

January 15, 2013

Brandon Harper  
First Water Systems, Inc.  
6950 Brixton Place  
Suwanee, GA 30024

Dear Brandon:

Enclosed please find your copy of First Water Systems final report entitled, "Purifier Specific Test Plan: Evaluation of Bacterial, Viral, and Cyst Reduction Capabilities of a Small Water Purifier Device Per NSF Protocol P248 and P231", MICROBIOTEST project 825-101.

If you have any questions or comments, or if you require any further information, please do not hesitate to contact the study director, Steve Zhou, directly or via e-mail at [steve.zhou@microbac.com](mailto:steve.zhou@microbac.com).

Very truly yours,



Laurie Williams  
Project Coordinator

cc: Donna Suchmann

## FINAL REPORT

# Purifier Specific Test Plan: Evaluation of Bacterial, Viral, and Cyst Reduction Capabilities of a Small Water Purifier Device per NSF Protocol P248 and P231

### TEST Device

First Water 40™ Treatment System, as deployed on the FW-1200™ Small Unit Water Purifier

### Sponsor

First Water Systems, Inc.  
6950 Brixton Place  
Suwanee, GA 30024

### Test Organisms

*Raoultella terrigena*  
MS2 coliphage  
fr coliphage  
*Cryptosporidium parvum* oocyst

### Study Director

S. Steve Zhou, Ph.D.

### Performing Laboratory

MicroBioTest  
A Division of Microbac Laboratories, Inc.  
105 Carpenter Drive  
Sterling, Virginia 20164

### Laboratory Project Identification Number

825-101

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**TEST SUMMARY**

**TITLE:** Purifier Specific Test Plan: Evaluation of Bacterial, Viral, and Cyst Reduction Capabilities of a Small Water Purifier Device per NSF Protocol P248 and P231

**STUDY DESIGN:** This study was performed according to NSF Protocol P248 and P231 and the signed protocol and project sheet(s).

**TEST MATERIALS SUPPLIED BY THE SPONSOR OF THE STUDY:**

**First Water 40™ Treatment System, as deployed on the FW-1200™ Small Unit Water Purifier, Lot No. 001, received at MICROBIOTEST on 12/11/2012**

**SPONSOR:** First Water Systems, Inc.  
 6950 Brixton Place  
 Suwanee, GA 30024

**CHALLENGE ORGANISMS:**

Category	Organism	Source	Host	Size (µm)	Required challenge	Actual challenge
Bacteria	<i>R. terrigena</i>	ATCC 33257	N/A	0.3 - 6	≥ 10 <sup>8</sup> / L	~ 10 <sup>9</sup> / L
Virus	MS2 coliphage	ATCC 15597-B1	<i>E. coli</i> (ATCC 15597)	0.024	≥ 10 <sup>7</sup> / L	~ 10 <sup>8</sup> / L
	fr coliphage	ATCC 15767-B1	<i>E. coli</i> (ATCC 19853)	0.019	≥ 10 <sup>7</sup> / L	~ 10 <sup>8</sup> / L
Cyst	<i>Cryptosporidium parvum</i> oocyst	Bunchgrass Farm (Deary, ID)	N/A	3 - 5	≥ 10 <sup>6</sup> / L	~ 10 <sup>6</sup> / L

**TEST WATERS:**

Parameter	Test Water Type I	
	Target	Actual
Chlorine Residual (mg/L)	≤ 0.1	0
pH	7.0 ± 0.5	7.3
Total Organic Carbon (TOC) (mg/L)	0.1 - 2	1.6
Turbidity (NTU)	< 1	0.7
Temperature (°C)	20 ± 5	21
Total Dissolved Solids	50 - 500	405
Alkalinity (mg/L as CaCO <sub>3</sub> )	100 ± 20	80
Color UV Absorption (/cm)	N/A	0.023
Color UV Transmittance (%)	N/A	94.95%
Background bacteria (CFU/L)	≥ 10 <sup>4</sup>	≥ 10 <sup>4</sup>

Parameter	Test Water Type IV	
	Target	Actual
Chlorine Residual (mg/L)	≤ 0.1	0
pH	7.0 ± 0.5	7.5
Total Organic Carbon (TOC) (mg/L)	10 - 15	11
Turbidity (NTU)	30 - 50	36.65
Temperature (°C)	4 ± 1	4
Total Dissolved Solids (mg/L)	1500 ± 300	1670
Alkalinity (mg/L as CaCO <sub>3</sub> )	100 ± 20	80
Color UV Absorption (/cm)	Measure & report	0.69
Color UV Transmittance (%)	Measure & report	20.42%
Background bacteria (CFU/L)	≥ 10 <sup>4</sup>	≥ 10 <sup>4</sup>

*Note: R. terrigena was used to adjust the background bacteria.*

## TEST OVERVIEW:

One Small Water Purifier (SWP) device was evaluated. The SWP's efficacy was tested using two water matrixes – General Test Water (Type I) and Challenge Test Water (Type IV). The test waters were prepared per NSF P248 and P231 and the water parameters was measured and confirmed to meet the specification prior to the test. For each water type, two sequential challenges were performed: the first with a combined challenge of bacteria (*Raoultella terrigena*) and MS2 bacteriophage; and the second with a combined challenge of the *Cryptosporidium parvum* oocyst and fr bacteriophage.

For each challenge run, the test microorganisms were spiked into the water, mixed, and an input control sample was immediately collected. Then 190 liters (approximately 50 gallons and equivalent to 10 void volumes) of the spiked water was loaded onto the SWP. The pass-through water was collected. Both the influent and effluent samples were assayed for the viability and counts of the microorganisms, in triplicates.

Between challenges by the spiked (seeded) water, the device was flushed with 190 liters of un-spiked test water that matches the water matrix of the seeded water to remove any residual challenged organisms from the previous run and to prime the test device for the next challenge.

The geometry mean of the microorganism counts from the influent and effluent samples was compared to determine the reduction capability of the SWP. The test device must achieve 99.9999% or 6 log reduction against bacteria, 99.99% or 4 log reduction against virus, and 99.9% or 3 log reduction against cysts to meet the P248/P231 criteria.

## TEST CONDITIONS:

Mechanisms of Action of Test Product:

Mechanical filtration and UV Irradiation

Neutralizer used:

Not applicable

Test temperature:

21C for Test Water I and 4C for Test Water IV

**Media and reagents:**

- Test organisms and the hosts (as applicable)
- Test Water I
- Test Water IV
- Nutrient Broth (NB)
- Nutrient Agar (NA)
- Phosphate Buffered Saline (PBS)
- Gram Stain Reagents
- Tryptic soy agar with yeast extract (base agar)
- Tryptic soy agar (0.5%) with yeast extract (soft agar)
- Phage buffer solution
- 5 mM CaCl<sub>2</sub>
- Crypto-A-Glo Fluorescent antibody kit
- Polysorbate 80 (Tween 80)
- 8.0 um and 0.2 um filters
- 1X PBS

The following technical personnel participated in this study:

S. Steve Zhou, Salimatu Jibril, David Kang, Kathryn Dormstetter,  
Angela Hollingsworth, Erica Flinn

### **STUDY DATES AND FACILITIES**

The laboratory phase of this test was performed at MICROBIOTEST, 105 Carpenter Drive, Sterling, VA 20164, from 12/11/2012 to 12/13/2012. The study director signed the protocol 12/10/2012. The study completion date is the date the study director signed the final report.

All changes or revisions of the protocol were documented, signed by the study director, dated and maintained with the protocol.

### **RECORDS TO BE MAINTAINED**

All testing data, protocol, protocol modifications, test material records, the final report, and correspondence between MICROBIOTEST and the sponsor was stored in the archives at MICROBIOTEST, 105 Carpenter Drive, Sterling, VA 20164, or at a controlled facility off site.

**MICROBIOTEST**

## RESULTS

Data and results are presented in Tables 1 – 5.

The geometric mean (GM) of each triplicate analysis (X) will be calculated for each influent and effluent as:

$$GM (\text{Log}_{10}) = [ (\text{Log}_{10}(X_1) + (\text{Log}_{10}(X_2) + (\text{Log}_{10}(X_3) ) ] / 3$$

$\text{Log}_{10}$  reduction = Counts per liter from Input Load Control ( $\text{Log}_{10}$  GM) – Counts per liter from effluent sample ( $\text{Log}_{10}$  GM)

**Table 1**  
***R. terrigena***

Water Type	Sample	Replicate	Counts (CFU/L)	Geometric Mean ( $\text{Log}_{10}$ CFU/L)
Type I	Influent	1	$2.4 \times 10^8$	8.38
		2	$2.4 \times 10^8$	
		3	$2.4 \times 10^8$	
	Effluent	1	0 (< 1)	< 0
		2	0 (< 1)	
		3	0 (< 1)	
Type IV	Influent	1	$8.2 \times 10^9$	9.92
		2	$7.9 \times 10^9$	
		3	$9.0 \times 10^9$	
	Effluent	1	0 (< 1)	< 0
		2	0 (< 1)	
		3	0 (< 1)	
Inoculum Stock Control			$6.3 \times 10^{11}$	11.80
Sterility Control			0	0

Note: The challenge bacterium was confirmed by Gram stain and colony morphology to be consistent with *R. terrigena*.



**RESULTS (continued)**

**Table 2  
 MS2 coliphage**

<b>Water Type</b>	<b>Sample</b>	<b>Replicate</b>	<b>Counts (PFU/L)</b>	<b>Geometric Mean (Log<sub>10</sub> PFU/L)</b>
Type I	Influent	1	3.5 x 10 <sup>8</sup>	8.65
		2	4.9 x 10 <sup>8</sup>	
		3	5.4 x 10 <sup>8</sup>	
	Effluent	1	1.3 x 10 <sup>4</sup>	4.01
		2	1.1 x 10 <sup>4</sup>	
		3	7.5 x 10 <sup>3</sup>	
Type IV	Influent	1	4.0 x 10 <sup>9</sup>	9.64
		2	4.3 x 10 <sup>9</sup>	
		3	4.8 x 10 <sup>9</sup>	
	Effluent	1	1.3 x 10 <sup>5</sup>	5.31
		2	2.8 x 10 <sup>5</sup>	
		3	2.4 x 10 <sup>5</sup>	
Sterility Control			0	0

**RESULTS (continued)**

**Table 3  
 fr coliphage**

<b>Water Type</b>	<b>Sample</b>	<b>Replicate</b>	<b>Counts (PFU/L)</b>	<b>Geometric Mean (Log<sub>10</sub> PFU/L)</b>
Type I	Influent	1	5.0 x 10 <sup>9</sup>	9.69
		2	4.8 x 10 <sup>9</sup>	
		3	4.9 x 10 <sup>9</sup>	
	Effluent	1	1.2 x 10 <sup>5</sup>	5.31
		2	1.8 x 10 <sup>5</sup>	
		3	3.1 x 10 <sup>5</sup>	
Type IV	Influent	1	3.1 x 10 <sup>9</sup>	9.57
		2	3.7 x 10 <sup>9</sup>	
		3	4.4 x 10 <sup>9</sup>	
	Effluent	1	2.0 x 10 <sup>5</sup>	5.38
		2	2.0 x 10 <sup>5</sup>	
		3	3.4 x 10 <sup>5</sup>	
Sterility Control			0	0

**RESULTS (continued)**

**Table 4**  
*Cryptosporidium parvum* oocysts

Water Type	Sample	Replicate	Counts (CFU/L)	Geometric Mean (Log <sub>10</sub> CFU/L)
Type I	Influent	1	1.3 x 10 <sup>6</sup>	6.05
		2	1.0 x 10 <sup>6</sup>	
		3	1.1 x 10 <sup>6</sup>	
	Effluent	1	2.2 x 10 <sup>1</sup>	1.81
		2	7.5 x 10 <sup>1</sup>	
		3	9.7 x 10 <sup>1</sup>	
Type IV	Influent	1	1.0 x 10 <sup>6</sup>	6.00
		2	1.0 x 10 <sup>6</sup>	
		3	1.0 x 10 <sup>6</sup>	
	Effluent	1	2.5 x 10 <sup>1</sup>	1.62
		2	7.5 x 10 <sup>1</sup>	
		3	2.5 x 10 <sup>1</sup>	

**RESULTS (continued)**

**Table 5  
 Reduction**


Water Type	Organism	Influent (Log <sub>10</sub> CFU/L)	Effluent (Log <sub>10</sub> CFU/L)	Log <sub>10</sub> Reduction	% Reduction	Pass/Fail
I	<i>R. terrigena</i>	8.38	< 0	> 8.38	> 99.999999	Pass
	MS2 coliphage	8.65	4.01	4.64	> 99.99	Pass
	fr coliphage	9.69	5.31	4.38	> 99.99	Pass
	oocyst	6.05	1.81	4.24	> 99.99	Pass
IV	<i>R. terrigena</i>	9.92	< 0	> 9.92	> 99.9999999	Pass
	MS2 coliphage	9.64	5.31	4.33	> 99.99	Pass
	fr coliphage	9.57	5.38	4.19	> 99.99	Pass
	oocyst	6.00	1.62	4.38	> 99.99	Pass

**CONCLUSIONS**

According to NSF P248 and P231, the test agent passes the Water Purifier Challenge Test if there is a 6.0-log reduction against bacteria, 4.0-log reduction against viruses and 3.0-log reduction against oocyst.

When tested as described, **First Water 40™ Treatment System, as deployed on the FW-1200™ Small Unit Water Purifier** passed the NSF P248 and P231 Water Purifier Challenge test when the organisms are tested using Water Type I and Water Type IV. The reduction values are presented in Table 5. All of the controls met the criteria established for a valid test. These conclusions are based on observed data.

**Study Director: MICROBIOTEST**

  
 \_\_\_\_\_  
 S. Steve Zhou, Ph.D.

01/14/2013  
 \_\_\_\_\_  
 Date

**MICROBIOTEST**

## INDEPENDENT LABORATORY CERTIFICATE OF ANALYSIS

### Evaluation of Bacterial, Viral, and Cyst Reduction Capabilities of a Small Water Purifier Device per NSF Protocol P248 and P231

**Reported to:** First Water Systems, Inc.  
 6950 Brixton Place  
 Suwanee, GA 30024

**Date Tested:** 12/11/2012  
**Project No.:** 825-101

**Product Tested:**

**First Water 40™ Treatment System, as deployed on the FW-1200™ Small Unit Water Purifier**, by First Water Systems, Inc. The product is defined by 1 micron mechanical filtration, carbon block filtration, Zeonic™ Virus Media, and an ultraviolet light dose of 40 mj/cm<sup>2</sup> at flow rates ≤ 20 gpm.

**Test Performed:** EPA and NSF P248 (2012) and P231 Biological Water Challenge Test

**Independent Laboratory Testing Results:**

Organism	Required % Reduction	Actual % Reduction	Pass/ Fail
<i>R. terrigena</i> (bacteria)	> 99.9999	> 99.999999	Pass
MS2 coliphage (virus)	> 99.99	> 99.99	Pass
fr coliphage (virus)	> 99.99	> 99.99	Pass
Cryptosporidium (cyst)	> 99.9	> 99.99	Pass

**Conclusions:**

Independent laboratory testing found that **First Water 40™ Treatment System, as deployed on the FW-1200™ Small Unit Water Purifier** achieved the microorganism contaminant reductions in accordance with the levels set forth by NSF and EPA in protocols P248 and P231.

**Laboratory Qualifications:**

Microbac Laboratories, Inc. operates one of the world's most diversified commercial testing and analytical laboratory groups in the environmental, food, pharmaceutical and other testing areas. The MicroBioTest division of Microbac has over 26 years of experience serving microbial and viral testing community and is fully compliant to Good Laboratory Practices (GLP) and ISO 17025.

**Reported by:** MICROBIOTEST



S. Steve Zhou, Ph.D.  
 Director, Virology and Molecular Biology  
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01/14/2013

Date