X. CONCLUSIONS AND RECOMMENDATIONS

Several data sources are critical to conducting a study such as the one contained in this report. In terms of water resource information, there is good data available on historical and regional information on Deer Creek and its hydrology, geology, and climate. This information was supplemented by gaging studies completed in Deer Creek and its tributaries, and the usefulness of the data was enhanced by the development of a numerical groundwater model.

In addition to water data, other information is vital to a water availability analysis, including the current and projected uses of the land within the watershed, data on permitted and un-permitted water uses, and current and projected population figures for the surrounding area. Much of this information was available from county and state agencies, although some estimation of un-permitted uses was necessary.

A. Hydrologic Findings

The flow records available for the three gaging stations on Deer Creek, supplemented by gaging studies in 2006, were used to analyze the quantity and distribution of water in the watershed. The process of base flow separation is used in hydrologic studies to discern the portions of streamflow attributable to surface runoff versus contributions from groundwater (base flow). The result of the base flow separation on Deer Creek flow records was that, on average, 67 percent of the total flow in Deer Creek is base flow, and the remaining third is surface runoff. The rates of recharge to the groundwater systems that support base flow in various subwatersheds of Deer Creek were found to be fairly homogenous within two regions. Recharge averages approximately 1.02 cfs/mi^2 in the area of the watershed lying to the north and west of a line approximately following U.S. Route 1, whereas the recharge in the lower third of the watershed is approximately 0.76 cfs/mi^2. Determination of these regional values was instrumental in extrapolating the long-term record at the Rocks gage to other areas of the watershed.

A water budget developed for the watershed indicates that in average years about 60 percent of precipitation to the watershed is lost as evapotranspiration, and about 40 percent is discharged to Deer Creek either as direct surface runoff or as base flow via groundwater. Slight increases in precipitation and in the proportion of base flow to total flow were detected over the period of record. Whether these changes are related to each other or are attributable to natural variations, climate change or changes within the watershed are not known and would require further study.

B. Water Use Findings

Major water users include the towns of Stewartstown and Shrewsbury in Pennsylvania, both of which have municipal well fields situated within the watershed. Currently, Stewartstown imports some additional water from elsewhere in York County, and Shrewsbury exports an un-quantified amount of Deer Creek water to a treatment plant in New Freedom. In Maryland, the City of Aberdeen operates a surface water intake on the creek's mainstem near Darlington to provide water supply to APG.

Other, non-permitted water use was estimated based on land use and population. Land use in the Deer Creek Watershed is predominantly agricultural (~58 percent) and forested (~33 percent), with limited amounts of developed land. Population projections compiled from Harford, Baltimore, and York Counties indicate an average of 24 percent population growth within the watershed between 2000 and 2025. This growth is concentrated along currently existing transportation corridors. In areas without major transportation corridors, growth is projected at much lower rates. The variation in projected growth in different subwatersheds is from under 5 percent growth to over 35 percent growth. The use of water for un-permitted commercial, industrial, and agricultural operations and for domestic wells was included in estimates, but was found to not be a substantial quantity. Less than 1 percent of the total available water is consumed (consumptive use) under current conditions, although for drought years, that amount may rise to 3 percent.

C. Water Availability Findings

Comparisons of water use and water supply, as depicted in Tables 14 and 15, showed that even without expected growth, the summer months currently exhibit a supply shortage at the Darlington gage under mild drought conditions, which pose an interruption of supply for APG. More severe droughts will present more serious deficits, and increased water demand upstream in the watershed will make downstream sources less reliable.

The total water use included in the budget analyses included a component for riparian needs – the passby flow. Allocation of this water for resource protection has the effect of making withdrawals from the watershed unreliable by rendering surface water unavailable for use during low flows. Although conditions do not decline to passby flow levels many – or even most – years, it is a reality that must be taken into consideration for long-term water resource planning.

Tables 23 through 26 show similar analyses for the subwatersheds, but on an annual basis and considering projected water use in 2010 and 2025. Under such conditions, certain subwatersheds, particularly those subject to development pressures, demonstrate water shortages in future drought scenarios. Figure 30 displays the subwatersheds with projected shortages.

Numerical modeling of the interactions with groundwater and surface water suggests that for any additional groundwater extraction, the full impact (equivalent to the total rate of pumping) will be observable within the base flow of Deer Creek within no more than 2.75 years, depending upon distance from surface water bodies. While this finding may limit the amount of groundwater that may be withdrawn, it does suggest that the short-term conjunctive use of wells during droughts to supplement unavailable surface water supplies may be an option.

In summary, the primary challenges for water supply in the watershed are population growth and urbanization within and adjacent to the watershed, and a supply that is already unreliable during moderate and severe droughts. State and federal governments have taken substantive steps to monitor and control water use within the watershed. These frameworks range from oversight and permitting functions of the SRBC to Maryland's designation of the watershed as a "Scenic River." These functions will become increasingly important as demand

for water in the Deer Creek Watershed grows. The following recommendations primarily address methods for monitoring future growth and planning for increased water use within the watershed so that water management decisions can be made with all the necessary information.

D. Recommendations

The best tool in long-term water resource management is accurate and complete data. The two most important aspects of data collection are water use and hydrology.

- Maryland and Pennsylvania should continue collection of reported water use data for all water users. Under existing programs, some of this information is provided on a voluntary basis. More comprehensive and periodic evaluations of actual water use would be helpful to monitoring water use.
- The importance of maintaining existing streamflow gaging on Deer Creek cannot be overstated. The data provided by the two USGS gaging stations is critical for water resource planning and drought management. However, there is no regular or periodic monitoring of flow in tributaries. As noted in this report, groundwater and surface water withdrawals may first impact tributaries closet to the user; they will also represent a larger, and therefore potentially more significant, proportion of the total flow. A systematic program of flow monitoring in tributaries, particularly those potentially impacted by major users or those hosting especially sensitive features, is recommended. The use of monitoring wells to track groundwater levels could also prove valuable.

It will be the goal of water resource managers to minimize and monitor the potential impacts of land development and increased water use in the Deer Creek Watershed. Some mechanisms currently exist for such efforts, but others may also be beneficial.

- As noted previously, land use in the Deer Creek Watershed is already an issue of concern, and is addressed by such programs as Maryland's Rural Legacy program, as well as zoning ordinances. Nonetheless, it is recommended that existing or more stringent (as adopted) guidelines for stormwater management during development be enforced by local governments so that future development within the watershed has as small an adverse impact as practicable on recharge to groundwater and base flow.
- During MDE, PADEP, or SRBC permitting activities for large users that involve surface water monitoring, it is recommended that streamflows be monitored both before and after the onset of extraction for a sufficient period of time to evaluate any potential impact on the stream. Depending upon a site's distance from a tributary, there may be delayed response in the stream, and this should be considered during planning.
- Permitting activities and drought management efforts should include water conservation as a means to avoid adverse impacts to the resources of the watershed.

Finally, the multiple and varied uses of the water resources of the Deer Creek Watershed – both natural and human – are an important part of its character, and it is important to recognize

when planning for future water use that there are different regions of the watershed with different hydrology, activities, and water demand.

- It may be desirable to conduct a more rigorous evaluation of the specific passby flow needs of each subwatershed for long-term planning purposes. Several methods are available for assessing the need, which may be driven by different uses (or a combination of uses) in each subwatershed, including aquatic habitat, recreation, fish migration, or protection of water supplies. At the time of this study's publication, both MDE and SRBC are considering review of appropriate passby flows; efforts should be coordinated between the agencies.
- Recreational opportunities are an important but often overlooked component of the varied uses of Deer Creek. Recreational interests should compile information on critical seasons and conditions for the maintenance of recreation, such as suitable levels for boating, and make that information available to water managers.
- The contents and findings of this study should be periodically updated with new data. SRBC is likely unable to commit resources to perpetual oversight of the study, but could serve in a guidance or advisory role. Updates or reviews of the study could be facilitated by linking it to an existing and ongoing effort, such as Harford County's Deer Creek Watershed Restoration Action Strategy.