Filter Inspection

(Troubleshooting and Maintenance)

Timothy D. Brett, P.E.
Territory Manager
Leopold, a Xylem brand
227 S. Division St.
Zelienople, PA 16063
724/452-6300

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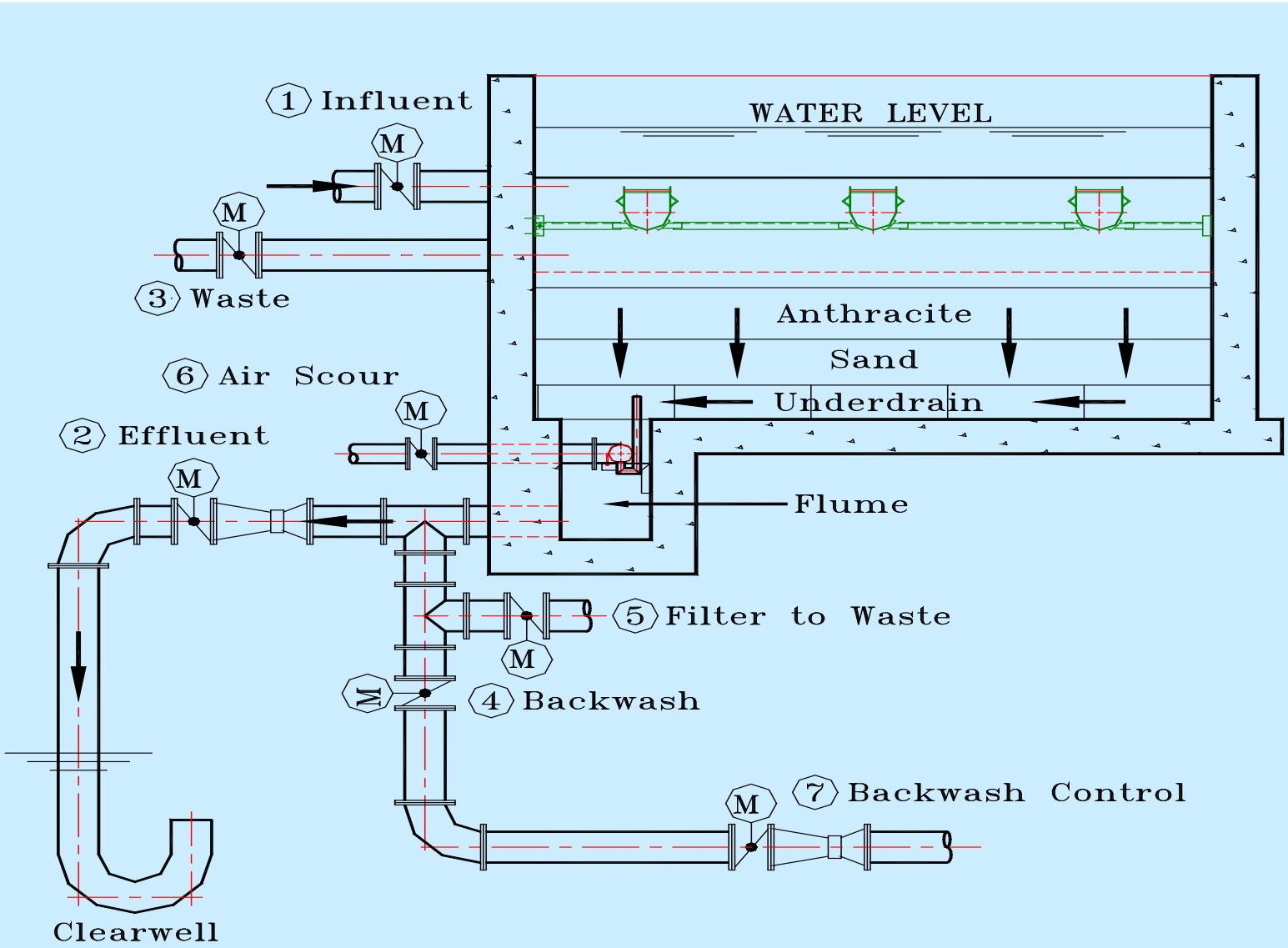
Gravity Granular Filters



Typical Filter in Filtration Mode

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Factors Affecting Filter Performance

- Inadequate pretreatment
- High solids events
- Inadequate filter backwashing
- Excessive or rapid change in filter hydraulic loading rates
- Inadequate filter system components

Filter Inspection/Troubleshooting

- **Source Water**
  - **Drinking Water**
    - **Groundwater, surface water or combination of both**
  - **Wastewater**
    - **Upstream processes, activated sludge, SBR, etc.**

- **Chemicals**
  - **Are proper chemicals being added and at the right locations?**
  - **Is there enough coagulation and flocculation time; are jar tests done?**
  - **Is the flash mixing intensity proper?**
  - **All chemicals upstream & downstream will eventually end up in your filters!!**

- **Clarification**
  - **Are the flocculated solids still the same size as they were in the flocculator?**
  - **Is the settling efficient?**

Filter Inspection/Troubleshooting

Filtration

- **Does the clarified water arrive in the filter without turbulence or headloss?**
- **Is the filter media submerged at the beginning of the filter run?**
- **Is the filter producing good quality water?**
- **Is the run time between backwashes long enough**?

Filter Inspection/Troubleshooting

Filter Operation

- **Observe the filter in backwash**
  - **Check the sequence of events and timing for proper operation**
  - **The backwash water should be uniform in color across the filter**

Air Scour

High Rate Backwash

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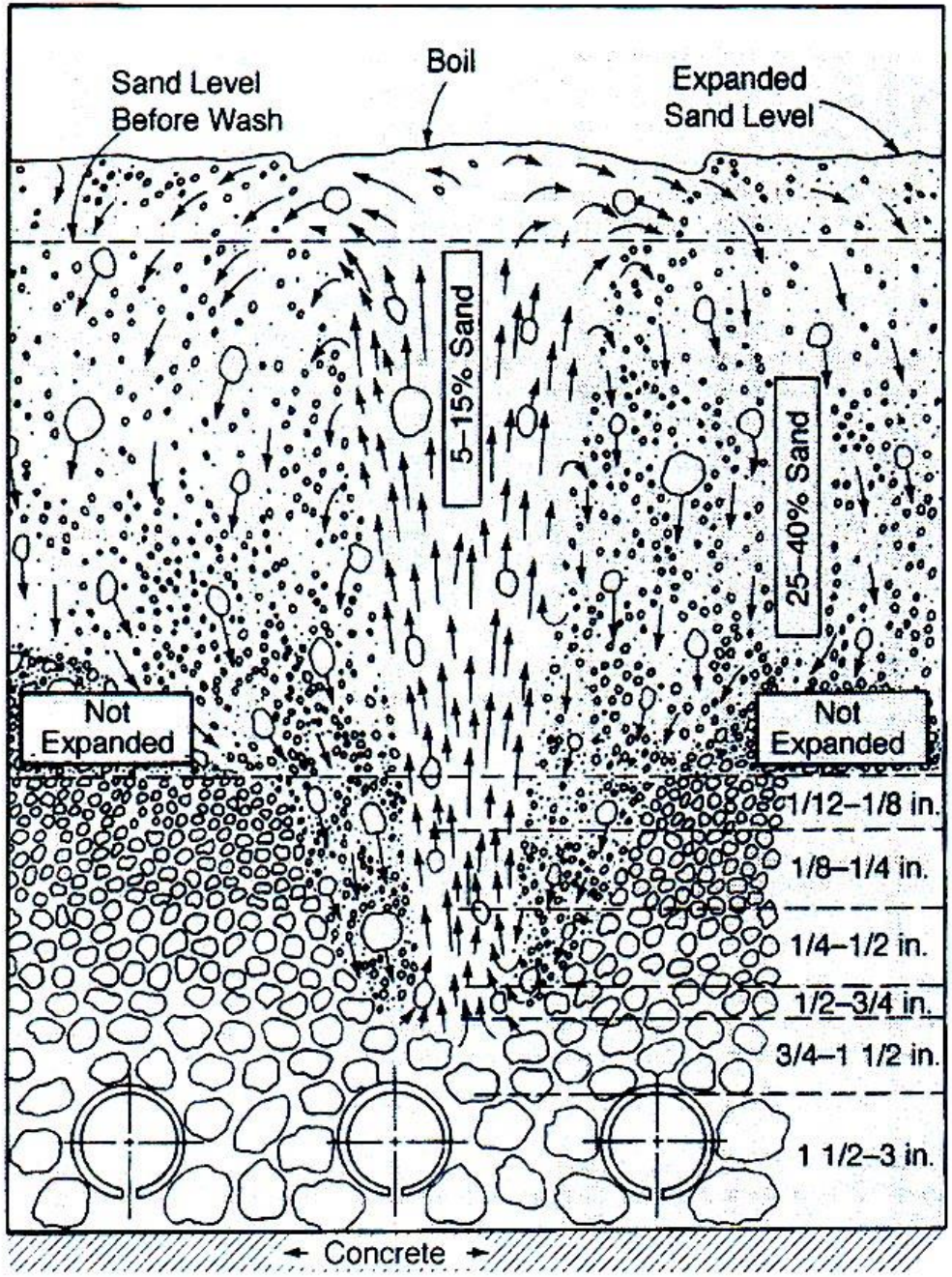
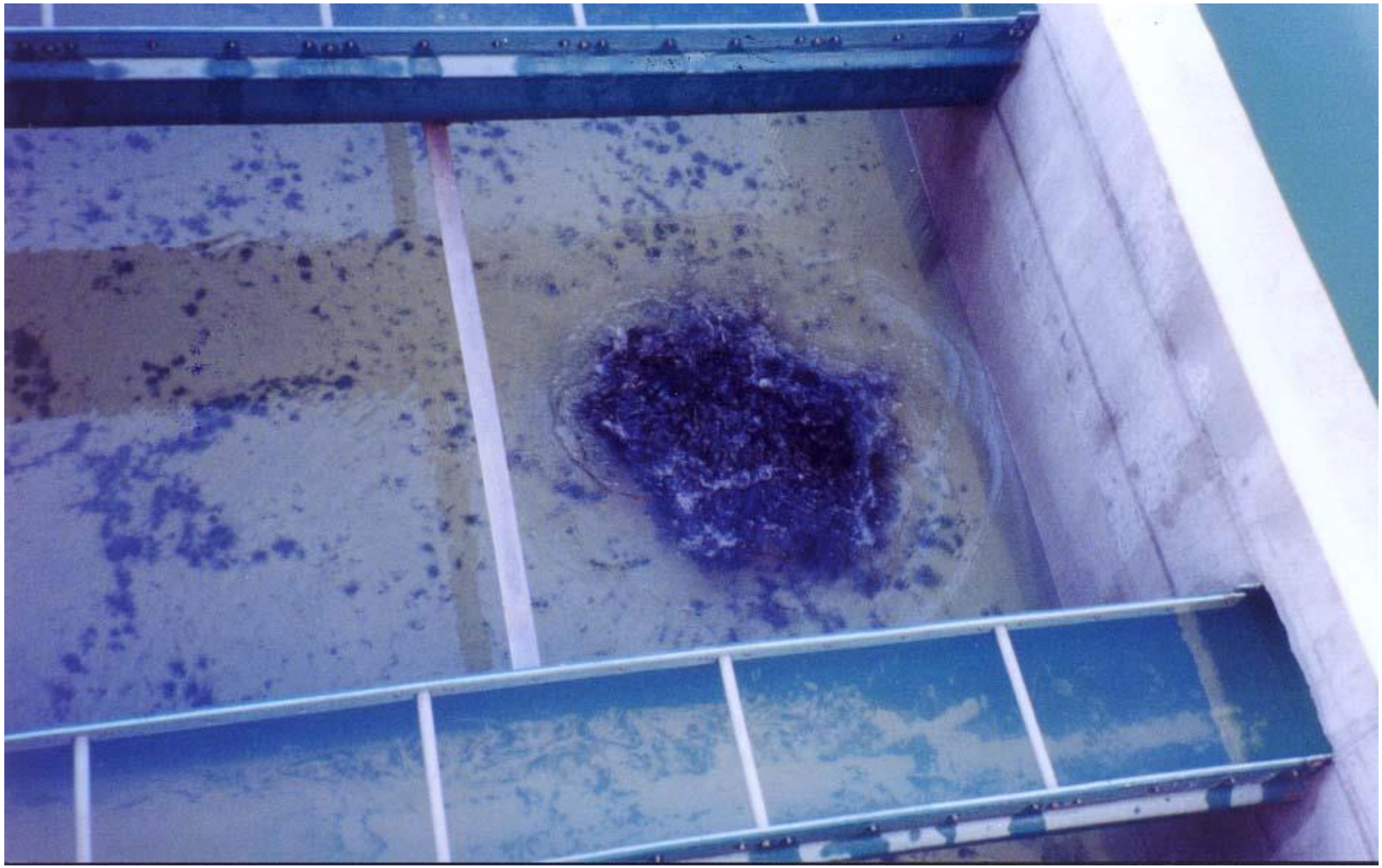
Disrupted Gravel



Air Scour with Boil

Water Wash with Boil



Filter Inspection/Troubleshooting

Media Appearance

- **Drain the filter and observe the surface**
  - **As the water breaks the surface the media should be level**
  - **Large lumps, cavities or cracks indicate upset bed and / or improper cleaning**
  - **Layers of mud or mud-balls indicate the filter is not clean**

Hole in Filter Media

Result of media support failure

Uneven Media Surface

Calcification of Media

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Dirty Filter Media

Increasing headloss causes bed to compact and shrink, resulting in cracks.

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Uncontrolled Air

Non-uniform release of air
Could be significant bubbles or large disruptive bursts
Large disruptive bursts can disrupt support gravel or cause structural damage
Water filling the void causes the damage

Disrupted Gravel

Result of Uncontrolled Air

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Result of Neglect

Sources of Uncontrolled Air and Solutions

Vortex - head tank or pump sump

- **Install baffles to prevent vortexing**

Pump cavitation - inadequate NPSH

- **Relieve pump suction restrictions or throttle pump discharge**

Dissolved air or gas in the influent

- **Degasify influent (stripping tower) or backwash more frequently**

Negative head in filter

- **Increase the positive head on the filter or terminate filter run at lower headloss**

Sources of Uncontrolled Air and Solutions

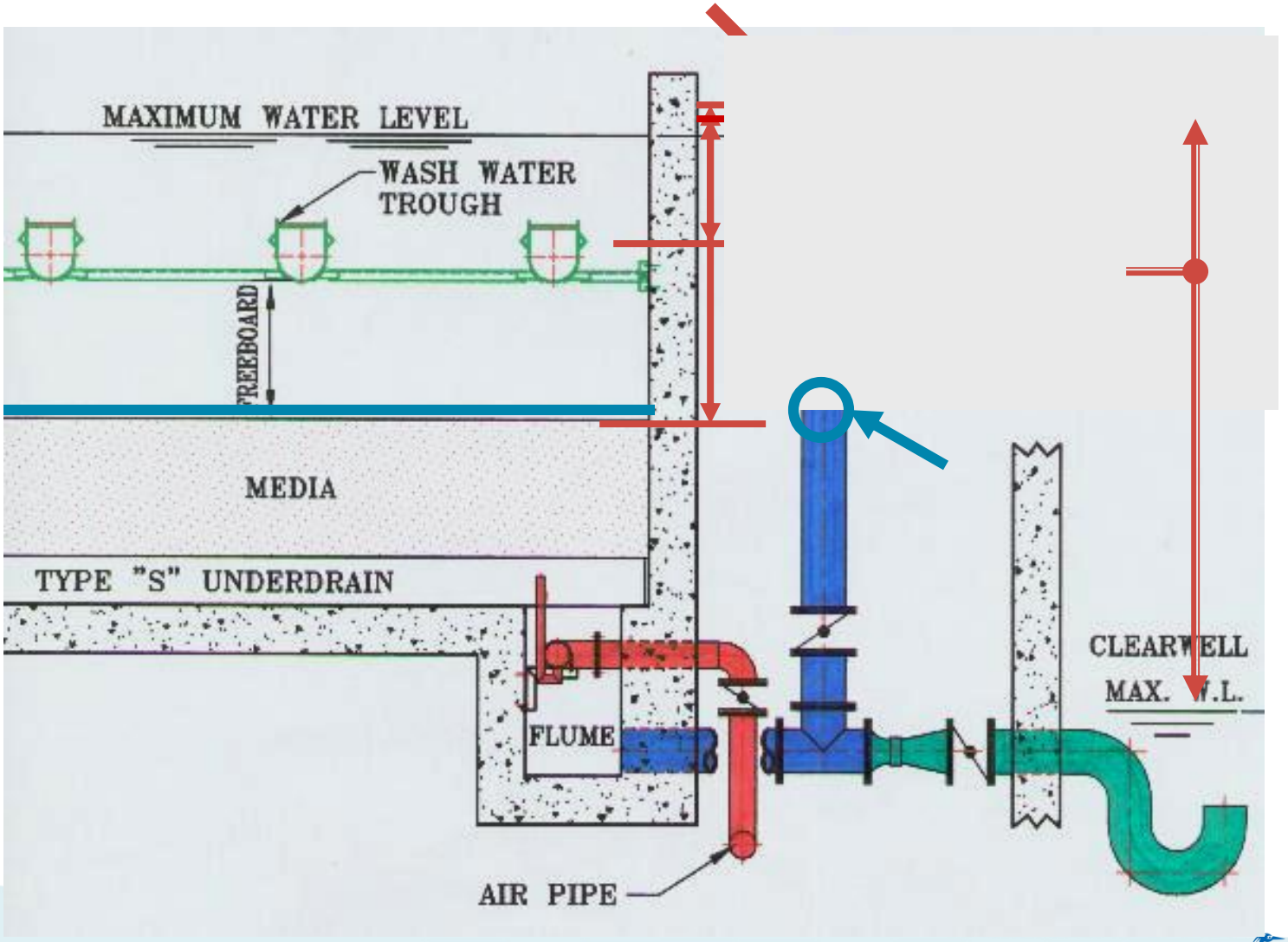
Air in backwash water

- Install flume vents and/or air release valves at high points in the backwash piping

Negative head in backwash pipe

- Air release valves - act as vacuum relief
  - Locate the backwash piping below the filter low water level
  - Install vacuum check valves on air release valves
- Leaks - piping, valves, etc.
  - Pressurize the piping at the beginning of backwash
  - Locate and fix leaks

High Backwash Pipe



Negative pressure and trapped air

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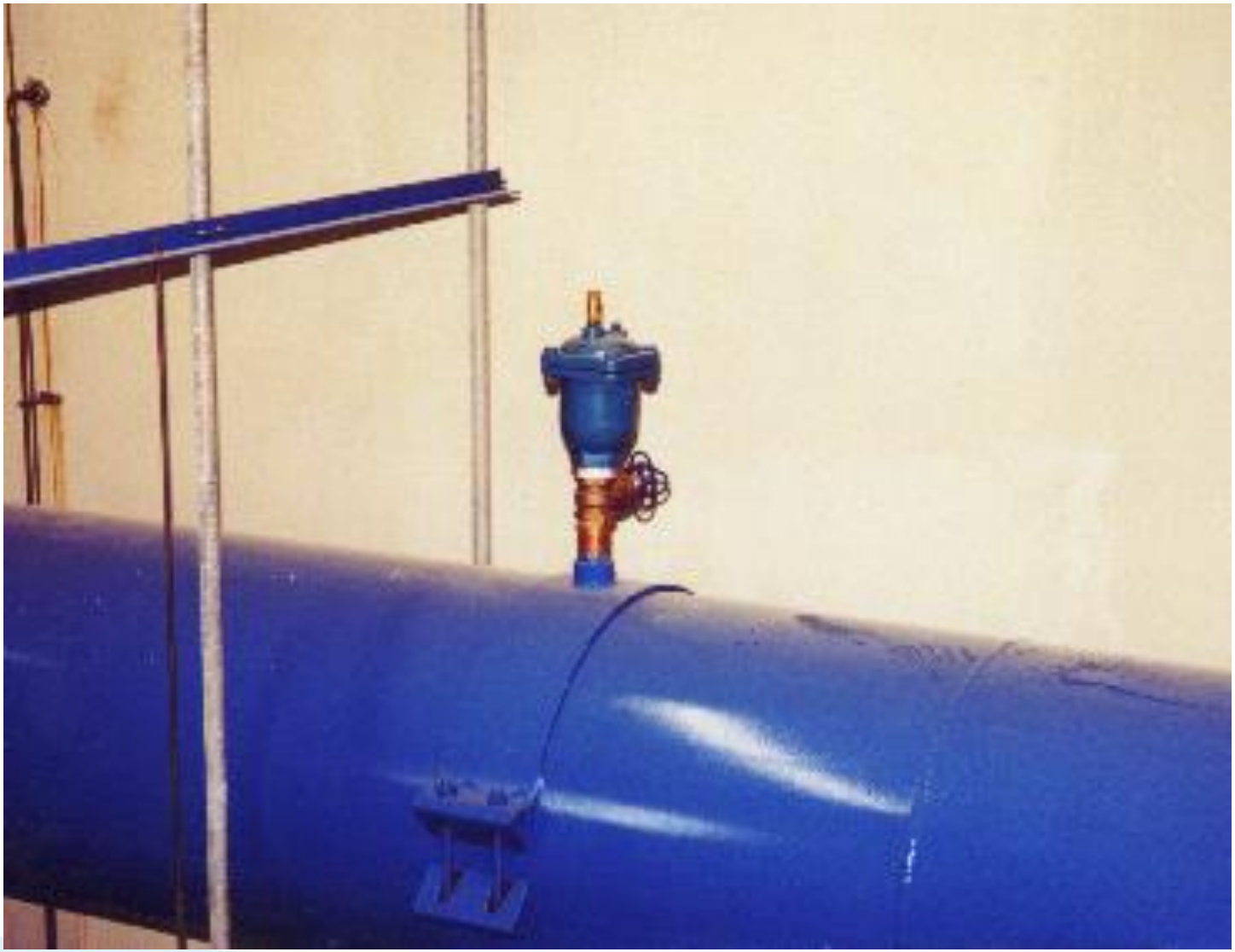
Air Release Valve



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Filter Maintenance

Filter Bed Inspection

- Generally observe filter operation
- Drain filter and evaluate surface wash
- Evaluate other structural components
- If possible inspect effluent/backwash plenum
- Inspect media
- Core filter media
- Probe gravel for levelness

Poor Rotation of Agitator

Nozzles clogged due to scaling of corroded pipe

Surface Wash Arms Bent

Typical Filter Coring Crew

UC Comparison Test

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What Leopold Looks For

Gradation before and after acid solubility

Acid solubility

- **<5% OK; 5-20% coating; >20% Coating**

Visual inspection before and after acid solubility

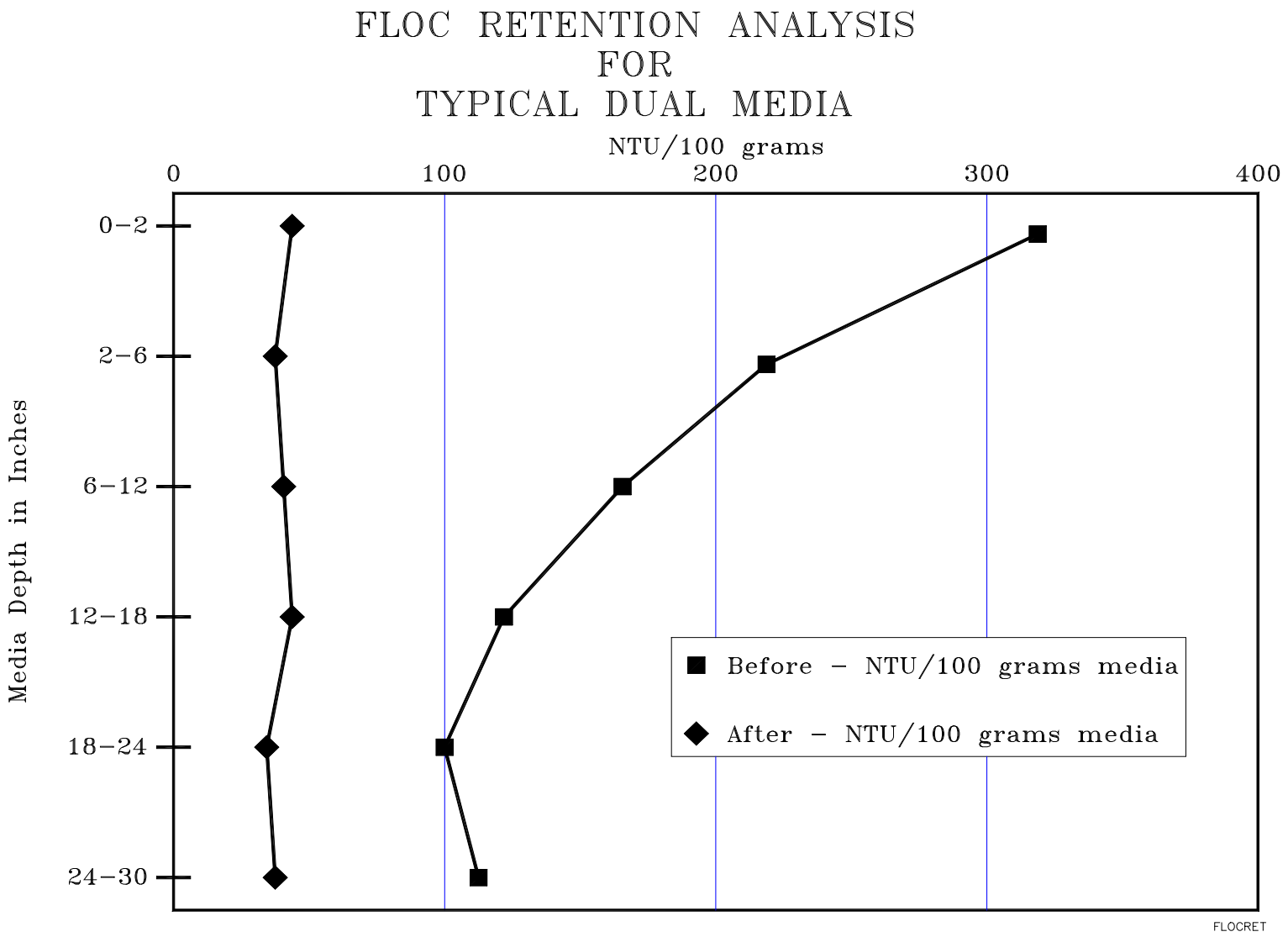
- **Coating color**
- **Roundness**
- **Sheen**

Solids Retention Guidelines

Solids Retained NTU/100 grams media	Condition	Action Needed
<30	Bed is too clean	Examine wash rate and length
30 – 60	Well cleaned and ripened bed	No action needed
60 – 120	Slightly dirty bed	Re-schedule retention analysis soon
>120	Dirty bed	Re-evaluate filter wash system & procedures
>300	Mudball problem	Rehabilitate bed

- by Susumu Kawamura

Solids Retention Analysis



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Skimming

- Removes fines from the surface of the filter
- Fines are generated by backwashing
- Fines are inherent in new material used for topping off
- For a typical 1.0 mm anthracite remove material finer than #20 or 0.841 mm
- Drain all of the liquid from the filter
- Use walking boards and a square-edged shovel
- Use a scooping motion; do not roll
- Count all tools (and workers)

Filter Bed Expansion

- **Insufficient bed expansion can result in dirty media since the dirt does not have an escape from the filter**

- **20-30% expansion is recommended**

- **Rise rates of 15-20 gpm/sf normal for 1 mm anthracite and 0.5 mm sand**

- **Measurements methods:**
  - **White disk on rod-measure expanded media; measure resting media after backwash**
  - **Collection of “organ” pipes at 1” (25 mm) increments**
  - **Pilot column**
  - **Expansion = difference ÷ bed depth x 100%**

Backwash Rate Adjustments

Temperature

- Due to seasonal variations
- Make a plot over the seasons
- Pilot unit useful to develop information

Expansion Measurements

- Using the expansion previously discussed
- Take core samples to periodically verify

Calculated rise rate-if no backwash flow meter

- Use a tape measure record the distance vs time
- Gravity backwash-driving head can vary

Placing Filter Into/Out of Service

Taking a filter out of service

- Keep filter media wet
- Maintain 5 ppm chlorine residual

Placing a filter into service

- backwash to clean and to remove chlorine residual
- Extended down period - Drain/visually inspect surface/remove extraneous material/skim if necessary and backwash
- If dry, visually inspect surface/remove extraneous material/skim if necessary/fill filter slowly, disinfect and allow to soak to remove any air before backwashing

Filter Bed Media Stock Measuring

To ensure sufficient media for filtration

Establish a program

- Take height measurements at least twice/year
- Replace anthracite at 1.5 to 2 inch (35-50 mm) loss (max)
- Operators required to observe backwash

Measuring media depth

- Filter should be in service so it is compacted
- Measurements taken from same permanent 4 to 6 locations
- Records should be kept for a history
- Any significant change should be investigated

Filter Turbidity

Purpose of monitoring turbidity

- Determine water quality and meet regulations
- Optimize filter performance
- Optimize backwash to reduce water usage

Each filter must be monitored – US IESWTR

- If >1.0 NTU self-assessment performed
- if >2.0 NTU comprehensive performance evalu.

Calibrate turbidimeters periodically - QA/QC in US EPA Guidance Manual for Turbidity

Filter Run Profile

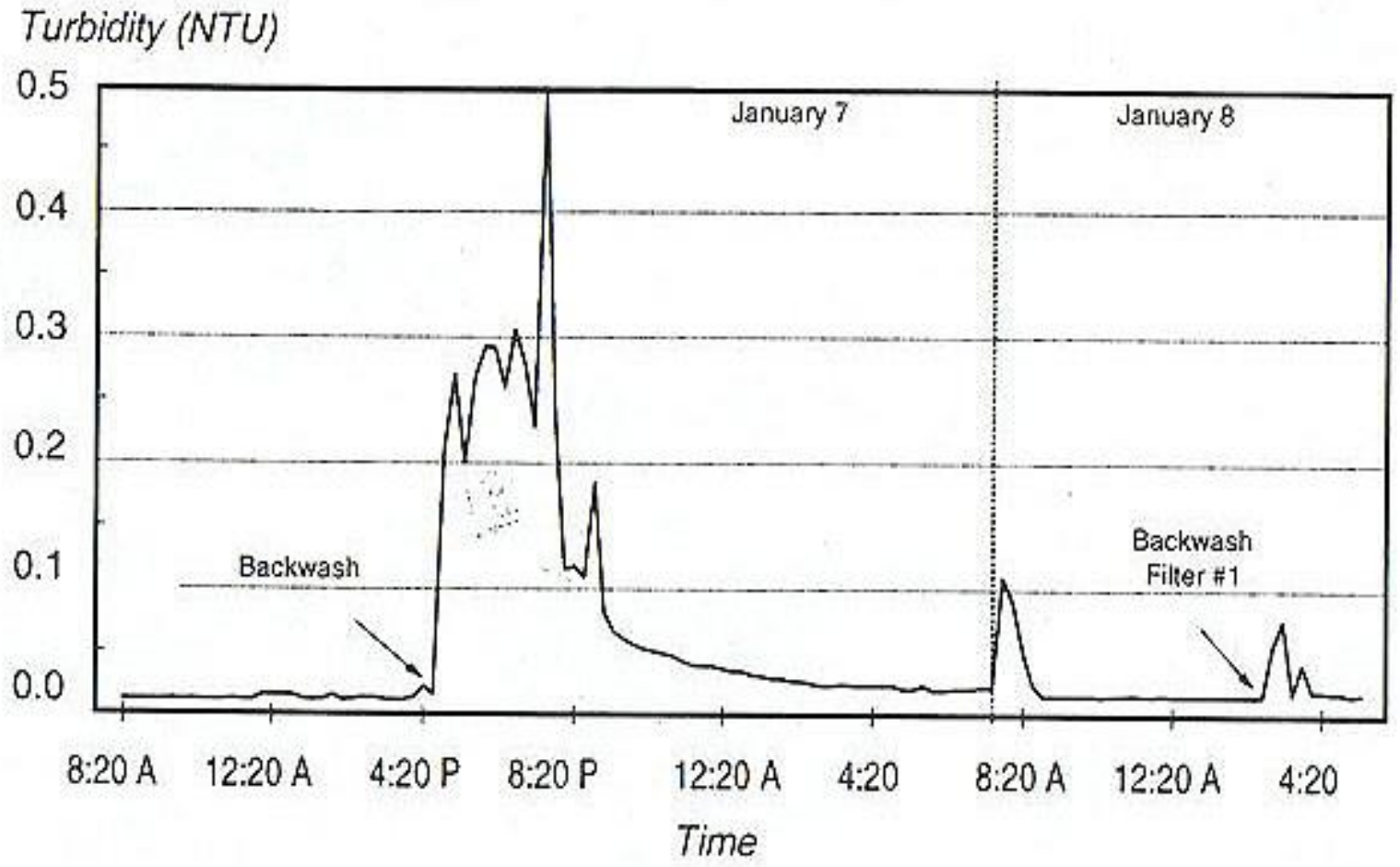


Figure 2-6. Example Filter Profile

Filter Turbidity and Headloss Analyses

Observation and interpretation

- **Interpret the effluent turbidity trend**
  - **Note ripening trend and rise after backwashing**

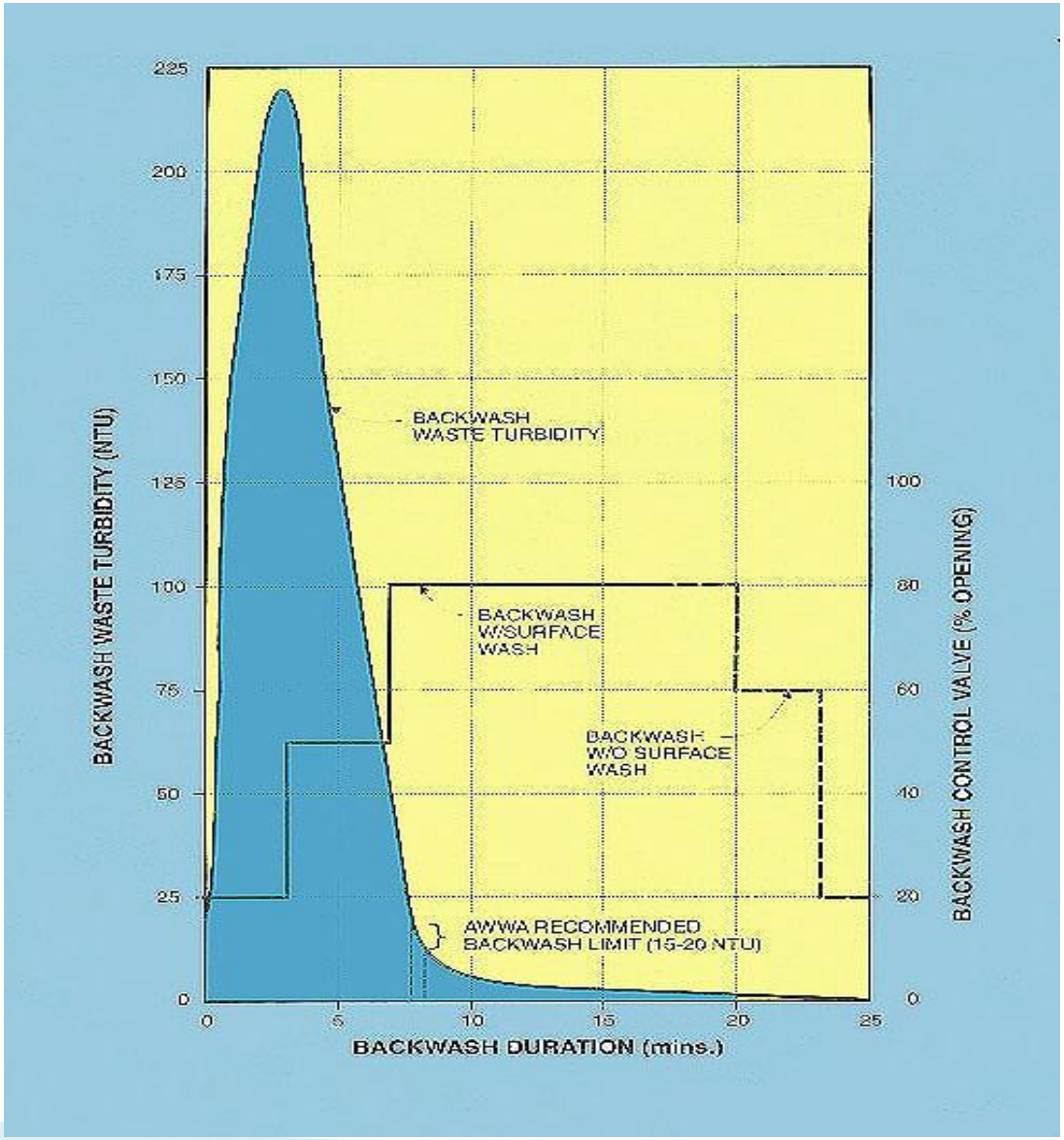
- **Determine if there is turbidity breakthrough**
  - **Could indicate poor coagulation, source quality change, mudballs, media disruption, etc.**

- **Interpret the headloss trend**
  - **Slow even increase indicates good ripening**
  - **Rapid rise could indicate surface blinding**

- **Analyze filter run times – UFRV = filtration rate x run time**

- **Quantify turbidity spiking after backwash**

Backwash Water Turbidity vs Time



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Filter Historical Records

Purpose is to establish long term trends for troubleshooting problems

Weekly operational data

- **Clean bed headloss**
- **Run time**
- **Average influent turbidity**
- **Average effluent turbidity**
- **Visual inspection results - good, action required, uncontrolled air, hydraulic shock, failures, media condition, etc.**

Monthly maintenance activity

- **Valves, controls, piping, pumps, structures, etc**

Questions??