Carollo Engineers

Digging Deeper: Case Studies in Filter Surveillance, Filter Excavation, and Underdrain Inspection



2026 PNWS AWWA

The hidden secrets under the surface….

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Agenda

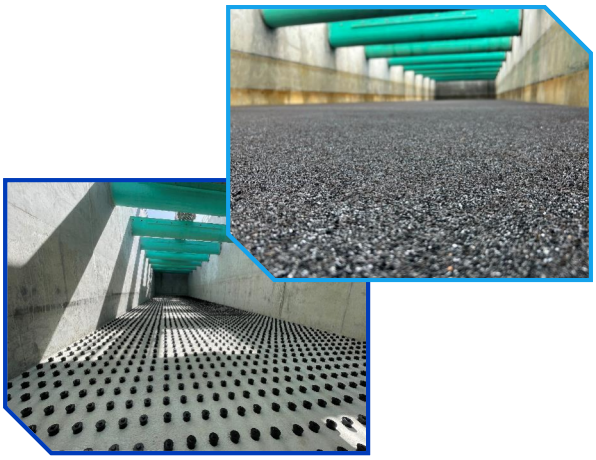
1. Regular Filter Inspections
2. Optimizing Filter Surveillance Practices
3. Digging Deeper: Filter Excavation
4. Tips for Effective Excavation and Inspection
5. Case Studies

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Why Regular Surveillance and Underdrain Inspection Matters

Filtration Depends on Two Critical Systems

- Media and Underdrains must both work correctly, in tandem for effective long-term operations.
- Media must be maintained to remove particles from filter influent.
- Underdrains must be maintained to retain media and effectively distribute backwash water.



When Either Is Compromised

- Turbidity breakthrough
- Shortened filter runs
- Uneven backwash distribution
- Accelerated media loss/degradation

The Hidden Risk: Surface-level monitoring cannot always detect subsurface problems like mudball formation, underdrain blockage, media loss.

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What Regular Surveillance Tells Us

- **Filter Performance Over Time**
  - » Identify performance benchmarks
  - » Compare performance with peer plants
- **Assess Filter Efficiency**
  - » Where solids being retained in the media
  - » Backwash effectiveness
- **Identify Potential Issues**
  - » Flag inconsistencies
  - » Mitigate potential catastrophes







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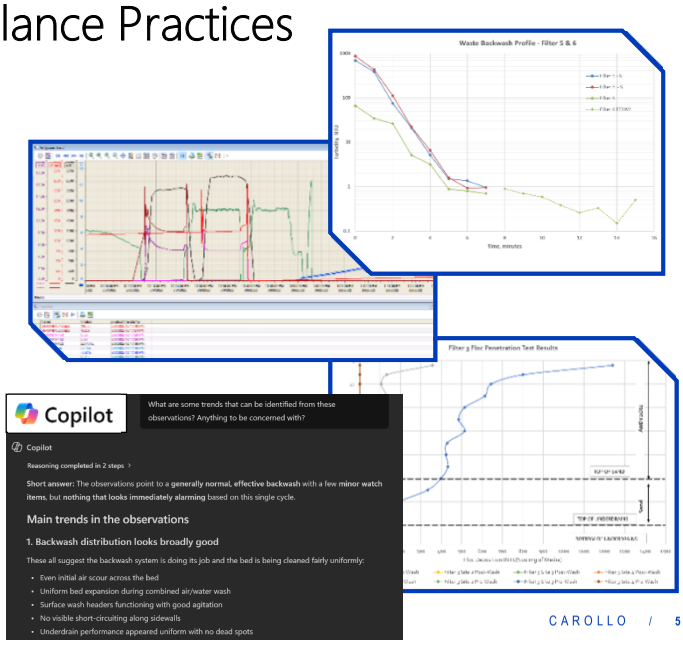
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Optimizing Filter Surveillance Practices

Data Collection Optimization

Performance Tracking
(collect on every filter run)

- Automate data collection in SCADA and running trending reports
  - Unit filter run volume calculation
  - Backwash pressure trending
  - Clean bed headloss trending
- Document observations
  - Backwash distribution uniformity

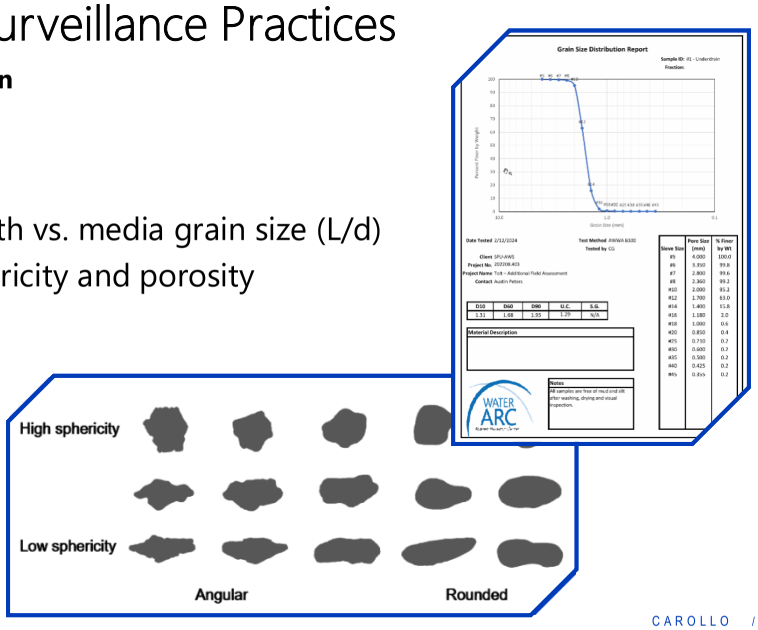


Optimizing Filter Surveillance Practices

Data Collection Optimization

Sieve Analysis
(collect annually)

- Compare media depth vs. media grain size (L/d)
- Measure media sphericity and porosity

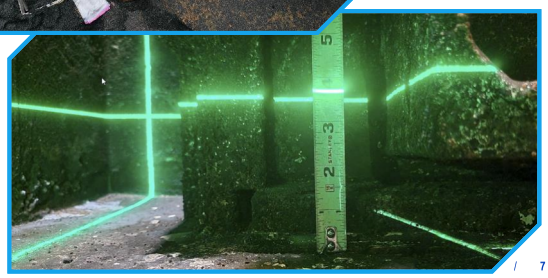


Optimizing Filter Surveillance Practices

Filter Surveillance Tools

- Avalanche Probe: Filter bed depth measurement
- Tube & Stopper: Filter coring tool
- Laser Level: Filter bed levelness measurement





When to Do Deep Inspection

Decision triggers for deeper assessment

Performance Drift
Unexplained turbidity, headloss, or run length changes

Unusual Backwash Behavior
Hot spots, uneven expansion, craters, or persistent mudballs

Planning Triggers
Rerating, rehabilitation, or regulatory compliance review

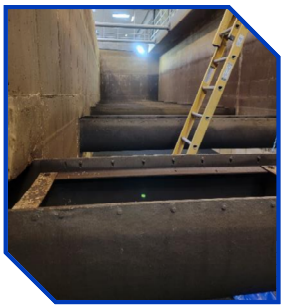
Operational Anomalies
Individual filter exceedances or unresolved filter-to-waste issues

Age-Based Assessment
Proactive condition assessment based on media and underdrain age









Digging Deeper: Areas of Investigation







- Media Evaluation
- Underdrain Assessment
- Plenum/Gullet Inspection

What to Look For in the Media and Underdrain from Above

Practical checklist for media excavation

Bulk Media Condition

- Intermixing of upper and lower media layers
- Mudball formation and cemented media
- Uneven layer depths across the filter
- Dead zones with no backwash activity

Media Grain Condition

- Changes in effective size or uniformity coefficient
- Precipitation on grains

Underdrain Condition

- Slot opening condition and size
- Support media presence
- Floor/base and/or anchorage integrity





What to Look For in the Underdrain, Plenum, & Gullet from Below

Practical checklist for underdrain and plenum inspection

Physical Condition
Cracked or broken blocks or missing nozzles
Structural deterioration of grout

Flow and Fouling
Orifice blockage from debris or biofilm accumulation
Sediment accumulation in the underdrain plenum
Uneven flow distribution indicators

Structural Integrity
Anchor bolt and lateral support condition
Evidence of media intrusion into the plenum
Signs of hydraulic uplift or settlement



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Tips for Effective Excavations and Inspections

- "Nesting Doll" filter excavation forms
- Short handled coal shovels
- Plenty of labor
- Good weather



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Tips for Effective Excavations and Inspections

- "Tried and True" Camera on a Stick



What's the safest underdrain inspection method? Not going in at all...

- Laser level, Boroscope Camera



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Safety First: Critical Requirements for In-filter Inspection

- **Utilize Established Confined Space Entry Protocols and Lock-Out/Tag-Out (or create them)**
  - Know your role and the roles of others in your group
  - Always check the environment before entry
- **Have Trained Safety and Rescue Personnel On-Site and Ready**
  - Utilize harnesses and retrieval systems when applicable
- **Drain-Down Procedures**
  - Fully drain the filter cell before entry
  - Confirm closed valves are effective
- **Protect the Media, The Excavation, & Support Layer**
  - Keep excavated media types separate
  - Use shoring and/or systems to avoid engulfment
  - Avoid disturbing support gravel (if applicable);

Stop Conditions: Halt work if water intrusion, gas detection, or instability develops







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Case Study Overview

Four plants: symptoms, inspection approach, findings, and lesson learned



Jordan Valley WTP, Utah
Filter upgrade project tied to capacity expansion to 268 MGD



Green River Filtration Facility, Washington
Major regional facility for Tacoma Water; filters up to 150 MGD



Polonio Pass WTP, California
Eight two-bay dual-media filters with approximately 43 MGD capacity



Tolt WTP, Washington
Seattle Public Utilities facility with 6-foot deep mono media filter beds

Polonio Pass WTP

Eight two-bay dual-media filters, 43 MGD

Plant Context

Dual-media filters with granular activated carbon over sand with nozzle underdrains

Why Inspection Was Done

Recurring overflow events during backwash resulted in lower high-rate backwash than design

What Was Found

Nozzle slots were clogged with an aluminum-silica precipitate causing over 8 feet of additional headloss and sieve analysis indicated older media was well outside design UC and ES.

Lesson Learned

Nozzle shape and filter media should be matched to avoid clogging. More fragile media should be monitored for degradation.



Jordan Valley WTP

Utah's largest WTP — $110M upgrade

Plant Context

Originally 180 MGD; expanding to 268 MGD with 16 filters

Why Inspection Was Done

Capacity expansion required condition data to justify higher loading rates

What Was Found

Confirmed filter underdrain type and spacing, not well documented in as-builts

Lesson Learned

"Nesting doll" approach to shallow media shoring is effective.





Green River Filtration Facility

Tacoma Water, completed 2015, 150 MGD

Plant Context

Dual media (50" of anthracite over 20" of sand), active biofiltration

Why Inspection Was Done

Air scour mal-distribution identified from the surface

What Was Found

Mudballs at the lower depths (dense, 50%+ solids)

Iron, Manganese plating out on stainless steel underdrains

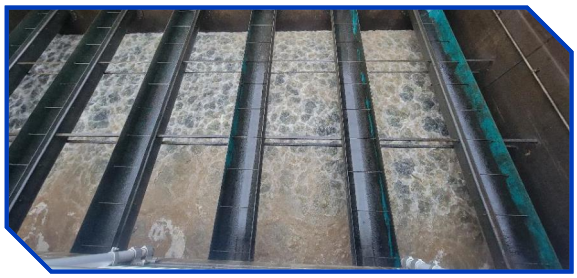
Lesson Learned

Extending filter run-times as long as possible has diminishing returns and potentially detrimental effects

Maximizing combined air water wash duration is critical for solids removal

Catalytic manganese removal deep in the filters may contribute to mudball formation

Underdrains in good shape, slots open and of expected size









Tolt WTP

Seattle direct filtration facility with pre-ozone

Plant Context

Seattle Public Utilities, historically contract operated by American Water

Why Inspection Was Done

Operations hand-off

What Was Found

Media and underdrains in good condition

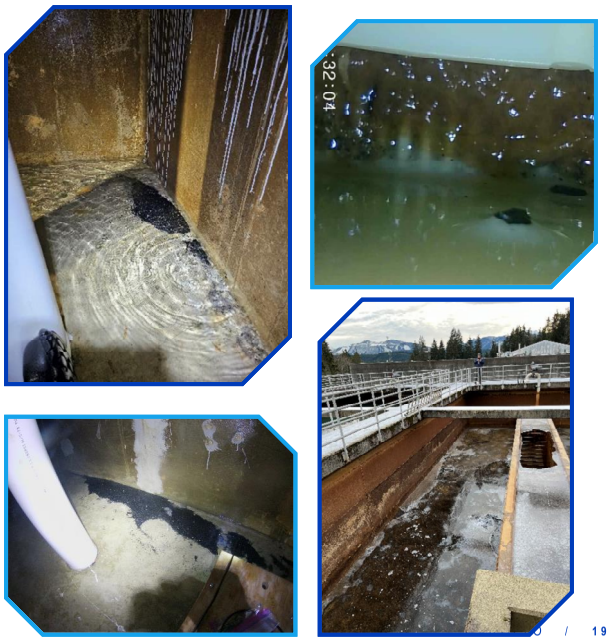
Pervasive orange bio-film in plenum

Lesson Learned

Robust biofilm may contribute to clogging of underdrain air inlet ports, survives backwashing

Minor media migration into plenum of one-filter under further investigation

Yes, it's always really cold when we do these inspections.



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Key Takeaways

1. Routine filter surveillance is necessary and valuable to spot issues early.
2. Deeper inspection can illuminate issues that surface monitoring cannot detect or identify the root cause of anomalies seen from the surface.
3. Careful planning & safe execution of media excavation and underdrain inspection is essential.

Questions?

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