

ENVIRONMENTAL ASSESSMENT

1. **Date:** August 11, 2016
2. **Name of Applicant:** Aquagenics Technologies
3. **Address:** 2764 Golfview Drive
Naperville, IL 60563
4. **Description of Proposed Action:**

A. Requested Action

The action requested in this food contact notification (FCN) is to establish clearance for a food contact substance (FCS) comprising an aqueous mixture of peroxyacetic acid (PAA), acetic acid, hydrogen peroxide, 1-hydroxyethylidene-1,1-diphosphonic acid (HEDP), and (optionally) sulfuric acid as an antimicrobial agent in the control of microorganisms commonly encountered in food processing and production, as described in the applications below.

Components of the FCS mixture in process water or ice will not exceed:

(1) 400 parts per million (ppm) PAA, 100 ppm HP, and 5 ppm HEDP in wash, rinse, dip, chiller water, or scald water for meat carcasses, parts, trim, and organs;

(2) 2000 ppm PAA, 500 ppm HP, and 27 ppm HEDP in spray, wash, rinse, chiller water, low-temperature (e.g. less than 40°F) immersion baths, or scald water for poultry carcasses, parts, trim, and organs;

(3) 230 ppm PAA, 57 ppm HP, and 3 ppm HEDP for washing, rinsing, or cooling of processed and preformed meat and poultry products;

4) 230 ppm PAA, 57 ppm HP, and 3 ppm HEDP to commercially prepare fish and seafood; and

(5) 350 ppm PAA, 88 ppm HP, and 5 ppm HEDP for fruits and vegetables in a processing facility.

B. Need for Action

The antimicrobial agent is intended for use in the inhibition and growth control of unwanted or pathogenic microorganisms in meat, poultry, fish and seafood, and fruit and vegetable processing which will provide safer food for consumers.

C. Locations of Use/Disposal

Location of use for the FCS is meat, poultry, fish and seafood, and fruit and vegetable processing facilities throughout the United States. The FCS may also be used aboard fishing vessels during initial evisceration and cleaning of freshly caught fish and seafood. When used on land, the waste process water is expected to be disposed of through the processing plant wastewater treatment facilities, publicly owned treatment works (POTW), or discharged directly to surface waters pursuant to a National Pollutant Discharge Elimination System (NPDES) permit. It is expected that wastewater resulting from use aboard fishing vessels will be disposed of in the ocean.¹

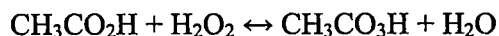
5. Identification of the Chemical Substances that are the Subject of the Proposed Action:

The subject of this notification is an aqueous solution, in equilibrium, containing peroxyacetic acid (CAS Reg. No. 79-21-0), acetic acid (CAS Reg. No. 64-19-7), hydrogen peroxide (CAS Reg. No. 7722-84-1), deionized water (CAS Reg. No. 7732-18-5), 1-hydroxyethylidene-1, 1-diphosphonic acid (CAS Reg. No. 2809-21-4), and optionally sulfuric acid (CAS Reg. No. 7664-93-9).

Table 1. Chemical Molecular Weight and Formula

Chemical Name	CAS Number	Molecular Mass	Molecular Formula
Peracetic acid	79-21-0	76.05 g/mol	C ₂ H ₄ O ₃
Acetic acid	64-19-7	60.05 g/mol	C ₂ H ₄ O ₂
Water	7732-18-5	18.01 g/mol	H ₂ O
Hydrogen peroxide	7722-84-1	34.01 g/mol	H ₂ O ₂
Sulfuric acid	7664-93-9	98.10 g/mol	H ₂ SO ₄
HEDP	2809-21-4	206.30 g/mol	C ₂ H ₈ O ₇ P ₂

In conventional preparations, peroxyacetic acid is manufactured by combining measured stoichiometric amounts of glacial acetic acid and hydrogen peroxide, in the presence of a homogenous acid catalyst.^{2,3} To prevent degradation upon storage, a stabilizer (i.e. HEDP) is typically added during production.³ The basic chemical equation for this reaction is shown below.



6. Introduction of Substances into the Environment:

A. As a Result of Manufacture

As stated under 21 CFR 25.40(a), an environmental assessment should concentrate on significant environmental issues arising from the use and disposal, rather than the production, of articles regulated by the FDA. The FCS is manufactured in plants that meet all applicable Federal, State, and local environmental regulations. Aquagenics Technologies asserts that there are no extraordinary circumstances pertaining to the manufacture of the FCS such as (1) unique emission

circumstances are not adequately addressed by general or specific emission requirements (including occupational) promulgated by Federal, State, or local environmental agencies and the emissions may harm the environment; (2) a proposed action threatens a violation of Federal, State, or local environmental laws or requirements (40 CFR 15078.27(b)(10)); and (3) production associated with a proposed action may adversely affect a species or the critical habitat of a species determined under the Endangered Species Act or the Convention on International Trade in Endangered Species of Wild Fauna and Flora to be endangered or threatened, or wild fauna or flora that are entitled to special protection under some other Federal law.

B. As a Result of Use and Disposal

For purposes of this assessment, the maximum concentration of each component in the concentrated products for the purpose of this analysis is:

Peroxyacetic Acid: 22 %
Hydrogen Peroxide: 5.5 %
Acetic Acid: 50 %
HEDP: 0.3 %
Sulfuric Acid: 0.5 %

Treatment of the process water at an on-site wastewater treatment facility and/or at a POTW is expected to result in complete degradation of PAA, hydrogen peroxide, and acetic acid.^{3,4,5,6} As all three compounds will degrade rapidly in contact with organic matter, these substances are not expected to be introduced into the environment to any significant extent as a result of all proposed use of the FCS.⁴ Furthermore, sulfuric acid will dissociate readily in the presence of water.⁷ Based on this, a qualitative evaluation of the environmental impacts for these compounds is not necessary. We have provided an evaluation to support these statements in Item 7 of the EA.

The only component that is likely to be present in measurable quantities in wastewater discharged to a POTW and to persist in the environment is HEDP.

HEDP is the chemical of environmental concern because of its persistence and behavior in the environment, as discussed under Item 7. Therefore, an evaluation of environmental impacts is necessary. As provided in Item 8 of the EA, we have determined it is appropriate to use an aquatic ecotoxicity endpoint of 10 mg/l and a terrestrial endpoint of 1000 mg/l to evaluate the environmental impacts of this action.

The target use concentrations of the individual chemical components, which will vary depending on the specified use application. The values are reported in ppm in Table 2, below.

Table 2. Use Concentration of Chemical Components in Specified Product Applications

Application	PAA	HP	HEDP	AA	SA
Meat carcasses, parts, trim, and organs	400 ppm	100 ppm	5 ppm	909 ppm	9 ppm
Poultry carcasses, parts, trim, and organs	2000 ppm	500 ppm	27 ppm	4546 ppm	45 ppm
Processed and preformed meat and poultry products	230 ppm	57 ppm	3 ppm	527 ppm	5 ppm
Commercial preparation of fish and seafood	230 ppm	57 ppm	3 ppm	527 ppm	5 ppm
Fruits and vegetables in a processing facility	350 ppm	88 ppm	5 ppm	797 ppm	8 ppm

As the use concentrations of HEDP for meat, processed and preformed meat and poultry, the commercial preparation of fish and seafood, and for fruits and vegetables in a processing facility are already well below both ecotoxicity endpoints, we expect that any refinement of these values (i.e. applying a dilution factor) will further reduce any environmental introductions that may occur. Therefore, introductions of HEDP from these uses will not present a significant environmental impact.

However, as the use level of HEDP in poultry processing (i.e. 27 ppm) is above the aquatic ecotoxicity endpoint, a quantitative assessment, calculating expected introduction concentrations (EICs) and expected environmental concentrations (EECs) for poultry processing, is provided below to evaluate environmental impacts.

Poultry Processing Facilities

In poultry processing facilities, the de-feathered eviscerated carcasses are generally sprayed before being chilled via submersion in baths. The carcass is carried on a conveyor through a spray cabinet and then submerged in the chiller baths. Parts and organs may also be chilled by submersion in baths containing the antimicrobial agent. Chiller baths typically include a "main chiller" bath and a "finishing chiller" bath, both containing the FCS. The majority of the solution containing the antimicrobial agent from a poultry carcass enters the plant's wastewater processing treatment facilities.

The poultry industry added "finishing chillers" in response to the U.S. Department of Agriculture Food Safety and Inspection Service's (FSIS) new performance standards for *Campylobacter* and *Salmonella*.⁸ The contents of the main chiller then enter the facility's wastewater treatment system before release to the environment.

We believe that HEDP will significantly partition to sewage sludge. The Human

and Environmental Risk Assessment Project (HERA) reports that the treatment steps at an on-site treatment facility or POTW, including sedimentation, aerobic or anaerobic treatment, filtration and chemical disinfection, will remove or decompose at least a portion of any HEDP that remains.⁹ According to the HERA report, HEDP is expected to be distributed into the various environmental compartments as follows:⁹

To sludge: 80 %
To water: 20 %
To air: 0 %

In applying the partition factor above, the expected introduction concentration (EIC) for water is estimated at 5.4 ppm (i.e. 20 % of 27 ppm).¹⁰

Applying the 80 % partition factor to 27 ppm provides a conservative expected environmental concentration (EEC) of 21.6 ppm for sludge.¹¹

To obtain the EEC for water, a dilution factor of 10 is applied to the EIC for water (5.4 ppm) in order to achieve a value of 0.54 ppm.¹²

A further discussion of the EEC values as compared to ecotoxicity endpoints is provided under Item 8 of the EA.

7. Fate of Substances Released into the Environment:

A. Ship-Based Processing

It is presumed that wastewater from ship-based processing will be discharged into open waters, which is common practice on fishing vessels.¹ As discussed above, the PAA, hydrogen peroxide, and acetic acid components of the antimicrobial agent in the waste process water would decompose rapidly.^{3,4,5,6} The same is true for sulfuric acid, which decomposes to sulfate in water, which is of no environmental concern at the proposed use levels.⁷ Thus, HEDP is the only component with the potential for bioaccumulation. However, a report on phosphonates, published by the Human and Environmental Risk Assessment (HERA) project, states that "the log K_{ow} values (octanol/water partition coefficient) are extremely low and range from -3.4 to -4.4", with the exact value dependent on the type of phosphonate product.⁹ Furthermore, the HERA report states that tests performed on ATMP and HEDP yielded bioconcentration factor (BCF) values of 5-17 and < 2-18, respectively.⁹ These results confirm that there is no foreseen risk of bioaccumulation in the organism or food chain.⁹ Studies into the half-life of HEDP vary, though the rate of degradation has been shown to occur very quickly for phosphonates in surface waters through the process of photodegradation.¹³ To this end, even if all of the HEDP in the highest estimate were discharged into the ocean, the concentration would be negligible.

B. Shore-Based Processing

Peroxyacetic acid and hydrogen peroxide are not expected to survive treatment at the primary wastewater treatment facilities described in the scenarios above. It is extensively documented that peracetic acid rapidly breaks down into acetic acid and oxygen upon contact with water (freshwater and saltwater sources), transition metals, sunlight, and organic matter such as soil.^{3,4} Likewise, hydrogen peroxide readily degrades into water and oxygen.⁴ The half-life of PAA in buffered solutions was 63 hours at pH 7 for a 748 ppm solution, and 48 hours at pH 7 for a 95 ppm solution.³ The half-life of hydrogen peroxide in natural river water ranged from 2.5 days when initial concentrations were 10,000 ppm, to 15.2 days when the concentration decreased to 250 ppm.¹⁴ Acetic acid decomposition under the same environmental conditions (water and soil) occurs relatively quickly as well, ultimately yielding the acetate ion and protonated hydrogen.¹⁵ In biodegradation studies of acetic acid, 99 % degraded in 7 days under anaerobic conditions.¹⁵ Thus, acetic acid is not expected to concentrate in the wastewater discharged to the POTW.

Sulfuric acid is a strong mineral acid that is totally miscible with water and dissociates readily to sulfate ions and hydrogen protons.⁷ Its pKa is 1.92 at 25°C.⁷ At pH 3.92, for example, the dissociation is 99 %, and sulfate ion concentration is 1.2×10^{-4} moles = 11.5 mg/l.⁷ At environmentally relevant concentrations, sulfuric acid is practically totally dissociated, sulfate is at natural concentrations, and any possible effects are due to acidification.^{7,16} This total ionization will imply also that sulfuric acid, itself, will not absorb on particulate matters or surfaces and will not accumulate in living tissues.⁷ Furthermore, it has been estimated that the amount of sulfur globally contributed to the atmosphere from all natural and man-made sources is about 100 to 200 million tons.¹⁶ If all sulfur from above mentioned sodium sulfate production were to go into the atmosphere, it would contribute less than 0.25 % to the world's total.¹⁶ Due to the low aquatic toxicity and natural recycling that occurs in the sulfur cycle, wide dispersive use of sodium sulfate does not present a major hazard to the environment.^{7,16}

We have estimated the potential environmental introductions of HEDP in sludge and water applying the 80:20 partition factors (see below). With respect to our calculations regarding EECs for water, we have incorporated the standard 10-fold dilution factor for discharge to surface waters of the effluent from an on-site treatment facility (or POTW), as mentioned above.^{17,18} Finally, we note that the EEC for sludge is a maximum for terrestrial impacts, as any sludge used as a soil amendment will likely be significantly diluted by soil or sludge from other sources.

Table 3. Worst-Case EICs and EECs for HEDP (ppm)

Application	HEDP	EIC _{water}	EEC _{sludge}	EEC _{water}
Meat carcasses, parts, trim, and organs	5	1.0 ¹⁹	4.0 ²⁰	0.10 ²¹
Poultry carcasses, parts, trim, and organs	27	5.4	21.6	0.54

Processed and preformed meat and poultry products	3	0.6	2.4	0.006
Commercial preparation of fish and seafood	3	0.6	2.4	0.006
Fruits and vegetables in a processing facility	5	1.0	4.0	0.10

Decomposition of HEDP occurs at a moderately slow pace of 33 % in 28 days.²² Our highest EEC calculated above for water of 0.540 ppm and our highest EEC for sludge of 21.6 ppm results from the use of the FCS to process poultry.¹¹ These values assume, in the very worst case, that all of the water used in a poultry processing plant is treated with the FCS, and represent the uppermost concentration from all of the uses proposed in the FCN.

8. Environmental Effects of Released Substances:

In each of the use scenarios described above, waste antimicrobial solution (from application and drainage) will be directed to an on-site wastewater treatment facility. There, it is expected that decomposition of all of the components excluding HEDP will occur prior to water being discharged. Below is a summary of the decomposition reactions, and if applicable, environmental persistence.

Peroxyacetic Acid (PAA): PAA rapidly decomposes to acetic acid and hydrogen peroxide (which decomposes into water and oxygen) when exposed to transition metals (such as Fe or Mn) and organic material.^{3,4} The fate of acetic acid is discussed below. However, the environmental release is anticipated to be well below concentrations found to have a negative impact on aquatic organisms. The 48-hour EC₅₀ for *Daphnia magna* ranges from 0.5 to 1.1 mg/l; the 96-hour EC₅₀ for *Oncorhynchus mykiss* and *Lepomis macrochirus* ranges from 0.91 to 2.0 mg/l and 1.1 to 3.3 mg/l, respectively.³

Hydrogen Peroxide: Hydrogen peroxide rapidly decomposes to water and oxygen when exposed to transition metals (such as Fe or Mn) and organic material.⁴ It is not expected to enter the environment after wastewater treatment. The 96-hour LC₅₀ is 16.4 µg/l and 37.4 µg/l for *Pimephales promelas* and *Ictalurus punctatus*, respectively.¹⁴ The 24-hour EC₅₀ for *Daphnia magna* is 7.7 mg/l.¹⁴ Several algae species are reported to have less than 5 % of the original chlorophyll content when exposed to hydrogen peroxide concentrations ranging from 1.7 to 17 mg/l for 24-48 hours.¹⁴

Acetic Acid: Summary ecotoxicity data from the High Production Volume (HPV) Assessment Plan for Acetic Acid and Salts indicate that acetic acid is not highly toxic to aquatic plant and animal species.¹⁵ In water, acetic acid dissociates into the acetate anion and hydrogen proton.¹⁵ The anion is readily biodegradable, with 99 % degraded after 7 days (anaerobic conditions, in the presence of activated sludge).¹⁵ The LC₅₀ for fathead minnow is 106-122 ppm (24-hour), 92-106 (48-hour), and 79-88 ppm (96-hour).¹⁵ The 48-hour LC₅₀ for rainbow trout is 105 ppm and the 48-hour EC₅₀ for *Daphnia magna* is 65 ppm.¹⁵ Toxicity thresholds for algae were reported on the MSDS for green algae (*Scenedesmus quadricauda*; 4000 ppm), blue-green algae (*Anacystis aeruginosa*; 90 ppm), and euglenoid (*Entosiphon sulcatum*; 78 ppm).

Sulfuric Acid: Sulfuric acid is a strong mineral acid that is used as a catalyst during peracetic acid formation, and to stabilize the pH of the final equilibrium solution. It is totally miscible with water and readily dissociates to sulfate ions and hydrated protons, neither of which is of any toxicological concern at the use levels proposed by this FCN.⁷ Small quantities of terrestrial or aquatic discharges are not expected to have any environmental effects, as sulfate is a ubiquitous anion already present in the ecosystem.¹⁶ Furthermore, sources of sulfate such as sulfuric acid and sodium sulfate are widely distributed in nature, and present in nearly all bodies of fresh and salt water.¹⁶ To this end, sulfate has a favorable ecological profile, participates in the sulfur cycle, and is a source of one of the most common ions found in all living organisms, where natural and industrial sources are virtually indistinguishable from one another.¹⁶ Finally, due to the low aquatic and terrestrial toxicity and natural recycling that occurs in the sulfur cycle of earth's biosphere, there is no anticipated ecological impact on land, in water, or by air.

1-Hydroxyethylidene-1,1-Diphosphonic acid (HEDP): The available ecotoxicity data for HEDP have been reviewed.^{9,23} As indicated in the previous section, according to the HERA report, 0 % of the HEDP at the on-site wastewater treatment facility or POTW is expected to be distributed into the air.⁹ Accordingly, HEDP is not expected to cause a significant impact in this environmental compartment.

a. Terrestrial Toxicity

The HERA report discusses biodegradation of HEDP and estimates a half-life in soil of 373 days.⁹ Therefore, HEDP is expected to degrade, albeit slowly, in soil. HEDP shows no toxicity to terrestrial organisms at levels up to 1000 mg/kg soil dry weight (No Observed Effect Concentration; NOEC).²³ Our maximum estimated concentration in sludge (21.6 ppm¹¹) is far below the NOEC given for *Eisenia foetida* (Earthworm). Therefore, there is no toxicity expected below 1000 mg/kg, and the FCS is not expected to have any terrestrial environment toxicity concerns at levels expected to be present in sludge. Moreover, the much smaller maximum level of HEDP present in the surface water (0.54 ppm¹²) is not expected to have any adverse environmental impact with respect to sedimentation based on the terrestrial toxicity endpoints available for plants, earthworms, and birds.²³

b. Aquatic Toxicity

Aquatic toxicity data for HEDP has been summarized and is shown in Table 4.^{9,23}

Table 4. Aquatic Environmental Toxicity Data for HEDP

Species	Endpoint	Concentration (mg/l)
<i>Aquatic Toxicity Data from Acute Studies (short term)</i>		
<i>Lepomis macrochirus</i>	96 hour LC50	868
<i>Oncorhynchus mykiss</i>	96 hour LC50	360
<i>Cyprinodon variegatus</i>	96 hour LC50	2180
<i>Ictalurus punctatus</i>	96 hour LC50	695

<i>Leuciscus idus melanatus</i>	48 hour LC50	207 to 350
<i>Daphnia magna</i>	24-48 hour EC50	165 to 500
<i>Palaemonetes pugio</i>	96 hour EC50	1770
<i>Crassostrea virginica</i>	96 hour EC50	89
<i>Selenastrum capricornutum</i>	96 hour EC50	3
<i>Selenastrum capricornutum</i>	96 hour NOEC	1.3
Algae	96 hour NOEC	0.74
<i>Chlorella vulgaris</i>	48 hour NOEC	≥100
<i>Pseudomonas putida</i>	30 minute NOEC	1000
<i>Aquatic Toxicity Data from Chronic Studies (long term)</i>		
<i>Oncorhynchus mykiss</i>	14 day NOEC	60 to 180
<i>Daphnia magna</i>	28 day NOEC	10 to <12.5
Algae	14 day NOEC	13

Examination of this table clearly shows that phosphonates, like other chelators, appear to be more toxic to algae compared to other species. Still, the maximum calculated EEC_{water} for this FCN is 0.54 ppm,¹² which is lower than the lowest toxicity endpoint of 0.74 for algae as presented in the table above.

However, the chelation effect was also observed during toxicity effects with invertebrates.^{9, 23} *Crassostrea virginica* (Eastern oyster), in shell deposition test, was the most sensitive species among the tested invertebrates.²³ As shell growth depends on Ca²⁺ metabolism and precipitation, the sensitivity was attributed to the Ca²⁺ chelating properties of phosphonates.²³ Chelation effects related to micronutrient depletion were probably also seen in a *Daphnia magna* reproduction test with HEDP in which the NOEC, based on number of offspring, was reported to be 0.1 mg/l.²³ However, the data recorded in this test clearly indicated that no concentration systemic toxicity effect relationship was found below 10 mg/l, which is well above the EEC_{water} of HEDP calculated for poultry processing (0.54 ppm¹²).

9. Use of Resources and Energy

The use of the FCS will not require additional energy resources for treatment and disposal of waste solution, as the components readily degrade. The raw materials used in the production of the mixture are commercially manufactured materials that are produced for use in a variety of chemical reactions and production processes. Energy used specifically for the production of the mixture components is not significant.

10. Mitigation Measures

The intended uses of the FCS are not reasonably expected to create any new environmental problem that would require mitigation measures of any kind. As discussed above, the use and disposal of the antimicrobial agent is not expected to result in significant adverse environmental impacts.

11. Alternatives to Proposed Action:

No potential adverse environmental effects are identified herein that would necessitate alternative actions to those proposed in this Food Contact Notification. The alternative of not approving the action proposed herein would simply result in the continued use of nearly identical products by the beef, poultry, fish and seafood, and fruit and vegetable industries. Such action would have no environmental impact. The addition of this product as an option available for meat, poultry, fish and seafood, and fruit and vegetable processors is not expected to increase the use of peroxyacetic acid antimicrobial products. Rather, the FCS will provide a replacement product for those peroxyacetic acid products already in use.


12. List of Preparers:

Aaron S. Powers, President, Aquagenics Technologies

Carrie L. Woodin, Ph.D., Chemistry, 2 years experience conducting environmental risk assessments.

13. Certification:

The undersigned preparer certifies that the information presented is true, accurate, and complete to the best of his knowledge.



Aaron S. Powers
President of Aquagenics Technologies
Date: August 11, 2016

14. List of References:

1. Fish Hold Effluent and Fish Hold Cleaning Wastewater Discharge. US Environmental Protection Agency Office of Wastewater Management. **2011**.
2. Zhao, X.; Zhang, T.; Zhou, Y.; Liu, D. Preparation of Peracetic Acid from Acetic Acid and Hydrogen Peroxide: Experimentation and Modeling. *The Chinese Journal of Process Engineering*. **2008**, *8*, 35-41.
3. Peracetic Acid and Its Equilibrium Solutions. ECETOC: European Centre for Ecotoxicology and Toxicology of Chemicals. **2001**, *JACC No. 40*.
4. Reregistration Eligibility Decision: Peroxy Compounds. Environmental Protection Agency. **1993**.
5. Jones, C.; Clark, J. Introduction to the Preparation and Properties of Hydrogen Peroxide. *of Hydrogen Peroxide and Derivatives*. Royal Society of Chemistry (Publisher). RSC Clean Technology Monographs. Cambridge, UK. **1999**, *Chapter 1*, 1-35.
6. Kitis, M. Disinfection of Wastewater with Peracetic Acid: a Review. *Environment International*. **2004**, *30*, 47-55.
7. Sulfuric Acid. The Organisation for Economic Co-operation and Development (OECD) SIDS Voluntary Testing Program for International High Production Volume Chemicals. **2001**.
8. New Performance Standards for Salmonella and Campylobacter in Young Chicken and Turkey Slaughter Establishments: Response to Comments and Announcement of Implementation Schedule. USDA FSIS Federal Register Notice 15282. **2011**, 76.
9. Phosphonates. Human & Environmental Risk Assessment (HERA) on Ingredients of European Household Cleaning Products. **2004**.
10. Calculation: $27 \text{ ppm} \times 0.2 = 5.4 \text{ ppm}$.
11. Calculation: $27 \text{ ppm} \times 0.8 = 21.6 \text{ ppm}$.
12. Calculation: $(27 \text{ ppm} \times 0.2)/10 = 0.54 \text{ ppm}$.
13. Nowack, B.; Stone, A. Competitive Adsorption of Phosphate and Phosphonates onto Goethite. *Water Research*. **2006**, *40*, 2201-2209.
14. Hydrogen Peroxide. ECETOC: European Centre for Ecotoxicology and Toxicology of Chemicals. **1993**, *JACC No. 22*.
15. Assessment Plan for Acetic Acid and Salts Category. U.S. High Production (HPV)

Chemical Challenge Program. Acetic Acid and Salts Panel, American Chemistry Council. **2001.**

16. Sodium Sulfate. Human & Environmental Risk Assessment (HERA) on Ingredients of European Household Cleaning Products. **2006.**

17. Rapaport, R. Prediction of Consumer Product Chemical Concentrations as a Function of Publicly Owned Treatment Works Treatment Type and Riverine Dilution. *Environmental Toxicology and Chemistry*. **1988**, 7, 107-115.

18. Holman, W. Estimating the Environmental Concentrations of Consumer Product Components. Aquatic Toxicology and Hazard Assessment: Fourth Conference, ASTM STP 737. Branson, D.; Dickson, K. Eds., American Society for Testing and Materials. **1981**, 159-182.

19. Sample Calculation: $5 \text{ ppm} \times 0.2 = 1.0 \text{ ppm}$.

20. Sample Calculation: $5 \text{ ppm} \times 0.8 = 4.0 \text{ ppm}$.

21. Sample Calculation: $(5 \text{ ppm} \times 0.2)/10 = 0.10 \text{ ppm}$.

22. Phosphonates. Human and Environmental Risk Assessment (HERA) on Ingredients of European Household Cleaning Products. Table 7: Inherent Biodegradation Tests. **2004.**

23. Jaworska, J.; Van Gendersen-Takken, H.; van de Plassche, E.; Feijtel, T. Environmental Risk Assessment of Phosphonates used in Domestic Laundry and Cleaning Agents in the Netherlands. *Chemosphere*. **2002**, 47, 655-665.