Optimization Assessment Spreadsheet (OAS) Instructions
Updated: October 7, 2003

Overview:

Surface water treatment plants are considered optimized when they can consistently meet the optimization performance goals in Table 1. The OAS is designed to assist plant staff collect and use turbidity data to determine where they stand with respect to the optimization goals and identify possible factors that limit the performance of their plant.

These instructions only explain the features of the spreadsheet and the elements of the reports. They do not provide information for interpreting possible performance limiting factors at specific plants.

The OAS consists of several different worksheets displayed as tabs at the bottom of the OAS workbook. Each tab presents options for data entry and reports generated by the spreadsheet after data entry.

Table 1. Optimized Performance Goals
Individual Sedimentation Basin Performance Goals
➢ Settled water turbidity less than 1.0 NTU 95 percent of the time when raw water turbidity is less than or equal to 10 NTU
➢ Settled water turbidity less than 2.0 NTU 95 percent of the time when raw water turbidity is greater than 10 NTU
Individual Filter Performance Goals
➢ Filtered water turbidity less than 0.10 NTU 95 percent of the time based on the maximum filter effluent turbidity for each day excluding the 15 minute period after bringing the filter on line (for plants without filter-to-waste capability)
➢ Maximum filtered water measurement of 0.30 NTU
Combined Filter Performance Goal
➢ Combined filter effluent turbidity of less than 0.10 NTU 95 percent of the time

Data Required for OAS

The OAS uses the plant's turbidity performance data and works with a year's worth of data at a time. The OAS can be used to assess a year of data or the plant's progress towards achieving optimized performance can be tracked by entering plant data daily throughout the year. The recommended way to populate the spreadsheet requires entering maximum daily values for

the following parameters:

- < Raw water turbidity.
- < Settled water turbidity of each sedimentation basin. (up to 4 basins)
- < Filtered water turbidity of each filter. (up to 12 filters)
- < Combined filter effluent

A maximum value for the day for each of these parameters is entered into the spreadsheet. For example, if the plant recorded a sedimentation basin effluent every 4 hours during the day, they would take the maximum value from the 6 readings and enter that value into the spreadsheet.

Table 2. presents monitoring guidelines for these process streams.

Table 2. Monitoring Guidelines

Process Stream	Monitoring Guidelines
Raw Water	Daily raw water turbidity
Individual Sedimentation Basins	Settled water turbidity at 4-hour intervals From each sedimentation basin
Individual Filter Effluents	On-line (continuous) turbidity from each filter
Combined Filter Effluents	Combined filter effluent at 4-hour time increments

OAS Data Entry Requirements

The OAS can handle a maximum of 366 daily data points for raw water, four different sedimentation basins, 12 filters, and the combined filter effluent. Those plants with more treatment processes requires creation of another OAS file to track the performance of these additional basins or the plant can choose to only include those basins with the worst performance. It is suggested that a separate OAS be created for each year instead of trying to keep a running year of data on one spreadsheet. Data entry is handled in two separate ways with two different worksheets provided, accessed through by tabs at the bottom of the workbook. **It is important that the proper worksheet be used for data entry.**

Data Entry Paste Worksheet

The "DataEntryPaste" worksheet is only used to populate the spreadsheet with electronic data. Figure 1. shows the "DataEntryPaste" worksheet for a plant with one sedimentation basin and five filters. This data has been electronically transferred to the OAS. Once all the data is copied into the worksheet, clicking on the green "TRANSFER" button activates a macro that converts the data to a standard format and

creates a data base. This database serves as the basis for the various reports in the OAS. The red "CLEAR" button clears the data entry area prior to electronically transferring a new data set into the worksheet.

Data Entry Values Worksheet

The "DataEntryValues" worksheet is only used for data entry when plant data is entered by hand. This worksheet also displays the database created when data is entered into the "DataEntryPaste" worksheet (Figure 1.) and after activation of the "TRANSFER" button. Figure 2. shows the "DataEntryValues" worksheet generated that becomes the basis for the other worksheets showing different plant performance summary reports.

At the top of the "DataEntryValues" worksheet, the plant's name and Public Water System (PWS) identification number are entered along with information on the performance goals against which the plant would like their data assessed including the regulatory requirements. This plant chose 2.0 NTU for the sedimentation basins and 0.1 NTU for the filters and a regulatory requirement of 0.3 NTU. Use of the optimized performance goals in Table 1. is recommended, but the plant has the option to enter other values for the performance goals.

After entering the value for the different performance goals, the OAS highlights, in yellow, those values that exceed the selected goals. Figure 2. which shows that, for the month of data shown, the sedimentation basin did not achieve the performance goal of 2.0 NTU on 1 /17/2002 and that filters 1,4 and 5 did not meet the 0.1 NTU filtered water goal.

Once the performance goals are entered on the "DataEntryValues" worksheet activating the green "UPDATE" button creates a series of worksheets summarizing the data in different ways. Activating the red "CLEAR" button removes all of the data from the spreadsheet so that it can be used for another data set. **It is important to note that every time that new data is entered in the OAS, the "UPDATE" button must be activated to generate updated summary reports.**

OAS Summary Reports

After activating the "UPDATE" button, the macros in the spreadsheet create a series of reports. A series of tabs across the bottom of the workbook identify the different worksheets that contain the different reports. The following summarizes each of the reports generated by the OAS.

Summary Worksheet

The "Summary" worksheet, shown in Figure 3., presents the "Treatment Barrier Performance Summary", which consists of four parts. The upper left section contains the "Turbidity Profile" with trend plots of the log of the turbidity values for raw, max sed, max filtered, and combined. The max sed and max filtered represent the maximum value of all of the sedimentation basins and filters for that day. If on a particular day filter 1 had the highest maximum, that would be the max filtered and plotted on this graph. The log scale of the turbidity values allows presentation of all the treatment process performance data on the same graph for determining if variations in raw water turbidity pass through the different treatment processes.

The right side of the worksheet provides the next two parts where two trend graphs are provided; "Maximum Daily Settled Water Turbidity" and "Maximum Daily Filtered Water Turbidity." These show how the plant's max sed, max filtered, and combined turbidities compare against the selected performance goals.

Finally at the lower left of the worksheet is a data summary table that provides some statistics on the data. The table presents the maximum, minimum, and average for all of the data along with the 95^{th} percentile value. RSQ provides a correlation between the raw, settled, filtered, and combined turbidities. The settled data is correlated with the raw while the filtered and combined are correlated with the settled. A high RSQ may indicate that the turbidity spikes are passing through the treatment processes. Based on experience with this parameter, a coefficient above about 0.25 indicates that turbidity pass-through may be occurring in a process. The last two columns of the table present the percent of time that the data met the selected performance goals. Note that the OAS calculates the 95^{th} percentile values using daily maximum values and not all the 4-hour discrete readings required by the regulations. Because of this, the 95^{th} percentile values in the OAS do not equate to the 95^{th} percentiles reported to the state for determination of regulatory compliance.

Optimization Trend Worksheet

Figure 4. shows the "Optimization Trend" worksheet that contains the "Optimization Trend Report" consisting of three sections. A table across the top of the worksheet contains a summary of the unit treatment process performance data by month. This worksheet shows the 95 percentile values calculated for the individual sedimentation and filtration processes and the percent of monthly values meeting specific performance goals. Calculation of the percentile for sedimentation uses the data for all the individual sedimentation basins while the calculation of the filtered water percentile uses the combined filtered water data. Charts located on the lower part of the report also plot these data.

For each month, the worksheet highlights in red the sedimentation basin and filter with the highest turbidity value. Since the example plant has only one sedimentation basin all of the monthly values are red. For the month of June, however, filter 4 at this plant had the highest turbidity of all the filters (0.21 NTU). A closer inspection

of the data for all of the filters shows that the range of values for all five filters was essentially the same. Looking at filter 4 one can see that it had the highest turbidity for five of the 12 months with three months above 0.2 NTU. In addition, one can see at the bottom of the table that Filter 4 met the goal of 0.10 NTU, only 83% of the time, compared to 93.7%, 89.3%, 92.9%, and 87.7% for Filters 1, 2, 3, and 5, respectively. Filter 4 also had the highest 95th percentile over the entire year (0.17 NTU) of all of the 5 filters. To optimize this plant the plant staff may try and determine if there are reasons for this filter consistently having the highest turbidity.

The "Optimization Trend Report" contains two trend graphs across the bottom with the "Settled Water Optimization Trend" on the left and the "Filtered Water Optimization Trend" on the right. Each of these graphs trend the same two sets of data; one related to the sedimentation basins and the other for the filters.

The most prevalent feature of these graphs is the various colored areas that are layered on top of each other. For each month, all of the data for the respective treatment process are sorted and placed into four categories; For the sedimentation basins the categories are >3 NTU, <3 NTU, <2 NTU and <1 NTU. For the filters the categories are >0.3 NTU, <0.3 NTU, <0.2 NTU and <0.1 NTU. The percent of time the data for that month is in each of the four categories is then plotted using the vertical axis on the left. Each category is plotted as a separate area on the chart so that the 0.1 NTU data (and then 0.2 NTU data, etc.) is on top of the other categories. Looking at the "settled water optimization trends" graph, in January 2002 the settled water was <1 NTU 61% of time, <2 NTU 84% of time and <3 NTU 100% of the time. Since none of the data was >3 NTU (the plant met < 3 NTUI 100% of the time in January), there is no white area showing in January. In April the plant met <3 NTU only 96.67% of the time; therefore, there is a small white area showing in April.

Though these trend graphs appear confusing at first, their main purpose is to allow the plant to quickly see how the plant performs throughout the year with respect to the optimization goals. There is a tendency to try and read more into them than is necessary. In looking at these graphs it is important to notice how much of the graph is covered with the layer representing the highest level of performance. In the "Settled Water Optimization Trends" graph the plant was almost completely optimized in November, but had less than optimum performance in August. It is also important to look at the trend in the different layers. Between September and November the performance of the sedimentation basins greatly improved. Between, July and September, however, there were problems with the sedimentation basin performance. The plant staff can use this information to assess changes in the plant during these time periods to determine and what results in the best performance.

These graphs also have a solid line that plots the 95% value each month, shown on the right vertical axis, for the sedimentation basins and filters. The intent of the trend line is to allow the plant to observe if the performance is improving based on the slope of the line. If the line is sloping downward, then performance is

improving. If it is sloping upward, then the changes in the plant are taking the performance in the wrong direction.

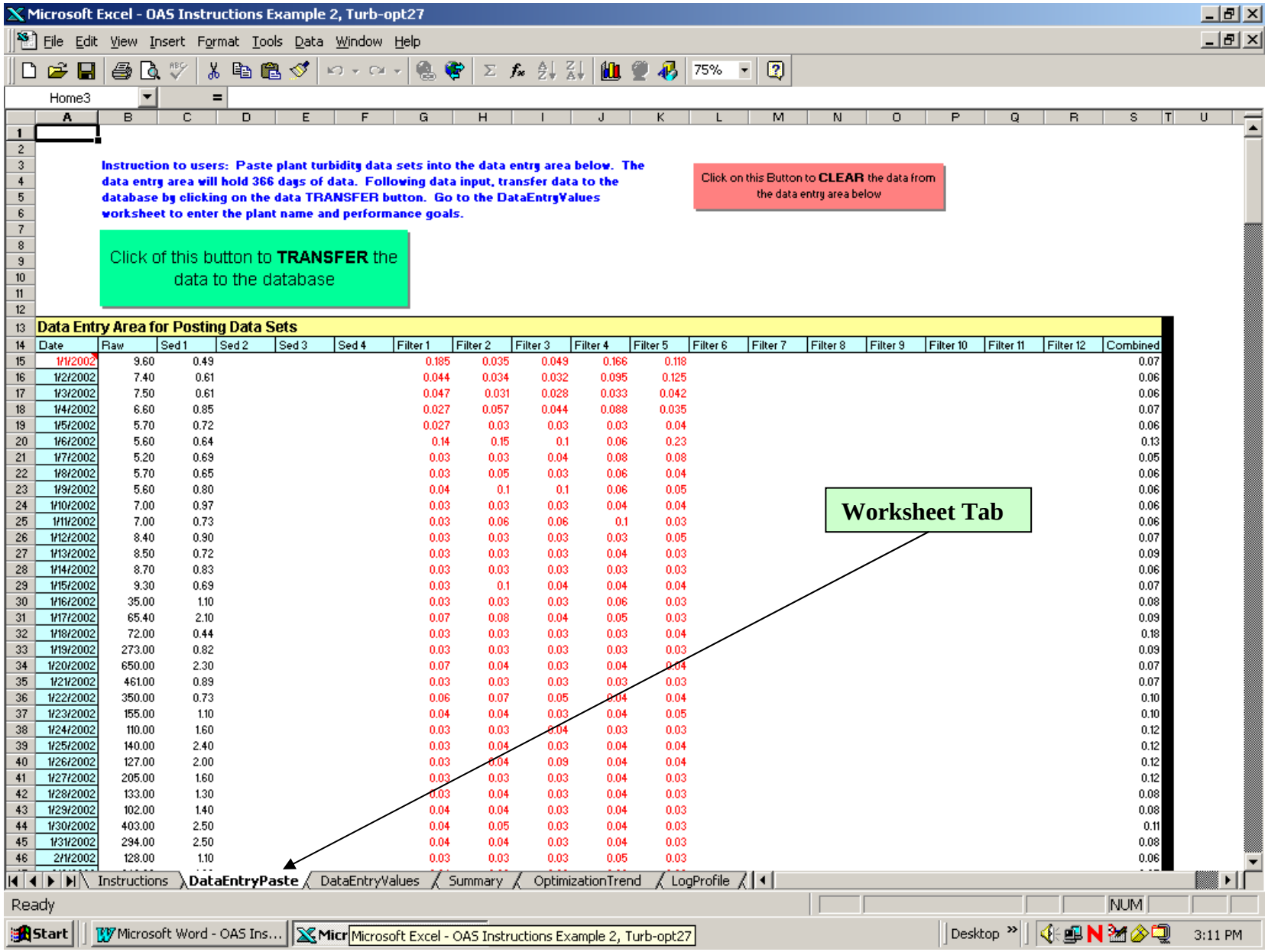
Other Summary Worksheets

The OAS also contains several other worksheets that provide graphical presentation of the performance data. Most of these are trend graphs of the performance of the individual treatment units. Up to four individual processes are shown on a single worksheet. Figures 5 and 6 show the "SedSum" and "FilterSum (1-4)" worksheets.

The remaining worksheets present single versions of some of the graphs on the "Summary" and "Optimization Trend" worksheets.

Long Term Trends Worksheet

The OAS only allows the analysis of one year of data at a time. Optimization of a treatment plant, however, occurs over several years and looking at trends between the different years can be beneficial. There is a separate long term trends spreadsheet that will allow development of the settled and filtered water optimization trend charts for a three year period. The last tab on the OAS is the "LT-Trend" worksheet which generates a table of data (shown in Figure 7.) that can be copied into the long-term trends spreadsheet. Figure 8. shows the output of the long term trends spreadsheet.



Date	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
1/1/2002	9.60	0.49				0.185	0.035	0.049	0.166	0.118								0.07
1/2/2002	7.40	0.61				0.044	0.034	0.032	0.095	0.125								0.06
1/3/2002	7.50	0.61				0.047	0.031	0.028	0.033	0.042								0.06
1/4/2002	6.60	0.85				0.027	0.057	0.044	0.088	0.035								0.07
1/5/2002	5.70	0.72				0.027	0.03	0.03	0.03	0.04								0.06
1/6/2002	5.60	0.64				0.14	0.15	0.1	0.06	0.23								0.13
1/7/2002	5.20	0.69				0.03	0.03	0.04	0.08	0.08								0.05
1/8/2002	5.70	0.65				0.03	0.05	0.03	0.06	0.04								0.06
1/9/2002	5.60	0.80				0.04	0.1	0.1	0.06	0.05								0.06
1/10/2002	7.00	0.97				0.03	0.03	0.03	0.04	0.04								0.06
1/11/2002	7.00	0.73				0.03	0.06	0.06	0.1	0.03								0.06
1/12/2002	8.40	0.90				0.03	0.03	0.03	0.03	0.05								0.07
1/13/2002	8.50	0.72				0.03	0.03	0.03	0.04	0.03								0.09
1/14/2002	8.70	0.83				0.03	0.03	0.03	0.03	0.03								0.06
1/15/2002	9.30	0.69				0.03	0.1	0.04	0.04	0.04								0.07
1/16/2002	35.00	1.10				0.03	0.03	0.03	0.06	0.03								0.08
1/17/2002	65.40	2.10				0.07	0.08	0.04	0.05	0.03								0.09
1/18/2002	72.00	0.44				0.03	0.03	0.03	0.03	0.04								0.18
1/19/2002	273.00	0.82				0.03	0.03	0.03	0.03	0.03								0.09
1/20/2002	650.00	2.30				0.07	0.04	0.03	0.04	0.04								0.07
1/21/2002	461.00	0.89				0.03	0.03	0.03	0.03	0.03								0.07
1/22/2002	350.00	0.73				0.06	0.07	0.05	0.04	0.04								0.10
1/23/2002	155.00	1.10				0.04	0.04	0.03	0.04	0.05								0.10
1/24/2002	110.00	1.60				0.03	0.03	0.04	0.03	0.03								0.12
1/25/2002	140.00	2.40				0.03	0.04	0.03	0.04	0.04								0.12
1/26/2002	127.00	2.00				0.03	0.04	0.09	0.04	0.04								0.12
1/27/2002	205.00	1.60				0.03	0.03	0.03	0.04	0.03								0.12
1/28/2002	133.00	1.30				0.03	0.04	0.03	0.04	0.03								0.08
1/29/2002	102.00	1.40				0.04	0.04	0.03	0.04	0.03								0.08
1/30/2002	403.00	2.50				0.04	0.05	0.03	0.04	0.03								0.11
1/31/2002	294.00	2.50				0.04	0.04	0.03	0.04	0.03								0.08
2/1/2002	128.00	1.10				0.03	0.03	0.03	0.05	0.03								0.06

Figure 1

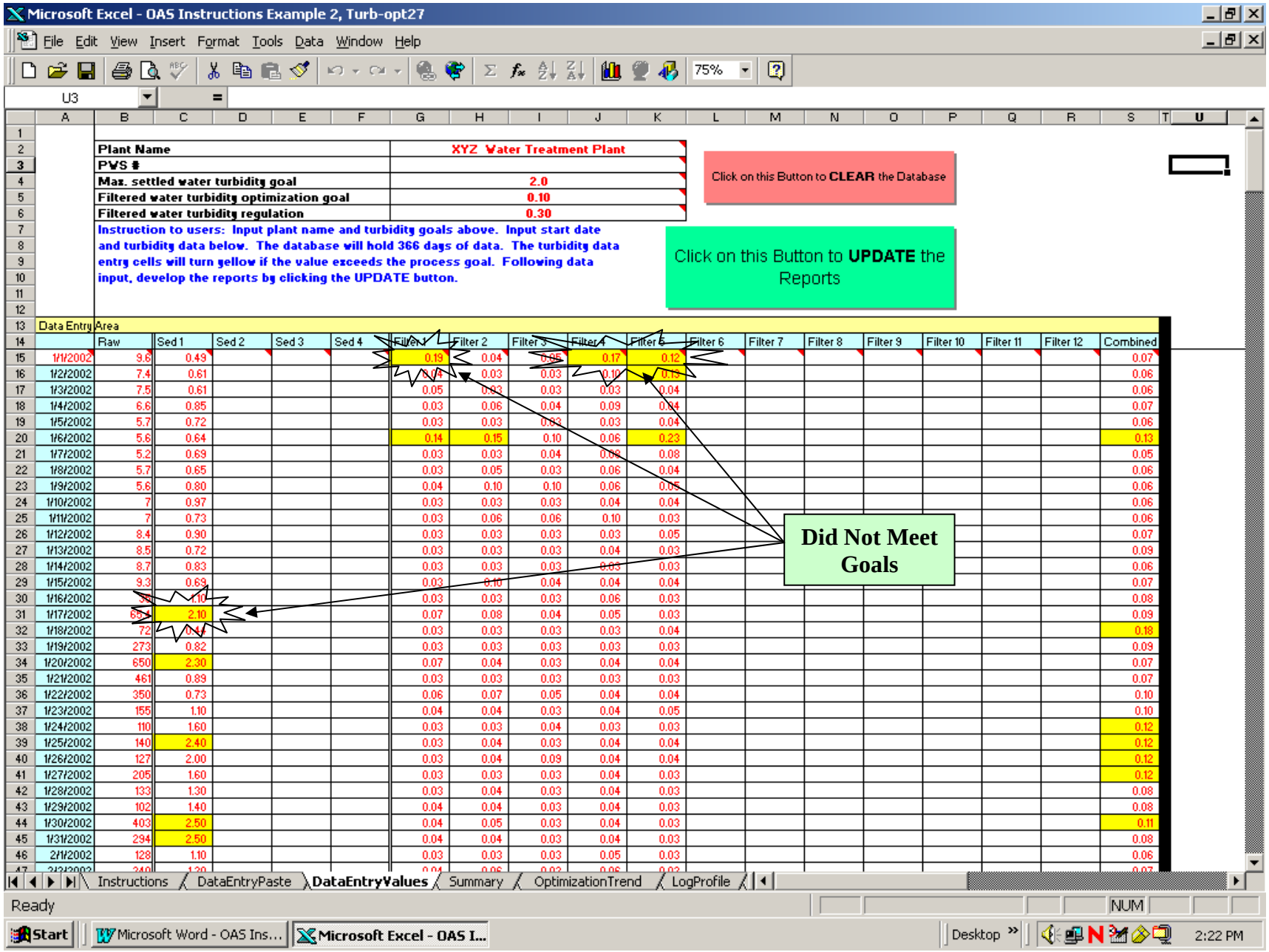
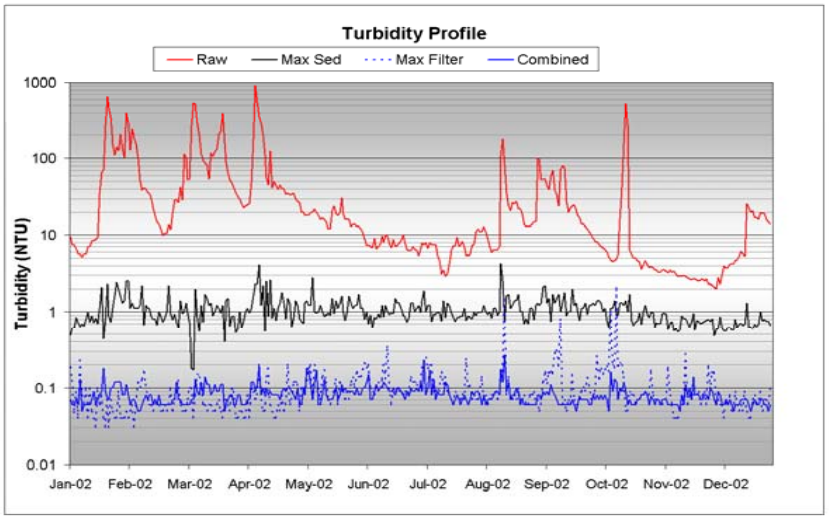
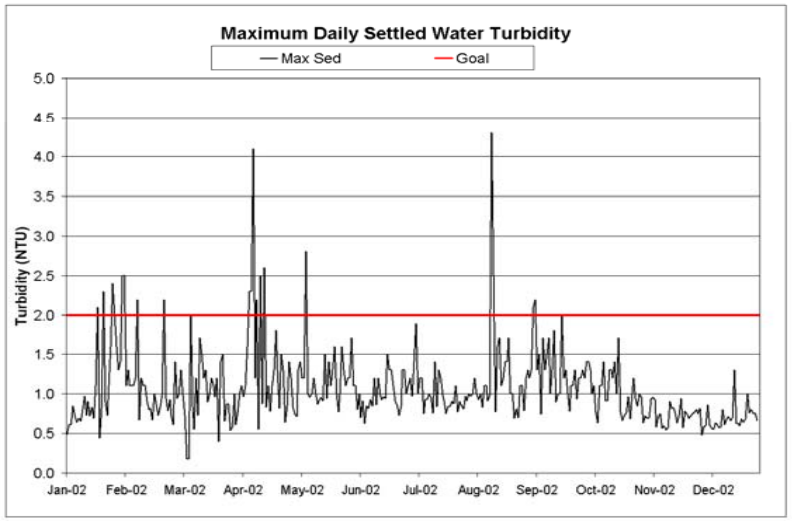

Microsoft Excel - OAS Instructions Example 2, Turb-opt27
Plant Name
XYZ Water Treatment Plant
PWS #
Max. settled water turbidity goal
2.0
Filtered water turbidity optimization goal
0.10
Filtered water turbidity regulation
0.30
Instruction to users: Input plant name and turbidity goals above. Input start 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
Did Not Meet Goals
Instructions
DataEntryPaste
DataEntryValues
Summary
OptimizationTrend
LogProfile
Ready

Figure 2.

XYZ Water Treatment Plant — **Treatment Barrier Performance Summary**





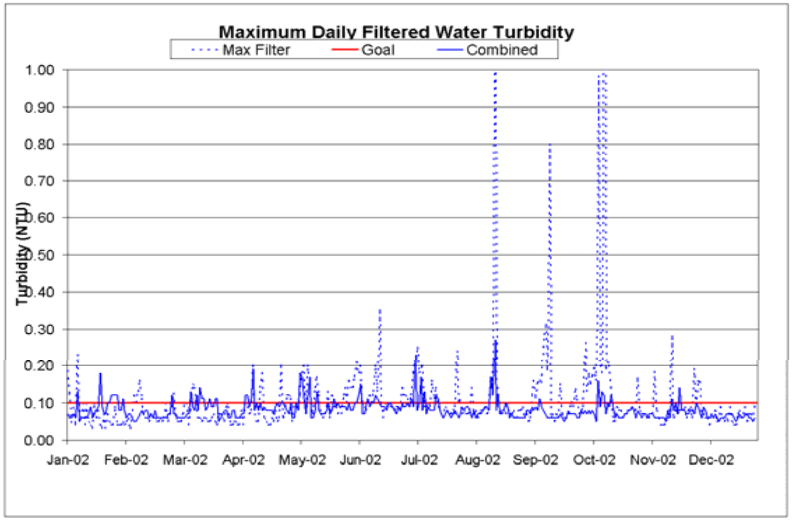
ANNUAL DATA	Avg	Min	Max	RSQ	95%	Opt. Goal	Reg.
	NTU	NTU	NTU		NTU	% Values	% Values
Raw Turbidity	48.0	2.0	914.0	n/a	218.6	n/a	n/a
Max. Settled Turbidity	1.1	0.2	4.3	0.13	2.0	95.1	n/a
Max. Filtered Turbidity	0.11	0.03	2.06	0.00	0.20	73.2	n/a
Combined Filtered Turbidity	0.08	0.05	0.27	0.12	0.12	86.6	100.0

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

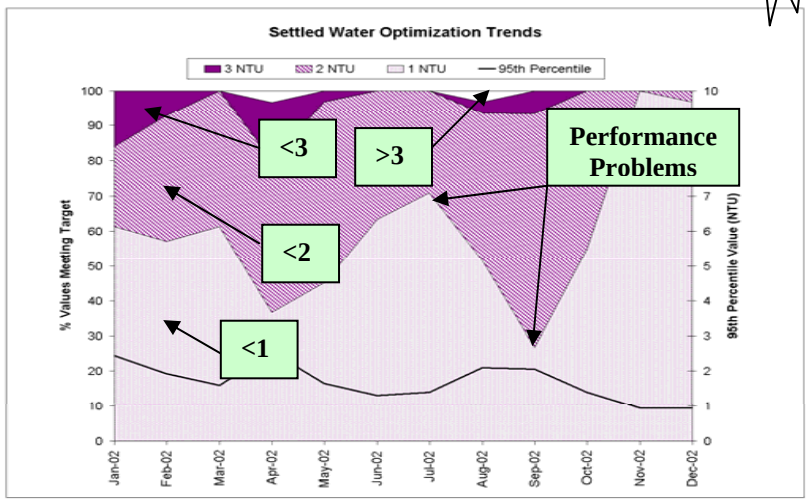
Figure 3.

XYZ Water Treatment Plant — Optimization Trend Report

	Settled Water Turbidity							Filtered Water Turbidity														
	95th Percentile Values (NTU)				% Values Meeting Goal			95th Percentile Values (NTU)												% Values Meeting Goal		
	Sed 1	Sed 2	Sed 3	Sed 4	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	0.3	0.2	0.1
Jan-02	2.45				100.00	83.87	61.3	0.11	0.10	0.10	0.10	0.12								0.13	100.00	100.00	77.4
Feb-02	1.92				100.00	92.86	57.1	0.12	0.08	0.06	0.07	0.06								0.08	100.00	100.00	96.4
Mar-02	1.60				100.00	100.00	61.3	0.12	0.07	0.06	0.08	0.05								0.13	100.00	100.00	74.2
Apr-02	2.56				96.67	80.00	36.7	0.10	0.12	0.08	0.14	0.10								0.12	100.00	100.00	86.7
May-02	1.65				100.00	96.77	45.2	0.10	0.15	0.18	0.14	0.12								0.17	100.00	100.00	77.4
Jun-02	1.30				100.00	100.00	63.3	0.13	0.14	0.15	0.21	0.14								0.12	100.00	100.00	83.3
Jul-02	1.40				100.00	100.00	71.0	0.10	0.19	0.11	0.20	0.19								0.15	100.00	96.77	80.6
Aug-02	2.10				96.77	93.55	51.6	0.17	0.14	0.12	0.12	0.11								0.15	100.00	96.77	87.1
Sep-02	2.06				100.00	93.33	26.7	0.07	0.08	0.07	0.19	0.25								0.09	100.00	100.00	96.7
Oct-02	1.40				100.00	100.00	54.8	0.13	0.19	0.19	0.21	0.20								0.13	100.00	100.00	87.1
Nov-02	0.94				100.00	100.00	100.0	0.08	0.12	0.14	0.09	0.09								0.11	100.00	100.00	93.3
Dec-02	0.93				100.00	100.00	96.8	0.06	0.09	0.05	0.10	0.07								0.09	100.00	100.00	100.0
Yr. 95%	2.00							0.12	0.15	0.18	0.17	0.16								0.12			
Yr. Goal	95.1%							93.7%	89.3%	92.9%	83.0%	87.7%								86.6%			

Worst Filter For Month

Highest Values All Filters



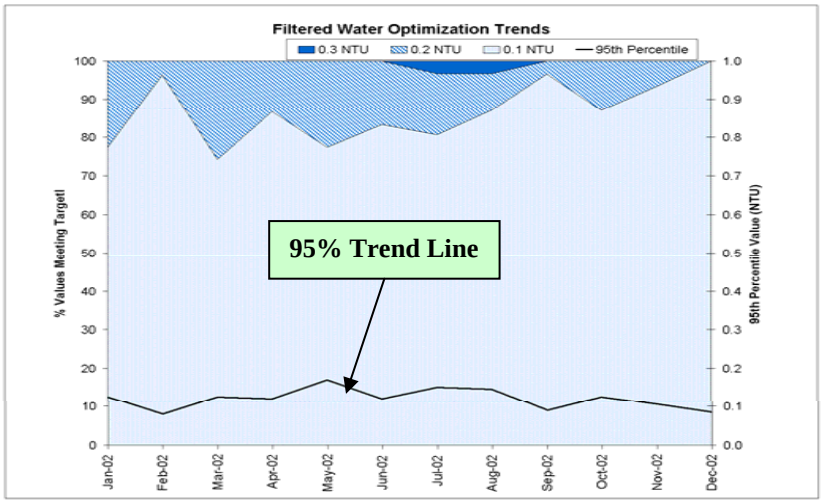


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Figure 4.

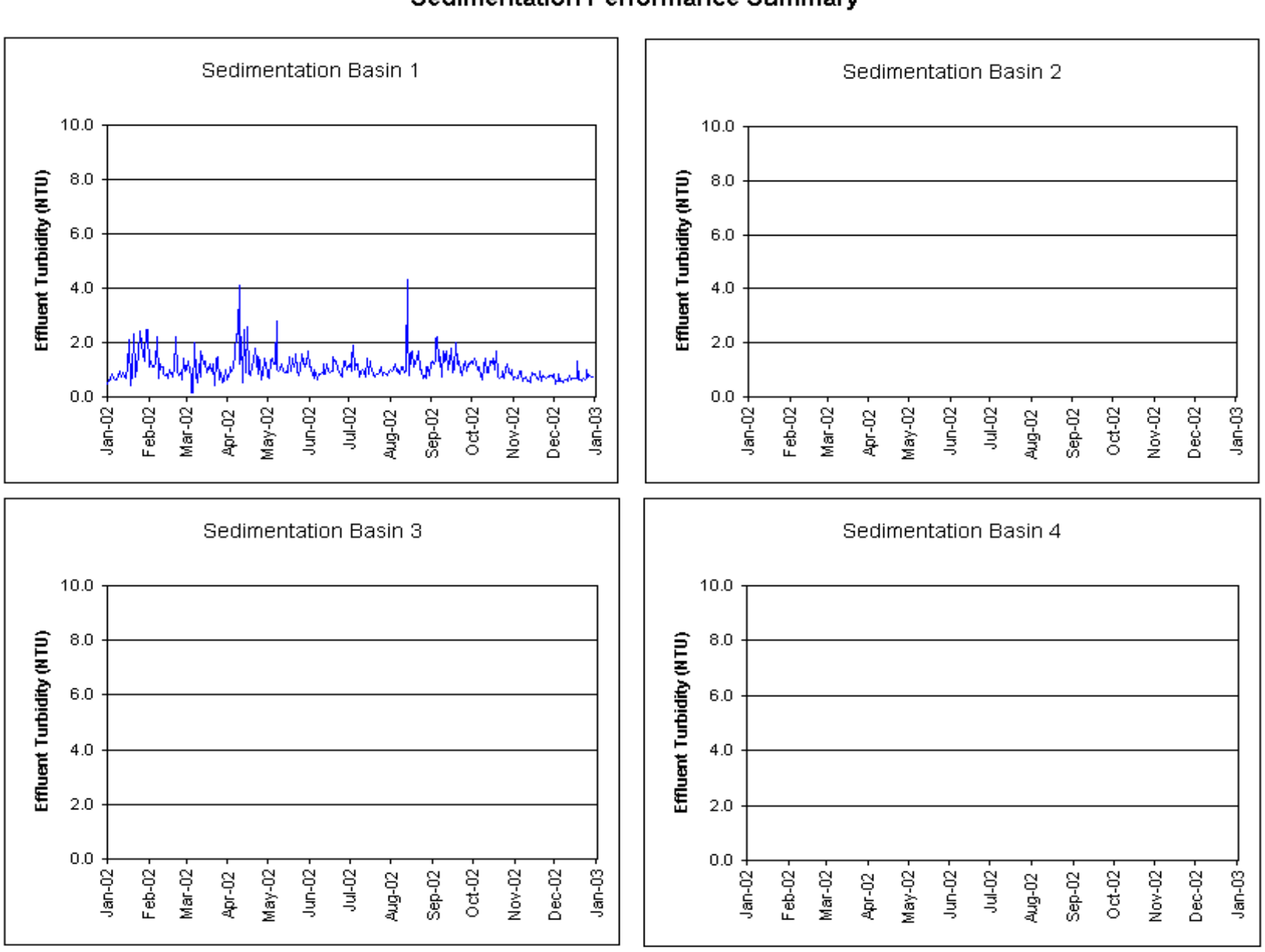

Sedimentation Performance Summary
Sedimentation Basin 1
Sedimentation Basin 2
Sedimentation Basin 3
Sedimentation Basin 4
Effluent Turbidity (NTU)
10.0
8.0
6.0
4.0
2.0
0.0
Jan-02
Feb-02
Mar-02
Apr-02
May-02
Jun-02
Jul-02
Aug-02
Sep-02
Oct-02
Nov-02
Dec-02
Jan-03

Figure 5.

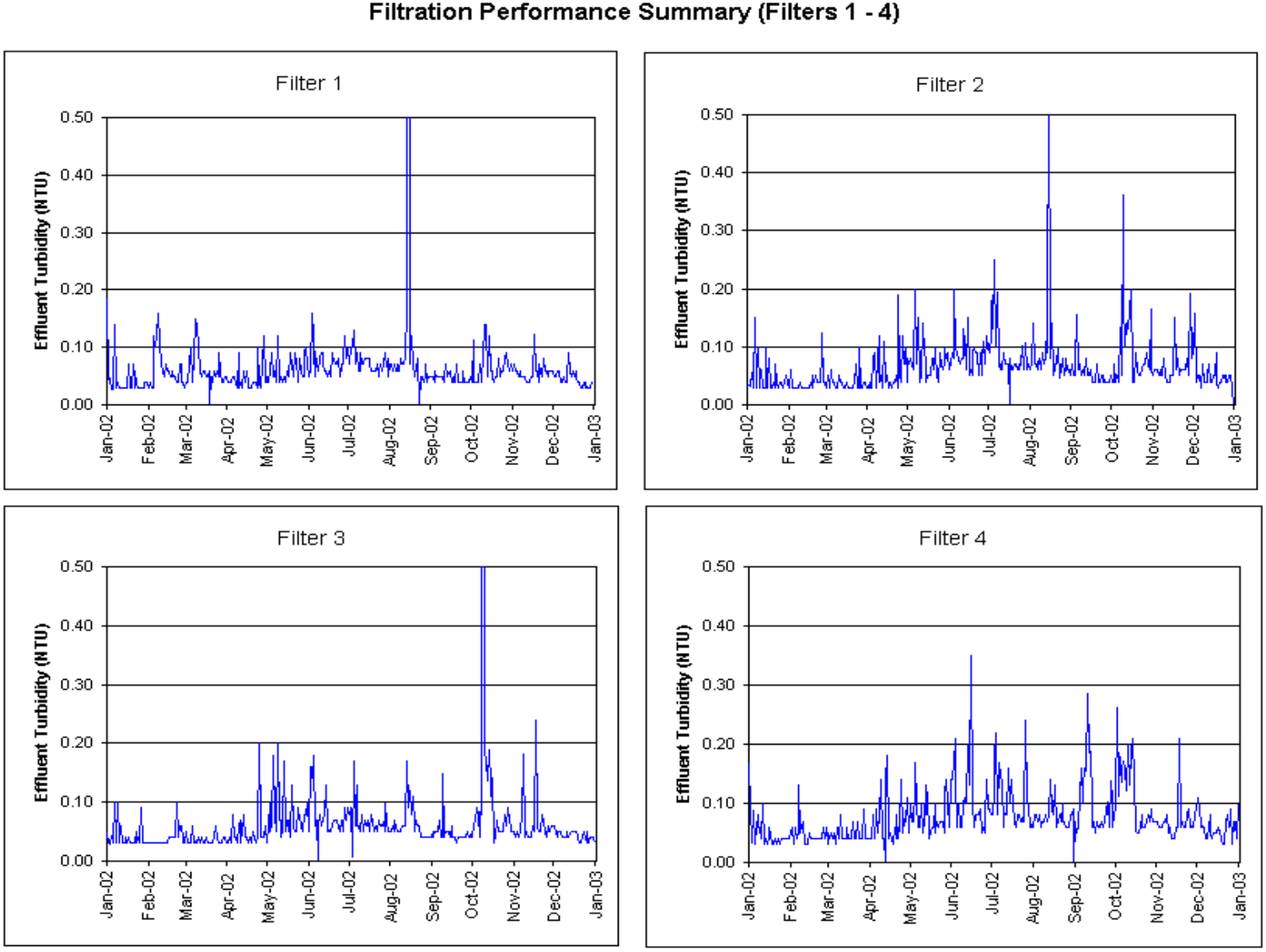

Filtration Performance Summary (Filters 1 - 4)
Filter 1
Filter 2
Filter 3
Filter 4
Effluent Turbidity (NTU)
0.00
0.10
0.20
0.30
0.40
0.50
Jan-02
Feb-02
Mar-02
Apr-02
May-02
Jun-02
Jul-02
Aug-02
Sep-02
Oct-02
Nov-02
Dec-02
Jan-03

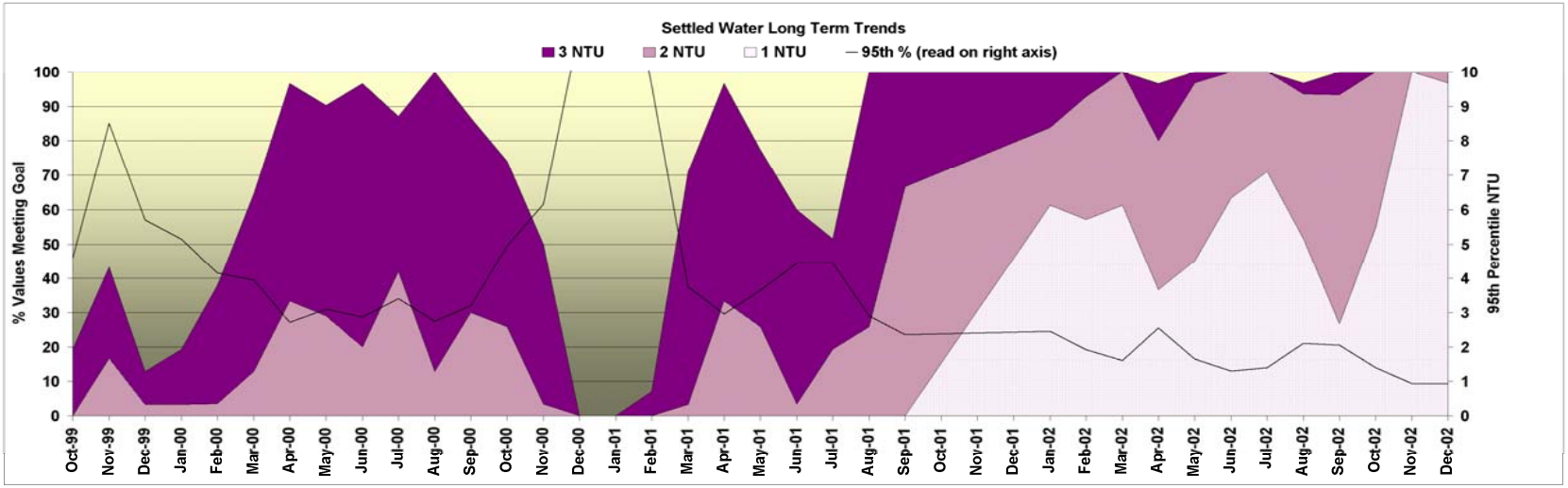
Figure 6.

	Settled Water				Combined Filtered Water			
	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
Jan-02	2.45	100.0	83.9	61.3	0.13	100.0	100.0	77.4
Feb-02	1.92	100.0	92.9	57.1	0.08	100.0	100.0	96.4
Mar-02	1.60	100.0	100.0	61.3	0.13	100.0	100.0	74.2
Apr-02	2.56	96.7	80.0	36.7	0.12	100.0	100.0	86.7
May-02	1.65	100.0	96.8	45.2	0.17	100.0	100.0	77.4
Jun-02	1.30	100.0	100.0	63.3	0.12	100.0	100.0	83.3
Jul-02	1.40	100.0	100.0	71.0	0.15	100.0	96.8	80.6
Aug-02	2.10	96.8	93.5	51.6	0.15	100.0	96.8	87.1
Sep-02	2.06	100.0	93.3	26.7	0.09	100.0	100.0	96.7
Oct-02	1.40	100.0	100.0	54.8	0.13	100.0	100.0	87.1
Nov-02	0.94	100.0	100.0	100.0	0.11	100.0	100.0	93.3
Dec-02	0.93	100.0	100.0	96.8	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.

Figure 7.

Plant Name	XYZ Water Treatment Plant
PWS #	



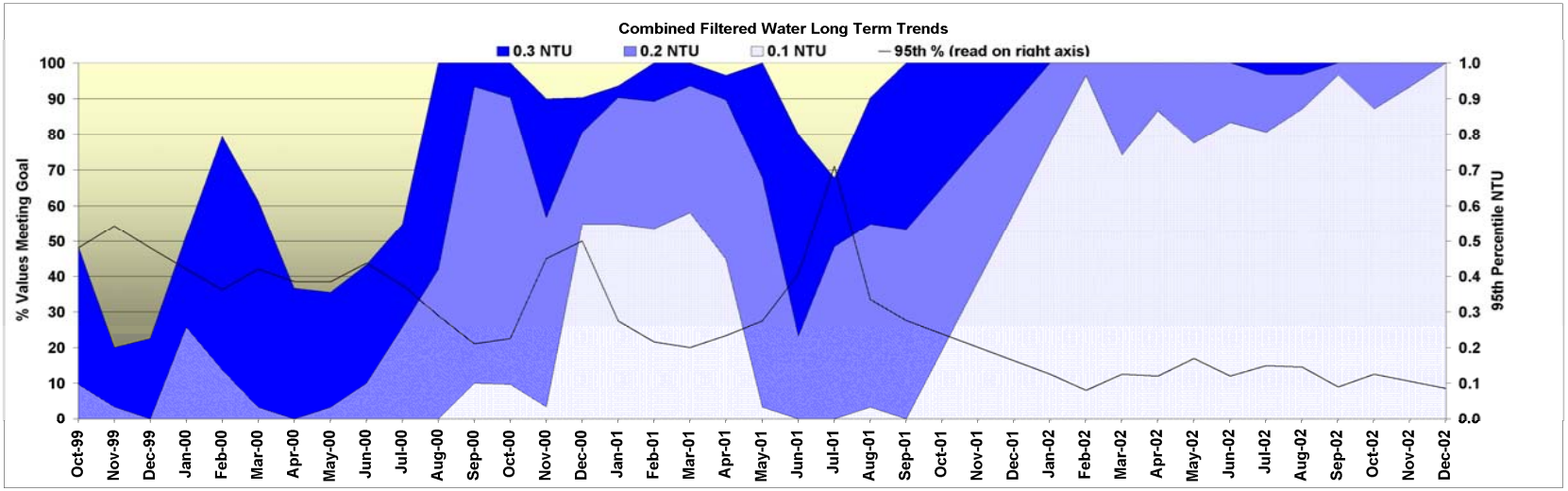


Figure 8.