DATE: 5 October 2012

TO: Office of Drinking Water Technical Staff

FROM: John J. Aulbach, II, PE, Director
Office of Drinking Water

SUBJECT: POLICY – Virginia's Optimization Program (VOP)

Project Leader: Robert Edelman

Reviewed by: Susan Douglas

SUMMARY STATEMENT

The Virginia's Optimization Program (VOP) is designed to minimize public health risks associated with drinking water beyond that achieved by simple adherence to regulatory standards. This is accomplished through treatment optimization. VOP establishes state-wide optimization criteria and a mechanism for monitoring and tracking goal attainment. The program is explained to the public and participating waterworks through the current VOP Public Information Document (PID). This memo provides further guidance to Office of Drinking Water (ODW) staff on implementing the VOP.

1. INTRODUCTION

The VOP PID states performance goals, provides uniform monitoring and reporting requirements for various surface water treatment rules and optimization performance criteria. The VOP PID is an active document and will be modified as goals are modified or as new goals are adopted. This PID is located on ODW's external website; the current document is attached to this memo.

2. BACKGROUND

The Composite Correction Program (CCP) was originally developed by the USEPA and Process Applications, Inc. to improve the performance of conventional water filtration plants (WTPs) and achieve compliance with the Surface Water Treatment Rule (SWTR). In recent years, the CCP has been used as a mechanism to assist in optimizing the performance of WTPs to levels of performance that exceed regulatory requirements via the USEPA Area-Wide Optimization Program (AWOP). This is implemented by region; VDH ODW participates in the EPA Region 3 AWOP.
The initial focus of AWOP has been optimization to achieve turbidity (particulate) removal goals. AWOP is being expanded to address disinfection, disinfection byproduct control, total organic carbon removal, distribution systems, and groundwater systems.

In addition the Water Research Foundation (WRF) and Partnership for Safe Water (PSW) published Criteria for Optimized Distribution Systems in 2010. ODW expects to evaluate the USEPA modules and WRF/PSF criteria and enhance the VOP to establish additional performance goals as VDH determines they will be beneficial to improving the performance of waterworks in Virginia. The PID will be updated in a timely manner to reflect any changes to the VOP.

ODW has adopted the following CCP model components: establish optimized performance goals, continuously monitor and assess performance data (through the monthly operation report review

process), and incorporate performance-based activities into existing surveillance programs (through the sanitary survey process).

3. OPTIMIZATION PERFORMANCE GOALS

VDH ODW periodically evaluates EPA AWOP programs, and AWWA/WRF established optimization programs and goals and develops goals for adoption in Virginia. These goals are intended to enhance public health protection and waterworks performance. Goals selected by VDH ODW have been outlined in the VOP PID.

4. REQUIRED MONITORING AND REPORTING – MONTHLY OPERATION REPORTS

Monitoring requirements for parameters to determine compliance with the SWTR and its successors and achievement of VOP goals are given in the VOP PID. A Monthly Operation Report template, in Excel format, and Instructions are available on the \odwsvr1\odwshare\03-Memos\301-Active Working Memos\301.02-Forms Letters Manuals folder. The Excel template must be customized for each waterworks, and may be updated as necessary. Alternatively, the waterworks may generate a monthly report using its own SCADA system software, provided that the content in the template is included.

During review of Monthly Operation Reports, District Engineers shall insure that the optimization performance data is entered into ODW's software program created for this purpose.

5. WEIGHTED RANKING OF PLANT PERFORMANCE

A report listing each eligible treatment plant and ranking its relative performance to others will be produced annually, following completion of Monthly Operation Report data entry for the calendar year. The initial report will be generated by an individual designated by the ODW Director, and provided to the VOP Committee to be finalized and posted on \odwsvr1\odwshare\02-Committees\203-Task Teams\AWOP-CPE\03-Statistics. This data is also reported annually to EPA Region 3.

Below is a table comparing relative weighted performance ranking of water treatment plants within a planning district or field office for the past calendar year. It may be used in sanitary surveys and separate correspondence to the waterworks manager and operators, with further discussion on optimization performance, progress, etc.

Virginia Optimization Program Rank

PWSID	WATER TREATMENT PLANTS in Planning District (or Field Office)	Rank

Relative ranking of WTP from year to year.

	2005	2006	2007	2008	2009	2010	2011
Number of VOP WTPs in Virginia	138	136	134	132	131	131	130
WTP Rank							
WTP Weighted Score (20.00 MAX)							
Excellence in Performance Award							

6. COORDINATION WITH SANITARY SURVEY PROGRAM

ODW engineers are encouraged to address Virginia's Optimization Program during sanitary surveys in order to increase waterworks owners and operators awareness of enhanced performance goals.

If the plant is working to optimize performance, the tables in the surface water treatment plant sanitary survey form (\odwsvr1\ odwshare \03-Memos\301-Active Working Memos\301.02-Forms Letters Manuals\WM851- Sanitary Surveys) may be used to review with the plant operators and managers during the field visit. They may also be prepared and sent with the ranking table to the waterworks in a separate transmittal.

END OF MEMO

Attachment: Public Information Document (Effective Date: 10-5-2012)

Virginia's Optimization Program Public Information Document

Effective October 5, 2012

VDH VIRGINIA DEPARTMENT OF HEALTH
Protecting You and Your Environment

Office of Drinking Water
Safe Drinking Water for a Healthy Virginia

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I. Introduction

To optimize is to make as perfect, effective, or functional as possible. The mission of Virginia's Optimization Program (VOP) is to encourage waterworks to provide water with a quality that exceeds minimum regulatory standards (i.e. *as perfect as possible*) and to operate water systems in an exemplary manner (i.e. *as effective and functional as possible*). VOP attempts to accomplish this mission by establishing optimization goals, communicating the goals to affected waterworks, and measuring performance.

The Virginia Department of Health believes that when waterworks owners and operators are aware of enhanced performance goals, and track specific performance measures, they will improve the finished water quality delivered to their consumers, and enhance public health protection.

II. Program Purpose and Scope

The purpose of VOP is to reduce the risks to public health associated with drinking water beyond the risk reduction inherent by adherence to regulatory standards. VOP is currently focused on enhanced particulate removal at surface water treatment plants with gravity flow, granular media filters.

This Manual states performance goals, provides uniform monitoring and reporting requirements for surface water treatment and optimization performance criteria.

III. Optimization Performance Goals

Optimization performance goals have been developed over a period of time, through research and actual plant performance studies by the U.S. Environmental Protection Agency, American Waterworks Association, and the waterworks industry. The bases of the goals are described in Appendix A.

Virginia adopted performance goals for clarification and filtration processes in surface water treatment plants with gravity flow, granular media filters effective January 1, 2005 (see Appendix B). Specific enhanced performance goals effective January 1, 2013, are given in Appendix C.

IV. Required Monitoring and Reporting – Monthly Operation Reports

Monitoring requirements for determination of compliance with the Surface Water Treatment Rule and its successors, the *Waterworks Regulations,* and achievement of VOP goals, are stated in Appendix C.

A Monthly Operation Report (MOR) must be submitted by the 10th of each month, preferably in electronic format by email attachment or on disk, for the prior month's operation. Submittal of paper reports is also an acceptable option. It is important to note the VDH MOR template attempts to provide a general statewide format for conventional water treatment plant staff to use in reporting data and reflect unit process performance. However, all plants are not the same and the template will need to be modified to reflect operation / performance of components and unit processes associated with each plant. To obtain a copy of the MOR template (Excel format) & Instructions and considerations to adapt the MOR to fit specific conditions at a particular water treatment plant contact the District Engineer.

V. Weighted Ranking of Plant Performance

In order for waterworks to evaluate the relative performance of their surface water treatment plant (with gravity flow, granular media filters) in comparison with other such facilities in the Commonwealth, and to provide waterworks with an incentive to improve the performance of their plants, a report listing each eligible treatment plant in the Commonwealth and ranking its relative performance to other treatment plants is produced annually, based on monthly operation report data for the calendar year.

The original weighted ranking criteria for surface water treatment plants with gravity flow, granular media filters are:

Measure	Multiplier
Fraction of filter-months in which VOP filter effluent goal of $\leq$ 0.1NTU $\geq$ 95% of readings was met	6
Fraction of filter-months in which VOP filter effluent goal of $\leq$ 0.3 NTU, 100% of readings, was met	5
Fraction of backwashes for the year in which the filters were returned to service with filter effluent turbidity $\leq$ 0.1 NTU	2
Fraction of clarifier-months in which VOP clarifier effluent goal was met	5
Fraction of filter-months for the year with backwash recovery peak turbidity $\leq$ 0.3 NTU, 100% of backwashes goal was met	1
Fraction of filter-months for the year with backwash recovery period $\leq$ 15 minutes, 100% of backwashes goal was met	1

Weighted ranking criteria for surface water treatment plants with gravity flow, granular media filters, effective January 1, 2013 reflect an increased measurement precision, change of relative weights, and change to an annual, rather than monthly, basis for some of the goals. The new criteria are:

Measure	Multiplier
Fraction of filter-months in which VOP filter effluent goal of $\leq$ 0.10 NTU $\geq$ 95% of readings was met	5
Fraction of filter-months in which VOP filter effluent goal of $\leq$ 0.3 NTU, 100% of readings, was met	5
Fraction of backwashes for the year in which the filters were returned to service with filter effluent turbidity $\leq$ 0.10 NTU	5
Fraction of clarifier-months in which VOP clarifier effluent goal was met	3
Fraction of backwashes for the year with backwash recovery peak turbidity $\leq$ 0.3 NTU	1
Fraction of backwashes for the year with backwash recovery period $\leq$ 15 minutes	1

Perfect Score = 20

- Clarifier-months = sum clarifiers in service for each month of calendar year
- Filter-months = sum of filters in service for each month of calendar year – may be odd number as a filter may be out of service for an entire month
- Backwash basis = all backwashes for the month prior to 2013
- Backwash basis = sum of all backwashes for all filters for the year starting in 2013

Appendix A: Basis for Optimization Performance Goals for Surface Water Treatment Plants Utilizing Gravity-Flow Granular-Media Filters

BACKGROUND

Microbial pathogens, including protozoan parasites, bacteria and viruses, can be physically removed as particles in flocculation, sedimentation and filtration processes or inactivated in disinfection processes. The level of protection a waterworks provides can be increased by optimizing the particle removal processes and by proper operation of the disinfection process [the multiple barrier strategy]. The performance goals address optimizing particle removal.

Strong evidence supports maximizing public health protection by optimizing particle removal in a water treatment plant. EPA's existing filter effluent turbidity standard of not exceeding 0.3 NTU in 95 percent or more of the measurements taken each month does not guarantee that microbial pathogens will not pass through filters.

CLARIFICATION GOALS

The basis for the clarification goals is field work during development of the Composite Correction Program, and experience gained from AWWA's *Partnership for Safe Water* and state optimization pilot programs. The clarification goals represent what is achievable at optimized water treatment plants. The intent of the goals is to enhance the particle removal performance of clarification processes, decrease the particle load on filters and improve the reliability of the multiple-barrier treatment plant for effectively treating water.

The USEPA, in the *Handbook – Optimizing Water Treatment Plant Performance Using the Composite Correction Program, 1998 Edition* (CCP) established the following individual sedimentation basin performance goals:

- Settled water turbidity less than 1 NTU 95 percent 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 percent of the time when annual average raw water turbidity is greater than 10 NTU.

Dugan (2001. *Controlling Cryptosporidium Oocysts Using Conventional Treatment,* JAWWA, 93, 12**,** pp. 64 – 76) linked effective *Cryptosporidum*, particle and spore removal to clarification log removals of turbidity, with log turbidity removal underestimating other log removals. In researcher designated 'optimal' coagulation trials, *Cryptosporidum*, particle and spore log removals were 1.3, 1.2 and 1.2, while they were less than 0.35 in suboptimal coagulation trials, i.e. effective coagulation more than tripled the log removals of *Cryptosporidum*, particles and spores by clarification. Nine optimal coagulation trials were conducted with raw water turbidity > 10 NTU. Clarified water turbidity was no more than 2.0 NTU (the VOP goal) in only four of the trials. One would expect increased log removals when the VOP goal is met.

Dugan's study provided documentation that the log reductions provided in the CCP goals were close to those needed for optimized performance.

Appendix A (cont.)

INDIVIDUAL FILTER EFFLUENT GOALS

The USEPA, in the *Handbook – Optimizing Water Treatment Plant Performance Using the Composite Correction Program, 1998 Edition* (CCP) established the following individual filter performance goals:

- Filtered water turbidity less than 0.1 NTU 95 percent of the time (excluding 15-minute period following backwashes) based on the maximum values recorded during 4-hour time increments
- Maximum filtered water measurement of 0.3 NTU

Studies that link effective *Cryptosporidum* and/or *Giardia* removal to a filter effluent turbidity goal of 0.1 NTU and less effective removals to filter effluent turbidities greater than 0.1 NTU include:

Patania, Nancy L. et al, 1996. *Optimization of Filtration for Cyst Removal* (90699), AWWA Research Foundation, determined that:

- When treatment conditions were optimized for turbidity and particle removal, effective removal of *Cryptosporidum* [2.7 – 5.9 logs] and *Giardia* [3.4 – 5.1 logs] was observed
- Turbidity was removed to a much lesser extent than *Giardia* or *Cryptosporidium*, therefore turbidity serves as a conservative surrogate indicator of *Giardia* or *Cryptosporidium* removal
- Meeting a filter effluent turbidity goal of 0.1 NTU was indicative of treatment performance producing the most effective cyst and oocyst removal
- Log cyst or oocyst removals were reduced up to 1.0 log when effluent turbidity was between 0.1 and 0.3 NTU [as compared to removals when turbidity < 0.1 NTU]
- chemical pretreatment is the single most important factor influencing *Giardia* or *Cryptosporidium* removal
- When chemical pretreatment is optimized for turbidity and particle removal with deep bed filter media designs – differences in filtration rate, filter media design and use of filter aid polymer did not impact *Giardia* or *Cryptosporidium* removals.

Huck, P. M. et al, 2002. *Effects of filter operation on Cryptosporidium removal,* JAWWA, 94.6, page 97 et. seq. observed substantial deterioration (several $\log_{10}$ units) in oocyst removal at the end of filter runs, even in the early stages of breakthrough. One instance involved filter effluent turbidity levels increasing but still < 0.1 NTU.

Emelko, M. B. et al, 2003. *Cryptosporidium and microsphere removal during late in-cycle filtration,* JAWWA, 95, 5, page 173 et. seq. describe pilot scale work to assess *Cryptosporidium* removal through filtration. They determined that:

- During stable operation [effluent = 0.04 NTU] *Cryptosporidium* reductions were 5 to 6 log
- At end of filter run as effluent approaches 0.1 NTU, *Crypto* reductions decrease to 2 to 3 log
- At breakthrough, as turbidity increases to 0.3 NTU, *Crypto* reductions decrease to 1.5 to 2 log
- Breakthrough of *Cryptosporidium* is due to nonattachment to the filter media.

The Huck and Emelko investigations, conducted after the initial establishment of the Composite Correction Program turbidity goals, demonstrated considerable deterioration in *Cryptosporidium* removal when filter effluent turbidity levels were increasing but still less than 0.1 NTU, revealing that the Composite Correction Program performance goals were not adequate.

ODW adopted a filter effluent turbidity goal of 0.10 NTU, effective January 1, 2013, in order to maintain more optimal *Cryptosporidium* removals than would be provided with a 0.1 NTU goal. The revised goal eliminates the increased amount of *Cryptosporidium* that could pass through the filter when the filter effluent turbidity is between 0.105 and 0.15 NTU. The revised goal has been demonstrated to be achievable by water treatment plants in Virginia.

Although a filter effluent turbidity goal of not exceeding 0.10 NTU does not guarantee that microbial pathogens will not pass through filters, it represents the current best practice for plants to achieve the greatest level of public health protection.

FILTER BACKWASH GOALS

The USEPA, in the *Handbook – Optimizing Water Treatment Plant Performance Using the Composite Correction Program, 1998 Edition* (CCP) established the following filter backwash goals:

- Maximum filtered water turbidity following backwash of less than 0.3 NTU
- Maximum backwash recovery period of 15 minutes (e.g. return to less than 0.1 NTU).

The basis for the filter backwash goals is field work during development of the Composite Correction Program, and experience gained from AWWA's *Partnership for Safe Water* and state optimization pilot programs. The backwash recovery goals represent what is achievable at optimized water treatment plants.

ODW has established the filter backwash goal of filtered water turbidity $\leq$ 0.10 NTU 95% of time a filter is placed into service following a backwash.

Amirtharajah, Appiah, 1988, *Some Theoretical and Conceptual Views of Filtration*, JAWWA, 80, 12, page 42, has shown that:

- More than 90% of the particles that pass through a well-operated filter do so during the initial stages of filtration following backwash.
- Two effluent turbidity peaks are experienced.
  - The first peak is associated with the backwash water remnants within and above the media (with a magnitude dependent on the effectiveness and time of backwash).
  - The second peak (usually larger than the first) is caused by influent particles passing through the filter when the efficiency of filtration is low. As particles are removed, filtration efficiency improves with the removed particles themselves acting as collectors.

The turbidity of the initial filter effluent may be less than 0.10 NTU, i.e. that of the backwash water, and the turbidity varies, passing through the two peaks, prior to decreasing to the operating level for the filter run. The intent of the backwash recovery period goals is to limit the peak effluent turbidity to no more than 0.3 NTU and the time to reach the peak and return to an operating level of no more than 0.10 NTU to no more than 15 minutes.

Appendix A (cont.)

Studies that revealed log removal of *Cryptosporidium* oocysts were 0.5 to 1 log lower during filter ripening than during stable filter operation conditions include:

1. Patania, et al. 1995 (previously referenced)
2. Swaim, P. D., et al, 1996. *High-Rate Direct Filtration for Giardia and Cryptosporidium Removal,* Proceedings 1996 AWWA Annual Conference, Ontario
3. Baudin, I. & Laine, J. M., 1998. *Assessment and Optimization of Clarification Process for Cryptosporidium Removal.* Proceedings 1998 AWWA WQTC, San Diego
4. Huck, P. M., et al. 2002 (previously referenced).

The public health significance of the filter backwash goals is to reduce the amount of *Cryptosporidia* and other possibly pathogenic particles that are in the drinking water that is provided to the public.

Appendix B: VOP Goals (January 1, 2005 through December 31, 2012)

Virginia evaluated the goals proposed in the CCP, in the EPA Area Wide Optimization Program (AWOP) and in the AWOP plans from other states and the research supporting these goals, and adopted similar goals. Key decisions included:

- Evaluate attainment of most optimization goals on a monthly rather than a yearly basis in order to provide more frequent feedback on plant performance, and to enable more rapid reaction to trends that may indicate poor performance.
- Adopt standards with 'less than or equal to', i.e. 'does not exceed', language in some instances in order to conform to the Surface Water Treatment Rule standard for filtered water turbidity (does not exceed 0.3 NTU).
- Utilize filtered water turbidity readings taken every 15 minutes (minimum), instead of the 4 hour frequency in the CCP and AWOP programs. (Continuous turbidity monitoring was not a standard practice when the CCP and AWOP programs were initially developed, but is now prevalent in Virginia.)
- Include backwash recovery period goals in order to assess effectiveness of backwash procedures.

Clarification[1] (Individual unit preferred, or other combinations as currently monitored)

- Water turbidity ≤ 1.0 NTU 95% of time when average raw water turbidity for month ≤ 10.0 NTU
- Water turbidity ≤ 2.0 NTU 95% of time when average raw water turbidity for month > 10.0 NTU

Filtration[2] (Individual Filters)

- Filtered water turbidity ≤ 0.1 NTU 95% of time
- Filtered water turbidity ≤ 0.1 NTU every time a filter is placed into service following a backwash
- Filtered water turbidity ≤ 0.3 NTU 100% of time
- Backwash recovery period[2] ≤ 15 min. (return to ≤ 0.1 NTU) in 100% of backwashes
- Peak turbidity ≤ 0.3 NTU during backwash recovery period[2] in 100% of backwashes

Minimum Data Monitoring Requirements

- Raw water turbidity @ 2 hr. intervals
- Clarified water turbidity @ 2 hr. intervals
- Filtered water turbidity @ 15 minute intervals, each filter (in conformance with SWTR) [3]
- Peak turbidity during backwash recovery, and period of recovery, each filter, every backwash

[1] Clarification includes sedimentation basins, upflow clarifiers, absorption clarifiers, dissolved flotation units.

[2] The backwash recovery period is the time following a filter backwash, commencing with the restoration of forward flow through the filter, continuing through a peaking of filter effluent turbidity, until the return of filter effluent turbidity to ≤ 0.1 NTU. ODW encourages operators to filter-to-waste during this period.

[3] Those WTPs that do not continuously monitor individual filters or that record data on charts may use a 2 hour interval.

Appendix C: VOP Goals (Effective January 1, 2013)

ODW has reevaluated the VOP goals and elected to:

- Increase the precision of individual unit filtered water goals from 0.1 NTU to 0.10 NTU in order to align Virginia's program with EPA's originally intended goal and maintain more optimal *Cryptosporidium* removals than would be provided with a 0.1 NTU goal.
- Establish filter backwash goals as a separate category with an annual evaluation period and a reduction in performance expectations from 100% of backwashes every month to 95% of backwashes for the year. The change from a monthly to annual evaluation period is to provide a more statistically valid basis for evaluation of performance among treatment plants by increasing the population of events being evaluated. The change from 100% to 95% performance expectation is to encourage the implementation of optimal backwashing procedures, i.e. a treatment plant is less likely to stop attempting to reach the performance standard if they miss it once in a while.

Clarification[1] (Individual unit preferred, or other combinations as currently monitored){monthly evaluation period}

- Effluent turbidity ≤ 1.0 NTU 95 % of time when average raw water turbidity for month ≤ 10.0 NTU
- Effluent turbidity ≤ 2.0 NTU 95 % of time when average raw water turbidity for month > 10.0 NTU

Filtration (Individual Filters) {monthly evaluation period}

- Filtered water turbidity ≤ 0.10 NTU 95 % of time
- Filtered water turbidity ≤ 0.3 NTU 100% of time

Filter Backwash (sum of all backwashes for all filters) {annual evaluation period}

- Backwash recovery period[2] ≤ 15 min. (return to ≤ 0.10 NTU) in 95% of backwashes
- Peak turbidity ≤ 0.3 NTU during backwash recovery period[2] in 95 % of backwashes
- Filtered water turbidity ≤ 0.10 NTU 95% of time a filter is placed into service following a backwash

Minimum Data Monitoring Requirements

- Raw water turbidity @ 2 hr. intervals (15 minute intervals if continuous monitoring is provided)
- Clarified water turbidity @ 2 hr. intervals (15 minute intervals if continuous monitoring is provided)
- Filtered water turbidity @ 15 minute intervals, each filter (in conformance with SWTR) [3]
- Filtered water turbidity when filter is returned to service following a backwash
- Peak turbidity during backwash recovery, and period of recovery, each filter, every backwash

[1] Clarification includes sedimentation basins, upflow clarifiers, absorption clarifiers, dissolved flotation units.

[2] The backwash recovery period is the time following a filter backwash, commencing with the restoration of forward flow through the filter, continuing through a peaking of filter effluent turbidity, until the return of filter effluent turbidity to ≤ 0.10 NTU. ODW encourages operators to filter-to-waste during this period.

[3] Those WTPs that do not continuously monitor individual filters or that record data on charts may use a 2 hour interval.

Appendix D: General Monitoring and Reporting Requirements –

Surface Water and Groundwater under the Direct Influence of Surface Water Treatment Plants with Granular Media Filters

LOCATION	PARAMETER	FREQUENCY (minimum required)	REPORTED
Raw Water	Flow, gal	Continuous	Daily & monthly totals; hours per day in operation
	pH	1 per 2 hours or cont.	Daily average & range
	Alkalinity, total, mg/l	Daily	Value
	Hardness, total, mg/l as $CaCO_3$	Daily	Value
	Temperature, ^{o}F	Daily	Value
	Turbidity, NTU	1 per 2 hours or cont.	Daily average & range
	Iron[1], Manganese, mg/l	Daily	Value
	Color[1], Odor	Daily	Value
	TOC[2], mg/l	1 per month	Value
	Bromide[3], mg/l	1 per month	Value
Post flash mix	pH	1 per 2 hours or cont.	Daily average & range
	Alkalinity, total, mg/l	Daily	Value
Applied Water [4]	Turbidity, NTU	1 per 2 hours or cont.	Daily average [5] & max
	Disinfectant residual [6], mg/l	1 per 2 hours or cont.	Daily average & range

Cleaning sedimentation basins/clarifiers	Report monthly	Last date each basin was cleaned

1. Only if removal is a treatment objective.
2. May be reported separately to VDH by owner or laboratory. Result is paired with TOC sample, taken no later than point of combined filter effluent. Alternative criteria maybe reported, per D/DBP Rule.
3. Only if ozone used and bromate monitoring reduction desired.
4. Individual basins preferred, or combined effluent
5. Also report total # of measurements; number & % <= 1.0 NTU, number & % < 2.0 NTU
6. Only if adding disinfection chemicals which produce a measurable residual parameter

Appendix D (cont.)

LOCATION	PARAMETER	FREQUENCY (minimum required)	REPORTED
Filtered Water - Individual Filters	Turbidity, NTU	Continuous [or 1 per 2 hours if continuous turbidimeter out of service] or 1 per 2 hours if continuous monitoring of individual filters is not provided	Max. daily value., total # measurements; number & % < 0.30 NTU, number & % < 0.10 NTU, Exceedance Scenarios & follow-up action.
Filtered Water – Representative Samples of Filtered Water	Turbidity, NTU combined filter effluent prior to entry into a clearwell, or clearwell effluent, or plant effluent prior to entrance to distribution system, or average of measures from each filter effluent at the determination time	1 per 4 hours	total # measurements; number & % < 0.3 NTU, number of results > 1.0 NTU;

Appendix D (cont.)

LOCATION	PARAMETER	FREQUENCY (minimum)	REPORTED
Finished Water	Flow, gal (water produced)	Continuous	Daily & monthly totals; hours per day in operation
	Flow, gal (water delivered= produced-consumed in plant)	Continuous	Daily total
	pH	1 per 2 hours or cont.	Daily average & range
	Alkalinity, mg/l, total	Daily	Value
	Hardness, mg/l, total & calcium	Daily	Value
	Iron [1], Manganese, mg/l; Color, Odor	Daily	Value
	Turbidity [2], NTU	1 per 2 hours or cont.	Daily average & range
	Disinfectant residual, mg/l	1 per 2 hours or continuous (>3300 pop)	Daily average & minimum
	Fluoride, mg/l (if added)	Daily	Value
	Fluoride Split Sample	Monthly	Values
	Corrosion Inhibitor, mg/l (if added)	Daily	Value
	Chlorite, mg/l (if ClO_2 used)	Daily	Value
	Bromate, mg/l (if ozone used)	1 per month (or reduced per Rule)	Value
	Chlorine dioxide, mg/l (if used)	Daily	Value
Recycled Flows[3]	Flow, gallons		Daily total

Continuous Monitoring Requirements:

- Measurements from continuous turbidity monitors shall be recorded (digitally or graphically) at least every fifteen minutes. Daily average, maximum and minimum shall be computed from the fifteen minute values.
- Continuous turbidity monitors shall be standardized daily and calibrated quarterly.

[1] Only if removal is a treatment objective.
[2] Only if chemical addition after filters, or if substituting for combined filtered water per ESWT Rule.
[3] Water quality parameters as determined by District Engineer.

Appendix D (cont.)

FILTER OPERATION

PARAMETER	REPORTED
Filter run time, each filter	Number of hours prior to backwash
Filter Head Loss, each filter	Prior to and after backwash
Filter Effluent Turbidity, each filter	Prior to backwash and when placed into clearwell
Backwash Water Volume	Total Gallons Used
Actual filter-to-waste (rewash) time	Minutes
Turbidity during backwash recovery period [1]	Maximum
Time of backwash recovery period [1]	Minutes
Filter Drop Test Results, each filter (unless SCADA or other auto method available)	Quarterly
Filter Rise Test Results, each filter (unless SCADA or other auto method available)	Quarterly

[1] Backwash recovery period extends from when filter is restarted after backwashing until filtered water turbidity <= 0.10 NTU

CHEMICAL ADDITION

FOR EACH CHEMICAL ADDED, REPORT
Weight applied (i.e.: "lb/day as P") - daily total Dosage (i.e.: "mg/L of total product" or "mg/L as PO_4") - daily average

CHEMICALS ADDED	FORM USED	MANUFACTURER / PRODUCT NAME	NSF 60? (yes or no)	POINT OF APPLICATION
Algaecide (copper sulfate, other)				
Coagulant				
Coagulant Aid (polymer)				
pH Adjustment (lime, caustic, soda ash)				
Adsorbent (activated carbon)				
Oxidant (chlorine, chlorine dioxide, ozone, potassium permanganate, other)				
Filter aids (polymer, other)				
Corrosion Inhibitor				
Fluoride				
Disinfectant (chlorine, chloramines, chlorine dioxide, other)				

Appendix D (cont.)

GIARDIA INACTIVATION

LOCATION	FREQUENCY (minimum)	REPORTED [1]
Prior to clearwell	daily	Log inactivation during peak hour flow
Clearwell only	daily	Log inactivation during peak hour flow
Total	daily	Log inactivation during peak hour flow

[1] Disinfection Profile data (per ESWT Rule) may be substituted