# Technical Memorandum

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| **To:** | Franklin County Industrial Development Corporation | **From:** | Brian Cote, Jessica Louisos, and Thomas Knowlton |
| **cc:** | Perrigo Nutritionals | **SLR International Corporation** | |
| **cc:** | Northwest Regional Planning Commission | **Date:** | December 17, 2025 |
| | | **Project No.** | 146.V20103.00001 |

**RE: Arrowhead Lake Water Intake Conceptual Design Alternatives**

## 1.0 Introduction

Arrowhead Lake (also known as Arrowhead Mountain Lake) is located along the Lamoille River in the towns of Georgia and Milton, Vermont. The lake consists of the impoundment created by the Clark Falls Dam located in Milton, and extends approximately 4 miles upstream to a section of rapids just above the Arrowhead Road Bridge in East Georgia. The Georgia Regional Industrial Park located nearby draws water from Arrowhead Lake at an intake located near the upstream end of the impoundment, and pumps to a water treatment plant located within the industrial park (Figure 1). The water treatment plant is owned and operated by the Georgia Industrial Development Corporation (GIDC), however the water intake and pump house is owned and operated by Perrigo Nutritionals, which is one of the industries located within the industrial park.

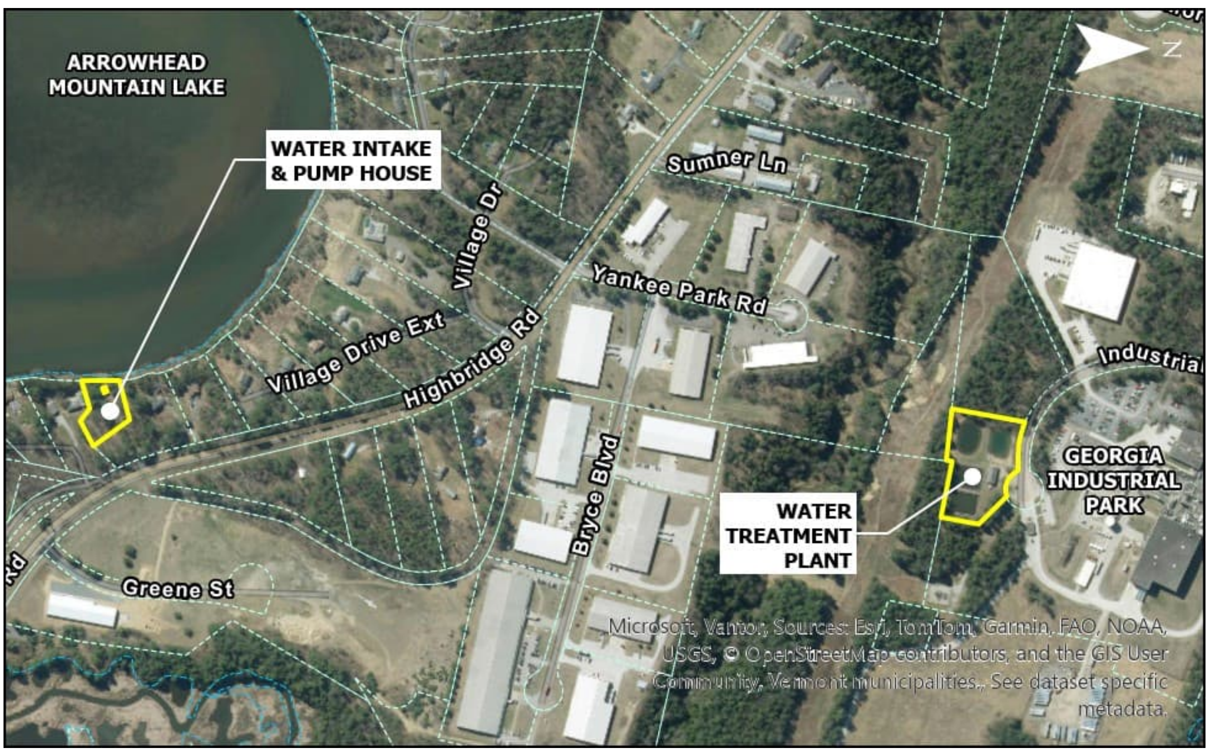


**Figure 1 Water Intake and Treatment Plant Location Map**

## 1.1 Water Intake

The existing 12-inch diameter water intake extends approximately 30 feet from the shoreline of Arrowhead Lake and is located in an area that is 4 to 5 feet deep. The intake is fitted with a stainless-steel intake screen that is positioned approximately 2.5 feet off the bottom of the lake. The water level in the lake is controlled by the dam downstream and therefore has the potential to fluctuate during portions of the year depending on the needs at the hydroelectric facility.

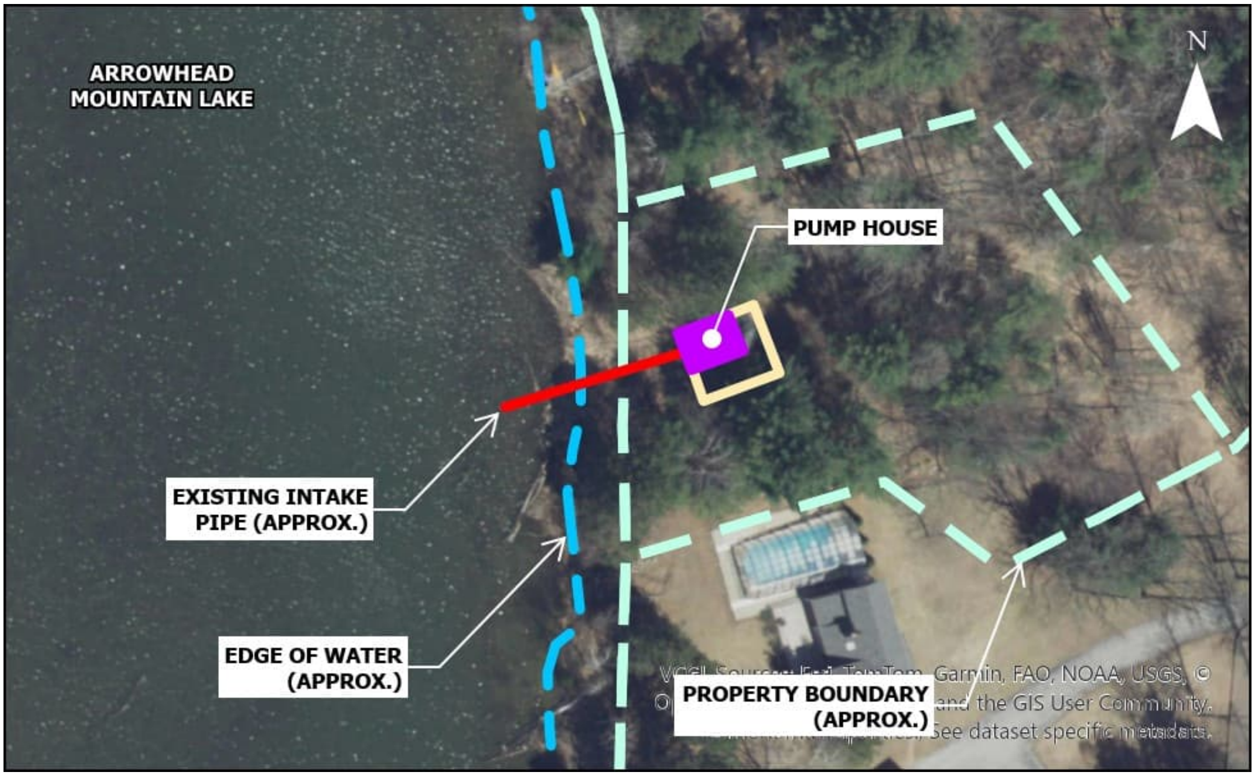


**Figure 2 Existing Water Intake and Pump House**

Water is drawn into the pump house through the intake pipe and pumped to the water treatment pipe using two 480-gallon-per-minute pumps. Only one pump is operated at a time with the second pump serving as a backup.

Issues at the water intake are largely due to turbidity in the water, including both sediment being carried into Arrowhead Lake by the Lamoille River and a layer of “fluff” or fine suspended sediment that sits at the bottom of the lake. During spring snow melt periods and after rainfall events, sediment being carried into Arrowhead Lake increases. The layer of soft suspended sediment at the bottom of the lake was observed to be approximately 12 to 18 inches thick.

Additionally, heavy vegetative growth exists in shallow portions of the lake, including floating and suspended algae. During field reconnaissance, large lobes of floating algae (Figure 3) were observed suspended in the water column in shallow areas of the lake and near the existing intake.

**Figure 3 Floating Algae (Outlined) Observed during Field Reconnaissance**

The sediment impacts the quality of the water being drawn into the system and therefore impacts the level of treatment required at the plant. The intake is also impacted by aquatic growth that accumulates and partially clogs the intake screen, requiring annual inspection and maintenance.

## 1.2 Water Treatment Plant

The water treatment plant is capable of producing up to 500,000 gallons of potable water per day; however, demand typically averages 150,000 to 200,000 gallons per day. The plant serves the facilities within the industrial park as well as the Town of Georgia’s wastewater treatment plant. Perrigo Nutritionals has the largest demand for potable water, typically using approximately 95% to 98% of the water produced per day.

Water pumped from Arrowhead Lake enters the treatment plant at the first of three settling lagoons used as primary treatment. The water then enters the treatment plant where secondary and tertiary treatment takes place, including treatment by three sand filters.

Operation of the treatment plant changes as turbidity entering the first lagoon increases. When turbidity reaches an elevated level, usually around 20 NTU, pumping is suspended and the plant will operate using the water stored in the lagoons for as long as possible until turbidity levels decrease. If the high turbidity persists longer than the supply of stored water, pumping is resumed; however, adjustments to the plant's operations are made to account for the increased turbidity that increases operating costs. Additionally, the plant needs to operate over a longer period of time to compensate for the increase in turbidity to treat the same amount of water.

# 2.0 Data Collection

Data collection began with a visit and tour of the water treatment plant, water intake, and pump house that took place on October 22, 2025. Information about the treatment plant's capabilities and issues related to water quality were shared with SLR. In addition, relevant information such as inspection reports and turbidity monitoring data were provided by the plant operators.

A field reconnaissance site visit was conducted on November 20, 2025 at the water intake. GPS survey and measurements were taken during the site visit, as well as measurements of water depth near the water intake location (Figure 4). Depth measurements revealed that deeper channel sections exist in some locations along the bottom of the lake – one approximately 70 to 90 feet from the shoreline and a second approximately 340 to 370 feet from the shoreline.

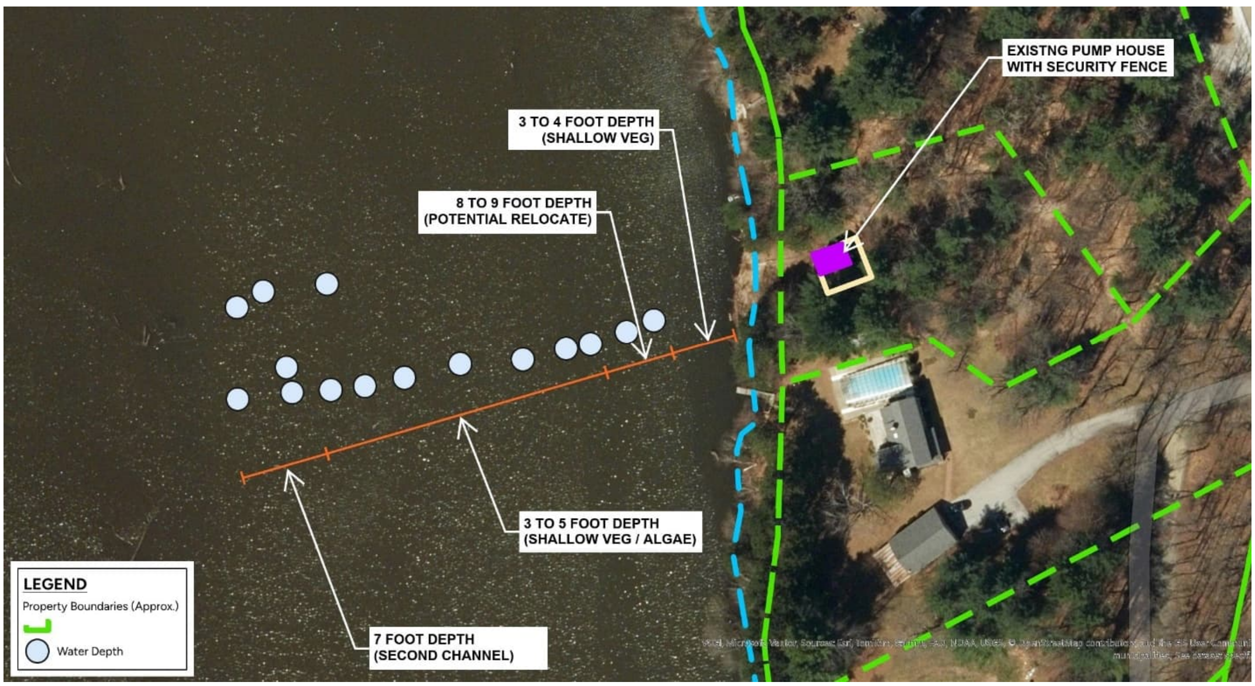


**Figure 4 Water Depth Measurements at the Water Intake**

While shallow areas were heavily vegetated and contained large amounts of floating algae, the deeper channel sections were found to contain less vegetation. The deeper channel areas may experience slightly higher flow velocities and current that helps to keep the channel areas clear.

# 3.0 Conceptual Alternatives

Based on the initial understanding of the water intake, the water treatment plant operations, and data and information collected to date, several alternatives have been developed to address issues with sediment at the water intake and turbidity entering the water treatment plant. The following subsections describe each alternative conceptually, provides primary advantages and disadvantages, and also provides a cost range for implementation of the alternative based on this initial understanding of the site. Given that there is limited design at this stage of the project, the project cost ranges are considered approximate and provided for comparative purposes.

## 3.1 Alternative 1 – Maintain Current Operations - “Do Nothing”

Under Alternative 1, the operation of the water treatment system would remain unchanged and continue as they currently do today. The current operations at the water intake and water treatment plant would continue, and procedures in place when incoming turbidity levels increase would remain.

### 3.1.1 Advantages

The primary advantage would be that there is no change in operating costs or maintenance requirements, as well as no capital expenditure to implement a new system or modification to the existing system.

### 3.1.2 Disadvantages

The drawback is that the issues that need to be addressed when elevated sediment and turbidity levels occur periodically would not change or improve. The buildup of heavy aquatic growth on the intake screen (Figure 5) would continue, requiring annual maintenance and inspections. The potential for a reduction in performance, capacity, and pumping efficiency, as annual buildup on the intake screen progresses, will also remain between maintenance intervals. Additionally, the potential to be in violation of treatment standards that need to be met in order to be in regulatory compliance, as has happened in the past during floods, would remain, since incoming water that has higher turbidity levels is more difficult to treat.

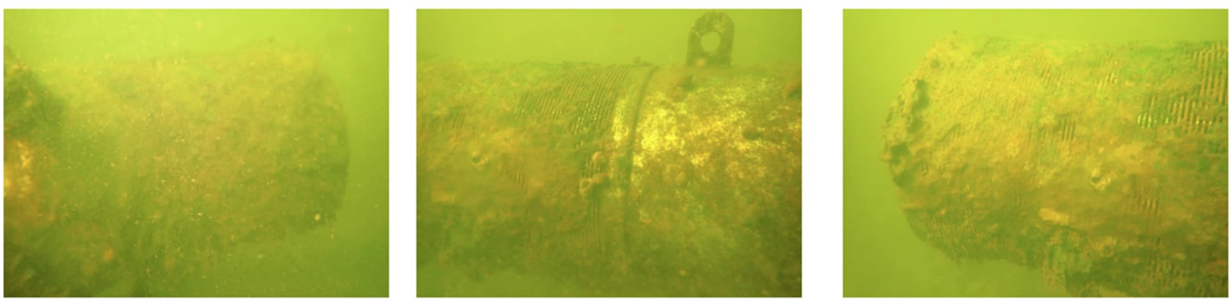

**Figure 5 Partially Clogged Intake Screen with Aquatic Growth (Source: August 2025 Inspection Report prepared by Aqueous Infrastructure Management Co.)**

### 3.1.3 Conceptual Cost Opinion – Alternative 1

The “Do Nothing” alternative does not require capital expenditure to implement. Current annual inspection and maintenance costs, as well as costs associated with additional treatment when turbidity levels increase would continue under Alternative 1.

## 3.2 Alternative 2 – Water Intake Pipe Extension

Alternative 2 consists of extending the existing water intake pipe further into Arrowhead Lake to position the intake in deeper water. The approach would be to add approximately 40 to 50 feet of pipe to the existing intake to reach a channel that is 8 to 9 feet deep (Figure 6). The existing intake is currently located approximately 30 feet from the shoreline in approximately 5 feet of water, and reportedly only about 2.5-feet off the bottom of the lake. A layer of fine, almost suspended sediment was observed during field reconnaissance where water depths were 3 feet or less, as well as the clumps of floating algae and aquatic vegetation. With the intake pipe extending into deeper water, several pipe supports would be required under the intake pipe.

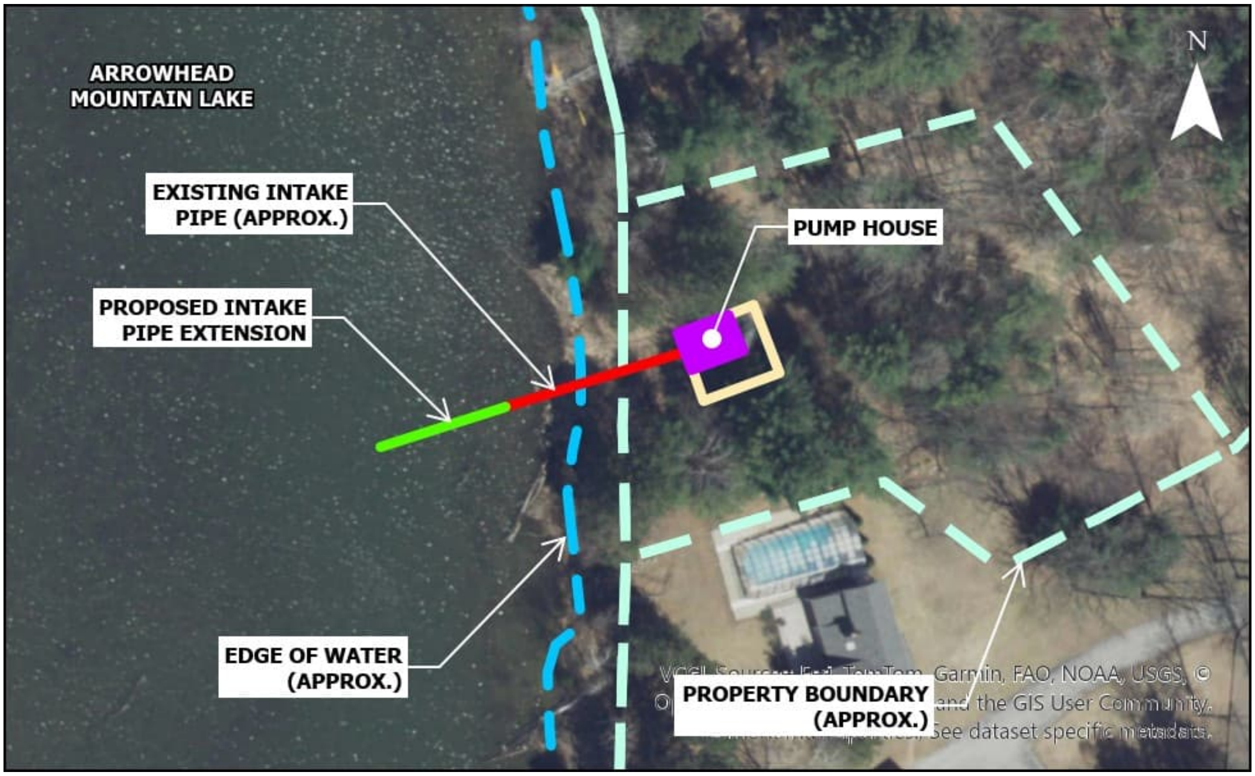


**Figure 6 Conceptual Design – Alternative 2**

In deeper water, the intake screen would sit further off the lake bottom and higher in the water column. During field reconnaissance the deeper channel areas of the lake were observed to be clearer with less aquatic vegetation and algae, indicating that there may be current that helps maintain the depth and clarity.

### 3.2.1 Advantages

The primary advantage of Alternative 2 is that water would be drawn into the intake pipe from a deeper channel within the lake and therefore less susceptible to impacts from suspended sediment, aquatic vegetation, and algae that accumulates along the lake bottom in shallow areas. Since the intake screen would be located higher in the water column, the growth of aquatic vegetation on the screen may also be reduced, therefore requiring less frequent maintenance and inspections.

### 3.2.2 Disadvantages

The primary disadvantage of Alternative 2 is that it would require capital expenditure to implement. In addition, Alternative 2 would likely require modification to existing regulatory permitting since implementation would relocate the intake. This alternative would incur soft costs as well such as engineering design and permitting. The safety of the public that uses

Arrowhead Lake for recreation would also need to be considered, since the intake would be located further from shore and in deeper water, potentially requiring special provisions to indicate the location of the intake. Although the intake would be located in deeper water, the need for inspection and periodic maintenance would not be fully eliminated; however, inspections should be required less frequently than now. Additional data such as flow velocity, turbidity, and depth would be required during design.

### 3.2.3 Conceptual Cost Opinion – Alternative 2

A conceptual opinion of probable project costs has been prepared for Alternative 2. Soft costs as well as a contingency have been included as a percentage of the construction costs. Costs for annual inspection and maintenance have not been included.

The conceptual project cost is expected to range between $175,000 to $225,000 to implement Alternative 2.

## 3.3 Alternative 3 – Self Cleaning Intake Screen

Under Alternative 3, the existing intake pipe would be retrofitted with a device that uses a backwash system that keeps the intake screen clear of debris. The device, such as the LAKOS Self-Cleaning Intake Screen product, protects the intake screen from the buildup of algae, leaves, moss, sticks, and other organics and debris. The device works by drawing water from the intake pipe and pumping it back to the intake through a small diameter pipe. The device is rotated by the backwash flow to blow the debris and build up away from the screen (Figure 7). In the case of the LAKOS device, the screen is rotated through the energy of the backwash flow only, and there are no gears or other mechanical parts.

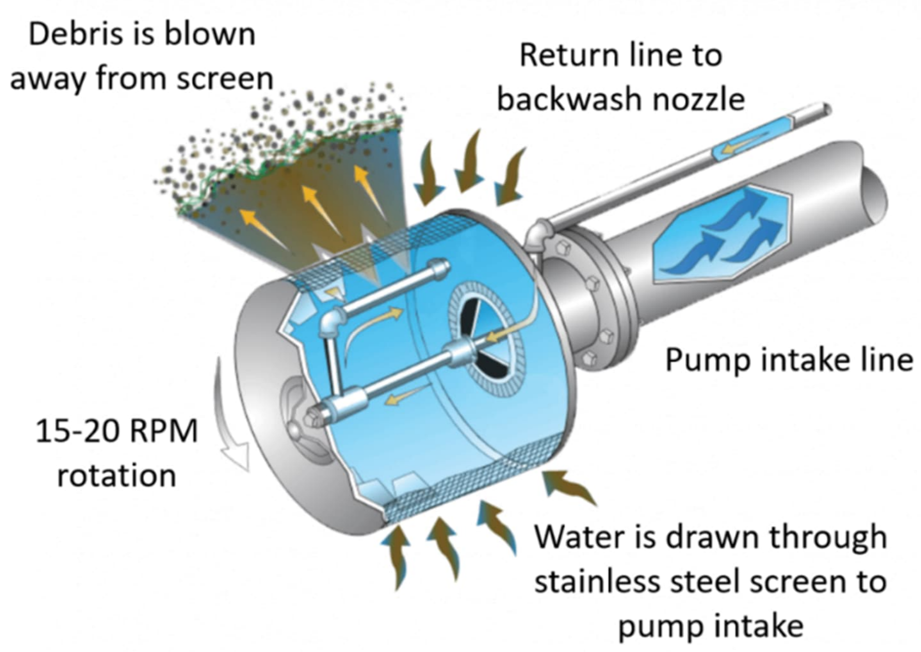


**Figure 7 Self-Cleaning Intake Screen Schematic (Source: LAKOS Filtration Solutions)**

The backwash flow is sourced by tapping into the intake pipe in the pump house (Figure 8). A booster pump is installed inside the pump house to pump the required flow of backwash water through the return line back to the intake screen that rotates the device. The backwash flow hydraulically operates the screen and debris is blown away from the screen to maintain clean conditions.

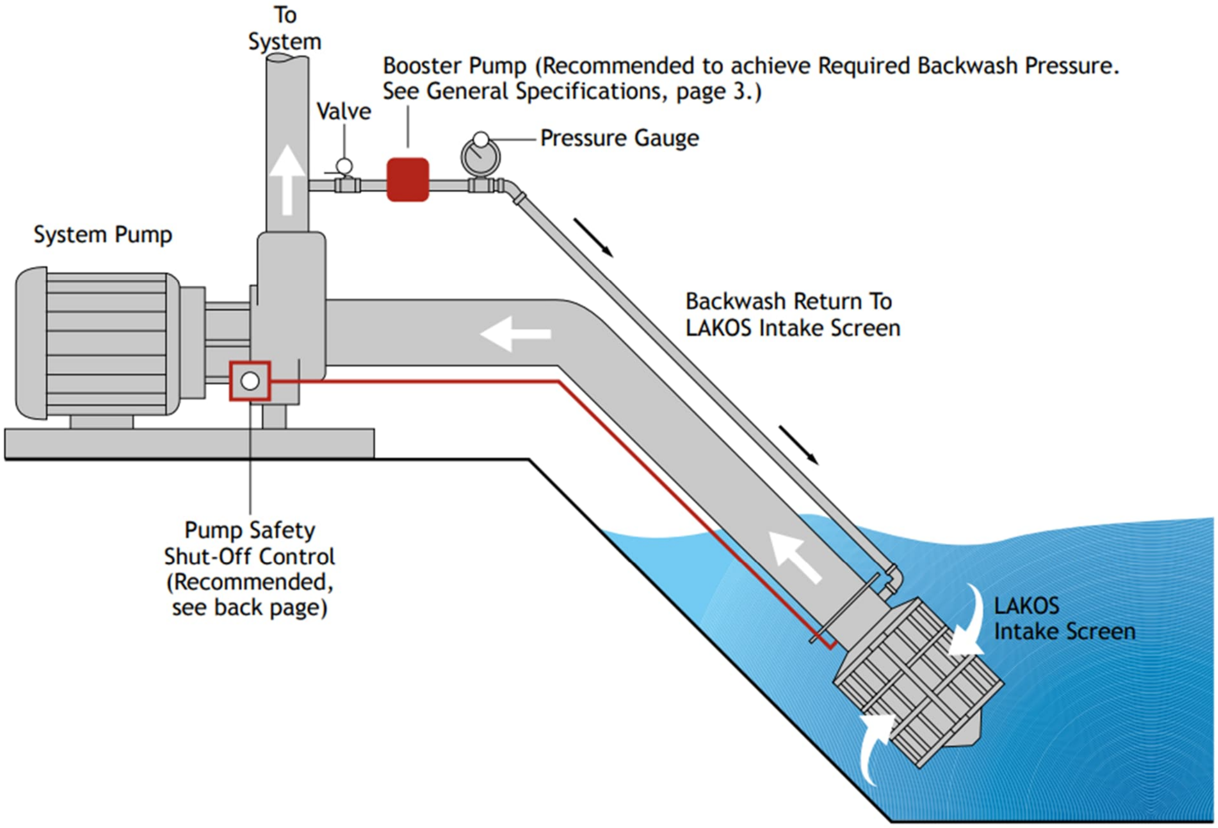


**Figure 8 Basic Installation for Self-Cleaning Intake Screen (Source: LAKOS Filtration Solutions)**

The self-cleaning screens can be operated continuously or as scheduled. The screens are capable of being used in fully or partially submerged conditions in both moving or static water. The intake screens are also designed to prevent harm to fish and aquatic organisms.

### 3.3.1 Advantages

The primary advantage of retrofitting the intake with a self-cleaning device is that the intake screen is maintained in a clear condition throughout the year. The self-cleaning device reduces the need for maintenance and prevents a potential reduction in performance that could occur as the existing screen becomes clogged with debris and aquatic growth. Permit modifications would not be anticipated since this would primarily be a retrofit to the existing system.

### 3.3.2 Disadvantages

The primary disadvantage of Alternative 3 is that the retrofit would require capital expenditure to implement, as well as installation of additional equipment within the existing pump house. Since a new system would be installed, additional operating costs would be incurred, however a significant increase in operating costs would not be anticipated. Design would be required to understand how operating costs would change.

Another potential disadvantage would be that the existing intake is located in a relatively shallow portion of the lake. The shallow depth may reduce efficiency and likely require continuous operation. The self-cleaning devices are also prone to clogging due to frazzle ice in shallow or partially submerged applications in cold regions. Since the device does rotate and the lake is used by the public for recreation, additional measures may be required to maintain safety around the water intake. Alternative 3 would also incur soft costs for engineering design and permitting.

### 3.3.3 Conceptual Cost Opinion – Alternative 3

A conceptual opinion of probable project costs has been prepared for Alternative 3. Soft costs as well as a contingency have been included as a percentage of the construction costs. Note that the costs associated with operation of the self-cleaning screen have not been included in the cost opinion. Additionally, maintenance costs have not been included, yet it would be anticipated that maintenance would be limited and required less frequently than the current practice of inspecting and cleaning the existing screen on an annual basis.

The conceptual project cost is expected to range between $100,000 to $175,000 to implement Alternative 3.

## 3.4 Alternative 4 – Intake Pipe Extension with Retrofit

Alternative 4 consists of extending the water intake pipe into deeper water combined with adding a self-cleaning screen to the end of the intake pipe. The combined alternative would allow the self-cleaning screen to be in deeper water with less exposure to sediment, aquatic vegetation, and algae that is more prominent in shallower areas of the lake. The self-cleaning screen would reduce the need for maintenance.

### 3.4.1 Advantages

The primary advantages of Alternative 4 would be similar to the advantages as described for Alternatives 2 and 3 above. Extending the pipe would position the intake in a deeper location and higher in the water column, away from the layer of soft suspended sediment and aquatic vegetation and algae. Positioning the intake in a deeper channel within the lake may benefit from greater current and higher flow velocities that would help maintain the depth and clarity. The self-cleaning intake screen would reduce the need for maintenance and cleaning of the screen, and maintain peak performance and efficiency that could diminish as clogging occurs with a standard intake screen.

### 3.4.2 Disadvantages

The primary disadvantages of Alternative 4 are similar to as described under Alternatives 2 and 3. This alternative would require the highest upfront capital expenditure to implement compared to the other alternatives presented. Alternative 4 would likely require modification to existing regulatory permitting since implementation would extend the pipe as well as relocating the intake that would be retrofitted with a self-cleaning device. As with Alternatives 2 and 3, this alternative would incur soft costs for engineering design and permitting. The safety of the public that use Arrowhead Lake for recreation would also need to be considered. Although the intake would be located in deeper water, the need for inspection and maintenance would not be fully eliminated; however, less maintenance should be required than now. Additional data such as flow velocity, turbidity, and depth would be required during design.

### 3.4.3 Conceptual Cost Opinion – Alternative 4

A conceptual opinion of probable project costs has been prepared for Alternative 4. Soft costs as well as a contingency have been included as a percentage of the construction costs. Note that the costs associated with operation of the self-cleaning screen have not been included in the cost opinion. Additionally, maintenance costs have not been included, however it is that the least maintenance is required with this alternative.

The conceptual project cost is expected to range between $250,000 to $325,000 to implement Alternative 4. Although the upfront costs are the highest, construction cost savings would occur if a combined intake extension with new self-cleaning intake screen project was implemented due to overlapping cost items. The cost of maintenance is likely low for this alternative.

## 3.5 Alternative 5 – Turbidity Monitoring

One of the primary issues with the treatment of the incoming water is related to turbidity that is linked to the sediment levels present in the water when drawn in from Arrowhead Lake. As flows in the river rise during spring snow melt and after heavier rainfall events that produce flooding, the sediment load entering the lake is also known to increase. The increase in turbidity requires special attention at the treatment plant and sometimes requires additional treatment that increases operating costs. Turbidity entering the settling lagoons or the plant does not seem to be monitored routinely, however some turbidity measurements of the incoming water were available (Table 1).

**Table 1 Turbidity Measurements (Provided by Plant Operators)**

| Date | Turbidity | | Notes |
|---|---|---|---|
| | Entering Primary | Entering Plant | |
| July 13, 2024 | 80 NTU | 12 NTU | During July 2024 flood, peak occurred on July 12th at approximately 16,300 CFS. |
| Week of Oct. 13, 2025 | 0.908 NTU | 0.350 NTU | During drought conditions. Stream flow approximately 160 CFS. |
| Week of Oct. 21, 2025 | 23 NTU | 1.57 NTU | After approximately 1.6 inches of rain. Stream flow approximately 2,500 CFS. |

Stream flow data for the Lamoille River just upstream of Arrowhead Lake have been continuously collected since 1929 by the United States Geological Survey (USGS). The discharge data are collected at the Lamoille River at East Georgia, VT USGS Gage (#04292500) and posted on the WaterWatch website (Figure 9).


**Figure 9 Lamoille River Stream Flow Data – Oct. 2025 (Source: USGS WaterWatch)**

Under Alternative 5, a routine turbidity monitoring program would be implemented that records turbidity entering the primary settling lagoons and entering the treatment plant (after primary treatment). The turbidity measurements would be recorded along with the streamflow data as recorded at the USGS gage located just upstream of Arrowhead Lake (Figure 10).

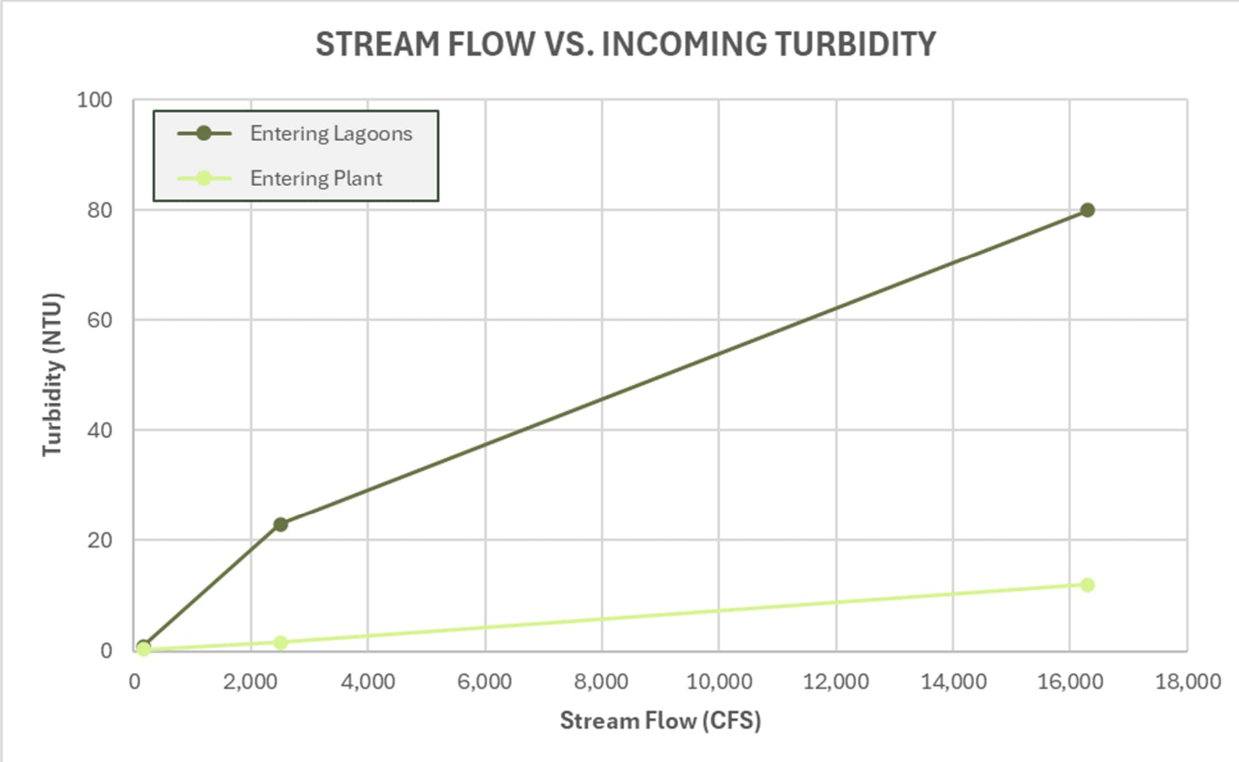


**Figure 10  Measured Turbidity at the Treatment Plant vs. River Flow**

The purpose for monitoring turbidity against stream flow would be to build a database that could be used to potentially identify trends and to understand if there is a threshold that can be related to a specific flow or range of flows in the river where turbidity levels begin rapidly increasing. Turbidity can be used as a surrogate for total suspended solids if a relationship is established.

If a threshold or inflection point is identified, measures could be taken at the treatment plant to proactively mitigate an anticipated rise in turbidity, or improvements at the treatment plant could be considered to help continue normal operation during periods of high turbidity. Additionally, the information could be used to plan for increased treatment requirements based on forecasted rainfall and associated increases in flow in the Lamoille River.

### 3.5.1 Advantages

The primary advantage of Alternative 5 is that it would be inexpensive to implement relative to other alternatives. Performing the turbidity measurements and recording the river flow could develop a database to allow for improved plant operations.

### 3.5.2 Disadvantages

Disadvanges include potential limitations during winter months as flow data may not be available due to gaging being impacted by ice. In addition, the collected data may not show a clear inflection point or threshold that would inform the need for change in treatment procedures at the plant. The USGS also periodically recalibrates the stream flow gages, which can change recorded data afterwards. If that occurs the data may become skewed, and it would be recommended to reach out to the regional USGS office to ask when the Lamoille River at East

Georgia gage was last calibrated and if there are any plans to recalibrate the gage in the near future prior to beginning a monitoring program.

### 3.4.3 Conceptual Cost Opinion – Alternative 5

Since the costs associated with Alternative 5 would largely be linked to additional labor for the Operations crew to record turbidity measurements and stream flow values, an engineer's opinion of probable cost was not prepared. Additional information such as sample frequency and methods would be needed to understand the cost that would be required for beginning a monitoring program.