Gray & Osborne, Inc.
CONSULTING ENGINEERS

TECHNICAL MEMORANDUM 20434-5

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FROM:	KEITH STEWART, P.E. RUSSELL PORTER, P.E.
DATE:	FEBRUARY 15, 2022
SUBJECT:	SUDDEN VALLEY WTP FILTRATION SYSTEM ANALYSIS LAKE WHATCOM WATER & SEWER DISTRICT, WHATCOM COUNTY, WASHINGTON G&O #20434.00

INTRODUCTION

In 2019, the Lake Whatcom Water and Sewer District (District) contracted with Gray & Osborne to perform a condition assessment of their existing Sudden Valley Water Treatment Plant (WTP) as part of a larger effort to analyze the District's water treatment facilities in order to prioritize funds for rehabilitation, modification, and/or replacement projects. The goal of the assessment and subsequent analysis is to identify potential improvements for the existing structures and treatment processes in an attempt to maximize treatment efficiency and extend the operational life of these facilities. The reports and technical memoranda generated as part of this assessment project will be used to develop a strategy for prioritizing modifications to the WTP to ensure it can efficiently and cost-effectively continue to provide clean potable water for existing and projected customers for decades to come.

This memo summarizes the assessment of the existing filtration system at the WTP, provides alternatives for water filtration, and provides a recommendation for modifications to the existing filter equipment.

BACKGROUND AND EXISTING FACILITIES

The District operates three Group A water systems – South Shore (DOH 95910), Eagleridge (DOH 08118), and Agate Heights (DOH 52957) – all of which are in and around the shores of Lake Whatcom, which lies southeast of Bellingham in Whatcom County, Washington. The District serves approximately 3,900 residential and commercial water system connections with a residential population of approximately 10,000 people.

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The South Shore system is the largest of the three systems and is supplied wholly by water treated at its Sudden Valley WTP. In addition to the WTP, the District also owns and maintains surface water source, storage, and distribution system facilities. The distribution system includes multiple pressure zones, four booster stations, and approximately 2.8 million gallons (MG) of storage in five reservoirs. The District also maintains a secondary intertie with the City of Bellingham Water System (DOH 50600) that is used only during emergency situations.

The existing WTP is a rapid-rate, direct filtration plant with a rated capacity of 2.0 million gallons per day (MGD), which is equivalent to approximately 1,400 gallons per minute (gpm), but currently operates at a reduced flow of 1.0 MGD (700 gpm). The maximum allowable water right for this source is 1,526 gpm; however, the equipment and components listed in the alternatives below will be sized to accommodate up to the rated flow of 1,400 gpm. This design flow is suitable to serve the projected buildout water demand of 1.3 MGD as listed in the District's 2018 Water System Comprehensive Plan.

Historically, the plant has performed well and provides high-quality finished water with turbidities of less than 0.1 nephelometric turbidity units (NTU). Raw water is collected from the adjacent Lake Whatcom from an outfall located at a depth of approximately 80 feet and approximately 350 feet from the typical shoreline. Lake Whatcom is a large lake that is moderately developed on the northern and western shores but is largely undeveloped on its eastern shore. Raw water quality from the Lake Whatcom source is fairly consistent with turbidity below 1.0 NTU for most of the year. Turbidity increases during the spring and fall runoff season, but typically remains below 5.0 NTU during these periods. Raw water pH is typically between 7.5 and 7.7 and raw water temperature varies between 6 and 8 degrees Celsius.

The WTP is housed in a partially below-grade concrete building located on Morning Beach Drive approximately 1 mile northeast of the intersection of Lake Whatcom Boulevard and Marigold Drive. The facility was constructed in 1972 and has undergone several minor improvements since that time, but was most recently upgraded in 1992. Prior to filtration, two centrifugal raw water pumps pump water from the Lake Whatcom intake to the WTP where alum coagulant is injected. After mixing with coagulant, water enters the flocculation basin before entering the filter distribution trough and the mixed-media filters. Water proceeds through the filters into the underdrain system, is combined with soda ash for pH adjustment, then proceeds to the below-grade clearwell. Two transfer pumps located in the WTP move water from the clearwell to the chlorine contact basin, which is a welded steel reservoir located adjacent to the WTP that provides additional chlorine contact time. From the chlorine contact basin, four finished water pumps pump water to the District's storage reservoirs and distribution system for consumption. Additional information on the coagulation, flocculation, and filtration systems – which are the primary subject of this memorandum – are provided below.

Coagulation and Flocculation

The District adds potassium aluminum sulfate (alum) to their raw water upstream of the existing flocculation basin to optimize their removal by coagulation of particles prior to direct filtration. The District purchases alum from a commercial vendor and has it delivered to the WTP. Coagulant is stored within a polyethylene storage tank and then injected to the raw water upstream of the flocculation tank. The existing alum storage tank has a capacity of 1,900 gallons, is a fully molded style, was originally installed in 1992, and does not have any seismic bracing or restraints. The existing alum metering pump is a PULSAtron diaphragm metering pump with a capacity of 44 gallons per day (gpd) at 100 pounds per square inch (psi).

Once alum is injected, raw water flows into the flocculation tank. The flocculation tank is a painted, welded steel tank with a diameter of 13.5 feet, a height of 8.6 feet, and a nominal volume of 9,000 gallons. The tank is divided into three equal sections and water flows through the tank in an over-under-over pattern. WTP staff drain and clean the flocculation tank and static mixer annually and any solids accumulated in the tank are disposed of as refuse. The staff typically remove up to 5 gallons of solids from this cleaning effort. The flocculation tank feeds the filter equalization trough, which in turn diverts water to each of the four filters described below.

The Sudden Valley WTP Assessment Report (Assessment Report) completed by Gray & Osborne in 2019 noted that the alum storage tank is old, in fair/poor condition, is beyond its recommended useful life, lacks seismic restraints or tiedowns, does not have direct line of sight from the parking lot during filling, does not contain level sensing equipment, and is adjacent to electrical equipment including Motor Control Center (MCC) 2. The Assessment Report also noted that the chemical metering pump must be calibrated on a daily basis by removing the injection fittings from the raw water piping which requires additional effort by the staff to maintain optimal chemical feed.

The Assessment Report also noted that the existing flocculation tank shows some localized areas of corrosion and coating fatigue – especially at the base, is undersized for the current and maximum operational flows (according to theoretical design values), is located in the center of the WTP Main Building which restricts access to other treatment components, and contributes to elevated moisture within the building which can lead to damage and/or corrosion of the electrical equipment.

Filtration

Water leaves the flocculation tank via 12-inch diameter ductile iron piping and is conveyed by gravity to the equalization trough. At the trough, water is evenly distributed between two separate filter structures. Filters 1 and 2 are contained within a welded and coated steel vessel while Filters 3 and 4 are contained within a marine-grade aluminum vessel. Both vessels sit atop concrete equipment pads. Each filter vessel contains two filter units and each unit consists of an inlet trough, filter media, underdrain system, surface wash and backwashing equipment, and filtered water piping.

Design criteria and technical information on filter media are listed in Table 1. The surface loading rate for all four filters of 2.4 gpm per square foot (gpm/sf) is within the maximum allowable rate listed by the Washington State Department of Health (DOH) for a multimedia filter (6 gpm/sf). The surface loading rate using only two filters is 4.8 gpm/sf (700 gpm/144 sf), which suggests that the WTP can operate at the typical flow rate with only two filters (one vessel) in service. Typically, the WTP operates for 10 to 16 hours each day, and often longer during warm summer months when water demand is high.

For comparison with the current rated capacity of the WTP (1,400 gpm), all of the filtration alternatives described later in this memorandum will be capable of providing filtration/treatment up to 1,400 gpm, even though the WTP currently operates at a flow of only 700 gpm. Providing filtration capacity up to 1,400 gpm now will allow the District, if desired, the flexibility to address/expand the components that currently limit their flows to 700 gpm. The WTP is physically limited to a flow of 1,000 gpm based on directive from DOH. This restriction is based on the level of CT they can provide with their existing system. The staff operates the WTP at 700 gpm in order to incorporate an additional factor of safety into their operations.

TABLE 1

WTP Filter Media Summary

Parameter	Value
Type	Gravity, Rapid-Rate Direct Filtration
Vessel Dimensions (ft, L x W x H)	8 x 9 x 8
Filter Area (sf)	288 (4 filters at 72 sf each)
Rate of Filtration @ 700 gpm (gpm/sf)	2.4
Rate of Filtration @ 1,000 gpm (gpm/sf)	3.5
Rate of Filtration @ 1,390 gpm (gpm/sf) (1)	4.8
Rate of Filtration @ 1,526 gpm (gpm/sf) (2)	5.3
Rate of Backwash (gpm/sf)	18.0
Design Media Depth (inches)	
#1A Anthracite (1.0 mm–1.1 mm)	18
F16 Sand (0.45 mm–0.55 mm)	9
#50 Garnet Sand (0.28 mm–0.38 mm)	4.5
#12 Garnet Gravel (1.46 mm–1.56 mm)	4.5
#3 Gravel (0.375 in.–0.1875 in.)	3
#2 Gravel (0.75 in.–0.375 in.)	3
#1 Gravel (1.50 in.–0.75 in.)	10

(1) Value is based on the WTP rated capacity of 2.0 MGD.
(2) Value is based on current South Shore Water System water right.

During normal filter operation, water is distributed evenly to all four cells and flows through the filter media and into the respective underdrain chambers. As it passes through the filter media, flocculated sediment and small particles are trapped and removed by the media, while filtered water passes into the underdrain system and on through the discharge piping to the clearwell. The discharge piping at each filter consists of isolation valves, flow control valves, chemical injection fittings, sample taps, and flow meters to ensure consistent operation.

As additional particles are adsorbed onto the filter media, the head loss through the filter media, the turbidity of the filtered water, and the water level within the filter vessel increases. To remove these trapped particles from the filter media, each filter bed is backwashed daily prior to operation. During the backwash of a filter cell, water from the distribution system served by the Division 7 Reservoir flows upward through the filter at approximately 1,300 gpm (18.0 gpm/sf). The backwash flow rate is measured by a magnetic flow meter on the backwash line located on the south wall of the WTP. At this flow rate, the media bed is fluidized to remove the accumulated sediment particles and the particle-laden backwash water flows into the filter cell waste trough and then to the backwash storage basin. Each filter also includes a surface wash system that consists of two supply arms with nine nozzles on each side (18 total nozzles). The pressure and flow of backwash water through these nozzles causes the arms to rotate and disperse spray that agitates the media surface. Spray from these nozzles only occurs during backwash and helps to prevent the formation of mudballs on the media bed. The complete backwash sequence includes the following steps:

- 4.0 minutes of surface wash only
- 2.5 minutes of surface wash and filter backwash
- 5 minutes of filter backwash
- Up to 20 minutes settling, equalization, and drainage
- 15 minutes of filter to waste

After this backwash sequence, the filters return to normal operation and water flows through the filters and into the clearwell. According to WTP staff, the entire backwash process for all four filters typically takes 120 to 160 minutes.

The backwash storage basin is located underground between the WTP Main Building and the Finished Water Pump Building. The basin has a volume of approximately 16,000 to 17,000 gallons and provides an opportunity for settling of the removed particles. Backwash water within the basin is pumped via submersible pumps several times during each backwash sequence to the residential sewer system where water proceeds to the City of Bellingham's Post Point Wastewater Treatment Plant (WWTP) for treatment. Overflow from the backwash basin is directed back to Lake Whatcom. An assessment of the backwash system and options for handling backwash wastewater will be addressed as part of this project, but will be discussed in a separate memorandum.

The existing flocculation tank, filter vessels, filters, and filter discharge piping are shown on Figures A-1, A-2, A3, and A-4 in Exhibit A.

The Assessment Report noted that the filters appear to be performing adequately and do not show a noticeable decrease in performance, filter run times, or rebound after backwashing within the past several years. Furthermore, the WTP meets all of the DOH Treatment Optimization Program (TOP) requirements, which set higher standards for monitoring and surface water treatment plant performance.

The Assessment Report did note that access to the filter discharge piping is very restricted due to spatial limitations, each filter vessel is accessible only via a single vertical ladder mounted to the side of the filter vessel, and the Filters 1 and 2 vessel does show some minor signs of corrosion and/or coating fatigue which has allowed localized corrosion of the steel.

The next section provides a brief description of some filtration alternatives for the District's consideration.

ALTERNATIVES ANALYSIS

The five alternatives listed below are provided to help the District determine the best course of action for their filtration system. Any modifications to the filtration equipment should be considered in the context of other changes that are recommended or desired for the WTP.

The goal for these alternatives is to address the findings for the flocculation tank and filter system listed in the Assessment Report and to continue to provide high-quality water to the District's customers for the next decades.

Alternative F1 – Continued Use of Existing Mixed Media Rapid Rate Direct Filtration Equipment

General

This alternative includes continuing to use the existing flocculation and filtration equipment with minimal modifications. Per our discussions with WTP operations staff, the existing equipment performs adequately and shows no noticeable decrease in performance.

Filtration

For this alternative, there are no recommended modifications to the existing operation of the filters or the filter discharge piping. The operations staff would continue to provide regular maintenance of the existing filters which includes maintaining an operable surface wash system, regular replacement or replenishment of filter media, visual observation of filter operation, recordkeeping of filter performance, and monitoring filter run times and post-backwash turbidity.

Based on the findings listed in the Assessment Report, we recommend that an additional ladder be provided at each filter vessel to improve access and safety, and to provide a secondary path of egress from the filter platform in the event that one of the paths is blocked. Additional ladders should be installed in the northeast corner of Filters 1 and 2, and in the northwest corner of Filters 3 and 4. These ladders can be welded or bolted to the filter vessels and will provide secondary access to the tops of the filter vessels.

Ladder materials should be painted steel and aluminum to match the materials for the respective filter vessels.

Additionally, we recommend that the coating system on Filters 1 and 2 be repaired in locations where corrosion is evident. Areas where repair is needed are mostly located along the baseplate around the perimeter of the filter vessel. For this repair, the corroded areas should be prepared using machine tool cleaning to bare metal (SSPC-SP11) and should be coated with two coats of high-grade, NSF 61-certified, epoxy coating system from Tnemec, Sherwin Williams, Ameron, or equal. It should be noted that during the WTP assessment, the filter's interior coating system could not be inspected because the filter was in operation. Given the relatively minor corrosion visible on the exterior and the fact that there is no visual evidence of significant corrosion or coating damage/deterioration on the steel exposed to view on the filter vessel, it is not anticipated that significant corrosion or coating damage exists below the media/water surface. If this alternative is selected, we recommend removing enough media to allow for an inspection of the filter's interior coating and if the coating is found to be damaged, repairing/replacing the damage with new coating materials.

Additionally, there are other modifications that could be done to improve the filters and ensure their longevity. The condition of the filter underdrain system is not known since it is inaccessible. The filter underdrains may require replacement with an updated system. The new underdrains would likely be modular with a media support deck and a collector system for the filtered water. It may be possible to retrofit the existing filter vessels with access ports to allow inspection of the underdrain system, a feature that is currently not available.

Another modification that could improve backwash performance is the addition of air scour. It may be possible to add a blower and an air scour system to improve the removal of particles during backwash. Most new installations include air scour. If air scour is added, it might be possible to remove the existing surface wash equipment. Plant staff have indicated that the surface wash equipment is maintenance intensive.

Lastly, we recommend that the flocculation tank coating system be repaired and/or replaced to prevent further corrosion and/or deterioration of the steel. Given the size of the tank, we recommend that the entire tank be prepared and recoated, even though corrosion is most evident above the existing water surface and at the baseplate/wall interface. Preparation and recoating of the flocculation tank will require that the tank be removed from service. We estimate that draining, drying, preparation, recoating, curing, and filling the tank can be accomplished in 2 to 4 weeks. During this period, temporary piping or tankage could be used to either bypass the existing flocculation tank or provide temporary flocculation volume. During this period, special attention should be given to operation of the WTP to ensure that the equalization trough does not overflow. Furthermore, if the District proceeds with this recommendation, we suggest that this work be completed during periods of low demand between December and March in order to minimize the duration of WTP operation.

An alternative to preparation and recoating the existing flocculation tank is to replace the tank with a plastic (fiberglass reinforced plastic [FRP] or high-density polyethylene [HDPE]) tank. Such a tank could be fabricated to mimic the existing tank and could be installed onto the existing concrete pad. An FRP tank would last for 20 to 30 years, would not be subject to corrosion, and could include a molded lid which would reduce ambient moisture within the WTP Main Building. This option would also decrease the downtime for the WTP. We estimate that draining the existing flocculation tank, removing the tank, installing a new plastic tank, reconnecting various components, and refilling the tank could be completed in 3 to 4 days. During this time, the WTP staff could provide temporary piping from the raw water pumps to the equalization basin trough or could elect to not operate the WTP if sufficient storage is available to serve system demands. Because the only access to the WTP is via a 3.5-foot wide single door, installation of a new plastic tank would require that the existing storefront windows be removed temporarily. In addition to these requirements, we recommend that if this option is selected, the District complete this replacement during periods of low system demand (December through March).

Building and Other

For this alternative, there are no recommended modifications to the existing WTP Main Building, WTP site, HVAC system, or Supervisory Control and Data Acquisition (SCADA) systems.

Furthermore, there are no recommended modifications to the existing WTP electrical equipment for the filters. Technical Memorandum 20434-1 provides some recommendations for existing MCC 1, MCC 2, and MCC 3 as well as the associated pumping equipment. It is anticipated that the capacity of the existing electrical service is sufficient to accommodate the recommendations for this alternative.

While this alternative does have a low capital cost, it does not adequately address the space restrictions in the WTP Main Building, or address the proximity of chemical storage and moisture to the existing electrical gear.

It is anticipated that the level of effort and time needed to operate and maintain the equipment included in this alternative is consistent with the current requirements.

Cost Estimate

The estimated cost to provide two new ladders, spot repair the coating on Filters 1 and 2, and prepare and recoat the flocculation tank is $90,000 including contingency (25 percent), Washington State sales tax (9.0 percent), and design/project administration (25 percent). A budgetary cost estimate for this alternative is provided in Exhibit B. The estimated cost to modify the existing filters as described above but replace the existing steel flocculation tank with a new plastic tank is $170,000 including contingency (25 percent), Washington State sales tax (9.0 percent), and design/project administration (25 percent). A budgetary cost estimate for this alternative is provided in Exhibit B. These costs represent a minimal project cost. If the condition of the underdrains proves sufficiently bad to require replacement or if the District decides to upgrade the filters with the optional features, such as air scour, to ensure filter system longevity and minimize operation and maintenance effort, the cost of this alternative could increase significantly. The extent of these modifications will depend upon the total scope so the cost at this time is speculative but could be in the range of $1 million.

Alternative F2 – Modified Use of Existing Mixed-Media Rapid-Rate Direct Filtration Equipment with New Flocculation Equipment

General

This alternative includes continuing to use the existing mixed-media direct-filtration systems, construction of a new separate building, removing the existing flocculation tank from service, installing stand-alone pretreatment equipment upstream of the existing filters within a new building, relocating the existing chemical systems to the new building, construction of an enclosed electrical room within the WTP Main Building, and rehabilitating the WTP Main Building to include additional work/laboratory and storage space.

Filtration

This alternative includes replacement of the existing flocculation tank with a new pretreatment system that could be a new flocculation tank, adsorption clarifier, or a dissolved air flotation unit. The new flocculation tank would be sized to optimize coagulation and flocculation.

An adsorption clarifier allows for coagulation and flocculation and also provides prefiltration of the flocculated particles and reduces the particle load on the filters, which can extend filter run times. Adsorption clarifiers use a raw water flush and air scour so backwashing with finished water is minimized. For this alternative, two adsorption clarifiers would be used, both of which are installed within a single vessel. The clarifiers would be operated in parallel and each clarifier would be capable of filtering up to 700 gpm. Clarifiers will be provided with level sensors, alarm floats, and control valves as required to provide successful pretreatment of the source water.

The clarifiers would require blowers to provide air for the air scour during the flush cycle. Typically, a single blower is sufficient; however, a redundant blower may be provided in the event that the primary blower is taken offline for maintenance. Given the residential and recreational nature of the site, the building may need to have features to attenuate the blower noise such as acoustical louvers or a dedicated blower room.

A third possible type of pretreatment is dissolved air flotation (DAF). DAF clarifies source water by injecting air into the flocculated water. The released air forms tiny bubbles which adhere to the flocculated particles causing the floc to float to the surface where it may be removed by a skimming device. DAF equipment is available in package units that include all of the components, equipment, controls, and tankage. Photo examples of DAF units are included as Figure A-10 in Appendix A. DAF technology was installed at the City of Bellingham water treatment plant.

With this alternative, the operations staff would continue to provide regular maintenance of the existing filters as described in Alternative F1. For this alternative, there are no recommended modifications to the existing operation of the filters or the filter discharge piping. We recommend that additional ladders be provided for the filters and that the existing coating system on Filters 1 and 2 be repaired as described in Alternative F1.

Liquid alum will continue to be added to the raw water supply upstream of the pretreatment and mixing will be provided by a static mixer in line with the raw water piping, downstream of the raw water pumps. The existing raw water pumps have a capacity of approximately 1,400 gpm at 25 feet total dynamic head (TDH), which should be sufficient to feed the proposed pretreatment and existing filter equipment.

Currently, the WTP adds a small amount of chlorine prior to the existing flocculation tank upstream of the filter vessels. This chlorine is not used for disinfection but is added to help reduce algae growth in the flocculation tank and filter vessels. Chlorine injection upstream of the filter vessels will be maintained in this alternative.

<u>Building and Other</u>

While the proposed pretreatment might physically fit within the existing WTP Main Building, installation would require significant effort due to the presence of existing treatment equipment and piping. Installation within the WTP Main Building would require the removal of the existing flocculation tank, chemical systems, piping, and storefront windows. Furthermore, it is not feasible to maintain WTP operation and produce water during the removal of the existing flocculation equipment and installation of a new system. Since replacement of the existing flocculation tank with pretreatment equipment in 1 to 2 days is not feasible, placing the new equipment in a separate building is the only feasible way to add pretreatment. Additionally, a new structure should be large enough to accommodate new alum equipment and relocated soda ash equipment as recommended in Technical Memorandum 20434-4. Providing additional space for the chemical addition systems in the proposed building will separate the chemical system from the electrical systems, thus reducing the potential for corrosion and/or damage. Furthermore, a new building to house the pretreatment and chemical systems would provide extra space in the existing WTP Main Building for a separate enclosed electrical room as well as laboratory and storage space. Approximately 1,800 square feet (sf) (57′ x 33′) is suitable to provide space for the new pretreatment equipment, chemical equipment, access clearances, piping, and a future pretreatment vessel as needed to accommodate future demands. The building could be constructed from a variety of materials, including wood truss/CMU, and would include several rollup doors for clarifier installation, maintenance, and removal. A proposed site/building plan is provided as Figure A-5. The figure shows an adsorption clarifier as the pretreatment technology.

Site improvements associated with the proposed building include asphalt paving to provide access to the facility. New facilities will be subject to all applicable stormwater requirements for construction of new buildings and the addition of new asphalt pavement. The construction of a new building adjacent to the existing WTP would be subject to the stipulations listed by Whatcom County for the Lake Whatcom Watershed. These requirements will include the need to provide either full infiltration on site or advanced treatment for phosphorous removal. Design of the required stormwater facilities will be provided once the building footprint and paving have been finalized, but a budget estimate for the anticipated requirements has been included with the alternative cost estimate included in Exhibit B. In addition, it should be noted that these regulations restrict clearing of the site so that only 35 percent of the existing tree canopy can be cleared.

The additional process treatment equipment recommended in this alternative will increase the electrical load on the facility by 10 to 20 horsepower (hp) to accommodate the proposed air scour blower(s). In addition to this new load, the proposed building will require additional heating, ventilation, and dehumidifier equipment. Furthermore, the proposed electrical room within the WTP Main Building will require separate ventilation and cooling equipment to maintain an appropriate temperature for the motor starters and other electronic components. For the purposes of this analysis, it is assumed that the existing electrical service to the site is sufficient to accommodate the proposed loads and that a new electrical supply will be sub-fed from the existing Finished Water Pump Building. A formal electrical analysis should be completed once the size of the proposed electrical loads are defined to confirm this assumption.

This alternative will include a new heating and ventilation system for the proposed building addition and new ventilation and cooling equipment for the proposed electrical room.

This alternative will require modifications to the District's existing SCADA system. New control set points, monitoring information, and alarms will be required to successfully operate the new clarifier equipment. The new signals can be incorporated into the District's existing SCADA system and will allow for monitoring and control of the new system per the District's protocols.

It is anticipated that the level of effort and time needed to operate and maintain the equipment included in this alternative is consistent with the current requirements.

This alternative successfully addresses spacing issues within the WTP, removes the flocculation tank as a source of moisture from the WTP Main Building, and along with relocation of the chemical delivery equipment, provides sufficient space to expand the WTP Main Building storage/laboratory space and construct an enclosed electrical room in order to protect the electrical equipment from exposure to moisture and chemicals. This alternative does represent a significantly higher capital cost when compared to Alternative F1.

Cost Estimate

The estimated cost to provide the items described above using an adsorption clarifier is $3,583,000 including contingency (25 percent), Washington State sales tax (9.0 percent), and design/project administration (25 percent). A budgetary cost estimate for this alternative is provided in Exhibit B.

Alternative F3 – Installation of New Mixed-Media Rapid-Rate Direct Filtration Equipment

General

This alternative includes removing the existing filters from service, construction of a new separate building, installation of new package filtration units that include a contact adsorption clarifier in the new building, relocating the existing chemical systems to the new building, construction of an enclosed electrical room within the WTP Main Building, and rehabilitating the WTP Main Building to include additional work/laboratory and storage space.

Filtration

Even though the existing filters were installed in 1972, rapid-rate mixed-media filtration technology has not changed significantly since that time. Current package filtration technology functions similarly to the WTP's existing filters, but can also include a pre-sedimentation basin (PSB), and/or a contact adsorption clarifier (CAC) upstream of the filter media. Package filtration units typically include a single vessel with separate sections for a PSB (if desired), a CAC, and the filter media. The units also include instrumentation and controls to ensure successful equipment operation as well as a control panel used to monitor and optimize the treatment process. PSBs accept raw water combined with coagulant and promote rapid settling and removal of the coagulated particles prior to introduction to the CAC. However, because raw water quality from the Lake Whatcom source is consistently less than 5 NTU and does not show significant seasonal variation, a PSB is not recommended for this application and will not be considered further. CACs provide prefiltration of coagulated particles and reduce the particle load on the media bed which can improve filter performance and extend filter run times. After the CAC, water flows to the filtration media where smaller particles are removed. Technical information for a typical package filtration with a CAC is provided in Exhibit C.

In addition to mixed-media filtration, there are other configurations of media that will successfully provide filtration for the District. The most notable of these is deep-bed monomedia filtration. In this configuration, a thicker volume of media with a consistent gradation is used to remove coagulated particles. The primary advantage of monomedia filtration is that longer filter run times can be achieved if filter rates are maintained below 6 gpm/sf. Additional benefits, including higher filtration rates, are possible with this technology if a media depth between 56 and 72 inches can be provided. For monomedia filtration, the diameter of the media particles should be between 1.2 and 1.5 millimeters (mm) and the depth of the media should be at least 60 inches in order to achieve the recommended bed depth-to-media particle diameter ratio of 1,300 (*Integrated Design and Operation of Water Treatment Facilities*, 2nd Edition, Kawamura, 2000).

Deep-bed monomedia is not usually available with steel package vessels because of the geometry of the units. For example, the existing filters have 52 inches of media including support gravels. Consequently, the existing filters just do not have the depth in the filter chamber to hold the 56 to 72 inches of media required for a deep bed. If this additional media were added to existing filters, the upper portion would be washed out during backwash. Deep-bed filtration is usually used in filter plants with deep cast concrete basins such as the City of Everett rather than package plants.

This alternative includes two 700 gpm package filters which would allow the WTP to operate with only one filter in service and provide filter capacity for up to the WTP's current rated capacity of 1,400 gpm. The proposed package filtration units will include CACs and are each roughly 28′ x 9′ x 9′ (L x W x H). A cross section of the proposed unit is provided on Figure A-6.

Filters will be provided with a control panel, level sensors, high-level alarm floats, and control valves as required to provide successful treatment of the source water.

The proposed mixed-media filters require blowers to provide air for the air scour mode of the backwash cycle. Typically, a single blower is sufficient; however, a redundant blower will be provided in the event that the primary blower is taken offline for maintenance.

Liquid alum will continue to be added to the raw water supply upstream of the filter unit and mixing will be provided by a static mixer in line with the raw water piping downstream of the raw water pumps. The existing raw water pumps have a capacity of approximately 1,400 gpm at 25 feet TDH, which should be sufficient to feed the proposed filtration equipment.

Currently, the WTP adds a small amount of chlorine to their existing flocculation tank upstream of the filter vessels. This chlorine is not used for disinfection, but is added to help reduce algae growth in the flocculation tank and filter vessels. Chlorine injection upstream of the filter vessels will be maintained in this alternative.

<u>Building and Other</u>

While the proposed filter units would physically fit within the existing WTP Main Building, installation would require significant coordination due to the presence of existing treatment equipment and piping. Installation at the current filter location would require the removal of the existing flocculation tank, chemical systems, existing piping, existing storefront windows, as well as reorganization of the existing backwash discharge trench drain that conveys water from the filter discharge piping to the buried backwash storage tank located adjacent to the WTP. Furthermore, any modifications will require significant coordination and/or planning to ensure that the WTP can remain functional during execution of the work. Since replacement of the existing filters in 1 to 2 days is not feasible, a second option is to install new components in a different location, connect them to the treatment system, and then remove the existing components. As such, we recommend that the District construct a separate building to house the new filter equipment. Additionally, a new structure should be large enough to accommodate new alum equipment and relocated soda ash equipment. Providing additional space for the chemical addition systems in the proposed building will separate the chemical system from the electrical systems, thus reducing the potential for corrosion and/or damage. Furthermore, a new building to house the filters and chemical systems would provide extra space in the existing WTP Main Building for a separate enclosed electrical room as well as laboratory and storage space. Approximately 3,300 sf (78′ x 42′) is required to provide suitable space for the new filter equipment, access clearances, piping, and a future third filtration package. The building could be constructed from a variety of materials, including wood truss/CMU, and would include several rollup doors to facilitate clarifier installation, maintenance, and removal. A proposed site/building plan is provided as Figure A-7.

After the new filter units are operational and the existing flocculation tank and filter vessels have been removed from the WTP Main Building, the existing building can be modified to provide for expanded laboratory/workspace as well as an enclosed electrical room.

Site improvements associated with the proposed building include asphalt paving to provide access to the facility. Stormwater facilities for this alternative would be similar to Alternative F2.

The additional process treatment equipment recommended in this alternative will increase the electrical load on the facility by 20 to 40 hp to accommodate the proposed air scour blowers. In addition to this new load, the new space will require additional heating, ventilation, and dehumidifier equipment. Furthermore, the proposed electrical room in the WTP Main Building will require separate ventilation and cooling equipment to maintain an appropriate temperature for the motor starters and other electronic components. For the purposes of this investigation, it is assumed that the existing electrical service to the site is sufficient to accommodate the proposed loads and that a new electrical supply will be sub-fed from the existing Finished Water Pump Building. A formal electrical analysis should be completed once the size of the proposed electrical loads are defined to confirm this assumption.

This alternative will include new heating and ventilation system for the proposed building addition, and new ventilation and cooling equipment for the proposed electrical room.

This alternative will require modifications to the District’s existing SCADA system. New control set points, monitoring information, and alarms will be required to successfully operate the new filtration equipment. Typically, package filtration systems are provided with a control panel that allows the WTP operations staff to monitor and control the function of the filter system. This control panel can be incorporated into the District's existing SCADA system and will allow for monitoring and control of the new system per the District's protocols.

It is anticipated that the level of effort and time needed to operate and maintain the equipment included in this alternative is consistent with the current requirements.

This alternative successfully addresses spacing issues within the WTP, removes the flocculation tank as a source of moisture from the WTP, and along with relocation of the chemical delivery equipment, provides sufficient space to expand the WTP Main Building storage/laboratory space and construct an enclosed electrical room in order to protect the electrical equipment from exposure to moisture and chemicals. This alternative does represent a significantly higher capital cost when compared to Alternatives F1 and F2.

Cost Estimate

This alternative is estimated to cost $5,876,000, including contingency (25 percent), Washington State sales tax (9.0 percent), and design/project administration (25 percent). A budgetary cost estimate for this alternative is provided in Exhibit B.

Alternative F4 – Installation of New Membrane Filtration Equipment

General

This alternative includes removing the existing filters from service, construction of a new separate building, installation of new membrane filtration equipment in the new building, relocating the existing chemical systems to the new building, construction of an enclosed electrical room within the WTP Main Building, and rehabilitating the WTP Main Building to include additional work/laboratory and storage space.

Filtration

Although still a relatively new technology, membrane filtration is now used more frequently for municipal water treatment. The process utilizes manufactured membranes of various materials (ceramics, polymers) under pressure to remove solids, turbidity, and to provide a 3-log reduction of *Giardia* and 2-log reduction of *Cryptosporidium*. In some membrane applications, specifically in ultra- and/or nano-filtration applications, additional credits can be provided for 1.5-log removal of waterborne viruses. Most membranes used for municipal water treatment are cylindrical, hollow-fiber materials and provide filtration via outside/in water flow.

For membrane filtration, raw water is treated via a 200 micrometer (µm) prefilter for removal of larger debris. As the membrane surface accumulates filtered particles, they must occasionally be cleaned via backwashing and air scouring. For this, filtered water is sent to a backwash supply tank, where the backwash cycle removes accumulated foulants through a reverse inside/out flow approximately every 20 to 60 minutes. Air scouring is provided during this phase to optimize the backwash process. A drain or filter-to-waste step is used to remove any additional accumulated material. Membrane integrity testing is conducted automatically once every 24 hours and this integrity test is capable of detecting a single fiber break. Maintenance cleans, chemically enhanced backwashes, and/or clean-in-place procedures are automated chemical cleaning processes used to recover membrane permeability and typically occur every 1 to 4 weeks, depending on the cleaning process.

For the purposes of this analysis, the proposed membrane filtration system will consist of the following components:

- Two skid-mounted, hollow-fiber membrane modules
  - 30 filter cartridges on each skid for a total of 60 cartridges

- Two prefilter water feed pumps
  - Pumps shall be approximately 1,600 gpm at 100 feet TDH

- One backwash pump
  - Pump shall be approximately 900 gpm at 90 feet TDH

- Two prefiltration units

- One compressed air system
  - Pneumatically operated valves
  - One regenerative blower
  - One airflow meter and transmitter

- Two turbidimeters
  - HACH TU5300sc

- Two flow meters
  - Magnetic flow meter with integral transmitter

- Pressure gauges as required for system monitoring

- One electrical control panel

- Two tanks
  - One feed supply equalization tank
  - One backwash supply tank

- One clean-in-place chemical cleaning skid
  - Sodium hypochlorite
  - Citric acid

The equipment listed above would allow the WTP to operate with only one membrane skid in service but would provide filter capacity for up to 1,400 gpm and would require an additional membrane skid in order to provide complete redundancy. Although only two filters are proposed for this alternative, space should be provided for a future third membrane skid unit. Each membrane skid has a footprint of approximately 150 sf (25′ x 6′) and an example of a typical membrane filtration unit is shown on Figure A-8. Typically, the filtration equipment is provided as a skid-mounted system that is ready for connection to the inlet and outlet piping reduces installation time and provides a clear definition for components to be provided by the equipment manufacturer and the contractor performing the installation.

Given that the existing filters are located at the rear of the WTP Main Building and because the proposed membrane filter skids are longer than the existing filters, it is not feasible to install the proposed membrane skids in the location of the existing filter vessels. As such, we recommend that the District install the membrane skids in a new building, connect them to the existing treatment system, then remove the existing filters and supporting equipment.

Given the raw water quality parameters of the Lake Whatcom source, liquid alum is not needed prior to membrane filtration. Removal of this equipment will increase the available space in the proposed building.

Although the existing raw water pumps have sufficient capacity for the current treatment equipment, membrane filtration equipment operates at a significantly higher pressure. New supply pumps will be installed to push water through the membrane cartridges in accordance with the manufacturer's recommendations.

The backwash system has specific flow and pressure requirements to ensure successful membrane filtration and the existing backwash system cannot meet these new requirements. A new backwash pump and backwash supply tank are provided for this alternative and will be sized per the membrane manufacturer's design criteria.

The backwash system for the membranes is automatic and based on filter run times and/or pressure drop across the filter membrane. The total water wasted between both the backwash and flow-to-waste cycles for the membrane system is approximately 45,000 gpd. Given the current filter wash cycle and flow-to-waste cycles, approximately 50,000 gallons is wasted. Thus, the use of membranes may reduce the total volume of water wasted by approximately 10 percent. This is of particular interest to the District since they pay municipal rates for all water wasted to the City of Bellingham's municipal wastewater treatment system, and any reduction in wastewater volume from the WTP will reduce operational costs.

Additional chemical cleaning equipment is required to maintain successful function of the filters. These systems are typically provided with the membrane filtration package, and include both sodium hypochlorite and citric acid storage and dosing equipment. These systems should be located in the proposed building addition described below.

Lastly, given that this alternative represents a "new" filtration technology for the District, it is likely that some form of pilot testing must be completed in order to demonstrate that the proposed technology is feasible for the Lake Whatcom source.

<u>Building and Other</u>

Due to space and project sequencing limitation, we recommend that the District construct a separate building to accommodate the new membrane equipment. A proposed site/building plan is provided as Figure A-9. This also includes relocation of the existing chemical equipment and reorganization of the existing WTP Main Building as described in Alternative F3.

Site improvements, stormwater improvements, electrical modifications, HVAC modifications, and telemetry and SCADA modifications will be similar to those described in Alternative F3.

Even though this alternative utilizes different technology than what is currently utilized, it is anticipated that the level of effort and time needed to operate and maintain the equipment included in this alternative is consistent with the current requirements.

This alternative successfully addresses spacing issues within the WTP, removes the flocculation tank as a source of moisture from the WTP, and along with relocation of the chemical delivery equipment, provides sufficient space to expand the WTP Main

Building storage/laboratory space and construct an enclosed electrical room in order to protect the electrical equipment from exposure to moisture and chemicals. This alternative does represent a significantly higher capital cost when compared to Alternatives F1 and F2.

Cost Estimate

This alternative is estimated to cost approximately $4,948,000, including contingency (25 percent), Washington State sales tax (9.0 percent), and design/project administration (25 percent). A budgetary cost estimate for this alternative is provided in Exhibit B.

SUMMARY OF ALTERNATIVES AND COST ESTIMATES

The alternatives described above highlight feasible alternatives for providing water filtration for the South Shore Water System. The alternatives are further analyzed below, and a final recommendation based on this analysis and discussions with District staff is provided at the end of this section.

It is important to note that all of these alternatives will require additional design and coordination with various stakeholders, one of which includes the Sudden Valley Community Association (SVCA). The SVCA owns much of the property adjacent to the WTP and would need to be consulted prior to implementation of any of the alternatives discussed in this memorandum. Furthermore, the District must consider that the property adjacent to the WTP is a public park with waterfront access and use of this public space will likely need to be maintained at all times. Other stakeholders include neighboring residential landowners and utility providers serving the area.

Alternative Summary

Alternative F1

Alternative F1 includes modifying the existing filter vessels with ladders and rehabilitating the existing Filters 1 and 2 coating system. No building, site, electrical, HVAC, or telemetry/SCADA improvements are included with this alternative.

Alternative F2

Alternative F2 includes removing the existing flocculation tank and installing new pretreatment equipment, either a new flocculator, adsorption clarifier, or DAF unit. The new pretreatment equipment would be installed within a new separate building that would be sized to also house new chemical dosing tanks and metering pump equipment.

Site improvements would include new piping and asphalt paving to provide access to the new building. Electrical, HVAC, and telemetry/SCADA improvements would be provided to equip and power the proposed building and new treatment equipment. Also, the existing WTP Main Building would be reconfigured to include additional storage/laboratory space. Finally, an electrical room will be constructed within the WTP Main Building to house the MCCs and other electrical gear, which will provide separation from the moisture associated with the treatment process.

Alternative F3

Alternative F3 includes installation of new package filtration equipment. This new equipment would be installed within a new separate building that would be sized to also house new chemical dosing tanks and metering pump equipment. Site improvements would include new piping and asphalt paving to provide access to the new building. Electrical, HVAC, and telemetry/SCADA improvements would be provided to equip and power the proposed building and new treatment equipment. The existing filters would be removed from the WTP Main Building, which would be reconfigured to include additional storage/laboratory space. Finally, an electrical room will be constructed within the WTP Main Building to house the MCCs and other electrical gear, which will provide separation from the moisture associated with the treatment process.

Alternative F4

Alternative F4 includes installation of new membrane filtration equipment. This new equipment would be installed within a new separate building that would be sized to also house new chemical dosing tanks and metering pump equipment. Site improvements would include new piping and asphalt paving to provide access to the new building. Electrical, HVAC, and telemetry/SCADA improvements would be provided to equip and power the proposed building and new treatment equipment. The existing filters would be removed from the WTP Main Building, which would be reconfigured to include additional storage/laboratory space. Finally, an electrical room will be constructed within the WTP Main Building to house the MCCs and other electrical gear, which will provide separation from the moisture associated with the treatment process.

Alternative Analysis

Advantages to Alternative F1 are its low capital cost. Disadvantages to Alternative F1 are that it does not address space constraints within the WTP Main Building, does not address the moist environment partially due to the presence of the flocculation tank, and does not allow for adequate separation between the chemical and electrical components. Alternative F1 allows for continued operation but does not address the long-term space and maintenance issues that would allow for assurance that the plant can continue producing high-quality water for the next decades.

Advantages to Alternative F2 are that it will provide additional space in the WTP Main Building for laboratory/storage and allow for construction of an electrical room to provide separation from a moist environment as well as treatment chemicals. Disadvantages to this alternative include a high capital cost and issues with construction of a new building near the existing WTP Main Building.

Advantages to Alternative F3 are that it will provide additional space in the WTP Main Building for laboratory/storage and allow for construction of an electrical room to provide separation from a moist environment as well as treatment chemicals. It will also replace equipment that is nearly 50 years old. Disadvantages to this alternative include a high capital cost and issues with construction of a new building near the existing WTP Main Building.

Advantages to Alternative F4 are that it will provide additional space in the WTP Main Building for laboratory/storage and allow for construction of an electrical room to provide separation from a moist environment as well as treatment chemicals. It will also replace equipment that is nearly 50 years old with new technology. Lastly, it should reduce the operation and maintenance requirements for WTP operational staff. Disadvantages to this alternative include a high capital cost and issues with construction of a new building near the existing WTP Main Building. In addition, the new system must be pilot tested prior to implementation, which will extend the project by 6 to 12 months.

It is difficult to provide a filtration recommendation without considering the other issues that are being considered at the treatment plant. For example, if the District decides to relocate the chemical feed equipment into a separate building, Alternatives F2, F3, and F4 become more favorable since the expansion of a new chemical building to house new prefiltration or filtration has an economy of scale.

Consequently, the final filtration recommendation will be deferred until the summary report is prepared that contains all of the information in the various technical memoranda to provide an optimized recommendation for the entire filter plant to ensure the District’s goal of continuing to provide high-quality treated water for decades to come.

EXHIBIT A

PHOTOGRAPHS OF EXISTING EQUIPMENT

FIGURE A-1

Flocculation Tank

FIGURE A-2

Filters 1 and 2

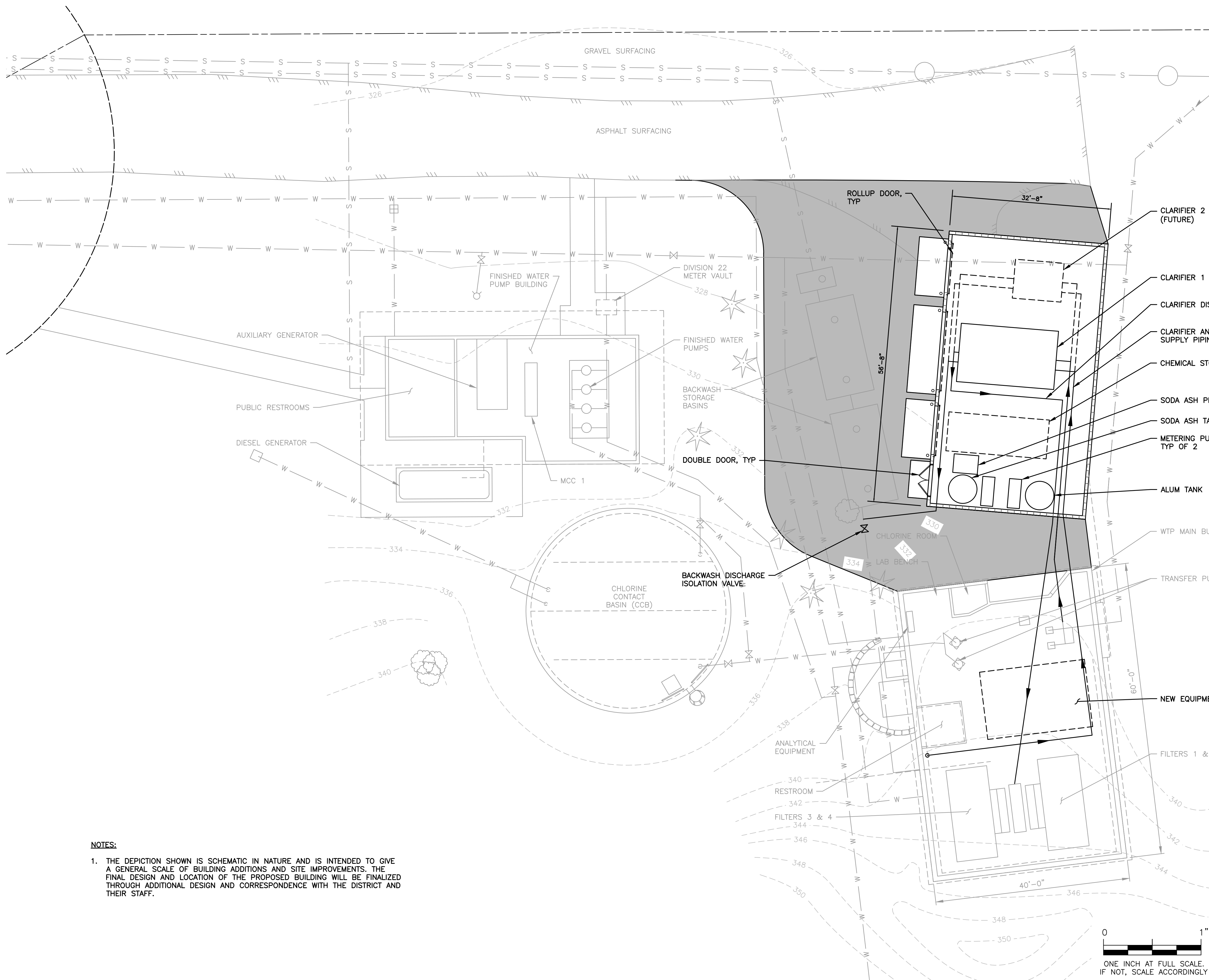
FIGURE A-3

Filters 3 and 4

FIGURE A-4

Filter Discharge Piping

L:\Lake Whatcom Water and Sewer District\20434.00 Sudden Valley WTP Assessment and Facility Improvements Plan\PLANSET\FIGURES\FIGURE A-5 Site.dwg, 12/21/2020 8:36 PM, PHILIP MARSHALL



NOTES:

1. THE DEPICTION SHOWN IS SCHEMATIC IN NATURE AND IS INTENDED TO GIVE A GENERAL SCALE OF BUILDING ADDITIONS AND SITE IMPROVEMENTS. THE FINAL DESIGN AND LOCATION OF THE PROPOSED BUILDING WILL BE FINALIZED THROUGH ADDITIONAL DESIGN AND CORRESPONDENCE WITH THE DISTRICT AND THEIR STAFF.

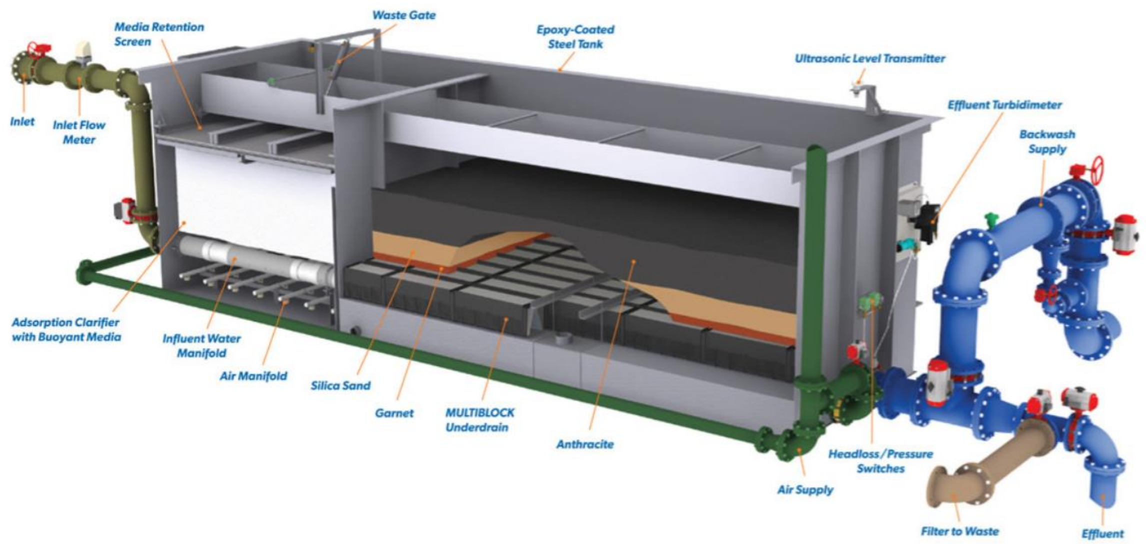
LAKE WHATCOM WATER AND SEWER DISTRICT

TECHNICAL MEMORANDUM 20434-5
FILTRATION SYSTEMS ANALYSIS

FIGURE A-5

ALTERNATIVE F2
MODIFIED USE OF EXISTING FILTER EQUIPMENT
SITE/BUILDING PLAN

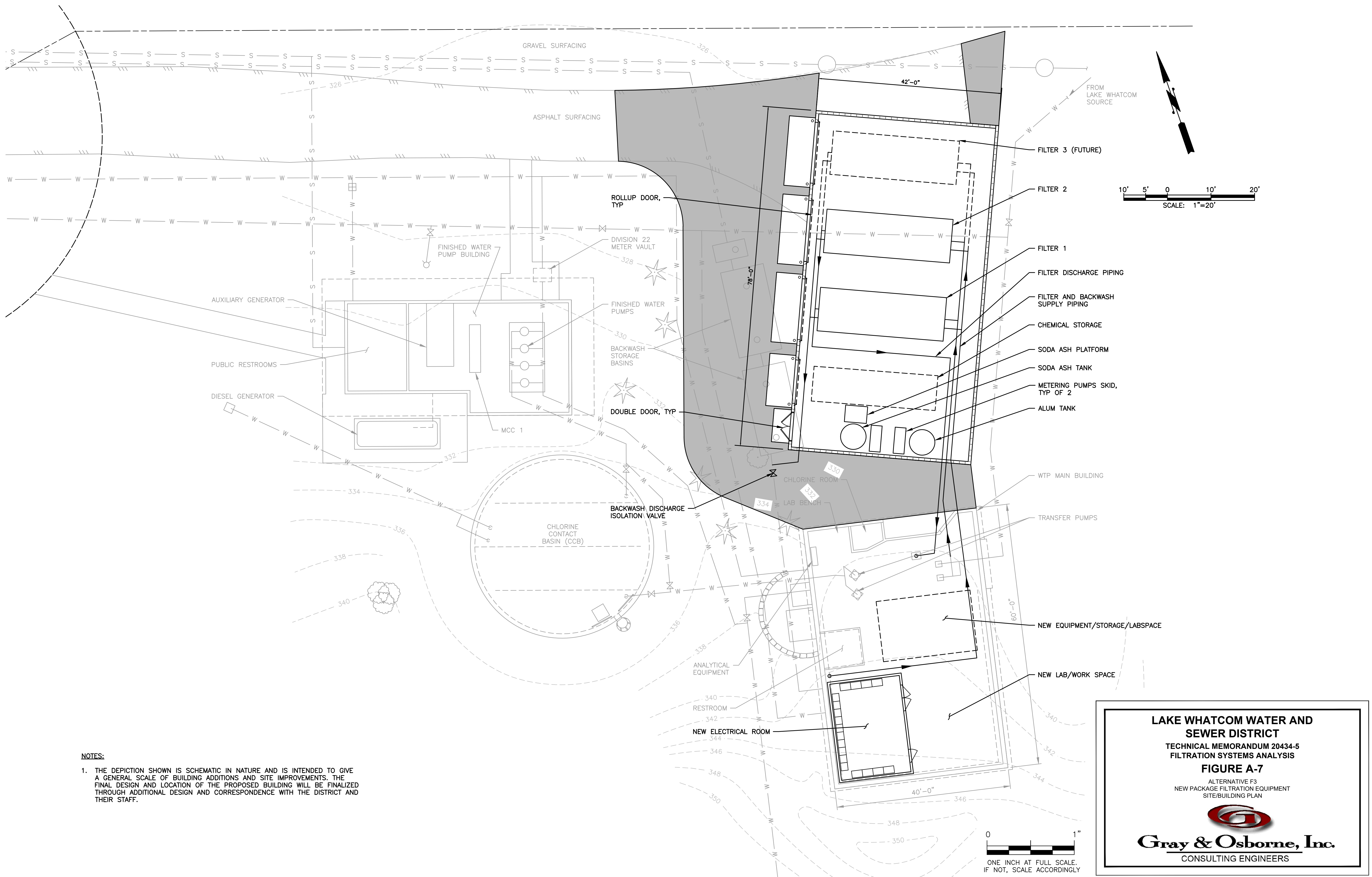
Gray & Osborne, Inc.
CONSULTING ENGINEERS



Courtesy of WesTech

FIGURE A-6

WesTech Trident Package Filtration System with CAC



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LAKE WHATCOM WATER AND SEWER DISTRICT

TECHNICAL MEMORANDUM 20434-5
FILTRATION SYSTEMS ANALYSIS

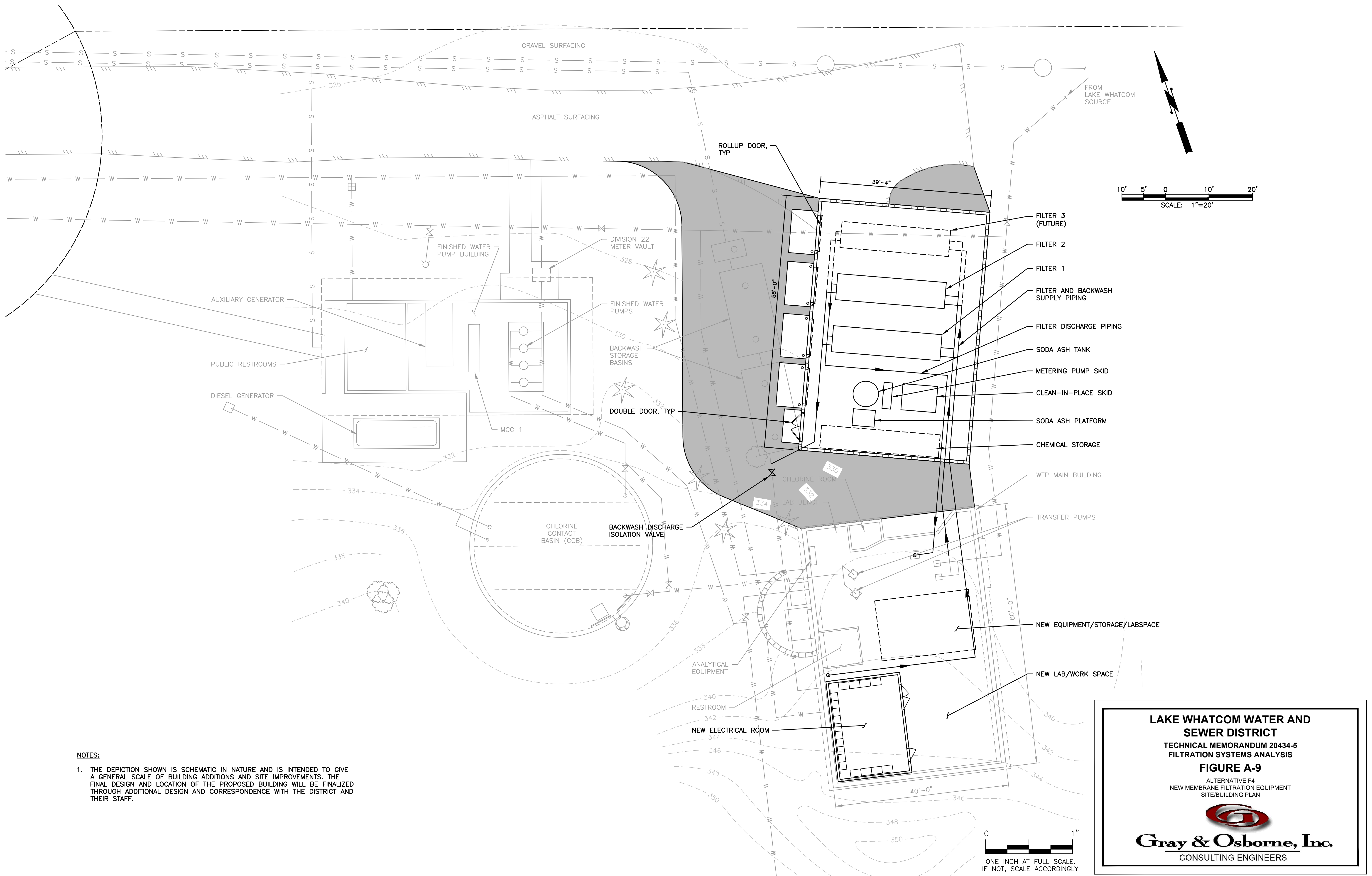
FIGURE A-7

ALTERNATIVE F3
NEW PACKAGE FILTRATION EQUIPMENT
SITE/BUILDING PLAN

Gray & Osborne, Inc.
CONSULTING ENGINEERS

FIGURE A-8

WesTech Ultrafiltration Module



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LAKE WHATCOM WATER AND SEWER DISTRICT

TECHNICAL MEMORANDUM 20434-5
FILTRATION SYSTEMS ANALYSIS

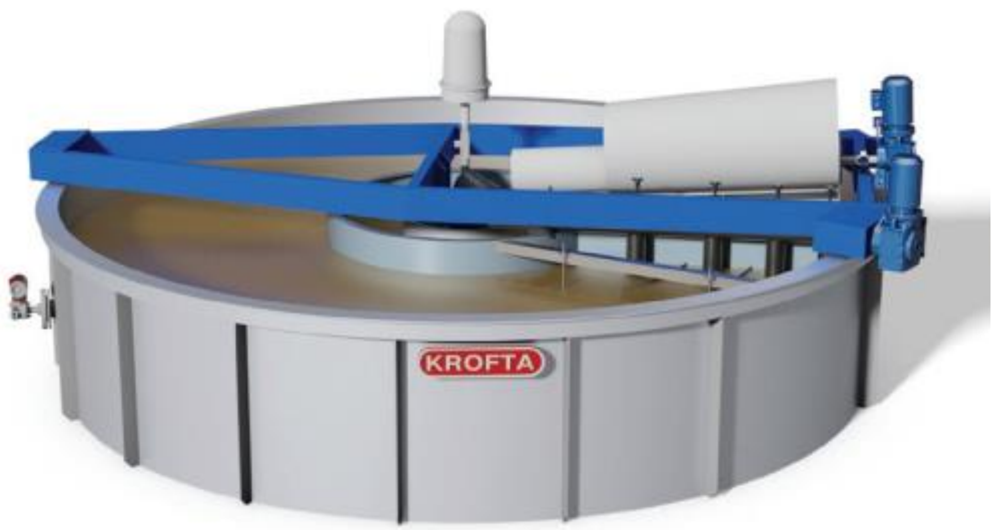
FIGURE A-9

ALTERNATIVE F4
NEW MEMBRANE FILTRATION EQUIPMENT
SITE/BUILDING PLAN

Gray & Osborne, Inc.
CONSULTING ENGINEERS

Evoqua RT Series

FRC PCL Series



Krofta Supracell Series

FIGURE A-10

Package DAF System and Circular DAF Clarifier

EXHIBIT B

RECOMMENDED ALTERNATIVE COST ESTIMATES

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-5 - Alternative F1
Continued Use of Existing Filters - Modified Flocculation Tank
November 10, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Mobilization and Demobilization	1	LS	$ 8,000	$ 8,000
2	Furnish and Install Additional Ladders	2	EA	$ 6,000	$ 12,000
3	Repair Filter 1/2 Coating	1	LS	$ 15,000	$ 15,000
4	Repair Flocculation Tank Coating	1	LS	$ 18,000	$ 18,000

Subtotal*	**$ 53,000**
Contingency (25%)	$ 13,300
Subtotal	**$ 66,300**
Washington State Sales Tax (9.0%)**	$ 6,000
Subtotal	**$ 72,300**
Design and Project Administration (25.0%)***	$ 18,100
TOTAL CONSTRUCTION COST	**$ 90,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-5 - Alternative F1
Continued Use of Existing Filters - New FRP Flocculation Tank
November 10, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE		AMOUNT	
1	Mobilization and Demobilization	1	LS	$	8,000	$	8,000
2	Furnish and Install Additional Ladders	2	EA	$	6,000	$	12,000
3	Repair Filter 1/2 Coating	1	LS	$	15,000	$	15,000
4	Replace Existing Flocculation Tank	1	LS	$	25,000	$	25,000

Subtotal*	**$**	**60,000**
Contingency (25%)	$	15,000
Subtotal	**$**	**75,000**
Washington State Sales Tax (9.0%)**	$	6,800
Subtotal	**$**	**81,800**
Design and Project Administration (25.0%)***	$	20,500
TOTAL CONSTRUCTION COST	**$**	**102,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-5 - Alternative F2
Modified Use of Existing Filters
November 10, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE		AMOUNT	
1	Mobilization and Demobilization	1	LS	$	174,000	$	174,000
2	Minor Change	1	LS	$	15,000	$	15,000
3	Erosion / Sedimentation Control	1	LS	$	15,000	$	15,000
4	Site Improvements	1	LS	$	20,000	$	20,000
5	New Building	1,800	SF	$	600	$	1,080,000
6	Adsorption Clarifier	1	LS	$	375,000	$	375,000
7	Proposed Building Piping	1	LS	$	20,000	$	20,000
8	Chemical System Modifications	1	LS	$	65,000	$	65,000
9	Electrical Modifications	1	LS	$	225,000	$	225,000
10	HVAC Modifications	1	LS	$	75,000	$	75,000
11	Telemetry / SCADA Modifications	1	LS	$	40,000	$	40,000

Subtotal*	**$**	**2,104,000**
Contingency (25%)	$	526,000
Subtotal	**$**	**2,630,000**
Washington State Sales Tax (9.0%)**	$	236,700
Subtotal	**$**	**2,866,700**
Design and Project Administration (25.0%)***	$	716,700
TOTAL CONSTRUCTION COST	**$**	**3,583,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-5 - Alternative F3
New Mixed Media Package Filtration Equipment
November 10, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Mobilization and Demobilization	1	LS	$ 285,000	$ 285,000
2	Minor Change	1	LS	$ 15,000	$ 15,000
3	Erosion / Sedimentation Control	1	LS	$ 15,000	$ 15,000
4	Site Improvements	1	LS	$ 20,000	$ 20,000
5	New Building	3,300	SF	$ 600	$ 1,980,000
6	Package Filtration Equipment	1	LS	$ 700,000	$ 700,000
7	Proposed Building Piping	1	LS	$ 30,000	$ 30,000
8	Chemical System Modifications	1	LS	$ 65,000	$ 65,000
9	Electrical Modifications	1	LS	$ 225,000	$ 225,000
10	HVAC Modifications	1	LS	$ 75,000	$ 75,000
11	Telemetry / SCADA Modifications	1	LS	$ 40,000	$ 40,000

Subtotal*	**$ 3,450,000**
Contingency (25%)	$ 862,500
Subtotal	**$ 4,312,500**
Washington State Sales Tax (9.0%)**	$ 388,100
Subtotal	**$ 4,700,600**
Design and Project Administration (25.0%)***	$ 1,175,200
TOTAL CONSTRUCTION COST	**$ 5,876,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-5 - Alternative F4
New Membrane Filtration Equipment
November 10, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Mobilization and Demobilization	1	LS	$ 240,000	$ 240,000
2	Minor Change	1	LS	$ 15,000	$ 15,000
3	Erosion / Sedimentation Control	1	LS	$ 15,000	$ 15,000
4	Site Improvements	1	LS	$ 20,000	$ 20,000
5	New Building	2,300	SF	$ 600	$ 1,380,000
6	Membrane Filtration Equipment	1	LS	$ 775,000	$ 775,000
7	Proposed Building Piping	1	LS	$ 30,000	$ 30,000
8	Chemical System Modifications	1	LS	$ 40,000	$ 40,000
9	Electrical Modifications	1	LS	$ 225,000	$ 225,000
10	HVAC Modifications	1	LS	$ 75,000	$ 75,000
11	Telemetry / SCADA Modifications	1	LS	$ 40,000	$ 40,000
12	Filter Pilot Testing	1	LS	$ 50,000	$ 50,000

Subtotal*	**$ 2,905,000**
Contingency (25%)	$ 726,300
Subtotal	**$ 3,631,300**
Washington State Sales Tax (9.0%)**	$ 326,800
Subtotal	**$ 3,958,100**
Design and Project Administration (25.0%)***	$ 989,500
TOTAL CONSTRUCTION COST	**$ 4,948,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-5 - Alternative F5
New Deep Bed Mono Media Package Filtration Equipment
November 10, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE		AMOUNT	
1	Mobilization and Demobilization	1	LS	$	248,000	$	248,000
2	Minor Change	1	LS	$	15,000	$	15,000
3	Erosion / Sedimentation Control	1	LS	$	15,000	$	15,000
4	Site Improvements	1	LS	$	20,000	$	20,000
5	New Building	2,500	SF	$	600	$	1,500,000
6	Package Filtration Equipment	1	LS	$	775,000	$	775,000
7	Proposed Building Piping	1	LS	$	30,000	$	30,000
8	Chemical System Modifications	1	LS	$	65,000	$	65,000
9	Electrical Modifications	1	LS	$	225,000	$	225,000
10	HVAC Modifications	1	LS	$	75,000	$	75,000
11	Telemetry / SCADA Modifications	1	LS	$	40,000	$	40,000
12	Filter Pilot Testing	1	LS	$	50,000	$	50,000

Subtotal*	**$**	**3,058,000**
Contingency (25%)	$	764,500
Subtotal	**$**	**3,822,500**
Washington State Sales Tax (9.0%)**	$	344,000
Subtotal	**$**	**4,166,500**
Design and Project Administration (25.0%)***	$	1,041,600
TOTAL CONSTRUCTION COST	**$**	**5,208,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

LAKE WHATCOM WATER AND SEWER DISTRICT

SUDDEN VALLEY WTP ASSESSMENT AND ALTERNATIVES ANALYSIS PROJECT
PRELIMINARY COST ESTIMATE

Technical Memorandum 20434-5
New Dissolved Air Flotation Clarifier
November 10, 2020
G&O# 20434.00

NO.	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	Mobilization and Demobilization	1	LS	$ 79,000	$ 79,000
2	Minor Change	1	LS	$ 15,000	$ 15,000
3	Erosion / Sedimentation Control	1	LS	$ 15,000	$ 15,000
4	Site Improvements	1	LS	$ 30,000	$ 30,000
5	Circular Clarifier	55	CY	$ 1,200	$ 66,000
6	DAF Clarifier Equipment	1	LS	$ 600,000	$ 600,000
7	Proposed Building Piping	1	LS	$ 20,000	$ 20,000
8	Chemical System Modifications	1	LS	$ 25,000	$ 25,000
9	Electrical Modifications	1	LS	$ 100,000	$ 100,000
10	Telemetry / SCADA Modifications	1	LS	$ 10,000	$ 10,000

Subtotal*	**$ 960,000**
Contingency (25%)	$ 240,000
Subtotal	**$ 1,200,000**
Washington State Sales Tax (9.0%)**	$ 108,000
Subtotal	**$ 1,308,000**
Design and Project Administration (25.0%)***	$ 327,000
TOTAL CONSTRUCTION COST	**$ 1,635,000**

* Costs listed are in 2020 dollars
** Current sales tax rate is 8.7%.
*** Standard project design and administration fees are 25% of the subtotal including contingency and tax and is provided for planning purposes only.

EXHIBIT C

SUPPORTING TECHNICAL INFORMATION

Trident®

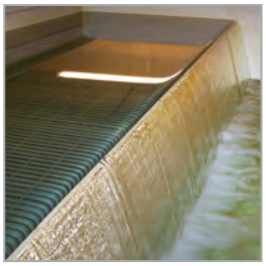
Package Water Treatment System

microfloc

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**

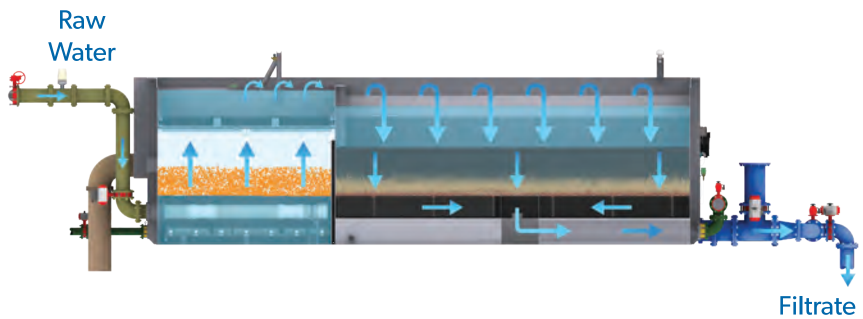
Industrial Process Water

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

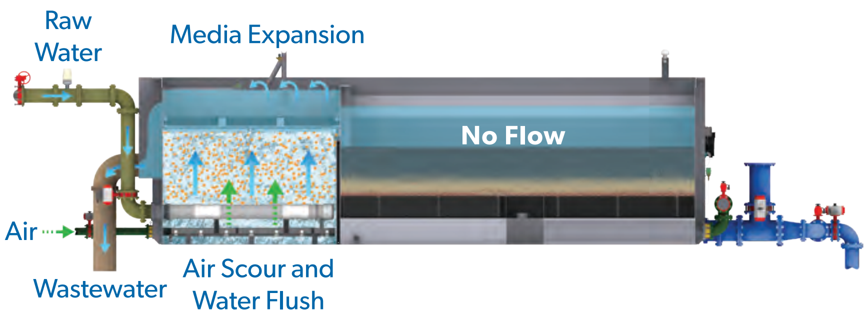
The Trident water treatment system utilizes a two-stage configuration consisting of an up-flow buoyant bead and compressible media Adsorption Clarifier® system followed by a conventional down-flow mixed media filter to produce high quality water.

Filtration Mode



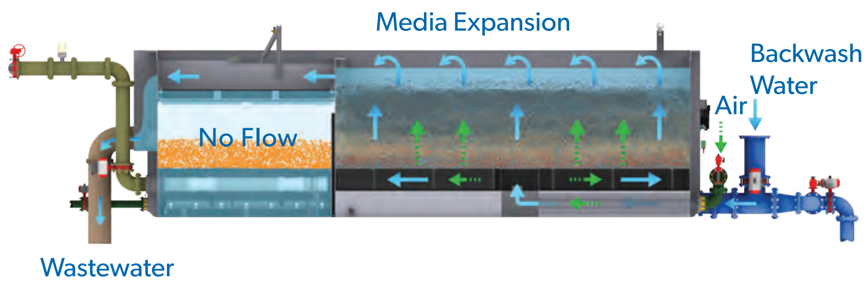
The treatment process is started when chemically dosed raw water enters the Adsorption Clarifier near the bottom of the tank where an upflow treatment process combines flocculation and clarification. From the Adsorption Clarifier, flow continues over a weir into the collection trough where it is distributed 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



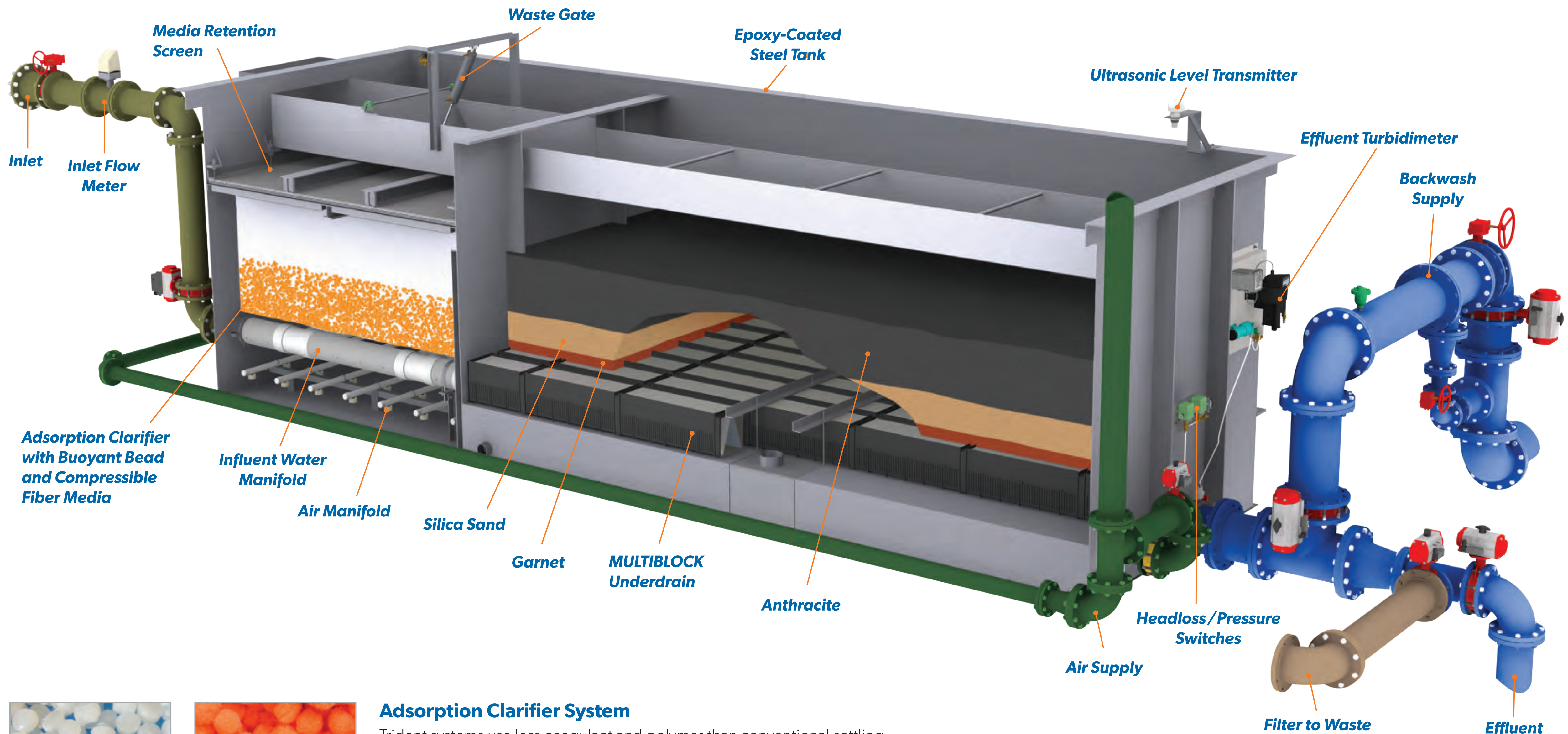
The Adsorption Clarifier is engineered to automatically initiate a flush cycle once headloss indicates that cleaning is required. When the cleaning is initiated, the waste gate and air scour valves are opened as raw water continues to flow. The air/water flush aggressively separates and removes the solids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

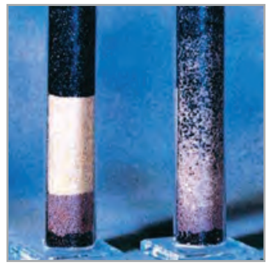
Optional Components
Air compressor package
Integrated plant PLC controls package
Backwash magnetic flow meter
Interconnecting walkways and platforms
Aluminum or stainless steel tanks
Inlet turbidimeter
pH monitor
Streaming current monitor
Static mixer


Adsorption Clarifier System

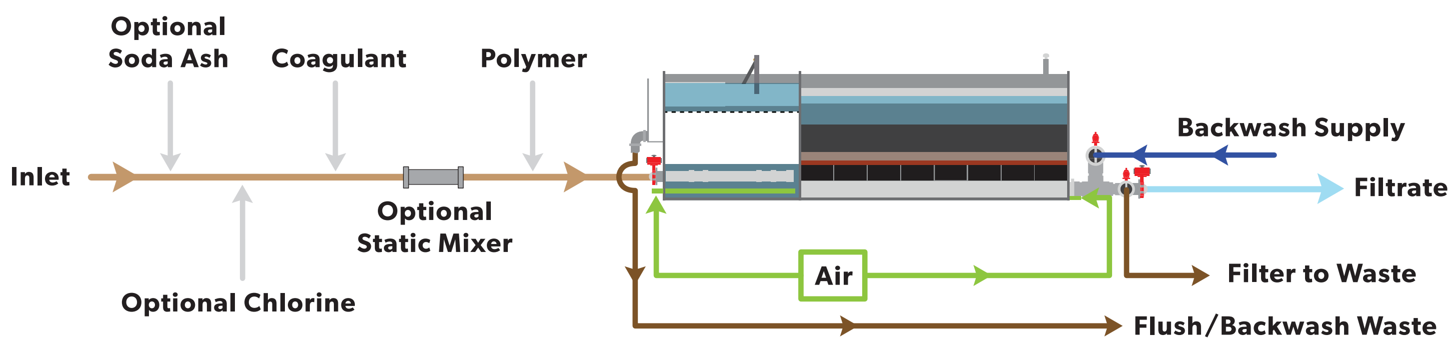
Trident systems use less coagulant and polymer than conventional settling type clarifiers. Within the Adsorption Clarifier system it is not necessary to form a settleable floc, which means floc size and settling time are not factors.
The buoyant media is rolled and scarified to greatly improve particulate removal. The compressible fiber media is used to capture more solids. 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, which has become the industry filtration 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.



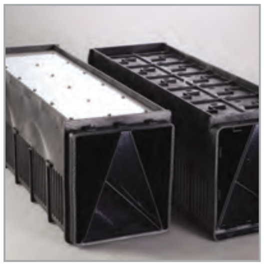
Trident Process Flow Diagram



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

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 2in	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
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info@westech-inc.com
Salt Lake City, Utah, USA

Trident® HS

Multi-Barrier Package Water Treatment System

microfloc

WesTech®

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.

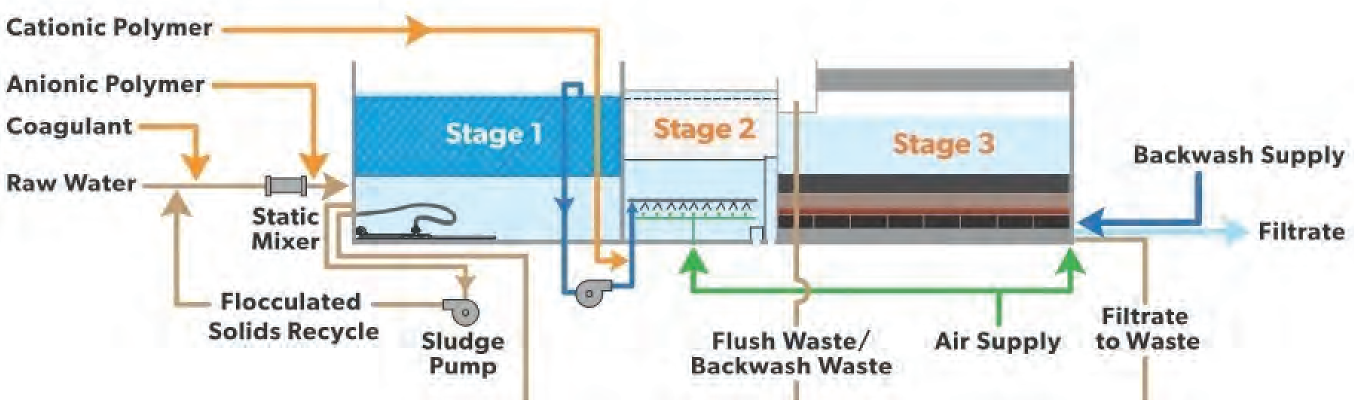
Stage 2 - Enhanced Clarification

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.

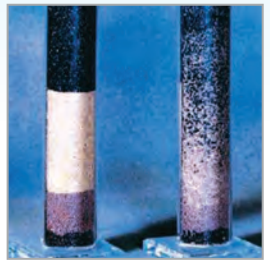
Trident HS Process Flow Diagram

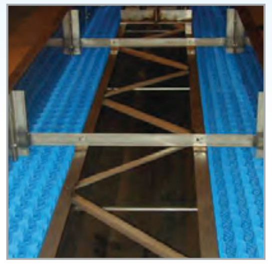


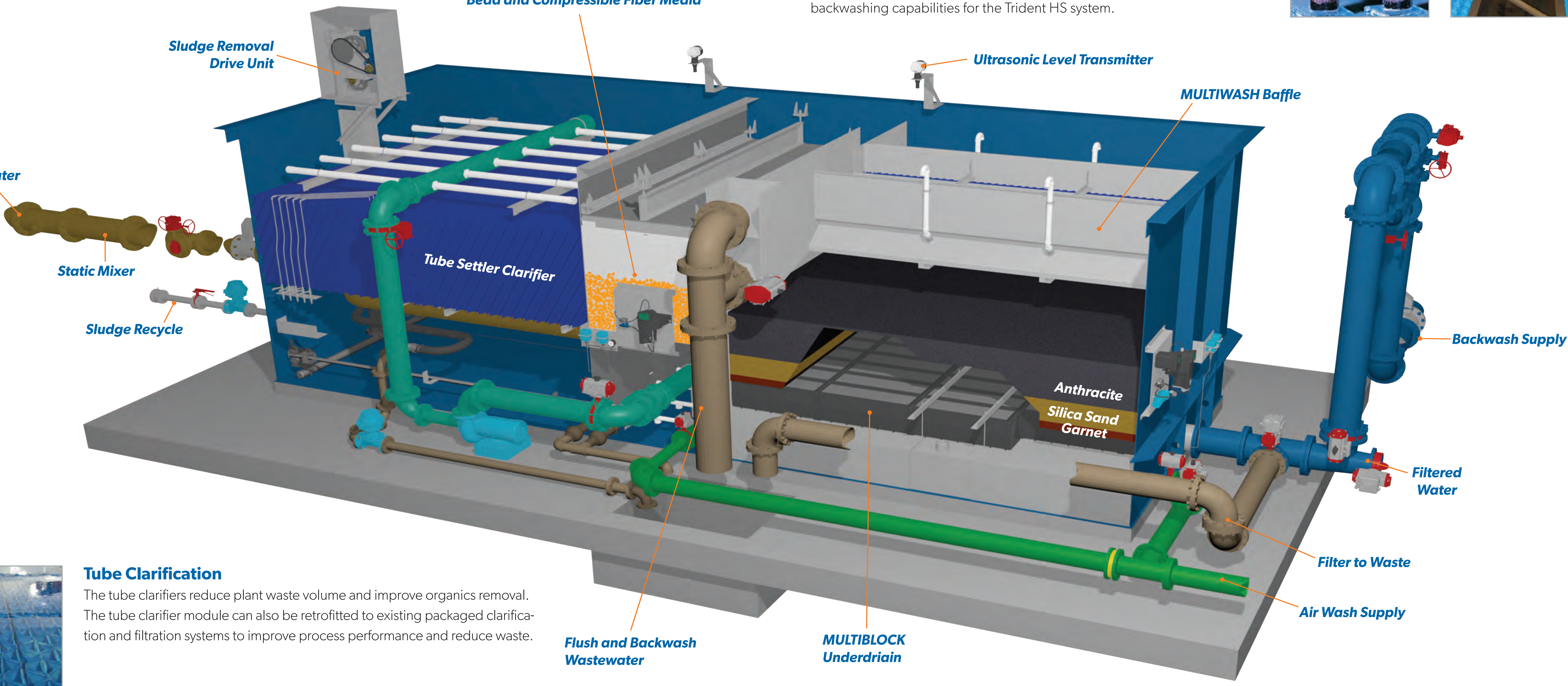
Complete Package Plant

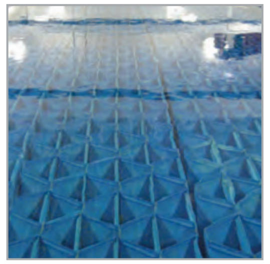
Mixed Media Filtration and MULTIWASH® Baffling

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.







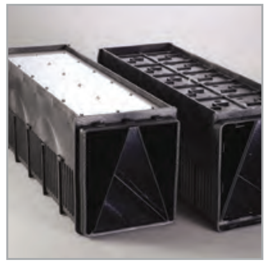


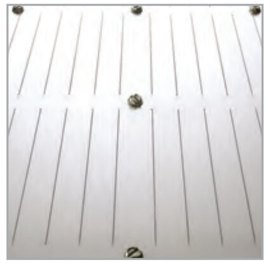
Tube Clarification

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.



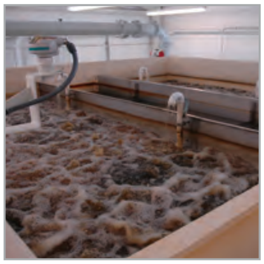


MULTIBLOCK® Underdrain with Laser Shield™

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

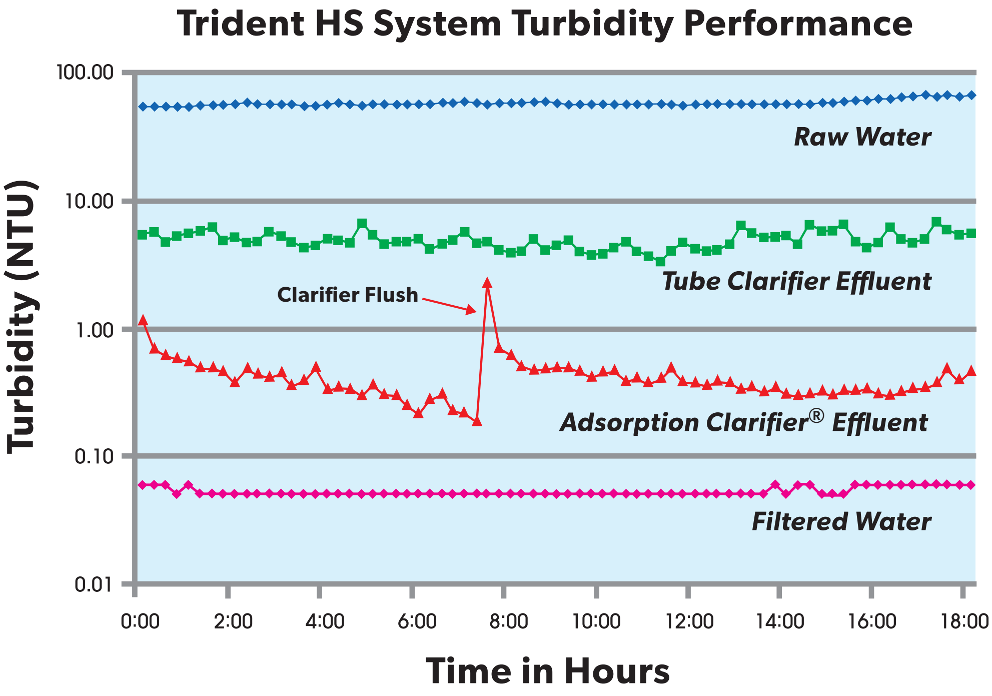
- The package design of the Trident HS system significantly reduces space between different treatment processes in your flow sheet, thus reducing floor space required.
- Operates at higher hydraulic loading rates than conventional systems.

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 Standard Sizes

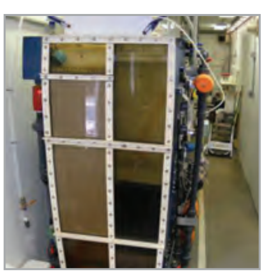
Trident HS Tank Sizes				
Model	**Length**	**Width**	**Height**	**Flow/Tank**
HS - 700	21′ 6″	9′ 0″	10′ 0″	350 gpm
HS - 1050	25′ 7″	11′ 0″	10′ 0″	525 gpm
HS - 1400	30′ 10″	12′ 0″	10′ 0″	700 gpm
HS - 2100	36′ 1″	15′ 0″	10′ 0″	1,050 gpm
HS - 2800	47′ 9″	15′ 0″	10′ 0″	1,400 gpm

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

ULTRAFILTRATION MEMBRANE SYSTEMS

Versatile membrane solutions for potable and process water treatment

SYSTEMS DESIGNED WITH YOU IN MIND

WesTech leads the way in membrane system innovation with versatile, open-platform designs, packaged pre-engineered systems, and solutions for challenging retrofit applications.

WesTech membranes provide potable and process water treatment solutions that are targeted to your needs. Our range of solutions include:

Open-Platform Systems

– A versatile, flexible system that is compatible with several modules from leading manufacturers

– VersaFilter™ Open-Platform Membrane Technology

Package Systems

– A standarized solution that is full featured but with a compact footprint

– AltaPac™ Ultrafiltration Membrane System

Conventional Ultrafiltration Membrane Systems

– Advanced membrane filtration technology with applications in potable and process water

– Innovative, space-saving designs

Retrofits

– Creative and cost-conscious solutions to upgrade existing membrane or conventional systems

– Available for most manufacturers' systems

Containerization

– Stand-alone, skid-mounted units allow for rapid installation for mobile or temporary needs

– Permanent installations and rental options

Refer to WesTech's reverse osmosis equipment options for post-treatment solutions that work seamlessly with our ultrafiltration systems.

MOBILE AND CONTAINERIZED ULTRAFILTRATION UNITS

QUICK SETUP.
SECURE INSTALLATION.
FLEXIBLE TIME PERIOD.

SIMPLE SOLUTIONS TO ENSURE UNINTERRUPTED SERVICE

Containerized or skid-mounted ultrafiltration units are effective solutions for your mobile or temporary needs.

BENEFITS

- Minimized downtime due to emergency situations– operations back online quickly
- Equipment can be contracted for as little as one month or for as long as the project requires
- Smaller footprint
- Installation and operations expertise provided
- Minimal setup time

OPEN-PLATFORM MEMBRANE TECHNOLOGY

VersaFilter: Better Design, More Options

Our ultrafiltration/microfiltration system featuring VersaFilter Open-Platform Membrane Technology offers more choices without increased costs. This innovative and versatile system is compatible with several modules from leading manufacturers.

VersaFilter™
Open-Platform Membrane Systems

VERSATILE AND ADAPTABLE

Adjustable features allow for future innovation; advanced automation and controls provide for flexible operation; and ancillary equipment is sized for wide compatibility.

VERSAFILTER ACHIEVES PERFORMANCE EXCELLENCE

- PRICE
- FLEXIBILITY
- RELIABILITY

The VersaFilter Open-Platform Membrane Technology will accommodate the best UF/MF modules now and in the future.

10+ UF/MF MODULES

Compatible with more than 10 UF/MF module types, including: Dow, Toray, Nanostone, Scinor, Hydranautics, and more.

PACKAGE MEMBRANE SYSTEMS

AltaPac Ultrafiltration Package Membrane System

The WesTech AltaPac is a skid-mounted package membrane system that includes all pumps, valves, and ancillary components for rapid installation and seamless operation of the equipment. Its complete automation, remote monitoring, low cost, and compact design make it an ideal choice for industrial and municipal applications.

KEY ALTAPAC BENEFITS

01
Guaranteed filtrate turbidity <0.1 NTU

02
Guaranteed SDI <3 for NF/RO pre-treatment

03
Certified 4-log for giardia, cryptosporidium

04
Flanged, single-side connections for <1 day install

05
3-sided access with low footprint

5 – 350 GPM

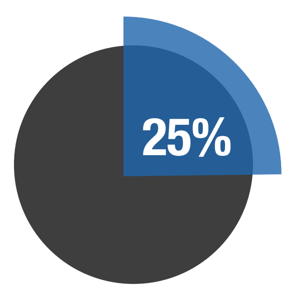
A full-featured water treatment system optimized for flow rates of 5 – 350 gpm

PRE-ENGINEERED.

STANDARDIZED.

FULL-FEATURED.

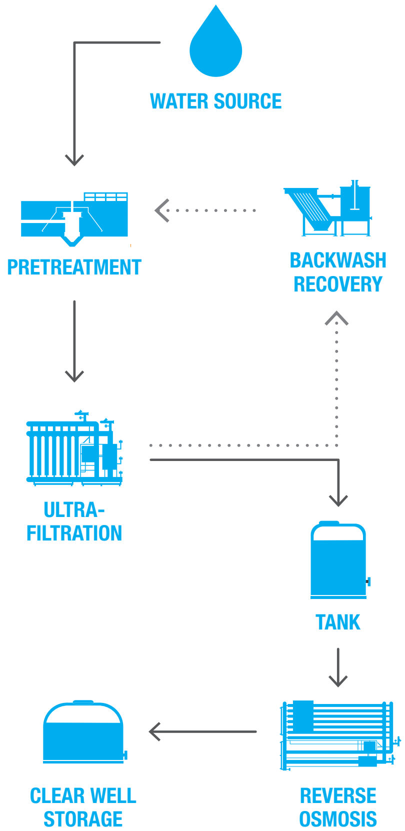
COMPACT FOOTPRINT.



Reduces footprint by more than 25% vs. comparable systems

THE WESTECH ADVANTAGE

Customers have been coming to WesTech for reliable solutions for over 45 years. Our technical expertise, complete process knowledge, and strong commitment to service make WesTech the best partner to achieve a state-of-the-art treatment system.



WE'RE BY YOUR SIDE THROUGH THE ENTIRE PROCESS

INTEGRATED CONTROLS WITH REMOTE MONITORING

Our Intelligent Controls simplify your operation with remote monitoring, data analysis, automatic sequencing with alarm protections, and complete plant integration.

WESTECH IS THE SUPERIOR CHOICE FOR:

01 Extensive ultrafiltration experience

02 Long-term customer service and support

03 Pre and post-treatment options

04 Optimized in-house controls

05 Packaged, pre-engineered systems

06 Flexible, open platform/universal custom systems

07 Mobile/containerized options

08 Versatility – solutions work with existing equipment

801.265.1000 info@westech-inc.com WesTech® westech-inc.com Salt Lake City, UT

Ultrafiltration Pilot Unit

Pilot Plant R212

WesTech ultrafiltration (UF) is the solution for reliable high-quality water production for potable water, wastewater, reuse, and industrial process applications. A pilot is used to demonstrate performance, test specific criteria, and verify design parameters for full-scale systems.

Applications:

- Potable Water
    - >99.99% Crypto/Giardia Removal
- Tertiary Wastewater
- Industrial Process Water
- Small Communities and Camps
- Sites with Footprint Constraints
- Pretreatment to RO/NF
    - Filtrate SDI <3

Pilot Specifications	
Flow Rate	5 - 75 gpm
Dimensions	11′- 4″ L x 4′- 10″ W x 11′- 1″ H
Shipping Weight	3,500 Pounds
Power Requirements	480 V, 3 ph, 60 Hz, 30 amp or 240 V, 1 ph, 60 Hz, 100 amp
Connection Sizes	2″ Flange - UF Feed 2″ Flange - Filtrate 2″ Flange - Backwash waste/Drain
Operational Control	Automatic

Contact WesTech today to implement a pilot test at your facility. Our responsive engineering team will help facilitate scheduling and pilot setup of the ultrafiltration pilot plant.

The R212 pilot plant includes:

- Feed and backwash supply tanks
- Feed and backwash supply pumps
- 200 µm pre-strainer
- Ultrafiltration membranes
- CIP and maintenance cleaning system
- Membrane integrity monitoring
- Automatic control system
- Instrumentation:
    - Feed turbidimeter
    - Filtrate turbidimeter
    - Flowmeters
    - Pressure transmitters
    - pH transmitter
- Compressed air system

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