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Alternate Water Supply Management Plan Point-of-Entry Treatment Systems

Wolverine World Wide, Inc.

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1.0 INTRODUCTION

This Alternate Water Supply Management Plan provides a description of the design, installation, operation, and maintenance related to Point-of-Entry Treatment (POET) systems offered to property owners in Plainfield and Algoma Townships, Michigan. Rose & Westra, a Division of GZA (R&W/GZA), has prepared this plan on behalf of Wolverine World Wide, Inc. (Wolverine) for use by Wolverine and its consultants and contractors. This plan, along with the appendices, presents information related to the operation and maintenance (O&M) of the POET systems.

This April 6, 2020 update presents changes pursuant to Consent Decree (CD) No. 1:18-cv-00039-JTM-ESC, effective February 19, 2020. The changes made to the POET O&M are established in Section 7.5 and Appendix L of the CD. The changes are primarily establishing a routine carbon change-out schedule and routine monitoring.

1.1 PROJECT BACKGROUND

In July 2017, Per- and Polyfluoroalkyl Substances (PFAS) were detected in water from a well in the House Street area, and since then, Wolverine has worked with the Michigan Department of Environment, Great Lakes, and Energy (EGLE), the Michigan Department of Health and Human Services (MDHHS), and the Kent County Health Department (KCHD) to sample private wells in the area. Wolverine immediately provided bottled water to potentially affected residences and available results have been shared with individual property owners and will continue to be shared as additional sampling takes place. Wolverine has provided and installed point-of-use (POU) and whole house POET systems. A separate maintenance memorandum has been completed for the POU filters. Since 2017, Wolverine has sampled over 1500 homes and installed and maintained over 530 POET systems. In addition, Wolverine has collected thousands of performance samples for the POET systems.

1.2 PLAN ORGANIZATION

This plan includes the following sections:

- Section 1 – Introduction: Provides an overview and background of the project objectives.
- Section 2 – Residential Well Identification, Monitoring, and Bottled Water Service: Provides an overview of the search areas, and past and future sampling plans.
- Section 3 – Communications with Affected Property Owners: Provides a description of communications with affected property owners;
- Section 4 – POET Systems: Presents a description of the POET systems and operation overview.
- Section 5 – O&M: Summarizes the O&M plans for the POET systems.
- Section 6 – Monitoring: Presents a description of work of the sampling and analysis plan for the POET systems.
- Section 7 – Cessation: Presents a description of the cessation of the POET system O&M as provided by Wolverine.

2.0 RESIDENTIAL WELL IDENTIFICATION, MONITORING, AND BOTTLED WATER SERVICE

2.1 INITIAL ACTIVITIES

Following the detection of PFAS in the House Street area, Wolverine began working with EGLE and MDHHS/KCHD to sample wells in the area. Wolverine offered to sample wells within the various sampling areas associated with

House Street as well as those in Wolven/Jewell, and provided bottled water while the laboratory results were pending.

2.2 PRIVATE WELL SAMPLING

If a drinking-water well was present on the property, permission to collect a groundwater sample for laboratory analysis was requested by R&W/GZA. R&W/GZA has maintained a list of locations where private wells have or have not been sampled. Additional residential drinking water well resampling will be conducted as part of the CD implementation. However, that sampling will be completed under a separate work plan.

3.0 COMMUNICATIONS WITH AFFECTED PROPERTIES

All members of the public can access the following websites to learn about the groundwater investigation and communications:

- Wolverine groundwater project website http://www.WeAreWolverine.com/
- KCHD website https://www.accesskent.com/Health/PFAS/belmont.htm
- MDHHS https://www.michigan.gov/mdhhs/
- Plainfield Charter Township https://www.plainfieldmi.org
- Algoma Township https://www.algomatwp.org
- MPART Michigan PFAS Action Response Team https://www.michigan.gov/pfasresponse

Additionally, each residence with a POET system installed was provided a reference card with contact information.

4.0 POET SYSTEMS

4.1 TREATMENT SYSTEM DESCRIPTION

POET systems were installed to treat water as it enters the building from the private well. Generally, the system was installed following the softener for wells with concentrations of PFOS+PFOA less than 70 parts per trillion (ppt). When the well concentration exceeds 70 ppt for PFOS+PFOA, the system was installed prior to the softener, thus treating all of the water. POET systems were typically installed where the existing water utilities were located, if space was available. Based on this installation, POET systems are designed to provide treated water to all fixtures such as sinks, showers/baths, and toilet and outside spigots when the concentration of PFOS+PFOA exceeds 70 ppt. If sample results find that the concentrations of PFOS+PFOA increases from below 70 ppt to above 70 ppt, the POET system will be re-piped to perform treatment prior to water softening.

Although the foregoing is a general rule regarding the installation, it should not be inferred that an installation following the softener will provide treatment for all Drinking Water Fixture Units (DFUs) in the home/building. Pre-softener branch service lines are common for drinking water taps and automatic-ice makers. As such, multiple inspections were performed to locate and treat all interior DFUs. An initial inspection (pre-installation) was performed by Culligan, the installer. Following installation, an initial sampling event was scheduled. The R&W/GZA sampling team reviewed and completed a checklist of the installation. One of the checklist items was to check for interior lines that were not piped to the influent of the POET systems.

The POET systems remove PFAS compounds through adsorption to granulated activated carbon (GAC). GAC is used in common household filters and POET systems, and have a proven track record for many applications, including for treatment of PFAS at multiple sites across the U.S. The POET systems connect to the existing water supply and distribution within the house. For commercial properties and high-water use residences, Wolverine has modified the typical installation to address additional requirements (as applicable). Multiple GAC columns have been installed in some situations.

The Culligan O&M Manual is included as Appendix A for reference/informational purposes only. A schematic of a typical POET system is also included in Appendix A. Provided below is a description of the major components of the POET system:

- Pre-filter:
  - Removes sand and sediment from the well water.
- Lead GAC:
  - Removes PFAS and other constituents that sorb to GAC. The GAC vessels are filled with Calgon F600 AW GAC. A typical POET system utilizes a 2-cubic-foot GAC vessel; however, in locations with the highest concentrations or high flows, multiple 2-cubic-foot vessels are utilized.
- Lag GAC:
  - Redundant vessel in case breakthrough occurs on the lead GAC.
- Post-filter:
  - Removes sand and sediment from treated water.
- Flow meter:
  - Monitors the volume of water treated/used.
- Ultra-Violet (UV) Lamp:
  - Removes bacteria that may be in the well water or present within the GAC vessels.

The nominal Empty Bed Contact Time (EBCT) is 4 minutes. This is controlled by restricting the maximum flow through the system to 8 gallons per minute (gpm). If it is determined that the user requires more than 8 gpm, a four column GAC system was installed to allow for a "high flow" water use of 16 gpm. There is no set protocol for installing the "high-flow" four-column system. In each building, its drinking water supply and needs was reviewed individually. The review may have included, but was not necessarily limited to, inlet water pressure, pressure loss with flow, DFU's, number of occupants, and size of home. A second criterion for the installation of multiple GAC columns was PFOS+PFOA concentration. Installations with total PFAS concentrations that exceed 7,500 ppt were identified as "high concentration" installations. The nominal EBCT for high concentration installations is 8 minutes.

4.2 OPERATION OVERVIEW

The POET systems operate using the existing water supply and pressurized flow from the existing pressure tank (or well pump if a pressure tank is not present) within the house. No additional pumps are needed as the water flows through the POET system and the PFAS are filtered out. The UV lamp is connected to household electrical service, but everything else is operated through hydraulic pressure provided by the existing pressure tank (or well pump). Once the water passes through the POET system, it enters the existing piping network within the house.

Sampling ports were installed prior to the POET systems, between the lead and lag GAC units, and after the POET systems to monitor performance (Section 6.0). Routine maintenance (Section 5.0) is completed by Culligan and monitoring is completed by R&W/GZA. The maintenance and monitoring is performed at Wolverine's expense.

All maintenance is pre-scheduled and does not require significant downtime (i.e., more than several hours). Residents are notified by the service representative before the water supply is temporarily interrupted so they may fill containers with water if needed during the service call. While it is unlikely a circumstance would occur that a POET system is down for maintenance other than a brief period during service, Wolverine will offer bottled water to residents in the event a long-term down period occurs.

4.3 POET SYSTEM STARTUP

An initial site visit was completed by Culligan to assess the existing water system and to select the optimal location for installation of the POET system. The basement has generally been identified as the optimal location for the POET system; however, if there is insufficient space, an alternative location may need to be identified.

Culligan then installed the system(s) as shown in Appendix A and in accordance with applicable plumbing codes. Approximately 200 gallons of water was flushed through the system to check piping connections, sampling ports, and flowmeter performance. Following the system flush, samples were collected as indicated in Section 6.0.

If the POET system remains dormant for more than three weeks, water should be flushed for a minimum of 25 minutes or 200 gallons or more prior to any use.

4.4 POET SYSTEM SHUTDOWN

In the event that one of the conditions in Section 7 of the CD and the O&M Plan scope of work (SOW) applies to a residence with a POET system, this system may be disconnected and can be removed. This is further discussed in Section 7.0.

Refer to informational **Appendix A** for the procedures for GAC management by Culligan and Calgon. In brief, the GAC will be managed to minimize and control any release of PFAS. The spent carbon will be transported to Calgon where it will be reactivated and the PFAS will be destroyed.

5.0 OPERATION AND MAINTENANCE (O&M)

O&M of the POET systems will be conducted by Culligan in coordination with each homeowner. Monitoring will be completed by R&W/GZA. The maintenance and monitoring will be performed at Wolverine's expense until one of the conditions in Section 7 of the CD, and the POET and POU O&M Plan SOW is met for that residence. Culligan contact information was supplied to the homeowner at the time of POET system installation. Routine maintenance for POET systems is well understood given their long-established use but vary for each POET depending on water usage and water chemistry. O&M will be tailored to each POET system based on monitoring (Section 6.0) to be protective of human health and to minimize interruptions for the homeowners once system performance and maintenance requirements have been established.

Homeowners are able to contact Wolverine, R&W/GZA, and/or Culligan directly to request assistance with their POET systems or to ask any questions regarding the system use and O&M.

5.1 PRESSURE/FLOW ISSUES

Reports of low pressure/flow are addressed in several ways; however, in general, the following protocol is used:

- Culligan performs an inspection of the system with the homeowners. The pressure gauges are read with demand. In addition, Culligan performs an informal assessment of the DFU and occupancy to determine if a high-flow system is required.
- If the Culligan review indicates the reported pressure/flow issue relates to the size of the POET system, a high-flow system is installed.
- If the Culligan review finds the influent pressure readings are low, a licensed well contractor will be scheduled to review the system and make adjustments if appropriate. Appropriate adjustments include replacing defective pressure switches and adjusting the pressure switches.
- If the licensed well contractor identifies other causes of pressure or flow issues, these are individually addressed, and corrections are made to resolve the homeowners pressure/flow issues.

5.2 SCHEDULE OF ACTIVITIES

Routine maintenance will be conducted at the following schedule:

- Pre- and post-filter replacement – every 4 months;
- A site inspection is completed during filter replacement to assess the condition of the POET system components (the UV quartz sleeve is cleaned, if needed, during these visits);
- UV quartz sleeve and lamp replacement – every 12 months; and
- GAC canister replacement – based on performance monitoring and as agreed upon in the CD and Section 5.5 of this plan.

The schedule for routine maintenance was established after performance monitoring data was gathered for over 24 months. Homeowners were notified of revisions to the O&M schedule.

5.3 WATER USAGE MONITORING

The flow meter volume will be documented at each property during the maintenance and performance monitoring events.

5.4 SEDIMENT FILTER CHANGE OUT

The pre- and post-sediment filter cartridges will be replaced every four months while in the O&M program provided by Wolverine.

The differential pressures across the POET systems will be documented at each property during each maintenance monitoring event. Section 5.0 includes responses to reports of low flow. If pressure readings by Culligan confirm an excessive pressure drop at any point in the system (sediment filter, GAC filter, etc.) that is the cause of a low flow, a correction will be made. These evaluations will be on-going and are specific for each system. Each instance is evaluated and addressed, as applicable.

5.5 GAC VESSEL CHANGE OUT

The frequency of change out of the GAC vessels is established in the February 19, 2020 CD. These change out frequencies are established below:

Monitoring Interval prior to CD	Proposed Carbon Change Out Intervals*
Weekly	6 months
Monthly	12 months
Quarterly	16 months
Semi-Annual	16 months
Annual	20 months**

* Carbon change out is removing the lead carbon vessel(s) and moving the lag vessel(s) into the lead position and installing a new vessel(s) in the lag position(s). This is detailed below. On a case-by-case basis, carbon change outs may occur off-schedule when unique issues such as unexpected pressure drop occurs across the POET system. If a POET system has been installed or a carbon change out has occurred at an individual address within six months prior to the Effective Date of the CD, that POET system will automatically be put on the carbon change-out schedule and monitoring will cease. Wolverine, after consultation with and approval from EGLE, may agree to postpone or cancel a scheduled change out to accommodate the scheduled installation of municipal water for the home. For example, if a carbon change out is scheduled 3 months or less prior to the scheduled municipal connection, the change out will be cancelled.

** The change out will occur earlier than 20 months if there is a demonstrated reduction in flow rate or increased pressure drop across the POET system prior to the expiration of 20 months (i.e., evidence of physical clogging rather than carbon exhaustion due to PFAS burden).

Additionally, if during performance monitoring, a change out will be completed when total PFOS+PFOA concentrations in a sample from the mid-point port (after the lead GAC vessel but prior to the lag GAC vessel) are greater than 35 nanogram per liter (ng/L). In addition, the GAC vessels may also be changed out due to reduced water delivery performance resulting from iron/carbonate build-up in the GAC. Pressure drop across the GAC vessels will be assessed during the routine O&M visits.

Routine GAC vessel change out will be conducted as follows:

- Remove the lead GAC vessel;
- Disconnect the lag GAC vessel and install in the lead position; and
- Install a replacement GAC vessel in the lag position.

Consistent with the American Water Works Association Standard 8604, the new media must soak in water for 24 to 48 hours before operation. With the exception of the Armory and Consolata Sisters installations, Culligan prepares a GAC vessel and performs the soak in their shop prior to delivery and installation. By this method, the GAC columns can be delivered and immediately placed into service.

A detection of PFOS+PFOA in a POET system effluent will be reviewed promptly. If the concentration is less than 10 ppt PFOS+PFOA and found on start-up, subsequent sampling will be evaluated. If the result is greater than 10 ppt and rising, the response will include changing out the lead vessel, moving the former lag vessels to the lead position and resampling. Following the receipt of resampling results, water chemistry and water usage data will be reviewed; the system performance will be evaluated; and adjustments will be made to the system as necessary.

For the Armory and Consolata Sisters installations, the systems are designed to allow for the operation of one filter while the replaced carbon is allowed to soak for 24 to 48 hours. If possible, the media in only one filter at a time will be replaced to provide PFAS free water for the 24 to 48 hours needed to soak new media for the Armory

and Consolata Sisters installations. Since the performance monitoring of these systems will not change, the above protocol for carbon change out will remain (i.e., based on performance monitoring; not a routine, scheduled interval).

The initial round of carbon change outs will be completed over an approximately four-to-eight month period after the Effective Date of the CD. The change outs will be prioritized by PFAS concentrations, with the pre-CD weekly intervals being the first group. Once a carbon change out has occurred at an individual system, the specified carbon change-out schedule will begin for that particular address (i.e., if a current weekly system is changed March 1, 2020 as part of the initial change out, the six-month schedule will be triggered with the next scheduled change on September 1, 2020 and so on).

5.6 UV SYSTEM MAINTENANCE AND CHANGE OUT

The UV lamp will be replaced on a 12-month basis as indicated by the manufacturer's recommendation.

Cleaning of the UV quartz sleeve is dependent on water hardness. The quartz sleeve will be inspected every four months and, if required, cleaned.

A brightly colored label was placed on the UV units with "Fluorescent Lamp: Do Not Disturb." In addition, this sticker includes "Warning: May contain scalding water."

6.0 MONITORING

The monitoring program was developed to verify POET system performance, inform O&M activities (Section 5.0), and communicate conditions and results to the affected private well owners. The monitoring program includes the sampling and analyses plan, data management, and reporting.

6.1 SAMPLING AND ANALYSIS PLAN

This section provides a sampling and analysis plan (SAP) for monitoring POET systems installed in residences or commercial buildings.

The SAP covers:

- Objectives of sampling;
- Sampling schedules;
- Preparation;
- Collection of samples and documentation;
- Sample shipment; and
- Analytical procedures and parameters.

The sampling methods summarized herein will be performed by R&W/GZA on behalf, and under the direction, of Wolverine. The monitoring will be performed at Wolverine's expense.

6.1.1 Objective

The goal of the SAP is to verify that POET systems are operated and maintained in a manner that reduces the concentrations of PFOS+PFOA to 10 ng/l (combined).

6.2 PURGE WATER

Buckets or other suitable containers will be used to collect purge water from each POET port prior to sample collection. The collected water then will be disposed into the nearest sink or drain at each residence. Discharge of the purge water to the septic system or ground surface is consistent with EGLE interoffice communication regarding purge water disposal from well sampling and development (EGLE, 1999).

6.3 SAMPLE SHIPPING

Sample bottles will be placed into the cooler and packed with double-bagged wet ice immediately following collection. Packing material will be used as necessary. A temperature blank will be placed in the cooler prior to shipment. The cooler shall be addressed to the appropriate laboratory and dispatched as soon as practical to ensure timely arrival.

6.4 ANALYTICAL METHOD AND PARAMETERS

PFAS will be analyzed using U.S. Environmental Protection Agency (EPA) Method 537 (rev. 1.1). The analytical parameters presented in Table 1 represent the 14 PFAS compounds and reporting limits used to evaluate the POET systems. A baseline water profile was developed for each POET system by analyzing the following parameters at startup: hardness and iron.

6.5 SAMPLING SCHEDULE

Sampling was conducted in three phases: startup, performance, and routine monitoring. Startup monitoring was intended to assess system integrity immediately following installation. Performance monitoring was intended to establish O&M schedules necessary to achieve water quality objective based on site-specific operating conditions. Routine monitoring is designed to monitor system performance on an ongoing basis, once site-specific O&M parameters are defined.

6.5.1 Startup Monitoring

After quality control inspections are complete, but before startup sample collection takes place, approximately 200 gallons were processed through the system by the installer. The treated water was discharged into the homeowner's drain(s) and septic system. Startup samples were collected as follows:

- Homes with previous non-detect well sample: influent only;
- Homes with 1 – 1,000 ppt total PFOS+PFOA: influent and mid-point sample; and
- Homes with higher than 1,000 ppt total PFOS+PFOA: influent, mid-point, and effluent sample.

6.5.2 Performance Monitoring Schedule

Performance monitoring was conducted to establish lead canister breakthrough time (and an associated treated water volume) to establish an appropriate schedule for routine monitoring and carbon change out. Initial performance sampling was conducted as follows:

- Homes with previous non-detect well sample: annual sampling of the influent. If low level PFOS+PFOA was observed in the influent, the home was placed into the 1 – 70 ppt group;
- Homes with 1 – 70 ppt total PFOS+PFOA: semi-annual sampling (influent and mid-point). If changes to the influent concentration fell into a different concentration range, the sampling frequency was adjusted accordingly;

- Homes with 71 – 1,000 ppt total PFOS+PFOA: Quarterly sampling (influent, mid-point);
- Homes with 1,001 – 30,000 ppt total PFOS+PFOA: Monthly sampling (influent, mid-point, and effluent); and
- Homes with 30,001+ ppt total PFAS: Weekly sampling (influent, mid-point, effluent).

6.5.3 Routine Monitoring Schedule

A routine monitoring schedule was to be established after a lead vessel breakthrough frequency is established for each system (defined as total PFOS+PFOA > 35 ppt). However, breakthrough was not established prior to the effective date of the CD.

The CD establishes a new routine sampling protocol for the POET systems, summarized in the following.

After the Effective Date of the CD, until the first carbon change out at each individual residence for (a) POET systems in municipal water areas, and (b) POET systems in filter areas where influent concentrations are above 10 ppt for PFOS+PFOA, the following routine monitoring will be performed:

Monitoring Interval Prior to CD	Proposed Monitoring after Effective Date of the CD until the first Carbon Change Out at Each Individual Residence
Weekly	Monthly
Monthly	Quarterly
Quarterly	Semi-Annual
Semi-Annual	None, if sampled since July 1, 2019. If not sampled since July 1, 2019, one additional sample will be collected within the first eight months after CD is effective.
Annual	None, if sampled since July 1, 2019. If not sampled since July 1, 2019, one additional sample will be collected within the first eight months after the CD is effective.

The notification process and GAC change-out triggers are discussed in Section 6.10.1.

After each carbon change out, R&W/GZA will schedule a site visit to confirm configuration and operation of the POET systems.

Once the presumptive carbon change outs begin, the following routine monitoring will be conducted. The sampling will be completed approximately 2 -4 weeks after the individual carbon change out occurs.

Monitoring Interval Prior to CD	Proposed Carbon Change Out Intervals	Percentage of Random Systems Sampled after GAC Change Out (CO)*	Ports Sampled for Performance Monitoring**
Weekly	6 months	100% first GAC CO and 25% subsequent GAC COs	IN-MP-EF
Monthly	12 months	100% first GAC CO and 12% subsequent GAC COs	IN-MP-EF
Quarterly	16 months	10%	IN-MP
Semi-Annual	16 months	5%	IN-MP
Annual	20 months	5%	IN

*For the three POET systems installed in the filter areas with known influent concentrations over 70 ppt PFOS+PFOA, influent and mid-point monitoring samples will be collected one time between each carbon change out.

**IN= Influent, MP = Midpoint, and EF = Effluent

At the locations with Type II water supplies (i.e., Armory and Convent), the POET systems will be maintained and monitored within their permit requirements until municipal water connections are provided.

6.6 PREPARATION FOR SAMPLING

A monitoring checklist will be completed for water sample collection at each private well, which also includes information on project contacts and required equipment and supplies. All equipment and supplies, including bottle ware, should be PFAS free.

6.6.1 Bottle Ware

New bottle ware will be used to transport samples for laboratory analyses and will be provided by the laboratory performing the analyses. The bottles will be prepared by the laboratory according to the analytical method and certified as clean. The bottles will not be opened until immediately before sample collection.

6.6.2 Field QA/QC

The following field quality control samples will be collected at a rate of one per 20 samples collected in accordance with the Project Quality Assurance Project Plan (QAPP): Field blanks, field duplicates, and matrix spike/matrix spike duplicates.

- Field blanks will be collected by pouring laboratory-supplied certified PFAS-free water into a sample container at the point of sample collection. The purpose of field blanks is to assess potential cross-contamination at the sample point.
- Field duplicates will be collected by filling one additional sample container with water from the sample point. The purpose of field duplicates is to assess variability in sample composition. Field duplicates are not intended to be blind duplicates.
- Matrix spike/matrix spike duplicate (MS/MSD) will be collected by filling two additional sets of sample bottles with water from the sample point. MS/MSD analyses are conducted by the analytical laboratory after samples have been collected and submitted. Analysis of known concentrations of analytes spiked in the MS/MSD samples indicate if matrix interference effects are occurring.
- QA/QC samples will be collected using the methods described in Section 6.7 and labeled as described in Section 6.63 The location of QA/QC samples will be entered into the Monitoring Checklist. QA/QC samples will be analyzed using the same analytical methods used for the primary sample.

6.6.3 Sample Naming and Labels

Sample numbers will consist of identification numbers that include the unique property identification (ID) and the sample port, (e.g., AA-influent, AF-mid-point, CM-effluent, etc.). Sample numbers for each POET system will be repeated for each sampling event with consistent spelling, with the two-digit sample date added to the end (i.e., AA-influent-day/month).

To prevent misidentification of samples, legible labels will be affixed to each sample container. The labels will be sufficiently durable to remain legible even when wet and contain the following information:

- Property ID;
- Sampling port location (i.e., influent, mid-point or effluent as shown on Figure 3);

- Name or initials of collector; and
- Date and time of collection.

6.6.4 Sample Collection Methods

Each POET system treats water at the point where it enters a residence and downstream of any equipment such as pressure tanks. Treatment system components are installed in series and include: two, 2-cubic-foot carbon vessels.

POET systems include three separate sample ports: influent, mid-point, and effluent. The influent port is situated between the pre-filter and lead carbon vessel. The mid-point sample port is situated between carbon vessels. The effluent sample port is situated after the totalizing meter.

6.6.5 Sample Collection

Field personnel will assess whether or not the treatment system has undergone regular use by checking the volume of water processed through the treatment system since the last visit. The field personnel will then check the system for leaks or damage and report any leaks or damage to the R&W/GZA project manager.

Samples will be collected from the effluent, mid-point, and then influent ports using the R&W/GZA Sampling Procedure for PFAS as specified in Standard Operating Procedure B-1 of the project-specific QAPP. Samples will be labeled according to Section 6.3.3, preserved according to Section 6.6.6, and a chain-of-custody (COC) filled out per Section 6.6.7. All samples will be shipped to the laboratory for analysis; the analyte list and reporting limits presented in Table 1 will be followed.

The Project Specific QAPP for PFAS prepared for EGLE by R&W/GZA outlines the sampling procedures. This was submitted to EGLE separate from this management plan.

6.6.6 Sample Preservation and Handling

Samples will be preserved in the field by placing the samples into an insulated cooler containing double-bagged wet ice immediately after sample collection. Upon receipt of the samples, authorized laboratory personnel will store and/or prepare the samples for analysis, taking into consideration the sample holding time.

6.6.7 Chain-of-Custody

Custody of samples, sample collection details (e.g., date, time, ID, requested analyses), shipment information, laboratory receipt, and laboratory custody until completion of analyses will be documented on a COC form. The COC will include the signature of the individuals collecting, shipping, and receiving each sample. Each sample will be entered on the COC. The COC will accompany each set of samples shipped to the laboratory. Each time custody of the samples changes, the receiving and relinquishing parties will sign, date, and add the time to the COC.

Upon receipt at the laboratory, the contents of the cooler will be compared with the COC. Any discrepancies will be noted on the COC or the laboratory's sample receipt form. If discrepancies occur, the samples in question will be segregated from normal sample storage and the field personnel notified for clarification. COC records will be maintained as part of the project records.

6.7 PURGE WATER

Buckets or other suitable containers will be used to collect purge water from each POET port prior to sample collection. The collected water then will be disposed into the nearest sink or drain at each residence. Discharge of the purge water to the septic system or ground surface is consistent with EGLE interoffice communication regarding purge water disposal from well sampling and development (EGLE, 1999).

6.8 SAMPLE SHIPPING

Sample bottles will be placed into the cooler and packed with double-bagged wet ice immediately following collection. Packing material will be used as necessary. A temperature blank will be placed in the cooler prior to shipment. The cooler shall be addressed to the appropriate laboratory and dispatched as soon as practical to ensure timely arrival.

6.8.1 Custody Seals

In cases where samples are to be shipped to the laboratory by a commercial carrier (e.g., FedEx), a custody seal will be placed on the sample shipping container to ensure the samples have not been disturbed during transport. One seal will be placed on the front of the cooler, across the opening. The seals will be signed and dated by the sampling personnel.

6.9 DATA MANAGEMENT

The objectives of data management include:

- Review of data quality, also known as data validation; and
- Data processing, or tracking and organizing the data using a database management system to facilitate reporting and prevent processing errors.

6.9.1 Preparation for Sampling

A monitoring checklist will be completed for water sample collection at each private well, which also includes information on project contacts and required equipment and supplies. All equipment and supplies, including bottle ware, should be PFAS free.

6.9.2 Data Validation

Data validation will be conducted in accordance with The National Functional Guidelines for Organic and Inorganic Data Review (NFG; EPA, 2008 and 2010) and the revised Project Specific QAPP. A Level 2a review for verification and validation based on completeness and compliance checks of sample receipt conditions and sample-related quality control results. A brief overview of procedures for data validation includes:

- Holding Times: Compare the time and date the sample was collected (on the COC) to the date analyzed in the laboratory report. Verify the dates are within the recommended holding times for the particular method;
- Blank Data (Method, Field, Trip): Verify through blank sample data results that no significant contamination issues exist from sampling activities, sample transport, storage at the sampling site, or laboratory analyses (where applicable);

- Laboratory Control Sample Data, Matrix Spike Data, and/or Surrogate Data: Verify the percent recovery of the spiked compounds is within acceptable laboratory criteria included in each laboratory report;
- Duplicate Analysis Data: Calculate the relative percent difference (RPD) of target compounds where both the native and field duplicate sample concentrations are greater than five times the reporting limit to demonstrate acceptable precision and reproducibility of the laboratory and/or field procedures. Laboratory duplicate RPD values will be compared to laboratory criteria. Field duplicate RPD values will be compared to a criterion of 30 percent for this project; and
- Overall Data Assessment: Examine the data package as a whole and compare it to (1) the COC to verify completeness, (2) the historical data to verify representativeness, and (3) the other Site data to verify comparability is being achieved.

Qualification of the data may result if the evaluation criteria are not met. Data qualification(s) will be presented in the sampling report.

6.9.3 Data Processing/Management

R&W/GZA maintains a database to house information relevant to the POET system monitoring.

6.10 REPORTING

R&W/GZA will call homeowners within approximately two weeks of receipt of the analytical results to report the results to individual property owners served by a POET system. R&W/GZA will provide data to the EGLE as required for their database. EGLE will be provided periodic updates regarding progress and with notification of POET systems.

6.10.1 POET System Reporting

A detection of PFOS+PFOA in the POET effluent will be reviewed promptly. If the concentration is less than 10 ppt and found on start-up, subsequent sampling will be evaluated. If the result is greater than 10 ppt and rising, the response will include changing out the lead and lag GAC vessels, and resampling. Following the receipt of resampling results, water chemistry and water usage data will be reviewed, the system performance will be evaluated, and adjustments made to the system as necessary.

The results of each monitoring event for each POET system will be communicated by R&W/GZA to the property owner served by a POET system.

If a mid-point sample exceeds 35 ppt for PFOS+PFOA, EGLE will be notified. If an effluent sample concentration is greater than 10 ppt, EGLE will be notified. These notifications will be made within 24 hours of receipt of the analytical data.

6.10.2 Periodic Reporting

Periodic reports will be provided to EGLE. Reports will be designed to respond to specific requests and may include:

- Details on the type and number of systems installed;
- Monitoring frequencies and changes to monitoring frequencies;
- Analytical data for each system;
- Volumes treated by each system;

- O&M records with addresses, names, and references to specific locations redacted;
- Carbon usage for each system;
- Summary of complaints or inquiries regarding the systems (e.g., taste, odor, copper concentration) and their resolution; and
- Discussion of any deviations from the AWSMP or analytical methods, and changes in the extent of impacts, changes in regulatory framework, or other relevant details.

7.0 CESSATION

Under the CD, the following cessation plan was established.

- Wolverine will stop providing POET system monitoring and/or carbon changeout (as specified above) when the individual residence is connected to municipal water. Wolverine will offer the POET to the homeowner if they wish to continue the O&M. In the case of a POET system with known concentrations above 10 ppt PFOS+PFOA, the lead GAC vessel will be removed prior to the continued use of the POET system by the owner.
- At the locations with Type II water supplies (i.e. Armory and Convent), the POET systems will be maintained and monitored within their permit requirements until municipal water connections are provided.
- After the Effective Date of the CD, in filter areas (as established in the CD), if a parcel has not had influent/raw water PFOS+PFOA concentrations exceeding 10 ppt, Wolverine will offer to remove the POET system at Wolverine's expense, or the resident may choose to keep the POET system if they assume operation and maintenance.

TABLE 1
PFAS ANALYTICAL PARAMETERS AND REPORTING LIMITS

PFAS by EPA Method 537 (rev. 1.1)	CAS	Approximate Reporting Limit
N-ethylperfluoro-1-octanesulfonamidoacetic acid (EtFOSAA)	2991-50-6	4
N-methylperfluoro-1-octanesulfonamidoacetic acid (MeFOSAA)	2355-31-9	4
Perfluoro-1-butane sulfonic acid (PFBS)	375-73-5	4
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	4
Perfluoro-n-decanoic acid (PFDA)	335-76-2	4
Perfluoro-n-dodecanoic acid (PFDoA)	307-55-1	4
Perfluoro-n-heptanoic acid (PFHpA)	375-85-9	4
Perfluoro-n-hexanoic acid (PFHxA)	307-24-4	4
Perfluoro-n-nonanoic acid (PFNA)	375-95-1	4
Perfluoro-n-octanoic acid (PFOA)	335-67-1	4
Perfluoro-n-tetradecanoic acid (PFTeDA)	376-06-7	4
Perfluoro-n-tridecanoic acid (PFTrDA)	72629-94-8	4
Perfluoro-n-undecanoic acid (PFUdA)	2058-94-8	4
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	4

APPENDIX A - CULLIGAN OWNER'S MANUAL

(INCLUDED FOR REFERENCE/INFORMATION ONLY)

Installation and Operation Manual

Exchange Carbon Filter System

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II. RECOMMENDED START UP PROCEDURE: 4

Carbon Filter Component Parts: 6

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Overview

This Portable Exchange Carbon Filtration System is designed to be installed in residential applications for the reduction of traces of organic chemical contamination from well water supplies. The system provides maximum flow rate of up to 8 GPM and includes a cartridge type sediment pre-filter (Dual Gradient 50-5 micron), a dual Carbon Filter system containing a total of 4 Ft^3 of a Filtrasorb F600AW Bituminous Coal Acid Washed Granular Activated Carbon (Culligan Cullar F600AW), cartridge type sediment post-filter (Dual Gradient 50-5 micron) and a final UV Light Water Sterilizer rated at 8 GPM flow rate. The system incorporates test ports in the inlet, in between the two carbon vessels and at the outlet of the system for monitoring the system efficiency. Also, a water totalizing meter is included in the outlet of the system to record water usage and facilitate service monitoring.

System Design – Typical Operation

System is installed on the main water line of the residence after the well pressure tank as indicated in the system flow diagram (Fig. 1) below. The first sediment filter is used for the removal of sediments and suspended matter. Then water flows through two (2) 10"x54" vessels in series each containing 2.0 Ft^3 of the Cullar F600AW (#SPC10776) Granular Activated Carbon media for the adsorption of traces of organic contaminants. The dual filter approach provides for a continuous back contingency. Following the carbon filter vessels a secondary cartridge type sediment filter is utilized to provide clean water to the residence. Finally, a UV light water sterilization unit is providing microbiological control prior to distribution of the water to the household.

The system operation is designed to be simple and maintenance free. Periodic exchange of the carbon filters is performed by your local Culligan dealer. Sampling ports are included during the installation to facilitate testing the system efficacy and determine when the carbon filter(s) need to be replaced. The spent carbon should be disposed according to applicable local and federal requirements as it may contain the contaminants being removed in the process and has to be treated accordingly.

Refer to this manual for further details and instructions for the system components.

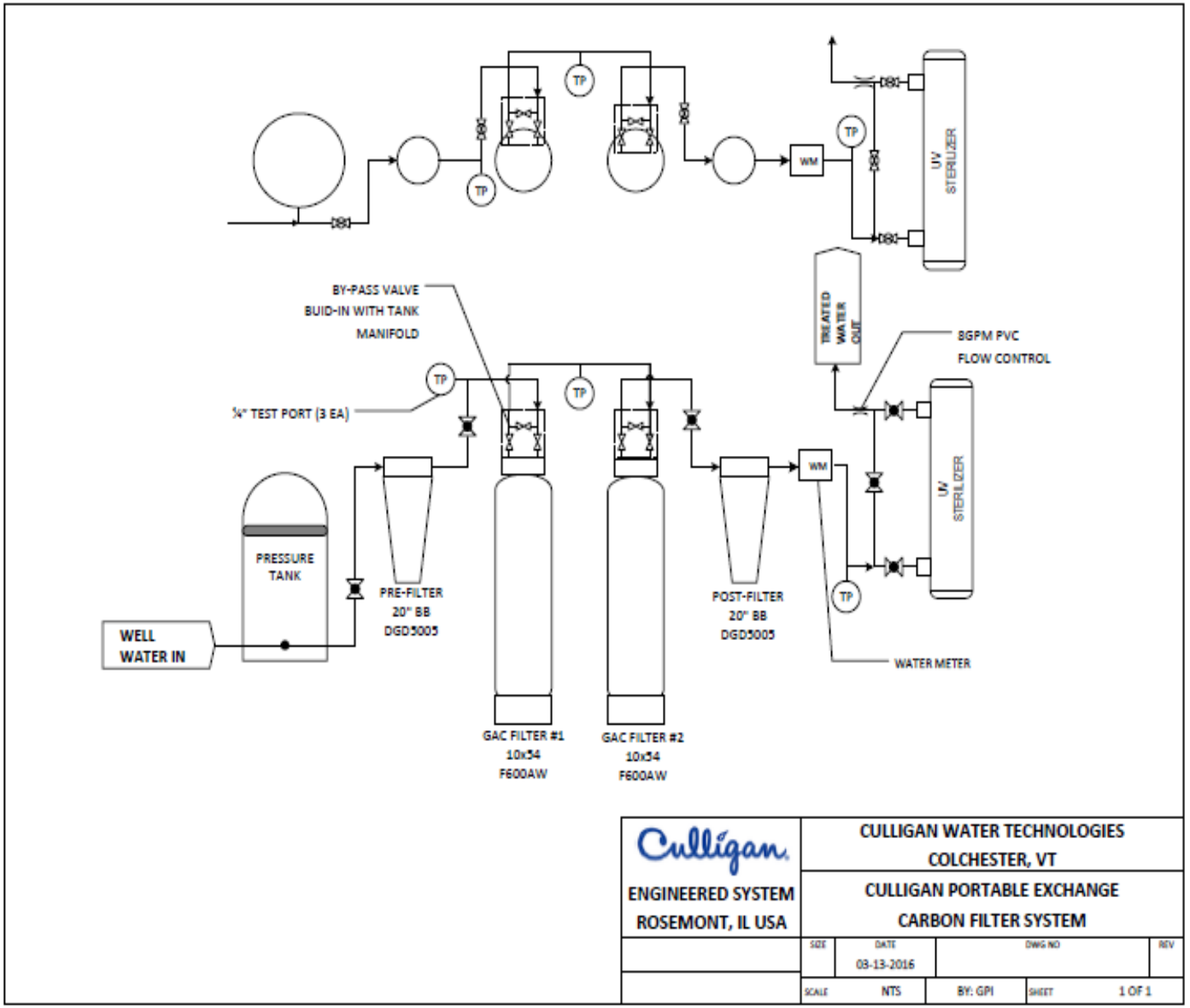


Figure 1: System Flow Diagram

PORTABLE EXCHANGE CARBON FILTERS

FILLING AND START UP PROCEEDURES

The following procedures should be followed every time a new Portable Exchange carbon filter is installed or exchange for an application. Every filter needs to be prepared according to the following instructions before it is placed in service.

I. FILLING PROCEEDURES:

1. Insert the Outlet distributor manifold in the tank and make sure it is properly centered
2. Cover the opening of the manifold with a clean rag.
3. Place a wide-mouth funnel in the tank opening.
4. Open one (1) 55 lbs. bag of Filtrasorb F600AW carbon. Slowly pour the carbon into the tank via the funnel. Fill the carbon within 2" – 3" from the top. Each tank depending on the size used should take 2 Ft^3 of carbon.
5. Fill the tank with water and allow the media to soak for 24-48 hours. The water level in the tank will decrease as the media soaks up water. Add water to the tank to keep the media submerged so all the media gets saturated.
6. Thread the tank closure with the inlet strainer into the tank; be careful not to miss thread.

II. RECOMMENDED START UP PROCEDURE:

1. It is advisable that every new filter is backwashed for 10 - 15 minutes at a flow rate of 5 – 8 GPM.
2. Easiest way to backwash the PE Carbon Tanks is utilizing a backwash funnel assembly, usually installed in a Culligan dealership. Backwash the media in the funnel for 10-15 minutes to make sure water is clean and all carbon fines are washed out.
3. Drop media back in the tank, drain excess water. Unit is ready to set in service.
4. If a backwash funnel is not available reverse the flow of the water on the tank manifold. Flow backwards to drain for 10-15 minutes at a flow rate no more than 5 GPM. If flow starts diminishing is because media is lifted around the top manifold. After 10-15 minutes make sure that the water to drain comes out clear. Reverse the flow and run to drain for another 5 min at 5 GPM to settle the bed.
5. You are ready to place the unit to service.
6. When installing the unit make sure that the Inlet & Outlet are hooked up correctly.

For servicing of the system contact the Culligan Dealer in your area.

Portable Exchange Carbon Filtration
Specifications and Operating Data

Cullar Portable Exchange Carbon Unit – 10x54 FRP Tank, 2.0 Ft^3

The 10"x54"-CARB FRP 1" will Provide:

Superior Quality Flow, gpm	: 3.1 @ 2 psi loss
High Quality Flow, gpm	: 4.7 @ 4 psi loss
Utility Quality Flow, gpm	: 6.3 @ 6 psi loss
Carbon Volume, ft^3	: 2.0

Miscellaneous Design Data:

Tank Size, in.	: 10x54
Tank Area, ft^2	: 0.54
Operating Pressure, psi	: 0-150
Oper. Temperature, °F	: 33-120

The 10"-CARB FRP 1" System Requirements:

Voltage	: None*
Pipe Conn, in NPT...	
Inlet	: 1.0
Outlet	: 1.0
Weight per tank, lbs...	
Shipping	: 132.0
Operating	: 195.0
Overall Dimensions, in....	
Width	: 11.0
Depth	: 12.0
Height	: 56.0

* Note: Voltage may be required for water quality instruments.

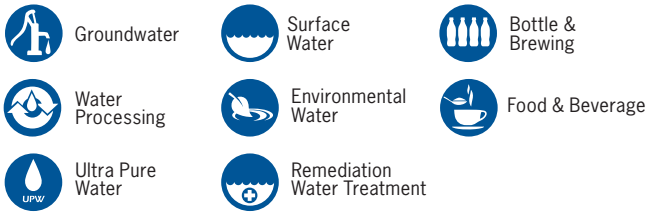
Cullar – Filtrasorb F600AW Activated Carbon Media:

The Filtrasorb F600AW media is a granular activated carbon for the removal of dissolved organic compounds from water. Such contaminants include taste and odor compounds, organic color, Total organic Carbon (TOC), and industrial organic compounds such as TCE, PCE and others. The F600AW is made of selected grades of bituminous coal and it is acid wash to provide cleanliness. See attached factory data sheet for more details.

FILTRASORB® 600

Granular Activated Carbon

Applications



With its enhanced high energy pore structure, FILTRASORB 600 is ideally suited for trace removal applications and offers a significant performance advantage over traditional activated carbon products used in these types of applications.

Specific applications include:

- Removal of MTBE
- Removal of DBCP
- Removal of THMs
- Removal of pesticides and herbicides
- Removal of other organics at concentrations < 1 ppm
- Potable water treatment
- Groundwater treatment
- Ultrapure water treatment

Description

FILTRASORB 600 is a granular activated carbon for the removal of dissolved organic compounds from water and wastewater as well as industrial and food processing streams. These contaminants include taste and odor compounds, organic color, total organic carbon (TOC), and industrial organic compounds such as TCE and PCE.

This activated carbon is made from select grades of bituminous coal through a process known as reagglomeration to produce a high activity, durable, granular product capable of withstanding the abrasion associated with repeated backwashing, hydraulic transport, and reactivation for reuse. Activation is carefully controlled to produce a significant volume of both low and high energy pores for effective adsorption of a broad range of high and low molecular weight organic contaminants.

FILTRASORB 600 is formulated to comply with all the applicable provisions of the AWWA Standard for Granular Activated Carbon (B604) and Food Chemicals Codex. This product may also be certified to the requirements of ANSI/NSF Standard 61 for use in municipal water treatment facilities. Only products bearing the NSF Mark are certified to the NSF/ANSI 61 - Drinking Water System Components - Health Effects standard. Certified Products will bear the NSF Mark on packaging or documentation shipped with the product.

Features / Benefits

- Produced from a pulverized blend of high quality bituminous coals resulting in a consistent, high quality product.
- Carbon granules are uniformly activated through the whole granule, not just the outside, resulting in excellent adsorption properties and constant adsorption kinetics.
- The reagglomerated structure ensures proper wetting while also eliminating floating material.
- High mechanical strength relative to other raw materials, thereby reducing the generation of fines during backwashing and hydraulic transport.
- Carbon bed segregation is retained after repeated backwashing, ensuring the adsorption profile remains unchanged and therefore maximizing the bed life.
- Reagglomerated with a high abrasion resistance, which provides excellent reactivation performance.
- High density carbon resulting in a greater adsorption capacity per unit volume.

Specifications[1]	FILTRASORB 600
Iodine Number, mg/g	850 (min)
Moisture by Weight	2% (max)
Abrasion Number	80 (min)
Trace Capacity Number, mg/g	16 (min)
Screen Size by Weight, US Sieve Series	
On 12 mesh	5% (max)
Through 40 mesh	4% (max)

[1]Calgon Carbon test method

Typical Properties*	FILTRASORB 600
Apparent Density (tamped)	0.62 g/cc
Water Extractables	<1%
Non-Wettable	<1%

*For general information only, not to be used as purchase specifications.

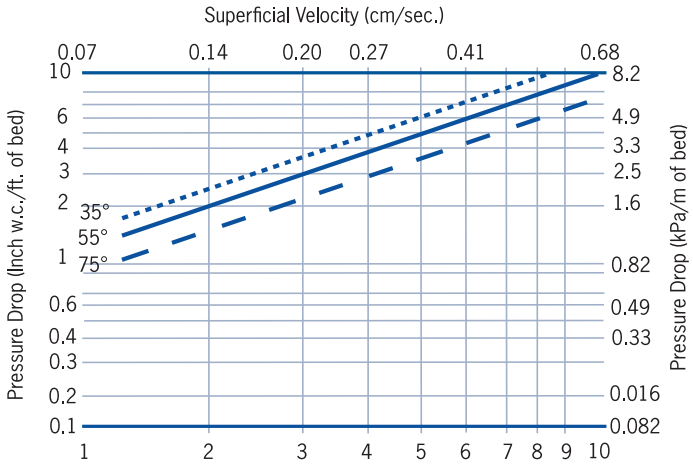
Safety Message

Wet activated carbon can deplete oxygen from air in enclosed spaces. If use in an enclosed space is required, procedures for work in an oxygen deficient environment should be followed.

DS-FILTRA60015-EIN-E1

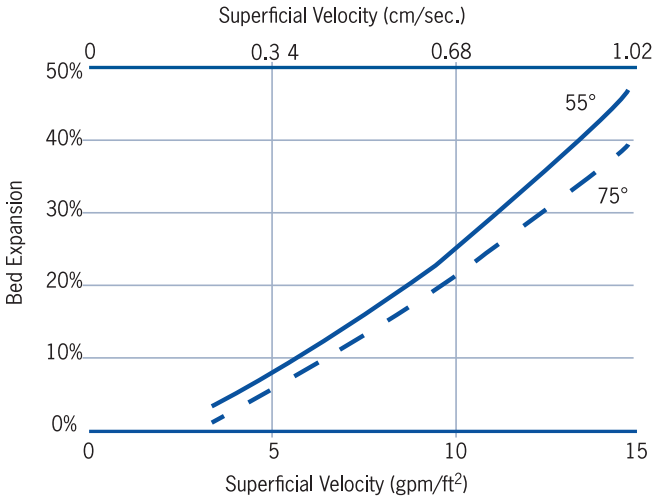
Typical Pressure Drop

Based on a backwashed and segregated bed



Typical Bed Expansion During Backwash

Based on a backwashed and segregated bed



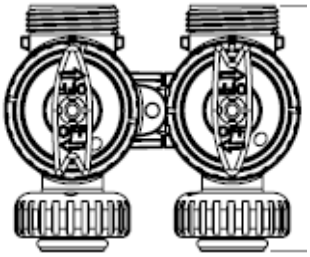
Safety Message

Wet activated carbon can deplete oxygen from air in enclosed spaces. If use in an enclosed space is required, procedures for work in an oxygen deficient environment should be followed.

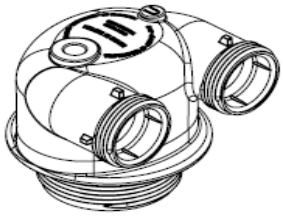
1.800.4CARBON calgoncarbon.com

DS-FILTRA60015-EIN-E1

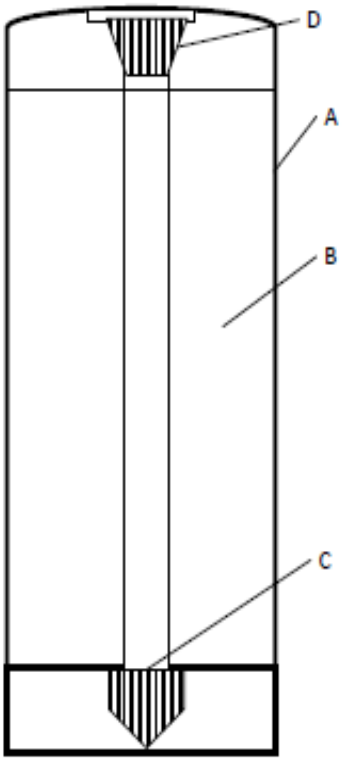
Carbon Filter Component Parts:



By-Pass Valve WS1 (#SPC10762)



In & Out Tank Head (#SPC10761)



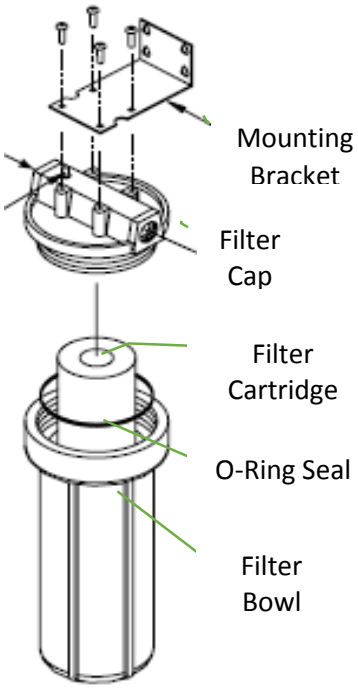
A. Filter Tank, FRP, 10”x54” (#SPC10770)

B. Carbon Media, 2 Ft^3, Cullar F600AW (#SPC10776)

C. Distributor Manifold (#SPC10773)

D. Top Distributor Basket (#SPC10765)

Filter Cartridge Replacement Procedures



The pre and post filter cartridges need to be replaced when a significant pressure drop across the filter increases, or in a regular intervals as determine by local water conditions.

1. Turn off water supply to filter. Depress red pressure-relief button to relief the pressure from the filter.
2. Using the filter wrench provided (#MS010522), unscrew the filter bowl.
3. Remove and discard old filter cartridge.
4. Clean the filter bowl with a damp cloth and rinse thoroughly.
5. Remove the wrapper from the new cartridge (#MS004512). Install the cartridge in the bowl, making sure it seals in the bottom of the bowl.
6. Check the O-ring seal (#MS404498) for dryness and cuts. Replace the seal if necessary and use silicone lube as needed.

   CAUTION! Do not use petroleum-based lubricants, which destroy the synthetic rubber seal.

7. Screw the filter bowl onto the filter cap and hand tighten. DO NOT OVER-TIGHTEN.
8. Slowly turn on the water supply to allow filter to fill with water and then press the red pressure-relief button on top of the filter cap to release trapped air.

UV Sterilizer # S8Q-PA-C (#D1022214)

Models:

S2Q-PA, S5Q-PA, S8Q-PA, S2Q-P/12VDC, S5Q-P/12VDC

NSF Standard 55 Class B Validated Models:

SV5Q-PA, SV8Q-PA

Powered by Sterilight

425 Clair Rd. W, Guelph, Ontario, Canada N1L 1R1
t. (+1) 519.763.1032 • tf. (+1) 800.265.7246 (US and Canada only)
t. (+31) 73 747 0144 (Europe only) • f. (+1) 519.763.5069
e-mail: info@viqua.com
www.viqua.com

System Tested and Certified by NSF International against CSA B483.1 and NSF/ANSI 55 for Disinfection Performance, Class B

MEMBER Water Quality Association

Section 1 Safety Information

These are the original instructions. Please read this entire manual before operating this equipment. Pay attention to all danger, warning, and caution statements in this manual. Failure to do so could result in serious personal injury or damage to the equipment.

Make sure that the protection provided by this equipment is not impaired. DO NOT use or install this equipment in any manner other than that specified in the installation manual.

1.1 Potential Hazards:

Read all labels and tags attached to the system. Personal injury or damage to the system could occur if not observed.

	Waste electrical and electronic equipment (WEEE). This symbol indicates that you should not discard wasted electrical or electronic equipment (WEEE) in the trash. For proper disposal, contact your local recycling/reuse or hazardous waste center.		This symbol indicates not to store any combustible or flammable material close to the system.
	This symbol indicates there is Mercury present.		This symbol indicates that the contents of the transport package are fragile and the package should be handled with care.
	This is the safety alert symbol. Obey all safety messages that follow this symbol to avoid potential injury. When on the equipment, refer to the Operational and Maintenance manual for additional safety information.		This symbol indicates safety glasses with side protection is required for protection against UV exposure.
	This symbol indicates a risk of electrical shock and/or electrocution exists.		This symbol indicates gloves must be worn.
	This symbol indicates the marked equipment may contain a component that can eject forcibly. Obey all procedures to safely depressurize.		This symbol indicates safety boots must be worn.
	This symbol indicates the system is under pressure.		This symbol indicates the operator must read all available documentation to perform required procedures.
	This symbol indicates there is a potential UV hazard. Proper protection must be worn.		This symbol indicates the plumber must use copper piping.
	This symbol indicates the marked item could be hot and should not be touched without care.		This symbol indicates that the system should only be connected to a properly grounded, grounding-type controller receptacle that is protected by a Ground Fault Circuit Interrupter (GFCI).
	This symbol indicates there is a potential for VERY hot water when flow is started.		

Warning: This product may contain chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

1.2 Safety Precautions:

⚠DANGER

Failure to follow these instructions will result in serious injury or death.

- **Electric Shock:** To avoid possible electric shock, special care should be taken since water is present near the electrical equipment. Unless a situation is encountered that is explicitly addressed by the provided maintenance and troubleshooting sections, DO NOT attempt repairs yourself, refer to an authorized service facility.
- **GROUNDING:** This product must be grounded. If it should malfunction or breakdown, grounding provides a path of least resistance for electric current to reduce the risk of electrical shock. This system is equipped with a cord having an equipment-grounding conductor and a grounding plug. The plug must be plugged into an appropriate outlet that is properly installed and grounded in accordance with all local codes and ordinances. Improper connection of the equipment-grounding conductor can result in a risk of electrocution. Check with a qualified electrician or service personnel if you are in doubt as to whether the outlet is properly grounded. DO NOT modify the plug provided with this system – if it does not fit in the outlet, have a proper outlet installed by a qualified electrician. DO NOT use any type of adapter with this system.
- **GROUND FAULT CIRCUIT INTERRUPTER PROTECTION**: To comply with the National Electrical Code (NFPA 70) and to provide additional protection from the risk of electric shock, this system should only be connected to a properly grounded, grounding-type controller receptacle that is protected by a Ground Fault Circuit Interrupter (GFCI) or to a residual current device (RCD) having a rated residual operating current not exceeding 30 mA. Inspect operation of GFCI as per manufacturer's suggested maintenance schedule.
- DO NOT operate the disinfection system if it has a damaged cord or plug, if it is malfunctioning or if it has been dropped or damaged in any manner.
- DO NOT use this disinfection system for other than intended use (potable water applications). The use of attachments not recommended or sold by the manufacturer / distributor may cause an unsafe condition.
- DO NOT install this disinfection system where it will be exposed to the weather or to temperatures below freezing.
- DO NOT store this disinfection system where it will be exposed to the weather.
- DO NOT store this disinfection system where it will be exposed to temperatures below freezing unless all water has been drained from it and the water supply has been disconnected.

⚠WARNING

- During extended periods of no water flow, the water in your chamber can become very hot (Approx. 60 °C) and potentially lead to scalding. It is recommended to run your water until this hot water has been purged from your chamber. Do not allow water to contact your skin during this time. To eliminate this condition, a temperature management valve can be installed at the outlet of your UV system.
- This system contains a UV Lamp. Do not operate the UV Lamp when it is removed from the chamber. Unintended use or damage of the system may result in the exposure of dangerous UV radiation. UV radiation may, even in little doses, cause harm to the eyes and skin.
- Changes or modifications made to this system without the consent of the manufacturer could render the system unsafe for operation and may void the manufacturer's warranty.

⚠CAUTION

Failure to follow these instructions could result in minor or moderate injury.

- Carefully examine the disinfection system after installation. It should not be plugged in if there is water on parts not intended to be wet such as, the controller or lamp connector.
- Due to thermal expansion concerns and potential material degradation due to UV exposure, it is recommended to use metal fittings and at least 10" of copper pipe on the outlet of your UV chamber.
- **Hg EXPOSURE**: The UV lamp contains mercury. If the lamp breaks, then avoid inhalation or ingestion of the debris and avoid exposure to eyes and skin. Never use a vacuum cleaner to clean up a broken lamp as this may scatter the spilled mercury. Obey local regulations and guidelines for the removal and disposal of mercury waste.

NOTICE

- The UV lamp inside the disinfection system is rated at an effective life of approximately 9000 hours. To ensure continuous protection, replace the UV lamp annually.
- The UV system is not to be used or played with by children. Persons with reduced physical, sensory or mental capabilities, or lack of experience and knowledge, are also not to handle the UV system unless they have been given supervision or instruction.
- This system is intended to be permanently connected to the water lines.
- This system is not intended to be used in or above water or outdoors or used in swimming pools when persons are in the pool.
- **EXTENSION CORDS**: If an extension cord is necessary, use only 3-wire extension cords that have 3-prong grounding-type plugs and 3-pole cord connectors that accept the plug from this system. Use only extension cords that are intended for outdoor use. Use only extension cords having an electrical rating not less than the rating of the system. A cord rated for less amperes or watts than this system rating may overheat. Exercise caution when arranging the cord so that it will not be tripped over or pulled. DO NOT use damaged extension cords. Examine extension cord before using and replace if damaged. DO NOT abuse extension cord. Keep extension cord away from heat and sharp edges. Always disconnect the extension cord from the receptacle before disconnecting this system from the extension cord. Never yank cord to pull plug from outlet. Always grasp the plug and pull to disconnect.
- If the supply cord is damaged, it must be replaced by a special cord or assembly available from the manufacturer or its service agent.
- **SYSTEM PROTECTION:** To protect your Controller, a UL1449 certified (or equivalent) transient voltage surge suppressor is strongly recommended.
- The UV lamp in this system conforms to the applicable provisions of the Code of Federal Regulations (CFR) requirements including, Title 21, Chapter 1, Subchapter J, Radiological Health.
- Read and understand the Owner's Manual before operating and performing any maintenance on this equipment.

1.3 Water Chemistry

Water quality is extremely important for the optimum performance of your UV system. The following levels are recommended for installation:

Water Quality and Minerals	Level
Iron	< 0.3 ppm (0.3 mg/L)
Hardness*	< 7 gpg (120 mg/L)
Turbidity	< 1 NTU
Manganese	< 0.05 ppm (0.05 mg/L)
Tannins	< 0.1 ppm (0.1 mg/L)
UV Transmittance	> 75% (call factory for recommendations on applications where UVT < 75%)

* Where total hardness is less than 7 gpg, the UV unit should operate efficiently provided the quartz sleeve is cleaned periodically. If total hardness exceeds 7 gpg, the water should be softened. If your water chemistry contains levels in excess of those mentioned above, proper pre-treatment is recommended to correct these water problems prior to the installation of your UV disinfection system. These water quality parameters can be tested by your local dealer, or by most private analytical laboratories. *Proper pre-treatment is essential for the UV disinfection system to operate as intended*.

Section 2 General Information

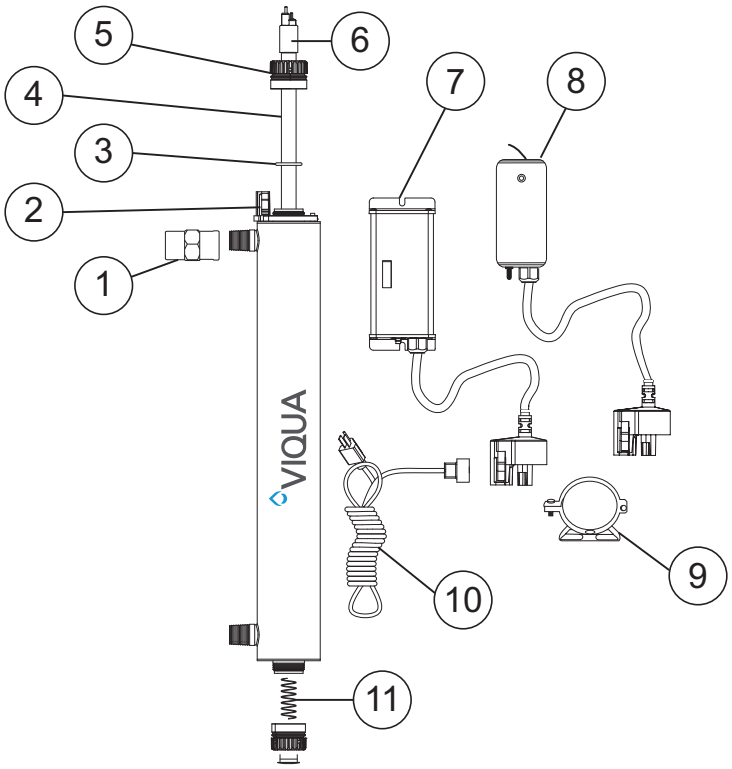


Figure 1 System Components

Item	Description	Part Number	UV Systems
1	Flow restrictor (Only for certified models)	440263-R	SV5Q-PA
		440264-R	SV8Q-PA
2	Lamp connector base	270276-R	Used on all systems
3	O-ring	410867	Used on all systems
4	Open-ended, 214 fused quartz sleeves with fire polished ends	QS-001	S1Q-PA
		QS-330	S2Q-PA
		QS-463	S5Q-PA, SV5Q-PA
		QS-810	S8Q-PA, SV8Q-PA
5	Retaining nut	RN-001	Used on all systems
6	Hard glass, coated Sterilumze®-EX UV lamps for long, consistent life (9000 hours)	S330RL	S2Q-PA
		S463RL	S5Q-PA, SV5Q-PA
		S810RL	S8Q-PA, SV8Q-PA
7	Controller (for 100-240V models only)	BA-ICE-S	S5Q-PA, S8Q-PA, SV5Q-PA, SV8Q-PA
8	Controller (for 12VDC models only)	BA-RO/P/12	S2Q-P/12VDC, S5Q-P/12VDC
9	2.5” Mounting brackets	410958-R	Used on all systems
10	IEC replacement power cords for VIQUA ICE Controller (sold separately)	260010	NORTH AMERICAN (NEMA 5-15P), 3-PRONG GROUNDED
		602637	CONTINENTAL EUROPEAN (CEE 7/7) 2-PIN WITH GROUND, “SCHUKO”
		260012	UK VERSION (BS 1363) 3-PRONG GROUNDED (5 AMP FUSE)
		260013	AUSTRALIAN VERSION (AS 3112) 3-PRONG GROUNDED
		260019	NO CONNECTOR, 3-WIRE, BARE LEADS
11	Spring	SP008	Used on all systems

Section 3 Installation

3.1 UV Disinfection System

⚠CAUTION

⚠ Electronic controller must be connected to a Ground Fault Protected Circuit (GFCI) receptacle. Ensure green ground wire ring terminal is securely fastened to ground stud on UV chamber.

The disinfection system is designed to be mounted either horizontally or vertically at the point-of-use or point-of-entry depending on the specific flow rate of the unit.

Note: *The ideal installation is vertical with the lamp connector on top. This is to prevent water damage from occurring on the lamp pins and lamp connector.*

- The controller should be mounted either above or beside the UV chamber. Always mount controller horizontally to prevent moisture from running down cordage and causing a potential fire hazard. Drip loops in all cordage connected to controller is highly recommended. Refer to Figure 5.
- The complete water system, including any pressure or hot water tanks, must be sterilized before start up by flushing with chlorine (household bleach) to destroy any residual contamination. Refer to Section 3.2.
- The disinfection system is intended for indoor use only. DO NOT install disinfection system where it may be exposed to the weather.
- Install the disinfection system on cold water line only, before any branched lines.
- A 5 micron sediment filter must precede the disinfection system. Ideally, the disinfection system should be the last treatment the water receives before it reaches the faucet.

Procedure:

1. Figure 2 shows the installation of a typical disinfection system and the related components that may be used for the installation. The use of a by-pass assembly is recommended in case the system requires “off-line” maintenance. In this case, note the system requires supplementary disinfection for the distribution system if any water is used during by-pass condition. In addition, during by-pass, the water will NOT be disinfected and a “DO NOT CONSUME THE WATER” tag should be physically installed on the by-pass assembly until such time as the system is sanitized and returned to service. For more information, refer to Section 3.2. If the water is to be consumed while the system is off-line, the water must be boiled for two minutes prior to consumption.

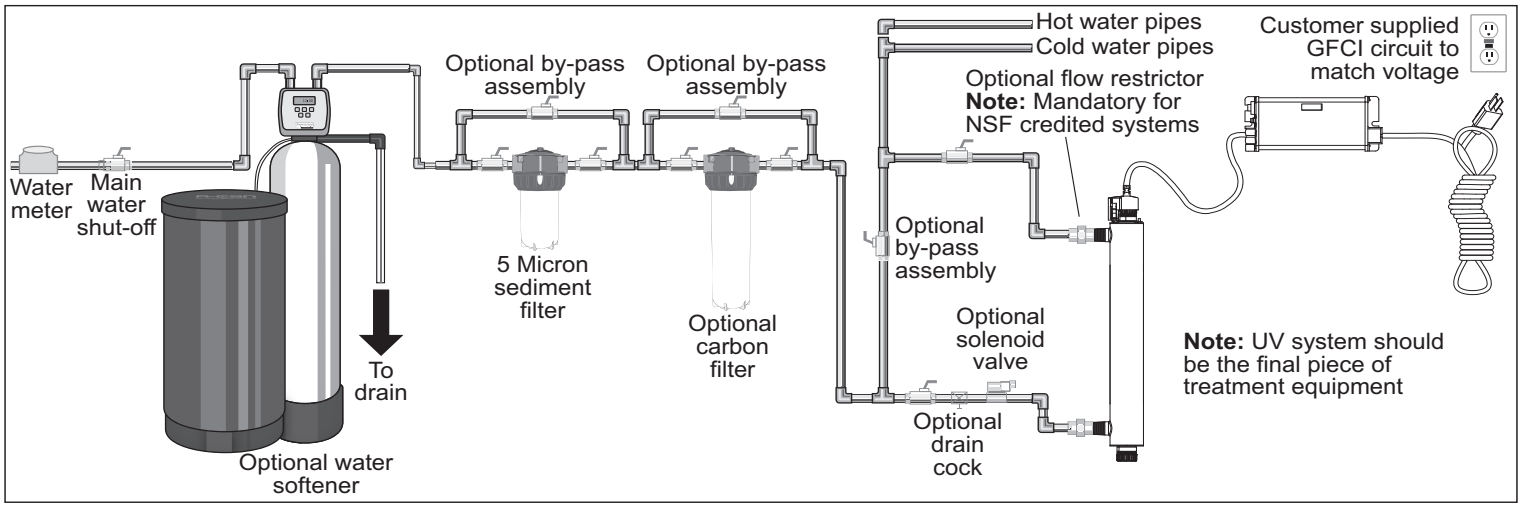


Figure 2 Disinfection System

2. Select a suitable location for the disinfection system and its related components. As it is recommended to install a GFCI, make sure that this is taken into consideration prior to any installation. The system can either be installed vertically (inlet port at the bottom) as shown in Figure 3 A, or horizontally as shown in Figure 3 B. However, the vertical installation is the most preferred method. When selecting a mounting location, leave enough space to allow the removal of the UV lamp and/or quartz sleeve (typically leave a space equal to the size of the UV chamber itself).

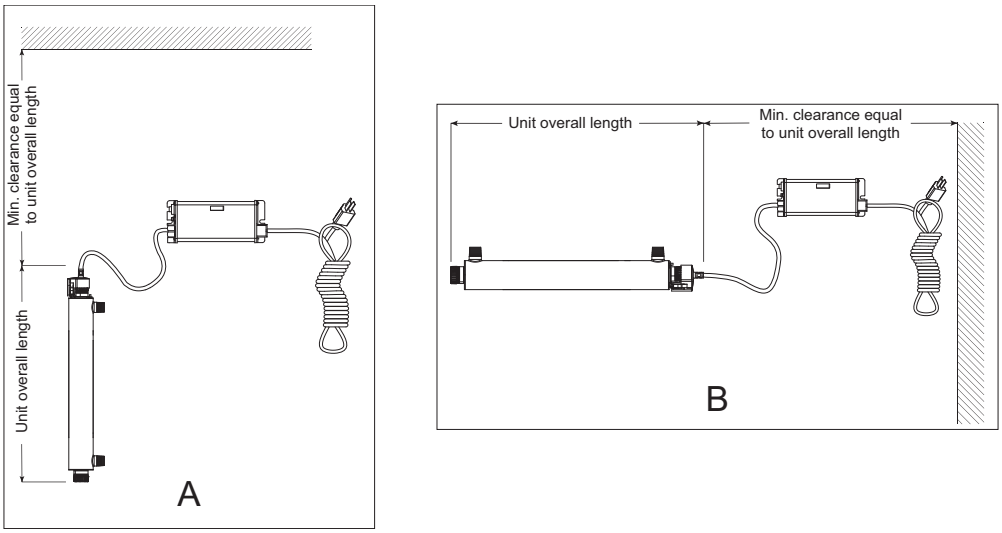


Figure 3 Disinfection Installation - Vertical and Horizontal

3. Mount the system to the wall using the supplied clamps. Various connection methods can be used to connect the water source to the system, however union type connectors are recommended. The use of a flow restrictor device will help to maintain the manufacturers rated flow. The flow restrictor should be installed on the outlet port and is designed to be installed in one direction only. Ensure that the flow of the water matches the flow direction as indicated on the flow restrictor. Refer to Figure 4.

   Note: *DO NOT solder connections while attached to the system as this could damage the O-ring seals.*

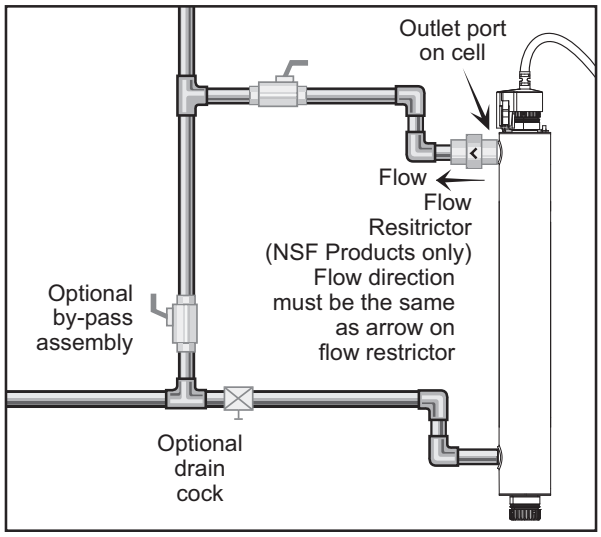


Figure 4 Flow Restrictor

4. Mount the VIQUA ICE controller horizontally to the wall, near the UV chamber. Ideally place the controller above the chamber and away from any water connection point, to prevent any water from potentially leaking onto the controller by means of a leak at a connection point or a “sweating” system. Make sure you allow for a “drip-loop” as shown in Figure 5 on the UV lamp, UV sensor, and power cord, again, to prevent any water from potentially entering the controller.

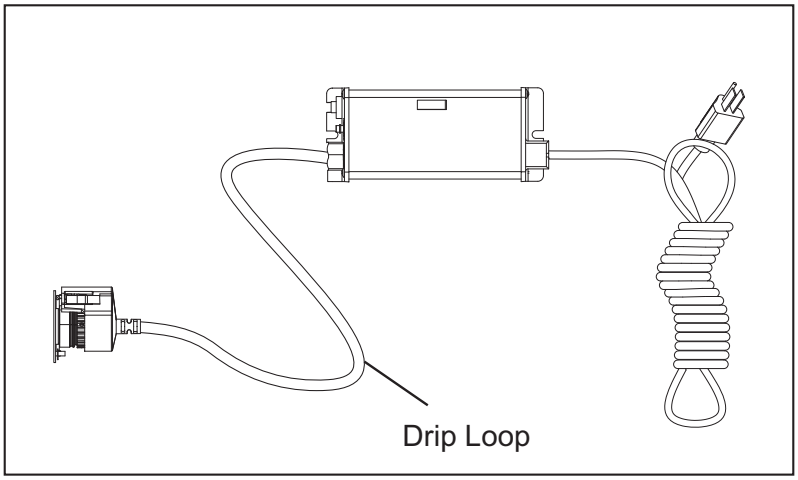


Figure 5 Drip Loop

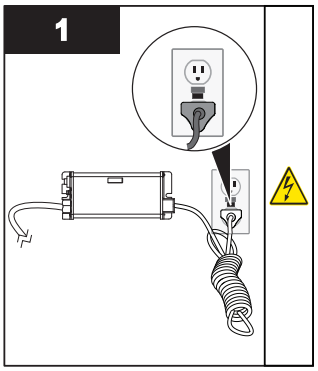
5. Install the UV lamp. Refer to Section 4.1.
6. When all plumbing connections are complete, slowly turn on the water supply and check for leaks. The most likely cause of leaks is from the O-ring seal. In case of a leak, shut water off, drain cell, remove the retaining nut, wipe the O-ring and threads. Clean and re-install.
7. Once it is determined that there are no leaks, plug the system into the ground fault interrupter and check controller to ensure the system is operating properly. The controller should illuminate without any alarms.

   Note: *DO NOT look directly at the glowing UV lamp.*
8. Allow the water to run for a few minutes to clear any air or dust that may be in the UV chamber.

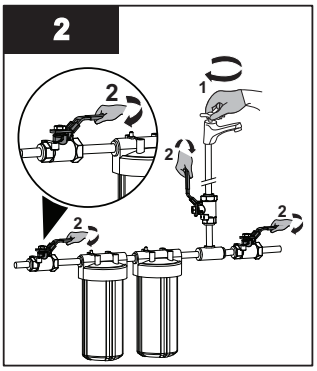
   Note: *When there is no flow, the water in the cell will become warm, as the UV lamp is always on. To remedy this, run a cold water tap anywhere in the house for a minute to flush out the warm water.*

3.2 Disinfection Procedure

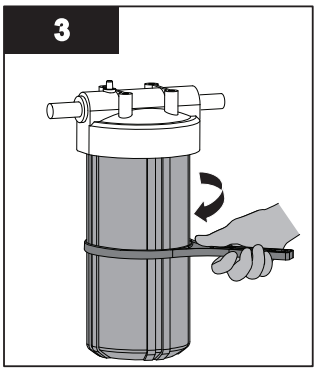
UV disinfection is a physical disinfection process and does not add any potentially harmful chemicals to the water. As UV does not provide a disinfection residual, it is imperative that the entire distribution system located after the UV be chemically disinfected to ensure that the plumbing system is free from any bacteriological contaminants. The disinfection process must be performed immediately after the UV unit is installed and repeated thereafter whenever the UV is shut down for service, without power, or inoperative for any reason. The procedure for sanitizing the plumbing system is readily accomplished as follows:



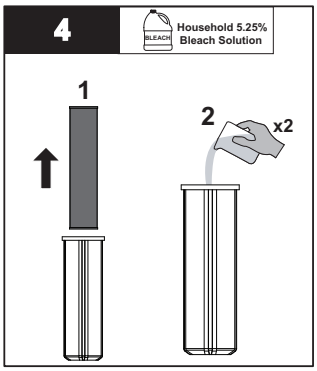
- Ensure the controller is plugged in for entire disinfection process.



- Shut off the water supply.
- Close each faucet.

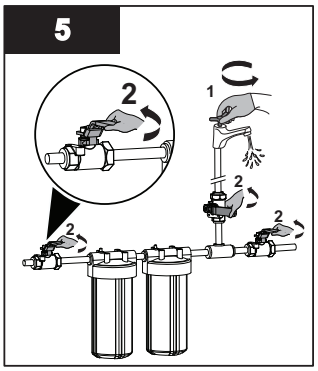


- Remove filter cartridge(s).

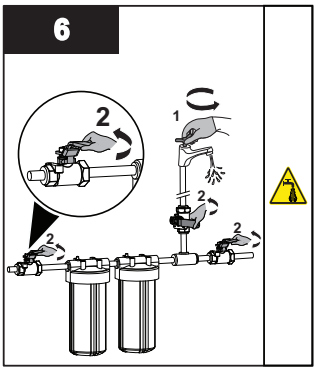


- Pour 2 cups of household bleach solution into the filter housing(s).

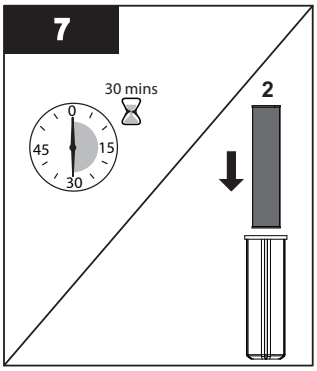
  Note: *DO NOT use Hydrogen Peroxide.*



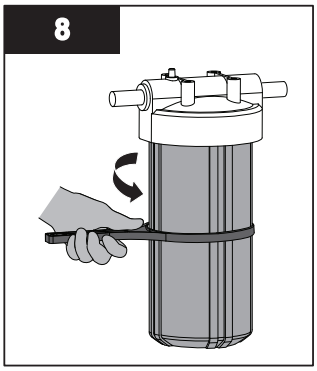
- Re-install the housings.
- Turn on the cold water supply.
- Open each faucet and all water openings until you smell the bleach and then close the faucets.



- Turn on the hot water supply.
- Open each faucet and all water openings until you smell the bleach and then close the faucets.



- DO NOT use water for 30 minutes.
- Flush the system until no chlorine smell is detectable and reinstall the filters.



- Reinstall filter housing(s).

Notes: *1) The addition of chlorine (bleach) to a hot water tank that has in the past been fed with untreated raw water with high levels of other contaminants (iron, manganese, hydrogen sulphide, organics, etc.) will result in oxidation of these contaminants and may require repeated flushing of the hot water tank. This contingency must be dealt with independently under the start-up procedure for any other conditioners that may form a part of the pre-treatment for the UV unit.*

2) The above disinfection procedure will result in a massive chlorine residual far in excess of the 0.5 to 1.0 mg/L typically present in municipally chlorinated water and of a magnitude consistent with the minimum 50 mg/L chlorine solution recommended for the disinfection of distribution systems known to be contaminated. DO NOT consume water until complete system has been flushed.

Section 4 Maintenance

⚠WARNING

- Always disconnect power before performing any work on the disinfection system.
- Always shut-off water flow and release water pressure before servicing.
- Regularly inspect your disinfection system to ensure that the power indicators are on and no alarms are present.
- Replace the UV lamp annually (or biennially if seasonal home use) to ensure maximum disinfection.
- Always drain the chamber when closing a seasonal home or leaving the unit in an area subject to freezing temperatures.

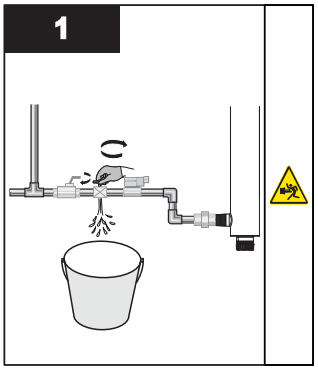
4.1 Replacing UV Lamp

NOTICE

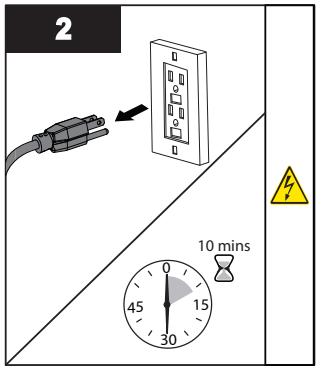
- Reset UV lamp life timer after UV lamp replacement. Refer to Section 5.1.3. Refer to www.lamprecycle.org for UV lamp disposal.
- DO NOT use water during replacement of UV lamp.

UV lamp replacement is a quick and simple procedure requiring no special tools. The UV lamp must be replaced after 9000 hours of continuous operation (approximately one year) in order to ensure adequate disinfection.

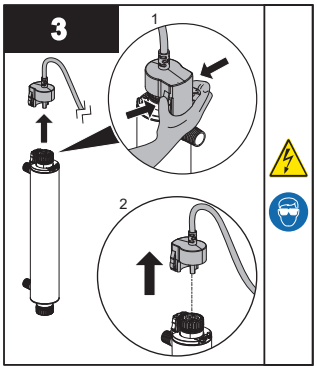
Procedure:



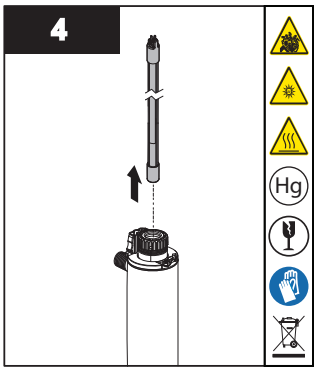
- Shut off the water line to chamber and release system pressure before servicing.



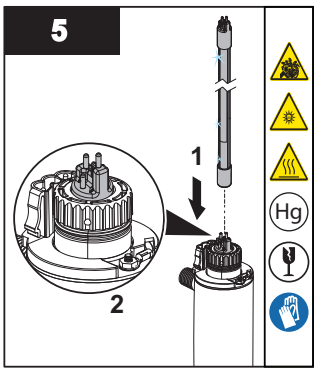
- Disconnect main power source and allow the unit to cool for 10 minutes.



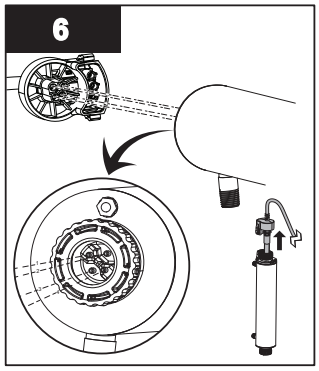
- Remove the lamp connector by squeezing the plastic locking tabs on the side of the connector.



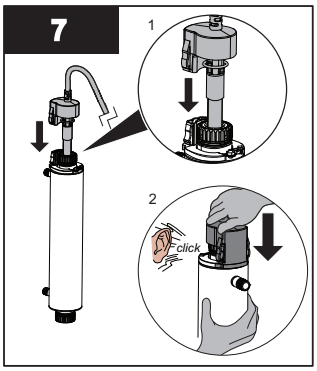
- Remove the lamp in upward direction from the chamber and lamp connector base.
- Always hold the lamp at the ceramic ends.



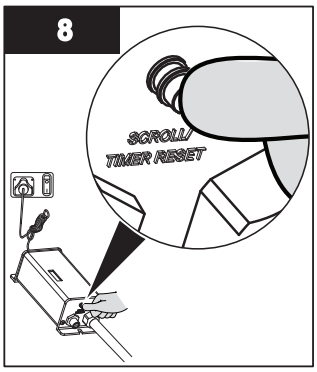
- Insert the new lamp fully into the chamber leaving about two inches of the lamp protruding from the chamber.



- Attach the connector to the lamp and note that the connector will only allow correct installation in one position.



- Push the lamp connector against lamp connector base together until an audible click is heard.
- Re-pressurize the system to check for leaks.



- Hold down the timer reset button and reapply power to the controller until you see rSEt, then release timer reset button.
- A 5 second delay will occur until you hear an audible tone and LED display will read once again 365.

VIQUA

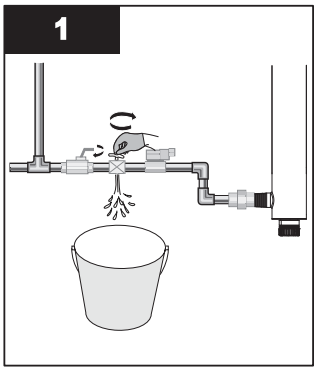
4.2 Cleaning and Replacing Quartz Sleeve

Note: *Minerals in the water slowly form a coating on the quartz sleeve. This coating must be removed because it reduces the amount of UV light reaching the water, thereby reducing disinfection performance. If the sleeve can not be cleaned, it must be replaced.*

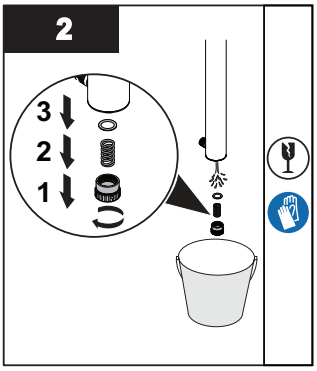
Prerequisites:

- Shut off water supply and drain all lines.
- Remove the UV lamp. Refer to Section 4.1.

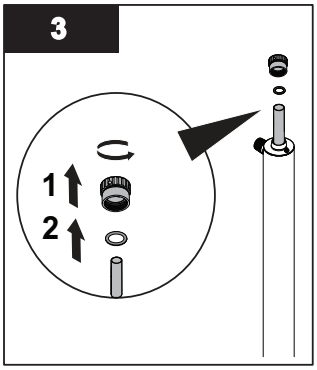
Procedure:



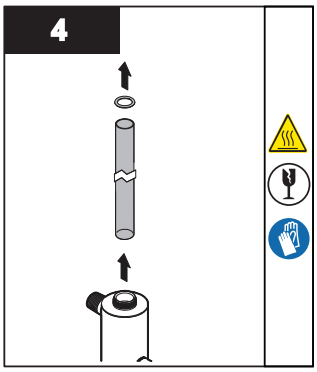
- Drain the chamber by using the drain port.



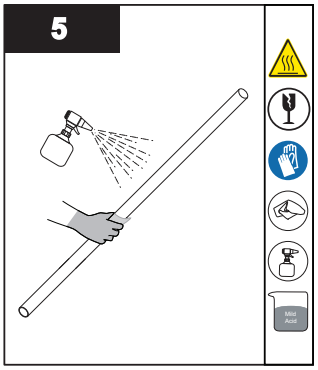
- Remove the bottom retaining nut, floating spring, and O-ring.



- Remove the top retaining nut and O-ring.

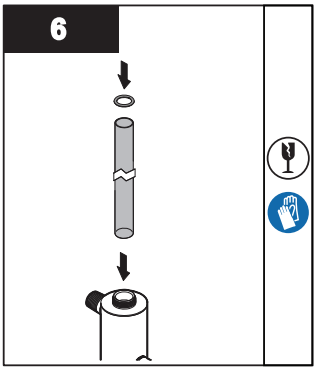


- Carefully, remove O-ring adhering to the quartz sleeve.
- Remove the quartz sleeve.

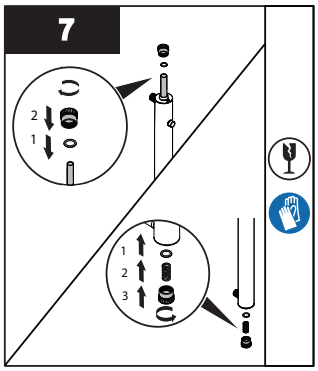


- Clean the quartz sleeve with a cloth soaked in CLR, vinegar or some other mild acid and then rinse with water.

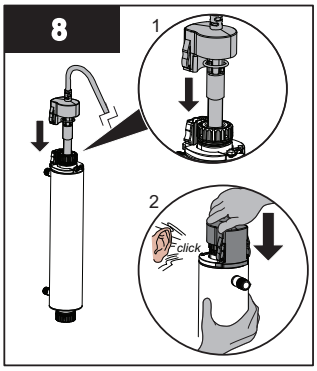
  Note: *If sleeve cannot be cleaned completely or it is scratched or cracked, then replace the sleeve.*



- Reinstall the quartz sleeve in the chamber allowing the sleeve to protrude an equal distance at both ends of the chamber.
- Slide supplied O-rings onto each end of the quartz sleeve.



- Reinstall the top and bottom retaining nuts, floating spring, and O-rings respectively.
- When service is complete, assemble the prerequisites in the reverse order of disassembly.



- Push the lamp connector against lamp connector base together until an audible click is heard.
- Plug in controller and verify the POWER-ON LED display.
- Re-pressurize the system to check for leaks.

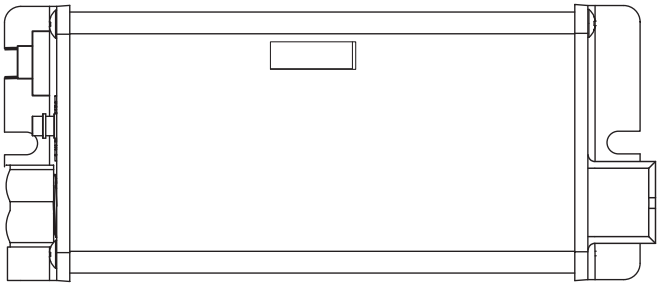
Note: *After replacing the UV lamp or quartz sleeve perform the disinfection procedure, refer to Section 3.2.*

Section 5 Operation

⚠ WARNING

The advanced warning system has been installed to provide the optimum protection against microbiological contamination in water. DO NOT disregard the warning signals. The best way to ensure optimum UV performance is to have the water microbiologically tested by a recognized testing agency on a regular basis.

5.1 Basic Systems Incorporating BA-ICE-S Controller



5.1.1 UV lamp Life Remaining (days)

365 The controller tracks the number of days of operation of the UV lamp and the controller. The default screen will display the total UV lamp life remaining (in days). The controller will count down the number of days remaining until the UV lamp requires changing (365 days to 1 day). At “0” days, the controller will display A3 and sound an intermittent audible chirp (1 second on, 5 seconds off), indicating the need to change the UV lamp.

5.1.2 Understanding your “A3” Code

A3 ***DEFERRAL*** - Once the “A3” or end of UV lamp life message is shown on the LED display, the audible alarm can be deferred up to 4 separate times. The delay is designed to allow you time to address the alarm while you obtain a new UV lamp. This can be done by simply depressing the timer reset button for 5 seconds, which is located on the left side of the controller. Each time the timer reset button is pressed the controller alarm is deferred seven days. Once the final 7 day deferral has been reached the alarm can only be silenced by changing the UV lamp and manually resetting the controller timer, refer to Section 4.1.

5.1.3 Resetting UV lamp Life

Refer to Section 4.1.

Note: *Even though the alarm on the system can be deferred for a period of time, it is important to address each and every alarm condition as they are indicating that there is a potential problem with the system and should be remedied.*

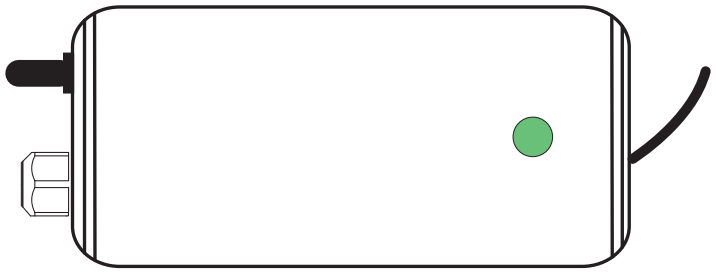
5.1.4 Total Days of Operation

1680 The controller also displays the total running time of the controller. To obtain this reading, press the push-button once. The total running time of the controller will be numerically displayed in days. This information will remain displayed for ten seconds and will then revert back to the UV lamp life remaining default screen. It should be noted that this value cannot be reset.

5.1.5 UV lamp Failure (Blank Screen)

When the system recognizes UV LAMP FAILURE (no current running through the UV lamp), the display will be blank (no default UV LAMP LIFE REMAINING screen) and the system will sound an intermittent audible tones (1 second on,1 second off). The system will remain in this state, until this condition is remedied.

5.2 12VDC Systems Incorporating BA-RO/P/12 Controller



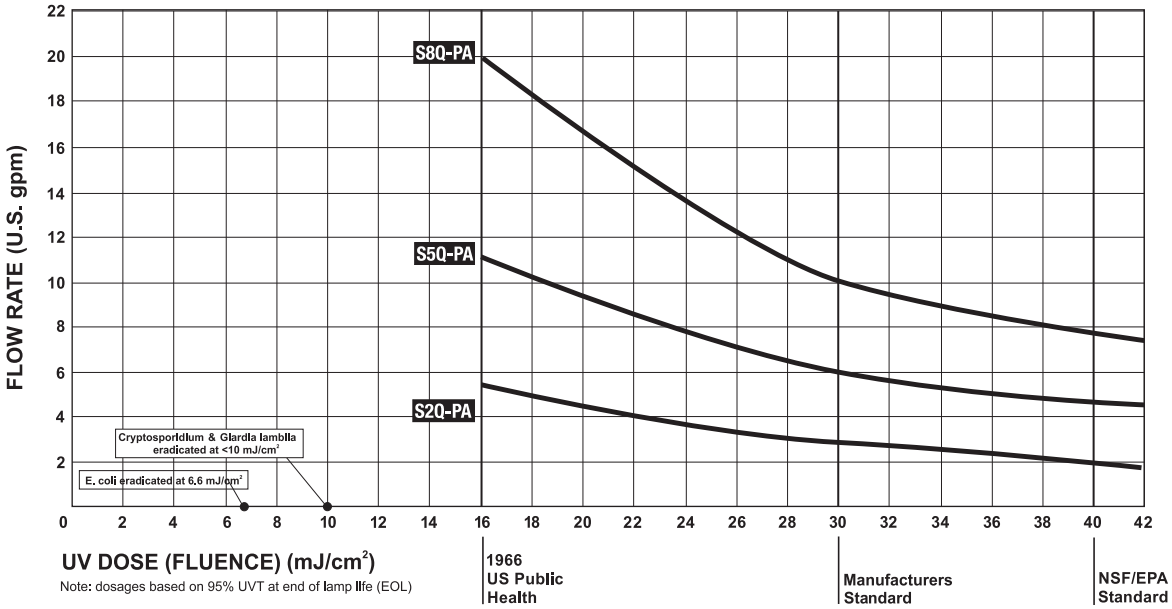
Green LED indicates UV lamp “ON”.

Section 6 Troubleshooting

Symptom	Possible Causes	Solutions
Pressure Drop	Sediment pre-filter clogged	Replace filter cartridge with appropriate 5 micron cartridge. ***Note:*** *Check source water supply as fluctuations may occur in source pressure.*
	Flow regulator	Flow regulator will result in pressure drop when approaching full flow.
High Bacteria Counts	Quartz sleeve is stained or dirty	Clean sleeve with scale cleaner and eliminate source of staining problem (ie. soften hard water, refer to Section 4.2.
	Change in feed water quality	Have source water tested to ensure that water quality is still within allowable limits for this system.
	Contamination in water lines after UV system (eg. power failures, plumbing	Disinfection system must have a bacterial free distribution system to work effectively. Refer to Section 3.2
	Possible break-through of sediment through pre-filter	Have source water tested for turbidity - may need stepped filtration in order to catch all sediment entering water system (20 micron filter followed by a 5 micron filter followed by UV
Heated Product Water	Common problem caused by infrequent use of water	Run water until it returns to ambient temperature.
Water Appears Milky	Caused by air in the water lines	Run water until air is purged.
Unit Leaking Water	Problem with O-ring seal (on retaining nut and/or UV sensor)	Ensure O-ring is in place, check for cuts or abrasions, clean O-ring, moisten with water/ lubricant and re-install, replace if necessary (410867).
	Condensation on UV chamber caused by excessive humidity & cold water	Check location of disinfection system and control humidity.
	Inadequate inlet/outlet port connections	Check thread connections, reseal with Teflon® tape and re-tighten.
System Shutting Down Intermittently	Interrupted controller	• Ensure system has been installed on its own circuit, as other equipment may be drawing power away from UV (ie. pump or fridge). • UV system should not be installed on a circuit which is incorporated into a light switch.
UV lamp Failure Alarm on - New lamp	Loose connection between UV lamp and connector	Disconnect UV lamp from connector and reconnect, ensuring that a tight fit is accomplished
	Moisture build up in connector may keep UV lamp and connector from making a solid connection	Eliminate chance of any moisture getting to the connector and/or lamp pins

DISPLAY FAULT MODES	
LED display reads “A3”	• UV lamp life expired - countdown is at “0” days. Refer to Section 5.1.2, Understanding your A3 Code. • Press reset button for a deferred alarm, replace UV lamp
LED display is blank	• Controller is in UV lamp failure mode. Refer to Section 5.1.5, UV Lamp Failure. Replace UV Lamp, refer to Section 4.1. • Power system down, allowing it to reset itself; apply power in order to confirm that the controller is able to power UV lamp • Check to see if there is sufficient power to the UV system
Green LED off (12 VDC only)	• UV lamp failure. Replace UV Lamp, refer to Section 4.1. • No input voltage to controller

Section 7 Manufacturer's Dose Flow Chart



Section 8 Specifications: Standard and Validated

Model		S2Q-P/12VDC/ S2Q-PA		S5Q-P/12VDC/ S5Q-PA/SV5Q-PA*		S8Q-PA/ SV8Q-PA*
Flow Rate	*NSF Class B Certified 16mJ/cm² @ 70% UVT	-		3.6 gpm (13.6 lpm) (0.8 m³/hr)		7 gpm (26.5 lpm) (1.6 m³/hr)
	US Public Health 16mJ/cm² @ 95% UVT	5 gpm (19 lpm) (1.1 m³/hr)		11 gpm (42 lpm) (2.5 m³/hr)		20 gpm (75 lpm) (4.5 m³/hr)
	VIQUA Standard 30 mJ/cm² @ 95% UVT	3 gpm (11 lpm) (0.7 m³/hr)		6 gpm (23 lpm) (1.4 m³/hr)		10 gpm (38 lpm) (2.3 m³/hr)
	NSF/EPA 40mJ/cm² @ 95% UVT	2 gpm (7 lpm) (0.4 m³/hr)		4.5 gpm (17 lpm) (1.0 m³/hr)		8 gpm (29 lpm) (1.8 m³/hr)
Dimensions	Chamber	43.2 cm x 6.4 cm (17" x 2.5")		56 cm x 6.4 cm (22" x 2.5")		90 cm x 6.4 cm (35" x 2.5")
	Controller 100-250 VAC	18.6 cm x 8.1 cm x 6.4 cm (7.3" x 3.2" x 2.5")		18.6 cm x 8.1 cm x 6.4 cm (7.3" x 3.2" x 2.5")		18.6 cm x 8.1 cm x 6.4 cm (7.3" x 3.2" x 2.5")
	Controller 12 VDC	13.5 cm x 4.3 cm x 5.8 cm (5.3" x 1.7" x 2.3")		13.5 cm x 4.3 cm x 5.8 cm (5.3" x 1.7" x 2.3")		-
Inlet/Outlet Port Size[1]		1/2" MNPT		3/4" MNPT"		3/4" MNPT
Shipping Weight		2.7 kg (6 lbs)		2.7 kg (6 lbs)		4.5 kg (10 lbs)
Electrical	Voltage[2]	100-240 V / 50/60 Hz	12 VDC	100-240 V / 50/60 Hz	12 VDC	100-240 V / 50/60 Hz
	Max. Current	0.6 Amp	1.8 Amp	0.6 Amp	1.8 Amp	0.6 Amp
	Power Consumption	22 W	20 W	30 W	27 W	46 W
	UV lamp Watts	17 W	15 W	25 W	20 W	37 W
Maximum Operating Pressure		125 psi (861 kPa)		125psi (861 kPa)		125 psi (861 kPa)
Minimum Operating Pressure		15 psi (103 kPa)		15psi (103 kPa)		15 psi (103 kPa)
Ambient Water Temperature		2-40 ºC (36-104 ºF)		2-40 ºC (36-104 ºF)		2-40 ºC (36-104 ºF)
UV Lamp Type		Sterilume™-EX (standard-output)		Sterilume™-EX (standard-output)		Sterilume™-EX (standard-output)
UV Chamber Material		304 SS		304 SS		304 SS

[1] Units ending in "/2B" have BSPT connections.

[2] Units ending in "/2" are for 230V applications.

Section 9 Manufacturer's Warranty

Our Commitment

VIQUA is committed to ensuring your experience with our products and organization exceeds your expectations. We have manufactured your UV disinfection system to the highest quality standards and value you as our customer. Should you need any support, or have questions about your system, please contact our Technical Support team at 1.800.265.7246 or technicalsupport@viqua.com and we will be happy to assist you. We sincerely hope you enjoy the benefits of clean, safe drinking water after the installation of your VIQUA disinfection system.

How to Make a Warranty Claim

Note: *To maximise the disinfection performance and reliability of your VIQUA product, the system must be properly sized, installed and maintained. Guidance on the necessary water quality parameters and maintenance requirements can be found in your Owner's Manual.*

In the event that repair or replacement of parts covered by this warranty are required, the process will be handled by your dealer. If you are unsure whether an equipment problem or failure is covered by warranty, contact our Technical Support team at 1.800.265.7246 or e-mail technicalsupport@viqua.com. Our fully trained technicians will help you troubleshoot the problem and identify a solution. Please have available the model number (system type), the date of purchase, the name of the dealer from whom you purchased your VIQUA product ("the source dealer"), as well as a description of the problem you are experiencing. To establish proof of purchase when making a warranty claim, you will either need your original invoice, or have previously completed and returned your product registration card via mail or online.

Specific Warranty Coverage

Warranty coverage is specific to the VIQUA range of products. Warranty coverage is subject to the conditions and limitations outlined under "General Conditions and Limitations".

Ten-Year Limited Warranty for VIQUA UV Chamber

VIQUA warrants the UV chamber on the VIQUA product to be free from defects in material and workmanship for a period of ten (10) years from the date of purchase. During this time, VIQUA will repair or replace, at its option, any defective VIQUA UV chamber. Please return the defective part to your dealer who will process your claim.

Three-Year Limited Warranty for Electrical and Hardware Components

VIQUA warrants the electrical (controller) and hardware components to be free from defects in material and workmanship for a period of three (3) years from the date of purchase. During this time, VIQUA will repair or replace, at its option, any defective parts covered by the warranty. Please return the defective part to your dealer who will process your claim.

One-Year Limited Warranty for UV lamps, Sleeves, and UV Sensors

VIQUA warrants UV lamps, sleeves, and UV sensors to be free from defects in material and workmanship for a period of one (1) year from the date of purchase. During this time, VIQUA will repair or replace, at its option, any defective parts covered by the warranty.Your dealer will process your claim and advise whether the defective item needs to be returned for failure analysis.

Note: *Use only genuine VIQUA replacement lamps and sleeves in your system. Failure to do so may seriously compromise disinfection performance and affect warranty coverage.*

General Conditions and Limitations

None of the above warranties cover damage caused by improper use or maintenance, accidents, acts of God or minor scratches or imperfections that do not materially impair the operation of the product. The warranties also do not cover products that are not installed as outlined in the applicable Owner's Manual.

Parts repaired or replaced under these warranties will be covered under warranty up to the end of the warranty period applicable to the original part.

The above warranties do not include the cost of shipping and handling of returned items.The limited warranties described above are the only warranties applicable to the VIQUA range of products. These limited warranties outline the exclusive remedy for all claims based on a failure of or defect in any of these products, whether the claim is based on contract, tort (including negligence), strict liability or otherwise. These warranties are in lieu of all other warranties whether written, oral, implied or statutory. Without limitation, no warranty of merchantability or of fitness for a particular purpose shall apply to any of these products.

VIQUA does not assume any liability for personal injury or property damage caused by the use or misuse of any of the above products. VIQUA shall not in any event be liable for special, incidental, indirect or consequential damages. VIQUA's liability shall, in all instances, be limited to repair or replacement of the defective product or part and this liability will terminate upon expiration of the applicable warranty period.

APPENDIX B - BACTERIAL GROWTH IN GRANULAR ACTIVATED CARBON FILTERS; HUMAN HEALTH AND DISINFECTION

Appendix B
Additional Information
Bacterial Growth in Granular Activated Carbon (GAC) Filters
Human Health and Disinfection
October 10, 2018, Revision March 6, 2019

As stated in the MDEQ's August 9, 2018 letter and as discussed in our July 25, 2018 meeting, several comments made by the MDEQ regarding the, *Alternate Water Supply Management Plan, Point-of-Entry Treatment Systems, Wolverine Worldwide, Inc.* (POET O&M Plan) may be addressed by additional information related to the bacteriological risks from the carbon filter systems as well as information regarding the operation of the ultra-violet (UV) lamp during interruptions in operation. Specific references in the MDEQ letter include; BP-4 and -12, Section 6.1.2.

The fundamental question/concern relates to the need for disinfection of the well water after GAC use. The POET system installation was designed with an UV light reactor that disinfects the treated water as a final step. R&W/GZA has indicated that the use of the UV on the filtered water is precautionary and not necessary for well water not contaminated with fecal bacteria. The use of the UV is a conservative measure to further ensure water quality but is not necessary to protect public health.

Bacterial Control – Well Water Systems

None of the well water systems that the POET system was installed had disinfection systems installed to control bacteria prior to the installation of the POET. In general, disinfection systems are not installed on residential well water supplies. Testing for coliform bacteria may be performed when the well is initially installed, following repairs or modification, and periodically as required by health agencies.

The premise that disinfection is required is based on the addition of the carbon filtration system. The MDEQ has made the following comments to argue the systems require disinfection:

- The source water bacteriological water quality is unknown and a moving target.
- Even if wells tested non-detect initially, they can become contaminated in a number of ways.
- Compared to a home without treatment, a GAC filter provides an excellent medium for bacteriological attachment and growth if exposure occurs.
- Bacteriological contamination poses an acute health risk.

The initial two and fourth bullet points are true for a well water supply with or without a GAC treatment system. These arguments would support a requirement to install a disinfection system on any private well water supply (with or without treatment) thus do not justify the addition of a disinfection system based on the installation of GAC treatment alone. Since a well system can become contaminated at any time, by a variety of ways, and bacteriological contamination is an acute health risk, periodic testing of the well water supply is performed in the absence of a carbon treatment system. The concern that differentiates the POET system from any residential well water system is stated in the third bullet point, *"Compared to a home without treatment, a GAC filter provides an excellent medium for bacteriological attachment and growth if exposure occurs."*

The statement may (or may not) have some merit, however, if exposure occurs (the well becomes contaminated), there is likely little difference in the acute health risk to the users of the well water if the system has a carbon filtration system or no treatment.

Although bacteria are known to colonize on the GAC (Point-of-Use [POU] or POE), the bacteria do not pose a health risk when the water being treated meets acceptable water quality standards. EPA and the World Health Organization (WHO) have opined that the use of disinfection in POU and POE systems is not required when the water entering the POE and/or POU meets acceptable water quality standards.

The WHO states, "Exposure to HPC (Heterotrophic Plate Count) microbiota is far greater in foodstuffs than through drinking-water." Exposure to HPC occurs through the air and other environmental sources. Section 1.4.2 Epidemiology in-part states, "The available body of evidence supports the conclusion that, in the absence of fecal contamination, there is no direct relationship between HPC values in ingested water and human health effects in the population at large. This conclusion is also supported indirectly by evidence from exposures to HPC in foodstuffs, where there is no evidence for a health effects link in the absence of pathogen contamination."

In summary, the use of GAC will increase the area for bacteria to regrow in a water system. However, in the absence of pathogenic contamination, bacteria do not pose a health risk. There is no evidence that has found health effects linked to non-pathogenic contamination. If the well were contaminated, an acute health risk would exist with or without a GAC system.

The WHO report includes a chapter (Chapter 8) on the immunocompromised individuals. The executive summary of the report includes recommendations that more study is required for, ". . the immunocompromised (especially infection control in health care facilities and susceptible persons in the public at large)." As summarized by the EPA, "Normal drinking water is not always suitable for all such individuals for all uses (e.g., wound irrigation). This relates to water safety in general and not to growth or HPC organisms in particular. Advice should be provided by public health authorities to at-risk groups in general and by practitioners responsible for individuals discharged to home care."

In summary, infections from HPCs of immunocompromised patients in the general community is unclear.

Bacterial Control – Carbon Systems

EPA states in a report entitled, *Water Health Series – Filtration Facts* that 4/10 Americans use a home water treatment. Most of these are Point-of-Use (POU) system that use carbon and do not include disinfection system. POU devices are commonly designed for a twelve-month service life.

Section 1.3.2 of the WHO Report states;

> Bacterial growth occurs in plumbed-in domestic water devices (including water softeners, carbon filters, etc.) and plumbed-in commercial devices, such as beverage vending machines. HPC values in water samples typically increase in such devices. Increases of HPC (due to growth) in these devices therefore do not indicate the existence of a health risk, as long as the entry water meets acceptable microbial water quality norms (e.g., WHO *Guidelines for Drinking-water Quality*).

Section 12.4 of the WHO Report states,

> "Health Canada, the US Environmental Protection Agency (EPA), the US Consumer Product Safety Commission and the Italian government have all, at one time or another, proposed banning activated carbon filters used in home drinking-water treatment devices because of the growth of HPC bacteria on the carbon media and subsequent rises in HPC counts in the filtered water (Regunathan and Beauman 1994). After further study, however, all four decided against banning the filters. At Health Canada, the decision was made following consultations with stakeholders and was based on the absence of evidence of any illness linked to such devices."

Similar to the regrowth of biofilms in water distribution systems, increased levels of HPC are not generally a health concern in drinking water treatment devices. Some experimental evidence has shown that the presence of heterotrophic bacteria HPC bacteria in POU and POE devices may be beneficial, since ordinary bacterial growth may reduce the number of disease-causing organisms through dilution, competition or predation inside the treatment device — i.e., in carbon filters, resin beds, bladder tanks, etc. (Rollinger and Dott 1987).

Snyder et.al, evaluated the water quality of POU powdered activated carbon (PAC) filters, ". . .to determine how such treatment might impact the bacteriological quality of private, residential drinking water supplies." Snyder's work concluded that PAC treatment does not compromise the bacteriological quality of drinking water from well water supplies. A number of additional results from this study follow:

- First draw samples (following overnight static periods) from well water supplies were only slightly higher than their corresponding influent counts.
- Snyder reported work performed by others (Geldreich and Reasoner) found that a six-week no-flow period increased bacterial counts 1,000 – 10,000-fold. Although this was indicated as a concern by some referenced reports, Snyder reported that several authors, ". . .suggest that activated carbon has no significant effect on bacterial levels in drinking water on the basis of their findings that bacterial densities were similarly increased in unfiltered water after periods of no use." Finally, Snyder reported, "An epidemiological study by Calderon gave little evidence to associate any health risks with the use of carbon filters."
- Fiore and Babineau (7) also found that a 2-minute flushing period reduced bacterial populations in filter effluents. As such, Snyder concludes that, "any potential public health concern from exposure to elevated HPC in POU filter effluents following periods of no use may be reduced or eliminated by flushing the POU device before use."
- Snyder references two studies (Camper and Reasoner) that suggested high densities of heterotrophs may prevent pathogenic bacteria from colonizing and persisting on GAC beds.

EPA Document Summary

As summarized in our previous response, an EPA document entitled, *Point-of-Use or Point-of-Entry Treatment Options for Small Drinking Water Systems* (EPA Document) summarizes that the use of disinfection for POU and POE systems is not required when the water entering the POE and/or POU meets acceptable water quality standards. Specifically, EPA states;

> ***"In view of these conclusions, it is appropriate to recognize that although bacterial growth occurs in POU and POE water treatment devices, the increase of HPC in these devices does not indicate that a health risk exists, so long as the water entering the device meets acceptable water quality standards."***

Although, this conclusion seems to be based on the WHO report and conclusions, the EPA report seems to contradict this conclusion in several locations. Specifically, when referencing regulations for drinking water the following text is included/referenced; " . . . *GAC media are prone to microbial colonization (heterotrophic bacteria) on the GAC media. Some form of HPC monitoring and/or disinfection should be considered when using POU GAC and when using POE GAC*. "

Although the references to the regulations raising concerns related to HPC's are accurate, the source of the HPC concerns related to GAC is found verbatum in the 1987 and 1988 Federal Register, 52 FR 25716, July 8, 1987; 53 FR 25111, July 1, 1988].

> As noted by the WHO, several countries including the USEPA proposed banning activated carbon filters used in home drinking-water treatment devices because of the growth of HPC bacteria. It would appear the scientific evidence as presented in the WHO report has concluded the HPC bacteria growth is not a health concern.

Summary

- EPA and the WHO have opined that the use of disinfection in POU and POE systems is not required when the water entering the POE and/or POU meets acceptable water quality standards.
- Exposure to HPC microbiota is far greater in foodstuffs than through drinking-water.
- 4/10 Americans use a home water treatment. Most of these are POU system that use carbon and do not include disinfection system.
- Bacterial growth occurs in carbon filters. HPC values in water samples typically increase in such devices. Increases of HPC (due to growth) in these devices do not indicate the existence of a health risk, as long as the entry water meets acceptable microbial water quality norms.
- The WHO report stated the EPA, the US Consumer Product Safety Commission proposed banning activated carbon filters used in home drinking-water treatment devices because of the growth of HPC bacteria on the carbon media and subsequent rises in HPC counts in the filtered water. However, after further study, decided against banning the filters.
- Snyder et.al, evaluated the water quality of POU PAC filters, ". . .to determine how such treatment might impact the bacteriological quality of private, residential drinking water supplies." Snyder's work concluded that PAC treatment does not compromise the bacteriological quality of drinking water from well water supplies.
- EPA document entitled, Point-of-Use or Point-of-Entry Treatment Options for Small Drinking Water Systems (EPA Document) summarizes that the use of disinfection for POU and POE systems is not required when the water entering the POE and/or POU meets acceptable water quality standards. Specifically, EPA states; "In view of these conclusions, it is appropriate to recognize that although bacterial growth occurs in POU and POE water treatment devices, the increase of HPC in these devices does not indicate that a health risk exists, so long as the water entering the device meets acceptable water quality standards."

- Infections from HPCs of immunocompromised patients in the general community is unclear. The EPA recommends that advice should be provided by public health authorities to at-risk groups in general and by practitioners responsible for individuals discharged to home care."

Although the WHO, Snyder et.al, and EPA Report present that the HPCs do not pose a health risk, both the EPA and Snyder suggest the users of the POE systems should be instructed to run water at full flow for at least 30 seconds before use after a prolonged period of quiescence. The EPA report states, ***"The system may want to consider post-treatment disinfection to ensure customer safety."*** This has been added to Section 4.3 of the POET O&M Plan.

References

Criteria and Procedures for Public Water Systems Using Point-of-Entry Devices. 53rd Fed Reg. July 1, 1988.

Snyder, Joseph W., et.al. September 20, 1995. Effect of Point-of-Use, Activated Carbon Filters on the Bacteriological Quality of Rural Groundwater Supplies. Applied and Environmental Microbiology, Dec, 1995 p. 4291-4295.

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World Health Organization. 2003. Heterotrophic Plate Counts and Drinking-water Safety. The Significance of HPCs for Water Quality and Human Health. IWZ Publishing; London, UK

Use of Non-Centralized Treatment Devices. 52 Fed Reg. 25716. July 8th, 1987.

United States Environmental Protection Agency. September 2005. Water Health Series – Filtration Facts. (816-K-05-002)

APPENDIX C - GRANULAR ACTIVATED CARBON DESIGN

Appendix C
Additional Information
Granular Activated Carbon Design
October 10, 2018, Revision March 6, 2019

As stated in the MDEQ's August 9, 2018 letter and as discussed in our July 25, 2018 meeting, several comments made by the MDEQ may be addressed by additional information related to the design of the carbon life based on flow, empty bed contact time (EBCT), and PFAS concentration. In addition, questions and concerns related to the calculation of predictive life of the carbon would support the frequency of sampling that was selected and changes to sampling frequency as discussed in the performance monitoring section (Section 6.1.3.2) of the "*Alternate Water Supply Management Plan, Point-of-Entry Treatment Systems, Wolverine Worldwide, Inc.*" (POET O&M Plan). Specific references in the MDEQ letter include; BP-8, 1. Section 1.2, 2. Section 4.1, 14. Section 6.1.3.2, and 15. Section 6.1.3.3.

Whole House Filter – Conceptual Design

The criteria mandated by Wolverine, when the decision was made to provide Whole House Filters (WHF), was the technology must be proven and used successfully for similar applications. Literature identified that both granular activated carbon (GAC) and reverse osmosis (RO) were effective for removal of PFAS compounds. R&W/GZA rejected the use of RO because the reject stream from the RO unit would need to be collected or discharged to the on-site septic system that discharges to the groundwater. Removing the PFAS from the groundwater and returning the concentrated PFAS back to the groundwater was not an acceptable solution. Based on this design criterion (not returning removed PFAS compounds to the groundwater), the use of RO was not acceptable. For the same reason, backwashing GAC columns was not be considered.

A number of factors that resulted in the recommendation by R&W/GZA of the Point-of-Entry Treatment (POET) system as developed by Culligan, utilizing Calgon Filtrasorb 600 GAC are summarized below:

- The system had been installed and operated at 500 homes in New Jersey and New York. Both the design and operation of the POET system for removal of PFAS has been demonstrated. No other supplier has equivalent experience with the two-stage GAC system.

- The system is generally in compliance and conforms with the document entitled, *"New York State Department of Environmental Conservation (Department) Point of Entry Treatment (POET) System Specification."*

- The system uses Filtrasorb 600 GAC from Calgon which is specified in the New York POET specification identified above. Filtratsorb 600 has been tested for PFAS removal and demonstrated to be effective. No other supplier provided information to confirm the proposed GAC has been used for and proven for removal of PFAS.

- Culligan had experience operating and maintaining hundreds of POETs in Bennington County, Vermont. We deemed it unlikely Culligan would agree to perform operation and maintenance on a system they have not supplied.

- Over 255 POETs were installed in Bennington County, Vermont by November 16, 2016. The highest concentration reported was 4,600 ppt PFOA (the concentration of other PFAS were not available). Following three months of monthly monitoring, no breakthrough was measure at the mid-point sampling point.

Whole House Filter – Detailed Design

Based on the above, R&W/GZA prepared a specification for the WHFs. The specification was delivered to the MDEQ on November 24, 2017 in response to the MDEQ's request. In general, the system is a two-stage granular activated carbon system equipped with pre- and post-sediment filters, an ultraviolet (UV) disinfection lamp, and flow meter.

R&W/GZA initially recommended performing an Accelerated Carbon Test (ACT) to assess GAC capacity using western Michigan groundwater. However, the ACT test would have delayed the installation of the WHF unit by two months. In the absence of an ACT, R&W/GZA used results from an isotherm study performed for Hoosick Falls, New York and the information available from the Bennington County, Vermont GAC systems. In the absence of an ACT for western Michigan groundwater, this data was used conservatively as will become evident in the following discussions.

Working with Culligan's plant design specialist, assuming similar flows and loadings, and low TOC concentration, Culligan believed that the two-stage, 4.0 cubic-foot system had been demonstrated for loadings up to 7,500 ppt PFAS using an EBCT of approximately 3.75 minutes (nominally 4 minutes). As stated in our prior correspondence, for high PFAS concentrations (defined as greater than 7,500 ppt), the EBCT was increased to 7.5 minutes (nominally 8 minutes) by installing four columns in a 2 x 2 configuration.

Although literature from Calgon recommended an EBCT of 8-10 minutes in the absence of an ACT, this general statement did not apply to the Wolverine design for the following reasons:

- The flow from a residential well is not continuous. Culligan's plant design specialist discounted this 8 to 10-minute EBCT stated in general Calgon literature since the flow is on-off and averages much less than the maximum flow of 8 gpm for the POET system.

- Culligan has hundreds of POET systems installed for residential purposes using the EBCT of 3.75 minutes.

- The groundwater did not contain detectable organic compounds which would compete with the PFAS adsorption.

- RW/GZA believed that periodic testing would be the best way to determine capacity and prepared an O&M manual that included performance monitoring.

The nominal EBCT for a standard POET system is 4 minutes. This is controlled by restricting the maximum flow through the system to 8 gallons per minute (gpm). If it is determined that the user requires more than 8 gpm, two systems will be installed in parallel (four GAC columns) to provide a "high flow" water use of 16 gpm.

Installations with total PFOA+PFOS concentrations that exceed 7,500 ppt were identified as "high concentration" installations. The nominal EBCT for high concentration installations is 8 minutes. This is performed by using four tanks. Although similar to the high flow system, the flow is restricted to 8.0 gpm which effectively doubles the EBCT.

Table 1 summarizes the POET system installations:

Table 1
POET System
Alternate Configurations

POET Configuration	GAC Columns	EBCT (minutes)	Max Flow (gpm)
Standard	Lead (2 CF) Lag (2 CF)	4	8
High Flow	Lead (4 CF) Lag (4 CF)	4	16
High Concentration	Lead (4 CF) Lag (4 CF)	8	8
High Flow & Concentration	Lead (8 CF) Lag (8 CF)	8	16

Periodic Testing-Performance Monitoring

The O&M plan includes recommendations for sampling frequency and locations (influent, mid-point, and effluent) for the POET systems. The recommendations are based on a combination of the influent concentration and estimated breakthrough time for PFOA+PFOS (through the lead carbon column.) The following sections provide additional information related to the sampling frequency and sample points.

Sampling Frequency

In order to establish the testing frequency, an estimate of the carbon life is needed. To estimate the carbon life, R&W/GZA used an equation from Metcalf & Eddy (M&E) Wastewater Engineering Treatment, Disposal, Reuse, 3rd Edition, page 323. The time of breakthrough (tb) was calculated using various concentrations of PFOA+PFOS, the X/M isotherm from Hooksick Falls, and the variables (flow and carbon mass) related to EBCT outlined above. The M&E equation includes a variable for the "% of carbon used." When calculating tb in the absence of known data for % of carbon used, M&E recommends using 25%. R&W/GZA used assumed an average residential flow of 350 gpd for calculation of tb.

Excerpt of M&E tb equation:

$$t_b = \frac{(x/m)_b M_c}{Q\left[C_i - (C_b/2)\right]\left[8.34\ \text{lb/Mgal} \cdot (\text{mg/L})\right]}$$

The following table summarizes the safety factors used for establishing the initial sampling frequencies:

Table 2
Carbon Breakthrough Calculations
Safety Factors Used

Description/Parameter	Values	Safety Factor (SF)
% Carbon Used	M&E recommends 0.25% - RW/GZA used 0.125%	2.0
Calculated Breakthrough of Lead Only	Recommended for normal operation – lag column provides 100% back-up	2.0
Adjust tb from calculation	Divide result by 2.0 to provide a safety factor of 2.0	2.0
Total Safety Factor		**8.0 (multiplicative)**

Table 3 summarizes the results of the calculation of tb for the lead column for various concentrations of PFOA+PFOS and the adjusted tb based on the SF applied to the calculation.

Table 3
Carbon Breakthrough Calculations
Summary of Results

PFOS+PFOA Concentration (ppt)	Cubic Foot GAC (CF)	tb (days)	tb Lead Column (days)	SF	tb Used (days)	Sampling Frequency/Notes
70	4	18,323	9,162	4	2,290	***70-200, Semi-annual***/annual seems appropriate, however in the absence of a column test – seems too long
200	4	5,271	2,635	4	659	***200-1,000, Quarterly***/quarterly is required for 1,000 ppt based on tb
1,000	4	979	490	4	122	***1,000-7,500, Monthly/***monthly required for tb at 7,500 ppt
7,500	8	257	127	4	32	***7,500-35,000, Weekly/***weekly required for tb at 35,000 ppt
35,000	8	55	28	4	7	

In the absence of any safety factors, the highest PFOA+PFOS concentration (35,000 ppt) was calculated to breakthrough in 55 days or detected at the mid-point sample tap in four weeks (28 days). The conservative approach used and outlined above requires sampling weekly.

Sampling Points

As stated in the Plan, "*Performance monitoring will be conducted to establish lead canister breakthrough time (and an associated treated water volume) to establish an appropriate schedule for routine monitoring and carbon change out*." More specifically, breakthrough (to mid-point) based on site-specific operating conditions is used to establish routine monitoring frequencies.

The rational for the sample points was summarized in our prior response letter dated May 15, 2018. In addition to that response, we have included additional rational for each range presented in Section 6.1.3.2 of the May 2018 O&M Plan:

- Homes with previous non-detect (ND) PFOS+PFOA well sample: annual sampling of the influent. If low level PFOS+PFOA is observed in the influent, then the home will be placed into the 1 – 70 ppt group.

Rational: Sampling of the effluent or mid-point of the POET system is unnecessary when the concentration of PFOS+PFOA in the influent is ND because no treatment is required. Thus, no demonstration of PFOS+PFOA removal is needed (when the concentration is ND). The rationale for sampling the influent is to verify no treatment is required. If sampling finds concentrations >1 ppt, the monitoring of influent and mid-point will be initiated on a semi-annual basis.

- Homes with 1 – 70 ppt total PFOS+PFOA: semi-annual sampling (influent and mid-point). Similarly, if changes to the influent concentration falls into a different concentration range, the sampling frequency will be adjusted accordingly;

Rational: Sampling of the effluent of the POET system is unnecessary when the concentration of PFOS+PFOA is 1-70 ppt because no treatment is required to protect public health. Thus, no demonstration of PFOS+PFOA removal is need (when the concentration is between1-70 ppt). The rationale for sampling the influent and mid-point is to verify that that no treatment is required. If sampling finds PFOS+PFOA concentrations >70 ppt, influent and mid-point monitoring will be initiated on a quarterly basis.

- Homes with 71 – 1,000 ppt total PFOS+PFOA: Quarterly sampling (influent, mid-point);

Rational: Sampling of the influent and mid-point is needed to monitor the system performance and calculate breakthrough. As stated above, the combination of the influent concentration and calculation of the time of PFOA+PFOS breakthrough from the lead carbon column is used to monitor the system. Breakthrough of the higher loadings (see below) will be used as a guide to estimate the loadings with concentrations that are less than 1,000 ppt. If sampling finds concentrations >1,000 ppt PFOS+PFOA, the monitoring of this system will be moved to a monthly basis.

- Homes with 1,001 – 7,499 ppt total PFOS+PFOA: Monthly sampling (influent, mid-point, and effluent); and

Rational: Sampling of the influent and mid-point is needed to monitor the system performance and calculate breakthrough. As stated above, the combination of the influent concentration and calculation of the time of PFOA+PFOS breakthrough from the lead carbon column is used to monitor the system. Although effluent sampling from the lag column is technically not needed for operation, the effluent sampling was included to verify that the filter system is operating effectively.

- Homes with 7,500+ ppt PFOS+PFOA: Weekly sampling (influent, mid-point, effluent).

Rational: Sampling of the influent and mid-point is needed to monitor the system performance and calculate breakthrough. As stated above, the combination of the influent concentration and calculation of the time of PFOA+PFOS breakthrough from the lead carbon column is used to monitor the system. Although effluent sampling from the lag column is technically not needed for operation, the effluent sampling was included to verify that the filter system is operating effectively.

GAC Performance Review

A review of the performance of two of the POET systems with the highest PFOA+PFOS loadings and comparison to the predicted performance discussed above is summarized in the following Table 4.

Table 4
Carbon Performance Review
Sampling Results as of August 3, 2018

Description	POET System #1	POET System #2
Days of Operation (days)	189	187
Total Flow Treated (gallon)	22,665	39,368
Average daily flow (gallon/day)	120	210
Average PFOA+PFOS Influent Concentration (ppt)	49,056	23,845
Predicted Operation Prior to Start-up		
Calculated days until breakthrough (days)	55	72
Safety Factor Used – lead column breakthrough	4	4
Estimated tb – breakthrough used for Performance Monitoring	14	18
Ratio - Actual tb: Estimated tb (as of August 3, 2018)	13.5:1	10.4:1

The WHF installations with the highest loadings (currently sampled weekly) have not experienced breakthrough

following six months of operation. Although we have not yet had breakthrough, the assumptions and safety factors used to calculate the days until breakthrough (tb) were conservative by over an order of magnitude. Stated another way, if we had conservatively calculated breakthrough to be one week, the actual time to breakthrough would be over ten weeks. Or if we had conservatively calculated breakthrough in one month, the actual time to breakthrough would be over ten months.

Routine Monitoring

As summarized in our May 15, 2108 response to your questions related to sample frequency in Section 6.1.3.3. of the O&M Plan, we reviewed the performance of the systems (based on three months of operation) and concluded, "*Based on the review of the performance monitoring as part of this response, we have modified the plan to require weekly sampling for homes with concentrations of PFOA+PFOS above 30,001 ppt. We will revise the monthly sampling range to 1,001 – 30,000 ppt and review this frequency following 9 months of operation.*"

The review outlined above is based on six months of weekly sampling data. The review of performance supports the prior conclusion to revise the monthly sampling range as discussed above.

Summary

The MDEQ's August 9, 2018 response to our May 15, 2018 letter simply repeated a number of prior comments included in the MDEQ's April 3, 2018 letter without commenting, discussing, or presenting any additional comments in response to our explanations and presentation of information related to the MDEQ's comments. The MDEQ include the following statement following a several of the repeated comments from the April 3, 2018 letter.

> "During the July 25, 2018 meeting, R&W/GZA agreed to include in the Plan the assumptions and calculations used as the basis to develop mid-stage breakthrough time estimates and the filter system designs for the anticipated contaminant loading and flow rates."

We believe the discussion of the assumptions and safety factors responds to both the initial design and monitoring plan and the proposed routine monitoring based on the performance of the first six months of operation.