Turbidity Data Integrity in Washington State

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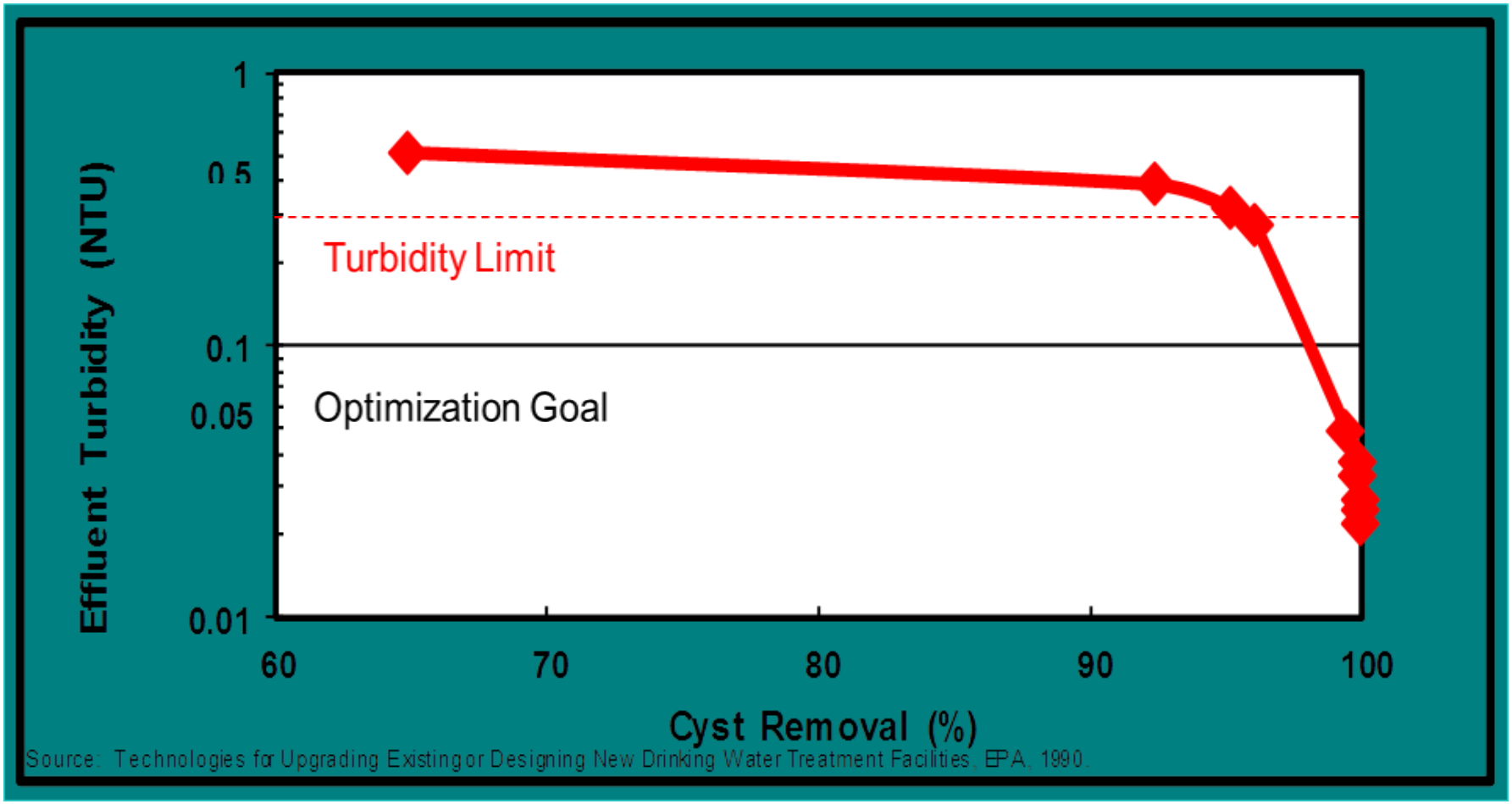
Office of Drinking Water

PNWS – AWWA Spring Conference 2015
Bellevue, Washington

PUBLIC HEALTH
ALWAYS WORKING FOR A SAFER AND HEALTHIER COMMUNITY

Optimization Lowers Risk



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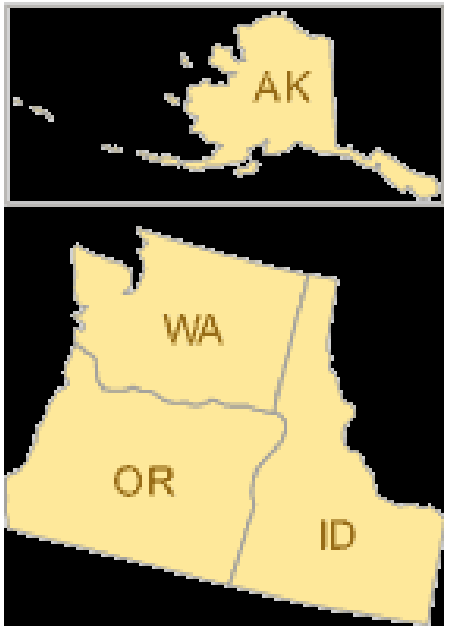
Enhance public health protection through optimizing the performance and operations of existing facilities.



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EPA Data Integrity Workshop
October 2012

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Office of Drinking Water's Mission

To protect the health
of the people of Washington State
by ensuring safe
and reliable
drinking water.

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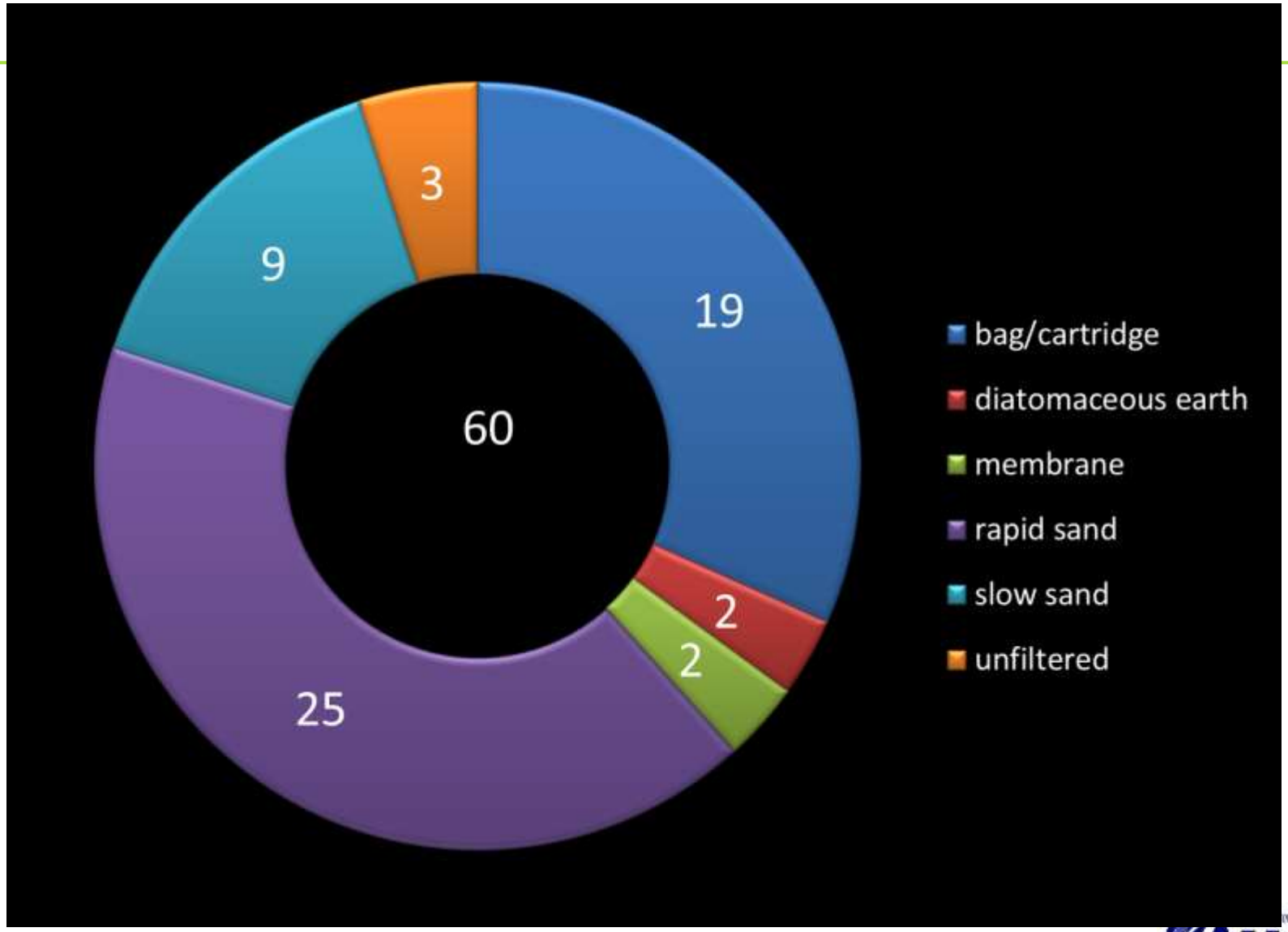
Surface Water Sources by Treatment Technology
Northwest Region



Operator Interview

Written SOP's-Turbidimeter Setup (Y/N)
Written SOP's-Calibration & Maintenance (Y/N)
Maintenance Logs (Y/N)
Equipment Manuals Available? (Y/N)
Calibration frequency
Completing weekly verification checks (Y/N)
Bulb replacement frequency
CFE reporting procedure (describe)
Max daily turbidity reporting procedure (describe)

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Instrument Settings & Installation

Instrument location
Current reading (NTU)
Scada/recorder reading (NTU)
SENSOR SETUP-CALIBRATE
CAL HISTORY last calibration (date)
SENSOR SETUP-CONFIGURE
Bubble reject (yes/no)
Signal Averaging (sec)
Data Log Interval (min)

Instrument Settings & Installation

SYSTEM SETUP-OUTPUT SETUP

Set transfer (mA)

Scale (0-20 or 4-20 mA)

Activation Low (NTU)

Activation High (NTU)

SYSTEM SETUP-ERROR HOLD MODE

Error Hold Mode (hold/xfer)

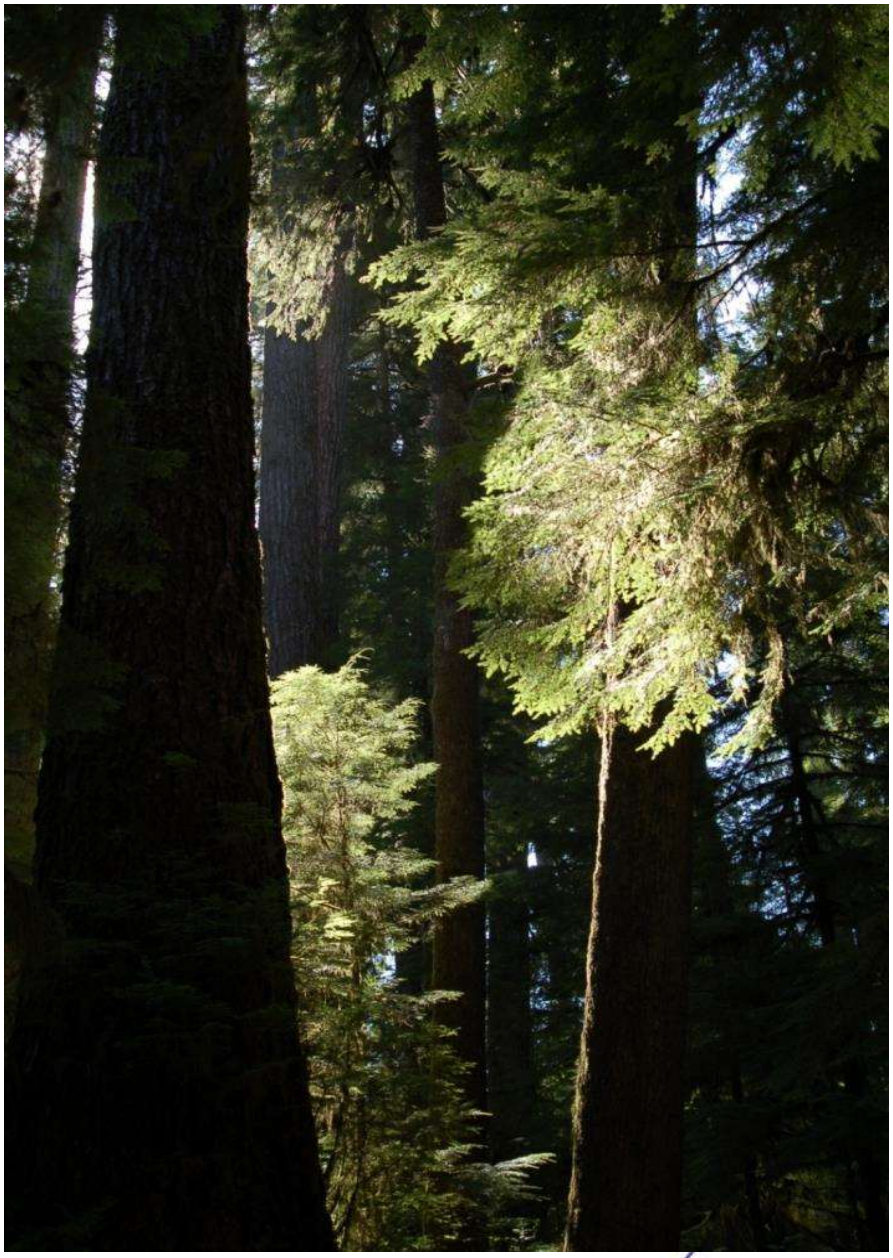
METER FLOWRATE (mL/min)

INSTALLATION DETAILS
Tap location, sample line length

Site Visit Record Sheet

- Turbidimeters and controllers
- Method for determining and recording CFE Finished four hour readings and the Max daily CFE on agency report
- Signal Span Setting (Max turbidity recorded and reported)
- Error Hold Mode (hold / xfer)
- Other discussion topics

What We Found



Error Mode

Controls value sent to SCADA/recorder when a communication error occurs between the sensor & controller

- Both Microtol and HACH SC controllers have this setting.
- Default setting for HACH SC controllers: “hold the last good reading.”
- If an error occurs when this is set to “hold,” the error will show on the controller screen, but not on the remote SCADA or chart recorder

100 %

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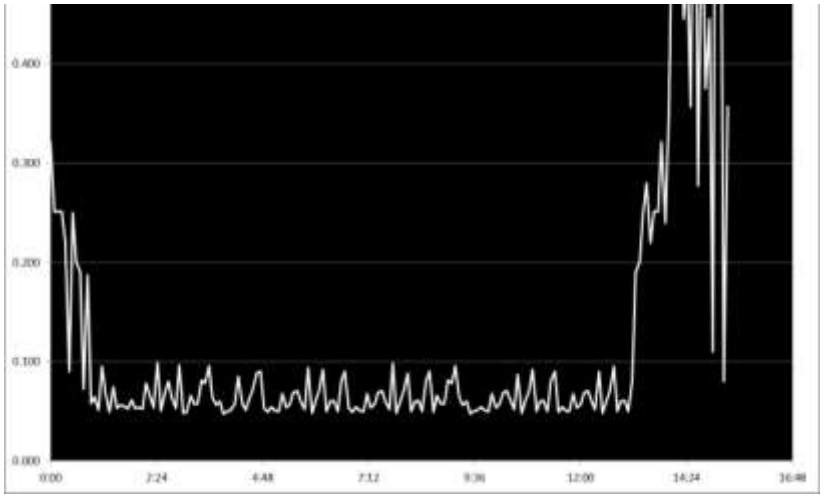
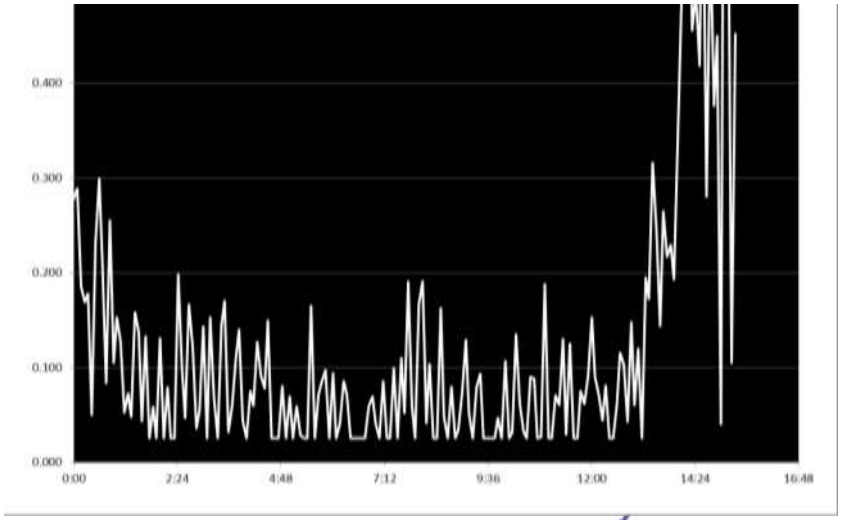
Signal Averaging

44%

Reduces “noise” in the data by averaging individual readings

- Goal: stable reading so you can detect particle events, trends and breakthrough.
- Typical options: 6, 30, 60, 90 secs (HACH)
- Default typically 30 secs.
- Use 6 secs. for calibration only.
- Higher values increase response time.





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Bulbs Not Replaced Annually

Tungsten bulb HACH – degrades over time, this degradation speeds up over time.

- HACH recommends bulbs be replaced at least once a year.
- Thirteen not replacing bulbs annually:
  - Replace when no longer able to obtain calibration.
  - Replace when light goes out.
  - Replace when light looks dim.
  - News to me – didn't know.
  - HACH scam may cost you money.
- Waiting to replace on failure or until unable to achieve calibration, may result in unit not holding the quarterly calibration.

52%

Weekly Verification:
Comparison check against a benchtop turbidimeter

64%

- Required under WAC 246-248-638 to:
  - Verify the instrument between calibrations.
  - Maintain proficiency with the backup turbidimeter.
- Benchtop will read higher. A good verification is +/- 10 percent or 0.05 NTU when below 0.5 NTU.
- *"My benchtop never matches the on-line instrument."*

≠

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Weekly Verification

"My benchtop never matches the on-line instrument"

0.030 NTU

Try this experiment

1. Start by calibrating both instruments.
2. Take a grab sample and pour it into an old scratched sample cell.
3. Take a reading.
4. Change to a new sample cell.
5. Wipe your hands all over it.
6. Take a reading.
7. Now, improve your technique.

Weekly Verification
Technique matters

Online turbidimeter	**0.03 NTU**	
Bench top turbidimeter:		
Old scratched sample cell	**0.47**	
New sample cell, wiped with your hands	**0.23**	
Clean the sample cell	**0.12**	
Apply silicone oil	**0.09**	
Orient the sample cell	**0.08**	***a good verification***

Weekly Turbidimeter Verification Check Documentation

Turbidimeter	SCADA Reading	Online Meter	Grab Sample	W/in 0.05 NTU *Y/N*
Filter #1	0.06	0.06	0.09	Yes
Filter #2	0.10	0.10	0.16	No
Filter #3	0.13	0.13	0.16	Yes
CFE	0.13	0.12	0.16	Yes

Follow up Action taken if difference > 0.05 NTU: Filter #2 online unit re-calibrated 3/3/2015.

Date:

Signed:

Measuring Turbidity

Common problems

- Non-functioning meter (antique)
- Not properly calibrated
- Scratched sample cells (buy new, use oil)
- Dirty sample cells (clean, don't use a shop cloth)
- Bubbles
- Stray light

More tips:

Follow the instructions in the equipment users manual.

Degas (let it sit for several minutes with loose cap).

Avoid condensation (cold sample/warm lab).

Evaluate sample tap.

Sample Flowrate

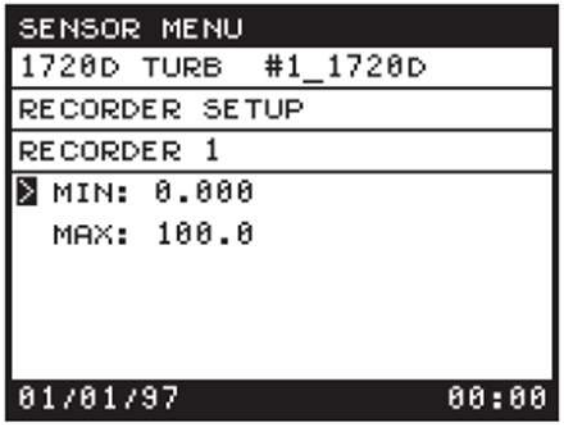
- Specified for all continuous instruments
- 200 – 750 mL/min HACH 1720E
- High flows = quicker response
- High flows + cold water = bubbles
- Greater than specifications may lead to overflows and incorrect readings
- Eyeball method
- Variable flows – filter head
- Measure and document

70%

Signal Span

Range of turbidity values that will be sent to the chart recorder or SCADA via 4 to 20 mA signal

- Balance range and resolution.
- Detect regulatory limits.
- Resolution for optimization.
- We found:
  - 4 mA = 0.000 NTU.
  - 20 mA = 0.5 to 100.0 NTU.



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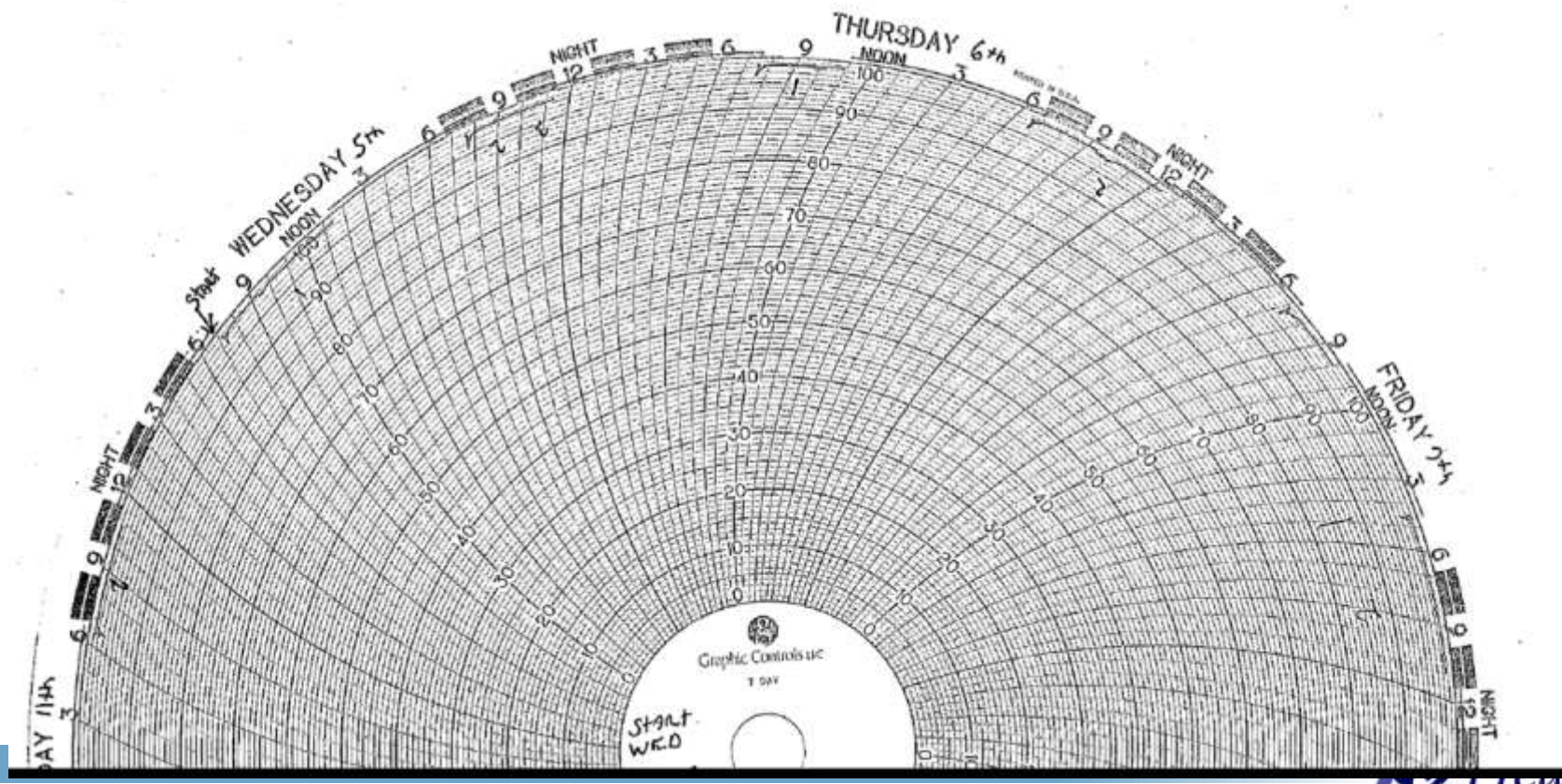
Signal Span-Circular Chart

Signal Span Setting	Each increment
0 – 100 NTU	1.0 NTU
0 – 10 NTU	0.1 NTU
0 – 5 NTU	0.05 NTU



Signal Span-Resolution

0-100 NTU		0-10 NTU		0-5 NTU	
mA	NTU	mA	NTU	mA	NTU
4.00	0.000	4.00	0.000	4.00	0.000
4.01	0.062	4.01	0.006	4.01	0.003
4.02	0.125	4.02	0.012	4.02	0.006
4.03	0.188	4.03	0.019	4.03	0.009
4.04	0.250	4.04	0.025	4.04	0.013
4.05	0.312	4.05	0.031	4.05	0.016
4.06	0.375	4.06	0.037	4.06	0.019
4.07	0.438	4.07	0.044	4.07	0.022
4.08	0.500	4.08	0.050	4.08	0.025
4.09	0.562	4.09	0.056	4.09	0.028
4.10	0.625	4.10	0.062	4.10	0.031
4.11	0.688	4.11	0.069	4.11	0.034
4.12	0.750	4.12	0.075	4.12	0.038
4.13	0.812	4.13	0.081	4.13	0.041
4.14	0.875	4.14	0.087	4.14	0.044
4.15	0.938	4.15	0.094	4.15	0.047
4.16	1.000	4.16	0.100	4.16	0.050
4.17	1.063	4.17	0.11	4.17	0.053
4.18	1.125	4.18	0.11	4.18	0.056
4.19	1.188	4.19	0.12	4.19	0.059
4.20	1.250	4.20	0.13	4.20	0.063
4.21	1.313	4.21	0.13	4.21	0.066
4.22	1.375	4.22	0.14	4.22	0.069
4.23	1.438	4.23	0.14	4.23	0.072
4.24	1.500	4.24	0.15	4.24	0.075
4.25	1.563	4.25	0.16	4.25	0.078
4.26	1.625	4.26	0.16	4.26	0.081
4.27	1.688	4.27	0.17	4.27	0.084
4.28	1.750	4.28	0.18	4.28	0.088
4.29	1.813	4.29	0.18	4.29	0.091
4.30	1.875	4.30	0.19	4.30	0.094
4.31	1.938	4.31	0.19	4.31	0.097
4.32	2.000	4.32	0.20	4.32	0.100

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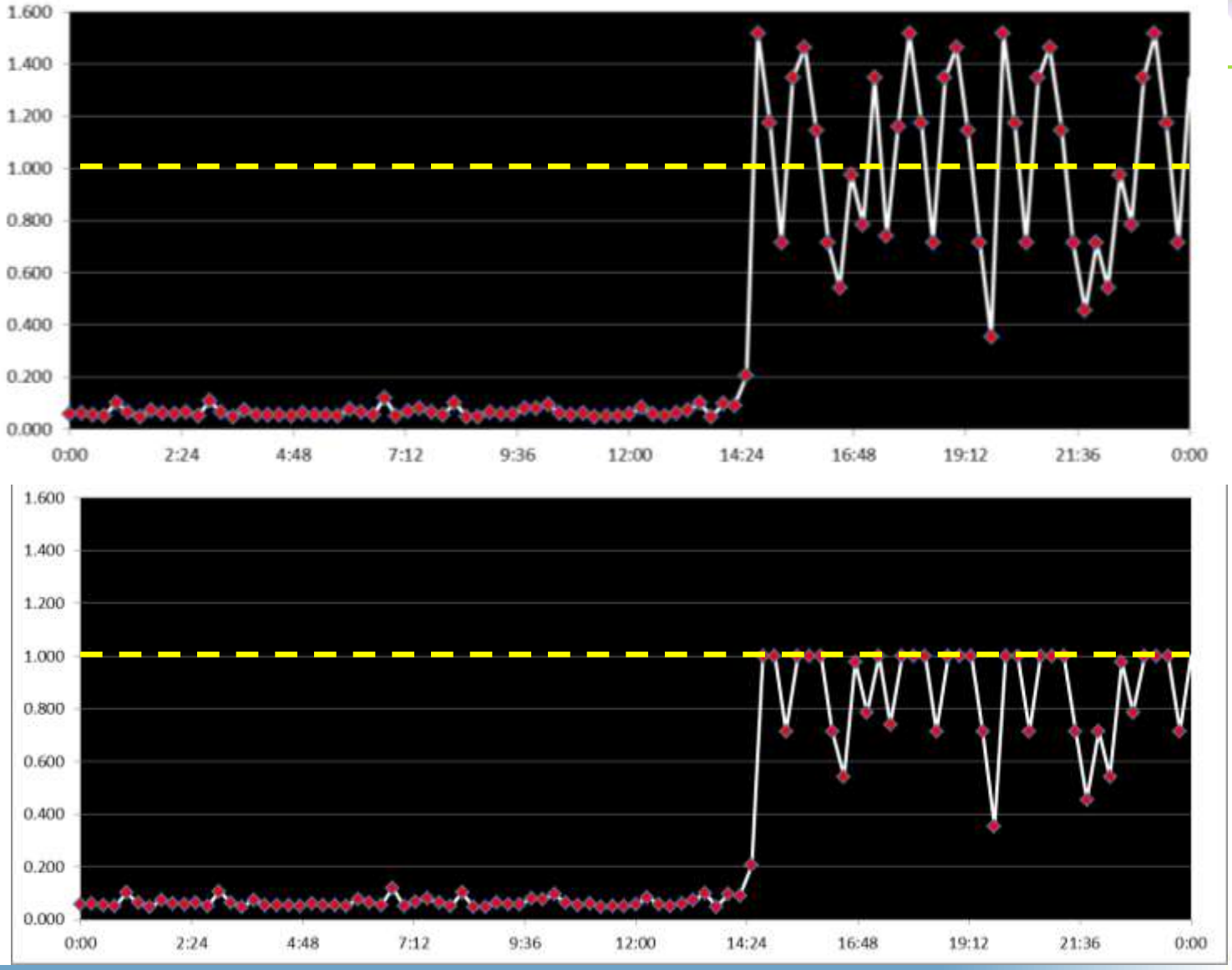
Data Capping

72%



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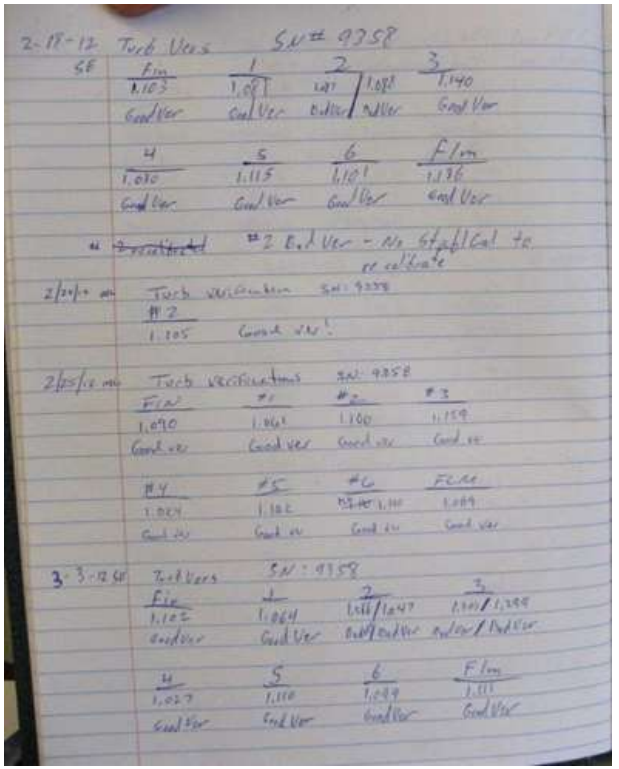
Inconsistent Settings Between Instruments 47%

No standard operating procedures (SOPs) for instrument setup

92%

No maintenance logs

40%



Simple Standard Operating Procedures for Turbidimeter Setup

PART THREE - OPERATION SECTION 3 - INSTRUMENT STARTUP

column can be used to write in entered setup values for convenient referral.

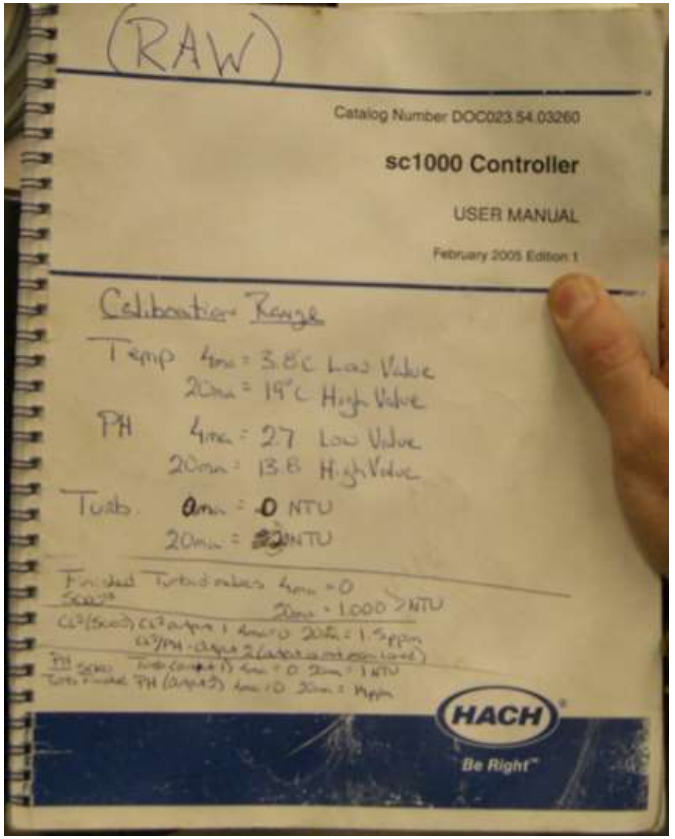
Table A — ENTRY RANGES AND DEFAULTS FOR SETUP KEYS

Displayed Identifier	Use	Entry Value Range Min.	Entry Value Range Max.	Default Value	Record Your Entry
"CAL NTU"	Sets turbidity calibration point.	2.00	100.0	40.0	
"SIM NTU"	Sets simulated turbidity value for diagnostic purposes. The analog and relay outputs respond to the displayed value.	0.000	100.0	50.0	
"ALARM A"	Sets setpoint at which Relay A trips.	0.000	100.0	100.0	
"DB A NTU"	Sets deadband for Relay A.	*	*	1.00	
"ALARM B"	Sets setpoint at which Relay B trips.	0.000	100.0	100.0	
"DB B NTU"	Sets deadband for Relay B.	*	*	1.00	
"HI OUT"	Sets high endpoint at which maximum analog outputs (20 mA, 1 mA and 5 VDC) are provided–the range expand feature.	0.100, 1.00 or 10.0	100.0	100.0	
"LO OUT"	Sets low endpoint at which minimum analog outputs (4 mA, 0 mA and 0 VDC) are provided–the range expand feature.	❖	❖	0.000	
"OFFSET"	Sets offset value to be applied to the measured turbidity value.	-0.999	+0.999	0.000	
"LOCK # ?"	Locks instrument with correct lock code.	0000▲	9999▲	0	
"UNLOCK #"	Unlocks instrument with correct unlock code.	000▲	999▲	000	

* Deadband range must be larger than 1% but smaller than 10% of the span of the measuring range in which the associated setpoint resides.

❖ The segment established by the HI OUT and LO OUT values cannot be smaller than 10% of the span of the measuring range in which the segment resides.

▲ For lock and unlock codes, see Part Three, Section 3.7.



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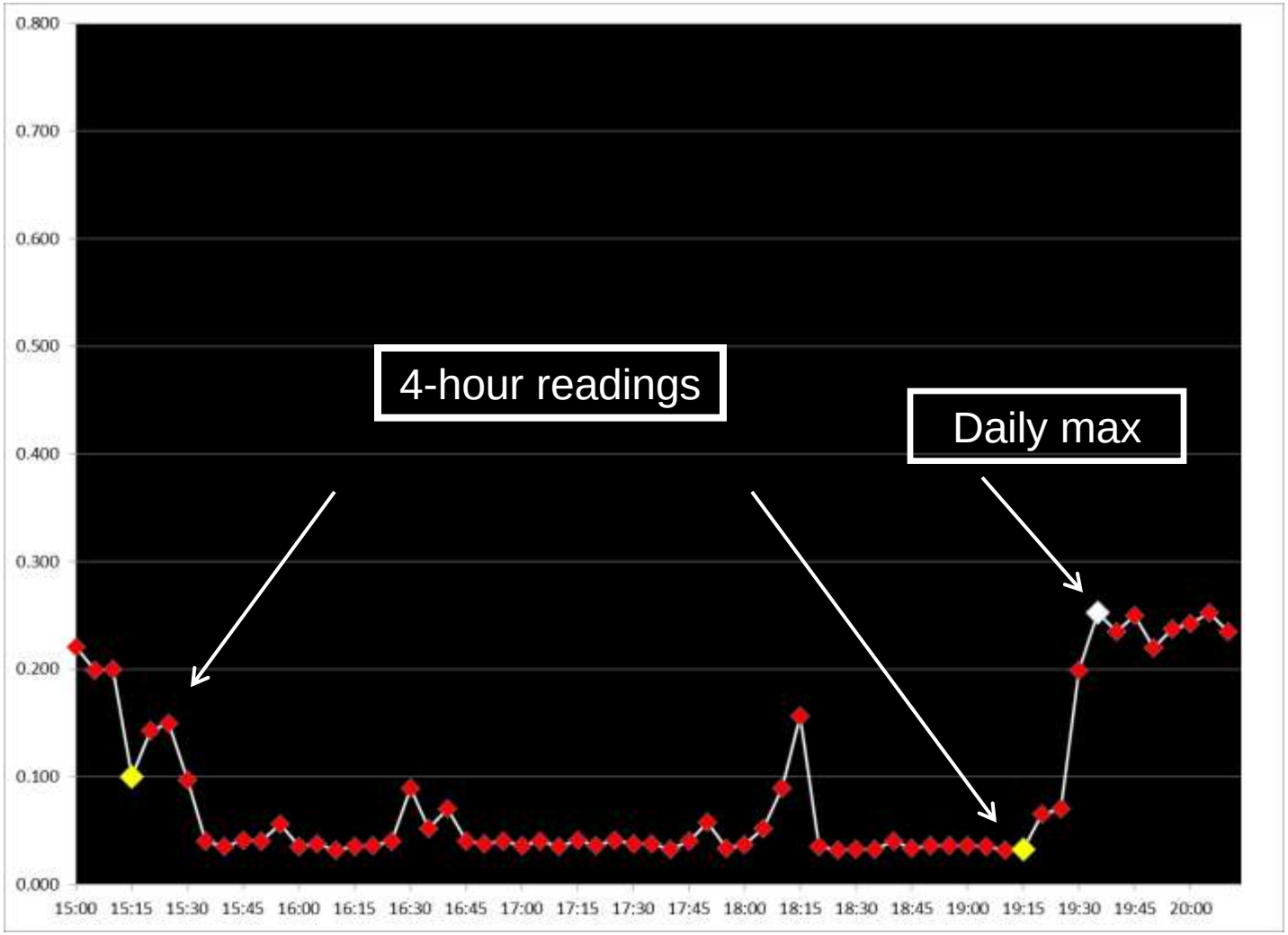
Primary Calibration

100%

Turbidity Reporting: Monthly Operations Report



40%

44%

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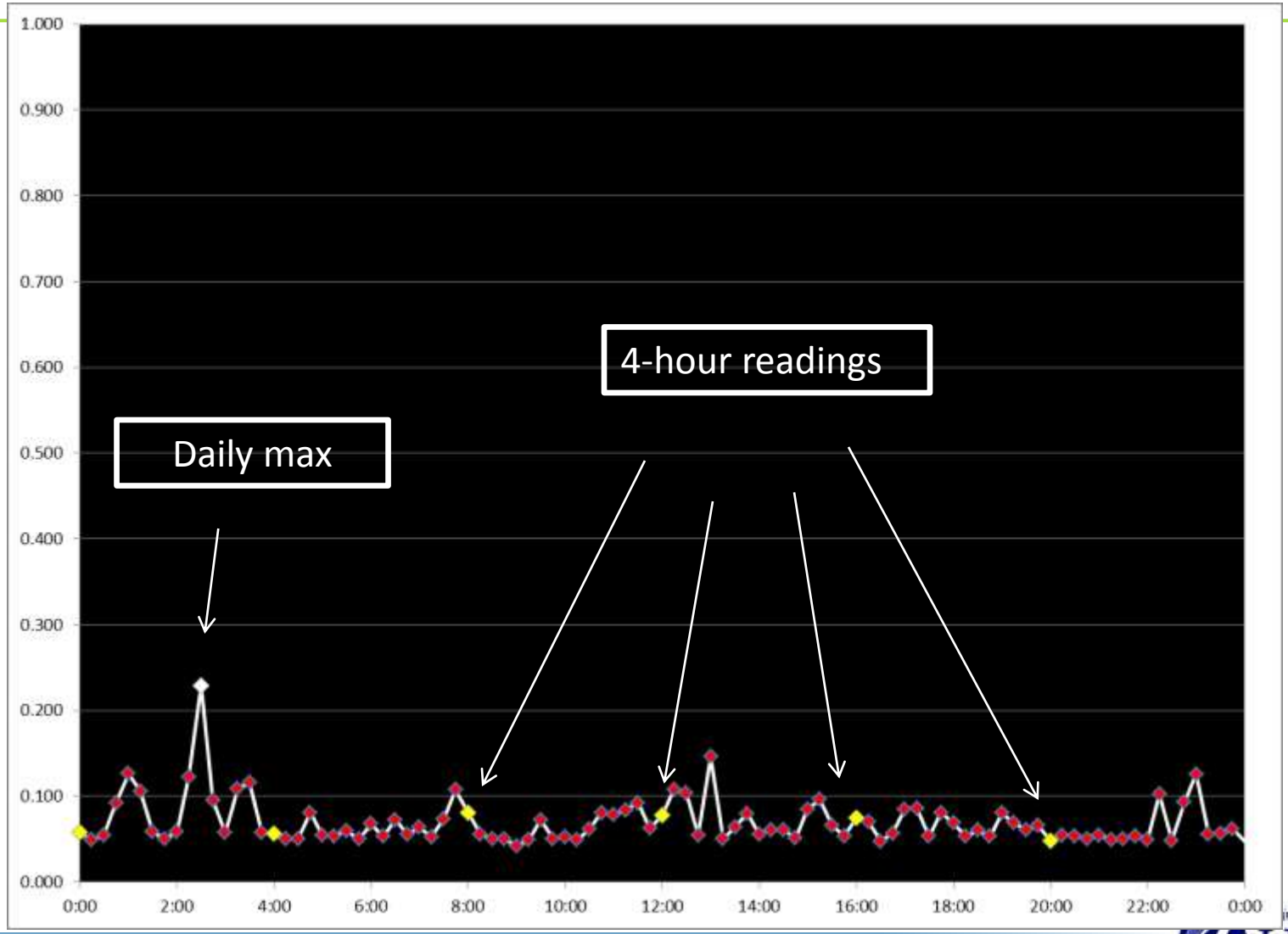
Turbidity Reporting: Monthly Operations Report



Data Integrity
Recorder doesn't match online instrument reading

16%

Caution!

The 4-20 mA scale in the turbidimeter/controller and the recorder/SCADA must match.

4 mA = 0.00 NTU
20 mA = 1.00 NTU

4 mA = 0.00 NTU
20 mA = 1.00 NTU

20 mA = 5.00 NTU

0.35 NTU

9.60 mA

5.12 mA

0.35 NTU

0.29 NTU

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Data Integrity

- No data recording device or inoperable recording device.

12%

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Installation Tips

- Use representative sample location.
- Tap the side of the pipe.
- Use short sample lines.
- Avoid pumping if you can.
- Don’t mix and match plumbing fittings.
- Replace sample tubing regularly.

Setup for Easy Maintenance

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Recommendations for Setup, Maintenance & Reporting

- Water Tap article
- Handout
- Agency guidance
- Dec. 2014 JAWWA

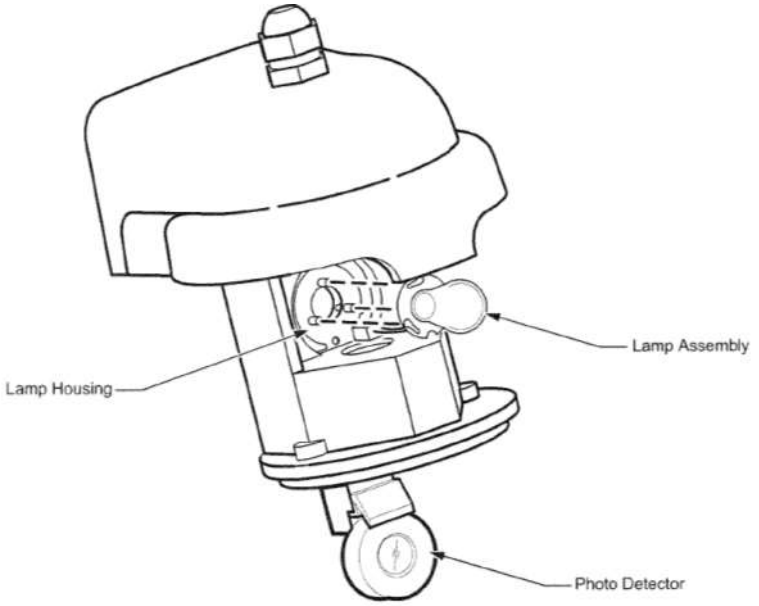
Recommended Turbidimeter Settings and Monitoring Guidelines for Rapid Rate Sand Filtration Plants
Office of Drinking Water, Washington State Department of Health

In rapid rate water filter plants treating surface water, turbidity measurements are the single most important parameter used to verify that the filtration process is working correctly and is removing potential pathogenic organisms from the source water. The accuracy of the turbidimeter data generated, recorded and reported to utilities and to health departments is affected by a surprising number of factors that include instrument settings, physical locations, electronic data manipulation, operational practices and human actions. The DOH conducted a study of 25 rapid rate filter plants in Washington State and found deficiencies in all 25 plants that could or did affect the accuracy of the turbidity data reported to the DOH. A deficiency shared by 92% of the surveyed plants was a lack of written standard operating procedures (SOP) for instrument settings and reporting. This guideline is intended to provide recommended turbidimeter settings and clarification on monitoring and reporting practices that were identified during this turbidity data integrity project.

Turbidimeter Setting or Activity	Recommendation
Written SOPs for turbidimeter settings	Required
Sample Flowrate	Measure at least monthly. Meet the manufacturer's specifications.
Error Hold Mode	Transfer to 0.0 NTU
Signal Averaging	30 sec
Weekly Verification Check *	Required. Record numbers. Can use ice pik method.
Bulb replacement	At least annually or as recommended by the manufacturer.
Instrument specific maintenance log	Required
Primary Calibration	At least quarterly.
Signal Span **	0 – 5 NTU for finished water.
Data recorder ***	Required. Must be calibrated to sensor output.
Bubble reject	On
Sensor datalog interval (if no scada / recorder)	1 or 5 minutes (1 min is preferred unless data storage or processing limitations exist).

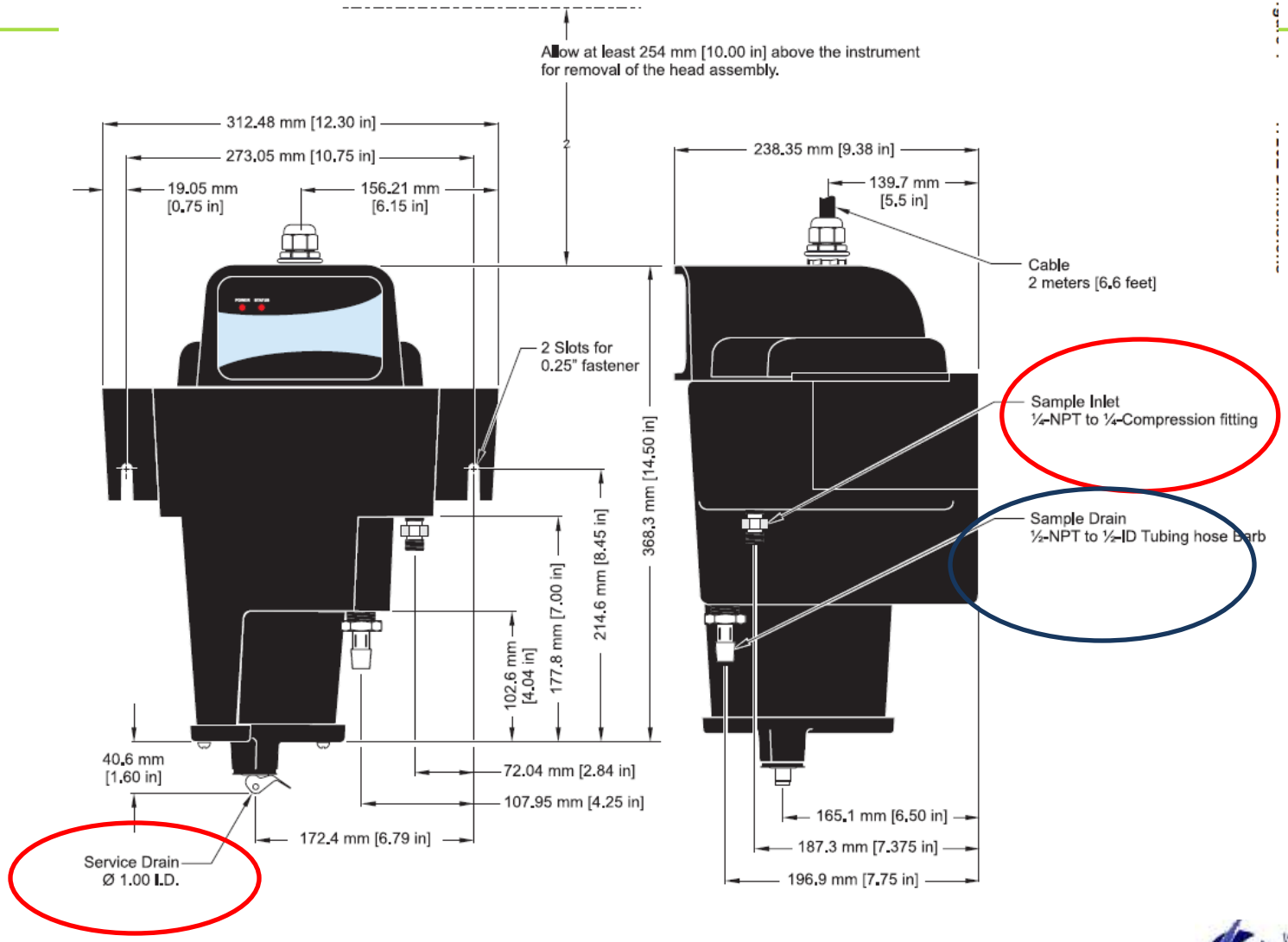
- * Weekly comparison of the continuous turbidimeters with a calibrated bench top turbidimeter is required for two primary reasons: To verify that the continuous units are maintaining accuracy between quarterly calibrations, and to maintain operator proficiency with the bench top unit. Should a continuous unit fail, ongoing turbidity monitoring would be required using the bench top unit. Results between the continuous unit and the bench top may not match. An acceptable difference between the values is 10% or +/- 0.05 NTU. If the difference between units is inconsistent or too large contact the DOH regional office or instrument manufacturer. The weekly verification values should be recorded in the turbidimeter specific maintenance logbook.
- ** The signal span / maximum value must be set above the regulatory limit for that monitoring location, i.e. the CFE turbidimeter must be able to measure and record turbidities exceeding 1.0 NTU and IFE turbidimeters must be able to measure and record turbidities exceeding 2.0 NTU.
- *** The instrument output must be scaled to match the SCADA or recorder scale.

Other Issues?



- Photo Cells
- Power supply
- Quality of replacement parts
- Best sample pumps
- Flow control
- Constant head

Where to collect grab sample-HACH 1720 series



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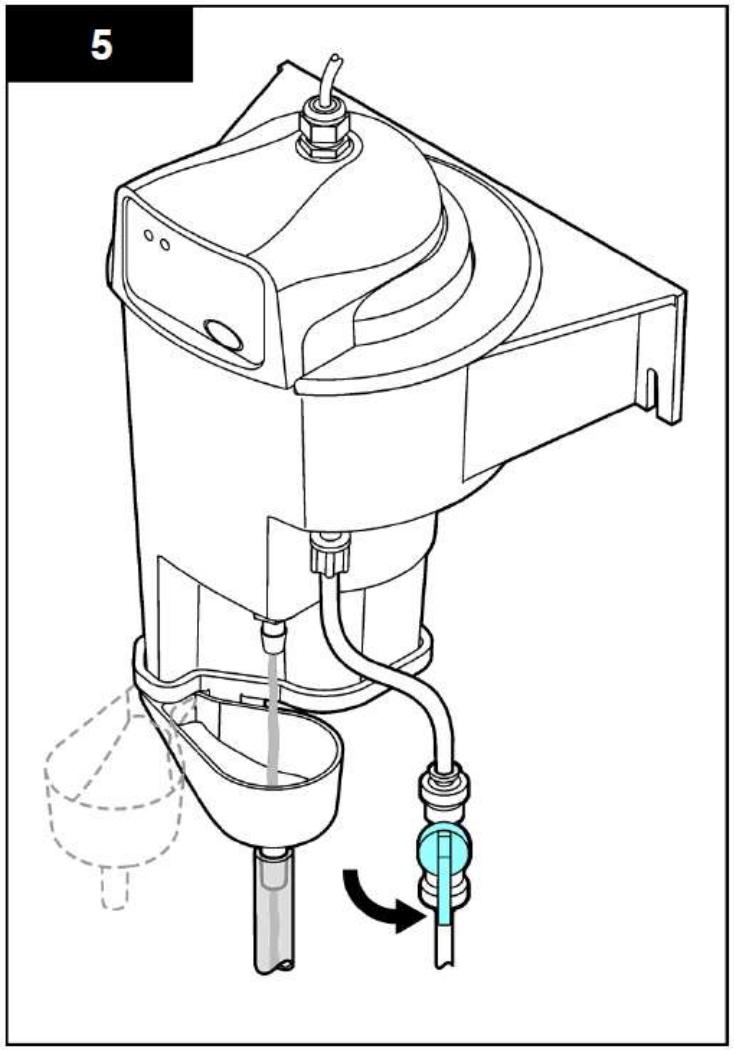
HACH 1720 Series Funnel Attachment



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Where to collect a grab sample - Microtol

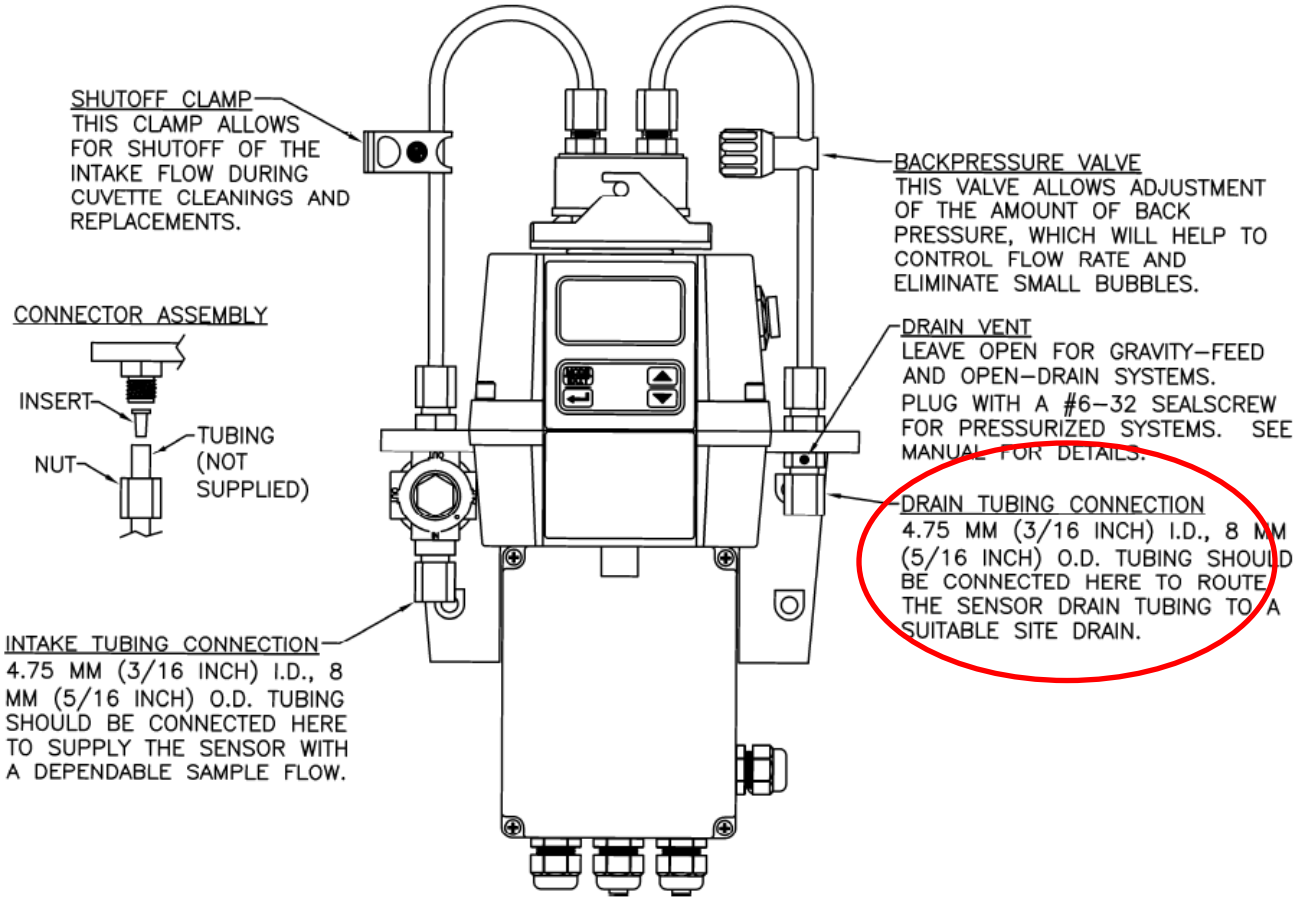

Figure 4: Recommended Plumbing for the Instrument

THANKS!

BIMC

Water District 19

Calmor Cove

Thunderbird Park

Thunderbird Terrace

Alcoa Intalco Works

Seattle Public Utilities

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Turbidimeter Calibration

http://www.youtube.com/watch?v=zjlNaNf3Olg

Treatment Optimization Program

The Washington Treatment Optimization Program (TOP) is an effort to improve the performance of surface water treatment facilities. TOP focuses on particle removal and disinfection to maximize public health protection from microbial contaminants.

The Washington Department of Health has adopted performance goals for all rapid rate surface water treatment plants in the state.

Optimized Performance

Filtration

- Filtered water turbidity is less than 0.1 NTU 95 percent of the time, based on maximum values recorded during 4-hour time intervals (excluding 15 minutes after filter backwash).
- Filtered water is below 0.1 NTU within 15 minutes of filter being in production.
- Maximum filtered water turbidity below 0.3 NTU.
- Filters are backwashed before breakthrough.
- Raw water turbidity changes do not affect filtered water turbidity.

Disinfection

- Required CT values are achieved at all times.

Turbidity Monitoring

- Raw water turbidity is monitored at least every 4 hours.
- Effluent turbidity is continuously recorded for each filter.
- Combined filter effluent turbidity is continuously recorded.

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Environmental Health Programs
Division of Drinking Water

For more information about TOP, please contact Stephen Baker at 360-236-3138 or stephen.baker@doh.wa.gov