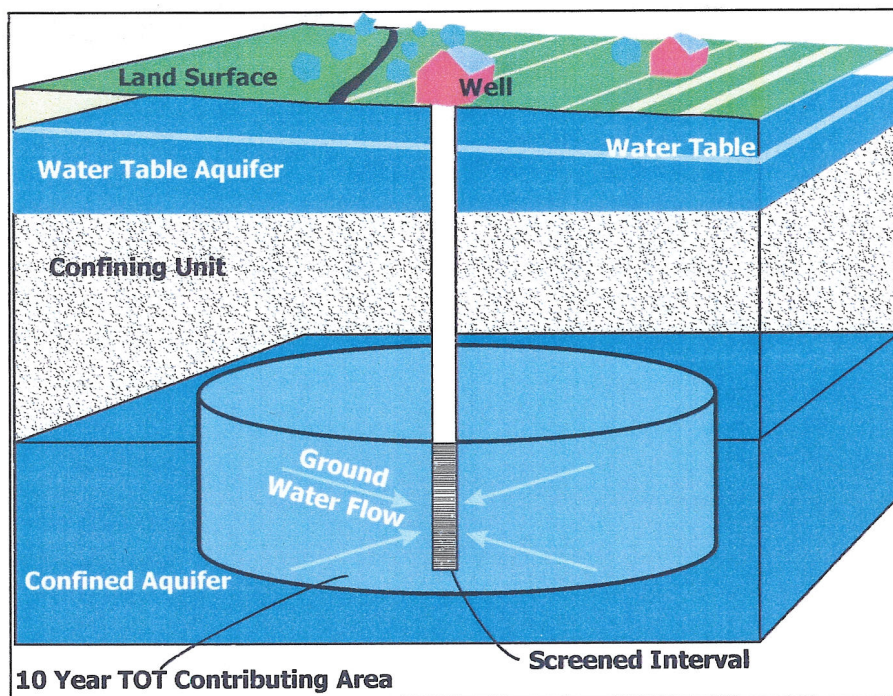


SOURCE WATER ASSESSMENT

FOR INDIAN ACRES AT CHESAPEAKE BAY

CECIL COUNTY, MD



Prepared By
Water Management Administration
Water Supply Program
March 2005



Robert L. Ehrlich
Governor

Kend P. Philbrick
Secretary

Michael S. Steele
Lt. Governor

Jonas A. Jacobson
Deputy Secretary

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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 Indian Acres of Chesapeake Bay Water System. 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 Indian Acres of Chesapeake Bay's water supply is a Coastal Plain confined aquifer-the Magothy. One well is currently being used to supply the water from this aquifer. The system has installed a second well and exercises it at least once a month. The Water Supply Program using methods approved by the U. S. EPA delineated the source water assessment area.

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 at Indian Acres at Chesapeake Bay is based on a review of the water quality data, potential sources of contamination, aquifer characteristics, and well integrity. Indian Acres of Chesapeake Bay's water supply is not susceptible to 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 Indian Acres of Chesapeake Bay Water System. The system is located in Cecil County, north of Knight Island Road and Dowdel Creek and east of Back Creek, south of Earlville, and pumps water from one primary well and one backup well. Both wells are located in the Magothy formation and have post hypochlorination treatment. The system is owned and operated by W.S.C., Inc. and currently serves a varying seasonal/year-round population with approximately 600 service connections.

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 this community 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	Well 1	CE-88-0041	278	253	1988	MAGOTHY
03	Well 3	CE-94-6192	275	240	2003	MAGOTHY

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 Indian Acres at Chesapeake Bay 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 Indian Acres at Chesapeake Bay water system 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. Indian Acres' wells pump water from the Magothy

formation, which is a confined aquifer consisting of light grey to white loose sand and fine gravel containing interbedded lignitic, pyritic and clay layers (Weigle and Webb, 1970). The top of the Magothy formation in the Indian Acres area is 150 feet below sea level. The formation outcrops approximately 6-7 miles northwest of the site, along the southeastern shoreline of the Chesapeake Bay and Elk River and the mouth of the Bohemia River.

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 Indian Acres at Chesapeake Bay 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:

$$r = \sqrt{\frac{Qt}{\pi nH}}$$

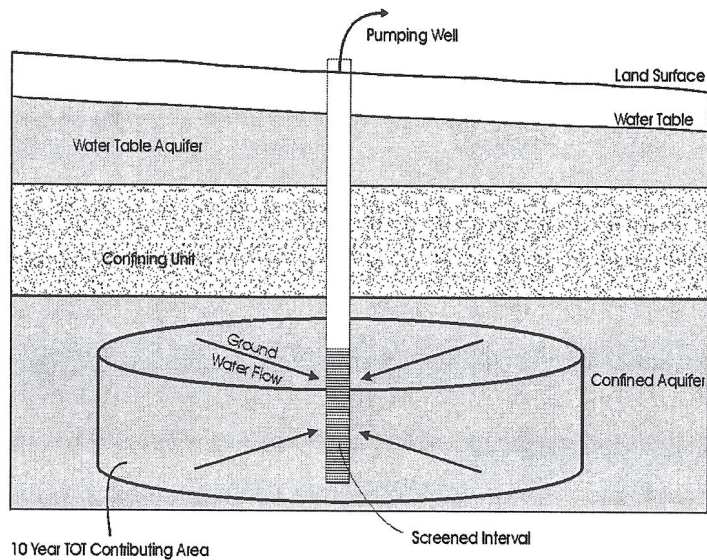
where r = calculated fixed radius (ft)
 Q = pumping rate of well (ft³/yr)
 n = aquifer porosity (dimensionless)
 H = length of well screen (ft)
 t = time of travel (yr.)

W.S.C., Inc. has a water appropriation permit for the Indian Acres water system for an annual average of 90,000 gallons per day (gpd).

A conservative estimate of porosity (n) of 25% was used for the aquifer based on published reports. Using these parameters the radius was calculated with the above equation for the WHPA delineation (Table 2). The circle shown in Figure 1 represents the aquifer zone of transport in the subsurface as illustrated below. Since the circle for Well 1 incorporates the one for Well 3, the larger circle represents the WHPA for the system.

Well Name	Well pumpage (Q) in gpd	Well pumpage (Q) in ft ³ /yr	Screened interval in feet (H)	Aquifer	Calculated radius for WHPA in feet (r)	Acreage of WHPA	Comments on WHPA
WELL 1	90,320	5,292,612	25	MAGOTHY	1642	194	circles
WELL 3	90,320	5,292,612	35	MAGOTHY	1388	139	merged

Table 2. Parameters used for the Wellhead Protection Area Delineation



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, no potential sources of contamination were identified within the Indian Acres at Chesapeake Bay WHPA. Therefore, except for the direct injection of contaminants into the deeper confined aquifer, Indian Acres' 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 Indian Acres is post hypochlorination for disinfection.

A review of the monitoring data since May 1996 for Indian Acres' water supply indicates that it meets the current drinking water standards for inorganic, radiological, microbiological, and organic compounds. 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
13	0	1	0	11	1	5	0

Table 3. Summary of Water Quality Samples for Indian Acres Water Supply

Inorganic Compounds (IOCs)

No IOCs above 50% of the MCL have been detected in Indian Acres' water supply.

Volatile Organic Compounds (VOCs)

No VOCs above 50% of the MCL, other than one detect of vinyl chloride, have been detected in Indian Acres' water supply. On July 24, 2001 vinyl chloride was detected in Well 1 at 1.2 ppb, which exceeds 50% of the MCL (2 ppb) for the parameter.

Synthetic Organic Compounds (SOCs)

No SOC above 50% of the MCL have been detected in Indian Acres' water supply.

Radionuclides

No radionuclides above 50% of the MCL have been detected in Indian Acres' 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. 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 May 1998 Indian Acres has conducted routine bacteriological sampling 81 times. All samples have been negative for total coliform bacteria.

SUSCEPTIBILITY ANALYSIS

Both wells serving Indian Acres' 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 Indian Acres' water supply to the various contaminant groups is 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 Indian Acres water supply.

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

Volatile Organic Compounds (VOCs)

No VOCs above 50% of the MCL, other than one detect of vinyl chloride, have been detected in Indian Acres' water supply. On July 24, 2001 vinyl chloride was detected in Well 1 at 1.2 ppb, which exceeds 50% of the MCL (2 ppb) for the parameter. Testing for vinyl chloride before and after this date has been negative. It appears that the detection may have been analytical error. All other VOC testing has shown no VOC results above 50% of the MCL have been detected in Indian Acres' 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, Indian Acres' water supply is **not** susceptible to volatile organic compounds.

Synthetic Organic Compounds (SOCs)

No SOCs above 50% of the MCL were detected in Indian Acres' water supply.

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

Radionuclides

No radionuclides above the 50% of the MCL were detected in Indian Acres' water supply.

Since the natural occurrence of radionuclides is not present in water from the Aquia aquifer, Indian Acres' 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 Indian Acres' has shown no positives for total coliform or fecal coliform. Therefore, Indian Acres' 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
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 4. Susceptibility Chart for Indian Acres 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 sealed as per State well construction regulations.

Water operation personnel should have a program for periodic inspections and maintenance of the supply well and backup well 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.

Weigle, J.M. and W.E. Webb, Maryland Geological Survey, Basic Data Report No. 4, 1970, 48 p.

SOURCES OF DATA

Water Appropriation and Use Permit No. CE1973G008
Public Water Supply Inspection Reports
Monitoring Reports
MDE Water Supply Program Oracle Database
MDE Waste Management Sites Database
DNR DOQQ Earville (2000)