How Optimization Can Improve Performance

NEW MEXICO DRINKING WATER BUREAU, TECHNICAL ASSISTANCE

MARTIN TORREZ AND PETER NATHANSON

What is AOWP?

- Primary goal is to maximize public health protection through optimization of existing water treatment and distribution facilities.
- Individual states formulate their own AWOP activities in a supportive environment that fosters teamwork and networking.
- Provides a framework to successfully incorporate optimization efforts in the day-to-day operation of the State Drinking Water Program.

Optimization Background

- Originally conducted plant evaluations to meet more stringent regulations
  - Late 80's SWRT – Lowered turbidity limit to 0.5 NTU
  - LT 1 ESWTR – Lowered turbidity limit to 0.3 NTU
  - LT 2 includes bin option to achieve Crypto credit by meeting lower turbidity levers (i.e., 0.15 NTU)

Optimization Background (cont.)

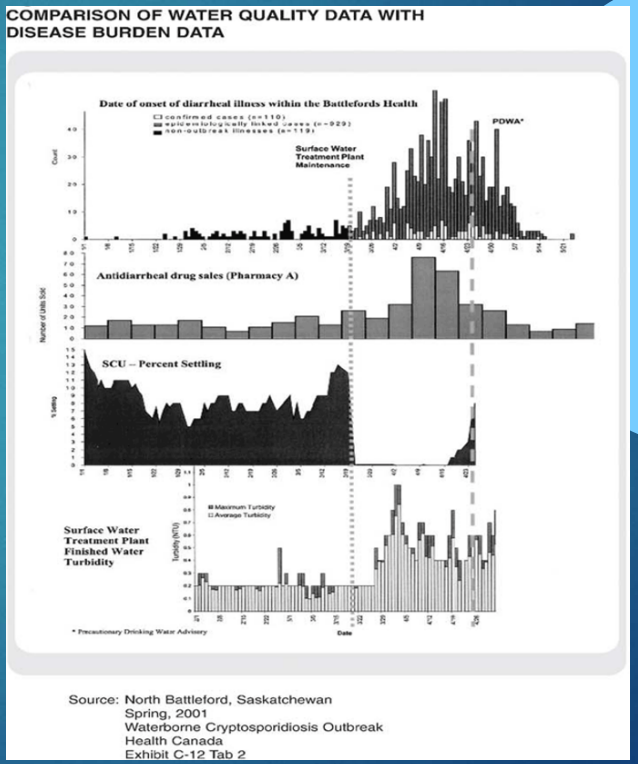
- Shift from regulatory compliance mentality to optimization of existing facilities
- Impetus for the shift:
  - Milwaukee (Cryptosporidium outbreak – 1993)
  - Research has identified that lower turbidities can significantly reduce public health risk (i.e., 0.10 NTU or lower)

Recent Outbreaks

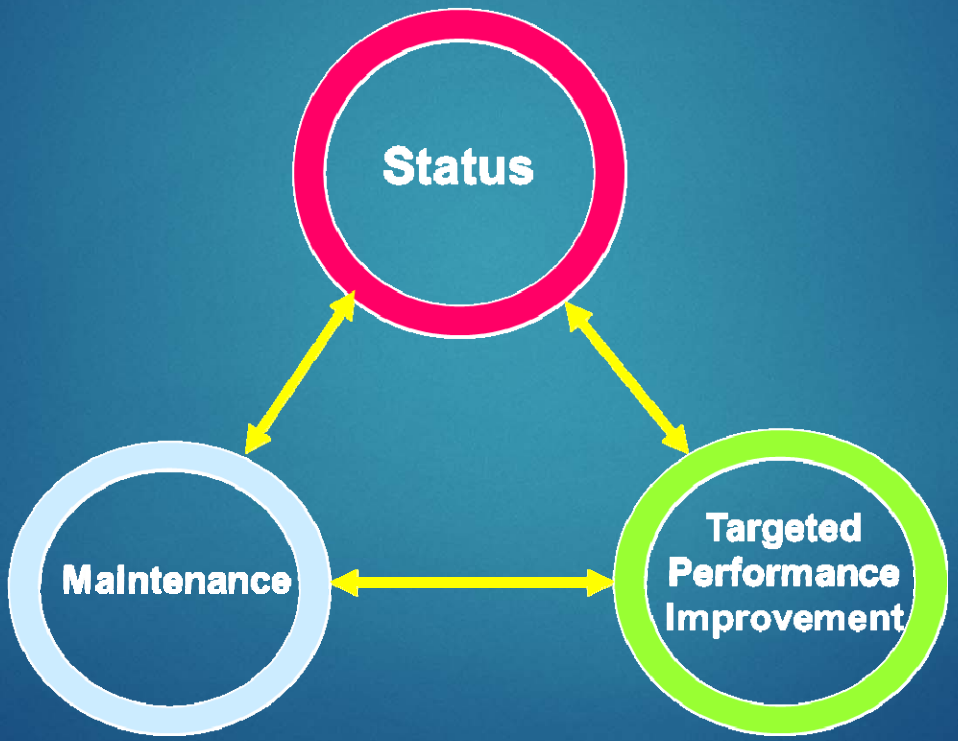
Location	Year	Type of System	Estimated Number of Cases
Bernalillo County, New Mexico	1986	Untreated surface water supply	78
Milwaukee County, Wisconsin	1993	Treated surface water supply	403,000
Cook County, Minnesota	1993	Treated surface water supply	27
Clark County, Nevada	1994	Treated surface water supply	78
N. Battleford, Saskatchewan	2001	Treated surface water supply	>5,000
Baker City, Oregon	2013	Surface water supply with disinfection treatment only	2,780
South Roscommon, Ireland	Ongoing Since 2011	Spring supply with disinfection treatment only	"Many"

North Battleford, Saskatchewan

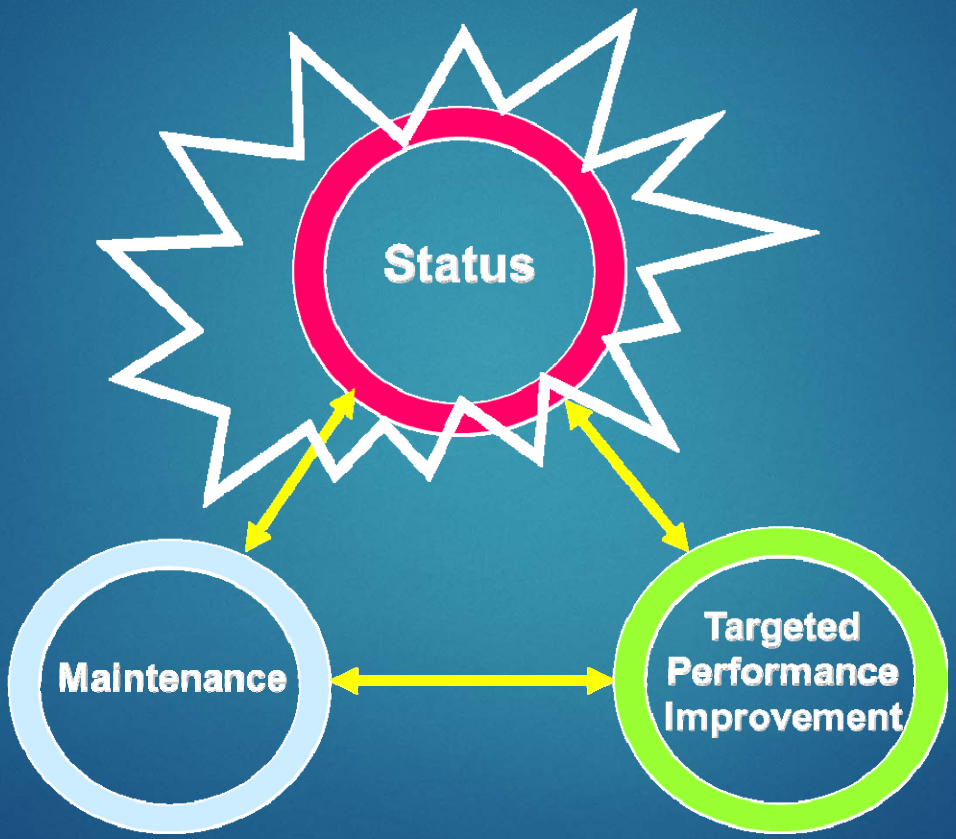
- Solids contact unit repaired/cleaned in March 2001
- Operators not concerned with loss of settling process
- Sewage effluent upstream may have passed over water intake
- Filter breakthrough occurred



AWOP Model Components



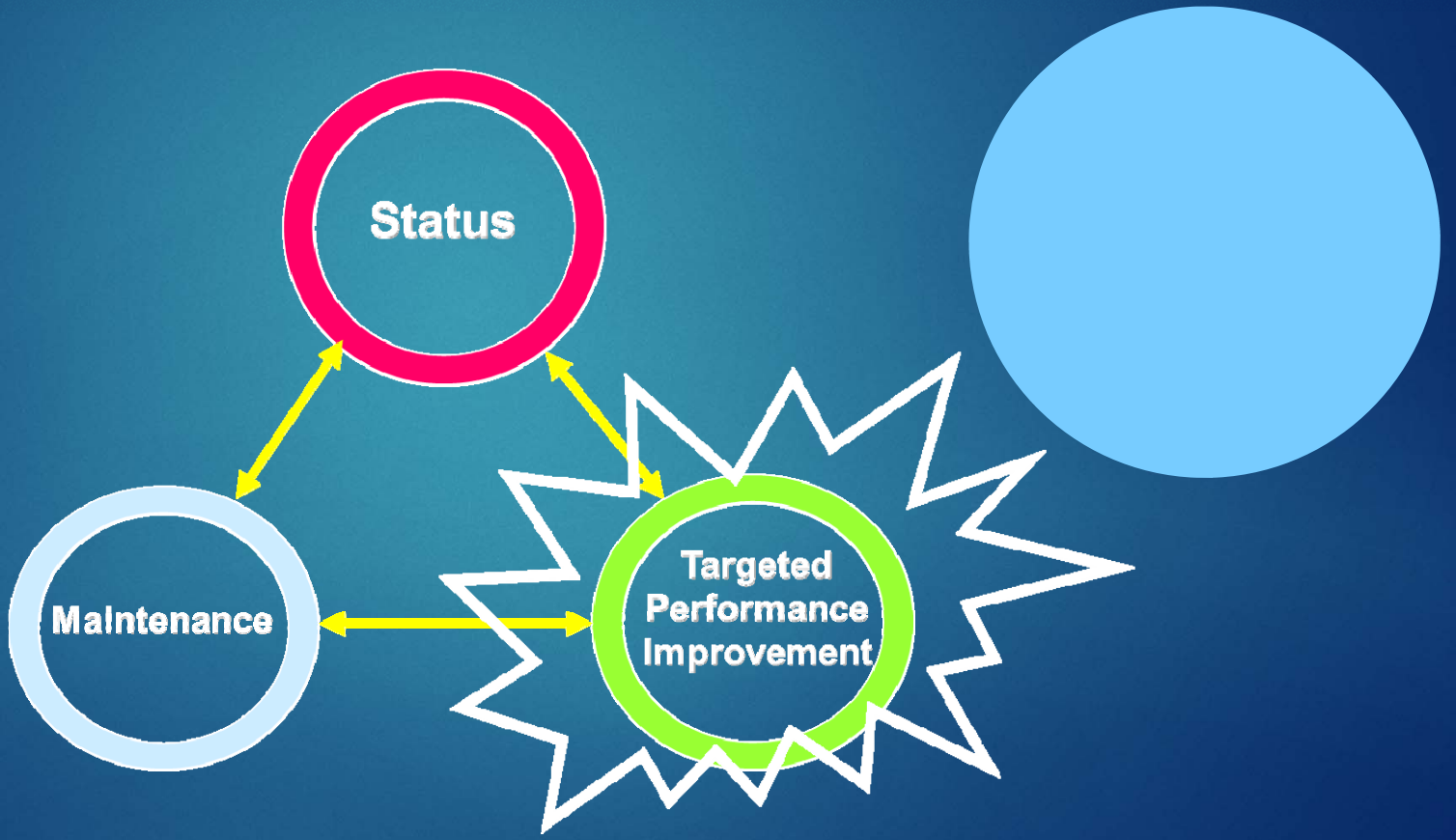
AWOP Model Components



Status Component

- The foundation of AWOP activities:
  - Prioritizes plants relative to public health risk, allowing allocation of resources to highest risk facilities.
  - Awareness building of water system (and state) staff.
  - Performance tracking of water systems – optimization assessment spreadsheet (OAS) available.
  - Provides information to document progress and success.

AWOP Model Components



Targeted Performance Improvement (TPI) Component

- The evaluation and technical assistance component of AWOP:
  - Deliberate, structured activities.
  - Targeted at individual or group of systems based on their performance (risk) status.
  - Intended to achieve measurable performance improvements and reliability
- Utilize status component to prioritize systems and assess TPI impact (i.e., track performance).
- Utilize different tools for various risk levels (high, medium, low risk systems).

Tools

- **Comprehensive Performance Evaluation**
- Developed by EPA and PAI to support SWTR compliance.
- Objective (third party) evaluation, by at least two evaluators, over 3 - 5 days.
- Identifies root causes of poor performance.
- Required by federal regulations if filter turbidity triggers exceeded.
- Excellent training opportunity for state and regional staff.
- CPE protocol has also been applied to DBP, distribution system, and ground water optimization.

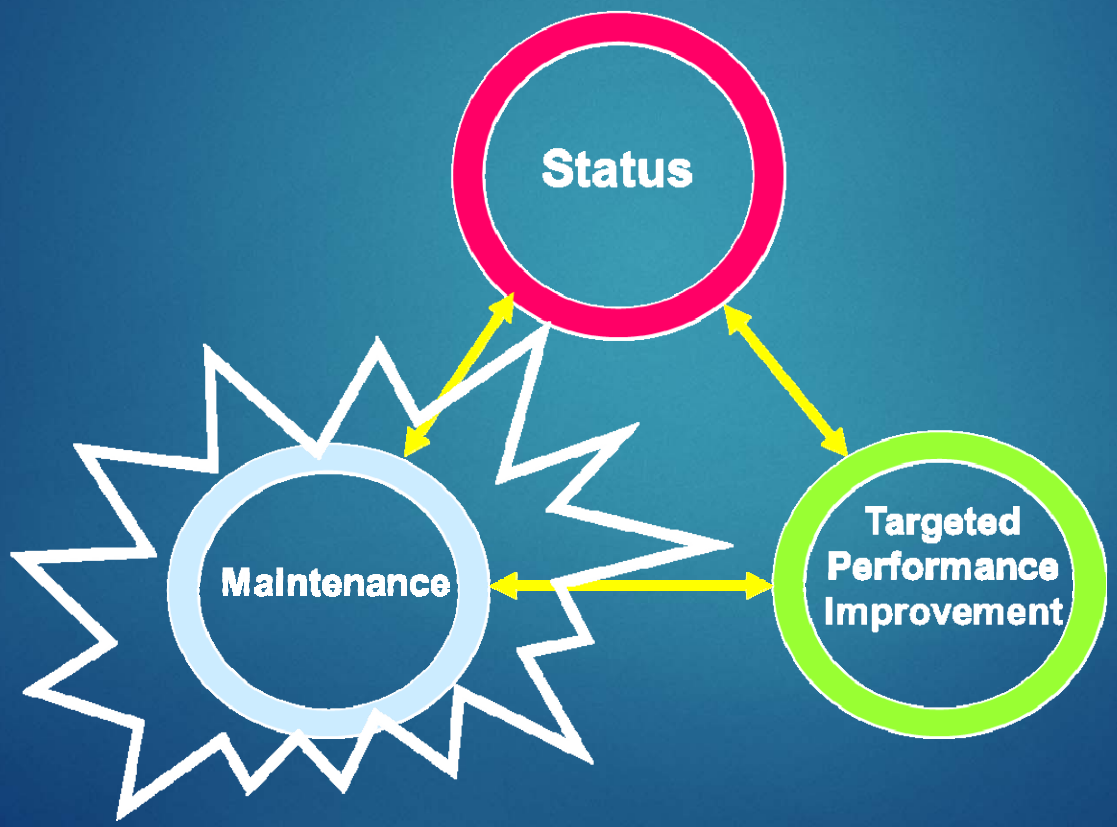
Tools

- **Performance Based Training**
- Approach for addressing common performance-limiting factors.
- Can be tailored to state-specific issues and types of treatment.
- 12 to 24-month training series with a group of plants (4-8).
- Quarterly sessions with homework.
- Focuses on developing priority-setting and problem-solving skills for water system staff.
- Assigned facilitators keep plants on track between sessions (phone calls, homework feedback).

Targeting Tools According to Risk

- High risk systems ⇒ CPE, individualized technical assistance
- Medium risk systems ⇒ CPE, PBT
- Low risk systems ⇒ enhanced sanitary surveys, entry of OAS data, self-assessments (e.g., AWWA Partnership for Safe Water)

AWOP Model Components



Maintenance Component Objectives

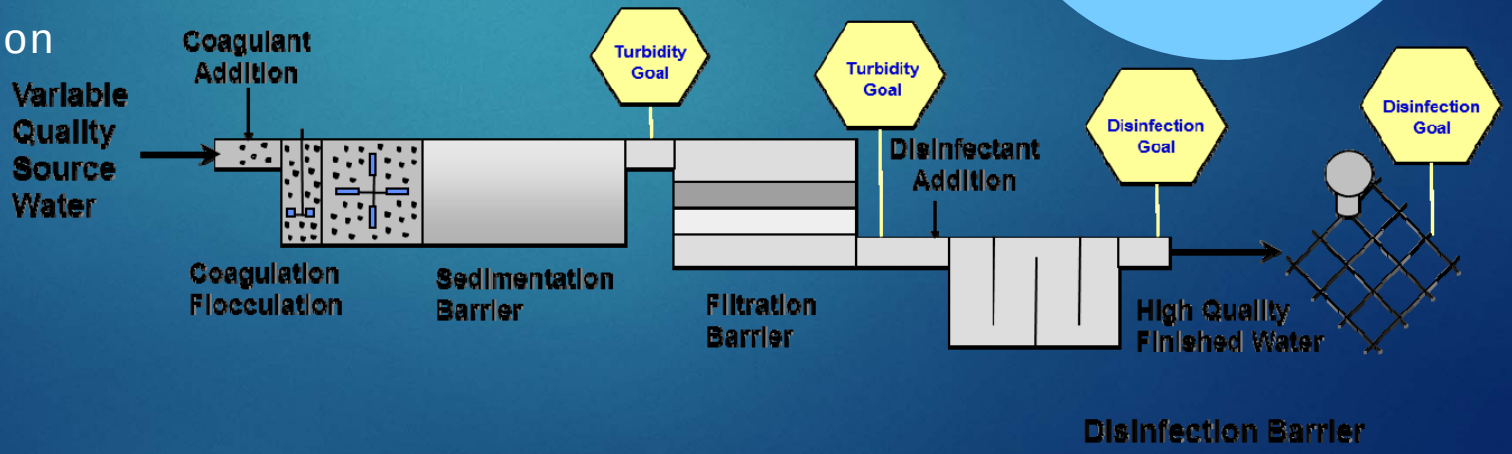
- To sustain AWOP activities within the state organization (i.e., personnel, resources, quality control)
- To integrate AWOP *"thinking"* into other aspects of drinking water programs
- To expand the impact of optimization efforts (i.e., incorporate data integrity concepts, apply to new regulations or performance goals, document and publish program successes)

Maintenance Component Example Areas of Focus

- Management awareness of AWOP and its success
- Revisions to sanitary survey procedures
- Revisions to monthly operating reports (MORs)
- Integrate with capacity development
- Enhancements to operator training
- Approach to deal with regulatory-triggered CPEs
- Ties to State Revolving Fund (SRF) loan approval
- Revisions to state design review of new systems

Optimized Performance Goals

- Optimization requires treatment beyond regulatory levels.
- Focus on multiple barrier strategy to enhance plant performance:
  - Particle removal (i.e., turbidity).
    - Coagulation/flocculation + sedimentation + filtration
  - Disinfection



Sedimentation Performance Goals

- Max Daily Turbidity:
  ≤ 2 NTU 95% time when source turbidity >10 NTU
- Max Daily Turbidity:
  ≤ 1 NTU 95% time when source turbidity ≤ 10 NTU
- Frequency of data acquisition from continuous meters:
  ≤ 15 minutes

Filtration Performance Goals

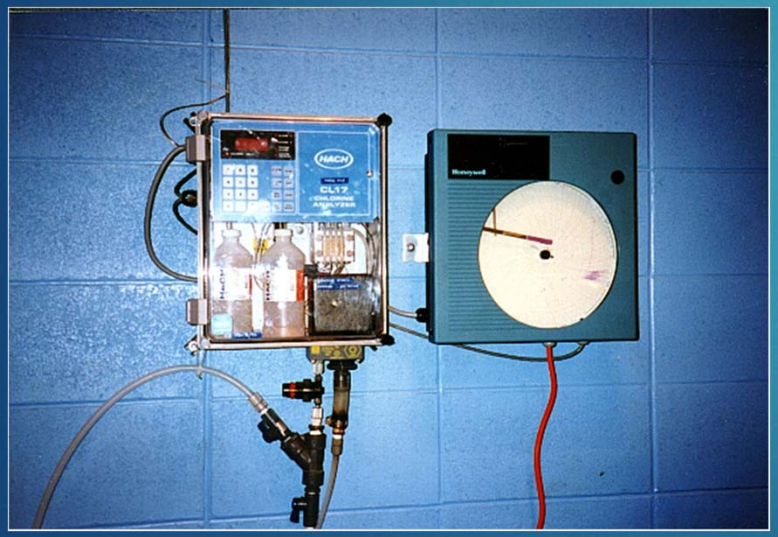
- Max Daily Turbidity:
  ≤ 0.10 NTU 95% time
- Maximum turbidity:
  ≤ 0.30 NTU
- Continuous monitoring for IFE and CFE

Filtration Performance Goals (cont.)

Post backwash turbidity:

- With filter-to-waste:
  - Minimize spike during filter-to-waste period
  - Return to service ≤ 0.10 NTU
- Without filter-to-waste:
  - ≤ 0.30 NTU maximum turbidity and return to ≤ 0.10 NTU in maximum 15 minutes

Disinfection Performance Goals



- CT values to achieve required inactivation of *Giardia* and virus:
  - Disinfection ratio > 1.0 (CT measured ÷ CT required)
- CT determination validated and documented on an annual basis

Optimization Assessment Spreadsheet – What is it?

- A spreadsheet is a powerful tool to analyze a plant's performance relative to optimized performance goals.
  - Each plant profile file holds 12 months of daily performance data.
  - Tool to monitor impact of optimization activities.
  - A cornerstone of optimization is ongoing performance data monitoring and trending.

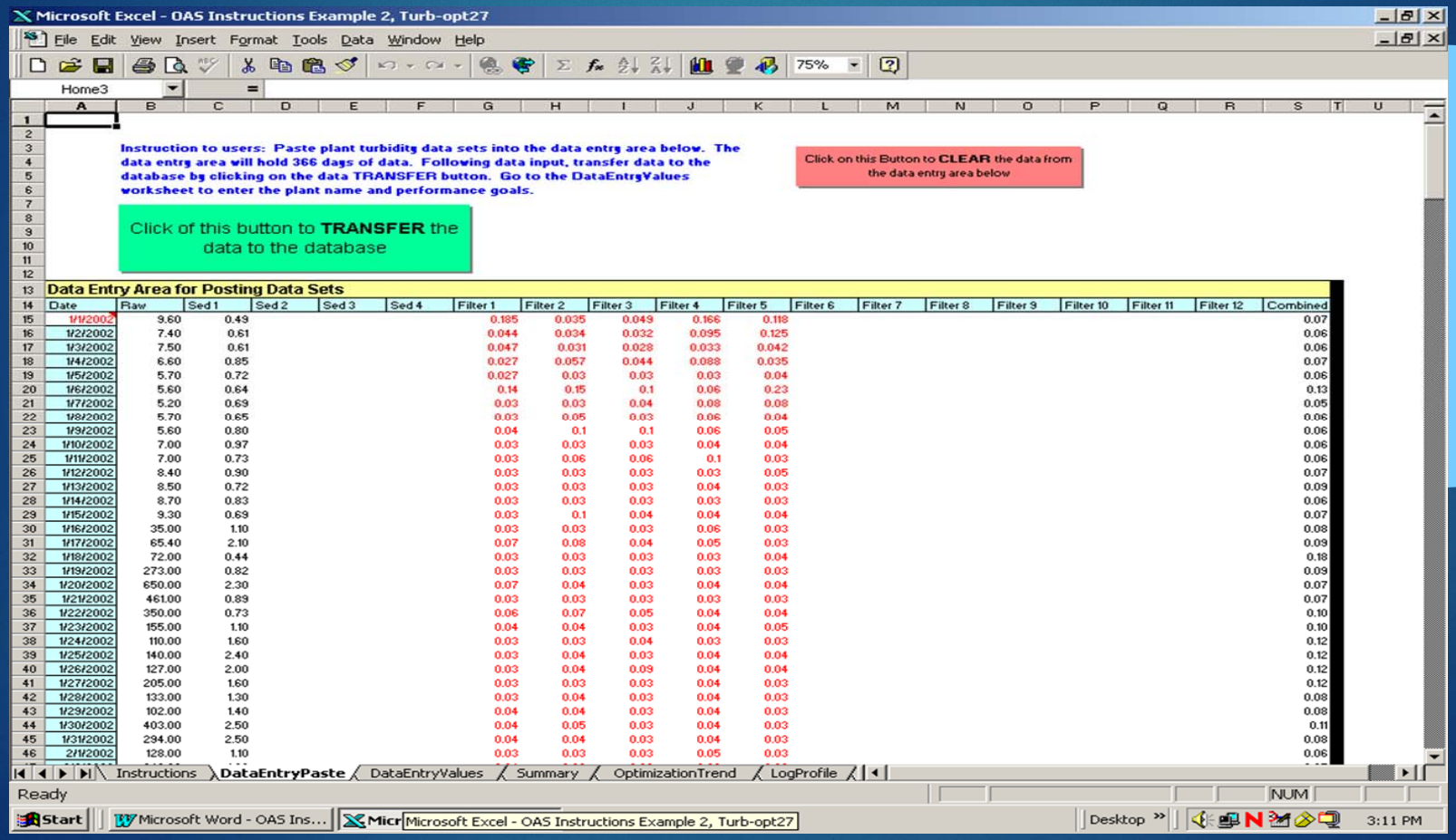
Description of OAS Spreadsheet

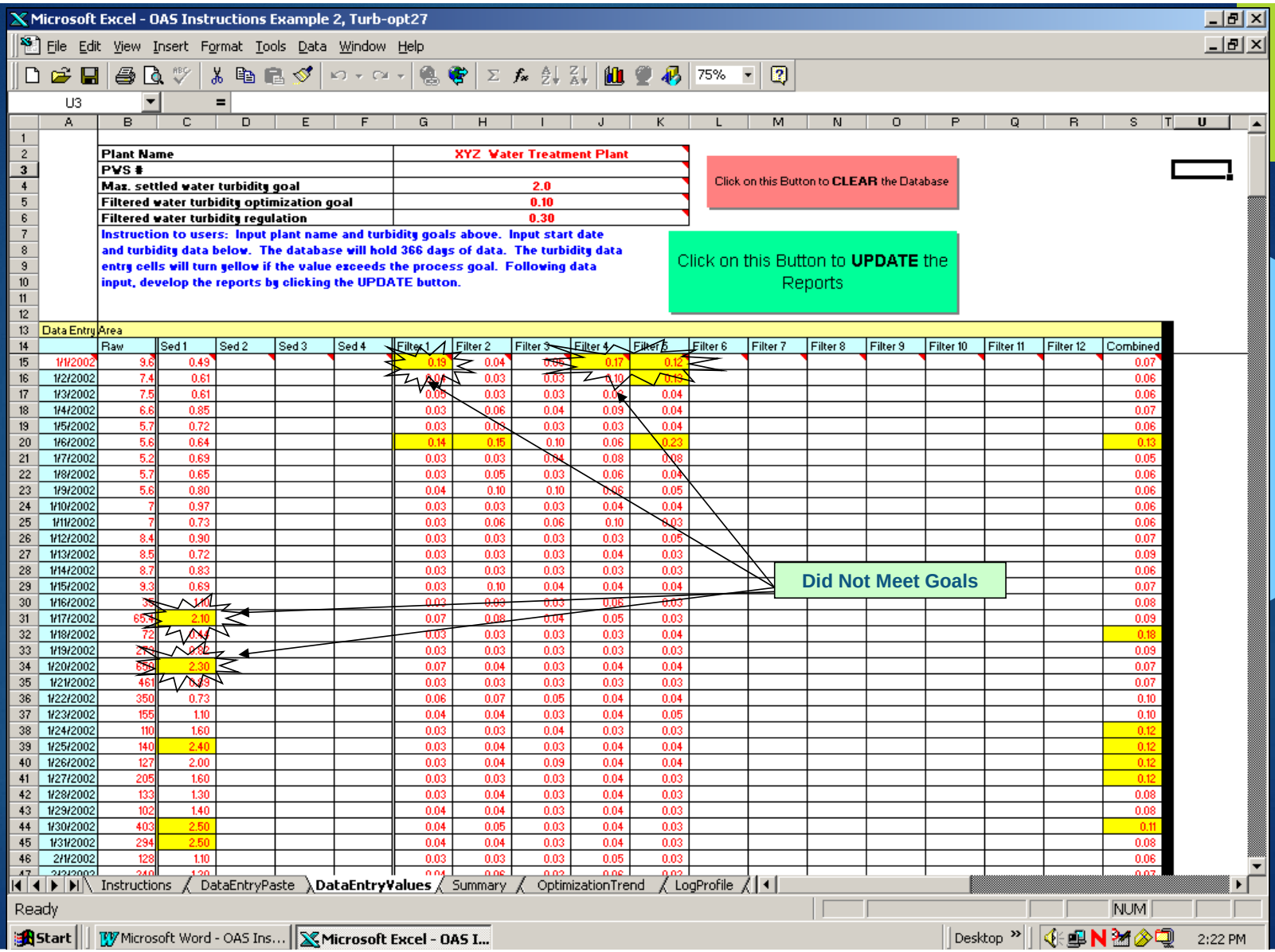
- Provided on resource CD:
  - (Turb-opt12filtersV32.xlsm)
- Optimization Assessment Software (OAS):
  - Software for both direct filtration and conventional plants
  - Allows for up to 4 sedimentation basins and 12 filters
- Long-term trending software:
  - Allows for viewing trends over 3 years

Description of Backwash Trending Spreadsheet

- Backwash Trending Software:
  - Allows for assessment of meeting backwash goals
  - Provided on resource CD:
    - (Filter Backwash Trending Spreadsheet V11.xlsm)

OAS Demonstration




Microsoft Excel - OAS Instructions Example 2, Turb-opt27
File Edit View Insert Format Tools Data Window Help
Plant Name
XYZ Water Treatment Plant
PWS #
Max. settled water turbidity goal
2.0
Filtered water turbidity optimization goal
0.10
Filtered water turbidity regulation
0.30
Instruction to users: Input plant name and turbidity goals above. Input start date and turbidity data below. The database will hold 366 days of data. The turbidity data entry cells will turn yellow if the value exceeds the process goal. Following data input, develop the reports by clicking the UPDATE button.
Click on this Button to CLEAR the Database
Click on this Button to UPDATE the Reports
Data Entry Area
Raw
Sed 1
Sed 2
Sed 3
Sed 4
Filter 1
Filter 2
Filter 3
Filter 4
Filter 5
Filter 6
Filter 7
Filter 8
Filter 9
Filter 10
Filter 11
Filter 12
Combined
Did Not Meet Goals
Instructions
DataEntryPaste
DataEntryValues
Summary
OptimizationTrend
LogProfile
Ready
Start
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Desktop
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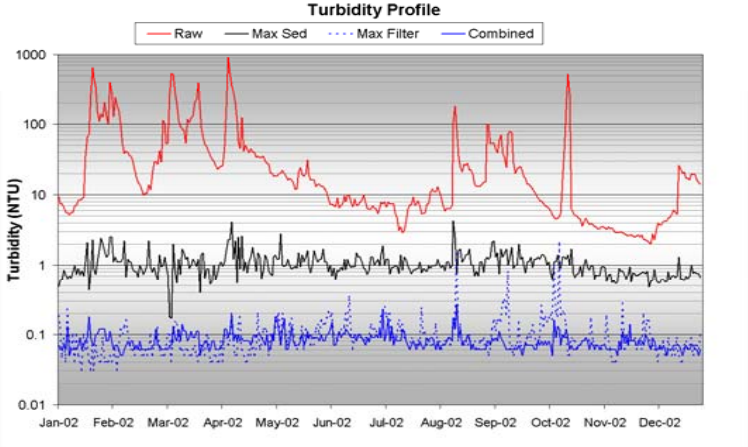
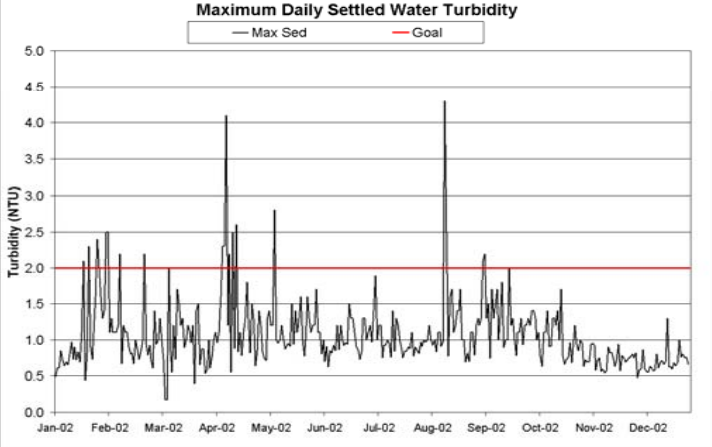
XYZ Water Treatment Plant

Treatment Barrier Performance Summary





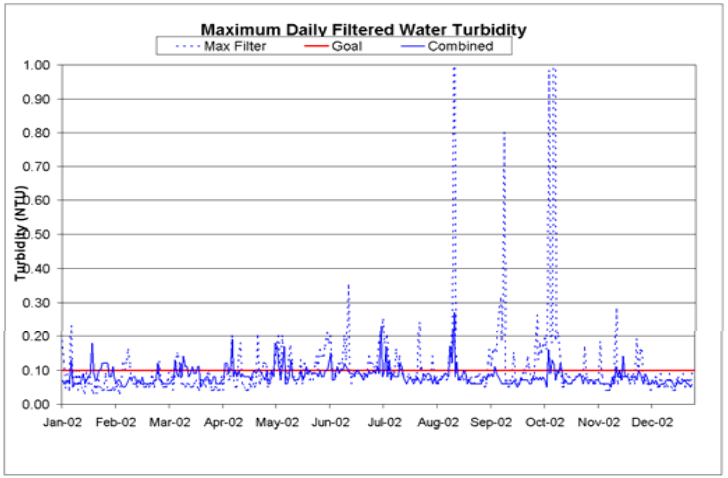
ANNUAL DATA	Avg	Min	Max	RSQ	95%	Opt. Goal	Reg.
	NTU	NTU	NTU		NTU	% Values	% Values
Raw Turbidity	48.0	2.0	914.0	n/a	218.6	n/a	n/a
Max. Settled Turbidity	1.1	0.2	4.3	0.13	2.0	95.1	n/a
Max. Filtered Turbidity	0.11	0.03	2.06	0.00	0.20	73.2	n/a
Combined Filtered Turbidity	0.08	0.05	0.27	0.12	0.12	86.6	100.0

RSQ = Correlation Coefficient for two selected data sets

95% = 95th Percentile value for data set

Opt. Goal = % of values in data set that are less than or equal to the selected optimization turbidity goal

Reg. = % of values in data set that are less than or equal to the regulated turbidity requirement

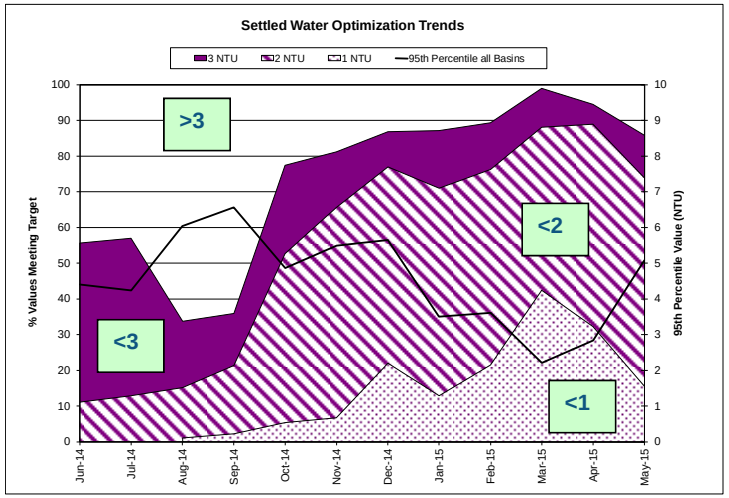


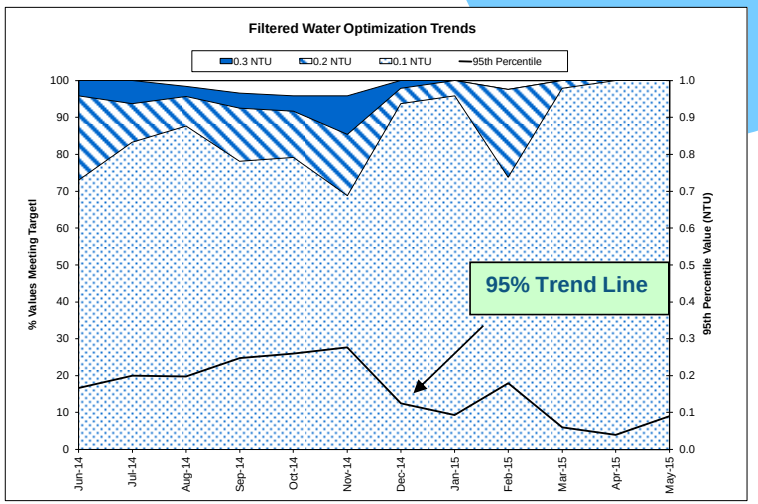
Optimization Assessment Software - Version 27

	Settled Water Turbidity								Filtered Water Turbidity																
	95th Percentile Values (NTU)					% Values Meeting Goal			95th Percentile Values (NTU)													% Values Meeting Goal All Filters		
	Sed 1	Sed 2	Sed 3	Sed 4	All Sed	3 NTU	2 NTU	1 NTU	Filter 1	Filter 2	Filter 3	Filter 4	Filter 5	Filter 6	Filter 7	Filter 8	Filter 9	Filter 10	Filter 11	Filter 12	Combined	All Filters	0.3	0.2	0.1
Jun-14	5.46	3.36	3.71		4.41	55.56	11.11		0.23	0.13	0.16	0.16	0.20	0.16							0.13	0.17	100.00	95.83	72.9
Jul-14	5.10	4.05	3.60		4.24	56.99	12.90		0.10	0.11	0.17	0.18	0.15	0.19							0.21	0.20	100.00	93.75	83.3
Aug-14	6.35	3.17	4.80		6.04	33.70	15.22	1.1	0.15	0.16	0.16	0.16	0.31	0.15							0.18	0.20	98.39	95.70	87.6
Sep-14	6.92	4.83	4.86		6.56	35.96	21.35	2.2	0.16	0.20	0.18	0.22	0.32	0.22							0.09	0.25	96.55	92.53	78.2
Oct-14	5.79	2.59	3.78		4.86	77.42	52.69	5.4	0.15	0.20	0.15	0.19	0.30	0.28							0.10	0.26	95.83	91.67	79.2
Nov-14	6.27	5.05	2.12		5.49	81.11	65.56	6.7	0.31	0.27	0.17	0.22	0.26	0.22							0.08	0.28	95.83	85.42	68.8
Dec-14	6.45	1.80	1.39		5.65	86.81	76.92	22.0	0.14	0.05	0.18	0.08	0.12	0.09							0.06	0.12	100.00	97.92	93.8
Jan-15	4.95	3.05	1.50		3.50	87.10	70.97	12.9	0.09	0.05	0.14	0.04	0.08	0.07							0.05	0.09	100.00	100.00	95.8
Feb-15	3.80	1.93	1.71		3.61	89.29	76.19	21.4	0.13	0.15	0.27	0.12	0.17	0.17							0.09	0.18	97.62	97.62	73.8
Mar-15	2.45	2.20	1.09		2.20	98.91	88.04	42.4	0.05	0.06	0.06	0.09	0.05	0.07							0.08	0.06	100.00	100.00	97.9
Apr-15	4.54	1.86	1.81		2.84	94.44	88.89	32.2	0.03	0.04	0.05	0.04	0.04	0.04							0.07	0.04	100.00	100.00	100.0
May-15	5.87	2.10	1.96		5.09	85.71	73.81	15.5	0.07	0.09	0.10	0.08	0.09	0.09							0.07	0.09	100.00	100.00	100.0
Yr. 95%	6.10	3.40	3.96						0.19	0.15	0.19	0.20	0.26	0.19							0.13				
Yr. Goal	32.7%	69.6%	60.5%						88.5%	88.5%	87.8%	87.1%	75.5%	83.5%							93.4%				

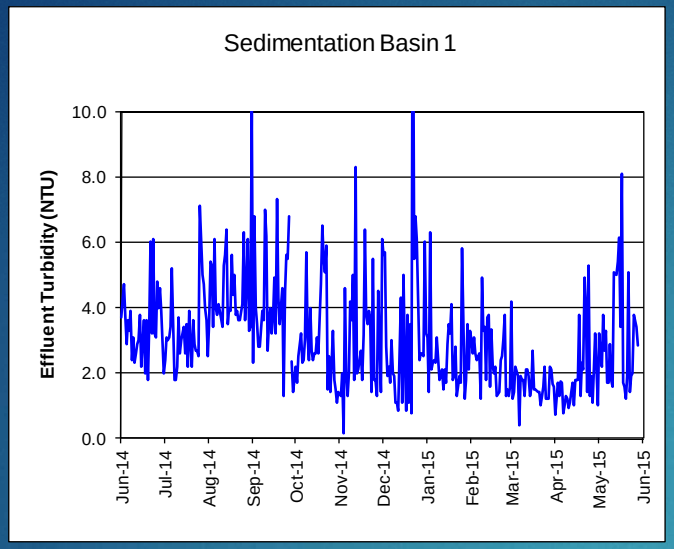
Worst Filter For Month

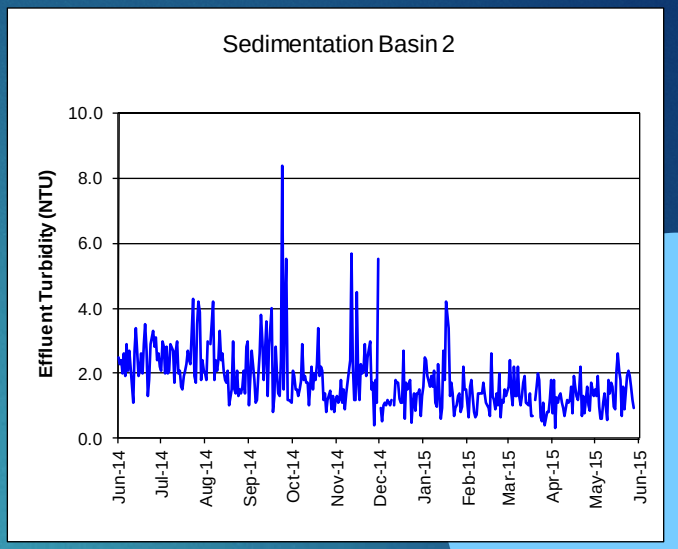
Highest Values All Filters

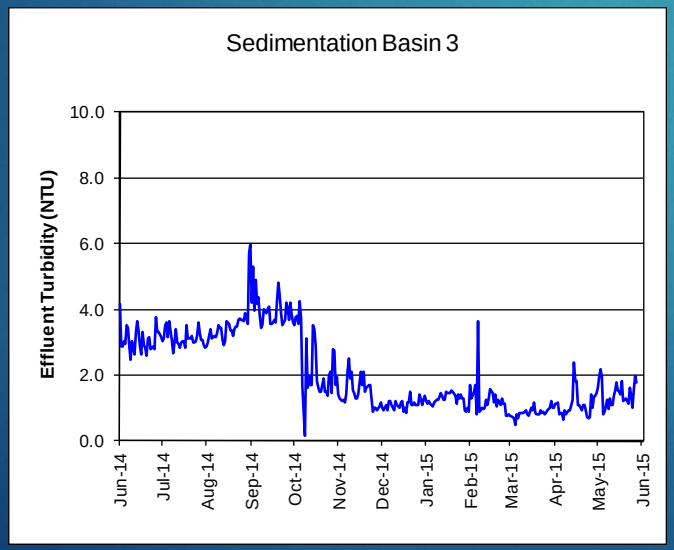


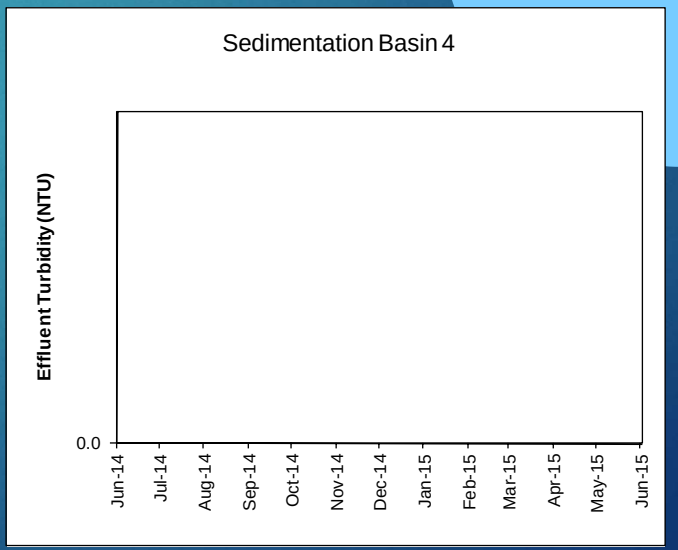


Sedimentation Performance Summary

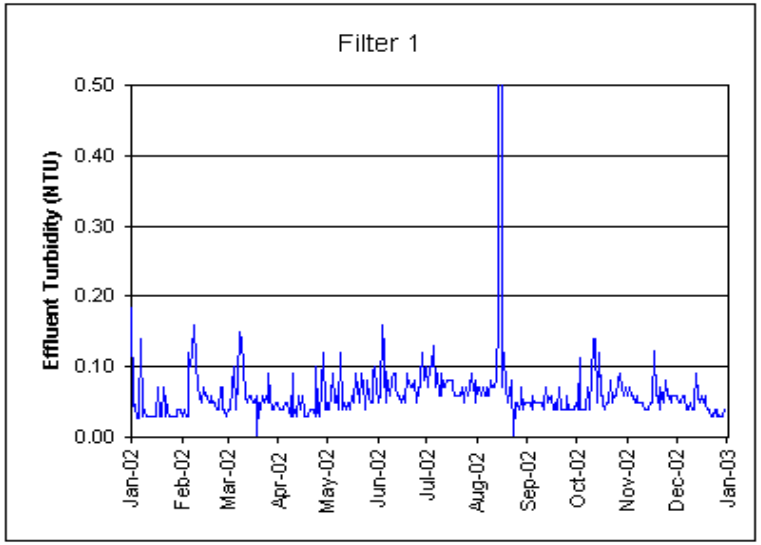


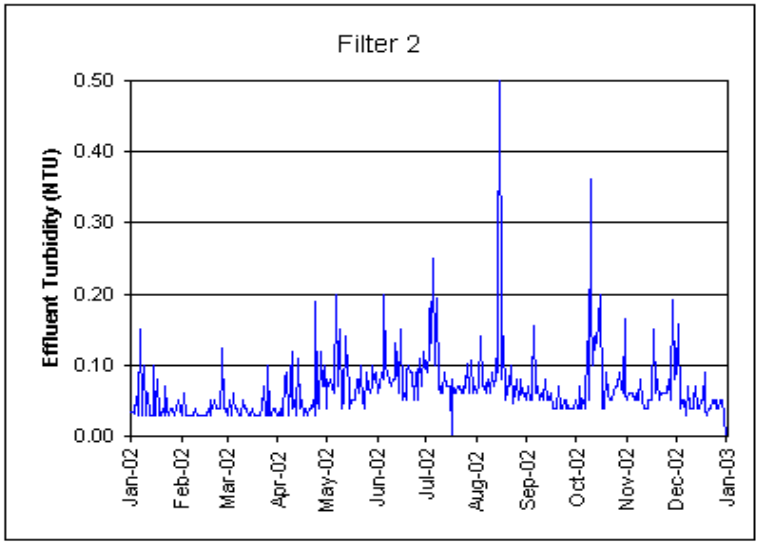


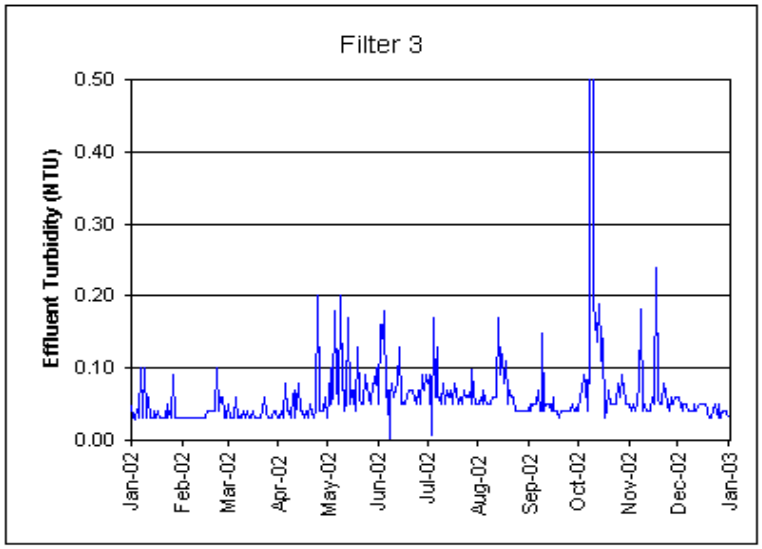


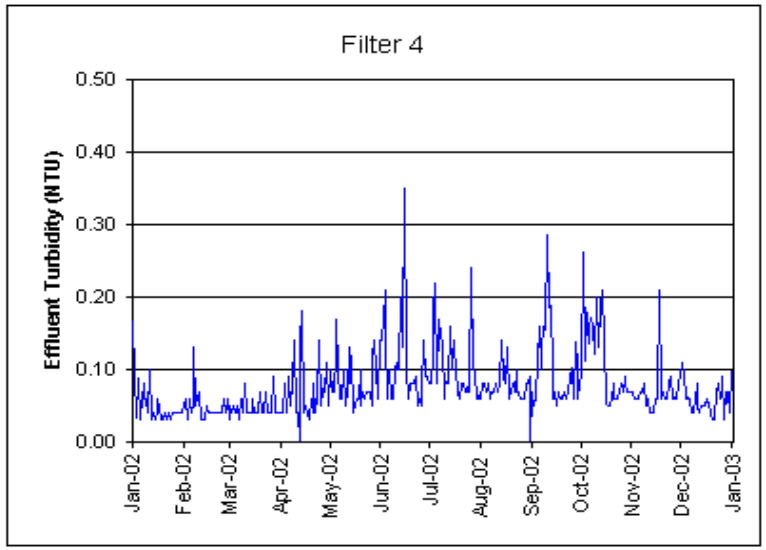


Filtration Performance Summary (Filters 1 - 4)







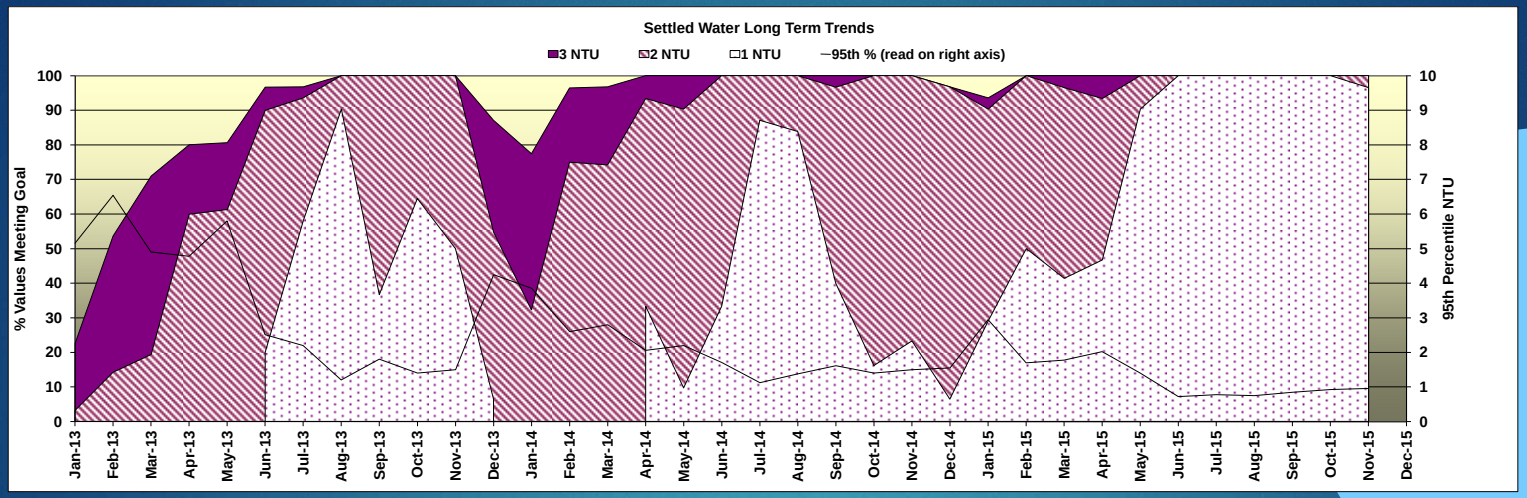


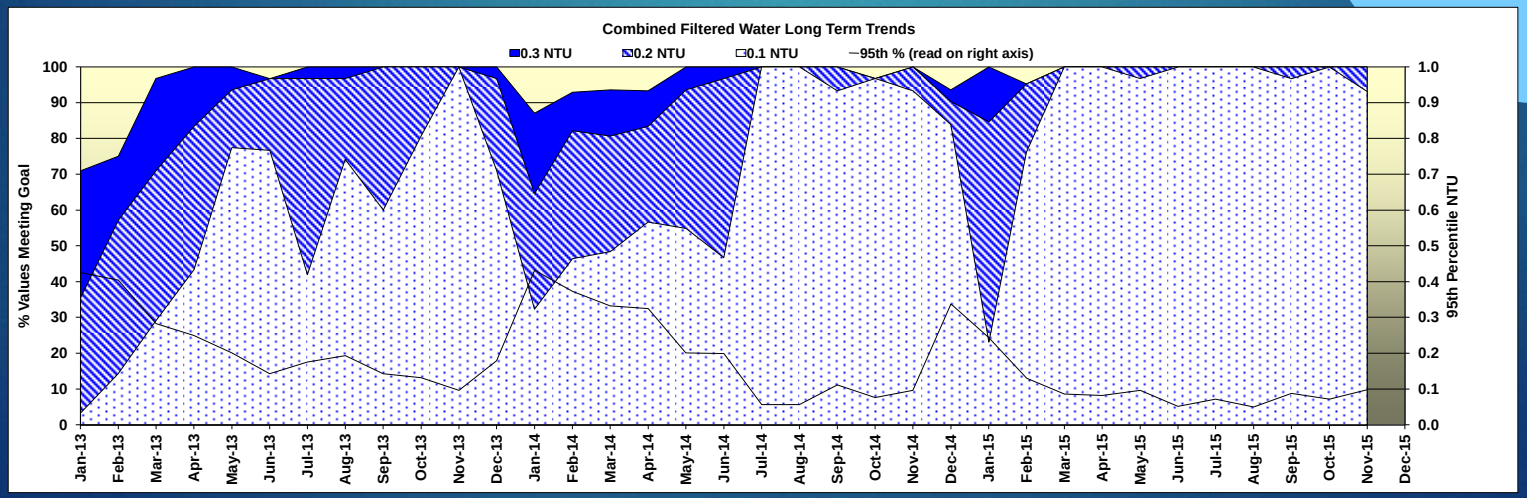
Data for Long Term Trends

	Settled Water				Filtered Water (All Filters)			
	95th %	% Values Meeting Goal			95th %	% Values Meeting Goal		
Month/Yr	Sed 1	3 NTU	2 NTU	1 NTU		0.3 NTU	0.2 NTU	0.1 NTU
Jun-14	5.46	55.6	11.1		0.17	100.0	95.8	72.9
Jul-14	5.10	57.0	12.9		0.20	100.0	93.8	83.3
Aug-14	6.35	33.7	15.2	1.1	0.20	98.4	95.7	87.6
Sep-14	6.92	36.0	21.3	2.2	0.25	96.6	92.5	78.2
Oct-14	5.79	77.4	52.7	5.4	0.26	95.8	91.7	79.2
Nov-14	6.27	81.1	65.6	6.7	0.28	95.8	85.4	68.8
Dec-14	6.45	86.8	76.9	22.0	0.12	100.0	97.9	93.8
Jan-15	4.95	87.1	71.0	12.9	0.09	100.0	100.0	95.8
Feb-15	3.80	89.3	76.2	21.4	0.18	97.6	97.6	73.8
Mar-15	2.45	98.9	88.0	42.4	0.06	100.0	100.0	97.9
Apr-15	4.54	94.4	88.9	32.2	0.04	100.0	100.0	100.0
May-15	5.87	85.7	73.8	15.5	0.09	100.0	100.0	100.0

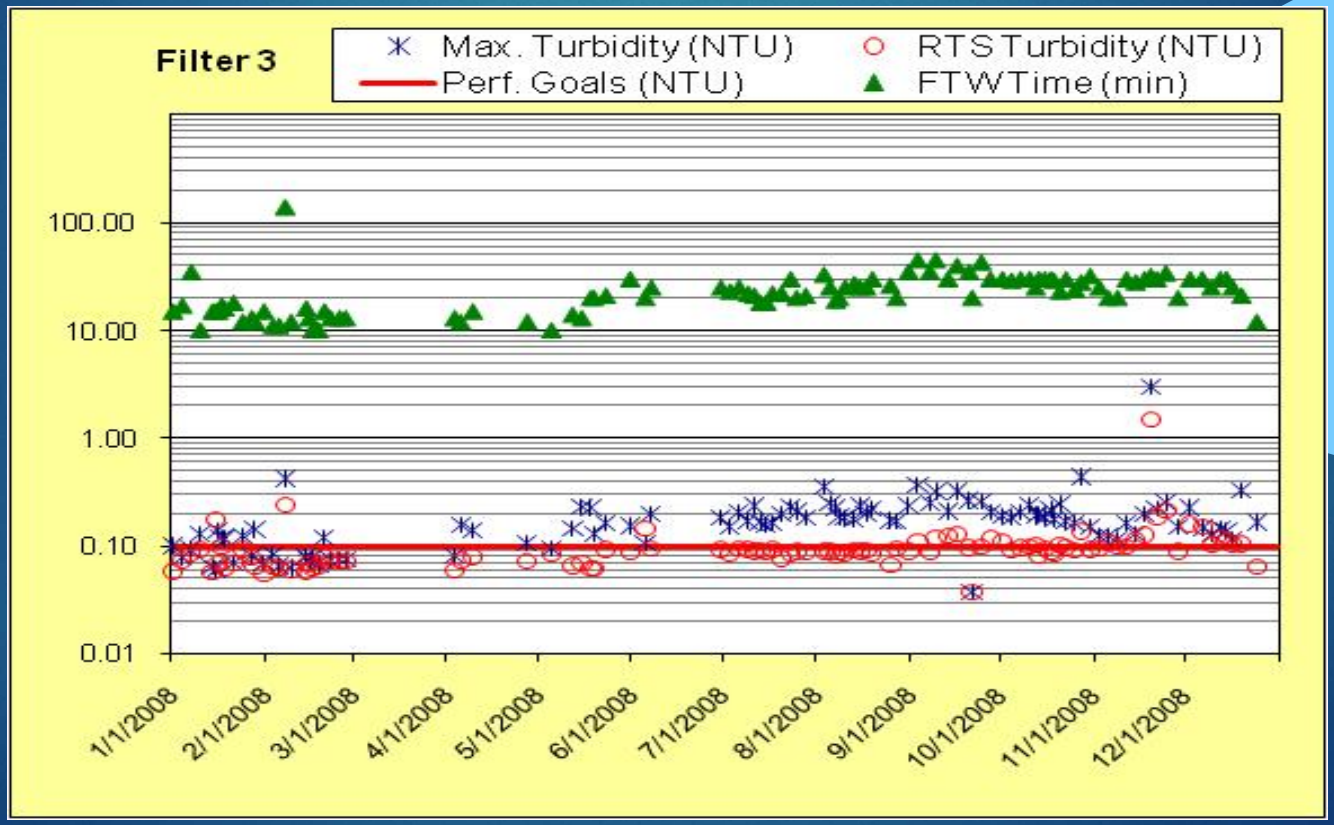
The area in blue can be copied to the long-term trend spreadsheet (LT_trend.xls) to develop up to three years of performance trends.

Plant Name	Rocky Mountain Water Treatment Plant
PWS #	1031009





Backwash Trending Spreadsheet Filter-to-Waste Example



Status Component

- Status component is the foundation of AWOP activities
  - Prioritizes plants relative to public health risk
  - Allows allocation of resources to highest risk facilities
  - Provides information to document progress/success
- Status component must be *"implementable"* – if not, it just doesn't work

New Mexico's Status Component

- Combined Filter Effluent
  - 95% of highest daily turbidity reading
- Treatment Technique Violations
  - Tier 1
  - Tier 2
- Source Water Vulnerability
  - Surface Water
  - GWUDI
  - LT2 Bin Classification
- Completeness of Performance Data Set
  - Settled water turbidity
  - Raw Water Turbidity
  - Backwash parameters