DynaSand® EcoWash™ Filter Full Scale Test Report

City of Pompano Beach, FL

September 1, 2010

Summary

Continuously backwashing sand filters are limited by high volume of backwash water and unoptimized filter performance. Using a methodical experiment protocol spanning June-August, 2010, at the City of Pompano Beach Reuse Utilities Plant, the DynaSand® EcoWash™ Filter was compared against standard design continuous backwash sand filters.

Using two identical DynaSand® cells, one cell was converted to a DynaSand EcoWash Filter while the other cell was left in its standard setup. Sampling equipment and some modifications were installed in both cells to ensure equal conditions in order to compare relative performance.

The DynaSand® EcoWash™ Filter cell was tested with several programmed and time-controlled backwash scenarios to reduce reject/backwash production while maintaining effluent quality within guidelines. Meanwhile, the Standard Operation filter cell was tested normally with continuous backwash. All data was logged via PLC in the Control Panel and daily samples were taken and analyzed in the lab for turbidity and total suspended solids. Over the three month full scale test, the results showed a 90-95% reduction in backwash production and energy use, coupled with a 15-25% average improvement in filtrate quality.

Further testing will continue for the purposes of scientific investigation and continued data collection. We can expect to continue testing a variety of time controlled and differential pressure controlled backwash scenarios to optimize the system even further.

Background

Throughout the past three decades, DynaSand® continuous backwashing filter has been successfully applied to thousands of installations, providing quality filtrate while offering minimal operator attention and maintenance requirements. A major perception in the industry is that continuous filters like the DynaSand® Filter produce significantly more total reject (backwash) than intermittent backwashing filters. Customers desire better quality to meet legislative and effluent requirements while minimizing total reject. The cost of reprocessing excess reject is a major concern as well.

This product has been developed to

- Reduce reject/ backwash rate
- Reduce operation and maintenance costs
- Improve energy efficiency
- Improve filtrate quality

DynaSand® EcoWash™ Filter Process Description

The DynaSand® EcoWash™ Filter allows continuous operation while utilizing time programmable or head loss controlled sand circulation and washing to reduce the amount of backwash water being produced.

The DynaSand® EcoWash™ Filter uses a reliable sand movement detection system that is tied to an alarm and monitored in the control room. Through modifications to the airlift design and operation, consistent sand movement is assured. Reject (backwash) water reduction is accomplished by automatic closing of the reject line during no backwash period. The redesigned airlift employs the same air flow (when in operation) as the previous design.

Backwashing is controlled by one of the two modes shown below, chosen by the operator. The frequency and the length of time for backwashing operation can be adjusted based on individual plant's influent conditions and effluent requirements.

Differential Pressure Controlled Mode

- Inlet/outlet levels measured
- Airlift/reject starts at programmed point
- Operates until differential is reduced to either minimum point or for a set period of time
- Timer override to assure periodic sand washing

Timer Controlled Mode

- Operator programs timer
- Timer initiates sand washing
- Differential pressure overrides timer

No Backwash Operation

During this phase, the reject valve is closed and the airlift is off, allowing the filter to accumulate solids. During this cycle, progressively more solids are captured and retained in the bed, and the newer incoming feed solids will have less room to pass through as the captured solids fill the space between media particles.

This phenomenon, where captured solids in sand filter beds result in higher filtration capability, is referred to as the Schmutzdecke Effect. The airlift remains off and the reject water line remains closed by activating the pneumatic valve via the control panel. The head loss will increase during this cycle as more and more solids are captured in the bed while filtrate quality improves. When the differential pressure reaches the set point or when the timer cycle is complete, the airlift is turned on and the reject valve is opened to facilitate backwash.

Backwash Operation

During this phase, the airlift is turned on and the reject valve is opened, allowing the filter to resume media washing. At the beginning of this cycle, the reject valve opens and a dual air burst in the airlift is employed to facilitate sand movement. The Sand Movement Detection System provides feedback to the control panel to confirm proper airlift operation and sand movement. The head loss quickly begins to drop until the end of this cycle. At the end of this cycle, the airlift is turned off and the reject valve is closed to stop the backwash, based on either the differential pressure or timer controlled mode.

Test Setup & Procedure

Testing Site

The full scale testing of the DynaSand® EcoWash™ Filter was performed at the City of Pompano Beach Reuse Water Utilities, Pompano Beach, FL. The Pompano Reuse Plant is an 8.64 MGD maximum capacity tertiary filtration (DynaSand® Filter) plant. The influent passes through a bar screen and a gate valve directs the flow to each filter. Influent turbidity ranges between 3 and 6 NTU and is drawn from the Broward County North Regional WWTP effluent discharge to the ocean. The plant currently has two separate DynaSand® Filters: the North Filter and the South Filter. The North filters consists of 4 cells with 2 standard bed filters per cell, while the South filters consists of 2 cells with 8 deep bed filters per cell. The test was conducted on the first two cells of the North Filter.

Test Setup

During the testing, Cell 1 was utilized for testing the DynaSand® EcoWash™ Filter and Cell 2 was utilized as a Standard Operation cell for comparative data collection purpose. A side by side comparison of test parameters was possible in this configuration. Refer to Figure 1 for the layout of test components.

The following modifications were installed in each cell to ensure equal conditions and for comparative data collection:

- Influent channel weir boxes to ensure equal flow
- Inline turbidity meters for measuring influent and effluent conditions
- Sensors to measure influent, reject, and effluent flow rates
- Differential Pressure Monitoring

Control Panel with Turbidity Meters

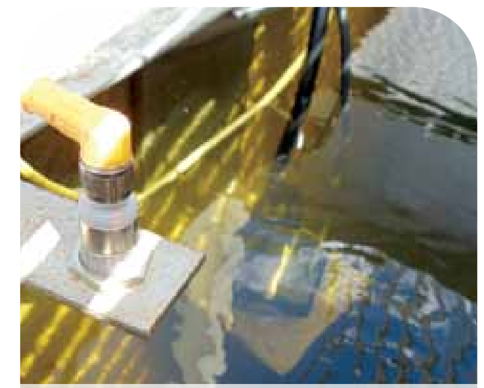
Influent Weir with Differential Pressure Monitoring

The following components were installed only in Cell 1 as part of the features of the DynaSand® EcoWash™ Filter:

- Sand Movement Verification System
- Differential Pressure Monitor
- Cell Air Control Panel
- Central Control Panel with PLC and HMI Screen
- Reject Water Reduction Control Valve
- Redesigned Airlift

Sand Movement Verification System

Reject Water Reduction Control Valve



Sensor for Flow Monitoring

Control Panel with PLC and HMI Screen

Cell Air Control Panel with Alarm

Procedure

Cell 1 (Test Cell/ DynaSand® EcoWash™ Filter) was set to run with a programmed time control backwash mode with head loss override. Cell 2 was left running normally with continuous backwash as per the standard operation of the filter. The data for influent turbidity, effluent turbidity, flow, and head loss were collected throughout the test. All turbidity, flow, and head loss values were logged continuously via Programmed Logic Controller (PLC). Flow to cells 3 and 4 were closed during these tests.

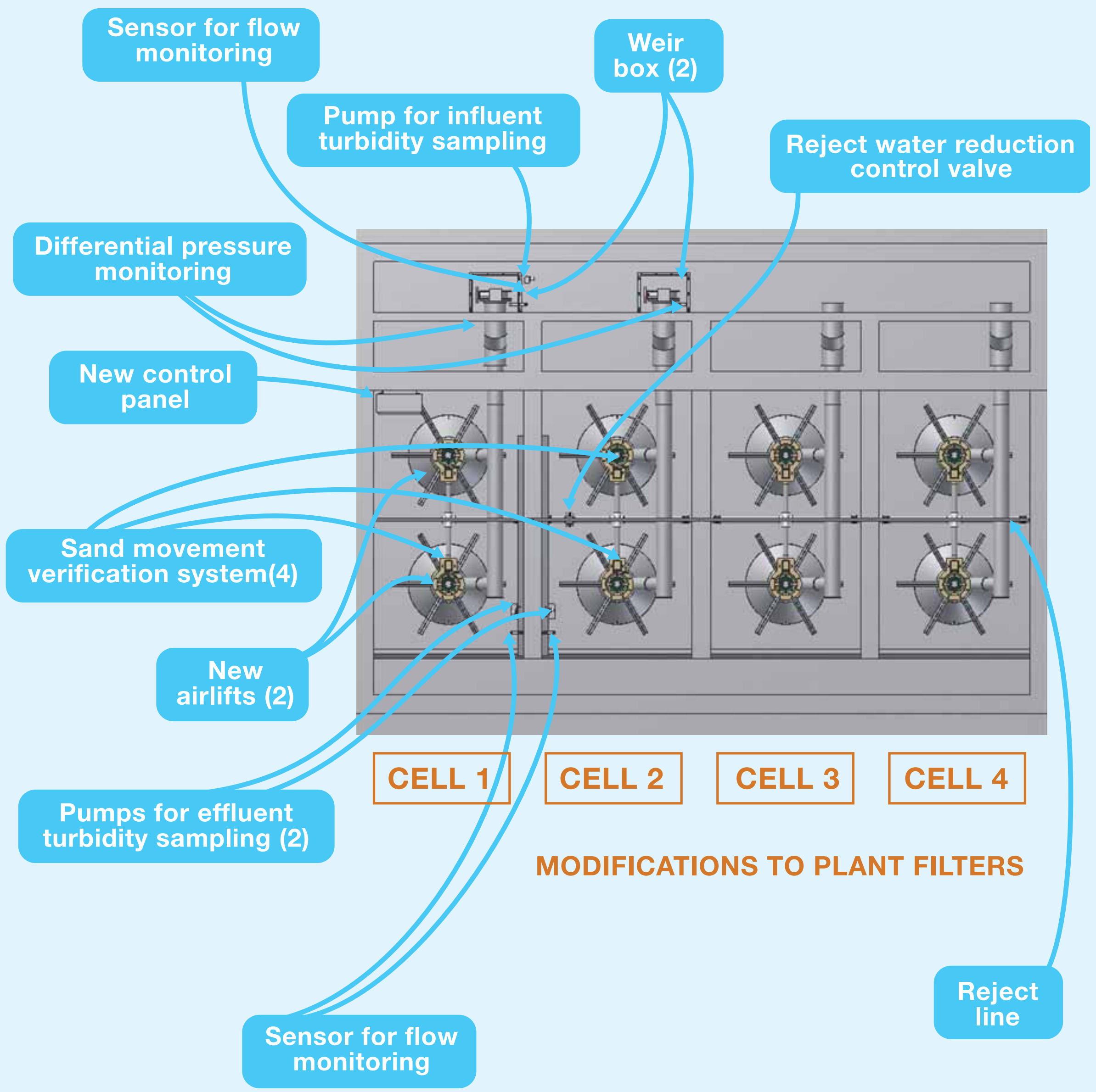
A Parkson staff member conducted the test throughout the test duration. The test was carried out only on work days by Parkson staff in the presence of a city employee on duty. The Standard Operation cell was operated in the normal mode of continuous backwashing.

In order to optimize the DynaSand® EcoWash™ Filter's performance, a systematic approach was taken to determining operational parameters such as length of time allotted to backwashing and length of time allotted to withholding the backwash process. Backwash ON and OFF times were determined based on several factors, such as influent turbidity, influent TSS, and turbidity spike characteristics.

In order to compare the performance of the different backwash modes in the test cell to the standard performance of the control cell, turbidity and total suspended solids were used as metrics. Results were compared for reduction in reject, consistency of effluent quality, and overall cost savings.

As such, turbidity, flow, and head loss were constantly monitored through in-line instrumentation and the HMI screen. Any spikes in turbidity were closely watched throughout the test duration. Daily samples of effluent were taken from both the DynaSand® EcoWash™ Filter cell and the Standard Operation Filter cell. The samples were analyzed at the City of Pompano Beach reuse facility laboratory using its established procedures for turbidity and TSS. The effluent from Cells 1 and 2 were then allowed to combine with the effluent from the South Filters and flow to a chlorine contact chamber where it would then be sent to the City of Pompano Beach as irrigation and reuse water.

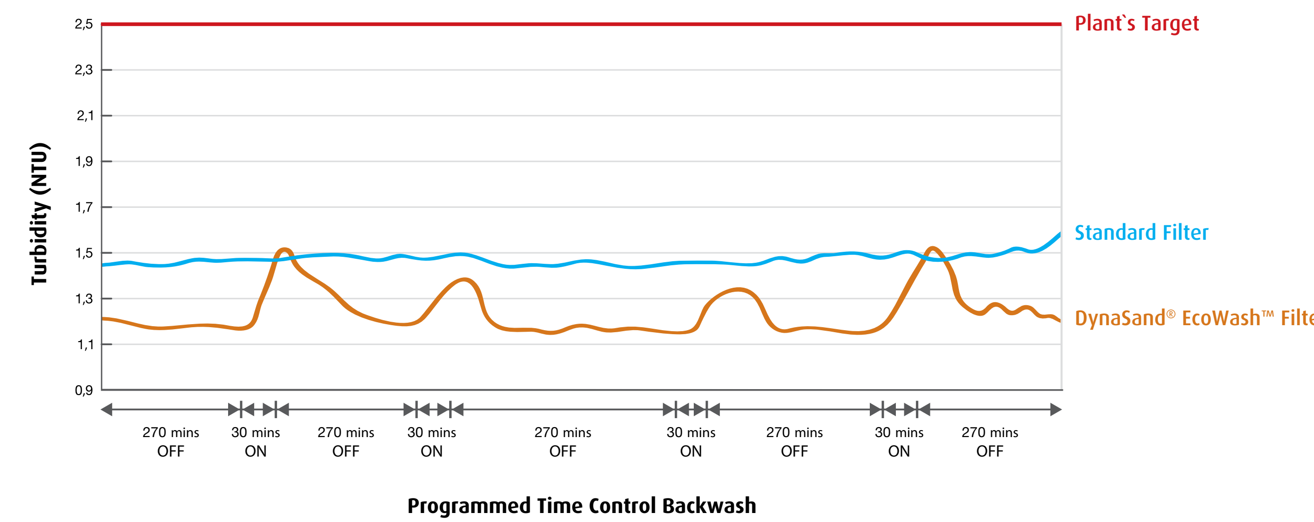
Figure 1

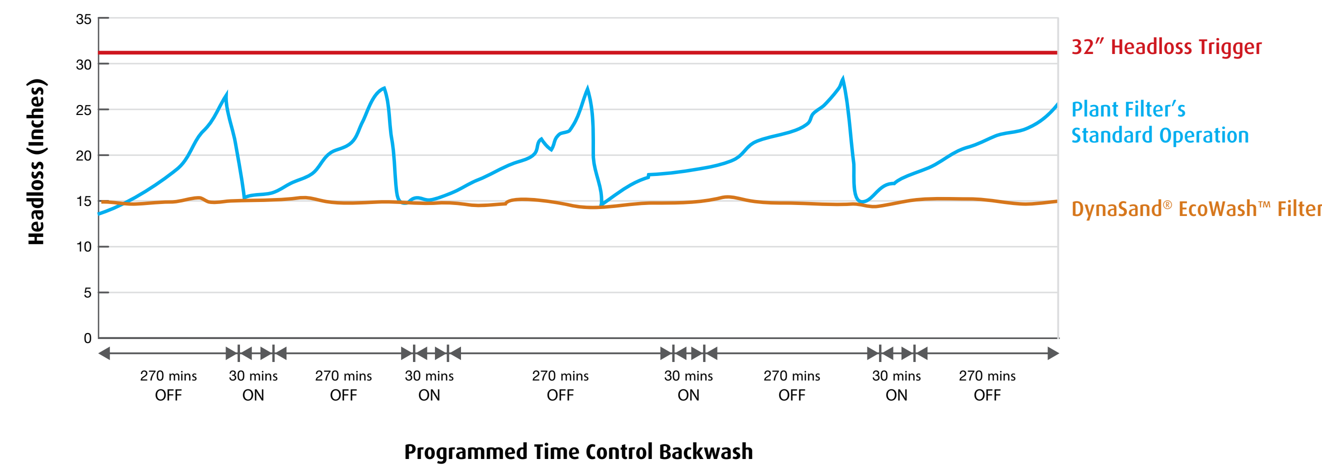


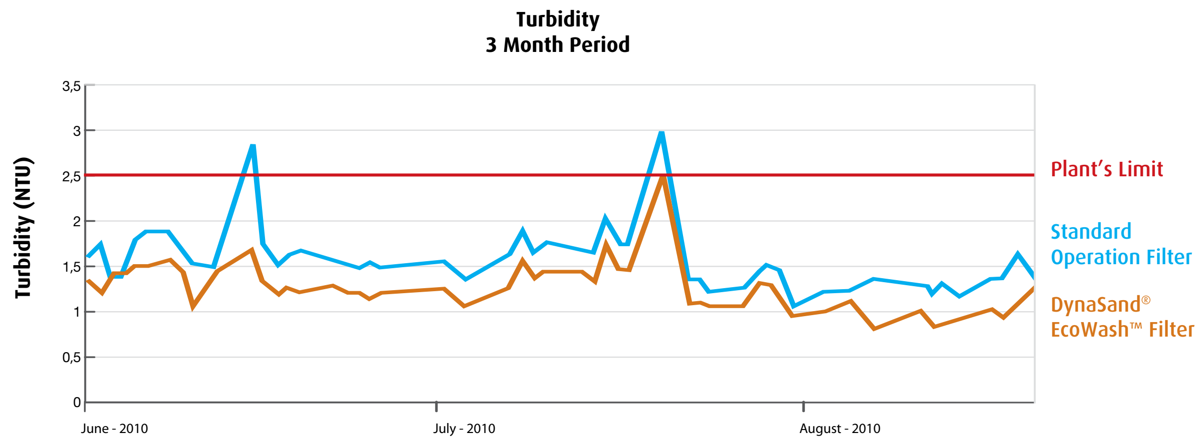
MODIFICATIONS TO PLANT FILTERS

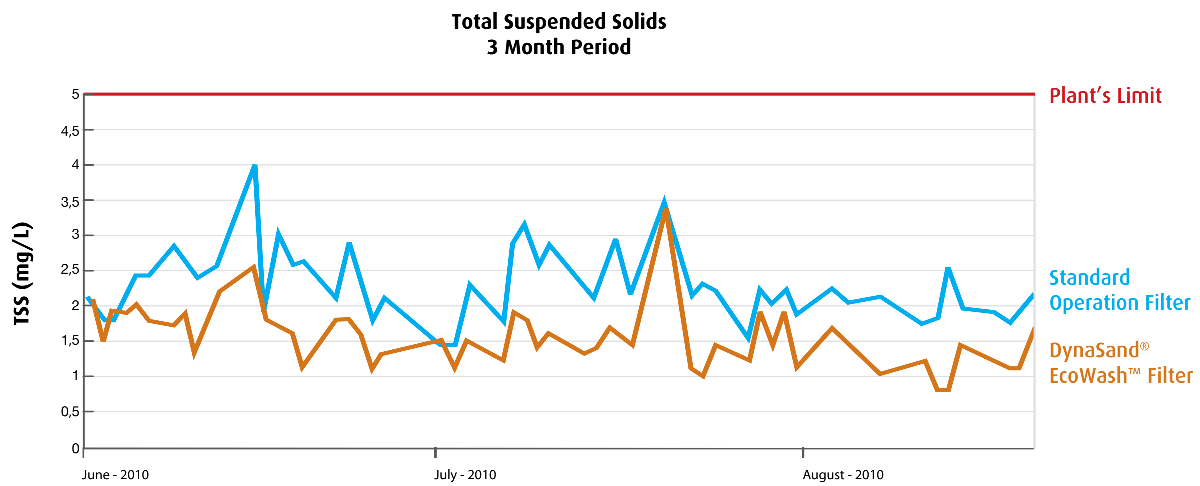
Test Results

Typical Turbidity and Headloss Profile









Analysis

Reduced Reject (Backwash)

Reject Analysis - Table 1

	DynaSand® EcoWash™ Filter	Standard Operation Filter
Total Backwash Time	30 Minutes/Cycle	300 Minutes/Cycle
Total Reject Flow	384 Gallons/Cycle	3600 Gallons/Cycle

Table 1 demonstrates that backwash time directly determines the total amount of backwash rejected. At an average rate of 12 gpm, the standard filter in constant backwash produced 3600 gallons of backwash per cycle. The DynaSand® EcoWash™ Filter backwashing only 30 minutes produced 384 gallons of backwash water during the same time period. This 90% reduction in backwash time corresponds with about 90% reduction in backwash volume.

Cost Savings

The backwash reduction and power consumption reduction offered by the DynaSand® EcoWash™ Filter has tremendous implications in large scale plants, such as the City of Pompano Reuse Plant, as shown in Table 2.

Furthermore, the DynaSand® EcoWash™ Filter requires significantly less energy to operate due to its intermittent use of the plant's air compressor. The following table illustrates the savings using airlift operating time as a basis for calculating the cost associated with running the air compressor.

Typical Savings for 16 Module - 5.76 MGD Capacity Plant - Table 2

Size	800 SqFt
Loading Rate	3.5 gpm/SqFt
Annual Total Flow, gallons	1472 million
Reject Flow @ 10 gpm/50 SqFt module	84 million
90% Reject Savings Flow, gallons	75.6 million
Reprocessing Savings @ $2.77/1000 gallons	$209,512
Additional Revenue from Increased Filtrate Sales @ $1.69/1000 gallons	$127,764
Total Value/Year	$337,276

Air Compressor Power Consumption -

Table 3 – Typical Savings for 5.76 MGD Capacity Plant

	DynaSand® EcoWash™ Filter Test Cell	Plant Filter's Standard Operation Cell
Annual Power Consumption	13,100 kW•h *	131,000 kW•h *
Annual Power Consumption Cost	$985**	$9,850**

*Based on 20 HP Air Compressor
**Average Florida Industry Cost - $.075 per kW•h

Effluent Quality

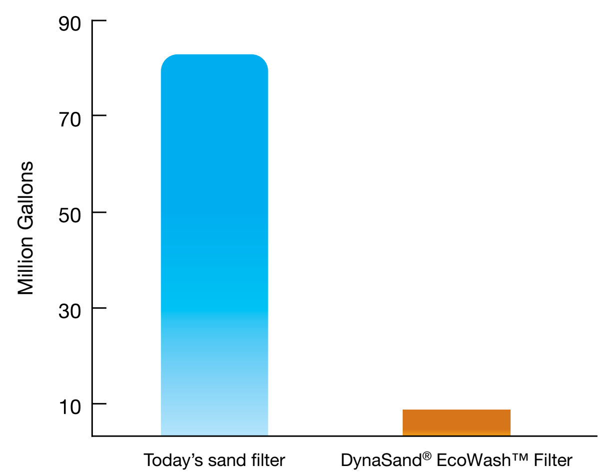
The results show a clear performance improvement in the DynaSand® EcoWash™ Filter Test Cell over the Standard Operation Cell, both in terms of filtrate turbidity and total suspended solids. The previous table illustrates the relative performance enhancement achieved using the DynaSand® EcoWash™ Filter. All of the filter effluent produced over the three month period was suitable for reuse purposes and was distributed to the City of Pompano Beach for irrigation use.

It is worth noting that the Standard Operation cell's filtrate exceeded the 2.5 NTU turbidity limit of the Pompano Reuse Plant twice during this three month test. This indicates the possibility of several thousand gallons of filtrate lost by the plant going into complete effluent reject, due to high turbidity. On the other hand, the DynaSand® EcoWash™ Filter never once exceeded the 2.5 NTU limit for the Pompano Reuse Plant during testing. This is important since a significant amount of reject produced every year is directly caused by effluent rejection due to turbidity exceeding the Pompano Reuse Plant's limit. The DynaSand® EcoWash™ Filter would have not have caused any effluent to be rejected during this test period.

Conclusion

The test results speak to the DynaSand® EcoWash™ Filter's proven performance in full scale installations by demonstrating reliable operation with significantly reduced backwash production and energy expenditures without suffering in effluent quality. Through this full scale test at the City of Pompano Beach Reuse Utilities, the DynaSand® EcoWash™ Filter has shown to drastically reduce backwash and energy consumption, while increasing overall filtrate quality and capacity.

Annual reject water production



This table gives the annual reject water production for a typical 16 Filter (50 SqFt) – 5.76 MGD capacity facility with standard sand filters as compared to the DynaSand® EcoWash™ Filter.

The DynaSand EcoWash Filter will consistently produce higher quality effluent on average despite slight spikes in turbidity of a backwashing cell, if any. The cumulative effect of several cells running simultaneously but with staggered backwash times guarantees that the individual contribution of one cell will be diminished by the combined high quality effluent of neighboring cells.

Another very important factor to consider is the relative ease of use for operators when it comes to maintenance and troubleshooting. With the built in Sand Movement Verification System, the operator will never be in doubt as to the proper working condition of every airlift in the DynaSand® EcoWash™ Filter. Furthermore, since the airlift is only in operation intermittently, the life of the airlift and the air compressor system are increased significantly.

Testing at the City of Pompano Beach Reuse Facility will continue for the purposes of scientific investigation and the continued collection of data for Parkson's internal information. We can expect to continue testing a variety of time controlled and differential pressure controlled backwash scenarios to optimize the system even further.

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