# Waterfree Urinal Research Project

## *Final Report*

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# Introduction

Falcon Waterfree Technologies, LLC. (FWT), manufacturers a unique line of waterfree urinal products of a patented, proprietary design. The waterfree urinal consists of a urinal bowl, currently manufactured by Ideal Standard, the European subsidiary of American Standard, a major international manufacturer of sanitary fixtures, which is fitted with a unique, patented SealTrap™ cartridge manufactured by FWT and filled with a proprietary sealant called AllSeal™. The cartridge is designed with a reservoir that collects urine. The AllSeal™ "floats" on top of the urine preventing the development and release of unacceptable odors into the restroom. The excess urine is discharged to the sewer system through the connecting pipe, thus saving a considerable volume of water that would normally be used to flush the urinal to achieve the same purpose.

FWT retained Dr. Birgitte K. Ahring, Ph.D., a professor in the Department of Civil and Environmental Engineering at the University of California Los Angeles (UCLA), to test and evaluate their product in an independent manner. Subsequently, Dr. Ahring retained the assistance of BioContractors, Inc., an applied environmental biotechnology consulting firm, to assist in conducting these tests and analyses. This report is the result of the testing and analyses completed for FWT.

# Executive Summary

## Summary of Urinal Testing

In September of 2000, FWT delivered to UCLA a prototype of the non-flushing, waterfree urinal they intend to market in the U.S. The urinal was installed on September 15, 2000 in Boelter Hall on the UCLA campus in the men's restroom located on the fifth floor, room 5754 and has been in continuous service since that date.

Urinal usage was monitored carefully over a period of six weeks. The waterfree urinal averaged 116.24 uses per day, or 813.68 uses per week. Based on the actual urinal usage recorded at UCLA, the AllSeal™ solution and SealTrap™ cartridges have operated properly and without problems. The manufacturer's design duty life of 7,000 uses before clogging of the SealTrap™ cartridge was actually exceeded both times the cartridge has been replaced. In the original installation, the SealTrap™ cartridge lasted for over 7,300 individual users. The second cartridge has lasted over 7,500 individual users, and has required only normal maintenance (cleaning and removal of trash, etc.) and has never clogged.

### *Bacterial Counting on Urinal Surfaces*

The UCLA research team sampled and counted organisms from the interior porcelain surfaces of both the waterfree urinal and an existing 3 gallon per flush (gpf) water flush urinal located in the same men's restroom at Boelter Hall at UCLA. This was done to evaluate the effect water flushing has on microbial growth on the urinal surfaces.

The data indicated that the cell count per square was lower for the waterfree urinal than for the flush urinal. While there were not sufficient data to conclude that the waterfree urinal would experience lower microbial growth rates under all conditions, the data do appear to support the conclusion that waterfree urinals would not experience greater bacterial growth rates than a water flush urinal. This conclusion is further supported by the ammonia gas concentration testing summarized below.

### *Aerobic and Anaerobic Testing*

The performance of the AllSeal™ solution was evaluated under both aerobic and anaerobic conditions to determine if it would biodegrade under normal operating conditions. The AllSeal™ solution was evaluated using the following two test protocols:

1. Anaerobic Conditions - ISO 11734:1995(E) Water Quality - Evaluation of the "Ultimate Anaerobic Biodegradability of Organic Compounds in Digested Sludge By Measurement Of The Biogas Production."

2. US EPA Method OPPTS 835.3100 Fate, Transport and Transformation Guidelines - Aerobic Aquatic Biodegradation.

The results of both test methods indicated that, under normal operating conditions, the AllSeal™ solution is not susceptible to either aerobic or anaerobic degradation and was highly effective at inhibiting virtually all microbial activity. Additional anaerobic testing under highly dilute conditions, such as would be found in a sewage treatment plant, indicated that the AllSeal™ solution did not inhibit biodegradation and was actually biodegradable.

***Ammonia Development and Testing***

Ammonia is a colorless gas with a very sharp odor. The odor is familiar to most people not only as the source of offensive odors in restrooms, but because it is used extensively in smelling salts, household cleaners, and window cleaning products. Ammonia also occurs naturally in the environment, and people are regularly exposed to low levels of ammonia in air, soil, and water. Ammonia exists naturally in the air at levels between one part and five parts per billion (ppb) of air. People can normally detect ammonia at approximately 50 ppm, although some people with particularly sensitive senses of smell can detect ammonia gas concentrations as low as 20 ppm. The test data clearly demonstrated that there was no statistically significant difference in the amount of ammonia gas measured inside the bowl or at the lip of either the waterfree or the water flush urinals. Further, none of the ammonia sampling data even approached the lower threshold detection limit (20 ppm) for humans. This supports the conclusion that neither a waterfree urinal nor a flush urinal will be a source of ammonia odor is properly maintained.

***Pipe Corrosion***

Very few data exist related to the corrosion of copper or copper alloys due to exposure to pure urine or urea. The limited data available do show that copper and most copper alloys have a high degree of resistance to corrosion when exposed to raw sewage. Since raw sewage is a highly aggressive suspension of solids and liquids, we believe it is a reasonably accurate indication of the probable resistance of copper to corrosion from exposure to undiluted urine. Given the high resistance to corrosion of copper and most copper alloys by such liquids, we conclude that it is highly unlikely that copper or most of its alloys would experience any type of accelerated corrosion due to exposure to undiluted urine from a waterfree urinal.

## Summary of Federal and State Legislation

The regulatory environment related to the use and disposal of the FWT waterfree urinal, SealTrap™ and AllSeal™ components is very complex. Because the waterfree urinal involves the discharge of a human bodily waste (urine) to a sanitary sewer for treatment, this aspect of its operation is regulated under the federal Clean Water Act (CWA), as well as the Safe Drinking Water Act (SDWA) and other related legislation and regulations. Since the SealTrap™ cartridge is also intended to be discarded after approximately 7,500 uses, this component is also regulated, primarily by the Resource Conservation and Recovery Act (RCRA) and its related legislation and regulations. Under the federal regulatory scheme, many aspects of the CWA and RCRA have been delegated, to greater or lesser degrees, to the states for additional regulatory development and enforcement. In addition, there are a number of other federal and state legislative acts that also regulate various aspects of the manufacture, sales and use of the product.

The primary implications of the various federal, state, and local laws, regulations, rules, codes and ordinances on the sales and use of the FWT waterfree urinal are summarized as followed:

### *Federal Water Legislation*

The Clean Water Act (CWA) is a 1977 amendment to the Federal Water Pollution Control Act of 1972, which set the basic structure for regulating discharges of pollutants to waters of the United States. The law gave the US EPA the authority to set effluent standards on an industry basis (technology-based) and continued the requirements to set water quality standards for all contaminants in surface waters.

No specific categorical standards appear to have been set under the CWA or the SDWA that would include waterfree urinals. All sanitary fixtures, including the waterfree urinal, are subject, however, to the “general prohibition” requirement of the CWA that prohibits discharging wastes to POTWs that can cause, or contribute to, the POTW 1) violating its NPDES permit or 2) the POTW sewage sludge violating sewage sludge standards.

None of the chemicals in the AllSeal™ solution, including chloroxylenol (which is listed as a non-toxic antiseptic chemical in, appear to problematic in that they should not adversely affect the ability of any POTW to violate its NPDES permit, nor will adversely affect the sewage sludge standards in the amounts subject to potential discharge (the potential discharge volumes are extremely small, typically less than .03 milliliters AllSeal™ per liter urine). In fact, chloroxylenol (the antimicrobial component in AllSeal™) is a common ingredient in antibacterial soap (typically 0.1 – 1.0 % weight per volume) and in several topical antiseptic liquids (up to 28% weight per volume) and is commonly discharged to POTWs throughout the US and many foreign countries without specific discharge limitations. In addition, the primary constituents of the AllSeal™ solution are a proprietary mixture of several fatty alcohols which remain liquid at normal ambient temperatures. As such, they will not coagulate or solidify in the collection piping systems of a POTW, and in fact, have the ability to dissolve other types of lipid compounds which can solidify at normal ambient temperatures, such as cooking grease and oils. Further, after reviewing the Los Angeles County Sanitation District’s and the Orange County Sanitation District’s discharge regulations, which are quite stringent, it appears that the FWT waterfree urinal should not require a specialized permit to use relative to POTW operations.

### *Federal Solid and Hazardous Waste Legislation*

Each of the primary chemicals in the proprietary solution know as AllSeal™ are a propriety mixture of several fatty alcohols that may be considered characteristic hazardous wastes under the Resource Conservation and Recovery Act (RCRA), 40 CFR Part 261. A minor chemical additive, used as an antimicrobial agent in the AllSeal™ solution, Chloroxylenol (CAS 88-04-0), is a chlorinated chemical and may be considered potentially hazardous as well. Each of these chemicals are further regulated under the federal Toxic Substances Control Act (ToSCA) as well as various related state and local laws, regulations, rules, codes and ordinances. ToSCA and RCRA, along Chloroxylenol is a very effective biocide that is used in very small amounts as a component of the AllSeal™, and is also a common ingredient in antimicrobial soaps and related products and is commonly discharged in small amounts to sanitary sewers throughout the US and internationally.

Most states prohibit the disposal of significant quantities of liquids as well as untreated human wastes in solid waste landfills. Disposal of minor amounts of such fluids which are securely contained, however, such as in consumer products like disposable baby diapers, adult incontinence products, etc. are not regulated. As a result, it is critical to ensure the proper disposal of the FWT waterfree cartridge. Toward this end, the standard operating instructions for the waterfree urinal SealTrap™ cartridge should be modified to include an instruction to discharge all remaining urine in the cartridge into the sewer before placing the SealTrap™ cartridge into a secure, sealable disposal bag and discarding it in a manner so as to ensure proper disposal.

Under 40 CFR Parts 260 – 299, the US EPA defines three classifications of hazardous waste generators. Under those definitions, any business that generates less than 220 pounds (100 kg) of hazardous wastes per month is a Conditionally Exempt Small Quantity Generator. To comply with the requirements for classification as a Conditionally Exempt Small Quantity Generator under the US EPA's rule, FWT must ensure that users of the SealTrap™ cartridge and AllSeal™ take proper steps to dispose of these components properly. To ensure compliance with this requirement, we recommend that FWT develop and include as part of the standard operating instructions included with each SealTrap™ cartridge and AllSeal™ package, a statement notifying users that it is their responsibility to properly dispose of the SealTrap™ cartridge and AllSeal™ in a permitted, licensed and regulated municipal solid waste landfill.

As a final measure to ensure proper disposal of the AllSeal™ and SealTrap™ cartridge assembly, we recommend that FWT include a sealed, liquid-proof disposal bag that is prominently marked with directions instructing users to ensure proper disposal in a properly in a permitted, licensed and regulated municipal solid waste landfill.

### *Federal Health and Safety Legislation*

In 1970, Congress passed the Williams-Steiger Occupational Safety and Health Act. This Act requires, among other things, that that the hazards of all chemicals produced or imported are evaluated, and that information concerning their hazards is transmitted to employers and employees. The transmittal of information is to be accomplished by means of comprehensive hazard communication programs, which are to include container labeling and other forms of warning, material safety data sheets and employee training.

To comply with the major public information provisions of this act and its associated regulations, we recommend that FWT continue to collect and provide purchasers of the FWT waterfree urinal with copies of the applicable MSDS documents upon request. Further, as required under the act, we recommend that FWT keep copies of all MSDS information received from their suppliers for all chemicals components of the FWT waterfree urinal on-site at all manufacturing, storage, distribution and sales locations. Finally, we recommend that FWT develop and undertake developing an appropriate Hazard Communications program for all employees related to the FWT waterfree urinal.

### *State of California Water Legislation*

The Porter-Cologne Water Quality Control Act is the basis of California's water quality control laws and regulatory programs designed to protect the state's waters. The act established nine Regional Water Quality Control Boards (RWQCBs) with the responsibility to oversee water quality on a day-to-day basis. The act also required the adoption of water quality control plans by each board, and these plans are subject to the approval of the SWRCB, and ultimately the US EPA. The plans are to be reviewed and updated. As noted previously, based on a review of the Los Angeles County Sanitation District's and the Orange County Sanitation District's discharge regulations, it appears that the FWT waterfree urinal will not require a specialized permit to use.

In 1976, the State of California enacted its own Safe Drinking Water Act as allowed under the federal Safe Drinking Water Act. Various amendments to the California act incorporated new federal requirements, and gave the state's Department of Health Services (DHS) discretion to set more stringent maximum concentration levels (MCLs) for toxic chemicals, and recommend minimum acceptable public health levels for such contaminants. The DHS is authorized to consider the technical and economic feasibility of reducing contaminants in setting MCLs. A review of the existing DHS regulations indicates no significant impact on the FWT waterfree urinal.

The California Safe Drinking Water and Toxic Enforcement Act of 1986 is better known as Proposition 65. Proposition 65 requires the Governor to publish a list of chemicals that are known to the State of California to cause cancer, birth defects or other reproductive harm. None of the information currently available in the MSDS sheets for any ingredient in the AllSeal™ solution indicates that the chemicals cause cancer, birth defects or any other reproductive harm, and are thus not likely covered under Proposition 65's various requirements.

### *California Children's Poison Protection Act*

California's Health and Safety Code, Sections 108750-108785 are known collectively as the Children's Poison Protection Act of 1990. The act requires, among other things, that any toxic household product manufactured on and after January 1, 1992, and sold in California, must include a non-toxic bittering agent unless the product is sold in a child-resistant safety packaging. Although the FWT waterfree urinal AllSeal™ solution is likely not specifically covered under this act, as a safety precaution we recommend the inclusion of a bittering agent, such denatonium benzoate, a bittering agent commonly used in very small quantities in many consumer products, to protect against accidental human ingestion. We also recommend that a prominent warning label be imprinted on the packaging containing the AllSeal™ solution warning against human consumption, notifying potential users that chloroxylenol is a potential skin irritant and may cause allergic reactions or contact dermatitis, and recommending immediate medical attention in case of accidental ingestion.

### *California Drought and Emergency Services Legislation*

In 1991, the Drought Emergency Relief and Assistance Act was passed. The act requires money for financial assistance to local water suppliers for emergency drought-relief water supply, technical assistance related to water conservation, and operation of a drought information center. The act also authorizes short-term commercial financing, backed by State Water Project revenues, to fund drought-relief measures. As a consequence, this act has minimal impact on the FWT waterfree urinal, except to the extent that during an occasion of drought, the use of the FWT waterfree urinal would likely constitute a Best Management Practice (BMP) for water conservation related to sanitary fixtures. As such, the FWT waterfree urinal may qualify for special state provided financial assistance, when available, to encourage businesses and municipalities to change out existing water flush urinals.

The Emergency Services Act authorizes the Governor of California to proclaim a state of emergency where he or she finds that conditions of disaster or extreme peril exist, caused by any of a variety of conditions including prolonged drought. Although possible, this act likely has little or no impact on issues related to FWT waterfree urinals, except perhaps under conditions of extended, severe drought where the Governor is empowered to require the adoption of a variety of actions by business and government entities throughout the state. Under such circumstances, again, the FWT waterfree urinal would likely constitute a Best Management Practice (BMP) for water conservation related to sanitary fixtures, as the Governor could require the purchase and installation of waterfree urinals as an emergency water conservation action.

## Lifecycle Cost Analysis Modeling

An integral element of the analysis completed by UCLA was the development of a lifecycle cost analysis (LCA) model. The LCA model developed by UCLA was designed to evaluate the economic implications of removing water flush urinals and replacing them with waterfree urinals. Because urinals have a long design service life and are not (generally) subject to obsolescence due to major technological innovation, the design life of 20 years was used. The default discount rate used in the model is 4.2% (other choices can be input to the model) and was obtained from the U.S. Office of Management and Budget Circular A-094a (January 2000 Revision to Appendix C) for use in evaluating long life projects, exclusive of inflation. The residual, or salvage value, of typical porcelain fixtures is generally zero, and was thus assumed to be zero. The LCA approach developed by UCLA complies with the applicable standards developed by the American Society for Testing and Materials (ASTM), West Conshohocken, PA.

To evaluate the effectiveness of the UCLA LCA model, three case studies were prepared using school districts from various locations throughout the State of California. In each case, the results of the UCLA LCA model indicated that converting to waterfree urinals was clearly preferred from an economic standpoint. In addition, the environmental benefits associated with water conservation clearly make conservation the highest priority "Best Management Practice."

## Urinal Testing

In September of 2000, FWT delivered a prototype of the non-flushing, waterfree urinal they intend to market in the U.S. The waterfree urinal consists of a urinal bowl manufactured by Ideal Standard, the European subsidiary of American Standard, a major international manufacturer of sanitary fixtures, and a standard SealTrap™ cartridge manufactured by FWT and filled with recommended volume of their proprietary sealant called AllSeal™. To test the performance of the waterfree urinal under actual conditions, the urinal was installed on September 15, 2000 in Boelter Hall on the UCLA campus in the men's restroom located on the fifth floor, room 5754. This men's restroom is one of two provided on the fifth floor of Boelter Hall and is routinely used by students, faculty and staff. Boelter Hall houses the Department of Civil and Environmental Engineering, among other academic units in the School of Engineering and Applied Sciences, and is used by over 2,500 students, faculty and staff daily at UCLA. The waterfree urinal was placed in service on September 18, 2000, and has been in continual use since that date.

The installation was accomplished by removing an existing 3 gallon per flush (gpf) urinal, and replacing it with the waterfree unit. The retrofit installation included removal of the flush urinal, removing the urinal hangers, capping the flush water line, drilling and mounting new urinal hangers, and attaching the waterfree urinal to the existing waste line using a flexible rubber adapter and band clamps. After installation, no distinctive signage or other identifying information was provided that would serve to alert users as to the nature of the new urinal and modify "normal" usage patterns of students, faculty or staff using the men's restroom in Boelter Hall.

Actual field testing began on October 9, the first full week of school at UCLA. To evaluate the lifecycle performance of the waterfree urinal, researchers from UCLA removed the initial cartridge and replaced it with a new unit. Removal and replacement of the cartridge required less than two minutes, including refilling. The SealTrap™ cartridge was inspected upon removal, and while some debris, primarily hair, was present, it was fully contained within the trap mechanism. These materials had no observable adverse affect on the operation of the unit. The fresh unit was installed so that UCLA researchers could monitor and accurately record actual usage rates and patterns based on the time of day and the day of the week.

The urinal usage data shown in Table 1 are for each 30 minute period beginning at the time of day indicated. The summary data shown above is an average of a random five-day sample for each time of day. Each sample day and time were randomly selected during a six-week period from October 9 through November 16, 2000. This period was chosen to avoid skewing the sample due to the Thanksgiving holiday. Based on the data presented in Table 1, the waterfree urinal averages 116.24 uses per day, or 813.68 uses per week (116.24 x 7 = 813.68).

**Table 1**
**Waterfree Urinal Usage Data**

| Time | Day of the Week | | | | | | | *Avg.* |
|---|---|---|---|---|---|---|---|---|
| | **Mon.** | **Tues.** | **Wed.** | **Thur.** | **Fri.** | **Sat.** | **Sun.** | |
| **6:00 AM** | 1.00 | 0.67 | 1.00 | 0.67 | 1.00 | 0.00 | 0.00 | ***0.62*** |
| **6:30 AM** | 2.00 | 2.33 | 1.33 | 1.67 | 1.33 | 0.00 | 0.00 | ***1.24*** |
| **7:00 AM** | 3.00 | 4.00 | 1.67 | 1.00 | 2.67 | 0.67 | 0.00 | ***1.86*** |
| **7:30 AM** | 3.67 | 2.33 | 3.33 | 1.67 | 3.00 | 0.67 | 0.00 | ***2.10*** |
| **8:00 AM** | 4.00 | 4.33 | 3.67 | 1.67 | 3.67 | 1.67 | 0.00 | ***2.71*** |
| **8:30 AM** | 5.00 | 4.33 | 3.00 | 4.00 | 4.33 | 2.33 | 0.00 | ***3.29*** |
| **9:30 AM** | 4.67 | 4.33 | 4.33 | 4.67 | 3.67 | 1.33 | 0.00 | ***3.29*** |
| **10:00 AM** | 4.33 | 3.67 | 5.33 | 5.67 | 4.67 | 2.33 | 0.00 | ***3.71*** |
| **10:30 AM** | 5.67 | 4.00 | 5.67 | 6.67 | 5.33 | 1.67 | 0.00 | ***4.14*** |
| **11:00 AM** | 7.00 | 3.67 | 7.00 | 5.67 | 5.33 | 5.33 | 1.67 | ***5.10*** |
| **11:30 AM** | 6.33 | 2.67 | 7.00 | 7.67 | 6.67 | 4.67 | 2.67 | ***5.38*** |
| **12:00 PM** | 6.33 | 3.67 | 5.33 | 8.33 | 6.33 | 4.00 | 2.67 | ***5.24*** |
| **12:30 PM** | 4.67 | 4.33 | 6.00 | 7.67 | 6.00 | 5.00 | 3.67 | ***5.33*** |
| **1:00 PM** | 7.00 | 6.00 | 8.00 | 6.67 | 6.67 | 3.33 | 3.00 | ***5.81*** |
| **1:30 PM** | 7.00 | 7.33 | 8.33 | 7.33 | 6.00 | 5.00 | 3.33 | ***6.33*** |
| **2:00 PM** | 5.33 | 6.67 | 5.67 | 6.33 | 6.00 | 3.33 | 2.67 | ***5.14*** |
| **2:30 PM** | 4.67 | 5.67 | 5.33 | 7.67 | 9.00 | 5.33 | 2.67 | ***5.76*** |
| **3:00 PM** | 4.00 | 5.67 | 5.00 | 6.00 | 4.67 | 4.33 | 3.00 | ***4.67*** |
| **3:30 PM** | 4.67 | 6.00 | 4.00 | 6.33 | 7.33 | 4.33 | 3.00 | ***5.10*** |
| **4:00 PM** | 4.33 | 5.33 | 3.67 | 4.67 | 6.67 | 2.00 | 2.33 | ***4.14*** |
| **4:30 PM** | 5.67 | 5.67 | 4.00 | 4.67 | 4.33 | 2.33 | 4.00 | ***4.38*** |
| **5:00 PM** | 4.67 | 4.00 | 5.00 | 4.33 | 4.33 | 2.33 | 2.33 | ***3.86*** |
| **5:30 PM** | 3.33 | 5.33 | 3.33 | 5.00 | 3.67 | 3.33 | 1.33 | ***3.62*** |
| **6:00 PM** | 4.67 | 4.00 | 5.67 | 3.00 | 2.67 | 2.33 | 1.00 | ***3.33*** |
| **6:30 PM** | 4.67 | 3.67 | 4.33 | 3.33 | 2.00 | 2.67 | 1.00 | ***3.10*** |
| **7:00 PM** | 4.00 | 4.33 | 4.00 | 3.00 | 2.33 | 2.00 | 2.00 | ***3.10*** |
| **7:30 PM** | 2.67 | 3.33 | 4.67 | 4.00 | 2.00 | 2.67 | 0.67 | ***2.86*** |
| **8:00 PM** | 3.00 | 1.67 | 2.67 | 2.33 | 2.00 | 2.00 | 1.00 | ***2.10*** |
| **8:30 PM** | 2.00 | 3.00 | 3.67 | 2.67 | 0.67 | 2.33 | 0.67 | ***2.14*** |
| **9:00 PM** | 3.00 | 3.00 | 2.67 | 2.67 | 0.67 | 1.67 | 0.00 | ***1.95*** |
| **9:30 PM** | 2.33 | 1.67 | 3.67 | 3.33 | 0.67 | 1.00 | 0.00 | ***1.81*** |
| **10:00 PM** | 1.67 | 1.00 | 2.00 | 2.00 | 0.67 | 0.33 | 0.00 | ***1.10*** |
| **10:30 PM** | 1.33 | 2.00 | 2.00 | 1.67 | 0.67 | 0.33 | 0.00 | ***1.14*** |
| **11:00 PM** | 1.00 | 1.67 | 1.67 | 0.33 | 0.67 | 0.33 | 0.00 | ***0.81*** |
| ***Tot. Avg. Daily Usage*** | ***138.67*** | ***131.33*** | ***144.00*** | ***144.33*** | ***127.67*** | ***83.00*** | ***44.67*** | ***116.24*** |

When the new SealTrap™ cartridge was installed on October 9, it was also charged with the proper amount of Allseal™ and returned to service the next day. As of the date of this report, the unit has been in continuous service for over nine weeks. Based on the urinal usage data shown in Table 1, this represents approximately 7,000 – 7,300 individual users. During this time, the cartridge has required only normal maintenance, and has never clogged.

## Bacterial Counting on Urinal Surfaces

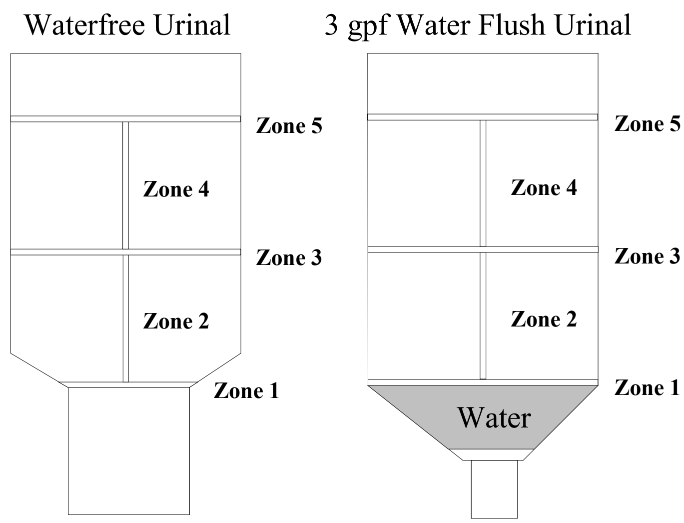
A waterfree urinal differs from a "regular" urinal (e.g. a water flushing urinal) in that it does not use water to rinse the porcelain surface of the urinal bowl between each use. Under most circumstances, human urine is sterile. Certain species microorganisms can, however, utilize nitrogen and are generally responsible for the distinctive "ammonia" odor associated with some restroom facilities. To evaluate the effect water flushing has on bacterial growth, the UCLA research team sampled and counted organisms from the interior porcelain surfaces of both the waterfree urinal and a water flush urinal to evaluate the effect water flushing has on microbial growth on the urinal surfaces.

The testing procedure consisted of collecting samples from both the waterfree urinal and a normal flush urinal using sterile swab. Each urinal was sampled by swabbing each of the zones, as shown in Figure 1. Each sample swab was placed in a 1.5 milliliter vial containing 200 milliliters of fixative. The fixative consisted of a phosphate buffer solution (13.6 grams $KH_2PO_4$ dissolved in 1 liter of water, with the pH adjusted to 7.2) mixed with 5% (weight/volume) glutaraldehyde, which was prepared fresh each day. Each vial was labeled and immediately taken to the laboratory for analysis. In addition to the five sample swabs per urinal (10 total samples), we also placed a sterile swab in a 1.5 milliliter vial containing 200 milliliter of fixative to serve as a blank.

Each sample vial was mixed in a vortex mixer for approximately 30 seconds and centrifuged for 5 seconds. Using a sterile syringe, we withdrew 100 milliliters of the sample/fixative mixture from the bottom of the vial (this contained the highest concentration of microbes after centrifuging). This sample was then injected into the sample introduction point of a clean counting chamber (hemocytometer) and cover glass. Each counting chamber slide was then allowed to acclimate for 15 minutes and was then examined.

To evaluate the quantitative difference caused by the elimination of water flushing in the waterfree urinal, it was necessary to determine cell concentration. Since any cells growing on either urinal will be in a reasonably transparent solution, we decided to determine cell density of the suspension spectrophotometrically using a counting chamber (hemocytometer), however, this form of determination simply provides a count of total microorganisms, but does not allow an assessment of cell viability, nor did it allow us to distinguish cell types.

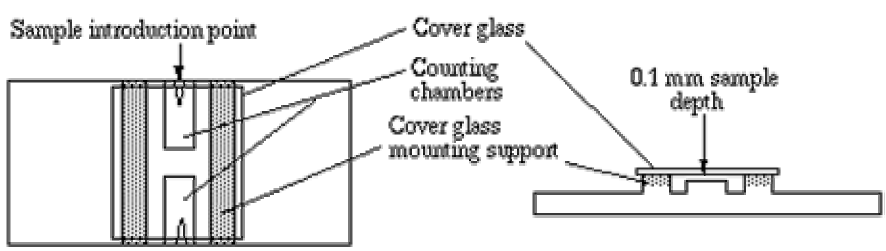
**Figure 1**
**Urinal Microbial Sampling Locations**




**Each sampling zone shown above is .125" wide across the full width of the urinal surface at the measurement point.**

The counting chamber we used is called a hemocytometer, since it was originally designed for performing blood cell counts. It works as shown in Figure 2, below.

**Figure 2**
**Counting Chamber**

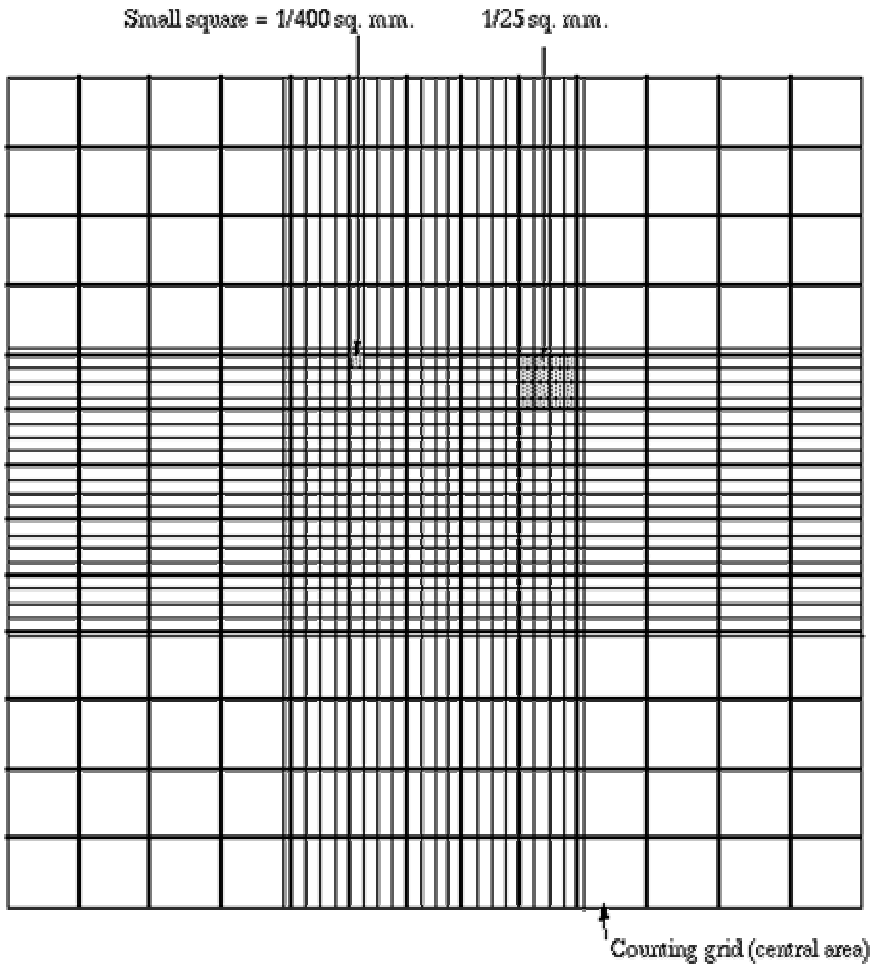



To prepare the counting chamber, the mirror-like polished surface was carefully cleaned with lens paper. The coverslip was also cleaned. Coverslips for counting chambers are specially made and are thicker than those for conventional microscopy, since they must be heavy enough to overcome the surface tension of a drop of liquid.

The coverslip was then placed over the counting surface prior to putting on the cell suspension. The suspension was introduced into one of the V-shaped wells with a syringe and needle. The area under the coverslip was filled by capillary action. Enough liquid was introduced so that the mirrored surface was just covered. The charged counting chamber was then placed on the microscope stage and the counting grid was brought into focus at low power (40x magnification with a 4x objective lens.)

One entire grid on standard hemocytometer with Neubauer rulings can be seen at this magnification. The main divisions separated the grid into 9 large squares (like a tic-tac-toe grid). Each square had a surface area of one square millimeter, and the depth of the chamber is 0.1 millimeters. Thus the entire counting grid lies under a volume of 0.9 cubic millimeters. The counting chamber grid arrangement is shown in Figure 3.

**Figure 3**
**Counting Chamber Grid**




The cell suspensions (obtained as described previously) were dilute enough so that the cells did not overlap each other on the grid, and were uniformly distributed. To perform the count, we determined the magnification needed to recognize the cell present, starting with a 10x magnification (1x objective lens.) We systematically counted the cells in selected squares so that the total count was a minimum of 100 cells (this is the number of cells needed for a statistically significant count.) For this study, the number of squares counted varied between 3 and 25 (for the control blank.) We consistently used a specific counting patter to avoid bias. For cells that overlapped a division line, we counted a cell as "in" if it overlapped the top or right line, and "out" if it overlapped the bottom or left line.

To obtain the final count data (in cells/milliliter,) we first divided the total count by 0.1 (the chamber depth) and then divided the result by the total surface area counted. For example if we counted 125 cells in each of the four large corner squares plus the middle, we would divide this cell count by 0.1, and then divide the result by 5 square millimeters (the total area counted.) Since there are 1,000 cubic millimeters per milliliters, this total was then multiplied by 1,000 to obtain the cell count per milliliter. The bacterial count data from the flush and waterfree urinals were calculated using this methods, and are as follows:

**Table 2**
**Bacterial Count Data**

| Date | 5 gpf Flush Urinal | | Falcon Waterfree | | Control Blank | |
|---|---|---|---|---|---|---|
| | Counts | Squares | Counts | Squares | Counts | Squares |
| **19-Oct** | 131 | 4 | 101 | 22 | 17 | 25 |
| **20-Oct** | 177 | 3 | 129 | 3 | 44 | 25 |
| **25-Oct** | 141 | 4 | 109 | 2 | 112 | 5 |
| **26-Oct** | 129 | 3 | 130 | 3 | 103 | 14 |
| **2-Nov** | 107 | 4 | 118 | 5 | 102 | 12 |
| **7-Nov** | 123 | 4 | 104 | 7 | 112 | 16 |
| **Average Counts/Square** | 36.7 cells/square | | 17.7 cells/square | | 5.0 cells/square | |

As can be seen in Table 2, the cell count per square is lower for the waterfree urinal than for the flush urinal. While there were not sufficient data to conclude that the waterfree urinal would experience lower microbial growth rates under all conditions, the data do appear to support the conclusion that waterfree urinals will not experience greater bacterial growth rates than a water flush urinal. This conclusion is further supported by the ammonia gas concentration data discussed in more detail Table 4.

## Aerobic and Anaerobic Testing of AllSeal™

The normal operation of the waterfree urinal will expose the AllSeal™ solution to microbial action. Therefore, FWT requested that the AllSeal™ solution be tested to evaluate its performance under both aerobic and anaerobic conditions. The procedures used were designed to evaluate potential biodegradation that might occur when chemical substances are released to aquatic environments. A high biodegradability result in these tests provided evidence that the test substance will be biodegradable in natural aerobic or anaerobic aquatic environments.

The aerobic test method consisted of a two-week inoculum buildup period during which aquatic microorganisms were provided the opportunity to adapt to the test compound (the AllSeal™ solution). The inoculum was introduced to three specially equipped Erlenmeyer flask containing the defined medium and test substance. A reservoir holding barium hydroxide solution was suspended in the flask. After inoculation, the flasks were sparged with $CO_2$-free air, sealed, then incubated and shaken in a dark temperature controlled enclosure. Periodically, samples of the test mixture containing the test substances were analyzed for dissolved organic carbon (DOC) and the $Ba(OH)_2$ from the reservoirs was titrated to measure the amount of $CO_2$ evolved. Differences in the amount of DOC consumed and the amount of $CO_2$ evolved in the control flask containing no test substance, and flasks containing the test substance were used to determine the degree of ultimate biodegradation.

### *Aerobic Test Method and Procedure*

The test method utilized was based on the US EPA's Method OPPTS 835.3100: Fate, Transport and Transformation Guidelines - Aerobic Aquatic Biodegradation. All samples were prepared in triplicate for the test compound, blank, reference substance and inhibition control in 250-mL Erlenmeyer flask with a suspended reservoir containing 1.25 ml of $Ba(OH)_2$.

The test materials included:

- AllSeal™ solution
- Dextrose (Mallinckrodt Baker, Inc.)
- Mercuric Chloride (Mallinckrodt Baker, Inc.)
- Inoculum was obtained from the Terminal Island sewage treatment plant operated by the City of Los Angeles in Long Beach, CA.

The flasks contained:

1. Test - 112.5 mL of deionized (DI) water 12.5 ml of acclimation medium, and AllSeal™ (10 mg/L.)
2. Blank -112.5 mL of deionized (DI) water, 12.5 ml of acclimation medium.
3. Reference - 112.5 mL of deionized (DI) water, 12.5 ml of acclimation medium and dextrose 10 mg/L.
4. Inhibition - 112.5 mL of deionized (DI) water, 12.5 ml of acclimation medium and HgCl2 10 mg/L.

All samples were incubated at 25°C in a shaker set at 125 rpm. Measurement of $CO_2$ and DOC were conducted several times, as indicated in Table 3 below. Dissolved organic carbon (DOC) analysis was performed by a Tekmar/Dohrmann Apollo 9000 TOC/DOC analyzer.

**Table 3**
**$CO_2$ Evolution**

| | | Test | | | Blank | | | $CO_2$ Evolution |
|---|---|---|---|---|---|---|---|---|
| Date | Day | Flask 1 | Flask 2 | Avg. | Flask 1 | Flask 2 | Avg. | (%) |
| 1/22/01 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1/27/01 | 5 | 1.8 | 1.4 | 1.6 | 1.5 | 1.8 | 1.65 | -0.30 |
| 2/03/01 | 12 | 1.6 | 0.9 | 1.25 | 2 | 1.9 | 1.95 | -4.20 |
| 2/07/01 | 16 | 1.6 | 2 | 1.8 | 2.1 | 2 | 2.05 | -1.50 |
| 2/16/01 | 25 | 1.3 | 1.3 | 1.3 | 1.9 | 1.4 | 1.65 | -2.10 |

The data shown in Table 3 clearly indicate that the AllSeal™ solution is inhibitory at normal room conditions.

***Anaerobic Test Method and Procedure***

To evaluate anaerobic biodegradation, ISO Method 11734:1995(E) Water quality - Evaluation of the "Ultimate Anaerobic Biodegradability of Organic Compounds in Digested Sludge - Method by Measurement of the Biogas Production" was adapted. All samples were prepared in triplicate for the test compound, blank, reference substance and inhibition control in 120-mL serum bottles.

The test materials included:

- AllSeal™ solution
- Sodium Benzoate (Mallinckrodt Baker, Inc.)
- Inoculum was obtained from the Terminal Island sewage treatment plant operated by the City of Los Angeles in Long Beach, CA. The primary digested anaerobic sludge was incubated at 35°C for 5 days for pre-digestion to reduce background gas production.

Each vial contained the following:

1. Test - 30 mL of the dilution medium, 5 mL inoculum and AllSeal™ 100mg/L
2. Blank - 30 mL of the dilution medium, 5 mL aliquot of inoculum
3. Reference - 30 mL of the dilution medium, 5 mL inoculum, Sodium Benzoate 100mg/L
4. Inhibition - 30 mL of the dilution medium, 5 mL inoculum and AllSeal™ 100mg/L and Sodium Benzoate 100mg/L

All samples were incubated at 35°C and biogas measurement were conducted every 3 to 5 days at room temperature. Anaerobic conditions were maintained by gas purging with pure $N_2$ gas during addition of all substances.

Gas measurements were taken using a Dresser Instruments pressure gage. Inorganic carbon analysis was performed by liquid chromatography (LC) using a Scientific Systems, Inc. (SSI) Model 501 detector and SSI Model 300 LC pump. Total Solids was measured using standard gravimetric methods.

The inoculum of digested sludge is added to an appropriate medium and incubated at 35°C + 2°C in sealed vials with a test chemical at an organic carbon concentration of 20 mg/l to 100 mg/l for up to 60 days.

The increase in headspace pressure in the test vial resulting from the production of carbon dioxide and methane is measured. A considerable amount of carbon dioxide will be dissolved in water or transformed to hydrogen carbonate or carbonate under the conditions of the test. The inorganic carbon is measured at the end of the test.

The amount of microbiologically produced carbon is calculated from the net gas production in the net inorganic carbon formation in excess over blank values. The percentage biodegradation is calculated from the total inorganic carbon formed and the measured, or calculated, amount of carbon added as a test compound. The biodegradation process is monitored by taking intermediate measurements of gas production during the test period.

**Table 1**
**Anaerobic Degradation**
**Headspace Pressure (mbar)**
**Concentrated AllSeal™ Solution**

| Date | Day | Test Avg. | Cum. | Blank Avg. | Cum. | Reference Avg. | Cum. | Inhibitory Avg. | Cum. |
|---|---|---|---|---|---|---|---|---|---|
| **11/10/00** | 0 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | 5 | 67.567 | 67.567 | 75.153 | 75.153 | 74.923 | 74.923 | 59.063 | 59.063 |
| | 7 | 0.223 | 67.790 | 0.188 | 75.342 | 0.216 | 75.140 | 0.193 | 59.256 |
| | 10 | 11.490 | 79.280 | 12.180 | 87.522 | 24.820 | 99.960 | 18.620 | 77.876 |
| | 12 | 10.340 | 89.620 | 8.960 | 96.482 | 16.297 | 116.256 | 26.197 | 104.073 |
| | 15 | 9.880 | 99.500 | 11.030 | 107.512 | 42.287 | 158.543 | 32.637 | 136.710 |
| | 17 | 6.430 | 105.930 | 5.627 | 113.138 | 14.250 | 172.793 | 14.940 | 151.650 |
| | 19 | 4.830 | 110.760 | 5.057 | 118.195 | 4.137 | 176.930 | 4.827 | 156.476 |
| | 21 | 6.210 | 116.970 | 6.207 | 124.402 | 7.357 | 184.286 | 6.897 | 163.373 |
| | 24 | 4.140 | 121.110 | 3.450 | 127.852 | 4.140 | 188.426 | 5.290 | 168.663 |
| | 26 | 4.830 | 125.940 | 0.920 | 128.772 | 0.000 | 188.426 | 0.460 | 169.123 |
| **12/8/00** | 28 | 2.530 | 128.470 | 4.370 | 133.142 | 4.600 | 193.026 | 1.840 | 170.963 |
| | 31 | 7.127 | 135.597 | 6.207 | 139.348 | 9.683 | 202.710 | 10.803 | 181.766 |
| | 34 | 0.460 | 136.057 | 1.380 | 140.728 | 0.690 | 203.400 | 1.380 | 183.146 |
| | 39 | 0.690 | 136.747 | 0.690 | 141.418 | 0.000 | 203.400 | 0.000 | 183.146 |
| | 41 | 4.370 | 141.117 | 5.520 | 146.938 | 3.910 | 207.310 | 5.290 | 188.436 |
| | 46 | 4.137 | 145.253 | 4.600 | 151.538 | 5.743 | 213.053 | 5.060 | 193.496 |
| | 50 | 0.460 | 145.713 | 0.460 | 151.998 | 0.000 | 213.053 | 0.460 | 193.956 |
| | 54 | 0.230 | 145.943 | 0.460 | 152.458 | 0.460 | 213.513 | 0.000 | 193.956 |
| | 56 | 1.150 | 147.093 | 3.910 | 156.368 | 1.610 | 215.123 | 1.840 | 195.796 |
| | 60 | 0.000 | 147.093 | 0.460 | 156.828 | 0.230 | 215.353 | 0.230 | 196.026 |
| **1/9/01** | 61 | 0.460 | 147.553 | 0.460 | 157.288 | 0.460 | 215.813 | 0.000 | 196.026 |

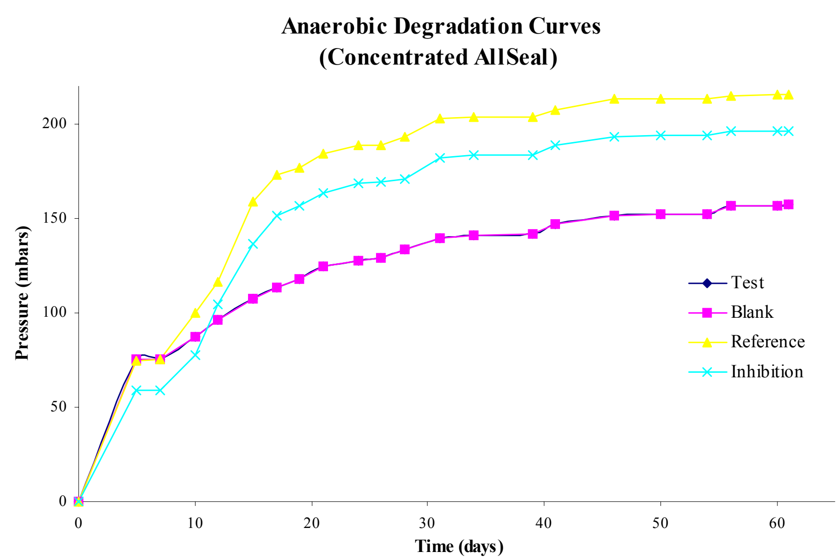
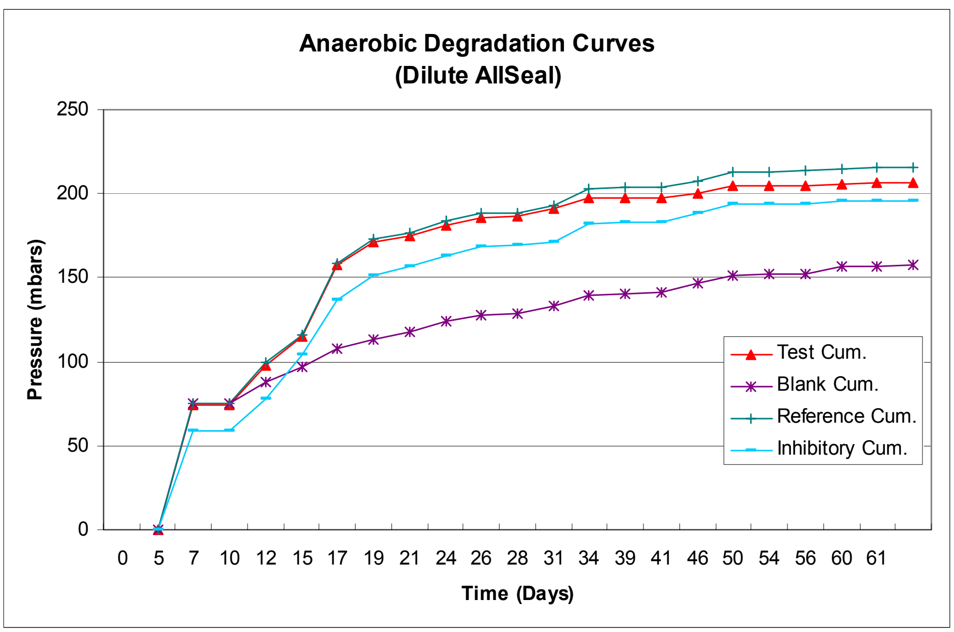



**Table 1**

## Anaerobic Degradation
## Headspace Pressure (mbar)
## Dilute AllSeal™ Solution

| Date | Day | Test Avg. | Test Cum. | Blank Avg. | Blank Cum. | Reference Avg. | Reference Cum. | Inhibitory Avg. | Inhibitory Cum. |
|---|---|---|---|---|---|---|---|---|---|
| **2/7/01** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 5 | 74.221 | 74.221 | 75.153 | 75.153 | 74.923 | 74.923 | 59.063 | 59.063 |
| | 7 | 0.216 | 74.437 | 0.188 | 75.342 | 0.216 | 75.14 | 0.193 | 59.256 |
| | 10 | 23.48 | 97.917 | 12.18 | 87.522 | 24.82 | 99.96 | 18.62 | 77.876 |
| | 12 | 17.5 | 115.417 | 8.96 | 96.482 | 16.297 | 116.256 | 26.197 | 104.073 |
| | 15 | 42.112 | 157.529 | 11.03 | 107.512 | 42.287 | 158.543 | 32.637 | 136.71 |
| | 17 | 13.225 | 170.754 | 5.627 | 113.138 | 14.25 | 172.793 | 14.94 | 151.65 |
| | 19 | 4.001 | 174.755 | 5.057 | 118.195 | 4.137 | 176.93 | 4.827 | 156.476 |
| | 21 | 6.755 | 181.51 | 6.207 | 124.402 | 7.357 | 184.286 | 6.897 | 163.373 |
| | 24 | 4.223 | 185.733 | 3.45 | 127.852 | 4.14 | 188.426 | 5.29 | 168.663 |
| | 26 | 1.219 | 186.952 | 0.92 | 128.772 | 0 | 188.426 | 0.46 | 169.123 |
| **3/7/01** | 28 | 4.122 | 191.074 | 4.37 | 133.142 | 4.6 | 193.026 | 1.84 | 170.963 |
| | 31 | 6.258 | 197.332 | 6.207 | 139.348 | 9.683 | 202.71 | 10.803 | 181.766 |
| | 34 | 0.024 | 197.356 | 1.38 | 140.728 | 0.69 | 203.4 | 1.38 | 183.146 |
| | 39 | 0.035 | 197.391 | 0.69 | 141.418 | 0 | 203.4 | 0 | 183.146 |
| | 41 | 2.924 | 200.315 | 5.52 | 146.938 | 3.91 | 207.31 | 5.29 | 188.436 |
| | 46 | 3.987 | 204.302 | 4.6 | 151.538 | 5.743 | 213.053 | 5.06 | 193.496 |
| | 50 | 0.366 | 204.668 | 0.46 | 151.998 | 0 | 213.053 | 0.46 | 193.956 |
| | 54 | 0.393 | 205.061 | 0.46 | 152.458 | 0.46 | 213.513 | 0 | 193.956 |
| | 56 | 0.964 | 206.025 | 3.91 | 156.368 | 1.61 | 215.123 | 1.84 | 195.796 |
| | 60 | 0.118 | 206.143 | 0.46 | 156.828 | 0.23 | 215.353 | 0.23 | 196.026 |
| **4/9/01** | 61 | 0.358 | 206.501 | 0.46 | 157.288 | 0.46 | 215.813 | 0 | 196.026 |



As can be clearly seen in the data shown above, the AllSeal™ solution is not inhibitory under dilute anaerobic conditions until most of the base substrate has been utilized. The curve plotting total gas production (in millibars) for the AllSeal™ solution is virtually identical to that for the reference standard, indicating nearly no inhibition of microbial activity during the test period. In fact, during the first 28 days, the gas production in two of the three test vials containing the AllSeal™ solution, the gas production was higher than for the reference standard, indicating that some of the AllSeal™ solution may have been biodegraded. After 28 days when the concentration of available substrate (Sodium Benzoate) was reduced due to biological conversion into headspace gas, the concentration of chlorozylenol rose gradually to a level that became slightly inhibitory.

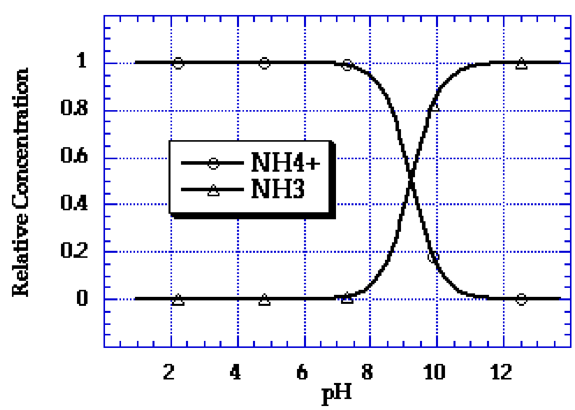
## Ammonia Development and Testing

Ammonia is among the most common odors found in restrooms. Fortunately, ammonia disperses easily, since is lighter than air (its density is 60% that of air), and does not settle in low lying areas the way hydrogen sulfide and other dense odorous compounds do. Another factor affecting the magnitude of ammonia volatilization is pH. Ammonia gas ($NH_3$) and aqueous ammonium ions ($NH_4^+$) are in equilibrium at a pH of about 9, with a higher pH forcing more ammonium ions ($NH_4^+$) into the gaseous form ($NH_3$). The equilibrium relationship is defined by the equation shown below in Figure 4. A plot of this equation, showing the relative concentrations of $NH_3$ and $NH_4^+$, is also provided in Figure 4. Under actual field conditions, the equilibrium relationship shown above would have to be corrected somewhat for other ions in solution and for conditions where the temperature is either higher or lower than 25°C.

**Figure 4**
**Equilibrium Relationship for Ammonia and Ammonium Ion**

$$NH_4^+ \longleftrightarrow NH_3 + H^+$$

$$\frac{[NH_3][H^+]}{[NH_4^+]} = 5.7 \times 10^{-10}$$




Ammonia is a colorless gas with a very sharp odor. The odor is familiar to most people not only as the source of offensive odors in restrooms, but because it is used extensively in smelling salts, household cleaners, and window cleaning products. Ammonia also occurs naturally in the environment, and we are regularly exposed to low levels of ammonia in air, soil, and water. Ammonia has been found in both soil and water samples at hazardous waste sites. Ammonia exists naturally in the air at levels between one part and five parts per billion (ppb) of air. For comparison, this represents five molecules of ammonia per 999,999,995 molecules of air equals 5 parts per billion of air. People can normally detect ammonia at approximately 50 ppm, although some people with particularly sensitive senses of smell can detect ammonia gas concentrations as low as 20 ppm. The physical and chemical properties of ammonia are summarized in Table 3.

The Occupational Safety and Health Administration (OSHA) has set a short-term (15 minute) exposure limit of 35 ppm for ammonia. The National Institute for Occupational Safety and Health (NIOSH) recommends that the level in workroom air be limited to 50 ppm for 5 minutes of exposure. The general procedure for the air sample collection and analysis of ammonia is described in OSHA Method No. ID-188. The validation of this method examines the use of a glass sampling tube containing 500 mg of carbon bead impregnated with sulfuric acid (CISA). Sampling tubes were obtained from Dräger, Inc. (Moislinger Allee, Germany).

**Table 3**
**Physical/Chemical Properties of Ammonia ($NH_3$)**

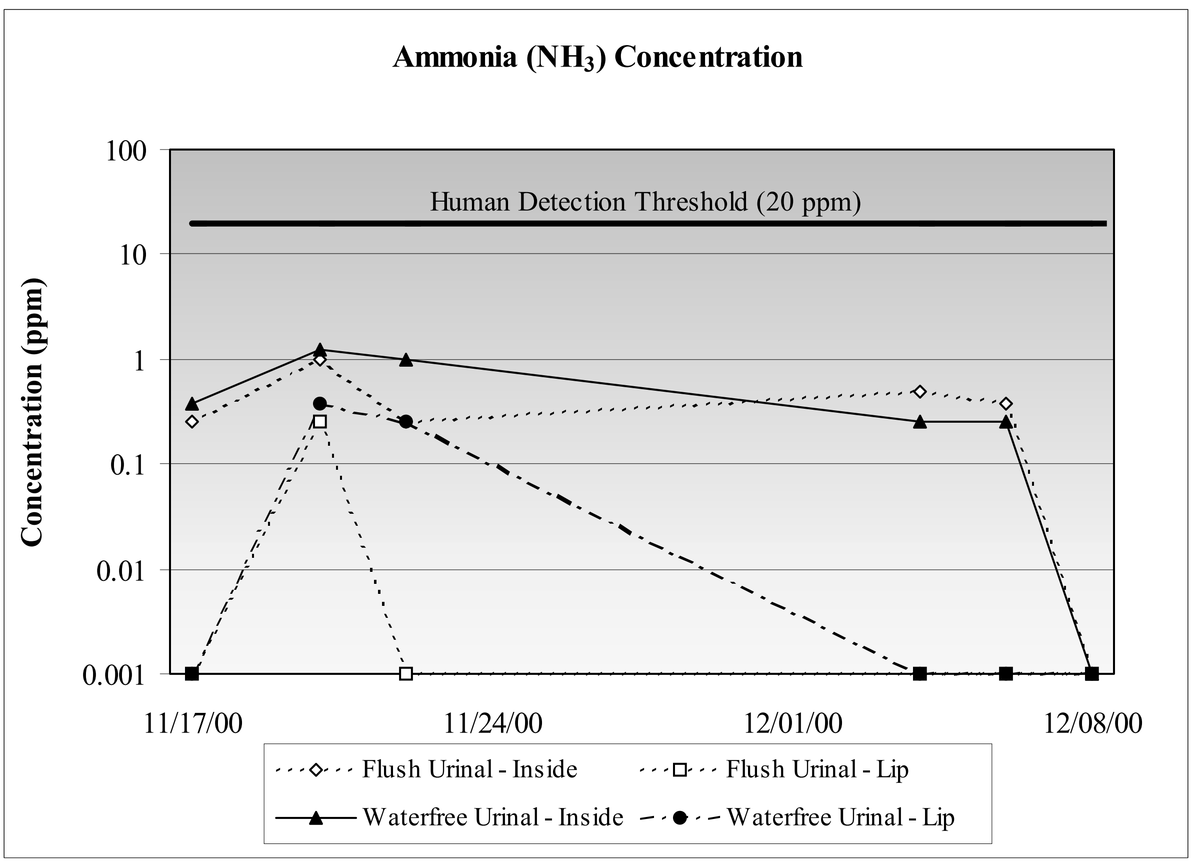
| | |
|---|---|
| CAS No. | 7664-41-7 |
| Formula weight | 17.03 |
| Boiling point | -33.35°C |
| Melting point | -77.7°C |
| Density, gas (air = 1) | 0.5967 |
| Density, liquid | 0.6818 (-33.35°C) |
| Critical temperature | 132.4°C |
| Critical pressure | $11.3 \times 10^3$ kPa |
| Autoignition temperature | 651°C |
| Flammable limits | 16-25% (by volume in air) |
| Solubility | Cold water (0°C) = 89.9 g/100 cc<br>Hot water (100°C) = 7.4 g/100 cc |
| Human detection threshold in air | Approximately 20 ppm |

Air samples were collected using Dräger Accuro hand pumps (Moislinger Allee, Germany) calibrated at flow rates of about 100 cubic centimeters per stroke. Air samples were performed using a Dräger tube with an indicator range of .25 – 3 ppm for ammonia. Samples were obtained in a variety of locations for each type of urinal, including immediately above the bottom of the urinal bowl (or just above the waterline, for the flush urinal), 6 inches in front of each urinal at the bowl lip level, and at the ceiling height of the room nearest the air return vent. The sample data are shown below in Table 4 for each type of urinal.

**Table 4**
**Ammonia Concentration in Air**

| Sample Date | NH$_3$ Concentration in Air (ppm) | | | | | |
|---|---|---|---|---|---|---|
| | 3 gpf Water Flush Urinal | | | Waterfree Urinal | | |
| | Inside | Lip | Background | Inside | Lip | Background |
| 11/17/2000 | 0.25 | 0.00 | 0.00 | 0.38 | 0.00 | 0.00 |
| 11/20/2000 | 1.00 | 0.25 | 0.00 | 1.25 | 0.38 | 0.00 |
| 11/22/2000 | 0.25 | 0.00 | 0.00 | 1.00 | 0.25 | 0.00 |
| 12/4/2000 | 0.50 | 0.00 | 0.00 | 0.25 | 0.00 | 0.00 |
| 12/6/2000 | 0.38 | 0.00 | 0.00 | 0.25 | 0.00 | 0.00 |
| 12/8/2000 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Mean* | *0.40* | *0.04* | *0.00* | *0.52* | *0.11* | *0.00* |
| *Std. Dev.* | *0.34* | *0.10* | *0.00* | *0.49* | *0.17* | *0.00* |
| *Sample Var.* | *0.12* | *0.01* | *0.00* | *0.24* | *0.03* | *0.00* |

**Figure 5**
**Ammonia Concentration Data**



As the data shown in Table 4 and Figure 5 clearly indicate, there is no statistically significant difference in the amount of ammonia gas measured inside the bowl or at the lip of either the waterfree or the water flush urinals. Further, and very importantly, none of the ammonia sampling data even approached the lower threshold detection limit (20 ppm) for humans.

## Pipe Corrosion

As noted previously, a waterfree urinal differs from a "regular" urinal (e.g. a water flushing urinal) in that it does not use water to rinse the urinal bowl, and consequently, urine is discharged to the sanitary sewer collection lines in a more concentrated form than would be the case with a water-flush urinal. The general characteristics and measurements of human urine are:

- Color: pale yellow to amber
- Appearance: clear to slightly hazy
- Specific gravity: normal is 1.1015 (with normal fluid intake), range between 1.001 and 1.040.
- pH: 4.5 – 8; average pH between 5 and 6
- Volume: 1500cc/24 hours (adult)

A healthy adult produces between 750 and 2500 ml of urine in a 24 hour period, at an average rate of approximately 25 to 30 ml/hr. Children excrete smaller quantities than adults, but the total volume excreted (voided) is greater than adults in proportion to their body size. The amount voided over any period is directly related to the individual's fluid intake, temperature, climactic conditions, and amount of perspiration.

The normal color of urine ranges from light yellow to dark amber, depending on the concentration of solutes in the urine. Urechrome is the name of the pigment that gives urine its characteristic yellow color. Many medications, some foods and several diseases can cause the urine to change color. Urine that has been standing for a period of time at room temperature has a distinct odor. After urine is voided from the bladder, certain species of bacteria can split urea molecules in the urine into ammonia. An unusual or disagreeable odor in freshly voided urine may also be due to drugs or certain foods. For example, asparagus produces a distinct smell in the urine.

Urine pH is used to classify urine as either a dilute acid or base solution. Seven is the point of neutrality on the pH scale. The lower the pH, the greater the acidity of a solution; the higher the pH, the greater the alkalinity. The glomerular filtrate of blood is usually acidified by the kidneys from a pH of approximately 7.4 to a pH of about 6 in the urine. Depending on the person's acid-base status, the pH of urine may range from 4.5 to 8. The kidneys maintain normal acid-base balance primarily through the reabsorption of sodium and the tubular secretion of hydrogen and ammonium ions. Urine becomes increasingly acidic as the amount of sodium and excess acid retained by the body increases. Alkaline urine, usually containing bicarbonate-carbonic acid buffer, is normally excreted when there is an excess of base or alkali in the body. Secretion of an acid or alkaline urine by the kidneys is one of the most important mechanisms the body uses to maintain a constant body pH. In people who are not vegetarians, the pH of urine tends to be acidic. A diet rich in citrus fruits, legumes, and vegetables raises the pH and produces urine that is more alkaline.

Most of the bacteria responsible for metabolizing urine make it more alkaline because the bacteria split urea into ammonia and other alkaline waste products. Such bacteria are commonly found in virtually all sanitary sewer collection pipes, and are responsible for the unpleasant “ammonia” smell commonly associated with bathrooms that are not sanitized frequently.

Normal human urine it approximately 96% water and 4% other dissolved substances, including:

- Urea
- Uric Acid
- Creatinine
- Sodium -Ammonium
- Potassium

The composition of normal urine (in grams/100 ml of urine)

**Table 5**
**Normal Urine Data**

| Component | Urine |
|---|---|
| Urea | 1.8 |
| Uric acid | 0.05 |
| Glucose | None |
| Amino acids | None |
| Total inorganic salts | <0.9-3.6 |
| Proteins and other macromolecules | None |

Since normal urine is usually slightly acidic (although this decreases rapidly as bacteria convert urea to ammonia and other alkaline compounds), the potential for accelerated corrosion of fixtures, surfaces and sanitary sewer piping was evaluated. A review of the pertinent literature related to corrosion resistance of various materials commonly associated with restrooms to urine, urea and sewage indicated the following:

**Table 6**
**Pipe Corrosion Resistance Data**

| Material Type | Resistance to Corrosion[1] | | |
|---|---|---|---|
| | **Urine** | **Urea** | **Sewage** |
| Carbon Steel | R | R | R |
| Stainless Steel | R | R | R |
| Copper | ND | R | R |
| PVC Plastic | R | R | R |
| Ceramics | R | R | R |
| Silicate Mortar | R | R | R |

1. Schweitzer, Philip A. "Corrosion Resistance Tables." Corrosion Technology, Vol. 4, M. Dekker, New York, New York, 1991.
R = resistant (<20 mils Penetration / year), NR = not resistant, ND = no data.

At the request of Falcon Waterfree Technologies, we also evaluated the specific resistance of a wide variety of copper alloys to urine, urea and raw sewage. These data are presented in Table 7, below:

**Table 7**
**Copper and Copper Alloy Pipe**
**Corrosion Resistance Data**

| Material | Alloy Type | Resistance to Corrosion* | | |
|---|---|---|---|---|
| | | Urine | Urea | Sewage |
| Copper | C11000 | ND | R[1] | R |
| | C12200 | ND | R[1] | R |
| Brass | C22000 | ND | ND | R |
| | C23000 | ND | ND | R |
| | C26000 | ND | ND | R |
| | C28000 | ND | ND | R |
| | C36000 | ND | ND | R |
| | C38500 | ND | ND | R |
| | C44300 | ND | ND | R |
| | C44500 | ND | ND | R |
| | C46400 | ND | ND | R |
| Bronze | C51000 | ND | ND | R |
| | C52100 | ND | ND | R |
| | C61300 | ND | ND | R |
| | C65100 | ND | ND | R |
| | C65500 | ND | ND | R |
| Copper - Nickel | C70600 | ND | ND | R |
| | C71500 | ND | ND | R |

* Copper Development Association/International Copper Association, "Copper & Copper Alloy Corrosion Resistance Database", D.B. Anderson, 1994.
1. Schweitzer, Philip A. "Corrosion Resistance Tables." Corrosion Technology, Vol. 4, M. Dekker, New York, New York, 1991.

Although little direct data exist on resistance of copper to corrosion by pure urine or urea, copper has been tested regarding its resistance to corrosion from exposure to raw sewage. Those data indicate that copper and most copper alloys have a high degree of resistance to corrosion when exposed to raw sewage. Since raw sewage is a highly aggressive suspension of solids and liquids, it is believed to accurately indicate the probable resistance of copper to corrosion from exposure to urine. Given its high resistance to corrosion, we conclude that it is highly unlikely that copper or most of its alloys would experience any type of accelerated corrosion due to exposure to undiluted urine from a waterfree urinal.

It is worth noting that, as previously stated, the waterfree urinals use a proprietary fatty-alcohol solution to seal the trap from the air in the restroom. This solution (AllSeal™) has a high affinity for most surfaces, forming a thick coating that would tend to increase resistance to corrosion. Because this solution also solubolizes most lipid compounds, it will also tend to dissolve and may help prevent the buildup of grease and other solid lipid compounds that tend to form blockages in sewage collection piping. Based on the available data, we foresee no difficulties associated with the use of a waterfree urinal with regard to accelerated corrosion of any of the materials or surfaces commonly used in restrooms.

# ALLSEAL™ CHEMICAL DATA

AllSeal™ is a proprietary mixture of various fatty alcohols and a bactericide, widely used for antimicrobial soaps, known as chloroxylenol. The proprietary mixture of various fatty alcohols are both aerobically and anaerobically biodegradable under normal circumstances. Chloroxylenol (also known as parachlorometaxylenol or PCMX) is an exceptionally broad spectrum bactericide and preservative with a long established and proven use in controlling bacteria, mildew and fungal growth in a wide range of applications (medical, domestic and industrial). Chloroxylenol is a chlorine substituted xylenol that acts similarly to hexachlorophene against microorganisms by causing disruption of cell walls and enzyme inactivation. Chloroxylenol is reported to have good activity against gram-positive bacteria, but is significantly less active against gram negative bacteria. Its activity against the tuberculosis organism, fungi and viruses is reported to be fair. Its rapidity of action and persistence are intermediate. Percutaneous penetration by chloroxylenol has been documented, but incidents of skin sensitization are low. Chloroxylenol activity is minimally affected by blood and organic material, but it can be neutralized by nonionic surfactants.

**Name of Substance**

- 4-Chloro-3,5-dimethylphenol
- Chloroxylenol
- Chloroxylenol [USAN:BAN:INN]
- Phenol, 4-chloro-3,5-dimethyl-
- p-Chloro-m-xylenol

**Cas Registry Number**

- 88-04-0

**Synonyms**

- 2-Chloro-5-hydroxy-1,3-dimethylbenzene
- 2-Chloro-5-hydroxy-m-xylene
- 2-Chloro-m-xylenol
- 3,5-Dimethyl-4-chlorophenol
- 4-06-00-03152 (Beilstein Handbook Reference)

- 4-Chloro-1-hydroxy-3,5-dimethylbenzene
- 4-Chloro-3,5-dimethylphenol
- 4-Chloro-3,5-xylenol
- 4-Chloro-m-xylenol
- AI3-08632
- BRN 1862539
- Benzytol
- Caswell No. 218
- Chloro-xylenol
- Chloroxylenolum [INN-Latin]
- Chlorxylenolum
- Clorossilenolo [DCIT]
- Cloroxilenol [INN-Spanish]
- Desson
- Dettol
- Dettol, liquid antiseptic
- EINECS 201-793-8
- EPA Pesticide Chemical Code 086801
- Espadol
- Husept Extra
- NSC 4971
- Nipacide MX
- Ottasept
- Ottasept Extra

- PCMX
- Phenol, 4-chloro-3,5-dimethyl-
- RBA 777
- Septiderm-Hydrochloride
- Willenol V
- p-Chloro-3,5-xylenol
- p-Chloro-m-xylenol

**Classification Code**

- Anti-infective agents, local
- Antibacterial
- Disinfectants
- Human Data
- Mutation data
- Reproductive Effect
- Schistosomicides
- Skin / Eye Irritant

**Molecular Formula**

$C_8H_9ClO$

**Typical Properties**

Form: crystals or crystalline powder

Color: white or cream

Odor: characteristic

Melting Point: 114-116 ºC

## Structural Similarities

Chloroxylenol is structurally similar to 4-Chloro-2,6-xylenol (CASRN: 1123-63-3) $C_8H_9ClO$

## Antimicrobial Activity

Chloroxylenol is a bactericidal active which, in a large number of differing formulations, has been proved over many years to be highly efficient against a wide range of microorganisms. Chloroxylenol is bactericidal, not merely bacteriostatic and control is afforded versus fungi, gram positive, gram negative bacteria and some viruses. Many virus types are resistant to chemical germicides including chloroxylenol but can be controlled by the use of easily formulated mixtures of chloroxylenol and other bactericides. Other general advantages of chloroxylenol preparations when compared with other bactericidal agents are:

- Chloroxylenol is compatible with a wide range of anionic and amphoteric surfactants and soaps and formulation is easy. Pine oil is a useful carrier and adjunct for chloroxylenol and bactericidal activity can be enhanced by its use.
- For various applications chloroxylenol may be formulated with other chlorinated phenols, sulfur and quaternary ammonium compounds. It is compatible with a wide variety of pharmaceuticals including hydrocortisones, pramoximes, propylparaban and sulphathiazoles.
- Dirt and particulate soil can inactivate all bactericides to a greater or lesser extent. chloroxylenol based formulations are more tolerant than most in this respect.
- Chloroxylenol is bactericidally active over a pH range of at least 4 - 9.
- Chloroxylenol exhibits low metal corrosivity; an important factor where instrument sterilization is involved.

## Solubility and Formulation

Chloroxylenol is only very slightly soluble in water even at high temperatures and only marginally more soluble in alkaline solution. It is soluble to a greater extent in alcohols such as ethanol and isopropanol (50- 87 g/100ml solvent) and in glycols and glycol ethers. The alcohol and glycol solutions are themselves highly soluble in sodium, potassium or triethanolamine soaps of oleic, ricinoleic, coconut or myristic fatty acids. The most popular soap is the sodium or potassium salt of castor oil (ricinoleic predominant).

For antiseptic skin/wound cleansers, disinfectants and detergent disinfectants, formulation is based on dissolving the chloroxylenol in soap solution in the presence of alcohol. Soap quantity is critical (lower bactericidal action can result due to envelopment of chloroxylenol in soap micelles). The most popular perfume addition is pine; pine oil, terpinolene, terpineol or blends. Such strong perfumes are sometimes deemed necessary to counter the strong "phenolic" odor of chloroxylenol but a distinctive note can be achieved by the further addition of small quantities of citronella, ionone, phenyl ether alcohol or similar aroma chemicals. Pine oil at certain levels can enhance bactericidal activity (e.g. versus salmonella typhi) but excessive concentrations can decrease activity towards staphylococcus type organisms.

**Toxicity Data**

There is a considerable wealth of published data relating to the toxicity of chloroxylenol. In general the product exhibits a very low order of toxicity. In summary:

$LD_{50}$ Acute Oral: Albino rats – 3,830 mg/kg body weight

$LD_{50}$ Acute: Dermal albino rabbits - average in excess of 1,000 mg/kg.

Subacute and Dermal Toxicity: Albino rabbits - dosage rate 1.5 ml/kg of body weight/day for 20 days. No gross or systemic toxicity or pharmacological indication of percutaneous absorption. Low level of irritation.

Acute Ocular Toxicity: Albino rabbits - draize test. Mild conjunctivitis results but with no indication of corneal or iritis damage.

Carcinogenic Activity: No data available for review indicate any carcinogenic activity for chloroxylenol.

**Applications**

Hospital and general medical uses of chloroxylenol-based formulations is normally as an antiseptic. Specific applications include:

- Surgical hand scrub operations
- Pre-operative skin preparation of patients
- Sterilization of instruments
- General cleaning of equipment and all hard surfaces to reduce cross infection
- Hospital sanitizing soaps, athletes foot and general first aid products can be formulated using chloroxylenol. It may be formulated in liquid, waterless hand cleanser, powder, cream or lotion form. Chloroxylenol also acts as a preservative in other pharmaceutical products.

The low toxicity of chloroxylenol has led to its wide-scale use in homes, offices and factories for a broad assortment of applications, including:

- Antiseptic skin wound cleaning and protectant formulations (liquids, creams, lotions)
- General disinfectants and combined detergent/disinfectants

- Antimicrobial soaps and health-care personal hand wash formulations
- Shampoo (especially anti-dandruff) formulations.
- Surface Coatings:  in-can preservation of aqueous coating products and as a fungicidal additive to paints used in humid rooms
- Glues and Adhesives:  prevent microbial decomposition and mold infestation (especially protein based glues)
- Cutting Oils (Lubricants):  prevention of microbial decomposition which can cause objectionable odors, clogging of filters, corrosion and indeed cutting fluid becoming unserviceable
- Leather Processing:  prevent mold formation and bacterial and fungal attack (especially in pickled pelts, vegetable tanned leathers, salted and dried raw hides)
- Paper Processing:  preserve filler suspensions, coating mixes, resin sizes, size dispersion and especially preservation of highly susceptible coating mixes and sizes.
- Textile Processing and Finishing:  fabric impregnation, (car roof linings, tarpaulins, rot proofing generally, cordage belts for fire hoses etc).  Preservation (lubricants, finishes, sizes, yarn humidifiers, spinning bath solutions and durable print thickeners).
- Concrete:  prevention of microbial decomposition of concrete additives used to slow down the setting and control the viscosity of concrete mixes.
- Fire Prevention:  preservative for protein-containing fire extinguishing products.
- Photographical:  prevent microbial attack in gelatins
- Polishes & other Wax Emulsions:  prevent microbial attack

# LIFECYCLE COST ANALYSIS MODELING

Lifecycle cost analysis (LCA) modeling is an economic evaluation technique well suited to compare alternative designs, with differing cost expenditures over a project's life. Calculations are made which convert all relevant costs to their equivalent present value. The alternative with the lowest total present value is the most economical or least cost approach.

LCA modeling is particularly well suited to evaluating whether the higher initial cost of an alternative is economically justified by reductions in future costs when compared to an existing alternative with no initial costs, but which has higher future costs. This is exactly the case when comparing the decision to replace an existing water-flush urinal with a waterfree urinal.

As is the case with most evaluation techniques, the real challenge in LCA modeling lies in making unbiased assumptions, that produce fair comparisons of alternatives. For sanitary fixture replacement projects, the key engineering assumptions include fixture usage, water usage, water value, sanitary connection fee values, operating costs for waterfree units, project design life, material service life for each alternate under consideration and any future maintenance or repair costs necessary to achieve the project service life. The key economic assumption is the value selected for the discount rate (time value of money). Other economic assumptions, such as the treatment afforded inflation and residual or salvage value, are less critical in their effect on the overall results and are excluded from UCLA's LCA model.

## Engineering Assumptions

### *Project Design Life*

The first step in any LCA model is to establish the project design life. This should be expressed as the number of years of useful life required of the sanitary fixture. In the case of some agencies or building owners, it is already a matter of policy. For example, a 10-year design life for primary sanitary fixtures is common. In the absence of a mandated project design life, the design life expectancy chosen should reflect the planning horizon for the project as selected by the owner.

A rational determination of design life must consider the potential for future obsolescence. For example, what is the risk that the current sanitary fixture will remain functionally adequate in the future? What action can be taken to increase capacity? Do you oversize the number of units installed now or not? Arbitrarily choosing an excessive design life as a hedge against significant, unanticipated future events or costs may appear prudent, but often proves wasteful. For example, how many urinals designed twenty years ago are functionally inadequate today? A realistic view of the factors that can and do contribute to functional obsolescence will set a practical upper limit on design life. A LCA model can prove very useful in helping to evaluate the economic implications of different design life assumptions.

## Economic Assumptions

### *Discount Rate*

The discount rate represents the value of money over time. It is the interest rate at which the project owner is indifferent about paying or receiving a dollar now or at some future point in time. The discount rate is used to convert costs occurring at different times to equivalent costs at a common point in time. A discount rate that includes inflation is referred to as a nominal discount rate. One that excludes inflation is referred to as a real discount rate. For the purposes of the LCA model developed for this project, we have used a real discount rate.

While in some public sector situations regulation or law may mandate the discount rate, there is no single correct discount rate for all situations. From an economic point of view, the discount rate should reflect the rate of interest that the owner could earn on alternative investment of similar risk and duration. Unfortunately, this lack of a specific or universal value can lead to confusion.

In the case of a municipality, state or federal government, there are often specific guidelines or policies that specify the appropriate discount rate. For example, the federal government, in Office of Management and Budget (OMB) Circular A-094a (January 2000 Revision to Appendix C), has established guidelines for the selection and use of discount rates. This document contains guidance for use in evaluating the LCA cost for federal projects. The current real discount rate for use in evaluating long life projects is 4.2%, exclusive of inflation. This rate is based on sound economic principles, and is required to evaluate most federal public sector projects. For state or local government projects, as well as private sector project, the federal discount rate is not likely appropriate for use in evaluating long life projects. As is noted in OMB Circular A-094a, the long-term value of money to the taxpayer or investors is estimated to be approximately 7%, exclusive of inflation. Most taxpayers or private investors would agree that this value is reasonable especially when considering long-term performance on investments. This is the default valued used in the UCLA Lifecycle Cost Model.

### *Borrowing Rates*

Some LCA methods suggest that the interest rate on the type of public borrowing needed to finance the project should be used for the discount rate. This is completely inappropriate. It mistakes the cost of borrowing for the value of money to the investor. In the case of all public projects, the taxpayer is the "investor" or owner. While public entities may borrow funds to finance the project, the taxpayer is obliged to repay the debt incurred. The debt is merely a financing vehicle. Accordingly, the expenditure of public funds represents funds that are no longer available for use by the taxpayer. As is noted in OMB A-94, the long-term value of money to the taxpayer is estimated to be approximately 7%, exclusive of inflation. Most taxpayers would agree that this value is reasonable especially when considering long-term performance on investments.

### *Inflation*

Since LCA analysis is primarily suited to evaluate and compare all costs over the life of a project for each alternative, the question of dealing with changes in cost (inflation) over time should be considered. Predicting future costs can never be done with certainty, especially over long periods of time. Past experience with the effects of inflation is, at best, only a guide to what may occur in the future. One commonly used index of general inflation is the Producer's Price published by the US government.

From a practical point of view, the effects of inflation can usually be ignored. This is because they are likely to affect all alternatives in a similar manner. The purpose of a LCA analysis is to determine the relative attractiveness of the alternatives under consideration. Therefore, the result of the evaluation (the ranking of alternates from lowest to highest cost) is generally not affected by the inclusion or exclusion of the effects of general inflation in the LCC calculations. Further, excluding inflation simplifies the calculation and reduces the chance of calculation errors influencing the results.

LCA calculations are most simply performed when all estimates of future costs are made in current dollars and are discounted to their present value using a nominal discount rate. This avoids the complexity inherent in attempting to accurately predict future costs. ASTM E-917 provides specific guidance on how to perform calculations using either real or nominal discount rates.

### *Residual Value*

The residual, or salvage value, of a facility and the end of the project design life theoretically should be included in a LCC analysis, as it reduces the overall cost of the alternate under consideration. However, given that the salvage value of typical porcelain fixtures is generally zero, we have ignored salvage value in the UCLA LCA model. In assuming that the salvage value is zero results in a more conservative assessment of the economic viability of converting a given set of normal flush urinals to waterfree urinals.

## Financial Calculations

The basic approach is to determine the present value of all estimated expenditures for each alternative under consideration, and the alternate with the lowest total present value represents the most economical alternative. The discount factors are given in Table 8, below:

**Table 8**
**Discount Factors for Discrete Compounding**

| Factor Name | Converts | Symbol | Formula |
|---|---|---|---|
| Single payment compound amount | P to F | (F/P, *i* %, n) | $(1+i)^n$ |
| Present worth | F to P | (P/F, *i* %, n) | $(1+i)^{-n}$ |
| Uniform series sinking fund | F to A | (A/F, *i* %, n) | $\frac{i}{(1+i)^n - 1}$ |
| Capital recovery | P to A | (A/P, *i* %, n) | $\frac{i(1+i)^n}{(1+i)^n - 1}$ |
| Compound amount | A to F | (F/A, *i* %, n) | $\frac{(1+i)^n - 1}{i}$ |
| Equal series present worth | A to P | (P/A, *i* %, n) | $\frac{(1+i)^n - 1}{i(1+i)^n}$ |
| Uniform gradient | G to P | (P/G, *i* %, n) | $\frac{(1+i)^n - 1}{i^2(1+i)^n} - \frac{n}{i(1+i)^n}$ |

Where: P = present value of an expenditure
A = Equal annual expenditure
F = Future value of an expenditure
G = Equal Gradient expenditure
i = discount rate
n = number of compounding periods (assume to be annually)

As a tool to compare the lifecycle costs associated with switching from a normal flush urinal to a waterfree urinal, UCLA developed an LCM well-suited to the analysis of the decision regarding whether to replace a normal water-flushed urinal with a waterfree urinal (see the computer model on the attached disk) using Microsoft Excel® software. This model allows the input and control over most of the variables of interest in evaluating this decision. The model is enclosed on the 5 ¼" floppy disk. The LCM approach developed by UCLA complies with the applicable standards developed by the American Society for Testing and Materials, West Conshohocken, PA, which include:

- Standard E833, Terminology of Building Economics,
- Standard E917, Practice for Measuring Life-Cycle Costs of Buildings and Building Systems,
- Standard E964, Practice for Measuring Benefit-to-Cost and Savings-to-Investment Ratios for Buildings and Building Systems,
- Standard E1057-99, Standard Practice for Measuring Internal Rate of Return and Adjusted Internal Rate of Return for Investments in Buildings and Building Systems,

- Standard E1074, Practice for Measuring Net Benefits for Investments in Buildings and Building Systems,

- Standard E1121, Practice for Measuring Payback for Investments in Buildings and Building Systems,

- ASTM Standard E1185 Guide for Selecting Economic Methods for Evaluating Investments in Buildings and Building Systems, and

- ASTM Standard E1765, Practice for Applying the Analytical Hierarchy Process (AHP) to Multiattribute Decision Analysis of Investments Related to Buildings and Building Systems.

## LCA Case Studies

To evaluate the effectiveness of the UCLA LCA model, the following three case studies have been prepared. To evaluate similar types of service under a variety of cost conditions, we selected three school districts from various locations throughout the State of California. We used a high discount rate (7%) to calculate the Net Present Value (NPV), the Benefit/Cost (B/C) ratio, the simple payback period and the Internal Rate of Return (IRR) for each case, since using a lower discount rate simply increases (or makes less negative) the NPV for a given alternative. The data and LCA results for each district is presented below:

***Oakland, CA Unified School District***

Student Population: 53,751 students (K-12 only, exclusive of adult education students)

Percentage male: 51.1% (Based on 1999-00 data, California Dept. of Education)

Number of buildings: 93

Average daily attendance: 94.1% (Based on 1998-99 data, California Dept. of Education)

Length of instructional year: 180 days

School hours (per day): 7 hours

Number of urinals: 1,343 (assume all are 3 gpf urinals)

Urinal uses per day: 2 per male student

Based on these data, as well as actual data for the cost of water, sewer, etc., the UCLA LCA model (see Appendix A) indicates that the key financial indicators are as follows:

Initial Capital Cost = $248,455.00

Annual Cost Savings = $126,174.82

NPV = $1,088,242.80

B/C ratio = 4.38

Simple Payback Period = 1.97 years

IRR = 51%

Based on these results, the conversion to waterfree urinals is clearly indicated.

***Long Beach, CA Unified School District***

Student Population: 94,590 students (K-12 only, exclusive of adult education students)

Percentage male: 50.9% (Based on 1999-00 data, California Dept. of Education)

Number of buildings: 86

Average daily attendance: 95% (Based on 1998-99 data, California Dept. of Education)

Length of instructional year: 180 days

School hours (per day): 7 hours

Number of urinals: 2,364 (assume all are 3 gpf urinals)

Urinal uses per day: 2 per male student

Based on these data, as well as actual data for the cost of water, sewer, etc., the UCLA LCA model (see Appendix A) indicates that the key financial indicators are as follows:

Initial Capital Cost = $437,340.00

Annual Cost Savings = $163,976.05

NPV = $1,299,824.59

B/C ratio = 2.97

Simple Payback Period = 2.67 years

IRR = 37%

Based on these results, the conversion to waterfree urinals is clearly indicated.

***Los Angeles, CA Unified School District***

Student Population:  722,727 students (K-12 only, exclusive of adult education students)

Percentage male: 51.0% (Based on 1999-00 data, California Dept. of Education)

Number of buildings: 655

Average daily attendance: 92.45% (Based on 1998-99 data, California Dept. of Education)

Length of instructional year: 180 days

School hours (per day): 7 hours

Number of urinals: 17,011 (assume all are 3 gpf urinals)

Urinal uses per day: 2 per male student

Based on these data, as well as actual data for the cost of water, sewer, etc., the UCLA LCA model (see Appendix A) indicates that the key financial indicators are as follows:

Initial Capital Cost = $3,147,035.00.00

Annual Cost Savings = $1,922,086.30

NPV = $17,215,574.59

B/C ratio = 5.47

Simple Payback Period = 1.64 years

IRR = 61%

Based on these results, the conversion to waterfree urinals is clearly indicated.

# REGULATORY OVERVIEW

## Federal Legislation

Water pollution legislation in the United States originated over 100 years ago with the passage of the Rivers and Harbors Act of 1899 to protect the navigable waters of the United States, portions of this act are still in effect today under the Army Corps of Engineers. The federal government gained additional pollution enforcement authority in the early 1900's by the passage of two pieces of legislation (The Public Health Services Act of 1912 and the Oil Pollution Act of 1924). In 1965 the federal authority was further strengthened with the adoption of the Water Quality Act, which set water quality standards for interstate waters. The National Environmental Policy Act (NEPA) of 1969 provided the impetus to establish the Environmental Protection Agency (EPA) and for the first time all pollution control programs related to water, air, solid wastes, pesticides and radiation were under one agency.

Today, water quality in the United States is regulated at the federal level primarily by two pieces of legislation; the Clean Water Act (CWA) of 1972 and the Safe Drinking Water Act (SDWA) of 1974. Additionally, toxic chemicals are also monitored/regulated under the Toxic Substances Control Act (TSCA) of 1976. Solid wastes and hazardous wastes are further regulated primarily under the Resource Conservation and Recovery Act (RCRA) of 1976. A brief overview of these four acts follows.

### *Clean Water Act*

Prior to 1972, Congress enacted a number of federal statutes dealing with water pollution, but the current structure of the Clean Water Act (CWA) was established by the Federal Water Pollution Control Act Amendments of 1972. The 1972 Act established two of the major elements of the existing statute, a national permit program and the requirement that industrial dischargers meet progressively more stringent technology based limits. The 1972 Act continued, with significant modifications, a water quality standards program that had been established in 1965.

The statute has been the subject of several sets of amendments since 1972. The Clean Water Act is a 1977 amendment to the Federal Water Pollution Control Act of 1972, which set the basic structure for regulating discharges of pollutants to waters of the United States. This law gave EPA the authority to set effluent standards on an industry-by-industry basis (technology-based) and continued the requirements to set water quality standards for all contaminants in surface waters. The CWA makes it unlawful for any person to discharge any pollutant from a point source into navigable waters unless a permit (NPDES) is obtained under the Act. The 1977 amendments focused on toxic pollutants. In 1987, the CWA was reauthorized and again focused on toxic substances, authorized citizen suit provisions, and funded sewage treatment plants (POTWs) under the Construction Grants Program.

The CWA provides for the delegation by EPA of many permitting, administrative, and enforcement aspects of the law to state governments. In states with the authority to implement CWA programs, EPA still retains oversight responsibilities.

The objective of this act was to restore and maintain the chemical physical and biological integrity of nations' waters. To accomplish that objective, the act aimed to attain a level of water quality that "provides for the protection and propagation of fish, shellfish, and wildlife, and provides for recreation in and on the water" by 1983 and to eliminate the discharge of pollutants into navigable waters by 1985.

The structure of the CWA has several distinct program elements that deal with control of water pollution. These elements include:

1. Direct Dischargers-NPDES Point Source Program. The Clean Water Act requires that every industrial and municipal facility that directly discharges pollutants into streams, lakes or the ocean have a permit. This permit is called a "National Pollutant Discharge Elimination System" or "NPDES" permit. This permit generally contains limitations on the quantity or concentration of pollutants that the facility can discharge.

2. Indirect Dischargers-Pretreatment Program. Facilities that discharge their wastes down a sewer to be treated by a municipal sewage treatment facility are called "indirect dischargers." They are required to meet "pretreatment" requirements that apply to the wastes they put in the sewer. These restrictions are established either by the federal government or the local municipal sewage treatment authority. Indirect dischargers are not , in most cases, required to have an NPDES permit.

3. Non-point Sources-Areawide Controls. Some pollution, such as agricultural runoff or runoff from city streets, is neither discharged by point sources nor put down a sewer. This type of pollution is called "areawide" or "non-point source pollution." Several sections of the CWA require local planning to control this type of pollution, but there is almost no effective regulatory controls for this type of pollution under the Clean Water Act. It is, however, the type of pollution that Congress is most likely to address in the future.

4. Dredge and Fill Program. Section 404 of the CWA establishes a separate national permit program for construction that results in dredging or filling of "wetlands." Criteria for permit issuance have been established by EPA, but the perm it itself is issued by the Army Corps of Engineers. This program is typically not addressed in detail in environmental law casebooks, but the dredge and fill program is one of the more significant federal programs regulating land use.

5. Oil Spill Program. Section 311 of the Clean Water Act contains provisions relating to reporting and cleanup of spills of oil and hazardous substances to navigable water. This program is totally distinct from other provisions of the

CWA. It has many elements in common with the Comprehensive Environmental Response, Compensation and Liability Act ("CERCLA"), but, unlike CERCLA, it applies to oil and it applies only to releases or threats of releases into navigable water.

The CWA requires the EPA to establish effluent limitations for the amounts of specific pollutants that may be discharged by municipal sewage plants and industrial facilities. The two-step approach to setting the standards includes: establishing a nationwide, base-level treatment through an assessment of what is technologically and economically achievable for a particular industry; and requiring more stringent levels of treatment for specific plants if necessary to achieve water quality objectives for the particular body of water into which that plant discharges. For example, EPA sets limits based on water quality to control pollution in waters designated by the states for drinking, swimming, or fishing.

The primary method by which the act imposes limitations on pollutant discharges is the nationwide permit program established under Section 402 and referred to as the National Pollutant Discharge Elimination System (NPDES). Under the NPDES program any person responsible for the discharge of a pollutant or pollutants into any waters of the United States from any point source must apply for and obtain a permit.

<u>Role of Pretreatment</u>

Industrial facilities that put their wastes in the sewer for treatment by a POTW are not generally considered "direct dischargers" or "point sources." Therefore they are not subject to the NPDES permit program. Rather, these sources are considered "indirect dischargers," and they are subject to the "pretreatment" program found in section 307(b) of the CWA. The CWA treats indirect dischargers differently because Congress thought it was unnecessary to require facilities to fully treat their wastes when the wastes are going to be treated again by the POTW Consequently, the pretreatment program focuses on situations where the POTW is not adequately treating industrial wastes. These include:

1. <u>Interference and Pass Through.</u> Pretreatment is necessary if the industrial waste will interfere with operation of biological treatment by the POTW. Large amounts of toxic pollutants, for example, may kill the bacteria that are part of the treatment system. In some cases, wastes are not effectively treated and simply pass through the POTW without being controlled.

2. <u>Contamination of Sewage Sludge-Sewage Sludge Guidelines.</u> Biological treatment systems used by POTWs produce large quantities of sewage sludge. Sewage sludge is organic material left after treatment of sewage, and it can be used as a fertilizer unless it is contaminated with toxic materials. Metals from industrial sources may, for example, settle into the sludge and limit the sludge's ability to be used.

EPA has developed criteria, as required by section 405 of the CWA, that define acceptable levels of pollutants in sewage sludge and specifies acceptable uses for sewage sludge. Under the CWA, POTWs, or in some cases industrial sources, will have conditions in their NPDES permit relating to the use of sewage sludge.

Types of Pretreatment Limitations

To prevent these problems, there are several types of limitations which may require facilities to "pretreat" their wastes before they are placed into the sewer.

1. Categorical Standards. EPA has developed technology-based pretreatment standards for categories of industrial sources in much the same way that it develops BPT, BAT, BCT and NSPS. These limitations are intended to reflect the level of pollution control that the facility would achieve if it were meeting BAT, BCT or NSPS but minus the average treatment that a POTW will provide. These "categorical standards" are nationally applicable numerical limits that facilities within given industrial categories must meet before putting wastes in the sewer. There is a program now in place in which facilities can get "credit" for the amount of toxic pollutants removed by their POTW.

2. General Prohibition. All indirect dischargers, regardless of whether categorical standards have been written for their industry, must also satisfy a "general prohibition." This provision prohibits facilities from discharging wastes to POTWs that cause or contribute to the POTW 1) violating its NPDES permit or 2) the POTW sewage sludge violating sewage sludge standards.

3. Local Limits. Local POTWs, to implement the general prohibition and ensure that they will not violate their NPDES permits, may develop local limits applicable to sources that discharge into the sewers. These local limits have been implemented through contracts or other agreements between the POTW and the facility. EPA is requiring that POTWs implement pretreatment requirements for significant indirect dischargers through documents that are very similar to NPDES permits.

No specific categorical standards appear to have been set under the CWA that would include waterfree urinals. All sanitary fixtures, including the waterfree urinal, are subject, however, to the "general prohibition" requirement of the CWA that prohibits discharging wastes to POTWs that can cause, or contribute to, the POTW 1) violating its NPDES permit or 2) the POTW sewage sludge violating sewage sludge standards. None of the chemicals in the AllSeal™ solution, including chloroxylenol (which is listed as a non-toxic antiseptic chemical in, appear to problematic in this regard given the extremely small quantities discharged (typically less than .03 ml/l). In fact, chloroxylenol (the antimicrobial component in AllSeal™) is a common ingredient in antibacterial soap (typically 0.1 – 1.0 % weight per volume) and in several topical antiseptic liquids (up to 28% weight per volume) and is commonly discharged to POTWs throughout the US and many foreign countries without specific discharge limitations. After reviewing the Los

Angeles County Sanitation District's and the Orange County Sanitation District's discharge regulations, it appears that the FWT waterfree urinal will not require a specialized permit to use.

***Safe Drinking Water Act***

The Safe Drinking Water Act was established to protect the quality of drinking water in the U.S. This law focuses on all waters actually or potentially designated for drinking use, whether from above ground or underground sources. The Act authorized EPA to establish safe standards of purity and required all owners or operators of public water systems to comply with primary (health-related) standards. State governments, which assume this power from EPA, also encourage attainment of secondary standards (nuisance-related).

The Safe Drinking Water Act, administered by the U.S. Environmental Protection Agency in coordination with the states, is the chief federal regulatory legislation dealing with drinking water quality. While this act provides for regulations for drinking water, these regulations also indirectly affected the quality of the wastewater that may be discharged into streams and rivers that are a supply source for a public water supply.

This act required the EPA to develop national health standards for public water supply systems in order to protect the public health, state and local governments have primary responsibility for implementing and enforcing the standards. Local water suppliers are required to monitor their water supplies to assure that regulatory standards are not exceeded. Citizens are to be informed of any violation of standards and can file citizens suit in federal court to secure compliance. Amendments were made to the act in 1977, 1986, and 1988. The EPA set primary standards to protect health from organic, inorganic and microbiological contaminants and for turbidity in drinking water in 1977. These Primary Drinking Water Standards were finalized in 1986. The Primary Drinking Water Standards are based on the toxic effects for certain organic and inorganic compounds and are stepped at maximum contaminant levels (MCL). The MCL is defined as the maximum allowed level of a contaminant in water which is delivered to any user of a public water system. The water quality standards have been established in terms of primary and secondary standards and are presented in terms of Primary MCLs and Secondary MCLs.

The 1986 amendments set a timetable for the EPA to establish standards for specific contaminants and increased the range of contaminants local water suppliers were required to monitor to include contaminants that did not yet have an MCL established.

The 1996 amendments made significant changes to the SDWA. The standard-setting process for drinking water contaminants established in the 1986 amendments was changed from a requirement that EPA adopt standards for a set number of contaminants on a fixed schedule to a process based on risk assessment and cost/benefit analysis. The 1996 amendments require EPA to publish (and periodically update) a list of contaminants not currently subject to NPDWRs and to periodically determine whether to regulate at least five contaminants from that list, based on risk and benefit considerations. As a result of the 1996 amendments, the EPA adopted a more ambitious schedule for promulgating the Disinfectant/Disinfection By-Products Rule and the Enhanced Surface Water Treatment Rule.

Based on a review of the existing legislation and regulations promulgated thus far, we do not believe that the SDWA will affect the FWT waterfree urinal. A review of the Primary and Secondary MCLs (see Appendix A) shows that none of the proprietary chemicals in the AllSeal™ solution are listed, and as such, are not constituents of concern of the SDWA. A review of the appropriate MSDS information indicates that these chemicals appear safe to use under normal circumstances.

### *Toxic Substances Control Act*

The Toxic Substances Control Act of 1976 was enacted by Congress to test, regulate, and screen all chemicals produced or imported into the U.S. Many thousands of chemicals and their compounds are developed each year with unknown toxic or dangerous characteristics. To prevent tragic consequences, TSCA requires that any chemical that reaches the consumer market place be tested for possible toxic effects prior to commercial manufacture.

Any existing chemical that poses health and environmental hazards is tracked and reported under TSCA. Procedures also are authorized for corrective action under TSCA in cases of cleanup of toxic materials contamination. TSCA supplements other federal statutes, including the Clean Air Act and the Toxic Release Inventory under EPCRA.

TSCA authorizes EPA to review chemicals before and after they enter commerce. To assess risks, EPA examines a chemical's toxicity or potential adverse effects and the amount of human and environmental exposures. If EPA finds that a chemical's risks are unreasonable, it can prohibit or limit its production, distribution, use, and disposal or take other action, such as requiring warning labels on the substance.

TSCA requires the industry to notify EPA at least 90 days before producing or importing a new chemical. These notices contain information, such as the chemical's molecular structure and anticipated uses, that EPA uses to evaluate the chemical's potential risks. TSCA also authorizes EPA to require manufacturers to perform tests or provide other data, such as production volumes, on existing chemicals. In addition, TSCA requires the industry to report to EPA any data that reasonably support a conclusion that a chemical presents a substantial risk.

Of about 72,000 substances in EPA's inventory of TSCA chemicals, 62,000 were already in commerce when EPA began to review new chemicals in 1979. EPA reviewed the remaining 10,000 substances as new chemicals and added them to the inventory when their manufacture began. Under earlier laws EPA had authority to control toxic substances only after damage occurred. The earlier laws did not require the screening of toxic substances before they entered the marketplace. TSCA closed the gap in the earlier laws by requiring that the health and environmental effects of all new chemicals be reviewed before they are manufactured for commercial purposes.

TSCA has four titles, however, only Title I is described below because of its relevance. Title I pertains to the control of toxic substances, and includes provisions for testing chemical substances and mixtures; manufacturing and processing notices; regulating hazardous chemicals substances and mixtures; managing imminent hazards; and reporting and retaining information.

There are several important record keeping and reporting requirements under TSCA. These requirements apply generally to chemical manufacturers, importers, processors, and distributors, and thus several provisions are likely to apply to FWT as a supplier of the AllSeal™ solution. These requirements include:

- Allegations of Significant Adverse Reactions Rule - TSCA Sec. 8(c): FWT is required to keep a file of allegations of significant adverse reactions (to human health or the environment) of any chemical you manufacture, import, process or distribute. FWT must also provide this information to EPA upon request.

- Unpublished Health and Safety Studies Rule - TSCA Sec. 8(d): FWT may be required to submit to EPA a list and/or copies of unpublished studies that address the health or safety issues of certain listed chemicals.

- Substantial Risk Information Requirement - Section 8(e): FWT is under a duty to report to EPA within 15 days any new information which reasonably supports the conclusions that the AllSeal™ solution may present a substantial risk of injury to health or the environment.

Therefore, we recommend that FWT keep and maintain appropriate records and attempt to document any reports of significant adverse reactions to human health or the environment which may be due to the use or discharge of the AllSeal™ solution. Such records, if any, should be compiled and maintained in a central location, and copies of such records must be made available to the US EPA upon request. To facilitate reporting, we recommend that FWT include a self-addressed, postage paid incident report form with each FWT waterfree urinal installation kit that will document the nature and extent of any alleged significant adverse reaction to human health or the environment which may be due to the use or discharge of the AllSeal™ solution.

### *Resource Conservation and Recovery Act*

The Resource Conservation and Recovery Act (RCRA) was passed in 1976, and gave EPA the authority to control hazardous waste from "cradle-to-grave." This includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous solid wastes.

The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances. RCRA focuses only on active and future facilities and does not address abandoned or historical sites (see CERCLA). The federal Hazardous and Solid Waste Amendments (HSWA), were passed in 1984 and amended RCRA to require the phasing out of land disposal of hazardous waste. Some of the other mandates of this strict law include increased enforcement authority for EPA, more stringent hazardous waste management standards, and a comprehensive underground storage tank program.

Structure of RCRA

The statute has separate programs that deal with hazardous wastes, non-hazardous solid wastes, underground storage tanks, and used oil.

- Hazardous Wastes - Subtitle C. The main focus of the statute has been on "Subtitle C" which contains the statutory provisions that regulate disposal of hazardous wastes. Subtitle C sets up a "cradle to grave" system which regulates hazardous waste from the point at which it is generated to the point of its disposal.

- Non-hazardous, Solid Wastes - Subtitle D. Subtitle D of RCRA has a limited regulatory program that applies to non-hazardous solid waste. Under subtitle D, the disposal of non-hazardous solid waste is legal only if done in "sanitary landfills." The US EPA has promulgated criteria defining "sanitary landfills."

- Underground Storage Tanks - Subtitle I. RCRA contains a separate program for regulating the storage of materials in underground storage tanks (USTs). The program applies to storage of a variety of wastes (other than hazardous wastes) and products (including gasoline) in underground storage tanks. The UST program requires, among other things, that owners and operators of underground storage tanks register their tanks with the government, upgrade their tanks to meet minimum technology requirements, and close their tanks properly when they remove them from service. Additionally, Subtitle I contains provisions relating to the cleanup of contamination from leaking USTs.

- Used Oil. Used oil, even if it is not a hazardous waste, is subject to regulation under RCRA. The US EPA has promulgated a complex set of regulations that apply to the recycling of used oil, including the burning of used oil as a fuel. The regulations impose requirements on the generators, transporters, sellers and recyclers of used oil.

Hazardous Wastes - Subtitle C

Subtitle C of RCRA contains most of the provisions that regulate the management and disposal of hazardous waste. RCRA is frequently described as being a "cradle to grave" system for regulating hazardous waste, and it imposes requirements on the generator and transporter of hazardous wastes and requirements on the "treatment, storage, and disposal facility" (TSDF) that receives the wastes. RCRA has two elements that are central to its cradle to grave system.

- Manifest Requirement. RCRA requires that a manifest accompany most shipments of hazardous waste. The manifest is signed by the generator, carried and signed by the transporter, and signed after receipt by an authorized TSDF After receipt of the waste, the TSDF must return a signed copy of the manifest to the original generator. If the generator does not receive the copy within a designated period of time, the generator is required to notify the government. This system is intended to ensure that wastes are actually received by an authorized disposal facility and not illegally dumped by the transporter.

- TSDF Permit Requirements. Under RCRA, neither generators nor transporters are required to have permits, but TSI)Fs are required to obtain federally mandated permits. These permits contain a variety of conditions including in most cases, groundwater or air monitoring, minimum technology, and requirements to plan and finance closing of the facility when it ceases to operate.

Definition of Hazardous Wastes

The requirements of Subtitle C apply to "hazardous wastes." In determining whether a material is a hazardous waste, it is necessary to 1) identify if the material is a "solid waste," and 2) to then determine if that waste meets the criteria for classification as a hazardous waste. A waste can be a solid waste even if it is not solid. The statutory and regulatory definitions of solid waste include material that is solid, liquid, or a contained gas. Under the statute and regulations, a material is a solid waste if it has been "discarded." A material will be classified as discarded if it meets one of three EPA regulatory criteria. These criteria include:

- Abandoned. If a material has been abandoned it is a solid waste. This includes simply throwing material away.

- Recycled. The US EPA claims that materials that are recycled are subject to regulation as hazardous waste under RCRA. This is perhaps the most complex and controversial part of EPA's regulatory definition. Under this definition, a material is classified as a solid waste depending on the type of material it is and the way it is to be recycled. To determine if a recycled material is initially classified as a solid waste, a generator must go through a series of steps. First, the generator must determine if the material is one of a specified group of secondary materials. These secondary materials include spent materials, sludges, byproducts, discarded commercial chemical products, and scrap metal. Second, the generator must determine if the materials are going to be recycled in one of four specified ways. These include recycling by a "use constituting disposal" (applying the material to the ground), burning it as a fuel, reclaiming the material or speculatively accumulating the material. The regulations contain definitions of these terms. Third, the generator must consult a reference chart or matrix and see if the combination of waste material and recycling method results in the material being classified as a solid waste. Even if a recycled material is defined as a solid waste on the chart, it may be exempted from classification as a solid waste if it is used or reused as an ingredient to make a product, as a substitute for a product, or, in some cases, returned for reuse in the original process from which it was generated.

- Inherently "Waste Like." The US EPA has also published a short list of certain materials that it has determined are solid wastes because they are "inherently waste like."

- Exclusions. The statute and the US EPA regulations specifically exclude a variety of materials from classification as solid waste. Two of the more important exclusions include domestic sewage and NPDES Point Source Dischargers. Wastes that go down a sewer to a municipal sewage treatment plant regulated under the Clean Water Act are not classified as solid wastes for purposes of RCRA. This includes industrial wastes placed in a sewer if they mix with domestic wastes. This is extremely important because it means that hazardous materials placed into the sewer are not regulated under RCRA. Rather they are regulated under the "pretreatment" program of the Clean Water Act. Industrial discharges that are regulated under the NPDES permit program in the Clean Water Act are not classified as solid wastes under RCRA. Note that this exclusion applies to the discharge itself Wastes generated as part of treatment of wastewater prior to discharge may be regulated under RCRA.

The US EPA has also published several "lists" of hazardous wastes. These lists include wastes from specific industries (such as certain sludges from petroleum refineries), certain types of wastes regardless of the industry which produces them (such as halogenated spent solvents), and certain discarded commercial chemical products. A generator does not need to test the waste to see if it is hazardous; if it is on the list it is classified as a hazardous waste. Generators may petition to have their particular wastes "delisted" by the US EPA, but this is time consuming and costly.

Even if a solid waste is not specifically listed, it may still be considered a hazardous waste if that particular waste, when tested, exhibits any of four hazard "characteristics." Each of these characteristics is defined by specific test methods.

(a) Ignitability. Ignitability refers to the tendency of a material to catch fire. Spent paint wastes may, for example, test as ignitable.

(b) Corrosivity. Corrosivity refers to the acidity or alkalinity (pH) of the waste. Spent acids may, for example, test as corrosive.

(c) Reactivity. Reactivity refers to the tendency of a material to explode. Certain wastes containing sodium, for example, may be reactive.

(d) Toxicity Characteristic or TC Rule. A solid waste may be classified as hazardous if it contains any one of a number of metals or organic constituents above levels set by the US EPA. This is called the toxicity characteristic or TC.

To determine if a solid waste contains these constituents above the regulatory levels, a liquid extract of the solid must first be obtained. This is done by using the "toxicity characteristic leachate procedure" or TCLP.

Under existing EPA rules, certain mixtures of hazardous and non-hazardous wastes or the residues derived from treatment of hazardous waste are classified as hazardous waste. The “mixture rule” basically provides that if a “listed” hazardous waste is mixed with a non-hazardous solid waste, the entire resulting mixture is treated as a hazardous waste. If, however, a “characteristic” hazardous waste (hazardous because it exhibits one of the four hazard characteristics) is mixed with a non-hazardous waste, the resulting mixture is only a hazardous waste if the mixture itself exhibits the characteristic.

The “derived-from rule” provides that any wastes derived from a listed hazardous waste are themselves a hazardous waste. Wastes derived from a characteristic hazardous waste are only hazardous if they exhibit a characteristic. Therefore, if a listed hazardous waste is incinerated, the ash remaining after the incineration is treated as a hazardous waste. Similarly, any sludge produced from the treatment of a listed hazardous waste is itself a hazardous waste.

Additionally, EPA has adopted a “contained-in” interpretation which generally provides that any material “containing” a listed hazardous waste is itself treated as a hazardous waste. The contained-in rule has been applied to contaminated soil and groundwater that contains leachate from listed hazardous waste.

RCRA and US EPA regulations contain a number of exclusions from classification as a hazardous waste. Note that these excluded materials may still be solid wastes; they are simply not classified as hazardous waste for purposes of the Subtitle C program. Two of the most important exclusions are:

- Household Hazardous Wastes. Household wastes are not classed as hazardous waste even though they may contain hazardous material such as old pesticide containers. This means, among other things, that neither homeowners nor in most cases the municipality that picks up household waste are regulated under Subtitle C. The household waste exclusion was originally adopted by EPA regulation, but in 1984 Congress adopted a cryptic reference to the household waste exclusion in a provision exempting certain municipal incinerators burning household wastes from regulation as treatment, storage or disposal facilities.

- Mining Wastes and Oil and Gas Exploration and Production Wastes. RCRA contains a specific statutory exclusion for most mining wastes and most wastes associated with the exploration and production of oil and gas. There is not, however, an exclusion for petroleum under RCRA, and used oils may be classified as hazardous waste.

Non-Hazardous Solid Wastes - Subtitle D

Subtitle D of RCRA establishes a limited regulatory program for the disposal of non-hazardous solid waste. This program is becoming increasingly important since EPA sets requirements for municipal landfills under Subtitle D. Remember that household hazardous waste is exempt from Subtitle C, and there for considerable amounts of hazardous waste may be legally disposed of in municipal landfills. The Subtitle D program has several key elements, including, but not limited to, the following:

- Sanitary Landfill Criteria. EPA has promulgated criteria for landfills receiving non-hazardous solid waste. Facilities meeting these criteria are known as "sanitary landfills." In addition to criteria generally applicable to facilities receiving non-hazardous wastes, EPA has also promulgated specific, more detailed requirements applicable to Municipal Solid Waste Landfills (MSWLFs). These criteria contain requirements similar to those imposed on hazardous waste treatment, storage and disposal facilities.

- Open Dumping Prohibition. RCRA contains a prohibition on the "open dumping" of non-hazardous solid waste. Open dumping includes disposal of solid waste anywhere other than at a sanitary landfill.

- Restricting Liquids in Landfill Rule. In general, landfills may not accept liquid wastes from tank trucks or in 55-gallon drums. However, a recent notice by the US EPA intends to extend the ban on liquids in landfills to include the intentional disposal of any liquids, or containers with liquids. This rule has not yet been adopted.

- Restrictions on Disposal of Untreated Human Wastes. The disposal of untreated human wastes, or containers holding any quantity of untreated human wastes, are banned from disposal.

Since most states prohibit the disposal of significant quantities of liquids, as well as untreated human wastes in solid waste landfills, we recommend including standard operating instructions that any remaining contents of the waterfree urinal SealTrap™ cartridge should be discharged carefully into the sewer before placing the spent SealTrap™ cartridge into a secure, sealable disposal bag and discarding it in a manner so as to ensure proper disposal in a permitted, licensed and regulated municipal solid waste landfill. Each bag should be labeled with the appropriate instructions for proper disposal.

### *The Emergency Planning and Community Right-to-Know Act of 1986 (SARA Title III)*

The Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA), also known as SARA Title III, created a program with two goals: to facilitate and promote planning for chemical emergencies at the state and local levels, and to provide information to the public about the chemicals used, stored, and released in their communities. To implement these two goals, EPCRA established a network of entities at the local, state, and federal level, and set requirements for gathering the information needed.

While EPCRA was the first mandatory governmental program requiring chemical emergency planning at the state and local level, the federal government and industry had addressed the issue prior to 1986. Congress passed several laws regulating the use and disposal of harmful chemicals, and some agencies instituted programs protecting those people in frequent contact with dangerous substances. Many states and local jurisdictions also developed requirements and programs. In addition, industry developed voluntary programs providing information to employees and the community concerning the chemicals used at facilities.

The EPCRA establishes requirements for Federal, State and local governments, Indian Tribes, and industry regarding emergency planning and "Community Right-to-Know" reporting on hazardous and toxic chemicals. The Community Right-to-Know provisions help increase the public's knowledge and access to information on chemicals at individual facilities, their uses, and releases into the environment. States and communities, working with facilities, can use the information to improve chemical safety and protect public health and the environment.

EPCRA has four major provisions:

- Emergency planning (Section 301- 303),
- Emergency release notification (Section 304),
- Hazardous chemical storage reporting requirements (Sections 311- 312), and
- Toxic chemical release inventory (Section 313).

Information gleaned from these four requirements will help States and communities develop a broad perspective of chemical hazards for the entire community as well as for individual facilities. Regulations implementing EPCRA are codified in Title 40 of the Code of Federal Regulations, parts 350 to 372. The chemicals covered by each of the sections are different, as are the quantities that trigger reporting. Table 1, below, summarizes the chemicals and thresholds.

**Table 1**
**EPCRA Chemicals and Reporting Thresholds**

| | **Section 302** | **Section 304** | **Section 311/312** | **Section 313** |
|---|---|---|---|---|
| **Chemicals Covered** | 356 extremely hazardous | >1,000 substances | 500,000 products | 650 toxic chemicals and categories |

| | | | | | |
|---|---|---|---|---|---|
| | substances | | | | |
| **Thresholds** | Threshold Planning Quantity 1-10,000 pounds on-site at any one time | Reportable quantity, 1-5,000 pounds, released in a 24-hour period | TPQ or 500 pounds for Section 302 chemicals; 10,000 pounds on-site at any one time for other chemicals | 25,000 pounds per year manufactured or processed; 10,000 pounds per year used; certain persistent bioaccumulative toxics have lower thresholds |

Source: US EPA, Office of Solid Waste and Emergency Response, Chemical Emergency Preparedness and Prevention Office, EPA Publication 550-F-00-004, March 2000.

Emergency Response Plans (Sections 301 - 303)

Emergency Response plans contain information that community officials can use at the time of a chemical accident. Community emergency response plans for chemical accidents were developed under section 303. The plans must:

- Identify facilities and transportation routes of extremely hazardous substances;
- Describe emergency response procedures, on and off site;
- Designate a community coordinator and facility coordinator(s) to implement the plan;
- Outline emergency notification procedures;
- Describe how to determine the probable affected area and population by releases;
- Describe local emergency equipment and facilities and the persons responsible for them;
- Outline evacuation plans;
- Provide a training program for emergency responders (including schedules); and,
- Provide methods and schedules for exercising emergency response plans.

Planning activities of LEPCs and facilities initially focused on, but were not limited to, the 356 extremely hazardous substances listed by EPA. The list includes the threshold planning quantities minimum limits) for each substance. Any facility that has any of the listed chemicals at or above its threshold planning quantity must notify the SERC and LEPC within 60 days after they first receive a shipment or produce the substance on site.

Emergency Notification Requirements (Section 304)

Facilities must immediately notify the LEPC and the SERC if there is a release into the environment of a hazardous substance that is equal to or exceeds the minimum reportable quantity set in the regulations. This requirement covers the 356 extremely hazardous substances as well as the more than 700 hazardous substances subject to the emergency notification requirements under CERCLA Section 103(a)(40 CFR 302.4). Some chemicals are common to both lists. Initial notification can be made by telephone, radio, or in person. Emergency notification requirements involving transportation incidents can be met by dialing 911, or in the absence of a 911 emergency number, calling the operator. This emergency notification needs to include:

- The chemical name;
- An indication of whether the substance is extremely hazardous;
- An estimate of the quantity released into the environment;
- The time and duration of the release;
- Whether the release occurred into air, water, and/or land;
- Any known or anticipated acute or chronic health risks associated with the emergency, and where necessary, advice regarding medical attention for exposed individuals;
- Proper precautions, such as evacuation or sheltering in place; and,
- Name and telephone number of contact person.

A written follow-up notice must be submitted to the SERC and LEPC as soon as practicable after the release. The follow-up notice must update information included in the initial notice and provide information on actual response actions taken and advice regarding medical attention necessary for citizens exposed.

Community Right-to-Know Requirements (Sections 311 - 312)

Under Occupational Safety and Health Administration (OSHA) regulations, employers must maintain a material safety data sheet (MSDS) for any hazardous chemicals stored or used in the work place. Approximately 500,000 products have MSDSs. EPCRA Section 311 requires facilities that have MSDSs for chemicals held above certain quantities to submit either copies of their MSDSs or a list of MSDS chemicals to the SERC, LEPC, and local fire department. If the facility owner or operator chooses to submit a list of MSDS chemicals, the list must include the chemical or common name of each substance and must identify the applicable hazard categories. These hazard categories are:

- Immediate (acute) health hazard;
- Delayed (chronic) health hazard;

- Fire hazard;
- Sudden release of pressure hazard; and
- Reactive hazard.

If a list is submitted, the facility must submit a copy of the MSDSs for any chemical on the list upon the request of the LEPC or SERC.

Facilities that start using a chemical or increase the quantity to exceed the thresholds must submit MSDSs or a list of MSDSs chemicals within three months after they become covered. Facilities must provide a revised MSDS to update the original MSDS if significant new information is discovered about the hazardous chemical.

Facilities covered by Section 311 must, under Section 312, submit annually an emergency and hazardous chemical inventory form to the LEPC, the SERC, and the local fire department. Facilities provide either a Tier I or Tier II form. Tier I forms include the following aggregate information for each applicable hazard category:

- An estimate (in ranges) of the maximum amount of chemicals for each category present at the facility at any time during the preceding calendar year;
- An estimate (in ranges) of the average daily amount of chemicals in each category; and,
- The general location of hazardous chemicals in each category.

The Tier II report contains basically the same information as the Tier I, but it must name the specific chemicals. Many states require Tier II information under state law. Tier II forms provide the following information for each substance:

- The chemical name or the common name as indicated on the MSDS;
- An estimate (in ranges) of the maximum amount of the chemical present at any time during the preceding calendar year and the average daily amount;
- A brief description of the manner of storage of the chemical;
- The location of the chemical at the facility; and
- An indication of whether the owner elects to withhold location information from disclosure to the public.

Because many SERCs have added requirements or incorporated the Federal contents in their own forms, Tier I/II forms should be obtained from the SERC. Section 31 information must be submitted on or before March 1 each year. The information submitted under sections 311 and 312 is available to the public from LEPCs and SERCs.

Toxics Release Inventory (Section 313)

EPCRA section 313 (commonly referred to as the Toxics Release Inventory or TRI) requires certain facilities (see box) to complete a Toxic Chemical Release Inventory Form annually for specified chemicals. The form must be submitted to the US EPA and the State on July 1 and cover releases and other waste management of toxic chemicals that occurred during the preceding calendar year. One purpose of this reporting requirement is to inform the public and government officials about releases and other waste management of toxic chemicals. The following information is required on the form:

- The name, location and type of business;
- Whether the chemical is manufactured (including importation), processed, or otherwise used and the general categories of use of the chemical;
- An estimate (in ranges) of the maximum amounts of the toxic chemical present at the facility at any time during the preceding year;
- Quantity of the chemical entering the air, land, and water annually;
- Off-site locations to which the facility transfers toxic chemicals in waste for recycling, energy recovery, treatment or disposal; and
- Waste treatment/disposal methods and efficiency of methods for each waste stream;

In addition, the Pollution Prevention Act of 1990 requires collection of information on source reduction, recycling, and treatment. EPA maintains a national TRI database, available on the Internet.

Additional EPCRA Requirements

Trade Secrets. EPCRA section 322 addresses trade secrets as they apply EPCRA sections 303, 311, 312, and 313 reporting; a facility cannot claim trade secrets under section 304 of the statute. Only chemical identity may be claimed as a trade secret, though a generic class for the chemical must be provided. The criteria a facility must meet to claim a chemical identity as a trade secret are in 40 CFR part 350. In practice, less than one percent of facilities have filed such claims.

Even if chemical identity information can be legally withheld from the public, EPCRA section 323 allows the information to be disclosed to health professionals who need the information for diagnostic and treatment purposes or local health officials who need the information for prevention and treatment activities. In non-emergency cases, the health professional must sign a confidentiality agreement with the facility and provide a written statement of need. In medical emergencies, the health professional, if requested by the facility, provides these documents as soon as circumstances permit.

Any person may challenge trade secret claims by petitioning the US EPA. The Agency must then review the claim and rule on its validity.

EPCRA Penalties. EPCRA Section 325 allows civil and administrative penalties ranging up to \$10,000 - \$75,000 per violation or per day per violation when facilities fail to comply with the reporting requirements. Criminal penalties up to \$50,000 or five years in prison apply to any person who knowingly and willfully fails to provide emergency release notification. Penalties of not more than \$20,000 and/or up to one year in prison apply to any person who knowingly and willfully discloses any information entitled to protection as a trade secret.

Citizens Suits. EPCRA Section 326 allows citizens to initiate civil actions against the US EPA, SERCs, and the owner or operator of a facility for failure to meet the EPCRA requirements. A SERC, LEPC, and State or local government may institute actions against facility owner/operators for failure to comply with EPCRA requirements. In addition, States may sue the US EPA for failure to provide trade secret information.

To comply with the major public information provisions of this act and its associated regulations, we recommend that FWT continue to collect and provide purchasers of the FWT waterfree urinal, as well as the general public, with copies of the applicable MSDS documents upon request. The box or packaging for the FWT waterfree urinal should carry an appropriate notice that such information is available for free upon written request.

### *Williams-Steiger Occupational Safety and Health Act of 1970*

In 1969 and 1970, the U.S. Congress concluded from committee studies that injuries and illnesses that arose out of work situations imposed a substantial burden on interstate commerce in terms of lost production, wage loss, medical expenses, and disability payments to employees. In order to assure safe and healthful working conditions for employees, Congress, in December 1970, passed the Williams-Steiger Occupational Safety and Health Act (OSHA or the "Act"). This Act required that every employer covered under the Act provide to his employees "employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees." The Act also authorized enforcement of new safety and health standards developed under the Act. Rules, amendments, and additions, promulgated in reference to the Act were placed in the Code of Federal Regulations (CFR). Title 29 deals with the U.S. Department of Labor and Parts 1903 and 1904 refer to the record keeping and posting requirements of OSHA. Part 1910, Section 1200 pertains to Hazard Communications regulations and standards. The purpose of this section is to ensure that the hazards of all chemicals produced or imported are evaluated, and that information concerning their hazards is transmitted to employers and employees. The transmittal of information is to be accomplished by means of comprehensive hazard communication programs, which are to include container labeling and other forms of warning, material safety data sheets and employee training.

Under the act, chemical manufacturers and importers shall obtain or develop a material safety data sheet for each hazardous chemical they produce or import. Employers shall have a material safety data sheet in the workplace for each hazardous chemical which they use. The general requirements include that each MSDS be in English (although the employer may maintain copies in other languages as well), and shall contain at least the following information:

- The identity used on the label, and, except as provided for in the section on trade secrets;
- If the hazardous chemical is a single substance, its chemical and common name(s);
- If the hazardous chemical is a mixture which has been tested as a whole to determine its hazards, the chemical and common name(s) of the ingredients which contribute to these known hazards, and the common name(s) of the mixture itself; or,
- If the hazardous chemical is a mixture which has not been tested as a whole:
- The chemical and common name(s) of all ingredients which have been determined to be health hazards, and which comprise 1% or greater of the composition, except that chemicals identified as carcinogens shall be listed if the concentrations are 0.1% or greater; and,

- The chemical and common name(s) of all ingredients which have been determined to be health hazards, and which comprise less than 1% (0.1% for carcinogens) of the mixture, if there is evidence that the ingredient(s) could be released from the mixture in concentrations which would exceed an established OSHA permissible exposure limit or ACGIH Threshold Limit Value, or could present a health risk to employees; and,

- The chemical and common name(s) of all ingredients which have been determined to present a physical hazard when present in the mixture;

- Physical and chemical characteristics of the hazardous chemical (such as vapor pressure, flash point);

- The physical hazards of the hazardous chemical, including the potential for fire, explosion, and reactivity;

- The health hazards of the hazardous chemical, including signs and symptoms of exposure, and any medical conditions which are generally recognized as being aggravated by exposure to the chemical;

- The primary route(s) of entry;

- The OSHA permissible exposure limit, ACGIH Threshold Limit Value, and any other exposure limit used or recommended by the chemical manufacturer, importer, or employer preparing the material safety data sheet, where available;

- Whether the hazardous chemical is listed in the National Toxicology Program (NTP) Annual Report on Carcinogens (latest edition) or has been found to be a potential carcinogen in the International Agency for Research on Cancer (IARC) Monographs (latest editions), or by OSHA;

- Any generally applicable precautions for safe handling and use which are known to the chemical manufacturer, importer or employer preparing the material safety data sheet, including appropriate hygienic practices, protective measures during repair and maintenance of contaminated equipment, and procedures for clean-up of spills and leaks;

- Any generally applicable control measures which are known to the chemical manufacturer, importer or employer preparing the material safety data sheet, such as appropriate engineering controls, work practices, or personal protective equipment;

- Emergency and first aid procedures;

- The date of preparation of the material safety data sheet or the last change to it; and,

- The name, address and telephone number of the chemical manufacturer, importer, employer or other responsible party preparing or distributing the material safety data sheet, who can provide additional information on the hazardous chemical and appropriate emergency procedures, if necessary.

If no relevant information is found for any given category on the material safety data sheet, the chemical manufacturer, importer or employer preparing the material safety data sheet shall mark it to indicate that no applicable information was found. Where complex mixtures have similar hazards and contents (i.e. the chemical ingredients are essentially the same, but the specific composition varies from mixture to mixture), the chemical manufacturer, importer or employer may prepare one material safety data sheet to apply to all of these similar mixtures.

The chemical manufacturer, importer or employer preparing the material safety data sheet must ensure that the information recorded accurately reflects the scientific evidence used in making the hazard determination. If the chemical manufacturer, importer or employer preparing the material safety data sheet becomes aware of any significant information regarding the hazards of a chemical, or ways to protect against the hazards, this new information must be added to the material safety data sheet within three months. If the chemical is not currently being produced or imported the chemical manufacturer or importer shall add the information to the material safety data sheet before the chemical is introduced into the workplace again.

To comply with the major public information provisions of this act and its associated regulations, we recommend that FWT continue to collect and provide purchasers of the FWT waterfree urinal with copies of the applicable MSDS documents upon request. Further, as required under the act, we recommend that FWT keep copies of all MSDS information received from their suppliers for all chemicals components of the FWT waterfree urinal on-site at all manufacturing, storage, distribution and sales locations. Finally, we recommend that FWT develop and undertake developing an appropriate Hazard Communications program for all employees related to the FWT waterfree urinal.

## State of California Legislation

In California, somewhat uniquely among US states, Article X, Section 2 of the state's constitution prohibits waste, or unreasonable use or unreasonable method of use, or diversion of water. Court decisions interpreting the state's constitution have stressed that a use reasonable in times of plenty may be unreasonable in time of shortage, and reasonable use must be determined in the light of statewide conservation considerations. These courts rulings lead, in part, to the adoption of the State of California Water Code, Section 275, which directs the Department and the SWRCB to take appropriate actions before courts, administrative agencies, and legislative bodies to prevent waste or misuse of water.

The State of California has developed environmental legislation in order to comply with federal environmental guidelines and legislation. The legislation enacted by the State is designed to provide for the protection of the public health, and to ensure environmental quality for state water resources.

### *Porter-Cologne Water Quality Control Act*

This act is California's comprehensive water quality control law and is a complete regulatory program designed to protect water quality and beneficial uses of the State's water. The act established nine Regional Water Quality Control Boards (RWQCBs) to oversee water quality on a day-to-day basis at the local/regional level. The act also required the adoption of water quality control plans by the nine RWQCBs for areas within their regions. These plans are subject to the approval of the SWRCB, and ultimately the US EPA. The plans are to be reviewed and updated. Each Basin Plan establishes:

1) beneficial uses of water designated for each water body to be protected;

2) water quality standards, known as water quality objectives, for both surface water and groundwater; and

3) actions necessary to maintain these standards in order to control non-point and point sources of pollution to the State's waters.

Permits issued to control pollution (i.e. waste-discharge requirements and Clean Water Act National Pollutant Discharge Elimination System permits, also known as NPDES permits,) must implement Basin Plan requirements (i.e. water quality standards), taking into consideration beneficial uses to be protected.

Regional Boards regulate all pollutant or nuisance discharges that may affect either surface water or groundwater. Any person proposing to discharge waste within any region must file a report of waste discharge with the appropriate regional board. No discharge may take place until:

1) the Regional Board issues waste discharge requirements or a waiver of the waste discharge requirements, and

2) 120 days have passed since complying with reporting requirements.

The primary method of implementing the plans is to require each discharger of waste that could impact the waters of the State to meet formal waste discharge requirements. Anyone discharging waste or proposing to discharge waste into the State's waters must file a "report of waste discharge" with the regional water quality control board within whose jurisdiction the discharge lies. Dischargers are subject to a wide variety of administrative, civil, and criminal actions for failing to file a report. After the report is filed, the regional board may issue waste discharge requirements that set conditions on the discharge. The waste discharge requirements must be consistent with the water quality control plan for the body of water and protect the beneficial uses of the receiving waters. The regional boards also implement Section 402 of the federal Clean Water Act, which allows the State to issue a single discharge permit for the purposes of both State and federal law.

Based on a review of the existing state legislation and pertinent regulations, and after a review of local regulations promulgated by the Los Angeles County Sanitation District's and the Orange County Sanitation District's discharge regulations, it appears that the FWT waterfree urinal is not specifically impacted by the act, and will not require specialized permits to install or use.

### *California Safe Drinking Water Act of 1976*

In 1976, California enacted its own Safe Drinking Water Act, requiring the Department of Health Services to regulate drinking water, including: setting and enforcing federal and State drinking water standards; administering water quality testing programs; and administering permits for public water system operations. The federal Safe Drinking Water Act allows the State to enforce its own standards in lieu of the federal standards so long as they are at least as protective as the federal standards.

Significant amendments to the California act in 1989 incorporated the new federal safe drinking water act requirements into California law, gave DHS discretion to set more stringent MCLs, and recommended public health levels for contaminants. DHS was authorized to consider the technical and economic feasibility of reducing contaminants in setting MCLs. The standards established by DHS are found in the California Code of Regulations, Title 22. The appropriate federal primary and secondary MCLs are shown in Appendix A and the appropriate state primary and secondary MCLs are shown in Appendix B.

A review of the existing DHS regulations indicates no significant impact on the FWT waterfree urinal. As noted previously, based on a review of the Los Angeles County Sanitation District's and the Orange County Sanitation District's discharge regulations, it appears that the FWT waterfree urinal will not require a specialized permit to use.

### *Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65)*

Growing public concerns about exposures to toxic chemicals provide the impetus for sponsorship of a initiative on the 1986 state ballot. That initiative became The Safe Drinking Water and Toxic Enforcement Act of 1986, better known by its original name: Proposition 65. Proposition 65 requires the Governor to publish a list of chemicals that are known to the State of California to cause cancer, birth defects or other reproductive harm. This list must be updated at least once a year. The two main provisions of the proposition are:

- Prohibition On Contaminating Drinking Water With Chemicals Known to Cause Cancer or Reproductive Toxicity. No person in the course of doing business shall knowingly discharge or release a chemical known to the state to cause cancer or reproductive toxicity into water or onto or into land where such chemical passes or probably will pass into any source of drinking water, notwithstanding any other provision or authorization of law except as provided in Section 25249.9.

- Required Warning Before Exposure To Chemicals Known to Cause Cancer Or Reproductive Toxicity. No person in the course of doing business shall knowingly and intentionally expose any individual to a chemical known to the state to cause cancer or reproductive toxicity without first giving clear and reasonable warning to such individual, except as provided in Section 25249.10.

After a major, but brief (as measured by the historic and geologic drought record) in 1987 – 1992, the wide-spread public and media interest in droughts heightened awareness of water supply reliability issues in the Legislature. Among the changes to the Safe Drinking Water and Toxic Enforcement Act adopted by the State of California were the following:

- Various technical and clarifying changes were made to Water Code provisions governing temporary and long-term water transfers.

- The use of potable water for specified non-potable purposes was declared to be a waste or unreasonable use of water if suitable, cost-effective reclaimed water supplies were available. Several measures expanding the types of applicable non-potable purposes were enacted.

- Leases of water for up to five years, with specified limitations, were exempted from SWRCB jurisdiction over water transfers.

- Groundwater substitution transfers were explicitly authorized; related findings were made.

- The Water Conservation in Landscaping Act directed the Department to draft and adopt a model water efficient landscape ordinance by July 1992. Local agencies not adopting their own ordinances by January 1993 were required to begin enforcement of the model ordinance as of that date.

- The Agricultural Water Suppliers Efficient Management Practices Act required the Department to establish an advisory committee to review efficient agricultural water management practices, and to offer assistance to agricultural water suppliers seeking improved efficiencies.

- The Water Recycling Act of 1991 set a statewide goal of recycling 700 taf/year by 2000 and 1 maf/year by 2010.

- The Agricultural Water Conservation and Management Act of 1992 authorized agricultural water suppliers to institute water conservation or efficient water management programs.

- The Department was required to develop standards for installation of gray water systems in residential buildings.

- Effective January 1992, water purveyors were required to meter new connections.

- CALTRANS was required to implement drought-resistant freeway landscaping, and to allow local agencies to place recycled water pipelines in highway rights-of-way. Another measure urged the Department of General Services to use drought resistant plants in new landscaping.

- The Urban Water Management and Planning Act, in effect since 1983, was amended in multiple sessions. Amendments in 1991 required water suppliers to estimate available water supplies at the end of one, two, and three years, and to develop contingency plans for shortages of up to 50 percent.

- The Department and the Department of Fish and Game were directed to submit various reports to the Legislature describing water supply availability and drought-related water needs for fish and wildlife.

Based on a review of the information currently available in the MSDS sheets for the ingredients in the AllSeal™ solution, there is no data indicating that any of the chemicals cause cancer, birth defects or any other reproductive harm, and are thus not likely covered under Proposition 65's various requirements.

### *Children's Poison Protection Act of 1990*

California's Health and Safety Code, Sections 108750-108785 are known collectively as the Children's Poison Protection Act of 1990. As defined under this act, household products include any product used under any of the following circumstances:

1. Directly on humans or pets.

2. In, on, or around any structure, vehicle, article, surface, or area associated with the household, including, but not limited to, nonagricultural outbuildings, noncommercial greenhouses, pleasure boats, and recreational vehicles.

3. In or around any preschool or day care facility.

The act further defines liquids to mean any liquid preparation that flows readily in its natural state at room temperature containing one or more soluble chemical substances usually dissolved in water or other solvents. Finally, the act defines toxic household product to mean any substance or mixture of substances that are customarily produced or distributed for sale for use in or about the household, or are customarily stored by individuals in or about the household, and the substance or mixture of substances have the capacity to produce significant personal injury or illness to humans when orally ingested in moderate amounts.

The act requires that any product which fits these criteria and is manufactured on and after January 1, 1992, and sold in California, shall include within the product a bittering agent that is nontoxic, in a concentration so as to render the product aversively bitter, unless the product is packaged with child-resistant safety closures in accordance with the federal Poison Prevention Packaging Act of 1970 and regulations adopted there under. Also covered are toxic household products that are required to be registered with the US EPA under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) is formulated for outdoor or food use economic poisons purposes, are required to be reformulated to include a bittering agent, no later than two years from the date when the Environmental Protection Agency has approved a bittering agent for use in outdoor or food use economic poisons.

Although the FWT waterfree urinal AllSeal™ solution is likely not specifically covered under this act, as a safety precaution we recommend the inclusion of a bittering agent, such denatonium benzoate, a bittering agent commonly used in very small quantities in many consumer products, to protect against accidental human ingestion. Adding as little as thirty parts of denatonium benzoate to one million parts of a liquid makes that liquid too bitter to be tolerated by most human subjects. This denaturant (trade name = Bitrex) has been thus described as the bitterest compound known.

To further protect the public, we recommend a prominent warning label be imprinted on the packaging containing the AllSeal™ solution warning against human ingestion. The warning label should be designed to comply with the requirements of all federal, state and local regulations. Generally, cautionary statements that are required by law, or regulations adopted pursuant to law, to be printed upon the labels of containers in which dangerous drugs, poisons, and other harmful substances are packaged shall be printed in the English language in a conspicuous place in type of conspicuous size in contrast to the typography, layout, or color of the other printed matter on the label. Unless a specific color is prescribed, the cautionary statements may be printed in any color, but preferably red, upon a plain and distinctly contrasting background.

### *Drought Emergency Relief and Assistance Act of 1991*

In 1991, the Governor created a "Drought Action Team" to develop a legislative proposal to enhance the State's ability to respond to drought conditions and to provide funding for local assistance activities. The major provisions of this Act included:

- Appropriate money for financial assistance to local water suppliers for emergency drought-relief water supply, technical water conservation assistance, and operation of the Department's Drought Information Center.

- Authorize the Department to obtain short-term commercial financing, backed by State Water Project revenues, to fund drought-relief measures.

- Give the governing body of a water supplier explicit authority to enter into contracts with the drought water bank or with other water suppliers for transfer of water outside the service area of the water supplier.

- Declare that no temporary transfer of water under any provision of law for drought relief in 1991 or 1992 would affect any water rights.

- Authorize water suppliers to contract with, and pay, their customers for water when customers voluntarily reduce or eliminate use of water.

- Appropriate money for the SWRCB to expedite and expand efforts to process petitions for temporary changes to water rights to accommodate drought-relief water transfers.

- Appropriate money for the DFG to maintain and protect populations of fish and wildlife and offset revenue losses. Priority would be placed on threatened and endangered species.

- Appropriate money for the Department of Health Services to augment the Emergency Clean Water Grant Fund.

- Appropriate money for the California Conservation Corps to increase corps membership by 300 to assist state agencies with drought-relief activities.

A review of the provisions of this act indicates a minimal impact on the FWT waterfree urinal, except to the extent that during an occasion of drought, the use of the FWT waterfree urinal would likely constitute a Best Management Practice (BMP) for water conservation related to sanitary fixtures. As such, the FWT waterfree urinal may qualify for special state provided financial assistance, when available, designed to encourage businesses and municipalities to change out existing water flush urinals.

### *The Emergency Services Act*

The Emergency Services Act authorizes the Governor to proclaim a state of emergency where he or she finds that conditions of disaster or extreme peril exist, caused by conditions such as flood, fire, storm, epidemic, riot, drought, earthquake, or volcanic eruption. These conditions of emergency must be beyond the control, or likely control, of the services, personnel, equipment and facilities of any single city or county. The emergency must also require the combined forces of a mutual aid region to combat.

Generally, the act is triggered by a local emergency proclamation and a request to the Governor to proclaim an emergency. The Governor may also proclaim an emergency without such a local request, if he finds that a state of emergency exists, and local authority is inadequate to cope with the emergency. The Governor must proclaim the termination of the state of emergency at the earliest possible date that conditions warrant.

Where a state of emergency has been proclaimed, the Governor's authority to respond includes:

- The Governor may make written orders and regulations which have the force and effect of law.
- The Governor may suspend the provisions of regulatory statutes, statutes prescribing procedures for conduct of state business, and state regulations, where he or she finds that strict compliance would impede mitigating the effects of an emergency.
- The Governor may commandeer or use private property or personnel. Compensation must be paid.
- The Governor has authority to exercise any police power of the State within the area designated in the emergency proclamation.
- The Governor may direct State agencies to use their personnel, equipment and facilities to prevent or alleviate damage or threatened damage due to the emergency.
- The Governor may undertake preparatory steps such as planning, mobilization of equipment, and training.

A review of the issues covered under this sweeping act indicates that it has little or no impact on the FWT waterfree urinals, except perhaps under conditions of extended, severe drought where the Governor is empowered to require the adoption of a variety of actions by business and government entities throughout the state. Under such circumstances, again, the FWT waterfree urinal would likely constitute a Best Management Practice (BMP) for water conservation related to sanitary fixtures, as the Governor could require the purchase and installation of waterfree urinals as an emergency water conservation action.

# Water Issues

## Overview

The water supplies used by Californians come from four major sources:

1. surface water released from reservoirs,
2. surface water directly diverted from unstored stream flows,
3. groundwater, and
4. reclaimed water.

Supplies derived from desalination (removal of salt), while important to a limited number of agencies relying on these sources, collectively represent less than one half percent of California's water supply.

Roughly three-quarters of California's runoff occurs north of Sacramento, while about the same proportion of water needs occurs south of Sacramento. Average annual statewide precipitation is about 23 inches, corresponding to a volume of nearly 200 million acre-feet over California's land surface. About 65 percent of this precipitation is consumed through evaporation and transpiration by plants. The remaining 35 percent comprises the State's average annual runoff of about 71 maf. Less than half this runoff is depleted by urban or agricultural use. Most of it maintains ecosystems in California's rivers, estuaries, and wetlands. Available surface water supply totals 78 maf when interstate supplies from the Colorado and Klamath Rivers are added.

On average, 75 percent of the State's average annual precipitation of 23 inches falls between November and March, with half of it occurring between December and February. A shortfall of a few major storms during the winter usually results in a dry year; conversely, a few extra storms or an extended stormy period usually produces a wet year. An unusually persistent Pacific high pressure zone over California during December through February predisposes the year toward a dry year. The influence of climatic variability on California's water supplies is much less predictable than are the influences of geographic and seasonal variability, as evidenced by the recent historical record of precipitation and runoff. For example, the State's average annual runoff of 71 maf includes the all-time low of 15 maf in 1977 and the all-time high (exceeding 135 maf) in 1983. Floods and droughts occur often, sometimes in the same year. The January 1997 flood was followed by a record-setting dry period from February through June; the flooding of 1986 was followed by six years of drought (1987-92).

To move water from the relatively “wet” northern areas to the dryer southern areas of California, as well as the interregional water transfers, an extensive system of conveyance infrastructure was constructed in response to the imbalance in the locations of supplies and demands.

## Groundwater Supplies

Under average hydrologic conditions, about 30 percent of California's urban and agricultural water needs are supplied by groundwater. This percentage increases in dry years when water users whose surface supplies are reduced turn to groundwater, if available. The amount of water stored in California's groundwater basins is far greater than that stored in the State's surface water reservoirs, although only a fraction of these groundwater resources can be economically and practically extracted for use. The greatest amounts of groundwater extraction occur in the Central and Salinas Valleys and in the Southern California coastal plain. At a 1995 level of development, California's estimated developed groundwater supplies were about 12.5 maf under average hydrologic conditions. This amount is exclusive of groundwater overdraft, estimated at about 1.5 maf annually. More than 1 maf of this estimated annual overdraft occurs in the San Joaquin Valley.

## Droughts in California

Drought is a gradual phenomenon. Although droughts are sometimes characterized as emergencies, they differ from typical emergency events. Most natural disasters, such as floods or forest fires, occur relatively rapidly and afford little time for preparing for disaster response. Droughts occur slowly, over a multiyear period. There is no universal definition of when a drought begins or ends. Impacts of drought are typically felt first by those most reliant on annual rainfall ranchers engaged in dryland grazing, rural residents relying on wells in low-yield rock formations, or small water systems lacking a reliable water source. Criteria used to identify statewide drought conditions do not address these localized impacts. Drought impacts increase with the length of a drought, as carry-over supplies in reservoirs are depleted and water levels in groundwater basins decline.

### *The 1987-92 Drought*

The most recent drought, a six-year event from 1987 to 1992, created havoc for federal, state, regional and local agencies, as well as for businesses and people. This drought was notable for its six-year duration and the statewide nature of its impacts. Because of California's size, droughts may or may not occur simultaneously throughout the entire state. The jet stream's position during the winter storm season is an important determinant of regional precipitation amounts. The State of California spans more than nine degrees of latitude (a north-to-south extent equaled or exceeded only by Alaska and Texas), and seldom experiences uniform levels of wetness or dryness. Defining drought conditions in urbanized coastal Southern California is complicated. Historically, imports (from Northern California, from the eastern Sierra, and from the Colorado River) have provided about 65 percent of the region's water supply. Hydrologic conditions in the Colorado River Basin may vary greatly from those being experienced in California; the extensive storage in the river basin further acts as a buffer to short-term hydrologic changes. Colorado River unimpaired flow at the gauging station used for interstate compact administration was below the long-term historical average during the 1987-92 drought, but a multi-year wet period just prior to the drought years had filled system reservoirs. When the State Water Project (SWP) sharply curtailed deliveries in 1991, the Metropolitan Water District (MWD), the most junior of California's major Colorado River water users, was able to maintain a full Colorado River Aqueduct due to availability of surplus river water.

Water users served by most of the State's larger suppliers did not begin to experience shortages until the third or fourth years of the drought. Reservoir storage provided a buffer against drought impacts during the initial years of the drought. The Central Valley Project (CVP) and the SWP met delivery requests during the first four years of the drought, but were then forced by declining reservoir storage to cut back deliveries substantially. In 1991, the SWP terminated deliveries to agricultural contractors and provided only 30 percent of requested urban deliveries. The CVP, with its larger storage capacity, reduced agricultural deliveries by 75 percent and urban deliveries by 25 percent in 1991.

By the third year of the drought, overall statewide reservoir storage was about 40 percent of average. Statewide reservoir storage did not return to average conditions until 1994, thanks to an unusually wet 1993. Some examples of surface water supply impacts included:

- Among large urban agencies' water development projects, the City and County of San Francisco's system experienced the greatest supply impacts, having only about 25 percent of total storage capacity in 1991. The City and County constructed two turnouts, one 75 cubic feet per second and the other 25 cfs, on the California Aqueduct to obtain access to supplies from water transfers.

- Lake Tahoe, the principal storage facility for the U.S. Bureau of Reclamation's Newlands Project in Nevada, not only fell below its natural rim but also reached a record low of more than a foot below the rim. Storage on the Truckee River system, all dedicated to Nevada uses, reached a low of ten percent of total capacity in 1991.

- The creek providing water for Markleeville, the county seat of Alpine County, dried up. A pipeline was constructed to a new water source. This example is typical of impacts faced by small rural water systems with marginal water supplies.

The drought spurred many water agencies to begin planning for new facilities to improve water supply reliability. Only two new water management facilities of regional scope were put into service during the drought. In Northern California, the Department's North Bay Aqueduct (NBA) pipeline was completed in 1988, replacing previously constructed interim facilities. The NBA was used to convey SWP water and water transfers to Napa

Valley communities experiencing significant shortages of local surface supplies. In the San Joaquin Valley, initial operational testing was being conducted for the Kern Water Bank (KWB), a project originally developed by the Department for SWP supply augmentation and subsequently turned over to local agencies to implement. In a 1990 test program, the Department banked about 100 thousand acre-feet of SWP water in what was then known as the Semitropic local element of the KWB. Semitropic Water Storage District returned, through exchange, about half the stored water in 1992.

Delta regulatory constraints affecting CVP and SWP operations during the drought were based on State Water Resources Control Board (SWRCB) Decision 1485. This decision took effect in 1978, immediately following the 1976-77 drought. Other operational constraints included water temperature standards established by SWRCB through Orders WR 90-5 and 91-01 for portions of the Sacramento and Trinity Rivers. On the Sacramento River below Keswick Dam, these orders included a daily average water temperature objective of 56° F during critical periods when high temperatures could be detrimental to survival of salmon eggs and pre-emergent fry.

Groundwater extraction increased substantially during the drought. The total number of well driller reports filed with the State of California Department of Water Resources was in the range of 25,000 reports per year for several years, up from fewer than 15,000 reports per year prior to the drought. The majority of the new wells drilled were for individual domestic supply. Water levels and the amounts of groundwater in storage declined substantially in some areas. As indicated earlier, groundwater extractions were estimated to exceed groundwater recharge by 11 maf in the San Joaquin Valley during the first five years of the drought. Precise surveys of the California Aqueduct identified an increase in subsidence along the aqueduct alignment in the San Joaquin Valley, in response to increased groundwater extractions.

Examples of impacts to groundwater supply included:

- Numerous private domestic wells went dry, as did wells supplying small systems in rural areas. Homeowners with private wells were forced to drill new wells or deepen existing ones. Groundwater users most at risk were typically those relying on extractions from small coastal basins with limited recharge, or on low-yield fractured rock formations such as those in the Sierra Nevada foothills. Dry wells at a number of small water systems in rural areas of the Sierra Nevada foothills resulted in the need to haul water. Counties affected included Butte, Amador, Mariposa, and Tuolumne.

- Water levels in Salinas Valley aquifers declined, and increased seawater intrusion was noted. San Antonio and Nacimiento Reservoirs, used by Monterey County Water Resources Agency for groundwater recharge, were only at six percent of capacity in 1991. The valley's extensive agricultural production relies almost entirely on groundwater. (A new water recycling project providing supplemental irrigation supplies in the Castroville area did not become operational until after the drought ended.)

- Some communities in the Central Coast area rely on small groundwater basins formed by coastal terrace deposits, with recharge to these basins being limited largely to direct precipitation over the basin. These communities typically experienced shortages throughout the drought, and instituted rationing in response. Santa Barbara experienced the largest water supply reductions of any of California's larger municipalities; its limited groundwater and local surface water supplies were unable to support area residents' needs. The city was forced to adopt several emergency measures, including a 14-month ban on lawn watering.

- Groundwater supplies ranged from none to minimal for the small North Coast communities that frequently experience water supply problems. In Mendocino, for example, supplies are provided by individual private wells. It has been estimated that ten percent of the town's wells go dry every year, an amount that increases to 40 percent during droughts. Other communities with problems included Weaverville and Fort Bragg (building moratoria/connection bans), Klamath (connected to a private well), and Willits (hauled water, installed temporary pipeline). Wells or springs serving several small water systems in the Russian River corridor went dry; water haulage was necessary.

In response to the drought, the majority of California's urban water retailers and water wholesalers implemented demand reduction techniques, either voluntary or mandatory, at some point during the drought. Demand reduction programs were typically accomplished through extensive customer education and outreach programs, but also included such programs as ultra-low flush toilet exchanges, bans or restrictions on lawn watering, etc. Mandatory rationing levels reached as high as 50 percent in some hard-hit communities. Small communities in isolated areas lacking back-up water sources and the ability to interconnect with other water agencies typically had no recourse other than demand reduction or water haulage.

Coastal communities' interest in seawater desalting likewise increased. The drought served as a catalyst for initiating research studies, bench scale tests, and demonstration projects, primarily in Southern California. Most of these efforts terminated with the end of the drought, because seawater desalting remains noncompetitive with other water supply augmentation options. The City of Santa Barbara did contract for installation of a modular, portable seawater desalting plant, in response to its severe reductions in local water supplies. The plant, rated at a production capacity of 7.5 taf/year, operated only during 1991. The plant was subsequently mothballed; later, part of its equipment was sold. During the time of its brief operation, it was the State's largest seawater desalting plant designed for providing municipal water supply.

### *The Drought and Emergency Management Actions*

As the 1987-92 drought entered its fifth year, carry-over storage in the State's major reservoirs had been depleted and water agencies throughout California were facing the prospect of major reductions in supplies. The Governor signed an executive order in 1991, creating a Drought Action Team and directing the team to coordinate a response to water supply conditions. The team was headed by the Director of DWR; its membership included representatives from nine other State agencies, with invited participation from additional State and federal agencies. Among other things, the team was charged with advising the Governor on “determining whether and when to proclaim a state of emergency due to drought conditions.”

Prior to formation of the Drought Action Team, the Governor had declared a state of emergency in the City and County of Santa Barbara in 1990, at the request of both jurisdictions. By early 1991, ten counties had declared local drought emergencies. By the end of 1991, 23 counties had declared local drought emergencies. Ultimately, no statewide declaration of emergency was made for the 1987-92 drought, although a declaration would almost certainly have been made but for the “March Miracle” rains in 1991. Had such a declaration been made, the Governor would have had broad powers to take emergency response actions, as summarized below. Prior to the “March Miracle,” for example, plans were being made to require that all communities develop strategies to respond to a worst case scenario of a 50 percent reduction in their normal water supplies.

Drought differs from other emergencies in that it occurs over a period of time, instead of being a sudden occurrence like fire, flood, or earthquake. Accordingly, its burdens on cities and counties are likely to be cumulative, rather than sudden and overwhelming. To invoke the extraordinary remedies of the Emergency Services Act, conditions of disaster or extreme peril to the safety of persons and property should exist, and not be a matter of speculation. The act permits the Governor to assign a State agency any emergency response activity related to the powers and duties of that agency. This assignment may be accomplished by executive order without the need of the Governor having to proclaim a state of emergency.

Declaration of a major disaster can only be made by the President when damage exceeds resources of state and local government and private relief organizations. Under a major disaster declaration, two types of federal assistance are provided, as authorized under the Stafford Act. Assistance to individuals and businesses may include:

- Temporary housing assistance
- Low interest loans (individuals, businesses, and farmers/ranchers)
- Individual and family grants

Assistance to state and local governments, special districts, and certain private nonprofit agencies may include:

- Debris clearance
- Repair/replacement of public property (roads, buildings)

- Emergency protective measures (search and rescue, demolition of unsafe structures)

- Repair/replacement of water control facilities

Public agencies often have specific powers in their enabling acts to adopt water rationing and other demand reduction measures. Municipal water districts, for example, have specific authority to adopt a drought ordinance restricting use of water, including the authority to restrict use of water for any purpose other than household use. During a local emergency, cities and counties may promulgate orders and regulations necessary for the protection of life and property, and they have the authority to provide mutual aid to any affected area. Where a county has declared an emergency, it is not necessary for cities affected by emergency conditions within the county to make an independent declaration of local emergency.

The State of California Water Code authorizes public and private water purveyors to declare a water shortage emergency and to adopt regulations and restrictions to conserve water. The governing body of a purveyor may declare a water shortage emergency whenever it determines that consumers' requirements cannot be satisfied without depleting the water supply to the extent that there would be insufficient water for human consumption, sanitation, and fire protection. The governing body may adopt regulations and restrictions on water delivery and use to conserve water for the greatest public benefit, with particular regard to domestic use, sanitation, and fire protection. The regulations may provide for connection moratoria. DHS has the authority to impose terms and conditions on permits for public drinking water systems to assure that sufficient water is available. This includes the authority to require an agency to continue its moratorium on new connections adopted pursuant to Water Code Section 350 et seq.

## Legal, Regulatory, and Institutional Changes

Heightened interest in supply reliability created by the drought, together with drought-induced ecosystem impacts, were factors leading to the development of some of the changes summarized below. The changes have mixed impacts on water agencies' abilities to respond to the next drought, some lessen water supply reliability and some improve it. The following descriptions focus on aspects of the laws, regulations, or institutional changes that could most affect water supply availability and water agencies' ability to respond to droughts.

- In 1994, the National Marine Fisheries Service listed winter-run Chinook salmon as an endangered species. This listing requires substantial changes to CVP operations to provide additional cold water in spawning areas downstream from Shasta Dam, and closures of Delta Cross-Channel gates. The listing also provided for numerical take limits at Banks and Tracy Pumping Plants, and for further temperature control operations at Lake Shasta. The CVP is now required to maintain a minimum Shasta September storage of at least 1.9 maf, except in the driest years. (Shasta storage declined to 0.6 maf during the 1976-77 drought, and to 1.3 maf during the 1987-92 drought.)

- The Central Valley Project Improvement Act of 1992 reallocated 800 taf of CVP water supply from project contractors to fishery purposes, plus additional project supply to provide firm water for wildlife refuges. Annual Trinity River instream flows of at least 340 taf were to be provided until a flow study conducted by the U.S. Fish and Wildlife Service was completed, at which time new flow requirements would be established. The act directed the Secretary of the Interior to carry out structural and nonstructural environmental restoration actions, including water acquisition for fishery and wildlife refuge purposes. One major structural restoration project affecting river operations has been completed, the $80+ million Shasta Dam Temperature Control Device, which reduces the need to forgo power generation at Shasta to provide cold water for salmon. CVP also authorized transfers of project water outside the CVP's service area, subject to many conditions. Some conditions, such as right of first refusal by entities within the service area, expired in 1999. To date, no out-of-service area transfers have occurred. The Secretary was authorized to carry out a land retirement program, targeted at drainage problem lands in the San Joaquin Valley. USBR is working with Westlands Water District to implement a land retirement program within the district.

- Delta smelt were listed as threatened in 1993. The primary water management action associated with their listing has been reduction of CVP and SWP exports from the Delta.

- The 1993 Emergency Services Act required the State Office of Emergency Services (OES), in coordination with other State agencies, to have a standardized emergency management system operational throughout California by the end of 1996. Local agencies are strongly encouraged to use SEMS, and must use it to be eligible for State funding of emergency response costs. SEMS incorporates the State's master mutual aid program. In response to a request from OES, or from a local agency via the mutual aid program, the Department must provide emergency response assistance, if resources are available. While drought per se is not an emergency, drought-related impacts, such as a local agency running out of water, could trigger a request for the Department to provide assistance in actions such as constructing a temporary pipeline.

- The Monterey Agreement, signed by the Department and SWP contractors in 1994, established principles to be incorporated in contract amendments (the Monterey Amendments) to be offered to the contractors. To date, all but two contractors (Plumas County Flood Control and Water Conservation District and Empire West Side Irrigation District) have accepted the amendments. The amendments changed the prior method of allocating water supply deficiencies, which reduced supplies to agricultural contractors before those of urban contractors were cut. Supplies are now to be allocated among contractors in proportion to their contractual entitlements. The amendments also reduced the SWP's total contractual commitment as part of transferring KWB lands to two contractors, and further provided that 130 taf of agricultural contractors' entitlements could be sold to urban contractors. Several amendment provisions gave contractors more flexibility in managing their SWP and non-SWP supplies. Contractors are allowed to store project water outside their service area boundaries and to have access to project facilities for wheeling non-project water. Agreements have already been executed with some contractors to enable storage of SWP water outside contractors' service areas. Examples include those with MWD, Santa Clara Valley Water District, ACWD, and Zone 7 Water Agency to allow them to store SWP water in SWSD's groundwater bank. The amendments allowed contractors participating in repayment costs of Castaic and Perris Reservoirs to conditionally withdraw water from the reservoirs, subject to replacement of the water within five years. The amendments also created a turnback pool (first operated in 1996) for internal annual reallocation of project water among project contractors, and provided dry-year rate relief for agricultural contractors.

- SWRCB adopted Decision 1631 in 1994, amending the City of Los Angeles' rights to divert from the Mono Lake Basin, in order to increase Mono Lake levels. The decision restricted diversions from the basin to 16 taf/year until the lake level reached elevation 6391, at which time diversions would be allowed to increase to about 31 taf/year, about one-third of historical diversions. (As of May 2000, the lake's elevation is 6384.5 feet.) Los Angeles implemented an aggressive water conservation program emphasizing plumbing fixture retrofits with substantial State financial assistance to help compensate for the shortfall. The City estimated that it replaced 750,000 toilets during the 1990s. Between 1994 and 1999, the Legislature appropriated $17.5 million out of an authorized $36 million to help Los Angeles implement demand reduction measures.

- The Bay-Delta Accord, executed as a three-year agreement in 1994 and then subsequently extended, set forth the State-federal CALFED Bay-Delta Program's three chief activities establishing water quality standards, coordinating operations of the CVP and SWP to meet water quality and environmental protection requirements, and developing a long-term solution to Delta problems. In 1995, SWRCB adopted a water quality control plan incorporating concepts contained in the Accord, followed by an interim order. Order WR 95-6 provided that the CVP and SWP would meet Bay-Delta Accord standards while SWRCB developed a new water right decision to apportion the responsibility for meeting standards among all users of Delta water. SWRCB's process to develop a new decision remains ongoing major changes from the former D-1485 to WR 95-6. CALFED released a first draft programmatic environmental impact report/environmental impact statement for a long-term Delta solution in 1998, followed by a redraft in 1999. A record of decision was signed in 2000, marking the end of CALFED's planning phase and a transition to initial implementation of some of the required actions, including its environmental restoration program. Other CALFED actions will begin a period of more detailed planning studies. The CALFED June 2000 action framework document called for the Governor to appoint a panel charged with developing a drought contingency plan by the end of 2000.

- The Department developed a proposed SWP supplemental water purchase program as a follow-up to the 1994 SWP water purchase program operated jointly with the drought water bank, and released draft programmatic environmental documentation covering a proposed six-year program. The proposed program would have entailed purchasing about 400 taf in drought years, with about half the amount coming from groundwater substitution. The Department did not go forward with the program due to opposition to groundwater substitution transfers in rural Sacramento Valley counties.

- A 1996 Federal Energy Regulatory Commission settlement agreement among the City and County of San Francisco, Modesto Irrigation District, Turlock Irrigation District, DFG, and others provided for increased instream flows in the Tuolumne River. The agreement is estimated to reduce San Francisco's Hetch Hetchy Aqueduct supplies by about 65 taf annually.

- Proposition 218, approved by voters in 1996, changed procedures used by local government agencies for increasing fees, charges, and benefit assessments. Assessments, fees, and charges imposed as an "incident of property ownership" are now subject to a majority public vote. Water-related charges potentially affected by Proposition 218 include some meter charges, acreage-based irrigation charges, and standby charges. Not all post-Proposition 218 proposed assessments to fund water agency charges have succeeded in receiving voter approval. Most water agencies use a combination of fees for water service and other charges or property assessments to cover operating costs. Depending on an individual agency's fee structure, it could experience financial problems during a drought, when water sales revenues are down and the need for voter approval would limit ability to increase assessments.

- In 1996 and 1997, NMFS listed Coho salmon in two coastal areas as threatened. In 1997, NMFS listed two coastal steelhead populations as threatened and one as endangered, followed by 1998 listing of Central Valley steelhead as threatened. In 1999, Central Valley spring-run Chinook and coastal Chinook were listed as threatened. USFWS listed Sacramento Splittail as threatened in 1999, but a July 2000 federal district court decision found that listing to be arbitrary and capricious. The CALFED Operations Group has been serving as the forum for coordinating day-to-day CVP and SWP operations with requirements for protecting listed species. Decisions have been based on use of near-real-time monitoring data to identify locations of listed migratory and resident species in the Delta and upstream rivers, together with take data at the pumping plants. The CALFED Operations Group has been following adaptive management techniques selecting a strategy, evaluating its effectiveness, and then either refining the strategy or adopting another approach.

- In 1997, the Colorado River Board released a draft plan outlining steps to reduce California's use of river water to the State's basic 4.4 maf apportionment, in years when surplus river water is not available. California water users have historically exceeded the basic apportionment by as much as 900 taf due to availability of surplus water and Arizona's and Nevada's unused apportionments. MWD is the most junior California water user; if the interstate apportionments were enforced in a year when surplus water was not available, the Colorado River Aqueduct would be only half full. Work to complete California's draft Colorado River Water Use Plan is continuing. The plan is based on the concept that the CRA will be kept full through transfers of conserved agricultural water (such as the Imperial Irrigation District/SDCWA transfer), water saved by lining the All American and Coachella Canals, and by implementing new groundwater storage projects. The groundwater storage projects would take surplus river water, when available, and recharge it in groundwater basins near the aqueduct.

- In late 1999, USBR and USFWS released a draft EIS identifying Trinity River instream flow alternatives. From 1981 to 1990, USBR provided instream flows of 287 taf in drought years and 340 taf in wet years. In 1991, the Secretary of the Interior directed that flows be increased to 340 taf per year, the amount subsequently required by CVPIA pending completion of USFWS' instream flow studies. Alternatives presented in the DEIS would substantially increase instream flows, correspondingly decreasing CVP water supplies. The federal agencies are currently considering public comments received on the DEIS.

- County groundwater management ordinances adopted in 1999 increased the percentage of California's counties with such ordinances to almost 30 percent. Most of the ordinances post-date the last drought. The numerous groundwater substitution transfers implemented as part of the Department's 1991 and 1992 drought water banks served to heighten local interest in use of county ordinances to control groundwater exports. In 1994, Butte County's ordinance withstood a legal challenge regarding the ability of cities and counties to issue such ordinances, encouraging other counties to consider this approach. The majority of county ordinances regulate groundwater exports from a county, typically by requiring a conditional use permit before export can occur. Permit issuance may be conditioned on findings that export will not result in groundwater overdraft, degrade groundwater quality, or otherwise impact local groundwater resources.

An observation that can be drawn from these changes in laws, regulations, and institutional conditions is that many of them reduce the amount of supplies historically available to agricultural and urban water users. Under either average water year or 1928-34 drought hydrology, for example, more than 1 maf of developed supply has been reallocated from urban and agricultural purposes to environmental purposes by CVP and Order WR 95-6. (This amount does not include reductions in Delta exports due to incidental take limits for listed fish species.) The loss of historically available Colorado River water will further increase the reduction in supplies.

In addition to dwindling water supplies, demographic trends affect water use patterns. California's population has increased by more than 6 million people since 1987, the first year of the last drought. According to the Department of Finance, California's population growth is shifting from the State's densely urbanized coastal areas to inland regions. Urban per capita water use is higher in the State's inland regions than it is in coastal areas, reflecting higher landscape water use due to warmer and dryer climatic conditions. Regions expected to have the highest percent growth rates over the next 20 years are the Inland Empire, Central Valley, and Sierra Nevada foothills. As greater development occurs in these inland areas, the ex-urban ring around them also expands. From a water demand perspective, the flight from suburban areas to low-density rural developments in areas such as the Sierra Nevada foothills is significant.

The potential for water demand hardening in California's large urbanized areas is another trend to monitor. Demand hardening occurs when agencies implement water conservation programs that result in permanent reductions in water use, such retrofitting plumbing fixtures or installing low water use landscaping. These measures lessen agencies' ability to implement rationing to reduce water use during droughts, and can result in greater impacts to urban water users (e.g., loss of residential landscaping) when rationing is imposed. For example, the extensive Los Angeles retrofit program helped the city maintain reductions in urban per capita water use it achieved during the last drought. These permanent water use reductions will make it more difficult for the city to duplicate its previous 15 percent water use reduction goal during a future droughts unless other innovative options are pursued (such as mandatory installation of waterfree urinals in public facilities.)

Interest in better coordination between land use planning performed by cities and counties and water supply planning performed by special districts is increasing, especially in areas experiencing significant development pressure. This subject was first addressed legislatively in 1995, with a requirement that cities and counties making specified land use decisions, such as amending a general plan, consult with local water agencies to determine if supplies are available, and to disclose findings through the California Environmental Quality Act process.

In its January 2000 report, Growth Within Bounds, the Commission on Local Governance for the 21$^{st}$ Century made several recommendations relating to orderly growth and the provision of infrastructure, including calling for a more proactive role by local agency formation commissions and for strengthening the linkage between local land use and water supply planning. In the context of drought preparedness, a stronger linkage would be particularly beneficial in the rural counties experiencing suburban flight from rapidly growing inland areas of the state. As indicated earlier, the low population densities and lack of ability to interconnect many small water systems makes these areas vulnerable to drought impacts.

The National Drought Policy Commission released a report in May 2000 that stressed the importance of planning response actions before droughts occur, to reduce the need for emergency relief actions. The federal role has historically focused on emergency relief actions, not on planning, especially in agricultural programs. The report noted that 88 drought-related federal programs had been funded within the last ten years, with USDA having the greatest federal responsibilities for drought response and assistance programs. Such programs may represent a major opportunity for market development purposes in the long run.

# APPENDIX A – NATIONAL WATER QUALITY STANDARDS

## Current Drinking Water Standards

National Primary Drinking Water Regulations (NPDWRs or primary standards) are legally enforceable standards that apply to public water systems. Primary standards protect drinking water quality by limiting the levels of specific contaminants that can adversely affect public health and are known or anticipated to occur in public water systems. Table 1 divides these contaminants into Inorganic Chemicals, Organic Chemicals, Radionuclides, and Microorganisms.

**Table A-1**
**National Primary Drinking Water Standards**

| Inorganic Chemicals | MCLG[1] (mg/L)[4] | MCL[2] or TT[3] (mg/L)[4] | Potential Health Effects from Ingestion of Water | Sources of Contaminant in Drinking Water |
|---|---|---|---|---|
| Antimony | 0.006 | 0.006 | Increase in blood cholesterol; decrease in blood glucose | Discharge from petroleum refineries; fire retardants; ceramics; electronics; solder |
| Arsenic | none[5] | 0.05 | Skin damage; circulatory system problems; increased risk of cancer | Discharge from semiconductor manufacturing; petroleum refining; wood preservatives; animal feed additives; herbicides; erosion of natural deposits |
| Asbestos (fiber >10 micrometers) | 7 million fibers per Liter | 7 MFL | Increased risk of developing benign intestinal polyps | Decay of asbestos cement in water mains; erosion of natural deposits |
| Barium | 2 | 2 | Increase in blood pressure | Discharge of drilling wastes; discharge from metal refineries; erosion of natural deposits |
| Beryllium | 0.004 | 0.004 | Intestinal lesions | Discharge from metal refineries and coal-burning factories; discharge from electrical, aerospace, and defense industries |
| Cadmium | 0.005 | 0.005 | Kidney damage | Corrosion of galvanized pipes; erosion of natural deposits; discharge from metal refineries; runoff from waste batteries and paints |
| Chromium (total) | 0.1 | 0.1 | Some people who use water containing chromium well in excess of the MCL over many years could experience allergic dermatitis | Discharge from steel and pulp mills; erosion of natural deposits |

| Inorganic Chemicals | MCLG[1] (mg/L)[4] | MCL[2] or TT[3] (mg/L)[4] | Potential Health Effects from Ingestion of Water | Sources of Contaminant in Drinking Water |
|---|---|---|---|---|
| Copper | 1.3 | Action Level=1.3; TT[6] | Short term exposure: Gastrointestinal distress. Long term exposure: Liver or kidney damage. Those with Wilson's Disease should consult their personal doctor if their water systems exceed the copper action level. | Corrosion of household plumbing systems; erosion of natural deposits; leaching from wood preservatives |
| Cyanide (as free cyanide) | 0.2 | 0.2 | Nerve damage or thyroid problems | Discharge from steel/metal factories; discharge from plastic and fertilizer factories |
| Fluoride | 4.0 | 4.0 | Bone disease (pain and tenderness of the bones); Children may get mottled teeth. | Water additive which promotes strong teeth; erosion of natural deposits; discharge from fertilizer and aluminum factories |
| Lead | zero | Action Level=0.015; TT[6] | Infants and children: Delays in physical or mental development.<br>Adults: Kidney problems; high blood pressure | Corrosion of household plumbing systems; erosion of natural deposits |
| Inorganic Mercury | 0.002 | 0.002 | Kidney damage | Erosion of natural deposits; discharge from refineries and factories; runoff from landfills and cropland |
| Nitrate (measured as Nitrogen) | 10 | 10 | "Blue baby syndrome" in infants under six months - life threatening without immediate medical attention. Symptoms: Infant looks blue and has shortness of breath. | Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits |
| Nitrite (measured as Nitrogen) | 1 | 1 | "Blue baby syndrome" in infants under six months - life threatening without immediate medical attention. Symptoms: Infant looks blue and has shortness of breath. | Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits |
| Selenium | 0.05 | 0.05 | Hair or fingernail loss; numbness in fingers or toes; circulatory problems | Discharge from petroleum refineries; erosion of natural deposits; discharge from mines |
| Thallium | 0.0005 | 0.002 | Hair loss; changes in blood; kidney, intestine, or liver problems | Leaching from ore-processing sites; discharge from electronics, glass, and pharmaceutical companies |

| Organic Chemicals | MCLG[1] | MCL[2] or | Potential Health Effects from | Sources of Contaminant in |
|---|---|---|---|---|

| | (mg/L)[4] | TT[3] (mg/L)[4] | Ingestion of Water | Drinking Water |
|---|---|---|---|---|
| Acrylamide | zero | TT[7] | Nervous system or blood problems; increased risk of cancer | Added to water during sewage/wastewater treatment |
| Alachlor | zero | 0.002 | Eye, liver, kidney or spleen problems; anemia; increased risk of cancer | Runoff from herbicide used on row crops |
| Atrazine | 0.003 | 0.003 | Cardiovascular system problems; reproductive difficulties | Runoff from herbicide used on row crops |
| Benzene | zero | 0.005 | Anemia; decrease in blood platelets; increased risk of cancer | Discharge from factories; leaching from gas storage tanks and landfills |
| Benzo(a)pyrene | zero | 0.0002 | Reproductive difficulties; increased risk of cancer | Leaching from linings of water storage tanks and distribution lines |
| Carbofuran | 0.04 | 0.04 | Problems with blood or nervous system; reproductive difficulties. | Leaching of soil fumigant used on rice and alfalfa |
| Carbon tetrachloride | zero | .005 | Liver problems; increased risk of cancer | Discharge from chemical plants and other industrial activities |
| Chlordane | zero | 0.002 | Liver or nervous system problems; increased risk of cancer | Residue of banned termiticide |
| Chlorobenzene | 0.1 | 0.1 | Liver or kidney problems | Discharger from chemical and agricultural chemical factories |
| 2,4-D | 0.07 | 0.07 | Kidney, liver, or adrenal gland problems | Runoff from herbicide used on row crops |
| Dalapon | 0.2 | 0.2 | Minor kidney changes | Runoff from herbicide used on rights of way |
| 1,2-Dibromo-3-chloropropane (DBCP) | zero | 0.0002 | Reproductive difficulties; increased risk of cancer | Runoff/leaching from soil fumigant used on soybeans, cotton, pineapples, and orchards |
| o-Dichlorobenzene | 0.6 | 0.6 | Liver, kidney, or circulatory system problems | Discharge from industrial chemical factories |
| p-Dichlorobenzene | 0.075 | 0.075 | Anemia; liver, kidney or spleen damage; changes in blood | Discharge from industrial chemical factories |
| 1,2-Dichloroethane | zero | 0.005 | Increased risk of cancer | Discharge from industrial chemical factories |
| 1-1-Dichloroethylene | 0.007 | 0.007 | Liver problems | Discharge from industrial chemical factories |
| cis-1, 2-Dichloroethylene | 0.07 | 0.07 | Liver problems | Discharge from industrial chemical factories |
| trans-1,2-Dichloroethylene | 0.1 | 0.1 | Liver problems | Discharge from industrial chemical factories |

| Organic Chemicals | MCLG[1] (mg/L)[4] | MCL[2] or TT[3] (mg/L)[4] | Potential Health Effects from Ingestion of Water | Sources of Contaminant in Drinking Water |
|---|---|---|---|---|
| Dichloromethane | zero | 0.005 | Liver problems; increased risk of cancer | Discharge from pharmaceutical and chemical factories |
| 1-2-Dichloropropane | zero | 0.005 | Increased risk of cancer | Discharge from industrial chemical factories |
| Di(2-ethylhexyl)adipate | 0.4 | 0.4 | General toxic effects or reproductive difficulties | Leaching from PVC plumbing systems; discharge from chemical factories |
| Di(2-ethylhexyl)phthalate | zero | 0.006 | Reproductive difficulties; liver problems; increased risk of cancer | Discharge from rubber and chemical factories |
| Dinoseb | 0.007 | 0.007 | Reproductive difficulties | Runoff from herbicide used on soybeans and vegetables |
| Dioxin (2,3,7,8-TCDD) | zero | 0.00000003 | Reproductive difficulties; increased risk of cancer | Emissions from waste incineration and other combustion; discharge from chemical factories |
| Diquat | 0.02 | 0.02 | Cataracts | Runoff from herbicide use |
| Endothall | 0.1 | 0.1 | Stomach and intestinal problems | Runoff from herbicide use |
| Endrin | 0.002 | 0.002 | Nervous system effects | Residue of banned insecticide |
| Epichlorohydrin | zero | TT[7] | Stomach problems; reproductive difficulties; increased risk of cancer | Discharge from industrial chemical factories; added to water during treatment process |
| Ethylbenzene | 0.7 | 0.7 | Liver or kidney problems | Discharge from petroleum refineries |
| Ethelyne dibromide | zero | 0.00005 | Stomach problems; reproductive difficulties; increased risk of cancer | Discharge from petroleum refineries |
| Glyphosate | 0.7 | 0.7 | Kidney problems; reproductive difficulties | Runoff from herbicide use |
| Heptachlor | zero | 0.0004 | Liver damage; increased risk of cancer | Residue of banned termiticide |
| Heptachlor epoxide | zero | 0.0002 | Liver damage; increased risk of cancer | Breakdown of hepatachlor |
| Hexachlorobenzene | zero | 0.001 | Liver or kidney problems; reproductive difficulties; increased risk of cancer | Discharge from metal refineries and agricultural chemical factories |
| Hexachlorocyclopentadiene | 0.05 | 0.05 | Kidney or stomach problems | Discharge from chemical factories |
| Lindane | 0.0002 | 0.0002 | Liver or kidney problems | Runoff/leaching from insecticide used on _andfi, lumber, gardens |
| Methoxychlor | 0.04 | 0.04 | Reproductive difficulties | Runoff/leaching from insecticide used on fruits, vegetables, alfalfa, livestock |

| Organic Chemicals | MCLG[1] (mg/L)[4] | MCL[2] or TT[3] (mg/L)[4] | Potential Health Effects from Ingestion of Water | Sources of Contaminant in Drinking Water |
|---|---|---|---|---|
| Oxamyl (Vydate) | 0.2 | 0.2 | Slight nervous system effects | Runoff/leaching from insecticide used on apples, potatoes, and tomatoes |
| Polychlorinated biphenyls (PCBs) | zero | 0.0005 | Skin changes; thymus gland problems; immune difficiencies; reproductive or nervous system difficulties; increased risk of cancer | Runoff from _andfills; discharge of waste chemicals |
| Pentachlorophenol | zero | 0.001 | Liver or kidney problems; increased risk of cancer | Discharge from wood preserving factories |
| Picloram | 0.5 | 0.5 | Liver problems | Herbicide runoff |
| Simazine | 0.004 | 0.004 | Problems with blood | Herbicide runoff |
| Styrene | 0.1 | 0.1 | Liver, kidney, and circulatory problems | Discharge from rubber and plastic factories; leaching from landfills |
| Tetrachloroethylene | zero | 0.005 | Liver problems; increased risk of cancer | Discharge from factories and dry cleaners |
| Toluene | 1 | 1 | Nervous system, kidney, or liver problems | Discharge from petroleum factories |
| Total Trihalomethanes (TTHMs) | none[5] | 0.10 | Liver, kidney or central nervous system problems; increased risk of cancer | Byproduct of drinking water disinfection |
| Toxaphene | zero | 0.003 | Kidney, liver, or thyroid problems; increased risk of cancer | Runoff/leaching from insecticide used on cotton and cattle |
| 2,4,5-TP (Silvex) | 0.05 | 0.05 | Liver problems | Residue of banned herbicide |
| 1,2,4-Trichlorobenzene | 0.07 | 0.07 | Changes in adrenal glands | Discharge from textile finishing factories |
| 1,1,1-Trichloroethane | 0.20 | 0.2 | Liver, nervous system, or circulatory problems | Discharge from metal degreasing sites and other factories |
| 1,1,2-Trichloroethane | 0.003 | 0.005 | Liver, kidney, or immune system problems | Discharge from industrial chemical factories |
| Trichloroethylene | zero | 0.005 | Liver problems; increased risk of cancer | Discharge from petroleum refineries |
| Vinyl chloride | zero | 0.002 | Increased risk of cancer | Leaching from PVC pipes; discharge from plastic factories |
| Xylenes (total) | 10 | 10 | Nervous system damage | Discharge from petroleum factories; discharge from chemical factories |

| Radionuclides | MCLG[1] (mg/L)[4] | MCL[2] or TT[3] (mg/L)[4] | Potential Health Effects from Ingestion of Water | Sources of Contaminant in Drinking Water |
|---|---|---|---|---|
| Beta particles and photon emitters | none[5] | 4 millirems per year | Increased risk of cancer | Decay of natural and man-made deposits |
| Gross alpha particle activity | none[5] | 15 picocuries per Liter (pCi/L) | Increased risk of cancer | Erosion of natural deposits |
| Radium 226 and Radium 228 (combined) | none[5] | 5 pCi/L | Increased risk of cancer | Erosion of natural deposits |

| Microorganisms | MCLG[1] (mg/L)[4] | MCL[2] or TT[3] (mg/L)[4] | Potential Health Effects from Ingestion of Water | Sources of Contaminant in Drinking Water |
|---|---|---|---|---|
| *Giardia lamblia* | zero | TT[8] | Giardiasis, a gastroenteric disease | Human and animal fecal waste |
| Heterotrophic plate count | N/A | TT[8] | HPC has no health effects, but can indicate how effective treatment is at controlling microorganisms. | n/a |
| *Legionella* | zero | TT[8] | Legionnaire's Disease, commonly known as pneumonia | Found naturally in water; multiplies in heating systems |
| Total Coliforms (including fecal coliform and *E. Coli*) | zero | 5.0%[9] | Used as an indicator that other potentially harmful bacteria may be present[10] | Human and animal fecal waste |
| Turbidity | N/A | TT[8] | Turbidity has no health effects but can interfere with disinfection and provide a medium for microbial growth. It may indicate the presence of microbes. | Soil runoff |
| Viruses (enteric) | zero | TT[8] | Gastroenteric disease | Human and animal fecal waste |

## National Secondary Drinking Water Standards

National Secondary Drinking Water Regulations (NSDWRs or secondary standards) are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. EPA recommends secondary standards to water systems but does not require systems to comply. However, states may choose to adopt them as enforceable standards (see Table 2, below.)

## Table A-2

## Secondary Water Quality Standards

| Contaminant | Secondary Standard | Contaminant | Secondary Standard |
|---|---|---|---|
| Aluminum | 0.05 to 0.2 mg/L | Iron | 0.3 mg/L |
| Chloride | 250 mg/L | Manganese | 0.05 mg/L |
| Color | 15 (color units) | Odor | 3 threshold odor number |
| Copper | 1.0 mg/L | pH | 6.5-8.5 |
| Corrosivity | Non-corrosive | Silver | 0.10 mg/L |
| Fluoride | 2.0 mg/L | Sulfate | 250 mg/L |
| Foaming Agents | 0.5 mg/L | Total Dissolved Solids | 500 mg/L |
| Zinc | 5 mg/L | | |

**Notes**

[1] Maximum Contaminant Level Goal (MCLG) - The maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on the health effect of persons would occur, and which allows for an adequate margin of safety. MCLGs are non-enforceable public health goals.

[2] Maximum Contaminant Level (MCL) - The maximum permissible level of a contaminant in water which is delivered to any user of a public water system. MCLs are enforceable standards. The margins of safety in MCLGs ensure that exceeding the MCL slightly does not pose significant risk to public health.

[3] Treatment Technique - An enforceable procedure or level of technical performance which public water systems must follow to ensure control of a contaminant.

[4] Units are in milligrams per Liter (mg/L) unless otherwise noted.

[5] MCLGs were not established before the 1986 Amendments to the Safe Drinking Water Act. Therefore, there is no MCLG for this contaminant.

[6] Lead and copper are regulated in a Treatment Technique which requires systems to take tap water samples at sites with lead pipes or copper pipes that have lead solder and/or are served by lead service lines. The action level, which triggers water systems into taking treatment steps if exceeded in more than 10% of tap water samples, for copper is 1.3 mg/L, and for lead is 0.015mg/L.

[7] Each water system must certify, in writing, to the state (using third-party or manufacturer's certification) that when acrylamide and epichlorohydrin are used in drinking water systems, the combination (or product) of dose and monomer level does not exceed the levels specified, as follows:

- **Acrylamide** = 0.05% dosed at 1 mg/L (or equivalent)
- **Epichlorohydrin** = 0.01% dosed at 20 mg/L (or equivalent)

[8] The Surface Water Treatment Rule requires systems using surface water or ground water under the direct influence of surface water to (1) disinfect their water, and (2) filter their water or meet criteria for avoiding filtration so that the following contaminants are controlled at the following levels:

- ***Giardia lamblia****:* 99.9% killed/inactivated
- ***Viruses:*** 99.99% killed/inactivated
- ***Legionella****:* No limit, but EPA believes that if *Giardia* and viruses are inactivated, *Legionella* will also be controlled.
- ***Turbidity:*** At no time can turbidity (cloudiness of water) go above 5 nephelolometric turbidity units (NTU); systems that filter must ensure that the turbidity go no higher than 1 NTU (0.5 NTU for conventional or direct filtration) in at least 95% of the daily samples in any month.
- ***HPC:*** No more than 500 bacterial colonies per milliliter.

[9] No more than 5.0% samples total coliform-positive in a month. (For water systems that collect fewer than 40 routine samples per month, no more than one sample can be total coliform-positive). Every sample that has total coliforms must be analyzed for fecal coliforms. There cannot be any fecal coliforms.

[10] Fecal coliform and *E. coli* are bacteria whose presence indicates that the water may be contaminated with human animal wastes. Microbes in these wastes can cause diarrhea, cramps, nausea, headaches, or other symptoms.

# APPENDIX B - STATE WATER QUALITY STANDARDS

Primary maximum contaminant levels (MCLs) are established by the State of California Department of Health Services (DHS) for a number of chemical and radioactive contaminants. Primary MCLs can be found in Title 22 California Code of Regulations (CCR) for inorganic chemicals, trihalomethane, radioactivity and organic chemicals. (See DHS' compilation of drinking water statutes and regulations.)

Three contaminants with primary MCLs also have secondary MCLs: aluminum, MTBE, and thiobencarb.

**Table B-1**
**State of California Primary Drinking Water Standards**

| **PRIMARY MAXIMUM CONTAMINANT LEVELS** All values are in milligrams per liter (mg/L), unless otherwise noted; 2° MCL = secondary MCL | |
|---|---|
| **Contaminant** | **Primary MCL** |
| **Inorganic Chemicals** | |
| Aluminum (2° MCL = 0.2 mg/L) | 1 |
| Antimony | 0.006 |
| Arsenic | 0.05 |
| Asbestos (MFL = million fibers per liter, for fibers exceeding 10 microns in length) | 7 MFL |
| Barium | 1 |
| Beryllium | 0.004 |
| Cadmium | 0.005 |
| Chromium | 0.05 |
| Cyanide | 0.2 |
| Fluoride | 2.0 |
| Mercury | 0.002 |
| Nickel | 0.1 |
| Nitrate (as $NO_3$) | 45 |
| Nitrate + Nitrite (sum as nitrogen) | 10 |
| Nitrite (as nitrogen) | 1 |
| Selenium | 0.05 |
| Thallium | 0.002 |
| **Optimal Fluoride Levels** | |
| **Annual average of maximum daily air temperature (degrees Fahrenheit, ºF)** | **Optimal Level (Range)** |
| 50.0 to 53.7 ºF | 1.2 (1.1-1.7) |
| 53.8 to 58.3 ºF | 1.1 (1.0-1.6) |
| 58.4 to 63.8 ºF | 1.0 (0.9-1.5) |
| 63.9 to 70.6 ºF | 0.9 (0.8-1.4) |
| 70.7 to 79.2 ºF | 0.8 (0.7-1.3) |
| 79.3 to 90.5 ºF | 0.7 (0.6-1.2) |

| | |
|---|---|
| **Radioactivity** | |
| Gross alpha particle activity (including radium-226 but excluding radon and uranium) | 15 picocuries per liter (pCi/L) |
| Gross beta particle activity | 50 pCi/L |
| Combined Radium-226 and Radium-228 | 5 pCi/L |
| Strontium-90 | 8 pCi/L |
| Tritium | 20,000 pCi/L |
| Uranium | 20 pCi/L |
| **Total Trihalomethanes** | |
| Sum of bromodichloromethane, dibromochloromethane, bromoform, and chloroform | 0.1 |
| **Organic Chemicals** | |
| **(a) Volatile Organic Chemicals (VOCs)** | |
| Benzene | 0.001 |
| Carbon tetrachloride | 0.0005 |
| 1,2-Dichlorobenzene (o-Dichlorobenzene) | 0.6 |
| 1,4-Dichlorobenzene (p-DCB) | 0.005 |
| 1,1-Dichloroethane (1,1-DCA) | 0.005 |
| 1,2-Dichloroethane (1,2-DCA) | 0.0005 |
| 1,1-Dichloroethylene (1,1-DCE) | 0.006 |
| cis-1,2-Dichloroethylene | 0.006 |
| trans-1,2-Dichloroethylene | 0.01 |
| Dichloromethane (Methylene chloride) | 0.005 |
| 1,2-Dichloropropane (Propylene dichloride) | 0.005 |
| 1,3-Dichloropropene | 0.0005 |
| Ethylbenzene (Phenylethane) | 0.7 |
| Monochlorobenzene (Chlorobenzene) | 0.07 |
| Methyl tert-Butyl Ether (MTBE) ($2^{o}$ MCL = 0.005 mg/L) | 0.013 |
| Styrene (Vinylbenzene) | 0.1 |
| 1,1,2,2-Tetrachloroethane | 0.001 |
| Tetrachloroethylene (PCE) | 0.005 |
| Toluene (Methylbenzene) | 0.15 |
| 1,2,4-Trichlorobenzene (Unsym-Trichlorobenzene) | 0.07 |
| 1,1,1-Trichloroethane (1,1,1-TCA) | 0.200 |
| 1,1,2-Trichloroethane (1,1,2-TCA) | 0.005 |
| Trichloroethylene (TCE) | 0.005 |
| Trichlorofluoromethane (Freon 11) | 0.15 |
| 1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113) | 1.2 |
| Vinyl chloride | 0.0005 |
| Xylenes (single isomer or sum of isomers) | 1.750 |

| (b) Non-Volatile Synthetic Organic Chemicals (SOCs) | |
|---|---|
| Alachlor (Alanex) | 0.002 |
| Atrazine (Aatrex) | 0.003 |
| Bentazon (Basagran) | 0.018 |
| Benzo(a)pyrene | 0.0002 |
| Carbofuran (Furadan) | 0.018 |
| Chlordane | 0.0001 |
| 2,4-D | 0.07 |
| Dalapon | 0.2 |
| 1,2-Dibromo-3-chloropropane (DBCP) | 0.0002 |
| Di(2-ethylhexyl)adipate | 0.4 |
| Di(2-ethylhexyl)phthalate (DEHP) | 0.004 |
| Dinoseb | 0.007 |
| Diquat | 0.02 |
| Endrin | 0.002 |
| Endothal | 0.1 |
| Ethylene dibromide (EDB) | 0.00005 |
| Glyphosate | 0.7 |
| Heptachlor | 0.00001 |
| Heptachlor epoxide | 0.00001 |
| Hexachlorobenzene | 0.001 |
| Hexachlorocyclopentadiene | 0.05 |
| Lindane (gamma-BHC) | 0.0002 |
| Methoxychlor | 0.04 |
| Molinate (Ordam) | 0.02 |
| Oxamyl | 0.2 |
| Pentachlorophenol | 0.001 |
| Picloram | 0.5 |
| Polychlorinated biphenyls (PCBs) | 0.0005 |
| Simazine (Princep) | 0.004 |
| 2,4,5-TP (Silvex) | 0.05 |
| 2,3,7,8-TCDD (Dioxin) | 0.00000003 |
| Thiobencarb (Bolero) ($2^o$ MCL = 0.001 mg/L) | 0.07 |
| Toxaphene | 0.003 |

Lead and copper have specific regulations in 22 CCR, Chapter 17.5 §64670, *et seq*. The lead and copper regulations use the term "action level" for each substance, for purposes of regulatory compliance. These action levels should not be confused with the DHS advisory action levels for unregulated chemical contaminants**.** Action levels for copper and lead, which are to be met at customer tap, are used to determine the treatment requirements that a water system is required to complete. The action level for copper is exceeded if the concentration of copper in more than 10 percent of tap water samples collected during any monitoring period conducted in accordance with 22 CCR §64682-§64685 is greater than 1.3 mg/L. Similarly, the action level for lead is exceeded if the concentration of lead in more than 10 percent of tap water samples collected in accordance with 22 CCR §64682-§64685 is greater than 0.015 mg/L. Failure to comply with the applicable requirements for lead and copper (22 CCR Chapter 17.5) is a violation of primary drinking water standards for these substances.

**Table B-2**
**State of California Action Levels for Lead and Copper**

| Chemical | Action Level (mg/L) |
|---|---|
| Copper | 1.3 |
| Lead | 0.015 |

Secondary MCLS are established for a number of chemicals, characteristics or constituents and address taste, odor, or appearance of drinking water. (See DHS' compilation of drinking water statutes and regulations.) Three contaminants with secondary MCLs also have primary MCLs: aluminum, MTBE, and thiobencarb.

**Table B-3**
**State of California Secondary Drinking Water Quality Standards**

| SECONDARY MAXIMUM CONTAMINANT LEVELS<br>All values are in milligrams per liter (mg/L), unless otherwise noted. 1$^o$ MCL = primary MCL | | | |
|---|---|---|---|
| **Chemical or Characteristic** | | **Secondary MCL** | |
| Aluminum (1$^o$ MCL = 1 mg/L) | | 0.2 | |
| Color | | 15 units | |
| Copper | | 1.0 | |
| Corrosivity | | Non-corrosive | |
| Foaming agents (MBAS) | | 0.5 | |
| Iron | | 0.3 | |
| Manganese | | 0.05 | |
| Methyl tertiary butyl ether (MTBE) (1$^o$ MCL = 0.013 mg/L) | | 0.005 | |
| Odor-Threshold | | 3 units | |
| Silver | | 0.1 | |
| Thiobencarb (Bolero) (1$^o$ MCL = 0.07 mg/L) | | 0.001 | |
| Turbidity | | 5 units | |
| Zinc | | 5.0 | |
| **Constituent** | **Secondary MCL Ranges** | | |
| | **Recommended** | **Upper** | **Short Term** |
| Total Dissolved Solids, or | 500 | 1,000 | 1,500 |
| Specific Conductance, micromhos | 900 | 1,600 | 2,200 |
| Chloride | 250 | 500 | 600 |
| Sulfate | 250 | 500 | 600 |