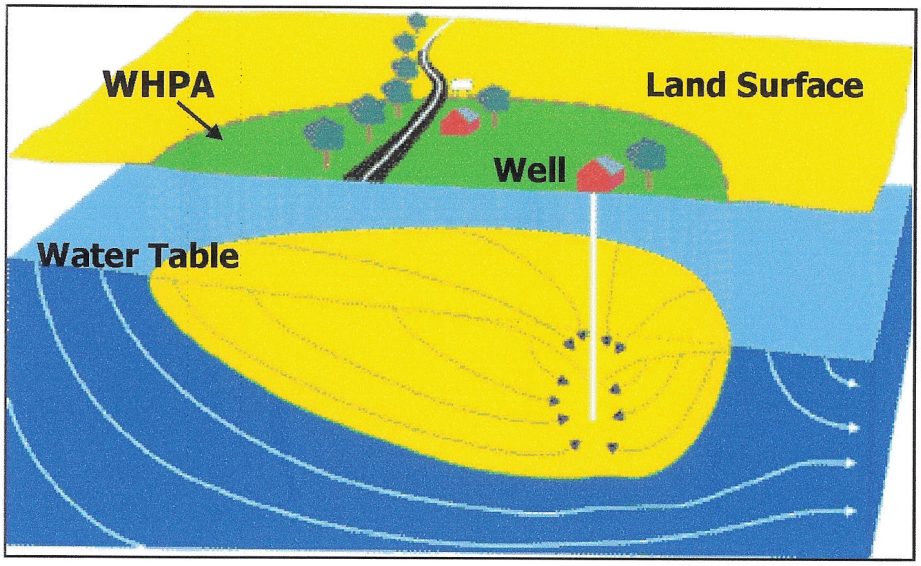
Source Water Assessment

for the Woodstock Job Corps Center

Baltimore County, MD



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MDE

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SUMMARY

The Maryland Department of the Environment's Water Supply Program (WSP) has conducted a Source Water Assessment for the Woodstock Job Corps Center 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 Woodstock Job Corps Center's water supply is an unconfined fractured-rock aquifer. The Source Water Assessment area was delineated by the WSP using U.S. EPA approved methods specifically designed for each source.

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 Woodstock water supply is susceptible to contamination by radon and volatile organic compounds. This water supply is not susceptible to other radiological compounds, inorganic compounds, synthetic organic compounds, and microbiological contaminants.

INTRODUCTION

The Water Supply Program has conducted a Source Water Assessment for the Woodstock Job Corps Center water system in Baltimore County. The Woodstock Job Corps Center is located approximately 10 miles west of the City of Baltimore near the Patapsco River and is outside of the city's water service area. The Woodstock system serves a population of 675 and has 8 service connections. Woodstock currently obtains its water supply from three wells.

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. The Woodstock Job Corps Center presently obtains its water supply from three wells (Nos. 1, 2, and 3). Several unused wells existed on the property but they have all recently been abandoned and sealed in accordance with well construction regulations. The three production wells are located along an unnamed tributary within the Patapsco River watershed just east of the river (Fig. 1). A review of the well completion reports and sanitary surveys of Woodstock's water system indicate that Well No. 1 was installed prior to the 1973 well construction regulations went into effect and may not meet the current construction standards. Well Nos. 2 and 3 were installed after the regulations went into effect and should meet standards. Inspection of the wells reveals that they are in good condition. Well No. 1 is located in its own pumphouse with a drain to prevent flooding. 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	WELL 1	n/a	257	n/a	BA1981G022 *(45,000)*	BALTIMORE GNEISS
01	WELL 2	BA920449	300	43		
01	WELL 3	BA942124	460	40		

Table 1. Woodstock Job Corps Center Well Information.

The Woodstock Job Corps Center has an appropriation permit issued for an average use of 45,000 gallons per day (gpd) and a maximum of 55,000 gpd in the month of maximum use. The average daily use was 29,222 gallons in 1999 and 32,964 gallons in 2000. The months of maximum use were May 1999 and July 2000 with an average daily use of 36,153 and 41,564 gallons respectively.

HYDROGEOLOGY

Woodstock 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 Woodstock wells draw water from the Baltimore Gneiss formation. The Baltimore Gneiss 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 Baltimore Gneiss 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 Wellhead Protection Area (WHPA) is considered the source water assessment area for the system. The source water assessment area for public water systems using wells in fractured-rock aquifers is the watershed drainage area that contributes to the well. The area should be modified to account for geological boundaries, ground water divides, and by annual average recharge needed to supply the well (MD SWAP, 1999). The watershed upstream of the wells has been delineated as the source water assessment area (Fig. 2). The WHPA is approximately 97 acres which provides a drought year recharge (400 gallons per day/acre) of approximately 40,000 gpd, which is close to the annual average use as listed above.

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.

Point Sources

MDE contaminant databases were searched for point sources of contamination within the WHPA. The Oil Control Program's registered tanks database lists a total of seven underground storage tanks at the Woodstock Job Corps Center (Fig 2). One tank has been removed and six are currently in use. There are four heating oil tanks (two 10,000-gallon, one 4,000-gallon, and one 2,000-gallon) and two gasoline tanks (one 4000-gallon and one 275-gallon). All tanks are located within the facility buildings and the single dot on Figure 2 represents all tanks. A 3000-gallon heating oil tank located on the St. Alphonsus Rodriguez Church, 10800 Old Court Rd., is also listed as currently in use. This church is located on the border of the WHPA (Fig. 2).

The water operator for the Woodstock system reported that in the early 1980's, a spill occurred while filling one of the tanks on the Woodstock property. Most of the spilled fluid went into the storm-drainage system and left through the creek that runs by the wells. This accident did not appear to impact the wells based on testing immediately following the spill.

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. 3). The land use summary is given in Table 2. The WHPA is split evenly between pastureland, forested land, and residential areas. A smaller proportion of the WHPA is covered by institutional land, which is the area used by the Woodstock Center. 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.

Agricultural land use 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. Additionally, residential areas may present a source of SOCs if pesticides and herbicides are not used carefully in gardens.

Type	Area (acres)	% of WHPA
Low Density Residential	25.5	26.3
Institutional	7.9	8.1
Pasture	38.0	39.2
Forest	25.5	26.4

Table 2. Land Use Summary

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 Woodstock water treatment plant currently has chlorination for disinfection.

A review of the monitoring data since 1993 for Woodstock's water indicates that the water supply meets drinking water standards. Radon-222 was the only contaminant present at a level of concern. Nitrate was the only inorganic compound detected, but levels are well below the MCL. Volatile and synthetic organic compounds have not been detected in the water supply. Ground water under direct influence testing results showed no indicators of microbiological pathogens in raw water samples from the wells. 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	10	0
Radiological Contaminants	2	2
Volatile Organic Compounds	9	0
Synthetic Organic Compounds	4	0
Microbiological Compounds*	3	0

Table 3. Summary of Water Quality Samples
*Raw water data

Inorganic Compounds (IOCs)

A review of the data shows that nitrate was the only contaminant detected in ten samples collected since 1993. Nitrate levels ranged from non-detectable to less than 2 ppm.

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. Two results of Radon-222 result are available and were reported at 2620 pCi/L in June 1994 and 1920 pCi/L in August 1997. These results are well above the lower proposed MCL of 300 pCi/L and their average is greater than 50% of the higher proposed MCL of 4000 pCi/L.

Volatile Organic Compounds (VOCs)

A review of the data shows that VOCs have not been detected in the wells currently in use. One sample collected from Well No. 1 in 1994 had detected benzene, xylene, toluene, and ethylbenzene at 2 ppb, results that are fewer than 50% of the MCL for each of these contaminants. This is **not** the same Well No. 1 that is currently in use and was abandoned with the other wells in the facility buildings.

Synthetic Organic Compounds (SOCs)

A review of the data shows that SOCs have **not** been detected in four samples collected since 1996.

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. All three wells were free of coliform bacteria.

SUSCEPTIBILITY ANALYSIS

The wells serving the Woodstock Job Corps Center 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 4 summarizes the susceptibility of Woodstock'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 the water supply but at levels well below the MCL. Sources of nitrate can generally be traced back to land use. Fertilization of agricultural fields and residential lawns, as well as residential septic systems are all sources of nitrate loading in ground water. Agricultural and residential areas cover a total of 65% of the WHPA. However, the area surrounding the well is covered by forest which provides a buffer from these potential sources of nitrate. Due to the low levels of nitrate found and the forested area the water supply is considered **not** susceptible to nitrate.

The water supply is **not** susceptible to other inorganic compounds 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 at an average level that is greater than 50% of the higher proposed MCL of 4000 pCi/L. 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 is susceptible to radon.

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

VOCs have not been detected in the water supply wells that are currently in use by the system. However, VOCs were detected in one of the abandoned wells and potential contaminant sources were identified within the WHPA. Due to the vulnerable nature of fractured rock aquifers and the presence of potential contaminant sources in the WHPA, the wells **are** susceptible to volatile organic compounds.

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

All three wells 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 Above 50% of MCL in WQ Samples?	Is Well Integrity a Factor?	Is the Aquifer Vulnerable?	Is the System Susceptible?
Nitrate	YES	NO	NO	YES	NO
Inorganic Compounds (except nitrate)	NO	NO	NO	YES	NO
Radiological Compounds	YES	YES	NO	YES	YES (RADON-222 ONLY)
Volatile Organic Compounds	YES	NO	NO	YES	YES
Synthetic Organic Compounds	YES	NO	NO	YES	NO
Microbiological Contaminants	YES	NO	NO	NO	NO

Table 4. Susceptibility Analysis Summary.

MANAGEMENT OF THE SOURCE WATER ASSESSMENT AREA

With the information contained in this report the Woodstock Job Corps Center is 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

- Encourage the County Planning and Environment Departments to form a planning team to implement a source water protection plan and participate in the team. 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, local business, 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 Woodstock 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.

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 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

- Woodstock 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.

- The facility should follow all tank testing and maintenance requirements for its underground storage tanks as outlined in the State's oil control regulations (COMAR 26.10).

- Periodic inspections and a regular maintenance program for the supply wells will ensure their integrity and protect the aquifer from contamination.

Changes in Use

- Woodstock 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 Woodstock should contact the Water Supply Program 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 BA1981G022
Public Water Supply Sanitary Survey Inspection Reports
MDE Water Supply Program Oracle® Database
MDE Waste Management Sites Database
Department of Natural Resources Digital Orthophoto Quarter Quadrangles for Ellicott City and Sykesville
USGS Topographic 7.5 Minute Quadrangles for Ellicott City and Sykesville
Maryland Office of Planning 1997 Baltimore County Digital Land Use Map
Maryland Office of Planning 1996 Baltimore County Digital Sewer Map

FIGURES

APPENDIX

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

EPA 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 fro 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; erosion 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 tanl 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 tanl 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 storage 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 industrial activities
Chlordane	zero	0.002	Liver or nervous system problems; increased risk of cancer	Residue of banned termiticide
Chlorobenzene	0.1	0.1	Liver or kidney problems	Discharge from chemical and agricultural chemical factories
2,4-D	0.07	0.07	Kidney, liver, or adrenal gland problems	Runoff from herbicide used on row crops
Dalapon	0.2	0.2	Minor kidney changes	Runoff from herbicide used on rights of way
1,2-Dibromo-3-chloropropane (DBCP)	zero	0.0002	Reproductive difficulties; increased risk of cancer	Runoff/leaching from soil fumigant used on soybeans, cotton, pineapples, and orchards
o-Dichlorobenzene	0.6	0.6	Liver, kidney, or circulatory system problems	Discharge from industrial chemical factories

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 from 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 allow 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 the 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 no 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 hum 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) 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 with 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 the 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 monor 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).

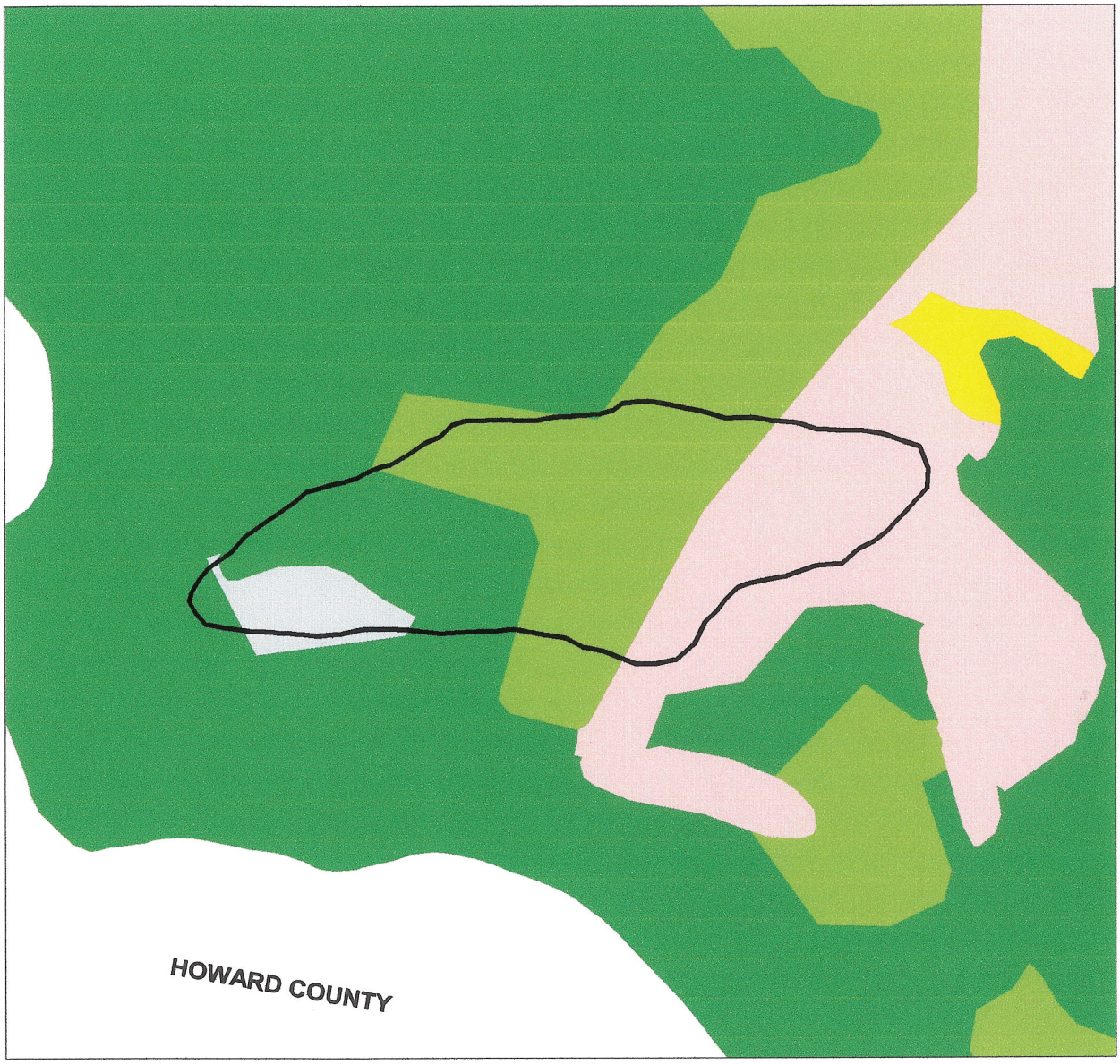
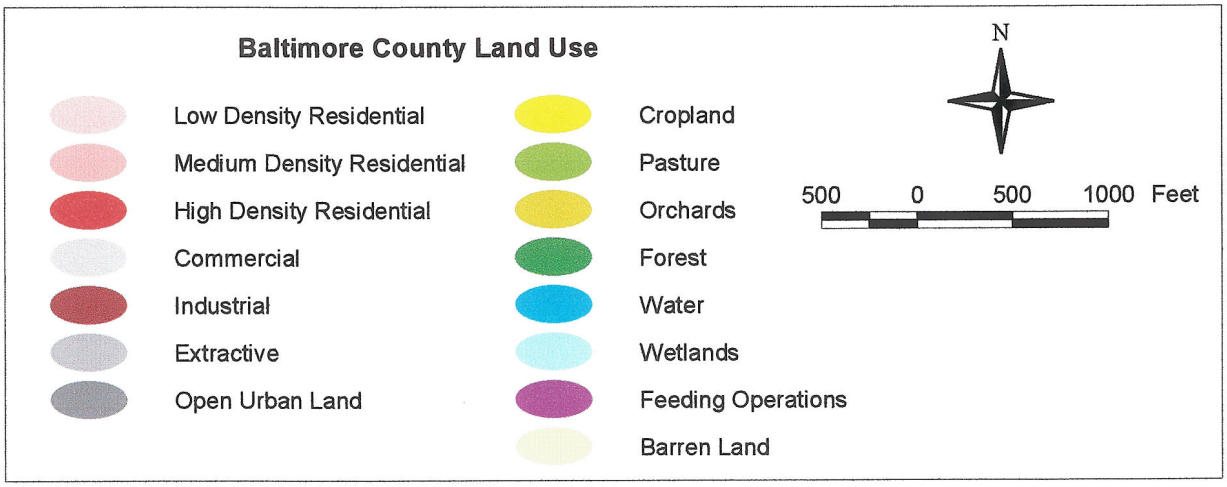
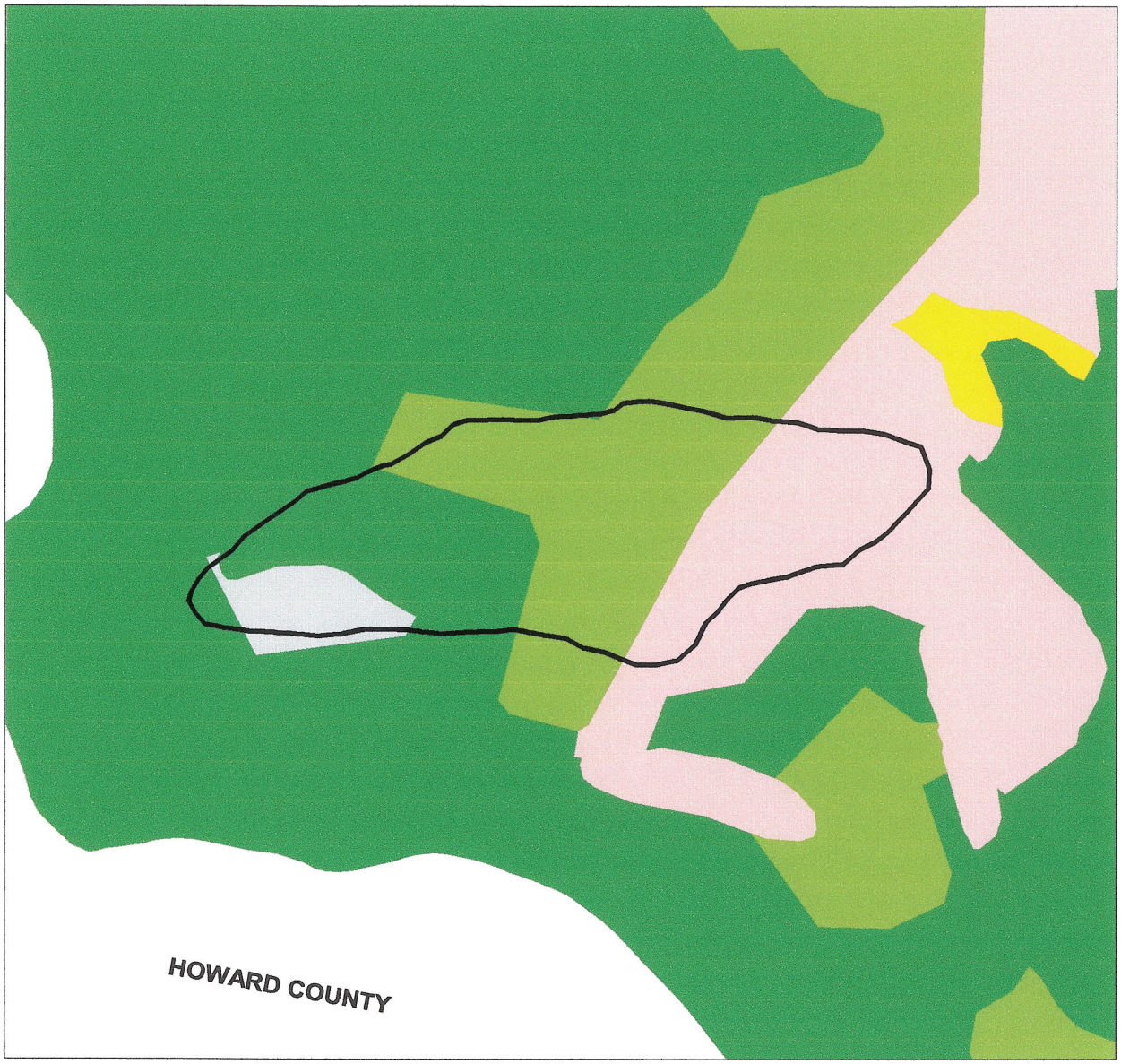


Figure 3. Land Use in the Woodstock Wellhead Protection Area.





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