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HEARING ON “THE BENEFITS AND CHALLENGES OF ECOSYSTEM MANAGEMENT THROUGH SUSTAINABLE AGRICULTURE: DELMARVA PENINSULA AS AN EXAMPLE”

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Mr. Chairman and Members of the Subcommittee, thank you for the opportunity to participate as a representative of the United States Geological Survey (USGS) in this hearing to discuss the benefits and challenges of ecosystem management on the Delmarva Peninsula, with respect to water resources.

Background

The USGS has been collecting and analyzing water- resources data on the Delmarva Peninsula for over 100 years. Data are collected through several USGS programs and in cooperation with other local, State, and Federal agencies. Data networks include streamgages with continuous records of stage and streamflow, some of which have been in continuous operation for over 60 years. The networks also include ground-water wells for tracking of water-level trends, and tide gages for measuring water levels in coastal bays. USGS programs also include hydrologic studies of ground-water aquifer systems, detailing the extent and thickness of individual aquifers and their hydraulic properties. Some of our ground-water studies employ ground-water flow models to describe regional patterns in the flow regime and changes in water levels brought about by pumping. Our work also includes studies of natural water chemistry and the extent of freshwater in these coastal aquifers. Data on ground-water and surface-water use are compiled and published to document trends in use for drinking water, industry, agriculture, and power generation. Water-quality has been of particular concern since the early 1970s and has been studied through numerous local and regional USGS Cooperative Water Program studies. Since the late 1980s, the USGS National Water-Quality Assessment Program (NAWQA) has been studying the occurrence and distribution of contaminants from human activities in ground water and surface water on the Delmarva Peninsula and their relation to overlying land uses. The transport of chemicals, including nutrients, pesticides, other organic contaminants, and sediment from human activities to surface-water resources has been the focus of recent USGS studies around the Chesapeake Bay.

Water Resources of the Delmarva Peninsula

The Delmarva Peninsula is underlain by a wedge of sand, gravel, silt, clay, and shells that thickens from 0 ft to the north to more than 8000 ft along the Atlantic Coast. The sediments form a layer-cake type of sequence of confined aquifers and confining units, overlain by an extensive unconfined surficial sand aquifer. The surficial aquifer varies in thickness from a few feet in the northern part of the peninsula to over 100 ft in the central part. The source of most fresh water on the peninsula is atmospheric precipitation that infiltrates through the soil zone into the surficial aquifer. Most of the water in the surficial aquifer travels along subsurface flow paths to discharge areas in streams, rivers and coastal areas. Some of the water in

the surficial aquifer travels along deeper flow paths to recharge the deeper confined aquifers. Most of the surface of the peninsula is a recharge area for the surficial aquifer and ground water in the surficial-aquifer system is generally less than 50 years old. The water table ranges from near the land surface in wetlands and coastal lowlands to over 30 feet beneath well-drained uplands. This resource is recharged through normal precipitation patterns. In contrast, recent dating of ground water in the deeper confined aquifers in Virginia indicates that the water in these aquifers was recharged over 1000 years ago. Water levels in many of the confined aquifers of the peninsula have shown a downward trend that corresponds to increases in pumpage over time. Some of the confined aquifers on the peninsula are affected by pumpage on the western shore of the Chesapeake Bay in southern Maryland.

It is estimated that the amount of fresh water available for water supply in one year on the peninsula would be about 1,500 million gallons per day (mgd), of which 90 percent is from deep and surficial ground-water sources. Of the 1,500 mgd available, the annual yield of the surficial aquifer is estimated to be about 1000 mgd. USGS water-use statistics indicate that total ground-water use on the Delmarva Peninsula in 2000 was approximately 200 mgd. Most public water supply comes from either the confined aquifers or relatively thick parts of the surficial aquifer. The surficial aquifer also provides water to individual homes and small public-supply systems in rural areas. Ground water is the sole source of individual domestic supply and the major source of water used for irrigation. In the northern part of the peninsula, rivers of the adjacent Piedmont Physiographic Province are a major source of public and industrial water supply.

Ground-water discharge is estimated to be the source of one-half to as much as three quarters of stream flow on the Delmarva Peninsula. Flow modeling indicates that most of this water is discharged from the surficial aquifer, with a smaller amount from deeper confined aquifers. The average age of water discharging to streams is 20 years. The remainder of stream flow is derived from overland runoff during storms and from melting snow.

The streams of the peninsula and ground water in the surficial aquifer are susceptible to contamination from human activities. Chemicals that are applied to the land surface in quantities greater than can be taken up by vegetation can leach through permeable surficial soils and sediments and contaminate shallow ground water. Other potential sources of contamination include leaking underground storage tanks, septic systems, and chemical spills. The chemicals that leach into the surficial aquifer are transported through the aquifer to discharge areas in local streams and rivers. Runoff from the land surface can also carry chemicals and sediment to surface water.

Agriculture is the dominant land use on the peninsula, covering about 48 percent of the land. As a result, nutrients and pesticides from agricultural sources are the most widespread contaminants in the surficial aquifer and surface water. In more urban areas, organic chemicals such as fuel compounds and household chemicals are typically present in the surficial aquifer. Recent study has shown that as the percentage of agricultural land use increases in the recharge areas around a well or in a watershed, nitrate concentrations in ground water and surface water also increase. The median nitrate concentration in wells sampled on the Delmarva Peninsula as part of the USGS NAWQA Program was about 5 milligrams per liter (mg/L), as compared to the natural background concentration of 0.4 mg/L. The median concentration of nitrate in small streams in the peninsula at base flow was about 3 mg/L. In many cases, wells and streams with higher concentrations of nitrate also have higher concentrations of pesticides. Recent studies have shown that 15-20 percent of the domestic wells in the peninsula exceed the U.S. Environmental Protection Agency's (EPA) Maximum Contaminant Level of 10 mg/l for nitrate in drinking water.

Water availability and water quality are the major water-resource considerations. Water-use statistics indicate that there is a large reservoir of fresh water potentially available for development on the Delmarva Peninsula—about 800 mgd in the surficial aquifer alone. Because of the interconnected nature of shallow ground water and surface water, increases in pumping from the surficial aquifer can have impacts on water levels in nearby shallow domestic wells, decrease streamflow, and affect water levels in wetlands. The surficial aquifer, which supplies streams with over half of their flow, is a vulnerable resource. Widespread contamination from the surface of the water table to the base of this aquifer has been documented. Changes in land use and chemical use will affect the amounts and types of contaminants that leach into ground water and eventually discharge to streams. The confined aquifer systems, while not affected by contamination from human sources, have more limitations on water-supply development because they are not readily recharged.

Understanding the availability of ground water for irrigation is important for the success of sustainable agriculture on the Delmarva Peninsula. Irrigation is the second largest user of ground water on the

peninsula. Drinking water follows as the third largest user. Water from the surficial aquifer, confined aquifers, and streams is withdrawn for irrigation. The distribution of sources of water for irrigation depends on the best available and accessible source for the large amounts of water needed for irrigation. Most of the declines in water-table levels in the surficial aquifer associated with pumping for irrigation and other water uses occur in the spring and summer. Under normal rainfall conditions, water levels in the surficial aquifer and streams completely recover over the fall and winter of each year. Current monitoring of ground water and surface water has not identified any long-term regional decreases in water levels in the surficial aquifer or in stream flow that can be related to irrigation from the surficial aquifer, or other sources of water withdrawal. Localized effects in areas with intensive irrigation from the surficial aquifer have not been monitored. Irrigation, in combination with withdrawals for public water supply, does have the potential to contribute to declining water levels in confined aquifers assuming current sources of irrigation pumpage. The effects of more intensive development of water resources for irrigation, and the effects of a long-term drought in combination with intensive irrigation have not been studied specifically on the Delmarva Peninsula.

Land-management practices including riparian buffers (forested or herbacaceous area between a stream, lake, or water body, and the adjacent land), timing of fertilizer and manure application, and the potential nutrient value of irrigation water may result in improved ground-water quality and, eventually, surface-water quality, and conditions in downstream estuaries. Although state-of-the-art land management practices intended to reduce ground-water contamination will help, some level of contamination will persist because of the sandy nature of most soil and aquifer sediments and the typically shallow water table of the Delmarva Peninsula.

Riparian buffers around streams and wetlands provide areas of uncontaminated aquifer recharge as well as habitat for wildlife and maintenance of healthy ecological systems in streams and downstream estuarine waters. Continuous riparian buffers along stream channels are known to physically limit the transport of sediment and particle-bound chemicals, such as the nutrients phosphorus, ammonia and organic nitrogen, which are primarily carried in runoff and present at much smaller concentrations in ground water. Riparian buffers may not have as great an effect on discharge of nitrate from ground water because much of the ground water discharging to streams flows beneath the riparian zone in areas with thick sandy surficial aquifers, such as on the Delmarva Peninsula. Riparian buffers do reduce nitrate inputs to ground water in areas immediately adjacent to streams, which have the shortest and shallowest ground-water flow paths to the streams. Buffering in headwater streams and ditches in watersheds will have the most immediate affect on surface-water quality because of relatively short transport times of water in these settings.

Land use change from agricultural and forests to urban development will change the stresses that effect water supply and water quality. Most of the development of public water-supply systems to support urban growth is likely to occur in confined aquifers where water supply is not easily recharged. Confined aquifers are commonly preferred for public supply on the peninsula because they avoid potential contamination problems present in the surficial aquifer, and the surficial aquifer system is not thick enough everywhere to supply enough water for large capacity public wells. Initially, shallow ground water beneath urban areas will contain chemicals from the previous land use. Over time, organic chemicals such as fuel and solvent compounds and other homeowner chemicals will more likely be detected in ground water. Nutrients may still be leached into ground water from lawn and golf course applications, although this has not been specifically studied on the Delmarva Peninsula. There are indications that current nutrient levels are lower in the surficial aquifer in areas affected by urban and suburban development than in areas affected by agriculture. Urbanization also results in increased runoff from roads and paved areas and potentially increases sediment and chemical transport to streams.

In summary, changes in the landscape and water use on the Delmarva Peninsula have very local effects at watershed scales because of the interconnectiveness of ground water and surface water.

Thank you, Mr. Chairman, for the opportunity to present this testimony. I will be pleased to answer questions.