INTRODUCTION

Briddletown is a residential community located approximately 1 mile east of the Town of Berlin in Worcester County. The Briddletown water system is owned and operated by the Worcester County Department of Public Works (DPW), Water and Wastewater Services. The system serves a population of 150 residents. The water is supplied by one well. Figure 1 shows the location of the supply well.

WELL INFORMATION

A review of the well completion report and sanitary surveys of the Briddletown water system indicates that the supply well was drilled in 1987 and meets the State's well construction regulations. The well has a yield of approximately 300 gallons per minute (gpm). Table 1 contains a summary of the well construction data.

SOURCE ID	SOURCE NAME	PERMIT NO	TOTAL DEPTH	CASING DEPTH	AQUIFER
01	BRIDDLETOWN WELL	WO811785	117'	97'	QUATERNARY

Table 1. Briddletown Well Information.

HYDROGEOLOGY

Briddletown's well obtains water from the Quaternary aquifer, which is also referred to as the Columbia aquifer (Bachman andWilson, 1979). In the Briddletown area, the Quaternary sediments are composed of the Beaverdam Sand and the Omar Formation. The Beaverdam Sand consists of tan to light brown medium to coarse-grained sand and is about 90 feet thick. The well is screened in this sand. Overlying the Beaverdam Sand is about 11 feet of grayish brown silty clay of the Omar Formation. The aquifer is considered to be unconfined since the clay bed overlying the screened interval is thin and leaky.

Based on water table maps (Weigle and Achmad, 1982), the ground water flow was determined to be east southeast with a gradient of 0.0015. The transmissivity of the aquifer is 4706ft^2/day and a porosity of 30% was assumed for the aquifer.

SOURCE WATER ASSESSMENT AREA DELINEATION

For ground water systems, a Wellhead Protection Area (WHPA) is considered the source water assessment area for the system. WHPAs were delineated for Briddletown's supply well using EPA's WHPA Code version 2.0, a user friendly two-dimensional ground water flow model. The permitted daily average for Briddletown is 20,000 gallons per day (2674ft^3/day). This was the quantity used for the model.

Delineation Zones

Zone 1: Zone 1 is the WHPA delineated using a 1 year time-of-travel (TOT) criterion. Zone 1 serves as the first zone of protection. The one year criterion was selected base on the maximum known survival times of microbial organisms in ground water. The delineated Zone 1 WHPA is oval in shape and has a maximum diameter of 350 feet.

Zone 2: Zone 2 is the WHPA delineated using a 10 year TOT criterion. It would take any chemical contaminant present at the Zone 2 boundary 10 years to reach the well (if it moves at the same rate as the ground water). Zone 2 provides adequate time for facilities outside the WHPA to address chemical contamination before it could reach the well. The delineated Zone 2 WHPA is oval is shape and has a maximum diameter of 900 feet.

POTENTIAL SOURCES OF CONTAMINATION

For this assessment, MDE Waste and Water Management databases were reviewed, staff consulted, and field inspections conducted, to identify potential sources of contamination in and around the Briddletown WHPA. In addition, MDE staff conducted a telephone interview with Mr. Gary Serman, the Water Superintendent for Briddletown's water supply, to discuss water quality concerns. A follow up field survey of the WHPA was conducted on December 23, 1999. No potential point sources of contamination were identified within the Briddletown WHPA.

One potential point source of contamination that was identified through the databases was the presence of two diesel fuel tanks next to the Stephen Decatur High School buildings. These tanks meet the State regulations and currently do not pose a threat to the supply.

Based on the Maryland Office of Planning's 1997 Land Use map, the land use within the WHPA is as follows:

LAND USE	TOTAL AREA (acres)	PERCENTAGE OF WHPA
Commercial	4.7	61
Cropland	3.0	39

Table 2. Land Use Summary for WHPA Zones 1 and 2

Figure 3 shows the land use in and around the Briddletown WHPA. Within Zone 1 the land use is equally divided between cropland and commercial. But a field inspection of the WHPA indicates that the area shown as cropland south of the well is now occupied by Stephen Decatur Middle School (figure 1). Hence currently, the entire WHPA is on school property, with cropland surrounding it to the east and west. The supply well is actually located in an athletic field.

Nitrates and synthetic organic compounds could be potential sources of contaminants to the water supply due to application of fertilizers and pesticides for landscaping the school properties and maintenance of the athletic fields. In addition, former and present cropland are potential sources of nitrates and pesticides.

A review of Maryland Office of Planning's Worcester County Sewer Map shows that the entire WHPA is in a no planned sewer service area. But inquires with the Town of Berlin indicated that the Town serves water and sewer service to both the schools surrounding the well. Stephen Decatur High School had an onsite septic system, which was located northwest of the WHPA. Residual nitrate may be a potential contaminant to the water supply.

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 data described is from the finished (treated) water unless otherwise noted. The treatment currently used at Briddletown is hypochlorination for disinfection, pH adjustment for corrosion control and ion exchange for iron removal.

MDE personnel discussed water quality issues and concerns with Mr. Gary Serman, Superintendent of Water Supply Operations for Briddletown in December 1999 and January 2000. Mr. Serman indicated that nitrate levels and sodium levels in the water supply were being closely monitored.

A review of the monitoring data since 1993 for Briddletown's finished water indicates that the system's water supply currently meets the drinking water standards. Nitrate was the only contaminant detected above 50% of the Maximum Contaminant Level (MCL). Table 4 summarizes the nitrate detects above the 50% MCL since 1993.

Inorganic Compounds (IOCs)

CONT ID	CONTAMINANT NAME	MCL (ppm)	SAMPLE DATE	RESULT (ppm)
1040	NITRATE	10	19-Nov-93	7.6
1040	NITRATE	10	02-Dec-94	7.9
1040	NITRATE	10	12-Apr-95	7.2
1040	NITRATE	10	29-Jan-96	7.1
1040	NITRATE	10	01-Mar-96	7.6
1040	NITRATE	10	17-May-96	7.3
1040	NITRATE	10	25-Jun-96	6.9
1040	NITRATE	10	16-Aug-96	7.7
1040	NITRATE	10	14-Nov-96	7.8
1040	NITRATE	10	14-Feb-97	7.3
1040	NITRATE	10	01-May-97	7.6
1040	NITRATE	10	05-Sep-97	8.3
1040	NITRATE	10	07-Nov-97	8.4
1040	NITRATE	10	19-Feb-98	8.1
1040	NITRATE	10	24-Apr-98	8.3
1040	NITRATE	10	18-Sep-98	8.8
1040	NITRATE	10	13-Nov-98	9.2
1040	NITRATE	10	21-Jan-99	9.5
1040	NITRATE	10	07-May-99	9.1
1040	NITRATE	10	18-Nov-99	9.2

Table 3. IOC results above 50% of the MCL for Briddletown's finished water since 1993.

The MCL for nitrate is 10 ppm. As shown above, nitrate was detected above 50% of the MCL in all the samples collected since 1993. Table 3 indicates that there is a gradual increase in the nitrate concentrations with time. This will be discussed in the susceptibility analysis section of this report.

Sodium was detected in the water supply at 98 ppm (6/25/96) and 74.3 ppm (7/13/99). No MCL or secondary MCL has been established for sodium at the present time. Mr. Serman indicated that the high values of sodium can be attributed to the use of sodium chloride for ion exchange and caustic soda (sodium hydroxide) for pH adjustment.

Sulfate was detected at 4.8 ppm (8/16/94), 16.2 ppm (6/25/96), and 16.6 ppm (7/13/99). Sulfate is an unregulated IOC and has a secondary MCL of 250 ppm. Sulfate is a naturally occurring compound in the aquifer sediments.

Barium is another naturally occurring IOC that was detected in the Briddletown supply. The MCL is 2 ppm and it was detected at 0.16 ppm (8/16/94).

Volatile Organic Compounds (VOCs)

Methyl-tert-butyl-ether (MTBE) was detected at 13 ppb (9/16/97), 23 ppb (7/13/99) and 21.2 ppb (03/07/00). MTBE is an unregulated VOC and has no MCL. EPA has issued an advisory recommending that levels be kept at or below 20 ppb based on taste and odor concerns. Based on limited data they also believe that this level is protective of public health.

Tetrachloroethene was detected at 0.9 ppb (7/13/99) and 1.2 ppb (03/07/00). Tetrachloroethene has an MCL of 5 ppb. 1,1,1-Trichloroethane was detected at 0.6 ppb (7/13/99) and 0.8 (03/07/00). 1,1,1-Trichloroethane has an MCL of 200 ppb.

Methylene chloride was detected at 9 ppb on 11/2/91. Methylene chloride has an MCL of 5 ppb. This detection was attributed to a laboratory error, since this compound is used to clean laboratory equipment and was found in samples collected from other locations that day.

Synthetic Organic Compounds (SOCs)

Dalapon was the only SOC that was detected at 0.06 ppb on 6/12/93 in samples collected since 1993. The MCL for Dalapon is 200 ppb. This detection was attributed to a laboratory error since dalapon was found in the laboratory blanks and in other samples collected that day.

Radionuclides

Gross beta was detected in a sample collected on 10/6/93 at 1.4 pCi/L. The MCL for gross beta is 50 pCi/L. It is a decay product of naturally occurring radioactive minerals in the aquifer sediments.

Microbiological Contaminants

Ground Water Under the Direct Influence of Surface Water (GWUDI) sampling was conducted for Briddletown's well on 12/16/98. The results were negative for the presence of total and fecal coliform for the water supply.

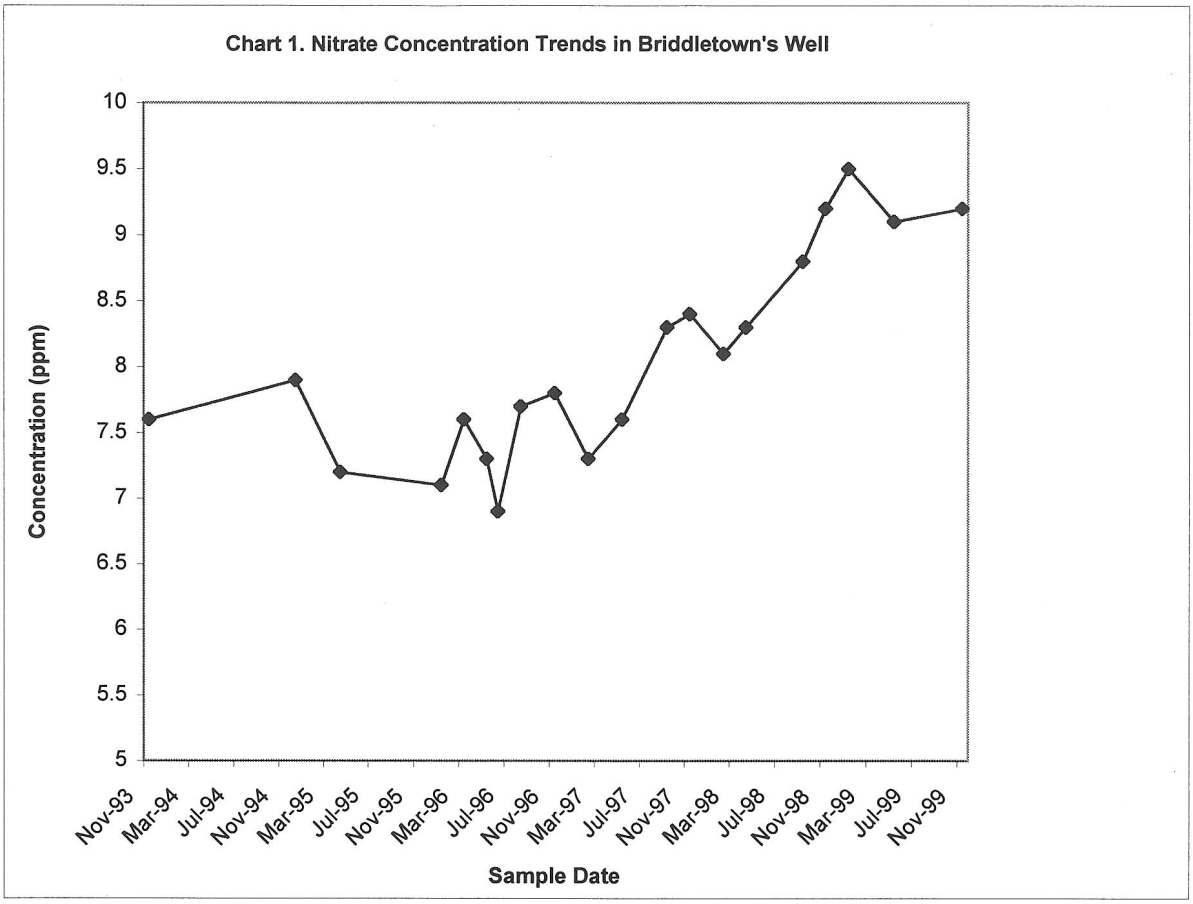
SUSCEPTIBILITY ANALYSIS

Briddletown's well obtains water from an unconfined aquifer. In general, water supplies in unconfined aquifers are susceptible to contamination from land use activities. The well completion report indicates the presence of about 11 feet of silty clay layer between the surface and the well screen. The clay bed may inhibit the infiltration of some of the surface contaminants into the aquifer. Continued routine monitoring of contaminants is essential in assuring a safe drinking water supply.

Inorganic Compounds (IOCs)

Nitrate has been detected in Briddletown's water supply at above the 50% MCL level since 1993. Sampling data indicates that the nitrate concentration levels have

been increasing with time. (Chart1). If the trend continues it will reach the MCL of 10 ppm shortly.



Sources of nitrate can be traced to land use. Fertilization of cropland and athletic fields, and onsite septic systems are non-point sources of nitrate in ground water. In the past the land use in and around Briddletown's WHPA was all cropland. The land was mainly used to raise corn. Even at the present time cornfields are present to the east and west of the WHPA (figure 3). The Stephen Decatur High School used to have an onsite septic system northwest of the WHPA. This has now been removed and the school is now tied to the Town of Berlin's pubic sewer. The presence of nitrate may be mainly attributed to historical and current agricultural practices. Nitrate may be originating outside the WHPA (older than 10 years) in the ground water (Jonathan et al, 1999). Use of fertilizers of school field maintenance and the old onsite septic system may have also contributed to the nitrate concentrations.

Stephen Decatur High School had its own water supply a few years ago. Due to excessive nitrates the school abandoned its supply, and connected to Berlin's water system. Another noncommunity water system drilled a well into the deeper confined aquifer to avoid the high nitrate levels in its water supply. Mr. Serman indicated that if the nitrate exceeds the MCL, Briddletown may obtain its water supply from the

Town of Berlin with whom they have a connection. Alternatively, they could drill a deeper new well in a confined aquifer.

Based on the above analysis, Briddletown's water supply **is** susceptible to nitrate.

Volatile Organic Compounds

VOCs were detected in Briddletown's water supply. MTBE was detected initially in 1997 and in greater concentrations in 1999. In addition, tetrachloroethene and 1,1,1-trichloroethane were also detected in 1999. MTBE is a gasoline additive, tetrachloroethene is used as a solvent for dry cleaning and 1,1,1-trichloroethane is used as a degreaser. No known sources potential sources of these VOCs were identified in the WHPA. An UST site outside the WHPA adjacent to the high school buildings (figure 2) is in compliance with State regulations. MDE's Oil Control Program is investigating the source of the MTBE. Possible sources of the VOC's maybe the related to the spills on Seahawk Road adjacent to the well or other past spills or activities in the WHPA.

Based on the above analysis, Briddletown's water supply **is** susceptible to VOCs.

Synthetic Organic Compounds (SOCs)

The current land use indicates that non-point sources like cropland and athletic fields exist within and around the WHPA. Pesticides and herbicides used for agricultural operations and landscaping and maintenance of school property are a potential threat. The Dalapon may have been used on the property at one time. Briddltown's water supply is currently **not** susceptible to SOC contamination. It has the potential for susceptibility to SOCs if best management practices are not followed in management of the land in and around the WHPA.

Radionuclides

Gross beta radiation was detected on time in 1993. However, the detected level was way below 50% of the MCL. Gross beta radiation may be attributed to the decay of naturally occurring minerals like uranium in the aquifer sediments. Briddletown's water supply is **not** susceptible to radionuclides.

Microbiological Contaminants

Based on coliform sampling data, Briddletown's water supply well was determined **not** to be susceptible to protozoans or bacteriological contaminants. The well may be susceptible to viral contaminants, as these are much smaller, can survive longer, and may not be effectively filtered by the aquifer as protozoans and bacteria. Future monitoring will be needed to determine susceptibility to viruses.

MANAGEMENT OF THE WHPA

Form a Local Planning Team

- The team should represent all the interests in the community. The water supplier, residents, the County Health Department, the County Board of Education, local planning agencies, local businesses, developers, and farmers should work to reach a consensus on how to protect the water supply.

Public Awareness and Outreach

- Pamphlets, flyers and bill stuffers sent to local residents, businesses, schools, and farmers will help educate the general public about Wellhead Protection. A MDE pamphlet entitled "Gardening in a Wellhead Protection Area" is such an example.
- Placing signs at the WHPA boundaries is a good way to make the public aware of protecting their source of water supply.

Monitoring

- Continue annual VOC and quarterly nitrate sampling and closely note any increase continued increase in concentrations of these contaminants and make plans to treat them if they exceed the MCLs or provide an alternate source of supply.
- Continue SOC sampling every 6 years and periodic sampling of radiological contaminants and other IOCs.
- Annual sampling for microbiological contaminants is a good check on well integrity.
- Contact MDE's Oil Control Program to get updates on existing USTs and any new USTs in and around the WHPA.

Planning/New Development

- To prevent increase in nitrate levels in the water supply, the school should not excessively fertilize their fields.
- Continue to stress the importance of a Comprehensive Water and Sewer Plan to ensure that new development (residential and commercial) adjacent to the WHPA is sewered. Currently, there is no planned sewer service for new developments along the east side of Seahawk Road.

Cooperative Efforts with Other Agencies

- The farming community should work with the Soil Conservation District to develop Best Management Practices (BMP) for farms located around the WHPA. The Cooperative Extension Service is available to develop nutrient management plans for farmers to match crop needs with fertilizer application. In particular, fall/winter cover crop practices can keep excess nitrogen from leaching into the ground water

Land Acquisition/Easements

- The availability of loans for purchase of and/or easements for the purpose of protecting water supplies is available from MDE. Loans are offered at zero percent interest and zero points.

Contingency Plan

- Comar 26.04.01.22 regulations require all community water systems to prepare and submit for approval a plan for providing a safe and adequate for providing a safe and adequate drinking water supply under emergency conditions.

Change in Uses

- Any increase in pumpage or the addition of new wells to the system will require revision of the WHPA since it is affected by pumpage. It is recommended that Briddletown contact the MDE Water Supply Program when an increase in pumpage is applied for or when new proposed wells are being considered.

Contaminant Source Inventory Updates/Well Inspection

- Briddletown should conduct its own detailed survey to ensure that there are no other potential sources of contamination within or adjacent to the WHPA. Since the WHPA is on school property, school maintenance staff should be involved in the survey.
- Water operation personnel should have a regular inspection and maintenance program for the supply well to ensure its integrity and to protect the aquifer from surficial contamination.