Pinellas County UTILITIES

SCB Denitrification System

Approved By: ______________________
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Purpose

This document provides information about the TETRA Denite® DeepBed™ Filtration System at the South Cross Bayou (SCB) WRF. This information will assist you in understanding, operating, maintaining, and troubleshooting the system.

Contents

Background

After completion of the Advanced Wastewater Treatment (AWT) construction at the South Cross Bayou Facility, the new permit no longer allowed deep well injection. It has been replaced by surface water discharge and an increased amount of reclaimed water usage. In order to discharge to surface water (Joe's Creek), nutrient removal is required. The TETRA Denite® DeepBed™ Filtration System aids in the process of removing nutrients (another main function of this system is to filter out suspended solids).

Nutrient Removal

The Denite system removes the nutrient, nitrogen. The system does this with the application of Methanol, an organic carbon, to the wastewater at the influent piping of the Denite system (see APP training document, "SCB Methanol System" for details). As the methanol-enriched wastewater is filtered through the filter media, facultative-anaerobic microorganisms growing on the surface of the sand converts the nitrate-nitrogen to gaseous nitrogen. Basically, after the microorganisms eat the food (methanol), water is pumped back through the sand stirring up the water in the tank. This allows the nitrogen gas to be emitted into the atmosphere.

Note: When it is not necessary to discharge effluent to the surface water (Joe's Creek), Methanol will typically not need to be added to the Denite System. In this case, the Denite System will act solely as a solids filter.

Solids Filtering

The TETRA Denite System uses a physical separation process (*solids filtering*), which consists of a 6′ deep layer of filter media (relatively coarse silica sand) to filter out suspended solids. The deep layer allows for capture and storage of large amounts of solids.

The accumulation of suspended solids and nitrogen gas in the filter bed causes a gradual build-up of head loss in the filter. This requires a periodic backwash for solids release and bumping for nitrogen gas release from the filter.

Table 1: Design Parameters

Parameters	Influent	Effluent
Plant Flow (MGD/GPM)		
Average	33/22,920	
Peak	66/45,840	
Filtration Rate (GPM/ft^2)		
Average (per filter)	2.32	
Peak (per filter)	4.64	
Total Suspended Solids (mg/L)		
Average	20	5
Peak	20	5
Nitrate-Nitrogen (mg/L)		
Average	9	2
Peak	9	2

Denitrification System

Processes

The following 3 sub-sections discuss the Filtering Process, Backwashing Cycle, and Bumping Cycle for the TETRA Denite® DeepBed™ Filtration System.

Filtering Process

Figure 1 illustrates the Filtering Process, which starts with the Filter Feed Pumps feeding wastewater to the Influent Water Header of the Denite System, where it is distributed to the two Filter Troughs of each of the twelve Filter Units. The wastewater spills over the top of the troughs evenly and settles through the Filter Media and Underdrain support. The filtered water travels through Central Drainage Channel and flows by gravity to the Clearwell. In the Clearwell, the filtered water fills up and flows over the weirs, flowing to the Effluent Header, where it flows by gravity to the Automatic Backwash (ABW) Sand Filters for final filtration.

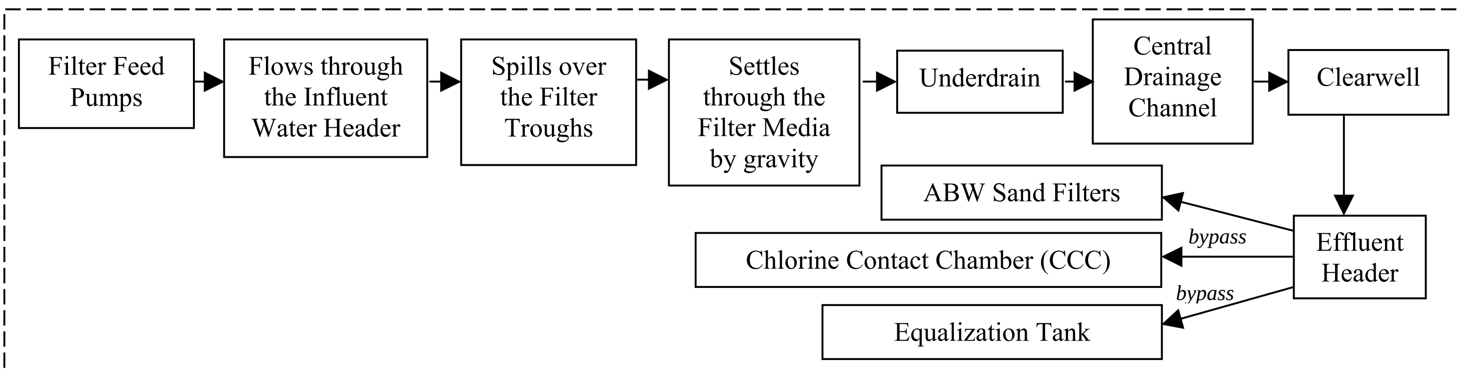

Figure 1: Denitrification filtering process flow diagram

Backwash Cycle

As the Denitrification system removes suspended solids and nitrate-nitrogen from the wastewater, the head loss in each filter vessel increases. The accumulation of material in the filter eventually will approach the maximum specific loading of the filter. The specific loading of the TETRA system is about 1.0 lb/sq. ft. Also, each pound of nitrate-nitrogen removed has about 0.5 lbs of suspended solids associated with it.

To bring the head loss in each filter unit back to its normal operating range, a Backwash Cycle (see figure 2) is initiated to remove the excess of suspended solids. This cycle automatically starts by a Timed Sequence that is programmed at the Human-machine Interface (HMI) in the Denite Control Room. Operators program the timed sequence depending on process performance. When the Backwash cycle is activated, a PLC sends a signal to turn on the Backwash Air Blowers, and another signal to the Backwash Pumps. When activated, the Backwash Air Blowers send air through the Air Laterals to the Central Drainage Channel. When the Backwash Pumps are activated, they will draw water from the Clearwell and pump it to the Central Drainage Channel. From the Central Drainage Channel, the injected air and water goes up through the Underdrain and Filter Media loosening the suspended solids from the sand. This will cause the dirty water to fill the filter unit and overflow into the Dirty Backwash Troughs (Filter Troughs). On average, Backwash cycles are timed to occur at a rate of 0.4 Backwash Cycles per Filter Unit per Day (or 5 of 12 Backwashed per day). The dirty backwash water travels by gravity into the Mudwell before flowing to the headworks of the plant.

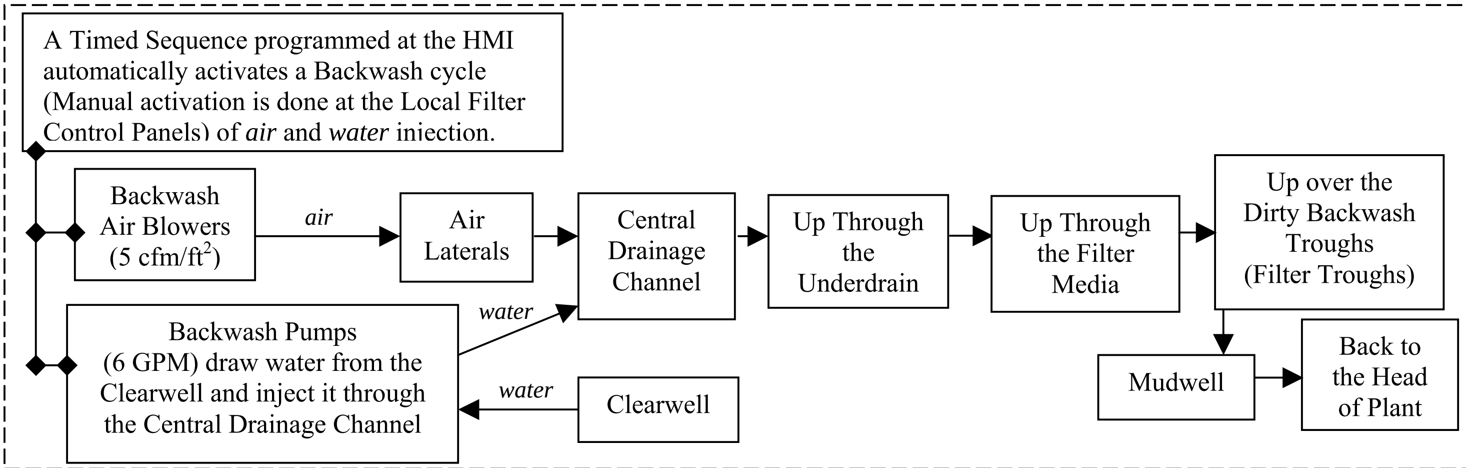

Figure 2: Backwash cycle for suspended solids removal

The backwash water and air rates used in TETRA filters are 6 gpm water and 5 cfm air per square foot of filter surface area. This produces a vigorous scrubbing action and flushes the captured material upward from within the filter bed, into the dirty backwash trough. The use of air and water simultaneously greatly increases the efficiency of the backwash and reduces the amount of backwash water required.

A Backwash Cycle can also be activated manually at the control panels located at the Denite Filter Units. There are two sets of two control panels that control six filter units each (or 3 units per individual panel).

At typical conditions of 10 mg/L influent TSS and 9 mg/L influent NO_3-N, the frequency of filter backwashing can be calculated. Backwashing frequency equals the pounds of suspended solids removed per square foot of filter surface each day, divided by the specific loading capacity in pounds per square foot per backwash.

Frequency (F_W) = **0.40 backwashes per filter per day**

Time between backwashes = 24 hours/0.40 = 60 hr cycle Number of filters backwashed in a day = 12 filters x 0.4 backwash/filter/day = 4.8

Backwash 5 of the 12 filters per day

This estimate is good for continuous filtration at the design loadings and flow rate. In practice, the frequency of backwash will be determined from actual operating experience.

Bumping Cycle

The main purpose of a Bumping cycle (see figure 3) is to allow the Microorganisms to release nitrogen gas into the atmosphere after consuming the Methanol. Also, to take care of head loss, a Bumping cycle is usually initiated before a Backwash cycle. A Bumping cycle automatically starts by a Timed Sequence that is programmed at the Human-machine Interface (HMI) in the Denite Control Room. Operators program the timed sequence depending on process performance. When the Bumping cycle is activated, a PLC sends a signal to turn on the Backwash Pumps drawing water from the Clearwell pumping it to the Central Drainage Channel. From the Central Drainage Channel the water travels up through the Underdrain and Filter Media loosening up the suspended solids from the sand and allowing the nitrogen gas produced by the microorganisms to be released into the atmosphere.

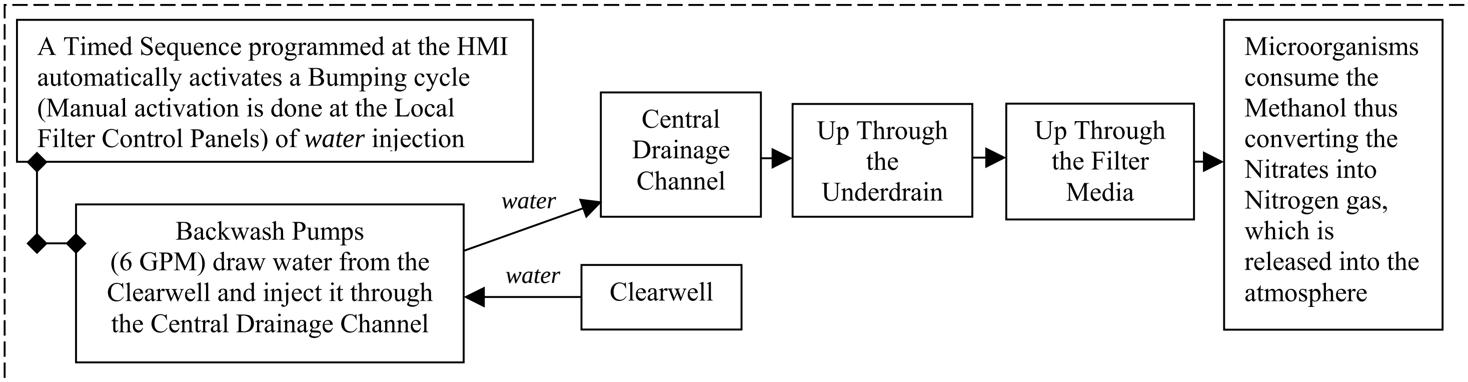

Figure 3: Bumping cycle for release of accumulated nitrogen gas

Filter bumping uses the same water rate as a backwash but no air. The filter is taken out of service momentarily and the backwash pump runs for a short period.

This injection of water causes a release of accumulated nitrogen gas.

The nitrogen gas that is generated during denitrification accumulates in the filter bed requiring a nitrogen release cycle (bumping) to remove it. Usually a Denite filter is capable of denitrifying 0.06 lb/ft2 of nitrate nitrogen before it requires a gas bumping. Based on this capacity (specific loading), an average influent nitrate concentration of 9.0 mg/L, and an average filtration rate of 2.32 gpm/ft2, the frequency of filter bumping can be calculated.

> Frequency (Fb) = 4.18 bumps per day.
>
> Between 4–5 bump cycles should be performed each day. Each cycle bumps all of the filter units sequentially. The time between bumps is 24 hours/4.18 = 4.78 hr cycle. The duration of the Bump Cycles is approximately 165 seconds.

Control Interlocks

The following major interlocks are incorporated in the control system:

- Only one filter can be backwashed or bumped at a time.
- A backwash cycle and a bump cycle cannot occur simultaneously.
- A backwash can only be initiated if the amount of water required for one filter backwash is accumulated in the Clearwell.
- A Bump cycle can only be initiated if the amount of water required for one bump cycle is accumulated in the Clearwell.
- Instrument Air Pressure Low Alarm must not be present in order to perform an automatic bump or backwash.

Table 2: System Components

The following table lists all of the major components of the TETRA Denite® DeepBed™ Filtration System and provides a description each component.

#	Component	Description
Denitrification Filter System		Consists of 12 gravity filters, 9.67′ wide and 85′ long each.
Influent Water Header		Runs the length of the Denitrification Filter System and supplies wastewater to the troughs of each of the 12 filters.
1.	Troughs	Piped to the influent water header and run the length of each filter unit (on each side). The edges of the troughs are 147″ above the top of the sand. During filtration, water enters the troughs and spills over evenly into the filters. At the start of a backwash through valve switching, the troughs also serve as collectors for the dirty backwash water rising up and overflowing out of the filter.
2.	Filter Media	6′ of 6 x 9 mesh relatively coarse silica sand.
3.	Coarse Gravel	Five graded layers totaling 1.5′, which supports the media.
4.	Underdrain	Formed by rows of plastic-jacketed concrete air/water distribution blocks, which supports the gravel and media.
5.	Underdrain Blocks	Rest on a concrete floor in which a central drainage channel is cast. Perform the following functions: 1. Provide solid structure, which supports gravel and sand. 2. Prevent sand or gravel from entering the underdrain system. 3. Minimize the possibility of damage to filter internals from hydraulic shock. 4. Serve as a filtrate collection system. 5. Evenly distribute backwash air and water across the entire area of the filter bed.
6.	Central Drainage Channel	Collects down-flowing filtered water (filtrate) and distributes clean backwash water upward during filter backwashing. It is capped by carbon steel plates spaced ¾″ apart.
7.	Air Laterals	Distribute air during filter backwash. The air inlet is located under the underdrain blocks and is made of stainless steel. The Air Laterals receive air from the Blowers in the Denite Blower Room.
8.	Clearwell	Located on ground level at the North side of the Denite System, it stores the filtered unchlorinated water from each filter unit for backwashing. The filtered effluent from each filter unit flows by gravity into the Clearwell. The excess of the Clearwell flows over the weirs to the ABW Sand Filters for additional solids filtering.
9.	Backwash Pumps (2)	Located on the top level at the East side of the Denite System, the Backwash pumps supply 4,930 gpm of water from the Clearwell to the bottom of the filter being backwashed or bumped. Only one pump operates at a time, while the other is in standby.
10.	Backwash Air Blowers (3)	Located in the Blower Room of the Denite System, the Blowers provide 2,125 cfm each of air for backwashing. Only two blowers operate at a time, while the other is in standby. These blowers do not operate during filter bumping.
11.	Mudwell	Collects the dirty backwash water by gravity. The dirty backwash water returns to the front of the plant for reprocessing.

#	Component	Description
12.	Controlling Equipment	
	Human Machine Interface (HMI)	Located in the Denite Control Room, this graphical user interface allows the operator to monitor and control all aspects of the TETRA Denite system. (*see the* O & M Manual for TETRA Denite® DeepBed™ Filtration System, Volume 1, pp.10-20 for more information)
	Local Filter Control Panels (2)	Located at the top level of the Denitrification system, two (2) control panels (UCP-0701A & B) are split into 2 sections and provide manual control for the operations of the 12 Denitrification Filters.
13.	Monitoring Equipment	
	Signal Output Module (SOM)	Hach Aqua Trend, located on the East wall of the Denite Blower Room. (APP Level 2 document available on this device)
	Power Supply	Hach PS1201, located on the East wall of the Denite Blower Room. (APP Level 2 document available on this device)
	Process Analyzer	ChemScan, located on the East wall of the Denite Blower Room. (APP Level 2 document available on this device)
	DO Analyzer	Royce Model 9200, located on the East wall of the Denite Blower Room. (APP Level 2 document available on this device)
	Turbidity Analyzer	Hach 1720D Turbidity Analyzer, located on the East wall of the Denite Blower Room. (APP Level 2 document available on this device)

Safety

Working on the Filters

Whenever personnel work in a filter unit, it is imperative to be sure that the filter vessel does not return to filtration mode or begin a backwash sequence. The individual filter switch should be switched "Out-of-Service."

Alternately, this can be done by placing the filter mode switch on the control panel to the MANUAL position and closing the filter influent and effluent valves. This alone is not sufficient since others could inadvertently open the valves or the valve opening could be activated by power failure. Filtration is the no-power position of the valves. The following steps should also be done:

1. Hand block valves should be closed and tagged.
2. Pneumatic actuators on valves are to be blocked after closing.
3. Turn off air supply and bleed pressure to pneumatic valves being worked on.
4. Disconnects are to be locked out or fuses removed after closing valves equipped with electric actuators.

Safety Features

The TETRA Denite® System is equipped with an emergency eye wash station, which is located at ground level of the Southeast corner of the Denite System. There is also an Eye Wash Panel Alarm (HS-0501) that will sound if the station is activated.

Control System Equipment

Main Control Panel (MCP)

The panel includes the necessary equipment, instruments, ancillary control devices, hardware, and logic to perform the automation functions of the Denite System.

Programmable Controller (PLC)

The Denite System uses a Square D Symax PLC with a Square D Model 600 Central Processing Unit. The PLC includes Input/Output (I/O) racks with I/O cards, communication cards, and auxiliary equipment and cables for PLC internal data transfer.

Processor Memory

The memory of the PLC is a 32K state-of-the-art processor operating in real-time.

Inputs/Outputs (I/O)

I/O racks, which are located in the MCP, include the following:

- Discrete input cards handle up to 32 inputs.
- Discrete output cards handle up to 16 outputs.
- Analog input cards handle up to 16 inputs.
- Analog output cards handle up to 4 outputs.

The system I/O is distributed as follows:

- Non-Isolated Discrete Inputs
- 115 VAC Output Modules
- Relay Output Modules
- Analog Input Modules
- Analog Output Modules

Human-machine Interface (HMI)

The HMI is an Allen Bradley 6180 Industrial Computer. This workstation acts as the interface for the plant operator to the PLC. The computer is installed with Wonderware software, which is fully programmed with TETRA’s filter screens.

Control System Operation

The operating mode is determined by the FILTER MODE selector switch located on the Main Control Panel (MCP).

Automatic

To operate the Denite filters in auto, put the filter mode selector in “Auto.”

The time of day HMI screen determines how often the filters are backwashed. There are indicators on the HMI that indicate “Next Filter to Backwash.” If a filter other than the one indicated is to be backwashed, push the “Filter Select” pushbutton to select the appropriate filter.

Backwash Cycle

The HMI and LCP pilot lights indicate which filter is in backwash. The Header screen on the HMI will indicate which step the backwash is in, the elapsed time in the step, and the next filter to be backwashed.

The table below breaks down the steps, duration, and actions of an automatic backwash cycle:

Table 3: Backwash Cycle

Step	Activity	Duration	Mechanical Action
1	Drain Down Filter	3.0 minutes	• Close Influent Valve
2		0.5 minutes	• Close Effluent Valve. • Open Dirty BW Water Valve.
3		0.5 minutes	• Open BW Air Valve. • Open Clean BW Water Valve.
4	Scour Filter with Air	2.0 minutes	• Start one BW Blower. • After 45 seconds, start another Blower. • Alarm if low flow after 45 seconds and until end of step 5. • Switch to standby Blower if necessary.
5	Scrub Filter with Air/Water	20.0 minutes	• Start BW Water Pump. • Throttle flow control valve to 4,930 gpm. • Alarm if low flow after 30 seconds and through end of step 6, switch to standby Pump if necessary.
6	Rinse Filter	5.0 minutes	• Stop BW Blowers. • Close BW Air Valve.
7		0.5 minutes	• Stop BW Water Pump. • Close Clean BW Water Valve.
8	Drain Down Filter	1.0 minutes	• Open Effluent Valve. • Close Dirty BW Water Valve.
9	Return Filter to Service	0.5 minutes	• Open Influent Valve.
33 Minutes Total			

Bumping Cycle

The HMI will display which filter is in a bump and which step the bump is in. The elapsed step time will also be displayed.

The table below breaks down the steps, duration, and actions of an automatic Bump cycle:

Table 4: Filter Bumping Cycle

Step	Duration	Mechanical Action
1	15 seconds	• Close Effluent Valve.
2	15 seconds	• Open Backwash Water Valve.
3	15 seconds	• Close any previous Backwash Water Valve.
4	120 seconds	• Open any previous Effluent Valve. • Start BW Water Pump if 1st filter. • Reset at end of step 4 if last filter.

Out of Service

Any filter may be taken out of service by turning its "In Service/Out-of-Service" selector switch located on the HMI screen. The HMI will display which filter is in or out of service. This automatically closes the filter's influent and discharge control valves.

Once these actions have been taken, the backwashing and bumping of any filter out of service is automatically skipped by the PLC and the filter will remain out of service even in "Manual" mode.

Sequencer

There are two sequencers (software elements). One runs the backwash cycle and the other runs the bump cycle. There is a "Backwash and Bump Sequencer Jog" pushbutton, which enables the operator to jog the backwash and bump sequencer at one minute intervals.

Semi-Automatic

Instead of waiting for the automatic time of day timer to timeout in order to start a backwash or bump, a pushbutton is provided on the HMI to initiate backwash or bump. After that, control is identical to the automatic mode of operation. The operator can return the filter plant to the automatic mode to resume automatic timing operations.

Manual

With the FILTER MODE selector switch in MANUAL, the system is controlled from any of the local control panels or from the HMI. A filter can be manually backwashed or bumped from its local control panel or HMI. The valves, blowers, and pumps can be operated in the same sequence as in the automatic mode. Interlocks prevent selecting more than one filter for backwash at a time. Each local panel has pilot lights to indicate each valve position, which are operated by limit switches on the valves. Each pump and blower set has pilot lights, which indicate run status. These lights also operate in the automatic mode.

Manual Backwashing Procedure

Notes:

The steps to manually operate a Backwash Cycle are the same sequence of steps that a PLC performs during an automatic Backwash.

Manual Backwashing is performed from the Local Control Panels, which are located on the top level of the Denite System next to the Filter Units. Check each local panel to ensure that all switches are in the normal filtration positions, which are the influent and discharge valves open, all other valves closed.

Before performing a manual backwash, the operator MUST check the Clearwell and Mudwell to verify sufficient capacity to perform a sufficient backwash.

1. Go to the main control panel and verify that no automatic backwash or bump is taking place. The Step indicator should be at zero (0).
2. Switch “Auto/Manual” switch to “Manual.” This will enable both local panels.
3. Return to the Local Panel and close the Influent Valve. This allows the filter to drain down through the still open effluent valve.
4. After approximately five minutes, close the effluent valve, open the backwash drain valve, open the backwash air supply valve, and open the clean backwash water valve.
5. Select and then turn on an airwash blower. Allow the air pattern to fully develop and stabilize, then turn on a second blower. Allow the filter to air scour for three minutes.
6. Select and then turn on a backwash water pump. After an additional 20 minutes, turn off the airwash blower and shut the backwash air supply valve.
7. After an additional 5 minutes of backwash water only rinse time, shut the backwash water pump off, close the clean backwash water supply valve, and close the backwash drain valve. Open the effluent valve and allow the filter to drain down.
8. After approximately 2 minutes of draindown time, open the influent valve to return the filter to service. If manual procedures are finished, place the “Auto/Manual” switch on the main control panel back to “Auto.”

Manual Bumping Procedure

A Bump cycle can be thought of as a short backwash without using the blower. Manual Bumping is performed from the local control panels. Check each local panel to ensure that all switches are in the normal filtration positions: influent and discharge valves open and all other valves closed.

Note: Before performing a manual Bump, the operator MUST check the Clearwell and Mudwell to verify sufficient capacity to perform a sufficient bump.

1. Go to the Main Control Panel and verify that no automatic Backwash or Bump is taking place (step indicator should be at zero (0)).

   If one is occurring and the operator needs emergency local control, try to wait for a long step where no valve is moving before moving to the next step. Note the filter that is next to backwash. Then switch "Auto/Manual" switch to the "Manual" position. This will enable all local panels. If a Backwash was in progress, it will be abandoned. If a valve was moving, its position will have to be reset at the valve. This is more likely to happen if an automatic Bump is abandoned, since the steps are shorter.
2. Return to the local panel and close the Effluent Valve. Open the Clean Backwash Water Supply Valve for the filter to be backwashed.
3. Select and turn on a backwash water pump for 2 minutes. Overflowing the weirs is OK as long as there is one available filter that is not high.
4. If another filter is to be bumped, repeat STEP 2 for that filter. Then immediately perform STEP 6 on the filter that was just bumped and wait 2 additional minutes. It is not necessary to turn off the backwash pump if this sequence is followed and all 12 filters can be bumped in as little as 32 minutes. On the last filter, resume this procedure at STEP 5.
5. Stop the backwash pump.
6. Open the effluent valve and close the backwash water valve.
7. If a filter backwash was interrupted, complete the backwash in manual.
8. Place the main control panel mode switch to "Auto." Ensure that the original next filter to be backwashed is still selected.
9. After approximately 2 minutes of draindown time, open the influent valve to return the filter to service. If manual procedures are finished, place the "Manual/Auto" switch on the main control panel back to "Auto."

Normal Filtration Mode Valve Positions

OPEN – Influent & Effluent Valves

CLOSED – Clean BW Water, Dirty BW Water, & BW Air Valves

Out-of-Service Mode Valve Positions

CLOSED – Influent, Effluent, Clean BW Water, Dirty BW Water, & BW Air Valves

System Monitoring

To operate the Denitrification System, the factors in the table below are monitored.

Table 5: Monitoring Factors

#	Monitoring Factor	Description	Frequency Checked	Desired Range
1.	Influent Flow	Instrument, location of instrument and measurement, and purpose of measurement.	daily (Mfg. recommended)	
2.	Influent Nitrate	Instrument, location of instrument and measurement, and purpose of measurement.	4 hours (Mfg. recommended)	
3.	N. Plant Phosphorus	Instrument, location of instrument and measurement, and purpose of measurement.		
4.	Effluent Turbidity	Instrument, location of instrument and measurement, and purpose of measurement.	daily (Mfg. recommended)	
5.	Effluent Nitrate	Instrument, location of instrument and measurement, and purpose of measurement.	4 hours (Mfg. recommended)	
6.	S. Plant Phosphorus	Instrument, location of instrument and measurement, and purpose of measurement.		
7.	Influent DO	Instrument, location of instrument and measurement, and purpose of measurement.		
8.	Methanol Tank 1 Level	Instrument, location of instrument and measurement, and purpose of measurement.		
9.	Methanol Tank 2 Level	Instrument, location of instrument and measurement, and purpose of measurement.		
10.	Backwash Air Flow (ICFM)	Instrument, location of instrument and measurement, and purpose of measurement.		
11.	Clean Backwash Water Flow	Instrument, location of instrument and measurement, and purpose of measurement.		
12.	Spent Backwash Water Flow	Instrument, location of instrument and measurement, and purpose of measurement.		
13.	Mudwell Level	Instrument, location of instrument and measurement, and purpose of measurement.		
14.	Clearwell Level	Instrument, location of instrument and measurement, and purpose of measurement.		

Data Collection

Accurate data is necessary for optimizing the process and for serving as a database for diagnosing process problems. Many problems that occur in wastewater filters take months or years to develop. A long-term database can help identify the problems to make the appropriate correction. It is recommended that the following data be collected on the TETRA Denite® System.

Table 6: Sampling Items

Data	Sampling Location	Frequency
Suspended Solids	Filter Influent and Effluent	daily
Nitrate Nitrogen	Filter Influent and Effluent	4 hours
Flow	Filter Influent	daily
BOD	Filter Influent and Effluent	daily
pH	Filter Influent and Effluent	daily
Total Phosphorus	Filter Influent and Effluent	weekly
Total Alkalinity	Filter Influent and Effluent	weekly
Dissolved Oxygen	Filter Influent and Effluent	weekly
Ammonia	Filter Influent and Effluent	weekly

All analyses should be done in accordance with the latest edition of the Standard Methods for the Examination of Water and Wastewater and the Florida Department of Environmental Protection Standard Operating Procedures.

Alarms

All alarm conditions are continuously monitored by the PLC. When an alarm condition occurs, an alarm light will flash and an audible signal will sound. This signal will be transmitted remotely by means of a general controls alarm.

The operator should acknowledge an alarm by silencing the horn with the “Silence” pushbutton. The light will stop flashing upon initiation of the reset button and remain steady until the fault is cleared. Even though the alarm condition may have cleared itself, the light will remain steady. Once the alarm condition has been cleared, the alarm light or lights will go out when the “Reset” pushbutton is pushed.

Note: All of the above does not apply to the “PC Failure” alarm. If the PC fails, the light will come on steady and the horn will sound. To silence the horn, open the MCP and turn the “PC Failure-Horn Silence” toggle switch to the off position.

The following table is a list of the alarms in the Main Panel:

Table 8: Main Panel Alarms

Alarm Type	Breakdown
Level	• Filter No. 1-12 High Level • Clearwell Low Level • Mudwell High Level • Methanol Tank Low Level • Methanol Tank High Level
Flow	• Low Air Flow Backwash Blowers • Low Water Flow Backwash Pumps
Valves	• Filter 1-12 Influent Open/Close Fault • Filter 1-12 Effluent Open/Close Fault • Filter 1-12 Backwash Water Open/Close Fault • Filter 1-12 Backwash Air Open/Close Fault • Filter 1-12 Dirty Backwash Water Open/Close Fault
Pumps, Blowers, & Compressor	• Backwash Pump 1 & 2 Fault • Backwash Blowers 1, 2, & 3 Fault • Air Compressor 1 or 2 Fault

Preventive Maintenance

Filters

There are no moving parts inside a filter requiring periodic maintenance; however, during the first year, each filter unit should be taken out of service and inspected once every quarter. The following items should be checked when doing the inspection:

1. Drain filter down and inspect media for mudball formation.
2. Inspect for media loss by measuring the distance from the top of the sand to the top edge of the upper trough. This distance should be approximately 147 inches. Record the level for later reference.
3. Fill the vessel with water to 2 inches over the top of the sand and check for the proper backwash air pattern using the backwash blowers.
4. The backwash water flow rate should be checked by a rise rate calculation. The proper rise rate is 9.6 inches per minute.

Note: After the first year of successful operation, the above inspection should be conducted once every year.

Auxiliary Equipment

Filter Control Valves

- Check for smooth operation, no air leaks, and not loose on mountings.

Backwash Air Blowers

- Check grease and oil level monthly.
- Oil should be changed out every 6 months using recommended oils.
- Air filters should be cleaned or replaced at the same interval.
- Check and adjust belt tension at 6-month intervals.

Control Panels

- Check monthly that cabinet thermostat is working and that condensate or water leaks are not a problem.

Troubleshooting

General

The TETRA Denite® DeepBed™ Filtration System is a relatively simple system with no internal moving parts, but difficulties can develop which adversely affect filtrate quality. Experience has shown that virtually all filter problems result from three operating errors:

1. **Inadequate Backwashing**

Problem	Recommended Initial Value
Backwash interval is too long	5 filters per day
Length of backwash is too short	20 minutes + 5 minutes
Low backwash water rates	4930 gpm
Uneven distribution of air & water across filter bed	Even fine bubble pattern

The recommended initial values for backwash intervals, backwash length, and backwash water rates are based on many years of experience in the filtration of wastewater. It is possible, however, that operation of this facility may demonstrate the need to modify the suggested initial values.

2. **Overloading the Filters**

If the following design loadings are exceeded, long term problems such as media encrustation, media plugging, mudball formation, and deterioration of filtrate quality can result.

Filter Plant Influent:
Plant Flow 33 MGD average
Suspended Solids 20 mg/L average

3. **Overdosing of Chemical Additives**

If polymer, coagulants, or other chemical additives are added ahead of the filters, addition rates must be controlled carefully. Overdosing can create serious long-term problems within the filter bed.

Frequent Filter High Level Alarm

The High level alarm is intended as an emergency backup. During normal operation, all backwashes should be initiated by an automatic timer before a high level develops. If frequent high level alarms become a problem, there are 3 possible causes that should be investigated:

1. Filter Overloading

Ensure that the maximum design loadings for flow and suspended solids are not being exceeded.

2. Inadequate Backwash

Backwashing efficiency can be analyzed by collecting 5–10 samples of dirty backwash water during a backwash, and developing a plot of suspended solids versus time. Ensure that the proper backwash settings are being adhered to, or consider modifying the settings, if necessary.

3. Gas Binding within the Media

The last 5 minutes of the backwash cycle consists of backwash water without any backwash air. This “rinse” phase is designed to remove residual air bubbles from the media, which otherwise creates an unnecessary head loss.

Air binding can be detected by manually bumping the filter at the conclusion of a backwash, and observing to see if there is a large release of air bubbles from the media.

- If air binding is a problem, lengthen the rinse cycle or check the backwash water rate during the rinse.
- If the air binding problem occurs often, the backwash air valve on that filter may be leaking a small amount of air when the blower is scrubbing other filters. Check that the valve is seating properly.
- If the air binding problem occurs on several filters, the problem may be insufficient bumping. Initiate a semi-automatic bump. If this clears up the problem, the bump interval timer should be set to bump the filters more frequently.

Inadequate Backwash Air

During a properly functioning backwash, the backwash air bubbles rising to the surface are evenly distributed over the entire surface area of the filter bed. Any significant variation from this pattern is not normal and must be investigated.

1. Backwash Air Boil

Backwash air rising to the surface of the filter in large quantities in one or more isolated columns may be an indication that there is a break in the air distribution piping, or that one or more of the air/water distribution blocks are broken or displaced. The only remedy for this problem is to remove the filter media and gravel and investigate the underdrain.

2. No Backwash Air

If no air is being discharged into the filter during backwash, check for the following:

- Backwash air blower not operating properly.
- Backwash air valve is not opening.
- Blower block valve or filter air block valve is not open.
- Blower pressure relief valve is stuck open.

Inadequate Backwash Water

If there is no backwash water or the backwash water flow is incorrect, it may be due to any or all of the following:

1. Backwash water flow control valve is not positioned properly.
2. Backwash pump did not turn on or is air bound.

The Backwash water rate can be checked by measuring the rise rate inside a filter cell directly. It should by 9.6 inches/minute.

Mudball Formation

Mudballing is the accumulation of a mass of the impurities retained in the filter media into one or more large solid balls. This can occur from inadequate backwashing, overloading the filters, or overdosing of chemical additives.

Once mudballs are allowed to form in a filter, it is very difficult if not impossible to backwash them out of the filter. If mudballs are allowed to grow in size and number, media replacement may become necessary.

Media Loss

There should be little loss from the filters during normal operation. The initial distance from the top edge of the trough to the sand surface should be measured during start-up and recorded. If large quantities of sand are washed out during backwash, then the backwash air and water rates may be too high or the air-water backwash cycle may need to be modified.

Abnormal Effluent Quality

1. **High suspended solids in the filter effluent**:

   This may be caused by an excessively high level of suspended solids in the influent, improper filter backwashing, or excessive methanol feed. Problem biological growth downstream of the filters can be caused by excess methanol.

2. **High nitrite or nitrate and low organic concentrations in the filter effluent; increased chlorine demand**:

   Insufficient methanol feed is the primary cause for this deficiency. An adjustment of the methanol feed is required.

3. **High organic and low nitrate concentrations in the filter effluent**:

   Great excess of methanol feed may be the cause. n adjustment of the methanol feed is required

4. **High nitrate and high organic concentrations in the filter effluent**:

   A deficiency of denitrifiers in the filter due to excessive backwashing. Less or shorter backwashing and reseeding of the filters is recommended.

   Another possible cause is excessive high flow rate or existence of toxic material in the wastewater. A comprehensive review of the treatment plant is recommended in order to determine the appropriate remedy.

References

For additional information, refer to:

- Operations and Maintenance Manual for TETRA Denite® DeepBed™ Filtration System, Volumes 1, 2, & 3.
- Standard Methods for the Examination of Water and Wastewater, 18th Edition. Ed. by Greenberg, Arnold E., Lenore S. Clesceri, and Andrew D. Eaton. APHA, AWWA, and WEF, Washington, D.C. 1992.

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