Data Integrity

Drinking Water Bureau, Technical Service Team

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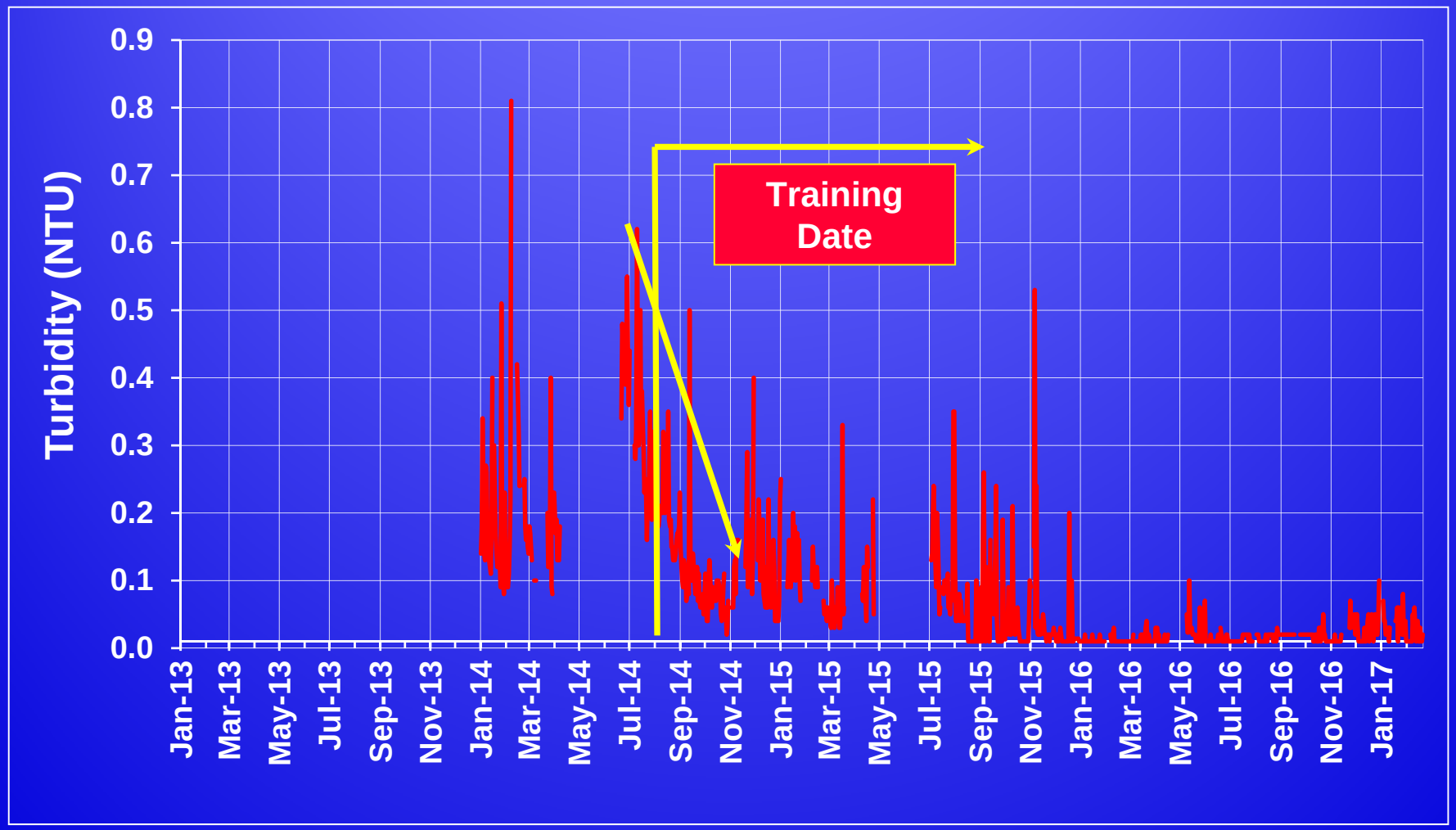
Data Integrity



Adopt Optimized Performance Goals - Steps

- Establish individual unit process goals:
  - Emphasize multiple barrier protection.
  - Emphasize need for continuous performance.
  - Encourage *"tenacity"* to maintain goals.
  - All operators must *"Buy-In."*
- Procure management support for goals.

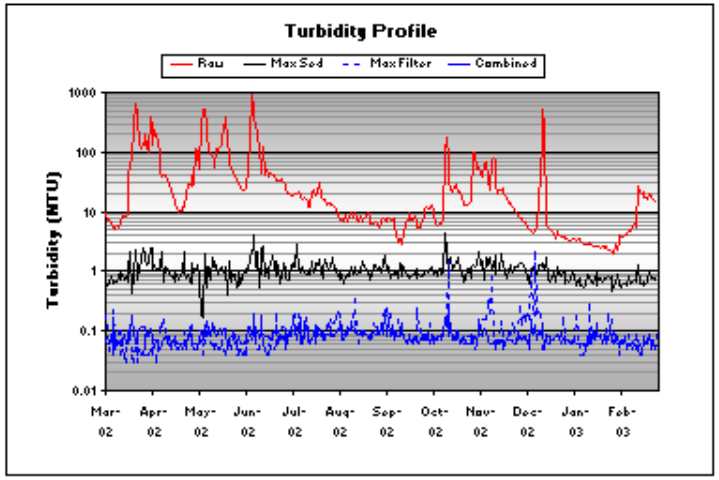
New Mexico Optimization Goals

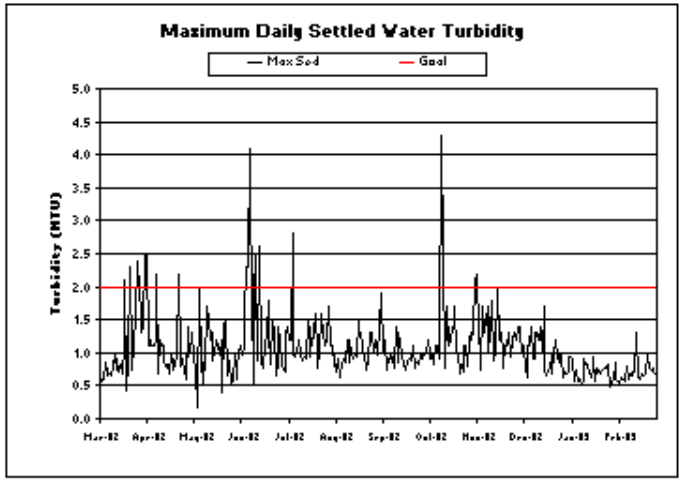
- Sedimentation Basin Performance Goals
  - Settled water turbidity less than 1 NTU 95% of the time when annual average raw water turbidity is less than or equal to 10 NTU
  - Settled water turbidity less than 2 NTU 95% of the time when annual average raw water turbidity is greater than 10 NTU
- Filter Performance Goals
  - Filtered water turbidity less than 0.1 NTU 95% of the time (excluding 15-minute period following backwashes) based on the maximum values recorded during 4-hour time increments
  - Maximum filtered water turbidity following backwash of less than 0.3 NTU, returning to 0.1 NTU within 15 minutes
- Disinfection Performance Goals
  - CT values to achieve required log inactivation for Giardia and virus

Start with Monitoring Performance!!

Rocky Mountain Water District 1031009

Treatment Barrier Performance Summary





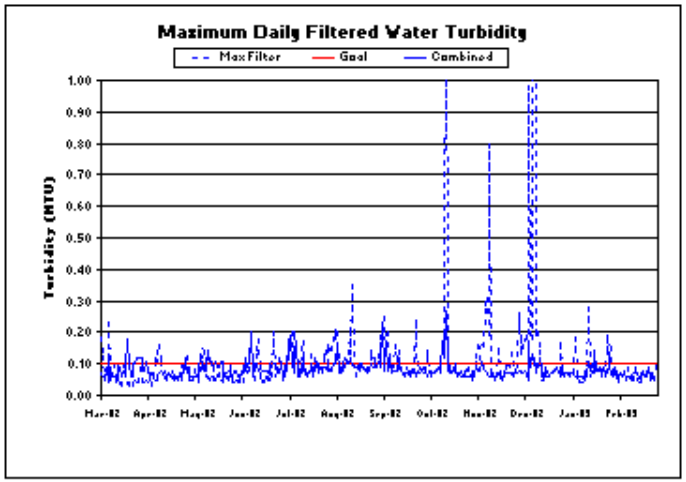
ANNUAL DATA	Avg NTU	Min NTU	Max NTU	RSQ	95% NTU	Opt. Goal % Values	Req. % Values
Raw Turbidity	48.0	2.0	914.0	n/a	218.6	n/a	n/a
Max. Settled Turbidity	1.1	0.2	4.3	0.13	2.0	95.1	n/a
Max. Filtered Turbidity	0.11	0.03	2.06	0.00	0.20	73.2	n/a
Combined Filtered Turbi	0.08	0.05	0.27	0.12	0.12	86.6	100.0

RSQ - Correlation Coefficient for two selected datasets

95% - 95th Percentile value for dataset

Opt. Goal - % of values in dataset that are less than or equal to the selected optimization turbidity goal

Req. - % of values in dataset that are less than or equal to the regulated turbidity requirement



Optimization Assessment Software - Version 27

Instructions | DataEntryPaste | DataEntryValues | Summary | OptimizationTrend | Log

Draw | AutoShapes

start | 4-28 meeting | Turb-opt27 | Microsoft PowerPoint ... | Desktop | 10:17 AM

Sampling, Testing, and Data Development

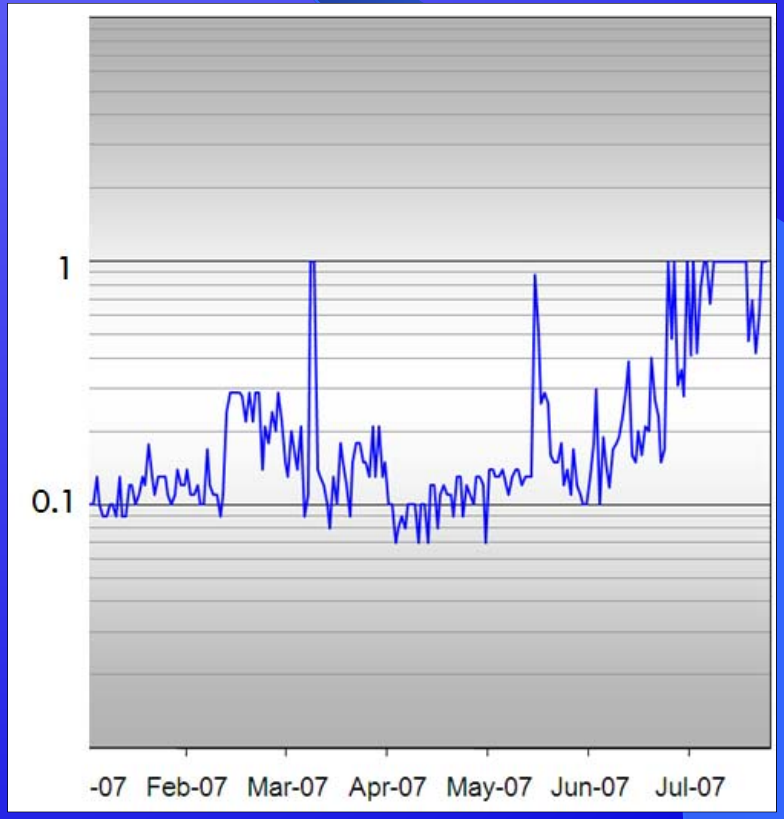
- Operational practices must be able to monitor performance for goals.
  - Sampling and Testing Guidelines must include turbidity sampling, testing, and reporting integrity.
  - Plant staff must utilize data development and trending to monitor progress.

Turbidity Sampling, Testing, and Data Integrity

- Turbidity data is basis for assessing performance status and improvements – it needs to be right!
- Common problems:
  - Sampling locations (not representative)
  - Measurement techniques (portable and bench meters)
  - Turbidimeter settings and data recording
  - Turbidimeter maintenance and calibration (frequency and approach)
  - Reporting data on plant logs and MOR (including interpretation of daily maximum turbidity)

Check Turbidimeter Settings Example Hach 1720D & E

- Signal output range – 0 to 1 NTU common for IFE but will result in *"capping"* of data during filter upsets.
  - May be compliance issue with determining the daily max. value.
- Check controller response to loss of communication with sensor – default is to report last known value.
- Turbidimeter flow rate – measurement better than visual check (200 – 750 mL/min recommended; check vendor manual).



Assess Sample Line Integrity

Turbidity Sampling, Testing, and Data Integrity (cont.)

- Data integrity will be focus of onsite workshop.
  - A plant tour and special studies will focus on this topic.
  - Document potential issues that might apply to your plant.
- Follow-up:
  - Evaluate data integrity as part of your training homework assignment.
  - Integrate data integrity assessments into your job duties.

Process Sampling and Testing for Optimization

- Implement a formal sampling and testing schedule:
  - Monitor raw water quality.
  - Monitor individual sedimentation basin performance (if applicable).
  - Monitor individual filter effluent (IFE).
  - Monitor combined filter effluent (CFE) performance.
  - Record on daily data log sheet.
- Identify maximum daily turbidity measurements for Optimization Assessment Software.
- Document approach as operational guideline.

Operational Guidelines – Why, Who, How

- Formalizes plant activities.
- Used as communications and training tool.
- Developed by the plant staff.
- Describe how to do a portion of the operator's activities.
- Shouldn't make the process *"hard."*
- Operators field test guidelines on other plant personnel.
- Encourage continuous modification and improvement.
- Examples provided in workshop.

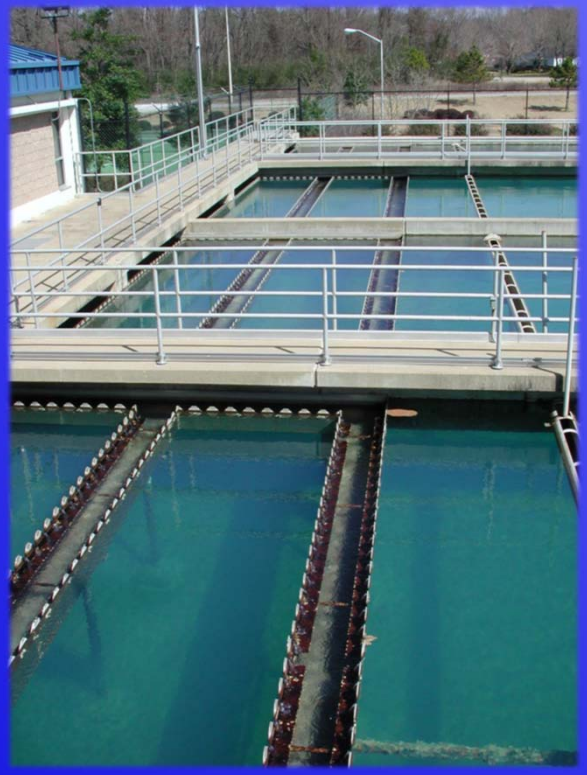
Basic Sampling and Testing Guideline to Support Optimization Goals Monitoring

Sample	Sample Location	Sample Type	Data Recording
Plant Raw Water	Tap by raw water sink	Grab every 4 hours	Maximum daily value
Sedimentation Basin Effluent	Individual basins at exit location	Grab every 4 hours	Maximum daily value
Filter Effluent	Individual filters (membrane units)	Continuous (max. during 15 minute period logged in SCADA)	Maximum daily value
Combined Filter Effluent	Entrance to clearwell	Continuous (max. during 15 minute period logged in SCADA)	Maximum daily value

Raw Water

- Measure raw water turbidity continuously or minimum of once per day (more frequently during rapid changes).
- Enter maximum value for the day in OAS.

Sedimentation Basin Monitoring

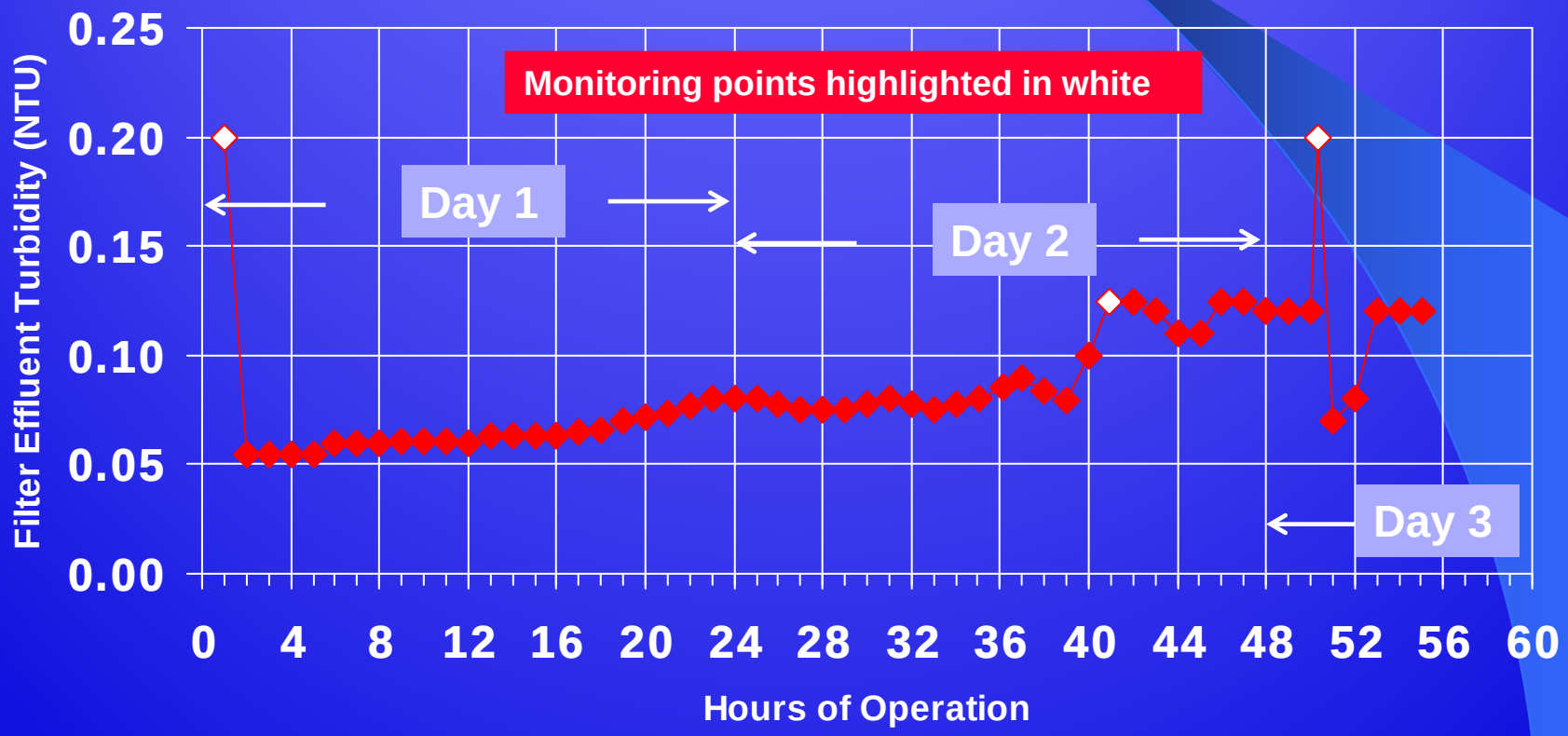


- Measure settled turbidity from exit of each basin.
- Frequency of SCADA logging from continuous meters: ≤ 15 minutes.
- Grab samples acceptable: minimum 4-hour sampling interval.
- Enter maximum value for the day in OAS.

Filter Monitoring

- Individual Filters:
  - Measure turbidity continuously (i.e., assess performance based on continuous data; log maximum turbidity during each 15-min period in SCADA).
  - Identify and record in OAS the maximum filtered water turbidity during each day that filter is operating (i.e., water going to clearwell).
  - Exclude turbidity during backwash and filter-to-waste times.
- Combined filter effluent:
  - Measure turbidity continuously (i.e., assess performance based on continuous data; log maximum turbidity during each 15-min period in SCADA).
  - Identify and record in OAS the maximum turbidity during each day that plant is operating.

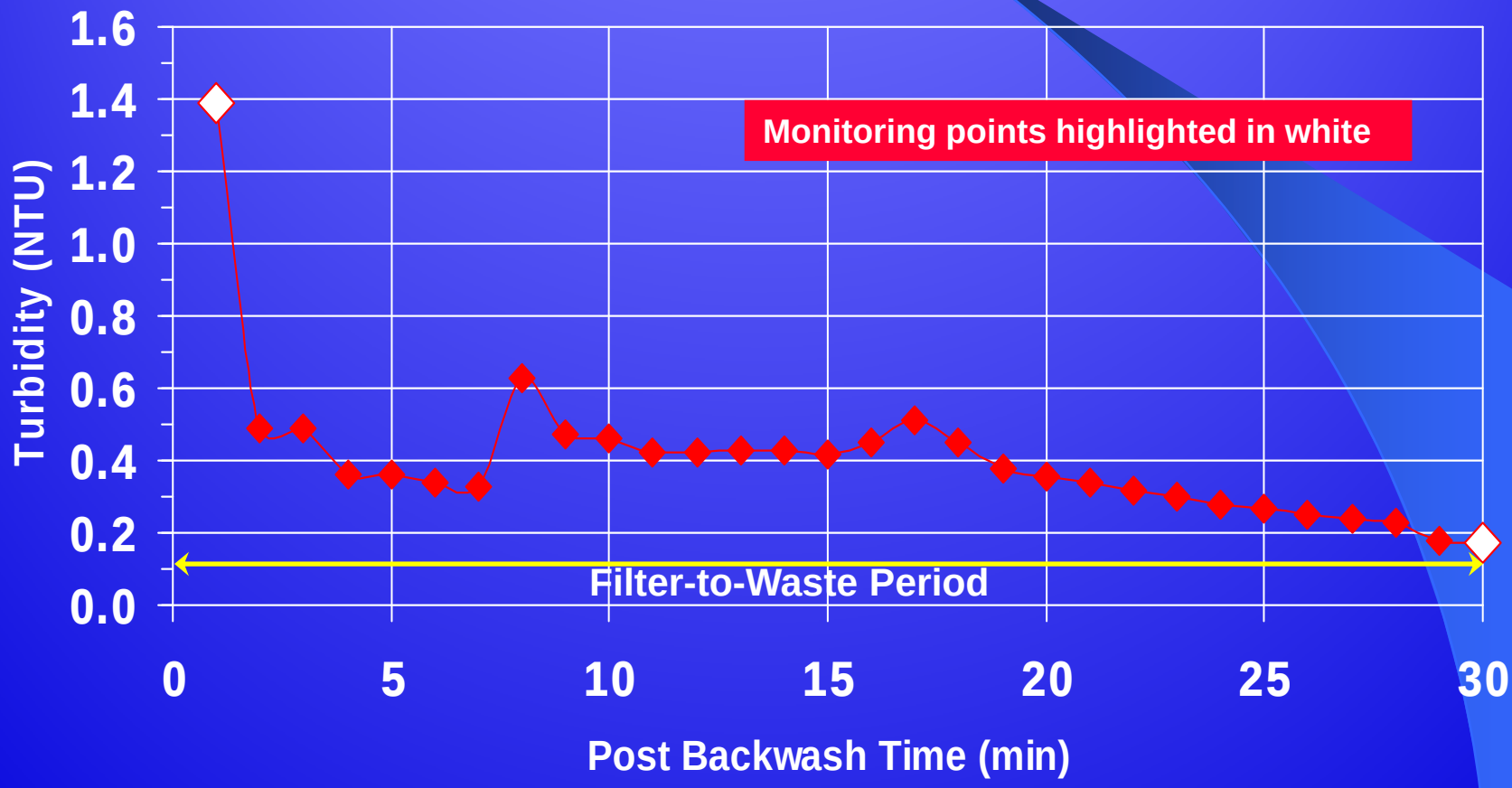
Filter Effluent Turbidity Maximum Daily Value



Filter Backwash Recovery

- Plants with filter-to-waste capability:
  - Identify and record maximum turbidity during filter-to-waste period.
  - Identify and record turbidity at the end of filter-to-waste period.
- Plants without filter-to-waste capability:
  - Identify and record maximum turbidity during 15-minute period after backwashed filter is placed in service.
  - Identify and record turbidity 15 minutes after backwashed filter is placed in service.
- These turbidity measurements should be taken following backwash of each filter.
- Enter data in the Backwash Trending Spreadsheet.

Post Backwash Turbidity Monitoring



Example Turbidity Monitoring Data Form

Plant Optimization Data Daily Log

Date	m/d/y		Operator						
Turbidity Data	Time	0800-1200	1200-1600	1600-2000	2000-2400	2400-0400	0400-0800	0400-0800	Daily Max.
Max. raw water	ntu								
Max. sedimentation 1	ntu								
Max. sedimentation 2	ntu								
Max. filter 1	ntu								
Max. filter 2	ntu								
Max. filter 3	ntu								
Max. filter 4	ntu								
Max. finished	ntu								
Post Backwash Data	Filter No.	1	2	3	4				
BW start time	H:M								
BW end time	H:M								
FTW turbidity spike (1)	ntu								
End FTW turbidity (2)	ntu								
FTW Time	minutes								

Values to OAS

(1) No FTW - record max. turbidity during first 15 minutes of return to service

(2) No FTW - record turbidity after first 15 minutes of return to serice

Data Integrity Special Studies

Areas of focus

- Assessing Turbidity Sampling Location and Proximity of Sample Location to Turbidimeter
- Online Turbidimeter O&M and Settings Configuration
- Interpreting and Reporting Turbidity Data (including turbidity data quality control)
- Portable and Bench Turbidimeter Monitoring and Comparison to Online Turbidimeters

Assessing Turbidity Sampling Location and Proximity of Sample Location to Turbidimeter

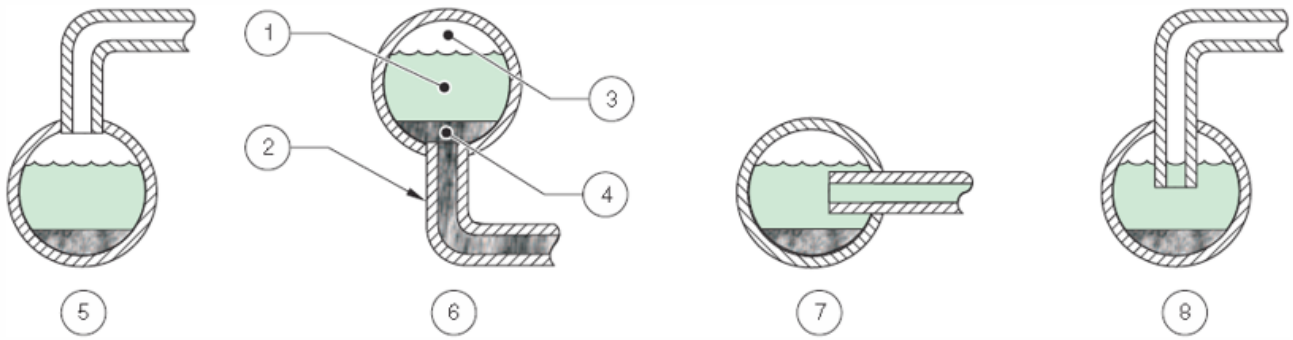
- **Is the location of the turbidity sampling representative of process performance?**
  - Is sample representative of process performance?
  - Is the sample ling length excessive?
  - What is the condition of the sample line?
  - Is turbidity impacted by pumping sample?
  - Is CFE before or after clearwell?

Sample Tap

- Diagram from Hach 1720E Manual

Installation

Figure 5 Sampling Techniques



1. Sample Flow	**4.** Sediment (Typical)	**7.** Good
2. Sampling Line to Sensor	**5.** Poor	**8.** Best
3. Air (Typical)	**6.** Poor	

Sample Line detention time

- Ideally, the sample detention time should be less than 1 minute for IFE and CFE sample taps.

Turbidimeter # Raw (Pre-Sedimentation)

Line Dia. (inch)	Line Length (ft)	Line Vol. (gal)	Flow Rate (gal/min)	Sample Line DT (min)
2.00	12.00	1.96	0.500	3.9
0.75	9.50	0.22	0.500	0.4
3.00	1.67	0.61	0.500	1.2
		0.00		0.0
Total				**5.6**

Online Turbidimeter O&M and Configuration (settings)

- Do the continuous reading turbidimeter maintenance program and calibration procedures adversely impact the quality of turbidity data in the plant?

Maintenance Activity

Maintenance Activity	Response
Written SOPs/guidelines?	
Maintenance logs?	
Sample line flushing, inspection, replacement?	
Calibration frequency (check history on controller)? [1]	
Verification frequency? [2]	
Photocell inspection and cleaning? [3]	
Bulb replacement frequency? [4]	
Flow rate check frequency? [5]	

(1) Recommended quarterly.
(2) Recommended weekly.
(3) Recommended quarterly. Check for damaged photocell (air bubble should be present in cell).
(4) Recommended annually.
(5) Recommended quarterly. Hach instrument range is 200 to 750 mL/min.

Turbidimeter Settings

Turbidimeter location								
Turbidimeter model								
Controller model and data logging setting [1]								
Signal averaging [2]								
Bubble reject [3]								
Error Hold Mode [4]								
Output span [5]								
Other								

[1] Check to see if current date and time are correct. Check frequency of data logging. Default is 15 minutes for Hach models.

[2] Default for Hach models is 30 seconds. This is acceptable in most cases.

[3] Default is *Yes* for Hach models. This is acceptable is most cases.

[4] Specific to Hach 1720E and FilterTrak 660 models. Default is to *Hold Outputs (HO)* and send last known value to SCADA when turbidimeter loses communication with controller. Better option is *Transfer Outputs (TO)* to send an operator-selected value to SCADA (e.g., 0, 10) to make operator aware of problem.

[5] To avoid *"capping"* of data to SCADA, the output span should be at least 0 to 5.1 NTU (applicable to analog signals).
Accessing output span for Hach SC200 controller: Menu/SC200 setup/Output setup (select 1 or 2; select Source to see which turbidimeter is highlighted and then Back button)/Activation (low value; high value).

Turbidimeter Verification

Turbidimeter	Instrument Values	Remote Location No.1 Values
Raw	655	654
Raw post Sed	73	73
Sed 4	2.17	2.25
Pre Sed	6.16	6.11
Filter 1	0.03	0.03
CFE	0.022	0.022

Interpreting and Reporting Turbidity Data (including turbidity data quality control)

- Does the approach followed by plant staff to determine the maximum daily raw, settled, IFE (membrane unit), and CFE turbidity represent the highest values for the day?

Determining the maximum daily turbidity values for the day

- How is data recorded during filter start-up and after a backwash? Is data excluded from reporting?
- How is data recorded during filter-to-waste (if available)?
- How is online turbidimeter data used to develop reports (e.g., optimization spreadsheet, MOR)?
- How is off-line filter operation addressed in online turbidimeter recording (e.g., turbidity data recording during filter backwash events excluded through software programming)?

Monitoring Location

Monitoring Location	How is the maximum daily turbidity value determined, and what is the data source?
Raw Water [1]	
Settled Water [2]	
IFE (membrane unit) [3]	
CFE [4]	

(1) Goal is to determine max. based on daily monitoring with increased frequency during changing source conditions.

(2) Goal is to determine max. based on monitoring every 4 hours for grab samples and every 15 minutes for online turbidimeters.

(3) Goal is to determine max. based on continuous monitoring when unit is in operation.

(4) Goal is to determine max. based on continuous monitoring.

OAS vs. Plants Values

- 3 months of data
- Compare to plants values
  - Maximum from SCADA trend chart – ideal
  - Maximum from data logger (i.e., 1-minute readings) – better than 15 minutes
  - Maximum from data logger (i.e., 15-minute readings) – acceptable
  - Maximum from daily grab samples – least desirable
- Plot OAS performance vs reported values

Access Stored Turbidity Data

Archived Turbidity Data	Findings
Ease of access and file format (e.g., csv, xls)	
Backup protocol and duration of records (1)	
Frequency of logging (2)	

(1) Routine backup is recommended (daily), and turbidity logs must be retained for ten years for compliance purposes.

(2) For regulatory compliance, IFE must be logged every 15 minutes. For optimization, logging at least every one minute is recommended.

Portable and Bench Turbidimeter Monitoring and Comparison to Online Turbidimeters

- Do the grab sample turbidity results accurately represent water quality and compare well with continuous reading turbidimeters (within an acceptable level of precision)?

Sample Handling and Testing Protocol

- Indexing sample cells
- Cleaning sample cells
- Oiling sample cells
- Approaches for addressing gas bubbles and condensation
- Use of signal averaging

Calibration and Verification

- Frequency
- Written Protocol

Sample Location	Continuous Turbidimeter Readings, NTU	Lab Turbidimeter Readings, NTU	Portable Turbidimeter Readings, NTU
Filter 1	0.021	0.37	0.58
Filter 2	0.032	0.26	0.39
CFE	0.023	.067	0.085

Conclusion

- Recognize that multiple *“small”* issues exist.
- Address issues systematically and tenaciously.
- Prioritize issues based on impact of achieving performance goals.