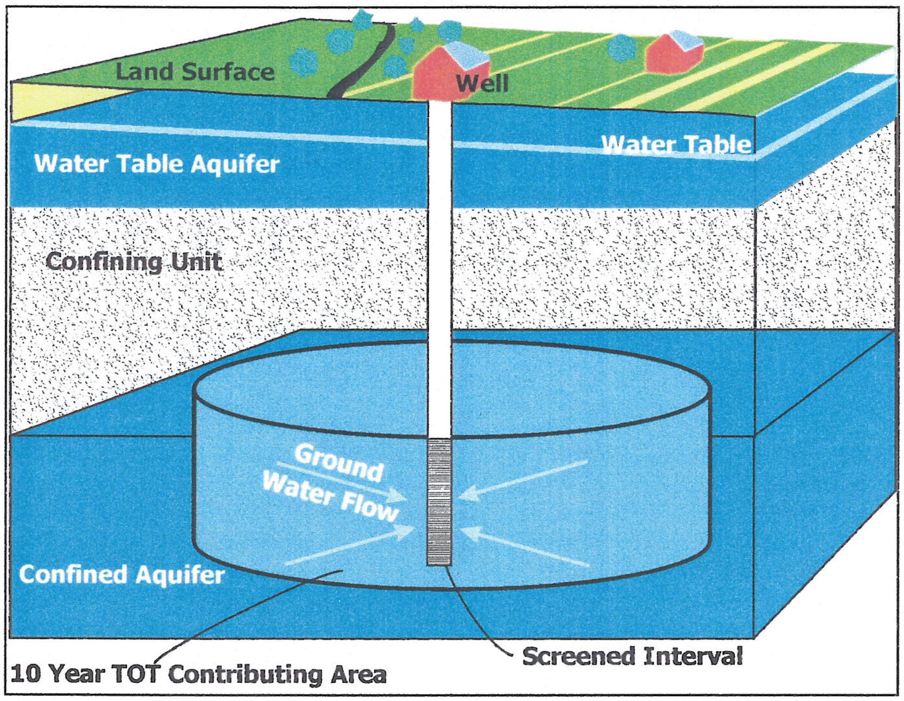
SOURCE WATER ASSESSMENT

FOR FORT GEORGE G. MEADE
ANNE ARUNDEL COUNTY, MD



Prepared By
Water Management Administration
Water Supply Program
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MDE

INTRODUCTION

The Maryland Department of the Environment (MDE) Water Supply Program (WSP) has conducted a source water assessment for Fort Meade' water supply system. This study has been completed as a supplement to the assessment that was performed by the U.S. Geological Survey in 1999. Fort Meade is located near Odenton in Anne Arundel County, Maryland. The system is owned and operated by U.S. Department of the Army and serves over 50,000 people.

HYDROGEOLOGY

Fort Meade is located in the Atlantic Coastal Plain Physiographic Province. This region is underlain by unconsolidated gravel, sand, silt and clay. The strata, such as those that are composed primarily of sand and gravel, yield substantial quantities of water to wells and are termed aquifers. Confining beds are usually composed primarily of silt and clay. In areas like the Atlantic Coastal Plain, where alternating layers of sand and clay occur, water becomes stored at great depths by over and underlying impermeable layers. The hydrostatic pressure of the water in these layers is greater than atmospheric pressure. In a well drilled to these layers the high hydrostatic pressure forces water in the well above the top of the sand layer. Such a well is known as an artesian well and the strata is known as a confined or an artesian aquifer. The clays that confine the aquifer also protect the aquifer from contamination from surface sources.

The wells at Fort Meade are completed in the Patuxent aquifer, the deepest of the confined aquifers in Anne Arundel County. The clay above is known as the Arundel Clay. It is a hard, dense clay later that is not capable of transmitting much water.

WELL INFORMATION

Well information was obtained from the Water Supply database, site visits, sanitary survey inspection reports and published reports. The six wells that are currently in use were all drilled between 1968 and 2003. Table 1 contains a summary of well construction data. There are also three unused wells in the Patapsco aquifer. Those wells are no longer used because of water quality problems in the Patapsco aquifer.

Table 1. Fort Meade Well Inventory

Owner's Number	Well Tag Number	Location	Total Depth	Casing Depth	Year Drilled	Status
1	AA680754	Mapes & O'Brien Roads	594'	490'	1968	in use
2	AA680667	Remount Road	604'	365'	1968	in use
3	AA813424	Range Road	672'	475'	1984	In use
4	AA813425	Range Road	692'	574'	1984	in use
5R	AA948678	Range Road	733'	601'	2003	In use
6	AA813423	Range Road	748	602	1984	In use

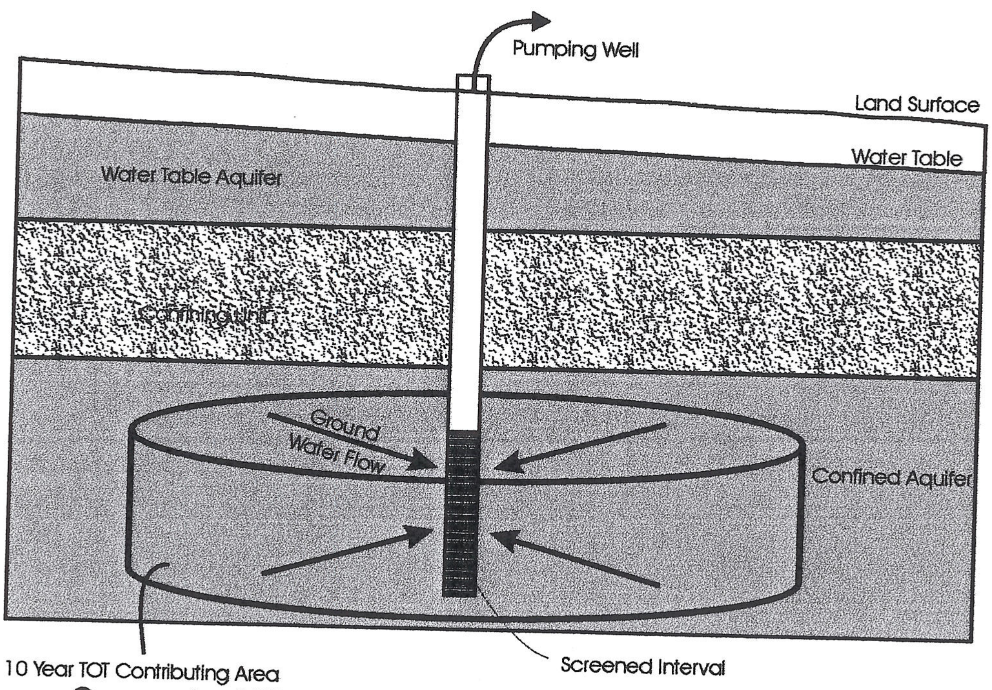
SOURCE WATER ASSESSMENT AREA DELINEATION

Source Water Assessment Areas (SWAA) were delineated for Fort Meade using the methodology described in Maryland's Source Water Assessment Plan (1999) for confined Coastal Plain aquifers. The method is often referred to as the Florida Method. The Florida Method is an analytical method devised to calculate the radius of a cylinder of aquifer material needed to store a volume of water pumped from a well over a specified period of time. The SWWA was calculated for each well using the following equation:

$$r = \sqrt{\frac{Qt}{\pi n H}}$$

where r = calculated fixed radius (ft)
Q = pumping rate of well (ft^3/yr)
n = aquifer porosity (dimensionless)
H = length of well screen (ft)
t = time of travel (yr.)

The area is a radial zone of transport in the aquifer. A ten-year time of travel is used and pumping rate and screened intervals are taken into account.



Conceptual illustration of a zone of transport for a confined aquifer

Fort Meade has a water appropriation and use permit which allows an average annual withdrawal of 2,000,000 gpd. Bi-annual water use reports that have been submitted to MDE indicate that during 2003 and 2004, they used an annual average of about 2,400,000 gpd. The wells are pumped equally so the pumping rate (Q) used for each well is based on the percentage of total actual use that the well supplies.

A conservative estimate of aquifer porosity (n) of 25% was found in published reports. The length of the screen (H) was obtained from well completion reports. Using these parameters, the radius for the source water assessment area delineation in Table 2 was calculated using the equation above. The circles are combined to form the larger Source Water Assessment Area shown in Figure 2. The circle represents the subsurface aquifer zone of transport illustrated above.

Table 2. Parameters Used for Source Water Assessment Area Delineations

Well Number	Q (ft^3/day)	N	H (in feet)	T (years)	r (feet)	acreage
1	14,407,902	0.25	104	10	1,328	127
2	20,518,075	0.25	239	10	1045	79
3	20,518,075	0.25	197	10	1152	95
4	20,518,075	0.25	118	10	1488	160
5	20,518,075	0.25	113	10	1520	166
6	20,518,075	0.25	146	10	1338	129

POTENTIAL SOURCES OF CONTAMINATION

In confined aquifers, surface sources of contamination are generally not a threat unless there is a direct pathway into the deeper aquifer. Common sources are abandoned wells, wells with damaged casings or un-grouted or improperly grouted wells. Wells that are not maintained may eventually corrode and provide a pathway for surface contaminant to enter the deeper aquifer. Through these pathways, potential sources of contamination identified at land surface have potential to impact the deeper aquifers. Table 3 lists the sites that were identified on the land surface above the zones of transport. Figure 2 shows the location of the wells and the surface contamination sites that are listed in Table 3.

The August 2004 inspection report, cracks and small openings in the well house/water treatment plant floors were noted at most of the wells. If a chemical spill were to occur at one of the plants, the associated well could be vulnerable to that chemical. A letter from the Department of Public Works in February 2005, indicated that the holes have been properly sealed. Site inspection in February, 2005 confirmed that the work was done.

Table 3. Ground Water Contamination Sites In The Patapsco Aquifer

	Ground Water Contamination Site	Address	Type Of Site	Contaminants of Concern	Aquifer(s) Affected
1	Fort Meade Landfill	Annapolis Road	landfill	VOC's, metals	Patapsco
2	Amtrack Maintenance Yard			SOC's, VOC's	Patapsco
3	National Semiconductor Plant	Samford Road	CHS	VOCs, metals	Patapsco
4	Fort Meade Fabricare Facility	Rock Avenue	CHS	VOC's	Patapsco
5	Bills Cleaners	Annapolis Road	CHS	VOCs	Patapsco
6	Handex of Maryland	Morgan Road	CHS	VOCs	Patapsco
7	Firestone Tires	Berger Road	CHS	VOCs	Patapsco
8	C & P Telephone	Annapolis Road	CHS	VOCs	Patapsco
9	Odenton Mobile	Annapolis Road	CHS	VOCs	Patapsco
10	Western Division Roads Facility	Duckins Street	UST	VOCs	Patapsco
11	Midway Water Co.	Midway Road	UST	heating oil	Patapsco
12	Fort Meade	Golf Course	IRR	microbiological contaminants	Patapsco

CHS = Controlled Hazardous Substance
UST = Underground Storage Tank
IRR= Irrigation With Treated Waste Water

There are several monitoring wells in the overlying Upper and Lower Patapsco aquifers. Some of these wells have shown contamination by volatile organic compounds above drinking water standards. Carbon tetrachloride, perchloroethylene and benzene were all above maximum contaminant levels in some wells. Contamination of atrazine was also found in domestic wells down gradient of the Amtrack RailroadYard. Significant quantities of atrazine were stored at the yard.

WATER QUALITY DATA

Water quality data stored in the Water Supply Program's database and system files was reviewed for Safe Drinking Water Act 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 at or greater than the 50% of its MCL for at least 10% of the samples, this assessment will describe the possible sources of the contaminant and if possible, locate the specific sources that are responsible for the elevated contaminant level. All data reported is from the finished or treated water unless otherwise noted. Major water treatment processes include chlorination, sedimentation, lime addition, filtration, fluoridation, corrosive control and disinfection.

Fort Meade was formerly supplied by both wells and a surface water intake on the Little Patuxent River. The system has not withdrawn water from the river since mid-2002 because of a build up of sediment near the intake structure. A review of available water quality from 1989 to present indicates a marked decrease in detects since the system has been using only ground water.

Inorganic Compounds (IOC's)

Only one IOC above the 50% MCL has been detected. In 1995, arsenic was detected at 0.006 ppm. This may be an anomalous sample because there have been no detects in the 13 subsequent samples. Flouride detects are attributed to injection during the water treatment process. Nitrates detects have ranged from 0.02 to 1.8 ppm. Detections of nitrates correspond to when the system used surface water. All other IOC detects are attributed to leaching from aquifer materials.

Volatile Organic Compounds (VOC's)

Chloroform, bromodichloromethane, dibromochloromethane, and bromoform have been detected in water samples since 1996. These compounds are trihalomethanes (THMS). THMS are disinfection by-products, which result from the reaction between chlorine and organic material present in the raw water. In September 1998, June 2000, and May 2002, total trihalomethanes exceeded 40 ppb. For regulated systems, the current MCL for TTHM's is 80 ppb. Fort Meade stopped using surface water during the summer of 2002. All water samples since that time have indicated much lower levels of trihalomethanes.

Synthetic Organic Compounds (SOC's)

Atrazine, dalapon, Dicamba, 2,4-D, alachlor(lasso), benzopyrene and di(2-ethylhexyl)phthalate have been detected in water samples at Fort Meade. Atrazine, dicamba, dalapon, and alachlor(lasso) are herbicides found in surface water runoff and have not been detected since Fort Meade discontinued use of the surface water intake. Di(2-ethylhexyl)phthalate, a plasticizer, has been detected several times, but has only exceeded half of the current MCL of 6 ppb in 1998. Di(zethyhexyl)phthalate was also detected in laboratory blank samples analyzed concurrently. The results of di(zethylhexyl) phthalate analysis are therefore not believed to reflect the actual water quality in the water system.

Radionuclides

Radionuclides have been measured three times since 1995. Gross Alpha, Gross Beta and Combined Raduim 226 and 228 have been detected but not at or above 50% MCL. Their presence is attributed to leaching of naturally occurring materials in the surrounding geologic formation.

Microbiological Contaminants

Routine bacteriological monitoring is conducted in the finished water for each community water system on a monthly basis and measures total coliform bacteria. Since Fort Meade's water supply uses disinfection as part of its treatment process, the finished water data does not give much indication of the quality of raw water directly from the wells. Total coliform bacteria are not pathogenic, but are used as an indicator organism for other disease-causing microorganisms. A major breach of the system such as due to flooding a well, ruptured water line or back siphonage of contaminated water could cause a positive total coliform result in the distribution system, and would require follow-up total and fecal coliform analysis. Since 1998, Fort Meade has conducted routine bacteriological sampling 99 times and there have been 10 occasions where samples tested positive for coliform as indicated in Table 4. In none of these occurrences were the positives attributed to the wells.

SAMPLE DATE	ROUTINE SAMPLES TAKEN	TOTAL COLIFORM POSITIVE SAMPLES	FECAL POSITIVE SAMPLE RESULTS
1-May-98	60	1	0
1-Jun-98	76	1	0
1-Aug-98	60	1	0
1-Sep-98	61	1	0
1-Jan-99	60	1	0
1-Feb-99	64	1	0
1-Mar-99	60	3	0
1-Dec-00	65	2	0
1-Jun-04	60	3	0
1-Jan-05	60	1	0

Table 4. Routine Bacteriological Samples from Distribution Since 1997

SUSCEPTIBILITY ANALYSIS

The wells serving Fort Meade withdraw water from a confined aquifer. Confined aquifers are naturally well protected from surface contamination because the confining layers provide a barrier to water movement between the surface and the deeper aquifer. A properly constructed well has a casing that extends from land surface, through the confining layers to the aquifer in use. Sufficient grouting around the well further protects the aquifer from surface contamination. Wells that are not in use or not properly maintained may eventually corrode and create a pathway for contaminants to migrate from the surface to the confined aquifers below. Only direct injection into the aquifer from point sources within the SWWA (like underground injection wells or improperly abandoned wells) could cause a potential contamination threat to the supply.

The information that was used to conduct the susceptibility analysis is as follows: (1) available water quality data (2) presence of potential contaminant sources in the WHPA (3) aquifer characteristics (4) well integrity and (5) the likelihood of change to natural conditions. The susceptibility of Fort Meade's water supply to the various contaminant groups is shown in Table 4 at the end of this section.

Inorganic Compounds (IOC's)

No IOCs above 50% of the MCL have been detected in Fort Meade's water supply since use of the surface water intake has been discontinued. Due to the naturally protected characteristics of the confined aquifers and the water quality data, Fort Meade's water supply **is not** susceptible to inorganic compounds.

Volatile Organic Compounds (VOC's)

No VOCs above 50% of the MCL have been detected in Fort Meade's water supply since mid-2002 when use of the surface water intake was discontinued. Due to the naturally protected characteristics of the confined aquifers, the water quality data, and the lack of potential sources of contamination in the aquifers, Fort Meade's water supply **is not** susceptible to volatile organic compounds.

Synthetic Organic Compounds (SOC's)

No SOCs above 50% of the MCL were detected in Fort Meade's water supply since mid-2002 when the use of the surface intake ceased. Due to the naturally protected characteristics of the confined aquifers, the water quality data, and the lack of potential sources of contamination, Fort Meade's water supply **is not** susceptible to synthetic organic compounds.

Radionuclides

The source of radionuclides in ground water can be traced back to the natural occurrence of uranium and thorium in rocks. Radionuclides that were detected in Fort Meade's samples are due to radioactive decay of uranium and thorium bearing minerals in the sediment that makes up the aquifer material so Fort Meade's water supply **is not** considered susceptible to radionuclides.

Microbiological Contaminants

Raw water monitoring for microbiological contaminants is not required of water systems in confined aquifers because they are considered naturally protected from sources of pathogens at the land surface. Therefore, Fort Meade's water supply **is not** susceptible to microbiological contaminants.

Table 4. Susceptibility Chart for Fort Meade's Water Supply

CONTAMINANT TYPE	Are Contaminant Sources present in the SWAA*?	Are Contaminants detected in WQ samples at 50% of the MCL	Is Well Integrity a Factor?	Is the Aquifer* Vulnerable?	Is the System Susceptible to the Contaminant
Inorganic Compounds	YES*	NO	NO	NO	NO
Volatile Organic Compounds	YES*	NO	NO	NO	NO
Synthetic Organic Compounds	YES*	NO	NO	NO	NO
Radionuclides	NO	NO	NO	NO	NO
Microbiological Contaminants	YES	NO	NO	NO	NO

* These Sources have been shown to affect the overlying Patapsco aquifers, but not the deeper Patuxent aquifer

MANAGEMENT OF THE WELLHEAD PROTECTION AREA

The information contained in this report, provides an overview of the risk of contamination to Fort Meade's ground water supply. Specific management recommendations for consideration are listed below:

Public Awareness and Outreach

The Consumer Confidence Report should report should list that this report is available to the general public through their county library, or by contacting the operator or MDE.

Monitoring

Continue to monitor for all required Safe Drinking Water Act contaminants. Annual raw water bacteriological testing is a good check on well integrity.

Contaminant Source Inventory Updates

Conduct a survey of the WHPA and inventory any potential sources of contamination, including unused wells that may not have been included in this report. Keep records of new development within the WHPA and new potential sources of contamination that may be associated with the new use.

Well Inspection/Maintenance

Work with the County Health Department to ensure that there are no unused wells within the WHPA. An improperly abandoned well can be a potential source of contamination to the aquifer. All unused wells must be abandoned and seal as per State well construction regulations.

Water operation personnel should have a program for periodic inspections and maintenance of the supply wells and backup wells to ensure their integrity and protect the aquifer from contamination.

Changes in Use

The system is required to notify the MDE Water Supply Program if new wells are to be added or increase in water usage is proposed. An increase in use or the addition of new wells may require revisions to the WHPA.

Ground Water Remediation

It is Important that Fort Meade's water supply be protected from contamination in the overlying Patapsco aquifer. The investigation and remedial action decisions should address the risks to the Patuxent aquifer.

New Wells

New wells for non-potable use should be prohibited from being constructed In the Patuxent aquifer. All new wells for potable uses in the Patuxent aquifer should be grouted to the top of the well screen.

REFERENCES

Maryland Department of the Environment, 2002, Comprehensive Performance Evaluation of the Fort George G. Meade Water Treatment Plant Anne Arundel County, Maryland, 26p.

Otton, E.G. and R.J. Mandle, 1984, Hydrogeology of the UpperChesapeake Bay Area, Maryland, With Emphasis on Aquifer in the Potomac Group, Maryland Geological Survey R.I.39, 62 p.

United States Environmental Protection Agency, Office of Ground-Water Protection, 1987, Guidelines for Delineation of Wellhead Protection Areas.

United States Geological Survey, 1999, A User's Guide for Source-Water Assessment and Protection at U.S. Army Installations, Pary 3 – Case Study: Source-Water Assessment for Ft. George G. Meade, Maryland, 26p.

SOURCES OF DATA

Water Appropriation and Use Permit Number AA1969G021
Public Water Supply Inspection Reports
Monthly Operating Reports
Monitoring Reports
MDE Water Supply Program Oracle Database
MDE Waste Management Sites Database

FIGURES

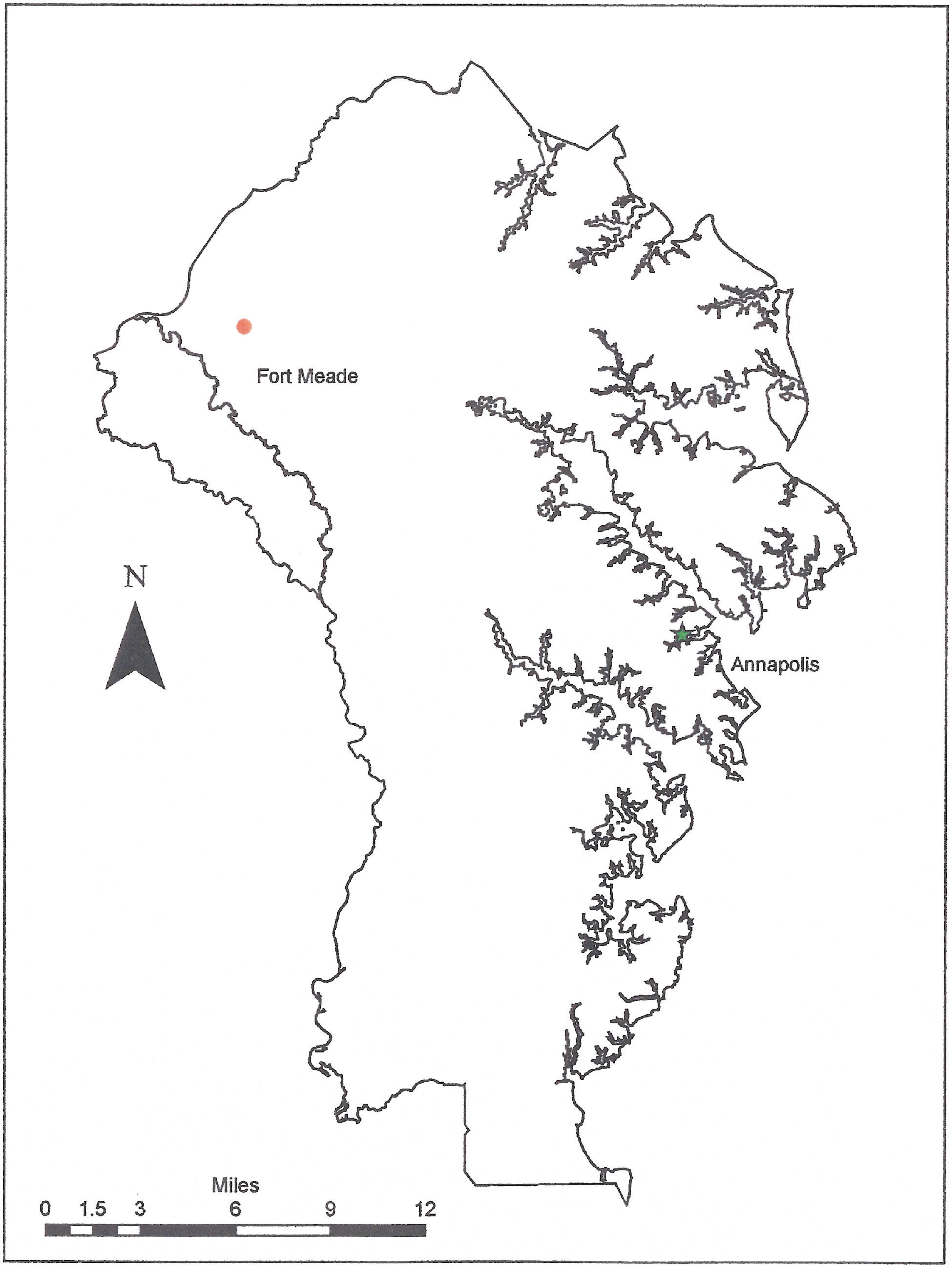


Figure 1. Location Map

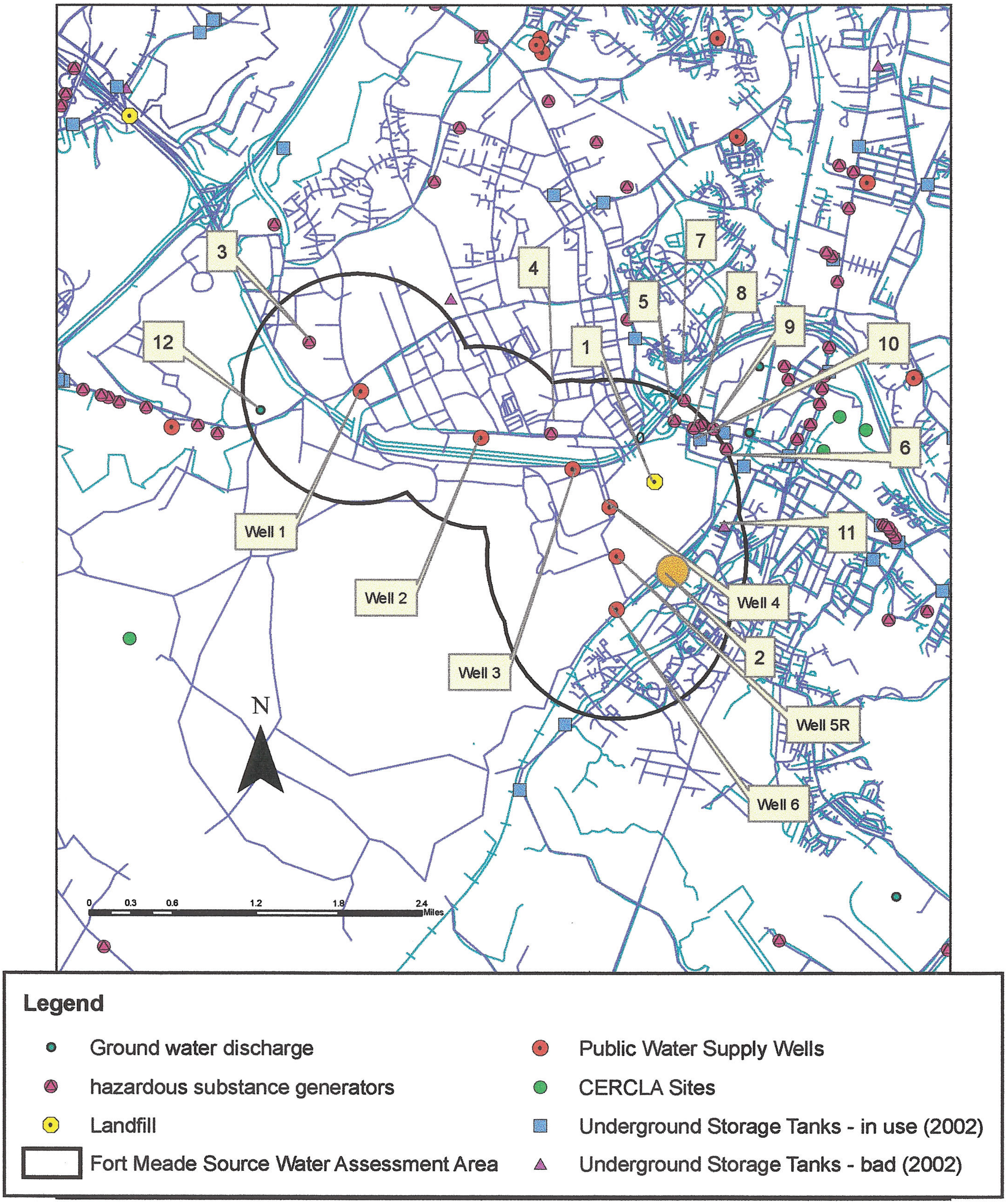


Figure 2. Fort Meade Source Water Assessment Area