Pennsylvania AWWA
American Water Works Association

Optimizing Performance of Granular Media Filters: How to Maintain and Operate

Prepared and Presented by Hollie Scott of AWI

What Kinds of Filters Are We Talking About?

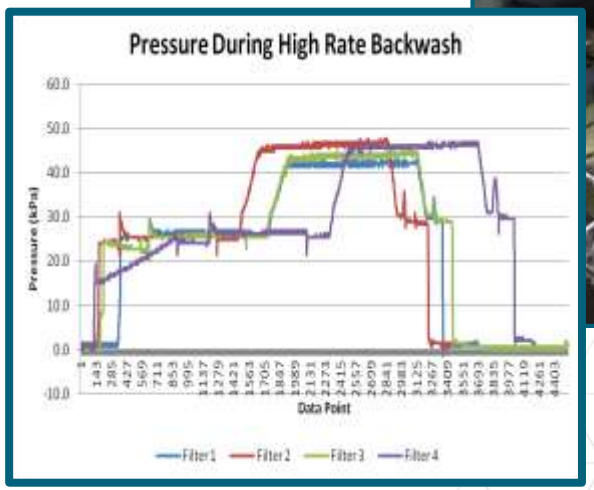
- For the purposes of this discussion, a granular media filter is a box of any shape with filter underdrains, troughs, and media that can be cleaned
  - Clarified water from a clarifier, groundwater under the influence, or source suitable for direct filtration enters a granular media filter
  - Water flows through a predetermined depth of granular media – typically some combination of sand, anthracite, and granular activated carbon (GAC)
  - Typical filter loading rates are 2 to 6 gpm/ft^2 (up to 10 gpm/ft^2 for GAC)
  - Some chemical dosing may take place prior to filtration to enhance the process
  - Water leaves the filter and goes into a clearwell ready for distribution or to be used backwashing to clean the filer

A Couple of Questions

- How many people in the audience work at facilities that use granular media filtration (as opposed to perhaps membranes)?
- I won't embarrass anyone by asking if your filtered water has ever not met standards but that is a fairly common occurrence – just ask Flint
- Who uses surface sweeps for filter cleaning?
- Who uses air scour for filter cleaning?
- What kinds of problems have you encountered?
- You aren't alone, just for fun try Googling the words "filter underdrain failure"

Observe and Record - Surveillance

- Filter operations should be proactive not reactive
- Filter surveillance is an ongoing process through which filter data is collected and compared with previous records



How Do You Assess Granular Filter Media Health?

1. Start by documenting the filtration system and its operating parameters
2. Routinely record and review system operating performance
3. Check backwash data and make observations during backwashing
4. Drain filters for inspection (occasionally inspect the filter media surface prior to backwashing)

What Issues Are You Looking for in Your Filters?

- A distressed filter media bed
- Loss of effective filter area
- Shortened filter run times
- Long filter ripening periods
- Inability to meet standards day in and day out
- Increasing clean bed headloss
- Shortened filter media "life"

1. Documenting the Filters

Everyone benefits when you document your starting point as a baseline

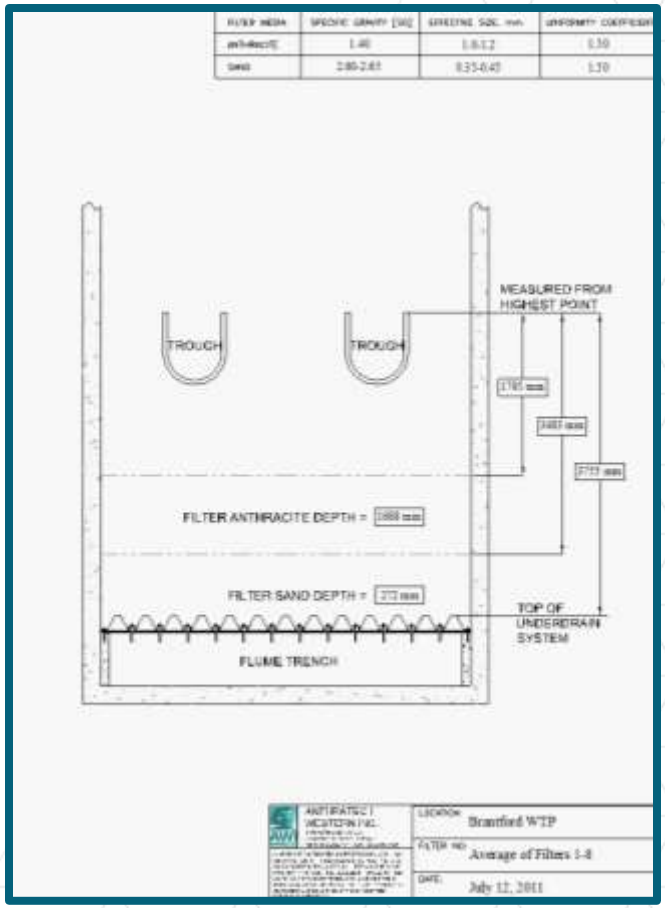
Information to Record - a Filter Data Sheet

- Facility characteristics (including pretreatment information)
- System flow rates
- Type of filters
- Size of filters
- Number of filters
- Filter internal design
- Backwash procedure

Parameter	Filter System
Influent Water Source	Surface Water
Filter Type	Open Top Gravity
Underdrain Type	AWI Phoenix
Filter Media Design	Dual-media
Number of Filters	8
Number of Cells per Filter	1
Filter Length	25 feet
Filter Width	10 feet
Area per Filter Bed	250 square feet
Total Filter Area	2,000
Typical Filter Loading Rates	
Loading Rate per Filter	1,000 – 1,100 l/min

Filter measurements

- Freeboard
- Effective freeboard
- Backwash trough dimensions
- Actual installed depth of filter media
- Total filter depth
- Confirm drawing measurements



A Filter Media Description

Filter Media Summary						
Filter #	Filter Anthracite			Filter Sand		
	E.S. (mm)	U.C.	Depth, mm	E.S. (mm)	U.C.	Depth, mm
Original Specifications	1.0-1.1	<1.50	600	0.45-0.55	<1.50	300
As Supplied	0.95	1.55		0.53	1.42	
As Installed						
Filter #1	0.95	1.52	605	0.60	1.31	305
Filter #2	1.02	1.46	580	0.57	1.29	305
Filter #3	1.06	1.38	590	0.49	1.47	295
Filter #4	1.00	1.50	605	0.54	1.34	290
Average	1.01	1.47	595	0.55	1.35	299

2. Record and Review Performance

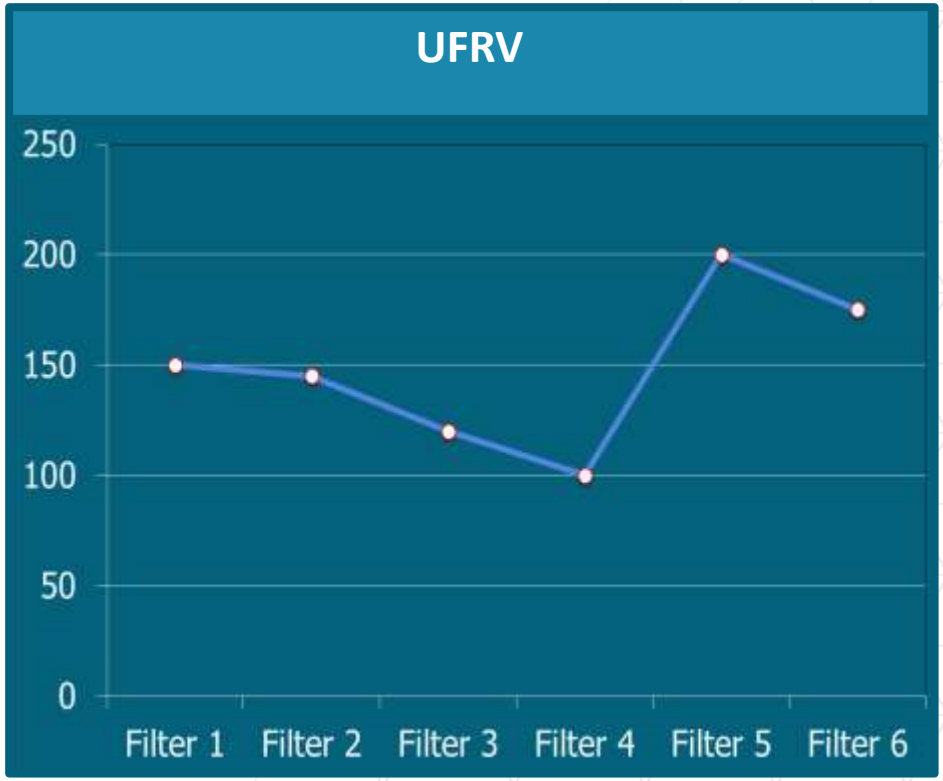
Accurate record keeping is an integral part of maintaining a filter

Filter Operating Parameters to Record and Review

- Influent and effluent quality
- Backwash frequency
- Backwash trigger
- Clean-bed head loss
- Backwash system pressure
- Air-scour system pressure
- Unit filter run volumes

Key Parameter – Unit Filter Run Volume (UFRV)

- UFRV – the volume of water filtered between backwashes
- Backwash initiated based upon:
  - Time
  - Headloss
  - Turbidity breakthrough

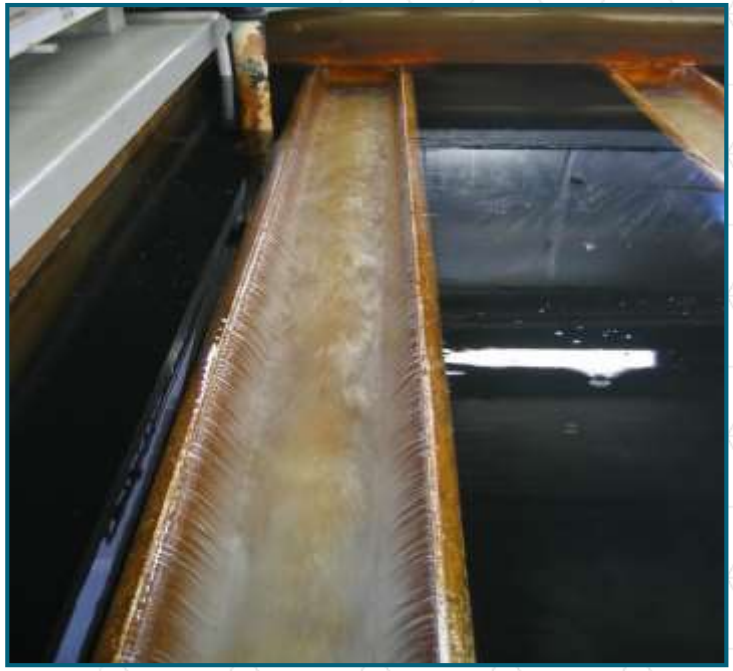


3. Observe During Backwashing and Check Backwash Data

Effective cleaning (backwashing) of the filter media is required to sustain the filtration process

What should You Observe?

- Look at cleaning patterns
- Observe backwash collection patterns
- Note air scour distribution
- Watch for filter media loss
- Review design operating procedures and confirm actual flow rates
- Record data and make general observations that can be saved for comparison later



Develop a Template to Record Data and Observations

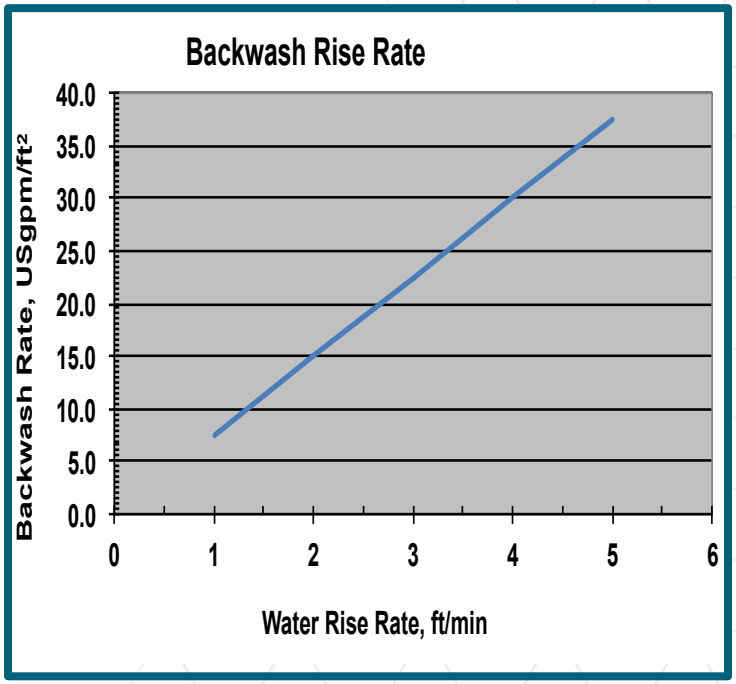
- A template should include:
  - Backwash procedure
  - Backwash duration
  - Backwash observations

Filtration Process Recovery Steps (backwash)			
Step	Flow Rate	Duration, minutes	Observations
Filter Drain Down			
Air Scour			
Refill & Air Venting			
High Rate BW			
BW Pressure			
Filter to Waste			
Total Time			

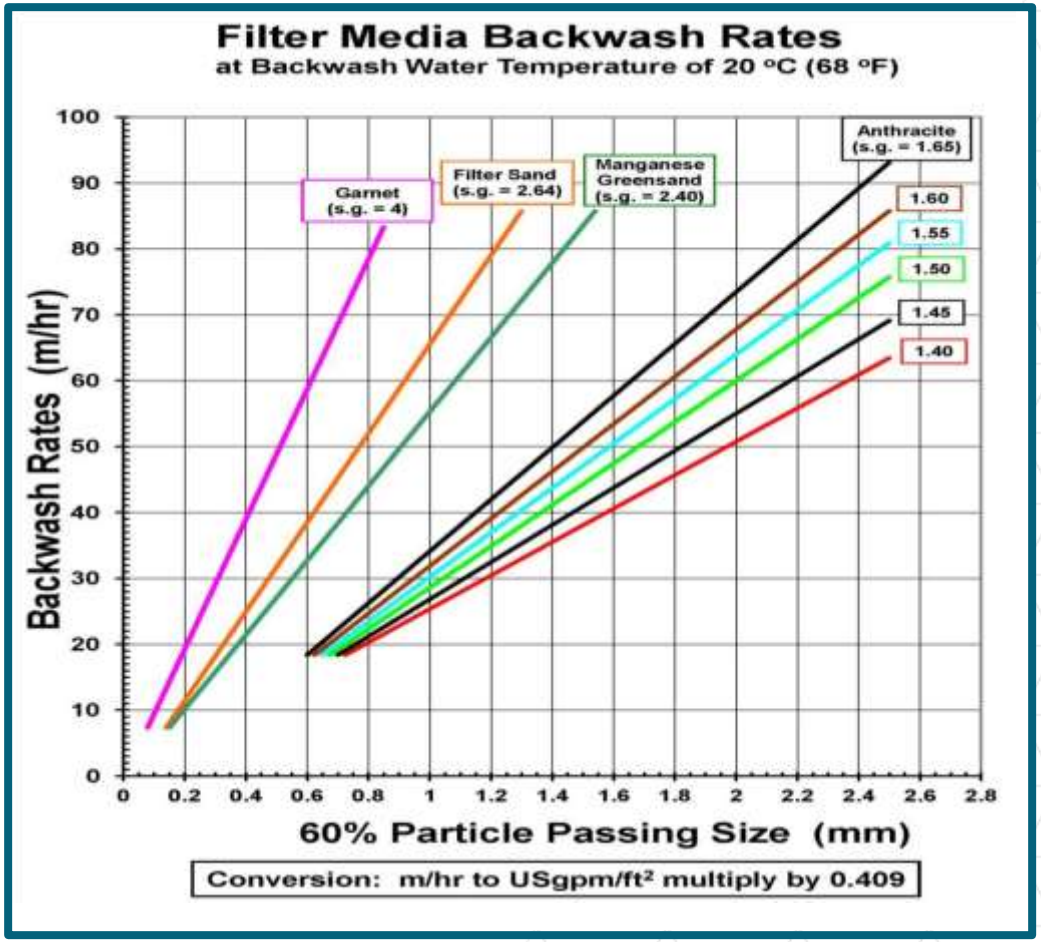
Note: This table is presented as an example only - backwash procedures are site specific and a template to record the data should be developed by the plant operating staff.

Confirm the Filter Backwash Rate

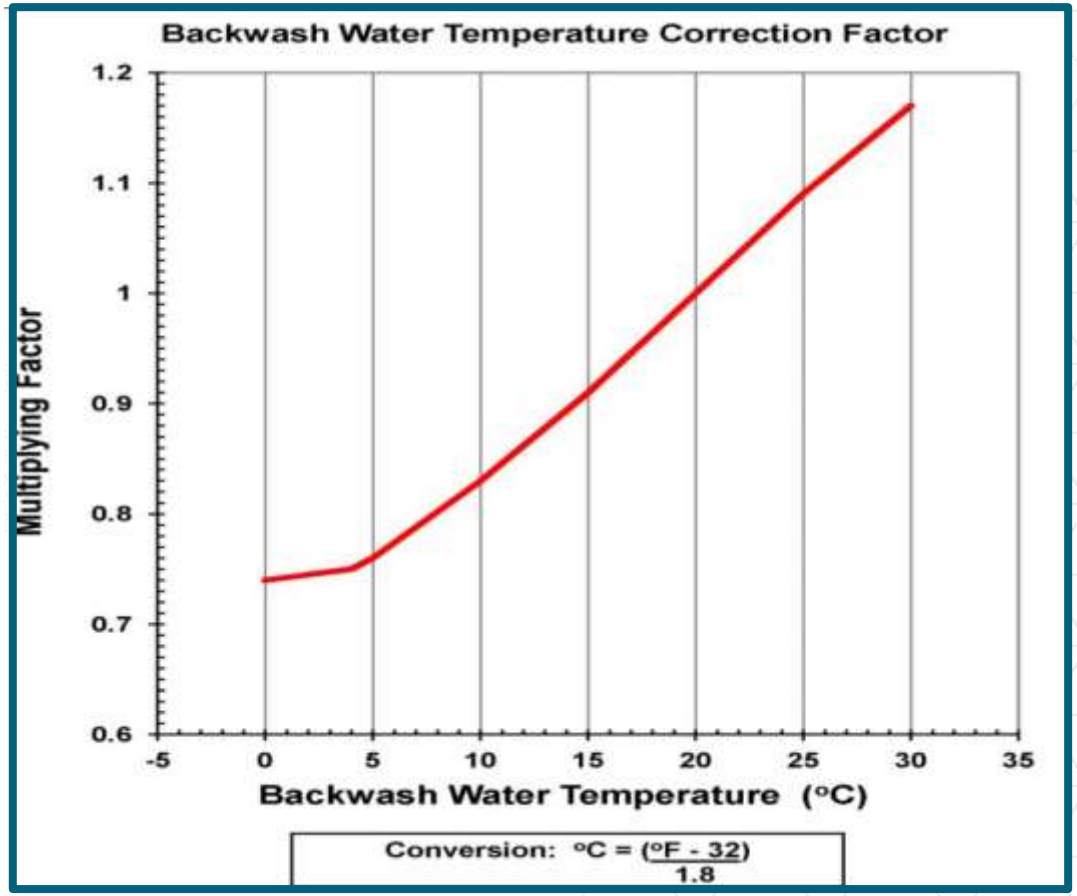
- As simple as using a tape measure and stop watch to determine the rate at which the level rises during backwashing
- An appropriate backwash rate depends upon:
  - Filter media size and density
  - Backwash water temperature
  - The backwash rate must be high enough to restratify media like sand, filter coal, and granular activated carbon based upon particle size and specific gravity



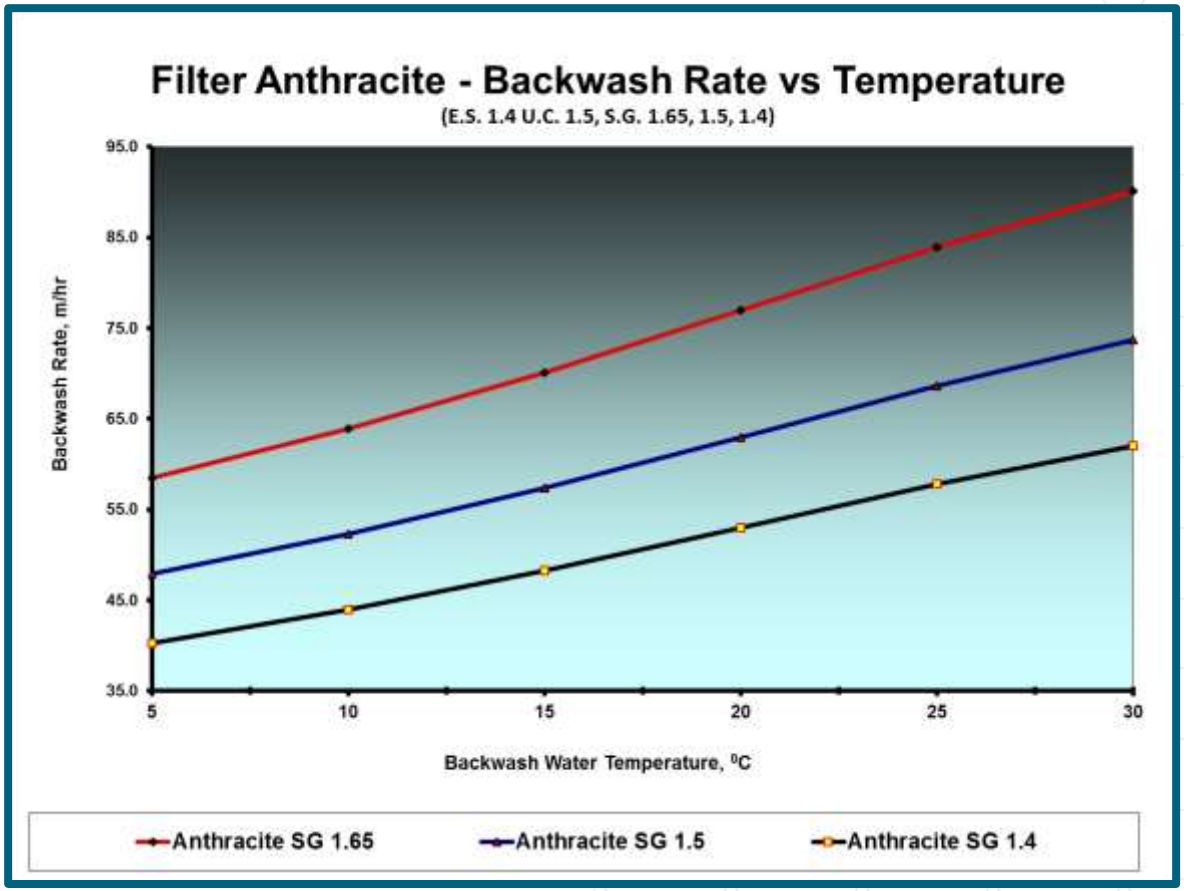
Effect of Filter Media Particle Size and Density



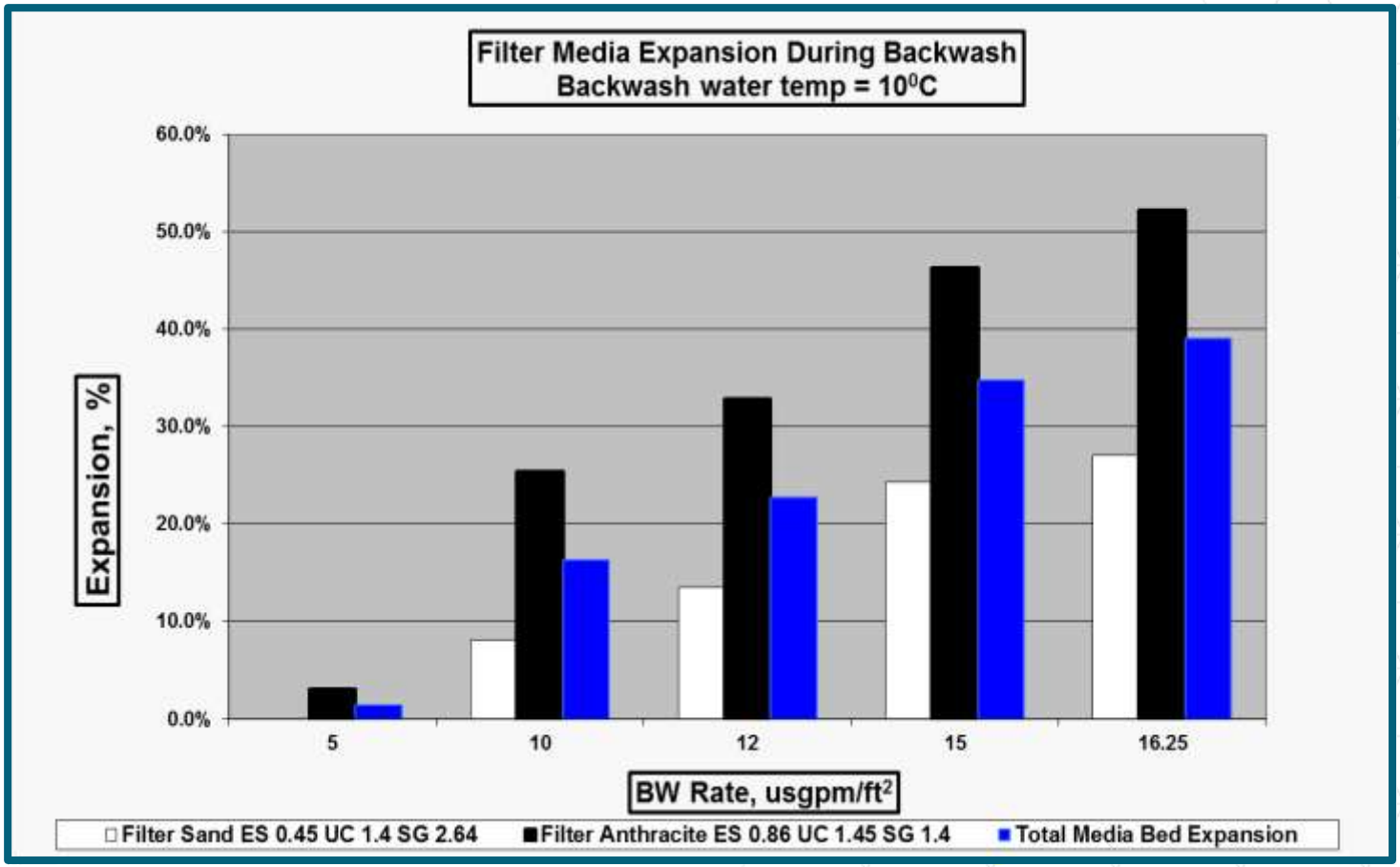
Effect of Water Temperature



Example – Impact of Temperature On Backwash Rate for Anthracite



Filter Media Bed Expansion During Backwash



Develop a Backwash Turbidity Profile

- What does it tell you:
  - How effective are your backwash procedures?
  - How long should your backwash duration be>
  - What should your turbidity end point be?

BW Time, minutes	BW Water NTU
1	600
2	350
3	150
4	75
5	15
6	4.5
7	2.5
8	2.1
9	2.0

Check and Record Backwashing Pressures

- Record pressures routinely
- Include both the flowrate and the temperature
- An increase in pressure indicates fouling or plugging
- A significant increase requires immediate attention

	Pressure, psi
Backwash pressure with new underdrain only, no filter media	10
Backwash pressure with new underdrain and filter media installed	10.5
Backwash pressure alarm	15
Immediate shutdown of backwash pump	17
Failure of underdrain system	23

4. Do a Periodic Thorough Filter Inspection

Simple observation can sometimes result in substantial savings

What Are the Elements of a Filter Inspection?

- Examine the filter media surface
- Take freeboard measurements
- Check the filter media depth
- Sample the filter media
- Excavate and look at the filter internal condition

Drain the Filter Prior to Backwashing and Observe the Media Surface

- The media surface should be level both before and after backwashing
- The media surface should be free of filter cracks
- There should be no visible mudballs

Measure the Filter Freeboard

- Measure from the filter surface to a reference elevation at multiple points around the filter
- Most often used reference is the top of the troughs
- Note that the "true" or "effective" freeboard is measured to the bottom of the troughs

Core the Filter Media to Get Representative Samples

- Coring gives an accurate view of media depth and variation
- Coring can be used to obtain samples for further analysis
  - Assess media cleaning effectiveness
  - Determine if media has degraded
- Coring helps assess the stratification achieved during backwashing

Note: The frequency of filter media sampling for the purpose of media analysis is site specific and likely infrequent.

Excavate the Filter Media

- Excavation is an effective way to determine media depth and obtain representative samples
- Excavation is labor intensive and may require moral support from fellow workers
- Excavation will be needed to get to the filter underdrain system in order to examine it

Inspect the Filter Underdrain System

Note: Proceed with caution as certain underdrain types can easily be damaged.

Inspect All of the Components Associated with the Filters

Want to Be Successful Operating Filters Long Term?

Be Proactive Not Reactive!

- Document and understand your filtration system
- Record and review performance
- Observe backwashing carefully
- Inspect the entire system routinely

Questions? Comments? What Do You Think?