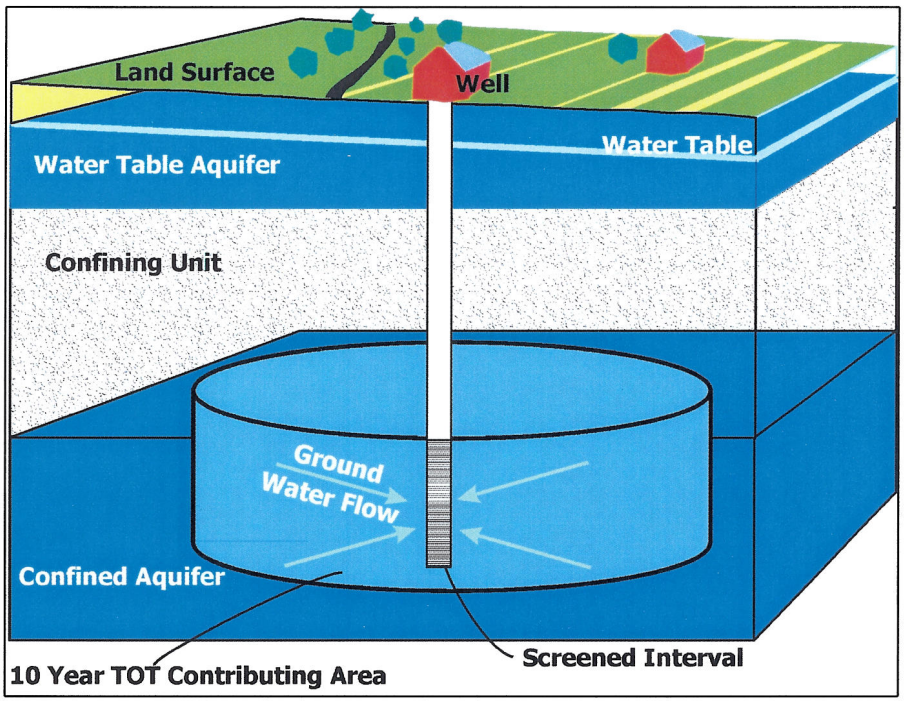
SOURCE WATER ASSESSMENT

FOR CHARLOTTE HALL COMMUNITY WATER SYSTEM

ST. MARY'S COUNTY, MD



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March 2006

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SUMMARY

The Maryland Department of the Environment's (MDE) Water Supply Program (WSP) has conducted a Source Water Assessment for the Charlotte Hall Water System. The system is owned and operated by the St. Mary's Metropolitan Commission. 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 source of Charlotte Hall's water supply is a Coastal Plain confined aquifer- the Aquia. Three wells are currently being used to supply the water from this aquifer. 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, and a review of MDE's databases. Well information and water quality data were also reviewed. A map showing the source water assessment area and potential contaminant sources is enclosed.

The susceptibility analysis for the water supply system is based on a review of the water quality data, potential sources of contamination, aquifer characteristics, and well integrity. Charlotte Hall's water supply is not susceptible to contaminants originating at the land surface due to the protected nature of confined aquifer. Due to the natural occurrence of arsenic in Aquia aquifer, Charlotte Hall's water supply may be susceptible to arsenic. However, it is not susceptible to other contaminants originating at the land surface due to the protected nature of confined aquifer.

INTRODUCTION

The Maryland Department of the Environment's (MDE) Water Supply Program (WSP) has conducted a Source Water Assessment for the Charlotte Hall Water System. The system is located in the northwestern part of St. Mary's County. Charlotte Hall is located on the west and east sides of Three Notch Road (MD Route 5), north of New Market, and pumps water from three wells located in the Aquia aquifer. The system is owned and operated by St. Mary's Metropolitan Commission (METCOM) and currently serves approximately 114 businesses and 5 homes. The Charlotte Hall water system was identified as a non-transient non-community water system until March 2006 at which time it was reclassified as a community water system. The system uses chlorine as a disinfectant to provide a barrier for microbiological contamination that could occur due to breaks or cross connections in the storage and distribution systems. The focus of this report however is possible risks to the water supply sources and does not address treatment, distribution, or storage issues.

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 systems indicates the wells serving these communities were drilled after 1973, when the State's well construction regulations went into effect, and meet current well construction standards for grouting and casing. Table 1 contains a summary of the well construction data.

SOURCE ID	SOURCE NAME	PERMIT NO	TOTAL DEPTH (ft)	CASING DEPTH (ft)	YEAR DRILLED	AQUIFER NAME
01	Charlotte Hall 1	SM-88-0632	505	433	1990	AQUIA
03	Charlotte Hall 2	SM-88-1932	572	432	1994	AQUIA
05	McKay's Plaza Well	SM-94-4144	540	510	2002	AQUIA

Table 1. Well Information.

HYDROGEOLOGY

Ground water flows through pores between gravel, sand and silt grains in unconsolidated sedimentary rock aquifers such as the aquifers used by Charlotte Hall water system. An aquifer is any formation that is capable of yielding a significant amount of water. The transmissivity is a measure of the amount of water an aquifer is capable of producing and is related to the hydraulic conductivity and the thickness of the aquifer. A confining layer is generally composed of fine material such as clay and silt, which transmits relatively very little water. Confined aquifers are those formations that are overlain by a confining unit. Confined aquifers are recharged from the water stored in the

confining unit above and from precipitation that infiltrates into the formation where it is exposed at the surface.

The Charlotte Hall area lies within the Atlantic Coastal Plain physiographic province. This province, which in Maryland includes roughly the area east of Interstate 95, is underlain by unconsolidated clastic sediments of Lower Cretaceous to recent age, which thicken to the southeast so that they appear wedge-shaped. These sediments crop out in a concentric band that lies parallel to the Fall Line, which marks the western boundary of the Coastal Plain.

Charlotte Hall's wells pump water from the Aquia aquifer, which is confined and is composed of fine to coarse-grained, greenish-brown sand that contains layers of grayish-green silt and clay, indurated calcite-cemented sand and fossil beds composed of shell debris (DNR, 1987). The top of the Aquia aquifer in the Charlotte Hall area is approximately 225 feet below sea level.

SOURCE WATER ASSESSMENT AREA DELINEATION

For ground water systems, a Wellhead Protection Area (WMPA) is considered to be the Source Water Assessment Area (SWAA) for the system. Source Water Assessment Areas (SWAAs) were delineated for both the Forrest Farm and the Villages at Leonardtown 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.)

METCOM has a water appropriation permit for the Charlotte Hall water system for an annual average of 57,200gallons per day (gpd). Current annual average water use is almost 90,000 gpd. METCOM has just recently applied to increase the annual average to 170,000 gpd. Source well, SM-88-0632, has a single well screen with a length of 30 feet. Source well, SM-88-1932, has two well screen lengths for a combined well screen length of 70 feet. Source well, SM-94-4144, has a single well screen with a length of 30 feet.

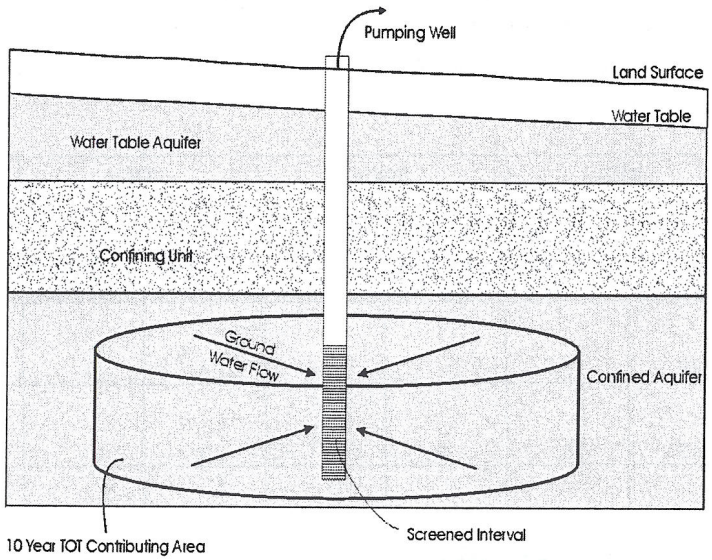
A conservative estimate of porosity (n) of 25% was used for the aquifer based on published reports. Using these parameters and current water usage the radius was calculated with the above equation for the WHPA delineation (Table 2A). A WHPA delineation was also calculated using these parameters and the requested water allocation (Table 2B). The circle shown in Figure 1 and Figure 2 represent the aquifer zone of transport in the subsurface as illustrated below.

System Name	Source ID	Well pumpage (Q) in gpd	Well pumpage (Q) in ft3/yr	Screened interval in feet (H)	Aquifer	Calculated radius for WHPA in feet (r)	Acreage of WHPA	Comments on WHPA
CHARLOTTE HALL	01	42,300	2,063,944	30	AQUIA	936	63	
	03	16,100	785,597	70		267	5	r = 600 Used
	05	32,200	1,571,106	30		817	48	

Table 2A. Parameters used for the Wellhead Protection Area Delineations Based on Current Water Usage

System Name	Source ID	Well pumpage (Q) in gpd	Well pumpage (Q) in ft3/yr	Screened interval in feet (H)	Aquifer	Calculated radius for WHPA in feet (r)	Acreage of WHPA	Comments on WHPA
CHARLOTTE HALL	01	81,600	3,981,420	30	AQUIA	1300	122	
	03	28,900	1,410,360	70		358	9.3	r = 600 used
	05	59,500	2,903,064	30		1110	89	

Table 2B. Parameters Used for the Wellhead Protection Area Delineations Based on Requested Allocation Amounts



Conceptual illustration of a zone of transport for a confined aquifer

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 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.

Potential sources of contamination identified at the land surface have the potential to impact the shallow water table aquifer. Based on the MDE databases, potential sources of contamination were identified within the Charlotte Hall WHPA included underground storage tanks and CHS generators. The location information for these sources was obtained from an existing database and was not field verified. Except for the direct injection of contaminants into the deeper confined aquifer, Charlotte Hall's water supply should be well protected from contamination.

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 all three Charlotte Hall water plants is post-hypochlorination for disinfection.

A review of the monitoring data since September 1987 for Charlotte Hall's water supply indicates that it meets the current drinking water standards for inorganic, microbiological, radiological, and organic compounds. The water quality sampling results are summarized in Table 3.

	IOCs		SOCs		VOCs		Radionuclides	
Plant No.	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
01	16	7	-	-	4	-	1	-
03	13	6	4	-	3	-	1	-
05	14	2	1	-	10	-	1	-

Table 3. Summary of Water Quality Samples for Charlotte Hall's Water Supply

Inorganic Compounds (IOCs)

IOCs above 50% of the MCL have been detected in Charlotte Hall water supply. Arsenic was the only contaminant detected at all three water plants at greater than 50% of the MCL. Other IOCs detected at greater than 50% of the MCL were chromium and thallium at Charlotte Hall 2. A summary of this data is shown below in Table 4.

PLANT NO.	CONTAMINANT	MCL (PPM)	SAMPLE DATE	RESULT
1	ARSENIC	0.01	8-Dec-95	0.006
			24-Sep-01	0.005
			6-Dec-01	0.005
			27-Mar-03	0.008
			21-Apr-04	0.006
			23-Jun-05	0.005
			14-Dec-05	0.006
2	ARSENIC	0.01	21-Nov-94	0.005
			6-Nov-00	0.006
			27-Mar-03	0.01
			19-Jul-05	0.0055
	CHROMIUM	0.1	7-Jan-02	0.05
	THALLIUM	0.002	4-Apr-01	0.003
3	ARSENIC	0.01	8-Dec-95	0.006
			27-Mar-03	0.009

Table 4. Regulated Inorganic Compounds (IOCs) Exceeding 50% of the MCL

Other IOCs detected at Charlotte Hall 1 include iron, sodium, chloride, and fluoride. Fluoride was detected in December 1995 at 0.4 ppm. The MCL for fluoride is 4 ppm. Iron was detected in December 2005 and June 2005 at 0.18 ppm and 0.11 ppm, respectively. There is no MCL for iron and the secondary standard is 0.3 ppm. Sodium was detected in December 2005, June 2005, April 2004, March 2003, and December 2001 at 9.4 ppm, 9.7 ppm, 6 ppm, 0.7 ppm, and 9.15 ppm. For people on severely sodium-restricted diets EPA recommends levels below 20 ppm in drinking water. Chloride was detected in March 2003 at 0.69 ppm. There is no MCL for chloride; the secondary standard is 250 milligrams per liter (mg/l).

The detection of chromium, nickel and thallium in samples collected at Charlotte Hall 2 appear to have occurred only one the once occasion. Chromium and nickel have not been detected since and thallium has not been confirmed in subsequent samplings. Other IOCs detected at this plant include barium, iron, sodium, chloride, selenium, nitrate, sulfate, and fluoride. Fluoride was detected in November 1994 at 0.3 ppm. The MCL for fluoride is 4 ppm. Barium was detected in July 2005 at 0.19 ppb. The MCL for barium is 2 ppm. Selenium was detected in April 2001 at 0.003 ppm. The MCL for selenium is 0.05 ppm. Nitrate was detected in March 1998, November 1994, and September 1987 at 0.3 ppm, 0.14 ppm, and 0.2 ppm, respectively. The MCL for nitrate is 10 ppm. Iron was detected in September 1987 at 0.13 ppm and sulfate was detected in November 1994 at 11

ppm. Iron and sulfate have secondary standards at 0.3 and 250 ppm, respectively. Sodium was detected in July 2005, March 2003, March 1998, November 1994, and September 1987 at 7.3 ppm, 0.81 ppm, 11.4 ppm, 6 ppm, and 9.94 ppm. For people on severely sodium-restricted diets EPA recommends levels below 20 ppm in drinking water. And, chloride was detected in March 2003 at 0.81 ppm. There is no MCL for chloride; the secondary standard is 250 milligrams per liter (mg/l).

Other IOCs detected at McKay's Plaza include iron, sodium, chloride, nitrate, nitrite, and fluoride. Fluoride was detected in August 2003 and December 1995 at 0.22 ppm and 0.4 ppm, respectively. The MCL for fluoride is 4 ppm. Nitrate was detected in March 1998 and April 1995 at 0.2 ppm and 0.12 ppm, respectively. The MCL for nitrate is 10 ppm. Nitrite was detected in April 1995 at 0.12, which has an MCL of 1 ppm. Iron was detected in August 2003 at 0.12 ppm. Iron has a secondary standard of 0.3 ppm. Sodium was detected in August 2003, March 2003, and March 1998 at 11 ppm, 0.75 ppm, and 10.6 ppm. For people on severely sodium-restricted diets EPA recommends levels below 20 ppm in drinking water. And, chloride was detected in March 2003 at 0.74 ppm. There is no MCL for chloride; the secondary standard is 250 milligrams per liter (mg/l).

The levels detected of all inorganic contaminants represent natural background conditions.

Volatile Organic Compounds (VOCs)

No VOCs above 50% of the MCL have been detected in Charlotte Hall's water supply. The only VOC detected at each of the water plants is chloroform. At Charlotte Hall 1 it was detected in December 2001 at 0.6 ppb and in October 2001 at 0.8 ppb. At Charlotte Hall2 it was detected in January 1997 at 0.9 ppb and in January 1996 at 1.5 ppb. At McKay's Plaza it was detected in December 2005 at 0.6 ppb, June 2005 at 0.6 ppb, September 2004 at 1.3 ppb, June 2003 at 1.6 ppb, in March 2003 at 0.8 ppb. Chloroform is formed as a result of chlorine reacting with natural organic compounds in the water during disinfection and is part of a group of VOCs known as trihalomethanes. The maximum contaminate level for total trihalomethanes is 80 ppb.

Synthetic Organic Compounds (SOCs)

No SOCs above 50% of the MCL have been detected in the Charlotte Hall water supply. The only contaminant detected on one occasion at two different water plants was di (ethylhexyl) phthalate (also known as DEHP). In September 1997 it was detected at 0.6 ppb at Charlotte Hall 2; and, in August 2003 it was detected at 0.4 ppb at McKay's Plaza. It must be noted that DEHP was also detected in the laboratory blank analyzed concurrently with both of these samples. The MCL for this contaminant is 6 ppb.

Radionuclides

No radionuclides above 50% of the MCL have been detected in Charlotte Hall's water supply. Gross beta was detected at all three water plants on one occasion each, March 27, 2003. The quantity of gross beta detected at Charlotte Hall 1 was 15.2 picoCuries/Liter (pCi/L), at Charlotte Hall 2 it was 14.3 pCi/L, and at McKay's Plaza it was 12.1 pCi/l. The MCL for gross beta is 50 pCi/L.

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. 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 October 1996 Charlotte Hall has conducted routine bacteriological sampling with no positive results.

SUSCEPTIBILITY ANALYSIS

All three wells serving Charlotte Hall's water system obtain water from a confined aquifer. 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 surficial aquifers into the deeper aquifer. 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 can 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 Charlotte Hall's water supply to the various contaminant groups is shown in Table 5 at the end of this section.

Inorganic Compound (IOCs)

IOCs above 50% of the MCL have been detected in the Charlotte Hall's water supply. Arsenic is present at all three of Charlotte Hall's water plants.

Some chemical elements (e.g. arsenic) are naturally occurring in the aquifer and in some instances can reach concentrations that pose a risk to water supply. In the case of confined aquifers, this is generally more problematic than contaminants at the land surface.

Based on the natural occurrence of arsenic in the aquifer and its presence in the water samples, Charlotte Hall's water supply **is susceptible** to arsenic. Due to the naturally protected characteristics of the confined aquifers, the water quality data, and the lack of potential sources of contamination, Charlotte Hall'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 Charlotte Hall'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, Charlotte Hall's water supply **is not susceptible** to volatile organic compounds.

Synthetic Organic Compounds (SOCs)

No SOCs above 50% of the MCL have been detected in Charlotte Hall'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, Charlotte Hall's water supply **is not susceptible** to synthetic organic compounds.

Radionuclides

No radionuclides above the 50% of the MCL were detected in Charlotte Hall's water supply.

Since the natural occurrence of radionuclides is not present in water from the Aquia aquifer, Charlotte Hall's water supply **is not susceptible** to other 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. Routine bacteriological testing at Charlotte Hall's has shown no positives for total coliform or fecal coliform. Therefore, Charlotte Hall'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
Arsenic	NO	YES	NO	YES	MAYBE
Inorganic Compounds	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 Charlotte Hall's Water Supply

MANAGEMENT OF THE WELLHEAD PROTECTION AREA

Specific management recommendations for consideration are listed below:

Public Awareness and Outreach

The Consumer Confidence Report should include a summary of this report and indicate that the full report is available to the general public through the 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 an increase in water usage is proposed. An increase in use or the addition of new wells may require revisions to the WHPA.

REFERENCES

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

Maryland Department of Natural Resources (DNR), 1987, The Quantity and Natural Quality of Ground Water in Maryland: DNR Water Resources Administration.

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. SM1966G006
Public Water Supply Inspection Reports
Monitoring Reports
MDE Water Supply Program Oracle Database
MDE Waste Management Sites Database
St. Mary's County ADC Map (2000)