cooling tower can treat 1,080 gpm at a hydraulic loading rate of 5 gpm/square foot, well below aeration column rates, which are typically 40 gpm/square foot and higher.

The cooling tower can provide the aeration needed to increase dissolved oxygen and reduce dissolved carbon dioxide for the water being reused. Employing the existing cooling tower as an aeration tower would require that the fan used for cooling be operated continually to provide a minimum amount of air flow for aeration. The existing 30-hp fan delivers 200 times more air than is needed for aeration (178,500 standard cubic feet per minute). The recommend option addresses this mismatch by including a combined aeration and oxygenation column for dissolved gas conditioning. The recommended option assumes that, whenever cooling is needed, the process flow (reuse water, river water or a combination of the two) will be directed to the existing cooling tower and the tower fan will be operated for cooling. Alternatively, whenever cooling of the process flow is not required, the flow can bypass the cooling tower and be directed to the combined aeration and oxygenation tower to remove dissolved carbon dioxide and add dissolved oxygen. This unit will be sized for 1,350 gpm at a hydraulic loading rate of approximately 40 gpm/square foot, resulting in a 7-foot-diameter unit. The oxygenation tower also will allow for the addition of pure oxygen gas to boost dissolved oxygen levels to 100 percent of saturation, which can be beneficial for fish culture at the facility.

### 4.4.4 Pathogen Disinfection

Particle filtration prior to UV disinfection is required to prevent shadowing of pathogens within or behind particles. In the recommended option, process water, whether reuse, river or a combination, that has been filtered with a micro-screen filter will be disinfected with UV irradiation. UV irradiation units will be installed on the line after the reuse pump station; a UV dose of 30,000 $\mu W\text{-}s/cm^2$ will be used for equipment sizing in order to achieve a log-4 (or 10,000 times) reduction in the most common fish pathogens, including *Flavobacterium columnare*. The power required for UV treatment is directly proportional to the UV transmittance of the water. The higher the transmittance, the lower the energy input required by the UV bulbs. The UV transmittance criteria used for sizing the UV unit will be 50 percent.

## 4.5 OPERATING CONDITIONS

It is recommended that the level of reuse be limited to 50 percent, at least during initial operation. Partial water reuse of 50 percent of the total water flow is a relatively safe level for maintaining water quality suitable for salmonids in raceway systems. This level of reuse should prevent a downward cycle in water quality that can be caused by poor solids control in linear rearing units.

As operators become comfortable with the operation of the water reuse system, the level of reuse can be increased to 75 percent without compromising the dissolved oxygen, dissolved carbon dioxide and ammonia. Operators should closely monitor whether solids increase and become problematic at the 75 percent reuse rate. If not, then the operational envelope of the reuse system can be increased to 75 percent (810 gpm), requiring only 25 percent of new river water (270 gpm) for the rearing channel portion of the facility.

Operators can further increase the level of reuse to 90 percent, but will have to closely monitor total ammonia nitrogen levels and pH and continue to monitor solids levels in the rearing channel. Reuse of 90 percent of the rearing channel water (972 gpm) would result in requiring only 10 percent of new river water (108 gpm) for the channel portion of the facility. Mass balances indicate that at 90 percent water reuse, the total ammonia nitrogen concentration would approach 1.0 mg/L at maximum biomass loading. Table 4-3 details these operational scenarios.

**Table 4-3.** Operational Scenarios for Water Reuse at SHSRF

| Water Reuse Level | Channel Reuse Flow (gpm) | Channel Makeup Flow from River (gpm) | Total Channel Flow (gpm) | Quarantine Flow from River (gpm) | Total Flow from River (gpm) |
|---|---|---|---|---|---|
| 0% | 0 | 1,080 | 1,080 | 270 | 1,350 |
| 50% | 540 | 540 | 1,080 | 270 | 810 |
| 75% | 810 | 270 | 1,080 | 270 | 540 |
| 90% | 972 | 108 | 1,080 | 270 | 378 |

The implementation of water reuse for SHSRF will primarily affect the natural rearing channel portion of the facility. The quarantine tanks and troughs are intended to still operate in a flow-through mode. Any therapeutic treatments (e.g., formalin) completed in the quarantine tanks and troughs can remain the same and will not affect the rearing channel. The salt treatments that are currently done in the rearing channel should also be able to remain the same at the lower rates of water reuse (i.e., 50% and 75%). At those levels, flushing occurs at a relatively high rate. At 90% water reuse, procedures for salt treatments may have to be modified to maintain the desired salt concentration and time of exposure.

## 4.6 PUMPING AND CONVEYANCE

The reuse pump station will be located in a common structure with the micro-screen filters. Under Option #3, the pumps will be sized to deliver the full facility flow of 1,350 gpm. River water from the intake pump station will be settled and filtered at the treatment structure, and the reuse pumps will be sized to deliver the entire facility flow through the UV unit and to the cooling tower or the oxygenation tower. Table 4-4 summarizes sizing criteria.

**Table 4-4.** Reuse Pump Sizing

| Description | Value |
|---|---|
| Design Flow | 1,350 gpm |
| Number of Reuse Pumps | 1 running (1 standby) |
| Reuse Pump Design Point | 1,350 gpm at 40’ TDH |
| Reuse Pump Motor Size | 2 each, 20 hp |

## 4.7 OPERATIONS AND CONTROLS

Option #3 has three operating modes:

- River water pump station discharging directly to the cooling tower or oxygenation tower, in a flow-through only mode

- River water pump station discharging to settling and filtration prior to be mixed with reuse water and pumped with the reuse pumps to the cooling tower
- Both the river water pump station and the reuse pump station discharging directly to the cooling tower and oxygenation tower and mixing in the head tank.

A hydraulic control box will divide flow between the existing effluent channel and the reuse pump station. An adjustable weir will be provided to balance the amount of flow being reused. When reuse pumps are operating, the level will drop downstream of the reuse drum filter, allowing water to pass through the filter. Any water not pumped will continue flowing down the effluent channel. A gate will be provided at the control box to shutoff flow to the reuse sump and allow draining and maintenance of the system. During detailed design, manual versus automated control to switch between flow-through and reuse operating modes will be reviewed.

Each drum filter will use a local control panel that controls filter cleaning cycle with a timer, level float, or both. Filter cleaning will include rotating the filter drum and operating a backwash pump. The backwash will discharge to the floodplain gravel bed. During the cleaning cycle, the water level in the pump sump downstream of the filter will increase. When the filter is dirty, the downstream water level will drop. This may require some overflow at the end of the cleaning cycle. The drum filter local controller will have an output for a general filter alarm that will be input to the facility PLC.

Reuse pumps will use floats or an ultrasonic level sensor to monitor water level in the pump sump. Pumps will run at a set speed. When the level sensor indicates low level, a controller will shut the pump off to protect the pump from running dry. Pump control alternatives will be reviewed, including controlling the pump speed with variable frequency drives and basing the speed on sump level or flow rate. This will allow different ratios of reuse to be implemented, and VFDs will improve the ability to match river pump station flow.

Under both operating modes, the reuse pumps will have capacity to deliver 1,350 gpm. Pump protection alarms will include pump motor high-temperature, motor seal leakage, low wet well level, and pump running with zero flow at the flow meter. These signals will be connected to the facility PLC from the local pump control panel. Low level in rearing channel and pump wet wells will be alarmed at stages allowing adequate time for operators to respond. These and other alarms and monitors for facility operation are described in Section 5.4.

## 4.8 EFFLUENT WATER TREATMENT AND DISCHARGE

It is expected that the overall SHSRF impact on the river will remain the same, as the fish rearing program is not changing. The implementation of water reuse will result in solids being collected at additional locations besides the cobble bed of the rearing channel, but all collected solids will be discharged to the gravel river bed and flushed during high river stage events, similar to the way solids are currently handled. In the future, solids captured in the micro-screen filters could be sent to simple settling basins for storage and periodic removal as required.

# 5. UTILITIES AND SUPPORT FACILITIES

## 5.1 SITE ANALYSIS AND PERMIT CONSIDERATIONS

### 5.1.1 Site Description

The facility occupies a broad floodplain terrace bench above the river at 401 feet above sea level, covering approximately 7 acres. The site is shaded by local topography, a mature canopy of coast live oak (*Quercus agrifolia*), and several large California sycamores (*Platanus racemosa*). Stream flow at the site is perennial, and augmented during dry months by releases from Los Padres Reservoir. The facility covers 9,300 square feet, including 480 square feet for a storage/office building, 2,400 square feet for rearing pools, and 6,400 square feet for a rearing channel. The single-story office, lab, and storage building is adjacent to the tanks and rearing channel. Access to the site is from San Clemente Drive by a gravel road that crosses the Carmel River over the San Clement Ford. The Ford is scheduled to be replaced with a bridge this year.

### 5.1.2 Proposed Site Alterations

Anticipated site work includes excavation for pipe trenches and water holding structures. To minimize surface disruption, pipe and utility trenches will be in common trenches and situated in existing roads where possible. Existing trees will be avoided when locating the new structures, and no trees will be removed on the upland site.

A new intake screen will require a small coffer dam in the river, excavation at the river bank, placement of a concrete slab near the river bottom, and a retaining wall at the river edge. This excavation will require removal of several willow trees that currently prevent undercutting. Reinforcement of the river bank in this area with riprap armoring will be needed. Size and placement of armoring will be recommended based on scour analysis preformed as part of the hydraulic and sediment analysis. Pipe trenches from the new intake screen to the new pump station will be made in the floodplain, avoiding trees where possible, and replacing the excavated material back into the trench.

### 5.1.3 Permit Considerations

The project would require review under the California Environmental Quality Act (CEQA). Project activities affecting the Carmel River would require permits from the U.S. Army Corps of Engineers (USACE), the Central Coast Regional Water Quality Control Board (RWQCB), and the California Department of Fish and Wildlife (CDFW). Activities that occur between the Carmel River and the landward extent of the riparian zone would require CDFW approval. County permits for construction of improvements would also be required.

USACE has issued Regional General Permit 24460S (RGP) allowing for streamlined approval of facility maintenance and other activities. CDFW and RWQCB have also issued approvals for activities allowed under the RGP through the Final Lake or Streambed Alteration Agreement Notification No. 1600-2013-0053-R4 and Resolution No. R3-2014-0041, respectively. Should USACE, CDFW, and RWQCB consider the proposed project activities to be covered under the RGP, project permitting would be completed through the streamlined notification processes defined in the agencies' respective approvals. However, because the RGP does not cover expansion of facilities, new approvals from USACE, RWQCB, and CDFW may be required (with specific concern for the intake structure).

The MPWMD is interested in phasing construction of the project so that the water reuse system could be constructed in advance of the new intake structure. In light of this, the following approach would be undertaken to obtain environmental and regulatory approvals:

1. Prepare a project description that characterizes the phased nature of the project.
2. Prepare a CEQA document that addresses the entirety of the project (the water reuse system, intake structure, and all other on-site improvements required). Despite planning for project components to be phased, the MPWMD and the project team plan to evaluate the entirety of the project in the Initial Study/Mitigated Negative Declaration (IS/MND). This would best convey the phased nature of the project as well as the overall project purposes, impacts and mitigation measures.
3. Commence permitting for the water reuse system as a first phase of the project. Water reuse system activities may proceed without approvals from the USACE and RWQCB, as they would not affect the Carmel River or other waters. CDFW approval may be required, should proposed activities affect vegetation within the riparian zone. Upon completion of the project description and concurrent with preparing the IS/MND, a pre-application consultation with CDFW would be conducted to confirm whether water reuse system activities would fall under their jurisdiction and require a Streambed Alteration Agreement.
4. Commence permitting for the intake as the final phase of the project. Upon completion of the project description and concurrent with preparing the IS/MND, a pre-application consultation with the resource agencies would be conducted to confirm whether new permits are required for the intake structure. Should the existing permits be determined not to be applicable or modifiable, new permit applications will be prepared along with the Biological Assessment that would be required for the federal Endangered Species Act (ESA) consultations.

   New approvals would likely include a USACE permit (either a Nationwide or Individual Permit, depending on the nature and degree of project impacts on waters of the U.S.), RWQCB Water Quality Certification or Waiver, and a CDFW Streambed Alteration Agreement. For a new USACE permit, USACE would need to initiate new consultations under the ESA with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service for California red-legged frog (federally threatened) and steelhead (federally threatened), respectively. It is assumed that formal consultations with these agencies would be required. Review under the California ESA (CESA) would also be required from CDFW; however, it does not appear that any CESA-listed species are present in the project area (the California red-legged frog is a California State species of special concern).

## 5.2 POTABLE WATER, FIRE PROTECTION, AND DOMESTIC WASTEWATER

It is not planned that this project will include any modification to potable water, fire protection or domestic water systems. A brief description of these system is provided for future reference and to evaluate total electrical loads.

Potable water is supplied from treatment of raw river water. A small amount of raw river water from the tank supply lines is booster-pumped south of the rearing channel to tanks at the top of the hill. The water is treated with ozone and gravity supplied to the office. The domestic water booster pump is approximately 1/2-hp. A yard hydrant and fire hose are included on the tank supply lines for fire protection with raw river water. A branch pipe from the tank supply line is connected to a drip irrigation system, requiring about 10 psi pressure to operate.

Domestic wastewater is discharged by a permitted onsite drain field. This is a gravity system consisting of a septic tank, distribution pipe, and perforated drain pipe in a gravel envelope. There are no pumps or alarms in this system. Periodic pumping of solids from the septic tank may be required.

## 5.3 ELECTRICAL POWER

Based on the record drawings for this project, the single line diagram on sheet E2.1 and site photos, the facility has a Square D 240V, 600A, 3-phase main switchboard installed. The photos also show that PG&E has three pole-mounted utility transformers rated at 25 kva each, for a total of 75 kva. The 75 kva can provide a maximum of 180A per phase to the facility. This service is sized to power the existing load without spare capacity.

The facility's power usage history record data for a period of one month was reviewed. Because the data is presented for the whole month, it is difficult to estimate the kilowatts per hour consumed for a particular period. It was concluded that the existing transformers can barely provide enough power to the existing system, and future expansion or addition of loads is not feasible. The existing switchboard can handle up to a 200-kva single 3-phase transformer or three 75-kva individual transformers. If future load exceeds capacity of the existing system, the project team will work with PG&E to review upgrade requirements, including increasing transformer or line size. PG&E will provide a cost estimate for the upgrade. MPWMD will review funding options for these improvements.

Emergency standby power is supplied by a single 175-kw generator. Equipment connected to the generator needs to be field-verified. As-built plans still show an old 75-kw generator connected to pumps P1, P2, and to Office Panel A, which is no longer the case. A 175-kw generator is connected to the cooling tower, cold well sump pumps, and river water pump station. Total generator load will be reviewed for the selected option; redistribution of the generator load may be advised.

## 5.4 CONTROL AND ALARM SYSTEMS

### 5.4.1 Existing System Description

Two electronic modules provide automatic operational control of the water supply at the facility, including the Monitrol Controller and the RACO Alarm. Monitrol is an electro-mechanical control system designed specifically for the aquaculture industry. It consists of a computer program and digital/analog circuits that control operation of automatic water pumps and the cooling system. The system monitors sensors for temperature, oxygen concentration, water levels in the pump gallery and cold well, and facility inflow from the river pumps. The oxygen and water temperature data are logged and recorded to a data file for later retrieval. Spare probes and sensors for the water level, oxygen and temperature are kept on-site for rapid replacement.

The RACO alarm system interconnects with the Monitrol system. The MPWMD installed it in 2002 to improve monitoring capability and provide an alarm system for important electro-mechanical components. The RACO alarm connects to a staff list via the AT&T phone system and MPWMD staff remotely monitor the status of the water pumps and electrical power system. The RACO system automatically notifies key MPWMD personnel by phone in case Pumps 1-5 malfunction, inflow rates decline, water levels in the cold well or pump gallery drop below established set points, or the PG&E power system is offline.

### 5.4.2 Proposed Upgrades

The Monitrol Aqua system is outdated and no longer supported by the vendor. Replacement of the system with a modern programmable logic controller and a computer with supervisory control and data acquisition software is recommended. The PLC will receive signals from sensors and remote panels and will be programmed to send control signals to the process equipment. The SCADA system will be the interface that allows operations staff to monitor and control the process system via the PLC. The SCADA will also interface with the alarm dialer; the existing RACO alarm dialer may still be used for this process. If it is feasible to install a broadband network connection, then the facility can be monitored and controlled from offsite rather than only receiving alarms through the phone line. This option will be reviewed during design.

A control system network consisting of physical wire connection to remote panels will be installed. Any equipment currently in place that can be reused will be reviewed by the electrical engineer during design and integrated into the new system. Remote panels will include the following:

- River pump station control panel
- Reuse pump station control panel
- Cooling system control panel.

Each of these panels will receive signals from the equipment and sensors in the vicinity of the panel. During design, the controls engineer will work with MPWMD operations staff to develop a complete list of alarms. Typical facility alarms include the following:

- River level low
- River pump station wet well level low
- River water pump station pump failed to start
- River water pump station general alarm
- Rearing channel level low
- Rearing channel DO low
- Head tank level low
- Cooling temperature high
- Cooling fan failed to start
- Reuse pump sump low
- Reuse pump failed to start
- Reuse pump station general alarm
- Drum filter general alarm
- UV system general alarm.

# 6. Cost Considerations

## 6.1.1 Cost Summary

Table 6-1 provides a cost estimate for project planning. The cost estimate is based on design concepts described in this report. Once an option is finalized, the design will be developed further and costs will be estimated more accurately. Additional cost breakdown is included in Appendix B.

**Table 6-1.** Concept Level Cost Summary

| Cost Item Description | Estimated Construction Cost |
|---|---|
| Mobilization & General Conditions | $112,000 |
| River Intake | $162,200 |
| River Intake Pump Station | $210,000 |
| Cooling Tower / Headbox | $80,000 |
| Re-use Treatment & Pumping | $456,500 |
| Site Civil & Piping | $128,300 |
| Electrical and Controls | $120,000 |
| Utility Upgrade (Place Holder) | $40,000 |
| **Total (Includes 8% tax, 25% contingency)** | **$1,766,880** |

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Basis of Design Report

# Appendix A. Mass Balance

**MPWMD System Mass Balances - 50% Partial Reuse System on the Natural Rearing Channel**
**Max Feeding of 1.0% for 34,000 39 g Fish**

| **Inputs** | | | | **Reference/Comments** |
|---|---|---|---|---|
| **Bio Plan** | | | | |
| Number of Tanks | 1 | | | |
| Channel | 43 | ft | Tank Rearing Volume | |
| Channel | 2.75 | ft | 3994 $ft^3$ | |
| Final Density | 11.7 | kg/m3 | | |
| Final Size before Stocking | 39 | g | | |
| Number of Fish in System | 34,000 | fish | | |
| Max Biomass On Hand | 1326 | kg | | |
| Maximum Feed Rate | 0.01 | BW/day | 29.21 | max lb feed/day (high estimate) |
| **Dissolved Oxygen** | | | **DO Saturation: f(T,Elev)** | |
| Max Water Temp | 17 | degC | 9.5 | |
| Elevation above Sea Level | 122 | m | | 401 ft ASL |
| Inlet DO | 8.57 | mg/L | | Cooling Tower Only (90% of sat) |
| **Outlet DO** | **7.78** | **mg/L** | 82% | > 80% of sat |
| DO Consumption Rate | 0.35 | kg DO/kg feed | | Summerfelt et al., 2004: *Salmo* data only |
| **Ammonia Nitrogen** | | | | |
| pH | 7.59 | | | f(Alkalinity, final DCO2) calculated using final DCO2 at 17 |
| Alkalinity | 92 | mg/L | | Needed |
| **Culture Tank TAN Level** | **0.18** | **mg/L** | | |
| **Culture Tank UIA Level** | **0.0013** | **mg/L** | | Target is < 0.0125 (pKa = 9.742 according to ammonia ca |
| Feed Protein Level | 44 | % | | high estimate (krill) |
| TAN Production Rate | 0.040 | kg TAN/kg feed | | f(%protein): Timmons et al., 2001; 0.040 is limit (krill) |
| **Carbon Dioxide** | | | | |
| **Culture Tank CO2 Level** | **5.28** | **mg/L** | | Max level of 15 to 20 mg/L |
| CO2 Production Rate | 0.48 | kg CO2/kg feed | | Timmons et al., 2001 |
| **Solids** | | | | |
| TSS Production Rate | 0.35 | kg TSS/kg feed | | Not Used |
| Tank Diameter to Depth Ratio | 15.6 | ft/ft | | Not Used |
| Tank Rotational Period at 2 BL/sec wall velocity | 104 | seconds | | Not Used |
| **Tank Exchange for Self Cleaning** | **27.66** | **minutes** | | 30-45 minutes is target |
| **Makeup Water** | | | | |
| **Make-up Flow Rate** | **540** | **gpm** | | 50% of 1080 gpm |
| Make-up Water DO Concentration | 8.6 | mg/L | | 90% saturation value |
| Make-up Water TAN Concentration | 0.00 | mg/L | | April 2015: Not Detected |
| Make-up Water CO2 Concentration | 4.55 | mg/L | | April 2015: Based on an Alk of 92 mg/L and pH of 7.7 |
| Make-up Water TSS Concentration | 0.5 | mg/L | | Variable |
| **Treatment Efficiency** | | | | |
| CO2 Removal Efficiency | 0.30 | ratio | | Cooling Tower Operation |
| TAN Removal Efficiency | 0.00 | ratio | | Assumes No Biofiltration |
| TSS Removal Efficiency | 0.40 | ratio | | Drum Filter Only |
| O2 transfer efficiency (worst case) | 65 | % transferred | | Not used |
| Daily ozone application rate | 0.02 | kg O3/kg feed | | Not used |

**REQUIRED FLOWS**

| | | |
|---|---|---|
| Reuse Flow Required based on DO | 540 | gpm |
| **Total Flow Required based on DO** | **1080** | **gpm** |
| Reuse Flow Required based on TAN | NA | gpm |
| **Total Flow Required based on TAN** | **NA** | **gpm** |
| Reuse Flow Required based on CO2 | 540 | gpm |
| **Total Flow Required based on CO2** | **1080** | **gpm** |
| **Total Flow Required based on TEX** | **1080** | **gpm** |

**DESIGN**

| | | | |
|---|---|---|---|
| **Design Total Flow** | **1080** | **gpm** | Select the Highest Required Total Flow |
| **Return Flow per tank** | **1080** | **gpm** | |
| **Sidewall Drain Flow per Tank** | **540** | **gpm** | |
| **Makeup Flow per Tank** | **540** | | |
| **Flow Reuse Fraction, R** | **0.50** | | Summerfelt et al., 2001 |
| **Culture Tank DO Concentration** | **7.8** | **mg/L** | Previously defined |
| **Culture Tank TAN Concentration** | **0.18** | **mg/L** | |
| **Culture Tank UIA Concentration** | **0.0013** | **mg/L** | < 0.0125 mg/L is max safe level |
| **Culture Tank CO2 Concentration** | **3.94** | **mg/L** | < 20 mg/L is safe |
| **Culture Tank TSS Concentration** | **1.38** | **mg/L** | |
| **Ratio UIA:TAN** | **0.0070** | | Target is < 0.0125 (pKa = 9.742 according to ammonia ca |
| **Tank Exchange Rate** | **28** | **minutes** | |
| **Flow through TAN at Design Total Flow** | **0.09** | **mg/L** | Summerfelt & Vinci, 2004 |
| **Flow through CO2 at Design Total Flow** | **5.63** | **mg/L** | Summerfelt & Vinci, 2004 |
| **Flow through Delta DO at Design Total Flow** | **0.79** | **mg/L** | Summerfelt & Vinci, 2004 |

**MPWMD System Mass Balances - 75% Partial Reuse System on the Natural Rearing Channel**
**Max Feeding of 1.0% for 34,000 39 g Fish**

| Inputs | | | Reference/Comments |
|---|---|---|---|
| **Bio Plan** | | | |
| Number of Tanks | 1 | | |
| Channel | 43 | ft | Tank Rearing Volume |
| Channel | 2.75 | ft | 3994 $ft^3$ |
| Final Density | 11.7 | kg/m3 | |
| Final Size before Stocking | 39 | g | |
| Number of Fish in System | 34,000 | fish | |
| Max Biomass On Hand | 1326 | kg | |
| Maximum Feed Rate | 0.01 | BW/day | 29.21 max lb feed/day (high estimate) |
| **Dissolved Oxygen** | | | **DO Saturation: f(T,Elev)** |
| Max Water Temp | 17 | degC | 9.5 |
| Elevation above Sea Level | 122 | m | 401 ft ASL |
| Inlet DO | 8.57 | mg/L | Cooling Tower Only (90% of sat) |
| **Outlet DO** | **7.78** | **mg/L** | 82% > 80% of sat |
| DO Consumption Rate | 0.35 | kg DO/kg feed | Summerfelt et al., 2004: *Salmo* data only |
| **Ammonia Nitrogen** | | | |
| pH | 7.62 | | f(Alkalinity, final DCO2) calculated using final DCO2 at 17 |
| Alkalinity | 92 | mg/L | Needed |
| **Culture Tank TAN Level** | **0.36** | **mg/L** | |
| **Culture Tank UIA Level** | **0.0027** | **mg/L** | Target is < 0.0125 (pKa = 9.742 according to ammonia ca |
| Feed Protein Level | 44 | % | high estimate (krill) |
| TAN Production Rate | 0.040 | kg TAN/kg feed | f(%protein): Timmons et al., 2001; 0.040 is limit (krill) |
| **Carbon Dioxide** | | | |
| **Culture Tank CO2 Level** | **4.91** | **mg/L** | Max level of 15 to 20 mg/L |
| CO2 Production Rate | 0.48 | kg CO2/kg feed | Timmons et al., 2001 |
| **Solids** | | | |
| TSS Production Rate | 0.35 | kg TSS/kg feed | Not Used |
| Tank Diameter to Depth Ratio | 15.6 | ft/ft | Not Used |
| Tank Rotational Period at 2 BL/sec wall velocity | 104 | seconds | Not Used |
| **Tank Exchange for Self Cleaning** | **27.66** | **minutes** | 30-45 minutes is target |
| **Makeup Water** | | | |
| **Make-up Flow Rate** | **270** | **gpm** | 25% of 1080 gpm |
| Make-up Water DO Concentration | 8.6 | mg/L | 90% saturation value |
| Make-up Water TAN Concentration | 0.00 | mg/L | April 2015: Not Detected |
| Make-up Water CO2 Concentration | 4.55 | mg/L | April 2015: Based on an Alk of 92 mg/L and pH of 7.7 |
| Make-up Water TSS Concentration | 0.5 | mg/L | Variable |
| **Treatment Efficiency** | | | |
| CO2 Removal Efficiency | 0.30 | ratio | Cooling Tower Operation |
| TAN Removal Efficiency | 0.00 | ratio | Assumes No Biofiltration |
| TSS Removal Efficiency | 0.40 | ratio | Drum Filter Only |
| O2 transfer efficiency (worst case) | 65 | % transferred | Not used |
| Daily ozone application rate | 0.02 | kg O3/kg feed | Not used |

**REQUIRED FLOWS**

| | | |
|---|---|---|
| Reuse Flow Required based on DO | 810 | gpm |
| **Total Flow Required based on DO** | **1080** | **gpm** |
| Reuse Flow Required based on TAN | NA | gpm |
| **Total Flow Required based on TAN** | **NA** | **gpm** |
| Reuse Flow Required based on CO2 | 810 | gpm |
| **Total Flow Required based on CO2** | **1080** | **gpm** |
| **Total Flow Required based on TEX** | **1080** | **gpm** |

**DESIGN**

| | | | |
|---|---|---|---|
| **Design Total Flow** | **1080** | **gpm** | Select the Highest Required Total Flow |
| **Return Flow per tank** | **1080** | **gpm** | |
| **Sidewall Drain Flow per Tank** | **810** | **gpm** | |
| **Makeup Flow per Tank** | **270** | | |
| **Flow Reuse Fraction, R** | **0.75** | | Summerfelt et al., 2001 |
| **Culture Tank DO Concentration** | **7.8** | **mg/L** | Previously defined |
| **Culture Tank TAN Concentration** | **0.36** | **mg/L** | |
| **Culture Tank UIA Concentration** | **0.0027** | **mg/L** | < 0.0125 mg/L is max safe level |
| **Culture Tank CO2 Concentration** | **3.42** | **mg/L** | < 20 mg/L is safe |
| **Culture Tank TSS Concentration** | **1.56** | **mg/L** | |
| **Ratio UIA:TAN** | **0.0075** | | Target is < 0.0125 (pKa = 9.742 according to ammonia ca |
| **Tank Exchange Rate** | **28** | **minutes** | |
| **Flow through TAN at Design Total Flow** | **0.09** | **mg/L** | Summerfelt & Vinci, 2004 |
| **Flow through CO2 at Design Total Flow** | **5.63** | **mg/L** | Summerfelt & Vinci, 2004 |
| **Flow through Delta DO at Design Total Flow** | **0.79** | **mg/L** | Summerfelt & Vinci, 2004 |

**MPWMD System Mass Balances - 90% Partial Reuse System on the Natural Rearing Channel**
**Max Feeding of 1.0% for 34,000 39 g Fish**

| Inputs | | | | Reference/Comments |
|---|---|---|---|---|
| **Bio Plan** | | | | |
| Number of Tanks | 1 | | | |
| Channel | 43 | ft | Tank Rearing Volume | |
| Channel | 2.75 | ft | 3994 | $ft^3$ |
| Final Density | 11.7 | kg/m3 | | |
| Final Size before Stocking | 39 | g | | |
| Number of Fish in System | 34,000 | fish | | |
| Max Biomass On Hand | 1326 | kg | | |
| Maximum Feed Rate | 0.01 | BW/day | 29.21 | max lb feed/day (high estimate) |
| **Dissolved Oxygen** | | | **DO Saturation: f(T,Elev)** | |
| Max Water Temp | 17 | degC | 9.5 | |
| Elevation above Sea Level | 122 | m | | 401 ft ASL |
| Inlet DO | 8.57 | mg/L | | Cooling Tower Only (90% of sat) |
| **Outlet DO** | **7.78** | **mg/L** | 82% | > 80% of sat |
| DO Consumption Rate | 0.35 | kg DO/kg feed | | Summerfelt et al., 2004: *Salmo* data only |
| **Ammonia Nitrogen** | | | | |
| pH | 7.65 | | | f(Alkalinity, final DCO2) calculated using final DCO2 at 17 |
| Alkalinity | 92 | mg/L | | Needed |
| **Culture Tank TAN Level** | **0.91** | **mg/L** | | |
| **Culture Tank UIA Level** | **0.0073** | **mg/L** | | Target is < 0.0125 (pKa = 9.742 according to ammonia ca |
| Feed Protein Level | 44 | % | | high estimate (krill) |
| TAN Production Rate | 0.040 | kg TAN/kg feed | | f(%protein): Timmons et al., 2001; 0.040 is limit (krill) |
| **Carbon Dioxide** | | | | |
| **Culture Tank CO2 Level** | **4.52** | **mg/L** | | Max level of 15 to 20 mg/L |
| CO2 Production Rate | 0.48 | kg CO2/kg feed | | Timmons et al., 2001 |
| **Solids** | | | | |
| TSS Production Rate | 0.35 | kg TSS/kg feed | | Not Used |
| Tank Diameter to Depth Ratio | 15.6 | ft/ft | | Not Used |
| Tank Rotational Period at 2 BL/sec wall velocity | 104 | seconds | | Not Used |
| **Tank Exchange for Self Cleaning** | **27.66** | **minutes** | | 30-45 minutes is target |
| **Makeup Water** | | | | |
| **Make-up Flow Rate** | **108** | **gpm** | | 10% of 1080 gpm |
| Make-up Water DO Concentration | 8.6 | mg/L | | 90% saturation value |
| Make-up Water TAN Concentration | 0.00 | mg/L | | April 2015: Not Detected |
| Make-up Water CO2 Concentration | 4.55 | mg/L | | April 2015: Based on an Alk of 92 mg/L and pH of 7.7 |
| Make-up Water TSS Concentration | 0.5 | mg/L | | Variable |
| **Treatment Efficiency** | | | | |
| CO2 Removal Efficiency | 0.30 | ratio | | Cooling Tower Operation |
| TAN Removal Efficiency | 0.00 | ratio | | Assumes No Biofiltration |
| TSS Removal Efficiency | 0.40 | ratio | | Drum Filter Only |
| O2 transfer efficiency (worst case) | 65 | % transferred | | Not used |
| Daily ozone application rate | 0.02 | kg O3/kg feed | | Not used |

**REQUIRED FLOWS**

| | | |
|---|---|---|
| Reuse Flow Required based on DO | 972 | gpm |
| **Total Flow Required based on DO** | **1080** | **gpm** |
| Reuse Flow Required based on TAN | NA | gpm |
| **Total Flow Required based on TAN** | **NA** | **gpm** |
| Reuse Flow Required based on CO2 | 972 | gpm |
| **Total Flow Required based on CO2** | **1080** | **gpm** |
| **Total Flow Required based on TEX** | **1080** | **gpm** |

**DESIGN**

| | | | |
|---|---|---|---|
| **Design Total Flow** | **1080** | **gpm** | Select the Highest Required Total Flow |
| **Return Flow per tank** | **1080** | **gpm** | |
| **Sidewall Drain Flow per Tank** | **972** | **gpm** | |
| **Makeup Flow per Tank** | **108** | | |
| **Flow Reuse Fraction, R** | **0.90** | | Summerfelt et al., 2001 |
| **Culture Tank DO Concentration** | **7.8** | **mg/L** | Previously defined |
| **Culture Tank TAN Concentration** | **0.91** | **mg/L** | |
| **Culture Tank UIA Concentration** | **0.0073** | **mg/L** | < 0.0125 mg/L is max safe level |
| **Culture Tank CO2 Concentration** | **3.38** | **mg/L** | < 20 mg/L is safe |
| **Culture Tank TSS Concentration** | **1.76** | **mg/L** | |
| **Ratio UIA:TAN** | **0.0080** | | Target is < 0.0125 (pKa = 9.742 according to ammonia ca |
| **Tank Exchange Rate** | **28** | **minutes** | |
| **Flow through TAN at Design Total Flow** | **0.09** | **mg/L** | Summerfelt & Vinci, 2004 |
| **Flow through CO2 at Design Total Flow** | **5.63** | **mg/L** | Summerfelt & Vinci, 2004 |
| **Flow through Delta DO at Design Total Flow** | **0.79** | **mg/L** | Summerfelt & Vinci, 2004 |

Basis of Design Report

# Appendix B. Equipment List and Major Equipment Data

**Sleepy Hollow Steelhead Rearing Facility** **10/19/2015**
**Existing and New Equipment List**

| ID | Equipment Name | Existing or New | Year Installed | Manufacturer & Model | Capacity or Size | Electrical Rating (HP or kW) |
|---|---|---|---|---|---|---|
| IS-1 | Intake Screen | N | | ISI Model C66-18 | 6.7 cfs at 0.25 ft/s approach velocity | 5 HP |
| P-1 | River Pump | N | | | 1350 gpm at 25.5' & 525 gpm at 72' | 30 HP |
| P-2 | River Pump | N | | | 1350 gpm at 25.5' & 525 gpm at 72' | 30 HP |
| P-3 | Reuse Pump | N | | | 1350 gpm at 40 ft | 20 HP |
| P-4 | Reuse Pump | N | | | 1350 gpm at 40 ft | 20 HP |
| P-6 | Portable Backup Pump | E | 2003 | Gorman Rupp - T4A3S-B | 500 gpm | Engine Driven |
| FM-1 | Intake Flow Meter | N | | Endress Hauser | 12" - 1350 gpm | N/A |
| FM-2 | Reuse Flow Meter | N | | Endress Hauser | 12" - 1350 gpm | N/A |
| LS-1 | Intake PS Level Sensor | N | | | | N/A |
| LS-2 | Reuse PS Level Sensor | N | | | | N/A |
| | Sand Separator | E | 2000 | Lakos - IHB-0285 | 285 gpm at Δ3 psi to 525 gpm at Δ12 psi, 4" inlet/outlet | N/A |
| DF-1 | Drum Filter - Reuse | N | | Hydrotech 1604 | 1080 gpm, 40 micron | 2 HP/1 HP |
| DF-2 | Drum Filter - RW Intake | N | | Hydrotech 1604 | 1350 gpm, 40 micron | 2 HP/1 HP |
| UV-1 | UV Treatment Equipment | N | | Trojan UVLogic, 12AL40 | 1350 gpm at 30,000 uWs/cm2 /50% UVT | 3.16 kVA |
| CT-1 | Cooling Tower | E | 2000 | IMECO - IMC-1218-485-1-30 | 900 gpm, Cooling from 78 F to 65 F at 61 F air temp | 30 HP |
| | Temperature Sensor | E | 2000 | | | N/A |
| | Domestic Booster Pump | E | 1996 | | | 2 HP |
| | Ozone System | E | | | | 1 HP |
| | Air Blower 1 | E | 1996 | Sweetwater | | 3.5 HP |
| | Air Blower 2 | E | 1996 | Sweetwater | | 3.5 HP |
| | Quarantine Tank Chillers (5 total) | E | 1999 | | Maintain 50 deg water at 5-10 gpm | (5 ea) 1/2 HP |
| | Rearing Trough Chillers (2 total) | E | 2006 | | | (2 ea) 1 HP |
| | Office - Panel A | E | 1996 | | 100 Amp Panel | 100 Amp |
| | Generator | E | 1996 | | | 75 KW |
| | Generator | E | 2000 | | | 175 KW |
| Tank-1 | Rearing Tank | E | 1996 | | 33 ft dia | N/A |

**Sleepy Hollow Steelhead Rearing Facility** **10/19/2015**
**Existing and New Equipment List**

| ID | Equipment Name | Existing or New | Year Installed | Manufacturer & Model | Capacity or Size | Electrical Rating (HP or kW) |
|---|---|---|---|---|---|---|
| Tank-3 | Rearing Tank | E | 1996 | | 22 ft dia | N/A |
| | Rearing Troughs (8 total) | E | 2006 | | 2' x 10' x 2' deep (200 gal) | N/A |
| QT-1 - QT-5 | Quarantine Tanks (5 total) | E | 1999 | | 8 ft dia x 3.5 ft deep (1200 gal) | N/A |
| | Treatment Tanks | E | 1999 | | 8' dia | N/A |

**Sleepy Hollow Steelhead Rearing Facility** **10/19/2015**

**Predesign Construction Cost Estimate**

**Option - 3**

| Item | Qty | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|
| **Mobilization and General Conditions** | | | | |
| Mobilization - 8% | 1 | LS | $97,000 | $97,000 |
| Demolition | 1 | LS | $10,000 | $10,000 |
| Erosion Control | 1 | LS | $5,000 | $5,000 |
| **River Intake** | | | | |
| Coffer Dam / Dewatering in River | 1 | LS | $25,000 | $25,000 |
| Site Prep / Excavation | 1 | LS | $10,000 | $10,000 |
| Concrete Slab and Wall at Intake Screen | 22.2 | CY | $1,000 | $22,222 |
| Intake Screen & Control Panel | 1 | LS | $75,000 | $75,000 |
| Spray Header Piping | 1 | LS | $5,000 | $5,000 |
| Bank Reinforcment and Restoration | 1 | LS | $25,000 | $25,000 |
| **River Intake Pump Station** | | | | |
| Pumps - 30 hp | 2 | EA | $37,500 | $75,000 |
| Wet Well Structure - 96" diameter x 20' deep | 1 | LS | $75,000 | $75,000 |
| Wet Well Mechanical | 1 | LS | $10,000 | $10,000 |
| Valve Vault Structure 6' x 8' w/ Hatch | 1 | LS | $15,000 | $15,000 |
| Valve Vault Mechanical | 1 | LS | $15,000 | $15,000 |
| Pump Control Panel | 1 | LS | $10,000 | $10,000 |
| Instrumentation | 1 | LS | $10,000 | $10,000 |
| **Cooling Tower / Headbox** | | | | |
| Raise Cooling Tower - Re-plumb | 1 | LS | $25,000 | $25,000 |
| New Headbox | 1 | LS | $20,000 | $20,000 |
| New Gas Column | 1 | LS | $20,000 | $20,000 |
| LOX Tank and System | 1 | LS | $15,000 | $15,000 |
| **Re-use Treatment & Pumping** | | | | |
| Site Prep / Excavation | 1 | LS | $12,000 | $12,000 |
| Diversion Box Structural | 1 | LS | $5,000 | $5,000 |
| Diversion Box Gate and Mechanical | 1 | LS | $5,000 | $5,000 |
| Filter and Basin Concrete Slab | 85.3 | CY | $1,000 | $85,333 |
| Metal Building Roof and Partial Walls | 2304 | SF | $50 | $115,200 |
| Drum Filter (1080-1350 gpm, 40 micron) | 2 | EA | $40,000 | $80,000 |
| Drum Filter Mechanichal | 1 | LS | $25,000 | $25,000 |
| Pumps - 20 hp | 2 | EA | $27,000 | $54,000 |
| Pump Valves and Mechanical | 1 | LS | $15,000 | $15,000 |
| Pump Control Panel | 1 | LS | $10,000 | $10,000 |
| Instrumentation | 1 | LS | $10,000 | $10,000 |
| UV Equipment - 1350 gpm at 30,000 uWs/cm2 | 1 | LS | $35,000 | $35,000 |
| UV Mechanical | 1 | LS | $5,000 | $5,000 |
| **Site Civil & Piping** | | | | |
| 4" Spraybar Supply (Common Trench) | 180 | LF | $25 | $4,500 |
| 10" RW/RU - Pressure | 140 | LF | $55 | $7,700 |
| 12" RW - Pressure | 445 | LF | $65 | $28,925 |

**Sleepy Hollow Steelhead Rearing Facility** **10/19/2015**

**Predesign Construction Cost Estimate**

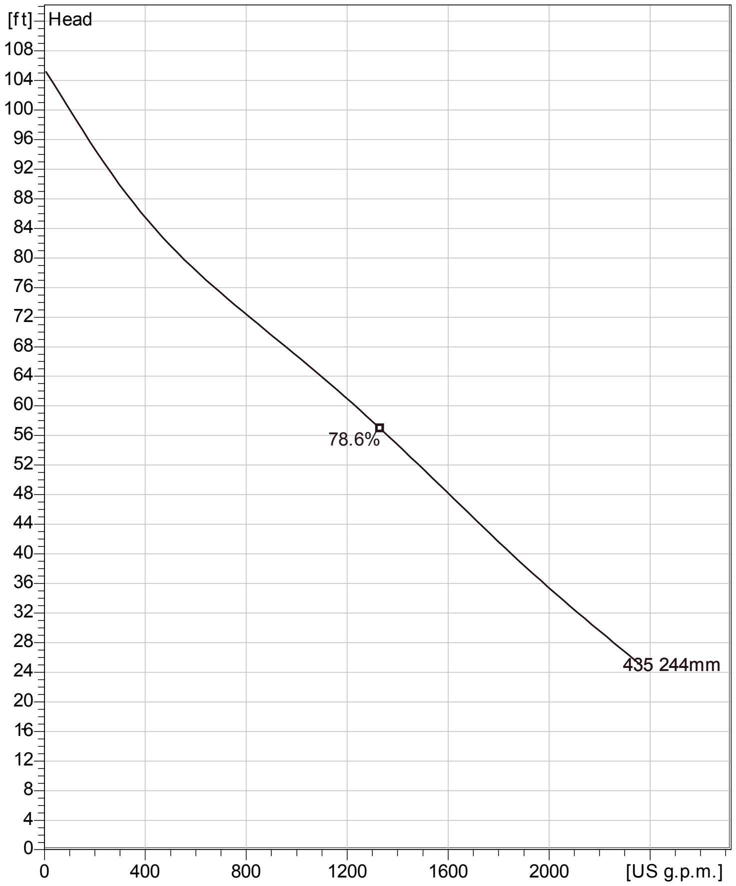
**Option - 3**

| Item | Qty | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|
| 12" RW/RU - Pressure (Common Trench) | 400 | LF | $45 | $18,000 |
| 12" RW/RU - Pressure | 205 | LF | $65 | $13,325 |
| 16" RW - Gravity (Deep) | 160 | LF | $100 | $16,000 |
| 4" Drain Pipe - Gravity - Backwash | 130 | LF | $30 | $3,900 |
| 8" Drain Pipe - Gravity - Headbox Overflow | 80 | LF | $40 | $3,200 |
| 12" Drain Pipe - Gravity - Reuse Overflow | 115 | LF | $50 | $5,750 |
| Valves, Fittings, Couplings Allowance | 1 | LS | $20,000 | $20,000 |
| Gravel Surface Restoration | 1000 | SY | $7 | $7,000 |
| **Electrical and Controls** | | | | |
| Site Electrical | 1 | LS | $100,000 | $100,000 |
| Control System and SCADA | 1 | LS | $20,000 | $20,000 |
| Utility Upgrade (Place Holder) | 1 | LS | $40,000 | $40,000 |
| | | | Subtotal | $1,309,000 |
| | | | 25% Contingency | $327,000 |
| | | | Sales Tax | $130,880 |
| **Option 3 - Total Construction Cost Estimate** | | | | **$1,766,880** |

SHSRF - River Pumps
Pre-Design Selection
10/19/15

# NP 3171 MT 3~ 435

## Technical specification




*Water, pure* *Curve ISO*

Note: Picture might not correspond to the current configuration.

**General**

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Possible to be upgraded with Guide-pin® for even better clogging resistance. Modular based design with high adaptation grade.

**Impeller**

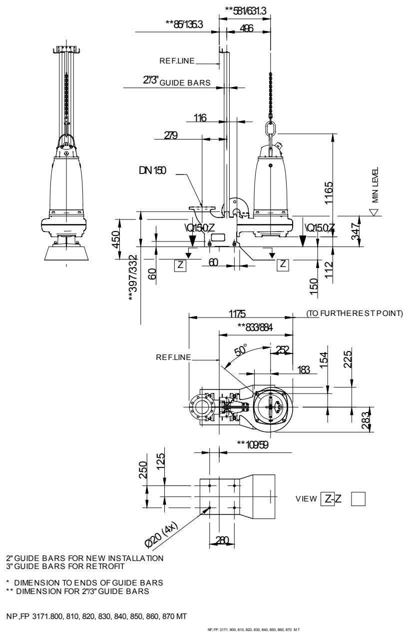
| | |
|---|---|
| Impeller material | Grey cast iron |
| Discharge Flange Diameter | 150 mm |
| Inlet diameter | 150 mm |
| Impeller diameter | 244 mm |
| Number of blades | 2 |

**Motor**

| | |
|---|---|
| Motor # | N3171.800 25-32-4KE-W IE3 30hp |
| Stator variant | 7 |
| Frequency | 60 Hz |
| Rated voltage | 230 V |
| Number of poles | 4 |
| Phases | 3~ |
| Rated power | 30 hp |
| Rated current | 66 A |
| Starting current | 455 A |
| Rated speed | 1770 1/min |
| Power factor | |
| 1/1 Load | 0.91 |
| 3/4 Load | 0.89 |
| 1/2 Load | 0.83 |
| Efficiency | |
| 1/1 Load | 93.6 % |
| 3/4 Load | 94.2 % |
| 1/2 Load | 94.2 % |

**Configuration**

**Installation: P - Semi permanent, Wet**




| Project | Project ID | Created by | Created on | Last update |
|---|---|---|---|---|
| | | | 2015-09-16 | |

# NP 3171 MT 3~ 435

## Performance curve

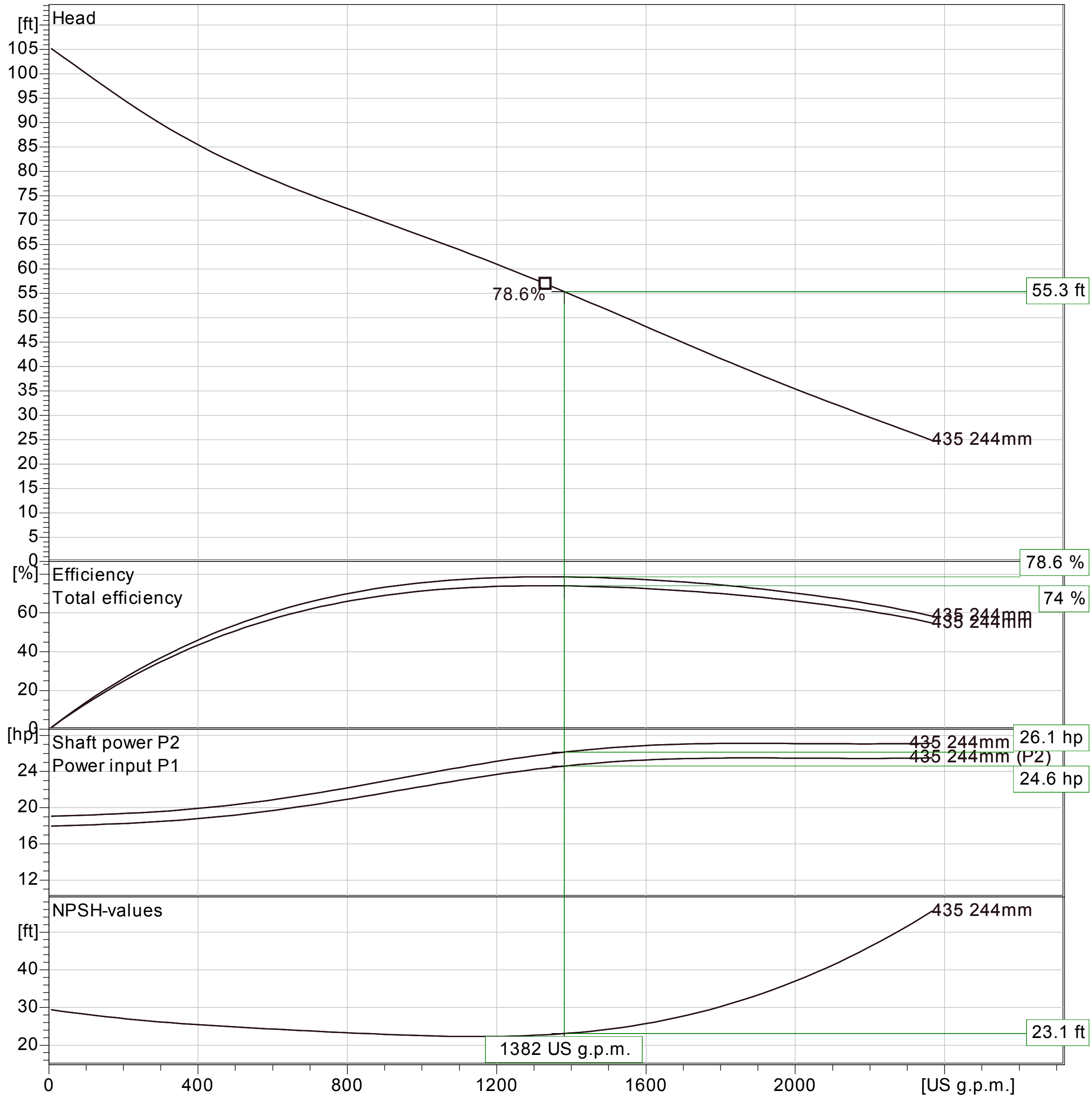
### Pump

| | |
|---|---|
| Discharge Flange Diameter | 150 mm |
| Inlet diameter | 150 mm |
| Impeller diameter | 244 mm |
| Number of blades | 2 |

### Motor

| | |
|---|---|
| Motor # | N3171.800 25-32-4KE-W IE3 30hp |
| Stator variant | 7 |
| Frequency | 60 Hz |
| Rated voltage | 230 V |
| Number of poles | 4 |
| Phases | 3~ |
| Rated power | 30 hp |
| Rated current | 66 A |
| Starting current | 455 A |
| Rated speed | 1770 1/min |

| Power factor | |
|---|---|
| 1/1 Load | 0.91 |
| 3/4 Load | 0.89 |
| 1/2 Load | 0.83 |
| **Efficiency** | |
| 1/1 Load | 93.6 % |
| 3/4 Load | 94.2 % |
| 1/2 Load | 94.2 % |

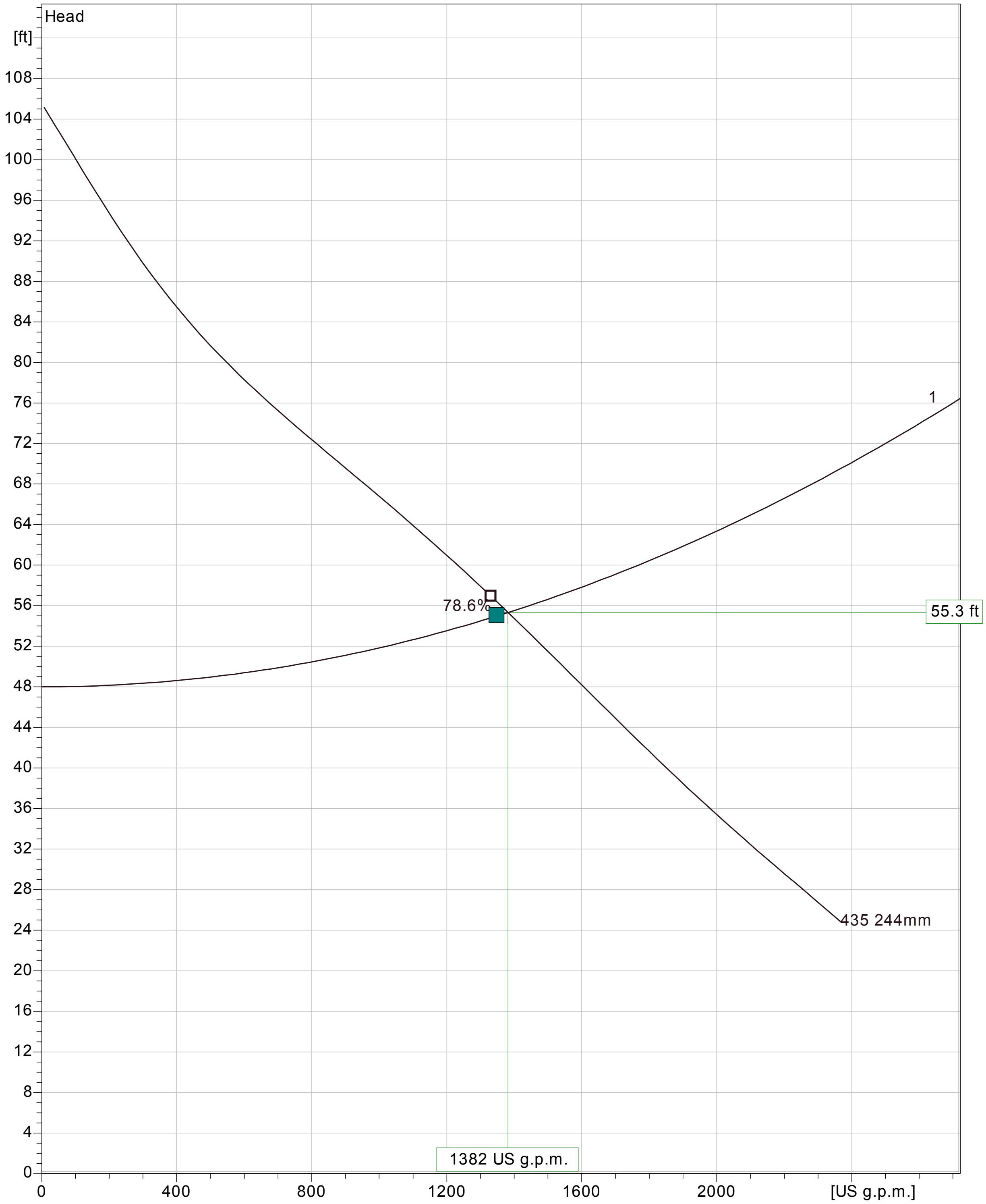



*Water, pure* *Curve ISO*

| Project | Project ID | Created by | Created on | Last update |
|---|---|---|---|---|
| | | | 2015-09-16 | |

# NP 3171 MT 3~ 435

## Duty Analysis




*Water, pure* *Curve ISO*

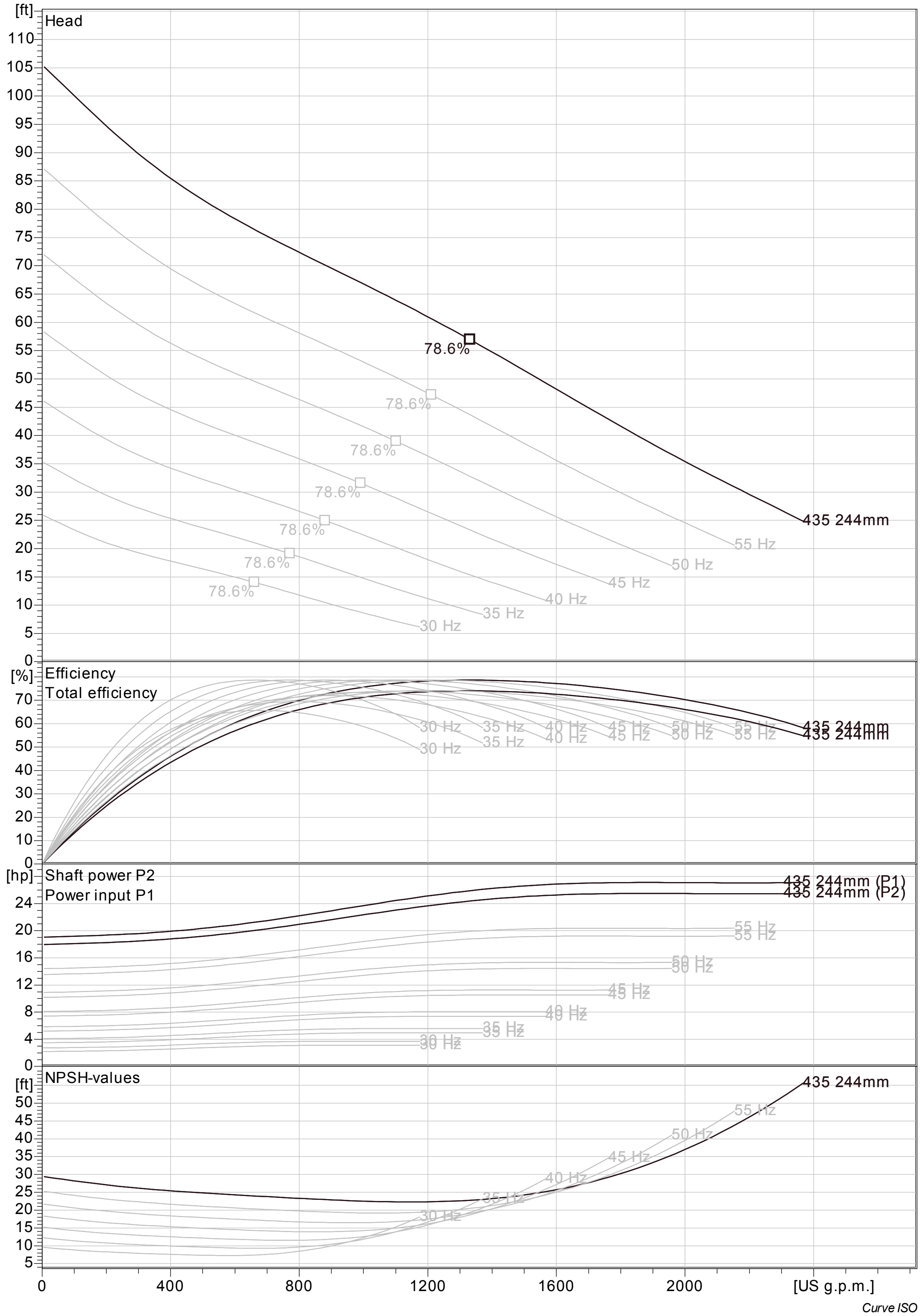
*Curve issue 10*

| Pumps running /System | Individual pump Flow | Head | Shaft power | Total Flow | Head | Shaft power | Pump eff. | Specific energy | NPSHre |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1380 US g.p.m. | 55.3 ft | 24.6 hp | 1380 US g.p.m. | 55.3 ft | 24.6 hp | 78.6 % | 235 kWh/US MG | 23.1 ft |

| Project | Project ID | Created by | Created on | Last update |
|---|---|---|---|---|
| | | | **2015-09-16** | |

Let's Solve Water

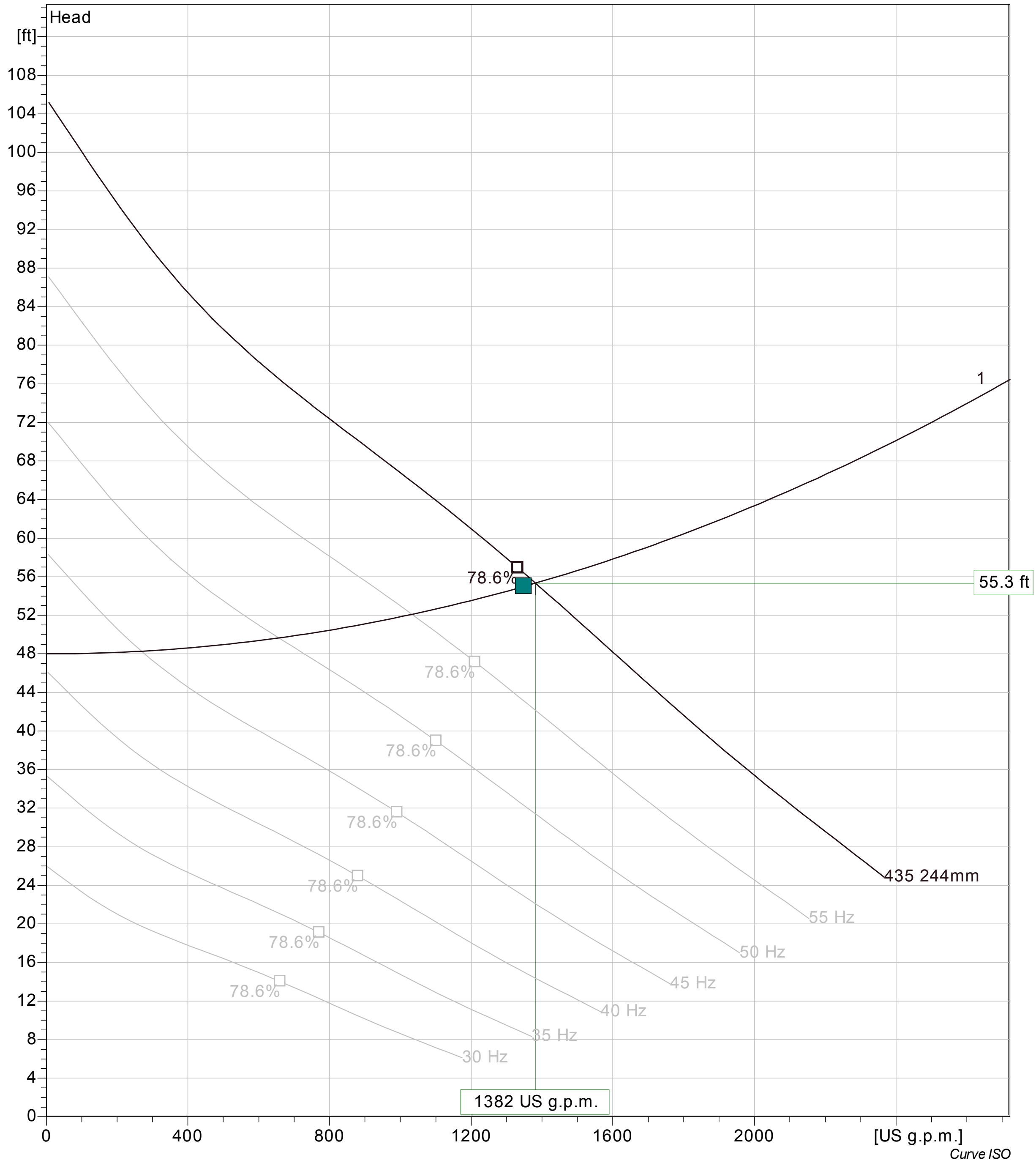
# NP 3171 MT 3~ 435
## VFD Curve




| Project | Project ID | Created by | Created on | Last update |
|---|---|---|---|---|
| | | | **2015-09-16** | |

# NP 3171 MT 3~ 435

## VFD Analysis




| Pumps running /System | Frequency | Flow | Head | Shaft power | Flow | Head | Shaft power | Hyd eff. | Specific energy | NPSHre |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 60 Hz | 1380 US g.p.m. | 55.3 ft | 24.6 hp | 1380 US g.p.m. | 55.3 ft | 24.6 hp | 78.6 % | 235 kWh/US MG | 23.1 ft |
| 1 | 55 Hz | 1030 US g.p.m. | 52.1 ft | 17.5 hp | 1030 US g.p.m. | 52.1 ft | 17.5 hp | 77.7 % | 224 kWh/US MG | 19.2 ft |
| 1 | 50 Hz | 657 US g.p.m. | 49.7 ft | 11.8 hp | 657 US g.p.m. | 49.7 ft | 11.8 hp | 69.7 % | 239 kWh/US MG | 17.2 ft |
| 1 | 45 Hz | 269 US g.p.m. | 48.3 ft | 7.7 hp | 269 US g.p.m. | 48.3 ft | 7.7 hp | 42.7 % | 386 kWh/US MG | 16 ft |
| 1 | 40 Hz | | | | | | | | | |
| 1 | 35 Hz | | | | | | | | | |

| Project | Project ID | Created by | Created on | Last update |
|---|---|---|---|---|
| | | | **2015-09-16** | |

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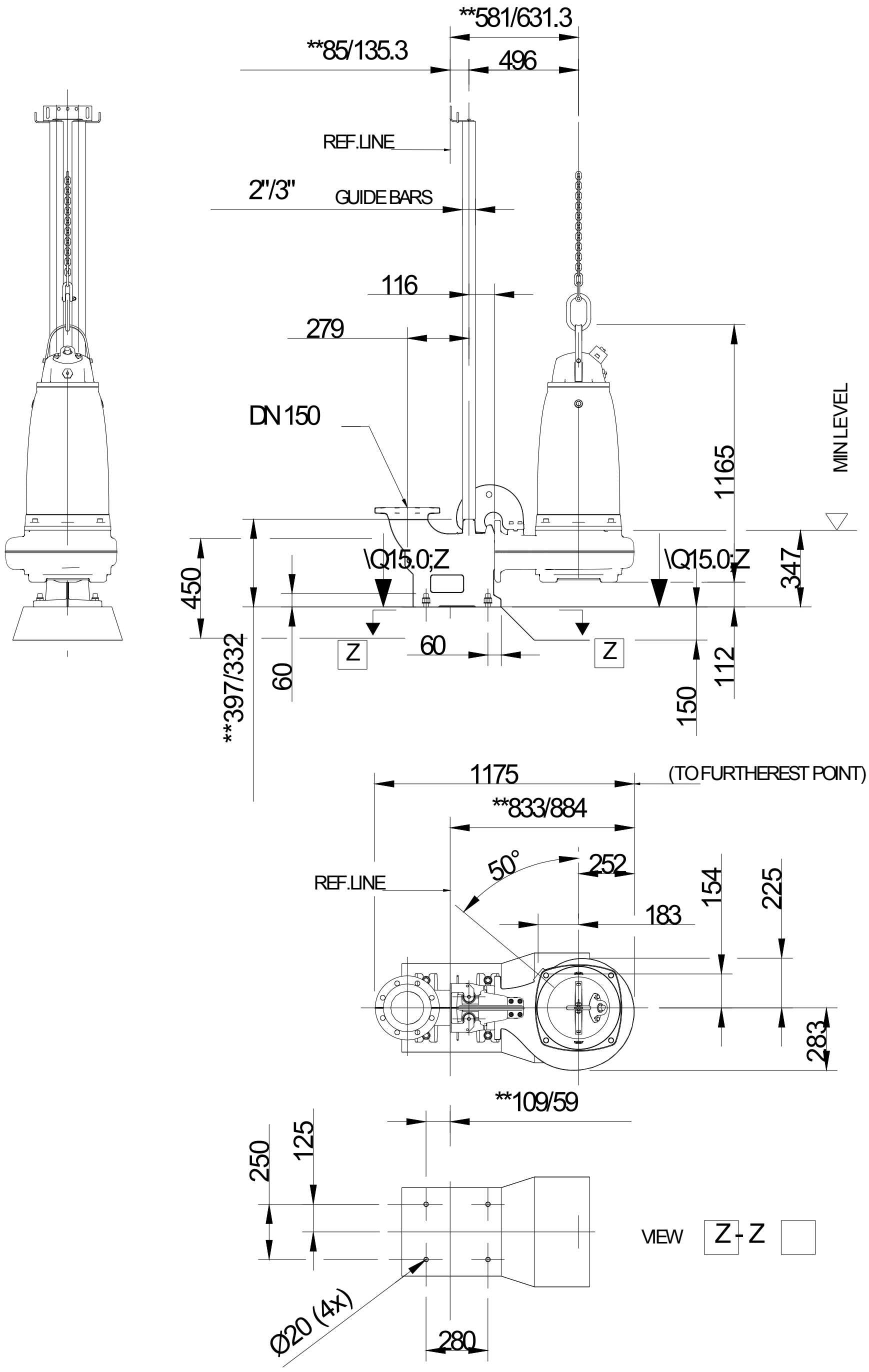
# NP 3171 MT 3~ 435

## Dimensional drawing

FLYGT




2" GUIDE BARS FOR NEW INSTALLATION
3" GUIDE BARS FOR RETROFIT

* DIMENSION TO ENDS OF GUIDE BARS
** DIMENSION FOR 2"/3" GUIDE BARS

NP,FP 3171.800, 810, 820, 830, 840, 850, 860, 870 MT

NP,FP 3171.800,810,820,830,840,850,860,870 MT

| Project | Project ID | Created by | Created on | Last update |
|---|---|---|---|---|
| | | | 2015-09-16 | |

Bell & Gossett
a xylem brand

SHSRF - Reuse Pumps
Pre-Design Selection
10/19/15

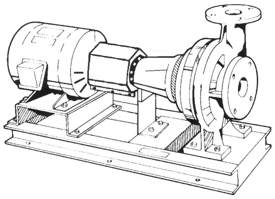
**SUBMITTAL**
**B-880.48**

**JOB:** Sleepy Hollow
**REPRESENTATIVE:**

**UNIT TAG:** Re-use Pumps
**ENGINEER:** Tetra Tech
**CONTRACTOR:**

**ORDER NO.**
**SUBMITTED BY:**
**APPROVED BY:**

**DATE: 10/19/2015**
**DATE:**
**DATE:**



# 6G
# Series e-1510
## Centrifugal Pumps - Base Mounted

### SPECIFICATIONS

FLOW 1350 HEAD 40
HP 20.00 RPM 1150
VOLTS
CYCLE 60 PHASE 3
ENCLOSURE ODP
APPROX. WEIGHT 1040
SPECIALS

**Note: Equipped with NEOPRENE coupling**

### MATERIALS OF CONSTRUCTION

☒ Stainless Steel Fitted

### FEATURES

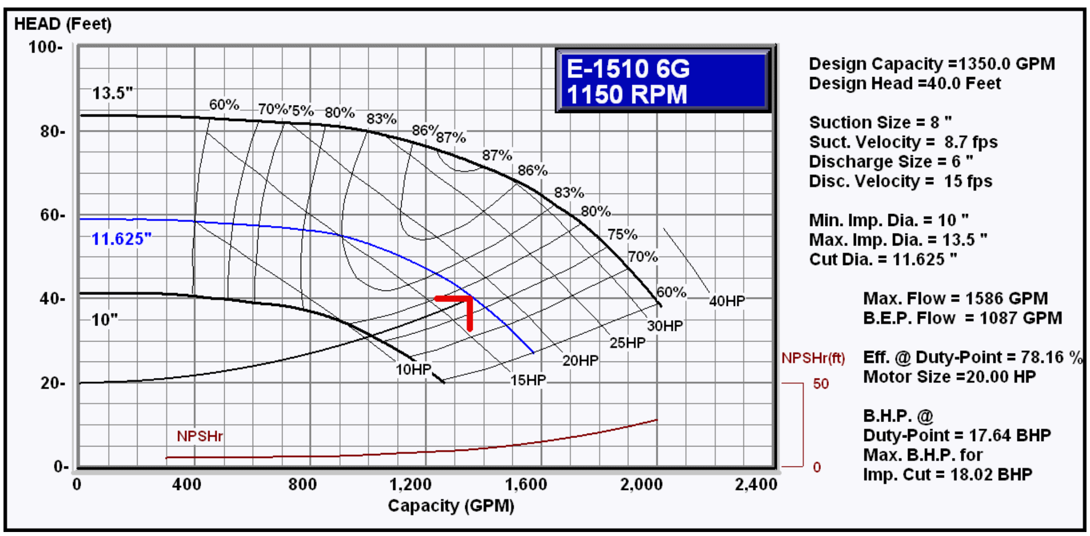
☐ i-ALERT™ Condition Monitor
☒ ANSI/OSHA Coupling Guard
☒ Center Drop Out Spacer Coupling
☒ Fabricated Heavy Duty Baseplate

### MAXIMUM WORKING PRESSURE

☐ 175 psi (12 bar) W.P. w/ 125# ANSI flange drilling
☐ 250 psi (17 bar) W.P. w/250# ANSI flange drilling (requires 1510-S)

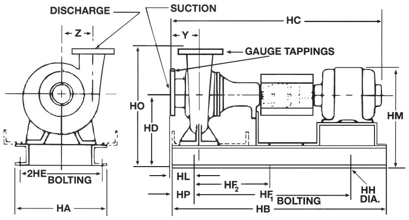
### TYPE OF SEAL

☐ Standard Seal (Buna-Carbon/Ceramic)
☐ -F Standard Seal w/ Flush Line (Buna-Carbon/Ceramic)
☐ -S Stuffing Box Construction w/ Flushed Mechanical Single Seal (EPR-Tungsten Carbide/Carbon)
☐ -PF Stuffing Box Construction w/ Packing (Graphite Impregnated Teflon)




xylem
Let's Solve Water

# Series e-1510 6G Centrifugal Pump Submittal




| FLANGE DIMENSIONS IN INCHES (MM) | | | |
|---|---|---|---|
| | SIZE | THICKNESS | O.D. |
| Discharge | 6" (152) | 1-7/16 (37) | 12-1/8 (308) |
| Suction | 8" (203) | 1-5/8 (41) | 14-3/4 (375) |

**FLANGES ARE:** **125# ANSI - STANDARD**
**250# ANSI - AVAILABLE**

**DIMENSIONS - Inches (mm)** **STANDARD SEAL**

| MOTOR FRAME | HA | HB | HC MAX | HD | 2HE | $HF_1$ | $HF_2$ | HH | HL | HM MAX | HO | HP | Y | Z |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | "L" FRAME | | | | | | | | | | | | | |
| 256T | 24 (610) | 56 (1422) | 49-5/8 (1260) | 16-1/2 (419) | 21-1/2 (546) | 44 (1118) | 22 (559) | 1 (25) | 6-1/4 (159) | 23-3/8 (594) | 30-1/2 (775) | 6 (152) | 6-1/2 (165) | 9-5/16 (237) |
| 284T | 24 (610) | 56 (1422) | 50-5/8 (1286) | 16-1/2 (419) | 21-1/2 (546) | 44 (1118) | 22 (559) | 1 (25) | 6-1/4 (159) | 24-1/2 (622) | 30-1/2 (775) | 6 (152) | 6-1/2 (165) | 9-5/16 (237) |
| ➡ 286T | 24 (610) | 56 (1422) | 52-1/8 (1324) | 16-1/2 (419) | 21-1/2 (546) | 44 (1118) | 22 (559) | 1 (25) | 6-1/4 (159) | 24-1/2 (622) | 30-1/2 (775) | 6 (152) | 6-1/2 (165) | 9-5/16 (237) |
| 324T | 24 (610) | 56 (1422) | 54-1/8 (1375) | 16-1/2 (419) | 21-1/2 (546) | 44 (1118) | 22 (559) | 1 (25) | 6-1/4 (159) | 25-5/8 (651) | 30-1/2 (775) | 6 (152) | 6-1/2 (165) | 9-5/16 (237) |
| 326T | 24 (610) | 56 (1422) | 55-5/8 (1413) | 16-1/2 (419) | 21-1/2 (546) | 44 (1118) | 22 (559) | 1 (25) | 6-1/4 (159) | 25-5/8 (651) | 30-1/2 (775) | 6 (152) | 6-1/2 (165) | 9-5/16 (237) |
| 364T | 24 (610) | 56 (1422) | 57-7/8 (1470) | 16-1/2 (419) | 21-1/2 (546) | 44 (1118) | 22 (559) | 1 (25) | 6-1/4 (159) | 26-3/4 (679) | 30-1/2 (775) | 6 (152) | 6-1/2 (165) | 9-5/16 (237) |
| 365T | 24 (610) | 56 (1422) | 58-1/2 (1486) | 16-1/2 (419) | 21-1/2 (546) | 44 (1118) | 22 (559) | 1 (25) | 6-1/4 (159) | 26-3/4 (679) | 30-1/2 (775) | 6 (152) | 6-1/2 (165) | 9-5/16 (237) |
| 404TS | 24 (610) | 56 (1422) | 58-5/8 (1489) | 16-1/2 (419) | 21-1/2 (546) | 44 (1118) | 22 (559) | 1 (25) | 6-1/4 (159) | 28-3/8 (721) | 30-1/2 (775) | 6 (152) | 6-1/2 (165) | 9-5/16 (237) |
| 405TS | 24 (610) | 56 (1422) | 59-3/8 (1508) | 16-1/2 (419) | 21-1/2 (546) | 44 (1118) | 22 (559) | 1 (25) | 6-1/4 (159) | 30 (762) | 30-1/2 (775) | 6 (152) | 6-1/2 (165) | 9-5/16 (237) |
| | "XL" FRAME | | | | | | | | | | | | | |
| 324T | 26 (660) | 59-1/4 (1505) | 58-7/8 (1495) | 17 (432) | 23-1/2 (597) | 47-1/4 (1200) | 23-5/8 (600) | 1 (25) | 6-1/2 (165) | 25-1/4 (641) | 31 (787) | 6 (152) | 6-1/2 (165) | 9-5/16 (237) |
| 326T | 26 (660) | 59-1/4 (1505) | 60-5/16 (1532) | 17 (432) | 23-1/2 (597) | 47-1/4 (1200) | 23-5/8 (600) | 1 (25) | 6-1/2 (165) | 25-1/4 (641) | 31 (787) | 6 (152) | 6-1/2 (165) | 9-5/16 (237) |
| 364TS | 26 (660) | 59-1/4 (1505) | 62-9/16 (1589) | 17 (432) | 23-1/2 (597) | 47-1/4 (1200) | 23-5/8 (600) | 1 (25) | 6-1/2 (165) | 26-1/8 (663.5) | 31 (787) | 6 (152) | 6-1/2 (165) | 9-5/16 (237) |
| 365TS | 26 (660) | 59-1/4 (1505) | 62-1/2 (1588) | 17 (432) | 23-1/2 (597) | 47-1/4 (1200) | 23-5/8 (600) | 1 (25) | 6-1/2 (165) | 27-1/4 (692) | 31 (787) | 6 (152) | 6-1/2 (165) | 9-5/16 (237) |
| 404TS | 26 (660) | 59-1/4 (1505) | 64-3/4 (1645) | 17 (432) | 23-1/2 (597) | 47-1/4 (1200) | 23-5/8 (600) | 1 (25) | 6-1/2 (165) | 28-7/8 (733) | 31 (787) | 6 (152) | 6-1/2 (165) | 9-5/16 (237) |
| 405TS | 26 (660) | 59-1/4 (1505) | 66-1/4 (1683) | 17 (432) | 23-1/2 (597) | 47-1/4 (1200) | 23-5/8 (600) | 1 (25) | 6-1/2 (165) | 28-7/8 (733) | 31 (787) | 6 (152) | 6-1/2 (165) | 9-5/16 (237) |
| 444TS | 26 (660) | 59-1/4 (1505) | 70-5/8 (1794) | 18 (457) | 23-1/2 (597) | 47-1/4 (1200) | 23-5/8 (600) | 1 (25) | 6-1/2 (165) | 29-3/4 (756) | 32 (813) | 6 (152) | 6-1/2 (165) | 9-5/16 (237) |

**Dimensions are subject to change. Not to be used for construction purposes unless certified.**

**At 1800 RPM operation and impeller diameters greater than 12.5", "XL" bearing frame required.**

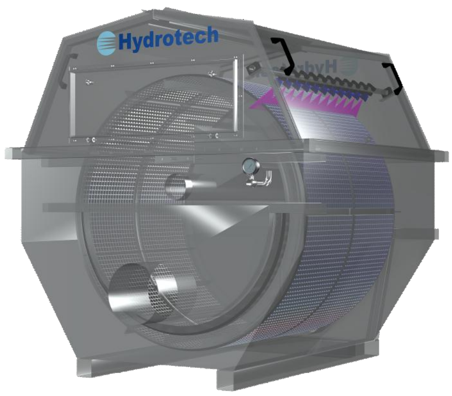
Xylem Inc.
8200 N. Austin Avenue
Morton Grove, IL 60053
Phone: (847)966-3700
Fax: (847)965-8379
www.xyleminc.com/brands/bellgossett

Let's Solve Water

## Technical specification: Hydrotech Drumfilter HDF1601-1F - HDF1604-1F

### Hydrotech Drumfilter

The Hydrotech Drumfilter is a mechanical, self-cleaning filter specially designed for high performance in systems where it is essential to prevent particles from fragmenting. The Drumfilter uses a unique design of filter panels that ensures careful handling of solids, which is essential in achieving the high filtration efficiency required in many applications.
Our Drumfilters are specially designed for the high standards of filtration demanded in industries such as aquaculture, swimming pools and industrial applications such as food processing.




The filter works without pressure and is robustly designed with few moving parts to ensure long life and low maintenance costs. By removing fine particles before they are dissolved, the filter reduces the risk of harmful bi-products contaminating the water.
Since march 2011, Hydrotech has been ISO9001 certified which is an additional step in reassuring a high quality product and the best possible support to our clients.

### Manufacturing

The Drumfilter is delivered according to EC Machinery Directive and welding is performed in accordance with European standards.

| Filter model | HDF1601-1F | HDF1602-1F | HDF1603-1F | HDF1604-1F |
|---|---|---|---|---|
| Filter area (m$^2$) | 1.8 | 3.6 | 5.4 | 7.2 |
| Number of filter panels | 4 | 8 | 12 | 16 |
| Number of backwash spray nozzles | 5 | 10 | 15 | 20 |
| Dry weight (kg) | 630 | 780 | 930 | 1 080 |
| Operational weight (kg) | 2 000 | 2 900 | 3 800 | 4 700 |
| Hydraulic capacity (l/s) | 50 | 70 | 125 | 180 |
| Backwash pump (Grundfos, 50 Hz) | CR1-15 | CR3-15 | CR3-17 | CR5-13 |
| Backwash pump, installed power (kW) | 0.75 | 1.1 | 1.5 | 2.2 |
| Backwash water flow at 7.5 bar (l/s) | 0.3 | 0.5 | 0.8 | 1.0 |
| Installed power (kW) | 1.3 | 1.65 | 2.05 | 2.75 |
| Approx. power consumption (kW/h), (backwash 30%) | 0.27 | 0.35 | 0.43 | 0.58 |


## Technical specification: Hydrotech Drumfilter HDF1601-1F - HDF1604-1F

| General data | |
|---|---|
| **Drum diameter (m)** | 1.6 |
| **SEW drive motor model** | S67 |
| **Drive motor, installed power (kW)** | 0.55 |
| **Transmission** | Helical-worm gear |
| **Backwash pressure (bar)** | 7.5 |
| **Backwash spray nozzles material** | Ceramic/plastic |
| **Drum rotation speed (rpm)** | 2.4 |
| **Water level detection** | Conductivity sensor |
| **Pressure gauge** | Impel analog pressure gauge |
| **Ambient temperature (°C)** | 0-40 |
| **Stainless steel quality according to quote or order confirmation** | |

| Control panel (P) | |
|---|---|
| **Make** | Rittal |
| **Protection** | IP65 |
| **Power supply** | 3 x 400 V, 50 Hz |


### Definition of the Hydrotech Drumfilter designation

HDF 16 01 - 1 F

*Type of microscreen filter*
HDF = Hydrotech Drum Filter

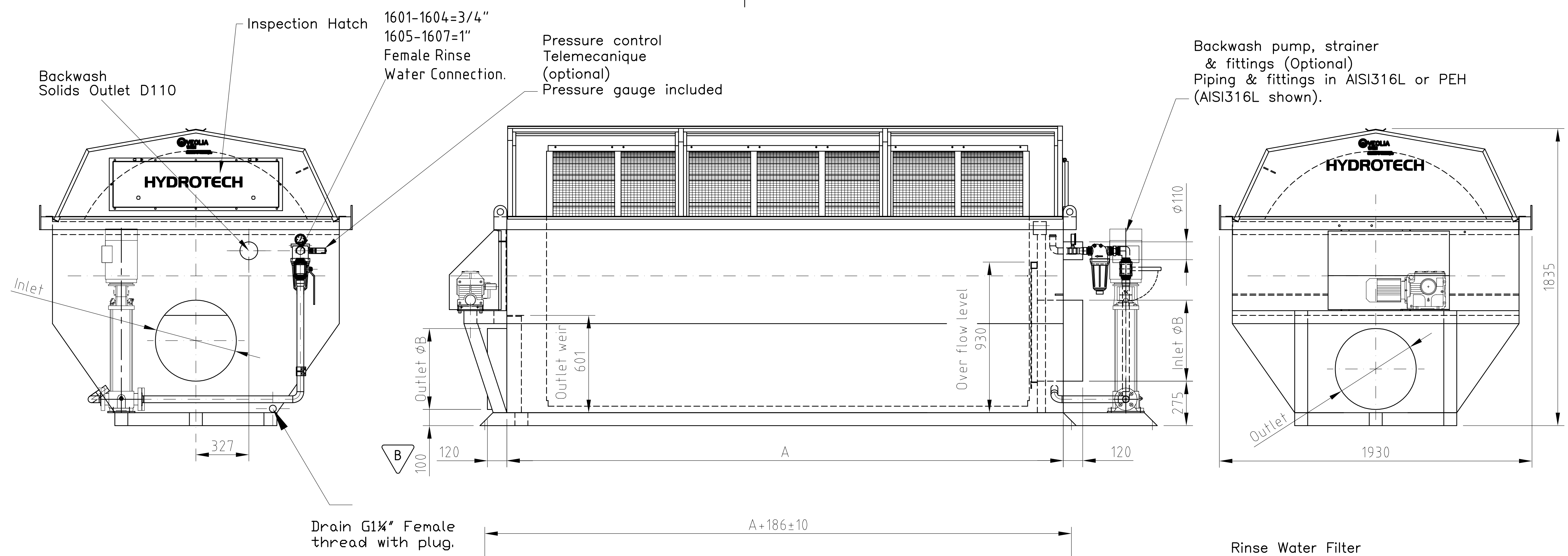
*Drum diameter*
16 = 1600 mm

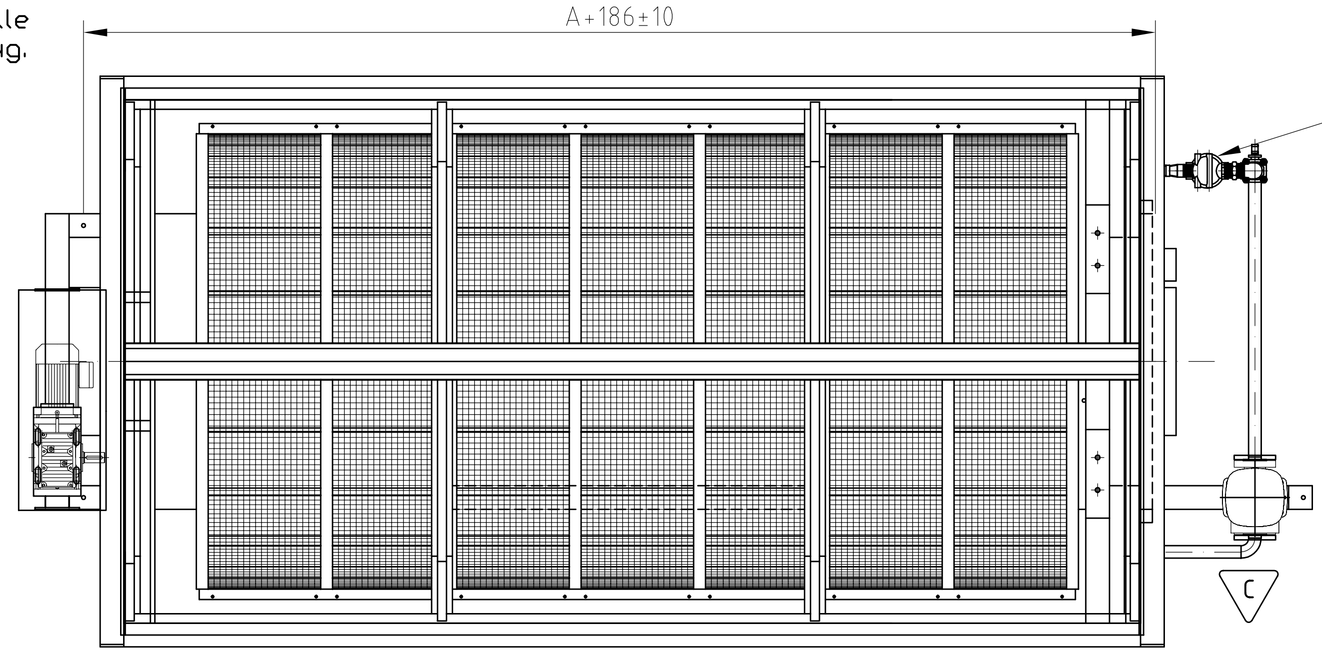
*Max. number of filter segments*

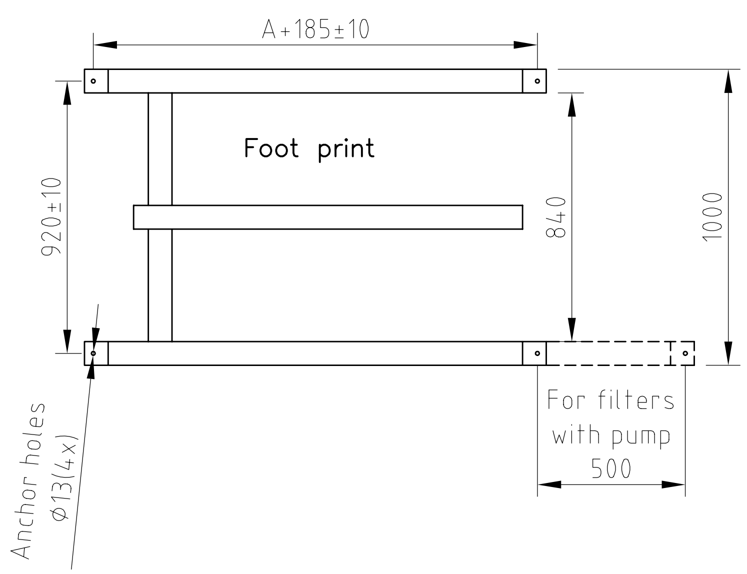
*Model*
F = Industrial model

*Discfilter type*
1 = Filter with tank
2 = Filter without tank

HYDROTECH
Mejselgatan 6
SE-235 32 Vellinge Sweden
Tel. +46 40-429530
Fax. +46 40-429531
E-mail: mailbox@hydrotech.se
Web: www.hydrotech.se




| TYPE | A | B |
|---|---|---|
| 1601 | 895 | 250 |
| 1602 | 1315 | 315 |
| 1603 | 1735 | 400 |
| 1604 | 2155 | 500 |
| 1605 | 2595 | 500 |
| 1606 | 3015 | 500 |
| 1607 | 3435 | 500 |

MAINTENANCE ACCESS SHOULD BE PROVIDED TO ALL FOUR SIDES OF THE FILTER, SIZED TO SUIT LOCAL REGULATIONS, TYPICALLY 1000 mm, BUT NOT LESS THAN 600 mm.

WE RESERVE THE RIGHT THAT WITHOUT ANY NOTICE TO CHANGE THE DESIGN OF THE EQUIPMENT

All dimensions in mm.

| C | Backwash pump & piping shown in drawing | 081125 | MaHo | |
|---|---|---|---|---|
| B | 100 was 80 | 060713 | EmS | |
| Ed. | Change and/or message no. | Date | Made by | c-m no. |

| Part no. | Quantity | Name | Material | Mod.-nr Blank Dimension | Remark |
|---|---|---|---|---|---|
| Designer | Drawn by ADn | Copy | Controlled by | Stand. ISO 2768-m | Approved | Scale 1:25 | Replaces | Replaced by |

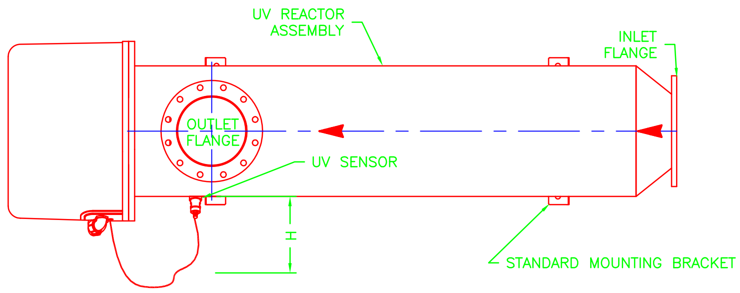
HYDROTECH

Measure drawing
(1607 drawn)
Drumfilter HDF1600-1H

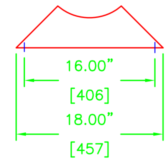
Date 050629

Draw. no. 3124 Edition C

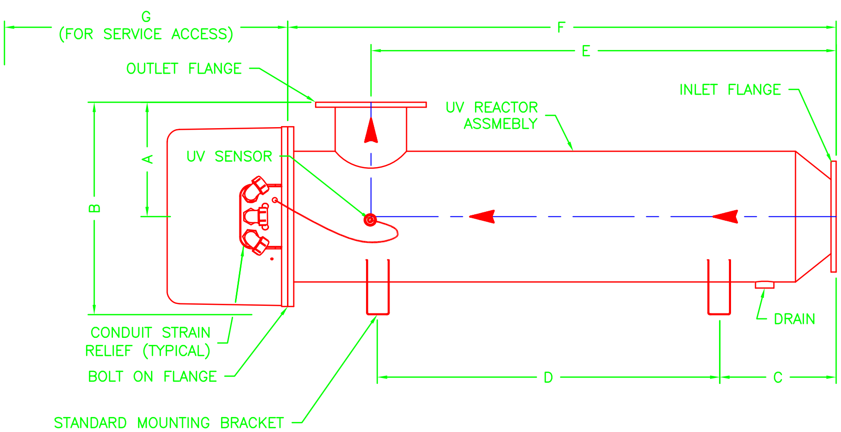
SHSRF - UV
Pre-Design Selection
10/19/15




TOP VIEW
SCALE: NOT TO SCALE




DETAIL A—A
SCALE: NOT TO SCALE (STANDARD MOUNTING BRACKETS)




FRONT VIEW
SCALE: NOT TO SCALE

**UVLOGIC GENERAL LAYOUT DIMENSIONS** (SEE CHART BELOW)

A: CHAMBER CENTRE-LINE (CENTRE OF INLET FLANGE) TO OUTLET FLANGE
B: BOTTOM OF MOUNTING FOOT TO OUTLET FLANGE
C: INLET FLANGE TO MOUNTING FOOT
D: CENTRE TO CENTRE OF MOUNTING FEET
E: INLET FLANGE TO CENTRE OF OUTLET FLANGE
F: OVERALL CHAMBER LENGTH WITH ENDPLATE/COVER REMOVED
G: MINIMUM SERVICE ACCESS FROM END OF CHAMBER FOR LAMP/SLEEVE MAINTENANCE
H: UV SENSOR PORT; MINIMUM SIDE ACCESS FOR MAINTENANCE

| MODELS | LAMP LENGTH | UV REACTOR ASSEMBLY DIAMETER | # LAMPS AVAILABLE | FLANGE TYPE | FLANGE SIZE | DIMENSION 'A' | DIMENSION 'B' | DIMENSION 'C' | DIMENSION 'D' | DIMENSION 'E' | DIMENSION 'F' | DIMENSION 'G' | DIMENSION 'H' | OPTIONAL WIPING SYSTEM AVAILABLE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12_L40<br>18_L40 | LONG | 16"<br>[406] | 12, 18 | ANSI/<br>DIN | 8"<br>[200] | 14.00"<br>[356] | 26.00"<br>[660] | 18.81"<br>[478] | 42.00"<br>[1067] | 60.00"<br>[1524] | 70.19"<br>[1783] | 70.00"<br>[1778] | 9"<br>[229] | AMWS |
| | | | | | 10" & 12" & 14"<br>[250, 300, 350] | 14.00"<br>[356] | 26.00"<br>[660] | 15.75"<br>[400] | 42.00"<br>[1067] | 57.00"<br>[1448] | 67.19"<br>[1707] | 70.00"<br>[1778] | 9"<br>[229] | AMWS |

NOTES:
: MAXIMUM OPERATING PRESSURE TO BE 150 psi [10 BAR].
: [ ] INDICATES MILLIMETERS UNLESS OTHERWISE SPECIFIED.
: CONNECTION SEALS AND HARDWARE TO BE SUPPLIED BY CUSTOMER.
: MOUNTING AND SAMPLING PORTS ARE TO BE SUPPLIED BY THE CUSTOMER.
: CLEARANCES FOR WIPING SYSTEMS FALL WITHIN CLEARANCES REQUIRED FOR SLEEVE REMOVAL.
: LAMP TYPES AVAILABLE: A — DISINFECTION
V — VALIDATED DISINFECTION
T — TOC REDUCTION LAMP

WIPING SYSTEM OPTIONS:
AMWS — AUTOMATIC MECHANICAL WIPING SYSTEM

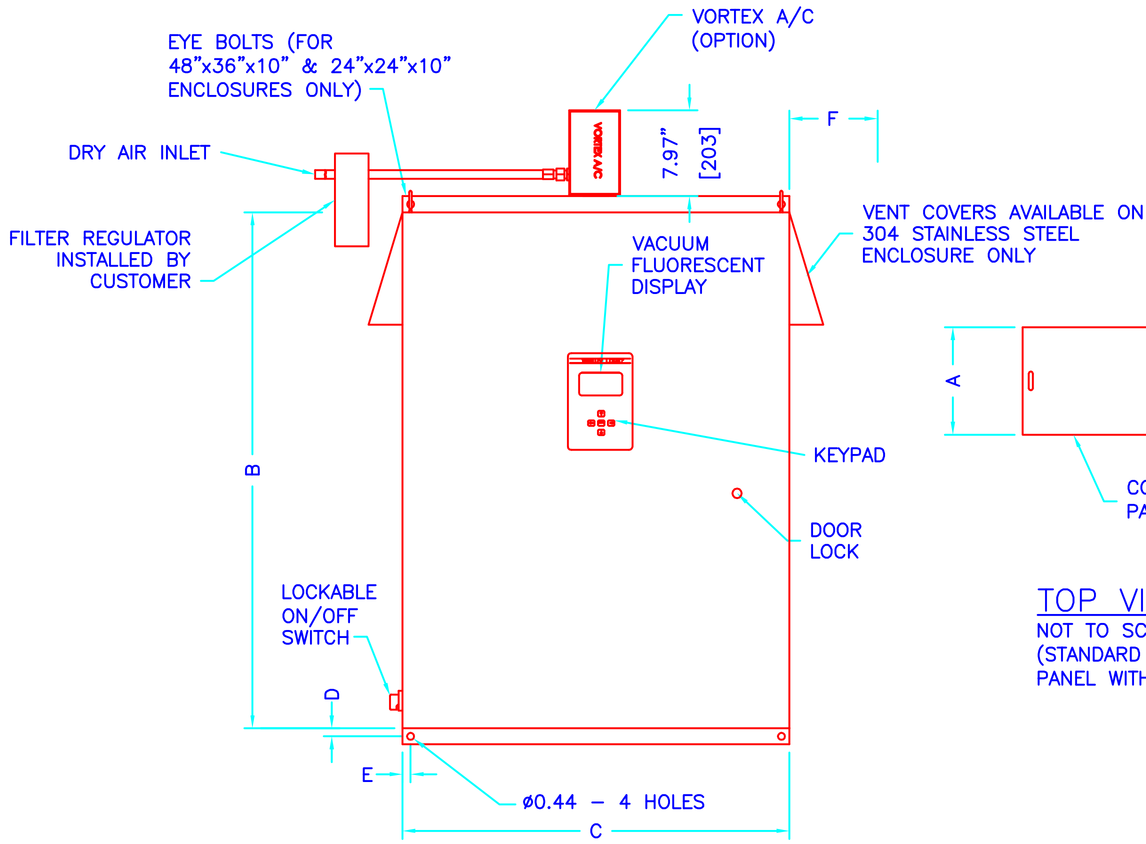
TROJANUV



| | | | |
|---|---|---|---|
| DESCRIPTION: STD, UVLOGIC AL40 SERIES | | STANDARD DRAWING NO. LG0037 | |
| DRAWN BY : DAC/JV | DATE : 2008—02—29 | REFERENCE NO. N/A | |
| CHECKED BY : RPC | DATE : 2008—02—29 | | |
| APPROVED BY : RPC | DATE : 2008—02—29 | DWG NO. D01 | REV. B2 |
| SCALE (8½x11) : NOT TO SCALE | LOG NUMBER : N/A | | |

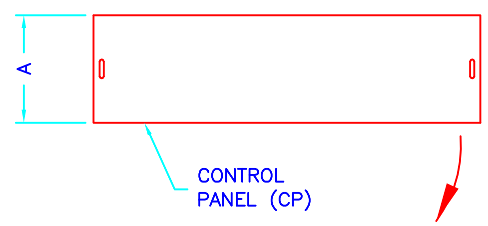
| REV. | DESCRIPTION | BY | DATE |
|---|---|---|---|
| | SEE SHEET 1 FOR REVISIONS | | |

## UL LOGIC PANELS




FRONT VIEW OF CP

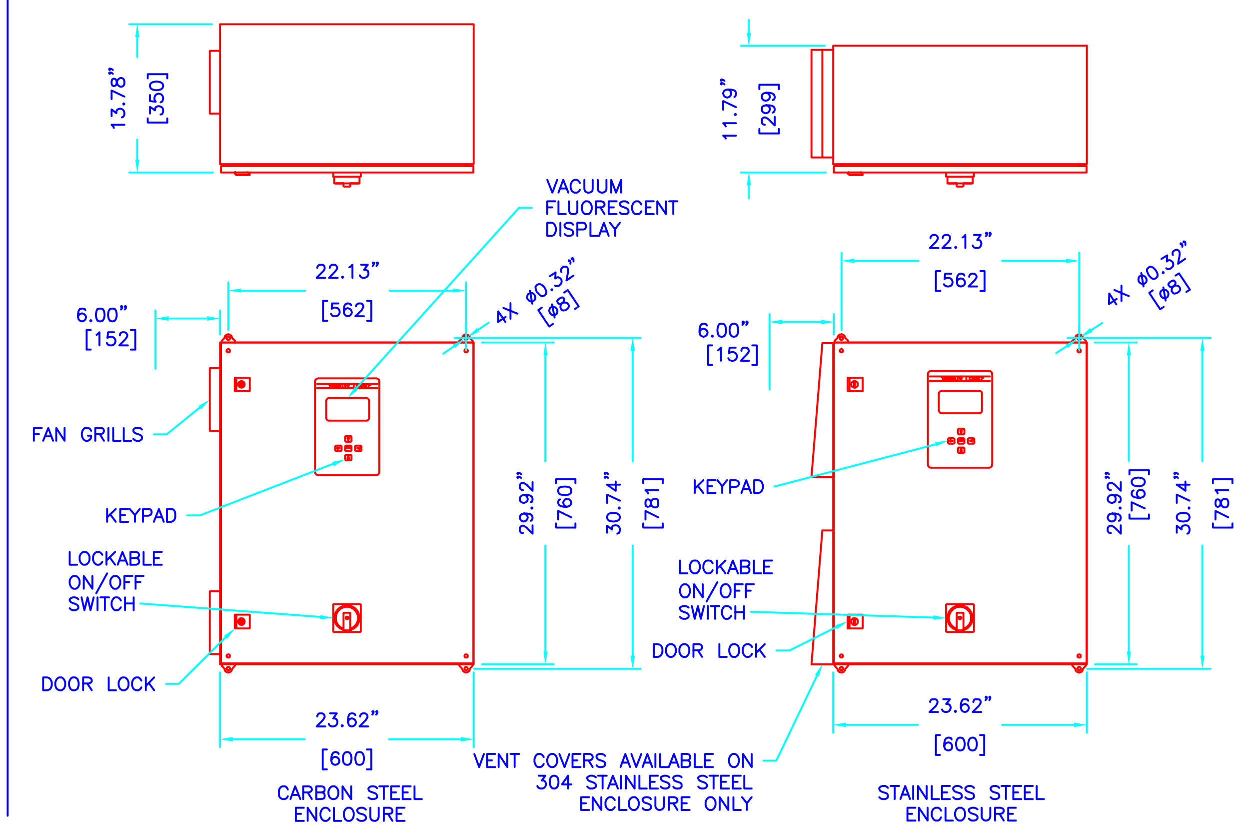
NOT TO SCALE (SHOWN WITH STAINLESS STEEL VENT COVERS)

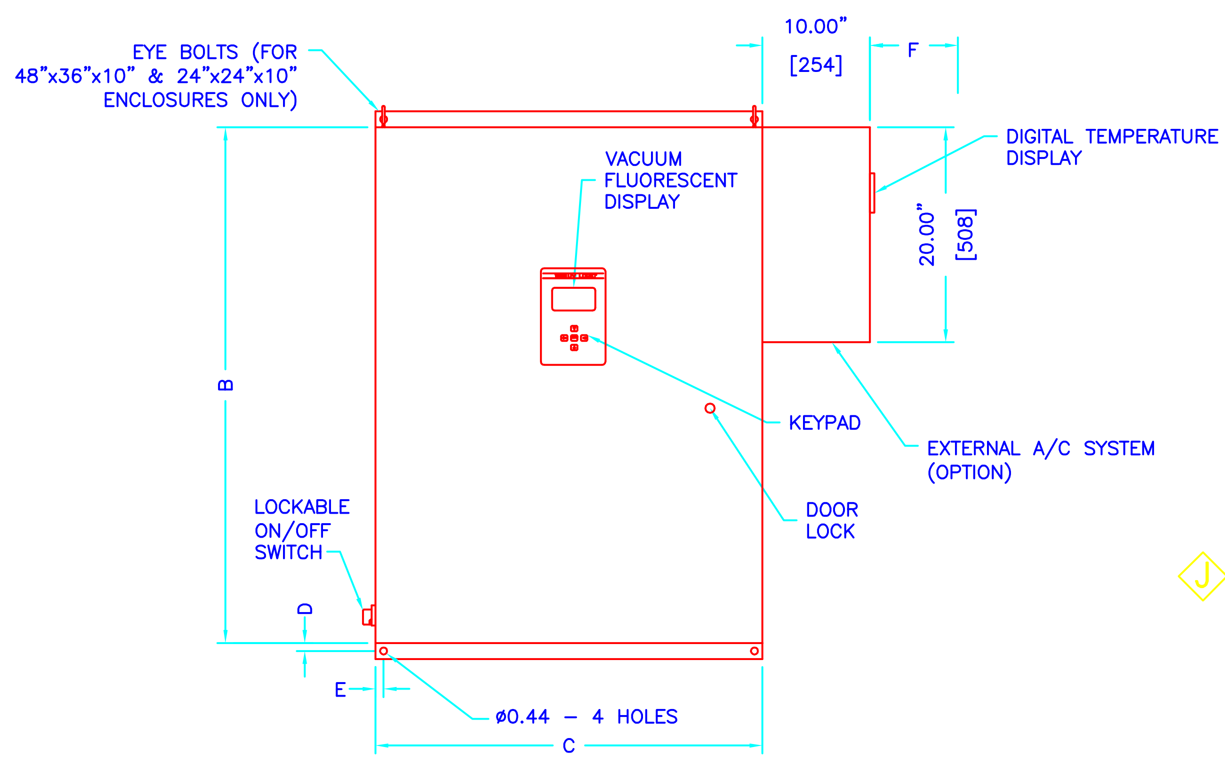



TOP VIEW OF CP

NOT TO SCALE (STANDARD CARBON STEEL PANEL WITH NO VENT COVERS)

## CE 2–12 LAMP LOGIC PANELS




FRONT VIEW OF CP W/EXTERNAL A/C MOUNTED

NOT TO SCALE

**AMALGAM UV UNITS GENERAL LAYOUT DIMENSIONS** (SEE CHART BELOW)

A: PANEL DEPTH
B: PANEL HEIGHT
C: PANEL WIDTH
D: VERTICAL DIMENSION FROM THE CORNER OF PANEL TO CENTER OF MOUNTING HOLE (TYPICAL OF 4)
E: HORIZONTAL DIMENSION FROM THE CORNER OF PANEL TO CENTER OF MOUNTING HOLE (TYPICAL OF 4)
F: REQUIRED CLEARANCE FOR VENTING

| MODELS | PANEL TYPE | DIMENSION 'A' | DIMENSION 'B' | DIMENSION 'C' | DIMENSION 'D' | DIMENSION 'E' | DIMENSION 'F' |
|---|---|---|---|---|---|---|---|
| 02AS20, 03AS20, 04AS20 06AS20, 03AL20, 04AL20 06AL20, 06AL30 | LOGIC | 10.00" [254] | 24.00" [610] | 24.00" [610] | 0.75" [19] | 0.75" [19] | 6.00" [152] |
| 08AS20, 08AL20 08AL30, 12AL30 12AS40 | | 10.00" [254] | 24.00" [610] | 30.00" [762] | 0.75" [19] | 0.75" [19] | 6.00" [152] |
| 18AS40, 18AL50 24AL50, 30AL50, 18AL40 | | 10.00" [254] | 48.00" [1220] | 36.00" [915] | 0.75" [19] | 0.75" [19] | 6.00" [152] |

NOTES:

: INTERCONNECTING CABLE LENGTH TO BE 15ft [5m].
: [ ] INDICATES MILLIMETERS UNLESS OTHERWISE SPECIFIED.
: CONNECTION HARDWARE TO BE SUPPLIED BY CUSTOMER.

| ITEM | QTY. | DRAWING NO. | DESCRIPTION |
|---|---|---|---|

DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED DO NOT SCALE DWG.

TOLERANCES UNLESS OTHERWISE SPECIFIED

| FRACTIONS | DECIMALS | ANGLES |
|---|---|---|
| ± 1/32 | .XX ± .03 .XXX ± .015 | ± .1° |

REFERENCE

| | | |
|---|---|---|
| DRAWN BY B. WICKS | DATE 4/12/06 | |
| CHECK | DATE | |
| ENG. | DATE | |
| APPROVED | DATE | |
| SCALE 1/12 | SHT 5 OF 5 | |

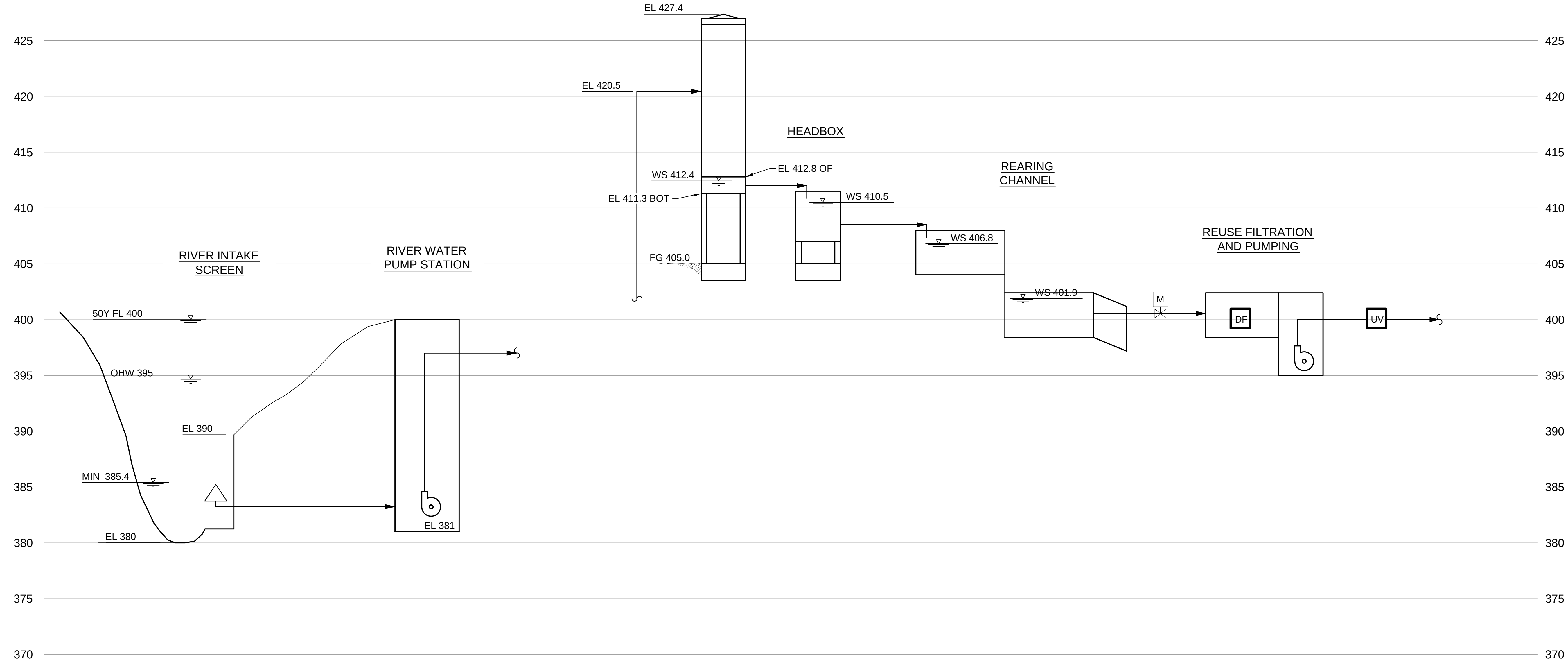
Aquafine Corporation
29010 AVENUE PAINE
VALENCIA, CA. 91355-4198 U.S.A.

TITLE: UV LOGIC UNITS GENERIC PANEL LAYOUT

DWG. NO. 42893 REV. J

Basis of Design Report

# Appendix C. Drawings




## LEGEND

| | |
|---|---|
| UV | UV UNIT |
| DF | DRUM FILTER |
| | PRESSURE REDUCING VALVE |
| M | PROPOSED MOTORIZED VALVE |
| M | EXISTING MOTORIZED VALVE |
| — — — | BUILDING OUTLINE |

## PIPE DESIGNATIONS

| | |
|---|---|
| CWE | CLEANING WASTE EFFLUENT TO GRAVEL BAR |
| OFD | OVERFLOW DRAIN TO RIVER |
| RU | RE-USE (UV & FILTER) |
| RW | RIVER WATER SUPPLY |
| RWT | RIVER WATER TREATED (UV & FILTER) |


TETRA TECH
www.tetratech.com
15350 SW Sequoia Pkwy, Ste 220
Portland, OR 97224
Tel 503.684.9097


PRE-DESIGN
OCTOBER 2015

| MARK | DATE | DESCRIPTION | BY |
|---|---|---|---|

MONTEREY PENINSULA WATER MANAGEMENT DISTRICT
SLEEPY HOLLOW STEELHEAD REARING FACILITY

RAW WATER INTAKE AND
WATER SUPPLY STSTEM UPGRADE

# HYDRAULIC PROFILE

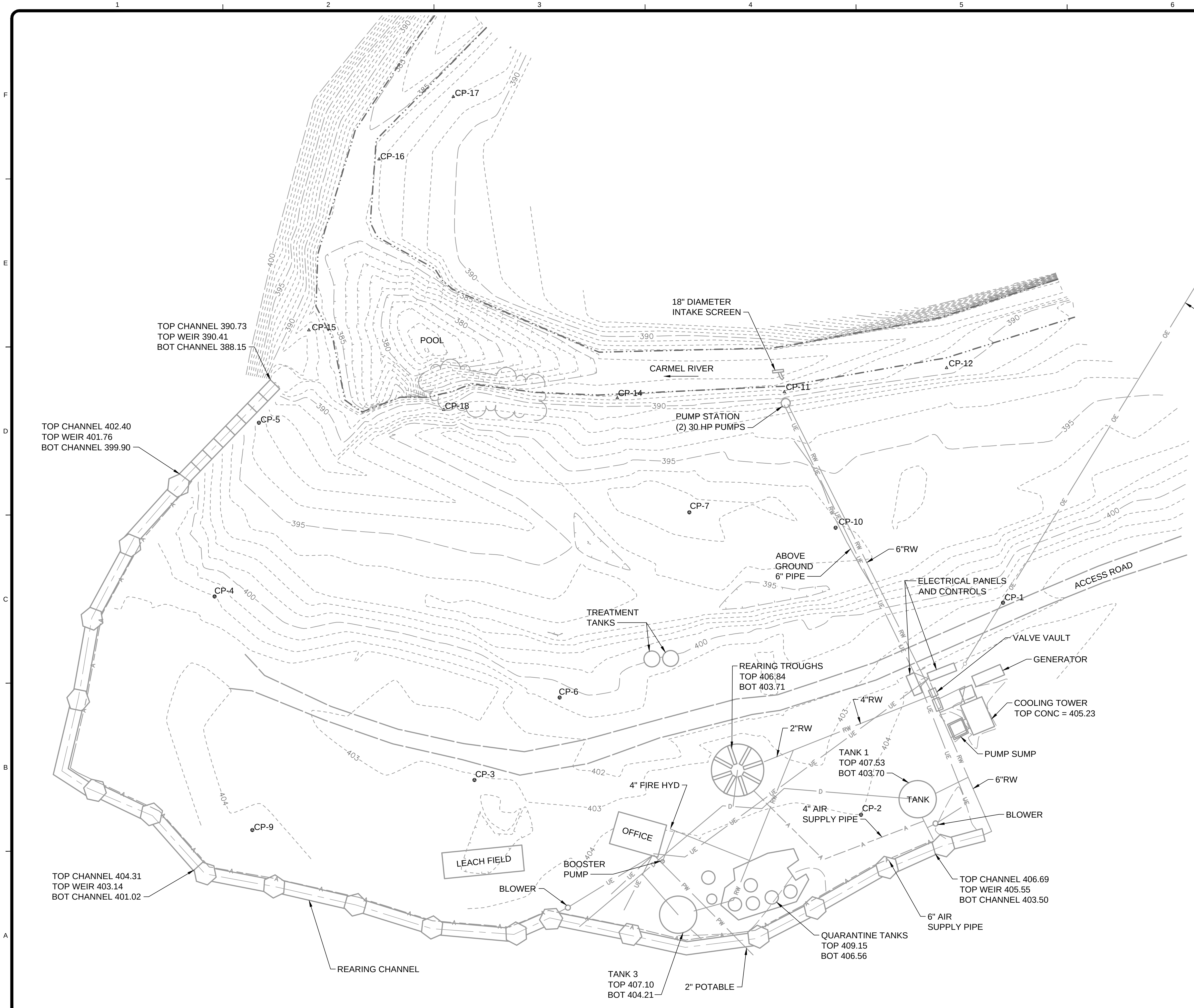
| | |
|---|---|
| Project No.: | 135-124674-15001 |
| Designed By: | DJN |
| Drawn By: | EGN |
| Checked By: | |

C-001



Bar Measures 1 inch

10/19/2015 8:10:54 AM - P:\124674\135-124674-15001\CAD\SHEETFILES\C-001 HYDRAULIC PROFILE.DWG - NORDHOLM, ERIK




N

0 15' 30' 60'

CONTROL POINT TABLE

| Point # | Northing | Easting | Elevation | Description |
|---|---|---|---|---|
| 1 | 2056057.47 | 5763271.68 | 402.55 | CP |
| 2 | 2055928.19 | 5763185.20 | 404.02 | CP |
| 3 | 2055949.34 | 5762949.72 | 403.17 | CP |
| 4 | 2056061.23 | 5762791.37 | 402.11 | |
| 5 | 2056167.13 | 5762818.43 | 393.67 | CP |
| 6 | 2055999.65 | 5763001.56 | 401.99 | WSE BM |
| 7 | 2056112.51 | 5763080.59 | 397.74 | CP |
| 9 | 2055918.82 | 5762814.39 | 404.20 | |
| 10 | 2056103.06 | 5763169.70 | 396.13 | FND CP SH02 |
| 11 | 2056185.88 | 5763138.53 | 388.18 | HUB |
| 12 | 2056200.60 | 5763237.33 | 390.05 | HUB |
| 14 | 2056182.24 | 5763036.77 | 387.45 | HUB |
| 15 | 2056223.59 | 5762848.92 | 388.78 | HUB |
| 16 | 2056327.72 | 5762891.69 | 386.89 | HUB |
| 17 | 2056365.82 | 5762936.84 | 387.99 | HUB |
| 18 | 2056175.14 | 5762931.11 | 390.93 | HUB |

ELEVATIONS NGVD 29


TETRA TECH
www.tetratech.com
15350 SW Sequoia Pkwy, Ste 220
Portland, OR 97224
Tel 503.684.9097


PRE-DESIGN
OCTOBER 2015

| MARK | DATE | DESCRIPTION | BY |
|---|---|---|---|

MONTEREY PENINSULA WATER MANAGEMENT DISTRICT
SLEEPY HOLLOW STEELHEAD REARING FACILITY
RAW WATER INTAKE AND
WATER SUPPLY STSTEM UPGRADE

# EXISTING SITE PLAN

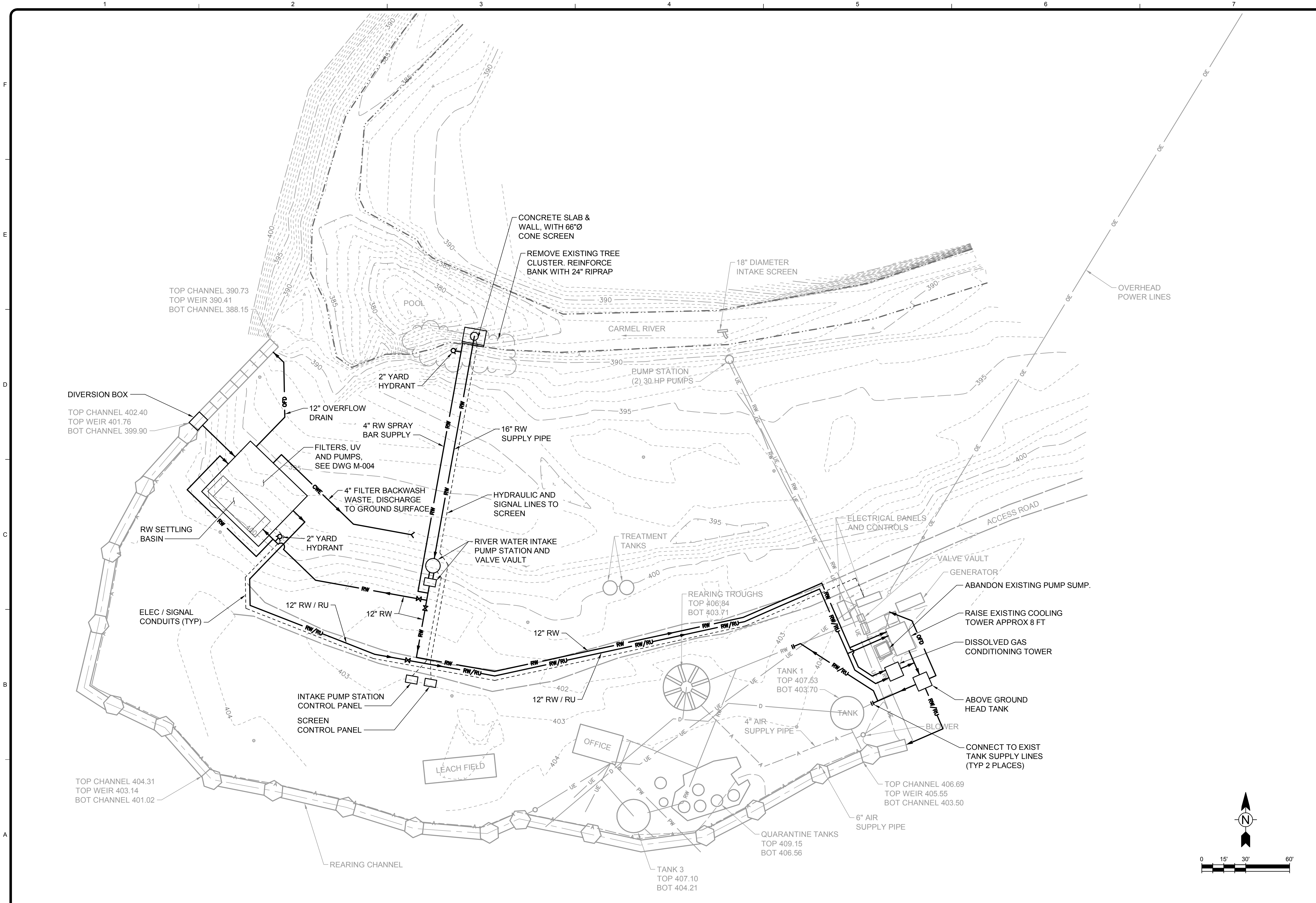
Project No.: 135-124674-15001
Designed By: DJN
Drawn By: EGN
Checked By:

C100



Bar Measures 1 inch

10/19/2015 8:13:04 AM - P:\124674\135-124674-15001\CAD\SHEETFILES\C-100 EXISTING SITE PLAN.DWG - NORDHOLM, ERIK




TETRA TECH
www.tetratech.com
15350 SW Sequoia Pkwy, Ste 220
Portland, OR 97224
Tel 503.684.9097

PRE-DESIGN
OCTOBER 2015

| MARK | DATE | DESCRIPTION | BY |
|---|---|---|---|

MONTEREY PENINSULA WATER MANAGEMENT DISTRICT
SLEEPY HOLLOW STEELHEAD REARING FACILITY

RAW WATER INTAKE AND
WATER SUPPLY STSTEM UPGRADE

# PROPOSED SITE PLAN

| | |
|---|---|
| Project No.: | 135-124674-15001 |
| Designed By: | DJN |
| Drawn By: | EGN |
| Checked By: | |

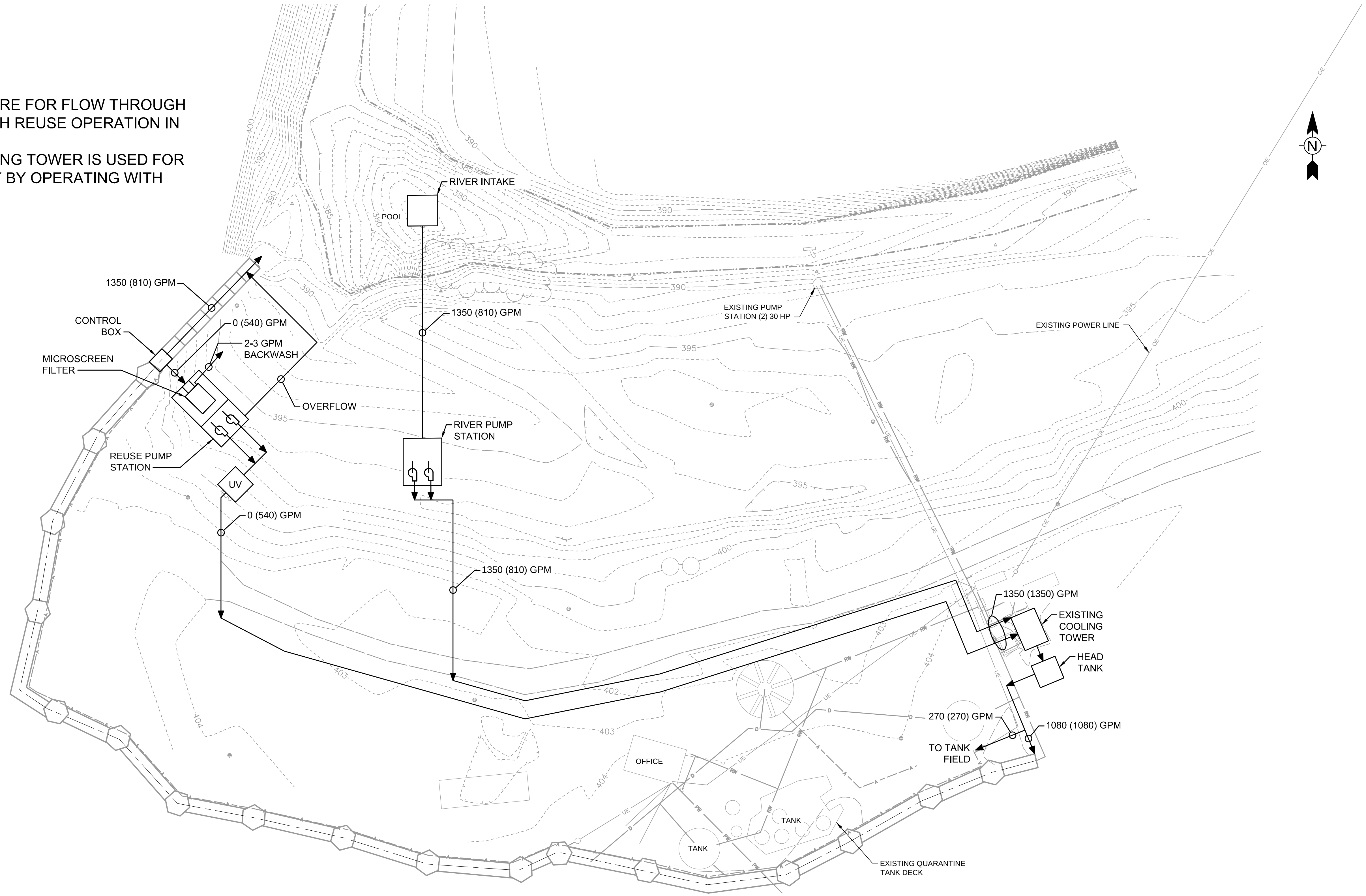
C-101



Bar Measures 1 inch

10/16/2015 5:41:41 PM - P:\124674\135-124674-15001\CAD\SHEETFILES\C-101 PROPOSED SITE PLAN.DWG - NORDHOLM, ERIK

NOTES:
1. FLOW VALUES ARE FOR FLOW THROUGH OPERATION WITH REUSE OPERATION IN PARENTHESES
2. EXISTING COOLING TOWER IS USED FOR AERATION ONLY BY OPERATING WITH THE FAN OFF.




TETRA TECH
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15350 SW Sequoia Pkwy, Ste 220
Portland, OR 97224
Tel 503.684.9097

PRE-DESIGN
OCTOBER 2015

| MARK | DATE | DESCRIPTION | BY |
|---|---|---|---|
| | | | |

MONTEREY PENINSULA WATER MANAGEMENT DISTRICT
SLEEPY HOLLOW STEELHEAD REARING FACILITY
RAW WATER INTAKE AND WATER SUPPLY SYSTEM UPGRADE

# PROCESS FLOW DIAGRAM OPTION #1

| | |
|---|---|
| Project No.: | 135-124674-15001 |
| Designed By: | BJV |
| Drawn By: | KLS |
| Checked By: | BJV |

M-001

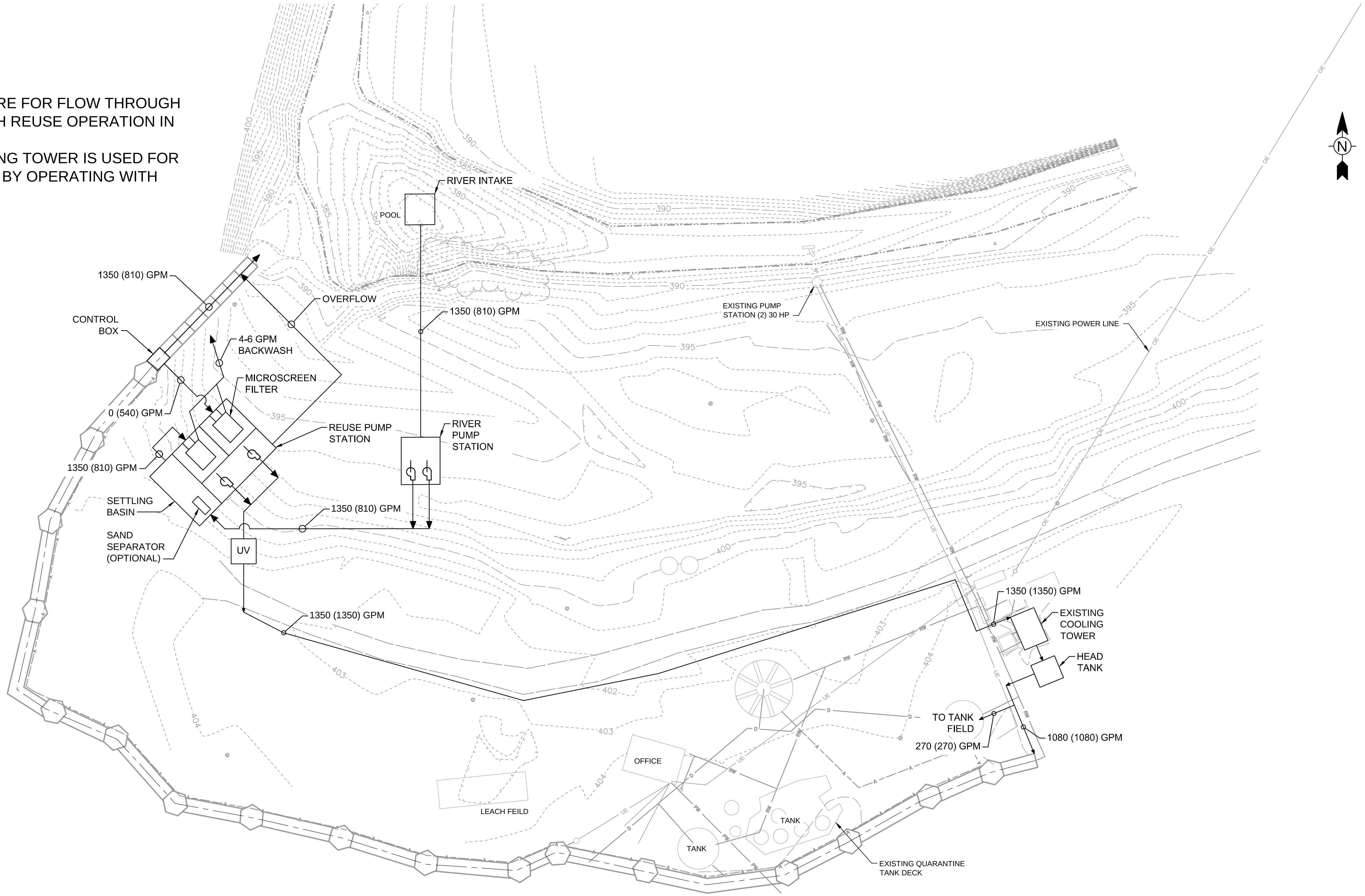


Bar Measures 1 inch

10/19/2015 7:51:53 AM - P:\124674\135-124674-15001\CAD\SHEETFILES\M-001-PROCESSFLOW_OPTION1.DWG - NORDHOLM, ERIK

NOTES:

1. FLOW VALUES ARE FOR FLOW THROUGH OPERATION WITH REUSE OPERATION IN PARENTHESES
2. EXISTING COOLING TOWER IS USED FOR AERATION ONLY BY OPERATING WITH THE FAN OFF.




0 15' 30' 60'
SCALE: 1" = 30'

TETRA TECH

www.tetratech.com
15350 SW Sequoia Pkwy, Ste 220
Portland, OR 97224
Tel 503.684.9097

PRE-DESIGN
OCTOBER 2015

| MARK | DATE | DESCRIPTION | BY |
| --- | --- | --- | --- |

MONTEREY PENINSULA WATER MANAGEMENT DISTRICT
SLEEPY HOLLOW STEELHEAD REARING FACILITY
RAW WATER INTAKE AND
WATER SUPPLY STSTEM UPGRADE

# PROCESS FLOW DIAGRAM
## OPTION #2

| | |
| --- | --- |
| Project No.: | 135-124674-15001 |
| Designed By: | BJV |
| Drawn By: | KLS |
| Checked By: | BJV |

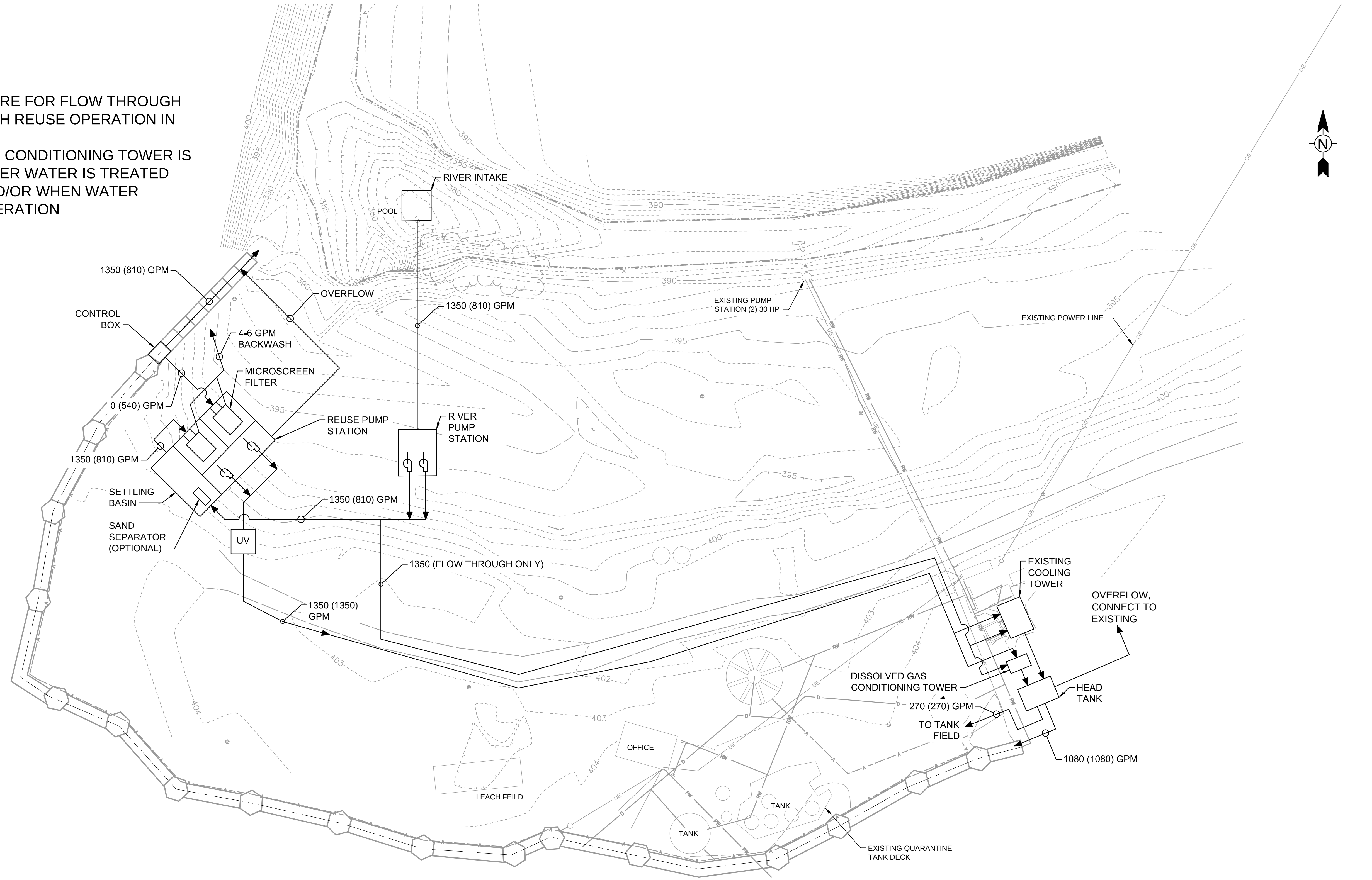
M-002



Bar Measures 1 inch

NOTES:

1. FLOW VALUES ARE FOR FLOW THROUGH OPERATION WITH REUSE OPERATION IN PARENTHESES
2. DISSOLVED GAS CONDITIONING TOWER IS USED WHEN RIVER WATER IS TREATED FOR SOLIDS AND/OR WHEN WATER REUSE IS IN OPERATION




TETRA TECH

www.tetratech.com
15350 SW Sequoia Pkwy, Ste 220
Portland, OR 97224
Tel 503.684.9097

PRE-DESIGN
OCTOBER 2015

| MARK | DATE | DESCRIPTION | BY |
|---|---|---|---|

MONTEREY PENINSULA WATER MANAGEMENT DISTRICT
SLEEPY HOLLOW STEELHEAD REARING FACILITY

RAW WATER INTAKE AND WATER SUPPLY SYSTEM UPGRADE

# PROCESS FLOW DIAGRAM OPTION #3

| | |
|---|---|
| Project No.: | 135-124674-15001 |
| Designed By: | BJV |
| Drawn By: | KLS |
| Checked By: | BJV |

M-003



Bar Measures 1 inch

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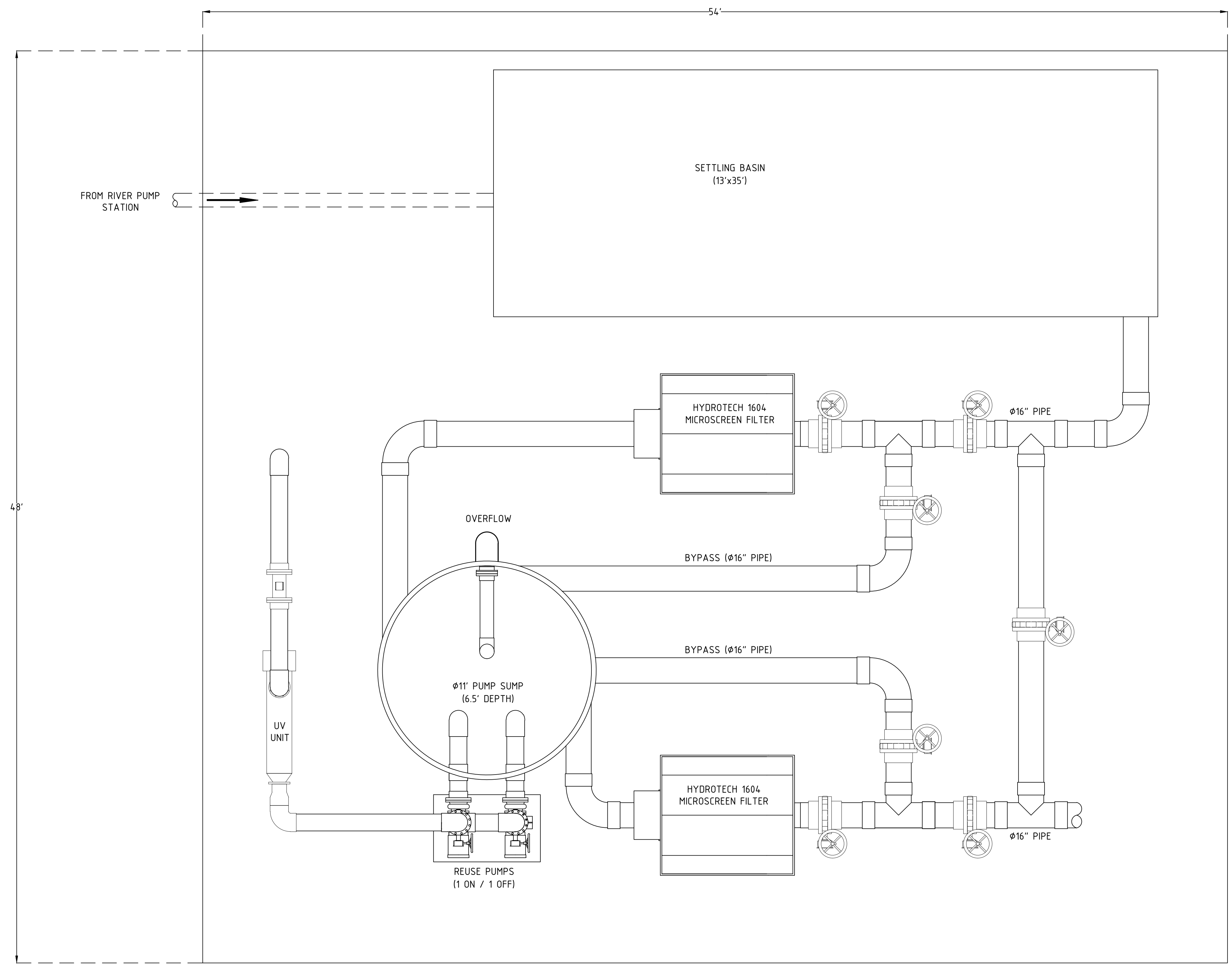



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MONTEREY PENINSULA WATER MANAGEMENT DISTRICT
SLEEPY HOLLOW STEELHEAD REARING FACILITY

RAW WATER INTAKE AND
WATER SUPPLY STSTEM UPGRADE

# PRELIMINARY EQUIPMENT LAYOUT

| | |
|---|---|
| Project No.: | 135-124674-15001 |
| Designed By: | BJV |
| Drawn By: | KLS |
| Checked By: | BJV |

M-004



Bar Measures 1 inch

10/19/2015 8:02:56 AM - P:\124674\135-124674-15001\CAD\SHEETFILES\M-004-REUSEEQUIPMENTLAYOUT.DWG - NORDHOLM, ERIK