Slow Sand Filter Guidance

Authorizing Service after Construction, Maintenance of Filter Bed, or Extended Shutdown

State of Idaho

Department of Environmental Quality

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Acknowledgements

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Prepared by
Idaho Department of Environmental Quality
Drinking Water Bureau
1410 N. Hilton St.
Boise, ID 83706

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Summary

This guidance defines the actions required by the Idaho Department of Environmental Quality (DEQ) before authorizing use of a slow sand filter following construction, maintenance of the filter bed, or an extended shutdown.

Purpose and Scope

All public water system (PWS) owners and operators that use slow sand filters must develop and follow DEQ-approved project-specific protocols for the filter ripening requirement of the "Idaho Rules for Public Drinking Water Systems" (IDAPA 58.01.08.523.09) before returning the filters to public service after construction, scraping, resanding, or an extended shutdown. Slow sand filters must be filtered-to-waste until they are biologically mature before being put into service following construction, scraping, resanding, or restarting after an extended shutdown (IDAPA 58.01.08.523.09).

Filter ripening ensures that the filter bed will be biologically mature enough to remove particulate and microbial contaminants including pathogens. This document defines the actions PWS owners and operators should take to demonstrate filter maturity to DEQ prior to initial start-up, following maintenance, or after an extended shutdown of a slow sand filter. This guidance also clarifies when DEQ's authorization for the PWS to serve the public is required. This document is not intended to provide guidance on operating a slow sand filtration plant; PWS owners and operators should refer to the approved Operations and Maintenance Manual (OMM).

DEQ guidance is intended to provide agency interpretations of rules and provide technical assistance to PWS owners and operators. This guidance does not have the force of law or regulation, nor does it replace best professional judgment.

Authority

Pursuant to the "Idaho Rules for Public Drinking Water Systems" (IDAPA 58.01.08.523.09), DEQ must approve project-specific protocols, review results, and provide authorization for a PWS to serve water to the public following slow sand filter construction, scraping, resanding, or restarting after extended shutdown.

Authority for controlling and regulating PWS facilities stems from Idaho Code Title 39, "Health and Safety." Under Idaho Code § 39-1, the Idaho Legislature has given the Idaho Board of Environmental Quality the authority to promulgate rules governing the quality and safety of drinking water. DEQ promulgated IDAPA 58.01.08 to control and regulate the design, construction, operation, maintenance, and quality control of PWSs and to provide a degree of assurance that such systems are protected from contamination and maintained free from contaminants that may injure the health of the consumer.

This guidance does not replace, supplant, or change any requirements under state or federal rules and regulations but may identify and reference relevant statutes, regulations, policy, and other guidance documents.

1 Background

Slow sand filters are a type of surface water treatment that uses both physical and biological processes to remove organic and inorganic material. Slow sand filters provide 90% to 99%+ reductions in bacteria and viruses and 2–4+ log removal of Giardia lamblia cysts and Cryptosporidium oocysts (NDWC 2000).

A significant amount of the particle removal in a slow sand filter occurs in the schmutzdecke. The biological activity of the schmutzdecke must be maintained to ensure adequate contaminant removal. Intermittent operation or changes in filter rates will reduce the effectiveness of the schmutzdecke (NDWC 2000).

Slow sand filter maintenance considerations include the following:

- The mechanical portion of the filter includes various grades of sand and support gravel with specified size and depth to ensure adequate filtration. The overall filter efficiency is highly dependent on temperature, flow rate, and filter bed depth.
- Slow sand filters, while relatively easy to maintain compared to other types of surface water treatment, do require periodic cleaning, which includes removal of the schmutzdecke. The frequency of cleaning will depend on the head loss, measured as a decline in the filtration rate, as schmutzdecke accumulates on the sand surface. Follow the DEQ-approved OMM for instructions on how and when to clean or resand the slow sand filter. If the facility does not have an OMM, work closely with the DEQ regional office to prepare a plan meeting the requirements of IDAPA 58.01.08.523.09.b.
- Filter ripening ensures that the filter bed will be biologically mature enough to remove contaminants following any disruption including scraping, resanding, or restarting after an extended shutdown. During the ripening process, the filtered water quality is poor and should be filtered-to-waste.
- Redundant filter beds or additional water sources should be provided to facilitate maintenance. IDAPA 58.01.08.523.02 requires redundant units for all new installations unless other sources are available. For existing slow sand filter installations, plant design capacity should be met with any unit out of service.

2 Filter Ripening

Filtered water from slow sand filters must be filtered-to-waste until the slow sand filters are biologically mature; this is referred to as filter ripening. All slow sand filters must be ripened before placing into service following construction, scraping, resanding, or restarting after extended shutdown (IDAPA 58.01.08.523.09).

2.1 Ripening Following Maintenance, Cleaning, or Disturbing the Filter

Actions that disturb the schmutzdecke, such as maintenance, cleaning, scraping, raking[1] , or vacuuming, reduce the filter's ability to remove contaminants. After a disturbance, the filter must be reripened and filtered-to-waste before treated water can be served to the public (IDAPA 58.01.08.523.09.a). Follow the OMM for instructions on how to ripen the filter after cleaning. DEQ also recommends using the following procedure:

- Filter-to-waste at 0.1 gallons per minute per square foot of filter surface area (IDAPA 58.01.08.300.c.iv). Continue wasting at this rate for the duration the filter was offline but no less than 24 hours. A lower filtration rate that matches the precleaning rate may be used if approved by DEQ in advance. To avoid disturbing the filter bed further, DEQ recommends restarting the filter at the precleaning flow rate and gradually increasing flow rates to the maximum allowable filtration rate.
- Check the effluent turbidity. Continue filtering-to-waste until the effluent turbidity measurements fall consistently below the precleaning level, unless otherwise approved by DEQ based on documentation provided by the design engineer (IDAPA 58.01.08.523.09.a). The rule states that effluent turbidity levels must fall below the precleaning level assuming the filter has been maintained. Effluent turbidity levels of water served to the public should be below 1 nephelometric turbidity unit (NTU), unless otherwise approved by DEQ and at no time exceed 5 NTU (IDAPA 58.01.08.300.02.c.ii[2]).
- Collect and evaluate raw and filtered water total coliform (TC) bacteria to demonstrate the filter is adequately ripened using an US Environmental Protection Agency (EPA)-approved enumeration method. DEQ recommends using EPA-approved analytical methods for these noncompliance, investigative samples. The recommended procedure is to filter-to-waste for at least 24 hours and until filtered water contains no more than 10 coliform/100 milliliter (mL) (if raw water total coliform [TC] is greater than or equal to 100 coliform/100 mL) or no more than 5 coliform/100 mL (if raw water TC is less than 100 coliform/100 mL).

2.2 Ripening Following Construction, Resanding, or Extended Shutdown

Slow sand filters must be filtered-to-waste prior to initial start-up, following resanding, or after an extended shutdown based on project-specific protocols approved by DEQ and incorporated into a DEQ-approved OMM (IDAPA 58.01.08.523.09.b). These protocols may be based on factors from standard literature (e.g., listed in IDAPA 58.01.08.002.02) but typically include factors such as minimum filter-to-waste time periods, bacteriological testing, and effluent turbidity. If approved protocols are not yet available, DEQ recommends the following procedure to ensure a biologically mature schmutzdecke and filter bed:

[1] To prevent pushing the schmutzdecke and other particles below the sand surface and deeper into the sand bed, DEQ recommends that the sand surface not be raked during filtration (down-flow mode).
[2] IDAPA 58.01.08.300.02.c.ii incorporates 40 CFR 141.73(b) by reference.

1. Backfill the sand bed with filtered water at a rate of 0.3 to 0.6 feet of bed depth per hour to displace air until the water level reaches the sand surface, at which point the backfill rate can be increased (AWWA 1991). Stop backfilling when the headwater level submerges the filter inlet (AWWA 1991).
2. Start operating the filter in the filter-to-waste mode, gradually[3] increasing the filtration rate to the maximum allowable filtration rate. Filter-to-waste until the schmutzdecke and filter beds are biologically mature.
3. The ripening period can range from a week to several months, with ripening occurring sooner with warmer temperatures and higher nutrient loads (AWWA 1991). DEQ recommends filtering-to-waste for at least 4 weeks.
4. Take daily effluent turbidity readings. Plotting turbidity measurements on a graph helps to indicate when an acceptable level has been reached (AWWA 1991).
5. Once the turbidity has dropped below 1 NTU in 95% of the highest daily readings (IDAPA 58.01.08.300.02.c.ii), DEQ recommends collecting and evaluating raw and filtered water TC bacteria weekly using an EPA-approved enumeration methodology to determine when the filter is adequately ripened. Continue monitoring effluent turbidity until the TC in the filtered water contains either no more than 10 coliform/100 mL (if raw water TC is greater than or equal to 100 coliform/100 mL) or no more than 5 coliform/100 mL (if raw water TC is less than 100 coliform/100 ml). At that point, DEQ recommends taking at least two filtered TC samples per week and plotting the results on a graph. Examples of acceptable maturity criteria are as follows:
    a. 3–5 coliform/100 mL in the filtered water in at least two consecutive samples, separated by at least 24 hours.
    b. Removal efficiency for TC has stabilized at a level agreeable to both the PWS operator and DEQ.

3 DEQ Approval to Serve the Public

After filter ripening, specific requirements must be met to demonstrate the filters are biologically mature prior to the PWS serving water to the public (IDAPA 58.01.08.523.09). These requirements are implemented after (a) cleaning and (b) construction, re-sanding, or restarting a slow sand filter following an extended shutdown.

3.1 Following Cleaning or Disturbing the Filter

DEQ approval to the PWS to serve the public is not required following scraping or cleaning of slow sand filters. Follow the procedures within the DEQ-approved OMM or a separate approved procedure to ensure adequate water quality prior to restarting service to the public. If a DEQ-approved procedure is not available, prepare a filter ripening plan for DEQ approval

[3] To prevent in-depth filter bed fouling, DEQ recommends the initial flow rate should start low and be gradually increased. For example, start with one fourth the allowable rate and increase, over a period of a few weeks, up to the maximum. If approved by DEQ, a lower, final flow rate can be considered if a lesser volume is needed from the water treatment plant when public service begins.

that generally follows the process described in section 2.1. A full OMM for all aspects of PWS operation is recommended.

3.2 Following Construction, Resanding, or Extended Shutdown

Following slow sand filter construction, resanding, or restarting the filter after an extended shutdown, sampling results from the filter-to-waste period must be provided to DEQ for review, and DEQ must provide authorization prior to restarting service to the public (IDAPA 58.01.08.523.09.b). Create a report with the data collected during the filter ripening process discussed in section 2.2 (turbidity, coliform, filtration rates, and duration of each phase) and submit to DEQ for evaluation. The PWS operator must receive DEQ's written authorization prior to restarting service of filtered water to the public.

4 Sand Requirements and Recommendations

For initial start-up or resanding, the sand specifications and sand support media must meet the criteria of IDAPA 58.01.08.523.05 and .06:

- New sand must be thoroughly washed before placement in the filter bed to remove any foreign matter (IDAPA 58.01.08.523.05.d). After washing, less than 0.5% by weight of the sand should pass through a #200 sieve. Fine particles will cause higher turbidity levels and unacceptable water quality (AWWA 1991). Fine particles may also plug the filter requiring replacement of all or some part of the sand bed or increase the filter-to-waste time necessary to put the filter back in service. Washed sand that will not be used immediately should be covered to prevent dust recontamination.
- Initially, and during resanding, at least 30 inches of filter sand must be placed on top of the graded support gravel (IDAPA 58.01.08.523.05.a and e). Removing too much sand during cleaning reduces the effectiveness of the filter. The sand depth must not drop below 24 inches (IDAPA 58.01.08.523.05.e).

References

AWWA (American Water Works Association). 1991. *Manual of Design for Slow Sand Filtration.* Denver, CO: AWWA Research Foundation and AWWA.

EPA (US Environmental Protection Agency). 2021. "Drinking Water Treatability Database: Slow Sand Filtration." EPA. *https://www.epa.gov/water-research/drinking-water-treatability-database-tdb.*

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Definitions

Terms defined in IDAPA 58.01.08 or Idaho Code § 39-01, et seq. have the meaning assigned to them in statute or rule. When the following terms are used in this guidance and are not otherwise defined in statute or rule, DEQ is referring to the following:

- **Cleaning or Disturbing**—Any action that disturbs the surface layer (schmutzdecke) of a slow sand filter bed, including, but not limited to, cleaning (by any means), scraping, flushing, raking, and vacuuming.
- **Extended Shutdown**—An extended shutdown is a period when the minimum rate of filtration is not maintained, typically for 24 hours or more, or any time the filter is drained. Resanding and seasonal are two types of extended shutdown. Resanding shutdowns may be a few hours to several days. Work should be completed expeditiously to minimize the amount of time a dewatered filter is offline. Seasonal shutdowns are typically for a period of multiple weeks or months often during cold climatic conditions and low system demands.
- **Filter-to-waste**—Filtering the water at normal rates (between minimum and maximum filtration rates) during the ripening process, but discharging to waste until the filter beds are mature. Filter-to-waste also includes another concept used during normal operation: slow sand filters produce slightly more water than is needed during the day because the rate of filtration cannot be changed quickly based on changes in demand. The excess produced water is also wasted.
- **Flushing**—With respect to filter beds, a designed cleaning process employed by some systems where filtered water from a neighboring filter bed gently expands, raises, and mobilizes the schmutzdecke material, which is then drained to waste from an adjustable pipe located just above the sand level.
- **Head Loss**—The loss of media permeability and increased flow resistance (AWWA 1991).
- **Maintenance Shutdown**—A maintenance shutdown is a period when the minimum rate of filtration is not maintained, does not last more than 24 hours, and does not require the filter to be drained. Maintenance shutdowns typically occur for cleaning, scraping, or repairs.
- **Maximum Allowable Filtration Rate**—One-tenth gallon per minute per square foot (IDAPA 58.01.08.300.02.c.iv).
- **Minimum Filtration Rate**—The minimum flow required to maintain a biologically mature schmutzdecke and filter bed and the functionality of the filter—at least 0.02 gallons per minute per square foot (IDAPA 58.01.08.523.11).
- **Raking**—Loosening of the top layer of the filter bed to improve the filtration rate without removal of sand.
- **Resanding**—The addition of sand that meets the requirements of IDAPA 58.01.08.523.05 to restore the sand bed to its original depth following repeated scrapings or after removing a substantial amount of existing sand for other reasons.

- **Ripening**—The process of filtering-to-waste until the schmutzdecke and entire sand bed depth of a slow sand filter are biologically mature, which provides adequate filtration removal.
- **Schmutzdecke**—The layer of material deposited on the top of the filter bed that causes head loss disproportionate to its thickness. It is characterized as a gelatinous, biologically active mat where the majority of particulate removal occurs (AWWA 1991).
- **Scraping**—Removal of the schmutzdecke and a thin layer of sand to reduce sand filter head loss and restore operational filtration rates.
- **Vacuuming**—Any removal of filter debris using suction.