

Filter Media Replacement: Theory and Practical Experience

2015 AWWA-PNWS Section Conference

April 30, 2015

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Agenda

- Basics of media specifications
- Regular monitoring and testing
- Media replacement decisions
- Operational and water quality considerations

...using Seattle's Tolt Water Treatment Facility as an example

Media Specifications

- Type
 - Sand, anthracite, garnet, other
- Depth
- Size characteristics
 - Effective size, ES
 - Uniformity coefficient, UC
- Other
 - Density
 - Hardness
 - Acid solubility

Tolt Media Specification

Monomedia anthracite

- Effective size, ES = 1.3 mm
- Uniformity coefficient, UC = <1.4
- Specific gravity = 56 psf
- Hardness = 3-4 on Mohs scale
- Acid solubility = <1%



Tolt Media Depth

- Generally, more media depth = more robust operation of filter
 - Less sensitive to temperature, turbidity, flow changes
- Original design for 60-in depth, at 10 gpm/ft²
- Revised design for 72-in depth, at 12 gpm/ft²
 - Saved construction \$

Regular Monitoring

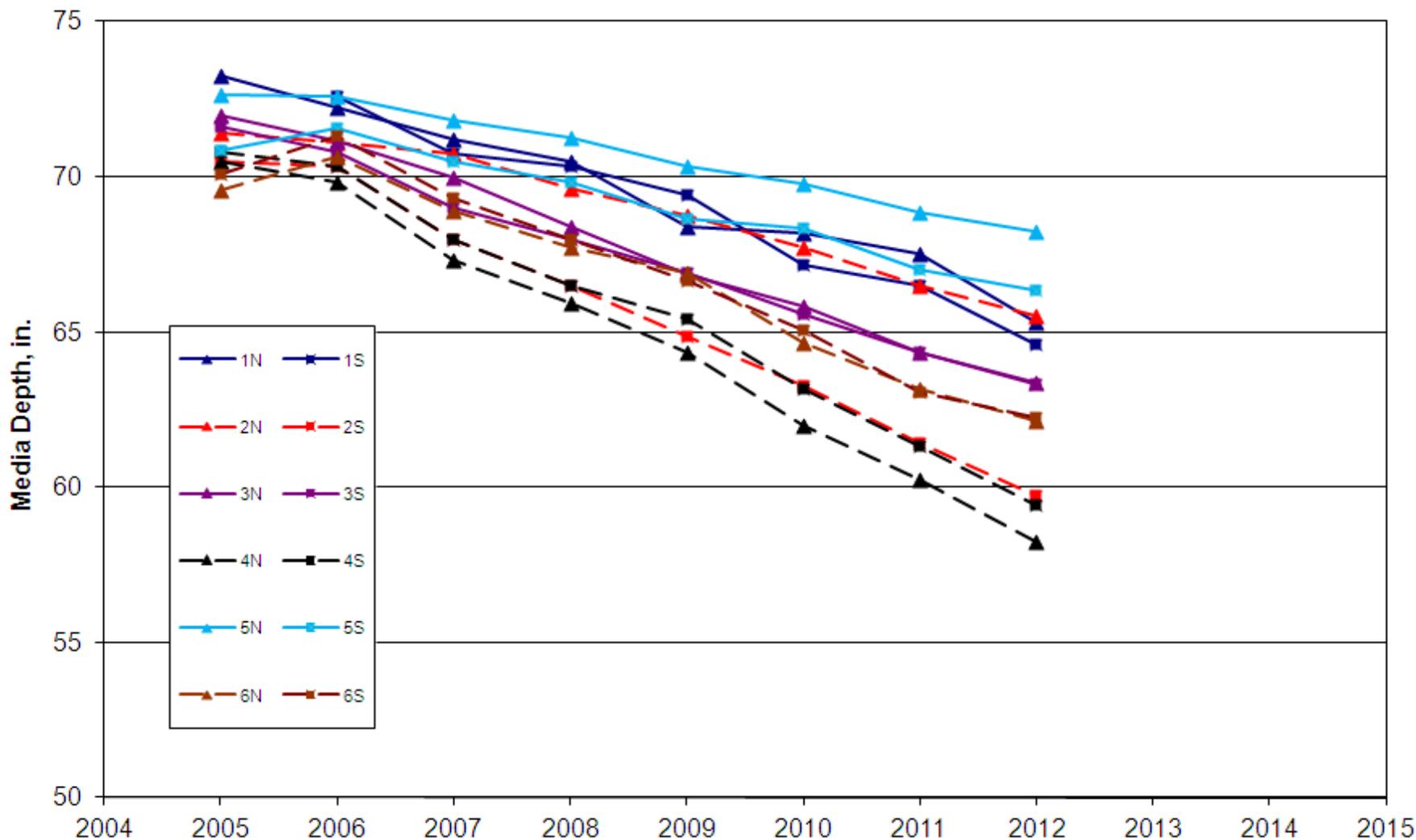
- Measure depth
 - Relative to bottom (don't damage underdrains!)
 - Relative to fixed elevation (e.g. top of wall)
- Core samples at various depths
 - Sieve analysis for ES and UC
 - Microscopic exam for angularity, biological, chemical
 - Floc retention profile
- Don't forget other filter inspection and maintenance!



Filter Media Loss

- Granular media filters lose media via backwash
 - Target <3-5%/yr losses
 - Optimize backwash if loss is excessive
 - Tolt ~1-2%/yr
- Media breaks down over time, finer particles migrate to top during backwash
- Replace:
 - Lost media
 - Excessively broken-down media

Tolt Media Depth (by filter half)



Sieve Analysis

- Done by laboratory
- Run media samples through sieves of different sizes and weigh portion that passes each sieve
- Graph results

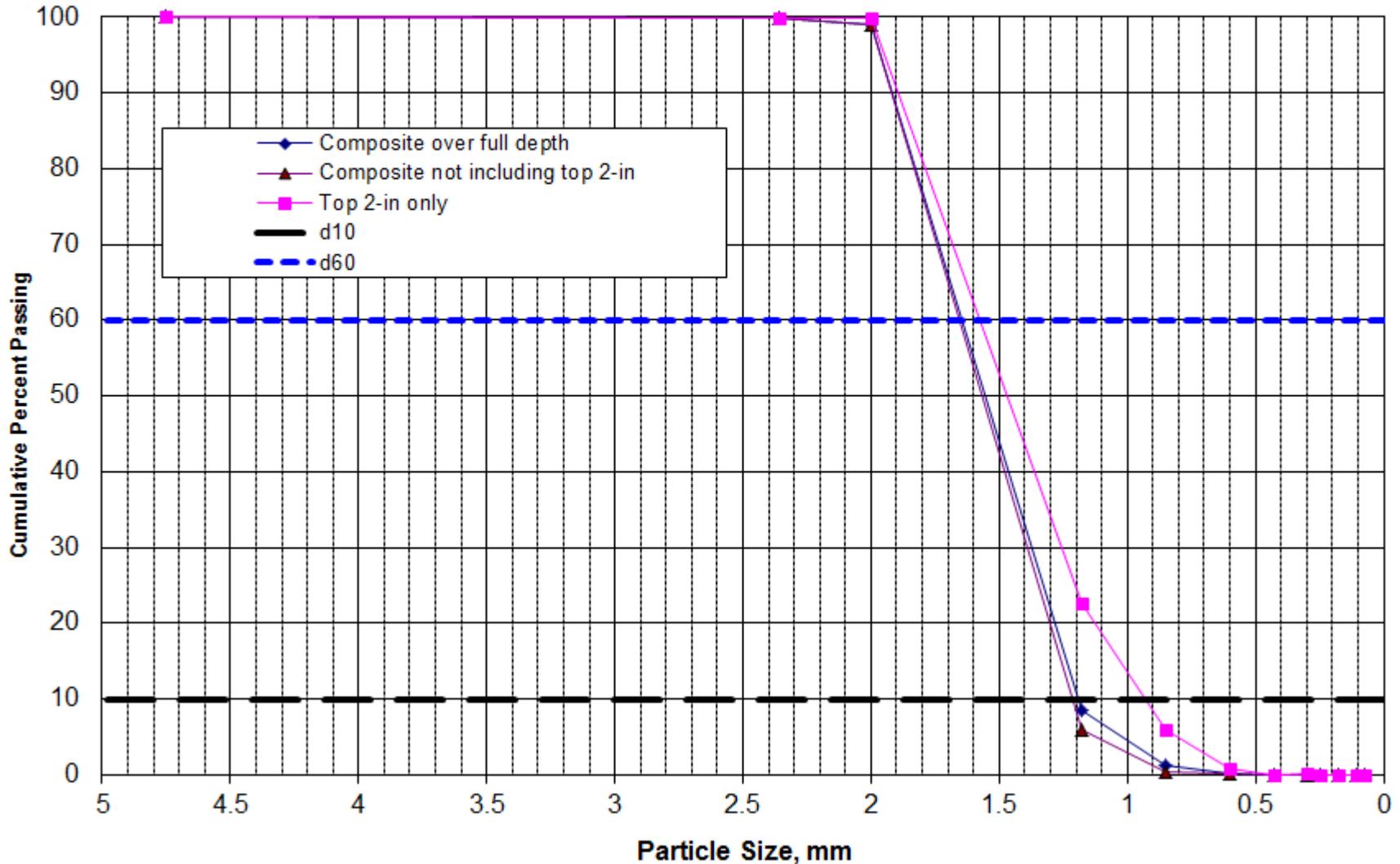


Sample Sieve Analysis

| Filter #5 | 2012 sample | (Samples taken after backwash) | | |
|-----------|-------------|--------------------------------|----------------------------------|---------------|
| Sieve # | Size, mm | Percent Passing | | |
| | | Composite over full depth | Composite not including top 2-in | Top 2-in only |
| 4 | 4.75 | 100.0 | 100.0 | 100.0 |
| 8 | 2.36 | 99.9 | 100.0 | 99.9 |
| 10 | 2 | 99.0 | 99.1 | 99.9 |
| 16 | 1.18 | 8.5 | 6.0 | 22.6 |
| 20 | 0.85 | 1.2 | 0.4 | 5.9 |
| 30 | 0.6 | 0.1 | 0.1 | 0.8 |
| 40 | 0.425 | 0.0 | 0.0 | 0.0 |
| 50 | 0.3 | 0.0 | 0.0 | 0.1 |
| 60 | 0.25 | 0.0 | 0.0 | 0.0 |
| 80 | 0.177 | 0.0 | 0.0 | 0.0 |
| 140 | 0.106 | 0.0 | 0.0 | 0.0 |
| 200 | 0.075 | 0.0 | 0.0 | 0.0 |

Sample Sieve Analysis Graph

Tolt TF - Filter #5 Media Analysis (2012)



Sample Sieve Analysis

| | d10 | d60 | ES = d10 | UC = d60/d10 |
|------------------------|---------|-----|------------|--------------|
| <i>Original Spec</i> | | | 1.3 mm | <1.4 |
| Composite | 1.2-1.3 | 1.7 | 1.2-1.3 mm | 1.3-1.4 |
| Composite w/o top 2-in | 1.2-1.3 | 1.7 | 1.2-1.3 mm | 1.3-1.4 |
| Top 2-in only | 0.95 | 1.6 | 0.95 mm | 1.7 |

Media Replacement Decisions

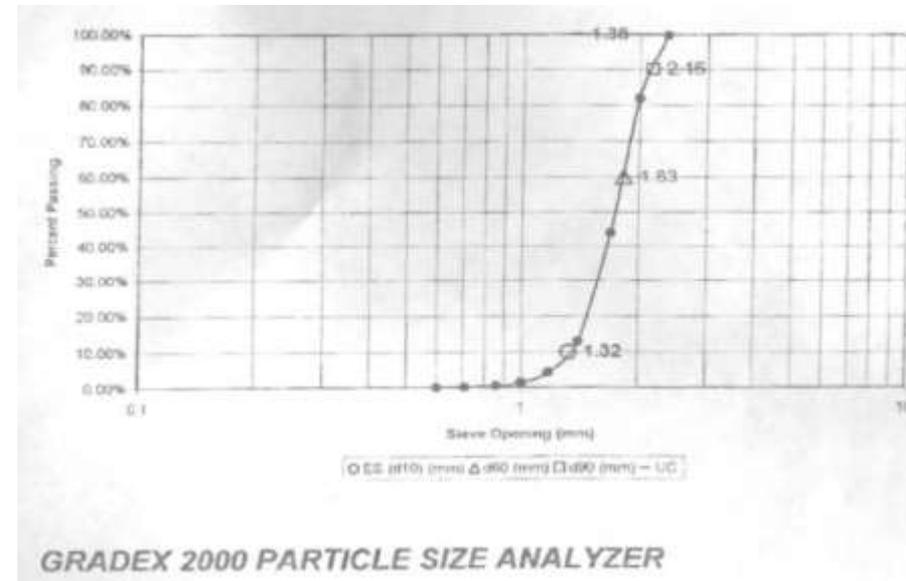
- Use results of monitoring to determine scope of replacement
 - Skim top few inches?
 - Top off?
 - Chemical cleaning?
 - Replace all media?
- Consider operational and water quality issues
 - Sequencing filters
 - Adequate “cleaning backwash” flow
 - Discharge of backwash water

Tolt Scope of Work

- No need to replace media except for top 2-in
- No need for chemical cleaning
- Top-off lost media
- Add media to lowest 3 of 6 filters
 - Lowest filters typically run less effectively, especially in challenging treatment conditions
 - About \$160,000 for 3 filters
 - Will top-off other 3 filters at a future date

Media Spec

- Original vendor proposal
 - ES = “1.0 - 1.3 mm”...???
 - Changed to 1.3 mm and UC <1.4
- Tested samples, sieve analysis
 - ES tested at 1.3 mm
 - UC <1.4



Steps per Filter

- Backwash filter and take out of service
- Skim fines off top and dispose
- Add media in “lifts”
- Backwash with water to level out media and wash out fines
- Skim fines again and dispose
- Backwash with air scour then water
- Fill filter with water, add hypochlorite to disinfect, give contact time
- Drain filter to 1-ft above media, then air scour to agitate media
- Backwash
- Put filter into normal operation

Backwash filter and take O/S

- Filter shown after backwash



Skim fines off top and dispose

- Use flat headed shovels to skim off top layer
- Bucket fines out of filter bay



Skimmed media ready for disposal



Add media

- Media added from 1-ton supersacks
- Media either physically dumped into filter beds or educted with water
 - Water came from utility water pump, with a backflow preventer
 - Supersacks loaded into hopper, dumping into water stream with eductor
- About 30 supersacks per filter

Add media: eductor

Water Supply



Injector (under hopper)



Add media: eductor



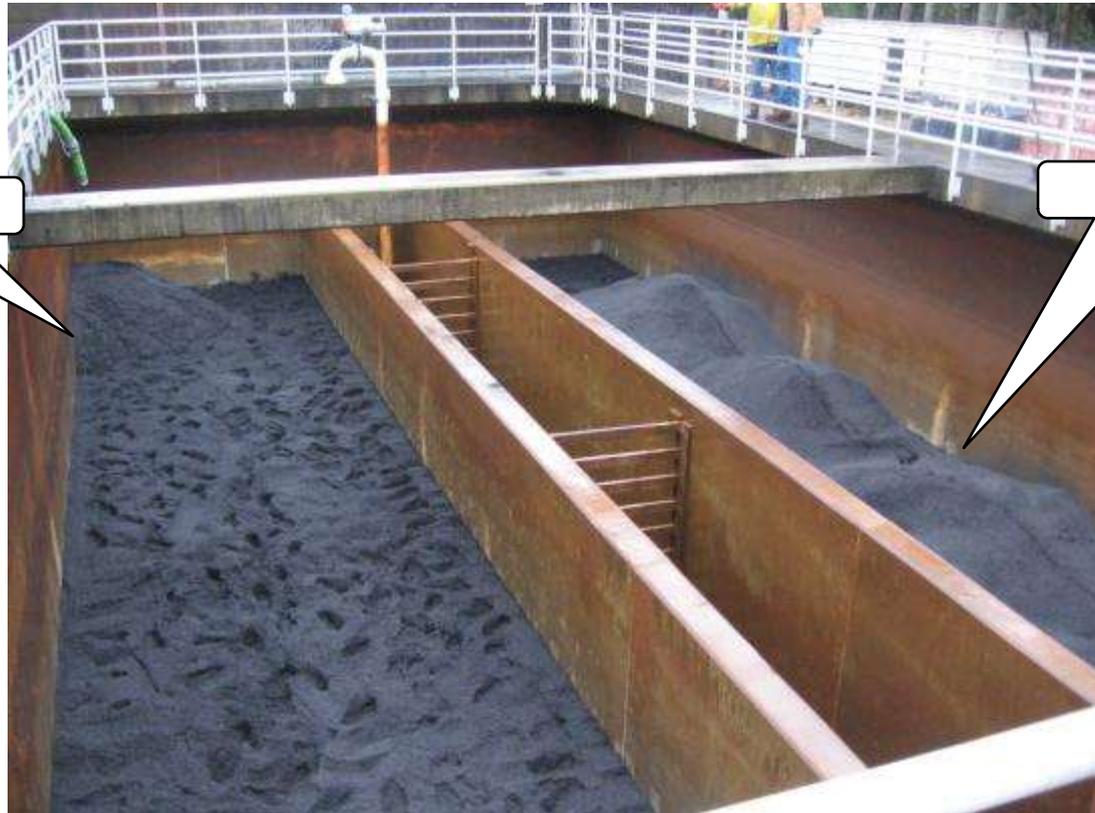
Add media: bag dump

- Only one filter half within forklift's reach



Add media

- Filter 6 south (bag dump) and north (eductor)



Filter 6 North

Filter 6 South

Backwash with water to level out media and wash out fines



Backwash with water to level out media and wash out fines

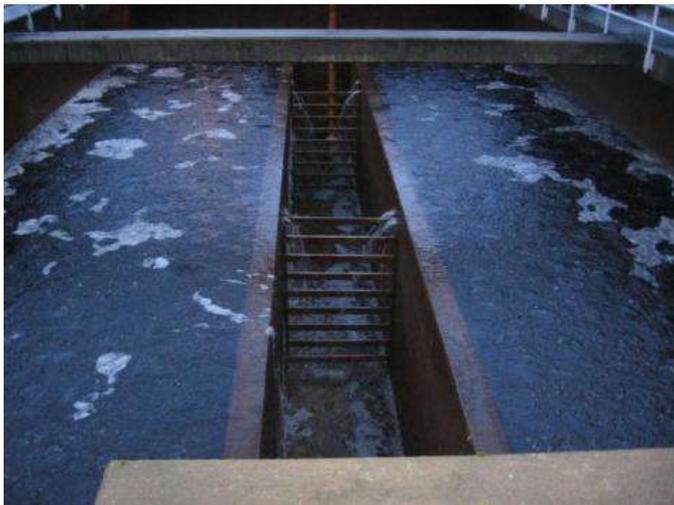
- Filter shown after backwash



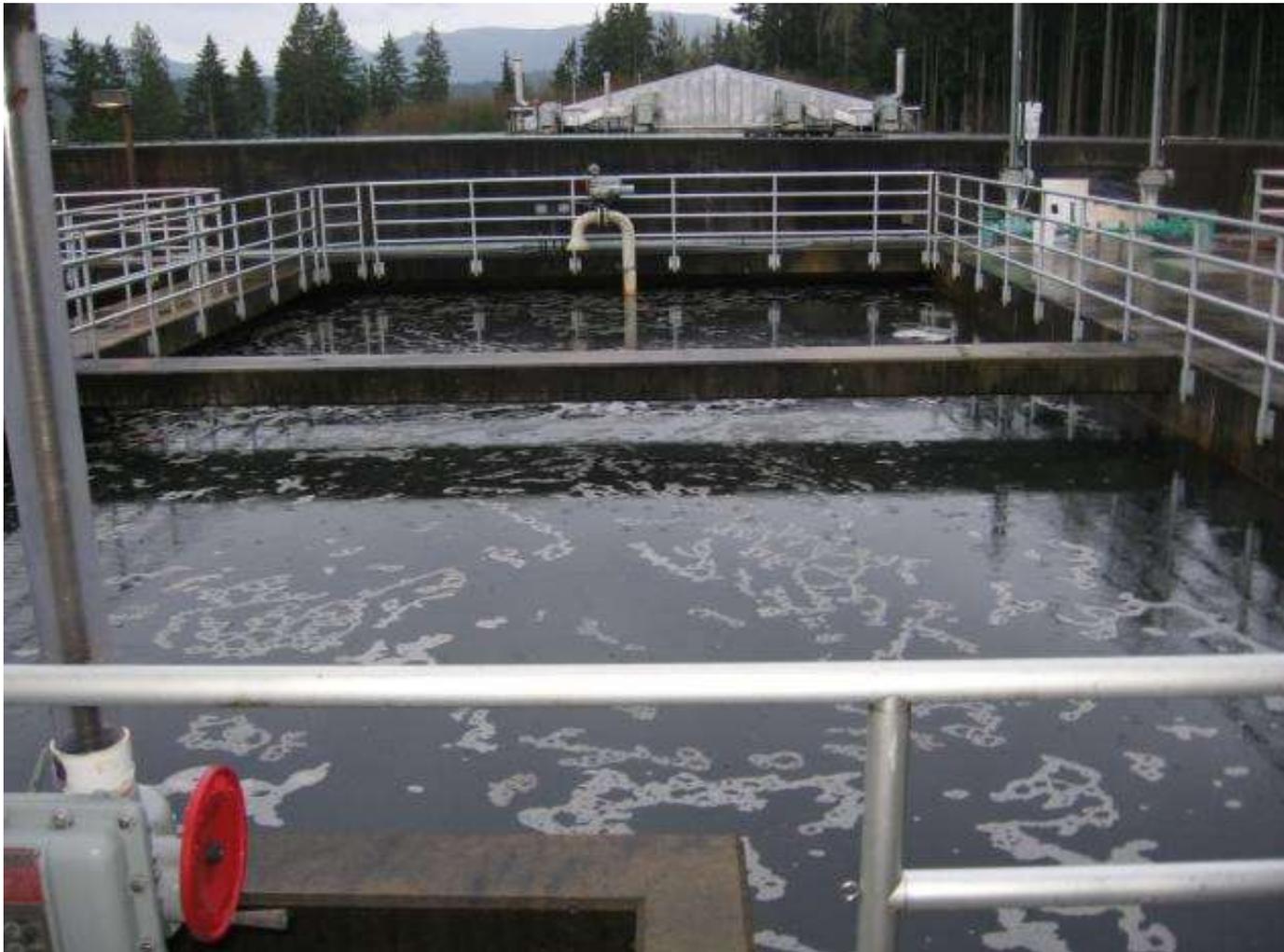
Skim fines from new media and dispose



Backwash with air scour then water



Fill filter with water, add hypochlorite to disinfect, contact time



Drain filter to 1-ft above media, then air scour to agitate



Backwash as needed

- Filter shown after backwash
 - Note black-ish color



Put filter into operation

- Filter shown after 12 hours of operation (normal green-ish color)



Backwash Water Disposal

- No sewer connection
- 4 backwash settling basins, supernatant back to head of plant
 - Recovery Basin 1 dedicated for washing new media
 - Decanted water pumped from RB 1 to RB 2
 - RB 2&4 used for normal backwashing
 - RB 3 contained dried solids, unavailable
- Equalization Basin used for normal filter-to-waste

Recovery Basin 1

- Shown during first media wash



Recovery Basin 1

- Shown immediately after media wash



Recovery Basin 1

- Shown an hour after second media wash



Recovery Basins

- Sample from RB1, upstream end, immediately after filter 2 initial wash



Recovery Basins

- Sample from RB1, halfway around, immediately after filter 2 initial wash



Recovery Basins

- Sample from RB1, downstream end, immediately after filter 2 initial wash



Work Complete

- Work went smoothly
- No water quality issues
- Washed fines from new media settled quickly
 - Filter-to-waste somewhat high in turbidity (~ 0.6 NTU) and particle count (~ 3000 total) but dropped down to OK levels within an hour or two
 - Better to have more settling capacity for washwater

Summary

- **Understand your media**
- **Monitor it regularly**
- **Plan out replacement carefully**
 - Scope
 - Operational and water quality considerations

Questions?

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