APPENDIX A:
WATER SUPPLY

Poolesville's Water Supply

Introduction

Poolesville currently relies entirely upon groundwater to supply the needs of its residents and businesses. Generally, unless it has been contaminated by some type of human activity such as industrial contaminants or by water-borne pathogens, groundwater provides a higher quality source of potable water than surface water, such as that from a river or lake. This is because the water is purified as it passes through the soil on its way to the subsurface aquifer or water-bearing region below the surface. Poolesville's groundwater supply has been studied and reviewed at frequent intervals. Because of the fractured bedrock aquifer underlying Poolesville, a perfect understanding of groundwater flow and availability may never be reached irrespective of the level of additional studies.

The Hydrologic Cycle

All groundwater has its source from precipitation. It is therefore helpful to explain the path -- or hydrologic cycle -- that water takes before it reaches consumers. .

The term hydrologic cycle refers to the constant, never-ending movement of water above, on and below the earth's surface (Figure 1). It begins with evaporation from exposed moist surfaces, lakes, rivers, streams, the ocean and the active transport by plants from the soil to the air -- a process known as evapotranspiration. The moisture forms clouds, which return the water to the earth as precipitation.

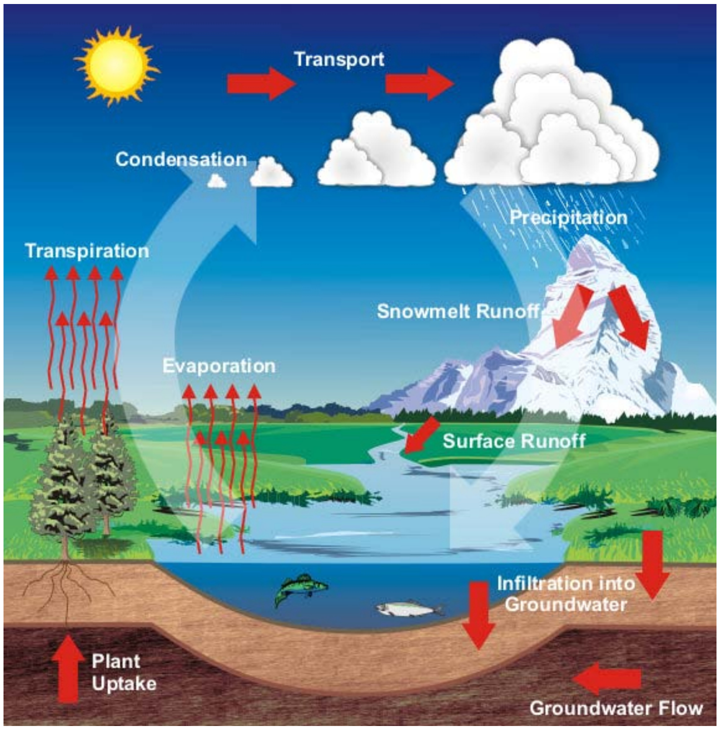

Figure 1. The hydrologic cycle

Precipitation—rain, melted snow, and hail--wets the land and begins to infiltrate into the ground. Infiltration rates are greatest in forests, growing on sandy soils and least in open land with clayey and silty loam soils. In Poolesville, the soils are generally silty and have a low permeability. During low to moderate rainfalls much of the water infiltrates; however, when the rate of precipitation exceeds the rate of infiltration, such as during heavy thunderstorms, overland flow or runoff begins.

The first infiltration provides soil moisture. After the soil becomes moist, the excess percolates slowly down through the layers of unsaturated soil to the saturation zone. In

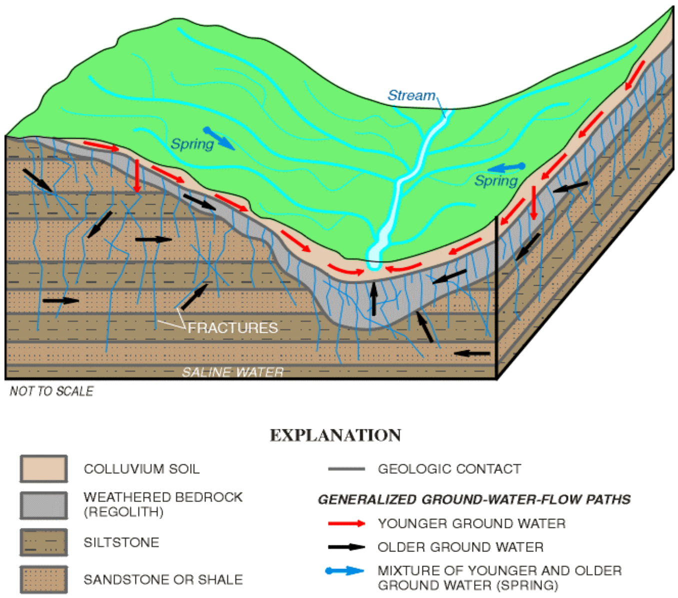

Figure 2.
Diagram of ground water occurrence in jointed and creviced consolidated sedimentary rocks.

Poolesville's case, there is a very thin layer of soil overlying a thick mantle of sandstone, shale and/or siltstone (Figure 2) deposited on the earth millions of years ago during the Triassic geologic period (known to geologists as the New Oxford Formation of the Newark Group) [5]. Because of this thin layer of soil, Poolesville's groundwater is highly susceptible to contamination from events that occur on the land surface.

Below the water table, the soil will be saturated until some type of confining layer stops the downward flow of water. Most of the groundwater available to Poolesville is located in crevices, fissures and fracture lines that run through the underlying bedrock (Figure 2). Groundwater-underlying Poolesville moves downward and sideways to sites of discharge (Figure 3). In the Poolesville area, discharge sites are generally seeps in the bottoms of streams and particularly into the Potomac River. The orientation of fractures and the movement of groundwater beneath Poolesville is generally in a northwest to southeast direction [5].

Water reaching streams and rivers, both by overland flow and from groundwater discharge, moves to the sea (down the Potomac River) where it is evaporated and begins the cycle anew.

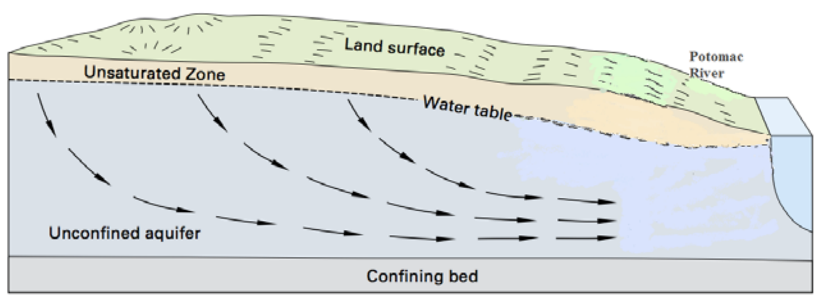

Figure 3. Stylized movement of ground water towards the Potomac River. Groundwater normally flows as a muted image of the land's surface. Poolesville's water movement primarily occurs in cracks and fractures. *(source:1)

Geology

The underlying geology effects Poolesville's water supply in many ways. To the north and northeast of Town, the land is predominantly underlain by phyllite. Phyllite is ancient, gray-green crystalline rock that has a slaty appearance with lustrous bands of mica.

To the west and northwest of Town, there is a diabase dike. Diabase is molten rock that welled-up from the earth's core millions of years ago. In this case, the molten rock filled a long, wide fracture in the sedimentary rock that runs between Dickerson and Beallsville, then west of

Poolesville to the Potomac River. Because the diabase is essentially impermeable, groundwater to the west of the dike is separated from that to the east of it. This fact has positive ramifications for Poolesville. One benefit of this dike's existence is that any groundwater contamination that might arise from leaks in the Dickerson landfill liner will most likely move west and south towards the Potomac River and much less likely contaminate Poolesville's water supply.

Unfortunately, the dike also limits the recharge area of the groundwater aquifer underlying Poolesville. The groundwater supplying Poolesville's wells is fed from a relatively small watershed. In fact, most of the recharge of the aquifer beneath Poolesville comes from precipitation that falls directly within the boundaries of Town or immediately to the northwest of it. Thus, if one pictures a layer of approximately 10 inches of water covering the surface of land in Town (1,940 undeveloped acres), it will provide an idea of the amount of groundwater theoretically available to the community through Town wells. The volume is approximately equivalent to 1.5 million gallons per day (GPD) or 1000 gallons per minute (GPM).

The rock immediately beneath the surface soils in the area of the Town contains numerous fissures, cracks and crevices (Figure 2). Unlike some areas of the country that are underlain with relatively homogeneous, unconfined deposits of course sands and gravels that form relatively uniform aquifers, the groundwater generally is channelized in these cracks and crevices. While the cracks and fractures may be several thousand feet long, they are generally no wider than a person’s small finger and may be only one to two feet high or less.

In a fractured rock aquifer, almost all of the groundwater flow is through a few open joints with the bulk of the aquifer contributing very little water. Transmissivity is defined as the rate that the aquifer can deliver water to a well through its entire thickness [1, 3, 5]. The rate of movement of water through the fractures is very high, but averaging this over the entire, largely non-producing, thickness of the aquifer gives a low value [2]. Thus, Poolesville’s water is more or less confined to small cracks and the yield of a well generally depends upon the number of fractures that it intercepts: the greater the number of fractures, the higher the yield.

While the water can be transmitted to the wells in the fractures fairly fast, the fact that most of the aquifer is composed of rock means that the ability of the aquifer to store water is limited primarily to that in the fractures themselves. Once water is drawn out of a fracture (in other words - sucked dry), there is little water within the "pores" of the rock to replace it. Replacing the water in the fractures depends upon recharge from precipitation.

While yields from the New Oxford Formation are relatively low compared to unconsolidated rock aquifers found in other parts of the country, yields from phyllite are even lower. Otton reported yields from such wells rated at 0.5 to 25 GPM [5]. The median yield for 9 of these wells was 7 GPM.

Drawdown

As water is pumped from a well, it decreases the water pressure in the fractures near it. As long as the rate of pumping does not exceed the transmissivity, the level of water in the well should remain relatively constant. During winter and spring months when groundwater is being recharged from above, recharge is greater than pumpage and Poolesville's well levels increase. During the summer months, however, when there is little recharge and the rock itself cannot give up much stored water, the levels in the wells typically decrease.

Well Yield and Usage

Well yields shown in Table 1 are the sustainable yield that is expected during a drought period, with yields potentially higher during periods of average or greater rainfall. These rates should allow the wells to run continuously without stressing the aquifer. The average daily usage of water for the Town for the last 2 years (2009-2010) was 409,000gpd and 409,320gpd respectively.

Table 1
(Characteristics of Poolesville's Eleven Wells)

Well Number	Aquifer	Depth (Feet)	Diameter (Inches)	Sustainable Yield (gpm)
2		453	6	100
3		285	6	60
4		600	6.5	40
5		500	6	100
6		500	8	110
7		700	8	45
8		500	8	65
9		800	8	125
10		762	8	75
12		500	8	72
13		500	8	51

The Water System

Presently, Poolesville has eleven wells in production and permanently connected to our water system. All water is treated with chlorine to protect against bacteriological contamination. Well # 2 has a filtration unit, which was installed in 2004 due to water bearing fractures located close to the surface. Wells 7, 9 & 10 are being equipped with radon and alpha emitter treatment systems.

A telemetry system in each well house operates the wells dependent on the level of the elevated storage tank. All of the wells in service are equipped with flow regulating valves, which allow operators to set the pumping rate and prevent it from exceeding drought-pumping conditions. This added protection ensures that each well's major water bearings zones are not dewatered. All wells, the 500,000-gallon elevated storage tank, and the 1 million gallon standpipe storage tank are protected with a security system.

Permitting

The Maryland Department of the Environment issues all Water Appropriation Permits for municipal systems. Permits are issued for each watershed and the available withdrawal is based upon the recharge area of the watershed within the Town boundaries. Poolesville consists of four watersheds: Horsepen Branch, Broad Run, Dry Seneca Creek and Russell Branch.

The following table shows the "theoretically" available groundwater based upon each watershed's area using a recharge of 254 gallons per day per acre. The Broad Run and Dry Seneca Creek Watersheds, have remaining groundwater capacity, while the Russell Branch and Horsepen Branch Watersheds are fully allocated. As the table indicates, the Town is allowed to withdraw more water from the Horsepen Branch watershed than is theoretically recharged because the withdrawal permit and the establishment of these wells occurred prior to the existing allocation methodology.

Watershed	Area (acres)	"Theoretically" Available groundwater (gpd)	Average Daily Allocation on a yearly basis (gpd)	Average Daily Allocation for Max. Month (gpd)	Potential Well capacity (gpd)	Remaining Available Groundwater (gpd)
Horsepen Branch (wells 2, 4, 6, 8 & 11)	588	149,000	293,000	388,000	597,600	0
Broad Run (well 12)	551	140,000	47,500	66,600	66,600	92,500
Dry Seneca Creek (wells 3,5 & 13)	973	247,000	194,500	273,400	303,400	52,500
Russell Branch (wells 7, 9 & 10)	450	115,000	115,000	182,000	359,000	0
Totals	2,562	651,000	650,000	909,600	1,326,600	145,000

Once the Jamison-Cattail well is placed on-line, it will effectively "tap-out" the Dry Seneca Creek watershed. Future well explorations should focus in the Broad Run watershed area as this area has approximately 92,500 gpd (64 gpm) of available groundwater supply.

Threats to Our Groundwater

Poolesville's groundwater is generally of high quality. It meets all current drinking water standards and only needs minimal treatment before it reaches the tap. In 2006 the Town adopted a Wellhead Protection Ordinance that reduces the threat to groundwater from contamination arising from stationary sources. A threat from mobile sources of contamination will always remain from tank trucks carrying such products as gasoline, home heating fuel and pesticides. Appropriate contingency plans for this occurrence have also been developed. The Town should continue to develop additional well fields as far removed from potential sources of contamination as possible. Further, the Town should pursue abandonment of in-Town private well and septic systems to limit this as a potential source of groundwater contamination. The Wellhead Protection Area is delineated as the corporate limits and in some areas, extends beyond Town boundaries (see Appendix E, Map 9). The Town believes the present planning process that reviews new development applications and changes in use provides a degree of protection for the Town's water supply.

As far back as 1981, however, the limited purification capabilities of Poolesville's thin soils were recognized [5]. It was estimated that if a chemical contaminant of the same viscosity as water was spilled at the intersection of Routes 109 and 107 (1,300 ft. from the nearest well), it would take anywhere from 9.5 months to four years to reach the well. At the faster rate of movement, a spill 100 feet from a well would contaminate it in approximately 22 days. The estimates made in 1981 recognized that the actual rates of movement through the aquifer might be much faster due to the fracturing and crevicing of the rock [5].

In 1991, Maryland Department of the Environment's Water Supply Program conducted a wellhead protection demonstration project for Poolesville [4]. Using various methods, MDE produced maps depicting the areas that needed to be protected from contamination to ensure that the Town's water supply remained safe. The study concluded:

> Since the wells are located throughout the Town, most of the Town is part of the WHPA. The impact of current land use can be assessed through groundwater monitoring and further protection of the supply can be achieved through land use controls.
>
> Groundwater in the Poolesville area appears to be particularly susceptible to contamination because of the thin soil cover and extensive fracturing of the underlying shale and sandstone. The recent detection of VOC's in the groundwater, albeit well below levels of health concern, demonstrates that this is in fact true.

Drought

On July 14, 1999, the COG Board of Directors established a "Task Force on Water Supply Issues" to review the region's water supply systems, drought emergency plans, and long-term water supply plans and needs. The "Water Supply and Drought Awareness and Response Plan" contains four stages and is currently designed primarily for those customers who use the

Potomac River for water supply. The Task Force will continue to focus its efforts on the expansion of this plan to incorporate other water supply systems (i.e., small public utilities, groundwater and agriculture), and development of a year-round wise water use campaign. The Task Force will also continue to address the relationships between water supply and the environment.

Looking Ahead to the Future

The well exploration efforts in 2001-2002 identified wells to meet the present and future needs of the Town's residents. All of these wells have been either constructed or funded in the Town's Capital Planning Process or through future Impact Fees. Any additional well exploration should be conducted in the Broad Run watershed. This would allow the Town to exceed its water supply demands and provide water if a contamination event occurred which permanently disabled one or more of our wells.

Finally, the owners of the vast majority of land south of Poolesville have sold-off their Transfer Development Rights and can never be developed in densities higher than one house per 25 acres. Thus, the land will remain primarily undeveloped and at low risk from chemical contamination. The Town will need to work with MDE to secure the necessary water rights for lands outside of Town.

Other Sources of Water

Alternatives to groundwater that have been previously explored, include developing a treatment plant on the Potomac River and connecting to the Washington Sanitary Sewer Commission (WSSC), which obtains its water from the Potomac River.

While both of these options are viable, neither is preferable to continued reliance upon groundwater to serve the needs of the Town. Not only would the Town be required to make a very large financial commitment to either option, but also the quality of potable water delivered to Town residents would decrease. While WSSC provides high quality, safe drinking water, treated surface water cannot compare with uncontaminated groundwater of the quality currently delivered to Town residents.

Conclusions

A great deal is known about Poolesville's water supply, far more than most small communities in Maryland. The water is generally located only within the fractures in the rock that underlay the Town. Wells that intercept these fractures are productive. Tapping into fractures that are not interconnected with others is essentially the same as tapping into a new aquifer. Because of the thin layer of soil overlying consolidated rock, the Town's groundwater supply is very susceptible to contamination.

While there will be an adequate supply of potable water to meet the Town's present and future needs under normal conditions, prudence dictates that additional yield be incorporated into the system to safeguard against unforeseen well operation problems or groundwater contamination.

The Town is limited by both physical and administrative considerations in where it can seek new groundwater sources. Well sites within the Town proper, except for the Broad Run watershed on the west side of Town (MDE permitting limitations), have been nearly exhausted. Additional wells within the boundaries (except for the northwest corner) will probably intersect the zones of influence of existing wells.

If the Town considers expanding its water supply outside of its corporate boundaries, they will need to pursue the use water rights with individual properties. MDE should be part of this pursuit since that agency will ultimately issue any appropriation permit to the Town for expansion of its water use. Alternatives of treating and piping Potomac River water to Town or connecting to WSSC will be very costly and provide a lower quality water than the Town now enjoys from its well fields.

Literature Cited

The following numbered sources of information represent the factual basis for this report. Copies of each are available for inspection at Town Hall.

1. Heath, R. C. 1982. Basic groundwater hydrology. USGS Water Supply Paper 2220. 81 pp.

2. Jones, W. K. 1991. Availability of groundwater at Poolesville, Maryland. Environmental Data. 5 pp.

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5. Otten, E. G. 1981. The availability of groundwater in Western Montgomery County, Maryland. MD Geological survey Report of Investigation. No. 34. 76 pp. + encl.