Patuxent Reservoirs
Triadelphia and Rocky Gorge

SOURCE WATER ASSESSMENT

for

Washington Suburban Sanitary Commission
Patuxent Water Filtration Plant

Prepared by
Maryland Department of the Environment
Water Management Administration
Water Supply Program

June, 2004

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EXECUTIVE SUMMARY

The 1996 Safe Drinking Water Act Amendments require states to develop and implement source water assessment programs to evaluate the safety of all public drinking water systems. A Source Water Assessment (SWA) is a process of evaluating the vulnerability of a source of public drinking water supply to contamination. This SWA was completed for the Triadelphia and Rocky Gorge Reservoirs owned and operated by the Washington Suburban Sanitary Commission. The two reservoirs in combination with Potomac River serve 1.6 million customers in Prince George's and Montgomery counties and a small portion of southern Howard County.

The Patuxent Reservoirs are located in the upper reaches of the Patuxent River in Central Maryland between the cities of Baltimore and Washington D.C. The reservoirs collect water from a 132 square mile watershed that spans three counties in the Sate of Maryland – Howard, Montgomery and Prince George's. The Brighton and T. Howard Duckett Dams were constructed in 1943 and 1954 respectively to create Triadelphia and Rocky Gorge Reservoirs. Water from Duckett Dam travels through three parallel pipelines to the Patuxent Filtration Plant for treatment.

The Patuxent Reservoirs Watershed encompasses approximately 132 square miles (85,000 acres) of mixed land use mostly in Howard and Montgomery counties. Most of the watershed is rural. Portions of Olney, Burtonsville, Laytonsville, Brookville, Sandy Spring and Ashton are the primary commercial and residential areas in the watershed.

Potential sources of contamination for the Patuxent Reservoirs include point and non-point sources, including transportation (e.g., highways), a railroad, a petroleum product pipeline, agriculture, on-site septic systems, and runoff from developed areas. There are five minor surface water discharges within the watershed. Three are for stormwater discharges, one is from a ground water remediation system and one for a small wastewater treatment plant.

WSSC maintains an extensive water quality monitoring program for the Patuxent Reservoirs and its tributaries, as well as the Patuxent Water Filtration Plant. Routine water sampling is conducted after filtration and at three locations within each of the reservoirs.

The susceptibility analysis indicates that phosphorus is the primary concern to the Patuxent Reservoirs. Turbidity, disinfection byproducts precursors iron, manganese and protozoan are also contaminants of concern.

Several recommendations are included in Section 9 of this report. They include:

- Strengthening the Watershed Protection Agreement
- Expanding protected property and improved management of forested lands
- Enhancing the existing water quality sampling program

- Reducing phosphorus loadings
- Implementing controls for spills at major highway crossings
- Analyzing traffic accident statistics and patterns including potential impacts of the proposed ICC on reservoir water quality
- Establishing good notification and emergency response procedures with potential contaminant sources

1.0 BACKGROUND

The 1996 Safe Drinking Act Amendments require states to develop and implement source water assessment programs to evaluate the potential for contaminants to affect the sources of all public drinking water systems. A Source Water Assessment (SWA) follows a process for evaluating the susceptibility of a public drinking water supply to contamination. The assessment does not address the treatment process or the storage and distribution of the water system, which are covered under separate provisions of the Safe Drinking Water Act. The Maryland Department of the Environment (MDE) is the lead state agency in this SWA effort.

There are three main steps in the assessment process: (1) *delineating* the watershed drainage area that is likely to contribute to the drinking water supply, (2) *identifying* potential contaminants within that area and (3) *assessing* the vulnerability of the system to those contaminants. This document reflects all of the information gathered and analyzed required by those three steps. MDE looked at many factors to determine the susceptibility of this water supply to contamination, including the size and type of water system, available water quality data, the characteristics of the potential contaminants, and the capacity of the natural environment to attenuate any risk.

Maryland has more than 3,800 public drinking water systems. Approximately 50 of Maryland's public drinking water systems obtain their water from surface supplies, either from a reservoir or directly from a river. The remaining systems use ground water sources. Maryland's Source Water Assessment Plan was submitted to the Environmental Protection Agency (EPA) in February 1999, and received final acceptance by the EPA in November 1999. A copy of the plan can be obtained at MDE's website, www.mde.state.md.us, or by calling the Water Supply Program at 410 537-3714.

2.0 DEVELOPMENT OF PATUXENT RESERVOIRS AS A WATER SUPPLY

The Triadelphia and Rocky Gorge Reservoirs, which are situated in tandem on the Patuxent River above Laurel, Maryland were originally intended as single-purpose water supply impoundments. The operation of the two reservoirs has been modified to provide a limited degree of flood protection for downstream communities (Burns & McDonnell, 1977). The Washington Suburban Sanitary Commission (WSSC) owns and operates the Triadelphia and Rocky Gorge Reservoirs. The reservoirs were created by the construction of the Brighton Dam (completed in 1943) and T. Howard Duckett Dam (completed in 1954). Triadelphia Reservoir contains an estimated 6.2 billion gallons of water; it is approximately five miles long with a surface area of 800 acres. Rocky Gorge Reservoir is approximately 13 miles downstream from Brighton Dam and has a capacity of 5.5 billion gallons. The reservoirs collect water from an approximate total of 132 square miles of watershed that spans three counties in the State of Maryland – Howard, Montgomery, Prince George's – and originates within a small portion of Frederick County. Water from Duckett Dam flows by gravity through a 60-inch steel pipe to the Rocky Gorge pumping station, located approximately 700 feet from the dam and is then pumped through three parallel pipelines (sizes 30", 36", and 42" in diameter) to the Patuxent Filtration Plant.

The Patuxent plant which has a maximum treatment capacity of 72 million gallons per day (mgd) was constructed in three stages. The first of four filter units was completed in 1944, the second in 1951, and the last two in 1955. The original plant consisted of four individual steel tanks which contained floculation chambers, settling basins, rapid sand filters and necessary piping and controls. Currently, the plant is undergoing a complete upgrade to increase efficiency and production. The Patuxent Water Treatment Plant upgrade is a two-phase program. The existing steel tankage process units will be replaced with new higher rate concrete tankage process units and various chemical feed and ancillary facilities will be upgraded or replaced. Phase 1 provides for 56 mgd nominal capacity and 72 mgd of emergency capacity. Phase 2 will expand the new plant to 72 mgd nominal capacity with 120 mgd of emergency capacity. Phase 2 also includes expansion of the existing raw water pump station at Rocky Gorge. Work on Phase 1 began in April 2000 and is scheduled for completion in Fall 2004. Design of the Phase 2 facilities is expected to be initiated within the next several months.

The Patuxent Plant in combination with the Potomac Plant serves 1.6 million customers in Prince George's and Montgomery counties and a small portion of southern Howard County. Figure 2.1 depicts the service area of these two plants. A separate source water assessment has been prepared for the WSSC Potomac Water Filtration Plant. A copy may be obtained from the WSSC.

Brighton and T. Howard Duckett Dams are concrete slab and buttress type. Brighton Dam is 80 feet high and 995 feet long; T. Howard Duckett Dam at Rocky Gorge is 131 feet high and 840 feet long.

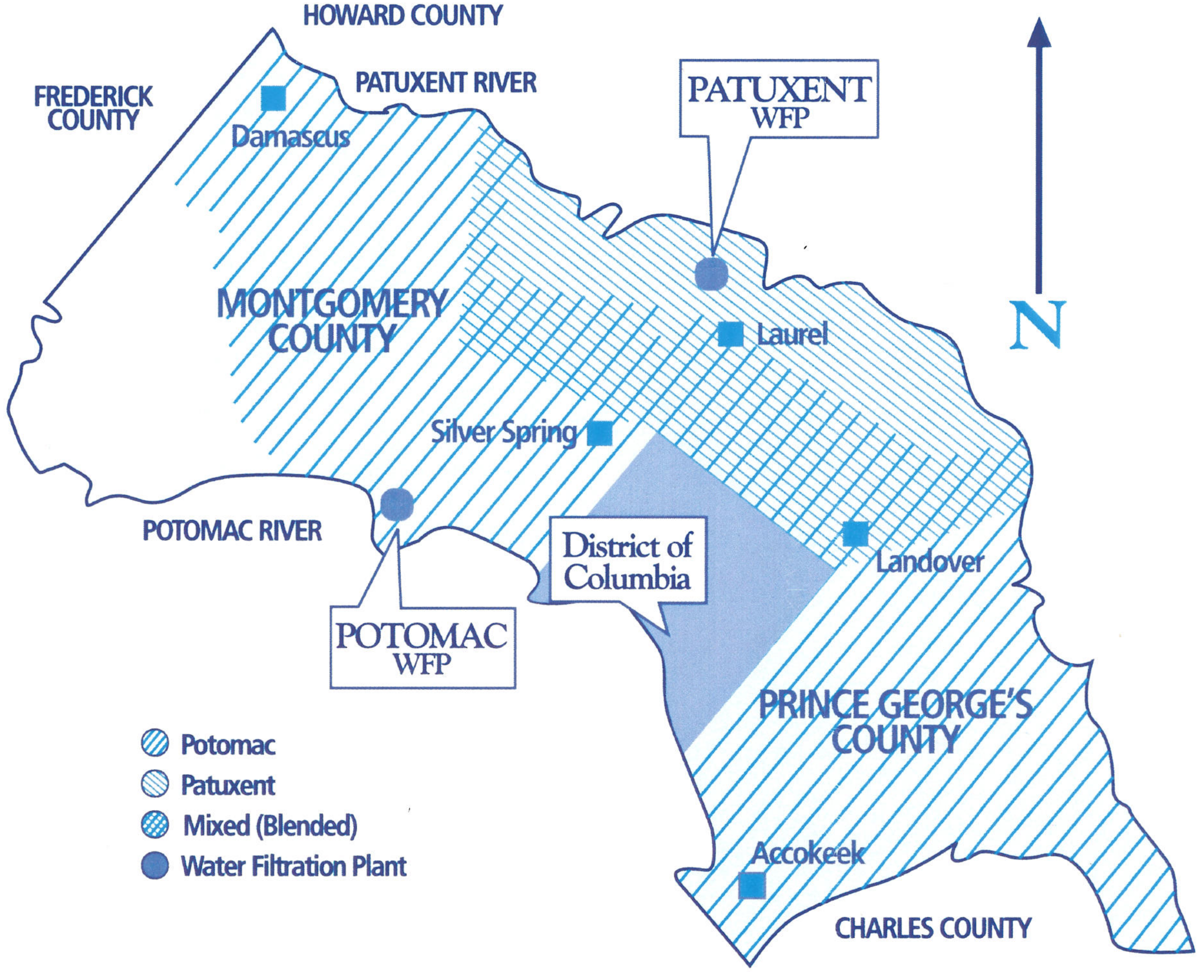


Figure 2.1 - The WSSC Service Area

3.0 DESCRIPTION OF SURFACE SOURCE

The Patuxent Reservoirs are located in the upper reaches of the Patuxent River in Central Maryland between the cities of Baltimore and Washington DC. The furthest upstream reservoir, known as the Triadelphia Reservoir, was created when the Brighton Dam was constructed. This reservoir is fed by an approximately 50,000 acre watershed in Montgomery and Howard counties. The lower reservoir is known alternately as the Rocky Gorge Reservoir and the T. Howard Duckett Dam. It collects water from an approximately 85,000 acre watershed.

The Patuxent River is the only river that originates and flows entirely within the State of Maryland, beginning at Parr's Ridge near the junction of Montgomery, Howard, Frederick and Carroll counties. The river provides a natural boundary between Montgomery and Howard counties, and delineates the northern border of Prince George's County.

Cattail Creek and Hawlings River are the two major streams besides the Patuxent River that feed the reservoirs. The major subwatersheds and their drainage areas are described in Section 5.0, "Watershed Characterization." These two streams are within the upper Patuxent River watershed.

The upper Patuxent River watershed is located in the Piedmont Physiographic Province. This province is characterized by rolling upland, cut by many streams and small tributaries. The underlying geologic formations in the watershed are primarily metamorphosed igneous and sedimentary rocks. The soil survey reports in Howard and Montgomery counties indicate that the soils in the watershed area consist mainly of Glenelg-Manor-Chester association. The Glenelg series contains deep, well-drained soils; the soils were formed from material weathered in place from crystalline rocks that contain large amounts of mica, mostly mica shist. The Chester soils series occur mostly on hilltops and the upper part of slopes. Chester series are from micaceous rocks such as mica schist or granitized schist. The Manor series consists of very deep, well-drained to somewhat excessively drained soil on the upland above the Patuxent River.

The upper Patuxent River watershed has a humid climate with average annual precipitation of 40 inches; the months of January and February typically are the driest and the months of July and August are the wettest due to periodic thunderstorms that typically occur during May through August.

4.0 RESULTS OF SITE VISITS

4.1 Intake Integrity/Description

Water is withdrawn from Rocky Gorge Reservoir through an intake structure located at T. Howard Duckett Dam. The spillway crest elevation is 285.0 mean sea level (msl) and spillway length is 840 feet. Both Duckett and Brighton Dams are slab and buttress type concrete dams. The intake structure consists of three sluice gates at elevations of 214, 242 and 271 msl with the maximum capacity of 171 mgd. The bottom sluice gate at elevation 214 is not operable due to silt buildup. Each sluice gate is six (6) feet wide and eight (8) feet high and feeds the 60-inch pipe to the pumping station.

Nine raw water pumps with combined capacity of 70 mgd deliver the water from the reservoir through three parallel pipelines (sizes 30", 36", and 42" in diameter) to the filtration plant. Patuxent Water Treatment Plant Phase 2 upgrade will include expansion of the existing raw water pump station and pipelines to provide the 120 mgd emergency capacity. MDE's Water Appropriation and Use Permit #PG19385001(07) allows withdrawal of a daily average of 72,000,000 gallons on a yearly basis and a maximum daily withdrawal of 120,000,000 gallons from Rocky Gorge Reservoir. Brighton and T. Howard Duckett Dams have received inspections from the U.S. Army Corps of Engineers (USACE) and MDE, Dam Safety Division. The USACE concluded that both Patuxent dams (Duckett and Brighton) are free of serious structural deterioration, with no tendency for tipping or sliding under probable maximum flood. The inspection found some minor deficiencies including minor cracks in the concrete, leaky and difficult to operate gates, etc. However, these were not safety and operational hazards; no corrective action was recommended in the near future. A wire mesh screen located at the 60-inch raw water line is cleaned manually, sometimes during every shift. Bar screens at the sluice gates are also cleaned manually every three months. WSSC is conducting a study to improve this labor intensive cleaning process and operation of the gates.

4.2 Operator Concerns and Observations

Iron and manganese are seasonal water quality concerns of the operation staff at the Patuxent Water Treatment Plant.

Air diffuser piping was installed at the bottom of the Rocky Gorge Reservoir near the intakes in order to control iron and manganese by avoiding anoxic conditions near the intakes. Another significant challenge for the operation staff is the control of aquatic growth in the reservoir. Copper sulfate is added during the summer months to minimize aquatic growth. From mid-August to November the aquatic grasses break off and clog the intake screens. Rocky Gorge Reservoir also experiences algae bloom during winter months, particularly late February-early March. Potassium permanganate and powdered activated carbon can be added to the raw water prior to pumping to the Patuxent Water Filtration Plant for taste and odor control.

5.0 WATERSHED CHARACTERIZATION

5.1 Source Water Assessment Area Delineation Method

An important aspect of the source water assessment process is to delineate the watershed area that contributes to the source of drinking water. A source water protection area is defined as the whole watershed area upstream from a water plant's intake (MDE, 1999). The source water area for the Patuxent Reservoirs were delineated by using Arc View Geographic Information Software (GIS), utilizing existing GIS data, and by collecting – location data using a Global Positioning System (GPS). GPS point locations were taken at the water source intake and differentially corrected (for an accuracy of ± 2 meters) at MDE. Once the intake location was established, the contributing area was delineated based on existing Maryland Department of Natural Resources digital watershed data and Maryland State Highway Administration digital stream coverage. Digital USGS 7.5 topographical maps were also used to perform "heads up" digitizing or editing watershed boundaries. Figure 5.1 shows the delineated area and subwatersheds.

5.2 General Characteristics

The drainage area above the WSSC's intake on the T. Howard Duckett Reservoir encompasses approximately 132 square miles (85,000 acres) of mixed land use mostly in Howard and Montgomery counties (53% in Howard and 46% in Montgomery). Approximately 1% of the watershed is in Frederick and Prince George's counties. Drainage to the reservoirs in Montgomery County represents 11% of the county's land area and in Howard County represents 27% of the entire county land area (George, Miles and Buhr, 1997). Figure 5.2 shows the land use within the reservoir watershed.

Table 5-1 shows the Howard and Montgomery counties land use distribution in the Patuxent Reservoirs.

Table 5-1. Howard and Montgomery Counties Land Use Distribution in the Patuxent Reservoirs Watershed

COUNTY 2000 LAND-USE	*Howard County*		*Montgomery County*	
	Total Acres	% of Watershed in county	Total Acres	% of Watershed in county
Low-Density Residential	8159.9	18.1	6056.6	15.4
Med/High Density Residential	294.4	0.7	1764.0	4.5
Commercial/Industrial	128.8	0.3	275.8	0.7
Open Urban Land	415.3	0.9	1049.2	2.7
Cropland	16748.1	37.2	11179.0	28.4
Pasture	3387.7	7.5	2975.7	7.5
Forest	14396.6	32.0	15335.9	38.9
Open Water	1188.5	2.6	763.1	1.9
Wetlands	34.9	0.1	na	na
Concentrated Agricutlure/CAFOs	265.8	0.6	20.7	0.1
TOTAL	45020.1	100.0	39419.9	100.0

Source: Maryland Department of Planning's 2000 land use data

5.3 Localized Characteristics

WSSC owns and controls 6.9 square miles (4,400 acres) of land contiguous to the Triadelphia and Rocky Gorge Reservoirs. This protected area is managed for the primary purpose of creating a buffer zone to control sediment and pollutant runoff. Secondary purposes include recreation and fish and wildlife management (*Comprehensive Management Planning Study for the Patuxent Reservoir Watershed*). Recreational activities including fishing, boating and limited hiking are allowed at the reservoirs with a permit obtained from WSSC. Residential development density is the highest around Rocky Gorge Reservoir compared to the other subwatersheds in the Upper Patuxent River watershed. Patuxent River State Park, located in Howard and Montgomery counties along the upper 12 miles of the Patuxent River, is comprised of 6,700 acres of natural areas and farmlands. Recreational use is primarily hunting, fishing, and horseback riding.

5.4 Major Subwatersheds

Maryland's Source Water Assessment Plan states that larger source water areas will be segmented into smaller subwatersheds to assist in the assessment and to identify watershed of concern. The Patuxent Reservoirs watershed was segmented into five major subwatersheds for this assessment. They were based on MD-DNR data and were edited by digital topographic maps. Figures 5.3 through 5.7 depict the five subwatersheds in the Patuxent River Reservoirs source water protection area.

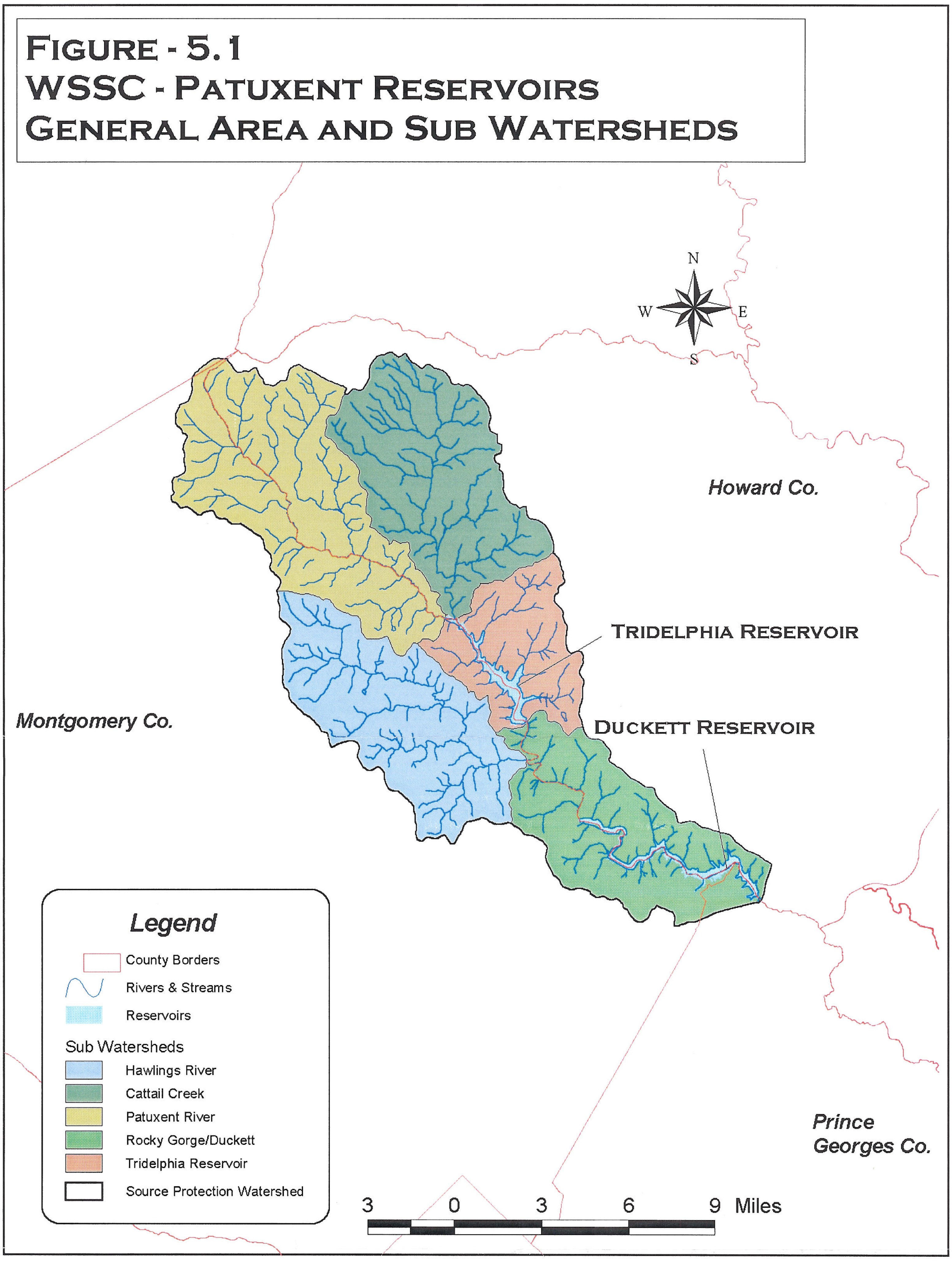


FIGURE - 5.1
WSSC - PATUXENT RESERVOIRS
GENERAL AREA AND SUB WATERSHEDS
N
W
E
S
Howard Co.
TRIDELPHIA RESERVOIR
DUCKETT RESERVOIR
Montgomery Co.
Legend
County Borders
Rivers & Streams
Reservoirs
Sub Watersheds
Hawlings River
Cattail Creek
Patuxent River
Rocky Gorge/Duckett
Tridelphia Reservoir
Source Protection Watershed
3 0 3 6 9 Miles
Prince Georges Co.

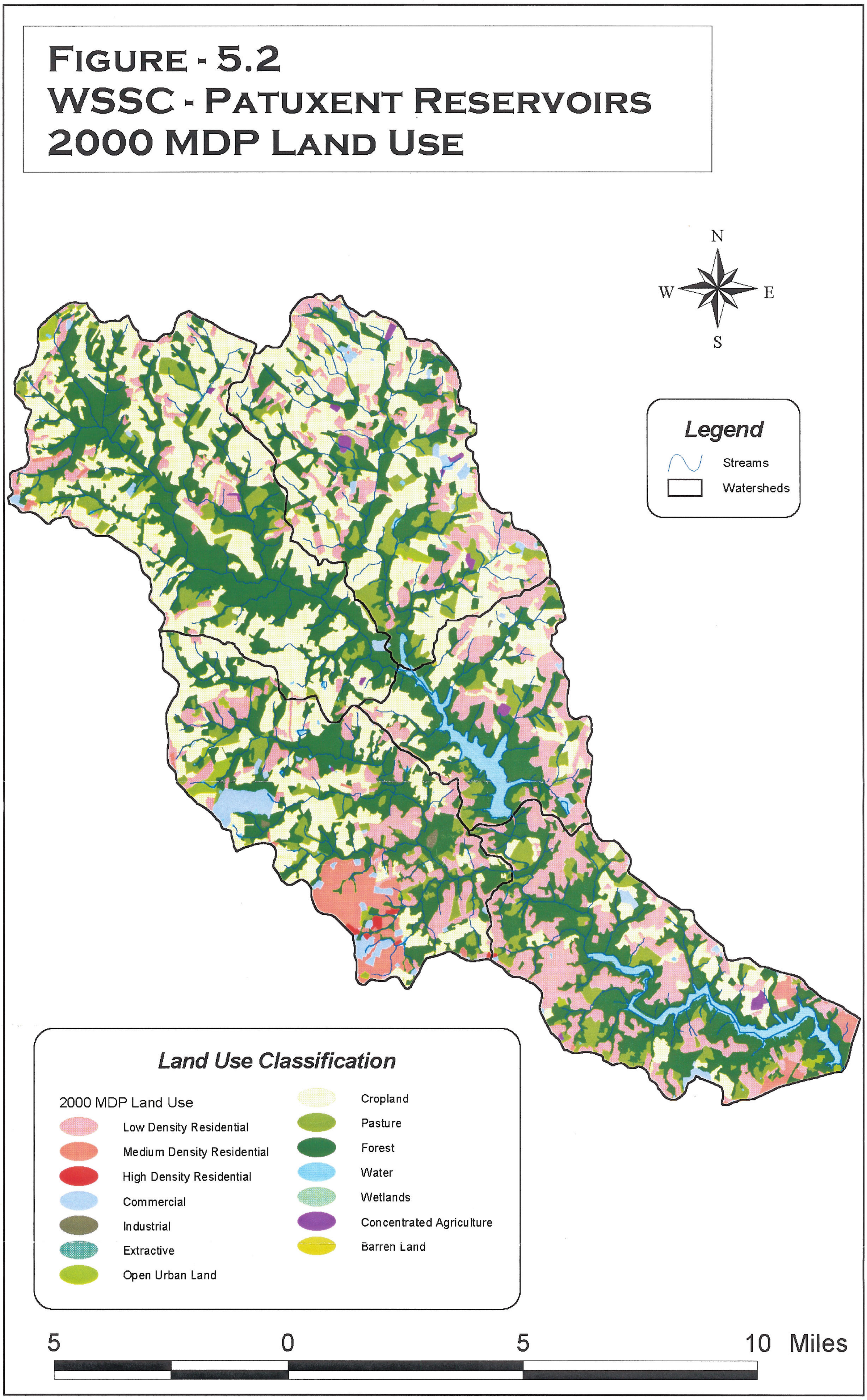
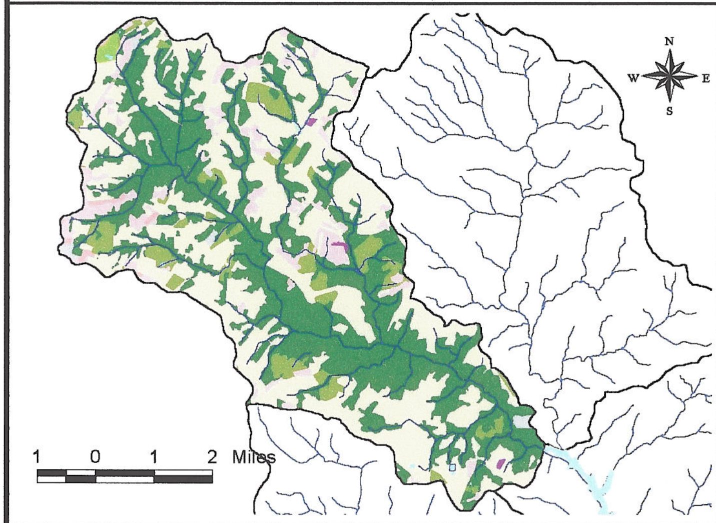


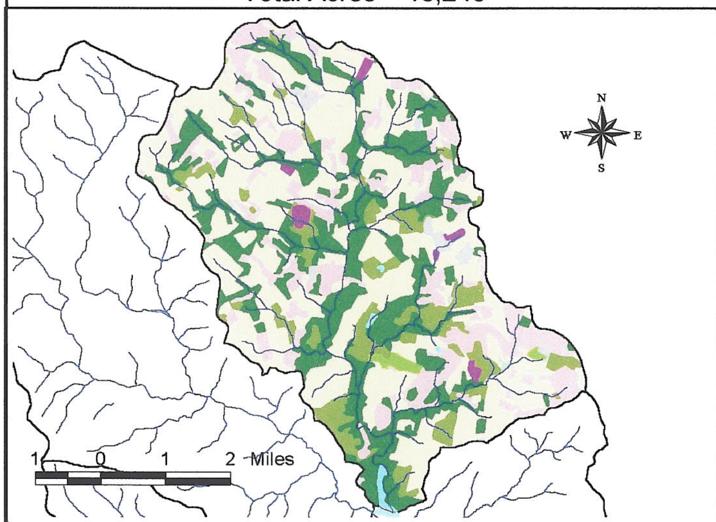
FIGURE - 5.2
WSSC - PATUXENT RESERVOIRS
2000 MDP LAND USE
N
W
E
S
Legend
Streams
Watersheds
Land Use Classification
2000 MDP Land Use
Low Density Residential
Medium Density Residential
High Density Residential
Commercial
Industrial
Extractive
Open Urban Land
Cropland
Pasture
Forest
Water
Wetlands
Concentrated Agriculture
Barren Land
5
0
5
10 Miles

Figure 5.3 UPPER PATUXENT RIVER	General Land Use	% Watershed
Total Area = 22,693	Residential	7%
	Agriculture	51%
	Forested	41%
	Other	1%



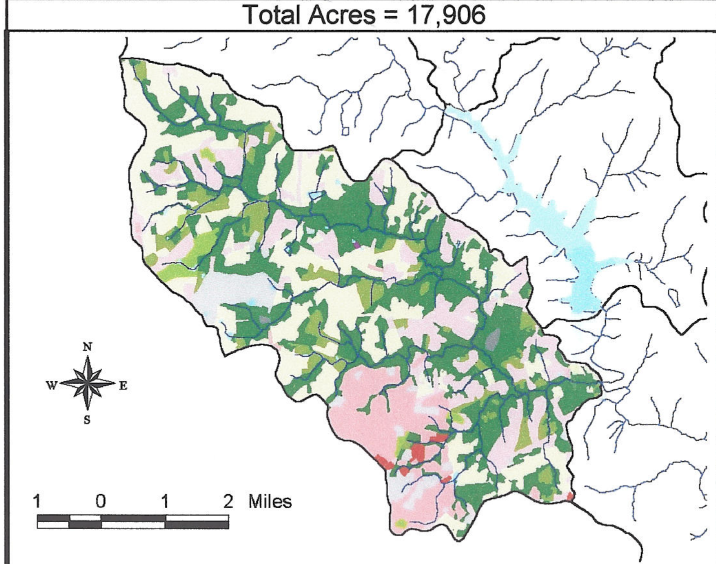
This is the largest subwatershed in the basin with the least residential development area. Approximately 40% of the subwatershed is forested and lies in the headwaters of the Patuxent River.

Figure 5.4 CATTAIL CREEK	General Land Use	% Watershed
Total Acres = 18,246	Residential	17%
	Agriculture	57%
	Forested	24%
	Other	2%



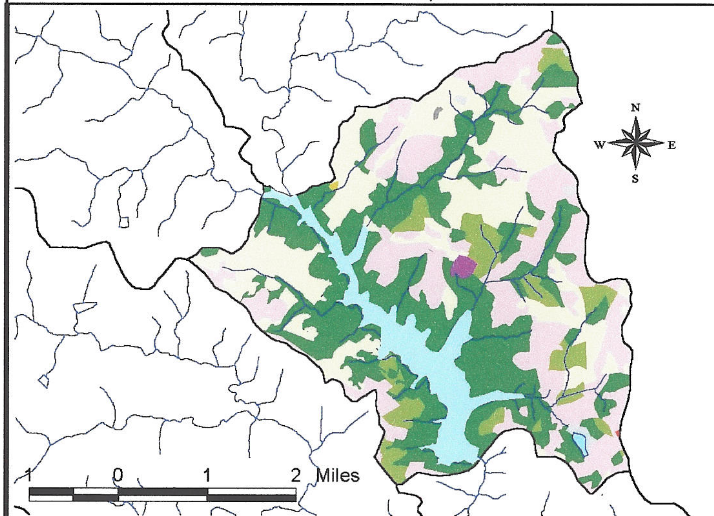
With 57% of agricultural land, this watershed is the most agricultural of the subwatersheds and the lowest percentage of forested lands. Almost the entire subwatershed is located in Howard County. Cattail Creek is a major tributary of the Upper Patuxent River, draining to Triadelphia Reservoir.

Figure 5.5 HAWLINGS RIVER	General Land Use	% Watershed
Total Acres = 17,906	Residential	25%
	Agriculture	35%
	Forested	33%
	Other	7%



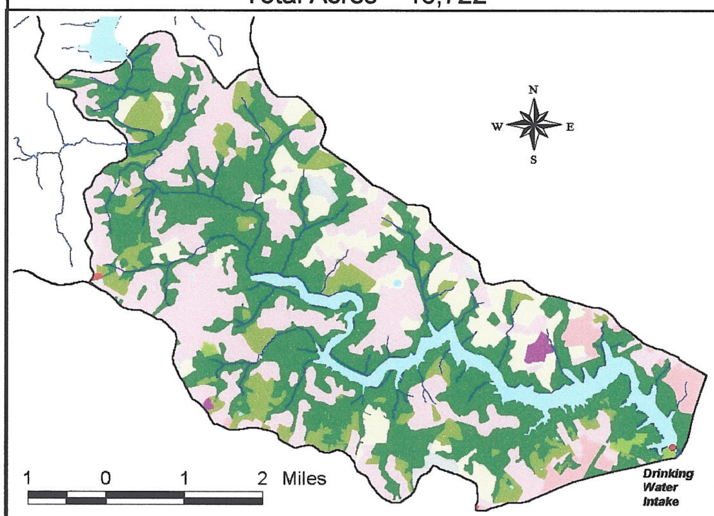
Hawlings River subwatershed, located in Montgomery County, drains to the T. Howard Duckett (Rocky Gorge) Reservoir. This subwatershed has the highest concentration of medium and low density residentail land use. The communities of Olney, Laytonsville and Brookville are located in this subwatershed.

Figure 5.6 TRIADELPHIA RESERVOIR	General Land Use	% Watershed
Total Acres = 9,811	*Residential*	25%
	Agriculture	32%
	Forested	33%
	Other	9%



Most of the forested land in this subwatershed is owned and maintained by WSSC. Recreational activities such as boating, fishing and hiking are the most frequent occurrings in this subwatershed.

Figure 5.7 ROCKY GORGE - DUCKETT RESERVOIR	General Land Use	% Watershed
Total Acres = 16,722	*Residential*	31%
	Agriculture	19%
	Forested	43%
	Other	7%



This subwatershed has the highest residential and forested land use in the Patuxent Reservoirs watershed area. Most of the forested land in this subwatershed is also owned and maintained by the WSSC. Sandy Spring, Ashton and Burtonsville areas are located in this sub-basin.

An area classed as concentrated agriculture ajoins the forest buffer near Columbia Pike.

6.0 POTENTIAL SOURCES OF CONTAMINATION

Watershed sources of contaminants in the Patuxent Reservoirs can be categorized as either point or non point sources and include agricultural activities, residential runoff, wastewater treatment plants, septic systems and erosion and disturbance of vegetation along the streams feeding the reservoir. Figure 6.1 depicts the potential point contaminant sources are made in the reservoir's source water assessment area.

6.1 Non Point Sources

According to Department of Planning land use data, 20,401 acres in Howard County and 14,175 acres in Montgomery County are used for agricultural purposes (cropland, pasture and concentrated animal feeding operations). Land used to grow crops can be a source of nutrients (from fertilizers), synthetic organic compounds (herbicides) and sediment load. Pastures for grazing livestock and concentrated animal feed lots can be sources of nutrients and pathogenic protozoa, viruses and bacteria from animal waste.

Developed lands account for 20% of Howard County's portion of the reservoir watershed and approximately 23% of Montgomery County's portion of the Patuxent reservoirs watershed. Sediment, nutrients, pathogens (*Giardia* and *Cryptosporidium*), total organic carbon (TOC), road salts and heavy metals are the most significant water supply concerns from runoff in developed areas. Lawn and pavement in the residential area results in increased storm water velocities and can cause streambed and stream bank erosion and transport of sediment into the reservoirs. Water quality impacts from new low density residential development are not as significant as impacts from previously developed areas, due to controls in place through state and county stormwater regulations.

6.2 Point Sources

Point sources are regulated to minimize water quality impacts through the National Pollutant Discharge Elimination System (NPDES). NPDES permits have been issued for five surface water discharges within the watershed. Three are for stormwater discharges, one is from a ground water remediation system and one is a sewage wastewater treatment plant discharge. Both wastewater discharges are classified as minor permits due to their low volumes of discharge. The Federal Emergency Management Agency (FEMA) in Montgomery County, NPDES Permit #MD0025666, is an activated sludge-type plant process consisting of influent pumping, screening, activated sludge, liquid chlorination, and liquid dechlorination using sodium thiosulfate. Sludge handling and treatment consists of sludge wasteing to a holding tank which is pumped and hauled off from the site. Treated effluent with an average rate of 655 gallons per day is discharges via an underground pipe to a tributary of Hawling River. Review of State compliance data indicates that FEMA Support Center Wastewater Plant experienced numerous violations of permit effluent limits for biochemical oxygen demand (BOD) and fecal coliform for the past three years. MDE's Compliance Program is currently working with FEMA Support Center to correct these problems.

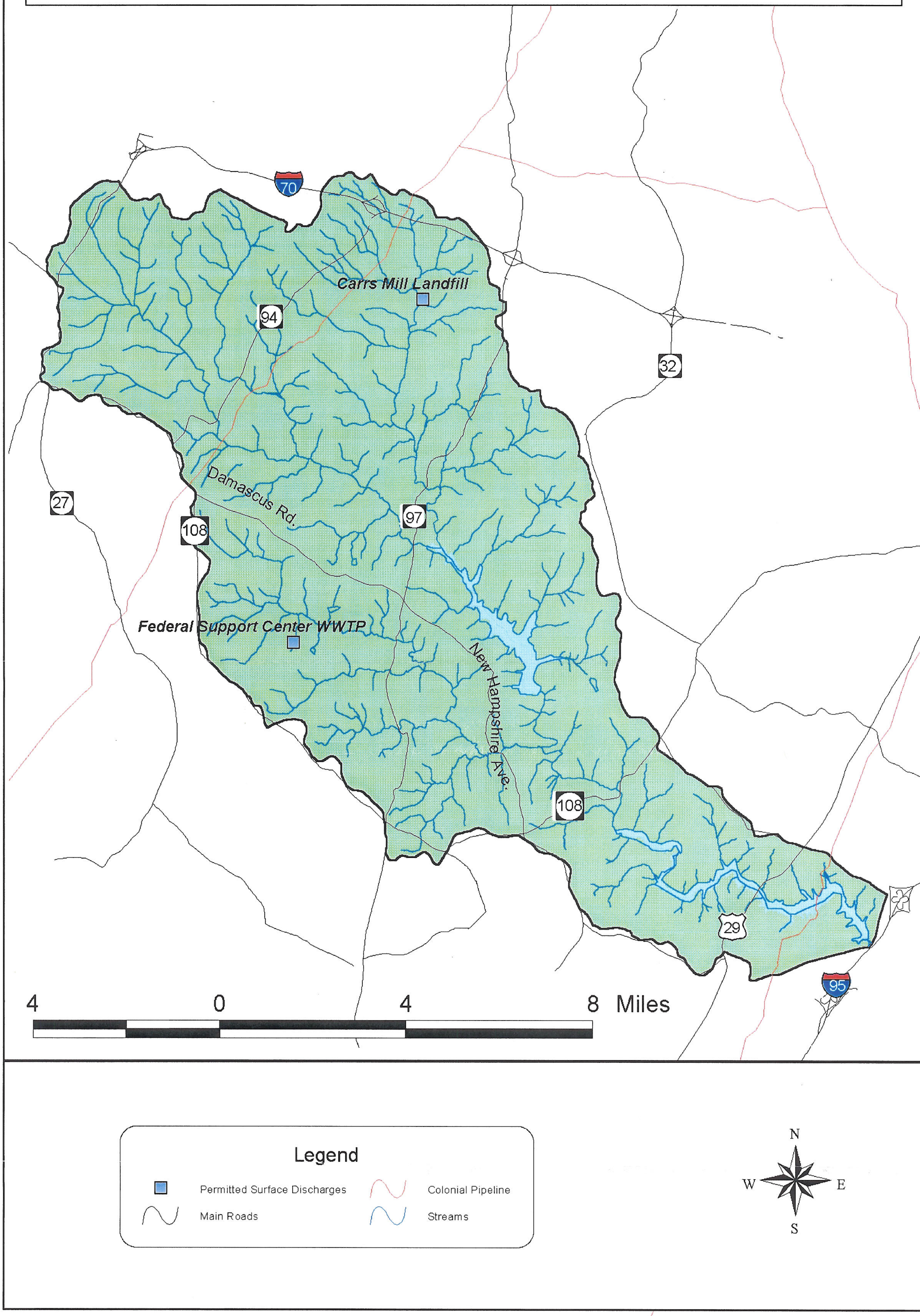
The Carrs Mill Landfill Groundwater Remediation System, Permit #MD0067873, consists of fourteen (14) recovery bedrock wells with an estimated discharge not to exceed 60 gpm. Groundwater is extracted using electric submersible pumps and transported through piping buried below the frost layer depth to a treatment building. Once within the treatment system, suspended sediments are removed from the extracted groundwater using bag filtration units. The extracted groundwater is treated to remove VOCs via air stripping. Treated groundwater from the air stripping unit is discharged to Cattail Creek adjacent to Bushy Park Road. The facility is currently in compliance with the requirements of the permit.

6.3 Transportation Related Concerns

Another potential source of contamination to the reservoirs is transportation, including highways, roads, and petroleum and gas pipelines. Routes 29, 108, 97, and 94 are used heavily for commercial traffic and cross portions of the Rocky Gorge Reservoir and main stem of the Patuxent River. All these routes especially Route 29 pose potential spill danger to the reservoirs because of their close proximity to the WSSC's raw water intake structure. A short segment of I-70 crosses the northern boundary of the reservoirs watershed and may be of concern for spills in the Cattail Creek Watershed. There are also numerous secondary roads and residential access roads throughout the watershed. Concentration of residential roads with heavy traffic within the watershed and lack of proper stormwater management practices in some urban areas can cause siltation of the Patuxent reservoirs.

Colonial Pipeline, an interstate carrier of petroleum products, crosses the Patuxent Watershed at two locations, one near Route 94 and another segment through the Rocky Gorge Reservoir close to the WSSC intake (this segment is abandoned). Pipeline accidents and leaking of petroleum products can cause contamination of raw water with volatile organic compounds

FIGURE - 6.1
WSSC - PATUXENT RESERVOIRS
POTENTIAL CONTAMINANT SOURCES & ROADS



7.0 REVIEW OF WATER QUALITY DATA

WSSC maintains an extensive water quality monitoring program for Patuxent Reservoirs (Triadelphia and Rocky Gorge). Routine sampling is performed at three locations in Triadelphia Reservoir and three locations in Rocky Gorge Reservoir. In addition, sampling and analysis of the raw water and treated water at the Patuxent Filtration Plant is carried out. Additional sources of water quality data reviewed for source water assessment areas include: MDE Water Supply Program's database for Safe Drinking Water Act contaminants; United States Geological Survey stream sampling data; MD Department of Natural Resources; and Howard and Montgomery Counties.

Water quality data for the Patuxent Reservoirs was compared with levels for healthy reservoirs and Maximum Contaminant Levels (MCLs) set by the U.S. Environmental Protection Agency. MCLs are established to ensure that drinking water is safe for human consumption. If the monitoring data shows that any contaminant is greater than 50% of a MCL at least 10% of available data points, a detailed susceptibility analysis will be performed for that contaminant and its potential sources.

7.1 Patuxent Filtration Plant Water Quality Monitoring

WSSC tests the raw and treated water at the Patuxent Filtration Plant for various contaminants (see Table 7-1). MDE also periodically analyzes samples of the treated water for contaminants regulated under the Safe Drinking Water Act. Raw water samples are collected at the plant prior to treatment; treated water samples are collected after the water passed through the treatment plant. A summary of this data is provided in Table 7-2a. Specific findings are discussed in the following sections.

7.1.1 Volatile Organic Compounds

On a monthly basis, the WSSC analyzes the treated and raw water for the 21 regulated volatile organic compounds (VOCs); (i.e., those for which a maximum contaminant level [MCL] has been established) and approximately 32 additional VOCs. MDE has conducted annual sampling for VOCs since 1988.

No VOCs have been detected in MDE's annual samples. However, WSSC reports a detection limit less than 0.5 ppb, and their results show traces of VOCs (see Appendix A). Table 7-2a summaries, by comparison, the results of all sampling. Only one contaminant, methylene chloride, was found to be above 50% of its MCL. Samples of both raw and treated water collected on September 25, 2001 had 13.4 and 11.4 ppb respectively, more than twice the MCL. Compliance, however, is based on annual average values and the one high sample did not result in the annual average being >50% of the MCL. The system also met the requirement that no contaminant exceed more than 50% of an MCL in 10% or more of the collected samples (the 50/10 requirement). Methylene chloride can be found in solvents used for paint removal and is also used in laboratories for analytical procedures. The subsequent samples, including a set of two samples taken September 27 2001, have not detected this chemical. The last previous detection was in 1998, three years previous and the reported level in the September 25, 2001 sample was seven times higher than the highest reported sample ever reported from this site. The September 25, 2001 sample appears to be an outlier. Therefore, volatile organic compounds, while present in the environment are not occurring at levels currently considered to be a concern. Total Trihalomethanes (THMs), however, are discussed in greater detail in disinfectant-by-products section below.

7.1.2 Synthetic Organic Compounds

WSSC tests the raw and treated water for Synthetic Organic Compounds (SOCs). MDE has conducted annual sampling of the treated water for SOCs since 1994.

No contaminants have exceeded more than 50% of an MCL in 10% or more of the collected samples (50/10 criteria). Table 7-2a summaries the results of all sampling. Table A-2 in Appendix A shows the resulting detections for SOCs since 1994 through 2001.

Although none of the SOC data exceeds the 50/10 criteria, alachlor, atrazine and simazine are of interest because they are commonly used as herbicides and have been detected frequently in the water from the Patuxent Filtration Plant. A review of all available data from several scientific studies (Glotfelty et.al, 1986 and Hackett, 1997) along with plant monitoring data suggests that the usage of herbicides has declined in Patuxent Reservoir watershed in the past twenty years. Figures 7.001 and 7.002 plot the detections of four herbicides since 1982 and 1995 respectively depicting the downward trend. Given the reduction in pesticide application rates, improved management practices and loss of agricultural land over this period, it is likely that these concentrations will continue to decrease in the future. Statewide pesticide statistics prepared by Maryland Department of Agriculture also indicate that the usage of atrazine and other herbicides has declined in Maryland in the past decade.

7.1.3 Heavy Metals

WSSC analyzes raw and treated water for metals (antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, thallium) and MDE has conducted annual sampling for metals since 1993.

Metals have not been detected at concentrations exceeding 50 percent of MCL in any of WSSC and MDE samples (1993 through 2001). Table 7-2a summaries the results of all sampling. All detections are shown in Table A-3 of Appendix A.

These data indicate that metals are not currently a concern for Patuxent Reservoirs.

7.1.4 Other Inorganics

This category includes nitrate/nitrite, fluoride, radionuclides, sulfate and sodium. Cyanide and asbestos are not analyzed by WSSC due to MDE waivers for these compounds for most water systems.

Patuxent Filtration Plant regularly tests for the presence of nitrate/nitrite, fluoride and other inorganic compounds. Fluoride results reflect added fluoride during treatment process. All the fluoride results in Table A-3 are treated water samples. Nitrate and sodium results during the last five years show no significant trends, and all results are well below MCLs. No contaminants have exceeded more than 50% of an MCL in 10% or more of the collected samples. Table 7-2a summaries the results of all sampling. A summary of testing results for IOCs detected in raw and treated water is shown in Table A-3 of Appendix A.

7.1.5 Turbidity

Turbidity is described as a measure of cloudiness of water. It is used to indicate water quality and treatment effectiveness. Higher turbidity level are often associated with higher levels of disease causing microorganisms such as viruses, parasites and bacteria.

Turbidity is measured in the raw water at the Patuxent Filtration Plant on a continuous basis. The monthly summary statistics for each month during the period 1997-2002 is presented in Table 7-2b. For the period 1997 through 2002 the average daily turbidity measured was 3.7 nephelometric turbidity units (NTU), the minimum turbidity measured was 1.0 NTU during month of May, 1997, and the maximum turbidity measured was 19.8 NTU during the month of March, 1998. The average turbidity of the raw water exceeds the current MCL[1]; therefore, turbidity is a contaminant of concern.

7.1.6 Protozoa, Viruses, and Total/Fecal Coliform

Cryptosporidium and *Giardia lamblia* are protozoans that can cause gastrointestinal illnesses in humans. These protozoans enter the environment through fecal contamination from infected humans and animals. Previous research has indicated that *Cryptosporidium* and *Giardia* are present in source waters for most U.S. surface water treatment plants (LeChevallier, et al, 1991).

WSSC collected monthly raw water samples for *Cryptosporidium* and *Giardia lamblia* from July, 1997 through December, 1998 (total of 18 monthly samples) for EPA's Information Collection Rule (ICR). In November of 1997, 15 *Giardia* cysts per 100 liters were identified, and in March and April of 1998, 18 and 33 *Cryptosporidium* oocysts per 100 liters respectively were identified. It is important to note that the ICR testing and sampling methods do not distinguish between the viable and nonviable cyst and oocysts. However, the results indicate that *Cryptosporidium* and *Giardia lamblia* are present in the Patuxent Reservoirs. While no MCL is established for protozoans, these are contaminants of concern for the Patuxent Reservoir system.

Fecal coliform monitoring tests are performed on the raw water at Patuxent Filtration Plant on a daily basis. A summary of the monthly average, median, maximum, and minimum concentrations during the period 1997 – 2002 are shown in Table 7-2b.

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[1] As of January 2002, turbidity may never exceed 1 NTU, and must not exceed 0.3 NTU in 95% of daily samples in any month.

The average monthly fecal coliform counts are below the Maryland raw water quality standard of 200 MPN/100 ML; this indicates that the Patuxent Reservoirs are not particularly susceptible to contamination by pathogenic organisms.

7.1.7 Disinfection Byproducts and Disinfection Byproduct Precursors

WSSC has been monitoring disinfection byproducts (DBPs) in the distribution system to monitor compliance with Stage 1 Disinfectants and Disinfection Byproduct Rule (DBPR) (Table 7-2d). The DBPs are total trihalomethanes (TTHMs) and haloacetic acids (HAA). The sum of the concentration of four compounds chloroform, bromochloromethane, dibromochloromethane, and bromoform comprise TTHM and the sum of five compounds mono-, di-, and tri-chloroacetic acids, and mono- and di-bromoacetic acids comprise HAA5. In addition, total organic carbon is used as a surrogate for precursors (DBPPs). TOC has been monitored in the raw and treated water. The TOC values by quarter are presented in Table 7-2c. The raw TOC values are higher in the first quarter of the year, followed by the summer period. Higher removal efficiencies also occur in the first quarter. The summer and fall periods had the highest treated water TOC values. Raw water summertime TOC values are likely suppressed by copper sulfate treatment that has commonly been used in Rocky Gorge Reservoir. A review of the disinfection by product data by season (See Table 7-2e) indicate that the warmest quarter (July – September) has the highest DBP levels. The average THM values during this period exceed the MCL of 80 ppb. However, because compliance with the "Stage One Disinfects and Disinfection Byproducts Rule" for THM is based on a running annual average, the system remained in compliance with the standard. Levels of disinfection byproducts in the treated water exceeds 50% of the recently established MCLs for total THM (80 ųg/L) and HAA (60 ųg/L). Because of the significance of the DBP issue and the potential role of watershed activities in limiting DBP precursors, DBPs and TOCs are considered contaminants of concern.

7.2 WSSC Water Quality Monitoring Program for In-Reservoir Monitoring Stations

Water quality samples have been collected on a seasonal and/or monthly schedule from Triadelphia and Rocky Gorge Reservoirs since 1997. Figure 7.1 shows the location of the three sampling sites in each reservoir (RG-1, RG-2, RG-3, TR-1, TR-2 and TR-3). The water quality parameters collected in each of these sampling sites are:

- Temperature
- pH
- Dissolved Oxygen (DO) concentration
- DO (percent saturation)
- Conductivity
- Chlorophyll *a*
- Turbidity
- Secchi Disk Depth
- Fecal Coliform
- Chloride (since 2000)
- Manganese

- Total Phosphorus
- Iron (Fe)
- Orthophosphates
- Alkalinity
- Total Kjehldahl Nitrogen (TKN)
- Suspended Solids
- Ammonia
- Algal Counts

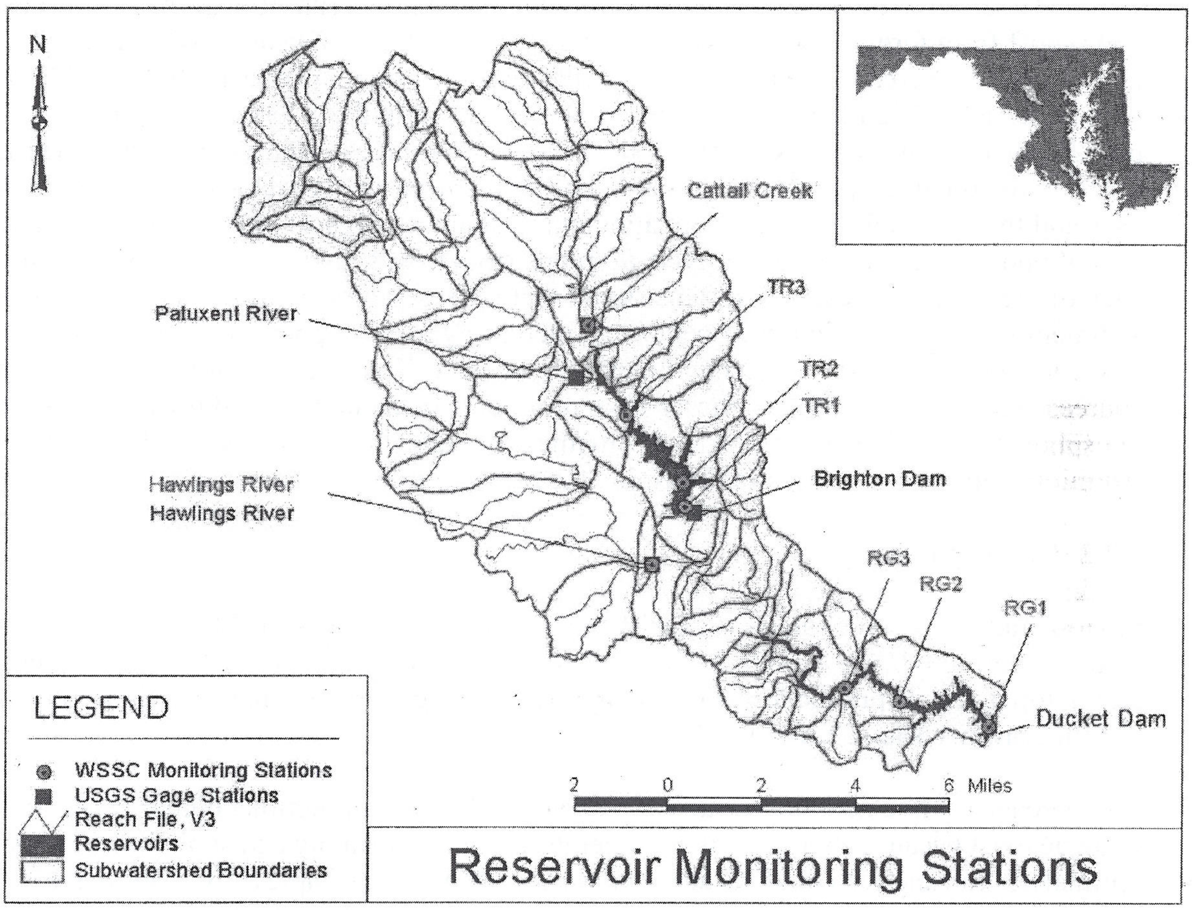


Figure 7.1. Reservoir Monitoring Stations

Data for total phosphorus, chlorophyll *a*, dissolved oxygen, nitrate/nitrite, iron, manganese, fecal coliform, and conductivity for years 1997 – 2002 and chlorophyll *a* (for years 1998-2002) were compiled and graphed for three in-reservoir stations for both Triadelphia and Rocky Gorge Reservoirs (Figures 7.01 through 7.27). The seasonal trends for these water quality parameters along with their treatability and public health issues are described in the next section.

7.2.1 Total Phosphorus

Since phosphorus is the limiting nutrient for these reservoirs, phosphorus reduction is needed to reduce eutrophication stresses on the reservoir system. Phosphorus is the eleventh most abundant mineral in the earth's crust; fresh water phosphorus exists in either particulate phase or a dissolved phase. Particulate matter includes living and dead plankton, precipitate of phosphorus, phosphorus absorbed to particulates and amorphous phosphorus. The dissolved phase includes inorganic phosphorus (generally in the soluble orthophosphate form), organic phosphorus excreted by organisms, and macromolecular colloidal phosphorus. External sources of phosphorus include agricultural and urban runoff, wastewater effluents and runoff from forested land. Estimates from watershed data indicate about one-third of the phosphorus delivered to the reservoirs is in the dissolved form. (Tetra Tech, May, 2003). Given the lack of significant point source discharges within the reservoir watersheds, practically all of phosphorus is delivered by non-point sources. Additional work is needed to quantify the relative contribution of total phosphorus from residential and agricultural land uses and the potential reduction from agricultural sources. Figures 7.01 and 7.02 illustrate loss of phosphorus as the water travels from upstream monitoring station to downstream in each of the Patuxent Reservoirs. This shows that the reservoirs are acting as nutrient and sediment sinks. These figures also show an increasing trend of phosphorus levels in the lower level of the reservoirs during the growing season. This could be attributable to several sources such as release of phosphorus from sediment due to anoxic conditions, input of phosphorus from tributary inflow, and settlement of algae from upper reservoir layers. Additional analysis is needed to determine the respective contributions.

7.2.2 Chlorophyll *a*

Phytoplankton (algae) biomass is usually measured by the amount of chlorophyll *a* in the water. Chlorophyll *a* is a photosynthetic pigment that serves as a measurable parameter for all phytoplanktonic production. On average, 1.5% of algal organic matter is chlorophyll *a* (North Carolina State University, 1994).

Algae generally live near the surface of reservoirs. In the summertime, higher concentrations of algae exist because shallow water temperatures, nutrient supply and sunlight levels are optimal. Some amounts of algae are always present in water samples at various depths. This baseline concentration reflects the presence of algae varieties (usually less numerous) that are adapted to colder temperatures and weaker sunlight or may include some dead algae cells that are settling to the reservoir bottom. An overabundance of algae is generally not a direct health issue, but one of consumer acceptance of drinking water. Increased odors and unpleasant tastes are a result of high algae concentrations in a water supply and are difficult to remove at the treatment plant. Also, algae contribute to the pool of THM precursors and are a source of turbidity in the water. Some blue green algae excrete toxins into water which can have negative health consequences.

Figure 7.03 shows the level of chlorophyll *a* as monthly average and Figure 7.04 shows the level of chlorophyll *a* during growing season for all six locations in Patuxent Reservoirs. As season goes on, chlorophyll *a* levels increases in Triadelphia compared to Rocky Gorge.

Lower levels in Rocky Gorge may be attributed to copper sulfate addition. The increase in Triadelphia reservoir begins in July and exceeds the targeted maximum value of 10 ug/liter by August.

7.2.3 Dissolved Oxygen

Dissolved oxygen (DO) is the amount of oxygen available in a water sample. Chemical and biological activities all use or release oxygen causing a continual change in DO concentration. Declining water quality conditions in a body of water can be indicated by a decreasing concentration of DO. Low DO levels are potentially serious because they allow for a higher solubility or release of manganese, iron, phosphorus and other soluble ions, which in turn cause an increase in turbidity, algae, and color in these waters. Low DO itself is not a health risk, but tastes and odors are increased as a result of anaerobic decomposition when DO concentrations drop.

Oxygen is also an important oxidant. High levels of DO aid in treatment of raw water by causing iron and manganese to precipitate out of the water. Long term contact with DO can even help degrade some organic compounds that cause taste and odor problems. High concentrations of DO are unfavorable for metal pipes because it accelerates corrosion.

Microbes play a key role in the loss of oxygen from surface waters. Microbes use oxygen as energy to break down long-chained organic molecules into simpler, more stable end-products such as carbon dioxide, water, phosphate and nitrate (North Carolina State University, 1994). As the organic molecules are broken down by microbes, oxygen is removed from the system and must be replaced by exchange at the air-water interface.

Figures 7.05 through 7.07 show level of dissolved oxygen over the surface, middle and bottom of Triadelphia and Figures 7.08 through 7.10 show the level of dissolved oxygen in different depths in Rocky Gorge Reservoir. The dissolved oxygen concentration trends are similar to other reservoirs in central Maryland (Baltimore City Reservoirs). Homogeneous waters from January through April produce an evenly distributed oxygen filled reservoir. In May, when thermal stratification begins, dissolved oxygen levels start declining in lower layers. By September and October, rapid reduction of dissolved oxygen occurs due to excess decaying algae depleting available oxygen. Normal conditions resume when turnover occurs in December and dissolved oxygen levels rise at all depths of the reservoir.

Reduction in nutrients delivered to the reservoirs will reduce the extent and duration of periods of low dissolved oxygen. Efforts are underway to model the amount of nutrient reduction needed to meet State water quality criteria.

7.2.4 Nitrate/Nitrite, Ammonia

Figures 7.11, 7.12 and 7.13 shows the level of nitrate/nitrite and Figures 7.13.1, 7.13.2 and 7.13.3 show the level of ammonia in months of May, July and September respectively for years 1997 through 2002. These figures illustrate that the nitrate level decreases through growing seasons and also the level drops from Triadelphia to Rocky Gorge. All results for nitrates are well below the of MCL of 10 mg/l.

Nitrogen makes up 78% of the atmosphere as gaseous molecular nitrogen, but most plants can use it only in the fixed forms of nitrate and ammonium. Nitrate and nitrite are inorganic ions occurring naturally as part of the nitrogen cycle. The nitrogen cycle is composed of four processes. The first, fixation, converts gaseous nitrogen into a biologically useful form. The second and third, ammonification and nitrification change the chemical from (oxidation state) of fixed nitrogen. The fourth process, denitrification, converts fixed nitrogen back to the unusable gaseous nitrogen state (North Caroline State University, 1994). High nitrate concentrations may cause Methoglobinemia (Blue Baby Syndrome) in infants.

Ammonia can be transported to a surface water body by overland flow after precipitation or irrigation, direct discharge of effluents from industry or sewage treatment plants and deposition of airborne particulates. Ammonia levels in surface water increase with increasing pH and temperature. At low pH and temperature, ammonia combines with water to produce an ammonium ion ($NH4+$) and a hydroxide ion ($OH-$). Ammonia is very soluble in water at low (acidic) pH.

The figures for ammonia concentration illustrate that the concentration in the bottom layer is significantly higher in Triadelphia Reservoir than the Rocky Gorge Reservoir. Ammonia concentrations are higher in the bottom layer of the reservoir, when compared to the middle and surficial levels, reflecting reducing conditions and conversion of nitrate-nitrite to ammonia.

7.2.5 Iron

Iron (Fe) is one of the most abundant of all elements. This metal occurs naturally in rocks and soils. Iron found in water can also be the result of corrosive water coming into contact with unprotected steel or iron mains, steel well casings and pumps. It can originate from industrial wastes or from acid runoff from mining operations. Iron is regulated as a secondary drinking water contaminant since there are no known health effects associated with the ingestion of this metal. Iron is primarily a concern from an aesthetic standpoint. Iron in drinking water can stain plumbing fixtures and laundry. It can also provide a nutrient source for some bacteria which grow in water distribution mains. These bacteria can cause red colored water, tastes and odors, and equipment failures. Iron solubility is related to many factors such as pH and dissolved oxygen levels. Iron is more soluble in waters with reducing conditions (i.e., low dissolved oxygen).

Figures 7.14, 7.15 and 7.16 depict the level of iron in months of May, July and September respectively. They indicate the iron concentration in the bottom layer is generally higher than the other layers for all three months, with the month of September being the among highest for both reservoirs at all locations.

7.2.6 Manganese

Manganese (Mn) is a metal similar to iron, occurring naturally in ores, but is more stable than iron. The concentration of manganese in surface waters remains insignificant unless dissolved oxygen concentration reaches low levels. Unlike oxidized forms of manganese which are insoluble, manganese can solubilize under reducing conditions (i.e., low dissolved oxygen). As with iron, manganese is a concern from an aesthetic viewpoint and thus, is regulated as a secondary contaminant. Manganese also may adversely affects the amount of chlorine needed at the treatment plant, although the low levels of dissolved manganese generally found at the Patuxent water treatment plant are not believed to pose this problem.

The results of manganese level in the reservoirs as shown on Figures 7.17, 7.18 and 7.19 are similar to iron and the lower layer in the reservoirs exhibit higher concentration of manganese.

7.2.7 Fecal Coliform

Figures 7.20 and 7.21 show the level of fecal coliform bacteria measured in Triadelphia and Rocky Gorge Reservoirs. The maximum concentrations indicate that Triadelphia Reservoir has a relatively higher amount of fecal coliform than Rocky Gorge Reservoir. The figures also illustrate reductions in fecal coliform concentration as water travels across the reservoirs. Both sedimentation and ultra violet radiation play important roles in reducing the level of fecal coliform as the water moves through each reservoir.

7.2.8 Conductivity

Conductivity is a measure of the ability of a water sample to carry an electric current. This ability depends on the presence of high concentrations of ions and the ion type. Inorganic compounds are good conductors, while organic compounds are not. Higher levels of conductivity provide evidence for increasing levels of pollution.

Figures 7.22 through 7.27 illustrate the levels of conductivity for six locations in the Patuxent Reservoirs. The data indicates a slight increase in conductivity values for the years 1999 through 2001 when compared to earlier years.

Table 7-1. Routine Water Quality Monitoring Parameters for Reservoirs and the Filtration Plant.

Parameter	Rocky Gorge in Reservoir	Triadelphia in Reservoir	Patuxent Filtration Plant
Chlorophyll *a*	X	X	-
Total Phosphorus	X	X	R,T
Total Algal Count	-	-	R
Algae Taxonomic Identification	-	-	-
Total Suspended Solids	X	-	-
Nitrate-Nitrogen	-	-	R,T
Nitrite	-	-	R,T
Nitrite/nitrate-Nitrogen	X	X	R,T
Ammonia-Nitrogen	X	X	R
Secchi Disk	X	X	-
Conductivity	X	X	R,T
Dissolved Solids	-	-	-
Manganese	X	X	R,T
Iron	X	X	R,T
Dissolved Oxygen	X	X	R,T
Color	-	-	R,T
Turbidity	X	X	R,T
PH	X	X	R,T
Temperature	X	X	R,T
Heterotrophic Plate Count (HPC)			
Total and Fecal Coliform	X[1]	X[1]	T
Chlorine Residual	-	-	T
Hardness	-	-	R,T
Alkalinity	X	X	R,T
Total Organic Nitrogen (TON)	X	X	R
Trihalomethanes (THM)	-	-	T
Halo Acetic Acid (HAA)	-	-	T
Cryptosporidium and Giardia	-	-	-
Fluoride	-	-	T
Total Organic Carbon (TOC)	X	X	R,T
Chlorides	X	X	R,T
Total Solids	-	-	-
Phosphate	X	X	R,T
Silica	-	-	-
Sulfates	-	-	R,T
Aluminum	-	-	R,T
Calcium	-	-	R,T
Magnesium	-	-	R,T
Potassium	-	-	R,T
Sodium	-	-	R,T
Arsenic	-	-	R,T
Radionuclides	-	-	T
Synthetic Organic Compounds (SOCs)	X	X	T
Volatile Organic Compounds (VOCs)	-	-	R,T
Inorganic Compounds	X	X	R,T

1 - Fecal Coliform only for Rocky Gorge and Triadelphia

R - Raw, T - Treated

Table 7-2a: Summary of Patuxent Filtration Plant Analytical Results.*

Contaminant Group	Time Period of Data Reviewed	Contaminants Exceeding 50% of MCL 10% of the time	Comments
Volatile Organic Compounds (VOCs)	March 1988 to Dec. 2002	None	One sample data showed methylene chloride above MCL. Annual average of all contaminants below 0.5 ppb fairly common.
Synthetic Organic Compounds (SOCs)	March 1994 to Oct. 2002	None	Levels of common herbicides used in row crops dropped significantly since the mid 1980s.
Heavy Metals	May 1995 to Dec. 2002	None	Chromium levels were often higher in treated water than raw water.
Nitrate/Nitrite	March 1993 to Dec. 2002	None	One nitrite sample reported 0.5 mg/l.
Fluoride	May 1995 to July 2002	None	All reported levels a result of fluoride addition for tooth decay prevention.
Radionuclides	Jan. 2000 to Dec. 2002	None	Limited data set no known sources of radioactivity in watersheds.
Fecal Coliform	Jan. 1997 to Dec. 2002	N/A	Fecal concentration sometimes exceeds 200 MPN/100 ml standard for natural waters (Contaminant of Concern)
Protozoa		N/A	Giardia and Crypto detected in several samples. (Contaminants of Concern)
Viruses	No available data		
Disinfection By Products	Jan. 1999 to Dec. 2002	THMs HAAs	Distribution samples indicate some locations in system will have difficulty with future regulatory levels. Management of DBPs can be achieved through treatment and/or watershed and reservoir management (contaminants of concern).
Turbidity	Jan. 1997 to Dec. 2002	Turbidity	Algae and sediment runoff contribute to turbidity (contaminants of concern).

*data collected by WSSC and MDE (both raw and treated water results)

Table 7-2b. Turbidity and Fecal Coliform in Patuxent Filtration Plant Raw Water

Month	Turbidity (NTU) (24-Hour Composites)			Fecal Coliforms (MPN # per 100 mL) (Based on Assays in Duckett Reservoir)			
	Avg.	Max.	Min	Avg.	Med.	Max	Min.
January	4.1	10.9	1.9	13	13	13	13
February	4.1	9.6	1.8	16	16	30	< 2
March	5.4	19.8	2.0	40.8	4.5	300	< 2
April	4.2	12.0	1.9	10.9	4	50	< 2
May	2.7	6.0	1.0	63.2	13	500	< 2
June	2.7	11.8	1.1	33.7	11	300	< 2
July	3.0	7.8	1.1	15.1	8	50	< 2
August	2.9	6.9	1.3	8.4	4	23	< 2
September	3.6	10.0	2.0	10.5	10.5	23	< 2
October	4.5	9.7	2.1	35.3	22	80	< 2
November	3.9	10.0	1.8	168.8	5.5	> 1600	< 2
December	3.0	5.1	1.7	NA[1]	NA	NA	NA

[1] NA: No assays for Fecal Coliform were made during December in the period from 1997 through 2002.

Table 7-2c. Quarterly Average Concentrations of Total Organic Carbon (1998, 2001 and 2002) at the Patuxent Treatment Plant

	Source TOC (mg/l)			Treated TOC (mg/l)			Percent TOC Removal		
Quarter	Average	Max	Min	Average	Max	Min	Average	Max	Min
Jan thru Mar	2.85	4.14	2.01	1.75	2.10	0.94	37.63%	77.29%	28.15%
Apr thru Jun	2.48	3.48	1.94	1.68	2.26	1.35	31.99%	49.43%	14.87%
Jul thru Sep	2.55	3.23	2.13	1.81	2.05	1.44	28.45%	44.19%	17.43%
Oct thru Dec	2.52	3.27	2.11	1.78	2.08	1.39	29.00%	39.64%	18.68%

Table 7-2d. Annual Concentrations of Disinfection Byproducts in Patuxent Distribution System (all sample locations)[1]

	TTHMs[2] (µg/L)			HAA[3] (µg/L)		
Year	Average	Maximum	Minimum	Average	Maximum	Minimum
1999	79.01	176.40	28.90	44.42	69.10	21.70
2000	64.40	136.80	19.90	40.97	58.50	25.20
2001	68.12	125.38	19.08	46.79	83.71	20.25
2002	71.60	162.02	26.70	46.33	83.70	19.93

[1] Based on samples from two locations:
Bowie State University, 14000 Jerico Park Road
State Highway Administration, 9300 Kenilworth Avenue

[2] TTHMs: Total Trihalomethanes is the sum of the concentrations of chloroform, bromodichloromethane, dibromochloromethane, and bromoform.

[3] HAA: Haloacetic acids is the sum of the concentrations of mono-, di-, and tri-chloroacetic acids and mono- and di-bromoacetic acids.

Table 7-2e. Quarterly Average Concentrations of Disinfection By Products in the Distribution System

DBP Patuxent – Jan 1999 thru Apr 2003 Aggregated by Quarter								
	THM				HAA5			
Quarter	Average	Max	Min	Count	Average	Max	Min	Count
Jan thru Mar	43.55	77.40	19.90	40	37.44	62.57	19.93	42
Apr thru Jun	56.28	101.40	19.08	42	45.13	65.94	25.70	46
Jul thru Sep	100.16	176.40	36.60	47	50.86	83.71	20.25	47
Oct thru Dec	71.66	115.68	28.90	44	43.11	69.10	21.70	46
Total	69.17	176.40	19.08	173	44.32	83.71	19.93	181

Figure 7.001 Acetochlor and Other Herbicides in Patuxent Raw or Finished Water From 1982 Thru 2000

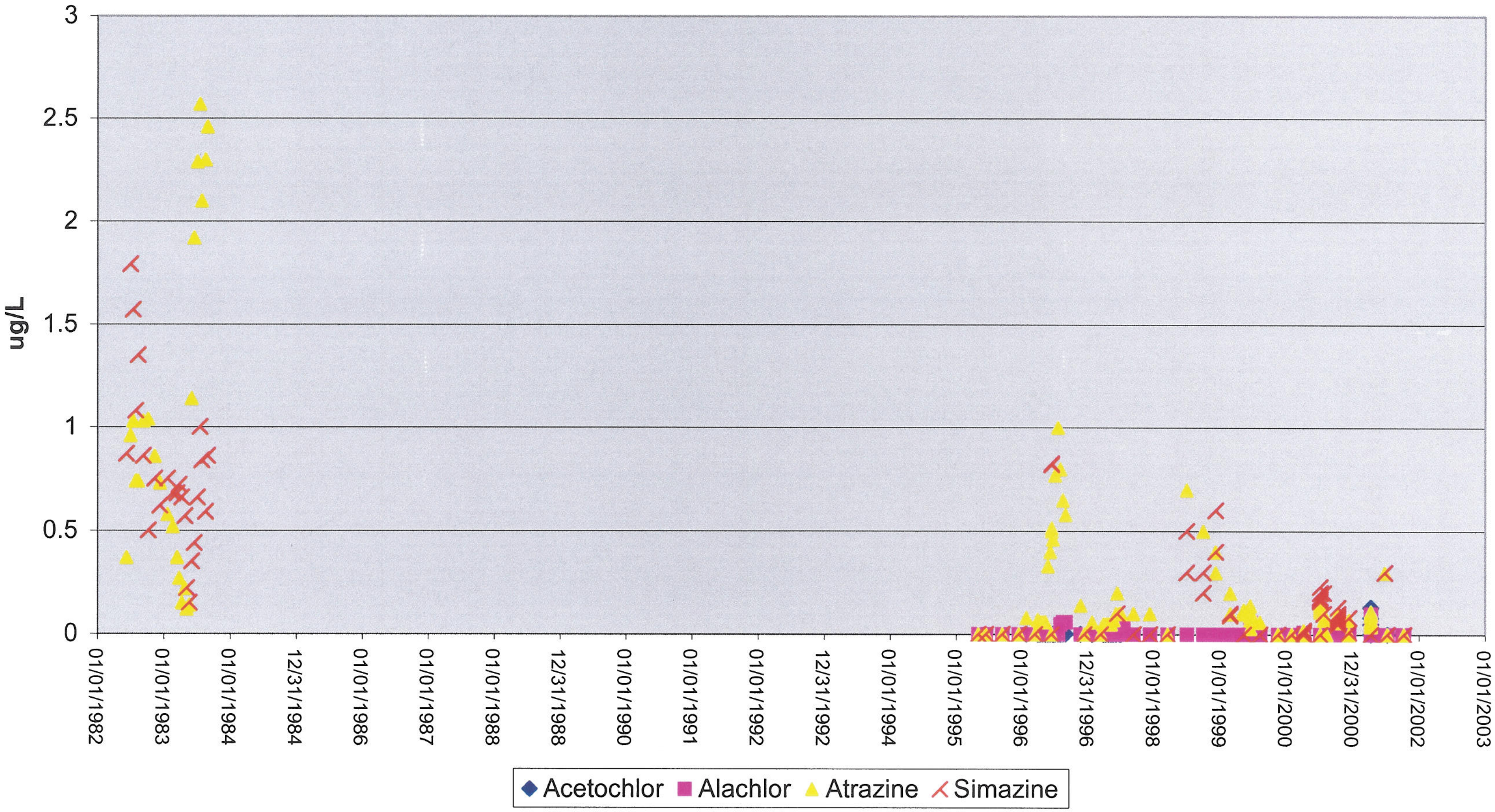


Figure 7.002 - Acetochlor and Other Herbicides in Patuxent Raw or Finished Water- Data Since 1995

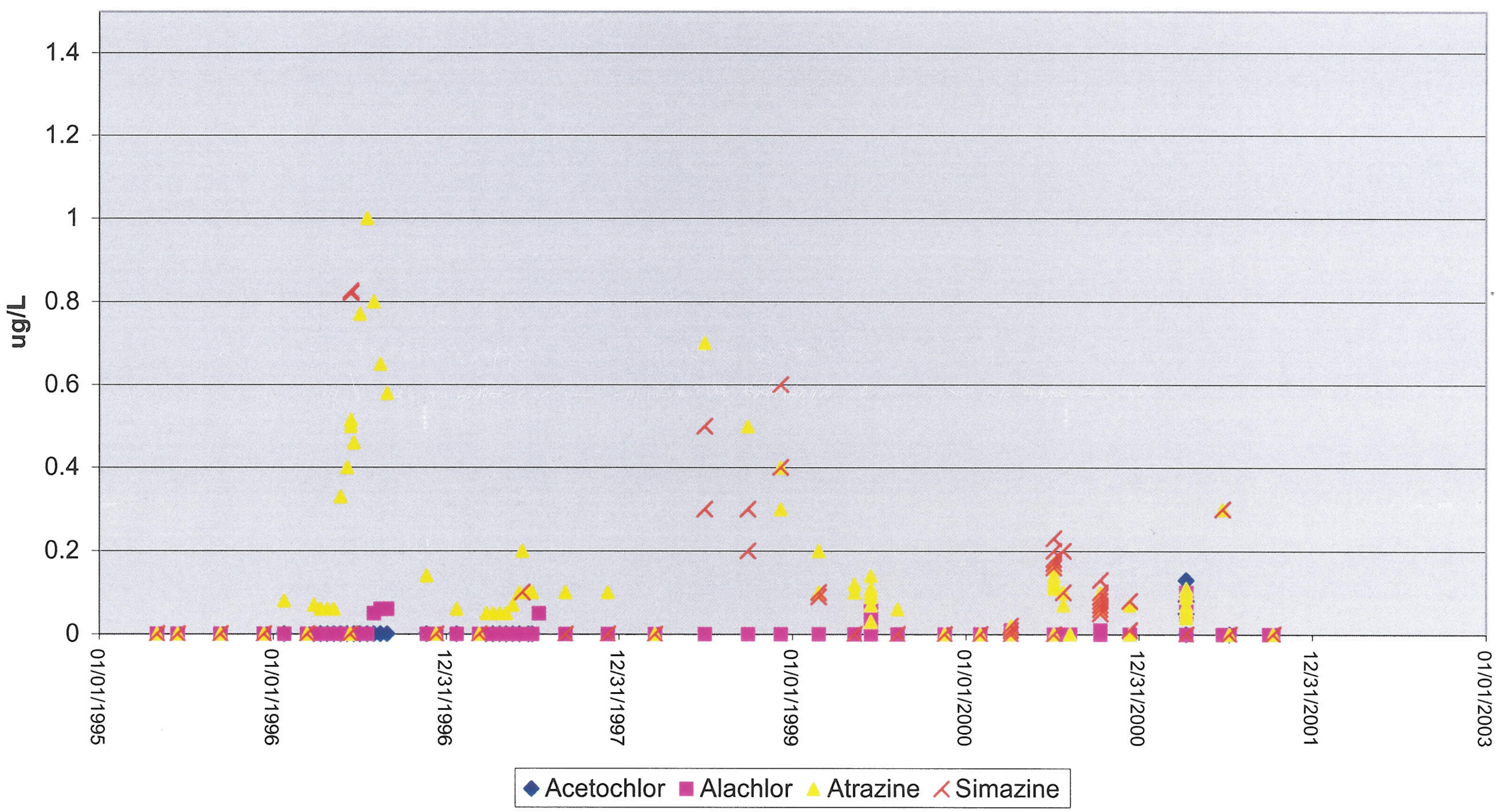
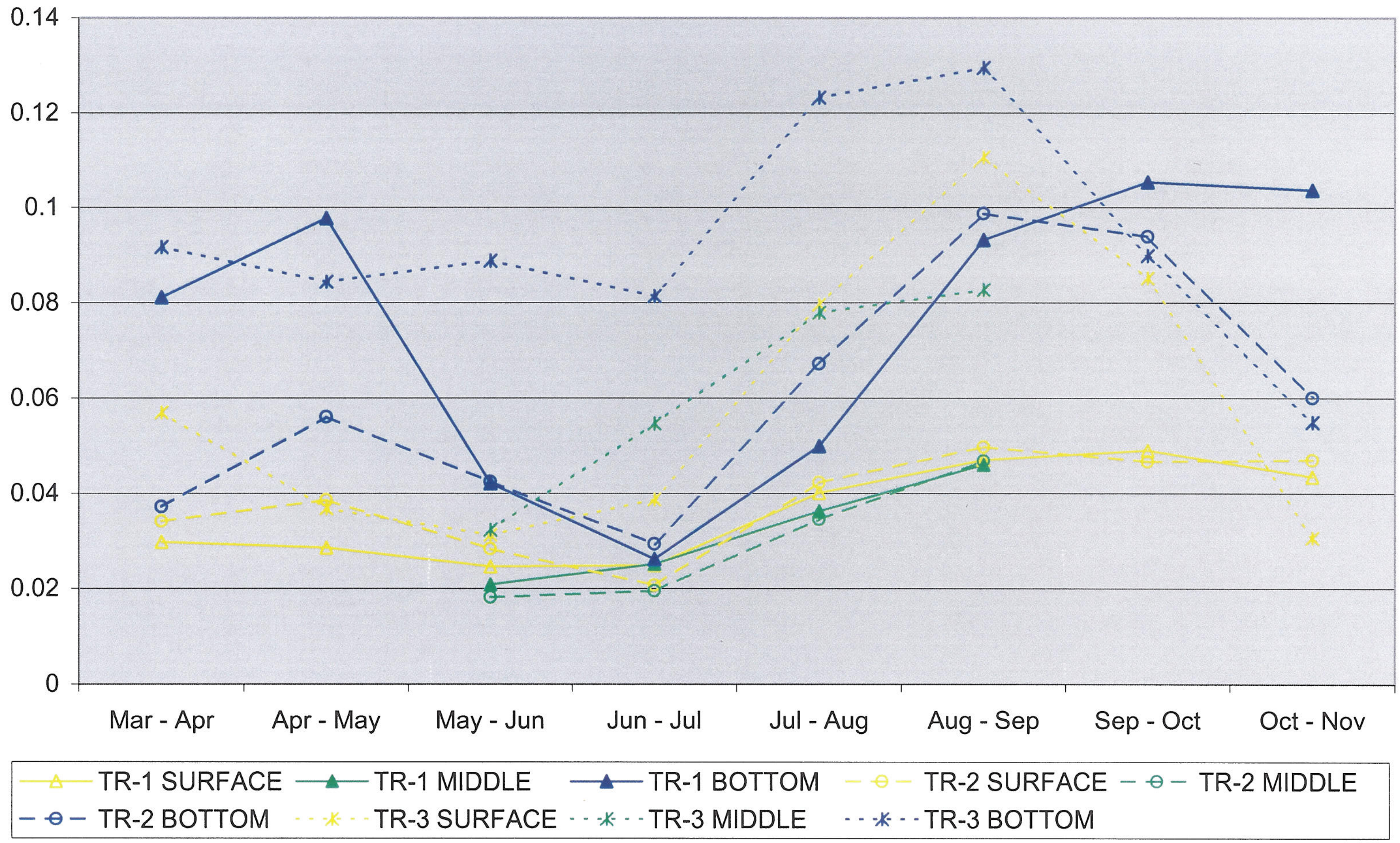
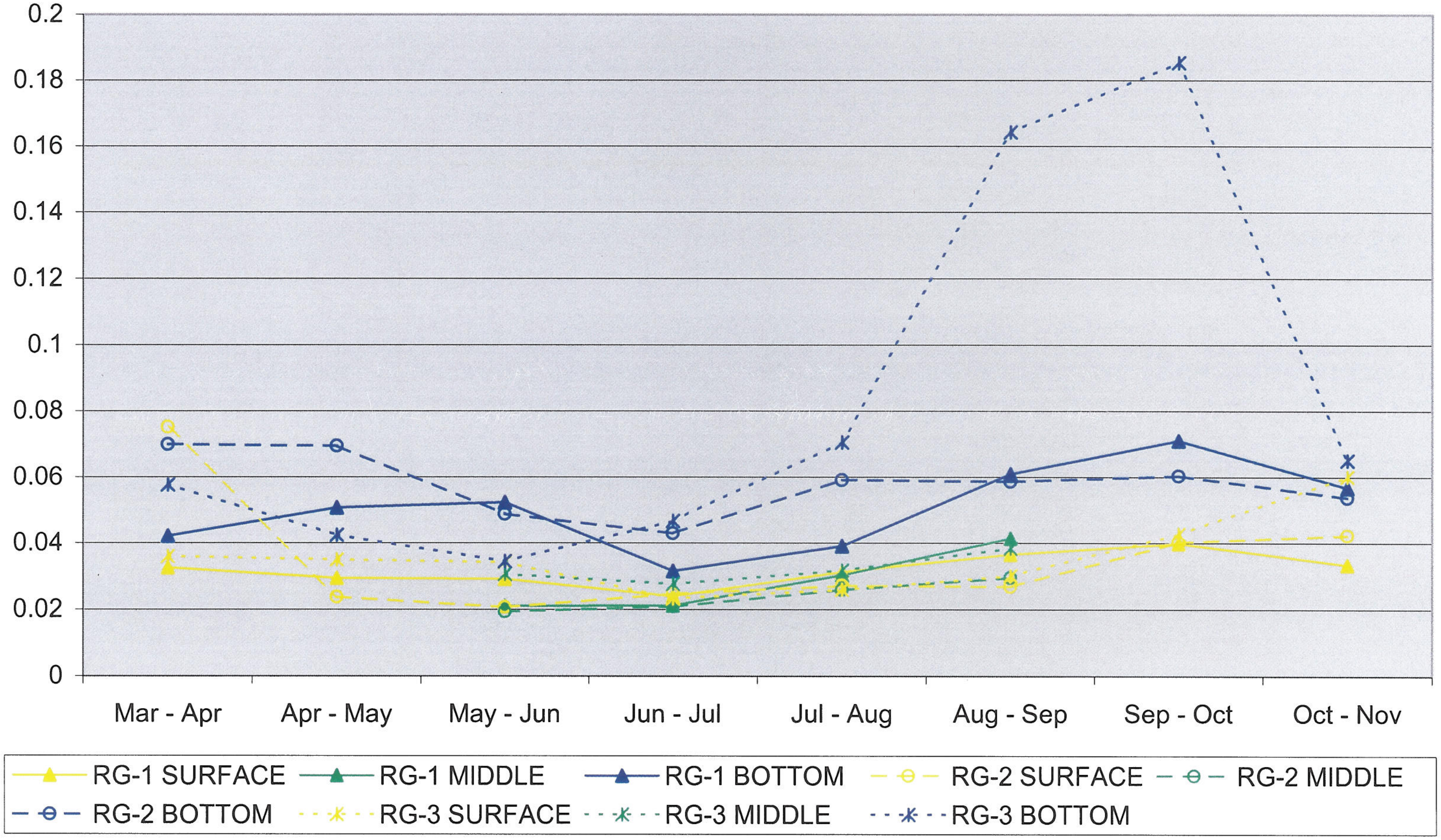


Figure 7.01 - Two Month Moving Average of Total Phosphorous in Triadelphia Reservoir at Several Locations and Depths from 1997 Thru 2002



Phosphorus data was censored by removing all data sampled on ten dates corresponding to the highest reported values of phosphorus in the field blanks.

Figure 7.02 - Two Month Moving Average of Total Phosphorous in T. Howard Duckett Reservoir at Several Locations and Depths from 1997 thru 2002



Phosphorus data was censored by removing all data sampled on ten dates corresponding to the highest reported values of phosphorus in the field blanks.

Figure 7.03 - Chlorophyll-a as a Monthly Average in Six Locations Using Data From 1998 Thru 2002

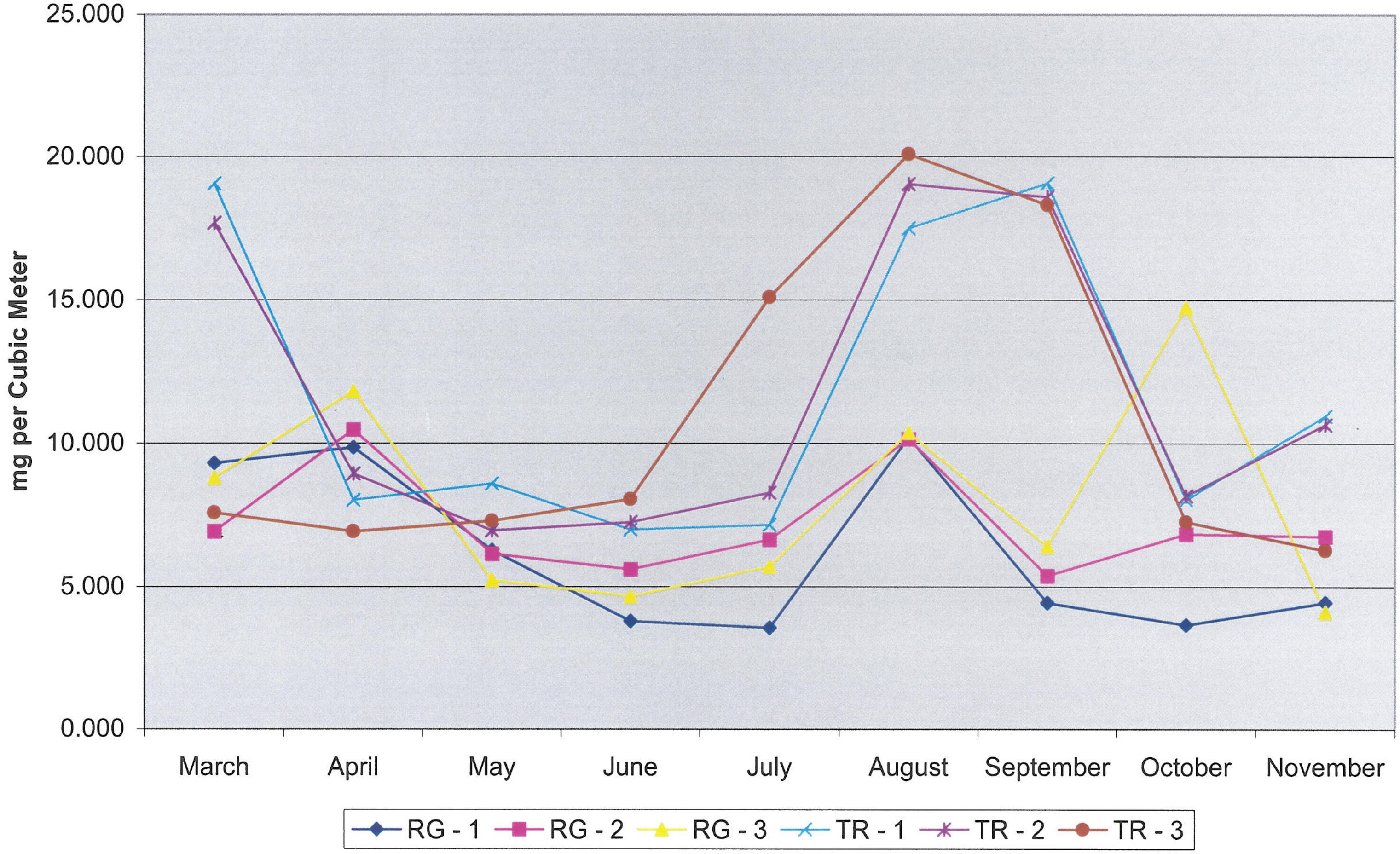


Figure 7.04 - Chlorophyll-a For Three Months at Six Locations Using Data From 1998 Thru 2002

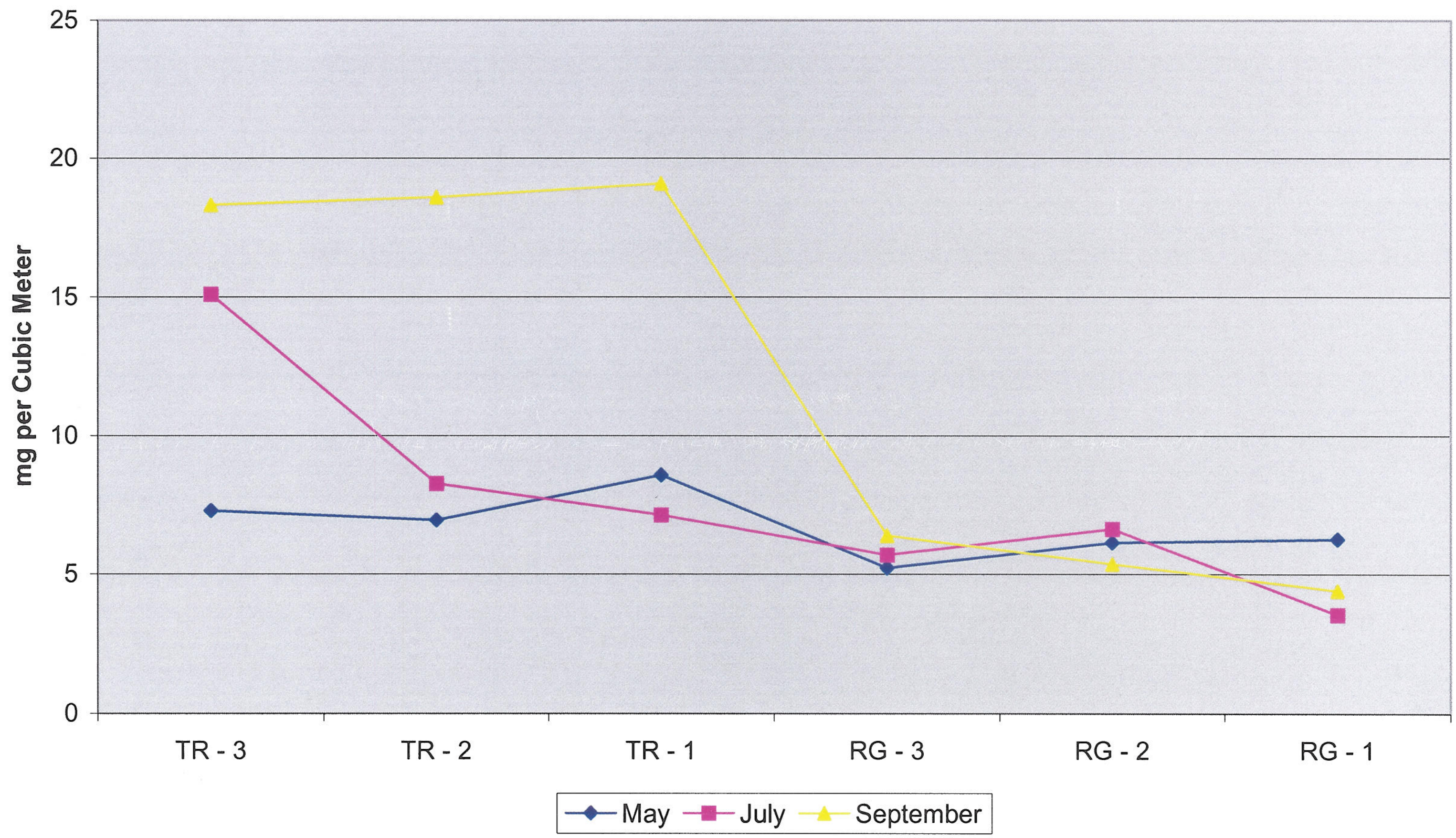


Figure 7.05 - Dissolved Oxygen Over the Surface of Triadelphia Reservoir

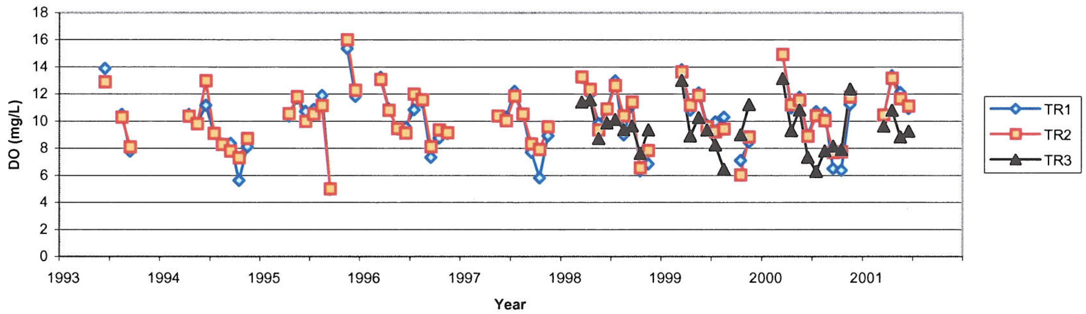


Figure 7.06 - Dissolved Oxygen Over the Middle of Triadelphia Reservoir

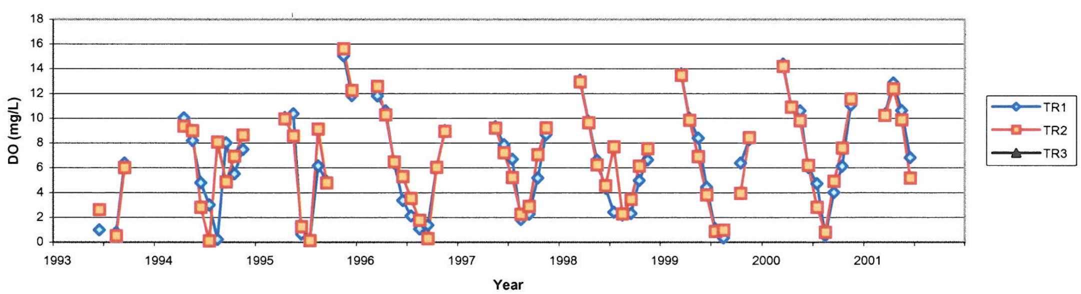


Figure 7. 07 - Dissolved Oxygen Over the Bottom of Triadelphia Reservoir

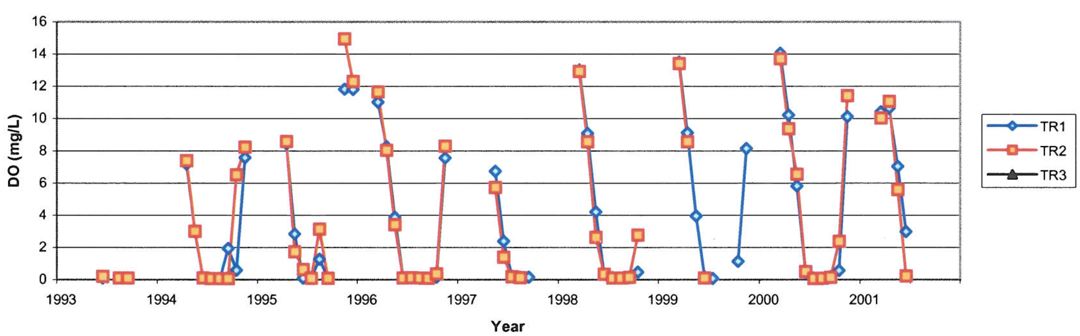


Figure 7.08 - Dissolved Oxygen Over the Surface of Rocky Gorge Reservoir

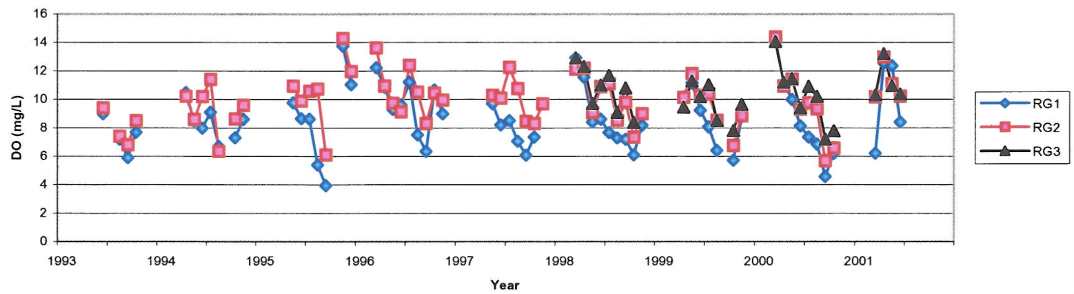


Figure 7.09 - Dissolved Oxygen Over the Middle of Rocky Gorge Reservoir

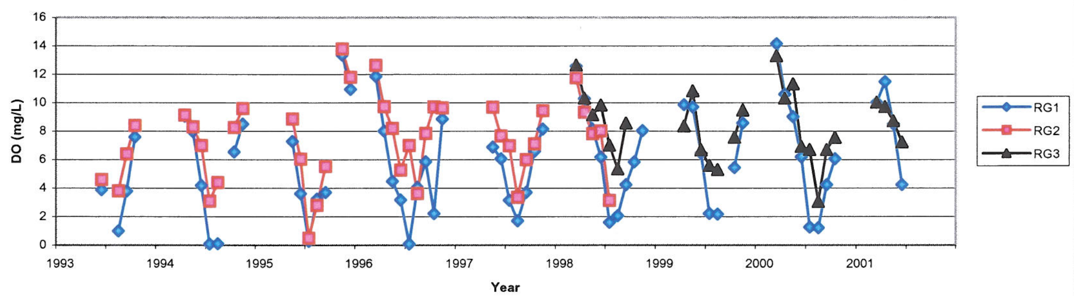
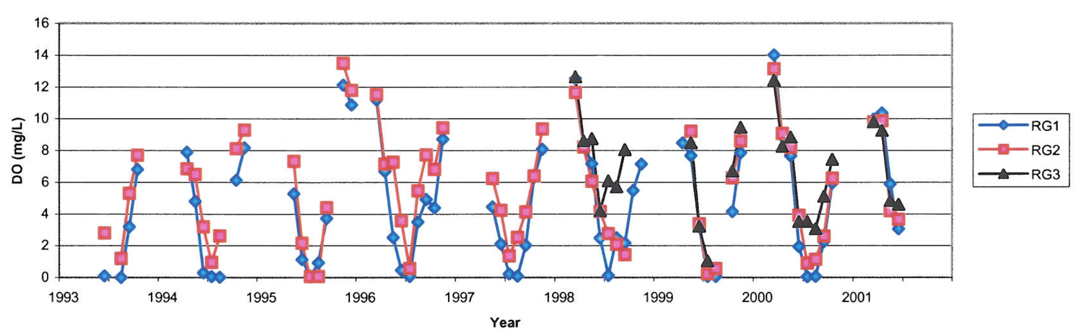


Figure 7.10 - Dissolved Oxygen Over the Bottom of Rocky Gorge Reservoir



Source: Resource Management Concepts (Draft Reservoir Data Analysis, December 2002)

Figure 7.11 - Total Nitrate and Nitrite in May at Six Locations at Different Depths in the Patuxent Reservoirs Using Data From 1997 Thru 2002

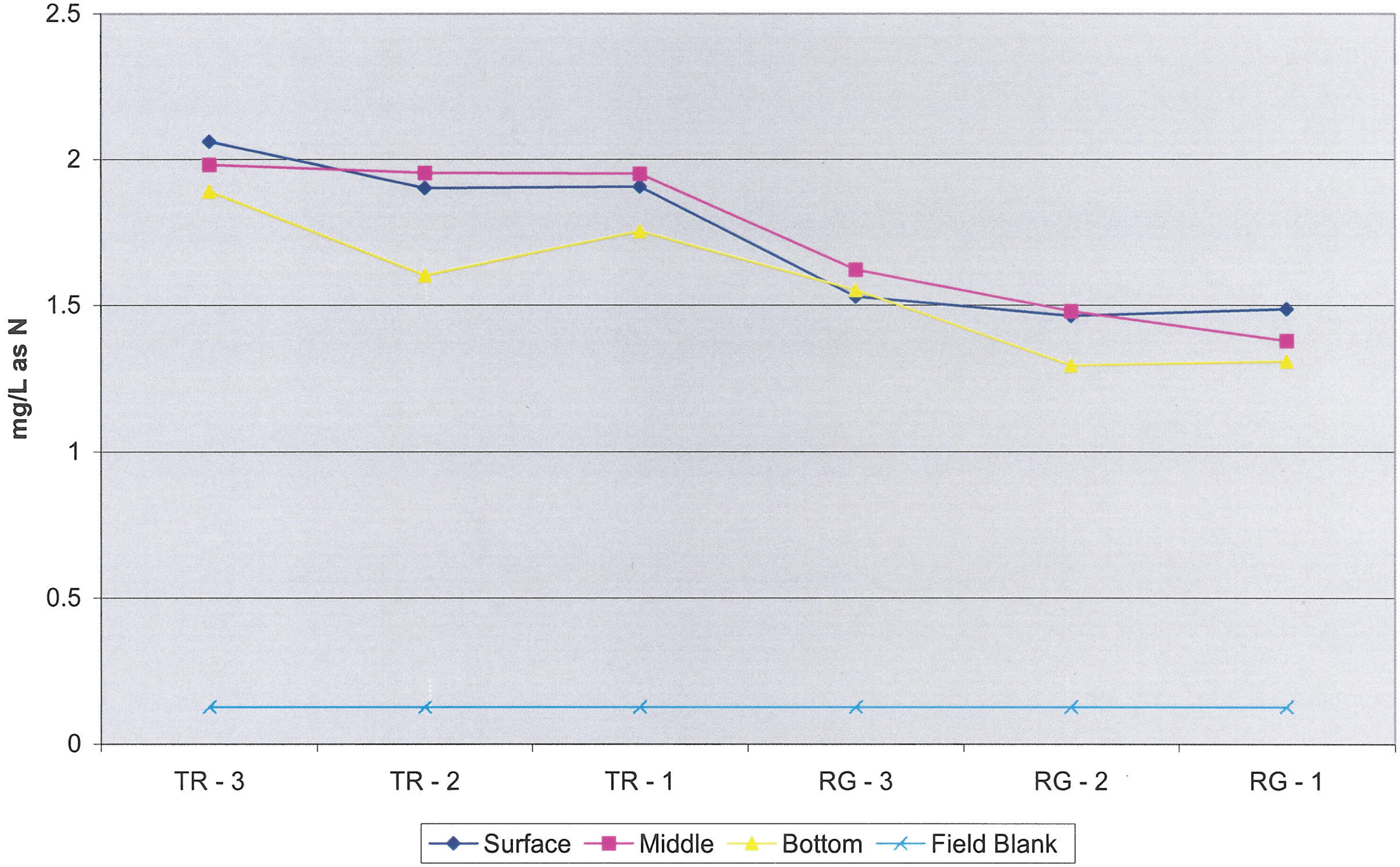


Figure 7.12 - Total Nitrate and Nitrite in July at Six Locations at Different Depths in the Patuxent Reservoirs Using Data From 1997 Thru 2002

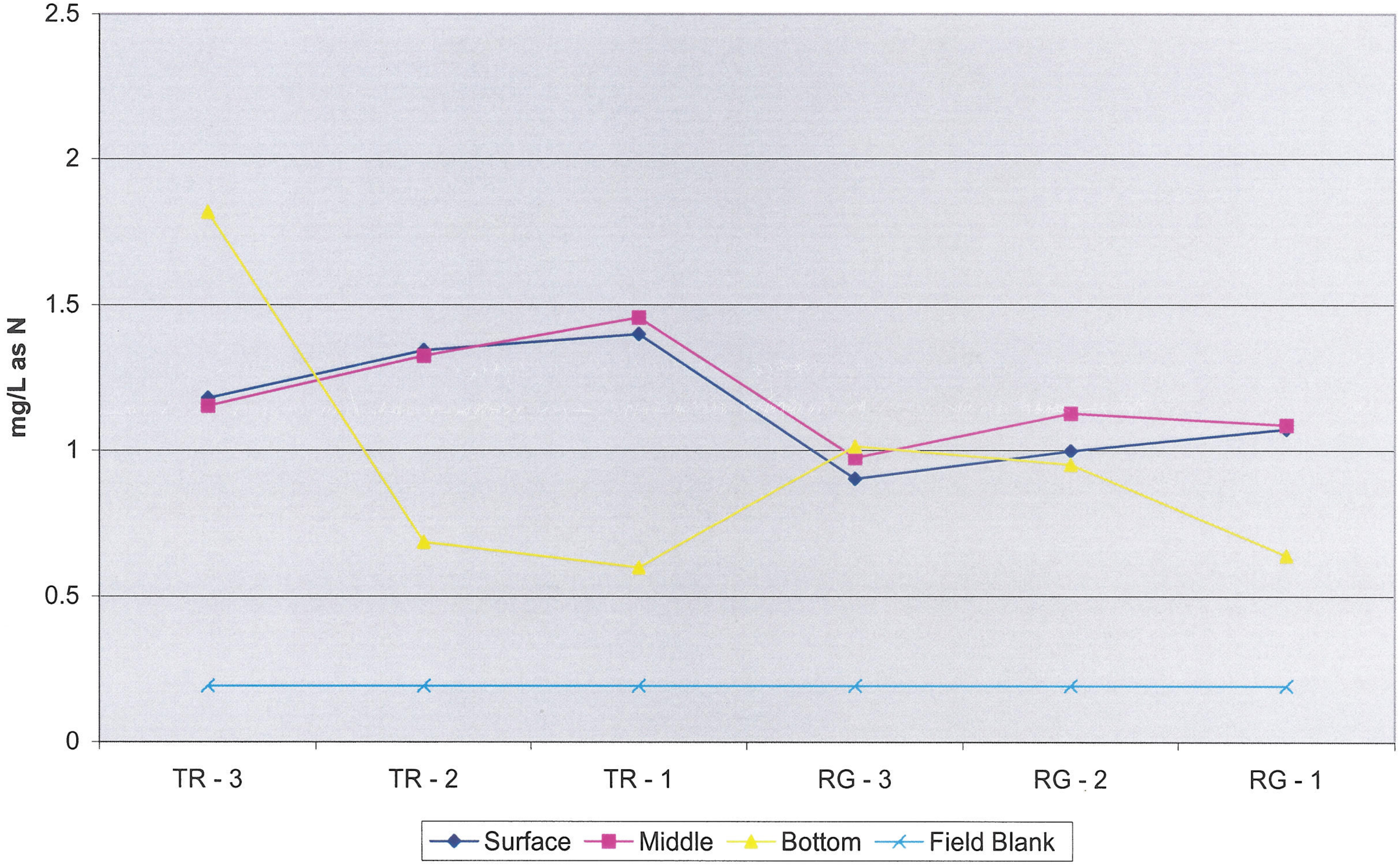


Figure 7.13 - Total Nitrate and Nitrite in September at Six Locations at Different Depths in the Patuxent Reservoirs Using Data From 1997 Thru 2002

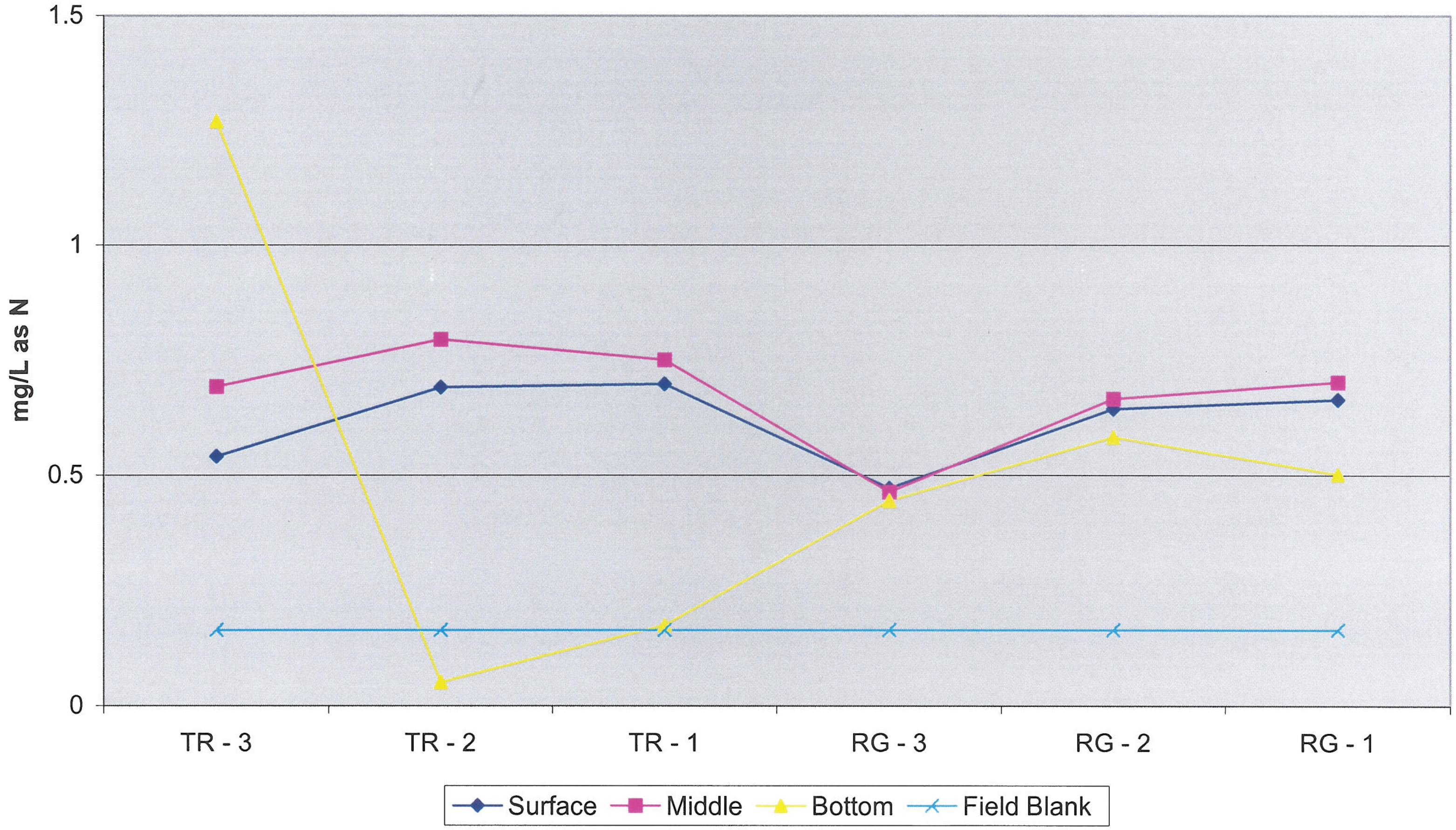


Figure 7.13.1 - Ammonia in May at Six Locations at Different Depths in the Patuxent Reservoirs Using Data From 1997 Thru 2002

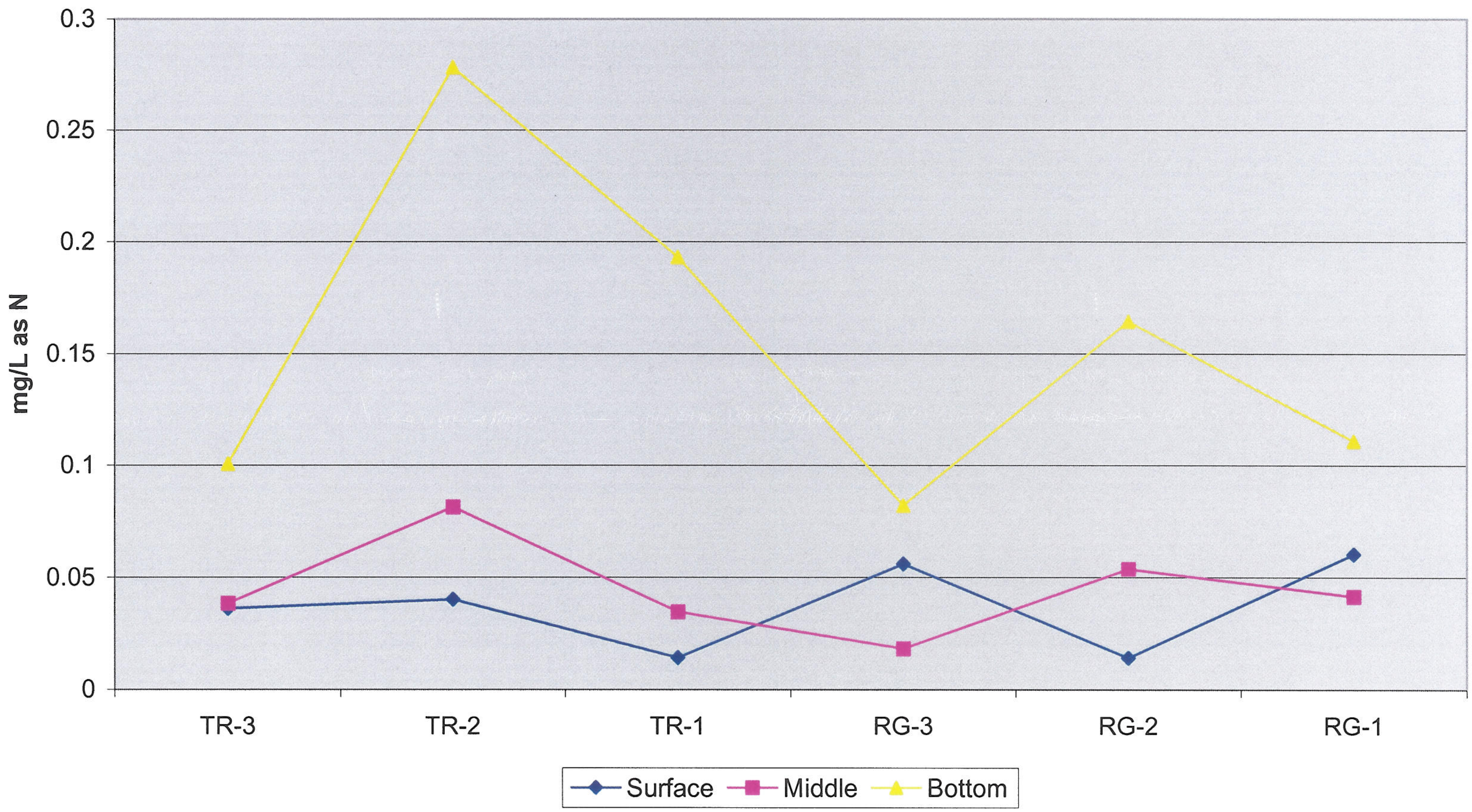


Figure 7.13.2 - Ammonia in July at Six Locations at Different Depths in the Patuxent Reservoirs Using Data From 1997 Thru 2002

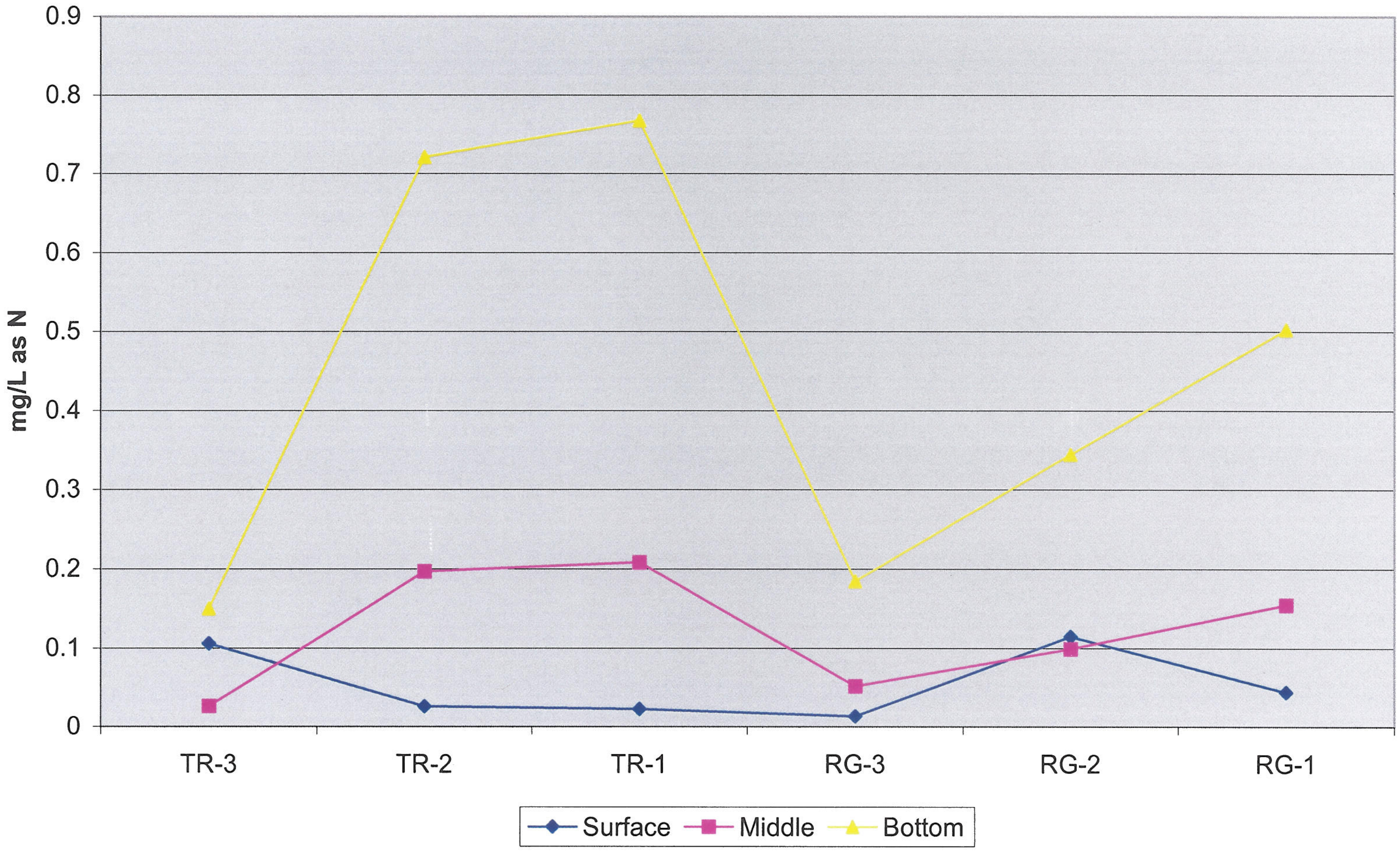


Figure 7.13.3 - Ammonia in September at Six Locations at Different Depths in the Patuxent Reservoirs Using Data From 1997 Thru 2002

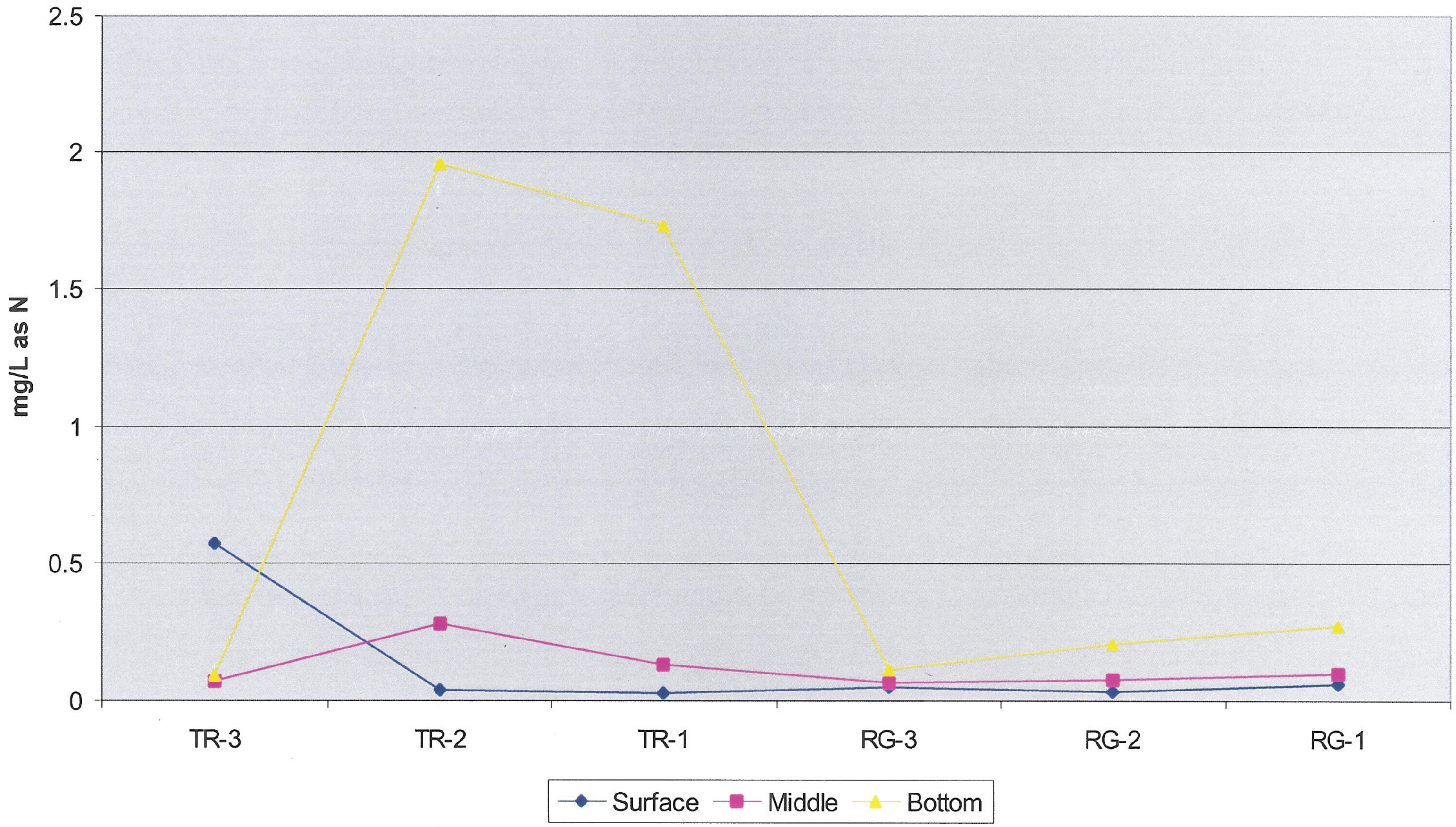


Figure 7.14 - Total Iron in May at Six Locations at Different Depths in the Patuxent Reservoirs Using Data From 1997 Thru 2002

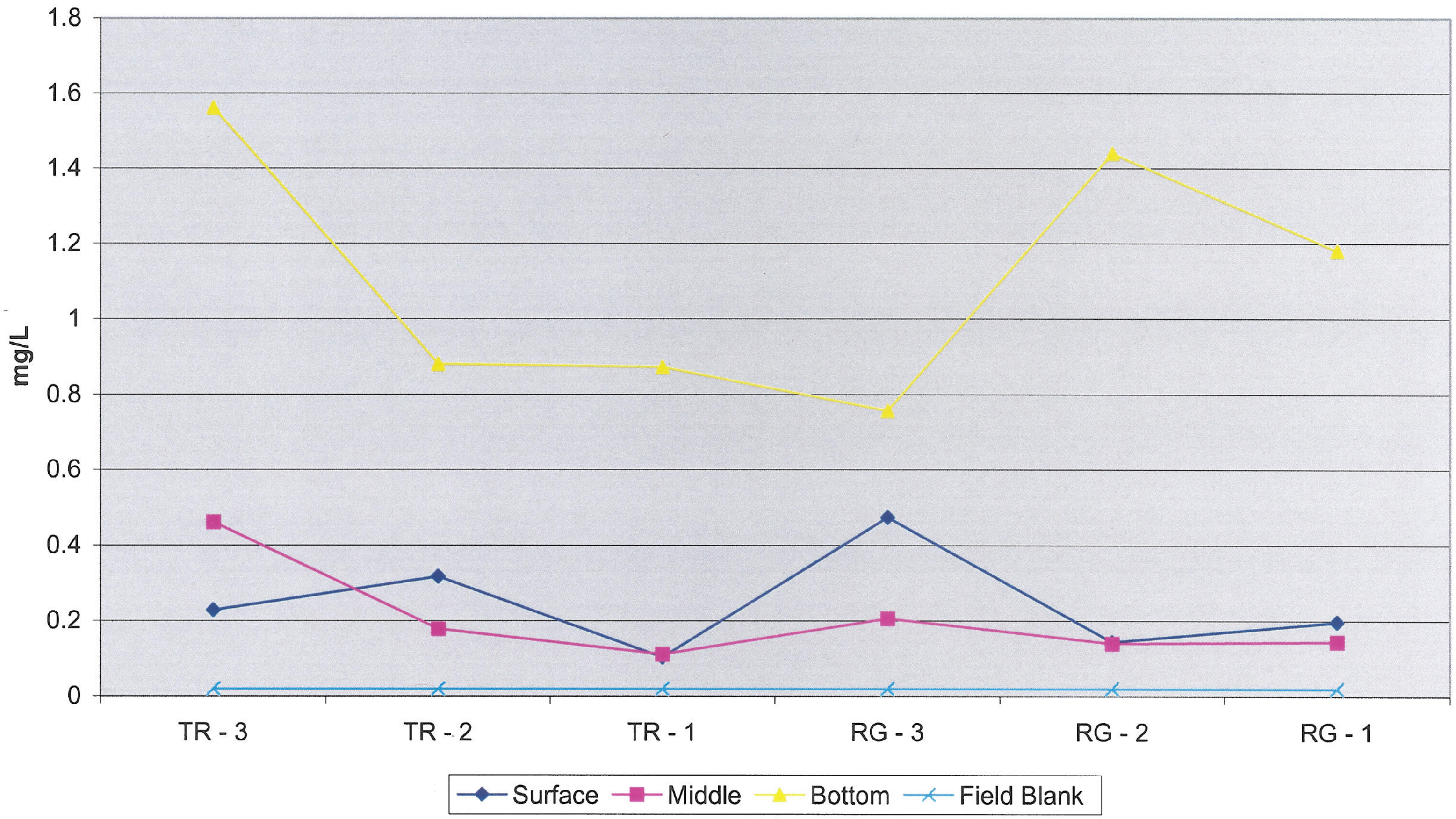


Figure 7.15 - Total Iron in July at Six Locations at Different Depths in the Patuxent Reservoirs Using Data From 1997 Thru 2002

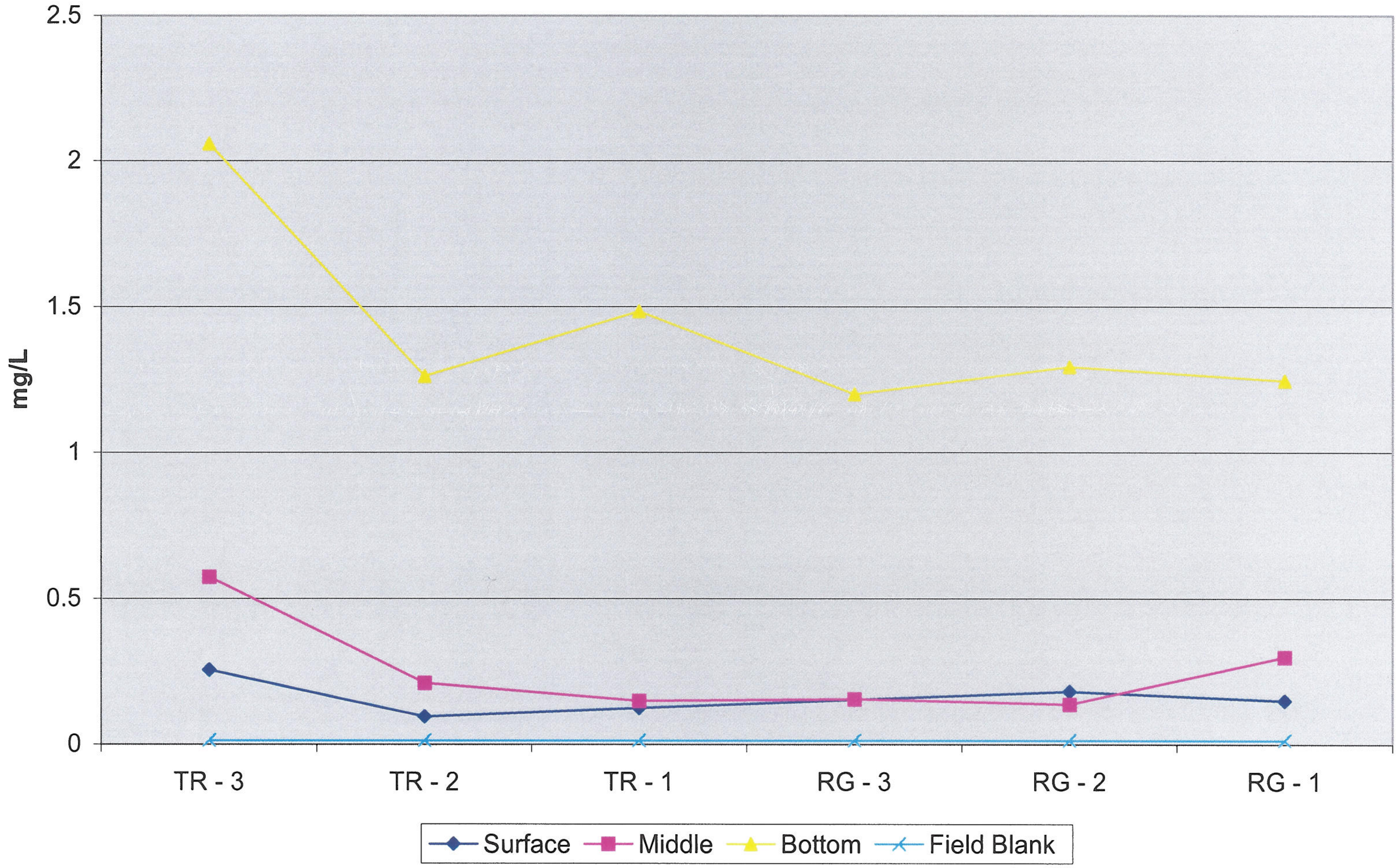


Figure 7.16 - Total Iron in September at Six Locations at Different Depths in the Patuxent Reservoirs Using Data From 1997 Thru 2002

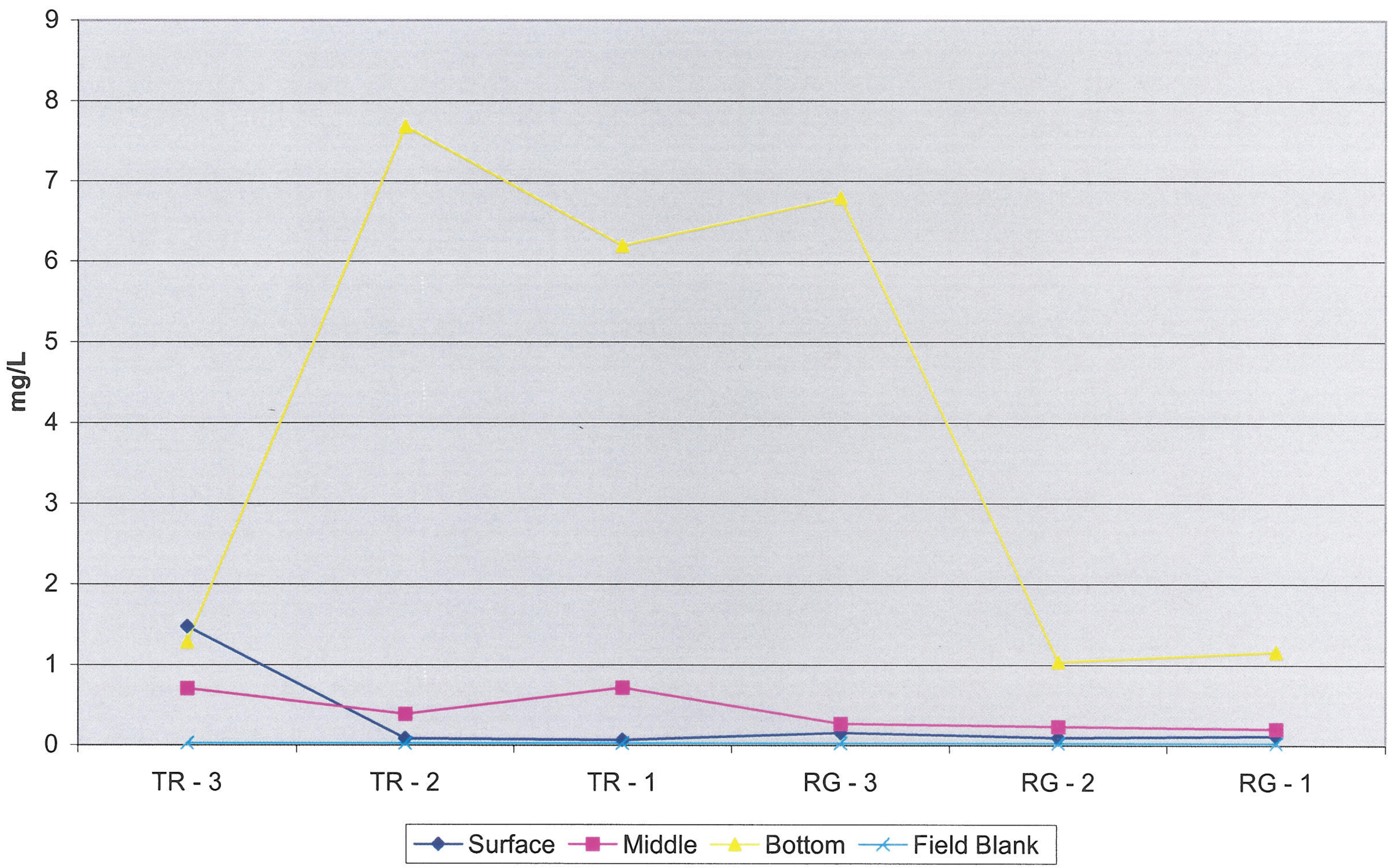


Figure 7.17 - Total Manganese in May at Six Locations at Different Depths in the Patuxent Reservoirs Using Data From 1997 Thru 2002

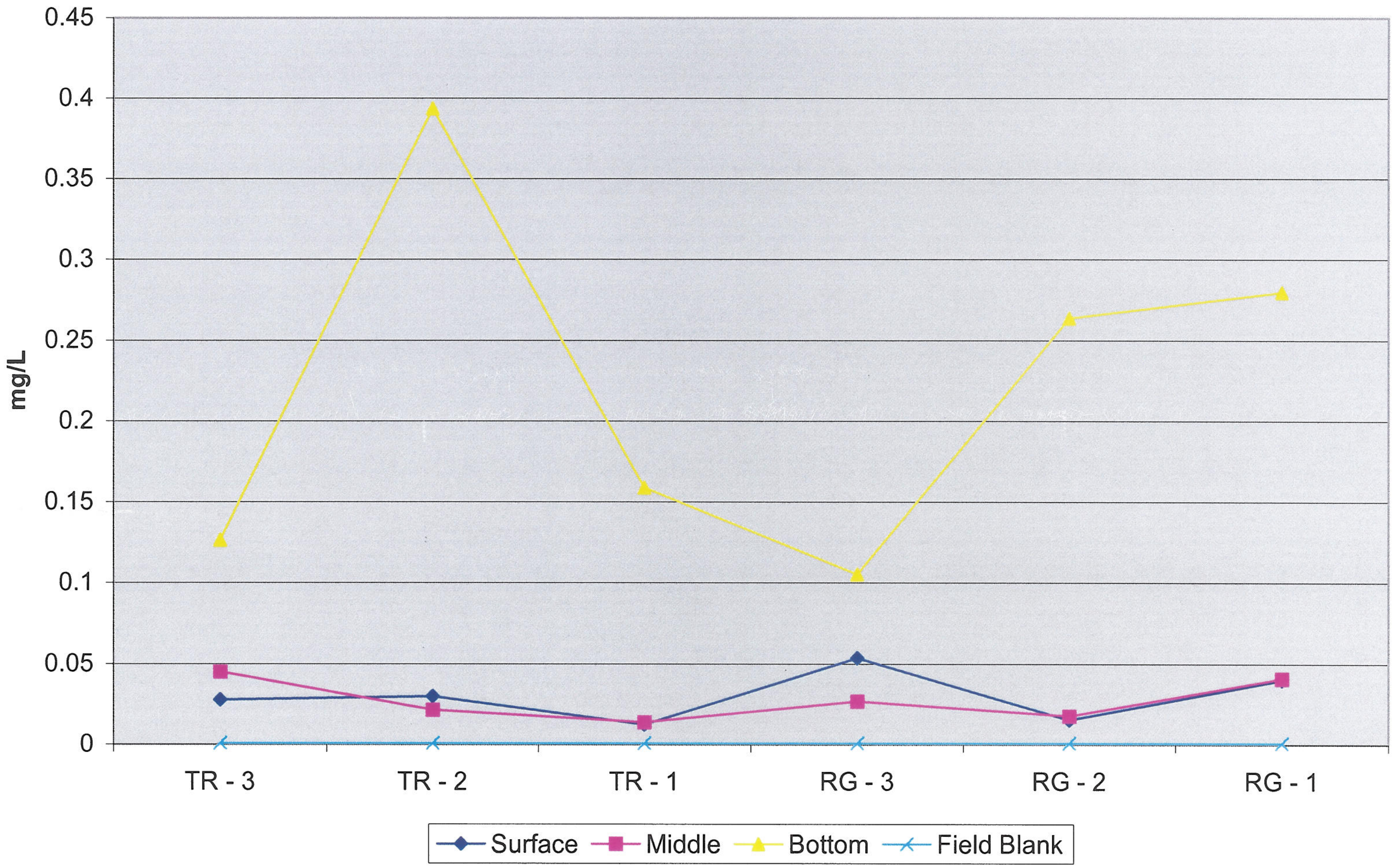


Figure 7.18 Total Manganese in July at Six Locations at Different Depths in the Patuxent Reservoirs Using Data From 1997 Thru 2002

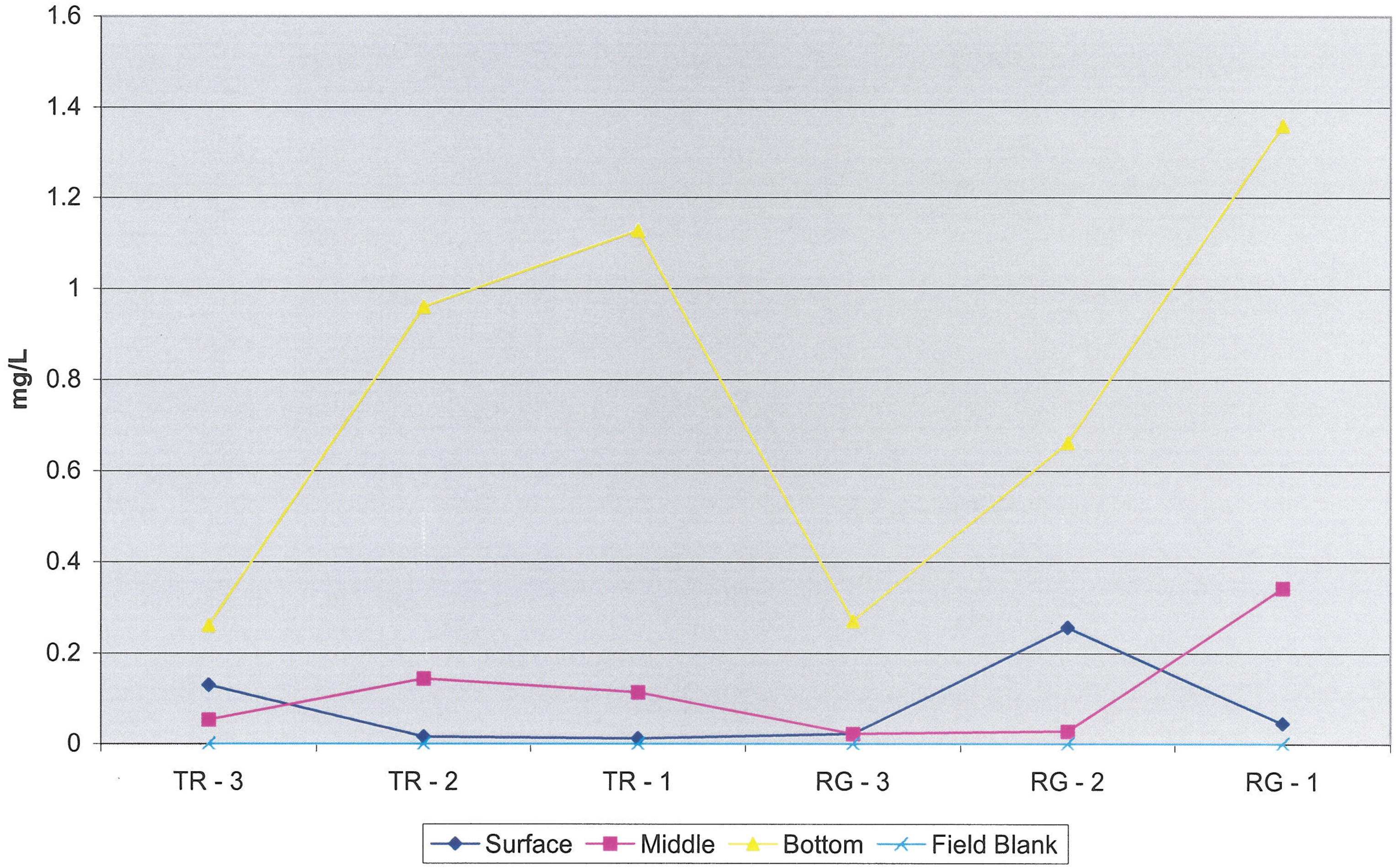


Figure 7.19 - Total Manganese in September at Six Locations at Different Depths in the Patuxent Reservoirs Using Data From 1997 Thru 2002

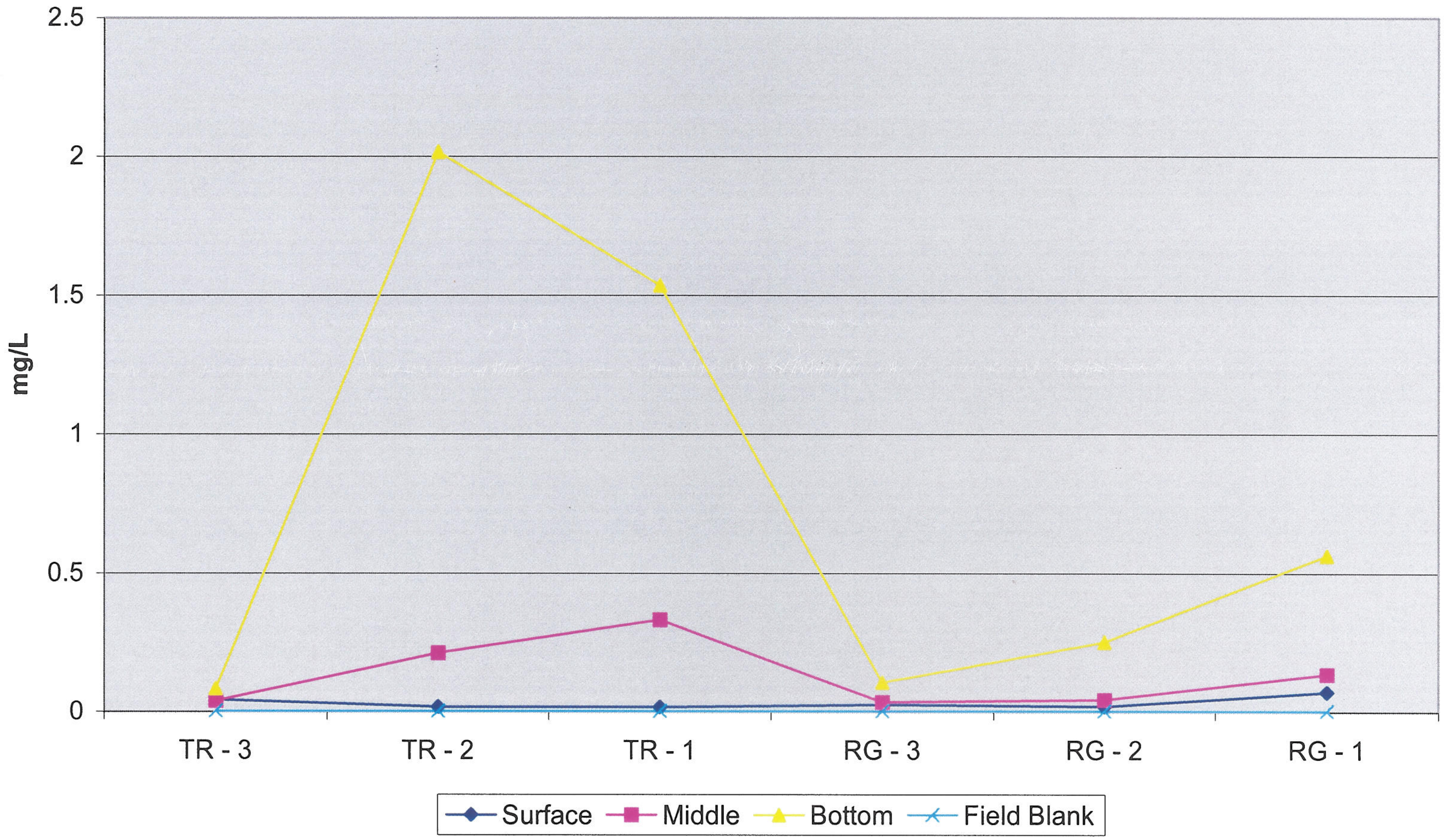


Figure 7.20 - Fecal Coliform in Triadelphia Reservoir

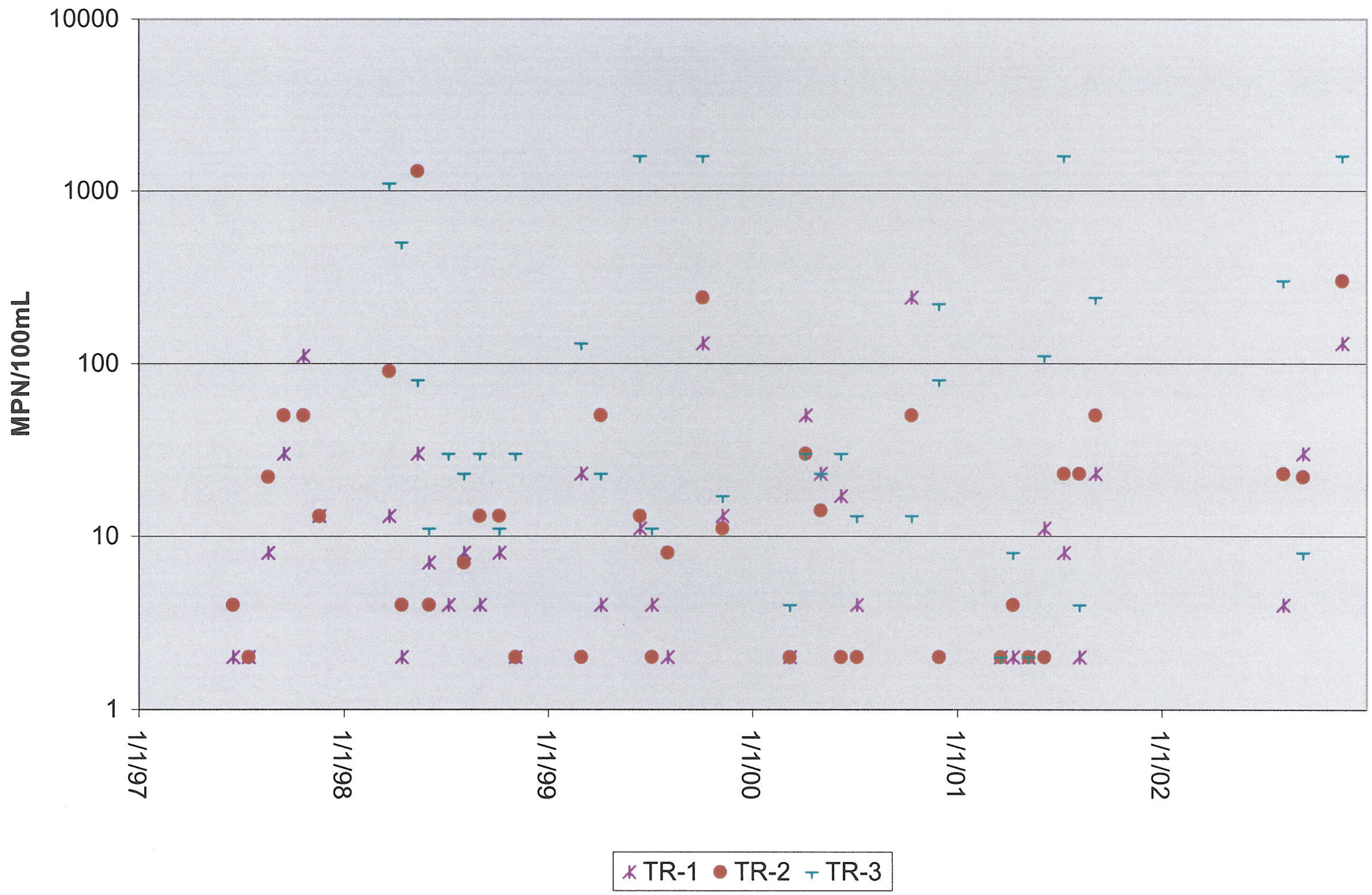


Figure 7.21 - Fecal Coliform in T. Howard Duckett Reservoir (Rocky Gorge Dam)

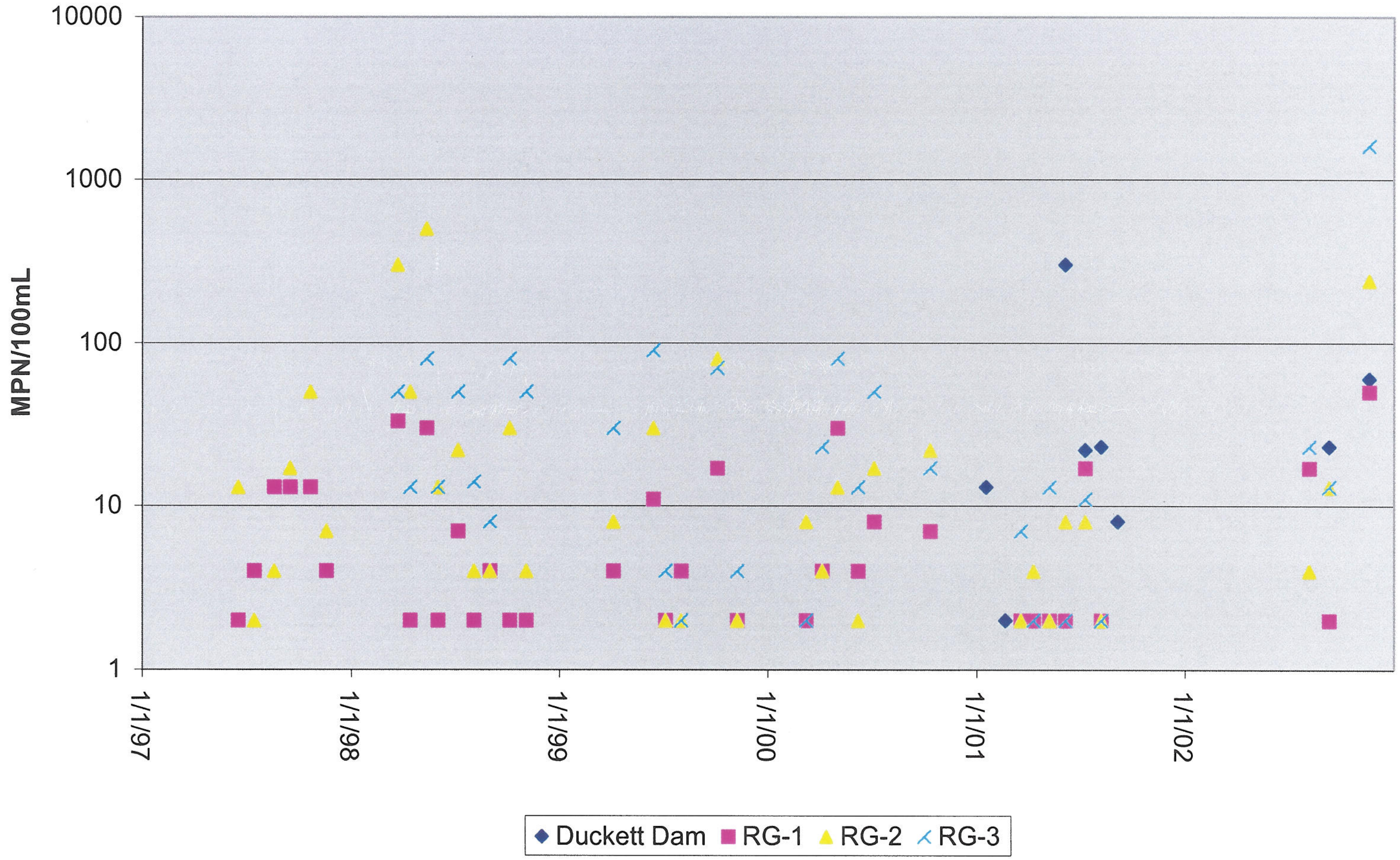


Figure 7.22 - Conductivity Over the Surface of Triadelphia Reservoir

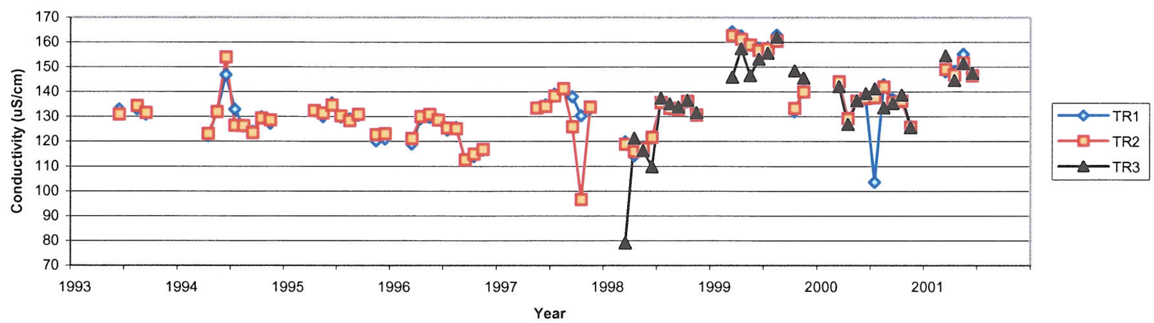


Figure 7.23 - Conductivity Over the Middle of Triadelphia Reservoir

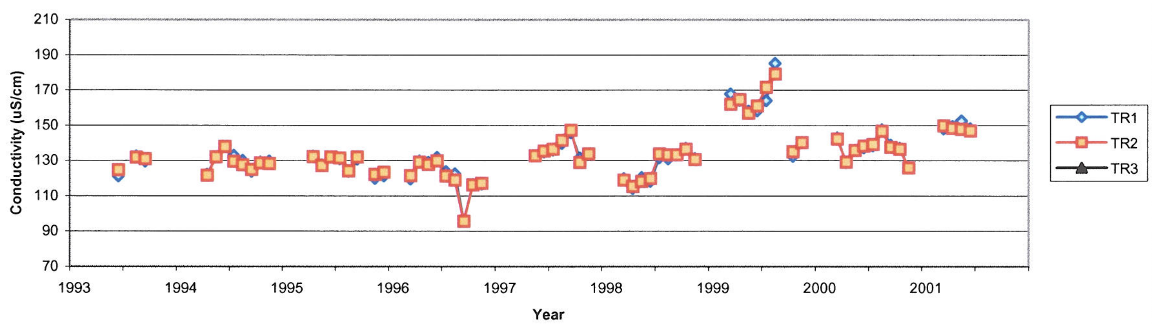
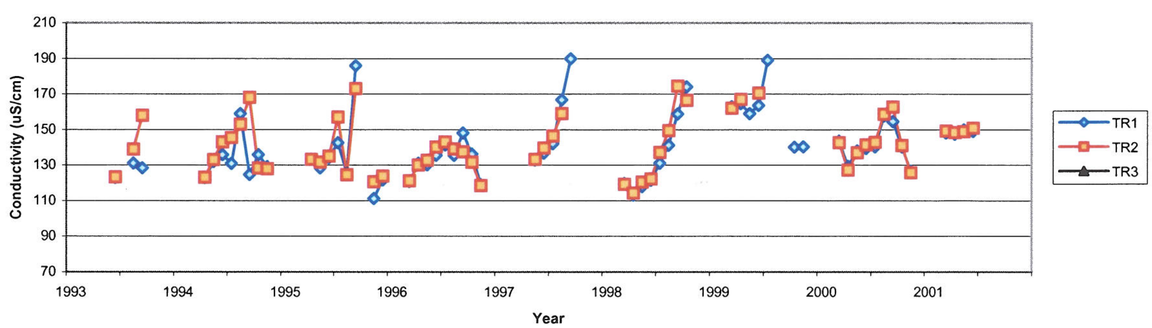
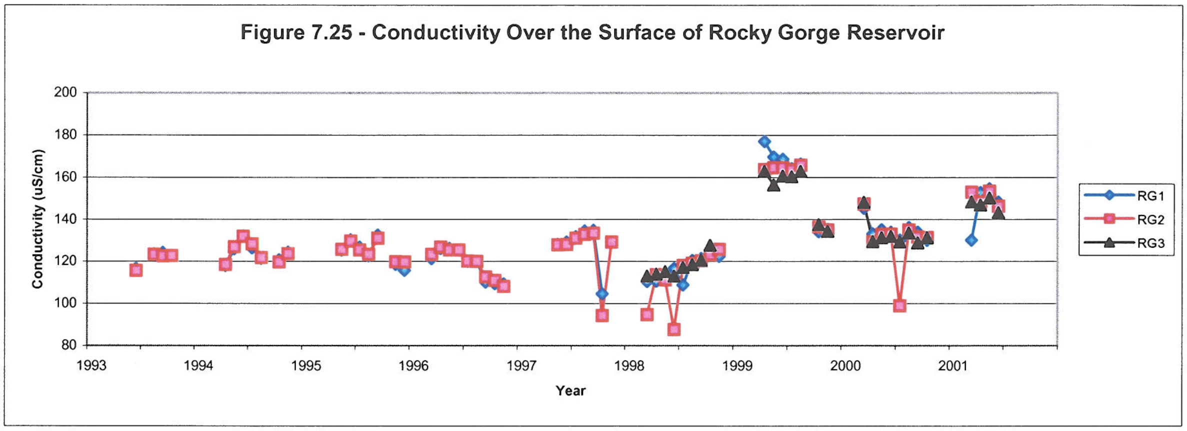
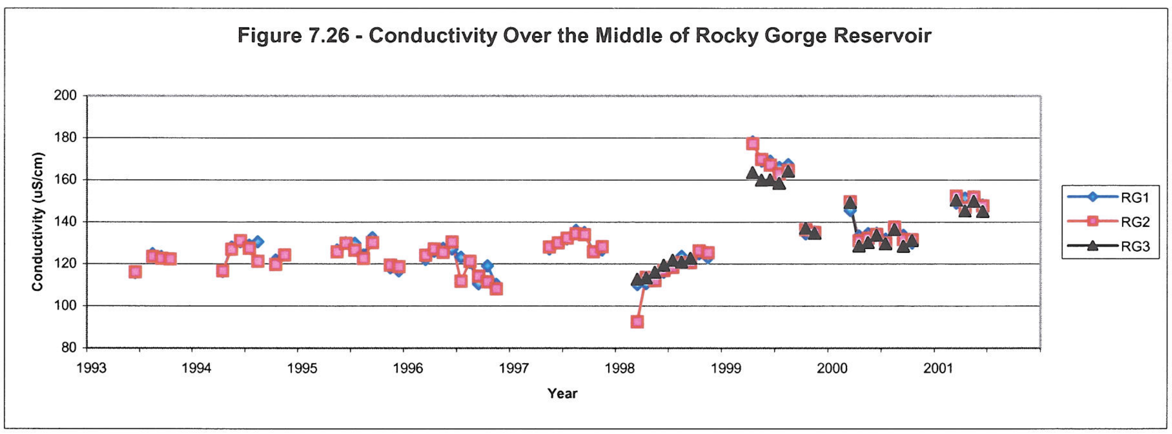
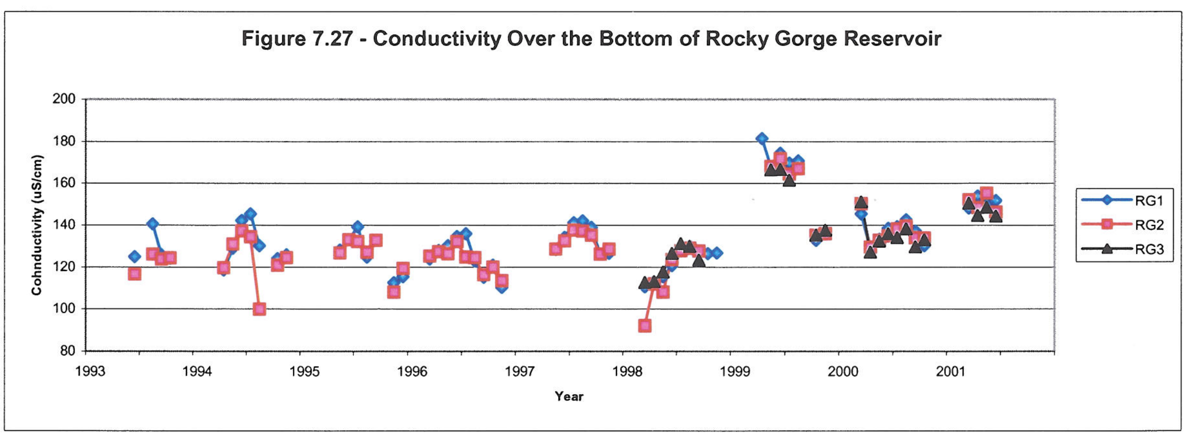


Figure 7.24 - Conductivity Over the Bottom of Triadelphia Reservoir









Source: Resource Management Concepts (Draft Reservoir Data Analysis, December 2002)

8.0 SUSCEPTIBILITY ANALYSIS

Each class of contaminants that have been detected in the water quality data were analyzed based on the potential they have of contaminating the Patuxent Reservoirs and WSSC water intake. This analysis identified suspected sources, evaluated the natural conditions that may decrease or increase the likelihood of contaminant reaching the intake, and evaluate the impacts that future changes within the watershed may have on the susceptibility of the water intake.

8.1 Volatile Organic Compounds

As discussed in Section 7.1.1, no VOCs exceed the criteria of exceeding 50% of the MCL in at least 10% of the collected samples. No VOCs have been detected in MDE's samples since 1988. The only VOC threat to the watershed is the potential of a hazardous spill or local contamination due to leaks in a pipeline/pumping station. The Patuxent Reservoirs are not susceptible to regular VOC contamination.

8.2 Synthetic Organic Compounds

There are several detects at the Patuxent Filtration Plant, but no SOCs exceed the criteria of exceeding 50%of the MCL in at least 10% of the collected samples. With the exception of only one compound; di(2-ethylhexyl) phthalate, all results are less than 50% of MCL. This compound was reported in corresponding laboratory blanks; therefore, reported quantities are not likely reflective of levels in the environment but rather laboratory artifacts. As discussed in Section 7.1.2, atrazine and simazine were detected frequently in the Patuxent Filtration Plant below 50% of MCLs. Review of Maryland Pesticide Statistics and other available data indicate that the usage of atrazine and simazine and other herbicides have substantially declined in the past 20 years.

Patuxent Reservoirs are not currently susceptible to SOC contamination. It is unlikely that the threat of SOCs entering the water supply will increase in the future, unless major land use changes occur and/or pesticide application to crops and residential yards increase dramatically. SOC will continue to be sampled annually by MDE if detections become more frequent or concentrations increase, a further investigation could be undertaken.

8.3 Heavy Metals

As discussed in Section 7.1.3, none of the metals exceeded 50% of an MCL in the treated or raw water. Therefore, the Patuxent Reservoirs are not susceptible to contamination by regulated heavy metals. A potential source of metals are spillage during transportation. The data also indicate that iron and manganese are common elements in the reservoirs and can be associated with aesthetic and nuisance effects such as taste and odor problems and fixture staining, but high concentrations are not necessarily a public health concern. The secondary drinking water standard for iron is 0.3 mg/l, for manganese 0.05 mg/l. Raw water data from the reservoirs showed high concentrations of iron and manganese. Anoxic conditions in the hypolimnion during the summer months probably result in the release of stored iron and manganese from the sediments. In response to this situation, WSSC installed aerators in Rocky Gorge near the intake to ensure adequate dissolved oxygen concentration in the bottom waters.

8.4 Other Inorganics

This category includes nitrate/nitrite, fluoride, sulfate and sodium that are occasionally detected in the finished water. Detectable concentrations have always been below the primary and recommended secondary standard for public health and do not exceed the criteria of exceeding 50% of the MCL in at least 10% of the samples. They are not a concern to the raw water supply at the levels observed. Sodium and chloride concentrations would be expected to be higher if the amount of road salt usage in the watershed increases. Sulfate is commonly detected in the raw water with maximum concentration 15.35 mg/l, well below the secondary MCL of 250 mg/l. Data from Patuxent Reservoirs monitoring stations indicate that nitrate concentrations are well below the MCL of 10 mg/l.

8.5 Turbidity and Sediment

Highly turbid water can cause additional demands on water treatment plants and sediment can carry harmful microorganisms and compounds into drinking water suppliers. Turbidity is used as a surrogate indicator for the presence of *Cryptosporidium* and *Giardia*, and increased water turbidity is indicative of elevated bacteria concentrations. Turbidity is caused by erosion of materials from the contributing watershed. Turbidity may be from a wide variety of materials, including soil particles and organic matter created by the decay of vegetation. During storm events and/or snowmelts, surface runoff increases. Runoff during a storm event occurs when the rate of precipitation exceeds the rate of infiltration. As runoff increases during a storm and/or snowmelt, the increased flow of water can cause soil and other material to erode, increasing suspended solids and raising the turbidity.

Sedimentation studies conducted by WSSC since the 1950's generally indicate a medium to higher than normal rate of "silting in" of the reservoirs (Ocean Surveys, Inc., June 1997). Following storm events, inflow from major tributaries bring massive loads of sediments to Triadelphia and Rocky Gorge Reservoirs (*Interim Report of the Patuxent Reservoir Protection Group*, March, 1995).

There are several factors in the watershed that can contribute to increased turbidity/sediment. Runoff from paved surfaces (residential and commercial developments) increases the amount of flow in tributaries quickly and leads to bank erosion. Allowing cattle and other livestock unfettered access to streams destroys protective vegetation along riparian areas where soils can runoff directly into a waterway. Also, row cropping on steep slopes and forestry operations throughout the watershed may contribute to increased sediment and turbidity.

While raw water turbidity is usually very low in Patuxent Filtration's raw water, the reservoir watershed system is still susceptible to turbidity and sedimentation. The presence of sources within the watershed and the relatively high sedimentation rate, along with the potential for future contamination (development, agricultural erosion, forestry) make turbidity and sedimentation an important water quality concern for the Patuxent Reservoirs.

8.6 Protozoa, Viruses, and Fecal Coliform

Most surface water sources in Maryland are potentially susceptible to these contaminants. Currently, the Patuxent Reservoirs are not particularly susceptible to contamination by pathogenic organisms under base flow conditions. Under certain hydrologic conditions, such as following snowmelt or a rainstorm, concentrations of these pathogens are expected to increase similar to other reservoirs in the State. The potential non-point sources of pathogenic protozoa, viruses, and bacteria in the source water of Patuxent Reservoirs include pasture (livestock), stormwater runoff, failing residential septic systems, and wildlife.

8.7 Disinfection Byproducts and Disinfection Byproduct Precursors

During the water treatment process disinfectants, like chlorine, interact with naturally occurring organic matter (NOM) in the water to produce disinfection byproducts, which are associated with human health risks (Cook, 2001). The U.S. Environmental Protection Agency (EPA) requires that large surface water systems comply with the Stage 1 Disinfectants and Disinfection Byproduct Rule (DBPR). The rule establishes MCLs for the most common and well-studies halogenated DBPs: total trihalomethane (TTHMs) and five of the nine haloacetic acids (HAAs) as well as bromate and chlorite. TTHM is defined as the sum of chloroform, bromoform, bromodichloromethane, and dibromochloromethane; HAA is defined as the sum of mono-, di-, and trichloroacetic acids and mono- and dibromacetic acids. The maximum contaminant levels (MCLs) set for TTHMs and HAAs are 80 mg/l and 60 mg/l respectively, based on a system-wide running annual average. Two modifications to the Stage 1 DBPR are upcoming under the Stage 2 DBPR. The Stage 2 DBPR will change the compliance monitoring locations and the way sampling results are averaged to determine compliance. The MCLs will remain the same; however, the compliance determination will be based on a location running annual average, as opposed to the system-wide used under Stage 1 DBPR. The change requires that the MCLs will have to be met at every monitoring location throughout the water system.

WSSC has been monitoring TTHM and HAAs in the Patuxent Filtration Plant distribution system (Table 7.2d); all of the reported maximum TTHM and HAAs levels were higher than the MCLs set by EPA. The running average concentration of TTHM also is near and sometimes exceeds the regulatory levels on some individual locations and may not be able to meet the future requirements.

In addition to MCLs, the DBPR requires the use of treatment techniques to reduce DBP precursors and to minimize the formation of known and unknown DBPs. It requires that a specific percentage of influent total organic carbon (TOC) be removed during treatment. The treatment technique uses TOC as a surrogate for natural organic matter (NOM), the precursor material for DBPs. A TOC concentration of greater than 2.0 mg/l in a system's raw water is the trigger for implementation of the treatment technique. Required removal of TOC by enhanced coagulation for plants using conventional treatment is shown in the following table:

Table 8.1 Total Organic Carbon Removal Requirements

Source Water TOC (mg/l)	Source Water Alkalinity (mg/l as CaCo3)		
	0-60	>60 to 120	>120
>2.0 – 4.0	35%	25%	15%
>4.0 – 8.0	45%	35%	25%
>8.0	50%	40%	30%

Review of the TOC data (Table 7.2c) collected by WSSC from 1999 through 2002 at the Patuxent Filtration Plant indicates that the treatment process removes the required percentage of TOC from the raw water. However, WSSC should continue monitoring for TOC in the raw water and finish water to ensure compliance with the DBPR.

Due to the nature of the watershed, the biological status of the reservoirs (in-reservoir process "algae blooms" and decomposition of aquatic plants) and occasionally high sample concentrations of HAA and THM, the Patuxent water system is susceptible to disinfection byproducts.

8.8 Reservoirs Eutrophication

Eutrophication can be defined as the addition of dissolved and particulate organic and inorganic materials to the reservoirs at a rate sufficient to increase biological production and decrease storage due to sedimentation (Cook, 2001). The flux of nutrients into the reservoirs from the watershed, and the possible cycling of nutrients from the reservoir sediment, is driving the eutrophication process in the Patuxent Reservoirs.

The trophic status of the reservoirs has been studied extensively since 1981 by WSSC and its environmental consultants and concluded that the Patuxent Reservoirs are under stress from eutrophication and that this condition will probably worsen in the future unless appropriate abatement measures are undertaken.

In order to understand the current water quality condition of the reservoirs, WSSC and MDE jointly funded the Patuxent Reservoirs hydrodynamic model. The model conducted by Tetra Tech, Inc., which applied the Army Corps of Engineers' CE_QUAL_W2 modeling framework, were linked to a detailed watershed model that had been previously developed for the reservoirs' drainage area. Flow and water quality inputs to the reservoirs models were generated by the watershed model. To ensure that the two reservoirs models make sound predictions, they were tested using 1997 hydrodynamics and water quality monitoring data. Model testing involved a multi step calibration and validation process for hydrodynamics (water surface elevation and temperature) and water quality constituents (nutrients, algae, and dissolved oxygen). The primary method of testing was through comparison of time series and water column profile plots during changing conditions. Although the modeling system has predicted the reservoir responses to watershed flow and nutrient contributions under existing and hypothetical conditions, there are a number of limitations of the model and the data set used in its development. Therefore, the findings are considered as preliminary and not suitable for decision making purposes. MDE, WSSC and members of the Patuxent Reservoirs Watershed Technical Advisory Committee are working together on a number of enhancements and recommendations to improve the models' predictive capability. The MDE TMDL Program is assuming the lead for model improvements and is in the process of developing recommendations for the modeling workgroup. The MDE Water Supply Program looks to the model to better define nutrient targets to protect the reservoirs from excessive eutrophication. As discussed in Section 7.2.1 regarding phosphorus, additional modeling and analysis is needed to better define how the specific sources of phosphorus interact and contribute to reservoir eutrophication..

9.0 RECOMMENDATIONS FOR SOURCE WATER PROTECTION PLAN

The underlying goal of the source water assessment process is to develop a source water protection plan. This assessment has identified specific contaminants of concern and reason for these concerns. The recommendations outlined below are designated to reduce the risks to the water supply from the sources of these contaminants. The commitment and efforts that WSSC and its partners (Montgomery, Howard and Prince George's counties) have made in implementing a watershed management protection program needs to continue and grow. The Patuxent Reservoirs are a critical component in the WSSC's water supply system and protection of these reservoirs is vital in ensuring a safe and adequate water supply for the customers of the WSSC. Existing protection and monitoring efforts need to be maintained and strengthened. Additional data is needed to better understand the behavior of certain contaminants within the reservoir system and measure the progress of the protection program. Described below are recommendations for the consideration of the WSSC and the Technical Advisory Group Committee.

9.1 Effective Watershed Management

9.1.1 Strengthening Watershed Protection Agreement

Approval of a functional master plan for the Patuxent River watershed by the Montgomery County Council on October of 1993, the formation of the Patuxent Reservoir Protection Group (PRPG) and the development of the Interim Report (1995) are the basis of the Patuxent Reservoirs Protection Agreement of October, 1996. This agreement established the general framework for protecting the long-term biological, physical, and chemical integrity of the Patuxent Reservoirs (see Appendix B for copy of the agreement). Under the Reservoir Watershed Protection Agreement, each participating organization (Howard County, Montgomery County, Prince George's County, Howard Soil Conservation District, Montgomery Soil Conservation District, Maryland National Capital Park and Planning Commission, and Washington Suburban Sanitary Commission) retains jurisdictional authority while taking a leadership position in implementing components of the agreed upon Action Plan. Every year, the Reservoirs Watershed Protection Policy Board reviews progress in implementing the Action Plan and a report summarizing reservoir condition and progress made in implementing the specific proposal of the Action Plan.

Given the importance of maintaining and improving the water quality of the Patuxent Reservoirs, it is vital that the signatory parties continue to work together to protect this important regional resource. The recommendations from the Comprehensive Watershed Management Planning Study (July 1997) completed under the direction of an interjurisdictional workgroup are still valid and should be implemented. A copy of the executive summary of the Comprehensive Management Planning Study for the Patuxent Reservoir Watershed is included in Appendix C.

9.1.2 Expanding and Managing Publicly Protected Property in the Watershed

A number of landholdings within the watershed are managed by public entities for source protection and environmental benefit. Opportunities for expanding these landholdings should be pursued at all levels for protection of water quality.

- WSSC Property
  A forest management study by the State Department of Natural Resources (DNR) is currently underway to assess the existing condition of the forest buffer zone around the Patuxent Reservoirs. The recommendations in the final report of the study should be considered for implementation. A similar study was conducted by DNR for the City of Baltimore's Loch Raven, Prettyboy and Liberty Reservoirs. A copy of this study with key findings can be obtained from Maryland Department of Natural Resources, Forest Service. WSSC should explore the possibility of acquiring land and conservation easements in sensitive areas and along the feeder streams contiguous with its current property. MDE offers loans at zero percent interest to community water systems for purchase of property or purchase of conservation easements.

- County Government
  Howard and Montgomery counties are currently implementing several preservation and conservation programs to improve and/or maintain water quality and to conserve farmland in the Patuxent Reservoirs Watershed. Among these programs, Howard and Montgomery counties' *Agricultural Land Preservation Program* and Montgomery County's *The Legacy Open Space Programs* are the most significant efforts in protecting the open space resources and agricultural lands in the watershed. These programs should be continued and enhanced. Existing programs to develop and implement soil-conservation and water quality plans and nutrient management plans on lands leased for agricultural use should be continued and enhanced.

- State Park Land
  Land above Triadelphia Reservoir may be available for acquisition by the park system. In particular, properties along stream corridors feeding into the main stream should be examined for availability. Related DNR programs should be reviewed for some site-specific restoration projects. In order to maximize the benefits of limited resources, the selection and implementation of projects should be coordinated with the Patuxent Reservoir Watershed Technical Advisory Committee.

- Land Use Management
  All resource agencies should pursue land management strategies on public lands that will assure water quality protection. These include: required implementation of soil-conservation and water quality plans on public lands leased for agricultural use; enforcement to assure that motorized vehicles, bicycles, and horses do not create excessive erosion areas on steep slopes and stream banks; enhancing and protecting

riparian buffers; and deer management and invasive plant control to protect buffer quality.

9.2 Water Quality Sampling Data for Reservoir and Watershed Monitoring

Reservoir monitoring and river monitoring recommendations as summarized in "Comprehensive Management Planning Study for the Patuxent Reservoirs Watershed" are still valid and should be continued.

In addition to the above recommendations, the following specific recommendations should be considered by the Reservoir Technical Advisory Committee (TAC) for implementation:

- Year-round sampling for all recommended parameters is recommended for the RG1 station near the intake
- Chlorophyll *a* measurements should be taken from top, middle and bottom for stations in Rocky Gorge and Triadelphia Reservoirs
- Add chlorophyll *a* measurements in river monitoring plan
- Conduct a study to determine the level of disinfectant by products precursors and most effective methods for control of DBP precursors formation potentials in the reservoirs. This study should be coordinated with efforts by USGS, regional water suppliers (City of Baltimore), MDE, EPA and other scientific sources
- Monitoring to measure the impact of implementing BMPs for agricultural and storm water non point source needs to be conducted. Monitoring should include sediment, temperature, pathogens and nutrients (total and dissolved phosphorus).
- Monitoring of streams receiving storm water runoff from developed lands is needed to better calibrate the watershed model.

9.3 Phosphorus Control

As discussed in Section 7.2.1, the phosphorus loading to the Patuxent reservoirs is mostly from residential and agricultural land uses in the watershed. Additional detail assessment and modeling should be conducted to quantify the relative contribution of phosphorus from the nonpoint sources. A strengthened phosphorus control strategy should be pursued by implementing the best management practices for agricultural land and control measures for urban nonpoint sources. Performance measures and goals for priority resources (reservoir/water supply, terrestrial habitat, stream system, aquatic biota, rural character, and public awareness and stewardship) established by the Patuxent Reservoir Watershed Protection Group Technical Advisory Committee should be implemented and reviewed periodically.

9.4 Protective Actions and Further Identifying Contamination Threats

9.4.1 Engineering Controls for Spills at Route 29 Bridge

The feasibility and cost of installing engineering controls for spills at the eastern Route 29 bridge should be evaluated. The integrity of the water quality at the Rocky Gorge Reservoir intake is most susceptible to a spill occurring on this bridge. One possible solution to be considered should be the installation of a collection system that would collect any spilled liquid and divert it to a collection area at one or both ends of the bridge. The collection areas(s) would be similar to a storm water collection basin and would provide sufficient storage capacity to contain the spilled material. Such a system should be designed to be low maintenance with a minimum of mechanical components.

9.4.2 Compiling Traffic Accident Statistics and Pattern Analysis

Traffic accident statistics for accidents involving hazardous materials should be compiled for the Patuxent Reservoirs watershed to identify potential problem locations. Particular attention should be paid to all streams, rivers and reservoir crossings. Determining the hazardous materials involved may be useful for planning for hazardous spills. This information is available from MDE's Emergency Response office.

A traffic study should be conducted to evaluate the patterns of hazardous material transport through the watershed. The types of hazardous material carriers (including septage haulers), and the frequency of passage through the watershed need to be evaluated. Emphasis should be placed on the Route 29 and 97 bridges over the reservoirs and part of I-70 within the watershed. The impact of the proposed Inter County Connector (ICC) connector to transportation of hazardous materials should also be evaluated.

9.4.3 Additional Evaluation of Potential Contaminant Sources

Existing information identifies potential contaminant sources by their general category and locates their proximity to the reservoirs. Specific and updated information concerning these potential sources of contaminants should be compiled. For example, the Colonial Pipeline (see Figure 6.1) represents a significant potential spill source. The formation of a notification procedure and spill prevention measures between the WSSC and the Colonial Pipeline and MDE should be considered. There are several other minor facilities located in the watershed that require periodic review of their NPDES permit compliance status. WSSC and key stakeholders should periodically conduct detailed field survey of the watershed to ensure any new potential sources of contaminants are identified and characterized.

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Other Sources of Information and Data

- EPA's Guidance Manual for Source Water Assessments
- EPA Information Collection Rule (ICR) Reports
- Maryland Department of Agriculture, Maryland Pesticide Statistics – triennial reports for 1997, 1994, 1991, 1988 and 1985.
- Maryland Department of Natural Resources
- Maryland Department of Planning 2000 Howard and Montgomery counties Land-use Maps
- MDE NPDES Permits
- MDE Waste Management Sites Database
- MDE Water Appropriation and Use Permits
- MDE Water Supply Inspection Reports
- MDE Water Supply Program Oracle Database
- WSSC Patuxent Filtration Plant Monthly Operating Reports (MORs) and Self-Monitoring Reports

Table A.1. VOCs Detected in Patuxent Water Treatment Plant, both Treated and Raw from 1991 thru 2001. **APPENDIX A**

Contaminant Name	MCL	Unit	Sample Date	Result	Raw or Finished Water Sample
1,2,4-TRICHLOROBENZENE	70	ug/L	4/2/96	0.3	F
1,2-DIBROMO-3-CHLOROPROPANE	0.2	ug/L	8/3/93	0.3	F
1,2-DIBROMO-3-CHLOROPROPANE	0.2	ug/L	4/8/97	0.2	F
1,2-DIBROMO-3-CHLOROPROPANE	0.2	ug/L	6/2/98	0.6	F
1,2-DICHLOROETHANE	5	ug/L	7/1/91	0.2	F
1,2-DICHLOROETHANE	5	ug/L	9/4/91	0.4	F
BENZENE	5	ug/L	6/2/98	0.1	F
CARBON TETRACHLORIDE	5	ug/L	8/1/91	1	F
CARBON TETRACHLORIDE	5	ug/L	10/5/92	0.6	F
CARBON TETRACHLORIDE	5	ug/L	1/4/93	0.1	F
CARBON TETRACHLORIDE	5	ug/L	12/9/97	1.1	F
ETHYLBENZENE	700	ug/L	7/1/91	0.1	F
ETHYLBENZENE	700	ug/L	8/1/91	0.3	F
ETHYLBENZENE	700	ug/L	7/5/94	0.1	F
ETHYLBENZENE	700	ug/L	8/2/94	0.1	F
ETHYLBENZENE	700	ug/L	8/1/95	0.1	F
METHYLENE CHLORIDE	5	ug/L	4/1/91	0.8	F
METHYLENE CHLORIDE	5	ug/L	7/1/91	0.8	R
METHYLENE CHLORIDE	5	ug/L	7/1/91	0.1	F
METHYLENE CHLORIDE	5	ug/L	8/1/91	0.4	F
METHYLENE CHLORIDE	5	ug/L	9/4/91	0.3	R
METHYLENE CHLORIDE	5	ug/L	9/4/91	0.4	F
METHYLENE CHLORIDE	5	ug/L	10/1/91	0.3	F
METHYLENE CHLORIDE	5	ug/L	11/1/91	0.9	F
METHYLENE CHLORIDE	5	ug/L	12/3/91	1.8	F
METHYLENE CHLORIDE	5	ug/L	2/4/92	1.8	F
METHYLENE CHLORIDE	5	ug/L	5/1/92	0.4	F
METHYLENE CHLORIDE	5	ug/L	1/4/93	0.2	F
METHYLENE CHLORIDE	5	ug/L	2/1/93	0.2	F
METHYLENE CHLORIDE	5	ug/L	6/1/93	0.3	F
METHYLENE CHLORIDE	5	ug/L	8/2/94	0.8	F
METHYLENE CHLORIDE	5	ug/L	1/3/95	0.2	F
METHYLENE CHLORIDE	5	ug/L	3/7/95	0.4	F
METHYLENE CHLORIDE	5	ug/L	9/5/95	0.4	F
METHYLENE CHLORIDE	5	ug/L	1/2/96	0.2	F
METHYLENE CHLORIDE	5	ug/L	4/2/96	0.2	F

Table A.1 continued

METHYLENE CHLORIDE	5	ug/L	8/4/98	0.5	F
METHYLENE CHLORIDE	5	ug/L	9/25/01	11.4	F
METHYLENE CHLORIDE	5	ug/L	9/25/01	13.4	R
TETRACHLOROETHYLENE	5	ug/L	4/2/96	0.2	F
TOLUENE	1000	ug/L	7/1/91	0.1	F
TOLUENE	1000	ug/L	9/4/91	0.2	F
TOLUENE	1000	ug/L	11/1/91	0.1	F
TOLUENE	1000	ug/L	5/4/93	0.2	F
TOLUENE	1000	ug/L	6/1/93	0.1	F
TOLUENE	1000	ug/L	1/3/95	0.3	F
TOLUENE	1000	ug/L	4/2/96	0.3	F
TOLUENE	1000	ug/L	6/2/98	0.1	F
TOLUENE	1000	ug/L	7/10/98	0.1	F
TOLUENE	1000	ug/L	9/1/98	0.1	F
TOLUENE	1000	ug/L	10/6/98	0.1	R
TOLUENE	1000	ug/L	2/2/99	0.1	F
TOLUENE	1000	ug/L	6/1/99	0.2	F
VINYL CHLORIDE	2	ug/L	4/2/96	0.1	F
XYLENES, TOTAL	10000	ug/L	7/1/91	0.8	F
XYLENES, TOTAL	10000	ug/L	8/1/91	0.4	F
XYLENES, TOTAL	10000	ug/L	9/4/91	0.2	F
XYLENES, TOTAL	10000	ug/L	10/1/91	0.3	F
XYLENES, TOTAL	10000	ug/L	7/8/92	0.1	F
XYLENES, TOTAL	10000	ug/L	8/4/92	0.2	F
XYLENES, TOTAL	10000	ug/L	8/3/93	0.1	F
XYLENES, TOTAL	10000	ug/L	9/7/93	0.2	F
XYLENES, TOTAL	10000	ug/L	6/7/94	0.1	F
XYLENES, TOTAL	10000	ug/L	7/5/94	0.2	F
XYLENES, TOTAL	10000	ug/L	8/2/94	0.2	F
XYLENES, TOTAL	10000	ug/L	10/4/94	0.1	F
XYLENES, TOTAL	10000	ug/L	1/3/95	0.1	F
XYLENES, TOTAL	10000	ug/L	7/5/95	0.2	F
XYLENES, TOTAL	10000	ug/L	8/1/95	0.4	F
XYLENES, TOTAL	10000	ug/L	4/2/96	0.3	F
XYLENES, TOTAL	10000	ug/L	6/1/99	0.3	F
o-DICHLOROBENZENE	600	ug/L	2/3/98	0.1	R
p-DICHLOROBENZENE	75	ug/L	2/3/98	0.2	R

Table A.2. SOCs Detected in Patuxent Water Treatment Plant, both Treated and Raw from 1995 thru 2001.

Contaminant Name	MCL	Units	Sample Date	Results	Raw or Finished Water Sample
1,2-DIBROMO-3-CHLOROPROPANE	0.2	ug/L	10/10/01	0.009	F
2,4-D	70	ug/L	6/26/01	0.19	R
2,4-D	70	ug/L	6/26/01	0.28	R
ATRAZINE	3	ug/L	6/13/96	0.515	F
ATRAZINE	3	ug/L	6/10/97	0.2	F
ATRAZINE	3	ug/L	9/9/97	0.1	F
ATRAZINE	3	ug/L	12/8/97	0.1	F
ATRAZINE	3	ug/L	6/30/98	0.7	F
ATRAZINE	3	ug/L	6/30/98	0.7	F
ATRAZINE	3	ug/L	9/29/98	0.5	F
ATRAZINE	3	ug/L	9/29/98	0.5	R
ATRAZINE	3	ug/L	12/7/98	0.4	R
ATRAZINE	3	ug/L	12/7/98	0.3	F
ATRAZINE	3	ug/L	2/25/99	0.1	F
ATRAZINE	3	ug/L	2/25/99	0.2	R
ATRAZINE	3	ug/L	5/11/99	0.12	F
ATRAZINE	3	ug/L	5/11/99	0.1	R
ATRAZINE	3	ug/L	8/10/99	0.06	R
ATRAZINE	3	ug/L	8/10/99	0.06	F
ATRAZINE	3	ug/L	7/25/00	0.07	R
ATRAZINE	3	ug/L	7/25/00	0.1	R
ATRAZINE	3	ug/L	12/12/00	0.07	F
ATRAZINE	3	ug/L	6/26/01	0.3	R
ATRAZINE	3	ug/L	6/26/01	0.3	R
CARBOFURAN	40	ug/L	6/26/01	0.9	R
CARBOFURAN	40	ug/L	6/26/01	0.9	R
CARBOFURAN	40	ug/L	10/2/01	0.9	R
DALAPON	200	ug/L	10/2/01	0.492	F
DI(2-ETHYLHEXYL) ADIPATE	400	ug/L	5/2/95	2.13	F
DI(2-ETHYLHEXYL) PHTHALATE	6	ug/L	5/2/95	4.73	F
DI(2-ETHYLHEXYL) PHTHALATE	6	ug/L	9/9/97	1	F
DI(2-ETHYLHEXYL) PHTHALATE	6	ug/L	6/30/98	0.8	F
DI(2-ETHYLHEXYL) PHTHALATE	6	ug/L	1/31/00	1.1	F
DI(2-ETHYLHEXYL) PHTHALATE	6	ug/L	1/31/00	1.1	F
DI(2-ETHYLHEXYL) PHTHALATE	6	ug/L	7/25/00	0.6	R

Table A.2 continued

DI(2-ETHYLHEXYL) PHTHALATE	6	ug/L	7/25/00	1.1	R
DI(2-ETHYLHEXYL) PHTHALATE	6	ug/L	10/10/01	0.24	R
SIMAZINE	4	ug/L	6/13/96	0.825	F
SIMAZINE	4	ug/L	6/10/97	0.1	F
SIMAZINE	4	ug/L	6/30/98	0.5	F
SIMAZINE	4	ug/L	6/30/98	0.3	F
SIMAZINE	4	ug/L	9/29/98	0.3	F
SIMAZINE	4	ug/L	9/29/98	0.2	R
SIMAZINE	4	ug/L	12/7/98	0.6	R
SIMAZINE	4	ug/L	12/7/98	0.4	F
SIMAZINE	4	ug/L	2/25/99	0.09	F
SIMAZINE	4	ug/L	2/25/99	0.1	R
SIMAZINE	4	ug/L	7/25/00	0.2	R
SIMAZINE	4	ug/L	7/25/00	0.1	R
SIMAZINE	4	ug/L	12/12/00	0.08	F
SIMAZINE	4	ug/L	12/12/00	0.01	F
SIMAZINE	4	ug/L	6/26/01	0.3	R
SIMAZINE	4	ug/L	6/26/01	0.3	R

Table A.3. IOCs Detected in Patuxent Water Treatment Plant, both Treated and Raw Water from 1995 thru 2001.

Contaminant Name	MCL	Units	Sample Date	Result	Raw or Finished Water Sample
ANTIMONY	0.006	mg/L	7/13/99	0.002	F
ANTIMONY	0.006	mg/L	8/10/99	0.004	F
ANTIMONY	0.006	mg/L	12/14/99	0.002	F
ANTIMONY	0.006	mg/L	5/9/00	0.001	F
ANTIMONY	0.006	mg/L	6/13/00	0.01	F
ANTIMONY	0.006	mg/L	8/8/00	0.001	F
ANTIMONY	0.006	mg/L	10/10/00	0.001	F
ANTIMONY	0.006	mg/L	5/8/01	0.002	
ANTIMONY	0.006	mg/L	5/8/01	0.001	
ANTIMONY	0.006	mg/L	9/11/01	0.001	
ANTIMONY	0.006	mg/L	12/11/01	0.001	
ARSENIC	0.01	mg/L	9/8/98	0.0008	F
ARSENIC	0.01	mg/L	9/8/98	0.0005	R
ARSENIC	0.01	mg/L	11/10/98	0.0005	R
ARSENIC	0.01	mg/L	12/8/98	0.0008	R
ARSENIC	0.01	mg/L	12/8/98	0.0007	F
ARSENIC	0.01	mg/L	10/10/00	0.001	F
ARSENIC	0.01	mg/L	11/14/00	0.001	F
ARSENIC	0.01	mg/L	8/14/01	0.001	
ARSENIC	0.01	mg/L	10/9/01	0.001	
ARSENIC	0.01	mg/L	11/27/01	0.001	
BARIUM	2	mg/L	7/14/98	0.0183	R
BARIUM	2	mg/L	7/14/98	0.0245	F
BARIUM	2	mg/L	8/11/98	0.018	F
BARIUM	2	mg/L	8/11/98	0.017	R
BARIUM	2	mg/L	9/8/98	0.018	F
BARIUM	2	mg/L	9/8/98	0.018	R
BARIUM	2	mg/L	10/13/98	0.018	F
BARIUM	2	mg/L	10/13/98	0.02	R
BARIUM	2	mg/L	11/10/98	0.019	F
BARIUM	2	mg/L	11/10/98	0.018	R
BARIUM	2	mg/L	12/8/98	0.02	R
BARIUM	2	mg/L	12/8/98	0.018	F
BARIUM	2	mg/L	2/9/99	0.019	F
BARIUM	2	mg/L	2/9/99	0.022	R

Table A.3 continued

BARIUM	2	mg/L	3/9/99	0.021	F
BARIUM	2	mg/L	4/13/99	0.022	R
BARIUM	2	mg/L	4/13/99	0.02	F
BARIUM	2	mg/L	4/13/99	0.02	F
BARIUM	2	mg/L	4/13/99	0.022	R
BARIUM	2	mg/L	4/13/99	0.023	F
BARIUM	2	mg/L	5/11/99	0.023	F
BARIUM	2	mg/L	5/11/99	0.022	R
BARIUM	2	mg/L	6/8/99	0.025	F
BARIUM	2	mg/L	6/8/99	0.028	F
BARIUM	2	mg/L	7/13/99	0.025	F
BARIUM	2	mg/L	7/13/99	0.024	F
BARIUM	2	mg/L	8/10/99	0.023	F
BARIUM	2	mg/L	8/10/99	0.024	F
BARIUM	2	mg/L	9/14/99	0.023	F
BARIUM	2	mg/L	9/14/99	0.023	F
BARIUM	2	mg/L	10/12/99	0.023	F
BARIUM	2	mg/L	10/12/99	0.022	F
BARIUM	2	mg/L	11/9/99	0.021	F
BARIUM	2	mg/L	11/9/99	0.02	F
BARIUM	2	mg/L	12/14/99	0.024	F
BARIUM	2	mg/L	12/14/99	0.021	F
BARIUM	2	mg/L	1/11/00	0.026	F
BARIUM	2	mg/L	1/11/00	0.021	F
BARIUM	2	mg/L	2/8/00	0.026	F
BARIUM	2	mg/L	2/8/00	0.025	F
BARIUM	2	mg/L	3/14/00	0.026	F
BARIUM	2	mg/L	3/14/00	0.023	F
BARIUM	2	mg/L	4/11/00	0.025	F
BARIUM	2	mg/L	4/11/00	0.023	F
BARIUM	2	mg/L	5/9/00	0.024	F
BARIUM	2	mg/L	5/9/00	0.022	F
BARIUM	2	mg/L	6/13/00	0.024	F
BARIUM	2	mg/L	7/11/00	0.025	F
BARIUM	2	mg/L	7/11/00	0.024	F
BARIUM	2	mg/L	8/8/00	0.023	F
BARIUM	2	mg/L	8/8/00	0.024	F
BARIUM	2	mg/L	9/12/00	0.021	F
BARIUM	2	mg/L	9/12/00	0.027	F

Table A.3 continued

BARIUM	2	mg/L	10/10/00	0.02	F
BARIUM	2	mg/L	10/10/00	0.019	F
BARIUM	2	mg/L	11/14/00	0.021	F
BARIUM	2	mg/L	11/14/00	0.022	F
BARIUM	2	mg/L	12/12/00	0.019	F
BARIUM	2	mg/L	12/12/00	0.017	F
BARIUM	2	mg/L	1/9/01	0.021	
BARIUM	2	mg/L	1/9/01	0.019	
BARIUM	2	mg/L	2/20/01	0.023	
BARIUM	2	mg/L	2/20/01	0.021	
BARIUM	2	mg/L	3/13/01	0.022	
BARIUM	2	mg/L	3/13/01	0.021	
BARIUM	2	mg/L	4/10/01	0.022	
BARIUM	2	mg/L	4/10/01	0.019	
BARIUM	2	mg/L	5/8/01	0.023	
BARIUM	2	mg/L	5/8/01	0.02	
BARIUM	2	mg/L	6/12/01	0.024	
BARIUM	2	mg/L	6/12/01	0.024	
BARIUM	2	mg/L	7/10/01	0.024	
BARIUM	2	mg/L	7/10/01	0.022	
BARIUM	2	mg/L	8/14/01	0.022	
BARIUM	2	mg/L	8/14/01	0.022	
BARIUM	2	mg/L	9/11/01	0.02	
BARIUM	2	mg/L	9/11/01	0.026	
BARIUM	2	mg/L	10/9/01	0.02	
BARIUM	2	mg/L	10/9/01	0.02	
BARIUM	2	mg/L	11/27/01	0.02	
BARIUM	2	mg/L	11/27/01	0.021	
BARIUM	2	mg/L	12/11/01	0.018	
BARIUM	2	mg/L	12/11/01	0.023	
CADMIUM	0.005	mg/L	11/10/98	0.00002	F
CADMIUM	0.005	mg/L	11/10/98	0.00008	R
CADMIUM	0.005	mg/L	2/9/99	0.00003	F
CADMIUM	0.005	mg/L	2/9/99	0.00015	R
CADMIUM	0.005	mg/L	4/13/99	0.0005	F
CADMIUM	0.005	mg/L	10/10/00	0.001	F
CHROMIUM	0.1	mg/L	11/10/98	0.002	R
CHROMIUM	0.1	mg/L	3/9/99	0.002	F
CHROMIUM	0.1	mg/L	3/14/00	0.002	F

Table A.3 continued

CHROMIUM	0.1	mg/L	4/11/00	0.001	F
CHROMIUM	0.1	mg/L	4/11/00	0.002	F
CHROMIUM	0.1	mg/L	5/9/00	0.001	F
CHROMIUM	0.1	mg/L	7/11/00	0.002	F
CHROMIUM	0.1	mg/L	8/8/00	0.001	F
CHROMIUM	0.1	mg/L	8/8/00	0.002	F
CHROMIUM	0.1	mg/L	9/12/00	0.002	F
CHROMIUM	0.1	mg/L	9/12/00	0.004	F
CHROMIUM	0.1	mg/L	10/10/00	0.027	F
CHROMIUM	0.1	mg/L	10/10/00	0.015	F
CHROMIUM	0.1	mg/L	11/14/00	0.015	F
CHROMIUM	0.1	mg/L	11/14/00	0.006	F
CHROMIUM	0.1	mg/L	12/12/00	0.022	F
CHROMIUM	0.1	mg/L	12/12/00	0.006	F
CHROMIUM	0.1	mg/L	1/9/01	0.011	
CHROMIUM	0.1	mg/L	1/9/01	0.009	
CHROMIUM	0.1	mg/L	2/20/01	0.01	
CHROMIUM	0.1	mg/L	2/20/01	0.005	
CHROMIUM	0.1	mg/L	3/13/01	0.01	
CHROMIUM	0.1	mg/L	3/13/01	0.012	
CHROMIUM	0.1	mg/L	4/10/01	0.015	
CHROMIUM	0.1	mg/L	4/10/01	0.008	
CHROMIUM	0.1	mg/L	5/8/01	0.008	
CHROMIUM	0.1	mg/L	5/8/01	0.004	
CHROMIUM	0.1	mg/L	7/10/01	0.01	
CHROMIUM	0.1	mg/L	7/10/01	0.01	
CHROMIUM	0.1	mg/L	8/14/01	0.007	
CHROMIUM	0.1	mg/L	8/14/01	0.003	
CHROMIUM	0.1	mg/L	9/11/01	0.002	
CHROMIUM	0.1	mg/L	9/11/01	0.001	
CHROMIUM	0.1	mg/L	10/9/01	0.004	
CHROMIUM	0.1	mg/L	10/9/01	0.004	
CHROMIUM	0.1	mg/L	11/27/01	0.022	
CHROMIUM	0.1	mg/L	11/27/01	0.001	
CHROMIUM	0.1	mg/L	12/11/01	0.002	
CHROMIUM	0.1	mg/L	12/11/01	0.001	
FLUORIDE	4	mg/L	5/2/95	0.91	F
FLUORIDE	4	mg/L	6/13/96	0.88	F
FLUORIDE	4	mg/L	7/14/98	0.86	F

Table A.3 continued

FLUORIDE	4	mg/L	9/8/98	0.99	F
FLUORIDE	4	mg/L	10/13/98	0.91	F
FLUORIDE	4	mg/L	11/10/98	0.92	F
FLUORIDE	4	mg/L	12/8/98	0.94	F
FLUORIDE	4	mg/L	2/9/99	1.15	F
FLUORIDE	4	mg/L	3/9/99	0.84	F
FLUORIDE	4	mg/L	4/13/99	0.98	F
FLUORIDE	4	mg/L	4/13/99	0.98	F
FLUORIDE	4	mg/L	5/11/99	0.95	F
FLUORIDE	4	mg/L	6/8/99	0.97	F
FLUORIDE	4	mg/L	7/13/99	1.01	F
FLUORIDE	4	mg/L	8/10/99	0.92	F
FLUORIDE	4	mg/L	9/14/99	0.97	F
FLUORIDE	4	mg/L	11/9/99	1.16	F
FLUORIDE	4	mg/L	12/14/99	0.96	F
FLUORIDE	4	mg/L	1/11/00	0.98	F
FLUORIDE	4	mg/L	2/8/00	0.92	F
FLUORIDE	4	mg/L	3/14/00	0.92	F
FLUORIDE	4	mg/L	4/11/00	1.12	F
FLUORIDE	4	mg/L	6/13/00	0.86	F
FLUORIDE	4	mg/L	7/11/00	0.91	F
FLUORIDE	4	mg/L	8/8/00	1.04	F
FLUORIDE	4	mg/L	9/12/00	0.86	F
FLUORIDE	4	mg/L	10/10/00	0.99	F
FLUORIDE	4	mg/L	12/12/00	1.02	F
FLUORIDE	4	mg/L	1/9/01	0.93	F
FLUORIDE	4	mg/L	2/20/01	1.09	F
FLUORIDE	4	mg/L	3/13/01	1.06	F
FLUORIDE	4	mg/L	4/10/01	0.9	F
FLUORIDE	4	mg/L	5/8/01	1	F
FLUORIDE	4	mg/L	6/12/01	1	F
FLUORIDE	4	mg/L	7/10/01	0.99	F
FLUORIDE	4	mg/L	8/14/01	0.89	F
FLUORIDE	4	mg/L	9/11/01	0.098	F
FLUORIDE	4	mg/L	11/27/01	0.98	F
FLUORIDE	4	mg/L	12/11/01	0.986	F
GROSS ALPHA	15	pCi/L	8/9/00	2	F
GROSS ALPHA	15	pCi/L	10/31/00	2	F
GROSS BETA	50	pCi/L	3/1/00	3	F

Table A.3 continued

GROSS BETA	50	pCi/L	8/9/00	5	F
GROSS BETA	50	pCi/L	10/31/00	5	F
NICKEL	0.1	mg/L	7/14/98	0.016	R
NICKEL	0.1	mg/L	11/9/99	0.003	F
NICKEL	0.1	mg/L	11/9/99	0.003	F
NICKEL	0.1	mg/L	12/14/99	0.003	F
NICKEL	0.1	mg/L	12/14/99	0.003	F
NICKEL	0.1	mg/L	3/14/00	0.002	F
NICKEL	0.1	mg/L	3/14/00	0.001	F
NICKEL	0.1	mg/L	4/11/00	0.001	F
NICKEL	0.1	mg/L	4/11/00	0.001	F
NICKEL	0.1	mg/L	5/9/00	0.002	F
NICKEL	0.1	mg/L	5/9/00	0.001	F
NICKEL	0.1	mg/L	7/11/00	0.001	F
NICKEL	0.1	mg/L	7/11/00	0.001	F
NICKEL	0.1	mg/L	9/12/00	0.001	F
NICKEL	0.1	mg/L	10/10/00	0.001	F
NICKEL	0.1	mg/L	11/14/00	0.001	F
NICKEL	0.1	mg/L	11/14/00	0.001	F
NICKEL	0.1	mg/L	12/12/00	0.001	F
NICKEL	0.1	mg/L	3/13/01	0.001	
NICKEL	0.1	mg/L	3/13/01	0.001	
NICKEL	0.1	mg/L	4/10/01	0.001	
NICKEL	0.1	mg/L	4/10/01	0.001	
NICKEL	0.1	mg/L	5/8/01	0.001	
NICKEL	0.1	mg/L	5/8/01	0.001	
NICKEL	0.1	mg/L	6/12/01	0.001	
NICKEL	0.1	mg/L	6/12/01	0.001	
NICKEL	0.1	mg/L	7/10/01	0.001	
NICKEL	0.1	mg/L	7/10/01	0.004	
NICKEL	0.1	mg/L	8/14/01	0.001	
NICKEL	0.1	mg/L	9/11/01	0.002	
NICKEL	0.1	mg/L	10/9/01	0.001	
NICKEL	0.1	mg/L	10/9/01	0.001	
NICKEL	0.1	mg/L	11/27/01	0.001	
NICKEL	0.1	mg/L	11/27/01	0.002	
NICKEL	0.1	mg/L	12/11/01	0.002	
NITRATE	10	mg/L	3/2/93	1.42	F
NITRATE	10	mg/L	7/6/93	1.06	F

Table A.3 continued

NITRATE	10	mg/L	5/2/95	2	F
NITRATE	10	mg/L	6/13/96	1.7	F
NITRATE	10	mg/L	3/18/97	2.1	F
NITRATE	10	mg/L	7/29/97	1.3	F
NITRATE	10	mg/L	10/14/97	1.1	F
NITRATE	10	mg/L	6/30/98	1.9	F
NITRATE	10	mg/L	8/11/98	2.5	F
NITRATE	10	mg/L	9/8/98	3.2	F
NITRATE	10	mg/L	11/10/98	2.8	F
NITRATE	10	mg/L	12/8/98	1.5	F
NITRATE	10	mg/L	2/9/99	1	F
NITRATE	10	mg/L	4/13/99	2.1	F
NITRATE	10	mg/L	5/11/99	1.8	F
NITRATE	10	mg/L	8/10/99	0.756	F
NITRATE	10	mg/L	8/10/99	0.693	F
NITRATE	10	mg/L	9/14/99	0.67	F
NITRATE	10	mg/L	9/14/99	0.65	F
NITRATE	10	mg/L	10/12/99	0.67	F
NITRATE	10	mg/L	10/12/99	0.66	F
NITRATE	10	mg/L	11/9/99	0.76	F
NITRATE	10	mg/L	11/9/99	0.8	F
NITRATE	10	mg/L	12/14/99	0.79	F
NITRATE	10	mg/L	12/14/99	0.77	F
NITRATE	10	mg/L	1/11/00	0.85	F
NITRATE	10	mg/L	1/11/00	0.84	F
NITRATE	10	mg/L	2/8/00	1.15	F
NITRATE	10	mg/L	2/8/00	1.17	F
NITRATE	10	mg/L	3/14/00	1.37	F
NITRATE	10	mg/L	3/14/00	1.377	F
NITRATE	10	mg/L	4/11/00	1.332	F
NITRATE	10	mg/L	4/11/00	1.316	F
NITRATE	10	mg/L	5/9/00	1.28	F
NITRATE	10	mg/L	5/9/00	1.47	F
NITRATE	10	mg/L	6/13/00	1.3	F
NITRATE	10	mg/L	6/13/00	1.3	F
NITRATE	10	mg/L	7/11/00	0.877	F
NITRATE	10	mg/L	7/11/00	0.824	F
NITRATE	10	mg/L	8/8/00	0.785	F
NITRATE	10	mg/L	8/8/00	0.758	F

Table A.3 continued

NITRATE	10	mg/L	9/12/00	0.678	F
NITRATE	10	mg/L	9/12/00	0.542	F
NITRATE	10	mg/L	10/10/00	0.661	F
NITRATE	10	mg/L	10/10/00	0.595	F
NITRATE	10	mg/L	11/14/00	0.625	F
NITRATE	10	mg/L	11/14/00	1.615	F
NITRATE	10	mg/L	12/12/00	0.652	F
NITRATE	10	mg/L	12/12/00	0.662	F
NITRATE	10	mg/L	1/9/01	0.904	
NITRATE	10	mg/L	1/9/01	0.858	
NITRATE	10	mg/L	2/20/01	1.154	
NITRATE	10	mg/L	2/20/01	1.12	
NITRATE	10	mg/L	3/13/01	1.171	
NITRATE	10	mg/L	3/13/01	1.17	
NITRATE	10	mg/L	4/10/01	1.46	
NITRATE	10	mg/L	4/10/01	1.481	
NITRATE	10	mg/L	5/8/01	1.441	
NITRATE	10	mg/L	5/8/01	1.482	
NITRATE	10	mg/L	6/12/01	1.3	
NITRATE	10	mg/L	6/12/01	1.333	
NITRATE	10	mg/L	7/10/01	1.237	
NITRATE	10	mg/L	7/10/01	1.186	
NITRATE	10	mg/L	8/14/01	0.789	
NITRATE	10	mg/L	8/14/01	0.833	
NITRATE	10	mg/L	9/11/01	0.495	
NITRATE	10	mg/L	9/11/01	0.581	
NITRATE	10	mg/L	10/9/01	0.598	
NITRATE	10	mg/L	10/9/01	0.597	
NITRATE	10	mg/L	11/27/01	0.54	
NITRATE	10	mg/L	11/27/01	0.571	
NITRATE	10	mg/L	12/11/01	0.578	
NITRATE	10	mg/L	12/11/01	0.603	
NITRITE	1	mg/L	6/13/96	0.002	F
NITRITE	1	mg/L	3/14/00	0.006	F
NITRITE	1	mg/L	4/11/00	0.009	F
NITRITE	1	mg/L	5/9/00	0.012	F
NITRITE	1	mg/L	6/13/00	0.027	F
NITRITE	1	mg/L	7/11/00	0.032	F
NITRITE	1	mg/L	7/11/00	0.003	F

Table A.3 continued

NITRITE	1	mg/L	8/8/00	0.008	F
NITRITE	1	mg/L	9/12/00	0.004	F
NITRITE	1	mg/L	10/10/00	0.093	F
NITRITE	1	mg/L	11/14/00	0.501	F
NITRITE	1	mg/L	12/12/00	0.006	F
NITRITE	1	mg/L	1/9/01	0.005	
NITRITE	1	mg/L	2/20/01	0.007	
NITRITE	1	mg/L	3/13/01	0.012	
NITRITE	1	mg/L	4/10/01	0.006	
NITRITE	1	mg/L	5/8/01	0.001	
NITRITE	1	mg/L	5/8/01	0.007	
NITRITE	1	mg/L	6/12/01	0.025	
NITRITE	1	mg/L	7/10/01	0.002	
NITRITE	1	mg/L	7/10/01	0.034	
NITRITE	1	mg/L	8/14/01	0.002	
NITRITE	1	mg/L	9/11/01	0.008	
NITRITE	1	mg/L	9/11/01	0.015	
NITRITE	1	mg/L	10/9/01	0.006	
NITRITE	1	mg/L	11/27/01	0.004	
SELENIUM	0.05	mg/L	1/11/00	0.002	F
SELENIUM	0.05	mg/L	4/11/00	0.05	F
SELENIUM	0.05	mg/L	5/9/00	0.001	F
SELENIUM	0.05	mg/L	7/11/00	0.001	F
SELENIUM	0.05	mg/L	7/11/00	0.001	F
SELENIUM	0.05	mg/L	2/20/01	0.001	
SELENIUM	0.05	mg/L	3/13/01	0.005	
SELENIUM	0.05	mg/L	3/13/01	0.005	
SODIUM		mg/L	5/2/95	11.1	F
SODIUM		mg/L	6/13/96	8.9	F
SODIUM		mg/L	7/14/98	7.31	R
SODIUM		mg/L	7/14/98	4.93	F
SODIUM		mg/L	8/11/98	5.97	F
SODIUM		mg/L	8/11/98	7.6	R
SODIUM		mg/L	9/8/98	5.7	F
SODIUM		mg/L	9/8/98	7.3	R
SODIUM		mg/L	10/13/98	6	F
SODIUM		mg/L	10/13/98	6.3	R
SODIUM		mg/L	11/10/98	6.4	F
SODIUM		mg/L	11/10/98	9.2	R

Table A.3 continued

SODIUM		mg/L	12/8/98	9.8	R
SODIUM		mg/L	12/8/98	6.4	F
SODIUM		mg/L	2/9/99	13.2	F
SODIUM		mg/L	2/9/99	14.9	R
SODIUM		mg/L	4/13/99	18.1	R
SODIUM		mg/L	4/13/99	18.1	R
SODIUM		mg/L	4/13/99	15	F
SODIUM		mg/L	4/13/99	15	F
SODIUM		mg/L	5/11/99	12.4	F
SODIUM		mg/L	5/11/99	15.2	R
SODIUM		mg/L	6/8/99	11.8	F
SODIUM		mg/L	6/8/99	16.2	F
SODIUM		mg/L	7/13/99	12.2	F
SODIUM		mg/L	7/13/99	12.1	F
SODIUM		mg/L	8/10/99	10.8	F
SODIUM		mg/L	8/10/99	11.6	F
SODIUM		mg/L	9/14/99	9	F
SODIUM		mg/L	9/14/99	10.5	F
SODIUM		mg/L	10/12/99	8.82	F
SODIUM		mg/L	10/12/99	8.75	F
SODIUM		mg/L	11/9/99	8.04	F
SODIUM		mg/L	11/9/99	7.79	F
SODIUM		mg/L	12/14/99	11.1	F
SODIUM		mg/L	12/14/99	7.89	F
SODIUM		mg/L	1/11/00	9.47	F
SODIUM		mg/L	1/11/00	7.67	F
SODIUM		mg/L	2/8/00	9.3	F
SODIUM		mg/L	2/8/00	8.45	F
SODIUM		mg/L	3/14/00	9.906	F
SODIUM		mg/L	3/14/00	9.06	F
SODIUM		mg/L	4/11/00	12.502	F
SODIUM		mg/L	4/11/00	8.829	F
SODIUM		mg/L	6/13/00	7.14	F
SODIUM		mg/L	7/11/00	9.634	F
SODIUM		mg/L	7/11/00	6.745	F
SODIUM		mg/L	8/8/00	6.562	F
SODIUM		mg/L	8/8/00	7.547	F
SODIUM		mg/L	9/12/00	7.012	F
SODIUM		mg/L	9/12/00	10.32	F

Table A.3 continued

SODIUM		mg/L	10/10/00	31.44	F
SODIUM		mg/L	10/10/00	5.651	F
SODIUM		mg/L	11/14/00	7.746	F
SODIUM		mg/L	11/14/00	9.168	F
SODIUM		mg/L	12/12/00	2.785	F
SODIUM		mg/L	12/12/00	2.926	F
SODIUM		mg/L	1/9/01	7.643	
SODIUM		mg/L	1/9/01	8.332	
SODIUM		mg/L	2/20/01	8.917	
SODIUM		mg/L	2/20/01	8.917	
SODIUM		mg/L	3/13/01	9.72	
SODIUM		mg/L	3/13/01	10.96	
SODIUM		mg/L	4/10/01	10.62	
SODIUM		mg/L	4/10/01	11.55	
SODIUM		mg/L	5/8/01	10.47	
SODIUM		mg/L	5/8/01	10.18	
SODIUM		mg/L	6/12/01	9.208	
SODIUM		mg/L	6/12/01	10.18	
SODIUM		mg/L	7/10/01	7.686	
SODIUM		mg/L	7/10/01	9.271	
SODIUM		mg/L	8/14/01	7.568	
SODIUM		mg/L	8/14/01	9.021	
SODIUM		mg/L	9/11/01	8.016	
SODIUM		mg/L	9/11/01	12.59	
SODIUM		mg/L	10/9/01	8.473	
SODIUM		mg/L	10/9/01	9.985	
SODIUM		mg/L	11/27/01	8.451	
SODIUM		mg/L	11/27/01	15.04	
SODIUM		mg/L	12/11/01	8.151	
SODIUM		mg/L	12/11/01	10.61	
THALLIUM	0.002	mg/L	7/11/00	0.001	F
THALLIUM	0.002	mg/L	7/11/00	0.001	F
THALLIUM	0.002	mg/L	10/10/00	0.001	F

PATUXENT RESERVOIRS WATERSHED PROTECTION AGREEMENT

This agreement is effective this 29th day of October, 1996, by and among Howard County, Montgomery County, Prince George's County (a body corporate and politic), the Howard Soil Conservation District (HSCD), the Montgomery Soil Conservation District (MSCD), the Maryland National Capital Park and Planning Commission (M-NCPPC), and the Washington Suburban Sanitary Commission (WSSC).

WHEREAS, the parties agree that the Patuxent Reservoirs Watershed includes the Triadelphia and T. Howard Duckett (Rocky Gorge) reservoirs, the contributing Patuxent River and its tributary streams and associated groundwater resources;

WHEREAS, the parties to the agreement recognize the importance of protecting the long-term biological, physical, and chemical integrity of the Patuxent Reservoirs Watershed;

WHEREAS, the parties recognize the work of the Patuxent Reservoirs Protection Group (PRPG) as valid and recognize that an interjurisdictional partnership is needed to promote reservoir watershed protection strategies;

WHEREAS, the parties desire to develop and implement a multi-barrier watershed management approach to assure the integrity of a continued supply of high quality potable water at reasonable cost;

WHEREAS, the parties acknowledge the importance of integrating a Patuxent Reservoir Protection Strategy with the Patuxent Tributary Strategy to address the goals of the 1987 Chesapeake Bay Agreement; and

WHEREAS, the parties desire that the benefits of and responsibilities for necessary actions be shared equitably by all parties.

NOW, THEREFORE, BE IT RESOLVED, that in consideration of the covenants and agreements set forth hereinafter, it is mutually covenanted and agreed as follows:

ARTICLE I - ESTABLISHMENT OF A PATUXENT RESERVOIR PROTECTION STRATEGY

The need for establishing a protection strategy as outlined in the interim report Developing a Patuxent Reservoir Protection Strategy (March 1995) is hereby recognized by the parties. The parties hereby agree to cooperate with each other regarding initiatives that will help fulfill recommendations of the "Interim Action Plan for Reservoir Protection" and to the "Development of a Long-Term Reservoir Protection Program" as outlined in that report.

ARTICLE II - POLICY BOARD

A. Members

The Policy Board ("Board") shall be composed of the County Executives for Howard County, Montgomery County, and Prince George's County; the Chairpersons for the Howard Soil Conservation District (HSCD) and the Montgomery Soil Conservation District (MSCD) Boards; the Executive Director for the Maryland-National Capital Park and Planning Commission (M-NCPPC); and the General Manager of the Washington Suburban Sanitary Commission. Any Board member may designate an alternate by written notification to other Board members.

The Policy Board may change its membership by consensus among existing members.

B. Functions

The Board shall meet yearly to receive the Technical Advisory Committee's annual report and to review ongoing activities and the results of studies targeted toward protecting the reservoirs and their resources. The Board may meet more frequently to consider issues and make recommendations as necessary. The Board shall encourage cooperative arrangements to ensure that all parties participate actively in programs and policies that maintain and improve water quality and habitat throughout the reservoirs watershed.

The Board shall consider:

1. Review and evaluation of information from the Technical Advisory Committee;
2. Strategies to address present or anticipated problems;
3. Work activities among parties for the coming year; and
4. Other matters found necessary or desirable for reservoir watershed protection.

The Board will agree by consensus on all recommendations, determinations, and proposals. The Board's decisions shall be advisory only, and shall not be binding on any political subdivision or agency participating in this agreement. An annual summary of the Board's decisions shall be prepared and made available to the public.

C. Chairpersons

The County Executives of Howard County, Montgomery County, and Prince George's County will serve successive terms as the Chairperson. The Chairperson will serve from July 1st of one year to June 30th of the following year. The County Executives will agree upon the order of the succession.

ARTICLE III - TECHNICAL ADVISORY COMMITTEE

A. Members

The Technical Advisory Committee ("Committee") consists of representatives from: (1) Howard County: Department of Health; Department of Planning and Zoning; and Department of Public Works; (2) Montgomery County: Department of Environmental Protection and Department of Permitting Services; (3) Prince George's County: Department of Environmental Resources and Department of Health; (4) the M-NCPPC; (5) the HSCD; (6) the MSCD; (7) State of Maryland: Department of Agriculture; Department of the Environment; and Department of Natural Resources; and (8) the WSSC.

The Committee will meet at least once per year to review the results of that year's work efforts, to recommend a work plan for the next year, and to prepare the annual report to the Board. The Committee will meet more frequently as needed to review, evaluate, and make recommendations on reservoir-related concerns.

The Committee may propose standing subcommittees or ad hoc workgroups as needed to evaluate specific reservoir protection issues. The subcommittees and workgroups may request representatives from agencies or groups that are not permanent members of the Committee to participate.

B. Functions

1. The Committee or designated workgroups shall meet as necessary to periodically review and evaluate existing problems and proposed actions which may affect the reservoirs and the watersheds, including the following functions:

   a. Providing sources of high quality raw water as a regional water supply system;

   b. Providing habitats to support high quality aquatic and riparian communities;

   c. Providing desirable places for environmental enhancement and wildlife habitat; and

   d. Providing aesthetic, recreational, and other beneficial uses.

2. The Committee or designated workgroups will work cooperatively to expeditiously recommend balanced pollution control strategies and management measures to:

   a. Control sediment loadings to the reservoirs;

   b. Minimize the levels of nutrients and pollutants entering the reservoirs and the tributary streams;

   c. Prevent degradation of the high quality, interconnected surface and groundwater resources of the tributary streams and throughout the watershed; and

   d. Encourage stewardship of the reservoirs watershed and resources.

3. The Committee may develop and formulate public education and outreach initiatives; urban, forestry, and agricultural best management practices; innovative site designs; alternative on-site disposal systems; natural resource management strategies; stream restoration projects; and any other measures that protect and enhance water quality or habitat throughout the watershed.

   Whenever major reservoir water quality problems must be addressed, the Committee shall evaluate alternative solutions and the cost-effectiveness of these measures in making recommendations for reservoir resource protection.

4. The Committee shall prepare a written report to submit to the Board for its annual meeting. The Annual Report shall include:

   a. Results of reviews and evaluations on reservoir protection issues;

   b. Progress on programs and practices being implemented by the parties to protect the reservoirs and their resources;

   c. Recommendations on strategies to encourage reservoir resource protection; and

   d. A recommended work plan for the coming year.

C. <u>Chairpersons of Committee and Workgroups</u>

The Committee and its workgroups shall agree by consensus on the method of selection and terms for Chairpersons to lead all meetings.

ARTICLE IV - MODIFICATIONS AND AMENDMENTS

A. Membership of the Policy Board

Any changes in Policy Board membership, except designation of an alternate, shall initiate the process for modification of this agreement. The modified agreement must indicate the change(s) in Policy Board composition and shall become effective after being signed by all members of the modified Policy Board.

B. Modification or Amendment of the Agreement

This agreement may be modified or amended by consensus of the Policy Board members. The Policy Board shall consider changes in membership or any other modifications and amendments of this agreement at its annual meeting.

Changes based on consensus among Policy Board members will initiate the process for agreement modification. The modified or amended agreement will not become effective until signed by all members of the Policy Board as defined in the modified or amended agreement.

ARTICLE V - RIGHTS OF PARTIES NOT TO BE ABROGATED

A. Nothing in this agreement shall limit or abrogate any right or rights delegated to any of the governments or agencies which are parties to this Agreement by acts of the General Assembly of the State of Maryland.

B. Each party hereto agrees that participation by any party to the agreement may be terminated by that party with three months written notice to the other parties of the agreement.

PATUXENT RESERVOIRS WATERSHED PROTECTION AGREEMENT

Charles I. Ecker
County Executive
Howard County

Date 10/29/96

Douglas M. Duncan
County Executive
Montgomery County

Date 11/6/96

Wayne K. Curry
County Executive
Prince George's County

Date 10/29/96

William E. Barnes
Chairman
Howard Soil Conservation District
Board of Supervisors

Date 10/29/96

George E. Lechlider
Chairman
Montgomery Soil Conservation District
Board of Supervisors

Date 10-29-96

Trudye Morgan Johnson
Executive Director
Maryland-National Capital
Park and Planning Commission

Date October 29, 1996

Cortez A. White
General Manager
Washington Suburban Sanitary Commission

Date 10/29/96

Executive Summary

Comprehensive Management Planning Study for the Patuxent Reservoir Watershed

Introduction

The Patuxent Reservoir Watershed (PRW) forms the drainage area for the Triadelphia and T. Howard Duckett (Rocky Gorge) reservoirs and is a significant water supply source for the Washington metropolitan area. The 132-square-mile watershed spans three counties in the state of Maryland—Howard, Montgomery, and Prince George's Counties—and originates from a small portion of Frederick County.

In 1993, the Montgomery County Council approved the Functional *Master Plan for the Patuxent River Watershed* and asked that the County Executive form an interjurisdictional working group to develop interim and long-term plans to protect the two Patuxent water supply reservoirs. The Patuxent Reservoir Protection Group (PRPG) was formed of representatives from local and state jurisdictions. The PRPG completed the strategic interim report *Developing a Patuxent Reservoir Protection Strategy* in March of 1995. The interim report identified a need for a long-term planning study to evaluate the monitoring, analysis, and tracking needs to support watershed management. The Comprehensive Watershed Management Planning Study (Study) was initiated in June 1996 under the direction of an interjurisdictional workgroup.

On October 29, 1996, the Patuxent Reservoirs Watershed Protection Agreement was signed by Howard County, Montgomery County, Prince George's County, the Howard Soil Conservation District (HSCD), the Montgomery Soil Conservation District (MSCD), the Maryland-National Capital Park and Planning Commission (M-NCPPC), and the Washington Suburban Sanitary Commission (WSSC). This agreement formalized the framework for a continuing effort to protect the biological, physical, and chemical integrity of the Patuxent Reservoir Watershed. Under the agreement, a Policy Board and Technical Advisory Committee (TAC) were established to continue the work of the PRPG. The Study report is intended to provide the framework for future efforts for cooperation in protecting the watershed resources and maintaining the demonstrated leadership in developing innovative and proactive environmental management programs.

Watershed-Based Protection Approach

In the Patuxent River Watershed there has been a long-standing recognition of the value of holistic watershed management in protecting the natural and water resources. Watershed management has evolved to incorporate a comprehensive ecosystem-based approach that recognizes the interrelationships of natural resources at the local level and in the larger reservoir drainage area. The ecosystem perspective places new challenges on watershed managers to address a variety of environmental stressors through the use of a complex network of monitoring, field assessment, and modeling tools. Such an approach recognizes the connectivity and interdependence of the health of the watershed and the continued high quality of the reservoirs' water supply.

The Study focuses on addressing a protection strategy for all of the important resources in the watershed. The reservoir supplies drinking water to a large population in the Washington metropolitan area. Maintaining the quantity and quality of this resource relies on the protection and management of all upstream resources. Such protection efforts will maintain and further improve the quality of life in the watershed including benefits such as stream condition and habitat, aesthetics, economic growth, and recreation. These are important factors for developing equitable allocation options to support a comprehensive watershed-reservoir management plan. Because of the interrelationships between resources, the Study recognizes the need for continuing an integrated watershed-reservoir resource management approach. The protection of stream corridors is an example of the connection between watershed and reservoir systems. The protection of stream banks not only maintains healthier streams, but also preserves the longevity of the reservoir storage capacity through the reduction of sediment loading, in addition to preserving and enhancing the aquatic and biological integrity of the watershed.

The Study identified a fundamental set of performance measures correspond to a cross-section of the important resources in the watershed, including reservoir/water supply, terrestrial habitat, stream system, aquatic biota, rural character and landscape, and public awareness and stewardship. The performance measures were selected based on extensive discussion among the work group members, review of the watershed-reservoir data, and an analysis of the interrelationships between watershed and reservoir systems. By considering the selected performance measures throughout the development of the Study recommendations the watershed-wide issues of the member jurisdictions were continuously addressed.

Importance of Ongoing Programs

The Study recognizes the importance of existing programs to the PRW watershed protection efforts and builds on these programs. The member jurisdictions are nationally recognized as environmentally proactive leaders in the development of protection programs. Over the past decades, the member jurisdictions have developed resource protection and restoration programs. The Study recognizes that to accomplish the objectives of the PRW agreement cost-effectively and to maintain a successful protection program, future efforts must be integrated with and build on existing program activities. Existing programs, administered as a part of missions of the member jurisdiction, address every resource of concern identified within the watershed. Continuation of many of these programs, including monitoring, tracking, GIS data preparation and maintenance, and public outreach initiatives, is essential to supporting the watershed protection efforts.

Several key program activities that are integral to the future development of the watershed study plan have been identified. GIS data preparation efforts by the member jurisdictions–in particular by M-NCPPC, Montgomery County, and Howard County–were considered essential for supporting the watershed studies. Adjustment of internal priorities to accelerate development of data layers that fall within the PRW watershed is strongly recommended. Ongoing chemical monitoring activities supported by the USGS and WSSC provide a baseline condition and tracking of water quality measures in the reservoirs and the Patuxent River at Unity. Biological monitoring efforts by Montgomery County, the Maryland Biological Survey, and volunteer monitoring in Howard County provide the basis for future watershed assessments. The development and testing of comparable biological assessment methods is recognized as a benefit to integration of results across the watershed.

Continued and expanded stormwater management, performed by the member agencies under the National Pollution Discharge Elimination System (NPDES), provides an essential resource to tracking of management activities within the watersheds. Tracking of forest management and farming activities, currently performed by the state and soil conservation districts, provides an additional data source for evaluation of management needs.

Summary of Recommendations

The review of programs, existing data, and performance measures for the resources within the watershed provided the background for the identification of new activities for watershed protection. Specific recommendations are identified in the body of the report. The recommendations address the key planning elements of GIS data and assessment tools, monitoring of environmental conditions, assessment and modeling tools, program tracking, and public outreach initiatives. Key features of the Study recommendations are as follows:

- Improvement and compilation of GIS data layers, interagency data exchange capabilities, and resource assessment tools.
- Expanded and coordinated physical, chemical, and biological monitoring activities.
- Watershed-specific technical tools to support watershed and reservoir assessment and modeling of future conditions.
- Tracking systems to enable evaluation of watershed status and support in prioritization of activities and allocations of resources.
- Expanded public outreach activities and integration of public participation in long-range planning.
- Initiation of work group activities to support continuing examination of data management and data exchange, to coordinate and plan biological monitoring activities, and to develop comparable methods for stream assessment.

Implementation

A phased approach is recommended for implementation of key recommendations to allow for flexibility and critical evaluations of program effectiveness at each phase. Table ES-1provides a summary of the implementation plan for a 10-year period. Activities are phased to reflect input from the members and the strategic coordination of data gathering and interpretation. Table ES-1also provides cost estimates for recommended activities for each year to allow for opportunities to conduct long-term fiscal planning. Prioritizing of information collection and data sharing is initiated in the earliest phases of the project and continued throughout all the phases. Resource and staff constraints can be addressed through in-house staffing, cooperative efforts, pursuit of external funding sources, and prioritized actions. Decision making is supported in the early phases based on available tools and information.

Costs are not shown for year 1, the Interim Phase, since only nonallocation alternatives are considered in that year. Continued planning and work group efforts during year 1 can be supported through in-house staff. For years 2 to 10, as shown in Table ES-1, cost estimates represent incremental resources that are needed to address work group recommendations for new initiatives, beyond those addressed under current programs. The implementation schedule can be adjusted to reflect the input of the member agencies as refined priorities and allocation options are identified. Preliminary priorities for Study recommendations are as follows:

- Initial data gathering efforts such as bioassessment and stream corridor assessments will have immediate benefits and should begin immediately.

- The importance of the river sampling program to evaluation of environmental conditions and tracking of inputs to the reservoirs suggests that this activity should also be a priority. Watershed monitoring information will be used to assess trends in tributary and reservoir health and can be used as baseline information for model calibration and validation as needed.

- Development of interagency data transfer capabilities and GIS assessment tools is recommended in order to support examination of existing information for the watershed.

- Development of modeling tools, beyond planning-level assessments, is targeted for years 4 and 5. Modeling tools development would be initiated based on the availability of monitoring data for testing and the identified needs to evaluate management questions.

The actual year-to-year implementation of the Study initiatives will depend on public outreach, funding allocations, and results from data gathering and interpretation efforts. This document builds the initial foundation from which the TAC can develop management recommendations, and it provides a basis for decision making and prioritization of implementation activities. By integrating new information and continuing priority setting, the initial foundation laid in this study should be continuously updated, making this a living document that supports continued and adaptive watershed planning.

Table ES-1: Estimated Costs for Implementation Plan

Activity	Year 2 Total Cost ($1,000)	Year 3 Total Cost ($1,000)	Year 4 Total Cost ($1,000)	Year 5 Total Cost ($1,000)	Years 6 - 10 Annual Cost ($1,000)
GIS Assessment Tools					
Planning-level assessment tools	105-115	12	12	12	12
Water Quality and Biological Monitoring Initiatives					
Bioassessment program	40-60 [a]	50-70 [b]	50-70 [b]	50-70 [b]	50-70 [b]
Reservoir monitoring [c]	20-45	20-45	20-45	--	--
River sampling tributary stations (large scale)	60-120	150-200	150-200	150-200	150-200
Field Assessment and Modeling					
Wetland assessment	60	50	50	50	50
Reservoir modeling	12	--	55-170 [d]	20	20
Watershed modeling	--	--	--	180 [e]	60
Stream assessment	30-40 [f]	50-70 [g]	50-70 [g]	50-70 [g]	50-70 [g]
Tracking of Management Programs and Activities					
Program tracking	15	15	15	15	15
Watershed Public Outreach Activities					
Various Activities	21.5-23	15	15	16.5-18	15
Watershed-specific Data Management					
Database management [h]	--	--	--	100	50
Special Studies					
Horse seminar	2	2	2	2	2
Targeted studies as identified and funded [i]	-	-	-	-	-
Administrative					
Patuxent Committee Support [j]	60	60	60	60	60
Totals	**425.5-552**	**424-539**	**479-709**	**705.5-797**	**534-624**

Notes:

[a] Cost represents biological program design. This cost may be reduced if the program design is accomplished through in-house contributions of staff time in sub-workgroup meetings.

[b] Costs may change depending on results of bioassessment design; e.g., if the design calls for less than the anticipated number of stations, the costs will be less. Majority of costs will be for Howard County that currently has limited biological assessment coverage.

[c] Reservoir monitoring costs shown are for one additional monitoring station in each reservoir for years 2-4. Ongoing costs funded by WSSC are estimated to be $50K to $55K and represent a combination of staff time commitments and funding for WSSC's laboratory.

[d] Costs are estimates for CE-QUAL-W2

[e] Costs are estimates for HSPF with GIS Interface

[f] Cost in year 2 represents physical stream assessment program design. This cost may be reduced if the program design is accomplished through in-house contributions of staff time in subworkgroup meetings.

[g] Costs may be reduced if stream assessment activities are integrated with the biological assessment program.

[h] Database management system development is defined as an option to be initiated if necessary in year 5.

[i] Other funding mechanisms to be determined.

[j] Administrative support including meeting preparation, meeting notes, annual reports, grant applications. This cost can be a contribution of in-house staff time.