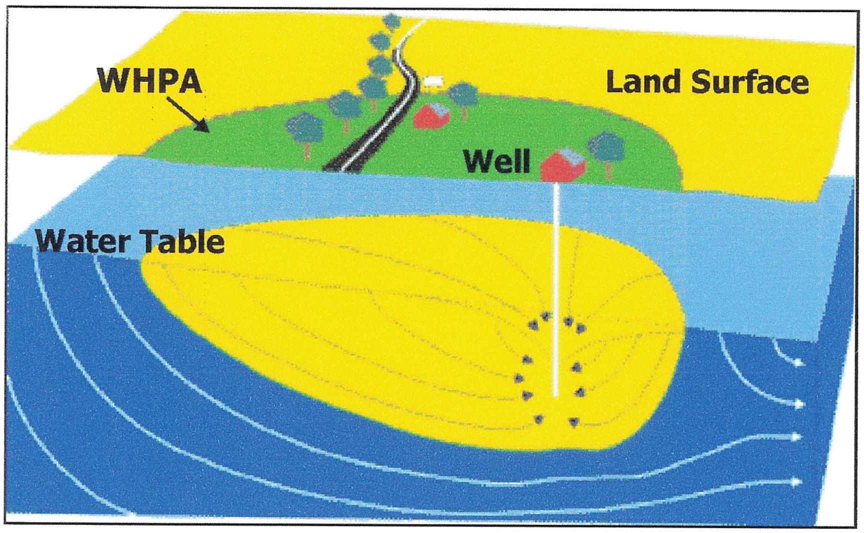
Source Water Assessment

for the Sunnybrook Water System

Baltimore County, MD



Prepared By
Maryland Department of the Environment
Water Management Administration
Water Supply Program
August 2001

TABLE OF CONTENTS

SUMMARY

The Maryland Department of the Environment's Water Supply Program (WSP) has conducted a Source Water Assessment for the Sunnybrook water system. The required components of this report as described in Maryland's Source Water Assessment Program (SWAP) are 1) delineation of an area that contributes water to the source, 2) identification of potential sources of contamination, and 3) determination of the susceptibility of the water supply to contamination. Recommendations for protecting the drinking water supply conclude this report.

The source of Sunnybrook's water supply is an unconfined fractured-rock aquifer. The Source Water Assessment area was delineated by the Baltimore County Department of Environmental Protection and Resource Management in a wellhead protection study conducted in 1992 using U.S. EPA approved methods.

Point sources of contamination were identified within the assessment area from field inspections, contaminant inventory databases, and previous studies. The Maryland Office of Planning's 1997 digital land use map for Baltimore County was used to identify non-point sources of contamination. Well information and water quality data were also reviewed. An aerial photograph and a map showing land use within the Source Water Assessment area are included in the report.

The susceptibility analysis is based on a review of the existing water quality data for the water system, the presence of potential sources of contamination in the individual assessment areas, well integrity, and the inherent vulnerability of the aquifer. It was determined that the Sunnybrook water supply is susceptible to contamination by nitrate and viruses, and may be susceptible to radon dependent upon the MCL that Maryland adopts for this contaminant. This water supply is not susceptible to other inorganic or radiological compounds, volatile organic compounds, synthetic organic compounds, and protozoa.

INTRODUCTION

The Water Supply Program has conducted a Source Water Assessment for the Sunnybrook water system in Baltimore County. Sunnybrook is located approximately 10 miles north of the City of Baltimore and is just outside of the city's water service area. The Sunnybrook system serves a population of 416 and has 120 service connections. Sunnybrook obtains its water supply from three wells that were installed by the County in the 1960's.

In 1991 the Baltimore County Department of Environmental Protection and Resource Management conducted a wellhead protection study in which they delineated wellhead protection areas (WHPAs) for eleven community water systems in the rural outskirts of the County. This report summarizes the information from the completed wellhead protection study and also contains the required components of Maryland's Source Water Assessment Plan: delineation, contaminant source inventory, and susceptibility analysis.

WELL INFORMATION

Well information was obtained from the Water Supply Program's database, site visits, well completion reports, sanitary survey inspection reports, and published reports. Sunnybrook presently obtains its water supply from three wells (Nos. 2, 7, and 9). All three wells are located along an unnamed tributary within the Overshot Run watershed and east of the Loch Raven reservoir (Fig. 1). A review of the well completion reports and sanitary surveys of Sunnybrook's water system indicate that all three wells were installed prior to 1973 when the well construction regulations went into effect and may not meet the current construction standards. Inspection of the wells reveals that they are in good condition and are each located in their own pumphouse. A summary of the well information is located in Table 1.

PLANT	SOURCE NAME	WELL PERMIT	TOTAL DEPTH	CASING DEPTH	APPROPRIATION PERMIT (*AMT IN GPD*)	AQUIFER
01	SUNNYBROOK 2	BA040885	208	18	BA1963G019 (*31,000*)	LWR PELITIC SCHIST WISSAHICKON
01	SUNNYBROOK 7	BA047126	172	55		
01	SUNNYBROOK 9	n/a	115	23		

Table 1. Sunnybrook Well Information.

The monthly operating reports submitted by the water system show that well Nos. 2 and 7 operate simultaneously and Well No. 9 pumps on its own. Sunnybrook has an appropriation permit issued for an average use of 31,000 gallons per day (gpd) and a maximum of 60,000 gpd in the month of maximum use. The average daily use was 27,194 gallons in 1999 and 24,884 gallons in 2000. The months of maximum use were July 1999 and May 2000 with an average daily use of 41,794 and 29,158 gallons respectively.

HYDROGEOLOGY

Sunnybrook lies within the Piedmont physiographic province, which is characterized by gently rolling hills and valleys. The bedrock underlying the Piedmont is some of the oldest in the State and consists of Precambrian and Paleozoic metamorphic and igneous rocks. The Sunnybrook wells draw water from the Loch Raven Schist formation. The Loch Raven Schist is an unconfined, fractured rock aquifer, which is a silicic metamorphic formation that is exposed across a large area in the central portion of the county. The primary porosity and permeability are generally small due to the dense nature of the metamorphic rocks. Ground water moves principally through secondary porosity, fractures and joint openings, and is recharged by precipitation percolating through soil and saprolite. The Loch Raven Schist is generally a low yielding aquifer unless major fracture intersections are encountered.

Ground water systems in crystalline rock tend to be localized and flow is within topographic divides towards the nearest perennial stream (Bolton, 1998). The water table is generally in the saprolite, which is characterized by high porosity and thus, the amount of storage often depends on the thickness of the saprolite. Stream valleys tend to follow fracture traces in Baltimore County (Nutter and Otton, 1969), and as a result wells drilled in draws and stream valleys tend to have higher yields than those on hilltops and slopes.

SOURCE WATER ASSESSMENT AREA DELINEATION

For ground water systems, a previously delineated Wellhead Protection Area (WHPA) may be considered the source water assessment area for the system. A WHPA was delineated in 1992 for Well Nos. 2, 7, and 9 using the US EPA WHPA code which requires the following input parameters: direction of ground water flow, ground water gradient, transmissivity of the aquifer, porosity of the aquifer, and pumping rate of the wells. The data used for aquifer parameters was mostly obtained from published reports for the specific aquifers and the pumping rates were determined from Sunnybrook's ground water appropriation permit. The WHPA encompasses the land area estimated to contribute water to the wells that represents a 10-year zone of transport. Since the information used to delineate the WHPA has not changed and the same wells are in use, the WHPA delineated is considered the source water assessment area for this system. The Sunnybrook wells are located directly adjacent to a stream. Fracture orientation may permit water from both the north and south sides of the stream to recharge the wells and thus the entire surface watershed was delineated as the WHPA. This area is much larger than the output from the WHPA code, however it coincides with the conservative approach outlined in the Maryland SWAP plan (MDE, 1999). Figure 2 shows the WHPA.

POTENTIAL SOURCES OF CONTAMINATION

Potential sources of contamination are classified as either point or non-point sources. Examples of point sources of contamination are leaking underground storage tanks, landfills, discharge permits, large-scale feeding operations, and CERCLA sites. These sites are generally associated with commercial or industrial facilities that use chemical substances that may, if inappropriately handled, contaminate ground water via a discrete point location. Non-point sources of contamination are associated with certain types of land use practices such as use of pesticides, application of fertilizers or animal wastes, or septic systems that may lead to ground water contamination over a larger area.

MDE staff inspected 3 facilities within the Sunnybrook WHPA in October 1998 for ground water discharge violations and no violations were issued.

Point Sources

A review of MDE contaminant databases revealed no notable point sources of contamination within the WHPA. Potential sources of contamination were identified in the original wellhead protection study (DEPRM, 1991). A horse farm near well No. 9 and the Hillendale Golf Course were noted as potential sources of contamination. These areas are shown as feeding operations and open urban land, respectively, on the land use map and are described below.

Non-Point Sources

The Maryland Office of Planning's 1997 Land Use map for Baltimore County was used to determine the predominant types of land use in the WHPA (Fig. 2). The land use summary is given in Table 2. A significant proportion (44%) of the WHPA is open urban land, which is covered by a golf course. The remainder of the WHPA is split evenly between forested land, residential areas, and cropland. A very small proportion of the WHPA is covered by agricultural facilities, however it is significant because of its proximity to Well 9. The Maryland Office of Planning's 1996 digital sewer map of Baltimore County shows that all of the WHPA is within an area of the county that is not planned for service.

Golf courses can be a significant source of nitrate or synthetic organic compounds in ground water from fertilizer or pesticides and herbicides if these products are not used properly. Agricultural land use (cropland and pasture) is commonly associated with nitrate loading of ground water and also represents a potential source of SOCs depending on farming practices and use of pesticides. Residential areas may be a source of nitrate from septic systems or lawn care practices. Addtionally, residential areas may present a source of SOCs if pesticides and herbicides are not used carefully in gardens.

Type	Area (acres)	% of WHPA
Residential	42.8	17.6
Open Urban Land	106.1	43.7
Cropland	32.1	13.2
Pasture	0.5	0.2
Agricultural Facilities	3.7	1.5
Forest	57.7	23.8

Table 2. Sunnybrook Land Use

WATER QUALITY DATA

Water Quality data was reviewed from the Water Supply Program's database for Safe Drinking Water Act (SDWA) contaminants. A list of contaminants regulated under the SDWA is included in the appendix. The State's SWAP defines a threshold for reporting water quality data as 50% of the Maximum Contaminant Level (MCL). If a monitoring result is greater than 50% of a MCL, the written assessment will describe the sources of such a contaminant and if possible, locate the specific sources that are the cause of the elevated contaminant level. All data reported is from the finished (treated) water unless otherwise noted. The Sunnybrook water treatment plant currently has chlorination for disinfection and pH adjustment for corrosion control.

A review of the monitoring data since 1993 for Sunnybrook's water indicates that the water supply meets drinking water standards. Of the inorganic compounds, nitrate was the only contaminant detected above the SWAP threshold level. Radon-222 was the only radiological contaminant present at a possible level of concern. Volatile and synthetic organic compounds have not been detected in the water supply. Indicators of microbiological pathogens have been detected in raw water samples from one well. The water quality sampling results are summarized in Table 3. The most recent monitoring schedule, which outlines the sampling requirements, due dates, and sampling frequencies for the water system, is included in the appendix.

Contaminant Group	No. Of Samples Collected	No. of Samples Above 50% of an MCL
Inorganic Compounds (except Nitrate)	4	0
Nitrate	11	2
Radiological Contaminants	3	0
Volatile Organic Compounds	7	0
Synthetic Organic Compounds	4	0
Microbiological Compounds	13	1

Table 3. Summary of Water Quality Samples

Inorganic Compounds (IOCs)

Nitrate levels fluctuate between less than 1 ppm to as high as 6 ppm (Table 4a). Nitrate was detected above the threshold level of 5 parts per million (ppm) in 2 of the 11 samples. Table 4a lists all nitrate data available from 1993 to 2000. No other inorganic compounds were detected.

Sample Date	Nitrate Result (ppm)	Wells in Use on Sample Date
20-Dec-93	4.1	Not available
28-Jun-94	4.4	Not available
31-Aug-94	2.7	Not available
13-Dec-95	1.3	Not available
04-Jun-96	2.9	No. 9
11-Jun-96	4.1	Nos. 2 & 7
21-Oct-97	**6.0**	Nos. 2 & 7
03-Sep-98	0.8	No. 9
22-Jun-99	2.7	No. 9
10-Aug-99	4.5	Nos. 2 & 7
08-Aug-00	**5.3**	Nos. 2 & 7

Table 4a. Nitrate Results from Sunnybrook Water Treatment Plant.
(MCL for Nitrate is 10 ppm, results in bold indicate greater than 50% of MCL.)

Radionuclides

There is currently no MCL for Radon-222, however EPA has proposed an MCL of 300 pCi/L or an alternate of 4000 pCi/L for community water systems if the State has a program to address the more significant risk from radon in indoor air. The EPA received many comments in response to their proposed rule, and promulgation may be delayed. The Radon-222 result reported for Sunnybrook was 145 pCi/L, which is just below 50% of the lower proposed MCL of 300 pCi/L.

Volatile Organic Compounds (VOCs)

A review of the data shows that VOCs have **not** been detected in seven samples collected since 1995.

Synthetic Organic Compounds (SOCs)

A review of the data shows that SOCs have **not** been detected in four samples collected since 1993.

Microbiological Contaminants

Raw water bacteriological data is available for each of the wells from evaluation for ground water under the direct influence of surface water (Table 4b). Well Nos. 2 and 7 were free of coliform bacteria. Well No. 9 had one positive detect of fecal coliform at a low concentration of 4 colonies/100 ml. The remaining 5 samples were negative for coliform.

Source Name	No. of Samples	No. of Total Coliform Positive	No. of Fecal Coliform Positive
SUNNYBROOK 2	6	0	0
SUNNYBROOK 7	1	0	0
SUNNYBROOK 9	6	1	1

Table 4b. Summary of raw water bacteriological results.

SUSCEPTIBILITY ANALYSIS

The wells serving the Sunnybrook water supply draw water from unconfined fractured-rock aquifers. Wells in unconfined aquifers are generally vulnerable to any activity on the land surface that occurs within the wellhead protection area. Therefore, continued monitoring of contaminants is essential in assuring a safe drinking water supply. The *susceptibility* of the source to contamination is determined for each group of contaminants based on the following criteria: 1) the presence of potential contaminant sources within the WHPA, 2) water quality data, 3) well integrity, and 4) the aquifer conditions. Table 5 summarizes the susceptibility of Sunnybrook's water supply to each of the groups of contaminants.

In the Piedmont region, if a well is constructed properly with the casing extended to competent rock and with sufficient grout, the saprolite serves as a natural filter and protective barrier. Properly constructed wells with no potential sources of contamination in their WHPA should be well protected from contamination.

Inorganic Compounds

Nitrate is present in 18% of samples at 5 ppm or greater (Table 4a). The MCL for nitrate is 10 ppm. Based on the monthly operating reports, nitrate samples tend to be higher when collected on dates when Well Nos. 2 and 7 were in use and lower when Well No. 9 was in use (Table 4a). Due to the residence time of storage tanks, however, it is impossible to make a direct correlation of water quality and individual wells because the samples are collected from the point of entry as opposed to the raw water from the well. Well No. 9 is located furthest downstream from the golf course and residences which may have an impact on the other wells. Alternatively, Well No. 9 may be pumping water from a different fracture than Well Nos. 2 and 7, thus the resulting difference in water quality.

Sources of nitrate can generally be traced back to land use. Fertilization of agricultural fields, golf courses, and residential lawns, as well as residential septic systems are all sources of nitrate loading in ground water. A golf course and agricultural areas cover a total of 58% of the WHPA. Medium-density residential with on site septic makes up approximately 18% of the WHPA. Due to the levels of nitrate found, the vulnerability of the fractured rock aquifers to land activity, and the presence of nitrate sources in the WHPA, the water supply is considered susceptible to this contaminant.

The water supply is **not** susceptible to inorganic compounds other than nitrate, based on water quality data and lack of potential contaminant sources within the WHPA.

Radionuclides

There is currently no MCL for Radon-222, however EPA has proposed an MCL of 300 pCi/L or an alternate of 4000 pCi/L if the State has a program to address the more significant risk from radon in indoor air. The EPA received many comments in response to their proposed rule, and promulgation may be delayed. Radon is present in the water supply just below 50% of the lower proposed MCL of 300 pCi/L. However, only one sample result is available. The median level of Radon-222 in schist aquifers was found to be 2900 pCi/L in a recent study of ground water quality in Baltimore County (Bolton, 1998). Thus, the level of radon may prove to be higher in the Sunnybrook water supply if additional samples are collected. The source of radon in ground water can be traced back to the natural occurrence of uranium in rocks. Radon is prevalent in ground water of crystalline rock aquifers due to radioactive decay of uranium bearing minerals in the bedrock. The EPA has information on proposed regulations for radon in indoor air and drinking water on their web site (http://www.epa.gov/OGWDW/radon.html). Currently, it appears that the water supply may be susceptible to radon if the lower MCL is adopted.

Other radiological contaminants were not detected in the water supply and no sources of these contaminants were identified. Therefore the water supply is **not** susceptible to radiological contaminants other than Radon-222.

Volatile Organic Compounds

The wells are **not** susceptible to volatile organic compounds. VOCs have not been detected in the water supply and no potential contaminant sources were identified within the WHPA.

Synthetic Organic Compounds

The wells are **not** susceptible to synthetic organic compounds. SOCs were not detected in the water supply. Potential sources of SOCs in the WHPA were identified within the WHPA. However, because these contaminants have not been detected, it appears that any pesticides and herbicides that may be used in the WHPA are degrading or being attenuated in the soil and are not reaching the wells.

Microbiological Contaminants

The presence of coliform bacteria in Well No. 9 indicates that it may be susceptible to viral contamination. Total coliform bacteria are a broad class of organisms found in the digestive tracts of human and animals, but may also occur in the natural environment. Fecal coliforms are a sub-group that is a more specific indicator of mammalian waste. The presence of these organisms in well water indicate that ground water moves through the soil and saprolite fast enough to allow for organisms with relatively long survival rates, such as viruses, to reach the wells. Only one sample had a low concentration of fecal coliform bacteria, and thus it is unlikely that organisms such as *Giardia* and *Cryptosporidium* that are normally associated with surface water would contaminate Well No. 9. The proximity of Well No. 9 to the streams and the horse farm may also be factors influencing susceptibility of this well to microbiological contaminants. Based on the available data, and presence of potential contaminants, Well No. 9 is considered susceptible to viruses but not susceptible to protozoa.

Well Nos. 2 and 7 did not have coliform bacteria in their raw water samples and thus are considered not susceptible to microbiological contaminants.

Contaminant Group	Are Contaminant Sources Present in WHPA?	Are Contaminants Detected In WQ Samples?	Is Well Integrity a Factor?	Is the Aquifer Vulnerable?	Is the System Susceptible?
Nitrate	YES	YES	NO	YES	YES
Inorganic Compounds (except nitrate)	NO	NO	NO	YES	NO
Radiological Compounds	YES	YES	NO	YES	YES (RADON ONLY)
Volatile Organic Compounds	NO	NO	NO	YES	NO
Synthetic Organic Compounds	YES	NO	NO	YES	NO
Microbiological Contaminants	YES	YES (WELL 9 ONLY)	NO	NO	YES (WELL 9 - VIRUSES ONLY)

Table 5. Susceptibility Analysis Summary.

Management of the Source Water Assessment Area

With the information contained in this report the Baltimore County DPW and the Sunnybrook community are in a position to protect its water supply by staying aware of the area delineated for source water protection and evaluating future development and land planning. Specific management recommendations for consideration are listed below:

Form a Local Planning Team

- The County should form a local planning team to begin to implement a source water protection plan. The team should represent all the interests in the community, such as the water supplier, home association officers, the County Health Department, local planning agencies, the local golf course, developers, and property owners, and residents within and near the WHPA. The team should work to reach a consensus on how to protect the water supply.
- A management strategy adopted by Sunnybrook should be consistent with the level of resources available for implementation. MDE remains available to assist in anyway we can help the process.
- MDE has grant money available for Wellhead Protection projects.

Public Awareness and Outreach

- The Consumer Confidence Report should list that this report is available to the general public through their county library, by contacting the town office or MDE.
- Conducting education outreach to the facilities that may present potential contaminant sources. Important topics include: (a) appropriate use and application of fertilizers and pesticides, (b) chemical storage, and (c) monitoring well installation.
- Road signs at the WHPA boundary are an effective way of keeping the relationship of land use and water quality in the public eye, and help in the event of spill notification and response.

Monitoring

- Continue to monitor for all Safe Drinking Water Act contaminants as required by MDE.
- Complete required ground water under direct influence testing for Well Nos. 2 and 9.

Planning/ New Development

- Review the State's model wellhead protection zoning ordinances for potential adoption. Coordinate with Baltimore County Department of Planning to adopt a wellhead protection ordinance.

Land Acquisition/Easements

- Loans are available for the purchase of property or easements for the protection of the water supply. Eligible property must lie within the designated WHPA. Loans are currently offered at zero percent interest and zero points. Contact the Water Supply Program for more information.

Contingency Plan

- Sunnybrook should have a Contingency Plan for its water system. COMAR 26.04.01.22 requires all community water systems to prepare and submit for approval a plan for providing a safe and adequate drinking water supply under emergency conditions.
- Develop a spill response plan in concert with the Fire Department and other emergency response personnel.

Contaminant Source Inventory Updates/ Inspections

- Water system owners should conduct their own field survey of the source water assessment area to ensure that there are no additional potential sources of contamination.
- Periodic inspections and a regular maintenance program for the supply wells will ensure their integrity and protect the aquifer from contamination.

Changes in Use

- Baltimore County DPW is required to notify MDE if new wells are to be put into service. Drilling a new well outside the current WHPA would modify the area, therefore Sunnybrook should contact the WSP if a new well is being proposed.

References

Bolton, D.W., 1996, Network Description and Initial Water-Quality Data from a Statewide Ground-Water-Quality Network in Maryland: Maryland Geological Survey Report of Investigations No. 60, 167 pp.

Bolton, D.W., 1998, Ground-Water Quality in the Piedmont Region of Baltimore Coutny, Maryland, Report of Investigations No. 66, 191 pp.

Committee on Health Risks of Exposure to Radon, 1999, Health Effects of Exposure to Radon: BEIR VI, (http://www.epa.gov/iaq/radon/beirvi1.html).

Cross, F.T., N.H. Harley, and W. Hofmann, 1985, Health effects and risks from ^{222}Rn in drinking water: Health Physics, vol. 48, no.5, p. 649-670.

MDE, Water Supply Program, 1999, Maryland's Source Water Assessment Plan, 36 p.

Nutter, L.J. and E.G. Otton, 1969, Ground Water Occurrence in the Maryland Piedmont: Maryland Geological Survey Report of Investigations No. 10, 56 pp

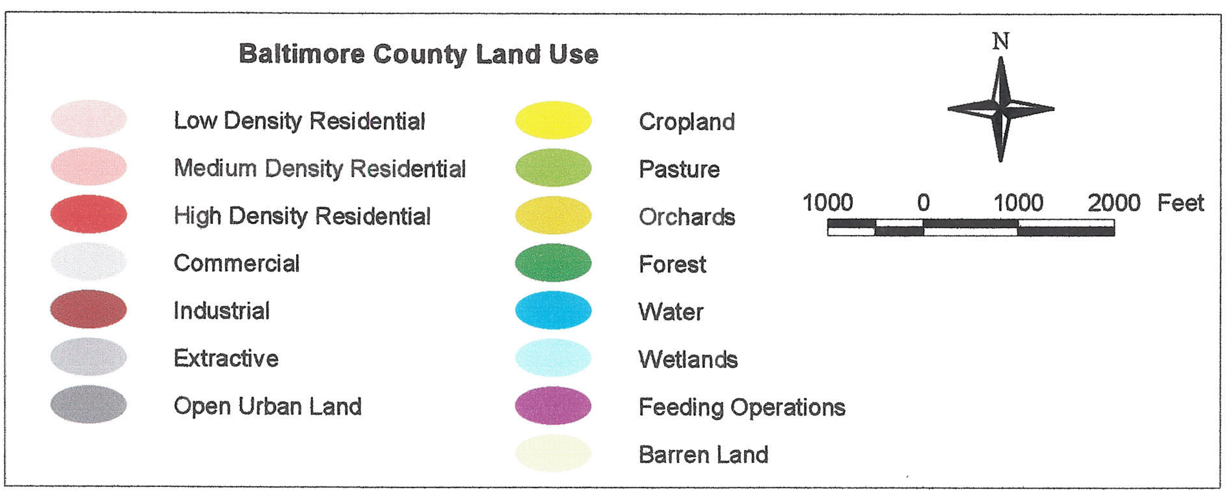
U.S. Environmental Protection Agency, 1991, Delineation of Wellhead Protection Areas in Fractured Rocks: Office of Ground Water and Drinking Water, EPA/570/9-91-009, 144 pp.

Other Sources of Data

Water Appropriation and Use Permit BA1963G019
Public Water Supply Sanitary Survey Inspection and Monthly Operating Reports
MDE Water Supply Program Oracle® Database
MDE Waste Management Sites Database
Department of Natural Resources Digital Orthophoto Quarter Quadrangles for Towson and Phoenix
USGS Topographic 7.5 Minute Quadrangles for Towson and Phoenix
Maryland Office of Planning 1997 Baltimore County Digital Land Use Map
Maryland Office of Planning 1996 Baltimore County Digital Sewer Map

FIGURES

Figure 3. Land Use in the Sunnybrook Wellhead Protection Area.



APPENDIX

United States Environmental Protection Agency | Office of Water (4606) | EPA 816-F-01-007 March 2001 www.epa.gov/safewater

National Primary Drinking Water Standards

Contaminant	MCLG[1] (mg/L)[2]	MCL or TT[1] (mg/L)[2]	Potential health effects from exposure above the MCL	Common sources of contaminant in drinking water
MICROORGANISMS				
Cryptosporidium	as of 01/01/02: zero	as of 01/01/02: TT[3]	Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and fecal animal waste
Giardia lamblia	zero	TT[3]	Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste
Heterotrophic plate count (HPC)	n/a	TT[3]	HPC has no health effects; it is an analytic method used to measure the variety of bacteria that are common in water. The lower the concentration of bacteria in drinking water, the better maintained the water system is.	HPC measures a range of bacteria that are naturally present in the environment
Legionella	zero	TT[3]	Legionnaire's Disease, a type of pneumonia	Found naturally in water; multiplies in heating systems
Total Coliforms (including fecal coliform and *E. coli*)	zero	5.0%[4]	Not a health threat in itself; it is used to indicate whether other potentially harmful bacteria may be present[5]	Total coliforms are naturally present in the environment; fecal coliforms and *E. coli* come from human and animal fecal waste.
Turbidity	n/a	TT[3]	Turbidity is a measure of the cloudiness of water. It is used to indicate water quality and filtration effectiveness (e.g., whether disease-causing organisms are present). Higher turbidity levels are often associated with higher levels of disease-causing microorganisms such as viruses, parasites and some bacteria. These organisms can cause symptoms such as nausea, cramps, diarrhea, and associated headaches.	Soil runoff
Viruses (enteric)	zero	TT[3]	Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Human and animal fecal waste
DISINFECTANTS AND DISINFECTION BYPRODUCTS				
Bromate	as of 01/01/02: zero	as of 01/01/02: 0.010	Increased risk of cancer	Byproduct of drinking water disinfection
Chloramines (as Cl_2)	as of 01/01/02: MRDLG=4[1]	as of 01/01/02: MRDL=4.0[1]	Eye/nose irritation; stomach discomfort, anemia	Water additive used to control microbes
Chlorine (as Cl_2)	as of 01/01/02: MRDLG=4[1]	as of 01/01/02: MRDL=4.0[1]	Eye/nose irritation; stomach discomfort	Water additive used to control microbes
Chlorine dioxide (as ClO_2)	as of 01/01/02: MRDLG=0.8[1]	as of 01/01/02: MRDL=0.8[1]	Anemia; infants & young children: nervous system effects	Water additive used to control microbes
Chlorite	as of 01/01/02: 0.8	as of 01/01/02: 1.0	Anemia; infants & young children: nervous system effects	Byproduct of drinking water disinfection
Haloacetic acids (HAA5)	as of 01/01/02: n/a[6]	as of 01/01/02: 0.060	Increased risk of cancer	Byproduct of drinking water disinfection
Total Trihalomethanes (TTHMs)	none[7] as of 01/01/02: n/a[6]	0.10 as of 01/01/02: 0.080	Liver, kidney or central nervous system problems; increased risk of cancer	Byproduct of drinking water disinfection
INORGANIC CHEMICALS				
Antimony	0.006	0.006	Increase in blood cholesterol; decrease in blood sugar	Discharge from petroleum refineries; fire retardants; ceramics; electronics; solder
Arsenic	none[7]	0.05	Skin damage; circulatory system problems; increased risk of cancer	Erosion of natural deposits; runoff from orchards; runoff from glass and electronics production wastes
Asbestos (fibers >10 micrometers)	7 million fibers per Liter (MFL)	7 MFL	Increased risk of developing benign intestinal polyps	Decay of asbestos cement in water mains; erosion of natural deposits
Barium	2	2	Increase in blood pressure	Discharge of drilling wastes; discharge from metal refineries; erosion of natural deposits

Contaminant	MCLG[1] (mg/L)[2]	MCL or TT[1] (mg/L)[2]	Potential health effects from exposure above the MCL	Common sources of contaminant in drinking water
Beryllium	0.004	0.004	Intestinal lesions	Discharge from metal refineries and coal-burning factories; discharge from electrical, aerospace, and defense industries
Cadmium	0.005	0.005	Kidney damage	Corrosion of galvanized pipes; erosion of natural deposits; discharge from metal refineries; runoff frc waste batteries and paints
Chromium (total)	0.1	0.1	Allergic dermatitis	Discharge from steel and pulp mills; erosion of natural deposits
Copper	1.3	TT[8]; Action Level= 1.3	Short term exposure: Gastrointestinal distress Long term exposure: Liver or kidney damage People with Wilson's Disease should consult their personal doctor if the amount of copper in their water exceeds the action level	Corrosion of household plumbing systems; erosion of natural deposits
Cyanide (as free cyanide)	0.2	0.2	Nerve damage or thyroid problems	Discharge from steel/metal factories; discharge from plastic and fertilizer factories
Fluoride	4.0	4.0	Bone disease (pain and tenderness of the bones); Children may get mottled teeth	Water additive which promotes strong teeth; erosio of natural deposits; discharge from fertilizer and aluminum factories
Lead	zero	TT[8]; Action Level= 0.015	Infants and children: Delays in physical or mental development; children could show slight deficits in attention span and learning abilities Adults: Kidney problems; high blood pressure	Corrosion of household plumbing systems; erosion natural deposits
Mercury (inorganic)	0.002	0.002	Kidney damage	Erosion of natural deposits; discharge from refineri and factories; runoff from landfills and croplands
Nitrate (measured as Nitrogen)	10	10	Infants below the age of six months who drink water containing nitrate in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tan sewage; erosion of natural deposits
Nitrite (measured as Nitrogen)	1	1	Infants below the age of six months who drink water containing nitrite in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	Runoff from fertilizer use; leaching from septic tan sewage; erosion of natural deposits
Selenium	0.05	0.05	Hair or fingernail loss; numbness in fingers or toes; circulatory problems	Discharge from petroleum refineries; erosion of natural deposits; discharge from mines
Thallium	0.0005	0.002	Hair loss; changes in blood; kidney, intestine, or liver problems	Leaching from ore-processing sites; discharge from electronics, glass, and drug factories
ORGANIC CHEMICALS				
Acrylamide	zero	TT[9]	Nervous system or blood problems; increased risk of cancer	Added to water during sewage/wastewater treatment
Alachlor	zero	0.002	Eye, liver, kidney or spleen problems; anemia; increased risk of cancer	Runoff from herbicide used on row crops
Atrazine	0.003	0.003	Cardiovascular system or reproductive problems	Runoff from herbicide used on row crops
Benzene	zero	0.005	Anemia; decrease in blood platelets; increased risk of cancer	Discharge from factories; leaching from gas storag tanks and landfills
Benzo(a)pyrene (PAHs)	zero	0.0002	Reproductive difficulties; increased risk of cancer	Leaching from linings of water storage tanks and distribution lines
Carbofuran	0.04	0.04	Problems with blood, nervous system, or reproductive system	Leaching of soil fumigant used on rice and alfalfa
Carbon tetrachloride	zero	0.005	Liver problems; increased risk of cancer	Discharge from chemical plants and other industri activities
Chlordane	zero	0.002	Liver or nervous system problems; increased risk of cancer	Residue of banned termiticide
Chlorobenzene	0.1	0.1	Liver or kidney problems	Discharge from chemical and agricultural chemica factories
2,4-D	0.07	0.07	Kidney, liver, or adrenal gland problems	Runoff from herbicide used on row crops
Dalapon	0.2	0.2	Minor kidney changes	Runoff from herbicide used on rights of way
1,2-Dibromo-3-chloropropane (DBCP)	zero	0.0002	Reproductive difficulties; increased risk of cancer	Runoff/leaching from soil fumigant used on soybeans, cotton, pineapples, and orchards
o-Dichlorobenzene	0.6	0.6	Liver, kidney, or circulatory system problems	Discharge from industrial chemical factories

Contaminant	MCLG[1] (mg/L)[2]	MCL or TT[1] (mg/L)[2]	Potential health effects from exposure above the MCL	Common sources of contaminant in drinking water
p-Dichlorobenzene	0.075	0.075	Anemia; liver, kidney or spleen damage; changes in blood	Discharge from industrial chemical factories
1,2-Dichloroethane	zero	0.005	Increased risk of cancer	Discharge from industrial chemical factories
1,1-Dichloroethylene	0.007	0.007	Liver problems	Discharge from industrial chemical factories
cis-1,2-Dichloroethylene	0.07	0.07	Liver problems	Discharge from industrial chemical factories
trans-1,2-Dichloroethylene	0.1	0.1	Liver problems	Discharge from industrial chemical factories
Dichloromethane	zero	0.005	Liver problems; increased risk of cancer	Discharge from drug and chemical factories
1,2-Dichloropropane	zero	0.005	Increased risk of cancer	Discharge from industrial chemical factories
Di(2-ethylhexyl) adipate	0.4	0.4	General toxic effects or reproductive difficulties	Discharge from chemical factories
Di(2-ethylhexyl) phthalate	zero	0.006	Reproductive difficulties; liver problems; increased risk of cancer	Discharge from rubber and chemical factories
Dinoseb	0.007	0.007	Reproductive difficulties	Runoff from herbicide used on soybeans and vegetables
Dioxin (2,3,7,8-TCDD)	zero	0.00000003	Reproductive difficulties; increased risk of cancer	Emissions from waste incineration and other combustion; discharge from chemical factories
Diquat	0.02	0.02	Cataracts	Runoff from herbicide use
Endothall	0.1	0.1	Stomach and intestinal problems	Runoff from herbicide use
Endrin	0.002	0.002	Liver problems	Residue of banned insecticide
Epichlorohydrin	zero	TT[9]	Increased cancer risk, and over a long period of time, stomach problems	Discharge from industrial chemical factories; an impurity of some water treatment chemicals
Ethylbenzene	0.7	0.7	Liver or kidneys problems	Discharge from petroleum refineries
Ethylene dibromide	zero	0.00005	Problems with liver, stomach, reproductive system, or kidneys; increased risk of cancer	Discharge from petroleum refineries
Glyphosate	0.7	0.7	Kidney problems; reproductive difficulties	Runoff from herbicide use
Heptachlor	zero	0.0004	Liver damage; increased risk of cancer	Residue of banned termiticide
Heptachlor epoxide	zero	0.0002	Liver damage; increased risk of cancer	Breakdown of heptachlor
Hexachlorobenzene	zero	0.001	Liver or kidney problems; reproductive difficulties; increased risk of cancer	Discharge from metal refineries and agricultural chemical factories
Hexachlorocyclopentadiene	0.05	0.05	Kidney or stomach problems	Discharge from chemical factories
Lindane	0.0002	0.0002	Liver or kidney problems	Runoff/leaching from insecticide used on cattle, lumber, gardens
Methoxychlor	0.04	0.04	Reproductive difficulties	Runoff/leaching from insecticide used on fruits, vegetables, alfalfa, livestock
Oxamyl (Vydate)	0.2	0.2	Slight nervous system effects	Runoff/leaching from insecticide used on apples, potatoes, and tomatoes
Polychlorinated biphenyls (PCBs)	zero	0.0005	Skin changes; thymus gland problems; immune deficiencies; reproductive or nervous system difficulties; increased risk of cancer	Runoff from landfills; discharge of waste chemicals
Pentachlorophenol	zero	0.001	Liver or kidney problems; increased cancer risk	Discharge from wood preserving factories
Picloram	0.5	0.5	Liver problems	Herbicide runoff
Simazine	0.004	0.004	Problems with blood	Herbicide runoff
Styrene	0.1	0.1	Liver, kidney, or circulatory system problems	Discharge from rubber and plastic factories; leaching from landfills
Tetrachloroethylene	zero	0.005	Liver problems; increased risk of cancer	Discharge from factories and dry cleaners
Toluene	1	1	Nervous system, kidney, or liver problems	Discharge from petroleum factories
Toxaphene	zero	0.003	Kidney, liver, or thyroid problems; increased risk of cancer	Runoff/leaching from insecticide used on cotton and cattle
2,4,5-TP (Silvex)	0.05	0.05	Liver problems	Residue of banned herbicide
1,2,4-Trichlorobenzene	0.07	0.07	Changes in adrenal glands	Discharge from textile finishing factories
1,1,1-Trichloroethane	0.20	0.2	Liver, nervous system, or circulatory problems	Discharge from metal degreasing sites and other factories
1,1,2-Trichloroethane	0.003	0.005	Liver, kidney, or immune system problems	Discharge from industrial chemical factories

Contaminant	MCLG[1] (mg/L)[2]	MCL or TT[1] (mg/L)[2]	Potential health effects from exposure above the MCL	Common sources of contaminant in drinking water
Trichloroethylene	zero	0.005	Liver problems; increased risk of cancer	Discharge from metal degreasing sites and other factories
Vinyl chloride	zero	0.002	Increased risk of cancer	Leaching from PVC pipes; discharge from plastic factories
Xylenes (total)	10	10	Nervous system damage	Discharge from petroleum factories; discharge fron chemical factories
RADIONUCLIDES				
Alpha particles	none[7]	15 picocuries per Liter (pCi/L)	Increased risk of cancer	Erosion of natural deposits of certain minerals that are radioactive and may emit a form of radiation known as alpha radiation
Beta particles and photon emitters	none[7]	4 millirems per year (mrem/yr)	Increased risk of cancer	Decay of natural and man-made deposits of certain minerals that are radioactive and may emit forms of radiation known as photons and beta radiation
Radium 226 and Radium 228 (combined)	none[7]	5 pCi/L	Increased risk of cancer	Erosion of natural deposits

NOTES

1 - Definitions

- 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 allo for a margin of safety and are non-enforceable public health goals.
- Maximum Contaminant Level (MCL) - The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to MCLGs as feasible using tl best available treatment technology and taking cost into consideration. MCLs are enforceable standards.
- Maximum Residual Disinfectant Level Goal (MRDLG) - The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contaminants.
- Maximum Residual Disinfectant Level (MRDL) - The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.
- Treatment Technique (TT) - A required process intended to reduce the level of a contaminant in drinking water.

2 - Units are in milligrams per liter (mg/L) unless otherwise noted. Milligrams per liter are equivalent to parts per million (ppm).

3 - EPA's surface water treatment rules require systems using surface water or ground water under the direct influence of surface water to (1) disinfect their water, and (2) filter their water or meet criteria for avoiding filtration so that the following contaminants are controlled at the following levels:

- *Cryptosporidium*:(as of January 1, 2002) 99% removal
- *Giardia lamblia*: 99.9% removal/inactivation
- Viruses: 99.99% removal/inactivation
- *Legionella*: No limit, but EPA believes that if *Giardia* and viruses are removed/inactivated, *Legionella* will also be controlled.
- Turbidity: At no time can turbidity (cloudiness of water) go above 5 nephelolometric turbidity units (NTU); systems that filter must ensure that the turbidity go nc higher than 1 NTU (0.5 NTU for conventional or direct filtration) in at least 95% of the daily samples in any month. As of January 1, 2002, turbidity may never exceed 1 NTU, and must not exceed 0.3 NTU in 95% of daily samples in any month.
- HPC: No more than 500 bacterial colonies per milliliter

4 - No more than 5.0% of samples may be total coliform-positive in a month. (For water systems that collect fewer than 40 routine samples per month, no more than one sample may be total coliform-positive during a month). Every sample that has total coliforms must be analyzed for either *E. coli* or fecal coliforms to determine whether hui n or animal fecal matter is present (fecal coliform and *E. coli* are part of the total coliform group). There may not be any fecal coliforms or *E. coli*.

5 - Fecal coliform and *E. coli* are bacteria whose presence indicates that the water may be contaminated with human or animal wastes. Disease-causing microbes (pathogens 1 these wastes can cause diarrhea, cramps, nausea, headaches, or other symptoms. These pathogens may pose a special health risk for infants, young children, and people witl severely compromised immune systems.

6 - Although there is no collective MCLG for this contaminant group, there are individual MCLGs for some of the individual contaminants:

- Haloacetic acids: dichloroacetic acid (zero); trichloroacetic acid (0.3 mg/L)
- Trihalomethanes: bromodichloromethane (zero); bromoform (zero); dibromochloromethane (0.06 mg/L)

7 - MCLGs were not established before the 1986 Amendments to the Safe Drinking Water Act. The standard for this contaminant was set prior to 1986. Therefore, there is no MCLG for this contaminant.

8 - Lead and copper are regulated by a Treatment Technique that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed thc action level, water systems must take additional steps. For copper, the action level is 1.3 mg/L, and for lead is 0.015 mg/L.

9 - Each water system must certify, in writing, to the state that when it uses acrylamide and/or epichlorohydrin to treat water, the combination (or product) of dose and monc level does not exceed the levels specified, as follows: Acrylamide = 0.05% dosed at 1 mg/L (or equivalent); Epichlorohydrin = 0.01% dosed at 20 mg/L (or equivalent).