

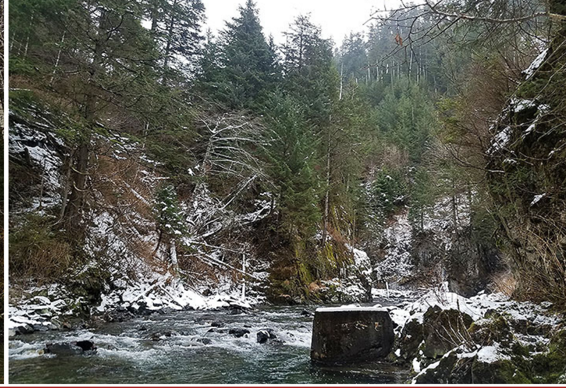

CITY AND BOROUGH OF SITKA, ALASKA

FILTRATION EVALUATION FOR CRITICAL SECONDARY WATER SOURCE

FINAL REPORT

APRIL 2018

CITY AND BOROUGH OF SITKA
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Acronyms and Abbreviations

%	percentage
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish & Game
ADOT	Alaska Department of Transportation and Public Facilities
APDES	Alaska Pollutant Discharge Elimination System
BLWTP	Blue Lake Water Treatment Plant
CBS	City and Borough of Sitka
CCF	Corrosion Control Facility
CFE	Combined Filter Effluent
cfs	Cubic feet per second
CIP	Clean In Place
CRW	CRW Engineering Group, LLC
CT	Chlorine Concentration * Time
DAF	Dissolved Air Flotation
EFM	Enhanced Flux Maintenance
FBRR	Filter Backwash Recycle Rule
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
ft	feet
FTW	Filter to Waste
˚F	degree Fahrenheit
gpm	gallons per minute
GPIP	Gary Paxton Industrial Park
IFE	Individual Filter Effluent
LAF	Limited Alternative to Filtration
NTU	Nephelometric Turbidity Units
kW	kilowatt
MGD	Million gallons per day
O&M	operation and maintenance
PWS	Public Water System
ROW	right-of-way
SDC	Engineering Services During Construction
SDWA	Safe Drinking Water Act
SWTR	Surface Water Treatment Rule
TWUA	Temporary Water Use Authorization
UV	Ultraviolet
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

References

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Indian River Evaluation. CRW Engineering Group, LLC. December 2017.

Membrane Filtration Guidance Manual. EPA. November 2005.

Temporary Filtration Evaluation Technical Memorandum. CH2M HILL. May 2012.

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1. Executive Summary

The City and Borough of Sitka (CBS) currently obtains water from Blue Lake for its municipal water supply. Water flows by gravity from an intake structure in the lake through rock tunnels and a penstock to the Blue Lake Water Treatment Plant (BLWTP). A 24-inch line from the penstock supplies water to the BLWTP with the rest of the water flowing to the Blue Lake hydropower facility. The intake, rock tunnels, penstocks and associated infrastructure are operated by the CBS Electric Department as part of the Blue Lake Hydroelectric Project (Blue Lake Hydro). Blue Lake Hydro is regulated by the Federal Energy Regulatory Commission (FERC), which requires periodic inspection and maintenance of regulated infrastructure to ensure continued safe operation. Routine inspection and maintenance of the intake gate, rock tunnels, penstocks and associated infrastructure require dewatering of these areas and outages of the penstock that supplies raw water to BLWTP.

CBS currently operates under a filtration avoidance waiver for drinking water treatment, one of seven utilities in the United States operating under this regulatory framework. The waiver has strict turbidity requirements. Exceeding the maximum turbidity levels more than two times in a 12 month period or five times in a 120 month (ten-year) period would trigger the requirement for providing filtration. CBS has experienced 3 turbidity events in the past 3 years. Additional turbidity events beyond the allowable exceedances will require CBS to pursue full time filtration.

This report provides a detailed conceptual analysis of filtration alternatives on two potential water sources for supplying water to the community during penstock outages and high turbidity events. This work was recommended in the January 2018 Dedicated Water Supply Report, which evaluated dedicated water supply sources for CBS. This report evaluated the feasibility of two general options: implementing filtration at the existing Indian River water source, or developing Sawmill Creek, downstream of Blue Lake, as a new source which would require filtration. The existing Blue Lake source and UV Facility would remain the primary supply, and the filtration plant would be used on an intermittent basis during penstock outages or high turbidity events. If the filtration avoidance waiver was revoked, the filtration plant could be used full time. This report also evaluated a number of pre-treatment options, including dissolved air flotation (DAF), up-flow clarification, and flocculation and settling. Filtration alternatives include granular media and microfiltration membrane systems, as recommended by the Dedicated Water Supply Report.

1.1 Conclusions

Based on the evaluation of capital and operating costs and non-monetary factors, an intermittent granular filtration plant treating Sawmill Creek water and located adjacent to the existing Ultraviolet (UV) Facility is the recommended alternative for operation during penstock outages and periods of high turbidity water when the UV Facility cannot be used. The primary advantages of this option are lower capital and operational treatment costs due to higher quality source water than Indian River for more affordable treatment options. Should the plant need to be used full time in the future, this option will provide a lower annual operating cost than other options.

The advantages and disadvantages of the recommended alternative are summarized below.

<u>Advantages:</u>

- Generally high quality source water with adequate existing water rights, but needs additional sampling to confirm.
- Good proximity to existing infrastructure (power, sewer, raw water, finished water).
- Relatively small footprint requirements.

- Multiple trains allow for flexibility in operating loading rates based on flow demands and water quality.
- Reduced backwash volumes compared to membrane filtration.
- No operator involvement in monitoring the system when it is offline.

Disadvantages:

- Difficult to construct intake and pipeline for conveying water during penstock outages.
- Limited ability to treat and dispose of large backwash water volumes.
- Does not provide a fully redundant water source.
- Coagulant dosing will be critical to successful filter operation. High quality source water may require higher coagulant doses.
- Seasoned operator experience and judgment will be needed to optimize treatment process.
- Additional water quality data from Sawmill Creek is needed to verify selection of the recommended pre-treatment which process.

Should the filtration avoidance waiver be revoked, the recommended filtration process could be used full time treating water from either Blue Lake or Sawmill Creek.

1.2 Recommendations

The intake construction in Sawmill Creek has the most uncertainty of the various components of the project. To help alleviate some of this uncertainty, survey and geotechnical work should be completed as soon as practical. To move forward with the selected alternative, the following activities should be pursued.

- Continue collection of water quality data, especially during high flow and poor water quality conditions to help identify the worst case water that will need to be treated.
- Work with ADEC to determine sampling required to establish a new source and start ADEC plan review process.
- Perform a geotechnical investigation that includes drilling rock cores to locate the intake. This work will allow for early site development and preliminary permitting activities, as well as facilitate the design of the intake and filtration building foundation.
- Perform a detailed survey of the intake location and site.
- Evaluate construction strategies to quickly and cost-effectively complete the project.
- Once the equipment supplier is selected, move forward with design, permitting, and construction.
- If the selected alternative requires a crossing of Sawmill Creek on the existing utility bridge, an evaluation of options to replace or augment the bridge should be performed.

2. Introduction, Background, Design Criteria

2.1 Introduction and Background

The City and Borough of Sitka (CBS) obtains water from Blue Lake for its municipal water supply. Water flows by gravity from an intake structure in the lake through rock tunnels and a penstock to the Blue Lake Water Treatment Plant (BLWTP). A 24-inch line from the penstock supplies water to the BLWTP with the rest of the water flowing to the Blue Lake hydropower facility. Blue Lake water is very high quality, and not required to be filtered. Disinfection is accomplished with the addition of chlorine and irradiation with UV light, in compliance with the CBS filtration avoidance waiver.

The intake, rock tunnels, penstocks and associated infrastructure are operated by the CBS Electric Department as part of the Blue Lake Hydroelectric Project (Blue Lake Hydro). Blue Lake Hydro is regulated by the Federal Energy Regulatory Commission (FERC), which requires periodic inspection and maintenance of regulated infrastructure to ensure continued safe operation. Routine inspection and maintenance of the intake gate, rock tunnels, penstocks and associated infrastructure require dewatering of these areas and outages of the penstock that supplies raw water to BLWTP.

The filtration avoidance waiver has a strict maximum turbidity requirement of 5.0 NTU. Exceeding the maximum turbidity level more than two times in a 12 month period or five times in a 120 month (ten-year) period would trigger the requirement for providing filtration. CBS has experienced 3 turbidity events in the past 3 years. Additional turbidity events beyond the allowable exceedances will require CBS to pursue full time filtration. When the Blue Lake water meets the filtration avoidance criteria, operation of the existing system provides plentiful, high-quality, affordable drinking water to CBS, and is the preferred treatment option.

CBS has evaluated many options to provide water during penstock outages and emergency shut-down's. Most of these options have revolved around providing a dedicated intake and water line to connect to the existing water treatment system. Several options have evaluated developing a new water source or utilizing historic sources, most of which require filtration. Since CBS has experienced several turbidity events in recent years, options to supply the community during penstock outages that also include filtration that could be used for turbidity events are evaluated in more detail in this report.

Filtration would be used intermittently; only when the existing surface water supply is unavailable, either due to high turbidity in Blue Lake, maintenance-related shutdowns of the hydropower penstock, and penstock emergencies. High turbidity events are caused by significant storm events in the water shed and sudden increases of flow through the hydropower facility due to hydropower facility operation. Penstock shutdowns involve inspections and maintenance that are performed by the Sitka Electrical Department every five years, or emergencies that require immediate shutdown of the equipment.

This report evaluated the feasibility of two general options: implementing filtration at the existing Indian River water source, or developing Sawmill Creek, downstream of Blue Lake, as a new source which would require filtration. This report also evaluated a number of pre-treatment options, including dissolved air flotation (DAF), up-flow clarification, and flocculation and settling. Filtration alternatives include granular media and microfiltration membrane systems, as recommended by the Dedicated Water Supply Report. Photo 1 shows an overview of the CBS water source locations and facilities described in this report.

Photo 1 - CBS Water System General Locations
1:Blue Lake, 2:UV Facility, 3:Sawmill Creek Source, 4:Indian River Source

The CBS water system has a 1.2-MG water storage tank as the primary storage in the system which is augmented by two additional tanks; Harbor Mountain (800,000 gallons); Whitcomb (1,000,000 gallons). This storage is inadequate to meet the system demands during a system outage. If penstock outages occurred during minimum flow periods, up to 14-million gallons of storage would be needed to allow a 5-day shutdown of the penstock. This is an impractical amount of storage for normal system operation, would have a cost of $40 to 50 million, and does not provide adequate storage for high turbidity events of unknown duration.

2.1.1 Previous Filtration Experience

Sitka has prior experience with potable water filtration. Indian River was used as a temporary water supply during the Blue Lake dam raising project in 2014. Water was filtered through membrane filters before entering the distribution system with no pre-treatment. Limited water quality data collected during the planning portion of the work indicated that direct filtration would provide adequate treatment. During the project, Sitka experienced a number of large storm events, each causing significantly worse raw water quality than expected based on the sampling in the planning period. The filter membranes adequately treated these high turbidities experienced during the storm events, but were unable to remove the large amounts of total and dissolved organic carbon from the river leading to high color, high chlorine demand, and high levels of disinfection byproducts in the treated water. The filters required more chemical cleaning than anticipated due to the unexpected turbidity and organics levels in the raw water. Based on this experience, the equipment provider for the rented microfiltration system recommended that any permanent installation on this source include pretreatment.

During the Blue Lake Dam raising project, the water treatment equipment was rented due to the temporary nature of the project, as this was more cost effective than purchasing the equipment. While the project provided water that met the needs of CBS at the time, the plant was difficult to operate, requiring CBS to retain a temporary full-time operator dedicated to the temporary plant. The temporary nature of the plant drove design decisions that would not be applicable for a permanent installation. During the design of the temporary filtration plant there was discussion about purchasing the membrane filtration units. The cost to purchase the units did not include any of the pumping, chemical delivery, chlorine contact tanks, or control system equipment that would be required for a permanent installation, which made the cost seem lower than the total project cost would be.

2.2 Design Flow

The UV Disinfection facility was constructed in 2015, and sized to meet current and future demands. The filtration facility will be sized to match the same capacity, as summarized in Table 1. The CBS water treatment flow rates are based on the use in the system which varies daily and seasonally. The water treatment equipment must be able to ramp up and down production quickly to meet the use in the system because the water system has limited storage and can only supply water for several hours without impacts to system users.

Table 1 - Design Flow Criteria

	Design Flow
Peak Hour/Future Flow	6.0 MGD
Average Summer Flow	4.0 MGD
Average Winter Flow	3.0 MGD
Minimum Flow	1.8 MGD

2.3 Water Source & Quality

Two water sources are available for an intermittent filtration facility, Sawmill Creek and Indian River.

2.3.1 Sawmill Creek

Sawmill Creek is located on the east end of Sitka (diamond 3 in Photo 1). Blue Lake is the headwater for Sawmill Creek, which discharges to Sawmill Cove. Flows in Sawmill Creek are largely controlled by the hydroelectric facility's release of water from a side line connected to the penstock (commonly referred to as the "fish valve"). The fish valve release provides the minimum in-stream flow requirement of 70 cfs (approximately 31,400 gpm) April 15-June 30 and 50 cfs (approximately 22,000 gpm) the rest of the year for the fishery, which thereby stabilizes the river from large variations in turbidity or flow. The fish valve is sized to provide a minimum of 70 cfs into Sawmill Creek at low levels in Blue Lake. During the high release periods, the valve does not have the capacity to meet municipal needs.

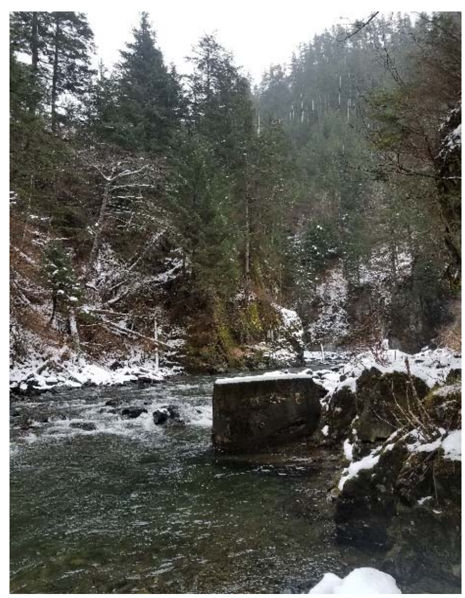


Photo 2 - Sawmill Creek Canyon

During penstock outages, the fish valve is also out of service for inspection and maintenance. In this case, the electric utility will open the Howell Bunger valve at the bottom of the dam to provide in stream flows. The valve has not been used in some time, and should be tested prior to relying fully on this option.

If Sawmill Creek was utilized as a water source, the hydroelectric facility would utilize the fish valve and Howell-Bunger valve to allow additional water to flow in the river to meet fishery-required in-stream flows and municipal needs. Flow and water quality in Sawmill Creek can also be impacted by storm events in the watershed, water spilling over the top of the dam, or water released from the Howell-Bunger valve in the bottom of the dam.

A new water intake in Sawmill Creek would be located upstream of tidal influences and the hydropower facility afterbay. The highest tide in the area is 13 feet above the mean sea level (MSL). Photo 1 shows the potential intake location in Sawmill Creek. Details of the intake configuration are discussed in Section 5.

Limited water quality data is available for Sawmill Creek because sampling is not required. CBS is currently collecting water quality data to determine average and maximum values of important parameters needed for sizing water treatment equipment and detailing the process selection. Preliminary water quality results are included in Appendix A and summarized in Table 2.

2.3.1.1 Sawmill Creek Water Rights

CBS holds adequate water rights in Blue Lake to meet its current and future water system needs. To utilize the water downstream of Blue Lake, a Temporary Water Use Authorization (TWUA) would be required from the Department of Natural Resources (DNR). The application must be completed in advance of any water withdraw and is good for a period of five years. The CBS electric department controls the flow in Sawmill Creek to maintain in-stream flow requirements for returning salmonid species, as well as providing water to the CBS water system and a fish hatchery.

Table 2 - Sawmill Creek Water Quality

Parameter	Average	Minimum	Maximum
Turbidity (NTU)[1]	0.62	0.44	0.98
Total Organic Carbon[2] (mg/L)	0.91	0.73	1.10
Total Dissolved Solids[2] (mg/L)	54.5	41.0	68.0
Total Suspended Solids[2] (mg/L)	1.9	0.8	3.0
1. 58 samples collected January - March 2018. 2. Three samples collected monthly January - March 2018			

The raw water quality from Sawmill Creek is generally very similar to Blue Lake with low turbidity, organic carbon, and solids. Observations from CBS staff indicate that during storm events or when the dam is spilling the water quality in Sawmill Creek changes, with increases in turbidity and solids. There are not monitoring requirements for Sawmill Creek so analytical samples have not been collected. Sampling is currently underway to determine the nature of the water quality changes.

2.3.2 Indian River

Indian River was the CBS water source until 1986 when the variable water quality and forthcoming filtration regulations compelled CBS to switch to Blue Lake as the primary water source. The existing intake is located on the west channel of a small island. The Indian River Water Treatment Plant (IRWTP) consists of a shallow underdrain/intake system under Indian River that feeds a small sand filter. Water from the bottom of the sand filter is pumped to the distribution system after chlorine injection. The filter cannot be backwashed or cleaned effectively, which reduces the amount of flow that can be produced by the filter. This filter system does not receive Giardia removal credit. Several of the existing pumps have failed and have not been repaired or replaced.

Indian River is a dynamic river, and its water quality fluctuates seasonally and with storm events. Water quality sampling was performed prior to the temporary filtration project in 2013 summarized in Table 3.

Table 3 - Indian River Water Quality

Parameter	Average	Minimum	Maximum
Turbidity (NTU)[1]	1.35	0.25	12.8[3]
Total Organic Carbon[2] (mg/L)	2.24	0.77	6.2
Total Dissolved Solids[2] (mg/L)	51.6	23.0	64.0
Total Suspended Solids[2] (mg/L)	5.2	0	5.2

1. 100 samples July-December 2013.
2. 6 samples collected July-December 2013.
3. August 2014 temporary filtration plant had samples with more than 100 NTU

A new water intake in Indian River would be located in the vicinity of the old intake and would draw water from the western river channel. During the temporary filtration project in August 2014, significant flooding occurred, which resulted in raw water turbidities of over 100 NTU and very high levels of organics. While this variation was unexpected based on seasonal storm sampling in preparation for the Indian River project, it shows the highly irregular nature of Indian River.

Photo 3 - Indian River Before & During Flood (August 2014, taken less than a week apart)

In addition to the water quality variability in Indian River, the reach where the intake would be located is dynamic where both erosion and deposition are active. There are high sediment and debris load which make channel position difficult to predict and maintain, complicating intake design. During low flow periods, most of the flow may be in the eastern channel, and depending on the intake design, it may not be possible to divert the needed system demand.

2.3.2.1 Indian River Water Rights

CBS maintains a 2.5 MGD (approximately 3 cfs) water right in Indian River. A larger water right would need to be secured to meet the required system demand of 6 MGD (9.3 cfs). Seasonal flows can range from 12 to 1,300 cfs. Water flow in Indian River is heavily influenced by precipitation events in the watershed. The river bed changes significantly during flood events, so an intake would need to be located and designed to capture flow through the alluvial portion of the river.

A TWUA can be requested for Indian River. As part of the request CBS and the Department of National Resources will have to demonstrate to the Alaska Department of Fish and Game (ADF&G) that the diversion would not violate ADF&G's instream flow rights for the river and the water right rights to operate the hatchery at the Sitka Sound Science Center. Should the flow drop below the ADF&G rights, the CBS TWUA would be shut down.

3. Regulatory Requirements

The Environmental Protection Agency (EPA) issued the Surface Water Treatment Rule (SWTR) in 1989, requiring all public water treatment facilities to filter and disinfect surface water sources unless filtration avoidance criteria is met. Enhanced SWTR's have been issued since 1989 and are designed to protect against water-borne pathogens including viruses, giardia, and cryptosporidium. Each pathogen category has individual removal or inactivation requirements depending on the source water quality and the treatment process. In addition, the SWTRs outline treatment and monitoring requirements including disinfectant residuals and turbidity limits.

Table 4 shows the required pathogen removal or inactivation for all types of systems. Sitka currently meets these requirements through chlorine and UV disinfection, utilizing a filtration avoidance waiver.

Table 4 – Required Pathogen Removal

	Giardia	**Virus**	***Cryptosporidium***
Filtration Avoidance Required Inactivation	3-log	4-log	3-log
Filtration Required Removal/Inactivation	3-log	4-log	2.5-log

For the purposes of this report, it is assumed that the UV facility will be offline while the filtration plant is online. Chlorine injection is required to maintain a residual in the distribution system for any treatment technology, and the ADEC frequently requires at least a 0.5-log Giardia inactivation by chlorine, even in systems with documented high removal/inactivation. Filtration equipment can readily provide 2.5-log removal. The combination of filtration and chlorination meets the required removal/inactivation of pathogens and additional treatment from UV is not advantageous. Operation of the UV equipment at the same time as the filter equipment would increase the operation and maintenance cost unnecessarily.

3.1 Filtration Avoidance

CBS is currently operating under a filtration avoidance waiver by meeting source water quality, site-specific criteria, and utilizing a combination of chlorine and UV disinfection. CBS is one of 8 utilities in the country utilizing filtration avoidance. Maintaining the filtration avoidance waiver is the least cost option for providing high quality water to CBS. Developing a secondary source to use when water quality does not meet the stringent filtration avoidance criteria would allow CBS to selectively utilize the treatment needed for the current source water conditions.

For filtration avoidance, source raw water must have no greater than 20 fecal coliforms per 100 mL sample and turbidity levels must not exceed 5 NTU more than two times in a 12 month period or five times in a 120 month period. If either of these criteria are not met, filtration must be installed within 18 months of the exceedance event. At the time of this report, Sitka has experienced 3 turbidity events in the past 3 years. Two turbidity events in one year, or two more events in the next 6 will put the filtration avoidance in jeopardy and may require the implementation of a full-time filtration system.

Several discussions with Scott Forgue, PE of the Alaska Department of Environmental Conservation (ADEC) Drinking Water program were held during the development of this project. Notes from these discussions are included in Appendix B. Construction of a filtration facility at Indian River or at Sawmill Creek would be considered developing a new secondary source, and would not have an impact on CBS's filtration avoidance waiver.

3.1.1 Limited Alternative to Filtration

The Safe Drinking Water Act provides provision for unfiltered systems called a Limited Alternative to Filtration (LAF) that allows a utility with very strict watershed control to consider alternative disinfection strategies. Washington is the only state known to have developed guidelines for a LAF, which allows for more coliforms to be present in the raw water than the filtration avoidance waiver provided one additional log-removal is provided and a third disinfectant is utilized. The LAF does not modify the 5 NTU maximum turbidity requirement of the filtration avoidance criteria. Based on conversation with Scott Forgue, PE of ADEC, if Alaska were to develop regulations allowing a LAF, it would likely use the Washington regulations as a guideline and would maintain the 5 NTU maximum turbidity standards. If a LAF was pursued for CBS, the high turbidity events in Blue Lake would continue to put the filtration avoidance at risk, so this regulatory pathway was not considered further for CBS.

3.2 Conventional and Direct Filtration

Conventional filtration consists of coagulation, flocculation and settling prior to filtration. Direct filtration does not include flocculation or settling, and consists only of coagulant injection to aid coagulation before filtration. Filter media can be comprised of granular media or membranes; however, cryptosporidium removal requirements for membrane filtration is dependent on individual system testing, described in Section 3.3.

Turbidity requirements for filtered water systems under the SWTRs consist of monitoring combined filter effluent (CFE) levels and individual filter effluent (IFE) levels. CFE levels must be no greater than 0.3 NTU. If this threshold is exceeded, reporting of IFE readings and filter performance assessment actions will be required. The filter performance assessments are based on the severity of the exceedance of the CFE reading, and includes detailed evaluation of the cause of the high turbidity, filter profiling, and filter self-assessments.

Table 5 shows filtration removal credits and the remaining required inactivation by chlorine disinfection. Disinfection removal varies depending on residual chlorine concentration, water temperature, pH, and the contact time between the water and disinfectant.

Table 5 – Conventional and Direct Filtration Pathogen Removal Credits

		Giardia	Virus	Cryptosporidium
Conventional Filtration	**Removal credit**	2.5-log	2.0-log	3-log
	Disinfection required	0.5-log	2.0-log	2.5-log
Direct filtration	**Removal credit**	2.0-log	1.0-log	3-log
	Disinfection required	1.0-log	3.0-log	2.5-log
Microfiltration	**Removal credit**	3.0-log	n/a	3.0-log
	Disinfection required	n/a	4.0-log	2.5-log

3.3 Membrane Filtration

Membrane filters can be used in conventional or direct filtration systems. This type of filter consists of small tube-like permeated fibers which capture particulates larger than one micrometer (0.001 millimeter or 3.9×10^{-5} inch) as water is passed through them. In 2005, the EPA published the Membrane Filtration Guidance Manual, which provides specific guidelines for determining the effectiveness of membranes for

Cryptosporidium removal through testing. Each membrane product undergoes challenge testing by the manufacturer to determine the maximum removal credits it is eligible to receive.

Once a membrane system is installed, direct or indirect integrity testing is required to verify that adequate particulate removal is occurring. Direct testing requires the system to be taken offline at least once per day, and pressurized with air to determine if there are any breaks in the membrane fibers. Continuous indirect integrity testing consists of continuous monitoring of the filtered water for a parameter that should be removed by the filtration process—generally turbidity. This process provides verification of the removal credits received through challenge testing. Turbidity requirements to verify Cryptosporidium removal for membrane filters require that IFE must measure below 0.15 NTU.

3.4 Backwash Disposal

Backwash disposal is regulated by ADEC wastewater regulations. The specific regulation in effect depends on the location of the backwash disposal. Most frequently Alaska Pollutant Discharge Elimination System (APDES) permits govern disposal into any waterbody. Solid waste regulations govern the disposal of solids into landfills or biosolids receiving areas.

3.4.1 Filter Backwash Recycling Rule (FBRR)

Many filtration facilities recycle some or all of the backwash to the head of the plant to reduce the amount of backwash that must be disposed of. The Filter Backwash Recycling Rule governs recycle practice with the aim of preventing pathogens from passing through systems into drinking water because backwash water may contain high concentrations of pathogens. The main components of the FBRR are:

- The recycle return location must be upstream of all treatment processes.
- The system must keep record of and report the quantity and quality of water recycled.

4. Pre-Treatment, Filtration, and Backwash Disposal Alternatives

Four pre-treatment/filtration and three backwash disposal alternatives were considered for further evaluation, as described below. Based on the Indian River Filtration project evaluation by CH2M in 2012, cartridge or bag filtration was not considered for further evaluation due to the same footprint and lack of adequately sized ADEC approved equipment challenges. Seawater Desalinization was also discussed but not evaluated further because of the very high cost and complexity of treatment as well as the challenges of intake construction and brine disposal.

4.1 Dissolved Air Flotation (DAF) and Granular Media Filtration

DAF is a pre-filtration process that uses minute air bubbles to suspend low-density solids like algae, organic compounds, and some sediment to float the solids to the surface of the basin, and then skim the solids to a collection trough. These compounds are typically difficult to remove by conventional sedimentation processes because they settle very slowly, especially with colder water temperatures. Additionally, these compounds readily float out of high-quality water. DAF is an effective alternative to sedimentation or adsorptive clarification. With the use of flotation, smaller coagulant doses can be used to remove contaminants. Clarified water from the DAF process flows through a conventional multimedia filtration step to receive the filtration credits required for surface water treatment.

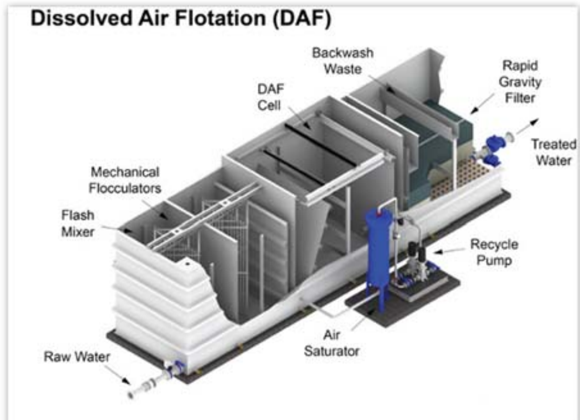


Photo 4 - DAF Package Plant

DAF is optimized when raw water average turbidities are between 0 and 10 NTU, with occasional spikes as high as 50 NTU, and TOC levels ranging up to 14 mg/L. Based on these requirements DAF would not be suitable for use at Indian River. The typical TOC values in Blue Lake and Sawmill Creek are low enough that the DAF process would likely provide more treatment than necessary, and based on conversation with DAF system manufacturers would be more expensive to construct and operate than some of the other options.

4.2 Granular Media Filtration

4.2.1 Process Description

A conventional granular media filtration facility would consist of a three-train package system. Each train would consist of pretreatment followed by filtration through a mixed media filter bed. Pre-treatment is dependent on water quality, raw water turbidity in excess of 75 NTU will require tube settlers followed by an up-flow adsorption clarifier. For raw water turbidity less than 75 NTU, just an up-flow adsorption clarifier is required prior to filtration. The system would be automated for coagulant dosing and control to respond to changing influent water quality. Appendix C includes additional details on the package granular media filtration options, and Photo 5 shows a schematic of an adsorption clarifier system. Several vendors supply this type of package equipment, which can provide competitive pricing during the equipment procurement phase of the project.

Filtered water would be pumped to an on-site tank to provide backwash supply and a buffer between the filter plant and the distribution system. Depending on the site of the plant, the tank could be sized to provide CT, or just backwash supply. Figure 1 shows a conceptual plant layout and size for the three-train system.

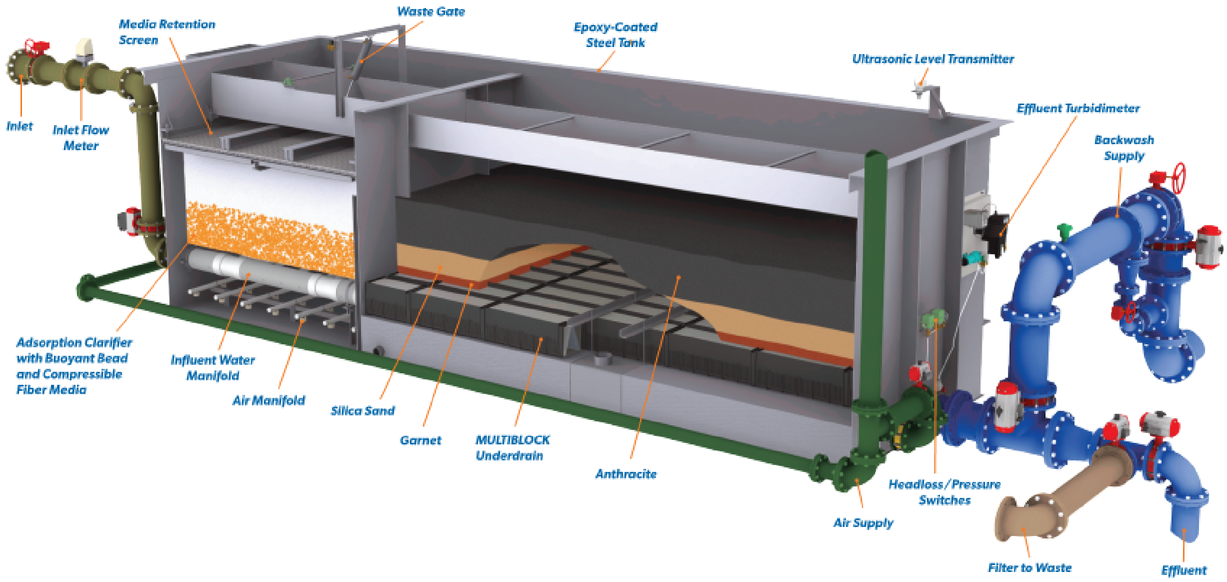


Photo 5 - Adsorption Clarifier System

4.2.2 Backwash

Solids are removed from the tube settlers using a gravity drain. This process is automated based on a timer. The up-flow clarifier process is periodically flushed with treated water to remove solids from the media. The granular media filter is also agitated with an air scour to remove solids during backwash. The waste streams would be discharged to the sanitary sewer or a secondary backwash recovery process to reduce loading the sewer system. For lower quality raw water that requires the tube settler, waste volumes are generally less than 5% of the total production (300,000 gallons/day at the full 6 MGD design capacity). For higher quality water with lower influent turbidity, waste volumes are around 3% of the total water production (150,000 gallons/day at the full 6 MGD design capacity). This assumes one backwash per day, which is the worst-case backwash requirement. Backwash handling is discussed in Section 4.4.

4.2.3 Startup, Shutdown, and Standby Considerations

With an automated control system for coagulant dosing, the start-up time from standby of either pre-treatment system followed by filtration is fairly short. Upon startup, one full process tank volume should be filtered to waste to be sure the system is operating correctly and to flush any entrained solids from the storage period out of the system. After the operating period is complete, the system should be backwashed with chlorinated water and allowed to drain. No operator involvement is required to monitor the system when it is offline. There are not specific requirements for frequency of operation, but good practice would start the filtration system up a minimum of every 6 months to exercise all of the system components and maintain operator familiarity with the system.

4.2.4 Advantages/Disadvantages

Advantages:

- Relatively small footprint requirement.

- Multiple trains allow for flexibility in operating loading rates based on flow demands and water quality.
- Reduced backwash volumes compared to membrane filtration.
- No operator involvement in monitoring the system when it is offline.
- Pre-treatment and granular media filtration is overall less complex than membrane filtration.

Disadvantages:

- Generally high quality water may be difficult to treat. With lower solids concentration in the raw water, optimizing a solids removal process will likely be difficult.
- Coagulant dosing is critical to successful filter operation. High quality source water may require higher coagulant doses.
- Seasoned operator experience and judgment will be needed to optimize treatment process.
- Additional water quality data from Sawmill Creek is needed to verify selection of the recommended pre-treatment process.

4.3 Membrane Filtration

4.3.1 Process Description

A package membrane filtration plant would be a direct filtration plant consisting of three membrane trains. The treatment equipment would include a pre-filter feed tank, coagulant injection, feed pumps to control flow through each membrane skid, self-cleaning screens to remove debris that could damage the membranes, membrane skids with racks, a filtered water tank, actuators, piping, and instrumentation, air compressors and blowers for backwash and membrane integrity testing, membrane cleaning chemical storage and feed systems, and backwash/chemical cleaning waste neutralization equipment. Photo 6 shows a typical membrane rack skid. Appendix B includes additional information on the membrane filtration equipment. Filtered water would be pumped from the individual filtrate tanks to the distribution system. Figure 1 shows a conceptual plant layout and size. Several vendors supply this type of package equipment, which can provide competitive pricing during the equipment procurement phase of the project.

Photo 6 - Package Membrane System

4.3.2 Backwash

The membranes would require three different types and intervals of cleaning. The membranes would be primarily cleaned with a reverse flow air/water backwash, which involves flowing treated water backwards through the membranes with air to remove particles on the outside of the membranes. This backwash would occur approximately every 20 minutes and last for about 2 minutes. Some solids and most organic materials are not removed through this process, so a more intensive cleaning process called Enhanced Flux Maintenance (EFM) using caustic soda and sodium hypochlorite would be performed approximately every 3 days. Lastly, a monthly intense chemical clean in place (CIP) using citric acid would be performed to remove organics and other membrane foulants not removed by normal backwash and EFM cycles. The regular backwash water could be discharged to the sanitary sewer. Alternately, the backwash could be settled with the decant water being recycled to the head of the filtration process with the solids being conveyed to the sewer or landfill depending on the solids percentage of the settled solids. The discharge from the chemical cleaning cycles would be neutralized using sodium bisulfite and be discharged to the sanitary sewer. Backwash handling is discussed in Section 4.4.

Typical membrane plant backwash quantities are approximately 10% of the process flow. For the full 6 MGD treatment capacity that CBS requires, this quantity can be up to 600,000 gallons/day.

4.3.3 Startup, Shutdown, and Standby Considerations

With an automated control system for coagulant dosing, the start-up time from standby mode is approximately 4 hours. Upon startup, the system should operate in a filter-to-waste mode to flush any high chlorine residual water from the membranes. After the operating period is complete, the system should be backwashed (or a CIP performed, depending on the end of run transmembrane pressures) and dosed with chlorine to protect the membranes from biological growth. The chlorine residual should be monitored weekly, which can be done automatically or manually, and more chlorine added if the residual starts to drop. The membrane system should be operated at least every 6 months to exercise all of the system components and maintain operator familiarity with the system.

4.3.4 Advantages/Disadvantages

Advantages:

- This technology is operationally familiar to operations staff from Blue Lake Dam project.
- Requires a simple process to take filter plant online/offline.
- Multiple trains allow for flexibility in operating loading rates, based on flow demands and water quality.
- Chemical dosing is not critical to pathogen removal success because the membrane pore size excludes pathogens.
- Automated system facilitates ease of intermittent operation.

Disadvantages:

- Large volume of backwash water must be managed.
- Larger footprint than granular media option due to pre-engineered membrane solution. A custom engineered system could have a smaller footprint, but would have a higher cost due to engineering requirements by the equipment vendor.
- More complex pumping systems will require more operator attention and involvement.
- Higher chemical use than granular media options for EFM and CIP cleaning.
- Less safe for operations staff due to chemical use for EFM and CIP cleaning.
- More complex ancillary process for EFM and CIP waste neutralization prior to backwash

4.4 Backwash Disposal

Backwash volumes produced by the various filtration alternatives can be significant and there are many options for backwash disposal. The filtration system is planned for intermittent operation so complex backwash disposal options that provide a very high level of solids separation at a high cost or operational complexity were not considered. Space for this type of equipment could be reserved during design should the filtration facility be operated full time. Backwash disposal options would also be used to manage water produced during filter to waste cycles.

Backwash water is dependent on the raw water quality of the source. Typical backwash water quality is summarized in Table 6 - Typical Backwash Water Quality.

Table 6 - Typical Backwash Water Quality

Parameter	Range
Total Suspended Solids (TSS) mg/L	100-1000
Biological Oxygen Demand (BOD) mg/L	2-10
Chemical Oxygen Demand (COD) mg/L	20-200

4.4.1 Disposal to Sanitary Sewer

Direct disposal to the sanitary sewer is the most simple disposal option. All backwash water and solids would be conveyed to the WWTP for treatment and disposal. Depending on the location of the facility, the capacity of the existing collection system may be inadequate for this option. Backwash flows are infrequent, but generally high in volume, so an equalization basin or tank would be provided to allow the flow to be pumped gradually into the sewer system. This would reduce the impact on the collection system and treatment plant.

The water quality of the backwash would impact the influent water to the WWTP. Any residual coagulant may increase solids removal in the clarifiers, which would increase the solids production by the WWTP. The BOD and TSS in the backwash water and the volume of the water would change the influent concentrations at the WWTP, which may impact the performance.

<u>Advantages</u>

- Least complex disposal option.

<u>Disadvantages</u>

- Would likely require very costly improvements to sanitary sewer collection system, depending on plant location.
- May impact performance of the WWTP.

4.4.2 Recycle

Rather than sending backwash water directly to the sanitary sewer, the water could be settled in the equalization tank, which would be outfitted with a moveable floating decant arm, as shown in Photo 7. The decant water would be recycled to the start of the filtration facility. Recycle flows are typically limited to no more than 10% of the plant influent flow rate, and must be injected upstream of all treatment processes. The size of an equalization and decant tank would be based on the backwash volumes anticipated from the selected filtration process.

Solids from the bottom of the equalization tank would be pumped to the sanitary sewer or a secondary solids handling process. The amount of solids removed from the bottom of the clarifier will depend on the raw water quality. Like the full backwash flow, routing these solids to the WWTP may have an impact on the WWTP performance. In this case, it may increase the solids loading on the WWTP slightly.

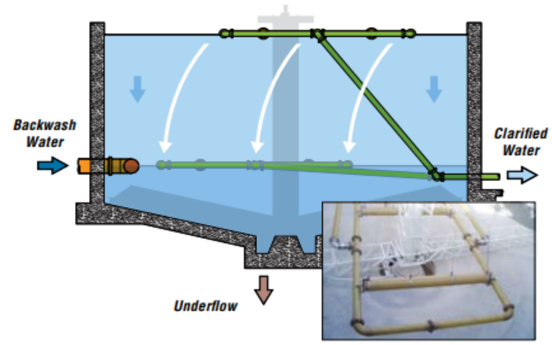


Photo 7 - Equalization Basin With Floating Decant

Advantages

- Reduces amount of backwash directed to the sanitary sewer.
- Recycles water to the start of the WTP, reducing overall system waste.

Disadvantages

- May impact performance of the WWTP.

4.4.3 Marine or Freshwater Outfall Discharge

Backwash water, either with our without settling, could be disposed of in in an existing storm drain system outfall. This discharge would require an APDES permit, governed by the ADEC general permit for Wastewater Discharges from Drinking Water Plants. The permit has effluent limits for chlorine, total dissolved solids, pH, aluminum, and arsenic. The effluent limits would require flow equalization and settling to remove solids prior to discharge. The permit would require monitoring of the regulated water quality parameters on a monthly basis and reporting of additional parameters semiannually.

Advantages

- No flow to the sanitary sewer, or impact to the WWTP.
- Depending on permit requirements, may have no need for flow equalization.

Disadvantages

- Requires APDES permit with reporting and monitoring requirements.
- Requires construction of a dedicated outfall.
- May be subject to changing discharge regulations over time.

5. Site and Source Alternatives

CBS has water rights in Blue Lake and Indian River for municipal use. There are two options for locations of a plant using Sawmill Creek as a water source: adjacent to the existing UV Facility, and at the old pulp mill filters. Development of new water sources was considered by CH2M in the 2018 Dedicated Water Line Report, and is not considered as part of this evaluation. Details of the water sources and potential WTP locations are summarized below.

5.1 Sawmill Creek – Adjacent to UV Facility

5.1.1 Description

The UV Facility is located on Lot 18 in the Gary Paxton Industrial Park (GPIP) and has vacant lots on either side of it (Lot 17 and Lot 19) which could be used for the filtration facility. Sawmill Creek Road, an ADOT road runs along the north side of all three lots. The GPIP board has indicated that they would prefer that a filtration facility be located on Lot 19 because Lot 17 is more appealing for prospective developers. Both Lots 17 and 19 are currently owned by CBS and would need to be acquired by the water department prior to construction of a filtration facility. Due to the GPIP preference for the development of Lot 19,

Lot 17 is located to the east of the UV Facility. The site is bordered by Sawmill Creek Road to the north, and Sawmill Cove Industrial Park Road to the east. CBS's raw water fire system main runs along the east side of the lot and a dysfunctional hydrant is located in the middle of the property, would need to be abandoned along with the raw water line that dissects the property. There is also an abandoned utility pole on one side of the lot. The site is generally level, with good access for construction and operations, and straightforward connections to the existing utilities. Based on the geotechnical investigation performed prior to the UV Facility construction and preliminary geotechnical excavations, subsurface conditions are not complex for construction of a new facility. Photo 8 – Sawmill Creek Site - Lot 17 Adjacent to UV Facility shows the site. The site has adequate available electrical power supply for any of the pretreatment and filtration options considered. Figures 2 and 3 show the proposed plant location and size, intake and piping connections.

Photo 8 – Sawmill Creek Site - Lot 17 Adjacent to UV Facility

Lot 19 is located to the west of the UV Facility. The site is bordered by Sawmill Creek Road to the north and west, and the UV Facility to the east. There is an existing utility ROW to the south of the lot. The site is generally level though at an elevation several feet higher than the UV Facility with adequate access for construction and operations. A preliminary geotechnical investigation determined that large amounts of fill have been placed on top of old Pulp Mill structures and concrete foundations on the site, so a geotechnical investigation and significant excavation to make the site a similar elevation to the UV Facility site will be required to utilize the site. Photo 9 shows the site, Figures 2A and 3A show a potential site layout utilizing Lot 19. The site has adequate available electrical power supply for any of the pretreatment and filtration options considered.

Photo 9 - Sawmill Creek Site – Lot 19 Adjacent to UV Facility

Lot 17 is the preferred location for a filtration facility. While it would be possible to locate the facility on Lot 19, several factors would drive up the construction cost and increase the complexity of operating the facility:

- The existing fill and old tank foundations would need to be removed for site development.
- The site would need to be excavated to a level similar to the UV Facility.
- A retaining wall or other structure would be required to maintain the integrity of Sawmill Creek Road.
- Connections to existing utilities (raw and treated water, potable water, sanitary sewer, power) would be more complex than Lot 17.
- Access around a new facility on Lot 19 would be complicated, making regular operations more complex than necessary.

5.1.1.1 Intake

An intake would need to be located in Sawmill Creek to pump water to the new filtration facility during penstock outages. During high turbidity events, water would be supplied from the existing penstock supply. The intake would consist of a wet well constructed in the river on the east bank, as close to the mouth as possible while avoiding any tidal water intrusion. The wet well would have a screen to prevent large debris and fish from entering the wet well. Submersible pumps would pump the water through a new pipeline, which would be routed up the canyon wall and across the existing pulp mill filter area, to connect to the existing raw water line near the BLWTP. The new raw water line would be designed to be completely drained when not in use. A connection to the existing raw water line in Sawmill Creek Road would be made to allow the plant to operate using the existing penstock water line during high turbidity events. Power for the intake would come from the pulp mill filters.

A geotechnical investigation would be required prior to design and construction of the intake. The investigation would include rock coring of the canyon wall to determine the quality of the rock and degree of anchoring required for the piping.

5.1.1.2 Pre-Treatment

The available water quality data, which is currently very limited, from Sawmill Creek indicates that it is good with low turbidity, high UV_{254} transmissivity, and low organics and other contaminant concentrations. Additional data should be collected during storm events, fish valve releases, and dam spillover to confirm that this water quality will remain consistently high. Because the water flow in Sawmill Creek is substantially controlled by the CBS electrical department, the reach of the river is not subject to the same erosion and deposition events as Indian River.

Based on the good raw water quality, the overall pretreatment needs for Sawmill Creek are fairly low. For all of the alternatives, coagulant addition would be required to help remove the few organics that are present. Provisions are also included to mitigate the uncertainty of the raw water quality, during storm events or other assumed higher turbidity events, coagulation would be critical to help remove particles from the water. The coagulant will be injected as far upstream as practical with a rapid mixer to allow for the longest contact time with the water possible.

- Up-flow Clarification & Granular Media Filtration - No tube settler pre-treatment would be required.
- Membrane Filtration - Coagulant addition would enhance organics removal and improve long term membrane performance.

5.1.1.3 Filtration

Any of the filtration alternatives discussed in Section 4 would provide adequate treatment. The site adjacent to the UV Facility is limited, so options with a smaller footprint would be favored at this site.

5.1.1.4 CT

Chlorine contact time (CT) would be accomplished by injecting chlorine at the UV Facility. This would require the installation of on-site hypochlorite generation equipment and the ancillary pumping equipment at the UV Facility, where space is already dedicated for this upgrade. The filtered water would flow through the UV Facility piping, chlorine would be injected, and the water would flow through the 30-inch transmission main to town, with CT reached along the pipeline before the first customer.

5.1.1.5 Backwash Disposal

Backwash from any of the pre-treatment and filtration processes would be routed to an equalization basin and recycle system. Solids would be pumped to the sanitary sewer system. The entire GPIP is served by a lift station with a force main that pumps the sewage along Sawmill Creek

Road through a series of lift stations to the WWTP for treatment. The lift stations along Sawmill Creek Road are generally small, so recycling the backwash to reduce the volume is necessary.

The final option for backwash disposal would be to settle and recycle the backwash water on site and pipe the settled solids to the existing sanitary sewer system.

5.1.2 Land Requirements

The existing lot is bounded by roads with existing rights of way (ROW). The CBS ROW could be adjusted, if needed to accommodate the filtration plant footprint. The site would be combined with the UV Facility site, providing one access point and a continuous fence around both facilities.

5.1.3 Potential Construction Problems

Construction of an intake in Sawmill Creek will be challenging. In the area above the tidally influenced zone, the creek is in a narrow canyon with shallow bedrock. Construction of an intake wet well will require rock blasting in the canyon or construction of a fish-friendly dam. The routing of the raw water pipeline from the intake to the WTP will also require a significant amount of rock blasting. Rock blasting work in the Sawmill Creek canyon will require permitting and construction windows that minimize disturbances on the anadromous fishery in the creek.

The location adjacent to the UV Facility provides good construction access with minimal interruption to existing utility operations during the construction of the filtration facility and associated infrastructure.

5.1.4 Advantages/Disadvantages

Advantages:

- High quality source water with adequate existing water rights.
- Good proximity to existing infrastructure (power, sewer, raw water, finished water).
- Generally known and good geotechnical conditions for construction.
- Available property with no need for demolition of existing infrastructure.

Disadvantages:

- Difficult to construct intake and pipeline to provide water during penstock outages.
- Limited ability to handle large volumes of backwash water.
- Does not provide a fully redundant water source.

5.2 Sawmill Creek – At Pulp Mill Filters

5.2.1 Description

A pulp mill operated in Sawmill Cove for nearly 35 years. The mill was closed in the early 1990's, with ownership of the mostly demolished infrastructure transferred to CBS in the late 1990's. The pulp mill filter basins are located on the northeast side of Sawmill Cove above the BLWTP and hydropower facility, as shown in Photo 10. The filter basins are approximately 200 feet in length on each side, with some existing walls. This site is level, with bedrock and shallow gravel fill supporting the existing infrastructure. Figures 4 and 5 show the proposed plant location and size, intake and piping connections. The site has adequate available electrical power supply for any of the pretreatment and filtration options considered.

Review of the filter basin drawings indicate that the existing filter floors could be used as the building foundation. Depending on the final building design several modifications to the slab may be required including; a concrete pedestal on the existing slab, cutting the slab to provide larger footings, or rock anchors to mitigate overturning forces. The building should have a concrete curb with waterstop poured around the outside to prevent water from entering the building. During design, an evaluation of the existing pulp mill filter floors would be conducted to confirm the concrete strength and reinforcing locations. It is assumed that these issues can be resolved for estimating the cost of this option.

Photo 10 - Pulp Mill Filter Basins

5.2.1.1 Intake

The intake considerations for this option are the same as those for the site adjacent to the UV Facility and are discussed in Section 5.1.1.1. Photo 11 shows the potential intake location.

A connection to the existing raw water line at the BLWTP would be made to allow the plant to operate using the existing penstock water line during high turbidity events. Power for the intake would come from the power supply for the new filter plant.

Photo 11 - Potential Intake Location in Sawmill Creek

5.2.1.2 Pre-Treatment

The pretreatment considerations for this option are the same as those for the site adjacent to the UV Facility and are discussed in Section 5.2.1.0.

5.2.1.3 Filtration

Any of the filtration alternatives discussed in Section 4 would provide adequate treatment. The site at the pulp mill is adequate for any of the filtration options.

5.2.1.4 CT

Chlorine contact time (CT) would be accomplished by injecting chlorine using the existing Blue Lake WTP gas chlorination system. Water would then flow through the 30-inch transmission main to town with CT reached along the pipeline before the first customer. When CBS is ready to replace the gas chlorination system, chlorine could be injected using an on-site hypochlorite generation system located at the UV Facility as described in the previous option.

5.2.1.5 Backwash Disposal

Backwash from any of the pre-treatment and filtration processes would be routed to an equalization basin and recycled. Solids would be pumped to the sanitary sewer system. This would require the sanitary sewer line on the bridge crossing Sawmill Creek to be upsized. The entire GPIP is served by a lift station with a force main that pumps the sewage along Sawmill Creek Road through a series of lift stations to the WWTP for treatment. The lift stations along Sawmill Creek Road are generally small, so recycling the backwash to reduce the volume for disposal is required.

The existing utility bridge over Sawmill Creek is aged. CBS staff requested that if the bridge were utilized for this project, that a new bridge would be considered. An evaluation and recommendation for a new bridge was outside the scope of this review, but should be considered if this site is selected.

5.2.2 Land Requirements

The existing facility has limited access and signage to keep out the general public. It is adequately sized to hold any of the filtration and pre-treatment options considered. Access would need to be maintained for the infrastructure that provides water to the hatchery as well as the existing bulk water delivery line. The filtration facility could be located to avoid any impacts to this existing infrastructure.

5.2.3 Potential Construction Problems

Construction of an intake in Sawmill Creek will be challenging. In the area above the tidally influenced zone, the creek is in a narrow canyon with shallow bedrock. Construction of an intake wet well will require rock blasting in the canyon or construction of a fish-friendly dam. The routing of the raw water pipeline from the intake to the WTP will also require a significant amount of rock blasting. Rock blasting work in the Sawmill Creek canyon will require permitting and construction windows that minimize disturbances on the anadromous fishery in the creek.

Demolition of the existing pulp mill filter walls is anticipated to be straightforward using a concrete saw to only remove the desired portions of the wall. There is uncertainty and risk with any demolition work, which is higher with selective demolition that hopes to leave portions of an aged structure undisturbed.

The location at the pulp mill filters provides good construction access with minimal interruption to existing utility operations during the construction of the filtration facility and associated infrastructure.

5.2.4 Advantages/Disadvantages

<u>Advantages:</u>

- High quality source water with adequate existing water rights.
- Level site with adequate space for facility.
- Less complex intake pipe routing than the UV Facility location.

- Good proximity to existing infrastructure (power, sewer, raw water, finished water).

Disadvantages:

- Some demolition of the existing pulp mill filters will be required for a reliable building foundation.
- Utilization of the existing filter base as the foundation will require a code waiver for minimum footing depths for frost protection.
- The slab will act as a thermal bridge between the interior and exterior of the building, which may cause condensation problems and increase the heating cost for the building.
- Need to provide sanitary sewer connection for backwash disposal, and limited ability to handle large volumes of backwash water due to wastewater collection system limitations along Sawmill Creek Road.
- Option does not provide a fully redundant source.
- Difficult to construct intake to supply water during penstock outages.

5.3 Indian River

5.3.1 Description

CBS's existing Indian River infiltration gallery and pumping station property could be used for a filtration facility. The property is located at the end of Indian River Road and is located between a hiking trail and Indian River. The site currently has a perforated pipe intake and a gated culvert to move water from the river into an off-channel infiltration gallery. When in use, water was pumped from the infiltration gallery into the distribution system with chlorine addition. To use this facility for a permanent filtration system, the existing infrastructure would need to be demolished and a new intake and treatment plant constructed. Figures 6 and 7 show the proposed plant location and size, intake and piping connections. The site has adequate available electrical supply for any of the pretreatment and filtration options considered.

The existing municipal water right in Indian River is for 2.5 MGD. A larger water right would be required to provide a permanent filtration system. Additionally, Indian River was recently determined to be a "regulatory floodway" by FEMA. The regluatory floodway determination requires modeling of the river system for downstream impacts from any new construction.

The transmission main from the Indian River site enters the distribution system downstream of the CBS Corrosion Control Facility (CCF) where soda ash is injected for pH adjustment. For short term operations, the CCF can be taken offline.

5.3.1.1 Intake

A new perforated pipe intake would be set in Indian River below the river bottom. Setting the infiltration pipes deeper will allow the system to collect water even when streamflow is low. The pipes would need to be installed with large rocks placed to help keep alluvial material covering the pipes and protect them from large debris moving through the riverbed. The pipes would be routed to a wet well constructed outside of the river channel, where pumps would be located to supply the filtration facility.

Photo 12 - Existing Perforated Pipe Intake

Depending on the final site layout and any influent head requirements for the treatment system, the raw water pumps from the temporary filtration project can be re-used, with additional pumps added to increase the flow from 4 MGD to 6 MGD.

5.3.1.2 Pre-Treatment

The available water quality data and experience operating the temporary filtration plant during the Blue Lake Dam project show that the water quality at Indian River is highly variable. During good weather periods, the river has low turbidity, high UV_{254} transmissivity, and low organics levels. Storm events can increase turbidity to over 100 NTU in a matter of hours as well as increase organics levels, potentially leading to significant disinfection byproduct formation.

Based on this variability, pretreatment will be required prior to filtration for any options considered. For all of the alternatives coagulant addition would be required. The coagulant will be injected upstream of any flocculation and settling process with a rapid mixer to allow for the longest possible contact time with the water.

- Up-flow Clarification & Granular Media Filtration – A tube-settler will be included in the treatment process to remove solids prior to clarification and filtration.
- Membrane Filtration – Flocculation and settling is required upstream of the membrane process to remove solids prior to filtration. This would be done by construction of two concrete flocculation and settling basins that would be outfitted with parallel plate settlers to reduce the overall basin dimensions.

5.3.1.3 Filtration

Of the filtration alternatives discussed in Section 4, only the tube settler, up-flow clarification, granular media filtration option or membrane filtration with pretreatment would provide adequate treatment of Indian River water, due to the extremely variable nature of the water quality. The site is small and so smaller footprint options are preferred.

5.3.1.4 CT

There is inadequate time in the distribution system between the Indian River site and the first customer to achieve CT. A welded steel CT tank would be constructed to provide CT prior to pumping water into the distribution system. The CT tank would be baffled to achieve a minimum baffle factor of 0.5, which allows the tank volume to be 450,000 gallons (60 feet in diameter and 32 feet high).

After CT is achieved, the water will be pumped to the distribution system. The high service pumps from the temporary filtration project can be reused, with additional pumps added to increase the flow from 4 MGD to 6 MGD.

5.3.1.5 Backwash Disposal

Backwash from any of the pre-treatment and filtration processes would be routed to the sanitary sewer system. This would require a main extension from the existing end of the system in Indian River Road. The lift stations between Indian River and the WWTP are better sized to accommodate the backwash flows from any of the pretreatment and filtration options than the Sawmill Creek alternatives.

5.3.2 Land Requirements

The existing site is small, much of which is occupied by the infiltration gallery. To have adequate space for pretreatment and filtration, the infiltration gallery will need to be filled in to serve as the foundation for the new facility. Even with this additional space, the site is small, and access around the site may be difficult. CBS owns land on the far side of the existing hiking trail, so the site could be expanded with a trail re-route if needed.

5.3.3 Potential Construction Problems

Construction at the Indian River site would be fairly straightforward. Because the site is independent from the rest of the CBS infrastructure, no complicated tie in work would be required.

5.3.4 Advantages/Disadvantages

Advantages:

- Fully redundant water source from Blue Lake and Sawmill Creek.
- Simple intake design with less complex construction.
- Sanitary sewer system better able to convey backwash water to WWTP.

Disadvantages:

- Inadequate existing water right, additional stream flow monitoring to facilitate an intake that can capture the needed flow is necessary.
- Significantly variable flow and riverbed complicates intake design and reliability challenging.
- Water quality in the river is highly variable, requiring a larger and more complicated treatment plant to meet treatment requirements.
- FEMA regulatory floodway designation would require extensive permitting work, which increases cost.
- Location in distribution system requires a clearwell for chlorine contact time prior to distribution.

6. Selection of an Alternative

6.1 Cost Estimates

6.1.1 Capital Costs

The estimated capital costs for each alternative are presented in Table 7. To allow for comparison with the alternatives developed in the CH2M Dedicated Water Line report, the same allowances for construction contingency, design and permitting, construction management, and administration were included in the costs. Detailed cost estimates for each alternative are provided in Appendix D.

Table 7 – Capital Costs

Alternative		Construction[1]	Design[2]	SDC[2]	Permitting[2]	Contingency[3]	Total ($M)
Sawmill Creek Lot 17	Up-flow Clarification & Granular Media Filtration	$11,350,000	$1,420,000	$1,130,000	$100,000	$3,970,000	$18.0
	Membrane Filtration	$15,626,000	$1,420,000	$1,560,000	$100,000	$5,470,000	$24.2
Sawmill Creek Lot 19	Up-flow Clarification & Granular Media Filtration	$11,528,000	$1,440,000	$1,150,000	$100,000	$4,030,000	$18.3
	Membrane Filtration	$15,815,000	$1,440,000	$1,580,000	$100,000	$5,540,000	$24.5
Sawmill Creek - At Pulp Mill Filters	Up-flow Clarification & Granular Media Filtration	$12,730,000	$1,590,000	$1,270,000	$100,000	$4,460,000	$20.2
	Membrane Filtration	$17,010,000	$1,590,000	$1,700,000	$100,000	$5,950,000	$26.4
Indian River	Flocculation, Settling, Up-flow Clarification & Granular Media Filtration	$14,247,000	$1,781,000	$1,420,000	$150,000	$4,990,000	$22.6
	Flocculation, Settling, and Membrane Filtration	$25,524,000	$2,137,200	$2,550,000	$150,000	$8,930,000	$39.3

1. The cost estimates are prepared based on preliminary information, and based on assumptions, vendor quotes, and preliminary estimates of quantities. The expected accuracy range for this type of estimate are -20% to -50% on the low end, and +30% to +100% on the high range side.

2. Estimates for design, engineering services during construction (SDC), and permitting are percentages of the construction value adjusted for project definition and complexity.

3. Contingency is set at 35% to match the CH2M Dedicated Water Line Report, and is the minimum recommended contingency for this project definition level.

6.1.2 O&M Costs

The operation and maintenance costs for the intake and pumping systems for each alternative will be very similar. The different operation costs are dependent on the treatment technology selected rather than the location.

Table 8 – Daily O&M Costs

	Treatment Technology	
	Up-flow Clarification & Granular Media Filtration	**Membrane Filtration**
Chemicals[1]	$500/day	$535/day
Power[2]	606 kWH/day	815 kWH/day
Startup/Shutdown Labor (hours)	9	6
Daily Operating Labor (hours)	5	5
Cost[3]	$1,400	$1,300

1. Assumes same coagulant dose for each water source. Indian River may have higher chemical use than Sawmill Creek due to lower quality raw water. Does not include chlorine cost, the dose is assumed to be the same for each.
2. Power consumption does not include raw water pumping, finished water pumping, or building use. Costs presented are for comparison of equipment provided for each technology.
3. Cost for one day of operation and one day of startup/shutdown.

Table 9 summarizes the annual O&M costs of a granular media filtration facility compared with the cost of operating the existing UV Facility. The operating costs for the filtration facility in this table assume 24 hour per day operation at an average annual flow of 3.0 MGD. The actual costs will vary based on flows, the final coagulation chemical selected, and the water quality which impacts the amount of chemical required. These costs should be reviewed and updated as the filtration facility design progresses.

Table 9 - Annual O&M Costs

Treatment System	Annual Operating Cost
Existing UV Facility[1]	$275,000
Filtration Facility with Penstock Supply[2]	$531,000
Filtration Facility with Sawmill Creek Supply[3]	$600,000

1. Based on 2017 Actual Operating Expenditures for Water Treatment

6.2 Non-Monetary Evaluation

The relative advantages and disadvantages of the filtration alternatives and site and source alternatives are compared using a numerical scoring approach. The scoring process is summarized in selection matrices. The left column of the matrix contains important criteria that are considered for comparing the alternatives. Each alternative was given a score (1 poor to 5 excellent) for each of the criterion. The scores for each alternative were summed to give a total score.

6.2.1 Location Alternatives

Table 10 - Location Non-Monetary Scores summarizes the non-monetary evaluation of the location alternatives.

Table 10 - Location Non-Monetary Scores

		Sawmill Creek - Adjacent to UV Facility		Sawmill Creek - At Pulp Mill Filters		Indian River	
	Weight	*Score*	*Weighted Score*	*Score*	*Weighted Score*	*Score*	*Weighted Score*
Raw Water Quality	3	5	15	5	15	2	6
Raw Water Availability (water rights)	4	5	20	5	20	2	8
Raw Water Availability (flow)	4	5	20	5	20	2	8
Intake Complexity	2	2	4	2	4	4	8
Pre-Treatment Requirements	4	4	16	4	16	2	8
Ability to meet CT	2	5	10	5	10	2	4
Backwash	2	3	6	2	4	4	8
Construction Complexity	2	5	10	3	6	3	6
Total Score			**101**		**95**		**56**

6.2.2 Treatment Technology Alternatives

Table 11 summarizes the non-monetary evaluation of the treatment technology alternatives.

Table 11 - Treatment Non-Monetary Scores

		Upflow Clarification & Granular Media Filtration		Membrane Filtration	
	Weight	*Score*	*Weighted Score*	*Score*	*Weighted Score*
Operational Complexity	4	4	16	3	12
Treatment Performance	4	4	16	5	20
Ease of Startup/Standby Transition	3	4	12	4	12
Operations Need In Standby	1	4	4	3	3
Amount of Backwash Production	3	5	15	3	9
Reliability	4	4	16	5	20
Safety	3	5	15	4	12
Total Score			**94**		**88**

7. Conclusion and Recommendations

7.1 Conclusion

Based on the evaluation of capital and operating costs and non-monetary factors, an intermittent filtration plant treating Sawmill Creek water and located on Lot 17 adjacent to the existing Ultraviolet (UV) Facility is the recommended alternative. The primary advantages of this option are lower capital and operational treatment costs due to higher quality source water that allows for more affordable treatment options.

The advantages and disadvantages of the recommended alternative are summarized below.

Advantages:

- Generally high quality source water with adequate existing water rights, but needs additional sampling to confirm.
- Good proximity to existing infrastructure (power, sewer, raw water, finished water).
- Generally known and good geotechnical conditions for construction.
- Available property with no need for demolition of existing infrastructure.
- Relatively small footprint requirements.
- Multiple trains allow for flexibility in operating loading rates based on flow demands and water quality.
- Reduced backwash volumes compared to membrane filtration.
- No operator involvement in monitoring the system when it is offline.

Disadvantages:

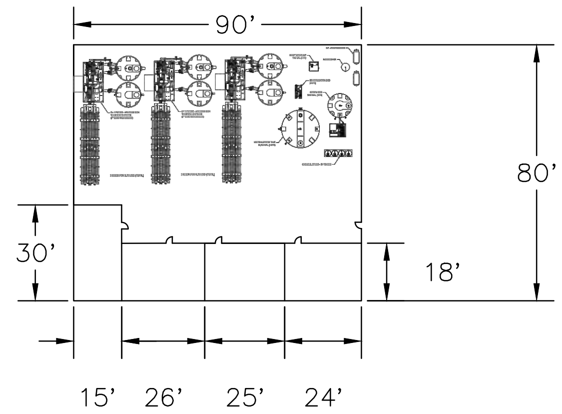
- Difficult to construct intake and pipeline for conveying water during penstock outages.
- Limited ability to treat and dispose of large backwash water volumes.
- Does not provide a fully redundant water source.
- Generally high quality water may be difficult to treat. With lower solids concentration in the raw water, optimizing a solids removal process may be difficult.
- Coagulant dosing will be critical to successful filter operation. High quality source water may require higher coagulant doses.
- Seasoned operator experience and judgment will be needed to optimize treatment process. Vendor or engineering support during the first few operational periods would help provide operator training.
- Additional water quality data from Sawmill Creek is needed to verify selection of the recommended pre-treatment which process.

7.2 Recommendations

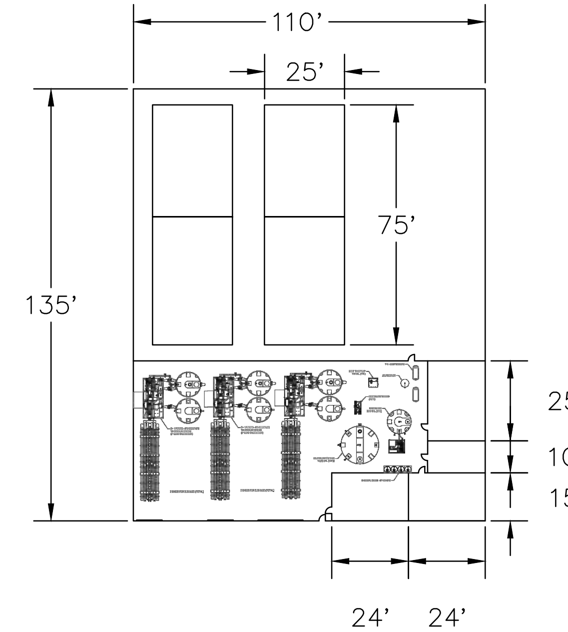
The intake construction in Sawmill Creek has the most uncertainty of the various components of the project. To help alleviate some of this uncertainty, survey and geotechnical work should be completed as soon as practical. To move forward with the selected alternative, the following activities should be pursued.

- Continue collection of water quality data, especially during high flow and poor water quality conditions to help identify the worst case water that will need to be treated.
- Work with ADEC to determine sampling required to establish a new source.
- Perform a geotechnical investigation that includes drilling rock cores to locate the intake. This work will allow for early site development and preliminary permitting activities, as well as facilitate the design of the intake and filtration building foundation.
- Perform a detailed survey of the intake location and site.
- Evaluate construction strategies to quickly and cost-effectively complete the project.
- Once the equipment supplier is selected, move forward with design, permitting, and construction.
- If the selected alternative requires a crossing of Sawmill Creek on the existing utility bridge, an evaluation of options to replace or augment the bridge should be performed.

END

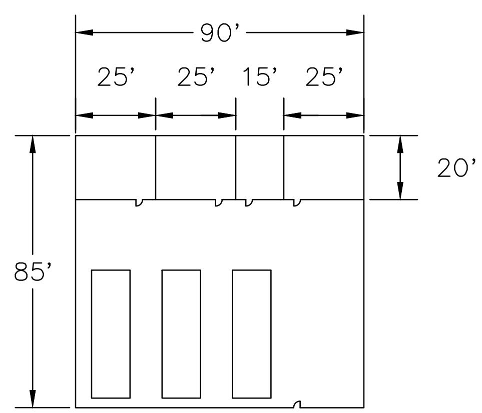


LOT 17, 19 & PULP MILL SITES
NO PRETREATMENT
THREE 2MGD MEMBRANE FILTER SYSTEMS
FOUR EQUIPMENT/WORK SPACES

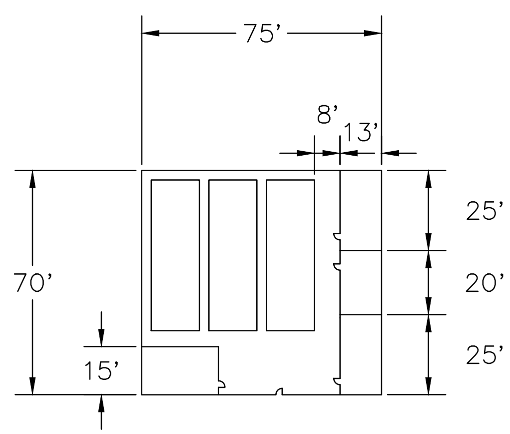


INDIAN RIVER
TWO 3MGD CONCRETE BASIN FLOC/SED PRETREATMENT
THREE 2MGD MEMBRANE FILTER SYSTEMS
FOUR EQUIPMENT/WORK SPACES

1 MEMBRANE FILTRATION BUILDINGS BY SITE

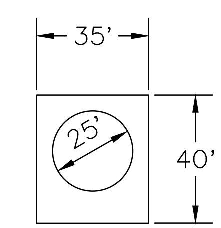


LOT 17, 19 & PULP MILL SITES
THREE 2MGD SYSTEMS (EACH 12'x40')
FOUR EQUIPMENT/WORK SPACES



INDIAN RIVER
THREE 2MGD HIGH SOLIDS SYSTEMS (EACH 15'x47')
FOUR EQUIPMENT/WORK SPACES

2 GRANULAR FILTRATION PACKAGE SYSTEMS BY SITE



3 BACKWASH EQUALIZATION AND RECYCLE SYSTEM

30' 0 30' 60'

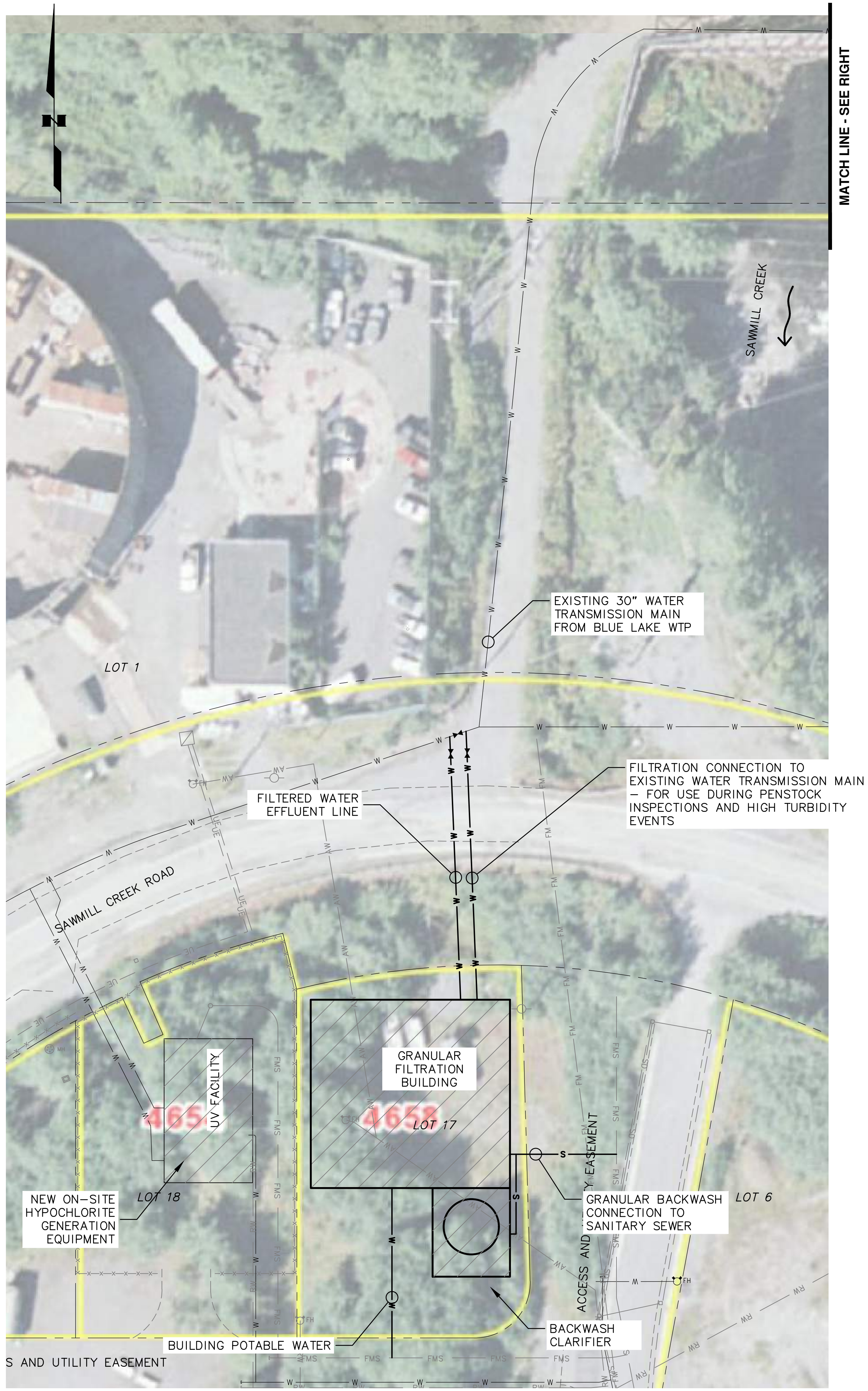
PROJECT: 21201.02
STATUS:

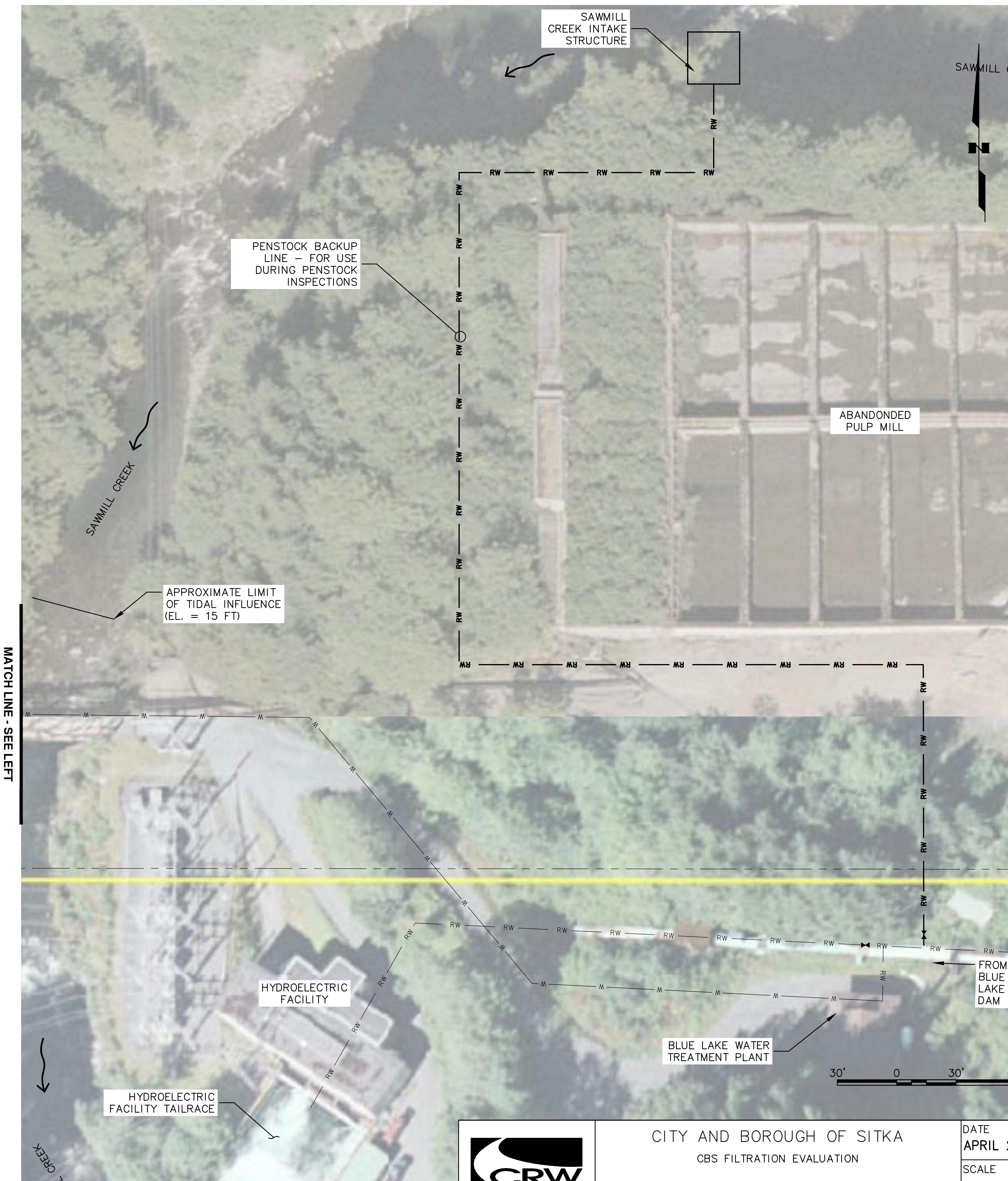
CRW ENGINEERING GROUP, LLC
3940 ARCTIC BLVD, SUITE 300
ANCHORAGE, ALASKA 99503
PHONE: (907) 562-3252
#AECL882-AK

CITY AND BOROUGH OF SITKA
CBS FILTRATION EVALUATION
EQUIPMENT LAYOUT
AND PLANT SIZE

DATE APRIL 2018
SCALE GRAPHIC
FIGURE 1

File: J:\JobsData\21201.02 Cbs Filtration Evaluation\00 CADD\02 Figures\04 Site Visits\21201.02 Building.dwg





PROJECT: 21201.02

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#AECL882-AK

CITY AND BOROUGH OF SITKA

CBS FILTRATION EVALUATION

SAWMILL CREEK LOT 17 – GRANULAR MEDIA FILTRATIONN

DATE	APRIL 2018
SCALE	GRAPHIC
FIGURE	2

File: J:\JobsData\21201.02 Cbs Filtration Evaluation\00 CADD\01 Working Set\01 Civil\21201.02 Sawmill Creek Site Plan.dwg

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PROJECT: 21201.02

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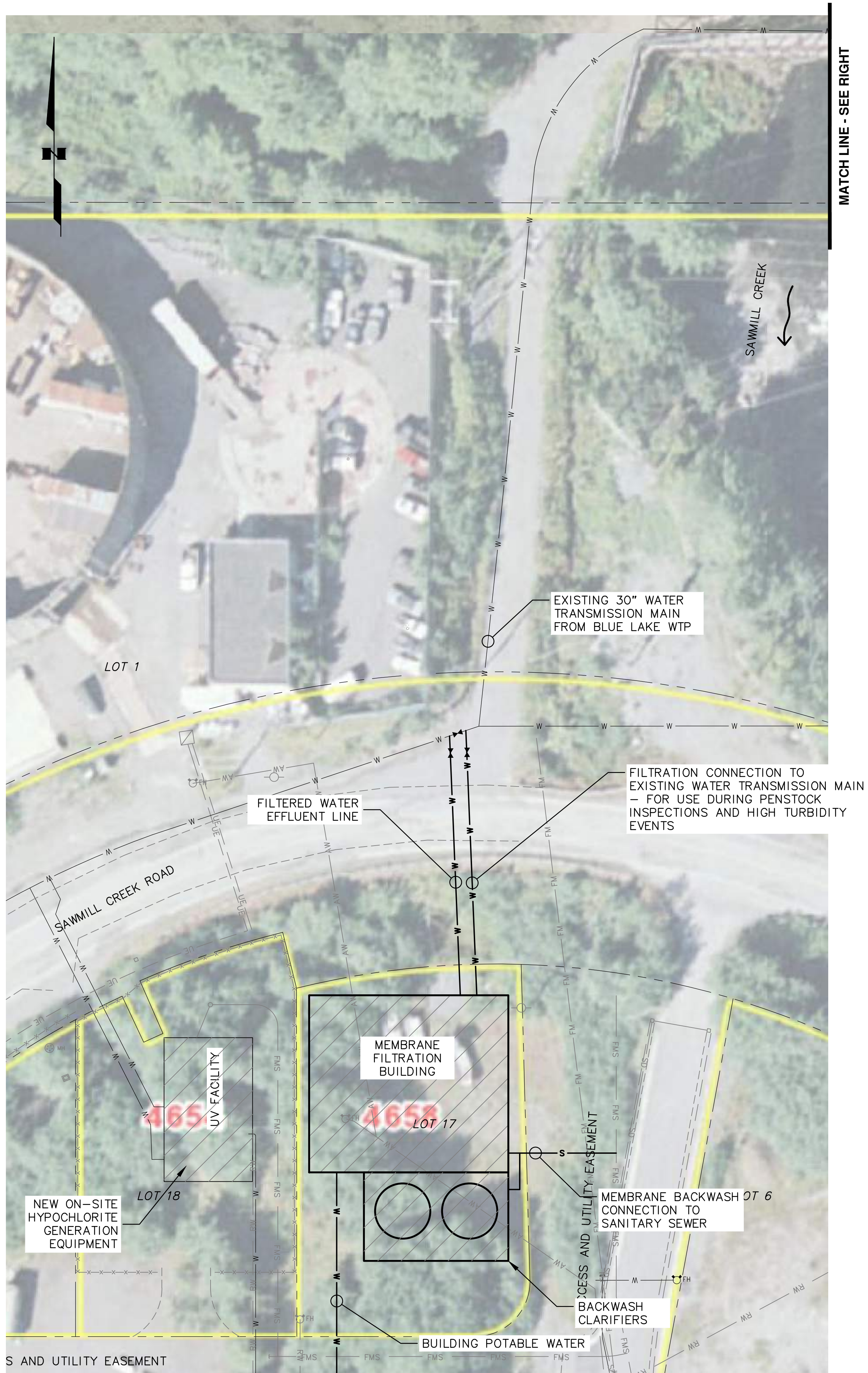
CITY AND BOROUGH OF SITKA

CBS FILTRATION EVALUATION

SAWMILL CREEK LOT 19 – GRANULAR MEDIA FILTRATION

DATE	APRIL 2018
SCALE	GRAPHIC
FIGURE	2A



PROJECT: 21201.02

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ANCHORAGE, ALASKA 99503
PHONE: (907) 562-3252
#AECL882-AK

CITY AND BOROUGH OF SITKA

CBS FILTRATION EVALUATION

SAWMILL CREEK LOT 17 – MEMBRANE FILTRATION

DATE	APRIL 2018
SCALE	GRAPHIC
FIGURE	3

File: J:\JobsData\21201.02 Cbs Filtration Evaluation\00 CADD\01 Working Set\01 Civil\21201.02 Sawmill Creek Site Plan.dwg

PROJECT: 21201.02

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CITY AND BOROUGH OF SITKA

CBS FILTRATION EVALUATION

SAWMILL CREEK LOT 19 – MEMBRANE FILTRATION

DATE	APRIL 2018
SCALE	GRAPHIC
FIGURE	3A

File: J:\JobsData\21201.02 Cbs Filtration Evaluation\00 CADD\01 Working Set\01 Civil\21201.02 Sawmill Creek Site Plan.dwg

30' 0 30' 60'

PROJECT: 21201.02

STATUS:

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PHONE: (907) 562-3252
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CITY AND BOROUGH OF SITKA

CBS FILTRATION EVALUATION

SAWMILL CREEK AT PULP MILL FILTERS – GRANULAR MEDIA FILTRATION

DATE: APRIL 2018

SCALE: GRAPHIC

FIGURE: 4

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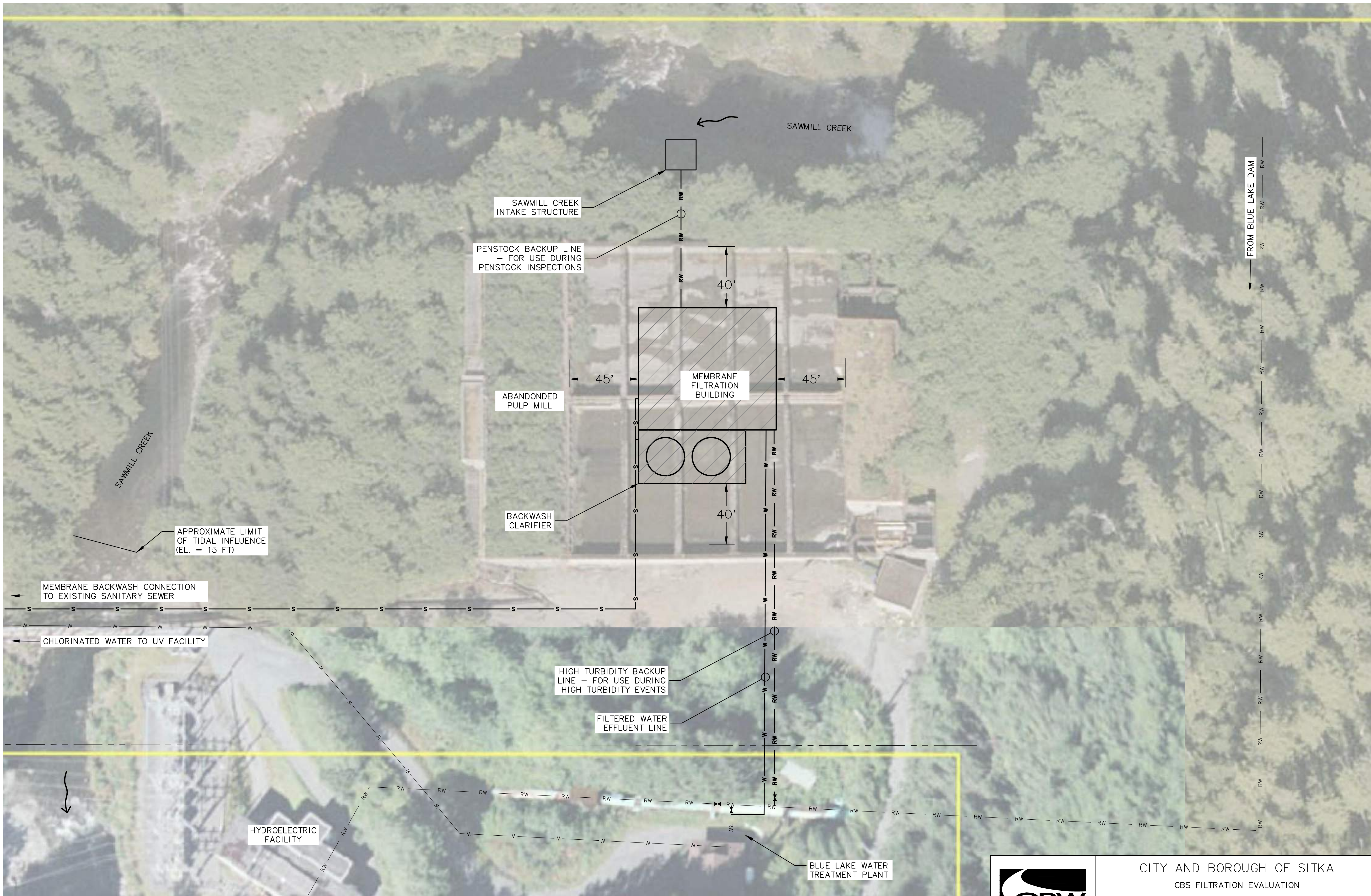

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PROJECT: 21201.02
STATUS:

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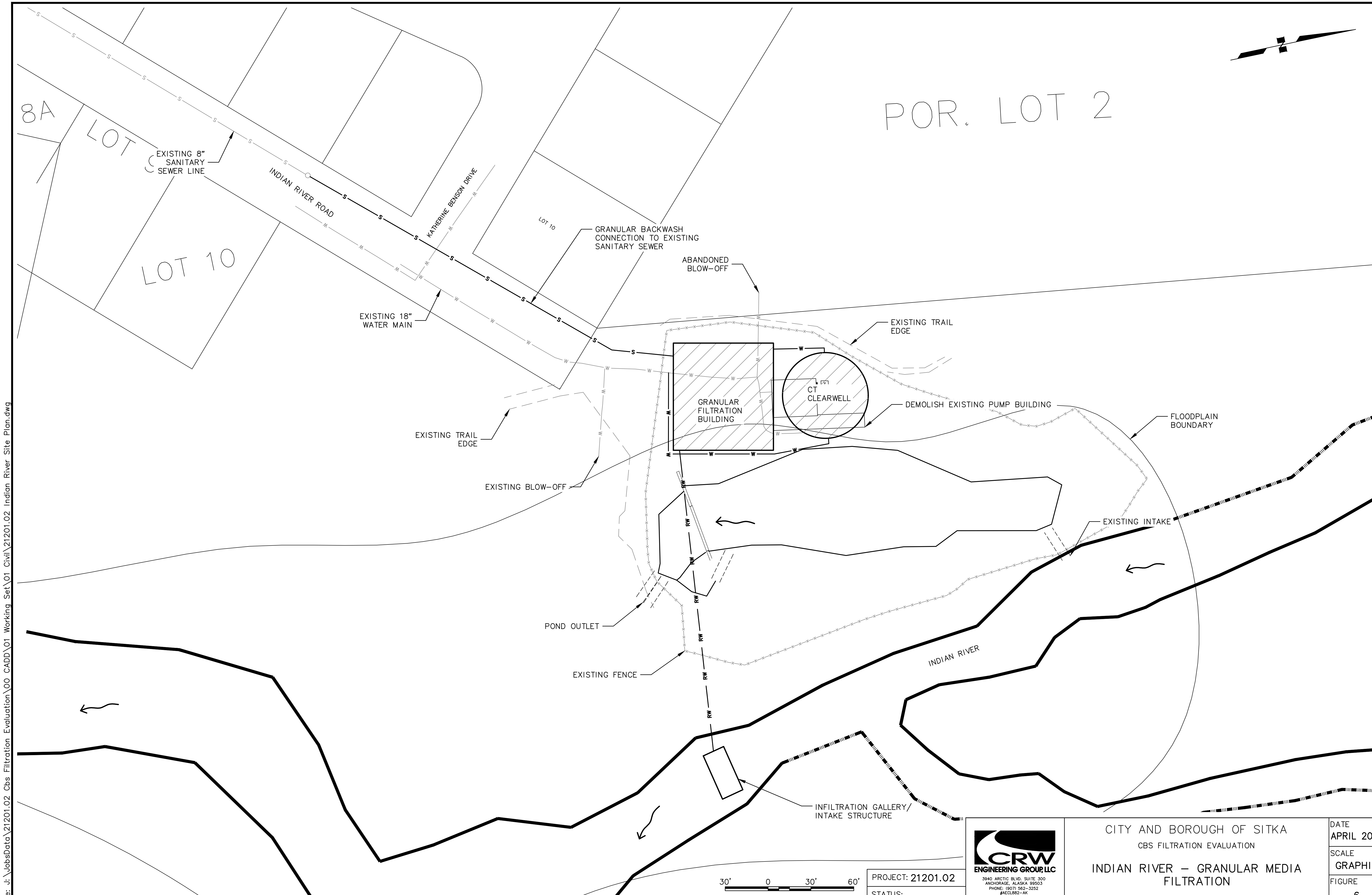
CITY AND BOROUGH OF SITKA
CBS FILTRATION EVALUATION

SAWMILL CREEK AT PULP MILL FILTERS – MEMBRANE FILTRATION

DATE: APRIL 2018
SCALE: GRAPHIC
FIGURE: 5



PROJECT: 21201.02

STATUS:

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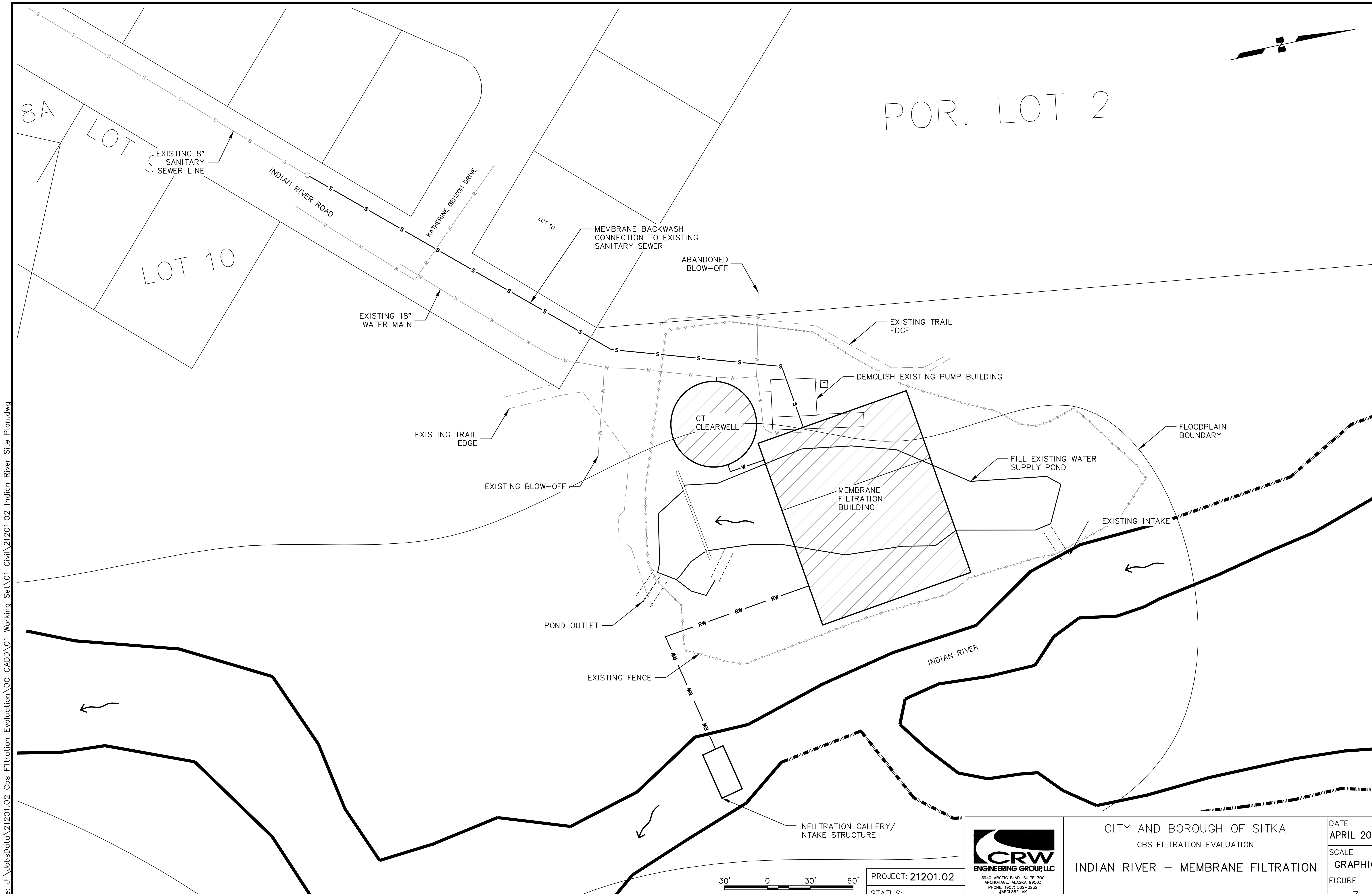
#AECL882-AK

CITY AND BOROUGH OF SITKA
CBS FILTRATION EVALUATION

INDIAN RIVER – GRANULAR MEDIA FILTRATION

DATE: APRIL 2018
SCALE: GRAPHIC
FIGURE: 6

File: J:\JobsData\21201.02 Cbs Filtration Evaluation\00 CADD\01 Working Set\01 Civil\21201.02 Indian River Site Plan.dwg



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Appendix A

Water Quality Data

City and Borough of Sitka - Temporary Filtration Design
Sawmill Creek - Daily Samples

Average	0.62		94.55	11.45	7.03
Min	0.44		92.80	9.20	6.70
Max	0.98		95.80	12.90	7.23

Date	Turbidity (NTU)	Notes	UV254	ALK	PH
1/9/2018	0.44	light snow			
1/10/2018	0.47	O/C 1" snow on ground			
1/11/2018	0.46	clear, 1" snow on ground			
1/12/2018	0.48	P/C, light snow on ground.			
1/15/2018	0.48	P/C , very warm, (60's), snow gone.			
1/16/2018	0.59	O/C Intermittent Showers			
1/17/2018	0.50	O/C	94.9		
1/18/2018	0.48	C			
1/19/2018	0.50	C	95.1	12.4	7.00
1/22/2018	0.52	snow, 2" on ground			
1/23/2018	0.52	snow, 2" on ground			
1/24/2018	0.46	snow, 2" on ground			
1/25/2018	0.55	O/C			6.7
1/29/2018	0.51	C			
1/30/2018	0.47	C			
1/31/2018	0.48	C			
2/1/2018	0.68	O/C			
2/2/2018	0.64	O/C		12.4	
2/5/2018	0.54	C			
2/6/2018	0.55	Light Snow			
2/7/2018	0.48	C			
2/8/2018	0.46	C			
2/9/2018	0.52	C			
2/12/2018	0.80	Rain	95.5	11.5	6.85
2/13/2018	0.72	snow			
2/14/2018	0.58	snow			
2/15/2018	0.56	Snow			
2/16/2018	0.66				
2/20/2018	0.84	C	95.3	10.1	7.23
2/21/2018	0.79	O/C			
2/22/2018	0.57	O/C			
2/23/2018	0.59	rain			
2/26/2018	0.76	snowy rain	95.2	10.8	7.04
2/27/2018	0.69	snow			
2/28/2018	0.62	snow			
3/1/2018	0.98	clear			
3/5/2018	0.68	clear			
3/6/2018	0.77	overcast	95.8	9.2	6.97
3/7/2018	0.66	overcast			
3/8/2018	0.66	overcast			
3/9/2018	0.65	light rain			
3/12/2018	0.56	light rain	92.8	11.4	7.04
3/13/2018	0.53	light rain			
3/14/2018	0.67	clear			
3/15/2018	0.61	clear			
3/16/2018	0.55	clear			
3/19/2018	0.72	light rain	93.5	11.5	7.21
3/20/2018	0.81	light rain			
3/21/2018	0.72	clear			
3/22/2018	0.63	overcast			
3/23/2018		overcast			
3/26/2018	0.79	overcast	93.8	12.9	7.09
3/27/2018	0.88	rain			
3/28/2018	0.88	clear			
3/29/2018	0.62	clear			
3/30/2018	0.68	clear			
4/2/2018	0.51	clear	93.6	12.3	7.18
4/3/2018	0.68				

City and Borough of Sitka - Temporary Filtration Design
Sawmill Creek Water Quality Results

Analyte	**1/29/2018**	**2/26/2018**	**3/19/2018**		
Aluminum (ug/L)	ND	64.9	ND		
Iron Total (ug/L)	32.9	159	ND		
Iron Dissolved (ug/L)	ND	48.3	ND		
Manganese (ug/L)	6.3	11.1	5.6		
Organic Carbon, Total (mg/L)	0.732	0.887	1.1		
Hardness, Total (mg/L as CaCO3)	8	16	11		
Alkalinity, Total (mg/L as CaCO3)	ND	ND	13		
Conductivity (umhos/cm)	35.6	37.2	34		
Total Dissolved Solids (mg/L)	41	68	ND		
Total Suspended Solids (mg/L)	0.8	3	ND		
Silt Density Index (%/min)	6.62	7.29	6.74		
Potassium (mg/L)			ND		
Sodium (mg/L)			1.4		
Sulfur (mg/L)			0.6		
Barium (mg/L)			0.0093		
Magnesiium (mg/L)			ND		
Strontium (mg/L)			0.0089		
Chloride (mg/L)			2.1		
Nitrate as N (mg/L)			0.44		
Fluoride			ND		
Sulfate (mg/L0			2.2		
Ammonia (mg/L)			0.14		
Silica, molybdate-reactive (mg/L)			1.8		
orto-Phopshpate (mg/L)			ND		
Organic Carbon, Dissolved (mg/L)			1.6		
Color, True			ND		

J - estimated value below reporting limit

City and Borough of Sitka - Temporary Filtration Design
Indian River - Daily Samples
Collected daily from the run of the river upstream from the infiltration pond inlet

Average	1.35
Min	0.25
Max	12.80

Date	Turbidity (NTU)	Date	Turbidity (NTU)
7/1/2013	1.78	9/12/2013	1.62
7/2/2013	0.33	9/13/2013	1.52
7/3/2013	0.52	9/16/2013	0.68
7/5/2013	0.32	9/17/2013	0.88
7/8/2013	0.86	9/18/2013	1.21
7/9/2013	0.86	9/19/2013	1.32
7/10/2013	0.75	9/20/2013	2.28
7/11/2013	0.60	9/23/2013	0.74
7/12/2013	0.51	9/24/2013	0.78
7/15/2013	0.48	9/25/2013	0.72
7/16/2013	0.40	9/26/2013	0.88
7/17/2013	0.37	9/27/2013	1.05
7/18/2013	0.25	9/30/2013	1.25
7/19/2013	0.33	10/1/2013	0.71
7/22/2013	0.28	10/2/2013	0.57
7/23/2013	0.35	10/3/2013	0.58
7/24/2013	0.98	10/4/2013	0.67
7/25/2013	1.58	10/7/2013	0.64
7/26/2013	0.34	10/8/2013	0.40
7/29/2013	0.72	10/9/2013	1.12
7/30/2013	0.52	10/10/2013	11.10
7/31/2013	0.45	10/11/2013	8.55
8/1/2013	0.47	10/14/2013	6.26
8/2/2013	0.51	10/15/2013	2.12
8/5/2013	0.80	10/16/2013	1.14
8/6/2013	0.55	10/17/2013	1.02
8/7/2013	0.60	10/20/2013	12.80
8/8/2013	0.57	10/21/2013	1.37
8/9/2013	0.66	10/22/2013	1.11
8/12/2013	0.77	10/23/2013	0.84
8/13/2013	0.92	10/24/2013	0.86
8/14/2013	1.04	10/25/2013	0.80
8/15/2013	1.10	10/28/2013	0.42
8/16/2013	1.18	10/29/2013	0.41
8/19/2013	1.45	10/30/2013	0.64
8/20/2013	1.57	10/31/2013	1.12
8/21/2013	1.58	11/1/2013	0.88
8/22/2013	1.60	11/4/2013	0.33
8/23/2013	1.74	11/7/2013	0.40
8/26/2013	1.74	11/8/2013	0.44
8/27/2013	1.28	11/12/2013	0.34
8/28/2013	1.72	11/13/2013	0.38
8/29/2013	2.13	11/15/2013	2.05
8/30/2013	1.88	11/19/2013	0.53
9/3/2013	1.92	11/22/2013	0.61
9/4/2013	2.02	11/25/2013	0.83
9/5/2013	2.55	11/26/2013	2.04
9/9/2013	1.88	11/27/2013	2.08
9/10/2013	1.68	11/29/2013	2.46
9/11/2013	1.72	12/2/2013	0.42

City and Borough of Sitka - Temporary Filtration Design

Indian River - Weekly Samples

Collected daily from the run of the river upstream from the infiltration pond inlet

min	-0.28	-6.7	9.8	0.031
max	12.8	7.5	20.4	0.26
average	1.57625	7.1	15.76956522	0.078681818

Date	Turbidity (NTU)	pH	Total Alkalinity (mg/L as CaCO3)	UV 254 (cm^{-1})	Notes
7/2/2013	0.33	7.3	13.3	0.097	River was high from rainfall 0.35
7/8/2013	0.86	6.7	10.2	0.260	River was high from rainfall 0.60
7/15/2013	0.48	7.5	17.7	0.037	River was low
7/22/2013	0.28	6.8	16.5	0.032	River was low
7/29/2013	0.71	6.8	16.0	0.033	River was low
8/5/2013	0.80	6.8	16.2	0.051	River was low Rainfall/Fish in Creek
8/12/2013	0.77	6.8	18.2	0.033	River was low/Fish in Creek
8/19/2013	1.45	7.0	18.0	0.113	River was low/Fish in Creek
8/26/2013	1.74	6.9	20.0	0.045	River was low/Fish in Creek
9/3/2013	1.92	7.0	19.7	0.081	River was low/Fish in Creek
9/9/2013	1.88	7.0	20.2	0.120	River was low/Fish in Creek
9/16/2013	0.68	7.1	20.4	0.033	River was low/Fish in Creek No Rain
9/23/2013	0.74	7.2	15.9	0.126	Lots of Rain over Weekend
9/30/2013	1.25	7.2	17.8	0.059	Lots of Rain over Weekend
10/7/2013	0.64	7.2	15.5	0.105	Lots of Rain over Weekend
10/14/2013	6.26	7.1	9.8	0.176	Lots of Rain over Weekend
10/20/2013	12.8	7.3	none	none	River was high, 1.6 inches of rain
10/21/2013	1.37	7.5	12.1	0.105	Lots of Rain over Weekend
10/28/2013	0.42	7.3	11.3	0.06	River is low and Clear
11/4/2013	0.33	7.3	15.9	0.049	River is low and Clear
11/12/2013	0.34	7.3	15.6	0.031	River is low and Clear
11/19/2013	0.53	6.9	15.0	0.039	River is low and Clear
11/25/2013	0.83	7.3	13.8		River is low and Clear
12/2/2013	0.42	7.1	13.6	0.046	River is low and Clear

City and Borough of Sitka - Temporary Filtration Design

Indian River - Weekly Samples

Collected from the run of the river, upstream of the gate that allows water into the pond

	7/30/2013	**8/29/2013**	**10/1/2013**	**10/9/2013**	**10/29/2013**	**12/3/2013**			
Notes	Run of River	Run of River	Run of River	Run of River			min	average	max
Alkalinity, Carbonate (mg/L as CaCO3)				ND	ND	ND	0.00	#DIV/0!	0.00
Alkalinity, Bicarbonate (mg/L as CaCO3)				15.1	14.8	14.8	14.80	14.90	15.10
Alkalinity, Total (mg/L as CaCO3)	20.4	22.8	17.6	15.1	14.8	14.8	14.80	17.58	22.80
Aluminum, Total (mg/L)	0.0157	0.0746	0.0213	0.539	0.0504	0.0882	0.02	0.13	0.54
Ammonia-N (mg/L)		1.09					1.09	1.09	1.09
Barium (mg/L)		0.00476					0.00	0.00	0.00
Carbon Dioxide (ug/L)		7410					7410.00	7410.00	7410.00
Chloride (mg/L)		2.92					2.92	2.92	2.92
Chlorine, Total (mg/L)		0.01					0.01	0.01	0.01
Color, Apparent (CU)		6					6.00	6.00	6.00
Color, True (CU)		6					6.00	6.00	6.00
Conductivity (umhos/cm)	52.6	71.5	54.8	50.1	45	51.1	45.00	54.18	71.50
Copper (mg/L)		0.00236					0.00	0.00	0.00
Fluoride (mg/L)		0.01					0.01	0.01	0.01
Hardness, Calcium (mg/L)	15.2		16.8		13.7	15.4	13.70	15.28	16.80
Hardness, Total (mg/L as CaCO3)	17.7	23.4	19.4	17.8	16	18.3	16.00	18.77	23.40
Iron, Dissolved (mg/L)	0.029	0.0238		0.157	0.072	0.0494	0.02	0.07	0.16
Iron, Total (mg/L)	0.06	0.28	0.0413		0.115	0.163	0.04	0.13	0.28
Magnesium (mg/L)		0.831					0.83	0.83	0.83
Manganese, Total (mg/L)	0.00188	0.0111	0.00316	0.0522	0.00495	0.00884	0.00	0.01	0.05
Nitrate-N (mg/L)		1.2					1.20	1.20	1.20
Organic Carbon, Dissolved (mg/L)		1.04					1.04	1.04	1.04
Organic Carbon, Total (mg/L)	0.77	1.5	1.64	6.2	2.49	0.81	0.77	2.24	6.20
pH	7.12	7.29	7.24	6.8	7.15	7.25	6.80	7.14	7.29
Phosphate, Ortho as P (mg/L)		0.18					0.18	0.18	0.18
Phosphate, Total as P (mg/L)		0.26					0.26	0.26	0.26
Potassium (mg/L)		0.809					0.81	0.81	0.81
Silica, Colloidal (mg/L)	3.89	4.45	4.09	2.82	3.77	4.21	2.82	3.87	4.45
Silica, Reactive (mg/L)		4.3					4.30	4.30	4.30
Silt Density Index (%/min)	16				73		16.00	44.50	73.00
Sodium (mg/L)		2.57					2.57	2.57	2.57
Strontium (mg/L)		0.0248					0.02	0.02	0.02
Sulfate (mg/L)		2.99					2.99	2.99	2.99
Sulfur (mg/L)		1.21					1.21	1.21	1.21
Total Dissolved Solids (mg/L)	58	48	55	64	62	23	23.00	51.67	64.00
Total Suspended Solids (mg/L)	ND	5.2	ND		ND	ND	5.20	5.20	5.20
Turbidity (NTU)	0.2	1.8	0.7		2.1	0.9	0.20	1.14	2.10
UV 254 (cm^{-1})	0.027		0.035	0.4	0.1	0.044	0.03	0.12	0.40

Appendix B

Correspondence

CRW ENGINEERING GROUP, LLC

Phone Call

Date: 2/2/2018 1:30 PM - 1:45 PM
Invitees: Rebecca Venot, Christi Meyn, Scott Forgue
Attendees: Rebecca Venot (CRW Engineering Group LLC), Christi Meyn (CRW Engineering Group, LLC), Scott Forgue (State of Alaska, Dept. of Environmental Conservation)
Reporter: Rebecca Venot – CRW Engineering Group, LLC
Location: Call to Scott Forgue
Project: CBS Filtration Evaluation
Subject: Filtration Alternative Regulation Discussion
Comments:

Rebecca and Christi called Scott Forgue to discuss the regulatory requirements of filtration in Sitka.

We outlined that we are evaluating filtration alternatives for use by Sitka during times the existing supply is not useable for either:
1. Hydropower facility pentstock use
2. Water quality in Blue Lake that does not meet the filtration avoidance requirements.

Indian River
We noted that Sitka does not currently have adequate water rights for normal situations, and would need to pursue additional water right. We explained that a permanent facility at Indian River would include:

- Intake improvements
- Pretreatment (coagulation/settling) for organics and turbidity removal
- Filtration
- Chlorine Injection
- CT Tank

Scott said he was glad that we were considering a more permanent installation that would include better pretreatment and CT than the temporary project in 2014. The facility would require 3 log giardia, 3 log cryptosporidium, 4 log virus treatment unless Sitka wants to sample for a bin determination for crypto.

Sawmill Creek
- We explained that a secondary intake would be provided downstream of the dam with a full filtration facility.
- Scott asked how we would work that into the existing infrastructure and piping schematic, and we noted that this is a big part of our project.
- The filtration plant would require the same level of treatment as Indian River.

Blue Lake Filtration Avoidance Waiver
- Scott said that the filtration avoidance waiver at Blue Lake would not be impacted by a secondary intake at Sawmill Creek. Utilizing different intakes with different treatment regimes is acceptable. There is nothing Scott is aware of in the state or

federal regulations that would indicate a requirement to filter all of the time once filtration is started.

- Scott also mentioned that Shilo had recently asked about declaring an intake at Sawmill Creek a filtration avoidance source. Scott provided her the sampling and source protection requirements, and admitted that it seemed doubtful that the source protection could be adequately met, and the water quality is likely not in compliance with the filtration avoidance requirements.

Cc: Shilo Williams (City and Borough of Sitka)

Site Visit

Date: 2/21/2018 9:15 AM - 6:15 PM

Invitees: Rebecca Venot, Christi Meyn, Shilo Williams, Joe Swain

Attendees: Rebecca Venot (CRW Engineering Group LLC), Christi Meyn (CRW Engineering Group, LLC), Shilo Williams (City and Borough of Sitka), Joe Swain (City and Borough of Sitka)

Reporter: Rebecca Venot – CRW Engineering Group, LLC

Location: Sitka

Project: CBS Filtration Evaluation

Subject: Filtration Evaluation Site Visit

Comments:

Tuesday February 20

Christi and Rebecca departed Anchorage at 9:45 pm, arriving in Sitka just after midnight and proceeded directly to the hotel.

Wednesday February 21

We met with Shilo and Joe at Shilo's office to go over the filtration packages and overall project details.

- Membrane filtration - Pall
  - Could use 3 trains for 6 MGD at Indian River with flocculation/settling pre-treatment.
  - Depending on the water quality at Sawmill Creek may be able to do direct filtration without a flocculation/settling process
  - Good discussion with Pall on intermittent operation
    - chlorine used to control growth in the membranes
    - Weekly chlorine check, with additional added if needed is typically all that's required for standby
    - Generally 1 day or less to prep system for operation.
- Membrane filtration - H2O Innovation
  - No response to request for additional information and increased flows yet.
- Flocculation/Settling - MRI
  - Basins with plate settlers for flocculation/settling
  - Either 2 3MGD trains or 3 2 MGD trains, built as concrete basins.
  - Either option is a similar size.
- Granular media filtration - WesTech
  - Package 3 train system with flocculation, settling, and filtration.
  - Fairly small footprint
  - Operational concerns with intermittent operation - CRW needs to follow up with WesTech for a discussion on this topic.
- Backwash

  - Can consider a basic recycle system, but due to intermittent nature, focus more on sending the backwash water directly to the sanitary sewer.
  - Need to consider sizing of wastewater system between filter plant and WWTP, as well as impacts on WWTP operation
  - Additional backwash flow will not be a concern for WWTP capacity as WWTP reaches approximately half of capacity during storm events in peak season.
  - Need to look into existing EPA discharge permit and if the addition of backwash will exceed flow limitations or other requirements
  - Provide space for potential future backwash handling on site if filtration use becomes a longer-term solution.
- Limited alternative to filtration
  - Could be useful, safe drinking water act allows each state to develop their own additional requirements.
  - Typically includes at least 1 log extra microbial inactivation requirement.
  - Washington state is the only state that has their own regulations in place
  - Will call Scott Forgue to discuss in detail
- Shilo provided an update on her desalinization research
  - Currently has a quote for $10M for the desal equipment only, that does not include intake, pre-treatment, pumping, outfall for brine, building, or any other system components.

The team then visited the Indian River site.

<u>Intake</u>

- Current water right is for only 2.5 MGD. Temporary project had a temporary water right for larger withdraw.
- River level currently so low that the intake configuration to provide water is uncertain.
- USGS stream gage for 2/21 indicated the flow was approximately 4,400 gpm (approx 6.2 MGD), so enough water may be available in the creek.
- The intake dam area had big logs that had not been there on previous visits
- Best option is likely an infiltration gallery, similar to the existing piping, but located deeper in the riverbed to allow the riverbed to shift and change above the piping, plumbed to a wet-well where pumps could be located.
- Smaller slots on the screens than the current configuration would reduce the gravel build-up in the piping.

<u>Site Layout</u>

- With pre-treatment, need nearly all of the available space- would need to fill in the existing infiltration pond or utilize it as excavated subgrade for pre-treatment.
- Clearwell about 600,000 gallons needed to achieve CT for the first customers.

- Finished water pumping required, could re-use pumps from temporary project.
- CBS owns the property on the other side of the hiking trail, but would need significant development and re-routing of the trail.

After lunch, we went to the UV facility
Site Layout

- Property adjacent to UV facility is potentially available, lot lines can be adjusted.
- Site has a raw water line for fire suppression and a hydrant that would need to be relocated.
- In general tie-in to main similar to the way the UV facility ties into the existing mains, no need to connect filter plant to UV plant directly
- Property across the street from the UV facility is considered high value by the industrial park, and would be challenging to secure.

We then visited the pulp mill filters
Site Layout

- Adequate space, level, already owned by the city
- Some existing infrastructure in southwest corner (bulk water and hatchery supply lines)
- Would require significant demolition

We visited the Thompson Harbor wastewater lift station and then wrapped up the day.

Thursday February 22
We toured the wastewater treatment plant as part of the WWTP building envelope/HVAC assessment.

We hiked up the canyon at Sawmill Creek to evaluate intake options.

- CBS controls the flow in SMC, so the river is much less dynamic than Indian River (dam blocks most flood events and sediment transport)
- The creek is subject to saltwater intrusion at the mouth and at least up to the tailrace of the hydropower facility, so a water system intake would need to be upstream of any tidal influence. The extent of tidal influence needs to be determined.
- Electric department provides a minimum of 50 cfs (22,400 gpm) in the stream at all times, additional releases for water supply are not a problem.
- Likely intake construction would be similar to the dam's backup hatchery supply pumps - a concrete structure with screen, and vertical turbine pumps.

We visited the hydropower facility tailrace to look at the hatchery pumps

- Tailrace is subject to saltwater intrusion, so this location wouldn't work for water supply pumps

- Design is simple, using vertical turbine pumps
- Could get drawings from electric utility if needed.

We visited the Blue Lake WTP to discuss connection points to the existing system

- If a filter plant was located at the pulp mill filters, could connect to the penstock and existing water system at the Blue Lake WTP, utilizing existing chlorination equipment.
- Pipe may need to be above ground with provisions for draining when not in use due to rock excavation required to get up above the penstock.

We debriefed at Shilo's office and Christi returned to Anchorage on the evening flight. Rebecca remained in Sitka for the WWTP HVAC/building envelope project on 2/23, and departed that evening.

Cc:

Phone Call

Date: 2/23/2018 3:00 PM - 3:30 PM
Invitees: Rebecca Venot, Scott Forgue, Shilo Williams
Attendees: Rebecca Venot (CRW Engineering Group LLC), Scott Forgue (State of Alaska, Dept. of Environmental Conservation), Shilo Williams (City and Borough of Sitka)
Reporter: Rebecca Venot – CRW Engineering Group, LLC
Location: Phone call to Scott Forgue
Project: CBS Filtration Evaluation
Subject: Limited Alternative to Filtration
Comments:

Shilo and Rebecca called Scott from Shilo's office to discuss the use of a Limited Alternative to Filtration (LAF) for CBS.

Alaska has not yet adopted the Safe Drinking Water Act's (SDWA) provisions for a LAF.

- Regulations adopting a LAF would need to be promogulated through the legislature.
- DEC would need to write the regulation, it would need to go out for public review, and then be incorporated into AAC 18.80.
- Process could take 1-2 years.
- If Sitka found that a LAF was applicable, they would need to request regulation promogulation through Scott.

Ketchikan Public Utilities (KPU) recently investigated the requirements a state program might require

- That work indicated that SDWA and the State of Washington are the only current regulatory examples
- DEC envisioned potentially going the same direction as Washington.
- KPU ended up coming into compliance with the existing regulations and did not pursue further.
- Significant watershed control is required for LAF implementation.

- The Washington LAF allows forgiveness for coliforms outside of the typical filtration avoidance quantities with one additional log-removal for each microbial contaminant provided and a third disinfectant.
- The SDWA does not require an additional disinfectant
- No modifications to turbidity requirements are made in the SDWA or Washington LAF.

Based on the lack of modification to turbidity requirements, a LAF would not likely be suitable for Sitka.
If a LAF were pursued, the Blue Lake watershed is in better compliance with the watershed control that is required for a LAF.

Phone Call

Date: 4/6/2018 9:40 AM - 9:55 AM
Invitees: Rebecca Venot
Attendees:
Reporter: Rebecca Venot – CRW Engineering Group, LLC
Location: Phone Call to Scott Forgue
Project: CBS Filtration Evaluation
Subject: Turbidity Events & Secondary Source
Comments:

Rebecca called Scot to discuss details of managing water sources if filtration is installed.

If filtration is installed on Sawmill Creek, Sitka will develop SMC as a secondary source to use during penstock outages or other problems.

- Current alternatives analysis shows use of the penstock to supply water to the filter plant if the penstock is in service and there is a high turbidity event.
- We are concerned that this would impact the filtration avoidance waiver on Blue Lake, and that we should remove this connection from the study, and plan to only rely on SMC during high turbidity events.

Scott replied that it shouldn't impact filtration avoidance if water from the penstock is filtered during high turbidity events.

- CFR indicates that filtration is required when the source can't meet filtration avoidance requirements, but the CFR is silent on the exact nature of how this is implemented.
- Scott cited
  - Juneau's ability to shut down filtration avoidance and use wells during the time they were maintaining filtration avoidance (have since installed filtration.
  - Cordova has several sources that it utilizes based on water quality.
- Our proposed method is a different way of solving the same problem.

Cc: Shilo Williams (City and Borough of Sitka)

Appendix C

Vendor Data

16133 W. 45th Dr.
Golden, Colorado 80403
Tel (303) 279-8373
Fax (303) 279-8429

BUDGET PROPOSAL FOR FLOCCULATION / SEDIMENTATION SYSTEM

DATE: February 8, 2018
PROJECT: Sitka, AK
REPRESENTATIVE: Chris Hanson
PHONE: 303-279-8373

The following is a proposal for the above referenced project. It includes two (2) complete flocculation/sedimentation systems, with each train designed at 3 MGD, as described below.

Flocculation:

A 3-stage Horizontal Paddle-wheel flocculation system will be provided based on the following design parameters:

Design flow per train:	3 MGD (2,083 gpm)
Detention time at design flow:	45 minutes
No. of stages per train:	3
Basin dimension (L,W,D):	35 ft x 25 ft x 15 ft (SWD)
Dimension of each stage (L,W,D):	11 ft x 25 ft x 15 ft (SWD)
Design G-value 1st Stage (Horsepower):	60 G^{sec-1} (2 HP)
Design G-value 2nd Stage (Horsepower):	45 G^{sec-1} (1 HP)
Design G-value 3rd Stage (Horsepower):	30 G^{sec-1} (0.5 HP)

Each flocculator system shall consist of:

1. Drive motor
2. Gear reduction gear box
3. VFD drive
4. Plastic/Stainless steel drive chain
5. Plastic/Stainless steel chain sprockets
6. Stainless steel shafts
7. UHMW-PE Split shaft bearings
8. Mixing paddles
9. All necessary brackets and fasteners including anchor bolts

Drive motor:

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Fax (303) 279-8429

The drive motor will be a 230/460 3 phase, totally enclosed, fan cooled, inverter duty rated, and premium efficiency. The horsepower will be determined based on the load requirements, the velocity gradient values, drive efficiencies and a predetermined safety factor.

Gear reducer:

The gear reduction is selected based on the required ratio to achieve the desired tip speed and horsepower for the process. All gear reduction units are to be Eurodrive with a AGMA II service factor and are provided with severe duty features and wash down ability.

Variable frequency drive:

An Allen-Bradley VFD will provide variable speeds to optimize the flocculation process. The VFD will be connected to the SCADA via Ethernet or hard wire for monitoring and operating functions. A torque monitor will protect the drive unit in case of a stall.

Chain and sprockets:

Chain and sprocket - The chain and sprocket transfers the power from the VFD to the drive shaft which is located underwater. The sprockets are T-304 stainless steel body and nylon teeth with T-304 stainless steel hardware. The chain is plastic or stainless steel dependent upon load.

Drive shaft:

The stainless steel shaft is sized based on process loads and horsepower. The shaft, hubs, turned down bearing sections are all T-304 stainless steel.

Drive shaft bearing:

The drive shaft bearings are located underwater. The bearings are UHMW-PE split-type and do not require grease. The bearings will be mounted on adjustable 304 S.S. bases to insure proper alignment.

Mixing paddles:

All paddles are made of 22 gauge 304 stainless steel. Each paddle will be 2” x 6”. The size and number paddles will be based on the desired velocity gradient.

Plate Settlers:

An inclined plate settler system will be provided based on the following design parameters:

Design flow per train: 3 MGD (2,083 gpm)
Plate loading rate: 0.25 gpm/ft^2

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Plate area efficiency factor:	90%
Basin dimension (L,W,D):	40 ft x 25 ft x 15 ft (SWD)
Dimensions of plate settler system (L,W,D):	24 ft x 24 ft x 9.4 ft
Plate settlers per cartridge:	95
Plate cartridges per basin:	4 (4 rows x 1 cartridges)
Effluent trough size:	12" x 12" (Inner) & 8" x 10" (Outer)
Head loss through system:	0.83 ft (estimated)

The inclined plate settler systems shall comprise the following elements:

1. Plate settlers w/ patented flow control deck
2. Effluent troughs w/ adjustable weirs
3. Support beams
4. Inlet Diffusers
5. All necessary brackets and fasteners including anchor bolts

All components are of T-304 stainless steel, unless otherwise specified.

Plate settlers:

The plate will be manufactured of 24 gauge minimum thickness. The plates will be shipped in packs which will allow installation with a crane. The plates will be inclined at an angle of 55° from the horizontal. The effluent flow at the top of the plate will be removed by the patented flow control deck. The flow will be removed across the full width of the plate in at least four (4) points to insure even distribution across the full width of the plate.

Effluent Troughs:

The effluent troughs will be located beside the plate rows and not over the plate rows to insure complete visibility of the plate settlers. The effluent troughs will be fastened to the supporting frames no less than every 24 inches to insure stability. The effluent troughs will be equipped with adjustable weirs to insure even flow distribution between the plates.

Support Beams:

The support beams shall be sized accordingly to support the plate packs within the specified deflection.

Inlet Diffusers:

The inlet diffusers mount over the inlet ports to reduce incoming velocities. The diffusers are sized to reduce the incoming flow velocity by a factor of 4. The diffusers are manufactured from 304 stainless steel and mount with wedge anchors, which are included.

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Sludge Collection:

A sludge collection system will be provided based on the following design parameters:

Basin dimension (L,W,D):	40 ft x 25 ft x 15 ft (SWD)
Collectors per basin:	1
Dimensions of sludge collector:	40 ft x 25 ft
Sludge flow per collector:	150-200 gpm
Solids removal concentration:	0.5-1.5%
Head loss through system:	2.5 ft (estimated)

The sludge collector systems shall comprise the following elements:

1. Header Assembly
2. Sludge Exit Pipe
3. Drive Unit
4. Control System

All equipment is to be 304 stainless steel.

Header Assembly:

Each Hoseless Cable-Vac^{TM} will have a header assembly designed to remove the settled solids from the basin floor via tangential feed orifices. The header assembly will be guided by the basin walls without the need of a rail. The Header Assembly consists of four 3" Dia. Suction header pipes and a 6" Dia. Collection Chamber. The solids are removed through orifices in the header pipes and travels into the collection chamber. The flow then enters the sludge exit pipe and exits the basin. The header assembly and orifices within will be sized by the manufacture according to the hydraulic requirements. The suction headers are equipped with Scraper Blades assure complete removal of solids at the ends of the basin.

Sludge Exit Pipe:

The 4" Dia. Sludge Exit Pipe extends from one end of the basin to the midpoint of the basin. The main body of the header assembly telescopes over the sludge pipe as it travels down the basin. The sludge exit pipe will terminate at the desired end of the basin, with a 4" Pipe Flange. The customer will need to provide fixed piping from this flange to the sludge discharge point and an electrically actuated sludge valve to control the sludge flow. MRI will control the opening/closing of this valve.

Drive Unit:

Each Cable–Vac^{TM} unit will have a drive which will move the header assembly by means of a 1/4" stainless steel cable. The drive unit contains a VFD controlled 1/4 HP AC Motor & Gearbox

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and is mounted on the concrete wall or walkway at either end of the basin. All mounting hardware and drive covers are included. All underwater cable sheaves and brackets are included.

Basic Control System:

The control panel to operate the new units shall be located at the plant operator's discretion. There will be one control panel to control all units. 120 VAC power shall be required to the location of each control panel. A ¾ inch conduit shall be required to be run from the control panel to the drive locations and the valve locations.

MRI control panels are designed to control the operation, monitoring and reporting the MRI Hoseless sludge collectors. These panels can be incorporated into the plant controls via communication through Ethernet communications through a RJ 45 connection allowing operation, monitoring and reporting to the plant SCADA.

Each control panel shall be equipped with the following:

- NEMA-12 Aluminum control housing
- Allen Bradley MicroLogix 1100 Programmable Logic Controller (PLC)
- Allen Bradley PanelView HMI Touch Screen Terminal (6")
- Unmanaged Ethernet Switch (5-8 Port)
- Allen Bradley Powerflex Variable Frequency Drive (VFD's)
- Internal DC Power Supply (120VAC to 24VDC)
- Main Line Surge Protectors (for 480VAC & 120VAC)
- Protective Circuit Breakers (AC only)

The control panels will have the following control options:

Hand/Off/Auto

Hand - The unit(s) can be operated from the panel location. All signals from a master control center will be ignored
Off - the unit will not operate at all
Auto - The unit(s) will be started and stopped from the master control center

Manual start (Hand)

Manual Start – Initiates run cycle

Alarm Reset

Alarm Reset – Indicates alarm condition and resets alarm

Travel Speed

Travel Speed – Selects Slow/Med/Fast travel speeds

The use of certain PLC's may add extra cost to the sludge collectors.

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Technical Documents:

A complete set of technical submittals along with installation instructions and O&M Manuals will be included.

Warranty:

All of MRI equipment is warranted against defects in material and workmanship for a period of 12 months after the equipment is put into service.

Installation Inspection and Start-up:

This proposal includes job site visits, by a factory representative for the purpose of installation inspection and mechanical start-up of each unit.

Schedule:

Technical Submittals: 10-12 weeks from receipt of Purchase Order.
Equipment Delivery: 16-18 weeks from approved submittals.

This quotation does not include any items other than those specifically listed above. This quotation does not include Federal, State or Local taxes, permits, duties or fees. All MRI equipment is protected by patents foreign and domestic, issued and pending.

<u>This proposal is valid for a period of 90 days.</u>

BUDGET PRICE FOR (2) 3-stage HPW FLOCCULATOR SYSTEMS: ***$175,000.00***
BUDGET PRICE FOR (2) 3 MGD PLATE SETTLER SYSTEMS: ***$310,000.00***
BUDGET PRICE FOR (2) HOSELESS SLUDGE COLLECTORS: ***$84,000.00***

FOB jobsite is included.

Signed: *Chris Hanson*

Meurer Research, Inc.

Sitka

Alaska

Engineer
CRW Engineers

Furnished by
Adrian Williams
awilliams@westech-inc.com

Represented by
John Simon
Goble Sampson Associates
Issaquah, Washington
(425) 392-0491
jsimon@goblesampson.com

WesTech Opportunity Number: 1830044
Tuesday, February 06, 2018

Item A – TRIDENT® HS Unit

Design Criteria	
Model	1-1/2 HS-2800
Number of Units	3
Tank Dimensions	47 ft 9 in Length x 15 ft 0 in Width x 10 ft 1 in Height
Trident HS Design Flow	4,200 gpm (6 MGD)
Trident HS Design Flow per Unit	1,400 gpm (2 MGD)
Tube Settler Loading Rate	5 gpm/ft^2
Adsorption Clarifier Loading Rate	15 gpm/ft^2
Mixed Media Filter Loading Rate	5 gpm/ft^2
Backwash Method	Air & Water
Material of Construction	Carbon Steel

Technical Description

The Trident® HS system combines tube settlers, Adsorption Clarification and mixed media filtration in a single package treatment system. Raw water is mixed with recirculated sludge and chemically conditioned before being sent to the tube settler section. The tube settler section removes gross solids. Operating in an enhanced coagulation mode, this section provides excellent TOC removal as well as providing good treatment for low quality or flashy waters. Settled sludge is recirculated back to the raw water to build large, fast settling particles and optimize chemical usage. Partially clarified water is then sent to the Adsorption Clarifier stage, where particles that do not easily settle are removed. The water then flows by gravity to a mixed media filter, where small particulates are removed. An optional UV disinfection system inactivates pathogens prior to discharge.

Key Features and Benefits

- Multi-barrier system provides consistently excellent water quality.
- Superlative performance on low quality and flashy waters.
- High rate system minimizes footprint.
- Package treatment system reduces construction time and cost.

The following budget pricing includes:

Tanks finish painted inside and primed on the exterior, bare metal on the bottom. Tube settlers, sludge removal drive and header, sludge recirculation pump, and clarifier transfer pump. Pumps include VFD controller with integral motor starter. Adsorption Clarifier® system MMAC media and retaining screen. MULTIBLOCK® underdrains with Laser Shield™ media retainer, Mixed Media, MULTIWASH® media retaining baffles on filter washtrough. One skid mounted coagulant feed package. Two skid mounted polyelectrolyte feed packages. Influent, inter-clarifier and filter turbidimeters. Two air wash blowers. Automatic and manual valves. Static mixer for combined influent flow. Magnetic flow meters for influent, sludge recirculation and backwash. Ultrasonic level transmitters for tube clarifier and filter. Compressed air system including air dryer and motor starter. Control system with master and local panels. Programmable Logic Controller (PLC) is included for controlling operating and cleaning cycles. Programming includes AQUARITROL® III chemical dosage control system. Freight to the jobsite and startup service.

This proposal has been reviewed and is approved for issue by Mike Stotzer on February 6, 2018.

Item B – Trident® Packaged Treatment System

Design Criteria	
Model	1-1/2 TR-840A
Number of Units	3
Dimensions	39 ft 10 in Length x 11 ft 11 in Width x 10 ft 1 in Height
Trident Design Flow	4,200 gpm
Trident Design Flow per Unit	1,400 gpm
Adsorption Clarifier Loading Rate	15 gpm/ft^2
Design Filter Loading Rate	5 gpm/ft^2
Backwash Method	Air & Water
Material of Construction	Carbon Steel

Technical Description

The Trident Packaged Treatment System combines a unique upflow Adsorption Clarifier® section with a downflow mixed media filter bed for high rate water treatment. The Adsorption Clarifier system includes a buoyant media for increased capture of contaminants with ease of flushing from the system. The mixed media filter combines different sized filter materials to capture decreasing sized particles through the depth of the filter bed. This package design provides reduced footprint and lower capital costs from conventional systems. The Trident system is capable of removing turbidity, suspended solids, color, iron, manganese, odor, taste and parasites such as Giardia lamblia and Cryptosporidium. The AQUARITROL® automatic process controller automatically adjusts chemical feed rates to changing water quality to dose the proper amount of chemicals. All materials in contact with potable water are NSF 61 approved. The system is modular for easy expansion for future needs.

Key Features and Benefits

- Reduces capital costs and footprints by using high rate, packaged treatment
- Simplifies operator interface with automatic control
- Removes the bulk of contaminants in the adsorption clarifier to increase filter run time
- Optimizes chemical dosing by the AQUARITROL automatic process controller
- Eases future expansion with modular design

The following budget pricing includes:

Painted steel tanks with all necessary tank internals including, Adsorption Clarifier buoyant media, MULTIBLOCK® underdrain with Laser Shield™ media retainer, and mixed media filter materials. Also, the system includes inlet flow control with adjustable setpoint, pneumatically operated butterfly valves, two chemical feed packages (normally alum and polyelectrolyte), the AQUARITROL automatic process control PLC program, effluent turbidimeter, two air blowers, and PLC control system, freight to the jobsite, and startup.

This proposal has been reviewed and is approved for issue by Mike Stotzer on February 6, 2018.

Budget Pricing

Proposal Name: Sitka, Alaska
Proposal Number: 1830044
Tuesday, February 06, 2018

1. Bidder's Contact Information

Company Name	WesTech Engineering, Inc.
Contact Name	Adrian Williams
Phone	801.265.1000
Email	awilliams@westech-inc.com
Address: Number/Street	3665 S West Temple
Address: City, State, Zip	Salt Lake City, UT 84115

2. Pricing

Currency		US Dollars
Scope of Supply		
A	TRIDENT® HS Unit	$2,070,000
B	Trident® Packaged Treatment System	$1,078,000
~~C~~	~~Stand Alone SuperSettler™ Model DRH-3120~~	~~$2,800,000~~
	Taxes (sales, use, VAT, IVA, IGV, duties, import fees, etc.)	Not Included

Prices are for a period not to exceed 30 days from date of proposal.

Field Service

Daily Rate	$960

Prices do not include field service unless noted, but it is available at the daily rate plus expenses. The customer will be charged for a minimum of three days for time at the jobsite. Travel will be billed at the daily rate. Any canceled charges due to the customer's request will be added to the invoice. The greater of visa procurement time or a two week notice is required prior to trip departure date.

3. Payment Terms

Submittals Approved	15%
Release for Fabrication	35%
Net 30 days from Shipment	50%

All payments are net 30 days. Partial shipments are allowed. Other terms per WesTech proforma invoice.

4. Schedule

Submittals, after PO receipt	6 to 8 Weeks
Customer Review Period	2 weeks
Ready to Ship, after Submittal Approval	18 to 20 weeks
Total Weeks from PO to Shipment	26 to 30 weeks

Terms & Conditions: This proposal, including all terms and conditions contained herein, shall become part of any resulting contract or purchase order. Changes to any terms and conditions, including but not limited to submittal and shipment days, payment terms, and escalation clause shall be negotiated at order placement, otherwise the proposal terms and conditions contained herein shall apply.

Freight: Prices quoted are F.O.B. shipping point with freight allowed to a readily accessible location nearest to jobsite. All claims for damage or loss in shipment shall be initiated by purchaser.

Paint: If your equipment has paint included in the price, please take note to the following. Primer paints are designed to provide only a minimal protection from the time of application (usually for a period not to exceed 30 days). Therefore, it is imperative that the finish coat be applied within 30 days of shipment on all shop primed surfaces. Without the protection of the final coatings, primer degradation may occur after this period, which in turn may require renewed surface preparation and coating. If it is impractical or impossible to coat primed surfaces within the suggested time frame, WesTech strongly recommends the supply of bare metal, with surface preparation and coating performed in the field. All field surface preparation, field paint, touch-up, and repair to shop painted surfaces are not by WesTech.

Trident® HS

Multi-Barrier Package Water Treatment System

The Trident® HS Package Water Treatment System

The Trident HS package treatment system provides multi-barrier protection for difficult-to-treat surface water, groundwater, industrial process water, and tertiary wastewater. The multi-barrier design of the Trident HS package consists of high-rate settling, adsorption clarification, and mixed media filtration.

Individually and collectively, the multiple treatment stages of the Trident HS system maintain superior effluent performance. The multi-barrier process is extremely well-suited for:

Water sources with:

- **High turbidity and color**
- **"Flashy" rivers and streams**
- **Reduction of High TOC/DBP precursors**
- **Cold waters**

Tertiary treatment in:

- **Water reclamation**
- **Phosphorus removal**

Trident HS Design Criteria

	Raw Water	Finish Water
Turbidity (NTU)	< 400	< 0.1
True Color (Pt-Co Units)	< 100	< 5
Combined Turbidity + Color	< 400	
Iron & Manganese (mg/L)	< 10	< 0.3 / 0.05
TOC (mg/L)		50 - 70% Removal
Phosphorus (mg/L)	< 5	< 0.1

Multi-Barrier Protection

Stage 1 - Chemical Conditioning / Tube Settling

Before water enters the treatment unit, coagulant and polymer are added to begin the coagulation and flocculation process. A sludge recycle flow is introduced near the coagulation point to aid in floc formation. This recycle flow also serves to maintain a steady-state solids concentration, minimizing variations in influent solids concentration.

For plants incorporating enhanced coagulation, the tube clarification stage reduces influent solids concentration prior to the Adsorption Clarifier® stage, leaving the majority of coagulated particles in the tube settler clarifier. For cold water conditions, the tube clarifier provides added detention time.

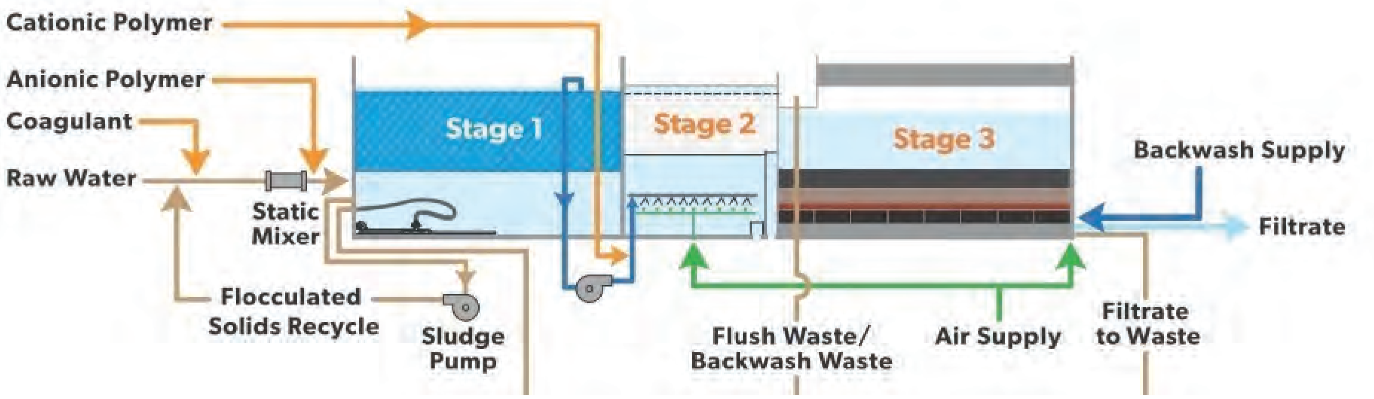
Stage 2 - Enhanced Clarification

A combined bed of both compressible and buoyant bead adsorption media provides second-stage clarification. The Adsorption Clarifier media further reduces solids prior to filtration. Captured solids are periodically flushed from the clarifier using an air / water combination. Tube-clarified water is used for the flushing process.

Stage 3 - Mixed Media Filtration

Mixed media filtration removes the remaining solids using a bed of anthracite, sand, and high-density garnet supported by a direct retention underdrain. For improved filtration, the media surface area per volume increases from top to bottom and the backwashing process incorporates simultaneous air / water backwashing and baffled washtroughs to prevent media loss and assure clean media.

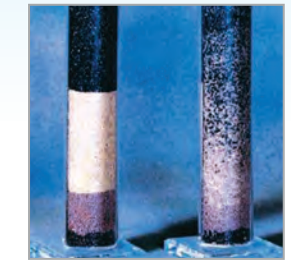
Trident HS Process Flow Diagram

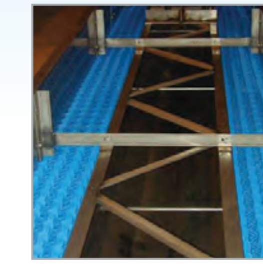


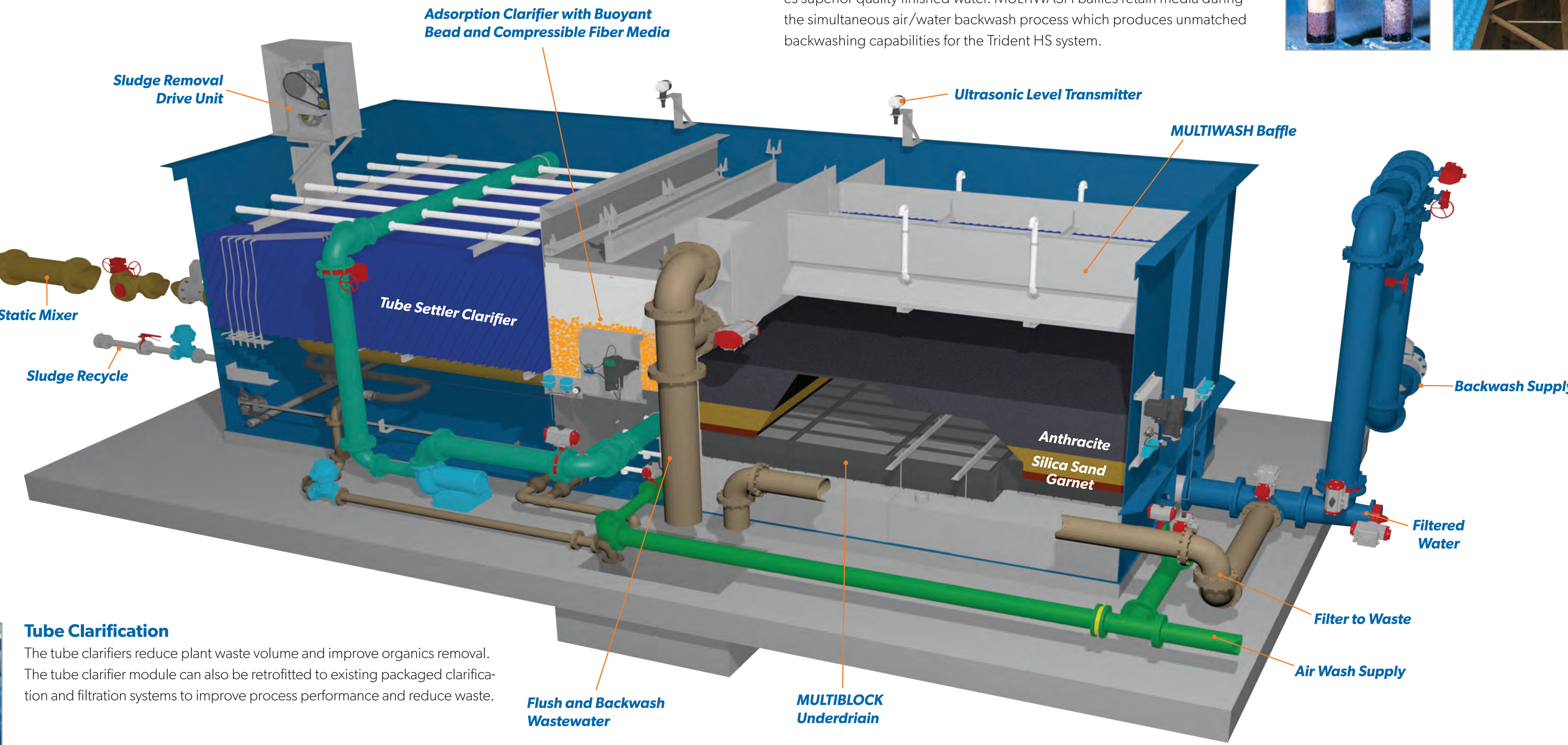
Complete Package Plant

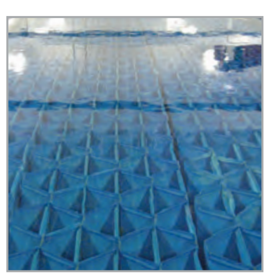
Mixed Media Filtration and MULTIWASH® Baffling

This Microfloc™ pioneered mixed media technology has become the industry standard for filtration. By using three or more granular materials of differing size and specific gravity, the progressive coarse-to-fine mixed media produces superior quality finished water. MULTIWASH baffles retain media during the simultaneous air/water backwash process which produces unmatched backwashing capabilities for the Trident HS system.









Tube Clarification

The tube clarifiers reduce plant waste volume and improve organics removal. The tube clarifier module can also be retrofitted to existing packaged clarification and filtration systems to improve process performance and reduce waste.

Adsorption Clarifier System

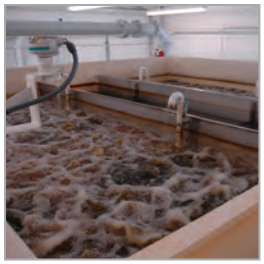
The unique design of the Adsorption Clarifier eliminates the need for settleable floc formation. Therefore, floc size and settling time are not factors. Because of this, Trident systems, as a whole, use significantly less coagulant and polymer than conventional settling clarifiers. The buoyant media is rolled and scarified to greatly improve particulate removal. The compressible fiber media is used to capture more solids. The buoyant and compressible fiber media are NSF-61 certified and typically will last the life of the system.

MULTIBLOCK® Underdrain with Laser Shield™

MULTIBLOCK underdrains offer the proven effectiveness of compensating dual lateral underdrain technology, which evenly collects filtered water. The MULTIBLOCK compensating orifice design also uniformly distributes backwash water and air to keep filters running at peak performance.

At less than one-tenth of an inch thick, the Laser Shield design reduces underdrain surface area per filter area by as much as 200 times when compared to porous bead designs, thus minimizing fouling potential.

Trident HS Efficiencies



Space Efficient

- The package design of the Trident HS system significantly reduces space between different treatment processes in your flow sheet, thus reducing floor space required.
- Operates at higher hydraulic loading rates than conventional systems.

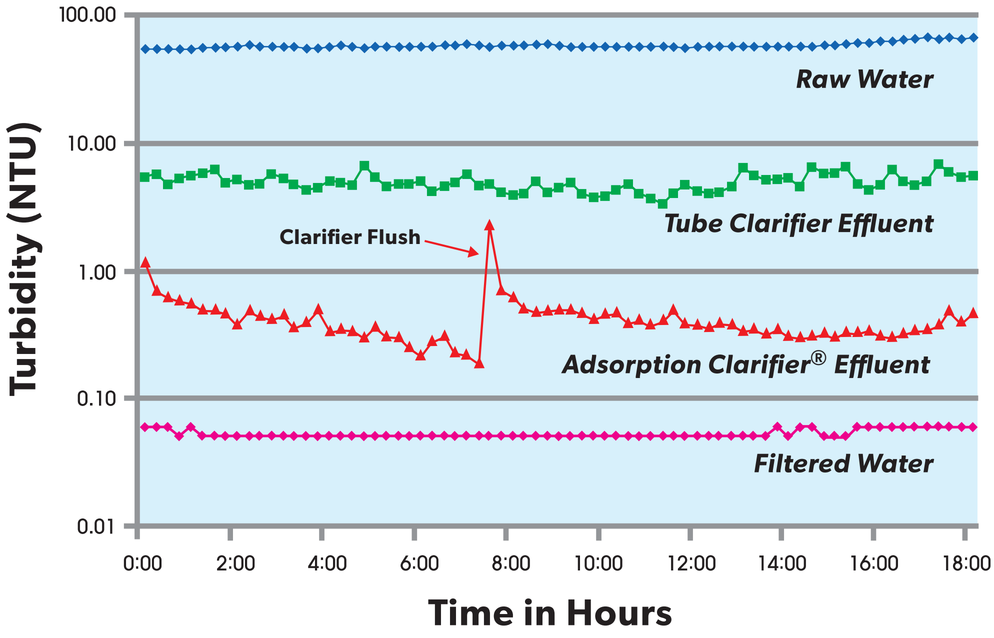
Chemically Efficient

- The Aquaritrol® III process controller uses inlet and outlet turbidity signals to automatically adjust chemical dosage. This results in a more efficient use of chemicals than a simple flow pacing.
- Keeps previously-reacted solids in the system to build floc in incoming water.
- Keeps a high solids inventory in the tube settler to compensate for sudden changes in raw water.
- Reuses partially-reacted chemicals.

Waste Efficient

- MULTIWASH systems provide a sustained air/water backwash at high rates, resulting in a vigorous backwash unmatched in the market.
- Proprietary MULTIWASH troughs retain media in the system.
- Can offer cleanliness and media-loss prevention guarantees.
- Tube settler leads to longer duration between Adsorption Clarifier flush sequences, reducing waste.
- Combined tube settler sludge blowdown, Adsorption Clarifier flush, and MULTIWASH backwash will generally be <5% total waste.

Trident HS System Turbidity Performance



Trident HS Standard Sizes

Trident HS Tank Sizes				
Model	**Length**	**Width**	**Height**	**Flow/Tank**
HS - 700	21′ 6″	9′ 0″	10′ 0″	350 gpm
HS - 1050	25′ 7″	11′ 0″	10′ 0″	525 gpm
HS - 1400	30′ 10″	12′ 0″	10′ 0″	700 gpm
HS - 2100	36′ 1″	15′ 0″	10′ 0″	1,050 gpm
HS - 2800	47′ 9″	15′ 0″	10′ 0″	1,400 gpm

Stretched models are available for applications that require larger filtration areas.

Standard Components
Epoxy-coated steel tank
Media
Internals
Actuated and manual valves
Inlet magnetic flow meter
Pressure transmitters
Ultrasonic level transmitter
Turbidimeters
Automated PLC controls
Backwash magnetic flow meter and control valve
Blower package
Transfer pump
Recirculation pump
Chemical feed packages (coagulant and polymer)

Optional Components
Integrated plant PLC controls package
Air compressor package
Interconnecting walkways and platforms
Aluminum or stainless steel tanks
Streaming current monitor

Getting the Right Fit

Trident HS Pilot and Lab Work

Trident HS package treatment pilots are available for onsite test work and can be used in a variety of treatment applications. Pilot testing may follow bench-scale testing as the final step in determining full-scale design and projected performance. WesTech's fully equipped sedimentation/filtration lab performs testing of site-sourced water samples to help determine the appropriate treatment for any given water.

microfloc

Represented by:

WesTech

Tel: 801.265.1000
westech-inc.com
info@westech-inc.com
Salt Lake City, Utah, USA

Trident®

Package Water Treatment System

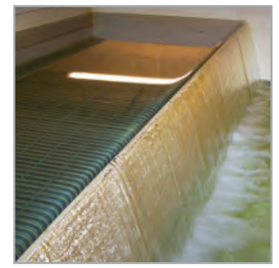
microfloc

WesTech®

The Trident® Package Water Treatment System

When Microfloc™ products first introduced the Trident technology, it represented a significant advancement in water and wastewater treatment for plant owners and operators. Not only did it remove turbidity, suspended solids, color, iron, manganese, odor, taste, and pathogens such as Giardia lamblia and Cryptosporidium, but it did so at a lower capital cost than conventional systems, in a smaller space, and at higher flow rates per unit area.

Today, more than 800 Trident technology systems, large and small, are at work all across North America and the world. Our Trident systems continue to evolve as we constantly strive to find ways to produce even higher quality treated water at higher flow rates per unit area and further reduce installation and operating costs.



Surface Water Treatment
- **Turbidity reduction**
- **Color removal**
- **Reduction of high TOC/DBP precursors**

Groundwater Treatment
- **Iron and manganese removal**
- **Arsenic**
- **Groundwater under the influence of surface water**

Tertiary Treatment
- **Water reuse**
- **Phosphorus removal**

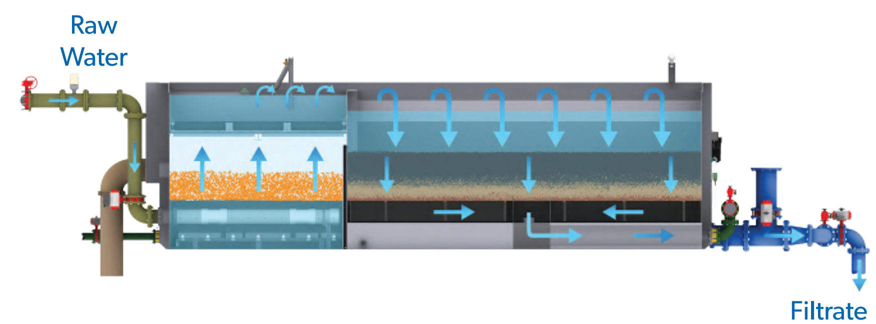
Industrial Process Water

Trident Design Criteria		
	Raw Water	**Finish Water**
Turbidity (NTU)	< 75	< 0.1
True Color (Pt-Co Units)	< 35	< 5
Combined Turbidity + Color	< 75	
Iron & Manganese (mg/L)	< 10	< 0.3 / 0.05

Proven and Efficient

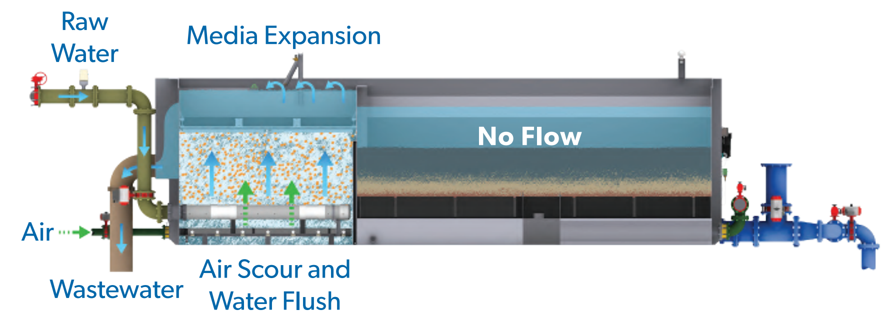
The Trident water treatment system utilizes a two-stage configuration consisting of an up-flow buoyant bead and compressible media Adsorption Clarifier® system followed by a conventional down-flow mixed media filter to produce high quality water.

Filtration Mode



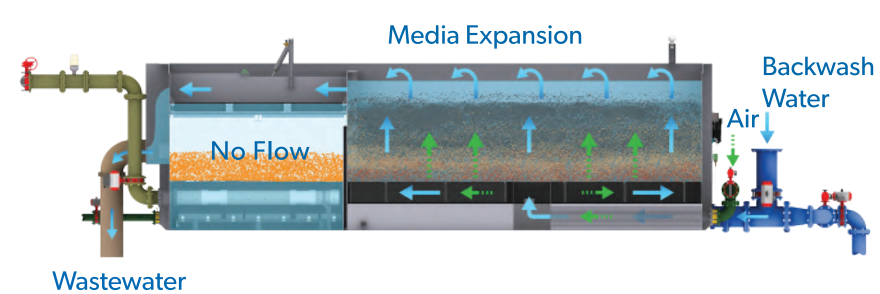
The treatment process is started when chemically dosed raw water enters the Adsorption Clarifier near the bottom of the tank where an upflow treatment process combines flocculation and clarification. From the Adsorption Clarifier, flow continues over a weir into the collection trough where it is distributed into the mixed media filtration chamber, after which it is collected by the MULTIBLOCK® underdrain with Laser Shield™ media retainer and exits the tank.

Buoyant Media Flush Mode



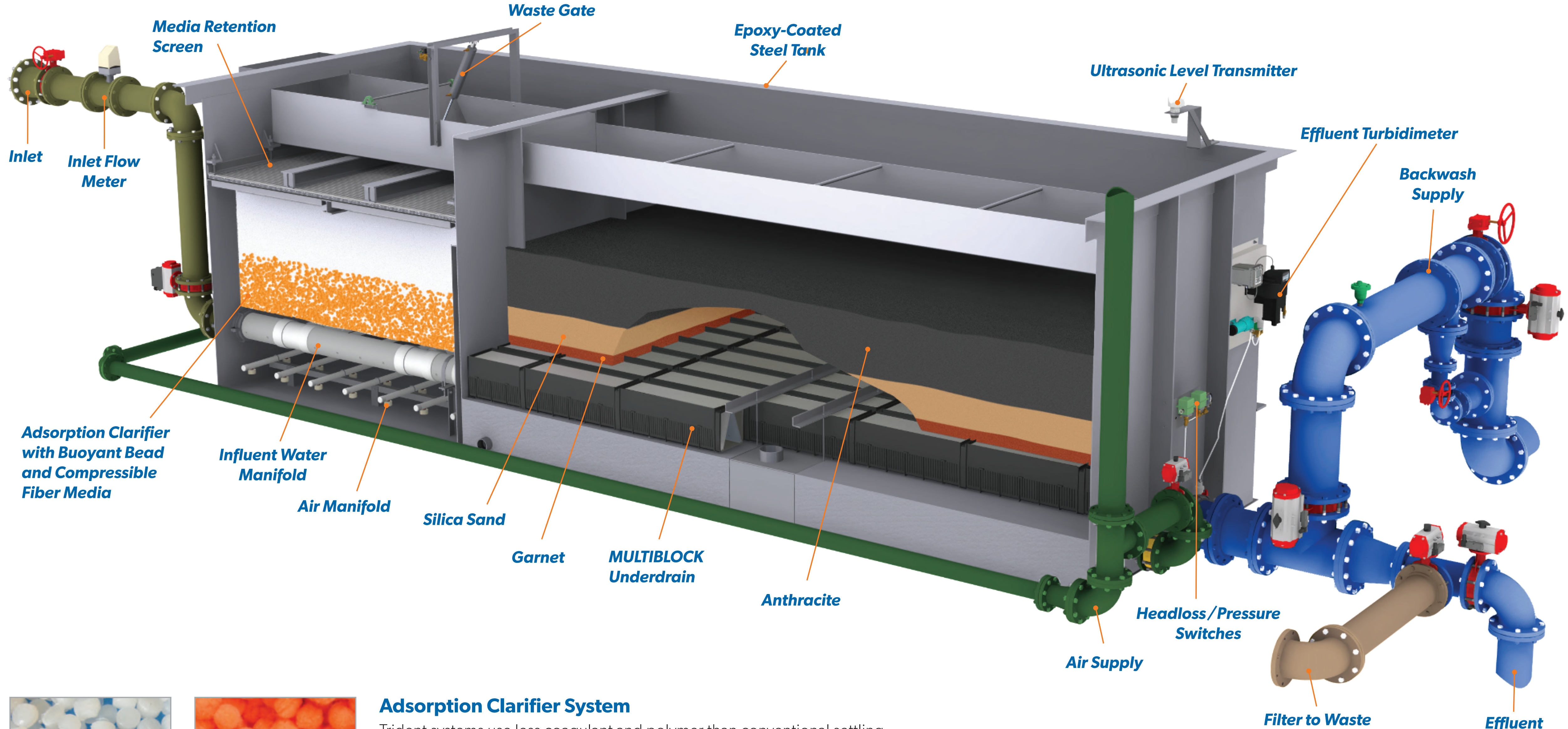
The Adsorption Clarifier is engineered to automatically initiate a flush cycle once headloss indicates that cleaning is required. When the cleaning is initiated, the waste gate and air scour valves are opened as raw water continues to flow. The air/water flush aggressively separates and removes the solids from the media. Solids are then discharged out through the waste pipe.

Backwash Mode



Like the Adsorption Clarifier flush, the backwash cycle is initiated when dirty bed headloss is reached in the mixed media filter section. The Trident inlet and outlet valves are closed and the air scour valve is opened to allow an air scour cycle. Solids from the backwash are then removed by water flowing up into the collection trough and discharged out through the waste pipe. A filter-to-waste sequence follows to ripen the filter media before returning the unit to service.

Complete Package Plant



Standard Components
Epoxy-coated steel tanks
Media
Internals
Actuated and manual valves
Inlet magnetic flow meter
Pressure transmitters
Ultrasonic level transmitter
Effluent turbidimeter
Automated PLC controls
Backwash control valves
Blower package
Chemical feed packages (coagulant and polymer)

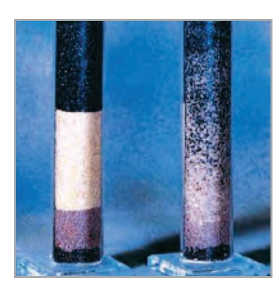
Optional Components
Air compressor package
Integrated plant PLC controls package
Backwash magnetic flow meter
Interconnecting walkways and platforms
Aluminum or stainless steel tanks
Inlet turbidimeter
pH monitor
Streaming current monitor
Static mixer

Adsorption Clarifier System

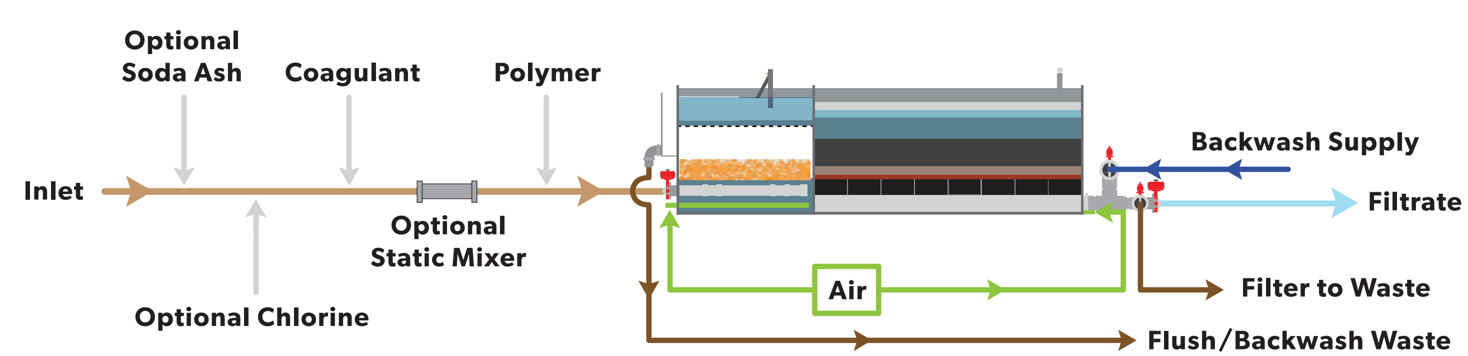
Trident systems use less coagulant and polymer than conventional settling type clarifiers. Within the Adsorption Clarifier system it is not necessary to form a settleable floc, which means floc size and settling time are not factors.
The buoyant media is rolled and scarified to greatly improve particulate removal. The compressible fiber media is used to capture more solids. Both the buoyant and compressible fiber media are NSF-61 certified and typically will last the life of the system.

Mixed Media Filtration

Microfloc pioneered mixed media technology has become the industry standard. By using three or more granular materials of differing size and specific gravity, the progressive coarse-to-fine mixed media produces superior quality finished water.



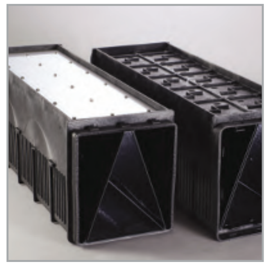
Trident Process Flow Diagram



Highly Efficient, Simple Operation

MULTIBLOCK

MULTIBLOCK underdrains provide a high-quality, low-cost, engineered product that is economical and versatile. MULTIBLOCK underdrains are fitted with the unique Laser Shield media retaining system that eliminates the need for support gravel. Combined air and water backwash is provided using this system.



- **Reduced profile underdrain**
- **Superior media retention capability**
- **Uniform distribution of water and air backwash**
- **NSF-61 approved**
- **Resistant to plugging and fouling**

Trident Process Controller Including the AQUARITROL® III

Trident package treatment units are supplied with fully automated programmable logic controls (PLC). These controls allow plant personnel to easily monitor operational parameters and control all treatment equipment and processes.

Changes in raw water characteristics and flow rate are automatically detected by the AQUARITROL III program. This PLC-based, feed-forward, loop control system monitors the filter effluent quality and continually evaluates and regulates influent chemical feed to maintain desired effluent water quality parameters. The operator sets an adjustable effluent quality setpoint and the Trident controls, utilizing the AQUARITROL III program, do the rest.

WesTech's electrical engineers and programmers can also integrate new whole plant operation or existing plant instruments into the Trident PLC controls. Complicated plant expansions are simplified by providing seamless integration of new and existing equipment.

- **Optimized and flexible process controls**
- **Chemical usage is maximized while maintaining performance**

Get More with Microfloc

Tri-Mite: Big Performance in a Small Water Treatment System

For lower flows, Microfloc offers the Tri-Mite® package water treatment plant. Using the same process as the Trident system, the Tri-Mite comes factory-assembled with pumps, controls, piping, valves, and an air scour blower mounted on the tank. These items are pre-plumbed and wired for simple, fast installation.

The Tri-Mite unit is available in five standard sizes as single units from 50 gpm to 350 gpm and as a two-unit system up to 700 gpm capacity. For flows less than 50 gpm, a single unit can be operated on an intermittent or reduced flow basis. These systems are perfect for new designs with future expansion in mind. The future additional tank would share the control panel, blower, and backwash pump of the first tank.

Equipment Upgrades and Expansions

If your unit is more than 10 years old, or has seen changes in raw water quality, it may be worthwhile to inquire about upgrading your Trident system. Common upgrades include enhanced PLC control systems, underdrain replacement accompanied with backwash upgrade, Trident HSR integrated presedimentation systems, and replacement of up-flow media. Retrofits are also available for other package treatment systems.

Stretch Customization

Some regulatory requirements may dictate a lower hydraulic loading through the filter cell. This is a simple change for the Trident system. An optional stretch filter cell is available to lower the hydraulic loading rate from 5 gpm/ft^2 to 4 gpm/ft^2. Other filter loading rates may also be achieved through custom design.

Standard Sizes

		Tri-Mite					Trident			
Influent Flow Rate GPM		**50**	**75**	**100**	**175**	**350**	**175**	**350**	**700**	**1400**
Tank Dimensions (Shipping)	Length	9 ft 0 in	9ft 2 in	11 ft 2 in	13 ft 9 in	23 ft 2 in	10 ft 1 in	14 ft 6 in	27 ft 10 in	39 ft 10 in
	Width	5 ft 8 in	7 ft 10 in	7 ft 8 in	9 ft 11 in	10 ft 2 in	6 ft 11 in	8 ft 11 in	8 ft 11 in	11 ft 11 in
	Height	8 ft 5 in	8 ft 6 in	8 ft 6 in	8 ft 2 in	8 ft 3 in	8 ft 5 in	8 ft 5 in	8 ft 5 in	10 ft 1 in
Weights	Shipping (lbs)	6,300	8,100	9,600	9,200	14,600	7,000	10,250	17,000	34,000
	Operating (lbs)	14,000	20,000	25,000	43,000	78,000	35,000	70,000	140,000	330,000
Tank Connections	Influent	2 in	3 in	3 in	4 in	6 in	4 in	6 in	8 in	12 in
	Effluent	2 in	3 in	3 in	4 in	6 in	6 in	8 in	12 in	16 in
	Backwash Supply	3 in	4 in	4 in	5 in	8 in	6 in	8 in	12 in	16 in
	Waste/Overflow	4 in	6 in	6 in	8 in	10 in	8 in	10 in	14 in	20 in
	Air Wash (Clarifier)	1.5 in	2 in	2 in	2 in	3 in	2 in	3 in	4 in	6 in
	Air Wash (Filter)	1.5 in	2 in	2 in	2 in	3 in	3 in	4 in	6 in	8 in
Waste Production	Flushing Flow Rate (gpm)	50	75	100	175	350	175	350	700	1,400
	Flushing Volume Per Cycle (gal)	500	750	1,000	1,750	3,500	1,750	3,500	7,000	14,000
	Mixed Media Per Cycle (gal)	900	1,350	1,800	3,150	6,300	3,500	7,000	1,4000	28,000
	Filter to Waste Per Cycle (gal)	250	375	500	875	1,750	875	1,750	3,500	7,000

microfloc

Represented by:

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Tel: 801.265.1000
westech-inc.com
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Salt Lake City, Utah, USA

Sitka

Alaska

Engineer
CRW Engineers

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(425) 392-0491
jsimon@goblesampson.com

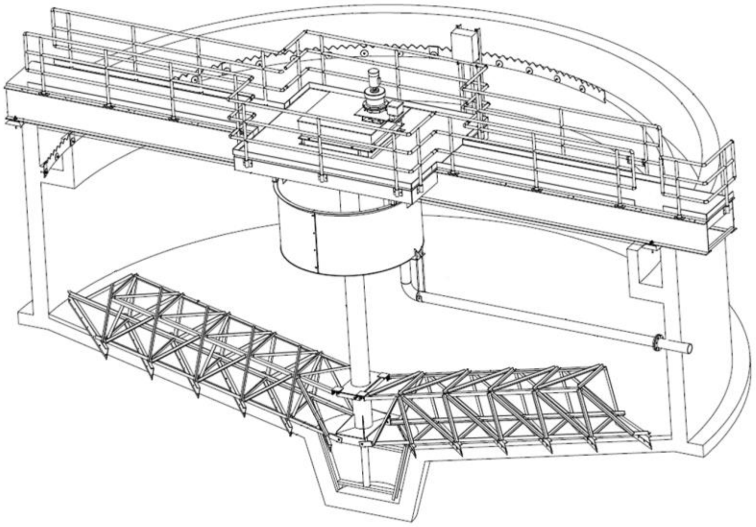
WesTech Opportunity Number: 1830044
Tuesday, April 10, 2018

Item A – Clarifier Mechanism WesTech Model Number CLS25

General Scope of Supply		
Description	**Unit**	**Dimension/Capacity**
Number of Clarifiers	Each	1
Application	-	Filter Backwash Clarification
Basin Diameter	ft	25
Tank Side Water Depth	ft	15
Freeboard	ft	1

Equipment Description

WesTech is a leader in providing proven clarification solutions. The WesTech Clarifier has many superior design, mechanical, and operational features and is a capable option for primary clarification applications.



This WesTech Clarifier is designed for the purpose of continuously separating and removing suspended solids.

Detailed Scope of Supply

Item	Unit/Size	Quantity	Description	Material
Drive Shaft	6" dia.	1	Drive shaft for transmitting torque from drive to rake arms	Steel
Rake Arms	25' dia.	1 Set	Rake arms for moving settled solids to center of tank for removal; includes stainless steel squeegees	Steel
Bridge	Full Span	1	Beam style bridge to span tank diameter, provides internal equipment support	Steel
Walkway	36"	1	Includes aluminum I-bar grating and aluminum 2-rail handrail	Steel/Aluminum
Drive Platform	min. 24" clearance around drive	1	Includes aluminum deck plate and aluminum 2-rail handrail	Steel/Aluminum
Anchor Bolts and Fasteners	Varies	TBD	-	304SS

Walkway Bridge

The walkway bridge supports the clarifier mechanism and allows access to the center platform and drive unit for equipment maintenance. It includes non-slip flooring and handrails along both sides and around the center platform, with sufficient clearance around the drive for easy maintenance.

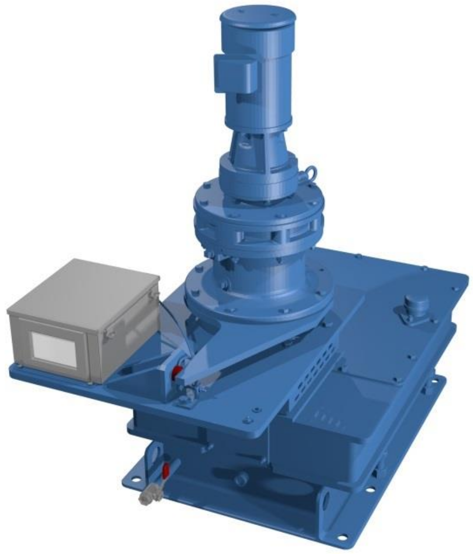
Rake Arms

Rake arms with segmented rake blades effectively move settled solids to the center of the tank for removal.

Drive Unit

Description	Unit	Dimension/Capacity
Drive Type		Shaft Drive
Continuous Torque Rating	Ft-lbs	3,125
Peak Torque	Ft-lbs	6,250
Rake Motor Characteristics		0.5 HP, 230/460 V, 3 Ph, 60 Hz
Alarm Torque		2 adjustable switches for alarm and motor cutout

WesTech drive units are delivered to the job site as a single, completely assembled and shop-tested unit, ready to be installed on the clarifier bridge. The result of a thorough design and meticulous component selection is a strong, reliable, high-quality drive that will provide a long service life with minimum maintenance.



Direct Coupling

Direct coupling of motor, reducer, and pinion shaft eliminates chain or belt drive transmissions, thus increasing efficiency and operator safety.

Electric Motor

The electric motor, direct coupled to a speed reducer, rotates the external gear by means of a pinion fastened to the output shaft of the speed reducer. The drive control pointer indicates the torque loading in percentages. The electric motor is totally enclosed, suitable for outdoor service, but other commercially available motors to suit environment or service, such as explosion proof, can be furnished. When required, a variable speed drive can be added to vary the output speed of the drive. This allows optimization of the process, which can result in long term savings.

Input Speed Reducer

The speed reducer, driven by the motor, is a completely sealed oil or grease lubricated unit. It is of the cycloidal type, which combines extremely high ratios with high efficiency and low wear in a compact unit. Torque transmitting elements roll rather than grinding or sliding, thus achieving efficiencies of 90 percent. Virtually no wear failures have occurred in properly sized WesTech drives. Even after 30 years of operation, many WesTech reducers are still in use.

Precision Bearing Advantages

Precision Manufacturing Tolerances

The bearings utilized are acceptable for high load, high speed applications and are manufactured by recognized bearing companies. The use of these precision bearings is widespread among larger and more heavily loaded clarifier and thickener mechanisms common to the metallurgical industries.

Exceptional long life and load capacities

Instead of applying the bearing load in four points on the bearing balls as with old-style strip lined bearings, the precision bearing utilizes a full band contact race with hardness equal to that of the strip liners. Calculated bearing life is at least five times that for strip liners of the same ball size and diameter. The need for splitting gears and housings is eliminated because of the superior service life.

Overturning Load Capacity

Strip lined bearings have no inherent overturning load capacity and must rely on the mechanism weight alone to hold the bearing race together. This capacity of the precision bearing makes possible tank settling, misalignment, and lack of precision leveling of the drive during installation and operation a far less determining factor in premature bearing failure.

Main Bearing Protection

WesTech gear housings protect from dirt and contamination using designed neoprene seals and gaskets, whereas strip lined bearings can only use a loose felt seal. WesTech precision gears also allow the bearing to run in a separate sealed grease cavity, which achieves additional protection from contamination.

Paint

Coating Area	Sandblast SSPC	Paint Type	Brand	Product #	Total DFT	Coats
Submerged Coating	SSPC-SP10 / NACE 2	Epoxy	Tnemec	N140-1255	4-6 mils	1, finish by others
Non-Submerged	SSPC-SP6 / NACE 3	Epoxy	Tnemec	N140-1255	4-6 mils	1, finish by others
Drive First Coat	SSPC-SP6 / NACE 3	Epoxy	Tnemec	N140F-1255	3-9 mils	1
Drive Unit		Polyurethane Enamel	Tnemec	1074U-B5712	2-5 mils	1

Controls & Instrumentation

Description	Type	Notes
Control Panel Type	NEMA 4X 304SS	With door mounted operators and status lights. One (1) magnetic combination motor starter, with internally reset thermal overloads, fail safe relays, terminal blocks, timers, repeat cycle timers, fuse and fuse blocks and other supporting hardware is provided. A control power transformer will provide 120 VAC for internal controls. The transformer will have both primary legs and one secondary leg fused.

WesTech Trips to the Site

Number of Trips	Number of Days	Includes
2	4	Installation inspection, startup, instruction of plant personnel, and observation of torque testing

Clarification and Comments

- Effluent collection by floating box decanter in the following section.
- Tank is not included at this time, current design is based on a concrete tank by others. WesTech can include a steel tank upon request.

Note: Any Item Not Listed Above to Be Furnished by Others.

Items Not by WesTech

Electrical wiring, conduit, or electrical equipment, piping, valves, or fittings, shimming material, lubricating oil or grease, shop or field painting, field welding, erection, assembly of component handrail, detail shop fabrication drawings, performance testing, bonds, unloading, storage, concrete work, or field service (except as specifically noted).

This proposal has been reviewed and is approved for issue by Brett Boissevain on April 10, 2018.

Item B – Box Decanter WesTech Model Number DEF33R

General Scope of Supply

Description	Unit	Dimension/Capacity
Number of Decanters	each	1
Application	-	Filter Backwash Decanting
Basin Diameter	ft	25
Side Water Depth	ft	15
Decant Flow Rate	gpm	37.5
Decant Range	feet	9

Equipment Description

A decanter allows the backwash water clarification basin to act as an equalization basin as well. The floating decanter will remain near the top of the surface, removing water below the surface to avoid any floating material. The box decanter uses a truss type cage as a travel guide, allowing for stops to limit the floating box travel. The unique floating decant mechanism rises and falls with the water level as backwash volume changes.

Detailed Scope of Supply

Item	Unit/Size	Description	Material
Box Decanter	2.5' square x 2.5" (minimum)	Includes submerged orifices for clarified water draw off, pipe strap, bar, and brackets	Steel
Discharge Hose	2.5" diameter	Flexible, reinforced hose	Rubber
Floats		Foam core floats	FRP
Float Supports		Float supports	Steel
Guide Rails	6", 40 (dia., sch.)	Float box guide rails	Steel
Anchor Bolts and Fasteners			Steel

Paint

Coating Area	Sandblast SSPC	Paint Type	Brand	Product #	Total DFT	Coats
Submerged Coating	SSPC-SP10 / NACE 2	Epoxy	Tnemec	N140-1255	4-6 mils	1, finish by others
Non-Submerged	SSPC-SP6 / NACE 3	Epoxy	Tnemec	N140-1255	4-6 mils	1, finish by others

WesTech Trips to the Site

Number of Trips	Number of Days	Includes
1	2	Installation inspection, startup, and instruction of plant personnel.

Note: Any Item Not Listed Above to Be Furnished by Others.

Items Not by WesTech

Electrical wiring, conduit, or electrical equipment, piping, valves, or fittings, shimming material, lubricating oil or grease, shop or field painting, field welding, erection, assembly of component handrail, detail shop fabrication drawings, performance testing, bonds, unloading, storage, concrete work, or field service (except as specifically noted).

This proposal has been reviewed and is approved for issue by Brett Boissevain on April 10, 2018.

Budget Pricing

Proposal Name: Sitka, Alaska
Proposal Number: 1830044
Tuesday, April 10, 2018

1. Bidder's Contact Information

Company Name	WesTech Engineering, Inc.
Contact Name	Adrian Williams
Phone	801.265.1000
Email	awilliams@westech-inc.com
Address: Number/Street	3665 S West Temple
Address: City, State, Zip	Salt Lake City, UT 84115

2. Pricing

Currency		US Dollars
Scope of Supply		
A	Clarifier Mechanism WesTech Model Number CLS25	$130,000
B	ox Decanter WesTech Model Number DEF33R	$55,000
	Taxes (sales, use, VAT, IVA, IGV, duties, import fees, etc.)	Not Included

Prices are for a period not to exceed 30 days from date of proposal.

Field Service

Daily Rate	$1,200

Prices do not include field service unless noted, but it is available at the daily rate plus expenses. The customer will be charged for a minimum of three days for time at the jobsite. Travel will be billed at the daily rate. Any canceled charges due to the customer's request will be added to the invoice. The greater of visa procurement time or a two week notice is required prior to trip departure date.

3. Payment Terms

Submittals Approved	15%
Release for Fabrication	35%
Net 30 days from Shipment	50%

All payments are net 30 days. Partial shipments are allowed. Other terms per WesTech proforma invoice.

4. Schedule

Submittals, after PO receipt	6 to 8 Weeks
Customer Review Period	2 weeks
Ready to Ship, after Submittal Approval	18 to 20 weeks
Total Weeks from PO to Shipment	**26 to 30 weeks**

Terms & Conditions: This proposal, including all terms and conditions contained herein, shall become part of any resulting contract or purchase order. Changes to any terms and conditions, including but not limited to submittal and shipment days, payment terms, and escalation clause shall be negotiated at order placement, otherwise the proposal terms and conditions contained herein shall apply.

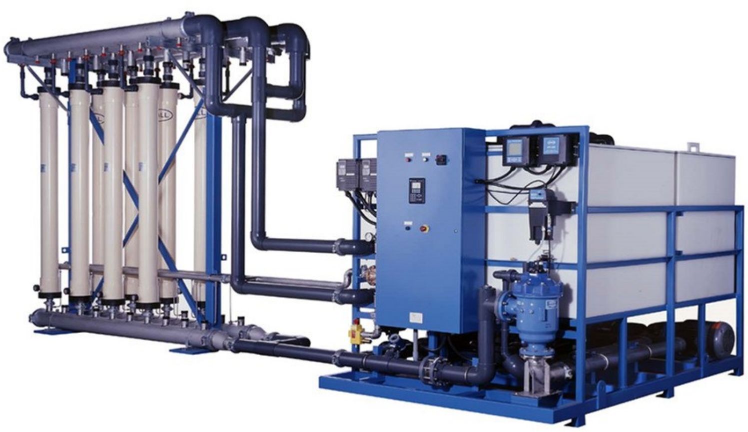
Freight: Prices quoted are **F.O.B. shipping point** with freight allowed to a readily accessible location nearest to jobsite. All claims for damage or loss in shipment shall be initiated by purchaser.

Paint: If your equipment has paint included in the price, please take note to the following. Primer paints are designed to provide only a minimal protection from the time of application (usually for a period not to exceed 30 days). Therefore, it is imperative that the finish coat be applied within 30 days of shipment on all shop primed surfaces. Without the protection of the final coatings, primer degradation may occur after this period, which in turn may require renewed surface preparation and coating. If it is impractical or impossible to coat primed surfaces within the suggested time frame, WesTech strongly recommends the supply of bare metal, with surface preparation and coating performed in the field. All field surface preparation, field paint, touch-up, and repair to shop painted surfaces are not by WesTech.

Pall Corporation
Budgetary Proposal

Pall ARIA™
Membrane Filtration System

City and Borough of Sitka Alaska: 5.62MGD



12/20/2017
Proposal #: OPP1015938-0-B

Submitted to:

CRW Engineering

Rebecca Venot

Submitted by:

Pall Water: Lance Gannon West Regional Sales

(607) 591-0077 lance_gannon@pall.com

Goble Sampson: John Simon

jsimon@goblesampson.com (425) 736 4584

PROPRIETARY & CONFIDENTIAL
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- to use this document and the information it contains exclusively for the above-stated purpose and to avoid use of the information for performance of the proposed work by recipient itself or any third party.

- to avoid publication or other disclosure of this document or the information it contains to any third party without the prior approval of Pall Corporation.

- to make only those copies needed for recipient's internal review, and

- to return this document and any copies thereof when they are no longer needed for the purpose for which furnished or upon the request of Pall Corporation.

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   - 3.3 Operational Parameters
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The following information can be provided upon request

- Warranty
- Overview of Pall Corporation
- Hollow Fiber Membrane System Overview
- Pall Standard Terms and Conditions

1 Pall Offering

1.1 Project Summary

We are pleased that the temporary water treatment trailer Pall provided in the past performed well and that City of Sitka is open to partnering with Pall again to improve the treatment capabilities/capacity at the existing plant. Pall is excited to offer the City of Sitka the following: MF Membrane Filtration technology will provide the City with approx. 5.62 MGD treatment capabilities during high turbidity events in the supply. The throughput of the proposed solution package will be based on further due diligence by Pall Water's Process Engineering team that involves a thorough understanding and assessment of seasonal source water quality conditions as well as asking for the City's input on the maximum system capacity requirement.

As requested, the proposed system has been designed to treat feed water with high suspended solid/turbidity. With operational and programing modifications, the Pall system can have automated start-stop functions then stored on stand-by till the next feed water upset. The recommended solution features the Pall (3) AP8 "package" water systems with the total number of modules spaces filled (104 per rack). The system consists of a fully integrated, skid mounted valve & module rack, CIP system, required ancillary equipment, install/commissioning support. Upon request, Pall can include both process (operational) and programming support services to integrate the new filtration system into the existing treatment processes (such as flow-pacing post filtration chlorine injection, UV system integration, storage tank level automation, etc). A CIP/washwater neutralization system is included. System redundancy has been excluded from the scope of supply but can be added based on requirements.

Once you have had sufficient time to review our offering, please direct any questions you may have back to myself and our team. Although design aspects and feasibility surrounding this project have not been fully defined, Pall looks forward to partnering up to support this objective. We appreciate the interaction with your team to explore the advantages of the Pall Membrane Filtration System.

1.2 Pricing Summary

Item	Description	Sale Price (US)
1	Aria™ Membrane Filtration System (Details Per Section 2)	$1,950,000

1.3 Delivery Schedule

The schedule provided is Pall's standard and reflects typical project execution. If requested, we would be happy to review customer schedule requirements and adjust where possible to accommodate project specific needs.

	Milestone	Typical Schedule
1	Acknowledgement of Purchase Order	Typically 1 to 2 weeks after Receipt of Purchase Order
2	Submittals/Shop Drawings	Typically 2 weeks after Acknowledgement of Purchase Order
3	Commence Manufacturing1	Typically 1 - 2 weeks after Submittals/Shop Drawings submitted

4	Equipment Ready to Ship and Preliminary O&M Manual	Typically 16 -22 weeks after Commence Manufacturing
5	Installation Completed (by Others)	Variable
6	Commissioning Complete/Final Acceptance	Approximately 6 weeks after Installation Completed

Note 1: For standard equipment, manufacturing may commence order acknowledgement. The schedule above assumes standard equipment and standard submittals.

1.4 Terms and Conditions

All sales made by Pall are subject to the terms contained within this Section 1.4 and *Additional Terms and Conditions of Sale of Systems and Made to Order Goods – The Americas* (Available upon request).

Price Validity	This proposal is for discussion purposes only, does not constitute a binding agreement on either party, and remains subject to corporate approval by both parties. The information contained herein is deemed confidential and is not to be shared with any third party.
Shipping Terms	The price does not include shipping costs. Delivery shall be FCA Seller's Shipping Point, INCOTERMS® 2010.
Payment Terms	Payment of invoiced amounts due to Seller shall be paid Net 30 days and as further defined in *Additional Terms and Conditions of Sale Systems and Made to Order Goods – The Americas*.
Bonds	No bonds of any type are included with this proposal.
Taxes	No taxes are included in the pricing. Payment of all Taxes related to the Goods and Services proposed shall be the exclusive responsibility of the Buyer as further defined in *Additional Terms and Conditions of Sale Systems and Made to Order Goods – The Americas*.

2 Scope of Supply

2.1 Scope Summary Table

Item Description	By PALL	By OTHERS
(1) Master Control Panel with Allen Bradley Logix PLC, or equal	X	
Design and supply of systems prior to membrane filtration system.		X
Feed Tank Included as part of AP Skid	X	
Feed Pump(s) and VFD(s) included as part of AP skid	X	
Feed Strainer included as part of AP Skid	X	
3 (3 + 0) AP8 Units, each factory assembled and tested unit including valves, instruments & I/O required for operation	X	
Each AP Unit will include a membrane module rack for on-site assembly and (104) hollow fiber membrane modules	X	
RF Tank Included as part of AP Skid	X	
RF Pump(s) included as part of AP Skid	X	
(1) 2500 gallon CIP System factory assembled and tested prior to shipment with valves, instruments, pumps, tank, heater as needed for operation	X	
(1) 12500 gallon Neutralization System factory assembled per the P&ID and tested prior to shipment:	X	
(2) Air Compressors (1) Air Receiver	X	
Chemical Storage Equipment		X
Supply of any required chemicals		X
Design and supply of anchor bolts for Pall supplied Equipment		X
Receiving, unloading and safe storage of equipment until ready for installation		X
Installation of all equipment		X
Design and supply of interconnecting pipe, inclusive of pipe supports and flexible connectors		X
Motor Control Center (MCC)		X
All wiring, cabling, and tubing for power supply, signals, communications, and to connections on Pall supplied equipment		X
Design, supply, and installation of all civil infrastructure inclusive of buildings, fire and safety protection, HVAC, walkways, platforms, etc.		X
All Permits		X

2.3 Submittal Description

The project schedule is based on submittals/shop drawings provided in electronic format via a secure FTP site for information only. This allows work to proceed on the project without a document approval process.

Submittals/Shop Drawings
P&ID
General Arrangement Drawings for Pall-Supplied Equipment
Electrical Interconnect Drawing (Power One-Line, I/O Interconnection, and Network Layout)
Electrical Drawings for Pall-Supplied Panels
Mechanical Replacement Parts List
Electrical Replacement Parts List
Compressed Air System Information
Installation Manual
Cutsheets for Pall-Supplied Off-Skid Components
Installation & Startup Checklist
Final Submittal (provided at completion of commissioning)
Operation and Maintenance Manual
Software License Transfer Documentation

2.4 Services and Labor

Commissioning & Training time is estimated to be 5 man-weeks. Training activities occur during the commissioning process.

Commissioning

Each day shall be considered 8 hours on site. Commissioning will begin once the system is fully installed. A commissioning Checklist is prepared specifically for each project during project execution. Commissioning shall consist of the activities outlined in the project specific Commissioning Checklist. Commissioning activities include:

- Confirmation of network communications
- Confirmation that I/O is connected to the control system
- Confirmation of MF System functionality (components are functioning and control system sequences are functional)
- Startup and tuning of Pall controls

Operator Training

Operator training is estimated to take 1 to 3 days depending on system complexity. Training is provided on-site by a Pall Field Service Engineer. The estimated time assumes that all staff are trained at the same time. Training time will be split between a classroom presentation and hands-on training with the equipment.

3 Technical Summary

3.1 Process Summary

Source Description:

Suface water: Indian River or Sawmill Creek (downstream of Blue Lake)

Treatment processes prior to Membrane Filtration System

Direct Coagulation up to 10 mg/L of aluminum-based coagulant

Membrane System Feed Water Characteristics

Quality of the water entering the Pall Membrane Filtration System as summarized in table below forms the basis of design for this proposal. In the event that the feed water to the membrane filtration system is outside these parameters the system performance, cleaning protocol, operating parameters, and/or warranties may be affected.

Parameter	Units	Range
Turbidity	NTU	0.2-75
TOC	ppm	Up to 5
Hardness	ppm	Less than 20
Alkalinity	ppm	Less than 20
TSS	ppm	5-40
Fe	ppm	<2.0
Mn	ppm	<1.0

Notes:

1 – Assumed Water Quality is based on typical water quality for similar source waters. The design parameters may change after review of actual source water quality data.

3.2 Treated Water Objectives

The proposed membrane system is designed to achieve the following results given the feed fluid conditions described in Section 3.1 of this proposal and operation of the system in accordance with the operation and maintenance manual.

Net Filtrate Capacity of 5.62 MGD

Turbidity less than 0.10 NTU 95% of the time, below 0.20 NTU at all times.

The membrane system offers a 2.5 Log reduction Giardia

3.3 Operational Parameters

Hollow Fiber Membrane System operational parameters at design flow		
Net Filtrate Capacity	5.62	MGD
Recovery	95.7%	%
Instantaneous Flux	40	GFD
FM (Backwash) Interval	27	Minutes
EFM Interval	1	Day(s)
CIP Interval	30	Days

3.4 Acceptance Criteria

The system shall be accepted by the end user upon completion of the following:

1) Completed system commissioning per section 2.4
2) Production of 1st useable effluent

Appendix D

Detailed Cost Estimates

Engineer's Estimate - Sawmill Creek Intake, UV Site - Lot 17, Membrane Filtration
Prepared By: C Meyn
Date: April 2018

ITEM NO.	WORK DESCRIPTION	UNIT	TOTAL QUANT.	UNIT PRICE	TOTAL COST
1	Intake Structure and Pumps	LS	1	$440,000	$440,000
2	Membrane Equipment	LS	1	$2,170,000	$2,170,000
3	Backwash Handling & Recycle	LS	2	$495,000	$990,000
4	Finished Water Pumps	LS	1	$184,000	$184,000
5	Piping and Valves Yard & Building	LS	1	$726,000	$726,000
6	Chlorine Equipment	LS	1	$110,000	$110,000
7	Pre-Engineered Metal Building w/Mech & Plumb	LS	1	$2,365,000	$2,365,000
8	Electrical & Controls	LS	1	$1,048,000	$1,048,000
				Subtotal Direct Costs:	$8,033,000
				Location Adjustment Factor (28%)	$2,249,000
				Subtotal w/ Location Adjustment:	$10,282,000
				General Conditions (15%)	$1,542,000
				Subtotal w/ General Conditions:	$11,824,000
				Mobilization/Demobilization (10%)	$1,182,000
				Prime Contractor Overhead (12%)	$1,419,000
				Prime Contractor Profit (8%)	$946,000
				Builder's Risk & Gen Liab Ins (1%)	$118,000
				Payment & Performance Bonds (1.16%)	$137,000
				Subtotal w/ Prime Markups	$15,626,000

Engineer's Estimate - Sawmill Creek Intake, UV Site - Lot 19, Membrane Filtration
Prepared By: C Meyn
Date: April 2018

ITEM NO.	WORK DESCRIPTION	UNIT	TOTAL QUANT.	UNIT PRICE	TOTAL COST
1	Intake Structure and Pumps	LS	1	$440,000	$440,000
2	Site Development	LS	1	$83,000	$83,000
3	Membrane Equipment	LS	1	$2,170,000	$2,170,000
4	Backwash Handling & Recycle	LS	2	$495,000	$990,000
5	Finished Water Pumps	LS	1	$184,000	$184,000
6	Piping and Valves Yard & Building	LS	1	$726,000	$726,000
7	Chlorine Equipment	LS	1	$110,000	$110,000
8	Pre-Engineered Metal Building w/Mech & Plumb	LS	1	$2,365,000	$2,365,000
9	Electrical & Controls	LS	1	$1,061,000	$1,061,000
				Subtotal Direct Costs:	$8,129,000
				Location Adjustment Factor (28%)	$2,276,000
				Subtotal w/ Location Adjustment:	$10,405,000
				General Conditions (15%)	$1,561,000
				Subtotal w/ General Conditions:	$11,966,000
				Mobilization/Demobilization (10%)	$1,197,000
				Prime Contractor Overhead (12%)	$1,436,000
				Prime Contractor Profit (8%)	$957,000
				Builder's Risk & Gen Liab Ins (1%)	$120,000
				Payment & Performance Bonds (1.16%)	$139,000
				Subtotal w/ Prime Markups	$15,815,000

Engineer's Estimate - Sawmill Creek Intake, UV Site - Lot 17, Granular Filtration
Prepared By: C Meyn
Date: April 2018

ITEM NO.	WORK DESCRIPTION	UNIT	TOTAL QUANT.	UNIT PRICE	TOTAL COST
1	Intake Structure and Pumps	LS	1	$440,000	$440,000
2	Granular Equipment	LS	1	$1,123,000	$1,123,000
3	Backwash Handling & Recycle	LS	1	$495,000	$495,000
4	Finished Water Pumps	LS	1	$184,000	$184,000
5	Piping and Valves Yard & Building	LS	1	$508,000	$508,000
6	Chlorine Equipment	LS	1	$110,000	$110,000
7	Pre-Engineered Metal Building w/Mech & Plumb	LS	1	$2,210,000	$2,210,000
8	Electrical & Controls	LS	1	$761,000	$761,000
				Subtotal Direct Costs:	$5,831,000
				Location Adjustment Factor (28%)	$1,633,000
				Subtotal w/ Location Adjustment:	$7,464,000
				General Conditions (15%)	$1,120,000
				Subtotal w/ General Conditions:	$8,584,000
				Mobilization/Demobilization (10%)	$858,000
				Prime Contractor Overhead (12%)	$1,030,000
				Prime Contractor Profit (8%)	$687,000
				Builder's Risk & Gen Liab Ins (1%)	$86,000
				Payment & Performance Bonds (1.16%)	$100,000
				Subtotal w/ Prime Markups	$11,345,000

Engineer's Estimate - Sawmill Creek Intake, UV Site - Lot 19, Granular Filtration
Prepared By: C Meyn
Date: April 2018

ITEM NO.	WORK DESCRIPTION	UNIT	TOTAL QUANT.	UNIT PRICE	TOTAL COST
1	Intake Structure and Pumps	LS	1	$440,000	$440,000
2	Site Development	LS	1	$83,000	$83,000
3	Granular Equipment	LS	1	$1,123,000	$1,123,000
4	Backwash Handling & Recycle	LS	1	$495,000	$495,000
5	Finished Water Pumps	LS	1	$184,000	$184,000
6	Piping and Valves Yard & Building	LS	1	$508,000	$508,000
7	Chlorine Equipment	LS	1	$110,000	$110,000
8	Pre-Engineered Metal Building w/Mech & Plumb	LS	1	$2,210,000	$2,210,000
9	Electrical & Controls	LS	1	$773,000	$773,000
				Subtotal Direct Costs:	$5,926,000
				Location Adjustment Factor (28%)	$1,659,000
				Subtotal w/ Location Adjustment:	$7,585,000
				General Conditions (15%)	$1,138,000
				Subtotal w/ General Conditions:	$8,723,000
				Mobilization/Demobilization (10%)	$872,000
				Prime Contractor Overhead (12%)	$1,047,000
				Prime Contractor Profit (8%)	$698,000
				Builder's Risk & Gen Liab Ins (1%)	$87,000
				Payment & Performance Bonds (1.16%)	$101,000
				Subtotal w/ Prime Markups	$11,528,000

Engineer's Estimate - Sawmill Creek Intake, Pulp Mill Site, Membrane Filtration
Prepared By: C Meyn
Date: April 2018

ITEM NO.	WORK DESCRIPTION	UNIT	TOTAL QUANT.	UNIT PRICE	TOTAL COST
1	Demolition and site prep	LS	1	$400,000	$400,000
2	Intake Structure & Pumps	LS	1	$440,000	$440,000
3	Membrane Equipment	LS	1	$2,170,000	$2,170,000
4	Backwash Handling & Recycle	LS	2	$495,000	$990,000
5	Finished Water Pumping	LS	1	$184,000	$184,000
6	Piping and Valves Yard & Building	LS	1	$1,053,000	$1,053,000
7	Pre-Engineered Metal Building w/Mech & Plumb	LS	1	$2,365,000	$2,365,000
8	Electrical & Controls Coordination	LS	1	$1,141,000	$1,141,000
				Subtotal Direct Costs:	$8,743,000
				Location Adjustment Factor (28%)	$2,448,000
				Subtotal w/ Location Adjustment:	$11,191,000
				General Conditions (15%)	$1,679,000
				Subtotal w/ General Conditions:	$12,870,000
				Mobilization/Demobilization (10%)	$1,287,000
				Prime Contractor Overhead (12%)	$1,544,000
				Prime Contractor Profit (8%)	$1,030,000
				Builder's Risk & Gen Liab Ins (1%)	$129,000
				Payment & Performance Bonds (1.16%)	$149,000
				Subtotal w/ Prime Markups	$17,010,000
				Contingency (30%)	$5,103,000
				TOTAL CONSTRUCTION COST:	$22,113,000

Engineer's Estimate - Sawmill Creek Intake, Pulp Mill Site, Granular Filtration
Prepared By: C Meyn
Date: April 2018

ITEM NO.	WORK DESCRIPTION	UNIT	TOTAL QUANT.	UNIT PRICE	TOTAL COST
1	Demolition and site prep	LS	1	$400,000	$400,000
2	Intake Structure and Pumps	LS	1	$440,000	$440,000
3	Granular Equipment	LS	1	$1,123,000	$1,123,000
4	Backwash Handling & Recycle	LS	1	$495,000	$495,000
5	Finished Water Pumping	LS	1	$184,000	$184,000
6	Piping and Valves Yard & Bldg	LS	1	$835,000	$835,000
7	Pre-Engineered Metal Building w/Mech & Plumb	LS	1	$2,210,000	$2,210,000
8	Electrical & Controls Coordination	LS	1	$854,000	$854,000
				Subtotal Direct Costs:	$6,541,000
				Location Adjustment Factor (28%)	$1,831,000
				Subtotal w/ Location Adjustment:	$8,372,000
				General Conditions (15%)	$1,256,000
				Subtotal w/ General Conditions:	$9,628,000
				Mobilization/Demobilization (10%)	$963,000
				Prime Contractor Overhead (12%)	$1,155,000
				Prime Contractor Profit (8%)	$770,000
				Builder's Risk & Gen Liab Ins (1%)	$96,000
				Payment & Performance Bonds (1.16%)	$112,000
				Subtotal w/ Prime Markups	$12,730,000
				Contingency (30%)	$3,819,000
				TOTAL CONSTRUCTION COST:	$16,549,000

Engineer's Estimate - Indian River, Membrane Filtration
Prepared By: C Meyn
Date: April 2018

ITEM NO.	WORK DESCRIPTION	UNIT	TOTAL QUANT.	UNIT PRICE	TOTAL COST
1	Demolition and site prep	LS	1	$28,900	$28,900
2	Intake Structure and Pumps	LS	1	$400,000	$400,000
3	Pretreatment Equipment	LS	1	$671,000	$671,000
4	Membrane Equipment	LS	1	$2,170,000	$2,170,000
5	Finished Water Pumping	LS	1	$184,000	$184,000
6	Piping and Valves Yard & Building	LS	1	$752,750	$752,750
7	CT Tank	LS	1	$635,000	$635,000
8	Chlorine Equipment	LS	1	$110,000	$110,000
9	Pre-Engineered Metal Building (110'x135')	LS	1	$6,450,000	$6,450,000
10	Electrical & Controls	LS	1	$1,711,000	$1,711,000
				Subtotal Direct Costs:	$13,120,000
				Location Adjustment Factor (28%)	$3,674,000
				Subtotal w/ Location Adjustment:	$16,794,000
				General Conditions (15%)	$2,519,000
				Subtotal w/ General Conditions:	$19,313,000
				Mobilization/Demobilization (10%)	$1,931,000
				Prime Contractor Overhead (12%)	$2,318,000
				Prime Contractor Profit (8%)	$1,545,000
				Builder's Risk & Gen Liab Ins (1%)	$193,000
				Payment & Performance Bonds (1.16%)	$224,000
				Subtotal w/ Prime Markups	$25,524,000

Engineer's Estimate - Indian River, Granular Filtration
Prepared By: C Meyn
Date: April 2018

ITEM NO.	WORK DESCRIPTION	UNIT	TOTAL QUANT.	UNIT PRICE	TOTAL COST
1	Demolition and site prep	LS	1	$21,050	$21,050
2	Intake Structure and Pumping	LS	1	$400,000	$400,000
3	Granular Equipment	LS	1	$2,070,000	$2,070,000
4	Finished Water Pumping	LS	1	$184,000	$184,000
5	Piping and Valves Yard and Building	LS	1	$640,500	$640,500
6	Chlorine Equipment	LS	1	$110,000	$110,000
7	Pre-Engineered Metal Building (110'x135')	LS	1	$2,297,500	$2,297,500
8	CT Tank	LS	1	$635,000	$635,000
9	Electrical & Controls Coordination	LS	1	$954,000	$954,000
				Subtotal Direct Cost:	$7,320,000
				Location Adjustment Factor (28%)	$2,050,000
				Subtotal w/ Location Adjustment:	$9,370,000
				General Conditions (15%)	$1,406,000
				Subtotal w/ General Conditions:	$10,780,000
				Mobilization/Demobilization (10%)	$1,078,000
				Prime Contractor Overhead (12%)	$1,294,000
				Prime Contractor Profit (8%)	$862,000
				Builder's Risk & Gen Liab Ins (1%)	$108,000
				Payment & Performance Bonds (1.16%)	$125,000
				Subtotal w/ Prime Markups	$14,247,000

O&M Cost Summary
Prepared By: C Meyn
Date: April 2018

Category	Granular Filtration	Membrane Filtration
Chemical cost	$500	$534
Power usage (kWH/day)	606	815
Labor (hrs/startup-shutdown)	9	6
Labor (hrs daily)	5	5

Treatment System	Annual O&M Costs
Existing UV Facility	$ 275,000
Filtration with Penstock Supply	$ 531,000
Filtration with Sawmill Creek Supply	$ 600,000

O&M Chemical Costs
Prepared By: C Meyn
Date: April 2018

Membrane Chemicals	**Cost/day**
Caustic	$6.96
Citric Acid	$21.39
Sodium Bisulfate	$4.87
Total	**$33**

Polymer Usage	**Quantity**	**Unit**
PAX XL-19	1	$/lb
PAX XL-19 Dose	20	mg/l
Daily water production	3,000,000	gpd
	125,000	gph
Chem Unit Weight	9.23	lb per gallon in sol/n
Coagulant pump pumping rate	2	gph
Coagulant used	54	gpd
	500.4	lb/day
Coagulant cost	**500**	**$/day**

O&M Power Usage
Prepared By: C Meyn
Date: April 2018

Membrane Power Usage	**Qty (kWH/day)**	**Source**
Consumables Allowance	815	Pall 3.75MGD O&M Estimate
Total	**815**	

Granular Power Usage			**Qty**	**Usage (hr/day)**	**Demand (kWH/day)**
Backwash Pump	5	hp	1	1	3.7
Air blower	7.5	hp	1	1	5.6
Filter effluent pump	10	hp	3	24	536.9
Backwash Recycle Pump	10	hp	1	8	59.7
				Total	**606**

SMC Pumping			**Qty**	**Usage (hr/day)**	**Demand (kWH/day)**
1400 gpm (80 ft head)	40	hp	1.5	24	1073.8

Finished Water Pumping			**Qty**	**Usage (hr/day)**	**Demand (kWH/day)**
1400 gpm pump (200 ft head)	125	hp	1.5	24	3355.7

General Building Lights/Heat/Power			**Qty**	**Usage (hr/day)**	**Demand (kWH/day)**
Lights	0.4	W/ft2	4000	8	32.0
Instrumentation/Controls	1	kW	1	24	0.02
Chemical Dosing Pump	0.03	KW	3	24	0.00
Heat	12.5	W/ft2	125000	12	1500.0
				Total	**1532.0**

O&M Labor Hours
Prepared By: C Meyn
Date: April 2018

Membrane Labor	**Qty (hrs)**
Startup	3
Shutdown	3
Total	**6**

Granular Labor	**Qty (hrs)**
Startup	6
Shutdown	3
Total	**9**

Regular Operations	**Qty (hrs)**
WTP Daily Walkthrough	2
WTP Daily Report	1
WTP Regular PM	1
Finished Water PS	1
Total	**5**

SMC Pump Station	
WTP Daily Walkthrough	1

Comparison of Filtration to Existing WTP Operations
April 2018
R. Venot

Existing Treatment Facility:
Fund 210 Division 600 Department 610

	2017	2080 hours/year budgeted
Labor	$ 72,587.79	$ 34.90
Fringe Benefits	$ 49,650.31	$ 23.87
Total	$ 122,238.10	$ 58.77
Operating Expenses	$ 152,606.59	Training, power, chemicals, repairs, services, tools, postage, other
Total Existing	**$ 275,000**	

New Filtration Facility:

Power	0.12 $/kwh	Estimated annual average cost
Labor (fully burdened)	$ 58.77 /$/hr	

Sawmill Creek Supply

Raw Water Pumping	$ 47,033
Chemicals	$ 182,646
Treatment Building Power	$ 93,640
Labor	$ 128,703
Finished Water Pumping	$ 146,977
Total	**$ 600,000**

Penstock Supply

Chemicals	$ 182,646
Treatment Building Power	$ 93,640
Labor	$ 107,252
Finished Water Pumping	$ 146,977
Total	**$ 531,000**