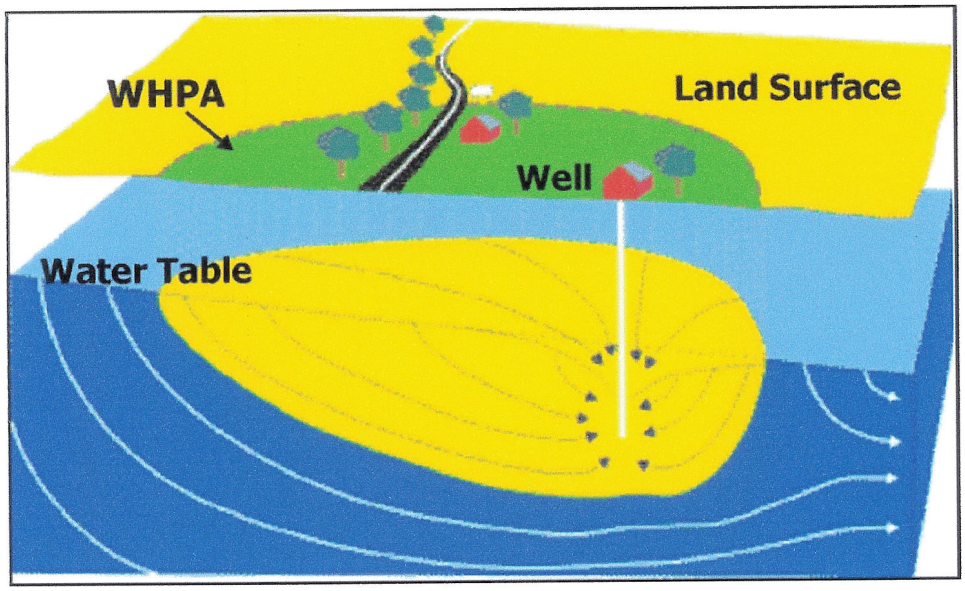
Source Water Assessment
for the Mill Bottom Water System
Frederick County, Maryland



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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 Mill Bottom 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 Mill Bottom'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 Mill Bottom water supply is susceptible to nitrate, some microbiological contaminants, and possibly radon. This water supply is not susceptible to other inorganic compounds, other radiological contaminants, volatile organic compounds, and synthetic organic compounds.

INTRODUCTION

The Water Supply Program has conducted a Source Water Assessment for the Mill Bottom water system in Frederick County. The Mill Bottom water system serves the Sam Hill Estates, Penn Shop Estates and Harvest Ridge subdivisions, which are located just south of interstate 70 near the Frederick/Montgomery county border. The water system serves a total population of 794 and has 294 service connections. 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 Mill Bottom system currently obtains it water supply from five wells. The wells are located adjacent to residential properties within the community (Fig. 1). A review of the well completion reports and sanitary surveys of Mill Bottom's water system indicates the wells were drilled after 1973 and should meet construction standards for grouting and casing. A summary of the well information is located in Table 1.

SOURCE ID	SOURCE NAME	PERMIT	TOTAL DEPTH	CASING DEPTH	YEAR DRILLED
01	WELL 1 LARSON LANE	FR-88-1435	95	52	1990
02	WELL 2 4029 LOMAR DRIVE	FR-88-1225	95	55	1990
03	WELL 3 4031 LOMAR DRIVE	FR-88-1050	100	42	1989
04	WELL 4	FR-88-1220	125	26	1990
05	WELL 5	FR-88-1211	100	56	1990

Table 1. Mill Bottom well information

The Mill Bottom water system has an appropriation permit to draw water from the Ijamsville formation for an average use of 155,000 gallons per day (gpd) and a maximum of 260,00 gpd in the month of maximum use. Based on the most recent pumpage reports, the average daily use was 73,697 gallons in 2000 and 64,660 gallons in 2001. The months of maximum use for the last two reported years were May 2000 and January 2001 with an average daily use of 159,905 and 85,651 gallons respectively. The reported use is considerably less than the total appropriated amount because all of the properties in the subdivisions have not been built out.

HYDROGEOLOGY

Mill Bottom 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 Marburg 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. Otton & Associates (1990) completed a fracture trace analysis in a well exploration project (Appendix A, Fig. 1). 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 (MDE, 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, Otton and Associates (1990) mapped fracture traces in and around the Mill Bottom property using aerial photography. The predominant fracture trace has a NNE-SSW trend and follows a small tributary through the property. Pump tests confirmed that the aquifer was anisotropic, and that wells located along the fracture trace interfered with each other but not with those off the fracture trace. Thus a hydraulic boundary was established on either side of the fracture trace and stream. 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 area needed to supply the average appropriated amount of 155,000 gpd using an estimated drought-year recharge of 400 gpd/acre is 388 acres. The delineated WHPA is 406 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 revealed no potential point source 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 residential land and and there are smaller areas of and forested and agricultural land.

Land Use Type	Total Acres	Percent of WHPA
Low-density Residential	314	77.3
Medium Density Residential	10	2.5
Open Urban Land	4	1.0
Pasture	19	4.6
Forest	59	14.6
Total	406	100

Table 2. Land Use Summary

Pasture land may be associated with nitrate loading of ground water due to production and disposal of animal waste. Residential areas without sewer service

may be a source of nitrate from septic systems. Additionally, residential areas may present a source nitrate and SOCs if fertilizers, pesticides, and herbicides are not used carefully in lawns and gardens.

The Maryland Office of Planning's 1996 digital sewer map of Frederick County shows that the majority of the WHPA is in an area of the county that is not planned for sewer service (Fig. 4). The remainder, approximately 140 acres, covers areas that are planned for sewer service in different time frames (Table 4).

Service Category	Total Acres	Percent of WHPA
3 Year Planned Service	104	25.7
4 to 6 Year Planned Service	17	4.1
7 to 20 Year Planned Service	12	3.0
Not Planned for Service	273	67.2
Total	406	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 Mill Bottom water system has one point of entry or plant, which has chlorination for disinfection, pH adjustment for corrosion control, ion exchange for nitrate removal, and fluoridation for health benefits.

A review of the monitoring data for Mill Bottom 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 is the only other contaminant present at a level of concern. The water quality sampling results are summarized in Table 4.

Inorganic Compounds (IOCs)

The data shows that nitrate levels were approaching the MCL of 10 ppm from the first samples collected in 1996 until May 1999 when an ion-exchange unit was installed to remove nitrate (Table 5). Since then, nitrate levels in treated water have fluctuated between 0.7 ppm and 6.9 ppm. Nitrate was detected above the SWAP threshold level of 5 parts per million (ppm) in 28 of 29 samples collected. Table 5 lists all available nitrate data for the system. No other inorganic compounds were detected above 50% of an 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. Only one Radon-222 result has been reported for Mill Bottom at 970 pCi/L, which is above the lower proposed MCL. No other radionuclides have been detected in the water supply.

Volatile Organic Compounds (VOCs)

A review of the data shows that VOCs have not been detected above 50% of an MCL. Disinfection byproducts grouped as trihalomethanes (THMs) and total xylenes are the only VOC's that have been detected, but at very low levels.

Synthetic Organic Compounds (SOCs)

No SOC's have been detected above 50% of an MCL. The SOC's that have been detected at low levels are Di(2-Ethylhexyl)Phthalate for which the highest level reported was 0.9 ppb and Dalapon at 0.093 ppb. The phthalate contaminant is commonly found in laboratory blank samples and the method for analyzing this contaminant was just starting to be used in 1995 and had many false positive results. Dalapon is a herbicide used to control grasses in a wide variety of crops and is also registered for use in a number of non-crop applications such as lawns, drainage ditches, along railroad tracks, and in industrial areas. The MCL for Dalapon is 200 ppb.

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 (GWUDI). This data showed that these wells are not under the direct influence of surface water. The raw water quality was very good with very low turbidity and was free of fecal coliform bacteria. Well 1 had total coliform bacteria at low levels in some samples.

Contaminant Group	No. of Samples Collected	No. of Samples above 50% of an MCL
Inorganic Compounds (except Nitrate)	3	0
Nitrate	32	29
Radiological Contaminants	7	1*
Volatile Organic Compounds	7	0
Synthetic Organic Compounds	3	0

Table 4. Summary of Water Quality Samples

*Proposed MCL for Radon of 300 pCi/L

SAMPLE DATE	RESULT (PPM)
01-Mar-96	8.1
14-May-96	7.3
19-Aug-96	8.2
04-Sep-96	8.4
05-Nov-96	8.4
29-Jan-97	8.5
19-May-97	9.2
04-Aug-97	9.2
06-Oct-97	9.3
12-Jan-98	9.3
13-Apr-98	9.1
06-Jul-98	9.3
06-Oct-98	8.6
03-Feb-99	8.9
11-May-99	4.6

SAMPLE DATE	RESULT (PPM)
19-Jul-99	6.0
26-Oct-99	5.5
26-Oct-99	5.5
26-Jan-00	5.7
05-Apr-00	5.7
05-Jul-00	5.8
03-Oct-00	5.4
07-Feb-01	5.5
18-Apr-01	6.9
15-Jul-01	6.8
18-Oct-01	6.3
31-Jan-02	5.6
10-Apr-02	6.8
03-Jul-02	6.0

Table 5. Nitrate Data from Mill Bottom water treatment plant

SUSCEPTIBILITY ANALYSIS

The wells serving the Mill Bottom 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 6 summarizes the susceptibility of Mill Bottom' 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 at or above 5 ppm in 97% of samples (Table 5). The MCL for nitrate is 10 ppm. Sources of nitrate can generally be traced back to land use. Fertilization of agricultural fields and residential lawns, and septic systems are all common sources of nitrate loading in ground water and are or were once present to some extent in the WHPA. Agricultural land in the WHPA has decreased in the last ten years as the residential subdivisions were built out. As less land is used for

agriculture, fertilizer use may decrease; however fertilizing lawns in new residential subdivisions has often caused an increase in nitrate in ground water. In addition, the residential areas within the WHPA with on-site septic systems are a source of nitrate to ground water.

Due to the levels of nitrate found, the vulnerability of the aquifer to land activity, and the presence of nitrate sources 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 the water supply above the lower 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 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.

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

Volatile Organic Compounds

The water supply is **not** susceptible to contamination by VOC's. No potential sources were identified within the WHPA, and VOC's have not been detected in significant levels.

Synthetic Organic Compounds

The water supply is **not** susceptible to synthetic organic compounds. SOCs have been detected in the water supply at low levels, but not above 50% of an MCL. A potential source of SOCs in the WHPA may be herbicide and pesticide use in agricultural areas, but based on water quality data these potential sources are not significantly impacting the water supply.

Microbiological Contaminants

Wells 2, 3, 4, and 5 did not have coliform bacteria in their raw water samples. Well 1 was free of fecal coliform bacteria, but did have some positive total coliform results in its raw water. The wells were determined not under direct influence of surface water and therefore, are **not** susceptible to microbiological contaminants that may be present in surface water such as *Giardia* and *Cryptosporidium*. Well 1 did have low levels of total coliform bacteria, which are ubiquitous in the environment, and *may* be

indicators of organisms with longer survival rates such as viruses. Without additional data however, it is not possible to determine whether or not this well is susceptible to viral contamination. Well 1 is susceptible to total coliform bacteria but not 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 [1]
Volatile Organic Compounds	NO	NO	NO	YES	NO
Synthetic Organic Compounds	YES	NO	NO	YES	NO
Microbiological Contaminants	YES	YES [2]	NO	YES	YES – Total Coliform Well 1 only [2]

Table 6. Susceptibility Analysis Summary.

[1] Lower proposed MCL for Radon

[2] There is no MCL for total 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 Mill Bottom 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.

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 Division or MDE.
- Conduct educational outreach to the residents in the WHPA on pollution prevention and potential contaminant sources. Important topics include: (a) appropriate use and application of fertilizers and pesticides in lawns and gardens and (b) chemical storage.
- 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.

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

- Mill Bottom's Contingency Plan was submitted 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.

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.

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Duigon, M.T., and J.R. Dine, 1987, Water Resources of Frederick County, Maryland, MGS Bulletin 33, 101 pp.

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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

Reinhardt, J. (1974), Geologic Map of the Frederick Valley, from Maryland Geological Survey Report of Investigations No. 23 (Plate 1).

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 FR1990G013
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 Damascus
USGS Topographic 7.5 Minute Quadrangles for Damascus
Maryland Office of Planning 2000 Frederick County Digital Land Use Map
Maryland Office of Planning 1996 Frederick County Digital Sewer Map

FIGURES

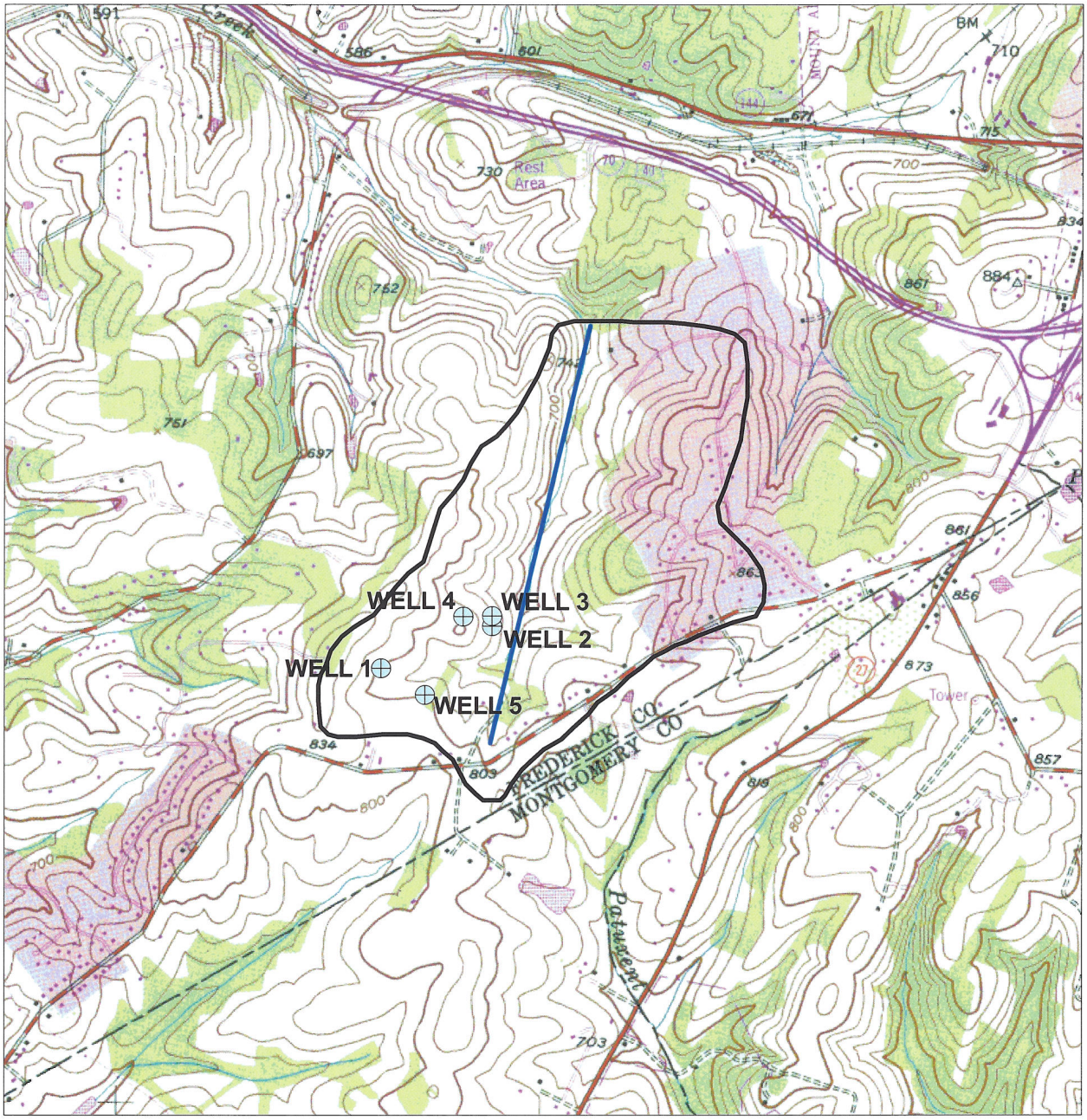


Figure 2. Mill Bottom Wellhead Protection Area (WHPA).

Legend

Wells

Fracture Trace

Wellhead Protection Area

N

1000 0 1000 2000 Feet

Base Map: USGS Topgraphic 7.5 Minute Quad for Damascus

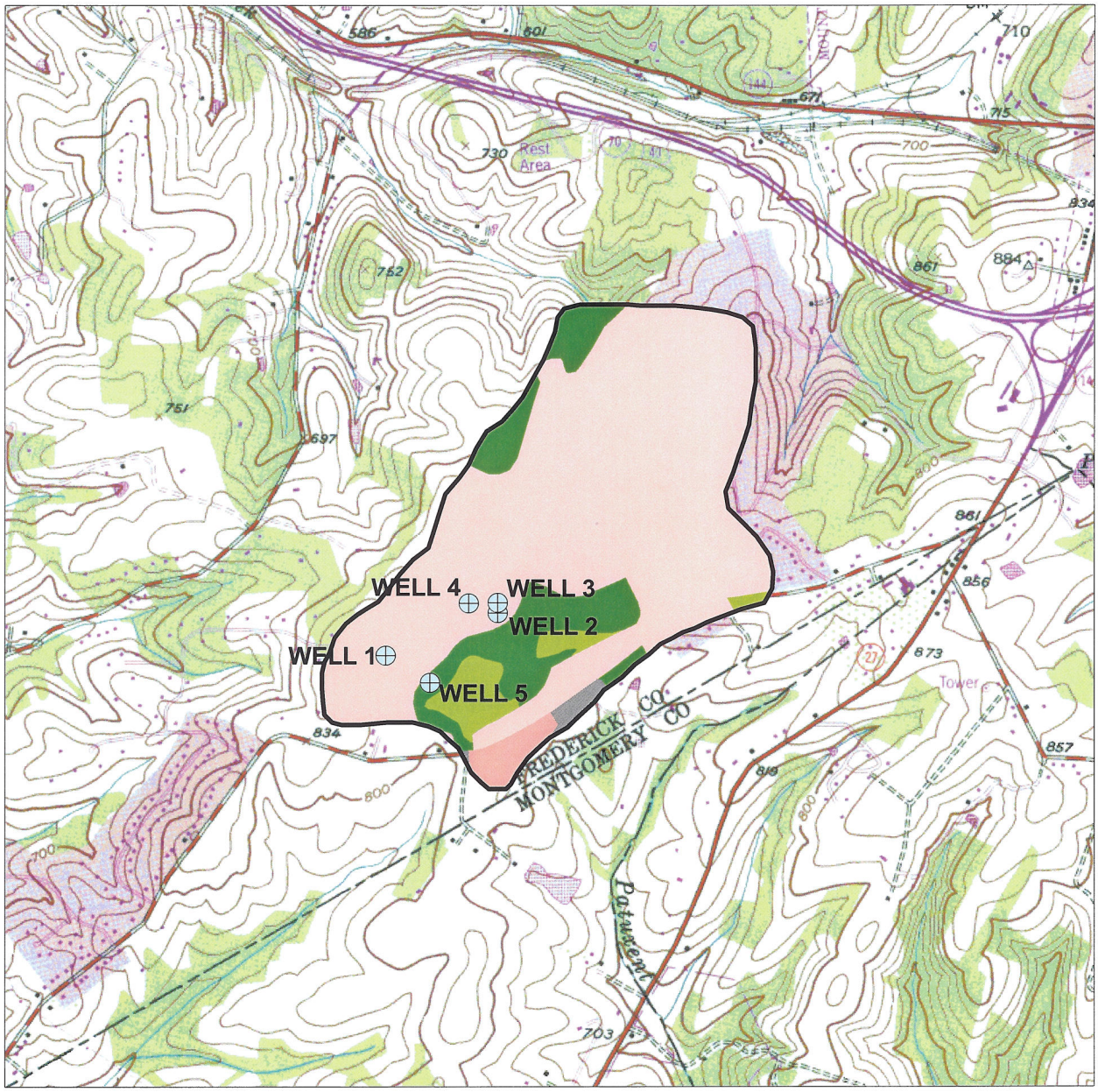


Figure 3. Land Use in the Mill Bottom WHPA.

Legend

Wells

WHPA

Frederick County 2000 Land Use

- Low Density Residential
- Medium Density Residential
- Open Urban Land
- Pasture
- Forest

N

1000 0 1000 2000 Feet

Base Map: USGS Topgraphic 7.5 Minute Quad for Damascus

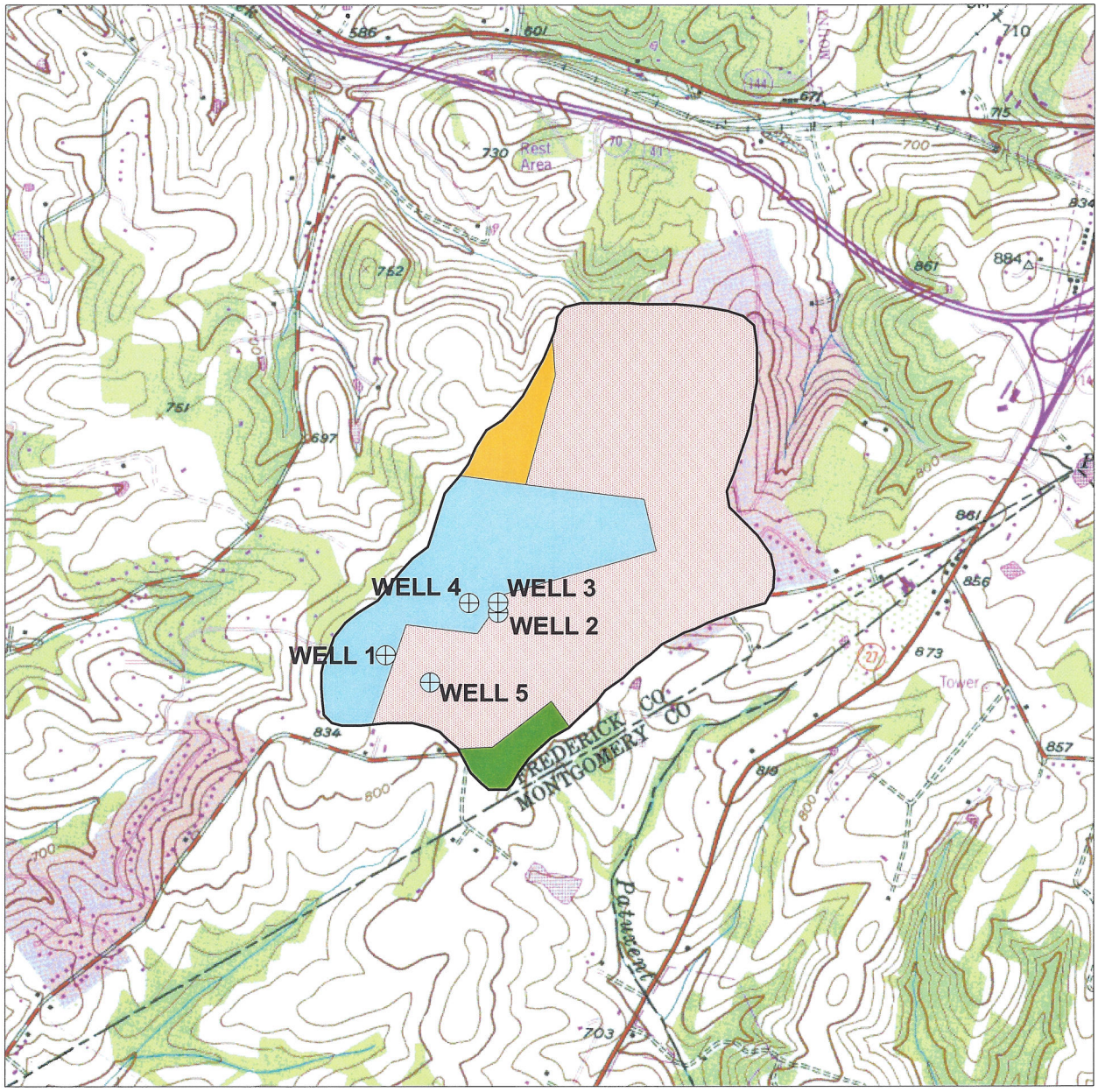
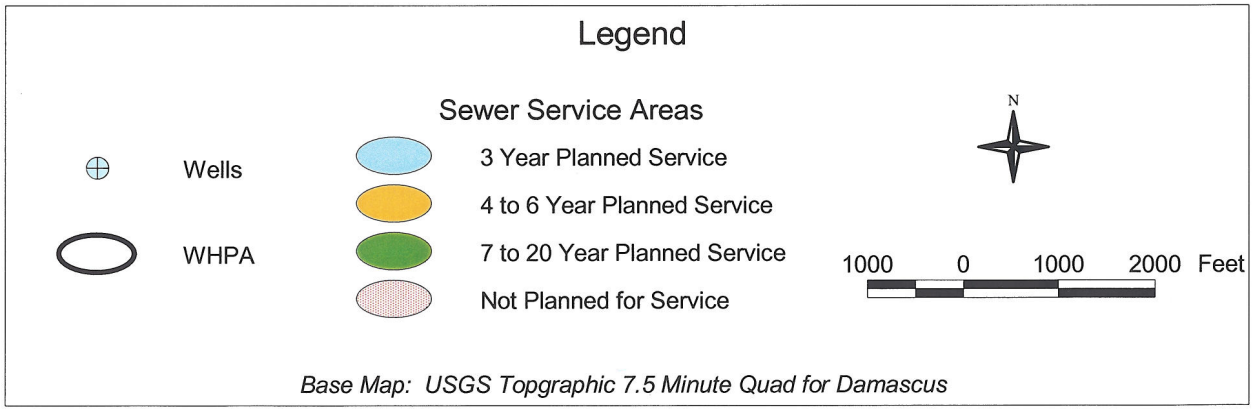


Figure 4. Sewer Service Areas in the Mill Bottom WHPA.



APPENDIX

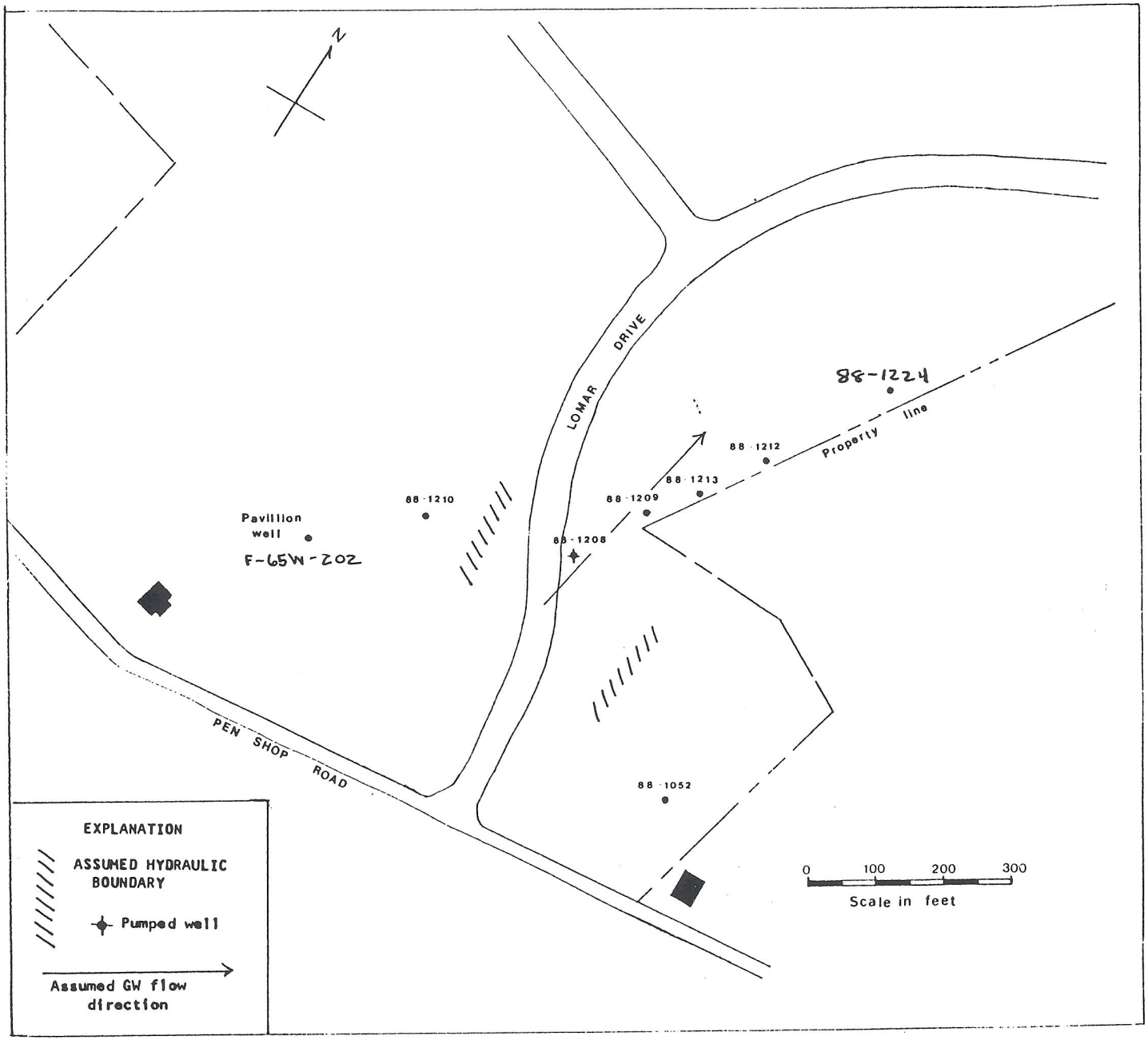


Figure 1. Map showing location of wells used in pump test of March 26-29, 1990, at Sam Hill Estates