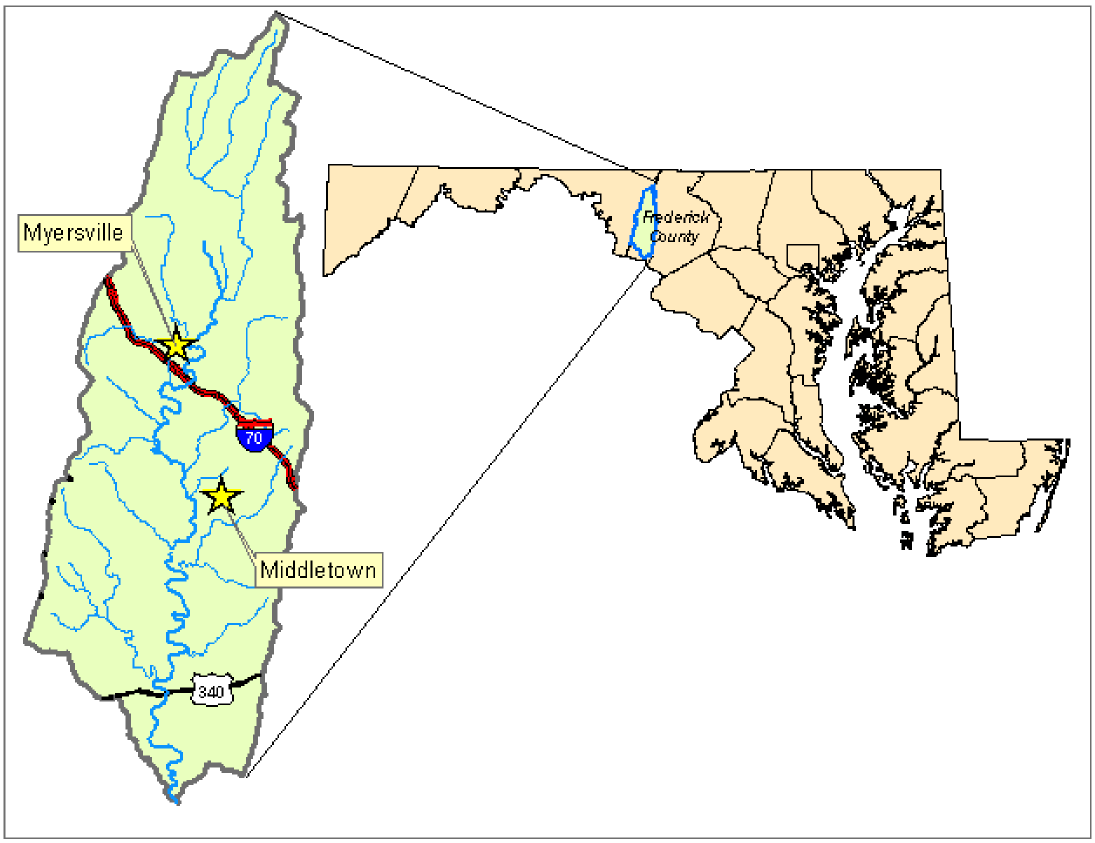
An Evaluation of the Water Resources in the Catoctin Creek Watershed

Frederick County, Maryland



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Executive Summary

During recent years, a growing population, changing land use patterns, and climate variations have forced Maryland citizens to face the reality that their water resources are not unlimited, and that proper planning is needed to ensure that that the State's water supplies remain sustainable. Appropriate water resource planning must rest on a thorough understanding of water availability and water use patterns. Based on a 2004 recommendation of the Advisory Committee on the Management and Protection of the State's Water Resources to analyze water availability for each of the State's watersheds, the Maryland Department of Environment (MDE) conducted an assessment of water availability and demand in the Catoctin Creek watershed of Frederick County. The purpose of the watershed assessment is to evaluate the available water supply within a watershed as it relates to existing water demands, and to assess the potential for existing resources to meet future water demands. The assessments are intended to assist local planners and water suppliers with planning for future water needs, and to help MDE staff better evaluate current policies and permitting decisions. The Catoctin Creek watershed is located in the southwest portion of Frederick County and is a watershed that is experiencing pressures from increasing development.

Current water use in the watershed is estimated at an annual average of 2.15 million gallons per day (mgd). Self-supplied domestic use accounts for 1.03 mgd (48% of total), while community water systems account for 762,000 gpd (35%). Agricultural, commercial and industrial uses make up the remainder of water demand. Current water use was estimated for each of ten sub-watersheds as well. Projected future water demand for the years 2020 and 2030 were estimated by increasing the current demand proportional to population projections. By 2030, water use in the watershed is expected to increase to 3.59 mgd as an annual average.

Ground water availability was estimated using basin-wide, annual ground water recharge rates derived from long-term streamflow data for Catoctin Creek. Recharge rates were derived for average year conditions (defined as a 1-in-2-year recurrence interval), for a 1-in-10-year recurrence interval (representing moderate drought conditions), and for a 1-in-20-year recurrence (representing more severe drought conditions). The drought recharge rates were applied to each of the 10 sub-watersheds to yield estimates of ground water availability, which were further adjusted to account for impervious areas and preservation of groundwater baseflow to streams. To account for the seasonal variability of recharge, quarterly recharge rates and changes in ground water storage were estimated for the three recurrence intervals in each of the subwatersheds.

Water availability from surface water sources was also based on long-term stream flow records. A reliable supply from a surface water source requires adequate storage to allow water use during low-flow periods when direct stream withdrawals are disallowed. Surface water availability was therefore evaluated in terms of the amount of reservoir storage that would be needed to meet a range of demands, given a range of drainage areas. The evaluation assumed an on-stream reservoir, and did not account for evaporative losses or the potential need to mitigate temperature impacts.

A comparison of demand and availability revealed that the current annual average water use represents about 4% of the water available in an average year over the entire watershed. However, in a 1-in-20-year drought, current demand is 8% of availability basin-wide, and within the 10 sub-watersheds, demand ranges between 3% and 25% of availability. By the year 2030, annual water demand may be as high as 43% of availability at the sub-watershed scale. The seasonal water availability analysis presents a more severe situation. In one sub-watershed, the current demand is 46% of availability in an average summer, and 194% of summer availability during a 1-in-20-year drought. While the seasonal estimates contain a fair degree of uncertainty, they point to potential adverse impacts to stream baseflow during droughts, and possibly on an annual basis.

Overall, the natural water quality in the Catoctin Creek watershed is very good. The major water quality issues related to ground water supplies – nitrates, MTBE, and bacteria – are all related to land use, pointing out the importance of source water protection. Under the State's program to evaluate Total Maximum Daily Loads (TMDLs) for impaired streams, Catoctin Creek is listed as having impaired water quality under several categories including bacteria, biological, nutrients, and sediments. Surface water sources are extremely vulnerable to land use practices, since runoff carries contaminants directly into streams. Protected lands, which can serve as undisturbed ground water recharge areas and protect surface water quality from impacts associated with developed lands, account for 12% of land area within the watershed.

The evaluation raises concerns in a number of areas. For example, an analysis of seasonal water availability indicates the potential for serious ecological impacts during the summer months from withdrawals in some of the more densely populated sub-watersheds. This indicates not only that communities in these sub-watersheds may need to seek alternative water sources to meet future demands, but also that MDE needs to reevaluate its policies and assumptions in order to insure that they are protective of the resource and consistent with current and projected usage trends. The study also highlights the need for additional data to better evaluate the impacts of cumulative withdrawals in the watershed, especially when seasonal factors are considered. Finally, the report points to the need for communities in this watershed to plan for and manage the resource to meet future water needs.

Table of Contents

1. Introduction

Maryland has been blessed with what has historically been perceived as an abundance of water, however, in recent years some communities have been challenged with meeting the demands of their growing populations. The 2002 drought had significant impacts on water resources statewide and prompted serious concern for the adequacy of the water resources to meet future demand. The Governor's Advisory Committee on the Management and Protection of the State's Water Resources was created in response to these concerns. The Committee was charged with several responsibilities, but focused its efforts on evaluating the sustained ability of the State to meet its projected water needs. The Committee's report (Wolman, 2004) provides insight into the wide range of water resource issues in Maryland and provides recommendations that focus on the ability of the State to responsibly manage Maryland's water resources for present and future generations. A specific recommendation of the Committee was to "Continue conducting the statewide evaluation of water supply sources, and repeat the evaluations at regular intervals to ensure consistency with changing demographics and resource conditions."

In response to this recommendation, the Maryland Department of the Environment, Water Supply Program (WSP) has conducted an assessment of the Catoctin Creek watershed. The intention of this assessment is a comprehensive evaluation of the water resource at the watershed scale that provides state and local water supply regulators, stakeholders, and planners with information necessary for assessing existing and future appropriations and planning for growth. The objectives of the assessment include estimating the water availability in the watershed, analyzing the current and future demands with respect to availability, and examining other environmental factors that may affect the availability of water supply resources in the present and future.

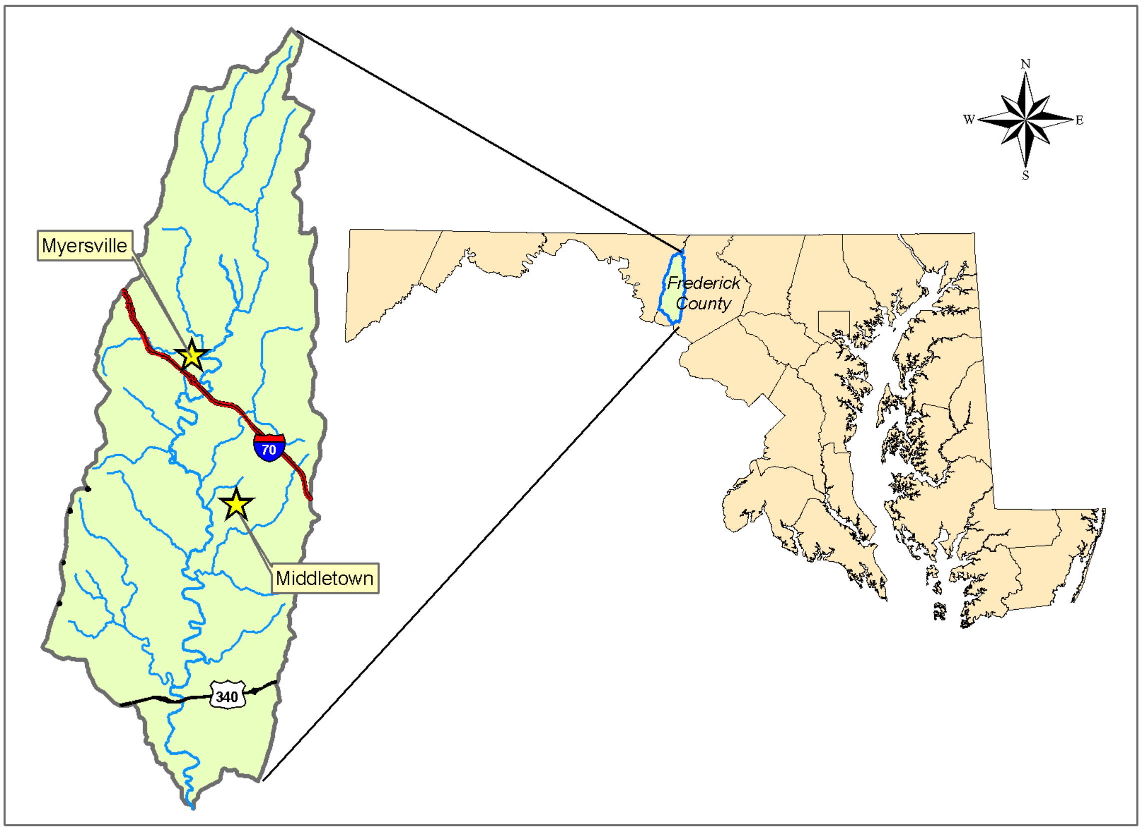
This report also includes recommendations for consideration by water resource managers and local governments that relate to our current understanding and interpretation of a sustainable water resource. The American Society of Civil Engineers (ASCE) Task Committee for Sustainability Criteria proposes the following definition of sustainability - "Sustainable water resource systems are those designed and managed to fully contribute to the objectives of society, now and in the future, while maintaining their ecological, environmental, and hydrological integrity" (Loucks, 2000). This definition suggests that we should abandon attempts to define a single, correct number that represents sustainable yield and that it may not be possible to completely address the full complexity of the question of sustainability (Maimone, 2004). A better approach is an adaptive management plan that accounts for water demand as well as available supply, the uncertainties in our understanding of the hydrologic system, and the need for stakeholder involvement with regard to establishing environmental, economic and political objectives.

This assessment utilizes data and analysis from a variety of sources and studies that have been conducted in or near the Catoctin Creek watershed. Studies on the water supply and the hydrologic system provide data to incorporate into estimating water availability (Duigon and Dine, 1987, Schultz et. al, 2004). Data from the U.S. Census Bureau and State and County planning agencies is used for evaluating current and future water demands in the watershed. Assessments of water quality that have been conducted as a result of Safe Drinking Water Act and Clean Water Act regulations provide information on the status of water quality in the watershed. This report attempts to incorporate the data as well as the findings of previous studies into a comprehensive evaluation of the water resources in the Catoctin Creek watershed.

2. Background

The Catoctin Creek watershed encompasses the southwestern portion of Frederick County and is framed by Catoctin Mountain on the east and South Mountain on the west (Figure 2.1). The main drainage flows through the Middletown Valley and eventually into the Potomac River approximately three miles upstream from Point of Rocks, Maryland. The Catoctin Creek watershed drains an area over 77,000 acres (120 square miles), which includes areas of forested mountain slopes, agricultural valleys and small towns. Interstate 70, which bisects the watershed south of the Town of Myersville, has spurred significant growth in the watershed due to its proximity to the Baltimore and Washington Metropolitan areas as well as the growing City of Frederick.

Figure 2.1 Location of the Catoctin Creek Watershed in Maryland (Not to Scale)



The population in the Catoctin Creek watershed, based on the 2000 U.S. Census, was 20,700. The primary population centers are the areas surrounding the Towns of Middletown and Myersville, and the unincorporated residential areas along Highway 340 near Jefferson. There are six community water supply systems located within the watershed, including the Towns of Middletown and Myersville, and four separate residential subdivisions (Briercrest, Fountaindale, Cambridge Farms, and Copperfield) with central water supply systems that are owned and operated by the Frederick County Division of Utilities and Solid Waste Management. Additional types of permit-regulated water uses include agricultural irrigation, livestock watering, commercial, and industrial.

Furthermore, self-supplied domestic residences represent a significant water use in the watershed. The majority of water use is from ground water sources, with a smaller proportion of surface water use by community water supplies and agricultural users. The estimated annual demand in the watershed is an average 2.15 million gallons per day.

The climate of Frederick County is temperate, moderately humid, with an average annual precipitation of approximately 43 inches (NOAA, 2005), which is similar to the statewide average. Average annual rainfall is higher (49 inches) at Catoctin Mountain Park (NOAA, 2005), which is located approximately 1 mile northwest of the northern boundary of the watershed and reflects the additional precipitation that falls on the mountaintops of Western Maryland. The underlying geology influences the physiographic and hydrologic characteristics of the watershed. The underlying bedrock dictates water movement through the unconfined fractured-rock aquifers. There are two major bedrock types in the watershed, both of which behave similarly with regard to ground water flow, and have differing soil and overburden characteristics that influence how water is recharged and stored in the aquifers. Precipitation infiltrates soil and a portion of it makes it to the water table as ground water recharge, which eventually discharges as the base flow component of streams. Prior research in the watershed provides a hydrologic budget for the stream gage on Catoctin Creek near Middletown, which estimated an annual average stream runoff of 10 inches/year and 10 inches/year of groundwater recharge (Duigon and Dine, 1987). A more recent study of annual water budgets estimated an average-year ground water recharge rate of 8.5 inches/year and 12.2 inches/year for the two distinct hydrogeomorphic types found in the Catoctin Creek watershed (Schultz et. al, 2004).

The concept of the hydrologic cycle provides an appropriate model for describing the hydrologic system in the Catoctin Creek watershed. Ground water and surface water are intimately related and all of the components of the hydrologic cycle have an influence on water availability. Disruptions to the natural system imposed by human use of the land will also have an influence on water availability. Due to the "quick turnaround" of water as it moves through the hydrologic system from precipitation to ground water recharge, certain activities on the land may introduce contaminants to ground water and eventually surface water supplies. In addition, over-development of the land results in a loss of recharge area for ground water and will increase direct runoff to streams, possibly impacting overall stream quality (CWP, 2003). Thus, water quantity and quality are both important when completing a comprehensive evaluation of a watershed.

The majority of the Catoctin Creek watershed is comprised of rural landscapes. The predominant land use in the watershed is agricultural followed by forested and other undeveloped areas. Much of the acreage in Frederick County that is classified as "prime farmland" by the U.S. Department of Agriculture lies in the Middletown Valley (Catoctin and Frederick Soil Cons. Dist., 1985). Almost one third of the watershed covers an area considered important for preservation as farmland, and thus has been designated a Rural Legacy Area (MD DNR, 2005). The purpose of the Rural Legacy Program is to protect Maryland's best remaining rural landscapes and natural areas through the purchase of land or conservation easements. While agriculture has historically dominated the landscape of the Catoctin Creek watershed, population growth in Frederick County and development pressure has transformed some agricultural areas, increasing the amount of land now occupied by low-density residential development. Middletown, Myersville, and the Jefferson area are all designated Priority Funding Areas due to their wastewater system capacity, thus much of the planned growth in this watershed is targeted in and around these three areas.

3. Water Supply Characteristics

In hydrologic settings such as Catoctin Creek, a water balance approach is an appropriate method of comparing water demands with the available water supply and can include both ground water and surface water demands since the eventual output is to the main stream. Similar to any budget, a water balance must take into account all inputs and outputs to the system. The hydrologic cycle can be considered a budget with the input from precipitation being balanced by ground water and surface water runoff, evapotranspiration, and changes in storage. Total runoff can be directly measured by stream gages and can be separated into ground and surface water components using standard hydrograph separation techniques. When evaluating a water balance over long-term conditions, changes in storage can be considered negligible and evapotranspiration is estimated from the remainder of the balance.

For the purposes of this report, the water balance concept is used to determine recharge rates for ground water and average flows for surface water in order to estimate water availability in the watershed. These values can then be compared to current and potential future water demands to provide a basis for evaluating the potential of the water supply. Difficulty arises in attempting to identify an amount of the total available water that can be used as an acceptable limit to maintain a sustainable water supply. Therefore, the numbers presented here simply compare what is currently being used with what is estimated as "available." The analysis is done at the subwatershed level, in order to improve the ability to spatially compare supply with demand and to provide a scale that is pertinent to policy and planning decision-makers as well as water users. The scale of watersheds used is the Maryland 12-digit watersheds delineation (MD DNR, 1998). It must be noted that water appropriation permit decisions are often made in subwatersheds that are smaller than the 12-digit scale, especially if the application for a permit is located in the headwaters of a watershed where the potential recharge area is limited. The minimum size of a watershed that will be considered for permit conditions, including the water balance and base flow protection is 1,280 acres (2 square miles). The average size of the subwatersheds used in this analysis is 7,700 acres (12 square miles). The 12-digit scale was chosen for the analysis herein because it represents an appropriate scale for planning purposes. This document does not intend to contradict the findings of an individual permit decision that is located within the study area.

3.1 Current Water Demand

Water is used from both ground water and surface water sources in Catoctin Creek watershed and water appropriation permits are issued by MDE for a variety of users including community water supply, agricultural[*], commercial, and industrial. In addition, ground water is used by self-supplied domestic residences throughout the

[*] Agricultural uses consist of both irrigation and livestock watering. Agricultural users that use less than an average 10,000 gpd are exempt from permit requirements and therefore may not be represented in the demand figures presented herein. However, permits are issued when requested by the user. Agricultural water uses that are less than 10,000 gpd are generally for livestock watering since irrigation needs are more likely to be greater than 10,000 gpd.

watershed, which do not require appropriation permits. Estimating the total current water demand for a watershed is important when planning for future potential growth, and determining whether future water demands may conflict with existing uses. Water use was separated by use type for the entire watershed (Table 3.1). The distribution of permits by use is shown in Figure 3.1. Community water supplies and self-supplied domestic users account for 84% of the total water use in the entire watershed.

Table 3.1 Water Use by Category in Catoctin Creek watershed.

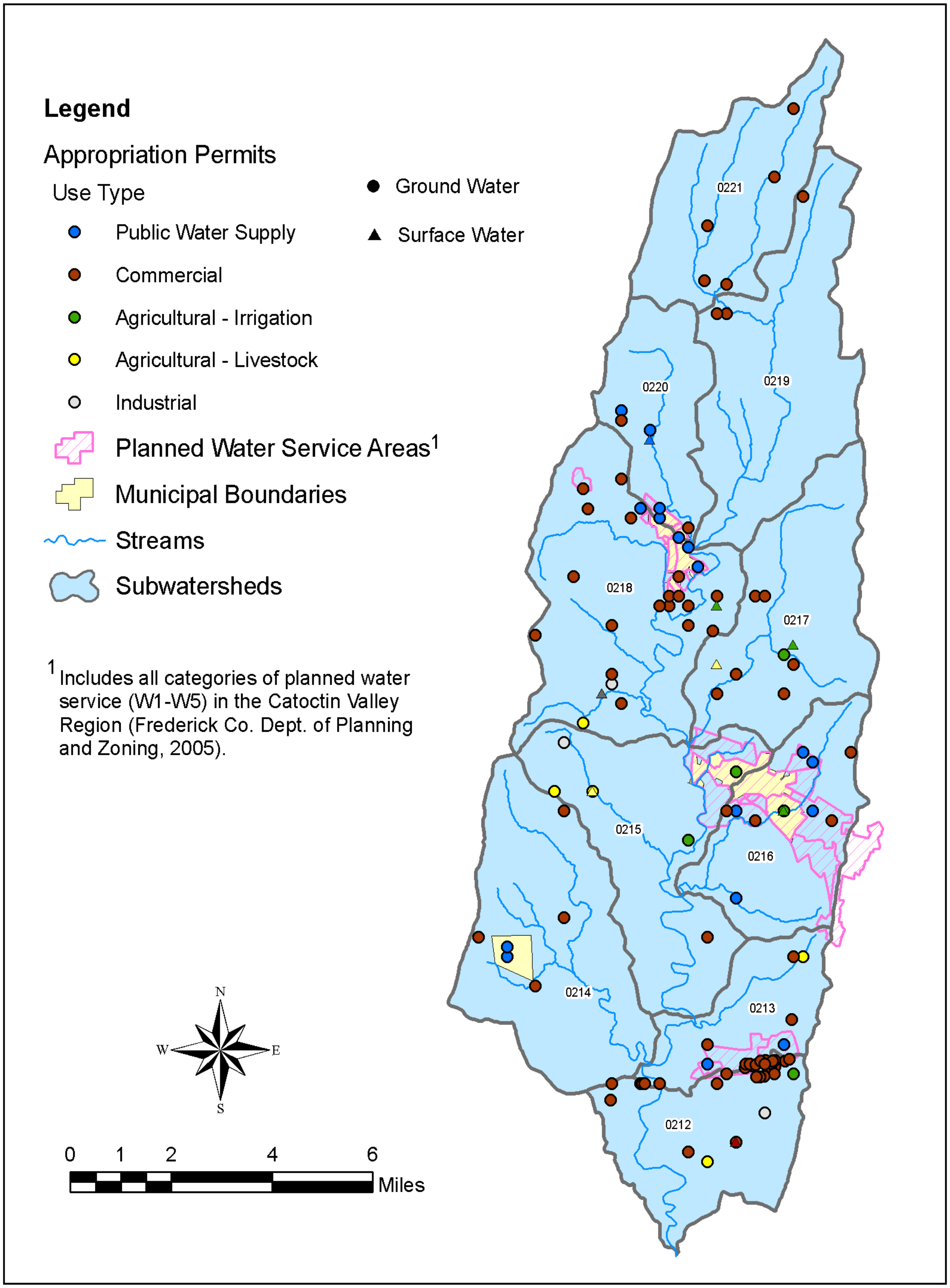
Use Category	No. of Permits	Reported Total Avg. GPD[1]	Percent of Total
Community Water Supply	20	762,434	35.4%
Commercial	81	108,682	5.0%
Agricultural - Irrigation	10	230,513	10.7%
Agricultural - Livestock	7	14,500	0.7%
Industrial	4	11,266	0.5%
Self-Supplied Domestic	n/a	1,026,480	47.7%
Totals	122	2,153,875	100.0%

[1] For permits that report pumpage, the average of four years (2000-2003) was used in the total. For permits that do not report pumpage, the permitted Avg. GPD is used in the total.

Water demand was summarized by subwatershed using water appropriation permit data for uses requiring a permit and by combining population data derived from the 2000 Census blockgroups (U.S. Census Bureau, 2000) with water service area boundaries for self-supplied domestic use. Water demand was calculated from permit data as the average reported use for the years 2000 through 2003 for permits greater than 10,000 gallons per day (gpd), which are required to report use. For the remaining permits, the permitted amount (in annual average gpd) was used in the subwatershed total. The subwatershed summary of appropriation permit data is given in Table 3.2 and a list of appropriation permits in the Catoctin Creek watershed is included in Appendix A.

Estimating self-supplied domestic use was not as straightforward, since determining the spatial distribution of population is complicated by the fact that subwatershed boundaries do not match those of community or census blockgroup boundaries. Therefore, a method was developed to determine a population on domestic wells using the U.S. Census Bureau data (U.S. Census, 2000) and Maryland Department of Planning land use data (MDP, 2003) combined with the Frederick County water service area maps (Fred. Co. Dept. of Planning and Zoning, 2005). The subwatershed population was obtained by intersecting the census blockgroup population with residential land use areas. Water service areas crossed subwatershed boundaries in several instances; therefore, a population value was assigned based on the proportion of the area that fell within the particular subwatershed boundaries. The population served by domestic wells was obtained by subtracting the population served by community water systems from the subwatershed population. An average per capita rate of 80 gpd was applied to the population to estimate the total subwatershed self-supplied domestic use (Table 3.3). The rate of 80 gpd/person is used by the USGS in estimating annual water withdrawals for the State of Maryland (Solley et. al, 1998). The estimated self-

Figure 3.1 Distribution of Water Appropriation Permits in the Catoctin Creek Watershed.



supplied domestic use is added with permitted uses to give the total demand for each subwatershed (Table 3.4). Self-supplied domestic use is essentially a non-consumptive use since most households on domestic wells dispose of wastewater through on-site septic systems. Most of the water drawn (approximately 70-90%) from a domestic well is returned to the ground through a domestic septic system and is recharged back to ground water. However, MDE permitting policy does not account for return flows from on-site septic systems in water balance because if the septic system fails, the likely remedy is to replace it with public sewer, in which case the return flow is lost.

Table 3.2 Subwatershed Water Appropriation Permit Data

	Ground Water Permits			Surface Water Permits			Total Permits		
ShedNum	No. of Permits	Reported (Avg. GPD)[1]	Permitted (Avg. GPD)	No. of Permits	Reported (Avg. GPD)[1,2]	Permitted (Avg. GPD)	No. of Permits	Reported (Avg. GPD)[1]	Permitted (Avg. GPD)
0212	26	36,100	36,100	1	2,500	2,500	27	38,600	38,600
0213	14	86,891	97,300	0	0	0	14	86,891	97,300
0214	7	4,000	4,000	0	0	0	7	4,000	4,000
0215	6	6,866	16,700	1	100	100	7	6,966	16,800
0216	10	498,015	711,500	1	14,698	10,000	11	512,713	721,500
0217	9	55,400	55,400	2	51,038	15,100	11	106,438	70,500
0218	27	203,625	252,150	2	11,814	23,000	29	215,439	275,150
0219	3	2,300	2,300	0	0	0	3	2,300	2,300
0220	7	87,716	128,700	1	64,182	40,000	8	151,898	168,700
0221	5	2,150	2,150	0	0	0	5	2,150	2,150
Totals	114	983,063	1,306,300	8	144,332	90,700	122	1,127,395	1,397,000

[1] For permits that report pumpage, the average of four years (2000 through 2003) was used in the total. For permits that do not report pumpage, the permitted Avg. GPD is used in the total.

[2] The total in the reported exceeds the permitted total in some cases due to special conditions related to supplemental permits. A permittee is allowed to exceed the permitted avg. gpd for a single permit as long as the total use for all permits that are supplemental does not exceed the total permitted amount.

Table 3.3. Subwatershed Population Data

	Census 2000 Data		Average rate = 80 gpd/person	
ShedNum	Housing Units	Population[1]	Population Outside Water Service[2]	Estimated Self-Supplied Domestic Water Demand
0212	566	1,585	1,466	117,280
0213	979	2,676	1,399	111,920
0214	508	1,409	1,409	112,720
0215	999	2,848	1,181	94,480
0216	1,575	4,324	1,030	82,400
0217	698	1,935	1,935	154,800
0218	999	2,839	1,520	121,600
0219	448	1,221	1,221	97,680
0220	321	901	704	56,320
0221	357	966	966	77,280
Totals	7,450	20,704	12,831	1,026,480

[1] Derived from intersecting census blockgroups and residential land use with subwatershed boundaries.

[2] Derived from intersecting subwatershed boundaries with population served in existing water service areas.

The total annual average demand in the Catoctin Creek watershed is estimated to be 2.15 million gallons per day (Table 3.4). Most of the water (93%) is obtained from ground water sources, while almost half (48%) of the water use in the watershed is by self-supplied domestic residences.

Table 3.4 Subwatershed Demand Data

		Total Permits			Estimated	
ShedNum	Acres	No. of Permits	Permitted Total (Avg. GPD)	Reported Use (Avg. GPD)[1]	Self-Supplied Domestic Use (Avg. GPD)[2]	Total Demand (Avg. GPD)
0212	6,313	27	38,600	38,600	117,280	155,880
0213	4,185	14	97,300	86,891	111,920	198,811
0214	10,166	7	4,000	4,000	112,720	116,720
0215	9,058	7	16,800	6,966	94,480	101,446
0216	6,556	11	721,500	512,713	82,400	595,113
0217	8,221	11	70,500	106,438	154,800	261,238
0218	11,107	29	275,150	215,439	121,600	337,039
0219	9,758	3	2,300	2,300	97,680	99,980
0220	4,694	8	168,700	151,898	56,320	208,218
0221	7,005	5	2,150	2,150	77,280	79,430
Totals	77,063	122	1,397,000	1,127,395	1,026,480	2,153,875

[1] For permits that report pumpage, the average of four years (2000-2003) was used in the total. For permits that do not report pumpage, the permitted Avg. GPD is used in the total.

[2] Self-Supplied Domestic use is estimated from population outside the water service area and an estimated rate of 80 gpd/person.

3.2 Projected Water Demand

A key component of water supply planning is accounting for growth and forecasting how that growth may impact water supply resources. One question that is often posed is "Can the resource provide for future growth?" In order to address this question, there must be some estimate of future water demand. Water demand projections for the years 2020 and 2030 were estimated from population projections for each subwatershed in the Catoctin Creek watershed.

Future population was projected based on the Washington Council of Government's Transportation Analysis Zones (TAZ) data (Wash. COG, 2003). The TAZ layer provides population forecasts for the years 2020 and 2030 and uses census tract boundaries to spatially define population growth. Future population was estimated based on the TAZ population density intersected with each subwatershed. The areas defined by the TAZ are larger than subwatersheds, which limits the spatial accuracy of this methodology. However, it coincides with the method used to estimate current population and represents the best available spatial data with which to project future population at the subwatershed scale. The 2020 and 2030 subwatershed population estimates for each subwatershed are given in Table 3.5.

Future water demand was calculated by increasing the current water demand proportional to the percentage increase in population. The assumption is made that population growth will coincide with water demand at the current per capita rate and includes all types of water use. This may be a valid assumption for water used for public and domestic supplies and possibly commercial use, but not necessarily for agricultural or industrial uses. However, since there is no simple way to predict how agricultural or industrial water use may change in the Catoctin Creek watershed, demands for these uses are assumed to increase in direct proportion to population, and are included with the total water use. The projected water demands for 2020 and 2030 are given in Table 3.5.

Table 3.5 Subwatershed Population and Demand Projections

ShedNum	2000 Population	2000 Water Demand	2020 Projected Population[1]	2020 Projected Demand[2]	2030 Projected Population[1]	2030 Projected Demand[2]
0212	1,585	155,880	2,135	209,971	2,547	250,490
0213	2,676	198,811	3,787	281,352	4,511	335,141
0214	1,409	116,720	2,000	165,678	2,402	198,979
0215	2,848	101,446	4,005	142,658	4,770	169,908
0216	4,324	595,113	6,158	847,527	7,330	1,008,829
0217	1,935	261,238	2,678	361,548	3,190	430,671
0218	2,839	337,039	3,919	465,254	4,668	554,173
0219	1,221	99,980	1,686	138,056	2,008	164,422
0220	901	208,218	1,243	287,253	1,481	342,254
0221	966	79,430	1,336	109,853	1,590	130,739
Totals	20,704	2,153,875	28,947	3,009,150	34,497	3,585,607

[1]Population projections derived from TAZ projection rates and subwatershed population calculated from 2000 Census blockgroup data.

[2] Projected water demand is calculated as a percent increase based on projected population increase.

There is considerable uncertainty in projecting water demand due to several unpredictable variables, including where population growth will actually occur and where the water supply will be developed to support that growth. The Frederick County Comprehensive Plan for the Middletown Region (Fred. Co. Planning, 1997) provides total potential population values for designated growth areas. These population projections can be compared with the population projections derived herein to examine their validity. The area designated as the Middletown Region Community in the Comprehensive Plan is comprised of an area that falls within and around the existing municipal boundary for the Town of Middletown. The total potential population predicted in the comprehensive plan is 10,349, which roughly equates to a 30-year projection. This designated growth region can be approximated to the subwatersheds 0216 and 0215, which together have a predicted 2030 population of 12,100, using MDE's methodology. The MDE methodology produces a significantly higher 2030 population (17%). The discrepancy is likely due to a combination of factors, including the inherent uncertainties of population forecasts and the differences in geographic areas covered by the two methods.

3.3 Water Availability

3.3.1 Ground Water

Estimating water availability is essential for planning for adequate water supplies for both existing demands and future growth. Determining the annual average water availability in a watershed is somewhat straightforward using standard techniques for analyzing streamflow data. However, due to a number of factors there is a limit to the confidence that can be placed in calculating water availability on an annual average basis at a large scale and applying it to smaller areas. Factors such as seasonal variability in ground water recharge and surface water flows, annual fluctuation in precipitation, natural variation in aquifer properties that affect recharge and flow, and other spatial disparities will cause water availability to differ temporally and spatially from that of the estimated annual average. In addition, the limited amount of long-term stream gage records makes it impossible to refine the analysis to a smaller scale. It is extremely data- and time-intensive to account for all of these factors on a watershed scale, thus the annual average estimate for water availability is considered the best estimate for the study area and is applied to each of the subwatersheds in Catoctin Creek. The USGS stream gage on Catoctin Creek near Middletown was used to determine effective recharge rates from annual base flows. In addition, a recent study used streamflow data and ground water levels to predict seasonal recharge rates (Schultz et. al., 2004). The annual and seasonal values provide the basis for estimating water availability for the subwatersheds in Catoctin Creek.

In a hydrologic budget, streamflow can be directly measured with a continuous stream gage. Hydrograph separation is a technique that is used to separate the streamflow record into base flow and storm flow components. In a watershed such as Catoctin Creek, ground water is under water table conditions and flow paths are orientated from topographic divides to discharge points such as streams. Therefore, the base flow component of streamflow is equal to ground water discharge and is balanced by ground water recharge, assuming the annual change in ground water storage is negligible. Stream gages with long-term records can be statistically analyzed to determine the average flows and to estimate base flow conditions that will occur at various recurrence intervals. Precipitation and streamflow vary with time; consequently annual base flow will also vary from year to year. The purpose of the statistical analysis is to predict how often certain base flow conditions might occur, based on what has occurred in the past. Thus, the 10-year recurrence interval is defined as the flow that has a one in ten probability of being equaled or exceeded in any given year. It is commonly referred to as “1 in 10 year drought” and, statistically speaking, these conditions could theoretically occur once every ten years, (although realistically it does not occur *every* 10 years but at some regularity based on probability). Recurrence intervals are important in estimating flood stages as well as low flow conditions that occur with droughts. Ground water appropriations are currently permitted by MDE based on recharge that is equal to the 10-year drought, which serves as a conservative estimate of recharge and thereby provides a margin of safety for water supplies during minor droughts. When estimating water availability for an individual permit decision, MDE policy accounts for losses due to impermeable surfaces and a subtraction for stream base flow protection. It must be noted that the water balance methodology can only be considered a conservative estimate when all other assumptions that were made when the policy was developed occur; specifically, that withdrawals are equally distributed throughout the basin and half of the watershed is in non-consumptive uses.

Estimates of ground water recharge derived from hydrograph separation provide a basis for estimating the amount of ground water available over average conditions in a watershed. MDE has developed a technique for deriving effective recharge rates (MDE, 2000) in a watershed that is applied during appropriation permitting decisions. The technique adapts the methodology from the USGS software PART (Rutledge, 1993) to perform the base flow analysis, and then uses the raw statistics to provide a rank and probability to determine recurrence intervals. The summary output is provided in the Appendix B. The effective recharge rates derived for the period of record at the Catoctin Creek gage at Middletown are 759 gpd/acre (10.2 inches), 424 gpd/acre (5.7 inches), and 372 gpd/acre (5.0 inches) for the 2, 10, and 20-year recurrence intervals, respectively. These values were applied as effective ground water recharge to each of the subwatersheds of Catoctin Creek.

The base flow analysis provides an estimate of the effective recharge based on the discharge to the stream. As discussed above, the 10-year drought recharge is applied for permitting purposes to provide a buffer for water supplies during below average rainfall years. However, if all ground water recharge was appropriated, theoretically there would be none remaining for stream base flow and the streams would eventually run dry. Maryland's appropriation permitting process for large ground water withdrawals limits the allowed withdrawal in order to provide some protection to streams. The current standard is to subtract a "minimum reserve flow" from the effective recharge. The minimum reserve flow is equivalent to the lowest flow that occurs once every ten years for seven consecutive days, commonly referred to as the 7Q10 low flow. The 7Q10 is the lowest average 7-day flow having a recurrence interval of 10 years. A 7Q10 flow of 0.871 ft^3 per second (563,000 gpd) was derived for the Catoctin Creek gage near Middletown using the USGS program SWSTAT (USGS, 2002). A minimum reserve flow for each subwatershed was determined by proportioning the 7Q10 flow value by area (Table 3.6). This value represents the amount of available ground water recharge that should not be withdrawn in order to provide a remainder for base flow to streams.

The estimated ground water availability is defined as the effective recharge minus the minimum reserve flow. The results are summarized by subwatershed as ground water availability values under three different recurrence intervals (Table 3.7).

Table 3.6 Minimum Reserve Flow as 7Q10 Flow Values Proportioned to Subwatershed Area.

ShedNum	Acres	7Q10 (CFS)	7Q10 (GPD)
0212	6,313	0.128	82,692
0213	4,185	0.085	54,822
0214	10,166	0.206	133,164
0215	9,058	0.184	118,654
0216	6,556	0.133	85,885
0217	8,221	0.167	107,691
0218	11,107	0.225	145,497
0219	9,758	0.198	127,826
0220	4,694	0.095	61,488
0221	7,005	0.142	91,760
Totals	77,063	1.563	1,009,479

Table 3.7 Annual Ground Water Availability for subwatersheds in the Catoctin Creek watershed.

Shed Num	Acres	Minimum Reserve Flow (GPD)	1 in 2 Year Recharge (GPD)	1 in 2 Year Ground Water Availability	1 in 10 Year Recharge (GPD)	1 in 10 Year Ground Water Availability	1 in 20 Year Recharge (GPD)	1 in 20 Year Ground Water Availability
0212	6,313	82,692	4,791,225	4,708,533	2,676,521	2,593,829	2,348,269	2,265,577
0213	4,185	54,822	3,176,445	3,121,623	1,774,457	1,719,635	1,556,835	1,502,013
0214	10,166	133,164	7,715,630	7,582,466	4,310,180	4,177,016	3,781,573	3,648,409
0215	9,058	118,654	6,874,908	6,756,254	3,840,528	3,721,874	3,369,520	3,250,866
0216	6,556	85,885	4,976,262	4,890,377	2,779,888	2,694,003	2,438,958	2,353,073
0217	8,221	107,691	6,239,701	6,132,010	3,485,683	3,377,992	3,058,193	2,950,502
0218	11,107	145,497	8,430,259	8,284,762	4,709,393	4,563,896	4,131,826	3,986,329
0219	9,758	127,826	7,406,337	7,278,511	4,137,400	4,009,574	3,629,983	3,502,157
0220	4,694	61,488	3,562,700	3,501,212	1,990,231	1,928,743	1,746,146	1,684,658
0221	7,005	91,760	5,316,636	5,224,876	2,970,031	2,878,271	2,605,782	2,514,022
Totals	77,063	1,009,479	58,490,103	57,480,625	32,674,312	31,664,834	28,667,085	27,657,607

Ground water Availability = Recharge - Minimum Reserve Flow

3.3.2 Seasonal Variation in Ground Water Availability

Ground water supplies under water table conditions, like those in the Catoctin Creek watershed, are vulnerable to relatively short term variations in climatic conditions. Average rainfall is generally consistent throughout the year, with monthly averages ranging from 2.7 to 4.6 inches (NOAA, 2005). The effects of below-average rainfall periods that last even a few months can be seen in the water supplies of the Catoctin Creek watershed. This is likely due to the poor storage capability of the crystalline bedrock underlying the watershed. There is essentially no primary porosity (open pore space in the bedrock) and secondary porosity (cracks in the bedrock that allow transmittal of ground water) is controlled by the density and spacing of fractures, which will vary spatially. In some locations the much more porous residuum, or overlying weathered bedrock, is thick enough to provide significant ground water storage. However, permeability is dependent on the connection to fractures, and this, together with residuum thickness will determine the conductivity of the aquifer.

Overall, storage capacity is poor in the Catoctin Creek watershed as demonstrated by studies of the hydrologic characteristics of shallow aquifer systems (Rutledge and Mesko, 1996). Rutledge and Mesko analyzed streamflow records to determine recession indices for gages and watersheds throughout the Mid-Atlantic and Southern States. The recession index is a measure of the rate of decrease in stream base flow due to dewatering of the aquifer over a period during which there is no recharge. It is a function of the aquifer's hydrologic properties, including storativity, transmissivity, and geometry. The less an aquifer's storativity, the less time it takes for it to drain, resulting in a smaller recession index. Catoctin Creek had one of the lowest recession indices of those in the aforementioned study area, which included watersheds in the Valley and Ridge, Blue Ridge and Piedmont physiographic provinces from New Jersey to Alabama.

The annual average water availability uses an estimate of ground water recharge for the entire year. During the summer months, evapotranspiration is greater and thus recharge is significantly lower. Decreased recharge and the poor storage capacity of the aquifer, coupled with the peak demand generally observed during the summer months, make it a critical time for water supply. The effects of below-average precipitation are particularly evident during the summer months. To improve the estimates of annual water availability, the Interstate Commission on the Potomac River Basin (ICPRB) conducted a seasonal water budget analysis, which provides seasonal availability estimates at the same three recurrence intervals as the annual water budget analysis (Schultz et. al., 2004). This analysis provides results as the quantity of water 'available' during the summer quarter (V_{Q3}), which is computed from quarterly values for recharge and the beginning of quarter storage. In the Catoctin Creek watershed, two, ten, and twenty-year V_{Q3} is estimated to be 210, 65, and 60 gpd/acre respectively. Using these values, the summer ground water availability can be estimated for each subwatershed (Table 3.8).

Table 3.8 Summer Ground Water Availability for subwatersheds in the Catoctin Creek Watershed.

Shed Num	Acres	Minimum Reserve Flow (GPD)	1 in 2 Year Summer Quarter VQ3[1] (GPD)	1 in 2 Year Summer Quarter Ground Water Availability[2] (GPD)	1 in 10 Year Summer Quarter VQ3[1] (GPD)	1 in 10 Year Summer Quarter Ground Water Availability[2] (GPD)	1 in 20 Year Summer Quarter VQ3[1] (GPD)	1 in 20 Year Summer Quarter Ground Water Availability[2] (GPD)
0212	6,313	82,692	1,325,665	1,242,973	410,325	327,633	378,762	296,070
0213	4,185	54,822	878,876	824,054	272,034	217,212	251,108	196,286
0214	10,166	133,164	2,134,807	2,001,643	660,774	527,610	609,945	476,781
0215	9,058	118,654	1,902,190	1,783,536	588,773	470,119	543,483	424,829
0216	6,556	85,885	1,376,862	1,290,977	426,171	340,286	393,390	307,505
0217	8,221	107,691	1,726,437	1,618,746	534,374	426,683	493,268	385,577
0218	11,107	145,497	2,332,534	2,187,037	721,975	576,478	666,438	520,941
0219	9,758	127,826	2,049,230	1,921,404	634,285	506,459	585,494	457,668
0220	4,694	61,488	985,750	924,262	305,113	243,625	281,643	220,155
0221	7,005	91,760	1,471,038	1,379,278	455,321	363,561	420,297	328,537
Totals	77,063	1,009,479	16,183,389	15,173,911	5,009,145	3,999,667	4,623,828	3,614,350

[1] VQ3 = Summer Recharge + Beginning of Quarter Storage values from (Schultz et. al., 2004)

[2] Summer Quarter Ground Water Availability = VQ3 - Minimum Reserve Flow

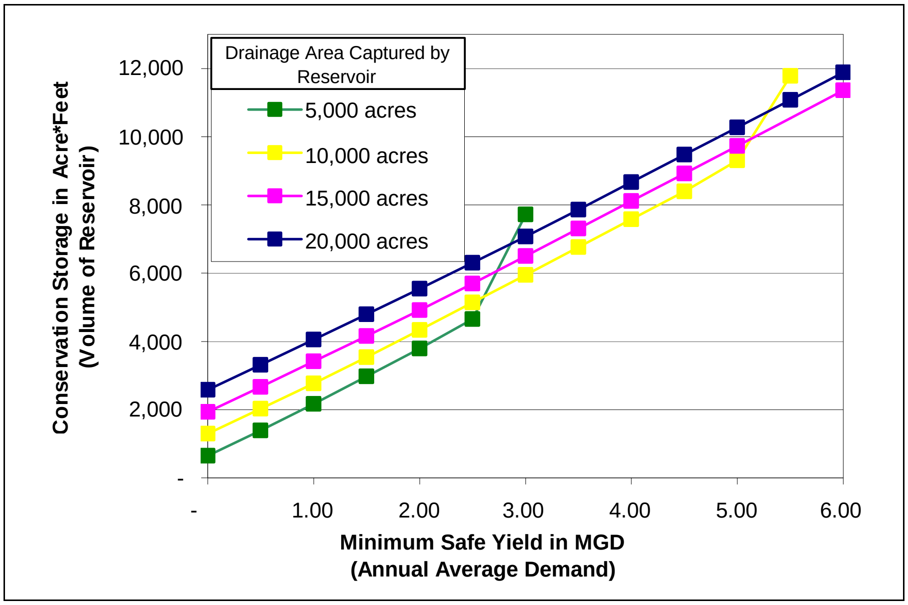
3.3.3 Surface Water

Estimating water availability from surface water sources is also based on an analysis of streamflow records from long-term stream gages. Surface water availability may be limited by low flow periods that occur seasonally or during extended periods with a lack of rainfall. To prevent unreasonable impacts to streams from surface water appropriations, Maryland regulations (COMAR 26.17.06.05.C.(2)) require that a minimum flow, commonly referred to as a “flowby”, be maintained past the point of withdrawal. The flowby, together with the natural variability of streamflow, limits the amount of water that may be withdrawn from a stream. In order to provide a reliable supply of water from a surface water source, artificial storage must be provided so that withdrawals can continue in times of reduced streamflow, such as drought. A method was devised that estimates the quantity of water that is reliably ‘available’ from a surface water source in the Catoctin Creek watershed. Specifically, the method described below predicts the amount of reservoir storage that would be necessary to provide a particular supply of water while maintaining flowby requirements for the stream. The water supply would be obtained from hypothetical reservoirs built on tributaries or the main stem of Catoctin Creek.

The method developed creates a “storage-safe yield curve”, the purpose of which is to provide an indication of the reservoir storage that is needed to meet a given demand. The safe-yield storage curve for the subwatersheds of Catoctin Creek is based on statistical analysis of the data from the stream gage on Catoctin Creek near Middletown. The curves are developed using the Maryland Most Common Flow Method (MD Method) as the flowby requirement for streams (MDE, 1986). With the MD Method, a low flow value is determined for each month of the year that is equal to the stream discharge that falls at the 15th percentile of the daily flows based on the entire streamflow record for that month. Although the MD Method derives twelve separate flowby values (one for each month), the common practice for permitting purposes has been to combine the monthly values into seasonal values. Therefore, two seasonal flowby values were determined from the historical record by a series of averaging of the monthly values. The flowby values are then applied to the streamflow period of record, during the appropriate season, to determine the reservoir volume necessary for a needed withdrawal of water.

The results of the surface water availability analysis are presented graphically as the storage-safe yield curves for four different drainage areas (Figure 3.2). The curves can be used to estimate the amount of reservoir storage volume needed to meet an average water demand, while maintaining minimum flow in the stream. The difference in the curves is a result of the flowby requirement. Each drainage basin is assigned a flowby by areally proportioning the flowby developed at the gage. The flowby is greater for a larger drainage area, which results in a larger storage volume necessary to meet the same demand. When the safe yield is equal to zero (x-axis), the volume (y-axis) is not equal to zero due to the required flowby for the stream. As an example from figure 3.2, in a stream basin that drains an area of 5,000 acres, the minimum size of a reservoir needed for a 1.0 million gallon per day (mgd) water withdrawal would be approximately 2,000 acre-feet. The same 1.0 mgd demand would require a 4,000 acre-feet reservoir in an area that drains 20,000 acres. This takes into account the larger flowby needed for the stream in a larger basin – in either case the flowby would be met by natural flow past the reservoir or by releases made from the reservoir.

Figure 3.2. Required Conservation Storage as a Function of Safe Yield for a Hypothetical Reservoir built in drainage basins with the indicated drainage capture area. Includes flowby allotments using the Maryland Most Common Flow Method.



The method developed herein is for general application only and provides a starting point to evaluate the practicality of an in-stream reservoir as a water supply. There are, however, a number of limitations to the method. The method does not apply to off-line reservoirs since they do not capture stream flow in the same effective manner nor does it account for losses due to evaporation. Moreover, it does not consider the temperature of the water to be discharged as flowby. COMAR 26.08.02.03 specifies maximum temperature criteria for discharges dependent on the stream's classification for use. In order to assure that the water released for flowby does not exceed these temperatures, the design of an in-stream reservoir must take into account the depth of water necessary to provide water supply storage and to provide insulation so that cooler water will be available for release as flowby during warmer months. The method provides some utility in that once a necessary storage volume is estimated, a topographic study can be completed to look at site suitability. Once a specific site is under consideration, a more specific analysis, including evaporation, temperature considerations, possible revisions in flowby to better support fisheries and necessary margins of safety must be conducted.

3.4 Water Demand vs. Water Availability

The water availability estimates were developed in this report on a subwatershed basis in order to provide a value with which to compare estimates of water demand. It must be recognized that these estimates are based on the best available hydrologic data, but will contain a degree of uncertainty due to the natural spatial variation in the hydrologic system. For example, ground water recharge estimates represent the average conditions upstream of the gage, which covers a much larger area than an individual subwatershed. The localized properties of an aquifer within a subwatershed and even within a specific wellfield may be significantly different than the average conditions in the whole watershed and therefore water availability may be greater or less than what is predicted. This study is based on a compromise between areas that are large but heterogeneous, and areas that are small but lack sufficiently detailed data. Given the available data and the purpose of this study, the average conditions give the best approximation for water availability at the subswatershed scale.

Water demand is presented as a percent of the estimated annual water availability for each subwatershed in Tables 3.9-3.11. The total current and projected demands are compared with ground water availability predicted for a typical year and both 10-year and 20-year droughts. The percentage gives an indication of where water supplies may be currently stressed or may be stressed in the future if water use increases as predicted. Current water demand in the Catoctin Creek watershed amounts to 4% of available water in a typical year; demand ranges from 1% to 12% in each of the ten subwatersheds. In a 20-year drought situation, the current demand in the entire watershed is 8% of the availability and ranges from 3% to 25% in the subwatersheds. Water demand in 2030 is predicted to increase to 6% of available water in an average year and may be as high as 43% at the subwatershed scale in a 20-year drought.

The water availability estimates provide a potential measure of how much water is "left" for collective uses. Current MDE permitting policy limits ground water withdrawals based on the area owned or controlled by the permittee that will provide recharge for ground water. The amount of water available to the permittee for withdrawal is determined using a recharge rate equivalent to a 10-year drought minus a minimum reserve flow for stream protection and an estimate of recharge loss (typically between 2 and 25%) due to impermeable surfaces based on land use in the recharge area. However, the question remains, how much of the available water can be used while ensuring a sustainable resource? Current MDE permitting policy was developed with the assumption that half of the water resources in a watershed would not be developed or would be developed with non-consumptive uses only. However, to date permit decisions have not been made with the goal of assuring that this assumption is not violated. Thus, in theory up to 100% of the available water resources may be developed. One approach that can be taken is to limit withdrawals to a certain percentage of water availability. For example, in Chester County, Pennsylvania, the Water Resources Authority has proposed a "maximum target" for withdrawals to 50% of the 1 in 25 year low flow in certain watersheds that contain "sensitive resources" or for drainage areas that contribute to first order streams (CCWRA, 2002). The availability estimates for Catoctin Creek developed herein, account for a minimum reserve flow (the 7Q10) for stream protection. However, this value may not be sufficient to protect first order streams and it is debatable whether such a low flow is adequate when considering all other uses for the water such as dilution of wastewater, biological needs, and downstream uses. It is highly unlikely that the 7Q10 would meet all of these needs if the maximum allowed use and low flows become the norm. In the same sense, the surface water analysis only looks at required low flows, which also may not meet the needs of all downstream users if surface water was used at the maximum allowable rate. The surface water analysis presented herein only determines the availability for maximum utilization of the watershed at the required flowby (the 15^{th} percentile flow), which may not be desirable under all circumstances.

A point of discussion with regard to the estimated "availability" is that it simply provides an amount of water that can theoretically be withdrawn from ground water. It does not, however, demonstrate the most efficient manner to withdraw ground water or whether it can be practically obtained given the typically low-yielding wells found in the aquifers of the Catoctin Creek watershed. As an example, the Town of Middletown has extensively explored for ground water in subwatershed 0216 over the last five years. During the drought of 2002, commonly thought of as a 50-year drought, the three large ground water users (Middletown, Fountaindale, and Glenbrook Golf Course) in subwatershed 0216 had an actual production rate of approximately 566,000 gpd or 21% of the estimated 2.69 mgd available in a 10-year drought derived herein[†]. Since then the addition of three wells in Middletown brings the total current rate of withdrawal permitted for the three same users to approximately 730,000 gpd, or 27% of the availability estimate for a 10-year drought. The average yield of the existing twenty

[†] Recharge to ground water during the drought of 2002 was considerably lower than a 10-year drought due to the significant lack of precipitation during the dormant season, the most crucial months for replenishing ground water storage. However, since we do not have an estimate for recharge rates in such a severe drought, the demand is compared with the 10-year drought availability estimates derived in this analysis.

wells used under these three appropriation permits and currently in use in subwatershed 0216 is 18 gallons per minute (gpm). This average yield does not include all of the wells that were drilled and abandoned due to low yield during well exploration. If all of the remaining 'estimated' available water could be recovered, it would take over 100 wells at the average yield of about 18 gpm, a highly impractical situation for a small community system to manage. In other areas of Central Maryland, ground water exploration efforts have been similarly unsuccessful in recovering all water that is theoretically available based on a water balance. As an example, the City of Westminster in Carroll County has recovered only one mgd from the twelve mgd theoretically available in the surrounding ground water basin after twenty years of exploration.

Another approach to examining a limit for withdrawals for water supply purposes is to evaluate the water demand during the summer months, which is the most critical time of the year as recharge decreases and more water is obtained from storage. Tables 3.12-3.14 show the average water demand as a percentage of the estimated summer quarter water availability. In the whole watershed, current demand is 14% of summer availability in a typical year and 60% in a 20-year drought. At the subwatershed scale, the current demand is as high as 46% of average-year availability and 194% in a 20-year drought. While the seasonal water availability estimates contain a fair degree of uncertainty, this still points to a potential concern with regard to adverse impacts to stream base flow during droughts and possibly on an annual basis in some areas of the watershed. The summer availability was determined by applying the recharge and storage areally to the subwatersheds in a similar fashion that annual recharge rates were applied to estimate annual average availability. This again only represents the average conditions over a heterogeneous area. Due to the variations in hydrological features in the fractured bedrock at any given location, the summer availability numbers may significantly over- or under-estimate what is truly 'available' during the summer months. If water withdrawals exceed recharge levels, the amount of water stored as ground water is reduced, thereby reducing the amount of water available as stream base flow.

Subwatershed 0216 is examined further to demonstrate the questions raised by the summer availability analysis. In this subwatershed, the current demand represents 46% of the estimated summer quarter (July through September) availability in a typical year and 194% of summer quarter availability in a 20-year drought. Most of the current water demand in this subwatershed is from the three ground water appropriation permits mentioned above, the Town of Middletown, Fountaindale, and Glenbrook Golf Course. The withdrawal points for these three permits are all concentrated within the drainage basin of Hollow Creek, an upstream tributary to subwatershed 0216, which comprises 2,548 acres (Figure 3.3). By applying the summer availability rates to the area of the Hollow Creek basin, the average year (1 in 2 year) summer quarter availability is approximately 535,000 gpd. The summer of 2004 was an average year with regard to precipitation, with a monthly average of 4.6 inches in Frederick County during July through September (NOAA, 2005). The average actual water use reported in July through September 2004 by the three permits was 598,000 gpd. The demand in the summer of 2004 represents 112% of the estimated summer availability in a typical year, which indicates that the predicted summer availability is not the practical limiting factor for aquifer yield. Whether or not the stream was impacted is unclear, since there is no gage and no flow observations are available.

During the summer quarter of 2002, commonly thought of as the peak of a 50-year drought, the actual water use was 566,000 gpd for the three ground water permits. This exceeds what is predicted to be available during a 20-year drought (393,000 gpd) for subwatershed 0216 and is almost four times what is predicted as available when applying the summer availability rates to the Hollow Creek basin only (153,000 gpd). During the drought of 2002 the expected consequences reportedly did occur. Hollow Creek was observed to be “bone dry” by an MDE hydrogeologist in late August of 2002, whereas other streams in subwatershed 0216, including nearby Cone Branch, and elsewhere in Frederick County were observed to have some flow on the same date. In addition, an aquatic biologist who lives next to Cone Branch reported that it was dry for most of the summer. The data and observations from Hollow Creek basin point to questions related to sustainability - whether seasonal adverse impacts to streams are occurring on an annual basis if summer availability is being exceeded, and whether or not it is okay to let a stream run dry in severe drought situations. Despite the fact that ground water withdrawals were significantly less due to a smaller population during the drought of 1966 (the drought of record), the stream gage on Catoctin Creek at Middletown measured zero flow for a 17 day stretch during late August and early September, 1966. It is clear that the most heavily developed subwatershed with regard to water resources is subwatershed 0216 and that its upstream tributaries were impacted as during the drought of 2002. However, it is not clear to what extent this may have been expected, due to the lack of continuous stream gage data on Hollow Creek. Unfortunately, it is not possible to analyze the relative impacts of withdrawals on the stream with non-anthropogenic impacts that may be expected in a drought as severe as that of 2002 without the appropriate historical streamflow data.

Lastly, it must be noted that the current demand used in the percentages (Tables 3.9-3.14) is total demand and the values were not separated into ground water and surface water components. This analysis assumes that ground water will continue to represent the predominant use in Catoctin Creek in the future. This may not be realistic considering the difficulty in locating a sufficiently high yielding well necessary for public water supplies in the aquifers underlying this watershed. The surface water analysis offers one alternative and provides a starting point for determining the practicality and the benefits of pursuing surface water supplies as a potential water supply for community water systems.

Figure 3.3 Locations of Withdrawal Points for three Ground Water Appropriation Permits (Middletown, Fountaindale, and Glenbrook Golf Course) in Subwatershed 0216.

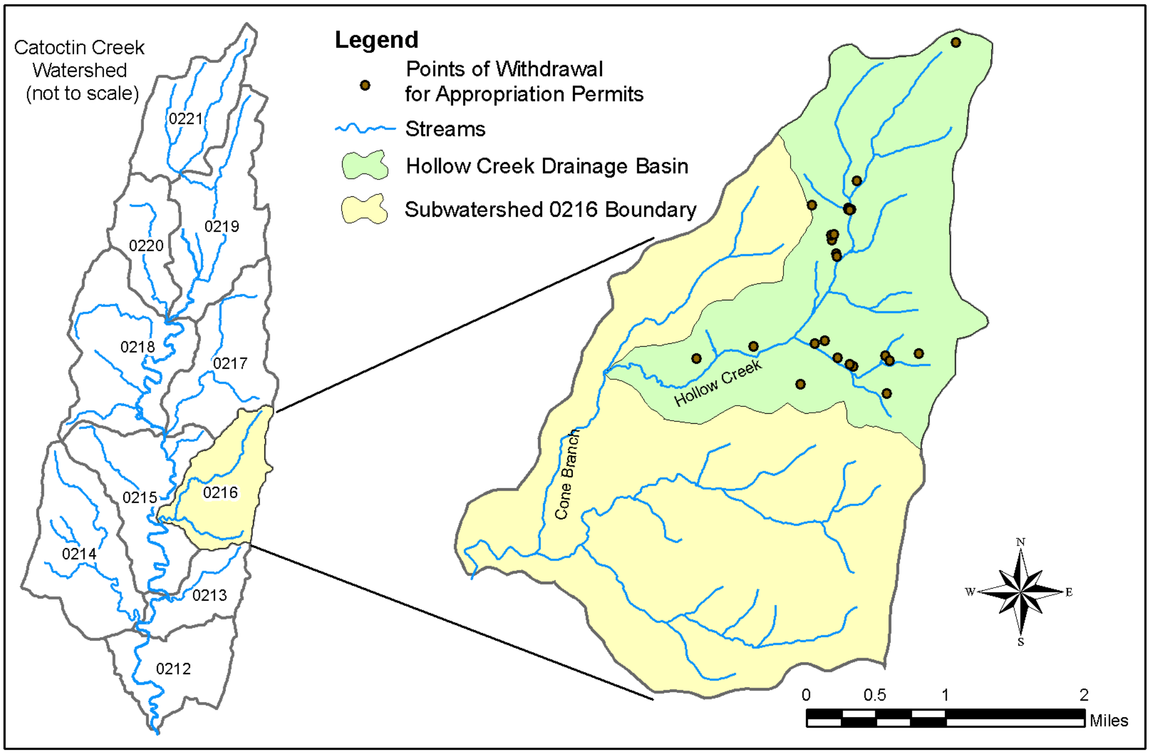


Table 3.9 Current and Future Water Demands Compared with Typical Year (1 in 2 Year) Annual Water Availability.

Shed Num	1 in 2 Year Ground Water Availability	2000-2003 Water Demand (GPD)	2000-2003 Demand as % of Available	2020 Demand (GPD)	2020 Demand as % of Available	2030 Demand (GPD)	2030 Demand as % of Available
0212	4,708,533	155,880	3.3%	209,971	4.5%	250,490	5.3%
0213	3,121,623	198,811	6.4%	281,352	9.0%	335,141	10.7%
0214	7,582,466	116,720	1.5%	165,678	2.2%	198,979	2.6%
0215	6,756,254	101,446	1.5%	142,658	2.1%	169,908	2.5%
0216	4,890,377	595,113	12.2%	847,527	17.3%	1,008,829	20.6%
0217	6,132,010	261,238	4.3%	361,548	5.9%	430,671	7.0%
0218	8,284,762	337,039	4.1%	465,254	5.6%	554,173	6.7%
0219	7,278,511	99,980	1.4%	138,056	1.9%	164,422	2.3%
0220	3,501,212	208,218	5.9%	287,253	8.2%	342,254	9.8%
0221	5,224,876	79,430	1.5%	109,853	2.1%	130,739	2.5%
Totals	57,480,625	2,153,875	3.7%	3,009,150	5.2%	3,585,606	6.2%

Table 3.10 Current and Future Water Demands Compared with Drought Year (1 in 10 Year) Annual Water Availability.

Shed Num	1 in 10 Year Ground Water Availability	2000-2003 Water Demand (GPD)	2000-2003 Demand as % of Available	2020 Demand (GPD)	2020 Demand as % of Available	2030 Demand (GPD)	2030 Demand as % of Available
0212	2,593,829	155,880	6.0%	209,971	8.1%	250,490	9.7%
0213	1,719,635	198,811	11.6%	281,352	16.4%	335,141	19.5%
0214	4,177,016	116,720	2.8%	165,678	4.0%	198,979	4.8%
0215	3,721,874	101,446	2.7%	142,658	3.8%	169,908	4.6%
0216	2,694,003	595,113	22.1%	847,527	31.5%	1,008,829	37.4%
0217	3,377,992	261,238	7.7%	361,548	10.7%	430,671	12.7%
0218	4,563,896	337,039	7.4%	465,254	10.2%	554,173	12.1%
0219	4,009,574	99,980	2.5%	138,056	3.4%	164,422	4.1%
0220	1,928,743	208,218	10.8%	287,253	14.9%	342,254	17.7%
0221	2,878,271	79,430	2.8%	109,853	3.8%	130,739	4.5%
Totals	31,664,834	2,153,875	6.8%	3,009,150	9.5%	3,585,606	11.3%

Table 3.11 Current and Future Water Demands Compared with Drought Year (1 in 20 Year) Annual Water Availability.

Shed Num	1 in 20 Year Ground Water Availability	2000-2003 Water Demand (GPD)	2000-2003 Demand as % of Available	2020 Demand (GPD)	2020 Demand as % of Available	2030 Demand (GPD)	2030 Demand as % of Available
0212	2,265,577	155,880	6.9%	209,971	9.3%	250,490	11.1%
0213	1,502,013	198,811	13.2%	281,352	18.7%	335,141	22.3%
0214	3,648,409	116,720	3.2%	165,678	4.5%	198,979	5.5%
0215	3,250,866	101,446	3.1%	142,658	4.4%	169,908	5.2%
0216	2,353,073	595,113	25.3%	847,527	36.0%	1,008,829	42.9%
0217	2,950,502	261,238	8.9%	361,548	12.3%	430,671	14.6%
0218	3,986,329	337,039	8.5%	465,254	11.7%	554,173	13.9%
0219	3,502,157	99,980	2.9%	138,056	3.9%	164,422	4.7%
0220	1,684,658	208,218	12.4%	287,253	17.1%	342,254	20.3%
0221	2,514,022	79,430	3.2%	109,853	4.4%	130,739	5.2%
Totals	27,657,607	2,153,875	7.8%	3,009,150	10.9%	3,585,606	13.0%

Table 3.12 Current and Future Water Demands Compared with Typical Year (1 in 2 Year) Summer Water Availability.

Shed Num	1 in 2 Year Summer Quarter Ground Water Availability (GPD)	2000-2003 Water Demand (GPD)	2000-2003 Demand as % of Available	2020 Demand (GPD)	2020 Demand as % of Available	2030 Demand (GPD)	2030 Demand as % of Available
0212	1,242,973	155,880	12.5%	209,971	16.9%	250,490	20.2%
0213	824,054	198,811	24.1%	281,352	34.1%	335,141	40.7%
0214	2,001,643	116,720	5.8%	165,678	8.3%	198,979	9.9%
0215	1,783,536	101,446	5.7%	142,658	8.0%	169,908	9.5%
0216	1,290,977	595,113	46.1%	847,527	65.7%	1,008,829	78.1%
0217	1,618,746	261,238	16.1%	361,548	22.3%	430,671	26.6%
0218	2,187,037	337,039	15.4%	465,254	21.3%	554,173	25.3%
0219	1,921,404	99,980	5.2%	138,056	7.2%	164,422	8.6%
0220	924,262	208,218	22.5%	287,253	31.1%	342,254	37.0%
0221	1,379,278	79,430	5.8%	109,853	8.0%	130,739	9.5%
Totals	15,173,911	2,153,875	14.2%	3,009,150	19.8%	3,585,606	23.6%

Table 3.13 Current and Future Water Demands Compared with Drought Year (1 in 10 Year) Summer Water Availability.

Shed Num	1 in 10 Year Summer Quarter Ground Water Availability (GPD)	2000-2003 Water Demand (GPD)	2000-2003 Demand as % of Available	2020 Demand (GPD)	2020 Demand as % of Available	2030 Demand (GPD)	2030 Demand as % of Available
0212	327,633	155,880	47.6%	209,971	64.1%	250,490	76.5%
0213	217,212	198,811	91.5%	281,352	129.5%	335,141	154.3%
0214	527,610	116,720	22.1%	165,678	31.4%	198,979	37.7%
0215	470,119	101,446	21.6%	142,658	30.3%	169,908	36.1%
0216	340,286	595,113	174.9%	847,527	249.1%	1,008,829	296.5%
0217	426,683	261,238	61.2%	361,548	84.7%	430,671	100.9%
0218	576,478	337,039	58.5%	465,254	80.7%	554,173	96.1%
0219	506,459	99,980	19.7%	138,056	27.3%	164,422	32.5%
0220	243,625	208,218	85.5%	287,253	117.9%	342,254	140.5%
0221	363,561	79,430	21.8%	109,853	30.2%	130,739	36.0%
Totals	3,999,667	2,153,875	53.9%	3,009,150	75.2%	3,585,606	89.6%

Table 3.14 Current and Future Water Demands Compared with Drought Year (1 in 20 Year) Summer Water Availability.

Shed Num	1 in 20 Year Summer Quarter Ground Water Availability (GPD)	2000-2003 Water Demand (GPD)	2000-2003 Demand as % of Available	2020 Demand (GPD)	2020 Demand as % of Available	2030 Demand (GPD)	2030 Demand as % of Available
0212	296,070	155,880	52.6%	209,971	70.9%	250,490	84.6%
0213	196,286	198,811	101.3%	281,352	143.3%	335,141	170.7%
0214	476,781	116,720	24.5%	165,678	34.7%	198,979	41.7%
0215	424,829	101,446	23.9%	142,658	33.6%	169,908	40.0%
0216	307,505	595,113	193.5%	847,527	275.6%	1,008,829	328.1%
0217	385,577	261,238	67.8%	361,548	93.8%	430,671	111.7%
0218	520,941	337,039	64.7%	465,254	89.3%	554,173	106.4%
0219	457,668	99,980	21.8%	138,056	30.2%	164,422	35.9%
0220	220,155	208,218	94.6%	287,253	130.5%	342,254	155.5%
0221	328,537	79,430	24.2%	109,853	33.4%	130,739	39.8%
Totals	3,614,350	2,153,875	59.6%	3,009,150	83.3%	3,585,606	99.2%

4.0 Environmental and other Factors Affecting Water Supply and Management

Water availability and demand are clearly two of the integral factors for effective planning for water resources. Water resources in a hydrologic setting such as Catoctin Creek are connected to what occurs on the land. Therefore, environmental factors that may affect availability or the cost-effectiveness of developing a water supply, such as land use and water quality, must also be considered for water supply planning purposes. In addition, water conservation measures and water use alternatives during times of drought or during normal conditions represent manners in which demand can be reduced through planning and outreach, thereby increasing water availability to users.

4.1 Water Quality

Water quality in a watershed can also be discussed as a cycle. Although the biogeochemical processes that determine water quality are quite complex, the basic principles are the same as a hydrologic budget. Precipitation chemistry and the biological and geochemical processes that occur as water moves through the system determine natural ground water quality. These same principles apply to surface water quality; however, dilution of chemical constituents and increased erosion associated with storm flows are additional processes that contribute to temporal changes in surface water quality. The quality of water in a watershed is significantly affected by activities that occur at the land surface. Human activities and land use practices are additional inputs to the water quality cycle. Large ground water withdrawals can change the natural flow paths in an aquifer or alter ground water chemistry, both of which can affect ground water quality. Water quality data is reviewed from previous studies of the water resources in the watershed to provide a general picture of water quality and to highlight issues that may affect future water supplies.

Overall, natural water quality in the Catoctin Creek watershed is very good. The Blue Ridge and Piedmont physiographic provinces have the lowest total dissolved solids (TDS) in ground water of the major physiographic settings and naturally occurring contaminants are generally not a concern (Bolton, 1996). Common anthropogenic contaminants, such as nitrate, are sometimes associated with certain types of land use. Sources of nitrate include wastewater discharge from onsite septic systems and wastewater treatment plants, animal waste, and fertilizers. While agriculture is a predominant land use, commonly used pesticides are not typically found in ground water at significant levels (Bolton, 1996), likely due to their quick degradation in soils. Concentrated animal farm operations (CAFO's) may be a concern due to the large quantity of animal waste produced in a relatively small area. Animal waste is a source of both nitrate and pathogens, which can impact both ground and surface water supplies.

4.1.1 Ground Water

The Water Supply Program has completed Source Water Assessments for each of the six community water systems in the Catoctin Creek watershed. The required components as described in Maryland's Source Water Assessment Program (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 (MDE, 1999). The goals of the assessments are to analyze the susceptibility and provide recommendations to protect the water supply sources from future contamination. The source water assessments provide a review of available water quality data from each existing community system. A summary of the findings as related to water quality that may reflect common trends for potential supplies within the watershed are provided below.

The six community water systems rely predominantly on ground water as their source of water supply. The exception is the Town of Myersville, which has a small reservoir that supplements their wells and springs. Based on the findings of the source water assessments, drinking water quality in the Catoctin Creek watershed is generally very good. Community water systems routinely monitor up to ninety-one regulated contaminants under Safe Drinking Water Act requirements. Some contaminants can be naturally occurring and are a product of geochemical reactions in ground water, such as iron, radionuclides, and many of the inorganic ions. Other contaminants have an anthropogenic source and are present in ground and surface water as a result of land use, improper disposal of chemicals, or spills.

The results of the source water assessments show that levels of regulated contaminants have not exceeded a maximum contaminant level (MCL) in the community water systems of the Catoctin Creek watershed. Some regulated contaminants were detected, but were not present at significant levels to categorize the water supply as susceptible under the SWAP guidelines. An example is nitrate, a common contaminant in unconfined aquifers throughout the State. The MCL for nitrate is 10 parts per million (ppm) and levels in the Catoctin Creek watershed range from non-detectable to 6.4 ppm. Two of the six water systems had consistent detections of nitrate but the water systems were classified as not susceptible based on SWAP guidelines since nitrate levels have remained consistent and below the MCL. There are many possible sources of nitrate in ground water, including human and animal waste and fertilizers applied to residential lawns, agriculture, and golf courses.

Methyl-tert-butyl-ether (MTBE) is another common contaminant that was detected in two of the six water systems. MTBE does not have an MCL and is currently unregulated under the Safe Drinking Water Act. However, the Water Supply Program has a policy of reporting any detections at or above 10 parts per billion (ppb) to MDE's Oil Control Program, which regulates petroleum storage tanks and initiates an investigation when such results are found in public wells. MDE recommends treatment to remove MTBE when levels exceed 20 ppb. MTBE is a fuel oxygenate added to gasoline in Maryland to control fuel emissions for air quality purposes. Unlike other regulated contaminants in petroleum products, such as benzene and toluene, MTBE dissolves readily in water and does not easily degrade or sorb to soil, and therefore can travel significant distances in ground water (Squillace, et. al., 1996). It is one of the most commonly detected volatile organic compounds in public water supplies across the State as well as in private wells throughout the country (Moran, et. al., 2004). The taste and odor threshold for MTBE is between 20 and 40 ppb. It is generally detected at low levels (less than 5 ppb), however higher results of MTBE contamination in Maryland have been associated with leaking underground storage tanks in localized areas. MTBE levels ranged from non-detectable to 17 ppb in the two systems in the Catoctin Creek watershed that detected the contaminant. Due to its high solubility and mobility, there is the potential for MTBE to be present in water supplies anywhere that MTBE-oxygenated gasoline is stored or used.

Another contaminant detected commonly in untreated water samples of the ground water supply was total coliform bacteria. These are not considered violations of Safe Drinking Water Act regulations, because they are not present in the finished water (the treated water distributed for human consumption). These results were obtained during special sampling under Ground Water Under Direct Influence (GWUDI) evaluations. The GWUDI evaluations were conducted as required by a special provision within the federal Surface Water Treatment Rule (SWTR). The SWTR stipulates that ground water sources that have the potential to contain pathogenic organisms normally associated with surface water sources must adhere to the more stringent treatment technique requirements of the SWTR. A special sampling protocol was followed that collected untreated water samples and analyzed them for Total Coliform, Fecal Coliform, and other surface water indicators from ground water sources to determine their GWUDI status. Total coliform bacteria group is an indicator organism that is ubiquitous in the environment. In deep ground water systems, the bacteria will not survive due to long travel times and the natural filtration capability of the ground water system. However, in shallower ground water systems that have shorter travel times, total coliform may persist, which may explain the common detection rate of total coliform.. The presence of total coliform alone in ground water does not necessarily indicate a threat of contamination by pathogenic organisms. The fecal coliform group is used as indicator for the potential of contamination by mammalian waste, which may carry with it disease causing microbiological contaminants, such as *Giardia*, *Cryptosporidium*, and viruses. Where fecal coliform is detected in raw ground water samples, the ground water supply is generally classified as GWUDI and compliance with more rigorous treatment techniques is required. Three of the largest producing wells in the Catoctin Creek watershed as well as some of the springs are classified as GWUDI. Additionally, other sources were found to have total coliform bacteria, but due to the lack of other indicators of surface water influence, they were not classified as GWUDI sources.

The major water quality issues related to ground water supplies - nitrate, MTBE, and bacteria - are all related to land use, which demonstrates the importance of source water protection efforts and preserving undeveloped land for future water supplies. The relatively rapid travel time in this shallow aquifer system allows for contaminants that originate from land use practices to reach existing ground water supplies where sources of the contaminants are nearby. Water quality issues related to these contaminants should be anticipated when developing future water supplies in this watershed.

4.1.2 Surface Water

Water quality data from the Town of Myersville's reservoir intake is also reviewed in the source water assessment. The results do not necessarily reflect the quality of the source water for all constituents, since most monitoring data is collected after the treatment process. However, raw water bacteriological samples were collected for a two-year period as part of the assessment and offer some indication of surface water quality in the upper portion of the watershed. A total of 81 raw water samples were analyzed for the indicator organisms fecal coliform and E. Coli. The results ranged from non-detectable to 79 fecal coliform colonies/100 ml and non-detectable to 47 E. Coli colonies/100 ml. Ninety-five percent of samples were positive for fecal coliform, although only 26% of the samples had a count of greater than 2 colonies/200 ml. The data indicate that surface water quality is relatively good in subwatershed 0220, where the intake is located. Since the intake is in an impoundment, which allows for settling, turbidity is not a major concern. It must be noted that this sampling point is located in the upstream reaches of the watershed and is not likely to reflect the stream water quality in the entire watershed.

Catoctin Creek has also been evaluated as required by the Clean Water Act for impairment classification and Total Maximum Daily Load (TMDL) development. Under section 303(d) of the Clean Water Act, states, territories, and authorized tribes are required to develop lists of impaired waters every two years. MDE's TMDL program evaluates available stream water quality data and designates streams as impaired based on specific criteria for the various constituents. A water body is considered "impaired" when it does not attain the designated use assigned to it in Maryland Regulations. If a stream is classified as impaired, a total maximum daily load must be assigned for the particular constituent, the intention of which is to improve water quality towards the stream's designated use. The law requires that MDE establish priority rankings for waters on the lists and develop TMDLs for these waters. A TMDL specifies the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and allocates pollutant loadings among point and nonpoint pollutant sources.

The 2004 303(d) list represents the current stream impairment analysis for watersheds across Maryland. Based on this listing, Catoctin Creek has been classified as impaired under several categories including bacteria, biological, nutrients, and sediments. Where data is available, the classification is based on specific segments within the watershed. The biological impairment category has been designated in three subwatersheds, 0217, 0218, and 0221.

The impairment classifications are based on separate criteria for each category. The biological classification is based on data available from the Maryland Biological Stream Survey (MBSS), and uses measurements of biological health, the "fish index" (FIBI) and the "benthic index", (BIBI). The bacteria category is based on fecal coliform data from core monitoring stations. The nutrient and sediment categories are based on a land use analysis in the watershed. A new model for nutrient and sediments is currently being evaluated and these impairment classifications may be revised if the new analysis warrants. The 303(d) summary list is included in Appendix C. The TMDL for each constituent is currently being developed and will address management practices for improving water quality in the streams of the watershed.

Surface water supplies are extremely vulnerable to land use practices since runoff will directly enter streams. In the early 1990's many communities in rural Maryland began to abandon their surface water supplies for ground water due to considerable changes to the federal Surface Water Treatment Rule (SWTR). The stringent treatment and monitoring requirements have made the pursuit of surface water supplies cost-prohibitive for smaller communities. The SWTR does include criteria that would allow for a waiver to many treatment requirements if the water quality of the source meets acceptable standards and source protection efforts are in place to ensure continued water quality.

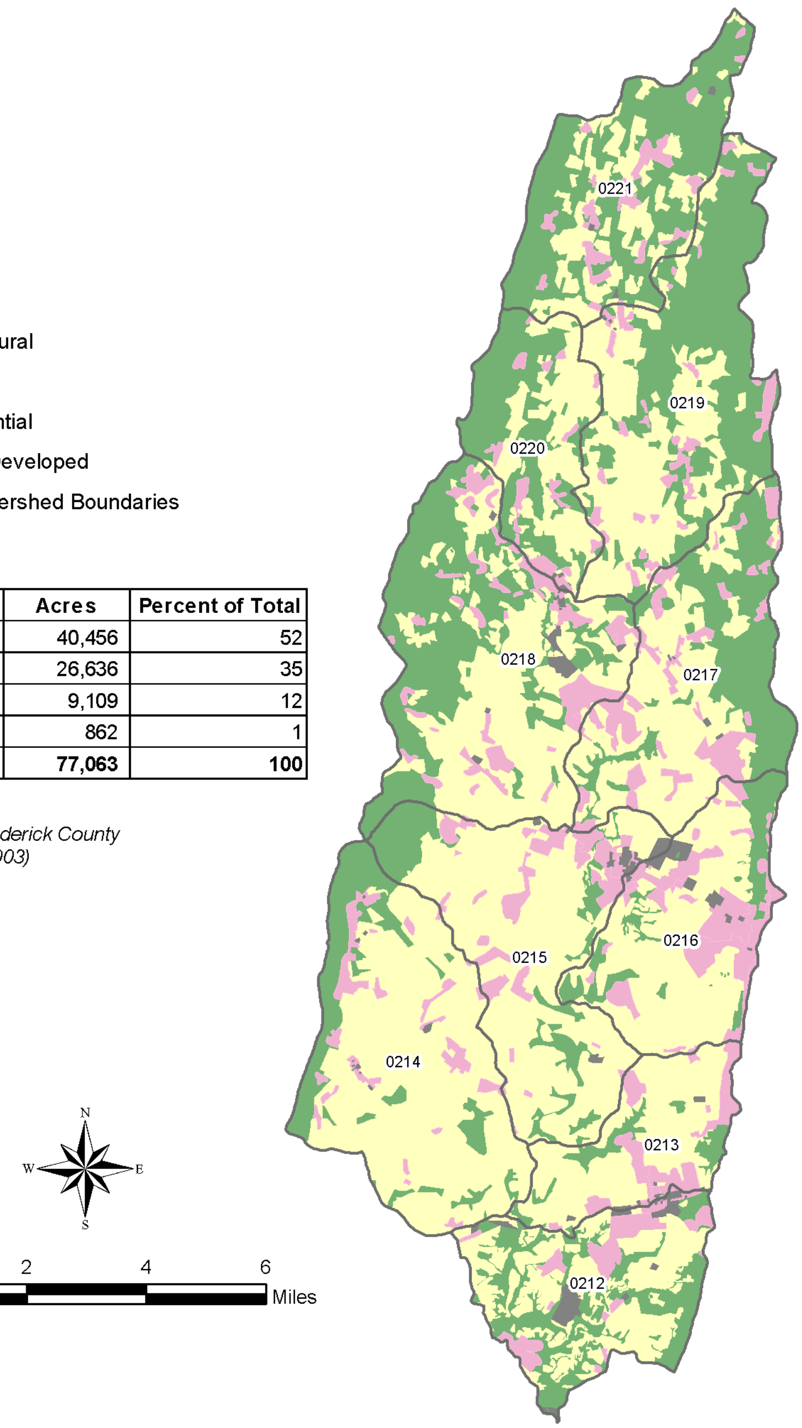
4.2 Land Use

Land development can impact water resources in several ways, such as changing the runoff and recharge patterns of the hydrologic cycle and introducing pollutants to water supplies. For these reasons, the land use patterns in the Catoctin Creek watershed are evaluated and summarized in the following section. A quantitative analysis of the specific impacts of land use on water quantity or quality is beyond the scope of this project. The information is provided as a first step towards consideration of land use planning with regard to water supply planning.

The Maryland Department of Planning's GIS layer of land use (MDP, 2003) for Frederick County was used to summarize land use patterns. MDP's classification types were grouped into four general land use categories – Agricultural, Natural, Residential and Other Developed. 'Agricultural' lands include cropland, pasture, orchards, and high density feeding operations. 'Natural' areas include areas of forested cover and water bodies. 'Residential' includes low, medium, and high-density areas, while 'Other Developed' includes commercial, industrial, institutional, and open urban land.

Land use was summarized for the entire watershed and for each subwatershed in Catoctin Creek. Overall, the predominant land uses in the Catoctin Creek watershed are agricultural (52%) and natural (35%) (Fig. 4.1). Residential and other developed lands amount to a total of 12% and 1%, respectively. In the headwaters of the watershed, natural areas are more prevalent while agricultural lands dominate the Middletown Valley. Patterns of land use are also variable at the subwatershed scale (Table 4.1). Residential and other developed lands amount to as little as 7% of subwatersheds 0214 and 0219, and as much as 27% of subwatershed 0216. Agricultural use dominates the land in the southeastern subwatersheds, where it comprises 72% and 74% of subwatersheds 0215 and 0214, respectively.

Figure 4.1 Generalized Land Use in the Catoctin Creek Watershed



Legend

Land Use[1]

Category

- Agricultural
- Natural
- Residential
- Other Developed
- Subwatershed Boundaries

Category	Acres	Percent of Total
Agricultural	40,456	52
Natural	26,636	35
Residential	9,109	12
Other Developed	862	1
Total	**77,063**	**100**

[1] *Based on 2002 Frederick County Land Use (MDP, 2003)*

Table 4.1. Land Use Summary for Catoctin Creek subwatersheds.

	General Land Use Category							
	Agricultural		Natural		Residential		Other Developed	
ShedNum	**Acres**	**% of Total**	**Acres**	**% of Total**	**Acres**	**% of Total**	**Acres**	**% of Total**
0212	2,890	46%	2,357	37%	789	12%	277	4%
0213	2,885	69%	482	12%	778	19%	39	1%
0214	7,551	74%	1,895	19%	697	7%	23	0%
0215	6,556	72%	1,307	14%	1,054	12%	141	2%
0216	3,842	59%	978	15%	1,562	24%	174	3%
0217	3,800	46%	3,072	37%	1,333	16%	16	0%
0218	5,012	45%	4,664	42%	1,278	12%	153	1%
0219	4,117	42%	4,972	51%	663	7%	6	0%
0220	1,934	41%	2,374	51%	374	8%	12	0%
0221	1,869	27%	4,535	65%	580	8%	20	0%
Total	**40,456**	**52%**	**26,636**	**35%**	**9,109**	**12%**	**862**	**1%**

The Center for Watershed Protection (CWP, 2003) developed a model for impervious cover in a watershed that predicts threshold limits that will have harmful effects on overall stream quality. Based on a variety of research studies, the general model predicts that stream quality may be impacted if 10% of the watershed is impervious cover. Stream quality is defined by several indicators and is grouped by four major categories - hydrologic, physical, water quality, and biological impacts. The model is purposefully simplistic, and the effects of imperviousness may vary for each category depending on the specific characteristics of the watershed. Laws in Maryland that regulate storm water runoff were created to limit the impacts of watershed development on overall stream quality. Maryland's stormwater regulations are designed to maintain after development, as nearly as possible, the predevelopment conditions and to prevent adverse impacts of stormwater runoff. Stormwater management practices, which are specified in Maryland's Stormwater Design Manual (MDE, 2000), help control nonpoint source pollution through the use of nonstructural and/or structural techniques to intercept surface runoff from developed areas, filter and treat this runoff, and then discharge it at a controlled rate. In addition, the performance standards for stormwater design include the determination of a recharge volume to maintain annual ground water recharge rates in order to maintain the hydrology of streams and wetlands during dry weather. Thus, stormwater management controls can be beneficial to streams for peak flows in discharge and in mitigating the potential effects on low-flow conditions.

Changes in stream hydrology in urbanized watersheds are well documented by numerous scientific studies. Increased runoff volume and flood frequency is a common consequence of watershed development. Conversely, increased impervious cover is expected to decrease recharge to ground water. Several studies on the East Coast and Mid-Atlantic have documented a relationship between impervious cover and increased runoff volume (CWP, 2003). The relationship between impervious cover and base flow is not as clear-cut. While some studies have demonstrated that baseflow declined in urbanized watersheds, other studies have been inconclusive in determining the effects of impervious cover on ground water recharge (CWP, 2003). Factors such as climate and geology, as well as return flows from leaking infrastructure may have an equally significant impact on base flow conditions. The research indicates that soil and aquifer conditions will determine the degree to which impervious cover will impact ground water recharge.

Effects on the water quality of streams are also seen with increased impervious cover in watersheds. Stormwater runoff can carry with it numerous pollutants that eventually end up in streams and compromise water quality. Pollutants that are frequently found in stormwater runoff can be grouped into nine broad categories - sediment, nutrients, metals, hydrocarbons, bacteria and pathogens, organic carbon, MTBE, pesticides, and deicers (CWP, 2003). The impact on stream quality will vary with pollutant type. For example, sediments affect habitat and aquatic biodiversity, while nutrients can cause eutrophication. In very general terms, an increase in impervious cover, and therefore stormwater runoff, correlates to an increase in the pollutant load of a watershed. How this might affect water supply sources is dependent on the types of pollutants present and the practicality or cost-effectiveness of treatment methods for those pollutants.

Developed lands are a rough corollary to the amount of impervious cover in a watershed, however the percent of developed land does not directly equate to imperviousness. Thus, caution should be taken in trying to interpret the land use summary above with regard to the impervious cover model. A GIS layer of impervious surfaces is currently being developed for the State of Maryland, and may provide a better analytic tool for watershed analysis in the future.

4.3 Protected Lands

Protected lands are areas that are not available for development because they are either privately owned land bound to a conservation easement or public lands designated as preserved open space. Development may be restricted or prohibited in additional areas due to the presence of natural features such as floodplains, wetlands, and sensitive flora and fauna. Since they limit the impacts of land use and impervious cover, protected lands are considered a benefit to natural resources including water supply sources.

The two largest conservation easement programs are managed by the State; the Maryland Department Agriculture (MDA) has an easement program to preserve farmland and the Maryland Environmental Trust (MET) has a program to preserve open land including all significant natural resources. There are additional easement programs run by independent conservation organizations. The Rural Legacy program designates areas in order to facilitate the process in obtaining conservation easements, although any land may be considered for a conservation easement.

Various types of protected lands are present in the Catoctin Creek watershed. The total area of protected lands, including public lands and conservation easements, in the watershed is approximately 17,600 acres or 23% of the land. Public lands and other areas that may be undevelopable, such as wetland and floodplains, are depicted in Figure 4.2. Figure 4.3 shows the currently existing agricultural easements in the watershed as well as the designated Rural Legacy Area. Summaries of protected lands by subwatershed are provided in Tables 4.2 and 4.3.

Protected lands provide benefits to the hydrologic system as undisturbed recharge areas for ground water. Natural areas also protect water resources from the potential impacts to water quality posed by developed lands. Lands that are undeveloped may represent a potential benefit to water appropriation permittees in their water balance. Currently, the MDA and MDE are discussing the potential of adding water conservation easements to lands under existing agricultural conservation easements. The benefits of undisturbed forested lands may be greater than agricultural areas where soil compaction may have some effect on recharge and overall stream quality may be impacted by the use of the land for crops or pasture (CWP, 2003). While recharge may not be the same as under natural conditions, undeveloped agricultural land can still represent a benefit to areas of centralized growth, such as towns, if they are not a competing use of water.

Table 4.2 Protected Lands in the Catoctin Creek Watershed

ShedNum	Total Acres	Public Land Acres	FEMA Floodplains Acres	Wetlands Acres	Sensitive Species Acres	Total Protected Land Acres	% of Total Area
0212	6,313	17	520	51	49	637	10%
0213	4,185	0	319	38	0	357	9%
0214	10,166	985	364	205	0	1554	15%
0215	9,058	296	673	71	0	1040	11%
0216	6,556	128	280	77	11	496	8%
0217	8,221	293	166	61	216	735	9%
0218	11,107	1120	497	95	0	1712	15%
0219	9,758	25	420	83	135	663	7%
0220	4,694	483	135	24	0	641	14%
0221	7,005	744	212	60	544	1560	22%
Totals	**77,063**	**4,090**	**3,585**	**764**	**955**	**9,395**	**12%**

Table 4.3 Agricultural Easement areas in the Catoctin Creek watershed

ShedNum	Total Acres	Acres Under Agricultural Easements	% of Total Area
0212	6,313	871	14%
0213	4,185	551	13%
0214	10,166	3190	31%
0215	9,058	852	9%
0216	6,556	512	8%
0217	8,221	467	6%
0218	11,107	1786	16%
0219	9,758	368	4%
0220	4,694	0	0%
0221	7,005	3	0%
Totals	**77,063**	**8,600**	**11%**

Figure 4.2 Public and Other Protected Lands in the Catoctin Creek Watershed

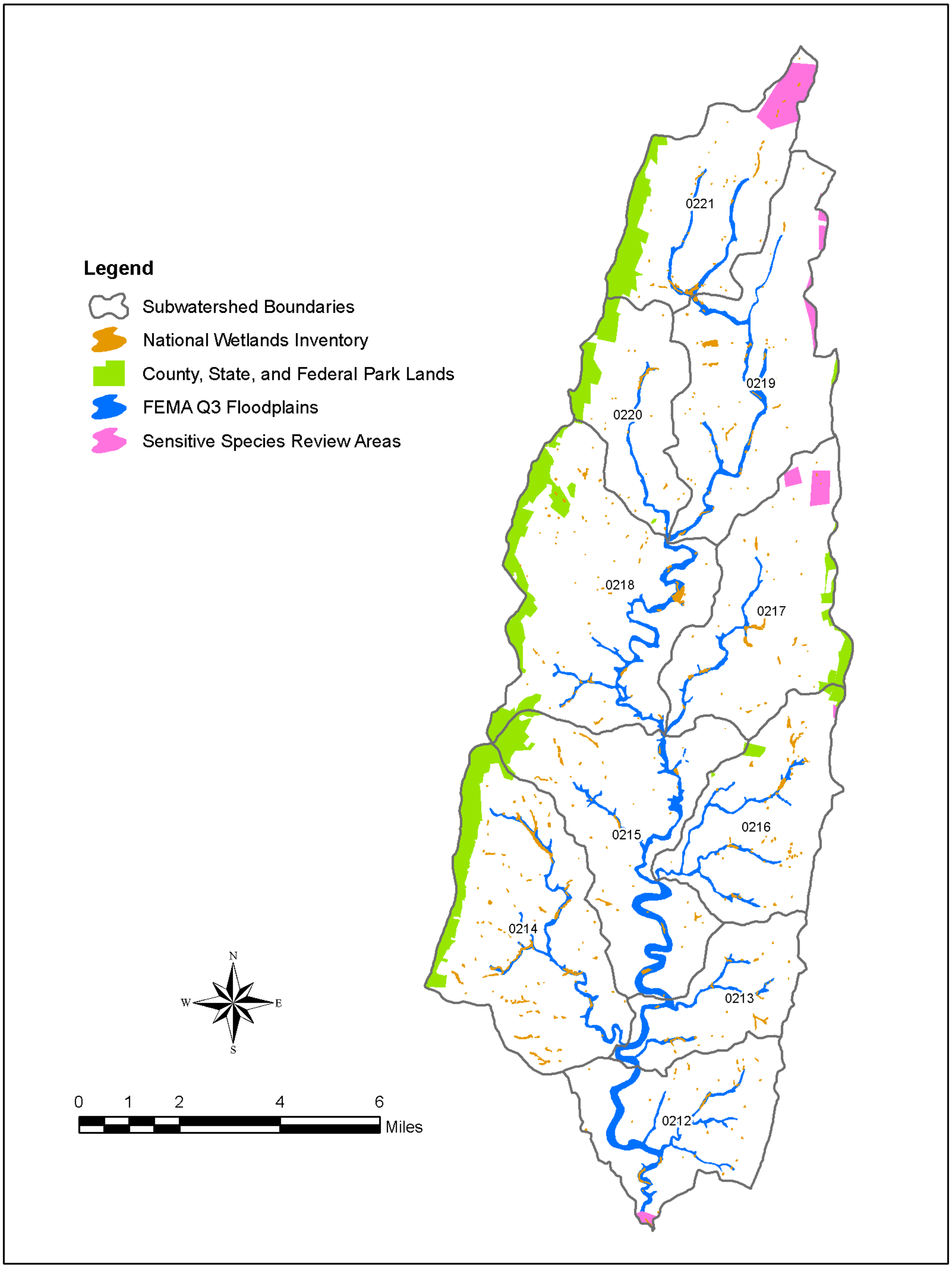
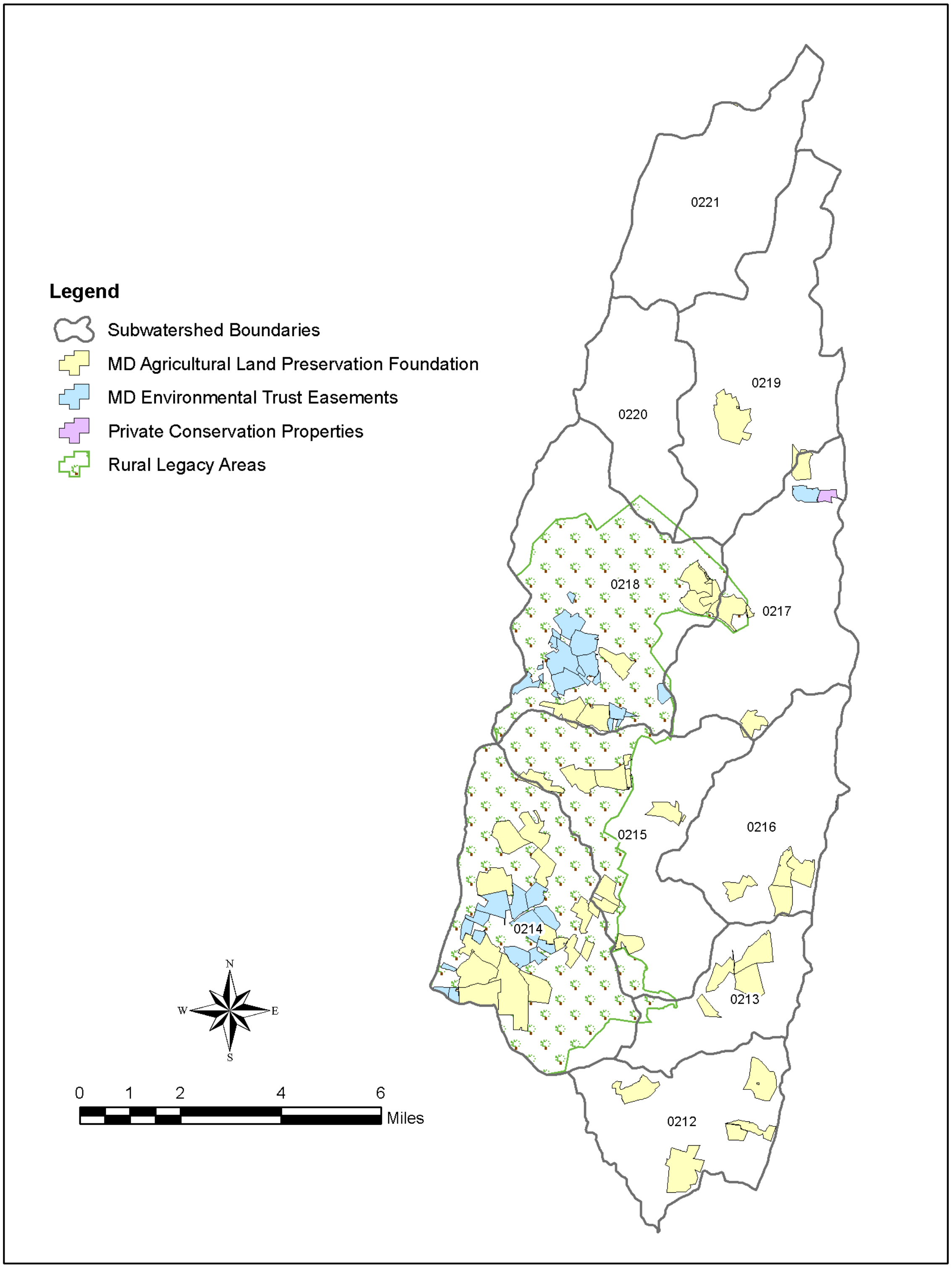


Figure 4.3 Agricultural Protected Lands in the Catoctin Creek Watershed



4.4 Statewide and Community Drought Management Programs

Maryland has a Drought Monitoring and Response Plan that divides the State into four regions (MDE, 2005). Catoctin Creek and Frederick County fall within the central region. MDE evaluates drought conditions each month on a regional basis, using data provided by water systems, the National Oceanic and Atmospheric Administration, and the U.S. Geological Survey's stream gages and ground water monitoring wells throughout the State. MDE is the primary agency for leading and coordinating drought activities. MDE conducts the monthly evaluations, updates drought status conditions, and makes recommendations to the Governor regarding the declaration of a drought emergency, which includes mandated water-use restrictions. Each county appoints a drought coordinator who is responsible for maintaining communications and coordinating with MDE throughout a drought emergency, as well as rendering decisions regarding applications received for exemptions to the mandatory restrictions. Local governments also establish local drought emergency public information and education programs.

In order to monitor potential drought conditions in a uniform manner across the State, Maryland uses four indicators of water sufficiency. The indicators are based on the amount of precipitation and the effect of the precipitation (or lack of precipitation) in the hydrologic system. The indicators include the amount of precipitation, stream flows, ground water levels, and reservoir storage. A staged process is used for defining drought conditions, using a drought status of normal, watch, warning, or emergency. During normal drought status, citizens are encouraged to practice wise water use, during watch status, heightened awareness is encouraged, during warning status citizens are asked to voluntarily reduce water use, and during drought emergency mandatory water use restrictions are imposed. The governor must declare a drought emergency by executive order. Drought indicators are monitored on an ongoing, year-round basis, and drought status is determined on a variable timeframe according to drought stage. During normal conditions, evaluation of drought indicators is conducted monthly; during periods of drought emergency, evaluations are conducted weekly.

The State's drought plan is designed to respond, using conservation measures, when climatic conditions trigger the potential for water supply shortages. Although water use restrictions have been mandated twice in recent years (1999 and 2002), the plan is designed to respond to weather patterns that result in hydrologic conditions that are relatively extreme and have not been commonplace at least in the last seventy-five years for which hydrologic data is available. The State's water appropriation permit process also considers risk for water supplies in moderate drought conditions with the use of drought year recharge rates in its water balance methodology.

The Town of Middletown has its own Water Conservation Public Alert System and accompanying ordinances, which allow the Town to impose reasonable restrictions on the use of water from the municipal water system during periods of short supply, protracted drought, excessive demand or other scarcity of water. The system uses a four-staged response, with Code Blue, Code Yellow, and Code Red I and II defined as normal conditions with no water use restrictions, voluntary conservation requested, and two levels of mandatory water use restrictions, respectively. The Town may impose penalties and cease water service for individuals who do not comply. A copy of Middletown's Water Conservation Public Alert System and Ordinance 02-04-01 are included in Appendix D. Middletown has implemented water use restrictions on a number of occasions when a drought emergency has not been in effect for the rest of Frederick County or the State's central region. Unless Middletown imposes more stringent water use restrictions, the Town and all other areas of the Catoctin Creek watershed would remain subject to any drought declarations imposed by MDE or Maryland's governor.

4.5 Alternatives for Meeting Future Water Demand

This analysis has highlighted water resources sustainability issues in some of the Catoctin Creek subwatersheds and indicates that some areas may face potential water supply shortfalls if growth continues as expected. There are a number of options for ensuring that water supplies serving communities in Catoctin Creek continue to provide sufficient quantities for the residents of this watershed. These options include the development of alternative water supplies; interconnection with other water systems where excess water supplies are available; reducing demand through water conservation, water efficiency technologies, and/or water reuse; or limiting future population growth in the areas of the watershed where water supplies are most limited.

Ground water is the predominant source of drinking water supplies in the watershed and has proven to be a safe, reliable, high quality source. However, recent concentrated ground water development in some of Catoctin Creek's subwatersheds have increased demand to levels that are approaching the available supply. Attempts to develop new large ground water supplies have been relatively unsuccessful, indicating that in some areas, alternative water supplies may need to be considered to supply future growth. The surface water availability analysis indicates that it may be possible to obtain sustainable amounts of water through development of an in-stream surface water reservoir. Although there are a number of issues inherent in the development of a surface water reservoir, including dam safety issues, potential wetlands impacts, private property issues, and the complexity of water treatment required for surface water sources, a reservoir could provide a stable dependable source of water for residents of this watershed. In Myersville, a feasibility study for a large surface water impoundment north of town has been proposed (Town of Myersville, 2005). Other sites in the watershed may also be appropriate. Building a surface water impoundment, however, is a long-term project that could take twenty years or more to bring to fruition. Another alternative to consider is transferring water from Frederick County's Potomac River treatment plant. However, to date, the areas in Catoctin Creek have not been included in the service area plans for the Potomac plant, and transporting water across such distances may incur prohibitive costs.

Water efficient technologies, cultural and behavioral adaptations, and water reuse technologies may offer another alternative for extending existing water supplies. Development of a water conservation plan could identify ways to optimize existing facilities and reduce the need for developing additional sources (MDE, 2000). Activities such as leak detection and repair, conservation rate structures, and fixture replacement programs may be able to reduce water demand in the subwatersheds where demand is likely to challenge supplies over the next thirty years. Since outdoor water use, especially in new residential development, can be a significant proportion of domestic water use, communities could encourage its citizens and developers to reevaluate their landscape designs to minimize outdoor watering needs. In addition, the communities may want to explore other options such as providing reused water for irrigation purposes, a practice that has helped communities in some other areas of the country meet their water supply needs.

Careful planning for future growth in this watershed could also mean directing new residents to areas of the watershed where water supplies are not as limited. County water supply planners need to consider all of the options when planning for future water needs in the watershed.

5.0 Conclusions

The evaluation of Catoctin Creek watershed brings to light several issues for managing the water resources in a manner that is sustainable for current and future water uses. Conclusions regarding the water supply's adequacy to meet demands and the adequacy of this assessment are summarized and discussed below.

5.1 The Need for Alternative Sources

The ground water supply is, in theory, adequate to meet existing and projected demands, based on the analysis conducted herein. However, as observed in certain localities within the Catoctin Creek watershed such as the Hollow Creek subwatershed, the *practical* limits of water use may already have been reached in some areas. Surface water is a potential water supply resource that is not currently utilized. With adequate storage and proper planning, surface water may represent an alternative for meeting future water supply demands. Further study on the feasibility of surface water supplies is needed.

The availability of ground water and surface water was examined in Section 3 to determine the adequacy of existing water resources to meet current and future demands in the Catoctin Creek watershed. By evaluating the demand relative to supply as indicated in Tables 3.9 – 3.11, the analysis suggests that, on an annual average basis, there is enough ground water to supply current and future needs during normal and drought conditions to 2030. This assumes that all ground water recharge (100%) is available for withdrawal and use. While the analysis was done at the subwatershed scale to help elucidate the issues at a scale relevant to water supply users and planners, it is still not small enough to indicate currently stressed areas that occur due to their location in headwater regions. Withdrawing water at a rate greater than it is being recharged results in depleting the natural storage in the aquifer, which will result in reduced baseflow to streams. The problems in the Hollow Creek subwatershed, as discussed in section 3.4, demonstrate the issues that arise when large ground water uses are concentrated in the upper reaches of a subwatershed. While the demand-availability analysis presented in this report would not necessarily recognize the significant problems in such localized areas, this analysis does indicate the subwatersheds where current use is *relatively* high and therefore may need closer examination, especially when planning for future demands.

The 'adequacy' of the surface water resources cannot be examined under current conditions, since it is an untapped resource. However, the availability analysis of surface water provides information on the reservoir storage required to supply future demands. Based on this information, the use of surface water may be a viable alternative to additional ground water use. The *feasibility* of surface water reservoirs must be thoroughly examined to determine whether or not surface water resources are an appropriate water supply for users in the Catoctin Creek watershed.

5.2 Uncertainty in the Water Availability Prediction

The analysis completed herein was conducted based on the best available information, but there are inherent uncertainties due to scale, lack of data, and/or methodology. Therefore, all proposed water uses must continue to be evaluated based on the specific merits of the proposed withdrawal and on the properties and characteristics of the water resource at the proposed withdrawal location.

The analysis performed in this report was completed with the best available data, but it must be recognized that all of the numbers carry a fair degree of uncertainty. For example, water availability is estimated from effective ground water recharge rates using the historical record of the stream gage. The average-year and drought-year recharge rates that are applied to each subwatershed are based on a single location on the main stem of the stream, and thus represent an average over the entire upstream region. The actual recharge that reaches ground water and is available for use by water suppliers is likely to vary in subwatersheds or even smaller localities, due to the spatial variability of aquifer properties, as well as differences in landscape characteristics and land use that affect recharge, as discussed in Section 3.3. The seasonal analysis was also based on conditions at the stream gage and presents similar uncertainties due to spatial conditions. Thus, predictions of water availability, both annually and seasonally, must be viewed with some caution, since in many cases the conditions at a particular withdrawal site may not be precisely predicted by looking at the average conditions in the subwatershed. Therefore, this analysis cannot replace or substitute the more detailed analyses that are performed under water appropriations applications, which are better suited to analyze the aquifer conditions and estimate sustainable well yields specific to the site under consideration. It also must be noted that all of the numbers are based on statistics and the probability of occurrence based on what has occurred in the past. This is a generally acceptable rule to follow in order to predict future conditions. However, it remains to be seen how the anthropogenic changes in the characteristics of the watershed might affect recurrence intervals for low flow conditions.

5.3 Impacts of Seasonal Variability

The ground water supply is adequate to meet demand during summer months of an average precipitation year, but may not be adequate to meet current or future demands during the summer months of a drought year. Additional monitoring of streams downstream of large withdrawals is needed to adequately assess the effect of summer demand on low flows and the subsequent impacts to natural and biological resources.

The seasonal availability analysis highlights additional potential concerns and challenges for meeting current and future water demands. This analysis examines the availability and demand during the summer months, which tends to be the most critical time for water supply. As indicated in Table 3.12, in the summer months the current demands for this watershed can be met in an average precipitation year, but during drought years (Tables 3.13 and 3.14), the water resources are expected to be stressed – with demand nearing or exceeding 100% of availability in three of the ten subwatersheds.

Future demands show similar patterns during the summer months and up to five of the ten subwatersheds may experience stressed conditions during drought years (Table 3.14). Again, it must be recognized that evaluating the data at the subwatershed scale may be deceptive and the problems may be more severe if examined at a finer scale. In both the annual and seasonal water availability-demand analyses, the larger question becomes "at what point is the use no longer sustainable?" Unfortunately, the lack of comprehensive monitoring data makes it impossible to answer this question with any confidence. Where water use percentages are relatively high in a subwatershed, it would be useful to install additional stream gages to determine what impacts are occurring and under what conditions are those impacts occurring on streams.

5.3 Need for Reevaluation of Current Policies

The availability-demand analysis reveals that current policies and assumptions applied to ground water appropriation permits may be outdated and not reflective of recent trends in development. This may result in conflicts between users and/or unreasonable impacts to existing users or water resources.

The availability-demand analysis points to inherent concerns about current MDE permitting policies and their underlying assumptions. The water balance policy uses a 10-year drought recharge rate applied to a land area to determine the amount of water available to a particular permittee. The policy has been implemented over the past twelve years with the assumption (based on development patterns during the 1980's) that half of the watershed would be left undeveloped or developed under non-consumptive water uses only. However, the State does not currently have programs in place to assure that land development occurs in a manner consistent with this assumption. If a watershed were fully developed with regard to water resources, what would occur in a 10-year drought situation? Theoretically, there would be a minimum reserve flow left for streams (currently equal to the 7Q10 low flow), but due to the uncertainties in the methods used to calculate recharge rates and low flows, there is likely to be a significant threat to streams. In addition, if a watershed were fully developed in terms of ground water withdrawals, streams may experience artificially low flows on a more consistent basis since the 10-year drought recharge rate is roughly half of the average year recharge rate. In reality, assuming that wastewater is returned to the same watershed, the streams will benefit from the eventual return flow from the wastewater treatment plant discharge (as they would in areas with on onsite sewage disposal). However, in areas with centralized water and wastewater, impacts in the upper reaches of a watershed are likely to occur, since community wastewater systems generally discharge at a location downstream of withdrawals. Furthermore, if ground water is being withdrawn at a rate near or greater than the recharge rate, the net effects might be increased drawdown, steeper ground water flowpaths, more ground water being taken from storage, and declining well yields. Other possible effects include decreased evapotranspiration and springs going dry.

5.4 Need for Statewide Water Resource Analysis

The study of water resources at the watershed scale is beneficial in evaluating the adequacy of water supplies with regard to meeting current and future demands, and in providing valuable information for planners, water resource managers, and water suppliers. Continued study of watersheds throughout the State will improve the ability to make recommendations on sustainability criteria, such as the percentage of available ground water that represents a sustainable demand as well as evaluating the suitability of existing and proposed policies for permitting, planning, and zoning.

Despite the uncertainties presented by this type of analysis, it still provides valuable insight into areas of concern and management needs. For example, in subwatersheds where the water demand exceeds the summer water availability estimates, additional monitoring data would greatly enhance our understanding of the significance of the summer water availability. Specifically, a stream gage installed at a location near large withdrawals would elucidate the effects of those large withdrawals on base flow and help to determine whether withdrawals are exceeding sustainable levels. In subwatershed areas where demand is approaching annual water availability, current zoning could be examined to test if the full-buildout patterns correspond with the underlying assumptions of the water balance policy. In addition the effects of changing land use could be better incorporated into water balance analysis by using the most up to date information on stormwater management design practices and their effects on recharge. Considering the benefits to water resources provided by protected lands, the evaluation of these areas highlights another potential issue for water resource managers. Specifically, can these areas be used to not only benefit the water resource but to offset the water suppliers' land area deficiencies when calculating their water balance? In addition, resource managers and planners should consider how this might act as an incentive for water suppliers to purchase easements to protect valuable natural land from further development. The identification of needs and the recommendations at the end of this section were developed taking into account the areas of concern revealed in this study.

6.0 Recommendations

The findings of this report highlight a number of specific needs related to water resource management in the State.

6.1 Water Resource Evaluation, Additional Studies

6.1.1 Evaluate the effectiveness of current policies with regard to the sustainability of water resources.

State water resource managers should examine the effectiveness of current permitting policies with regard to preventing unreasonable impacts. For example, as this report indicates, current methodologies for determining water availability in the piedmont geology (i.e. water balance calculation) may not adequately preserve the sustainability of the resource in the face of full development in a watershed. In addition, there are apparent conflicts between the water balance approach and State smart growth policies that encourage high-density development. Further study is needed to define or develop a more rigorous methodology to examine unreasonable impacts and sustainability relative to sensitive biological or other natural resources. One possible approach is to define a limit for withdrawals as a percentage of total available ground water. As an example, in Chester County, Pennsylvania, where water resources are under similar hydrogeologic conditions as Catoctin Creek, a watershed study has proposed the identification of "sensitive" water resources including first order streams, and a withdrawal limit of 50% of available ground water (CCWRA, 2002).

6.1.2 Evaluate seasonal impacts to streams, particularly during dry summers.

The State's water appropriation permitting process estimates annual recharge rates based on a 10-year drought occurrence. The data reported here indicate that there may be additional concerns related to seasonal water availability. In some situations, seasonal recharge and storage may be the limiting factor for water use and exceeding these values may introduce unreasonable impacts on the resource. State officials will be working to identify means for evaluating these potential impacts, such as requiring additional stream gages for large ground water withdrawal permits.

6.1.3 Determine whether water resource management issues are similar in other watersheds.

This report evaluates one watershed, and it is important to know whether the issues identified in this report are specific to Catoctin Creek, or whether there are regional or statewide issues related to water resource management that need to be addressed. MDE intends to evaluate additional watersheds to determine whether similar and/or other issues exist in Maryland in order to better evaluate the effectiveness of current policies aimed at maintaining sustainable water resources.

6.2 Improved Planning to Better Protect Water Resources

County and Municipal governments should examine their development plans with respect to water availability and consider the limitations of water withdrawals in subwatersheds where sustainable limits are being reached. In addition, local governments should consider how land use affects water availability in terms of quantity and quality and incorporate this into planning and zoning to protect valuable water resources. Local government officials, including county and municipal planners, in general need to seriously consider the availability of water resources to provide for future growth. This includes evaluating potential competition with other users and sustainability of water resources. Specifically:

6.2.1 Local planners should develop future water demand projections based on full build out conditions under the current zoning and land use plans.

Emphasis should be placed on subwatersheds with existing or projected demands that are relatively high with respect to available ground water. In addition, local planners should evaluate any proposed changes to zoning based on these full build out scenarios and the resulting changes in water demand.

6.2.2 Local governments and water suppliers should pool their resources to evaluate whether alternatives to meeting future water demands can be effective.

Potential options for consideration include water supply alternatives such as interconnections and reservoir development.

6.2.3 Water suppliers should implement demand management strategies and other conservation measures, such as water pricing, water recycling and reuse where feasible, in order to maximize the efficient use of their water supply resources.

6.2.4 Local planners and environmental health officials should examine their regulations for consistency with regard to development, planning, and protection of valuable water resources.

Specifically, is current and future zoning consistent with best management practices and State regulations for stormwater design and Total Maximum Daily Load requirements? For example, best management practices for stormwater should be utilized and structures properly maintained to protect stream quality and ground water recharge. Individual well and septic construction regulations should be enforced to protect both the quality and quantity of ground water resources.

6.2.5 Local governments should implement the recommendations of Source Water Assessment reports.

These reports, which have been developed for public water systems, provide valuable recommendations for protecting water quality for existing water supply sources. These recommendations should be implemented for existing source water recharge areas and considered for areas that represent recharge for future water supply sources. Specific examples include implementing local ordinances that focus on pollution prevention and purchasing land to protect it from future development.

6.2.6 State and Local governments should work with stakeholders towards the creation of a water resource easement that allows water suppliers to purchase the water rights on protected lands.

Easements for rural land preservation are an effective management strategy for protection of water quality. However, the existing land preservation programs do not prohibit water use on protected lands, thus they cannot currently be considered non-developable with respect to the water balance policy used for water appropriations. Planners, local governments, and water suppliers should work with the agricultural community to identify properties where conservation easements could be combined with such water resource easements to protect valuable water resources and augment water supplies in terms of water balance.

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Appendix A - List of Appropriation Permits in the Catoctin Creek Watershed

Permit Number	Type	Reports Use?	Permitted Avg. GPD	Permitted Max. GPD	2000-2003 Avg. GPD*	Aquifer or Stream Name	Remarks	First Use Description	First Use Percent	Second Use Description	Second Use Percent	Subwatershed
FR1953G002	G	N	2,000	2,500	2,000	CACTOCTIN METABASALT	JEFFERSON MOTEL	Commercial	100			0212
FR1957G005	G	N	500	2,000	500	CACTOCTIN METABASALT	GATHLAND STATE PARK	Recreational	100			0214
FR1961G003	G	N	350	500	350	CACTOCTIN METABASALT	CONSTRUCTION COMPANY	Commercial	100			0218
FR1961G013	G	N	2,000	3,000	2,000	GRANODIORIT & BIOTIT GRANIT GNEISS	DAIRYMEN, INC.	Commercial	100			0212
FR1962G006	G	N	500	1,000	500	CACTOCTIN METABASALT	BRADDOCK HEIGHTS FACILITY #38230	Commercial	100			0216
FR1964G004	G	N	100	500	100	CACTOCTIN METABASALT		Commercial	100			0218
FR1964S003	S	Y	40,000	150,000	64,182	LITTLE CATOCTIN CREEK	MYERSVILLE (LITTLE CATOCTIN CREEK) MUNICIPAL WATER SUPPLY	Municipal Water Supply	100			0220
FR1965G005	G	N	350	500	350	METARHYOLIT & ASSOC. PYROCLAS SEDIMENTS	CHURCH	Institutional	100			0221
FR1965G021	G	N	300	500	300	METARHYOLIT & ASSOC. PYROCLAS SEDIMENTS	GARFIELD METHODIST CHURCH	Institutional	100			0219
FR1966G012	G	Y	330,000	500,000	234,595	CACTOCTIN METABASALT	FOUNTAINDALE/BRADDOCK HEIGHTS SUBDIVISIONS	Municipal Water Supply	100			0216
FR1966G013	G	Y	35,000	50,000	25,382	METARHYOLIT & ASSOC. PYROCLAS SEDIMENTS	I-70 REST AREAS AT SOUTH MOUNTAIN	Institutional	100			0218
FR1968G008	G	N	5,500	8,200	5,500	GRANODIORIT & BIOTIT GRANIT GNEISS	VALLEY ELEM. SCHOOL	Institutional	100			0212
FR1968G010	G	N	500	1,000	500	GRANODIORIT & BIOTIT GRANIT GNEISS	CHANGE OF ADDRESS	Commercial	100			0214
FR1968G020	G	N	300	400	300	CACTOCTIN METABASALT	MYERSVILLE CHEVRON	Commercial	100			0218
FR1969G011	G	N	300	3,000	300	CACTOCTIN METABASALT		Institutional	100			0219
FR1969G012	G	N	200	1,000	200	CACTOCTIN METABASALT	CLUB HOUSE AND COMMUNITY PARK	Institutional	100			0221
FR1969G015	G	N	500	1,000	500	SWIFT RUN FORMATION		Institutional	100			0212
FR1969G022	G	N	1,000	2,000	1,000	CACTOCTIN METABASALT	TRACTOR SERVICE FACILITY	Commercial	100			0218
FR1970G002	G	N	3,000	4,500	3,000	CACTOCTIN METABASALT	VALLEYDALE APARTMENTS	Mobile Home Parks/ Apartment Buildings/Condominiums	100			0212
FR1970G008	G	N	1,500	2,500	1,500	CACTOCTIN METABASALT	SOUTH MOUNTAIN NATURAL ENVIRONMENT AREA	Recreational	100			0218
FR1970G014	G	Y	62,000	100,000	52,877	CACTOCTIN METABASALT	CAMBRIDGE FARMS & BRIERCREST APTS - 189 CONNECTIONS TO SYSTEM	Municipal Water Supply	100			0213
FR1970G019	G	N	1,000	1,500	1,000	CACTOCTIN METABASALT		Commercial	50	Comercial Washing Processes	50	0218
FR1971G003	G	N	1,000	3,000	1,000	CACTOCTIN METABASALT	CAMP WESTMAR	Institutional	100			0221
FR1972G005	G	N	400	600	400	CACTOCTIN METABASALT	JEFFERSON AMOCO	Commercial	100			0212

* Average daily use for years 2000 to 2003 for permits required to report.

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Permit Number	Type	Reports Use?	Permitted Avg. GPD	Permitted Max. GPD	2000-2003 Avg. GPD*	Aquifer or Stream Name	Remarks	First Use Description	First Use Percent	Second Use Description	Second Use Percent	Subwatershed
FR1972G008	G	N	100	200	100	CACTOCTIN METABASALT	MYERSVILLE FACILITY #38092	Commercial	100			0220
FR1973G020	G	N	1,700	2,500	1,700	CACTOCTIN METABASALT	WOLFSVILLE ELEMENTARY SCHOOL	Institutional	100			0219
FR1974G018	G	N	300	500	300	GRANODIORIT & BIOTIT GRANIT GNEISS	JEFFERSON MARKET - GROCERY	Commercial	100			0213
FR1974G023	G	N	100	300	100	CACTOCTIN METABASALT	CHANGE OF NAME AND ADDRESS	Institutional	100			0216
FR1974G025	G	Y	250,000	375,000	233,034	CACTOCTIN METABASALT	MIDDLETOWN MUNICIPAL WATER SUPPLY (WELLS 1-13, 15, AND SPRINGS)	Municipal Water Supply	100			0216
FR1974G225	G	Y	71,000	88,500	18,652	CACTOCTIN METABASALT	MIDDLETOWN WELLS (CONE BRANCH WELLS 14 & 16)	Municipal Water Supply	100			0216
FR1975G010	G	N	300	500	300	METARHYOLIT & ASSOC. PYROCLAS SEDIMENTS		Institutional	100			0220
FR1975G014	G	N	200	1,000	200	CACTOCTIN METABASALT	CAR WASHING AND LAWN IRRIGATION	Lawns and Parks	50	Commercial - Undefined	50	0215
FR1975G016	G	N	8,000	15,000	8,000	CACTOCTIN METABASALT	READY MIX CONCRETE USE	Product Manufacturing	100			0218
FR1975S016	S	N	3,000	9,000	3,000	CATOCTIN CREEK	READY MIX CONCRETE USE	Product Manufacturing	100			0218
FR1978G015	G	N	900	2,900	900	CACTOCTIN METABASALT	CAMP ECHO LAKE AT SOUTH MOUNTAIN-SOUTH MOUNTAIN STATE PARK	Recreational	100			0218
FR1979G008	G	N	8,600	20,100	8,600	CACTOCTIN METABASALT	SKYCROFT BAPTIST CONFERENCE/RETREAT CENTER - ADDED 3 WELLS	Institutional	100			0218
FR1979G015	G	N	1,000	1,500	1,000	CACTOCTIN METABASALT	EXCAVATING CONTRACTOR	Commercial	100			0218
FR1980G006	G	N	100	200	100	GRANODIORIT & BIOTIT GRANIT GNEISS		Commercial	100			0212
FR1982G001	G	N	100	200	100	CACTOCTIN METABASALT	JEFFERSON BRANCH OFFICE	Commercial	100			0213
FR1982G006	G	N	100	200	100	CACTOCTIN METABASALT	JEFFERSON BRANCH	Commercial	100			0212
FR1983G002	G	N	500	800	500	METARHYOLIT & ASSOC. PYROCLAS SEDIMENTS	ENGINEERED CONSTRUCTION PRODUCTS (SUB-CONTRACTOR)	Commercial	100			0221
FR1986G012	G	N	2,500	3,000	2,500	CACTOCTIN METABASALT	MCDONALD FAST FOOD	Commercial	100			0218
FR1986G014	G	N	2,500	3,500	2,500	CACTOCTIN METABASALT	PROFESSIONAL BUILDING	Commercial	100			0212
FR1986G017	G	N	1,000	1,600	1,000	GRANODIORIT & BIOTIT GRANIT GNEISS	BLUE & GRAY PROPERTIES APARTMENT BUILDING (ADDRESS CHANGE)	Mobile Home Parks/ Apartment Buildings/Condominiums	100			0214
FR1986G019	G	N	1,500	2,000	1,500	GRANODIORIT & BIOTIT GRANIT GNEISS	APARTMENT HOUSE	Mobile Home Parks/ Apartment Buildings/Condominiums	100			0214
FR1986G020	G	N	300	500	300	GRANODIORIT & BIOTIT GRANIT GNEISS	WASTEWATER TREATMENT PLANT	Municipal Water Supply	100			0216
FR1986G031	G	N	800	1,600	800	CACTOCTIN METABASALT	CHANGE OF NAME	Commercial	100			0218
FR1987G004	G	Y	13,000	26,000	12,481	CACTOCTIN METABASALT	MYERSVILLE MUNICIPAL SUPPLY (WTP WELL)	Municipal Water Supply	100			0218

* Average daily use for years 2000 to 2003 for permits required to report.

Appendix A - List of Appropriation Permits in the Catoctin Creek Watershed

Permit Number	Type	Reports Use?	Permitted Avg. GPD	Permitted Max. GPD	2000-2003 Avg. GPD*	Aquifer or Stream Name	Remarks	First Use Description	First Use Percent	Second Use Description	Second Use Percent	Subwatershed
FR1987G020	G	Y	40,000	60,000	18,160	WEVERTON FORMATION	MYERSVILLE MUNICIPAL SUPPLY (SPRINGS)	Municipal Water Supply	100			0220
FR1987G024	G	N	200	400	200	CACTOCTIN METABASALT	BANK	Commercial	100			0218
FR1987G034	G	Y	28,300	47,300	27,014	GRANODIORIT & BIOTIT GRANIT GNEISS	FR CO WATER & SEWER DEPT. - COPPERFIELD SUBDIVISION	Municipal Water Supply	100			0213
FR1987G035	G	N	2,400	3,600	2,400	CACTOCTIN METABASALT	ADDING WAREHOUSES	Commercial	100			0212
FR1987G036	G	N	2,000	3,000	2,000	CACTOCTIN METABASALT	LANDER ROAD BUSINESS PARK	Commercial	100			0212
FR1987G037	G	N	100	300	100	CACTOCTIN METABASALT	WAREHOUSE (LOT #3)	Commercial	100			0212
FR1987G104	G	Y	22,500	37,600	11,674	CACTOCTIN METABASALT	MYERSVILLE MUNICIPAL SUPPLY (ASHLEY HILLS WELLS)	Municipal Water Supply	100			0218
FR1987G204	G	Y	15,600	17,300	16,394	CACTOCTIN METABASALT	MYERSVILLE-DEER WOODS WATER SUPPLY	Municipal Water Supply	100			0220
FR1988G007	G	N	500	800	500	GRANODIORIT & BIOTIT GRANIT GNEISS	DUPLEX DWELLING	Mobile Home Parks/ Apartment Buildings/Condominiums	100			0216
FR1988G012	G	N	800	1,200	800	CACTOCTIN METABASALT	MYERSVILLE CONVENIENCE CENTER	Commercial	100			0218
FR1988G019	G	N	2,000	3,000	2,000	GRANODIORIT & BIOTIT GRANIT GNEISS	BEACHLEY	Agricultural - Potable	10	Livestock Watering	90	0215
FR1988G021	G	N	2,000	3,000	2,000	GRANODIORIT & BIOTIT GRANIT GNEISS	CHANGE OF OWNER	Institutional	100			0215
FR1988G033	G	N	100	200	100	CACTOCTIN METABASALT	CHURCH	Institutional	100			0217
FR1988G035	G	Y	42,200	46,800	28,454	CACTOCTIN METABASALT	MYERSVILLE-CANADA HILL WATER SUPPLY	Municipal Water Supply	100			0220
FR1988G037	G	N	5,000	8,000	5,000	CACTOCTIN METABASALT	DAIRY FARM	Livestock Watering	54	Agricultural - Potable	46	0218
FR1989G008	G	N	100	200	100	GRANODIORIT & BIOTIT GRANIT GNEISS	CHURCH	Institutional	100			0213
FR1989G016	G	N	600	900	600	CACTOCTIN METABASALT	MYERSVILLE MEDICAL CENTER	Institutional	100			0218
FR1989G035	G	N	100	200	100	GRANODIORIT & BIOTIT GRANIT GNEISS	U.S. POSTAL SERVICE	Institutional	100			0213
FR1989G037	G	N	1,000	1,500	1,000	GRANODIORIT & BIOTIT GRANIT GNEISS	RIDING SCHOOL.	Agricultural - Potable	10	Livestock Watering	90	0212
FR1990G001	G	N	2,700	3,500	2,700	CACTOCTIN METABASALT	OFFICE/WAREHOUSE.	Commercial	100			0218
FR1990G035	G	N	100	300	100	CACTOCTIN METABASALT	VALLEY RANGE (GOLF)	Commercial	100			0217
FR1991G030	G	N	100	300	100	GRANODIORIT & BIOTIT GRANIT GNEISS	CHURCH	Institutional	100			0214
FR1992G006	G	N	200	400	200	CACTOCTIN METABASALT	BUILDER - AGRIC. BLDGS, FENCES	Industrial	100			0212
FR1992G008	G	N	300	500	300	CACTOCTIN METABASALT		Institutional	100			0214

* Average daily use for years 2000 to 2003 for permits required to report.

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FR1992G011	G	N	4,000	6,000	4,000	CACTOCTIN METABASALT	HOLTERHOLM DAIRY FARM	Livestock Watering	100			0213
FR1992G017	G	N	2,300	4,000	2,300	GRANODIORIT & BIOTIT GRANIT GNEISS	LIVESTOCK WATERING & CLEANUP USE AT DIARY FARM	Livestock Watering	100			0215
FR1992S003	S	N	100	200	100	LITTLE CATOCTIN CREEK	LIVESTOCK WATERING	Livestock Watering	100			0217
FR1992S017	S	N	100	200	100	MIDDLE CREEK	LIVESTOCK WATERING	Livestock Watering	100			0215
FR1993G014	G	N	900	1,500	900	CACTOCTIN METABASALT	4 UNIT APARTMENT BLDG	Mobile Home Parks/ Apartment Buildings/Condominiums	100			0212
FR1993G017	G	N	2,500	7,000	2,500	GRANODIORIT & BIOTIT GRANIT GNEISS	NURSERY	Commercial	100			0212
FR1993S017	S	N	2,500	7,000	2,500	UNNAMED TRIBUTARY	NURSERY	Commercial	100			0212
FR1994G012	G	N	7,500	10,000	7,500	GRANODIORIT & BIOTIT GRANIT GNEISS	WESTERN MARYLAND RESIDENTIAL SCHOOL	Institutional	100			0212
FR1994G015	G	N	100	200	100	CACTOCTIN METABASALT	FLORIST	Commercial	100			0213
FR1995G001	G	N	600	1,000	600	CACTOCTIN METABASALT	CHURCH & HALL	Institutional	100			0216
FR1995G002	G	N	1,200	1,500	1,200	GRANODIORIT & BIOTIT GRANIT GNEISS	DAYCARE	Institutional	100			0212
FR1995G022	G	Y	38,000	57,000	13,409	CACTOCTIN METABASALT	COMMUNITY WATER SUPPLY (MYERSVILLE TOWN PARK SITE)	Municipal Water Supply	100			0218
FR1995G024	G	N	100	200	100	GRANODIORIT & BIOTIT GRANIT GNEISS	HORSE STABLE/ RIDING LESSONS	Institutional	100			0214
FR1995G025	G	N	300	500	300	CACTOCTIN METABASALT	FARM EQUIPMENT SALES	Commercial	100			0212
FR1996G017	G	N	5,000	7,500	5,000	CACTOCTIN METABASALT	MD NATIONAL GOLF CLUB - GOLF COURSE	Golf Course	100			0217
FR1996G027	G	N	300	500	300	GRANODIORIT & BIOTIT GRANIT GNEISS	JEFFERSON FAMILY DENTISTRY	Commercial	100			0213
FR1997G002	G	N	300	500	300	CACTOCTIN METABASALT	WHOLESALE AUTO SALES, HOME AND OFFICE	Commercial	100			0212
FR1997G023	G	N	500	800	500	CACTOCTIN METABASALT	BEAUTY SHOP	Commercial	100			0218
FR1997G034	G	Y	10,000	15,000	3,808	CACTOCTIN METABASALT	MYERSVILLE'S RESERVOIR WELL	Municipal Water Supply	100			0220
FR1997G039	G	N	300	700	300	CACTOCTIN METABASALT	LANDSCAPING	Nurseries	100			0212
FR1997G043	G	Y	58,000	200,000	9,234	CACTOCTIN METABASALT	GLENBROOK GOLF COURSE (IRRIGATION WELLS)	Golf Course	100			0216
FR1997S013	S	Y	15,000	250,000	50,938	LITTLE CATOCTIN CREEK	MARYLAND NATIONAL GOLF CLUB	Golf Course	100			0217
FR1997S043	S	Y	10,000	450,000	14,698	HOLLOW ROAD CREEK	GLENBROOK GOLF COURSE (IRRIGATION POND)	Golf Course	100			0216
FR1998G001	G	N	700	1,000	700	CACTOCTIN METABASALT	BEAUTY SHOP	Commercial	100			0217

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Permit Number	Type	Reports Use?	Permitted Avg. GPD	Permitted Max. GPD	2000-2003 Avg. GPD*	Aquifer or Stream Name	Remarks	First Use Description	First Use Percent	Second Use Description	Second Use Percent	Subwatershed
FR1998G019	G	N	900	1,000	900	BALTO. GABBRO COMPLEX	BEAUTY SALON AT 3726B JEFFERSON PIKE IN JEFFERSON	Commercial	100			0213
FR1998G022	G	Y	102,000	400,000	99,029	CACTOCTIN METABASALT	MUSKET RIDGE GOLF CLUB	Golf Course	100			0218
FR1998G030	G	N	500	600	500	CACTOCTIN METABASALT	TOWN OF MIDDLETOWN	Recreational	100			0216
FR1998G034	G	N	300	500	300	CACTOCTIN METABASALT	CHURCH	Institutional	100			0217
FR1998G035	G	N	300	500	300	CACTOCTIN METABASALT	RETAIL	Commercial	100			0212
FR1998G038	G	Y	9,900	10,000	66	CACTOCTIN METABASALT	RUDY SPRING WATER CO.	Industrial	100			0215
FR1998S022	S	Y	20,000	288,000	8,814	CATOCTIN CREEK	GC IRRIGATION - SW PONDS	Golf Course	100			0218
FR1999G005	G	N	400	600	400	GRANODIORIT & BIOTIT GRANIT GNEISS	CHURCH	Institutional	100			0213
FR1999G010	G	N	300	500	300	GRANODIORIT & BIOTIT GRANIT GNEISS	GENERAL COMMERCIAL	Commercial	100			0212
FR1999G011	G	N	300	500	300	GRANODIORIT & BIOTIT GRANIT GNEISS	GENERAL COMMERCIAL	Commercial	100			0212
FR1999G016	G	N	100	200	100	SWIFT RUN FORMATION	WELDING - CONSTRUCTION	Commercial	100			0213
FR1999G017	G	N	400	600	400	CACTOCTIN METABASALT	LANDSCAPE - MAINTENANCE	Commercial	100			0218
FR1999G022	G	N	5,000	8,000	5,000	CACTOCTIN METABASALT	MUSKET RIDGE GOLF COURSE CLUBHOUSE	Recreational	100			0218
FR1999G044	G	N	100	300	100	CACTOCTIN METABASALT	SEED & FEED	Commercial	100			0218
FR2000G038	G	N	100	200	100	METARHYOLIT & ASSOC. PYROCLAS SEDIMENTS	GARFIELD UNITED METHODIST CHURCH - PICNIC AREA	Recreational	100			0221
FR2001G013	G	N	300	500	300	GRANODIORIT & BIOTIT GRANIT GNEISS	ALL AMERICAN DECKING/DECKING COMPANY LEASES PROPERTY	Commercial	100			0213
FR2001G021	G	N	6,000	12,000	6,000	CACTOCTIN METABASALT	GANLEY PROPERTY - 2 HEAT PUMPS	Residential Heat Pumps	100			0217
FR2001G027	G	Y	42,000	226,000	42,000	CACTOCTIN METABASALT	MARYLAND NATIONAL GOLF, L.P.	Golf Course	100			0217
FR2001G030	G	N	700	1,000	700	CACTOCTIN METABASALT	PALMER ANIMAL HOSPITAL	Institutional	100			0217
FR2002G005	G	N	300	500	300	CACTOCTIN METABASALT	PRESCHOOL AND AFTER SCHOOL PROGRAM	Institutional	100			0218
FR2003G012	G	N	300	500	300	GRANODIORIT & BIOTIT GRANIT GNEISS	BROOKSIDE INN	Commercial	100			0213
FR2003G020	G	N	100	300	100	GRANODIORIT & BIOTIT GRANIT GNEISS	FREDERICK COUNTY HIGHWAY DEPARTMENT	Institutional	100			0212
FR2003G043	G	Y	20,500	30,800	20,500	CACTOCTIN METABASALT	MYERSVILLE FARM SBDN	Municipal Water Supply	100			0220
FR2003G049	G	N	300	1,000	300	GRANODIORIT & BIOTIT GRANIT GNEISS	NURSERY STOCK IRRIGATION	Nurseries	100			0215

* Average daily use for years 2000 to 2003 for permits required to report.

Appendix A - List of Appropriation Permits in the Catoctin Creek Watershed

Permit Number	Type	Reports Use?	Permitted Avg. GPD	Permitted Max. GPD	2000-2003 Avg. GPD*	Aquifer or Stream Name	Remarks	First Use Description	First Use Percent	Second Use Description	Second Use Percent	Subwatershed
FR2005G013	G	N	300	500	300	CACTOCTIN METABASALT	CHURCH & MEETING HOUSE	Institutional	100			0212
FR2005G019	G	N	500	1,000	500	CACTOCTIN METABASALT	MARYLAND NATIONAL GOLF COURSE CLUBHOUSE	Commercial	100			0217

* Average daily use for years 2000 to 2003 for permits required to report.

Appendix B - Baseflow Data

Annual Streamflow and Base Flow Values by Year				
Year	Streamflow Raw inches	Streamflow Raw inches	Base Flow inches	Base Flow inches
	Average	Median	Average	Median
1947 is an incomplete year with 153 values				
1948	19.2493	11.3705	13.6391	8.726
1949	18.5107	10.7614	12.5764	8.9434
1950	18.8086	11.5735	13.1045	10.085
1951	15.6906	9.7461	11.5942	7.7897
1952	25.0949	14.0101	15.081	11.269
1953	17.0153	8.5279	12.9053	5.1369
1954	6.7819	3.8578	4.9885	2.9811
1955	13.5634	6.7005	8.612	5.8414
1956	14.4103	6.9035	10.214	5.697
1957	12.0617	5.6852	8.8355	4.0082
1958	16.2439	7.7157	12.2738	5.7041
1959	7.1179	4.67	5.319	3.6576
1960	12.9436	8.0203	9.1208	7.3096
1961	13.085	3.4518	9.4273	2.6852
1962	12.1289	4.2639	8.7382	3.5437
1963	9.067	4.2639	5.7251	3.9117
1964	13.9014	3.8578	10.1681	2.2151
1965	8.3433	1.7259	6.0451	1.1479
1966	8.8717	4.67	5.8081	4.2496
1967	14.0794	10.5583	10.6186	8.6188
1968	12.4715	7.7157	9.136	6.6592
1969	6.8916	5.2792	4.9756	4.371
1970	18.0904	10.5583	12.5548	8.4068
1971	18.9271	12.1827	13.604	11.1674
1972	31.297	17.2588	19.2328	14.1903
1973	18.2553	10.9644	13.3305	9.0725
1974	13.8943	7.7157	10.0572	6.5292
1975	26.5232	16.6496	17.2352	14.6703
1976	20.2299	11.0659	12.6312	8.5562
1977	15.5917	6.0913	10.3697	5.2792
1978	17.656	7.5126	11.2475	6.4964
1979	26.9547	14.4162	16.7368	13.2719
1980	12.364	6.0913	9.545	4.467
1981	8.5501	5.0761	5.9904	3.7755
1982	12.1277	5.6852	8.9813	4.9347
1983	18.6944	9.5431	13.1143	6.9035
1984	22.7027	10.7614	16.4554	8.971
1985	13.1101	7.9187	9.1352	6.5772
1986	10.8784	5.2792	8.332	4.467
1987	10.9082	6.7005	8.1673	5.0116
1988	13.0784	4.7715	7.8131	4.0082
1989	14.5046	8.1218	10.3365	7.0842
1990	13.7558	9.34	10.0743	8.0572
1991	11.148	5.0761	9.0641	3.6548
1992	19.5172	9.7461	12.3991	8.4507
1993	23.998	9.34	16.1364	6.2399

Appendix B - Baseflow Data

Annual Streamflow and Base Flow Values by Year				
Year	Streamflow Raw inches	Streamflow Raw inches	Base Flow inches	Base Flow inches
	Average	Median	Average	Median
1994	20.0784	8.3248	14.1592	6.6276
1995	8.7745	7.5126	6.937	6.3099
1996	41.6857	25.3806	25.6696	21.479
1997	10.3871	6.0913	8.3537	5.6207
1998	26.0488	5.6852	16.7177	3.5447
1999	8.2237	5.0761	5.6428	4.1696
2000	14.5598	7.9187	10.6329	6.7384
2001	8.4958	2.8426	6.9487	1.9724
2002	6.4512	2.8426	4.2095	1.9272
2003	33.9235	23.1471	22.5539	19.8765
2004	18.6395	13.1979	13.5467	11.6105
2005 is an incomplete year with 23 values				

Appendix C

Catoctin Creek Watershed Impairments

From Maryland 303(d) Category 5 List found at
http://www.mde.state.md.us/Programs/WaterPrograms/TMDL/Maryland%20303%20dlist/303d_search/

Listing Year: 1996
Basin Name: CATOCTIN CREEK
Basin Code: 02140305
Waterbody Type: Non-tidal
Subbasin Code:
Listing Category: 5
Impairment Category: Sediments
Potential Sources: Non-point, Natural
Priority: Low
Notes:
Impairment Addressed in 2 Years?: No

Listing Year: 1996
Basin Name: CATOCTIN CREEK
Basin Code: 02140305
Waterbody Type: Non-tidal
Subbasin Code:
Listing Category: 5
Impairment Category: Nutrients
Potential Sources: Non-point, Natural
Priority: Low
Notes:
Impairment Addressed in 2 Years?: Yes

Listing Year: 2002
Basin Name: CATOCTIN CREEK
Basin Code: 02140305
Waterbody Type: Non-tidal
Subbasin Code: 021403050221
Listing Category: 5
Impairment Category: Biological
Potential Sources: Unknown
Priority: Low
Notes:
Impairment Addressed in 2 Years?: Yes

Listing Year: 2002
Basin Name: CATOCTIN CREEK
Basin Code: 02140305
Waterbody Type: Non-tidal
Subbasin Code: 021403050217
Listing Category: 5
Impairment Category: Biological
Potential Sources: Unknown
Priority: Low
Notes:
Impairment Addressed in 2 Years?: Yes

Listing Year: 2002
Basin Name: CATOCTIN CREEK
Basin Code: 02140305
Waterbody Type: Non-tidal
Subbasin Code: 021403050218
Listing Category: 5
Impairment Category: Biological
Potential Sources: Unknown
Priority: Low
Notes:
Impairment Addressed in 2 Years?: Yes

Listing Year: 2004
Basin Name: CATOCTIN CREEK
Basin Code: 02140305
Waterbody Type: Non-tidal
Subbasin Code:
Listing Category: 5
Impairment Category: Bacteria
Potential Sources: Unknown
Priority: Medium
Notes:
Impairment Addressed in 2 Years?: Yes

Appendix D

Town of Middletown Water Conservation and Public Alert System
Town of Middletown Ordinance 02-04-01

Available from:
http://www.middletown.md.us/index.asp?Type=B_BASIC&SEC={17D422FF-C4B2-4381-82B2-311B0EF2C221

The Middletown Water Conservation Public Alert System

In order to keep Middletown residents informed of our drinking water supply status the Burgess and Commissioners developed the following Public Alert System:

CODE BLUE: No water restrictions. Ground water conditions are in the normal range.

Critical Factors: Spring flows range between 60,000 -130,000 gpd. Water table levels in wells are at normal historical levels.

CODE YELLOW: Voluntary water conservation is requested. Ground water conditions are decreasing at a rapid rate. Residents are requested to follow water conservation practices as outlined in Tips to Prevent Water Waste. No penalties or enforcement are rendered.

Critical Factors: Spring flows range between 30,000--59,000 gpd. Water table levels in wells are below historic levels and dropping. Water levels in the wells are monitored weekly.

CODE RED, Level I: Mandatory water restrictions are instituted by the Burgess & Commissioners per Ordinance 02-04-01. Severe drought conditions are present. Enforcement with penalties will occur.

Critical Factors: The governor declares a drought emergency, and/or spring flows are below 29,000 gpd and/or the water table levels in wells are far below historic levels and are dropping. Water levels in wells are monitored bi-weekly.

Mandatory Water Restrictions for use of Potable water fromTown's water system:

- Watering of grass is prohibited. This includes athletic and/or playing fields.
- Gardens may only be watered with watering cans/buckets or handheld hoses that have an automatic shut off.
- Washing paved surfaces such as streets, roads, sidewalks, driveways, garages, parking areas, tennis courts, and patios is prohibited.
- Use of water for the operation of ornamental fountains, artificial waterfalls, misting machines, and reflecting pools is prohibited, except for systems that continuously recycle water.
- No vehicle washing, including automobiles, trucks, trailers and boats. Except cleaning of emergency vehicles if necessary to preserve the proper functioning and safe operation of the vehicle.
- Private (homeowners) pools and exterior hot tubs may not be filled or topped off.
- Golf courses must have a water conservation plan in effect that shows a 10% reduction in usage, even if they do not use town water.
- Connecting to town fire hydrants is prohibited, except for emergency purposes.
- All other residential, business and industrial water users are requested to voluntarily reduce water consumption by 10%.
- Any additional restrictions the Burgess and Commissioners deem necessary per Ordinance 02-04-01.

Use of rain barrels and gray water (i.e. used bath water) is permitted and encouraged.

CODE RED, Level II: Code Red, Level I mandatory water restrictions plus building restrictions/commercial water use restrictions.

Critical Factors: The raw water reservoirs can not be kept full on a daily basis.

- **All outside water use of any kind is prohibited;**
- **All businesses and residents are required to reduce potable water consumption by 10%**
- **No issuance of building permits;**
- **Violation of these restrictions will result in a $100 fine and immediate disconnection of water service. NO WARNING WILL BE ISSUED.**

Public Notification of Code Status:

- Water faucet signs will be erected at the entrances to town with a color coded water drop. A blue water drop represents Code Blue, a yellow water drop represents Code Yellow and a red water drop represents Code Red.
- The code status will be posted on the town web page.
- A code status change will be announced in The Citizen newspaper.

Ordinance 02-04-01

This ordinance authorizes the Burgess and Commissioners to impose and enforce water restrictions under certain conditions.

Section II:

A. The Burgess and Commissioners may impose reasonable restrictions on the use of water from the municipal water system during periods of short supply, protracted drought, excessive demand or other scarcity of water. Such restrictions may include, but are not limited to limitations on or prohibitions against the use of water from the municipal water system as determined by the Burgess and Commissioners.
B. Any water use restriction imposed pursuant to this Section shall be determined and announced at a regular or special meeting to the Burgess and Commissioners and shall be published in a newspaper of general circulation in the town.
C. Penalties for violating water restrictions:
    1. Any person connecting to a Town fire hydrant for any non-emergency purpose will be subject to a $1,000 fine for each offense.
    2. Any landlord, tenant, or other individual in possession of real property violating the terms and conditions of any water restriction shall be subject to the following:
        a. Filling or topping off of pools or outdoor hot tubs will result in a $500 fine and disconnection of water service.
        b. For all other violations, the first offense will result in a written warning and notification to refrain from any further violation.
        c. Each Subsequent offense will result in a $100 fine and disconnection of water service.
        d. Any landowner, tenant or individual in possession who has had service disconnected to his or her property pursuant to this Section shall not have such service reconnected until the current re-connection fee established by the town of Middletown is paid. Any further violation of the water restriction by that individual after re-connection of water service shall result in water service again being disconnected to such property and service shall not be reconnected until the currently established reconnection fee is paid to the town.