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MEMORANDUM

1201-1

TO: Jim Stewart (Borough)

cc: Jon Hoisak (Veolia)
John Batorski (Veolia)
Jim Binder (ARI)

FROM: Kathleen A. Luvisi

DATE: December 17, 2009

SUBJECT: **Phosphorus Removal – Planning Level Cost Estimates**

It is anticipated that the CT DEP will issue a draft NPDES permit to Naugatuck in the near future. The draft permit is expected to include phosphorus limits. Presently, the Naugatuck WWTP does not include a phosphorus removal process.

At the request of the Borough of Naugatuck, ARI has conducted a preliminary review of phosphorus removal technology and equipment, and has obtained two planning level cost estimates from equipment vendors. This is a preliminary review and does not imply that other equipment vendors will not be suitable. The analysis is meant to obtain a sense of cost implications of phosphorus removal: a more detailed analysis will be required to confirm viability and refine cost estimates.

1.0 Anticipated CT DEP Phosphorus Discharge Limits

On June 22, 2009, a meeting was held at the CT DEP office in Hartford for all permittees who are affected by the new phosphorus limits. At that time, the CT DEP presented the Draft General Permit for Phosphorus Discharges. It should be noted that the General Permit is in draft form and the limits have not yet been finalized.

The Draft General Permit includes an “Average Seasonal Load Cap” for Total Phosphorus for the period April 1 through October 30 each year. The Average Seasonal Load Cap for the Naugatuck WWTP is 28.75 pounds per day. This is the average of the Total Phosphorus daily effluent loads for the period April 1 through October 30. If the average Total Phosphorus in the effluent (during the period April 1 through October 30) is greater than the Average Seasonal Load Cap for two consecutive calendar years, or any two out of three consecutive calendar years, then a plan must be prepared and implemented which

reduces the Total Phosphorus in the effluent. The Draft General Permit includes a compliance schedule for study and implementation of a plan to reduce the Total Phosphorus loading to a value below the Average Seasonal Load Cap.

The Draft General Permit also includes concentration based limits. These concentration based limits are also seasonal, in effect from April 1 through October 30 each year. The concentration based limits are 0.97 mg/L for a monthly average limit and 2.18 mg/L for a daily maximum limit.

There are another set of more stringent limits in the Draft General Permit which are included in the context of a compliance schedule. The compliance schedule includes two effluent Total Phosphorus limits: 0.7 mg/L and 0.2 mg/L. It is not clear whether these limits are monthly average limits or daily maximum limits. It appears that the selection of either 0.7 mg/L or 0.2 mg/L is made by the CT DEP permit writer. Conversations between representatives of Veolia and representatives of CT DEP indicate that the more stringent effluent limit of 0.2 mg/L Total Phosphorus will probably be the effluent limit for the Naugatuck WWTP. The dates in the compliance schedules are different, depending on which effluent limit is selected.

The concentration limits in the Draft General Permit are inconsistent and clarification is needed. However, to be conservative for purposes of this cost analysis, the more stringent limit of 0.2 mg/L has been used. Calculation of the effluent Total Phosphorus loading using the effluent Total Phosphorus concentration of 0.2 mg/L and the average flow rate of 5.3 MGD results in an effluent Total Phosphorus loading of 8.8 pounds per day. This is lower than the Average Seasonal Load Cap of 28.75 pounds per day. Calculation of the effluent Total Phosphorus loading using the effluent Total Phosphorus concentration of 0.2 mg/L and the peak flow rate of 17.5 MGD results in an effluent Total Phosphorus loading of 29.2 pounds per day. This loading is slightly higher than the Average Seasonal Load Cap of 28.75 pounds per day. With a limit of 0.2 mg/L, the compliance schedule in the Draft General Permit is as follows:

Action	**Due Date**
Retain one or more qualified consultants acceptable to the Commissioner. Notify the Commissioner in writing of the identity of such consultants. Submit to the Commissioner a description of the consultants qualifications.	On or before 90 days after the date of issuance of the permit.
Submit for the Commissioner's review and written approval an engineering report which describes and evaluates alternative actions which may be taken by the permittee to achieve compliance with the Phosphorus limitations. This report is to include lists of permits and approvals, and a schedule for design and construction activities.	On or before 240 days after the date of issuance of the permit.

Action	Due Date
Submit for the Commissioner's review and written approval, contract plans and specifications for the approved remedial actions, a revised list of permits and approvals, and a revised schedule for obtaining all required permits and approvals.	On or before 300 days after the date of issuance of the permit. (unless another deadline is specified in writing by the Commissioner)
Submit progress reports to the Commissioner.	Quarterly reports, beginning sixty days after approval of the report referenced above.
Complete the approved actions in accordance with the approved schedule.	On or before four years after the date of issuance of the permit.

2.0 Existing Phosphorus Effluent Loadings

The Naugatuck WWTP began measuring effluent Total Phosphorus and Orthophosphates concentrations on a monthly basis in January 2008. Influent Total Phosphorus and Orthophosphates were measured on a monthly basis beginning in March 2008. These samples were composite samples and were collected one day each month. Orthophosphates are compounds containing phosphate (PO_4^{3-}). Orthophosphates are part of the Total Phosphorus measurement. Orthophosphates are readily taken up by plants and can contribute to algae blooms in surface waters. Data for Total Phosphorus and Orthophosphates are summarized below for the period ending June 2009. (Note: the Draft General Permit specifies limits for Total Phosphorus only.)

Summary of Total Phosphorus and Orthophosphates Data

	Minimum	Maximum	Average
Influent Total Phosphorus (Note 1)	3.2 mg/L	8.0 mg/L	5.4 mg/L
Effluent Total Phosphorus (Note 2)	3.6 mg/L	16.0 mg/L	8.0 mg/L

	Minimum	Maximum	Average
Influent Orthophosphates (Note 1)	1.6 mg/L	5.8 mg/L	3.6 mg/L
Effluent Orthophosphates (Note 2)	3.2 mg/L	11.0 mg/L	7.2 mg/L

Note 1. This data is from the period March 2008 through June 2009.
Note 2. This data is from the period January 2008 through June 2009.

Summary of Seasonal Total Phosphorus and Orthophosphates Data
April 2008 through October 2008

	Minimum	Maximum	Average
Influent Total Phosphorus	4.8 mg/L	7.1 mg/L	5.8 mg/L
Effluent Total Phosphorus	3.6 mg/L	11.0 mg/L	7.3 mg/L

	Minimum	Maximum	Average
Influent Orthophosphates	1.6 mg/L	5.5 mg/L	3.5 mg/L
Effluent Orthophosphates	3.2 mg/L	11.0 mg/L	7.0 mg/L

Note: This data is from the period April 2008 through October 2008.

Generally, the effluent Total Phosphorus and effluent Orthophosphates are higher than the influent values. It appears that sludge processing operations for the Merchant Sludge are adding soluble phosphorus to the wastewater, and it is being discharged in the WWTP effluent.

For the April 1 through October 30 period, which is the period when the Average Seasonal Load Cap would be in effect, the average Total Phosphorus load in the effluent is 278 pounds per day. This compares with the proposed Average Seasonal Load Cap of 28.75 pounds per day, based on a flow of 4.8 MGD. The loading of 278 pounds per day is more than nine times larger than the proposed Average Seasonal Load Cap.

3.0 Phosphorus Removal Processes

There are two methods of removing phosphorus from wastewater: biological phosphorus removal and chemical precipitation.

Biological phosphorus removal is accomplished by encouraging the growth of a population of micro-organisms which selectively uptake phosphorus into their cell bodies. These micro-organisms are then removed from the wastewater by settling. Thus, the soluble phosphorus is biologically converted to particulate phosphorus and removed from the wastewater. Metcalf & Eddy[1] indicates that biological phosphorus removal can achieve effluent Total Phosphorus concentrations in the range of 1.0 mg/L to 1.5 mg/L. Because the Naugatuck wastewater contains a higher than typical amount of phosphorus (due to the sludge processing operations), it is not certain whether the proposed Draft General Permit limits can be achieved by the use of biological phosphorus removal.

Chemical precipitation is accomplished by adding a chemical coagulant such as lime, alum, or ferric chloride to the wastewater. The phosphorus combines with the chemical coagulant to form a chemical sludge, or floc, which can be separated from the wastewater by settling or filtering. Chemical precipitation processes can achieve effluent Total Phosphorus concentrations as low as 0.05 mg/L[2].

To meet a permit limit of 0.2 mg/L, biological phosphorus removal is not likely to be a suitable option for the Naugatuck WWTP. Therefore, for this preliminary analysis, chemical precipitation was selected as the proposed method of phosphorus removal.

4.0 Information Obtained from Equipment Suppliers

ARI contacted two vendor's representatives in order to obtain planning level cost data for chemical phosphorus removal. This is not to imply that other vendors or processes do not exist, but only to present a preliminary basis for analysis. Discussions with these two

[1] Metcalf & Eddy (1991), *Wastewater Engineering: Treatment, Disposal, Reuse.* (pp.433-434, 726-731). New York, McGraw Hill,
[2] Strom, P.F. (2006). Technologies to Remove Phosphorus from Wastewater. *New Jersey Effluents* 40(4): pp. 31-35.

vendors indicated that the existing high levels of phosphorus in the WWTP effluent (average 8.0 mg/L) could be reduced to a level of 1.0 to 2.0 mg/L, by chemical addition in the secondary clarifiers. Additional phosphorus removal to meet a discharge level of 0.2 mg/L would be accomplished by adding the phosphorus removal systems described below. The average and peak flows used for design consideration were 5.3 MGD and 17.5 MGD, respectively. These are the average and peak flows for the period January 2008 through June 2009. For this preliminary analysis, actual flows, not design flows, were used. Further evaluation will be necessary for the specification of the average and peak flows to be used for the detailed design.

4.1 Kruger ACTIFLO System

As described by their literature, "Krüger, Inc. (Krüger) is a water and wastewater solutions provider specializing in advanced and differentiating technologies." Krüger is a subsidiary of Veolia Water Solutions and Technologies. The phosphorus removal technology proposed by Krüger is the ACTIFLO® process. The process consists of chemical addition, flocculation, and ballasted settling to separate the phosphorus containing floc from the wastewater.

The ACTIFLO® process is intended to be installed downstream of the secondary clarifiers. A chemical coagulant (e.g., alum or ferric chloride), along with microsand, would be added to the wastewater in a coagulation tank. The wastewater will then flow into a maturation tank. This allows a period of contact time for the chemical to coagulate with the phosphorus and to form the chemical floc. The ACTIFLO® process uses the microsand as a seed for the formation of the chemical sludge (floc). The microsand also acts as a ballast or weight for the chemical floc so that it is more easily settled out of the wastewater. The higher settling velocities of the microsand ballasted floc result in higher clarifier overflow rates, smaller clarifier sizes, and reduced system footprint. After settling, the microsand is separated from the chemical floc in a hydrocyclone and recycled back to the head of the process and reused.

The Krüger ACTIFLO® design is based upon a Total Phosphorus concentration of 1.0 mg/L entering the process, and a peak flow of 17.5 MGD. The expected effluent Total Phosphorus concentration is less than 0.1 mg/L. This is sufficient to meet the expected CT DEP Total Phosphorus limit of 0.2 mg/L. The Total Phosphorus concentration of 1.0 mg/L entering the process was assumed by the Krüger representative after being informed by ARI that some phosphorus removal would occur in the secondary clarifiers by dosing with coagulant.

The ACTIFLO® process as specified in the vendor's estimate contains two process trains (one active and one standby). Each process train includes the following equipment:

- Coagulation Tank
- Maturation Tank
- Settling Tank
- Sand Recirculation Pump

- Hydrocyclone

Specific information regarding the Krüger proposal is attached as Attachment A.

The quoted price for the Krüger system is $1,725,000. This price quote includes freight costs. The price does not include design, installation or O&M Manuals. Mr. Thomas Perry of Kreuger, Inc. provided an estimate that installation costs would be an additional $1,200,000.

Krüger provided an estimate of O&M Costs on a "per day" basis as follows:

• Sand Consumption		$4.42 per day
• Polymer Consumption		$23.21 per day
• Coagulant Consumption		$263.00 per day
• Electricity Cost		$49.69 per day
	Total:	$340.42 per day

Assuming that the Krüger system operates continuously year-round, the estimated annual operating cost is $124,215 per year. This estimate may need to be adjusted, since the proposed Total Phosphorus limits are seasonal limits. Additional discussions with CT DEP would be needed to determine whether or not the Krüger system would be operated continuously year-round. Also, the Krüger representative assumed a power cost of $0.08 per KWh. This value may not be accurate for the cost of power at the Naugatuck treatment plant.

4.1 Blue Water Technologies

Blue Water Technologies submitted a proposal for their Blue PRO® system for phosphorus removal. The Blue PRO® system consists of chemical addition and flocculation and a moving sand bed filter which separates the floc solids from the wastewater.

The Blue PRO® system would be installed downstream of the secondary clarifiers. The wastewater would be mixed with the chemical coagulant (ferric chloride) and would pass into the Rapid Conditioning Zone. This allows sufficient mixing time for the formation of the chemical floc. The mixture then flows to the bottom of the moving bed sand filter. As the mixture flows up through the sand filter, the chemical floc is trapped in the sand filter, and the filtered water exits the sand filter at the top of the unit. The sand particles in the filter move slowly from the top of the filter to the bottom of the filter. The sand particles at the bottom of the filter are lifted back up to the top of the filter by an airlift pump. A washbox at the top of the filter separates the sand particles from the waste particles, which flow from the filter through a reject line. The cleaned sand particles are deposited back at the top of the filter. The waste particles in the reject line, containing iron and phosphorus and other contaminants, may be recycled to the solids handling system or to another location in the plant.

The Blue PRO® system design is based upon a Total Phosphorus concentration of less than 2.0 mg/L entering the process, a monthly average flow of 5.3 MGD, and a peak flow of 17.5 MGD. The expected Total Phosphorus effluent concentration is less than 0.2 mg/L. The Total Phosphorus concentration of 2.0 mg/L entering the process was assumed by the Blue PRO® representative after being informed by ARI that some phosphorus removal would occur in the secondary clarifiers by dosing with coagulant.

The Blue PRO® system is scaled up in size by adding filter units. For the monthly average flow, a total of six Blue PRO® filters are specified. For the peak daily flow, a total of fifteen Blue PRO® filters are specified.

Each filter contains the following equipment:

- 1 Reactive Filter (concrete)
- 4 Washboxes (fiberglass)
- 4 Airlifts (schedule 40 PVC)
- 4 Central Feed Chambers (fiberglass)
- Air Control Panel (NEMA 4x)

The entire system contains the following equipment

- Stairs, Grating and Handrail (aluminum)
- Air Compressor and Air Dryer
- 2 Phosphorus Removing Chemical Pump Skids
- NEMA 4 System Control Panel
- Filter Media (delivered in super sack bags)

Specific information regarding the Blue Water Technologies is attached as Attachment B.

The quoted price for the Blue PRO® system for fifteen filters is $1,980,000. The estimated freight cost is $170,000. This price does not include design, concrete pad, site preparation, installation, electrical or piping.

Blue PRO® has also quoted O&M costs as follows:

• Ferric Chloride (40% Bulk at FE at $2.30 per gallon)	$233,000 per year
• Power Cost (at $0.11 per KWh)	$51,300 per year
• Operations (at $50 per man hour)	$26,000 per year
Total	$310,300 per year

The costs are annualized costs for full year operation. These numbers may need to be adjusted, since the proposed Total Phosphorus limits are seasonal limits. Additional discussions with CT DEP would be needed to determine whether or not the Blue PRO® system would be operated continuously year-round. Also, the Blue PRO® representative

assumed a power cost of $0.11 per KWh. This value may not be accurate for the cost of power at the Naugatuck treatment plant.

5.0 Design Considerations/Conclusions

A more detailed engineering evaluation is required to confirm viability, assess other potential impacts on plant operation, and provide a firmer cost estimate. Pilot testing would also need to be done on the Naugatuck wastewater, in order to optimize the type and dose of chemical for the technology which is selected.

The preliminary cost estimates are based upon removal of phosphorus by adding a coagulant to the secondary clarifiers to reduce the Total Phosphorus to a level of 1.0 mg/L to 2.0 mg/L. The cost of this chemical addition has not been considered in this report. Also, the addition of coagulant to the secondary clarifiers will increase the volume of sludge generated at the Naugatuck treatment plant. This issue needs to be studied in further detail to determine the effect, if any, on the Merchant Sludge capacity of the incinerator.

The phosphorus removal process will produce a chemical sludge that is rich in phosphorus. When this sludge is processed in the Naugatuck sludge processing facilities, specifically the centrifuges, or the belt filter presses, it may result in soluble phosphorus being recycled back to the head of the treatment plant.

Engineering and pilot studies should also address whether the phosphorus removal technology impairs the operation of the Incineration Facilities.

ATTACHMENT A

Vendor Information from Kruger

ATTACHMENT B

Vendor Information from Blue Water Technologies

ATTACHMENT A

Vendor Information from Kruger

KRÜGER

August 26, 2009

Kathleen A. Luvisi, P.E.
Alternative Resources, Inc
1732 Main St.
Concord, MA 01742

Re: 2 x 5.3 MGD ACTIFLO® System
Naugatuck, CT WWTP
Krüger Project No: 42070906

Dear Ms. Luvisi:

Please find enclosed our *preliminary* design proposal for the above referenced project. Based on the effluent requirements, Krüger has proposed the ACTIFLO® Turbo process for tertiary treatment of phosphorus. Enclosed is our price estimate, design summary, layout, and equipment scope of supply for a 2 x 17.5 MGD ACTIFLO® system. The proposed system provides the ability to treat the peak daily flow (17.5 MGD) to an effluent total phosphorus concentration of ≤ 0.1 mg/l with one train out of service.

Please note the following requirements prior to the raw water entering the ACTIFLO® system:

- Removal of particles greater than 6 mm in size which typically occurs in upstream processes, in tertiary applications.
- A reliable and accurate flow signal for each process train to ensure accurate chemical addition.
- Proper dispersion of the coagulant (upstream of the ACTIFLO Turbo system).

The corresponding scope of supply is detailed in the following pages and summarized below:

- Mechanical equipment related to the ACTIFLO® Turbo system,
- ACTIFLO® Turbo system based PLC control panel,
- Process instrumentation and Spare parts.

The schedule of delivery shall be as follows:

- Shop drawings will be submitted within 6-8 weeks of receipt of an executed contract by all parties.
- All equipment will be delivered within 18-20 weeks after receipt of approved shop drawings. Approval must be in the written form.
- Installation manuals will be furnished upon delivery of the equipment.
- O&M Manuals will be submitted within 90 days after receipt of approved shop drawings

Over the past 8 years, Kruger has been very active in establishing performance expectations along with specific design criteria for our ACTIFLO process in regards to phosphorus removal from domestic wastewater sources. This process knowledge development has come from our design engineers working closely with our full scale phosphorus removal installations (5 currently in operation with 4 more currently under design or construction) coupled with our research and development efforts in pilot testing different water sources throughout the country. Our efforts over the years have shown that the ACTIFLO® process can treat clarified effluent from numerous biological treatment processes (fixed film, activated sludge, processes with or without biological phosphorus removal) and still achieve extremely low total phosphorus levels (less than 0.05 mg/l TP).

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In regards to tertiary treatment applications, The ACTIFLO® process offers many advantages to include:

1) A small process footprint that can fit into the existing site or be retrofitted into existing basins no longer in use
2) A low system head loss (typically < 1.8 feet) that allows for incorporation of ACTIFLO system into the existing hydraulic profile without the need for pumping.
3) Low operating costs
4) The ability to treat influent total phosphorus levels of 0.2 – 2.5 mg/l to the same effluent phosphorus levels by simply increasing the chemical feed rates.
5) The ability to meet future phosphorus limits (< 0.1 mg/l) by adding more chemicals as opposed to adding more equipment
6) The same tertiary treatment trains can also be used to treat storm flows when needed
7) The ability to handle an increase in solids loading for a prolonged period of time while maintaining consistent effluent quality (solids washout during peak flow conditions).

Krüger appreciates the opportunity to provide this proposal to you. If you have any questions or need further information, please contact our local representative, Ed Quann or me.

Respectfully,
I. Krüger Inc.

Thomas Perry
Product Manager
ACTIFLO® Systems

ATT
cc: Brian Frewerd, Robert Clay, Mattt Cotton, Reid Staton, project file (Krüger)

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VEOLIA WATER
Solutions & Technologies

ACTIFLO® Proposal for

Naugatuck, CT

Krüger Project No.: 42070906

Kathleen A. Luvisi, P.E.
Alternative Resources, Inc
1732 Main St.
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August 26, 2009

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KRÜGER

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1. Company Introduction

I. Krüger Inc. (Krüger) is a water and wastewater solutions provider specializing in advanced and differentiating technologies. Krüger provides complete processes and systems ranging from biological nutrient removal to mobile surface water treatment. The ACTIFLO® Microsand Ballasted Clarifier, BIOCON® Dryer, BIOSTYR® Biological Aerated Filter (BAF), NEOSEP™ MBR and HYDROTECH Discfilters are just a few of the innovative technologies offered by Krüger. Krüger is a subsidiary of Veolia Water Solutions and Technologies (VWS), a world leader in engineering and technological solutions in water treatment for industrial companies and municipal authorities.

VWS, present throughout the world, develops a global approach responding to specific needs of customers at each of their production facilities. This has allowed VWS to become the world leader in design, project management, and execution of projects for water and wastewater treatment plants. The company also creates dedicated technology solutions to meet its customer's needs. Its unique portfolio of differentiating technologies, developed by the group's R&D centers, ensures unsurpassed innovation and control of each treatment line for public organizations and industries. Furthermore, a whole range of associated services is offered on each site to guarantee the technical efficiency and life expectancy of the installed solutions. VWS continually extends and enriches its offer, to guarantee expertise and competence at every step of the projects it undertakes.

Krüger prides itself for being a customer focused organization that provides solutions to challenges faced by municipalities and not just another equipment supplier. To achieve this, Krüger has gathered a force of process experts, trained sales staff, and project managers that share our vision and priorities.

2. Process Description

The ACTIFLO® process is a compact clarification system that utilizes microsand as a seed for floc formation. The microsand provides surface area that enhances flocculation and acts as a ballast or weight. The resulting sand ballasted floc display unique settling characteristics, which allow for clarifier designs with high overflow rates and short retention times. These designs result in system footprints that are between 5 and 20 times smaller for water and 5 to 50 times smaller for wastewater applications than conventional clarification systems of similar capacity.

ACTIFLO® differs from conventional clarification in that it provides microsand as a ballasting agent in the flocculation process step. The microsand serves several important roles in the ACTIFLO® process such as forming a seed which promotes the formation of large stable, high-density floc, and dampening the effects of changes in the raw water quality due to its high concentration within the process. The microsand is effectively removed from the chemical sludge and reused in the process due to its chemically inert qualities. The ballasted floc has considerably higher settling velocities than conventional floc and allows significantly higher clarifier overflow rates. The higher overflow rates possible with ACTIFLO® translate directly into reduced process volume, reduced system footprint, and significant reductions in total civil cost. Overall, these factors provide a process that is extremely efficient in the treatment of "difficult" waters, stable with changes in raw water quality, and relatively easy to operate and optimize.

The ACTIFLO® process is currently in operation worldwide in small communities as well as large metropolitan areas. In drinking water treatment, the ACTIFLO process can be applied to both ground and surface waters where either better performance or cost reduction is desired. It is ideally suited for difficult to treat waters such as rapidly fluctuating sources or extreme conditions. The process consistently displays efficient removals from raw waters containing turbidity (high and low), color, TOC, algae, particle counts, Cryptosporidium, iron, manganese, arsenic and other typical undesirable water contaminants.

In wastewater treatment, the ACTIFLO® process is appropriate for use in any application that would benefit from physical-chemical treatment including coagulation, flocculation and settling. It can be applied to primary and tertiary wastewater treatment where either better performance or cost reduction is desired. It is ideally suited for storm water treatment including CSO, SSO or other overflows due to its high performance, small footprint, and extremely short start-up time. The process consistently displays efficient removals of TSS, BOD, Total P, COD, metals, fecal coliform, and other typical wastewater contaminants, which can be removed by physical-chemical processes.

Listed below are several advantages that ACTIFLO® process offers compared to conventional treatment alternatives:

- Reduced footprint 5 to 50 times smaller than conventional clarification processes resulting in low installation costs
- Large sand particle surface area serve as a “seed” for floc formation which when combined with polymer produces a large, stable floc with fast settling characteristics
- Enhanced coagulation allows for variable process chemistry with efficient chemical usage
- Flexible and stable process for handling fluctuating water quality while continuously delivering high quality effluent
- Rapid start-up and shut-down with a short hydraulic retention time

3. Design Summary

Tables 1 and 2 summarize the design criteria and preliminary process parameters for the proposed design.

Table 1: Design Criteria

Parameter	Units	Value
Design Capacity per Train, peak day[1]	MGD	17.5
Number of Trains Required	--	2 (1 duty, 1 standby)
Influent Total Phosphorus, Average	mg/L	1.0
Expected Effluent Total Phosphorus, Average	mg/L	< 0.1

1. Each train will be capable of treating the peak daily flow of 17.5 MGD.

Table 2: ACTIFLO® Process Parameters

Process Parameters	
Coagulation Tank HRT, min	1.5
Maturation Tank HRT, min	4.0
Rise Rate at Design Capacity, gpm/ft^2	40
Sand Recirculation Pumps per Train	2 duty
Sand Recirculation Pump Capacity, gpm	180
Number of Hydrocyclones	1 per duty pump
Estimated Sludge Concentration, % solids	0.1 to 0.5
Sludge Discharge per Train at Design Flow, gpm	288
Number of trains	2
Coagulation Tank	
Length, ft	11.6
Width, ft	11.6
Side Water Depth, ft	19.0
Maturation Tank	
Length, ft	15.6
Width, ft	23.2
Side Water Depth, ft	19.0
Settling Tank	
Length, ft	23.2
Width, ft	23.2
Side Water Depth, ft	19.0

4. Scope of Supply

Krüger is pleased to present our scope of supply which includes process engineering design, equipment procurement, and field services required for the proposed treatment system, as related to the equipment specified. The work will be performed to Krüger's high standards under the direction of a Project Manager. All matters related to the design, installation, or performance of the system shall be communicated through the Krüger representative giving the Engineer and Owner ready access to Krüger's extensive capabilities.

Process and Design Engineering

Krüger can provide process engineering and design support for the system as follows:

- Equipment specifications for equipment supplied by Krüger
- Technical instructions for operation and start-up of the system
- Equipment location drawings and installation plans
- Project specific O&M manuals

Field Services

Krüger will furnish a Service Engineer as specified at the time of start-up to inspect the installation of the completed system, place the system in initial operation, and to instruct operating personnel on the proper use of the equipment. Specifically, Krüger will provide:

- On-site equipment checkup and start-up assistance, including advice during construction and operator training, for a period not exceeding fifteen (15) man days and three (3) site visits.

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Equipment Supply

Krüger will supply the following equipment associated with the system:

- Mechanical Equipment

Description	Units Per Train	Total No. of Units
Coagulation Tanks		
• Coagulation tank top entering mixer(s), 10 HP, TEFC, 460/3/60 motor, 304 stainless steel shaft and impellers.	1	2
Maturation Tanks		
• Maturation tank top entering mixer(s), 15 HP, TEFC, 460/3/60 inverter duty motor, 304 stainless steel shaft, and impellers.	1	2
• TURBOMIX® Draft Tube, 304 stainless steel with supports, flux converter cells.	1	2
• Anti-Vortex Baffles, 304 stainless steel	2	4
• VFD to be supplied by others	--	By Others
• Weir wall stilling baffles, 304 stainless steel with supports.	1 set	2 sets
• Fabricated hanging wall, 304 stainless steel support structure with HDPE walls	1	2
Settling Tanks		
• Sludge scraper assemblies, 304 stainless steel, center drive, 1.0 HP, TEFC, 460/3/60 inverter duty motor, speed reducer, complete with drive shaft, shaft protector, rake arms and blades.	1	2
• VFD to be supplied by others	--	By Others
• Lamella tube module sets, polystyrene.	1 set	2 sets
• Lamella tube supports, 304 stainless steel.	1 set	2 sets
• Lamella tube tie-down assembly, wire rope, clips, etc. 304 stainless steel.	1 set	2 sets
• Effluent collection troughs, 13.5' length, 1.5' width, 304 stainless steel.	6	12
• Supports for collection troughs, 304 stainless steel.	1 set	2 sets

Description	Units Per Train	Total No. of Units
Microsand Recycle Circuits		
• Microsand recirculation pumps, centrifugal, cast iron body, with rubber-lined volute and impeller, hydrostatic gland seal, drip pan, 180 gpm capacity, 15 HP, TEFC, 460/3/60 motor with V-belt and pulley drive.	2 duty	4
• Discharge side pump isolation valves, 4" diameter, eccentric plug type, manual	2	4
• Suction side pump isolation valves, 4" diameter, eccentric plug type, manual	2	4
• Flush connection valve, 1½" diameter, ball valve	2	4
• Safematic sealwater units, complete with pressure gauge, flowmeter and proximity switch.	2	4
• Microsand Recirculation Pump Pressure Transmitter, Endress + Hauser Cerbar M PMC45 Transmitter w/Integral Display and isolation ball valve	1 (Per Duty Pump)	4
• Hydrocyclones, 180 gpm capacity, urethane.	2 duty	4
• Hydrocyclone pressure gauge assembly, complete with diaphragm seals and isolation valves.	2	4
• Hydrocyclone support stand, 304 stainless steel.	2	4
• Hydrocyclone feed header with Sand concentration sampling assembly, complete with ball valve and tygon tubing.	2	4
• Imhoff Cone for Sand Concentration Sampling.	--	2
• Hydrocyclone overflow (sludge) piping, connecting hydrocyclone overflow to sludge discharge piping.	2	4
• Microsand for Start-up (Tons)	18	36

- Instrumentation and Control System

PLC Based Control Panel

One (1) PLC Based Control panel(s) will be supplied, as specified below, to control the ACTIFLO® Processes based on operator set points. All I/O will be wired to field terminations as required. The Control Panel will be completely assembled, tested, and programmed for the required functionality. One U. L. labeled Panel will be comprised of the following:

NEMA 12 Freestanding Enclosure (Indoor Installation Only)	Saginaw or Equal
Backpanel & Panel Shelf	Saginaw or Equal
120VAC Surge Protection	Innovative Tech
20A Main Circuit Breaker, 1-Pole, 120VAC (MCB)	Square D
24VDC Power Supply 5A	Phoenix Contact
MCR I-I Isolator 4-20mA/4-20mA for Analog Inputs	Phoenix Contact
PT 2X2 24DC ST Plugtrab Surge Arrestor for Analog Inputs/Outputs	Phoenix Contact
PT 2X2 BE Plugtrab Surge Arrestor Base for Analog Inputs/Outputs	Phoenix Contact
UKK 5 Double Level Terminal Block w/Screw Connection for Field I/O	Phoenix Contact
UK5N Terminal Block w/Screw Connection for 120VAC Power Connections	Phoenix Contact
2.0A, 3.0 A, 7.0A, 15.0A Circuit Breakers	Allen Bradley or equal
Interposing Output Relay, 2PDT, Form C Contact, 24VDC w/Relay Base	Allen Bradley or equal
Control Logix PLC Processor	Allen Bradley
Control Logix PLC Power Supply	Allen Bradley
Control Logix PLC 10 Slot Chassis	Allen Bradley
Control Logix PLC 4-20mA Analog Input Module	Allen Bradley
Control Logix PLC 4-20mA Analog Output Module	Allen Bradley
Control Logix PLC Discrete Input Module–	Allen Bradley
Control Logix PLC Discrete Output Module	Allen Bradley
Control Logix PLC Ethernet Module	Allen Bradley
Panelview 1000 Color Touch-screen w/Ethernet	Allen Bradley
10/100 Base T Ethernet Switch w/5 RJ-45 Ports	N-Tron
Push Button, Flush Mount Non-Illuminated	Square D
Misc. Wire, Wire Duct, and Cabinet Light	Generic
Receptacle w/ Box/Cover, UL Listed	Generic
Alarm Horn (Supplied loose for mounting by contractor)	Generic

Panel design is based on control of Kruger supplied equipment included in Kruger's scope of supply. If control of additional equipment beyond Kruger's scope of supply is required, please contact Kruger for a price adder. The PLC Control Panel will include the necessary input/output I/O plus 10% hardwired spare to support the Kruger supplied ACTIFLO® equipment as well as the door mounted items such as pushbuttons etc.

- Instrumentation

Description	Total No. of Units
• Raw water turbidimeter, Hach Solitax w/SC100 Controller	1
• pH meter for raw water, Hach pH Sensor w/SC100 Controller	1
• pH meter after coagulant addition, Hach pH Sensor w/SC100	2

Controller • Settled water turbidimeter, Hach Soliatx w/SC100 Controller	2

- Spare Parts

Description	Units Per Train	Total No. of Units
Mechanical Spare Parts • Coagulation tank mixer bearings and seals	--	2 sets
• Maturation tank mixer bearings and seals	--	2 sets
• Apex tips	1 Per Hydrocyclone	4
• Pump V-belts	1 Per Pump	4

5. Design Options

In addition to the proposed system as detailed herein, Krüger is able to further incorporate our process and controls expertise into water treatment plants, allowing municipalities to meet stringent effluent requirements and future plant upgrades. Krüger is able to offer our instrumentation and controls expertise to build upon the proposed system by providing a customized plant-wide SCADA system or designing a Motor Control Center (MCC), providing municipalities a single source responsibility for plant controls. Please contact Krüger if the options below are of interest to be included in the current proposed system or future upgrades.

- Motor Control Center (MCC) – Krüger can also supply MCCs, typically Square D, for all Krüger supplied equipment. The MCCs can be supplied in either a hard-wired configuration or "smart" configuration. The hard-wired configuration is the typical MCC and these can be supplied to match the specifications and the electrical contract drawings. The "smart" MCC configuration consists of either communications resident to the MCC or a PLC in one of the MCC sections. The "smart" MCC is easily expandable and reduces the amount of wiring to the PLC panel, allowing for lower installed costs and more flexibility in the future.

- Plant-wide and Process Specific SCADA - Krüger can supply SCADA systems for either plant-wide or process specific applications. Wonderware is Krüger's standard SCADA environment but other SCADA platforms are available upon request (iFix, Citect, RSView, etc.). Krüger's SCADA system provides the plant operation staff with a highly customized, flexible, powerful plant monitoring operations package. The staff can utilize the system to record, analyze, and distribute plant process and runtime data, as well as reduce risk via remote plant alarm notifications. Krüger's SCADA system supplies reports and information that can be used for advanced troubleshooting. In addition, it provides remote access for the plant personnel to monitor plant operations and for Krüger (with limited access) in order to aid in troubleshooting or problem resolution.

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6. Pricing, Payment Terms, and Schedule

Pricing

The price for the ACTIFLO® system, as defined herein, including process and design engineering, field services, and equipment supply is **$1,725,000**

Please note that the above pricing is expressly contingent upon the items in this proposal and are subject to I. Krüger Inc. Standard Terms of Sale detailed herein.

This pricing is FOB shipping point, with freight allowed to the job site. This pricing does not include any sales or use taxes. In addition, pricing is valid for ninety (90) days from the date of issue and is subject to negotiation of a mutually acceptable contract.

Terms of Payment

The terms of payment are as follows:

- 10% on receipt of fully executed contract
- 15% on submittal of shop drawings
- 75% on the delivery of equipment to the site

Payment shall not be contingent upon receipt of funds by the Contractor from the Owner. There shall be no retention in payments due to I. Krüger Inc. All other terms per our Standard Terms of Sale are attached.

All payment terms are net 30 days from the date of invoice. Final payment not to exceed 120 days from delivery of equipment.

Schedule

- Shop drawings will be submitted within 6-8 weeks of receipt of an executed contract by all parties.
- All equipment will be delivered within 18-20 weeks after receipt of written approval of the shop drawings.
- Installation manuals will be furnished upon delivery of equipment.
- Operation and Maintenance Manuals will be submitted within 90 days after receipt of approved shop drawings.

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7. I. Krüger Inc. Standard Terms of Sale

1. Applicable Terms. These terms govern the purchase and sale of the equipment and related services, if any (collectively, "Equipment"), referred to in Seller's purchase order, quotation, proposal or acknowledgment, as the case may be ("Seller's Documentation"). Whether these terms are included in an offer or an acceptance by Seller, such offer or acceptance is conditioned on Buyer's assent to these terms. Seller rejects all additional or different terms in any of Buyer's forms or documents.

2. Payment. Buyer shall pay Seller the full purchase price as set forth in Seller's Documentation. Unless Seller's Documentation provides otherwise, freight, storage, insurance and all taxes, duties or other governmental charges relating to the Equipment shall be paid by Buyer. If Seller is required to pay any such charges, Buyer shall immediately reimburse Seller. All payments are due within 30 days after receipt of invoice. Buyer shall be charged the lower of 1 ½% interest per month or the maximum legal rate on all amounts not received by the due date and shall pay all of Seller's reasonable costs (including attorneys' fees) of collecting amounts due but unpaid. All orders are subject to credit approval.

3. Delivery. Delivery of the Equipment shall be in material compliance with the schedule in Seller's Documentation. Unless Seller's Documentation provides otherwise, Delivery terms are F.O.B. Seller's facility.

4. Ownership of Materials. All devices, designs (including drawings, plans and specifications), estimates, prices, notes, electronic data and other documents or information prepared or disclosed by Seller, and all related intellectual property rights, shall remain Seller's property. Seller grants Buyer a non-exclusive, non-transferable license to use any such material solely for Buyer's use of the Equipment. Buyer shall not disclose any such material to third parties without Seller's prior written consent.

5. Changes. Seller shall not implement any changes in the scope of work described in Seller's Documentation unless Buyer and Seller agree in writing to the details of the change and any resulting price, schedule or other contractual modifications. This includes any changes necessitated by a change in applicable law occurring after the effective date of any contract including these terms.

6. Warranty. Subject to the following sentence, Seller warrants to Buyer that the Equipment shall materially conform to the description in Seller's Documentation and shall be free from defects in material and workmanship. The foregoing warranty shall not apply to any Equipment that is specified or otherwise demanded by Buyer and is not manufactured or selected by Seller, as to which (i) Seller hereby assigns to Buyer, to the extent assignable, any warranties made to Seller and (ii) Seller shall have no other liability to Buyer under warranty, tort or any other legal theory. If Buyer gives Seller prompt written notice of breach of this warranty within 18 months from delivery or 1 year from beneficial use, whichever occurs first (the "Warranty Period"), Seller shall, at its sole option and as Buyer's sole remedy, repair or replace the subject parts or refund the purchase price therefore. If Seller determines that any claimed breach is not, in fact, covered by this warranty, Buyer shall pay Seller its then customary charges for any repair or replacement made by Seller. Seller's warranty is conditioned on Buyer's (a) operating and maintaining the Equipment in accordance with Seller's instructions, (b) not making any unauthorized repairs or alterations, and (c) not being in default of any payment obligation to Seller. Seller's warranty does not cover damage caused by chemical action or abrasive material, misuse or improper installation (unless installed by Seller). THE WARRANTIES SET FORTH IN THIS SECTION ARE SELLER'S SOLE AND EXCLUSIVE WARRANTIES AND ARE SUBJECT TO SECTION 10 BELOW. SELLER MAKES NO OTHER WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR PURPOSE.

7. Indemnity. Seller shall indemnify, defend and hold Buyer harmless from any claim, cause of action or liability incurred by Buyer as a result of third party claims for personal injury, death or damage to tangible property, to the extent caused by Seller's negligence. Seller shall have the sole authority to direct the defense of and settle any indemnified claim. Seller's indemnification is conditioned on Buyer (a) promptly, within the Warranty Period, notifying Seller of any claim, and (b) providing reasonable cooperation in the defense of any claim.

8. Force Majeure. Neither Seller nor Buyer shall have any liability for any breach (except for breach of payment obligations) caused by extreme weather or other act of God, strike or other labor shortage or disturbance, fire, accident, war or civil disturbance, delay of carriers, failure of normal sources of supply, act of government or any other cause beyond such party's reasonable control.

9. Cancellation. If Buyer cancels or suspends its order for any reason other than Seller's breach, Buyer shall promptly pay Seller for work performed prior to cancellation or suspension and any other direct costs incurred by Seller as a result of such cancellation or suspension.

10. LIMITATION OF LIABILITY. NOTWITHSTANDING ANYTHING ELSE TO THE CONTRARY, SELLER SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL, SPECIAL, PUNITIVE OR OTHER INDIRECT DAMAGES, AND SELLER'S TOTAL LIABILITY ARISING AT ANY TIME FROM THE SALE OR USE OF THE EQUIPMENT SHALL NOT EXCEED THE PURCHASE PRICE PAID FOR THE EQUIPMENT. THESE LIMITATIONS APPLY WHETHER THE LIABILITY IS BASED ON CONTRACT, TORT, STRICT LIABILITY OR ANY OTHER THEORY.

11. Miscellaneous. If these terms are issued in connection with a government contract, they shall be deemed to include those federal acquisition regulations that are required by law to be included. These terms, together with any quotation, purchase order or acknowledgement issued or signed by the Seller, comprise the complete and exclusive statement of the agreement between the parties (the "Agreement") and supersede any terms contained in Buyer's documents, unless separately signed by Seller. No part of the Agreement may be changed or cancelled except by a written document signed by Seller and Buyer. No course of dealing or performance, usage of trade or failure to enforce any term shall be used to modify the Agreement. If any of these terms is unenforceable, such term shall be limited only to the extent necessary to make it enforceable, and all other terms shall remain in full force and effect. Buyer may not assign or permit any other transfer of the Agreement without Seller's prior written consent. The Agreement shall be governed by the laws of the State of North Carolina without regard to its conflict of laws provisions.

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Attachment I

Brochure

VEOLIA WATER
Solutions & Technologies

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ACTIFLO® Turbo Microsand Ballasted Clarification Process

VEOLIA WATER
Solutions & Technologies

ACTIFLO® Turbo

Rapid, Compact, Efficient

Unparalleled Experience in Flocculation/Settling

Since its launch in 1989, ACTIFLO® has been constantly improved to optimize its performance and applications. With more than 450 references installed worldwide, Veolia Water Solutions & Technologies has unparalleled experience which has made it possible to develop the next generation of microsand ballasted clarifiers.

The ACTIFLO® Turbo Process

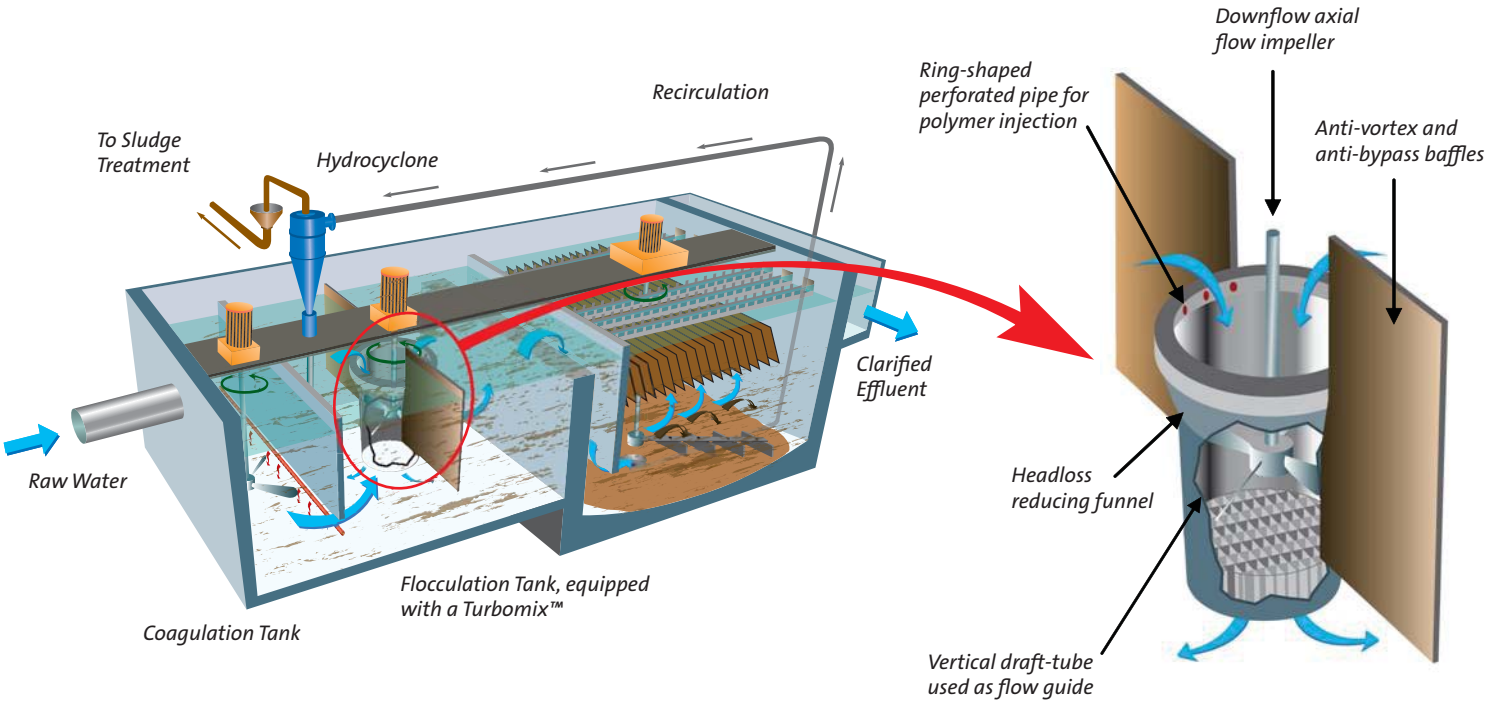
ACTIFLO® Turbo is equipped with:

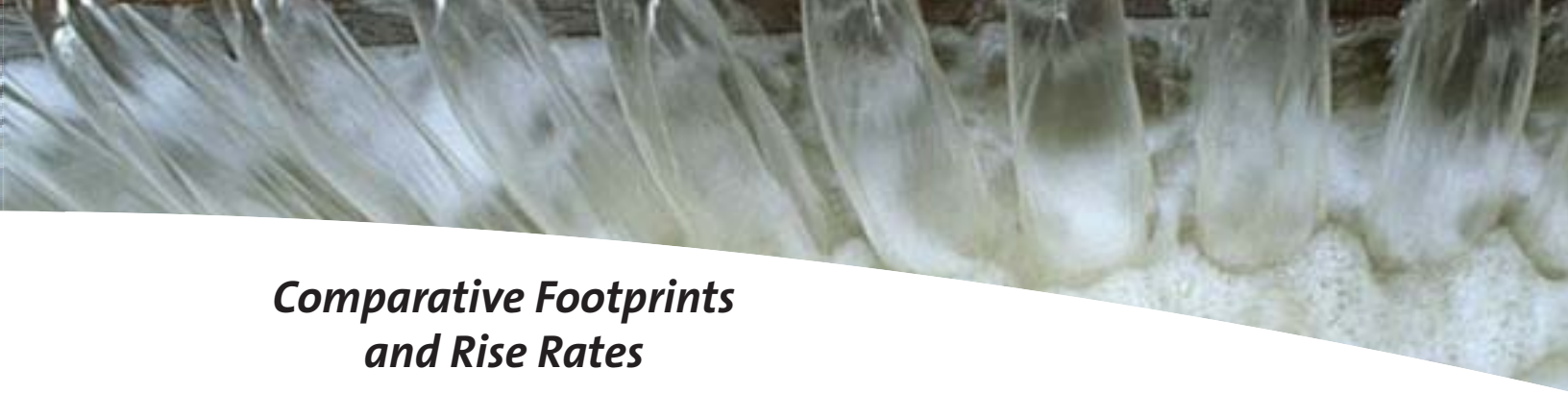
- Coagulation tank
- Flocculation tank with Turbomix™
- Hydraulically optimized settling tank with lamella
- Hydrocyclone for microsand recovery, alternatively a VWS MA hydrocyclone with integrated microsand washing facility

The Turbomix™, a Major Improvement in Flocculation

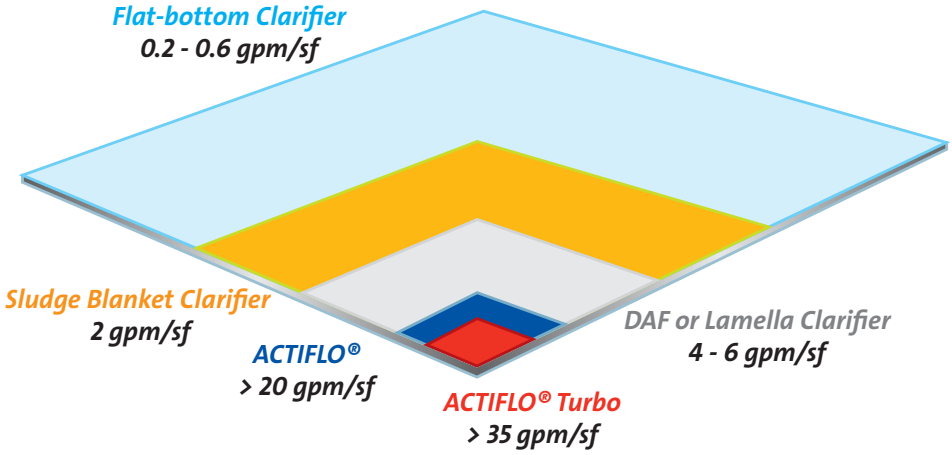
At the heart of the ACTIFLO® Turbo system, the Turbomix™ was designed to enhance the flocculation efficiency by introducing the following features:

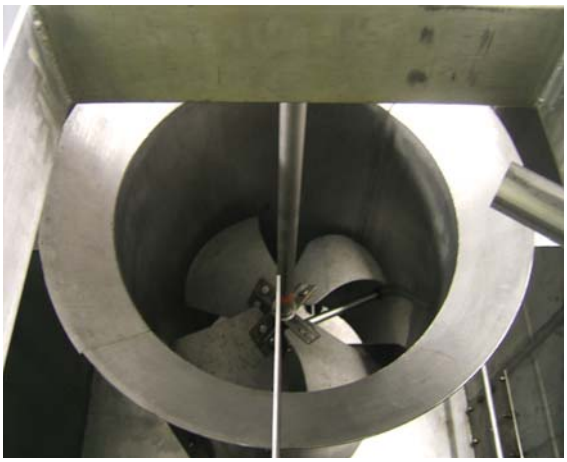
- High level of homogeneous mixing of the coagulated water with the microsand and polymer
- Reduced retention times
- Reduced energy consumption





Comparative Footprints and Rise Rates





Turbomix™ enables an intense mix of ballast with the flocculant and suspended matter within the maturation tank, which leads to stable floc formation protected from the mechanical destruction of a mixing device.

Benefits Of ACTIFLO® Turbo

More Compact
ACTIFLO® Turbo footprint is approximately half of ACTIFLO®

Easier Start-Up
Very quick start-up, less than 5 minutes

Optimized Design
Injection tank omitted

Flocculation Improved
Addition of Turbomix™

Increased Rise Rate
> 35 gpm/sf for drinking water and process water

Package Units
Extremely compact pre-fabricated and pre-assembled steel units for easy installation and low civil costs with flows ranging from 0.25 to 7.5 MGD

Raw Water Treatment

The ACTIFLO® process consistently delivers high quality effluent from raw waters containing both high and low turbidity, TOC, algae, cryptospridium, giardia, iron, manganese, arsenic, TSS, BOD, and other typical water contaminants.

The ACTIFLO® process ensures high quality clarified settled effluent when treating raw water including the following difficult conditions low temperature, high turbidity water up to several thousand NTU, low turbidity, TOC (essential for prevention of disinfection by-products), iron and manganese (from surface or ground water sources), color as high as 500 PCU, algae, cryptosporidium and giardia.

KRÜGER

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Phone 919.677.8310
Fax 919.677.0082

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krugerincmarketing@veoliawater.com

VEOLIA WATER
Solutions & Technologies

KRÜGER
HPD
WHITTIER FILTRATION
N.A. WATER SYSTEMS
JOHN MEUNIER
BIOTHANE
CROWN SOLUTIONS

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Attachment II

Preliminary Drawing(s)

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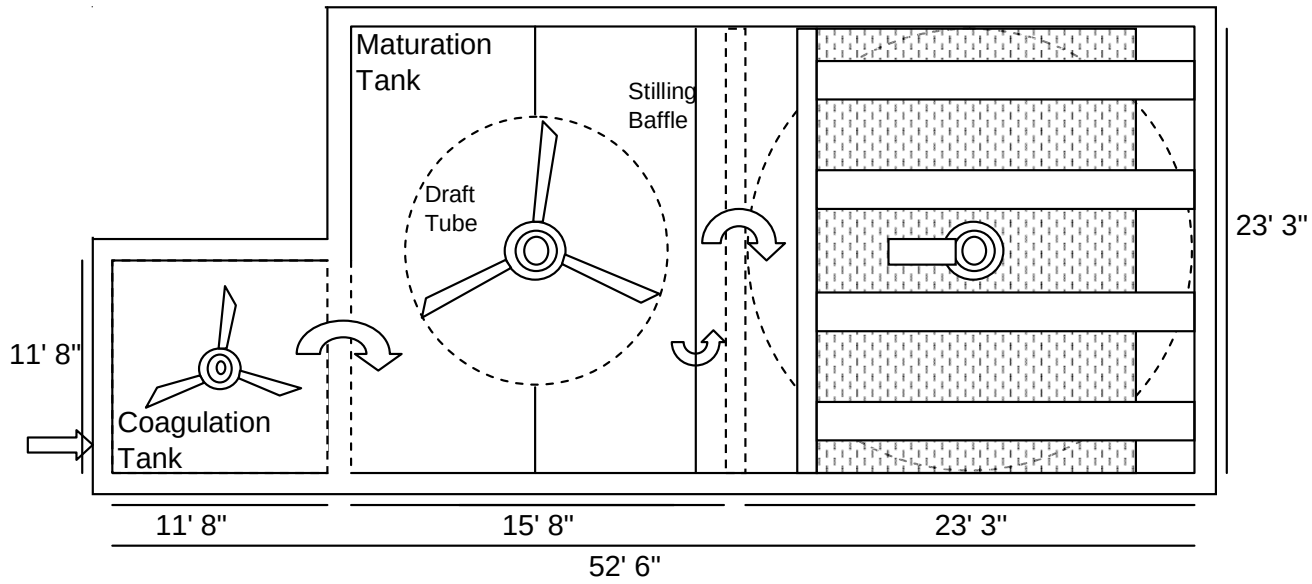
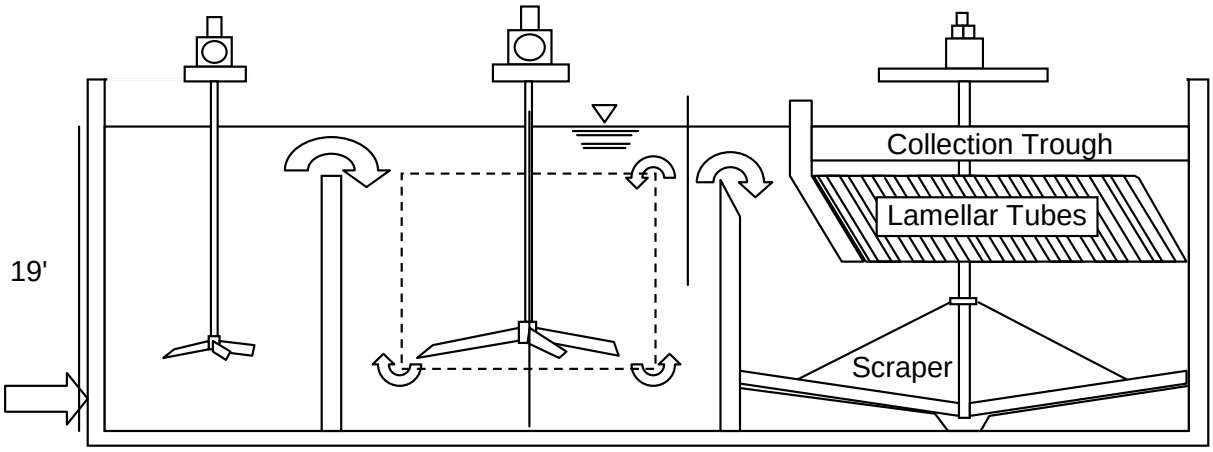
Preliminary ACTIFLO Turbo Single Train Layout
Naugatuck, CT
Total Capacity = 18 MGD
Capacity per Train: 5.3 mgd ADF/17.5 mgd PDF MGD





Coagulation Tank Maturation Tank Tube Settler with Scraper

VEOLIA WATER
Solutions & Technologies

Operating Cost Estimate

Name of Project	Naugatuck WWTP, CT
Notes	5.3
Date	23-Sep-09
Designer's Initials	PIP

Sand Consumption	
Estimated Sand Loss Range, (g/m^3)	1.0 - 2.0
Estimated Sand Loss, (g/m^3)	1.0
Design Flow Rate, (MGD)	5.3
Sand Loss, (lbs/day)	44
Sand Loss, (tons/day)	0.022
Sand Cost, ($/tons)	$200
Sand Cost @1.0 g/m^3 ($/day)	$4.42

Polymer Consumption	
Estimated Polymer Dosage Range, (ppm)	0.1 - 1.0
Average Polymer Dosage, (ppm)	0.30
Design Flow Rate, (MGD)	5.3
Polymer Consumption @ Average Dosage (lbs/day)	13.2606
Polymer Consumption @ Average Dosage (tons/day)	0.007
Polymer Cost, ($/tons)	$3,500
Polymer Cost @ Average Dosage ($/day)	$23.21

Coagulant Consumption	
Coagulant Type	Ferric Chloride
Estimated Coagulant Dosage Range, (ppm)	10 to 30 ppm
Average Coagulant Dosage, (ppm)	35.00
Design Flow Rate, (MGD)	5.3
Coagulant Consumption @ Average Dosage (lbs/day)	1547.1
Coagulant Consumption @ Average Dosage (tons/day)	0.77
Coagulant Cost, ($/tons)	$340
Coagulant Cost @ Average Dosage ($/day)	$263.00

Energy Consumption	
Coagulation Mixer HP per Train	8.0
Injection Mixer HP per Train	0.0
Maturation Mixer HP per Train	10.7
Scraper HP per Train	1.0
Sand Pump Hp per Train	15.0
HP per Train	34.7
Total HP	34.7
HP per MGD	6.55
KWhr/day	621.1
KWhr/1000 gallons	0.117
Cost per KWhr	$0.08
Energy Cost, ($/day)	$49.69

Estimated Daily Operating Cost	$340.32
Estimated Operating Cost per 1,000 Gallons	$0.064

at 100% nominal capacity based on the opererating parameters shown

ATTACHMENT B

Vendor Information from Blue Water Technologies

Blue Water Technologies, Inc.

August 12, 2009

Kathleen A. Luvisi, P.E.
Project Engineer
Alternative Resources, Inc.
1732 Main St.
Concord, MA 01742

Subject: **Blue PRO® Phosphorus Removal Budgetary Proposal**
Naugatuck, Connecticut
Proposal # 910185-1

Dear Ms. Luvisi:

Blue Water Technologies, Inc. (Blue Water) appreciates the opportunity to provide this proposal to you for the above referenced project. Blue Water's core technology is the patent-pending Blue PRO® process, described in scientific literature as "Reactive Filtration". Critical and unique concepts in the reactive filtration patent are the "reactive filter media" and the "continuous regeneration" of that media. Reactive filter media maximizes the efficiency of the filter by promoting adsorption in combination with co-precipitation. Continuously regenerating the reactive filter media is accomplished by using a moving bed filter to constantly grind the surface of the media, creating fresh sites for adsorption. For this reason, no backwashing or exchange of media is necessary, which reduces operations and maintenance hassle and cost.

Blue Water offers a broad platform of water treatment technology products, from primary wastewater treatment to advanced effluent polishing steps to environmental remediation processes. Our team strives to meet customers' needs cost-effectively, considering both capital expense and ongoing operations and maintenance costs. Additionally, we keep an eye on the future by looking for sustainability in our technologies, including environmentally-friendly materials and energy conservation.

1.0 Equipment Features and Benefits:

- Unparalleled treatment efficiencies to ultra low levels.
- No back flushing or system cycling required, continuous operation. Reject solids can be recycled to the head of the plant and, thus, do not require separate disposal or processing.
- Use of ferric and recycling the rejects can replace or greatly reduce alum use and also provide the added benefit of plant-wide odor control and easier-to-dewater biosolids.
- Available in fiberglass, or in-ground concrete.
- Advanced washbox design to maximize performance.
- Patented recess chamber minimizes media bridging.
- Safety-minded design focused on easy operator access to filter and filter operation.

1.1 System Design:

The Blue PRO® process is depicted in Figure 1. Influent wastewater enters at the left of the diagram. A commonly available water treatment chemical (typically a form of iron) is added to the wastewater before it passes into the rapid conditioning zone. This zone allows the proper contact time for the mixture to be optimized for both co-precipitation and adsorption processes. This combination of removal mechanisms makes the system more effective than other treatment processes; Blue PRO® is able to overcome chemical equilibrium and diffusion limitations that other technologies have. The mixture enters the moving bed sand filter through distribution arms at the bottom of the sand bed, and then flows upward through the sand bed. After filtration, clean water discharges from the top of the filter on the right. In the filter the sand moves slowly from top to bottom, then returns to the top of the filter via an airlift located in the central assembly. A washbox at the top of the filter separates sand from waste particles. The sand falls back to the top of the bed. The residuals, including the iron and phosphorus or other contaminants, exit in a separate line and can be routed to the plant's existing solids handling system or recycled to another place in the plant.

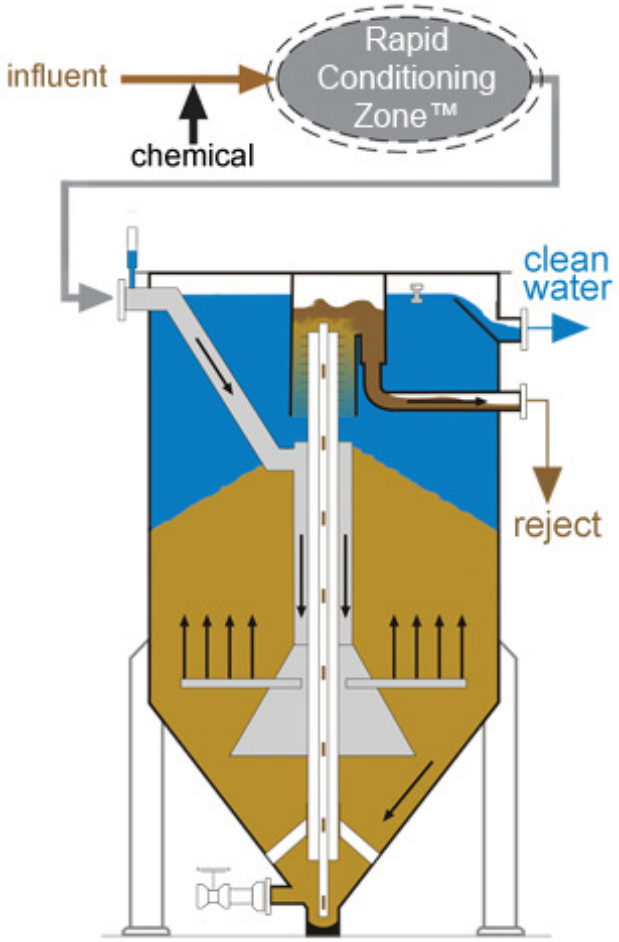


Figure 1

The Blue PRO® technology provides flexibility to a wastewater treatment plant. The modular system of filters is installed as tertiary treatment, which is located near the end of the plant's treatment train. Depending on the influent phosphorus concentration and the targeted permit level, a plant may require one pass through Blue PRO® or may run the filters in series to attain even lower phosphorus concentrations. The Blue PRO® process has additional advantages beyond phosphorus removal, including suspended solids and turbidity removal.

2.0 Basis of Design:

	Influent*	Effluent*
Average Daily Flow (ADF)	5.3 MGD	
Peak Daily Flow (PDF)	17.5 MGD	
Total Suspended Solids (TSS)	10 mg/L	< 5 mg/L
Total Phosphorus (TP)	< 2 mg/L**	28.75 LBS/day
Total Phosphorus (ADF)		< 0.700 mg/L
Total Phosphorus (PDF)		< 0.200 mg/L
Soluble non reactive Phosphorus (SnRP)	< 0.200 mg/L	
pH	5.5 - 8.5	
Alkalinity***	40 mg/L as $CaCO_3$	

* Arithmetic Monthly Average
** Effluent of secondary system after bulk dosing
*** In the case of a two-pass system, alkalinity of 70 mg/L as $CaCO_3$ is required.

3.0 Proposed Treatment System:

CASE I – TREATING ADF (5.3 MGD)

Blue Water is pleased to provide the Blue PRO® filter system with a total of six (6) Blue PRO® CF-200 UFC filter in a single pass configuration with associated ancillary equipment to treat the above referenced waste stream The overall dimensions of each filter are approximately 17′-2″ W x 17′-2″ L x 18′-2″ H with a total system footprint of approximately 40′ W x 60′ L x 5′ H above ground (compressors can be mounted where convenient).

Combined filter area: 1200 square feet
Average loading rate: 3.3 gpm/square feet including rejects
Filter bed depth: 60 inches

The proposed Blue PRO® filters system, will be complete and will include the following:

(6) Model CF-200 UFC (concrete) Blue PRO® "Reactive Filters"
(24) Washboxes (fiberglass)
(24) Airlifts (Type schedule 80 PVC)
(24) Central feed chambers (fiberglass)
(1) Lot stairs, grating, and handrails (aluminum)
(1) Air compressor and air dryer
(6) Air control panel (NEMA4X)
(2) P removal chemical pump skids
(1) NEMA 4 system control panel
(1) Lot filter media delivered in super sack bags

CASE II – TREATING PDF (17.5 MGD)

Blue Water is pleased to provide the Blue PRO® filter system with a total of fifteen (15) Blue PRO® CF-200 UFC filter in a single pass configuration with associated ancillary equipment to treat the above referenced waste stream The overall dimensions of each filter are approximately 17'-2" W x 17'-2" L x 18'-2" D with a total system footprint of approximately 40' W x 160' L x 5' H above ground.

Combined filter area: 3000 square feet
Peak loading rate: 4.2 gpm/square feet including rejects
Filter bed depth: 60 inches

The proposed Blue PRO® filters system, will be complete and will include the following:

(15) Model CF-200 UFC (concrete) Blue PRO® "Reactive Filters"
(60) Washboxes (fiberglass)
(60) Airlifts (Type schedule 80 PVC)
(60) Central feed chambers (fiberglass)
(1) Lot stairs, grating, and handrails(aluminum)
(15) Air control panel (NEMA4X)
(1) Air compressor and air dryer
(2) P removal chemical pump skids
(1) NEMA 4 system control panel
(1) Lot filter media delivered in super sack bags

4.0 Equipment Price and Included Field Engineering:

Blue Water budgetary price of components and service for this project is

CASE I – TREATING ADF **$825,000**
- Freight Estimate $68,000

CASE II – TREATING PDF **$1,980,000**
- Freight Estimate $170,000

Equipment is F.O.B. factory with freight prepaid and billed at cost. The price does not include any import, sales, use, excise or similar taxes, fees, permits, etc. This proposal is valid for a period of sixty (60) days unless extended in writing by Blue Water.

Proposed Terms:
25% (net 30 days) with order
25% (net 30 days) with approval of drawings and submittals
45% (net 30 days) with delivery of the equipment to the jobsite
5% (net 30 days) payable upon startup not to exceed 45 days from delivery

The price includes an allowance for factory trained **Manufacturer's Services** as noted below:

- Five (5) – eight (8) hour days in five (5) trips for start-up and training.

Additional time, if requested by the Owner, shall be invoiced at prevailing rates. Expenses associated with any additional field engineering will be invoiced at actual cost plus 10%.

4.1 Estimated Operating Costs:

Ferric chloride (40% Bulk at FE at $2.30 a gallon)	$ 233,000 per year
Power cost at ($0.11 per KWH)	$ 51,300 per year
Operations ($50/Man Hour)	$ 26,000 per year

Electrical service 460 VAC/3Ø/60 Compressor
120 VAC/1Ø/60 Control Panel

5.0 Estimated Submittal and Shipping Dates:

Blue Water is prepared to ship equipment in approximately sixteen (16) to twenty-four (24) weeks from the receipt of approved drawings, submittals, and a signed release to fabrication. While drawings are issued for approval, they are intended for informational purposes only. The drawings will remain Blue Water property and may not be used by others for fabrication.

6.0 Warranty:

Equipment will be warranted against manufacturer's defects in accordance with Blue Water's standard warranty for twelve (12) months from start-up or fourteen (14) months from date of shipment, whichever comes first, when operated at stated conditions and according to the instructions in Blue Water's operations and maintenance manual.

7.0 Work by "Others":

The following items are not included in this **Scope of Supply**, but may be required for these systems:

- Preparation of structural engineering drawings for all concrete work.
- Concrete material and its placement, embedments or anchors.
- Site preparation, unloading, placement and installation of equipment. Installation of all Blue Water supplied equipment.
- Ancillary tanks (chemical feed tanks, flow equalization tanks, etc.).
- Buildings (if required) and building utilities and HVAC.
- Supply and connection of electrical service to Blue Water supplied control panel. Supply, installation, and connection of interconnecting circuits between Blue Water supplied panels and auxiliary panels and/or instrumentation and/or motorized devices.
- Supply and installation of required drain piping, influent piping, effluent piping, reject piping, all associated valves, required pipe support, and appurtenances to and from the connection point on Blue Water supplied equipment. Piping inside the concrete filter vessel is included
- Supply and installation of interconnecting vent, drain, and airlines and their associated valves and appurtenances.
- Reject disposal, handling and/or processing.
- Supply and installation of insulation and heat tracing of any piping or tubing (if required).
- Chemicals required for operation.

Thank you for your consideration on this project. If you have questions or need more information, please feel free to contact our local representative, Tom Valorose of J&R Engineered Equipment at (508) 738-0152 or myself at (208) 209-0391.

Sincerely,

Matt Schowengerdt, P.E.
Director of Sales

Blue Water Technologies, Inc.
10450 N. Airport Drive
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Phosphorus Removal

Blue PRO®

Advanced Phosphorus Removal

Blue PRO® uses reactive filtration to lower phosphorus to extremely low levels. Reactive filtration features continuous regeneration of reactive filter media within a moving bed filter.

A hydrous ferric oxide (HFO) coating is formed on the media surface, abraded away within the filter, and continuously regenerated. HFO allows adsorption of phosphorus, a more efficient removal mechanism than coagulation-filtration for removing contaminants to extremely low levels. Through adsorption Blue PRO® is able to achieve total phosphorus levels <0.010 mg/L.

Single-pass systems may meet total phosphorus regulations as low as 0.1 mg/L, depending on the influent concentration. Lower limits are achieved with two-pass systems, and reject recycle. With these alternative configurations, full-scale installations have reached <0.010 mg/L. Blue Water maintains an active research program to continually improve performance for limit-of-technology phosphorus removal results.

Blue PRO® is more cost effective than any other tertiary treatment technologies for phosphorus removal to low levels. It has lower operations and maintenance costs than biological phosphorus removal and MBR for phosphorus removal, and consumes less chemical than dosing schemes in secondary systems.

Advantages of Blue PRO® over other technologies:

- **Low capital and O&M costs**
- **Continuous flow – no interruption for backwash or changing media**
- **Modular design easily handles capacity increases**
- **Simple operation, low chemical use, and no pH adjustment**

Blue PRO® 1.5 MGD Installation

The Blue PRO® System

Blue PRO® systems are available in a number of configurations to accommodate any system size or phosphorus regulation. The filters are available as free-standing fiberglass units or as concrete installations. Smaller units may be mounted on skid systems for mobility. The modular nature of the filters allows easy system expansion.

Waste particulates, including the iron and phosphorus, are continuously separated from the process flow. Reject recycle refers to the return of process residuals to an earlier point in a wastewater plant. Blue PRO® reject particulates contain significant adsorptive capacity. Recycling this material can achieve significant additional phosphorus reduction through the plant's secondary system, further reducing the final effluent phosphorus concentration. Phosphorus is not released in the secondary system or through digestion. No change is required in the plant's sludge handling system, plus the iron helps control odor and may produce a drier biosolid.

The Blue PRO® filters may also be used for denitrification, and this application may be combined with phosphorus removal. Nutrient removal projects are currently installed around the country. In addition, pilot projects are currently operating in several different states. Contact Blue Water for information about piloting at your location.

Blue PRO® applications include:

- Tertiary phosphorus removal
- Combined phosphorus removal and denitrification
- Combined phosphorus and algae removal

BLUE WATER TECHNOLOGIES INC

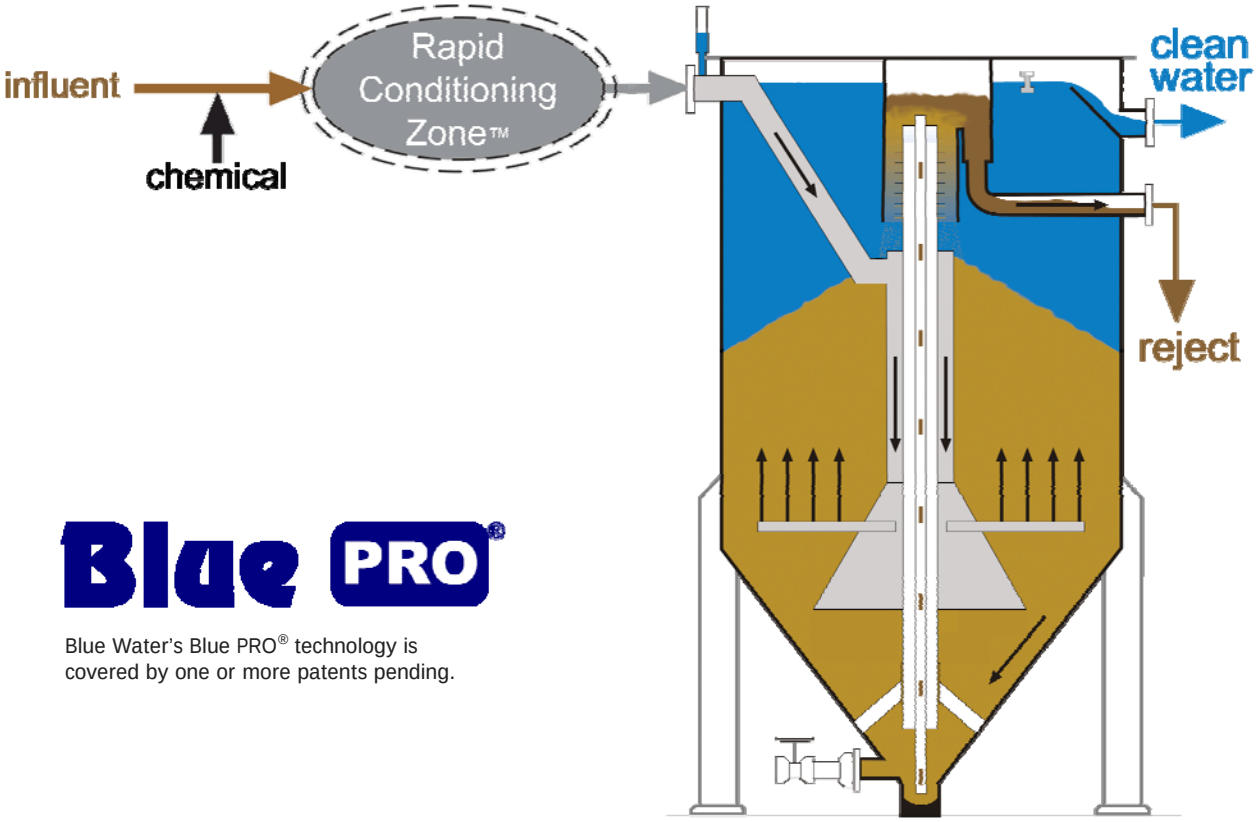
Blue Water for a Green World®

For more information, please contact Blue Water:

(888) 710-2583, sales@blueh2o.net, www.blueh2o.net

Modular Blue PRO® reactive filtration systems are available in the following models:

Blue PRO® Models	Flow Rate	Footprint
Skid systems	5-100 gpm	8' x 10' and up
CF-50 fiberglass	0.25 MGD	8' diameter
CF-50 concrete	0.25 MGD	7' x 7'
Quad concrete	1 MGD	15' x 15'



Blue PRO®

Blue Water's Blue PRO® technology is covered by one or more patents pending.

Blue Water is proud to offer a broad platform of water treatment technologies, from primary wastewater treatment to advanced effluent polishing steps to environmental remediation processes. We strive to meet our customers' needs cost-effectively, considering both capital expense and ongoing operations and maintenance costs. Additionally, we keep an eye on the future by looking for sustainability in our technologies, including environmentally friendly materials and energy conservation.

Blue Water for a Green World®

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