

***CITIZEN'S GUIDE TO
VOLATILE SYNTHETIC
ORGANIC CHEMICALS
IN
DRINKING WATER***

COMMONWEALTH OF PENNSYLVANIA
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BUREAU OF WATER SUPPLY MANAGEMENT

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Introduction

This *Citizen's Guide* provides an explanation of the protection afforded users of public water systems regarding volatile synthetic organic chemical (VOC) contamination, and methods whereby users of individual water systems can assess the safety of their water supplies and reduce exposure to VOCs if necessary. Fact sheets for 21 VOCs most commonly detected in surface and ground water have been included to provide a brief summary of how each chemical is normally used, health effects information, and methods of removing VOCs from drinking water.

VOCs are man-made substances that tend to volatilize or evaporate from water. These chemicals are commonly used as solvents, degreasers and dry cleaning chemicals. Through accidental spills, runoff, and improper disposal of certain industrial,

agricultural and domestic wastes, VOCs find their way into public and private water systems. VOCs have been found in both surface (i.e., rivers, lakes) and ground (i.e., wells) drinking water supplies. Higher levels are frequently found in ground-water systems since VOCs in surface water evaporate readily or are broken down by sunlight.

All public water systems must comply with the maximum contaminant levels (MCLs) for the 21 VOCs in this guide.

The Department of Environmental Protection (DEP) does not have the authority to regulate individual water systems. However, as a service to the public, the staff of the DEP will interpret and evaluate the analytical results of samples collected from private, individual water systems. Enforceable contaminant limits do not exist for individual water systems.

Safety of Public Water Systems

Regulated Public Water Systems

DEP regulates public water systems, which are defined as systems that provide water to the public for human consumption and have at least 15 service connections or regularly serve an average of at least 25 individuals daily at least 60 days out of the year. Regulated systems are either community water systems or noncommunity water systems. A community water system is a public water system which serves a residential population such as a municipality, mobile home park or nursing home. A noncommunity system serves a nonresidential population such as a restaurant, campground or factory.

To ensure that public water systems are complying with drinking water quality standards and conducting appropriate water quality compliance monitoring, DEP staff perform a variety of surveillance activities including sanitary surveys and inspections of systems, assessments of the vulnerability of water sources to contamination and development of programs to protect the quality of water sources. Drinking water quality standards or MCLs for the VOCs in this guide have been developed by the U. S. Environmental Protection Agency (EPA), and have been adopted and are currently in effect in Pennsylvania.

MCL Development Process

Risk Assessment

Standards limiting the concentration of contaminants in public drinking water have been developed to protect the consumer from possible short-term and long-term adverse

health effects. Contaminants are usually selected for regulation based on potential health risks and their occurrence or potential occurrence in drinking water.

The first phase of the extensive standard development procedure requires that each contaminant go through a risk assessment process. A complete contaminant risk assessment consists of the following steps:

- (1) Hazard identification-- determination of whether a chemical causes an adverse health effect. This is accomplished through gathering and evaluating two types of data: (a) data on the types of health injury or disease that might be produced by a chemical, and (b) data on the conditions of exposure under which injury or disease is produced. This data is obtained through animal and epidemiological studies. Lifetime animal studies are the primary method used for determining the carcinogenic and noncarcinogenic properties of a substance with the assumption that effects in humans can be inferred from effects in animals. Epidemiological studies compare the health status of a group of persons who have been exposed to a suspect agent with that of a comparable nonexposed group.
- (2) Dose-response assessment-- determination of the relation between the amount of exposure to a chemical and an adverse health effect. Dose response is normally established through animal studies.
- (3) Human exposure assessment-- determination of past, current and anticipated human exposure to a

chemical. This process involves estimating the number of people exposed to a substance and the magnitude, duration, and timing of the exposure.

- (4) Risk characterization--determination of the possibility that humans will experience adverse health effects. This step involves combining the information from the first three steps to determine the likelihood that humans will experience any of the various forms of toxicity associated with a substance.

Determining an MCL--General Information

When the risk assessment process is completed, a maximum contamination level goal (MCLG) is determined for the tested contaminant. The MCLG is a level at which no known or anticipated adverse health effects occur and which allows an adequate margin of safety.

During the second phase of standards development, an MCL is established for the contaminant by setting it as close to the MCLG as is feasible. The MCL is considered feasible if the best available water treatment technology can efficiently remove the contaminant to or below the MCL level, and if laboratories are able to analyze for the contaminant at this level or lower with available methods. When EPA evaluates treatment available for removal of a particular contaminant from drinking water, it considers commercial availability, removal efficiencies, treatment compatibility, reliability, economic impact and ability to comply with the MCL. Evaluation of the economic impact of an MCL includes the cost for removal of a contaminant from all size water systems, determination of the number of systems the MCL will affect, laboratory analytical fees, and the added cost to water customers.

Risk assessment and the eventual establishment of drinking water MCLs has been based on the assumption that adverse health effects are primarily the result of ingestion. Recent studies indicate that the use of

water containing volatile contaminants, for purposes other than drinking, especially bathing, may also allow the contaminants to enter the body through inhalation and skin absorption. The Federal-State Toxicology and Risk Assessment Committee, a network of federal and state regulators and risk assessors concerned with drinking water issues, has concluded that exposure to VOCs through inhalation is on the average equivalent to exposure from ingestion, and that in the worst case, dermal absorption of VOCs could be as much as 25 percent of the exposure from ingestion. Although these other routes of entry have not been specifically considered when establishing VOC MCLs, the current MCLs incorporate conservative uncertainty factors that counteract consumer exposure from multiple routes of entry.

Concentrations for VOC MCLGs and MCLs are reported in milligrams per liter (mg/L) or micrograms per liter ($\mu\text{g/L}$). One milligram per liter equals about one part per million (an example of one part per million is approximately one drop in 141 12-ounce sodas) and one microgram per liter equals about one part per billion (an example of one part per billion is approximately one drop in 141,000 12-ounce sodas).

Contaminants selected for MCL development, based on potential health risks and occurrence in drinking water, are divided into two major groups--carcinogens and noncarcinogens. Carcinogens are contaminants which may cause cancer, based on the findings of animal or human studies, and noncarcinogens are contaminants which may pose a health risk other than cancer. The MCLG/MCL development process differs for each group. The following is an explanation of each of these processes.

Determining an MCL for Noncarcinogens

For noncarcinogen MCL development, a reference dose (RfD) is calculated for each contaminant. The RfD is an estimate of the amount of a chemical that a person can be exposed to on a daily basis that is not anti-

culated to cause adverse health effects over the person's lifetime. The RfD is usually expressed in milligrams of chemical per kilogram of body weight per day (mg/kg/day).

The RfD is derived based on data primarily from scientific studies of animals subjected to varying doses of a particular chemical. The RfD is the amount of a chemical that has caused little or no adverse effects in an animal or human, divided by an uncertainty factor. The uncertainty factor takes into account intra and interspecies diversity and sensitivities, limited or incomplete data, significance of the adverse effect, length of exposure and pharmacokinetics (behavior of the chemical in the body). This uncertainty factor can range from one to 10,000. The more uncertain scientists are about the contaminant concentration below which consumers will not experience an adverse health effect, the greater the uncertainty factor. For example, an uncertainty factor of 10 could be used in conjunction with a valid study of results from prolonged ingestion by humans, while an uncertainty factor of 1,000 could be used in conjunction with limited or incomplete results of experimental animal studies. EPA attempts to establish MCLs at a concentration which is conservative enough to protect all consumers, taking into consideration numerous uncertainties.

The MCL is then determined from the RfD by assuming that the protected individual weighs 70 kilograms (154 pounds), drinks two liters (approximately two quarts) of water per day and that as much as 80 percent of the daily intake of a chemical may come from other sources (e.g., air, food, etc.).

Determining an MCL for Carcinogens

The EPA has developed the following five carcinogen classification groups:

Group A: Human Carcinogen

Sufficient evidence in human population studies to support causal association between exposure and cancer.

Group B: Probable Human Carcinogen

B1--Limited evidence in human population studies.

B2--Sufficient evidence from animal studies and inadequate or no evidence in humans.

Group C: Possible Human Carcinogen

Absence of data in humans. Limited evidence from animal studies.

Group D: Not Classified

Inadequate animal evidence.

Group E: No Evidence of Carcinogenicity for Humans

No evidence in multiple studies.

If toxicological evidence gathered during the risk assessment process leads to the classification of a contaminant as a human (Group A) or probable human (Group B) carcinogen, the MCLG is set at zero. The reason being that the MCLG is a health goal which is to pose little or no risk and it generally is agreed that there is no threshold for carcinogens, meaning that any exposure is assumed to represent some risk.

Estimates of carcinogenic risk associated with contaminated drinking water are based on a lifetime (70 years) consumption of two liters per day of water containing contaminants exhibiting carcinogenic potential. The risk is expressed as the number of cases of cancer in excess of those normally expected for a specified number of people (normal life-style accounts for about 25 percent of the population experiencing cancer during a lifetime) due to lifetime consumption of two liters of water per day containing a contaminant at a specified concentration. For example, in a case where water consumption has been estimated to represent a carcinogenic

risk of one in one million you would expect to see one additional case of cancer per one million people in a lifetime or a total of 250,001 cases, compared to the currently expected 250,000 cases due to normal life-style.

Another way of expressing this same risk is to state that if there is a 25 percent chance of a person experiencing cancer due to normal life-style, then that same person drinking water containing a contaminant at the one in one million cancer risk level over a 70-year lifetime would increase the risk of cancer from 25 percent to 25.0001 percent.

Mathematical models are used to calculate drinking water concentrations associated with various excess lifetime cancer risk levels. The risk estimates are conservative, meaning that the actual risk experienced by a consumer will probably be less than the calculated risk. EPA attempts to establish MCLs for carcinogens at a concentration associated with excess lifetime cancer risks in the range of one in 10,000 to one in one million, while considering available analytical methods, treatment technology and economic and regulatory impact.

The carcinogenic potential of each of the VOCs in this guide can be found in Table 2 - VOC Summary. Cancer risks are listed for all VOCs classified as A, B1 or B2 carcinogens. The following discussion of risk is intended to provide consumers with a better understanding of risk as it relates to drinking water contamination.

Risk Associated with Drinking Water Contamination

Types of Risk

There are two types of risk--voluntary and involuntary. Cigarette smoking is an example of a voluntary risk which many individuals have chosen to take, knowing that this increases the risk of respiratory cancer. An example of an involuntary risk is consuming contaminated drinking water unknowingly, since drinking water is a basic need.

Risk of contaminant-induced disease has been

defined by EPA as the, "estimation of the association between the exposure to a substance and the incidence of some disease, based on scientific data." Quantitative risk is expressed as the number of incidences of a disease per total population exposed to the causative substance. For example, a risk of one in one million for a lifetime indicates that one person in every one million people exposed to the causative contaminant can be expected to experience a specified disease. To better visualize the relative size of one in one million, consider this ratio with regard to some commonly-used quantity such as time. A one in one million time ratio is equivalent to one second in 11.6 days, one minute in 1.9 years or one day in 2,740 years.

In an attempt to place the risk associated with consuming contaminated water in the proper perspective, the following is a list of common activities, which if performed only one time by an individual during his or her lifetime, increases the chance of death by one in one million.

ACTIVITY	CAUSE OF DEATH
Drinking 1/2 liter of wine	Cirrhosis of the liver
Traveling 300 miles by car	Accident
Traveling 10 miles by bicycle	Accident
Flying 1,000 miles by jet	Accident
Living two months in average natural stone or brick building	Cancer caused by radioactivity
Smoking 1.4 cigarettes	Cancer, heart disease
Living two months with a smoker	Cancer, heart disease
One chest X-ray	Cancer caused by radiation

It is not possible to live in a world without risk, but it is the objective of regulatory agencies to maintain a proper balance between a controllable risk to which individuals are exposed and the benefits associated with the activity creating the risk.

Health Advisories

In addition to establishing MCLs to protect consumer health, EPA has developed guidance documents known as Health Advisories (HAs) for specific drinking water contaminants. HAs describe concentrations of contaminants in drinking water at which no adverse health effects can be expected by the consumer following one-day, 10-day, longer-term (approximately seven years), and lifetime (70 years) exposure. HA levels are not legally enforceable standards and do not consider any possible carcinogenic risk from lifetime exposure to these contaminants, but the advisories do discuss the carcinogenic potential of the contaminants. These guidance levels are used to determine the potability of water when a contaminant is detected but no MCL has been developed, and to determine if water containing a contaminant for which an MCL exists can be safely consumed for a limited period of time while the contamination problem is being corrected.

HA levels are derived in a manner similar to development of an MCL. The primary

differences being that HA levels are entirely health-based, whereas MCL development also considers available analytical and treatment techniques, and the peer review process is much more extensive for development of an MCL.

Table 2 - VOC Summary included in this guide lists HA values. The one-day and 10-day HA values assume the protected individual is a 10-kilogram (22-pound) child consuming one liter (approximately one quart) of water per day, and the lifetime HA values assume the protected individual is a 70-kilogram (154-pound) adult consuming two liters of water per day. Two longer-term HA values have been developed for most of the contaminants, assuming for one HA value that the protected individual is a 10-kilogram child and for the other that the protected individual is a 70-kilogram adult. When calculating HA values, it is assumed that 100 percent of an individual's exposure to a contaminant comes from drinking water, except for lifetime values which are adjusted to account for other sources of exposure such as food or air.

Safety of Individual Water Supplies

Potential for VOC Contamination

Individual water supplies are not regulated by DEP or EPA. It is the responsibility of home owners to monitor the quality of the water from their supply. The potential for VOCs in drinking water often depends on present and previous land use in the area around a water source. VOCs are used in all size businesses, found in most homes and are frequently transported from one location to another. Businesses such as dry cleaners, gas stations and industrial fabricators use VOCs to clean, degrease or complete other processes to produce their product. Accidental spillage of these chemicals and improper disposal techniques contribute to VOCs finding their way into drinking water. Abandoned lots or dumps on which debris is accumulating, landfills that were built prior to the use of liners and leachate treatment systems, and on-lot septic systems also increase the potential for contamination of drinking water.

Testing Drinking Water for Contaminants

The best way to determine if VOCs are in drinking water is to have the water tested by a DEP-certified laboratory. Certification means that a particular laboratory has been evaluated by DEP and found to be qualified to collect, analyze and report results of water samples within quality control guidelines. Laboratories which are not certified may be less qualified and/or less objective in interpreting sample results and providing recommendations to address any detected contamination, especially if they will profit by sale of equipment or services to correct the contamination problem.

Laboratories are certified for different types of contaminants (i.e., microbiological, inorganic, organic and radiological), so it is important to mention the type of contaminant the water is to be tested for when requesting information on a certified laboratory. The name and number of a local certified laboratory can be obtained from regional DEP offices.

Private wells should be tested for bacteria at least once a year and for chemicals every three years.

Interpretation of Analytical Results

Table 2 - VOC Summary lists all the VOCs addressed in this guide. A Chemical Abstracts Service (CAS) number is provided with each chemical listing. Many chemicals have several different names by which they are identified, but each chemical has only one CAS number. The CAS number should always be used in conjunction with the chemical name to avoid any misunderstanding.

The results of drinking water analyses should be compared to the values on Table 2 - VOC Summary. It is very important to check the units in which results are reported. The units used in the table are mg/L (milligrams per liter). If results are reported in µg/L (micrograms per liter), they can be converted to mg/L by dividing by 1,000.

EXAMPLE: Result reported as 1.234 µg/L

$$\frac{1.234\text{mg}}{L} \times \frac{1\text{mg}}{1,000\text{mg}} = 0.001234\text{mg} / L$$

To convert mg/L to µg/L, multiply by 1,000.

Any analytical result at or below the MCLs listed on Table 2 - VOC Summary is considered by DEP and EPA to be a safe level for lifetime consumption. If levels are higher than the MCLs, corrective action may be needed.

Methods of Reducing Exposure to VOCs

Home owners with a private, individual water system contaminated by VOCs have several options to correct the problem. A home owner can secure a new source of water supply or treat the existing source to remove the VOCs

A new source of water supply could include connecting to a public water system, extending the depth of an existing well, drilling a new well or purchasing DEP-permitted bottled water. In most cases, connecting to a public water system, if available, would probably be the best way to ensure that water meets current drinking water standards. Extending an existing well or drilling a new well will not guarantee that the new source of water supply will not contain the same contaminants as the existing source. Using bottled water will reduce risk due to ingestion, but will not address inhalation or dermal exposure.

The most common method used by home owners to remove VOCs from drinking water is to install a point-of-use (POU) or point-of-entry (POE) water treatment device. A POU device treats only the water at a single tap (e.g., at the kitchen sink), while a POE device treats all the water entering the home. The advantage of a POE device is that inhalation and dermal exposure are addressed since it treats all the water entering the home. The disadvantage is that POE devices are more expensive. Home treatment devices are

generally not required to protect public health when consumers are receiving water from a public water system that meets state and federal health standards.

POU and POE Treatment Devices for VOC Removal

Individual water system owners most commonly remove VOCs from drinking water with activated carbon units. Activated carbon filters use carbon material made from coal, charcoal, wood or bone to remove VOCs from drinking water. The carbon contains a vast network of minuscule channels and extensive surface area to which contaminants become attached or adsorbed as the water passes through it. Table 1 lists adsorbability of activated carbon for specific VOC compounds in drinking water. Of the 21 VOCs listed, only vinyl chloride is not efficiently removed by activated carbon. Aeration units in well ventilated areas work best for this contaminant.

The VOC removal efficiency of activated carbon filters depends on a number of factors including the length of time contaminated water is in contact with the activated carbon, the type of carbon used, and the extent of drinking water contamination. Before purchasing a unit, the volume of water which the unit is to treat daily and the quality of the water (i.e., specific contaminants and the concentration of these contaminants) to be treated should be determined. This information will be necessary in deciding which unit will do the best job of removing the contaminants of concern and last the longest without need for replacement.

TABLE 1

Removal of VOCs From Drinking Water By Activated Carbon Adsorption

The following VOC compounds are listed in decreasing order of activated carbon adsorbability. 1,2,4-Trichlorobenzene would probably be the most easily removed and vinyl chloride would probably be the most difficult to remove. The relative adsorbability may vary depending on contaminant concentrations and the number and type of contaminants in the water.

- | | | | |
|-----|------------------------|-----|----------------------------|
| 1. | 1,2,4-Trichlorobenzene | 12. | 1,2-Dichloropropane |
| 2. | 1,4-Dichlorobenzene | 13. | 1,1,2-Trichloroethane |
| 3. | 1,2-Dichlorobenzene | 14. | Benzene |
| 4. | Styrene | 15. | cis-1,2-Dichloroethylene |
| 5. | Ethylbenzene | 16. | 1,1-Dichloroethylene |
| 6. | Chlorobenzene | 17. | 1,2-Dichloroethane |
| 7. | Carbon Tetrachloride | 18. | trans-1,2-Dichloroethylene |
| 8. | Toluene | 19. | Chloroform |
| 9. | Tetrachloroethylene | 20. | Dichloromethane |
| 10. | Trichloroethylene | 21. | Vinyl Chloride |
| 11. | 1,1,2-Trichloroethane | | |

Additional Information on Home Treatment Devices

The January 1990 issue of *Consumer Reports* contains an article entitled "Fit to Drink?" which rates several leading brands of home drinking water treatment devices. A local library may have this issue of *Consumer Reports* or you can contact *Consumer Reports* at:

Consumer Reports
P.O. Box 53016
Boulder, CO 80322

DEP also has published a *Citizen's Guide to Home Drinking Water Treatment Devices*, which is available from regional DEP offices.

Neither EPA nor DEP certify, approve, or endorse POU/POE home treatment units. Since these devices are not certified by the government, anyone can manufacture and sell such devices. Occasionally a device may have a label that reads, "Registered with the EPA." This registration is required for devices that contain a chemical treatment that inhibits the growth of bacteria on the filter material. Registration means that the filter has been

tested and found not to leach unacceptable levels of the bactericide. The registration process does *not* include an evaluation of VOC removal efficiency nor the ability to kill harmful bacteria.

The NSF International (NSF) is a private organization that tests and certifies treatment devices. An NSF seal on the unit certifies that it has met the standards set by the Foundation. Units evaluated to determine their ability to remove VOCs from drinking water are listed under NSF Standard No. 53 Drinking Water Treatment Units--Health Effects, or Standard No. 58 Reverse Osmosis Drinking Water Treatment Systems. Those contaminants which are effectively removed by the device will be listed on the unit. An NSF listing of home treatment devices can be obtained by writing to:

NSF International
P.O. Box 130140
Ann Arbor, MI 48113-0140
Telephone: 313-769-8010 or
215-340-0680

Temporary Solutions for VOC Removal

Boiling is another method which has been used by some home owners to remove VOCs from drinking water. Although boiling is not the recommended method of home treatment, due to the possibility of inhaling vaporized VOCs, studies show that vigorously boiling water for ten minutes will remove most of the VOCs. The efficiency of the boiling process depends on the vigorous boiling being maintained for a full ten minutes and assumes that the water will be allowed to cool in a container open to the atmosphere. If this removal method is used, it is very important to ventilate the area in which the water is

boiled to avoid inhalation of VOCs. In addition, the concentration of the other contaminants in the water which are not removed by boiling may increase. The increased concentration is due to the loss of water during boiling.

Use of unboiled water for bathing, washing clothes or dishes, flushing toilets, etc. poses a health risk due to inhalation or dermal exposure to VOCs. Since inhalation is a primary contributor to the total body intake of VOCs, second only to ingestion, it is important to ventilate the bathroom during and after bathing, and to ventilate the laundry room and kitchen when washing clothes and dishes.

**TABLE 2
VOC SUMMARY**

Chemical (CAS Number)	Noncarcinogenic advisories (mg/L)					Regulatory Levels		Caracinogenic Potential		PQL (mg/L)
	10-kg Child			70-kg Adult		MCLG (mg/L)	MCL (mg/L)	EPA 10 ⁻⁶ Cancer Risk(mg/L)	EPA Carcinogen Group	
	One-Day	Ten-Day	Longer Term	Longer Term	Lifetime					
Benzene (71-43-2)	0.2	0.2			NA	0	0.005	0.001	A	0.005
Carbon Tetrachloride (56-23-5)	4	0.2	0.07	0.3	NA	0	0.005	0.0003	B ₂	0.005
Chlorobenzene (mono) (108-90-7)	2	2	2	7	0.1	0.1	0.1	NA	D	0.005
o-Dichlorobenzene (95-50-1)	9	9	9	30	0.6	0.6	0.6	NA	D	0.005
p-Dichlorobenzene (106-46-7)	10	10	10	40	0.075	0.075	0.075	NA	C	0.005
1,2-Dichloroethylene (107-06-2)	0.7	0.7	0.7	2.6	NA	0	0.005	0.0004	B ₂	0.005
1,1-Dichloroethylene (75-35-4)	2	1	1	4	0.007	0.007	0.007	NA	C	0.005
cis-1,2-Dichloroethylene (156-59-2)	4	3	3	11	0.07	0.07	0.07	NA	D	0.005
trans-1,2- Dichloroethylene (156-60-5)	20	2	2	6	0.1	0.1	0.1	NA	D	0.005
Dichloromethane (75-09-2)	10	2			NA	0	0.005	0.005	B ₂	0.005
1,2-Dichloropropane (78-87-5)		0.09				0	0.005	0.0006	B ₂	0.005
Ethylbenzene ^a (100-41-4)	30	3	1	3	0.7	0.7	0.7	NA	D	0.005
Styrene ^a (100-42-5)	20	2	2	7	0.1	0.1	0.1	NA	C	0.005
Tetrachloroethylene (127-18-4)	2	2	1	5	NA	0	0.005	0.0007	B ₂	0.005
Toluene ^a (108-88-3)	20	2	2	7	1	1	1	NA	D	0.005
1,2,4-Trichlorobenzene (120-82-1)	0.1	0.1	0.1	0.5	0.07	0.07	0.07	NA	D	0.005
1,1,1-Trichloroethane (71-55-6)	100	40	40	100	0.2	0.2	0.2	NA	D	0.005
1,1,2-Trichloroethane (79-00-5)	0.6	0.4	0.4	1	0.003	0.003	0.005	NA	C	0.005
Trichloroethylene (TCE) (79-01-6)					NA	0	0.005	0.003	B ₂	0.005
Vinyl Chloride (75-01-4)	3	3	0.01	0.05	NA	0	0.002	1.5x10 ⁻⁵	A	0.002
Xylenes (Total) (1330-20-7)	40	40	40	100	10	10	10	NA	D	0.005

Notes: CAS = Chemical Abstracts Service

NA = Not Appropriate

PQL = Practical Quantitation Level

(This is the lowest analytical concentration level that can be reliably determined within specified limits of precision and accuracy during routine laboratory operating conditions)

^a Dermal contact during bathing and showering may pose a significant risk at concentrations of concern via the ingestion route.

Benzene

(CAS #71-43-2)

- A. **Synonyms:** None
- B. **Properties:** Benzene is a clear, colorless, volatile liquid which is lighter than water, soluble (1,780 mg/L) in water and has a characteristic odor.
- C. **Uses:** It is used primarily as an intermediate in the manufacture of a wide variety of organic compounds including synthetic rubber, plastics, styrene, detergents, paint strippers and pesticides. Most of the benzene produced is used as a chemical intermediate in the manufacture of styrene.
- D. **Source of Exposure:** The greatest release of benzene is from the marketing and use of petroleum fuels. Smoking also may be a significant exposure source for a portion of the population. Water intake is not normally a major source of benzene exposure.
- Benzene also has been found in fruits, fish, vegetables, nuts, dairy products, meat, poultry and eggs. The National Cancer Institute (NCI) has reported that an individual could ingest as much as 250 µg (0.000005 pounds) per day.
- E. **Routes of Entry:**
1. Oral—readily absorbed following ingestion
 2. Inhalation—readily absorbed in the lungs
 3. Dermal—absorbed through the skin, but not as readily as through other routes of exposure.
- F. **Some Health Effects:**
1. Acute Effects—central nervous system disturbances
 2. Chronic Effects—blood cell production disorders. It is classified as a human carcinogen by EPA.
- G. **Water Treatment:** EPA has identified granular activated carbon adsorption and packed tower aeration as the best available treatment technologies for removing benzene from drinking water.

Carbon Tetrachloride

(CAS #56-23-5)

- A. **Synonyms:** Methane tetrachloride; Tetrachloromethane; Perchloromethane
- B. **Properties:** Carbon tetrachloride is a colorless, volatile liquid which is heavier than water, soluble (785 mg/L) in water and exhibits an ether-like odor.
- C. **Uses:** It is used in the manufacture of chlorofluoromethanes, grain fumigants, fire extinguishers, solvents and cleaning agents. The major use of carbon tetrachloride has been in the production of chlorofluoromethane refrigerants and propellants. The EPA regulation of chlorofluorocarbon propellants will most likely substantially reduce the demand for carbon tetrachloride production for this purpose.
- D. **Sources of Exposure:** Urban atmospheres and some industrial environments have been the source of the highest recorded concentrations of carbon tetrachloride. Water and food are only minor sources.
- E. **Routes of Entry:**
1. Oral—readily absorbed following ingestion
 2. Inhalation—readily absorbed in the lungs
 3. Dermal—absorbed through the skin, but not as readily as through other routes of exposure.
- F. **Some Health Effects:**
1. Acute Effects—gastrointestinal and central nervous system disturbances
 2. Chronic Effects—cirrhosis of the liver and dermatitis. It is classified as a probable human carcinogen by EPA.
- G. **Water Treatment:** EPA has identified granular activated carbon adsorption and packed tower aeration as the best available treatment technologies for removing carbon tetrachloride from drinking water.

Chlorobenzene

(CAS #108-90-7)

- A. **Synonyms:** Monochlorobenzene; Benzene chloride; Chlorobenzol; Phenyl chloride
- B. **Properties:** Chlorobenzene is a clear, colorless, volatile liquid which is heavier than water and soluble (500 mg/L) in water.
- C. **Uses:** It is used as a solvent for pesticide formulations and in the manufacture of phenols, degreasing agents, aniline and chloronitrobenzene.
- D. **Sources of Exposure:** The highest chronic levels of exposure have been found in the air at and around sites manufacturing and using chlorobenzene.
- E. **Routes of Entry:**
 - 1. Oral—readily absorbed following ingestion
 - 2. Inhalation—readily absorbed in the lungs
 - 3. Dermal—absorbed through the skin, but not as readily as through other routes of exposure.
- F. **Some Health Effects:**
 - 1. Acute Effects—respiratory irritation and central nervous system disturbances
 - 2. Chronic Effects—may cause kidney and liver damage.
- G. **Water Treatment:** EPA has identified granular activated carbon adsorption and packed tower aeration as the best available treatment technologies for removing chlorobenzene from drinking water.

***o*-Dichlorobenzene**

(CAS #95-50-1)

- A. **Synonyms:** 1,2-Dichlorobenzene; *o*-DCB
- B. **Properties:** *o*-Dichlorobenzene is a clear, volatile liquid which is heavier than water, soluble (145 mg/L) in water and has a strong benzene-like odor.
- C. **Uses:** It is used mainly in the manufacture of pesticides, and also as a solvent for waxes, oil, asphalt, paint and metal degreasing.
- D. **Sources of Exposure:** The highest level of chronic exposure is via air at production sites and the area surrounding these facilities. Accidental spills and ground-water contamination at land disposal sites account for *o*-dichlorobenzene contamination of drinking water.
- E. **Routes of Entry:**
 - 1. Oral—readily absorbed following ingestion
 - 2. Inhalation—readily absorbed in the lungs
 - 3. Dermal—absorbed through the skin, but not as readily as through other routes of exposure.
- F. **Some Health Effects:**
 - 1. Acute Effects—inhale of vapor may result in eye and nose irritation, and skin irritation may result from liquid contact
 - 2. Chronic Effects—respiratory and central nervous system disturbances, blood disorders and liver damage.
- G. **Water Treatment:** EPA has identified granular activated carbon adsorption and packed tower aeration as the best available treatment technologies for removing *o*-dichlorobenzene from drinking water.

***p*-Dichlorobenzene**

(CAS #106-46-7)

- A. **Synonyms:** 1,4-Dichlorobenzene; p-DCB
- B. **Properties:** p-Dichlorobenzene is a white, crystalline solid which is heavier than water, slightly soluble in water and has a penetrating odor.
- C. **Uses:** It is used primarily in moth control (balls and powder) and in lavatory deodorant. A significant amount of p-Dichlorobenzene is used in the production of polyphenylene sulfide resin and as an intermediate in the production of other chemicals.
- D. **Sources of Exposure:** The highest level of chronic exposure is via air at production sites and the area surrounding these facilities. In the home, moth balls, diaper pail deodorizers and toilet bowl deodorizers can produce low-level exposure. Accidental spills and ground-water contamination at land disposal sites account for p-dichlorobenzene contamination of drinking water.
- E. **Routes of Entry:**
 - 1. Oral—readily absorbed following ingestion
 - 2. Inhalation—readily absorbed in the lungs
 - 3. Dermal—absorbed through the skin, but not as readily as through other routes of exposure.
- F. **Some Health Effects:**
 - 1. Acute Effects—warm fumes or strong solutions may cause slight skin irritation. Inhalation of particles and fumes may be painful to the eyes and nose
 - 2. Chronic Effects—respiratory and central nervous system disturbances, blood disorders and liver damage.
- G. **Water Treatment:** EPA has identified granular activated carbon adsorption and packed tower aeration as the best available treatment technologies for removing p-dichlorobenzene from drinking water.

***1,2*-Dichloroethane**

(CAS #107-06-2)

- A. **Synonyms:** Ethylene dichloride; EDC; 1,2-DCE
- B. **Properties:** 1,2-Dichloroethane is a colorless, volatile liquid which is heavier than water, soluble (870 mg/L) in water and exhibits a chloroform-like odor and sweet taste.
- C. **Uses:** It's major use is in the manufacture of vinyl chloride. Formerly used as a gasoline additive, as an insecticidal fumigant, in paint and varnish removers, as a metal degreaser and in soap and scouring compounds.
- D. **Sources of Exposure:** Most environmental releases result from direct production and use of this chemical and its presence in gasoline. When used as a fumigant, the potential exists for small amounts of 1,2-dichloroethane to remain in treated agricultural products. 1,2-Dichloroethane has been detected in ground and surface community water supplies, with the highest concentrations being found near industrialized areas. For the majority of the U.S. population, the greatest source of exposure is from air.
- E. **Routes of Entry:**
 - 1. Oral—readily absorbed following ingestion
 - 2. Inhalation—readily absorbed in the lungs
 - 3. Dermal—absorbed through the skin, but not as readily as through other routes of exposure.
- F. **Some Health Effects:**
 - 1. Acute Effects—central nervous system disturbances and eye, nose and throat irritation
 - 2. Chronic Effects—may cause liver, kidney, lung, heart, adrenal and gastrointestinal tract damage. It is classified as a probable human carcinogen by EPA.
- G. **Water Treatment:** EPA has identified granular activated carbon adsorption and packed tower aeration as the best available treatment technologies for removing 1,2-dichloroethane from drinking water.

1,1-Dichloroethylene

(CAS #75-35-4)

- A. **Synonyms:** Vinylidene chloride; 1,1-DCE; Dichloroethene
- B. **Properties:** 1,1-Dichloroethylene is a clear, colorless, volatile liquid which is heavier than water and soluble (2,500 mg/L) in water.
- C. **Uses:** It is used in the manufacture of polyvinylidene chloride copolymers which in turn are used in the manufacture of food wrappings, nonflammable synthetic fibers and interior coatings for storage tanks and pipings.
- D. **Sources of Exposure:** Most exposure is from contaminated air during direct production and use of the chemical. It has been detected in both raw and finished drinking water.
- E. **Routes of Entry:**
 - 1. Oral—readily absorbed following ingestion
 - 2. Inhalation—readily absorbed in the lungs
 - 3. Dermal—absorbed through the skin, but not as readily as through other routes of exposure.
- F. **Some Health Effects:**
 - 1. Acute Effects—central nervous system and respiratory system disturbances
 - 2. Chronic Effects—can cause liver and kidney damage.
- G. **Water Treatment:** EPA has identified granular activated carbon adsorption and packed tower aeration as the best available treatment technologies for removing 1,1-dichloroethylene from drinking water.

cis-1,2-Dichloroethylene

(CAS #156-59-2)

- A. **Synonyms:** 1,2-DCE; cis-1,2-DCE; 1,2-Dichloroethene
- B. **Properties:** cis-1,2-Dichloroethylene is a clear, colorless, volatile liquid which is heavier than water, soluble (3,500 mg/L) in water and has a pleasant odor.
- C. **Uses:** It is used primarily as a chemical intermediate in the production of chlorinated compounds. It is also used in a solvent mixture for fats, rubber, phenol and camphor, for retarding fermentation and as a coolant in refrigeration plants.
- D. **Sources of Exposure:** The major source of exposure to cis-1,2-dichloroethylene is from contaminated drinking water except in areas near production sites where air exposures may dominate. It has been detected in both raw and finished drinking water, principally from ground-water sources.
- E. **Routes of Entry:**
 - 1. Oral—readily absorbed following ingestion
 - 2. Inhalation—readily absorbed in the lungs
 - 3. Dermal—absorbed through the skin, but not as readily as through other routes of exposure.
- F. **Some Health Effects:**
 - 1. Acute Effects—central nervous system disturbances and liver damage
 - 2. Chronic Effects—liver and kidney damage.
- G. **Water Treatment:** EPA has identified granular activated carbon adsorption and packed tower aeration as the best available treatment technologies for removing cis-1,2-dichloroethylene from drinking water.

trans-1,2-Dichloroethylene (CAS #156-60-5)

- A. **Synonyms:** 1,2-DCE; trans-1,2-DCE; 1,2-Dichloroethene
- B. **Properties:** trans-1,2-Dichloroethylene is a colorless, volatile liquid which is heavier than water, soluble (6,300 mg/L) in water, and has a pleasant odor.
- C. **Uses:** It is used primarily as a chemical intermediate in the production of chlorinated compounds. It is also used as a general solvent for organic material, in dye extraction, perfume manufacturing, in lacquers and medicine, as a refrigerant and to decaffeinate coffee.
- D. **Sources of Exposure:** The major source of exposure to trans-1,2-dichloroethylene is from contaminated water except in areas near production sites where air exposures may dominate. It has been detected in both raw and finished drinking water, principally from ground-water sources.
- E. **Routes of Entry:**
1. Oral—readily absorbed following ingestion
 2. Inhalation—readily absorbed in the lungs
 3. Dermal—absorbed through the skin, but not as readily as through other routes of exposure.
- F. **Some Health Effects:**
1. Acute Effects—central nervous system disturbances, nausea, weakness and cramps
 2. Chronic Effects—liver, nervous system and circulatory system damage.
- G. **Water Treatment:** EPA has identified granular activated carbon adsorption and packed tower aeration as the best available treatment technologies for removing trans-1,2-dichloroethylene from drinking water.

Dichloromethane (CAS #75-09-2)

- A. **Synonyms:** Methylene chloride; Methylene dichloride; Methylene bichloride; DCM
- B. **Properties:** Methylene chloride is a colorless, volatile liquid which is heavier than water and soluble (20,000 mg/L) in water.
- C. **Uses:** The dichloromethane produced in the United States is used in the manufacture of paint and varnish removers, aerosol products, metal cleaning products, insecticides and fumigants.
- D. **Sources of Exposure:** Humans are exposed to dichloromethane in food, air and drinking water. In food, the highest concentrations have been found in spices (i.e., cassia, all-spice and nutmeg). Air exposure is most frequently attributed to working in or living near a chemical plant manufacturing or using dichloromethane or the use of paint removers or aerosols.
- E. **Routes of Entry:**
1. Oral—readily absorbed following ingestion
 2. Inhalation—readily absorbed in the lungs
 3. Dermal—absorbed through the skin, but not as readily as through other routes of exposure.
- F. **Some Health Effects:**
1. Acute Effects—central nervous system disturbances and heart and kidney damage
 2. Chronic Effects—liver damage. It is classified as a probable human carcinogen by EPA.
- G. **Water Treatment:** EPA has identified packed tower aeration as the best available treatment technology for removing dichloromethane from drinking water.

1,2-Dichloropropane

(CAS #78-87-5)

- A. **Synonyms:** Propylene dichloride; 1,2-DCP
- B. **Properties:** 1,2-Dichloropropane is a colorless liquid, soluble in water (2,700 mg/L) and heavier than water. Taste and odor are noted at 5 µg/L in drinking water.
- C. **Uses:** It is used as a solvent for oils and fats, in dry cleaning and degreasing operations and was produced as a by-product in a discontinued mixture marketed as a soil fumigant.
- D. **Sources of Exposure:** 1,2-Dichloropropane has been found in both surface and ground water, in fish and at low levels in air.
- E. **Routes of Entry:**
 - 1. Oral—absorbed from the gastrointestinal tract
 - 2. Inhalation—absorbed
 - 3. Dermal—absorbed, but not as rapidly as through the other routes.
- F. **Some Health Effects:**
 - 1. Acute Effects—liver effects, headaches, vertigo (loss of upright balance) and eye watering in humans after inhalation
 - 2. Chronic Effects—liver damage and anemia in test animals and dermatitis in humans. It is classified as a probable human carcinogen by EPA.
- G. **Water Treatment:** EPA has identified granular activated carbon adsorption and packed tower aeration as the best available treatment technologies for removing 1,2-dichloropropane from drinking water.

Ethylbenzene

(CAS #100-41-4)

- A. **Synonyms:** Ethyl benzol; Phenyl ethane
- B. **Properties:** Ethylbenzene is a clear, colorless liquid with an aromatic odor, soluble in water (152 mg/L) and lighter than water. Taste and odor in water are noted at 29 µg/L.
- C. **Uses:** It is used in styrene and acetophenone manufacture, as a solvent and as an asphalt and naphtha constituent. Ethylbenzene is a normal component of gasoline.
- D. **Sources of Exposure:** Low levels have been found in ground-water supplies.
- E. **Routes of Entry:**
 - 1. Oral—readily absorbed from the gastrointestinal tract in test animals
 - 2. Inhalation—64 percent of dose absorbed by human volunteers
 - 3. Dermal—118 micrograms per cm² per hour absorbed through skin in humans.
- F. **Some Health Effects:**
 - 1. Acute Effects—sleepiness, fatigue, headaches, and mild eye and respiratory irritation in humans after inhalation exposure at a concentration greater than 100 mg/L (air)
 - 2. Chronic Effects— has been shown to damage the liver and kidneys in animal studies.
- G. **Water Treatment:** EPA has identified granular activated carbon adsorption and packed tower aeration as the best available treatment technologies for removing ethylbenzene from drinking water.

Styrene

(CAS #100-42-5)

- A. **Synonyms:** Ethenylbenzene; Styrol; Cinnamol
- B. **Properties:** Styrene is a colorless, oily liquid with a characteristic sweet and pleasant odor, soluble (320 mg/L) in water and lighter than water. Taste and odor may be noted at or above 10 µg/L in drinking water.
- C. **Uses:** It is used predominantly in the production of polystyrene plastics and resins. Styrene is also used as an intermediate in the production of other materials, such as ion exchange resins and copolymers.
- D. **Sources of Exposure:** Styrene has been detected in ambient air in source dominated areas. Low-level contamination of food is expected and styrene is likely to occur in some drinking water.
- E. **Routes of Entry:**
1. Oral—rapid and virtually complete absorption
 2. Inhalation—human studies have shown approximately 2/3 of the administered concentration is retained and absorbed by the lungs
 3. Dermal—may be readily absorbed based on its permeability coefficient.
- F. **Some Health Effects:**
1. Acute Effects—central nervous system effects such as drowsiness, listlessness and an altered sense of balance in human volunteers following inhalation
 2. Chronic Effects—blood and liver effects in test animals.
- G. **Water Treatment:** EPA has identified granular activated carbon adsorption and packed tower aeration as the best available treatment technologies for removing styrene from drinking water.

Tetrachloroethylene

(CAS #127-18-4)

- A. **Synonyms:** PCE; Perchloroethylene; 1,1,2,2-Tetrachloroethylene; Perc
- B. **Properties:** Tetrachloroethylene is a colorless, volatile liquid which is heavier than water, soluble (150 mg/L) in water and exhibits a chloroform-like odor.
- C. **Uses:** One-half of the tetrachloroethylene produced each year is used in the dry cleaning industry. It is also used for industrial metal cleaning, as a general purpose solvent, heat-transfer medium and in the manufacture of fluorocarbons which are used as aerosols, lubricants and electrical insulators.
- D. **Sources of Exposure:** Occupational exposure in and around dry cleaning establishments, metal cleaning operations and some chemical plants are the primary sources of exposure. High levels in drinking water are normally the result of spills or improper waste disposal.
- E. **Routes of Entry:**
1. Oral—readily absorbed following ingestion
 2. Inhalation—readily absorbed in the lungs
 3. Dermal—absorbed through the skin, but not as readily as through other routes of exposure.
- F. **Some Health Effects:**
1. Acute Effects—central nervous system disturbances and possible liver damage
 2. Chronic Effects—central nervous system disturbances, liver and kidney damage. Carcinogenicity assessment is under review by EPA.
- G. **Water Treatment:** EPA has identified granular activated carbon adsorption and packed tower aeration as the best available treatment technologies for removing tetrachloroethylene from drinking water.

Toluene

(CAS #108-88-3)

- A. **Synonyms:** Methylbenzene; toluol
- B. **Properties:** Toluene is a clear, colorless liquid with a sweet pungent odor, soluble in water (535 mg/L) and lighter than water. Taste and odor are noted at or above 40 µg/L in drinking water.
- C. **Uses:** The major use of toluene is as a blending agent in the production of gasoline to improve its octane rating. Toluene also is used as a starting material in the production of benzene and other organic solvents, a solvent for paints, coatings, gums, oils and resins.
- D. **Sources of Exposure:** Toluene is found at low levels in food and drinking water. Air is the major source of exposure.
- E. **Routes of Entry:**
 - 1. Oral—relatively rapid absorption by the gastrointestinal tract in test animals
 - 2. Inhalation—rapid absorption by lungs in humans
 - 3. Dermal—may be readily absorbed based on its permeability coefficient.
- F. **Some Health Effects:**
 - 1. Acute Effects—central nervous system effects in humans with such symptoms as fatigue, headache, nausea, muscular weakness, confusion and lack of coordination
 - 2. Chronic Effects—in humans, central nervous system and peripheral nervous system effects characterized by impaired memory, speech, vision and hearing, tremors and equilibrium disorders. Chronic exposure at high levels in humans have been associated with damage to the liver and kidney.
- G. **Water Treatment:** EPA has identified granular activated carbon adsorption and packed tower aeration as the best available treatment technologies for removing toluene from drinking water.

1,2,4-Trichlorobenzene

(CAS #120-82-1)

- A. **Synonyms:** TCB; asym-Trichlorobenzene; Hostetex L-Pec
- B. **Properties:** 1,2,4-Trichlorobenzene is a colorless, volatile liquid which is heavier than water and slightly soluble in water.
- C. **Uses:** It is used primarily as a dye carrier and a herbicide intermediate. It also is used as a heat-transfer medium, dielectric fluid and a solvent.
- D. **Sources of Exposure:** Occupational exposure is the primary source of exposure. It generally gets into drinking water by discharges from industrial activities.
- E. **Routes of Entry:**
 - 1. Oral—readily absorbed following ingestion
 - 2. Inhalation—readily absorbed through the lungs
 - 3. Dermal—absorbed through the skin, but not as readily as through other routes of exposure.
- F. **Some Health Effects:**
 - 1. Acute Effects—has caused damage to several organs in animal studies
 - 2. Chronic Effects—has been shown to cause damage to several organs, including the adrenal glands.
- G. **Water Treatment:** EPA has identified granular activated carbon adsorption and packed tower aeration as the best available treatment technologies for removing 1,2,4-trichlorobenzene from drinking water.

1,1,1-Trichloroethane

(CAS #71-55-6)

- A. **Synonyms:** 1,1,1-TCA; Methyl chloroform; Triethane
- B. **Properties:** 1,1,1-Trichloroethane is a colorless, volatile liquid which is heavier than water and slightly soluble in water.
- C. **Uses:** Most of the 1,1,1-trichloroethane produced each year is used in metal degreasing. It is also used in inks, shoe polish, metal-cutting oils and as a vapor depressant in aerosols.
- D. **Sources of Exposure:** The major source of exposure is by air. The general population can be exposed to 1,1,1-trichloroethane due to its common use in home and office products. Occupational exposure and living near plants producing or using 1,1,1-trichloroethane represent the most significant exposure hazards. In drinking water, most exposure can be attributed to ground-water contamination from improper waste disposal activities.
- E. **Routes of Entry:**
1. Oral—readily absorbed following ingestion
 2. Inhalation—readily absorbed in the lungs
 3. Dermal—absorbed through the skin, but not as readily as through other routes of exposure.
- F. **Some Health Effects:**
1. Acute Effects—central nervous system and serum enzyme disturbances
 2. Chronic Effects—liver damage.
- G. **Water Treatment:** EPA has identified granular activated carbon adsorption and packed tower aeration as the best available treatment technologies for removing 1,1,1-trichloroethane from drinking water.

1,1,2-Trichloroethane

(CAS #79-00-5)

- A. **Synonyms:** Vinyl trichloride; β -trichloroethane; Ethane trichloride; 1,1,2-TCE
- B. **Properties:** 1,1,2-Trichloroethane is a colorless liquid which is heavier than water and has a pleasant odor.
- C. **Uses:** It is used in the production of 1,1-dichloroethylene, as a solvent for chlorinated rubber, and in fats, oils, waxes and resins.
- D. **Source of Exposure:** Less than four percent of the more than 700 public water systems in Pennsylvania which have tested for 1,1,2-trichloroethane detected it. Most of the detections were below the MCL of 0.005 mg/L.
- E. **Routes of Entry:**
1. Oral—extensively absorbed following ingestion by test animals
 2. Inhalation—readily absorbed in the lungs
 3. Dermal—readily absorbed through the skin of test animals.
- F. **Some Health Effects:**
1. Acute Effects—liver damage and inflammation of gastrointestinal tract were noted in animal studies
 2. Chronic Effects—liver damage.
- G. **Water Treatment:** EPA has identified granular activated carbon adsorption and packed tower aeration as the best available treatment technologies for removing 1,1,2-trichloroethane from drinking water.

Trichloroethylene

(CAS #79-01-6)

- A. **Synonyms:** TCE; Trichloroethene; Acetylene trichloride; Tri; Trilene
- B. **Properties:** Trichloroethylene is a clear, colorless, volatile liquid which is heavier than water, soluble (1,366 mg/L) in water and exhibits a chloroform-like odor.
- C. **Use:** It is used primarily as a metal degreasing agent and also is used in the textile industry for finishing operations.
- D. **Sources of Exposure:** The major source of exposure to trichloroethylene is contaminated water and to a lesser extent air. Occupational exposure and living near metal degreasing operations and chemical plants producing trichloroethylene represent the most significant exposure hazards. Most of the trichloroethylene found in drinking water can be attributed to ground-water contamination from improper waste disposal activities.
- E. **Routes of Entry:**
 - 1. Oral—readily absorbed following ingestion
 - 2. Inhalation—readily absorbed in the lungs
 - 3. Dermal—absorbed through the skin, but not as readily as through other routes of exposure.
- F. **Some Health Effects:**
 - 1. Acute Effects—central nervous system disturbances and heart, liver and kidney damage
 - 2. Chronic Effects—central nervous system depression and heart damage. It is classified as a probable human carcinogen by EPA.
- G. **Water Treatment:** EPA has identified granular activated carbon adsorption and packed tower aeration as the best available treatment technologies for removing trichloroethylene from drinking water.

Vinyl Chloride

(CAS #75-01-4)

- A. **Synonyms:** Monochloroethylene; Chloroethene
- B. **Properties:** Vinyl Chloride is a colorless gas which is soluble (2,763 mg/L) in water and has a faintly sweet odor.
- C. **Uses:** It is used primarily in the manufacture of polyvinyl chloride (PVC) resins for the building and construction industries.
- D. **Sources of Exposure:** Occupational exposure and living near plants producing vinyl chloride present significant exposure hazards.
- E. **Routes of Entry:**
 - 1. Oral—readily absorbed following ingestion
 - 2. Inhalation—readily absorbed in the lungs
 - 3. Dermal—absorbed through the skin, but not as readily as through other routes of exposure.
- F. **Some Health Effects:**
 - 1. Acute Effects—central nervous system disturbances and skin and eye irritation after inhalation
 - 2. Chronic Effects—liver changes, nerve damage and immune reaction to human workers exposed to vinyl chloride by inhalation. Reproductive and developmental damage in animal inhalation studies. It is classified as a human carcinogen by EPA.
- G. **Water Treatment:** EPA has identified packed tower aeration as the best available treatment technology for removing vinyl chloride from drinking water.

Xylenes

(Mixture of Ortho, Meta and Para Isomers)
(CAS #1330-20-7)

- A. **Synonyms:** Dimethylbenzene; Xylol
- B. **Properties:** Xylenes are a clear liquid, soluble in water (about 175 mg/L), lighter than water and volatile. Taste and odor are noted at or above 20 µg/L in drinking water.
- C. **Uses:** Natural component of aviation and automobile gasoline; used in the manufacture of solvents and protective coatings, and in the synthesis of many organic chemicals, pharmaceuticals and vitamins.
- D. **Sources of Exposure:** Low levels occur in drinking water, food and air. As a natural component of petroleum, most releases of xylenes to water are due to spills or leaks of gasoline and other petroleum products. Because of xylenes' volatility, air is likely to be the major source of exposure.
- E. **Routes of Entry:**
1. Oral—absorbed in test animals
 2. Inhalation—absorbed
 3. Dermal—absorbed.
- F. **Some Health Effects:**
1. Acute Effects—central nervous system and effects in humans
 2. Chronic Effects—damage to the central nervous system
- G. **Water Treatment:** EPA has identified granular activated carbon adsorption and packed tower aeration as the best available treatment technologies for removing xylenes from drinking water.

Additional Information on VOCs

This guide provides some basic information on VOCs in drinking water. More detailed information can be obtained from the organizations that have been discussed or publications that have been listed in the guide. The following are additional sources of VOC information:

- Public water system serving your home
- EPA Region III in Philadelphia, (215) 814-2300
- EPA Safe Drinking Water Hotline, (800) 426-4791
- EPA Health Advisories for each of the 21 VOCs in this guide. Available from the National Technical Information Service 1-800-553-6847 or (703) 605-6000.
- Regional DEP offices

Southeast Region, (610) 832-6059

Northeast Region, (570) 826-2511

Southcentral Region, (717) 705-4708

Northcentral Region, (570) 327-3675

Southwest Region, (412) 442-4217

Northwest Region, (814) 332-6899

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Commonwealth of Pennsylvania
Tom Ridge, Governor

Department of Environmental Protection
James M. Seif, Secretary

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