June 29, 2015

Village Water Filters
1258 Rainbow Drive #2839
Silverthrone, CO 80498

RE: Biological filtration efficacy testing of the filters provided by Village Water Filters; BCS 1506169, 1506170 and 1506171.

To whom it may concern,

We have conducted the requested filtration efficacy study on the filters received on June 17th, 2015. The experimental set up and challenge of the water filters was designed to evaluate the filters' microbiological contaminant removal efficacy. It is intended to demonstrate their efficacy on the removal of bacteria, cysts, and amoeba from a contaminated water supply source. The contaminant species and water parameters selected were based on NSF/ANSI water purifier test protocols and the specifications Village Water Filters provided.

In the following pages, you will find a summary of the methodology used and the results of our analysis. Should you have any questions or concerns, please do not hesitate to contact me.

Best Regards,

George Lukasik, Ph.D.
Laboratory Director

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Test Article:

On June 17th, 2015 three filter cartridges from Village Water Filters were received and assigned BCS ID's 1506169, 1506170, and 1506171 respectively.

Test Matrix; General Test Water:

Reverse osmosis water was used throughout the study. General Test Water 1 made from reverse osmosis water was used to pre rinse the filters prior to testing. Total dissolved solids, alkalinity, turbidity, and pH were adjusted to NSF P248 guidelines using sodium hydroxide, ISO 12103-1 A2 Fine Test Dust (Powder Technology Inc., USA), and Synthetic Sea Salt (VWR International, USA). The pH of the water was 7.75, turbidity was < 1.0 NTU, alkalinity was 120 ppm, total dissolved solids were measured at 490 ppm, and Total Organic Carbon was < 0.1 ppm. Temperature was maintained between 22°C and 25°C.

Test Matrix; Challenge Test Water:

Challenge Test Water made from reverse osmosis water was used for the initial efficacy testing, passage of ten liters through each filter, and the final efficacy testing following the passage of ten liters of P248 Challenge Test Water. Total dissolved solids, turbidity,

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alkalinity, and pH were adjusted to NSF P248 guidelines using sodium hydroxide, ISO 12103-1 A2 Fine Test Dust (Powder Technology Inc., USA), and Synthetic Sea Salt (VWR International, USA). The pH of the water was adjusted to 7.8, alkalinity was 120 ppm, turbidity was 48, NTU, total dissolved solids were measured at 1500 ppm, and total organic carbon was analyzed to be 13.5 ppm.

Study Date:

Study was initiated on June 23rd, 2015 and completed on June 24th, 2015.

Test System / Challenge Species:

Bacteria: *Raoultella terrigena* ATCC ® 33257 reference stock culture was obtained from Microbiologics® (MN, USA) and maintained as per supplier's recommendations. The lyophilized culture was hydrated and propagated on Tryptic Soy Agar (TSA, Neogen Inc., MI). Prior to the date of the study, a broth culture (Tryptic Soy Broth (TSB), Neogen Inc., MI) was started from a single colony. The culture was incubated at 36.5 ± 0.5 ºC for 15-18 hrs. On the day of the study, the culture was centrifuged once at 4,000 rpm for 5 minutes and suspended in laboratory grade reagent water. Bacteria were enumerated by spread plating onto TSA. Duplicate 0.1 and 1.0 ml samples of each of

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the collected filters' effluent and influent (1/1000 dilution) were plated and incubated at 36.5°C for 18-20 hours as per Standard Method 9215C (APHA, 2012).

Parasite/Cysts surrogate: Fluoro-Max Green Fluorescent Polymer Microspheres (Lot 43393) were obtained from Thermo Scientific (Fremont, CA). SuperStick™ (Lot 113, Waterborne, USA) multiwell slides were used for enumeration. Enumeration was performed by fluorescence microscopy using FITC filters. Briefly, duplicate 0.5 ml aliquots of each of the collected sample or sample dilution were applied to the well slides. The slides were dried at 36.5º C. They were then mounted (No-Fade™, Waterborne, USA) and observed using epifluorescence microscopy. The numbers of microspheres on each slide were counted and concentrations were determined.

Challenge study Description / Methodology:

The provided filters were fitted with appropriate connections to the source of General Test Water 1. The line pressure was maintained at 1.5 PSI ±0.2 throughout the study. The filters were initially rinsed each with 1.0 liter of General Test Water (pH 7.0±0.5) each at an initial flow of 550-650 ml/min. For challenge water preparation, aliquots of the indicated species were added to 5 liters of NSF P248 Challenge Test Water (pH

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9.0±0.2). The water was homogenized and a sample was removed for enumeration. Additionally, a sample was also removed and preserved at the end of the challenge study. Following the initial rinse of each filter, 750ml of challenge water were passed through each filter at a flow rate of 500-600 ml/min. The first 700ml from each filter were discarded and the final 50 milliliters were collected. Each filters' effluent was collected in a sterile 50 ml Corning® tubes. Pressure and time elapsed for the volumes collected were recorded by a validated measuring device. Filters' influent and effluent samples were assayed as per Standard Methods and Lab Standard Operating Procedures (SOP F-1). All analysis was conducted, at minimum, in duplicates for each sample volume and dilution analyzed. The respective percent reductions were determined based on the concentration obtained in the filter influent and effluent at each specific challenge point.

Following the initial challenge, 10 liters of NSF P248 Challenge Test Water was made through each of the filters. Flow rate declined to 450-500 ml/min following the passage of 10 liters of NSF P248 Challenge Test Water. Following the water passage, the filters were subjected to the previously described microbial challenge.

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Performed by: Kintin Ng/George Lukasik
June 23rd, 2015

Analyzed by: Kintin Ng
June 23rd, 2015

Study Supervisor: George Lukasik, Ph.D.
June 23-24, 2015

Study data are summarized in the provided table(s). The results presented pertain only to the study conducted on the test articles/samples provided by the client (or client representative). The study was authorized and commissioned by the client. The results presented pertain only to the samples analyzed and identifier number(s) indicated. The data provided is strictly representative of the study conducted using the material/samples/articles provided by the client (or client's representative) and it's (their) condition at the time of test. The study and data obtained under the laboratory conditions may not be representative or indicative of a real-life process and/or application. Positive, negative, and neutralization controls were performed as outlined in the method and as per Good Laboratory Practices. All analyses were performed in accordance with laboratory practices and procedures set-forth by our NELAP/TNI accreditation standards (ISO 17025) unless otherwise noted. BCS makes no express or implied warranty regarding the ownership, merchantability, safety or fitness for a particular purpose of any such property or product.

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Study Sponsor: Village Water Filters
Test Articles: Village Water Filters; BCS 1506169, 1506170, 1506171
Project: Village Water Filters Testing
Study: Filtration Efficacy / Pressure 1.5 PSI
Test Parameter: *Raoultella terrigena*, ATCC 33257 (Bacteria)

Challenge Species	Challenge Point	Average Influent Concentration	Average concentration (cfu/ml) in the filters' effluents following each challenge			Average percent reduction of the indicated species following each challenge
			Filter A BCS1506169	Filter B BCS1506170	Filter C BCS506171	
Raoultella terrigena[1]	Initial Challenge	4.2×10^5 cfu/ml	< 0.45*	< 0.45*	< 0.45*	> 99.9999%* (>6 $\log_{10}$)
	Following 10 liters of NSF P248 Challenge Test Water		< 0.45*	< 0.45*	< 0.45*	> 99.9999%* (>6 $\log_{10}$)

[1] *Raoultella terrigena* (ATCC 33257) was obtained from ATCC and propagated on Tryptic Soy Agar (TSA, Becton Dickinson, USA). It is used as a bacterial model to evaluate filters' bacterial removal efficacy. The bacteria was enumerated as colony forming units (cfu) following incubation at 36.5°C for 24 hours as per Standard Method 9215C (APHA, 2012).

* No species were detected in the filter's effluent for the volume analyzed. Filter effluent samples were analyzed in duplicates at 0.1 and 1.0 ml. Total volume analyzed 2.2ml; thus less than 1 cfu was present in 2.2 ml. This translates to a concentration of less than 0.45 cfu/ml (<0.45).

** Provided filters were subjected to the challenge study as described in the methods section. Filters' influent and effluent samples were assayed for the respective challenge species as per Standard Methods and Lab Standard Operating Procedures (SOP F-1). The respective percent reductions were determined based on the species' concentration obtained in the filter influent and effluent samples.

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Study Sponsor: Village Water Filters
Test Articles: Village Water Filters; BCS 1506169, 1506170, 1506171
Project: Village Water Filters Testing
Study: Filtration Efficacy / Pressure 1.5 PSI
Test Parameter: 3.0 µM Fluorescent Microspheres as Cyst and Amoeba Surrogate

Challenge Species	Challenge Point	Average Influent Concentration	Average concentration (microspheres/ml) in the filters' effluents following each challenge			Average percent reduction of the indicated species following each challenge
			Filter A BCS1506169	Filter B BCS1506170	Filter C BCS506171	
3.0 micron Microspheres[1]	Initial Challenge	6.8×10^4 microspheres/ml	< 1.0*	< 1.0*	< 1.0*	> 99.999%* (>5 $\log_{10}$)
	Following 10 liters of NSF P248 Challenge Test Water		2	2	3	99.996% (>4.5 $\log_{10}$)

[1]Three micron green fluorescent latex microspheres (Fluoro-Max Green Fluoroscent Polymer Microspheres 2.9µm, Thermo Scientific CA, USA) were used as surrogates for Cryptosporidium oocysts. It is used to determine filter's parasitic removal efficacy. The microspheres were enumerated by fixing onto SuperStick Slides (Waterborne, Inc, USA) and viewing by UV fluorescence microscopy.
* No species were detected in the filter's effluent for the volume analyzed. Filter effluent samples were analyzed in duplicates 0.5 ml volumes. Total volume analyzed 1.0ml; thus less than 1 microsphere was present in 1.0 ml. This translates to a concentration of less than 1.0 / ml (<1.0).
** Provided filters were subjected to the challenge study as described in the methods section. Filters' influent and effluent samples were assayed for the respective challenge species as per Standard Methods and Lab Standard Operating Procedures (SOP F-1). The respective percent reductions were determined based on the species' concentration obtained in the filter influent and effluent samples.

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