Attachment B:

Potential Impacts to the Cannonsville Reservoir Posed By the Proposed Action

The Cannonsville Reservoir is one of four reservoirs that make up the Delaware Watershed. See Figure 1. On average, the Delaware Watershed provides 50% of the unfiltered drinking water supplied by New York City each day. The watershed for the Cannonsville Reservoir is primarily forested and agricultural. Most water enters the reservoir from the West Branch of the Delaware River, while some flow comes from Trout Creek. See Figure 2. Water leaves the Cannonsville Reservoir in one of three ways: a stream release at the dam; a spillway structure when the reservoir is full; and an aqueduct, the West Delaware Tunnel, to Roundout Reservoir.

Improvements in Cannonsville Reservoir Water Quality

A longstanding problem for the Cannonsville Reservoir has been nuisance algae blooms in the growing seasons (May through October) caused by excessive discharges of phosphorus from the West Branch and Trout Creek into the Reservoir. Prior to 2002, the New York City Department of Environmental Protection ("DEP") had designated the watershed for Cannonville Reservoir as a "phosphorus-restricted basin" because of the excessive phosphorus. In a phosphorus-restricted basin, construction of new sewage treatment plants and expansion of existing plants are prohibited and strict stormwater requirements apply, significantly restricting new development.

From 1997 through 2001, the five-year running geometric mean concentration of phosphorus in the Reservoir exceeded 20 parts per billion (ppb).[1] 20 ppb is routinely accepted as the upper limit for controlling excessive growth of algae and other aquatic plants in a reservoir and DEC has set 20 ppb as the benchmark for water quality in the Cannonsville Reservoir.[2]

Much of the elevated phosphorus was attributed to discharges of effluent from the ten wastewater treatment plants ("WWTPs") in the Cannonsville Basin. In particular, the three largest facilities, located in Walton, Stamford, and Delhi, accounted for most of the excessive phosphorus discharges to the Reservoir.[3] Discharges from farms were also believed to be a significant source of the pollution.

The problems in the Cannonsville Basin have been addressed through public investments of over $70 million to upgrade WWTPs and implement "whole farm planning" and other best management programs to prevent pollution. In addition, DEP has spent almost $45 million to secure the pollution reductions obtained through those programs by acquiring land in that basin. The acquired lands will not be developed so that future pollutant discharges from them will be prevented. Instead these lands will forever act as buffers to absorb any polluted stormwater

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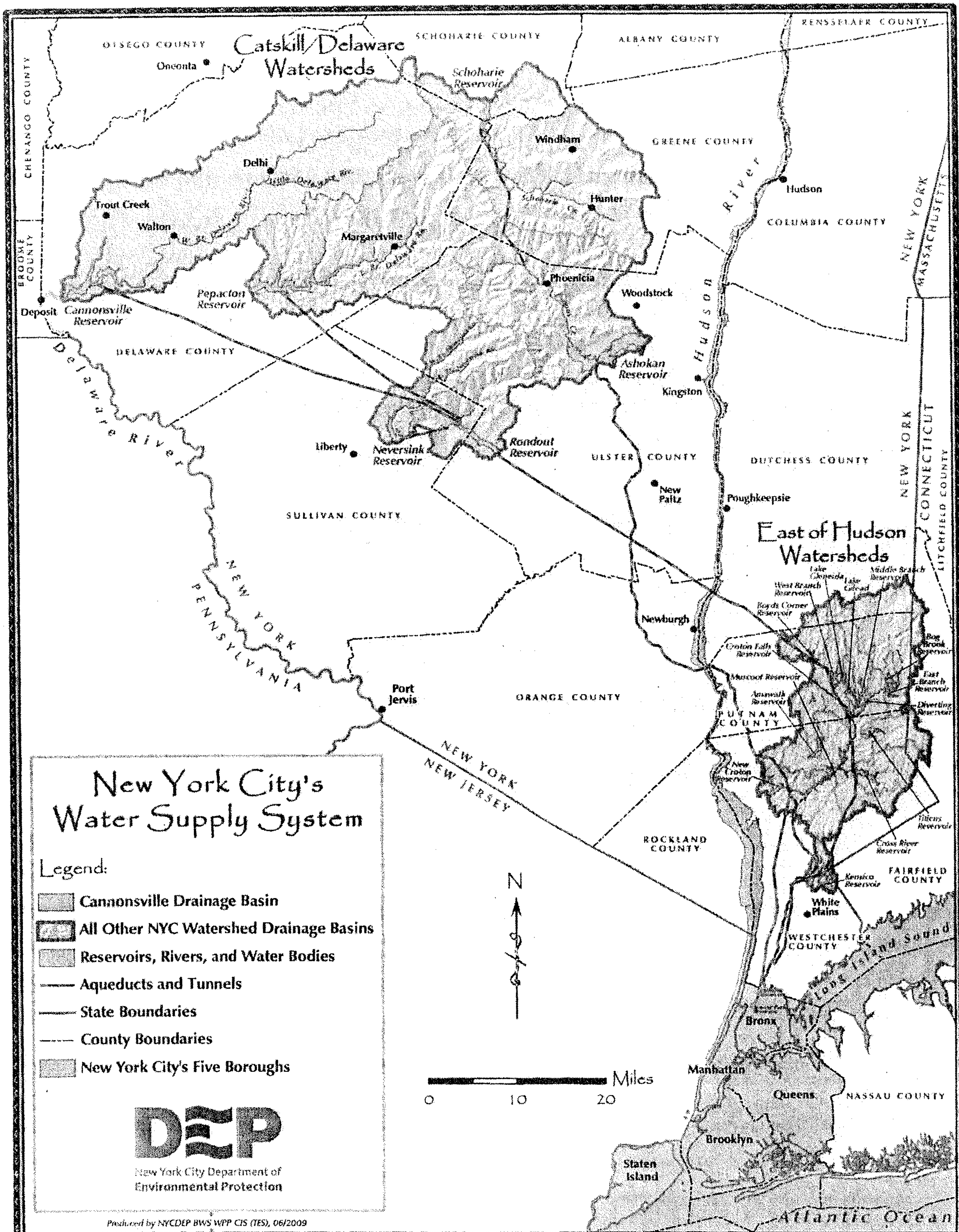
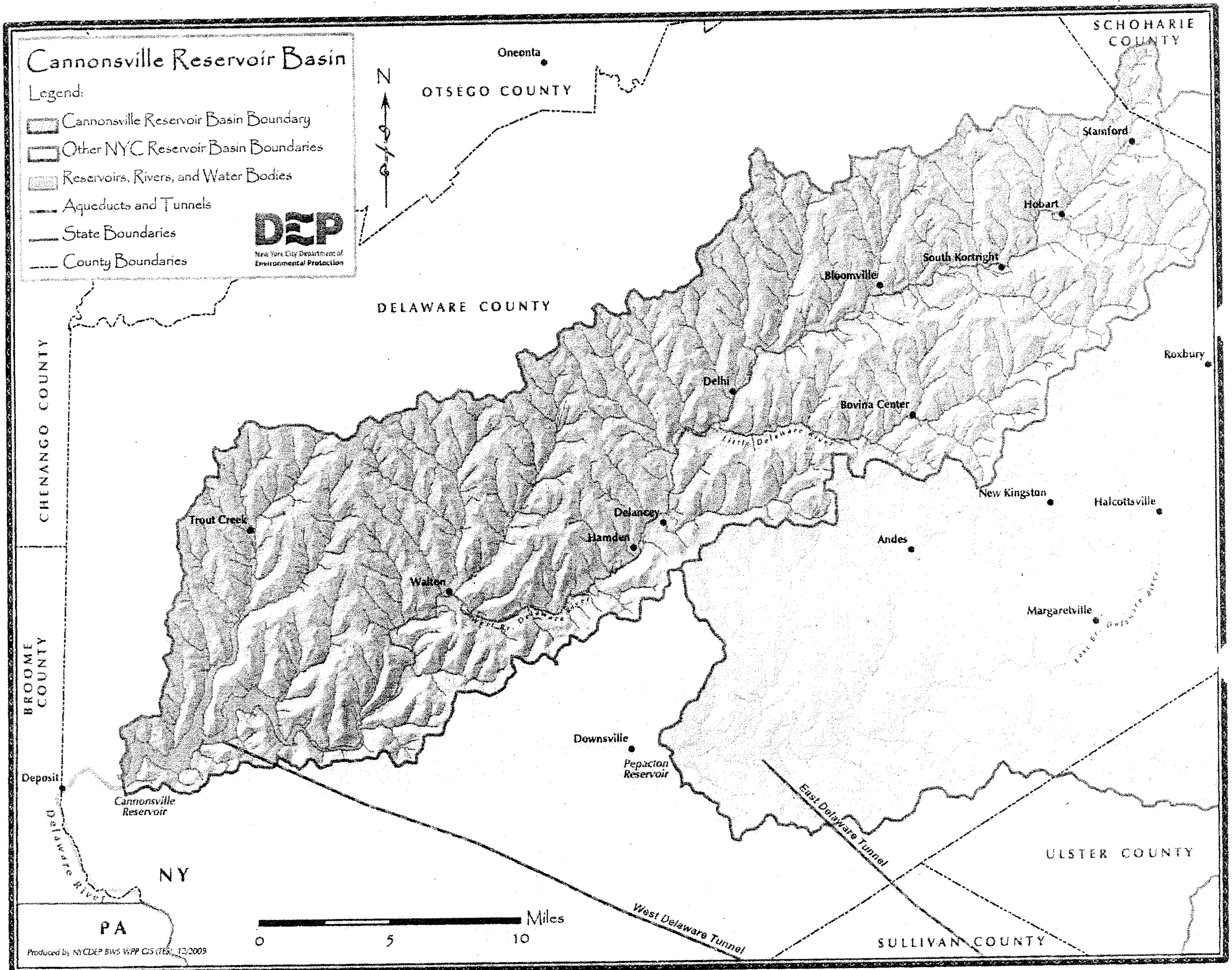
1 NYCDEP, "2008 Watershed Water Quality Annual Report" (July 2009), pp. 147-48.

2 NYSDEC, 1993, Division of Water Technical and Operational Guidance Series (1.1.1), Ambient Water Quality Standards and Guidance Values.

3 NYCDEP, "Proposed Phase II TMDL Calculations for Cannonsville Reservoir" (March 1999).



New York City's Water Supply System
Legend:
Cannonsville Drainage Basin
All Other NYC Watershed Drainage Basins
Reservoirs, Rivers, and Water Bodies
Aqueducts and Tunnels
State Boundaries
County Boundaries
New York City's Five Boroughs
DEP
New York City Department of Environmental Protection
Produced by NYCDEP BWS WPP CIS (TES), 06/2009
Catskill/Delaware Watersheds
East of Hudson Watersheds
OTSEGO COUNTY
SCHOHARIE COUNTY
ALBANY COUNTY
RENSSELAER COUNTY
CHENANGO COUNTY
BROOME COUNTY
GREENE COUNTY
COLUMBIA COUNTY
DELAWARE COUNTY
ULSTER COUNTY
DUTCHESS COUNTY
SULLIVAN COUNTY
ORANGE COUNTY
PUTNAM COUNTY
ROCKLAND COUNTY
WESTCHESTER COUNTY
FAIRFIELD COUNTY
LITCHFIELD COUNTY
NASSAU COUNTY
NEW YORK
MASSACHUSETTS
CONNECTICUT
PENNSYLVANIA
NEW JERSEY
Oneonta
Delhi
Trout Creek
Walton
Deposit
Margaretville
Windham
Hunter
Phoenicia
Woodstock
Hudson
Kingston
Liberty
New Paltz
Poughkeepsie
Newburgh
Port Jervis
White Plains
Schoharie Reservoir
Cannonsville Reservoir
Pepacton Reservoir
Ashokan Reservoir
Neversink Reservoir
Rondout Reservoir
West Branch Reservoir
Boyds Corner Reservoir
Croton Falls Reservoir
Muscoot Reservoir
Amawalk Reservoir
New Croton Reservoir
Bog Brook Reservoir
East Branch Reservoir
Diverting Reservoir
Titicus Reservoir
Cross River Reservoir
Kensico Reservoir
Middle Branch Reservoir
Lake Gleneida
Lake Gilead
Hudson River
Delaware River
Long Island Sound
Atlantic Ocean
Bronx
Manhattan
Queens
Brooklyn
Staten Island
N
Miles
0
10
20



Cannonsville Reservoir Basin
Legend:
Cannonsville Reservoir Basin Boundary
Other NYC Reservoir Basin Boundaries
Reservoirs, Rivers, and Water Bodies
Aqueducts and Tunnels
State Boundaries
County Boundaries
New York City Department of Environmental Protection
N
Oneonta
OTSEGO COUNTY
SCHOHARIE COUNTY
DELAWARE COUNTY
CHENANGO COUNTY
BROOME COUNTY
ULSTER COUNTY
SULLIVAN COUNTY
Stamford
Hobart
South Kortright
Bloomville
Roxbury
Delhi
Bovina Center
Little Delaware River
New Kingston
Halcottsville
Delancey
Hamden
Andes
Trout Creek
Walton
Margaretville
East Br. Delaware River
West Br. Delaware River
Downsville
Pepacton Reservoir
Deposit
Cannonsville Reservoir
Delaware River
East Delaware Tunnel
West Delaware Tunnel
NY
PA
Miles
0
5
10
Produced by NYCDEP BWS WPP GIS (TES), 12/2009

runoff from upland areas that might otherwise feed streams which discharge into the Cannonsville Reservoir.

These public investments have been generally successful in reducing phosphorus pollution. Since 2002, the annual geometric mean for total phosphorus concentrations have generally been below 20 ppb:

Annual Geometric Mean for Total Phosphorus during the Growing Season

Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Phosphorus	**15.4 ppb**	**15.1 ppb**	**19.6 ppb**	**20.5 ppb**	**14.0 ppb**	**13.4 ppb**

However, this does not mean that water quality at the Cannonsville Reservoir is no longer at risk. While the annual geometric mean for total phosphorus concentration has generally been below 20 ppb, in 2006 that benchmark was exceeded and in 2005 it was nearly reached as a result of weather conditions. More frequent and intense precipitation events occurred, resulting in greater stream flows and velocities, and more phosphorus was washed into the Reservoir. Thus, reducing the amount of phosphorus entering the Cannonsville Reservoir continues to be a high priority.

The Risk to Cannonsville Water Quality

Stormwater pollution from the disturbance of soils associated with the development of land for the Proposed Action could increase discharges of phosphorus into the Cannonsville Reservoir. If not properly controlled, stormwater pollution could undermine the recent improvements in water quality obtained by DEP.

Phosphorus is ordinarily found attached or adsorbed to soil particles. During heavy rainfall events or snow melt, surface soils can become dislodged, and they and their associated phosphorus can become mobile. A number of soil factors influence soil transport, including slope and the degree to which stormwater runs off as sheet flow across the ground surface or infiltrates into the ground. Stormwater, transporting soil particles (including phosphorus) downhill, often flows into larger waterbodies, such as a streams, wetlands, and reservoirs.

Surface soils and the phosphorus found with them are disturbed at natural gas development and production sites. For example, areas of disturbed soil would include: developing access roads, well pads and sites, staging areas, and pipelines. The environmental impact of proposed earthmoving and soil disturbance activities associated with natural gas development and extraction were not evaluated in the DSGEIS. That evaluation should occur and include the following: evaluation of soil and topographic characteristics, estimates of the scale of development (i.e., number of wells and well pads to be developed), and quantification of the risk of potential discharges of phosphorus in stormwater runoff to the Cannonsville Reservoir.

To illustrate how that work can be carried out, we performed a preliminary analysis of soil conditions and slopes within the Cannonsville Basin as a first step. The analysis demonstrates a potential for substantial phosphorus discharges to the Reservoir from the Proposed Action if stormwater runoff is not properly controlled and treated.

Data concerning slopes, hydrologic soil classification, erosion factor, and surface runoff potential indicate that the Cannonsville Reservoir could be adversely impacted by soil disturbances associated with large scale natural gas development in that watershed.

We recommend that additional environmental review be performed to complete our analysis. The Bureau could employ stormwater models, such as the Revised Universal Soil Loss Equation (RUSLE), to predict soil loss at these natural gas development sites. It can also evaluate phosphorus transport and its potential introduction to the Cannonsville Reservoirs and others in the WOH Watershed by modeling how much phosphorus is associated with the predicted lost soil.

We performed our preliminary analysis as follows: Site-specific information about soils was obtained from DEP for the 291,082 acre Cannonsville Reservoir Watershed. The total acreage of each soil type and its percent occurrence was calculated using GIS. Soil types were evaluated using the NRCS Soil Survey Geographic (SSURGO) database for Delaware (October 10, 2008) and Schoharie (December 11, 2006) Counties and the National Soil Information System (December 8, 2009).

<u>Slopes</u>: Slope is the difference in elevation between two points and is reported as a percentage. Slopes exceeding 15% are often regarded as "steep" slopes. <u>See</u> "New York City Watershed Memorandum of Agreement," January 21, 1997, ¶ 63(b)(iii)(E); 10 NYCRR Part 75, Appendix 75-A, § 75-A.4. Steep slopes inhibit the retention of water on a land surface, promote the rapid movement of water on the surface, increase the potential for soil slippage and accelerated erosion from wind and water, makes use of machinery to move soils without causing erosion difficult, and limit the environmentally safe use of the soil.

Surface slopes in the 291,082 acre Cannonsville Reservoir Watershed are quite steep. Almost half of such surfaces (about 49%), including 10.5% which have "very steep" slopes (slopes of 35% to 70%).

<u>Hydrologic Soil Groups</u>: The Natural Resources Conservation Service ("NRCS") has grouped soils into four distinct classes based on the degree to which stormwater runs off along the surface or, instead, infiltrates into the ground:

A: Low Runoff Potential (water "seeps" into the ground quickly)
B: Moderately Low Runoff Potential
C: Moderately High Runoff Potential
D: High Runoff Potential[4]

[4] USDA NRCS 2009 Part 630 <u>Hydrology National Engineering Handbook</u> Chapter 7 Hydrologic Soil Groups http://policy.nrcs.usda.gov/OpenNonWebContent.aspx?content=22526.wba.

Group A soils are often sandy, whereas Group D soils often have a high clay content or a restrictive layer (e.g., bedrock). Approximately ninety percent of the soils within the Cannonsville Reservoir Watershed are classified as C, D, or C/D. As a result, such soil tends to generate large volumes of stormwater runoff. Large volumes of runoff result in higher velocity of flow, greater erosion, and increased phosphorus and other pollutants transported in stormwater.

Erosion Factor (Kf): Erosion is an important process that affects soil formation and may remove all or parts of the soils formed in natural landscapes. Evaluating the degree of erosion that takes place is important in assessing the health of the soil and in assessing the soil's potential for different uses. Soil "erosion factors" were developed to quantify how susceptible soil particles (e.g., sand, silt, clay, <2.0 millimeters in size) are to being detached from soil and rock by water. The Kf soil erosion factor also accounts for freeze thaw cycles and predicts long term average soil loss. Approximately ninety-six percent of the soils in the Cannonsville Basin have Kf erosion factors of .28 or greater, indicating that erosion of soil particles at this Watershed represents an environmental risk to the Cannonsville Reservoir.[5]

Surface Runoff Characteristic: "Surface Runoff" is the water that flows off the surface of the land without percolating into the soil. The surface runoff characteristic measures the potential for surface runoff on a land surface due to precipitation. Applying the surface runoff description to the soil properties data presented in the NRCS Soil Survey Geographic (SSURGO) database for Delaware and Schoharie Counties and the National Soil Information System, approximately 84% the Cannonsville Reservoir Watershed soils demonstrate high (24%) to very high (60%) surface runoff potential. Conversely, approximately 8% of the surface runoff potential is characterized as moderate and another 8% is slow to negligible. This data indicates that the surface runoff potential from soils in this watershed represents a significant environmental risk to the Cannonsville Reservoir.

These data demonstrate that disturbance of surface soil in the Cannonsville Reservoir Watershed could pose a substantial risk of stormwater pollution.

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[5] http://soildatamart.nrcs.usda.gov/documents/SSURGOMetadataTableColumnDescriptions.pdf