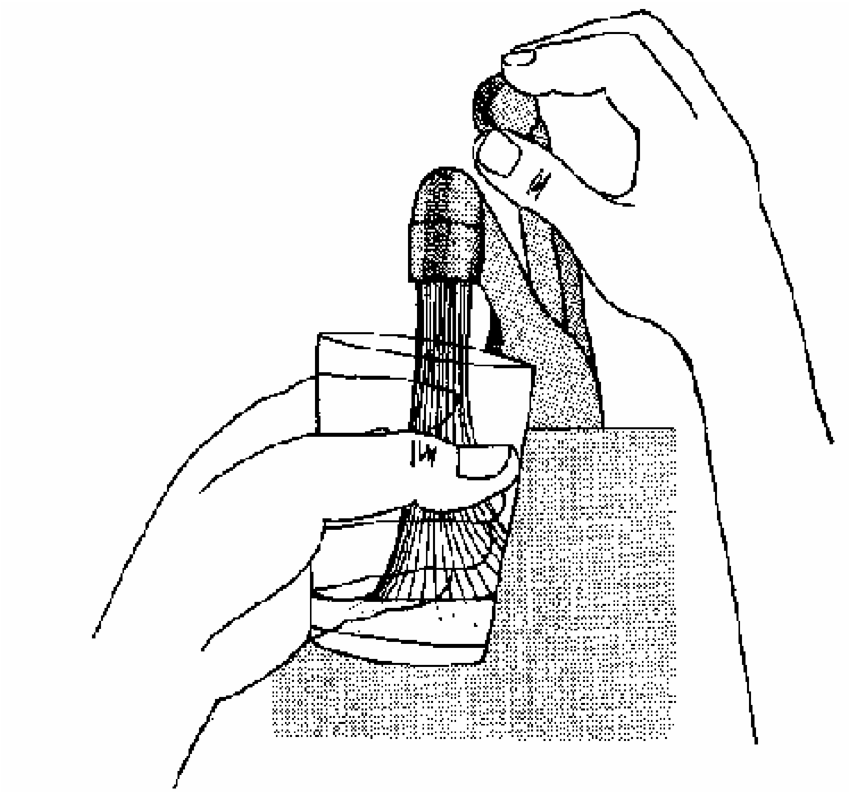
INTERPRETING DRINKING WATER QUALITY ANALYSIS

WHAT DO THE NUMBERS MEAN?

6th Edition*



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*** PLEASE NOTE: This reflects changes in the Safe Drinking Water Act effective 2/2005. Previous editions are no longer accurate.**

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The 6th Edition of “Interpreting Drinking Water Quality Analysis, What Do the Numbers Mean?” is an update of an already recognized publication, requiring input from many people.

We would like to thank **Fred Dickert** of the NJ Department of Environmental Protection (NJDEP) Bureau of Safe Drinking Water; **Perry Cohn** of the NJ Department of Health and Senior Services; **Gloria Post, Judy Louis** and **Tom Atherholt** of the NJDEP, Division of Science, Research and Technology; and also from the NJDEP Bureau of Safe Drinking Water, **Pat Bono, Nasir Butt, Randi DeMartini, Bill Dietz, Felicia Fieo, Sandy Krietzman, Joe Ludovico, Matt Maffei, Diane Pupa, Sonny Saroya, John Shevlin,** and **Matt Wilson**. Additional thanks to **Barker Hamill**, Chief, Bureau of Safe Drinking Water, for allowing the use of his staff in this endeavor.

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INTRODUCTION

This publication summarizes the information necessary for interpreting drinking water quality analyses performed by water testing laboratories. It focuses on testing results obtained from drinking water supplies from public water systems and non-public water systems (home wells). It is intended primarily for homeowners, but environmental organizations, health departments, and commercial water testing laboratories and others should find this material of interest and value.

For readers who are not familiar with the terms and chemical expressions used in the text, a brief list of definitions follows the main text in “Definition of Terms.”

WHAT IS PURE WATER?

We know that all life is dependent on water and that water exists in nature in many forms - clouds, rain, snow, ice, and fog; however, strictly speaking, chemically pure water does not exist for any appreciable length of time in nature. Even while falling as rain, water picks up small amounts of gases, ions, dust, and particulate matter from the atmosphere. Then, as it flows over or through the surface layers of the earth, it dissolves and carries with it some of almost everything it touches, including that which is dumped into it by man.

These added substances may be arbitrarily classified as biological, chemical (both inorganic and organic), physical, and radiological impurities. They include industrial and commercial solvents, metals and acid salts, sediments, pesticides, herbicides, plant nutrients, radioactive materials, road salts, decaying animal and vegetable matter, and living microorganisms, such as algae, bacteria, and viruses. These impurities may give water a bad taste, color, odor, or cloudy appearance (turbidity), and cause hardness, corrosiveness, staining, or frothing. They may damage growing plants and transmit disease. Many of these impurities are removed or rendered harmless, however, in municipal drinking water treatment plants.

Pure water means different things to different people. Homeowners are primarily concerned with domestic water problems related to color, odor, taste, and safety to family health, as well as the cost of soap, detergents, “softening,” or other treatments required for improving the water quality. Chemists and engineers working for industry are concerned with the purity of water as it relates to scale deposition and pipe corrosion. Regulatory agencies are concerned with setting standards to protect public health. Farmers are interested in the effects of irrigation waters on the chemical, physical, and osmotic properties of soils, particularly as they influence crop production; hence, they are concerned with the water’s total mineral content, proportion of sodium, or content of ions “toxic” to plant growth.

One means of establishing and assuring the purity and safety of water is to set a standard for various contaminants. A standard is a definite rule, principle, or measurement that is established by governmental authority. The fact that it has been established by authority makes a standard official and legal. Standards are based on the principals of sound science and risk-based standard setting, while appropriately balancing economic factors as allowed according to applicable laws and regulations. Where human health data or other scientific data are sparse, standards have sometimes been established on an interim basis until better information becomes available.

The Safe Drinking Water Act (SDWA) sets minimum standards to be met by all public water systems. New Jersey and most other states have established their own drinking water regulations using federal regulations as a basis. State regulations may be more stringent than the federal regulations. In New Jersey, these same drinking water standards also apply to nonpublic (or private) drinking water systems, and are used to determine well failures in accordance with the NJ Private Well Testing Act (PWTA).

INTRODUCTION TO THE SAFE DRINKING WATER ACT

The Federal Safe Drinking Water Act (P.L. 93-523) was signed into law in 1974 and amended several times thereafter. The act authorized the U.S. Environmental Protection Agency (USEPA) to establish a cooperative program among local, state, and federal agencies for drinking water. Under the SDWA, the primary role of the federal government was to develop national drinking water regulations that protect public health and welfare. The states could request the responsibility of implementing the regulations and monitoring the performance of public water systems. The public water systems themselves were responsible for treating and testing their own drinking water to ensure that the quality consistently met the standards set by the regulations.

As directed by the SDWA, the USEPA developed primary and secondary drinking water regulations designed to protect public health and welfare. These regulations establish several important definitions. They include the following:

A *Public Water_System* means a system for the provision to the public of water for human consumption through pipes or other constructed conveyances, if the system has at least 15 service connections or regularly serves at least 25 individuals daily at least 60 days out of the year. A public water system is either a "community water system" or a "non-community water system." Basically, a community system serves water to a residential population, whereas a non-community system serves water to a nonresidential population.

A *Community Water System* means a public water system which serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents.

A *Non-community Water System* means a public water system that is not a community water system. A *non-community water system* is either a "transient non-community water system" or a "non-transient non-community water system." A "*non-transient non-community water system*" means a public water system that is not a community water system and that regularly serves at least 25 of the same persons over six months per year. Examples include separate water systems that serve schools, factories, industrial parks, and office buildings. A "*transient non-community water system*" means a non-community water system that does not regularly serve at least 25 of the same persons over six months of the year. Examples include separate water systems that serve motels, restaurants, campgrounds, highway rest stops and parks.

Please note that if the establishments mentioned above are served by a community water system, they are considered to be a part of that system and therefore are not subject to separate regulation. Since certain contaminants have adverse health effects only when consumed regularly over a long period, the distinctions between community, transient non-community and non-transient non-community systems are important in determining which contaminants must be monitored to protect public health.

A-280 AMENDMENTS TO THE NEW JERSEY SAFE DRINKING WATER ACT

The New Jersey Safe Drinking Water Act became law in September 1977. The New Jersey Department of Environmental Protection (NJDEP) is the primary agency for implementing the SDWA in New Jersey. <u>All regulations promulgated by USEPA are automatically adopted as New Jersey regulations.</u> In January 1984, the governor of New Jersey signed into law amendments to the New Jersey Safe Drinking Water Act. These amendments (P.L. 1983, c.443), commonly called A-280, required all public community water supplies to be periodically tested for a specified list of organic chemicals. The amendments also required the development of standards for these listed contaminants, as well as additional contaminants of concern due to their occurrence in ground and/or surface waters and potential for human health effects. Many of these chemicals are present in water supplies throughout the nation because of their widespread industrial and domestic use. New Jersey was one of the first states to require monitoring for these chemicals and now is a leading state in the development of additional drinking water standards. Regulations establishing New Jersey Maximum Contaminant Levels (MCLs) for 16 organic contaminants were published on January 3, 1989, N.J.A.C. 7:10-16. MCLs for additional contaminants were adopted in 1996, and one new MCL was proposed and adopted in 2004.

The A-280 amendments state that the goals of New Jersey's MCLs for carcinogens shall permit cancer in no more than one in a million persons ingesting that chemical for a lifetime, within the limits of medical, scientific, and technological feasibility. The MCLs for non-carcinogens shall eliminate, within the limits of practicality and feasibility, all adverse physiological effects that may result from ingestion. The New Jersey Drinking Water Quality Institute was established by the A-280 amendments to review scientific studies of the effects of chemicals detected in drinking water and recommend limits (MCLs) for each chemical. The Institute is comprised of representatives from the water suppliers, the general public, the academic science community, the NJDEP, and the New Jersey Department of Health and Senior Services (NJDHSS). These amendments, as well as additional MCLs adopted by NJDEP in 1996, lead to a reduction of risk and an improvement of drinking water statewide.

HEALTH EFFECTS OF DRINKING WATER CONTAMINANTS

Chemicals that are toxic and might be found in drinking water may cause either acute or chronic health effects. An acute effect usually follows a large dose of a chemical and occurs almost immediately. Examples of acute health effects are nausea, lung irritation, skin rash, vomiting, dizziness, and, in the extreme, death.

The levels of chemicals in drinking water, however, are rarely high enough to cause acute health effects. They are more likely to cause chronic health effects, effects that occur after exposure to small amounts of a chemical over a long period. Examples of chronic health effects include cancer, birth defects, organ damage, disorders of the nervous system, and damage to the immune system.

Evidence relating chronic human health effects to specific drinking water contaminants is very limited. In the absence of exact scientific information, scientists predict the likely adverse effects of chemicals in drinking water using laboratory animal studies and, when available, human data from clinical reports and epidemiological studies. The standard development process uses assumptions that are protective of public health in that they tend to err on the side of caution in assessing potential health risks.

USEPA and New Jersey classifies compounds for carcinogenicity potential according to the "weight of evidence" approach as stated in the Agency's current Guidelines for Carcinogen Risk Assessment (1986). These Guidelines specify five carcinogenicity classifications:

Group A - Human carcinogen (sufficient evidence from human epidemiological studies).
Group B - Probable human carcinogen.
  Group B1 - Limited evidence from human epidemiological studies
  Group B2 - Sufficient evidence in animals and inadequate or no data in humans.
Group C - Possible human carcinogen (limited evidence of carcinogenicity in the absence of human data).
Group D - Not classifiable (inadequate human and animal evidence of carcinogenicity). Group D chemicals are treated as non-carcinogens for purposes of risk assessment.
Group E - Evidence of noncarcinogenicity for humans (no evidence of carcinogenicity in at least two adequate animal tests in different species or in both epidemiological and animal studies).

Recently proposed revisions to the USEPA Guidelines for Carcinogen Risk Assessment may eliminate the alphanumeric categorization of carcinogens and may place greater emphasis on the mechanism through which chemicals produce cancer and their relevance to human risk.

The possible health effects of a contaminant in drinking water differ widely, depending on whether a person consumes the water over a long period, briefly, or intermittently. Thus, monitoring requirements for systems serving permanent populations (community water systems and non-transient non-community water systems) may be more comprehensive than for those systems serving transient or intermittent users (transient non-community water systems).

Maximum contaminant levels are based, directly or indirectly, on an assumed drinking water rate of two liters (about two quarts) per 70 kilograms (about 154 lbs.) per person per day over a 70 year span. MCLs for organic and inorganic contaminants (except nitrate*) are based on the potential health effects of long-term exposure, and they provide substantial protection to virtually all consumers. The uncertainty in this process is due in part to the variations in the knowledge of and the nature of the health risks of the various contaminants.

*see nitrate in *Inorganic Chemical Maximum Contaminant Levels* section

SETTING STANDARDS

MAXIMUM CONTAMINANT LEVELS (MCLs)

Standards set under authority of the SDWA are called Maximum Contaminant Levels (MCLs). An MCL is the highest amount of a specific contaminant allowed in the water delivered to any customer of a public water system. An MCL may be expressed in milligrams per liter (mg/l), which is the same for the purposes of water quality analysis as parts per million (ppm). The MCLs can also be expressed as micrograms/liter (µg/l) which is equivalent to parts per billion (ppb). One thousand micrograms per liter (1000 µg/l) is equivalent to one milligram per liter (1 mg/l). MCLs have been set by the USEPA and the NJDEP to provide a margin of safety to protect the public health.

Impurities in drinking water that are regulated and have an adverse health impact are grouped into six categories: inorganic chemical contaminants, volatile organic chemical contaminants, synthetic organic chemical contaminants, microbiological contaminants, radiological contaminants, and disinfection by-products.

The process of setting primary standards (MCLs) for drinking water contaminants is based on three criteria: (1) the contaminant causes adverse health effects; (2) instruments are available to detect the contaminant in drinking water; and (3) the contaminant is known to occur in drinking water.

The regulatory agency first looks at all the toxicological data on a contaminant usually obtained from chronic and subchronic animal studies. Occasionally human clinical or epidemiological data are also available. Experts use this information to estimate the concentration of a drinking water contaminant that may be toxic and the concentrations, if any, that may cause no adverse effects.

For chemicals that do not cause cancer, standards are based on a factor developed from animal or, less frequently, human studies called the Reference Dose (RfD), formerly called the Acceptable Daily Intake or ADI. The RfD is the estimate of the daily dose of a substance that a person can ingest over a lifetime without suffering any adverse health effects, and also incorporates uncertainty (safety) factors to provide a conservative margin of safety. Typically, the RfD is set hundreds to thousands of times less than the doses causing health effects in laboratory tests.

Regulators use the RfD to establish a Maximum Contaminant Level Goal (MCLG) (called Health-based Maximum Contaminant Level in New Jersey) for a contaminant. The MCLG is the concentration of a contaminant that experts believe a person can drink safely over a lifetime. It is based entirely on health considerations and, as a health goal, is set at a level where no adverse health effects should occur. The MCLG, which is not enforced by the USEPA or NJDEP, is used to set enforceable drinking water standards.

The MCL, the primary standard enforced by the USEPA and NJDEP, is set as close as possible to the MCLG. In setting an MCL, USEPA professionals consider, in addition to health effects, the feasibility and the combined cost of analyzing water for a contaminant and for treating water to remove the contaminant. Therefore, the MCL is often less stringent than the MCLG; however, by statute, the MCL must be set as close as is feasible to the MCLG.

In setting MCLs for chemicals believed to cause cancer, a different risk assessment process is used, and it is assumed that any concentration results in some risk of cancer. Consequently, the MCLG is set at zero. But, a zero level is not always possible to achieve, nor is it possible to measure because of the sensitivity of the analytical equipment and the limitations of analytical methods. USEPA incorporates cost and treatability considerations into the MCLs for carcinogens as with the noncarcinogenic MCLs; these MCLs must be set as close as is feasible to the MCLG.

In 1984, the A-280 Amendments required NJDEP to set drinking water standards for 22 contaminants listed in the A-280 amendments. At that time, there were no USEPA MCLs for these chemicals. The standard-setting process was specified in the 1983 amendments to the New Jersey Safe Drinking Water Act (A-280) and is in some ways different from the federal process for these chemicals. The carcinogenic MCLs were to be calculated with a goal such that no more than one in one million persons ingesting that chemical in drinking water over a lifetime would develop cancer (one in one million risk), within the limits of medical, scientific, and technological feasibility. This means that certain technological limitations, such as the ability to analyze and treat the chemical, had to be considered when establishing the MCL. The MCLs for non-carcinogens were calculated in the same manner as for the federal MCLs. In 1987, USEPA published MCLs for eight volatile organic chemicals that are also on the A-280 list. In nearly all cases, the MCLs developed by New Jersey for the same compounds were more stringent than the federal government's.

Setting drinking water standards is an imperfect process, rarely based on conclusive human evidence. Data relating human health effects to chemicals in drinking water are limited, and scientists have to rely on mathematical modeling for predicting the effects of drinking small amounts of chemicals for many years. In addition, regulatory decisions frequently incorporate economic, political, and social considerations. Therefore, it is important to understand that primary standards or MCLs for drinking water contaminants do not guarantee that water with a contaminant level below the standard is risk-free; nor do they mean that water with a higher contaminant level is unsafe.

Specific limits have not yet been set for every toxic, carcinogenic, or undesirable contaminant that might enter a public water supply. While the need for continued attention to chemical contaminants in water is recognized, the regulations are limited by available scientific and engineering data on which those judgments of safety can be made.

Table 1 lists the MCLs for public and non-public drinking water supplies in New Jersey (as of January 2002). The table combines both the federal and New Jersey Safe Drinking Water Act regulations. These regulations are subject to continuous change. Contact the NJDEP - Bureau of Safe Drinking Water, P.O Box 426, Trenton, NJ 08625-0426 for more current information, or visit the Division of Water Supply website at www.state.nj.us/dep/watersupply/.

Table 2 lists unregulated contaminants for which USEPA has set monitoring requirements as part of the Unregulated Contaminant Monitoring Rule of 1999. Unregulated contaminants are those for which USEPA has not established drinking water standards. The purpose of unregulated contaminant monitoring is to assist USEPA in determining the occurrence of unregulated contaminants in drinking water and whether future regulation is warranted.

Table 3 lists New Jersey State Secondary Drinking Water Regulations which includes contaminants in drinking water which may adversely affect the taste, odor, or appearance of the water, or which may otherwise adversely affect the public welfare.

> For a detailed explanation of the Safe Drinking Water Program, refer to the Federal Safe Drinking Water Act regulations [40 CFR Parts 141, 142, 143] and the New Jersey Safe Drinking Water regulations [N.J.A.C. 7:10-1 *et seq.*].

Table 1: Maximum Contaminant Levels (MCLs) for Public Drinking Water Supplies in New Jersey

VOLATILE ORGANIC CHEMICALS	MCL (in ppb or µg/l)
Benzene	1*
Carbon tetrachloride	2*
1,3-Dichlorobenzene	600*
1,2-Dichlorobenzene	600
1,4-Dichlorobenzene	75
1,1 Dichloroethane	50*
1,2-Dichloroethane	2*
1,1-Dichloroethylene	2*
cis-1,2-Dichloroethylene	70
trans-1,2-Dichloroethylene	100
1,2-Dichloropropane	5
Ethylbenzene	700
Methyl Tertiary Butyl Ether (MTBE)	70*
Methylene chloride	3*
Chlorobenzene	50*
Naphthalene	300*
Styrene	100
1,1,2,2-Tetrachloroethane	1*
Tetrachloroethylene	1*
Toluene	1,000
1,2,4-Trichlorobenzene	9*
1,1,1-Trichloroethane	30*
1,1,2-Trichloroethane	3*
Trichloroethylene	1*
Vinyl chloride	2
Xylenes (Total)	1,000*

* NJ MCL [A-280]

SYNTHETIC ORGANIC COMPOUNDS	**MCL (in ppb or µg/l)**
Alachlor	2
Aldicarb	No MCL, Monitoring Required
Aldicarb Sulfone	No MCL, Monitoring Required
Aldicarb Sulfoxide	No MCL, Monitoring Required
Atrazine	3
Benzo(a)pyrene	0.2
Carbofuran	40
Chlordane	0.5*
Dalapon	200
Dibromochloropropane (DBCP)	0.2
Di(2-ethylhexyl)adipate	400
Di (2-ethylhexyl)phthalate	6
Dinoseb	7
Diquat	20
Endothall	100
Endrin	2
Ethylene dibromide (EDB)	0.05
Glyphosate	700
Heptachlor	0.4
Heptachlor Epoxide	0.2
Hexachlorobenzene	1
Hexachlorocyclopentadiene	50
Lindane	0.2
Methoxychlor	40
Oxamyl	200
PCB's (polychlorinated biphenyls)	0.5
Pentachlorophenol	1
Picloram	500
Simazine	4
Toxaphene	3
2,3,7,8-TCDD (Dioxin)	0.00003
2,4-D	70
2,4,5-TP (Silvex)	50

*NJ MCL [A-280]

INORGANIC CHEMICALS	**MCL (in ppb or µg/l)**
Antimony	6
Arsenic	50***
Asbestos	7 million fibers/liter (longer than 10 µm)
Barium	2,000
Beryllium	4
Cadmium	5
Chromium	100
Copper[1]	1,300**[AL]
Cyanide	200
Fluoride (naturally occurring)	4,000
Lead[1]	15**[AL]
Mercury	2
Nickel	+
Nitrate	10,000 (as N)

Nitrite	1,000 (as N)
Total nitrate and nitrite	10,000 (as N)
Selenium	50
Thallium	2

*** Current MCL. Effective January 23, 2006, the Federal arsenic MCL will be 10 ppb. The New Jersey MCL for arsenic of 5 ppb will be effective January 23, 2006.
** An [AL] action level is not an MCL. It is a trigger point at which remedial action is to take place
+ No MCL – Monitoring Required

MICROBIOLOGICAL CONTAMINANTS

Coliform bacteria

For private home wells Absence of Fecal Coliform bacteria/100 ml

For public water systems Coliform bacteria standards are based on the presence or absence of coliform in a sample. The number of samples collected by a public water system is determined by the size of the population served. A system collecting at least 40 samples/month can have coliform in no more that 5% of the samples. A system collecting fewer than 40 samples/month can have no more than one coliform positive. Any number exceeding these amounts triggers an MCL exceedence.

TURBIDITY

No more than 5% of the samples may exceed 0.3 Nephelometric Turbidity Units (NTU) nor any sample exceed 1 NTU.

RADIOLOGICAL CONTAMINANTS	**MCL**
Gross alpha activity (including Radium 226, but excluding radon and uranium)	15 picoCuries/l
Radium (combined) 226/228	5 picoCuries/l
Uranium	30 µg/l
Beta particle and photon emitters	4 millirem/year

DISINFECTION BYPRODUCTS	**MCL (µg/l)**
Trihalomethanes (TTHM) Total of Dichlorobromomethane, Chlorodibromomethane, Bromoform and Chloroform	80 (running annual average)
Haloacetic Acids (HAA5) (the sum of the concentrations of mono-, di-, and trichloroacetic acids and mono-, and dibromoacetic acids)	60 (running annual average)
Chlorite (three sample set monthly average)	1,000
Bromate (running annual average)	10

DISINFECTANT RESIDUALS

(Maximum Residual Disinfectant Level, MRDL*(µg/l))**

Chlorine (as Cl_2) (running annual average)	4,000
Chloramine (as Cl_2) (running annual average)	4,000
Chlorine Dioxide (as ClO_2) (daily samples)	800

While the addition of disinfectants to drinking water is effective in controlling many microorganisms, they react with natural organic and inorganic matter in source water and distribution systems to form disinfection byproducts. Results from toxicology studies have shown several disinfection byproducts (e.g., bromodichloromethane, bromoform, chloroform, dichloroacetic acid and bromate) to be carcinogenic in laboratory animals. Other disinfection byproducts (e.g. chlorite, bromodichloromethane, and certain haloacetic acids) have also been shown to cause adverse reproductive or developmental effects in laboratory animals. Several epidemiology studies have suggested a weak association between certain cancers (e.g., bladder or reproductive) and developmental effects and exposure to chlorinated water. More than 200 million people nationwide consume water that has been disinfected. Because of the large population exposed, health risks associated with disinfection byproducts, even if small, need to be taken seriously. For these reasons, MCLs and MRDLs have been set at the above levels (compliance is based on an annual average for trihalomethanes, haloacetic acids, and bromate and on a monthly average for chlorite).

These MCLs and MRDLs apply to all community and nontransient, noncommunity water systems that treat their water with a chemical disinfectant for either primary or residual treatment.

***Maximum residual disinfectant level is defined as the level of a disinfectant added for water treatment that may not be exceeded at the consumer's tap without an unacceptable possibility of adverse health effects. For a more complete definition, see 40CFR §141.2.

Table 2: List of Unregulated Contaminants for which USEPA Has Set Monitoring Requirements Pursuant to the Unregulated Contaminant Monitoring Rule

List 1 Assessment Monitoring Contaminants

Acetochlor
2,4-dinitrotoluene
2,6-dinitrotoluene
DCPA mono acid
DCPA di acid
4,4'DDE
EPTC
Methyl *tertiary* Butyl Ether (MTBE)
Molinate
Nitrobenzene
Perchlorate
Terbacil

List 2 Screening Survey Contaminants

CHEMICAL
Diazinon
2,4-dichlorophenol
2,4-dinitrophenol
1,2-diphenylhydrazine
Disulfoton
Diuron

Fonofos
Linuron
2-methyl-1-phenol
Nitrobenzene
Prometon
Terbufos
2,4,6-trichlorophenol
Alachlor ESA*
RDX*
MICROBIOLOGICAL
Aeromonas

List 3* **Pre-Screen Testing Contaminants**

Chemical
Polonium-210
Lead-210

Microbiological
Adenoviruses
Caliciviruses
Coxsackieviruses
Cyanobacteria
Echoviruses
Helicobacter pylori
Microsporidia

* The monitoring period for Alachlor ESA, RDX and all List 3 contaminants will be performed only after future rulemaking specifies methods. The next UMCR listing cycle begins in 2006.

Table 3: New Jersey Secondary Drinking Water Standards (Recommended Upper Limits (RULs) or Optimum Range)

Physical Characteristics	**Recommended Upper Limit or Optimum Range**
Color	10 color units (standard cobalt scale)
pH	6.5 to 8.5 (optimum range)
Odor	3 Threshold odor number
Taste	No objectionable taste

Chemical Characteristics	**Recommended Upper Limit (mg/l or ppm)**
ABS/L.A.S.	0.5
Aluminum	0.2
Chloride	250
Fluoride	2

Hardness (as $CaCO_3$)	250
Iron	0.3
Manganese	0.05
Silver	0.1
Sodium	50
Sulfate	250
Total Dissolved Solids	500
Zinc	5

WHAT DO THE MAXIMUM CONTAMINANT LEVEL (MCL) NUMBERS MEAN?

According to N.J.A.C. 7:10, the "Maximum Contaminant Level" or "MCL" means the maximum permissible level of a contaminant in water, measured at the point of entry to the distribution system, in the distribution system or at the free-flowing outlet of the ultimate user of a public water system or other water system to which State primary drinking water regulations apply.

ORGANIC CHEMICAL MAXIMUM CONTAMINANT LEVELS

New Jersey has promulgated stricter standards for some contaminants than those developed by the federal government, and also regulates some additional compounds. More detailed information on many of the regulated chemicals can be found at the following USEPA website: http://www.epa.gov/safewater/mcl.html#mcls.

Volatile Organic Compounds

All volatile organic compounds listed below with high occupational exposure and in laboratory testing affect the nervous system. The levels usually encountered in drinking water contamination are not high enough to cause nervous system effects. The volatile organic compounds following are synthetic.

BENZENE **MCL 1 µg/l**

Benzene is a natural component of crude oil and natural gas. Industry uses benzene in the production of rubber, styrene, and pesticides. Benzene's volatility and water solubility provide the potential for environmental migration. Benzene production by the petrochemical and petroleum refining industries ranks 16th on the list of the top 50 chemicals produced in the United States. At present there is no known intentional use of benzene in consumer products for home use. Gasoline in the United States contains an average of 0.8 percent benzene. Human exposure to benzene has been associated with aplastic anemia and acute myelogenous leukemia; benzene is listed as a human carcinogen (USEPA Group A).

CARBON TETRACHLORIDE **MCL 2 µg/l**

Carbon tetrachloride is manufactured by the chlorination of methane, propane, ethane, propylene, or carbon disulfide and as a by-product of vinyl chloride and perchloroethylene production. The major use of carbon tetrachloride is in the manufacture of chlorofluorocarbons, which are used as refrigerants, foam-blowing agents, and solvents. Carbon tetrachloride has been shown to induce liver neoplasms in hamsters, mice, and rats and is classified as a probable human carcinogen (USEPA Group B2).

***1,2*-DICHLOROBENZENE** **MCL 600 µg/l**
***1,3*-DICHLOROBENZENE** **MCL 600 µg/l**
***1,4*-DICHLOROBENZENE** **MCL 75 µg/l**

Chlorinated benzenes are used as intermediates in the production of organic chemicals, including other chlorinated benzenes and in herbicides, pesticides, fungicides, dyes, rubber, process solvents, and deodorizing agents. In humans the Dichlorobenzenes (DCB) produce acute effects on the respiratory, hematologic, urinary, and central nervous systems. Chronic exposures can result in liver injury and other toxic effects. DCBs are not acutely toxic to animals. Chronically exposed animals may develop central nervous system, liver and kidney damage. 1,2-DCB and 1,3-DCB are considered non-carcinogens (Group D), while 1,4-DCB is classified as a possible human carcinogen (Group C).

1,1-DICHLOROETHANE MCL 50 µg/l

1,1-Dichloroethane is a chlorinated aliphatic hydrocarbon that has been detected in drinking water supplies. This compound is one of the less toxic chlorinated aliphatics. 1,1-Dichloroethane has been used as a chemical intermediate and as a solvent for extraction and degreasing. Exposure of cats to 1,1-dichloroethane by inhalation was found to produce kidney damage. A Maximum Contaminant Level of 50 ug/l was derived by NJDEP to protect against renal damage. 1,1-dichloroethane is considered to be a non-carcinogen (Group D).

1,2-DICHLOROETHANE MCL 2 µg/l

1,2-Dichloroethane (ethylene dichloride) is produced in greater amounts than any other hydrocarbon. Its major use is in the production of vinyl chloride; additionally, it is used as a solvent, in consumer products, as a lead scavenger in gasoline, and as a grain fumigant. Humans are exposed via the air and water, primarily near industrial sites 1,2-Dichloroethane has been shown to cause cancer in rats and mice, and according to EPA, liver and kidney damage as well. It is classified as a probable human carcinogen (Group B2).

1,1-DICHLOROETHYLENE MCL 2 µg/l
1,2-DICHLOROETHYLENE *(cis)* MCL 70 µg/l
1,2-DICHLOROETHYLENE *(trans)* MCL 100 µg/l

1,1-Dichloroethylene (1,1-DCE) is a chemical intermediate of polyvinylidene chloride copolymers used in barrier coatings by the packaging industry. 1,2-Dichloroethylenes have a limited use as solvents and preservatives. No estimates of current production levels are available; however use is not widespread. The instability of dichloroethylenes and their limited solubility in water diminish the potential for human exposure in drinking water. Dichloroethylenes at high exposure concentrations can depress the central nervous system and produce narcosis that may result in death. 1,1-dichloroethylene has been shown to cause liver and kidney injury in animal studies. Limited evidence from animal studies are used to classify 1,1-DCE as a possible human carcinogen (Group C). The 1,2-dichloroethylenes have been shown to damage the liver, circulatory system and nervous system in animal studies. They are considered to be non-carcinogens (Group D).

1,2-DICHLOROPROPANE MCL 5 µg/l

This organic chemical is used as a solvent and a pesticide. When soil and climactic conditions are favorable, 1,2-dichloropropane may get into drinking water by runoff into surface water or by leaching into groundwater. It may also get into drinking water through improper waste disposal. This chemical has been shown to cause cancer and to damage a number of organs (liver, kidney and bladder) of laboratory animals such as rats and mice exposed at high levels over their lifetimes. 1,2-Dichloropropane is classified as a probable human carcinogen (Group B2).

ETHYLBENZENE **MCL 700 µg/l**

This organic chemical is a major component of gasoline. It generally gets into water by improper waste disposal or leaking gas tanks. This chemical has been shown to damage the kidney, liver and nervous system of laboratory animals such as rats exposed to high levels during their lifetimes. Ethylbenzene is considered to be a non-carcinogen (Group D).

METHYL TERTIARY BUTYL ETHER (MTBE) **MCL 70 µg/l**

MTBE is used to increase the octane rating of gasoline and has been added to gasoline to meet the requirements of the Clean Air Act, which require increased oxygen content of gasoline in both CO and ozone non-attainment areas. Typical concentrations of MTBE in gasoline are 2 to 2.7 percent by weight for increased octane rating and 11 to 15 percent by volume for complying with the Clean Air Act. It is more water soluble than other components of gasoline and moves through soil more rapidly than these other components. An MCL of 70 ug/l for MTBE has been derived by NJDEP based on increased kidney weight seen in subchronic gavage studies and its classification as a possible human carcinogen (Group C).

METHYLENE CHLORIDE (Dichloromethane) **MCL 3 µg/l**

This organic chemical is a widely used solvent. It is used in the manufacture of paint remover, as a metal degreaser and as an aerosol propellant. It generally gets into drinking water after improper discharge of waste disposal. This chemical has been shown to cause cancer (and liver damage) in laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. It is classified as a probable human carcinogen (Group B2).

MONOCHLOROBENZENE **MCL 50 µg/l**

Monochlorobenzene is an intermediate in chemical and pesticide production and a process solvent for various organic compounds. It is also a process solvent for methylene diisocyanate, various adhesives, polishes, waxes, pharmaceuticals, and natural rubber. Human exposure has been occupationally related or accidental. Brief exposure to this chemical can result in central nervous system depression and hepatic and renal disorders. Effects of chronic exposure involve depression of both the central nervous system and peripheral nervous system, and respiratory tract irritation. In animals, chronic exposure causes hepatic and kidney changes and increased liver weights. Monochlorobenzene is considered to be a non-carcinogen (Group D).

NAPHTHALENE **MCL 300 µg/l**

Naphthalene is a white crystalline solid recovered during the processing of petroleum or coal tar. It is released into the water by industrial processes. Individuals are exposed to naphthalene primarily by inhalation through the use of mothballs. Overexposure to naphthalene in humans has been associated with increase in cataract formation and the occurrence of hemolytic anemia. In experimental animals, naphthalene has caused lung damage and cataracts. Naphthalene is considered as a non-carcinogen (Group D), and it does not appear to be mutagenic on the basis of limited studies. As a result, an MCL of 300 ug/l was developed by NJDEP.

STYRENE **MCL 100 µg/l**

This organic chemical is commonly used to make plastics and is sometimes a component of resins used for drinking water treatment. Styrene may get into drinking water from improper waste disposal. This chemical has been shown to damage the liver, kidney, blood and nervous system of laboratory animals when exposed to high levels during their lifetimes. Styrene is classified as a possible human carcinogen (Group C).

1,1,2,2-TETRACHLOROETHANE **MCL 1 µg/l**

1,1,2,2-Tetrachloroethane was once used extensively as an industrial solvent and intermediate, but it presently has limited use since less toxic substitutes are available. The compound has been detected in New Jersey surface water and groundwater supplies. 1,1,2,2-Tetrachloroethane is a known toxicant to the liver, kidney, and central nervous system in both humans and laboratory animals. USEPA classifies it as a possible human carcinogen (Group C) since there is limited animal and no human evidence for carcinogenicity.

TETRACHLOROETHYLENE (PCE) **MCL 1 µg/l**

Tetrachloroethylene is a colorless liquid used primarily as a solvent in the dry cleaning of fabrics. To a lesser extent it is used as a degreasing solvent in metal industries and as a chemical intermediate in the synthesis of other compounds. It is not frequently detected in surface waters because of its volatility but is found most often in groundwater. Tetrachloroethylene can cause liver damage and is also classified as a probable human carcinogen (Group B2) by NJDEP.

TOLUENE **MCL 1,000 µg/l**

This organic chemical is used as a solvent and in the manufacture of gasoline. It generally gets into water by improper waste disposal or leaking underground storage tanks. This chemical has been shown to damage the kidney, liver and nervous systems of laboratory animals such as rats and mice exposed to high levels during their lifetimes. Some industrial workers who were exposed to relatively large amounts of this chemical during working careers also suffered damage to the liver, kidney, and nervous system. Toluene is considered to be a non-carcinogen (Group D).

1,2,4-TRICHLOROBENZENE **MCL 9 µg/l**

This organic chemical is used as a dye carrier and as a precursor in herbicide manufacture. It generally gets into drinking water by discharges from industrial activities. This chemical has been shown to cause damage to several organs, including the liver, kidney, and adrenal glands. NJDEP has set the drinking water standard for 1,2,4- trichlorobenzene at 9 ppb to protect against the risk of these adverse health effects. 1,2,4-Trichlorobenzene is considered to be a non-carcinogen (Group D).

1,1,1-TRICHLOROETHANE **MCL 30 µg/l**

1,1,1-Trichloroethane is a commonly used industrial solvent which has gained widespread use largely because of its low toxicity compared with other chlorinated hydrocarbons. Cold cleaning and vapor degreasing are its major commercial applications. Additionally, it is used as a spot remover and as a component of adhesives, coatings, and aerosols. Long-term exposure of experimental animals to 1,1,1-Trichloroethane has been associated with liver damage. NJDEP has set the MCL for 1,1,1-Trichloroethane at 30 ug/L. 1,1,1-Trichloroethane is considered to be a non-carcinogen (Group D).

1,1,2-TRICHLOROETHANE MCL 3 µg/l

This organic chemical is an intermediate in the production of 1,1,2-Trichloroethylene. It generally gets into water by industrial discharge of wastes. This chemical has been shown to damage the kidney and liver of laboratory animals such as rats exposed to high levels during their lifetimes. 1,1,2-Trichloroethane is considered to be a possible human carcinogen (Group C).

TRICHLOROETHYLENE (TCE) MCL 1 µg/l

Trichloroethylene is a colorless liquid used extensively as a solvent in the vapor degreasing of fabricated metal parts. It may be found in printing inks, varnishes, paints, lacquers, adhesives, spot removers, rug cleaners, and disinfectants. It is no longer used in food, drugs, or cosmetics. The major source of it in the environment is volatilization during production and use. Trichloroethylene is toxic to the liver and causes liver cancer in laboratory animals. The USEPA classifies Trichloroethylene as a probable human carcinogen (Group B2).

VINYL CHLORIDE MCL 2 µg/l

Vinyl chloride is a synthetic chemical with no natural sources. In the United States, vinyl chloride has been synthesized commercially for over 50 years, reaching a production level of 7.5 billion pounds in 1984. Vinyl chloride is used in the production of polymer (polyvinyl chloride), the most widely used plastic in the world, in the manufacture of piping, and conduit, electrical wire insulation and cables, food packaging materials, floor coverings, and a variety of other industrial products. It has been shown to induce liver damage and liver cancer in rats, mice, hamsters, and humans and is classified as a human carcinogen (Group A).

XYLENE(S) (Total) MCL 1,000 µg/l

The xylenes are widely used as solvents for inks, rubber, gums, resins, adhesives, and lacquers; as thinners and paint removers; in the paper coating industry; as a component of paint, varnishes, dyes, cements, cleaning fluids, and aviation fuels; as solvents and emulsifiers for agricultural products; in perfumes, insect repellents, pharmaceuticals, and in the leather industry. Its use is increasing as a “safe” replacement for benzene and in gasoline as part of the benzene-toluene-ethylbenzene-xylene (BTEX) component. The MCL set by NJDEP for xylenes is 1,000 µg/l. Adequate human data on the carcinogenicity of xylenes are not available, and the available animal data are inconclusive as to the ability of xylenes to cause a carcinogenic response. Xylenes are considered to be non-carcinogenic (Group D).

Synthetic Organic Compounds

The chlorinated hydrocarbons comprising most, but not all of the following synthetic organic compounds, are one of the most important groups of synthetic organic pesticides because of their wide use, great stability in the environment, and toxicity to mammals and insects. The symptoms of poisoning, regardless of the compound involved or the route of entry, are similar but may vary in severity. Mild cases of poisoning are characterized by headache, dizziness, gastrointestinal disturbances, numbness and weakness of the extremities, apprehension, and hyperirritability. When absorbed into the body, some of the chlorinated hydrocarbons are slowly metabolized and are stored in the fat. Based on these and other facts, limits in drinking water have been calculated primarily on the basis of the extrapolated intake that would cause minimal toxic effects in mammals (rats and dogs).

ALACHLOR MCL 2 µg/l

This organic chemical is widely used as a pesticide. When soil and climatic conditions are favorable, alachlor may get into drinking water by runoff into surface water or by leaching into groundwater. This chemical has been shown to cause cancer in laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. It is also toxic to the liver, kidney and spleen. Alachlor is classified as a probable human carcinogen (Group B2) by USEPA.

ATRAZINE MCL 3 µg/l

This organic chemical is an herbicide. When soil and climatic conditions are favorable, atrazine may get into drinking water by runoff into surface water or by leaching into groundwater. This chemical has been shown to affect offspring of rats and the heart of dogs. Atrazine is currently considered to be a possible human carcinogen (Group C) by USEPA.

BENZO[A]PYRENE MCL 0.2 µg/l

The major source of benzo[a]pyrene in drinking water is the leaching from coal tar lining and sealants in water storage tanks. Cigarette smoke and charbroiled meats are a common source of general exposure. This organic chemical has been shown to cause cancer in animals such as rats and mice when the animals are exposed at high levels. It is considered by USEPA to be a probable human carcinogen (Group B2).

CARBOFURAN MCL 40 µg/l

This organic chemical is a pesticide. When soil and climatic conditions are favorable, carbofuran may get into drinking water by runoff into surface water or by leaching into groundwater. This chemical has been shown to affect the nervous and reproductive systems of such laboratory animals as rats and mice exposed at high levels over their lifetimes. Some humans who were exposed to relatively large amounts of this chemical during their working careers also suffered adverse effects to the nervous system. Effects on the nervous system are generally rapidly reversible. Carbofuran is considered to be a non-carcinogen by USEPA.

CHLORDANE MCL 0.5 µg/l*

Chlordane is a wide-spectrum insecticide. It is persistent in the soil. In 1980, 10 million pounds of chlordane were used to treat soil for termites by subsurface injection. Until 1983, chlordane was used on agricultural crops, such as corn and citrus, as well as home

lawns and gardens to control soil insects and ants. In 1983, the USEPA banned all uses of chlordane except for underground termite control. In 1988, USEPA banned *all* uses. Human exposure to chlordane has occurred by occupational and accidental means. Toxic effects of chronic exposure include skin irritation, blurred vision, exhaustion, liver damage, severe gastroenteritis, anorexia, weight loss, and death. Based on liver tumors in rodents, chlordane has been classified as a probable human carcinogen (Group B2) by USEPA and NJDEP.
***NJ MCL (A-280)**

DALAPON **MCL 200 µg/l**

This organic chemical is a widely used herbicide. It may get into drinking water after application to control grasses in crops, drainage ditches and along railroads. This chemical has been shown to cause damage to the kidney in laboratory animals when the animals are exposed to high levels over their lifetimes. Dalapon is considered to be a non-carcinogen (Group D).

DIBROMOCHLOROPROPANE (DBCP) **MCL 0.2 µg/l**

This organic chemical was once a popular pesticide. When soil and climatic conditions are favorable, DBCP may get into drinking water by runoff into surface water or by leaching into groundwater. This chemical has been shown to damage the kidney, liver, and testes of laboratory animals such as rats and mice exposed at high levels over their lifetimes. DBCP is classified as a probable human carcinogen (Group B2).

DI(2-ETHYLHEXYL)ADIPATE **MCL 400 µg/l**

Di(2-ethylhexyl)adipate is a widely used plasticizer in a variety of products, including synthetic rubber, food packaging materials and cosmetics. It may get into drinking water after improper waste disposal. It can damage the liver and reproductive system and is considered a possible human carcinogen (Group C).

DI(2-ETHYLHEXYL)PHTHALATE **MCL 6 µg/l**

Di(2-ethylhexyl)phthalate is widely used in the production of polyvinyl chloride (PVC) resins. It may get into drinking water after improper waste disposal. This chemical has been shown to cause cancer in laboratory animals such as rats and mice exposed to high levels over their lifetimes and are considered a probable human carcinogen (Group B2).

DINOSEB **MCL 7 µg/l**

Dinoseb is a widely used pesticide and generally gets into drinking water after application on orchards, vineyards and other crops. This chemical has been shown to damage the thyroid and reproductive organs in laboratory animals such as rats exposed to high levels. It is considered to be non-carconogenic (Group D).

DIQUAT **MCL 20 µg/l**

This organic chemical is a herbicide used to control terrestrial and aquatic weeds. It may get into drinking water by runoff into surface water. This chemical has been shown to cause cataract formation in laboratory animals such as dogs and rats exposed at high levels over their lifetimes. Diquat is considered to be a non-carcinogen (Group D).

ENDOTHALL **MCL 100 µg/l**

This organic chemical is a herbicide used to control terrestrial and aquatic weeds. It may get into water by runoff into surface water. This chemical has been shown to damage the gastrointestinal tract of laboratory animals exposed at high levels over their lifetimes. Endothall is considered a non-carcinogen (Group D).

ENDRIN **MCL 2 µg/l**

Since 1986, this organic chemical pesticide has not been produced or sold for general use in the United States. However, this chemical is persistent in treated soils. It accumulates in sediments and aquatic and terrestrial animals and plant life. This chemical has been shown to damage the liver and cause convulsions in laboratory animals exposed at high levels over their lifetimes. Endrin is considered to be non-carcinogenic (Group D).

ETHYLENE DIBROMIDE (EDB) **MCL 0.05 µg/l**

This organic chemical was once a popular pesticide. When soil and climactic conditions are favorable, EDB may get into drinking water by runoff into surface water or by leaching into groundwater. This chemical has been shown to damage the respiratory system, nervous system, liver, heart, and kidneys of laboratory animals and to cause cancer in laboratory animals. EDB is classified as a probable human carcinogen (Group B2).

GLYPHOSATE **MCL 700 µg/l**

This organic chemical is a herbicide used to control grasses and weeds. It may get into drinking water by runoff into surface water. This chemical has been shown to damage kidneys and cause reproductive effects in laboratory animals such as rats and mice exposed to high levels over their lifetimes. Glyphosate is considered to be non-carcinogenic (Group D).

HEPTACHLOR **MCL 0.4 µg/l**
HEPTACHLOR EPOXIDE **MCL 0.2 µg/l**

These organic chemicals were once popular pesticides. Heptachlor epoxide was not produced commercially, but formed by the chemical and biological transformation of heptachlor in the environment. When soil and climatic conditions are favorable, heptachlor may get into drinking water by runoff into surface water or by leaching into groundwater. Heptachlor use stopped in 1988. This chemical has been shown to cause extensive liver damage and cancer in laboratory animals such as rats and mice exposed at high levels over their lifetimes. It is considered a probable human carcinogen (Group B2).

HEXACHLOROBENZENE **MCL 1 µg/l**

This organic chemical is produced as an impurity in the manufacture of certain solvents and pesticides. This chemical has been shown to cause liver and kidney damage and cause reproductive effects and cancer in laboratory animals such as rats and mice when the animals are exposed to high levels during their lifetimes. It is considered a probable human carcinogen (Group B2).

HEXACHLOROCYCLOPENTADIENE **MCL 50 µg/l**

This organic chemical is used as an intermediate in the manufacture of pesticides and flame retardants. It may get into water by discharge from production facilities. This chemical has been shown to damage the kidney and the stomach of laboratory animals when exposed to high levels over their lifetimes. It is considered to be non-carcinogenic (Group E).

LINDANE MCL 0.2 µg/l

Lindane (gamma isomer of 1,2,3,4,5,6-hexachlorocyclohexane) is an insecticide registered for commercial and home use. Lindane is the active ingredient in several prescribed shampoos used for the elimination of head lice. Lindane is slightly soluble in water and will volatilize to the atmosphere from soil or water. It is persistent in soils (half-life greater than 100 days), though it does undergo rapid biotransformation under anaerobic conditions. Acute exposure of animals to Lindane results in neurological and behavioral effects. The liver and the kidney appear to be the primary target organs for Lindane toxicity. Lindane is classified as a possible human carcinogen (Group C).

METHOXYCHLOR MCL 40 µg/l

Methoxychlor, a chemical closely related to DDT, has been used as an insecticide for approximately 40 years. Methoxychlor has been widely used in home and garden applications, as well as on domestic animals, trees, and in waters. The half-life for Methoxychlor in water is estimated to be 46 days, and thus it is not considered to be persistent. Methoxychlor is toxic to the liver, kidney, and the heart. It also retards growth when administered at high dose levels to animals. It is considered to be a non-carcinogen (Group D).

OXAMYL MCL 200 µg/l

This organic chemical is used as a pesticide for the control of insects and other pests. It may get into drinking water by runoff into surface water or leaching into ground water. This chemical has been shown to decrease body weight and cause slight effects on the nervous system of laboratory animals exposed to high levels for long time periods. It is considered a non-carcinogen (Group E).

POLYCHLORINATED BIPHENYLS (PCBs) MCL 0.5 µg/l

Polychlorinated biphenyls (PCBs) have been used commercially for over 50 years primarily as dielectrics, (electrical insulators in large transformers and capacitors). Their chemical inertness has led to their wide dissemination and persistence in the environment, although production is now banned. As many as 209 different compounds of PCBs are possible. These compounds exist in varying proportions in commercial mixtures called Aroclors. Commercial PCB mixtures are distinguished by a number (e.g., Aroclor 1254) which is based on the average percentage of chlorinated chemicals or congeners in the mixture. Human exposure to PCBs has resulted largely from consumption of contaminated food and from the work environment. PCBs accumulate in the fatty tissues and skin of humans and other animals. PCBs cause cancer in laboratory animals exposed over a lifetime and also adversely affect the neurological development of infants exposed prenatally and through breast milk. PCBs are considered probable human carcinogens (Group B2).

PENTACHLOROPHENOL MCL 1 µg/l

Pentachlorophenol is an organic chemical used as a wood preservative, herbicide, disinfectant, and defoliant. It generally gets into drinking water by runoff into surface water or leaching into groundwater. This chemical has been shown to damage the liver, kidneys and reproductive systems and to cause cancer in laboratory animals exposed to high levels during their lifetimes. Pentachlorophenol is considered a probable human carcinogen (Group B2).

PICLORAM **MCL 500 µg/l**

This organic chemical is used as a pesticide for broadleaf weed control. It may get into drinking water by runoff into surface water or leaching into groundwater as a result of pesticide application and improper waste disposal. This chemical has been shown to cause damage to the liver in laboratory animals such as rats when the animals are exposed at high levels over their lifetimes. It is considered to be non-carcinogenic (Group D).

SIMAZINE **MCL 4 µg/l**

This organic chemical is a herbicide used to control annual grasses and broadleaf weeds. It may leach into groundwater or run off the land with precipitation into the surface water. This chemical causes tremors, damage to testes, kidneys, liver and thyroid, gene mutations and cancer in laboratory animals exposed at high levels during their lifetimes. It is considered a possible human carcinogen (Group C).

TOXAPHENE **MCL 3 µg/l**

Toxaphene (a mixture of C_{10} chlorinated camphenes with an approximate overall empirical formula of $C_{10}H_{10}Cl_5$) is a persistent, broad-spectrum insecticide. This product was used extensively on food and fiber crops for many years, but current registered uses are limited. The USEPA Toxaphene Work Group reported that toxaphene is highly persistent and accumulates in the environment. Acute exposure to Toxaphene damages the liver and kidney, and results in a variety of central nervous system effects, including salivation, hyper-excitability, behavioral changes, and convulsions. Toxaphene has been classified as a probable human carcinogen (Group B2).

2,3,7,8-TCDD (Dioxin) **MCL 0.00003 µg/l**

This organic chemical is an impurity in the production of some pesticides and at one time a by-product of the paper industry. It may get into drinking water by industrial discharge of wastes. This chemical has been shown to cause cancer and a variety of reproductive and developmental effects, from reduced fertility to birth defects in laboratory animals such as rats and mice when the animals are exposed at high levels over their lifetimes. Dioxin is considered a probable human carcinogen (Group B2).

2,4-D (2,4-DICHLOROPHENOXYACETIC ACID) **MCL 70 µg/l**

2,4-D (2,4-dichlorophenoxyacetic acid) is a systemic herbicide used to control broadleaf weeds. 2,4-D is sold in a variety of forms called salts, esters, and other derivatives that are very soluble in water. 2,4-D and its derivatives undergo both chemical and biological degradation when released to the environment. Soil residues break down in approximately six weeks and repeated application usually does not lead to accumulation. Nearly 60 percent of the domestically available 2,4-D is used on agricultural crop sites. The remainder is used on range and pastureland, industrial and commercial sites, lawns, turf and forests. 2,4-D is currently registered for aquatic weed control in ponds, lakes, reservoirs, marshes, bayous, drainage ditches, canals, rivers, and streams. 2,4-D has been detected in many surface and groundwaters. The compound has been detected in wastewaters and hazardous wastes; it is mobile and widely used on many crops. 2,4-D damages the kidneys, blood, and liver of laboratory animals given high doses for long periods of time. 2,4-D is considered a non-carcinogen (Group D).

2,4,5-TP (SILVEX) MCL 50 µg/l

2,4,5-TP [2-(2,4,5-trichlorophenoxy) propionic acid], or Silvex, is an herbicide that has been used for weed and brush control on rangeland and rights of way, pastures, commercial or ornamental turf, home weed control, and weed control in and along canals and other waterways. 2,4,5-TP is soluble in water, and its environmental persistence is expected to have a relatively short time frame. 2,4,5-TP affects the liver and kidney of experimental animals exposed over a long time period. It is considered to be non-carcinogenic (Group D).

INORGANIC CHEMICAL MAXIMUM CONTAMINANT LEVELS

ANTIMONY MCL 6 µg/l

Antimony, a metal, occurs naturally in soils, groundwater and surface waters and is often used in the flame retardant industry. It is also used in ceramics, glass, batteries, fireworks and explosives. It may get into drinking water through natural weathering of rock, industrial production, municipal waste disposal or manufacturing processes. This element has been shown to decrease longevity and alter blood levels of cholesterol and glucose in laboratory rats exposed to high levels during their lifetimes. Antimony is considered to be non-carcinogenic (Group D).

ARSENIC MCL 50 µg/l*

Areas with elevated levels of arsenic, a metal, in geologic materials are found throughout the United States. Most of the arsenic produced is a by-product of the smelting of copper, lead, and zinc ores. Arsenic has been found in both groundwater and surface waters from both natural processes and industrial activities, including smelting operations, use of arsenical pesticides, and industrial waste disposal. Arsenic exposure causes disease of the skin in humans, and chronic animal studies have shown body weight changes, decreased blood hemoglobin, liver damage, and kidney damage. Arsenic has been classified in USEPA's Group A (known human carcinogen), based upon evidence of human carcinogenicity through inhalation and ingestion exposure.

[*] A New Jersey MCL for arsenic of 5 µg/l will become effective January 23, 2006.
USEPA has adopted a standard of 10 µg/l that will become effective on January 23, 2006.

ASBESTOS MCL 7 million fibers/l (longer than 10 µm)

Asbestos is a naturally occurring mineral. Most asbestos fibers in drinking water are less than 10 micrometers (µm) (1µm = 10^{-6} meters) in length and occur in drinking water from natural sources and from corroded asbestos-cement pipes in the distribution system. The major uses of asbestos were in the production of textiles, plastics, cements, floor tiles, paper products, paint, and caulking and in transportation-related applications. Asbestos was once a popular insulating and fire-retarding material. Inhalation studies have shown that various forms of asbestos have produced lung tumors in laboratory animals, and human epidemiology studies have shown that inhalation of asbestos causes lung cancer and mesothelioma in exposed individuals. The available information on the risk of developing gastrointestinal tract cancer associated with the ingestion of asbestos from drinking water is limited. Ingestion of intermediate-range chrysotile asbestos fibers greater than 10 micrometers in length is associated with benign tumors in male rats. USEPA has set the drinking water standard for asbestos at 7 million long fibers per liter to reduce the potential risk of cancer or other adverse health effects that have been observed in laboratory animals ingesting asbestos.

BARIUM **MCL 2,000 µg/l**

Barium is a naturally occurring metal found in many types of rock, such as limestone and sandstone, and soils in the eastern United States. Certain geologic formations in California, Arkansas, Missouri, and Illinois are known to contain barium levels about 1,000 times higher than those found in other portions of the United States. Areas associated with deposits of coal, petroleum, natural gas, oil shale, black shale, and peat may also contain high levels of barium. Principal areas where high levels of barium have been found in drinking water include parts of Iowa, Illinois, Kentucky, and Georgia. Acute exposure to barium in laboratory animals and humans results in a variety of cardiac, gastrointestinal, and neuromuscular effects. Barium exposure has also been associated with hypertension in animals. Barium has been classified in USEPA's Group D (not classifiable), based upon inadequate data from animal studies.

BERYLLIUM **MCL 4 µg/l**

Beryllium occurs naturally in soils, ground water and surface waters and is often used in electrical equipment and electrical components. It generally gets into water from runoff from mining operations, discharge from processing plants and improper waste disposal. Beryllium compounds have been associated with damage to the bones and lungs and induction of cancer in laboratory animals exposed at high levels over their lifetimes. There is limited evidence to suggest that beryllium may pose a cancer risk via drinking water exposure. Therefore, USEPA based the health assessment on noncarcinogenic effects with an extra uncertainty factor to account for possible carcinogenicity.

CADMIUM **MCL 5 µg/l**

Cadmium, a metal, is found naturally in very low concentrations in most rocks, as well as in coal and petroleum and often in combination with zinc. Geologic deposits of cadmium can serve as sources to groundwater and surface water, especially when in contact with soft, acidic waters. Cadmium uses include electroplating, nickel-cadmium batteries, paint and pigments, and plastic stabilizers. It is introduced into the environment from mining and smelting operations and industrial operations, including electroplating, reprocessing cadmium scrap, and incineration of cadmium-containing plastics. The remaining cadmium emissions are from fossil fuel use, fertilizer application, and sewage sludge disposal. Cadmium may enter drinking water as a result of corrosion of galvanized pipe. Landfill leachates are also an important source of cadmium in the environment. Acute and chronic exposure to cadmium in animals and humans results in kidney dysfunction, hypertension, anemia, and liver damage. The kidney is considered to be the critical target organ in humans chronically exposed to cadmium by ingestion. Cadmium has been classified in EPA's Group B1 (probable human carcinogen), based upon evidence of carcinogenicity in humans through inhalation exposure. However, since cadmium has not been shown to be carcinogenic through ingestion exposure, the compound is regulated as a non-carcinogen (Group D) in drinking water based upon chronic toxicity data.

CHROMIUM **MCL 100 µg/l**

Chromium is a naturally occurring metal that in drinking water forms compounds with valences of +3 (trivalent chromium, chromium III) and +6 (hexavalent chromium, chromium VI), with the trivalent state being the more common. Although chromium is not currently mined in the United States, wastes from old mining operations may enter surface and groundwater through runoff and leaching. Chromate wastes from plating operations may also be a source of water contamination. Fossil fuel combustion, waste incineration, cement plant emissions, chrome plating, and other metallurgical and chemical operations may result in releases of chromium to the atmosphere. Chromium III and chromium VI have greatly differing toxicity characteristics. Chromium III is a nutritionally essential element. Chromium VI is much more toxic than Chromium III and has been shown to produce liver and kidney damage, internal hemorrhage, and respiratory disorders. Also, subchronic and chronic exposure to Chromium VI in the form of chromic acid can cause dermatitis and ulceration of the skin. Chromium has been classified in USEPA's Group A (human carcinogen), based upon positive inhalation data for Chromium VI in humans and animals. However, since chromium has not been shown to be carcinogenic through ingestion exposure, chromium is regulated in drinking water as a non-carcinogen (Group D) based upon chronic toxicity data.

COPPER 1,300 µg/l (Action Level)

Copper, a reddish-brown metal, is often used in plumbing of residential and commercial structures that are connected to water distribution systems. Copper contaminating drinking water as a corrosion by-product occurs as the result of the corrosion of copper pipes that remain in contact with water for a prolonged period. Copper is an essential nutrient, but at high doses has been shown to cause stomach and intestinal distress, liver and kidney damage, and anemia. Persons with Wilson's disease, a rare genetic disorder that causes excessive copper accumulation in the liver or brain, may be at higher risk of health effects due to copper contamination. Public water systems serving over 50,000 people or fewer that have copper concentrations below 1.3 parts per million in more than 90 percent of tap water samples (the USEPA action level) are not required to install or improve their treatment. Any public water system that exceeds the action level must also monitor its source water to determine whether treatment to remove copper in source water is needed.

CYANIDE MCL 200 µg/l

Cyanide is used in electroplating, refining of gold from ore, steel processing, plastics, synthetic fabrics and fertilizer products. It usually gets into water as a result of improper waste disposal. Cyanide compounds are highly toxic, causing harm by interfering with the body's use of oxygen, essentially causing suffocation. Cyanide is non-carcinogenic and is classified as Group D.

FLUORIDE MCL 4,000 µg/l

Federal regulations require that naturally occurring fluoride not exceed a concentration of 4 mg/l in drinking water. This MCL has been established to protect public health. Exposure to drinking water levels above 4 mg/l for many years may result in some cases of crippling skeletal fluorosis, which is a serious bone disorder.

Fluoride in drinking water at levels of approximately 1 mg/l reduces the number of dental cavities 30-60% percent in baby teeth below rates in communities with little or no fluoride. Therefore, some public water systems add fluoride chemicals to the water. However, some children exposed to levels of fluoride greater than about 2 mg/l may develop dental fluorosis. Dental fluorosis, in its moderate and severe forms, is a brown staining and/or pitting of the permanent teeth. Because dental fluorosis occurs only when developing teeth (before they erupt from the gums) are exposed to elevated fluoride levels, households without children are not expected to be affected by this level of fluoride. Children living in towns with fluoridated water should not take fluoridated vitamins or receive dentist-applied fluoride treatment. Federal law also requires that notification take place when monitoring indicates that the fluoride exceeds 2 mg/l. This is intended to alert families about dental problems that might affect children under nine years of age. Families with children under the age of nine with fluoride exceeding 2 mg/l are encouraged to seek other sources of drinking water for their children to avoid the possibility of staining and pitting.

LEAD 15 µg/l (Action Level)

Lead, a heavy metal, can cause a variety of adverse health effects in humans. At relatively low levels of exposure, these effects may include interference in red blood cell chemistry, delays in normal physical and mental development in babies and young children, deficits in the attention span, hearing, and learning abilities of children, and increases in blood pressure of some adults. Lead has been classified in EPA's Group B2 (probable human carcinogen), based upon evidence of kidney tumors in rats by the oral route.

Materials that contain lead have frequently been used in the construction of water supply distribution systems and plumbing systems in private homes and other buildings. The most commonly found materials include service lines, pipes, brass and bronze fixtures, and solders and fluxes. Lead in these materials can contaminate drinking water as a result of the corrosion that takes place when water comes into contact with those materials. EPA's national primary drinking water regulation requires all public water systems to optimize corrosion control to minimize lead contamination resulting from the corrosion of plumbing materials. Public water systems serving 50,000 people or fewer that have lead concentrations below 15 parts per billion (ppb) in more than 90 percent of tap water samples (the USEPA action level) have optimized their corrosion control treatment. Any public water system that exceeds the action level must also monitor its source water to determine whether treatment to remove lead in source water is needed. Any public water system that continues to exceed the action level after installation of corrosion control and/or source water treatment must eventually replace all lead service lines contributing in excess of 15 ppb of lead to drinking water. Any public water system that exceeds the action level must also undertake a public education program to inform consumers of ways they can reduce their exposure to potentially high levels of lead in drinking water.

The following steps can be taken to minimize your exposure to lead:

1. Flush your plumbing to counteract the effects of "contact time." Flushing involves allowing the cold water to run until a change in temperature occurs (minimum of one minute). Water drawn during flushing doesn't have to be wasted. It can be saved for other uses such as washing dishes or clothes and watering plants.
2. Do not consume hot tap water. Hot water tends to aggravate lead leaching when brought in contact with lead plumbing materials.
3. For private wells, steps can be taken to make water less corrosive. Water-treatment devices for individual households include calcite filters and other devices to lessen acidity.
4. Insist on lead-free materials for use in repairs and newly installed plumbing.
5. Lead can be removed from your tap water by installing point-of-use treatment devices now commercially available, which include: ion-exchange filters, reverse osmosis devices, and distillation units. (For more information on home

water treatment devices call NJDEP's Bureau of Site Remediation (609) 984-5862.)

6. Bottled water can be purchased for drinking and cooking purposes.

MERCURY MCL 2 µg/l

Mercury, a heavy metal, exists in several basic forms: elemental mercury, the inorganic salt and organic mercury compounds (methyl mercury). Mercury levels in coal range from 10-46,000 ppb. The major use of mercury is in electrical equipment (batteries, lamps, switches, and rectifiers). Mercury may also enter the environment from mining, smelting, and fossil fuel combustion. Inorganic mercury is the form of mercury primarily found in drinking water, and drinking water regulations are based on the inorganic form. Inorganic mercury is considered to be non-carcinogenic (Group D), and the principal target organ of inorganic mercury is the kidney.

NITRATE (NO_3^-) MCL 10,000 µg/l

NITRITE (NO_2^-) MCL 1,000 µg/l

Nitrate is the more stable oxidized form of a nitrogen compound in most environmental media. Most nitrogenous materials in natural waters tend to be converted to nitrate, and, therefore, all sources of combined nitrogen (particularly organic nitrogen and ammonia) should be considered as potential nitrate sources. Nitrates occur naturally in mineral deposits (generally sodium or potassium nitrate), in soils, seawater, freshwater systems, the atmosphere, and in regional plant life. Lakes and other static water bodies usually have less than 1 mg/l of nitrate/nitrogen. Groundwater levels of nitrate/nitrogen may range up to 20 mg/l or more, with higher levels characteristically occurring in shallow aquifers beneath areas of extensive development. Major sources of nitrates or nitrite in drinking water include fertilizer, sewage, feedlots and septic tanks.

The toxicity of nitrate in humans is due to the body's reduction of nitrate to nitrite. This reaction takes place in saliva of humans at all ages and in the gastrointestinal tract of infants during the first three months of life. Toxic effects of nitrite include vasodilation / cardiovascular effects at high dose levels and methemoglobinemia at lower dose levels. Methemoglobinemia, "Blue-Baby Syndrome," is an effect in which hemoglobin in red blood cells is oxidized to methemoglobin, which cannot deliver oxygen to the cells, resulting in asphyxia. Infants up to three months of age are the most susceptible subpopulation with regard to nitrate. This is due to the fact that in the adult and child, about 10 percent of ingested nitrate is transformed to nitrite, while 100 percent of ingested nitrate can be transformed to nitrite in the infant. The effects of methemoglobinemia are rapidly reversible when discovered early, and there are usually no long-term effects. Nitrate/nitrite are considered to be non-carcinogenic and are classified as Group D. USEPA has set the drinking water standard at 1 mg/l for nitrite to protect against the risk of adverse health effects. USEPA has also set a drinking water standard for nitrate (converted to nitrite in humans) at 10 mg/l and for the sum of nitrate and nitrite at 10 mg/l.

SELENIUM MCL 50 µg/l

Selenium, a metal, occurs in U.S. soils in the western states. The more alkaline soil tends to make selenium more water-soluble, and increased plant uptake and accumulation occur. The greatest use of selenium compounds is in electronic and photocopier components, but they are also widely used in glass, pigments, rubber, metal alloys, textiles, petroleum, medical therapeutic agents, and photographic emulsions. Selenium is nutritionally essential at low levels, but excessive exposure can cause hair and fingernail loss, damage to kidney and liver tissue, and toxicity to the nervous and circulatory systems. Selenium is considered non-carcinogenic and been classified in USEPA's Group D.

THALLIUM **MCL 2 µg/l**

Thallium, a metal, is found naturally in soils and is used in electronics, pharmaceuticals, and the manufacture of glass and alloys. Thallium compounds have been shown to damage the kidney, liver, brain and intestines of laboratory animals exposed at high levels over their lifetimes.

MICROBIOLOGICAL MAXIMUM CONTAMINANT LEVELS

The Coliform Test

The fact that a water supply has been used for a long time without any adverse effects is no guarantee of its safety. Residents of a community may develop a tolerance for certain bacteria to which they are regularly exposed, but strangers often become ill from drinking the same water. For this reason it is important that drinking water be tested regularly for bacteriological quality.

The standard bacteriological method for judging the suitability of water for domestic use is the coliform test. This method of analysis detects the presence of coliform bacteria, which are found in the natural environment (soils and plants) and in the intestines of humans and other warm-blooded animals. They are discharged in the bowel movement. Any food or water sample in which this group of bacteria is found, is to be suspected of having come into contact with domestic sewage, animal manure, or with soil or plant materials. It follows that such a water supply may contain pathogenic (disease causing) bacteria and viruses that cause such serious human illnesses as typhoid fever, dysentery, hepatitis, etc.

The present regulations require water systems to take a minimum number of microbiological samples each month in the distribution system based upon the number of persons being served. The larger the population served, the more microbiological samples required per month.

The two standard methods for determining the numbers of coliform bacteria in a water sample are the multiple tube fermentation technique and the membrane filter technique. In the multiple tube fermentation technique, a series of fermentation tubes containing special nutrients is inoculated with appropriate quantities of water to be tested and incubated. After 24 hours, the presence or absence of gas formation in the tubes is noted. This is considered a presumptive test for the presence of coliform organisms. A confirming test performed for drinking water samples involves a similar technique using the culture from the positive presumptive test in a different nutrient medium.

In the <u>membrane filter technique</u>, which is less time consuming, an appropriate quantity of water to be tested is filtered through a specially designed membrane filter which traps bacteria. The filter is removed and placed in a special dish with nutrients and incubated for 24 hours. The typical coliform colony has a metallic surface sheen. The results are usually expressed as number of coliform colonies per 100 ml of water sample.

Total Coliform Rule (effective January 1, 1991)

The number of routine samples analyzed each month by public water systems (PWS) is based on population size. The results of the analytical testing will be reported as either the PRESENCE or ABSENCE of coliform bacteria. If all samples show absence, then the system is in compliance. If the sample shows the presence of total coliform bacteria, three things happen:

1. The lab will automatically test the sample for either Fecal Coliform or *Escherichia coli* (*E.coli*) bacteria.

2. For systems that serve a population equal to or less than 1,000 individuals, the PWS must collect four REPEAT samples within the next 24 hours. Three REPEAT samples must be performed for systems with greater than 1,000 individuals. The repeat samples must be taken at the original sample point, one immediately upstream of the original site, and one immediately downstream of the original site. The fourth sample can be taken from any sample point. If any of the repeat samples come back indicating a presence of coliform, another set of repeat samples will need to be taken.

3. The following month the PWS will need to take a total of at least five ROUTINE samples. If the PWS normally takes less than five routine samples per month, the operator will need to take whatever number of penalty samples to bring the total up to five for the month.

For systems collecting less than 40 samples per month, there may be no more than one Total Coliform positive sample per month. For systems collecting over 40 routine samples per month, the operator may have no more than five percent of the samples total coliform positive per month. In either case, if any sample (routine or repeat) is Fecal Coliform or *E.coli* positive, then the system is automatically in violation of the MCL for total coliform.

There are three different violations:

1. Monitoring Violation: The required number of routine samples per month were not taken.
2. Non-acute Quality Violation: When the total coliform has been detected in excess of the MCL, but no Fecal Coliform or *E. coli* have been detected.
3. Acute Quality Violation: Both Total Coliform and either Fecal Coliform or *E. Coli* have been detected. Acute quality violations result in Boil Water Advisories being issued within 72 hours.

Public notice is dependent on the type of violation that has occurred. The violation must be reported to the state by the end of the working day.

MAXIMUM CONTAMINANT LEVELS FOR TURBIDITY

Turbidity in water is caused by the presence of suspended matter, such as clay, silt, fine particles of organic and inorganic matter, and plankton and other microscopic organisms. The standard measure of turbidity, the turbidity unit (TU), is an expression of the optical property of a water sample which causes light to be scattered and absorbed rather than transmitted in straight lines through the sample. As the number of particles increases, more light is scattered, and higher turbidity readings are obtained. The measuring instrument is called a nephelometer, and the readings are expressed as nephelometric turbidity units (NTU) or turbidity units.

Turbidities in excess of five TUs are easily detectable in a glass of water and are usually objectionable for aesthetic reasons. Clay or other inert suspended particles in drinking water may not adversely affect health, but water containing such particles may require treatment to make it suitable for its intended use. Following a rainfall, variations in groundwater turbidity may be an indication of surface pollution.

TURBIDITY MCL No more than 5% of samples may exceed 0.3 Nephelometric Turbidity Units (NTU)

For water systems using conventional filtration or direct filtration, the turbidity level of representative samples of a system's filtered water must be less than or equal to 0.3 NTU in at least 95 percent of the measurements taken each month, measured as specified in the Code of Federal Regulations [CFR 141.173 (a)], and at no time may representative samples exceed 1 NTU. A public water system may use alternative filtration technology if it demonstrates to the State that the alternative filtration technology, in combination with disinfectant treatment, consistently achieves 99.9 percent removal and/or inactivation of *Giardia lamblia* cysts and 99.99 percent removal and/or inactivation of viruses, and 99 percent removal of *Cryptosporidium* oocysts, the State may approve the alternate filtration technology.

RADIOLOGICAL CONTAMINANTS

The use of atomic energy as a power source for industrial needs, the use of radiological materials for medical diagnosis and treatment, the mining of radioactive materials, and naturally occurring radioactive geological formations have made it necessary to establish limiting concentrations for the intake into the body of radioactive substances. These limits apply to food as well as drinking water.

There are adverse health effects from radiation, and unnecessary exposure should be avoided. The MCLs for radionuclides in drinking water in the current regulations are intended to limit the human intake of these substances so that the total radiation exposure of any individual will not exceed those defined in the Radiation Protection Guides recommended by the Federal Radiation Council. Humans have always been exposed to natural radiation from water, food, and air, and the quantity of radiation a person is exposed to vary with the background radioactivity. Water of high radioactivity is unusual; nevertheless, it is known to exist in certain areas, from either natural or man-made sources.

Radiological data are available for certain areas in publications of the U.S. Environmental Protection Agency (www.epa.gov), U.S. Public Health Service (www.usphs.gov), U.S. Geological Survey (www.usgs.gov), and from federal, state, or local agencies. For information or recommendations on specific problems, the appropriate agency should be contacted.

The NJDEP has identified elevated levels of naturally occurring radioactivity in drinking water obtained from certain locations in southern and northern New Jersey.

In southern New Jersey, natural radioactivity is present in drinking water being drawn from the Kirkwood -Cohansey aquifer. This shallow aquifer, as well as two minor aquifers in the area, are the predominant sources of drinking water in the New Jersey Coastal Plain for both public and private wells in southern New Jersey. The Kirkwood - Cohansey aquifer is present in all or parts of Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, Monmouth, Ocean, and Salem Counties. The highest levels of radioactivity were found to be related to the acidity of the water, agricultural land use, and the presence of elevated concentrations of nitrate and magnesium in the water.

In northern New Jersey, high levels of uranium in drinking water are most likely to be found in the Highlands Province and neighboring regions of North Jersey. It is also possible for radium and radon to be found in water in this area. The Highlands Province lies within the southeastern portions of Sussex and Warren Counties, as well as major portions of Hunterdon, Morris and Passaic and small parts of Bergen and Somerset. In Pennsylvania, this region is called the Reading Prong while in New York, it is called the Hudson Highlands.

Additional information can be found at the Division of Water Supply website: www.state.nj.us/dep/watersupply/htm.

NJDEP recommends water testing and treatment if the MCL is exceeded for private well owners in the affected areas.

RADIOACTIVITY (RADIONUCLIDES)	**MCLs (see below)***
Gross Alpha Particle Activity, Radium 226 and Radium 228	
Combined Radium 226 and Radium 228	5 pCi/l
Gross alpha particle activity (Including Radium 226 but excluding radon and uranium)	l5 pCi/1
Uranium	30μg/l

Man-made Radioactivity

The average annual concentration of beta particle and photon radioactivity from man-made radionuclides in drinking water shall not produce an annual dose equivalent to the total body or any internal organ greater than 4 millirem/year. Tritium must be equal to or less than

20,000 pCi/l, and Strontium-90 must be equal to or less than 8 pCi/l, provided that if both of the latter are present, the sum of their annual dose equivalent to bone marrow shall not exceed 4 millirem/year.

If gross beta particle activity exceeds 50 pCi/l, major radioactive constituents must be identified, and appropriate organ and total body doses must be calculated.

*These MCLs are summarized. Consult the Code of Federal Regulations 141.15 and 141.16 for complete requirements.

DISINFECTION BY-PRODUCTS

TRIHALOMETHANES (TOTAL THMs) MCL 80 µg/l (running annual average)

Disinfection by-products are formed by the reaction of free chlorine with certain natural organic compounds in the water. Formation occurs during chlorination and can continue to occur as long as free chlorine and organic matter is available. Other trihalomethanes are formed by the reaction of bromine or iodine with the same group of organic compounds.

Trihalomethanes are members of a group of organic chemicals that contain three halogen atoms, one carbon atom and one hydrogen atom. The halogen atoms important in the formation of trihalomethanes in water are chlorine, bromine, and iodine. At most locations, only four of the ten possible trihalomethanes can occur in significant concentrations in chlorinated drinking water. They are trichloromethane (Chloroform), dichlorobromomethane, chlorodibromomethane, and tribromomethane (Bromoform). Chloroform is the trihalomethane usually found in the highest concentrations.

The effects of chloroform on the human body are still under study, but one test has found that high doses of chloroform can be carcinogenic to rats and mice. Therefore, the USEPA considers chloroform a potential human carcinogen. The USEPA also believes that the other trihalomethanes are implicated, by association, as potential carcinogens.

The primary drinking water regulations provide an MCL of 80 µg/l, as a running annual average, for total trihalomethanes (TTHMs) along with associated monitoring and reporting requirements. This MCL applies to all community and non-community water systems that add a disinfectant (oxidant) to the water in any part of the drinking water treatment process.

HALOACETIC ACIDS MCL 60 µg/l (running annual average)

Haloacetic Acids (HAAS) are a group of chemicals that are formed along with other disinfection byproducts when chlorine or other disinfectants used to control microbial contaminants in drinking water react with naturally occurring organic and inorganic matter in water. The regulated haloacetic acids, known as HAA5s, are: monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid. USEPA has published the Stage 1 Disinfectants/Disinfection Byproducts Rule to regulate

HAA5s at 60 parts per billion annual average. This standard became effective for large surface water public water systems in December 2001 and for small surface water and all groundwater public water systems in December 2003. Haloacetic acids are considered by USEPA as likely to be carcinogenic to humans, so that people who have been exposed to them over many years may have an increased risk of cancer.

TREATMENT TECHNIQUE REQUIREMENTS FOR LEAD AND COPPER ACTION LEVELS

The USEPA has established action levels for lead and copper. The action level for lead is exceeded if the concentration of lead in more than ten percent of tap water samples collected during any monitoring period is greater than 0.015 mg/l. The action level for copper is exceeded if the concentration of copper in more than ten percent of the tap water samples collected during any monitoring period is greater than 1.3 mg/l.

Corrosion Control Treatment

Public water systems must collect tap water samples for lead and copper from high-risk homes.

Corrosion Control Studies

1. Systems triggered into the corrosion control treatment requirements may first have to conduct studies to compare the effectiveness of:

   -pH and alkalinity adjustment (reduces the acidity of the water);
   -calcium adjustment (promotes the formation of protective coating inside pipes and plumbing); and
   -addition of phosphate or silica-based corrosion inhibitor (forms protective coating inside pipes and plumbing).

2. All large public water systems (serving >50,000 people) are required to conduct such studies.

3. Small and medium-size public water systems (serving <50,000 people) that exceed the lead or copper action level are required to first submit a recommendation for optimal corrosion control treatment to the State.

4. The State will either approve the recommended treatment or require the installation of an alternative treatment. The State may, as an alternative, require small and medium-size public water systems to conduct the corrosion control treatment studies described above.

5. Any public water system that conducts corrosion control studies must recommend an optimal corrosion control treatment to the State on the basis of study results and monitoring data.

6. States will either approve a system's recommendation or designate an alternative treatment as optimal.

Corrosion Control Treatment

1. Once treatment is specified by the State, public water systems will have 24 months to install optimal corrosion control treatment and 12 months to collect follow-up samples.

2. States will assign values for a set of water quality parameters that constitute optimal corrosion control treatment:

-pH;
-alkalinity;
-calcium, when carbonate stabilization is used;
-orthophosphate, when an inhibitor with a phosphate compound is used; and
-silica, when an inhibitor with a silicate compound is used.

2. A public water system must continue to operate within the water quality parameters established by the state.

Source Water Treatment

1. All public water systems that exceed the tap water lead or copper action level must collect source water samples and submit the data with a treatment recommendation to the state.

2. States may specify one of the following treatments, or an alternative treatment at least as effective, for the system to install: a) ion exchange, b) reverse osmosis, c) lime softening, or d) coagulation/filtration.

3. Once treatment is specified by the state, systems will have 24 months to install source water treatment and 12 months to collect follow-up source water samples.

4. States will review follow-up source water monitoring results and assign maximum permissible lead and copper concentrations in source water entering the distribution system.

5. Public water systems must continue to deliver water to all entry points in the distribution system that does not exceed the maximum permissible lead and copper concentrations established by the state.

6. Source water monitoring will be standardized to three, six and nine year cycles after treatment or the state determines no treatment is necessary.

Public Education

1. Informs the public about the adverse health effects of lead and explains the steps people can take in their homes to reduce their exposure to lead in drinking water (i.e., flushing the tap; cooking with cold water rather than hot; checking for lead solder in new plumbing; and testing their water for lead).

2. All public water systems exceeding the lead action level must deliver the USEPA-developed public education program to their customers within 60 days.

3. Every 12 months, systems must deliver:

> -bill stuffers to their customers and brochures to all institutions in the community frequented by women and children (i.e., health departments, hospitals, clinics, etc.), and
>
> -the public education material to the editorial departments of major newspapers serving the community.

4. Every 6 months, public water systems must submit a public service announcement on lead in drinking water to major television and radio stations serving the community.

5. Every 12 months, nontransient noncommunity public water systems must post information notices in each building served by the system and deliver brochures to all of the system’s customers.

6. The public education program must be delivered by a public water system for as long as the system exceeds the lead action level.

LEAD SERVICE LINE REPLACEMENT

1. All public water systems that continue to exceed the lead action level after installing optimal corrosion control treatment and source water treatment must replace lead service lines that contribute in excess of 15 parts per billion (ppb) to total tap water lead levels.

2. A public water system must replace seven percent of its lead lines each year or demonstrate that the lines not replaced contribute less than 15 ppb of lead to drinking water at the tap.

3. A public water system must replace the entire lead service line unless it can demonstrate that it does not control the entire line. Water systems must offer to replace the owner’s portion of the service line.

4. A public water system that exceeds the lead action level after installing optimal corrosion control treatment and source water treatment has 15 years to replace all lead service lines.

WHAT DOES THE SECONDARY RECOMMENDED UPPER LIMIT OR OPTIMUM RANGE MEAN?

The physical characteristics and chemical contaminants covered by these regulations are those which may adversely affect the aesthetic quality of drinking water, such as taste, odor, color, and appearance, and which thereby may deter public acceptance of drinking water provided by public water systems.

Secondary levels represent reasonable goals for drinking water quality but are not enforceable. Rather, they are intended as guidelines. Odor, color, taste, and other aesthetic qualities are important factors in the public's acceptance and confidence in the public water system; thus, states have encouraged the implementation of the Recommended Upper Limits or Optimum Ranges so that the public will not be driven to obtain drinking water from potentially lower quality, higher risk sources.

Table 3, New Jersey Secondary Drinking Water Standards - Recommended Upper Limits (RULs) and Optimal Ranges, lists the standards currently in effect. New Jersey requires periodic monitoring for secondary contaminants in public community water systems. The standards define upper and lower limits for these substances in drinking water to protect the public welfare. Failure of test results to fall within these limits may constitute grounds for unacceptability of the water supply.

ABS/LAS FOAMING AGENTS RUL 0.5 mg/l

ABS/LAS are classes of chemicals called surfactants. They are the main ingredients in detergents, because they attract both oil and water. They bond with oil and cause water to soak into dirt, and with their foaming activity, release into the wash water. LAS is more biodegradable than ABS, resulting in more rapid breakdown into carbon dioxide and water. The 0.5 mg/l limit for foaming agents is based upon the fact that, at higher concentration levels, the water may exhibit undesirable taste and foaming properties. Also, concentrations above the limit may be indicative of undesirable contaminants or pollutants from questionable sources, such as infiltration by sewage. Because no standardized "foamability test" exists, this property is determined indirectly by measuring the anionic surfactant concentration in the water utilizing the Methylene Blue Test. Many substances other than detergents, however, will cause foaming, and their presence will be detected by the Methylene Blue Test.

ALUMINUM RUL 0.2 mg/l

USEPA and NJDEP believe that in some waters post-precipitation of aluminum may take place after treatment. Alum is frequently used as a precipitating agent in clarifying surface waters. This could cause increased turbidity and aluminum water quality slugs under certain treatment and distribution changes. These regulatory bodies also agree with the World Health Organization (WHO, 1984) that "discoloration of drinking water in distribution systems may occur when the aluminum level exceeds 0.1 mg/l in the finished water." WHO further adopts a guidance level of 0.2 mg/l in recognition of difficulty in meeting the lower level in some situations. While USEPA encourages utilities to meet a level of 0.05 mg/l where possible, it still believes that varying water quality and treatment situations necessitate a flexible approach.

CHLORIDE RUL 250 mg/l

The RUL of 250 mg/l for chloride is the level above which the taste of the water may become objectionable to the consumer. In addition to the adverse taste effects, high chloride concentration levels in the water contribute to the deterioration of domestic plumbing, water heaters, and municipal waterworks equipment. High chloride concentrations in the water may also be associated with the presence of sodium in drinking water. Elevated concentration levels of sodium may have an adverse health effect on normal, healthy persons. In addition, a small segment of the population may be on severely restricted diets requiring limitation of their sodium intake. For the preceding reasons, the RUL for chloride represents a desirable and reasonable level for protection of the public welfare.

COLOR RUL 10 CU

In some instances, color may be objectionable to some people at as low as 5 CU. Color may be indicative of large quantities of organic chemicals, inadequate treatment, high disinfectant demand, and the potential for production of excess amounts of disinfectants' by-products such as trihalomethanes. Natural color may be caused by decaying leaves, plants, and soil organic matter. It may also result from the presence of such metals as iron and manganese (which also have RULs), or copper (which has an Action Level), as well as color from industrial sources. While color itself is not usually objectionable from the standpoint of health, its presence is aesthetically objectionable and suggests that the water may need additional treatment. Experience has shown that rapid changes in color levels lead to greater consumer complaints, as opposed to a relatively constant color level.

FLUORIDE RUL 2 mg/l
(artificially adjusted water supplies)

The examination of the teeth of many thousands of children, and the fluoride analysis of hundreds of water supplies showed a remarkable relationship between the concentration of waterborne fluoride and the incidence of dental caries. The relationship, or actually three distinct relationships, are as follows:

1. When the fluoride level exceeds about 1.5 ppm, any further increase does not significantly decrease the incidence of decayed, missing, or filled teeth, but does increase the occurrence and severity of mottling.
2. At a fluoride level of approximately 1.0 ppm, the optimum occurs - maximum reduction in caries with no aesthetically significant mottling.
3. At fluoride levels below 1.0 ppm some benefits occur, but caries reduction is not so great and gradually decreases as the fluoride levels decrease until, as zero fluoride is approached, no observable improvement occurs.

For these reasons, NJDEP regulations recommend a range of 0.8 to 1.2 mg/l fluoride for drinking water supplies in which the fluoride concentration is artificially adjusted. The fluoride levels are adjusted by the addition of a variety of fluoride containing compounds, such as fluosilicic acid, sodium silicofluoride, or sodium fluoride.

The optimum fluoride concentration in the water for a given community depends on climatic conditions because the amount of water (and consequently the amount of fluoride) ingested by children is primarily influenced by air temperature. It should be noted that when fluoride is artificially adjusted, it is particularly advantageous to maintain fluoride concentration at or near the optimum. Children living in towns with fluoridated water should not take fluoridated vitamins or receive dentist-applied fluoride treatment. The reduction in dental caries experienced at optimum fluoride concentrations will diminish by as much as 50% when fluoride concentration is 0.2 mg/l below the optimum.

For a list of the public water systems in New Jersey serving and the municipalities receiving either artificially adjusted or naturally occurring fluoridated water, see items 1 and 2 at the following web site: http://www.state.nj.us/dep/watersupply/quality.htm

HARDNESS (WATER HARDNESS) RUL 250 mg/l

Water hardness is caused by the polyvalent metallic ions, primarily calcium, magnesium, manganese and iron dissolved in water. Hardness commonly is reported as an equivalent concentration of calcium carbonate ($CaCO_3$).

The concept of hardness comes from water supply practice. It is measured by soap requirements for adequate lather formation and as an indicator of the rate of scale formation in hot water heaters and low-pressure boilers. The reaction of soap with hard water is one source of the “ring around the tub.” A commonly used classification follows:

Classification of Water by Hardness Content

Concentration $CaCO_3$ (mg/l)	Concentration $CaCO_3$ (gpg)	Hardness Description
0-75	0-5	soft
75-150	5-9	moderately hard
150-300	9-18	hard
300 and up	18 and up	very hard

Hardness is sometimes expressed as grains per gallon (gpg). To convert milligrams per liter (mg/l) or parts per million (ppm) to grains per gallon (gpg), use the formula below:

17.1 (mg/l) or (ppm) = gpg

Natural sources of hardness principally are limestones which are dissolved by percolating rainwater made acidic by dissolved carbon dioxide. Industrial sources include discharges from operating and abandoned mines.

Hardness in fresh water frequently is distinguished as carbonate and non-carbonate fractions. The carbonate fraction is chemically equivalent to the bicarbonates present in water. Since bicarbonates generally are measured as alkalinity, the carbonate hardness usually is considered equal to the alkalinity. When water containing bicarbonate or “temporary” hardness is heated, carbon dioxide is driven off, converting the bicarbonate into carbonates which precipitate to form the hard scale found in cooking utensils, pipes, hot water tanks, and boilers. This scale reduces the capacity of pipes to carry water and does not transmit heat well. Detergents minimize the adverse effects of hard water in washing and other processes, and proper water softening entirely eliminates the hard water problem.

When hardness exceeds 18 mg/l, it generally causes problems, and a water softener should be considered. Water softened to zero hardness is corrosive. It is therefore desirable to blend a proportion of non-softened water with extremely soft water.

IRON RUL 0.3 mg/l

The secondary *recommended upper limit* for iron is based on an unpleasant taste of the water and staining of laundry. At 1.0 mg/l a substantial number of people will note the bitter astringent taste of iron. Also at this concentration, it imparts a brownish color to laundered clothing and stains plumbing fixtures with a characteristic rust color. Staining can result at levels of 0.05 mg/l, lower than those that are detectable to taste buds (0.1-1.0 mg/l). Iron is an essential nutrient, but some people who drink water with iron levels well above the *recommended upper limit* could develop deposits of iron in a number of organs of the body (hemochromatosis). Therefore, the RUL of 0.3 mg/l represents a reasonable compromise, as adverse aesthetic effects are minimized at this level.

MANGANESE RUL 0.05 mg/l

The RUL was set to prevent aesthetic and economic damage. Excess manganese produces a brownish color in laundered goods and impairs the taste of tea, coffee, and other beverages. Concentrations may cause a dark brown or black stain on porcelain plumbing fixtures. As with iron, manganese may form a coating on distribution pipes. These may slough off, causing brown blotches on laundered clothing or black particles in the water. Manganese is an essential nutrient, and toxicity is not expected from levels that would be encountered in drinking water.

ODOR 3 Threshold Odor Number

Odor is an important quality factor affecting the drinkability of water. Odors for certain substances in water may be detected at extremely low concentrations. This may be indicative of the presence of organic and inorganic pollutants that may originate from municipal and industrial waste discharges or from natural sources. The Threshold Odor Number of water is the dilution factor required before the odor is minimally perceptible. A threshold odor number of 1 indicates that the water has characteristics comparable to odor-free water, while a threshold odor number of 4 indicates that a volume of the test water would have to be diluted to four times its volume before the odor became minimally perceptible. For precise work, a panel of five or more testers is required, and the threshold odor number is based on the greatest amount of dilution that elicits a positive odor response from one of the testers. The threshold odor number level of 3 was determined to be appropriate because most consumers find the water at this limit acceptable. Determination of odor below this level is difficult because of possible interferences from other sources and variability of the sensing capabilities of the personnel performing the test.

pH OPTIMAL RANGE 6.5-8.5

This is a numerical expression of the hydrogen ion concentration indicating the degree to which a water is acidic or alkaline. These various degrees are represented on a scale of 0 to 14, with 0 being most highly acidic, 14 most alkaline, and 7 neutral.

Low pH levels are objectionable because of the corrosive effect on metal pipes and fixtures, causing leaching of lead from solder in pipes in older homes, of lead from brass plumbing fixtures, and the metallic taste frequently associated with low pH water. Additionally, dissolved iron in low pH water stains porcelain plumbing fixtures. High pH levels are undesirable since they may impart a bitter taste to the water. Furthermore, the high degree of mineralization associated with alkaline waters will result in the encrustation of water pipes and water-using appliances. The combination of high alkalinity and calcium with low pH levels may be less corrosive than water with a combination of high pH, low alkalinity, and calcium content. High pH levels also depress the effectiveness of disinfection by chlorination, thereby requiring the use of additional chlorine or longer contact times.

A range of 6.5 - 8.5 was determined as that pH which would achieve the maximum environmental and aesthetic benefits.

SILVER RUL 0.1 mg/l

Silver is a relatively rare metal. Its major commercial uses are in photography, electric/electronic components, sterling and electroplate, and alloys and solder. Environmental releases can occur during ore mining and processing, product fabrication, and disposal. However, because of the great economic value of silver, recovery practices are typically used to minimize losses. The only adverse effect resulting from chronic exposure to low levels of silver in animals and humans is argyria, a blue-gray discoloration of the skin and internal organs. Argyria is markedly disfiguring and is a permanent, irreversible effect. Argyria is the result of silver deposition in the dermis and at basement membranes of the skin and other internal organs. There is no evidence that exposure to silver results in mutagenic or carcinogenic effects. Silver has been classified in USEPA’s Group D (not classifiable), based upon inadequate data in animals and humans. The current RUL for silver is based upon one gram of silver resulting in argyria.

SODIUM RUL 50 mg/l

Sodium is the principal cation in the hydrosphere. It is derived geologically from the leaching of surface and underground deposits of salts (e.g., sodium chloride) and from the decomposition of sodium aluminum silicates and similar minerals. The sodium ion is a major constituent of natural waters. Human activities also contribute sodium to water supplies, primarily though the use of sodium chloride as a deicing agent, and the use of washing products. Salt is about 40% sodium and 60% chlorine (in the chloride ion (Cl-) form). Normal salt intake of about 5 grams/day from all sources equates to about 2 grams (2000 mg) of sodium. Drinking eight glasses of water/day (about two liters) with the sodium concentration at 50mg/l, (the recommended upper limit), will contribute 100 mg of sodium to the daily intake. It has been estimated that food accounts for approximately 90 percent of the daily intake of sodium, whereas drinking water contributes up to the remaining 10 percent. When it is necessary to know the precise amount of sodium present in a water supply, a laboratory analysis should be made. If home water softeners utilizing the ion-exchange method are used, the amount of sodium will be increased. For this reason, water that has been softened should be analyzed for sodium when a precise record of individual sodium intake is needed. For healthy persons, the sodium content of water is unimportant because the intake from salt is so much greater, but for persons placed on a low-sodium diet because of heart, kidney, circulatory ailments, or complications in pregnancy, sodium in water must be considered. There are also potassium softeners available at a higher cost.

SULFATE RUL 250 mg/l

High concentrations of sulfate in drinking waters have three effects: (1) water containing appreciable amounts of sulfate (SO_4) tends to form hard scales in boilers and heat exchangers; (2) sulfates cause taste effects; and (3) sulfates can cause laxative effects with excessive intake.

The laxative effect of sulfates is usually noted in transient users of a water supply because people who are accustomed to high sulfate levels in drinking water have no adverse response. Diarrhea can be induced at sulfate levels greater than 500 mg/l but typically near 750 mg/l.

While sulfate imparts a slightly milder taste to drinking water than chloride, no significant taste effects are detected below 300 mg/l.

Sulfate cannot readily be removed from drinking water, except by distillation, reverse osmosis, or electrodialysis, but these are expensive. As with water having high levels of chloride, it is recommended that either an alternative source be used or that the high sulfate water be diluted with a lower sulfate containing water.

TASTE No Objectionable Taste

Taste, like odor, depends on contact of a stimulating substance with the appropriate receptor cell in the body. The stimuli are chemical in nature, and the term “chemical senses” often is applied to odor and taste. Water is a neutral medium, always present on or at the membranes that perceive a sensory response. In its pure form, water cannot produce odor or taste sensations. No satisfactory theory of olfaction ever has been devised, although many have been formulated. Humans and animals can avoid many potentially toxic foods and waters because of adverse sensory response. Without this form of primitive sensory protection many species would not have survived. Today, these same senses often continue to provide the first warning of potential hazards in the environment.

Some substances, such as certain inorganic salts, produce taste without odor and can be evaluated by the taste test. Many other sensations ascribed to the sense of taste actually are odors, even though the sensation is not noticed until the material is taken into the mouth. Standard Methods for the Examination of Water and Wastewater, 15th edition, describes a Taste Rating Test. The purpose of the test is to estimate the taste acceptability of the drinking water. Briefly, up to 10 samples are given to selected panel members who have been selected at trial orientation sessions. Rating involves a series of steps where the panel members take water into their mouths and form an initial judgment on a rating scale. The rating scale ranges from 1 to 9 with 1 being “I would be very happy to accept this water as my everyday drinking water” to 9 “I can’t stand this water in my mouth and I could never drink it.” Averages of all ratings are determined with a mean and standard deviation reported. This number can then be used to determine whether or not the water has any objectionable taste to the majority of consumers.

TOTAL DISSOLVED SOLIDS (TDS) RUL 500 mg/l

Total Dissolved Solids (TDS) may have an influence on the acceptability of the water in general. High TDS values may be an indication of the presence of excessive concentrations of some specific substance, not included in the Safe Drinking Water Act, which would make the water aesthetically objectionable to the consumer. The life of home hot water heaters decreases by approximately one year for each additional 200 mg/l of TDS in water above the typical household level of 220 mg/l. The RUL of 500 mg/l for TDS is reasonable because it represents an optimum value commensurate with the aesthetic level to be set as a desired water-quality goal.

ZINC RUL 5 mg/l

Zinc is found in some natural waters, most frequently in areas where it is mined. It is not considered detrimental to health unless it occurs in very high concentrations. It imparts an undesirable taste to drinking water. For this reason, the RUL of 5 mg/l was set.

BIOLOGICAL CHARACTERISTICS

Certain forms of aquatic vegetation and microscopic animal life in natural waters may be either stimulated or retarded in their growth by water-quality factors. The growth of algae and other microscopic plants found floating on the surface of the water is stimulated by light, temperature, nutrients such as nitrogen and phosphorus, and pH conditions. Their growth may in turn be retarded by changes in pH, temperature, excessive cloudiness or darkness, or the presence of certain species of bacteria.

Cycles of growth and decay of the cellular material of these microorganisms may result in the production of by-products that may adversely affect the quality of the water supply. The same general statements may be made regarding the growth cycles of other nonpathogenic bacteria and harmless microorganisms.

Thus, to prevent problems, a water source should be as free from biological activity as possible. To achieve this: (a) water sources should be selected that support a minimum of plant and animal life; (b) the supply should be protected from contamination by biological agents; (c) the introduction of nutrients, organic chemicals, and fertilizing materials should be avoided; and (d) treatment for the destruction of biologic life or its by-products should be instituted as needed.

TESTING THE WATER

Public Water Systems

Under the Safe Drinking Water Act (SDWA), all public water systems are required to sample and test their water supplies according to a fixed schedule for all contaminants for which MCLs have been set. For example, transient non-community water systems serving ground water sample for microbiological contaminants quarterly and for nitrates on an annual basis. A community water system, on the other hand, must monitor at a minimum, monthly for bacteria based on population served. As an example, a water system serving up to 4,900 people must take five microbiological samples from the water distribution system per month, whereas a system serving 500,000 people must take 210 samples a month. Larger systems are required to take even more samples.

The point-of entry to the distribution system is the sampling location for nitrates/nitrites, inorganics, volatile organics, synthetic organic compounds, radionuclides, secondary parameters (physical characteristics and chemical contaminants) and sometimes asbestos. Trihalomethanes, haloacetic acids, iron, manganese and in some cases, asbestos are sampled in the distribution system. The sampling point for lead and copper is, in most cases, the kitchen tap. Most community water systems have multiple points of entry. Tests for inorganic contaminants, for example, must be taken at each point-of-entry to the water distribution system and repeated each year for community systems utilizing surface sources, and every 3 years for those utilizing groundwater sources unless there are MCL exceedences or other problems.

The Community and non-transient non-community Compliance Monitoring Requirements, provides a summary of the base monitoring requirements for the major contaminant groups regulated by the Safe Drinking Water Act. Federal regulations provide a mechanism for both increasing monitoring and decreasing monitoring for the contaminant groups listed on Table 4. If a test exceeds a "trigger" value (0.5 ppb for a volatile organic), increased monitoring is required until the test results for that contaminant is determined to be "reliably and consistently" below the MCL. For inorganics, the trigger value is the MCL. Refer to Table 4 and 40 CFR §141.23 and N.J.A.C. 7:10-5.2 for more details. Waivers to reduce or eliminate sampling for synthetic organics are issued to water systems for individual points-of-entry based on contaminant use in the vicinity of the well head and susceptibility of the water sources to contamination. Prior sampling results can be used to decrease monitoring, through waiver-by-rule provisions, for some contaminant groups.

Table 4: Community and Non-Transient Non-Community Compliance Monitoring Requirements

Contaminants	Base Requirements Ground Water Surface Water		Trigger that Increases Sampling	Waivers for Base Requirements*
Asbestos	1 Sample every 9 years		>MCL	YES Based on Vulnerability Assessment
Nitrate	Annual Quarterly After 1 year<50% of MCL, surface water system may reduce to an annual sample		>50% MCL	NO
Nitrite	1 Sample: If <50% of MCL, state discretion		>50% MCL	NO
Inorganics	1 Sample every 3 years	Annual Sample	>MCL	YES Based on analytical results of 3 rounds
VOC	4 Quarterly samples every 3 years Annual after 1 year of no detects		>0.5µg/l	YES Based on Vulnerability Assessment
Pesticides and PCBs	4 Quarterly samples every 3 years After 1 round of no detects; systems >3300 reduce to 2 samples per year every 3 years; systems <3300 reduce to 1 sample every 3 years		Method Detection Limit (MDL)	YES Based on Vulnerability Assessments
Unregulated 6 IOC 24 SOCs	1 Sample 4 Consecutive quarterly samples		N.A.	YES Based on Vulnerability Assessments
Radionuclides (for community water systems only)	Initial: 4 consecutive quarterly samples. Reduced: If initial monitoring average < MDL, then 1 sample every 9 years; if >/= MDL but </= 50% of MCL, then 1 sample every 6 years, if > 50% of MCL, then 1 sample every 3 years		> MCL	YES Final 2 quarters may be waived if first 2 quarters < MDL. State may grandfather previous data in place of initial monitoring.

If your public water system fails to comply with certain aspects of the Safe Drinking Water Act, public notification is required. The exact type and frequency of notification depend on the seriousness of any potential adverse health effects that may be involved. Tier 1 notification for community water systems, which includes failure to comply with an established maximum contaminant level or treatment technique or a compliance schedule for a variance or exemption, requires newspaper notification, mail notification, and notification of electronic media. Tier 2 notification for community water systems, including failure to monitor or utilize the proper testing methodology or when a variance or exemption is granted, requires newspaper notification only. This emphasis on public notification and involvement is designed to bring about voluntary compliance as quickly as possible without costly, time-consuming legal battles.

Consumer Confidence Reports (CCR)

No later than July 1st of each year, every community water system must mail to their customers a water quality report indicating test results of the prior calendar year. These reports must contain information on the source of their water, detections and MCL exceedences (if any) of regulated contaminants. Characterization of risks (if any) from exposure to any contaminants detected in the drinking water must also be stated in an accurate and understandable manner. A complete description of the required CCR contents can be found at 40 CFR §141.151 *et seq.,* known as Subpart O-Consumer Confidence Reports.

Those served by a public water system and concerned about the water quality should be able to obtain the complete water test results required under the SDWA directly from the local water utility. In addition, the NJDEP has copies of limited water analyses performed by the state, and can be obtained by contacting the following Office:

NJ Department of Environmental Protection
Bureau of Safe Drinking Water
P.O. BOX 426
Trenton, NJ 08625-0426

(609) 292-5550

Additional information on drinking water can be obtained by writing to:

U.S. Environmental Protection Agency
Office of Ground Water and Drinking Water
1200 Pennsylvania Avenue NW
Washington, DC 20460

(800) 426-4791 (Drinking Water Hotline)

The USEPA regional office for New Jersey is located at:

U.S. Environmental Protection Agency Region 2
Office of Drinking Water
290 Broadway, 24th floor
New York, NY 10007-1866

(212) 637-5000

Local watershed associations or environmental groups may also have collected drinking water quality information.

New Public Non-community Water Systems

Under New Jersey regulations and under local authority, a sample of raw water from every proposed public non-community water system must be tested for certain specific contaminants.

Table 5: New Public Non-Community Water Systems- Initial Testing Required For Certification

BACTERIA (TOTAL COLIFORM)
INORGANIC CHEMICALS
VOLATILE ORGANIC COMPOUNDS (VOCs)
RADIONUCLIDES
SECONDARY CONTAMINANTS (PHYSICAL CHARACTERISTICS AND CHEMICAL CONTAMINANTS)

If the sample is total coliform positive, the total coliform positive culture medium must be analyzed to determine if fecal coliform are present, except that *E. coli* may be tested for in lieu of fecal coliform.

Additionally, if the system uses a surface water source, the administrative authorities shall require the system owner to sample and analyze the water for disinfection by-products and pesticides. The administrative authority may also require additional treatment of the water.

New Potable Wells (Non-Public Water Systems)

(also known as private or domestic water systems)

Under the NJ Safe Drinking Water Act, responsibility for monitoring non-public (such as private domestic wells) is delegated to local health agencies. Local health agencies may require testing for more parameters in addition to the state mandated list. Contact your County or Municipal Health Department for the county specific testing requirements. Under recent revisions to the New Jersey regulations, a sample of raw water from every proposed non-public water system must be analyzed for the following:

Table 6: Tests Required For New Wells (N.J.A.C. 7:10-12.30(a)(c))

BACTERIA (TOTAL COLIFORM)
NITRATES
IRON
MANGANESE
pH
LEAD
ALL VOLATILE ORGANIC COMPOUNDS WITH MCLs

In addition to the parameters previously listed, if the water system is located in ATLANTIC, BURLINGTON, CAPE MAY, CUMBERLAND, GLOUCESTER, MONMOUTH, OCEAN or SALEM COUNTY, Mercury must also be a tested parameter.

In addition to the parameters previously listed, if the water system is located in BERGEN, ESSEX, HUDSON, HUNTERDON, MERCER, MIDDLESEX, MORRIS, PASSAIC, SOMERSET, or UNION COUNTY, Arsenic must also be a tested parameter.

In addition to the parameters previously listed, if the water system is located in ATLANTIC, BURLINGTON, CAMDEN, CAPE MAY, CUMBERLAND, GLOUCESTER, HUNTERDON, MERCER, MIDDLESEX, MONMOUTH, OCEAN or SALEM COUNTY, tests for *GROSS ALPHA PARTICLE ACTIVITY, DETERMINED USING THE 48-HOUR RAPID GROSS ALPHA TEST,* IN ACCORDANCE WITH N.J.A.C. 7:18 must be performed.

The local Board of Health having jurisdiction may require additional testing. New Jersey regulations state that local authorities may require testing for inorganics, VOCs and/or radionuclides. The local board of health may also require additional treatment of the water.

RECOMMENDED WATER TESTS FOR EXISTING HOME WELLS
(PRIVATE WELLS / NONPUBLIC WATER SYSTEMS)

Regular water testing is an important step that private well owners should take to assure that their water supply is safe to drink. Public water supplies are protected under the State and Federal Safe Drinking Water Acts. However, private well owners are solely responsible for monitoring the quality of their own well water and for maintaining their own well. Other than the initial testing required by New Jersey State and local regulations for a newly constructed well, regularly scheduled water testing for possible contamination should be performed by the well owner.

Where a water sample is collected can have a great influence on the water test results. In some cases it is preferable to collect the sample after the water has passed through a permanently installed water system so that the consumer will know if the treated water is safe to drink. In other situations, the purpose of collecting the sample is to determine if there is a potential threat to the water supply from the raw (untreated) well water itself. The following recommendations will specify whether a finished (treated) or raw (untreated) water sample is recommended. If there isn't a "whole-house" treatment system already installed (such as a water softener or carbon filtration unit), sampling for any of the following parameters may be collected at the kitchen tap. These samples would be considered to be raw water samples.

At a minimum, annual testing should be performed for microorganisms (total coliform bacteria) and nitrate. These samples should be finished (treated) water samples collected at a kitchen or the primary tap used for drinking water.

- If the total coliform sample result is "positive" for the presence of bacteria, a follow-up sample should be collected and analyzed using an analytical method that will quantify the number of bacteria colonies for total coliform and fecal coliform.

- If the test result for nitrate is 5 ppm or higher, and if the well is located in an agricultural or former agricultural area, a repeat sample should be analyzed for herbicides using USEPA Method 507. Also recommended is the collection of a second raw water sample, at the same time, to confirm the concentration of nitrate.

Additional Recommendations for Sampling of Private Well Systems*

Sample one time – All testing should be performed by a NJ State Certified Drinking Water Laboratory**

- Arsenic – Raw water sample
- Gross Alpha Particle Activity – Raw water sample. If the first sample result is at or above the MCL and a water softener or ion exchange unit is already installed in the house, collect a second finished water sample at the kitchen tap.
- Mercury – Raw water sample

*****If your home was purchased after September 2002, you may already have some of these test results available to you as a result of the Private Well Testing Act.

Sample once every 3-5 years:

- Lead - Finished cold water sample collected from the kitchen tap
- All volatile organic compounds with established MCLs - If the concentration is at or above 50% of the MCL, retest annually. If the concentration is at or above the MCL, contact your local health officer.

The New Jersey Spill Compensation Fund provides reimbursement for direct and indirect damages caused by the discharge of a hazardous substance. For information concerning the applicability of the New Jersey Spill Compensation Fund for remediation, the NJDEP's Environmental Claims Administration (609-777-0101) should be contacted. For information about the availability or status of water supply treatment options, Rocky Richards, Section Chief in the NJDEP's Bureau of Site management (609-984-2990) should be contacted.

A useful web site for New Jersey private well owners is: www.state.nj.us/dep/rpp/.
The "NEWS" section includes: *A North Jersey Homeowner's Guide to Radioactivity in Drinking Water - Uranium* and *A South Jersey Homeowners Guide to Radioactivity in Drinking Water – Radium.*

**For a list of New Jersey State certified drinking water laboratories, contact the NJDEP's Office of Quality Assurance at 609-292-3950.

SELLING A HOME WITH A PRIVATE WELL – PRIVATE WELL TESTING ACT

Please note that the sampling requirements as described in the following section relating to the Private Well Testing Act, to occur at a property transfer or rental, are mandatory, not optional.

The Private Well Testing Act (PWTA), as set forth by N.J.S.A. 58:12A-26 *et seq*., was signed into law in March of 2001 and testing became effective in September of 2002. The PWTA and corresponding regulations (N.J.A.C 7:9E) requires specific sampling and analysis of raw (untreated) water from private potable wells for water quality whenever a property is transferred by a contract of sale or the property is leased. Specifically, the PWTA applies to:

- The contract of sale for a subject property that gets its drinking water from a private well located on the property, or
- The contract of sale for a subject property that gets its drinking water from a well that has less than 15 service connections or that does not regularly serve an average of at least 25 individuals daily for at least 60 days of the year, or
- The leasing of any property that receives its drinking water from a private well that isn't required to be tested under any other state law (such as the NJ Safe Drinking Water Act, N.J.A.C 7:10 *et seq*.).

Whenever testing is required under the law and corresponding regulations, untreated well water must be tested for specific analytical parameters. These parameters include total coliform, nitrates, iron, manganese, pH, lead and all volatile organic chemicals (VOCs) for which MCLs have been established by state regulations. Additionally, an analysis for arsenic, mercury and 48-hour gross alpha particle activity are required in certain counties. Arsenic testing is required to be performed in Bergen, Essex, Hudson, Hunterdon, Mercer, Middlesex, Morris, Passaic, Somerset and Union Counties. Mercury testing is required to be performed in Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, Monmouth, Ocean and Salem Counties. The 48-hour rapid gross alpha test is required to be performed in Atlantic, Burlington, Camden, Cape May, Gloucester, Mercer, Middlesex, Monmouth, Ocean and Salem Counties.

The purpose of the PWTA is to provide buyers and sellers, as well as tenants, of properties where the water supply is a private well with water quality information. For transfers of title at a closing of sale, the buyer and seller must certify in writing that they have received written copies of the PWTA test results. Lessors of rental properties where the drinking water is supplied by a private well are required to test for the PWTA parameters and to provide a written copy of the test results to the tenants within 30 days of receiving the results. Landlords must retest in accordance with the PWTA regulations every five years.

A laboratory that is appropriately certified by the NJDEP's Office of Quality Assurance (OQA) must perform the PWTA testing. When the testing is completed, the laboratory is required to provide a copy of the test results to the client within five days on a designated form titled the *New Jersey Private Well Water Test Reporting Form*. Additionally, the laboratory is required to electronically submit a complete copy of the test results to the NJDEP, and the NJDEP electronically notifies the appropriate county or local health agency if there is a failure for any of the required PWTA parameters so that they can take the appropriate action(s). Although it is expected for prices to vary, the NJDEP estimates that the costs should range between $450 and $650. Questions regarding laboratory certification should be directed to the OQA at (609) 292-3950.

The PWTA has developed an informative website that can be accessed via the Internet at www.nj.gov/dep/pwta. The NJDEP encourages New Jersey residents to visit the PWTA website to obtain the latest information concerning the PWTA Program. Available from the website is the complete Private Well Testing Act and corresponding regulations, a list of PWTA parameters with applicable standards and frequently asked questions. A list of New Jersey Drinking Water Certified Laboratories is also shown, however, ***please note that not all***

New Jersey Drinking Water Certified Laboratories have certification for private well testing in accordance with the PWTA. Should you have any unanswered questions regarding the PWTA, please either call the Private Well Testing Act Program at 1-866-479-8378 or e-mail your question to submitquestionPWTA@dep.state.nj.us.

WATER TESTING - WHERE SHOULD I GET MY WATER ANALYZED?

GENERAL INFORMATION ON WATER TESTING

Amateurs should take water samples only under the direction of a New Jersey State Certified Drinking Water laboratory***. Sampling for purposes of the Private Well Testing Act must be done by either an employee of a certified drinking water laboratory certified to collect PWTA samples, or by an authorized representative of such a laboratory.***

There are three types of sampling locations depending on the contaminant of interest. The sampling locations are point-of-entry (POE) after treatment, in the water distribution system, and at the resident's tap. The purpose of these three types of sampling locations is to differentiate between contamination derived from the source water, as a result of water treatment or contamination derived from the distribution pipes.

The goal of drinking water sampling should be to collect a sample under the worst conditions. Checking water quality a day after a heavy rainfall is a good idea. If corrosive water is suspected, a sample for lead or copper should be taken first thing in the morning, without letting the water run, after the water has been in the pipes for at least six hours,. This is called a "first draw sample." For other tests, wait until mid-morning after a good quantity of water has been used (laundry, dishwasher, etc.). Samples for bacteria (total coliform) must be collected using sterile containers and under sterile conditions. In addition, keep a record of all water test results and any changes over time to discover any problems.

SERVICES FREE OF CHARGE

Tests for total hardness and certain chemical impurities may be obtained from companies selling or renting water-conditioning equipment. They will also make recommendations for equipment to correct the problems. However, as a precaution, any recommendations should be rechecked with an independent laboratory and/or your local health department to ensure impartial analysis.

Refer to the Yellow Pages of the telephone directory under "Water Softening" or "Water Conditioning" for the names of local dealers.

STATE-CERTIFIED PRIVATE LABORATORIES

Water testing should be done only at New Jersey State Certified Drinking Water Laboratories.

Important: Laboratories gain or lose state certification on an almost daily basis. To ensure that a laboratory is currently certified for testing in a particular category as regulated by the NJDEP (i.e., microbiological, limited chemical, atomic absorption, gas chromatography, or organic chemicals), call:

NJDEP
Office of Quality Assurance
PO Box 424
Trenton, NJ 08625-0424
(609) 292-3950
Web site: www.nj.gov/dep/oqa

Private laboratories will collect samples and make tests for fees ranging from $12 and up, depending on the type of test. Most local, county, and state health departments in New Jersey will not test water from private home wells unless there is public health concern.

A laboratory near one's home is most likely to be familiar with problems in that area and can best advise as to which pollutants to test for.

Certain sanitary and environmental engineering consulting firms are available for hire for unusual or difficult water quality problems. Consult the telephone Yellow Pages under "Engineers - Sanitary."

WHAT TO DO IF YOUR DRINKING WATER EXCEEDS AN MCL OR RUL

FACTS TO CONSIDER BEFORE TREATING YOUR WATER

Many water quality problems can be controlled or eliminated by using a variety of drinking water treatment devices. Before proceeding with the selection process, there are several facts to be considered.

- ***If an MCL Is Exceeded, Consult Your Health Department.***
  MCLs are health-based standards. You may be assuming a risk if you continue to drink the water. Young children and infants are particularly susceptible to lead and nitrate exceedences. RULs are primarily aesthetic standards.

- ***Always Retest To Be Certain You Have A Problem***.
  If you have an exceedence of an MCL, it is always a good practice to have your water retested to ensure accuracy of the analysis. The second analysis should be performed by a different laboratory to confirm initial results.

- ***Consult With A Water-Quality Expert And/Or Your Local Health Department***
  When you are certain you have a particular contamination problem, an excellent informational resource is NSF International. This is a non-profit organization, offering unbiased information regarding many topics, including effective drinking water treatment devices. Their web site address is www.nsf.org.
  When visiting this site, go to **Consumer**, then **Drinking Water** and then **Home Water Treatment**. Your local health official or the NJDEP-Bureau of Safe Drinking Water may also be consulted if uncertainties arise.
- ***Consider Alternatives***

Availability and cost of public water supplies or other alternatives including deeper private wells should be considered. If the home unit is preferred, depending upon the contaminant, consider the use of either a whole-house, faucet, or line-bypass unit. Bottled water may also be an alternative.

When you have more than one water-quality problem, choosing a treatment device is more complex. Many times you cannot treat one problem without treating another first. Many times, two problems can be eliminated with a single treatment device.

- ***Select Unit***
  After choosing a treatment process, select a unit to install. Criteria for unit selection may include field experience, independent evaluations by NSF International and the Water Quality Association. Points to consider are equipment safeguards, maintenance requirements, initial and ongoing costs, and warranties or performance guarantees by the dealer.

- ***Purchase and Install***
  Reputable dealers, licensed plumbers, and certified installers should ensure that the device will perform according to specifications and warranties.

- ***Monitor and Maintenance***

Safe operation of a home treatment unit requires monitoring and maintenance by an independent third party. While the above approach costs money not typically included in the purchase and installation price, the consumer should receive a safer product if this approach is followed.

Table 7: Additional water testing recommendations for common problems or special situations

PROBLEM	COMMON SIGNS/SITUATIONS	CAUSES	TEST RECOMMENDED
"Hard" Water	Large amount of soap required to form suds. Insoluble soap curd on dishes and fabrics. Hard scaly deposits in pipes and water heater.	Calcium, magnesium, manganese, and iron (may be in the form of bicarbonates, carbonates, sulfates or chlorides).	Hardness Test
Rusty colored water	Rust stains on the clothing and porcelain plumbing fixtures. Metallic taste to water. Rust coating in toilet tank. Faucet water turns rust colored after exposure to air	Iron or manganese, or iron bacteria.	Iron Test, Manganese Test

PROBLEM	COMMON SIGNS/SITUATIONS	CAUSES	TEST RECOMMENDED
"Rotten egg" odor	Iron, steel, or copper parts of pumps, pipes and fixtures corroded. Fine black particles in water (commonly called black water). Silverware turns black	Hydrogen sulfide gas, sulfate-reducing bacteria, or sulfur bacteria	Hydrogen Sulfide Test
"Acid" water	Metal parts on pump, piping, tanks, and fixtures corroded. Red stains from corrosion of galvanized pipe, blue-green stains from corrosion of copper or brass	Carbon dioxide. In rare instances, mineral acid - sulfuric, nitric or hydrochloric	pH Test, Langlier Index Test
Cloudy turbid water	Dirty or muddy appearance.	Silt, sediment, microorganisms.	Check well construction with local well driller
Chemical odor of gasoline, fuel oil	Well near abandoned fuel oil tank, gas station.	Leaking underground storage tank.	Volatile Organic Compound scan or specific fuel component
Unusual chemical odor	Well near dump, junkyard, landfill, industry or dry-cleaner.	Groundwater contamination, underground injection.	Check with County or local Health Dept., Organic Chemical scan, Heavy Metals
No obvious problem	Well located in area of intensive agricultural use	Long-term use of pesticides and fertilizers	Test for pesticides used in area, Nitrate Test
Recurrent gastrointestinal illness	Recurrent gastrointestinal illness in guests drinking the water	Cracked well casing, cross connection with septic system	Bacteria (Coliform Test), Nitrate Test
Sodium-restricted diet, salty, brackish, or bitter taste	Well near seawater, road salt storage site or heavy salted roadway	Saltwater intrusion, groundwater contamination	Chloride, Sodium. Total Dissolved Solid (TDS)

Testing for specific trace organic chemicals is expensive and requires sophisticated equipment costing thousands of dollars. For accurate and reliable results, testing should be done in a state certified drinking water laboratory.

Home Drinking Water Treatment Technologies

ACTIVATED CARBON FILTRATION

Effective for:

- Some Organic Chemicals
- Taste
- Trihalomethanes
- Some Pesticides
- Odor

This technology uses any of several carbonaceous materials such as bituminous coal, coconut shells, lignite, peat, or wood. Activation is the process whereby the carbonaceous material is fragmented under high heat by steam in the absence of oxygen. Granules and exposed pores are created. Certain contaminants in water such as organic chemicals will adhere to the exposed surfaces of the many pores, through a variety of sorption processes. Studies have shown that activated carbon is most effective in removing large (high molecular weight) impurities and those with comparatively low solubility in water. It is, therefore, most effective in removing pesticides, benzene, and halogenated organics such as trichloroethylene (TCE). Activated carbon filters will significantly improve taste and odor of drinking water and will effectively remove chlorine and specific adsorbable organics such as trihalomethanes (THMs), including chloroform.

Activated carbon filters work best when first put in service. With use, the adsorption capacity of the carbon becomes used up and the filter no longer removes as much of the contaminants and will do a poorer job on the most difficult ones. In fact, contaminants can leach off the filter at higher concentrations than the influent concentration when the filter becomes overloaded. Most manufacturers state or suggest a life for the filter media in gallons treated, but this generally presumes some unstated concentration, mix of contaminants, or contact time. Manufacturers frequently state guidelines for determining when the filter needs replacement: return of poor taste or odor, color change of the filter media, reduced flow through the filter, etc. This may be satisfactory if the contaminant is only an annoyance but not if it is a health hazard. Unfortunately, many hazardous contaminants do not cause off-tastes, odors, or color at the concentrations found in water supplies. The only way to determine if the filter has removed them to acceptable levels is by repeated testing of the treated water. When using the units to remove health-related contaminants it is preferable to install two units in series (one after the other), with a water sample tap between the units. Testing can then be done to determine when one unit is saturated with contaminants and needs to be replaced.
When replacing exhausted media, place the partially exhausted media first and the new media next in series.

Some water treatment units contain silver, which manufacturers claim prevents the growth of bacteria and acts as a bacteriostatic agent. These units are registered with the Environmental Protection Agency (USEPA) as bacteriostatic units. The main requirement of the registration is that the units do not release excessive amounts of silver. Registration does not imply that the USEPA has examined the effectiveness of the units. A few units are designed to be microbiological purifiers and contain a chemical disinfectant; such units would be subject to registration by USEPA and would be required to prove the purification claims. ***Manufacturers of water treatment units are required to obtain an establishment (Est.) registration number to identify their plant. Some manufacturers have used their establishment (Est.) number to make it appear that USEPA has endorsed or approved their product. This is not the case.***

AIR STRIPPING (also called Packed Tower Aeration)

Effective for:

Some Volatile Organic Chemicals
Iron (with filtration)
Hydrogen Sulfide
Radon Gas

Until recently this technology has been limited to large operations at water treatment plants, but a few manufacturers now have developed point-of-use (POU) aeration devices for home water treatment. In air stripping columns, water flows downward by gravity while a mechanical blower pumps air upward from the bottom of the column. As the water flows down through the column it passes over a packing material which increases the area of the air-liquid interphase. Volatile organic compounds are transferred from the water to the air that is vented outside. The volatile organic chemicals (VOCs) which are most commonly detected in groundwater can be removed by air stripping.

In POU applications, up to 90 percent removal of VOCs can be expected. Aeration is also effective in removing certain inorganic contaminants including hydrogen sulfide and iron. However, use of air stripping towers to remove iron requires post-treatment filtration. The rate at which VOCs are removed from water by aeration (or the mass transfer characteristics of the compound) depends on several factors: The water flow rate; air/water ratio; type of packing material; height of packing material; temperature of the water and air; type of VOCs and concentration of the VOC(s).

Air stripping does have several limitations. The removal efficiency of air stripping columns is largely dependent on the type of VOCs present in the water and the ease with which they are stripped from the water. Once the water passes through the column it is necessary to have storage and additional pumping facilities to distribute it through the house. The electrical energy costs of pumping the water to and away from the tower, as well as running the blower, must also be considered. It is also a good idea to require a performance guarantee, or a period of pilot testing with frequent monitoring, to ensure adequate removal of contaminants.

BOTTLED WATER

Effective for:

A temporary solution to
some water-quality problems
Aesthetic problems
Emergency situations

Bottled water may be an alternative when a home well is contaminated. In a household with an infant, bottled water could be substituted for a water source that has high nitrate levels. In some instances, out of necessity, families buy water by the caseload or carboys for years. Where the contamination cannot be traced or an alternative found, bottled water becomes a long-term solution. The question is often asked, “Are bottled waters safer or healthier than public water supplies?” The bottled water industry adheres to a plant inspection program established by the American Sanitation Institute (ASI). According to the International Bottled Water Association, "Industry products come from protected sources, are bottled in facilities regulated as food plants, and processed using good manufacturing practices approved by the federal government."

The United States Food and Drug Administration (FDA) regulates bottled waters on a national level, but New Jersey has promulgated its own standards which require that bottled waters meet all the MCLs under the N.J. Safe Drinking Water Act. In New Jersey, bottled water is regulated by the New Jersey Department of Health and Senior Services (NJDHSS), not by the NJDEP. The FDA has established standards of quality for bottled drinking water; however, it exempts mineral waters because, by their very nature, they exceed physical and chemical limits prescribed in the Bottled Drinking Water Standard. The FDA has established "Good Manufacturing Practice Regulations" for processing and bottling of all bottled waters. NJDHSS has additional regulations for bottling. These outline in detail the sanitary conditions under which the water is to be obtained, processed, bottled, and tested. They require that waters be obtained from sources free from pollution and be "of good sanitary quality" when judged by the results of bacteriological and chemical analyses. Water bottlers must list the addition of salt and carbon dioxide on their labels, and they are prohibited from making "objectionable therapeutic claims."

To answer the question, "Are bottled waters safer or healthier than public water supplies?" you must investigate your water supply to be sure it is as pure and risk-free as you want it to be. If you are on a public water system, find out where your water comes from, what contaminants it is tested for, and whether any are present in quantities that pose a health question or risk to you. A reliable source of information is the annual Consumer Confidence Report, or water quality report mailed, by June 30 of each year, to all customers of public community water systems.

If your public water system either fluoridates their delivered water or supplies naturally fluoridated water at optimal concentrations, the user of bottled water will not receive the benefits of the fluoridated water. However, bottled waters can originate from water systems that fluoridate. See www.state.nj.us/watersupply/quality.htm/. Publications 11 and 12 list the public water systems that serve and municipalities that receive fluoridated drinking water, either artificially adjusted or naturally occurring. If you decide that bottled water is for you, investigate the bottled water you select. After all, there is no need to spend a lot of money on bottled water if it is no better than your own tap water.

CHLORINATORS

Effective for:

- Bacteria (Coliforms)
- Microbiological Contamination

Chlorinators can be used for noncommunity water supplies; however, this technology is not recommended by DEP for private homeowners since the chemicals used in this type of treatment can be dangerous. Ultraviolet radiation or ceramic filters would be more appropriate for the homeowner with a microbiological problem.

Continuous chlorination of a private well should be considered only as a last resort. Well disinfection or shock chlorination, as it is sometimes called, should always be attempted first before purchasing chlorination equipment. Shock chlorination can be accomplished by mixing a strong chlorine solution with the water in the well and letting it stand for a few hours. This will kill the coliform and most disease-causing organisms. As a general practice, a new well should be shock chlorinated before being put in use, and again whenever it is opened to replace the pump or to remove sand and sediment from the bottom of the hole. The procedure is explained in "Potable Water -- Directions for Disinfecting a Well -- Circular 598." A copy can be obtained from your county office of Rutgers Cooperative Research & Extension.

The positive-displacement chlorinator, the most reliable type of device for this purpose, consists of a small electrical chemical-feed pump. The amount of chlorine fed can be increased or decreased with a simple adjustment of a control knob. Operation of an electric hypochlorinator can be synchronized with that of the well pump, so that both start and stop at the same time. Flow-actuated positive-displacement hypochlorinators (water-meter type) dispense the chlorine solution in proportion to the actual flow rate of the water. This type of equipment operates only if water is flowing in the pipe. The dosage of chlorine is more accurately attuned to the rate of flow than it is to the on-off cycle of the well pump. Aspirators or suction-type chlorinators are not positive displacement and generally are not reliable, because the chlorine dosage varies with the pressure and flow rate in the pipeline to which it is attached. Minerals precipitating from the water and the chlorine solution will clog the small jets in the aspirator, and this will prevent the chlorine from being drawn into the system. It is important to inspect the chlorine solution storage tank and chlorinators frequently to be sure that a supply of chlorine solution is always available and that the equipment is working properly. Calcium hypochlorite, in powder or tablets, can be used as a concentrated source of chlorine to mix a stock solution.

Concentrated hypochlorite dissociates faster than low concentration, therefore use of low concentration (5.0%) is recommended, and it is safer to use than high concentration hypochlorite. Mix according to directions on the label so as to obtain the proper concentration of chlorine in the mixture. After mixing, use only the clear solution; discard the bottom sediment because it may clog the hypochlorinator.

DISTILLATION

Effective for:

- All Inorganic Chemicals, i.e., Nitrates, Sodium Chloride
- Some Organic Chemicals

In this technology, water is heated until it turns to steam. The steam is circulated in coils and then encounters a cooling process, either circulation of cool water or a fan. The subsequent reduction in temperature causes the steam to condense as distilled and purified water, purged of most dissolved or suspended contaminants. Distillation is the only water purification process which removes with absolute certainty microorganisms such as bacteria and viruses which may cause diseases and may be contained in the feed-water. Distillation also removes trace amounts of heavy metals, all organic chemicals if they are not carried over in the steam, nitrates, and other inorganic anions.

Distilled water, because it is essentially mineral-free, is more corrosive than tap water. It tends to dissolve substances with which it is in contact more rapidly than tap water. Notably, carbon dioxide from the air is rapidly absorbed, making the water acidic and even more corrosive. Many metals are dissolved by distilled water. Because of the absence of minerals, distilled water may not be the ideal drinking water. It has been described as tasteless and flat. It is recommended that you try some before purchasing a unit.

Other drawbacks are that it is very slow, although somewhat more rapid than reverse osmosis, and energy cost (electricity) is high. A problem with some distillation units is that they allow certain organic contaminants with a lower boiling point than water (some pesticides, for example) to vaporize with the water, re-condense, and end up with the processed water. A type of unit called a “fractional distiller” avoids this problem, but not all distillers are of this type. Maintenance can be a problem, depending on the design of the units. The minerals and other contaminants left behind in the boiling chamber can build up, interfering with the operation of the unit. Hard water can quickly clog a distiller. Some units are easy to clean by hand; others are difficult or require a strong acid. Many models have reset switches and timers that make automatic operation possible. These features may be desirable when distilled water is continuously used. If water is the coolant medium, waste of water may be even higher than reverse osmosis. All distillers should be Underwriters Laboratories (UL) listed. The warranty may be limited or full. Frequency of cleaning the distiller varies with the quantity of impurities in the water.. Some manufacturers recommend cleaning the machine after every third distillation. White vinegar may be used by leaving it in the boiling tank overnight, or a special cleaner made by the appliance manufacturer may be used.

ION EXCHANGE

Effective for:

- Hard Water (Water Softening)
- Manganese
- Some Heavy Metals
- Uranium
- Combined radium 226 and radium 228
- Beta particle and photon radioactivity
- Calcium
- Iron

Ion exchange is a combined physical and chemical process in which ions (charged particles) that are dissolved in water are transferred to, and held by a solid material or exchange resin. The system used for water softening contains a cation (positively charged particle) exchange resin. Positively charged sodium ions are used to coat most common cation exchange resins. When water containing dissolved calcium, for example, contacts the resin, calcium ions are "exchanged" for, or trade places with, the loosely held sodium ions on the resin. In this way the calcium and magnesium ions responsible for hardness are removed from the water and placed on the exchange resin, a process that makes the water "soft."

In this process, however, sodium ions are added to the water. Eventually a point is reached when very few sodium ions remain on the resin, thus no more calcium or magnesium ions can be removed from the incoming water. The resin at this point is said to be "exhausted," or "spent," and cannot accomplish further water treatment until it is "recharged" or "regenerated." Most whole-house systems have a bypass to allow for large volume use of untreated water to water the lawn, or to fill up pools, etc. While softeners are used primarily to reduce the damage of scale and other deposits, and to enhance water for cleaning purposes, cation exchangers have an added benefit of reducing toxic metals such as lead and barium, as well as radium, a radioactive material. (Anion exchange units operate on the same principle, but they are used primarily to treat well water supplies containing relatively high levels of nitrates.)

Once an analysis of water is available, selection of a water softening unit depends on the hardness of the raw water and the amount of water to be softened. You may also choose between manual, automatic, semiautomatic, and fully automatic units, which differ in the degree to which the consumer must participate in the regeneration of exhausted resins. As mentioned previously, if a manual unit is selected, you should also consider the frequency of regeneration. The newest equipment is available with digital controls and many programmable options.

MECHANICAL FILTRATION

Effective for:

- Turbidity
- Dirt
- Sediment
- Particulates (Loose Scale)

Mechanical filtration, often referred to as particulate or turbidity filtration, removes dirt, sediment, and loose scale from the incoming water. This technology employs sand, filter paper, or compressed glass wool or other straining material and operates as a fine sieve would, clearing the water of dirt, sediment, and coarse and fine particulates including rust particles. The result is physically cleaner, clearer, and aesthetically more pleasing water, but with essentially no removal of harmful dissolved organic or inorganic chemical contaminants. These filters ***will not*** remove nitrates, heavy metals, pesticides, volatile organic compounds or other dissolved chemicals. Only filters with a special rating will remove microbial contaminants such as bacteria and/or viruses.

REVERSE OSMOSIS

Effective for:

- Certain Inorganic Chemicals
- Combined radium 226 and radium 228
- Beta particle and photon radioactivity
- Nitrates
- Dissolve Solids
- Uranium
- Gross alpha particle activity

Reverse osmosis (RO) treatment decreases the dissolved impurities in water. It successfully treats water with high salt content, cloudiness, and dissolved minerals, such as sulfate, calcium, magnesium, sodium, potassium, manganese, chloride, nitrate, fluoride, boron, and orthophosphate. RO also is effective with some detergents, some taste-, color-, and odor-producing chemicals, certain organic contaminants, and specific pesticides.

RO units work by passing water under normal pressure at the tap through cellulosic or noncellulosic (polyamide) membranes. A cellulose acetate membrane will not be degraded by chlorine present in municipal water systems. A polyamide membrane will be degraded and, therefore, must be preceded by an activated carbon filter for chlorine removal when chlorinated water is to be treated. Normal pressure at the tap will force filtered water through the membrane and leave behind dissolved solids. Reverse osmosis will remove 90-95 percent of most dissolved contaminants. Membrane density in the sub-micron range will also reject all types of bacteria. Reverse osmosis under-sink installations are costly and require space not ordinarily available in small homes. The usual installation requires three separate cartridges: one for particulates, one for activated carbon, and the reverse osmosis membrane. This results in a costly cartridge replacement program because the useful lives of the separate cartridges vary.

Whatever the installation, countertop or under the sink, reverse osmosis is slow and wasteful of water. For every gallon of potable water obtained, between 4 and 6 gallons of water will go down the drain. It may be necessary to process 30 gallons of water in order to obtain 5 gallons of drinking water. The system may be in operation up to 33 hours intermittently to produce 5 gallons of filtered water, but as the tank is being filled drinking water is available on demand. Manufacturers are attempting to increase membrane life and water recovery rates. You should be sure that the water-quality problem you are treating warrants a treatment method that is relatively expensive and wastes large quantities of water.

ULTRAVIOLET RADIATION

Effective for:

- Bacteria (coliforms)
- Microbiological contamination

This technology uses a special light bulb which produces ultraviolet light. The ultraviolet (or U.V.) radiation must pass through every particle of water with a minimum dose to be effective in water purification. In clear water this is not difficult to achieve. However, turbid water may permit disease-causing organisms to "hide behind" particles, shielding them from contact with the killing radiation. There are several effective U.V. water purifiers on the market. They are used in whole-house treatment applications, and are effective at destroying all disease-causing organisms if the radiation is at the proper wavelength and of sufficient intensity. When operating properly, U.V. systems can produce bacteria-free and virus-free water (most claim a 99.9 percent killing rate). The process leaves no residue, taste, or odor. This factor can be a drawback, however, as there is no way to measure if the system is doing its job except by performing a bacteria test on the water. Some systems incorporate a meter that measures the U.V. radiation being transmitted through the water. A quartz window through the side of the irradiating chamber allows the ultraviolet rays to activate a photoelectric cell which measures the intensity of the U.V. If insufficient radiation is present, it is set to turn off the water pump and/or actuate an alarm. The major problem with most U.V. systems is the collection of sediment and growth of algae inside the irradiation chamber. New designs are available which may help to eliminate this problem. In one new U.V. system, water flows through Teflon tubes surrounded by irradiating U.V. lights. This eliminates the fouling on the quartz tubes and appears to be an effective and relatively maintenance-free method.

If you need more information about home water treatment technologies and devices, write or call your county office of Rutgers Cooperative Research & Extension, or contact the NJDEP-Bureau of Safe Drinking Water.

DEFINITIONS OF TERMS

ACUTE HEALTH EFFECT – An immediate (i.e., within hours or days) adverse health effect that may result from exposure to certain drinking water contaminants.

ADMINISTRATIVE AUTHORITY - A governmental organization, such as United States Environmental Protection Agency (USEPA), New Jersey Department of Environmental Protection (NJDEP), New Jersey Department of Health and Senior Services (NJDHSS), or county or local Board of Health having jurisdiction.

AQUIFER – A natural underground layer, often of sand and gravel, that contains water.

CARCINOGENIC - producing or tending to produce cancer.

CHRONIC HEALTH EFFECT – The possible result of exposure over many years to a drinking water contaminant at levels above the Maximum Contaminant Level.

CONTAMINANT - any physical, chemical, biological, or radiological substance or matter in the water.

DISSOCIATE – breaking of a chemical compound into simpler constituents.

DISTILLED WATER - water that has been purified by passing through an evaporation-condensation cycle. It contains minute amounts of dissolved solids. Multiple distilling will further lower the dissolved solids.

GRAINS PER GALLON (gpg) - an obsolete expression needed to denote water hardness. To convert gpg to ppm, multiply the hardness in grains per gallon by l7.l.

GROUND WATER - Any water found beneath the surface of the ground, as opposed to surface water.

INORGANIC CONTAMINANTS – Mineral based compounds such as metals, nitrates and asbestos. These chemicals are naturally occurring in some water, but can also get into water through farming, chemical manufacturing, and other human activities.

ION - an electrically charged atom or group of atoms which results when one or more electrons are gained or lost; resulting in either a positive (+) or negative (-) charge. It can be made up of one element or a group of elements; for example, the calcium (Ca^{++}) or bicarbonate (HCO_3^-) ions.

MAXIMUM CONTAMINANT LEVEL (MCL) - The maximum permissible level of a contaminant in water that is allowed in drinking water. MCLs are set as close to the MCLG as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards. In New Jersey, these numbers extend to and include non-public (private wells) water systems.

MAXIMUM CONTAMINANT LEVEL GOAL (**MCLG**) – The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety. MCLGs are non-enforceable health goals.

MICROGRAM PER LITER (ug/l) - a metric unit of measurement used to denote the concentration of chemicals or other substances in water. ug/l and ppb are equivalent expressions of concentration (10^{-6} grams/liter).

MILLIGRAM PER LITER (mg/l) - a metric unit of measurement used to denote the concentration of chemicals or other substances in water. mg/l and ppm are equivalent expressions of concentration (10^{-3} grams/liter).

MILLILITER (ml) - a unit of volume denoting one-thousandth of a liter; 3,785 ml equal 1 gallon.

MILLIMHO (mmho) - a unit of conductance reciprocal to ohm. It is useful in determining total concentration of dissolved salts or minerals in water.

MUTAGENIC - capable of inducing a mutation, in this instance an alteration of the genes or chromosomes of an organism.

NEPHELOMETER – An instrument that measures turbidity in water.

NON-PUBLIC WATER SYSTEM – A private well, one used by a single dwelling, or a group of several homes or businesses not meeting the definition of a public water system.

ORGANIC CONTAMINANTS – Carbon based chemicals such as solvents and pesticides.

PART PER BILLION (ppb) - a unit of measurement used to denote the concentration of chemicals or other substances. The unit implies a part of something in one billion parts of water or other substances. The following comparisons help in putting this concentration in perspective; one inch in 16,000 miles, one cent in $10,000,000, one drop in 60,000 quarts of liquid or 1 second in 32 years. ppb and ug/l are equivalent expressions of concentration.

PART PER MILLION (ppm) - a unit of measurement used to denote the concentration of chemicals or other substances. The unit implies a part of something in one million parts of water or other substances. The following comparisons help in putting this concentration in perspective; one inch in 16 miles, one cent in $10,000, one drop in 60 quarts or 1 second in 12 days. ppm and mg/l are equivalent expressions of concentration.

PICOCURIE (pCi) – A unit of measurement. The quantity of radioactive material producing 2.22 nuclear transformations per minute.

POINT-OF-ENTRY TREATMENT DEVICE (**POE**) - a treatment device for the purpose of reducing contaminants in the drinking water distributed throughout the house or building and applied to the drinking water line entering a house or building.

POINT-OF-USE TREATMENT DEVICE (**POU**) - a treatment device used for the purpose of reducing contaminants in drinking water and applied to a single tap.

POTABLE WATER - any water used or intended to be used for drinking and culinary purposes.

PRIMARY DRINKING WATER REGULATION (STANDARD) - A regulation which applies to a public water system, specifies contaminants in drinking water which have adverse health effects, sets an MCL or treatment technique for the contaminant, and assures compliance. In New Jersey, these standards extend to and include non-public water systems.

RECOMMENDED UPPER LIMIT (RUL) – the optimum range for secondary contaminants (i.e. iron, manganese and pH) in accordance with the New Jersey State Drinking Water Regulations.

SALT (GENERAL TERM) - a class of compounds, such as sodium chloride ($NaC1$), calcium chloride ($CaCl_2$), or calcium carbonate ($CaCO_3$).

SECONDARY DRINKING WATER REGULATION (STANDARD) - A regulation which applies to a public water system, specifies contaminants which are primarily aesthetic or physical, and sets a recommended upper limit (RUL) or optimum range for the contaminant. Examples are unpleasant odor or appearance that may cause a substantial number of people to discontinue using the water. In New Jersey, these Secondary Standards extend to and include non-public water systems.

SPRING - a natural surface feature where groundwater issues from the rock or soil onto the land or into a body of water.

SURFACE WATER - the water found or contained in a stream, pond, lake, reservoir, or other natural watercourse. A surface source or surface supply, as opposed to ground water.

TERATOGENIC - tending to cause developmental changes and malformations in the unborn.

TURBIDITY – The cloudy appearance of water caused by the presence of tiny particles. High levels of turbidity may interfere with proper water treatment and monitoring. Turbidity is measured with an instrument called a Nephelometer.

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