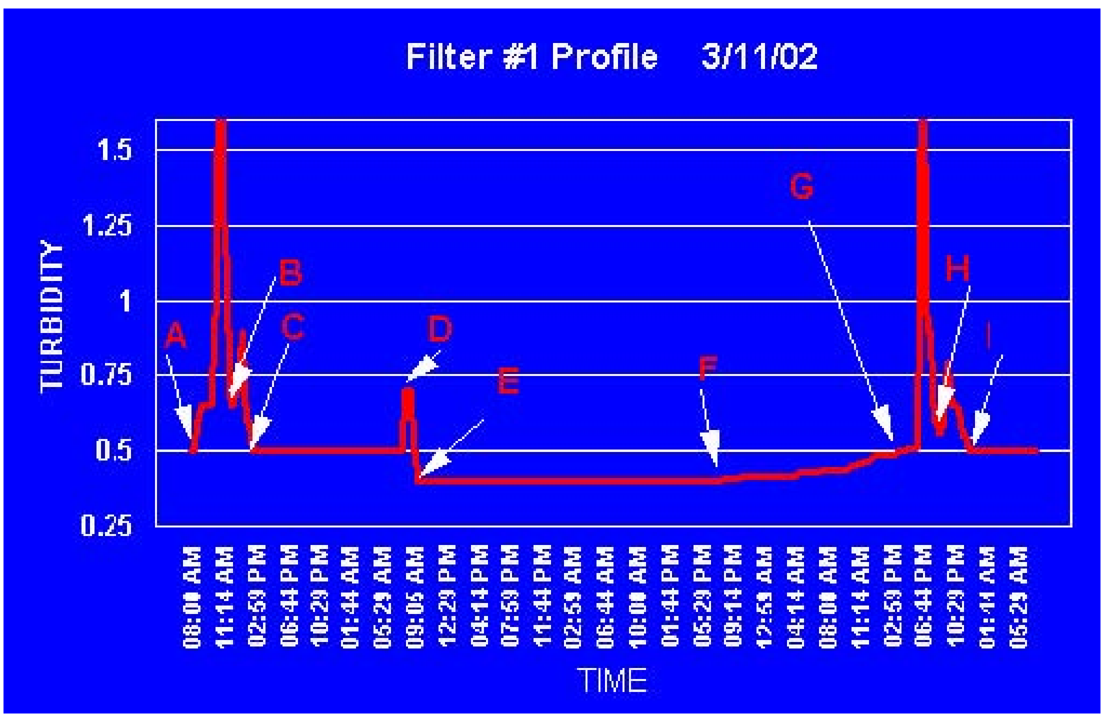
Filter Self-Assessment

Example Report



Purpose

EPA's Interim Enhanced Surface Water Treatment Rule (IESWTR) and Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR) may require certain water systems to conduct a filter self-assessment. This report includes an example of an acceptable filter self-assessment report.

Additional Resources

Listed below are some additional resources for filter assessments:

Most of the AWWA resources can be obtained at www.AWWA.org . Most of the EPA resources can be obtained from the National Service Center for Environmental Publications at 1-800-490-9198.

- AWWA Video: "Filter Surveillance Techniques for Water Utilities" Catalog #65160 (32 minutes).
- AWWA, 1998, "How to Do a Complete Examination of Your Filters (Without Incurring the Wrath of the Filter Gods)," Annual Conference Workshop Summary.
- AWWA and ASCE (American Society of Civil Engineers), 1990. Water Treatment Plant Design, second edition, McGraw-Hill, New York.
- AWWARF and AWWA, 2002, "Filter Maintenance and Operations Guidance Manual," Project #2511.
- Bender, J.H., R.C. Renner, B.A. Hegg, E.M. Bissonette, and R.J. Lieberman, 1995, "Voluntary Treatment Plant Performance Improvement Program Self-Assessment Procedure," Partnership for Safe Water, USEPA, AWWA, AWWARF, Association of Metropolitan Water Agencies, Association of State Drinking Water Administrators, and National Association of Water Companies.
- James M. Mongomery Consulting Engineers, Inc., 1995, Water Treatment Principles and Design, John Wiley & Sons, Inc.
- Kawamura, Susumu, 2000, "Integrated Design and Operation of Water Treatment Facilities," second edition.
- Peck, B., T. Tackman, and G. Crozes, no date specified, Testing the Sands – The Development of a Filter Surveillance Program.
- Pizzi, Nick, 1997, "Maintaining Filters: Part I of a Series-Bed Depth," Ohio Section AWWA Winter 1997 Newsletter.
- Pizzi, Nick, 1998, "Maintaining Filters: Part II of a Series-Bed Expansion," Ohio Section AWWA Spring 1998 Newsletter.
- Pizzi, Nick, 1999, "Final in the Filtration Series-Achieving Balance," Ohio Section AWWA Spring 1999 Newsletter.

- Smith, J.F., A. Wilczak, and M. Swigert, no date specified, Practical Guide to Filtration Assessments: Tools and Techniques.
- US EPA, 1998, Handbook: Optimizing Water Treatment Plant Performance Using the Composite Correction Program,
- EPA/625/6-91/027.
- US EPA, 1998, "National Primary Drinking Water Regulations: Interim Enhanced Surface Water Treatment Rule; Final Rule." 63 FR 69477, December 16.
- Wolfe, Tim, 1998, "Maintaining Filters: Part IV of a Series-Backwashing," Ohio Section AWWA Winter 1998 Newsletter.
- Wolfe, T.A. and N.G. Pizzi, 1998, "Optimizing Filter Performance."

Introduction

XYZ Water Treatment Plant was required to perform a filter self-assessment on filter #1 as a result of elevated turbidities over the past 3 months. IESWTR and LT1ESWTR require that a filter self-assessment be conducted for any individual filter that has a measured turbidity level greater than 1.0 nephelometric turbidity units (NTU) in two consecutive measurements taken 15 minutes apart in each of 3 consecutive months. This report summarizes the findings of our self-assessment on filter #1 and shows our plans to correct the problems that we found.

Filter Self-Assessment Components

As recommended by Chapter 5 of EPA's Guidance Manual for Compliance with the Interim Enhanced Surface Water Treatment Rule: Turbidity Provisions, the self-assessment of filter #1 includes the following components:

- a general description of the filter;
- the development of a filter run profile;
- an assessment of the hydraulic loading conditions of the filter;
- an assessment of the actual condition and placement of the media;
- a description of backwash practices;
- an assessment of the condition of the support media/underdrains; and
- an assessment of the filter rate-of-flow controllers and filter valving.

In addition, EPA requires that water systems:

- identify and prioritize factors limiting filter performance; and
- assess the applicability of corrections.

Description of the Filter

Filter #1 is one of four dual media filters at the XYZ Water Treatment Plant. Each filter is 10' x 10' with 100 ft^2 of filter surface area. Each filter is designed to have 20 inches of anthracite and 9 inches of sand. None of the filters are equipped with filter-to-waste capabilities or surface wash or air wash. No special procedures are used when placing the filter into service.

Limiting factors:

- No special procedures are used when placing the filter into service.
- No filter-to-waste capabilities.
- No surface wash or air wash.

Filter Profile

Figure 1 below shows a turbidity profile for filter #1. The filter run ended at 80 hours of run time. The filter was then backwashed and placed into service with a turbidity of about 2 NTU. Filter #1 then recovered to a turbidity of approximately

0.5 NTU within 15 minutes. This is not typical of the other three filters at the XYZ Water Treatment Plant. The other filters typically recover to <0.1 NTU within 15 minutes. This is an indication that the problem is within filter #1 and not a result of poor pre-treatment.

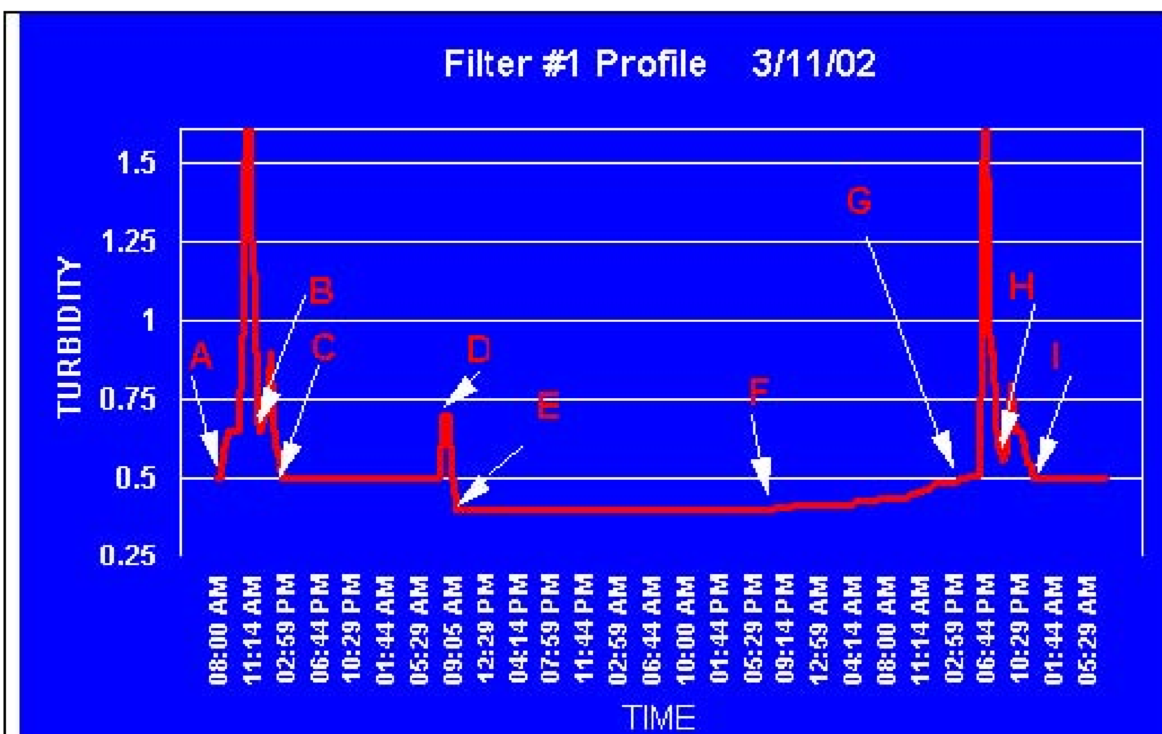


Figure 1. Effluent turbidity profile of filter #1

A. 10:30 AM Day 1 filter #1 backwashed @ 0.65 NTU

B. 12:29 PM Day 1 filter # 1 placed into service @ 0.65 NTU

C. 2:59 PM Day 1 filter #1 recovers @ 0.5 NTU

D. 8:45 AM Day 2 filter #3 backwashes

E. 9:30 AM Day 2 performance of filter #1 improves because filter #3 has been washed which reduces the loading on filter #1

F. 8:29 PM Day 2 performance of filter #1 begins to degrade

G. 6:59 PM Day 3 filter #1 backwashed @ 0.51 NTU

H. 8:44 PM Day 3 filter #1 placed into service @ 0.56 NTU

I. 12:14 AM Day 4 filter #1 recovers @ 0.5 NTU

Limiting factors:

- Significant turbidity spike when placing filter #1 into service following backwash.
- Filter #1 recovers to 0.5 NTU after backwash while other filters recover to 0.1 NTU.
- Filter #1 turbidity increases when filter #3 is backwashed.

Hydraulic Loading Conditions of the Filter

The permitted capacity of XYZ Water Treatment Plant is 1,728,000 gallons/day or 1,200 gpm maximum instantaneous flow rate. This is based on the designed filtration rate of 4 gpm/ft^2 with one filter out-of-service. The plant is always operated at or under 1,200 gpm with the average being 1,100 gpm. In addition, the flow is divided evenly among all filters. When a filter is being backwashed, the flow is divided among the remaining filters, still not exceeding 400 gpm/filter.

Limiting factors:

- None noted.

Condition and Placement of the Media

The design specifications for the media in all filters are as follows:

Design Media Conditions

Anthracite

- effective size 1.0 mm
- uniformity coefficient 1.3
- percent weight loss <1.0%

Sand

- effective size 0.45 mm
- uniformity coefficient 1.3
- percent weight loss <1.0%

We collected core samples of filter #1 and had our lab conduct a media analysis according to AWWA Standard B100-96. We found that the current condition of the media is as follows:

Current Media Conditions

Anthracite

- effective size 1.3 mm uniformity
- coefficient 1.5 percent
- weight loss 15.0%

Sand

- effective size 0.55 mm
- uniformity coefficient 1.4
- percent weight loss 11.0%

These results show that a coating has developed on our media. The coating is black in color. According to our lab and our media supplier, it is probably a manganese dioxide coating. Our media is 10 years old and we were advised to consider cleaning or replacing the media in the near future.

During the filter inspection there were no signs of surface cracking, mounding of media or separation from the walls. We saw no boiling of media or vortexing. As a result we felt no need to do an extensive inspection of the underdrains. However, mudballs were present on the surface of the filter bed. No mudballs were found beneath the surface of the media. Inspection of the core samples showed an interface of about 2 to 3 inches between the sand and anthracite.

Excessive floc carry-over to the filters was noticed.

Our operators also conducted a floc retention analysis as described in Integrated Design and Operation of Water Treatment Facilities, 2nd edition, by Susumu Kawamura. The results of the floc retention analysis were 740 NTU/100 grams of media. These results indicate that filter #1 has mudball problems.

While mapping the support gravel, operators found that filter #1 had only 25 inches of filter media. This is of some concern to us, because we thought that we had 29 inches of media.

Limiting factors:

- Only 25 inches of media in filter #1.
- Floc retention analysis results indicate that the filter is still dirty.
- Manganese dioxide coating on the filter media.
- Excessive floc carry-over to the filters.

Backwash Practices

Filters are backwashed when they reach:

- a terminal head loss >=6 ft
- individual filter effluent turbidity >= 0.3 NTU
- filter run time >=80 hours

The backwash procedures are as follows:

- 5 minutes-filter draw down
- 3 minutes-low wash at 8 gpm/ft^2
- 5 minutes-high wash at 14 gpm/ft^2
- 3 minutes-low wash at 8 gpm/ft^2
- then the filter is placed into service

The backwash procedure is programmed into the computer and is not routinely changed. The backwash duration is not extended if the filter is still dirty at the end of the wash. Backwash rates are not adjusted as water temperatures change.

Backwash rates are limited by the amount of head pressure in the backwash storage tank.

All waste backwash water is sent to the lagoon and then the supernatant is slowly pumped to the sanitary sewer at a rate of 10 gpm. The sludge from the lagoon is cleaned two times per year and the sludge is sent to a landfill.

Our operators built a media expansion tool using a telescopic paint roller pole. A white disk is attached at the end of the pole. The expansion tool is similar to the one used by DEP during filter plant performance evaluation (FPPE) evaluations to measure the percent bed expansion. We determined that filter #1 is getting about 4 inches of bed expansion. Since we only have about 25 inches of media, this converts to about 12 percent bed expansion. This is lower than our manufacturer's recommendation of 20-30 percent bed expansion. Our manufacturer said that since our media has a coating on it, then our underdrains may be fouled with a similar coating. Coated media and fouled underdrains may be part of the cause of the poor bed expansion. He recommended that when we replace our media that we should also remove the gravel and inspect the underdrains for fouling. He also said that our other filters may have similar problems.

In addition, poor bed expansion could be the result of low backwash rates.

Limiting factors:

- Percent filter bed expansion is only 12 percent.
- Low backwash rates.
- Backwash rates are not adjusted as water temperatures change.
- Backwash duration is not extended if the filter is still dirty.
- Mudballs on the surface of filter #1.

Support Media and Underdrains

Our operators mapped the gravel layer using a ½-inch steel rod as described in an AWWA Filter Surveillance video that we purchased for operator training. They found that the gravel layer was within 2 inches of variance. According to Chapter 5 of EPA's Guidance Manual for Compliance with the Interim Enhanced Surface Water Treatment Rule: Turbidity Provisions, the gravel layer should not deviate more than 2 inches. The operators also discovered that we only have a total of 25 inches of filter media. This was verified by digging a test hole and measuring the depth to the gravel layer. Please see figure 2 below for a map of filter #1 support gravel.

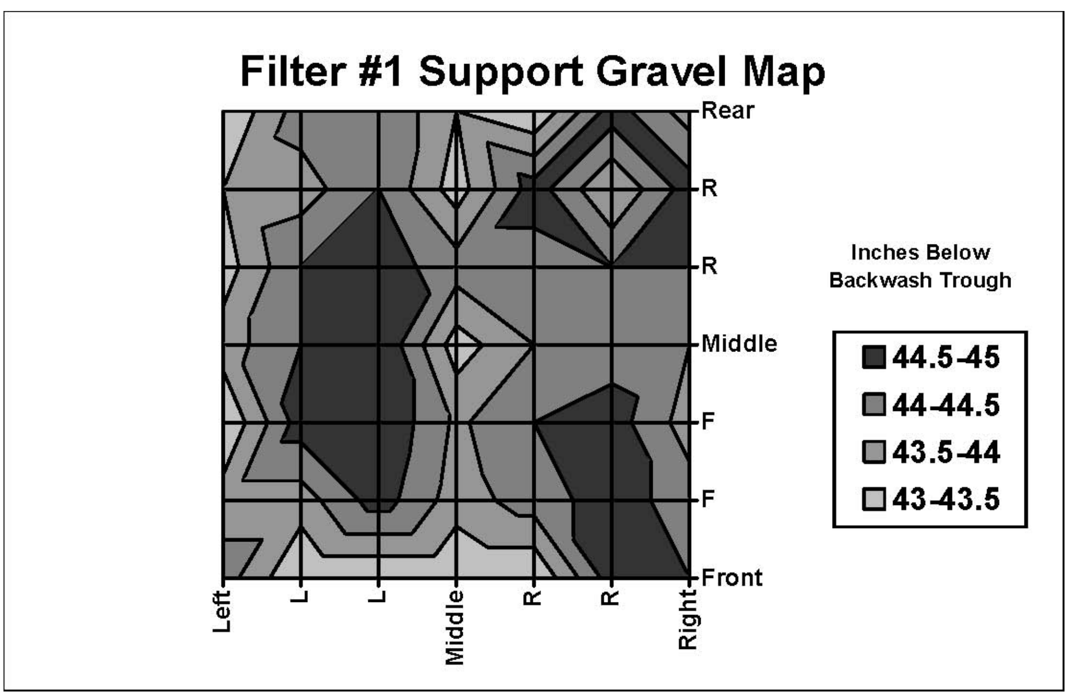


Figure 2. Map of filter #1 support gravel in inches below the backwash trough.

In addition, no media was found in the clearwell, no air boiling was observed during the backwash and no vortexing was seen while the filter was draining.

We suspect that our underdrains may have some manganese dioxide fouling. As a result, a more in-depth inspection of the underdrains will be conducted when the filters are rebuilt.

Limiting factors:

- The underdrains may be fouled.

Rate-of-Flow Controllers and Filter Valving

We contacted the manufacturer of our rate-of-flow control valves for information on assessing the performance of the valves. The manufacturer sent us a new operations manual and offered to send a technician to assist us for $1,000/day plus expenses. We then contacted the ABC Water Treatment Plant because we knew that they had the same kind of valves. One of their operators knew a great deal about valves and came to our plant and trained all of our operators on how to fine-tune our rate-of-flow control valves. We found this to be of great value and have added this to our quarterly operator-training program. No major problems were found with the rate-of-flow control valves or any other valves.

Limiting factors:

- None noted.

Limiting Factors

Below are the performance limiting factors identified during the self assessment of filter #1. These factors are listed in priority order with number one having the highest priority. In addition, each limiting factor has an assessment of the applicability of corrections beneath it. In other words, this is how we determined how applicable it would be to correct each limiting factor. We feel that making the corrections listed below will improve the performance of filter #1 and ensure that turbidity excursions over 1 NTU will not occur in the future.

1. Significant turbidity spike when placing filter #1 into service following backwash. No special procedures for placing a filter into service after backwashing. No filter-to-waste capabilities.

Applicability of Corrections: Unfortunately, our plant was designed without filter-to-waste capabilities or we would be able to send this spike to waste. While reading some filter optimization literature we found a couple of special procedures for placing a filter into service after backwashing. The first two that we plan to try immediately are:

- Allow the filter to rest for 1 hour before placing it into service; and
- Ramp valves open slowly when placing the filter on-line.

If these two procedures do not reduce our turbidity spike when placing a filter in service, we will then try using a filter aid polymer.

The addition of filter-to-waste piping has been budgeted into our 3-year plan.

2. Percent filter bed expansion is only 12 percent. Low backwash rates. The underdrains may be fouled.

Applicability of Corrections: The backwash rate was increased to 15 gpm/ft^2, which produced a 14 percent bed expansion. Although this is still short of the recommended 20-30 percent bed expansion, the head pressure provided by our backwash storage tank limits the backwash rate. However, we feel that the coating on the media may make it more difficult to fluidize the filter bed and the result is a lower percent bed expansion. In addition, we believe that the underdrains may be fouled with a similar coating and, as a result, the flow is restricted creating a lower backwash rate. XYZ Water Treatment Plant plans to rebuild filter #1 this coming winter when the demand for water is lower. The rebuild will consist of removing all media and support gravel, inspecting and opening any fouled holes in the underdrains, then new support gravel and media replacement.

The remaining three filters will be rebuilt within the following 2 years.

3. Backwash rates are not adjusted as water temperatures change.

Applicability of Corrections: Now that our operators have an expansion tool and have had some practice using it, we plan to measure the filter bed expansion on each filter at least once per month. The backwash rate will be adjusted seasonally as the water temperature changes in order to meet our goal of 25 percent bed expansion. As stated earlier, our backwash rate is limited by the amount of head pressure in our backwash tank. Hopefully after filter #1 is rebuilt we will have more flexibility to increase the backwash rates.

4. Backwash duration is not extended if the filter is still dirty.

Applicability of Corrections: This has already been resolved. Operators have been instructed to observe each backwash. If the water over the filter is still dirty at the end of the high wash, then the high wash is extended until the filter is clean. The time is then programmed into the computer so that the next backwash will automatically be adjusted.

5. Mudballs on the surface of filter #1. Floc retention analysis results indicate that the filter is still dirty.

Applicability of Corrections: Scraping and removing the surface of the filter bed have removed most mudballs. The formation of these mudballs is probably a combination of:

- excessive floc carry-over to the filter
- no surface wash
- low filter bed expansion
- low backwash rate
- inadequate backwash duration

These are all limiting factors that will be addressed independently.

6. Only 25 inches of media in filter #1.

Applicability of Corrections: Filter media is expensive; we feel that topping off the filters with new media now would be a waste of new media, since we plan to rebuild this filter. All media will be replaced within the next 6 months. The filter will then be brought up to the design standard of 20 inches of anthracite and 9 inches of sand.

7. Manganese dioxide coating on the filter media.

Applicability of Corrections: As stated earlier, the filter media will be replaced with all new media within the next 6 months. In addition, we are looking into optimizing our manganese removal in the sedimentation basin. We are planning to move the potassium permanganate feed point upstream to the raw water intake to give more contact time prior to adding our coagulant. We are also planning to add intra-basin baffling to our sedimentation basin and pilot the use of a polymer as a floc aid to help settle our floc in the basin. In addition, our chemical supplier suggested that we set pH goals for our coagulation process. We plan to have these changes implemented by this winter so that this problem can be resolved before filter #1 has new media. Hopefully this will reduce the amount of floc carry-over to the filters; thereby reducing the formation of mudballs and manganese dioxide on the new filter media.

8. Excessive floc carry-over to the filters.

Applicability of Corrections: As stated above, we are planning to add intra-basin baffling to our sedimentation basin and pilot the use of a polymer as a floc aid to help settle our floc in the basin. In addition, our chemical supplier suggested that we set pH goals for our coagulation process. We plan to have these changes implemented by this winter so that this problem can be resolved before filter #1 has new media. This will hopefully reduce the amount of floc carry-over to the filters.

9. No surface wash capabilities.

Applicability of Corrections: Operators have been instructed to use a rake to agitate the surface of the media before initiating the low wash cycle. Hopefully this will help break up the blanket on top of the filter enough to prevent mudballs. The addition of a mechanical surface wash system has been placed in our budget for the 2-year plan.

10. Filter #1 recovers to 0.5 NTU after backwash while other filters recover to 0.1 NTU. Filter #1 turbidity increases significantly when filter #3 is backwashed.

Applicability of Corrections: Although these are two of our greatest concerns, they have received a lower priority because we are uncertain of the cause. This problem will hopefully be remedied once the filter is rebuilt. We plan to do a thorough inspection of the underdrains in filter #1 when it gets rebuilt within the next 6 months. This will continue to be a limiting factor that we will stay aware of until the cause is identified and resolved.