SOURCE WATER ASSESSMENT

FOR THE CITY OF BOWIE

PRINCE GEORGES COUNTY, MD

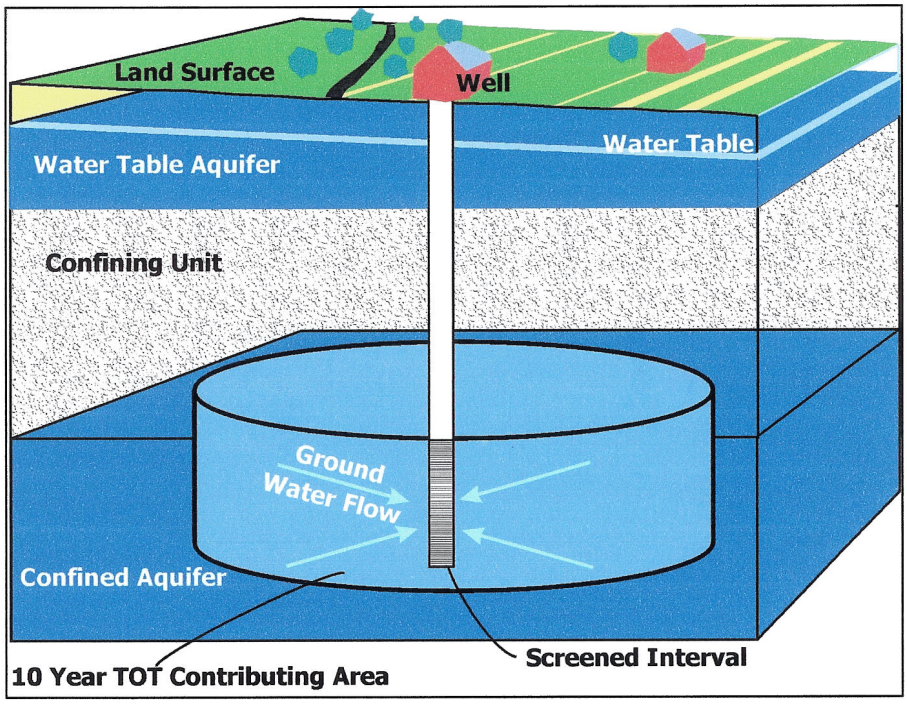

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TABLE OF CONTENTS

SUMMARY

The Maryland Department of the Environment's (MDE) Water Supply Program has conducted a Source Water Assessment for the City of Bowie. The major components of this report as described in Maryland's Source Water Assessment Plan (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 management of the assessment area conclude this report.

The sources of the Bowie's water supply are three Coastal Plan confined aquifers- the Magothy, Patapsco and Patuxent. Six wells are currently being used to pump the water out of these aquifers. The source water assessment area was delineated by the Water Supply Program using methods approved by the U. S. EPA.

Potential sources of contamination within the assessment area were identified based on MDE site visits, a review of MDE's databases. Well information and water quality data were also reviewed. A map showing the source water assessment areas and potential contaminant sources is enclosed.

The susceptibility analysis for Bowie's water supply is based on a review of the water quality data, potential sources of contamination, aquifer characteristics, and well integrity. It was determined that Bowie's water supply is not susceptible contaminants originating at the land surface due to the protected nature of confined aquifers. The water supply is susceptible to naturally occurring iron in the aquifers. The system has installed treatment to remove iron from the raw water.

INTRODUCTION

The Maryland Department of the Environment's (MDE) Water Supply Program has conducted a Source Water Assessment for the City of Bowie. The City of Bowie is located approximately 15 miles northeast of Washington, D.C in Prince Georges County. The City owns and operates its water supply system that serves a population of 24,475. Currently, the water is being pumped from six wells (Nos. 1 – 6) and treated at a plant located at Bradford Lane. In 1992, the City of Bowie was awarded a Wellhead Protection Demonstration grant by the U.S. Environmental Agency (EPA), through which the City funded a Wellhead Protection Program study conducted by Horsley & Witten, Inc. The Horsley & Witten (1993) report was a major source of information for this assessment.

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. A review of the well data and sanitary surveys of the system indicates that four of the wells (Nos. 1, 2, 3 and 5) were drilled prior to 1973, when the State's well construction regulations went into effect, and may not meet current construction standards. Well Nos. 4R and 6 should meet construction standards for grouting and casing. Table 1 contains a summary of the well construction data. The database indicates that the City also has two wells for monitoring and two unused wells.

SOURCE ID	SOURCE NAME	PERMIT NO	TOTAL DEPTH (ft)	CASING DEPTH (ft)	YEAR DRILLED	AQUIFER NAME
01	Bowie 1(A) Brierdale	PG034997	192	110	1959	MAGOTHY FM
02	Bowie 2 (B) Brierdale	PG034998	700	457	1959	PATAPSCO FM
03	Bowie 3 (D) Spangler Ln	PG043623	733	503	1961	PATAPSCO FM
04	Bowie 4R Plant	PG880226	1158	1143	1989	PATUXENT FM
05	Bowie 5 (F)	PG650085	980	905	1965	PATUXENT FM
06	Bowie 6	PG811879	715	425	1988	PATAPSCO FM

Table 1. City of Bowie Well Information.

HYDROGEOLOGY

Three Coastal Plain aquifers are used by the City of Bowie - the Magothy, Patapsco and Patuxent Formations. As can be seen from table 1, one well obtains water from the Magothy, three wells obtain water from the Patapsco and two wells from the Patuxent Formations. The Patapso and Patuxent lie below the Magothy, with the Patuxent found directly above the crystalline bedrock which forms the base of the Coastal Plain aquifer system. These two formations are both part of the Potomac group and are

separated by a thick clay layer mapped as the Arundel Clay. A clay layer also separates the Magothy and Patapsco Formations.

In the Bowie area the Magothy, Patapsco and Patuxent aquifers are confined since they have overlying layers of clay and their outcrop areas are 1.5 miles (north and west of Well 1 A), 7.5 miles and 20 miles west of the City, respectively. The City may consider conducting further analysis or studies to confirm the confined nature of the Magothy aquifer. Ground water flow rates (in feet per day) were estimated for each aquifer for the wellhead protection study in 1993, and were as follows: Magothy: 0.61; Patapsco: 0.12; and Patuxent: 0.18. In the study, the age of the water was estimated by analyzing samples from each aquifer for tritium. The Magothy aquifer sample contained only trace concentrations of tritium suggestion a combination of older water mixing with newer water containing higher tritium concentrations. The samples from the Patapso and Patuxent aquifers contain no tritium suggesting much older water. Based on the ground water flow rates, it takes approximately 900 years for the recharge water to flow to the Bowie wells in the Patapsco aquifer and approximately 1,600 years in the Patuxent aquifer.

SOURCE WATER ASSESSMENT AREA DELINEATION

Source Water Assessment Areas (SWAAs) were delineated for the Bowie wells using the methodology described in Maryland's Source Water Assessment Plan (1999) for confined aquifers in the Coastal Plain, often referred to as the "Florida Method". The area is a radial zone of transport within the aquifer and is based on a 10 year time of travel (TOT), pumping rate and the screened interval(s) of the well or wells included in the SWAA, and the porosity of the aquifer (see illustration below for conceptual model). The Florida Method is a modification of Darcy's Law for radial flow to a well and the SWAA's were calculated using the following volumetric equation:

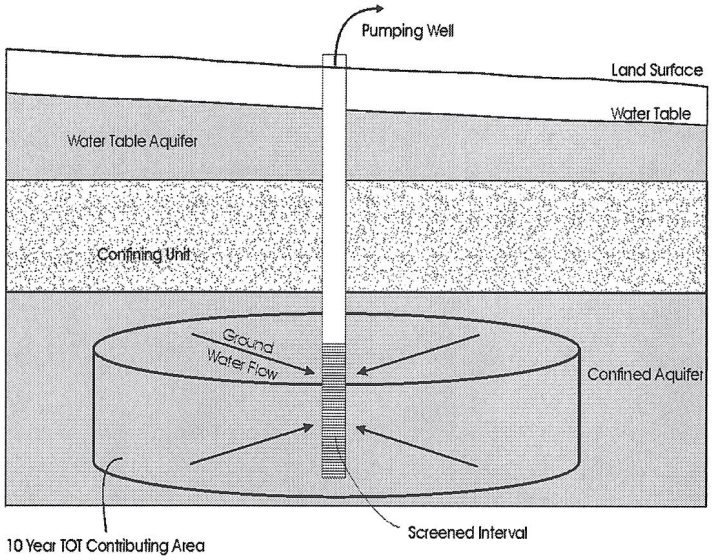
$$r = \sqrt{\frac{Qt}{\pi n H}}$$

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.)

Bowie has three water appropriation permits, one for each aquifer. Table 2 provides the values used and the calculated radius for each well. The pumping rate (Q) used is the permitted daily average for the particular aquifer that the well is screened in. The total appropriated amount was used for each of the Patapsco and Patuxent aquifer wells, since most of the time the wells are rotated and pumped alternately.

A conservative estimate of porosity (n) of 25% was used for each of the aquifers based on published reports. The lengths of the well screen (H) were obtained form well

completion reports. In the instance that there were multiple screens, the sum of the individual screen lengths was used. Using these parameters the radius was calculated with the above equation for the SWAA delineation (Table 2). However for well 4R the screen length for well 5 of 75 feet was used rather than the very limited 10 feet screen length. The full saturated thickness of the aquifer in 87 feet. The circles for wells in the same aquifer were merged to form one larger SWAA. This resulted in one SWAA for each of the aquifers as shown in Figure 1. The circles represent the aquifer zone of transport in the subsurface as illustrated below.



Conceptual illustration of a zone of transport for a confined aquifer

Well Name	Well pumpage (Q) in gpd	Well pumpage (Q) in ft3/yr	Screened interval in feet	Aquifer	Calculated radius for SWAA in feet	Acreage of WHPA	Comments on SWAA
BOWIE 1 (A) BRIERDALE	200000	9758054	82	MAGOTHY FM	1300	111	
BOWIE 2 (B) BRIERDALE	1500000	73185403	75	PATAPSCO FM	3600	1624	Wells 2, 3 and 6 circles merged
BOWIE 3 (D) SPANGLER LN	1500000	73185403	96	PATAPSCO FM	3200		
BOWIE 6	1500000	73185403	85	PATAPSCO FM	3400		
BOWIE 4R PLANT	1300000	63427349	75	PATUXENT FMN	3300	1324	Wells 4R and 5 circles merged
BOWIE 5 (F)	1300000	63427349	75	PATUXENT FM	3300		

Table 2. Parameters used for the Source Water Assessment Area delineations

POTENTIAL SOURCES OF CONTAMINATION

In confined aquifer settings, sources of contamination at the land surface are generally not a threat unless there is a pathway for direct injection into the deeper aquifer such as unused wells or along well casing that are not intact or have no grout seal. Wells that are not being maintained will eventually corrode and provide a pathway for contaminants present in the shallow aquifers at higher-pressure heads to migrate to the deeper aquifers.

Potential sources of contamination are classified as either point of non-point sources. Examples of point sources of contamination are leaking underground storage tanks, landfills, ground water discharge permits, large scale feeding operations and Superfund sites. These sites are generally associated with commercial or industrial facilities that use chemical substances that may, if inappropriately handled, contaminate ground water via discrete point location. Non-point sources of contamination are associated with certain types of land use practices such as the use of pesticides, application of fertilizers or animal wastes, or septic systems that may lead to ground water contamination over a larger area. All potential sources of contamination are identified at the land surface and therefore have the potential to impact the shallow water table aquifer. Therefore as long as there is no potential for direct injection into the deeper confined aquifers, Bowie's water supply should be well protected from ground water contamination. As indicated in the 1993 wellhead protection study for Bowie, the recharge area for the Magothy aquifer is within a fifty-year time of travel zone. The identification of potential sources of contamination in this area is beyond the scope of the State's source water assessment procedures. The reader is referred to the 1993 wellhead protection study for more information

Potential contaminant sources are identified if they fall within the SWAA for awareness and to ensure that the deep aquifers do not become affected by unused wells or poorly constructed wells in the water supply aquifers. Table 3 lists the facilities identified from MDE databases, as potential sources of contamination and their locations are shown in figure 1. Underground Storage Tanks (UST) sites are facilities that store petroleum or heating oil on site in underground tanks registered with the MDE Waste Management Administration. Controlled Hazardous Substance Generators (CHS) are facilities that may use or store any hazardous substance on site. The contaminants associated with the types of facilities are based on generalized categories and often the potential contaminant depends on the specific chemicals and processed being used at the individual facility. . The potential contaminants are not limited to those listed in table 4. Potential contaminants are grouped as Volatile Organic Compounds (VOC), Synthetic Organic Compounds (SOC) and Heavy Metals (HM).

ID	Type	Site Name	Address	Potential Contaminant	Status
1	UST	Bowie High School	15200 Annapolis Rd	VOC	1 tank, 1 removed
2	UST	Bowie Fire Dept. Co. #29	15454 Annapolis Rd	VOC	2 tanks, 2 removed
3	CHS	Diplomat Cleaners	15642 Annapolis Rd	VOC	
4	UST/CHS	Belair Amoco	15700 Annapolis Rd	VOC	3 tanks, 6 removed
5	UST/CHS	Exxon # 25765	15711 Annapolis Rd	VOC	5 tanks removed
6	CHS	Hilltop Cleaners	6822 Racetrack Rd	VOC	
7	UST	Nevey Shalom Synagogue	12215 Torah Ln	VOC	1 tank
8	UST/CHS	Mobil Oil S/S 2634999	3233 Stonybrook Dr	VOC	6 tanks, 4 removed
9	CHS	Merchant's Tire & Auto	3298 Superior Ln	VOC	
10	CHS	Morning Sun Cleaners	3296 Superior Ln	VOC	
11	CHS	Bowie Internal Medicine	3231 Superior Ln	VOC	
12	UST	Wastewater Pump Stat #4	12626 Brunswick Ln	VOC	1 tank
13	UST	Wastewater Pump Stat # 2	2200 Belair Rd	VOC	1 tank
14	UST	Bowie City Hall	2614 Kenhill Dr	VOC	1 tank

Table 3. Potential Contaminant Point Sources within the Bowie SWAA (see figure 1 for locations).

WATER QUALITY DATA

Water Quality data was reviewed from the Water Supply Program's database and system files 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 50% of a MCL, this assessment will describe the sources of such a contaminant and, if possible, locate the specific sources which are the cause of the elevated contaminant level. All data reported is from the finished (treated) water unless otherwise noted. The treatment currently used at Bowie is gaseous chlorination for disinfection, aeration, flocculation, sedimentation and filtration for iron removal, pH adjustment for corrosion control and addition of fluoride.

A review of the monitoring data since 1993 for Bowie's water supply indicates that it meets the current drinking water standards. The water quality sampling results are summarized in Table 3.

IOCs		SOCs		VOCs		Radionuclides	
No. of Samples Collected	No. of samples > 50% MCL	No. of Samples Collected	No. of samples > 50% MCL	No. of Samples Collected	No. of samples > 50% MCL	No. of Samples Collected	No. of samples > 50% MCL
15	0	5	1*	11	0	4	0

Table 4. Summary of Water Quality Samples for Bowie's Water Supply

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Inorganic Compounds (IOCs)

No IOCs above 50% of the MCL have been detected in Bowie's water supply since 1993. A review of the monthly operating reports, indicates that iron is present in the raw water at levels between 4 and 5 mg/l. Iron does not have an MCL but has a secondary standard based on taste and odor of 0.3 mg/l. The raw water that is being treated at Bowie's water plant is a combination from the Magothy, Patapsco and Patuxent aquifers. According to published reports the highest iron levels are in the Patapsco and lowest in the Magothy. Raw water quality data for Well 6 (Patapsco) shows iron levels at 10.8 mg/l.

Volatile Organic Compounds (VOCs)

No VOCs above 50% of the MCL have been detected in Bowie's water supply since 1993. The only VOCs that have been detected are very low levels of trihalomethanes (THMs). THMs are disinfection by-products formed as a result of the reaction between chlorine and dissolved organic compounds in the water supply. Low levels of THMS are typical for ground water systems.

Synthetic Organic Compounds (SOCs)

The only SOC detected above 50% of the MCL since 1993 was di (2-ethylhexyl) phthalate. Phthalate was detected at 4.5 ppb, in a sample collected on January 7, 2004. The MCL for phthlate is 6 ppb. Phthalate was found in laboratory blanks in samples collected on the same day and therefore this result does not represent the water quality. 2, 4-D was detected one time at 0.757 ppb in a sample collected on January 9, 2002. The MCL for dalapon is 70 ppb.

Radionuclides

No radionuclides above 50% of the MCL were detected in Bowie's water supply. Low levels of gross alpha, gross beta, radium and radon have been detected in the water supply.

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 Bowie's water supply uses disinfection for its treatment, 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 or the aquifers would likely cause a positive Total coliform result despite disinfection and would require follow-up total and fecal coliform analysis. Since 1994 Bowie has conducted routine bacteriological sampling 94 times, but no samples had any detections of total coliform bacteria.

SUSCEPTIBILITY ANALYSIS

The wells serving Bowie's water supply pump water from three confined aquifers. Confined aquifers are naturally well protected from activity on the land surface due to low permeability sediments that provide a barrier for water movement from the surface into the aquifer below. A properly constructed well with the casing extended to the confining layer above the aquifer and with sufficient grout should be well protected from contamination at the land surface. Wells that are not being used or maintained will eventually corrode and provide a pathway for contaminants present in the shallow aquifers at higher-pressure heads to migrate to the deeper aquifers. 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 the natural conditions. The susceptibility of Bowie's water supply to the various contaminant groups in shown in table 4 at the end of this section.

Inorganic Compound (IOCs)

No IOCs above 50% of the MCL have been detected in the Bowie water supply. Based on the natural occurrence of iron in the three aquifers supply Bowie, and high levels of iron in the raw water, Bowie's water supply **is** susceptible to iron.

Due to the naturally protected characteristics of the confined aquifers, the water quality data, and the lack of potential sources of contamination, Bowie's water supply **is not** susceptible to the other inorganic compounds.

Volatile Organic Compounds (VOCs)

No VOCs above 50% of the MCL have been detected in Bowie's water supply.

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, Bowie's water supply **is not** susceptible to volatile organic compounds.

Synthetic Organic Compounds (SOCs)

No SOCs above 50% of the MCL were detected in Bowie's water supply.

Due to the naturally protected characteristics of the confined aquifers, the water quality data, and the lack of potential sources of contamination, Bowie's water supply **is not** susceptible to synthetic organic compounds.

Radionuclides

No radionuclides above 50% of the MCL were detected in Bowie's water supply. Only low levels of naturally occurring radium, radon, gross alpha and gross beta radiation have been detected in Bowie's water supply.

Based on the water quality data, Bowie's water supply **is not** susceptible to radiological contaminants.

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. Routine bacteriological testing for these plants revealed no positive Total Coliform in the water supply. Therefore, Bowie's water supply **is not** susceptible to microbiological contaminants.

CONTAMINANT TYPE	Are Contaminant Sources present in the WHPA?	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
Iron	YES*	NO**	NO	NO	YES
Inorganic Compounds (except nitrate)	NO	NO	NO	NO	NO
Volatile Organic Compounds	NO	NO	NO	NO	NO
Synthetic Organic Compounds	NO	NO	NO	NO	NO
Radionuclides	NO	NO	NO	NO	NO
Microbiological Contaminants	NO	NO	NO	NO	NO

Table 5. Susceptibility Chart for Bowie's Water Supply

**Naturally occurring in the aquifer*

*** Present in raw (untreated) water*

MANAGEMENT OF THE WELLHEAD PROTECTION AREA

The City of Bowie took the initiative to promote Wellhead Protection in 1993, when they applied for and received a grant from the EPA to develop a Wellhead Protection Program. A Wellhead Protection Program report was completed by Horsley & Witten, Inc. in October 1993.The report provided a comprehensive section on water quality management strategies (Page 22). Also a *Summary of Wellhead Protection Tools* is shown in Table 7 of the Horsley & Witten report.

For the wellhead protection study the City selected 25 year TOT and 50 year TOT for delineating the wellhead protection areas. It is up to the City to decide which areas to use for wellhead protection implementation. The Source Water Assessment Areas were based on the criteria established by MDE in its EPA approved Source Water Assessment Plan (1999) for completion of the source water assessment for all public water systems. These areas can also considered by the City as wellhead protection areas if so desired.

The Consumer Confidence Report should list that the Source Water Assessment has been completed and the report is available to the general public through the county public library or by contacting MDE.

REFERENCES

Horsley & Witten, Inc., 1993, Final Report Wellhead Protection Program, Bowie, Maryland, 30 p.

Mack, Frederick, 1966, Ground water in Prince Georges County, Maryland, Department of Geology, Mines and Water Resources, Bulletin 29, 101p.

Maryland Department of the Environment, Water Supply Program, 1999, Maryland's Source Water Assessment Plan, 36 p.

Tompkins, Michael D, 1983, Prince George's County Ground-Water Information: Well records, chemical-quality data, pumpage, appropriation data, observation Well records, and well logs, Water Resources Basic Data Report No. 13, 160 p.

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

SOURCES OF DATA

Water Appropriation and Use Permit No. PG1961G008, PG1961G108, PG1961G208
Public Water Supply Inspection Reports
Monthly Operating Reports
Monitoring Reports
MDE Water Supply Program Oracle Database
MDE Waste Management Sites Database
Prince Georges digital ADC Map 2000