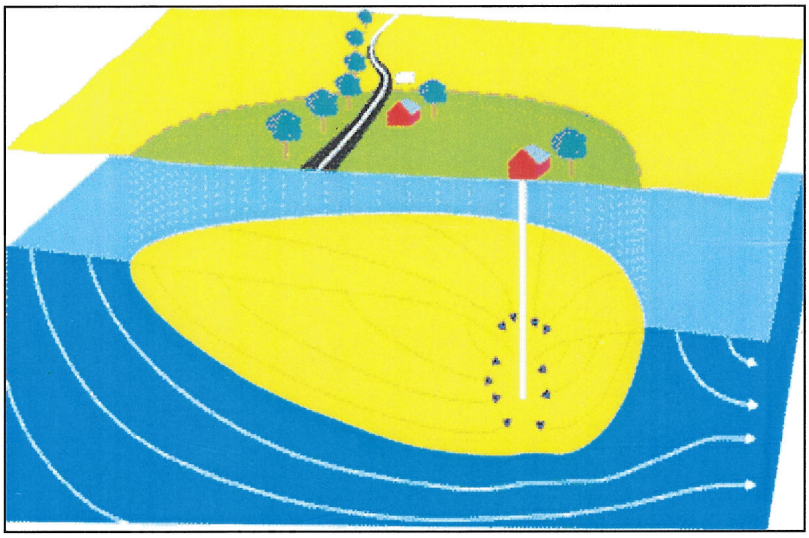
SOURCE WATER ASSESSMENT

FOR THE MOUNT SAINT MARY'S UNIVERSITY

FREDERICK COUNTY, MD



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SUMMARY

The Maryland Department of the Environment's Water Supply Program (WSP) has conducted an assessment of the vulnerability of the Mount Saint Mary's University ground water sources to contamination. The required 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 sources, 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 sources of the Mount Saint Mary's University water supply draw water from unconfined fractured rock aquifers known as the Frederick Limestone, and Weverton Formations respectively. Unconfined aquifers are generally vulnerable to any activity on the land surface that occurs within the wellhead protection area (WHPA). The system currently uses 3 wells to obtain their drinking water. The WHPA was delineated using U.S. EPA approved methods specifically designed for each source.

Potential sources of contamination within the assessment area were identified based on site visits, database reviews and land use maps. Well information and water quality data were also reviewed. Figures showing land use, sewerage coverage, and potential contaminant sources within the Wellhead Protection Area, and an aerial photograph of the well locations are enclosed at the end of the report.

The susceptibility analysis for the Mount Saint Mary's University 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 the Mount Saint Mary's University wells are susceptible to contamination by naturally occurring arsenic, and radionuclides. Should the EPA adopt a drinking water standard for radon-222, the Mount Saint Mary's University wells may also be susceptible to this naturally occurring contaminant. The Mount Saint Mary's University water supply was determined not susceptible to volatile organic compounds, synthetic organic compounds, microbiological pathogens, and other regulated inorganic compounds.

INTRODUCTION

Mount Saint Mary's University is located about 1.8 miles southwest of Emmitsburg in Frederick County (Figure 1). The community water system serves a population of about 1900, which includes students, faculty, various summer programs, and others affiliated with the university. The Town of Emmitsburg also purchases up to about 10,000 gallons per day (gpd) of university water for use during low-flow conditions through a permanent interconnection with this system. The water system is privately owned and operated by the university. The water is supplied by three production wells pumped from two water treatment plants to eight service connections. The primary water supply is obtained from Wells 3 and 5, which is treated at Plant 1. Well 6, located near the Morgan track, is used primarily for irrigation purposes, for emergency supply to the fire hydrants, and as a backup potable supply. Other sources of water at the University include the Grotto Spring, a brick-lined reservoir (Appendix A), Roddy Quarry, and old cisterns. The Grotto Spring serves a transient population that collects the spring water from a constructed tap at the Grotto of Lourdes National Shrine area. The spring water flows through cartridge filters, and is treated with ultra-violet disinfection prior to distribution at the collection tap. The spring is no longer connected to the university's potable water supply. The other alternate sources are also disconnected from the system and are no longer used as potable water supplies. They are occasionally used for irrigation purposes only. The various water sources and treatment plant locations are shown on Figure 1.

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 well data and sanitary surveys of the Mount Saint Mary's University water system indicates that Wells 3 and 6 meet current well construction standards for grouting and casing. Well 5 was originally drilled in 1936, thirty-seven years before regulations went into effect. However, in 1998, according to Plant Operator Phil Valentine, the original casing was removed, the well was re-drilled, re-cased above grade, and grouted according to current construction standards. As shown in Appendix A, it is located behind a butterfly bush and small flowerbed inside a steel drainpipe ring whose casing terminates about 4 inches above ground surface (Appendix A). Wells with casings that terminate near or below grade may be prone to flooding, which exposes the water supply to a variety of contaminants in storm water runoff. Well 3, whose casing extends to about two feet above ground level, is located in farmland, and is protected by a concrete manhole ring (Appendix A). Well 6 is located outside and about 25 feet south of Morgan track (Appendix A & Figure 1). Its casing extends to about one foot above grade.

The Public Drinking Water Information System (PDWIS) database indicates that all other former wells for this system have been abandoned and sealed. Table 1 contains a summary of the well construction data.

PLANT ID	SOURCE NAME	WELL PERMIT NO.	TOTAL DEPTH (ft.)	CASING DEPTH (ft.)	YEAR DRILLED	AQUIFER
01	WELL 3	FR738096	425	51	1980	FREDERICK LIMESTONE
01	WELL 5	n/a	850	n/a	1936	WEVERTON FORMATION
02	WELL 6	FR738105	475	48	1980	FREDERICK LIMESTONE

Table 1. Mount Saint Mary's University Well Construction Information

Water Appropriation Permit Nos. FR1975G013 (for Wells 3 and 5), and FR1975G413 (for Well 6) allow the system to use a combined average of 180,000 gpd and 375,000 gpd in the month of maximum use. Based on reported pumpage data from 1995-2004, the combined water useage from the two plants has never exceeded the total allocation limits granted from the water appropriation permits for this system. According to the 2004 Sanitary Survey Report, Well 3 is pumped at about 130 gallons per minute (gpm), Well 5 is pumped at about 30 gpm, and when Well 6 is used, it is pumped at about 120 gpm.

HYDROGEOLOGY

Mount Saint Mary's University is located in the Triassic Upland sub-province of the Western Piedmont physiographic province. The underlying formations include red shales of Triassic Age which uncomformably overlie limestones and conglomerates of the Frederick Valley. Based on published reports, a geologic map of Frederick County, and a detailed hydrogeologic study conducted by T.A. Houston and Associates in 1985, the Mount Saint Mary's University Wells 3 and 6 are completed in the Frederick Limestone of Late Cambrian Age. The Frederick Limestone consists of thin-bedded, slabby, dark-blue limestone, and shale with clayey partings (Meyer & Beall, 1958). Based on the hydrogeologic study, Well 6 penetrates the Frederick Limestone cavity at approximately 375 feet below ground surface (T.A. Houston & Associates, 1985). The cavernous, carbonate aquifer is overlain by the Gettysburg Shale. The Frederick Limestone may be high yielding due to percolating ground water that causes the dissolution of carbonate minerals enlarging fractures, joint openings, and bedding planes and thus increasing the storage and movement of ground water through the aquifer. These enlarged solutional openings behave as extensive, interconnected conduits (Duigon & Dine, 1987). According to the Geologic Map of Frederick County and published reports, Wells 3, and 6 were both drilled near the Triassic Border Fault that augments an already complex hydrogeologic setting. The main fault along the Catoctin Mountain front separates the metamorphic and metavolcanic rocks of the Blue Ridge province to the west from the metasedimentary rocks of the Western Piedmont province to the east (Nutter, 1975).

Well 5 is completed in the Weverton Formation also of Cambrian age. The Weverton Formation consists of interbedded white to dark gray quartizites, phyllites, and coarse quartz conglomerates at its base (Duigon & Dine, 1987). The Weverton

forms along ridges, rocky ledges, and mountain slopes in this area (Meyer & Beall, 1958). The primary porosity and permeability of this aquifer is small due to the crystalline nature of the rock. Ground water moves through secondary porosity, fractures, and joint openings, and is recharged by precipitation percolating through the overlying soils, and weathered bedrock. The yield of a well in crystalline rock depends primarily on the number of fractures penetrated by the well. These fractures may cut across contacts between the same or differing formations having similarly low primary permeabilities. Therefore, the aquifers in this setting often cannot be distinguished by their individual geologic formations. Typically, the water table in the aquifer mimics the surface topography.

According to the Geologic Map of Frederick County, and available well completion reports, and published reports, the aquifers used by the university wells are uncomformably overlain by the Gettysburg Shale of Triassic Age (Duigon & Dine, 1987). This formation consists of relatively impermeable layers of red shales, siltstones, and sandstones. These layers have very low effective primary porosity, and thus offer great resistance to the flow of ground water. Therefore, they may act as aquitards or semi-confining units to the underlying aquifers (Smith Environmental Technologies Corp, 1995). An aquitard is defined as a formation that yields some water, but usually not enough to meet even modest demands (Driscoll, 1986). Well 6 is described as penetrating approximately 375 feet of this semi-confining layer of shale, and completed in the cavernous, Frederick limestone aquifer (T.A. Houston & Associates, 1985). Ground water in this setting may occur under unconfined, semi-confined, or confined conditions. Unconfined aquifer conditions occur where the fractures are numerous and well connected. Semi-confined or confined conditions may occur with depth due to the gradual decrease in the number and width of rock fractures (Duigon & Dine, 1987). In this region, unconfined aquifer conditions may occur to a maximum depth of about 250 feet below ground surface, below which, semi-confining or confining conditions may exist (Smith Environmental Technologies Corp, 1995). The university wells were drilled to 425, 475, and 850 feet below ground surface respectively, which suggests that they may be considered semi-confined, or confined. Confined aquifers are naturally protected from land use activities at the ground surface due to the confining layers that provide a barrier for water movement from the surface into the aquifers below. This rationale will be used later in the susceptibility section of this report. However, due to the complex hydrogeologic structure of the formations in this region, and that a fractured rock aquitard is not a fully confining unit, the aquifers used by the university wells are considered unconfined for conservative purposes.

SOURCE WATER ASSESSMENT AREA DELINEATION

For ground water systems, a Wellhead Protection Area (WHPA) is considered the source water assessment area for the system. Ground water flow in unconfined fractured rock aquifers is complex and cannot be accurately modeled by a homogeneous analytical model. Consistent with the recommended delineation in the Maryland Source Water Assessment Plan (MDE, 1999), the watershed drainage area

that contributes ground water to the supply wells methodology was used. The delineation area was modified to account for topography, ground water drainage divides including the downgradient stagnation points as calculated by a uniform flow analytical model (see Appendix B), significant land features, estimating the underlying Frederick Limestone cavernous layer for Wells 3 and 6 by overlaying available geologic maps, and by using a conservative calculation of total ground water recharge during a drought. The delineated WHPA is considered the area in which any contaminant present could ultimately reach the wells.

The Mount Saint Mary's University WHPA is irregularly shaped, and has an area of 624.3 acres. The boundaries of the WHPA extend outward from the wells based on upgradient topography, and downgradient ground water divides or stagnation points (Figure 2). The calculations completed in Appendix B indicate that the downgradient distances from Wells 3, and 6 are approximately 655 feet, and 500 feet respectively. It must be noted that these distances are for estimation purposes only, as this method is based on homogeneous aquifer flow, which may not be the case in this complex geologic setting. Water level monitoring data from nearby wells, and more advanced modeling techniques are necessary to more accurately delineate the extent of this WHPA.

To better define this area using available information, the annual average recharge needed to supply the wells was also calculated. A drought condition recharge value of 290 gpd per acre (or approximately 3.9 inches per year) was used to estimate the total ground water contribution area required to supply the wells. This data was obtained from the one-in-ten year mean drought base flows reported from the Monocacy River, Bridgeport gauge station (Hammond, 2000). The current Water Appropriation Permits for the Mount Saint Mary's University supply wells is for a combined average daily withdrawal of 180,000 gallons. The total ground water contribution area was calculated from the following equation:

Recharge Area (acre) = Average Use (gpd) / Drought Condition Recharge (gpd/acre)

From the above equation, the total ground water contributing area during a drought is approximately 621 acres. The delineated WHPA of 624.3 acres is therefore adequate to meet the average daily ground water usage during a drought. The WHPA indicates a general ground water flow direction toward the southeast.

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, controlled hazardous substance generators, ground water discharge permit sites, and known ground water contamination sites. These sites are generally associated with commercial or industrial facilities that use or store 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 the use of pesticides, application of fertilizers, animal wastes, or septic systems that may lead to ground water contamination over a larger area.

The WSP met with Mount Saint Mary's University Operator, Phil Valentine, in April and June 2005 to discuss water quality concerns, and to observe the integrity of the wells. Also, data was collected regarding the locations of the wells using Global Positioning System (GPS) equipment, and a windshield survey was conducted to locate and map potential sources of contamination located within and near the WHPA using the GPS.

Point Sources

A review of MDE contaminant databases as well as the field surveys revealed some potential point sources of contamination near the Mount Saint Mary's University WHPA. Facilities that have underground storage tanks (USTs), and leaking underground storage tanks (LUSTs), are located near the WHPA (Figure 3). In addition, miscellaneous sites (MISC) such as a farm supply/hardware business handles and stores chemicals, and the University's wastewater treatment plant are also shown on Figure 2. Table 2 lists the facilities identified and their potential types of contaminants. The contaminants are based on generalized categories and often the potential contaminant depends on the specific chemicals and processes being used or which had been used at the facility. The potential contaminants are not limited to those listed. Potential contaminants are grouped as Volatile Organic Compounds (VOC), Synthetic Organic Compounds (SOC), Heavy Metals (HM), Nitrate/Nitrite (NN), and Microbiological Pathogens (MP).

ID	Type[1]	Site Name	Address	Potential Contaminant[1]
1	UST, LUST	E-Z Fill Getty Gas Stop	16603 S. Seton Ave.	VOC
2	UST	Holtzople Gas/Diesel	16424 Old Frederick Rd.	VOC, HM
3	LUST	Mountain Manor Treatment Center	9701 Keysville Rd.	VOC
4	MISC	Zurgable Bros. Farm Supplies/Hardware	16663 Old Emmitsburg Rd.	SOC, NN
5	MISC	Mt. St. Mary's Univ. Wastewater Plant	South of U.S. Rt. 15	MP, NN
6	MISC	Pond at Mt. St. Mary's Univ.	South of U.S. Rt. 15	MP, HM, SOC

Table 2. Potential Contaminant Point Sources within or near the Mount Saint Mary's University Wellhead Protection Area (see Figure 2 for locations)

[1] UST = underground storage tanks, LUST = leaking underground storage tanks, MISC = miscellaneous sites
VOC = volatile organic compounds, SOC = synthetic organic compounds, HM = heavy metals
NN = nitrate/nitrite, MP = microbiological pathogens

The MDE Oil Control Program reports two open cases located near the Mount Saint Mary's University WHPA. Both sites had petroleum releases from underground storage tank or line leaks resulting in ground water contamination. The sites are mapped as leaking underground storage tanks (LUSTs) as shown

on Figure 2. A summary of these cases can be found in Appendix C. The reader may contact the Oil Control Program for additional information.

Inspections of facilities located within and near the WHPA are being completed by MDE staff to determine the potential of any unpermitted ground water discharges (e.g. open floor drains) to the unconfined aquifers. No violations have been reported to date. The reader may contact the specific programs within the MDE Waste and Water Management Administrations for additional information on any of the potential contaminant sites described in this report.

The storage of heating oil in residential underground tanks, and spills during the transportation of chemical products on U.S. Route 15, and MD Routes 76, and 806 are also potential sources of contaminants that could reach the water supply (Figures 2 & 3). The application of de-icing chemicals on these roads and on university property during the winter months may also be a source of chlorides to the water supply.

Non-Point Sources

The Maryland Office of Planning's 2002 digital land use map for Frederick County was used to determine the predominant types of land use in the Mount Saint Mary's University WHPA (Figure 3). The breakdown of land use types is shown on Table 3. Note that forestland, followed by commercial (i.e. the university), then cropland make-up the largest portion of land use in the WHPA.

LAND USE TYPE	TOTAL AREA (acres)	PERCENTAGE OF WHPA
Low Density Residential	24.49	3.92
Medium Density Residential	4.72	0.76
Commercial	156.84	25.12
Cropland	146.71	23.50
Pasture	9.02	1.45
Forest	277.72	44.49
Water	4.75	0.76
Total Area	624.25	100.00

Table 3. Land Use in the Mount Saint Mary's University WHPA (See Figure 3)

Lawn and athletic field maintenance, and landscaping activities on campus are all potential non-point sources of nitrates, microbial pathogens, and SOCs to ground water. Activities at the Mount Saint Mary's University could pose a potential risk of contamination to their water supply. The university should maintain a Best Management Practices (BMP) plan with emphasis on hazardous material handling, fertilizer and pesticide application, petroleum product storage, de-icing practices, and wastewater discharge within the WHPA. According to Phil Valentine, all former underground tanks on university property have either been removed or sealed in-place. The existing petroleum tanks on-campus are double-

walled, above ground tanks with containment vaults that meet current regulations. The university also continues to use coal-fired boilers to supplement their heat source during the winter months.

Agricultural land use such as cropland, and pasturelands are commonly associated with nitrate loading of ground water and also represent a potential source of SOCs depending on farming practices and the use of pesticides. Additionally, residential areas using private septic systems that are commonly associated with nitrate loading of ground water may also be a source of nitrate. Fertilizers and pesticides used for gardening and lawn care practices in residential areas may also be potential sources of nitrate, or SOCs depending on their application. Storm water runoff is also a concern since it may contain various contaminants that could infiltrate into the ground near the supply wells.

The Maryland Office of Planning's 1996 Frederick County Sewerage coverage map indicates that 14.3% of the WHPA has public sewer service (Figure 4). The University's Wastewater Treatment Plant serves this area. The remaining areas have no planned service as shown on Table 4. With the exception of the residential properties located within the WHPA, areas with no planned sewer service are primarily in forested, and agricultural lands when compared with the 2002 designated land use map (Figures 3 and 4).

Mount Saint Mary's University has a surface water permit to discharge 100,000 gpd of treated wastewater from its treatment plant to Saint Mary Run which discharges into Toms Creek. Since the supply wells likely are not under the direct influence of surface water based on sampling results from Well 3, and local geology, these discharges should not impact the water quality of this ground water system.

SEWER SERVICE AREA CATEGORIES	TOTAL AREA (acres)	PERCENTAGE OF WHPA
No Planned Service Area	535.05	85.71
Existing Service Area	89.20	14.29
Total Area	624.25	100.00

Table 4. Sewerage Coverage in the Mount Saint Mary's University WHPA (see Figure 4)

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 raw ground

water from Wells 3 and 5 is treated at the Mount Saint Mary's University Plant 1 with sodium hypochlorite for disinfection, and pressure sand filtration for particulate removal prior to distribution. Well 6 is treated at Plant 2 with sodium hypochlorite for disinfection purposes when used as a potable supply.

A review of the monitoring data since 1993 indicates that the Mount Saint Mary's University water supply meets the current drinking water standards. Table 5 shows the number of samples collected for each class of contaminant, and the number of samples where a contaminant was greater than 50% of an MCL.

PLANT ID	Nitrate		SOCs		VOCs		IOCs (except nitrate)		Radionuclides	
	No. of Samples	No. of samples > 50% MCL	No. of Samples	No. of samples > 50% MCL	No. of Samples	No. of samples > 50% MCL	No. of Samples	No. of samples > 50% MCL	No. of Samples	No. of samples > 50% MCL
01	26	0	8	0	9	0	22	4	12	10
02	4	0	3	0	6	0	3	2	4	4

Table 5. Summary of Water Quality Samples for the Mount Saint Mary's University Water Supply

Inorganic Compounds (IOCs)

The only IOC detected above 50% of its MCL is arsenic. Arsenic was detected above the 50% MCL threshold periodically at both plants as shown on Table 6. Out of the 12 samples collected for arsenic from Plant 1 since 1993, 6 samples were non-detects, 2 samples were detected below, and 4 samples were above the 50% MCL threshold. The first two samples collected at Plant 2 since 2001 were above the MCL threshold, and the latest sample collected was a non-detect. The arsenic standard was recently lowered from 0.050 parts per million (ppm) to 0.010 ppm by the USEPA. Nitrate levels are well below levels of concern in all of the samples collected from both plants since 1993. The MCL for nitrate is 10 ppm. The average nitrate level since 1993 at Plant 1 is 1.16 ppm. The average of the four nitrate samples collected since 2001 at Plant 2 is 2.45 ppm. No other regulated IOCs were detected at levels of concern from either Plant from available sampling data since 1993.

PLANT ID	CONTAMINANT	MCL (ppm)	SAMPLE DATE	RESULT (ppm)
01	ARSENIC	0.010	9-May-97	0.005
01			12-Dec-01	0.006
01			9-May-02	0.005
01			20-Oct-04	0.006
02			17-Jul-01	0.005
02			10-Jan-02	0.007

Table 6. IOC Detects above 50% of the MCL in the Mt. St. Mary's Univ. Water Supply

Volatile Organic Compounds (VOCs)

The only VOC detected from 9 sets of available sampling data at Plant 1 was monochlorobenzene at 0.3 parts per billion (ppb) in 1990, well below its MCL of 100 ppb, and disinfection by-products known as trihalomethanes (THMs). The monochlorobenzene detect appears anomalous since it was only detected in one sample and not detected again in seven subsequent samples. From six sampling events since 2001 at Plant 2, the only VOC detected besides THMs was 1,2,4-Trimethylbenzene. This is an unregulated VOC that was detected once in 2001 at 7 ppb, but has not been detected again from five subsequent sampling sets.

Disinfecton byproducts were detected periodically at Plant 2 from two sets of sampling data at low levels in 2001, and again in 2003. The sum total of the four trihalomethanes (TTHM) detected was 1.2 ppb in November 2001, and 16.8 ppb in May 2003. TTHMs were also detected at Plant 1 from 4 sets of sampling data since 1997 at levels ranging from 5 to 21.3 ppb. For regulated systems, the current MCL for TTHMs is 80 ppb. Disinfection byproducts are the result of a reaction between chlorine used for disinfection and organic material in the water supply. No THMS were detected from the latest set of sampling results in August 2004 at Plant 2.

Synthetic Organic Compounds (SOCs)

Di(2-ethylhexyl) phthalate, Di(2-ethylhexyl) adipate, and dalapon were the only SOCs detected from 8 sets of available sampling data from Plant 1, and 3 sets of sampling data from Plant 2 since 1994. Di(2-ethylhexyl) phthalate was detected twice at both plants at low levels well below the MCL of 6 ppb. Di(2-ethylhexyl) adipate was detected in one sample only at Plant 1 in May 1995 at 1.15 ppb. The MCL for this SOC is 400 ppb. Adipate was not detected again from six subsequent sampling sets. These SOCs were also detected in all of the laboratory blank samples and therefore the results are not interpreted to represent actual water quality. Dalapon was detected at Plant 1 in 1995 at 0.5 ppb, and again in 1998 at 0.22 ppb respectively. The MCL for dalapon is 200 ppb. It was not detected from the latest sampling results in 2004.

Radionuclides

Radiological contaminants were detected above 50% of their respective MCLs in the Mount Saint Mary's University wells as shown on Table 7. Gross alpha and beta radiation are measures of alpha and beta particle activity that are used as indicators for the presence of other natural and man-made radionuclides. If the gross alpha particle activity is greater than its MCL of 15 pCi/L, samples must then be collected for uranium, radium-226 and radium-228. For a system to exceed the MCL for gross alpha, the contribution from combined uranium to the gross alpha measurements must be deducted prior to comparing the results to the 15 pCi/L standard. As shown on Table 7, the "adjusted" gross alpha results are obtained by subtracting the combined uranium activity from the gross alpha

or short-term gross alpha particle activity. The results indicate that gross alpha is in compliance with the EPA standard of 15 pCi/L. Additional information about the radionuclides rule can be found at: www.epa.gov/safewater/rads/final.

Radon-222 was also detected from single sets of sampling data tested at each plant (Table 7). At present, there is no MCL for radon-222, however EPA has proposed an MCL of 300 pCi/L or an alternate MCL 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. Gross beta was also detected persistently at both plants at levels well below its MCL of 50 pCi/L. Other radionuclides detected at low levels from sampling data at Plant 1 only include radium-226, radium-228, and uranium-234, 235, and 238. Radium is formed from the spontaneous radioactive decay of uranium, and thorium, which may naturally occur in fractured rock aquifers (Bolton, 2000).

PLANT ID	CONTAMINANT	MCL (pCi/L)	SAMPLE DATE	RESULT (pCi/L)
01	GROSS ALPHA	15	19-Sep-94	11.8
01	GROSS ALPHA	15	27-Feb-99	15
01	RADON-222	300*	9-Nov-99	620
01	GROSS ALPHA	15	28-Jan-03	12
01	GROSS ALPHA	15	11-Sep-03	17
01	GROSS ALPHA (SHORT TERM)	15	11-Sep-03	19
01	COMBINED URANIUM	45	11-Sep-03	12.6
01	GROSS ALPHA, ADJUSTED	15	11-Sep-03	6.4
01	GROSS ALPHA	15	17-Nov-03	14
01	GROSS ALPHA	15	11-Feb-04	9
01	GROSS ALPHA	15	20-May-04	16
01	GROSS ALPHA (SHORT TERM)	15	20-May-04	20
01	COMBINED URANIUM	45	20-May-04	12.9
01	GROSS ALPHA, ADJUSTED	15	20-May-04	7.1
01	GROSS ALPHA	15	9-Aug-04	25
01	COMBINED URANIUM	45	9-Aug-04	17.1
01	GROSS ALPHA, ADJUSTED	15	9-Aug-04	7.9
01	GROSS ALPHA	15	12-Oct-04	23
01	GROSS ALPHA (SHORT TERM)	15	12-Oct-04	27
01	COMBINED URANIUM	45	12-Oct-04	12.1
01	GROSS ALPHA, ADJUSTED	15	12-Oct-04	14.9
02	GROSS ALPHA	15	24-Apr-01	12
02	RADON-222	300*	24-Apr-01	1590
02	GROSS ALPHA	15	17-Jul-01	9
02	GROSS ALPHA	15	13-Nov-01	14
02	GROSS ALPHA	15	14-Jan-02	12

Table 7. Radionuclides Detected above 50% of their Existing or Proposed MCLs

* Lower proposed MCL

Microbiological Contaminants

Raw water samples were collected and tested for bacteria for Well 3 to determine whether the source is ground water under the influence of surface water (GWUDI). All of the wells were initially classified as high risk to surface water influence. The protocol for high risk GWUDI sampling requires sets of rainfall event sampling to be collected as soon as possible after a minimum of 0.5 inches of rainfall in 24 hours has occurred, and dry weather samples to be collected after a minimum of 7 days of less than 0.5 inches of precipitation. A set is defined as one sample per day for four consecutive days. As shown on Table 8, the test results for Well 3 were negative for the presence of total and fecal coliform bacteria. No GWUDI data is available for Wells 5 and 6 to date.

SOURCE NAME	RAIN DATE	RAIN AMOUNT (inches)	REMARK	SAMPLE DATE	PH	TURBIDITY (NTU)	TOTAL COLIFORM (col/100 ml)	FECAL COLIFORM (col/100ml)
WELL 3	26-Jun-95	0.7	WET SET	26-Jun-95	7.3	0.23	-1.1	-1.1
	26-Jun-95	0.7	WET SET	27-Jun-95	7.2		-1.1	-1.1
	26-Jun-95	0.7	WET SET	28-Jun-95	7.5	0.04	-1.1	-1.1
	26-Jun-95	0.7	WET SET	29-Jun-95	7.4	0.03	-1.1	-1.1
	17-Jul-95	0	DRY	17-Jul-95	7.4	0.07	-1.1	-1.1

Table 8. Raw Water GWUDI Test Results Completed for the Mount Saint Mary's University Supply Wells

SUSCEPTIBILITY ANALYSIS

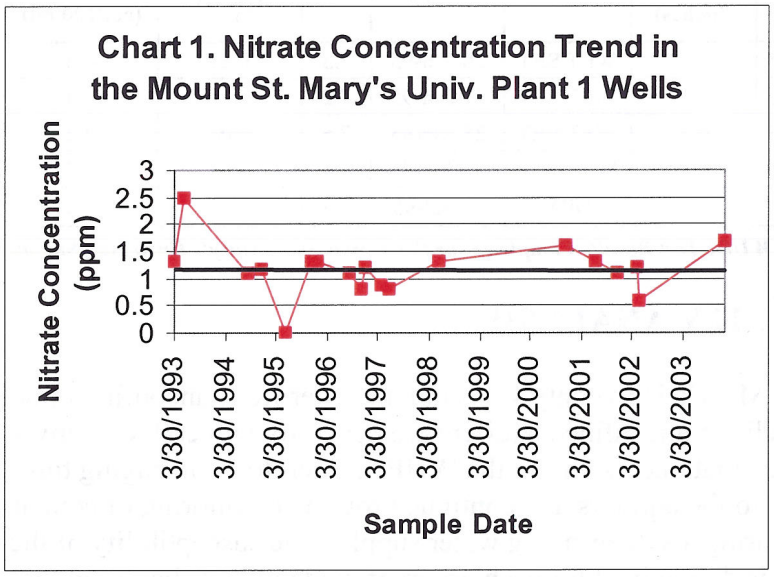
The Mount Saint Mary's University wells obtain water from unconfined fractured rock aquifers. Wells in unconfined aquifers are generally vulnerable to any activity on the land surface that occurs within the WHPA. Therefore, managing this area to minimize the risk to the aquifers and continued routine monitoring of contaminants is essential in assuring a safe drinking water supply. The susceptibility of the wells to contamination is determined for each group of contaminants based on the following criteria: (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.

Inorganic Compounds (IOCs)

EPA lowered the MCL for arsenic from 0.050 ppm to 0.010 ppm on February 22, 2002. The regulations have been effective for new sources since January 23, 2004. Existing water systems must meet the new standard by January 23, 2006. Arsenic is a naturally occurring element that is periodically present in the Mount Saint Mary's University aquifer formations at levels greater than 50% of this new MCL standard (Table 6). Twelve sets of data have been collected since 1993 at Plant 1. Arsenic was not detected in 6 samples collected from 1993-1998. It was detected below levels of concern from sets of data collected in January 1996, and in July 2001. The four sets of data that were above the 50% MCL threshold, including the latest data set, are shown on Table 6 in the Water Quality Data section. Plant 2 had arsenic detects above 50% of the MCL in 2

samples (Table 6). However, it was not detected from the latest sample collected in October 2004. Arsenic is more prevalent in confined, unconsolidated aquifers of the Atlantic Coastal Plain province (Bolton, 2003), but has also been detected to a lesser extent in fractured rock aquifers in Maryland. Based on the natural occurrence of arsenic in aquifer material, and its presence periodically above 50% of the newly established MCL, the Mount Saint Mary's University wells **are** susceptible to arsenic.

Nitrate is not present in the ground water supply at levels above 50% of its MCL of 10 ppm. Chart 1 shows the nitrate concentration trend in Plant 1 over the past eleven years. The available data shows that nitrate levels have been consistently low, and neither increasing nor decreasing. The average of the four nitrate samples collected since 2001 at Plant 2 is 2.45 ppm.



Sources of nitrate can generally be traced back to land use. Fertilizer applied to agricultural and athletic fields, residential lawns, and effluent from residential and commercial on-site septic systems are non-point sources of nitrate in ground water. A review of Table 3 indicates that cropland covers 23.5%, and residential properties utilizing private septic systems cover 4.7% of the WHPA respectively. As shown in Appendix A, and Figure 3, Well 3 is located in the middle of farmland. However, based on the sampling data history, nitrate has not been detected at levels of concern for this system. As discussed in the Hydrogeology section, the low nitrate results may be attributed to the semi-confining Gettysburg Shale aquitard that may provide a natural barrier for contamination at the surface from reaching the aquifers below. According to System Operator Phil Valentine, the farmers in the WHPA use Best Management Practices (BMPs) regarding the proper quantities of fertilizers placed so that excess nitrate from manure does not leach into the ground water during recharge periods. Due to all of these factors, the Mount Saint Mary's University wells are **not** susceptible to nitrate contamination.

Low levels of other inorganic constituents detected in the wells may likely represent the naturally occurring levels present in the aquifers from dissolving minerals in the bedrock. Therefore, the water supply **is not** susceptible to other regulated inorganic compounds other than arsenic, based on available water quality data.

Volatile Organic Compounds (VOCs)

The only volatile organic compounds that have been regularly detected at low-levels from sets of available sampling data since 1997 are the disinfection by-products known as trihalomethanes (THMs). THMs are the result of a reaction between chlorine used for disinfection and organic material in the water supply. The sum total of the four trihalomethanes (TTHM) detected in 4 sets of sampling data at Plant 1 since 1997 ranged from 5 to 21.3 ppb. TTHMs were also detected at Plant 2 from two out of six sampling events with levels ranging from 1.2 to 16.8 ppb. These levels are typical of levels measured at other ground water systems in Maryland. The MCL for TTHMs is 80 ppb. No THMS were detected from the latest set of sampling results in August 2004 at Plant 2.

Single detects of monochlorobenzene at Plant 1 in 1990, and the unregulated VOC, 1,2,4-trimethylbenzene at Plant 2 in 2001 appear anomalous since these compounds were not detected again from several subsequent data sets. Potential VOC point sources were identified near the Mount Saint Mary's University WHPA (Figure 2). However, these sources do not appear to have a significant impact on the wells based on the available water quality data. Therefore, the Mount Saint Mary's University ground water supply is **not** susceptible to VOC contamination.

Synthetic Organic Compounds (SOCs)

The current land use suggests that the potential non-point sources of SOCs located within the WHPA are primarily agricultural areas that account for 23.5 percent (Table 3), and athletic fields and other land associated with the Mount Saint Mary's University. Pesticides and chemicals used on residential lawns and gardens are a minor potential threat. However, typical lawn maintenance herbicides are very biodegradable and should not pose a significant SOC risk if applied properly. The university should adhere to a Best Management Practices (BMP) plan regarding the proper useage of lawn fertilizers, outdoor pesticide applications, and the storage of hazardous chemicals in the WHPA in order to prevent ground water contamination.

The only SOC detects from eight sets of sampling data at Plant 1, and three sets of sampling data at Plant 2 were Di(2-Ethylhexyl) Phthalate, Di(2-Ethylhexyl) Adipate, and dalapon, all well below 50% of their respective MCLs. The low-level phthalate detects from both plants, and the single low-level adipate detect

from Plant 1 in 1995 were also detected in the laboratory blanks and therefore do not represent actual water quality. Dalapon was reported in two samples at Plant 1 in 1995, and again in 1998 at very low levels well below its MCL of 200 ppb. Dalapon is a herbicide used on orchards, beans, lawns, and road/railway lines. The water quality results indicate that synthetic chemicals are not being over-applied in the WHPA. Based on this analysis, the ground water supply at Mount Saint Mary's University is **not** susceptible to SOC contamination.

Radionuclides

There is currently no MCL for radon-222, however EPA has proposed an MCL of 300 pCI/L or an alternative of 4000 pCi/L if the State has a program to address the more significant risk from radon in indoor air. Based on single samples collected at both plants, the levels were well above the lower proposed MCL of 300 pCi/L (Table 7). The source of radon and other radiological contaminants in ground water can be traced back to the natural occurrence of uranium in rocks. Radon may be prevalent in ground water of carbonate, and crystalline rock aquifers due to the radioactive decay of uranium bearing minerals in the bedrock. Although gross alpha is currently in compliance with the EPA standard of 15 pCi/L as discussed in the Water Quality Data section, it has been detected persistently at levels above 50% of the MCL at both plants. The results indicate that gross beta was also detected consistently at both plants at levels well below its MCL of 50 pCi/L. Other radionuclides detected at low levels at Plant 1 include radium-226, radium-228, and uranium-234, 235, and 238. Uranium 234 and 238 have extremely long half-lives, and are very mobile under oxidizing conditions. This enables them to be transported great distances in ground water (Bolton, 2000).

Based on the available sampling data, and the natural occurrence of uranium in rocks of the Frederick Valley, the Mount Saint Mary's University wells **may be** susceptible to radon-222 based on the lower proposed MCL and **are** susceptible to other radionuclides.

Microbiological Contaminants

Based on limited raw water bacteriological data (Table 8) the Mount Saint Mary's University Well 3 was determined not to be under the direct influence of surface water. No GWUDI data is available to formally evaluate Wells 5 and 6. However, some assumptions can be made from the available data, and the hydrogeology of these wells. The presumption that the Gettysburg Shale is a semi-confining unit overlying the wells' aquifers as described in the Hydrogeology section may help to inhibit bacteria and other microbiological pathogens at the surface from reaching the aquifers below. Microbial organisms in ground water generally have a maximum survival time of one year, and therefore they would have long since perished in a semi-confined aquifer setting. According to System Operator Phil Valentine, and available Well Completion Reports, the university's wells were properly constructed with casings extending

to bedrock, and sufficiently grouted. Based on all of these factors, the wells should be well protected from microbiological contaminants originating at the ground surface. Additionally, Well 6 was drilled in the same year, to a similar depth, in the same aquifer, and within about 2500 feet of Well 3. Therefore, it can be assumed that the raw water GWUDI data collected for Well 3 may also apply to Well 6. Based on these deductions, the supply wells are **not** susceptible to any microbiological contaminant present at the surface including *Giardia and Cryptosporidium*. However, the university should consider conducting GWUDI testing for Wells 5 and 6 to confirm this conclusion.

MANAGEMENT OF THE WHPA

The following recommendations should be considered for the protection of the Mount Saint Mary's University water supply:

Local Planning Team

- Forming a local planning team to develop a wellhead protection strategy is in the best interest of Mount Saint Mary's University. Such a team should represent the university, other property owners in the WHPA, and County Planning and Environmental Health Departments. The team should work together to reach a consensus on how to protect the water supply.

Public Awareness and Outreach

- The Consumer Confidence Report should include a summary of this report and information that this report is available to the general public through their county library, or by contacting the university or MDE.
- Since most of the WHPA lies within the property owned by the university, MDE recommends the implementation of a campus-wide awareness program to minimize contamination occurrences within the WHPA. The university should provide letters and flyers to students, faculty, and personnel to inform them about environmentally conscientious waste management practices within the WHPA.
- Conduct educational outreach to commercial facilities near the WHPA where potential contaminant sources may be present. Important topics include: (a) compliance with MDE and federal guidelines for USTs, (b) best management practices, (c) proper chemical storage practices, (d) reporting chemical and petroleum spills, and (e) proper use and application of fertilizers and pesticides.
- Placing signs at the WHPA boundaries is a good way to make the public aware of protecting the water supply sources.

Planning/New Development

- The preservation of the existing forested recharge areas within the WHPA is an important step that the university can take to ensure the long-term safety of the ground water supply.
- Mount Saint Mary's University should stay in contact with the Frederick County Planning Department regarding any proposed construction within or near the WHPA to ensure that it will not have any adverse affects on water quality. Plans

for new construction on-campus should stress the importance of adequate protection of the ground water sources.

Cooperative Efforts with Other Agencies

- Mount Saint Mary's University should request the assistance of the University of Maryland Agricultural Extension Service and the Soil Conservation Service to work with farmers to continue Best Management Practices (BMP's) for cropland located in the WHPA.
- The university may also want to participate in the New Conservation Reserve Program (CREP) applicable to the cropland located within the wellhead protection area. Government funding is available to qualified farmers equal to the cost and financial benefit of farming the area. The Natural Resources Conservation Service is responsible for determining the environmental benefits of each acre offered for participation.

Monitoring

- Continue to monitor for all Safe Drinking Water Act contaminants as required by MDE.
- The university should conduct GWUDI testing for Wells 5 and 6 to confirm that they are not under the direct influence of surface water.
- Annual raw water bacteriological testing of each well is a good check on well integrity.
- The university should stay in contact with the MDE Oil Control Program for the latest updates regarding open cases near the WHPA.
- Periodic inspections and a regular maintenance program of the supply wells will ensure their integrity and protect the aquifers from contamination.

Contingency Plan

- COMAR 26.04.01.22 regulations require all community water systems to have a plan for providing a safe and adequate drinking water supply under emergency conditions. The University has a permanent interconnection with the Town of Emmitsburg to supply or receive water during an emergency.

Changes in Use

- Any increase in pumpage or addition of new wells to the system may require revision to the WHPA. The system is required to contact the Water Supply Program when an increase in pumpage is applied for and when new wells are being considered.

Contaminant Source Management

- Guidelines should be developed to assist university facilities personnel in the proper handling and storage of hazardous materials including petroleum products, the proper application of fertilizers and pesticides on campus grounds including athletic facilities, and de-icing, and wastewater discharge practices with emphasis on protecting ground water quality.

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MDE Water Supply Program Oracle® Database
MDE Waste Management Sites Database
MDE Environmental Permits Database
MD Department of Natural Resources 1998 Digital Orthophoto Quarter Quadrangles for Emmitsburg, SW
USGS 7.5 Minute Series Topographic Maps, Emmitsburg & Blue Ridge Summit Quadrangles
MD Office of Planning 2002 Frederick County Digital Land Use Map
MD Office of Planning 1996 Frederick County Digital Sewerage Coverage Map
ADC® Digital Maps for Frederick County
MD State Highway Administration Roads Map

FIGURES

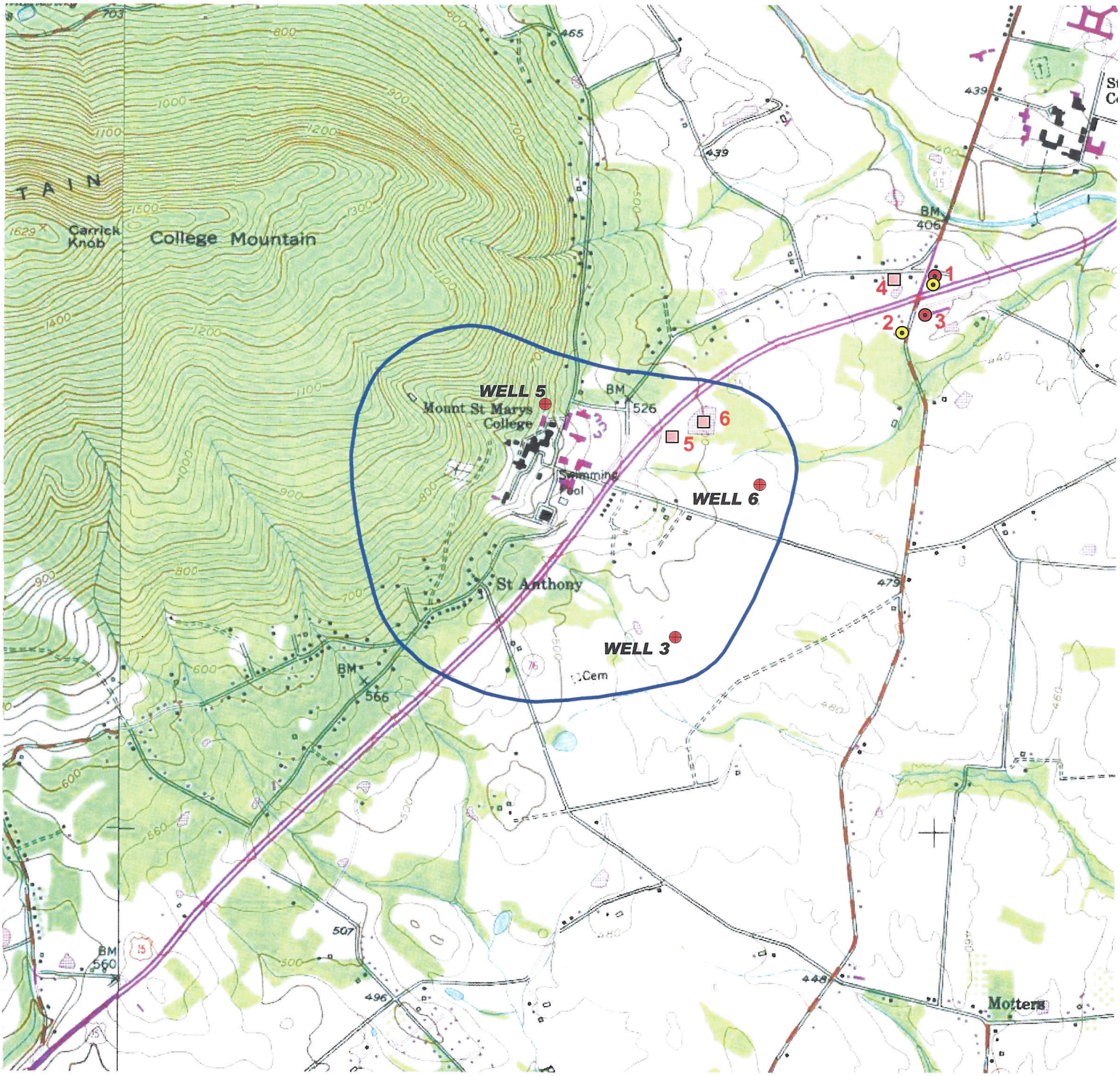


Figure 2. Mount Saint Mary's University Wellhead Protection Area with Potential Contaminant Sources

LEGEND

- Supply Wells
- Underground Storage Tanks (USTs)
- Leaking USTs
- Miscellaneous Sites
- Wellhead Protection Area

N

2000 0 2000 Feet

Base Map: USGS 7.5 Minute Series Quads for Emmitsburg & Blue Ridge Summit

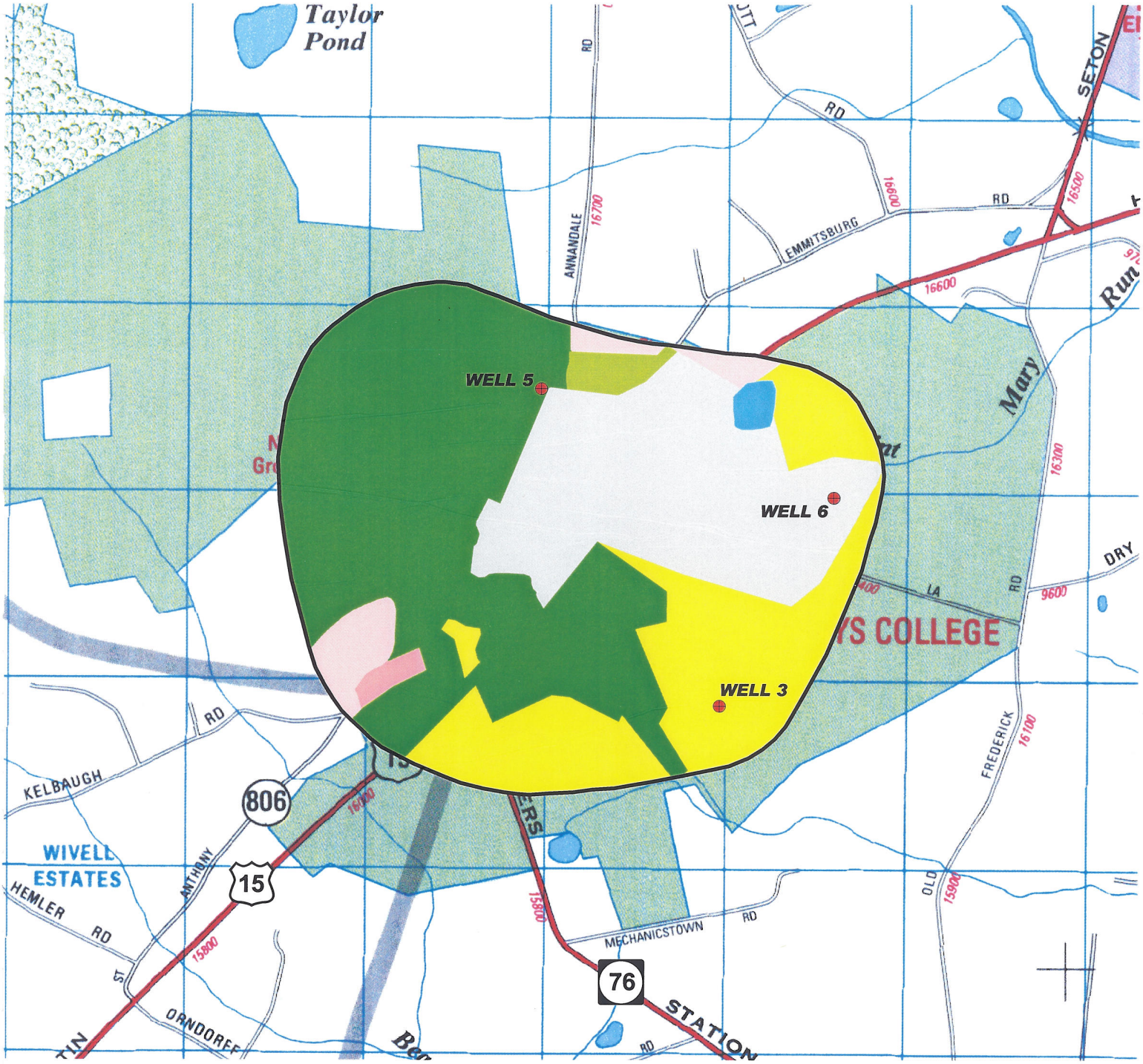


Figure 3. Land Use in the Mount Saint Mary's University Wellhead Protection Area

LEGEND

- Supply Wells
- Wellhead Protection Area

Frederick County Land Use

- Low Density Residential
- Medium Density Residential
- Commercial
- Cropland
- Pasture
- Forest
- Water

N

1500 0 1500 Feet

Base Maps: MD Dept. of Planning 2002 Digital Land Use Map, and ADC Digital Map for Frederick County

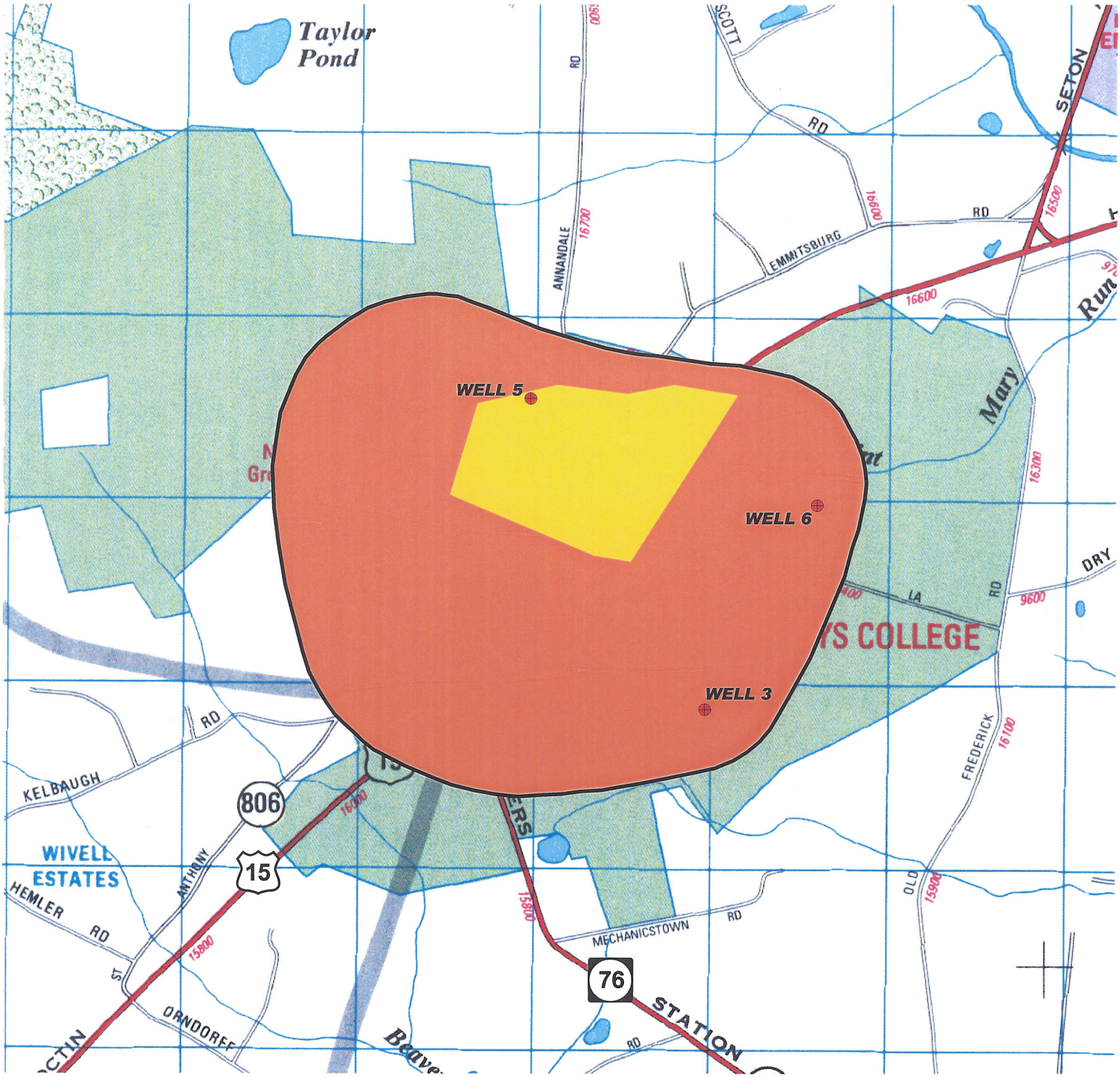


Figure 4. Sewer Service in the Mount Saint Mary's University Wellhead Protection Area

LEGEND

- Supply Wells
- Wellhead Protection Area

Frederick County Sewerage Coverage

- No Planned Service Area
- Existing Service Area

N

1500 0 1500 Feet

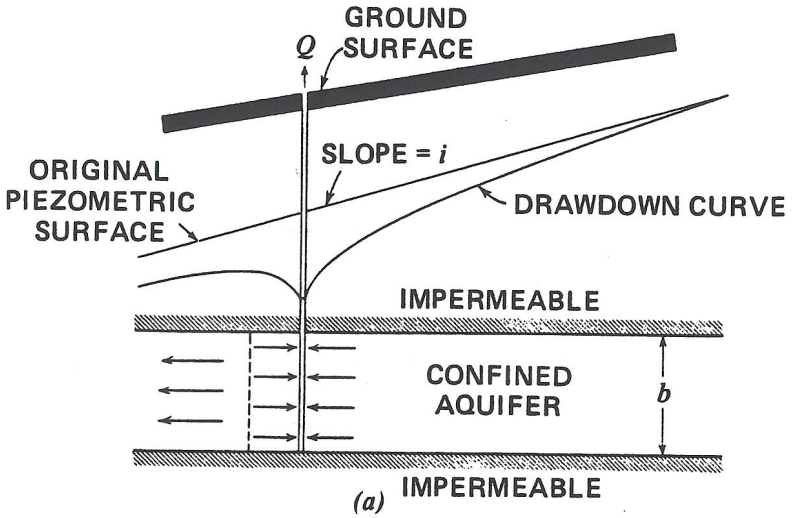
Base Maps: MD Dept. of Planning 1996 Digital Sewerage Coverage Map, and ADC Digital Map for Frederick County

APPENDICES

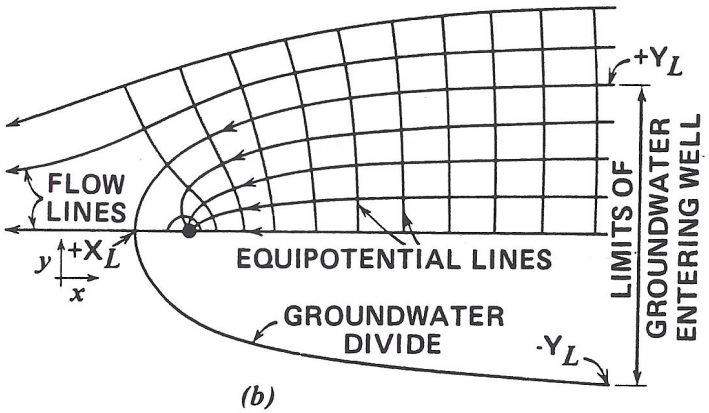
APPENDIX B

Distance to Down Gradient Stagnation Point Calculations

WHPA Delineation Using the Uniform Flow Analytical Model



(a)



(b)

$$\underbrace{-\frac{Y}{X} = \tan\left(\frac{2\pi Kbi}{Q}Y\right)}_{\text{UNIFORM-FLOW EQUATION}}$$

$$\underbrace{X_L = -\frac{Q}{2\pi Kbi}}_{\text{DISTANCE TO DOWN-GRADIENT NULL POINT}}$$

$$\underbrace{Y_L = \pm\frac{Q}{2Kbi}}_{\text{BOUNDARY LIMIT}}$$

LEGEND:

- Pumping Well

Where:
Q = Well Pumping Rate
K = Hydraulic Conductivity
b = Saturated Thickness
i = Hydraulic Gradient
π = 3.1416

SOURCE: Todd, 1980

NOT TO SCALE

(OVER) →

DISTANCE TO DOWN GRADIENT (STAGNATION) POINTS:

$$X = \frac{Q}{2\pi T i}$$

FOR WELL 6

WHERE

X = DISTANCE TO THE DOWNGRADIENT DIVIDE (IN FT.)

Q = PUMPING RATE OF WELL

FOR WELL 6, THIS IS 70,000 gpd OR 9358 ft^3/day

T = AQUIFER TRANSMISSIVITY = K x b

FOR WELL 6, A CONSERVATIVE ESTIMATE OF 1000 gpd/ft OR 134 ft^2/day WAS USED.

i = HYDRAULIC GRADIENT OF THE WATER TABLE

FOR WELL 6, i = 40'/1800' OR 0.02222

$$X = \frac{9358\ ft^3/day}{2\pi(134\ ft^2/day)(0.02222)}$$

$$X \simeq 500'$$

FOR WELL 3

WHERE

Q = 110,000 gpd OR 14,706 ft^3/day

T = 134 ft^2/day

i = 40'/1500' OR 0.02666

$$X = \frac{14706\ ft^3/day}{2\pi(134\ ft^2/day)(0.02666)}$$

$$X \simeq 655'$$

APPENDIX C

Summary of MDE Oil Control Program Open Cases Near WHPA

CASE NO.	NAME	LOCATION	STATUS AS OF JUNE 2005
03-0882FR	E-Z Fill Getty Stop Gas	16603 S. Seton Ave. Emmitsburg, MD 21727	Contact Finka Cathey of the MDE Oil Control Program to obtain information regarding this case.
97-0482FR	Mountain Manor Treatment Center	9701 Keysville Rd. Emmitsburg, MD 21727	Became an open case in 1997 as a result of a referral letter sent by MDE Water Management Admin. MTBE was originally detected in the domestic well on this property at 33 ppb. A granular activated carbon (GAC) system was installed. The most recent sampling results conducted in 2003 show all VOC levels below MDE action levels. The Oil Control Program is continuing to monitor this case to ensure that continued sampling is conducted, and that the GAC system is still in operation and effectively removing VOCs. There is no data indicating that the VOC contamination has moved away from this site.

MDE Oil Control Program Open Cases near the Mount Saint Mary's University Wellhead Protection Area