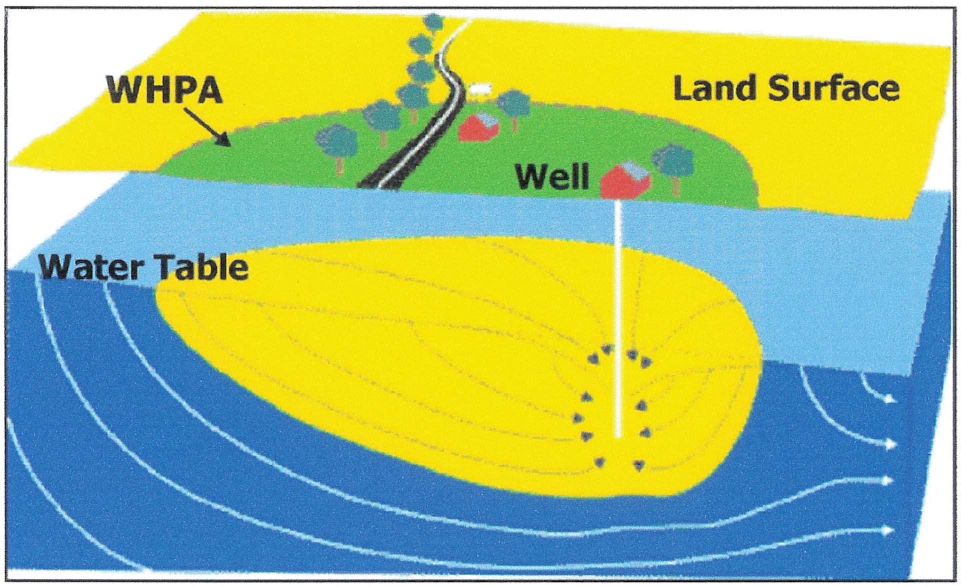
Source Water Assessment for the Urbana High School Water System Frederick County, Maryland



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Water Management Administration
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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 Urbana High School 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 Urbana High School'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 this source type.

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 2000 digital land use map for Frederick County was used to identify non-point sources of contamination. Well information and water quality data were also reviewed. An aerial photograph and maps showing contaminant sources and 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 source water assessment area, well integrity, and the inherent vulnerability of the aquifer. It was determined that the Urbana High School water supply is susceptible to nitrate, radon, and some microbiological contaminants. This water supply is not susceptible to other inorganic compounds, other radiological contaminants, volatile organic compounds, and synthetic organic compounds. An effective local wellhead protection strategy should be developed to address the dramatic increase in nitrate levels at Well 1.

INTRODUCTION

The Water Supply Program has conducted a Source Water Assessment for the Urbana High School water system in Frederick County. The Urbana High School is located approximately eight miles southeast of the City of Frederick and east of Interstate 270. The water system serves a total population of 1,374 students, faculty and staff at the school. The water system is owned and operated by the Frederick County Division of Utilities and Solid Waste Management.

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 Urbana High School system obtains it water supply from two wells (Table 1). The wells are located on the school property south of the main campus (Fig. 1). Three additional test wells are located adjacent to the stream to the south of the production wells. These wells were drilled during well exploration, but have never been put into service. A review of the well completion reports and sanitary surveys of Urbana High School's water system indicates the two production wells were drilled after 1973, when well construction regulations went into effect, and should meet current construction standards. A summary of the well information is located in Table 1.

SOURCE ID	SOURCE NAME	PERMIT	TOTAL DEPTH	CASING DEPTH	YEAR DRILLED
02	WELL 1	FR-88-2602	300	61	1991
01	WELL 2	FR-88-3563	300	61	1993

Table 1. Urbana High School well information

The Urbana High School water system has an appropriation permit to draw water from the Ijamsville Formation for an average use of 27,000 gallons per day (gpd) and a maximum of 41,000 gpd in the month of maximum use. Based on the most recent pumpage reports, the average daily use was 13,514 gallons in 1999 and 9,766 gallons in 2000. The months of maximum use for the last two reported years were June 1999 and September 2000 with an average daily use of 29,766 and 13,634 gallons respectively.

HYDROGEOLOGY

The Urbana High School is in the Piedmont lowlands physiographic province of eastern Frederick County, which is characterized by gently rolling hills with some deeply cut valleys. This portion of the county is underlain by a series of meta-sedimentary and metavolcanic rocks that are structurally complex and the stratigraphic and structural relationships of these geologic units are poorly understood. Ijamsville and Urban formations are mapped at the surface and either of these formations is likely to be encountered in the subsurface. The Ijamsville formation is described as a blue, green, or purple phyllite, with interbedded metasiltstone and metagraywacke (Cleaves, et al., 1968). This formation is an unconfined, fractured rock aquifer whose primary porosity and permeability are small due to compaction and re-crystallization associated with metamorphism. Ground water moves principally through secondary porosity - fractures, fault planes, and joint openings - and is recharged by precipitation percolating through soil and saprolite. Due to the low primary porosity, large production wells are not common in this formation unless significant, water-bearing fractures are encountered. A fracture trace analysis was completed in a well exploration project for this site and the wells were constructed based on this analysis. This information along with pump tests conducted on the wells was used in the delineation as described in the next section of this report.

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 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).

Hydrogeologic mapping identifies the physical and hydrologic features that control ground water flow (EPA, 1991). Hydrogeologic mapping was used to identify drainage basin boundaries and geologic features that influence ground water flow. Fracture traces are surface expressions of vertical, closely spaced joints and fractures in the bedrock below. Highly developed fracture systems in bedrock aquifers readily transmit water; thus fracture trace analysis is commonly used to locate high yield wells in fractured bedrock aquifers. A well intercepting a fracture, or fracture zone, will demonstrate a drawdown pattern that is greatest along the trace of the fracture(s). As noted above, fracture traces were mapped in and around the Urbana High School property using aerial photography. The predominant fracture traces follow the drainage patterns through the southern part of the property. Based on this information, the WHPA was delineated as the watershed drainage area of the small tributary upgradient of the wells and is extended downgradient to include the entire length of the fracture trace. The WHPA is approximately 71 acres and is shown in Figure 2.

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

A review of MDE contaminant databases and a site visit revealed no potential point sources of contamination within the WHPA.

Non-Point Sources

The Maryland Office of Planning's 2000 digital land use for Frederick 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 majority of the WHPA is made up of pasture land with smaller areas of forested, cropland, and institutional land (the school).

Land Use Type	Total Acres	Percent of WHPA
Institutional	10	14.2
Cropland	6	7.9
Pasture	43	60.6
Forest	12	17.3
Total	71	100

Table 2. Land Use Summary

Agricultural land (cropland and pasture) may be associated with nitrate loading of ground water and also represents a potential source of SOCs depending on fertilizing practices and use of pesticides. In 1997, Frederick County Bureau of Water and Sewer (now Division of Utilities) documented spreading of manure adjacent to Well 1. Animal waste is rich in nutrients and may contain pathogens, both of which present a risk to the water supply. The aerobic breakdown of manure will result in elevated levels of nitrate nitrogen in ground water. Institutional land is generally paved which contributes to the concentration of storm water runoff, which could present a source of contamination to the water supply if it is not properly managed.

Over fertilizing athletic fields on the school property can also result in elevated nitrate levels.

The Maryland Office of Planning's 1996 digital sewer map of Frederick County shows that most of the WHPA is an area of the county that is planned for future sewer service (Fig. 4). Only a small portion on the eastern side of the WHPA is not planned for service. Table 3 summarizes the sewer service categories in the WHPA.

Service Category	Total Acres	Percent of WHPA
4 to 6 Year Planned Service	65	90.9
7 to 20 Year Planned Service	4	5.1
Not Planned for Service	3	4.0
Total	71	100

Table 3. Sewer Service Area Summary

WATER QUALITY DATA

Water Quality data was reviewed from the Water Supply Program's database for Safe Drinking Water Act (SDWA) contaminants. 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, this 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 Urbana water system has one point of entry or plant, which has chlorination for disinfection and aeration for radon removal as its treatment.

A review of the monitoring data for Urbana High School water indicates that the water supply meets drinking water standards. No contaminants were detected above 50% of an MCL, with the exception of nitrate. Radon was the only other contaminant present at a level of concern. The water quality sampling results are summarized in Table 4.

Contaminant Group	No. of Samples Collected	No. of Samples above 50% of an MCL
Inorganic Compounds (except Nitrate)	4	0
Nitrate	9	3
Radiological Contaminants	2	1
Volatile Organic Compounds	8	0
Synthetic Organic Compounds	2	0

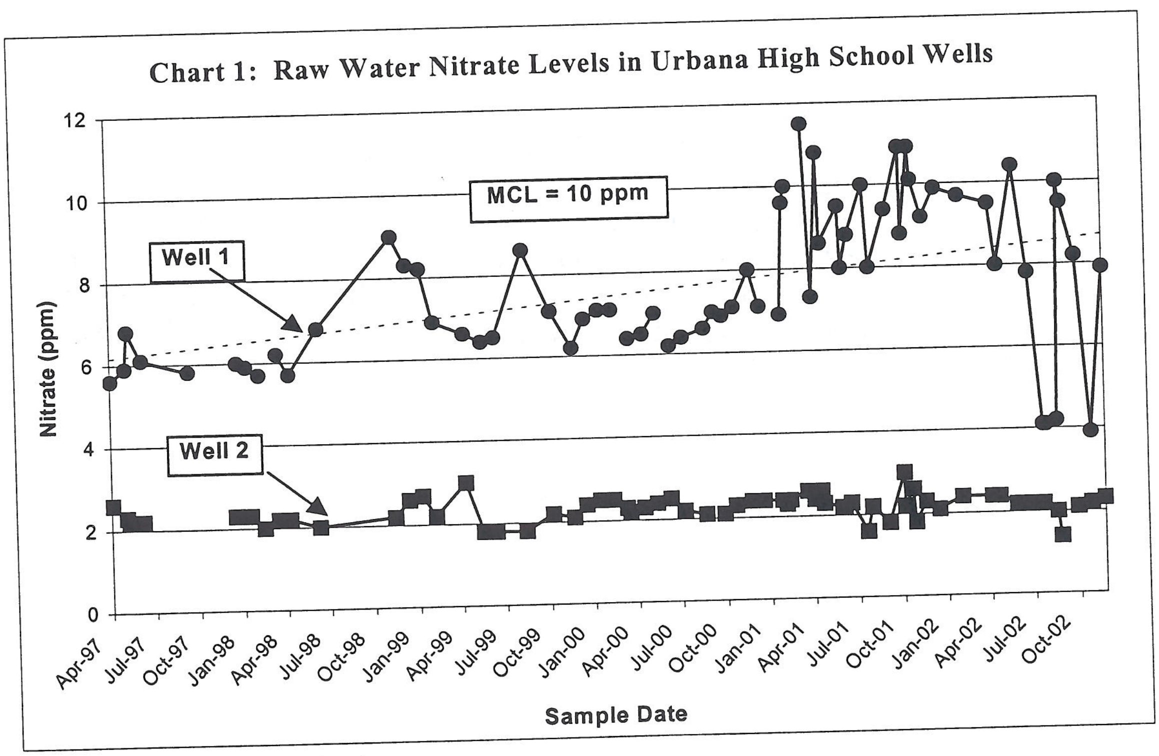
Table 4. Summary of Water Quality Samples

Inorganic Compounds (IOCs)

A review of the data shows that nitrate levels in the water supply range from 2.1 to 5.1 ppm in point of entry samples (Table 5). Nitrate was detected above the SWAP threshold level of 5 parts per million (ppm) in three of a total of nine samples collected at the point of entry. Monthly Raw water nitrate samples have been collected from each of the wells since 1997. Chart 1 illustrates the significant rise in nitrate levels in Well 1 over that time period, including several results from Well 1 that exceeded the MCL. Also evident is the significant difference in nitrate concentrations between the two wells. Nitrate levels in Well 2 have remained stable over the six-year period at an average of 2.2 ppm. No other inorganic compounds were detected above 50% of an MCL.

SAMPLE DATE	RESULT (PPM)
29-Feb-96	3.6
01-Oct-96	3.6
28-Jan-97	2.1
11-Jan-98	2.4
04-Feb-99	5.0
14-Dec-99	5.0
09-Feb-00	5.1
08-Feb-01	4.5
26-Mar-02	4.5

Table 5. Nitrate Data from Urbana High School Point of entry.



(See Appendix for Data in Chart)

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. Radon-222 was sampled from Well 1 before it was put into service and the level was reported for Urbana High School at 3394 pCi/L, which prompted the installation of the aeration unit. Since then, the only other reported level from treated water was non-detectable for radon. No other radionuclides have been detected in the water supply.

Volatile Organic Compounds (VOCs)

A review of the data shows that several volatile organic compounds have been detected at very low levels and well below 50% of an MCL. Some of the contaminants detected are petroleum products and their byproducts. Other VOC's that have been detected at very low levels are disinfection byproducts grouped as trihalomethanes (THMs).

Synthetic Organic Compounds (SOCs)

The only synthetic organic compound that has been detected above 50% of an MCL was Di(2-Ethylhexyl)Phthalate for which the highest level reported was 12.3 ppb The phthalate contaminant is commonly found in laboratory blank samples. The laboratory blank sample analyzed at the same time as this sample had a phthalate level of 12.6 ppb and therefore the level of 12.3 ppb in the sample is considered not valid.

Microbiological Contaminants

Raw water bacteriological data is available for each of the wells (Table 6a, 6b) from evaluation for ground water under the direct influence of surface water (GWUDI). Although fecal coliform was detected in each of the wells, the concentration was extremely low and the presence was not consistent. Therefore, the wells are not under the direct influence of surface water. The overall raw water quality was very good with low turbidity and other parameters such as temperature and pH were stable.

Rainfall Date	Rain Amount (inches)	Sample Date	Temp (deg. C)	pH	Turbidity (NTUs)	Total Coliform* (col/100ml)	Fecal Coliform* (col/100ml)
n/a	n/a	25-Sep-96				6.9	-1.1
n/a	n/a	14-Nov-96				3.6	1.1
n/a	n/a	19-Nov-96				3.6	-1.1
n/a	n/a	11-Dec-96				-1.1	-1.1
n/a	n/a	15-Jan-97				2.2	-1.1
n/a	n/a	12-Feb-97				-1.1	-1.1
		22-Mar-01	13	6.6	0.61	23.1	-1.1
		23-Mar-01	14	6.4	0.14	23.1	-1.1
		24-Mar-01	12	6.5	0.15	23.1	-1.1
21-Mar-01	1.15	25-Mar-01	13	6.5	0.1	9.2	-1.1
		27-Mar-02	14	6.7	0.43	-1.1	-1.1
		28-Mar-02	15	6.7	0.42	1.1	-1.1
		29-Mar-02	15	6.7	1.5	2.2	-1.1
		30-Mar-02	14	6.6	0.43	2.2	-1.1
26-Mar-02	0.5	31-Mar-02	14.7	6.4	0.28		
		28-May-02	14.5	6.7	0.41	2	-2
		29-May-02	15	6.7	0.22	-2	-2
		30-May-02	14.5	6.7	0.32	-2	-2
27-May-02	0.5	31-May-02	14.5	6.5	0.16	-2	-2
n/a	n/a	27-Jun-02	17	6.6	0.15	-1.1	-1.1

Table 6a. Ground Water Under Direct Influence Data from Well 1 (Raw Water).

Rainfall Date	Rain Amount (inches)	Sample Date	Temp (deg. C)	pH	Turbidity (NTUs)	Total Coliform* (col/100ml)	Fecal Coliform* (col/100ml)
n/a	n/a	31-Jul-96				23	2.2
n/a	n/a	12-Aug-96				2.2	-1.1
n/a	n/a	14-Nov-96				1.1	-1.1
n/a	n/a	11-Dec-96				1.1	-1.1
n/a	n/a	15-Jan-97				-1.1	-1.1
		22-Mar-01	12	6.5	0.63	9.2	-1.1
		23-Mar-01	13	6.3	0.34	23.1	-1.1
		24-Mar-01	13	6.4	0.17	9.2	-1.1
21-Mar-01	1.15	25-Mar-01	12	6.3	0.16	9.2	-1.1
		27-Mar-02	14	6.5	0.24	3.6	-1.1
		28-Mar-02	14	6.6	0.35	5.1	-1.1
		29-Mar-02	16	6.5	2.5	5.1	-1.1
		30-Mar-02	15	6.5	0.47	6.9	-1.1
26-Mar-02	0.5	31-Mar-02	15.2	6.4	0.11		
		28-May-02	14.5	6.3	1.14	-2	-2
		29-May-02	15	6.6	0.21	2	2
		30-May-02	14.5	6.5	0.11	4	2
27-May-02	0.5	31-May-02	14.5	6.3	0.56	2	-2
n/a	n/a	27-Jun-02	17	6.4	0.36	23.1	-1.1

Table 6b. Ground Water Under Direct Influence Data from Well 2 (Raw Water).

*Negative symbol indicates less than the detection level specified.

SUSCEPTIBILITY ANALYSIS

The wells serving the Urbana High School 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 7 summarizes the susceptibility of Urbana High School's water supply to each of the groups of contaminants.

In fractured rock settings, 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 above 5 ppm in 36% of samples collected (Table 5). The MCL for nitrate is 10 ppm. Sources of nitrate can generally be traced back to land use. Fertilization of agricultural and athletic fields, animal waste associated with pasture land, and septic systems are common sources of nitrate loading in ground water and are present to some extent in the WHPA. The increase of nitrate observed in Well 1 has not been attributed to a particular contaminant source at this time. However, since Well 2 has not witnessed the same effect, it is likely to be a source that is in closer proximity to Well 1 and has been active over the last six years. Nitrate levels have significantly increased and since nitrate sources are present in the WHPA, the water supply **is** susceptible to this contaminant.

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. Radon is present in raw water close to the higher proposed MCL. 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 consolidated 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.

The water supply is **not** susceptible to other radionuclides. Other radionuclides were not detected above 50% of an MCL and thus, the aquifer is not a source of these contaminants in this area.

Volatile Organic Compounds

Low levels of petroleum products have been detected in the water supply, however there are no significant sources that have been identified in the WHPA. Stormwater runoff from parking lots could be a potential source of these contaminants. The VOC's found were at very low levels and thus the water supply is considered **not** susceptible to contamination by VOC's.

Synthetic Organic Compounds

The water supply is **not** susceptible to synthetic organic compounds. The only SOC detected was likely to be a false positive and there are no significant sources of SOC's in the WHPA.

Microbiological Contaminants

Each of the wells had fecal coliform bacteria at very low levels in some of their raw water samples (2 colonies/100 ml was the highest concentration detected). Due to the low concentration these wells were determined to be **not** under direct influence of surface water. Therefore, the wells are **not** susceptible to microbiological contaminants that may be present in surface water such as *Giardia* and *Cryptosporidium*. The presence of low levels of total coliform bacteria, which are ubiquitous in the environment, and fecal coliform bacteria *may* an indicate that organisms with longer survival rates such as viruses could reach the wells. Without additional data however, it is not possible to determine whether or not the water supply is susceptible to viral contamination. The presence of coliform may also be associated with a break in the integrity at the wellhead, such as the broken electrical conduit observed in a well inspection in May of 2002. The wells **are** susceptible to total coliform bacteria and fecal coliform bacteria.

Contaminant Group	Are Contaminant Sources Present in WHPA?	Are Contaminants Detected Above 50% of MCL?	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[1]	NO	YES	YES
Volatile Organic Compounds	YES	NO	NO	YES	NO
Synthetic Organic Compounds	NO	NO	NO	YES	NO
Microbiological Contaminants[2]	YES	NO	NO	YES	YES – Coliform bacteria only[2]

Table 7. Susceptibility Analysis Summary.

[1] Raw water samples

[2] There is no MCL for coliform. Presence is considered a violation in *finished* water samples.

Management of the Source Water Assessment Area

With the information contained in this report the Frederick County Division of Utilities and Solid Waste Management is in a position to protect the Urbana High School 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 Division of Utilities and Solid Waste Management should continue to work with the County Planning Department and Wellhead Protection committee to implement a County Wellhead Protection Ordinance. The committee should ensure that all interests in the community are represented, such as the water supplier, home association officers, the County Health Department, local businesses, developers, and property owners, and residents within and near the WHPA.
- A management strategy adopted by the Division and the County 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, such as developing and implementing wellhead protection ordinances, digitizing layers that would be useful for wellhead protection (such as geology), and developing additional protection strategies. An application can be obtained by contacting the water supply program.

Nitrate Contamination

- Potential sources of nitrate for Well 1 were identified as both the athletic fields and manure applied to pasture land. Soil nitrogen test could be used to help identify the most significant sources. The Division of Utilities should work with both the school system and through the Soil Conservation Service to address this issue. Costly nitrate treatment can be avoided by taking action now.

Public Awareness and Outreach

- 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.
- Annual raw water bacteriological testing is a good test for well integrity. In addition, conducting the testing under wet weather conditions provides information in the "worst-case scenario", since fecal coliform has been detected in prior wet weather samples.

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

- Urbana High School's Contingency Plan was submitted to and approved by MDE in November 2001. 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

- The Division 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

- The Division 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 the Water Supply Program should be notified if a new well is being proposed.

Unused Wells

- MDE notified the school system in a letter dated May 10, 1997 that the unused test wells located on the school's property should be abandoned and sealed by a licensed well driller in accordance with COMAR. These wells may present an avenue for contamination of the aquifer and therefore are a risk to the water supply.

References

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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 FR1993G015
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 Urbana
USGS Topographic 7.5 Minute Quadrangles for Urbana
Maryland Office of Planning 2000 Frederick County Digital Land Use Map
Maryland Office of Planning 1996 Frederick County Digital Sewer Map

FIGURES

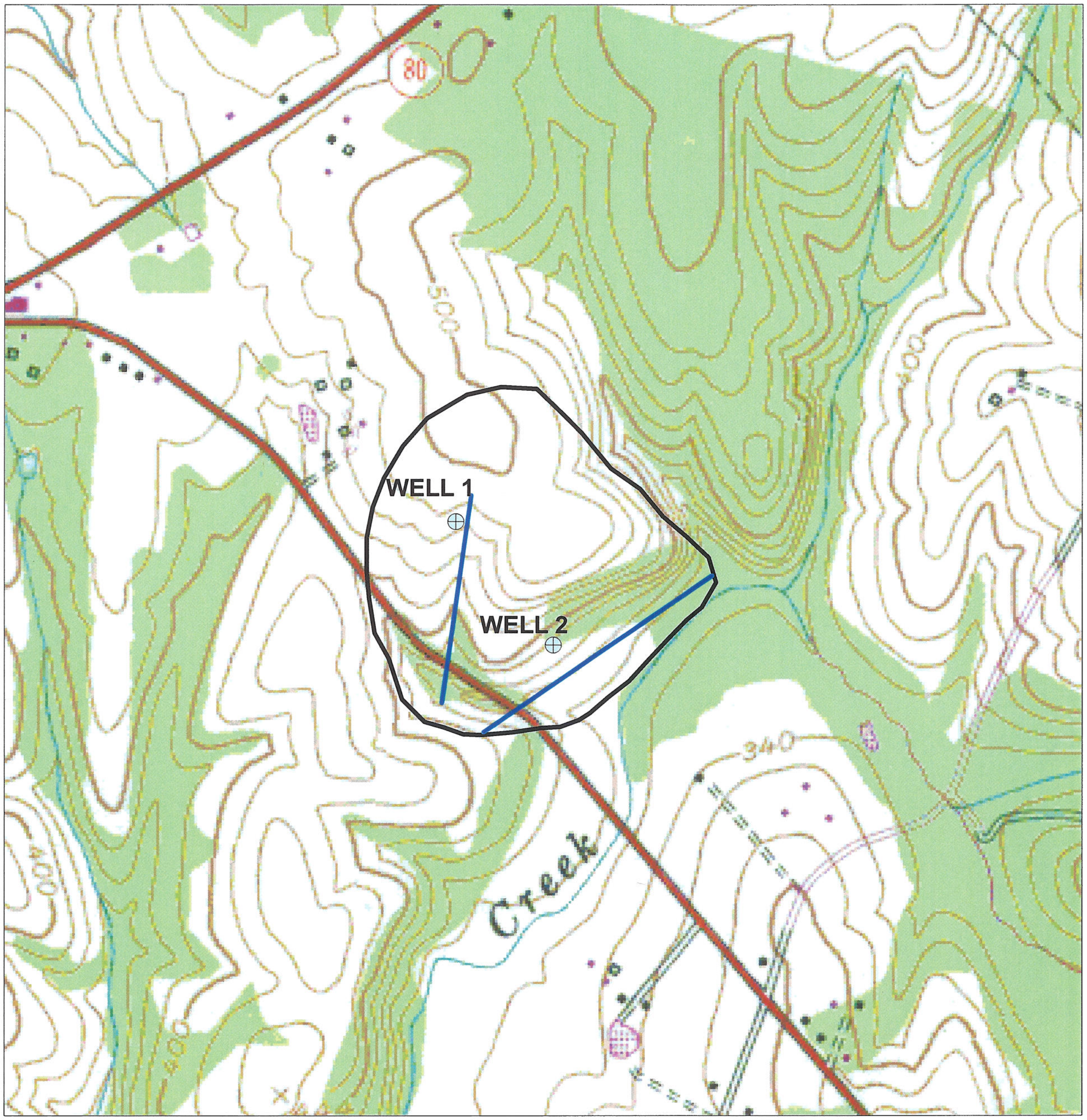


Figure 2. Urbana High School Wellhead Protection Area (WHPA).

Legend

Wells

Fracture Trace

Wellhead Protection Area

N

500 0 500 1000 Feet

Base Map: USGS Topgraphic 7.5 Minute Quad for Urbana

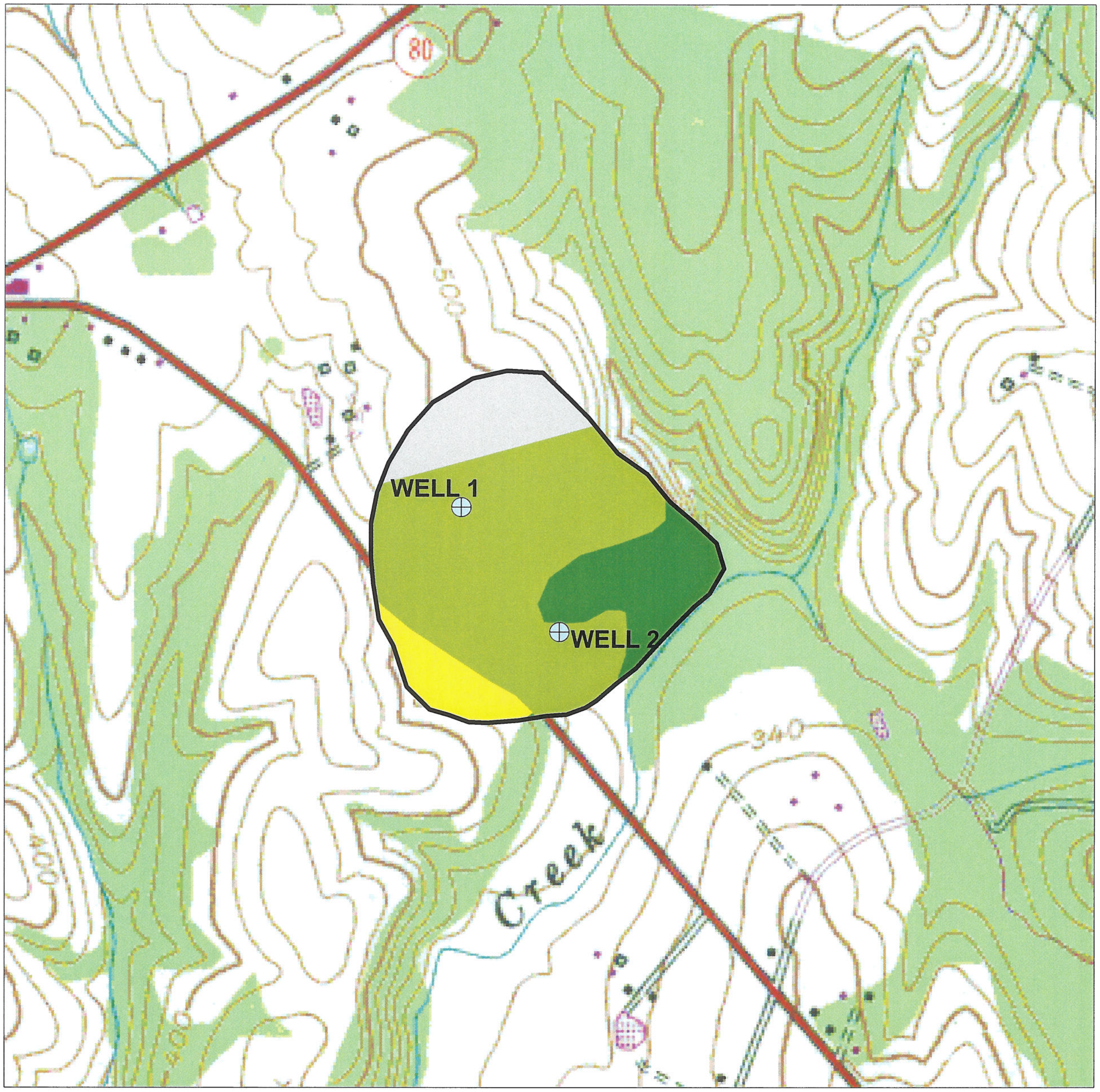
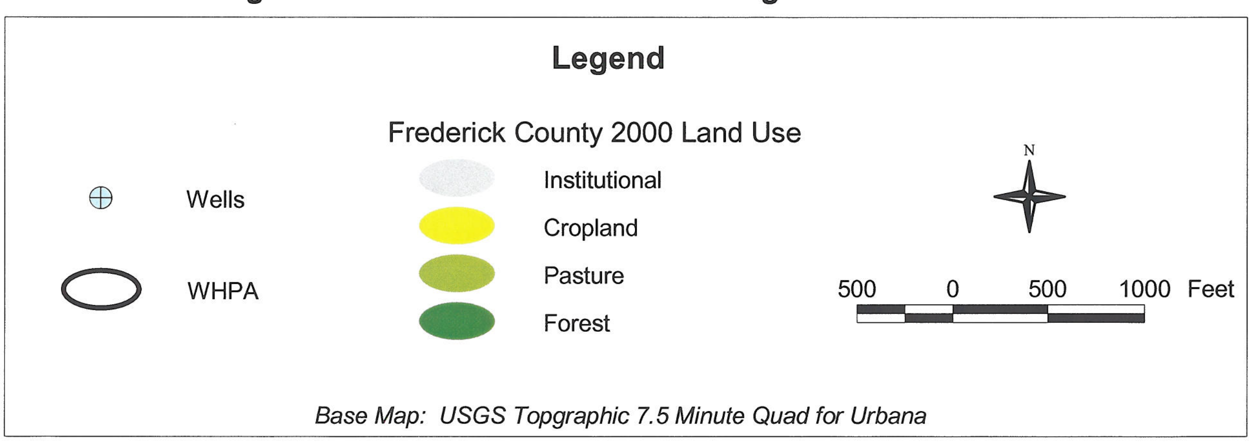


Figure 3. Land Use in the Urbana High School WHPA.



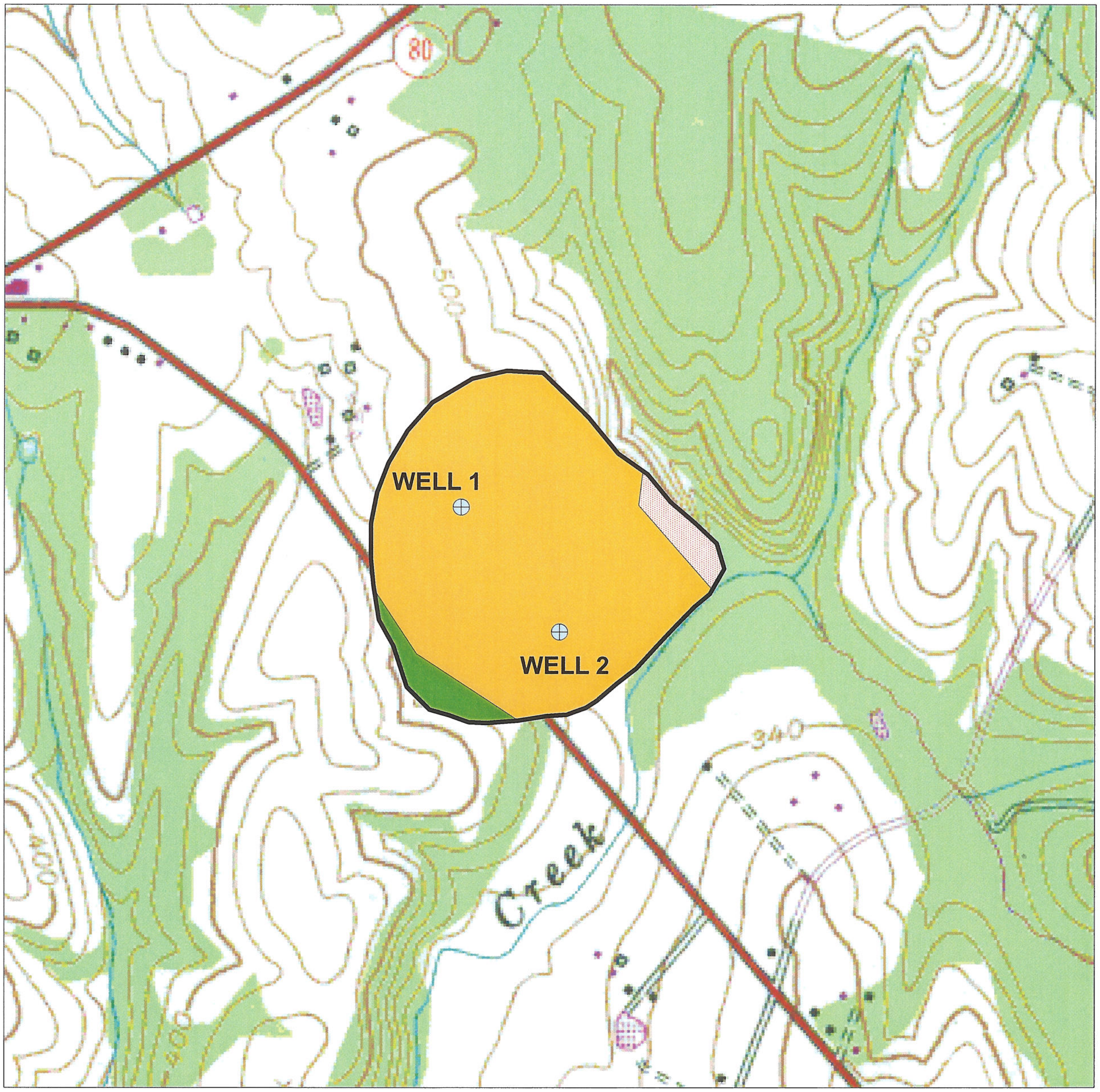


Figure 4. Sewer Service Areas in the Urbana High School WHPA.

Legend

Wells

WHPA

Sewer Service Areas

4 to 6 Year Planned Service

7 to 20 Year Planned Service

Not Planned for Service

N

500 0 500 1000 Feet

Base Map: USGS Topgraphic 7.5 Minute Quad for Urbana

APPENDIX

Raw Water Nitrate Data - Urbana High School Wells
(Provided by Frederick County Division of Utilities)

	Nitrate Level (ppm)	
Sample Date	Well 1	Well 2
04/28/1997	5.6	2.6
05/29/1997	5.9	2.3
06/03/1997	6.8	2.2
07/02/1997	6.1	2.2
10/08/1997	5.8	
01/11/1998		2.3
01/17/1998	6.0	
02/04/1998	5.9	
02/11/1998		2.3
03/03/1998	5.7	
03/11/1998		2.0
04/10/1998	6.2	2.2
05/05/1998	5.7	2.2
07/06/1998	6.8	2.0
12/09/1998	9.0	2.2
01/07/1999	8.3	2.6
02/04/1999	8.2	2.7
03/03/1999	6.9	2.2
05/05/1999	6.6	3.0
06/10/1999	6.4	1.8
07/07/1999	6.5	1.8
09/07/1999	8.6	1.8
11/02/1999	7.1	2.2
12/16/1999	6.2	2.1
01/11/2000	6.9	2.4
02/09/2000	7.1	2.5
03/07/2000	7.1	2.5
04/04/2000		2.3
04/11/2000	6.4	2.2
05/11/2000	6.5	2.3
06/06/2000	7.0	2.4
07/05/2000		2.5
07/06/2000	6.2	
08/02/2000	6.4	2.2
09/15/2000	6.6	2.1
10/05/2000	7.0	
10/23/2000	6.9	2.1

	Nitrate Level (ppm)	
Sample Date	Well 1	Well 2
11/16/2000	7.1	2.3
12/19/2000	8.0	2.4
01/09/2001	7.1	
01/13/2001		2.4
02/20/2001	6.9	2.4
03/01/2001	9.6	2.3
03/07/2001	10.0	
03/08/2001		2.4
04/13/2001	11.5	2.6
04/27/2001	7.3	2.4
05/12/2001	10.8	2.6
05/16/2001	8.6	2.3
06/23/2001	9.5	2.2
06/27/2001	8.0	2.2
07/11/2001	8.8	2.3
08/13/2001	10.0	1.6
08/23/2001	8.0	2.2
09/27/2001	9.4	1.8
10/29/2001	10.9	3.0
10/30/2001	8.8	2.2
11/16/2001	10.9	2.6
11/21/2001	10.1	1.8
12/13/2001	9.2	2.3
01/10/2002	9.9	2.1
02/27/2002	9.7	2.4
04/30/2002	9.5	2.4
05/15/2002	8.0	2.4
06/20/2002	10.4	2.2
07/18/2002	7.8	2.2
08/14/2002	4.1	2.2
08/21/2002	4.1	
09/12/2002	4.2	2.0
09/19/2002	10.0	1.4
09/25/2002	9.5	
10/24/2002	8.2	2.1
11/20/2002	3.9	2.2
12/18/2002	7.9	2.3

Summaries:	Well 1	Well 2
Maximum	11.5	3.0
Minimum	3.9	1.4
Average	7.6	2.3